BRIGGS LAKE CHAIN ASSOCIATION

HEALTHY LAKES PARTNERSHIP

SAVING OUR LAKES FOR THE FUTURE

2003-2004

September 2003

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BRIGGS LAKE CHAIN ASSOCIATION

INTRODUCTION

Eight people from the Briggs Lake Chain Association participated in the Healthy Lakes Program sponsored by the Initiative Foundation, the Elk River Watershed Board, the Sherburne Soil and Water Conservation District and others. The goal of the program was to train participants in the continuing development of our Lake Management Plan which is to help maintain and improve the quality of our lakes so they will remain usable in the future.

On June 15, 2002 the Briggs Lake Chain Association held a visioning session attended by twenty five persons. The focus was to find out what members and other persons from the community with vested interest, viewed our lakes and helped get information to help direct our program in planning for the future of our lakes.

Topics that came up in discussion included: Water Quality, Fisheries Management Plan, Aquatic Vegetation, Wildlife, Exotic Species, Land Use and Zoning, Managing Water Surface Use Conflict and Public Access. All persons present were given the opportunity to express their opinions and desires for change.

By reviewing the outcomes of this session the committee has developed the following proposal to be presented for additional grants to help achieve the Briggs Lake Chain Association and the Healthy Lakes Committee achieve goals to maintain and improve the quality of our lakes.

HISTORY

The following historical perspective of the Briggs Lake Chain and Big Elk Lake was written by Jo-Ann Haggenmiller, President (1997-99).

<u>The History and Trivia of the Briggs Lake Chain Association</u>

Briggs Lake, Big Elk Lake, Lake Julia, Rush Lake

The Briggs Lake Chain Association started around 1951 when Rexford Johnson, Stan Smith and a few others from Lake Julia sat down and organized the Association with Rex Johnson being the first president. The problems seem to be much the same today as they were in 1951, water quality being the main concern. The three lakes; Briggs, Julia and Rush have an abundance of curly pond weed and algae. All four lakes, Big Elk included have a problem with the water levels. We see flooding when there is a lot of snow in the winter and heavy rains during the spring and summer, low water levels when there is light snow and rain, not only in the immediate area but from the streams up north and the Elk River. We also have an excess of carp. In 1983 a carp trap was put in Rush Lake and later moved to Big Elk Lake. The carp trap was disposed of in 1998. During the winter of 1990 the Association hired a professional fisherman (Ken Seeman) to harvest the carp in Briggs Lake and Big Elk Lake. This is being continued on a need basis. Big Elk Lake harvested carp before they joined the Briggs Lake Chain Association and used money they made from pull tabs sold at the Elk Lake Resort.

Stocking pan fish and walleyes was also a concern. In the spring of 1975 with the help of the Minnesota Department of Natural Resources fish rearing ponds were made on the property of Don Nelson and Joe Goener depositing around 300,000 fish. The ponds were about 20 acres in size.

In order to raise money to pay for these things the pancake breakfast was started as the result of adjacent eight property owners on the north side of Lake Julia in what was called the "Pilot Lite." The breakfasts were held at the "Funny Farm" which was the lake home of Stan and Margaret Smiths, (11695 – 42nd Street, Lake Julia). The money was used to buy copper sulfate to put along the shores to get rid of algae. The breakfast soon became too big for that site. The Association took it over in 1971 and moved it to what was the Briggs Lake Resort on Cottonwood Bay (today it is the Public Access of Briggs Lake).

Later the breakfast moved to Clearview Elementary School in Clear Lake. Because of insurance costs and liability it was moved to the Clear Lake Town Hall where we still hold it every year on the last Sunday of August.

In the beginning the pancake breakfast helped defray the cast of copper sulfate. About 15 motor boats with poles extending over the sides of the boats to hold gunny sacks would line up side by side and circle the lake adding copper sulfate as it dissolved from the sacks.

Membership and attendance were a problem. The meetings were held on Saturday afternoon. In 1970 the association voted the have information speakers at the meetings. In 1971 they change the meetings to Saturday mornings. In the beginning members would ride around the lakes in their cars and boats and use bull horns to announce the meeting. The Executive Board would meet monthly all year with general meetings in June, July, August and September. Today the Executive Board meets May through September with special meetings as needed although we are again discussing becoming a year-round organization. The general meetings are the second Saturday of June through September. These meetings were first held at the Palmer Town Hall, moved to Cottonwood Resort and then to the Palmer Park and in 2001 we are back at the Palmer Town Hall.

The first "secchi disk" readings to measure the transparency of the water were taken in our lakes by Walter Feehan. In 1988 Paul Kinney set up a committee of Citizen Lake Monitoring program (one from each lake) to take secchi disk readings during the summer in all lakes belonging to the association and report to the Minnesota Pollution Control Agency. Paul Fors (Lake Julia) and Earl Dibb (Briggs Lake), have received awards from the MPCA for taking the secchi disk readings and reporting the readings to the MPCA for over 10 years.

In 1968 the channel between Lake Julia and Briggs Lake was dredged out. In 1970 the Clear Lake Fire Department took over the protection of the southern half of Palmer Township with includes the lakes. In 1969 the Association was studying the possibility of a weed harvester to cut the curly pond weed. In 1991 the Association hired a professional to cut the weeds and individual property owners could contract through the Association to use chemicals in front of their property to spray for weeds because it is too shallow for the cutter to get in and cut. In 2000 and 2001 the association decided to give the chemicals a try (in the allotted amount of acreage from the MDNR). To pay for this donations were asked from the individual property owners and later Palmer Township.

For many years the Association had a directory of property owners around the lakes. In 1992 a Palmer Township/Elk Lake directory was published with yellow page advertising sold to help pay for the cost of harvesting the curly pond weed. This was done under the direction of Peter Iverson and Reinhold Zahler sold advertising. When Peter moved away Joyce Hauge took over the task and continues to do it today (2001). The directory includes all of Palmer Township and Big Elk Lake residents. It can be picked up at the Association meetings and the Briggs Lake General Store.

The Association would hold a pot luck picnic in June to start the summer season. Later the picnic was changed tot he July meeting with the Association providing lunch in celebration of the Fourth of July and giving awards or the pontoon/boat parade held on the Fourth of July and sponsored by the Association. The parade has had as many as 50 entries and as few as 12.

In 1984 the Association purchased the chairs for the pavilion at Palmer Park. Big Elk Lake joined the Association in 1991 and turned over their pull tab money in 1998.

The Briggs Lake Chain Association sponsored a trash pick up day for the property owners around the lakes. In 1991 the Palmer Township implemented the “Palmer Environmental Committee” and the committee sponsors an “Earth Day” in the spring. Trash is brought to the Palmer Town Hall and hauled away from there with the cost defrayed by the Township and Sherburne County. Many Association people help in this effort and the Association has members on the PEC.

In 1985 Palmer Township and Clear Lake Township were given street addresses and we were no longer a rural route. In 1990 the Association started the Adopt a Highway Program with the State of Minnesota doing three miles of clean up on State Highway 25 running two miles north of Highway 16 and one mile south of highway 16. In 1993 rain gauges were obtained from the MDNR and rain fall is taken by Association members around the lakes and reported to the MPCA.

In 1994 natural gas was brought to Palmer Township.

Carla Suckert was instrumental with the help of the MDNR with the first plantings of bull rushes that grew in our lakes. We tried to plant more bull rushes over the years but for the most part they did not catch and grow.

In 1997 we started “Our Lake Management Plan” committee with the help of State Representative, Leslie Schumacher, Minnesota Department of Natural Resources, Montrose, Paul Diedrich and Sherburne Soil and Water, Mark Basiletti. In 1998 we had the plan in writing with Paul Dietrich being the author. Today (2001) we are working on the problems stated in the plan one by one. In 2001 work has begun on the erosion into the Bayou on Briggs Lake because of these people and our Lake Management Plan. This committee meets yearly with the people mentioned above and Association members.

In 1998 the Association received its tax exempt (501-C) with the Federal Government, previously we were only State Tax exempt.

In 2000 the Association received an award from Sherburne Soil and Water Conservation District for their cooperation and we received the Outstanding Conservationist award from the Minnesota Association of Soil and Water Conservation Districts.

In 1946 lakeshore development of Rush Lake was started by John and Ruth Stimmler. They cut out and platted 52 lots and called the development Hi Lo Park. They put in a road and advertised the lots for sale in the "Minneapolis Tribune" Sunday Paper selling as many as five lots on Sunday. These were 50 foot lots and they got from $300 to $900 a lot selling on a contract for deed basis. In 1947 they cut out 20 lots on the north side of the lake and called these Hill Side Park. When John and Ruth sold the farm to Felix Schmisming Sr. they again cut off 16 lots which they called the South Side Park.

Presidents of the Briggs Lake Chain Associaiton:
Year running January 1 to December 31

1951-52	Rexford Johnson	Lake Julia	
1953-54	Stan Smith	Lake Julia	
1955-68	Unknown, could not find records		
1969-70	Al Beckman	Briggs Lake	
1971-72	Virgil Kilness	Rush Lake	
1973-74	Russ Christensen	Briggs Lake	
1975-April 76	Clyde Peterson	(Passed away while president)	
1976-77	Bud Summers	Rush Lake	
1978-79	Peter Bach	Briggs Lake	
1980-81	Richard Thiemer	Briggs Lake	
1983-83	Stan Smith	Lake Julia	
1984-85	Edward J. Buzicky	Briggs Lake	
1986-87	Paul Kinney	Briggs Lake	
1988-89	Bernie Lundstrom	Briggs Lake	
1990-91	George (Jiggs) Mikel	Briggs Lake	
1992-93	Loretta Graves	Lake Julia	
1994-95	James Clinton	Big Elk River	
1996-July 97	Norm Clark	Brigs Lake	(Moved away July 1997)
1997-99	Jo-Ann Haggenmiller	Rush Lake	
2000-01	Art Kress	Lake Julia	
2002-03	Walt Munsterman	Rush Lake	

Bibliography Information taken from:

Secretaries minutes
Talking to old timers around the Lakes
Memoirs of John Stimmler

Any mistakes or ommisions are not intentional

Compiled by Jo-Ann Haggenmiller, President (1997-99)
June 28, 2001

Additional historical information can be found in Appendix 1.

SUMMARY OF LAKE CHARACTERISTICS

The Briggs Lake Chain Association is made up of members from four lakes and the surrounding area. Briggs, Rush and Julia are lakes that are connected by channels and Big Elk Lake is located a short distance away and has water running into to it from the Elk River and Lily Creek which is the out source from the other three lakes.

The sizes of the lakes are as follows: Big Elk Lake-352 acres with a watershed area of 154,381 acres, Briggs-406 acres, Julia-137 acres and Rush 161 acres with a watershed of 9,588 acres for all three. All four lakes are located in Sherburne County.

All of the lakes are considered shallow lakes with Briggs ranging from 25 feet to the others at about 15 feet and less.

Shoreland zoning for Big Elk is General Development and Briggs, Julia and Rush Recreational Development.

At present there are over 500 seasonal and permanent homes directly on the four lakes. In addition there are many homes near the lakes and in the watershed area.

DESCRIPTION OF THE WATERSHED

The Watershed and Hydrology of the Lakes

The Briggs Lake Chain and Big Elk Lake watersheds are sub-watersheds of the Elk River Watershed, which is part of the Upper Mississippi River Basin (Map 1). All of the lakes would be considered “drainage” or “flow through” lakes in that streams flow into and out of the lakes. Briggs Creek flows into Briggs Lake from the northeast and a small creek enters Lake Julia from the northeast. As stated, Lily Creek is the outflow for these three lakes. The Elk River flows through Big Elk Lake entering the lake at the northwest and exiting to the southeast. During periods of high water following spring runoff and heavy rains the Elk River often overflows its banks flowing into Briggs Lake through the “bayou”, a channel located at the southwest end of Briggs Lake.

Drainage lakes typically have relatively large watersheds. For comparison, seepage lakes, which receive most of their water from ground water and lack stream inlets and outlets have relatively small watersheds. The ratio of watershed size to lake area size is one predictor of expected water quality. Lakes with large watershed to lake area ratios are predicted to have higher levels of nutrients and productivity as compared to lakes with small watershed to lake area ratios that are otherwise similar in depth and land use.

Precipitation

Precipitation is well distributed throughout the growing season. In Sherburne County, National Weather Service monitoring sites are located at the St. Cloud Airport, near Santiago and in Elk River. The 30-year average annual precipitation is 27.43 inches for St.

Cloud, 30.63 inches for Santiago and 29.58 inches for Elk River. An average of 19.47 inches (for Santiago) falls during the growing season (May-Sept).

Soils and Topography of the Briggs Lake Chain and Big Elk Lake Watershed

Deposits left by retreating glaciers formed the topography and soils of the watershed. The topography and soils of the watershed can be divided into two general areas. Glacial tills associated with moraines and drumlin fields comprise the upper portion of the watershed. Soils are predominantly loamy in this area. On this landscape, soil infiltration rates are low and runoff tends to rapidly concentrate in low areas where intermittent streams carry runoff to main channels. These soils are susceptible to water erosion. The lower part of the watershed consists of sandy outwash and sand and gravel deposits associated with river terrace. Upland soils in this portion of the watershed are predominantly coarse textured and have a high infiltration rate. Because of the gently sloping topography and well-drained sandy soils, this part of the watershed is not as susceptible to erosion from water. Wind erosion, however, is a common problem. Because of the rapid movement of water through these soils the shallow ground water is susceptible to pollution from surface sources. Wetlands and lakes occupy low areas throughout the watershed. Approximately 9% of the total area of the watershed consists of wetlands and lakes. Wetlands are characterized by soils with high organic content.

Land Use

The approximate land use for the watersheds is:

	Forest	Water and Marsh	Pasture and Open	Cultivated	Urban Residential
Briggs Chain	23%	12%	25%	27%	13%
Big Elk Lake	13%	9%	34%	42%	2%
North Central Hardwoods Forest	6 – 25%	14 – 30%	11 – 25%	22 – 50%	2 – 9%

Many zoning regulations are based upon the Shoreland Management Act and/or the Minnesota Department of Natural Resources (DNR) classification of a given lake. The DNR has classified all lakes within Minnesota as General Development (GD), Recreational Development (RD), or Natural Environmental (NE) lakes, and assigned a unique identification number to the lake for ease of reference. Counties in turn have used these classifications as a tool to establish minimum lot area (width and setbacks) that is intended to protect and preserve the character reflected in the classification.

Big Elk is a GD lake, and Briggs, Julia, and Rush are RD. In Sherburne County the zoning standards associated with each water body class are:

Class	Min. Lot Size	Min. Lot Width (feet)	Structure Setback (feet)	Setback from Sewage Treatment
NE	* see note below	200	150	150
RD	* see note below	150	100	100
GD	* see note below	150	75	75

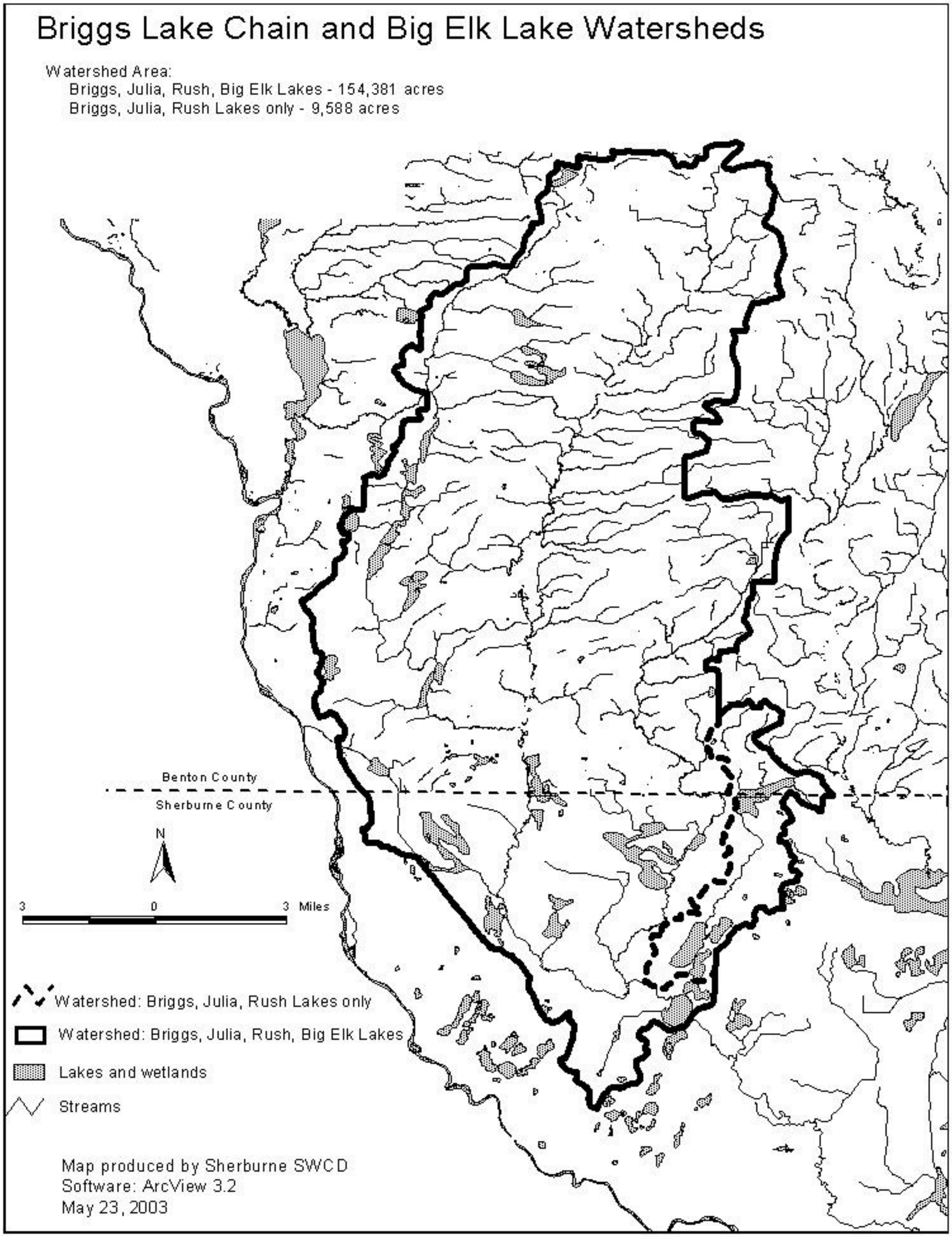
* For new development, Sherburne County requires that lot sizes adhere to the underlying zoning requirement for the district. The Briggs Chain and Big Elk Lake are in the Agricultural District. The minimum lot size in the Agricultural District is 5 acres although lots may be smaller for Planned Unit Developments.

Most lakes have numerous properties that are “grand fathered,” or developed prior to the establishment of these restrictions. In general, these pre-existing uses are allowed to remain unless they are identified as a threat to human health or environment.

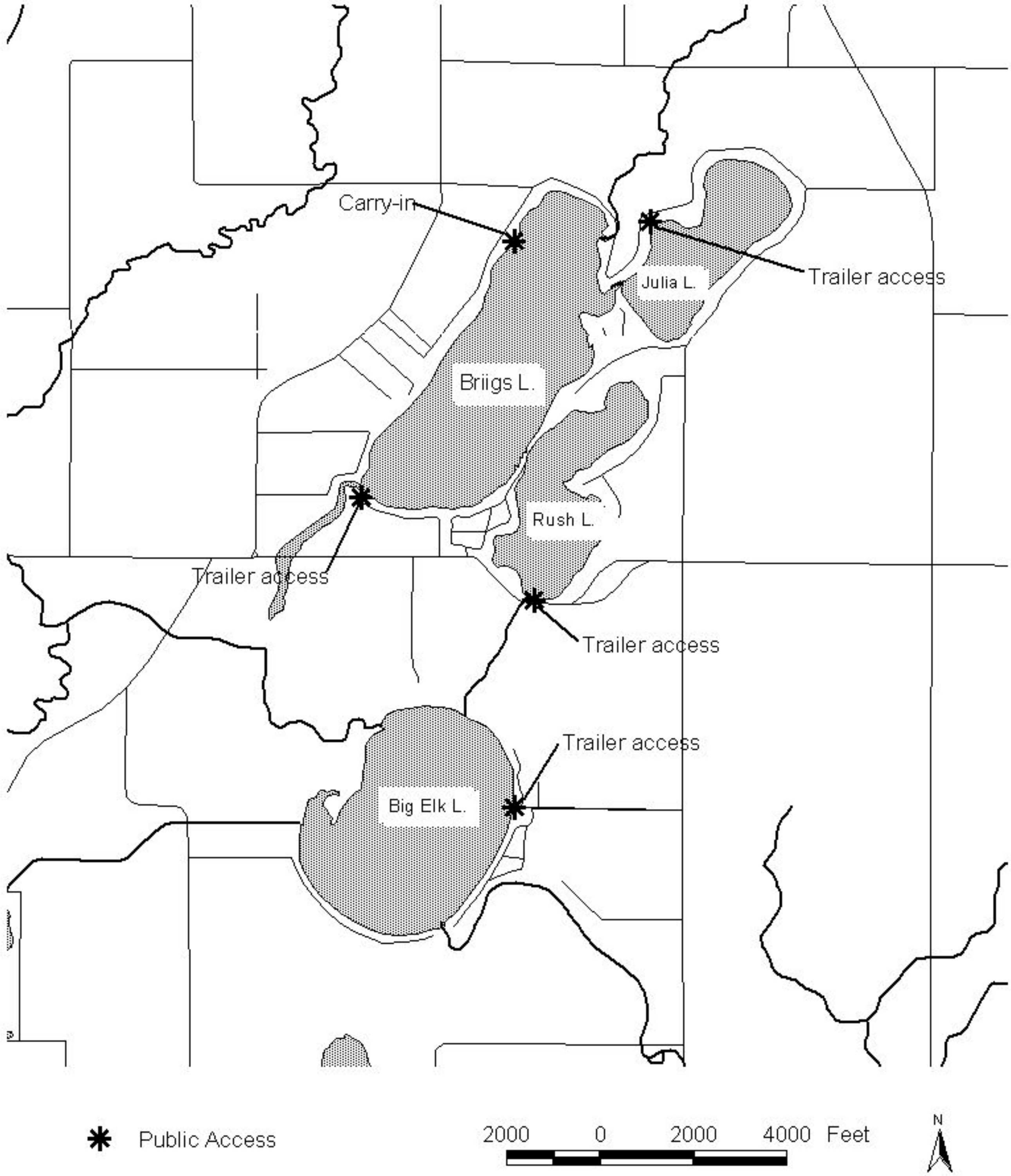
Public Access

There are trailer accesses on Briggs, Rush, Julia and Big Elk Lakes. Briggs Lake also has one carry-in access (Map2).

Map 1 Watersheds



Map 2 Public Access Locations



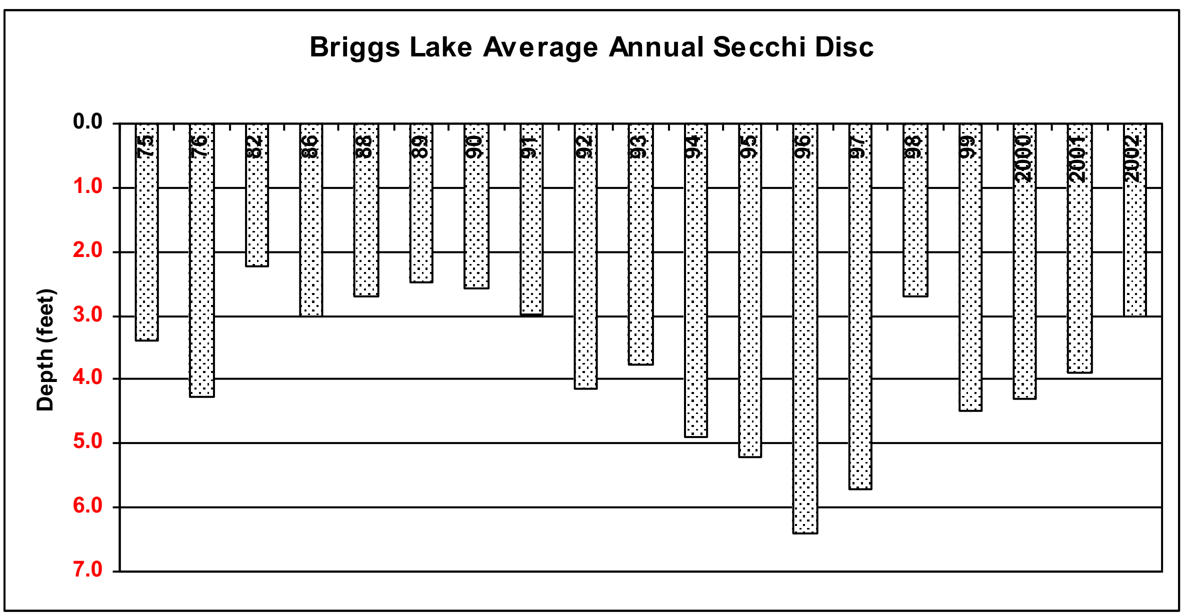
Water Quality

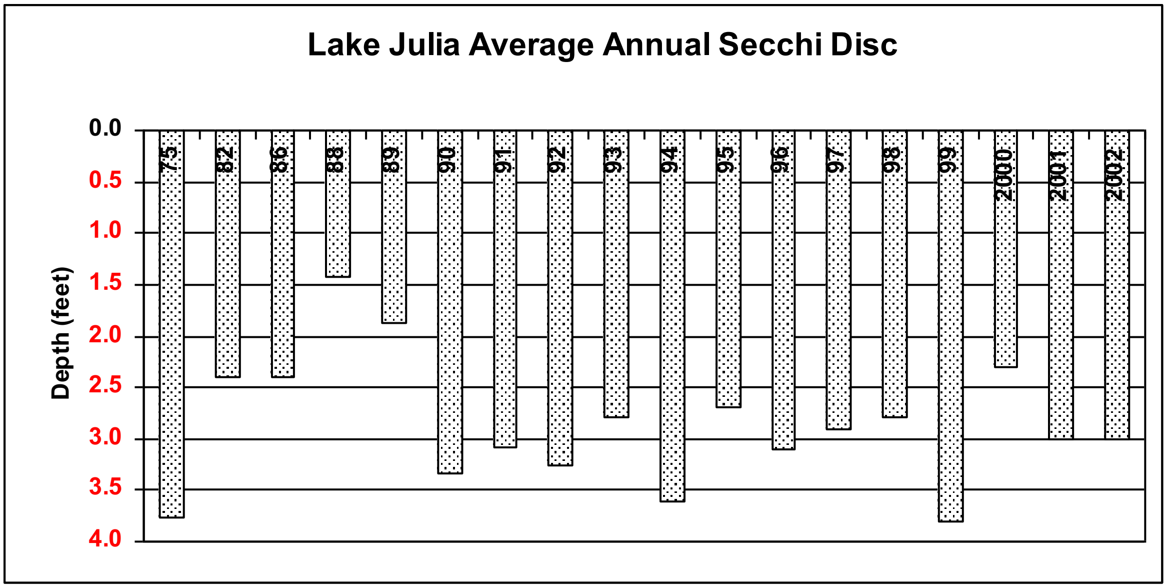
The lakes are located in the part of Minnesota known as the North Central Hardwoods Forest Ecoregion [NCHF] (see Figure 1). This is significant for evaluating water quality data and expectations since typical ranges and predicted water quality are based on ecoregion data sets.

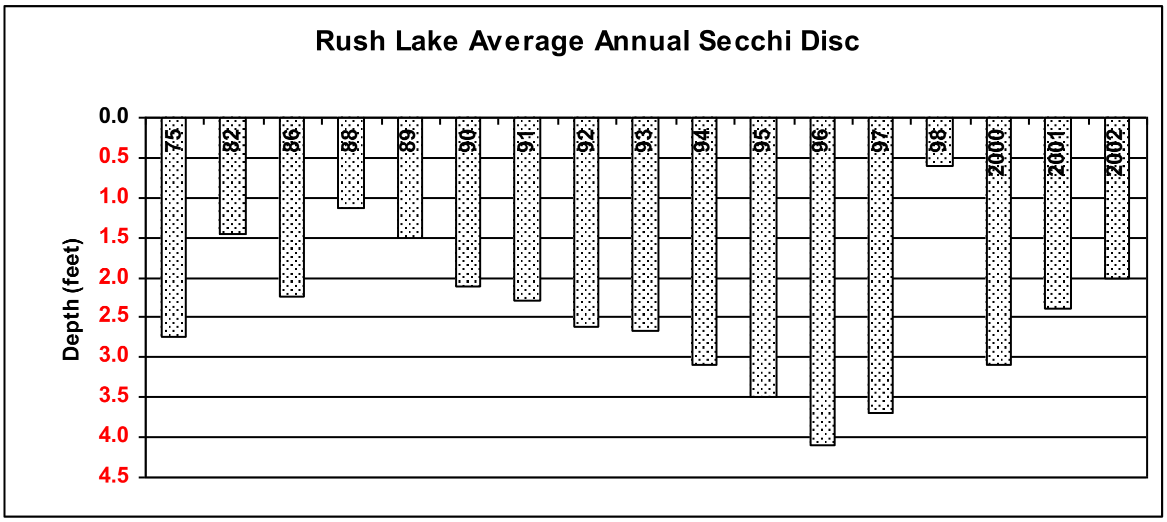
Secchi Disc monitoring provides information on a lake's water quality by gauging the transparency of the water. Secchi transparency data can be used to convey information on the quality of lakes and is directly related to the amount of algae (chlorophyll *a*) growth in the lake. The relative abundance of algae in a lake is dependent on the availability of plant nutrients. Generally phosphorus is the "limiting" or most important nutrient for algae growth in the NCHF Ecoregion.

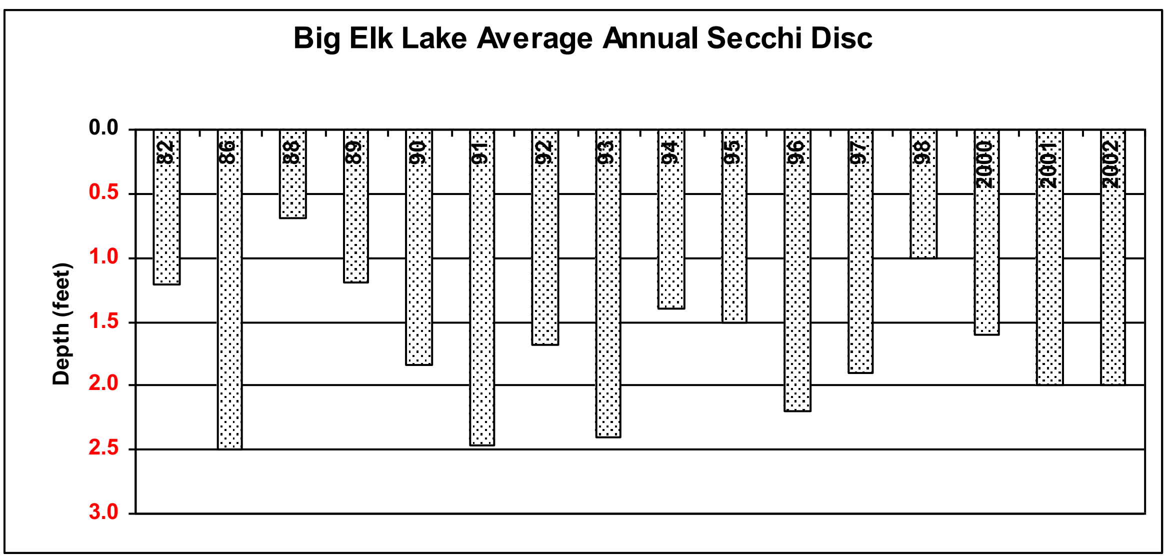
Water quality data for the Briggs Lake Chain and Big Elk Lake is available from several sources. Sherburne County has contracted with St. Cloud State University to monitor water quality every 3 to 4 years starting in 1982. Secchi Disc data is also available from participation in the MPCA's Citizen Lake Monitoring Program (CLMP). The appendix lists other sources of data concerning the lakes.

The following graphs show the average annual secchi disc measurements for each of the lakes from the combined St. Cloud State University and CLMP data.




Lake Julia Average Annual Secchi Disc
Depth (feet)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
75
82
86
88
89
90
91
92
93
94
95
96
97
98
99
2000
2001
2002


Rush Lake Average Annual Secchi Disc
Depth (feet)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
75
82
86
88
89
90
91
92
93
94
95
96
97
98
2000
2001
2002


Big Elk Lake Average Annual Secchi Disc
Depth (feet)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
82
86
88
89
90
91
92
93
94
95
96
97
98
2000
2001
2002

The typical range of Secchi Disc transparency for the NCHF ecoregion is 4.9 to 10.5 feet (the 25 to 75 percentile range).

The term “trophic status” refers to the level of productivity in a lake (the relative amount of algae growth) as measured by phosphorus content, algae abundance, and depth of light penetration measured with a Secchi Disc. Lakes are often classified according to four levels of trophic status:

OLIGOTROPHIC LAKE: A relatively nutrient-poor lake, it is clear and deep with bottom waters high in dissolved oxygen.

MESOTROPHIC LAKE: Midway in nutrient levels between the Eutrophic and Oligotrophic lakes.

EUTROPHIC LAKE: A nutrient-rich lake--usually shallow, "green", and with limited oxygen in the bottom layer of water.

HYPEREUTROPHIC LAKE: Has the highest nutrient concentrations and algae, and are often characterized as "green" with strong odors.

Carlson’s Trophic State Index (TSI) is a common scale used for characterizing a lake’s trophic status or productivity. The TSI can be calculated from the Secchi Disc transparency, chlorophyll-a, and total phosphorus measurements. All three parameters are available for the Briggs Chain of lakes and for Big Elk Lake. In addition to the Secchi disc data, phosphorus and chlorophyll-a data is available from monitoring done by St. Cloud State University and the MPCA. 7 years of phosphorus data are available for Briggs, Julia and Rush lakes and 6 years of phosphorus data are available for Big Elk Lake. 8 years of Chlorophyll-a data are available for Briggs, Julia and Rush lakes and 7 years of chlorophyll-a data are available for Big Elk Lake. These data were gathered from 1982 through 2002.

The following table provides an indication of the expected Trophic Status of lakes given one or more of three water quality parameters. The Trophic State Index can be calculated for a lake given any three of the indicators.

Relationship between trophic status and water quality parameters

Parameter	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Trophic State Index	<40	41-50	51-65	>65
Total Phosphorous (ug/L)	<12	13-25	26-66	>66
Chlorophyll-A (ug/L)	<3	3-7	8-33	>34
Secchi Transparency (ft)	>12.1	12.1 - 5.9	5.9 – 2.6	<2.6

Using the available data for Secchi disc transparency, total phosphorus and chlorophyll-a and the above table, the long term average TSI and trophic status of the lakes would be determined as:

	Trophic State Index - Secchi Disc	Trophic State Index – Total Phosphorus	Trophic State Index – Chorophyll-a	Trophic Status
Briggs Lake	58	72	64	Eutrophic
Lake Julia	62	70	61	Eutrophic
Rush Lake	66	75	67	Hypereutrophic
Big Elk Lake	70	82	73	Hypereutrophic

The above table shows the average TSI values based on long-term averages however the calculated TSI fluctuates from year to year with variations in rainfall and temperature patterns. Calculating the TSI using each of the three parameters results in somewhat different values. By evaluating the TSI calculated from each of the three parameters, the best estimate of the trophic status of the lakes can be determined.

HEALTHY LAKES PARTNERSHIP

"SAVING OUR LAKES FOR THE FUTURE"

The Briggs Lake Chain Association has entered into the Healthy Lakes Partnership with the Elk River Watershed Association and The Initiative Foundation for the purpose of improving the quality of our lakes and the surrounding property.

The Healthy Lakes Partnership Committee has set the goal of **Improving Our Water Quality** which will be incorporated into the Lake Management Plan as we continue to gather information and update the material in the plan.

There are three sub goals that we will work with to work toward achieving this goal. They are: **Land Use and Zoning, Shoreline and In-Water Vegetation and Updating Our Lake Management Plan.**

There are three different committees working with each of these sub-goals. The committees meet the second Thursday of the month at 7pm at the Palmer Township hall. The committees are still looking for more volunteers. If you are interested please feel welcome to attend the committee meetings.

The Committee has already received $800.00 from the Initiative Foundation to help us get started. As we continue to develop more plans and incorporate them into the Lake Management Plan we may be entitled to more grant monies to help us continue our projects.

Following is an update on what the committees have been doing.

Shoreline and In-Water Vegetation Committee:

All of the lakes in the Briggs Lake Chain are fed by mostly water that comes from agriculture lands, consequently putting an abundance of fertilizers in the run-off water. Although some of this problem is slowly being helped by better farming practices and legislation which limits some use of commercial fertilizers, there still is a problem with the amount of fertilizers being deposited in the lakes from lakeshore properties.

The Shoreline and In-Water Vegetation committee will be working with the Sherburne Soil and Water Conservation District in cooperation with Prairie Restorations out of Princeton to involve lakeshore owners and those living near the lakes to restore and improve vegetation to help catch and absorb some of the run-off before it gets into the lakes.

There will be some information sessions held in the spring to help involved property owners learn more about how to use and care for the plants and other topics such as which fertilizers and detergents are best to use.

Land Use and Zoning:

The intent of this committee will be to investigate land use and zoning issues to determine if steps can be taken to improve the present conditions of our lakes and to prepare for the inevitable future development of the Briggs Lake Chain and the surrounding watershed.

This years goals include assisting new and existing lakeshore owners in proper shoreline maintenance through an educational newsletter delineating the most restrictive ordinances from the county, township, and DNR in a less confusing format.

Having this information in one place rather than in three different places should make it easier to work on our properties without fear of "missing something" in the regulations. The newsletter should be ready for distribution this year, when lakeshore owners begin work on their properties.

We are also hoping to work with the proper governmental organizations on watershed improvements and a surface water ordinance that would allow the closing of lake accesses when flooding occurs. This could greatly reduce shoreline damage from wakes during frequent high water periods experienced on the lake chain.

Updating the Lake Management Plan for The Briggs Chain of Lakes, Briggs, Rush, Julia and Big Elk Lake in Sherburne County:

It will be the goal of this committee to work with Sherburne County, The State of Minnesota and any other entities that have information we need to update the plan.

The Sherburne Soil and Water Conservation District, The Minnesota Department of Natural Resources, the Minnesota Pollution Control Agency and St. Cloud State University do on going data collection and we need to get this new information into our plan.

It will be the intent to keep this plan updated every three years.

GOALS OBJECTIVES and ACTIONS

***GOAL 1:* Updating the Lake Management Plan and keeping it updated on a three year program.**

Objective 1: Gather information from all organizations and groups that collect data on the four lakes and get it incorporated into the Lake Management Plan.

Actions:
1. Establish a Lake Monitoring Committee to over see the programs. .

Timeline: 2003/ongoing Budget: Volunteer time.
Responsibility: Association Executive Board

2. In 2003 continue to monitor all lakes using the secchi disks as part of the MPCA's Citizens Lake Monitoring Program and forwarding such information to the Environmental Protection Agency's database which is available to all state agencies. This would allow us to get the data for our lakes.

Timeline: 2003/ongoing Budget:$50.00
Responsibility: Secchi Disk Readers Committee

3. In 2004, begin a water sampling program to test the lakes. This will take training and equipment or lab samples to be sent in to a lab if we cannot get the equipment.

Timeline: 2003/ongoing Budget :$1500.00
Responsibility: Lakes Monitoring Committee

4. In 2003 begin to acquire data from Governmental agencies, such as the Department of Natural Resources, Fisheries, Sherburne County Soil and Water Conservation District, Elk River Watershed District, Saint Cloud State University and any other groups who may have data.

Timeline: 2003/ongoing Budget: $100.00
Responsibility: Lakes Monitoring Committee

5. Education of Association members by sharing information and findings by using resources from various agencies.

Timeline: 2003/ongoing Budget: $250.00
Responsibility: Healthy Lakes Partnership Committee

GOAL 2: **Establish an ongoing education of Land Use and Zoning Ordinances for all lake property owners.**

Objective 1: Collect ordinances from all levels of governmental agencies and keep property owners aware of all ordinances and update them with any changes

Actions:

1. Collect data from State, County, Townships and DNR on all ordinances affecting lakes.

    Timeline: 2003/ongoing Budget: $100.00
    Responsibility: Land Use and Zoning Committee

2. Educate lakeshore owners in proper shoreline maintenance through educational publications delineating the most restrictive ordinances and best management practices.

    Timeline: 2003/ongoing Budget: $250.00
    Responsibility: Healthy Lakes Partnership Committee

3. Monitor land use and zoning by observation of what is occurring around the lakes and report concerns so persons do observe ordinances.

    Timeline: 2003/ongoing Budget: Volunteer
    Responsibility: Land Use and Zoning Committee

4. Establish a Land Use and Zoning Committee.

    Timeline: 2003/ongoing Budget: Volunteer
    Responsibility: Association Executive Board

Goal 3: **Maintain and improve water quality and shoreline stabilzation by use of Shoreline and In-Water Vegetation.**

Objective 1: Work in cooperation with the Sherburne Soil and Water Conservation District and Prairie Restorations to involve lakeshore owners and those living near the lakes in methods to help restore and improve vegetation which will help catch and absorb some of the run-off water and fertilizers before it gets into the lakes and also stabilize the shore line.

Actions:

1. Establish a Shoreline and In-Water Vegetation Committee.

   Timeline: 2003/ongoing　　Budget: $100.00
   Responsibility: Association Exectutive Board

2. Send newsletter to all property owners explaining the program from Sherburne Soil and Water Conservation District and Prairie Restorations on how to get plants.

   Timeline: 2003　　Budget: $250.00
   Responsibility: Shoreline and In-Water Vegetation Committee

3. Educate as to how plants should be used by having a workshop anyone who is interested. This would be done at a local site with the help of trained persons.

   Timeline: 2003　　Budget: $150.00
   Responsibility: Shoreline and IN-Water Vegetation Committee

4. Monitoring sites and using and informing members of success.

   Timeline: 2003/ongoing　　Budget: Volunteers
   Responsibility: Shoreline and In-Water Vegetation Committee

CONCLUSION

We understand that this project is just a beginning and the more goals and action may be added we believe this is a good start.
This proposal was put together by a group of lakeshore owners numbering between 6-10 persons at each of our monthly meetings.
Outside advisors such as Mark Basiletti from the Sherburne County Soil and Water Conservation District, Paul Diedrich from the Minnesota Department of Natural Resouces(Fisheries) and Don Hickman, Environmental Specialist from the Initiative Foundation and Doug Malchow, Extension Educator, attended some meetings and were used as resources.

The following list of persons are those who some input into the preparation of this proposal:

George Kydd, Suzanne Chmielewski, Sue Brown, Terry Polsfuss, Kevin Robak, Karen Jones, David Jones,Charlie Gammon,
Adele Munsterman, Walter Munsterman, Norma Dalton, George Dalton, Joanne Soyett, Robert Soyett, Cynthia Braunreiter,
Tony Braunreiter, Gayle Gilbert, Don Gilbert, Betsy Wergin, Jack McCann, Leslie Schumacher and the resource persons mentioned before

RESOURCES:

Lake Management Plan 2000 Revision--Briggs Chain of Lakes
Sherburne Soil and Water Conservation District--Mark Basiletti
MN Department of Natural Resources, Montrose Fisheries--Paul Diedrich
Initiative Foundation--Don Hickman, Environmental Specialist
Minnesota Extension Educator--Doug Malchow
Palmer Township
Clear Lake Township
Briggs Lake Chain Association

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Glossary, Abbreviations and Acronyms

Aerobic: Aquatic life or chemical processes that require the presence of oxygen.

Algal bloom: An unusual or excessive abundance of algae.

Alkalinity: Capacity of a lake to neutralize acid.

Anoxic: The absence of oxygen in a water column or lake; can occur near the bottom of eutrophic lakes in the summer or under the ice in the winter.

Best Management Practices (BMPs): A practice determined by a state agency or other authority as the most effective, practicable means of preventing or reducing pollution.

Buffer Zone: Undisturbed vegetation that can serve as to slow down and/or retain surface water runoff, and assimilate nutrients.

Chlorophyll a: The green pigment in plants that is essential to photosynthesis.

Conservation Easement: A perpetual conservation easement is a legally binding condition placed on a deed to restrict the types of development that can occur on the subject property.

Eutrophication: The aging process by which lakes are fertilized with nutrients.

Eutrophic Lake: A nutrient-rich lake – usually shallow, “green” and with limited oxygen in the bottom layer of water.

Exotic Species: Any non-native species that can cause displacement of or otherwise threaten native communities .

Fall Turnover: In the autumn as surface water loses temperature they are “turned under” (sink to lower depths) by winds and changes in water density until the lake has a relatively uniform distribution of temperature.

Feedlot: A lot or building or a group of lots or buildings used for the confined feeding, breeding or holding of animals. This definition includes areas specifically designed for confinement in which manure may accumulate or any area where the concentration of animals is such that a vegetative cover cannot be maintained. Lots used to feed and raise poultry are considered to be feedlots. Pastures are not animal feedlots.

Groundwater: water found beneath the soil surface (literally between the soil particles); groundwater is often a primary source of recharge to lakes.

Internal Loading: Nutrients or pollutants entering a body of water from its sediments.

Lake Management: The process of study, assessment of problems, and decisions affecting the maintenance of lakes as thriving ecosystems.

Littoral zone: The shallow areas (less than 15 feet in depth) around a lake's shoreline, usually dominated by aquatic plants. These plants produce oxygen and provide food, shelter and reproduction areas for fish & animal life.

Native Species: An animal or plant species that is naturally present and reproducing.

Nonpoint source: Polluted runoff – nutrients or pollution sources not discharged from a single point. Common examples include runoff from feedlots, fertilized lawns, and agricultural fields.

Nutrient: A substance that provides food or nourishment, such as usable proteins, vitamins, minerals or carbohydrates. Fertilizers, particularly phosphorus and nitrogen, are the most common nutrients that contribute to lake <u>eutrophication</u> and nonpoint source pollution.

pH: The scale by which the relative acidity or basic nature of waters are accessed,

Photosynthesis: The process by which green plants produce oxygen from sunlight, water and carbon dioxide.

Point Sources: Specific sources of nutrient or pollution discharge to a water body, i.e., a stormwater discharge pipe.

Riparian: The natural ecosystem or community associated with river or lake shoreline.

Secchi Disk: A device measuring the depth of light penetration in water.

Sedimentation: The addition of soils to lakes, which can accelerate the "aging" process by destroying fisheries habitat, introducing soil-bound nutrients, and filling in the lake.

Trophic Status: The level of growth or productivity of a lake as measured by phosphorus, content, algae abundance, and depth of light penetration.

Watershed: The surrounding land area that drains into a lake, river, or river system.

Common Biological or Chemical Abbreviations

BOD	Biological Oxygen Demand
°C	degree(s) Celsius
cfs	cubic feet per second (a common measure of rate of flow)
cfu	colony forming units (a common measure of bacterial concentrations)
chl *a*	Chlorophyll *a*
cm	centimeter
COD	Chemical Oxygen Demand
Cond	conductivity
DO	dissolved oxygen
FC	fecal coliform (bacteria)
ft	feet
IR	infrared
l	liter
m	meter
mg	milligram
ml	milliliter
NH_3-N	nitrogen as ammonia
NO_2-NO_3	nitrate-nitrogen
NTU	Nephelometric Turbidity Units, standard measure of turbidity
OP	Ortho-phosphorus
ppb	parts per billion
ppm	parts per million
SD	Standard Deviation (statistical variance)
TDS	total dissolved solids
TN	total nitrogen
TP	total phosphorus
TSI	trophic status index
TSI (C)	trophic status index (based on chlorophyll *a*)
TSI (P)	trophic status index (based on total phosphorus)
TSI (S)	trophic status index (based on Secchi disc transparency)
TSS	total suspended solids
µg/l	micrograms per liter
µmhos/cm	micromhos per centimeter, the standard measure of conductivity
UV	Ultraviolet

Guide to common acronyms

State and Federal Agencies

BWSR	Board of Soil & Water Resources
COE	U.S. Army Corps of Engineers
CRP	Conservation Reserve Program - A federal government conservation program
DNR	Department of Natural Resources
DOJ	United States Department of Justice
DOT	Department of Transportation
DTED	Department of Trade and Economic Development
EPA	U.S. Environmental Protection Agency

EQB	MN Environmental Quality Board
IRRRB	Iron Range Resources & Rehabilitation Board
LCMR	Legislative Commission on Minnesota Resources
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
NRCS	Natural Resources Conservation Service, United States Dept. of Agriculture
OEA	MN Office of Environmental Assistance
OSHA	Occupational Safety and Health Administration
RIM	Reinvest In Minnesota - A State of Minnesota Conservation Program
SCS	Soil Conservation Service
SWCD	Soil & Water Conservation District
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USFWS	United States Fish & Wildlife Service

Regional, watershed, community development, trade and advocacy groups

30 Lakes	Thirty Lakes Watershed District
ACCLA	Association of Cass County Lake Associations
AMC	Association of Minnesota Counties
APA	American Planning Association
BCIP	Blandin Community Investment Program
COLA	Coalition of Lake Associations
IF	Initiative Foundation
LARA	Crow Wing County Lakes And Rivers Alliance
LMC	League of Minnesota Cities
MAT	Minnesota Association of Townships
MSBA	Minnesota School Board Association
MCIT	Minnesota Counties Insurance Trust
MHB	Mississippi Headwaters Board
Mid-MnMA	Mid-Minnesota Association of Builders
MLA	Minnesota Lake Association
MnSCU	Minnesota State Colleges and Universities
RCM	Rivers Council of Minnesota
TIF	Tax Increment Financing

Appendix 1. Historical Information

Historical Data Briggs Lake Chain Improvement Association

Briggs Lake is situated in Palmer Township (originally named Briggs Township, which included the present Haven Township). Briggs Lake is named after the early settler named Joshua Briggs who homesteaded a farm on the West Side of Briggs Lake. It is not known how the names of the other lakes in the chain, Lake Julia and Rush Lake were derived.

In the 1950's, a group of concerned citizens formed Briggs Lake Improvement Association a fraternal organization. The goal of the organization was to improve the recreational values of the lakes. These goals included increasing the fish population, curtailing the algae growth in the lakes and also to improve the roads around the lakes.

The fish population was improved by the stocking of fingerlings by the Department of Natural Resources (DNR) fisheries division. The harvesting of Carp during the winter months also improved the recreational fishing. The algae bloom was addressed by the application of copper sulfide under license by the DNR. Annual dues to the organization and private donations provided the funding of these activities.

The lack of support from the Town Board regarding the upgrading of the roads prompted the organization to hold a pancake breakfast fund raising at a private residence on Lake Julia. The monies raised from this annual endeavor allowed the organization to add a bituminous topping to the gravel roads adjacent to the lakes. The annual Pancake Breakfast remains a fundraising event for the organization, and the Town Board has taken up the task of upgrading all the roads in the township.

On July 16th 1968 the Briggs Lake Chain Improvement Association was incorporated as a nonprofit corporation. This action was undertaken to improve the organization's accountability and to provide the opportunity to achieve greater fund raising capabilities. The incorporation would also permit the application for available grant monies.

In 1990 the members of the organization voted to allow the inclusion of the Big Elk Lake Improvement Association into its membership. The Big Elk Lake Improvement Association was incorporated on 19 June 1971 with 12 named incorporators. It is assumed that the inclusion of the Big Elk Lake Improvement Association into the Briggs Lake Chain Improvement Association has dissolved the former organization.

Over the years the organization has been involved with many environmental studies and projects with various governmental and educational organizations. Included in these organizations are the DNR, St. Cloud State University, Minnesota Pollution Control Agency, Sherburne County Soil and Water, the Extension Division of the University of Minnesota, and the Army Corps of Engineers.

Some of the studies and citizen monitoring programs and activities include:

Secchi disc measurements 1975 SCSU Water Quality for Briggs, Julia and Rush Lakes.

Secchi disc measurements 1982 SCSU Water Quality for Big Elk Lake.

Secchi disc measurements continuously since 1988 MN Pollution Control Agency.
Secchi disc measurements 2000 Stream Monitoring Program MPCA.

Septic Leachate Survey 1991, Water Research Management Inc.
Phosphorous Loading of Lakes 1992, Water Research Management Inc.
16 Year Water Quality Report 1982-1997, Keith Knutson SCSU.
Aquatic Plant Surveys 1993 and 1998, MN Department of Natural Resources.
Water Chemical Analysis 1997, SCSU.
Water Chemical Analysis 1998, MPCA (Latest Data Available).
MDNR Fisheries Initial Fish Investigation; 1940 Big Elk Lake, 1970 Briggs Chain.
MDNR Fisheries Fish Survey every 6 years since 1970.

Other Lake Association Projects undertaken with varying degrees of success includes:

Briggs to Julia Channel dredging.
Bulrush and other Native Plant transplantation.
Carp Trap installation and maintenance.
Semi-annual Road (Ditch) Clean-up Highway 25.

Lake Association Weed and Algae activities:

In the 1960 and 1970's timeframe an annual copper sulfite program was undertaken under MDNR licensing and monitoring. This activity was abandoned due to adverse sediment and lack of progress in results.

A weed-harvesting program was initiated in 1990 when the advent of curly pondweed invaded the Briggs Chain. In 1998 approximately 100 thousand pounds of weeds were removed. In 1999 the program was not successful.

In 2000 the association decided to undertake a chemical treatment program.

The weed program is the most costly undertaking the association is involved in, and there is no foreseen long-term solution to the curly pondweed problem.

Lake Safety:

There are no registered fatalities in the Sherburne County Sheriff's records. However talking with long term residents of the area, there are recollections of instances of drowning in Briggs, Julia and Elk Lakes. It may be that the fatalities are listed as to the specific cause of death which may have been other causes, like heart failure, etc. rather than drowning. The request to the sheriff's department was for all fatalities in all four lakes.

Lake Classification:

The lake classification pertains to the various zoning and construction set back requirements, as well as the development of specific parameters that lake water quality determines.

Big Elk Lake is classified as a General Development Lake.

Briggs Lake, Julia Lake and Rush Lake are classified as Recreational Development Lakes.

The Water Quality parameters for the Briggs Lake Chain lakes are determined by the MINLEAP Computer Model and the Central Hardwood Forest (Ecoregion) parameters. The Briggs Lake Chain is located in the Central Hardwood Forest Region of the State of Minnesota.

Compiled by George Kydd, Member

Briggs Lake Area Alternate Septic Systems (BLAASS)

History of BLAASS Team

Nine members of the Briggs Lakes Chain Association (BLCA) attended the Unsewered Community Education Program (UCEP) sponsored by the University of Minnesota Extension Office during the fall of 2000. From this group, Don Gilbert, Gayle Gilbert, George Kydd, Suzanne Chmielewski, and Joanne Soyett, along with BLCA members Bob Soyett and Terry Polsfuss formed the BLAASS team. In addition, Mark Basiletti, from the Sherburne County SWCD, and Doug Malchow, from the U of M Extension Office-Stearns County, worked with the team.

The core BLAASS group met October 26, 2000 to determine their purpose and how they would proceed. (Purpose). The group met with the Sherburne County Board of Commissioners December 12, 2000 to request that the fees associated with providing the BLAASST with the names and addresses and other requested information be waived. This request was granted and the information was received in January 2001.

Monthly meetings of the team were scheduled for the second Thursday of each month at the Palmer Town Hall. The January and February 2001 meetings had to be cancelled due to the inclement weather. Palmer Township allowed the Team to use their facilities for the meetings and as a mailing address for the surveys and correspondence. Clear Lake Township donated $500 towards the costs of printing and mailing surveys.

In March of 2001 the draft of a survey was begun along with a letter that was sent to all members of the BLCA with the first newsletter, notifying the members of the purpose of the survey. Work on the survey continued during April and May.

In June the draft of the survey was completed and the surveys were mailed to 585 property owners around the four lakes.

As of July 26, 110 surveys had been completed and received. Results of the surveys were plotted on maps of the lakes.

A representative from John Oliver & Associates attended the August meeting and discussed various options after visiting the Oak Ridge Beach area of Elk Lake and the Three Lakes Point area on Briggs. He also presented “ballpark” costs for several of the options.

Sara Heger from the University of Minnesota spoke at the September meeting of the BLCA to explain septic systems and to try to generate interest in the program.

Bridget Chard, Small Communities Project Coordinator in Brainerd, met with the Team on September 13 and explained the processes necessary to form districts, etc. and related costs.

The BLAASS team met on October 11 to discuss the lack of interest on the part of the property owners around the lakes. It was decided to suspend meetings until April 11, 2002, to see if more interest in he septic program could be generated.

Appendix 2. Summary of available information for the Briggs Lake Chain and Big Elk Lake

Department of the Army, Corps of Engineers, Initial appraisal study for flooding problems on the Briggs Lake Chain. 1987

Results: The study shows that the cost to provide permanent flood protection for the lakes would be greater than the benefits that would be derived from the protection.

Septic Leachate Survey of Briggs Chain of Lakes. October 1991. Water Research and Management Inc. Sauk Rapids.

Summary: A septic leachate survey was conducted on the Briggs Chain of Lakes in early August 1991. Approximately 10% of the 463 residential units were leaching septic effluent into the lake system.

1992 Water Quality Monitoring Report, Briggs Chain of Lakes, Sherburne County, MN. October 1992. Water Research and Management Inc. Sauk Rapids.

Summary: The largest phosphorous inputs to Elk Lake are from the Elk River (77% of TP in 1992). The largest inputs into the Briggs Chain are from Briggs Creek (42%), and erosion (includes wind erosion) 24%. Only 6% of the TP entered via septic systems and cultural activities.

Sherburne County 16 Year Water Quality Monitoring Report for 1982-1997. Keith Knutson, Department of Biological Sciences, St. Cloud State University. Available from Mark Basiletti, Sherburne County Soil and Water Conservation District.

A compilation of water quality data for the Briggs Lake Chain. There are secchi disc readings for 12 years between 1982 and 1997. Continuous since 1988. Total phosphorous and chlorophyl a readings for three years: 1986, 1988 and 1993.

Results: Secchi disk, TP, and Chrolophyl a values all produce trophic status indices that mean eutrphic conditions.

MPCA, March 1999. Reference Lake and Trend Monitoring Summary for Sherburne County, Minnesota, 1998. (Lakes: Birch, Julia, Briggs, Rush, Big Elk).

Secchi data for Briggs, Rush and Julia Lakes reveal slight increases in transparency over time. No long term trend is evident for Big Elk Lake.

Fisheries Information from the Minnesota Department of Natural Resources. Located at 7372 State Highway 25 SW, Montrose, MN 55363. 612/675-3301.

Fisheries lake surveys, population assessments and management plans, dissolved oxygen testing, fish stocking records, lake maps, some water quality and aquatic plant information.

Results: water quality favors crappie and walleye. Other species present are northern pike, largemouth bass, bluegill, bullhead and carp. The Briggs Chain is stocked with walleye and northern pike. Elk Lake has self-sustaining populations.

Aquatic Plant Management Aquatic Plant Manager, Terry Ebinger, 1601 Minnesota Avenue, Brainerd, MN 56401. 21/828-2535.

Results: Curled pondweed grows in nuisance proportions. Other native species are less abundant. The Briggs Chain of Lakes Association has dedicated significant resources to the removal of unwanted aquatic vegetation. Big Elk Lake is subject to algal blooms which limit water clarity and vegetation.

Appendix 3. Average Annual Secchi Disc Transparency

Average annual secchi disc measurements for each of the lakes from the combined St. Cloud State University and CLMP data.

Briggs Lake		Lake Julia		Rush Lake	
Year	Secchi Disc (ft)	Year	Secchi Disc (ft)	Year	Secchi Disc (ft)
75	3.4	75	3.8	75	2.7
76	4.3	82	2.4	82	1.5
82	2.2	86	2.4	86	2.2
86	3.0	88	1.4	88	1.1
88	2.7	89	1.9	89	1.5
89	2.5	90	3.3	90	2.1
90	2.6	91	3.1	91	2.3
91	3.0	92	3.3	92	2.6
92	4.2	93	2.8	93	2.7
93	3.8	94	3.6	94	3.1
94	4.9	95	2.7	95	3.5
95	5.2	96	3.1	96	4.1
96	6.4	97	2.9	97	3.7
97	5.7	98	2.8	98	0.6
98	2.7	99	3.8	2000	3.1
99	4.5	2000	2.3	2001	2.4
2000	4.3	2001	3.0	2002	2.0
2001	3.9	2002	3.0		
2002	3.0				

Big Elk Lake	
Year	Secchi Disc (ft)
82	1.2
86	2.5
88	0.7
89	1.2
90	1.8
91	2.5
92	1.7
93	2.4
94	1.4
95	1.5
96	2.2
97	1.9
98	1.0
2000	1.6
2001	2.0
2002	2.0

Appendix 4. Fisheries and Aquatic Plant Information

Source: Minnesota Department of Natural Resources, Montrose Fisheries.

Table 6.1. 1999 net catches of fish species from the Briggs Chain of Lakes. Numbers in bold print represent values which are below or above the expected range of values (for lake class 43). Net catches for northern pike, redhorse, white sucker, walleye, yellow perch are based on gill nets. All others are trap nets. Numbers are number of fish per 24 hr net set.

Species	Briggs	Julia	Rush	Big Elk	Expected values
Black Bullhead	**0.1**	**0.2**	**-**	**0.5**	11.2-107.9
Black Crappie	3.3	6.2	1.8	**0.3**	1.9-24.7
Bluegill	**70.4**	**36.8**	**15.7**	**0.8**	1.3-20.0
Bowfin	-	**0.2**	**0.2**	1.0	0.3-1.7
Brown Bullhead	-	-	**0.3**	-	0.3-5.7
Common Carp	0.6	**0.2**	**0.7**	1.5	0.8-5.8
Golden Redhorse	-	-	-	-	
Golden Shiner	-	-	-	-	0.2-1.3
Largemouth Bass	-	0.3	0.5	-	0.2-1.3
Northern pike	3.5	**10.0**	7.0	5.0	1.4-8.5
Pumpkinseed Sunfish	**6.9**	1.0	3.0	**0.2**	0.3-5.2
Shorthead Redhorse	-	1.8	-	0.5	
Walleye	**1.7**	4.3	3.0	4.3	2.0-15.8
White Crappie	-	-	-	-	0.3-4.2
White Sucker	**5.5**	2.8	2.0	**18.8**	1.0-5.5
Yellow Bullhead	1.2	**3.3**	2.5	0.7	0.6-2.8
Yellow Perch	16.5	13.5	3.7	**2.3**	4.0-24.5

During 1999 the catch of bluegill was above the expected level on the lakes while the catch of black crappie was within the range of expected values. The population of walleye was consistent with net catches in 1993 but electrofishing results suggested that the population was higher. Northern pike catches increased somewhat from 1993 and the catch is highest in Julia Lake.

Table 6.2. A list of aquatic plant species found growing along transects at Briggs, Rush and Julia Lakes during August 1993. Number is frequency of occurrence. Data for Big Elk Lake was collected in 1999.

Species	Briggs	Julia	Rush	Big Elk
Muskgrass	45	100	20	
Sedge			30	10
Coontail	15	40	10	
Canada Waterweed	100	70	80	10
Blue flag		10		
Lesser duckweed			20	
No. Watermilfoil	5			
Bushy pondweed	50	10		20
White waterlily	5		60	
L. White waterlily			50	
Yellow waterlily	5			
L. Yellow waterlily	5			
Curled pondweed	30	90	70	20
Reed Canary grass			20	60
Sago pondweed	5		20	60
Narrowleaf pondweed	80	10		10
Flatstem pondweed	15	60	30	
Hardstem bulrush	10			
River bulrush			20	10
Softstem bulrush			10	10
Great water dock			10	
Arrowhead	20		10	
Common cattail			10	

Appendix 5. Citizen Stream Monitoring Program

The Citizen Stream Monitoring Program sponsored by the Minnesota Pollution Control Agency (MPCA) uses volunteers to monitor the river and stream water for its transparency. The transparency is measured using a tube with a small "secchi disk" in the bottom. The tube is marked in centimeter (cm) increments with 60 cm being the maximum.

The volunteers monitor daily rainfall amounts and do the transparency tests weekly during open water conditions. They also measure the stream stage from a reference point above the water.

Minnesota is comprised of 7 ecoregions.

The Briggs Lake Chain of Lakes is in the North Central Hardwood Forest (NCHF) Region.

The Briggs Lake Chain is also in the Upper Mississippi River Drainage Basin.

The Briggs Lake Chain is in the Department of Natural Resources (DNR) Maintenance Watershed Number 17. Hydrological Unit Number 07010203.

The data gathered by the MPCA are stored in the U.S. Environmental Protection Agency's water quality Storage and Retrieval database (STORET).

Lake water quality is affected by total phosphorus (TP), suspended solids (algae) and the amount of dissolved oxygen or lack of oxygen for the fish and underwater plant population.

Stream water quality is a measure of water clarity, and is affected by dissolved and suspended materials. The more suspended materials, predominantly silts and clay particles, the lower the water transparency.

The NCHF range of concentrations for stream data gathered from 1970 thru 1992 for total phosphorus, suspended solids and turbidity in the 25, 50 and 75 percentile are:

Total Phosphorus (mg/L)			Total Suspended Solids (mg/L)			Turbidity (NTU)		
25%	50%	75%	25%	50%	75%	25%	50%	75%
0.06	0.09	0.15	4.8	8.8	16.0	3.0	5.1	8.5

Note: 1 mg/L = 1 ppm = 1000 ppb

2000 Summary for Briggs Lake Chain Hydrologic Unit 7010203 data:

	Transparency			Measure	Rainfall		Stream Stage (inches)		
	mean	min	max	Number	inches		high	low	change
Briggs Creek	58	38	60	17	8.3		34.5	40	5.5
Rush Lake Outlet	37	12	60	17	8.3		198	216	18
Elk River at Co. #6	51	33	60	17	8.3		193	220	27
Elk River at Co. #53	19	11	40	17	8.3		165	179	14

2001 Summary for Briggs Lake Chain Hydrologic Unit 7010203 data:

	Transparency			Measure	Rainfall		Stream Stage (inches)		
	mean	min	max	Number	inches		high	low	change
Briggs Creek		40	60	34			+24	38	62
Rush Lake Outlet		8	60	34			141	216	75
Elk River at Co. #6		17	60	34			120	213	93
Elk River at Co. #53		8	55	33			99	175	76

2002 Summary for Briggs Lake Chain Hydrologic Unit 7010203 data:

	Transparency			Measure	Rainfall		Stream Stage (inches)		
	mean	min	max	Number	inches		high	low	change
Briggs Creek		43	>60	30	30.62		+15	36.5	51.5
Rush Lake Outlet		7	>60	30			155	213	58
Elk River at Co. #6		17	>60	30			126.5	205.5	79
Elk River at Co. #53		13	53	30			108.5	171.5	63

Appendix 6. 2002 St. Cloud State University Water Quality Report

Trophic States of Briggs, Rush, and Julia Lakes, Sherburne County, Minnesota during 2002

By Charles Rose and Mindy Luthens
Department of Environmental and Technological Studies
204 Headley Hall
St. Cloud State University

St. Cloud, MN 56301

Introduction

Lake monitoring involves looking at potentially many aspects of lake physics, biology and chemistry. Some of the most useful measurements are water transparency, algal abundance, total phosphorus (TP), temperature, and dissolved oxygen. Water transparency can easily be determined using a Secchi disc (SD). This black and white disc is lowered over the shaded side of the boat, until it is no longer visible, then raised until visible. The point at which it can barely be seen is recorded. In order for the Sechi disc readings to be reliable and comparable among lake systems, they should be taken at the same spot over regular intervals during the summer season (Lampert and Sommer 1997). A photosynthetic pigment common to all algae is chlorophyll-*a* (chl-*a*). By measuring chl-a one is assessing the amount of algae present within a water sample. In open water areas of lakes, chl-*a* is a good measure of the amount of free-floating algae (phytoplankton) present (Horne and Goldman 1994). In freshwater systems, phosphorus is a common "limiting nutrient" which controls the amount of algal growth in a lake and therefore the lake's clarity. Total phosphorus measures both the amount of phosphorus molecules dissolved in a water sample and the phosphorus contained within the cells of organisms. Dissolved oxygen is necessary for the survival of fish, other animals, and a variety of microorganisms in lakes. Two sources of dissolved oxygen to a lake are oxygen gas from the atmosphere dissolving into the water and photosynthesis by aquatic plants and algae.

Another important factor in understanding lakes is their layering or stratification, which is caused by solar radiation heating the water's surface. Mixing due to wind allows this heat to penetrate into the lake, but often not to the bottom. The epilimnion or warm layer is generally two to five meters in depth; therefore shallow systems tend not to stratify. This layer is well oxygenated due to photosynthesis and mixing (Cole 1988). Algal blooms within the epilimnion can give lakes a greenish hue, which can increase throughout the summer and dissipates after the lake turns over in the fall (Cole 1988). Water becomes less dense as it is warmed, the cooler water sinks to the bottom resulting in a lower layer called the hypolimnion. Algae (and the phosphorus they contain) can sink to the lake's bottom, feeding bacteria and animals. The oxygen-using process of respiration (or decomposition) by bacteria and animals depletes the amount of this gas dissolved within the water (Horne and Goldman 1994) while releasing nutrients such as phosphorus. In lakes that contain a large amount of decomposable material, oxygen depletion in the hypolimnion is very great and some anaerobic (without dissolved oxygen) bacterial processes may result. Water with a steep decline in temperature is known as thermocline or metalimnion, and is the dividing line between these layers. During spring and fall, when top and bottom water are both equally cold, lake stratification breaks down and the water mixes top to bottom. This turnover redistributes dissolved oxygen to the bottom waters (to the benefit of fish and bottom-dwelling animals) and phosphorus to top waters (where in the spring, algae may absorb it for further growth).

In addition to temperature and dissolved oxygen, the pH of lake water may also change within a lake's depth profile. Dissolved oxygen and pH are generally highest in the upper layer and decrease near the bottom of the lake below the thermocline. The term pH is used to express the concentration of H+ ions dissolved in water and measures the water's acidity or alkalinity. When pH is below 6.5 metals such as aluminum, zinc and mercury become more soluble in water and at increased levels are toxic to fish and other organisms. Under normal conditions, pH ranges between 7.0 and 9.0, meaning it tends to be more alkaline (or basic). The H^+ concentration fluctuates throughout lakes due to changes in sunlight, diurnal changes, heavy rainfall or intervention by humans. Photosynthesis raises pH by removing dissolved carbon dioxide (carbonic acid) from the water; respiration releases carbon dioxide and lowers the pH. At the lake bottom, microbial decomposition releases phosphorus and also chemicals such as ammonium and hydrogen sulfide, which can be converted to nitric acid and sulfuric acid, respectively. Calcium carbonate and other compounds within the lake act as buffers reducing changes in pH.

One useful concept for understanding the health of a lake is its trophic state. Essentially, a trophic state is a measure of the productivity of a lake. Lakes can be divided into several categories, including oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Oligotrophic lakes are very clear and have low concentrations of nutrients, while hypereutrophic lakes are characterized by having high nutrient concentrations and resulting algal growth; sometimes they are dominated by blue-green algae or scum-forming green algae (Horne and Goldman 1994). Mesotrophic and eutrophic lakes have characteristics between those extremes.

Total phosphorus, chl-*a*, and Secchi disc can be converted to the Carlson's Trophic State Index (Carlson 1977) which is widely used by Minnesota governmental agencies (Heiskary 1985). These chemical, biological, and physical measurements are converted to a scale from 0 to 100 using the following formulas:

Trophic State Index Phosphorus=14.42*ln (TP in µg/L) + 4.15

Trophic State Index Chlorophyll-*a* =9.81*ln (chl-*a* in µg/L) + 30.6

Trophic State Index Secchi = 60-14.41* ln (SD in meters)

An overall TSI value can be found from averaging these values. Lakes are then divided into categories based on their levels: 0-40 oligotrophic, 41-50 mesotrophic, 51-60 eutrophic and 61-100 hypereutrophic. Generally, the idea that phosphorus is a limiting nutrient within the system is only true when the values are less then five units from each other, if they are not, more investigation may be needed. This study, then, is designed to classify the study lakes into one of these categories and to use historical Secchi data. This study will also try to determine if there have been changes in the lake's quality over time.

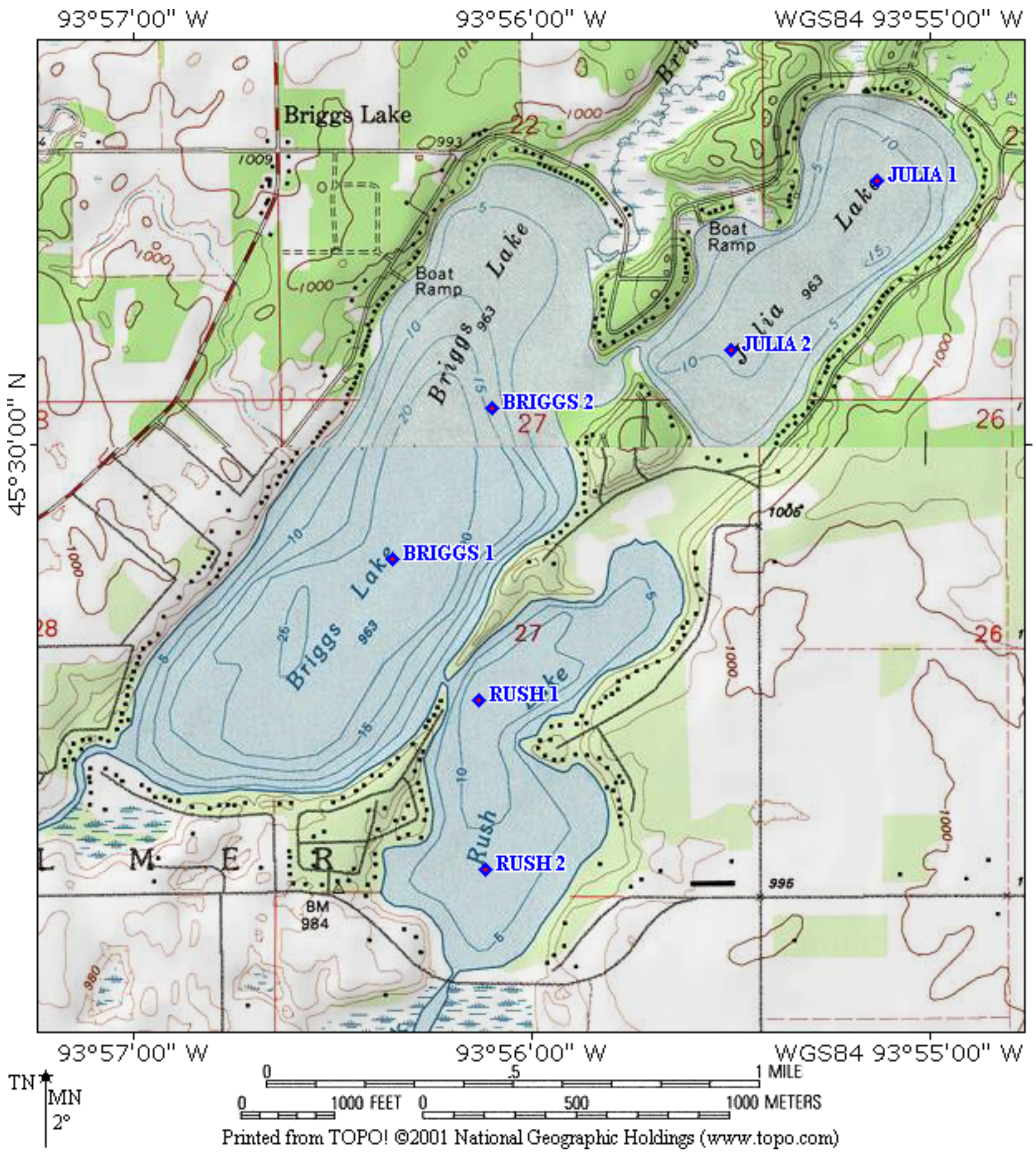

Figure 1. Sampling sites for study lakes during 2002.

Procedure

Nine lakes chosen for this project (based on past data) are Big Elk, Briggs, Eagle, Julia, Little Elk, Long, Pickerel, Round, and Rush. During 2001, Long, Round, and Pickerel Lakes were sampled. Briggs, Julia, and Rush were sampled during 2002. During 2003, Big Elk, Little Elk, and Eagle will be sampled. This cycle can be repeated on a regular basis.

The sampling protocol was designed to match those used by the Minnesota Pollution Control Agency (Heiskary, 1994). Two sites were selected for sampling, one in the deepest basin and the other in an alternate location (Figure 1). Field sampling was done monthly by St. Cloud State University students (graduate student Matt Vollbrecht and undergraduate student Mindy Luthens) under the supervision of Dr. Charles Rose in the Environmental and Technological Studies Department. Sampling took place during June, July and August. The locations conformed with existing sampling locations of other government agencies such as the Minnesota Department of Natural Resources and MPCA and were marked using a Garmin eTrex Vista global positioning system handheld unit (Garmin, International, Olathe, Kansas).

Three main parameters were taken at each site. First, a Secchi reading was taken over the shaded side of the boat. Next, an integrated water sample (tube sampler) was taken of the upper two meters of the epilimnion and placed into an opaque 2 liter bottle which had previously been washed with phosphorus-free soap, rinsed with acid, and thrice rinsed with distilled water. This sample is used to assess the amount of chl-*a* and total phosphorus within the upper water column. A (hypolimnion) sample for total phosphorus was taken from the deepest site using a 1 liter van Dorn bottle and transferred into a pre-washed 1 liter bottle. Some samples were taken as field duplicates in order to check the accuracy of sampling. All samples were placed in a cooler and kept at approximately 4º C and were transported back to SCSU. Surface samples were taken at both locations while a bottom sample was taken from each lake's site with the greatest depth. Using an YSI Model 6820 multiparameter water meter (Yellow Springs Inc., Yellow Springs, Ohio), profiles were taken using the following probes: dissolved oxygen, temperature and pH. Before each monthly field sampling the instruments were calibrated according to the manufacture's instructions.

In the lab samples were filtered then the filters frozen in order for a chl-*a* test to be completed. The filtering was done using a Gelman Type A/E, 47 mm fiberglass filters at low pressure (< 15 psi). The transfer of the filter into a petri dish was done with Teflon coated forceps so that contamination did not occur. The dishes were then wrapped with aluminum foil and frozen. Samples in which total phosphorus would be measured were placed in 100 ml bottles. One blank was also taken using distilled water, to ensure there was no contamination. The prepared samples were then sent to the Minnesota Department of Health (MDH) for analysis; total phosphorus was analyzed using a persulfate digestion followed by spectrophotometric analysis using the ascorbic acid method, chl-*a* was analyzed using the trichromatic method (APHA 1995).

Long-term trends in lake water clarity were analyzed using yearly averages of Secchi disc depth from 1975 through 2002. Data for these analyses came from the MPCA database, the Sherburne county data collected by Dr. Keith Knutson of SCSU and this study. The significance of changes over time was determined using a Sen's Slope/Mann-Kendall test (Gilbert 1987) with WQSTAT Plus software (Intelligent Design Technologies, Longmont, CO).

Table 1. Measured parameters and average TSI values for Briggs Lake, 2002.

	Site 1				**Site 2**			
	June	July	August	**TSI**	June	July	August	**TSI**
Chl-*a* (µg/L)	26	42	108	**71**	21	73	105	**72**
TP (µg/L)	145	234	301	**82**	53	163	209	**76**
SD (m)	1.6	0.5	0.6	**62**	1.8	0.5	0.5	**61**
TSI	**64**	**73**	**77**	**71**	**58**	**73**	**76**	**69**

Results and Discussion

Briggs Lake

Throughout the summer of 2002, the amount of total phosphorus and chl-a increased in both basins of Briggs Lake (Table 1). Rain in June and July which flooded the lake may have increased the amount of phosphorus through agricultural and residential runoff of fertilizers as well as other sources. During July, our boat was launched from the parking lot of the public landing. For the summer, chl-*a* averaged 63 µg/L, epilimnion total phosphorus averaged 147 µg/L, and the Secchi disc clarity averaged 0.9 meters. The overall average TSI value was 70. A seasonal upward trend can be seen in these data (Table 1). These values are higher than previously reported data for this lake. MPCA (2002) records previous TSIP of 67, TSIC of 70 and TSIS of 56 (Overall TSI of 64). As previously noted, the various TSI values should be within about five units. In both our data and MPCA data, chl-*a* values are lower than corresponding total phosphorus values. This suggests that not all of the phosphorus was being utilized by algae for chl-*a* production. Also, both our data and MPCA data indicate that this lake is clearer (as measured by Secchi transparency) than lakes with the corresponding algae values. One explanation for this anomaly may be that algae are concentrated in dense "clumps" that allow more clarity than "normal" between them. This may be an inferred property of colonies of algae growth. During the months of analysis, there was an algal bloom that covered the surface of the lake.

Stratification occurred at about 4 meters in the lake and was found only at site 1 (Figure 2). Dissolved oxygen, temperature, and pH were lower in the hypolimnion. Temperature increased from June to July, decreasing slightly in August at the surface. The increase in depth during July, was due to flooding. The hypolimnion total phosphorus averaged

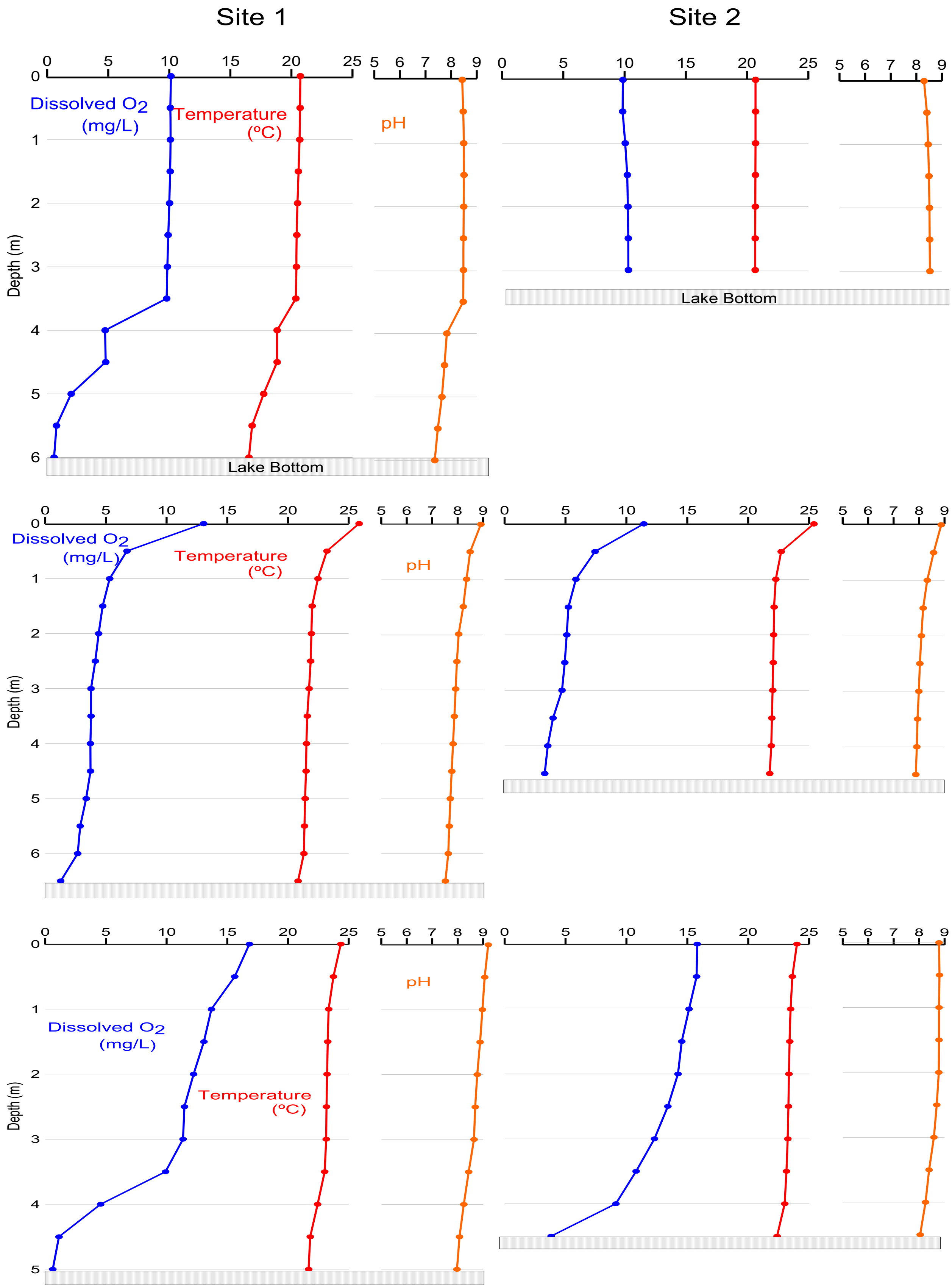

Figure 2. Depth profiles for Briggs Lake, June 16 (upper), July 14 (middle), and August 11 (lower).

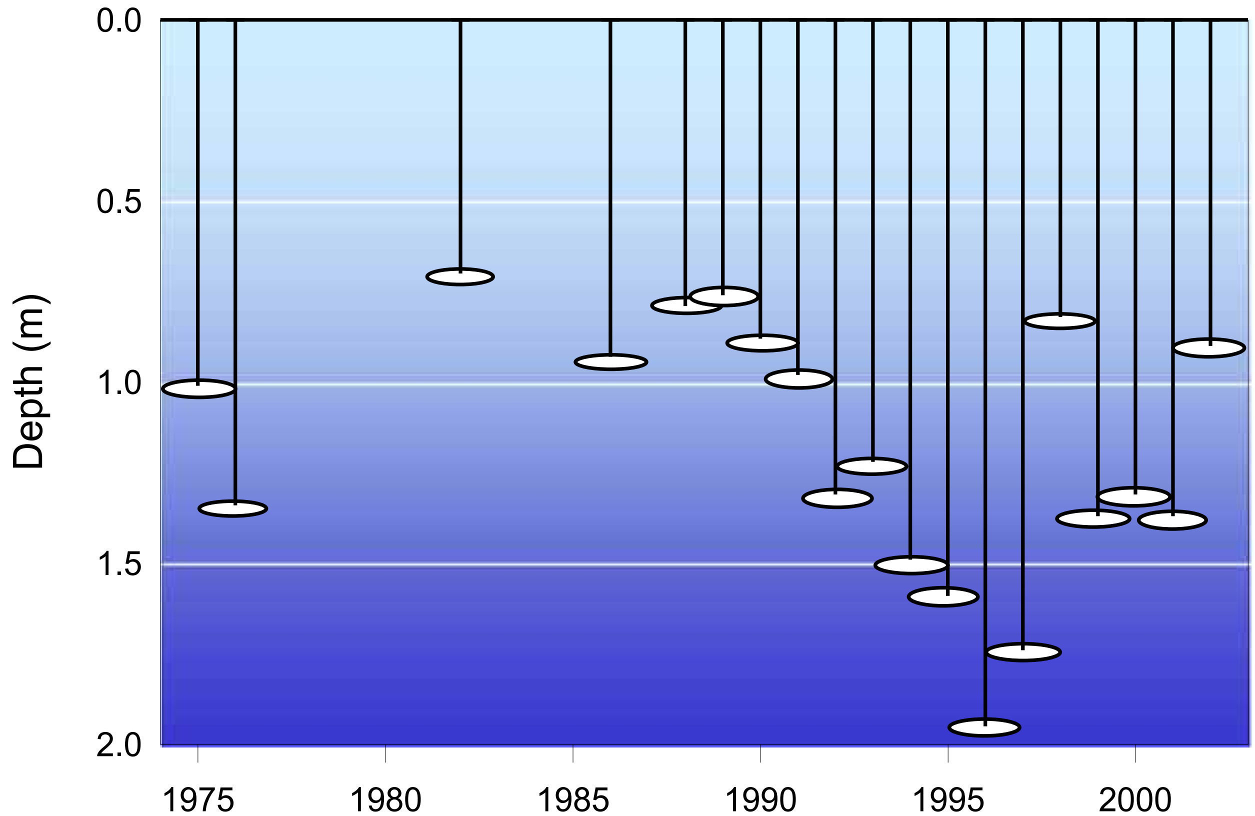

Figure 3. Long-term changes in Secchi depths (1975-2002) for Briggs Lake. Deeper Secchi disc readings indicate clearer water.

387 µg/L and increased over the summer. The oxygen depletion and total phosphorus concentration in the hypolimnion, as well as the TSI values all indicate that this lake should be classified as hypereutrophic.

Long-term Secchi data indicates a downward (improving) trend (Figure 3). This trend is significant at $p > 0.1$, but not significant at $p < 0.05$. Many factors affect the yearly variation in these data including climate and best management practices for keeping phosphorus out of the lake.

Rush Lake

As in Briggs Lake, flooding in July is a likely reason for changes in the TSI parameters (Table 2). Total phosphorus and chl-a generally increased after June, while Secchi disc depth decreased. For this lake, total phosphorus, chl-*a*, and Secchi averaged 165 µg/L, 59 µg/L and 0.6 m respectively. (One total phosphorus samples was lost due to equipment failure.) The average TSI for the year was 72. These values are in the same range as previously measured (TSIP = 70, TSIC = 72, TSIS = 63, Overall TSI = 68) as reported by the MPCA (2002). Again, the TSIS values are lower than the other TSI values. Rush Lake is very shallow (Figure 4) and was mixed throughout the water column; therefore stratification

Table 2. Measured parameters and average TSI values for Rush Lake, 2002.

	Site 1				**Site 2**			
	June	July	August	**TSI**	June	July	August	**TSI**
Chl-a (µg/L)	20	20	98	**68**	39	66	113	**73**
TP (µg/L)	76	214	219	**78**	149	208	N/A	**79**
SD (m)	1.0	0.4	0.4	**67**	1.1	0.4	0.4	**67**
TSI	**62**	**72**	**77**	**71**	**67**	**75**	**76**	**73**

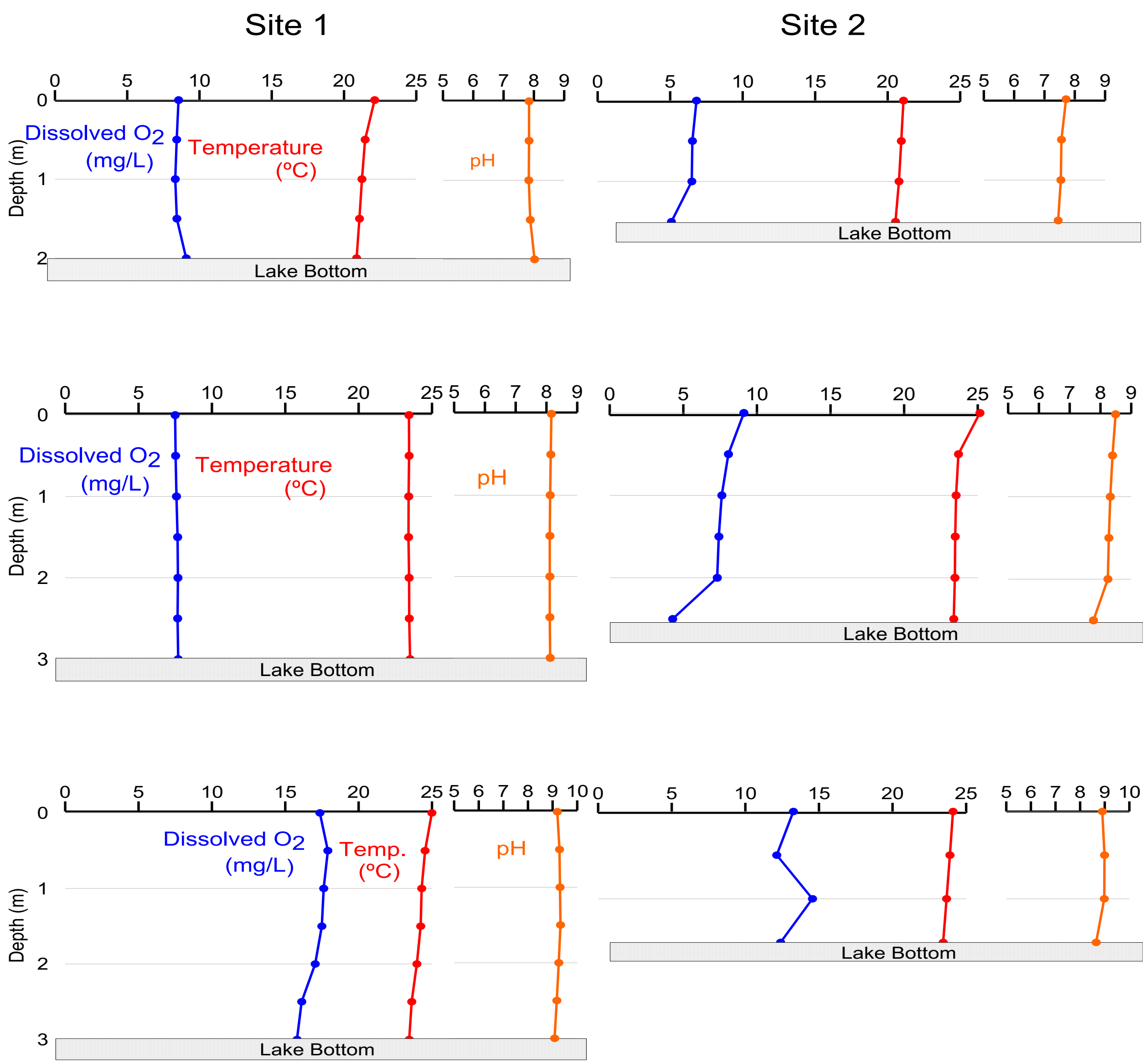

Figure 4. Depth profiles for Rush Lake, June 16 (upper), July 14 (middle), and August 11 (lower).

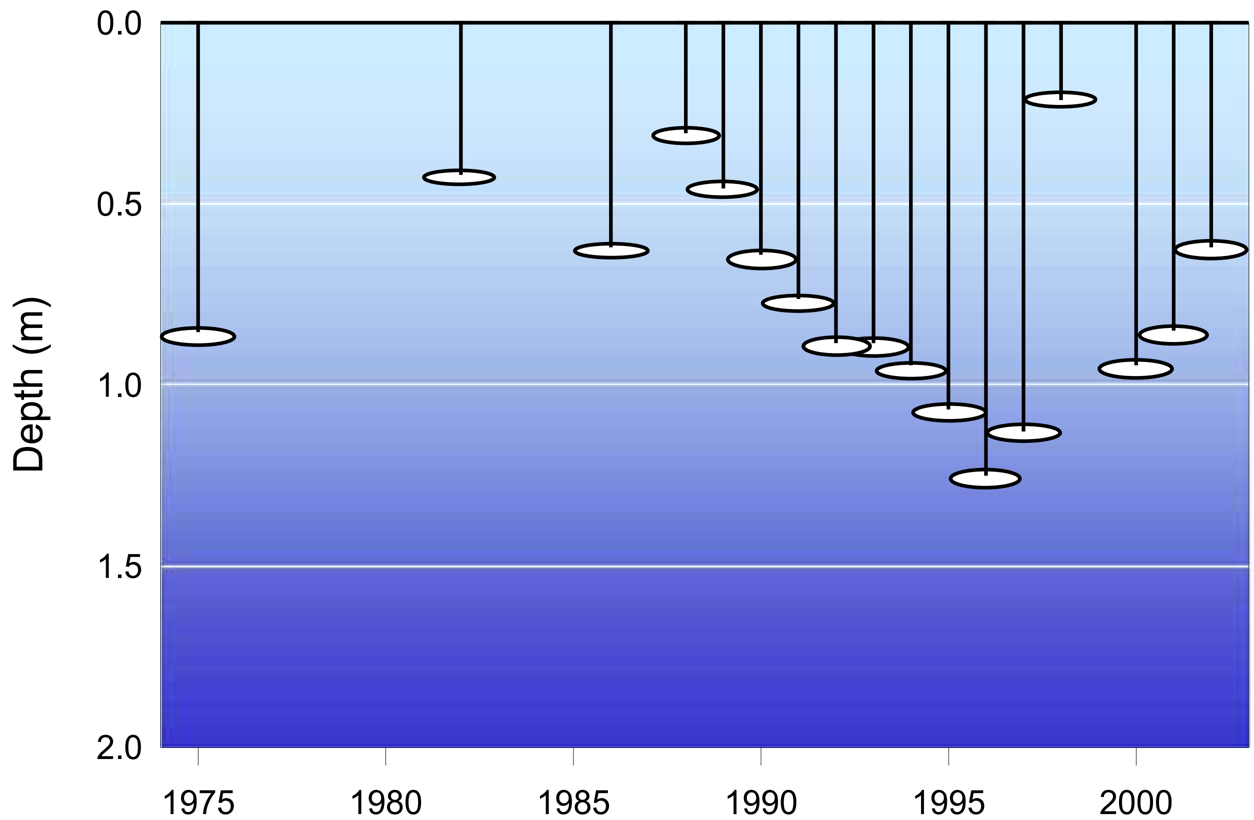

Figure 5. Long-term changes in Secchi depths (1975-2002) for Rush Lake.

never formed. Generally, there was little change in temperature, dissolved oxygen, or pH. The August dissolved oxygen concentrations were notably high, this is probably due to photosynthesis by algae on a cloudless day. Phosphorus from the sediments can easily mix into the upper waters under these circumstances, and this distribution can be uneven. Total phosphorus near the bottom of site 1 averaged 174 µg/L, with a large increase after June. Rush should be classified as a hypereutrophic lake. There was a positive trend in the 1975-2002 Secchi disc data (Figure 5) but it was not significant ($p > 0.10$).

Lake Julia

Julia Lake had better water quality than its neighboring lakes in this study (Table 3) and had an overall TSI value of 64. For this lake, total phosphorus, chl-*a*, and Secchi averaged 66 µg/L, 32 µg/L and 0.9 m respectively. As with the other study lakes, there were important increases in total phosphorus and chl-*a* between June and July. The TSI values in Table 3 are slightly higher than MPCA values (TSIP = 61, TSIC = 61, TSIS = 62, Overall TSI = 61). Julia should be considered a hypereutrophic lake. This should be expected of shallow lakes (Figure 6) in areas with fertile soil such as central Minnesota.

Table 3. Measured parameters and average TSI values for Lake Julia, 2002.

	Site 1				Site 2			
	June	July	August	**TSI**	June	July	August	**TSI**
Chl-a (µg/L)	10	33	52	**64**	15	32	53	**65**
TP (µg/L)	51	71	67	**62**	51	77	77	**65**
SD (m)	1.0	1.0	0.6	**63**	1.0	0.9	0.7	**62**
TSI	**58**	**64**	**67**	**63**	**59**	**64**	**68**	**64**

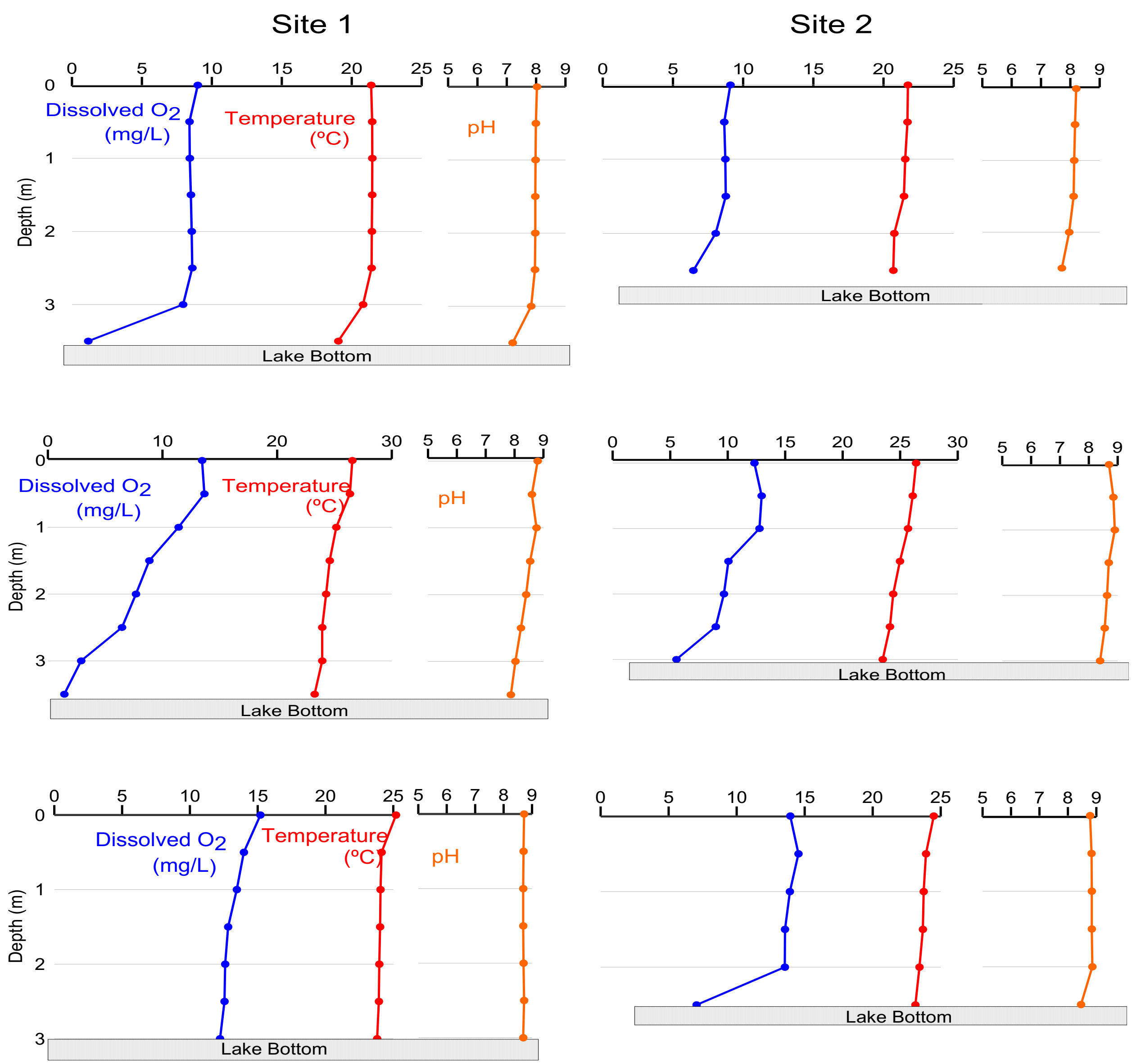

Figure 6. Depth profiles for Julia Lake, June 16 (upper), July 14 (middle), and August 11 (lower).

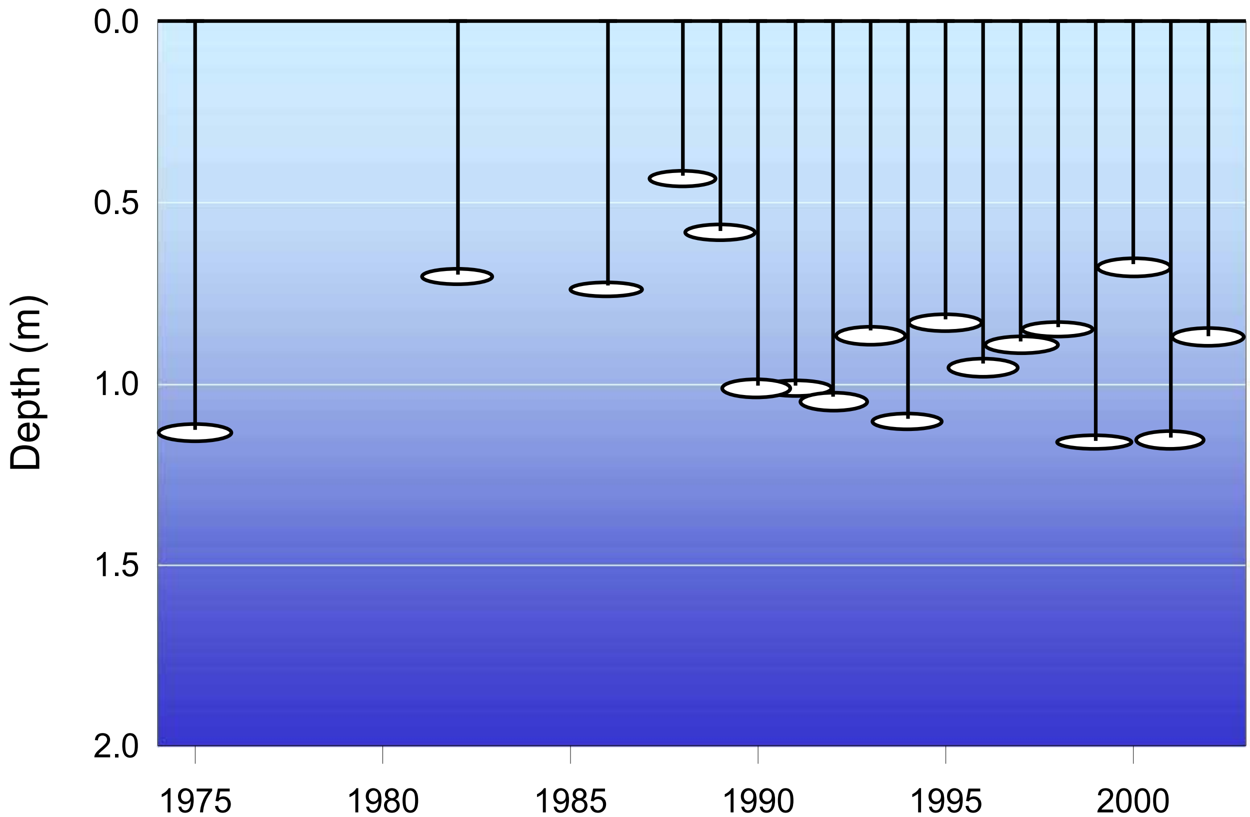

Figure 7. Long-term changes in Secchi depths (1975-2002) for Julia Lake.

No definite thermocline formed during sampling, but temperature, pH and especially dissolved oxygen were lower near the lake's bottom. Total phosphorus near the bottom of site 1, 266 µg/L, was higher than the epilimnon indicating that stratification was occurring (the August sample was lost due to equipment error). No significant trend ($p > 0.10$) was detected in the long-term Secchi disc observations (Figure 7).

Conclusions

The United States Environmental Protection Agency has mapped seven ecoregions in Minnesota using information on soils, landform, potential natural vegetation, and land use. Using this classification scheme, the MPCA has established ecoregion similarities for lake chemistry and lake morphometry through the sampling of hundreds of lakes in each ecoregion. Sherburne County is part of the North Central Hardwood Forest Ecoregion (NCHF) of Minnesota. This Ecoregion is characterized by fertile soil with agriculture being the dominant land use. Almost one-third of the land within the NCHF is cultivated primarily to feed dairy cattle, with poultry farm concentrations, cash crops, and pasture land making up 10 to 15 percent (Omernik, 1987). The MPCA has determined a range of trophic state conditions typical to the region. According to the MPCA, a typical lake in this ecoregion is expected to be eutrophic and the median lake TSI is about 56.

Table 4. Comparisons of Lake TSI with the North Central Hardwood Forest Ecoregion data (MPCA 2002).

Lake	Average TSI	Estimated Percentile	Trophic State
Briggs	70	15	Hypereutrophic
Rush	72	12	Hypereutrophic
Julia	65	25	Hypereutrophic

Table 4 shows that all lakes sampled have lower water quality than the median for this ecoregion. All three of these lakes have lower water quality for these parameters than the typical NCHF lake. Reasons for these results likely include the shallowness of the lakes studied, the fertile soil surrounding the lakes, and the development of the lakes. Runoff from lawn can carry phosphorus into the lakes stimulating algal growth while other sources of phosphorus include erosion and dust particles as well as other organic material including pollen, grass clippings, other plant material, and animal wastes. Failing individual sewage treatment systems (septic drain fields) within the watershed may also contribute to the phosphorus inputs to the lake. Other things equal, septic systems closer to the lake are more likely to contribute significant amounts of phosphorus. Lowering the phosphorus level in these lakes, thereby decreasing algal growth and increasing the water clarity will require a long-term, systematic effort, improving one lawn, one septic system, one field at a time. However, the positive trends in water clarity from 1975 to 2002 (despite being not statistically significant) provide hope that the quality of these lakes will continue to improve.

Acknowledgements

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Appendix A. Data for Study Lakes 2002

		Sherburne		
	Briggs Lake	County	2002	DNR # 71-0146
Site 1	N45º 29' 48"	Site 2	N45º 30' 4"	
	W93º 56' 21"		W93º 56' 6"	
	Depth (m)	Temperature-C	D.O. (mg/l)	pH
16-Jun-02				
Site 1	0	20.7	10.1	8.4
	0.5	20.7	10.1	8.5
	1	20.7	10.1	8.5
	1.5	20.6	10.1	8.5
	2	20.5	10	8.5
	2.5	20.4	9.9	8.5
	3	20.4	9.8	8.5
	3.5	20.4	9.8	8.5
	4	18.8	4.7	7.8
	4.5	18.8	4.8	7.7
	5	17.7	2	7.6
	5.5	16.8	0.8	7.5
	6	16.5	0.6	7.4
	Secchi (m)	1.6		
Site 2	0	20.7	9.7	8.3
	0.5	20.7	9.8	8.4
	1	20.7	10.1	8.5
	1.5	20.7	10.2	8.5
	2	20.7	10.3	8.5
	2.5	20.7	10.3	8.5
	3	20.7	10.3	8.5
	Secchi (m)	1.75		
14-Jul				
Site 1	0	25.9	13.1	8.9
	0.5	23.2	6.7	8.5
	1	22.7	5.3	8.4
	1.5	22	4.7	8.2
	2	21.9	4.4	8
	2.5	21.9	4.1	8
	3	21.7	3.8	7.9
	3.5	21.6	3.8	7.9
	4	21.5	3.7	7.8
	4.5	21.5	3.7	7.8
	5	21.4	3.4	7.7
	5.5	21.4	2.9	7.7
	6	21.3	2.7	7.6

	6.5	20.8	1.3	7.5
	Secchi (m)	0.5		
Site 2	0	25.4	11.4	8.9
	0.5	22.7	7.4	8.6
	1	22.3	5.8	8.3
	1.5	22.1	5.2	8.2
	2	22.1	5.1	8.1
	2.5	22.1	4.9	8
	3	22	4.7	8
	3.5	21.9	4	7.9
	4	21.9	3.5	7.9
	4.5	21.8	3.3	7.9
	Secchi (m)	0.5		
11-Aug				
Site 1	0	24.4	16.8	9.2
	0.5	23.7	15.6	9.1
	1	23.4	13.7	9
	1.5	23.3	13.1	8.9
	2	23.2	12.2	8.8
	2.5	23.2	11.5	8.7
	3	23.2	11.4	8.6
	3.5	23	9.9	8.4
	4	22.4	4.6	8.2
	4.5	21.8	1.1	8.1
	5	21.7	0.6	8
	Secchi (m)	0.6		
Site 2	0	24	15.8	8.8
	0.5	23.6	15.8	8.8
	1	23.5	15.1	8.8
	1.5	23.4	14.5	8.8
	2	23.3	14.2	8.8
	2.5	23.3	13.4	8.7
	3	23.3	12.3	8.6
	3.5	23.1	10.8	8.4
	4	23	9.13	8.3
	4.5	22.4	3.8	8
	Secchi (m)	0.5		

Total Phosphorus

	June	July	August
Site 1-top	66	152	241
Site 1-bottom	223	276	661
Site 2-top	53	163	209

Total Chl-a	June	July	August
Site 1-top	25.9	42.3	108
Site 1-bottom	N/A	N/A	N/A
Site 2-top	21.2	72.6	105
Site 2-bottom	N/A	N/A	N/A

	Rush Lake	Sherburne County	2002	DNR # 71-0147	
Site 1	N45º 29' 33"	Site 2	N45º 29' 15"		
	W93º 56' 8"		W93º 56' 7"		
	Depth (m)	Temperature-C	D.O. (mg/l)		pH
16-Jun					
Site 1	0	22.1	8.6		7.8
	0.5	21.5	8.4		7.8
	1	21.2	8.3		7.8
	1.5	21.1	8.4		7.9
	2	20.9	9.1		8
	Secchi (m)	1.1			
Site 2	0	21.1	6.8		7.7
	0.5	21	6.5		7.6
	1	20.8	6.5		7.5
	1.5	20.5	5.1		7.5
	Secchi (m)	1.1			
14-Jul					
Site 1	0	23.4	7.5		8.2
	0.5	23.4	7.5		8.1
	1	23.4	7.6		8.1
	1.5	23.4	7.7		8.1
	2	23.4	7.7		8.1
	2.5	23.5	7.7		8.1
	3	23.5	7.7		8.1
	Secchi (m)	0.4			
Site 2	0	25.2	9.1		8.5
	0.5	23.7	8.1		8.4
	1	23.5	7.6		8.3
	1.5	23.5	7.4		8.3
	2	23.5	7.3		8.2
	2.5	23.4	4.3		7.8
	Secchi (m)	0.4			
11-Aug					
Site 1	0	25	17.4		9.2
	0.5	24.5	17.9		9.3
	1	24.3	17.6		9.3

	1.5	24.3	17.5	9.3
	2	24	17	9.3
	2.5	23.6	16.1	9.2
	3	23.5	15.8	9.1
	Secchi (m)	0.4		
Site 2	0	24.1	13.3	8.9
	0.5	24	12.1	9
	1	23.7	14.7	9
	1.5	23.4	12.4	8.7
	Secchi (m)	0.35		

Total Phosphorus

	June	July	August
Site 1-top	83	219	192
Site 1-bottom	76	203	246
Site 2-top	149	208	N/A

Total Chl-a

	June	July	August
Site 1-top	20.3	20.1	97.7
Site 1-bottom	N/A	N/A	N/A
Site 2-top	39.7	66.4	113
Site 2-bottom	2.1	N/A	N/A

	Lake Julia	Sherburne County	2002	DNR # 71-0145
Site 1	N45º 30' 28"	Site 2	N45º 30' 10"	
	W93º 55' 8'		W93º 55' 30"	

	Depth (m)	Temperature-C	D.O. (mg/l)	pH
16-Jun				
Site 1	0	21.4	9	8
	0.5	21.5	8.4	8
	1	21.5	8.4	8
	1.5	21.5	8.5	8
	2	21.4	8.6	8
	2.5	21.4	8.6	8
	3	21	7.9	7.8
	3.5	19	1.2	7.2
	Secchi (m)	1		
Site 2	0	21.7	9.1	8.2
	0.5	21.7	8.7	8.2
	1	21.6	8.7	8.1
	1.5	21.5	8.8	8.1

	2	20.8	8	8
	2.5	20.7	6.5	7.7
	Secchi (m)	1		
14-Jul				
Site 1	0	26.6	13.5	8.8
	0.5	26.4	13.7	8.9
	1	25.2	11.4	8.8
	1.5	24.6	8.9	8.5
	2	24.3	7.7	8.4
	2.5	23.9	6.5	8.2
	3	23.5	2.9	8
	3.5	23.3	1.4	7.9
	Secchi (m)	1		
Site 2	0	26.4	12.3	8.7
	0.5	26.1	13	8.9
	1	25.7	12.8	8.9
	1.5	25	10.1	8.7
	2	24.4	9.7	8.6
	2.5	24.1	9	8.6
	3	23.5	5.6	8.4
	Secchi (m)	0.9		
11-Aug				
Site 1	0	25.2	15.2	8.7
	0.5	24.1	14	8.7
	1	24.1	13.5	8.7
	1.5	24	12.8	8.7
	2	24	12.6	8.7
	2.5	23.9	12.6	8.7
	3	2.8	12.2	8.7
	Secchi (m)	0.6		
Site 2	0	24.5	13.9	8.8
	0.5	23.9	14.5	8.8
	1	23.8	13.9	8.8
	1.5	23.7	13.6	8.8
	2	23.4	13.5	8.9
	2.5	23.1	7.1	8.5
	Secchi (m)	0.65		

Total Phosphorus

	June	July	August
Site 1-top	83	219	192
Site 1-bottom	76	203	246
Site 2-top	149	208	N/A

Total Chl-a

	June	July	August
Site 1-top	20.3	20.1	97.7
Site 1-bottom	N/A	N/A	N/A
Site 2-top	39.7	66.4	113
Site 2-bottom	2.1	N/A	N/A