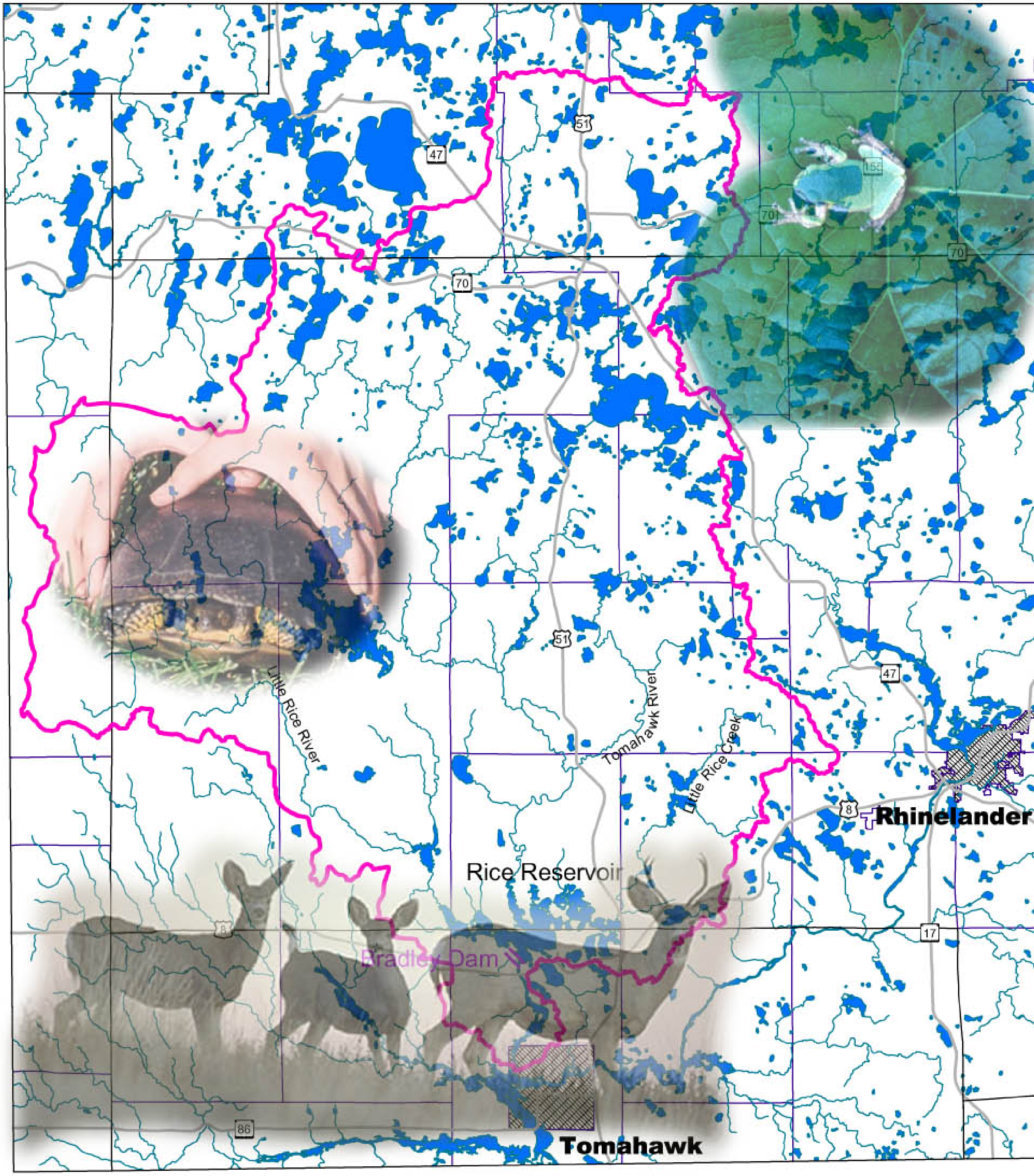
Rice Reservior Inventory and Assessment

Lake Nokomis, Bridge Lake and Deer Lake

Volume 1 - Report Text



By
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Aquatic Resources, Inc. & Vierbicher Associates, Inc.

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I. EXECUTIVE SUMMARY

A. Background

The Lake Nokomis Concerned Citizens (LNCC) received three lake planning grants (LPL 704, 705, and 708) from the Wisconsin Department of Natural Resources (WDNR) to complete a study of three lakes (Nokomis, Bridge and Deer) in the Rice Reservoir. The original objective of the study was to examine environmental impacts of the Reservoir's fluctuating water levels authorized in the Federal Energy Regulatory Commission (FERC) license, which controls operation of the Reservoir's dam. After initiation, however, the study's objective was adjusted to focus on understanding existing lake information and collecting new watershed and water quality data to augment existing lake/reservoir management and operation plans. This change in study focus resulted in much less emphasis on several planned components of the study. For example, less effort was expended assessing the potential for wild rice development, evaluating the fisheries (especially the management of the greater redhorse), and on evaluating shoreline erosion and shoreline stabilization techniques. Most of the project effort on shoreline erosion was expended on discussions of the ownership of the 30-feet strip around Lake Nokomis with WVIC. The planned project activities educating the public on alternatives to rip rap, sea walls and other structures was foregone as a result of the shoreline ownership issue not getting resolved. However, the improved lake understanding that resulted from the careful review of existing data and collection of new water quality data completed during this study will be quite useful in the future to help develop a comprehensive lake management plan for the entire Rice Reservoir. Furthermore, the public participation, involvement and education resulting from this project has greatly improved awareness of lake management issues both in general and specific to these three lakes. The LNCC membership, local property owners, and area citizens were exposed to the project on numerous occasions through, public meetings, LNCC newsletters, by media coverage from the local news paper and radio stations. This improved public awareness has result in increased membership in LNCC, greater participation in LNCC fundraisers, and additional public inquiries about LNCC activities and organization. The net result of the publics involvement will likely be an increased willingness to actively participate in future lake management activities.

Principally Rand Atkinson, a Professional Aquatic Ecologist with AQUATIC RESOURCES, INC, performed work on these lake-planning grants. His work was closely coordinated with the WDNR lake management staff through quarterly meetings and routine technical review of project progress. Joseph M. Dorava, PE of VIERBICHER ASSOCIATES INC. prepared the project's final report with review by Rand, LNCC, and WDNR staff.

B. Public Survey

The study of the three lakes in the Rice Reservoir began with a comprehensive survey of public opinion and perceptions about the lakes. These surveys were sent to 825 shoreline property owners and 476 (58 percent) of them were returned completed. The public survey results indicate the majority of property owners are full time residents who have been on the lake between 6 and 10 years. Most survey respondents are concerned with fluctuating water levels, maintaining access to the lake, and preserving the lakes' scenic beauty. In addition to collecting public opinion, the survey also helped to educate the public about lake issues and relations between lake uses, watershed land uses, and water quality. Specific educational objectives of the LNCC were to improve their memberships' understanding of how reservoir operations affect popular lake uses such as recreational boating and fishing which are affected by water level changes. The LNCC also wanted to address shoreline property owner's concerns with bank erosion and degrading water quality and how they are also affected by Reservoir operations.

These educational objectives were addressed in this study through the public survey, newsletter articles, and presentations at LNCC meetings.

C. Data Review

The study progressed with a careful review of existing data describing the three lakes and their water quality. Considerable data were available from reports prepared by WDNR and records kept by the Wisconsin Valley Improvement Company (WVIC), who are the owners of the Bradley Dam that impounds the Rice Reservoir. Because this information was collected for different reasons, by individuals with varying skill levels, in different locations, and using different methods, it is not always directly comparable nor can it accurately indicate time trends. However, as an indication of general lake health and for establishing an evaluation of water quality at a point in time, the information is useful.

Generally, existing data indicates that Bridge Lake has some eutrophic characteristics but there is insufficient data to determine its trophic condition. Therefore, it needs additional water quality monitoring. Deer Lake has water quality that is fair to excellent. However, it is very sensitive to increased phosphorus loading and it too will need additional monitoring. Lake Nokomis has water quality that is poor to very poor and is less sensitive to increased phosphorus loading than Deer Lake.

These three lakes drain more than 540 square miles of land stretching from Minoqua to Rhinelander that is primarily undeveloped. As a result, the tributary systems provide water to the lakes that is of high quality. Once the water reaches the Rice Reservoir however, it will generally increase in temperature, decrease its dissolved oxygen content, promote additional nuisance plant growth, and concentrate any pollutants carried to the lakes.

D. Data Collection

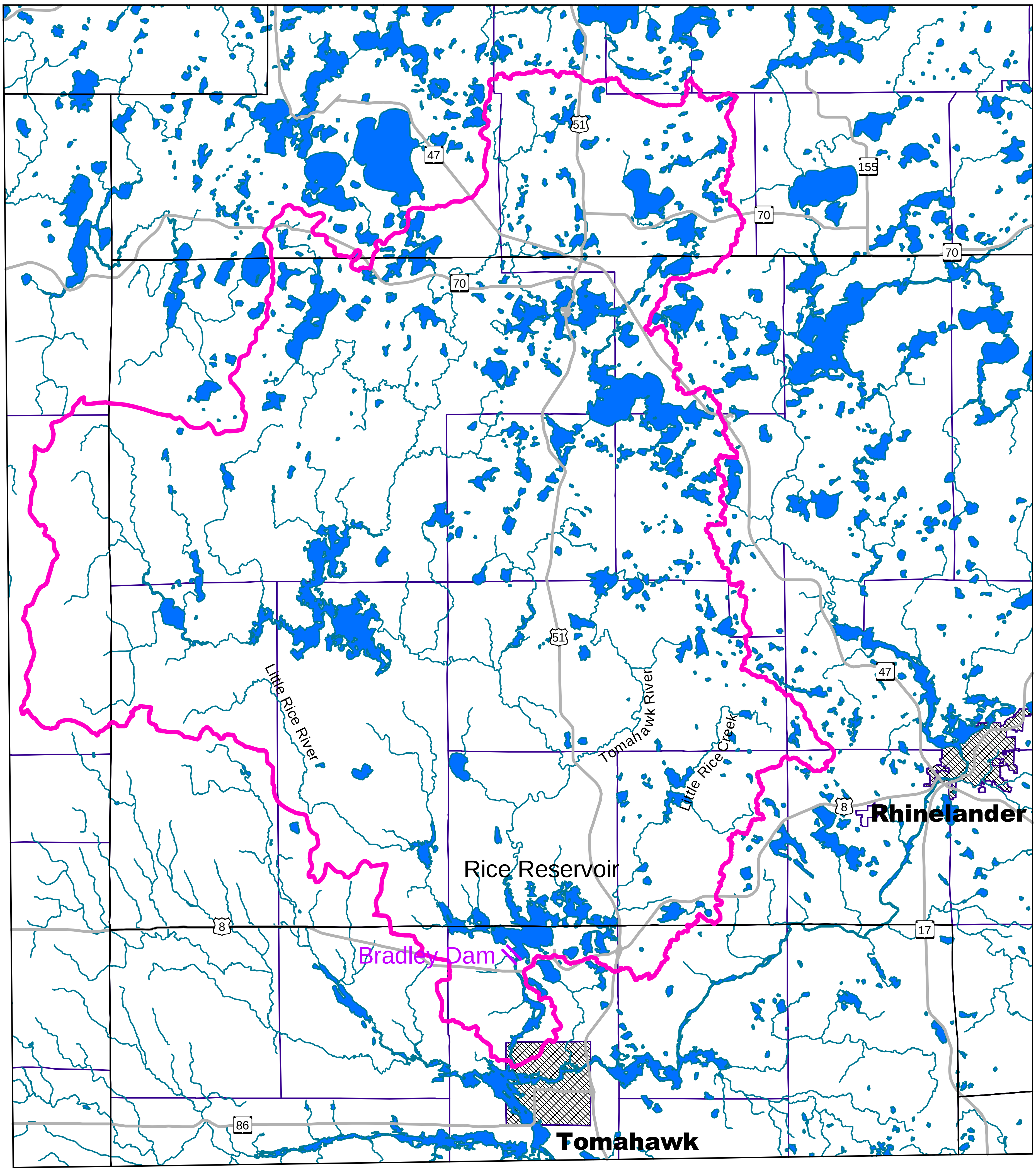
Following review of the existing water quality data, additional information describing the lakes was collected by the LNCC. This new information generally confirms the conclusions drawn previously, that Lake Nokomis has worse water quality than either Deer Lake or Bridge Lake. Nearly 200 seechi disk measurements were made during the summer of 2000 and 2001 by the LNCC and they varied among the three lakes with Deer Lake having the greatest depths of visibility, followed by Bridge and Nokomis. This lake relation extends to the aquatic plant community as well, where more than 300 samples were collected and 36 species of aquatic plants were found in Deer Lake while Bridge and Nokomis had 26 and 24 species respectively. The water quality in these lakes is influenced considerably by their depth, volume, tributary inflow, and dam overflow rate.

Deer Lake has no major tributaries and is essentially separated from the other two lakes with only a small connecting channel between Bridge and Deer Lake. It is also very deep, as much as 60 feet, and its shoreline is much less developed. As a result, it is somewhat better protected from degradation and buffered from pollutants that potentially have a greater influence on the other two lakes. Eutrophication of Lake Nokomis and Bridge Lake is evident in the water quality data.

Slowing this ongoing eutrophication process and reducing the potential for further degradation of the Rice Reservoir lakes require a better understanding of how land use activities along the Reservoir and in its watershed affect the lakes. At that point, opportunities to manage nutrient and sediment flow to the lakes will need to be explored.

Rice Reservoir Watershed

(544 Square Miles)



Legend

August 5, 2003

Rice Reservoir Water Shed

Surface Water

Lakes

State and U.S. Highways

State Trunk Highway

U.S. Highway

Cities

Dam

N
W E
S

1" = 20,000'

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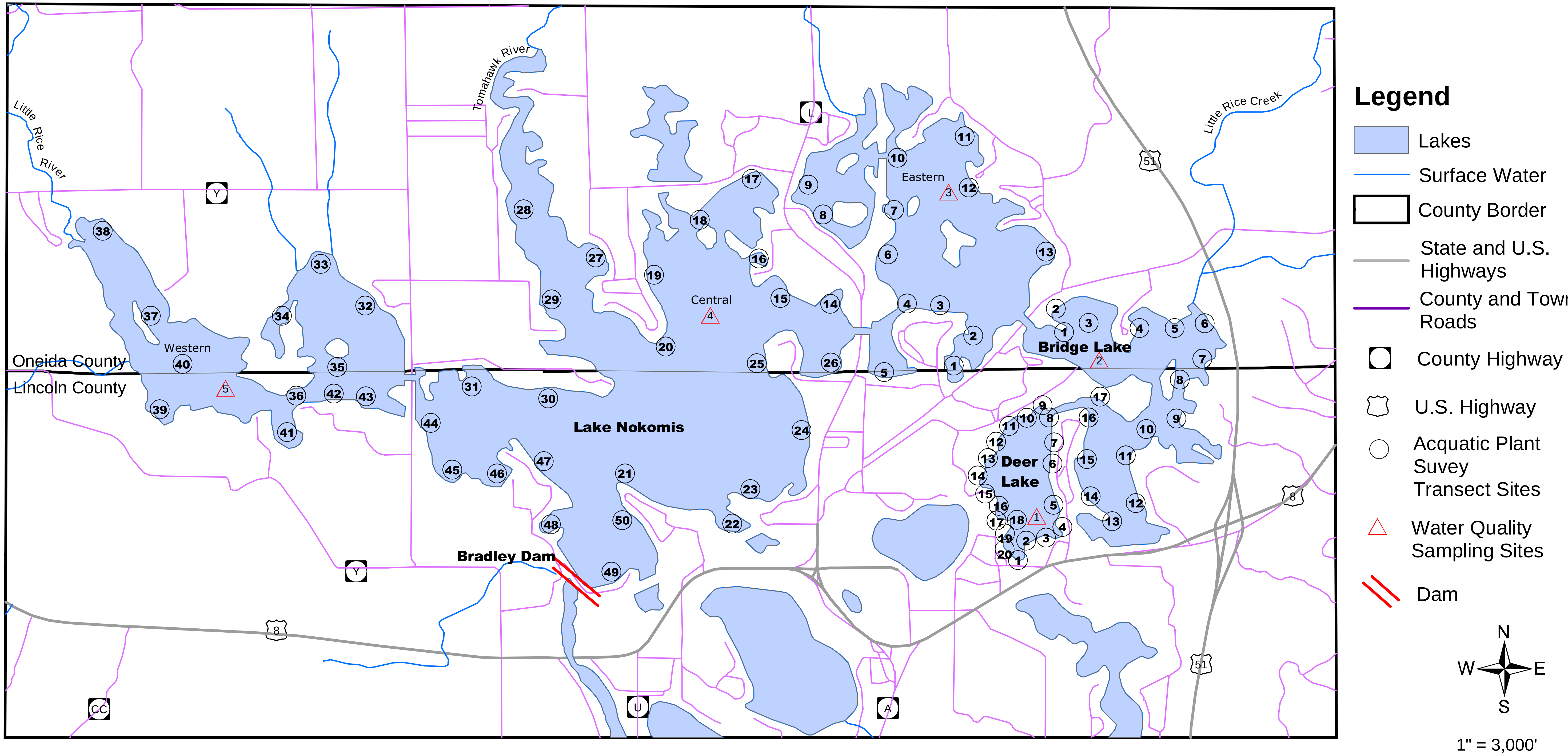
Rice Reservoir Lake Sampling Sites



August 5, 2003

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E. Fisheries

Although data is sparse to describe the fishery in the individual lakes, the Rice Reservoir and its major tributaries support productive fisheries. Generally, these are pan fish fisheries but there is also a good walleye fishery and some northern pike and muskellunge in the Reservoir and its tributaries. There are reports of greater redhorse (a state listed threatened or endangered species) in the Reservoir system, but this fact has had little influence on management of the fishery or Reservoir operations per Dave Seibel, a fisheries biologist with the WNDR. Also, there are reports of fish kills during low water periods. This occurs either in the winter months when the Reservoir is low as a result of seasonal drawdown and much of it is frozen or during the hot summer when water levels are naturally low. Seibel attests that these fish kills, although unsightly, have not had a substantial effect on the fishery. The fishery in the Reservoir is monitored by the WDNR and they implement management practices such as seasonal bag and size limits when warranted. The productivity of this fishery is an indication of what these lakes can support in their present condition.

F. Results and Recommendations

The study of the three lakes in the Rice Reservoir has provided the LNCC and the general public with a better understanding of what management activities are most important and where they will get the greatest public benefit from investments in lake management. In addition, the results of this study provide direction to the LNCC and the general public for developing more comprehensive lake management plans for the Reservoir. For example, immediate alteration of dam operations to improve lake access and or water quality may not be possible or practical, whereas improving public perception of dam operations and its influence on water quality is a realistic objective. Furthermore, working with the WDNR and the Wisconsin Valley Improvement Company (WVIC) to continue to consistently monitor the health of the Reservoir lakes will improve everyone's understanding of the influence of dam operations on the lakes.

Therefore, it is recommended that the LNCC begin working with the WDNR Self Help Monitoring Program to develop consistent long-term lake water quality monitoring. In addition, the LNCC should work closely with the WVIC to coordinate water quality monitoring activities to improve consistency in the data collected and to expand the areas covered by the monitoring programs. The LNCC should also expand its public education activities to include workshops on issues important to its membership, such as shoreline erosion and stabilization. To help address the shoreline erosion issues, the LNCC should also continue work closely with the WVIC to obtain private ownership of the 30-foot strip surrounding the Reservoir that currently is retained by the WVIC. The LNCC should also coordinate closely with the local Townships and Counties to implement shoreline ordinances that control development adjacent to the lakes.

Using the techniques described above, the LNCC should begin to develop a comprehensive lake management plan that describes watershed, shoreline, and Lake Practices that will protect or enhance water quality. Development of this plan should be done with a thorough public consensus building process that includes comprehensive public participation and education components. Once a plan is developed, the LNCC can work with local management agencies such as the townships, county, and the WDNR to implement necessary regulatory measures to promote beneficial lake management.

II. INTRODUCTION

A. Physical Setting

The 4,111 acre Rice Reservoir is in north central Wisconsin on the border of Lincoln and Oneida Counties, about five miles north of Tomahawk and 20 miles southwest of Rhinelander (Figure 1). The Reservoir was formed in 1911 with the damming of the confluence of the Tomahawk and Little Rice Rivers by the Wisconsin Valley Improvement Company (WVIC) (Figure 1). The Bradley Dam impounding the Rice Reservoir has a height of nearly 18 feet and when constructed it flooded Nokomis, Bridge and Deer Lakes and their connecting stream watercourses. Discharge from the Rice Reservoir immediately enters another Reservoir (the Jersey City Flowage) along the Tomahawk River before joining the Wisconsin River near Tomahawk.

Since impoundment, the Rice Reservoir has become quite popular as a recreational destination and an attractive residential setting. Today, it is one of the most populated reservoirs in northern Wisconsin. The Rice Reservoir has more than 800 buildings along its 79-mile perimeter. Shoreline land uses consist of seasonal and year-round homes as well as considerable commercial development including lodges, restaurants, and taverns. The Reservoir is bordered by STH 51 to the east and STH 8 to the south and is bisected north and south by CTH Y and L (old 51) (Figure 1). The surrounding townships maintain roads to access developed areas primarily in the Town of Bradley in Lincoln County and the Town of Nokomis in Oneida County (Figure 1 and 2).

Both Bridge Lake and Lake Nokomis receive water from tributary streams that become especially important during Reservoir drawdown and drought conditions. Deer Lake does not have any major tributaries, it is much deeper, and it is isolated from the other Rice Reservoir lakes by a narrow shallow channel (Figures 1 and 2). As a result of its depth and isolation, Deer Lake is less affected by Reservoir operations than either Bridge Lake or Lake Nokomis. Consideration of these lakes separately and as a connected system will give a more accurate picture of the management opportunities for protecting and enhancing the water quality of the Rice Reservoir.

The Tomahawk and Little Rice Rivers and Little Rice Creek are the main tributaries entering the Rice Reservoir and drain about 544 square miles of primarily undeveloped woodland, lake shoreline and wetlands (Figure 1). Because these tributaries are generally undeveloped, they contribute high quality water to the reservoir and help support productive fisheries. The Tomahawk River enters the Reservoir from the north, Little Rice River from the west, and Little Rice Creek from the east. The Tomahawk River originates in the lakes north and east of Minocqua, joins the Squirrel River and travels about 20 miles before reaching the Willow Reservoir and from there flows another 20 miles before entering the Rice Reservoir. The Little Rice River originates in Lamer Springs and flows more than 18 miles through undeveloped woodland and through Killarney Lake before entering the Rice Reservoir. Little Rice Creek originates in Goodyear Springs northeast of Rhinelander and flows through Goodyear, Oneida, Hancock, and Gary Lakes for about 15 miles before reaching the Rice Reservoir.

The WVIC operates the Rice Reservoir along with four other man-made reservoirs and 16 natural-lake reservoirs as a single system known as the Wisconsin River Headwaters System. These linked reservoirs are operated by WVIC with the primary purpose of producing "as nearly a uniform flow of water as practicable in the Wisconsin and Tomahawk Rivers " Wis. Stats. §182.70(2). Water in the WVIC managed reservoir system is stored and released as needed to adjust for natural variations in river flow. The WVIC typically lowers their reservoirs in fall and winter to prepare for spring snowmelt. The extent of the lowering or drawdown in any given year depends principally on seasonal precipitation patterns. During the study period (1999-2001) water level in the Rice Reservoir has been drawn down more than ten feet from September to May and has been drawn down nearly four feet from June to August (Figure 3).

The basic physical and chemical characteristics of Rice Reservoir, such as its depth, width, clarity, and temperature are closely related to the operation of the Bradley Dam and the remaining reservoirs in the Wisconsin River Headwater System. Lakefront property owners are concerned about the influence the reservoir system has on the three lakes making up the Rice Reservoir. When water levels are low, their principal concerns are an increased difficulty accessing the lakes, a decline in wildlife viewing opportunities, and an offensive odor and unsightly aesthetics resulting from decaying exposed bare shoreline. These concerns are commonly perceived as resulting from the profitable operation of the Bradley Dam. The public also typically believes operation of the Dam could be easily altered to satisfy public concerns. Once the inter-relationships of the Wisconsin River Headwater System and its operational objectives are better understood, these public perceptions may change. However, at this time it is beneficial to understand how the public perceives the reservoir system operation and to document the present state of water quality in the lakes so that proper management objectives for the lakes can be established.

B. Purpose and Scope

Concerns of lakefront property owners and visitors prompted an assessment of the Rice Reservoir and an inventory of the basic water quality characteristics of the three lakes in the Reservoir. This assessment and inventory were partially funded by grants from the WDNR Lake Management Program, and by funding and volunteer support from the LNCC, and the Tomahawk Fishing Unlimited Inc. Club.

The WDNR, in their Upper Wisconsin River Northern Sub-Basin Plan, classify the lakes in the Rice Reservoir differently based on each lake's relative sensitivity to phosphorus loading and its trophic condition. Bridge Lake has insufficient data to assess its trophic condition and it needs additional water quality monitoring. Deer Lake has water quality that is fair to excellent and it is sensitive to increased phosphorus loading. Deer Lake is also identified as needing additional monitoring. Lake Nokomis has water quality that is poor to very poor and is less sensitive to increased phosphorus loading than Deer Lake. Through this study, the water quality of the lakes in the Rice Reservoir will be characterized and then management strategies developed to protect and enhance the lakes.

The assessment portion of this study included an evaluation of public perception of the lakes' health relative to principal public uses, an evaluation of the access and quality of the lake frontage relative to water levels and erosion, and an evaluation of public opinion and observations. This assessment was completed with an extensive survey of lakefront property owners and a detailed review of existing data describing the lakes' water quality and their fisheries.

The inventory portion of the study was completed by collecting basic water quality characteristics including, water clarity, water temperature, and dissolved oxygen concentration. Some basic aquatic habitat data were also collected during the inventory including the number of species of aquatic vegetation found at various depths and locations in each lake.

This initial assessment and inventory describing the public perception of the Reservoir and documenting its basic water quality and aquatic habitat characteristics will be useful for concerned citizens, lake users, and lake managers in developing a more comprehensive management plan to ensure the long-term health and viability of the Rice Reservoir lakes. Although this report is a basic assessment and inventory, it also includes a description of alternative management strategies and objectives to initiate planning for the future management of these lakes.

III. ASSESSMENT OF PUBLIC OPINION AND PERCEPTIONS

A. Background

A lakefront property owner's survey was developed to gather information from residents living on the Rice Reservoir. Five primary areas of information were collected in the survey including property owner demographics, shoreline erosion, fish and wildlife, pothole and fish stranding, and Reservoir access.

This information will be used to educate property owners about lake issues and to develop lake management strategies to address issues of concern to the public.

B. Results

A property owner's survey was mailed out in the summer of 2000 to 825 shoreline property owners identified from property tax roles. Of the 825 surveys mailed, 476 (58 percent) were returned completed.

C. Property Owner Demographics

Question #1 asked how long the property on the Rice Reservoir had been owned by the respondent. The answers ranged from 1 to 82 years. The largest group of respondents were those who have lived on the lake 6 to 10 years.

Property Owner Demographics		
Length of Time with Property	**# Respondents**	**% Respondents**
0-5 years	67	16%
6-10 years	88	21%
11-15years	58	14%
16-20 years	38	9%
21-25 years	38	9%
26-30 years	35	8%
31-35 years	29	7%
36-40 years	17	4%
41-82 years	56	13%

Question #2 asked owners to check one of several options that described their property and dwelling type.

Property and Dwelling Description		
Dwelling or Property Use Description	**# Respondents**	**% Respondents**
Year-round home	261	62%
Three-season home	27	6%
Summer cottage	63	15%
Winterized cottage	48	11%
Vacant land	21	5%
Not Applicable	3	1%

Question #3 and #4 related to lake property use. The results are broken down into categories to describe weekend and weekday use. Four hundred twenty two (52 percent) of property owners responded that they use their lake property a total of 14,447 weekends per year. They also indicated that annually, a total of 2,572 people use their lake property during those weekends. This means that those homeowners spend an average of 34 weekends per year at their lake property and an average of 6 people use each dwelling during those weekends. These 422 respondents also spend 57,272 weekdays at their property with 1,851 people using their lake property during this time. This means that those respondents spend average 136 weekdays per year at their lake property and an average of 4 people use each dwelling during those weekdays.

Property Use Time Spans		
Property/Facility Use (# People)	**Weekends/Year (# People)**	**Weekdays/Year (# People)**
Year-Round Home Use (261)	11,554 (1397)	50,048 (1171)
Three-Season Homes (27)	687 (176)	2045 (161)
Summer Cottages (63)	963 (633)	2,081 (247)
Winterized Cottages (48)	1,090 (246)	2,607 (149)
Vacant Land (21)	153 (60)	491 (13)
Business (2)	(120)	(110)

Question #5 related to land use priorities and recreational value of their Rice Reservoir property. Respondents were asked to rank their uses from a list of brief recreational descriptions.

Land Use Priorities	
Recreational Description	Priority Ranking
Scenic Beauty & Tranquility	1
Pleasure Boating	2
Fishing	3
Swimming	4
Wildlife Viewing	5
Duck Hunting	6
Water & Jet Skiing	7

D. Shoreline Erosion

Questions #6 through #9 assessed the effects of erosion on the respondents' shoreline. Four hundred thirty-two property owners who own 71,826 feet (13.52 miles) of shoreline responded. Approximately, 44 percent of the shoreline or 32,282 feet (6.1 miles) was described by property owners as eroded. Approximately, 53 percent of the shoreline or 37,895 feet (7.2 miles) was described as stable. Annual shoreline loss rates ranging from 0.06 to 2.5 feet were reported by respondents. Most respondents agree that erosion can effect the aquatic vegetation, navigation, fisheries, and upland areas.

Erosion Effects	
Description of Shoreline…	Feet of Shoreline Described….
Shoreline Described	71,826 (13.6 mi.)
Described as Eroded	32,282 (6.1 mi.)
Described as Stable	37,895 (7.2 mi.)
Described as Stabilized by Rock RipRap	11,201 (2.1 mi.)
Described as Stabilized by Seawall	12,289 (2.3 mi.)
Described as Stable & Natural	5,187 (0.98 mi.)

Shoreline Loss	
Property Location	**Average Loss of Shoreline Feet per Year (Range)**
West Nokomis	0.82 (0.09-2.5)
Tomahawk Arm	0.63 (0.34-1.18)
East Nokomis	0.34 (0.12-0.91)
Central Nokomis	0.21 (0.06-0.39)
Little Rice Arm	0.17 (0.09-0.23)
Bridge Lake	0.16 (0.06-0.24)

Erosion and Sediment Deposit Effect	
Erosion Effect	Agree with Effects Statement
Aquatic Vegetation Changes	80%
Recreation, Navigation, Access	75%
Fisheries Effected	65%
Upland Vegetation & Soil Loss	59%

E. Fish and Wildlife

Questions #10 and #11 of the survey focused on fish and wildlife observations. The total number of observations of each fish and wildlife was divided by the total respondents to determine the percentage of observation.

The percentage of respondents that observed loons, eagles, and osprey were 50 percent, 44 percent, and 25 percent, respectively. Ducks, blue herons, and geese were observed by 40 percent, 12 percent, and 9 percent. Crayfish, clams, and frogs were observed by 29 percent, 14 percent, and 5 percent, of respondents respectively.

Bass and walleye were the most observed game fish, while bluegills were the most observed of all fish species. Muskellunge and northern pike were most observed in Lake Nokomis. Besides these two species, Bridge Lake dominated all fish observations except for pumpkinseed and black crappie, which were observed mostly in Lake Nokomis.

F. Potholes and Fish Stranding

Question #11 asked if there were areas adjacent to the owners' property where fish are stranded during winter and summer drawdown. If YES, did they witness dead fish in the past?

Thirty-four percent of the respondents stated they observed stranded fish during winter drawdown. The highest number of observations came from Bridge Lake residents followed closely by Lake Nokomis. Thirty-seven percent of the respondents stated they observed stranded fish during summer drawdown. The highest number of observations came from Lake Nokomis residents followed closely by those living on Bridge Lake.

G. Reservoir Access

Question #12 asked the respondents to prioritize the recreational uses described in Question #5 and explain how Reservoir water level affected each of the top four priorities.

The highest priority lake use of "Scenic Beauty & Tranquility" received comments on the loss of water next to their shoreline and the bleakness of a large expanse of bare shoreline or offensive odor from the decay of exposed shoreline. The second ranking priority of "Pleasure Boating" received comments regarding reduced or no access during summer drawdown and other comments about navigational hazards resulting from changing water levels. For the third priority, "Fishing", comments centered on draw down effects on access, as a habitat loss issue, and a possible declining fishery. "Swimming", the fourth priority, was affected by loss of access and changes both negative and positive in the substrate due to drawdown. The fifth priority, "Wildlife Viewing", received comments about the altered use of their shoreline and islands by loons over time. The respondents also noted habitat for waterfowl including aquatic vegetation loss or changes as well as loss of island habitat due to erosion. Hunting and perch sites for eagles and ospreys were reported as lost from erosion of shoreline trees and island habitat. Spawning and forage areas for fish were also reported as disrupted by drawdowns.

Question #13 asked "In 1999, how many feet of pier did you need to reach three feet of water in May, June, July, August, and September?" Those respondents that could reach three feet of water each month with less than 40 feet of pier were considered reasonably able to access the water. Those respondents that would need 40 feet of pier or more to reach three feet of water each month were considered to have restricted access to the Rice Reservoir for recreational purposes.

Percentage of Shoreline Respondents Unable to Access Rice Reservoir by Month					
	May	**June**	**July**	**Aug.**	**Sep.**
Little Rice Arm	57%	80%	67%	83%	92%
West Nokomis	26%	30%	36%	41%	66%
Tomahawk Arm	17%	25%	45%	52%	59%
Central Nokomis	26%	32%	45%	51%	76%
East Nokomis	17%	18%	38%	56%	59%
E. Nokomis NW Bay	10%	10%	33%	55%	55%
Bridge Lake	40%	44%	60%	80%	87%
Deer Lake	69%	67%	62%	79%	87%
Average	33%	38%	48%	62%	73%

On average, in May 1999, 33 percent of the respondents could not access the Reservoir. Figure 3 shows the water levels in May 1999 and during the remainder of the study period. As the summer months proceeded into fall, the average percentage of respondents who could not access the Reservoir increased as follows: June-38 percent, July-48 percent, August-62 percent, and September-73 percent.

Question #14 stated "The scenic beauty and tranquility, as well as wildlife habitat has been disrupted by water level fluctuations and shoreline development. We are working to stabilize the water levels to lessen these disruptions." We followed up that statement with the question "Would you be willing to work to change your shoreline back to a more natural state if assistance was available?"

A nearly 2 to 1 margin of respondents were in favor of restoring their shoreline to a natural state if assistance was available.

H. Other Public Involvement

In addition to the public survey, described in detail above, that was used to solicit public opinion, the public participation and involvement in the project was extensive. LNCC new letters and meeting minutes spanning the project duration 1999 - 2003 document numerous contacts with the membership where lake management issues were discussed (appendix). Furthermore, draft versions of the study report was reviewed by LNCC leaders, key organization committees, and discussed with the entire membership at the 2002 and 2003 annual meetings. Additional public education and involvement was provided by media coverage of important LNCC activities, including newspaper and radio coverage of the annual meeting, pontoon raffle fund raiser, and floating bog. The media coverage provided valuable contact with the general public who otherwise would not have been contacted directly through this project.

IV. WATER QUALITY OF THE RICE RESERVOIR

A. Existing Water Quality Data

As part of their operational license requirements, WVIC monitors the water quality of the Rice Reservoir at several locations. They monitor many quality-related characteristics that include the concentration of total phosphorus and chlorophyll a, and they record secchi disk readings to determine water clarity. Measuring these three parameters helps to monitor the trophic status of the Reservoir. The WVIC maintains a database of their data and provides the WDNR and the FERC with annual reports on their monitoring. These reports and the database are available for review by contacting the WVIC, WDNR, or FERC.

Generally, the WVIC data confirm the WDNR conclusions described earlier that Lake Nokomis has poor water quality characteristics and eutrophic conditions, such as elevated phosphorus and chlorophyll a concentrations and low water clarity. Bridge Lake also has some eutrophic conditions but it needs additional water quality monitoring. Deer Lake generally has good water quality. The long term monitoring of trophic status conditions is necessary to determine trends and to assess the benefits of lake management activities.

B. Existing Fisheries Data

The fisheries of the Rice Reservoir have been documented in numerous past surveys spanning 1949-2002. Generally, these previous surveys cover Lake Nokomis more thoroughly than the other two lakes and indicate that there is a productive fishery in the Reservoir lakes. Walleye and perch are the main game and panfish. However, there also are muskellunge and northern pike in the Reservoir system. The greater redhorse, which is listed as a threatened species in Wisconsin, was found in previous fish surveys but their presence has not been a substantial lake management issue per Dave Seibel of the WDNR. In addition, fish kills have been reported on the Rice Reservoir, primarily during the winter as a result of freeze-out, but also during the summer when water levels are low. Seibel attests that these fish kills although unsightly, have not resulted in concern for the fishery.

C. LNCC Collected Water Quality Data

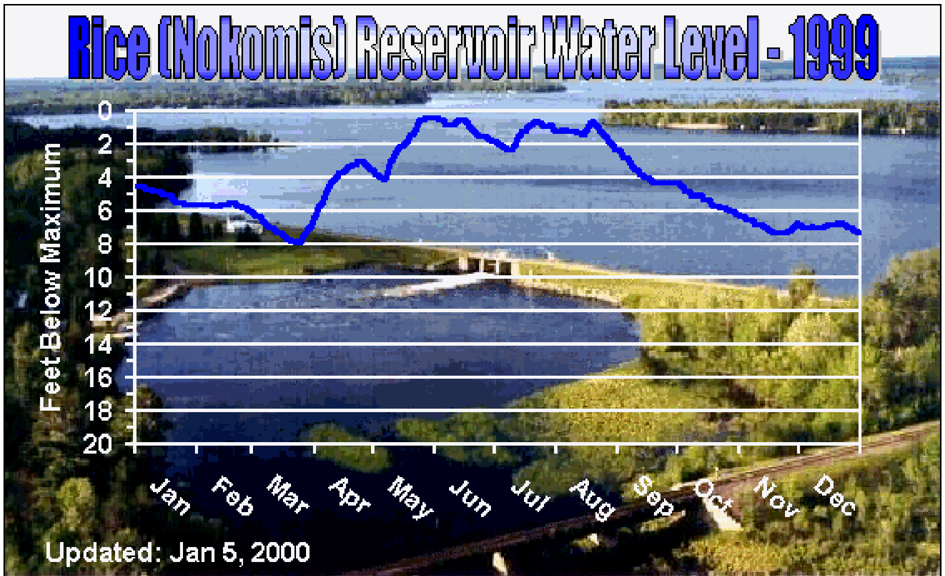
1. Methods and Motivation

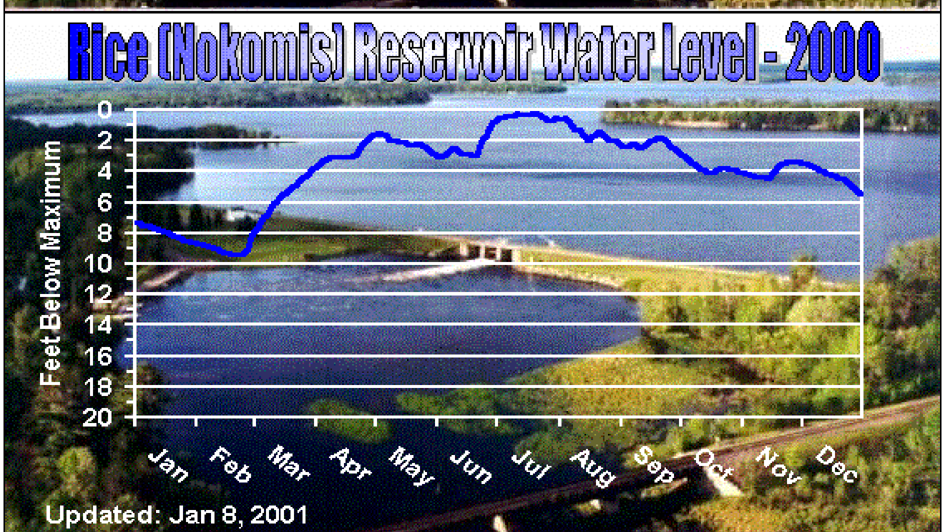
Data describing the water quality of the Rice Reservoir was collected by LNCC primarily by a professional aquatic ecologist or volunteers trained by this ecologist and working under his direct supervision. This information was collected using standard WDNR Long Term Lake Monitoring Program sampling protocols. The sampling protocols are also typically used by the WDNR Self Help Lake Monitoring Program and can be obtained by contacting local WDNR offices, the Wisconsin Association of Lakes, or private consultants experienced with lake sampling.

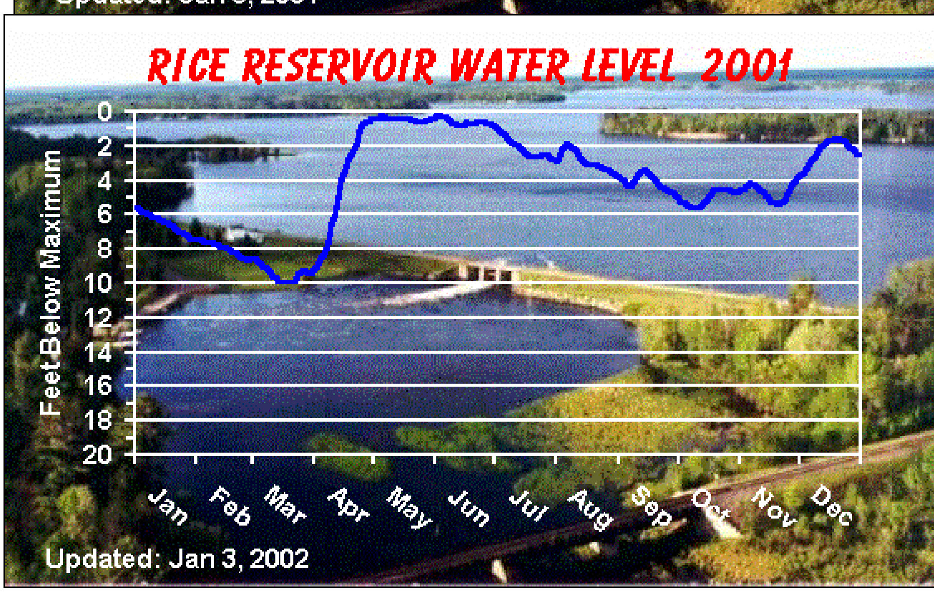
The water quality data collected by LNCC primarily included dissolved oxygen concentration, water temperature, and secchi disk depth. The dissolved oxygen concentration in water indicates how much biologic activity it can support. For example, dissolved oxygen is required by fish and must be available in concentrations of sufficient quantity to support them, typically 2-5 mg/l, depending on fish species and

WATER LEVELS RICE RESERVOIR

1999-2001 STUDY PERIOD DATA FROM WVIC







water temperature. Dissolved oxygen is supplied to the water by direct assimilation from the atmosphere and by photosynthesis of aquatic vegetation. Dissolved oxygen concentration is directly related to water temperature. The cooler the water the more oxygen it can hold. Measurements of dissolved oxygen concentration are often reported in mg/l and as a percentage of the total saturation level, indicating about how much oxygen could be held in the water at a specific temperature. Generally, the LNCC data describing dissolved oxygen concentration were collected at a depth of two feet below the surface with an electronic probe that provided a digital readout of dissolved oxygen concentration. The type of probe, its calibration records, and the level of training of the instrument operator were not readily available with these data sets. Water temperature also effects biologic activity and if it is excessively high or low, it can kill fish. Generally, measurements of water temperature made by LNCC were taken at a depth about two feet below the surface. Again the temperature measurements were made with an electronic probe that provided a digital temperature reading and the exact type or model of probe, its calibration records, and the level of training of the instrument operator were not readily available with these data sets. Secchi readings indicate the depth of light penetration into the water column. A standard size white and black disk is lowered into the water until it disappears, indicating the approximate depth of light penetration. Usually, light penetration depths indicate how deep plant growth can be sustained. Additional water chemistry data were collected in each lake to determine the general quality of the water. In addition, the aquatic plants were sampled in each lake using numerous transects (Figure 2) to characterize the plant community relative to the lake's water quality. Water quality sampling locations included one primary site in Deer Lake (#1) and another in Bridge Lake (#2) and three sites in Lake Nokomis (#3 Eastern), (#4 Central), and (#5 Western), which are shown on Figure 2.

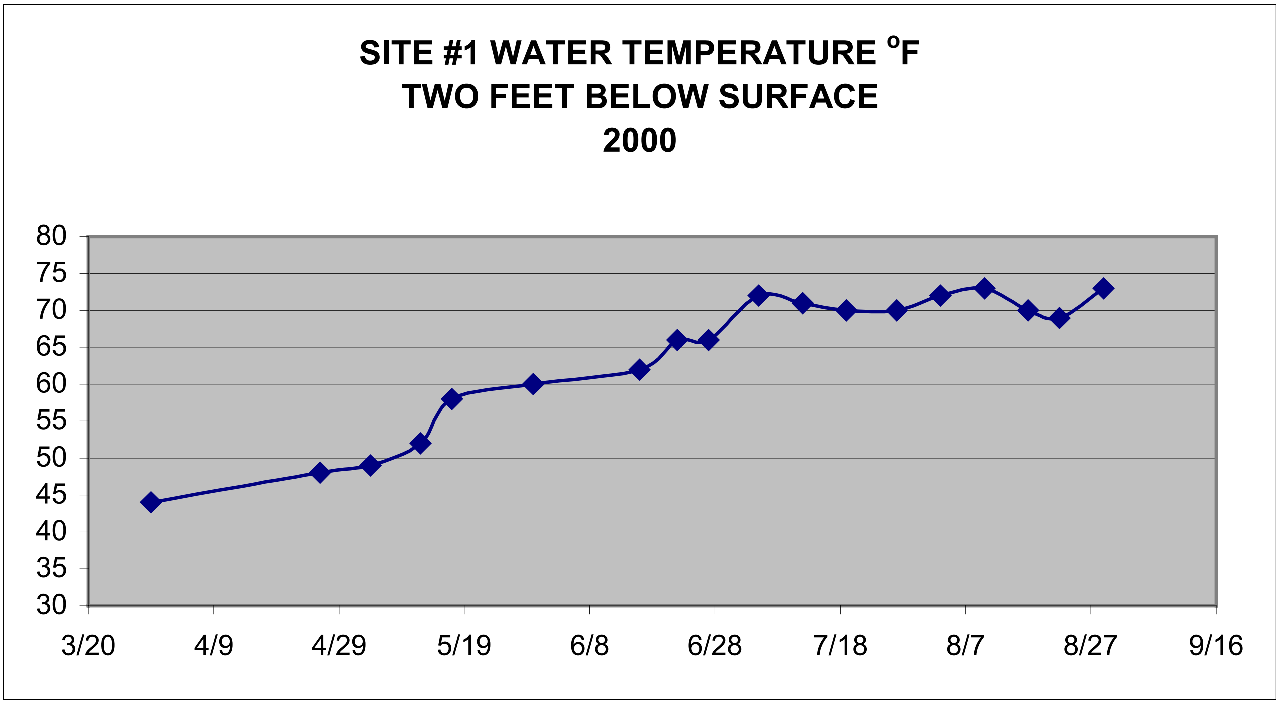
2. Results

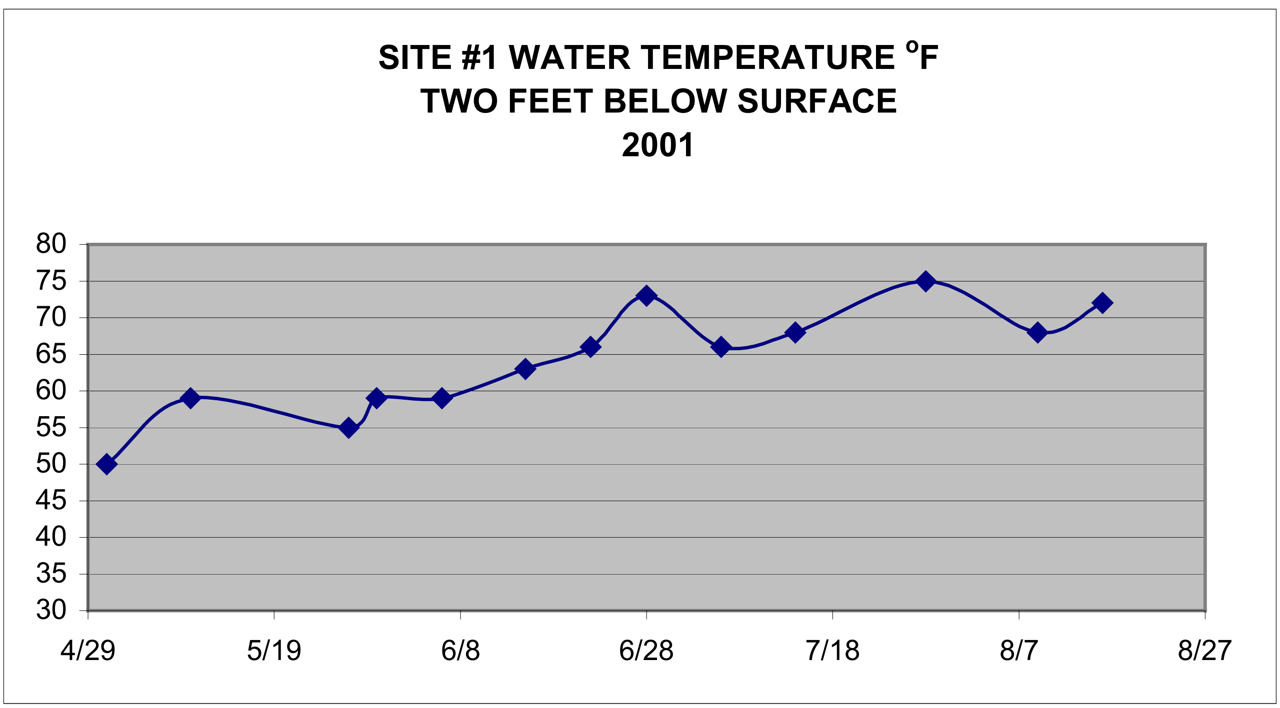
a. Deer Lake Site #1

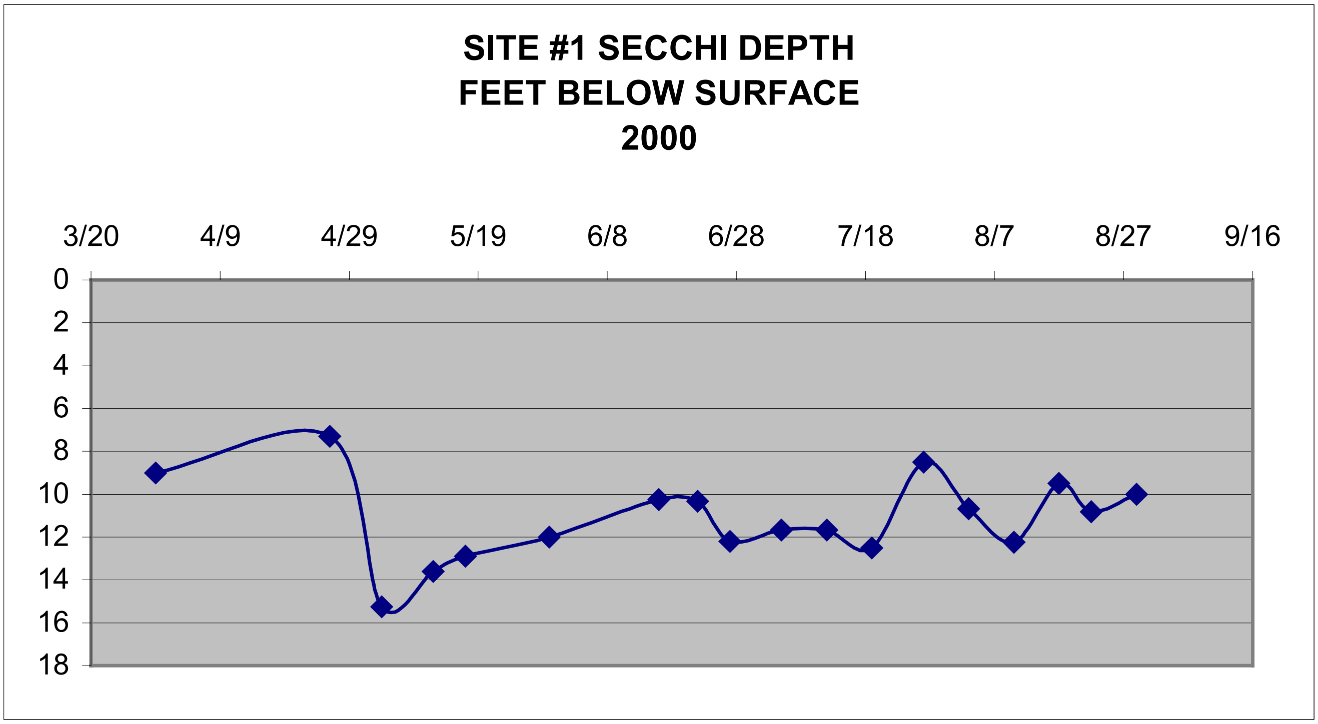
Deer Lake is about 156 acres in size and has a maximum depth of 62 feet. It was essentially isolated from Bridge Lake and Lake Nokomis until the Bradley Dam was constructed. If the Rice Reservoir drops more than about five feet, the shallow channel between Deer and Bridge Lake becomes un-navigable and Deer Lake again becomes isolated from the rest of the Rice Reservoir. Most of Deer Lake's shoreline quickly drops to deep-water, but there are several large wetland areas along the shoreline. Dissolved oxygen concentration, water temperature, secchi disk readings, and water chemistry data were collected in a deep-water area on the south side of the Lake at location #1 during 2000 and 2001 (Figure 2, 4-7 and Table 1).

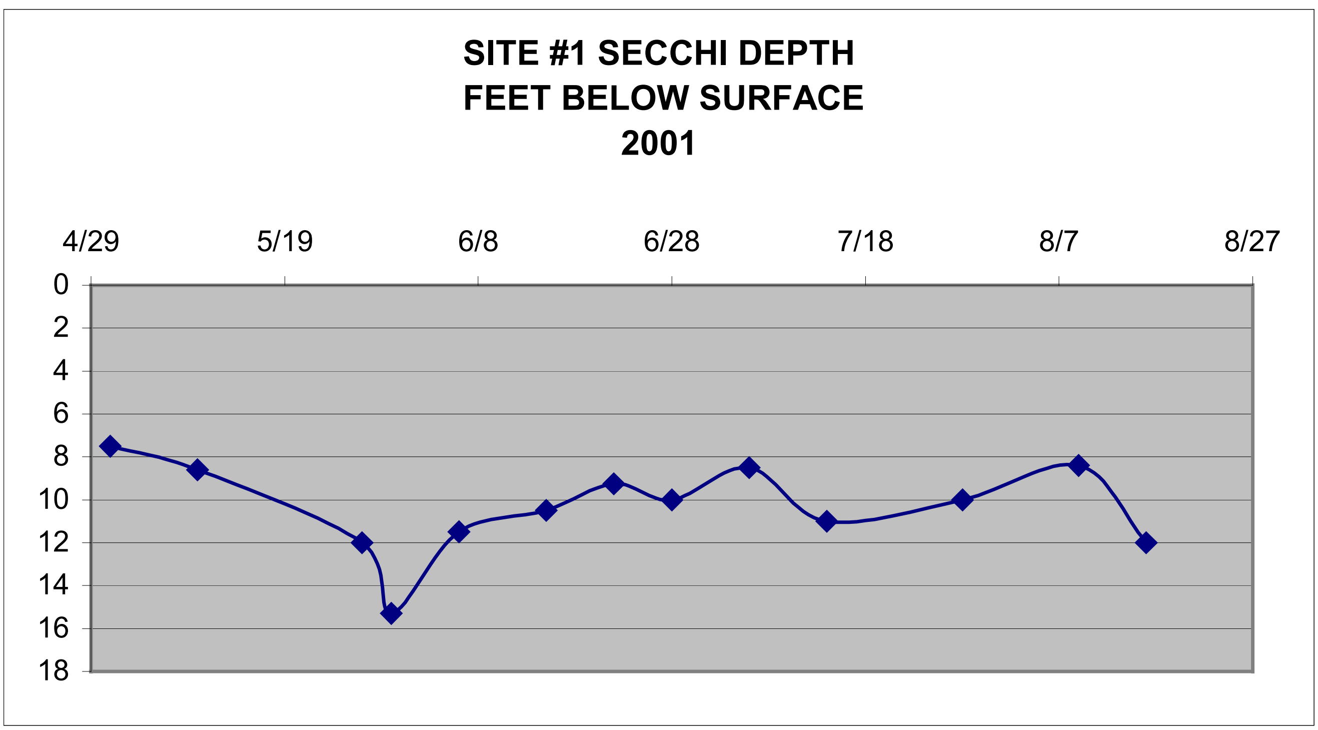
Nineteen secchi readings at this location in 2000 ranged from 7.3 to 15.25 feet and averaged 11.1 feet. Thirteen secchi readings in 2001 ranged from 7.5 to 15.3 feet and averaged 10.2 feet. (Figure 4).

The aquatic plant community in Deer Lake was surveyed on August 1 and 7 of 2000, with 20 transect samples that extended from shallow to deep-water (Figure 2). The transects chosen represent 80 sampling sites ranging from 0 to 15 feet. The sampling identified 39 species of aquatic and semi-aquatic plants (Appendix). Fourteen submerged aquatic plants were identified in 19 of the 20 sites sampled in the 9.1 to 15 feet depth. Thirteen submergents, three emergents,


SITE #1 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2000
80
75
70
65
60
55
50
45
40
35
30
3/20
4/9
4/29
5/19
6/8
6/28
7/18
8/7
8/27
9/16


SITE #1 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2001
80
75
70
65
60
55
50
45
40
35
30
4/29
5/19
6/8
6/28
7/18
8/7
8/27

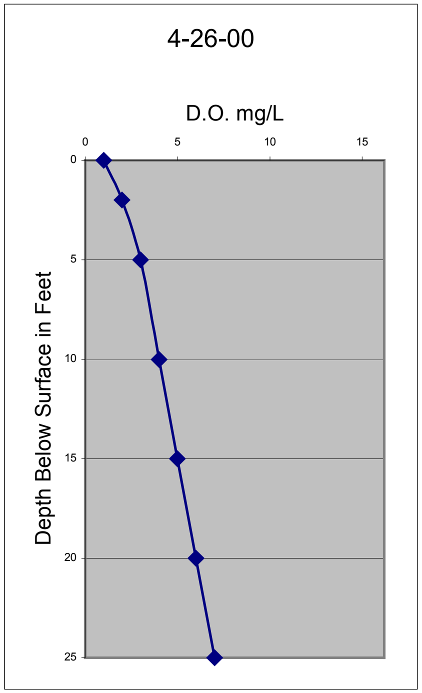

SITE #1 SECCHI DEPTH
FEET BELOW SURFACE
2000
3/20
4/9
4/29
5/19
6/8
6/28
7/18
8/7
8/27
9/16
0
2
4
6
8
10
12
14
16
18

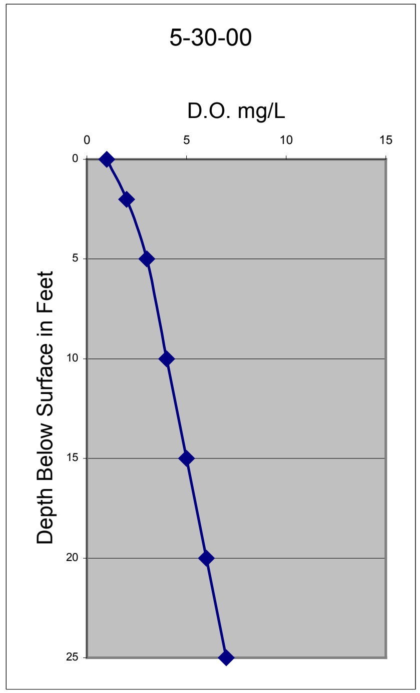

SITE #1 SECCHI DEPTH
FEET BELOW SURFACE
2001
4/29
5/19
6/8
6/28
7/18
8/7
8/27
0
2
4
6
8
10
12
14
16
18

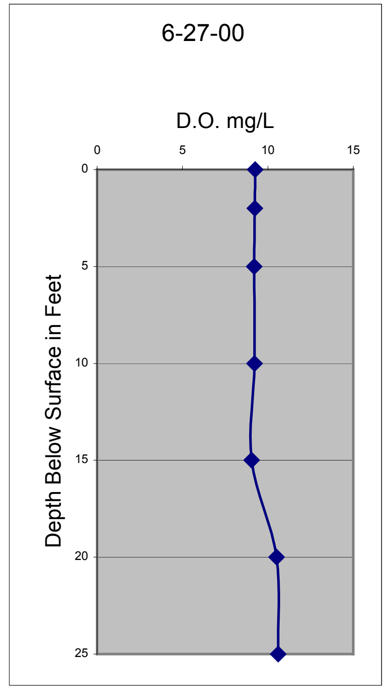
SITE #1

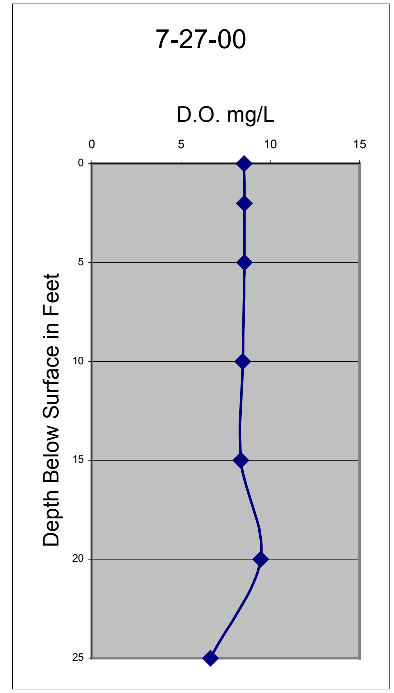
2000	Secchi	Temp	2001	Secchi	Temp
30-Mar	9	44	1-May	7.5	50
26-Apr	7.3	48	10-May	8.6	59
4-May	15.25	49	27-May	12	55
12-May	13.6	52	30-May	15.3	59
17-May	12.9	58	6-Jun	11.5	59
30-May	12	60	15-Jun	10.5	63
16-Jun	10.25	62	22-Jun	9.25	66
22-Jun	10.33	66	28-Jun	10	73
27-Jun	12.2	66	6-Jul	8.5	66
5-Jul	11.67	72	14-Jul	11	68
12-Jul	11.67	71	28-Jul	10	75
19-Jul	12.5	70	9-Aug	8.4	68
27-Jul	8.5	70	16-Aug	12	72
3-Aug	10.67	72			
10-Aug	12.25	73			
17-Aug	9.5	70			
22-Aug	10.83	69			
29-Aug	10	73			

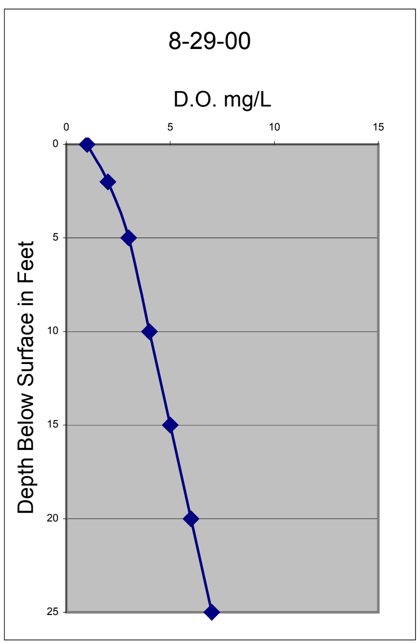
DEER LAKE
2000
DISSOLVED OXYGEN CONCENTRATION

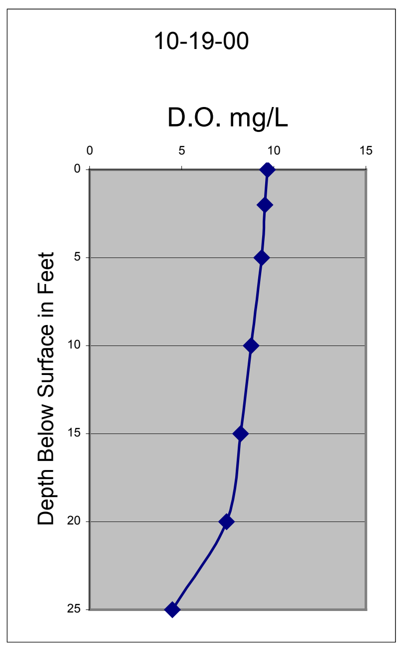


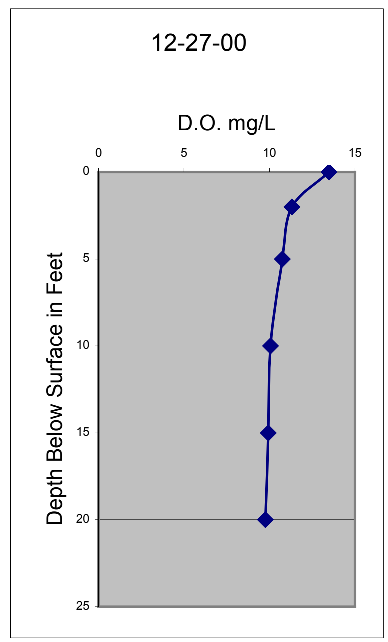










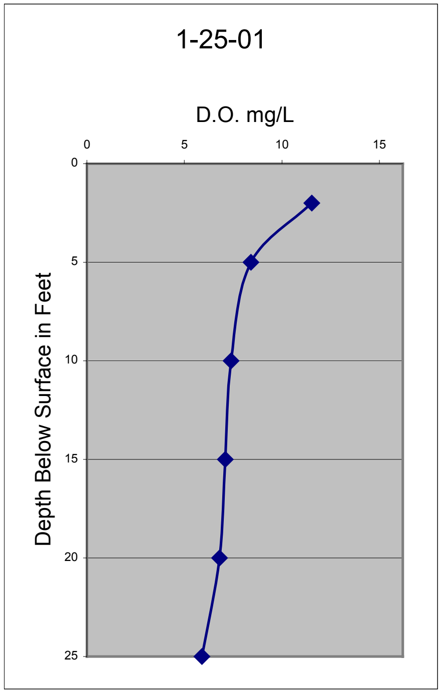


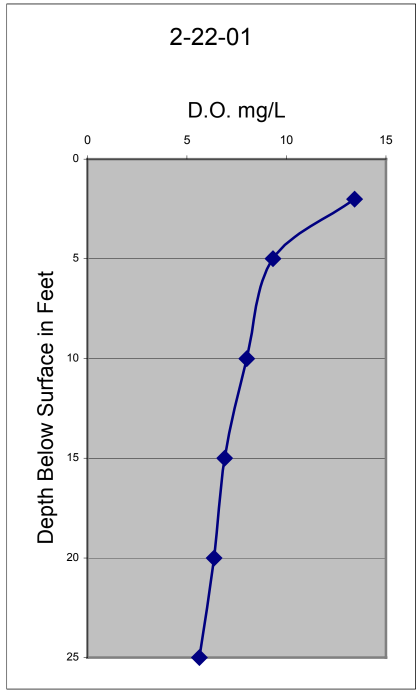
2000 Dissolved Oxygen - Deer Lake

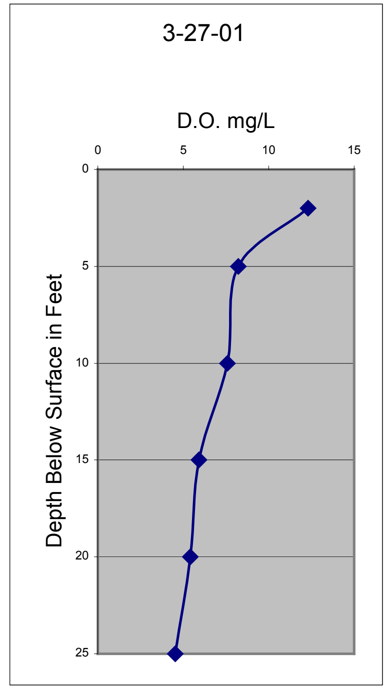
26-Apr	30-May	27-Jun	27-Jul	29-Aug
12.69	10.04	9.25	8.53	8.55
		9.24	8.55	
13.29	10.21	9.2	8.55	8.55
13.98	10.61	9.22	8.46	8.46
13.8	12.63	9.05	8.35	8.43
12.98	10.88	10.5	9.47	8.30
12.26	8.48	10.6	6.65	8.21

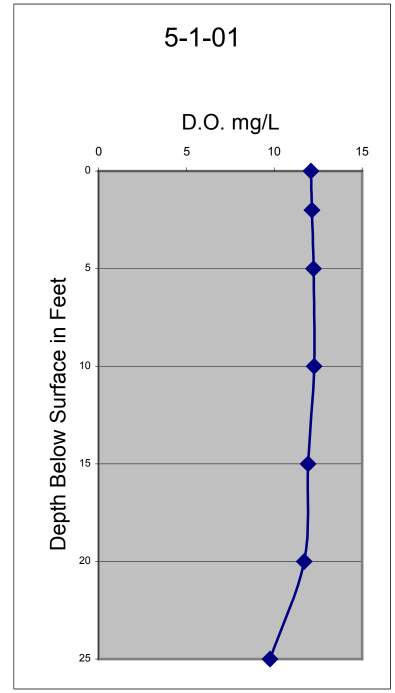
19-Oct		27-Dec
9.65		13.49
9.52		11.31
9.34		10.74
8.77		10.06
8.19		9.93
7.43		9.76
4.5		

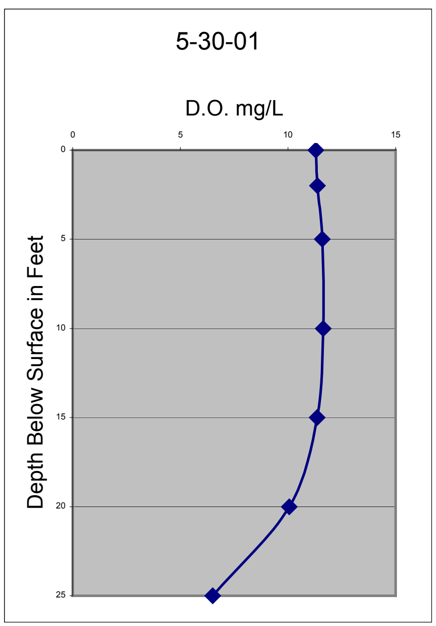
DEER LAKE
2001
DISSOLVED OXYGEN
CONCENTRATION

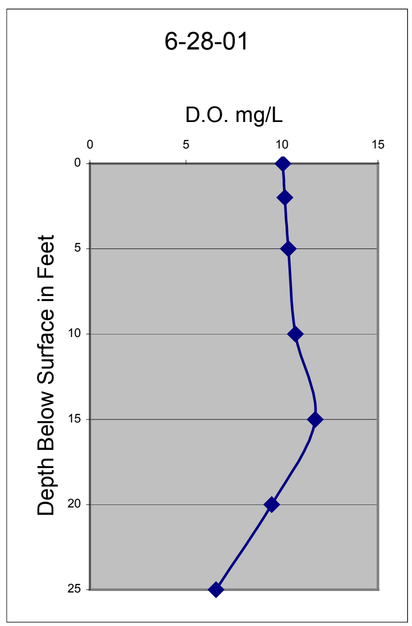


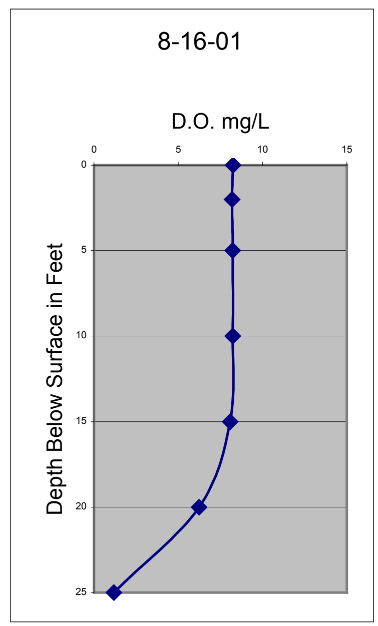


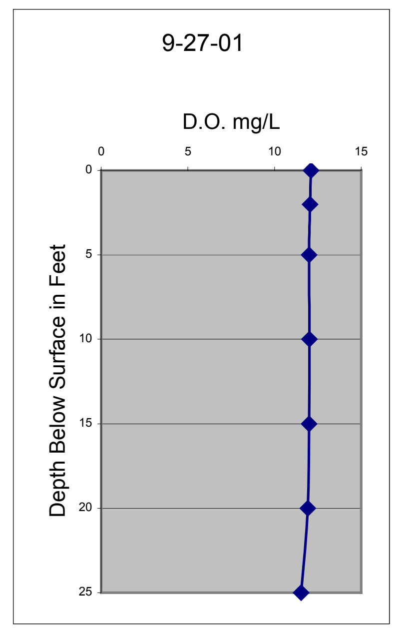












2001 Dissolved Oxygen - Deer Lake

	25-Jan	22-Feb	27-Mar	1-May	30-May
0				12.09	11.3
2	11.54	13.43	12.3	12.14	11.37
5	8.42	9.32	8.22	12.24	11.59
10	7.4	8	7.59	12.27	11.63
15	7.1	6.89	5.91	11.93	11.36
20	6.8	6.37	5.42	11.71	10.06
25	5.9	5.62	4.53	9.76	6.51

	28-Jun	16-Aug	27-Sep
0	10.05	8.26	12.1
2	10.15	8.19	12.05
5	10.33	8.24	12
10	10.7	8.24	12.02
15	11.73	8.08	12
20	9.46	6.23	11.92
25	6.57	1.17	11.54

Table #1 Water Quality Data for Rice Reservoir – LNCC Data for 2000 and 2001

	Site #1 Deer Lake				Site #2 Bridge Lake				Site #3 Eastern Nokomis				Site #4 Central Nokomis			
	April 26, 2000		*May 1, 2001*		*April 26, 2000*		*May 1, 2001*		*April 26, 2000*		*May 1, 2001*		*April 26, 2000*		*May 1, 2001*	
	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom	2-Feet Below Surface	2-Feet Above Bottom
Secchi Reading (feet)	7.3		7.5		6	6	4.9'		8		6.5		8		4.6	
Temperature (F)	55	41	55	44	56	51	63	56	52	45	56		45		57	57
T. Phosphorus (ug/l)	<25	<25	48	140	<25	<25	30	43	<25	71	8+47	30	<25		41+44	31
Chlor a (ug/l)	3.47		13		<0.1		12		1.07		5		4.81		17	
Turbidity (NTU)	1.1	1.41	1.5	44.7	1.42	1.93	2.5		0.84	2.3	2.1	3	1.72	2.3	4	2.8
Suspended Solids (mg/l)	<2.47	3.33	2	129	<2.13	<2.05	2		2.06	<2.25	3	2	<2.0	4.8	3	3
T. Dissolved Solids (mg/l)	64	77	50	48	79	78	60		71	96	62	66	88	65	56	52
Conductivity (UMHOS/CM)	73.4	69.8	74	67	81.9	82.1	68		90.6	90.3	81	81	86.6	88.9	62	62
Color (SU)	5	5	25	20	20	25	55	50	10	10	30	30	30	20	65	60
pH Lab (SU)	7.88	7.74	7.71	7.21	7.79	7.43	7.56		7.71	7.62	7.62	7.61	7.82	7.69	7.45	7.48
Alkalinity (mg/l)	23.9	24.4	27	23	29.4	32.5	25		29.4	35.5	31	30	30.5	35.5	23	23
Hardness (mg/l)			28	31			30	31			35	37			29	29
Sol. Phosphorus (mg/l)	<25	<25	ND	ND	<25	<25			<0.025	550			<0.025	<0.025	0.21+ND	ND
Ammonia-N (mg/l)	<0.06	<0.06	ND	0.032	<0.06	<0.06	ND	0.022	<0.06	<0.06	.026+0.19	0.032	<0.06	<0.06	0.68+0.62	0.62
T. Kjel. Nitrogen (mg/l)	0.68	0.72	0.56	1.72	0.61	<0.05	0.51	0.57	<0.5	3.28	0.5+0.5	0.43	0.74	0.51	0.8+0.069	0.71
NO3-NO2-N (mg/l)	<0.3	<0.3	0.327	0.027	<0.03	<0.03	ND	0.2	<0.3	<0.3	.073+.593	0.066	<0.3	<0.3	2.6	2.3
Sol. Chloride (mg/l)	5.68	5.34	3.5	3.5	<5.00	<5.00	2.8		5.2	5.08	3	3	5.38	5	5.2	<4.5
Sol. Sulfate (mg/l)	<5.00	<5.00	ND	ND	5.23	5.31	ND		5.04	5.02	<4.5	<4.5	5.27	5.11	8	8
Calcium (mg/l)	6.43	6.15	7.1	8.1	8.42	7.78	7.6		8.77	8.98	9.3	9.8	9.17	9.69	0.67	0.66
Iron (mg/l)	0.202	0.131	0.2	2.6	0.291	0.315	0.46	0.98	0.233	0.321	0.53	0.63	0.371	0.814	2.2	2.2
Magnesium (mg/l)	2.22	2.13	2.4	2.7	2.89	2.69	2.5	2.7	2.79	3.08	2.8	3	2.76	2.93	37	37
Manganese (mg/l)	0.007	0.009	9	60	0.018	0.018	12	54	0.016	0.019	13	20	0.021	0.056	0.9	1.1
Potassium (mg/l)	<1.00	<1.00	1	1	<1.00	<1.00	0.9	0.9	<1.00	<1.00	0.7	1	<1.00	<1.00	1.8	1.8
Sodium (mg/l)	2.91	2.96	2.7	2.7	2.77	2.68	2.4	2.4	3.06	3	2.4	2.5	2.49	2.74	9.7	9.66
Silica (mg/l)			5.11	5.22			12.7				13.1	13.3				

	Site #5 Western Nokomis
	June 27, 2000
Secchi Reading (feet)	2.5
Temperature (c)	20.1
T. Phosphorus (ug/l)	0.04
Ammonia-N (mg/l)	0.15
T. Kjel. Nitrogen (mg/l)	0.93
NO3-NO2-N (mg/l)	0.3
T. Org. Nitrogen	0.78
T. Nitrogen	1.23
Dissolved Oxygen	7.38
% Oxygen Sat.	81.3

and one floating plant were found in 19 of the 20 sampling locations in the 5.1 to 9.0 feet depth. In the 2.6 to 5.0 feet water depth, 10 submergents, 6 emergents, 1 floating, and 2 wetland plants were found in only 11 of the 20 sample sites. Five wetland, ten emergent, ten submergent, and one floating plant were found at 13 of the 20 sampling sites. Seventy two percent of the plants found in the 0-2.5 feet depth were found in shoreline wetland areas isolated from the main body of Deer Lake. The wetland species of willow (Salix sp,) and 3 different rushes dominated the 0 to 2.5 feet depth. (Appendix). Emergent aquatic plants are also abundant in the 2.5-5.0 feet depth range and a few were also found in the 5.1 to 9.0 feet range. In the 5.1 to 9.0 feet depth range, needle spike rush dominated the hard sand bottom areas. (Appendix)

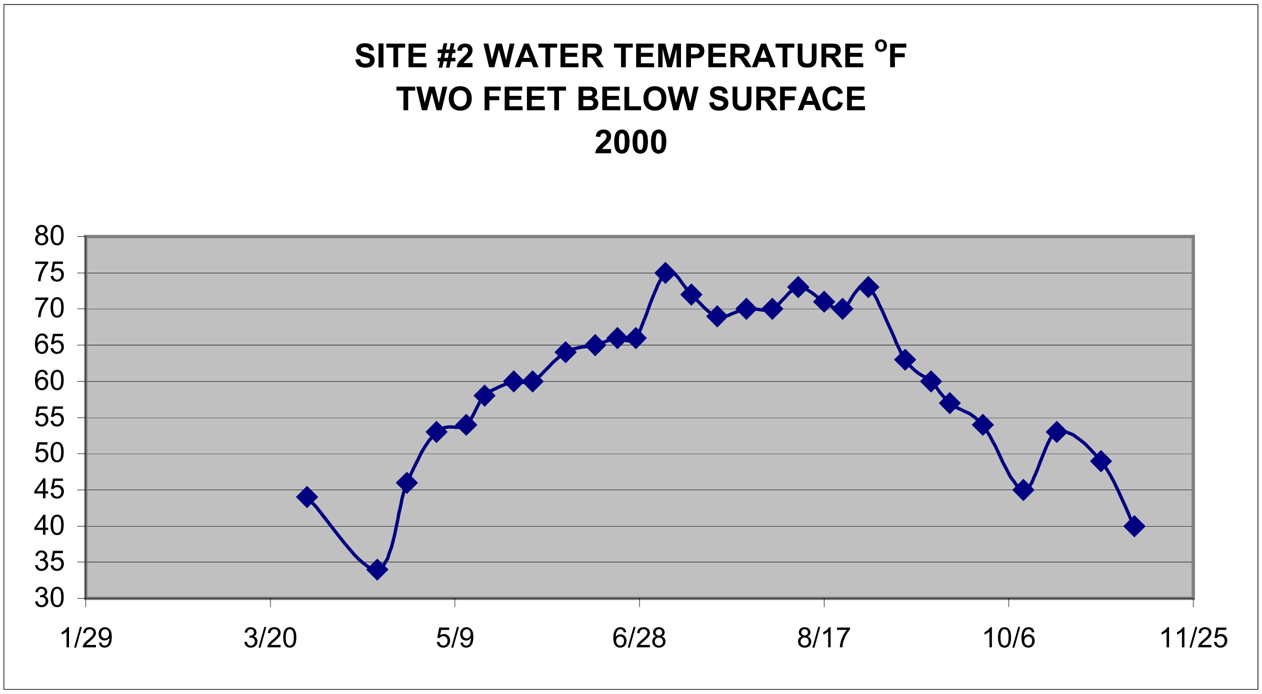
b. Bridge Lake Site #2

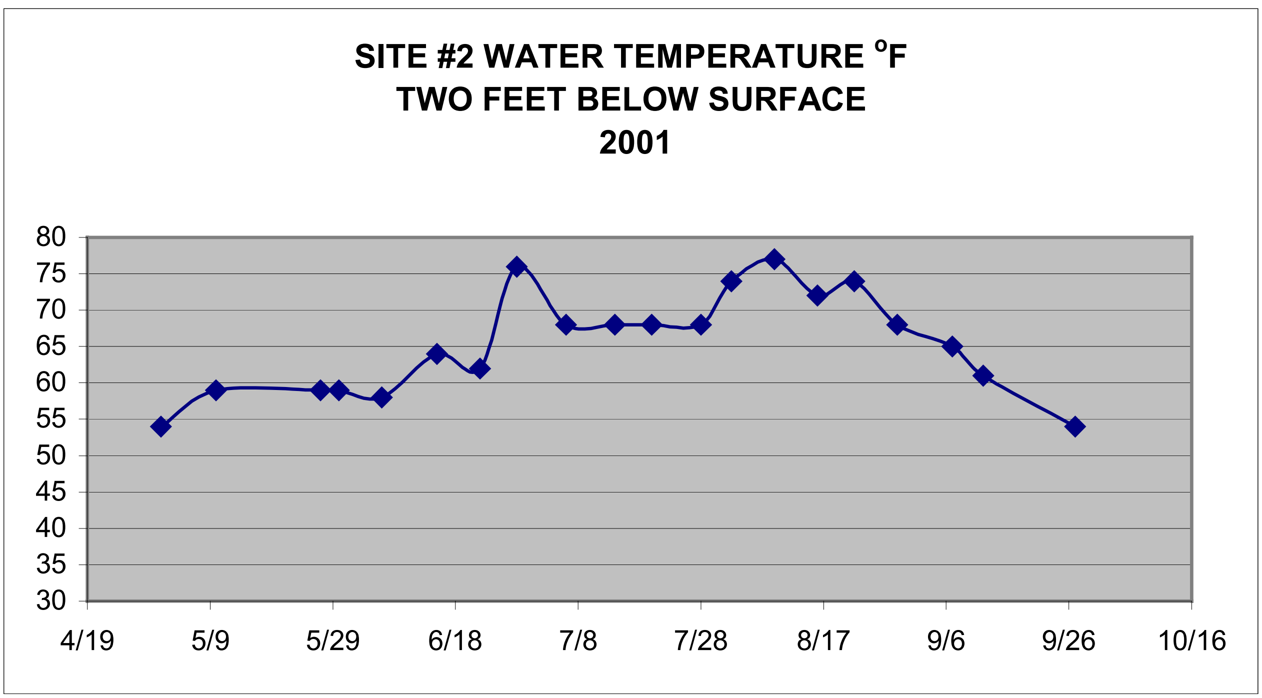
Bridge Lake was formed when the Rice Reservoir flooded peat and marshland low areas of outwash plain east of CTH N and the main body of Lake Nokomis. Two small tributaries flow into Bridge Lake generally from the east. Little Rice Creek is the largest tributary and enters from the northeast and an unnamed tributary enters Bridge Lake from the southeast after passing under STH 8 and STH 51. Little Rice Creek originates at Hancock Lake and flows through Gary Lake, a shallow lake that is approximately three miles upstream of Bridge Lake. Bridge Lake ends as the combined flow of these tributaries passes under the CTH N bridge (Figure 1 and 2).

Water quality data were collected in Bridge Lake in a deep spot where the Little Rice Creek bed intersects the old railroad trestle pilings at location #2 (Figure 2 and 8-11). Twenty-nine secchi readings in 2000 ranged from 1.7 to 11.7 feet and averaged 4.99 feet. Twenty secchi readings in 2001 ranged from 2.5 to 6.25 feet and averaged 4.25 feet.

Dissolved oxygen concentration and water temperature profiles in 2000 and 2001 indicated little temperature changes from the Lake surface to the bottom at this location except at spring run off on April 26, 2000. During summer, temperatures were often a degree warmer at the surface and one or two degrees cooler within 4 to 6 feet from the bottom. Both winter and summer oxygen levels dropped below 5.0 mg/l oxygen in the bottom 2 to 6 feet at this location. (Tables 1).

The aquatic plant community in Bridge Lake was surveyed on June 27 and 30 of 2000, with 25 transect samples that extended from shallow to deep-water. The transects were chosen to represent varying habitats including eroded to non-eroded, developed to non-developed, protected and unprotected bays, and channel areas (Figure 2). Eighty-six sampling sites ranging from 0 to 15 feet identified 26 species of aquatic and semi-aquatic plants (Appendix). Five species of submerged aquatic plants were identified in 6 of the 13 sites sampled in the 9.1 to 15 feet depth. Twelve submergents, one emergent, and one wetland plant were found in 18 of the 23 sampling locations in the 5.1 to 9.0 feet depth. Elodea dominated the plants species found in the 5.1 to 15 feet depth. In the 2.6 to 5.0 feet water depth 10 submergents, 3 emergents, 1 floating, and 1 wetland plant were found in 18 of the 25 sample sites. Bushy Pondweed and Elodea





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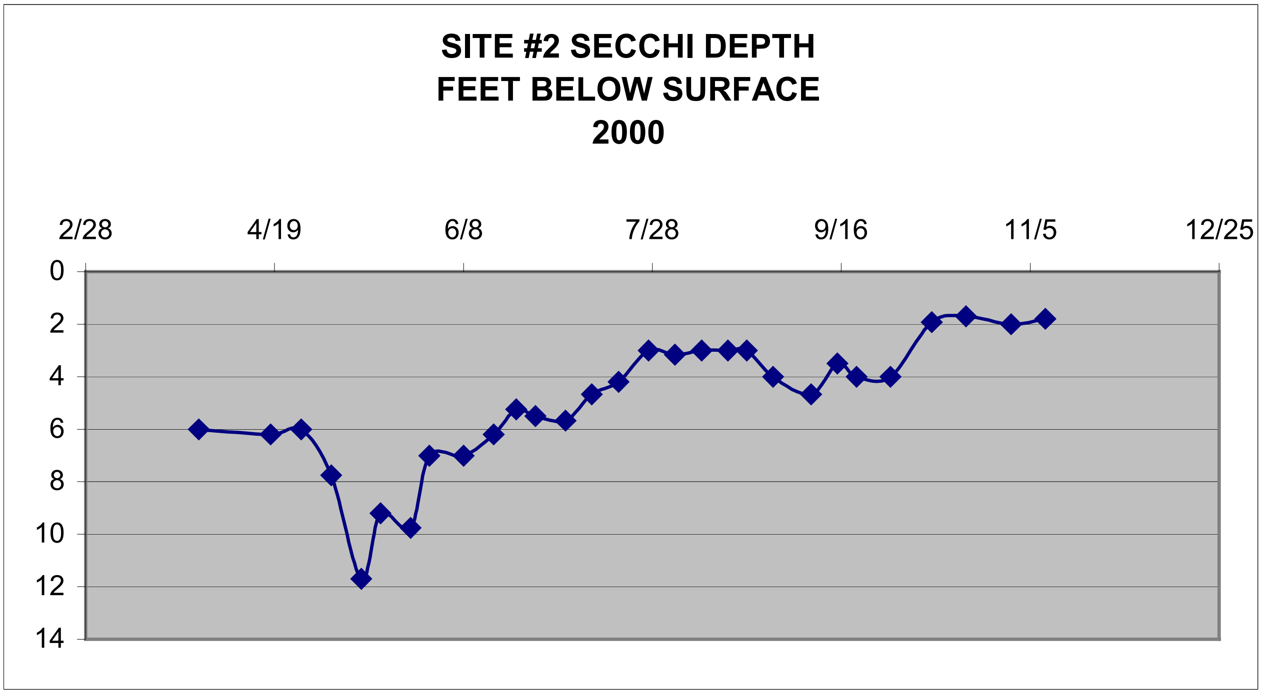
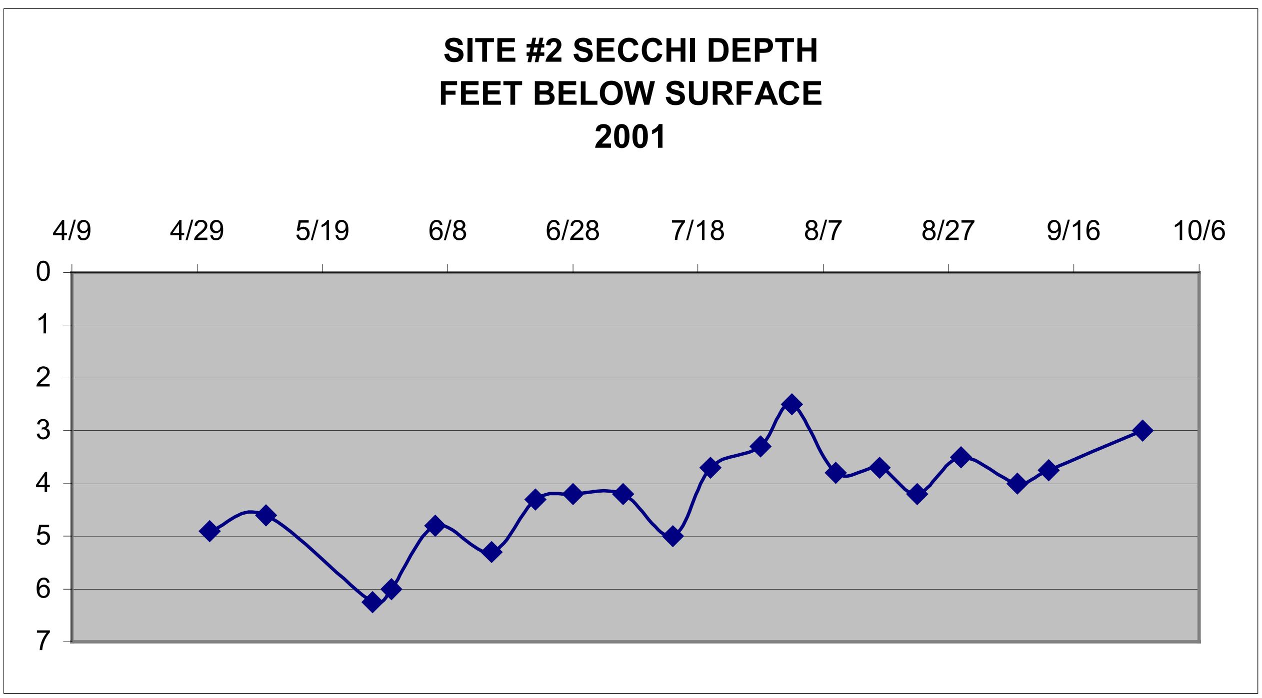
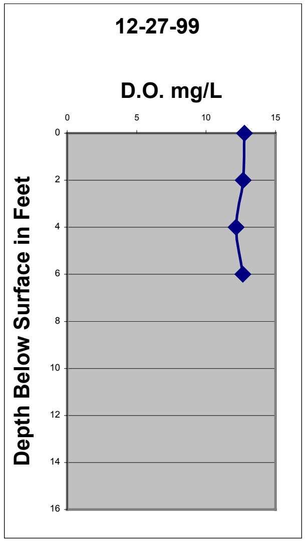

SITE #2 SECCHI DEPTH
FEET BELOW SURFACE
2000
2/28
4/19
6/8
7/28
9/16
11/5
12/25
0
2
4
6
8
10
12
14

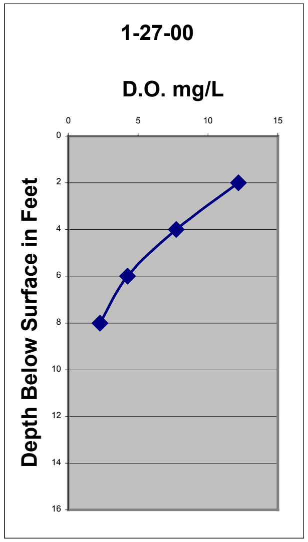

SITE #2 SECCHI DEPTH
FEET BELOW SURFACE
2001
4/9
4/29
5/19
6/8
6/28
7/18
8/7
8/27
9/16
10/6
0
1
2
3
4
5
6
7

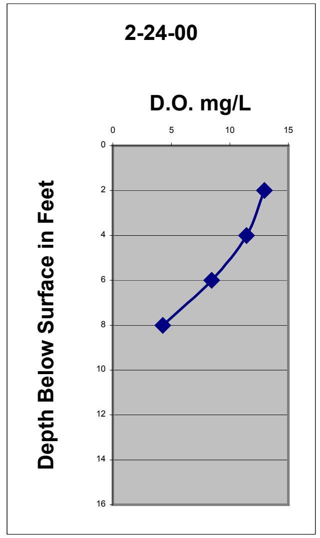
SITE #2

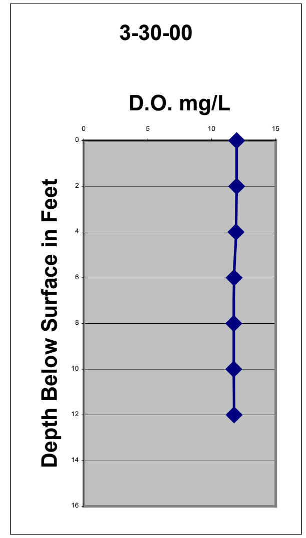
2000	Secchi	Temp	2001	Secchi	Temp
30-Mar	6	44	1-May	4.9	54
18-Apr	6.2	34	10-May	4.6	59
26-Apr	6	46	27-May	6.25	59
4-May	7.75	53	30-May	6	59
12-May	11.7	54	6-Jun	4.8	58
17-May	9.2	58	15-Jun	5.3	64
25-May	9.75	60	22-Jun	4.3	62
30-May	7	60	28-Jun	4.2	76
8-Jun	7	64	6-Jul	4.2	68
16-Jun	6.2	65	14-Jul	5	68
22-Jun	5.25	66	20-Jul	3.7	68
27-Jun	5.5	66	28-Jul	3.3	68
5-Jul	5.67	75	2-Aug	2.5	74
12-Jul	4.67	72	9-Aug	3.8	77
19-Jul	4.2	69	16-Aug	3.7	72
27-Jul	3	70	22-Aug	4.2	74
3-Aug	3.17	70	29-Aug	3.5	68
10-Aug	3	73	7-Sep	4	65
17-Aug	3	71	12-Sep	3.75	61
22-Aug	3	70	27-Sep	3	54
29-Aug	4	73			
8-Sep	4.67	63			
15-Sep	3.5	60			
20-Sep	4	57			
29-Sep	4	54			
10-Oct	1.92	45			
19-Oct	1.7	53			
31-Oct	2	49			
9-Nov	1.8	40			

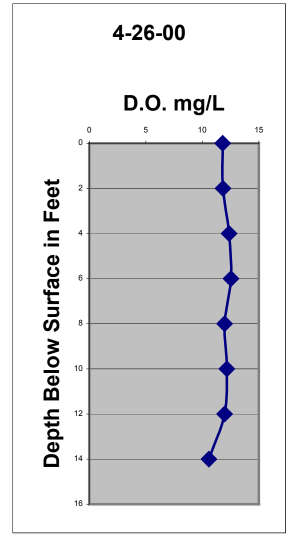
SITE #2 BRIDGE LAKE
1999-2000
DISSOLVED OXYGEN CONCENTRATION

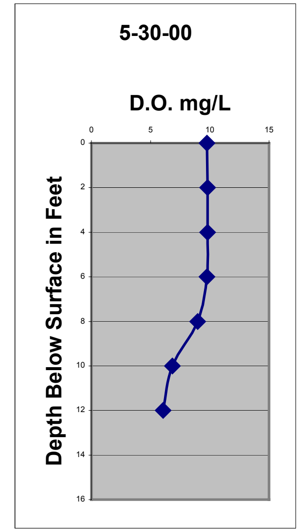


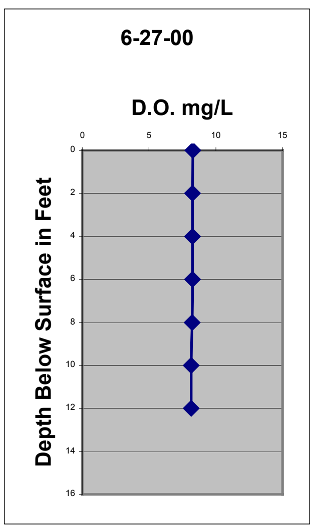


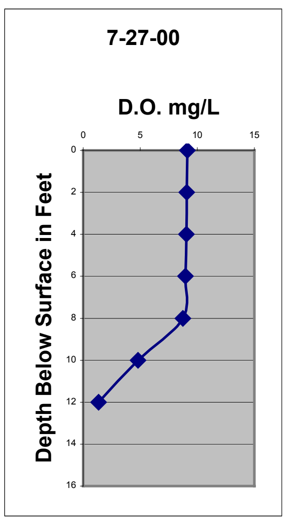


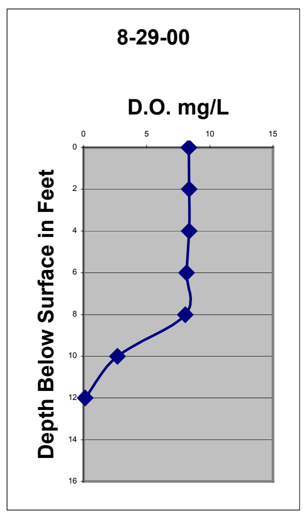


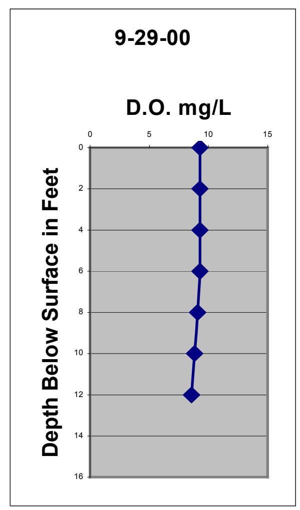


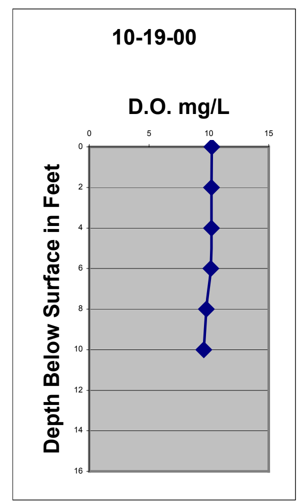


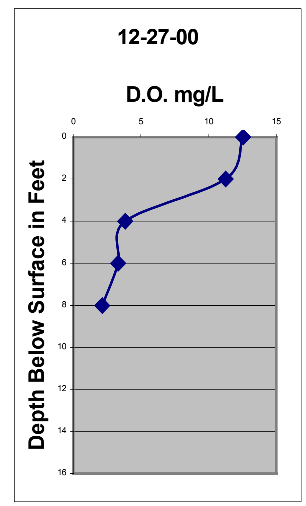










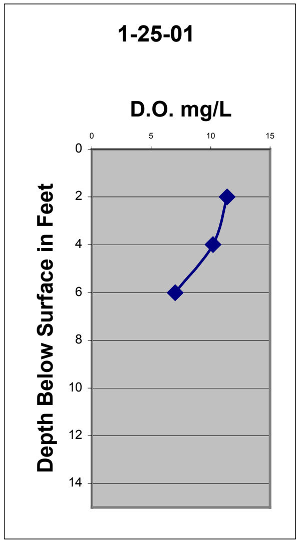


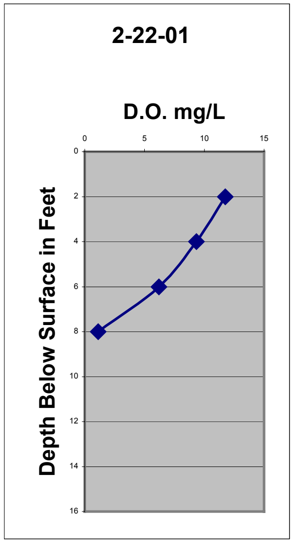
2000 Dissolved Oxygen - Bridge Lake #2

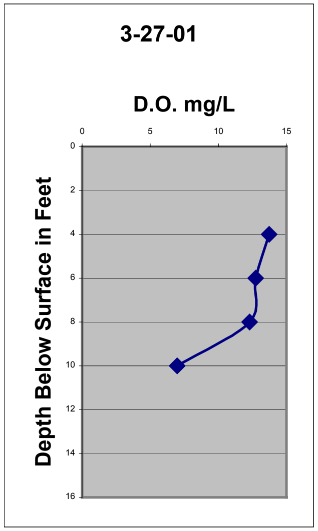
29-Dec	27-Jan	24-Feb	30-Mar	26-Apr
12.75			11.94	11.81
12.66	12.18	12.96	11.95	11.82
12.15	7.73	11.41	11.89	12.38
12.65	4.24	8.45	11.74	12.54
	2.28	4.27	11.73	11.98
			11.72	12.16
			11.74	11.97
				10.59

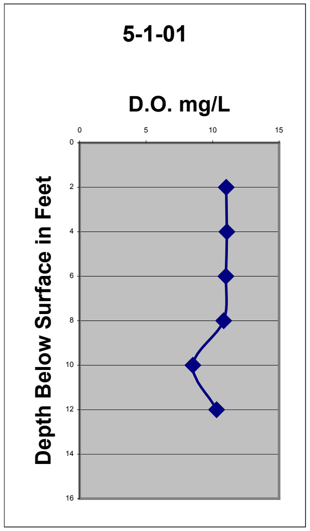
30-May	28-Jun	27-Jul	29-Aug	29-Sep	19-Oct	28-Dec
9.3	8.91	9.63	7.78	9.39	9.65	11.58
9.28	8.91	9.76	7.87	9.35	9.65	10.21
9.34	8.91	8.81	7.9	9.25	9.62	10.93
9.25	8.88	8.57	7.69	9.25	9.58	8.21
9.25	8.86	8.29	7.51	9.2	9.61	4.07
9.22	8.81	8.25	7.44	9.15	8.9	2.23
9.12	8.73	8.28	7.48	8.92	8.41	
9.02	8.7	6.6	7.43	8.92		
	8.55	1.53	1.25	9.44		

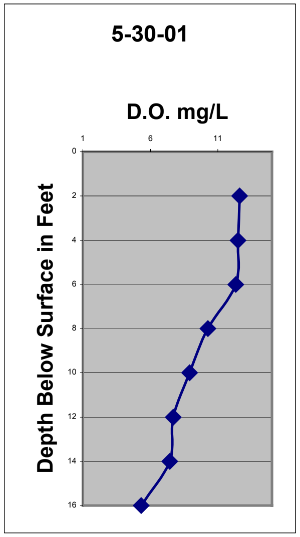
SITE #2 BRIDGE LAKE
2001
DISSOLVED OXYGEN
CONCENTRATION

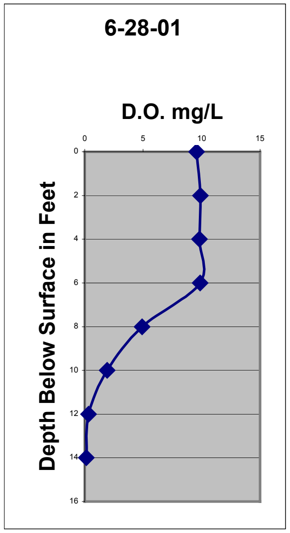


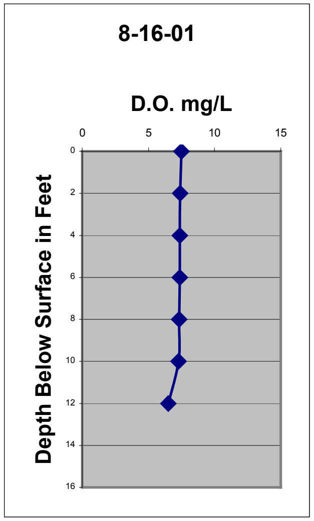












2001 Dissolved Oxygen - Bridge Lake #2

	25-Jan	22-Feb	27-Mar	1-May	30-May
				10.98	12.42
2	11.39	11.75		11.02	12.6
4	10.21	9.34	13.74	11.08	12.49
6	7.01	6.2	12.73	11	12.31
8		1.13	12.29	10.82	10.26
10			6.98	8.51	8.9
12				10.29	7.68
14					7.44
16					5.32

	28-Jun	16-Aug
0	9.57	7.5
2	9.89	7.4
4	9.83	7.39
6	9.86	7.39
8	4.9	7.32
10	1.92	7.29
12	0.32	6.5
14	0.14	
16		

dominated this depth. The willow (Salix sp.) dominated the 0 to 2.5 feet depth (Appendix).

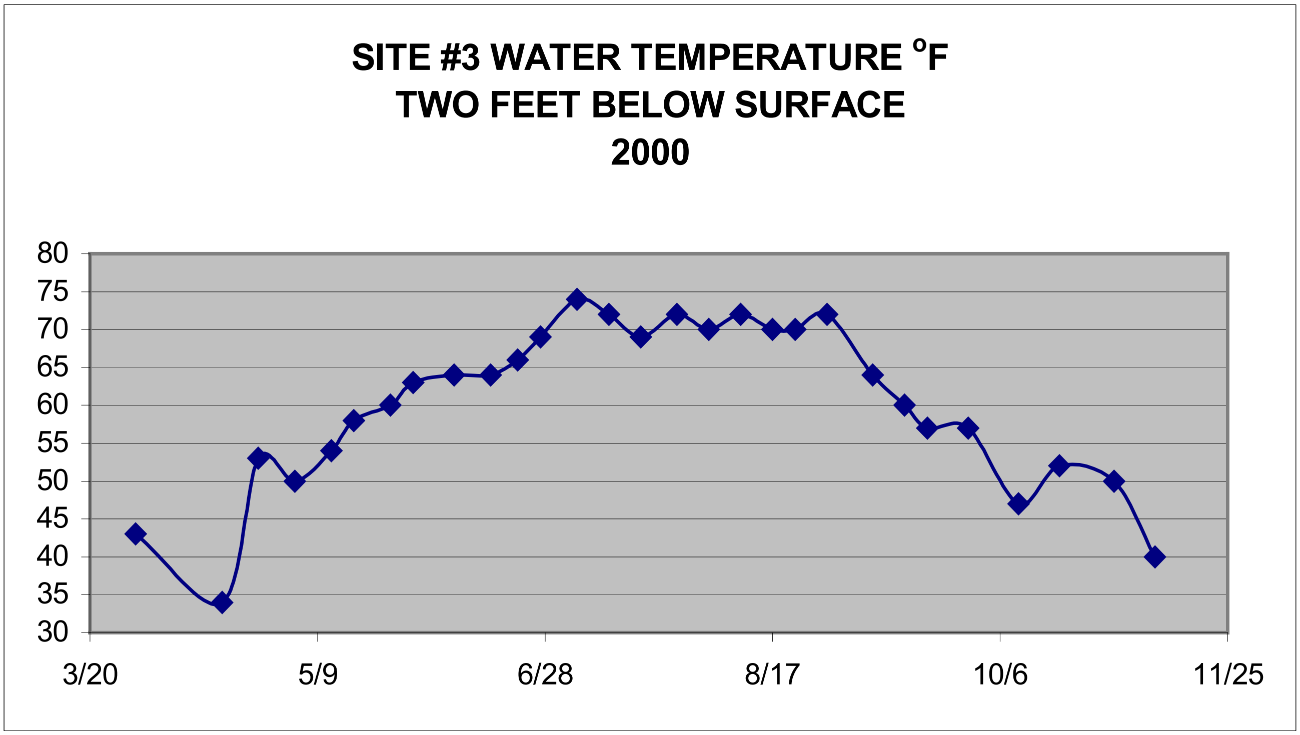
c. Eastern Nokomis site #3

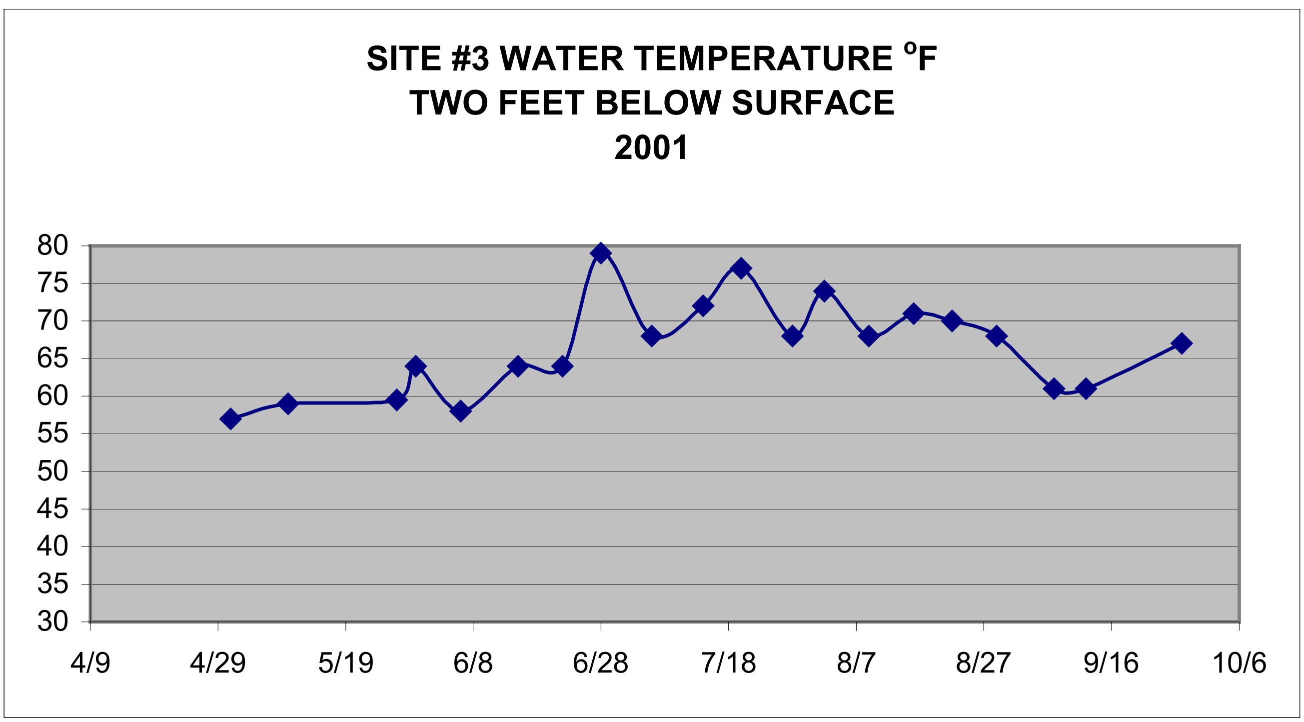
Eastern Nokomis is the second largest open area of the Rice Reservoir. The CTH L Bridge and Honeymoon Bay border it on the southwest, CTH N on the southeast, the large bay west of the snowmobile and bike trail and East of CTH L, and the main body west and southwest of Lake Nokomis Road. Little Rice Creek flows from Bridge Lake and crosses the southern end of this area of the Reservoir under the CTH L Bridge. Small spring flows can be found entering into this area of the Reservoir from the northwest and northeast. Several large islands, floating bogs, and peninsula landforms break up most wide expanses of open water which then are less than a mile across.

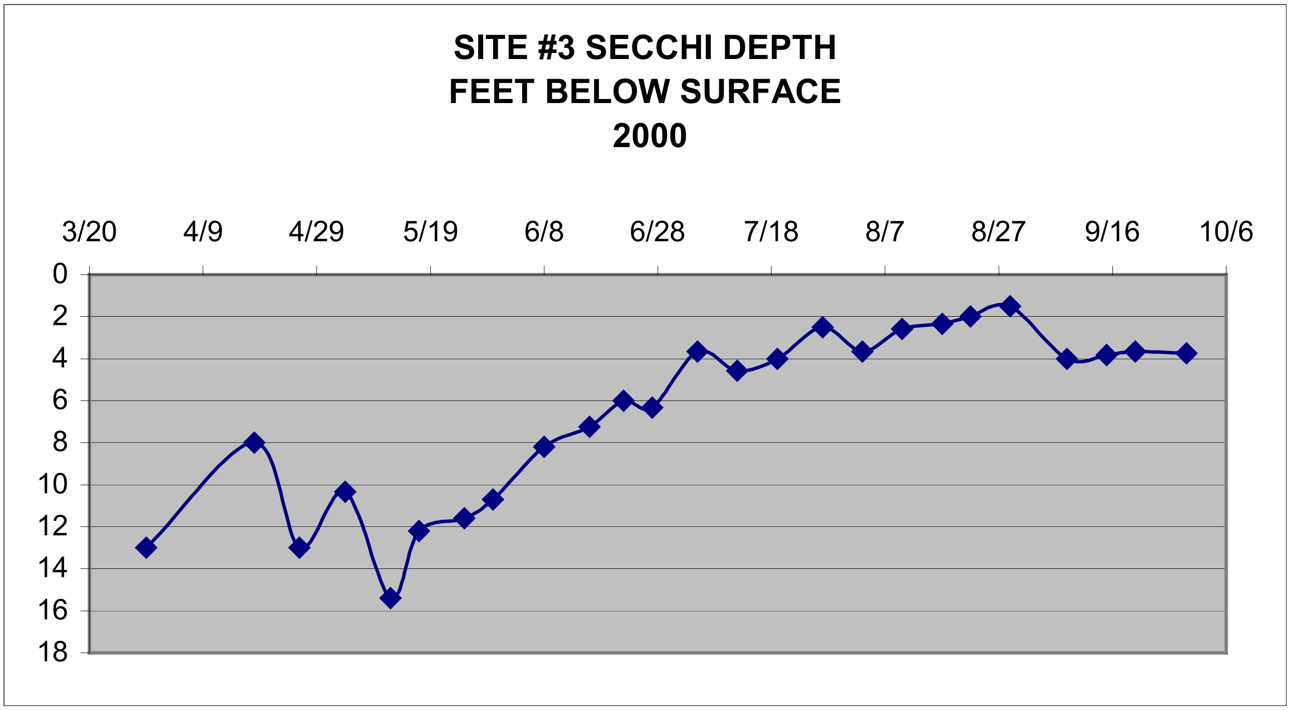
Water quality data were collected in the East Nokomis area of Rice Reservoir in 2000 and 2001 in the deepest area of the largest bay at location # 3 (Figure 1, 2 and 12-15). Twenty-nine secchi readings in 2000 ranged from 1.5 to 15.4 feet and averaged 6.23 feet. Twenty secchi readings in 2001 ranged from 2.0 to 8.5 feet and averaged 5.02 feet.

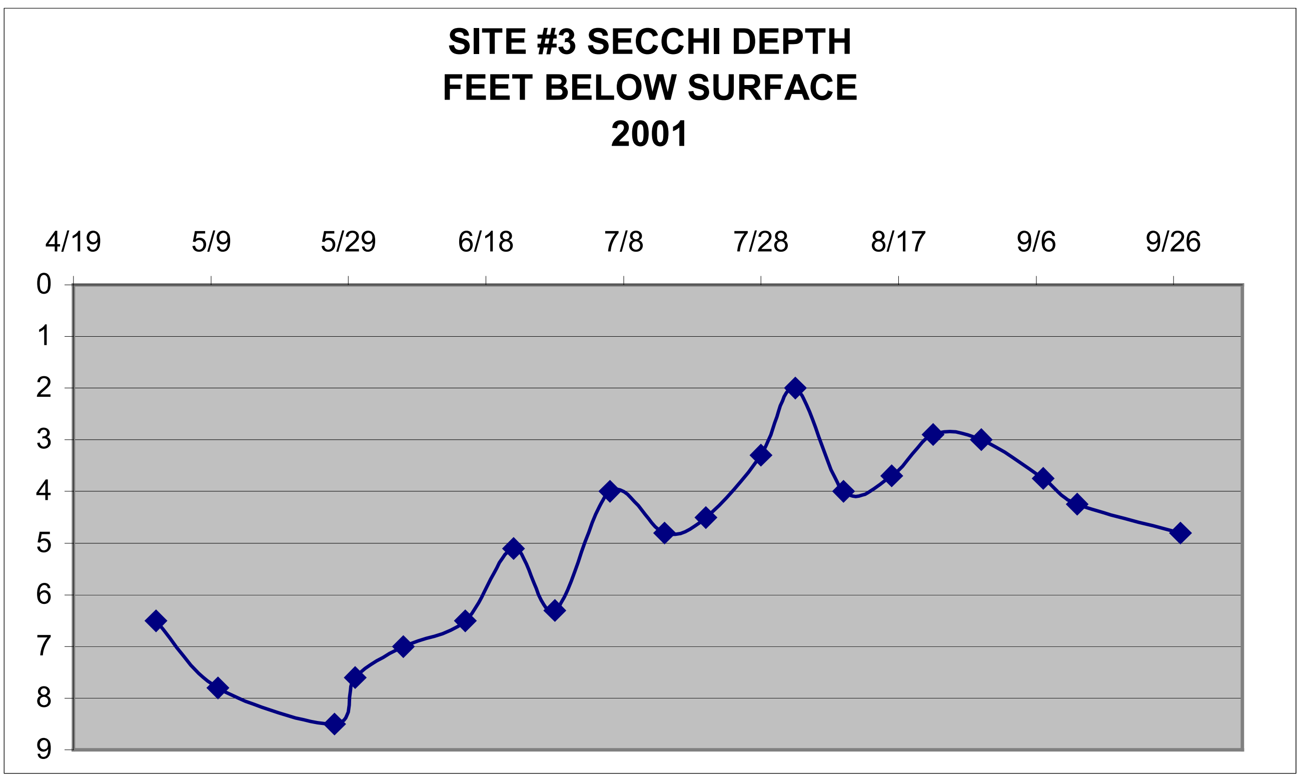
Water temperature varied throughout the season and reached a maximum during the hottest days of summer. Dissolved oxygen levels remained above 5.0 mg/l through most of the water column except during winter ice cover and mid-summer when dissolved oxygen near the bottom dropped quickly. Water chemistry samples collected from site #3 in 2000 and 2001 indicate an increase in nutrients at the bottom of the water column (Table 1).

The aquatic plant community in the East Nokomis area of the Rice Reservoir was surveyed on June 30, 2000, with 13 transect samples that extended from shallow to the deep-water. The transects were chosen to represent varying habitats including eroded to non-eroded, developed to non-developed, and protected bays to open water areas. Fifty-two sampling sites ranging in depth from 0 to 15 feet identified 20 species of aquatic and semi-aquatic plants (Appendix). Seven species of submerged aquatic plants were identified in 6 of the 13 sites sampled in the 9.1 to 15 feet depth. Eight submergents and one floating plant were found in 7 of the 13 sampling locations in the 5.1 to 9.0 feet depth. In the 2.6 to 5.0 feet water depth, six submergents, one emergent, one floating, and no wetland plants were found in 5 of the 13 sample sites. Only three of the six submergent species were found at more than one sampling site at this depth. Elodea dominated this depth as it was found in 3 of the 13 sampling sites. The wetland species of willow (Salix sp,) and Smartweed (Polygonum natans) dominated the 0 to 2.5 feet depth (Appendix).


SITE #3 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2000
80
75
70
65
60
55
50
45
40
35
30
3/20
5/9
6/28
8/17
10/6
11/25


SITE #3 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2001
80
75
70
65
60
55
50
45
40
35
30
4/9
4/29
5/19
6/8
6/28
7/18
8/7
8/27
9/16
10/6





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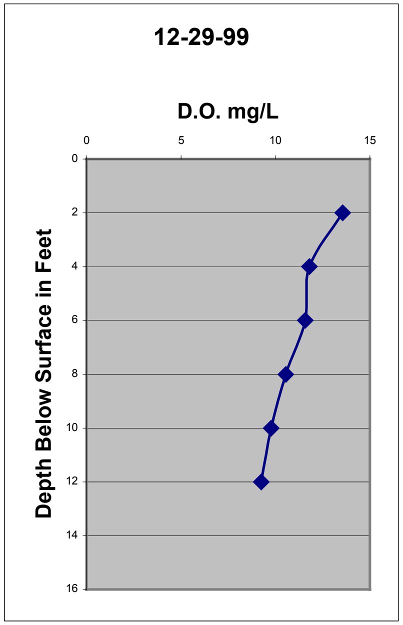
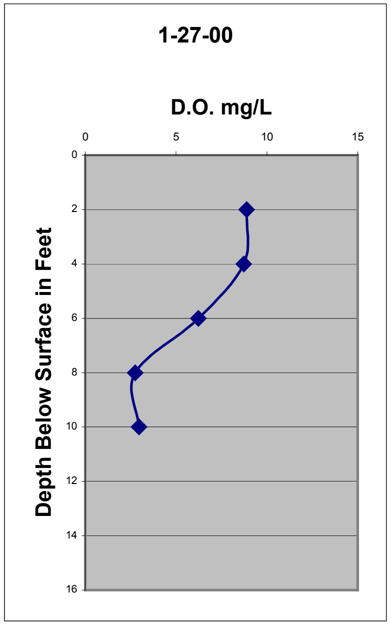
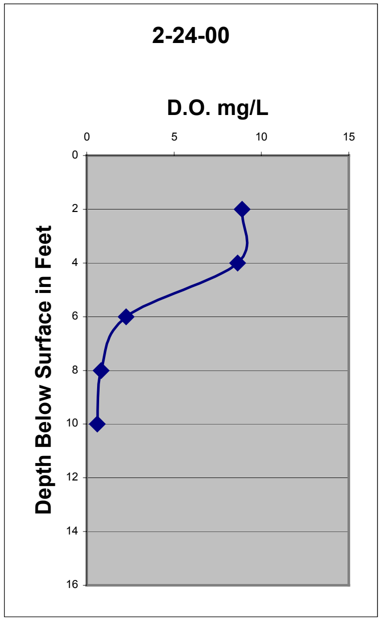
SITE #3

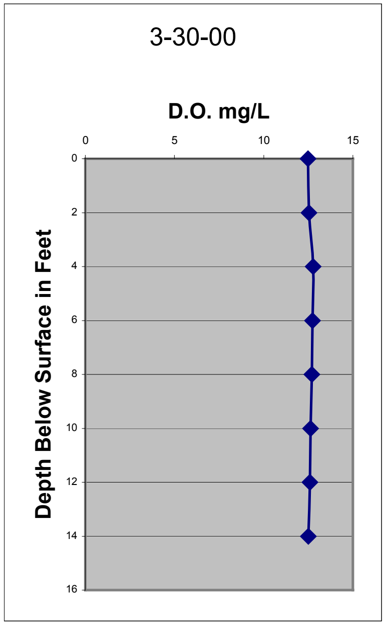
2000	Secchi	Temp	2001	Secchi	Temp
30-Mar	13	43	1-May	6.5	57
18-Apr	8	34	10-May	7.8	59
26-Apr	13	53	27-May	8.5	59.5
4-May	10.33	50	30-May	7.6	64
12-May	15.4	54	6-Jun	7	58
17-May	12.2	58	15-Jun	6.5	64
25-May	11.6	60	22-Jun	5.1	64
30-May	10.7	63	28-Jun	6.3	79
8-Jun	8.2	64	6-Jul	4	68
16-Jun	7.25	64	14-Jul	4.8	72
22-Jun	6	66	20-Jul	4.5	77
27-Jun	6.33	69	28-Jul	3.3	68
5-Jul	3.67	74	2-Aug	2	74
12-Jul	4.58	72	9-Aug	4	68
19-Jul	4	69	16-Aug	3.7	71
27-Jul	2.5	72	22-Aug	2.9	70
3-Aug	3.67	70	29-Aug	3	68
10-Aug	2.58	72	7-Sep	3.75	61
17-Aug	2.33	70	12-Sep	4.25	61
22-Aug	2	70	27-Sep	4.8	67
29-Aug	1.5	72			
8-Sep	4	64			
15-Sep	3.83	60			
20-Sep	3.67	57			
29-Sep	3.75	57			
10-Oct		47			
19-Oct		52			
31-Oct		50			
9-Nov		40			

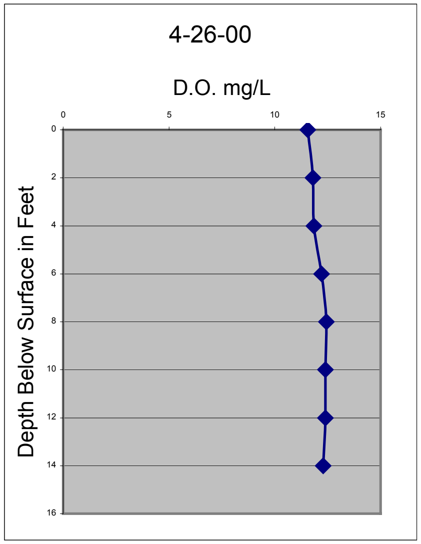
SITE #3 NOKOMIS
2000
DISSOLVED OXYGEN CONCENTRATION

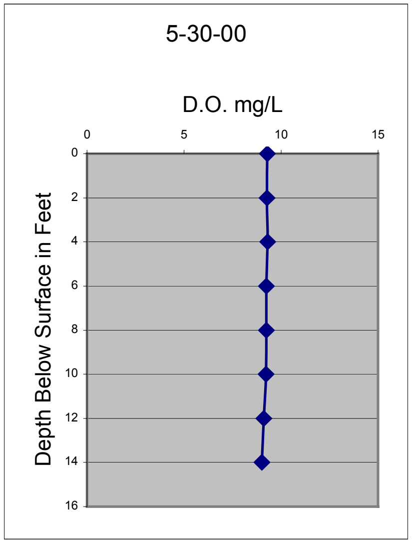


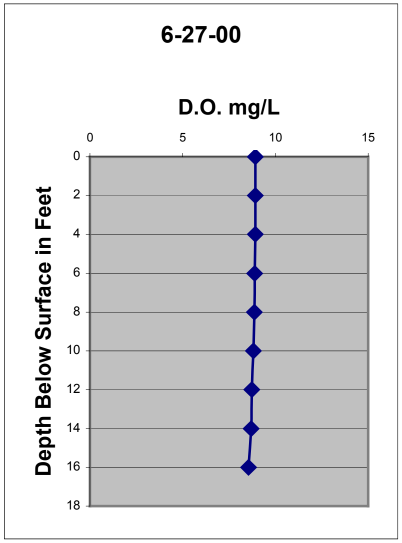


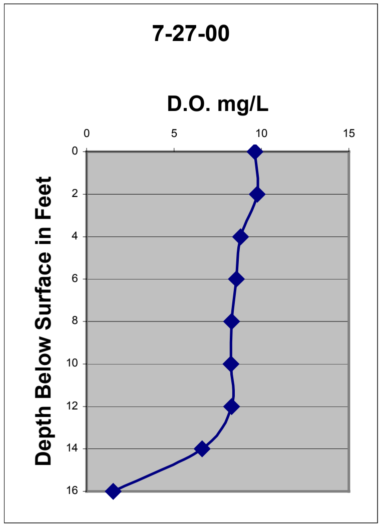




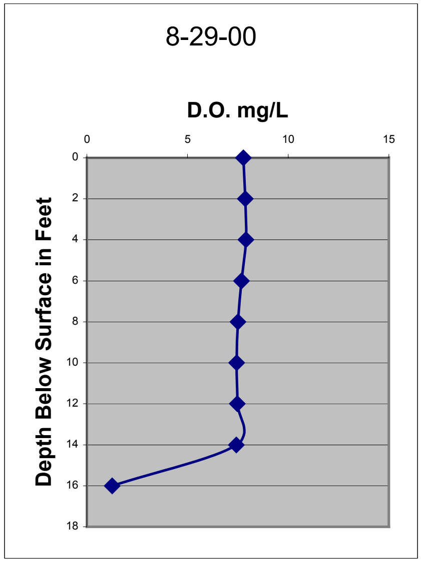


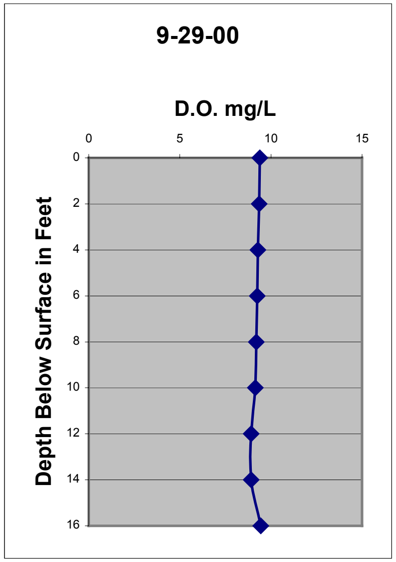


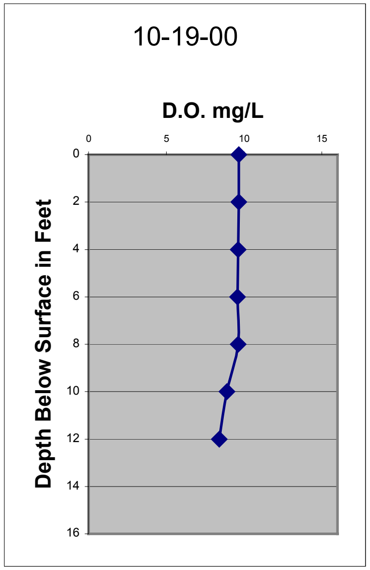


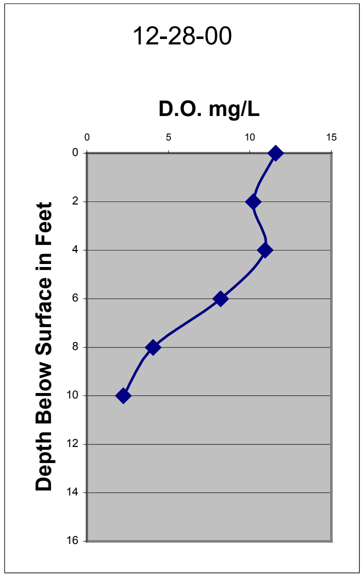


SITE #3 NOKOMIS
2000
DISSOLVED OXYGEN CONCENTRATION
Page 2







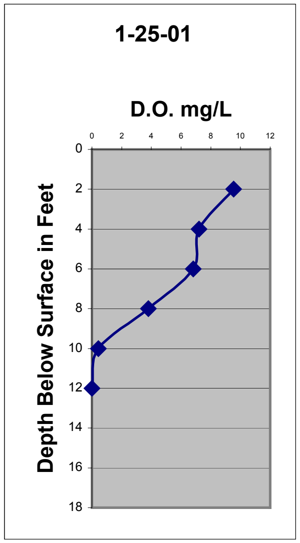


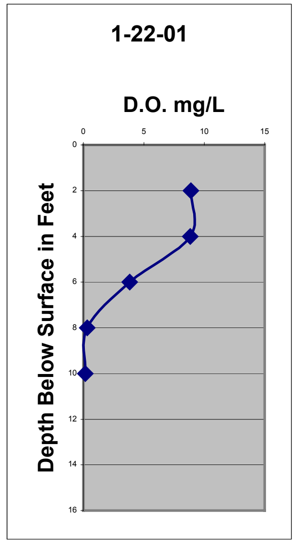
	1999	2000	Dissolved Oxygen - Nokomis #3		
	29-Dec	27-Jan	24-Feb	30-Mar	26-Apr
0				12.48	11.56
2	13.56	8.88	8.9	12.54	11.81
4	11.81	8.73	8.64	12.77	11.85
6	11.59	6.23	2.26	12.74	12.21
8	10.55	2.75	0.83	12.7	12.43
10	9.77	2.95	0.6	12.63	12.39
12	9.25			12.59	12.39
14				12.51	12.28

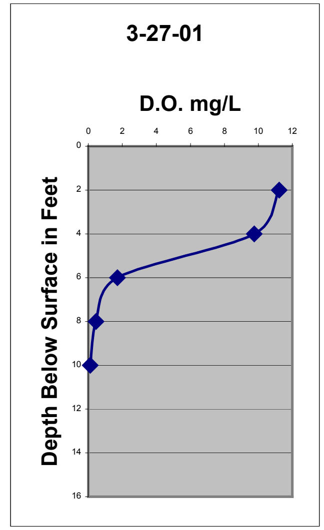
	30-May	27-Jun	27-Jul	29-Aug	29-Sep
0	9.3	8.91	9.63	7.78	9.39
2	9.28	8.91	9.76	7.87	9.35
4	9.31	8.91	8.81	7.9	9.28
6	9.25	8.88	8.57	7.69	9.25
8	9.25	8.86	8.29	7.51	9.2
10	9.22	8.81	8.25	7.44	9.15
12	9.12	8.73	8.28	7.48	8.92
14	9.02	8.7	6.6	7.43	8.92
16		8.55	1.53	1.25	9.44

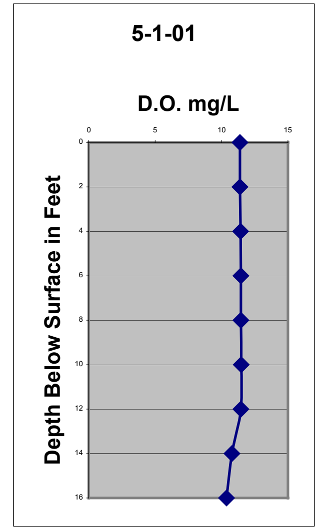
	19-Oct	28-Dec
0	9.65	11.58
2	9.65	10.21
4	9.62	10.93
6	9.58	8.21
8	9.61	4.07
10	8.9	2.23
12	8.41	
14		
16		

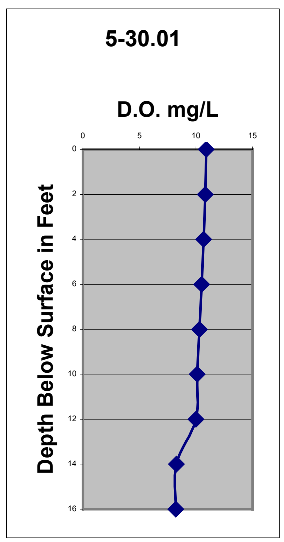
SITE #3 NOKOMIS
2001
DISSOLVED OXYGEN CONCENTRATION

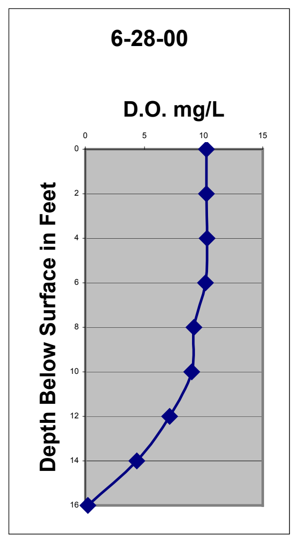


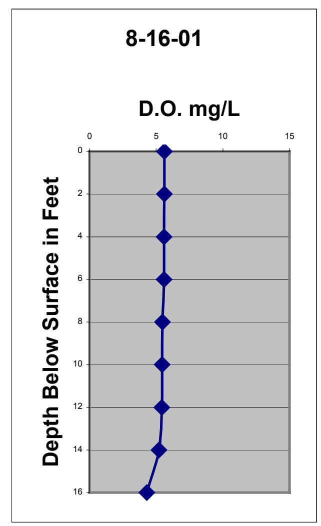












2001 Dissolved Oxygen - Nokomis #3

	25-Jan	22-Feb	27-Mar	1-May	30-May
0				11.38	10.9
2	9.54	8.89	11.23	11.39	10.82
4	7.2	8.84	9.75	11.44	10.68
6	6.82	3.84	1.72	11.46	10.5
8	3.8	0.33	0.45	11.45	10.31
10	0.44	0.16	0.12	11.47	10.1
12	0			11.46	10
14				10.78	8.25
16				10.38	8.21

	28-Jun	16-Aug
0	10.25	5.62
2	10.25	5.61
4	10.31	5.58
6	10.17	5.58
8	9.2	5.47
10	9.01	5.44
12	7.14	5.43
14	4.35	5.2
16	0.22	4.3

d. Central Lake Nokomis Site #4

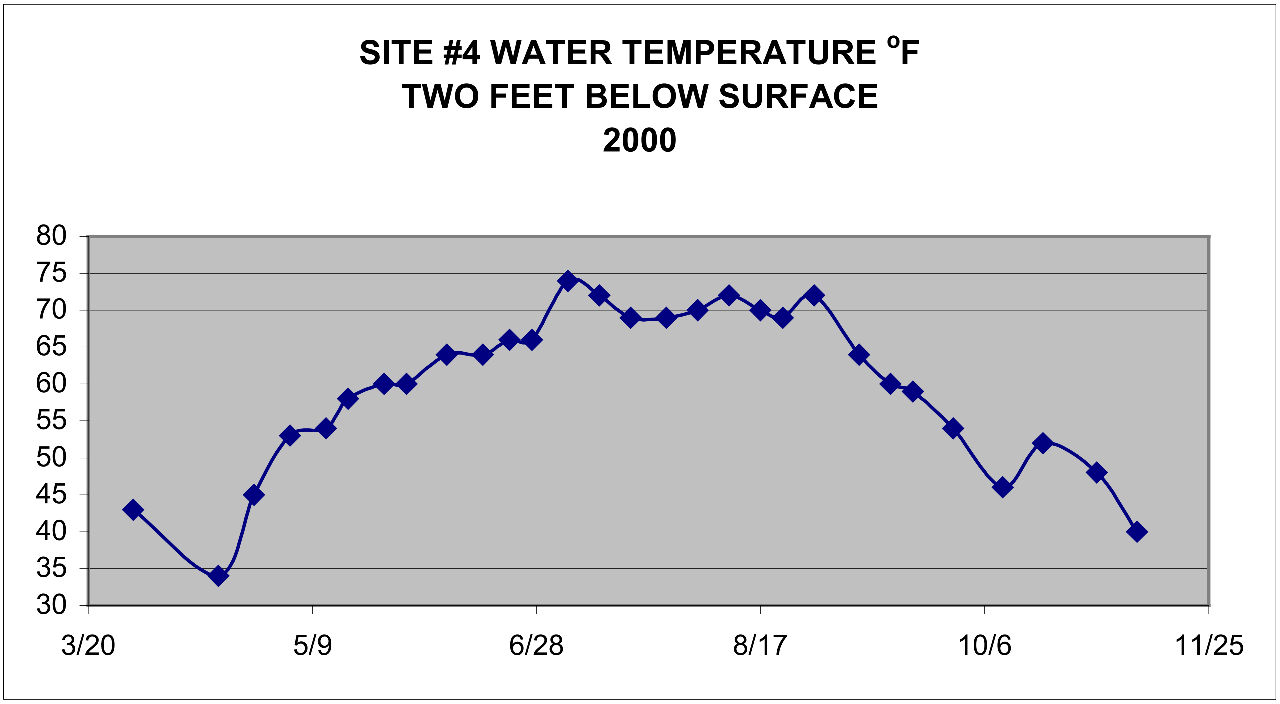
Central Lake Nokomis is the largest open area of the Rice Reservoir. The Tomahawk Arm is bordered by the CTH Y Bridge on the west, the Tomahawk River and Point of Pines on the north, the large outlet bay on the south, and the County Trunk L bridge on the east (Figure 1 and 2). The Tomahawk River joins the Little Rice River and Little Rice Creek in this area of the Reservoir and Point of Pines stream contributes a small flow at the northeast corner of this area. There are only a few small islands in this central area of the Reservoir and wide expanses of open water varying from one to two miles wide are common (Figure 2).

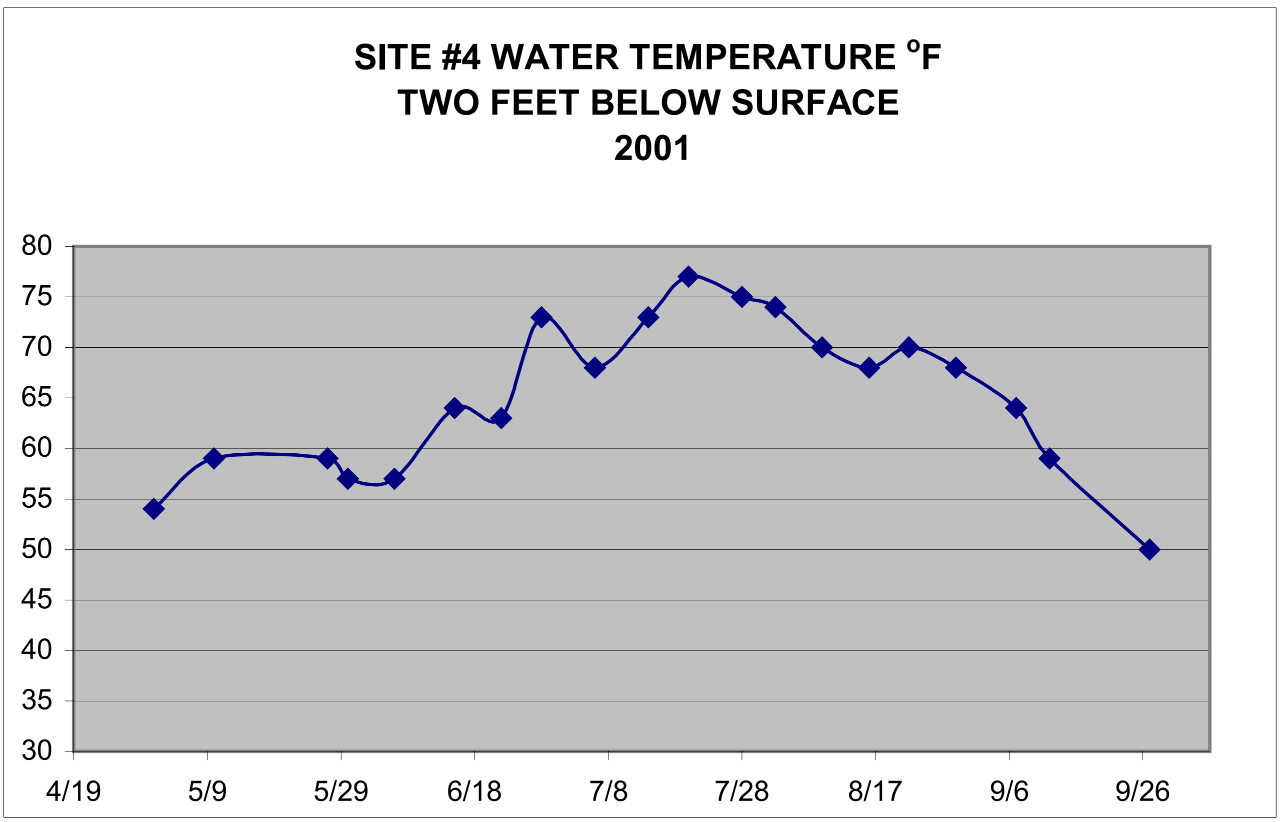
Water quality date were collected in the main body of Rice Reservoir in 2000 and 2001 in a deep area of the largest bay at location # 4 (Figure 1, 2 and 16-21). In 2000, secchi disk readings ranged from 2.0 to 8.8 feet and averaged 4.75 feet. Twenty secchi readings in 2001 ranged from 0.20 to 6.0 feet and averaged 3.49 feet.

At this location, dissolved oxygen concentrations remained above 5.0 mg/l throughout the water column through the entire sampling period except on February 24, 2000, and March 27, 2001.

Water chemistry samples from Central Lake Nokomis were collected in 2000 and 2001 as part of this study by LNCC. Data for chlorophyll a and phosphorus indicated that during the summer of 2000, total phosphorus ranged from 29 to 43 ug/l while chlorophyll a ranged from 7 to 38 ug/l. In 2001, total phosphorus ranged from 27 to 63 ug/l and chlorophyll a ranged from 8 to 26 ug/l (Table 1).

The aquatic plant community in Lake Nokomis was surveyed on July 10 and 11 of 2000 with 25 transect samples that included shallow and deep-water. The transects were chosen to represent varying habitats in the Tomahawk Arm and main body of Lake Nokomis. Ninety-six sampling sites ranging from 0 to 15 feet identified 24 species of aquatic and semi-aquatic plants. (Appendix). Five species of submerged aquatic plants were identified in only 4 of the 23 sites sampled in the 9.1 to 15 feet depth. Eight submergents and one floating plant were found in only 9 of the 25 sampling locations in the 5.1 to 9.0 feet depth. In the 2.6 to 5.0 feet water depth 8 submergents, 3 emergents, 1 floating, and 1 wetland plant were found in 9 of the 25 sample sites. The three emergent species found at 6 of the 25 sampling sites were all in dense beds. Bushy pondweed dominated this depth as it was found in 7 of the 9 sites where macrophytes were present. The semi-aquatic invasive Reed Canary Grass and willows dominated the 0 to 2.5 feet depth (Appendix).





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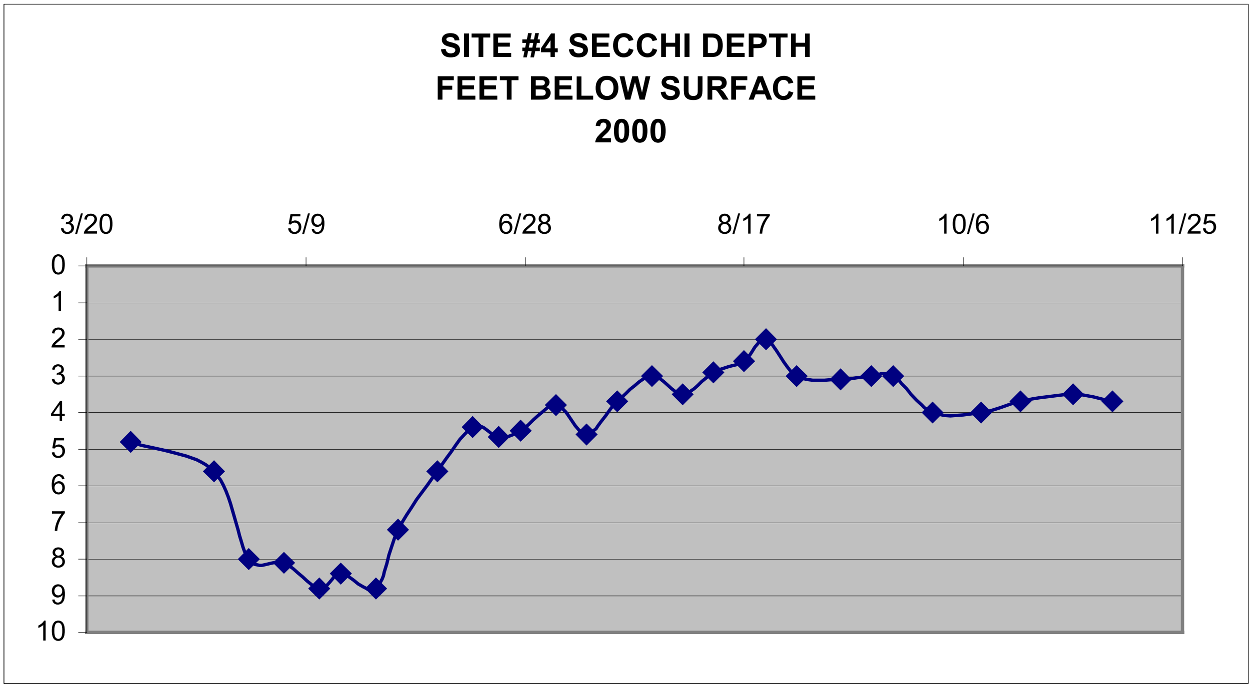

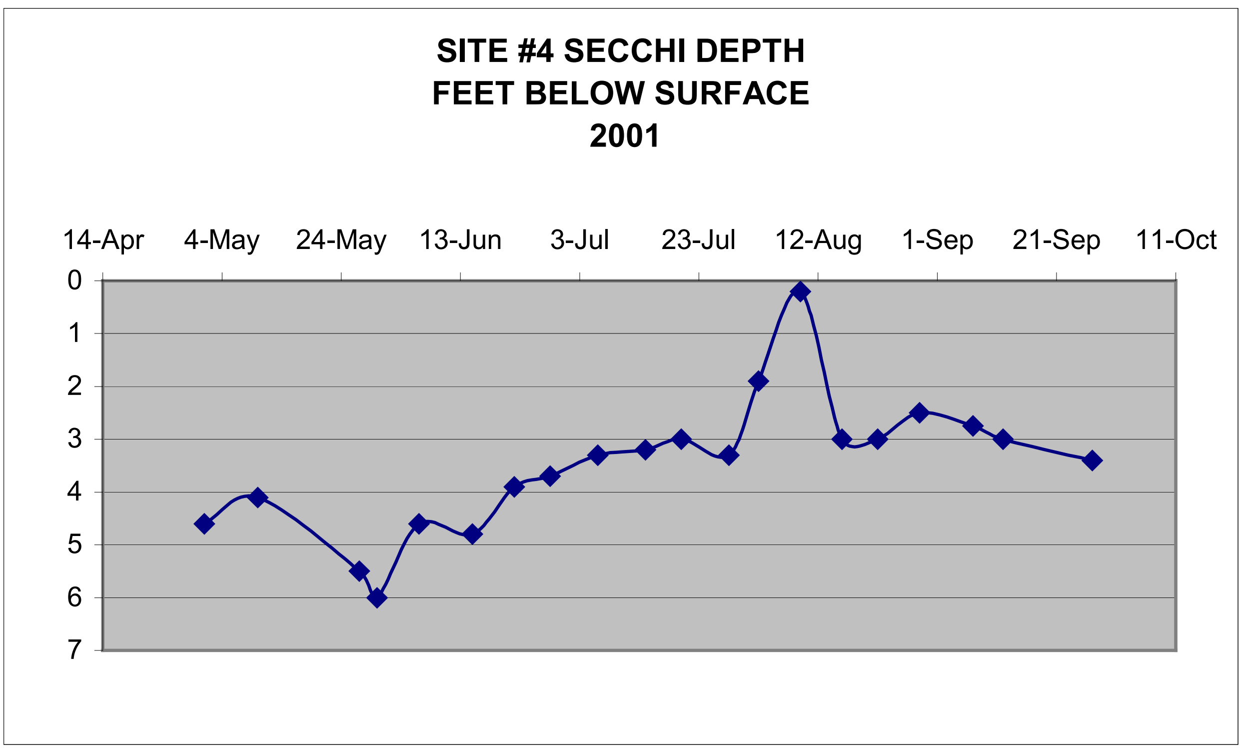

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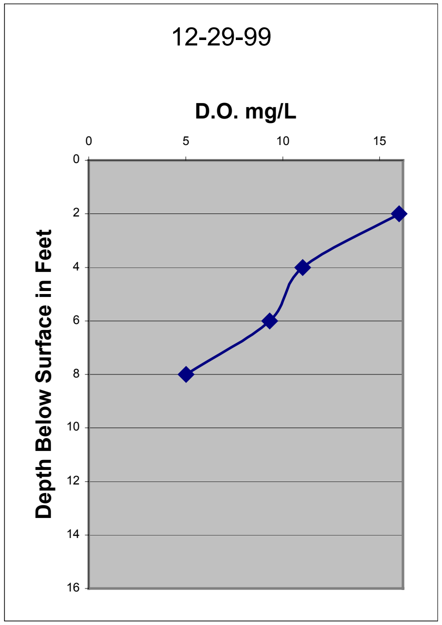
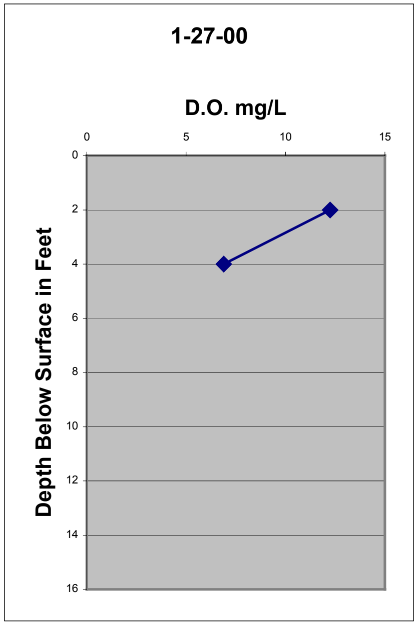
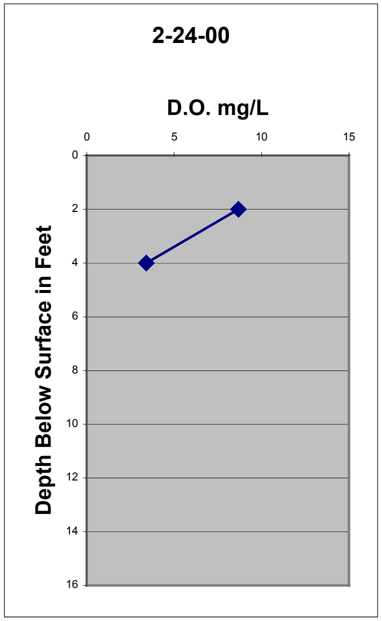
SITE #4

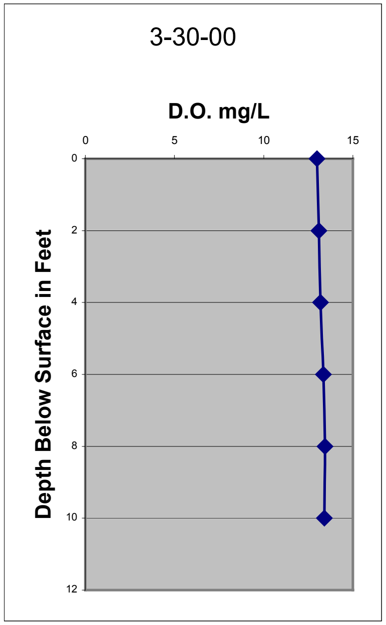
2000	Secchi	Temp	2001	Secchi	Temp
30-Mar	4.8	43	1-May	4.6	54
18-Apr	5.6	34	10-May	4.1	59
26-Apr	8	45	27-May	5.5	59
4-May	8.1	53	30-May	6	57
12-May	8.8	54	6-Jun	4.6	57
17-May	8.4	58	15-Jun	4.8	64
25-May	8.8	60	22-Jun	3.9	63
30-May	7.2	60	28-Jun	3.7	73
8-Jun	5.6	64	6-Jul	3.3	68
16-Jun	4.4	64	14-Jul	3.2	73
22-Jun	4.67	66	20-Jul	3	77
27-Jun	4.5	66	28-Jul	3.3	75
5-Jul	3.8	74	2-Aug	1.9	74
12-Jul	4.6	72	9-Aug	0.2	70
19-Jul	3.7	69	16-Aug	3	68
27-Jul	3	69	22-Aug	3	70
3-Aug	3.5	70	29-Aug	2.5	68
10-Aug	2.9	72	7-Sep	2.75	64
17-Aug	2.6	70	12-Sep	3	59
22-Aug	2	69	27-Sep	3.4	50
29-Aug	3	72			
8-Sep	3.1	64			
15-Sep	3	60			
20-Sep	3	59			
29-Sep	4	54			
10-Oct	4	46			
19-Oct	3.7	52			
31-Oct	3.5	48			
9-Nov	3.7	40			

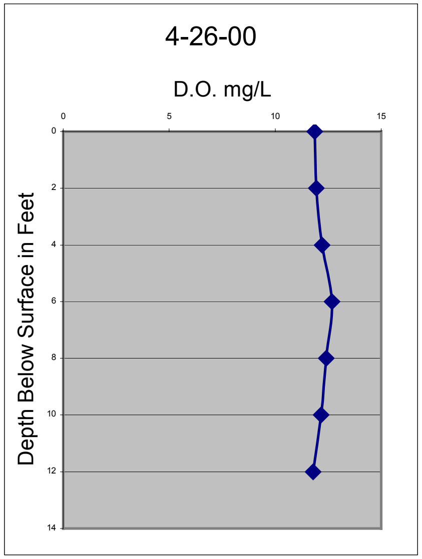
SITE #4 NOKOMIS
1999-2000
DISSOLVED OXYGEN CONCENTRATION

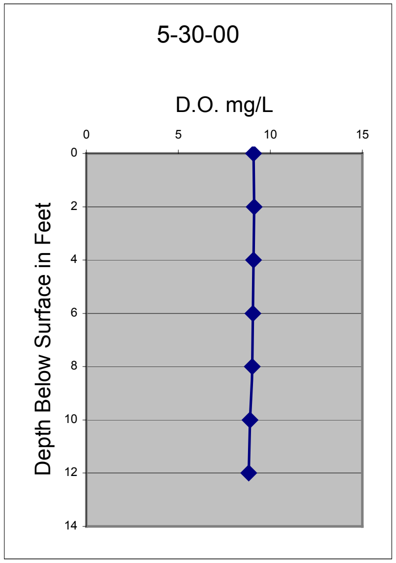


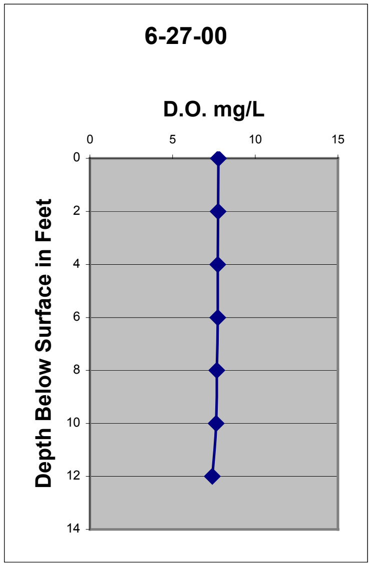


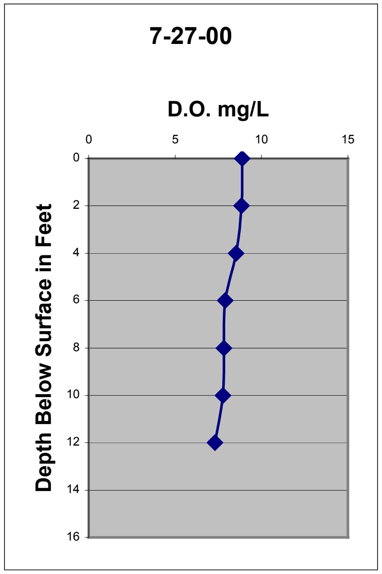




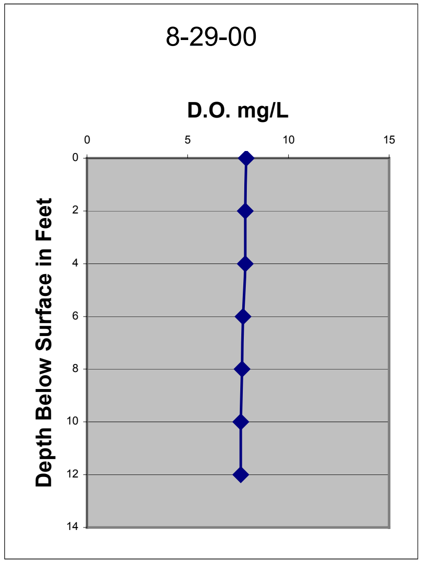


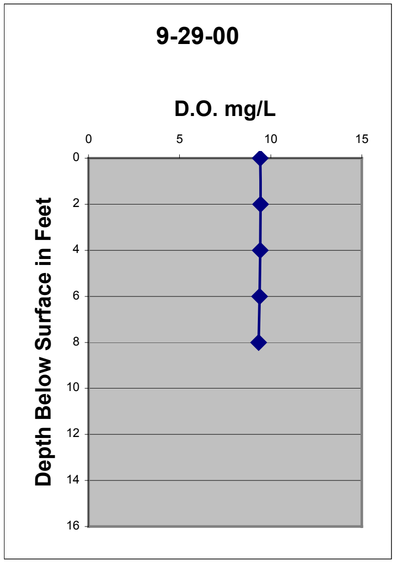


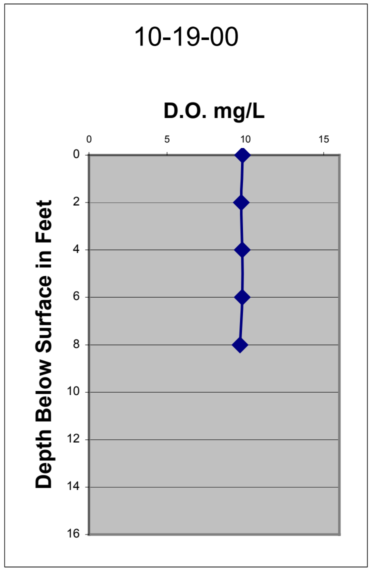


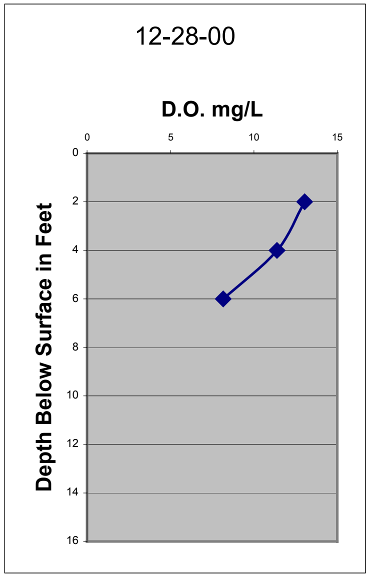


SITE #4 NOKOMIS
1999-2000
DISSOLVED OXYGEN
CONCENTRATION
Page 2







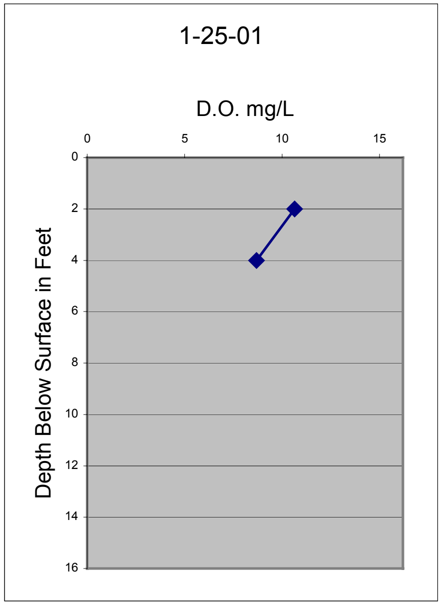


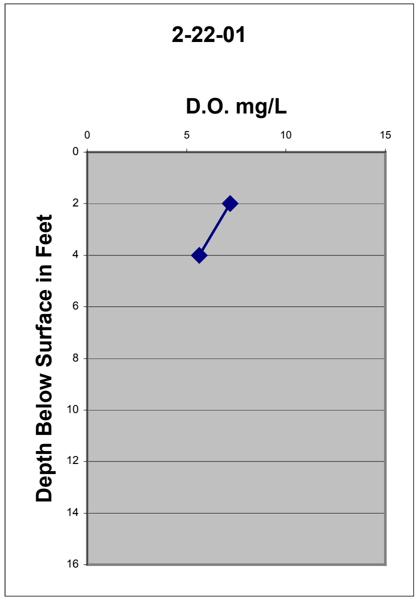
	1999	2000	Dissolved Oxygen - Nokomis #4		
	29-Dec	27-Jan	24-Feb	30-Mar	26-Apr
0				12.98	11.86
2	16.01	12.25	8.67	13.09	11.93
4	11.03	6.89	3.41	13.18	12.21
6	9.33			13.34	12.67
8	5.02			13.43	12.41
10				13.4	12.17
12					11.78
14					

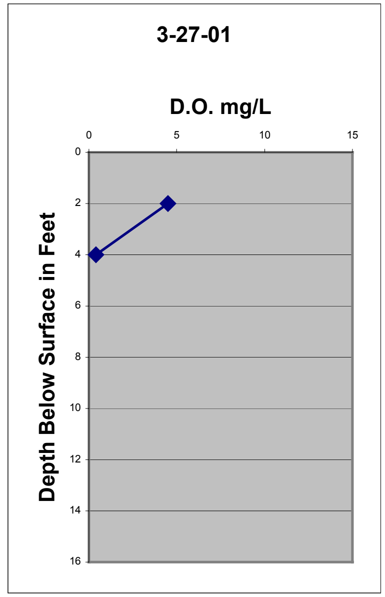
	30-May	27-Jun	27-Jul	29-Aug	29-Sep
0	9.09	7.78	8.89	7.9	9.42
2	9.12	7.75	8.85	7.85	9.44
4	9.09	7.74	8.53	7.85	9.42
6	9.04	7.73	7.9	7.74	9.39
8	9.02	7.67	7.83	7.7	9.34
10	8.9	7.64	7.77	7.63	
12	8.83	7.4	7.31	7.63	
14					
16					

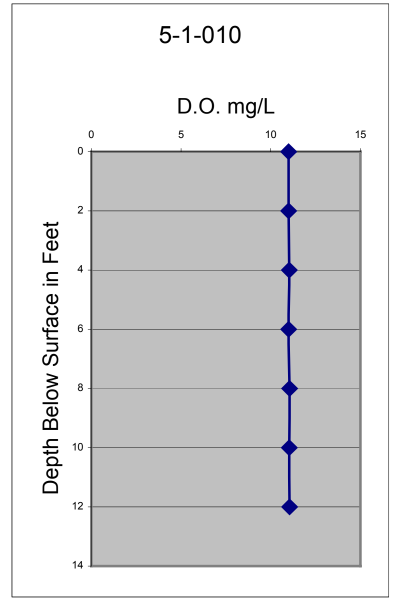
	19-Oct	28-Dec
0	9.82	
2	9.74	13.03
4	9.81	11.39
6	9.8	8.16
8	9.66	
10		
12		
14		
16		

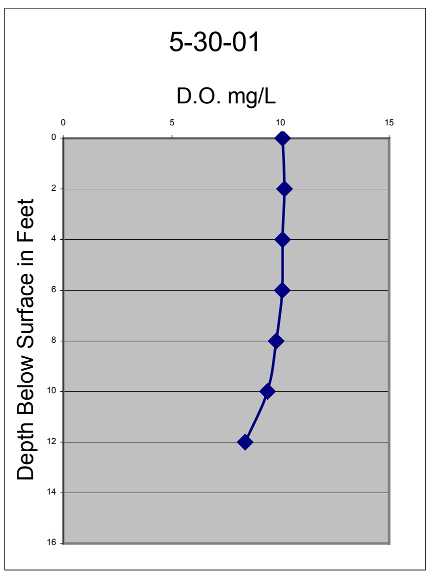
SITE #4 NOKOMIS
2001
DISSOLVED OXYGEN CONCENTRATION

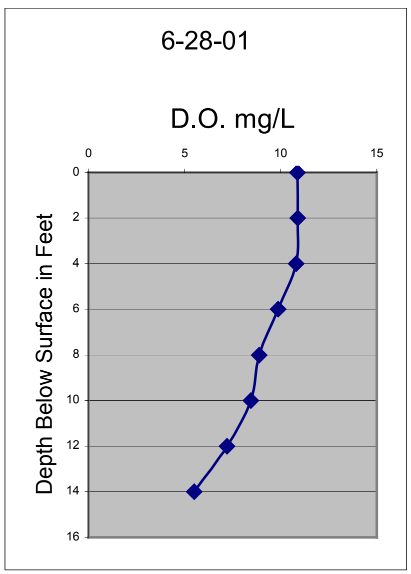


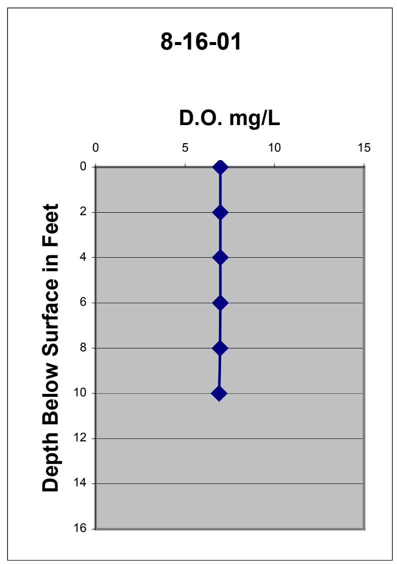


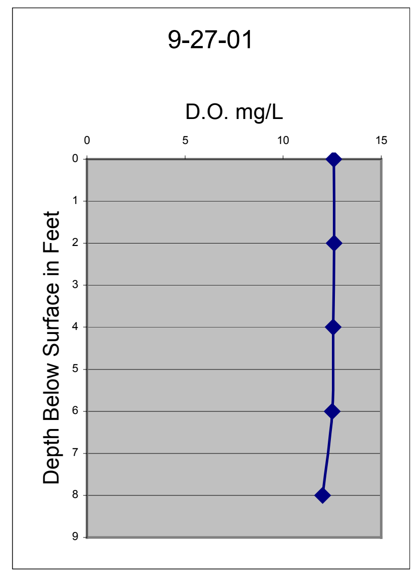




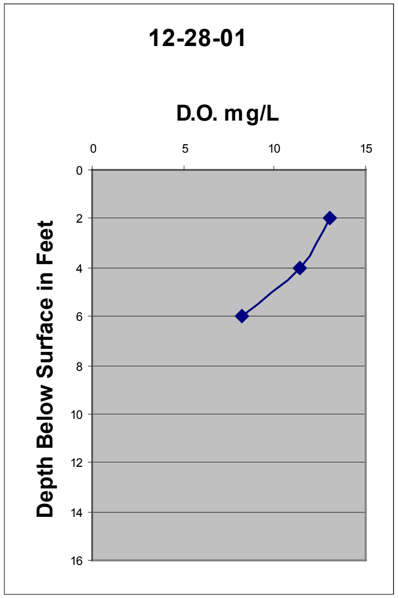








SITE #4 NOKOMIS
2001
DISSOLVED OXYGEN
CONCENTRATION
Page 2



2001 Dissolved Oxygen - Nokomis #4

	25-Jan	22-Feb	27-Mar	1-May	30-May
0				11	10.10
2	10.64	7.2	4.5	11	10.19
4	8.69	5.63	0.4	11.04	10.10
6				11	10.08
8				11.05	9.81
10				11.03	9.41
12				11.06	8.37
14					

	28-Jun		16-Aug	27-Sep	28-Dec
0	10.87		6.98	12.58	
2	10.89		6.98	12.6	13.03
4	10.81		6.98	12.55	11.39
6	9.87		6.97	12.5	8.16
8	8.88		6.95	12.02	
10	8.45		6.91		
12	7.2				
14	5.5				
16					

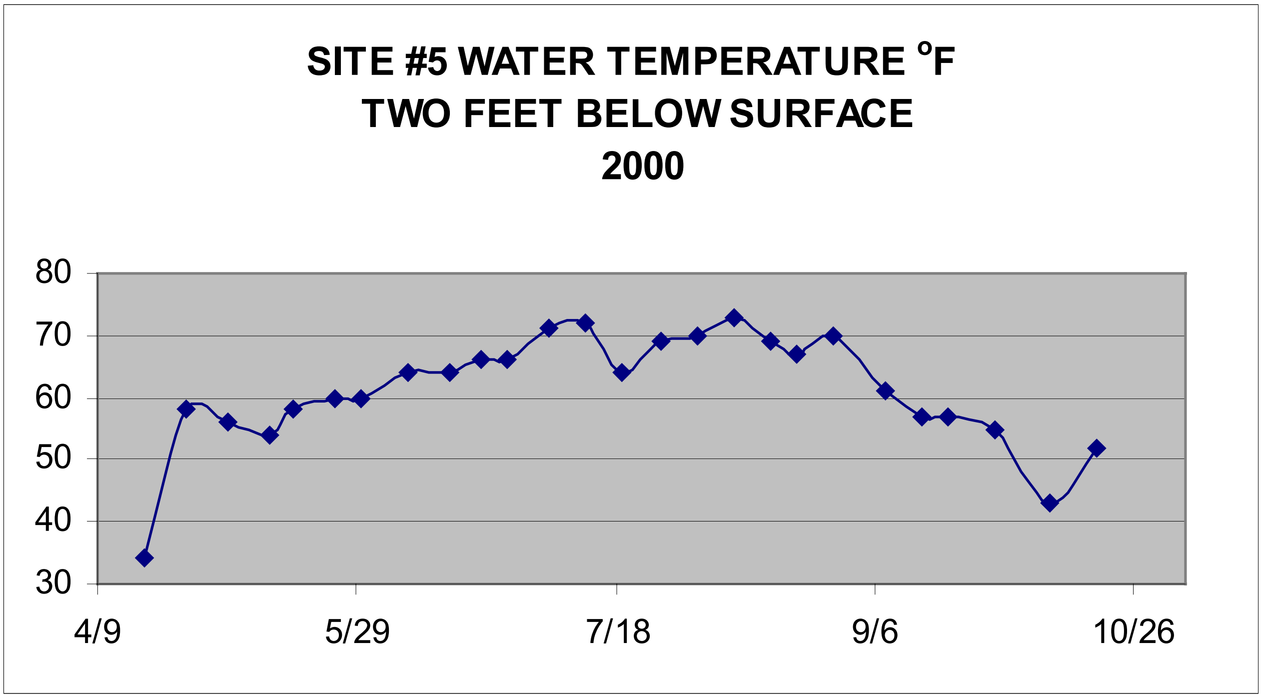
e. Western Lake Nokomis Site #5

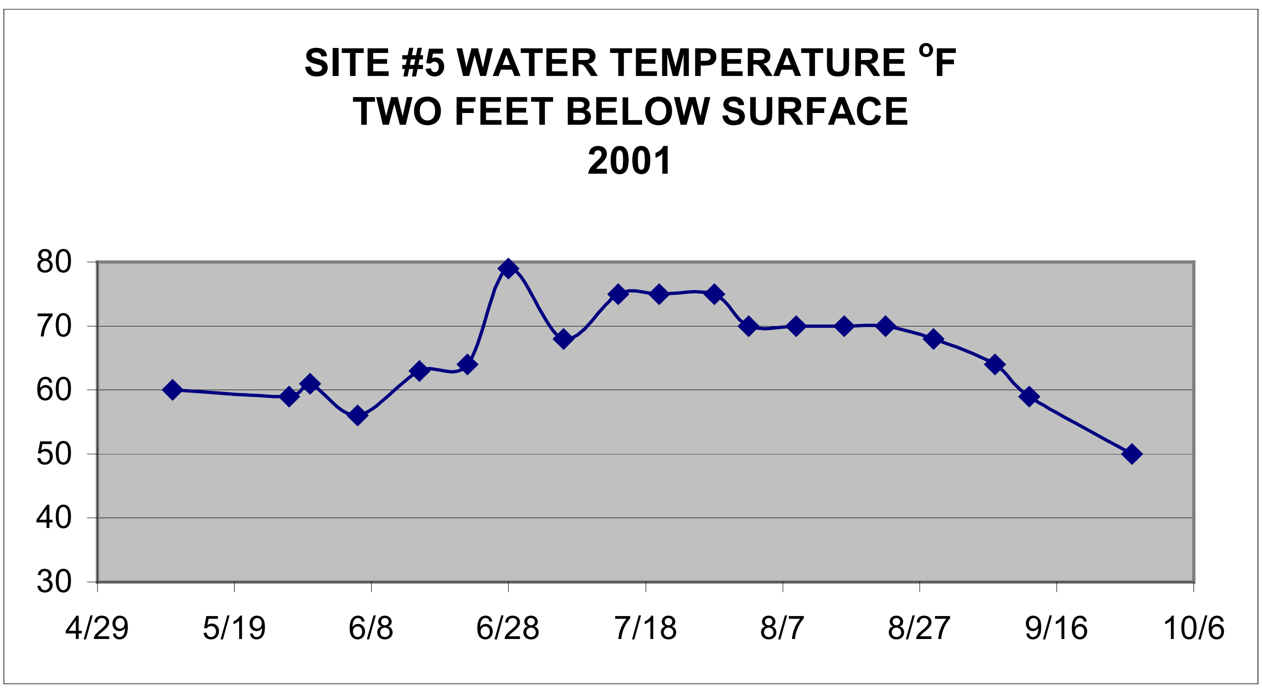
The Western Lake Nokomis Site consists of the Little Rice Arm of Rice Reservoir, which begins downstream from the outlet of the Killarney Reservoir, between Kelly Dam and Flowage Road (Figure 1). The Western Lake Nokomis area ends where the Reservoir narrows as it passes under CTH Y.

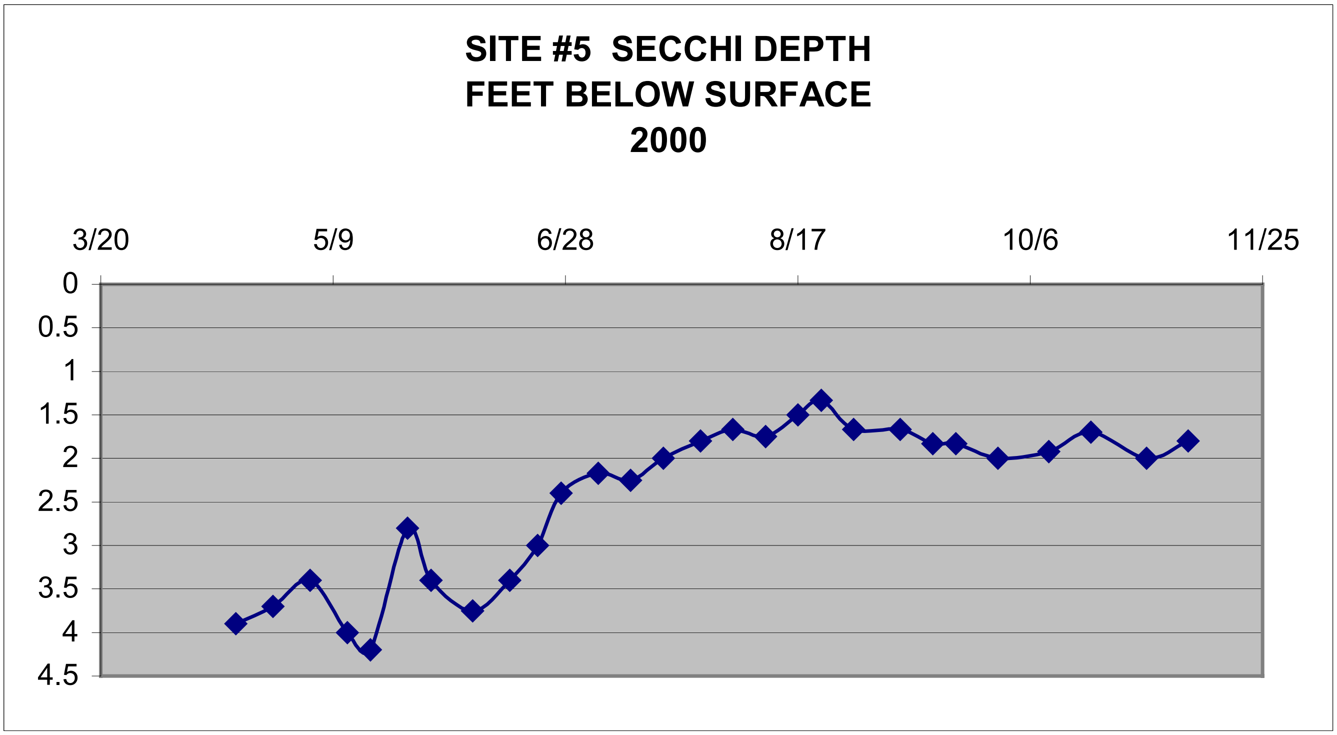
Water quality data in the Western Lake Nokomis area were collected in a deep channel area south of the western tip of the large island at location #5 (Figure 2 22 and 23). Twenty-eight secchi readings in 2000 ranged from 1.2 to 4.2 feet and averaged 2.5 feet. Nineteen secchi readings in 2001 ranged from 0.2 to 3.4 feet and averaged 2.0 feet.

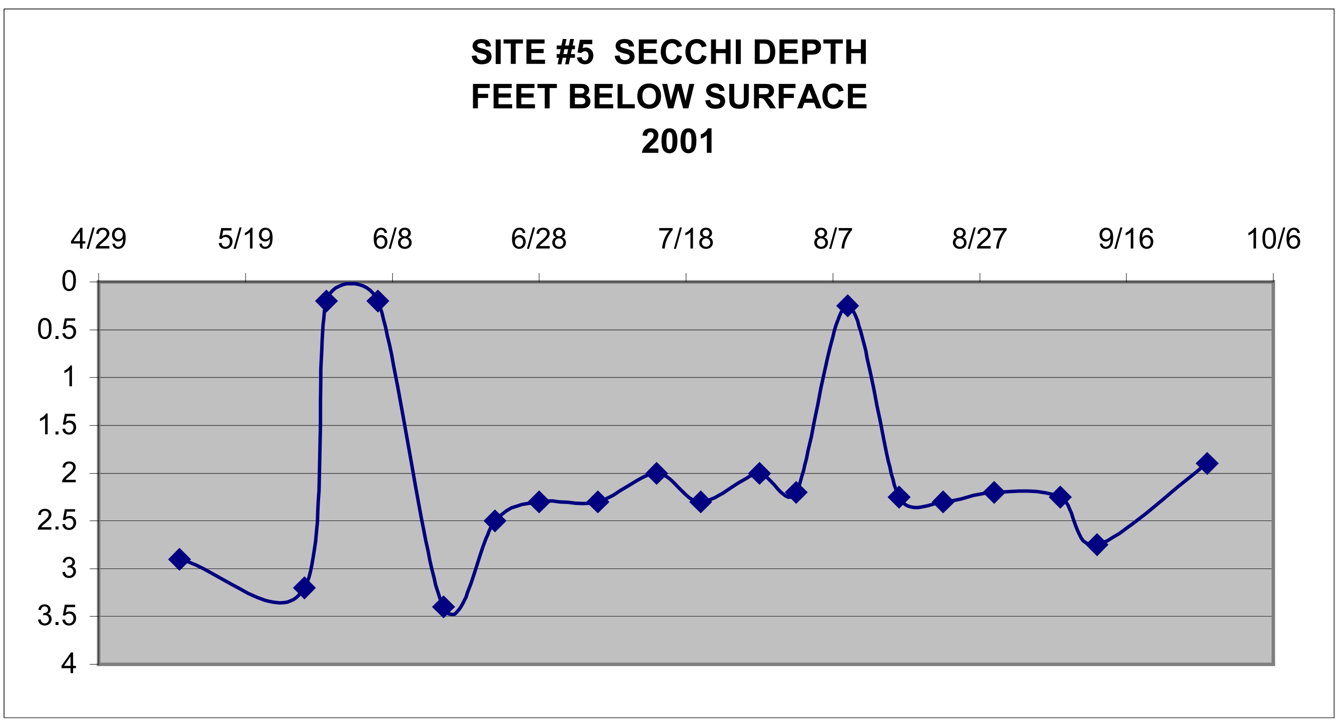
Dissolved oxygen concentration, temperature readings and water chemistry data collected at this site is summarized in Table 1.

The aquatic plant community of Western Lake Nokomis was surveyed on July 13, 2000 at 12 transect locations that extended from the shoreline to deepwater (Figure 2). Twenty-seven species of aquatic and semi-aquatic plants were identified from 44 sampling sites ranging in depth from 0 to 10 feet (Appendix). A single sago pondweed was the only plant found in water greater than nine feet deep. Only eight species were found in the 5.1 to 9.0 feet depth. In the 2-5 feet range, 15 aquatic and semi-aquatic plants were identified. Emergent and floating plants dominated this shallow depth range. Of the six submergents identified, only two were found at single locations to be abundant. The semi-aquatic invasive Reed Canary Grass and emergents dominated the 0 to 2.5-feet depth. Most of the abundant aquatic plant species found were in isolated backwater areas.


SITE #5 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2000
80
70
60
50
40
30
4/9
5/29
7/18
9/6
10/26


SITE #5 WATER TEMPERATURE °F
TWO FEET BELOW SURFACE
2001
80
70
60
50
40
30
4/29
5/19
6/8
6/28
7/18
8/7
8/27
9/16
10/6





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SITE 5

	secchi	temp.		secchi	temp
	2000			2001	
18-Apr	3.9	34			
26-Apr	3.7	58			
4-May	3.4	56			
12-May	4	54	10-May	2.9	60
17-May	4.2	58	27-May	3.2	59
25-May	2.8	60	30-May	0.2	61
30-May	3.4	60	6-Jun	0.2	56
8-Jun	3.75	64	15-Jun	3.4	63
16-Jun	3.4	64	22-Jun	2.5	64
22-Jun	3	66	28-Jun	2.3	79
27-Jun	2.4	66	6-Jul	2.3	68
5-Jul	2.17	71	14-Jul	2	75
12-Jul	2.25	72	20-Jul	2.3	75
19-Jul	2	64	28-Jul	2	75
27-Jul	1.8	69	2-Aug	2.2	70
3-Aug	1.67	70	9-Aug	0.25	70
10-Aug	1.75	73	16-Aug	2.25	70
17-Aug	1.5	69	22-Aug	2.3	70
22-Aug	1.33	67	29-Aug	2.2	68
29-Aug	1.67	70	7-Sep	2.25	64
8-Sep	1.67	61	12-Sep	2.75	59
15-Sep	1.83	57	27-Sep	1.9	50
20-Sep	1.83	57			
29-Sep	2	55			
10-Oct	1.92	43			
19-Oct	1.7	52			
31-Oct	2				
9-Nov	1.8				

Table #2 Water Quality Indices for Rice Reservoir
LNCC Data for 2000 and 2001

YEAR 2000

	6/27/2000		7/27/2000		8/29/200	
	Raw Data	Index TSI Score	Raw Data	Index TSI Score	Raw Data	Index TSI Score
Deer Lake Site #1						
Secchhi Reading (meter)	3.72	41	2.59	46	3.05	44
T. Phosphorus (ug/l)	14	53	13	48	10	46
Chlor a (ug/l)	2.5	42	4.2	46	35	61*
Bridge Lake Site #2						
Secchhi Reading (meter)	1.68	53	0.91	61	1.22	57
T. Phosphorus (ug/l)	38	57	53**	53	47	59
Chlor a (ug/l)	2.6	42	34	61	22	58*
Nokomis Lake Site #3						
Secchhi Reading (meter)	1.93	51	0.76	64	0.46	71
T. Phosphorus (ug/l)	33	55	53	53	51	59
Chlor a (ug/l)	11	53	51	64	11*	53*
Nokomis Lake Site #4						
Secchhi Reading (meter)	1.37	56	0.91	61	0.91	61
T. Phosphorus (ug/l)	34	56	42	57	43	57
Chlor a (ug/l)	8	50	38	62	22*	58*

YEAR 2001

	6/28/2001		7/26/2001		8/16/2001	
	Raw Data	Index TSI Score	Raw Data	Index TSI Score	Raw Data	Index TSI Score
Deer Lake Site #1						
Secchhi Reading (meter)	3.05	44	3.05	44	3.66	41
T. Phosphorus (ug/l)	20	52	9	45	14	49
Chlor a (ug/l)	5	47	2.1	40	35	61
Bridge Lake Site #2						
Secchhi Reading (meter)	1.25	57	1.25	57	1.13	58
T. Phosphorus (ug/l)	36	56	53	59	59	60
Chlor a (ug/l)	3.3	44	40	62	22	58
Nokomis Lake Site #3						
Secchhi Reading (meter)	1.92	51	1.01	60	1.13	58
T. Phosphorus (ug/l)	44	58	46	58	82	62
Chlor a (ug/l)	3.7	45	37	62	11	53
Nokomis Lake Site #4						
Secchhi Reading (meter)	1.13	58	1.01	60	0.91	61
T. Phosphorus (ug/l)	36	56	60	60	63	60
Chlor a (ug/l)	22.1	58	26	59	22	58

**Using 2001 Chlor data*
***Using 2001 TP data*

V. CONCLUSIONS AND DISCUSSION

Water quality data collected by the LNCC in 2000 and 2001 document mesotrophic to eutrophic conditions in the Rice Reservoir Lakes. Water quality indices called Trophic Status Index (TSI) that are based on near-surface concentrations of total phosphorus, chlorophyll a and secchi readings were computed (Tables 2). TSI indices computed for Lake Nokomis and Bridge Lakes indicate eutrophic conditions from mid-summer through September while mesotrophic conditions prevailed in Deer Lake.

High concentrations of nutrients, especially phosphorus combined with warm water temperatures and sunlight can cause elevated algae populations, a major symptom of eutrophication. Eutrophication is a process by which lakes are enriched with nutrients that increase the production of aquatic plants and algae. A number of water related problems often occur with excessive algae growth including foul odors, foul water taste, and fish kills (Zurawell 2000).

The source of excess nutrients can be runoff from the watershed, ground water, and recycling from the lake bed sediments. When little thermal stratification exists in a lake or when there is low oxygen concentrations near the lakebed, there is a better opportunity for nutrients stored in the lakebed to be released to the overlying waters. A nutrient or phosphorus budget has not been calculated for the Rice Reservoir, but internal loading and nutrients entering from the watershed are the most likely sources.

Algae blooms combined with mercury-related fish consumption advisories are generally signs that conditions exist that potentially allow toxins to be cycled into the food chain. Mercury is a naturally occurring carcinogenic metal that does not break down, but is recycled between land, water, and air (Stahl and Simon 2000). Fish consumption by humans is being restricted across the United States. Animal deaths have been linked to the production of potent neuro (nerve) and hepato (liver) toxins by an algae bloom forming species of cyanobacteria (Carmichael 1994). Once established, cyanobacteria may further alter conditions to favor its own growth, reduce growth rates of more beneficial algae, and reduce light availability to bottom areas where rooted plants could grow (Zurawell 2000).

Clams, mussels, and other aquatic organisms accumulate toxins by feeding directly on toxin producing cyanobacteria. Where freshwater bivalves are rarely harvested for human consumption, fish and wildlife are still potentially exposed to the toxins through consumption (Falconer and Choice 1992). Recent research has found that fish and animals associated with aquatic environments also risk exposure to toxins through the consumption of aquatic invertebrates (Eriksson et al. 1989). Cyanobacteria toxins are primarily absorbed by the submerged aquatic plants, coontail, and Elodea (Pflugmacher et al. 1998). Elodea is the most abundant and dense submerged aquatic plant in the Rice Reservoir and coontail is also found throughout the deeper water areas of the Reservoir.

Continued monitoring of the water quality of the lakes in the Rice Reservoir will provide data to identify problems like those described above before they are insurmountable. Understanding the status and trends in water quality will also help develop and implement lake management strategies that both protect and improve the quality of the lakes.

Water front property owners indicate that conditions in the Rice Reservoir are less than desirable. Furthermore water quality is likely to deteriorate as more nutrients enter the Reservoir from the watershed and existing internal nutrients stored in the lake bed sediment are recycled into the water column. Degrading water quality can negatively affect the fishery, tourism, recreation, and shoreline living which are all highly valued by the local lake residents.

The water quality assessment and inventory data collected by the LNCC as part of the lake management planning activities helped address many concerns expressed by lakefront property owners during their completion of the survey questionnaire. For example, lakefront property owners who value observing aquatic wildlife and enjoy fishing and recreating on the lake, want to understand if degrading water quality will impair their future experiences. The water quality data collected and the historical data that were reviewed, generally indicate poor water quality in Lake Nokomis and Bridge Lake and better water quality in Deer Lake. That determination indicates that the experience of many lakefront property owners on the Rice Reservoir can be enhanced with improved water quality. If additional herons, ospreys, and eagles visit the lake because there are fewer algae blooms and more fish, then both the fishermen and wildlife viewers will benefit.

Understanding lake user desires and the current status of water quality on the Reservoir is an initial step to developing long-range plans for protecting and enhancing the water quality and improving the experiences lake users have. As data are collected to document the existing water quality conditions in the Reservoir, lake users and managers must also understand how other activities may be affecting water quality. For example, are land use changes both on the lakeshore and throughout the watershed contributing substantially to water quality impairment? Is the operation of the Bradley Dam and other reservoirs in the WVIC system affecting water quality? Are there subtle changes in climate patterns that are creating changes in water quality? When we better understand the realm of influences on water quality in the Rice Reservoir, we can then identify management opportunities to improve and protect water quality. For example, if we can change the timing or magnitude of withdrawals from the Reservoir during critical periods of high temperature and high phosphorus inflow to keep the reservoir full excessive algae blooms may be averted. If we can create land use controls that limit fertilizer applications and allow for shoreline vegetation buffers, maybe nutrient inflow to the Reservoir can be reduced considerably.

These lake management opportunities and other appropriate strategies can be explored during the development of a comprehensive lake management plan. Development of this plan would draw upon the knowledge and experiences of the lake users and lake front property owners, land management agencies, fisheries biologists, hydrologists, and reservoir operators. Then, through informational and educational programs, volunteer efforts, and the cooperation of local government agencies, appropriate management practices would be implemented that preserve the desired experience for all users of the Rice Reservoir.

VI. RECOMMENDATIONS

The following recommendations are offered to improve overall lake water quality and to address the concerns of lakefront property owners expressed during the survey. In addition, many of these activities provide information useful in educating and informing the public so that better lake management decisions are possible. It will be very important to develop cooperative lake management activities with reservoir operators (WVIC), natural resource managers (WDNR), local units of government, (townships, counties, cities), local businesses, and the public. Some of the recommended activities will promote these cooperative relations and develop an understanding of each organization's or agency's role in lake management.

1. Hold public meetings to distribute the results of this initial assessment and inventory of the Rice Reservoir.

2. Develop a wide public consensus on lake management objectives and goals.

3. Meet with reservoir operators (WVIC) and natural resource managers (WDNR) and local units of government to discuss the status of the lakes and various management alternatives to improve water quality and meet lake management objectives and goals. Specifically address ownership of the 30-feet buffer strip around Lake Nokomis.

4. Discuss lake management alternatives with local fisheries biologists, aquatic ecologists, and hydrologists to evaluate the possible consequences of various lake management practices.

5. Develop a lake management plan that describes various lake management activities that will meet the management objectives and goals for the Rice Reservoir.

6. Monitor the trophic status of the lakes in Rice Reservoir using data collected by volunteers, WVIC, LNCC, and WDNR.

7. Implement appropriate lake management activities and develop additional lake monitoring programs to determine the effectiveness of lake management activities. For example, since reducing shoreline erosion is desirable by the public management practices such as shoreline vegetation buffers should be implemented to reduce erosion, along with a program to monitor the practice's success should be designed and implemented.

8. Consider strengthening the LNCC organization to a formal lake management district to facilitate statutory taxing authority to help finance lake management activities and enhance relations with state and local governments.

9. Collect data describing the condition of long-term water quality integrators such as macroinvertebrates, which document water quality characteristics over a period of a few months, or fish that reflect conditions over several months to a few years, or lake bed sediments, which integrate water quality over periods of several years to decades.

10. Inventory lake shoreline erosion and promote rehabilitation of eroded sites and protection of stable sites. Provide public education and participation opportunities to promote lake shoreline protection.

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