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Lake Management Plan For Blue Lake Minocqua, Wisconsin

This document is dedicated to the memory of Betty Buchheit Myers, who was the ecological conscience of Blue Lake for many years. Betty tested Blue Lake's waters, identified its plants and lovingly cared for its flora, fauna and ecosystem long before such concerns were popular. She taught its residents to be concerned about these things, too; consequently, Blue Lake remains one of the most pristine lakes in Wisconsin. Thanks, Betty—you will long be remembered.

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The Genesis of the Lake Management Plan

In the fall of 2007, a survey was sent to all lake property owners asking their likes, dislikes, and concerns regarding living on Blue Lake. This was the first step in the formulation of this Lake Management Plan. Initially, we thought that we could address all aspects of your responses, but it soon became apparent that this was biting off much more than we could chew given that we were doing it with only Blue Lake Preservation Association (BLPA) volunteers, no government grant monies and without using any professional consulting firms. It was decided to limit the plan to those concerns that dealt specifically with preserving the water quality of Blue Lake.

It is to their credit that more than twenty people thought Blue Lake was important enough to deserve the use of their valuable time and talents to put this plan together. The old adage that says that “many hands make light work” was certainly fitting in this project. Not only was work “light”, but it was also a lot of fun! I hope that all volunteers enjoyed it as much as I did.

It has been through Blue Lake property owners’ direction, plus in-depth study and input from the volunteers, that this product, The Lake Management Plan for Blue Lake, is being presented to you. It is important to remember that this is only the beginning. At the end of this document, you will find actions that the planning committee recommends be taken. It will be up to you, the property owners, to decide if these recommendations will be implemented.

Respectfully submitted,

Dan Pagel
Chairman
Lake Management Planning Committee
Blue Lake Preservation Association
January 2, 2011

Introduction

Blue Lake has been a premier lake that has been valued by those who lived and recreated on it throughout the history of Minocqua, Wisconsin. Blue Lake is valued by the families who use and enjoy the lake for its wonderful water quality, scenic beauty, peacefulness, recreational opportunities, and the quality of life it offers its residents.

Blue Lake is approximately 456 acres in size and in normal times is 49 feet deep. Located in the Town of Minocqua, Oneida County, it is described by Surface Water Resources of Oneida County (1966) as "a soft water seepage lake having slightly acid, clear water of very high transparency. Sand is the dominant littoral material (70%) with rubble (20%) and some gravel and muck." The lake is fed by groundwater, precipitation, and limited runoff. There is a stream outlet located on the northwest shore of the west lobe of the lake.

Purpose of the Lake Management Plan

The Blue Lake Preservation Association (BLPA) has created a committee charged with the responsibility of developing a lake management plan for Blue Lake. The purpose of the plan is to:

- Create a basis for the protection and enhancement of the water quality of Blue Lake through the study of past and current water quality conditions.
- Develop goals to protect the attributes of the lake.
- Inform and educate lake residents and users about the condition of Blue Lake.
- Implement activities which will protect and improve Blue Lake for future generations.

Why is it Important to Protect Water Quality?

The BLPA has always been concerned with protecting the quality of Blue Lake. Protecting the quality of the lake and its watershed was the primary reason for forming the association in 1975.

The protection of water quality, aquatic life, fisheries, natural beauty, and quality of life for Blue Lake residents is dependent on the continued stewardship of the Blue Lake Preservation Association as well as all who live on and use the lake. The development of riparian property increases water runoff and nutrient inputs to Wisconsin's lakes (United States Geological Survey 2003). Runoff studies conducted on several northern Wisconsin lakes found that phosphorus inputs to lakes from developed lots were eight times higher than phosphorus inputs from adjacent undeveloped forested lands.

Phosphorus is the nutrient responsible for stimulating algae growth in most lakes in Wisconsin including Blue Lake. The major sources of phosphorus to northern Wisconsin lakes are from failing septic systems, lawn fertilizers, and increased runoff from roof tops, roadways, and other impervious surfaces associated with developed lake lots. Decreasing phosphorus inputs to Blue Lake will improve water quality conditions for future generations.

High quality shore land habitats are critical to the protection and production of fisheries and aquatic life. Over 90 percent of the aquatic life that lives in Blue Lake is dependent on the near shore shallow water habitat for some or all life stages. This is why it is critical to protect and improve the shoreland habitats of Blue Lake. Several studies of Wisconsin lakes (Christensen 1996, Schindler 2000, Jennings *et. al.* 2003, Woodford and Meyer 2003, Lindsay *et. al.* 2002, Garrison *et. al.* 2005, and Garrison and Wakeman 2000) have documented that current and historical development practices have been detrimental to Wisconsin lake ecosystems. Water quality, fish populations, aquatic insects and plants, and near shore habitat have all been significantly degraded in developed Wisconsin lakes. The protection and restoration of lake shorelines can restore many critical habitat features.

Recreational Water Use and Water Quality Survey October 2007

In 2007 the Blue Lake Management Planning Committee surveyed every property owner on the lake. Of the 141 surveys sent, 103 replies were received. The survey asked several questions regarding why people chose to own property on Blue Lake, how people used the lake, what was the surveyed perception of the quality of the lake, and a variety of additional questions related to owning and recreating on the lake. When asked what they liked most about Blue Lake, most appreciated the water quality and clarity along with peacefulness and scenic beauty.

Property owners are for the most part, part-time users of the lake. Of the responders, fewer than 15% called themselves full-time residents. Just under 20% were full-time summer residents and the rest considered themselves part-time residents. They enjoy water activities of all types, including boating, fishing, and swimming. In smaller numbers, many took advantage of winter sports such as snowmobiling, skiing, and snowshoeing.

People reported that they are happy with the quality and clarity of the lake, although 61% of the people felt that the lake quality has deteriorated in the past five years. Only 1% felt that it has improved.

The ages of our lake users cover a wide range. The greatest number is in the 46-65 year group with the over 65 the smallest, but very well represented.

Many of the property owners have been on the lake a long time. Almost 48% have owned for over 20 years.

The survey found that a few topics were very important to many people. The areas that owners felt it most important to address were landowner education, septic system inspection and pumping, and monitoring of the water quality.

The prevention of the introduction of invasive species, improvement of fishing, boat use and the compliance with boating laws, and land trusts were also mentioned.

The Lake Management Planning Committee looked at the results of the Recreational Water Use and Water Quality Survey and discussed these and other possible areas of concern for the health of Blue Lake. Within the restraints of a reasonable time frame and the limited availability of manpower, it was decided to concentrate on three major areas:

- Lake Water Quality
- Aquatic Vegetation
- Watershed Analysis

The remainder of this report will cover these topics with a discussion of each, followed by actions recommended, if any.

Lake Water Quality

Three water quality parameters are often used to describe water quality. Thus lakes can be compared with others in the same region and also, by using historical data, water quality can be viewed to see if there were changes over time. These parameters are focused on:

1. **Phosphorus.** Phosphorus is a nutrient that controls the growth of plants in the vast majority of Wisconsin lakes. Blue Lake is no exception. The term "plants" includes both *algae* (one-celled) and *macrophytes* (multi-celled). Monitoring phosphorus concentrations gives us a better understanding of the growth rates of the plants within Blue Lake.

2. **Chlorophyll-a.** Chlorophyll-a is the pigment in plants that is used during photosynthesis. Chlorophyll-a concentrations indicate algal abundance within Blue Lake.

3. **Secchi disk readings.** Secchi disk readings measure water clarity. This parameter is the most used and easiest for non-professionals to understand. Measuring Secchi disk depths over long periods of time is one of the best methods of monitoring lake health. The measurement is done by lowering a weighted, 20 cm. diameter disk, with alternating black and white quadrants, into the water and recording the depth just before it disappears from view.

These three parameters are inter-related. Phosphorus is a significant contributor to algal abundance, which is measured by chlorophyll-a levels. Water clarity, measured with a Secchi disk, is affected by the particulates suspended in the water. Most of the time, the most common particulate matter is algae, so that directly affects water clarity.

As lakes age, nutrients accumulate within it and its productivity increases. The aging process goes through different stages, called trophic states. A "young" lake is called *oligotrophic* and is generally clear, deep, and free of weeds or large algae blooms. This lake is low in nutrients and does not support a large fish population.

Lakes further along in their aging process are called *mesotrophic*. They have more nutrients and may be less clear. Also, they may be devoid of oxygen in the late summer.

The final trophic state, that of an "old" lake, is called *eutrophic*. Eutrophic lakes are high in nutrients and support a large biomass (all the plants and animals living in a lake). They are even less clear and usually weedy or subject to frequent algae blooms. They support large fish populations, but are susceptible to oxygen depletion. Rough fish (suckers, carp, etc.) are common in eutrophic lakes.

Every lake, including Blue Lake, will naturally progress through these states; however, without the effect of human development, this process can take thousands of years. Monitoring the trophic state of our lake gives us a method by which to gauge the health of Blue Lake over time.

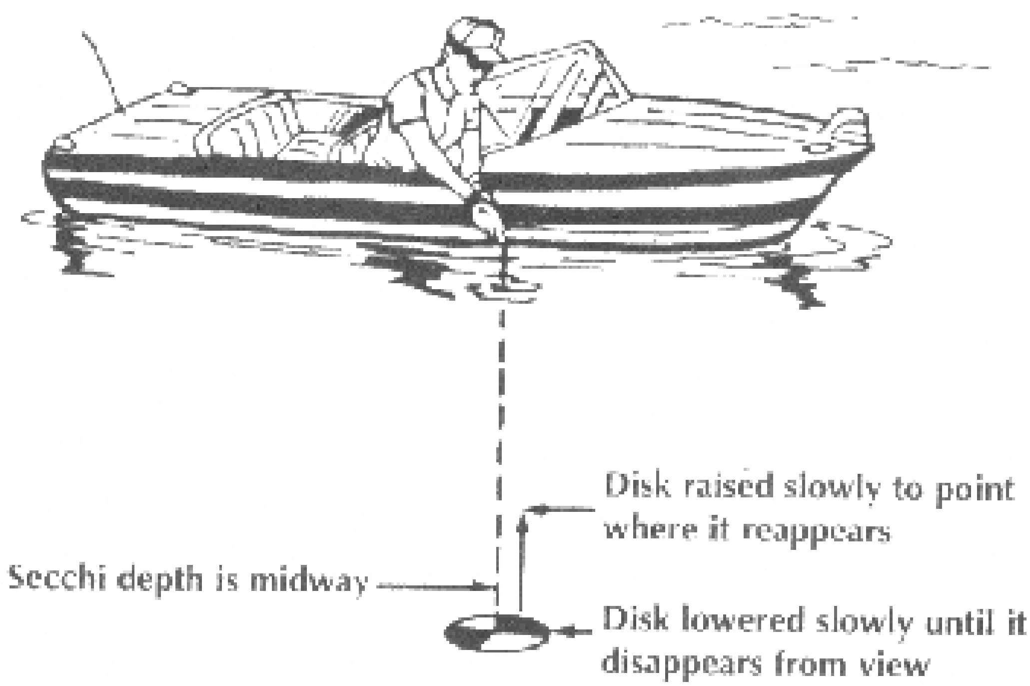
Several studies have been conducted on Blue Lake to assess its health and condition. These studies are detailed on the following pages.

Citizen Monitoring Data Collection Begun in 1993

The best method available to monitor the state of Blue Lake is using the Wisconsin Citizen Lake Monitoring Network. The network, originally called "Self-Help Lake Monitoring", began in 1986 and monitored 126 lakes for water clarity by interested and active citizen volunteers. Currently the program has over 1100 active volunteers monitoring over 850 lakes.

In 1990 volunteers were given the opportunity to get involved in more extensive lake sampling. Blue Lake became actively involved with the program around 1993 when Betty Myers started collecting Secchi, temperature, chlorophyll, phosphorous, and dissolved oxygen data. Joined by Dick Johnson around 1996, the lake now has many years of data that allow DNR managers to assess the state of nutrient enrichment in the lake.

At the end of each sampling season, reports are received that outline Blue Lake's data from the past year, as well as every other year that the lake has been sampled. The reports include an Annual Report, which is the summary of the data and observations recorded, a graph of current Secchi depths as well as the previous year's depths, and a Trophic State Index graph that tells where data points fall in relation to the approximate Trophic States of lakes. The reports for Blue Lake are accessible online at: www.DNR.wi.gov/lakes/CLMN/reportsanddata .



Taking Secchi disk readings

Looking at Blue Lake's monitoring numbers from 1993 to 2009, there isn't much differentiation and the readings remain fairly constant. Overall, the water quality is very good, but water quality isn't as good as it was historically and residents should not take it for granted because it can be compromised. Changes in Trophic State Index numbers over the years show that to be true. The west lobe is still categorized as oligotrophic, but the east lobe has transitioned to being mesotrophic. What would take thousands of years in nature has occurred within many lake residents' lifetime.

Core Sample, July 10, 2003

A paleolimnological assessment of lake sediments (core sample) was conducted in July 2003 to assess water quality changes from pre-settlement conditions through history to present day (Garrison 2003).

Paleolimnology is the study of lake sediments to recreate the water quality history of a lake. A paleolimnological assessment was done to reconstruct the changes in water quality in Blue Lake from the early 1800's to the present day. Each year Blue Lake receives a fresh layer of sediment, and within this layer of sediments is stored the water quality characteristics of the lake for that year. This annual layering of sediment is similar to a tree receiving a growth ring each year. The sediments are sampled by taking a vertical core down through the annual layers of sediment and the individual layers of sediment are sectioned, dated, and analyzed to recreate the water quality history of the lake. A sediment core was taken from the 49 foot deep area in the west basin in 2003 by Paul Garrison of the Wisconsin DNR. Sediment from the top of the core was compared with a section deeper in the core. The assumption was that the upper sample represented present conditions while the deeper sample was indicative of water quality conditions at least 100 years ago.

Paleolimnologist Paul Garrison and Blue Lake resident Mark Bergeon preparing to use “the bomb”, the piece of equipment with which they will retrieve the core sample from the bottom of Blue Lake.

Changes in the abundance of important diatoms (a type of algae) in the top verses the bottom of the sample, are enlightening. An increase of one type, *planktonic*, indicates that phosphorus levels have increased during the last 100 years. The decline of another diatom, *Navicula*, and the increase of yet another, *benthic Fragilaria*, also indicate an increase in phosphorus during the last 100 years. The dominant diatom in the *planktonic* community is *Cyclotella glomerata*, which indicates the phosphorus concentration is low even though it has increased.

Dr. Garrison summarizes by stating that while water quality is still very good in Blue Lake, it likely is not as good as historical levels. The increased nutrient levels are an indication that steps should be taken to reduce nutrient input from the watershed before algal blooms become a problem. It is much more difficult to restore a lake to good water quality than to prevent its degradation.

(See Appendix A)

Aquatic Vegetation

Although many lake residents consider rooted aquatic plants (macrophytes) to be “weeds” and a nuisance, they are actually an essential element in a healthy lake ecosystem. It is important to understand the importance of the lake plants and the many functions they serve in maintaining and protecting the lake.

Aquatic vegetation provides habitat and food for many kinds of aquatic life, including fish, insects, amphibians, waterfowl, and even terrestrial wildlife. For instance, wild celery serves as a favorite food for ducks and geese. In addition, many of the insects eaten by young fish rely heavily on aquatic plants and the organisms attached to them as their primary food source. Plants also provide cover for feeder fish and zooplankton (microscopic or barely visible animals that eat algae). Furthermore, rooted aquatic plants prevent shoreline erosion and the resuspension of sediments and nutrients by absorbing wave energy and locking sediments within their root masses. In areas where plants do not exist, waves can resuspend bottom sediments decreasing water clarity and increasing plant nutrient levels that may lead to algae blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by some types of algae, which helps minimize nuisance algae blooms.

Under certain conditions, plant populations may become a problem and require control measures. Excessive growth can limit recreational use and affect fish population. Exotic plant species, like Eurasian water-milfoil and curly-leaf pondweed, can upset the balance of a lake ecosystem by out competing native plants and reducing species diversity.

There are many techniques available that can be used to control and enhance aquatic plants. Regulations for any aquatic plant management programs put out by the WDNR are covered in NR 109. Some of these techniques include shoreland restoration, manual removal of nuisance plants, harvesting, chemical treatment, biological controls, nutrient reduction and bottom screens (landscape type fabrics used to block weed growth in lakes. They are placed over the plant bed and anchored to the lake bottom by staking or weights).

At this time, no extreme measures are needed in Blue Lake; however, shoreland restoration and nutrient reduction should be encouraged.

Aquatic Plant Survey, 2008, 2009

In order to get baseline information on the plant community in Blue Lake an aquatic plant survey was undertaken.

(See Appendix B) ………

The east lobe was sampled the summer of 2008 and the west lobe was sampled the summer of 2009. By mapping and monitoring aquatic plants, we can determine which lake areas may be sensitive to runoff and disturbance. We can also watch for problems in plant communities (such as introduction of non-native plants and loss of plant diversity) that may be warning signals for the entire lake ecosystem, or we may find improvements (such as the re-establishment of native species or an increase in species diversity) that may result from lake and watershed management activities.

Blue Lake residents gathering aquatic plants for the survey. L to R: Cindy Crochiere, Teresa Colianni, Cheryl Kamba (hidden), Sandy Wickman of the DNR and Bill Clark.

The aquatic plant survey team did not find evidence of any non-native (invasive) plants during this survey. It is important, however, for everyone who uses Blue Lake to be aware of the possibility of their introduction. Make sure all boats are not bringing any aquatic invasive species into the lake. When on or in the water, look for evidence of non-native plants. Become familiar with what the most common invasives look like, especially Eurasian Water Milfoil and Curly Leaf Pondweed.

Eurasian Water Milfoil

Curly Leaf Pondweed

In the event that any aquatic invasive species is discovered in Blue Lake by any lake user, immediately inform a member of the Blue Lake Association Board of Directors.

Aquatic plants are an excellent indicator of water quality. Some plants are not tolerant of turbidity and other disturbances. These plants will disappear as development pressures increase. As water quality deteriorates some aquatic plants will become more problematic and can reach nuisance levels. A decrease in diversity or an increase of one particular species may be an early warning sign of changing water quality.

Floristic Quality Index (FQI)

Stan Nichols (Wisconsin Geological and Natural History Survey) developed the Floristic Quality Index (FQI) to help assess lake quality using the aquatic plants that live in a lake. To determine the Floristic Quality Index of Blue Lake, we need to know the number of different species and the identity of those species in the lake.

Next, each species is assigned a number, called the coefficient of conservatism, indicating how typical this plant is of pristine conditions. Plants typically found in more nutrient rich and/or disturbed waters are given lower numbers. Nichols assigned this coefficient of conservatism to 128 lake plants found in Wisconsin. Together, the number of species found, the identity of those plants, and the coefficient of conservatism associated with each plant help quantify lake quality.

The Floristic Quality Index varies around Wisconsin but ranges from 3.0 to 44.6 with a median of 22.2. The Floristic Quality Index is particularly valuable for comparing lakes around the state or looking at a single lake over time. Generally, higher FQI numbers mean better lake quality.

The survey found 15 plant species in the east lobe that computed out to an FQI of 26.6. In the west lobe, 24 species were found, which computes out to an FQI of 33.9. If the two lobes are taken as one body of water, 26 different species were found (the same type of plant was sometimes found in both lobes for a total of 26) and the resulting FQI was 36.5.

(See Appendix C)

Littoral Zone Frequency

Littoral zone frequency of occurrence indicates *how often a species was found considering only areas that are less than or equal to the maximum depth of plant growth.* It is calculated by taking the total number of times a species is sampled divided by the total number of points at which depth was less than or equal to the maximum depth of plant growth. Thus we consider only sites in the lake at which, given light requirements, the growth of plants is possible. It serves as another indicator of water quality.

(See Appendix D)

Watershed Analysis

The watershed analysis began with a delineation of the Blue Lake drainage basin using a U.S.G.S. 7.5-Minute Quadrangle Map (topographic map). The watershed delineation was then transferred to a Geographic Information System (GIS). These data, along with land use data acquired from Oneida County, were then combined to determine and map the preliminary watershed land uses. The land uses were then field verified by volunteers from the Blue Lake Preservation Association. The drainage basin and land use data were combined to create Figures 1 and 2 on the following pages. Figure 1 on page 12 shows Blue Lake's watershed and Figure 2 on page 13 depicts the zoning.

There are two major contributors to water quality issues associated with a lake's watershed: the size of the watershed and the uses of the land within the watershed. Typically, there is a direct correlation between watershed size and amount of sediments and nutrients that enter the lake; the smaller the watershed, the smaller the amounts of nutrients and sediments that enter the lake.

Watershed to lake ratio is one way to evaluate the potential impact of the watershed on the lake. In general, lakes with a ratio of less than 10 to 1 do not have management problems associated with excessive amounts of phosphorus and/or sediments entering the lake from its drainage basin. Blue Lake is approximately 456 acres in size (WDNR Aug 1972 Historical Lake Map) and has a small watershed of approximately 500 acres. Therefore, its watershed to lake ratio is approximately 1 to 1. No streams or lakes discharge into Blue Lake.

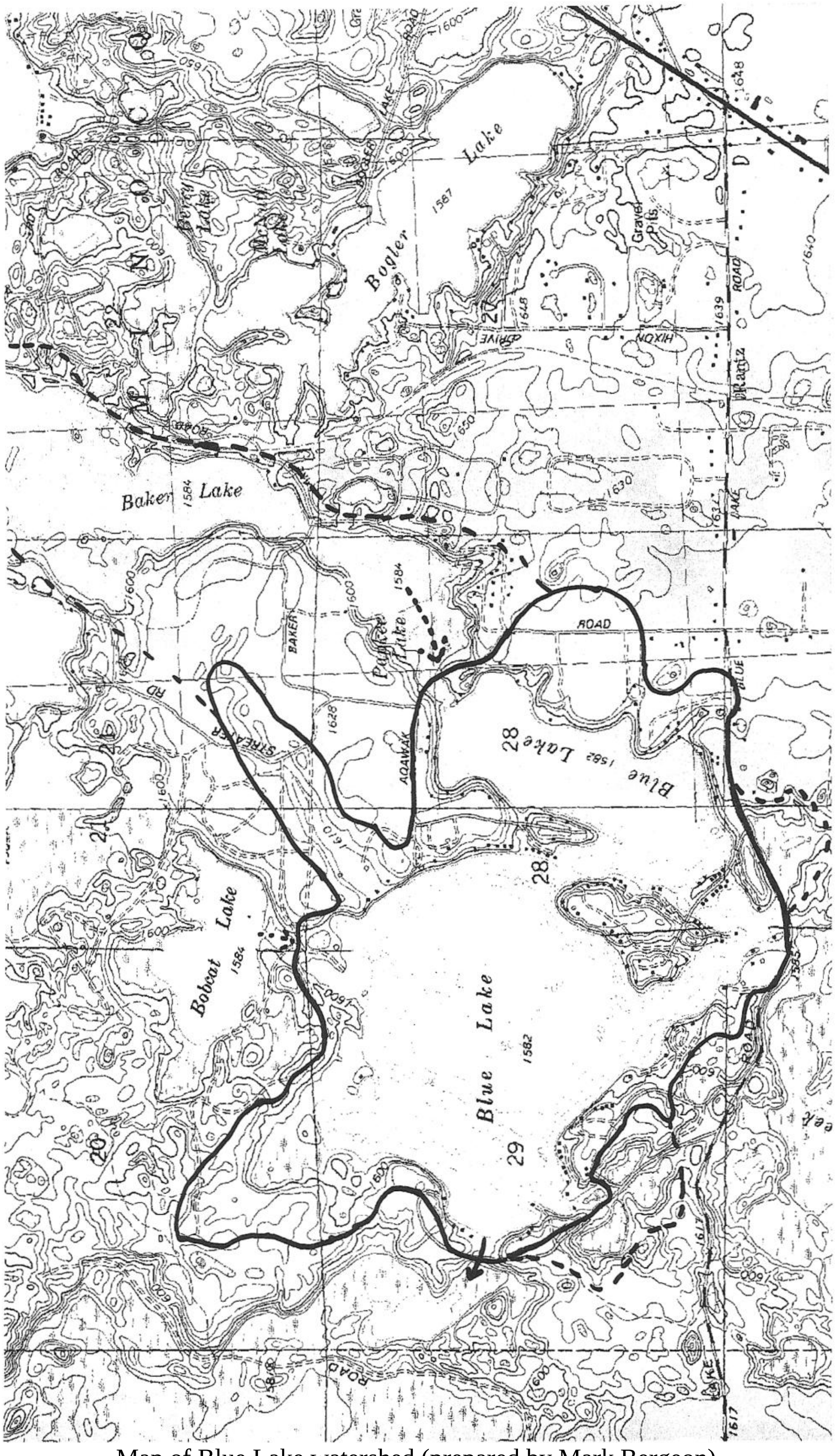
Land use within the drainage basin also has a direct impact on water quality. Agricultural areas and residential/urban areas reduce natural infiltration and typically increase surface runoff which carries nutrients and sediments to a lake. Conversely, vegetated areas, such as forests, grasslands, and wetlands, allow surface water to infiltrate into the ground and do not produce excessive runoff.

Land uses in the Blue Lake watershed consist primarily of single family residences, both seasonal and year round, small areas of recreational (Camp Agawak, Blue Lake Resort, Belle Terre Resort and Blue Lake Pines Lodge) and small areas of forestry. The land use is reflected by the zoning designation as shown on Figure 2 on page 13.

Observations of the watershed indicate that the majority of the land within the watershed remains forest and wetlands. The majority of the residential lots remain forested with limited urban type landscaping. However, some lots have landscaping that includes large lawn areas and impermeable surfaces (roofs, decks, and driveways) that tend to promote runoff.

The watershed setting and land uses within the watershed give Blue Lake landowners almost complete control of the amount of sediments and nutrients that enter the lake. Proper land management can reduce the amount of runoff associated with overdevelopment of shorelines by minimizing future landscaping, especially on the lake side of properties, and by restoring areas where existing landscaping has had major impacts on the shoreline.

Figure 1: Blue Lake Watershed



Map of Blue Lake watershed (prepared by Mark Bergeon)

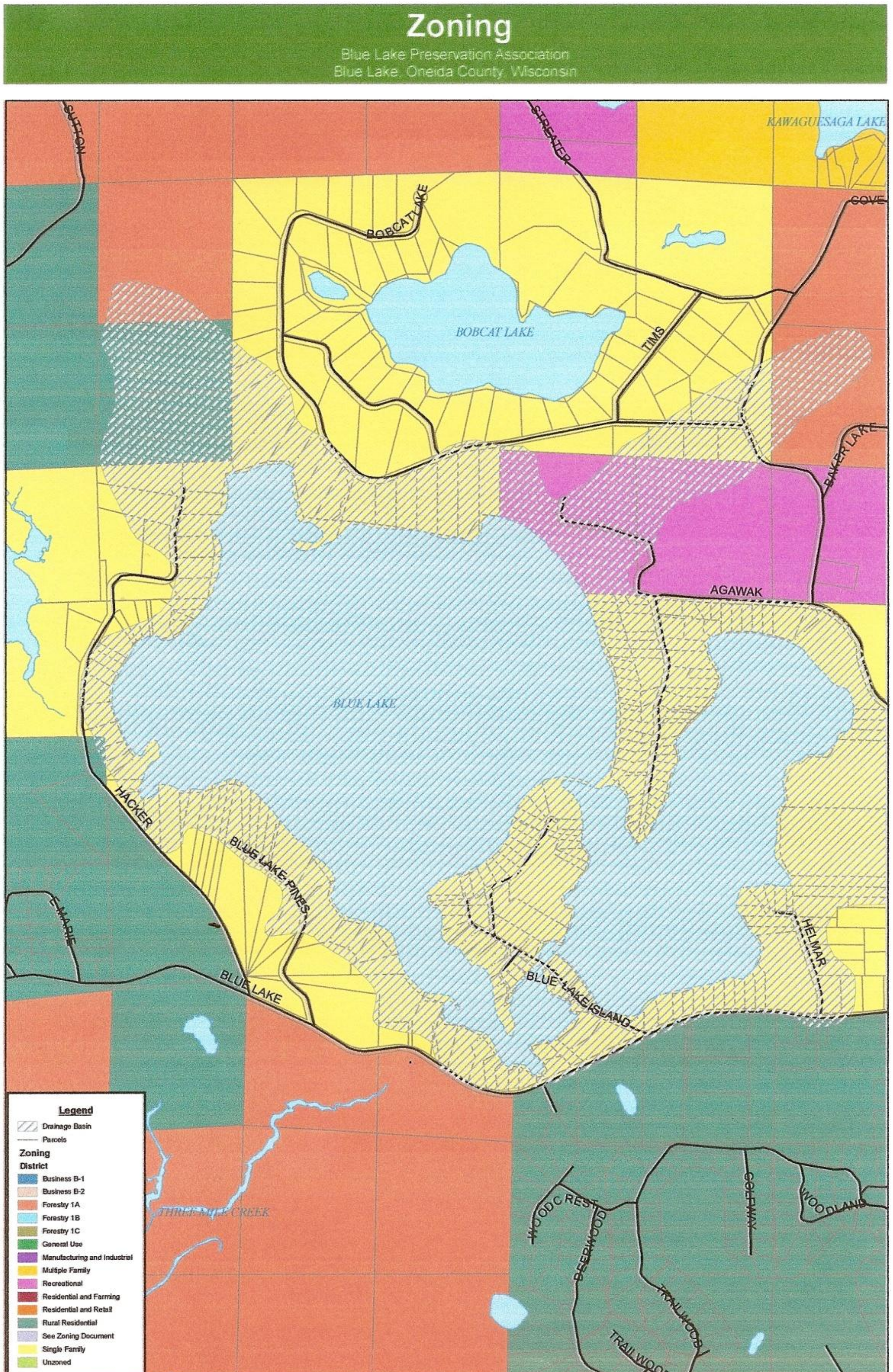
Key

Surface water on the lake side of solid black line flows into Blue Lake.

Solid arrows show flow of surface water.

Dashed lines show areas where water may flow into Blue Lake depending upon such factors as roads and sandy soil which may prevent the water's natural flow

Figure 2: Zoning



Map by Matt Bergeon

Shoreland Development

The shoreland development on Blue Lake has increased dramatically since first started in the late 1800's. With this development, a certain amount of decrease in water quality and wildlife habitat has occurred. Many people who move to or build on shoreland areas attempt to replicate the suburban landscapes they are accustomed to by converting natural shoreland areas to the "neat and clean" appearance of manicured lawns and flowerbeds. The conversion of these areas immediately leads to destruction of habitat utilized by birds, mammals, reptiles, amphibians, and insects. The maintenance of these areas contributes to decreased water quality by increasing inputs of phosphorus and sediments into the lake. Removal of native plants from shallow, near-shore areas destroys habitat used by fish, mammals, birds, insects, and amphibians while leaving bottom and shoreline sediments vulnerable to wave action caused by boating and wind. Furthermore, the dumping of sand to create beach areas destroys spawning, cover, and feeding areas utilized by aquatic wildlife. The removal of fallen trees and other woody debris from shoreline areas in an attempt to maintain the "neat and clean" appearance also removes habitat and food for aquatic and terrestrial flora and fauna.

In addition, when a landowner develops a waterfront lot, many changes take place including the addition of driveways, houses, decks, garages, sheds, piers, rafts and other structures, wells and septic systems. Many of these changes result in the compaction of soil and the removal of trees and native plants, as well as the addition of impervious (hard) surfaces, all of which alter the path that precipitation takes to the water. Each of these alterations also decreases the ability of the shoreland area to serve its natural functions. For every percent of a lot that is converted to impervious surfaces, there is one less percent capable of filtering rainwater or providing food and shelter on which wildlife depends.

Shoreland development is regulated by state and county laws. Wisconsin DNR, Chapter NR-115, was recently revised and passed into law on February 1, 2010. The purpose of NR-115 is to establish *minimum* shoreland zoning standards and to limit the direct and cumulative impacts of shoreland development on water quality, near-shore aquatic, wetland and upland wildlife habitat and natural scenic beauty.

Blue Lake has had a unique set of stricter county zoning laws that have been in place since 1980, thanks to the work of a strong, newly formed lake association. The first ordinance requires that any new subdivision of property has a minimum of 200' of shoreline. The second disallows double density, or two homes built on one parcel. The third prohibits back lake access.

While regulations can protect shoreland areas going forward, steps can be taken now to restore shoreland areas that have already been compromised. Shorelands can be restored to create natural conditions that enhance wildlife and plants and improve our Blue Lake water quality. A buffer zone, an area of native vegetation that naturally links the water's edge and the land, can be planted to attract wildlife, filter pollutants, reduce erosion, and retain water for dry periods. The Oneida County Land and Water Conservation Committee has a cost share program designed for shoreline conservation practices for Oneida County landowners. The program offers a cost share incentive for landowners who wish to restore an indigenous habitat to their land. Landowners can be reimbursed up to 70% for the cost of purchasing and planting native trees, shrubs, plants, and other materials.

Septic Systems

The fact that the majority of the watershed is currently forested, in wetlands, or vegetated in some other fashion helps limit excess runoff carrying phosphorus and other pollutants that enter Blue Lake. With the exception of conversion of forested areas to residential lots, an increased loading rate from septic systems will likely have the greatest impact on the health of the lake. Increased loading from septic systems could occur in primarily two ways:

- Septic system failure and/or decreased efficiency
- Additional septic systems being installed around the lake.

Newer septic systems tend to function better than older systems, so the immediate concern should be with the existing, older systems on the lake that have not been recently inspected. According to Wisconsin State Statute 145.245(4), a septic system is considered to be failing if untreated wastewater backs up into the building, seeps to the soil surface, enters surface or groundwater, or moves into the soil's saturated zone. With the exception of being backed up into the building, all of these failures could potentially increase nutrient loading to the lake. The Wisconsin Department of Commerce estimates that nearly one in five septic systems is failing in Wisconsin. (Upper and Lower Post Lakes Comprehensive Lake Management Plans, August 2003).

Unfortunately, dealing with septic system issues on lakes is a very touchy subject because restoring a failing system can result in a large expense for the property owner. However, if the protection of Blue Lake truly is the goal of the Blue Lake Preservation Association and its members, these inhibitions towards septic system problems must be overcome. Indeed, the Water Quality Survey (2007) shows that septic concerns are a priority for a large percentage of respondents. Under certain conditions, landowners who are required to update their system may be eligible to apply for a Wisconsin Fund Grant through the Oneida County Planning and Zoning Department. Eligibility criteria are stringent, however. The system must have been constructed prior to July 1, 1978 and must meet owner income and occupancy limitations. Grant limits vary by type of system installed and can be found in the Wisconsin Department of Commerce Code (Chapter Comm. 87.30).

At their August 30, 2009 meeting, the Oneida County Board of Supervisors approved amendments to chapter 13 of the Oneida County Private Onsite Wastewater Treatment System (POWTS) Ordinance. The amendment requires *all* properties in Oneida County with a POWTS, better known as "septic system", to become enrolled in the county's maintenance program no later than October 1, 2013. The maintenance program, mandated by the State of Wisconsin under Comm. 83.04(4) of the Wisconsin Administrative Code, is designed to ensure that all POWTS throughout the county are functioning properly. Residents enrolled in the maintenance program are required to have their POWTS visually inspected every three years and, if found necessary, have septic tank pumped.

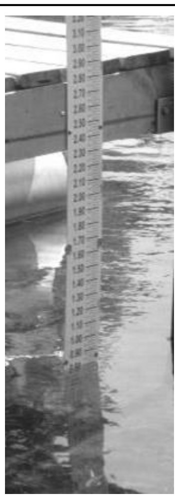
RECOMMENDATIONS

WATER QUALITY

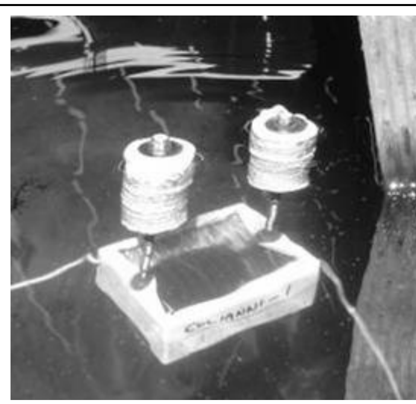
The water quality of Blue Lake is, at the present time, quite good, and there is no need for aggressive in-lake treatments to correct existing problems. There are; however, many measures that can be taken to protect the lake in the coming years. The most appropriate plan is to protect, and perhaps slightly enhance, the current water quality of the lake through implementation of the recommendations stated below. These measures are seen as deserving of the highest priority.

- Continuous water quality monitoring is an essential component in any lake management plan. Long-term datasets help lake managers detect subtle trends in water quality that cannot be detected with only a year's or season's worth of data. Fortunately for Blue Lake, thanks to the foresight of longtime residents, we have a long history of water data available through the Wisconsin Citizen Lake Monitoring Network. This data includes chlorophyll-a, total phosphorous, Secchi disk transparence, and dissolved oxygen (DO) profiles. It is imperative that this program be ongoing. Any interested lake resident should be encouraged to join the effort.

- Programs are in place to collect meteorological data in the form of precipitation and temperature (air and water) measurements, tracking lake water levels, and gathering periodic algae samples for future analysis. Instruments used to gather this information are shown here. These programs should be continued.


Staff gauge to measure water depth


Rain gauge


Diatometer to collect algae samples


L: Air temperature thermometer;
R: Total immersion water temperature thermometer

AQUATIC VEGETATON

- An aquatic invasive species rapid response plan should be developed.
- A clean boat/clean water program should be instituted in a form appropriate for Blue Lake.
- Biological monitoring efforts should be instituted to include rusty crayfish, zebra mussels, Eurasian Water Milfoil, purple loosestrife, and other invasive species.
- Comprehensive aquatic plant surveys should be done every five years and comparisons made with previous surveys to ascertain changes in the lake's plant community.
- Educational programs should be developed and presented to lake residents to help identify aquatic invasive species. The programs should encourage lake users to look for invasives every time they are on or around the water, especially near docks and boat landings.

SEPTIC SYSTEMS

- Educate lake homeowners on the effects failing Private Onsite Wastewater Treatment Systems (POWTS) have on the lake.
- Educate lake homeowners on the current POWTS ordinance.
- BLPA sponsored program to bring, by whatever means necessary, every POWT, current and abandoned, into compliance with county and state ordinances.

SHORELAND RESTORATION

- Educate landowners about responsible shoreland practices.
- Assist homeowners with information and provide resources related to shoreland restoration.
- BLPA provide information about incentives to homeowners to encourage them to restore their shoreline.
- BLPA monitor Oneida County zoning laws and how they might impact Blue Lake development.

People who helped with the Blue Lake Management Plan

BLUE LAKE

Mark Bergeon
Matthew Bergeon
Tom Bose
Bill Clark
Teresa Colianni
Cindy Crochiere
John Gray
Cynthia Holmberg
Mark Holmberg
Ron Holmberg
Dick Johnson
Cheryl Kamba
Sylvia Knust
Margaret Krueger
Betty Myers
Dan Pagel
Sue Pagel
Bob Reed
Candy Simpson
Jane Wierschem
Ken Wierschem

DNR/UW-EXTENSION

Paul Garrison
Susan Knight
Sandy Wickman

APPENDIX A
SEDIMENT CORE RESULTS

RESULTS OF SEDIMENT CORE TAKEN FROM BLUE LAKE, ONEIDA COUNTY, WISCONSIN

Paul Garrison, Wisconsin Department of Natural Resources
November 2003

Aquatic organisms are good indicators of a lake's water quality because they are in direct contact with the water and are strongly affected by the chemical composition of their surroundings. Most indicator groups grow rapidly and are short lived so the community composition responds rapidly to changing environmental conditions. One of the most useful organisms for paleolimnological analysis are diatoms. These are a type of algae which possess siliceous cell walls, which enables them to be highly resistant to degradation and are usually abundant, diverse, and well-preserved in sediments. They are especially useful, as they are ecologically diverse. Diatom species have unique features as shown in Figure 1, which enable them to be readily identified. Certain taxa are usually found under nutrient poor conditions while others are more common under elevated nutrient levels. Some species float in the open water areas while others grow attached to objects such as aquatic plants or the lake bottom.

By determining changes in the diatom community it is possible to determine water quality changes that have occurred in the lake. The diatom community provides information about changes in nutrient and pH conditions as well as alterations in the aquatic plant community.

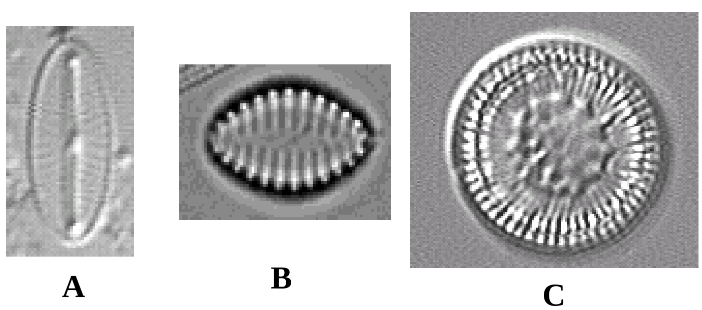


Figure 1. Micrographs of diatoms similar to those found in the Blue Lake sediment core. The diatoms on the left, *Navicula atomus* var. *permitis* and *Staurosira construens* var. *venter* are typically found growing attached to plants or on the sediments. The diatom on the right, *Cyclotella comensis* is found floating in the open water. This diatom was not found in the core but is somewhat similar to *C. glomerata* which was common.

I have examined the diatoms from the cores taken on 10 July 2003 near the deep area of Blue Lake. The sediment core was collected from a water depth of 17 meters with a gravity corer. I examined sediment from the top of the core and a section deeper in the core. It is assumed that the upper sample represents present conditions while the deeper sample is indicative of water quality conditions at least 100 years ago.

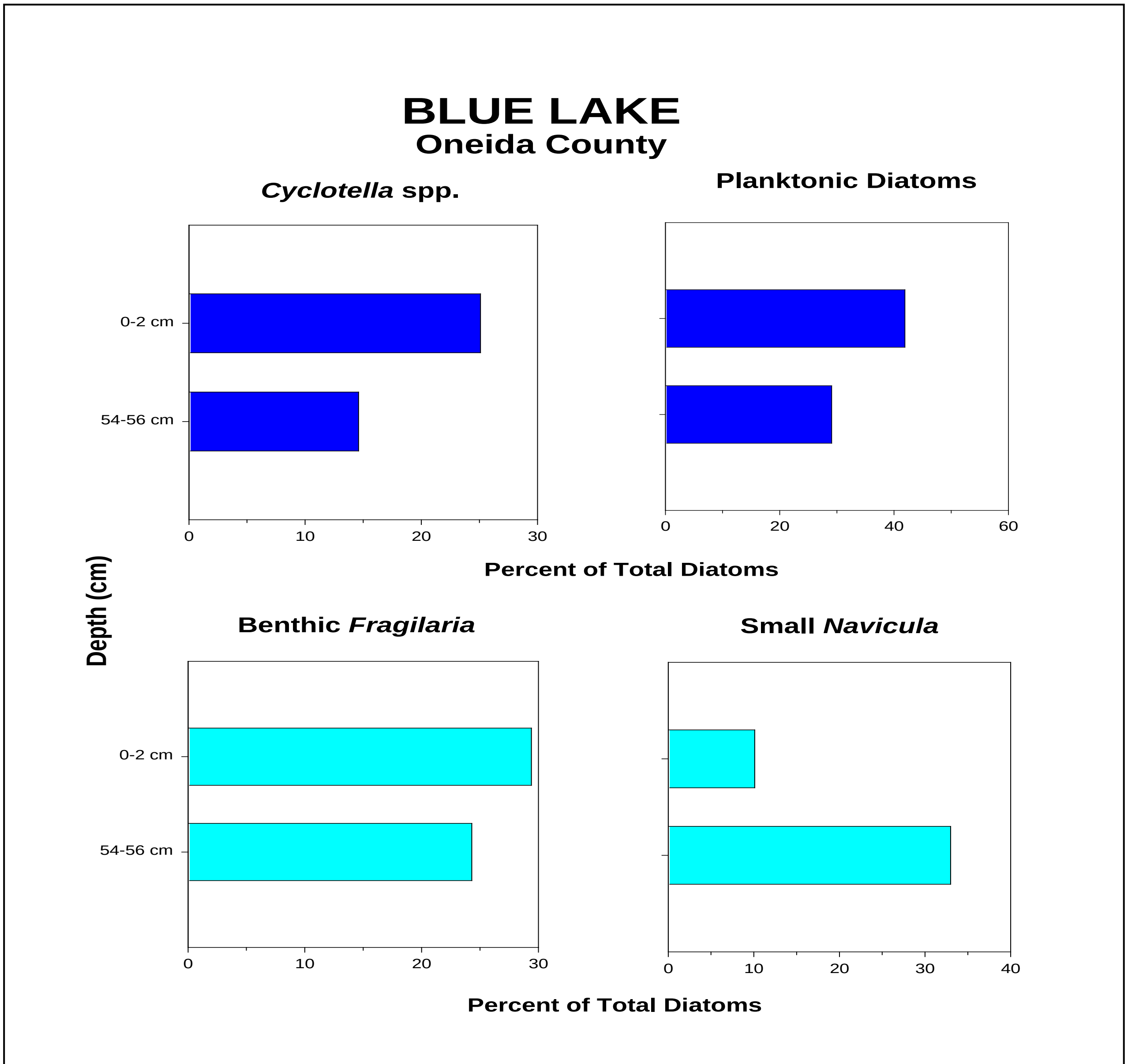


Figure 2. Changes in the abundance of important diatoms found at the top and bottom of the Blue Lake sediment core. An increase in planktonic diatoms indicates that phosphorus levels have increased during the last 100 years. The dominant diatom in the planktonic community is *Cyclotella glomerata*, which indicates the phosphorus concentration is low even though it has increased. The decline of small *Navicula* and increase of benthic *Fragilaria* also indicates an increase in phosphorus during the last 100 years.

In Blue Lake, historically the major component of the diatom community are those species that grow attached to plants or on the lake bottom (benthic *Fragilaria* and small *Navicula*)(Figure 2). The principal benthic *Fragilaria* was *Staurosira construens* var. *venter* and the most common small *Navicula* was *N. atomus* var. *permitis* (Figure 1). Historically planktonic diatoms (diatoms that float in the open water) made up about 30% of the diatom community. The principal component of this community was *Cyclotella glomerata* (Figure 1). In recent sediments, planktonic diatoms have increased in importance and are nearly 50% of the diatom community. Also small *Navicula* have declined while benthic *Fragilaria* have increased. These changes indicate that there has been a small increase in phosphorus in the lake water. Many other studies have found that planktonic diatoms increase as a percentage of the total diatom community in response to increased phosphorus. Other studies have also found that small *Navicula* decline with increasing phosphorus levels and are replaced, in part by benthic *Fragilaria*, e.g., *S. construens* var. *venter*.

Many other sediment core studies in Wisconsin have found a significant increase in aquatic plants as a result of shoreline development. This does not appear to be the case in Blue Lake. Increases in the plant community appear to be localized and not on the scale of other northern Wisconsin lakes.

In summary, the diatom community indicates Blue Lake that nutrient levels in Blue Lake have increased during the last 100 years. The increase, while significant, is small, probably on the order of 2-4 µg L^{-1}. While water clarity is still very good in Blue Lake it likely is not as good as historical levels. The increased nutrient levels are an indication that steps should be taken to reduce nutrient input from the watershed before algal blooms become a problem. It is much more difficult to restore a lake to good water quality than to prevent its degradation.

TABLE 1. DIATOM COUNTS FROM THE BLUE LAKE SEDIMENT CORE.

BLUE LAKE
Oneida County

Core Top (0-2 cm)

TAXA	Number	Prop
Achnanthidium levanderi	3	0.014
Achnanthidium minutissima	1	0.005
Achnanthidium sp.	6	0.029
Asterionella formosa	14	0.067
Aulacoseira ambigua	2	0.010
Cyclotella bodanica var. lemanica	5	0.024
Cyclotella glomerata	42	0.202
Cyclotella stelligera	5	0.024
Fragilaria crotonensis	2	0.010
Fragilaria cotonensis var. oregona	6	0.029

BLUE LAKE
Oneida County

Core Bottom (60-62 cm)

TAXA	Number	Prop
Achnanthidium levanderi	2	0.010
Achnanthidium sp.	2	0.010
Asterionella formosa	12	0.058
Aulacoseira ambigua	3	0.015
Cyclotella glomerata	20	0.097
Cyclotella pseudostelligera	1	0.005
Cyclotella stelligera	9	0.044
Navicula atomus var. permitis	47	0.228
Navicula lanceolata	1	0.005
Navicula perparva	7	0.034

Navicula atomus var. permitis	17	0.082
Navicula pseudoventralis	2	0.010
Navicula minima	1	0.005
Navicula seminuloides	3	0.014
Navicula subtilissima	1	0.005
Navicula (GV)	1	0.005
Navicula sp.	1	0.005
Nitzschia palea	1	0.005
Nitzschia fonticola	1	0.005
Nitzschia gandersheimiensis	1	0.005
Nitzschia gracilis	1	0.005
Nitzschia sp.	8.5	0.041
Pinnularia biceps	3	0.014
Pinnularia sp.	1	0.005
Sellaphora pupula	2	0.010
Sellaphora bacillum	4	0.019
Staurosira construens	1	0.005
Staurosira construens var. venter	56	0.270
Staurosira elliptica	3	0.014
Tabellaria flocculosa str. IIIp	7	0.034
Tabellaria floccolosa (central area)	2	0.010
Tabellaria flocculosa str. III	1	0.005
Tabellaria flocculosa var. linearis	1	0.005
Unknown	2	0.010
TOTAL	207.5	1.000
Chrysophyte scales	4	
Chrysophyte cysts	35	
Pediastrum coenubia	1	
Planktonic taxa		0.419
Nonplanktonic taxa		0.571

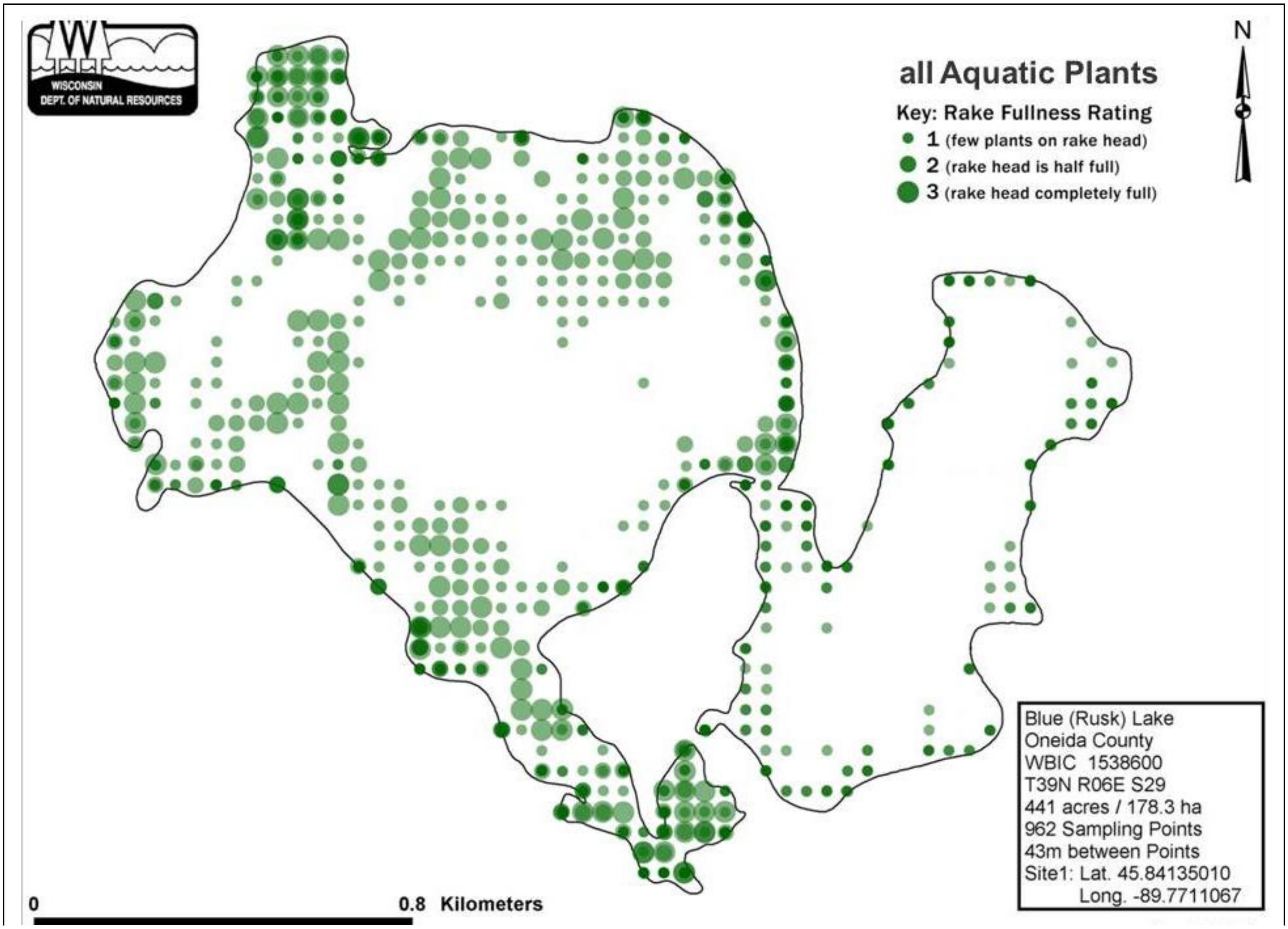
Navicula minima	1	0.005
Navicula seminuloides	8	0.039
Navicula subtilissima	3	0.015
Navicula sp. (short)	5	0.024
Navicula sp.	6	0.029
Nitzschia palea	3.5	0.017
Nitzschia sp.	0.5	0.002
Pinnularia abaujensis	1	0.005
Psammothidium subatomoides	1	0.005
Pseudostaurosira brevistrata	6	0.029
Sellaphora rectangularis	1	0.005
Stauroneis anceps f. gracilis	3	0.015
Stauroneis phoenicenteron f. gracilis	1	0.005
Staurosira construens var. venter	41	0.199
Staurosira elliptica	1	0.005
Staurosirella pinnata	2	0.010
Synedra radians	2	0.010
Tabellaria flocculosa str. IIIp	12	0.058
Tabellaria flocculosa (central area)	1	0.005
Unknown (raphid)	3	0.015
TOTAL	206	1.000
Chrysophyte scales		
Chrysophyte cysts	20	
Pediastrum coenubia	2	
Scenedesmus coenubia	4	
Tetraedron coenubia	1	
Planktonic taxa		0.291
Nonplanktonic taxa		0.694

Appendix B
Aquatic Plant Survey, 2008-2009

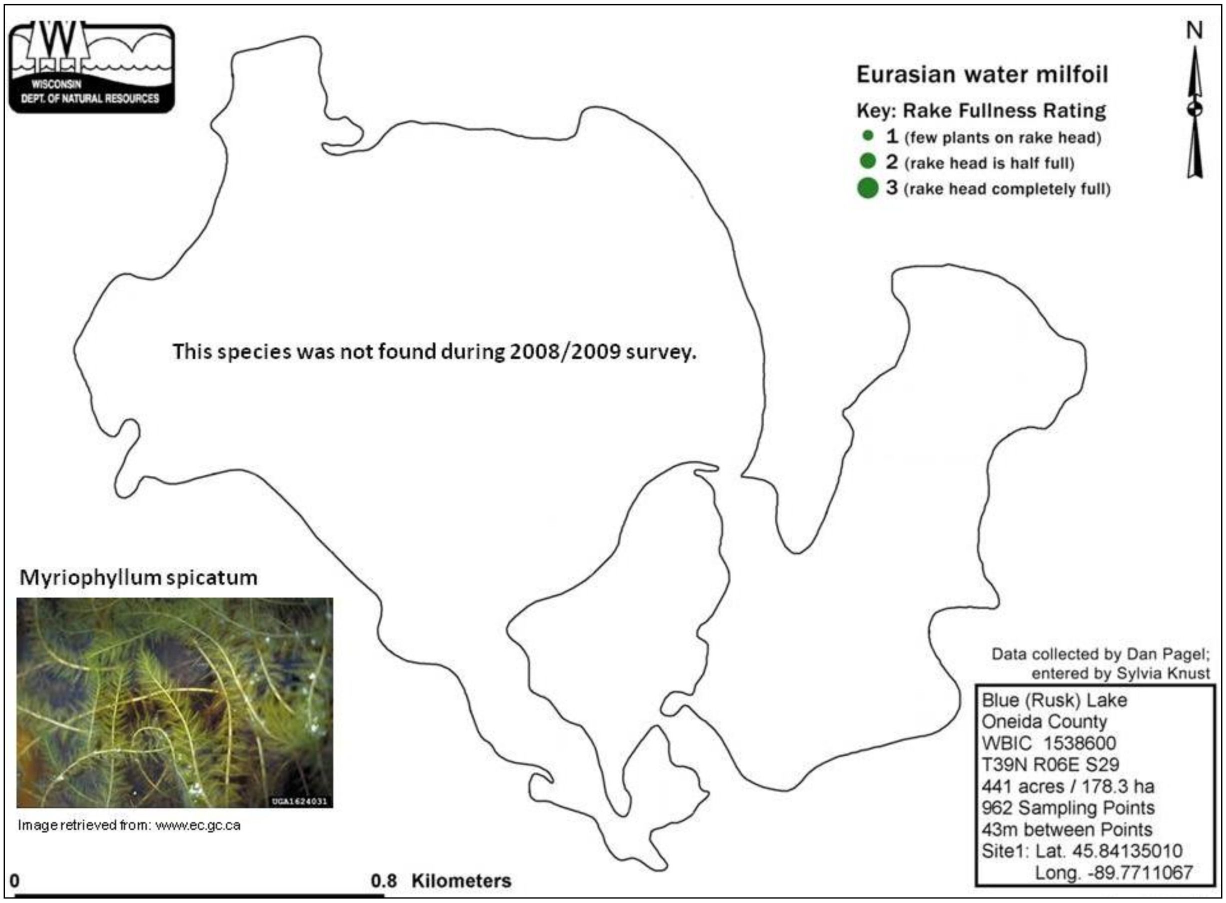
Part I – Graphic Representation of Plants Species Found at each Sampling Point

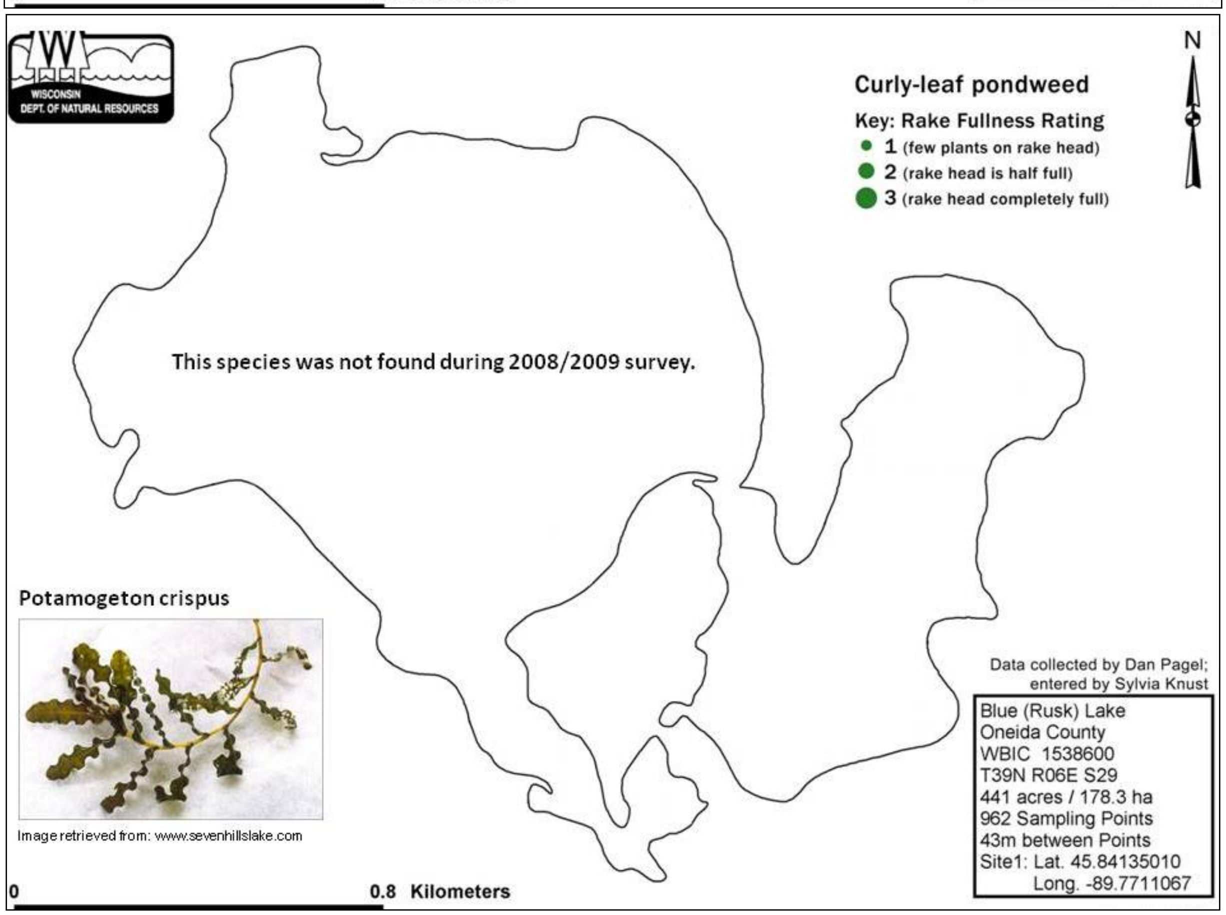
The slide immediately below is a **combination of all individual plant species** found on the lake. The size of the green circle indicates the amount of a single plant species at that location (see Rake Fullness Rating key), while the transparency of the dot indicates how many different plant species were found at that point.

Additional key for 'all Aquatic Plants' slide:
- low concentration of **different** species
- high concentration of **different** species



On the following pages each plant species is represented individually. The size of the circle indicates the concentration of the plant found (see the Rake Fullness Rating key at the top right corner of each slide).


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Eurasian water milfoil
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
This species was not found during 2008/2009 survey.
Myriophyllum spicatum
Image retrieved from: www.ec.gc.ca
Data collected by Dan Pagel;
entered by Sylvia Knust
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Curly-leaf pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
This species was not found during 2008/2009 survey.
Potamogeton crispus
Image retrieved from: www.sevenhillslake.com
Data collected by Dan Pagel;
entered by Sylvia Knust
Blue (Rusk) Lake
Oneida County
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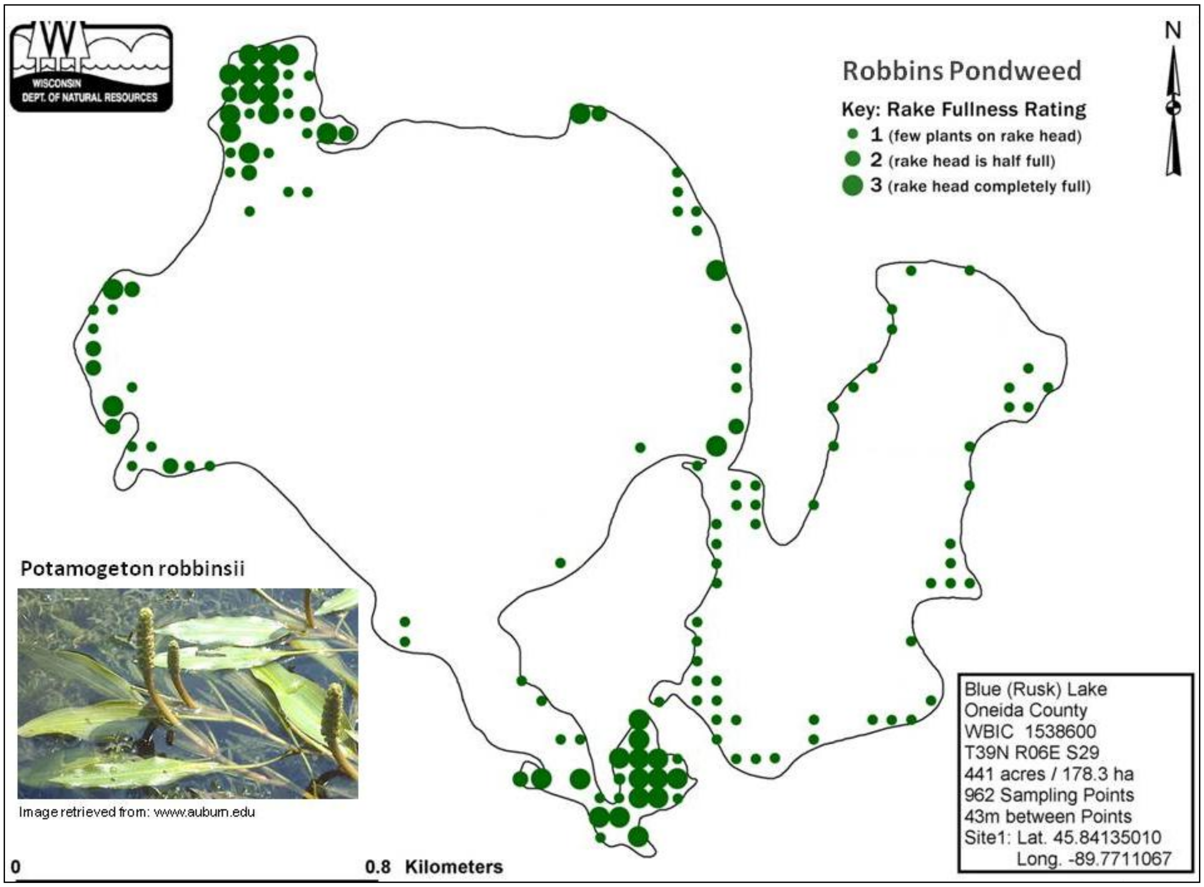
Long. -89.7711067
0
0.8 Kilometers


Robbins Pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
WISCONSIN DEPT. OF NATURAL RESOURCES
Potamogeton robbinsii
Image retrieved from: www.auburn.edu
Blue (Rusk) Lake
Oneida County
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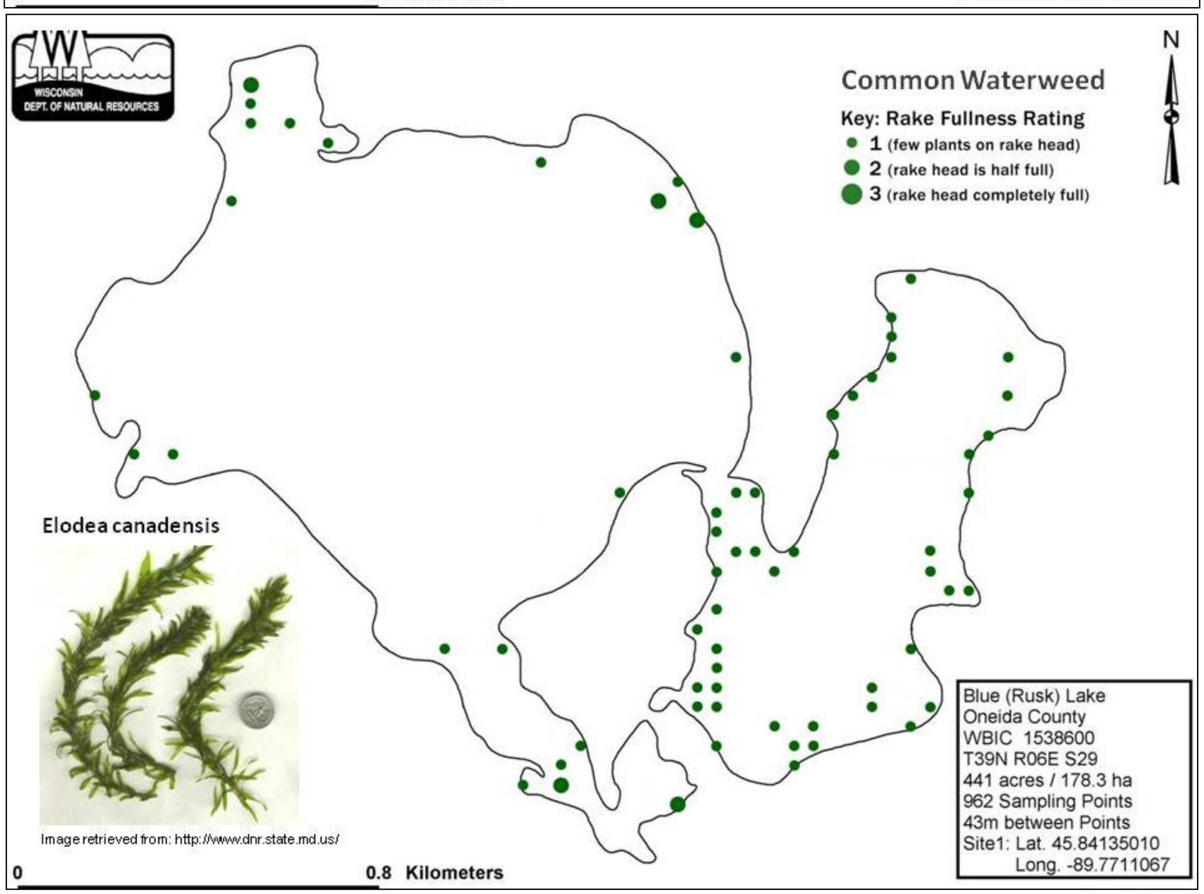
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers


Common Waterweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
WISCONSIN DEPT. OF NATURAL RESOURCES
Elodea canadensis
Image retrieved from: http://www.dnr.state.md.us/
Blue (Rusk) Lake
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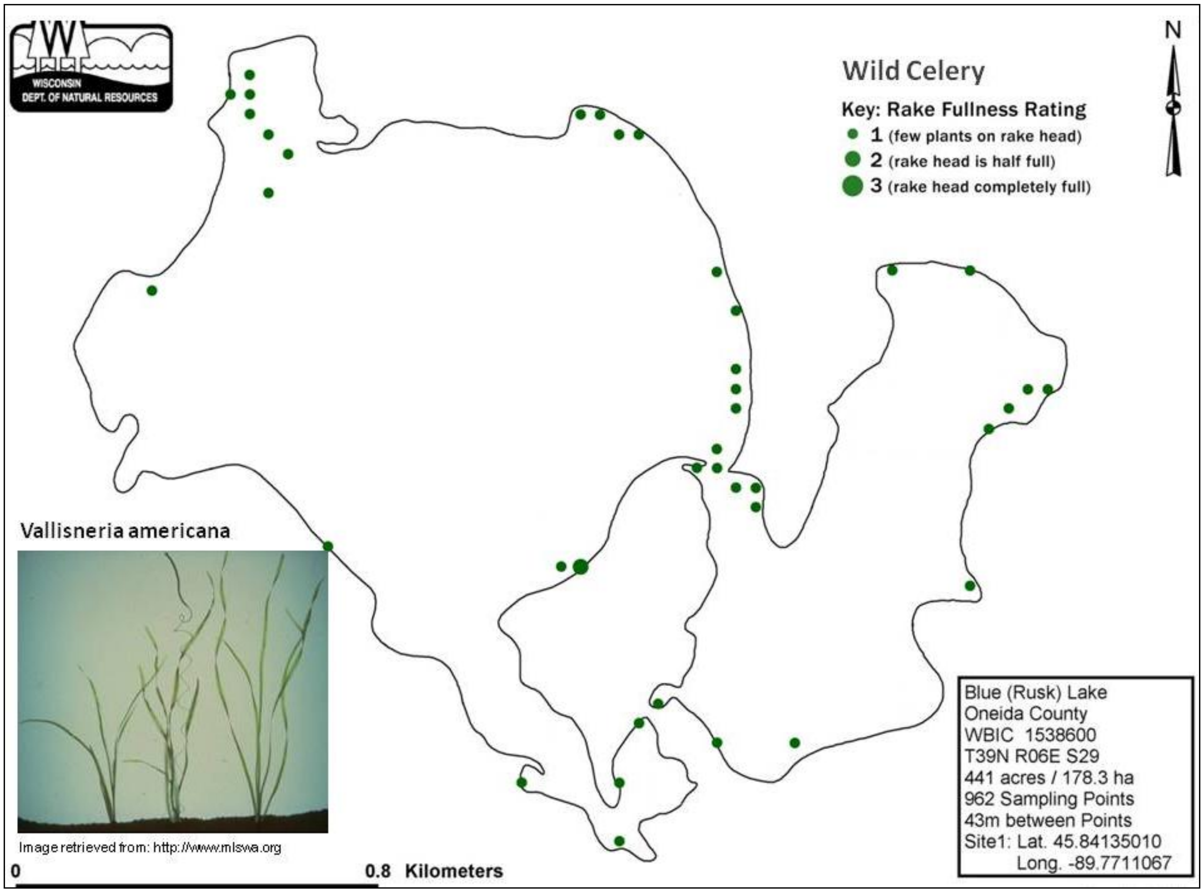
0
0.8 Kilometers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DEPT. OF NATURAL RESOURCES
N
Wild Celery
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Vallisneria americana
Image retrieved from: http://www.mlswa.org
0
0.8 Kilometers
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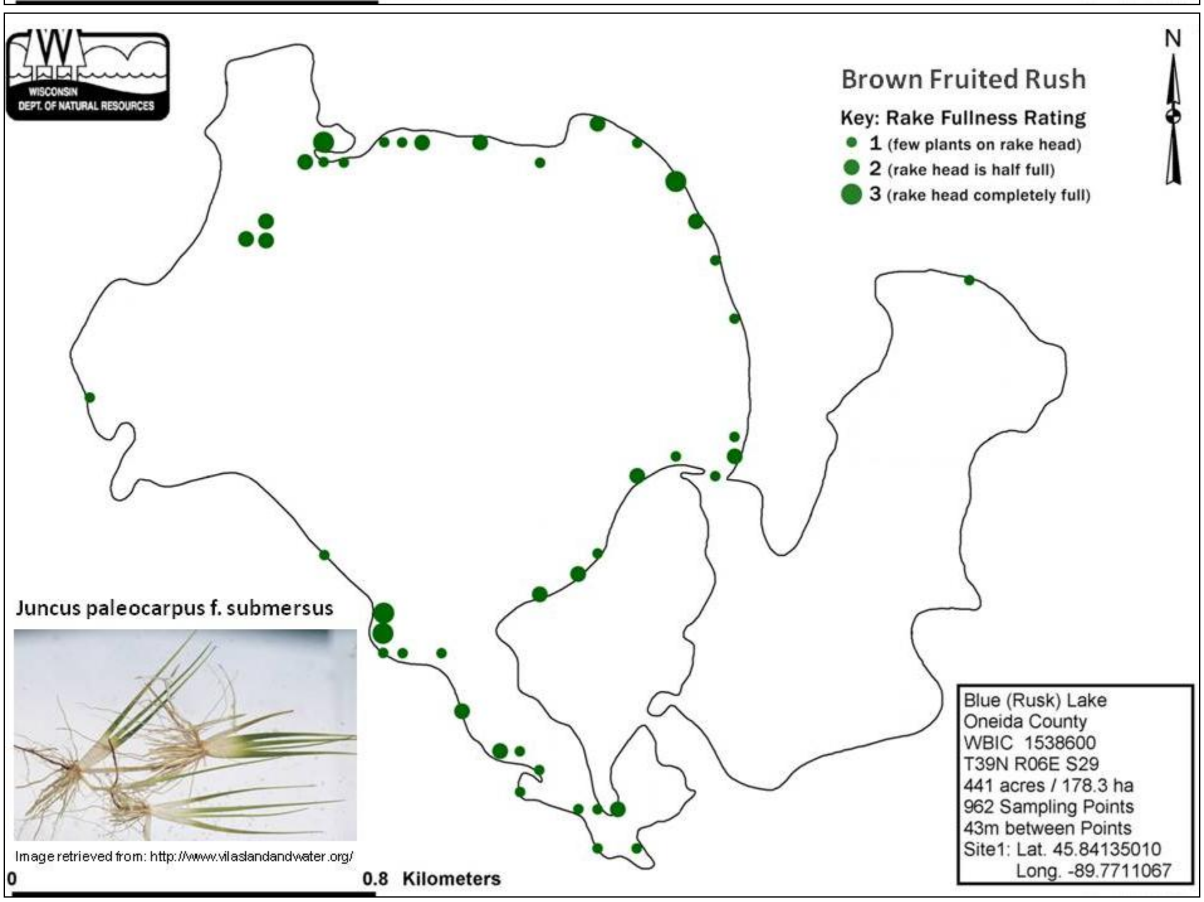
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DEPT. OF NATURAL RESOURCES
N
Brown Fruited Rush
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Juncus paleocarpus f. submersus
Image retrieved from: http://www.vilaslandandwater.org/
0
0.8 Kilometers
Blue (Rusk) Lake
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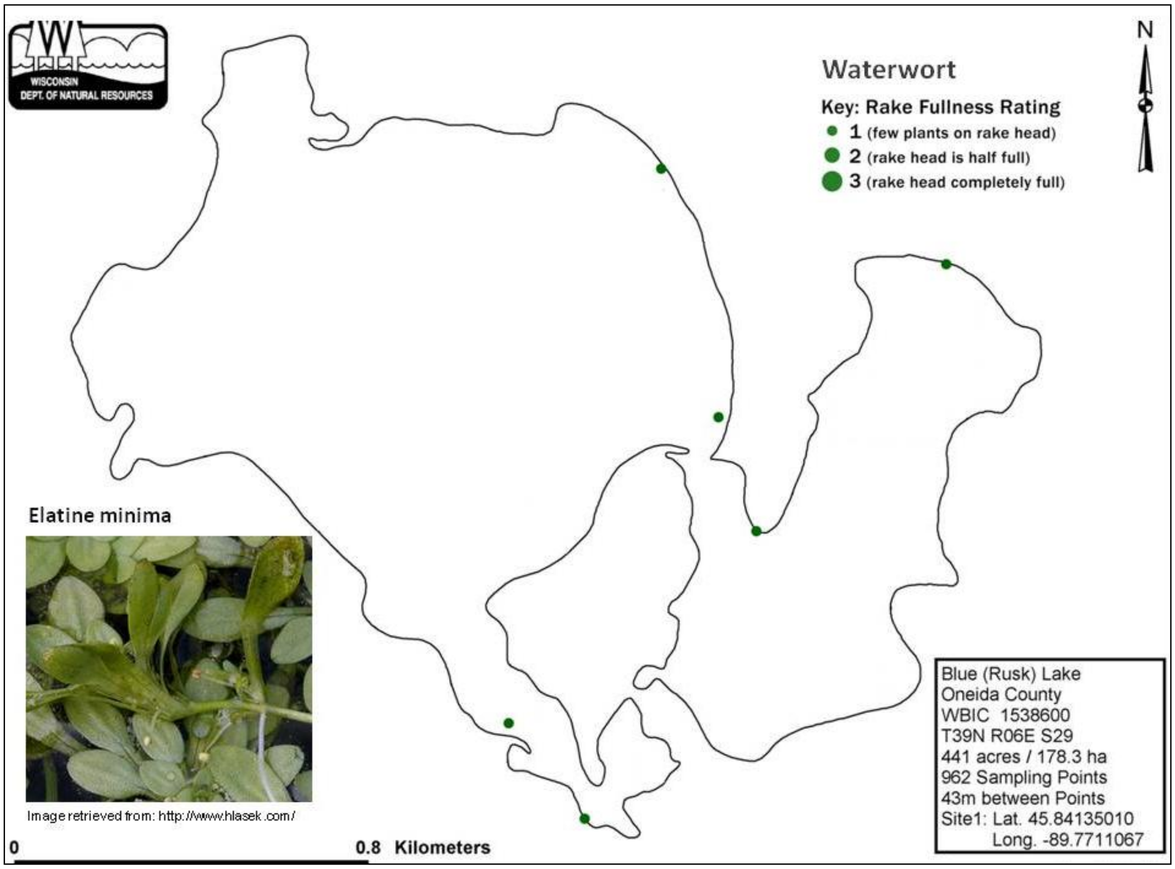

WISCONSIN
DEPT. OF NATURAL RESOURCES
Waterwort
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Elatine minima
Image retrieved from: http://www.hlasek.com/
0
0.8 Kilometers
Blue (Rusk) Lake
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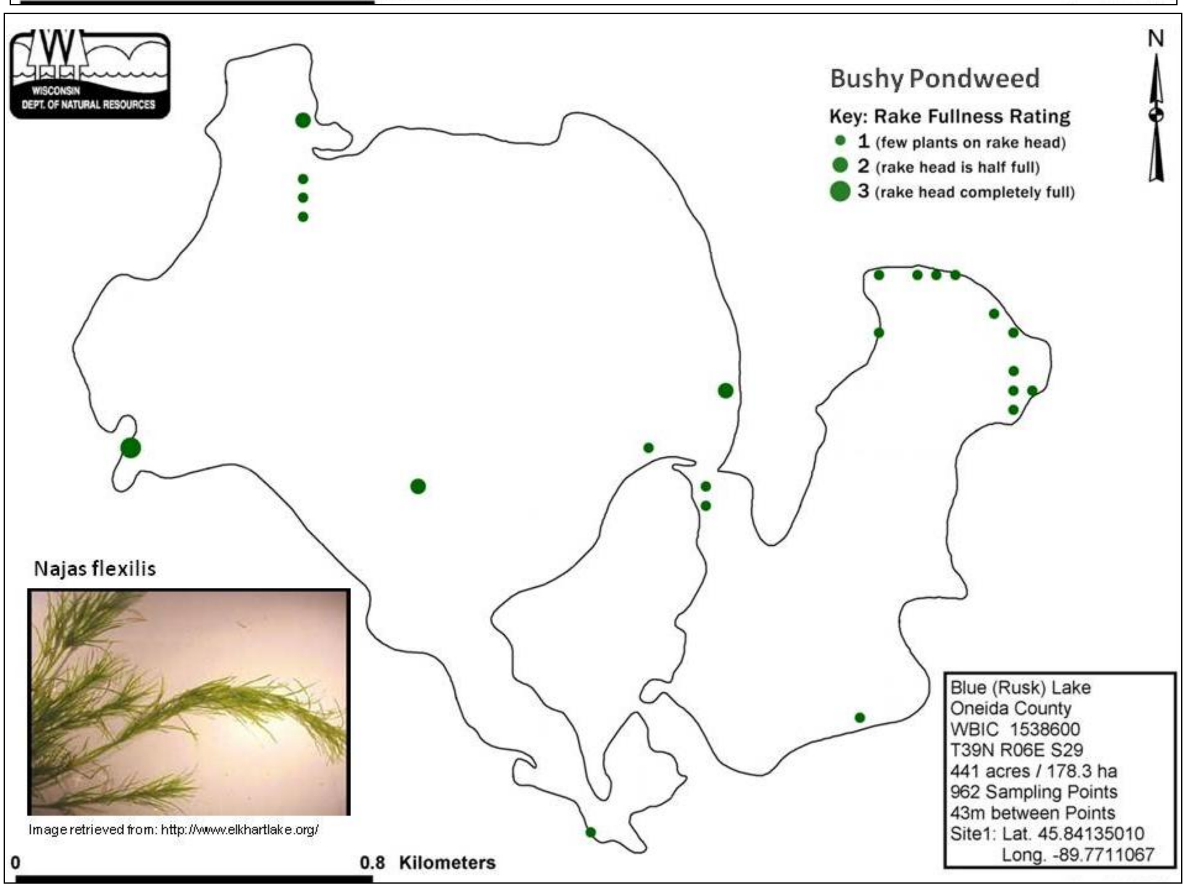

WISCONSIN
DEPT. OF NATURAL RESOURCES
Bushy Pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Najas flexilis
Image retrieved from: http://www.elkhartlake.org/
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
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T39N R06E S29
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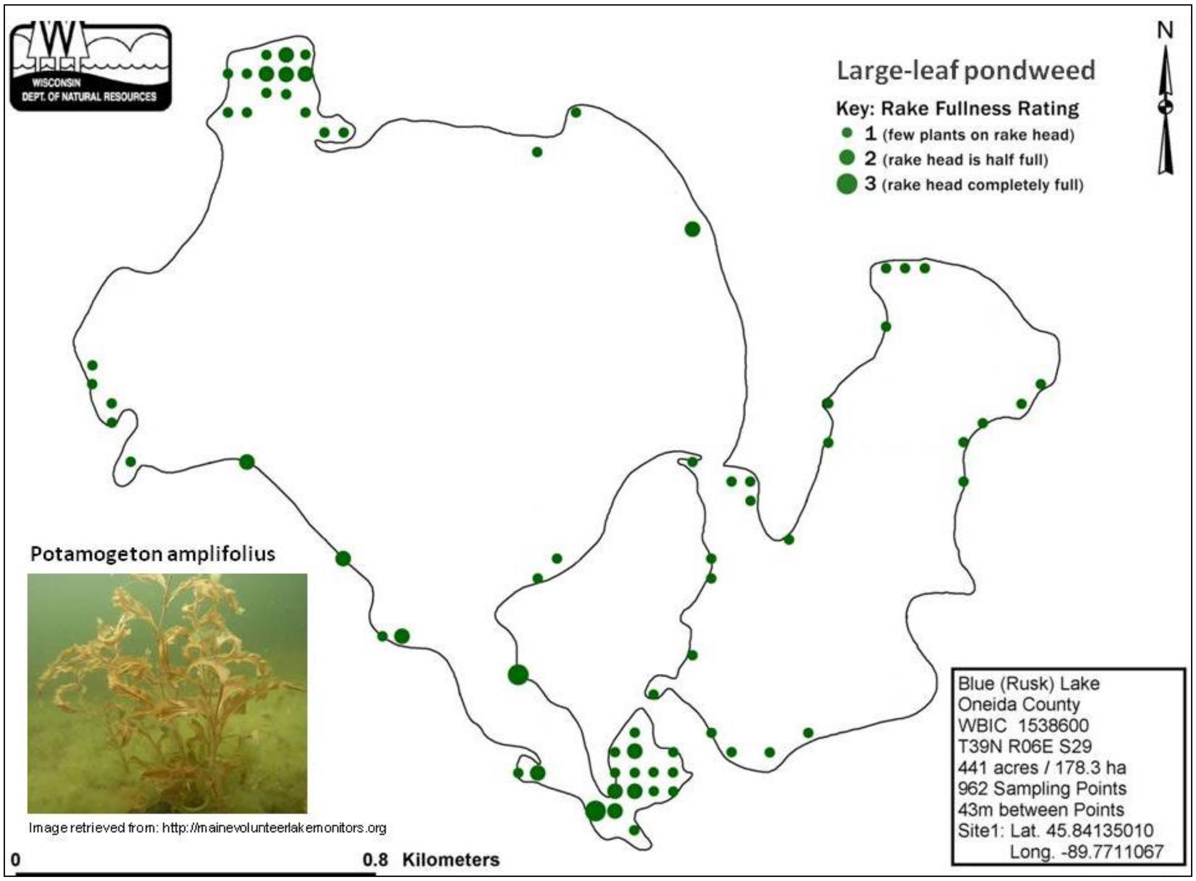

WISCONSIN DEPT. OF NATURAL RESOURCES
N
Large-leaf pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Potamogeton amplifolius
Image retrieved from: http://mainevolunteerlakemonitors.org
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
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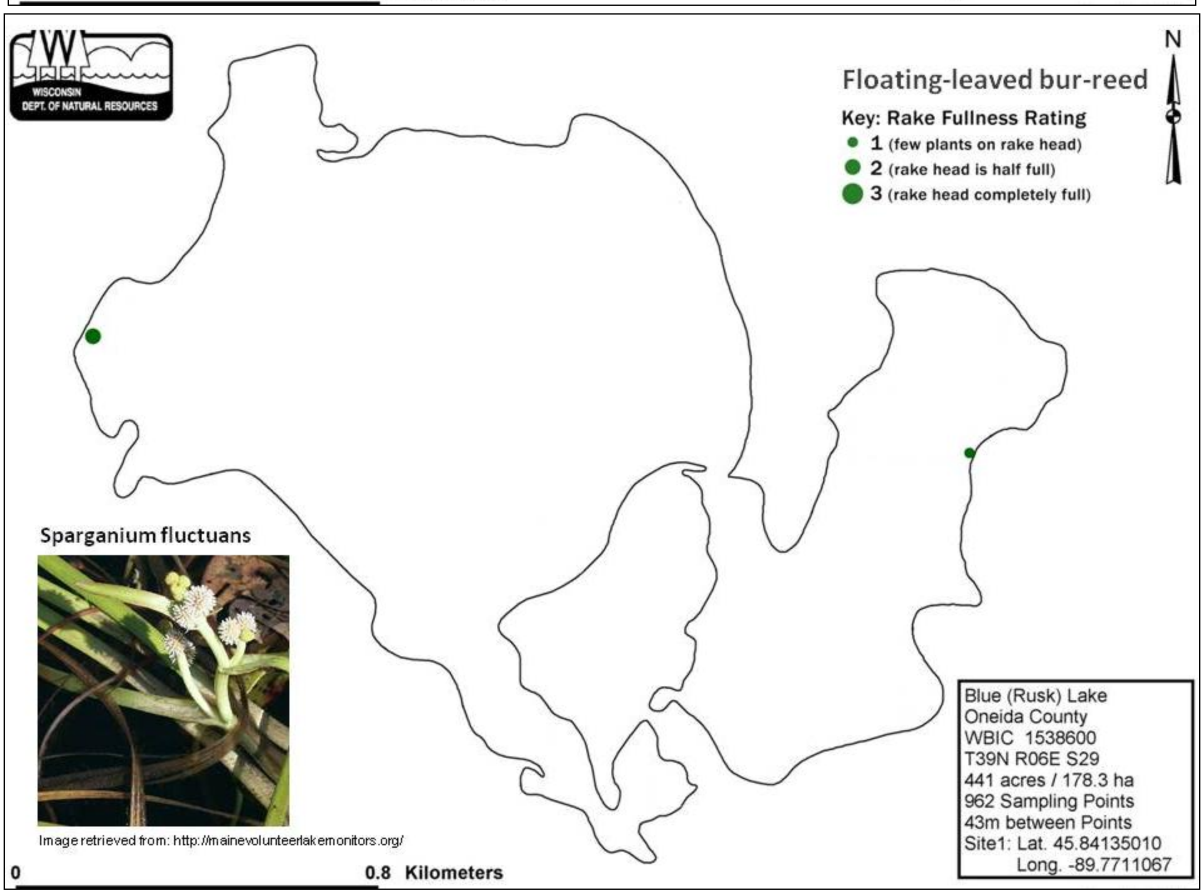

WISCONSIN DEPT. OF NATURAL RESOURCES
N
Floating-leaved bur-reed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Sparganium fluctuans
Image retrieved from: http://mainevolunteerlakemonitors.org/
0
0.8 Kilometers
Blue (Rusk) Lake
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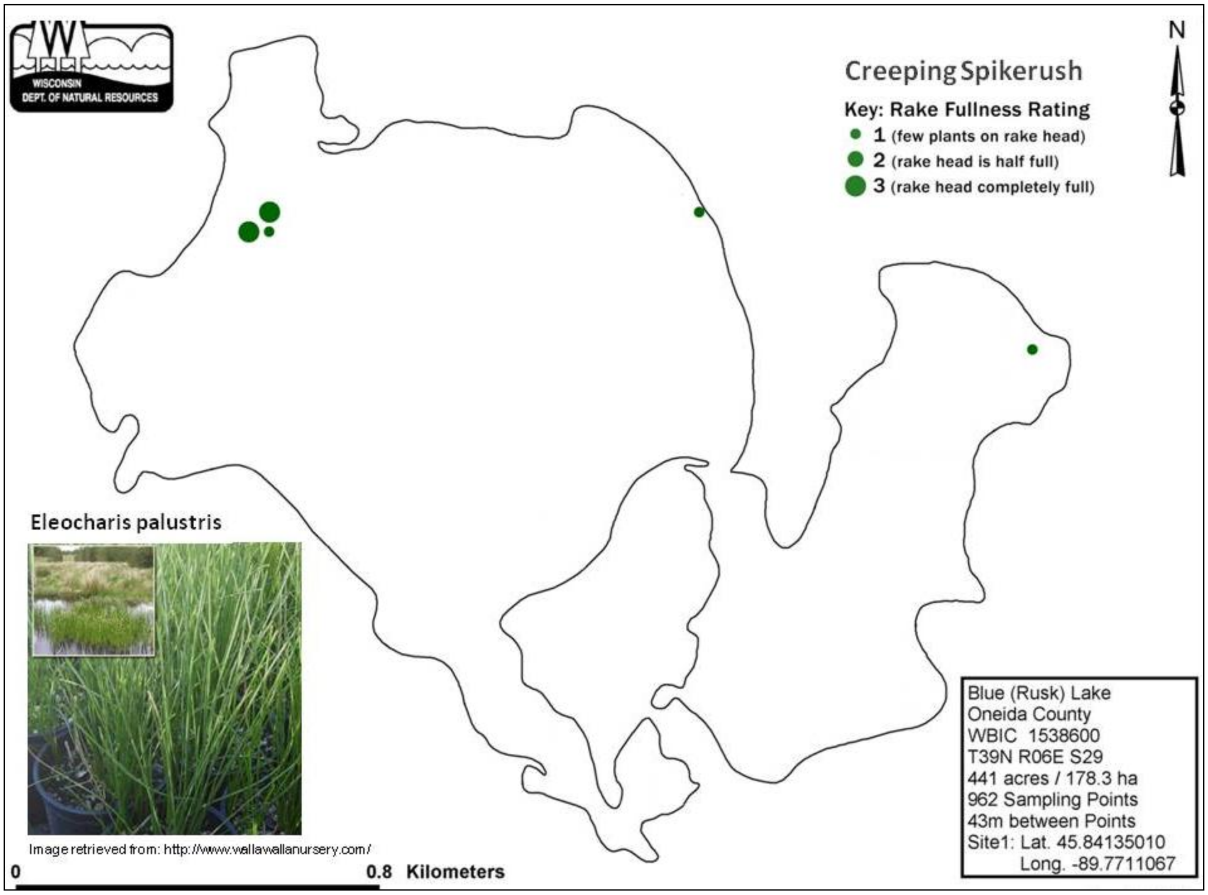

Creeping Spikerush
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
WISCONSIN DEPT. OF NATURAL RESOURCES
Eleocharis palustris
Image retrieved from: http://www.wallawallanursery.com/
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
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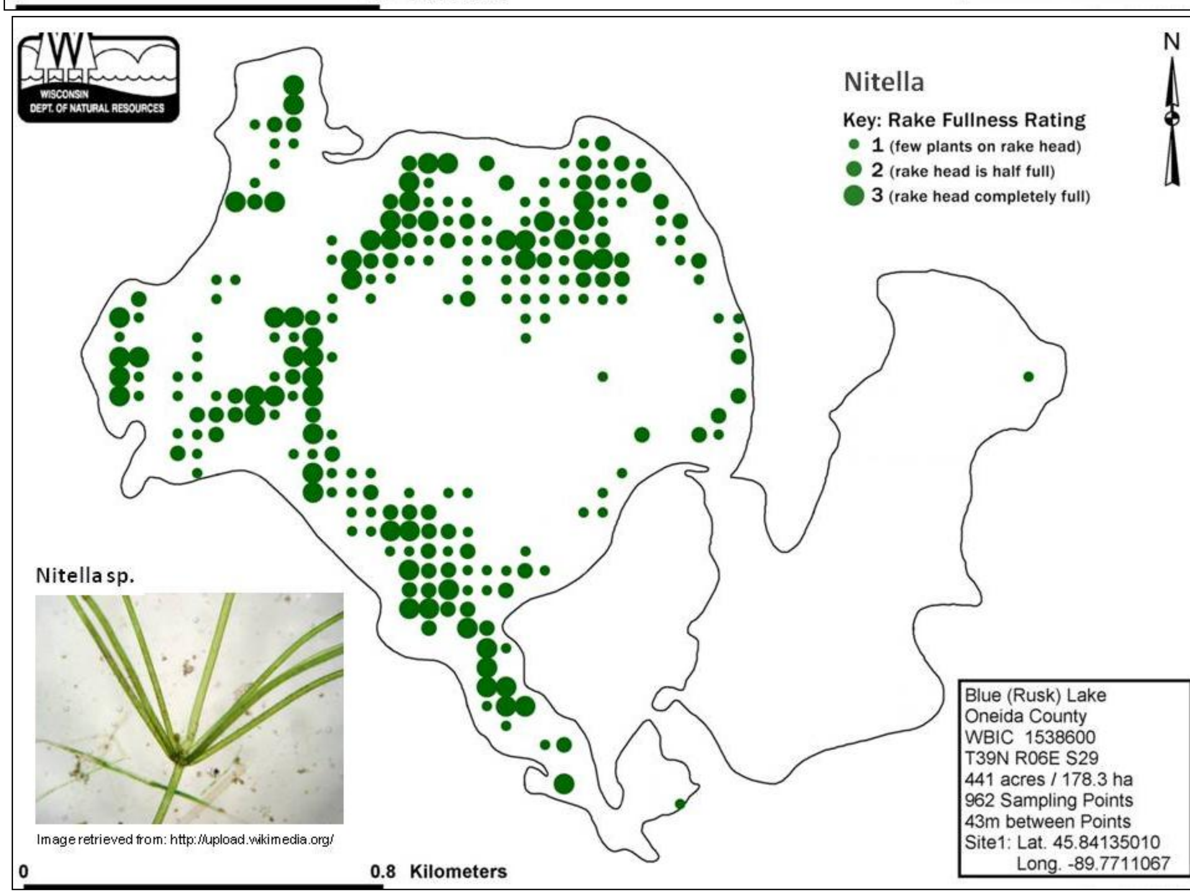

Nitella
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
WISCONSIN DEPT. OF NATURAL RESOURCES
Nitella sp.
Image retrieved from: http://upload.wikimedia.org/
0
0.8 Kilometers
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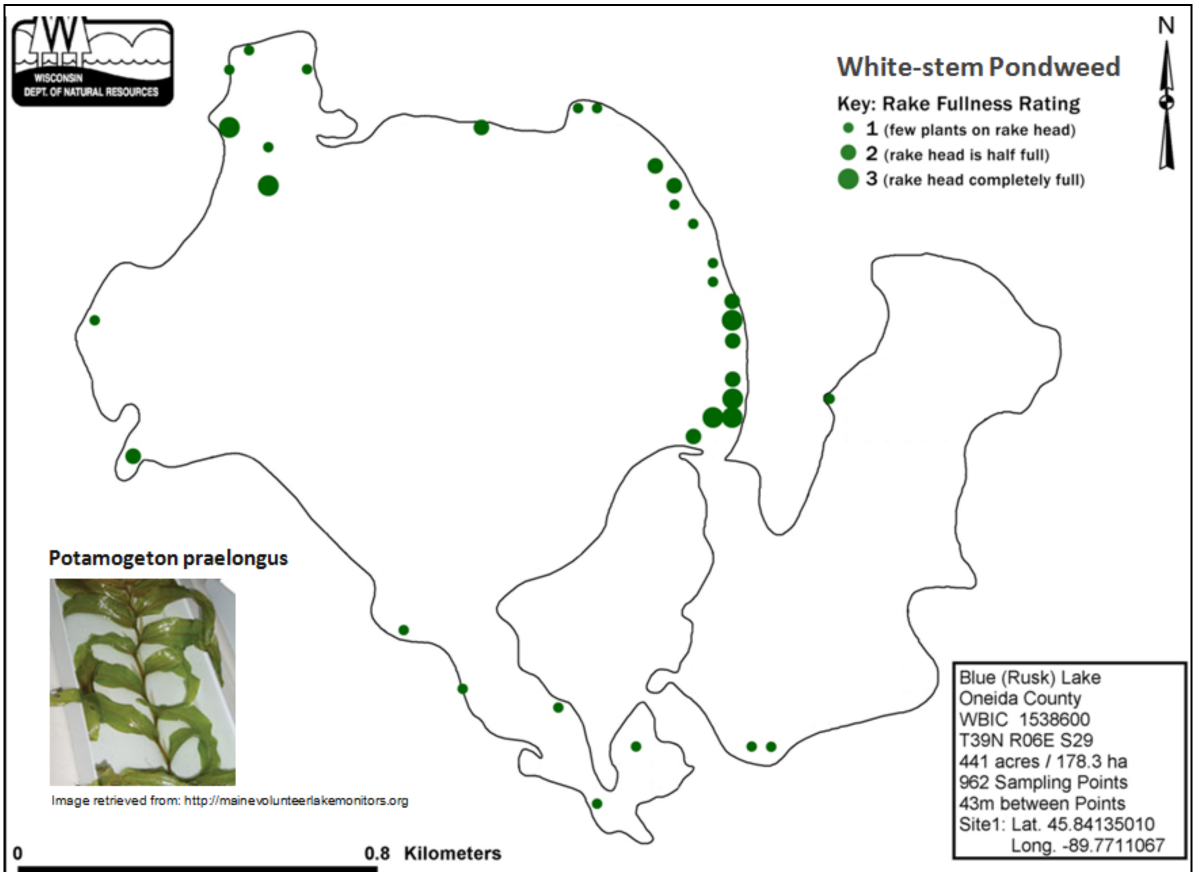
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DEPT. OF NATURAL RESOURCES
N
White-stem Pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Potamogeton praelongus
Image retrieved from: http://mainevolunteerlakemonitors.org
0
0.8 Kilometers
Blue (Rusk) Lake
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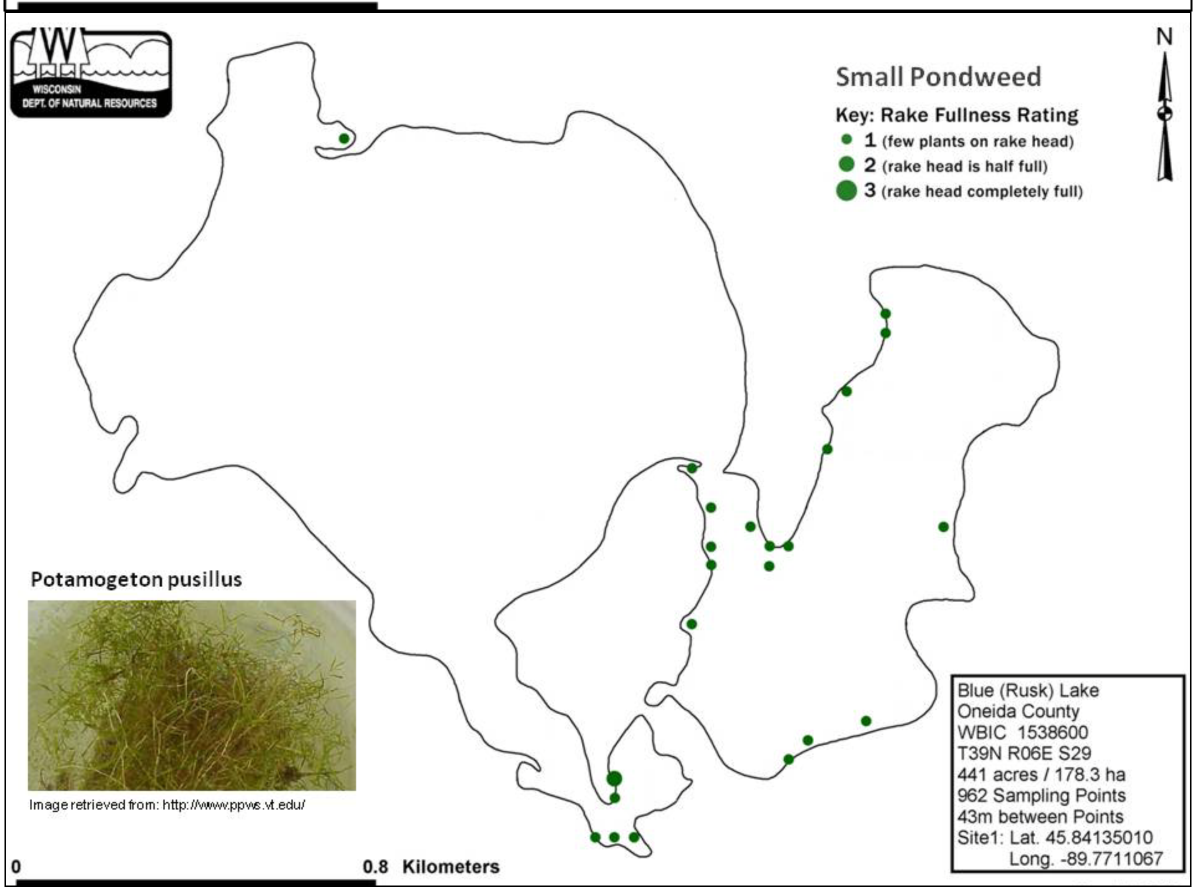
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DEPT. OF NATURAL RESOURCES
N
Small Pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Potamogeton pusillus
Image retrieved from: http://www.ppws.vt.edu/
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
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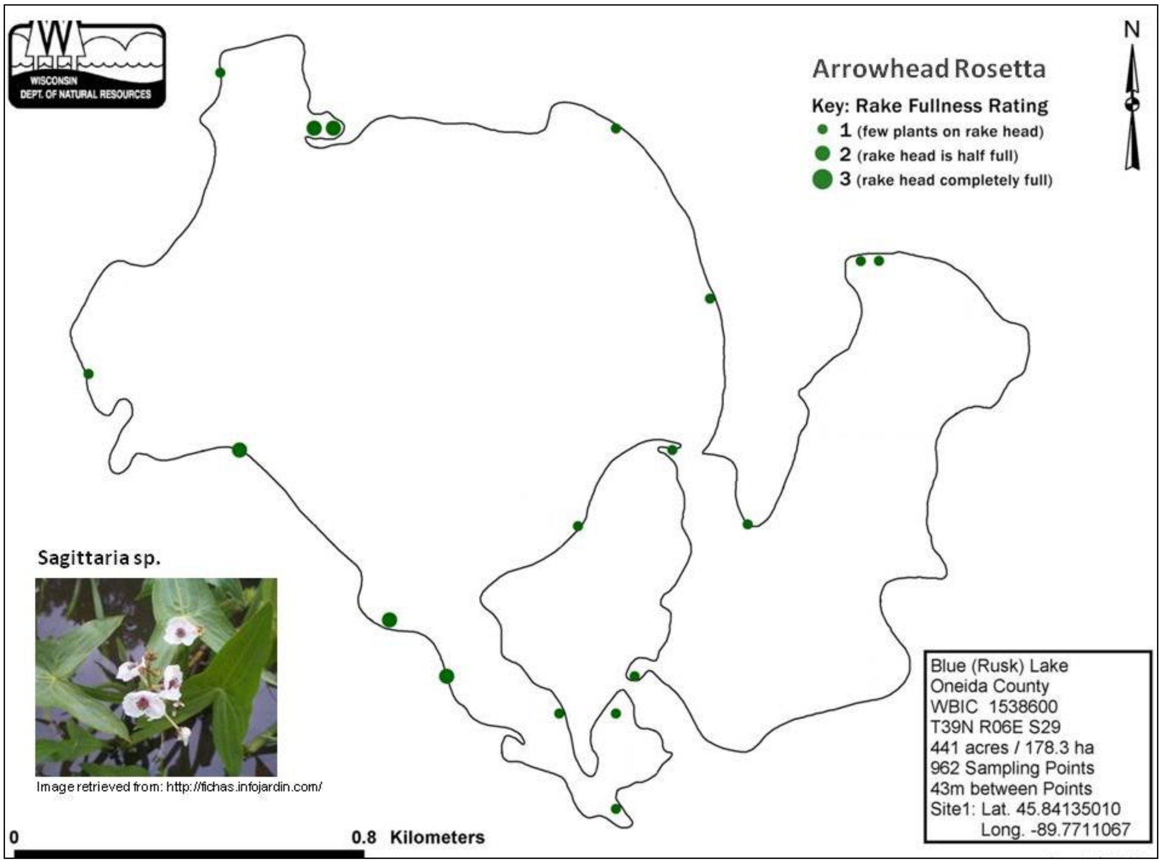

WISCONSIN DEPT. OF NATURAL RESOURCES
Arrowhead Rosetta
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Sagittaria sp.
Image retrieved from: http://fichas.infojardin.com/
Blue (Rusk) Lake
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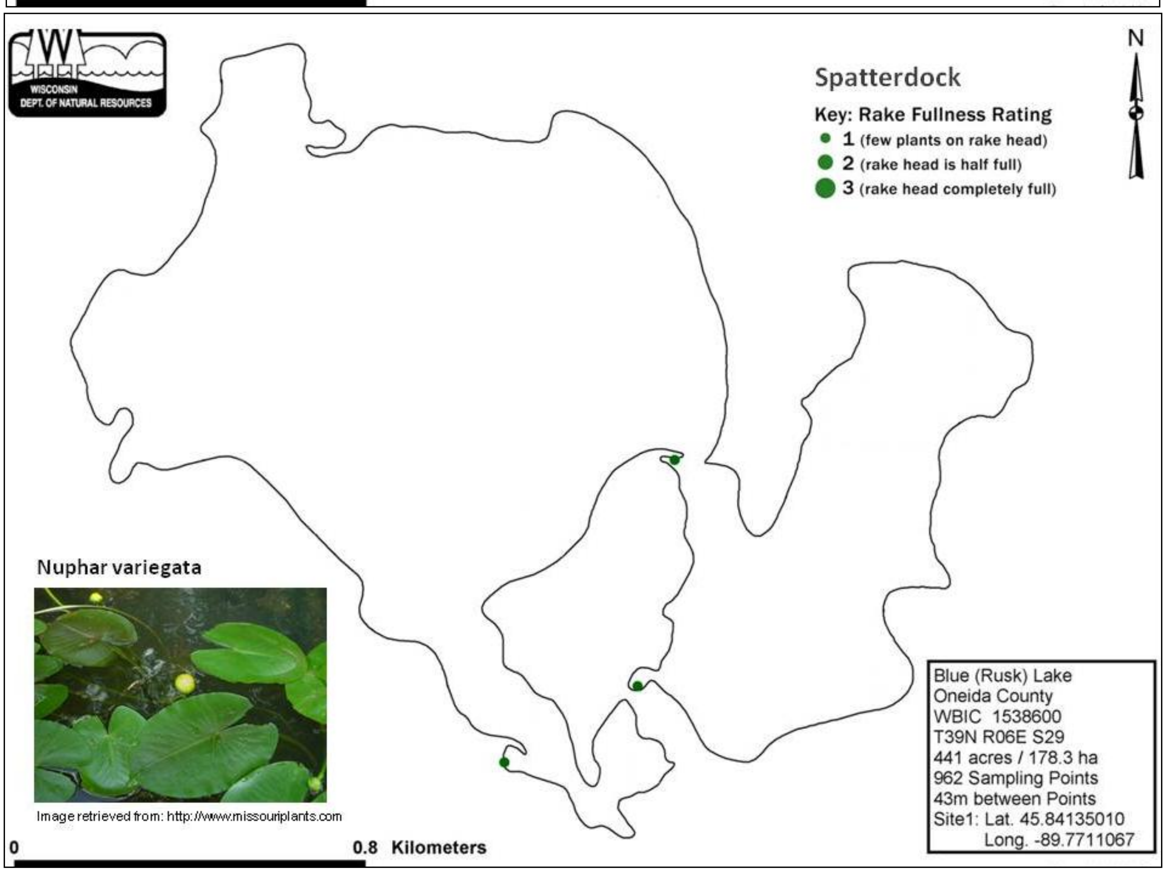
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers



WISCONSIN DEPT. OF NATURAL RESOURCES
Spatterdock
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Nuphar variegata
Image retrieved from: http://www.missouriplants.com
Blue (Rusk) Lake
Oneida County
WBIC 1538600
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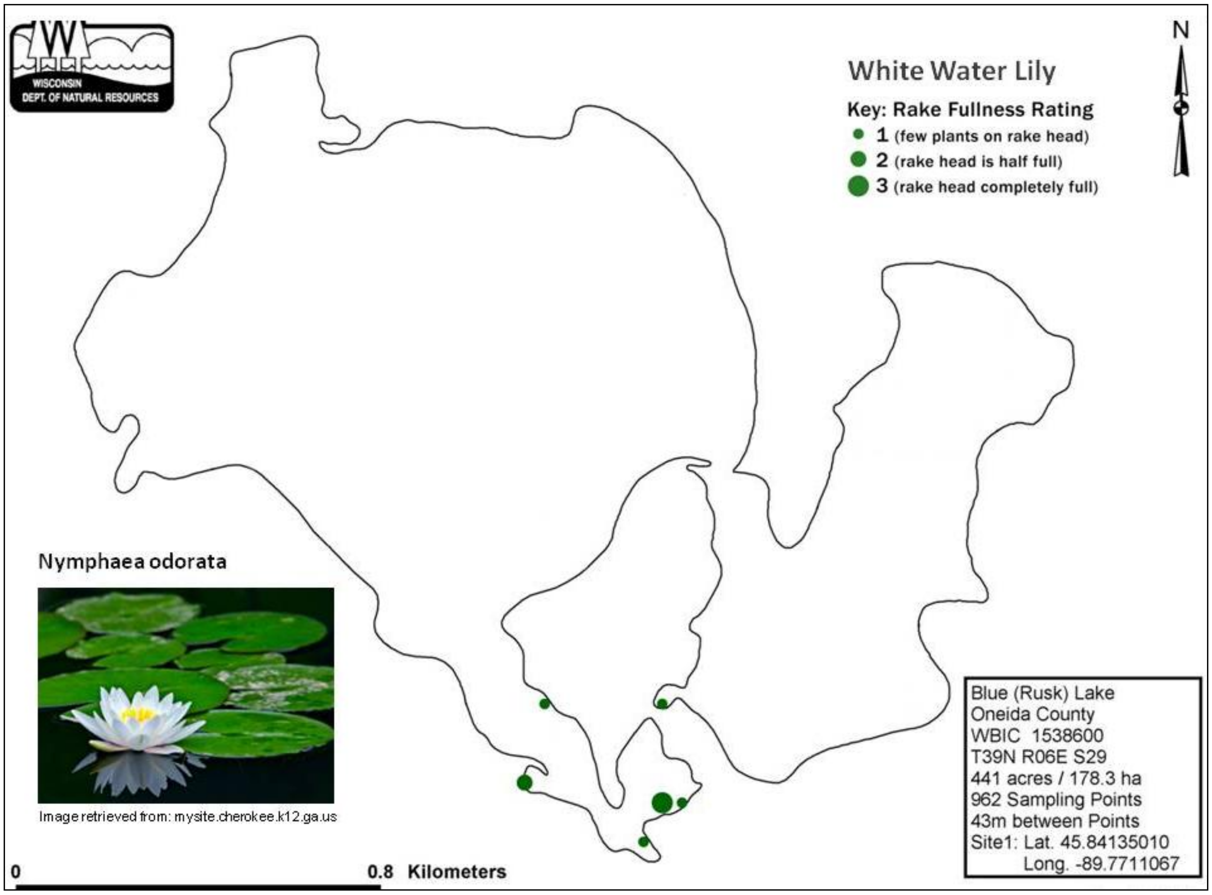
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
White Water Lily
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Nymphaea odorata
Image retrieved from: mysite.cherokee.k12.ga.us
Blue (Rusk) Lake
Oneida County
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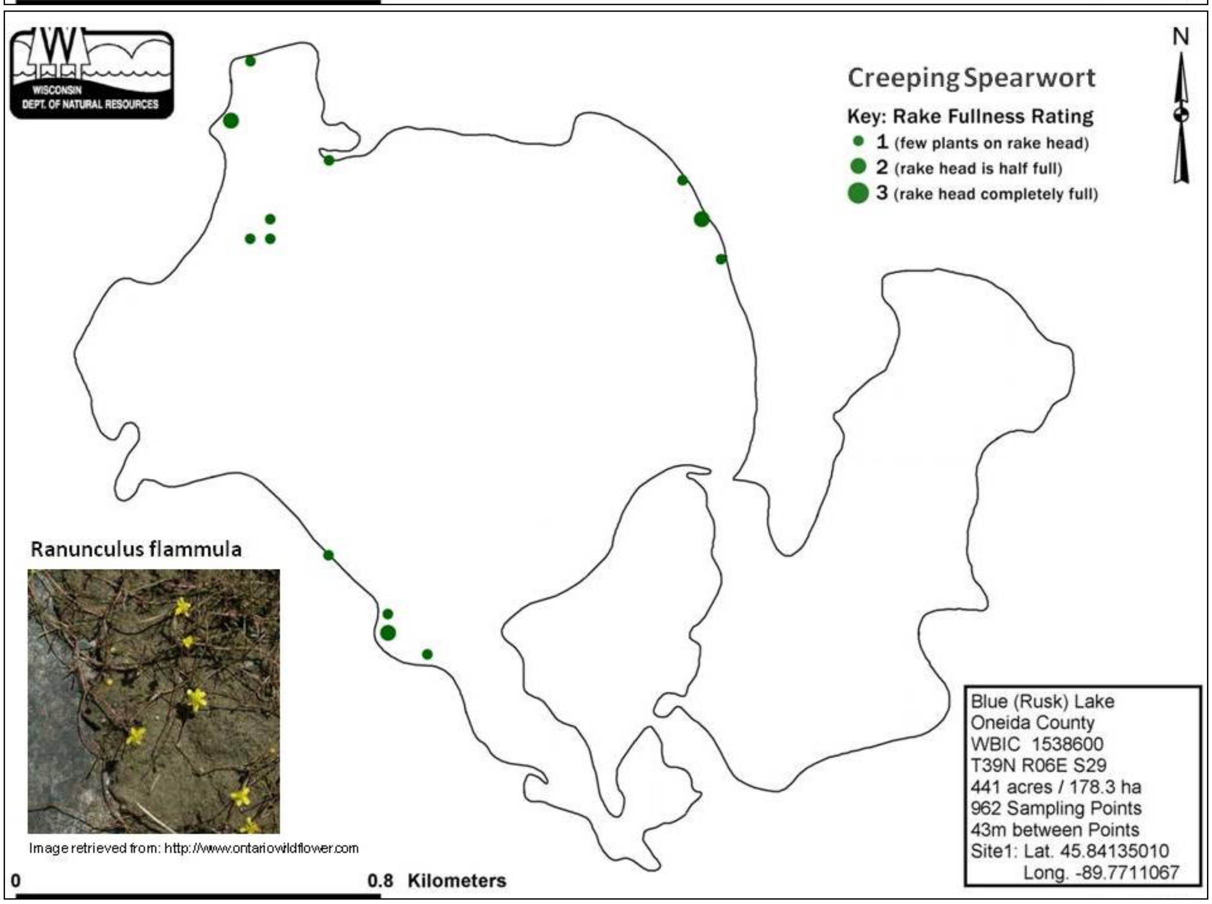
0
0.8 Kilometers


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Creeping Spearwort
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Ranunculus flammula
Image retrieved from: http://www.ontariowildflower.com
Blue (Rusk) Lake
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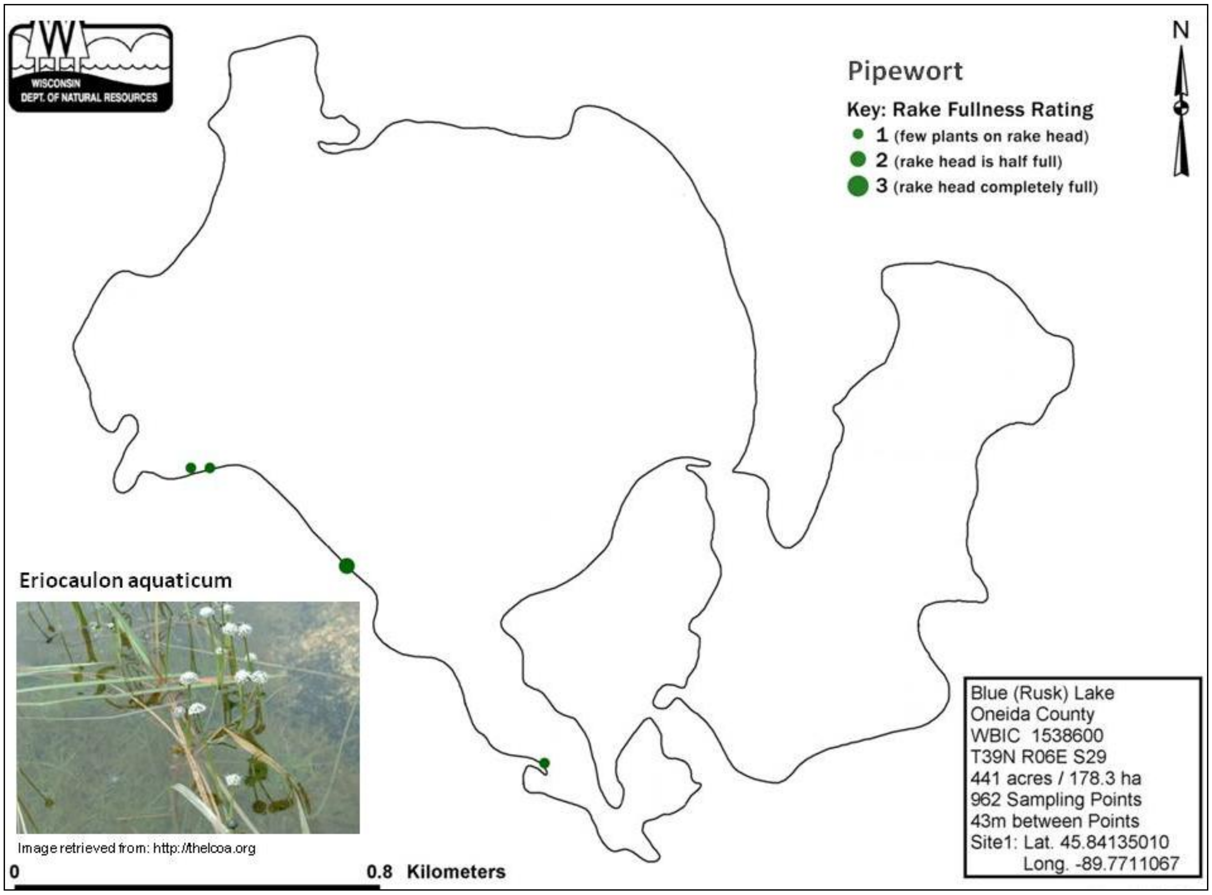
0.8 Kilometers


WISCONSIN
DEPT. OF NATURAL RESOURCES
Pipewort
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Eriocaulon aquaticum
Image retrieved from: http://thelcoa.org
0
0.8 Kilometers
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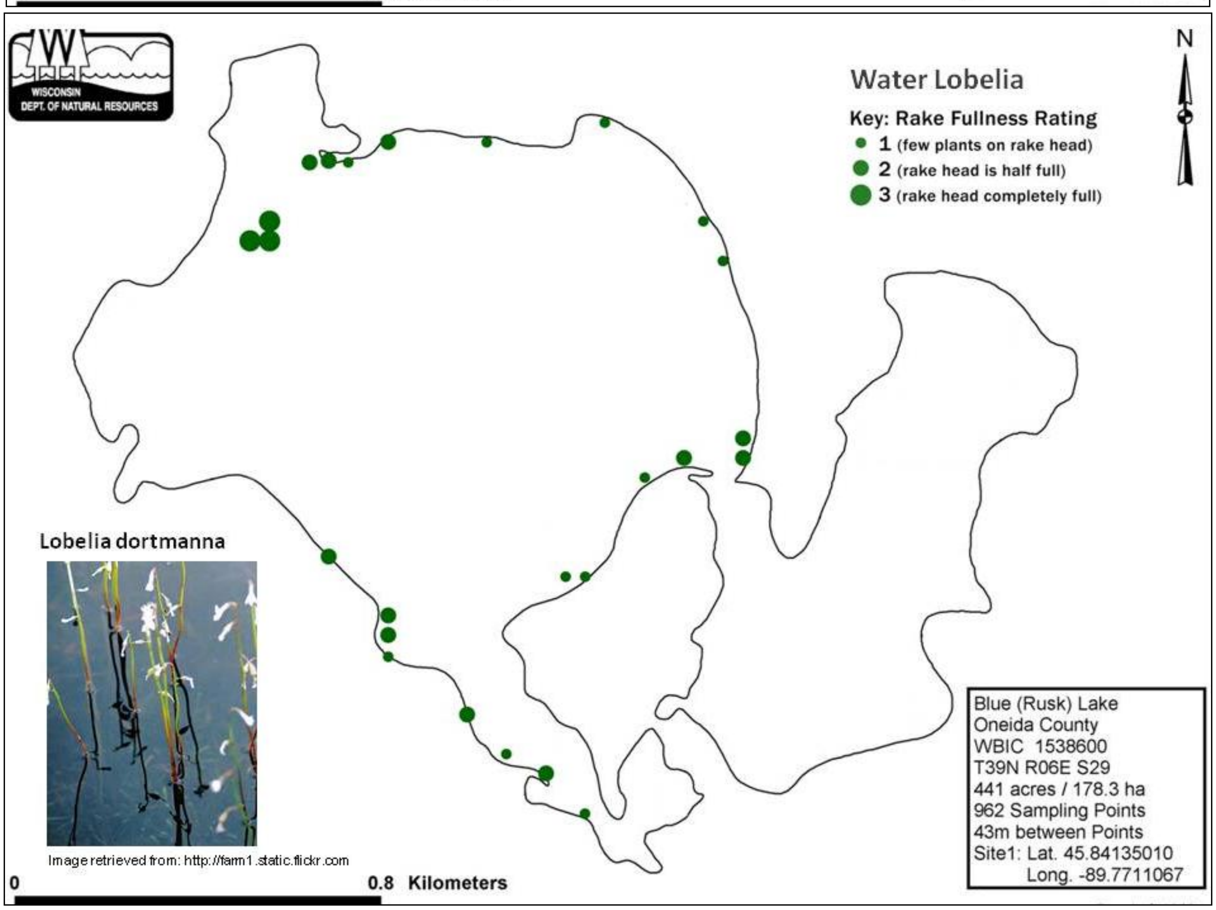
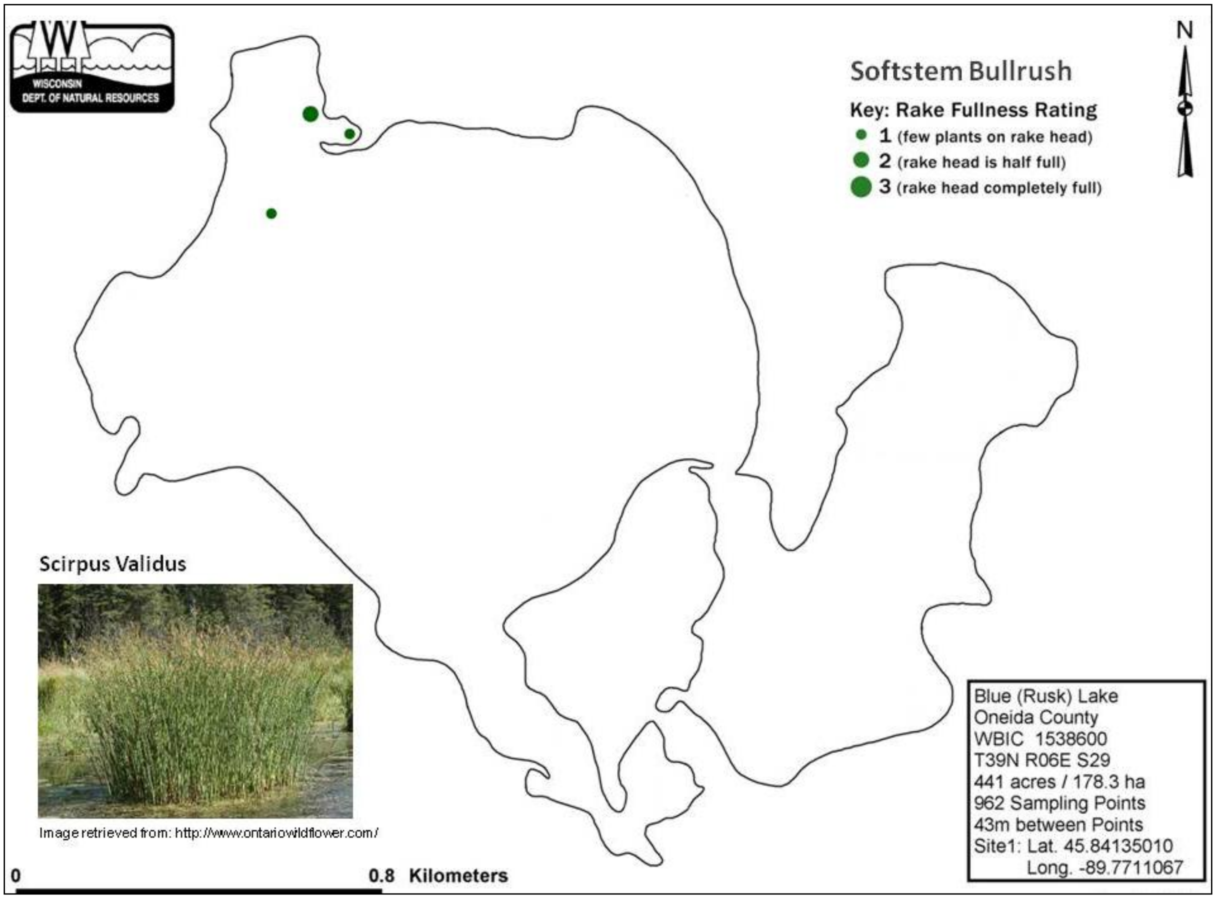
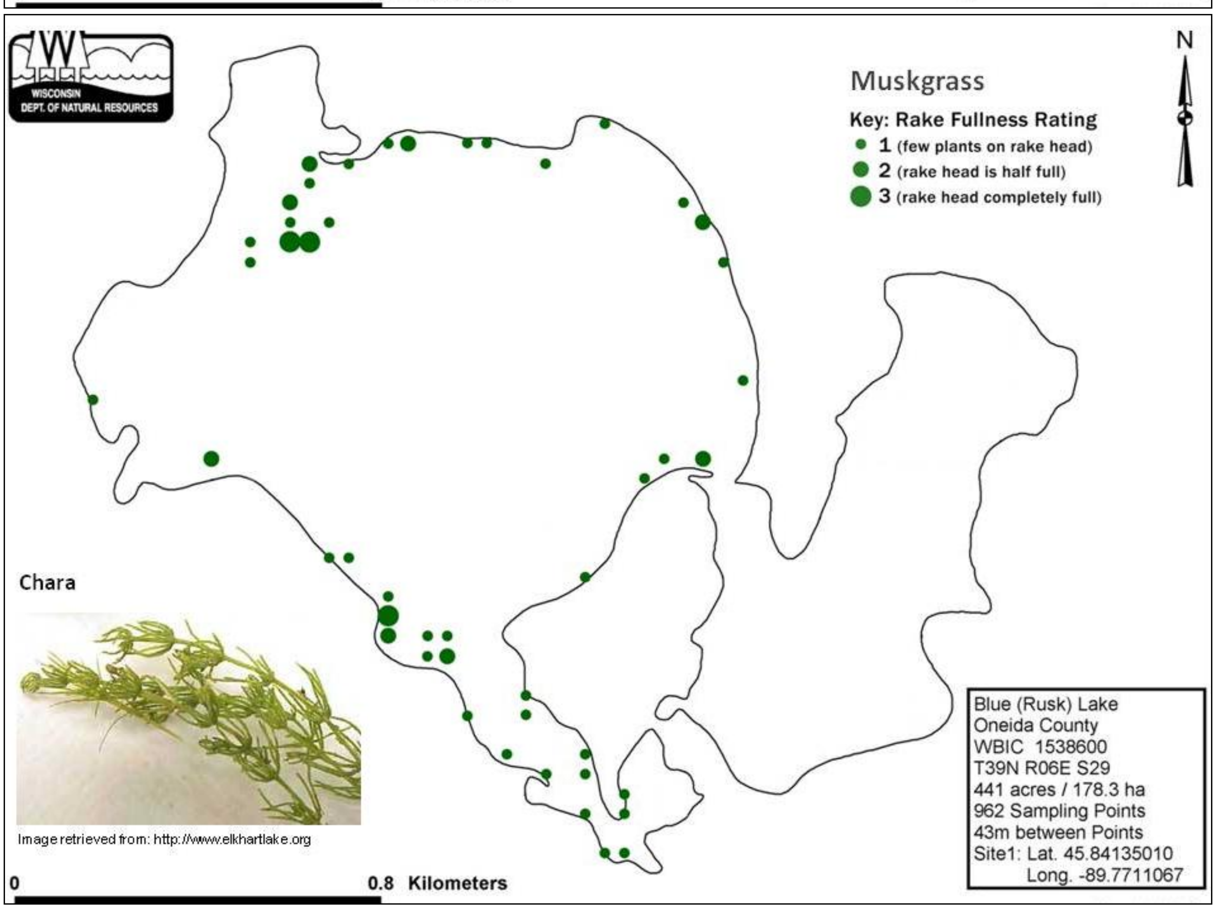
Long. -89.7711067

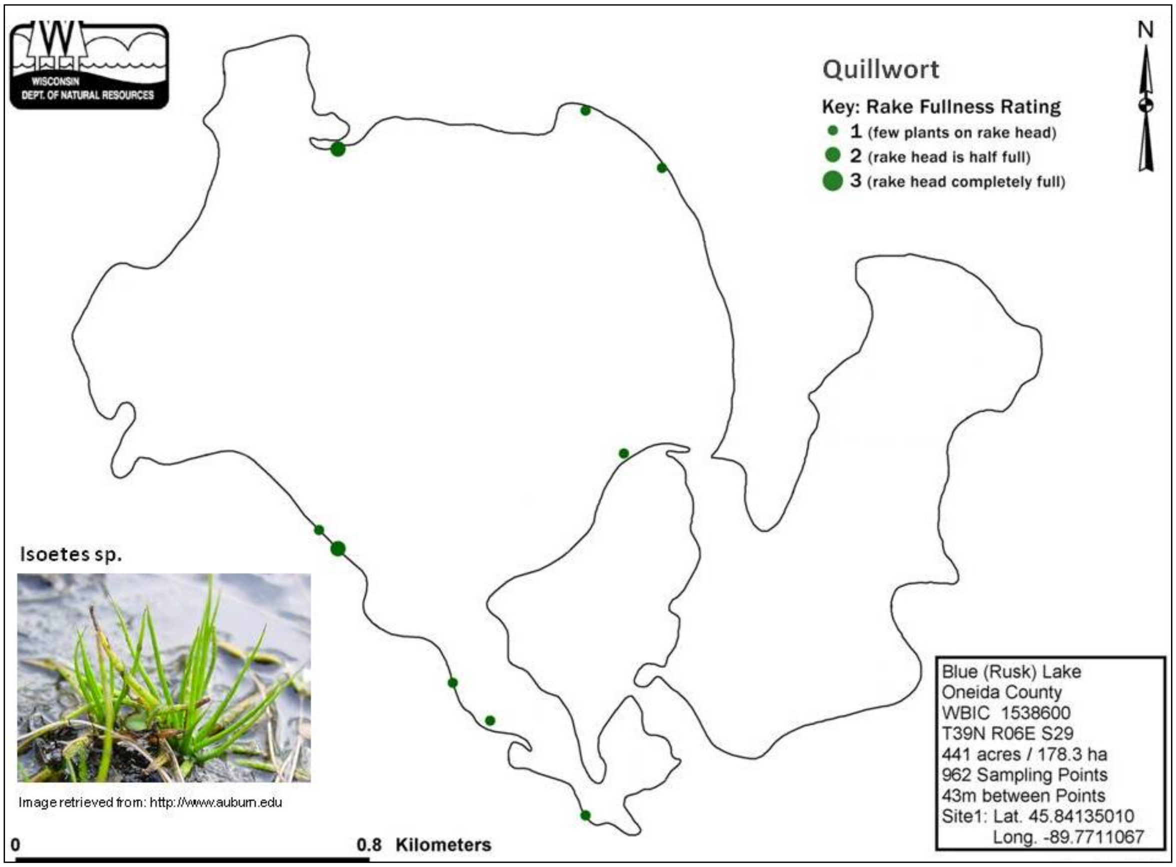

WISCONSIN
DEPT. OF NATURAL RESOURCES
Water Lobelia
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Lobelia dortmanna
Image retrieved from: http://farm1.static.flickr.com
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067

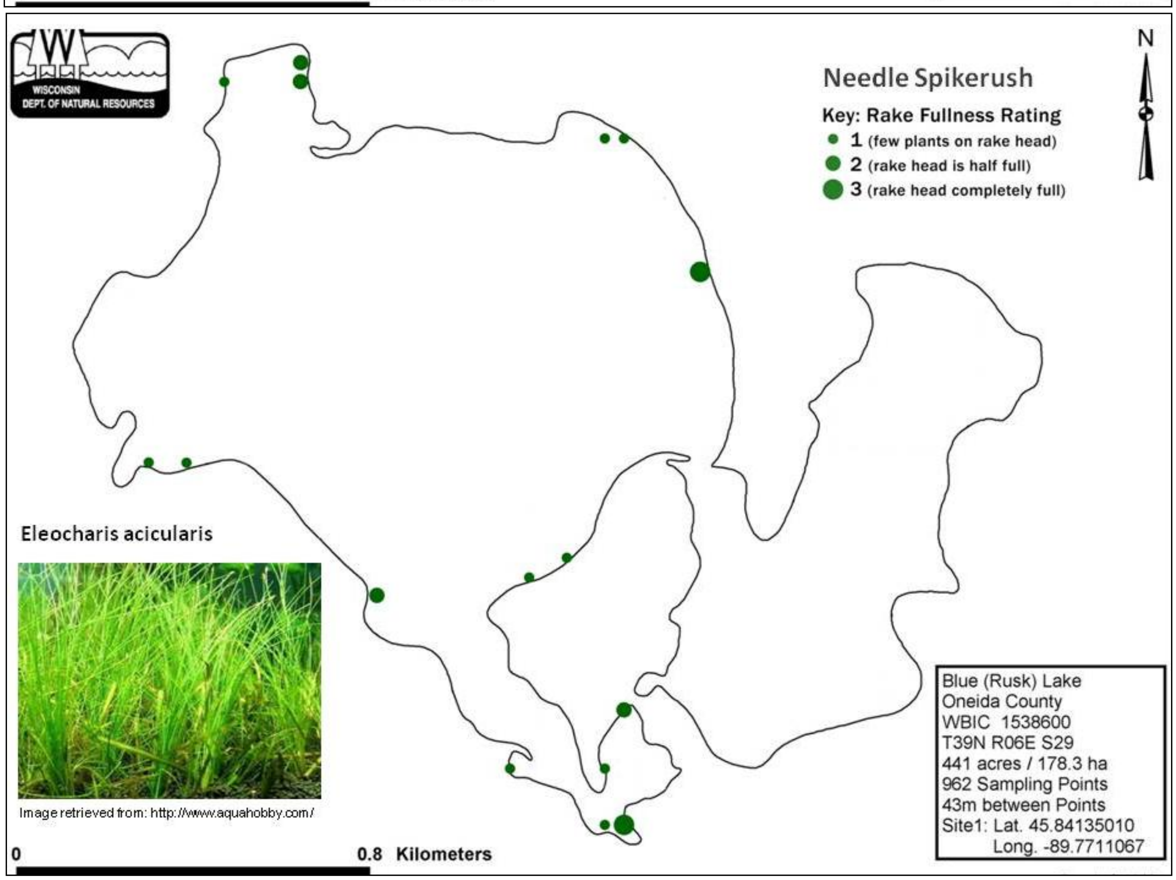


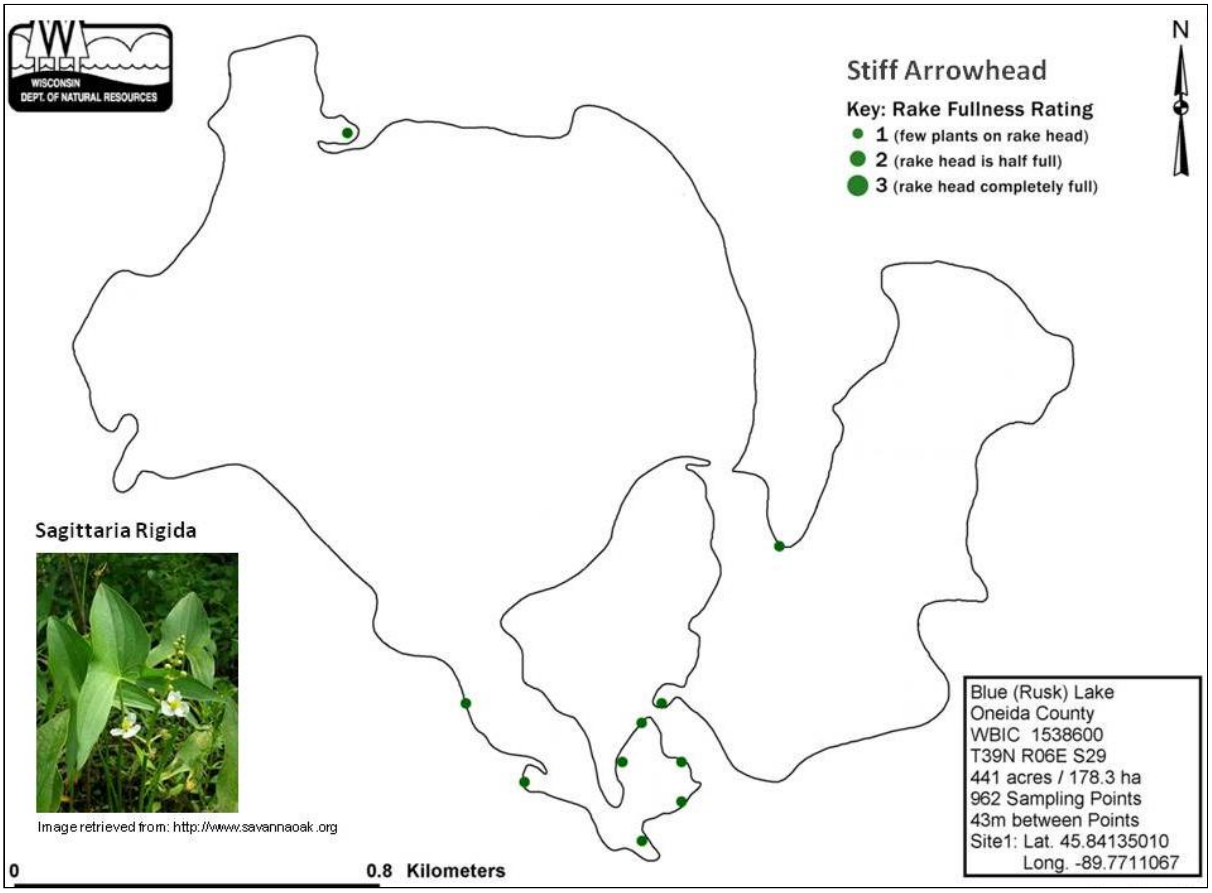
WISCONSIN
DEPT. OF NATURAL RESOURCES
Softstem Bullrush
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Scirpus Validus
Image retrieved from: http://www.ontariowildflower.com/
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers

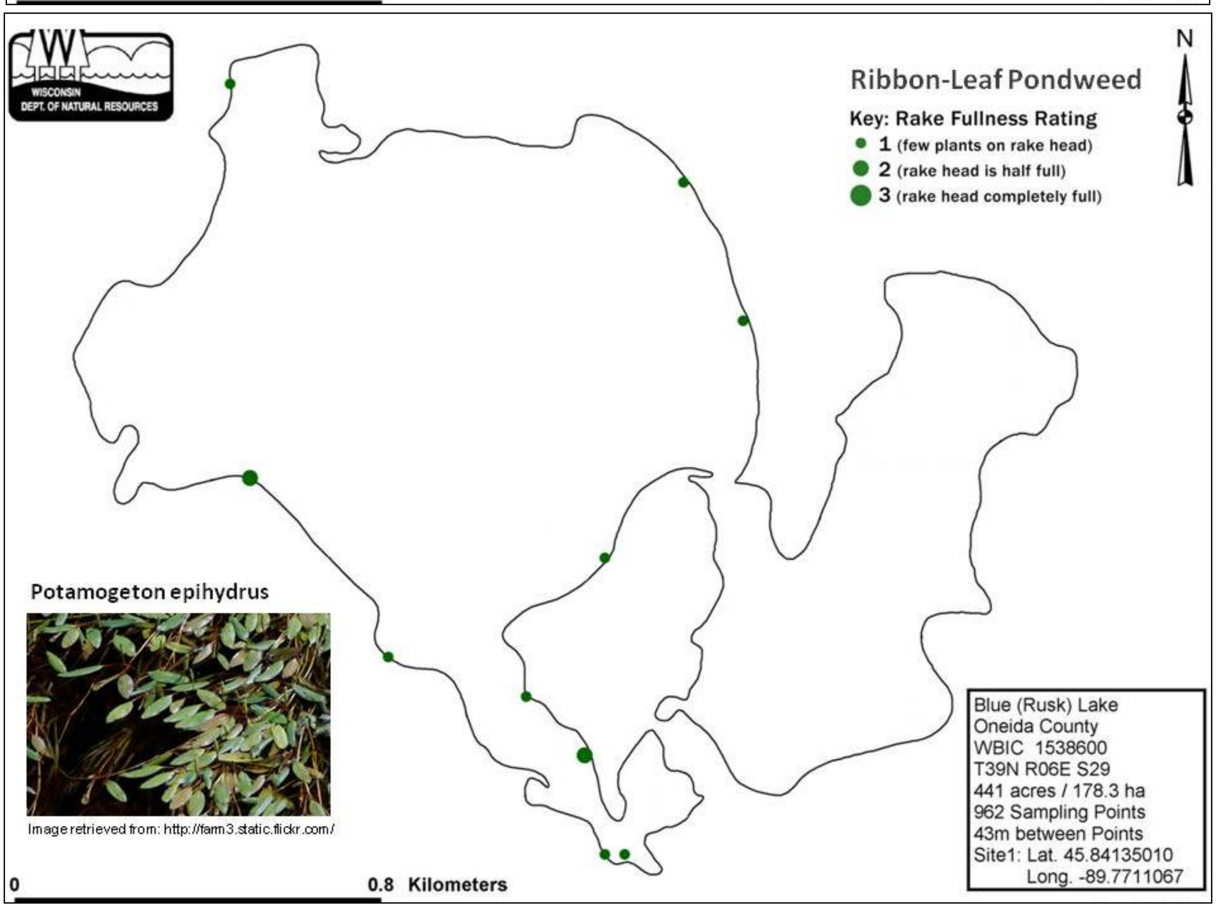


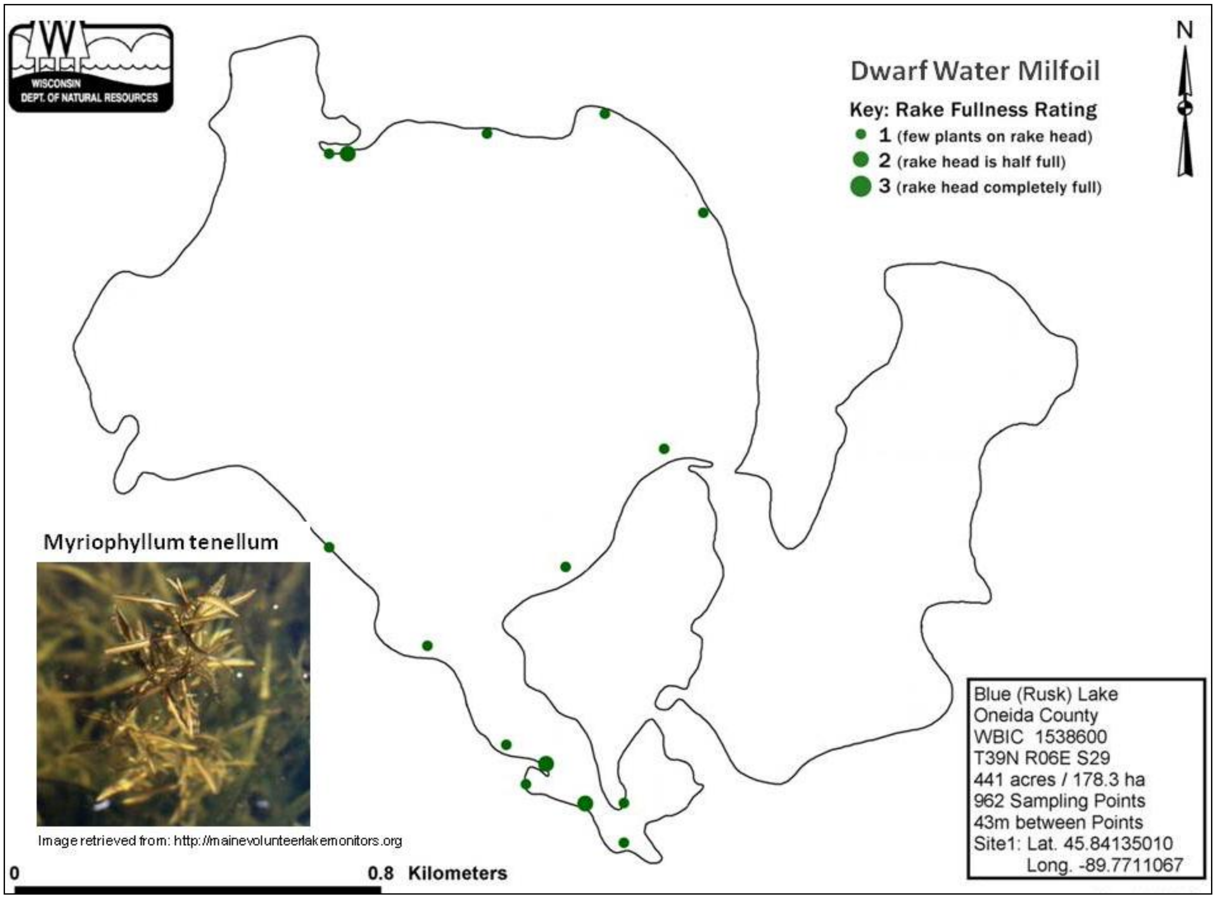
WISCONSIN
DEPT. OF NATURAL RESOURCES
Muskgrass
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Chara
Image retrieved from: http://www.elkhartlake.org
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers

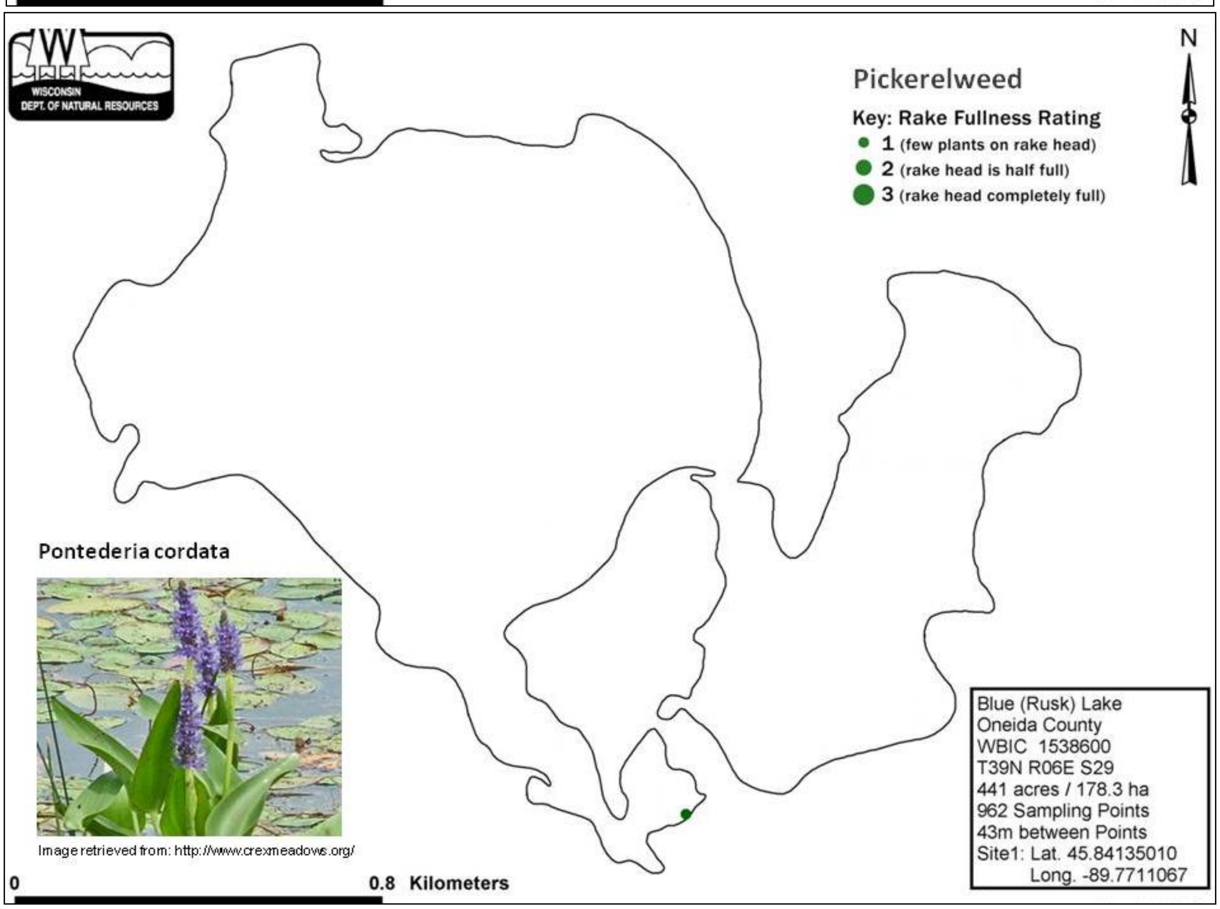

WISCONSIN
DEPT. OF NATURAL RESOURCES
Quillwort
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Isoetes sp.
Image retrieved from: http://www.auburn.edu
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067

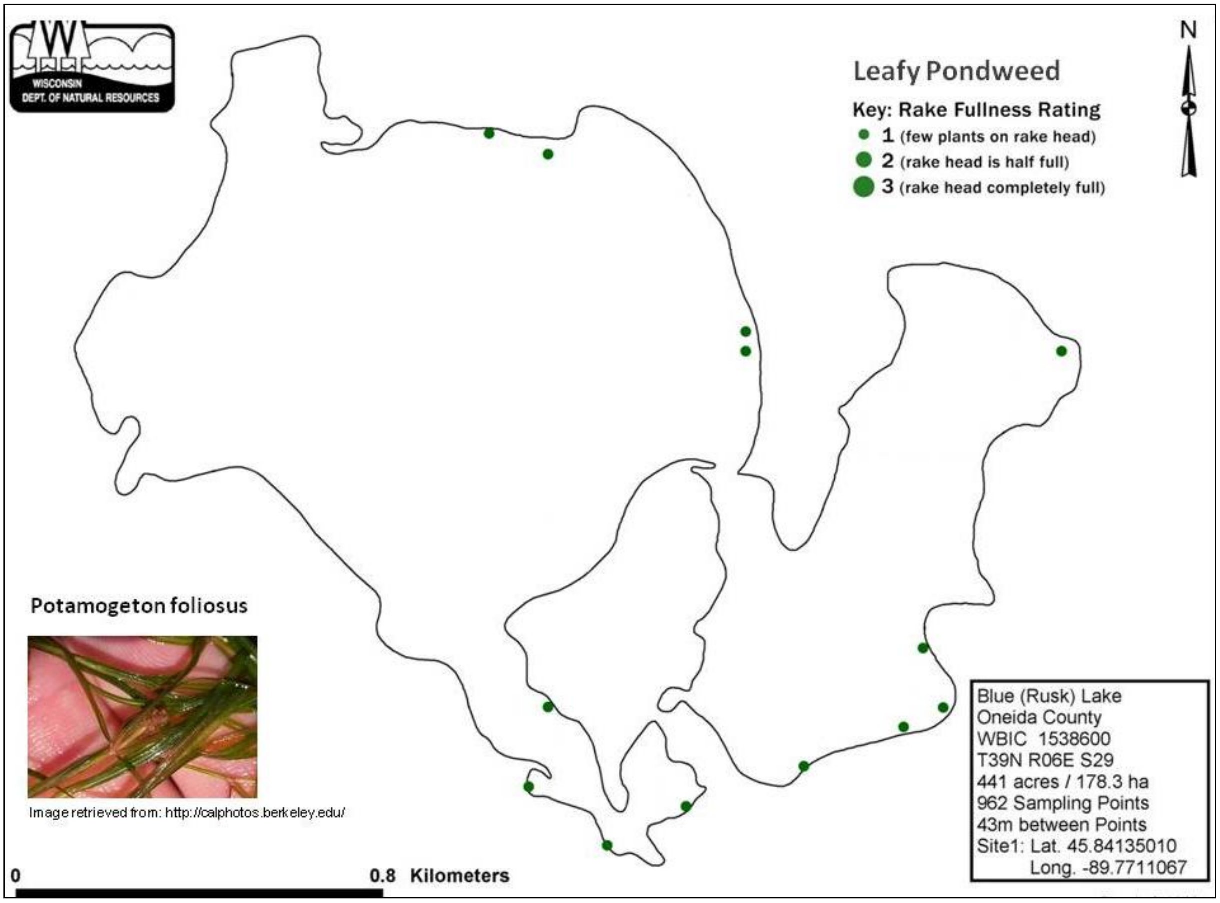

WISCONSIN
DEPT. OF NATURAL RESOURCES
Needle Spikerush
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Eleocharis acicularis
Image retrieved from: http://www.aquahobby.com/
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067


WISCONSIN DEPT. OF NATURAL RESOURCES
Stiff Arrowhead
N
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Sagittaria Rigida
Image retrieved from: http://www.savannaoak.org
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers

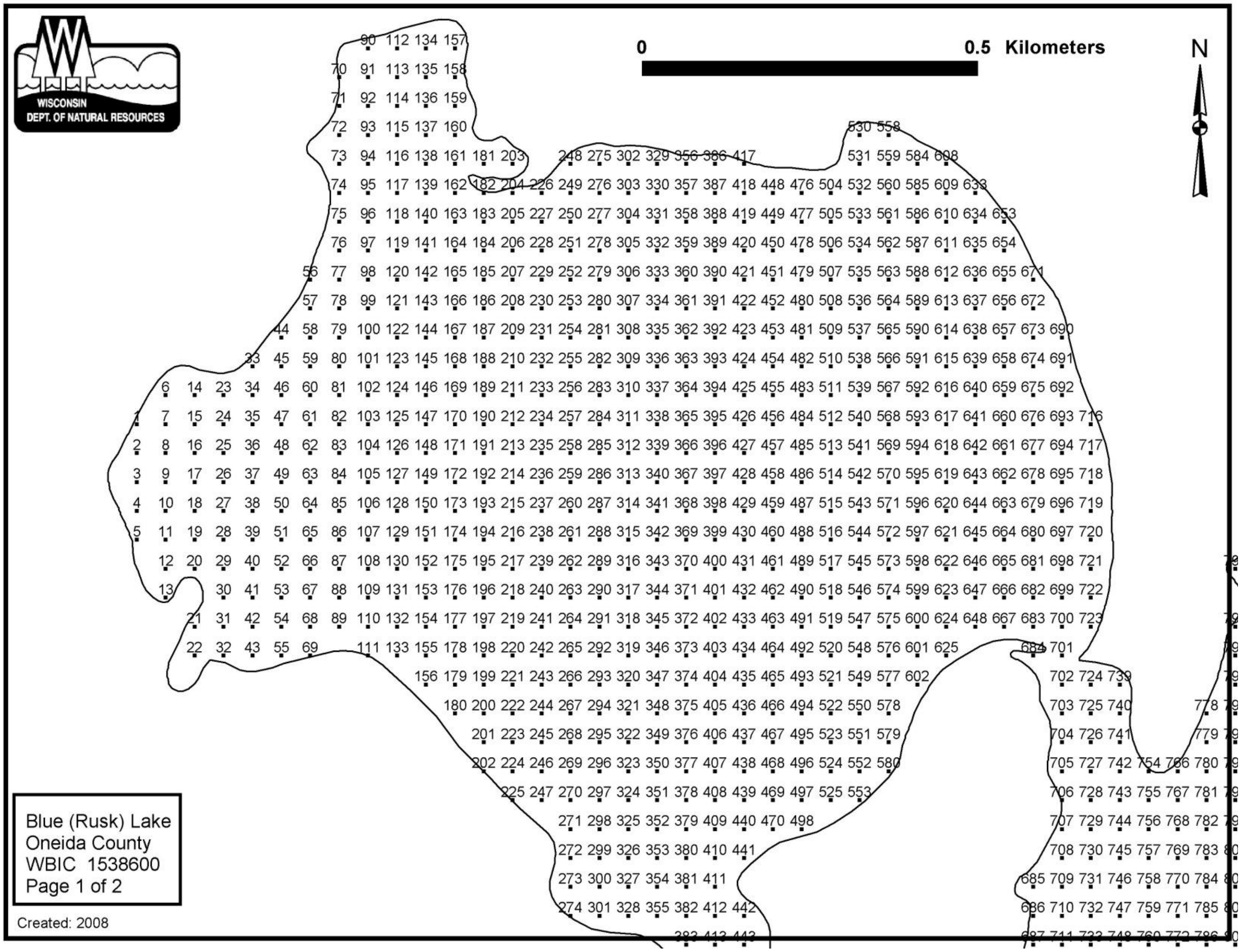

WISCONSIN DEPT. OF NATURAL RESOURCES
Ribbon-Leaf Pondweed
N
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Potamogeton epihydrus
Image retrieved from: http://farm3.static.flickr.com/
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers


WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Dwarf Water Milfoil
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Myriophyllum tenellum
Image retrieved from: http://mainevolunteerlakemonitors.org
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067

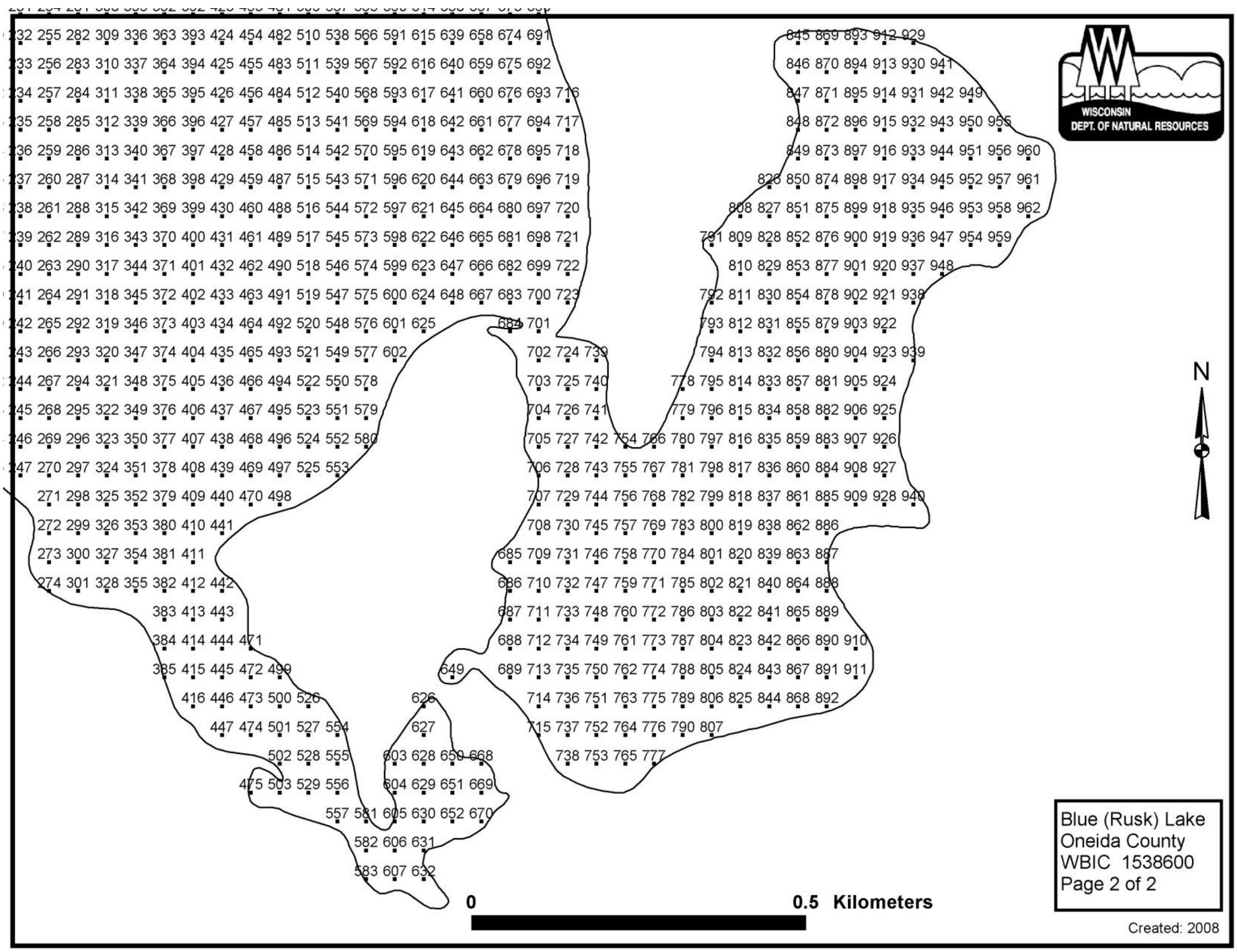

WISCONSIN
DEPT. OF NATURAL RESOURCES
N
Pickerelweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
Pontederia cordata
Image retrieved from: http://www.crexmeadows.org/
0
0.8 Kilometers
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067


WISCONSIN
DEPT. OF NATURAL RESOURCES
Leafy Pondweed
Key: Rake Fullness Rating
1 (few plants on rake head)
2 (rake head is half full)
3 (rake head completely full)
N
Potamogeton foliosus
Image retrieved from: http://calphotos.berkeley.edu/
Blue (Rusk) Lake
Oneida County
WBIC 1538600
T39N R06E S29
441 acres / 178.3 ha
962 Sampling Points
43m between Points
Site1: Lat. 45.84135010
Long. -89.7711067
0
0.8 Kilometers

Blue Lake Sampling Points, West Lobe



Blue Lake Sampling Points, East Lobe



Part II : Species Found at Each Sampling Point (raw data)

Sampling Point*	Depth (ft)	Number of species found	Species found
1	6	2	21 26
2	7	2	19 21
3	9	1	21
4	6	2	16 21
5	5	5	1 5 8 16 23
6	7	1	21
7	13	2	12 21
8	15	1	12
10	14	1	12
11	10	1	12
12	6	2	16 21
13	5	2	16 21
14	10	2	12 21
15	15	1	12
17	17	1	12
18	16	1	12
19	9	2	12 21
21	5	3	5 11 21
22	4	3	16 19 21
23	15	1	27
31	7	1	21
32	4	1	3
38	20	1	12
39	22	1	12
41	17	1	12
42	12	2	5 12
43	5	2	16 21
48	19	1	12
49	19	1	12
50	20	1	12
52	22	1	12
53	20	1	12
54	13	1	12
55	2	4	3 6 12 21
59	20	1	12

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
60	18	1	12
65	22	1	12
66	23	1	12
67	19	1	12
68	9	1	1
69	2	2	6 21
70	3	6	3 16 17 19 21 23
71	3	3	21 22 27
72	5	2	16 21
73	6	2	19 21
74	4	1	21
75	5	1	21
76	9	2	5 12
80	22	1	12
86	26	1	12
87	25	1	12
90	4	3	19 21 22
91	6	4	5 16 21 27
92	8	3	5 21 27
93	9	5	5 12 16 21 27
95	8	1	21
96	8	2	12 21
97	11	1	12
98	10	2	12 21
99	1	6	1 4 8 9 12 22
100	21	1	1
107	26	1	12
108	26	1	12
111	1	3	16 17 23
112	6	2	16 21
113	8	2	16 21
114	9	2	16 21
115	9	2	12 21
116	9	2	12 27
117	10	4	5 12 19 21

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
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23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
119	11	3	12 19 27
120	1	6	4 8 9 12 22 25
121	2	5	4 8 9 12 22
125	28	1	12
126	30	1	12
128	26	1	12
129	30	1	12
130	29	1	12
134	6	2	16 21
135	8	3	12 16 21
136	9	3	12 16 21
137	9	3	5 12 21
138	7	1	12
139	8	1	27
141	12	2	1 21
142	5	1	1
143	3	1	1
147	32	1	12
148	34	1	12
149	35	1	12
150	33	1	12
151	35	1	12
154	28	1	12
157	1	2	3 16
158	2	4	3 16 19 21
160	6	4	11 16 21 25
161	4	1	21
162	2	3	1 8 9
163	7	2	1 11
164	12	2	11 21
165	10	1	11
166	5	1	1
170	36	1	12
171	37	1	12
172	38	1	12

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
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23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
173	38	1	12
174	37	1	12
175	37	1	12
176	37	1	12
177	35	1	12
178	35	1	12
179	30	1	12
181	3	5	5 8 16 21 23
182	6	4	8 9 10 22
185	10	1	1
186	14	1	12
187	22	1	12
189	33	1	12
190	37	1	12
192	40	1	12
196	39	1	12
197	38	1	12
198	37	1	12
199	35	1	12
202	1	7	1 7 8 9 10 22 27
203	2	6	16 20 21 23 24 25
204	2	5	1 7 8 9 10
209	30	1	12
210	30	1	12
220	40	1	12
221	38	1	12
222	34	1	12
223	26	1	12
224	12	1	1
225	2	3	6 7 16
230	35	1	12
231	37	1	12
232	38	1	12
233	39	1	12
242	41	1	12

Key	**Species**	**Common Name**
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
243	39	1	12
244	37	1	12
245	32	1	12
248	2	3	1 8 9
251	31	1	12
252	34	1	12
253	32	1	12
254	38	1	12
255	40	1	12
267	39	1	12
268	36	1	12
269	28	1	12
271	7	1	1
272	3	5	1 3 8 9 22
273	4	4	1 8 9 22
274	2	4	8 9 16 17
275	2	2	1 8
276	29	1	12
277	32	1	12
278	34	1	12
279	35	1	12
280	38	1	12
281	40	1	12
293	41	1	12
294	39	1	12
295	37	1	12
296	32	1	12
297	26	1	12
298	20	1	12
299	16	1	12
300	9	1	21
301	4	5	8 16 19 21 23
302	14	1	8
303	30	1	12
304	30	1	12

Key	**Species**	**Common Name**
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
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26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

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Sampling Point*	Depth (ft)	Number of species found	Species found
305	35	1	12
306	37	1	12
307	39	1	12
308	40	1	12
320	40	1	11
321	39	1	12
322	37	1	12
323	35	1	12
324	30	1	12
325	28	1	12
326	23	1	12
327	8	2	1 12
328	2	3	1 10 22
330	24	1	12
332	33	1	12
333	37	1	12
334	39	1	12
337	41	1	12
347	40	1	12
349	37	1	12
350	35	1	12
351	33	1	12
352	31	1	12
353	23	1	12
354	15	1	1
355	7	3	1 5 8
356	7	1	1
359	29	1	12
360	36	1	12
361	38	1	12
362	39	1	12
363	40	1	12
364	40	1	12
374	40	1	12
376	39	1	12

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
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18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
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22	Ranunculus flammula	Creeping spearwort
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26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
377	38	1	12
378	36	1	12
379	33	1	12
380	29	1	12
381	26	1	12
385	2	7	1 7 8 9 19 23 24
386	5	6	1 8 9 10 18 19
387	21	1	12
390	34	1	12
391	36	1	12
392	37	1	12
408	36	1	12
409	27	1	12
411	26	1	12
412	27	1	12
413	26	1	12
414	24	1	12
415	19	1	12
419	18	1	12
422	27	1	12
423	29	1	12
424	34	1	12
425	38	1	12
439	35	1	12
440	18	1	12
442	17	2	5 12
444	22	1	12
445	26	1	12
446	24	1	12
447	1	6	1 2 7 8 9 10
450	20	1	12
451	23	1	12
452	19	1	12
453	19	1	12
454	25	1	12

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
455	32	1	12
456	38	1	12
457	42	1	12
468	41	1	12
469	32	1	12
471	6	4	1 16 17 21
472	25	1	12
474	5	2	1 8
475	2	11	3 5 8 10 12 13 16 18 21 24 27
476	4	4	1 8 16 18
477	16	1	12
478	31	1	12
479	29	1	12
480	23	1	12
481	22	1	12
482	26	1	12
483	32	1	12
484	37	1	12
497	35	1	12
498	6	3	3 8 16
499	13	3	14 18 21
501	11	1	12
502	1	5	1 6 8 9 10
503	4	2	16 21
504	25	1	12
505	37	1	12
506	38	1	12
507	37	1	12
508	35	1	12
509	35	1	12
510	37	1	12
511	37	1	12
525	18	5	9 10 16 21 27
526	8	1	19
527	12	2	12 21

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
528	11	1	5
529	8	2	5 12
530	6	4	16 19 21 27
531	24	1	12
532	35	1	12
533	39	1	12
534	38	1	12
535	38	1	12
536	37	1	12
537	37	1	12
538	39	1	12
539	38	1	12
550	39	1	12
553	4	4	1 3 8 9
554	5	5	1 5 17 21 23
555	6	1	1
556	9	1	21
557	1	4	1 8 9 10
558	1	8	1 7 8 9 10 19 21 27
559	30	1	12
560	36	1	12
561	38	1	12
562	38	1	12
563	38	1	12
564	37	1	12
565	38	1	12
566	38	1	12
567	38	1	12
571	39	1	12
577	31	1	12
578	20	1	12
580	1	3	8 17 23
581	2	2	8 21
582	6	3	16 19 21
583	2	9	1 2 7 8 11 17 18 20 21

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
584	16	2	3 27
585	30	1	12
586	35	1	12
587	38	1	12
590	39	1	12
591	37	1	12
592	38	1	12
601	18	1	12
602	6	1	5
603	2	3	16 21 24
604	2	6	1 3 16 20 21 27
605	1	6	1 8 10 16 20 21
606	5	2	16 21
607	1	6	1 3 10 17 20 27
608	1	4	3 8 23 27
609	15	1	12
610	23	1	12
623	37	1	12
624	19	1	21
625	3	4	1 7 8 9
626	2	4	3 21 24 27
627	3	3	16 21 23
628	4	3	16 19 21
629	4	2	16 21
630	4	2	16 21
632	2	8	3 8 14 16 20 21 23 24
634	8	1	19
635	18	2	5 12
636	27	1	12
637	36	1	12
648	8	3	1 10 11
649	2	6	13 14 16 21 23 27
650	3	1	21
651	4	2	16 21
652	3	3	14 16 21

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
653	1	9	2 5 7 8 17 21 22 24 27
654	5	3	1 19 21
655	11	3	12 19 21
656	28	1	12
657	39	1	12
667	6	2	8 9
668	1	3	16 21 24
669	3	2	16 21
670	1	8	5 12 14 15 16 18 21 24
671	1	8	1 4 5 8 9 10 21 22
672	2	3	16 19 21
673	22	1	12
674	29	1	12
682	25	1	12
683	10	2	1 19
684	1	6	13 16 20 21 23 27
685	3	3	5 20 21
686	4	1	21
687	5	2	16 21
688	7	2	5 21
689	7	2	5 21
690	1	4	1 8 9 22
691	5	4	3 19 21 27
692	16	1	19
693	30	1	12
698	15	1	12
699	9	2	12 19
700	10	2	21 27
701	1	2	8 27
702	6	1	11
703	9	3	5 11 20
704	10	2	5 21
705	8	2	20 21
706	3	4	5 16 20 21
707	8	2	16 21

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
708	13	1	5
710	12	1	5
711	12	1	5
712	13	2	5 21
713	14	2	5 21
714	11	1	21
715	5	4	5 16 21 27
716	5	6	8 12 17 19 23 27
717	7	4	12 18 19 21
718	10	4	5 12 18 19
719	11	3	1 21 27
720	6	5	11 12 19 21 27
721	5	2	19 27
722	3	5	2 8 9 19 21
723	2	2	8 9
724	7	4	5 16 21 27
725	10	1	21
727	18	1	5
736	16	1	21
738	3	2	16 21
739	3	4	5 16 21 27
740	5	2	21 27
741	7	3	16 20 21
742	15	1	5
753	8	2	19 21
754	4	4	2 20 23 24
755	18	2	5 20
763	18	1	5
765	7	3	16 19 21
766	8	3	5 16 20
776	8	2	5 27
777	3	3	5 18 20
778	10	1	21
789	16	2	5 21
790	4	4	5 16 20 21

Key	**Species**	**Common Name**
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
791	8	4	5 16 19 21
792	6	4	5 16 20 21
808	7	3	5 20 21
826	9	2	5 21
842	21	1	5
843	17	1	5
844	10	3	11 20 21
845	5	4	11 16 23 27
847	4	3	5 20 21
848	3	5	5 11 16 20 21
849	15	1	5
868	7	2	18 21
869	12	4	5 16 21 23
888	11	3	5 18 21
892	10	2	5 21
893	12	2	11 16
907	16	1	5
908	15	1	5
909	15	1	21
911	8	3	5 18 21
912	11	1	11
925	13	1	20
926	12	1	21
927	12	1	21
928	12	2	5 21
929	3	5	2 8 11 21 27
938	3	4	5 16 21 26
939	3	2	5 21
940	4	4	5 16 21 27
948	5	3	5 16 27
949	7	1	11
951	21	1	5
953	12	2	5 21
954	9	2	21 27
955	10	2	4 11

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Sampling Point*	Depth (ft)	Number of species found	Species found
957	7	3	11 12 21
958	6	2	11 27
959	6	3	11 16 21
960	10	1	18
962	5	4	11 16 21 27

Key	Species	Common Name
1	Chara	Muskgrasses
2	Elatine minima	Waterwort
3	Eleocharis acicularis	needle spikerush
4	Eleocharis palustris	creeping spikerush
5	Elodea canadensis	Common waterweed
6	Eriocaulon aquaticum	Pipewort
7	Isoetes sp.	Quillwort
8	Juncus paleocarpus f. submersus	Brown-fruited rush
9	Lobelia dortmanna	Water lobelia
10	Myriophyllum tenellum	Dwarf water milfoil
11	Najas flexilis	Bushy pondweed
12	Nitella sp.	Nitella
13	Nuphar variegata	Spatterdock
14	Nymphaea odorata	White water lily
15	Pontederia cordata	Pickerelweed
16	Potamogeton amplifolius	Large-leaf pondweed
17	Potamogeton epihydrus	Ribbon-leaf pondweed
18	Potamogeton foliosus	Leafy pondweed
19	Potamogeton praelongus	White-stem pondweed
20	Potamogeton pusillus	Small pondweed
21	Potamogeton robbinsii	Robbins (fern) pondweed
22	Ranunculus flammula	Creeping spearwort
23	Sagittaria sp.	Arrowhead Rosetta
24	Sagittaria Rigida	Stiff Arrowhead
25	Scirpus Validus	Softstem Bullrush
26	Sparganium fluctuans	Floating-leaved bur-reed
27	Vallisneria americana	Wild celery

*Points not listed were either not sampled or had no vegetation.

Data and graphics organized by Sylvia Knust

Appendix C
Floristic Quality Index (FQI)

Floristic Quality Index (FQI) - East Lobe				
Species	**Common Name**	**C**	**species present=1**	**FQI**
Elatine minima	Waterwort	9	1	9
Eleocharis palustris	Creeping spikerush	6	1	6
Elodea canadensis	Common waterweed	3	1	3
Juncus palocarpus f. submersus	Brown-fruited rush	8	1	8
Najas flexilis	Bushy pondweed	6	1	6
Nitella	Nitella	7	1	7
Nuphar variegata	Spatterdock	6	1	6
Nymphaea odorata	White water lily	6	1	6
Potamogeton amplifolius	Large-leaf pondweed	7	1	7
Potamogeton foliosus	Leafy pondweed	6	1	6
Potamogeton praelongis	White-stem pondweed	8	1	8
Potamogeton pusillus	Small pondweed	7	1	7
Potamogeton robbinsii	Robbins pondweed	8	1	8
Sparganium fluctuans	Floating-leaf-bur-reed	10	1	10
Vallisneria americana	Wild celery	6	1	6
N			15	
mean C				6.8667
FQI				26.594

Floristic Quality Index (FQI) - West Lobe				
Species	**Common Name**	**C**	**species present=1**	**FQI**
Chara	Muskgrasses	7	1	7
Elatine minima	Waterwort	9	1	9
Eleocharis acicularis	Needle spikerush	5	1	5
Eleocharis palustris	Creeping spikerush	6	1	6
Elodea canadensis	Common waterweed	3	1	3
Eriocaulon aquaticum	Pipewort	9	1	9
Isoetes echinospora	Spiny-spored quillwort	8	1	8
Juncus palocarpus f. submersus	Brown-fruited rush	8	1	8
Lobelia dortmanna	Water lobelia	10	1	10
Myriophyllum sibericum	Northern water-milfoil	7	1	7
Myriophyllum tenellum	Dwarf water-milfoil	10	1	10
Najas flexilis	Bushy pondweed	6	1	6
Nitella	Nitella	7	1	7
Nymphaea odorata	White water lily	6	1	6
Pontederia cordata	Pickerelweed	9	1	9
Potamogeton amplifolius	Large-leaf pondweed	7	1	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8	1	8
Potamogeton praelongis	White-stem pondweed	8	1	8
Potamogeton robbinsii	Robbins pondweed	8	1	8
Ranunculus flammula	Creeping spearwort	9	1	9
Sagittaria rigida	Stiff arrowhead	8	1	8
Schoenoplectus tabernaemontani	Softstem bulrush	4	1	4
Sparganium fluctuans	Floating-leaf-bur-reed	10	1	10
Vallisneria americana	Wild celery	6	1	6
N			24	
mean C				7.416666667
FQI				36.33409785

Floristic Quality Index (FQI) - Overall				
Species	**Common Name**	**C**	**species present=1**	**FQI**
Chara	Muskgrasses	7	1	7
Elatine minima	Waterwort	9	1	9
Eleocharis acicularis	Needle spikerush	5	1	5
Eleocharis palustris	Creeping spikerush	6	1	6
Elodea canadensis	Common waterweed	3	1	3
Eriocaulon aquaticum	Pipewort	9	1	9
Juncus palocarpus f. submersus	Brown-fruited rush	8	1	8
Lobelia dortmanna	Water lobelia	10	1	10
Myriophyllum sibericum	Northern water-milfoil	7	1	7
Myriophyllum tenellum	Dwarf water-milfoil	10	1	10
Najas flexilis	Bushy pondweed	6	1	6
Nitella	Nitella	7	1	7
Nuphar variegata	Spatterdock	6	1	6
Nymphaea odorata	White water lily	6	1	6
Pontederia cordata	Pickerelweed	9	1	9
Potamogeton amplifolius	Large-leaf pondweed	7	1	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8	1	8
Potamogeton praelongis	White-stem pondweed	8	1	8
Potamogeton pusillus	Small pondweed	7	1	7
Potamogeton robbinsii	Robbins pondweed	8	1	8
Ranunculus flammula	Creeping spearwort	9	1	9
Sagittaria latifolia	Common arrowhead	3	1	3
Sagittaria rigida	Stiff arrowhead	8	1	8
Schoenoplectus tabernaemontani	Softstem bulrush	4	1	4
Sparganium fluctuans	Floating-leaf-bur-reed	10	1	10
Vallisneria americana	Wild celery	6	1	6
N			26	
mean C				7.153846
FQI				36.4776

Table prepared by Sylvia Knust

Appendix D
Species Present

% Frequency of Occurrence (Littoral): This estimation of frequency of occurrence is calculated by taking the total number of times a species is sampled divided by the total number of points at which depth was less than or equal to the maximum depth of plant growth. Thus, we consider only sites in the lake at which, given light requirements, the growth of plants is possible.

Common Name	**Scientific Name**	**% Frequency of Occurrence (Littoral)**
Eurasian water milfoil	*Myriophyllum spicatum*	0.00
Curly-leaf pondweed	*Potamogeton crispus*	0.00
Nitella	*Nitella sp.*	36.59
Robbins (fern) pondweed	*Potamogeton robbinsii*	20.41
Large-leaf pondweed	*Potamogeton amplifolius*	10.50
Common waterweed	*Elodea canadensis*	9.77
Muskgrasses	*Chara*	6.85
Brown-fruited rush	*Juncus paleocarpus f. submersus*	6.41
Wild celery	*Vallisneria americana*	5.83
White-stem pondweed	*Potamogeton praelongis*	4.81
Water lobelia	*Lobelia dortmanna*	3.64
Bushy pondweed	*Najas flexilis*	3.35
Small pondweed	*Potamogeton pusillus*	3.35
Arrowhead Rosetta	*Sagittaria sp.*	2.62
Needle spikerush	*Eleocharis acicularis*	2.33
Dwarf water milfoil	*Myriophyllum tenellum*	2.19
Leafy pondweed	*Potamogeton foliosus*	1.90
Creeping spearwort	*Ranunculus flammula*	1.90
Ribbon-leaf pondweed	*Potamogeton epihydrus*	1.46
Stiff arrowhead	*Sagittaria Rigida*	1.46
Quillwort	*Isoetes sp.*	1.31
Waterwort	*Elatine minima*	0.87
Creeping spikerush	*Eleocharis palustris*	0.73
White water lily	*Nymphaea odorata*	0.87
Pipewort	*Eriocaulon aquaticum*	0.58
Spatterdock	*Nuphar variegata*	0.44
Softstem bullrush	*Scirpus Validus*	0.44
Filamentous algae	*Filamentous algae*	0.29
Floating-leaved bur-reed	*Sparganium fluctuans*	0.29
Pickerelweed	*Pontederia cordata*	0.15

Table prepared by Sylvia Knust