

LAKES STUDIES TEAM

Mission

The purpose of the work team is to provide oversight and technical guidance on hydrology and water quality for District lake projects assigned to the team. Lakes are defined in the broadest sense to include both natural and artificial lakes. The team will provide a consistent policy for execution of lake projects, including planning and budgeting, data collection and management, and report preparation and review. For some projects, the team, or a subset of it, will be involved in all phases of the project—from proposal development to final report preparation. For other projects, the team will serve as a resource and review board.

Team Members

William J. Rose, Hydrologist/Engineering
John F. Elder, Research Hydrologist/Biology
Dale M. Robertson, Research Hydrologist/Chemistry
Gerald L. Goddard, Hydrologic Technician
Daniel L. Olson, Hydrologic Technician
Brett M. Esser, Hydrologic Technician
Elizabeth A. Mergener, Student Trainee (Hydrology)
Elissa D. Roerish, Hydrologic Technician
Rebecca L. Rewey, Hydrologic Technician
Stephanie M. Berg, Hydrologic Technician



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LAKE WATER-QUALITY MONITORING, CHEMICAL AND BIOLOGICAL MONITORING OF SELECTED LAKES

PROJECT CHIEF:

William J. Rose

LOCATION:

Selected lakes in Wisconsin

PROJECT NUMBER:

WI 13300

PERIOD OF PROJECT:

June 1983–Continuing



COOPERATORS:

In the 2001 water year:

Big Cedar, Booth, Buffalo, Eagle Spring, Lac La Belle, Little Green, Lauderdale, Middle Genesee, Okauchee, Potter, Powers, and Wind Lake Districts; City of Muskego (Big Muskego and Little Muskego Lakes); townships of Sand Lake (Big Sissabagama), and Wascott (Whitefish Lake); and Village of Oconomowoc Lake (Oconomowoc Lake) and St. Croix Tribe.

In the 2002 water year:

Big Cedar, Booth, Eagle Spring, Lac La Belle, Lauderdale, Little Green, Middle Genesee, Okauchee, Potter, Powers, and Wind Lake Districts; city of Muskego (Big Muskego and Little Muskego Lakes); and village of Oconomowoc Lake (Oconomowoc Lake)

PROBLEM

Lakes are a significant and valuable resource in the State of Wisconsin and are

experiencing increased pressure from development and use. Many lakes do not have adequate water-quality information available for management of the lake or to assess water-quality trends. Hence, their water quality needs to be assessed and documented.

OBJECTIVE

Objectives of this project are to: (1) determine the current water quality and trophic status of lakes, (2) assess the condition of specific lakes in comparison with other lakes of the same type in the region, and (3) build a quantitative database so that any detrimental changes or trends that might occur in the future can be detected quickly and evaluated objectively.

APPROACH

For most lakes in the program water quality will be monitored in February, April, June, July, and August. Depth profiles of dissolved-oxygen concentration, temperature, pH, and specific conductance will be determined. In April, the lakes will be sampled for analysis of the major anions and cations, nitrogen, and dissolved phosphorus. Secchi-depth measurements will be made for all months (except February), and total phosphorus and chlorophyll *a* samples will be collected and analyzed. Lake stage will be measured at each of the five visits to the lake. For some lakes, such as those with multiple basins, more than one site on the lake is monitored.

PROGRESS (July 2001 to June 2002)

Data were collected, published, and archived for 14 lakes during water year 2001. The locations of lakes included in the monitoring program for water years 2001–2002 are shown on the following map.

PLANS (July 2002 to June 2003)

Fourteen to sixteen lakes will be monitored in water year 2002. Data collected during the year will be compiled and transmitted to the respective cooperator. The data will be prepared for publication in the annual report “Water Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2002.”

ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF, AND PHOSPHORUS LOADING TO, PIKE LAKE IN WASHINGTON COUNTY

COOPERATOR:

Pike Lake Management District

PROJECT CHIEF:

William J. Rose

LOCATION:

Southwestern Washington
County

PROJECT NUMBER:

WI 17301

PERIOD OF PROJECT:

October 1998 to September 2002

**PROBLEM**

The following are issues of concern: near-bottom phosphorus concentrations in the lake appear to be increasing over time, indicating possible increasing phosphorus release from lake sediments; trophic state of the lake is borderline mesotrophic-eutrophic and information on various phosphorus loading sources and rates are not available to evaluate potential changes in lake condition under present, increased, or decreased loading scenarios; the effects of increasing development in the watershed and resulting increasing storm runoff and discharge from wastewater treatment plants into the Rubicon River are unknown; the effectiveness of the present partial inlet diversion or short-circuiting of inflow to the outlet is unknown; and the potential for additional phosphorus load reduction to the lake with enhanced diversion is unknown.

OBJECTIVE

Objectives are to define the hydrology and water budget of the lake, determine the phosphorus loads from various sources and develop a phosphorus budget for the

lake, assess the effectiveness of the inlet diversion and potential for improved diversion, and evaluate the effects of increases or decreases in phosphorus loading on the trophic status of the lake.

APPROACH

The study will consist of gage installation and two years of data collection followed by data analysis and report preparation. Data collection will be done from December 1998 through November 2000. Flow and water-quality data will be collected at the Rubicon River inlet to, and outlet from, the lake and at selected other inflows. These data will be used to describe the hydrology and water budget of the lake, calculate an annual phosphorus budget for the lake and evaluate effects of loading changes on the lake's trophic status. In-lake water-quality data will be provided by the Wisconsin Department of Natural Resources.

PROGRESS (July 2001 to June 2002)

Water and phosphorus budgets were computed. The Rubicon River was the dominant source of phos-

phorus entering the lake. However, much of that phosphorus (about 70 percent) got “short circuited” to the lake’s outlet. A data summary and progress report was prepared for the lake district. Data were published in the annual report “Water Resources Data–Wisconsin.”

PLANS (July 2002 to June 2003)

A report in the Water-Resources Investigations Report series will be published to describe the results of the study.

MISCELLANEOUS MONITORING ASSOCIATED WITH LAKES

COOPERATOR:

City of Muskego
Little Muskego Lake Management
District
Whitewater/Rice Lakes
Management District
Wind Lake Management District
Town of Baraboo

PROJECT CHIEF:

William J. Rose

LOCATION:

Statewide

PROJECT NUMBER:

WI 17302

PERIOD OF PROJECT:

October 1998–Continuing

**PROBLEM**

Monitoring miscellaneous, single hydrologic aspects of lakes is needed, but does not warrant establishing separate projects or subprojects. This monitoring is typically narrow in scope, such as flow or loading from a single lake tributary or lake stage, and is usually a prelude to, or follow-up from, a more comprehensive lake study.

OBJECTIVE

The objective is to collect lake stage, streamflow, stream-water quality, and constituent load data as needed. These lake-related monitoring efforts will be managed and financially tracked in this subproject of WI 17300.

APPROACH

Monitoring that fits into this subproject will be done using appropriate standard USGS practices.

PROGRESS (July 2001 to June 2002)

Monitoring of flow, phosphorus loading, and suspended-sediment loading to Little Muskego Lake at the mouth of Jewel Creek continued. Monitoring of flow, sediment and phosphorus from Big Muskego Lake continued. Flow in a small tributary with intermittent diversions to Devil Lake was monitored. Water levels in Big Muskego, Whitwater, and Wind Lakes were monitored.

PLANS (July 2002 to June 2003)

Monitoring at last year's sites will continue. Data will be published in the annual reports "Water Resources Data–Wisconsin" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes."

WISCONSIN LAKES, GREEN LAKE TRIBUTARY MONITORING

COOPERATOR:

Green Lake Sanitary District

PROJECT CHIEF:

William J. Rose

LOCATION:

Green Lake County

PROJECT NUMBER:

WI 17303

PERIOD OF PROJECT:

October 1977–Continuing

**PROBLEM**

Silver Creek is the primary source of phosphorus to Green Lake. Continued documentation of suspended sediment and phosphorus loads from major tributaries helps to explain the lake's water quality. Data are needed to determine changes in loads over time and loading variability in relation to streamflow.

OBJECTIVE

The objectives of this project are to determine suspended sediment and phosphorus loads in relation to streamflow in selected tributaries to Green Lake.

APPROACH

Streamflow will be monitored continuously at selected sites. Water-sediment samples will be collected manually and by automatic samplers during storm runoff. Suspended-sediment and nutrient concentrations will be determined. Daily, monthly, and annual mean suspended-sediment and nutrient loads will be computed.

PROGRESS (July 2001 to June 2002)

Streamflow and water quality were monitored at the Silver Creek inlet to Green Lake and at the mouth of White Creek. The Silver Creek site is equipped with an acoustic velocity meter, a stage gage, and an automatic water sampler. The White Creek site is a conventional stream-gaging site and is equipped with an automatic water sampler. Streamflow, phosphorus, and suspended-sediment loading to the lake were determined for both sites.

A gage on the Puchyan River near the outlet of Green Lake was operated to monitor flow from the lake. Water samples were collected manually for phosphorus analysis. Streamflow, load and concentration data were published in the report "Water Resources Data–Wisconsin, Water Year 2001."

PLANS (July 2002 to June 2003)

Streamflow and water-quality monitoring at the Silver Creek and White Creek inlets and at the Puchyan River outlet will be continued. Streamflow, phosphorus, and suspended-sediment loads will be published in the annual report, "Water Resources Data–Wisconsin."

ASSESSMENT OF THE HYDROLOGY, WATER QUALITY, AND PHOSPHORUS LOADING OF MUSKELLUNGE LAKE, VILAS COUNTY

COOPERATOR:

Muskellunge Lake Association
(Little St. Germain Lake District)

PROJECT CHIEF:

William J. Rose

LOCATION:

North Central Wisconsin,
Vilas County

PROJECT NUMBER:

WI 17308

PERIOD OF PROJECT:

June 2000 to September 2002

**PROBLEM**

Members of the Muskellunge Lake Association are concerned over the perceived deteriorating water quality of the lake. Available water-quality data collected since 1973 indicate the lake is eutrophic with a possible declining trend in quality. The sensitivity of the lake's water quality to changes in nutrient loading associated with additional residential development within the lake's watershed is unknown. An understanding of the hydrology of the lake and determination of the sources and amounts of phosphorus entering and leaving the lake are needed for evaluating management alternatives and for the development of a comprehensive lake management plan.

OBJECTIVE

The objectives are to: (1) define the hydrology and water budget of Muskellunge Lake, (2) determine ground-water recharge areas for ground water discharging into the lake, (3) determine the phosphorus loads from various sources and develop a phosphorus budget

for the lake, (4) evaluate current lake water quality (trophic state) in relation to longer-term trends and to current nutrient loading from external sources, (5) evaluate the effects of incremental increases or decreases in phosphorus loading on the trophic status of the lake. These increases or decreases in loading would correspond to what might result from various development and management scenario's within the lake's watershed, and (6) determine the spatial distribution of oxygen within the lake during winter.

APPROACH

The study will consist of installation of instrumentation for data collection, data analysis and interpretation, and report preparation. Data will be collected from May 2000 through October 2001. Lake water-quality monitoring will begin in May 2000 and continue through August 2001. Instrumentation needed for the water and phosphorus budget determination will be installed in October 2000. Data collection for water and phosphorus budget determination will be for one year

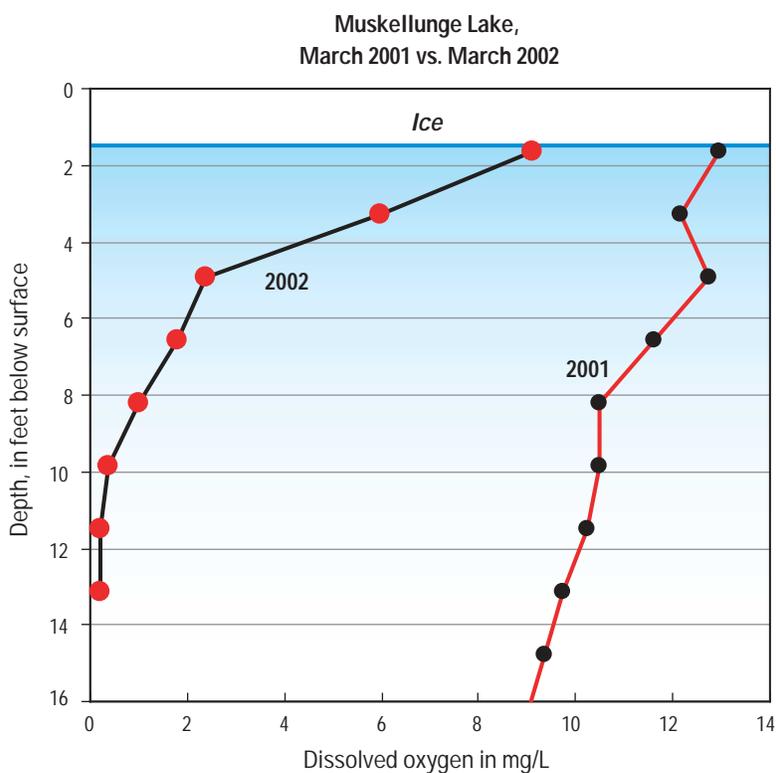
November 2000 through October 2001. Lake water quality data and water and phosphorus information will be evaluated through the use of several loading/water-quality response models in WILMS (Panuska, 2000). These models will assess the lake's sensitivity to incremental increases or decreases in phosphorus loading.

PLANS (July 2002 to June 2003)

Data from the study will be interpreted and reported in a U.S. Geological Survey Water-Resources Investigations Report.

PROGRESS (July 2001 to June 2002)

All data collection for the study were completed November 30, 2001. Data were archived and published in the Wisconsin District's two annual data reports.



Dissolved oxygen concentrations under the ice in Muskellunge Lake during a winter with aeration (2001) and a winter without aeration (2002).

HYDROLOGIC INVESTIGATION OF POWELL MARSH AND ITS RELATION TO DEAD PIKE LAKE

COOPERATOR:

Wisconsin Department of Natural Resources

PROJECT CHIEFS:

William J. Rose
James T. Krohelski

LOCATION:

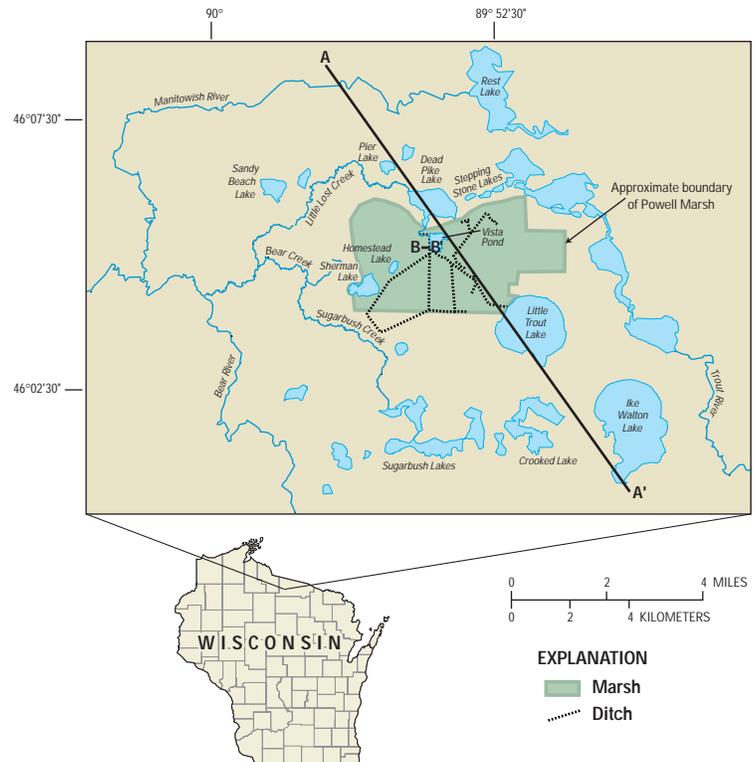
Vilas County

PROJECT NUMBER:

WI 17309

PERIOD OF PROJECT:

May 2000 to July 2002



PROBLEM

An extensive system of ditches and shallow ponds was constructed in Powell Marsh in the 1950s. The marsh is a large part of Dead Pike Lake's watershed. Lake-area residents are concerned that the ditch and pond system has fostered the production of an iron precipitate and is damaging the aesthetic quality of the lake. The hypothesis is that iron, which is likely to be present in wetland soils, is being mobilized by anoxic conditions and locally increased ground-water gradients due to ditch and pond construction. Once the reduced iron reaches the main ditch draining to Dead Pike Lake, the iron is oxidized, forming the precipitate.

OBJECTIVE

The objectives are to: (1) identify the chemistry (parameters that govern iron) of water at various points in the marsh, pond, aquifer, ditch, and lake system, (2) define the hydrology of the pond, marsh, aquifer, ditch, and lake system, and (3) determine the effects of lowering ground-water gradients near the ditch conveying the iron precipitate to Dead Pike Lake.

APPROACH

A first phase of the study will consist of reconnaissance, identification of site chemistry, monitoring, and development of a ground-water-flow model. The second phase will consist of monitoring, and model calibration and prediction. At the conclusion of the first phase, a meeting will be held with WDNR personnel and interested lake-area residents to explain study findings and plans for the second phase. The second phase will include a report describing findings and results of model prediction. The model will be available to WDNR and the USGS, if required, will answer requests for additional model runs.

PROGRESS (July 2001 to June 2002)

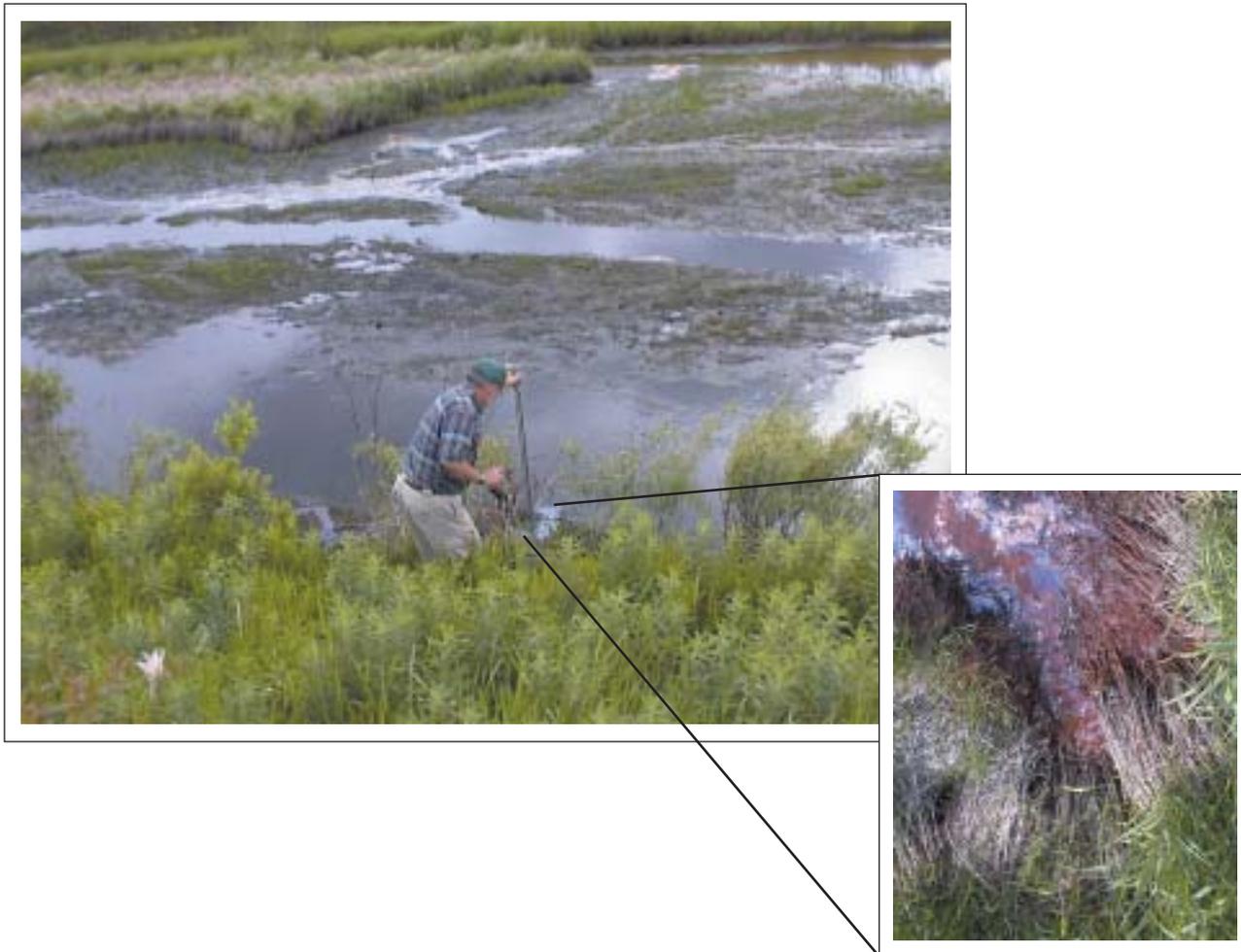
The final interpretive report for the study has been completed, approved, and published.

PLANS

Project is completed.

REPORT

Krohelski, J.T., Rose, W.J., and Hunt, R.J., 2002, Hydrologic investigations of Powell Marsh and its relation to Dead Pike Lake, Vilas County, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 02-4034, 20 p.



LAUDERDALE LAKES RESTORATION MONITORING

COOPERATOR:

Lauderdale Lakes Lake
Management District

PROJECT CHIEF:

Herbert S. Garn

LOCATION:

Walworth County

PROJECT NUMBER:

WI 17310

PERIOD OF PROJECT:

October 1998 to September 2002

**PROBLEM**

The Lauderdale Lakes Lake Management District is implementing actions and practices designed to reduce nutrient loading to the lakes from agricultural and near-shore residential sources. Actions include wetland restoration and enhancement, stormwater management practices, and lawn fertilization practices to demonstrate the feasibility of applying such techniques for protecting or improving the water quality of lakes in southeastern Wisconsin. The effectiveness of these practices is not known and needs to be determined.

OBJECTIVE

The objective is to conduct water monitoring needed to assess the results and effectiveness of selected practices being implemented to reduce phosphorus loading to these lakes.

APPROACH

Several types of monitoring will be conducted and will be used to evaluate the effectiveness of practices to

be installed around the lakes to improve runoff water quality. Water-monitoring efforts include: (1) monitoring continuous discharge, total phosphorus and solids loads from an ephemeral tributary to Green Lake that will be receiving treatments to improve runoff quality, (2) monitoring in-lake water quality of Middle Lake to describe and quantify lake water quality during the restoration period, and (3) monitoring surface runoff from representative lawns around Lauderdale Lakes and determining the effect of various lawn fertilizing practices on phosphorus content of lawn runoff. Use of regular fertilizer, use of non-phosphorus fertilizer, and no fertilizer application are the practices that will be evaluated.

PROGRESS (July 2001 to June 2002)

Lawn runoff monitoring was conducted at 16 sites during the growing season to determine nutrient content; two seasons of lawn monitoring were completed on September 30, 2001. A total of 23 runoff events were sampled over the two seasons and total phosphorus concentrations observed in lawn runoff samples had maxi-

mums greater than 15 mg/L. Lawn fertilizer applications did not affect nitrogen concentrations in runoff, but did affect phosphorus concentrations. Lawn sites with regular fertilizer applications had median phosphorus concentrations in lawn runoff that were greater than those from nonphosphorus fertilizer sites and unfertilized sites. Phosphorus concentrations in runoff from nonphosphorus-fertilizer sites were similar to those from unfertilized sites. Streamflow gaging and water-quality monitoring of the ephemeral tributary on the northeast side of Green Lake, and water-quality monitoring of Middle Lake were also completed on September 30, 2001. All data were reviewed for the water year and published in the annual data report series

“Water Resources Data–Wisconsin” and in the lake data report for Water Year 2001. A report was prepared presenting the results of nutrient concentrations in runoff from lawn sites adjacent to Lauderdale Lakes.

PLANS (July 2002–June 2003)

Project is completed.

REPORTS

Garn, H.S., 2002, Effects of lawn fertilizer on nutrient concentration in runoff from lakeshore lawns, Lauderdale Lakes, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 02–4130, 6 p.

WATER QUALITY OF THE RED CEDAR LAKES IN RESPONSE TO HYDROLOGIC AND PHOSPHORUS LOADING

COOPERATOR:

Town of Cedar Lake

PROJECT CHIEFS:

Dale M. Robertson
William J. Rose

LOCATION:

Washburn and Barron Counties

PROJECT NUMBER:

WI 17311

PERIOD OF PROJECT:

September 2000 to December 2002

**PROBLEM**

In order to establish realistic water-quality goals for the Red Cedar Lakes (Balsam, Red Cedar, and Hemlock Lakes) accurate nutrient loading estimates are needed to enable water-quality models to be calibrated and used to develop response curves for the lakes. With calibrated models each lake's response to incremental increases or decreases in phosphorus loading can be evaluated.

OBJECTIVE

The objectives of this project are to: (1) quantify the phosphorus and sediment loading into and out of Balsam, Red Cedar, and Hemlock Lakes, (2) allocate the loading of phosphorus to its major contributing areas in the watershed or upstream lakes, and (3) determine the response of these lakes to present and future phosphorus loading scenarios. A better understanding of the relative contributions of phosphorus from critical locations and the response of the lakes to various scenarios will help in the development of a lake-management plan for the Red Cedar Lakes.

APPROACH

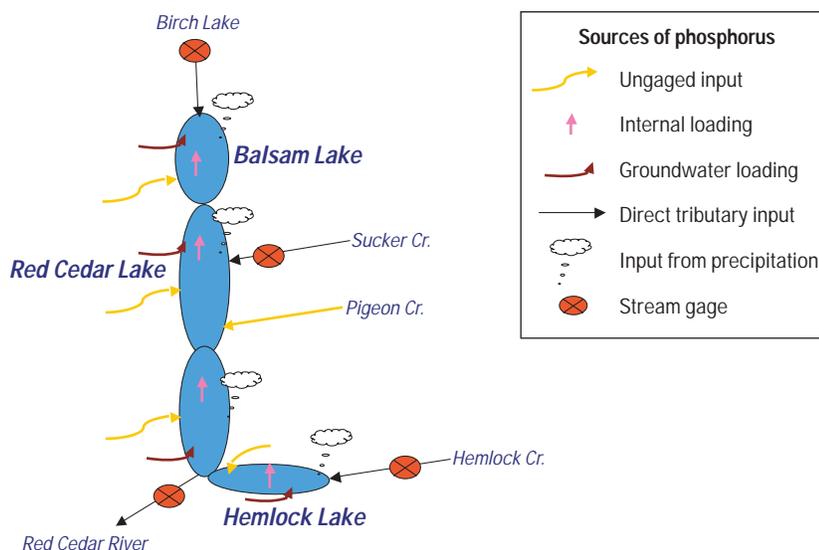
Water quality will be sampled 6 times/year in Balsam, Hemlock, and Red Cedar Lakes. To estimate the nutrient loading at Birch Lake Outlet and Red Cedar Outlet, daily streamflow will be measured and samples will be collected 12 to 15 times per year. To estimate nutrient loading from direct tributaries loading, two sites (Hemlock Creek and Sucker Creek) will have automated recording gages installed and will be sampled with automatic water samplers. Phosphorus load data at the stream sites will be used to estimate unit-area loads for unmonitored portions of the basins. These data will be used to develop complete hydrologic and phosphorus budgets for each lake. Concurrent water and phosphorus budgets for the lakes and in-lake water-quality data will be used to calibrate BATHTUB for the lakes. The BATHTUB model will be used to estimate the response of each of the lakes to various phosphorus-loading scenarios.

PROGRESS (July 2001 to June 2002)

All flow and water-quality data were collected and loads were computed from all gaged sites. Complete loading from the watershed was estimated. Stream data were compiled and published in the report “Water Resources Data–Wisconsin, Water Year 2001.” Lake data were compiled and published in “Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2001.”

PLANS (July 2002 to June 2003)

The BATHTUB model will be developed for the system and used to determine the response of each lake to changes in nutrient loading. A summary report will be prepared and published.



Schematic for BATHTUB model for the Red Cedar Lakes

ASSESSMENT OF PHOSPHORUS LOADING, WINTER ANOXIA, AND STAGE REGULATION OF LITTLE ST. GERMAIN LAKE, VILAS COUNTY

COOPERATOR:

Little St. Germain Lake District

PROJECT CHIEFS:

William J. Rose
Dale M. Robertson

LOCATION:

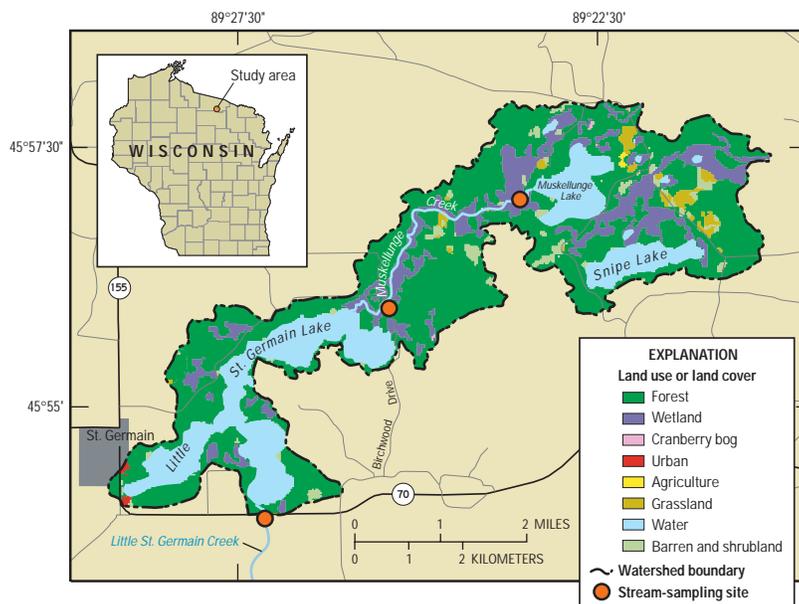
10 miles west of Eagle River

PROJECT NUMBER:

WI 17313

PERIOD OF PROJECT:

August 1996 to June 2001



PROBLEM

Little St. Germain Lake consists of four main basins (East Bay, Upper East Bay, South Bay, and West Bay) separated by narrows. Muskellunge Creek, the lake's only inlet stream, enters East Bay. A dam at the lake's outlet is used to regulate lake stage and flow from South Bay. Hence, the net flow of water is from East Bay to South Bay. Summer water quality ranges from good to very good in the West Bay, fair to good in the South Bay, and poor to very poor in the East Bay, based on monitoring from 1992–1994. Dissolved oxygen was absent at the South Bay monitoring site in late winter each year from 1992–1994. The areal extent and cause of the oxygen problem was identified in studies from 1994–2000. The Lake District is considering various measures to improve lake water quality. These include aeration of Upper East and South Bays in winter and possible treatment of Muskellunge Creek water before it enters the lake.

OBJECTIVE

The primary objectives of this project are to:
(1) continue the water-quality trend monitoring at sites

in the four main basins of the lake, (2) continue monitoring to determine water and phosphorus loading to the lake from Muskellunge Creek, (3) identify sources of phosphorus to Muskellunge Creek, (4) determine spatial and temporal distribution of oxygen in winter before and after installation of aeration systems, (5) model ground-water/lake-water interaction and estimate loading of phosphorus to lake from ground water, and (6) synthesize all data, new and old, to evaluate the effectiveness of aeration systems and refine lake water and phosphorus budgets.

APPROACH

The Lake's water and phosphorus budgets will be defined to better resolution than in previous studies. In particular, ground-water inflow and outflow will be quantified through modeling aided by data from piezometers installed around the lake's perimeter. Determination of inflow to the lake from Muskellunge Creek will be improved by the operation of a continuous stage monitor. Measurements of flow and phosphorus concentration will be made at three locations along Muskellunge Creek to identify general source areas for phosphorus. Phosphorus loading from ground water

will be based on data from sampled near-lake piezometers and inflow estimates generated by the ground-water model (GFLOW). Lake-water quality trend monitoring will continue at the four main basins of the lake. Measurements will be made to determine the spatial and temporal distribution of oxygen in winter before and after installation of aeration systems. All new and old data will be synthesized to evaluate the effectiveness of the aerations systems and to refine lake water and phosphorus budgets.

PROGRESS (July 2001 to June 2002)

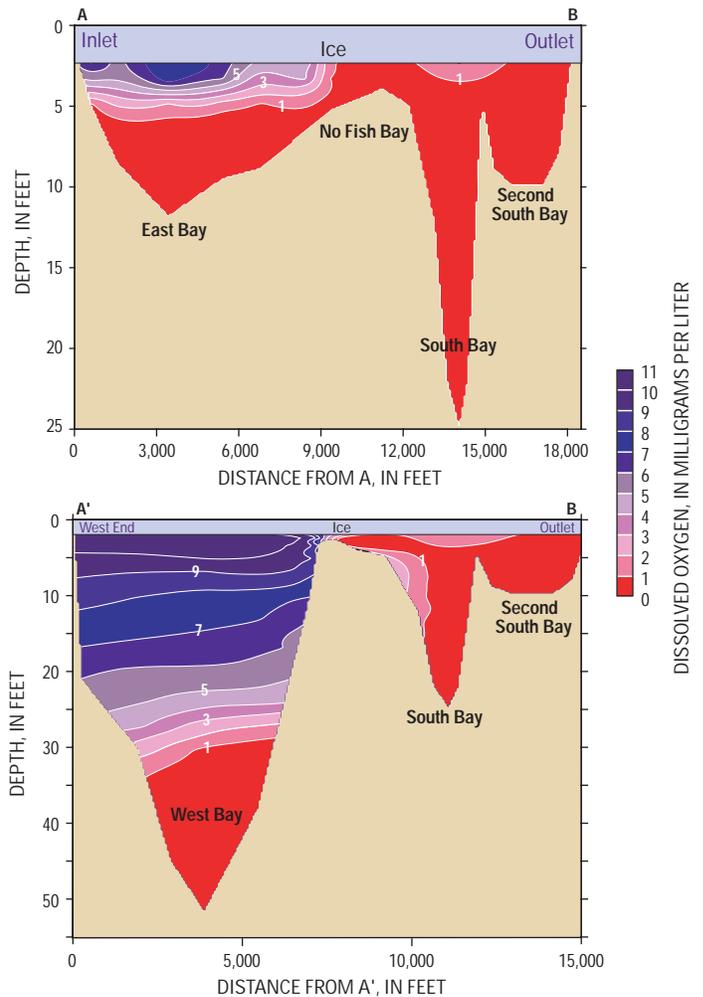
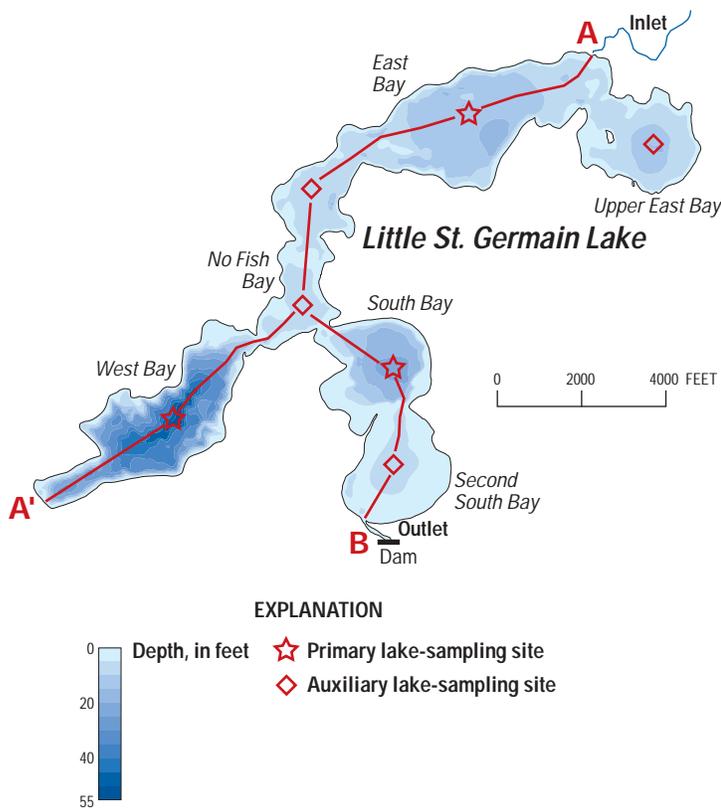
Data monitoring continued as scheduled. The Lake District installed aerators in the Upper East Bay and Northeast Bay.

PLANS (July 2002 to June 2003)

A third aerator will be installed in the South Bay. Monitoring will continue as scheduled.

REPORTS

Robertson, D.M. and Rose, W.J., 2000, Hydrology, water quality, and phosphorus loading of Little St. Germain Lake, Vilas County, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 00-4209, 8 p.



Distribution of dissolved oxygen under the ice in Little St. Germain Lake, Wis., March 18, 1997.

ASSESSMENT OF THE WATER QUALITY, HYDROLOGY, AND BIOLOGY OF GENEVA LAKE

COOPERATOR:

Geneva Lake Environmental
Agency

LOCATION:

Walworth County

PROJECT NUMBER:

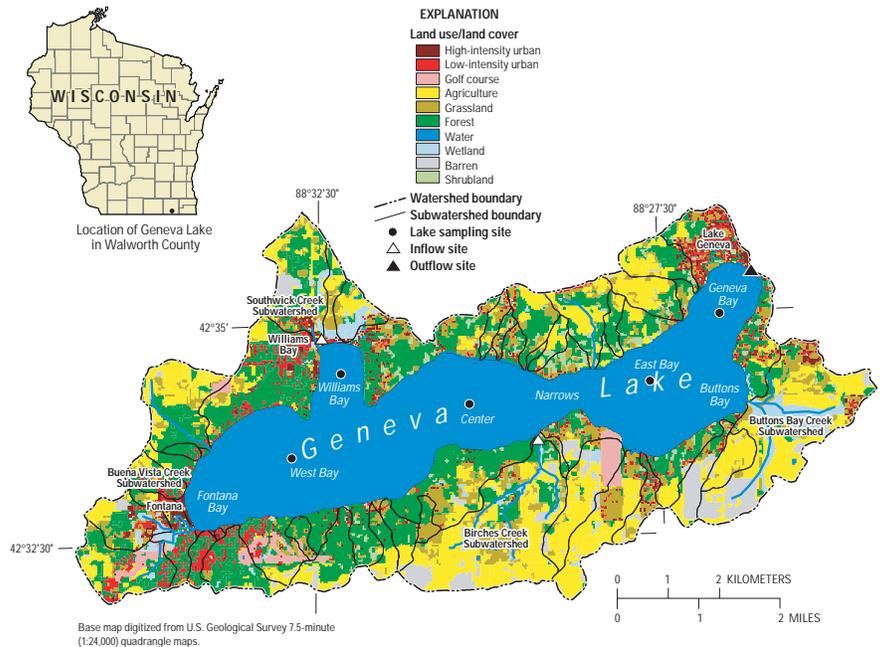
WI 17314

PROJECT CHIEF:

Dale M. Robertson

PERIOD OF PROJECT:

March 1997–Continuing



PROBLEM

Concerns have arisen over the potential decline in the water quality of Geneva Lake because of increased urban development and recreational use. The public perception is that the water quality of Geneva Lake is declining; however, little direct evidence is available to support or deny the perceptions. To reduce the impact on the lake, efforts are being made to decrease the point and nonpoint-source pollution to the lake. However, more water-quality and biological information are needed to determine which pollution prevention strategies will be most cost effective.

OBJECTIVES

The objectives of this project are to: (1) document the water quality and planktonic populations in the lake, (2) estimate phosphorus and sediment loading to the lake, (3) determine the historical water quality of the lake by examining lake sediments, and (4) construct hydrologic and phosphorus budgets for the lake.

APPROACH

Phosphorus and streamflow were monitored at two locations upstream of Geneva Lake and at the outlet from which loads of phosphorus to and from the lake were estimated. Water quality and plankton populations were monitored from 1997 to the present. Nutrient and phosphorus budgets will be constructed for the lake. Sediment cores will be analyzed to estimate sedimentation rates and the historical water quality of the lake. Eutrophication models will be used to evaluate various nutrient load scenarios.

PROGRESS (July 2001 to June 2002)

Lake sampling continued at the deep hole in the West Basin. Lake data were compiled for publication in the report, "Water Resources Data–Wisconsin, Water Year 2001" and "Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2001." A phosphorus budget was constructed for the lake. Nutrient load reduction scenarios were modeled for the lake using WILMS. A dynamic model was configured for the lake and used to estimate evaporation and examine changes

in dissolved oxygen concentrations. Sediment cores were analyzed and the results were published. A Water-Resources Investigations Report was published summarizing the results of the project.

PLANS (July 2002 to June 2003)

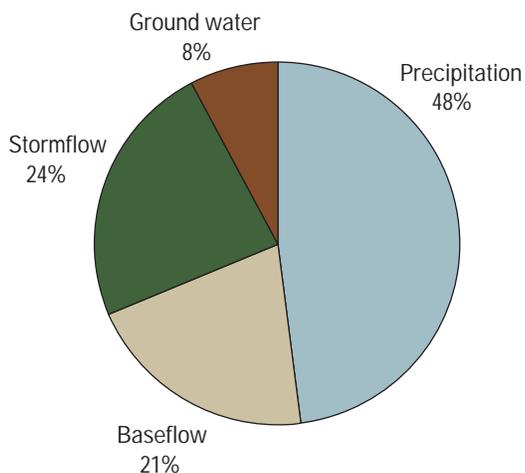
Approximately monthly lake sampling in the west bay will continue. Lake data will be continued and compiled and published in the Water Resources Data–Wisconsin reports.

REPORTS

Elder, J.F., Robertson, D.M., and Garrison, P.J., 2000, Chemical composition of surficial deposits in Geneva Lake, Wisconsin. U.S. Geological Survey Fact Sheet 121–00, 4 p.

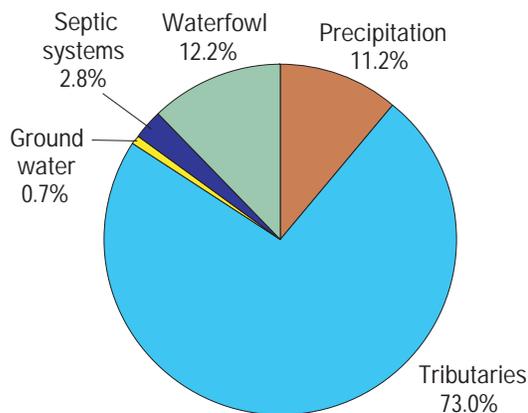
Robertson, D.M., Goddard, G.L., Mergener, E.A., Rose, W.J., and Garrison, P.J., 2002, Hydrology and water quality of Geneva Lake, Walworth County, Wisconsin; U.S. Geological Survey Water-Resources Investigations Report 02–4039, 73 p.

1998 Inflow



Total - 37,500,000 cubic meters

1998 - Phosphorus Input



Total - 3,200 kilograms

Hydrologic and phosphorus budgets estimated for Geneva Lake during water year 1998. These data were used to develop water-quality models for the lake.

DETERMINATION OF STREAMFLOW, PHOSPHORUS, AND SOLIDS LOADS ENTERING AND LEAVING SINISSIPPI LAKE, DODGE COUNTY

COOPERATOR:

Village of Hustisford

PROJECT CHIEF:

David J. Graczyk

LOCATION:

Central Dodge County

PROJECT NUMBER:

WI 17317

PERIOD OF PROJECT:

December 2001 to September 2003

**PROBLEM**

Sinissippi Lake was formed in 1845 by construction of a dam on the Rock River south of Horicon Marsh. The watershed area for the shallow (average depth 4.5 ft.) 2,855 acre lake is about 511 square miles. The lake is hypereutropic with phosphorus concentrations ranging from 200 to 400 micrograms per liter. Secchi depths during summer average about 0.2 meters. Local, state, and federal source agencies are concerned with the quality of Lake Sinissippi. Basic data are lacking to define the sources and magnitude of streamflow, phosphorus, and solids entering and leaving Sinissippi Lake.

OBJECTIVE

The objective of this project is to provide a quantitative understanding of solids and phosphorus loads entering Sinissippi Lake from the Rock River at Horicon and Dead Creek, and leaving Sinissippi Lake at the outlet in Hustisford.

APPROACH

Streamflow, phosphorus, and suspended-solids load monitoring will be done at Rock River at Horicon and Hustisford and Dead Creek near Hustisford. A stream gage, employing conventional stage-discharge rating techniques will be installed at Rock River at Hustisford. The Rock River at Horicon and Dead Creek near Hustisford will be equipped with an acoustic velocity meter (AVM) gage because flat gradients preclude conventional gaging. Samples will be collected by an automatic sampler at Dead Creek and by manual sampling at the two Rock River sites. Loads will be calculated using streamflow-concentration-integration techniques.

PROGRESS (July 2001 to June 2002)

Monitoring sites were installed at the three sites. The monitoring sites are: 05424057 Rock River at Horicon, 05424075 Dead Creek at Arrowhead Trail near Hustisford, and 05424082 Rock River at Hustisford. All

stations were installed and operational on December 1, 2001. Water-quality samples were collected at each of the sites during non-event periods on a bi-weekly and monthly schedule (winter periods). Water samples were collected more frequently during runoff events.

PLANS (July 2002 to June 2003)

Monitoring of the sites will continue through the 2002 water year and continue through November 2002. Daily streamflow, total phosphorus and suspended solids loads will be calculated. All data will be published in the annual data report "Water Resources Data–Wisconsin, Water Year 2002."

HYDRODYNAMIC DATA COLLECTION FOR THE DESIGN OF MC COOK RESERVOIR

COOPERATOR:

U.S. Army Corps of Engineers

PROJECT CHIEFS:

Dale M. Robertson
Gary P. Johnson

LOCATION:

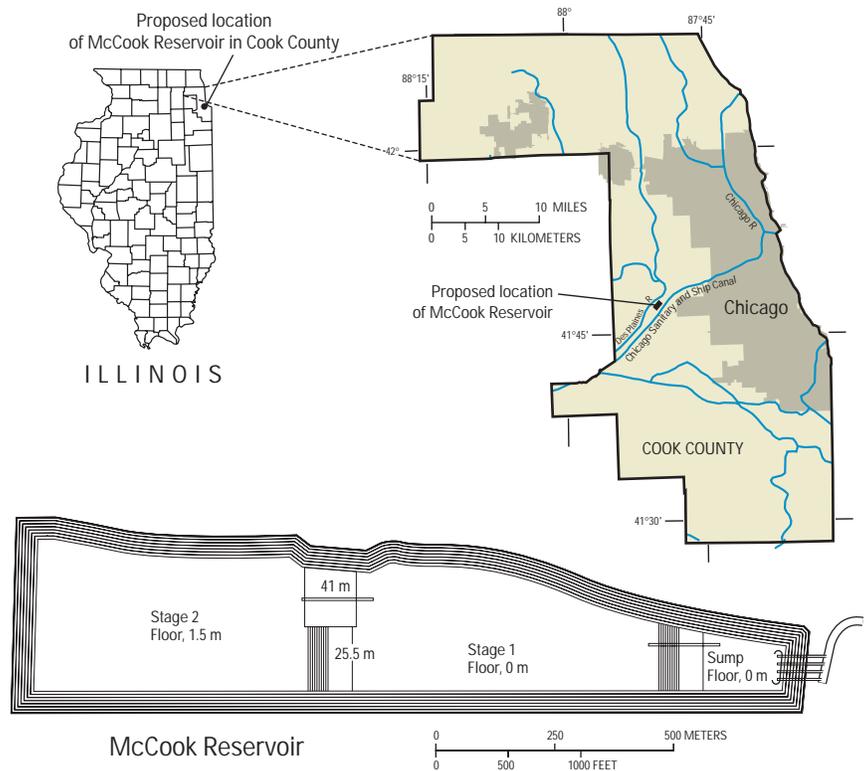
Chicago, Illinois; Urbana, Illinois;
and Snake River, Washington

PROJECT NUMBER:

WI 17318

PERIOD OF PROJECT:

1994–Continuing



PROBLEM

The U.S. Army Corps of Engineers is designing a flood-control reservoir (McCook Reservoir) to store excess stormwater and sewage from combined sewer overflows (CSO's) as part of the Chicagoland Underflow Plan/Tunnel and Reservoir Plan. During storm events, CSO's will be diverted through dropshafts into a series of deep tunnels and into the reservoir. The CSO's will be stored in the reservoir until the water can be treated. A coarse-bubble aeration system is being designed by the Corps to prevent stratification and anoxic conditions from developing in the reservoir. Submersible mixers, surface mixers, and/or other devices may also be required to enhance water movement in the reservoir. The aeration/mixing system will be designed based on results from simulations of a finite-volume numerical model being developed by the Corps for simulating three-dimensional incompressible flow extended to compute the flow produced by bubble aerators. To test the ability of the model to help design the

aeration/mixing system, hydrodynamic data are needed to help verify the accuracy of the model.

OBJECTIVES

The objectives of this project are to: (1) collect hydrodynamic data (velocity and mixing patterns) from laboratory tanks, and shallow (Egan Quarry, Ill.) and deep (Lower Granite Lock on the Snake River, Wash.) systems, (2) test some of the assumptions used in the three-dimensional model, and (3) review the design reports and model simulations by the Corps.

APPROACH

The general approach in this project is to collect data to demonstrate mixing patterns (velocity data with acoustic doppler velocimeters and acoustic doppler current profilers augmented with dyes and water-quality data) in laboratory tests at the U.S. Army Corps of Engineers, Waterways Experiment Station, Miss. and at Urbana, Ill., in a shallow lake (Egan Quarry, Ill.), and in

a deep system (Lower Granite Lock on the Snake River, Wash.). One-dimensional aeration models will be applied in the shallow and deep systems to aid in choosing sites for data collection. These data will be used by the Corps to evaluate the accuracy of their three-dimensional model. One-dimensional aeration models will also be applied to test some assumptions required in modeling the mixing in McCook Reservoir. Data will also be collected in the deep system to determine the rate of oxygen transfer from the bubbles in the aeration system.

PROGRESS (July 2001 to June 2002)

Tests at the Waterways Experimental Station and in Egan Quarry were completed in previous years. Experiments in the test tank in Urbana were run and will continue. The final site for the deep water experiments was chosen at the Lower Granite Lock on the Snake River, Wash.

PLANS (July 2002 to June 2003)

Experiments in the test tank in Urbana will be completed. All deep-water experiments will be

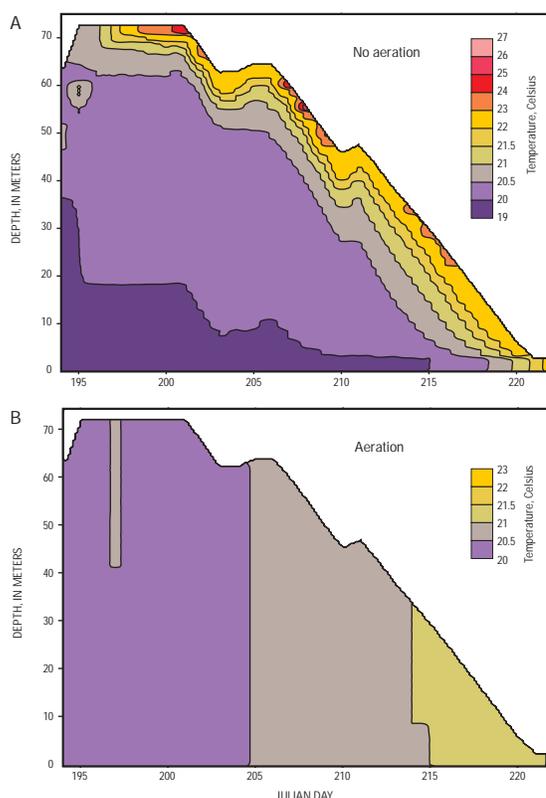
designed and conducted (sampling planned during February and March, 2003).

REPORTS

Johnson, G.P., Hornewer, N.J., Robertson, D.M., and Olson, D.T., 2000, Methodology, data collection, and data analysis for determination of water-mixing patterns induced by aerators and mixers: U.S. Geological Survey Water Resources Investigations Report 00-4101, 72 p.

Robertson, D.M., 2000, One-dimensional simulation of stratification and dissolved oxygen in McCook Reservoir, Illinois: U.S. Geological Survey Water Resources Investigations Report 00-4258, 17 p.

Hornewer, N.J., Johnson, G.P., Robertson, D.M., and Hondzo, M., 1997, Field-scale tests for determining mixing patterns associated with coarse-bubble air diffuser configurations, Egan Quarry, Illinois, *in* Environmental and Coastal Hydraulics: Protecting the Aquatic Habitat, Proceedings of the International Association of Hydraulic Research, San Francisco, Calif., USA, p. 57-63.



Simulated water temperature distribution in McCook Reservoir, Illinois, with and without aeration.

RESPONSE OF THE ST. CROIX RIVER POOLS TO VARIOUS PHOSPHORUS LOADING SCENARIOS

COOPERATOR:

Wisconsin Department of Natural Resources

PROJECT CHIEFS:

Dale M. Robertson
Bernard N. Lenz

LOCATION:

St. Croix National Scenic Riverway

PROJECT NUMBER:

WI 17319

PERIOD OF PROJECT:

December 2001 to September 2002



PROBLEM

The St. Croix National Scenic Riverway, Wisconsin and Minnesota, is one of the original eight components of the National Wild and Scenic Rivers Act. Due to the proximity of this area to the Minneapolis/St. Paul, Minnesota metropolitan area, the Riverway has experienced increased use and developmental pressure. Several pools are in the lower 100 km of the Riverway. Presently, each of the pools in the lower reach of the Riverway is eutrophic to hypereutrophic because of high nutrient loading, primarily phosphorus loading. To protect these pools, managing agencies understand the need to limit phosphorus loading to the pools; however, it is not known how the pools will respond to changes in phosphorus loading.

OBJECTIVE

The objectives of this project are to calibrate and apply the BATHTUB model to the St. Croix River pools to provide a better understanding of the sensitivity and

expected response of each of the pools to decreased and increased phosphorus loading. In future studies, the calibrated model can be used to evaluate the effects of specific management scenarios supplied by the Basin Team.

APPROACH

To determine the sensitivity of each of the St. Croix River pools to decreases and increases in phosphorus loading, the BATHTUB model will be calibrated using pool and tributary data collected in previous studies (WI21300: Lenz, B.N., Robertson, D.M., Fallon, J.D., and Ferrin, R., 2001, Nutrient and suspended-sediment loads and benthic invertebrate data for tributaries to the St. Croix River, Wisconsin and Minnesota, 1997–99: U.S. Geological Survey Water-Resources Investigations Report 01–4162, 57 p.). Two separate BATHTUB models will be attempted to be developed; one model for St. Croix Falls Reservoir and one for Lake Malla-lieu/Lake St. Croix. Water quality in the various pools may respond differently during various flow regimes;

therefore, sensitivity and scenario evaluations for total phosphorus and chlorophyll *a* concentrations and water clarity will be performed for 1999, and also for a period with relatively low flows throughout the basin (using flow data from 1988) and for a period with relatively high flows throughout the basin (using flow data from 1996). During each of these flow regimes, phosphorus loading from each tributary will be estimated by use of flow-to-load relations based on 1997–99 data, and loading from other sources will be assumed to be similar to that estimated for 1999.

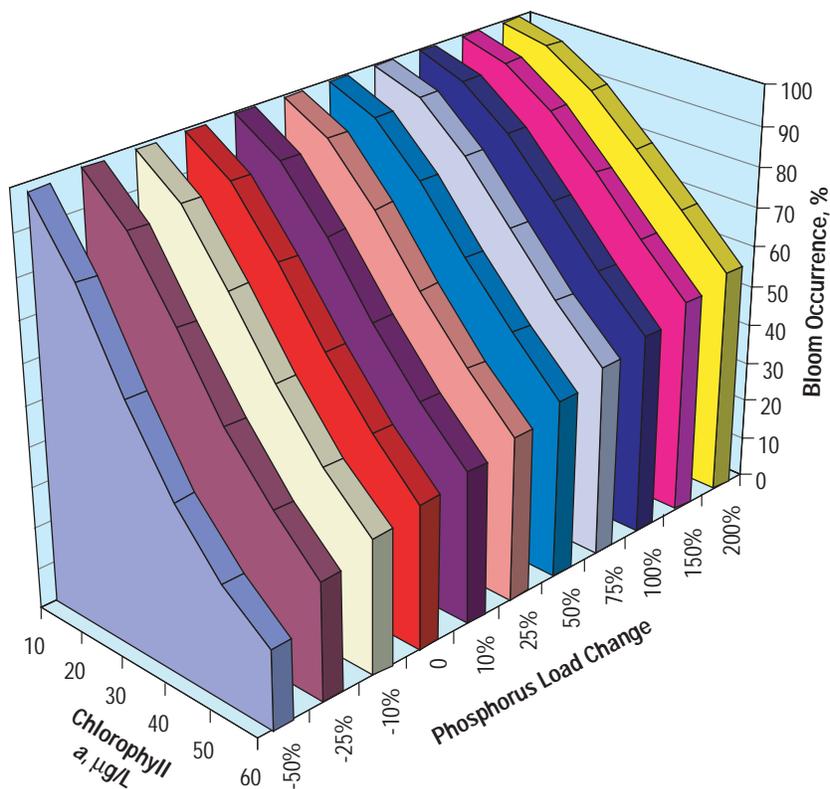
PROGRESS (July 2001 to June 2002)

All modeling was completed and draft of final report is in review.

PLANS (July 2002 to June 2003)

Publish final report.

Lake Mallalieu - Algal Bloom Response - 1999 Flows



Change in the occurrence of algal blooms (percent of days from May through September) as a function of phosphorus loading and how an algal bloom is defined, on the basis of BATHTUB simulations.

ASSESSMENT OF THE HYDROLOGY, WATER QUALITY, AND BIOLOGY OF DELAVAN LAKE

COOPERATOR:

Town of Delavan

PROJECT CHIEFS:

Dale M. Robertson
Gerald L. Goddard

LOCATION:

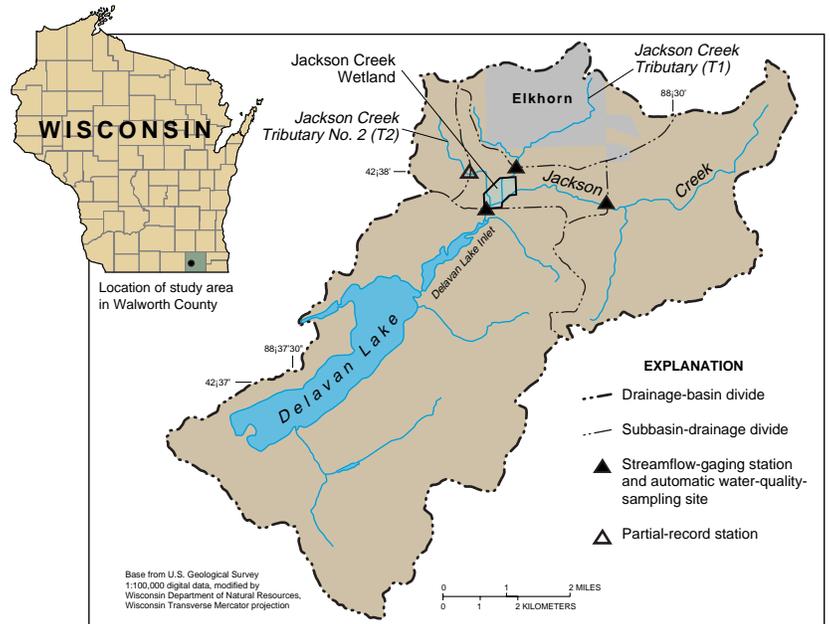
Walworth County

PROJECT NUMBER:

WI 18101

PERIOD OF PROJECT:

August 1983–Continuing



PROBLEM

Eutrophication of Delavan Lake has accelerated since the 1940s, resulting in a hypereutrophic lake with severe blue-green algae blooms. Extensive rehabilitation efforts were implemented from 1990–1993 to improve the lake’s water quality. Monitoring of the lake and nutrient and sediment loads to the lake is continuing to determine the effectiveness of rehabilitation effort and guide future management decisions.

OBJECTIVE

The objectives of this project are to: (1) quantify the effectiveness of rehabilitation efforts by measuring streamflow and nutrient and suspended sediment loads at Jackson Creek tributary near Elkhorn, Jackson Creek at Mound Road (wetland outlet), Delavan Lake Inlet at Highway 50, and at the lake’s outlet, (2) measure water quality, and plankton populations in the lake, and (3) determine the trapping efficiency of the wetland for phosphorus and suspended sediment.

APPROACH

Nutrients, suspended sediments, and streamflow are monitored at Jackson Creek tributary, the wetland outlet at Mound Road, at Highway 50, and the lake outlet. Nutrient concentrations, dissolved oxygen, water temperature, pH, specific conductance, and planktonic populations are monitored within the lake. The effectiveness of the wetland is estimated by examining changes in the morphometry of the wetland ponds and changes in phosphorus and suspended sediment export at Mound Road.

PROGRESS (July 2001 to June 2002)

Streamflow was monitored continuously at three inflow sites and at one outflow site. Water samples were collected monthly and during storm runoff events at all stream sites. Water samples were analyzed for nutrients and suspended sediment. The water quality at the center of the lake was monitored. The 2001 water-year data were compiled and published in USGS annual reports,

“Water Resources Data–Wisconsin, Water Year 2001” and “Water-Quality and Lake-Stage Data for Wisconsin Lakes, Water Year 2001.” Lake phosphorus concentrations in 1996–2001 were similar to those prior to rehabilitation that was completed in 1993; however, summer water clarity was greater and chlorophyll *a* concentrations approached conditions similar to those prior to lake rehabilitation. Additional sediment deposition was measured in the wetland ponds.

PLANS (July 2002 to June 2003)

The monitoring program will be continued. Data will be compiled for publication.

REPORTS

Robertson, D.M., Goddard, G.L., Helsel, D.R., and MacKinnon, K.L., 2000, Rehabilitation of Delavan Lake, Wisconsin: Lake and Reservoir Management, v. 20, no. 1, p. 155–176.

Panuska, J.C., and Robertson, D.M., 1999, Estimating phosphorus concentrations following alum treatment using apparent settling velocities: Lakes and Reservoir Management, v. 15, no. 1, p. 28–38.

Robertson, D.M., Elder, J.F., Goddard, G.L., and James, W.F., 1998, Dynamics in phosphorus retention in wetlands

upstream of Delavan Lake, Wisconsin: Lakes and Reservoir Management, v. 14, no. 4, p. 466–477.

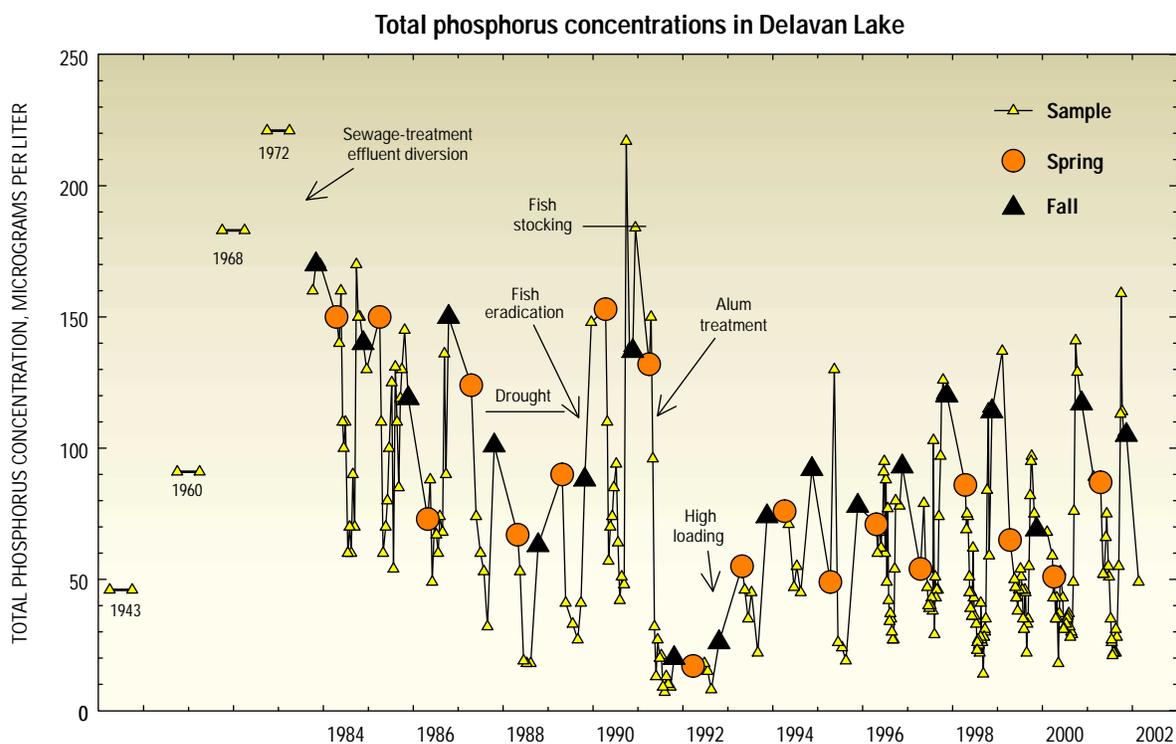
Elder, J.F., Manion, B.J., and Goddard, G.L., 1997, Mesocosm experiments to assess factors affecting phosphorus retention and release in an extended Wisconsin wetland: USGS Water-Resources Investigations Report 97-4272, 14 p.

Goddard, G.L., and Elder, J.F., 1997, Retention of sediments and nutrients in Jackson Creek Wetland near Delavan Lake, Wisconsin, 1993–95, USGS Water-Resources Investigations Report 97–4014, 22 p.

Elder, J.F., and Goddard, G.L., 1996, Sediment and nutrient trapping efficiency of a constructed wetland near Delavan Lake, Wisconsin, 1993–1995: U.S. Geological Survey Fact Sheet 232–96.

Robertson, D.M., Field, S.J., Elder, J.F., Goddard, G.L., and James, W.F., 1996, Phosphorus dynamics of Delavan Lake inlet in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 96–4160, 18 p.

Field, S.J., and Duerk, M.D., 1988, Hydrology and water quality of Delavan Lake in southeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 87–4168, 61 p.



Surface phosphorus concentrations in Delavan Lake. Important remedial efforts and climatic events are identified.