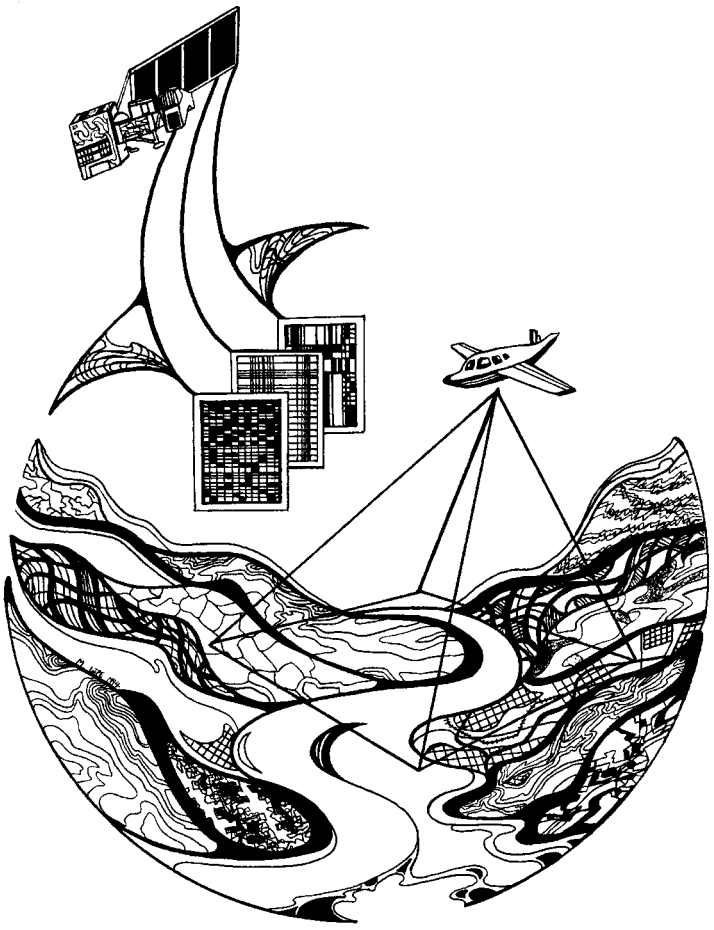
Long Term Resource Monitoring Program

Program Report

95-P006

Geospatial Application:

Aquatic Habitat Analysis and Visualization Tool



This PDF file may appear different from the printed report because of slight variations incurred by electronic transmission. The substance of the report remains unchanged.

May 1995

Geospatial Application:
Aquatic Habitat Analysis and Visualization Tool

by
Douglas A. Olsen
National Biological Service
Environmental Management Technical Center
575 Lester Avenue
Onalaska, Wisconsin 54650

May 1995

The Environmental Management Technical Center issues LTRMP Program Reports to provide Long Term Resource Monitoring Program partners with programmatic documentation, procedures manuals, training manuals, and geospatial applications.

National Biological Service
Environmental Management
Technical Center

CENTER DIRECTOR
Robert L. Delaney

SCIENCE ADVISOR
John W. Barko

INFORMATION AND TECHNOLOGY
SERVICES DIRECTOR
Norman W. Hildrum

GEOSPATIAL APPLICATIONS
DIRECTOR
Frank D'Erchia

REPORT EDITOR
Terry D'Erchia

Cover graphic by Mi Ae Lipe

The National Biological Service . . . gathering, analyzing, and sharing the biological information necessary to support the wise stewardship of the Nation's natural resources.

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, an office of the National Biological Service, in cooperation with the five Upper Mississippi River System (UMRS) states, Illinois, Iowa, Minnesota, Missouri, and Wisconsin, with guidance and Program responsibility provided by the U.S. Army Corps of Engineers. The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers.

The mission of the LTRMP is to provide decision makers with information to maintain the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

The strategy to conduct spatial analysis to provide support to LTRMP Partner activities is included in the LTRMP Operating Plan (USFWS 1992) as Strategy 1.3.2, *Select New Problems for Research*, Substrategy 1, *Definition and Systemic Inventory of Aquatic Habitats*, and Work Unit A, *Interdisciplinary Aquatic Habitat Inventory, Mapping, and Analysis*.

This manual was developed with funding provided by the Long Term Resource Monitoring Program.

Additional copies of this report may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-553-6847).

This report should be cited as:

Olsen, D. A. 1995. Geospatial Application: Aquatic habitat analysis and visualization tool. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin. May 1995. LTRMP 95-P006. 5 pp.

Contents

Figures

Geospatial Application: Aquatic Habitat Analysis and Visualization Tool

By Douglas A. Olsen

Abstract

The Aquatic Habitat Analysis and Visualization Tool is a program and interface that allows users to view and create habitat models using the pre-improvement water quality data collected for the Finger Lakes Habitat Rehabilitation Project (HREP). The Finger Lakes HREP is a hydrologic modification of a backwater lake complex in upper Pool 5 of the Mississippi River. The program and interface were implemented using Arc Macro Language and require the workstation version of ARC/INFO geographic information system software (ESRI, Redlands, CA).

Introduction

The Environmental Management Program (EMP) for the Upper Mississippi River System (UMRS) was authorized by the Water Resources Development Act of 1986. The act authorizes the U.S. Army Corps of Engineers (Corps), in partnership with the U.S. Department of the Interior and five UMRS states, to administer a program of long-term monitoring, research, and habitat rehabilitation on the UMRS. The National Biological Service Environmental Management Technical Center (EMTC) conducts long-term monitoring of UMRS natural resources and ecological research, and is participating in a series of investigations associated with EMP Habitat Rehabilitation and Enhancement Projects (HREPs).

Currently, personnel from the EMTC, the National Fisheries Research Center, the Waterways Experiment Station, Eau Galle Limnological Laboratory, and the Minnesota Department of Natural Resources are engaged in investigations in the Finger Lakes complex. The study site consists of six connected lakes located in UMRS Pool 5 just downstream from the dike at Lock and Dam 4, near Kellogg, Minnesota (Fig. 1). As noted by Barko et al. (1993):

> Several of these lakes experience low oxygen concentrations and extreme water temperatures, conditions that substantially reduce their suitability for fish. To improve fish habitat, the Corps, St. Paul District, will retrofit an existing culvert system and install additional controlled-flow culverts to regulate the hydrology of the lake complex. Pre- and post-construction monitoring data are being obtained by the State of Minnesota as well as Federal participants to evaluate project success. The Finger Lakes Project is designed to examine the effects of management measures directed toward fisheries improvements, with attention also given to the effects on other important and interrelated variables. Ongoing studies focus on changes in hydrology, water quality, sedimentation, vegetation, fish, and invertebrates.
>
> The project, authorized in FY 1991, is anticipated to span a 4- to 5-year period.

Aquatic Habitat Analysis and Visualization Tool

The Aquatic Habitat Analysis and Visualization Tool was developed to provide investigators with an adaptable geographic information system (GIS) application to allow analysis and visualization of the dynamic mosaic of aquatic habitat patches that occurs in the UMRS. The tool incorporates spatial data about aquatic habitat from the study area. The program allows the user to interactively define specific aquatic habitat types, analyze the spatial and temporal occurrence of the habitat patches, and visualize the results. The simple graphical user interface provided can be used effectively with no training or prior GIS knowledge. The program and interface were implemented using Arc Macro

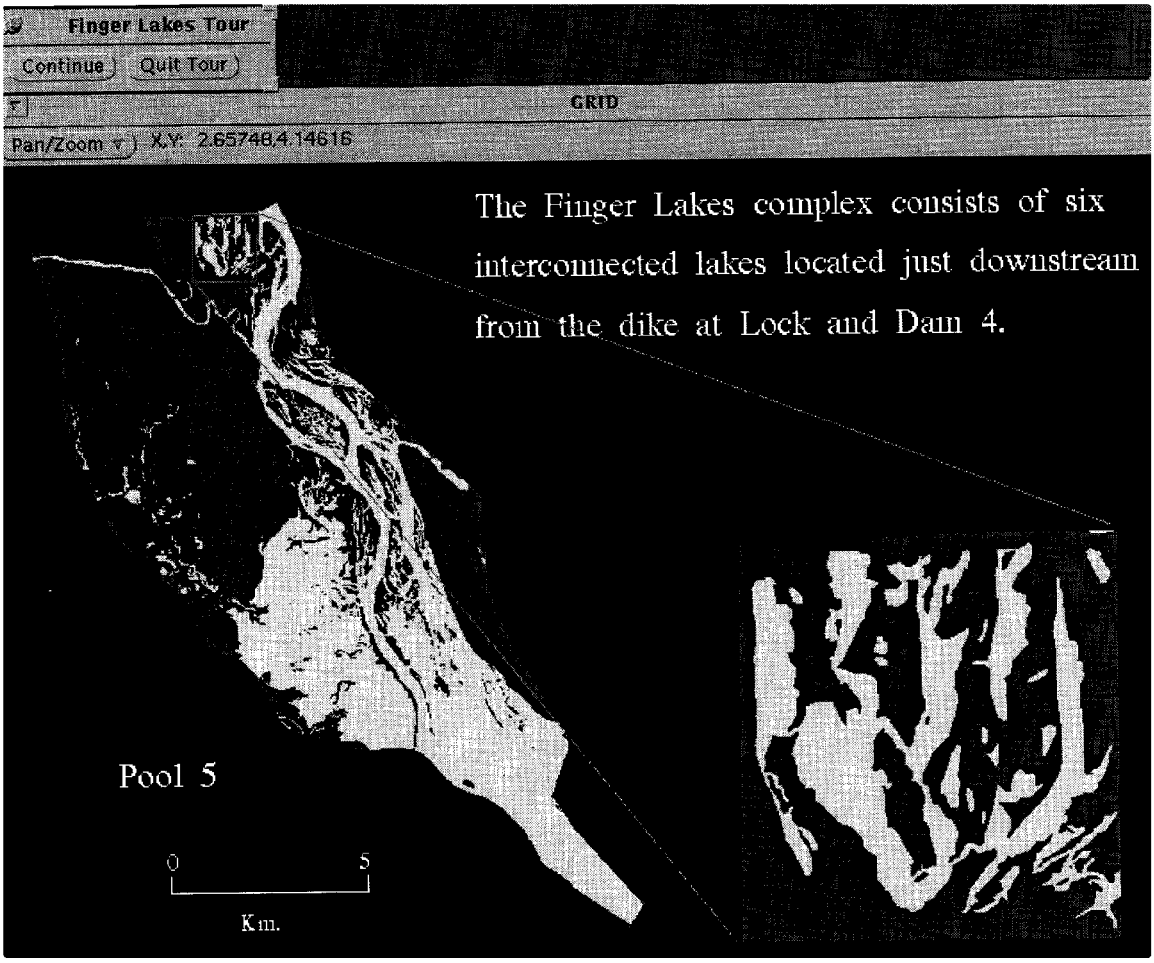


Figure 1. Location of Finger Lakes complex

Language and require the workstation version of ARC/INFO geographic information system software (ESRI, Redlands, CA).

Spatial data on bathymetry, substrate type, vegetation, water temperature, and dissolved oxygen from Lower Peterson and Third Lakes in the Finger Lakes complex were used for development of the pilot tool.

Finger Lakes Aquatic Habitat Data

Bathymetric data were mapped using a shallow draft boat equipped with a chart recorder. Survey transects were closely spaced across the Finger Lakes open water areas. Water surface elevation was monitored daily at the Lock and Dam 4 tailwater.

Water temperature and dissolved oxygen data were measured at 23 locations in Lower Peterson Lake and at 27 locations in Third Lake. Sampling locations were systematically located along transects across the lakes. Data were obtained from the same set of sampling locations approximately biweekly during the open water season and approximately monthly during winter from August 1991 through August 1993. Water temperature and dissolved oxygen were measured near the surface (0.1 m below the surface) and near the bottom (0.1 m above the bottom). Sampling was conducted in the morning (approximately 0800 to 1000 h) and in the afternoon (approximately

1400 to 1600 h) on each sampling date. Only one lake was sampled on each sampling date. Weather, ice conditions, and sampling difficulties resulted in missing data for some sampling events.

GIS techniques were used to interpolate continuous surfaces for bathymetry, water temperature, and dissolved oxygen from the original point-sampled data.

Substrate type was surveyed using visual and tactile methods at many sampling sites in Lower Peterson and Third Lakes. GIS datasets were manually interpolated from these sampling points.

Vegetation data were automated for 1989 and 1992 from 1:15,000-scale color-infrared aerial photographs. Aerial photography missions were flown during August for both years.

Using the Aquatic Habitat Analysis and Visualization Tool

Overview of Main Menu Options

The **ABOUT THE FINGER LAKES** option starts a slide show describing the study area, HREP objectives, and sampling strategy.

The **VIEW** option brings up a menu of options for viewing the water quality and other data.

The **STATISTICS** option generates statistics about the current view. (Active only with specific **VIEW** options.)

The **QUIT** option exits the Finger Lakes Water Quality Visualization Tool.

View Menu Options

PETERSON LAKE brings up a menu of options for viewing Lower Peterson Lake water temperature or dissolved oxygen surfaces for a single date. This option provides a side-by-side view showing the bottom and surface data for either the morning or afternoon sampling run. The **STATISTICS** button on the main menu bar is active when using this option.

THIRD LAKE brings up a menu of options for viewing Third Lake water temperature or dissolved oxygen surfaces for a single date. This option provides a side-by-side view showing the bottom and surface data for either the morning or afternoon sampling run. The **STATISTICS** button on the main menu bar is active when using this option.

CUSTOM VIEW brings up a menu of options for viewing any two available datasets side by side. The user chooses the desired dataset for view one (left) and pushes the "Define View One" button. If additional data about view one is needed, a sub-menu will pop up. Sub-menus vary, depending upon the dataset chosen. Bathymetry views require the user to select a date, as the bathymetry data are adjusted for water surface elevation on individual sampling days. Water quality views require the user to select a date, a sampling time (morning or afternoon), and a sampling depth (surface or bottom). Vegetation views require the user to select a date (1989 or 1992). After the user applies the sub-menu choices and pushes the "Define View One" button, the view one definition text changes from "Undefined" to the title of the dataset chosen. The same procedure is followed for defining view two. Both views must be defined prior to execution of this menu. The **STATISTICS** button on the main menu bar is not active when using this option.

HABITAT DEFINITION brings up a menu of options for defining a habitat for either Lower Peterson or Third Lakes (Fig. 2). The user selects the lake of choice and the desired sampling time (morning or afternoon), indicating with the slider bars in the Depth Range section the range of water depths to use in the habitat definition. Moving the "To" slider bar all the way to the right selects all

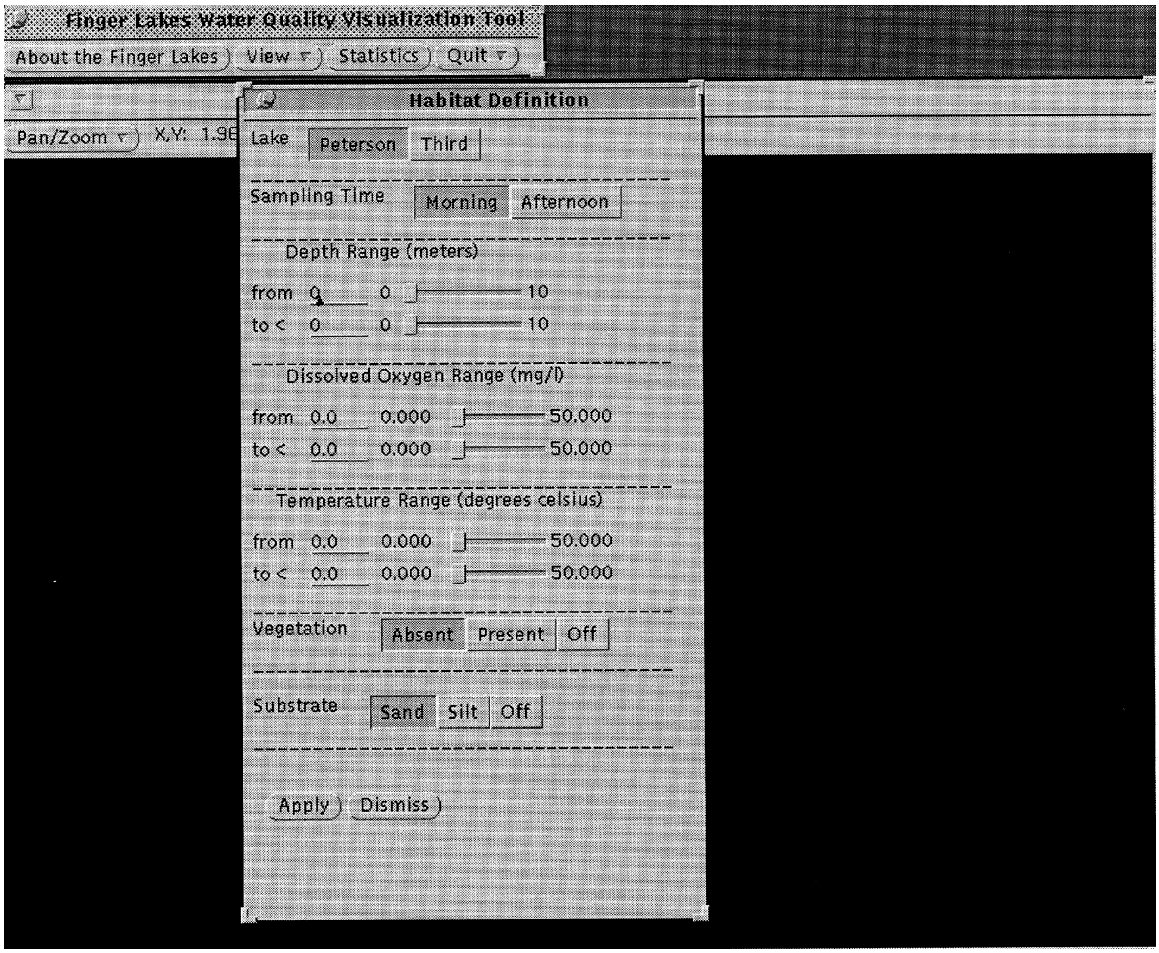


Figure 2. Habitat definition menu

depths above the "From" slider bar value. The same procedure is used to define the ranges for dissolved oxygen and temperature. Next, the user selects the desired settings for "Vegetation" (absent or present) and "Substrate" (sand or silt). Selecting "Off" removes that habitat parameter from the model. Clicking on the "Apply" button closes the Habitat Definition menu and brings up the Sampling Date menu to the right of the main display window. The user selects a date from this menu and clicks the "Apply" button to execute the model for the selected date using the previously defined habitat parameters. Areas displayed in red are areas meeting the criteria for the defined habitat on the selected day and sampling time. Habitat area and volume statistics are calculated and displayed for both sampling depths (surface and bottom). It is assumed that the surface measurements represent the upper half of lake volume and the bottom measurements represent the lower half. Volume statistics are then calculated as 1/2 depth * area. Water elevation is taken into consideration in the calculation of habitat volumes. Bathymetry data are corrected to the actual depth on a given sampling day as measured at the Pool 4 tailwater. Because terrestrial floodplain elevation data are unavailable, lake shorelines are assumed to remain static at the elevation of 660 ft above mean sea level.

RUN MOVIE brings up a menu of available animations. These preselected habitat definitions automatically cycle through all available sampling dates, showing the spatial/temporal change in the defined habitat.

Summary

The Aquatic Habitat Analysis and Visualization Tool resulted from a preliminary investigation into developing a GIS methodology for modeling distribution and temporal change in aquatic habitats. Although the first stage of the investigation was limited to data collected from the Finger Lakes complex in upper Pool 5, the techniques developed are relevant to any aquatic area where sufficient data exist. The next stage of the investigation will focus on Lake Onalaska (Pool 7), where more sophisticated habitat definitions will be attained by including additional information such as current velocity data from numerical hydrologic models.

The Aquatic Habitat Analysis and Visualization Tool and database for the Finger Lakes investigation are available on disk upon request. To obtain a copy, contact the Information Transfer and Media Services Group, National Biological Service, Environmental Management Technical Center, 575 Lester Avenue, Onalaska, Wisconsin 54650 (608/783-7550, extension 66).

References

Barko, J. W., R. F. Gaugush, W. F. James, B. J. Johnson, T. J. Naimo, J. T. Rogala, S. J. Rogers, and D. M. Soballe. 1993. Hydrologic modification for habitat improvement in the Finger Lakes: Pre-Project Report Number 2, 1993. U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin; U.S. Fish and Wildlife Service, National Fisheries Research Center, La Crosse, Wisconsin; and U.S. Army Corps of Engineers, Waterways Experiment Station, Eau Galle Limnological Laboratory, Spring Valley, Wisconsin, April 1993. EMTC 93-T002. 57 pp. (NTIS # PB93-181865)

U.S. Fish and Wildlife Service (USFWS). 1992. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002. 179 pp. (NTIS #PB94-160199)

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, D.C. 20503			
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE May 1995	3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE Geospatial Application: Aquatic habitat analysis and visualization tool			5. FUNDING NUMBERS
6. AUTHOR(S) Douglas A. Olsen			
7. PERFORMING ORGANIZATION NAME AND ADDRESS National Biological Service Environmental Management Technical Center 575 Lester Avenue Onalaska, Wisconsin 54650			8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Biological Service Environmental Management Technical Center 575 Lester Avenue Onalaska, Wisconsin 54650			10. SPONSORING/MONITORING AGENCY REPORT NUMBER 95-P006
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Release unlimited. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161 (call toll free 1-800-553-6847)			12b. DISTRIBUTION CODE
13. ABSTRACT (Maximum 200 words) The Aquatic Habitat Analysis and Visualization Tool is a program and interface that allows users to view and create habitat models using the pre-improvement water quality data collected for the Finger Lakes Habitat Rehabilitation Project (HREP). The Finger Lakes HREP is a hydrologic modification of a backwater lake complex in upper Pool 5 of the Mississippi River. The program and interface were implemented using Arc Macro Language and require the workstation version of ARC/INFO geographic information system software (ESRI, Redlands, CA).			
14. SUBJECT TERMS GIS, ARC/INFO, AML, GRID, modeling, HREP			15. NUMBER OF PAGES 5 pp. 16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT

The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information to maintain the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the National Biological Service, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.