UPPER MISSISSIPPI RIVER RESTORATION

POST-CONSTRUCTION

INITIAL PERFORMANCE EVALUATION REPORT

2014

FOR

STUMP LAKE COMPLEX

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

US Army Corps of Engineers
St. Louis District

ALTON POOL

ILLINOIS RIVER MILES 12.7 – 7.2

JERSEY COUNTY, ILLINOIS

ACKNOWLEDGEMENTS

Many individuals of the St. Louis District, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and Illinois Department of Natural Resources contributed to the development of this Post-Construction Performance Evaluation for the Stump Lake Complex Habitat Rehabilitation and Enhancement Project.

US Army Corps of Engineers
St. Louis District

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

EXECUTIVE SUMMARY

General. The design of the Stump Lake Complex was to provide the physical conditions necessary to improve and enhance wetland habitat quality. As stated in the Definite Project Report, the Stump Lake Complex Habitat Rehabilitation and Enhancement Project (HREP) was undertaken to primarily address sedimentation and lack of water level management. These problems were contributing to the direct loss of resident and migratory wildlife and fish habitat due to water-to-land conversion and to poor water quality (i.e., water clarity) during summer months. In addition, the lack of reliable water level management resulted in poor moist soil plant production which is a key food source for resident and migratory wildlife.

Purpose. The purposes of this Performance Evaluation Report (PER) are as follows:

1. Document the pre- and post-construction monitoring activities for the Stump Lake Complex
2. Summarize and evaluate project performance on the basis of project goals and objectives as stated in the Definite Project Report (DPR)
3. Summarize project operation and maintenance efforts
4. Provide recommendations concerning future project performance evaluation
5. Share lessons learned and provide recommendations concerning the planning and design of future HREP projects

Project Goals and Objectives. The specific goals and objectives as stated in the DPR were to:

1. Enhance wetland habitat for resident and migratory wildlife
    a. Decrease sedimentation into wetland units
    b. Improve water level management
    c. Increase reliable food production for migratory wildlife
    d. Increase total wetland values for migratory wildlife
2. Enhance aquatic habitat for slackwater fishes
    a. Reduce potential for backwater sedimentation
    b. Increase depth of photic zone
    c. Increase total habitat availability and quality for slackwater fishes

Project Performance Monitoring. Pre- and post-project monitoring, both qualitative and quantitative, was performed in accordance with the Performance Evaluation Monitoring Appendix (DPR-Appendix K) and Section 7.e from the original DPR. Quantitative monitoring and performance evaluation was conducted by the U.S. Army Corps of Engineers, while the sponsor was responsible for pre-project monitoring and field observations post-construction. The period of data collection covered in this report includes quantitative and qualitative post-project monitoring 1999 to 2005.

Evaluation of Project Objectives. For the evaluation period of 1999 to 2005, observations were made with regard to the efficacy of the objectives in meeting project goals. In addition, general conclusions were drawn regarding project features that may affect future project design.

1. Enhance wetland habitat for migratory and resident wildlife

a. <u>Decrease sedimentation into wetland units</u>

i. Evaluation Criteria: Reduce to sedimentation below 0.5 inches per year.

ii. General Observation: Appears sedimentation has decreased below 0.5 inches per year in the northern section of the complex, while the southern section appears to be above 0.5 inches per year.
iii. Results: The total average net sedimentation was 0.46 inches per year
iv. Success: Sedimentation rate has met the evaluation criteria of less than 0.5 inches per year.
v. Conclusion: The project showed some areas of success in reducing the sedimentation rate.
vi. Lessons Learned & Recommendations: This criterion met the needs of evaluating the project performance. Future efforts should also examine opportunities to further decrease sedimentation rates in the project area. While sedimentation rates in Upper Stump Lake have decreased, the rates in Lower Stump Lake have remained high. Monitoring of the sedimentation rate should continue and if it does not decrease in the future then the features used to address sedimentation may need to be re-evaluated for use in future HREPs.

b. <u>Improve means to control wetland unit water levels independent of river stage</u>
i. Evaluation Criteria: Estimation of days the complex was inundated based on river stage and levee height was used as the evaluation criteria (criteria modified from original design in DPR)
ii. Results: Without the project's exterior levee, the complex would have been inundated for 1338 days. With the project, the days the site was inundated was reduced to 58 days.
iii. Success: Number of inundated days has met the evaluation criteria for improving water level management.
iv. Conclusion: The project was successful in improving water level management.
v. Lessons Learned & Recommendations: Even though the number of inundated days was not the original evaluation criteria as described in the DPR, it did meet the needs for evaluating the project performance. The number of inundated days could be used in future evaluations.

c. <u>Increase reliable food production for wildlife</u>
i. Evaluation Criteria: Acres of shallow marsh annuals (moist soil plants)
ii. General Observation: Vegetation surveys show a large amount of moist soil plants present at the complex. Hunter success data shows an increasing trend in average number of ducks taken per year which may be tied to reliable food production; however the same trend in hunter success was observed at other nearby refuges making this evidence less conclusive. Overall, it appears that food production has increased.
iii. Results: Land cover data shows a 211.7-acre or 99.8% increase in shallow marsh annuals (a moist soil unit) since 1989; however these results do not capture the annual fluctuations that are observed at the site.
iv. Success: Acres of shallow marsh annuals has met the evaluation criterion for increasing reliable food production for wildlife.
v. Conclusion: The project was successful in increasing food production for wildlife.

vi. Lessons Learned & Recommendations: This criterion met the needs of evaluating the project performance; and could be used in future evaluations.

d. Increase total wetland values for migratory wildlife
   i. Evaluation Criteria: Increase habitat units (HUs).
   ii. General Observation: No WHAG analysis has been performed since project completion yet.
   iii. Conclusion: No conclusions at this time.

2. Enhance aquatic habitat for slackwater fishes

a. Reduce potential for backwater sedimentation
   i. See 1a above

b. Increase photic zone
   i. Evaluation Criteria: Percent change from pre-project conditions using seasonal Secchi disk readings.
   ii. General Observation: Mean Secchi disk readings show an increase in the photic zone throughout the year.
   iii. Results: The photic zone increased in depth (as measured by Secchi disk readings) by 4.6%, 11.1%, 40.3%, and 34.7% for fall, winter, spring, and summer, respectively.
   iv. Success: Visibility readings using a Secchi disk has met the evaluation criterion for increasing the photic zone.
   v. Conclusion: The project was successful in increasing the depth of the photic zone.
   vi. Lessons Learned & Recommendations: This criterion met the needs of evaluating the project performance; and could be used in future evaluations.

c. Increase total habitat values for slackwater fishes
   i. Evaluation Criteria: Increase habitat units
   ii. General Observation: No AHAG analysis has been performed since project completion yet.
   iii. Conclusion: No conclusions at this time.

Evaluation of Project Operation and Maintenance. The OMRR&R Manual was completed in 2003. Features with operation and maintenance requirements include the riverside and interior levees, the pumping station, the drainage structure, the fish passage structure, and the stop-log structures. The general guidance of proper water resource management in order to maintain an optimum fish and wildlife habitat is as follows: January 1 thru March 1 all lakes are maintained at fall management pool; March 1 through May 1 spring river flows begin allowing river water in and fish passage; May 1 through June 15 maintain management pool level; June 15 thru September 15 drawdown for moist soil production; and September 15 thru December 31 recharge and maintain fall management pool. Annual project inspections shall be performed for the purpose of noting routine deficiencies and initiating corrective actions. Operation cost during the period of evaluation for this report includes a total of $35,220.

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POST-CONSTRUCTION
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2013

STUMP LAKE COMPLEX

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

ALTON POOL

ILLINOIS RIVER MILES 7.2 – 12.7

JERSEY COUNTY, ILLINOIS

1. INTRODUCTION

The Stump Lake Complex Habitat Rehabilitation and Enhancement Project (HREP) is part of the Upper Mississippi River Restoration (UMRR, formerly known as the Environmental Management Program). The UMRR was authorized by Congress in Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662). Habitat Rehabilitation and Enhancement Program (HREP) construction is one element of the UMRR. The projects provide site-specific ecosystem rehabilitation. They are intended and designed to offset the adverse ecological effects of impoundment and river regulation through a variety of modifications, including flow introductions, modification of channel training structures, dredging, island construction, and water level management.

1.1 Purpose of Project Evaluation Reports

The purposes of this Project Evaluation Report for the Stump Lake Complex HREP are to:

1. Document the pre- and post-construction monitoring activities for the Stump Lake Complex HREP
2. Summarize and evaluate project performance on the basis of project goals and objectives as stated in the Definite Project Report (DPR)
3. Summarize project operation and maintenance efforts
4. Provide recommendations concerning future project performance evaluation
5. Share lessons learned and provide recommendations concerning the planning and design of future HREP projects

1.2 Scope

This report summarizes available monitoring data, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) information, and project observations made by the U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), and Illinois Department of Natural Resources (IDNR). The period of data collection covered in this report includes post-construction monitoring from 1999 to 2005.

1.3 Project References

Published reports which relate to the Stump Lake Complex HREP are presented below.

1. Definite Project Report with Integrated Environmental Assessment, Stump Lake Complex Habitat Rehabilitation and Enhancement Project, St. Louis District Corps of Engineers, Final January 1992.
2. Manual for Operation, Maintenance, Repair, Replacement, and Rehabilitation, Stump Lake Habitat Rehabilitation and Enhancement Project, St. Louis District Corps of Engineers, November 2003.
3. Yin, Y., H. Langreher, J. Nelson, T. Blackburn, T. Cook, W. Popp, and J. Winkleman. 2000. 1998 annual status report: Status and trend of submersed and floating-leaved vegetation in thirty-two backwaters in Pool 4, 8, 13, and 26 and La Grange pool of the Upper Mississippi River System. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, June 2000. LTRMP – 2000-P003. 21 pp. + Appendices A-B.
4. Yin, Y., H. Langrehr, T. Shay, T. Cook, R. Cosgriff, M. Moore, and J. Petersen. 2011. Vegetation Sampling in the Upper Mississippi River System: Annual Update. [online] http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/vegetation_update.html. Accessed on 21 June 2011.

1.4 Project Location

The Stump Lake Complex project is located in Jersey County, Illinois on the left descending bank of the Illinois River, between 7.2 to 12.7 (Fig. 1). This 2,958-acre bottomland area includes Upper and Lower Stump Lakes, Fowler Lake, Flat Lake, Long Lake, and Deep Lake and contains 1,098-acres of open wetlands, 252-acres of cropland, and 1,578-acres of forests, and 30-acres of improvements such as roads, access areas, etc.

The Stump Lake Complex has been managed by the Illinois Department of Natural Resources since the 1950s. Public use and water control facilities for wetland management have been in place since the 1960s.

Located on Federal lands and waters originally acquired for the 9-foot navigation project, the Stump Lake Complex is managed as part of the Mississippi River State Fish and Wildlife Management Area by the Illinois Department of Natural Resources under Cooperative Agreements between the Department of the Interior and the Corps of Engineers.

2. PROJECT PURPOSE

2.1 General

The design of the Stump Lake Complex HREP was to provide the physical conditions necessary to enhance and maintain wetland habitat quality. The specific goals as stated in the Definite Project Report (DPR) were to:

1) Enhance wetland habitat for resident and migratory wildlife

2) Enhance aquatic habitat for slackwater fish

In order to achieve these goals, conversion of water to land due to sedimentation and unregulated fluctuating water level at the site needed to be addressed. These problems were contributing to the direct loss of fish and wildlife habitat and impacted production of aquatic vegetation available for resident and migratory wildlife. The problems, opportunities, goals, objectives and features implemented to address the goals and objectives are listed in Table 1.

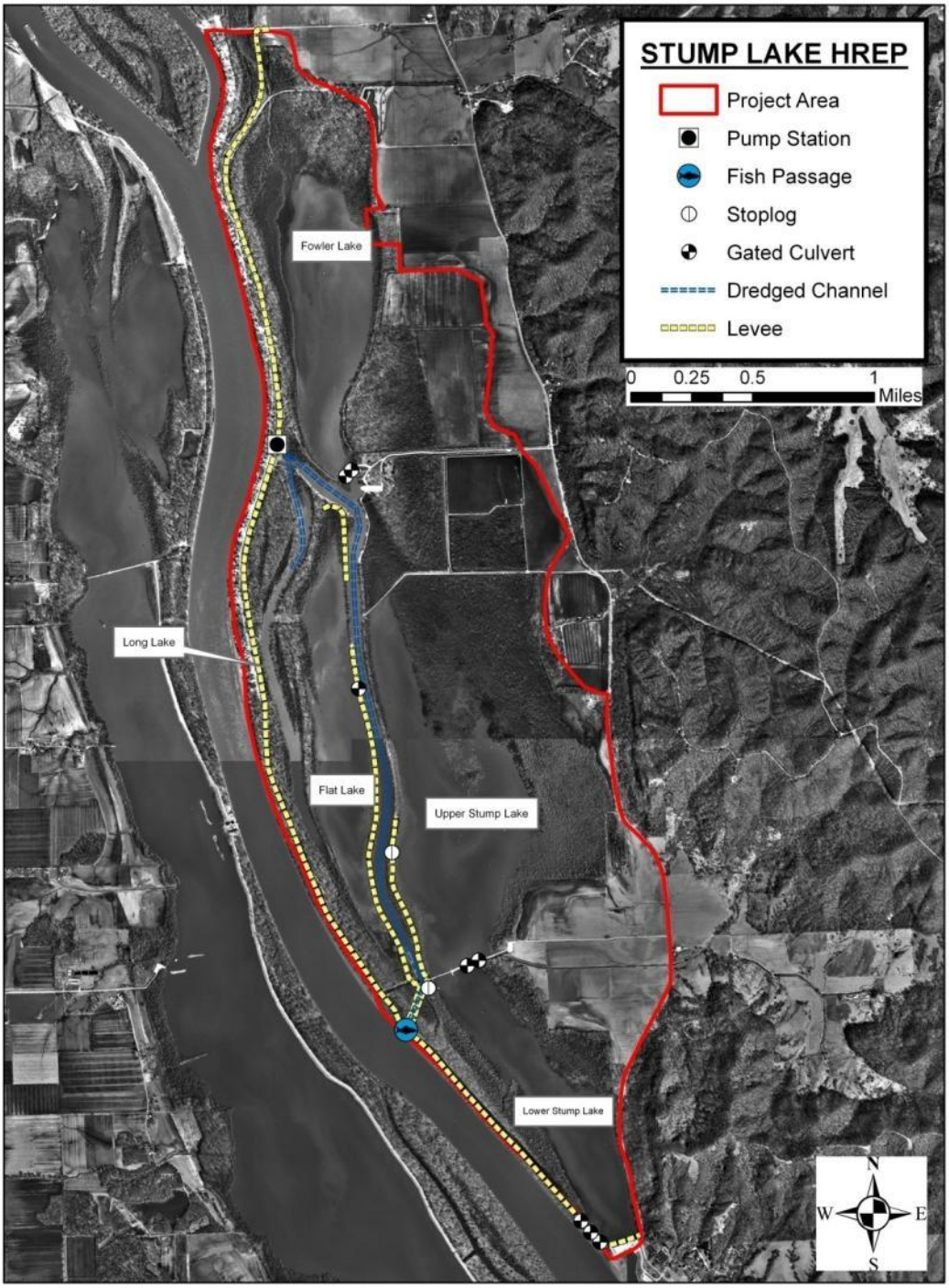


Figure 1. Stump Lake Complex HREP project area and project features

Table 1. Problems, opportunities, goals, objectives, and features

PROBLEMS	OPPORUNTITIES	GOALS	OBJECTIVES	RESTORATION FEATURES
Sedimentation & water level fluctuations	Provide sediment protection and improved water level management. Improved water management would allow for a more reliable production of wildlife food during summer months and migration. Removing sediments and deepening Long Lake and Deep Lake would provide restored off-channel water area and enhance conditions for fish reproduction	Enhance wetland habitat for resident & migratory wildlife	Decrease sedimentation	Construct riverside levee/dike
				Remove sediment from Long Lake and Deep Lake
			Improve water level management	Construct riverside levee/dike
				Construct wetland unit containment levees
				Install wetland unit water control structures
				Install water pumping system
			Increase reliable food production for wildlife	Construct wetland unit water control structures
			Increase total wetland values for migratory wildlife	All
		Enhance aquatic habitat for slackwater fish	Reduce potential for backwater sedimentation	Remove sediment from Long Lake and Deep Lake
				Construct riverside levee/dike
			Increase photic zone in project waters	Construct riverside levee/dike
				Remove sediment from Long Lake and Deep Lake
			Increase total habitat values for slackwater fishes	Construct water control/fish passage structures
				Construct riverside levee/dike
				Remove sediment from Long Lake and Deep Lake

2. 2 Management Plan

Table 2 provides the general actions (no specific water levels defined) followed from the Project Regulation Plan in the DPR.

Table 2. Original project regulation plan for Stump Lake Complex as stated in the DPR

Time Frame	Management Action	Purpose
Jan 1 – March 1	All lakes maintained at Fall Management pool	Provide foraging habitat for migrants
Mar 1 – May 1	Spring river flows begin, let water in	To protect levees and allow fish passage
May 1 – Jun 15	Maintain Management pool level	Provide access to fish spawning and rearing habitat; provide habitat to breeding birds
Jun 15 – Sept 15	Drawdown	Moist soil food production
Sept 15 – Dec 31	Recharge and maintain Fall Management pool	Provide foraging habitat for fall migrants

3. PROJECT DESCRIPTION

3.1 Project Features

The Stump Lake Complex HREP included a combination of riverside levee/dike, containment levees, water control structures/fish passage structures, sediment removal, and a water pumping system (see Figure 1 for locations of features). Appendix A provides photos of some of the project features. A detailed description of each of these features is provided below.

Riverside levee/dike. The riverside levee/dike is a 5.5 mile low-profile earthen levee (top of levee elevation varies from 427.0 to 426.5 NGVD) that parallels the Illinois River shoreline and the perimeter of the Wildlife Management Area. The levee was necessary to reduce siltation that occurs from frequent floods and to improve wetland unit water control capabilities. The levee provides 3- to 4-year flood frequency protection and is estimated to prevent 79 percent of river-borne sediment from entering the project site. The levee has a 10-foot crown width and 1 on 3 side slopes. Borrow areas for levee construction run along the landside of the levee (approximately 34 acres) and provide additional open wetland habitat.

Containment levees. Seven low-level interior wetland unit containment levees (elevation 422.0 NGVD) were constructed in specific "low spots" around the perimeters of the four main wetland compartments (Fowler, Flat, Lower Stump, Upper Stump) to allow effective water level management capabilities and to compensate for existing sedimentation. Borrow areas used to construct the three miles of levees (approximately 14 acres) provide additional open wetland habitat.

Water control structures/fish passage structures. Gravity flow sluice-gated culverts and stop-log structures were installed to perform and control watering and dewatering of the wetland compartments as management objectives dictate. Culverts were sized to handle capability for watering and/or dewatering wetland units within a 2-week period (dependent upon river level conditions). Basic data on water control/fish passage structures follows:

- Long Lake to Fowler Lake. Two 36-inch corrugated metal pipes (CMP) with sliding gate culverts installed (used existing structures).
- Long Lake to Flat Lake. One 42-inch CMP with sluice gates and gatewells installed (replaced one existing 36-inch gated culvert).
- Long Lake to Upper Stump Lake. One 8-foot-wide concrete stop log structure that allows water control and boat passage installed (replaced one existing 36-inch gated culvert).
- Upper Stump Lake to Lower Stump Lake. Two 42-inch CMP with sluice gates and gatewells installed (replaced two existing 36-inch gated culverts).
- Long Lake to Lower Stump Lake. One 8-foot-wide concrete stop log structure and open channel to allow water control and boat passage installed.
- Lower Stump Lake to Illinois River. Three 42-inch CMP with sluice gates and gatewells installed (replaced two existing 24-inch and one existing 36-inch gated culverts).
- Long Lake to Illinois River. Two-chamber concrete fish passage and water control structure with four 42-inch sluice gates installed. Each chamber is 10 feet wide and 7 feet 9 inches high.
- Existing stop log structure across Long Lake was removed.
- A 5,000 gallon-per-minute portable pump was provided to the local sponsor.

Sediment removal. Long Lake and Deep Lake were very shallow due to sedimentation. Dredging was required to ensure adequate water conveyance between the riverside pump and the wetland compartments and to restore suitable backwater habitat for fish spawning and rearing and to allow boat passage for recreation. Dredging depths varied approximately every 500 feet between elevation 414.0 and 416.0 NGVD, making the lake 3 to 5 feet in depth, on average. The upper 2,400 feet of Deep Lake and the entire 12,800 feet or 2.5-mile length of Long Lake were dredged. A 60-foot-wide channel was dredged down the middle of these narrow sloughs. Approximately 160,027 cubic yards of sediment were removed and deposited into the Upper and Lower Flat Lake wetland compartment. Sediment deposition elevated the bottom of Flat Lake from approximately 417.5 to 419.0 NGVD. This still allows the wetland to be managed as a moist soil unit. However, a 5,000 gallon-per-minute portable pump is used to supplement the gravity flow structure into Flat Lake due to the lack of head differential.

Water pumping system. A 90 cfs reversible pumping system on the Illinois River was installed to allow flooding or draining of the wetland compartments. Two permanently-located pumps operated by one portable drive unit were provided. The outlets/inlets for the wetland complex are located at the upper end of Long lake where Deep and Long Lakes merge. This is the closest (approximately 600 feet) and most efficient location to reach the Illinois River from the wetland complex.

3.2 Project Construction

From the original DPR, the Stump Lake Complex HREP project total project cost was estimated at $4,059,300 (FY1992). Construction of the project was performed in three items under three separate contracts.

1. Item I. Item I consisted of construction of the riverside levee and 4 of the interior levees and was completed in 1997 at a cost of $1,269,403.45.
2. Item II. Item II consisted of construction of the remaining three interior levees, dredging at Long Lake and Upper Deep Lake, construction of all water control/fish passage structures, and construction of a boat ramp. This item was completed in 1998 at a cost of $2,012,424.70.

3. Item III. Item III consisted of construction of the reversible pumping system on the Illinois River near the intersection of Long Lake and Deep Lake. This item was completed in 1995 at a cost of $953,552.89.

3.3 Project Operation and Maintenance

General. In the original DPR it was estimated that the Stump Lake Complex HREP would require minimal maintenance. Operation and maintenance responsibilities for the Stump Lake Complex HREP were originally outlined in the DPR, with estimated annual O&M cost of the project of $33,700. The acceptance of these responsibilities was formally recognized by an agreement signed by the Illinois Department of Natural Resources and the St. Louis District, USACE.

The 2003 Project Operation, Maintenance, Repair, Replacement, and Rehabilitation Manual (OMRR&R Manual) provides a description of operation and maintenance requirements. The OMRR&R Manual for the project delegated responsibilities and procedures for post project activities. Project operation and maintenance generally consists of the following:

1. Mowing and other maintenance of the perimeter and interior levees to ensure integrity during flood events. Other levee maintenance activities include herbicide applications, burrowing animal control, reseeding, fertilizing, etc.
2. Operation and maintenance of the pump station and water control structures to achieve desired water levels, fish passage, sediment control, etc. during all seasons.
3. Inspections conducted in conjunction with USACE personnel at least annually.
4. Emergency operations during flood conditions.

Project Features Requiring Maintenance. Maintenance of the project features was to be completed on an as needed basis to maintain their structural integrity and continued function in the manner for which they were designed.

1. Pumping station: All visible concrete surfaces should be inspected for cracks, spalling, corrosion, or exposed reinforcement. Repairs shall be made within 30 days of discovery, including grouting, coating repair, epoxy repairs, and fastener replacement. Any serious damage should be reported immediately to USACE and USFWS.
2. Pumping station retaining walls: Simple repairs, such as painting and fasteners repair, should be performed by IDNR. Any serious damage should be reported immediately to USACE and USFWS.
3. Water control structures: Simple repairs such as replace damaged stop-logs, repair cracks in concrete, replace leaking connections, and periodic painting of structures, etc. should be done as required by IDNR. Any serious damage should be reported immediately to USACE and USFWS for determination of corrective action.

4. PROJECT PERFORMANCE MONITORING

4.1 General

Performance monitoring of the Stump Lake Complex HREP has been conducted by USACE, IDNR, and UMRR - Long Term Resource Monitoring Program (LTRMP) to help determine the extent to which the design meets the habitat improvement objectives. Information from this monitoring will also be used, if required, for adaptive management (e.g., when ascertaining whether rehabilitation or modification of portions of this project would be the wisest choice).

The monitoring and performance evaluation matrix is outlined in Table 3. The success of the project relative to original project objectives shall be measured utilizing data, field observations, and project inspections provided by IDNR, UMRR - LTRMP, and USACE. Pre- and post-project monitoring, both qualitative and quantitative by each of the involved agencies is summarized below.

1. U.S. Army Corps of Engineers: The Corps of Engineers was responsible for collecting pre-project sediment transects and water quality data. Post-project data which is Corps responsibility includes sediment transects, water quality data, and forest inventory. The Corps of Engineers has the overall responsibility to measure and document project performance.
2. Illinois Department of Natural Resources: IDNR is responsible for operating and maintaining the Stump Lake Complex HREP. IDNR was responsible for pre- and post-project fish and wildlife surveys. In addition, IDNR was to provide reports on evidence of sediment deposition, stage data within the managed units, observations on water clarity, and evidence of fishing success. The annual post-construction field observations required of IDNR are summarized in Table 4.
3. UMRR-LTRMP: The UMRR-LTRMP was responsible for conducting pre- and post-project vegetation surveys.

4.2 Project-Induced Habitat Changes

Stump Lake Complex HREP habitat conditions have experienced some changes since the pre-project monitoring. With the project, the number of acres of shallow marsh vegetation and water clarity have both increased, improving wetland and aquatic habitat conditions for fish and resident and migratory wildlife.

USACE Foresters have observed declines in the quality and diversity of the forest areas surrounding Upper Stump and Fowler Lake since 2008. These declines may be related to the extended impoundment of the water in these areas due to the constructed berms holding spring floodwaters on the forested lands longer than what would have occurred without the berms.

Table 3. Monitoring and Performance Evaluation Matrix

Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Sedimentation Problem Analysis	System-wide problem definition. Evaluates planning assumptions	USFWS	USFWS (EMTC)	UMRR-LTRMP	Leads into pre-project monitoring; defines desired conditions for plan formulation
Pre-project monitoring	Identifies and defines problems at HREP site. Established need for proposed project feature	IDNR	IDNR	IDNR	Attempts to begin defining baseline. See DPR.
Baseline monitoring	Establishes baselines for performance evaluation	USACE	Field station or sponsor thru Cooperative Agreements or Corps	UMRR-LTRMP	See DPR for location and sites for data collection and baseline information. Actual data collection will be accomplished during Plans & Specification phase.
Data Collection for Design	Includes identification of project objectives, design of project, and development of performance evaluation plan	USACE	USACE	UMRR-HREP	Comes after fact sheet. This data aids in defining the baseline
Construction Monitoring	Assesses construction impacts; assess permit conditions are met	USACE	USACE	UMRR-HREP	Environmental protection specifications to be included in construction contract documents. Inter-agency field inspections will be accomplished during project construction phase
Performance Evaluation Monitoring	Determine success of project as related to objectives	USACE (quantitative) , sponsor (field observations)	Field station or sponsor thru Cooperative Agreements or Corps	UMRR-LTRMP Cooper-ative	Comes after construction phase of project
Analysis of Biological Responses to Project	Evaluates predictions and assumptions of habitat unit analysis. Determine critical impact levels, cause-effect relationships, and effect on long-term losses of significant habitat	USFWS	USFWS (EMTC)	UMRR-LTRMP	Problem Analysis and Trend Analysis studies of habitat projects

Table 4. Annual Post-Construction Field and Quantitative Observation Requirements

Annual Post Construction Field & Quantitative Measurements						
Goals	**Objectives**	**Unit of Measure**	**Enhancement Measure**	**Field Observation**	**Quantitative Monitoring Plan**	**Monitoring Intervals (Years)**
Enhance wetland habitat for migratory & resident wildlife	Decrease sedimentation into wetland units	Inches/year	Levees Dike	Evidence of recent sediment deposition	Perform survey cross-sections for sedimentation	5
	Improve means to control wetland unit water levels independent of river stage	Graphed comparison between river stage and actual interior water levels achieved	Levee Gated drains Ditching Pumps Dredging	Evidence of a water stage differential based on recorded stage data at the site	Corps river stage data to be plotted against sponsor provided interior water stage data, and against expected interior stage data	5
	Increase reliable food production for wildlife	Acres	Levee, water control structures	Presence of wildlife	Perform vegetation survey	5
	Increase total wetland values for migratory wildlife	Habitat Units (HU)	All	Annual presence of wildlife	With assistance from IDNR, Corps will perform habitat analysis using WHAG	1, 5, 15, 50
Enhance aquatic habitat for slackwater fishes	Reduce potential for backwater sedimentation	Inches/year	Levees Dike	Evidence of recent sediment deposition	Perform survey cross-sections for sedimentation (soundings)	5
	Increase photic zone	Percent change from present	Dike Dredging	Observed visual clarity of backwater as compared to adjacent river water	Perform visibility readings with Secchi Disk	5
	Increase total habitat values for slackwater fishes	HU	All	Evidence of fishing success	With assistance from IDNR, Corps will perform habitat AHAG	1,5, 15, 50

5. PROJECT EVALUATION

5.1 Construction and Engineering

Under three separate contracts, construction began in 1995 and final construction was completed in 1999.

5.2 Costs

In the original DPR, cost estimates for the entirety of the project were $4,059,300 (FY1992). Initial costs were $2,701,500 for construction, $970,800 for planning, engineering, and design, and $387,000 for construction management. To date, total estimated project cost is $5,944,000 (http://www.mvs.usace.army.mil/pm/empmain.htm; accessed 20 June 2011).

5.3 Operation and Maintenance

In the original DPR, the average annual O&M cost was calculated to be approximately $33,700 with total annual operating cost of $15,120 (FY1990), and total annualized maintenance cost of $18,623 (FY1990). This amount included fuel, cleanout of structures, levee repair/maintenance, and pump maintenance (Table 15 in DPR). During the evaluation period of this PER, the total O&M cost has been $35,220. Table 5 provides O&M history and cost for the Stump Lake Complex HREP. Appendix B provides the pumping history in hours and total gallons used for dewatering and flooding for Flat Lake, Fowler Lake, and Stump Lake.

Table 5. Operation and Maintenance History for the Stump Lake Complex HREP

PUMPS	
Repair Activity	**Cost ($)**
Return lines and sleeves for injectors	120
Fuel shut-off solenoids	500
Air filters	800
Jack shaft repairs	200
Torsional dampener	1800
Dampener rebuild	300
Batteries	250
Fuel line	50
Jack shaft bearings	2800
Rebuild both Deran gear boxes	9200
Install and remove gear boxes	2400
Belts	900
Hydraulic motor repairs	1500
Replacement hose	3000
SUBTOTAL	**23,820**
LEVEES	
Repair Activity	**Cost ($)**
Rip rap for repair both sides of fish passage structure	2500
Repairs to Long Lake/Flat Lake levee – 4 times	5000
Periodic repairs to interior levees	3500
Planting for closing levee	400
Flood debris removal – site staff handles but sometimes it is 1.5 weeks to complete with dozer	
SUBTOTAL	**11,400**
GRAND TOTAL	**35,220**

5.4 Effectiveness of Project Goals

Table 6 summarizes the performance evaluation plan for Stump Lake Complex HREP goals and objectives.

Table 6. Performance Evaluation Plan showing without project, with project and year 50 target criteria. Values as listed in the original DPR Table 7 (except for the improve water level management objective which was not listed).

Goal	Objective	Enhancement Measure	Units	Without Project	With Project Today*	Year 50 target with project
Enhance wetland habitat for migratory and resident wildlife	Decrease sedimentation into wetland units	Levees, water control	Inches/ year	0.33-0.55	0.46	0.06-0.12
	Improve water level management	Levee, water control, dredging	Days inundated**	1338	58	Not specified in DPR
	Increase reliable food production for wildlife	Levee, water control	Acres	212.1	423.8	Not specified in DPR
			% frequency of SAV**	rare	rare	Not specified in DPR
	Increase total wetland values for migratory wildlife	All	AAHUs	1114	In development	1503
Enhance aquatic habitat for slackwater fishes	Decrease sedimentation into backwaters	Levees, water control	Inches/ year	0.33-0.55	0.46	0.06-0.12
	Increase photic zone	Water control, dredging	% change	0	22.7% increase across all seasons	Not specified in DPR
	Increase total habitat values for slackwater fishes	All	AAHUs	844	In development	1196

***** Project conditions during the evaluation period for the current report

****** Modified from original evaluation criterion as listed in the original DPR

Goal 1. Enhance wetland habitat for migratory and resident wildlife

Objective 1.1 Decrease sedimentation into wetland units

General. One of the specific project objectives for the Stump Lake Complex HREP was to reduce sedimentation into the wetland units. The levees and dike were installed to reduce the sedimentation to below 0.5 inches per year.

Results. Prior to the project, the area showed evidence that the site's wetlands were slowly filling, which is detrimental to fish and wildlife. No pre-project transect surveys were completed prior to construction. However, evaluation of aerial photographs taken in 1956 and 1989 illustrate the conversion of water to land at a rate of 3.4 acres/year. It is the responsibility of the USACE to perform survey cross-sections for sedimentation every 5 years. A baseline survey was done after project completion in 1999. In 2004 these transects were surveyed again. The 1999 and 2004 transects were compared to determine amount of shared length, sedimentation (amount of increase between 1999 and 2004), and scour (amount of decrease between 1999 and 2004). Net sedimentation was calculated by taking the difference between sedimentation and scour. The summarized results are shown in Table 7. The detailed results are provided in Appendix C. Figure 2 depicts the locations of sediment transects.

Table 7. Comparison of sedimentation rates between 1999 and 2004

Location	Shared length (feet)	Sedimentation (inches)	Scour (inches)	Net (inches)	Total/year (inches)	Meet <0.5 inches/year Goal
Range 1	7572.11	1.72	0.54	1.18	0.24	Yes
Range 2	4334.00	2.35	0.71	1.64	0.33	Yes
Range 3	8286.00	2.11	0.46	1.65	0.33	Yes
Range 4	3655.60	3.89	1.01	2.88	0.58	No
Range 5	2074.70	4.19	0.15	4.04	0.81	No
Across all Ranges AVERAGE	**5184.48**	**2.85**	**0.57**	**2.28**	**0.46**	**YES**

Conclusion. The project features did provide the ability to meet the objective of decreased sedimentation into wetland units. The goal of less than 0.5 inches/year of sedimentation in the Stump Lake Complex has been met with the average across all sampled locations of 0.46 inches/year. The goal has been technically met, however the project had hoped the results would have been further below the 0.5 inches/year mark. While sedimentation rates in Upper Stump Lake (Ranges 1-3) have decreased, the rates in Lower Stump Lake (Ranges 4-5) have not decreased as much. Even though not all areas met the criteria, a lesson learned includes that decreasing sedimentation is a 2-step process, with first step being have sediment fall out prior to open river habitat. From this knowledge, ranges 4-5 had higher sediment fall-out and could be viewed as sacrificial areas to prevent sedimentation in the larger open water habitat areas. Life expectancy of these areas is not as long as the other deeper areas.

The former site manager suggested that, during flooding, the water control structures at the southern end of the site are opened allowing water to enter the site. These floodwaters most likely carry sediment into the site as well. The criterion met the needs of evaluating the project performance, and the sediment berm was effective. Future efforts could also examine opportunities to further decrease sedimentation rates in the project area such as improving the backflow entry area designs (range 5). Monitoring of the sedimentation rate should continue and if it does not decrease in the future then the features used to address sedimentation may need to be re-evaluated for use in future HREPs.

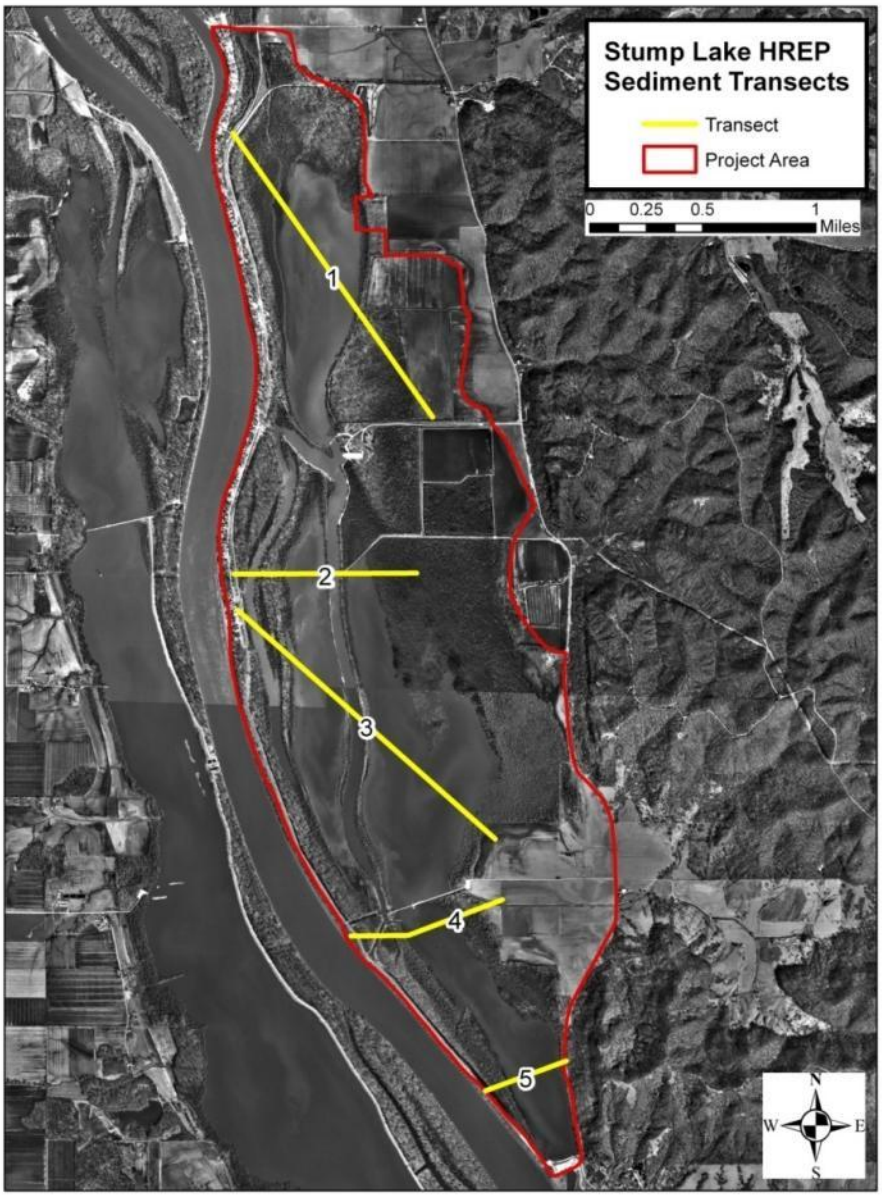


Figure 2. Stump Lake Complex HREP 1999 and 2004 sedimentation transect locations

Objective 1.2 Improve means to control wetland unit water levels independent of river stage

General. One of the specific project objectives for the Stump Lake Complex HREP was to improve water level management. The riverside dike/levee, containment levees, water control/fish passage structures, and the pumping system were installed to reduce the number of days inundated during the evaluation period.

Results. Water level management was estimated based on available data from the Illinois River stage height and levee height data. Stage height for the Hardin and Grafton gages since 1997 (year exterior levee was completed) were used. The lowest elevations found at Stump Lake for pre- and post-project were used to determine the water level needed to inundate the site. These heights were 420 feet and 426.02 feet, respectively. The lowest elevations were found to be about one-third the distance from the Grafton gage to the Hardin gage or at river mile 7.2. This distance was used to determine the stage height at that lowest point. The days the complex would be inundated with and without project exterior levee were then calculated (Fig. 3).

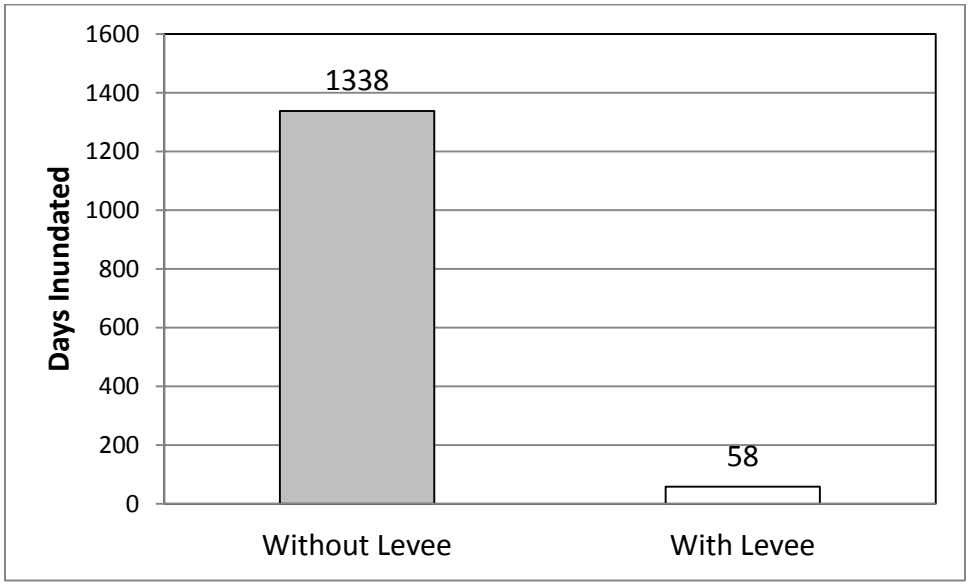


Figure 3. Number of days the Stump Lake Complex area would have inundated with and without the HREP project from 1997 – 2005. 1997 was the start of evaluation period because this was the year the exterior levee was completed.

Conclusion. The project features were successful in providing the ability to meet improved water level management. Since the exterior levee completion (1997-2005), the site had been inundated only 58 days, while without the project the site would have been inundated 1338 days. Based on this data, the project has been successful in eliminating 96% of the possible days inundated by the Illinois River. Using the number of inundated days showed to be an effective criterion in evaluating the project performance, and could be used in future evaluations. Regular monitoring and recording of river levels at the gauge installed at the confluence of the Illinois River and Long Lake coupled with recording of interior water levels is recommended in order to be able to provide a more accurate representation of the water control abilities of the Stump Lake HREP in future years.

Objective 1.3 Increase reliable food production for resident and migratory wildlife

General. One of the specific project objectives for the Stump Lake Complex HREP was to increase reliable food production for resident and migratory wildlife. The riverside dike/levee, containment

levees, water control/fish passage structures, and the pumping system were installed to assist in the creation of moist soil vegetation. Moist soil vegetation serves as productive areas for food used for resident and migratory wildlife, including wildlife. Several different data sources were utilized to examine the results for this objective, which included comparing land cover, vegetation surveys, and hunter success.

1) UMRR-LTRMP data were examined pre- and post-project to determine changes in land cover/land use as well as aquatic vegetation.
    a. Land Cover/Land Use
        i. General. The Upper Mississippi Environmental Science Center (UMESC) was contracted to examine the land cover changes in a 3153.7-acre area using the 31-Class vegetation classification system from pre-project (1989) to post-project (2000).
        ii. Results. Figure 4 illustrates the changes in land cover classes from 1989 to 2000, which shows a significant increase in moist soil vegetation. Land cover/land use change data showed an increase in Shallow Marsh Annual Class (+ 211.7 acres) and Rooted Floating Aquatic Class (+167.8 acres). The data also showed a decrease in Open Water Submerged Aquatic Vegetation (-372.9 acres). The Shallow Marsh Annual Class, the most desired class for food production, increased from 212.1 acres in 1989 to 423.8 acres in 2000, an increase of 211.7 acres or 99.8%. Further details are available in Appendix D.
        iii. Conclusions. Land Cover/Land Use did show an increase in acreage of shallow marsh annuals; however, drawing conclusions about project success based solely on two points in time should be done with caution. Aquatic vegetation can fluctuate annually based on floods, droughts, etc.; therefore, other data could be used to supplement the land cover/land use data when evaluating project performance.
    b. Aquatic Vegetation
        i. General. EMP-LTRM submersed aquatic vegetation (SAV) data for percent frequency of occurrence were examined pre-project (1993-1998) and post-project (1999-2004). Submersed aquatic vegetation included Canadian waterweed (*Elodea Canadensis*), Coon's tail (*Ceratophyllum demersum*), Longleaf pondweed (*Potamogeton nodosus*), sago pondweed (*P. pectinatus*), small and leafy pondweeds (*P. pusillus, P. foliosus*), southern waternymph (*Najas guadalupensis*). Prior to 1998, LTRMP collected vegetation transect data every year in spring and summer. In 1998, sampling protocol changed to stratified random sampling. Due to this change sampling methods comparing pre- and post-project percent frequency of occurrence should not be done.
        ii. Results.
            1. Pre-project: Overall, aquatic vegetation was rare in the Alton Pool in the 1990s (Yin et al. 2000), making Stump Lake and other backwaters important in providing this habitat. Stump Lake had moderately high to high percentages of SAV between 1991 and 1993; however the flood of 1993 led to little SAV found within the vegetation transects by 1994. Since then, SAV had recovered in Stump Lake (Fig. 5).

2. Post-project: The change to stratified random sampling for SAV in 1998 has led to the inability to compare pre- and post-project conditions. Percent frequency of occurrence was computed by dividing the number of sites where a species was recorded by the number of sites investigated in the stratum × 100. Overall, SAV was limited in Pool 26 (Alton Pool) with small increases occurring immediately following low water, but these seldom persisted (Johnson and Hagerty 2008). LTRMP SAV sampling in Pool 26 was terminated after 2004. Figure 6 illustrates the changes in percent frequency of SAV occurrence using data collected from the stratified random sampling design (1998-2004).

iii. Conclusions. Overall, percent frequency of occurrence of submersed aquatic vegetation within the Lower Alton Pool remains low. Prior to 1998, vegetation transects located within Pool 26 (included Stump Lake transects) showed a relatively moderate to high frequency of occurrence of SAV. The stratified random sampling design changed how the data were collected limiting comparison of pre- and post-project conditions. Overall, post-1998, within the Lower Alton Pool SAV remains low. The use of this evaluation criterion for future HREPs will be useful if data used for comparison were collected by the same methods. Since the Stump Lake Complex HREP was completed at the same time as the SAV data collection change, no conclusion on project performance can be made at this time. Future evaluations of the Stump Lake Complex HREP project should only use post-1998 data to determine if the project is meeting the long-term goal of increasing reliable food production for resident and migratory wildlife.

2) An HREP vegetation study was conducted in 2002 by the Illinois Natural History Survey. Sampling was stratified into three habitat types: aquatic, wetland, and forested. Standard Long Term Resource Monitoring program procedures for Stratified Random Sampling of aquatic vegetation were used to sample 20 sites each of submersed vegetation, emergent vegetation, and forested sites. Species composition and cover were recorded at each site (Appendix E provides the full HREP study report).

Results. No pre-project sampling was conducted. By the 2002 survey, presence of a large amount of emergent vegetation was evident. This report shows *Echinochloa esculenta* (Japanese millet), *Echinochloa muricata* (Rough barnyard grass), *Leptochloa fascicularis* (Bearded sprangletop), *Cyperus erythrorhizos* (Redroot flatsedge), *Amaranthus tuberculatus* (Roughfruit amaranth), *Leersia oryzoides* (Rice cutgrass), and *Sagittaria latifolia* (Broadleaf arrowhead) were the most common emergent species. These species also provide good forage for resident and migratory wildlife. In addition, beaver are keeping out *Cephalanthus occidentalis* (Common buttonbush) and *Salix nigra* (Black willow) through their cutting back of these species that would normally crowd out emergent vegetation.

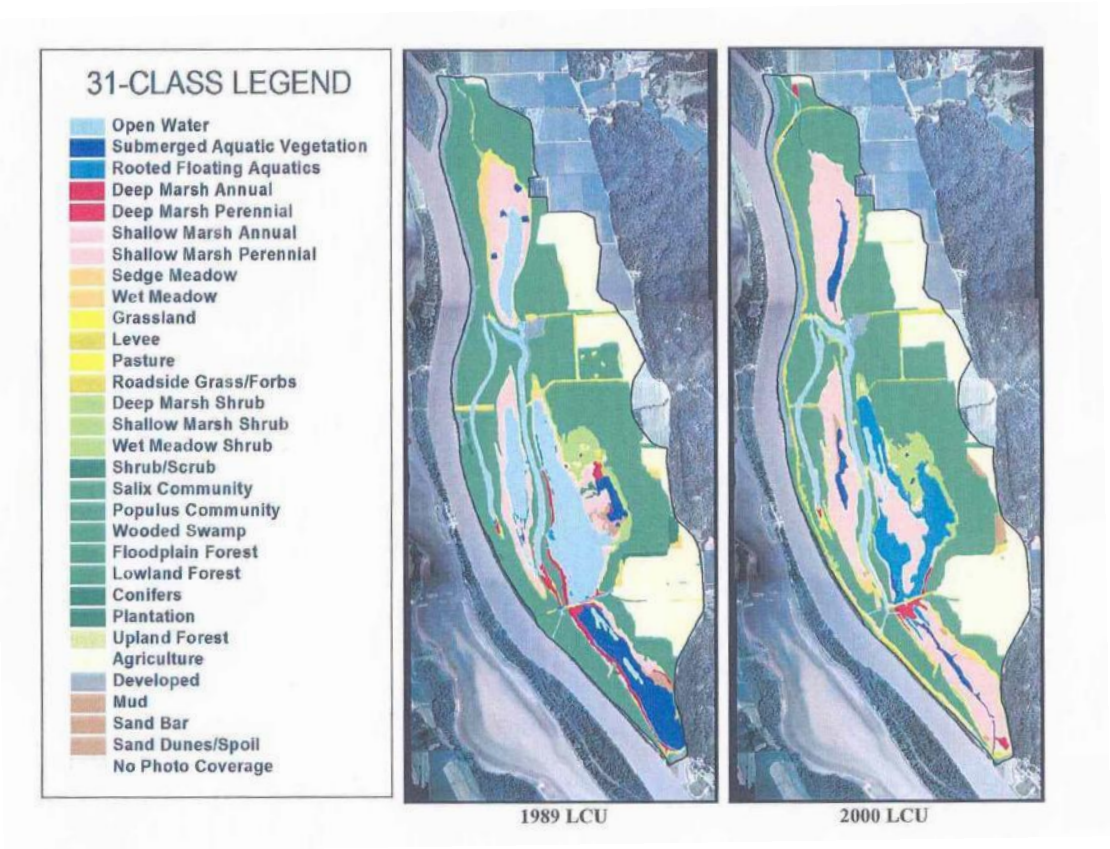


Figure 4. 31 Class land cover/land use map comparing the Stump Lake Complex HREP in 1989 and 2000.

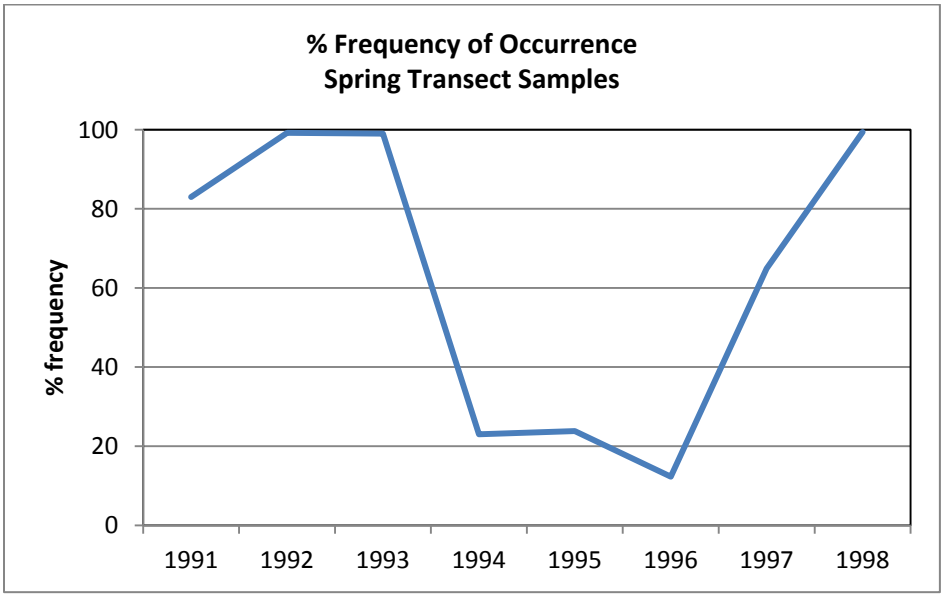


Figure 5. Percent frequency of occurrence of submersed aquatic vegetation in spring vegetation transects located at Stump Lake from 1991 to 1998 (Data from Yin et al. 2000).

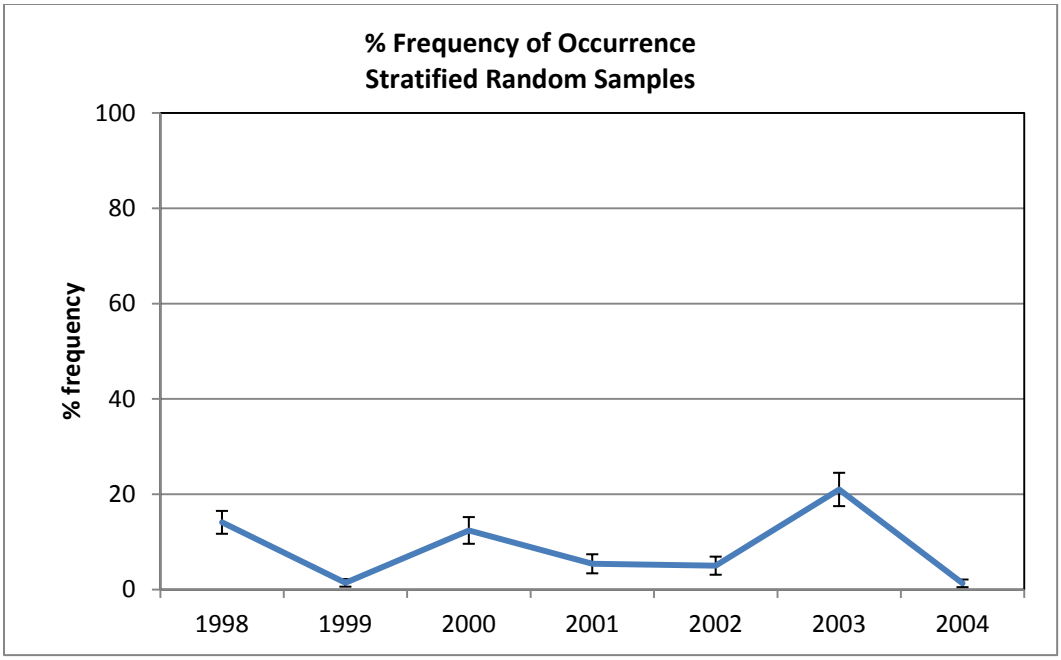


Figure 6. Percent frequency of occurrence of submersed aquatic vegetation in stratified random sampling sites located in Lower Alton Pool, Illinois River from 1998 to 2004 (Data from Yin et al. 2011).

3) Hunter success records since 1960 were examined for the Stump Lake Complex HREP in order to see if hunter success had increased since the construction of the project. An increased number of wildlife could indicate greater water level management and increased emergent vegetation at the site. An attempt at showing improvement in production for wildlife can be done by examining the numbers of birds taken at the site during the hunting season pre- and post- project. Average number of ducks taken per year since 1966 was examined in attempt to extrapolate some conclusions (Fig. 7).

   Results. The trend seen in the hunter success data shows that the average number of birds taken since the project completion has been experiencing an upward trend suggesting that the project is having the desired effect of increasing the reliable resident and migratory wildlife food production. However, data from nearby refuges also show similar trends. It is difficult to attribute the increase in the average number of birds killed to increased food production because other refuges have similar trends. Therefore, using hunter success as a criterion to measure success is inconclusive and should not be used alone to evaluate future HREP projects because hunter success is dependent on annual population fluctuations and weather.

   Conclusion. The project features were successful in providing the ability to meet increased reliable food production for resident and migratory wildlife. Using land cover/land use data and the vegetation surveys were successful in evaluating the project performance, and should be used in future HREP projects with a similar project objective; however, hunter success should not be used for future evaluations of project performance due to confounding environmental factors not related to project features.

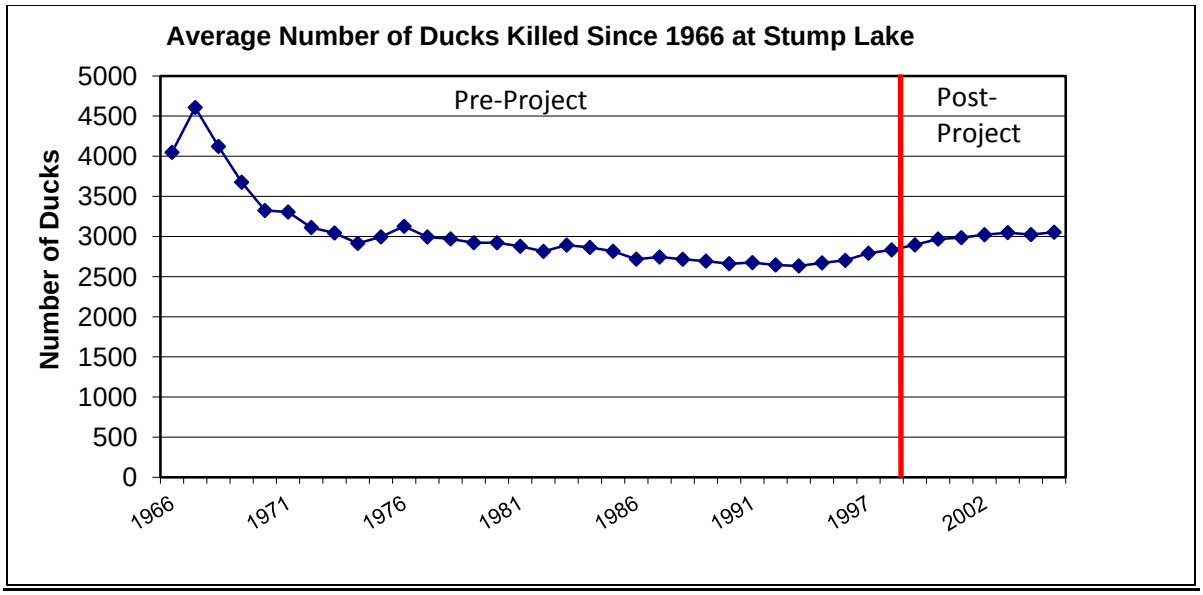


Figure 7. Average number of ducks killed since 1966 at Stump Lake Complex HREP. Red line designates HREP construction completion.

Objective 1.4 Increase total wetland habitat values for migratory wildlife

General. One of the specific project objectives for the Stump Lake Complex HREP was to increase total wetland habitat values for migratory wildlife. All project features were installed to assist in increasing the habitat value at the Stump Lake Complex HREP. The Wetland Habitat Appraisal Guide (WHAG) was used in the original DPR and was recommended for use in subsequent project evaluations. At the time the original DPR was completed, WHAG was viewed as being a tool to measure project success; however based on new modeling information using WHAG to evaluate real-life conditions is not appropriate. WHAG is a planning tool used to estimate differences between potential alternatives. Since the Corps committed to evaluate the project using WHAG, the Corps plans on performing a WHAG in the future.

Results. Appendix E of the original DPR discusses the results of the original WHAG analysis for the Stump Lake Complex HREP in detail. From the original DPR WHAG analysis, without project resulted in 1114 AAHUs, while by target year 50 with the project resulted in 1503 AAHUs. No post-project habitat evaluation has been performed at this time.

Goal 2. Enhance aquatic habitat for slackwater fishes

Objective 2.1 Reduce potential for backwater sedimentation

See discussion above under Objective 1.1

Objective 2.2 Increase photic zone

General. One of the specific project objectives for the Stump Lake Complex HREP was to increase the photic zone. The exterior levee and water control structures were used to improve water clarity thereby increasing the photic zone. Percent change from pre-project conditions was used as the evaluation criterion.

Results. Secchi disk readings (a method used to measure water clarity) were taken from nine points in the Stump Lake Complex seasonally between 1990-1997 (pre-project data) and from 1999-2000 (post-project data). Figure 8 shows the location of sample sites. Every site was not sampled every season due to occurrences of flooding or lack of adequate depth to take accurate readings (Appendix F contains the data used). The Secchi disk readings are greater after project completion for all seasons (Fig. 9). The photic zone increased from pre-project conditions by 4.6%, 11.1%. 40.3%, and 34.7% for fall, winter, spring, and summer, respectively.

Conclusions. From the one-year of post-construction monitoring, the project features appear to be successful in providing the ability to increase the photic zone within the Stump Lake Complex HREP. However, additional post-construction monitoring would be beneficial in drawing stronger conclusions. The goal of increasing the percent change in the photic zone from pre-project conditions has been met for each season. The greatest increase in the photic zone occurred in spring and summer. Fall and winter samples did show an increase, but due to the variable data the increase may not be significantly different from pre-project conditions. Due to flooding and shallow depth, not all season-year combinations were sampled the same number of times (i.e., fall pre-project had 62 samples while post-project had 9 samples). As environmental conditions allow, more consistent data collection should allow for better evaluation in the future. Monitoring of the photic zone through Secchi disk readings should continue and should be used in future evaluations as well as other future HREP projects.

Objective 2.3 Increase total habitat values for slackwater fishes

General. One of the specific project objectives for the Stump Lake Complex HREP was to increase total habitat values for slackwater fishes. All project features were installed to assist in increasing the aquatic habitat value at the Stump Lake Complex HREP. The Aquatic Habitat Appraisal Guide (AHAG) was used in the original DPR and was recommended for use in subsequent project evaluations. The Wetland Habitat Appraisal Guide (WHAG) was used in the original DPR and was recommended for use in subsequent project evaluations. At the time the original DPR was completed, AHAG was viewed as being a tool to measure project success; however based on new modeling information using AHAG to evaluate real-life conditions is not appropriate. AHAGis a planning tool better used to estimate differences between potential alternatives.

Results. Appendix E of the original DPR discusses the results of the original AHAG analysis for the Stump Lake Complex HREP in detail. From the original DPR AHAG analysis, without project resulted in 844 AAHUs, while by target year 50 with the project resulted in 1196 AAHUs. Due to new information on the appropriate use of AHAG/WHAG models, no post-project habitat evaluation using these models will be performed.

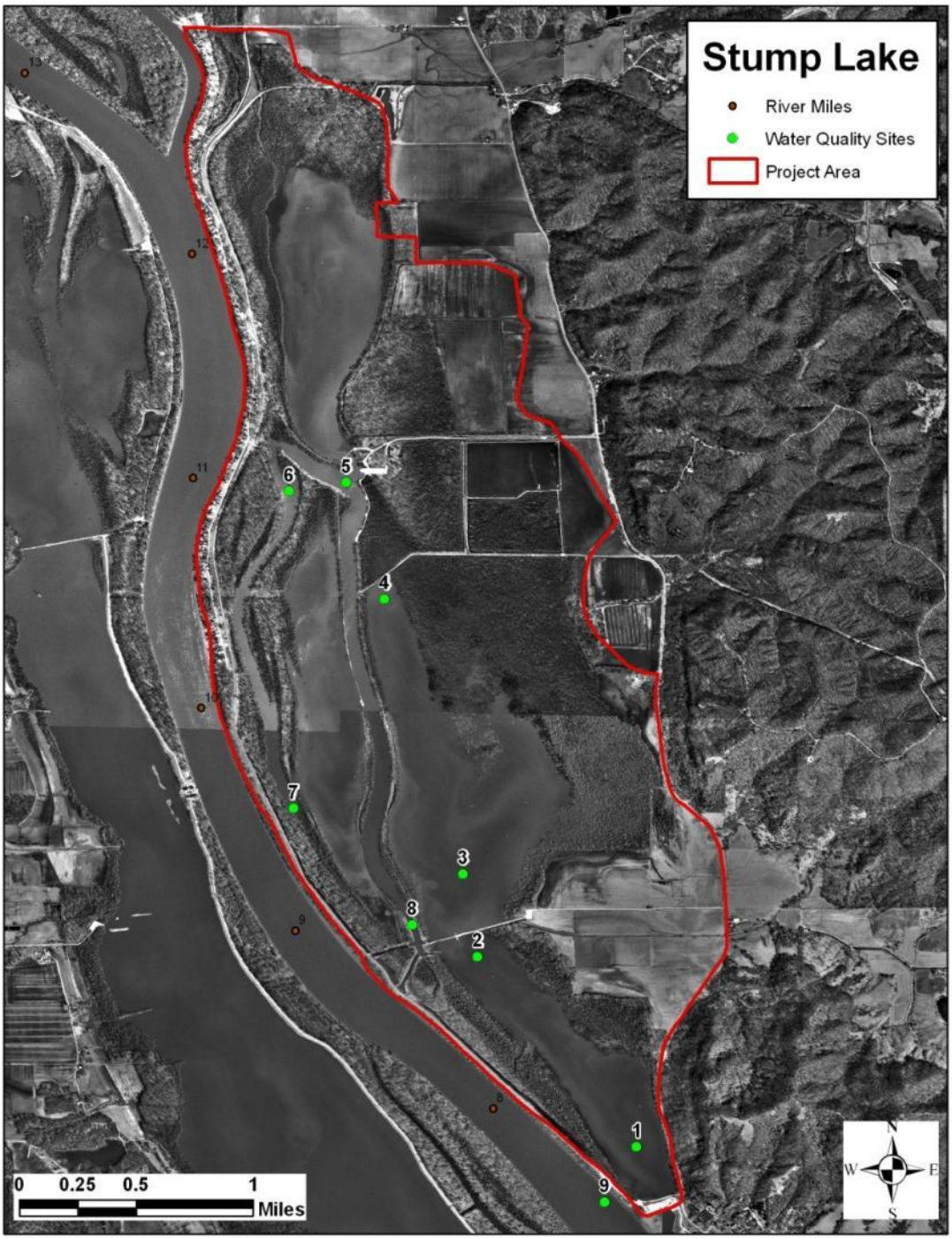


Figure 8. Stump Lake Complex HREP water quality (Secchi disk readings) sites

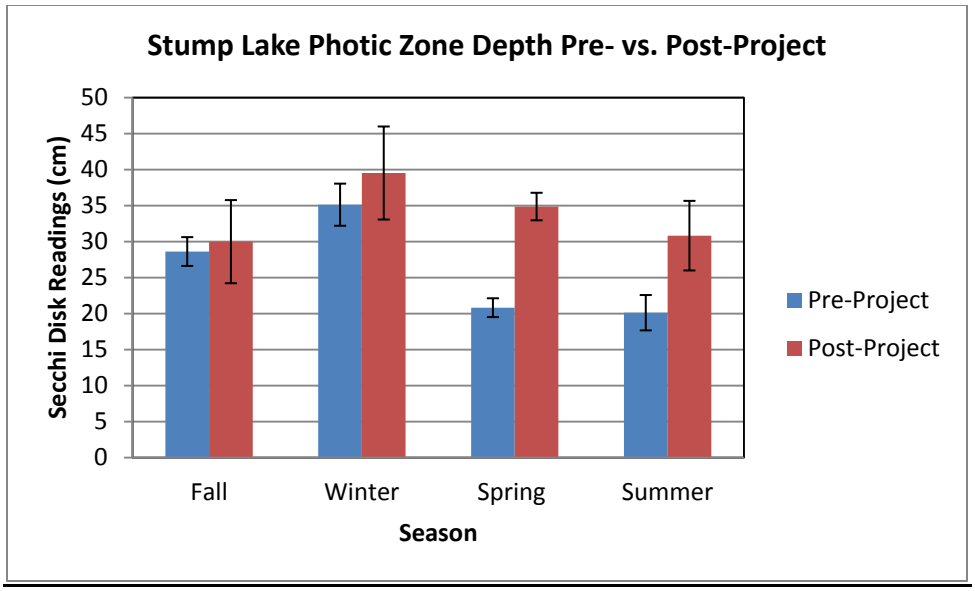


Figure 9. Seasonal means (±standard error) for photic zone depth as measured by Secchi disk readings (cm) for pre-project (1990-1997) and post-project (1999-2000).

6. LESSONS LEARNED AND RECOMMENDATIONS FOR FUTURE SIMILAR PROJECTS

Overall, the goals and objectives have been achieved almost fully for the Stump Lake Complex HREP (Table 8). The exterior levee has been successful in keeping out sediment laden water leading to a decreased sedimentation rate and increased photic zone; however, sedimentation into Lower Stump appears to be less than what was desired with this HREP. The influences of back filling from the mainstream river on sedimentation rates needs to be further examined in order to determine a possible effective solution for future HREPs. The interior levees and water control structures are improving water level management of individual units which has increased the reliable food source for resident and migratory wildlife.

The evidence used to support these conclusions is not ideal due to the nature of the environment. Large rivers flood preventing data collection. In an ideal world, all data samples would be collected; however in the real world this is not always the case. Therefore, monitoring and record keeping should occur as best as possible given the environmental conditions. In general, more samples allow for better data analysis and more accurate evaluation of project performance. Drawing definitive conclusions based on a limited data set should be used with caution.

Additionally, project performance evaluation criteria may need to be adapted from the original DPR due to data availability as well as new information and methods becoming available. For this project, the original criterion of interior water levels was changed to number of inundated days which showed to be a useful performance criterion. Based on recent information on models, AHAG and WHAG should be used as planning tools to compare potential benefits of alternatives and should not be used for evaluation of project performance. Therefore, altering the performance criteria from the original DPR may be needed for future HREPs.

As future HREP projects are developed seeking to improve water level management to benefit migratory wildlife, the concern with declines in adjacent forest lands should be accounted for during project development. Typically, a site like Stump Lake would drain the area after waterfowl season in spring/summer to promote moist soil vegetation and then re-flood in early fall/through winter.

However, what often happens is that the spring floodwaters prevent site management from draining the areas after waterfowl season. By the time the floodwaters are drained, it is late into the growing season, which stresses the trees. If it is late into the growing season, and no opportunity for a successful moist soil vegetation production, the sites may remain flooded in preparation for the fall migration. If this happens, the trees may remain inundated (not necessarily standing water, but an abnormally high water table) for 16-18 months or longer if the following spring is wet. Even though flooded timber does provide habitat benefits to waterfowl, over the long-term the prolonged inundation is leading to dramatic loss in more desirable tree species (i.e., oaks) and an increase in more flood tolerant species, such as silver maple. As future HREPs are being considered with similar goals and objectives as Stump Lake, the planning team should take into account the potential negative effects to forest resources, and consider developing water level management plans using reduced target water elevations in some years and/or managing the water control structures in such a way that has them set to drain immediately as the floodwaters recede.

Overall, evaluation criteria that could be used in future HREPs with similar goals and objectives include:

- Sedimentation rates
- Number of inundated days (if no water level data are available)
- Change in land cover/land use (acres)
- % frequency of occurrence of submersed aquatic vegetation
- Vegetation surveys (need pre- and post-project methods to be the same)
- Water quality sampling (need consistent sampling during pre- and post-project evaluation, as environmental conditions allow)

Evaluation criteria used in this Stump Lake Complex HREP Project Evaluation Report which may need further evaluation for use in future HREPs include:

- Hunter success
- AHAG/WHAG pre- and post-project comparison to measure success

Table 8. Overall status of achieving the goals and objectives for the Stump Lake Complex HREP.

Goals	Objectives	Status
Enhance wetland habitat for resident and migratory wildlife	Decrease sedimentation into wetland units	Successful
	Improve water level management	Successful
	Increase reliable food production for resident and migratory wildlife	Successful
	Increase total wetland values for migratory wildlife	*
Enhance aquatic habitat for slackwater fishes	Reduce backwater sedimentation	Succesful
	Increase photic zone	Successful
	Increase total habitat values for slackwater fishes	*

* AHAG/WHAG models not appropriate to use evaluate project performance

7. REFERENCES

Yin, Y., H. Langreher, J. Nelson, T. Blackburn, T.Cook, W. Popp, and J. Winkleman. 2000. 1998 annual status report: Status and trend of submersed and floating-leaved vegetation in thirty-two backwaters in Pool 4, 8, 13, and 26 and La Grange pool of the Upper Mississippi River System. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, June 2000. LTRMP – 2000-P003. 21 pp. + Appendices A-B.

Yin, Y., H. Langrehr, T. Shay, T. Cook, R. Cosgriff, M. Moore, and J. Petersen. 2011. Vegetation Sampling in the Upper Mississippi River System: Annual Update. [online] http://www.umesc.usgs.gov/reports_publications/ltrmp/veg/vegetation_update.html. Accessed on 21 June 2011.

Johnson, B.L., and K.H. Hagerty, editors. 2008. Status and trends of selected resources of the Upper Mississippi River System. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, December 2008. Technical Report LTRMP 2009-T002. 102 pp + Appendices A-B.

Stump Lake Complex HREP Project Evaluation Report

Appendix A - Photos

Gated culverts on Fowler Lake

Main Pump

Fish Passage Structures

Lower Stump Lake

Stump Lake Complex HREP Project Evaluation Report

Appendix B – Water Pumping History

Dewatering of Flat Lake

YEAR	HOURS	GPM	Total Gallons	Acre Feet	Max Gallon Daily
1999	65	12,000	46,800,000	140	17,280,000
2000	204		146,880,000	441	
2001	77		55,440,000	166	
2002	54		38,880,000	117	

Flooding Flat Lake

YEAR	HOURS	GPM	Total Gallons	Acre Feet	Max Gallon Daily
1997	191	12,000	137,520,000	413.00	17,280,000
1998	166		169,320,000	508.00	24,480,000
1999	162		116,640,000	350.00	17,280,000
2000	218		156,960,000	470.88	
2001	135		97,200,000	291.60	
2002	182		131,040,000	393.12	
2003	140		100,800,000	302.40	
2004	141		101,520,000	304.56	
2005	149		107,280,000	321.84	

Flooding Fowler Lake

YEAR	HOURS	GPM	Total Gallons	Acre Feet	Max Gallon Daily
1996	41	17,000	41,820,000	125.46	24,480,000
1997	164	12,000	118,080,000	354.24	17,280,000

Flooding Stump Borrow Pit

YEAR	HOURS	GPM	Total Gallons	Acre Feet	Max Gallon Daily
1997	55	12,000	39,600,000	119	17,280,000
1999	60		43,200,000	130	

Fall Flooding Stump Lake

YEAR	HOURS	Total Gallons	Acre Feet
1996	312	992,160,000	125.46

Summer Dewatering of Stump Lake

YEAR	HOURS	Total Gallons	Acre Feet
1998	255	810,900,000	2,432.70
1999	457	1,453,260,000	4,359.79
2000	401	1,275,180,000	3,825.54
2005	86	273,480,000	830.44
2006	74	235,320,000	705.96

Stump Lake Complex HREP Project Evaluation Report

Appendix C – Sedimentation Survey

CEMVS-ED 24 March 2004

MEMORANDUM FOR CEMVS-ED-SG

SUBJECT: Survey Request for Stump Lake Project, Jersey County, Illinois, UMRS-EMP

1. Request that sedimentation surveys be performed at Stump Lake as part of the post project monitoring program for completed EMP projects. The purpose of these surveys is to determine the amount of sedimentation that has occurred since project completion.

2. In 1999, baseline sedimentation surveys were established using 5 transect ranges for Stump Lake as shown on the attached image (Encl 1). Kenneth Balk & Associates, Inc. was the surveyor. These surveys can be found at the MVS CADD directory N:\EMP\Stump\Sedimentation. Verify and provide surveys using horizontal datum of 1927 (NAD 27), Vertical Datum of 1929 (NGVD) and State Plane Coordinates using Illinois West Zone, being consistent with past project surveys. All surveys shall be in English units.

3. The following survey data and products are required:

a. Sedimentation Surveys. Reference baseline sedimentation surveys as performed and as identified in paragraph 2 above. Use the identical interval as was used in the 1999 baseline surveys in obtaining the elevation data for each transect. The station, elevation and field description of each data point is documented in the 1999 baseline surveys. In general, most of the transects show field shots taken approximately every 100 feet except at planimetric features such as roads, levees, utilities, ditches, etc. where data was data points were taken at a closer interval. The terrain along the transect will require land based and hydrographic survey techniques. Identify and record the water surface level at each water body encountered along each transect.

b. Survey Products. Field data points obtained shall be used to generate a profile along the 5 established transects. Profiles shall include the 1999 baseline data and shall be labeled appropriately to identify each. Line style and pattern shall be uniquely distinguishable to easily determine the difference in the two data sets. The profile should show major planimetric features such as edge of roads, levees, utilities, etc. Profile scale should be 1”=100’ horizontal and 1”=2’ vertical for a standard size “D” drawing. Survey report should be generated showing the following in tabular form for each transect; Station, 1999 Elevation, 2004 Elevation, change in elevation, Description (data point).

CEMVS-ED

SUBJECT: Survey Request for Stump Lake Project, Jersey County, Illinois, UMRS-EMP

c. The surveys shall be furnished as 3D CADD files using the St. Louis District standard level designations. All text call outs describing the previous features shall be on a separate level. In addition to field books, all CADD files & ASCII data, and reports are to be placed on either 3.5 inch floppy or CD ROM to be compatible with St. Louis District Intergraph Microstation.

4. The funded work item for this survey work is 0305KL in the amount of $20,000. Please complete these surveys and output products by 31 May 2004. If you have any questions, please contact the undersigned at (8245).

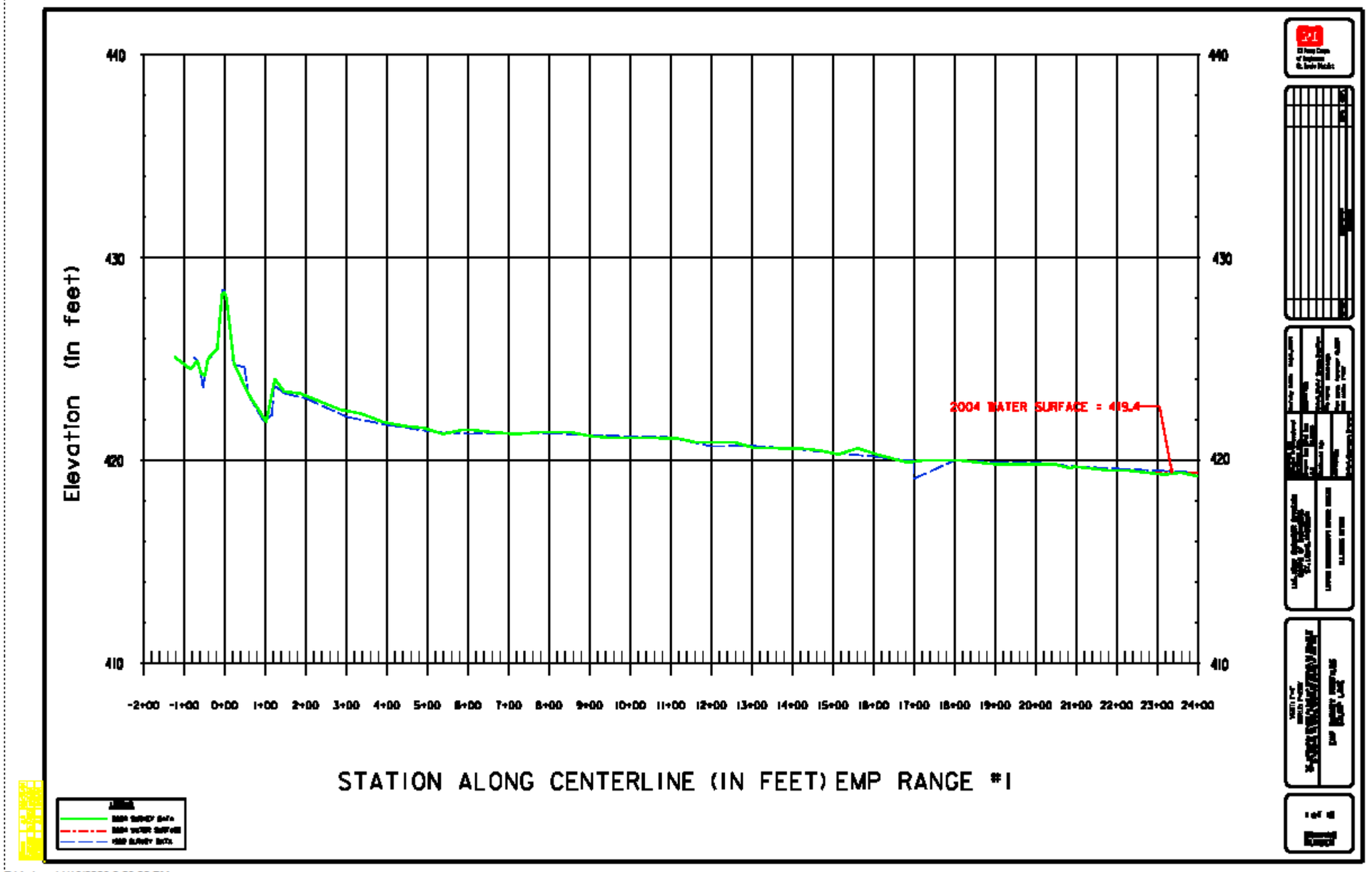
/s/

Gary Lee, P.E.

Civil Engineer

Encl.

CF: PM-N Thompson/Markert



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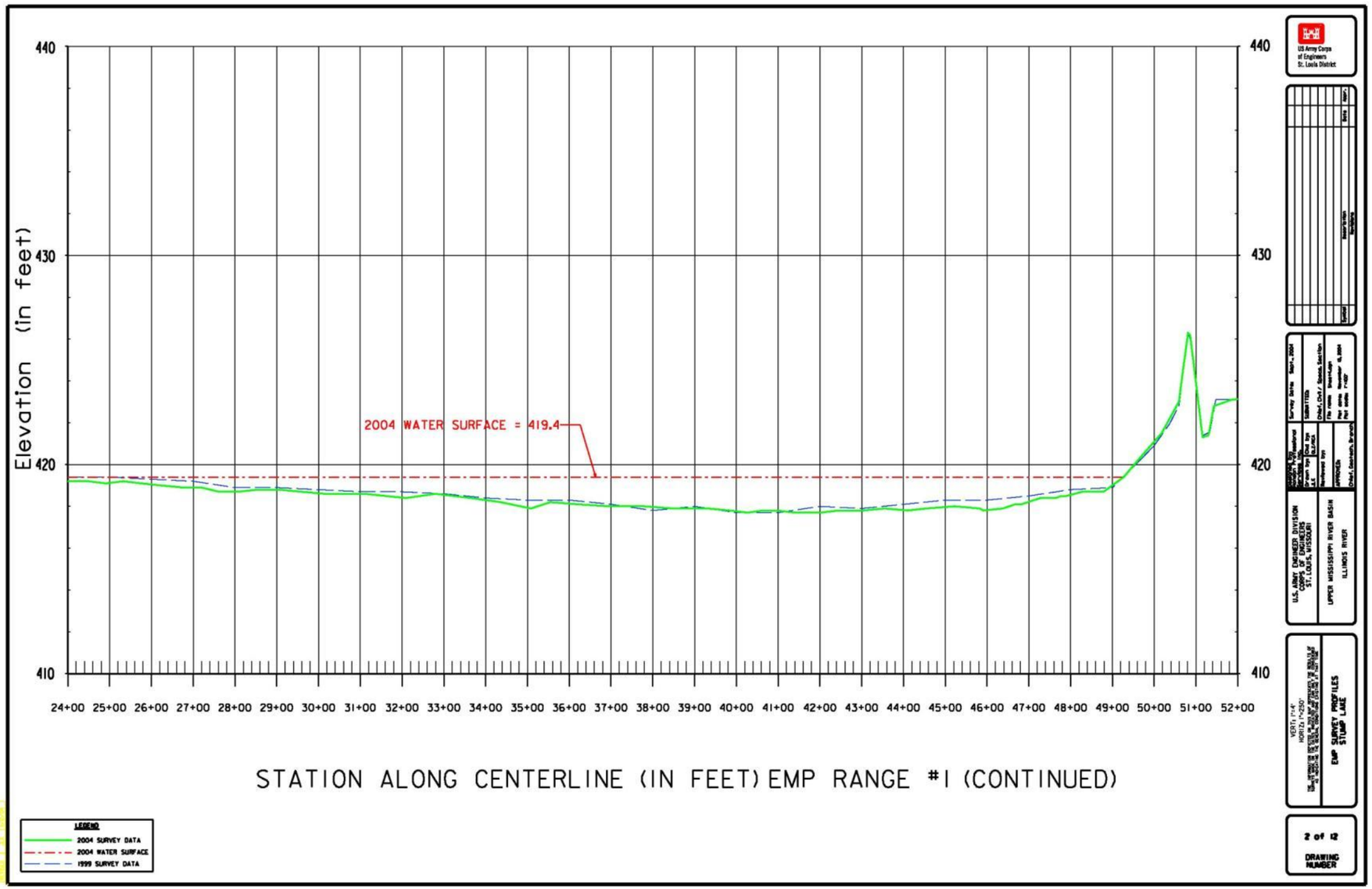

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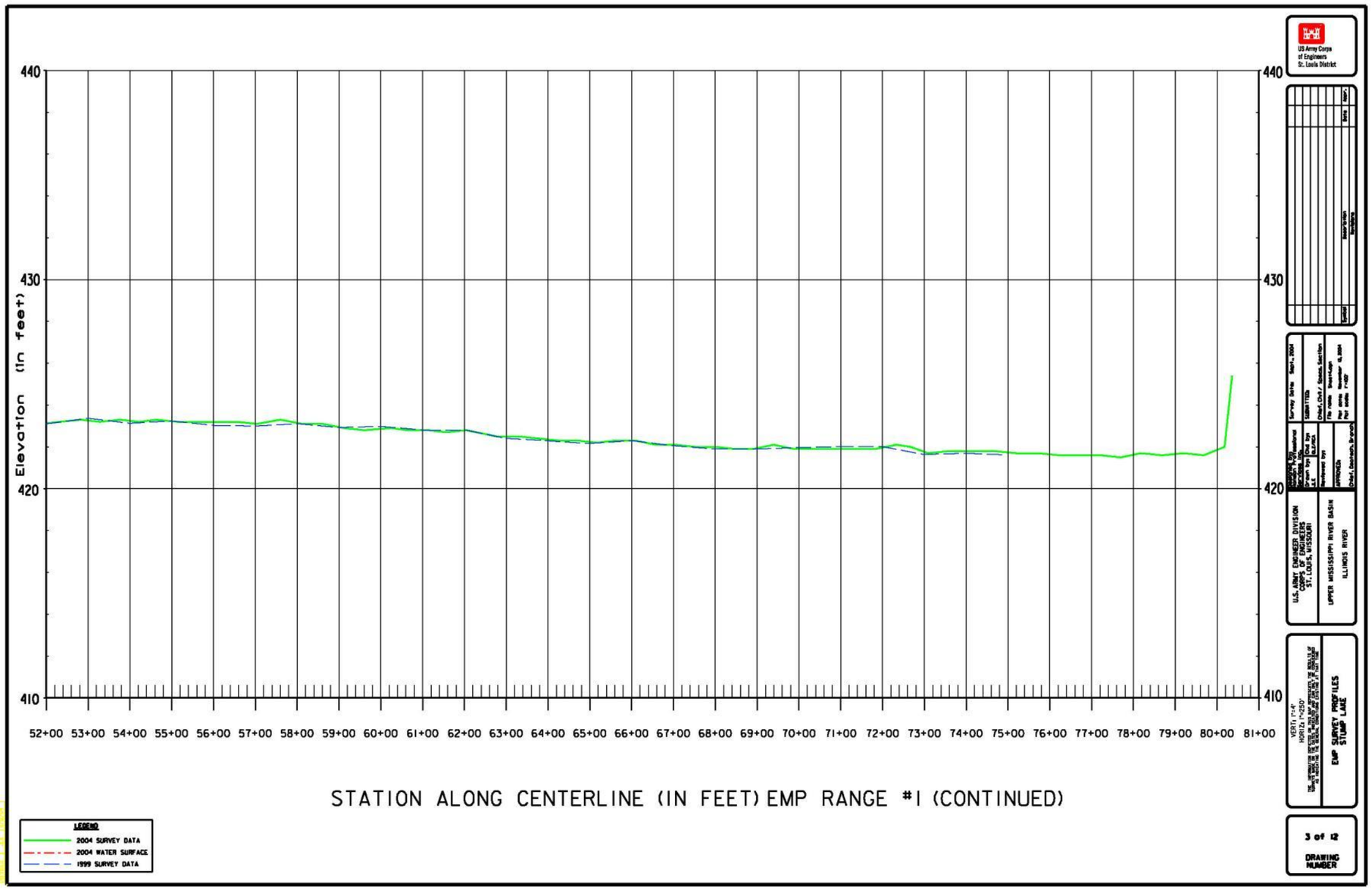

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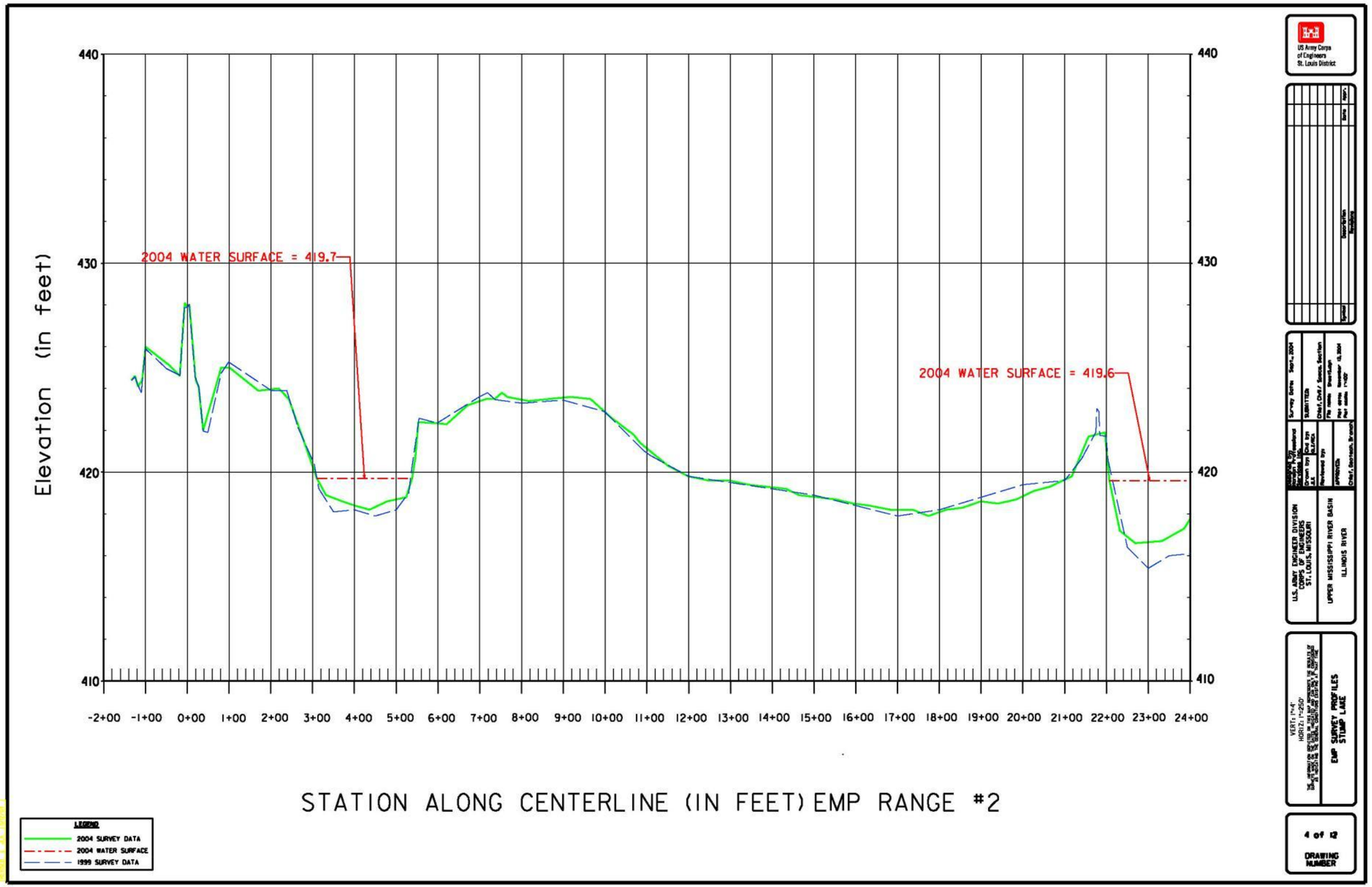

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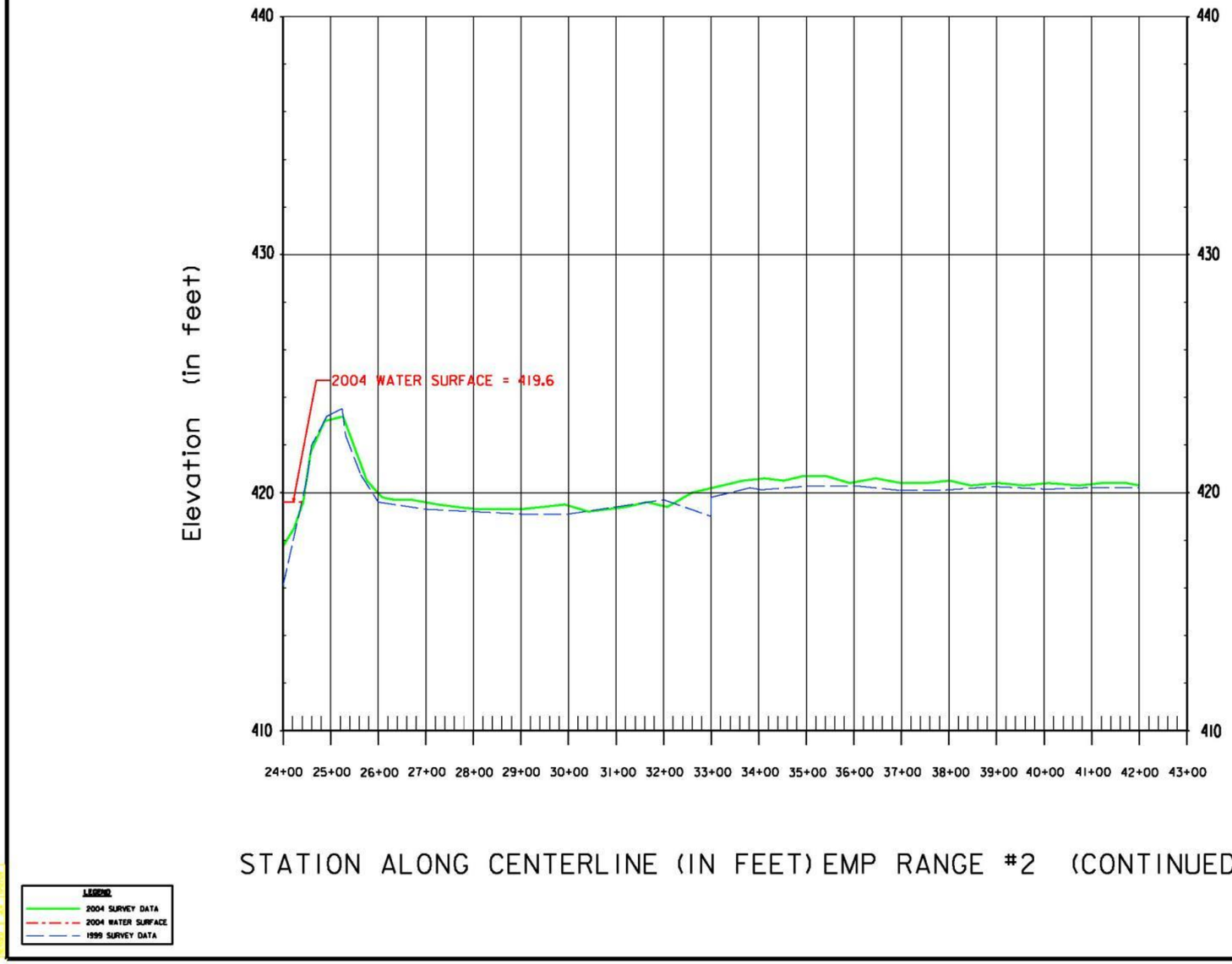

US Army Corps of Engineers
St. Louis District

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

UPPER MISSISSIPPI RIVER BASIN
ILLINOIS RIVER

VERT. 1"=4'
HORIZ. 1"=200'

EMP SURVEY PROFILES
STUMP LAKE

5 of 12
DRAWING NUMBER

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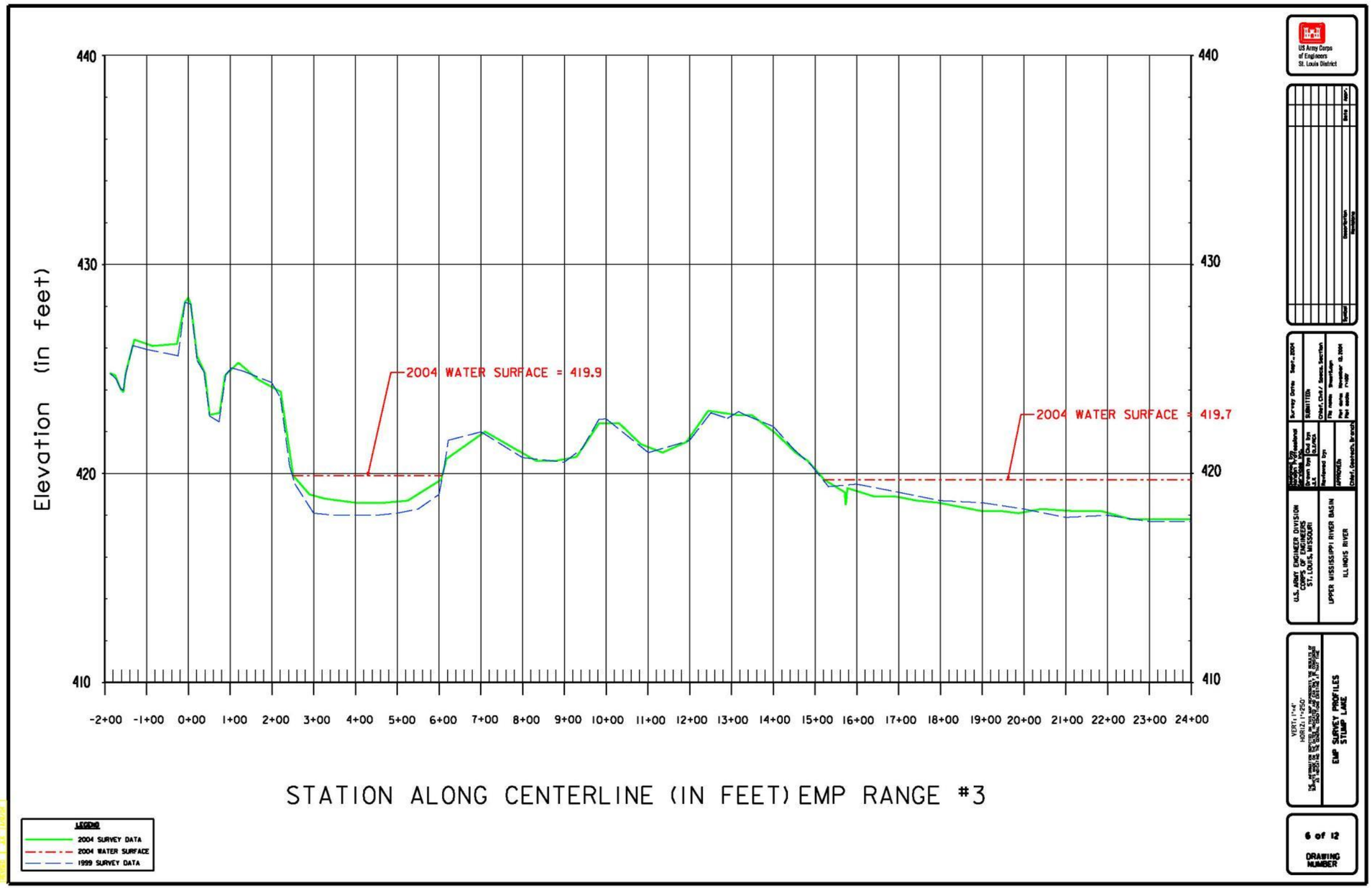

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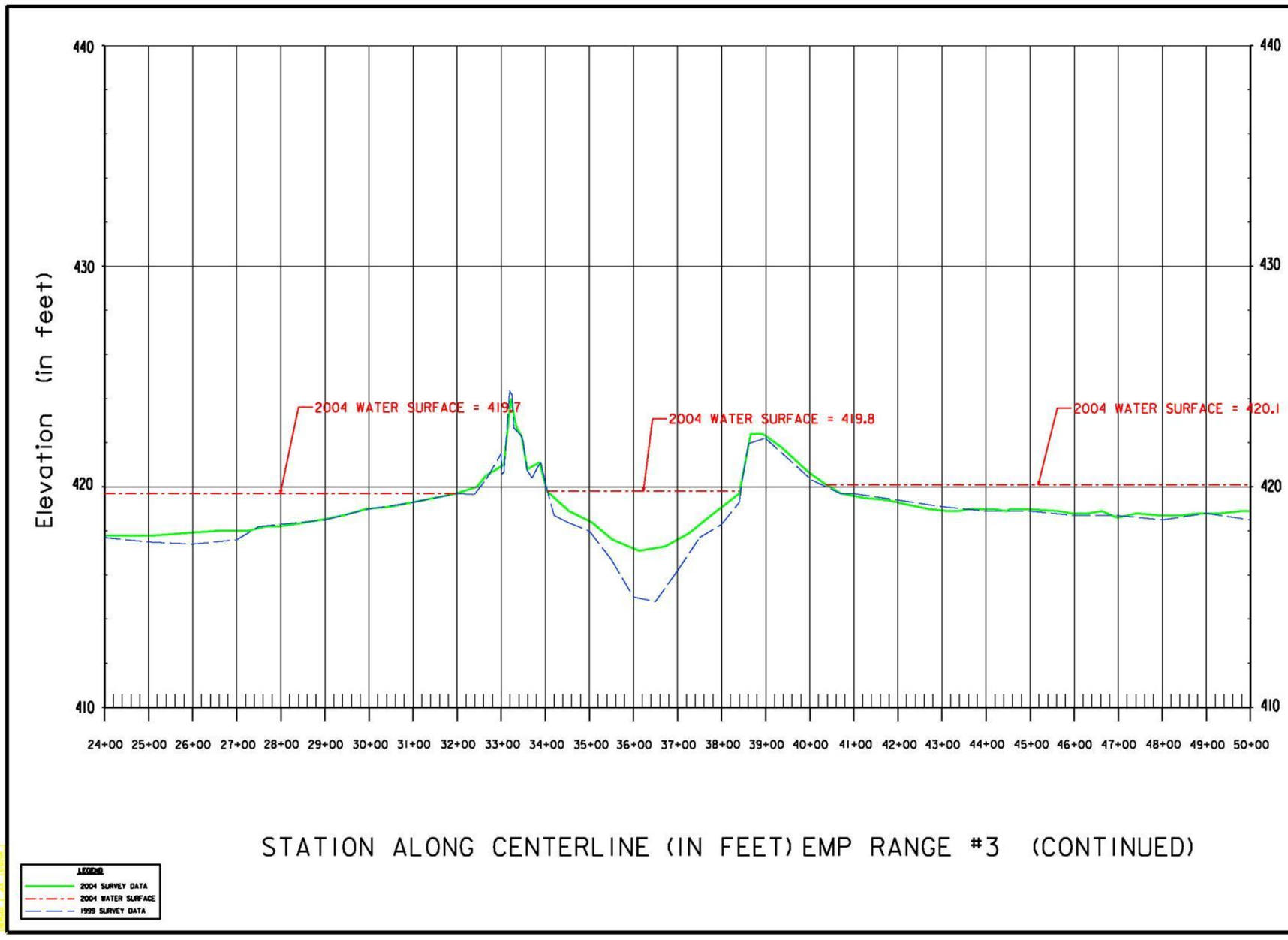

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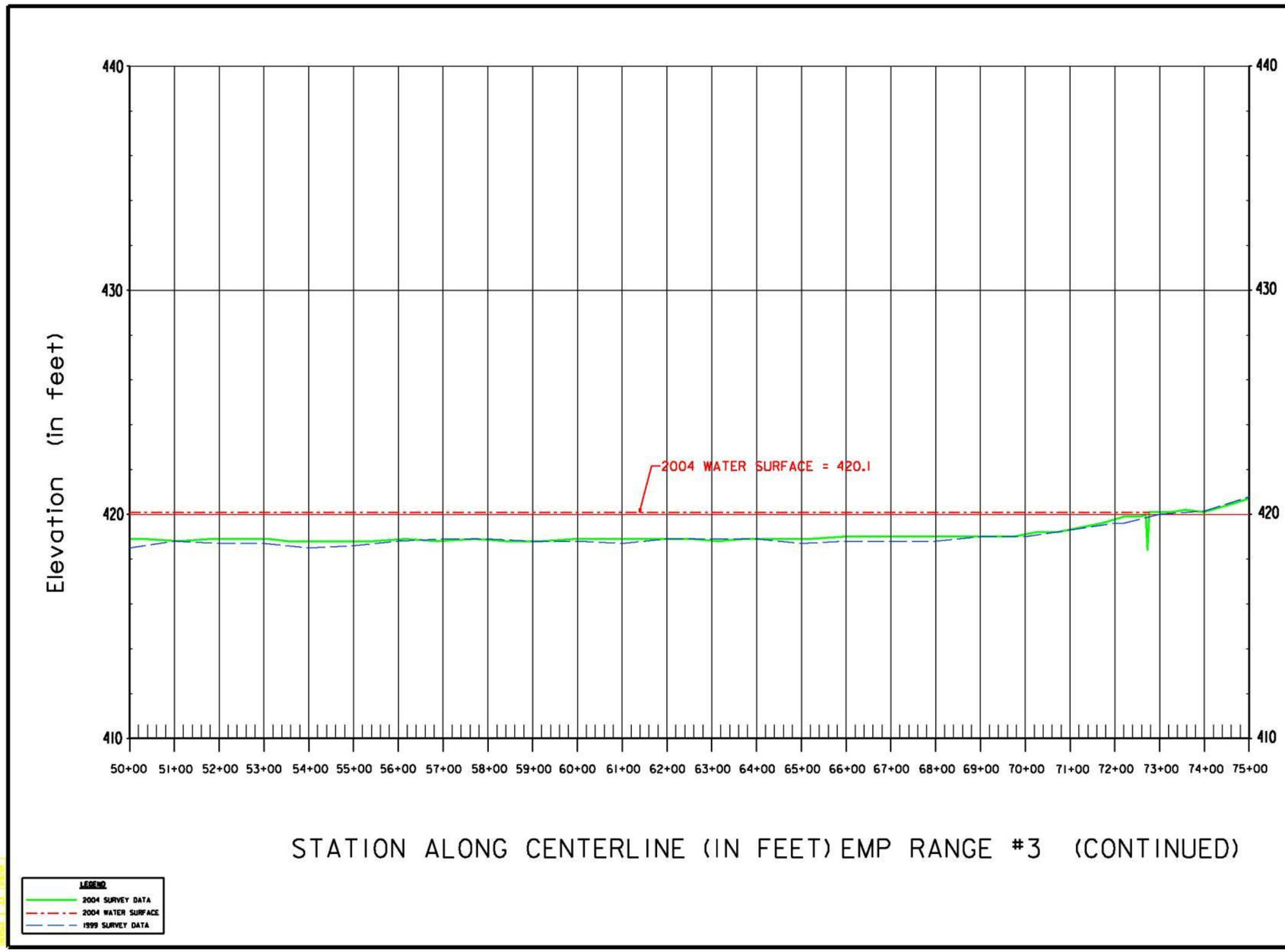

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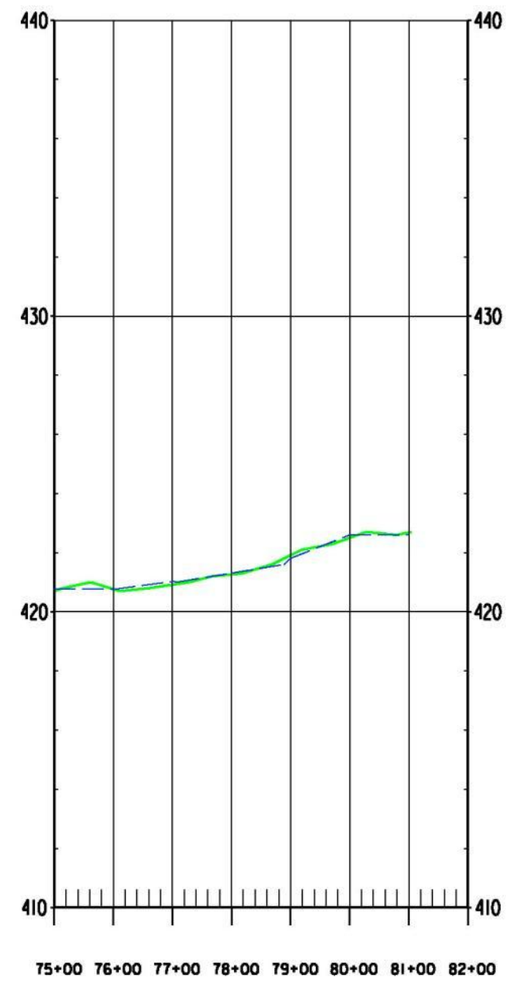

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LEGEND
2004 SURVEY DATA
2004 WATER SURFACE
1999 SURVEY DATA

US Army Corps of Engineers
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UPPER MISSISSIPPI RIVER BASIN
ILLINOIS RIVER

EMP SURVEY PROFILES
STUMP LAKE

VERT. 1"=4'
HORIZ. 1"=250'

9 of 12
DRAWING NUMBER

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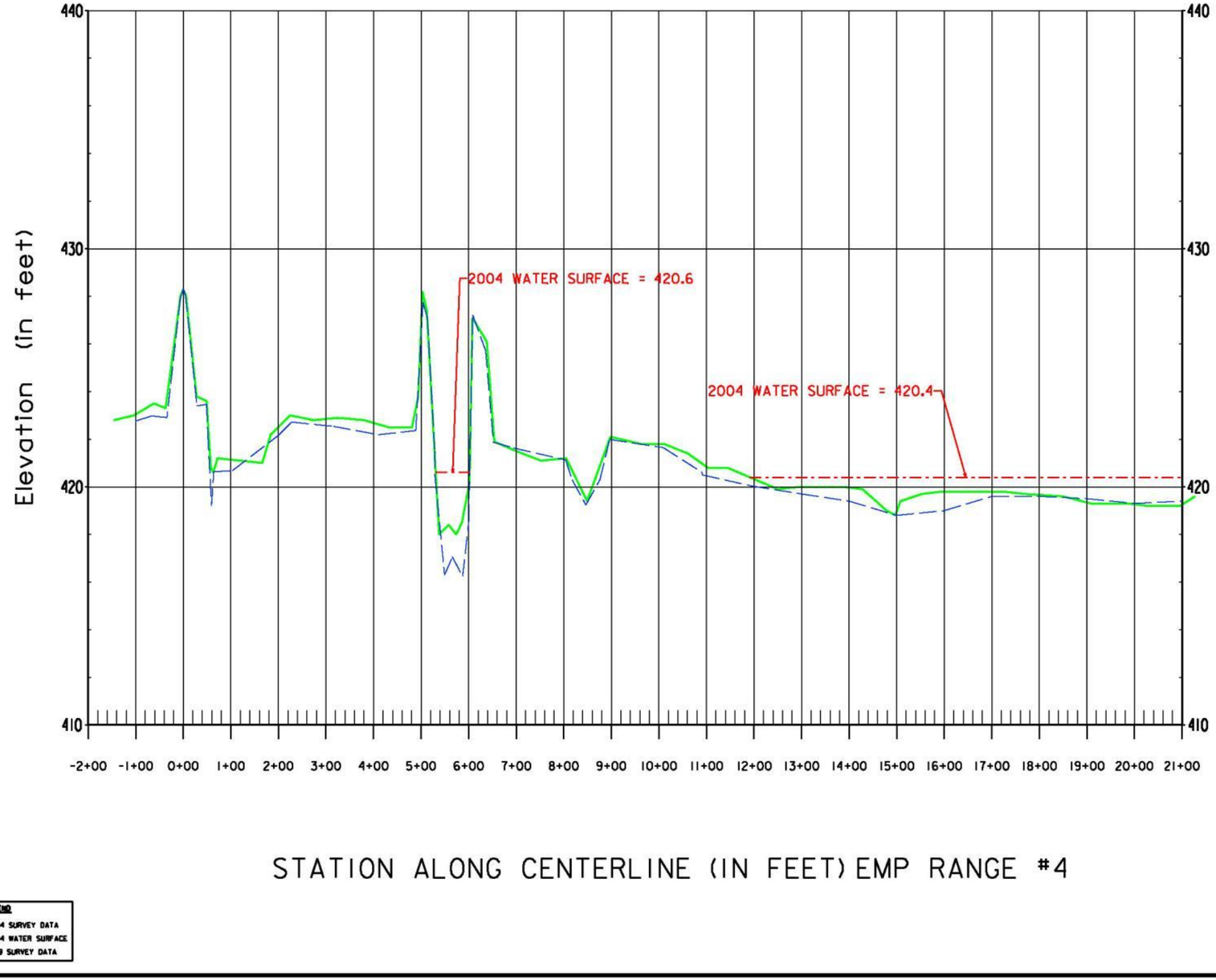

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UPPER MISSISSIPPI RIVER BASIN
ILLINOIS RIVER

EMP SURVEY PROFILES
STUMP LAKE

10 of 12
DRAWING NUMBER

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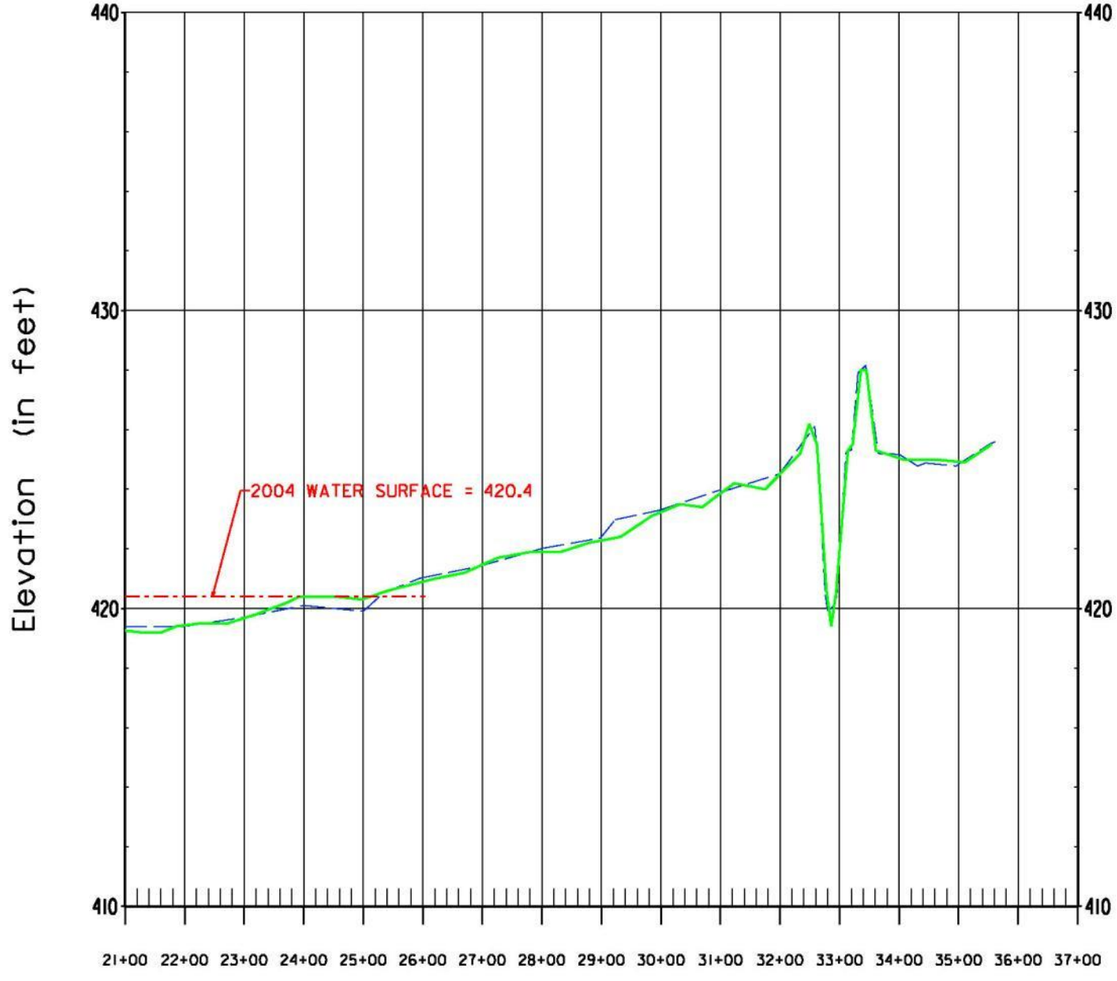

STATION ALONG CENTERLINE (IN FEET) EMP RANGE #4 (CONTINUED)

LEGEND
2004 SURVEY DATA
2004 WATER SURFACE
1999 SURVEY DATA

US Army Corps of Engineers
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UPPER MISSISSIPPI RIVER BASIN
ILLINOIS RIVER

VERT: 1"=4'
HORIZ: 1"=250'

EMP SURVEY PROFILES
STUMP LAKE

11 of 12
DRAWING NUMBER

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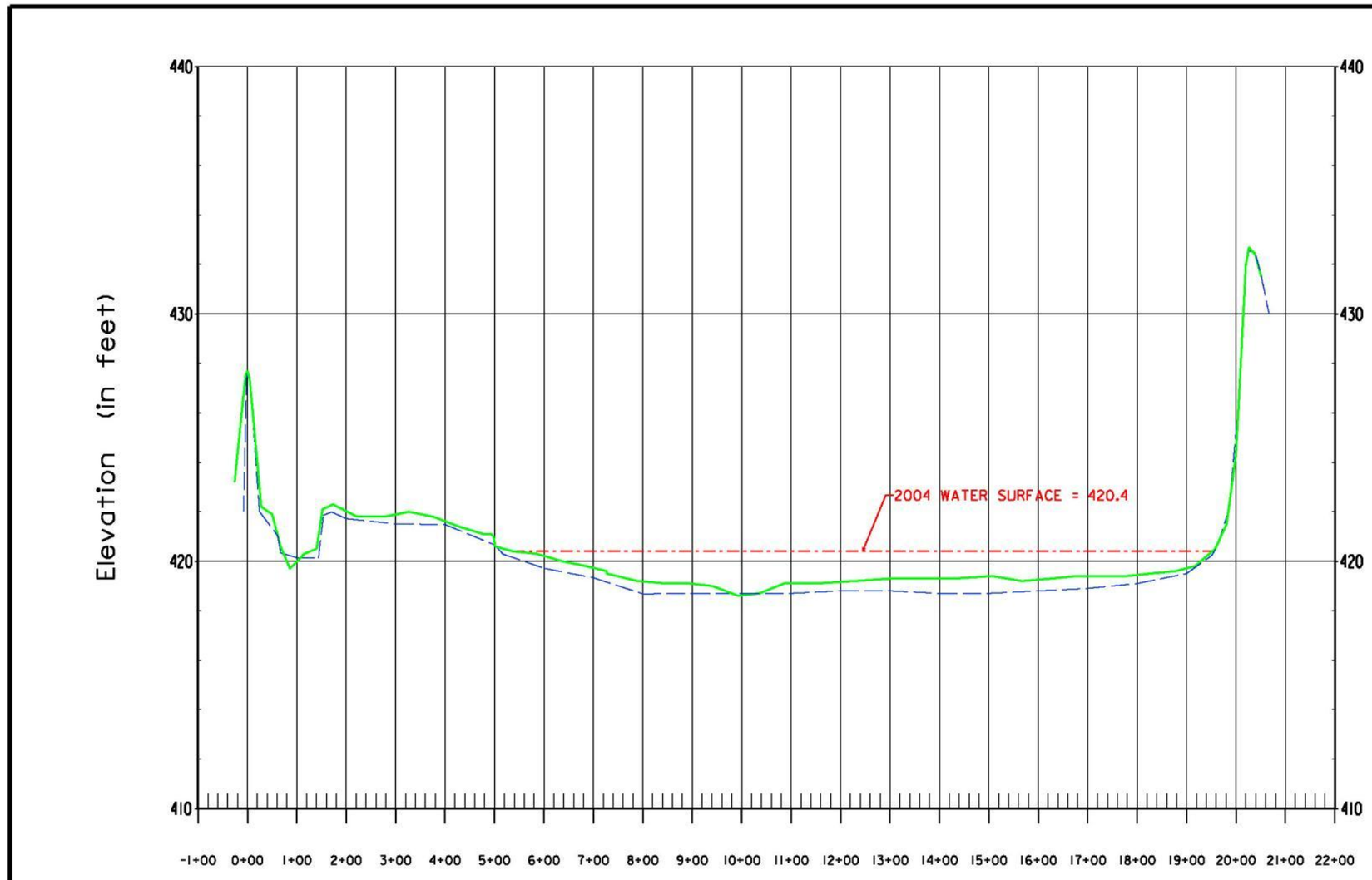

US Army Corps of Engineers St. Louis District

U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI

UPPER MISSISSIPPI RIVER BASIN
ILLINOIS RIVER

VERT. 1"=4'
HORIZ. 1"=250'

EMP SURVEY PROFILES
STUMP LAKE

12 of 12
DRAWING NUMBER

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Stump Lake Complex HREP Project Evaluation Report

Appendix D – Land Cover Study

Summary of Land Cover/Land Use Change for Stump Lake HREP
River Miles 7.2 - 12.7 of the Alton Pool, Illinois River

Location/Description

The Stump Lake Wildlife Management Area is located on the left descending bank of the Illinois River,
and extends from Illinois River Mile 7.2 to 12.7 in Jersey County, Illinois. The 2,958 acre project
includes Upper and Lower Stump Lakes, Fowler Lake, Flat Lake, Long Lake, and Deep Lake and
contains approximately 2167 acres of terrestrial habitat, and 1050 acres of aquatic/emergent habitat.

This project consists of:

A low sediment deflection levee was constructed to reduce siltation and improve wetland unit water control.

Seven low level interior levees around the perimeters of the four main wetland compartments allow effective water level management.

Sluice gates and stop log structures were constructed to control watering/dewatering.

Dredged Long Lake and the upper portion of Deep Lake to improve water delivery and facilitate fish movement, spawning, and rearing.

A reversible pumping system on the Illinois River allows flooding or draining of the wetland compartments.

The Stump Lake area has illustrated ongoing conversion from water to land due to excessive sedimentation. The area has also lacked the ability to manage for moist soil vegetation due to a lack of water level management capabilities caused by aging water control structures and limited protection from high bank events on the Illinois River. To counteract the effects of sedimentation, create better moist soil production units, and provide better fisheries off channel habitat at Stump Lake, a combination of features (sediment deflection levees, interior levees, pumps and gravity control structures, dredging) was utilized in this project. It is expected that the combination of these features improve those features mentioned above. It is also thought that the regeneration of hard mast trees to the interior forested area will be improved. The Project was completed in 2000

Goal

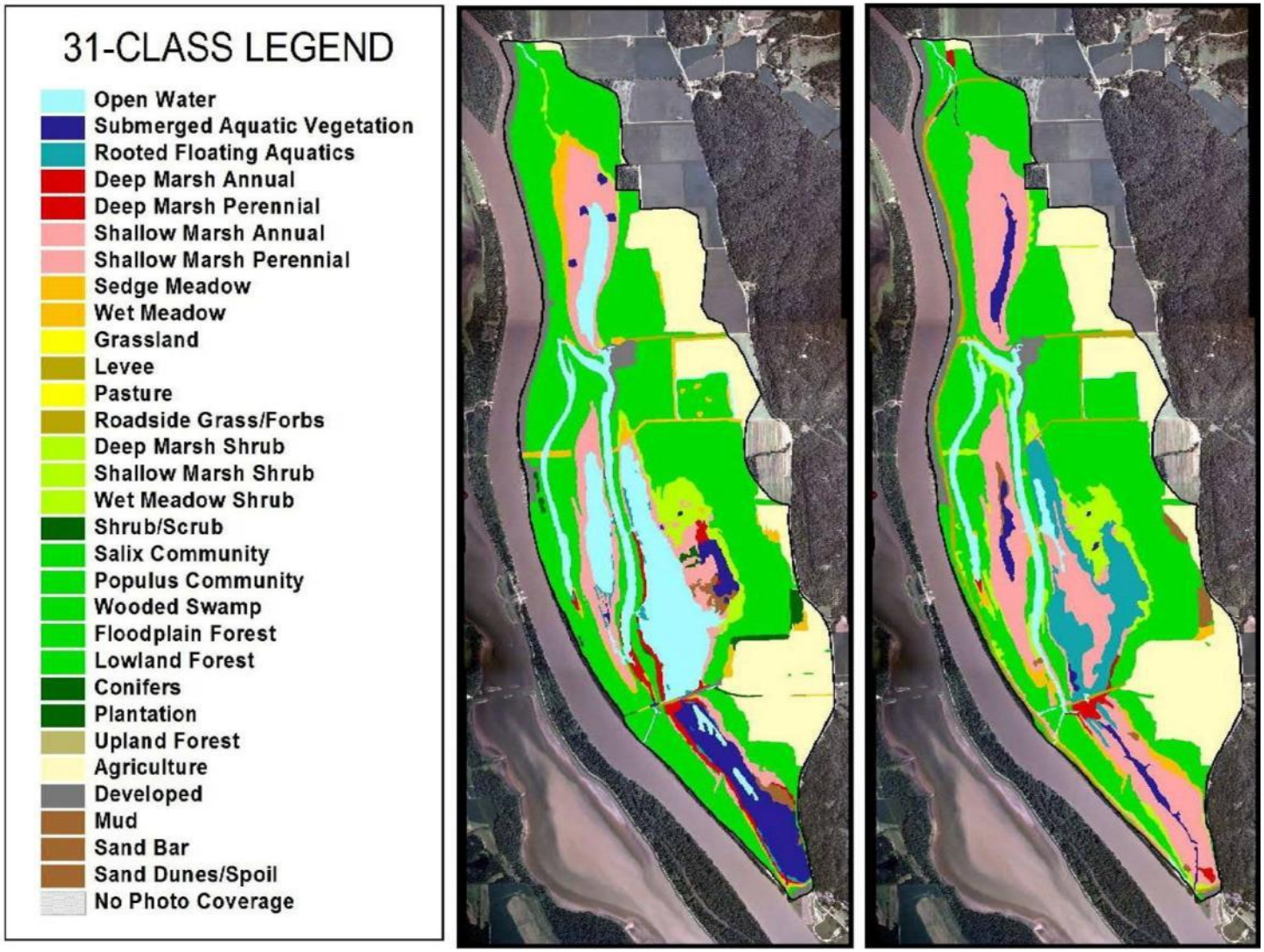
Counteract the effects of sedimentation, create better moist soil production units, and provide better fisheries off channel habitat.

Results

A total of 3153.7 acres were mapped using the generalized 31-Class vegetation classification system (see Table 1). The biggest changes occurring between 1989 and 2000 were increases in both the Shallow Marsh Annual class (+211.7 acres) and Rooted Floating Aquatic class (+167.8 acres) and a decrease in the combined Open Water/Submerged Aquatic Vegetation classes (-372.9 acres). If the Open Water, Submerged Aquatic Vegetation, and Rooted Floating Aquatic classes are all combined (-205.1 acres total), it is apparent that these classes have essentially been replaced by the Shallow Marsh Annuals indicating successful production of moist soil units.

Table 1. Summary of Vegetation Classes for Stump Lake HREP (Alton Pool, Illinois River)

Class_31	1989				2000				Ac. Change 1989 to 2000	% Change 1989 to 2000
	Count	% of Total	Acres	% of Total	Count	% of Total	Acres	% of Total		
Agriculture	7	3.3	481.4	15.3	11	4.6	486.7	15.4	5.3	1.1
Deep Marsh Perennial	14	6.5	51.5	1.6	5	2.1	20.8	0.7	-30.7	-59.6
Deep Marsh Shrub	1	0.5	3.6	0.1	0	0.0	0	0.0	-3.6	n/a
Developed	7	3.3	100.1	3.2	3	1.3	101.1	3.2	1.0	1.0
Floodplain Forest	25	11.7	580.5	18.4	47	19.8	899.6	28.5	319.1	55.0
Levee	0	0.0	0	0.0	6	2.5	68.5	2.2	68.5	100.0
Lowland Forest	23	10.7	727.6	23.1	13	5.5	271.7	8.6	-455.9	62.7
Mud	4	1.9	22.7	0.7	7	3.0	25.8	0.8	3.1	13.9
Open Water	**10**	**4.7**	**438**	**13.9**	**20**	**8.4**	**147.3**	**4.7**	**-290.7**	**-66.4**
Populus Community	10	4.7	85.5	2.7	14	5.9	73	2.3	-12.5	14.6
Roadside Grass/Forbs	3	1.4	8.4	0.3	12	5.1	24.5	0.8	16.1	190.2
Rooted Floating Aquatics	**24**	**11.2**	**16.8**	**0.5**	**3**	**1.3**	**184.6**	**5.9**	**167.8**	**998.6**
Salix Community	2	0.9	1.9	0.1	13	5.5	44.1	1.4	42.2	2273.3
Shallow Marsh Annual	**12**	**5.6**	**212.1**	**6.7**	**17**	**7.2**	**423.8**	**13.4**	**211.7**	**99.8**
Shallow Marsh Perennial	12	5.6	71.3	2.3	19	8.0	134.1	4.3	62.8	88.1
Shallow Marsh Shrub	2	0.9	74.7	2.4	2	0.8	79.9	2.5	5.2	6.9
Shrub/Scrub	13	6.1	28.9	0.9	0	0.0	0	0.0	-28.9	n/a
Submerged Aquatic Vegetation	**12**	**5.6**	**145.5**	**4.6**	**10**	**4.2**	**63.3**	**2.0**	**-82.2**	**-56.6**
Wet Meadow	30	14.0	96.5	3.1	12	5.1	48.3	1.5	-48.2	50.0
Wet Meadow Shrub	3	1.4	6.7	0.2	23	9.7	56.6	1.8	49.9	742.6
TOTALS	**214**	**100.00**	**3153.7**	**100.00**	**237**	**100.00**	**3153.7**	**100.00**		



1989 LCU 2000 LCU Figure 1. 31-Class vegetation classification for 1989-2000.

Stump Lake Complex HREP Project Evaluation Report

Appendix E – 2002 HREP Vegetation Survey Report

Aquatic, Emergent and Forest Communities of Pharrs Island, Clarksville Wildlife Refuge, Stag Island, Stump Lake, and Dresser Island Habitat Rehabilitation Enhancement Projects.

Report for the US Army Corps of Engineers.

By Robert J. Cosgriff and John Chick
Illinois Natural History Survey
Great Rivers Field Station
8450 Montclair Avenue
Brighton, IL 62012

Introduction

Major river systems have been used as a means of transportation since the beginning of human civilization. Since that time, humans having been trying to construct obstacles in the river that will direct flow, deepen and maintain channels and prevent erosion in order to provide a more dependable means of river transport and flood control. The Upper Mississippi River System (UMRS) is a prime example of river management to maintain a navigable river channel and to reduce the effects of annual flooding. Twenty-seven lock and dams have been constructed to raise and maintain a deep, navigable waterway. River levels are maintained at high elevations during summer months, whereas prior to lock and dam construction water levels dropped to barely navigable. Revetments and wing dams are used to prevent bank erosion and direct river flow. The sacrifice paid to maintain a navigable waterway is loss of natural river dynamics. Under natural conditions, wild rivers wind and cut new main and side channels across their floodplains. These side channels eventually silt in providing valuable backwaters to wildlife and plant communities. With continued sedimentation, these backwaters progress from aquatic habitats to emergent grasslands and shrublands. Eventually, forest communities may take over as the landform increases in elevation and river fluctuations stabilize. Over the past 60-70 years, many reaches of the UMRS have lost these backwaters as the natural progression to terrestrial habitat has proceeded without the addition of new backwaters. Backwaters are vital to the survivorship of many species of wildlife, fish, invertebrates, and plants. The loss of these important backwaters has required natural resource managers to come up with solutions that will maintain and create new backwaters for the flora and fauna of the UMRS. As a result, the US Army Corps of Engineers, Environmental Management Program has instituted many Habitat Rehabilitation Enhancement Projects (HREP) to address backwater issues. These HREP's can involve the dredging of sediment from backwaters to reset the natural cycle of sedimentation, construction of dikes and levees to keep heavily silt-laden water out and reduce sedimentation, construction of islands to reduce wind fetch and disturbance to aquatic plants and invertebrates, and recently, the use of Environmental Pool Management to decrease water levels during summer months to allow backwater sediments to compact and allow establishment of aquatic and emergent vegetation. The purpose of this study was to examine the vegetative communities of five locations to determine the effect of HREP's in maintaining healthy aquatic, emergent and forest communities. The key HREP's included Pharrs Island and Clarksville Wildlife Refuge on Pool 24, Stag Island on Pool 25, and Stump Lake and Dresser Island on Pool 26. Sampling occurred in the Summer of 2002 in aquatic, emergent and forest communities.

Methods

Sampling was stratified into three habitat types, aquatic, wetland and forested. Standard Long Term Resource Monitoring Program procedures for Stratified Random Sampling of aquatic vegetation were used to sample 20 submersed vegetation sites at all but Dresser Island (Yin et al., 2000). There were 31 sites sampled at Dresser Island. Random sites were generated utilizing Random Point Generator 1.1 extension for ArcView.

Emergent vegetation was sampled using a 10 meter line quadrat technique. Ten emergent sites were sampled at Pharrs Island, Clarksville Wildlife Refuge and Stag Island, fifteen at Dresser Island and twenty at Stump Lake. Sites were randomly generated utilizing Random Point Generator extension for ArcView. At each of the sites, ten alternating .5 m^2 quadrats were used to sample species composition. In addition, cover for each species was estimated within each of the quadrats.

Forest plot installation HREP (2002).

Forested vegetation was sampled utilizing a 10 meter radius nested plot technique. Ten random sites were generated utilizing Random Point Generator 1.1 extension for ArcView at Pharrs Island, Clarksville Wildlife Refuge, Stag Island, and Dresser Island. Whereas, 20 sites were randomly generated at Stump Lake. At each of the sites, 1 m^2 quadrats were sampled in 8 cardinal directions, including N (9 m from center), E (9 m from center), S (9 m from center), W (9 m from center), NE (5 m from center), SE (5 m from center), SW (5 m from center), and NW (5 m from center). Within each quadrat, species composition and cover was estimated. In addition, tree seedling density (trees < 3 cm in diameter) was estimated. Within each of the plots, all trees > 3 cm diameter were identified and diameter estimated.

2000 Aerial photo of Stump Lake HREP. Photo courtesy of Upper Midwest Environmental Sciences Center.

IV. Stump Lake

The goal of the Stump Lake HREP was to isolate the backwaters in the Stump Lake complex from the Illinois River in order to reduce the rate of sedimentation and provide moist soil units for migratory wildlife. The HREP was completed in 1998 and is located near river mile 8 of the Illinois River at the confluence with the Mississippi River. The site encompasses approximately 2167 acres of terrestrial vegetation and 1050 acres of aquatic/emergent habitat.

Results/Discussion

Lotus (*Nelumbo lutea*) Bed at Stump Lake (2001). Photo by Robert Cosgriff

Nelumbo lutea, *N. guadalupensis*, *S. cuneata*, and *E. crus-galli* were the most frequent plants encountered in the aquatic habitat at Stump Lake (Table 18). *Nelumbo lutea* also had a high mean cover of approximately 48% at sites were it occurred. Other species with high mean cover included *Leptochloa panicoides*, *S. latifolia*, and *E. crus-galli*. Approximately 28% of the sites at Stump Lake had no vegetation. Additional species are those plant species identified as being within the sampling area but not measured within the subsampling area. Also included in this group are non-rooted-floating plant species. *Lemna minor*, *S. polyrrhiza*, *E. crus-galli*, and *W. columbiana* frequented many of the sites sampled (Table 19). Emergents and trees made up a large percentage of the plants encountered in the aquatic habitat. This is the result of management for moist soil units,

Table 18. Frequency and cover of vegetation in aquatic habitats of the Stump Lake HREP.

Species (n)	Frequency	Relative Frequency	Mean Cover	STD	Nativity	Life Form
Amaranthus tuberculatus (7)	5.83	7.00	10.00	0.00	Native	Forb
Cephalanthus occidentalis (1)	0.83	1.00	10.00	-----	Native	Shrub
Cyperus erythrorhizos (18)	15.00	18.00	36.67	9.70	Native	Grass-Like
Echinochloa crus-galli (22)	18.33	22.00	48.18	20.39	Introduced	Grass
Echinochloa walteri (1)	0.83	1.00	10.00	-----	Native	Grass
Fraxinus pennsylvanica (1)	0.83	1.00	10.00	-----	Native	Tree
Ipomoea lacunosa (1)	0.83	1.00	10.00	-----	Native	Vine
Leersia oryzoides (5)	4.17	5.00	10.00	0.00	Native	Grass
Leptochloa panicoides (17)	14.17	17.00	52.35	33.08	Native	Grass
Ludwigia peploides (1)	0.83	1.00	10.00	-----	Native	Rooted-Floating
Najas guadalupensis (31)	25.83	31.00	0.00	0.00	Native	Submergent
Nelumbo lutea (42)	35.00	42.00	47.62	33.19	Native	Rooted-Floating
Populus deltoides (3)	2.50	3.00	10.00	0.00	Native	Tree
Potamogeton foliosus (6)	5.00	6.00	0.00	0.00	Native	Submergent
Potamogeton nodosus (8)	6.67	8.00	0.00	0.00	Native	Submergent
Potamogeton pectinatus (7)	5.83	7.00	0.00	0.00	Native	Submergent
Sagittaria cuneata (23)	19.17	23.00	10.00	0.00	Native	Forb
Sagittaria latifolia (6)	5.00	6.00	50.00	0.00	Native	Forb
Zosterella dubia (3)	2.50	3.00	0.00	0.00	Native	Submergent
No Aquatic Vegetation (33)	27.50	33.00	-----	-----	-----	-----

Table 19. Additional species sampled in aquatic habitats of the Stump Lake HREP.

Species (n)	Frequency	Relative Frequency	Mean Cover	STD	Nativity	Life Form
Amaranthus tuberculatus (2)	10.00	4.17	10.00	0.00	Native	Forb
Cyperus erythrorhizos (1)	5.00	2.08	30.00	-----	Native	Grass-like
Echinochloa crus-galli (4)	20.00	8.33	10.00	0.00	Introduced	Grass
Ipomoea lacunosa (1)	5.00	2.08	10.00	-----	Native	Vine
Lemna minor (15)	75.00	31.25	38.00	30.05	Native	Non-Rooted-Floating
Leptochloa panicoides (1)	5.00	2.08	10.00	-----	Native	Grass
Najas guadalupensis (2)	10.00	4.17	-----	-----	Native	Submergent
Populus deltoides (1)	5.00	2.08	10.00	-----	Native	Tree
Polygonum hydropiperoides (1)	5.00	2.08	10.00	-----	Native	Forb
Potamogetan pectinatus (1)	5.00	2.08	-----	-----	Native	Submergent
Sagittaria cuneata (1)	5.00	2.08	10.00	-----	Native	Forb
Spirodela polyrrhiza (14)	70.00	29.17	30.71	34.30	Native	Non-Rooted-Floating
Wolffia columbiana (4)	20.00	8.33	80.00	20.00	Native	Non-Rooted-Floating

the purpose of the HREP. It may also indicate some sedimentation. *Echinochloa crus-galli* was the only exotic species encountered in our sampling of the aquatic habitat of Stump Lake HREP. However, the origin of this species seems to be debatable and may actually be a native species. Approximately 85% of the sites sampled had a soft silt clay substrate and the remaining 15% had a hard clay substrate. The mean water depth was 0.24 meters (std 0.25, n = 120).

Echinochloa esculenta, *Echinochloa muricata*, and *Cyperus erythrorhizos* dominated moist soil unit at Stump Lake

Echinochloa esculenta, *E. muricata*, *L. panicoides*, *C. erythrorhizos*, *A. tuberculatus*, *L. oyzoides*, *S. latifolia* were the most frequently encountered species at the Stump Lake emergent sites (Table 20). Mean cover for these species was also high. These species are common to the UMRS, especially sites managed as moist soil units (Galatowitsch and McAdams, 1994). Most of the above mentioned species are valuable as forage for wildlife and in some instances may be aerially seeded in many backwaters of the UMRS. Ecosystems of particular interest included a shrub/grass mosaic on the eastern side of the Stump Lake complex. Here beaver and local management seemed to play an important role in manipulating community dynamics. *Cephalanthus occidentalis* and *Salix nigra* are encroaching upon the emergent beds of Stump Lake in this area. However, beaver and local management have been cutting back these woody species promoting an impressive stand of wetland grass species. Additionally, the beaver have been cutting ditches allowing for adequate water resources to reach back into this large grassland expanse. The result is a *S. fluviatilis* and *L.*

Scirpus fluviatilis and *Leersia oryzoides* community at Stump Lake (2001). Photo by Robert Cosgriff

oryzoides (occupying the beaver cuts) vegetative community. The non-rooted nature of *S. polyrrhiza*, *L. minor* and *W. columbiana* allows these species to move into emergent areas with fluctuations in water levels. All three of these species were common in the emergent beds of Stump Lake. *Echinochloa esculenta* was the only exotic species encountered in the emergent habitat of Stump Lake. This species is commonly planted in backwaters for wildlife forage and cover.

Table 20. Percent frequency and mean percent cover of plant species on emergent sites at Stump Lake

Species (n)	Frequency	Mean Cover	STD	Nativity	Life Form
Ambrosia trifida (1)	0.50	5.00	-----	Native	Forb
Amaranthus tuberculatus (54)	27.00	19.28	18.20	Native	Forb
Cephalanthus occidentalis (1)	0.50	1.00	-----	Native	Shrub
Cyperus erythrorhizos (56)	28.00	44.27	29.56	Native	Grass-like
Cyperus strigosus (1)	0.50	1.00	-----	Native	Grass-like
Echinochloa esculenta (130)	65.00	40.15	34.01	Introduced	Grass
Echinochloa muricata (126)	63.00	20.84	23.50	Native	Grass
Echinochloa walteri (20)	10.00	9.55	8.75	Native	Grass
Eragrostis pectinacea (1)	0.50	5.00	-----	Native	Grass
Hibiscus laevis (1)	0.50	2.00	-----	Native	Forb
Ipomoea lacunosa (7)	3.50	6.00	4.73	Native	Vine
Leptochloa fascicularis (1)	0.50	1.00	-----	Native	Grass
Lemna minor (61)	30.50	86.59	31.74	Native	Forb
Leersia orzyoides (44)	22.00	28.05	34.71	Native	Grass
Leptochloa panicoides (73)	36.50	21.45	21.13	Native	Grass
Ludwigia peploides (14)	7.00	2.50	1.29	Native	Forb
Nelumbo lutea (24)	12.00	14.04	12.81	Native	Forb
Paspalum fluitans (4)	2.00	1.00	0.00	Native	Grass
Phyla lanceolata (1)	0.50	1.00	-----	Native	Vine
Polygonum hydropiperoides (2)	1.00	6.00	1.41	Native	Forb
Sagittaria latifolia (43)	21.50	46.12	32.86	Native	Forb
Scirpus fluviatilis (10)	5.00	11.20	11.92	Native	Grass-like
Spirodela polyrrhiza (100)	50.00	53.09	47.71	Native	Forb
Symphyotrichum lateriflorum (1)	0.50	2.00	-----	Native	Forb
Wolffia columbiana (49)	24.50	100.00	0.00	Native	Forb
Xanthium strumarium (10)	5.00	7.30	8.55	Native	Forb

Maple-Ash forest community at Stump Lake (2002). Photo by Robert Cosgriff.

The forest communities of Stump Lake were very diverse (Table 21). *Forestiera acuminata* and *A. saccharinum* had the greatest stem density. However, the difference in relative density between these two species and the co-dominants was small compared to other forest communities. Approximately 14% of the trees sampled at Stump Lake were dead snags. Like the Clarksville Refuge, past high intensity flooding events in 1993 and 1995, as well as poor drainage with HREP construction has led to high mortality in mature trees. *Forestiera acuminata* is a subcanopy tree that

Table 21. Density (per hectare), mean diameter (cm), and frequency of occurrence of trees at the Stump Lake HREP. The measurements were relativized and summed to compute species importance values.

Species (n)	Density	Relative Density	Mean DBH	STD	Relative Diameter	Frequency	Relative Frequency	IV
Acer negundo (7)	11.13	0.87	23.29	11.53	8.49	10.00	2.04	**11.40**
Acer saccharinum (230)	365.7	28.54	16.57	15.00	6.04	90.00	18.37	**52.94**
Carya illinoensis (4)	6.36	0.50	40.50	24.42	14.76	10.00	2.04	**17.30**
Celtis occidentalis (8)	12.72	0.99	17.38	12.81	6.34	20.00	4.08	**11.41**
Cephalanthus occidentalis (39)	62.01	4.84	3.10	0.38	1.13	25.00	5.10	**11.07**
Crataegus spp. (1)	1.59	0.12	9.00	-----	3.28	5.00	1.02	**4.43**
Diospyros virginiana (30)	47.7	3.72	6.23	5.53	2.27	15.00	3.06	**9.05**
Forestiera acuminata (236)	375.24	29.28	4.83	2.08	1.76	45.00	9.18	**40.22**
Fraxinus pennsylvanica (58)	92.22	7.20	20.33	12.49	7.41	65.00	13.27	**27.87**
Populus deltoides (8)	12.72	0.99	44.63	31.22	16.27	25.00	5.10	**22.36**
Quercus lyrata (33)	52.47	4.09	24.61	10.86	8.97	40.00	8.16	**21.23**
Salix nigra (31)	49.29	3.85	30.32	16.64	11.05	25.00	5.10	**20.00**
Snag (116)	184.44	14.39	21.28	16.75	7.76	90.00	18.37	**40.52**
Ulmus americana (4)	6.36	0.50	12.25	7.37	4.47	20.00	4.08	**9.04**
No Trees (1)	1.59	0.12	-----	-----	-----	5.00	1.02	**1.14**
Total	**1281.54**	**100.00**	**274.32**	**-----**	**100.00**	**490.00**	**100.00**	**300.00**

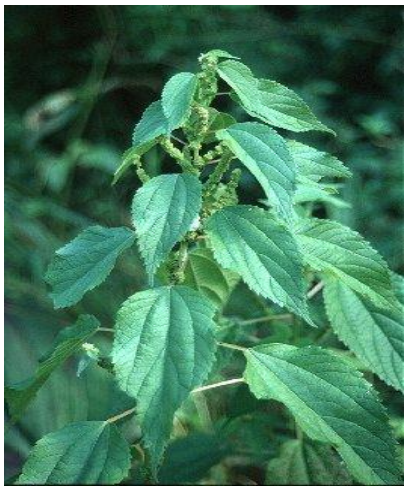
Quercus lyrata seedlings in an oak forest at Stump Lake (2002). Photo by Robert Cosgriff.

never dominates the overstory, consequently, this species mean diameter of only 4.8 cm is a result of plant form. Most of the species encountered were of a moderate sized, mid-successional species indicating that these forests have not yet matured. However, there were larger *P. deltoides*, *S. nigra* and *Carya illinoensis* trees present at these sites. *Acer sachharinum* was encountered in 90% of the sites. Other frequently encountered tree species included *F. pennsylvanica*, *F. acuminata*, and *Quercus lyrata*. Importance values (sum of relative density, relative diameter, and relative frequency) were used to describe species dominance at the Stump Lake HREP. *Acer saccharinum* and *F. acuminata* were the dominant species. All of the tree species encountered are common to the UMRS. *Carya illinoensis* and *Q. lyrata* were abundant hard mast species at Stump Lake. The combined importance value of hard mast trees was approximately 30, indicating that they are well represented. Soft mast species (*C. occidentalis*, *Crataegus spp.*, *Diospyros virginiana*, and *F. acuminata*) were also common and had a combined importance value of 65. The abundance of hard and soft mast species at Stump Lake provides important foraging opportunities to many species of wildlife.

Table 22. Percent frequency, percent cover and mean density (per hectare) of tree seedlings at the Stump Lake HREP.

Species (n)	Frequency	Mean Cover	STD	Mean Density	STD
Acer sachharinum (38)	23.8	2.1	2.3	5374.9	4812.5
Carya illinoensis (1)	0.6	1.0	-----	62.5	-----
Celtis occidentalis (16)	10.0	7.2	10.4	2500.0	2900
Cephalanthus occidentalis (53)	33.1	10.2	14.4	9750.6	10518.75
Diospyros virginiana (15)	9.4	2.7	3.5	3999.6	5250
Forestiera acuminata (54)	33.8	6.1	11.1	112562.1	432281.3
Fraxinus pennsylvanica (74)	46.3	7.5	12.2	27625.9	32343.75
Gleditsia triacanthos (3)	1.9	1.3	0.6	249.9	112.5
Morus alba (1)	0.6	1.0	-----	62.5	-----
Populus deltoides (2)	1.3	0.5	0.7	687.5	800
Quercus lyrata (26)	16.3	5.0	5.7	7312.5	6250
Salix nigra (6)	3.8	2.7	3.7	437.5	150
Taxodium distichum (1)	0.6	1.0	-----	62.5	-----
Ulmus americana (11)	6.9	4.3	6.1	1000.0	618.75
			Total	**171688.0**	

Fraxinus pennsylvanica, *F. acuminata*, *Cephalanthus occidentalis*, and *A. saccharinum* were the most frequently encountered woody seedlings in the forests of Stump Lake (Table 22). These species also had a high mean seedling density. *Quercus lyrata* had a relatively lower frequency of occurrence. However, on sites where this species did occur, mean seedling density was generally high. The number of oak seedlings identified at this HREP is much higher than regeneration identified at other forest sites on the UMRS (Cosgriff, unpublished data). This may indicate that regeneration of hard mast trees is occurring. However, there was a lack of hard mast species in the sapling cohorts at Stump Lake. This indicates that there is some factor (available sunlight, high water table) bottlenecking seedlings from growing into sapling cohorts. There was also an abundance of soft mast species in the seedling bank. The presence of *C. occidentalis* as trees, saplings and seedlings at Stump Lake is unusual since this species experienced very high rates of mortality (90-100%) during the 1993 and 1995 flood events. *Taxodium distichum* may be considered an exotic to the forests of this area. This species is native to the floodplains of southern Illinois and was planted extensively in areas of Stump Lake during the 1930's. Some regeneration was noted in isolated locations far from the areas planted. However, no saplings and trees outside of the planted areas were discovered.



Boehmeria cylindrica. Photo by Emmet J. Judziewicz.

There were 44 species of plants identified in the understory of forested sites at Stump Lake (Table 23). Of these species, *I. lacunosa*, *B. cylindrical*, *L. virginica*, *V. cinerea*, *Bidens aristosa*, and *C. radicans* were the most frequently encountered species. All of the species encountered are common to the UMRS (Galatowitsch and McAdams, 1994; Knutson and Klaas,

1998). Surprising was the lack of dominance by *T. radicans*. This species dominates the understory of the floodplain forests of this area, but is lacking here. *Alisma plantago-aquatica*, *E. crus-galli*, and *I. hederacea* were the only exotics encountered. None of these species occurred frequently.

Stump Lake Complex HREP Project Evaluation Report
Appendix F – Water Quality Data

Stump Lake Secchi Disk Readings (cm) by season for pre-project (1990-1997) and post-project (1999-2000). Number of samples (n) is provided for each season pre- and post-project.

	PRE-PROJECT (n = 62)								POST PROJECT (n = 9)	
FALL	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1999**	**2000**
Site 1		27	31		20	36	80	29		50
Site 2	42	66	50		56	9	14	29		60
Site 3	48	60	60		49	9	12	29		40
Site 4	42	31	40		22	9	8	29		20
Site 5	36	41	30		24	13	15	29		30
Site 6	23	48	24		21	13	16	29		30
Site 7	22	24	20		19	6	13	29		20
Site 8	22	41	47		19	3	12	29		10
Site 9	19	26	30		26	20	20	29		10

	PRE-PROJECT (n = 35)								POST PROJECT (n = 8)	
SPRING	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1999**	**2000**
Site 1		30			28			22		34
Site 2		20			24	18	10	22		36
Site 3		25			25	3	10	22		40
Site 4					22	24		22		41
Site 5					15	33	13	22		37
Site 6					15	25	8	22		31
Site 7					18		13	22		24
Site 8					24	18	12	22		36
Site 9					45	27	26	22		

	PRE-PROJECT (n = 26)								POST PROJECT (n = 14)	
WINTER	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1999**	**2000**
Site 1					20	31	37		37	9
Site 2					46	25	49		70	84
Site 3					29		62		0	58
Site 4					39	38	0.5		39	38.5
Site 5					42	33	62			22
Site 6					43	38	69			56
Site 7					35	17	29			58
Site 8					30	36	30		40	32
Site 9					30	14	29		10	

	PRE-PROJECT (n = 38)								POST PROJECT (n = 6)	
SUMMER	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1999**	**2000**
Site 1				78			33	0		30
Site 2		12	15	37		10	17	0		30
Site 3		13	35	36		13	17	0		54
Site 4		12	10	36			17	26		
Site 5		10	20	24	14	12	13			22
Site 6				35			13			
Site 7							15			
Site 8		12	22	29		9	20			23
Site 9				15	54	24	7			26