Comprehensive Lake Management Plan

Update 2021

Wheeler Lake

Wheeler Lake Association

COMPREHENSIVE LAKE MANAGEMENT PLAN
UPDATE 2021
WHEELER LAKE

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1.0 Executive Summary

The Wheeler Lake Association (WLA) has a long history dating back to 1938. It was formed to address resource management concerns on Wheeler Lake and has been doing so for over 70 years. The Association has been active in a number of recent lake management activities on Wheeler Lake including: Clean Boats, Clean Waters program, habitat improvement, invasive species management, and Citizen Lake Monitoring program for water quality. WLA contracted Flambeau Engineering to assist in the update of the comprehensive lake management plan (CLMP) that was prepared in 2011 for Wheeler Lake. The Wheeler Lake CLMP Update includes an aquatic plant survey and evaluation, water quality review, fishery assessment, shoreland assessment, lake user survey, all of which are used to update the CLMP. The CLMP Update also recommends specific management activities for the lake system, which are discussed in this plan.

An aquatic plant survey was complete in 2019. A point intercept survey was completed to determine what species of plants exist, where they are located and the density. The survey indicated a diverse species of native vegetation with moderate to low densities. Vegetation was found growing up to the depth of 30 feet indicating very good water clarity.

Eurasian watermilfoil has been present in Wheeler Lake since 2006 and has been managed with herbicide and contracted hand pulling. Annually from 2006 to present, a spring survey has been completed to document the location of EWM followed by treatments with herbicide or hand pulling as needed. These methods have proven to be successful at managing the EWM and keeping the population in check. The impact on the individual beds has varied from eliminating the beds to decreasing the density of plants in the bed. However, these treated beds rebound or new beds emerge that have required repeated treatments at several locations on the lake. One area in particular that required repeated treatments is the beds near the boat landing; these beds were the first to be discovered and have required several annual treatments. In 2019, EWM had spread to cover more than 22 acres (an all time high); an aggressive approach was implemented to help manage the EWM. In 2019 an herbicide treatment of 22 acres was completed with apparent success. EWM was substantially reduced to 2.2 acres in 2020. A small area (1.5 ac) of persistent EWM was again treated in 2020. Continued monitoring and treatment of EWM will be required to successfully manage the invasive plant.

The water quality of Wheeler Lake is very good based on data collected over the years. The quality has remained stable when comparing a sample from 1976 to many samples collected from 1986 to 2020. The clarity is very good with secchi reading to 31.5 feet and total phosphorus average at 10 ug/l. This classifies the lake as oligotrophic meaning it is a deep, clear lake with low nutrient levels, low productivity and a desirable fishery of large gamefish.

The watershed of Wheeler Lake is relatively small compared to the area and depth of the lake and there is no inlet or outlet stream. This results in a long residence time; meaning the water that enters the lake stays in the lake for an extended period before it leaves through evaporation or groundwater seepage. The watershed is mostly forested with heavy development along the shoreline of the lake.

Wheeler Lake has a good fishery of walleye, northern pike, largemouth and smallmouth bass and panfish. The populations are moderate and the size structure is good. The population of some species, in particular walleye, has been declining over the years due to high harvest and low recruitment. Improving habitat on the lake may help stabilize or increase fish populations.

The shoreland area of the lake is highly developed with nearly every parcel containing some form of development. Despite the development, the vegetation in the shoreland area is generally good with canopy cover exceeding 50% on nearly all parcels and a good portion containing some natural shrub and herbaceous cover. Most of the lots have a pier and a boat lift along with a trail or steps leading to the waters edge. Few of the lots contain large amounts of impervious area or lawn. There are several parcels that are highly developed that could benefit from shoreland improvements.

The lake user survey indicates users are generally satisfied with the quality of the lake and the recreational experience it provides. A variety of watercraft are used on the lake but the majority are non-motorized. The lake is generally enjoyed in a low impact way including swimming, canoe/kayaking and viewing the scenery. Respondents feel AIS is a current and future threat to the lake and support active methods of management.

2.0 Introduction

Wheeler Lake is a seepage lake located in Oconto County in Section 22, T33N, R16E, Town of Lakeland. The lake watershed is mostly forested with little development. The lake shore is highly developed with only a small area on the north side that is not developed with homes or seasonal cabins. Wheeler Lake contains a moderately diverse aquatic plant community (14 species in 2019) and is a naturally reproducing walleye water listed as WDNR Priority Navigable Waterway (PNW). PNW are waters that are designated by statute and rule and have sensitive fish and/or aquatic habitat. Naturally reproducing walleye populations in ceded territory, such as Wheeler Lake, are included in the PNW category and are not eligible for waterway and wetland permit exemptions. Though the aquatic ecosystem in Wheeler Lake is diverse, the aquatic invasive species (AIS) Eurasian watermilfoil was confirmed within the lake in 2006. Chinese mystery snail is another confirmed AIS, rusty crayfish are assumed to be present but there is no record of WDNR confirmation of this AIS. There is one public boat landing and a public picnic/swimming beach owned by United States Forest Service (USFS). These ample access and recreational areas draw statewide users to this area of Oconto County. The good fishery of walleye, smallmouth and largemouth bass and panfish offer great fishing opportunities. The lake experiences above average fishing pressure; especially during the winter months. Though good for the community, this diverse and expansive user group presents a unique and extensive threat for the introduction of new AIS or the spread of existing AIS to not only surrounding water bodies, but to the local water bodies of fishermen & vacationers alike.

Wheeler Lake Association has a long history dating back to 1938; meeting minutes from 1938 to present are held by the Association. In 1977 WLA became more structured and became a business entity with an EIN (Employer Identification Number); in 1987 WLA was incorporated and in 2008 became a 501c3 non-profit organization. WLA has protected and help improve the lake for 80 plus years; the activities include habitat improvement projects, lake water quality monitoring, invasive species control, and Clean Boats Clean Waters (boat landing monitoring). The most recent project WLA pursued is the update of the CLMP that was completed in 2011. The intent of this grant was to update the 2011 plan as it would be a prerequisite for seeking WDNR funding for management and control of an established AIS population and also for implementation of detailed aspects of the lake management plan. The focus of the updated plan is to identification of specific objectives for implementation. To achieve this goal the following tasks were accomplished through this project:

- Review of water quality data, comparison and recommendations
- Aquatic plant community survey, mapping and management recommendations
- Shoreland and coarse woody habitat assessment
- Fishery data review and evaluation
- Lake user survey
- Public education on AIS
- Update of comprehensive lake management plan incorporating all of the above

3.0 Baseline Information

Available information was collected and reviewed for each aspect of the plan. Following is a summary of the collected information.

3.1 Lake History and Morphology

Wheeler Lake is located in the Town of Lakewood, Sections 22 and 27, T33N, R16E, in northern Oconto County, Wisconsin. A location map is included in the Figures section. The following table summarizes the lake's physical attributes:

Table 1 - Physical Attributes

Lake Name	Wheeler Lake
Lake Type	Seepage
Surface Area (acres)	293
Maximum depth (feet)	35
% over 20 ft. deep	30
Shoreline Length (miles)	3.95
Public Landing	Yes

Source: Wisconsin Lakes, WDNR 2005 and WDNR Lake Survey map, 1970

Wheeler is a relatively deep lake with limited plant growth and clear water; a bathymetric map is included in the Figures section. Wheeler Lake provides year-round recreational activities ranging from fishing, swimming, waterskiing, pleasure boating, to snowmobiling, and more. Wheeler Lake is located in ceded territory and is harvested each year during the spearing season.

Wheeler Lake is located in glacial sediment that was deposited by the Mapleview Member of the Holy Hill formation transported by the Green Bay Lobe of the Laurentide Ice Sheet. The sediment consists of gravelly sand and sandy gravel deposited by outwash rivers that carried meltwater from melting glacier. The sediment immediately surrounding the lake was deposited on ice that later melted resulting in the collapse of the overlying sediment and destruction of the original deposited surface (Attig, 1999). The lake was formed by a large block of ice that was deposited and eventually melted leaving a large depression. An ice-marginal ridge lies to the north and west of the lake.

3.2 Aquatic Plants

Aquatic plants are vital to the health of a water body. Wheeler Lake supports a moderately diverse native plant population with isolated beds of the invasive Eurasian watermilfoil. The lake is oligotrophic which means it has low nutrient levels and low productivity which leads to low to moderate plant growth; this is typical of the deep, cold, kettle lakes. The lake is vegetated to a depth of 30 feet but the plants tend to be low growing and sparse. There are few beds of dense vegetation on the lake. The vegetation that is present is a mix of submerged and floating leaf species that offers good fish habitat. The floating leaf vegetation is generally located in the quiet bays and the submerged in the littoral perimeter of the lake. The present condition of the lake vegetation is very similar to what was reported in the 1950 fishery survey report. The report stated that lily beds of medium density were scattered throughout the protected bays; various types of vegetation were found in scarce to medium abundance and there was a very slight algae bloom (Burdick, 1950).

The aquatic invasive species, Eurasian watermilfoil (EWM), was first discovered in the south bay near the boat landing in 2006. Annual surveys and treatments with granular 2,4-D, Procellacor and Aqua Strike have been effective in limiting the spread and density of the beds. EWM has covered a maximum of 22.1 acres and as little as 1.5 acres since it was first discovered. Isolated beds appear on the west shore, the south bay at the boat landing and the northeast bay on a recurring basis. Historically, treatment with 2,4-D eliminates the beds for a time but they tend to reappear or new beds establish in the area. In 2019, a new approach was taken and Procellacor and Aqua Strike were used on 6 beds located from the south bay, up the west shore and across the northern portion of the lake. This method of management appears to have been successful for at least short term control; further follow-up is needed to determine how well it results in long term control.

3.3 Water Quality

The water quality of lakes is assessed using a three parameter approach called Trophic Status Index (TSI). The TSI is measured by determining the amount of nutrients in the water and the water clarity. Water samples are collected to measure chlorophyll a and total phosphorus. Chlorophyll a is the green pigment found in all living plants, it is an indirect measure of the phytoplankton (algae) in the water; phosphorus is a nutrient that is used by all plants. In general the higher the chlorophyll a and phosphorous the lower the water quality. A secchi disk is a black and white disk that is used to measure water clarity. The disk is lowered into the water and the depth at which it can no longer be seen is recorded; the greater the depth the better the water quality. Calculations are made to determine the TSI for each parameter and overall. The TSI value corresponds to a level of productivity: oligotrophic, mesotrophic and eutrophic. Oligotrophic lakes have low nutrients and productivity and high clarity; eutrophic lakes have high nutrients and productivity and low clarity; mesotrohpic lakes are in between.

The water quality of Wheeler Lake is good to very good based on total phosphorus, chlorophyll a and secchi depths. The trophic status index (TSI) indicates an oligotrophic lake with low productivity and high clarity.

3.4 Watershed

The Wheeler Lake watershed encompasses approximately 985 acres; of which 293 acres (30%) is lake surface. Most of the watershed is forested with relatively little development. Historically the watershed consisted of Northern hardwoods, dominated by a mix of hemlock, sugar maple, basswood, and white pine were present throughout. Currently the shores of Wheeler Lake have a high density of development.

In 2011, the watershed of Wheeler Lake was mapped and land use determined. The watershed is the land that contributes water through surface runoff to the lake. The watershed plays an important role in water quality; anything that is placed on the land in the watershed will eventually make its way to the lake. If there are nutrients that are placed on the land such as fertilizers on lawns and agricultural fields these nutrients will enter the lake and increase fertility. The watershed is relatively small when compared to the surface area and volume of the lake. There are no inlet or outlet streams to the lake and the topography of the watershed is somewhat bowl shaped. A smaller watershed may account in part for the good water quality and low productivity of the lake; there is less area to gather nutrients from the land surrounding the lake.

A study completed by the Town of Lakewood looked at future landuse and impacts to the area lakes. The study determined TSI for Wheeler Lake based on historic, existing and full-build land use; full-build was based on zoning restrictions at the time of the study. The study found the TSI to increase from 38 (very good) for historic land use to 41 (very good) for existing land use to 45 (very good) for full-build land use (Robert E. Lee Study). Wheeler Lake could expect an increase in total phosphorous (TP) loading of 83% and a TP increase of 4 mg/m3. The increase of developed area was projected to be 58% at the full-build scenario. The study predicts there will be a noticeable change in water quality but it will not be severe and the changes will impact more sensitive vegetation and animal life.

3.5 Fishery

The following table identifies the fish species the WDNR lists as being present in Wheeler Lake.

Table 2 – Summary of Wheeler Lake Fishery

Fish Species	Present	Common	Abundant
Northern Pike	x		
Walleye		x	
Largemouth Bass		x	
Smallmouth Bass		x	
Panfish		x	

Source: WDNR Wisconsin Lakes Publication # PUB-FH-800, 2005

The most recent fisheries survey was conducted by WDNR in 2014 on Wheeler Lake. The survey indicated that the dominant gamefish species in the lake were largemouth bass and panfish. The walleye population has declined due to poor natural recruitment and harvest. Walleye is the most sought-after fish in this lake and has the lowest specific catch rate of all species. Fall recruitment surveys indicate low populations of young walleye and possibly the need to reduce harvest levels. Wheeler Lake is located in ceded territory and is harvested during the spearing season.

3.6 Goals of Management Plan

The purpose of the CLMP is to protect the quality of Wheeler Lake and manage EWM. This is accomplished by reviewing data collected in the past and comparing to current data, setting management goals and making recommendations to reach the goals. The goals of this plan are as follows:

Active Goal: To manage Eurasian watermilfoil to improve recreation, aesthetics and protect native plant population.

Active Goal: Implement and maintain an aquatic invasive species monitoring program that will survey for invasive species, and if found, monitor their locations and extent of population spread.

Active Goal: To continue and expand the WDNR Clean Boats, Clean Waters program on Wheeler Lake.

Active Goal*:* To continue and expand the Wheeler Lake comprehensive water quality monitoring program through the WDNR Citizen Lake Monitoring Network. The program would include Water Clarity Monitoring and Water Chemistry Monitoring.

Active Goal: To work in concert with the WDNR staff and representatives of fishing related businesses to evaluate Wheeler Lake fish management practices and develop goals in order to maintain and enhance a quality family sport fishery.

Active Goal: To provide education and information to shoreline property owners regarding how native aquatic plant protection and shoreline management can slow the spread of aquatic invasive plants, improve the lake fishery, improve wildlife habitat and affect the quality of the water in the lake.

Active Goal: To encourage the incorporation of water quality protection measures in the design, construction and maintenance of all lake access sites on Wheeler Lake (e.g. storm water control, site drainage control, appropriate plant matter disposal, and watercraft wash down facilities if found to be needed).

4.0 Project Methods

Offsite and onsite research methods were used during this study. Offsite methods included a thorough review of available background information on the lake, its watershed, aquatic plants and water quality. An onsite visit was conducted to view the lake and confirm land use in the watershed.

4.1 Existing Data Review

A variety of resources was researched to develop a thorough understanding of the ecology of the lake. Information sources included:

- Local and regional geologic, limnologic, hydrologic, fisheries and hydrogeologic research
- Discussions with lake association members
- Available topographic maps and aerial photographs
- Data from WDNR and WLA files

4.2 Aquatic Plant Analysis

The aquatic plant community of the lake was surveyed on September 8 & 9, 2019 by Flambeau Engineering. The lake was previously survey by WDNR research staff in 2007 at sample points determined in accordance with the WDNR guidance; a total of 871 points were mapped. These same points were sampled in 2019. Latitude and longitude coordinates and sample identifications were assigned to each intercept point on the grid (Appendix A). The typical procedure was followed for aquatic plant surveys: geographic coordinates were uploaded into a global positioning system (GPS) receiver. The GPS unit was then used to navigate to intercept points. At each intercept point, plants were collected by tossing a specialized rake on a rope and dragging the rake along the bottom sediments. All collected plants were identified to the lowest practicable taxonomic level (e.g., typically genus or species) and recorded on field data sheets. Visual observations of aquatic plants were also recorded. Water depth and, when detectable, sediment types at each intercept point were also recorded on field data sheets. The point intercept method was used to evaluate the existing emergent, submerged, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR Worksheets.

4.3 Water Quality Methods

Water quality monitoring has been completed on the lake since 1976. The data that was gathered is posted on the WDNR SWIMS (Surface Water Integrated Monitoring System). Most recently, data was also collected by WLA in from 2006 to 2020. The following water quality information is available:

- Water clarity (Secchi depth) - 1986 to 2013 (Citizen Lake Monitoring)
- Total phosphorus – 1976 to 2020 (Citizen Lake Monitoring)C
- Chlorophyll a – 2006 to 2020 (Citizen Lake Monitoring)
- Calcium, hardness, magnesium – 2011 and 2019 (CLMP grant)
- Conductivity, pH, alkalinity, total Kjeldahl nitrogen – 2009 to 2019 (CLMP grant)

- Nitrate plus nitrite – 2009 and 2019 (CLMP grant)

The collected data was reviewed to assess water quality trends, averages, highs and lows.

4.4 Watershed

A watershed assessment was completed as part of the 2011 plan and was not updated in the current plan. Since the water quality has remained stable and little land use has changed in the watershed, this section was not updated but is included in this plan as it is useful information.

The watershed was mapped using a web based program created by Purdue University (HYMAPS-OWL) and hand delineation on USGS topographic maps. The land use was determined by HYMAPS-OWL and verified through field observation and aerial photography. The information gathered was then used to input into the WiLMS model to determine phosphorus loading into the lake.

The direction of groundwater flow was estimated based on topographic maps and well records. A USGS topographic map with ten foot contours was used to determine land slope; it is assumed groundwater slope followed the land slope. Lake elevations and wetland elevations were assessed; groundwater elevations were assumed to be close to lake water surface and wetland elevations. One USGS well record was found near the lake to estimate groundwater elevation.

The information collected in the 2011 plan is included in Appendix H.

4.5 Fishery

There are a number of fisheries reports available for Wheeler Lake. The following reports were reviewed:

- Fisheries Survey Report – 2008
- Fish Management Report - 2014
- Wisconsin Walleye Management Plan – 1998
- Biological Survey of Wheeler Lake – 1950
- 2011 Daily Spearing Report

Several conversations and email exchanges were completed with WDNR fishery staff. A conversation with Chip Long, fish biologist, and reports provided by him were a source of important habitat and fishery improvement recommendations.

4.6 Lake User Survey

A lake user survey was created by the Association to gather public input on the lake including overall quality, how it has changed, opinions on management methods and how the lake is used. The survey was reviewed and approved by WDNR. A total of ____ surveys were mailed and ____ surveys were received for a return rate of ____%.

4.7 Shoreland and Coarse Woody Habitat Assessment

The shoreland and coarse woody habitat surveys were completed according to DRAFT Lake Shoreland & Shallows Habitat Monitoring Field Protocol Wisconsin Department of Natural Resources May 27, 2016. The data was collected to provide important and useful information to local and regional resource managers, community stakeholders and may be used for:

- Teaching and outreach
- Identifying areas for protection or restoration
- Targeting future Critical Habitat Designations within lakes
- Creating lake management plans
- Creating county comprehensive plans
- Aiding management at the county level
- Planning Aquatic Plant Management
- Evaluating trends in lakeshore habitat over time (repeat survey every ~5 years)
- Understanding trends in lake ecology (e.g., fish, wildlife, invasive species)

The survey consists of assessing and documenting the health of the riparian shoreland; the land from the edge of the water landward 35 feet. The habitat including percent cover of canopy, shrub/herb layer, impervious surfaces and manicured lawn are documented. Also included are runoff concerns, bank modifications (riprap, seawalls), human structures (piers, boats, boathouse, lifts, etc.) and aquatic plants. A georeferenced photo of each lot is taken.

A coarse woody habitat survey is completed along the shoreline in water less than 2 feet deep. All wood at least 4-in in diameter and 5-feet long are documented with a GPS and rated based on branching, if it touches the shore and the amount of wood in the water.

5.0 Discussion of Project Results

A discussion of data and results from all tasks completed for the plan update are included below.

5.1 Aquatic Plant Ecology

Aquatic plants are vital to the health of a water body. Unfortunately, people all too often refer to rooted aquatic plants as "weeds" and ultimately wish to eradicate them. This type of attitude, and the misconceptions it breeds, must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants (macrophytes) are extremely important for the wellbeing of a lake community and possess many positive attributes. Despite their importance, aquatic macrophytes sometimes grow to nuisance levels that hamper recreational activities. This is especially prevalent in degraded ecosystems. The introduction of certain aquatic invasive species (AIS), such as EWM, can often exacerbate nuisance conditions, particularly when they compete successfully with native vegetation and occupy large portions of a lake.

When "managing" aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contains high percentages of desirable native species. To be effective, aquatic plant management in most lakes must maintain a plant community that is robust, species rich, and diverse. Appendix B includes a discussion about aquatic plant ecology, habitat types and relationships with water quality.

5.1.1 Aquatic Invasive Species

Aquatic Invasive Species (AIS) are aquatic plants and animals that have been introduced by human action to a location, area, or region where they did not previously exist. AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new "home". Some AIS have aggressive reproductive potential and contribute to a decline of a lake's ecology and interfere with recreational use of a lake. Common Wisconsin AIS include:

- Eurasian Water Milfoil
- Curly Leaf Pondweed
- Zebra Mussels
- Mystery Snails
- Rusty Crayfish
- Spiny Water Flea
- Purple Loosestrife

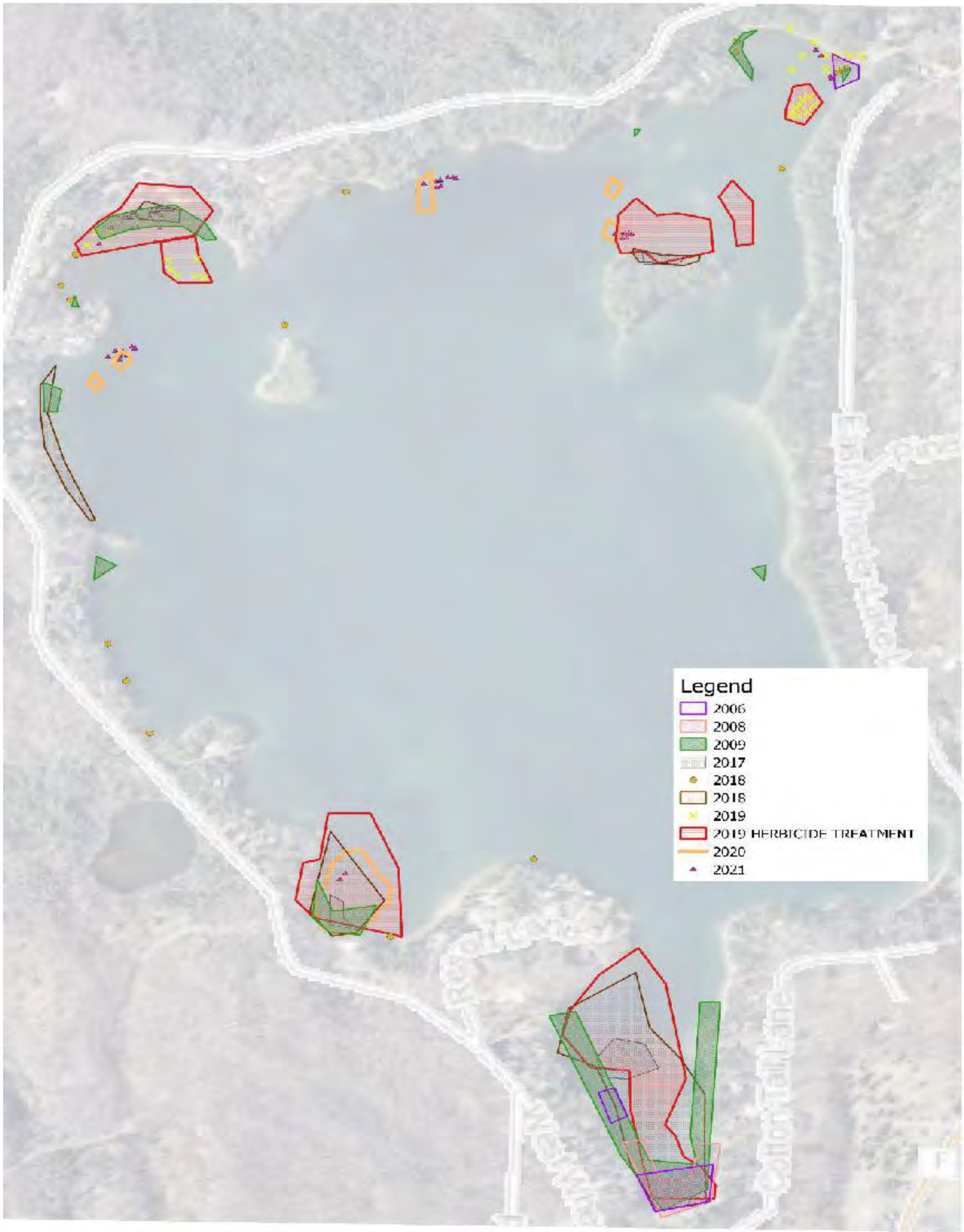
Wheeler Lake has two documented invasive species: Eurasian watermilfoil (EWM) and Chinese mystery snail; rusty crayfish was also present but not confirmed by WDNR records. According to local lake users, rusty crayfish were present in Wheeler Lake in the past but the population has decreased over the years; however, this species has not been documented by WDNR. Early during the infestation, the crayfish population was high and caused a nuisance. Intensive trapping took place for several years and the crayfish population has decreased. The high population of bass in Wheeler Lake may have helped reduce rusty crayfish numbers also. The rusty crayfish may have had an impact on the native plant population and could be partially responsible for the spread of EWM within the lake. Rusty crayfish are prolific vegetation eaters and can nearly wipe out beds of vegetation. They eat four times the amount of food a native crayfish eats and will eat small fish, insects, fish eggs and aquatic plants. They are messy eaters and when they snip off a plant to eat they only eat a small portion and the remainder floats away. By eating this way they can decimate native plant populations and spread EWM. They are also very aggressive toward native crayfish and chase them out of prime habitat which makes the natives susceptible to predation by larger fish. A map indicating AIS in neighboring waterways is included in the Figures section.

Eurasian Watermilfoil

The EWM has been actively managed since it was discovered in 2006 and rusty crayfish have been trapped to control numbers. A consultant was hired in 2006 to guide the Association in their EWM control efforts and to apply chemical herbicide. From 2006 until 2018, small stands of EWM were treated using 2,4-D with limited effectiveness. The treated stands would subside but EWM would pop up adjacent to the treated areas. The EWM covered an area ranging from 1.5 to 5.3 acres from 2006 to 2011. In 2018 the EWM expanded and DASH was used to treat 5.5 acres. The EWM continued to expand and in 2019 a total of 22.1 acres was treated with herbicide (Procellacor and Aquastrike). ProcellaCOR is a selective systemic herbide that is absorbed by aqautic plants and best applied to actively growing plants. It requires shorter exposure times to be effective. Aqua Strike is a combintaiton of endothall and diquat dibromide, is a contact herbicide that is best applied to growing plants and requires a shorter contact time. Both of these were effective in the areas where applied.

The herbicide treatments were very effective but small stands persisted that were treated using hand pulling; a total of 38.5 cf of EWM was removed in July and August 2019. In 2020 a small, dense stand of EWM persisted in the bay at the public beach; Procellacor was again used on 3.5 acres in this area. Hand pulling treatment followed at small, scattered stands for a total of 88 cf of EWM removed in July 2020. The following figure shows the locations of EWM from 2006 to 2021.

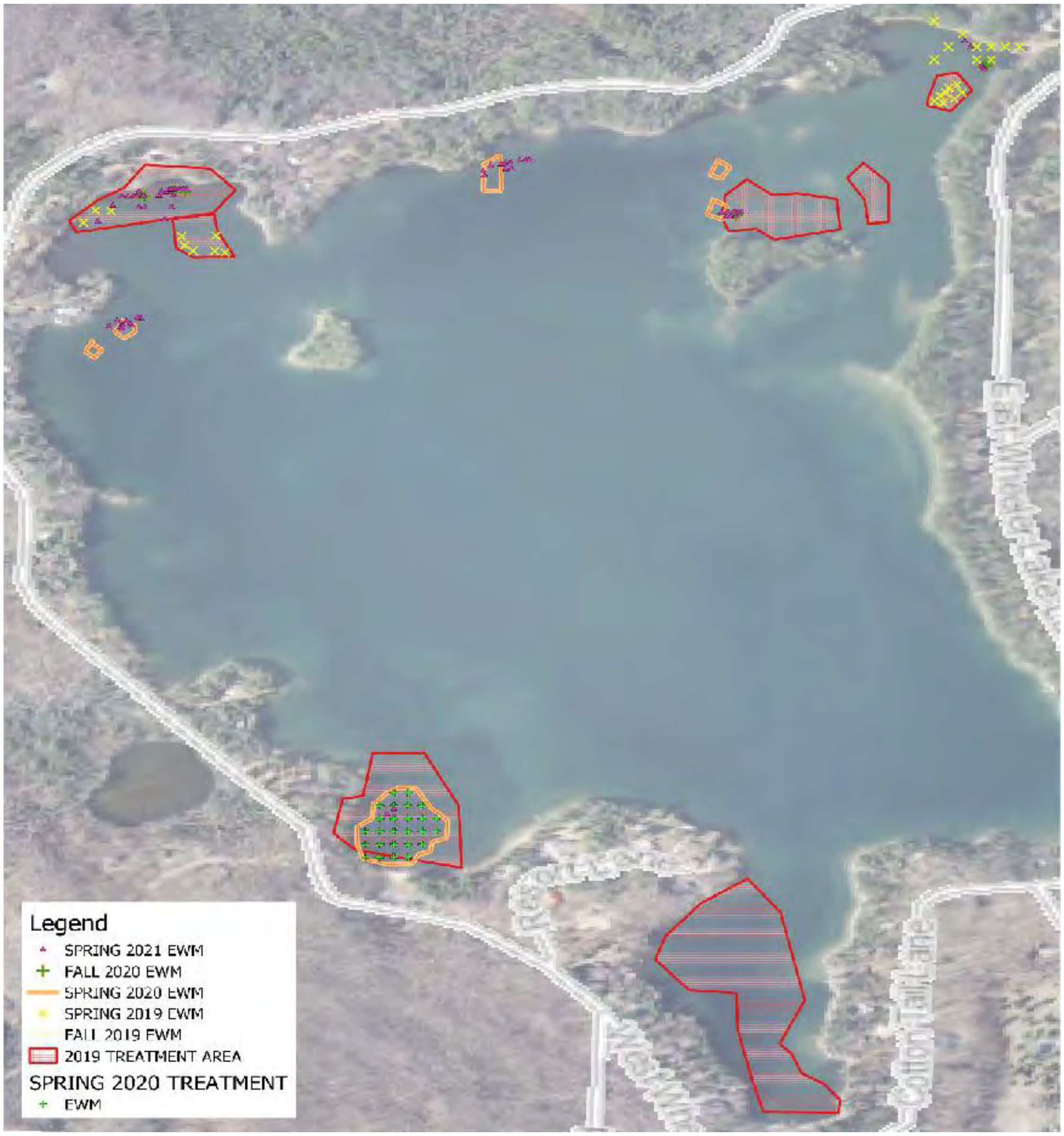
Figure 1 – EWM Locations 2006 to 2021



EWM was first discovered in 2006 in an isolated area in the south bay near the boat landing and in the far northeast bay. In 2009 it had spread to cover the perimeter of the south bay and in isolated, small beds around the lake. It continued to spread, until in 2018 it dominated the south bay and dense, larger stands were scattered around the lake. The maximum area of EWM was in 2019 when it covered at least 22.1 acres; the herbicide treatment in 2019 effectively decreased the EWM.

The following figure shows the location of EWM from 2019 – 2021 and the treatment areas.

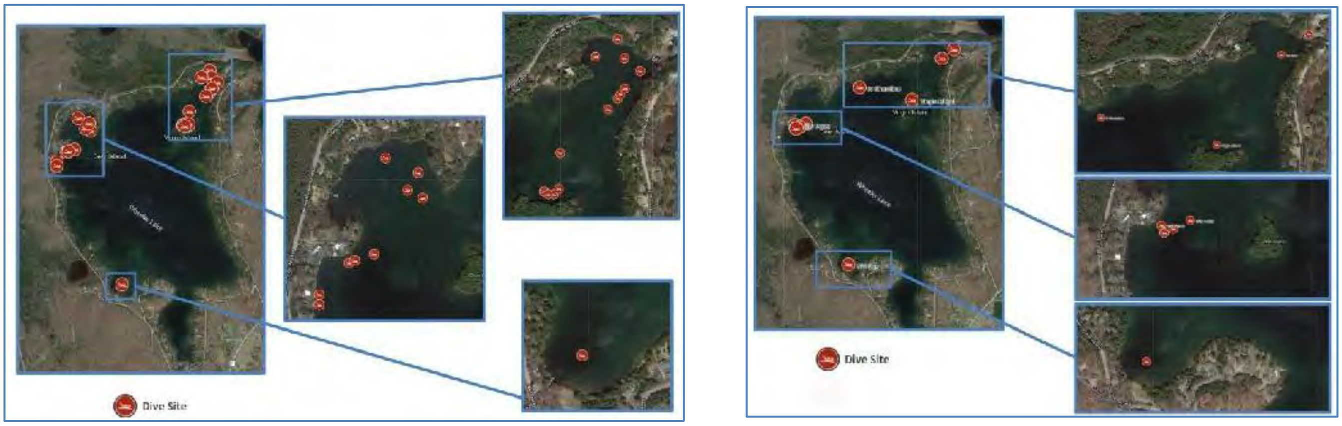
Figure 2 - EWM Location and Herbicide Treatment 2019-2021



The 2019 treatment was very effective and virtually eliminated EWM from the south bay and reduced the remaining beds to scattered, isolated plants. A follow up treatment with Procellacor was completed in the beach bay for a small, dense persistent stand. The 2021 spring EWM survey indicated small stands of scattered plants along the northern portion of the lake.

Professional hand pulling was used in conjunction with the herbicide treatments. In 2019 and 2020, divers completed follow-up treatment in the herbicide treated areas and areas that were not targeted with herbicide. The following figures show the locations of harvesting.

Figure 3 - 2019 and 2020 Hand Harvesting



Hand pulling or harvesting is most effective in shallow areas with scattered EWM, that is why this method was used in areas not targeted by herbicide and as a follow-up to the herbicide treatments. It consists of snorkelers/divers pulling the individual plants by hand and removing them from the water. A second method, DASH (Diver Assisted Suction Harvesting) is best used in small (<1/3 ac), dense stands in deeper water. This method consists of a boat equipped with a pump and suction hose that "vacuums" the plants from the lakebed. A hose guided by a diver is used to target EWM and remove it from the lake. Since it requires a boat and diver it is best suited for small, deep, dense stands of EWM.

EWM favors habitat with fertile, fine textured sediments and has a history of dominating systems that are eutrophic and nutrient rich. EWM prefers lakes with highly disturbed lake beds, high nitrogen and phosphorus runoff and heavily used lakes. There have been studies conducted on the relationship between native vegetation and EWM (Nichols et al 1997). Two plants that have been found to indicate suitable habitat for EWM are *Potamogeton illinoensis* and *Stuckenia pectinata*. These plants have a very high correlation with EWM and have similar alkalinity, pH and conductivity preference. The following table lists the preference of EWM, *P. illinoensis* and *S. pectinata* and the values of each parameter in Wheeler Lake.

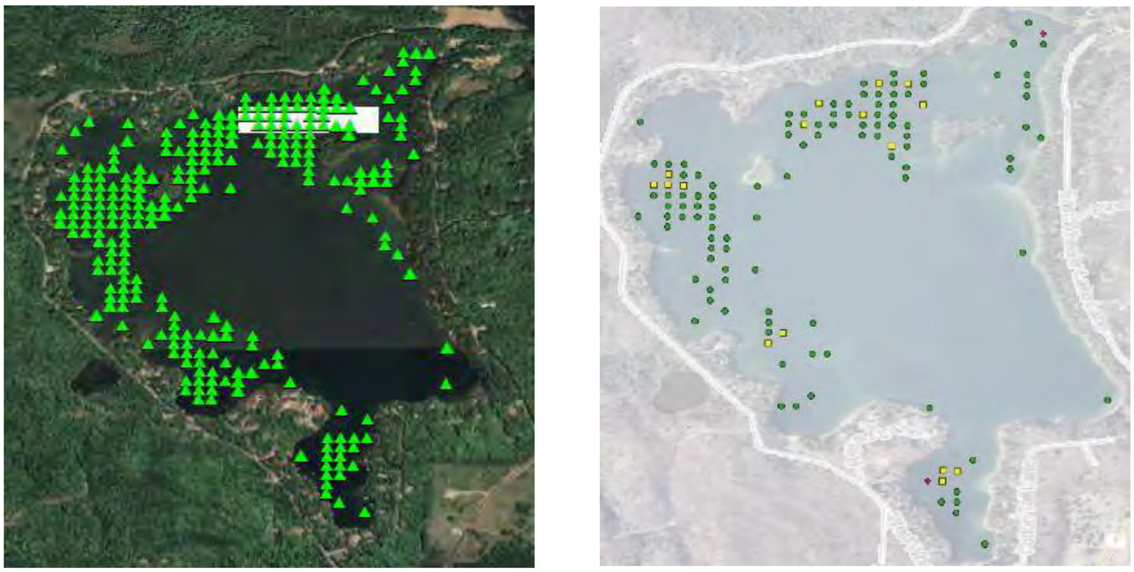
Table 3 - EWM Water Quality Preference

Parameter	Preference	Wheeler Lake
Alkalinity mg/l	130-150	84-99
pH units	8.0-8.3	7.9--8.4
Conductivity umhos/cm	225-250	181-209

As shown in the table above the water quality of Wheeler Lake does not fall in the preference range of EWM for alkalinity or conductivity. Wheeler also has low levels of nutrients whereas EWM prefers high levels of nutrients.

A third plant that may be a very good indicator of suitable EWM habitat is *Najas flexilis* because it is an annual species that rapidly invades disturbed areas as EWM often does. Wheeler Lake contains *N. flexilis, P. illinoensis* and *S. pectinata*. The most abundant plant in Wheeler was found to be *N. flexilis* in the 2007 study; *P. illinoensis and S. pectinata* were found at low densities. The locations of *N. flexilis* may indicate locations favorable for EWM growth. The following figure shows the location of *Najas flexilis* in the 2007 survey.

Figure 4 – Locations of *Najas flexilis* in Wheeler Lake – 2007 and 2019



Based on the area of the lake that is inhabited by *N. flexilis* there is a large area that could be favorable habitat for EWM. Considering the unfavorable water quality for EWM (alkalinity and conductivity), low nutrient levels, and low density of the most closely correlated plants (*P. illinoensis* and *S. pectinata)*; Wheeler Lake is not a likely candidate for EWM domination. However, in less productive lakes such as Wheeler, EWM is generally restricted to areas with nutrient rich, disturbed sediments. This area could include the littoral area from a water depth of about 3 feet to 15 feet. Control measures such as herbicide treatments and hand-pulling appear to be effective at curbing EWM spread and density and should be continued to prevent widespread EWM beds.

5.1.2 2019 Aquatic Plant Analysis

An aquatic plant survey was completed by Flambeau Engineering on September 8 & 9, 2019. The point intercept survey mapped 871 sample locations, 860 of these were sampled; the remaining points were at depths beyond plant growth. Of the 860 points sampled 445 points had vegetation. The aquatic macrophyte community of the lake included 14 floating leaved, emergent, and submerged aquatic vascular plant species during 2019.

During the 2019 survey vegetation was identified to a maximum depth of 30 feet (photic zone). A moderately diverse plant community inhabited the lake during 2019. The most abundant aquatic plant identified during the aquatic plant survey was musk grass (*Chara* sp). It exhibited a 19.6% frequency of occurrence (percent of photic zone intercept points at which the taxa was detected). It was present at 36.8% of the sites with vegetation and had a 23.4% relative frequency of occurrence. This plant is often found in sand or mud substrate and in deeper water and grows from 10 cm to 30 cm tall.

Variable pondweed (*Potamogeton gramineus*) was the second most abundant species occurring at 16% of the photic zone. It was present at 30.1% of the sites with vegetation and had a 19.1% relative frequency of occurrence. This plant is usually found in water about 1 m deep but can grow in very shallow water to several meters deep on firm sediment. It is typically found growing with muskgrass and slender naiad. The plant ranges in size from 30 cm to 70 cm tall.

Slender naiad (*Najas flexilis*). It exhibited a 14.7% frequency of occurrence in the photic zone. It was present at 27.6% of the sites with vegetation and had a 17.6% relative frequency of occurrence. This plant is often found in sand and gravel substrate and grows up to 1 m long

Appendix B includes a brief description of the aquatic plants identified.

The species that were most abundant were found growing in deeper areas of the lake, are smaller, low growing species and prefer sand and gravel substrate. The vegetation composition and density support the oligotrophic classification. The lake appears to have supported low plant density in recent history based on notes in the 1950 WDNR fishery survey. It stated that plant growth was moderate to sparse.

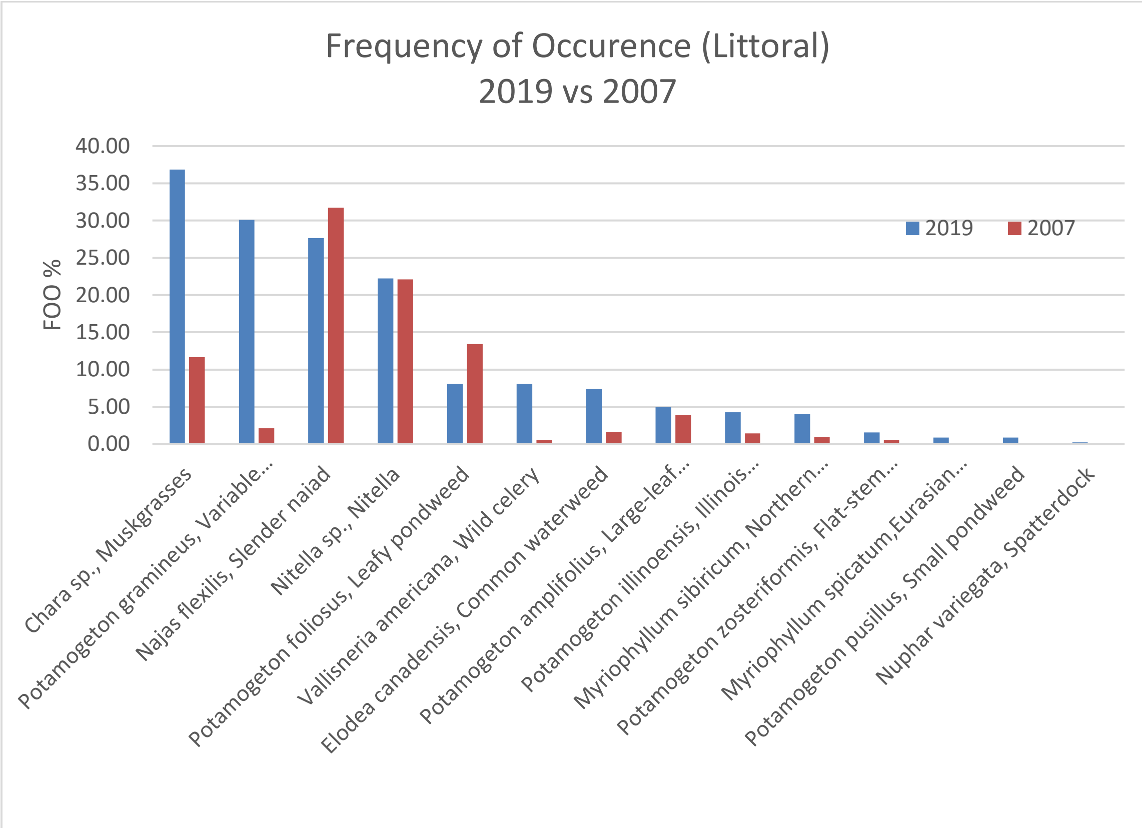
The table below lists the taxa identified during the 2019 aquatic plant survey. The next table summarizes these overall aquatic plant community statistics.

Table 4 Taxa 2019 Aquatic Plant Survey

	Freq of Occurrence (Littoral)	
Species	**2019**	**2007**
Chara sp., Muskgrasses	36.85	11.65
Potamogeton gramineus, Variable pondweed	30.11	2.14
Najas flexilis, Slender naiad	27.64	31.75
Nitella sp., Nitella	22.25	22.12
Potamogeton foliosus, Leafy pondweed	8.09	13.44
Vallisneria americana, Wild celery	8.09	0.59
Elodea canadensis, Common waterweed	7.42	1.66
Potamogeton amplifolius, Large-leaf pondweed	4.94	3.92
Potamogeton illinoensis, Illinois pondweed	4.27	1.43
Myriophyllum sibiricum, Northern water-milfoil	4.04	0.95
Potamogeton zosteriformis, Flat-stem pondweed	1.57	0.59
Myriophyllum spicatum, Eurasian water milfoil	0.90	0
Potamogeton pusillus, Small pondweed	0.90	0.12
Nuphar variegata, Spatterdock	0.22	0.12

The following graph depicts the species frequency of occurrence (littoral) for 2019 and 2007.

Figure 5 – Frequency of Occurrence Aquatic Plants 2019 vs 2007



The change in the plant community from 2007 to 2019 can be seen above. Several species increased by a significant amount and several decreased. The significance of observed changes is determined by the Chi-square method; this analysis was completed using WDNR provided worksheets. The following species showed a significant increase from 2007 to 2019: muskgrass, waterweed, variable pondweed and wild celery. The following species showed a significant decrease: slender naiad, nitella, leafy pondweed.

Maps of each species location are included in the Figures section.

The data collected from the plant survey was analyzed using a spreadsheet created by WDNR. This spreadsheet calculates statistics so comparisons can be made in a single lake for subsequent plant surveys and compared to other lakes across the state or region. The following statics were calculated for Wheeler Lake:

- Taxonomic richness - the total number of taxa detected. In Wheeler Lake a total of 14 species were documented during the survey.
- Maximum depth of plant growth: Plants were found to be growing at 30 feet. This is quite deep and due to the clear water that allows deep light penetration on this lake.
- Community frequency of occurrence - number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth: 53.23 indicating that the majority of sites that plants could grow are supporting vegetation.
- Average Number of all Species per Site – vegetated sites only: 1.57. This indicates that although there is a diverse population of plants throughout the lake the populations

are segregated and a few species dominate. Half of the species that were found were low in density and found at less than ten points in the lake.

- Average Number of all Species per Site – shallower that maximum depth: 0.83. A number less than 1 indicates that vegetation was not found at all points where light penetration allows plants to grow.
- Simpson Diversity Index (SDI) - an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population. 0.86
- Floristic Quality Index (FQI) - method that uses a predetermined Coefficient of Conservatism (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site

  Higher FQI numbers indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. FQI varies around the state of Wisconsin and ranges from 3.0 to 44.6 with the average FQI of 22.2 (WDNR, 2005). The Wheeler Lake FQI calculated from the 2019 aquatic plant survey data was 22.19 with an average coefficient of conservatism of 6.15. This FQI value is slightly lower than Wisconsin's northern region mean of 24.3 and suggests that Wheeler Lake exhibits good water quality when using aquatic plants as an indicator. The following table summarizes the FQI values.

Table 6 - Data Summary Comparison 2019 vs 2007

Data Summary	2019	2007
Total number of sites visited	860	856
Total number of sites with vegetation	445	580
Total number of sites shallower than maximum depth of plants	836	841
Frequency of occurrence at sites shallower than maximum depth of plants	53.23	68.97
Simpson Diversity Index	0.85	0.79
Maximum depth of plants (ft)**	30	30.5
Average number of all species per site (shallower than max depth)	0.83	0.94
Average number of all species per site (veg. sites only)	1.57	1.37
Average number of native species per site (shallower than max depth)	0.83	0.94
Average number of native species per site (veg. sites only)	1.57	1.37
Species Richness	14	19

The data above indicates a slight reduction in the lakebed that is covered with vegetation from 69% to 53%. This could be due to the high water that was evident in 2019 which increases water depth and decrease the lakebed that is in the photic zone and can support plant life. If this is the case, the plants will reappear when the water level recedes and the photic zones returns to normal.

Species richness also decreased; this was the result of several species that were documented at one location in 2007 not being observed during 2019. The species are likely still present but were not encountered during the PI survey.

Plant communities are divided into types based on where the plant normally grows. Emergent plants have leaves that extend above the surface of the water and are found near the shorelines of lakes in shallower water. Free-floating plants are not attached to the bottom and float anywhere in the water depending on wind and currents. Floating-leaf plants are rooted plants that have leaves floating on the surface. They are usually found at intermediate depths between emergent and submersed zones. Submersed plants have most of their leaves growing underwater although a few leaves may float on the surface. They are found from shallow to deep zones. Wheeler Lake had the following plants in these communities in 2007/2019:

Floating-leaf plants

- *Nuphar variegata* (spatterdock)
- *Nymphaea odorata* (white water lily)

Submersed plants

- *Chara sp.* (chara or muskgrass) [algal]
- *Elodea canadensis* (elodea or common waterweed)
- *Myriophyllum sibiricum* (northern water-milfoil)
- *Myriophyllum spicatum* (Eurasian water-milfoil)
- Najas *flexilis* (bushy pondweed or slender naiad)
- *Nitella sp.* (nitella) [algal]
- *Potamogeton amplifolius* (large-leaf pondweed)
- *Potamogeton foliosus* (large-leaf pondweed)
- *Potamogeton gramineus* (variable leaf pondweed)
- *Potamogeton illinoensis* (Illinois pondweed)
- *Potamogeton pusillus* (small pondweed)
- *Potamogeton zosteriformis* (flat-stem pondweed)
- *Vallisneria americana* (wild celery)

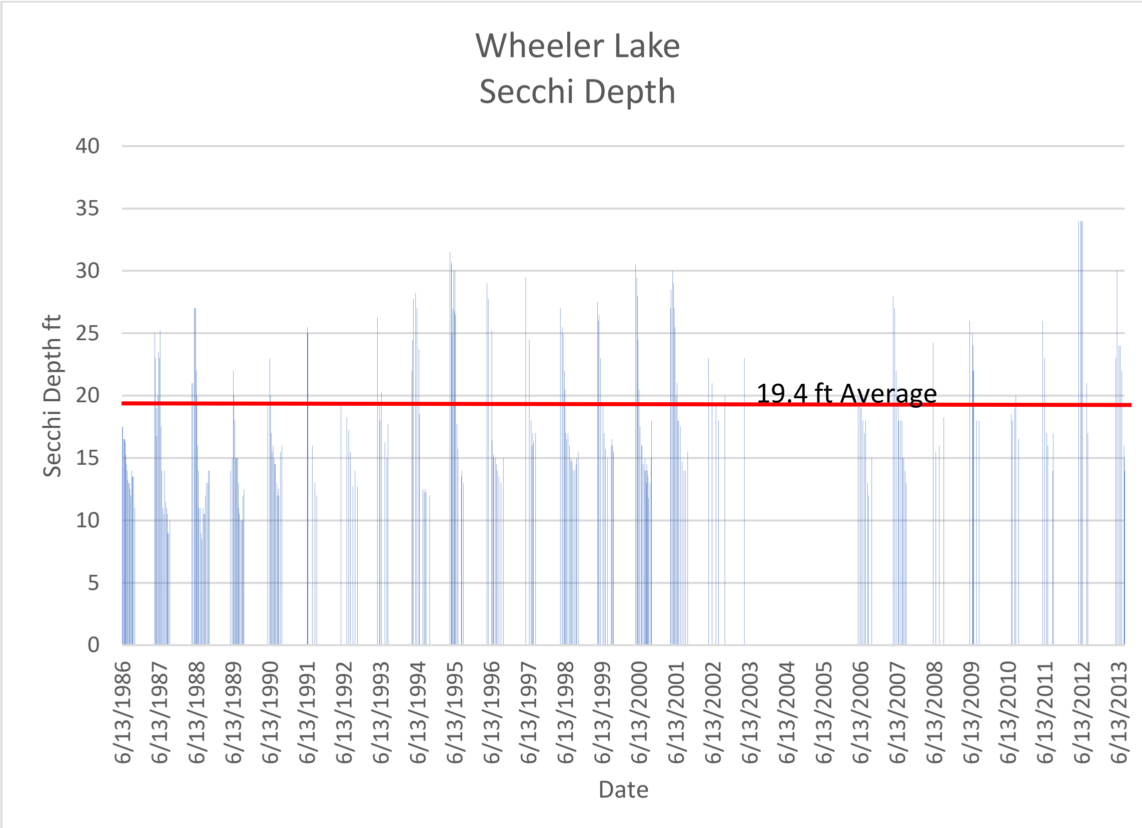
5.2 Water Quality

The water quality in Wheeler Lake is good and indicates an oligotrophic system with low productivity. This means that the water has low nutrients, high clarity and supports low to moderate plant and aquatic organism growth. Water quality is further discussed in the sections below.

5.2.1 Water Clarity

The historical water clarity average based on Secchi disk readings is very good at 19.4 feet and ranges from 8.5 to 34 feet. The Wisconsin average Secchi disk reading in 2005 was 10 feet (Larry Bresina, The Secchi Disk and Our Eyes - Working Together to Measure Clarity of Our Lakes; internet document). The following graph illustrates the historical water clarity measurements on Wheeler Lake.

Figure 6 – Secchi Depths

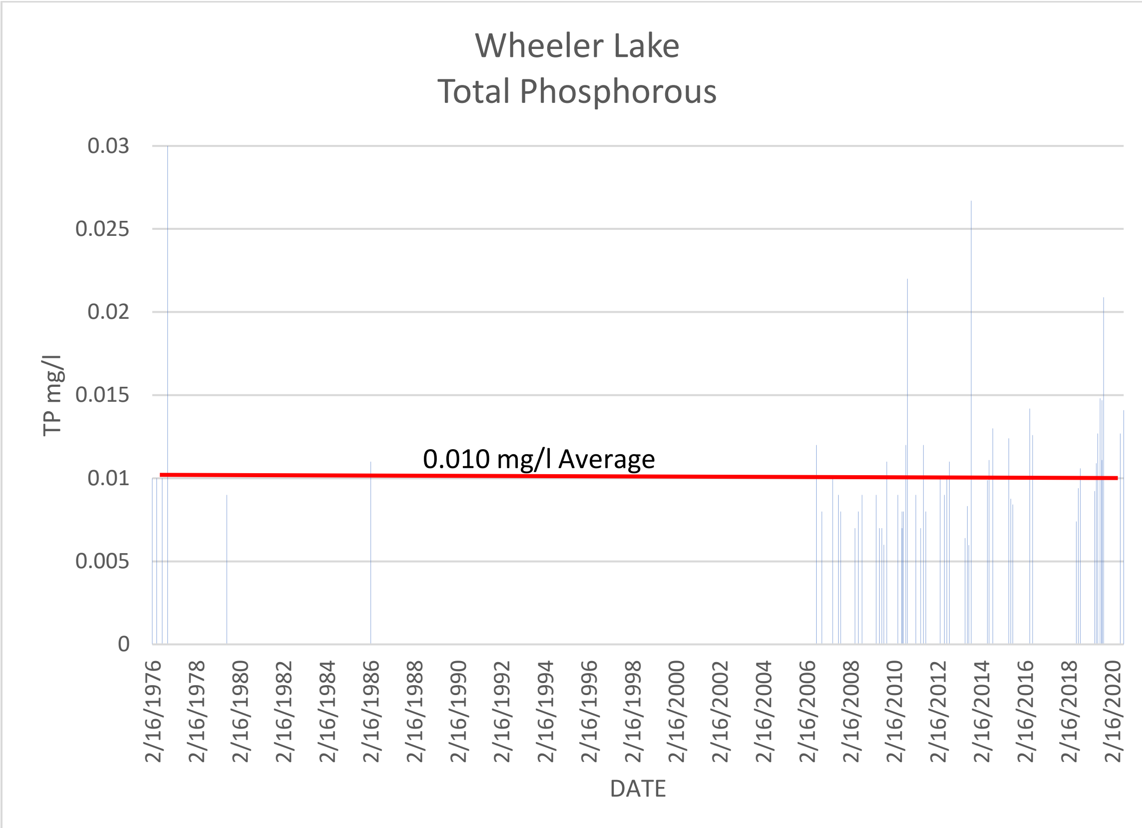


The high water clarity allows for deep penetration of light allowing for plant growth at great depths. The maximum depth that plants generally grow is approximately 30 feet. In this lake plant growth was found at this maximum depth. The high clarity is due to clear, unstained water and low algae populations.

5.2.2 Total Phosphorus and Chlorophyll *a*

Historically, Wheeler Lake has had an average phosphorus reading of 0.01 milligrams per liter (mg/L). The total phosphorus has varied from 0.006 mg/L to 0.0148 mg/L. The following graphs illustrate the historical phosphorus measurements on the lake.

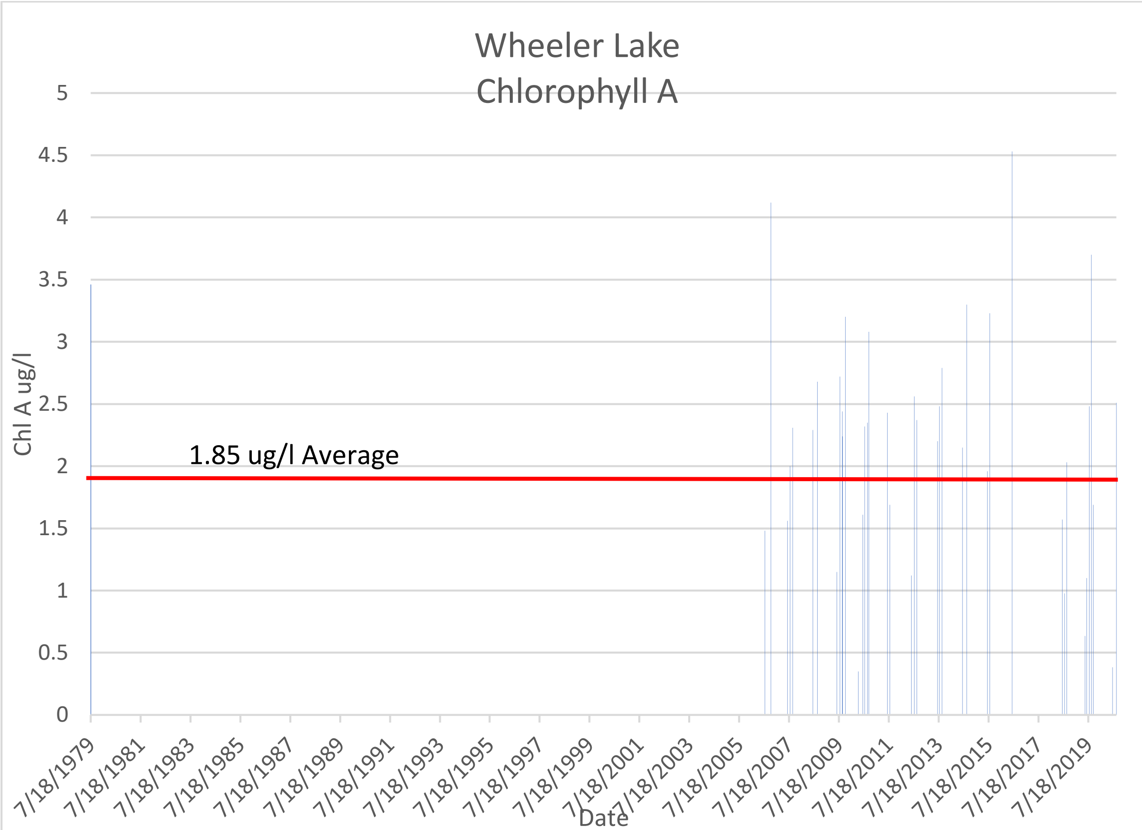
Figure 7 – Phosphorus Concentrations



Total Phosphorus (TP) is a measure of nutrients available for plant growth and high concentrations can promote excessive plant growth. In more than 80% of Wisconsin lakes phosphorous is the key nutrient affecting the amount of algae and plant growth. Phosphorous comes from a variety of sources, many of which are human related and include animal and human waste, soil erosion, detergents, septic systems and runoff from agricultural land and lawns. On lakes with high development in the near shore area fertilization of lawns and failing septic systems can contribute high amounts of phosphorous to the water. The TP average for the lake is 0.010 mg/l indicating very good water quality. A range of 0.005 to 0.015 indicates very good water quality. The average for lakes in Wisconsin is 0.025 mg/l. According to TP values the water quality of Wheeler Lake is very good and above average for WI lakes.

Chlorophyll *a* data has an average of 1.85 micrograms per liter (ug/L - parts per billion). Data ranged from 0.382 ug/L to 4.53 ug/L. The following graphs illustrate the historical chlorophyll a values on the lake.

Figure 8 – Chlorophyll a Concentrations



Chlorophyll a is green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae suspended in the water column of a lake. Chlorophyll a is used as a common indicator of water quality (Shaw et al, 2004). Higher chlorophyll a values indicate lower water quality. The average value in the lake is 1.85 ug/l indicating low levels of algae and an oligotrophic classification.

5.2.3 Trophic State Index

Trophic State Index (TSI) values are assigned to a lake based on total phosphorus, chlorophyll *a*, and water clarity values. The TSI is a measure of a lake's biological productivity. The TSI used for Wisconsin lakes is described in the table below. The values of each parameter for Wheeler Lake are listed in the last row.

Table 7 – TSI Description and Values

Category	TSI	Lake Characteristics	Total P *(ug/l)*	Chlorophyll a *(ug/l)*	Water Clarity *(feet)*
Oligotrophic	1-40	Clear water; oxygen rich at all depths, except if close to mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes.	< 12	<2.6	>13
Mesotrophic	41-50	Moderately clear; increasing probability of low to no oxygen in bottom waters.	12 to 24	2.6 to 7.3	13 to 6.5
Eutrophic	51-70	Decreased water clarity; probably no oxygen in bottom waters during summer; warm-water fisheries only; blue-green algae likely in summer in upper range; plants also excessive.	> 24	>7	<6.5
Wheeler Lake	36	Oligotrophic	10.0	1.85	19.4

Adopted from Carlson 1977, Lillie and Mason, 1983, and Shaw 1994 et. al.

The historic water clarity, total phosphorus, and chlorophyll a data indicate that Wheeler Lake is an oligotrophic lake. Oligotrophic lakes are usually clear, deep and free of weeds or large algae blooms. They are low in nutrients and do not support large fish populations. They can however develop a food chain capable of sustaining a very desirable fishery of large gamefish.

5.2.4 Additional Water Chemistry

Additional water chemistry data was collected under this grant project. The lake was sampled for calcium, chlorophyll a, conductivity, pH, alkalinity, hardness, magnesium, nitrate plus nitrate, total Kjeldahl nitrogen and total phosphorus. The results of the sampling are below.

Table 8 - Wheeler Lake Water Chemistry

Parameter	Units	Sample Date 10/17/2009	9/1/2010	2/19/2011	5/28/19	7/15/19	9/3/19
Calcium	mg/l			22.2	18.6		
Chlorophyll a	ug/l	3.2	2.44	ND	0.636		
Conductivity	us/cm	182	181	209	169		
pH		8.11	8.37	7.91	8.31		
Alkalinity	mg/l	84	84.7	98.7	77.6		
Hardness	mg/l			103	85.4		
Magnesium	mg/l			11.5	9.47		
Nitrate+Nitrite	mg/l	ND					
Total Kjeldahl Nitrogen	mg/l	0.5	0.54	0.8	0.46	0.498	0.455
Total Phosphorus	mg/l	0.011	0.006	0.009	0.011		0.011
TSS	mg/l				ND		

An explanation of each parameter and how it affects water quality follows.

Carbonate System including Calcium, Magnesium, Alkalinity and Hardness – the carbonate system provides acid buffering through two alkaline compounds: bicarbonate and carbonate. These compounds are usually found with two hardness ions: calcium and magnesium. The hardness and alkalinity of a lake are affected by the type of mineral in the soil and watershed rock and by how much the lake water comes into contact with these minerals. The hardness value indicates moderately hard water. Hard water lakes tend to have marl deposits and produce more fish and aquatic plants that soft water lakes. Alkalinity acts to buffer the lake from acid rain. Alkalinity value indicates the lake is nonsensitive to acid rain.

Conductivity – measure of a waters ability to conduct an electrical current and is related to the amount of dissolved substances in the water. Conductivity is about twice the hardness in uncontaminated waters in Wisconsin; if much greater than twice it may indicate presence of contaminants such as sodium, chloride, nitrate or sulfate. The conductivity ranges from 169 – 209 us/cm; about twice the hardness.

pH – an index of waters acid level and an important component of the carbonate system; it is the negative logarithm of the hydrogen ion concentration. Lower pH water has more hydrogen ions and are more acidic than higher pH waters. Lake water in Wisconsin ranges from 4.5 in acid bog lakes to 8.4 in hardwater lakes. A range of pH of 7.9 to 8.4 falls in the normal range of lake water and indicates a hardwater lake.

Nitrate + Nitrite and Total Kjeldahl Nitrogen (TKN) – forms of nitrogen that exist in lake water. Nitrogen is in all organic matter and is released during decomposition. Nitrogen cycles in a lake through organic matter (plants), sediment, water and air. A lake is nitrogen limited if the ratio of total nitrogen to total phosphorous is less than 10:1. Nitrate + nitrite plus total Kjeldahl nitrogen equals total nitrogen. Nitrate + nitrite was not detected, TKN ranged from 0.45 – 0.8

mg/l. Since nitrate + nitrite was not detected total nitrogen (TN) is equal to TKN. TN of 0.5 to 0.8 mg/l indicates mesotrophic to eutrophic conditions. The ratio of TN:TP ranges from 45:1 to 90:1 indicating the lake is phosphorous limited as are 90% of lakes in Wisconsin. Algae growth in these lakes is limited by the amount of phosphorous in the system. Sources of nitrogen include fertilizer, animal and human waste and in some cases groundwater.

5.2.5 WiLMS Modeling Results

WiLMS was used in 2011 to predict the water quality of the lake in the future and compare results to lakes in the ecoregion; this was not updated due to little to no change in the watershed land use. WiLMS estimated phosphorus loading based on lake characteristics such as drainage area, runoff, lake surface area and volume, septic systems on the lakeshore and land use. According to the model the total phosphorous loading to the lake per year is most likely 212 lbs; this equates to 0.72 lbs per acre of watershed per year. All sources are non-point sources meaning they come from landuse and are not direct discharges of water into the lake. The following table lists the loading from landuse in the watershed.

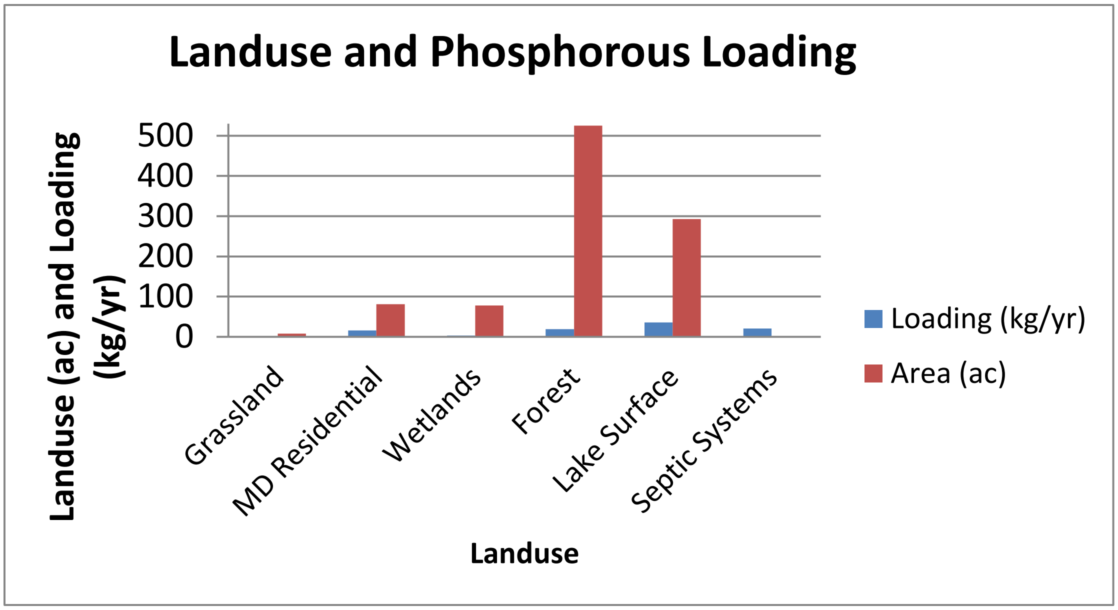
Table 9 - Phosphorus Loading per Landuse

Landuse	Area (ac)	Loading (kg/yr)
Grassland	8	1
Medium Density Residential	81	16
Wetlands	78	3
Forest	525	19
Lake Surface	293	36
Septic Systems	421 – (capita-years)	21

The lake surface is listed as the highest contributor of phosphorous; this is due to the large surface area of the lake compared to the size of the watershed. Phosphorus enters the lake surface through fallout from the atmosphere and there is no way to reduce this form of loading. The second largest contributor is listed as septic systems. WiLMS calculates and estimates the loading of phosphorous from septic systems but this is a very loose estimate. To get an accurate estimate the age and efficiency of the systems should be evaluated, an accurate count on the number of systems, and the actual use of the systems needs to be estimated. The loading number generated for this study should be used for a general estimate only. The forested area and residential areas contribute similar phosphorus loads even though the area of forest is more than six times the area of residential. To decrease phosphorus loading to the lake efforts should be focused on the residential area on the shoreline and the septic systems.

The following chart depicts the area in acres of each landuse and the loading in kg/yr of each landuse. This chart shows that the largest landuse by far is forested but it contributes a small portion of total phosphorous.

Figure 9 - Landuse and Phosphorus Loading



WiLMS data was also used to determine internal loading of phosphorous; this is phosphorous that is released from the sediments of the lake. The lake has a negative internal load meaning that phosphorous is deposited and is not released from the sediment. The model also predicts the trophic response based on chlorophyll a, total phosphorous and secchi depth. The following are the predicted values:

Use chl_a to predict Secchi depth (m)	4.4 m
Use total phosphorus to predict Secchi depth (m)	3.0 m
Use total phosphorous to predict Chl_a(ug/l)	5.1 ug/l

The actual trophic status of the lake is better than the model predicts.

WiLMS calculates the trophic status index (TSI) based on total phosphorous, chlorophyll a and secchi depth and compares it to the TSI in regional lakes. The following table lists the TSI for Wheeler and the regional lakes.

Table 10 - TSI Comparison

TSI Parameter	Wheeler TSI	Wheeler Classification	Range Regional Lakes	Regional Classification
Average TSI	37	Oligotrophic	42-50	Mesotrophic
Total Phosphorus TSI	37	Oligotrophic	37-52	Oligotrophic to Eutrophic
Chlorophyll a TSI	37	Oligotrophic	43-60	Mesotrophic to Eutrophic
Secchi TSI	34	Oligotrophic	38-50	Oligotrophic to Mesotrophic

The comparison indicates that the TSI values of total phosphorus, chlorophyll a and secchi are lower than regional lakes. This indicates that the lake is less productive and has better water quality than most lakes in the region.

5.3 Watershed

The watershed of a lake has a direct impact on the lake water quality and in turn vegetation, fish and wildlife in and around the lake. The watershed for Wheeler Lake is mostly forested with heavy development around the perimeter of the lake. In this lake the riparian area (shoreland) has the largest impact on the lake due to its close proximity, development and natural state of the remaining watershed. The following table lists the acres and percent of area of each land cover.

Table 11 – Land Cover in Watershed

Land Cover	Acres	Percent
Water	11.1	1.1
Low Density Residential	80.9	8.2
Grass	8	0.8
Forest	525.2	53.4
Wetland	77.8	7.9
Lake	293	28.6
Total	984.0	

The watershed area is 984 acres and the lake surface area is 293 acres. This is a relatively small watershed compared to the size of the lake which means there is a relatively small amount of water entering the lake from the watershed. This increases the residency time of the lake; the amount of time a drop of water entering the lake takes to leave the lake. In a seepage lake such as Wheeler, there is no inlet or outlet. Water enters the lake through overland flow from the watershed, direct precipitation on the lake surface and groundwater. Water leaves the lake through evaporation and groundwater infiltration. The residency time of the lake is estimated to be greater than 730 days based on phosphorous, drainage area, lake area, and depth. Lakes with long retention times tend to have better water quality. There tends to be a lower nutrient input from the watershed and the nutrients that are contributed are recycled in the lake during mixing in spring and fall.

The shoreland of Wheeler Lake is heavily developed; developed land inputs much more sediment, phosphorous and nitrogen than undeveloped land. Developed land can input 296 lbs/ac-yr while forest inputs 54 lbs/ac-yr. Reducing clearing of the lots and increasing buffers of natural vegetation along the shorelines can decrease the nutrient and sediment inputs. Most of the shoreland along the lake has good tree cover and a maintained (mowed) herbaceous layer; what appears to be lacking is the shrub layer. A strip of native grasses, shrubs and trees from the water's edge to 30 feet inland provides a buffer that filters overland flow from the developed land. This buffer also decreases erosion of the bank of the lake from wind and wave action. The use of sediment controls during construction is also important. A small are of bare ground during construction can contribute a large amount of sediment.

The direction of groundwater flow was investigated. A United States Geological Survey (USGS) topographic map was used to determine land elevation, slope, lake elevations and wetland elevations. USGS groundwater data was also searched. One well was found near the lake. Records from 1963 to 1970 indicate the groundwater was 3 to 1 foot below the land surface; this corresponds with the elevation of the lake surface. According to the maps the groundwater appears to flow toward the northeast to the North Branch Oconto River.

The watershed map is included in Appendix H.

5.4 Fishery

The fishery of Wheeler Lake is very important to the lake users. Historically the lake has produced a good population of bass, walleye and panfish that have attracted anglers. In recent years the walleye population has been steadily declining. According to a lake survey report completed in 2014 by WDNR the walleye population declined to a low of 187 and is likely due to walleye harvest and poor natural recruitment. To improve the walleye population, stocking began in 2014. Following is a summary of the fishery of Wheeler Lake.

Species Present and Populations

Based on the 2014 Report Wheeler Lake supports a fishery of walleye, largemouth bass, northern pike, smallmouth bass, bluegill, rock bass, yellow perch, black crappie and white suckers. A survey completed in 1950 listed most of the same species including: bluegill, largemouth bass, northern pike, perch, smallmouth bass and suckers. In the 1950 survey walleye were not present. Stocking of walleye first began in 1930 with very poor survival. From 1964-1970 a total of 97,000 walleye fingerlings were stocked. Stocking ended in 1970 and the lake supported a naturally reproducing walleye population for several decades; it is classified as a Priority Navigable Waterway due to this feature.

The walleye population on Wheeler Lake is a major concern for the lake users. The surveys conducted by WDNR has indicated a steady decline of the walleye population in the lake. The data indicates the following estimate walleye populations:

Table 12 - Walleye Data

Survey Year	Primary Recruitment	Population Estimate
1994	Natural	2983
2008	Remnant	811
2014	Remnant	187

The 2008 Fisheries Survey indicated walleye harvest and poor natural recruitment were the main causes for reduced population. The report recommended fall recruitment surveys in alternate years to determine if poor recruitment persists. Stocking of large fingerling walleye was recommended if fall surveys indicated poor recruitment and low natural reproduction.

In 2014 a series of fish surveys and a fish management report was completed on Wheeler Lake. The surveys indicated continued reduction of the walleye population. A number of recommendations were made to increase walleye numbers

- Change walleye fishing regulations that would increase minimum length limit (MLL) from 15 to 18 inches with daily bag limit of 3. This increases the adult density of walleye and delays harvest of fish until they have the opportunity to spawn multiple times.
- Manage largemouth bass by removing MLL and keep daily bag limit of 5.

- Stock large fingerling walleye at a rate of 5/ac in alternate years. Stocking larger fingerling produce more consistent year class strength and build up the walleye population.

The WDNR fishery biologist was contacted to discuss the walleye fishery and how it can be improved. The following information was provided by Chip Long, WDNR Fishery Biologist:

- Stocking has been done as follows:

Year	Species	Number Stocked	Average Length (in)	Source Type
2014	WALLEYE	9844	2.6	WDNR
2015	WALLEYE	1465	8.2	WDNR
2016	WALLEYE	1464	7.4	WDNR
2017	BLUEGILL	1700	6.0	LAKE ASSCN
2017	WALLEYE	1407	3.2	WDNR
2017	WALLEYE	1464	7.9	WDNR
2018	YELLOW PERCH	1500	5.5	LAKE ASSCN
2019	WALLEYE	1407	7.0	WDNR

- Fall surveys were conducted in 2013, 2014, 2015, 2016 and 2020 to assess fall recruitment. The only year natural reproduction identified was in 2020. Information collected during 2014 surveys support stocking larger fingerling. These surveys target age 1 and age 2 fish and are used to document natural reproduction; no population estimates are made from these surveys.
- A full survey of the lake is scheduled for 2022 to assess fish populations. It is anticipated that an improvement in walleye abundance will be seen since the stocking of large fingerling walleye began in 2015 and natural reproduction was confirmed in 2020.
- Stocking is occurring on an alternate year basis with large fingerling.

The following information on fish population was taken from the 2014 survey.

- Overall, 1,438 fish representing 10 species were collected during the 2014 sampling season (Table 4). The five most abundant species collected by number were rock bass (32%), largemouth bass (19%), white sucker (11%), yellow perch (9%) and bluegill (8%).
- All panfish species (yellow perch, bluegill, black crappie) showed an improvement in both size structure and abundance between 2008 and 2014. In order to maintain this component of the fishery and stabilize the forage base, WDNR recommends reducing the bag limit of panfish from 25/angler/day to 10/angler/day.

<u>Walleye</u>

A total of 105 walleye were captured ranging from 12.6 to 22.6 inches in length, average 18 inches. Growth is average for fish below 8 years and below average for fish 9+ years. There was a significant reduction in the number of walleye from 2008 to 2014.

Figure 14 – Length Frequency of Walleye

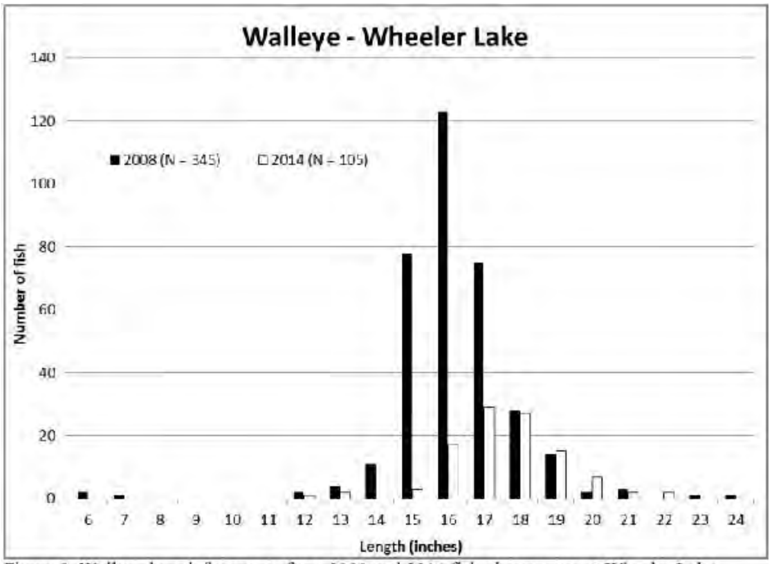


Figure 8. Walleye length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

<u>Largemouth Bass</u>

Largemouth bass size class structure had declined from 2001 to 2008 and again in 2014. The abundance is stable but the size class has diminished. A total of 269 LMB were captured ranging from 4.8 to 20.2 inches, average 12.1 inches. Growth is below average and there are fewer larger fish. Natural reproduction and recruitment is occurring.

Figure 15 - Largemouth Bass Length Frequency

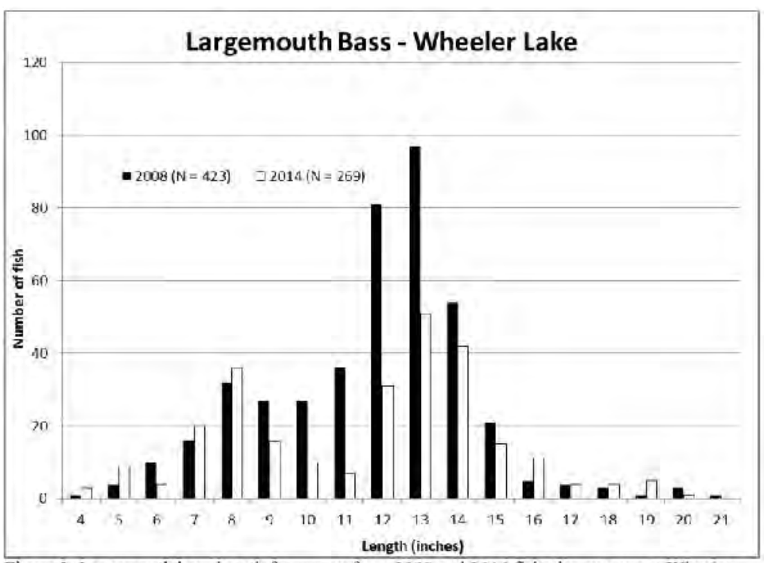


Figure 2. Largemouth bass length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

Northern Pike

A total of 78 NP were captured ranging from 10.3 to 39.3 inches, average 19.4 inches.

Figure 16 – Length Frequency of Northern Pike

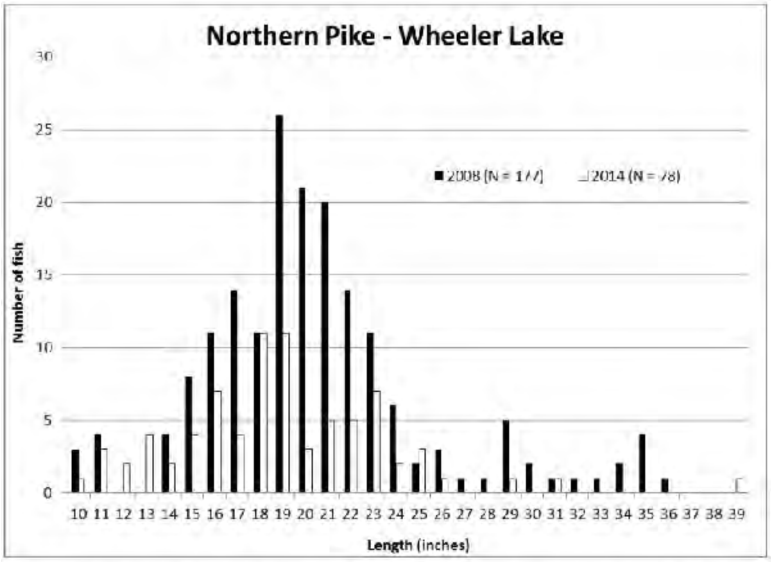


Figure 10. Northern pike length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

Smallmouth Bass

A total of 40 SMB were captured ranging from 4.3 to 17.1 inches, average 9.4 inches. Growth is slightly below average. The population has declined and it is not clear why; natural reproduction and recruitment is occurring at a rate to maintain the population.

Figure 17 – Length Frequency of Smallmouth Bass

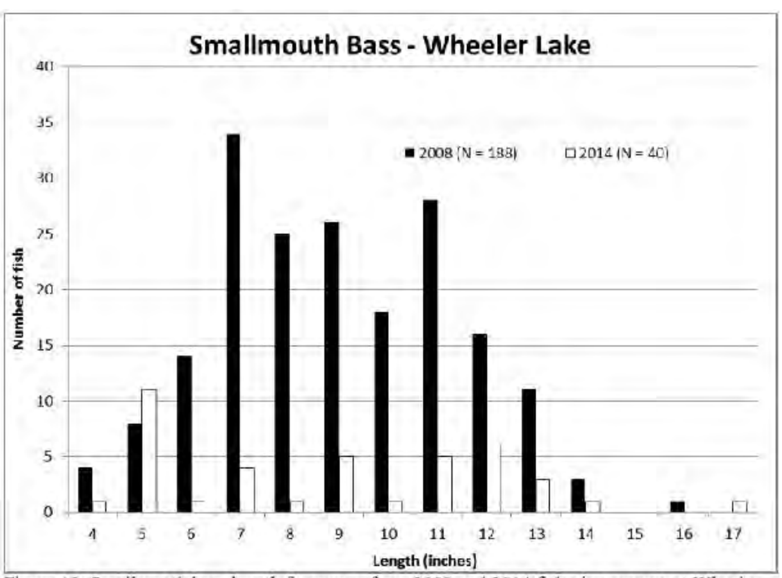


Figure 13. Smallmouth bass length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

Bluegill

Nearly twice as many bluegill were collected in 2014 as in 2008. A total of 118 bluegill were capture ranging from 2 to 10.2 inches, average 6.5 inches. Growth is average. Natural reproduction and recruitment is occurring.

Figure 18 – Length Frequency of Bluegill

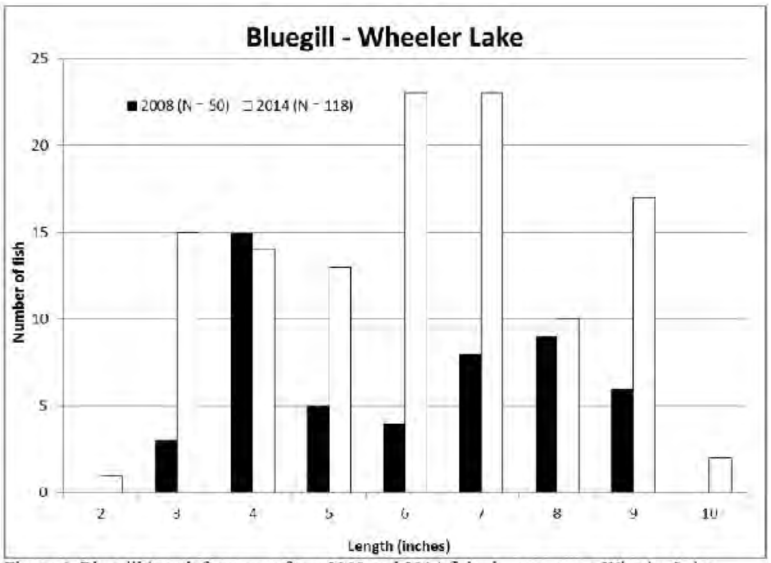


Figure 6. Bluegill length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

The following table is a summary of the number of fish caught during the 2014 survey with a comparison to 2008 survey. Based on percentage of population, yellow perch, bluegill, and black crappie increased; white sucker, walleye and smallmouth bass decreased; largemouth bass was stable.

Table 10 – Comparison of relative abundance 2008 to 2014

Table 7. Comparison of species relative abundance between 2008 and 2014 surveys on Wheeler Lake; Oconto County, WI.

2014			2008		
Species	No.	%	Species	No.	%
Rock bass	463	32.2%	White sucker	879	35.5%
Largemouth bass	269	18.7%	Largemouth bass*	423	17.1%
White sucker	158	11.0%	Walleye	345	13.9%
Yellow perch	134	9.3%	Rock bass	307	12.4%
Bluegill	118	8.2%	Smallmouth bass*	188	7.6%
Walleye	105	7.3%	Northern pike*	177	7.1%
Northern pike	78	5.4%	Yellow perch	76	3.1%
Black crappie	67	4.7%	Bluegill	69	2.8%
Smallmouth bass	40	2.8%	Black crappie	9	0.4%
Yellow bullhead	6	0.4%	Yellow bullhead	3	0.1%
Total	1,438		Total	2,476	
			*** Includes recaptured fish.**		

Fishing Pressure

A creel survey was completed by WDNR in 2008-2009 on Wheeler Lake . According to this survey anglers spent 12,614 hours or 43.0 hours per acre fishing on the lake during the 2008 season. The state average was 33.6 hours per acre. February was the most heavily fished month and the least was October. The most sought after fish was walleye followed by bluegill, northern pike, largemouth bass, yellow perch, black crappie, smallmouth bass and rock bass. The following table lists the species, the hours of effort and catch rates.

Table 11 – Comparison of Creel Survey 2008-2009

Table 2. Comparison of creel survey synopses, Wheeler Lake, 2008-09 fishing seasons.

CREEL YEAR: 2008-09

SPECIES	DIRECTED EFFORT (Hours)	PERCENT OF TOTAL	TOTAL CATCH	SPECIFIC CATCH RATE (Hrs/Fish) *	TOTAL HARVEST	SPECIFIC HARVEST RATE (Hrs/Fish) **	MEAN LENGTH OF HARVESTED FISH
Walleye	5497	20.65%	193	28.6	154	36.0	17.1
Northern Pike	5077	19.07%	899	6.4	403	13.0	20.8
Smallmouth Bass	1283	4.82%	818	1.9	11	188.7	15.8
Largemouth Bass	4810	18.07%	3391	1.7	133	36.0	15.6
Yellow Perch	3047	11.45%	983	3.3	507	6.2	9.8
Bluegill	5358	20.13%	2046	2.6	893	6.1	8.6
Rock Bass	106	0.40%	851	0.6	51	2.2	9.1
Black Crappie	1442	5.42%	322	4.5	216	6.8	10.2

* A blank cell in this column indicates that no fish of a given species were caught by anglers who specifically targeted that species.

** A blank cell in this column indicates that no fish of a given species were harvested by anglers who specifically targeted that species.

From the data in the table we can see that 28.6 hours was spent to catch one walleye. The walleye was the most sought after game fish but the least caught fish. It also has the highest harvest rate at 80%; of 194 walleye caught 154 were harvested. This table also shows that bass are caught in high numbers but very few are harvested. Only 1% of smallmouth and 4% of largemouth are harvested. A high percentage of crappie are harvested also; 67% of crappie caught are harvested.

Fish Habitat

Wheeler Lake has a healthy fish population but the prized walleye has been declining in numbers over the years. This is likely due to increased fishing pressure and poor natural recruitment. The poor recruitment may be related to the decrease in suitable habitat for the young fish. Wheeler Lake is oligotrophic and as a result has low aquatic plant growth and will not support a high density of fish. According to the 1950 fishery survey there was a high amount of woody habitat in the lake. This was due to the wooded shoreline contributing fallen trees to the lake which creates great habitat for all fish species. As time passes the trees decay and loose the branches that create valuable habitat. This can be seen as you boat around the lake; there are plenty of trees in the lake but they are old and only the boles of the trees remain. There may be inadequate spawning habitat for walleyes also. Walleyes prefer rocky, windswept shorelines to spawn. Increasing the habitat and structure and improving spawning areas on the lake may help increase the fish populations.

Habitat improvements were discussed with Chip Long. WDNR partnered with the Wheeler Lake Association to build fish cribs over the last 6 or 7 years that were placed throughout the lake at strategic locations.

The US Forest Service completed a fish sticks project around both islands in the lake in 2020. A total of 45 trees were placed around the east island and 15 trees were placed around the west island.

According to Mr. Long, enhancing walleye spawning habitat in a cooperative effort between WDNR and the lake association should be a priority. Spawning reefs are typically located along the southeast shorelines since prevailing winds are from the north/northeast. The wave action keeps eggs aerated and free of silt so they can hatch. The projects could be completed without cost to the land owners but permission and coordination with the land owner would be required. Grants from WDNR and Oconto County are available to complete this work. Specific locations could be pinpointed during the spring fyke netting surveys. Contact Chip Long, WDNR Fishery Biologist at 715-582-5017 or Christopher.Long@Wisconsin.gov.

5.5 Lake User Survey

Wheeler Lake Association conducted a survey of lake users to determine recreational activities on the lake and concerns the users have regarding the lake. Following are results of the survey.

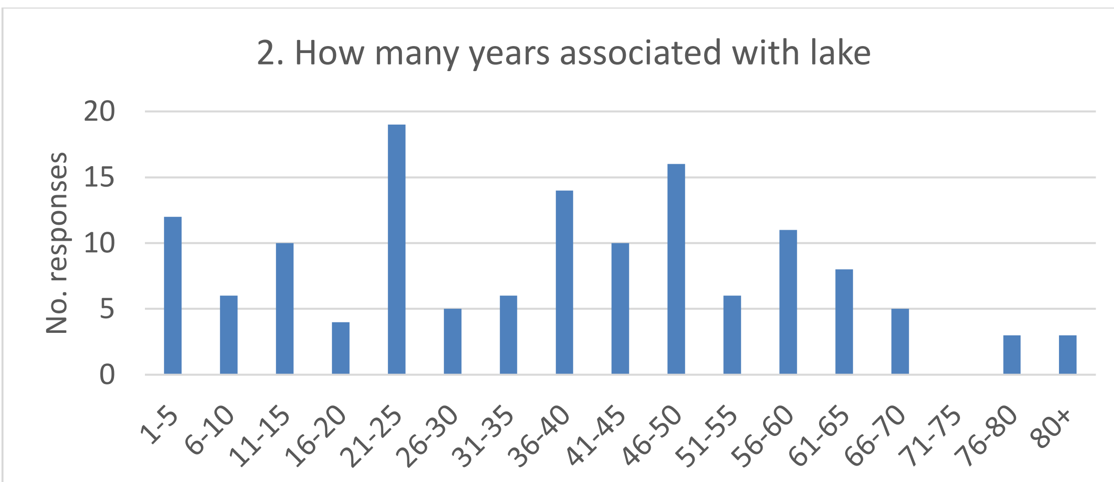
Question 1 – What is your affiliation with Wheeler Lake?

The vast majority are seasonal waterfront landowners.

No. Responses	Affiliation
101	Waterfront landowner – seasonal
28	Waterfront landowner – year-round
9	Nearby resident – seasonal
2	Nearby resident – year-round

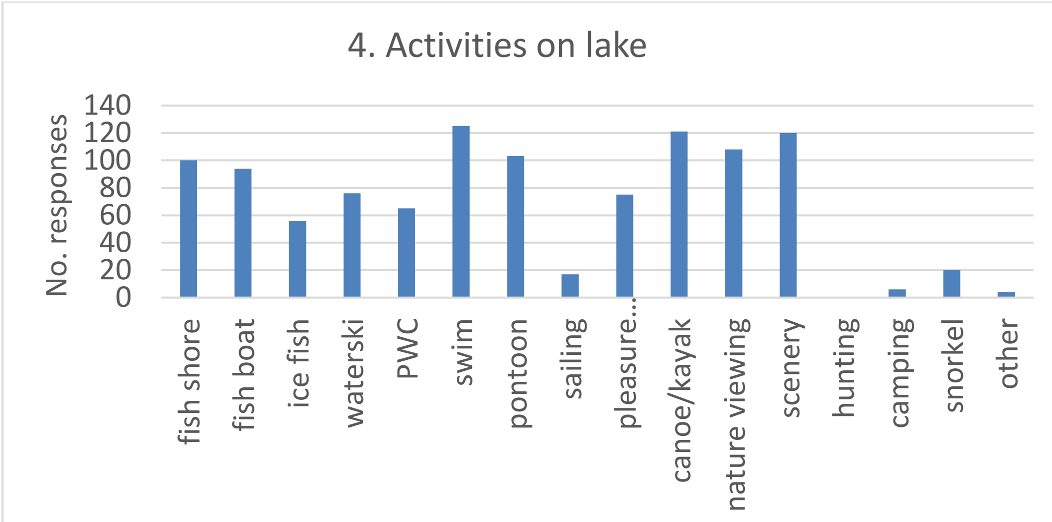
Question 2 – How many years have you been associated with Wheeler Lake?

Most of the respondents have associated with the lake for 21-25 years, followed by 46-50 years, 36-40 years and new residents at 1-5 years.



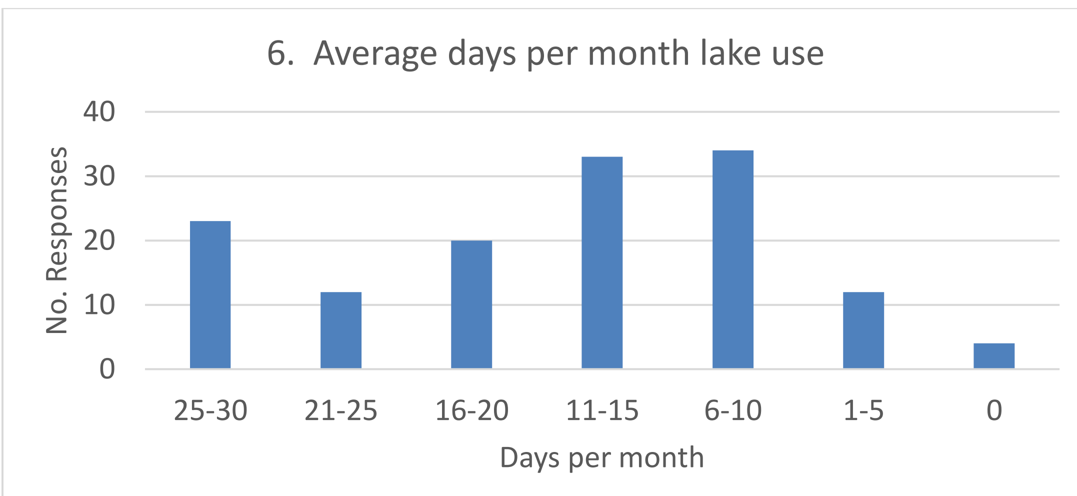
Question 4 – What activities do you participate in?

The top 3 activities area swimming, canoe/kayaking and enjoying the scenery.



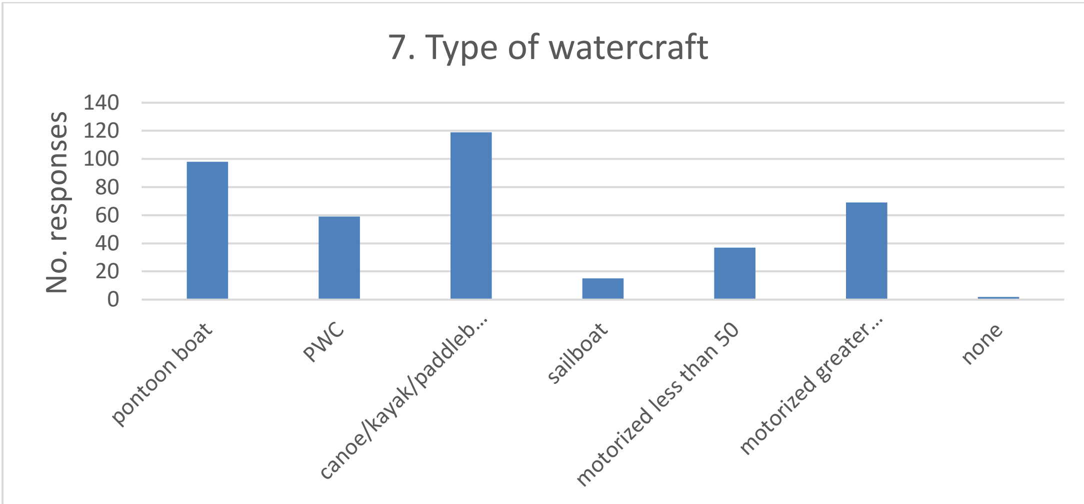
Question 6 – What is the average number of days per month that you use the lake during summer months?

The majority of users are on the lake 6-15 days per month.

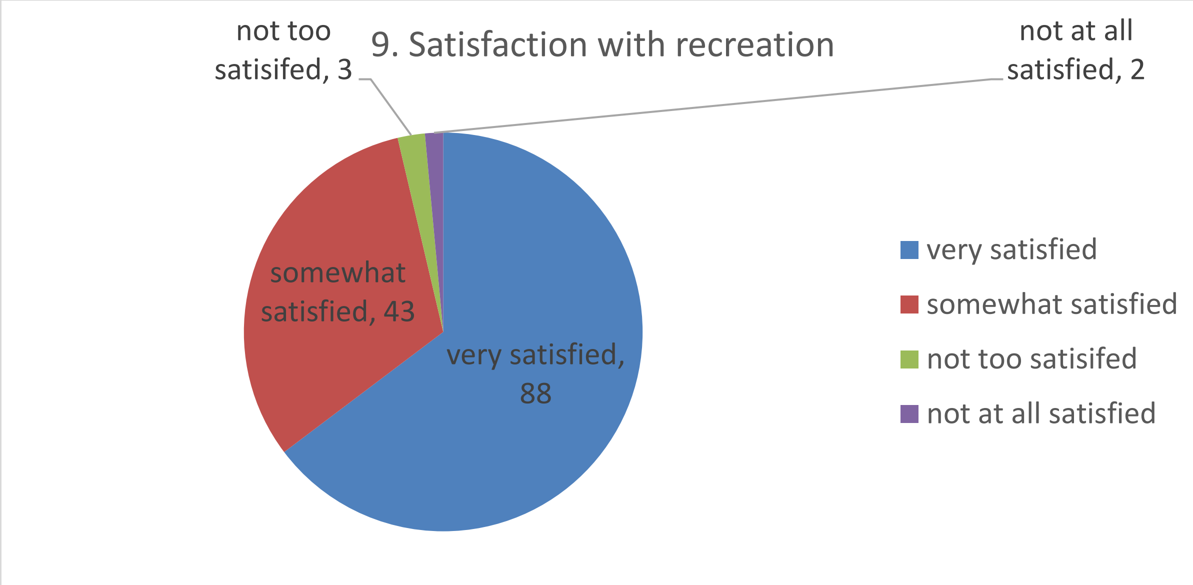


Question 7 – What type of watercraft do you use?

The majority use non-motorized canoes, kayaks, paddleboards or pontoon boats. During summer months 77% keep their boats in the water and 22% use the public launch.



Question 9 – How satisfied have you been with your recreational experience on the lake?
The vast majority are very satisfied with recreation on the lake.



Question 10 – Rank the top 3 concerns on the lake

1 – Aquatic invasive species (AIS) (32)

2 – Aquatic invasive species (AIS (32)

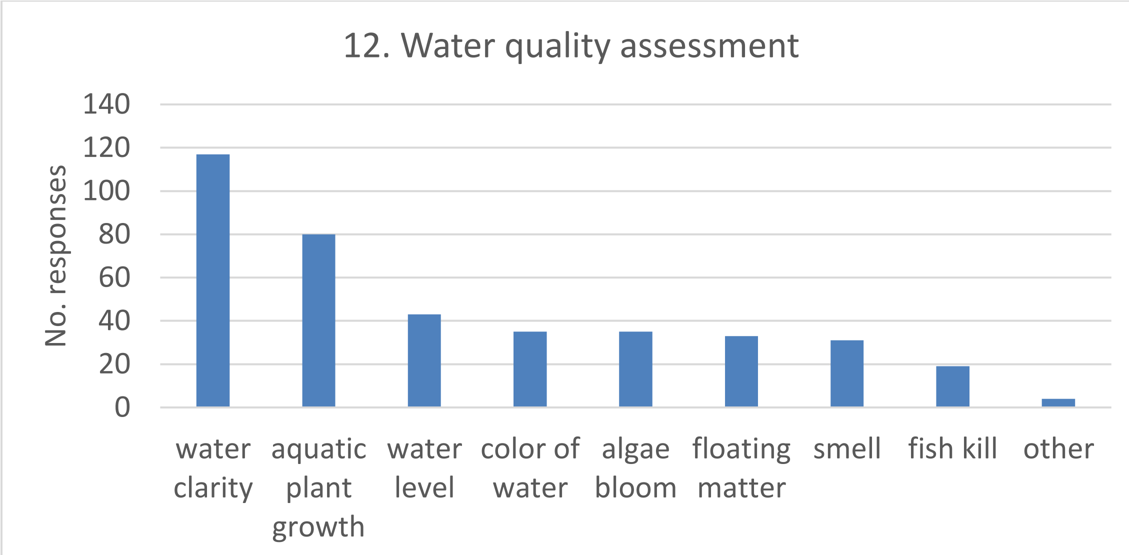
Excessive plant growth (22)

3 – Excessive boat traffic (21)

Question 11 – Personal opinion on overall quality of the lake
The vast majority feel the quality is good to excellent.

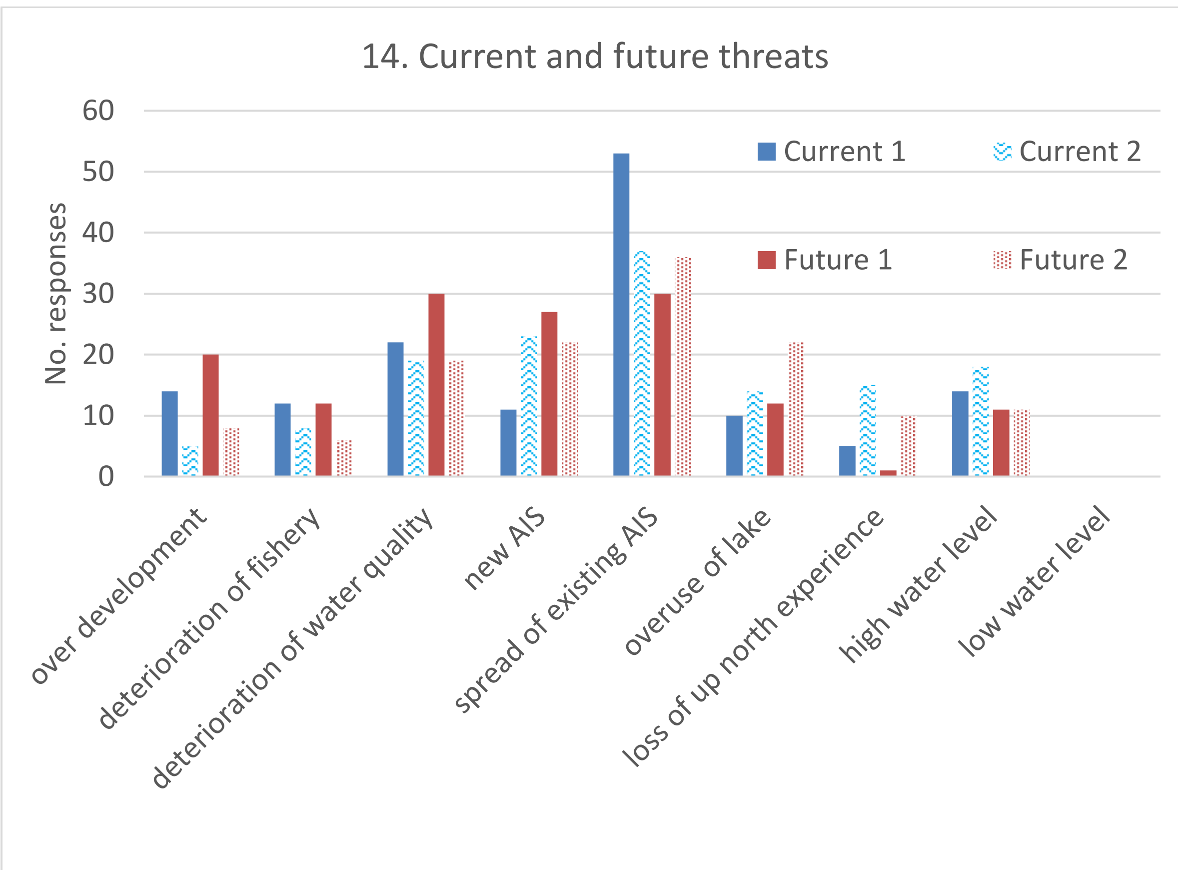
Question 12 – What do you think of when assessing water quality?

The two most important aspects are water clarity and aquatic plant growth.



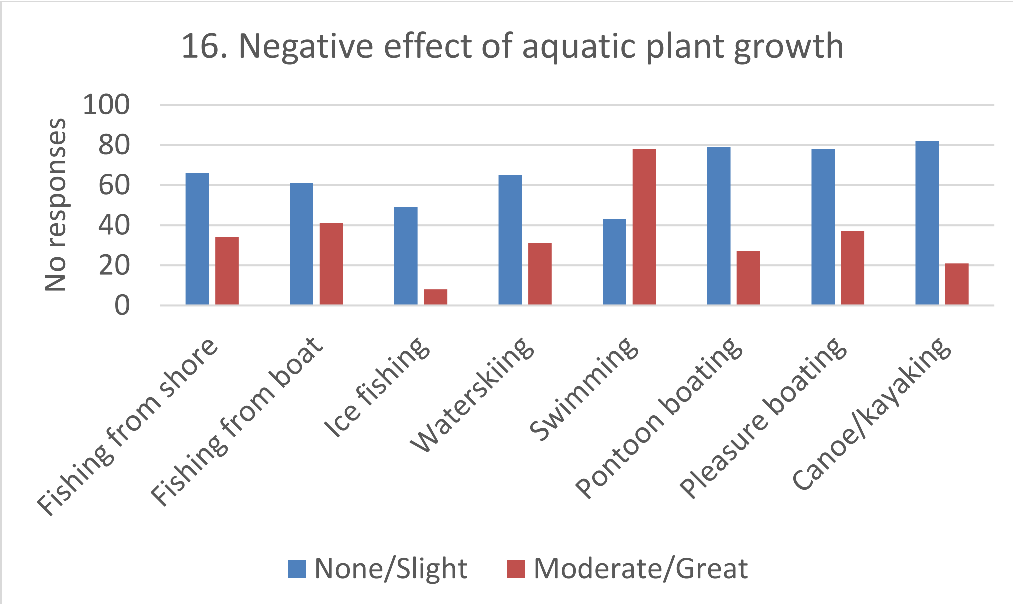
Question 14 – What are the greatest current and future threats to the lake?

Spread of existing aquatic invasive species is the No. 1 current and future threat.



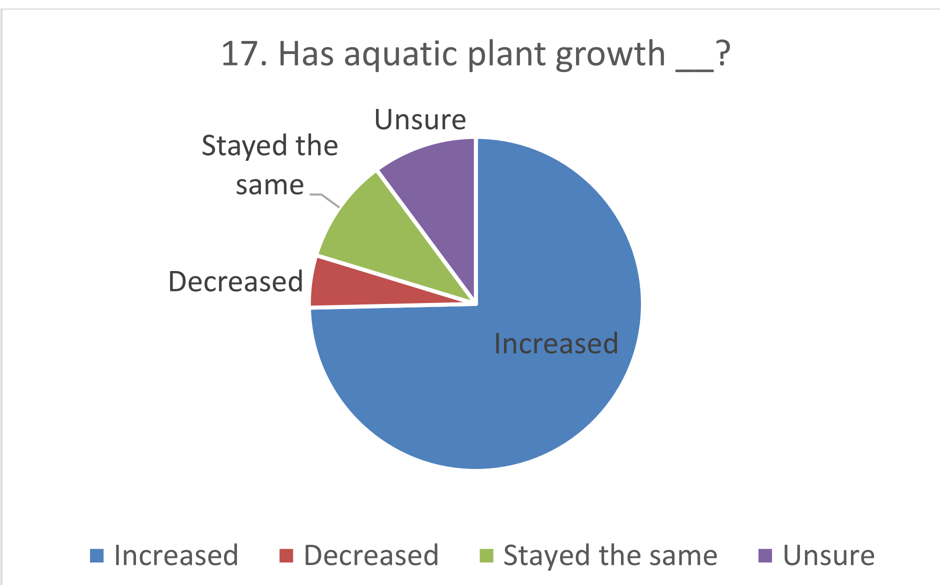
Question 16 – Indicate the extent of negative effects of aquatic plant growth on the following:

Aquatic plant growth has the highest negative effect on swimming; little effect on boating and mixed effect on fishing.



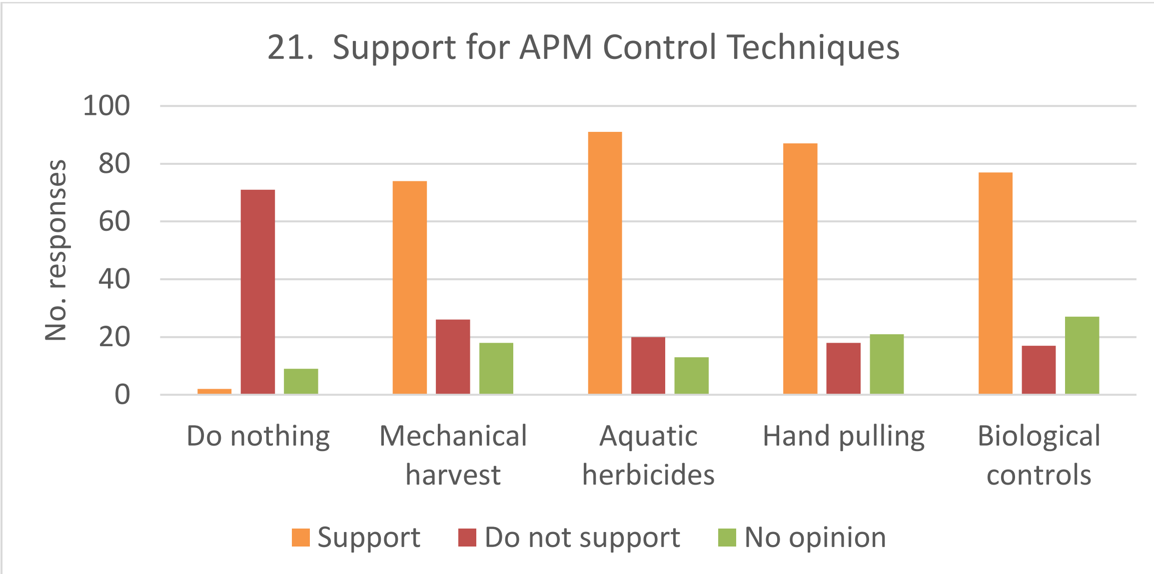
Question 17 – Has aquatic plant growth ____?

Users feel aquatic plant growth has increased over the years.



In a series of questions regarding invasive aquatic plant management the vast majority (86%) feel Wheeler Lake Association has adequately addressed this issue. 72% feel a comprehensive lake management plan should used to guide AIS management while 28% feel it is best to manage problem areas only; none of the respondents thought Do Nothing was appropriate.

The following control techniques were ranked:

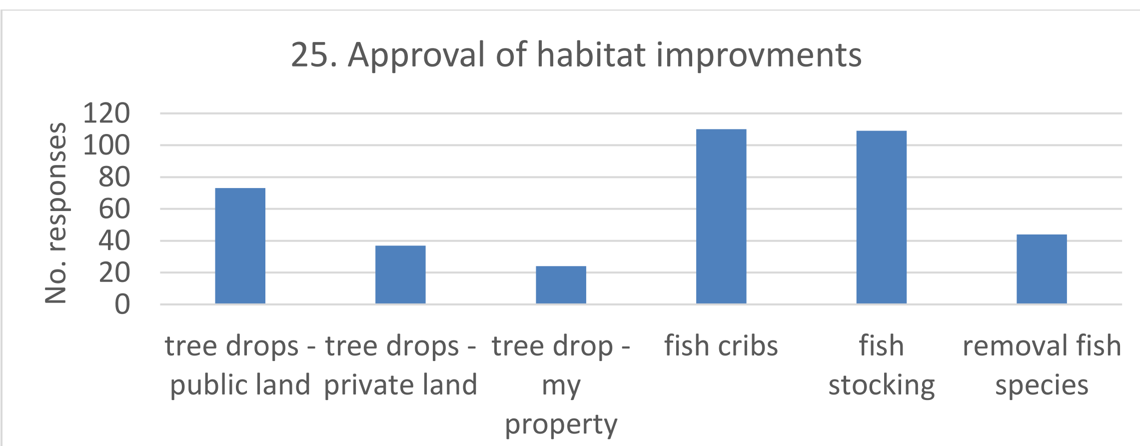


Some form of management is supported; herbicide use is highly supported followed by hand pulling.

The final question concerns fish habitat in the lake.

Question 25 – Would you approve of the following habitat improvements?

A majority of respondents support habitat improvements; mainly fish cribs, stocking and tree drops on public land.



5.6 Shoreland Assessment

WDNR suggests an assessment of the fish and wildlife habitat including a characterization of shoreline habitat as part of the lake management plan if lake management recommendations are to be funded by a WDNR Surface Water Grant. This assessment documents the current condition and level of development on each property on the lakeshore (from shoreline to 35ft landward). It also collects data on the near shore area in the lake such as aquatic plant growth and location of all coarse woody habitat. WDNR has prepared a draft "Lake Shoreland and Shallow Habitat Monitoring Field Protocol, May 27, 2016". This document outlines the procedure for surveying, assessing and mapping the habitat in the lakeshore area including the riparian buffer, bank and littoral zones. It was used to complete the assessment on the lake.

The Coarse Woody Habitat Survey was completed on May 21, 2020 when visibility on the lake was the best. All pieces of wood greater than 4 inches in diameter and 5 feet long located in 2 feet of water or shallower were documented using GPS and the WDNR forms. The shoreland assessment took place in July 13, 2020 when the shoreland vegetation was growing and use of the lakeshore is the highest. To gather available data on the shoreland lots, maps were prepared using the County GIS website showing each, individual parcel along with its boundaries. Navigation to each individual parcel was aided using an app on a GPS enabled iPad; this was used to take georeferenced photos and record data to a spreadsheet.

A total of 343 pieces of wood were mapped and rated along the entire shoreline (3.95 miles). The figure below indicates the location of the wood documented. Although the lake looks like it has a lot of woody habitat, the figure is misleading. Only 54 (16%) of the pieces of wood had a few branches, and only 8% (29) had a full crown. The vast majority has deteriorated to the point that only the bole of the tree is left. Although this deteriorated wood still provides habitat, trees with branches provide more diverse habitat. Wood was found at the following locations on the lakes.

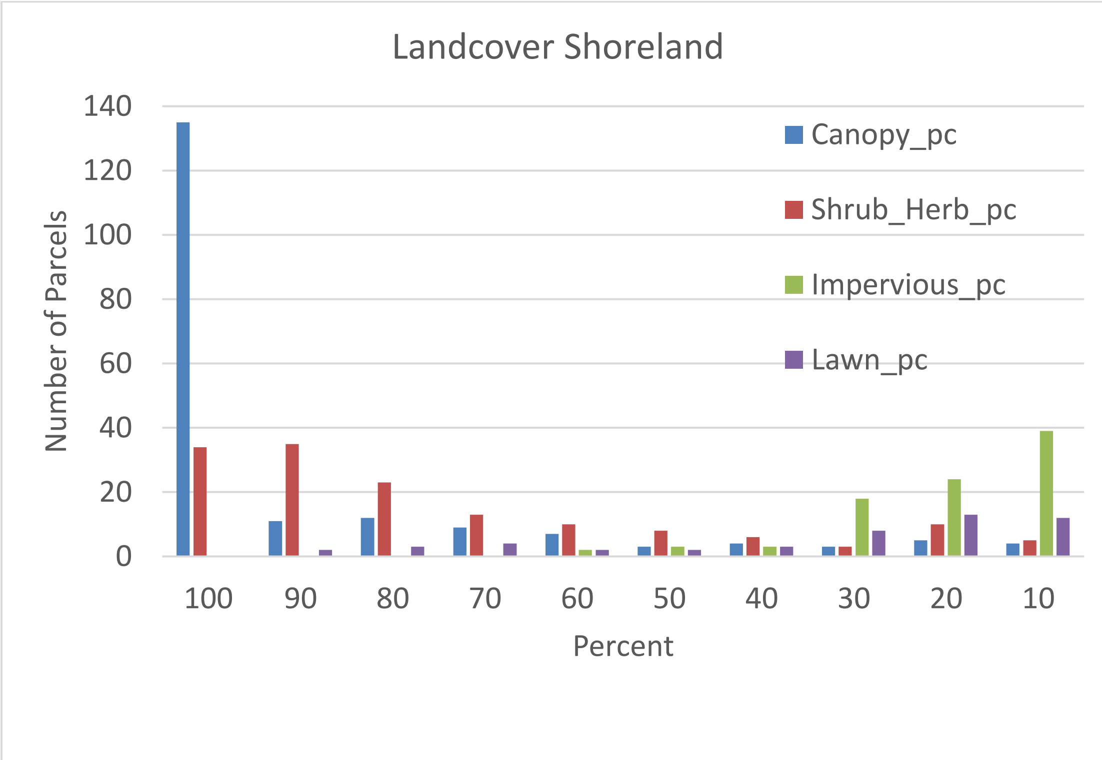
Figure 20 - Coarse Woody Habitat May 2020

In 2020, the US Forest Service completed a fish sticks projects around both of the islands in Wheeler Lake. A total of 45 trees were placed around east island and 15 trees were placed around the west island. All trees were secured with anchors to prevent them from moving and causing a navigation hazard.

The Shoreland Assessment was completed July 13, 2020 when the shoreland vegetation was at its peak and recreation on the lake is highest. There was a total of 210 parcels evaluated along the shoreline. The development on the lake is very high with nearly all of the privately-owned parcels containing a home or cabin. Although the lake is highly developed, the shoreland area has a good amount of natural vegetation. The following data was collected:

The following figure shows the landcover in the shoreland area.

Figure 21 - Landcover in the Shoreland



- The parcels generally have good canopy cover; the majority of lots had 100% tree cover.
- The majority of the parcels have 50% or greater shrub and/or herbaceous plants present.
- There is a good number of lots with impervious areas, typically consisting of steps, decks/patios and boathouses. The vast majority of these lots have 30% or less impervious area.
- There is very little maintained lawn in the shoreland; if lawn is present, it typically covers less than 30% of the parcel

The following table indicates the number of shoreland features on the parcels. The first column lists the number of parcels that contain the feature; the second column lists the total number of features (some parcels contained more than one).

Table 12 - Shoreland Features

Shoreland Feature	No. Parcels	Total Count
Buildings	47	49
Boats	149	365
Piers	156	269
Boat lift	89	118
Raft	46	46
Boathouse	39	48
Trail	37	37
Sea Wall	17	810
Riprap	45	2755
Emergents	13	13
Floating leaf	12	12
Firepits	8	8
Structures	101	101

- The majority (41%) of the parcels have a building in the shoreland. Most have a boat house but some have sheds or a portion of the house/cabin in the shoreland area.
- There are many watercraft on the shoreline; 71% of the parcels had watercraft present during the survey for a total of 365 present.
- Piers were on 75% of the parcels with many having multiple piers.
- Boatlifts were common with 42% of the parcels containing at least one; several lots had multiple lifts.
- Many of the parcels had either a trail (18%) or steps (37%) for access to the lake.
- Seawalls and riprap are used in isolated areas for erosion control.
- There were few parcels with emergent and/or floating leaf vegetation present.
- Structures on the lake typically consisted of steps, decks or patios in the shoreland.

The figure below shows the locations that are highly developed and could benefit from shoreland improvements. The following parcels had one or more of the following: low canopy and shrub/herbaceous cover, high impervious and lawn area, numerous piers and lifts or buildings in the shoreland area.

Figure 21 - Highly Developed Parcels

Section 6.3 includes information on shoreland improvement and resources for planning and implementation.

6.0 Management Alternatives and Recommendations

Based on the goals of the stakeholders as mentioned in section 3.5, several management alternatives are available for this plan. Some general alternatives are discussed below.

6.1 Aquatic Plant Management Recommendations

More information on management alternatives is included in Appendix E. Currently, the Northern Region of the WDNR is working under an aquatic plant management strategy that is officially titled Aquatic Plant Management Strategy, Northern Region WDNR, Summer, 2007 (working draft), or commonly referred to the NOR Region APM Strategy (Appendix D). This strategy lays out an approach for acceptable aquatic plant management in Northern Region lakes. The strategy protects native aquatic plant communities in northern Wisconsin and does not allow permits to control native plants unless documented circumstances of nuisance levels exist.

6.1.1 Manage EWM

Wheeler Lake has an established population of EWM that has been managed for 15 years (since 2006). The method, up until 2019, had been spring surveys to document location of EWM beds and treatment with granular 2,4-D at 150 lbs/ac. This was a somewhat effective treatment that reduced or eliminated the beds for a period of time. However, the EWM continued to rebound and spread following treatments. The beds of EWM in Wheeler Lake tend to be smaller and vary from dense to scattered plants; some are located in bays and others are in more open areas. 2,4-D is most effective when used in isolated areas where the concentration and contact time is suffcient to kill the plant. This made this method ineffective on Wheeler Lake for many areas due to reduced concentration and contact time in the more open bed locations. If 2,4-D is to used in the future it is recommended that limno curtains be used to contain the herbicide to increase concentration and contact time.

In 2019, when EWM was at maximum coverage (22.1 acres), new herbicides were used; Procellacor and Aqua Strike. These are herbicides that require less contact time to be effective. They need to be applied to growing plants early in the season when water temperatures are cooler. These appeared to be effective in the areas they were used and are recommended for future use.

Hand harvesting and DASH are alternatives that are recommended in conjunction with herbicide treatments. Hand harvesting is recommeneded for shallow areas with scattered plants. DASH is recommeneded for small (<1/3 ac), dense, deep stands. These methods can be used alone or following herbicide treatments.

The following recommendations are made for the management of EWM.

AQUATIC INVASIVE SPECIES MONITORING

Volunteer/Association Monitoring

A citizen lake monitoring program for EWM is critical to document beds for professional mapping and treatment. A tour of the lake should be conducted in summer to document all beds of EWM when it is at peak growth. A GPS unit should be used to mark the locations of clumps and beds; this information can be provided to the consultant that is mapping the EWM for treatment. This will allow the consultant to target the areas with known beds and reduce time on the water searching for newly formed beds. All of the data collected should be provided to the consultant as GPS coordinates or a simple map showing the approximate location of the EWM that was observed.

One approach to invasive species monitoring involves all of the lake residents. Some lakes have encouraged each resident to monitor the lake along their property for AIS, in particular EWM. During the annual meeting or through a newsletter a specific time period could be set aside for each resident to look at the lake along their shoreline and report any AIS that they find. A training session during the annual meeting could be held to introduce AIS and increase awareness.

The University of Wisconsin-Extension Lake's Program provides training for all AIS monitoring and coordinates the Citizen Lake Monitoring Program. More information about the program is available by contacting Citizen Lake Monitoring Network Education Specialist, (715) 346-3989, website: http://www.uwsp.edu/cnr/uwexlakes/clmn/.

Professional Monitoring

For areas that have been treated, detailed monitoring of the treatment areas by a consultant is recommended. WDNR has protocol that must be followed if treatments are funded through a grant. This monitoring before and after treatment documents the location and density of the beds and allows for tracking of treatment effectiveness. The protocol can be found at http://WDNR.wi.gov/org/water/fhp/lakes/PrePostEvaluation.pdf. In some areas of the state WDNR requires a consultant other than the one apply the treatments to complete the pre and post surveys. Surveys should be conducted at various times to be sure all EWM is found. Peak growth occurs during summer months and this is the best time to map all active beds. A fall survey may be best for beds that were treated earlier in the season to check for regrowth. An early spring survey may be used to accurately map the beds that need treatment that year.

Completing lake-wide aquatic plant point intercept surveys every 5 years to monitor changes in the overall aquatic plant community and the effects of the APM activities is also recommended. Aquatic plant communities may change with varying water levels, water clarity, nutrient levels, and aquatic plant management actions. Completing a point intercept survey using the same points as in the 2007/2019 survey will allow changes in the plant community to be tracked. This is important considering the effects the EWM herbicide treatments may have on the lake and the impact of the rusty crayfish populations.

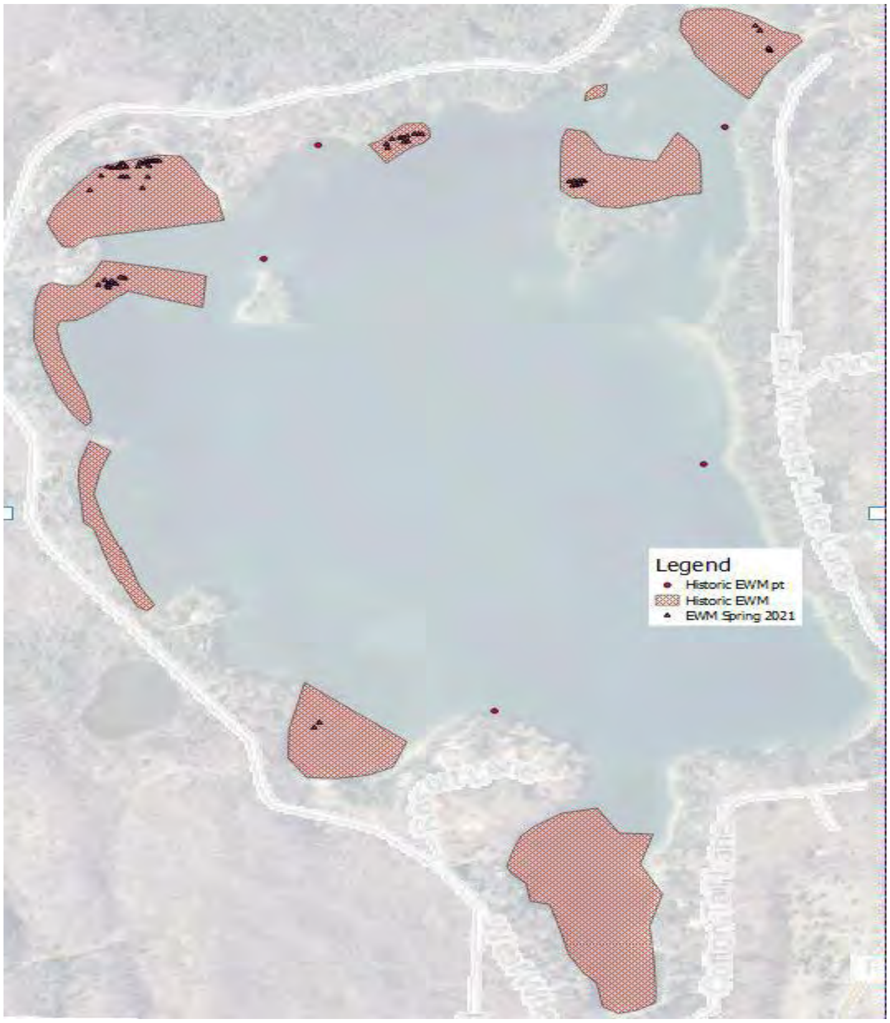
EWM has been effectively managed on Wheeler Lake over the last 5 years by applying herbicide to the mapped beds in the early spring/summer. This has kept the spread and density of the plant in check but has not eliminated it. In most cases EWM will not be eliminated from a lake after introduction but a more aggressive approach to management may help to reduce the amount of EWM. Closely monitoring the existing beds and keeping a vigilant eye on the lake for new beds will help in the process. The sooner action can be taken on a new or expanding stand the better the chances are for control. A more aggressive treatment option may be pursued by using a combination of herbicide treatment with hand pulling. After treatment with herbicide the beds should be monitored throughout the growing season and if new plants emerge they should be pulled immediately. Incorporating this practice with the current control method and monitoring programs may result in an overall reduction of bed density and spread.

The following options are recommended:

- Use DASH or hand harvesting when effective.
    - DASH for dense beds (rake density >1) smaller than 1/3 acre.
    - Hand harvesting for shallow, scattered plants. Shallow bays with good visibility less than 5 feet deep with scattered plants to clumps of plants. Coverage of EWM < 10% in bay or bed.
- Continued use of ProcellaCOR or Aqua Strike as needed.
    - Isolated beds with a density of >1 and greater than 1/3 acre
    - Bays with scattered/clumps of EWM with coverage >10%
    - Treat early in spring after plants are actively growing
- 2,4-D with Limno Curtains.
    - Can be used in place of ProcellaCOR or Aqua Strike.
    - Enclose treatment area with limno curtains prior to application and leave in place for two days.
- Monitor EWM
    - Conduct visual survey of entire lake perimeter in water 15 feet or shallower during late summer/early fall months
    - Mark locations of EWM using GPS. Map permitter of beds and locations of scattered plants/clumps
    - Determine which areas are appropriate for herbicide treatment or DASH/hand harvesting
    - Complete detailed assessment of beds for herbicide treatment including average depth, density of plants, mark accurate permitter of bed for herbicide application.

The following figure shows the areas of historic EWM stands and mapped EWM in 2021. These locations need to be monitored annually for EWM.

Figure 22 – Historic EWM Locations for Monitoring



Clean Boats/Clean Waters Campaign

Measures for the prevention of the introduction of AIS to the lake and spread of EWM and rusty crayfish to other waters should be a priority. To prevent the spread of AIS into and out of Wheeler Lake, a monitoring program such as Clean Boats/Clean Waters is an excellent choice. WLA already has an active CBCW program and this should be continued and expanded if possible. There is one public landing on Wheeler Lake and it is being monitored. This program is carried out by trained volunteers who inspect the incoming boats at public launches. Signage also accompanies the use of CBCW to inform lake users of proper identification of AIS and boat inspection procedures. Education of the public, along with private property and resort owners, about inspecting watercraft for AIS before launching a boat or leaving access sites on other lakes could help prevent new AIS infestations. Contact with lake users at this time is a great way to distribute other educational materials. Continuation of this program is recommended and should be promoted by the current CBCW coordinator on the lake.

6.2 Water Quality Recommendations

The water quality on Wheeler Lake is very good and has remained relatively stable based on the snapshot of samples taken in 1976 and 2006-2020. The clarity is excellent which allows aquatic plants to grow at greater depths in this lake. Protection of the water quality is important to maintain this state of the water. The following recommendations are made to protect the water quality.

CITIZEN LAKE MONITORING

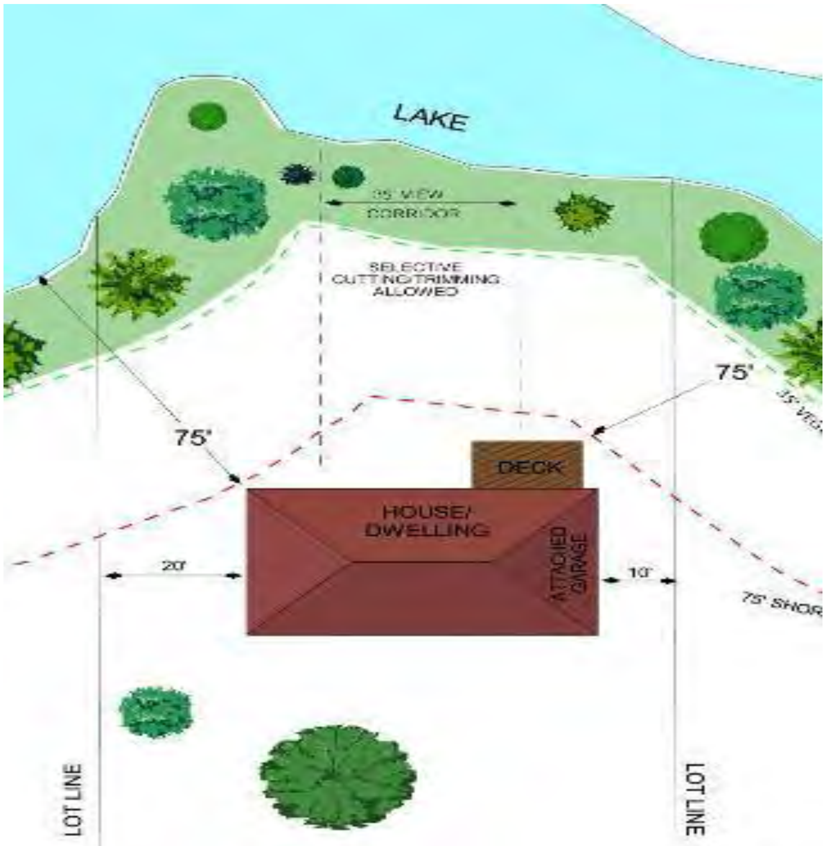
This WDNR/UW-Extension program trains volunteers to collect water samples for analysis at the state lab. The samples are collected throughout the summer months and analyzed for total phosphorous, chlorophyll a and secchi readings are collected. The data allows calculation of trophic status and changes in water quality can be tracked over the years. The annual averages of secchi depth, total phosphorous and chlorophyll a should be calculated and added to the graphs in section 5.2.3 to track trends. If the annual averages show a trend towards mesotrophic conditions action should be taken to further reduce phosphorous input. Actions that should be considered now and in the future to reduce phosphorous input are discussed in the following sections. Additional water quality parameters were tested for in 2009-2011 and 2019. These should be repeated every 10 years to track the numbers to see if there are any changes that may indicated a deterioration of water quality.

6.3 Aquatic Plant Protection and Shoreline Management

Protection of the native aquatic plant community is needed to slow the spread of Eurasian watermilfoil, curly-leaf pondweed and other AIS from lake to lake and within a lake once established. Therefore, riparian landowners should refrain from removing native vegetation. Additionally, Eurasian watermilfoil and curly-leaf pondweed can thrive in nutrient (phosphorus and nitrogen) enriched waters or where nutrient rich sediments occur. Two simple actions can prevent excessive nutrients and sediments from reaching the lake.

The first activity is the restoration of natural shorelines, which act as a buffer for runoff containing nutrients and sediments. Properties with seawalls, manicured lawn to water's edge and active erosion would be good candidates for shoreland restorations. Establishing natural shoreline vegetation can sometimes be as easy as not mowing to the water's edge. Native plants can also be purchased from nurseries for restoration efforts. Shoreline restoration has the added benefits of providing wildlife habitat, erosion prevention and it may deter geese from entering. A vegetated buffer area can also prevent surface water runoff from roads, parking areas and lawns from carrying nutrients to the lake. The following figure is a county publication and shows the elements of the shoreland.

Figure 23 - Elements of the Shoreland



Oconto County has further information on shoreland zoning at the following site:
https://www.co.oconto.wi.us/departments/forms_and_documents/?department=a67c24bc2735&subdepartment=c041c5a0384b

Oconto County has a very informative section on their website addressing shoreland restoration.
Contact
Patrick Virtues - Department Head
Phone: 920-834-6827
Fax: 920-834-6821

For more information visit the following site:
https://www.co.oconto.wi.us/departments/?department=a67c24bc2735&subdepartment=c041c5a0384b

The second easy nutrient prevention effort is to use lawn fertilizers only when a soil test shows a lack of nutrients. A relatively new Wisconsin law prohibits the application of turf fertilizer containing phosphorus except in certain circumstances. Phosphorous containing fertilizer may be used when planting a new lawn or when a soil test indicates the soil is low in phosphorous. Fertilizer may not be applied to impervious surfaces or frozen ground under the new law. More information can be found in Wisconsin Statute 94.643. The fertilizers that were commonly used for lawns and gardens have three major plant macronutrients: Nitrogen, Phosphorus, and Potassium. These are summarized on the fertilizer package by three numbers. The middle number represents the amount of phosphorus. Since most Wisconsin lakes are "Phosphorus limited", meaning additions of phosphorus can cause increased aquatic plant or algae growth, preventing phosphorus from reaching the lake is a good practice. Local retailers and lawn care companies can provide soil test kits to determine a lawn's nutrient needs. Of course, properties with an intact natural buffer require very little maintenance, and no fertilizers.

In highly developed lakes such as these the emergent and floating leaf plant communities are typically lacking. This has been a problem in these lakes for many years and continues to present day. Protection and enhancement of these specific plant communities is recommended as they provide habitat that is needed by many fish, invertebrates, waterfowl and wildlife. Protect the stands that are existing by avoiding them with boat motors, obey slow/no wake areas, avoid placing piers/lifts/rafts in the stand and do not remove plants from near shore areas.

A possible source of nutrients to a lake is the septic systems surrounding the lake. Septic systems should be properly installed and maintained in order to prevent improperly treated wastewater, which carries substantial nutrients, from reaching the lake. Property owners who are not sure if their septic system is adding nutrients to the lake should contact a professional inspector and have their system assessed.

A shoreland area that could benefit from improvements is the boat landing. The boat landing should be assessed to determine if best management practices may be needed. The paved road to the boat landing may be acting as a conduit for stormwater carrying sediment, nutrients and other pollutants into the lake. During a rain event a visual observation can be made to determine if the runoff is carrying sediment. After a rain event inspecting the shoreline for sediment deposits or erosion will indicate if corrective action is needed. Oconto County Land Conservation may be able to assist in assessing the landing for stormwater best management practices. Other practices that may be useful at the landing are trash cans for not only trash but for aquatic plants that are removed from boats. Keeping the signage up to date is also important to be sure all users have the most current information.

6.4 Fishery Recommendations

Wheeler Lake supports a good sport fishery but the numbers and size of some of the species has been declining over the years. This may be due to fishing pressure and low recruitment. Wheeler Lake is naturally a low productivity lake but steps can be taken to increase and improve habitat on the lake which may help to stabilize and increase these populations. To formulate a plan that will have the best chance to succeed, a meeting with WDNR fishery biologist to determine best strategies is recommended. WDNR has data from past surveys that may help to guide the habitat improvement efforts. WDNR can recommend strategies to determine the best locations for spawning habitat improvement; locations, size, number and depth of crib placement and locations for tree drops. There may be a number of other habitat improvements that could be completed on the lake. A long term approach should be taken and these improvements can take place over several years as funds and labor are available. Projects that may improve habitat include: fish sticks, cribs and walleye spawning beds.

6.5 Public Education and Involvement

Public education is a very important part of any plan. The WLA should continue to keep abreast of current AIS issues throughout the County, Region and State. The County Land Conservation Department, the WDNR Lakes Coordinator, Wisconsin Lakes (formerly known as Wisconsin Association of Lake [WAL]) and the UW Extension are good sources of information. Wisconsin Lakes is a state wide non-profit organization that works to protect and enhance the quality of lakes throughout the state. Wheeler Lake Association is a member of Wisconsin Lakes and the continued membership is encouraged. More information can be found at http://wisconsinlakes.org/index.html. UW-Extension website has information on all aspects of lakes from lake ecology to lake groups. A wealth of information can be found at the following website: http://www4.uwsp.edu/cnr/uwexlakes/.

7.0 Conclusion and Recommended Action Plan

7.1 Recommended Active Goals

The recommended action plan includes actions for Wheeler Lake based on the recommendations listed above in Section 6. The WLA president has approved the following active goals. It will be up to residents of Wheeler Lake and the WLA to determine the actions, find the funding, and gather the individuals needed to implement the active goals.

Active Goal: To implement and maintain an aquatic invasive species monitoring program that will survey for invasive species, and if found, monitor their locations and extent of population spread.

Action: Each spring volunteers should survey the littoral zone of the lake for new AIS and EWM. New AIS should be correctly identified and location(s) recorded with GPS. EWM beds should be located with GPS and size of beds measured to track changes over the seasons. Provide locations of EWM to consultant. Train members in Citizen Lake Monitoring protocol for AIS. More information on protocol can be found at http://www4.uwsp.edu/cnr/uwexlakes/CLMN/publications.asp and training information can be found at http://www4.uwsp.edu/cnr/uwexlakes/clmn/training.asp

Action: Contract with a consultant to monitor, map and recommend treatment of EWM beds. Annual monitoring, mapping and treatment will be needed to effectively manage EWM.

Timing: Begin monitoring Summer 2021 and continue on annual basis. Train volunteers ASAP.

Active Goal: To continue and expand the WDNR Clean Boats, Clean Waters program on Wheeler Lake.

Action: Volunteers should be recruited and trained so there is plenty of staff to monitor the boat landing. The landing should be monitored as much as possible concentrating on the busiest times such as holidays and weekends. Following is contact information for the CBCW coordinator:

Erin McFarlane
Clean Boats, Clean Waters Program Coordinator
Wisconsin Invasive Species Program
Phone: (715) 346-4978
Erin.mcfarlane@uwsp.edu

Timing: Train volunteers at next training session. Begin monitoring by Memorial Day and continue throughout the summer months, target busy holiday weekends.

Active Goal: To provide visitors with educational information concerning the potential impact their activities could have on introduction of aquatic invasive species, wildlife, habitats and Wheeler Lake water quality.

Action: Signs at the boat landing should be maintained and updated to stay current. UW-Extension has examples of signs at boat landings warning of AIS at the following site: http://www4.uwsp.edu/cnr/uwexlakes/cbcw/graphics.asp

Timing: Check signs in late winter/early spring and update if needed so current information is posted by Memorial Day.

Active Goal: To continue and expand the Wheeler Lake comprehensive water quality monitoring program through the WDNR Citizen Lake Monitoring Network.

Action: The program should include Water Clarity Monitoring and Water Chemistry Monitoring. Samples should be collected monthly May through October to test for phosphorus and chlorophyll a or as often as funds will allow. Members should be trained in CLMN protocol; training information can be found at: http://www4.uwsp.edu/cnr/uwexlakes/clmn/

Timing: Attend training sessions ASAP and begin monitoring in May. Continue monitoring on an annual basis and train volunteers as needed.

Active Goal: Improve fish and wildlife habitat in Wheeler Lake.

Action: Work in concert with the WDNR staff to evaluate Wheeler Lake fish management practices and develop goals in order to maintain and enhance a quality family sport fishery. WDNR can assist in preparing a plan to improve habitat on the lake. WDNR contact information follows:

Chip Long
Wisconsin Dept. of Natural Resources
101 N Ogden Rd
Peshtigo WI 54157-0208
715-582-5017
Christopher.Long@Wisconsin.gov

Timing: Contact WDNR staff in late winter/early spring to plan actions for the following summer.

Active Goal: To provide education and information to shoreline property owners regarding how native aquatic plant protection and shoreline management can slow the spread of aquatic invasive plants (if they become introduced), improve the lake fishery, improve wildlife habitat and affect the quality of the water in the lake.

Action: Include a presentation on shoreland restoration at one of the WLA meeting. Oconto County includes information on shoreland restoration in their website at

the following site:
http://www.co.oconto.wi.us/services/qrst/?service=625b73e427dd. Use the data collected in the shoreland assessment to target parcels that could benefit the most from improvements.

Active Goal: To encourage the incorporation of water quality protection measures in the design, construction and maintenance of all lake access sites on Wheeler Lake (e.g. storm water control, site drainage control, appropriate plant matter disposal, and watercraft wash down facilities if found to be needed).

Action: Assess boat landing to determine which best management practices are appropriate. Education of riparian landowners with private access roads/landings should be educated on water quality protection.

Active Goal: To meet on a regular basis with local government agencies and representatives of lakes located within Oconto County to identify essential and new lake management issues and determine collaborative solutions.

Action: Coordinate a lake fair for regional lakes where local agencies and citizens can exchange ideas and educate the public on issues.

7.2 Pursue Grant Funding to Implement Actions

There are a number of grants available through WDNR to implement actions outlined in this plan and to complete further research and projects on Wheeler Lake. Following is a brief description of the grants available through WDNR.

Small Scale Lake Management Planning

Funding Amount: $3,000
Local Match: 33%
Purpose: funding to collect and analyze information needed to protect and restore lakes and watersheds.
Eligible Projects:

- Lake monitoring such as water quality and aquatic plants
- Lake education such as activities that will collect/disseminate information about lakes to educate public on lake use, lake ecosystem and lake management techniques
- Organization development such as assist management units in formation of goals/objectives for management of lake
- Studies/assessments to implement management goals and expanding monitoring.

Large Scale Lake Management Planning

Funding Amount: $25,000
Local Match: 33%
Purpose: funding to collect and analyze information needed to protect and restore lakes and watersheds.
Eligible Projects:

- Gathering and analysis of physical, chemical and biological information
- Describing present and potential land uses in watershed and on shoreline
- Reviewing jurisdictional boundaries and evaluating ordinances that relate to zoning, sanitation or pollution control or surface use
- Assessment of fish, aquatic life, wildlife and their habitats
- Gathering and analyzing information from lake property owners/users
- Developing, evaluation, publishing, distributing alternative courses of action and recommendations in a lake management plan

Lake Protection Grant

Funding Amount: $200,000
Local Match: 25%
Purpose: Funding for large, complex, technical projects for lake protection
Eligible Projects:

- Purchase of land or conservation easements
- Restoration of wetlands and shorelands to protect water quality
- Development of local regulations to protect lakes and education activities necessary to implement them
- Lake management plan implementation project recommend in WDNR approved plan
    - Watershed management projects
    - Lake restoration
    - Diagnostic feasibility studies

Aquatic Invasive Species Education, Planning and Prevention Grant

Funding Amount: $150,000
Local Match: 25%
Purpose: Educate lake users on AIS
Eligible Projects:

- Educational programs including workshops, training or coordinating volunteer monitors.
- Develop prevention and control plans for AIS
- Monitor, map and assess waterbodies for AIS or studies that will aid in prevention AIS
- Watercraft inspection and education projects (CBCW). Inspectors must be trained and staff boat launch facilities a minimum of 200 hours between May 1 and October 30. Limited to $4,000 per boat launch facility.

Aquatic Invasive Species Established Population Control Project

Funding Amount: $200,000
Local Match: 25%

Purpose: Provide for eradication/substantial reduction and long term control of AIS with goal of restoring native species.

Eligible Projects:

- Department approved control activities recommended in control plan
- Experimental or demonstration project in WDNR approved plan
- Purple loosestrife bio-control project

Aquatic Invasive Species Early Detection and Response

Funding Amount: $20,000

Local Match: 25%

Purpose: Provide assistance in response to pioneer AIS.

Eligible Projects: Identification and removal by approved methods of small, pioneer population of AIS. Localized beds must be present less than 5 years and less than 5 acres in size or less than 5% of lake area. Control of recolonization following completion of an established population control project is eligible.

Aquatic Invasive Species Research and Demonstration

Funding Amount: $500,000

Local Match: 25%

Purpose: Funding for cooperative research or demonstration activity between sponsor and WDNR

Aquatic Invasive Species Maintenance and Containment

Funding Amount: full cost of aquatic plant management permit

Local Match: 25%

Purpose: Funding for department approved management at desired level of AIS where eradication is not possible. Monitoring and reporting are required.

7.3 Closing

This Comprehensive Lake Management Plan Update was prepared in cooperation with the Wheeler Lake Association. It includes major components outlined in the WDNR CLMP Guidance. This plan is a guide document that needs to be evaluated on a regular basis to determine if it is meeting the needs of the lake. Annual review of the document is recommended. The Active Goals should be assessed to determine if they are relevant, if the goals are being reached or if new goals need to be added. It is recommended to review the goals at each annual meeting. A lake and its watershed are always changing and adapting due to natural and man-made influences; the plan needs to be assessed to be sure it is adequately addressing these changes also.

8.0 References

While not all references are specifically cited, the following resources were used in preparation of this report.

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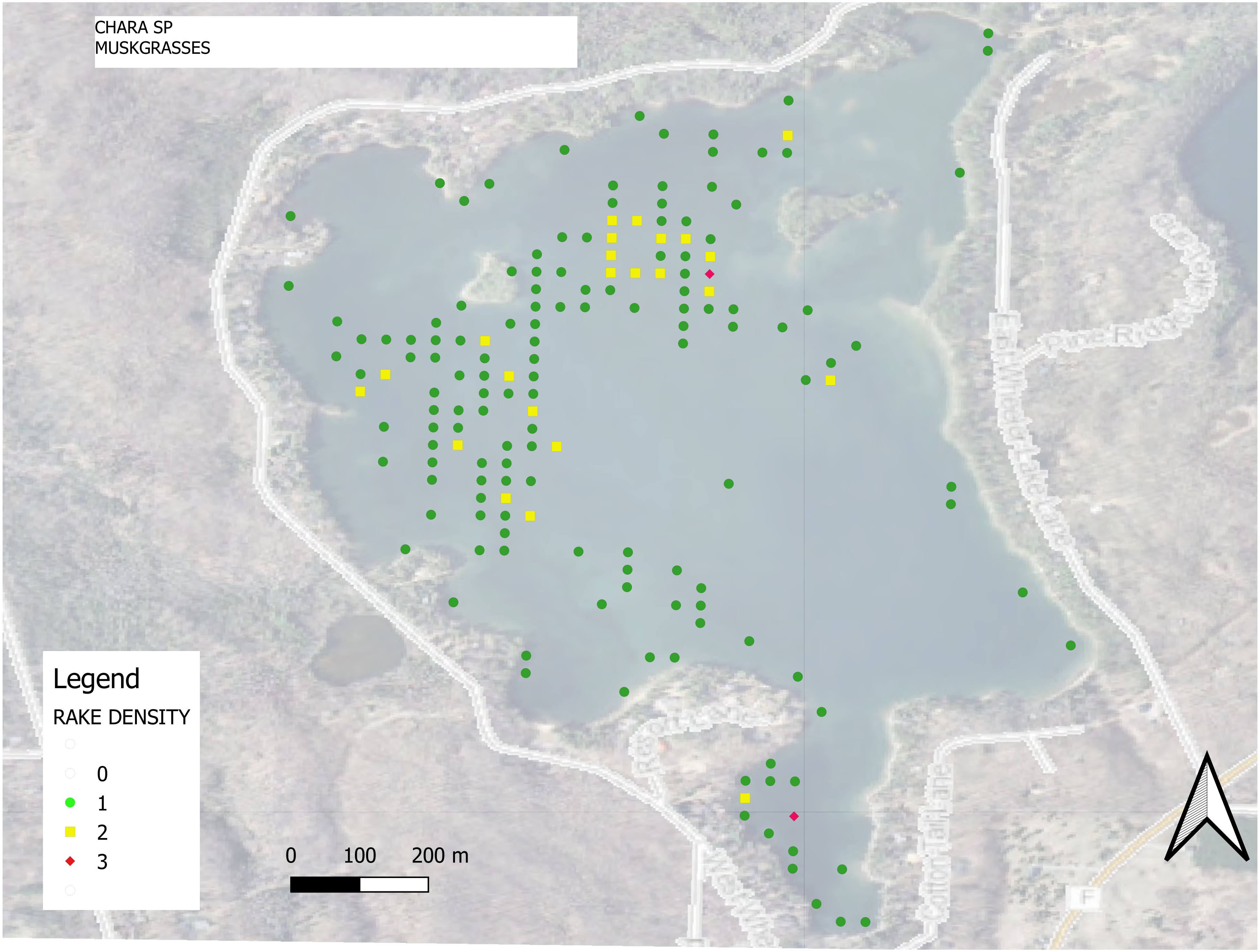
FIGURES

POINT INTERCEPT MAPS

- CHARA SP
- ELODEA CANADENSIS
- MYRIOPHYLLUM SIBIRICUM
- MYRIOPHYLLUM SPICATUM
- NAJAS FLEXILIS
- NITELLA SP
- NUPHAR VARIEGATA
- POTAMOGETON AMPLIFOLIUS
- POTAMOGETON FOLIOSUS
- POTAMOGETON GRAMINEUS
- POTAMOGETON ILLINOENSIS
- POTAMOGETON PUSILLUS
- POTAMOGETON ZOSTERIFORMIS
- VALLISNERIA AMERICANA
- RAKE FULLNESS
- SUBMERSED
- FLOATING LEAF
- SEDIMENT


CHARA SP
MUSKGRASSES
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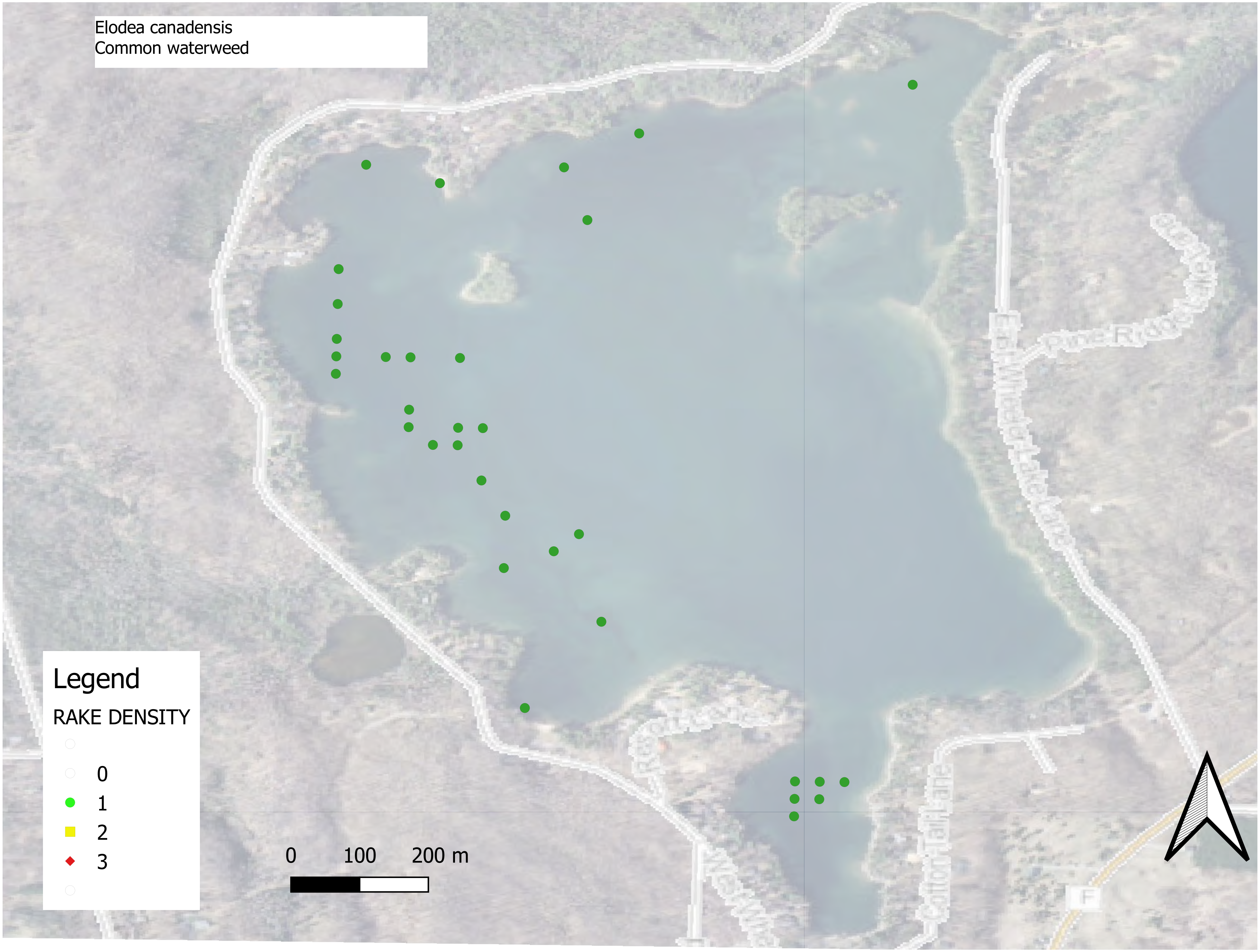
Elodea canadensis
Common waterweed
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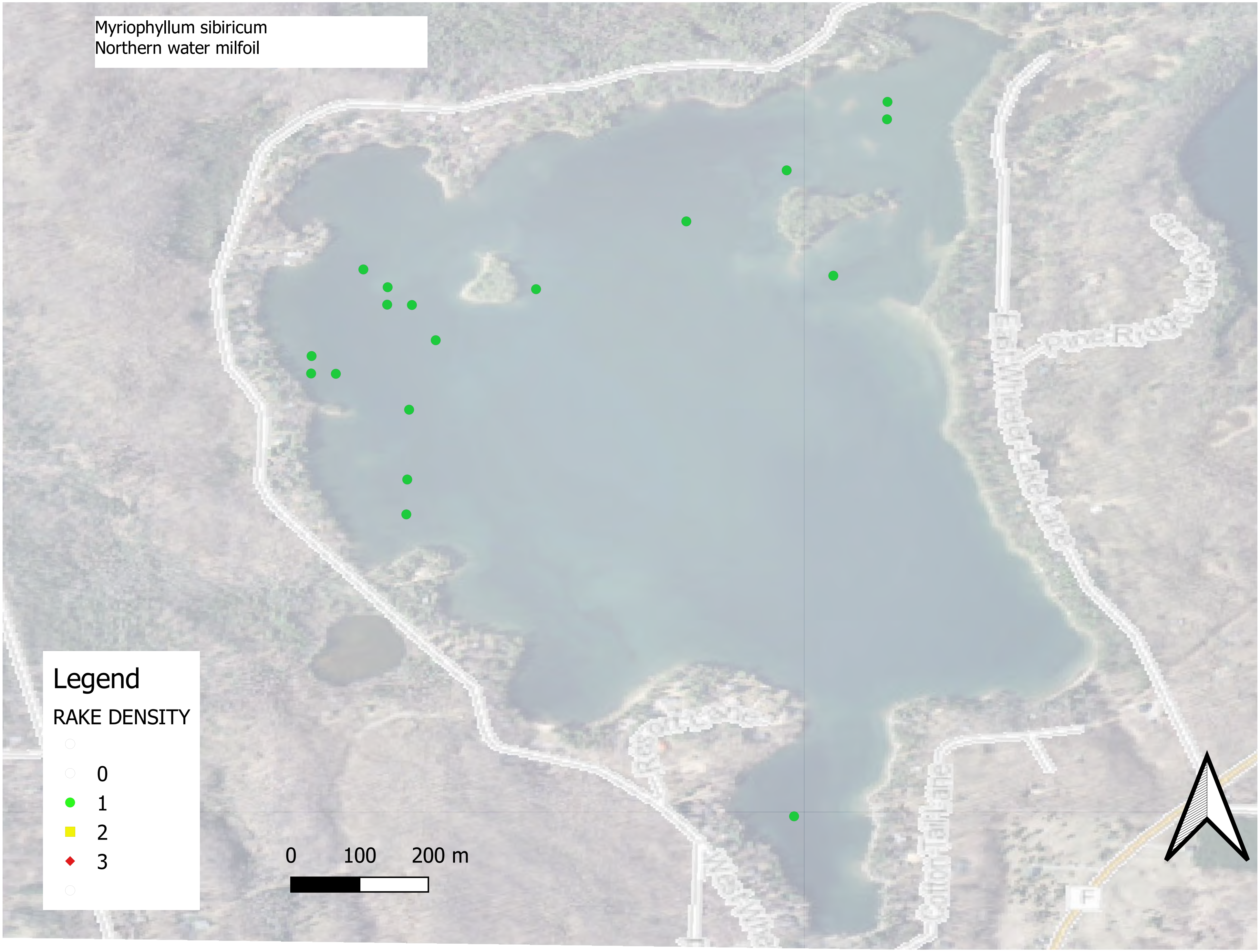
Myriophyllum sibiricum
Northern water milfoil
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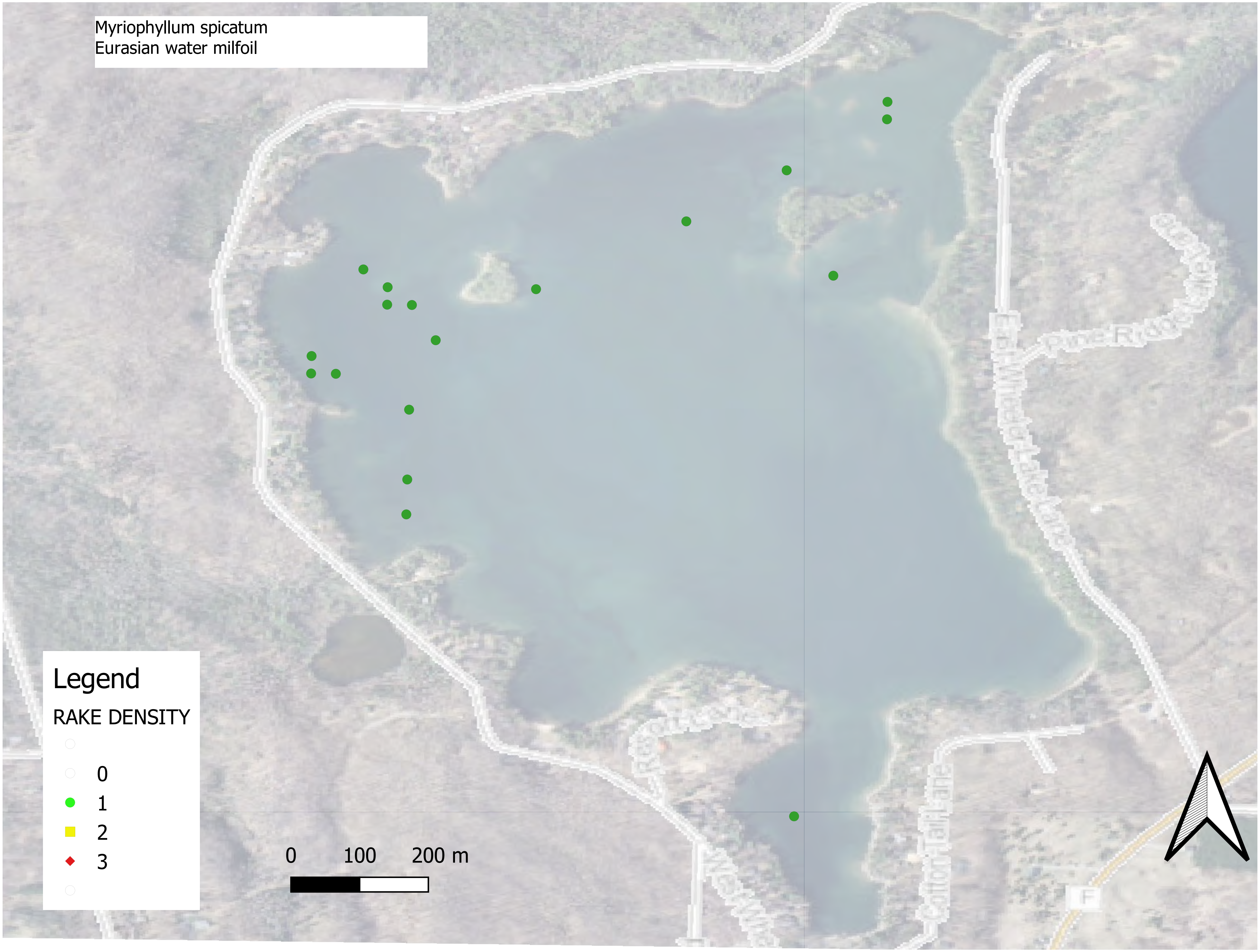
Myriophyllum spicatum
Eurasian water milfoil
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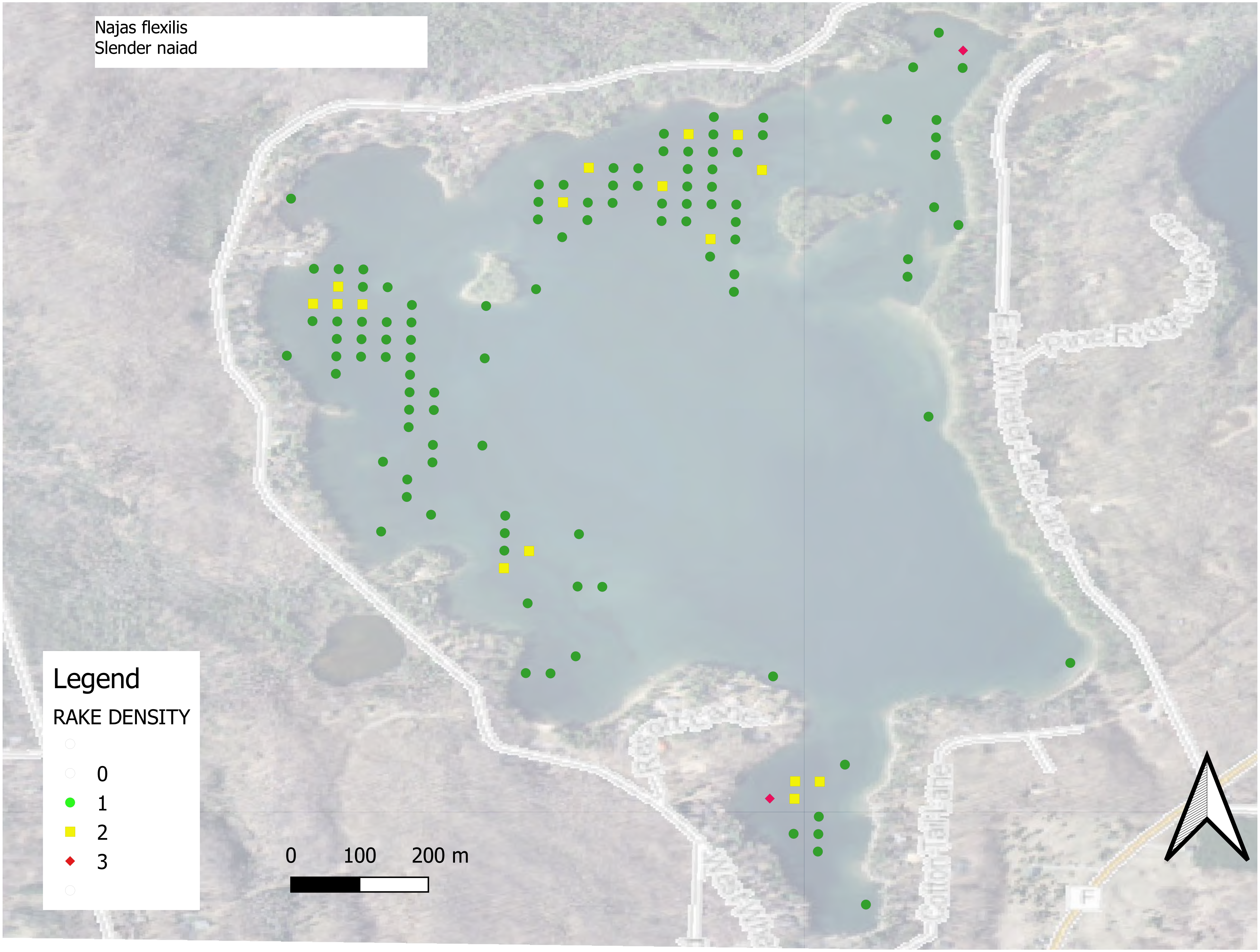
Najas flexilis
Slender naiad
Legend
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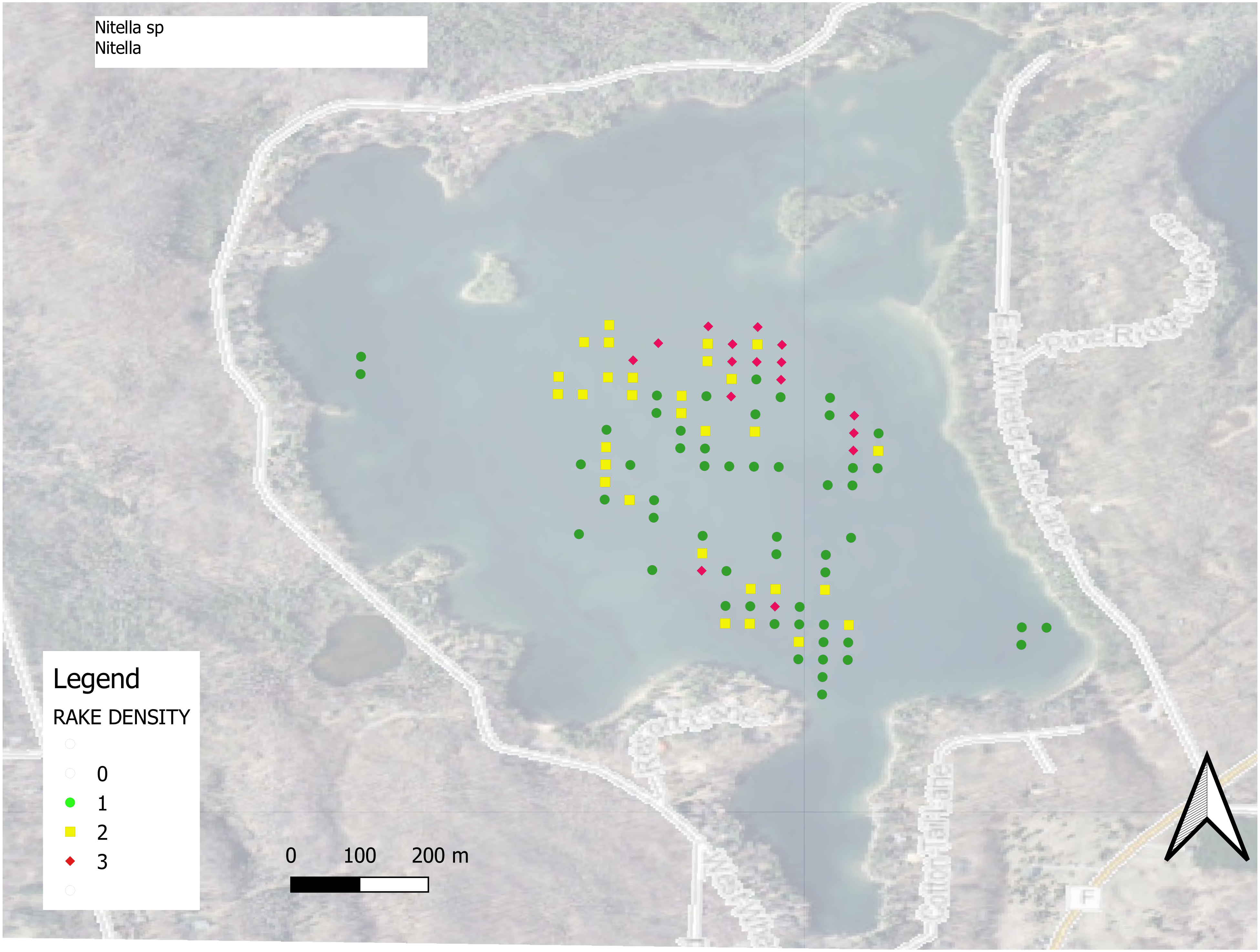
Nitella sp
Nitella
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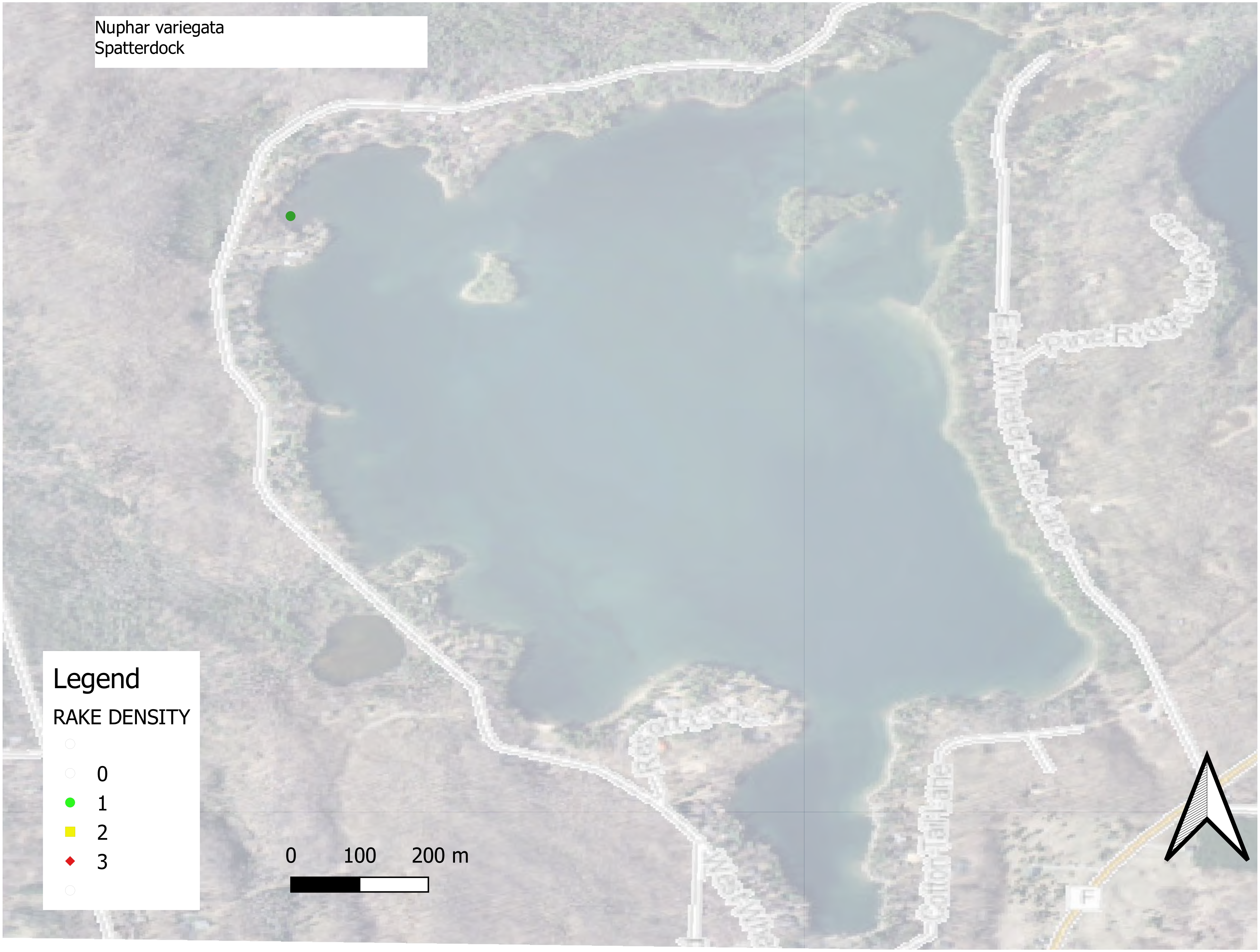
Nuphar variegata
Spatterdock
Legend
RAKE DENSITY
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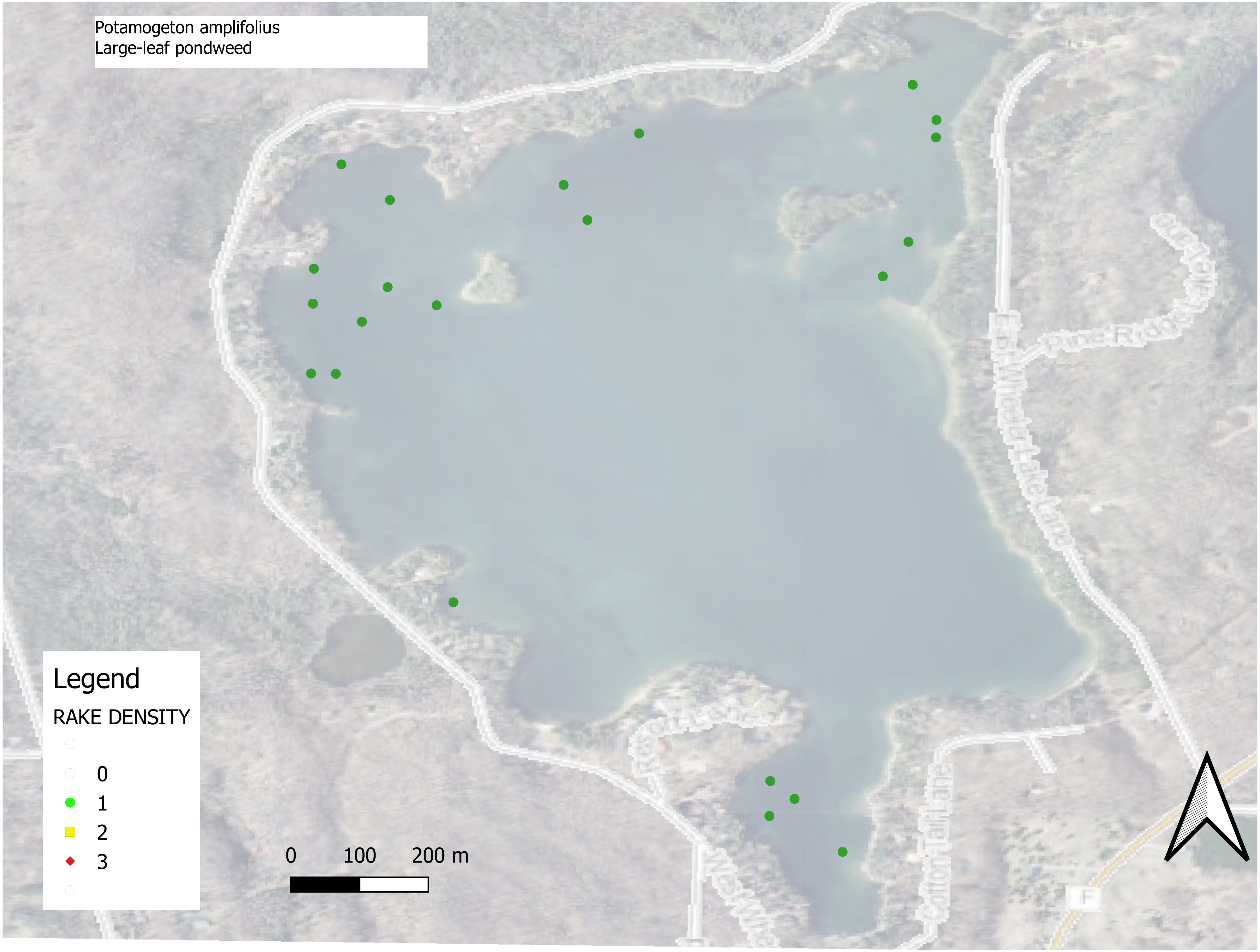
Potamogeton amplifolius
Large-leaf pondweed
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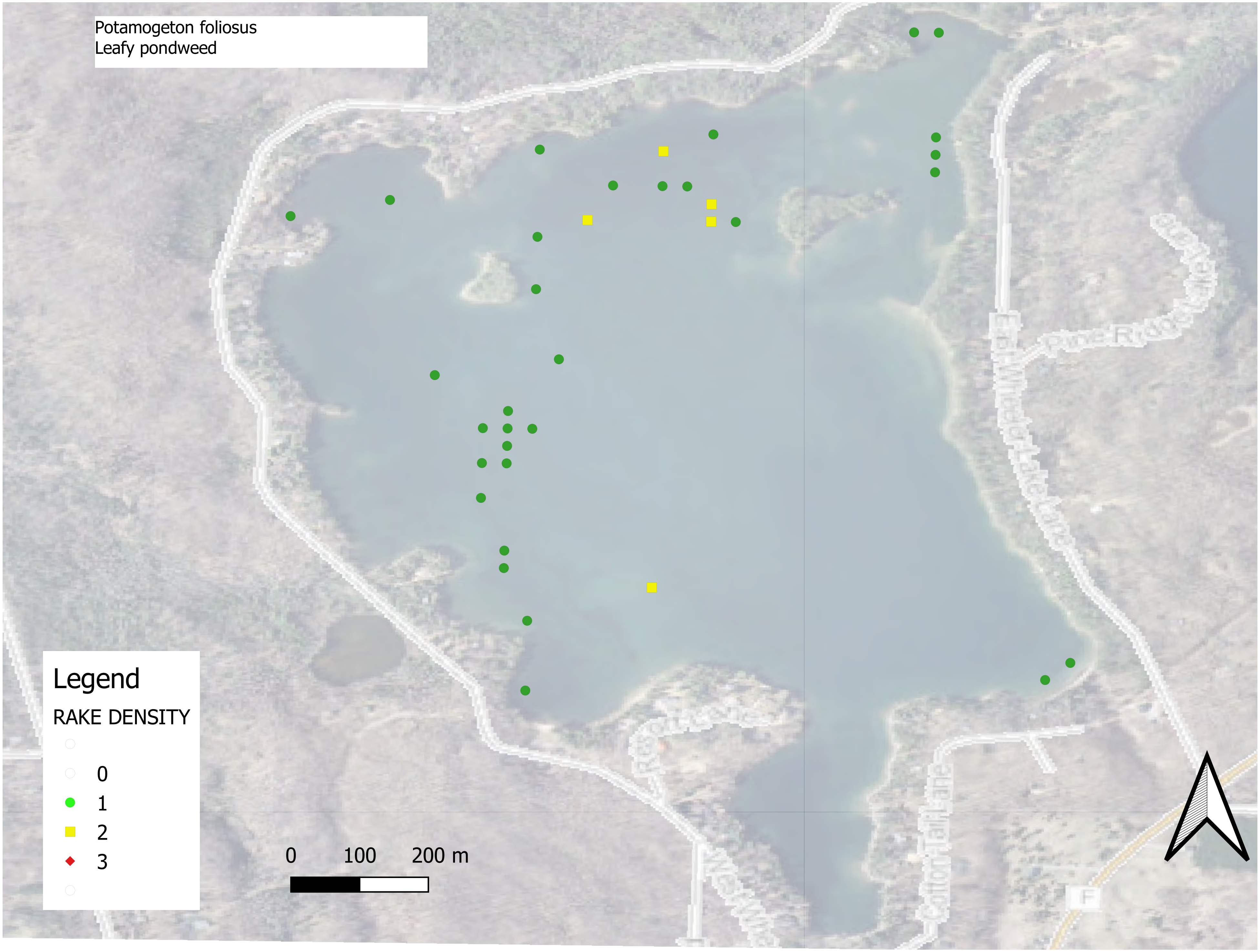

Potamogeton foliosus
Leafy pondweed
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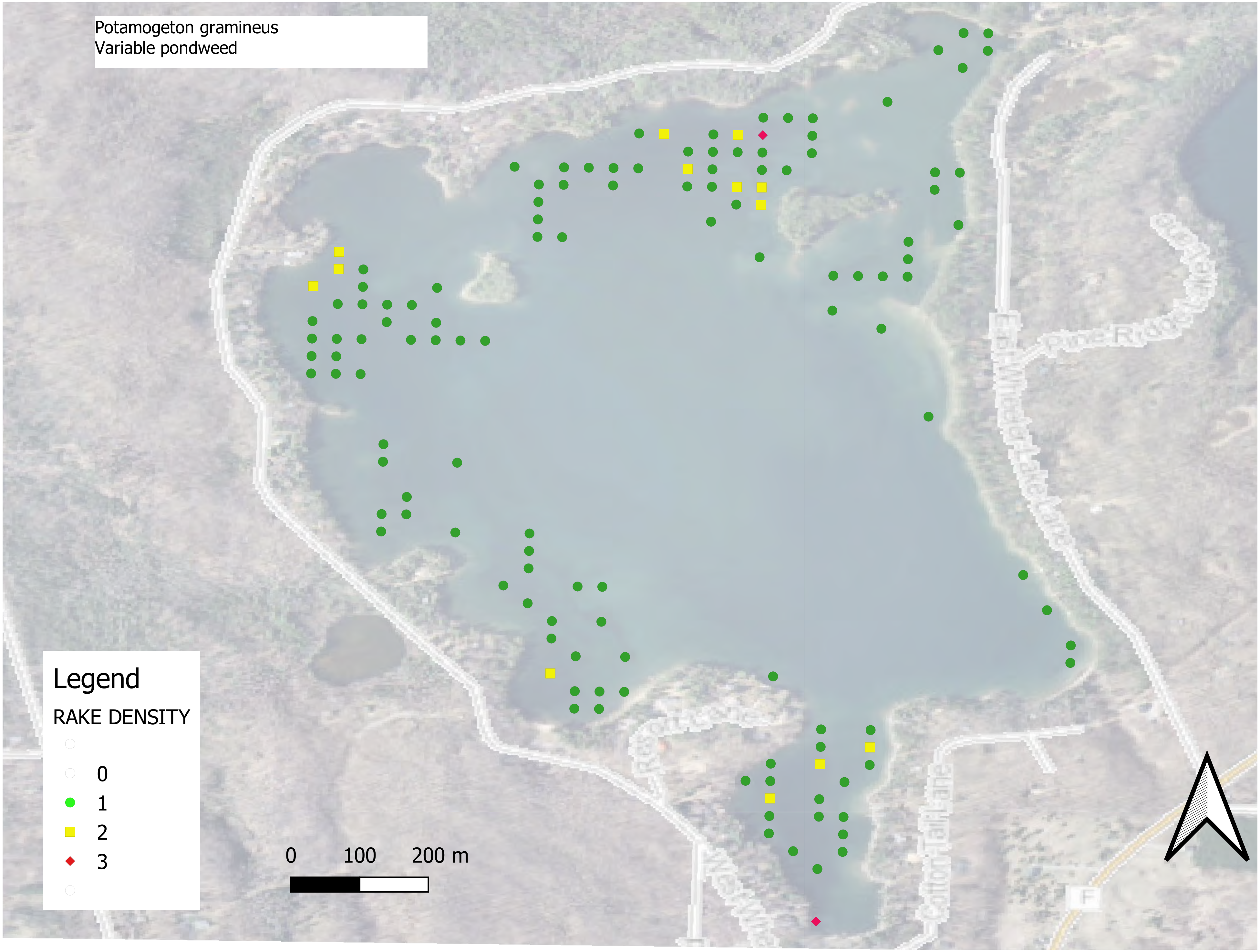
Potamogeton gramineus
Variable pondweed
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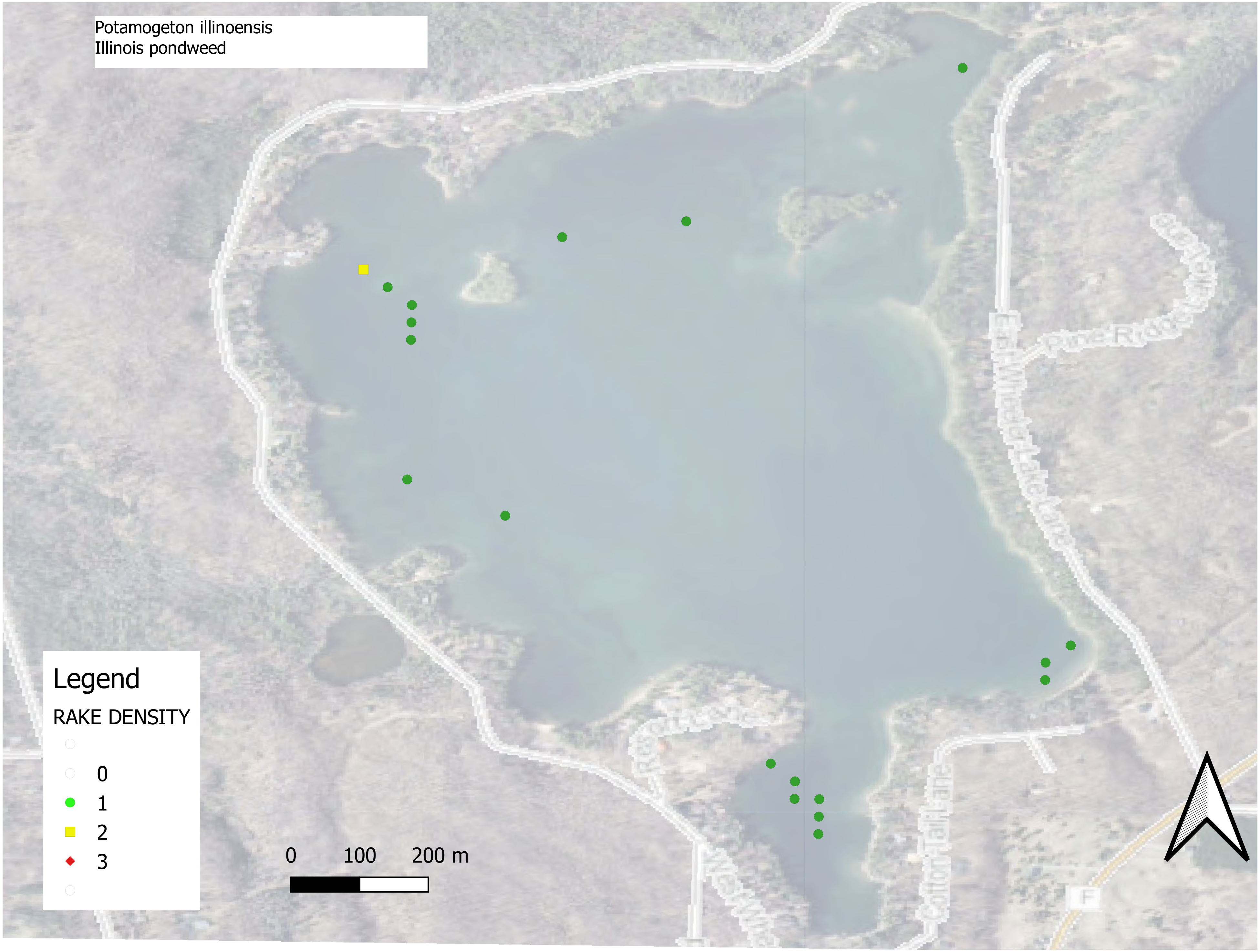
Potamogeton illinoensis
Illinois pondweed
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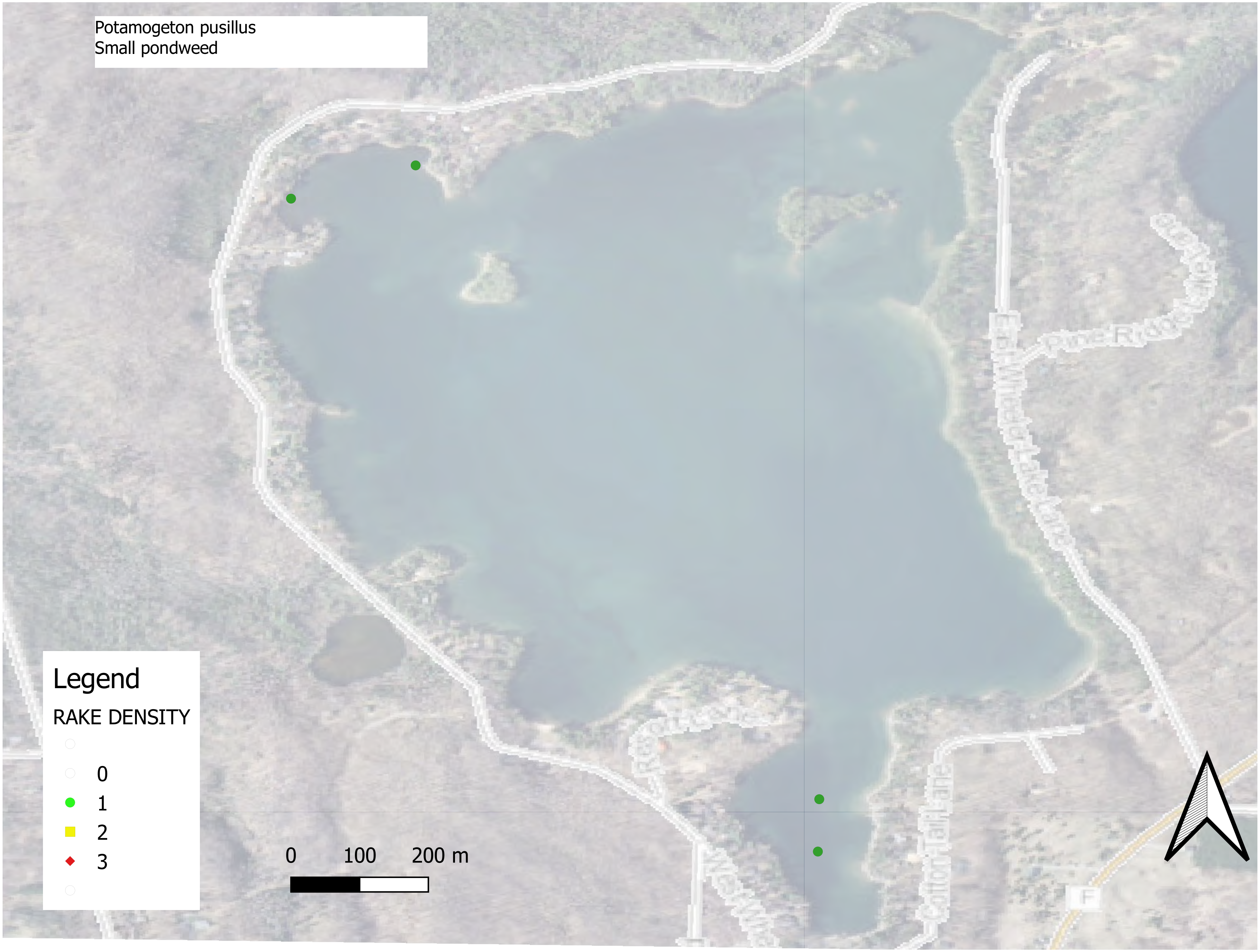
Potamogeton pusillus
Small pondweed
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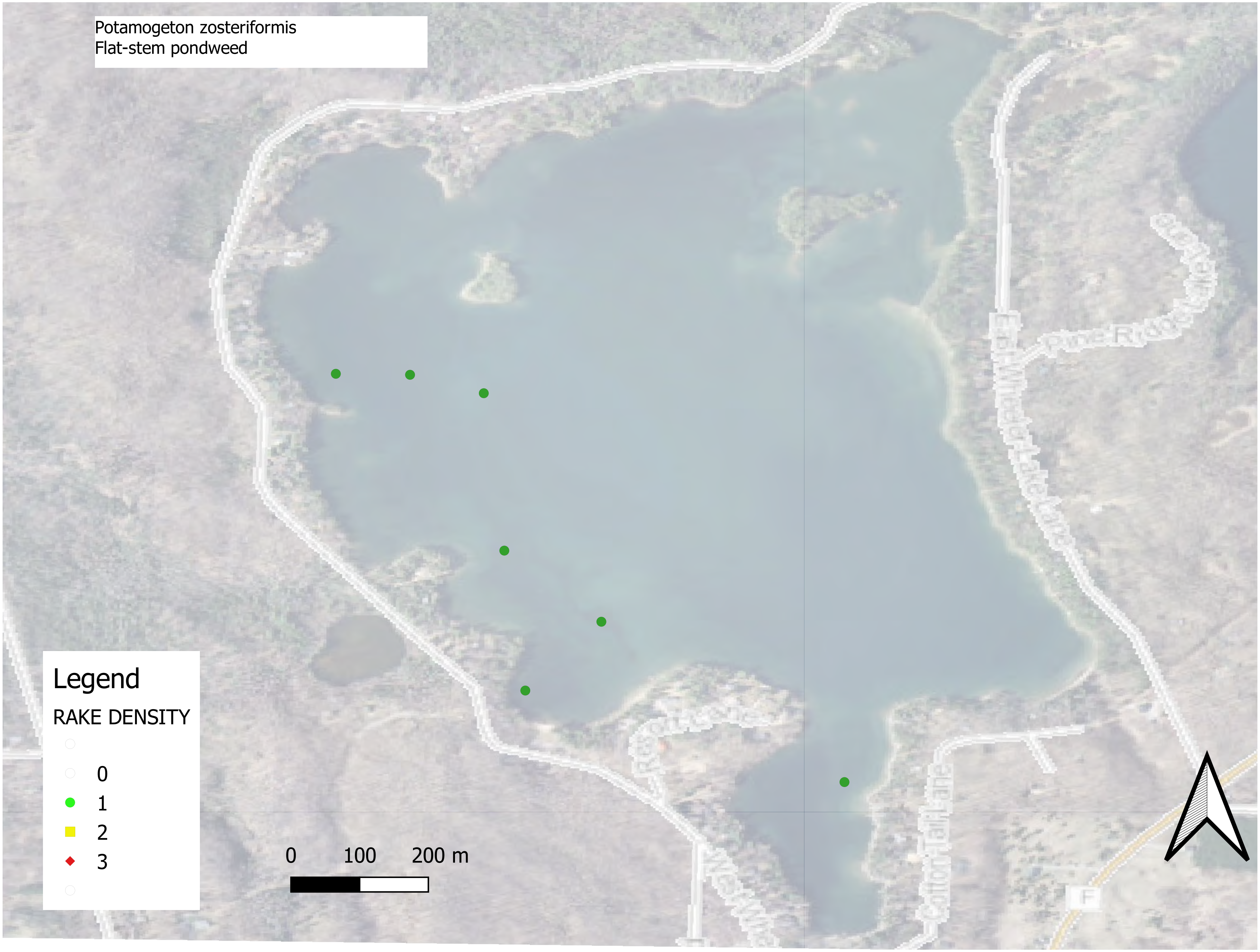
Potamogeton zosteriformis
Flat-stem pondweed
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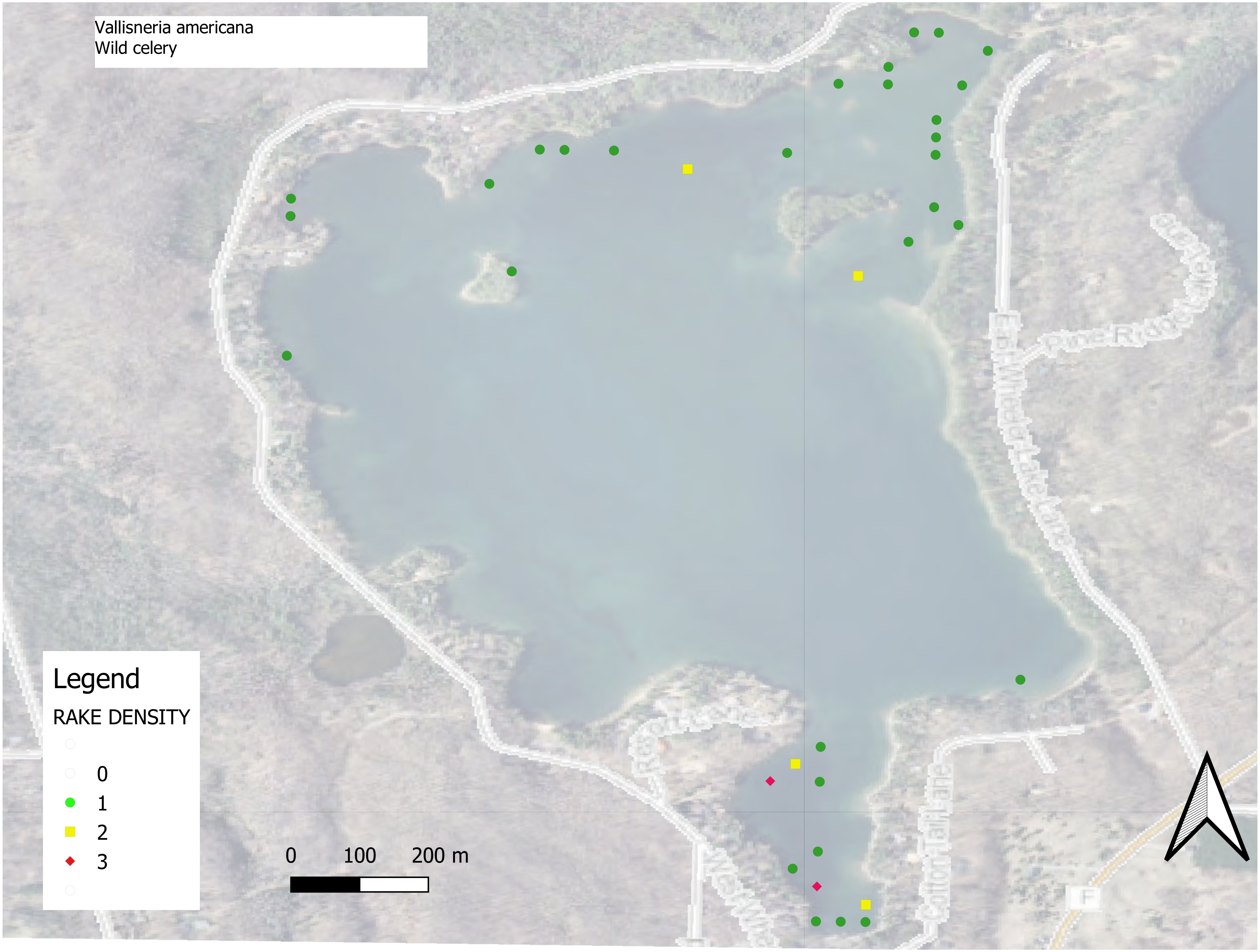
Vallisneria americana
Wild celery
Legend
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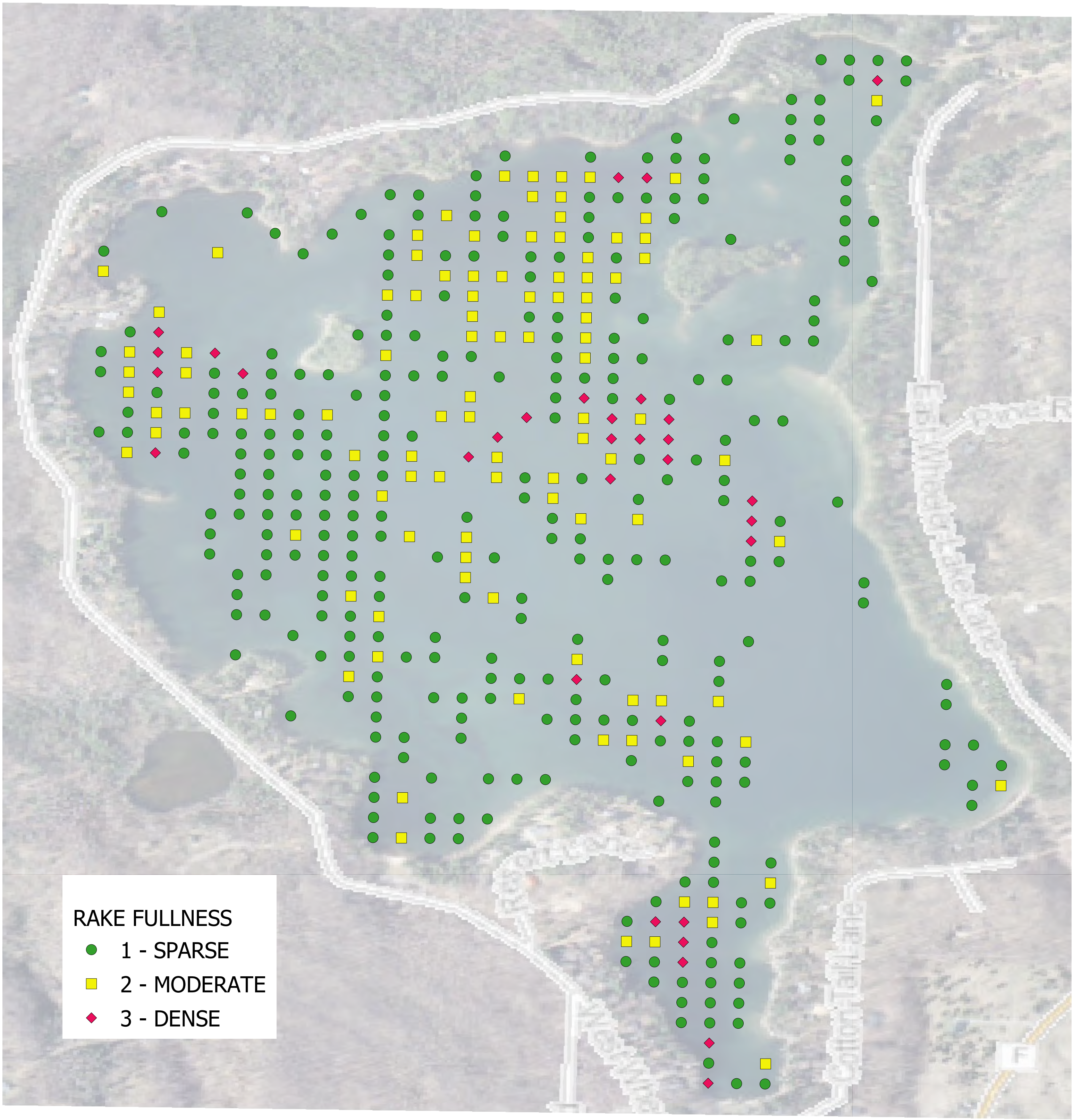
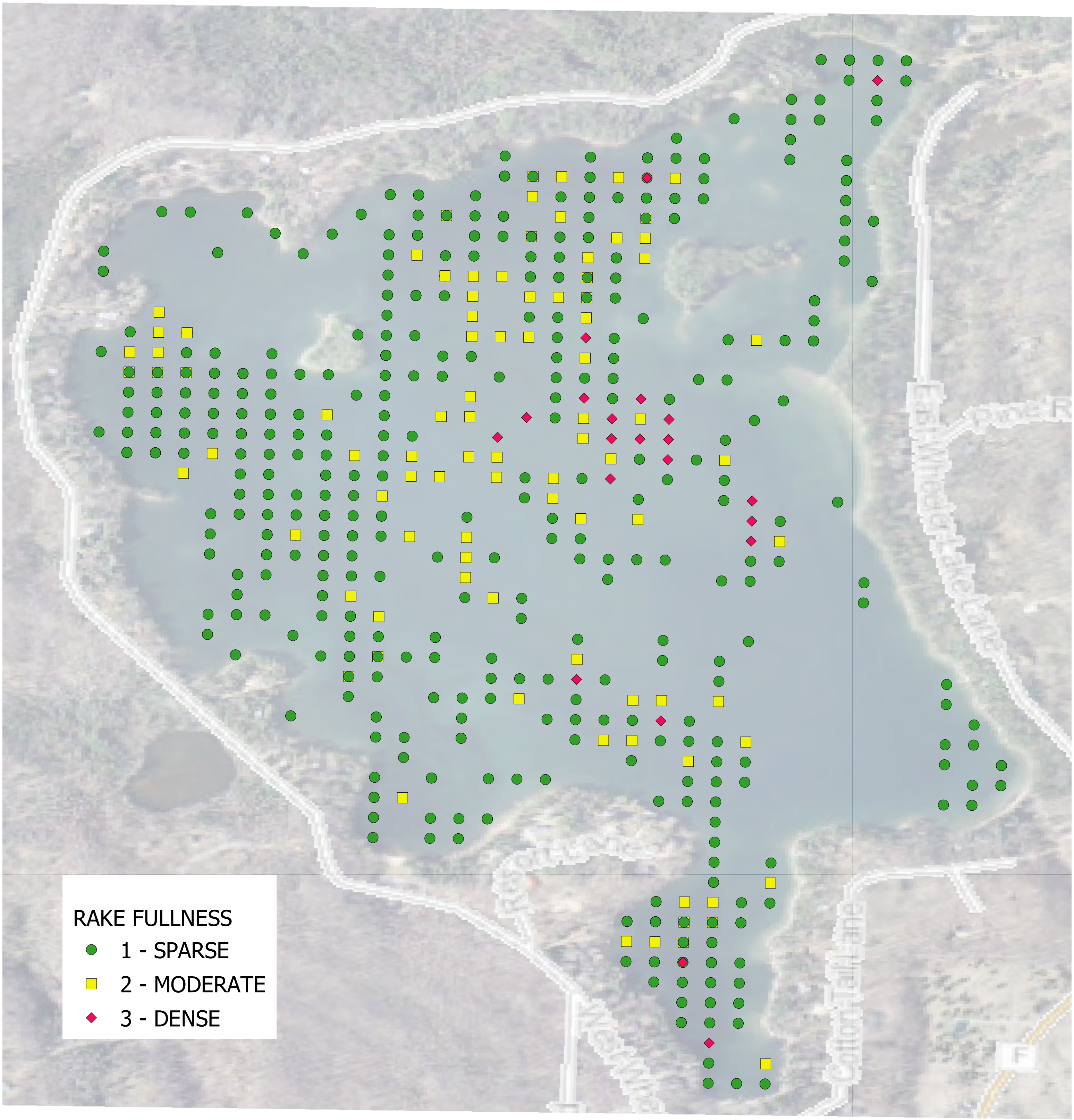


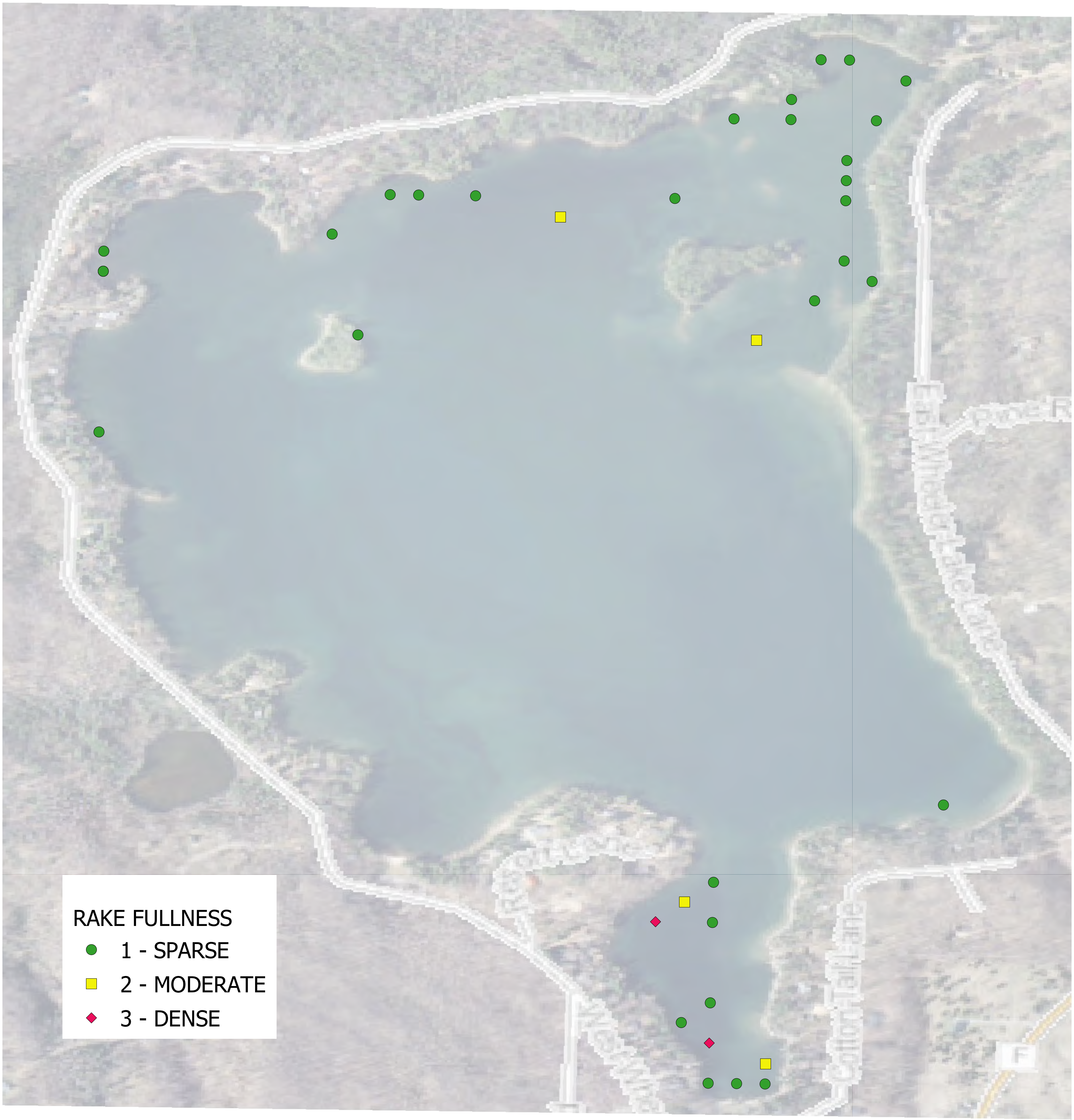
WHEELER LAKE AQUATIC VEGETATION
SEPTEMBER 8 & 9, 2019

RAKE FULLNESS ALL VEGETATION



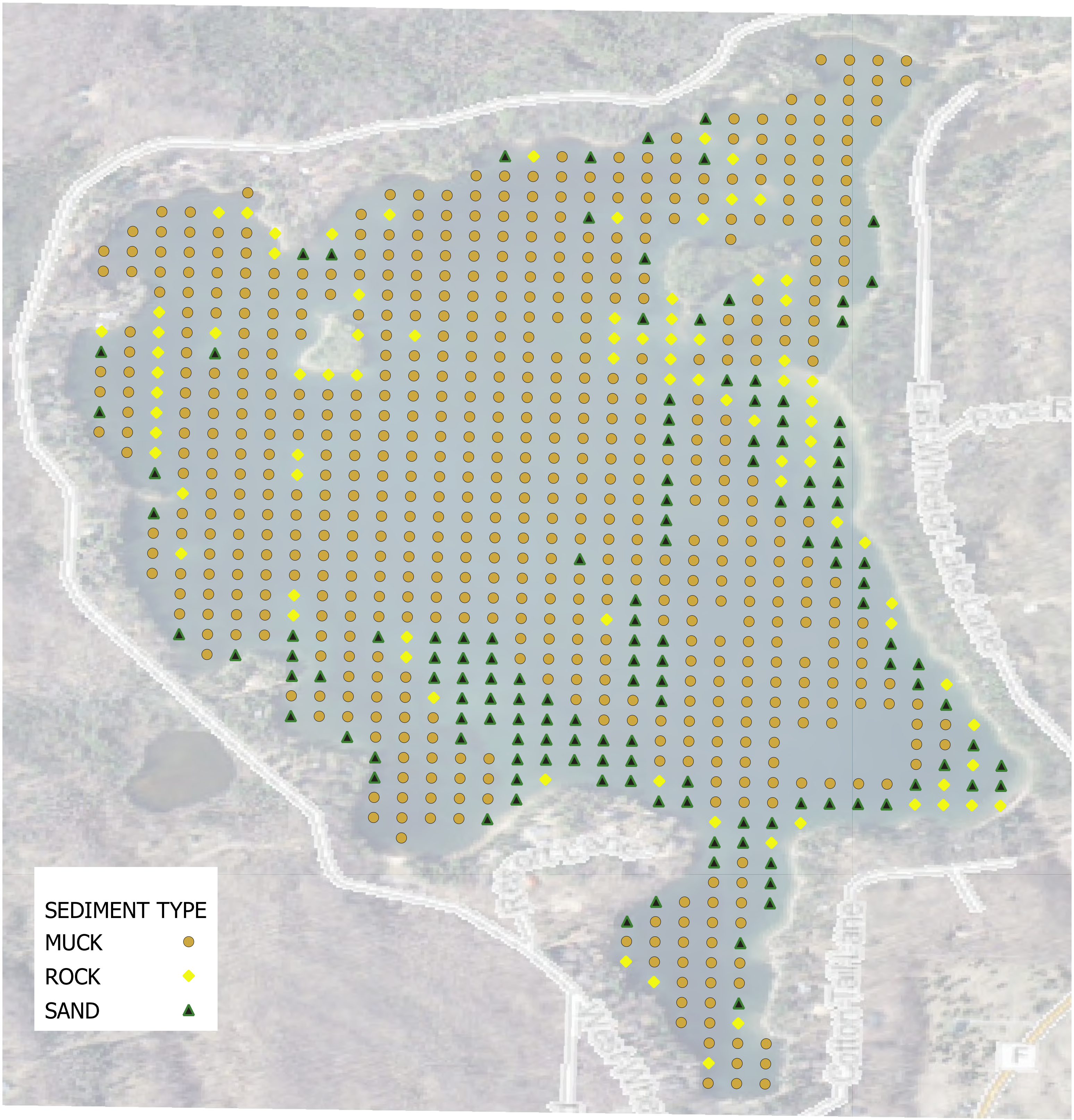
WHEELER LAKE AQUATIC VEGETATION
SEPTEMBER 8 & 9, 2019

SUBMERSED VEGETATION



WHEELER LAKE AQUATIC VEGETATION
SEPTEMBER 8 & 9, 2019

FLOATING LEAF VEGETATION



WHEELER LAKE AQUATIC VEGETATION
SEPTEMBER 8 & 9, 2019

SEDIMENT TYPE

Appendix A – Point Intercept (PI) Data

- PI Stats
- Comparison Species Presence/Absence
- PI Points Map
- PI Points Coordinates

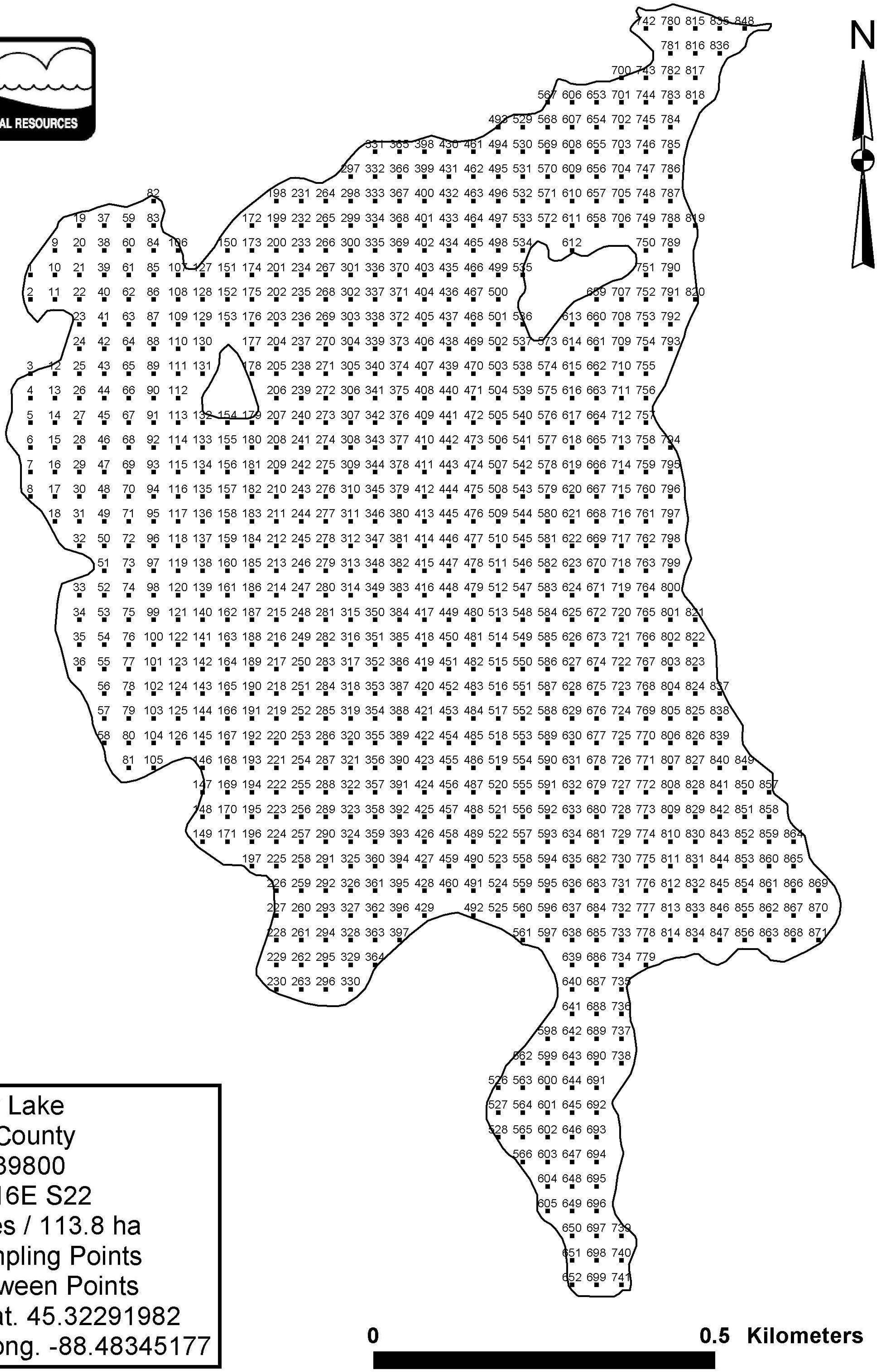
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		**STATS**	Total vegetation	*Myriophyllum spicatum* ,Eurasian water milfoil	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton foliosus, Leafy pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton pusillus, Small pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Vallisneria americana, Wild celery
2	**Lake**	WHEELER															
3	**County**	OCONTO															
4	**WBIC**																
5	**Survey Date**	9/8, 9/9/2019															
6		**INDIVIDUAL SPECIES STATS:**															
7		**Frequency of occurrence within vegetated areas (%)**		0.90	36.85	7.42	4.04	27.64	22.25	0.22	4.94	8.09	30.11	4.27	0.90	1.57	8.09
8		**Frequency of occurrence at sites shallower than maximum depth of plants**		0.48	19.62	3.95	2.15	14.71	11.84	0.12	2.63	4.31	16.03	2.27	0.48	0.84	4.31
9		**Relative Frequency (%)**		0.6	23.4	4.7	2.6	17.6	14.1	0.1	3.1	5.1	19.1	2.7	0.6	1.0	5.1
10		Relative Frequency (squared)	0.15	0.00	0.05	0.00	0.00	0.03	0.02	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
11		**Number of sites where species found**		4	164	33	18	123	99	1	22	36	134	19	4	7	36
12		**Average Rake Fullness**	1.38	1.75	1.16	1.00	1.00	1.16	1.63	1.00	1.00	1.14	1.13	1.05	1.00	1.00	1.22
13		**#visual sightings**															
14		**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present
15																	
16		**SUMMARY STATS:**															
17		**Total number of sites visited**	**860**														
18		**Total number of sites with vegetation**	**445**														
19		**Total number of sites shallower than maximum depth of plants**	**836**														
20		**Frequency of occurrence at sites shallower than maximum depth of plants**	**53.23**														
21		**Simpson Diversity Index**	**0.85**														
22		**Maximum depth of plants (ft)****	**30.00**														
23		**Number of sites sampled using rake on Rope (R)**	**0**														
24		**Number of sites sampled using rake on Pole (P)**	**0**														
25		**Average number of all species per site (shallower than max depth)**	**0.83**														
26		**Average number of all species per site (veg. sites only)**	**1.57**														
27		**Average number of native species per site (shallower than max depth)**	**0.83**														
28		**Average number of native species per site (veg. sites only)**	**1.57**														
29		**Species Richness**	**14**														
30		**Species Richness (including visuals)**	**14**														

WHEELER LAKE

WHEELER

2007 survey total points	856					
2019 survey total points	860				Increase/Decrease	
	2007 prese	2019 prese	p	Significant	(proportion	Sample Size Problem
Myriophyllum spicatum,Eurasian water milfoil	0	4	0.045752	*	+	
Chara sp., Muskgrasses	96	164	5.69E-06	***	+	
Elodea canadensis, Common waterweed	14	33	0.005206	**	+	
Myriophyllum sibiricum, Northern water-milfoil	8	18	0.049505	*	+	
Najas flexilis, Slender naiad	267	123	6.98E-17	***	-	
Nitella sp., Nitella	186	99	1.3E-08	***	-	
Nuphar variegata, Spatterdock	1	1	0.997368	n.s.	-	Warning:Expected value too sma
Nymphaea odorata, White water lily	1		0.316041	n.s.	-	Warning:Expected value too sma
Potamogeton amplifolius, Large-leaf pondweed	33	22	0.127216	n.s.	-	
Potamogeton foliosus, Leafy pondweed	113	36	3.33E-11	***	-	
Potamogeton gramineus, Variable pondweed	18	134	8.75E-23	***	+	
Potamogeton illinoensis, Illinois pondweed	12	19	0.209241	n.s.	+	
Potamogeton pusillus, Small pondweed	1	4	0.180771	n.s.	+	
Potamogeton zosteriformis, Flat-stem pondweed	5	7	0.567811	n.s.	+	
Stuckenia pectinata, Sago pondweed	1		0.316041	n.s.	-	Warning:Expected value too sma
Vallisneria americana, Wild celery	5	36	1.03E-06	***	+	
Aquatic moss	1		0.316041	n.s.	-	Warning:Expected value too sma
Filamentous algae	4		0.044749	*	-	

WISCONSIN
DEPT. OF NATURAL RESOURCES



Wheeler Lake
Oconto County
WBIC 439800
T33N R16E S22
281 acres / 113.8 ha
871 Sampling Points
36m between Points
Site1: Lat. 45.32291982
Long. -88.48345177

Created: 2006

sampling point	Latitiude	Longitude
1	45.32291982	-88.48345177
2	45.32259588	-88.48346042
3	45.32162407	-88.48348635
4	45.32130014	-88.48349499
5	45.3209762	-88.48350364
6	45.32065226	-88.48351228
7	45.32032832	-88.48352092
8	45.32000439	-88.48352957
9	45.32323766	-88.48298393
10	45.32291372	-88.48299258
11	45.32258979	-88.48300123
12	45.32161797	-88.48302717
13	45.32129404	-88.48303582
14	45.3209701	-88.48304446
15	45.32064616	-88.48305311
16	45.32032222	-88.48306175
17	45.31999829	-88.4830704
18	45.31967435	-88.48307905
19	45.3235555	-88.48251609
20	45.32323156	-88.48252474
21	45.32290762	-88.48253339
22	45.32258368	-88.48254204
23	45.32225975	-88.48255069
24	45.32193581	-88.48255934
25	45.32161187	-88.48256799
26	45.32128794	-88.48257664
27	45.320964	-88.48258529
28	45.32064006	-88.48259394
29	45.32031612	-88.48260259
30	45.31999219	-88.48261123
31	45.31966825	-88.48261988
32	45.31934431	-88.48262853
33	45.31869644	-88.48264583
34	45.3183725	-88.48265447
35	45.31804856	-88.48266312
36	45.31772462	-88.48267177
37	45.32354939	-88.4820569
38	45.32322546	-88.48206555
39	45.32290152	-88.4820742
40	45.32257758	-88.48208285
41	45.32225364	-88.48209151
42	45.32192971	-88.48210016
43	45.32160577	-88.48210881
44	45.32128183	-88.48211746
45	45.3209579	-88.48212611
46	45.32063396	-88.48213476
47	45.32031002	-88.48214342
48	45.31998608	-88.48215207
49	45.31966215	-88.48216072

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53	,	45.3183664	,	-88.48219532
54	,	45.31804246	,	-88.48220397
55	,	45.31771852	,	-88.48221262
56	,	45.31739459	,	-88.48222127
57	,	45.31707065	,	-88.48222992
58	,	45.31674671	,	-88.48223857
59	,	45.32354329	,	-88.4815977
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61	,	45.32289541	,	-88.48161501
62	,	45.32257148	,	-88.48162367
63	,	45.32224754	,	-88.48163232
64	,	45.3219236	,	-88.48164098
65	,	45.32159967	,	-88.48164963
66	,	45.32127573	,	-88.48165828
67	,	45.32095179	,	-88.48166694
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69	,	45.32030392	,	-88.48168425
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72	,	45.31933211	,	-88.48171021
73	,	45.31900817	,	-88.48171886
74	,	45.31868423	,	-88.48172751
75	,	45.31836029	,	-88.48173617
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77	,	45.31771242	,	-88.48175347
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87	,	45.32224143	,	-88.48117314
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268	,	45.32252257	,	-88.47795017
269	,	45.32219864	,	-88.47795885
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Appendix B – Plant Ecology

AQUATIC PLANT TYPES AND HABITAT

Aquatic plants can be divided into two major groups: microphytes (phytoplankton and epiphytes) composed mostly of single-celled algae, and macrophytes that include macro algae, flowering vascular plants, and aquatic mosses and ferns. Wide varieties of microphytes co-inhabit all habitable areas of a lake. Their abundance depends on light, nutrient availability, and other ecological factors.

In contrast, macrophytes are predominantly found in distinct habitats located in the littoral (i.e., shallow near shore) zone where light sufficient for photosynthesis can penetrate to the lake bottom. The littoral zone is subdivided into four distinct transitional zones: the eulittoral, upper littoral, middle littoral, and lower littoral (Wetzel, 1983).

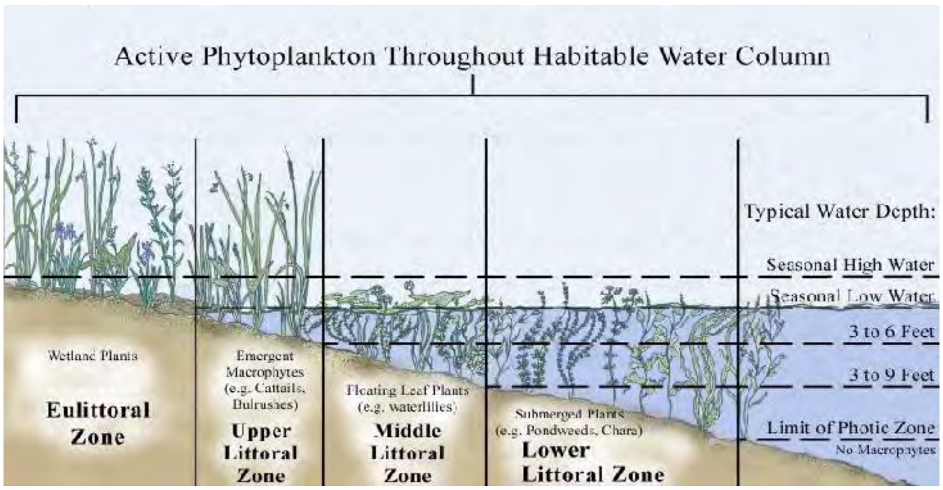
Eulittoral Zone: Includes the area between the highest and lowest seasonal water levels, and often contains many wetland plants.

Upper Littoral Zone: Dominated by emergent macrophytes and extends from the shoreline edge to water depths between 3 and 6 feet.

Middle Littoral Zone: Occupies water depths of 3 to 9 feet, extending deeper from the upper littoral zone. The middle littoral zone is often dominated by floating-leaf plants.

Lower Littoral Zone: Extends to a depth equivalent to the limit of the photic zone, which is the maximum depth that sufficient light can support photosynthesis. This area is dominated by submergent aquatic plant types.

The following illustration depicts these particular zones and aquatic plant communities.



Aquatic Plant Communities Schematic

The abundance and distribution of aquatic macrophytes are controlled by light availability, lake trophic status as it relates to nutrients and water chemistry, sediment characteristics, and wind energy. Lake morphology and watershed characteristics relate to these factors independently and in combination (NALMS, 1997).

AQUATIC PLANTS AND WATER QUALITY

In many instances aquatic plants serve as indicators of water quality due to the sensitive nature of plants to water quality parameters such as water clarity and nutrient levels. To grow, aquatic plants must have adequate supplies of nutrients. Microphytes and free-floating macrophytes (e.g., duckweed) derive all their nutrients directly from the water. Rooted macrophytes can absorb nutrients from water and/or sediment. Therefore, the growth of phytoplankton and free-floating aquatic plants is regulated by the supply of critical available nutrients in the water column. In contrast, rooted aquatic plants can normally continue to grow in nutrient-poor water if lake sediment contains adequate nutrient concentrations. Nutrients removed by rooted macrophytes from the lake bottom may be returned to the water column when the plants die. Consequently, killing too many aquatic macrophytes may increase nutrients available for algal growth.

In general, an inverse relationship exists between water clarity and macrophyte growth. That is, water clarity is usually improved with increasing abundance of aquatic macrophytes. Two possible explanations are postulated. The first is that the macrophytes and epiphytes out-compete phytoplankton for available nutrients. Epiphytes derive essentially all of their nutrient needs from the water column. The other explanation is that aquatic macrophytes stabilize bottom sediment and limit water circulation, preventing re-suspension of solids and nutrients (NALMS, 1997).

If aquatic macrophyte abundance is reduced, then water clarity may suffer. Water clarity reductions can further reduce the vigor of macrophytes by restricting light penetration. Studies have shown that if 30 percent or less of a lake areas occupied by aquatic plants is controlled, water clarity will generally not be affected. However, lake water clarity will likely be reduced if 50 percent or more of the macrophytes are controlled (NALMS, 1997).

Aquatic plants also play a key role in the ecology of a lake system. Aquatic plants provide food and shelter for fish, wildlife and invertebrates. Plants also improve water quality by protecting shorelines and the lake bottom, improving water quality, adding to the aesthetic quality of the lake and impacting recreational activities.

Appendix C – Information on Aquatic Invasive Species (AIS)

INVASIVE AQUATIC PLANTS

Invasive species have invaded our backyards, forests, prairies, wetlands, and waters. Invasive species are often transplanted from other regions, even from across the globe. "A species is regarded as invasive if it has been introduced by human action to a location, area, or region where it did not previously occur naturally (i.e., is not native), becomes capable of establishing a breeding population in the new location without further intervention by humans, and spreads widely throughout the new location " (Source: WDNR website, Invasive Species, 2007). AIS include plants and animals that affect our lakes, rivers, and wetlands in negative ways. Once in their new environment, AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new "home". Some AIS have aggressive reproductive potential and contribute to ecological declines and problems for water based recreation and local economies. AIS often quickly become a problem in already disturbed lake ecosystems (i.e. one with relatively few native plant species). While native plants provide numerous benefits, AIS can contribute to ecological decline and financial constraints to manage problem infestations.

Eurasian Watermilfoil *(Myriophyllum spicatum)*

EWM is the most common AIS found in Wisconsin lakes. EWM was first discovered in southeast Wisconsin in the 1960's. During the 1980's, EWM began to spread to other lakes in southern Wisconsin and by 1993 it was common in 39 Wisconsin counties. EWM continues to spread across Wisconsin and is now found in the far northern portion of the state including Vilas County.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist (WDNR website, 2007).

Once established in an aquatic community, EWM reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl (WDNR website, 2007).

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms of infested lakes (WDNR website, 2007).

Curly leaf pondweed *(Potamogeton crispus)*

Curly-leaf pondweed (CLP) spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making CLP one of the first nuisance aquatic plants to emerge in the spring.

The leaves of curly-leaf pondweed are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early July.

CLP becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. CLP forms surface mats that interfere with aquatic recreation in mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches (WDNR website, 2007).

Purple Loosestrife (Lythrum salicaria)

Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth form. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers. Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000

seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months (WDNR website, 2007).

OTHER AQUATIC INVASIVE SPECIES

The following AIS are not plants, but are mentioned here because they also can significantly disrupt healthy aquatic ecosystems.

Rusty Crayfish *(Orconectes rusticus)* are large crustaceans that feed aggressively on aquatic plants, small invertebrates, small fish, and fish eggs. They can remove nearly all the aquatic vegetation from a lake, offsetting the balance of a lake ecosystem. More information about this invader can be found at http://WDNR.wi.gov/invasives/fact/rusty.htm.

Zebra Mussels *(Dreissena polymorpha)* are small freshwater clams that can attach to hard substrates in water bodies, often forming large of thousands of individual mussels. They are prolific filter feeders, removing valuable phytoplankton from the water, which is the base of the food chain in an aquatic ecosystem. More information about this invader can be found at

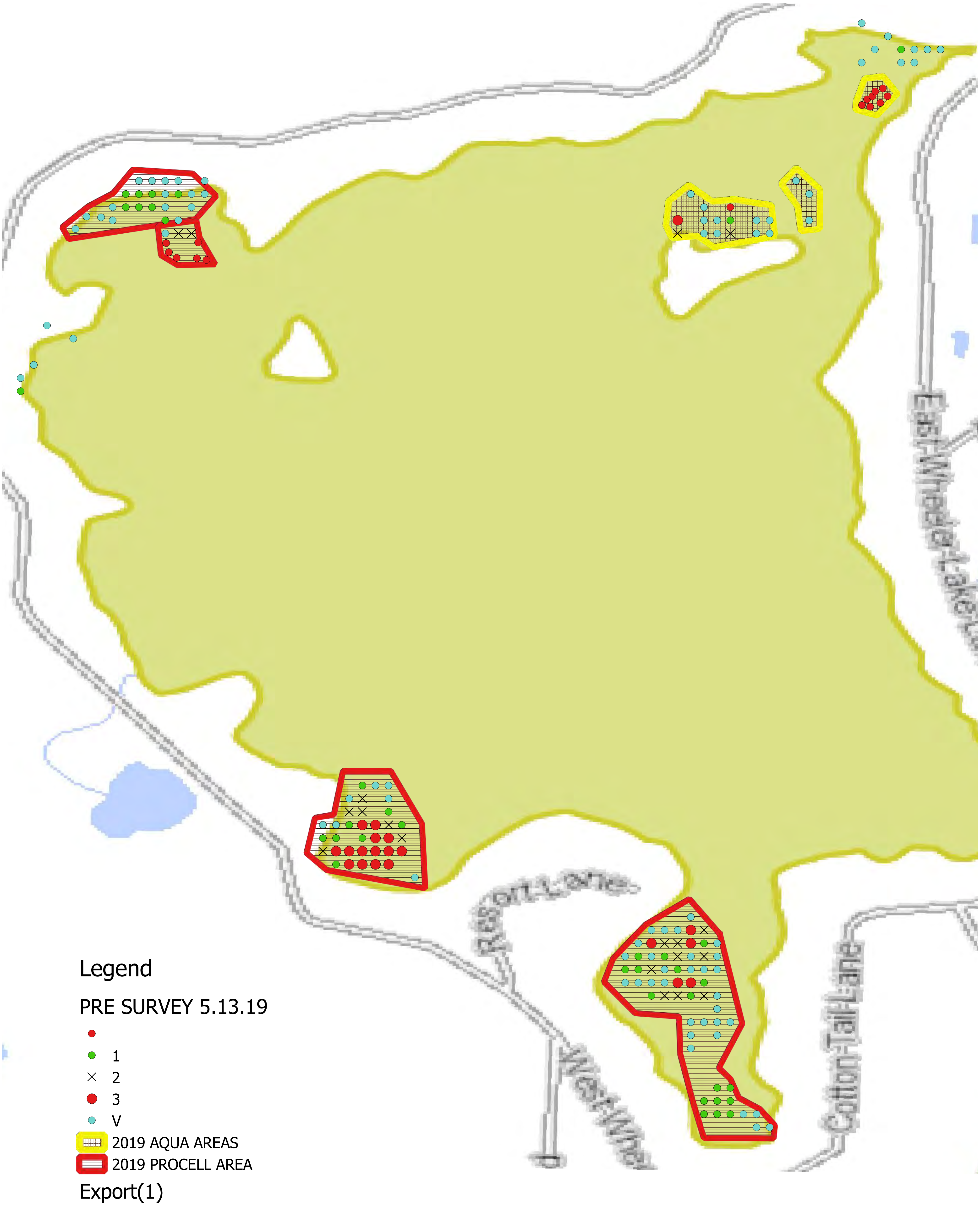
http://WDNR.wi.gov/invasives/fact/zebra.htm.

Spiny Water Fleas (*Bythotrephes cederstoemi)* are predatory zooplankton (tiny aquatic animals) that have a barbed tail making up most of their body length (one centimeter average). They compete with small fish for food supplies (zooplankton) and small fish cannot swallow the spiny water flea due to the long spiny appendage. More research is being completed to determine the potential impacts of the spiny water flea. More information about this invader can be found at

http://WDNR.wi.gov/invasives/fact/spiny.htm.

Appendix D – EWM Management

Monitoring Maps 2019 TO 2021


Resort Lane
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2019 AQUA AREAS
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State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
2984 Shawano Avenue
Green Bay WI 54313-6727

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

April 18, 2019

Wheeler Lake Association
17577 E Wheeler Lake Lane
Lakewood, WI 54138

Permit No. NE 2019-43-3666
Permit Fee - Received $520.00

Subject: 2019 Permit to Chemically Treat Eurasian Watermilfoil, in Wheeler Lake in Oconto County.

Amended May 20, 2019 – Site F will be using Aquastrike, see condition number 4.

Dear Wheeler Lake Association:

The Department has received and reviewed your application to chemically treat Eurasian Watermilfoil in Wheeler Lake, Oconto County. The permit application proposes to use the aquatic herbicide Aquastrike and ProcellaCOR to treat up to 19.5 acres of Eurasian Watermilfoil. Your permit application meets the minimum requirements by law and a permit is being issued with the following conditions. Issuance of the permit is not an endorsement or approval for the actions authorized. Please contact the Department if you have any questions.

PERMIT CONDITIONS

1.) The chemical treatment shall be performed in compliance with Wisconsin Administrative Code Chapter NR 107. Chemical treatment shall be performed in accordance with label directions and existing pesticide laws.

2.) Early season treatment targeting Eurasian Watermilfoil must occur when water temperature is near 60 degrees Fahrenheit, taken two feet below the water surface at the treatment site. If the temperature restrictions are exceeded, no treatment may take place unless permission is obtained from the Department.

3.) A pretreatment and post treatment sub-polygon survey according to the WDNR's pre-post treatment survey protocol must be performed on treatment areas A, B, and E on the attached map.

4.) ProcellaCOR will be used as sites A and B with a target concentration of 2 and 3 PDU. Aquastrike will be used at site E at 1.62 gallon acre-foot. Treatment for sites C, D will be determined following the spring survey. Hand pulling will occur if manageable; if not ProcellaCOR at 5+ PDU/ac-ft will be used. Treatment site F will be using Aquastrike.

5.) Herbicide concentration sampling for sites A and B will occur at 1,3,6, 12 & 24 hours after treatment (HAT). Samples will be collected and sent to Sepro for testing. Sampling for Aquastrike (endothall) at site E will occur at 1, 3, 6, 12 & 24 HAT collected and sent to State Lab of Hygiewne for testing

6.) Chapter NR 107.04(4) Wisconsin Administrative Code states that the applicant, Wheeler Lake Association, must certify a copy of the application has been provided to any affected property owners, and in the case of chemical applications for rooted aquatic plants, to any riparian property owners adjacent to and within the treatment area.

7.) All boat landings and access points on the Wheeler Lake system must be posted prior to treatment with a map showing treatment areas. Pesticide application warning sign postings must be visible from both the water and shore per NR 107.08 (7) (a).

8.) The permit holder shall submit the enclosed form 3200-111, Aquatic Plant Management Treatment Record for each treatment as follows:

   a. 30 days after the treatment
   b. Immediately, if any unusual circumstances occur during treatment
   c. By October 1 of this year if no treatment occurred

9.) Any data generated that is funded wholly or in part by state grants is considered public domain and shall be submitted to the Department.

10.) You must notify Brenda Nordin of the Department of Natural Resources at 920-360-3167 or Brenda.nordin@wi.gov 4 working days prior to any chemical treatment applications.

11.) The following steps should be taken *every time* you move your equipment to avoid transporting invasive viruses and species. To the extent practicable, equipment and gear used on infested waters should not be used on other non-infested waters.

   a) Inspect and remove aquatic plants, animals, and mud from your equipment.
   b) Drain all water from your equipment, including but not limited to tracked vehicles, barges, boats, silt or turbidity curtain, hoses, sheet pile and pumps.
   c) Dispose of aquatic plants, animals in the trash. Never release or transfer aquatic plants, animals or water from one water body to another.
   d) Wash your equipment with hot (>104º F) and/or high pressure water OR allow your equipment to dry thoroughly for 5 days OR follow a current disinfection protocol at the following website **http://dnr.wi.gov/fish/vhs/.**

IMPORTANT NEW INFORMATION FOR 2011

Attached to this letter is a summary of the proposed requirements for a point source discharge of an excess or residual pesticide pollutant directly to waters of the state under a Clean Water Act (known as the Wisconsin Pollutant Discharge Elimination System or WDPES) permit. Pesticide point source pollutants, including aquatic herbicides, discharged after April 9, 2011 will need to be covered under a WPDES Pesticide General Permit. Your coverage letter under the new WPDES permit will be sent to you in late March 2011 unless you inform the Department that WPDES coverage is not needed for the project. You will not need to submit a new application or notice of intent to the Department for the activities covered by this NR107 permit. If you would like to stay informed of the WPDES requirements as they are finalized, please visit the following website and register for updates via GovDelivery: http://dnr.wi.gov/org/water/wm/ww/aquaticpesticides.htm.

Please feel free to contact me at 920-360-3167 or by e-mail at Brenda.nordin@wisconsin.gov.

Sincerely,

Brenda Nordin
Water Resource Management Specialist

cc: James Scharl – Wisconsin Lake and Pond Resource
Ken Dolata – Oconto County LWCD
Zach Snobl – DATCP Enforcement Specialist
Paul Hartrick – DNR Conservation Warden, Oconto
Chip Long – Fish Biologist, Oconto

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that the Wisconsin statutes and administrative rules establish time periods within which requests to review Department decisions must be filed. For judicial review of a decision pursuant to sections 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review must name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to section 227.42, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. All requests for contested case hearings must be made in accordance with section NR 2.05(5), Wis. Adm. Code, and served on the Secretary in accordance with section NR 2.03, Wis. Adm. Code. The filing of a request for a contested case hearing does not extend the 30 day period for filing a petition for judicial review


Legend
2019 AQUA AREAS
FALL 2019 EWM
2019 PROCELL AREA

SePRO Research & Technology Campus FasTEST*

16013 Watson Seed Farm Road, Whitakers, NC 27891

Chain of Custody: COC5185 **LABORATORY REPORT**

Customer Company **Customer Contact**

Company Name Wisconsin Lake & Pond Res LLC	Contact Person: James Sharl
Address: N7828 Town Hall Rd, Eldorado, WI 54932	E-mail Address: jim@wisconsinlpr.com
	Phone: 920.872.2032

Waterbody Information

Waterbody:	Wheeler Lake - WI
Waterbody size:	293
Depth Average:	4

Sample ID	Sample Location	Test	Method	Results	Sampling Date / Time
CTM15592-1	A-1	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15593-1	A-3	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15594-1	A-6	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15595-1	A-12	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/30/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15596-1	A-24	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/30/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15597-1	B-1	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	24.0	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15598-1	B-3	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15599-1	B-6	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15600-1	B-12	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	

CTM15601-1	B-24	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/30/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15602-1	D-1	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	11.5	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15603-1	D-3	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	2.7	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15604-1	D-6	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15605-1	D-12	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/29/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	
CTM15606-1	D-24	ProcellaCOR/florpyrauxifen-benzyl (ug/L)	FAST 16	<1	05/30/2019
		ProcellaCOR acid/florpyrauxifen (ug/L)	FAST 16	<1	

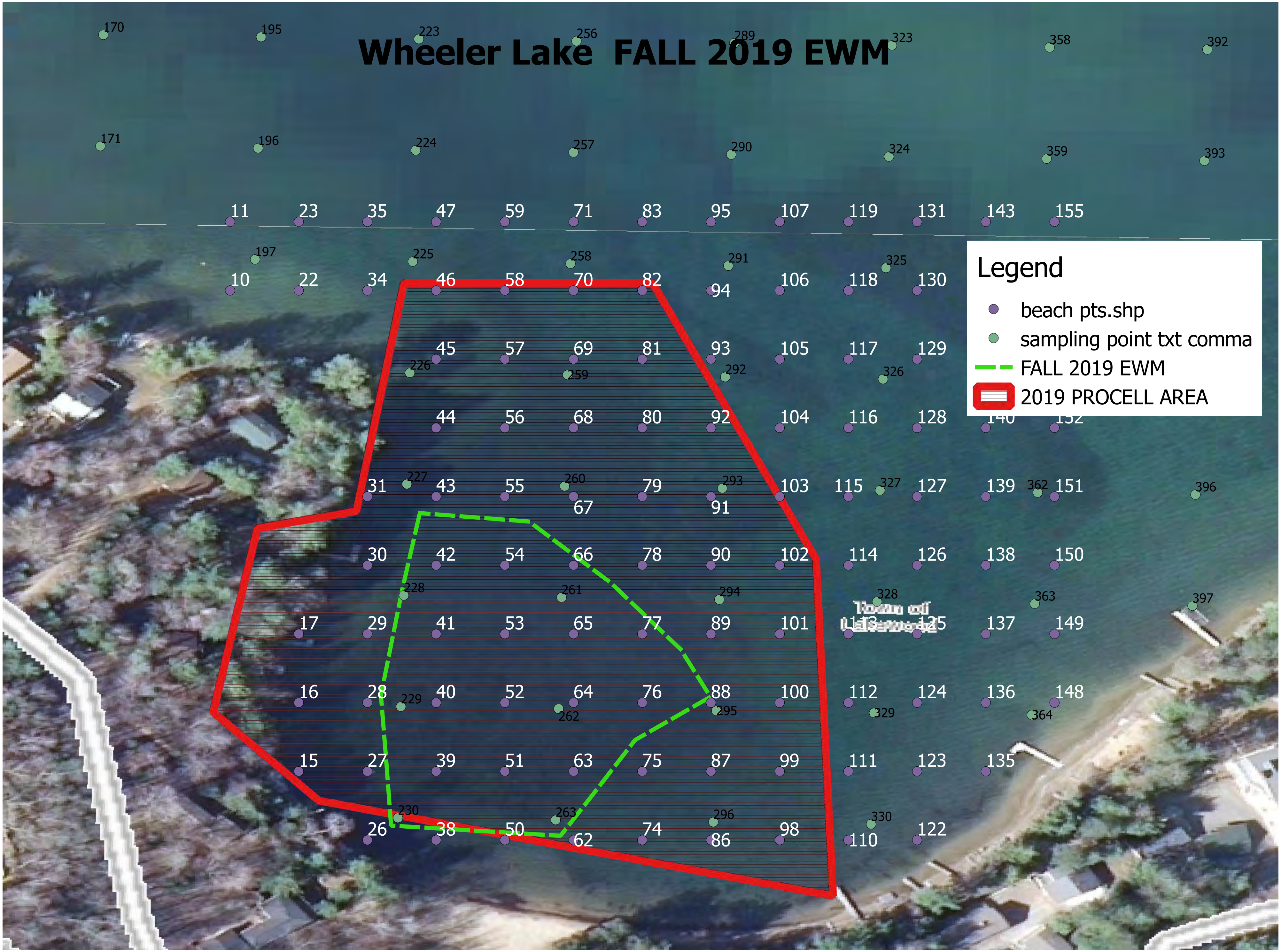
ANALYSIS STATEMENTS:
SAMPLE RECEIPT /HOLDING TIMES: All samples arrived in an acceptable condition and were analyzed within prescribed holding times in accordance with the SRTC Laboratory Sample Receipt Policy unless otherwise noted in the report.
PRESERVATION: Samples requiring preservation were verified prior to sample analysis and any qualifiers will be noted
in the report.
QA/QC CRITERIA: All analyses met method criteria, except as noted in the report with data qualifiers.
COMMENTS: No significant observations were made unless noted in the report.
MEASUREMENT UNCERTAINTY: Uncertainty of measurement has been determined and is available upon request.

Laboratory Information
Date / Time Received: 06/05/19 11:00 AM
Date Results Sent: Friday, June 21, 2019

This entire report was reviewed and approved for release.

Reviewed By: Laboratory Supervisor


Legend
2019 AQUA AREAS
FALL 2019 EWM
2019 PROCELL AREA


Wheeler Lake FALL 2019 EWM
Legend
beach pts.shp
sampling point txt comma
FALL 2019 EWM
2019 PROCELL AREA

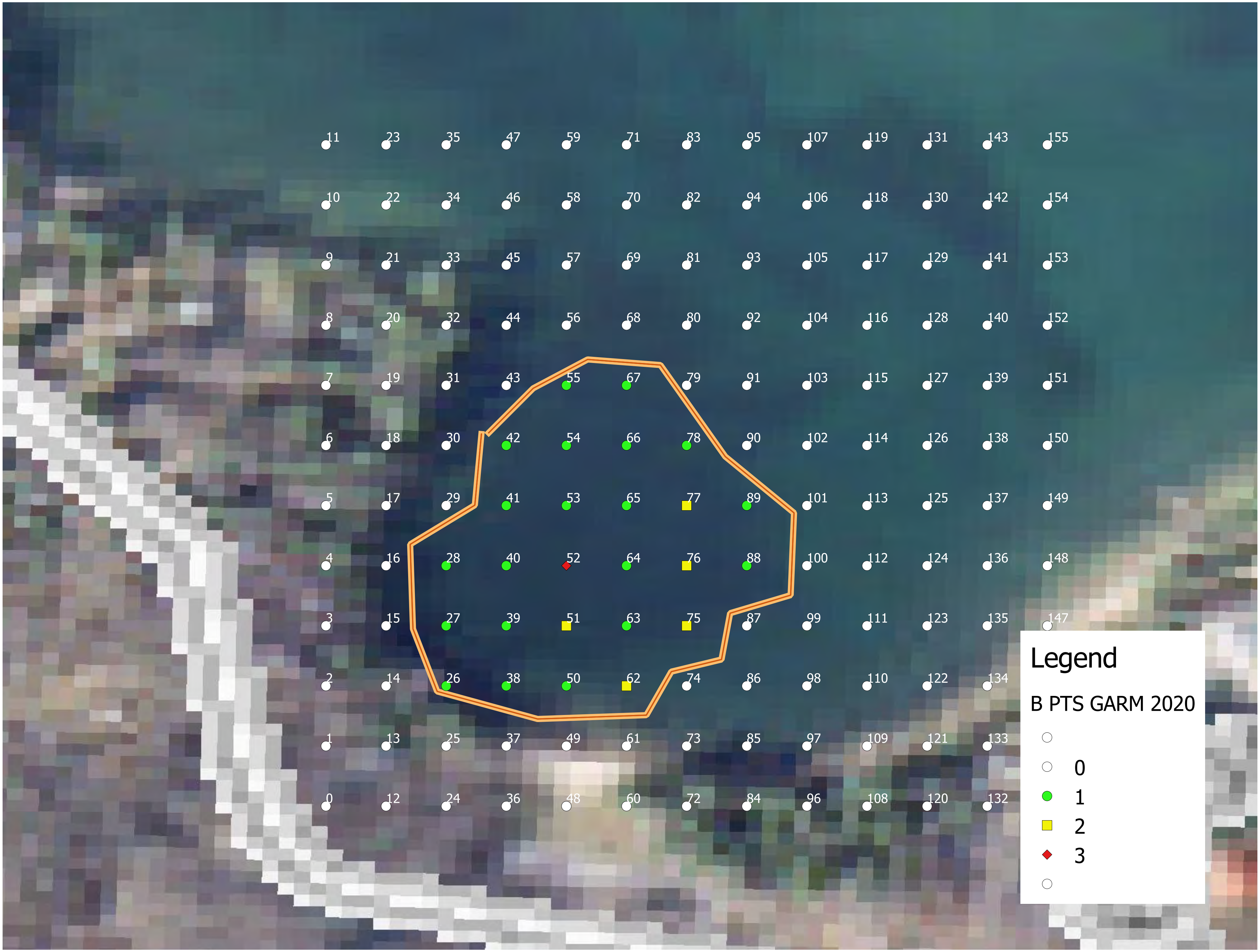
Map of Wheeler Lake Dive Sites

Detailed Diving Activities

Date	Dive Location	Latitude	Longitude	Time Under-water	AIS CF Removed	AIS Density	Avg Water Depth	Native By-Catch (CF)	Native Species	Native Density	Substrate Type
7/15/19	C	45.32100	-88.48400	1.33	0.5	Low	9	<0.5	Northern Milfoil	Low	Organic
7/15/19	F1	45.32515	-88.47120	1	1.0	Low	6	<0.5	Pondweeds	Medium	Organic
7/15/19	F2	45.32640	-88.47120	1.25	0.5	Low	5.5	<0.5	Northern Milfoil	Medium	Organic
7/16/19	E	45.32320	-88.47340	1.33	2.5	Medium	6.5	<0.5	Pondweeds	High	Organic
7/16/19	E	45.32320	-88.47340	1	1.5	Medium	6.5	<0.5	Pondweeds	High	Organic
7/16/19	C	45.32080	-88.48400	0.83	0.0	Low	7	0.00	None	Medium	Organic
7/16/19	C	45.32177	-88.48251	0.17	1.0	Medium	14	<0.5	Pondweeds	High	Organic
7/16/19	F1	45.32524	-88.47112	1	0.5	Low	5.5	<0.5	Pondweeds	High	Organic
7/16/19	E	45.32320	-88.47340	1.42	0.5	Low	6.5	<0.5	Pondweeds	High	Organic
7/16/19	E	45.32320	-88.47340	0.67	0.5	Low	6.5	<0.5	Pondweeds	High	Organic
7/17/19	C	45.32160	-88.48320	1.25	0.5	Low	7.5	0.00	None	Medium	Organic
7/17/19	F1	45.32600	-88.47100	1.08	0.5	Low	5	0.00	None	High	Organic
7/17/19	F1	45.32572	-88.47053	0.92	0.5	Low	5	0.00	None	High	Organic
7/17/19	B	45.31379	-88.47857	0.58	5.0	High	13	0.00	None	Low	Organic
7/17/19	D	45.32360	-88.48220	1.33	0.0	Low	5.5	0.00	None	Low	Organic
7/17/19	D	45.35584	-88.48169	1	8.5	High	8	0.50	Pondweeds	Medium	Organic
Total					**23.5**						

Detailed Diving Activities

Date	Dive Location	Latitude	Longitude	Time Under-water	AIS CF Removed	AIS Density	Avg Water Depth	Native By-Catch (CF)	Native Species	Native Density	Substrate Type
8/8/19	E	45.32401	-88.47292	0.92	0.5	Low	8	0.00	None	Low	Organic
8/8/19	F1	45.32536	-88.47099	2.67	0.5	Low	6	0.00	None	High	Organic
8/8/19	D	45.32284	-88.48119	1.67	2.5	Low	10	0.00	None	Low	Organic
8/8/19	D	45.32299	-88.48160	0.75	1.5	Low	10	0.00	None	Low	Organic
8/20/19	E	45.32314	-88.47312	1.67	0.5	Low	6.5	<0.5	Pondweeds	High	Organic
8/20/19	E	45.32314	-88.47312	1.25	0.5	Low	6.5	<0.5	Pondweeds	High	Organic
8/20/19	F2	45.32603	-88.47187	1.42	0.5	Low	5.5	<0.5	Pondweeds	High	Organic
8/20/19	F1	45.32492	-88.47150	0.42	1.0	Low	6.5	<0.5	Pondweeds	High	Organic
8/20/19	D	45.32332	-88.48131	1.67	3.0	Low	6	0.00	None	Medium	Organic
8/21/19	D	45.32332	-88.48131	1.5	0.5	Low	6.5	0.00	None	Medium	Organic
8/21/19	E	45.32325	-88.47296	1.25	0.5	Low	6.5	<0.5	Pondweeds	High	Organic
8/21/19	F2	45.32603	-88.47187	1.08	0.5	Low	5	<0.5	Pondweeds	High	Organic
8/21/19	C	45.32165	-88.48304	1.33	2.0	Medium	3	<0.5	Pondweeds	High	Organic
8/21/19	E	45.32314	-88.47329	1.42	1.0	Low	6.5	0.00	None	High	Organic
Total					**15.0**						


Legend
B PTS GARM 2020
0
1
2
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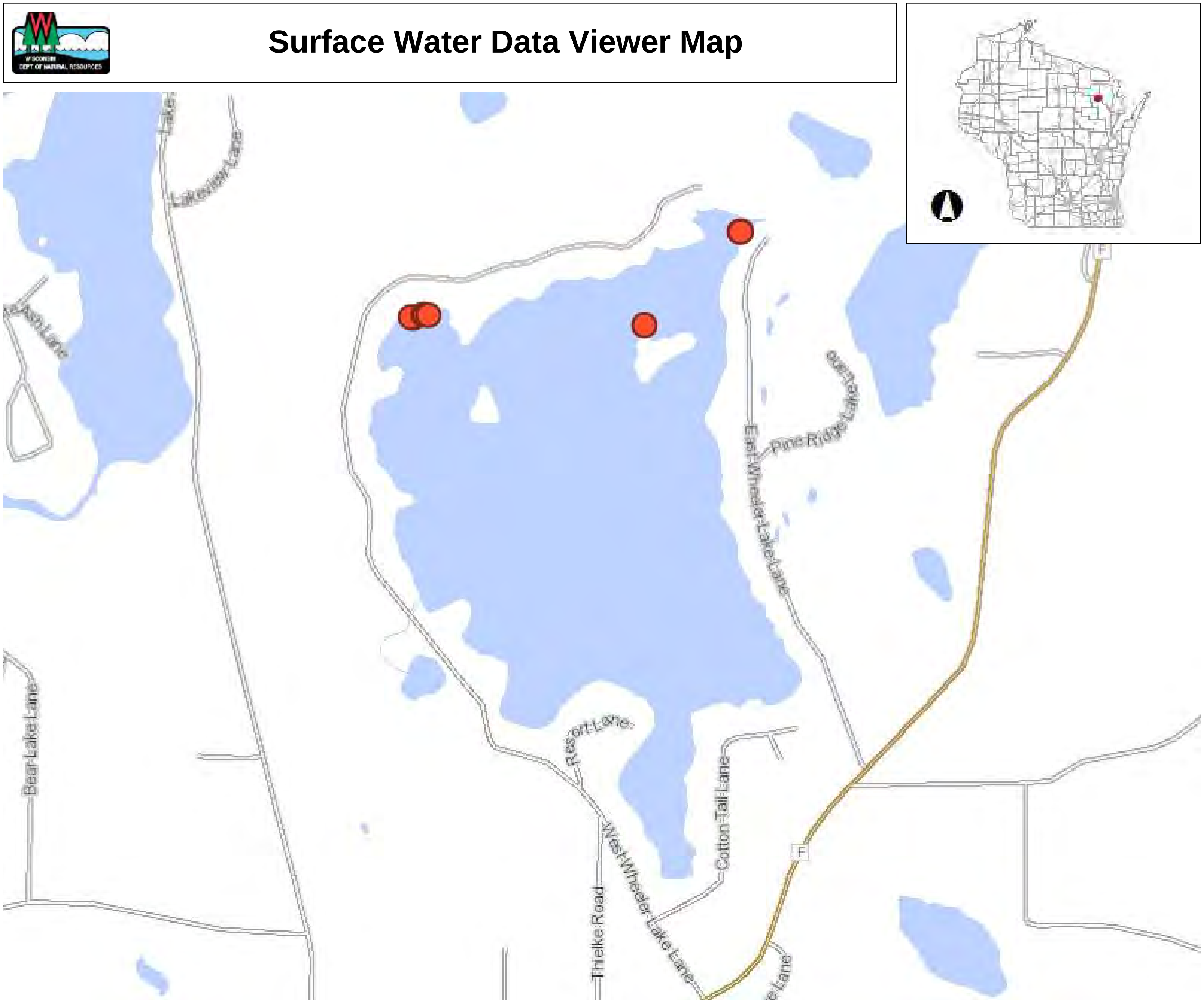
Surface Water Data Viewer Map



Legend

- Municipality
- State Boundaries
- County Boundaries
- Major Roads
  - Interstate Highway
  - State Highway
  - US Highway
- County and Local Roads
  - County HWY
  - Local Road
- Railroads
- Tribal Lands
- Rivers and Streams
- Intermittent Streams
- Lakes and Open water

0.5 | 0 | 0.25 | 0.5 Miles

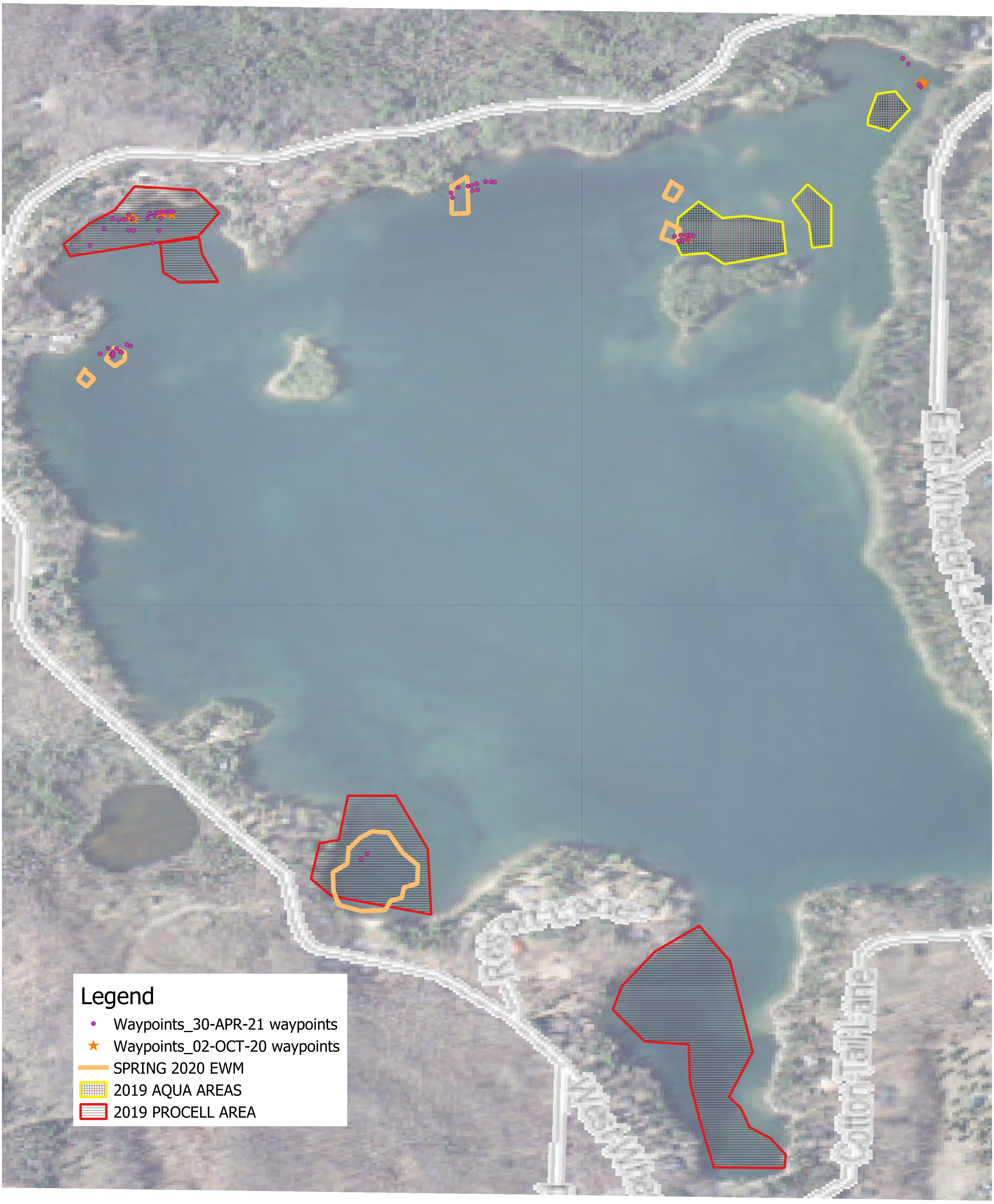
NAD_1983_HARN_Wisconsin_TM

1: 15,840

Notes

Map of Wheeler Lake Dive Sites

WHEELER LAKE
SPRING EWM SURVEY
APRIL 30, 2021



Appendix E – Aquatic Plant Management Alternatives

Management Options for Aquatic Plants

Option	Permit Needed?	How it Works	PROS	CONS
No treatment	N	Do not treat plants	Protects native species that can prevent spread of invasive or exotic species, enhance water quality, and provide habitat for aquatic fauna	May allow small population of invasive plants to become larger, more difficult to control later
			No financial cost	
			No system disturbance	
			No harmful effects of chemicals	
			Permit not required	
Mechanical Control	Required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season
		Wide range of techniques, from manual to highly mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase turbidity and nutrient release
a. Handpulling/Manual raking	Y/N	SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive
		Works best in soft sediments	Can be highly selective	Needs to be carefully monitored
			Can be done by shoreline property owners without permits within an area <30 ft wide OR where selectively removing EWM or CLP	Roots, runners, and even fragments of some species (including EWM) will start new plants, so all of plant must be removed
			Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species	Small-scale control only

b.	Harvesting	Y	Plants are "mowed" at depths of 2-5 ft, collected with a conveyor and off-loaded onto shore	Immediate results	Not selective in species removed
			Harvest invasives only if invasive is already present throughout the lake	EWM removed before it has the opportunity to autofragment, which may create more fragments than created by harvesting	Fragments of vegetation can re-root
				Usually minimal impact to the lake	Can remove some small fish and reptiles from lake
				Harvested lanes through dense weed beds can increase growth and survival of some fish	Initial cost of harvester expensive
				Can remove some nutrients from lake	
Biological Control		Y	Living organisms (e.g. insects or fungi) eat or infect plants	Self-sustaining; organism will over-winter, resume eating its host the next year	Effectiveness will vary as control agent's population fluctates
				Lowers density of problem plant to allow growth of natives	Provides moderate control - complete control unlikely
					Control response may be slow
					Must have enough control agent to be effective
a.	Weevils on EWM*	Y	Native weevil prefers EWM to other native water-milfoil	Native to Wisconsin: weevil cannot "escape" and become a problem	Need to stock large numbers, even if some already present
				Selective control of target species	Need good habitat for overwintering on shore (leaf litter) associated with undeveloped shorelines
				Longer-term control with limited management	Bluegill populations decrease densities through predation
b.	Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortalitiy	May be species specific	Largely experimental; effectiveness and longevity unknown
				May provide long-term control	Possible side effects not understood
				Few dangers to humans or animals	

c.	Allelopathy	Y	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long-term, maintenance-free control	Initial transplanting slow and labor-intensive
				Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermilfoil growth	Spikerushes native to WI, and have not effectively limited EWM growth
					Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d.	Restoration of native plants	N; strongly recommend plan and consultation with DNR	Diverse native plant community established to repel invasive species	Native plants provide food and habitat for aquatic fauna	Initial transplanting slow and labor-intensive
				Diverse native community more repellant to invasive species	Nuisance invasive plants may outcompete plantings
				Supplements removal techniques	Largely experimental; few well-documented cases

Physical Control	Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Drawdown	Y, May require Environmental Assessment	Lake water lowered; plants killed when sediment dries, compacts or freezes	Can be effective, especially when done in winter, provided drying and freezing occur. Sediment compaction is possible over winter	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Must have a water level control device or siphon	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced
		Season or duration of drawdown can change effects	Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality	May impact attached wetlands and shallow wells near shore
			Success for EWM, variable success for CLP*	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning
			Restores natural water fluctuation important for all aquatic ecosystems	Winter drawdawn must start in early fall or will kill hibernating reptiles and amphibians
				Controversial
b. Dredging	Y	Plants are removed along with sediment	Increases water depth	Expensive
		Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
		For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
		Extensive planning required		Sediment testing is expensive and may be necessary
				Removes benthic organisms
				Dredged materials must be disposed of
				Severe impact on lake ecosystem

c.	Dyes	Y	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity	Appropriate for very small water bodies
				Usually non-toxic, degrades naturally over a few weeks.	Should not be used in pond or lake with outflow
					Impairs aesthetics
					Affects to microscopic organisms unknown
d.	Mechanical circulation (Solarbees)	Y	Water is circulated and oxygenated	Reduces blue-green algae	Method is experimental; no published studies have been done
			Oxygenation of water decreases ammonium-nitrogen, which is a preferred nutrient source of EWM, theoretically limiting EWM growth (has not been demonstrated scientifically)	May reduce levels of ammonium-nitrogen in the water and at the sediment interface, which could reduce EWM growth	Although EWM prefers ammonium-nitrogen to nitrate, it will uptake nitrate efficiently, so EWM growth may not be affected
				Oxygenated water may reduce phosphorus release from sediments if mixing is complete	Units are aesthetically unpleasing
				Reduces chance of fish kills by aerating water	Units could be a navigational hazard
e.	Non-point source nutrient control	N	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use)	Attempts to correct source of problem, not treat symptoms	Results can take years to be evident due to internal recycling of already-present lake nutrients
				Could improve water clarity and reduce occurrences of algal blooms	Expensive
				Native plants may be able to compete invasive species better in low-nutrient conditions	Requires landowner cooperation and regulation
					Improved water clarity may increase plant growth

Chemical Control	Required under NR 107	Granules or liquid chemicals kill plants or cease plant growth; some chemicals used primarily for algae Results usually within 10 days of treatment, but repeat treatments usually needed	Some flexibility for different situations Some can be selective if applied correctly Can be used for restoration activities	Possible toxicity to aquatic animals or humans, especially applicators May kill desirable plant species, e.g. native water-milfoil or native pondweeds Treatment set-back requirements from potable water sources and/or drinking water use restrictions after application, usually based on concentration May cause severe drop in dissolved oxygen causing fish kill, depends on plant biomass killed, temperatures and lake size and shape Controversial
a. 2,4-D (Weedar, Navigate)	Y	Systemic[1] herbicide selective to broadleaf[2] plants that inhibits cell division in new tissue Applied as liquid or granules during early growth phase	Moderately to highly effective, especially on EWM Monocots, such as pondweeds (e.g. CLP) and many other native species not affected. Can be used in synergy with endotholl for early season CLP and EWM treatments Widely used aquatic herbicide	May cause oxygen depletion after plants die and decompose Cannot be used in combination with copper herbicides (used for algae) Toxic to fish
b. Endothall (Aquathol)	Y	Broad-spectrum[3], contact[4] herbicide that inhibits protein synthesis Applied as liquid or granules	Especially effective on CLP and also effective on EWM May be effective in reducing reestablishment of CLP if reapplied several years in a row in early spring Can be selective depending on concentration and seasonal timing Can be combined with 2,4-D for early season CLP and EWM treatments, or with copper compounds Limited off-site drift	Kills many native pondweeds Not as effective in dense plant beds Not to be used in water supplies Toxic to aquatic fauna (to varying degrees) 3-day post-treatment restriction on fish consumption

c.	Diquat (Reward)	Y	Broad-spectrum, contact herbicide that disrupts cellular functioning Applied as liquid, can be combined with copper treatment	Mostly used for water-milfoil and duckweed Rapid action Limited direct toxicity on fish and other animals	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads Toxic to aquatic invertebrates Needs to be reapplied several years in a row Ineffective in muddy or cold water (<50°F)
d.	Fluridone (Sonar or Avast)	Y; special permit and Environmental Assessment may be required	Broad-spectrum, systemic herbicide that inhibits photosynthesis; some reduction in non-target effects can be achieved by lowering dosage Must be applied during early growth stage Available with a special permit only; chemical applications beyond 150 ft from shore not allowed under NR 107	Effective on EWM for 1 to 4 years with aggressive follow-up treatments Applied at very low concentration Slow decomposition of plants may limit decreases in dissolved oxygen Low toxicity to aquatic animals	Affects many non-target plants, particularly native milfoils, coontails, elodea, and naiads, even at low concentrations. These plants are important to combat invasive species Requires long contact time: 60-90 days Demonstrated herbicide resistance in hydrilla subjected to repeat treatments, EWM has the potential to develop resistance Unknown effect of repeat whole-lake treatments on lake ecology
e.	Glyphosate (Rodeo)	Y	Broad-spectrum, systemic herbicide that disrupts enzyme formation and function Usually used for purple loosestrife stems or cattails Applied as liquid spray or painted on loosetrife stems	Effective on floating and emergent plants such as purple loosestrife Selective if carefully applied to individual plants Non-toxic to most aquatic animals at recommended dosages	Effective control for 1-5 years Ineffective in muddy water Cannot be used near potable water intakes RoundUp is often illegally substituted for Rodeo Associated surfactants of RoundUp believed to be toxic to reptiles and amphibians No control of submerged plants

f.	Triclopyr (Renovate)	Y	Systemic herbicide selective to broadleaf plants that disrupts enzyme function	Effective on many emergent and floating plants	Impacts may occur to some native plants at higher doses (e.g. coontail)
			Applied as liquid spray or liquid	More effective on dicots, such as purple loosestrife; may be more effective than glyphosate	May be toxic to sensitive invertebrates at higher concentrations
				Results in 3-5 weeks	Retreatment opportunities may be limited due to maximum seasonal rate (2.5 ppm)
				Low toxicity to aquatic animals	Sensitive to UV light; sunlight can break herbicide down prematurely
				No recreational use restrictions following treatment	Relatively new management option for aquatic plants (since 2003)
g.	Copper compounds (Cutrine Plus)	Y	Broad-spectrum, systemic herbicide that prevents photosynthesis	Reduces algal growth and increases water clarity	Elemental copper accumulates and persists in sediments
			Used to control planktonic and filamentous algae	No recreational or agricultural restrictions on water use following treatment	Short-term results
				Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Precipitates rapidly in alkaline waters
					Small-scale control only, because algae are easily windblown
					Toxic to invertebrates, trout and other fish, depending on the hardness of the water
					Long-term effects of repeat treatments to benthic organisms unknown
					Clear water may increase plant growth

h.	Lime slurry	Y	Applications of lime temporarily raise water pH, which limits the availablity of inorganic carbon to plants, preventing growth	Appears to be particularly effective against EWM and CLP	Relatively new technique, so effective dosage levels and exposure requirements are not yet known
				Prevents release of sediment phosphorus, which reduces algal growth	Short-term increase in turbidity due to suspended lime particles
				Increases growth of native plants beneficial as fish habitat	High pH detrimental to aquatic invertebrates
					May restrict growth of some native plants
i.	Alum (aluminum sulfate)	Y	Removes phosphorus from water column and creates barrier on sediment to prevent internal loading of phosphorus	Most often used against algal problems	Must not eat fish for 30 days from treatment area
			Dosage must consider pH, hardness and water volume	Improves water clarity	Minimal effect on aquatic plants, or increased light penetration may increase aquatic plants
					Toxic to aquatic animals, including fish at some concentrations

***EWM - Eurasian water-milfoil**
***CLP - Curly-leaf pondweed**
[1]Systemic herbicide - Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.
[2]Broadleaf herbicide - Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.
[3]Broad-spectrum herbicide - Affects both monocots and dicots.
[4]Contact herbicide - Unable to move within the plant; kills only plant tissue it contacts directly.

Techniques for Aquatic Plant Control Not Allowed in Wisconsin

	Option	How it Works	PROS	CONS
Biological Control				
a.	Carp	Plants eaten by stocked carp	Effective at removing aquatic plants	Illegal to transport or stock carp in Wisconsin
			Involves species already present in Madison lakes	Carp cause resuspension of sediments, increased water temperature, lower dissolved oxygen levels, and reduction of light penetration
				Widespread plant removal deteriorates habitat for other fish and aquatic organisms
				Complete alteration of fish assemblage possible
				Dislodging of plants such as EWM or CLP turions can lead to accelerated spreading of plants
b.	Crayfish	Plants eaten by stocked crayfish	Reduces macrophyte biomass	Illegal to transport or stock crayfish in Wisconsin
				Control not selective and may decimate plant community
				Not successful in productive, soft-bottom lakes with many fish predators
				Complete alteration of fish assemblage possible
Mechanical Control				
a.	Cutting (no removal)	Plants are "mowed" with underwater cutter	Creates open water areas rapidly	Root system remains for regrowth
			Works in water up to 25 ft	Fragments of vegetation can re-root and spread infestation throughout the lake
				Nutrient release can cause increased algae and bacteria and be a nuisance to riparian property owners
				Not selective in species removed
				Small-scale control only
b.	Rototilling	Sediment is tilled to uproot plant roots and stems	Decreases stem density, can affect entire plant	Creates turbidity
		Works in deep water (17 ft)	Small-scale control	Not selective in species removed
			May provide long-term control	Fragments of vegetation can re-root
				Complete elimination of fish habitat
				Releases nutrients
				Increased likelihood of invasive species recolonization

c.	Hydroraking	Mechanical rake removes plants from lake Works in deep water (14 ft)	Creates open water areas rapidly	Fragments of vegetation can re-root May impact lake fauna Creates turbidity Plants regrow quickly Requires plant disposal
Physical Control				
a.	Fabrics/ Bottom Barriers	Prevents light from getting to lake bottom	Reduces turbidity in soft-substrate areas Useful for small areas	Eliminates all plants, including native plants important for a healthy lake ecosystem May inhibit spawning by some fish Need maintenance or will become covered in sediment and ineffective Gas accumulation under blankets can cause them to dislodge from the bottom Affects benthic invertebrates Anaerobic environment forms that can release excessive nutrients from sediment

Aquatic Plant Management

Aquatic plants are a critical component in an aquatic ecosystem. Any management of an ecosystem can have negative or even detrimental effects on the whole ecosystem. Therefore, the practice of managing aquatic plants should not be taken lightly. The concept of Aquatic Plant Management (APM) is highly variable since different aquatic resource users want different things. Ideal management to one individual may mean providing prime fish habitat, for another it may be to remove surface vegetation for boating. The practice of APM is also highly variable. There are numerous APM strategies designed to achieve different plant management goals. Some are effective on a small scale, but ineffective in larger situations. Others can only be used for specific plants or during certain times of the growing season. Of course, the types of plants that are to be managed will also help determine which APM alternatives are feasible. The following paragraphs discuss the APM methods used today. The discussion is largely adopted from *Managing Lakes and Rivers, North American Lake Management Society, 2001*, supplemented with other applicable current resources and references. The methods summarized here are largely for management of rooted aquatic plants, not algae. While some methods may also have effects on nuisance algae blooms, the focus is submergent rooted aquatic macrophytes. This information is provided to allow the user to gain a basic understanding of the APM method, it is not designed to an all-inclusive APM decision-making matrix. APM alternatives can be divided into the following categories: Physical Controls, Chemical Controls, and Biological Controls.

Physical Controls

Physical APM controls include various methods to prevent growth or remove part or all of the aquatic plant. Both manual and mechanical techniques are employed. Physical APM methods include:

- Hand pulling
- Hand cutting
- Bottom barriers
- Light limitation (dyes, covers)
- Mechanical harvesting
- Hydroraking/rototilling
- Suction Dredging
- Dredging
- Drawdown

Each of these methods are described below. The costs, benefits, and drawbacks of each APM strategy are provided.

Hand Pulling: This method involves digging out the entire unwanted plant including stems and roots with a hand tool such as a spade. This method is highly selective and suitable for shallow areas for removing invasive species that have not become well established. This technique is obviously not for use on large dense beds of nuisance aquatic plants. It is best used in areas less than 3 feet, but can be used in deeper areas with divers using scuba and snorkeling equipment. It can also be used in combination with the suction dredge method. In Wisconsin, hand pulling may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

Advantages: This technique results in immediate clearing of the water column of nuisance plants. When a selective technique is desired in a shallow, small area, hand pulling is a good choice. It is also useful in sensitive areas where disruption must be minimized.

Disadvantages: This method is labor intensive. Disturbing the substrate may affect fish habitat, increase turbidity, and may promote phosphorus re-suspension and subsequent algae blooms.

Costs: The costs are highly variable. There is practically no cost using volunteers or lakeshore landowners to remove unwanted plants, however, using divers to remove plants can get relatively expensive. Hand pulling labor can range from $400 to $800 per acre.

Hand Cutting: This is another manual method where the plants are cut below the water surface. Generally the roots are not removed. Tools such as rakes, scythes or other specialized tools are pulled through the plant beds by boat or several people. This method is not as selective as hand pulling. This method is well suited for small areas near docks and piers. Plant material must be removed from the water. In Wisconsin, hand cutting may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

Advantages: This technique results in immediate clearing of the water column of nuisance plants. Costs are minimal.

Disadvantages: This is also a fairly time consuming and labor intensive option. Since the technique does not remove the entire plant (leaves root system and part of plant), it may not result in long-term reductions in growth. This technique is not species specific and results in all aquatic plants being removed from the water column.

Costs: The costs range from minimal for volunteers using hand equipment up to over $1,000 for a hand-held mechanized cutting implement. Hand cutting labor can range from $400 to $800 per acre.

Bottom Barriers: A barrier material is applied over the lake bottom to prevent rooted aquatics from growing. Natural barriers such as clay, silt, and gravel can be used although eventually plants may root in these areas again. Artificial materials can also be used for bottom barriers and anchored to the substrate. Barrier materials include burlap, nylon, rubber, polyethylene, polypropylene, and fiberglass. Barriers include both solid and porous forms. A permit is required to place any fill or barrier structure on the substrate of a waterbody. This method is well suited for areas near docks, piers, and beaches. Periodic maintenance may be required to remove accumulated silt or rooting fragments from the barrier.

Advantages: This technique does not result in production of plant fragments. Properly installed, it can provide immediate and multiple year relief.

Disadvantages: This is a non-selective option, all plants beneath the barrier will be affected. Some materials are costly and installation is labor intensive. Other disadvantages include limited material durability, gas accumulation beneath the cover, or possible re-growth of plants from above or below the cover. Fish and invertebrate habitat is disrupted with this technique. Anchored barriers can be difficult to remove.

Costs: A 20 foot x 60 foot panel cost $265, while a 30 foot x 50 foot panel cost $375 (this does not include installation costs). Costs for materials vary from $0.15 per square foot ($ft^2$) to over $0.35/ ft^2. The costs for installation range from $0.25 to $0.50/ ft^2. Barriers can cost $20,000 to $50,000 per acre.

<u>Light Limitation:</u> Limiting the available light in the water column can prevent photosynthesis and plant growth. Dark colored dyes and surface covers have been used to accomplish light limitation. Dyes are effective in shallow water bodies where their concentration can be kept at a desired concentration and loss through dilution is less. This method is well suited for small, shallow water bodies with no outlets such as private ponds.

Surface covers can be a useful tool in small areas such as docks and beaches. While they can interfere with aquatic recreation, they can be timed to produce results and not affect summer recreation uses.

<u>Advantages:</u> Dyes are non-toxic to humans and aquatic organisms. No special equipment is required for application. Light limitation with dyes or covers method may be selective to shade tolerant species. In addition to submerged macrophyte control, it can also control the algae growth.

<u>Disadvantages:</u> The application of water column dyes is limited to shallow water bodies with no outlets. Repeated dye treatments may be necessary. The dyes may not control peripheral or shallow-water rooted plants. This technique must be initiated before aquatic plants start to grow. Covers inhibit gas exchange with the atmosphere.

<u>Costs:</u> Costs for a commercial dye and application range from $100 to $500 per acre.

<u>Mechanical Harvesting:</u> Mechanical harvesters are essentially cutters mounted on barges that cut aquatic plants at a desired depth. Maximum cutting depths range from 5 to 8 feet with a cutting width of 6.5 to 12 feet. Cut plant materials require collection and removal from the water. Conventional harvesters combine cutting, collecting, storing, and transporting cut vegetation into one piece of equipment. Transport barges and shoreline conveyors are also available to remove the cut vegetation. The cut plants must be removed from the water body. The equipment needs are dictated by severity of the aquatic plant problem. Contract harvesting services are available in lieu of purchasing used or new equipment. Trained staff will be necessary to operate a mechanical harvester. To achieve maximum removal of plant material, harvesting is usually completed during the summer months while submergent vegetation is growing to the surface. The duration of control is variable and re-growth of aquatic plants is common. Factors such as timing of harvest, water depth, depth of cut, and timing can influence the effectiveness of a harvesting operation. Harvesting is suited for large open areas with dense stands of exotic or nuisance plant species. Permits are now required in Wisconsin to use a mechanical harvester.

<u>Advantages:</u> Harvesting provides immediate visible results. Harvesting allows plant removal on a larger scale than other options. Harvesting provides flexible area control. In other words, the harvester can be moved to where it is needed and used to target problem areas. This technique has the added benefit of removing the plant material from the water body and therefore also eliminates a possible source of nutrients often released during fall decay of aquatic plants. While removal of nutrients through plant harvesting has not been quantified, it can be important in aquatic ecosystem with low nutrient inputs.

<u>Disadvantages:</u> Drawbacks of harvesting include: limited depth of operation, not selective within the application area, and expensive equipment costs.

Harvesting also creates plant fragments, which can be a concern since certain plants have the ability to reproduce from a plant fragment (e.g. Eurasian watermilfoil). Plant fragments may re-root and spread a problem plant to other areas. Harvesting can have negative effects on non-target plants, young of year fish, and invertebrates. The harvesting will require trained operators and maintenance of equipment. Also, a disposal site or landspreading program will be needed for harvested plants.

Costs: Costs for a harvesting operation are highly variable dependant on program scale. New harvesters range from $40,000 for small machines to over $100,000 for large, deluxe models. Costs vary considerably, depending on the model, size, and options chosen. Specially designed units are available, but may cost more. The equipment can last 10 to 15 years. A grant for ½ the equipment cost can be obtained from the Wisconsin Waterways Commission and a loan can be obtained for the remaining capital investment. Operation costs include insurance, fuel, spare parts, and payroll. Historical harvesting values have been reported at $200 up to $1,500 per acre. A survey of recent Wisconsin harvesting operations reported costs to be between $100/acre and $200/acre.

A used harvester can be purchased for $10,000 to $20,000. Maintenance costs are typically higher.

Contract harvesting costs approximately $125/per hour plus mobilization to the water body. Contractors can typically harvest ¼ to ½ acre per hour for an estimated cost of $250 to $500/per acre.

Hydroraking/rototilling: Hydroraking is the use of a boat or barge mounted machine with a rake that is lowered to the bottom and dragged. The tines of the rake rip out roots of aquatic plants. Rototilling, or rotovation, also rips out root masses but uses a mechanical rotating head with tines instead of a rake. Harvesting may need to be completed in conjunction with these methods to gather floating plant fragments. This application would best be used where nuisance populations are well established and prevention of stem fragments is not critical. A permit would be required for this type of aquatic plant management and would only be issued in limited cases of extreme infestations of nuisance vegetation. In Wisconsin, this method is not looked upon favorably or at all by the WDNR.

Advantages: These methods have the potential for significant reductions in aquatic plant growth. These methods can remove the plant stems and roots, resulting in thorough plant disruption. Hydroraking/rototilling can be completed in “off season” months avoiding interference with summer recreation activities.

Disadvantages: Hydroraking/rototilling are not selective and may destroy substrate habitat important to fish and invertebrates. Suspension of sediments will increase turbidity and release nutrients trapped in bottom sediments into the water column potentially causing algal blooms. These methods can cause floating plant and root fragments, which may re-root and spread the problem. Hydroraking/rototilling are expensive and not likely to be permitted by regulatory agencies.

Costs: Bottom tillage costs vary according to equipment, treatment scale, and plant density. For soft vegetation costs can range from $2,000 to $4,000 per acre. For dense, rooted masses, costs can be up to $10,000 per acre. Contract bottom tillage reportedly ranges from $1,200 to $1,700 per acre (Washington Department of Ecology, 1994).

Suction Dredging: Suction dredging uses a small boat or barge with portable dredges and suction heads. Scuba divers operate the suction dredge and can target removal of whole plants, seeds, and roots. This method may be applied in conjunction with hand cutting where divers dislodge the plants. The plant/sediment slurry is hydraulically pumped to the barge through hoses carried by the diver. Its effectiveness is dependent on sediment composition, density of aquatic plants, and underwater visibility. Suction dredging may be best suited for localized infestations of low plant density where fragmentation must be controlled. A permit will be required for this activity.

Advantages: Diver suction dredging is species –selective. Disruption of sediments can be minimized. These methods can remove the plant stems and roots, resulting in thorough plant disruption and potential longer term control. Fragmentation of plants is minimized. This activity can be completed near and around obstacles such as piers or marinas where a harvester could not operate.

Disadvantages: Diver suction dredging is labor intensive and costly. Upland disposal of dredged slurry can require additional equipment and costs. Increased turbidity in the area of treatment can be a problem. Release of nutrients and other pollutants can also be a problem.

Costs: Suction dredging costs can be variable depending on equipment and transport requirements for slurry. Costs range from $5,000 per acre to $10,000 per acre.

Dredging

Sediment removal through dredging can work as a plant control technique by limiting light through increased water depth or removing soft sediments that are a preferred habitat to nuisance rooted plants. Soft sediment removal is accomplished with drag lines, bucket dredges, long reach backhoes, or other specialized dredging equipment. Dredging has had mixed results in controlling aquatic plant, however it can be highly effective in appropriate situations. Dredging is most often applied in a major restructuring of a severely degraded system. Generally, dredging is an activity associated with other restoration efforts. Comprehensive pre-planning will be necessary for these techniques and a dredging permit would be required.

Advantages: Dredging can remove nutrient reserves which result in nuisance rooted aquatic plant growth. Dredging, when completed, can also actually improve substrate and habitat for more desirable species of aquatic plants, fish, and invertebrates. It allows the complete renovation of an aquatic ecosytem. This method has the potential for significant reductions in aquatic plant growth. These methods can be completed in “off season” months avoiding interference with summer recreation activities.

Disadvantages: Dredging can temporarily destroy important fish and invertebrate habitat. Suspension of sediments usually increases turbidity significantly and can possibly releases nutrients causing algae blooms. Dredging is extremely expensive and requires significant planning. Dredged materials may contain toxic materials (metals, PCBs). Dredged material transportation and disposal of toxic materials are additional management considerations and are potentially expensive. It could be difficult and costly to secure regulatory permits and approvals.

Costs: Dredging costs depend upon the scale of the project and many other factors. It is generally an extremely expensive option.

Drawdown: Water level drawdown exposes the plants and root systems to prolonged freezing and drying to kill the plants. It can be completed any time of the year, however is generally more effective in winter, exposing the lake bed to freezing temperatures. If there is a water level control structure capable of drawdown, it can be an in-expensive way to control some aquatic plants. Aquatic plants vary in their susceptibility to drawdown, therefore, accurate identification of problem species is important. Drawdown is often used for other purposes of improving waterfowl habitat or fishery management, but sometimes has the added benefit of nuisance rooted aquatic plant control. This method can be used in conjunction with a dredging project to excavate nutrient-rich sediments. This method is best suited for use on reservoirs or shallow man-made lakes. A drawdown would require regulatory permits and approvals.

Advantages: A drawdown can result in compaction of certain types of sediments and can be used to facilitate other lake management activities such as dam repair, bottom barrier, or dredging projects. Drawdown can significantly impact populations of aquatic plants that propagate vegetatively. It is inexpensive.

Disadvantages: This method is limited to situations with a water level control structure. Pumps can be used to de-water further if groundwater seepage is not significant. This technique may also result in the removal of beneficial plant species. Drawdowns can decrease bottom dwelling invertebrates and overwintering reptiles and amphibians. Drawdowns can affect adjacent wetlands, alter downstream flows, and potentially impair well production. Drawdowns and any water level manipulation are often highly controversial since shoreline landowners access and public recreation are limited during the drawdown. Fish populations are vulnerable during a drawdown due to over-harvesting by fisherman in decreased water volumes.

Costs: If a suitable outlet structure is available then costs should be minimal. If dewatering pumps would be required or additional management projects such as dredging are completed, additional costs would be incurred. Other costs would include recreational losses and perhaps loss in tourism revenue.

Chemical Controls

Using chemical herbicides to kill nuisance aquatic plants is the oldest APM method. However, past pesticides uses being linked to environmental or human health problems have led to public wariness of chemicals in the environment. Current pesticide registration procedures are more stringent than in the past. While no chemical pesticide can be considered 100 percent safe, federal pesticide regulations are based on the premise that if a chemical is used according to its label instructions it will not cause adverse environmental or human health effects.

Chemical herbicides for aquatic plants can be divided into two categories, systemic and contact herbicides. Systemic herbicides are absorbed by the plant, translocated throughout the plant, and are capable of killing the entire plant, including the roots and shoots. Contact herbicides kill the plant surface in which in comes in contact, leaving roots capable of re-growth. Aquatic herbicides exist under various trade names, causing some confusion. Aquatic herbicides include the following:

- Endothall Based Herbicide
- Diquat Based Herbicide
- Fluridone Based Herbicide
- 2-4 D Based Herbicide
- Glyophosate Based Herbicide
- Triclopyr Based Herbicide
- Phosphorus Precipitation

Each of these methods are described below. The costs, benefits, and drawbacks of each chemical APM alternative are provided.

Endothall Based Herbicide: Endothall is a contact herbicide, attacking a wide range of plants at the point of contact. The chemical is not readily transferred to other plant tissue, therefore regrowth can be expected and repeated treatments may be needed. It is sold in liquid and granular forms under the trade names of Aquathol® or Hydrothol®. Hydrothol is also an algaecide. Most endothall products break down easily and do not remain in the aquatic environment. Endothall products can result in plant reductions for a few weeks to several months. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

Advantages: Endothall products work quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

Disadvantages: The entire plant is not killed when using endothall. Endothall is non-selective in the treatment area. High concentrations can kill fish easily. Water use restrictions (time delays) are necessary for recreation, irrigation, and fish consumption after application.

Costs: Costs vary with treatment area and dosage. Average costs for chemical application range between $400 and $700 per acre.

Diquat Based Herbicide: Diquat is a fast-acting contact herbicide effective on a broad spectrum of aquatic plants. It is sold under the trade name Reward®. Diluted forms of this product are also sold as private label products. Since Diquat binds to sediments readily, its effectiveness is reduced by turbid water. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

Advantages: Diquat works quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

Disadvantages: The entire plant is not killed when using diquat. Diquat is non-selective in the treatment area. Diquat can be inactivated by suspended sediments. Diquat is sometimes toxic to zooplankton at the recommended dose. Limited water used restrictions (water supply, agriculture, and contact recreation) are required after application.

Costs: Costs vary with treatment area and dosage. A general cost estimate for treatment is between $200 and $500 per acre.

Fluoridone Based Herbicide: Fluoridone is a slow-acting systemic herbicide, which is effectively absorbed and translocated by both plant roots and stems. Sonar® and Avast!® is the trade name and it is sold in liquid or granular form. Fluoridone requires a longer contact time and demonstrates delayed toxicity to target plants. Eurasian watermilfoil is more sensitive to fluoridone than other aquatic plants. This allows a semi-selective approach when low enough doses are used. Since the roots are also killed, multi-season effectiveness can be achieved. It is best applied during the early growth phase of the plants. A permit and extensive planning is required for use of this herbicide.

Advantages: Fluoridone is capable of killing roots, therefore producing a longer lasting effect than other herbicides. A variety of emergent and submersed aquatics are susceptible to this herbicide. Fluoridine can be used selectively, based on concentration. A gradual killing of target plants limits severe oxygen depletion from dead plant material. It has demonstrated low toxicity to aquatic fauna such as fish and invertebrates. 3 to 5 year control has been demonstrated. Extensive testing has shown that, when used according to label instructions, it does not pose negative health affects.

Disadvantages: Fluoridine is a very slow-acting herbicide sometimes taking up to several months for visible effects. It requires a long contact time. Fluoridine is extremely soluble and mixable, therefore, not effective in flowing water situations or for treating a select area in a large open lake. Impacts on non-target plants are possible at higher doses. Time delays are necessary on use of the water (water supply, irrigation, and contact recreation) after application.

Costs: Costs vary with treatment area and dosage. Treatment costs range from $500 to $2,000 per acre.

2,4-D Based Herbicide: 2,4-D based herbicides are sold in liquid or granular forms under various trade names. Common granular forms are sold under the trade names Navigate® and Aqua Kleen®. Common liquid forms include DMA 4® and Weedar 64®. 2,4-D is a systemic herbicide that affects broad leaf plants. It has been demonstrated effective against Eurasian watermilfoil, but it may not work on many aquatic plants. Since the roots are also killed, multi-season effectiveness may be achieved. It is best applied during the early growth phase of the plants. Visible results are evident within 10 to 14 days. A permit is required for use of this herbicide.

Advantages: 2,4-D is capable of killing roots, therefore producing a longer lasting effect than some other herbicides. It is fairly fast and somewhat selective, based on application timing and concentration. 2,4-D containing products are moderately to highly effective on a few emergent, floating, or submersed plants.

Disadvantages: 2,4-D can have variable toxicity effects to aquatic fauna, depending on formulation and water chemistry. 2,4-D lasts only a short time in water, but can be detected in sediments for months after application. Time delays are necessary on use of the water (agriculture and contact recreation) after application. The label does not permit use of this product in water used for drinking, irrigation, or livestock watering.

Costs: Costs vary with treatment area and dosage. Treatment costs range from $300 to $800 per acre.

Glyophosate Based Herbicide: Glyophosate has been categorized as both a contact and a systemic herbicide. It is applied as a liquid spray and is sold under the trade name Rodeo® or Pondmaster®. It is a non-selective, broad based herbicide effective against emergent or floating leaved plants, but not submergents. It's effectiveness can be reduced by rain. A permit is required for use of this herbicide.

Advantages: Glyophoshate is moderately to highly effective against emergent and floating-leaf plants resulting in rapid plant destruction. Since it is applied by spraying plants above the surface, the applicator can apply it selectively to target plants. Glyophosate dissipates quickly from natural waters, has a low toxicity to aquatic fauna, and carries no restrictions or time delays for swimming, fishing, or irrigation.

Disadvantages: Glyophoshate is non-selective in the treatment area. Wind can dissipate the product during the application reducing it's effectiveness and cause damage to non-target organisms. Therefore, spray application should only be completed when wind drift is not a problem. This compound is highly corrosive, therefore storage precautions are necessary.

Costs: Costs average $500 to $1,000 per acre depending on the scale of treatment.

Triclopyr Based Herbicide: Triclopyr is a systemic herbicide. It is registered for experimental aquatic use in selected areas only. It is applied as a liquid spray or injected into the subsurface as a liquid. Triclopyr is sold under the trade name Renovate® or Restorate®. Triclopyr has shown to be an effective control to many floating and submersed plants. It has been demonstrated to be highly effective against Eurasian watermilfoil, having little effect on valued native plants such as pondweeds. Triclopyr is most effective when applied during the active growth period of younger plants.

Advantages: This herbicide is fast acting. Triclopyr can be used selectively since it appears more effective against dicot plant species, including several difficult nuisance plants. Testing has demonstrated low toxicity to aquatic fauna.

Disadvantages: At higher doses, there are possible impacts to non-target species. Some forms of this herbicide are experimental for aquatic use and restrictions on use of the treated water are not yet certain.

Biological Controls

There has been recent interest in using biological technologies to control aquatic plants. This concept stems from a desire to use a "natural" control and reduce expenses related to equipment and/or chemicals. While use of biological controls is in its infancy, potentially useful technologies have been identified and show promise for integration with physical and chemical APM strategies. Several biological controls that are in use or are under experimentation include the following:

- Herbivorous Fish
- Herbivorous Insects
- Plant Pathogens
- Native Plants

Each of these methods are described below. The costs, benefits, and drawbacks of each biologic APM method are provided.

Herbivorous Fish: A herbivorous fish such as the non-native grass carp can consume large quantities of aquatic plants. These fish have high growth rates and a wide range of plant food preferences. Stocking rates and effectiveness will depend on many factors including climate, water temperature, type and extent of aquatic plants, and other site-specific issues. Sterile (triploid) fish have been developed resulting in no reproduction of the grass carp and population control. This technology has demonstrated mixed results and is most appropriately used for lake-wide, low intensity control of submersed plants. Some states do not allow stocking of herbivorous fish. In Wisconsin, stocking of grass carp is prohibited.

Advantages: This technology can provide multiple years of aquatic plant control from a single stocking. Compared to other long-term aquatic plant control techniques such as bottom tillage or bottom barriers, costs may be relatively low.

Disadvantages: Sterile grass carp exhibit distinct food preferences, limiting their applicability. Grass carp may feed selectively on the preferred plants, while less preferred plants, including milfoil, may increase. The effects of using grass carp may not be immediate. Overstocking may result in an impact on non-target plants or eradication of beneficial plants, altering lake habitat. Using grass carp may result in algae blooms and increased turbidity. If precautions are not taken (i.e. inlet and outlet control structures to prevent fish migration) the fish may migrate and have adverse effects on non-target vegetation.

Costs: Costs can range from \$50/acre to over \$2,000/acre, at stocking rates of 5 fish/acre to 200 fish/acre.

Herbivorous Insects: Non-native and native insect species have been used to control rooted plants. Using herbivorous insects is intended to selectively control target species. These aquatic larvae of moths, beetles, and thrips use specific host aquatic plants. Several non-native species have been imported under USDA approval and used in integrated pest management programs, a combination of biological, chemical, and mechanical controls.

These non-native insects are being used in southern states to control nuisance plant species and appear climate-limited, their northern range being Georgia and North Carolina. While successes have been demonstrated, non-native species have not established themselves for solving biological problems, sometimes creating as many problems as they solve. Therefore, government agencies prefer alternative controls.

Native insects such as the larvae of midgeflies, caddisflies, beetles, and moths may be successful APM controls in northern states. Recently however, the native aquatic weevil *Euhrychiopsis lecontei* has received the most attention. This weevil has been associated with native northern water milfoil. The weevil can switch plant hosts and feed on Eurasian watermilfoil, destroying it's growth points. While the milfoil weevil is gaining popularity, it is still experimental.

Advantages: Herbivorous insects are expected to have no negative effects on non-target species. The insects have shown promise for long term control when used as part of integrated aquatic plant management programs. The milfoil weevils do not use non-milfoil plants as hosts.

Disadvantages: Natural predator prey cycles indicate that incomplete control is likely. An oscillating cycle of control and re-growth is more likely. Fish predation may complicate controls. Large numbers of milfoil weevils may be required for a dense stand and can be expensive. The weevil leaves the water during the winter, may not return to the water in the spring, and are subject to bird predation in their terrestrial habitat. Application is manual and extremely time consuming. Introducing any species, especially non-native ones, into an aquatic ecosystem may have undesirable effects. Therefore, it is extremely important to understand the life cycles of the insects and the host plants.

Costs: Reported costs of herbivorous insects rang from $300/acre to $3,000/acre.

Specifically, the native milfoil weevils cost approximately $1.00 per weevil. It is generally considered appropriate to use 5 to 7 weevils per stem. Dense stands of milfoil may contain 1 to 2 million stems per acre. Therefore, costs of this new technology are currently prohibitive.

Plant Pathogens: Using a plant pathogen to control nuisance aquatic plants has been studied for many years, however, plant pathogens still remain largely experimental. Fungi are the most common pathogens, while bacteria and viruses have also been used. There is potential for highly specific plant applications.

Advantages: Plant pathogens may be highly species specific. They may provide substantial control of a nuisance species.

Disadvantages: Pathogens are experimental. The effectiveness and longevity of control is not well understood. Possible side effects are also unknown.

Costs: These techniques are experimental therefore a supply of specific products and costs are not established.

Native Plants: This method involves removing the nuisance plant species through chemical or physical means and re-introducing seeds, cuttings, or whole plants of desirable species. Success has been variable. When using seeds, they need to be planted early enough to encourage the full growth and subsequent seed production of those plants. Transplanting mature plants may be a better way to establish seed producing populations of desirable aquatics. Recognizing that a healthy, native, desirable plant community may be resistant to infestations of nuisance species, planting native plants should be encouraged as an APM alternative. Non-native plants can not be translocated.

Advantages: This alternative can restore native plant communities. It can be used to supplement other methods and potentially prevent future needs for costly repeat APM treatments.

Disadvantages: While this appears to be a desirable practice, it is experimental at this time and there are not many well documented successes. Nuisance species may eventually again invade the areas of native plantings. Careful planning is required to ensure that the introduced species do not themselves become nuisances. Hand planting aquatic plants is labor intensive.

Costs: Costs can be highly variable depending on the selected native species, numbers of plants ordered, and the nearest dealer location.

Aquatic Plant Prevention

The phrase "an ounce of prevention is worth a pound of cure" certainly holds true for APM. Prevention is the best way to avoid nuisance aquatic plant growth. Prevention of the spread of invasive aquatic plants must also be achieved. Inspecting boats, trailers, and live wells for live aquatic plant material is the best way to prevent nuisance aquatic plants from entering a new aquatic ecosystem. Protecting the desirable native plant communities is also important in maintaining a healthy aquatic ecosystem and preventing the spread of nuisance aquatics once they are present.

Prolific growth of nuisance aquatic plants can be prevented by limiting nutrient (i.e. phosphorus) inputs to the water body. Aeration or phosphorus precipitation can achieve controls of in-lake cycling of phosphorus, however, if there are additional outside sources of nutrients, these methods will be largely ineffective in controlling algae blooms or intense aquatic macrophyte infestations. Watershed management activities to control nutrient laden storm water runoff are critical to controlling excessive nutrient loading to the water bodies. Nutrient loading can be prevented/minimized by the following:

- Shoreline buffers
- Using non-phosphorus fertilizers on lawns
- Settling basins for storm water effluents

Appendix F – Wheeler Lake Water Quality Data

Water Quality SWIMS Database 1950 to 2020

DNR Parameter	Description	Result	Units	Present/Ab	Start Date/Time
410	ALKALINITY TOTAL CACO3	87.4	MG/L		4/25/10
410	ALKALINITY TOTAL CACO3	84.7	MG/L		9/1/09
410	ALKALINITY TOTAL CACO3	85	MG/L		2/16/76
410	ALKALINITY TOTAL CACO3	80	MG/L		10/27/76
410	ALKALINITY TOTAL CACO3	85	MG/L		2/18/86
410	ALKALINITY TOTAL CACO3	80	MG/L		7/27/76
410	ALKALINITY TOTAL CACO3	84	MG/L		10/17/09
410	ALKALINITY TOTAL CACO3	86.1	MG/L		7/2/10
410	ALKALINITY TOTAL CACO3	84.1	MG/L		9/28/10
410	ALKALINITY TOTAL CACO3	77.6	MG/L		5/28/19
410	ALKALINITY TOTAL CACO3	76.4	MG/L		9/28/19
410	ALKALINITY TOTAL CACO3	73	MG/L		4/29/76
410	ALKALINITY TOTAL CACO3	98.7	MG/L		2/19/11
410	ALKALINITY TOTAL CACO3	105	MG/L		7/18/79
410	ALKALINITY TOTAL CACO3	59	MG/L		7/18/79
				83.06667	
				105	
				59	
1105	ALUMINUM TOTAL	25	UG/L		2/18/86
916	CALCIUM TOTAL	20	MG/L		2/16/76
916	CALCIUM TOTAL	20	MG/L		10/27/76
916	CALCIUM TOTAL	20	MG/L		2/18/86
916	CALCIUM TOTAL	18	MG/L		7/27/76
916	CALCIUM TOTAL	18	MG/L		4/29/76
916	CALCIUM TOTAL	17	MG/L		7/18/79
916	CALCIUM TOTAL	13	MG/L		7/18/79
				23.33333	
				59	
				13	
918	CALCIUM TOTAL RECOVERABLE	20.6	MG/L		4/25/10
918	CALCIUM TOTAL RECOVERABLE	**	MG/L		10/17/09
918	CALCIUM TOTAL RECOVERABLE	19	MG/L		7/2/10
918	CALCIUM TOTAL RECOVERABLE	17.2	MG/L		9/28/10
918	CALCIUM TOTAL RECOVERABLE	18.6	MG/L		5/28/19
918	CALCIUM TOTAL RECOVERABLE	17.6	MG/L		9/28/19
918	CALCIUM TOTAL RECOVERABLE	22.2	MG/L		2/19/11
				18.55385	
				22.2	
				17.2	
940	CHLORIDE	1	MG/L		2/16/76
940	CHLORIDE	0	MG/L		10/27/76
940	CHLORIDE	1.8	MG/L		2/18/86
940	CHLORIDE	1	MG/L		7/27/76
940	CHLORIDE	1	MG/L		4/29/76
940	CHLORIDE	1	MG/L		7/18/79

940	CHLORIDE	1	MG/L		7/18/79
				0.971429	
				1.8	
				0	
32210	CHLOROPHYLL A UNCORRECTED	3.46	UG/L		7/18/79
32210	CHLOROPHYLL A UNCORRECTED	3.46	UG/L		7/18/79
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0.35	UG/L		4/25/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.44	UG/L		9/1/09
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.31	UG/L		9/6/07
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.15	UG/L		6/14/09
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.24	UG/L		9/7/09
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.72	UG/L		7/31/09
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.35	UG/L		9/5/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.43	UG/L		6/26/11
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.03	ug/L		9/2/18
99717	CHLOROPHYLL A, FLUORESCENCE (WE	3.23	UG/L		7/31/15
99717	CHLOROPHYLL A, FLUORESCENCE (WE	3.2	UG/L		10/17/09
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0	UG/L		7/2/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.48	ug/L		7/28/19
99717	CHLOROPHYLL A, FLUORESCENCE (WE	3.7	ug/L		9/1/19
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.48	UG/L		7/25/13
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.79	UG/L		9/3/13
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.96	UG/L		6/29/15
99717	CHLOROPHYLL A, FLUORESCENCE (WE	3.08	UG/L		9/28/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.12	UG/L		6/10/12
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.56	UG/L		7/22/12
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.37	UG/L		8/30/12
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0.636	ug/L		5/28/19
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.32	UG/L		7/25/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.57	ug/L		6/30/18
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.69	ug/L		9/28/19
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.48	UG/L		7/25/06
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.61	UG/L		7/1/10
99717	CHLOROPHYLL A, FLUORESCENCE (WE	3.3	UG/L		8/31/14
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.1	ug/L		6/23/19
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0.976	ug/L		7/31/18
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.2	UG/L		6/28/13
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0	UG/L		2/19/11
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2	UG/L		7/31/07
99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.56	UG/L		6/24/07
99717	CHLOROPHYLL A, FLUORESCENCE (WE	4.12	UG/L		10/25/06
99717	CHLOROPHYLL A, FLUORESCENCE (WE	0.382	ug/L		7/3/20
99717	CHLOROPHYLL A, FLUORESCENCE (WE	4.53	UG/L		6/26/16
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.15	UG/L		6/30/14

99717	CHLOROPHYLL A, FLUORESCENCE (WE	1.69	UG/L		7/31/11
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.29	UG/L		6/29/08
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.68	UG/L		9/2/08
99717	CHLOROPHYLL A, FLUORESCENCE (WE	2.51	ug/L		8/31/20
				2.090095	
				4.53	
				0	
80	COLOR	5	PT-CO		2/18/86
95	CONDUCTIVITY, UMHOS/CM @ 25C	187	US/CM		4/25/10
95	CONDUCTIVITY, UMHOS/CM @ 25C	181	US/CM		9/1/09
95	CONDUCTIVITY, UMHOS/CM @ 25C	168	UMHOS/CM		2/16/76
95	CONDUCTIVITY, UMHOS/CM @ 25C	151	UMHOS/CM		10/27/76
95	CONDUCTIVITY, UMHOS/CM @ 25C	176	UMHOS/CM		7/27/76
95	CONDUCTIVITY, UMHOS/CM @ 25C	182	US/CM		10/17/09
95	CONDUCTIVITY, UMHOS/CM @ 25C	183	US/CM		7/2/10
95	CONDUCTIVITY, UMHOS/CM @ 25C	181	US/CM		9/28/10
95	CONDUCTIVITY, UMHOS/CM @ 25C	169	uS/cm		5/28/19
95	CONDUCTIVITY, UMHOS/CM @ 25C	164	uS/cm		9/28/19
95	CONDUCTIVITY, UMHOS/CM @ 25C	152	UMHOS/CM		4/29/76
95	CONDUCTIVITY, UMHOS/CM @ 25C	209	US/CM		2/19/11
95	CONDUCTIVITY, UMHOS/CM @ 25C	186	UMHOS/CM		7/18/79
95	CONDUCTIVITY, UMHOS/CM @ 25C	156	UMHOS/CM		7/18/79
				174.6429	
				209	
				151	
300	DISSOLVED OXYGEN FIELD	9.8	MG/L		2/16/76
300	DISSOLVED OXYGEN FIELD	9.9	MG/L		10/27/76
300	DISSOLVED OXYGEN FIELD	8.7	MG/L		7/27/76
300	DISSOLVED OXYGEN FIELD	10	MG/L		4/29/76
300	DISSOLVED OXYGEN FIELD	9.5	MG/L		7/18/79
300	DISSOLVED OXYGEN FIELD	4.6	MG/L		7/18/79
				8.75	
				10	
				4.6	
40002	EURASIAN WATERMILFOIL (MYRIOPHY		Y/N		7/19/06
900	HARDNESS TOTAL CACO3	89	MG/L		2/16/76
900	HARDNESS TOTAL CACO3	87	MG/L		10/27/76
900	HARDNESS TOTAL CACO3	90	MG/L		2/18/86
900	HARDNESS TOTAL CACO3	81	MG/L		7/27/76
900	HARDNESS TOTAL CACO3	79	MG/L		4/29/76
				85.2	
				90	

				79	
899	HARDNESS TOTAL RECOVERABLE CAL(	95.7	MG/L		4/25/10
899	HARDNESS TOTAL RECOVERABLE CAL(*E		MG/L		10/17/09
899	HARDNESS TOTAL RECOVERABLE CAL(	90.4	MG/L		7/2/10
899	HARDNESS TOTAL RECOVERABLE CAL(	82.4	MG/L		9/28/10
899	HARDNESS TOTAL RECOVERABLE CAL(	85.4	MG/L		5/28/19
899	HARDNESS TOTAL RECOVERABLE CAL(	83.6	MG/L		9/28/19
899	HARDNESS TOTAL RECOVERABLE CAL(	103	MG/L		2/19/11
				87.86364	
				103	
				82.4	
46570	HARDNESS, CA MG CALCULATED (MG,	87.002	MG/L		2/16/76
46570	HARDNESS, CA MG CALCULATED (MG,	87.002	MG/L		10/27/76
46570	HARDNESS, CA MG CALCULATED (MG,	89.8846	MG/L		2/18/86
46570	HARDNESS, CA MG CALCULATED (MG,	82.008	MG/L		7/27/76
46570	HARDNESS, CA MG CALCULATED (MG,	77.89	MG/L		4/29/76
46570	HARDNESS, CA MG CALCULATED (MG,	75.393	MG/L		7/18/79
46570	HARDNESS, CA MG CALCULATED (MG,	69.523	MG/L		7/18/79
				85.28903	
				89.8846	
				69.523	
74010	IRON	0.08	MG/L		7/18/79
74010	IRON	0.08	MG/L		7/18/79
80410	Lake 10 Year Chla Lower 80% Percenti	2.335638			7/31/15
80413	Lake 10 Year Chla REC Lower 80% Per	0			7/31/15
80412	Lake 10 Year Chla REC Upper 80% Per	0			7/31/15
80409	Lake 10 Year Chla Upper 80% Percenti	2.7954732			7/31/15
80408	Lake 10 Year Mean Chla FAL Assessme	2.5655556			7/31/15
80411	Lake 10 Year Mean Chla REC Assessme	0			7/31/15
80414	Lake 10 Year Mean TP Assessment Va	11.353636			6/30/16
80416	Lake 10 Year TP Lower 80% Percentile	9.0028176			6/30/16
80415	Lake 10 Year TP Upper 80% Percentile	12.316256			6/30/16
927	MAGNESIUM TOTAL	9	MG/L		2/16/76
927	MAGNESIUM TOTAL	9	MG/L		10/27/76
927	MAGNESIUM TOTAL	9.7	MG/L		2/18/86
927	MAGNESIUM TOTAL	9	MG/L		7/27/76
927	MAGNESIUM TOTAL	8	MG/L		4/29/76
927	MAGNESIUM TOTAL	8	MG/L		7/18/79
927	MAGNESIUM TOTAL	9	MG/L		7/18/79
921	MAGNESIUM TOTAL RECOVERABLE	10.7	MG/L		4/25/10
921	MAGNESIUM TOTAL RECOVERABLE **		MG/L		10/17/09
921	MAGNESIUM TOTAL RECOVERABLE	10.5	MG/L		7/2/10
921	MAGNESIUM TOTAL RECOVERABLE	9.6	MG/L		9/28/10

921	MAGNESIUM TOTAL RECOVERABLE	9.47	MG/L		5/28/19
921	MAGNESIUM TOTAL RECOVERABLE	9.63	MG/L		9/28/19
921	MAGNESIUM TOTAL RECOVERABLE	11.5	MG/L		2/19/11
				9.469231	
				11.5	
				8	
1055	MANGANESE	30	UG/L		7/18/79
1055	MANGANESE	30	UG/L		7/18/79
71921	MERCURY	0.7	MG/KG		2/18/86
71935	MERCURY	0.084	UG/G		5/27/08
71935	MERCURY	0.1	UG/G		5/27/08
71935	MERCURY	0.46	UG/G		5/27/08
71935	MERCURY	0.076	UG/G		5/27/08
71935	MERCURY	0.18	UG/G		5/27/08
71935	MERCURY	0.26	UG/G		5/27/08
71935	MERCURY	0.16	UG/G		5/27/08
71935	MERCURY	0.31	UG/G		5/27/08
71935	MERCURY	0.32	UG/G		5/27/08
71935	MERCURY	0.37	UG/G		5/7/08
71935	MERCURY	0.35	UG/G		5/7/08
71935	MERCURY	0.28	UG/G		5/27/08
71935	MERCURY	0.18	UG/G		5/27/08
71935	MERCURY	0.16	UG/G		5/27/08
71935	MERCURY	0.27	UG/G		5/27/08
71935	MERCURY	0.38	UG/G		5/27/08
71935	MERCURY	0.74	UG/G		5/27/08
71935	MERCURY	0.24	UG/G		4/27/94
71935	MERCURY	0.4	UG/G		4/27/94
71935	MERCURY	0.57	UG/G		4/27/94
71935	MERCURY	0.45	UG/G		10/12/94
71935	MERCURY	0.49	UG/G		4/27/94
71935	MERCURY	0.37	UG/G		4/27/94
71935	MERCURY	0.33	UG/G		10/12/94
71935	MERCURY	0.34	UG/G		4/26/94
71935	MERCURY	0.26	UG/G		4/26/94
71935	MERCURY	0.35	UG/G		4/26/94
71935	MERCURY	0.4	UG/G		4/27/94
71935	MERCURY	0.22	UG/G		4/27/94
71900	MERCURY TOTAL	0.74	UG/L		2/18/86
				0.34	
				0.74	
				0.076	
625	NITROGEN KJELDAHL TOTAL	0.54	MG/L		4/25/10
625	NITROGEN KJELDAHL TOTAL	0.54	MG/L		9/1/09

625	NITROGEN KJELDAHL TOTAL	0.4	MG/L		2/18/86
625	NITROGEN KJELDAHL TOTAL	0.5	MG/L		10/17/09
625	NITROGEN KJELDAHL TOTAL	0.51	MG/L		7/2/10
625	NITROGEN KJELDAHL TOTAL	0.455	MG/L		9/3/19
625	NITROGEN KJELDAHL TOTAL	0.6	MG/L		9/28/10
625	NITROGEN KJELDAHL TOTAL	0.46	MG/L		5/28/19
625	NITROGEN KJELDAHL TOTAL	0.503	MG/L		9/28/19
625	NITROGEN KJELDAHL TOTAL	0.498	MG/L		7/15/19
625	NITROGEN KJELDAHL TOTAL	0.8	MG/L		2/19/11
				0.527818	
				0.8	
				0.4	
608	NITROGEN NH3-N DISS	0.24	MG/L		2/16/76
608	NITROGEN NH3-N DISS	0.04	MG/L		10/27/76
608	NITROGEN NH3-N DISS	0.06	MG/L		2/18/86
608	NITROGEN NH3-N DISS	0.09	MG/L		7/27/76
608	NITROGEN NH3-N DISS	0.0424	MG/L		5/28/19
608	NITROGEN NH3-N DISS	ND	MG/L		9/28/19
608	NITROGEN NH3-N DISS	0.27	MG/L		4/29/76
608	NITROGEN NH3-N DISS	0.06	MG/L		7/18/79
608	NITROGEN NH3-N DISS	0.03	MG/L		7/18/79
				0.10405	
				0.27	
				0.03	
61574	NITROGEN NH3-N UN-IONIZED	0.0010227	MG/L		2/16/76
61574	NITROGEN NH3-N UN-IONIZED	7.753E-05	MG/L		10/27/76
61574	NITROGEN NH3-N UN-IONIZED	0.009019	MG/L		7/27/76
61574	NITROGEN NH3-N UN-IONIZED	0.0038721	MG/L		4/29/76
619	NITROGEN NH3-N UN-IONIZED % TOT	0.0012435	MG/L		2/16/76
619	NITROGEN NH3-N UN-IONIZED % TOT	9.427E-05	MG/L		10/27/76
619	NITROGEN NH3-N UN-IONIZED % TOT	0.0109661	MG/L		7/27/76
619	NITROGEN NH3-N UN-IONIZED % TOT	0.004708	MG/L		4/29/76
613	NITROGEN NO2-N DISS	0.003	MG/L		7/18/79
613	NITROGEN NO2-N DISS	0.002	MG/L		7/18/79
631	NITROGEN NO3+NO2 DISS (AS N)		MG/L	ND	4/25/10
631	NITROGEN NO3+NO2 DISS (AS N)	0.03	MG/L		2/16/76
631	NITROGEN NO3+NO2 DISS (AS N)	0.02	MG/L		10/27/76
631	NITROGEN NO3+NO2 DISS (AS N)	0.02	MG/L		2/18/86
631	NITROGEN NO3+NO2 DISS (AS N)	0.02	MG/L		7/27/76
631	NITROGEN NO3+NO2 DISS (AS N)	*ND	MG/L		10/17/09
631	NITROGEN NO3+NO2 DISS (AS N)		MG/L	0.09	4/29/76

				0.0225	
				0.03	
				0.002	
618	NITROGEN NO3-N DISS	0.02	MG/L		7/18/79
618	NITROGEN NO3-N DISS	0.02	MG/L		7/18/79
605	NITROGEN ORGANIC		MG/L	0.34	2/16/76
605	NITROGEN ORGANIC	0.42	MG/L		10/27/76
605	NITROGEN ORGANIC	0.35	MG/L		7/27/76
605	NITROGEN ORGANIC		MG/L	0.2	4/29/76
605	NITROGEN ORGANIC	0.32	MG/L		7/18/79
605	NITROGEN ORGANIC	0.37	MG/L		7/18/79
				0.365	
				0.42	
				0.02	
600	NITROGEN TOTAL	0.4	MG/L		7/18/79
600	NITROGEN TOTAL	0.38	MG/L		7/18/79
301	OXYGEN, DISSOLVED, PERCENT OF SA	67.1241	%		2/16/76
301	OXYGEN, DISSOLVED, PERCENT OF SA	81.1475	%		10/27/76
301	OXYGEN, DISSOLVED, PERCENT OF SA	103.572	%		7/27/76
301	OXYGEN, DISSOLVED, PERCENT OF SA	86.2078	%		4/29/76
400	PH FIELD	7.8	SU		2/16/76
400	PH FIELD	7.2	SU		10/27/76
400	PH FIELD	8.4	SU		7/27/76
400	PH FIELD	8	SU		4/29/76
403	PH LAB	8.27	SU		4/25/10
403	PH LAB	8.37	SU		9/1/09
403	PH LAB	8.1	SU		2/16/76
403	PH LAB	8	SU		10/27/76
403	PH LAB	8	SU		2/18/86
403	PH LAB	8.5	SU		7/27/76
403	PH LAB	8.11	SU		10/17/09
403	PH LAB	8.54	SU		7/2/10
403	PH LAB	8.21	SU		9/28/10
403	PH LAB	8.31	SU		5/28/19
403	PH LAB	8.19	SU		9/28/19
403	PH LAB	7.7	SU		4/29/76
403	PH LAB	7.91	SU		2/19/11
403	PH LAB	7.63	SU		2/19/11

403	PH LAB	7.6	SU		7/18/79
403	PH LAB	8.3	SU		7/18/79
				8.057	
				8.54	
				7.2	
671	PHOSPHATE ORTHO DISS	0.006	MG/L		2/16/76
671	PHOSPHATE ORTHO DISS	0.004	MG/L		10/27/76
671	PHOSPHATE ORTHO DISS	0.008	MG/L		7/27/76
671	PHOSPHATE ORTHO DISS	0.005	MG/L		4/29/76
671	PHOSPHATE ORTHO DISS	0.006	MG/L		7/18/79
				0.0058	
				0.008	
				0.004	
665	PHOSPHORUS TOTAL	0.009	MG/L		4/25/10
665	PHOSPHORUS TOTAL	0.006	MG/L		9/1/09
665	PHOSPHORUS TOTAL	0.008	MG/L		9/6/07
665	PHOSPHORUS TOTAL	0.009	MG/L		4/25/09
665	PHOSPHORUS TOTAL	0.007	MG/L		6/14/09
665	PHOSPHORUS TOTAL	0	MG/L		9/7/09
665	PHOSPHORUS TOTAL	0.007	MG/L		7/31/09
665	PHOSPHORUS TOTAL	0.012	MG/L		9/5/10
665	PHOSPHORUS TOTAL	0.012	MG/L		6/26/11
665	PHOSPHORUS TOTAL	0.01	MG/L		2/16/76
665	PHOSPHORUS TOTAL	0.03	MG/L		10/27/76
665	PHOSPHORUS TOTAL	0.011	MG/L		2/18/86
665	PHOSPHORUS TOTAL	0.01	MG/L		7/27/76
665	PHOSPHORUS TOTAL	0.0106	MG/L		9/2/18
665	PHOSPHORUS TOTAL	0.00842	MG/L		7/31/15
665	PHOSPHORUS TOTAL	0.011	MG/L		10/17/09
665	PHOSPHORUS TOTAL	0.007	MG/L		7/2/10
665	PHOSPHORUS TOTAL	0.0111	MG/L		9/3/19
665	PHOSPHORUS TOTAL	0.0148	MG/L		7/28/19
665	PHOSPHORUS TOTAL	0.0147	MG/L		9/1/19
665	PHOSPHORUS TOTAL	0.00597	MG/L		7/25/13
665	PHOSPHORUS TOTAL	0.0267	MG/L		9/3/13
665	PHOSPHORUS TOTAL	0.0124	MG/L		5/26/15
665	PHOSPHORUS TOTAL	0.00877	MG/L		6/29/15
665	PHOSPHORUS TOTAL	0.022	MG/L		9/28/10
665	PHOSPHORUS TOTAL	0.009	MG/L		6/10/12
665	PHOSPHORUS TOTAL	0.01	MG/L		7/22/12
665	PHOSPHORUS TOTAL	0.011	MG/L		8/30/12
665	PHOSPHORUS TOTAL	0.0109	MG/L		5/28/19
665	PHOSPHORUS TOTAL	0.008	MG/L		7/25/10
665	PHOSPHORUS TOTAL	0.00923	MG/L		4/28/19
665	PHOSPHORUS TOTAL	0.0074	MG/L		6/30/18
665	PHOSPHORUS TOTAL	0.0209	MG/L		9/28/19

665	PHOSPHORUS TOTAL	0.012	MG/L		7/25/06
665	PHOSPHORUS TOTAL	0.008	MG/L		7/1/10
665	PHOSPHORUS TOTAL	0.013	MG/L		8/31/14
665	PHOSPHORUS TOTAL	0.01	MG/L		4/1/12
665	PHOSPHORUS TOTAL	0.0142	MG/L		5/8/16
665	PHOSPHORUS TOTAL	0.0064	MG/L		5/23/13
665	PHOSPHORUS TOTAL	0.0127	MG/L		6/23/19
665	PHOSPHORUS TOTAL	0.01	MG/L		4/29/76
665	PHOSPHORUS TOTAL	0.0094	MG/L		7/31/18
665	PHOSPHORUS TOTAL	0.00833	MG/L		6/28/13
665	PHOSPHORUS TOTAL	0.009	MG/L		2/19/11
665	PHOSPHORUS TOTAL	0.009	MG/L		7/31/07
665	PHOSPHORUS TOTAL	0	MG/L		6/24/07
665	PHOSPHORUS TOTAL	0.008	MG/L		10/25/06
665	PHOSPHORUS TOTAL	0.0127	MG/L		7/3/20
665	PHOSPHORUS TOTAL	0.01	MG/L		4/25/07
665	PHOSPHORUS TOTAL	0.0126	MG/L		6/26/16
665	PHOSPHORUS TOTAL	0.00989	MG/L		5/30/14
665	PHOSPHORUS TOTAL	0.0111	MG/L		6/30/14
665	PHOSPHORUS TOTAL	0.007	MG/L		5/7/11
665	PHOSPHORUS TOTAL	0.008	MG/L		7/31/11
665	PHOSPHORUS TOTAL	0.007	MG/L		5/4/08
665	PHOSPHORUS TOTAL	0.008	MG/L		6/29/08
665	PHOSPHORUS TOTAL	0.009	MG/L		9/2/08
665	PHOSPHORUS TOTAL	0.0141	MG/L		8/31/20
665	PHOSPHORUS TOTAL	0.009	MG/L		7/18/79
665	PHOSPHORUS TOTAL	0.01	MG/L		7/18/79
				0.010489	
				0.03	
				0	
937	POTASSIUM, TOTAL	1.1	MG/L		2/16/76
937	POTASSIUM, TOTAL	1	MG/L		10/27/76
937	POTASSIUM, TOTAL	0.9	MG/L		2/18/86
937	POTASSIUM, TOTAL	0.97	MG/L		7/27/76
937	POTASSIUM, TOTAL	0.9	MG/L		4/29/76
937	POTASSIUM, TOTAL	1	MG/L		7/18/79
937	POTASSIUM, TOTAL	1.4	MG/L		7/18/79
				1.038571	
				1.4	
				0.9	
78	SECCHI DEPTH	14.025	METERS	4.25	10/27/76
78	SECCHI DEPTH	11.55	METERS	3.5	7/27/76
78	SECCHI DEPTH	13.2	METERS	4	4/29/76
78	SECCHI DEPTH	12	IN	144	7/18/79
49701	SECCHI DEPTH - FEET	27	FEET		5/27/88
49701	SECCHI DEPTH - FEET	9	FEET		9/15/87
49701	SECCHI DEPTH - FEET	11.5	FEET		8/21/87

49701	SECCHI DEPTH - FEET	23	FEET	6/17/87
49701	SECCHI DEPTH - FEET	19	FEET	5/16/87
49701	SECCHI DEPTH - FEET	13.5	FEET	10/2/86
49701	SECCHI DEPTH - FEET	13	FEET	8/16/86
49701	SECCHI DEPTH - FEET	14.5	FEET	7/25/86
49701	SECCHI DEPTH - FEET	16.5	FEET	7/4/86
49701	SECCHI DEPTH - FEET	17.5	FEET	6/13/86
49701	SECCHI DEPTH - FEET	16	FEET	8/10/91
49701	SECCHI DEPTH - FEET	25	FEET	6/24/91
49701	SECCHI DEPTH - FEET	12	FEET	9/13/90
49701	SECCHI DEPTH - FEET	13	FEET	8/22/90
49701	SECCHI DEPTH - FEET	16	FEET	7/18/90
49701	SECCHI DEPTH - FEET	20	FEET	6/21/90
49701	SECCHI DEPTH - FEET	12.5	FEET	9/30/89
49701	SECCHI DEPTH - FEET	10.5	FEET	8/18/89
49701	SECCHI DEPTH - FEET	15	FEET	7/31/89
49701	SECCHI DEPTH - FEET	15	FEET	7/9/89
49701	SECCHI DEPTH - FEET	22	FEET	6/17/89
49701	SECCHI DEPTH - FEET	14	FEET	10/15/88
49701	SECCHI DEPTH - FEET	10.5	FEET	9/7/88
49701	SECCHI DEPTH - FEET	8.5	FEET	8/9/88
49701	SECCHI DEPTH - FEET	16.75	FEET	5/21/87
49701	SECCHI DEPTH - FEET	15.5	FEET	9/28/90
49701	SECCHI DEPTH - FEET	12	FEET	9/21/89
49701	SECCHI DEPTH - FEET	34	FEET	6/23/12
49701	SECCHI DEPTH - FEET	24.25	FEET	6/7/08
49701	SECCHI DEPTH - FEET	15.5	FEET	7/4/08
49701	SECCHI DEPTH - FEET	16	FEET	8/8/08
49701	SECCHI DEPTH - FEET	18.25	FEET	9/20/08
49701	SECCHI DEPTH - FEET	24.5	FEET	6/7/00
49701	SECCHI DEPTH - FEET	15.25	FEET	7/20/86
49701	SECCHI DEPTH - FEET	17	FEET	8/29/97
49701	SECCHI DEPTH - FEET	22	FEET	4/18/94
49701	SECCHI DEPTH - FEET	21	FEET	8/4/12
49701	SECCHI DEPTH - FEET	17	FEET	8/18/12
49701	SECCHI DEPTH - FEET	24	FEET	6/22/13
49701	SECCHI DEPTH - FEET	24	FEET	7/4/13
49701	SECCHI DEPTH - FEET	22	FEET	7/20/13
49701	SECCHI DEPTH - FEET	20	FEET	6/22/88
49701	SECCHI DEPTH - FEET	27	FEET	6/9/88
49701	SECCHI DEPTH - FEET	27	FEET	6/3/88
49701	SECCHI DEPTH - FEET	10	FEET	9/27/87
49701	SECCHI DEPTH - FEET	9	FEET	9/9/87
49701	SECCHI DEPTH - FEET	10.5	FEET	9/2/87
49701	SECCHI DEPTH - FEET	11	FEET	8/29/87
49701	SECCHI DEPTH - FEET	10.5	FEET	7/31/87
49701	SECCHI DEPTH - FEET	11	FEET	7/19/87

49701	SECCHI DEPTH - FEET	17.5	FEET	7/4/87
49701	SECCHI DEPTH - FEET	23.5	FEET	6/8/87
49701	SECCHI DEPTH - FEET	20	FEET	5/31/87
49701	SECCHI DEPTH - FEET	23	FEET	5/8/87
49701	SECCHI DEPTH - FEET	25	FEET	5/1/87
49701	SECCHI DEPTH - FEET	13.5	FEET	9/24/86
49701	SECCHI DEPTH - FEET	13.5	FEET	9/20/86
49701	SECCHI DEPTH - FEET	14	FEET	9/13/86
49701	SECCHI DEPTH - FEET	12	FEET	9/6/86
49701	SECCHI DEPTH - FEET	13	FEET	8/23/86
49701	SECCHI DEPTH - FEET	13.25	FEET	8/6/86
49701	SECCHI DEPTH - FEET	14	FEET	7/31/86
49701	SECCHI DEPTH - FEET	16.5	FEET	7/9/86
49701	SECCHI DEPTH - FEET	16.5	FEET	6/26/86
49701	SECCHI DEPTH - FEET	17.5	FEET	6/17/86
49701	SECCHI DEPTH - FEET	14	FEET	7/4/88
49701	SECCHI DEPTH - FEET	13	FEET	9/2/91
49701	SECCHI DEPTH - FEET	25	FEET	6/25/91
49701	SECCHI DEPTH - FEET	25.5	FEET	6/21/91
49701	SECCHI DEPTH - FEET	12.5	FEET	9/4/90
49701	SECCHI DEPTH - FEET	12	FEET	8/27/90
49701	SECCHI DEPTH - FEET	14.5	FEET	8/8/90
49701	SECCHI DEPTH - FEET	15	FEET	7/26/90
49701	SECCHI DEPTH - FEET	15.5	FEET	7/6/90
49701	SECCHI DEPTH - FEET	17	FEET	6/26/90
49701	SECCHI DEPTH - FEET	23	FEET	6/15/90
49701	SECCHI DEPTH - FEET	10	FEET	9/18/89
49701	SECCHI DEPTH - FEET	10	FEET	9/9/89
49701	SECCHI DEPTH - FEET	10	FEET	8/31/89
49701	SECCHI DEPTH - FEET	13	FEET	8/6/89
49701	SECCHI DEPTH - FEET	15	FEET	7/24/89
49701	SECCHI DEPTH - FEET	15	FEET	7/15/89
49701	SECCHI DEPTH - FEET	20	FEET	6/22/89
49701	SECCHI DEPTH - FEET	14	FEET	5/22/89
49701	SECCHI DEPTH - FEET	14	FEET	10/24/88
49701	SECCHI DEPTH - FEET	13	FEET	9/25/88
49701	SECCHI DEPTH - FEET	12	FEET	9/14/88
49701	SECCHI DEPTH - FEET	10.5	FEET	8/30/88
49701	SECCHI DEPTH - FEET	9	FEET	8/1/88
49701	SECCHI DEPTH - FEET	11	FEET	7/23/88
49701	SECCHI DEPTH - FEET	18	FEET	8/13/02
49701	SECCHI DEPTH - FEET	23	FEET	5/7/02
49701	SECCHI DEPTH - FEET	20	FEET	5/25/06
49701	SECCHI DEPTH - FEET	19	FEET	6/27/06
49701	SECCHI DEPTH - FEET	18	FEET	7/11/06
49701	SECCHI DEPTH - FEET	17	FEET	7/26/06
49701	SECCHI DEPTH - FEET	18	FEET	8/9/06

49701	SECCHI DEPTH - FEET	13	FEET	8/27/06
49701	SECCHI DEPTH - FEET	12	FEET	9/7/06
49701	SECCHI DEPTH - FEET	15	FEET	10/7/06
49701	SECCHI DEPTH - FEET	20	FEET	6/14/06
49701	SECCHI DEPTH - FEET	16	FEET	6/28/88
49701	SECCHI DEPTH - FEET	21	FEET	5/13/88
49701	SECCHI DEPTH - FEET	14	FEET	8/8/87
49701	SECCHI DEPTH - FEET	25.25	FEET	6/23/87
49701	SECCHI DEPTH - FEET	11	FEET	10/17/86
49701	SECCHI DEPTH - FEET	12.5	FEET	8/30/86
49701	SECCHI DEPTH - FEET	16.25	FEET	7/14/86
49701	SECCHI DEPTH - FEET	12	FEET	9/22/91
49701	SECCHI DEPTH - FEET	16	FEET	10/11/90
49701	SECCHI DEPTH - FEET	14.5	FEET	7/31/90
49701	SECCHI DEPTH - FEET	19.5	FEET	5/22/90
49701	SECCHI DEPTH - FEET	11	FEET	8/10/89
49701	SECCHI DEPTH - FEET	18	FEET	7/2/89
49701	SECCHI DEPTH - FEET	13	FEET	10/7/88
49701	SECCHI DEPTH - FEET	11	FEET	8/20/88
49701	SECCHI DEPTH - FEET	18.25	FEET	7/13/92
49701	SECCHI DEPTH - FEET	15	FEET	8/12/99
49701	SECCHI DEPTH - FEET	23	FEET	6/2/99
49701	SECCHI DEPTH - FEET	14	FEET	9/3/98
49701	SECCHI DEPTH - FEET	17	FEET	7/14/98
49701	SECCHI DEPTH - FEET	25.5	FEET	5/18/98
49701	SECCHI DEPTH - FEET	24.5	FEET	6/27/97
49701	SECCHI DEPTH - FEET	15	FEET	7/24/96
49701	SECCHI DEPTH - FEET	13	FEET	9/12/95
49701	SECCHI DEPTH - FEET	30	FEET	6/22/95
49701	SECCHI DEPTH - FEET	12.25	FEET	9/8/94
49701	SECCHI DEPTH - FEET	28.25	FEET	5/28/94
49701	SECCHI DEPTH - FEET	15	FEET	8/16/93
49701	SECCHI DEPTH - FEET	12.75	FEET	10/26/92
49701	SECCHI DEPTH - FEET	14	FEET	8/21/00
49701	SECCHI DEPTH - FEET	29.5	FEET	5/25/00
49701	SECCHI DEPTH - FEET	14	FEET	8/14/00
49701	SECCHI DEPTH - FEET	17.5	FEET	8/1/01
49701	SECCHI DEPTH - FEET	27	FEET	6/1/01
49701	SECCHI DEPTH - FEET	21	FEET	5/2/88
49701	SECCHI DEPTH - FEET	15	FEET	6/6/89
49701	SECCHI DEPTH - FEET	23	FEET	5/20/13
49701	SECCHI DEPTH - FEET	30	FEET	6/3/13
49701	SECCHI DEPTH - FEET	26	FEET	6/5/09
49701	SECCHI DEPTH - FEET	25	FEET	7/4/09
49701	SECCHI DEPTH - FEET	24	FEET	7/5/09
49701	SECCHI DEPTH - FEET	22	FEET	7/7/09
49701	SECCHI DEPTH - FEET	22	FEET	7/13/09

49701	SECCHI DEPTH - FEET	18	FEET	8/9/09
49701	SECCHI DEPTH - FEET	18	FEET	9/4/09
49701	SECCHI DEPTH - FEET	22	FEET	6/15/88
49701	SECCHI DEPTH - FEET	14	FEET	7/10/87
49701	SECCHI DEPTH - FEET	11	FEET	7/12/88
49701	SECCHI DEPTH - FEET	12.75	FEET	9/13/92
49701	SECCHI DEPTH - FEET	27.5	FEET	5/1/99
49701	SECCHI DEPTH - FEET	16	FEET	7/13/00
49701	SECCHI DEPTH - FEET	14	FEET	9/2/01
49701	SECCHI DEPTH - FEET	18.5	FEET	7/20/10
49701	SECCHI DEPTH - FEET	18	FEET	8/1/10
49701	SECCHI DEPTH - FEET	19	FEET	8/23/10
49701	SECCHI DEPTH - FEET	20	FEET	9/5/10
49701	SECCHI DEPTH - FEET	16.5	FEET	10/1/10
49701	SECCHI DEPTH - FEET	26	FEET	5/29/11
49701	SECCHI DEPTH - FEET	23	FEET	6/17/11
49701	SECCHI DEPTH - FEET	17	FEET	7/4/11
49701	SECCHI DEPTH - FEET	14	FEET	9/2/11
49701	SECCHI DEPTH - FEET	16	FEET	7/17/11
49701	SECCHI DEPTH - FEET	17	FEET	9/9/11
49701	SECCHI DEPTH - FEET	16	FEET	8/10/13
49701	SECCHI DEPTH - FEET	14	FEET	8/17/13
49701	SECCHI DEPTH - FEET	16.5	FEET	9/20/99
49701	SECCHI DEPTH - FEET	14.5	FEET	9/30/98
49701	SECCHI DEPTH - FEET	15	FEET	7/10/96
49701	SECCHI DEPTH - FEET	26.75	FEET	6/16/95
49701	SECCHI DEPTH - FEET	21	FEET	6/30/01
49701	SECCHI DEPTH - FEET	19.41	FEET	7/16/02
49701	SECCHI DEPTH - FEET	23	FEET	4/26/03
49701	SECCHI DEPTH - FEET	20	FEET	10/14/02
49701	SECCHI DEPTH - FEET	21	FEET	6/8/02
49701	SECCHI DEPTH - FEET	34	FEET	5/18/12
49701	SECCHI DEPTH - FEET	34	FEET	6/8/12
49701	SECCHI DEPTH - FEET	34	FEET	6/16/12
49701	SECCHI DEPTH - FEET	17.25	FEET	8/2/92
49701	SECCHI DEPTH - FEET	16	FEET	9/15/99
49701	SECCHI DEPTH - FEET	17	FEET	7/8/99
49701	SECCHI DEPTH - FEET	26.5	FEET	5/18/99
49701	SECCHI DEPTH - FEET	14	FEET	9/17/98
49701	SECCHI DEPTH - FEET	15	FEET	8/13/98
49701	SECCHI DEPTH - FEET	16	FEET	7/29/98
49701	SECCHI DEPTH - FEET	17	FEET	6/22/98
49701	SECCHI DEPTH - FEET	25	FEET	5/29/98
49701	SECCHI DEPTH - FEET	16.25	FEET	8/7/97
49701	SECCHI DEPTH - FEET	18	FEET	7/14/97
49701	SECCHI DEPTH - FEET	13	FEET	9/19/96
49701	SECCHI DEPTH - FEET	14	FEET	8/12/96

49701	SECCHI DEPTH - FEET	15.25	FEET	7/6/96
49701	SECCHI DEPTH - FEET	27.75	FEET	5/15/96
49701	SECCHI DEPTH - FEET	14	FEET	8/28/95
49701	SECCHI DEPTH - FEET	17.75	FEET	7/10/95
49701	SECCHI DEPTH - FEET	30	FEET	6/9/95
49701	SECCHI DEPTH - FEET	12	FEET	10/12/94
49701	SECCHI DEPTH - FEET	12.5	FEET	8/9/94
49701	SECCHI DEPTH - FEET	23.75	FEET	6/29/94
49701	SECCHI DEPTH - FEET	24.5	FEET	4/26/94
49701	SECCHI DEPTH - FEET	16.25	FEET	7/28/93
49701	SECCHI DEPTH - FEET	19.25	FEET	6/2/93
49701	SECCHI DEPTH - FEET	14	FEET	10/4/92
49701	SECCHI DEPTH - FEET	13	FEET	10/1/00
49701	SECCHI DEPTH - FEET	14.5	FEET	9/2/00
49701	SECCHI DEPTH - FEET	28	FEET	6/2/00
49701	SECCHI DEPTH - FEET	11.75	FEET	9/16/00
49701	SECCHI DEPTH - FEET	17.5	FEET	6/27/00
49701	SECCHI DEPTH - FEET	18	FEET	7/16/01
49701	SECCHI DEPTH - FEET	30	FEET	5/15/01
49701	SECCHI DEPTH - FEET	25.5	FEET	6/7/01
49701	SECCHI DEPTH - FEET	15	FEET	10/12/96
49701	SECCHI DEPTH - FEET	28	FEET	5/10/07
49701	SECCHI DEPTH - FEET	27	FEET	5/21/07
49701	SECCHI DEPTH - FEET	22	FEET	6/6/07
49701	SECCHI DEPTH - FEET	20	FEET	6/24/07
49701	SECCHI DEPTH - FEET	18	FEET	7/2/07
49701	SECCHI DEPTH - FEET	18	FEET	7/17/07
49701	SECCHI DEPTH - FEET	18	FEET	8/2/07
49701	SECCHI DEPTH - FEET	15	FEET	8/8/07
49701	SECCHI DEPTH - FEET	15	FEET	8/22/07
49701	SECCHI DEPTH - FEET	14	FEET	9/3/07
49701	SECCHI DEPTH - FEET	13	FEET	9/11/07
49701	SECCHI DEPTH - FEET	15.5	FEET	10/10/01
49701	SECCHI DEPTH - FEET	15.5	FEET	8/19/92
49701	SECCHI DEPTH - FEET	19.5	FEET	5/20/92
49701	SECCHI DEPTH - FEET	15.5	FEET	10/8/99
49701	SECCHI DEPTH - FEET	16	FEET	10/1/99
49701	SECCHI DEPTH - FEET	15.75	FEET	7/19/99
49701	SECCHI DEPTH - FEET	19.5	FEET	6/24/99
49701	SECCHI DEPTH - FEET	26	FEET	5/11/99
49701	SECCHI DEPTH - FEET	15.5	FEET	10/22/98
49701	SECCHI DEPTH - FEET	15	FEET	10/8/98
49701	SECCHI DEPTH - FEET	14.75	FEET	8/25/98
49701	SECCHI DEPTH - FEET	14.75	FEET	8/10/98
49701	SECCHI DEPTH - FEET	16.5	FEET	7/1/98
49701	SECCHI DEPTH - FEET	20.5	FEET	6/16/98
49701	SECCHI DEPTH - FEET	22	FEET	6/8/98

49701	SECCHI DEPTH - FEET	27	FEET		4/29/98
49701	SECCHI DEPTH - FEET	17	FEET		7/30/97
49701	SECCHI DEPTH - FEET	16	FEET		7/23/97
49701	SECCHI DEPTH - FEET	29.5	FEET		5/23/97
49701	SECCHI DEPTH - FEET	13.5	FEET		8/27/96
49701	SECCHI DEPTH - FEET	14.5	FEET		8/6/96
49701	SECCHI DEPTH - FEET	16.4	FEET		6/24/96
49701	SECCHI DEPTH - FEET	25.25	FEET		6/19/96
49701	SECCHI DEPTH - FEET	29	FEET		5/3/96
49701	SECCHI DEPTH - FEET	13.5	FEET		8/23/95
49701	SECCHI DEPTH - FEET	15.75	FEET		7/19/95
49701	SECCHI DEPTH - FEET	26.5	FEET		6/28/95
49701	SECCHI DEPTH - FEET	27	FEET		5/31/95
49701	SECCHI DEPTH - FEET	25	FEET		5/24/95
49701	SECCHI DEPTH - FEET	30.5	FEET		5/18/95
49701	SECCHI DEPTH - FEET	30.75	FEET		5/18/95
49701	SECCHI DEPTH - FEET	31.5	FEET		5/2/95
49701	SECCHI DEPTH - FEET	12.5	FEET		8/30/94
49701	SECCHI DEPTH - FEET	12.25	FEET		8/22/94
49701	SECCHI DEPTH - FEET	18.5	FEET		7/5/94
49701	SECCHI DEPTH - FEET	27	FEET		6/9/94
49701	SECCHI DEPTH - FEET	27.75	FEET		5/6/94
49701	SECCHI DEPTH - FEET	17.75	FEET		8/28/93
49701	SECCHI DEPTH - FEET	20.25	FEET		6/21/93
49701	SECCHI DEPTH - FEET	18	FEET		6/10/93
49701	SECCHI DEPTH - FEET	26.25	FEET		5/15/93
49701	SECCHI DEPTH - FEET	15	FEET		10/15/00
49701	SECCHI DEPTH - FEET	13.5	FEET		9/13/00
49701	SECCHI DEPTH - FEET	14	FEET		9/6/00
49701	SECCHI DEPTH - FEET	15	FEET		8/12/00
49701	SECCHI DEPTH - FEET	14.5	FEET		7/29/00
49701	SECCHI DEPTH - FEET	20.5	FEET		6/16/00
49701	SECCHI DEPTH - FEET	30.5	FEET		5/13/00
49701	SECCHI DEPTH - FEET	13	FEET		8/30/00
49701	SECCHI DEPTH - FEET	16	FEET		7/15/00
49701	SECCHI DEPTH - FEET	18	FEET		10/17/00
49701	SECCHI DEPTH - FEET	14	FEET		9/18/01
49701	SECCHI DEPTH - FEET	14.75	FEET		8/17/01
49701	SECCHI DEPTH - FEET	27	FEET		4/26/01
49701	SECCHI DEPTH - FEET	28.5	FEET		5/1/01
49701	SECCHI DEPTH - FEET	29	FEET		5/25/01
49701	SECCHI DEPTH - FEET	20	FEET		6/20/01
49701	SECCHI DEPTH - FEET	18	FEET		7/5/01
49701	SECCHI DEPTH - FEET	15	FEET		8/14/13
				18.42582	
				31.5	
				12.25	

955	SILICA, DISSOLVED (MG/L AS SI02)	1	MG/L		2/18/86
929	SODIUM TOTAL	1	MG/L		2/16/76
929	SODIUM TOTAL	1	MG/L		10/27/76
929	SODIUM TOTAL	1	MG/L		2/18/86
929	SODIUM TOTAL	1	MG/L		7/27/76
929	SODIUM TOTAL	1	MG/L		4/29/76
929	SODIUM TOTAL	3	MG/L		7/18/79
929	SODIUM TOTAL	1	MG/L		7/18/79
				1.285714	
				3	
				1	
945	SULFATE TOTAL	8	MG/L		2/16/76
945	SULFATE TOTAL	5	MG/L		10/27/76
945	SULFATE TOTAL	5.3	MG/L		2/18/86
945	SULFATE TOTAL	11	MG/L		7/27/76
945	SULFATE TOTAL	5	MG/L		4/29/76
				6.86	
				11	
				5	
134	TOTAL DISSOLVED SOLIDS 180 C (DO N	110	MG/L		4/25/10
76	TURBIDITY	0.6	FTU		2/16/76
76	TURBIDITY	1.5	FTU		10/27/76
76	TURBIDITY	1	FTU		7/27/76
76	TURBIDITY	0.6	FTU		4/29/76
76	TURBIDITY	1	FTU		7/18/79
76	TURBIDITY	3.5	FTU		7/18/79
				1.366667	
				3.5	
				0.6	
30002	ZEBRA MUSSEL, VELIGER	No			8/6/08
30002	ZEBRA MUSSEL, VELIGER	No			6/30/10
30002	ZEBRA MUSSEL, VELIGER	No			10/25/12
30002	ZEBRA MUSSEL, VELIGER	No			7/12/17
30002	ZEBRA MUSSEL, VELIGER	No			8/14/13

Appendix G – Resource for Additional Information

Oconto County Zoning – Shoreland Development

http://www.co.oconto.wi.us/departments/forms_and_documents/?department=a67c24bc2735&subdepartment=c041c5a0384b

Wisconsin Department of Natural Resources

General Lakes Information - http://WDNR.wi.gov/lakes/

AIS General Information- http://WDNR.wi.gov/invasives/

Aquatic Plants - http://WDNR.wi.gov/lakes/plants/

Citizen Lake Monitoring - http://WDNR.wi.gov/lakes/CLMN/

Clean Boats, Clean Waters - http://WDNR.wi.gov/lakes/CBCW/

Grants - http://WDNR.wi.gov/lakes/grants/

Lake Organizations - http://www4.uwsp.edu/cnr/uwexlakes/lakelist/

Monitoring Forms - http://WDNR.wi.gov/lakes/monitoring/

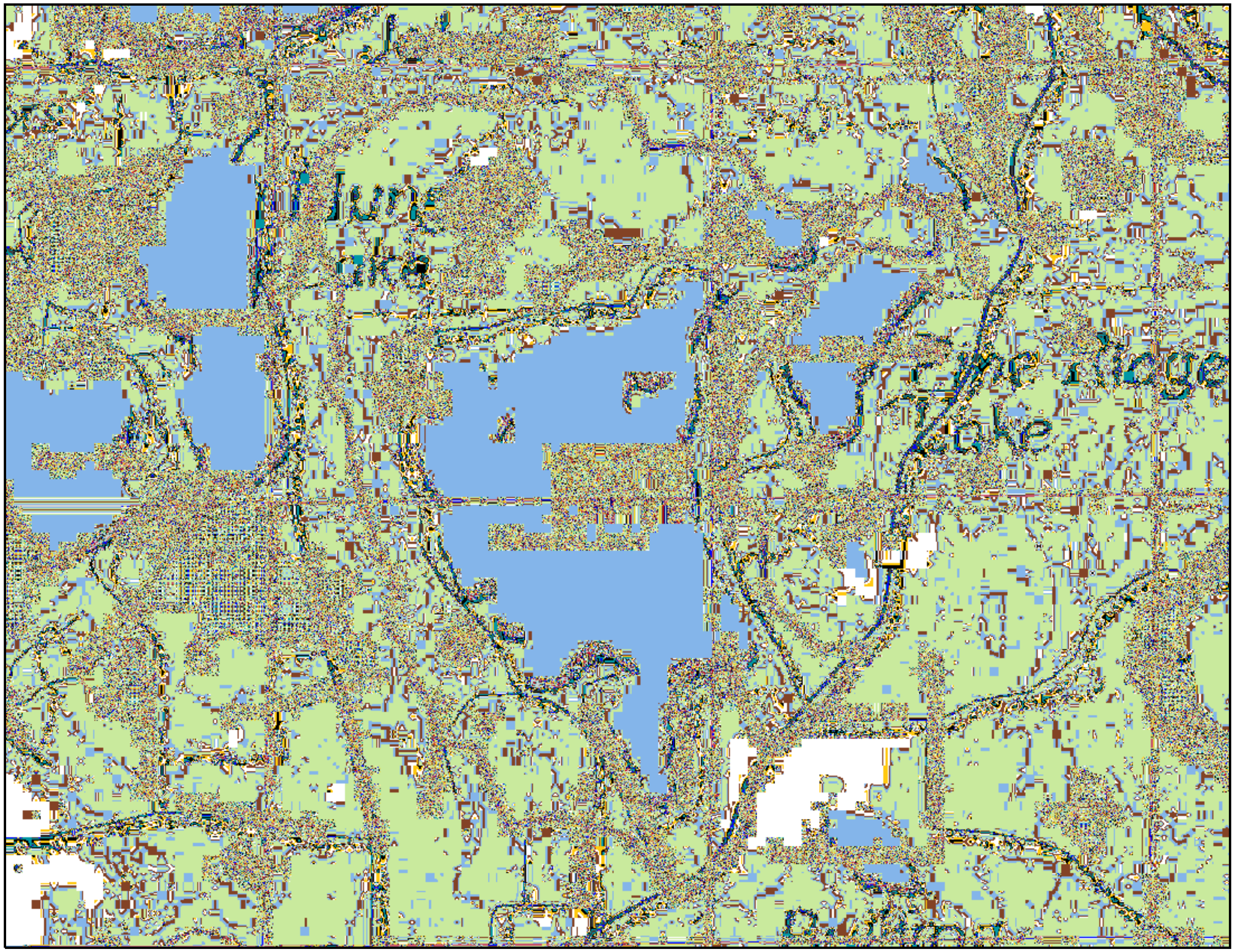
WDNR Lake Contact Information - http://WDNR.wi.gov/lakes/contacts/Topics.aspx

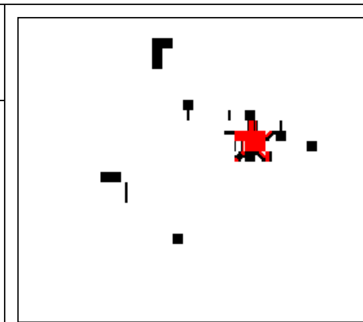
UW – Extension Lakes - http://www4.uwsp.edu/cnr/uwexlakes/

Wisconsin Association of Lakes - http://www.wisconsinlakes.org/

Appendix H – Wheeler Lake Watershed

Map Created on May 17, 2010





Legend

Major Highways

Local Roads

PLSS Townships

PLSS Sections

Civil Towns

Civil Town

DNR Wetland Points

Excavated Pond

Dammed Pond

Upland

Wetland

Filled or Drained Wetland

24K Open Water

24K Rivers and Shorelines

Intermittent

Fluctuating

Perennial

Cities and Villages

City

0 2250 4500 6750 ft.

Scale: 1:24,000

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

Appendix I – Wheeler Lake Fishery

- 2014 Fishery Survey Report

WHEELER LAKE

Oconto County

2014 Fish Management Report

Christopher C. Long – Senior Fisheries Biologist

Wisconsin Department of Natural Resources
101 N. Ogden Rd.
Suite A
Peshtigo, Wisconsin 54157

2015

Wheeler Lake - Oconto County, Wisconsin
2014 Fish Management Report

Christopher C. Long, Fisheries Biologist, Date

Michael Donofrio, Fisheries Supervisor, Date

Randy Schumacher, Eastern District Supervisor, Date

SUMMARY

Lake and location:
Wheeler Lake, Oconto County, T33N R16E Sec 27

Physical / chemical attributes (Wisconsin DNR, 1977):
Surface acres: 293
Maximum depth (ft): 35
Average depth (ft): 15
Shoreline length (mi): 4.0
Lake type: Seepage (80% over 20 ft)
Basic water chemistry: Neutral, clear water of high transparency, Secchi = 13 ft.
Littoral substrate: 40% gravel, 30% rubble, 20% sand and 10% muck.
Aquatic vegetation: Sparse; Eurasian water milfoil is present.
Other features: This lake is highly developed with over 150 homes along the shoreline. It is located within the Ceded Territory.

Purpose of survey:
Determine the current status of fishery and evaluate walleye fishing mortality.

Surveys:
WDNR Survey ID: 496447865 – Spring fyke netting (5/6/2014 – 5/14/2014)
WDNR Survey ID: 496447868 – Gamefish/Panfish electrofishing (6/10/2014)
WDNR Survey ID: 515077102 – Fall juvenile walleye electrofishing (9/24/2014 & 10/7/2014)

Fishery:

The fishery of Wheeler Lake is comprised of panfish species (bluegill, yellow perch, black crappie and rock bass) and gamefish species (walleye, largemouth bass and northern pike).

EXECUTIVE SUMMARY

- Wheeler Lake is located in northern Oconto County just east of Lakewood. At 293 acres, it is one of the larger lakes in the immediate area. There is one access point/boat landing on the lake. The U.S. Forest Service also owns a public beach on the west side of the lake.
- The Wisconsin Department of Natural Resources (WDNR) stocked small fingerling walleye from 1964 to 1970. No walleye stockings have occurred since 1970 because surveys revealed the walleye fishery was being sustained through natural reproduction.
- A creel survey conducted during the 2008/2009 fishing season revealed that fishing pressure (hours/acre) on Wheeler Lake was 43.0 hours/acre which was lower than the Oconto County average (70.6 h) but more than the Statewide average (33.6 h).
- Overall, 1,438 fish representing 10 species were collected during the 2014 sampling season (Table 4). The five most abundant species collected by number were rock bass (32%), largemouth bass (19%), white sucker (11%), yellow perch (9%) and bluegill (8%).
- During the survey, 269 largemouth bass were collected. Bass ranged in length from 4.8 to 20.2 in and averaged 12.1 in (Figure 2). Bass are reaching legal size (14 in) between ages 6 and 10.
- One hundred thirty-four yellow perch were collected during the 2014 survey (Table 4). Perch ranged in length from 6.5 to 10.9 in and averaged 8.2 in (Figure 4). Perch growth was slightly above average at all ages (Figure 5).
- A total of 118 bluegill was collected and ranged in length from 2.4 to 10.2 in and averaged 6.5 in (Figure 6). Sixty-four percent of the bluegill measured were 6.0 in or greater and considered harvestable. Most age groups were well represented and growth was relatively average at all ages compared to the mean length at age of bluegill in northern Wisconsin (Figure 7).
- A total of 105 walleye was collected during both electrofishing and fyke netting (2.0/NN). Walleye ranged in length from 12.6 to 22.6 in and averaged 18.0 in across all samples (Figure 8). The Schnabel multiple census fyke net population estimate for walleye was 260 (95% CI of 174 to 512 and a recapture rate of 17%) or approximately 0.9 adult walleye/acre.
- During the survey, 67 black crappie were collected. Crappie ranged in length from 6.6 to 12.0 in and averaged 10.2 in (Figure 11). Growth was slightly above average at all ages and consistent to the mean length at age of crappie in northern Wisconsin (Figure 12).
- All panfish species (yellow perch, bluegill, black crappie) showed an improvement in both size structure and abundance between 2008 and 2014. In order to maintain this component of the fishery and stabilize the forage base, I recommend reducing the bag limit of panfish from 25/angler/day to 10/angler/day.
- A change to the walleye fishing regulations will be presented at the 2015 Spring Hearings whereby the minimum length limit (MLL) would increase from 15 to 18 inches with a daily bag limit of 3 fish. If adopted, this regulation would be effective in May, 2016.
- Local anglers and the Wheeler Lake Association membership have expressed an interest in reestablishing a quality walleye fishery; managing largemouth bass with a 14-inch MLL seems counterproductive. Largemouth bass abundance is relatively stable, but the 2014 survey revealed that size structure waned since 2008. Therefore, I recommend removing the 14-inch MLL in favor of no MLL. The daily bag limit of 5 fish/angler/day would remain unchanged. This regulation proposal would apply only to largemouth bass, not smallmouth bass.
- The next comprehensive fisheries survey (fyke netting, spring and fall electrofishing) of Wheeler Lake is scheduled for 2022 and will focus on the age, growth, abundance, and recruitment of the dominant gamefish.

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INTRODUCTION

Wheeler Lake is located in northern Oconto County just east of Lakewood. At 293 acres, it is one of the larger lakes in the immediate area and offers a variety of recreational opportunities in addition to fishing. There is one access point/boat landing on the lake which is maintained by the Town of Lakewood off of Wheeler Lake Lane. The U.S. Forest Service owns and operates a public beach on the west side of the lake.

The Wisconsin Department of Natural Resources (WDNR) stocked small fingerling walleye from 1964 to 1970. No walleye stockings have occurred since 1970; because fish surveys revealed the walleye fishery was being sustained through natural reproduction.

A creel survey conducted during the 2008/2009 fishing season (open water and ice fishing) revealed that 21% of fishing effort was targeted at walleye. The total catch of walleye during the creel survey period was 193 fish with a harvest of 154 walleye. Anglers fished a total of 28.6 hours to catch a walleye and 36.0 hours to harvest a walleye. Fishing pressure (hours/acre) on Wheeler Lake was 43.0 hours/acre which was lower than the Oconto County average (70.6) but more than the Statewide average (33.6).

The last fisheries survey of Wheeler Lake was conducted in 2008 (Donofrio, 2009). The survey indicated that the walleye population in Wheeler Lake had declined to just 2.8 adults per acre. Donofrio (2009) recommended stocking large fingerling walleye if future fall surveys failed to document improved recruitment and significant natural reproduction. Largemouth bass and northern pike populations exhibited good numbers and size structure while panfish (bluegill and crappie) appeared to be under-represented in the survey. The 2008 survey revealed all species exhibited slower growth compared to other northeastern Wisconsin lakes.

The goal of the 2014 comprehensive fisheries survey was to assess the status of the fishery by characterizing gamefish populations based on relative abundance, proportional stock density (PSD), relative stock density (RSD), catch per unit effort (CPUE) and mean length at capture (age and growth). Comparisons to the 2008 fisheries survey were made where applicable.

METHODS

Data collection:

Standard fyke nets (3-foot hoop, $^{3}/_{4}$-bar, 1.5-inch stretch), mini-fyke nets ($^{1}/_{4}$-inch stretch with turtle exclusion) and a standard WDNR electrofishing boat were used to collect fish on

Wheeler Lake. Sampling gear, effort, date, and target species for the survey are listed in Table 2. All gamefish and panfish were measured to the nearest 0.1 inch total length (TL) and separated into half-inch groups (X.0-X.9 for inch group and X.5-X.9 for half-inch group). A sub-sample of scales or dorsal spines was collected for age and growth analysis from all gamefish. Aging structures (scales or spines) were collected from 5 non young-of-the-year (YOY) fish per half inch group. If gender could be determined, structures from 5 fish per sex were collected per half inch group. Aging structures for panfish and nongame fish consisted of 5 samples per half inch group when gender could not be established. Ages were assigned to each fish using standard WDNR procedures.

Data analysis:

Relative abundance was calculated as the percentage each species represented from the total sample (i.e. 22 fish of a single species from a sample of 100 total fish = 22% relative abundance). Catch per unit effort (CPUE) was calculated as catch by gear divided by sampling effort for each species collected. Length frequency distributions were tabulated for dominant gamefish and panfish. These distributions consist only of fish that were measured and combined electrofishing and fyke net samples. Proportional stock density (PSD) and relative stock density for **p**referred length fish ($RSD^{\mathbf{P}}$) were calculated for dominant gamefish (Anderson and Neumann 1996). Preferred lengths of various gamefish have a minimum length between 45 and 55% of the world record length for that species (Table 3; Anderson and Neumann 1996). Stock, quality, and preferred lengths were used as proposed by Gabelhouse (1984). Mean length at capture/age data was calculated for dominant gamefish and compared to the average of mean length at age for northern Wisconsin.

A population estimate for walleye was obtained during the spring fyke net survey by giving each captured fish a top caudal fin clip. Marks (fin clips) were noted is subsequent collections until the survey was complete. The Schumacher-Eschmeyer and/or Schnabel formulas for multiple census were used to generate population estimates (Schneider, 1998; Schnabel, 1938).

RESULTS

Overall, 1,438 fish representing 10 species were collected during the 2014 sampling season (Table 4). The five most abundant species collected by number were rock bass (32%), largemouth bass (19%), white sucker (11%), yellow perch (9%) and bluegill (8%).

A total of 463 rock bass was collected which accounted for 32% of the fish collected (Table 4). Rock bass ranged in length from 4.1 to 12.0 in (inches) and averaged 7.0 in (Figure 1). Electrofishing CPUE was 27.3/h and fyke net CPUE was 7.0/NN (Tables 5 & 6). Rock bass were not aged but several age groups were represented as evidenced by the length frequency distribution (Figure 1). Successful reproduction and recruitment of rock bass was evident.

During the survey, 269 largemouth bass were collected. Bass ranged in length from 4.8 to 20.2 in and averaged 12.1 in (Figure 2). Thirty percent of the largemouth bass collected were over the 14-in minimum length limit (Figure 2). Electrofishing yielded a CPUE of 58.5/h and fyke netting a CPUE of 2.6/NN (Tables 5 & 6). Largemouth bass PSD was 21 and RSD^P was 0 from the electrofishing sample while PSD was 95 and RSD^P was 26 from the fyke net sample. Bass PSD was not within the desirable range for a balanced population from either the fyke netting or electrofishing sample (Table 3). The RSD^P for largemouth bass was in the desirable range from the fyke net sample (Table 3). A sample of 50 largemouth bass was aged from the fyke net sample and 63 from the electrofishing sample. Largemouth bass growth was below average from age 6 and older compared to the mean length at age for bass in northern Wisconsin (Figure 3). Bass are reaching legal size (14 in) between ages 6 and 10. Successful reproduction and recruitment of largemouth bass was evident.

White sucker made up 11% of the fish collected totaling 158 fish (Table 4). White suckers ranged in length from 5.2 to 23.5 in. Electrofishing CPUE was 0/h and fyke net CPUE was 2.5/NN (Tables 5 & 6).

One hundred thirty-four yellow perch were collected during the 2014 survey (Table 4). Perch ranged in length from 6.5 to 10.9 in and averaged 8.2 in (Figure 4). Electrofishing yielded a CPUE of 1.8/h and fyke netting a CPUE of 2.1/NN (Tables 5 & 6). A subsample of 49 yellow perch was aged from 3 to 7 years old. Perch growth was slightly above average at all ages compared to the mean length at age for yellow perch in northern Wisconsin (Figure 5).

Bluegill accounted for 8% of the fish collected in 2014 (Table 4). A total of 118 bluegill was collected and ranged in length from 2.4 to 10.2 in and averaged 6.5 in (Figure 6). Sixty-four percent of the bluegill measured were 6.0 in or greater and considered harvestable. Bluegill electrofishing CPUE was 61.8/h and fyke netting CPUE was 1.3/NN (Tables 5 & 6). Bluegill PSD was 21 and RSD^P was 0 from the electrofishing sample while PSD was 81 and RSD^P was 35 from the fyke net sample. Neither PSD nor RSD^P were within the desirable range for a balanced bluegill population from either sample (Table 3). A representative subsample of 57 bluegill was aged from 3 to 9 years old. Most age groups were well represented and growth was relatively average at all ages compared to the mean length at age of bluegill in northern Wisconsin (Figure 7). Successful reproduction and recruitment of bluegill was obvious.

A total of 105 walleye was collected during both electrofishing and fyke netting (2.0/NN). This total does not include recaptured fish. Electrofishing for walleye was conducted in April, September and October with CPUE's of 2.0/h, 0/h and 0/h, respectively. Walleye ranged in length from 12.6 to 22.6 in and averaged 18.0 in across all samples (Figure 8). Walleye PSD and RSD^P from the spring fyke net sample was 97 and 11, respectively. Walleye PSD was well above the desirable range of 30 to 60 (Table 3). A subsample of 68 walleye from fyke nets was aged from 3 to 14 years old. Compared to the average length at age for northern Wisconsin, walleye growth was average until age 8 and below average at age 9 and older (Figure 9). The Schnabel multiple census fyke net population estimate for walleye was 260 (95% CI of 174 to 512 and a recapture rate of 17%) or approximately 0.9 adult walleye/acre.

Seventy-eight northern pike were collected during the 2014 survey (Table 4). Pike ranged in length from 10.3 to 39.3 in and averaged 19.4 in (Figure 10). Electrofishing yielded a CPUE of 1.0/h and fyke netting a CPUE of 1.2/NN (Tables 5 & 6). Northern pike PSD was 39 and RSD^P was 4. Due to the difficulty of obtaining accurate ages of northern pike, no pike were aged from this survey.

During the survey, 67 black crappie were collected. Crappie ranged in length from 6.6 to 12.0 in and averaged 10.2 in (Figure 11). Electrofishing CPUE was 2.6/h and fyke net CPUE was 16.0/NN (Tables 5 & 6). Black crappie PSD was 94 and RSD^P was 67. A representative subsample of 36 crappie was aged from 3 to 7 years old. Growth was slightly above average at all ages and consistent to the mean length at age of crappie in northern Wisconsin (Figure 12).

Smallmouth bass made up 3% of the fish collected totaling 40 fish (Table 4). Smallmouth ranged in length from 4.3 to 17.1 in and averaged 9.4 in (Figure 13). Electrofishing CPUE was 14.9/h and fyke net CPUE was 0.2/NN (Tables 5 & 6). Smallmouth bass PSD was 38 and RSD^P was 6 from the electrofishing sample while PSD was 92 and RSD^P was 17 from the fyke net sample. Smallmouth PSD was within the desirable range for a balanced population from the electrofishing sample (Table 3). A sample of 12 smallmouth bass was aged from the fyke net sample and 26 from the electrofishing sample. Smallmouth are reaching legal size (14 in) between ages 9 and 10 (Figure 14). Smallmouth bass growth was slightly below average at most ages (Figure 14). Successful reproduction and recruitment of smallmouth bass was observed.

DISCUSSION

Wheeler Lake is relatively infertile because it is a seepage lake with a small (640 acres) upland, forested watershed. Primary production, which forms the base of all aquatic food chains, is lacking. However, populations of panfish (bluegill, yellow perch, black crappie and rock bass) and gamefish (northern pike, walleye, largemouth bass and smallmouth bass) are present and offer anglers a respectable fishing opportunity.

The total number of fish collected during the 2014 survey declined by over 40% compared to the 2008 survey (Table 7). Even though spring arrived late in northeast Wisconsin in 2014, which could have affected our results, the timing and duration of spring fyke netting was similar between recent survey years (2014: May 6th – May 14th; 2008: April 28th – May 7th) but only 8 fyke nets were set in 2014 compared to 10 in 2008. The reduced total catch during the 2014 survey could simply be a consequence of the normal fluctuations fish populations experience as a result of natural forces such as weather, predation, competition or harvest.

Historically, white sucker has been extremely abundant in Wheeler Lake. In 2008, white sucker accounted for 36% of the fish collected but in 2014 accounted for only 11% (Table 7). While white sucker are not targeted by anglers, their contribution to the fishery is important. White sucker fry and fingerlings are an important forage species for predator species such as bass, walleye and northern pike. If our sample truly represents a decline in white sucker abundance, we should anticipate predator species to shift their forage preference to other species, specifically panfish.

The number of rock bass collected between 2008 and 2014 increased from 307 to 463, respectively (Table 7). Surprisingly, rock bass was the most abundant species collected in 2014 and accounted for 32% of the fish collected (Table 7). Increased catch of rock bass was observed in all inch groups between 2008 and 2014 (Figure 1). Because small, intermediate and large rock bass were collected, we conclude that reproduction and recruitment are stable.

The total number of largemouth bass collected declined between 2008 and 2014 because largemouth bass were not collected during fall electrofishing in 2014 (Tables 6 and 7). Bass were the second most abundant species collected in both years however; the number of intermediatedsized bass was greater in 2008 (Figure 2). Excluding the fall collection of largemouth bass in 2008, the abundance of bass has remained relatively stable. Even though largemouth bass abundance is stable, size structure diminished between surveys. Between 2008 and 2014 electrofishing PSD and RSD^P declined from 66 to 21 and 8 to 0, respectively. Harvest does not appear to be impacting the population because in 2008 a creel survey indicated that out of the 3,391 largemouth bass that were caught, only 133 were harvested (Tobias, 2009). The decline in bass abundance is not necessarily bad especially since there is an overwhelming desire locally to restore a quality walleye fishing opportunity to Wheeler Lake.

Smallmouth bass abundance declined between 2008 and 2014 (Table 7 and Figure 13). Like largemouth bass, smallmouth bass were not collected during the fall electrofishing sample in 2014. The exact cause for the decline in smallmouth bass abundance is unclear (even while accounting for the fall collection in 2008). However, reproduction and recruitment are adequate to maintain the smallmouth bass population. Growth was not estimated for smallmouth bass in 2008 but the 2014 age and growth evaluation showed that smallmouth growth was below average at all ages compared to other lakes in northern Wisconsin (Figure 14).

Walleye accounted for 7% of the survey catch in 2014 which was down from 14% in 2008 (Table 7). Population estimates confirmed the decline in adult density from 2.8 adult walleye per acre in 2008 to 0.9/acre in 2014. The walleye fishery has been maintained by natural reproduction for the last several decades. Therefore, due to the decline in adult walleye density and the lack of recruitment, 9,844 small-fingerling walleye marked with oxytetracycline (OTC) were stocked in 2014. In order to determine the level of natural reproduction and the contribution of stocking, young-of-the-year (YOY) walleye are collected in the same year as stocking. Otoliths are removed from the YOY collected and examined for marks. The subsequent proportion of marked to unmarked fish determines the level of natural reproduction compared to the contribution of stocked walleye. Unfortunately, no YOY walleye were collected in 2014 after 2 nights of electrofishing that encompassed the entire shoreline each night.

Walleye growth appeared to be average through age 8 and then below average at older ages compared to other lakes in northern Wisconsin (Figure 9). For example, one of the walleye we collected during spring electrofishing had a floy tag (tag number 1142). Data revealed that this male walleye was tagged in 2001 at 14.4 inches however; the fish was not aged. In 2008, the same fish (tag number 1142) was recaptured and measured 16.1 inches and was aged at 12 years old. By

2014, this same fish was recaptured again and measured only 16.8 inches long. Male walleye typically grow much slower than female walleye however, this example clearly demonstrates just how slow male walleye are grow in Wheeler Lake, and likely other seepage lakes in northern Oconto County.

Walleye 1142 was not aged in 2014, and assuming the assigned age in 2008 is correct (age 12), fish 1142 is at least 18 years old, if not older. Since the "oldest" fish in our sample was age 14, it's probable that we are grossly underestimating walleye ages using dorsal spines. Even though otoliths (ear bones) would provide better length at age estimation, at this time we cannot justify sacrificing a substantial number of fish from an already suffering population to determine the exact age of walleye in Wheeler Lake.

Between 2008 and 2014, fyke net CPUE for yellow perch increased from 0.8/NN to 2.1/NN, respectively (Table 6). Additionally growth was slightly above average compared to other lakes in northern Wisconsin (Figure 5). Overall, perch abundance, growth and size structure improved since 2008.

Almost twice as many bluegill were collected in 2014 than 2008 and PSD and RSD^P improved slightly between years (Table 7). Furthermore, more bluegill were collected in all length bins, except between 4.0 and 4.9 inches, in 2014 (Figure 6). Significantly more 6, 7 and 9-inch bluegill were collected in 2014 than 2008 (Figure 6). Bluegill growth, while average compared to other lakes in northern Wisconsin, was comparable between surveys (Figure 7). Reproduction and recruitment are sufficient to maintain their numbers.

The relative abundance of black crappie almost tripled between 2008 and 2014 from < 1% to 5%, respectively (Table 7). Crappie are cyclic spawners meaning that successful reproduction and recruitment can be highly variable and unpredictable from year to year. Only 3 crappie were collected during the 2008 survey (Table 7 & Figure 11). The recent survey indicated one large year class around 10 inches. This year class made up a significant proportion of the crappie measured during the 2014 survey (Figure 11). This example illustrates the inconsistency of reproduction and recruitment however, crappie fishing should be good for the next couple of years.

CONCLUSIONS & RECOMMENDATIONS

All panfish species (yellow perch, bluegill, black crappie) showed an improvement in both size structure and abundance between 2008 and 2014. In order to maintain this component of the fishery and stabilize the forage base, I recommend reducing the bag limit of panfish from 25/angler/day to 10/angler/day. This change is especially critical since white sucker, another important forage species, declined dramatically between 2008 and 2014.

Small fingerling walleye were stocked by WDNR in 2014 (Table 1). This stocking resulted in no YOY walleye being collected in either September or October 2014 (Table 6). This stocking may have failed since Wheeler Lake has extremely clear water and is lacking significant primary production. Therefore in the future, I recommend stocking large fingerling walleye at the rate of 5/acre (1,465 total) in alternate years. Until WDNR can submit and fill a walleye stocking quota, the Wheeler Lake Association should purse stocking large fingerling walleye. Stocking large fingerling walleye would produce more consistent year class strength, build up the walleye population and improve fishing opportunities.

A change to the walleye fishing regulations was drafted several years ago whereby the minimum length limit (MLL) would increase from 15 to 18 inches and the daily bag limit will be 3 fish; unless otherwise dictated by tribal declarations. This regulation is designed to increase the adult density of walleye and delay harvest until fish have had the opportunity to spawn multiple times. This proposal will be included in the 2015 Wisconsin Conservation Congress Spring Hearing Questionnaire. If adopted, this proposal would go into effect the first Saturday in May, 2016.

Local anglers and the Wheeler Lake Association membership have expressed an interest in reestablishing a quality walleye fishery; managing largemouth bass with a 14-inch MLL seems counterproductive. Largemouth bass abundance is relatively stable but the 2014 survey revealed that size structure waned since 2008. Therefore, I recommend removing the 14-inch MLL in favor of no MLL. The daily bag limit of 5 fish/angler/day would remain unchanged. This regulation proposal would apply only to largemouth bass, not smallmouth bass.

Approximately 40 fish cribs have been constructed by the Wheeler Lake Association since 2011/2012. Additional habitat initiatives (i.e. "fish sticks") should be pursued by the Wheeler Lake Association in cooperation with WDNR, and possibly the U.S. Forest Service. Cost sharing grants are also available to implement a "fish sticks" project. Interested parties should visit the following links for more information: http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html ; http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/resources/healthylakes/FishSticks-HealthyLakesFactSheetSeries.pdf.

The next comprehensive fisheries survey (fyke netting, spring and fall electrofishing) of Wheeler Lake is scheduled for 2022 and will focus on the age, growth, abundance, and recruitment of the dominant gamefish. Boat access to Wheeler Lake is adequate since anglers have a single boat landing, but parking is limited. Shore fishing opportunities are essentially nonexistent for the general public. Boaters are reminded to remove all vegetation from their boat and trailer before leaving to limit the spread of this and other invasive species. A map of Wheeler Lake can be found at the following internet address; http://dnr.wi.gov/lakes/maps/DNR/0439800a.pdf

ACKNOWLEDGEMENTS

WDNR would like to thank the Wheeler Lake Association for their continued efforts to improve fish habitat.

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APPENDIX I – TABLES

Table 1. Recent stocking history of Wheeler Lake; Oconto County, WI.

Year	Species	Strain	Age Class	Number Stocked	Avverage Length	Source
2014	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	9,844	2.6	WDNR

Table 2. Sampling gear, date, target species, sampling effort, and location (distance) for 2014 fisheries survey on Wheeler Lake; Oconto County, WI.

Gear	Date	Target Species	Sampling Effort hours (h) or net night (NN)	Shoreline Distance (mi)
Fyke net	May 6 - May 14	All fish	64 NN	
Electrofishing	May 14	Walleye	1.5 h	3.0
Electrofishing	June 10	All fish	0.6 h	1.0
		Gamefish	2.0 h	3.0
Electrofishing	September 24 & October 7	YOY Walleye	4.0 h	8.6

Table 3. Proposed length categories for various fish species. Measurements are total lengths for each category in inches. Updated from Anderson and Neumann (1996), Bister et al. (2000), Hyatt and Hubert (2001).

Species	PSD	RSD-P	Stock	Quality	Preferred	Memorable	Trophy
Black crappie			5	8	10	12	15
Bluegill	20 - 40	5 - 20*	3	6	8	10	12
Brown bullhead			5	8	11	14	17
Largemouth bass	40 - 70	10 - 40*	8	12	15	20	25
Muskellunge	30 - 60		20	30	38	42	50
Northern pike	30 - 60		14	21	28	34	44
Pumpkinseed	20 - 40		3	6	8	10	12
Rock bass	20 - 60		4	7	9	11	13
Smallmouth bass	30 - 60		7	11	14	17	20
Walleye	30 - 60		10	15	20	25	30
Yellow perch	30 - 50		5	8	10	12	15
Yellow bullhead			4	7	9	11	14

*Range based on management strategy for balanced populations.

Table 4. Number, relative abundance (%), and length range (in) of fishes collected in 2014 from Wheeler Lake; Oconto County, WI.

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER			
*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (inches)
Rock bass	463	32.2%	4.1 - 12.0
Largemouth bass	269	18.7%	4.8 - 20.2
White sucker	158	11.0%	5.2 - 23.5
Yellow perch	134	9.3%	6.5 - 10.9
Bluegill	118	8.2%	2.4 - 10.2
Walleye	105	7.3%	12.6 - 22.6
Northern pike	78	5.4%	10.3 - 39.3
Black crappie	67	4.7%	6.6 - 12.0
Smallmouth bass	40	2.8%	4.3 - 17.1
Yellow bullhead	6	0.4%	7.2 - 13.3
Total	1,438		

* Common names of fishes recognized by the American Fisheries Society.

Table 5. Comparison of spring fyke netting data between 2008 and 2014 collected from Wheeler Lake; Oconto County, WI.

2014 Fyke Netting (64*)			2008 Fyke Netting (100*)		
	Total	**Mean Catch**		Total	Mean Catch
Species	**Catch**	**per net night**	Species	Catch	per net night
Rock bass	448	7.0	White sucker	877	8.8
Largemouth bass**	163	2.6	Walleye**	403	4.0
White sucker	158	2.5	Rock bass	281	2.8
Yellow perch	133	2.1	Northern pike**	155	1.6
Walleye**	125	2.0	Largemouth bass**	85	0.9
Bluegill	84	1.3	Yellow perch	75	0.8
Northern pike**	78	1.2	Bluegill	55	0.6
Black crappie	67	1.1	Smallmouth bass**	12	0.1
Smallmouth bass**	12	0.2	Black crappie	9	0.1

* Sampling effort in net nights for each corresponding year.

**Includes recaptured fish.

Table 6. Seasonal electrofishing summary for 2008 and 2014 surveys on Wheeler Lake; Oconto County, WI.

	Spring electrofishing						Gamefish/Panfish electrofishing						Fall electrofishing					
	2014 May			2008 May			**2014 June**			2008 May			**2014 Sept./Oct.**			2008 October		
Species	**Total Catch**	**CPUE / hour**	**CPUE / mile**	Total Catch	CPUE / hour	CPUE / mile	**Total Catch**	**CPUE / hour**	**CPUE / mile**	Total Catch	CPUE / hour	CPUE / mile	**Total Catch**	**CPUE / hour**	**CPUE / mile**	Total Catch	CPUE / hour	CPUE / mile
Bluegill							**34**	**61.8**	**34.0**	14	20.9	14.0						
Yellow perch							**1**	**1.8**	**1.0**	1	1.5	1.0						
Northern pike							**2**	**1.0**	**0.5**	7	2.8	1.8				15	4.9	2.7
Walleye	**3**	**2.0**	**1.0**	32	12.0	6.4	**0**	**0**	**0**	7	2.8	1.8	**0**	**0**	**0**	11	3.6	2.0
Largemouth bass							**114**	**58.5**	**28.5**	199	79.6	49.8				139	45.6	25.3
Rock bass							**15**	**27.3**	**15.0**	26	38.8	26.0						
Smallmouth bass							**29**	**14.9**	**7.3**	78	31.2	19.5				98	32.1	17.8

Table 7. Comparison of species relative abundance between 2008 and 2014 surveys on Wheeler Lake; Oconto County, WI.

2014			2008		
Species	No.	%	Species	No.	%
Rock bass	463	32.2%	White sucker	879	35.5%
Largemouth bass	269	18.7%	Largemouth bass*	423	17.1%
White sucker	158	11.0%	Walleye	345	13.9%
Yellow perch	134	9.3%	Rock bass	307	12.4%
Bluegill	118	8.2%	Smallmouth bass*	188	7.6%
Walleye	105	7.3%	Northern pike*	177	7.1%
Northern pike	78	5.4%	Yellow perch	76	3.1%
Black crappie	67	4.7%	Bluegill	69	2.8%
Smallmouth bass	40	2.8%	Black crappie	9	0.4%
Yellow bullhead	6	0.4%	Yellow bullhead	3	0.1%
Total	1,438		Total	2,476	
			*** Includes recaptured fish.**		

Table 8. Current (2014-2015) fishing regulations for Wheeler Lake; Oconto County, WI.

Species	Fishing Season	Daily Limit	Minimum Length
Largemouth bass	May 3- March 1	5	14 inches
Smallmouth bass	May 3- June 20	Catch and release	
	June 21- March 1	5 in total with LMB	14 inches
Northern pike	May 3 - March 1	5	None
Walleye	May 3- March 1	Daily bag limit varies based on tribal declarations	15 inches
Panfish (bluegill, black crappie, and yellow perch)	Open all year	25 in total	None
Bullheads	Open all year	None	None
Rock bass	Open all year	None	None

APPENDIX II – FIGURES

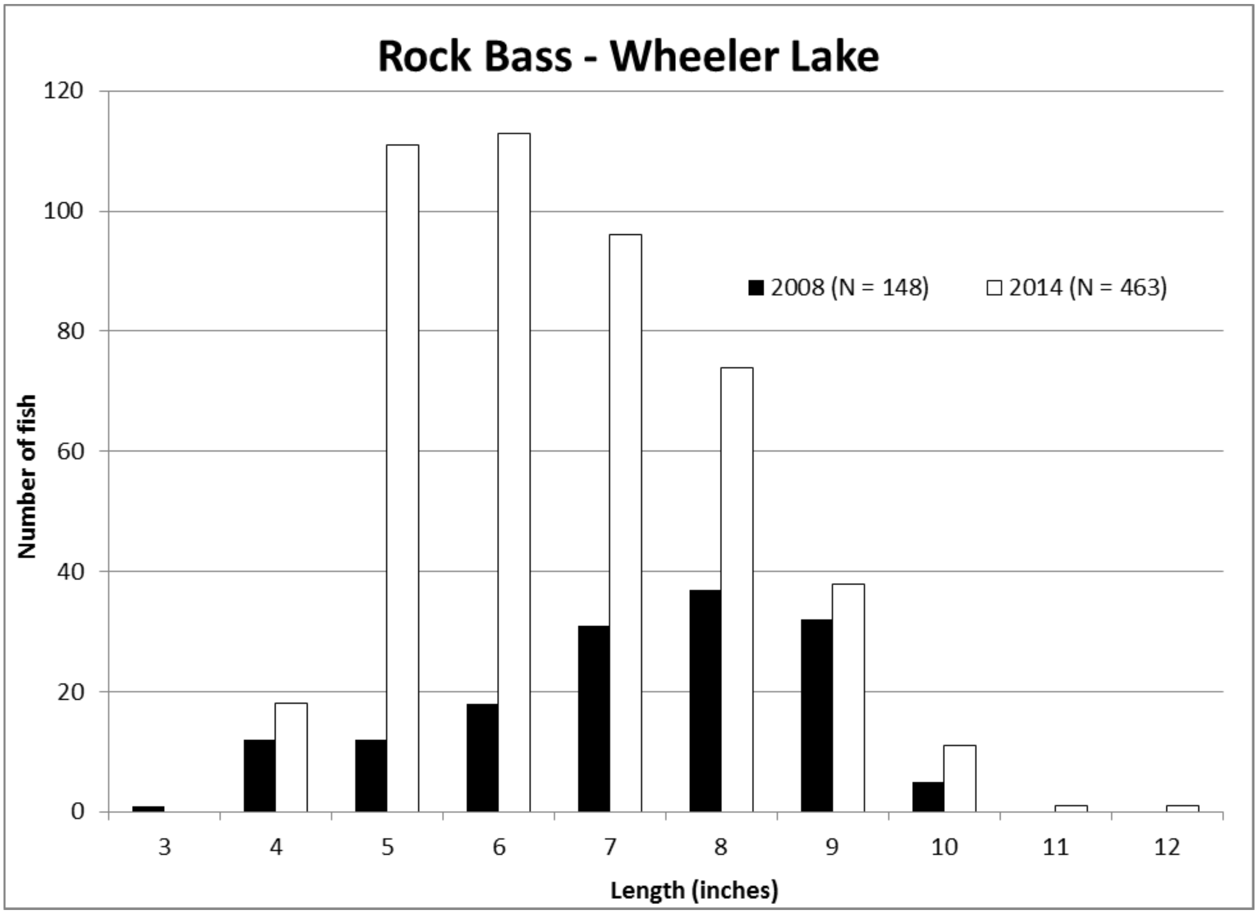


Figure 1. Rock bass length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

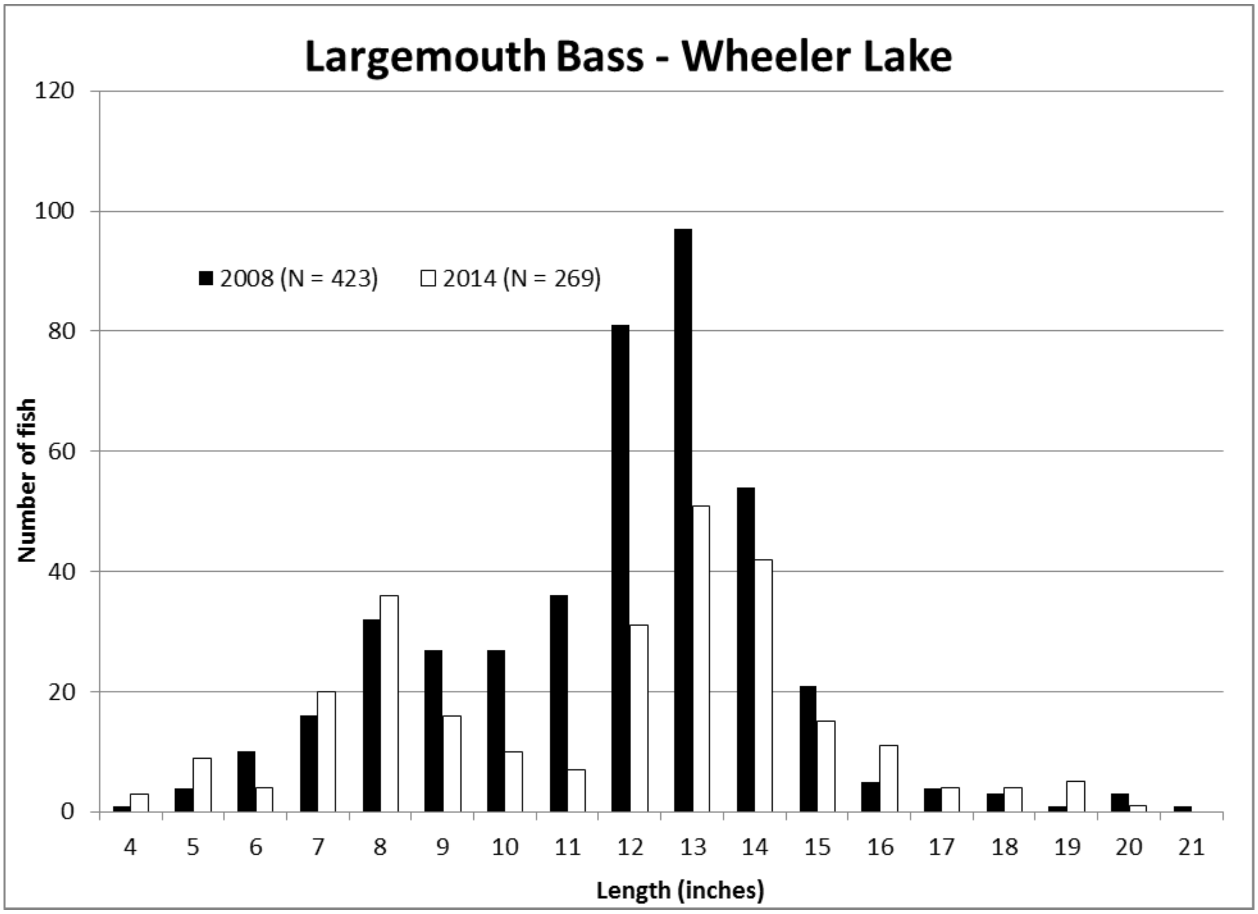


Figure 2. Largemouth bass length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

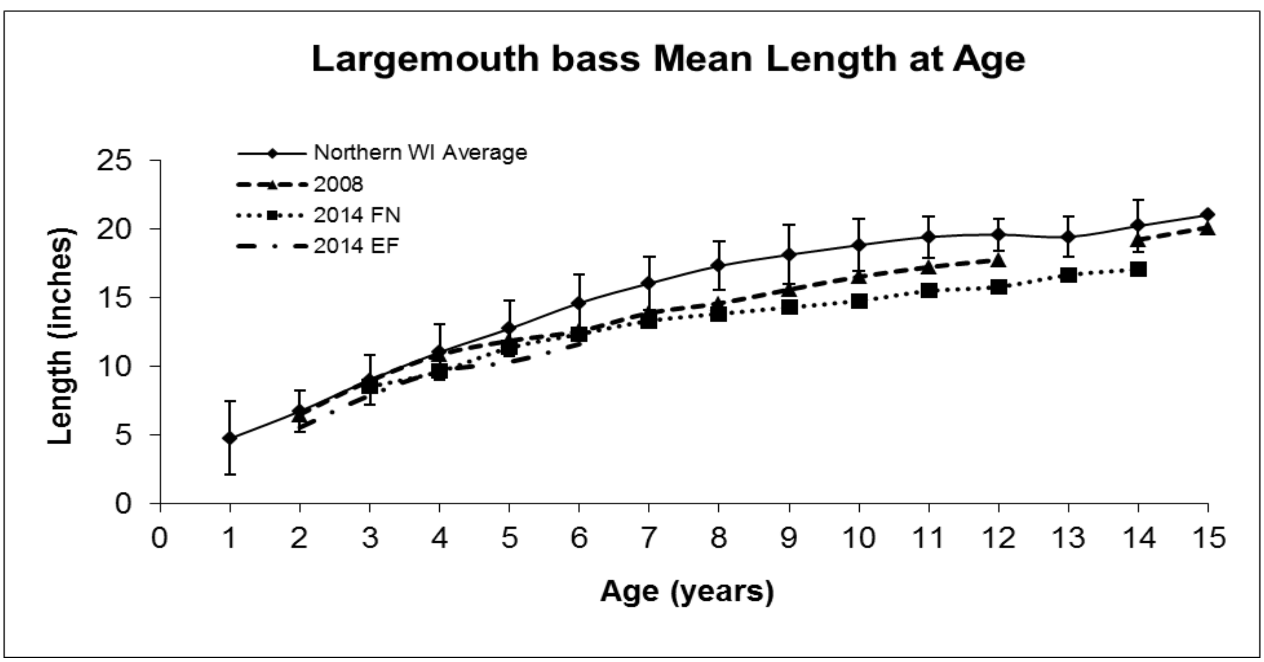


Figure 3. Largemouth bass mean length at age comparison from Wheeler Lake; Oconto County, WI.

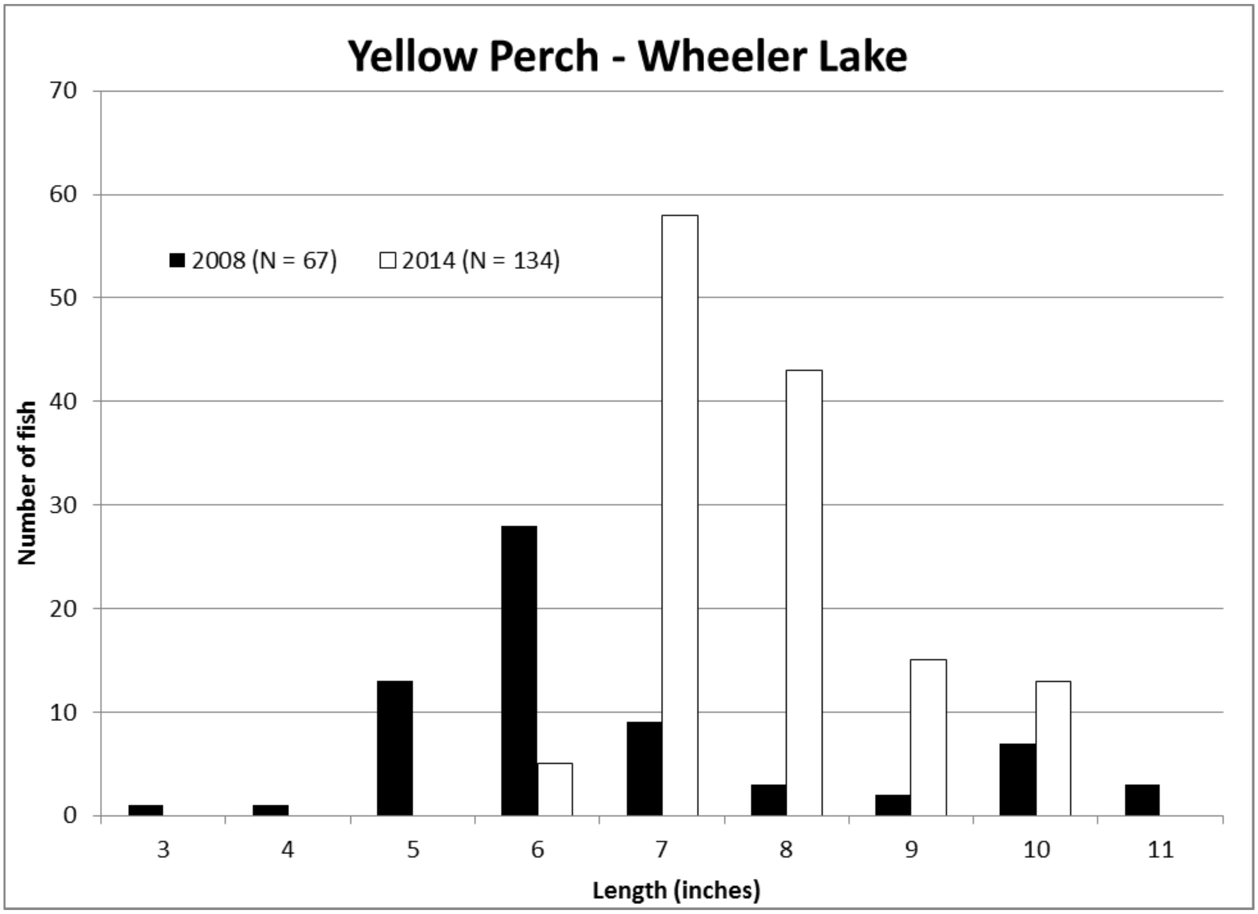


Figure 4. Yellow perch length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

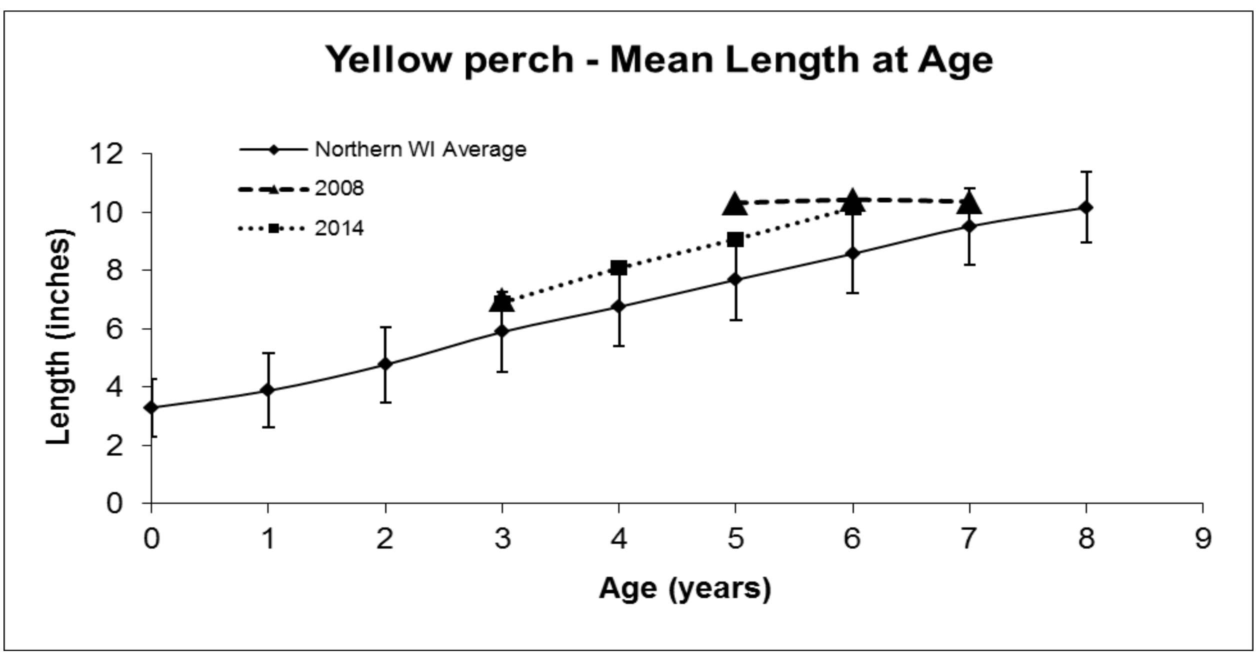


Figure 5. Yellow perch mean length at age comparison from Wheeler Lake; Oconto County, WI.

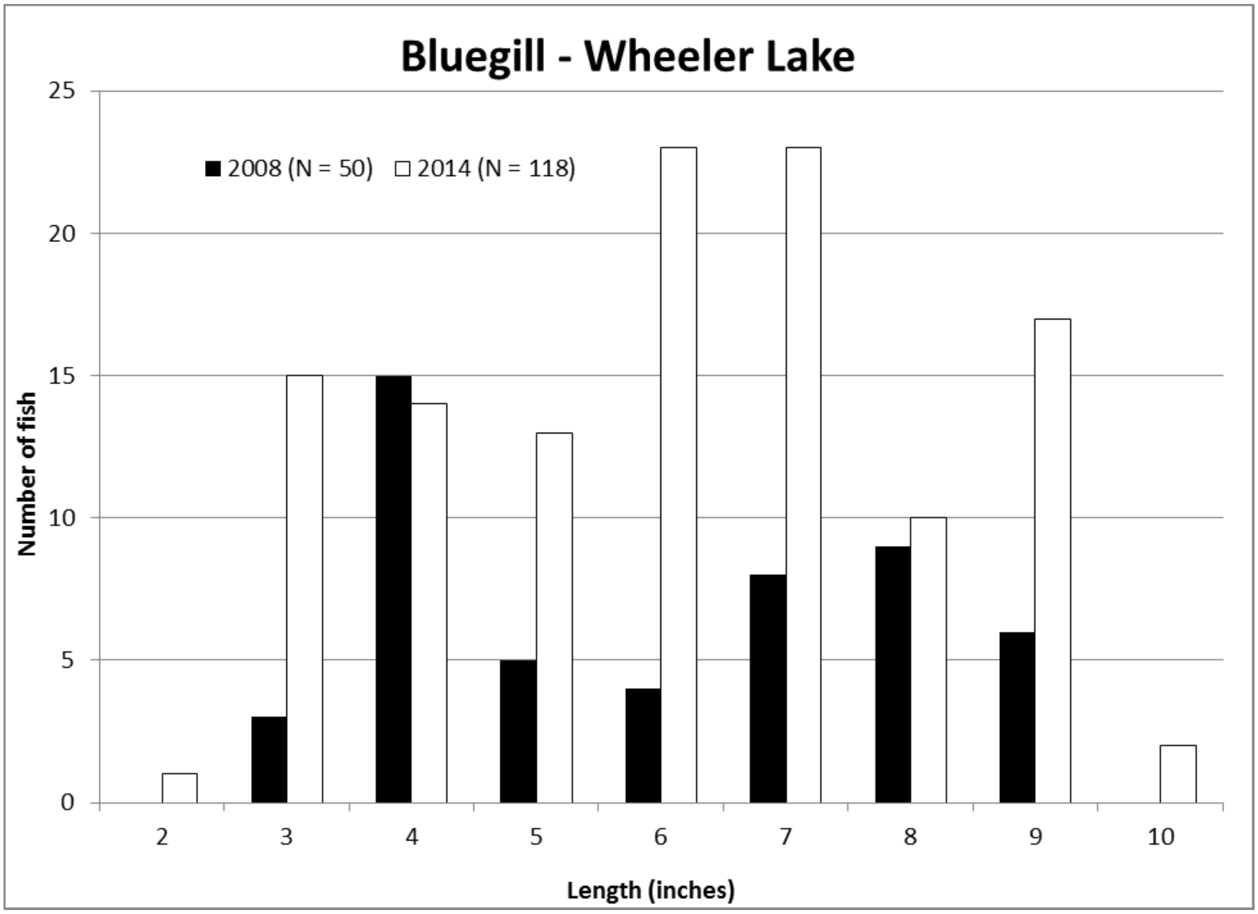


Figure 6. Bluegill length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

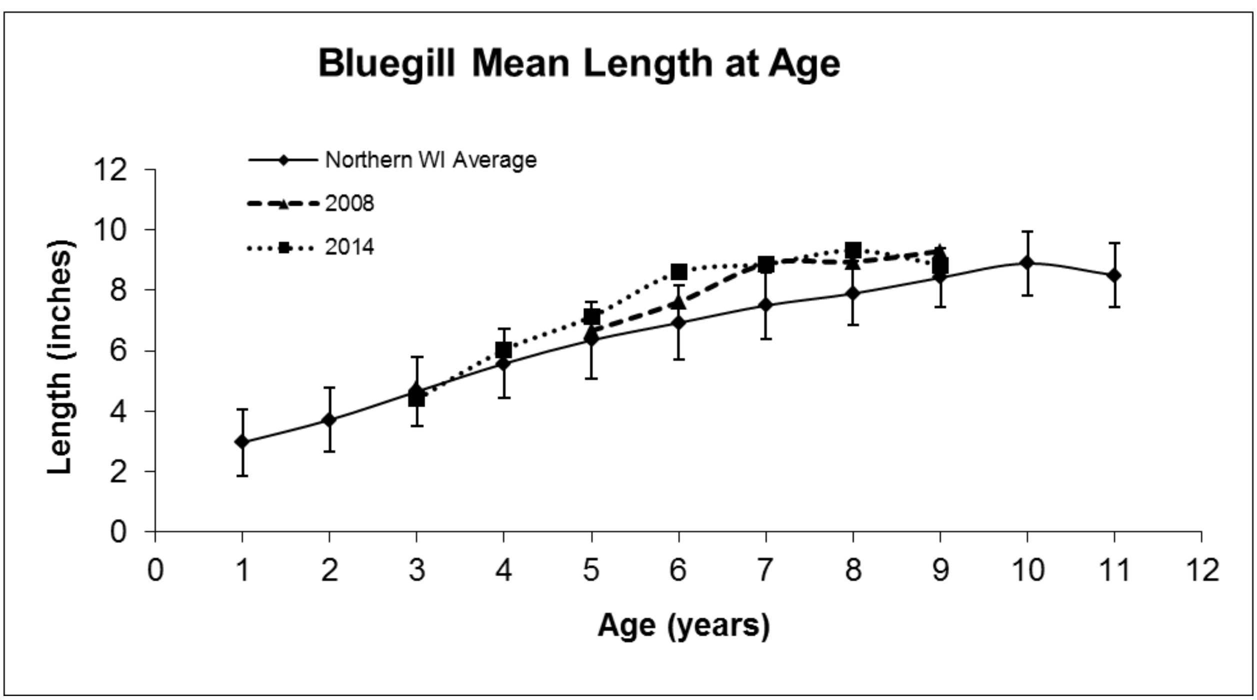


Figure 7. Bluegill mean length at age comparison from Wheeler Lake; Oconto County, WI.

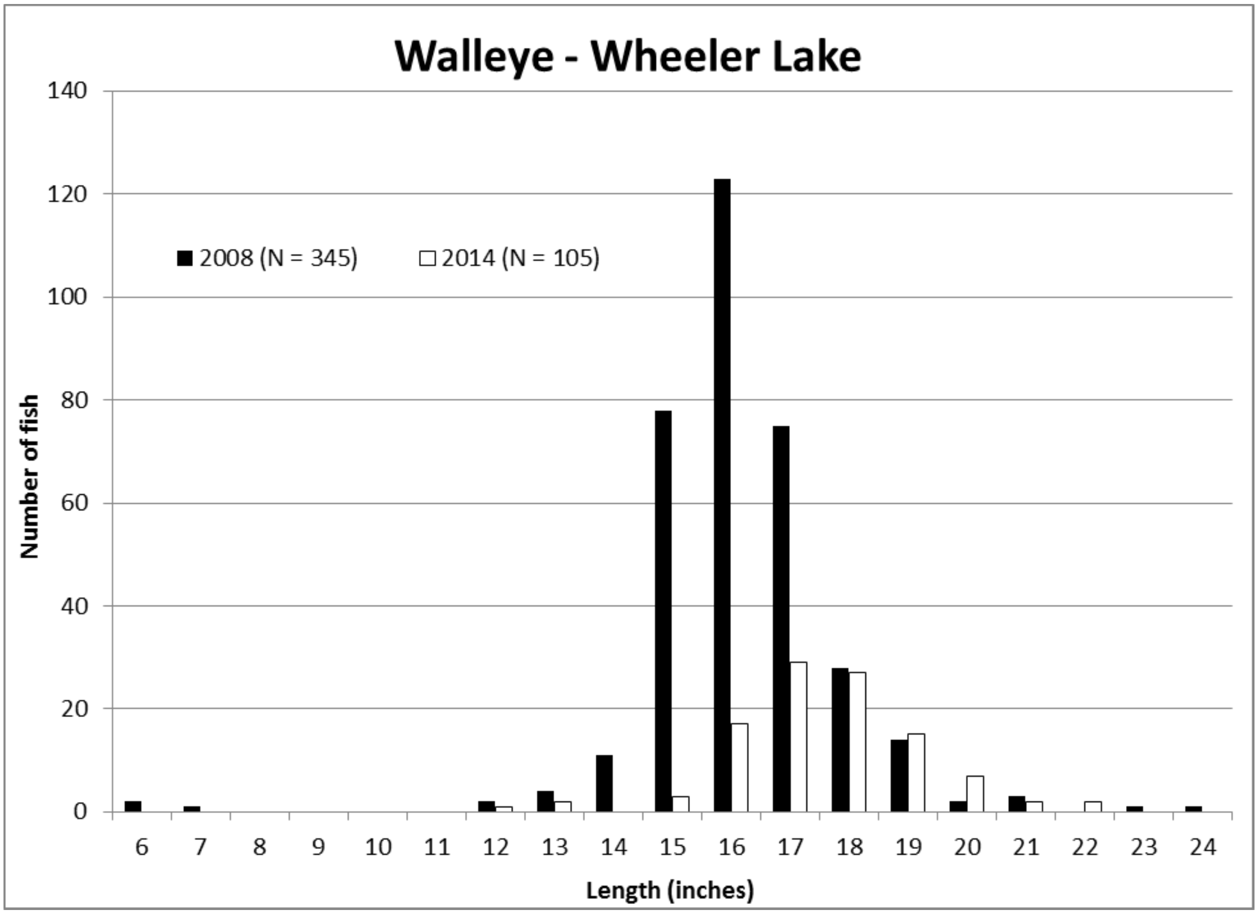


Figure 8. Walleye length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

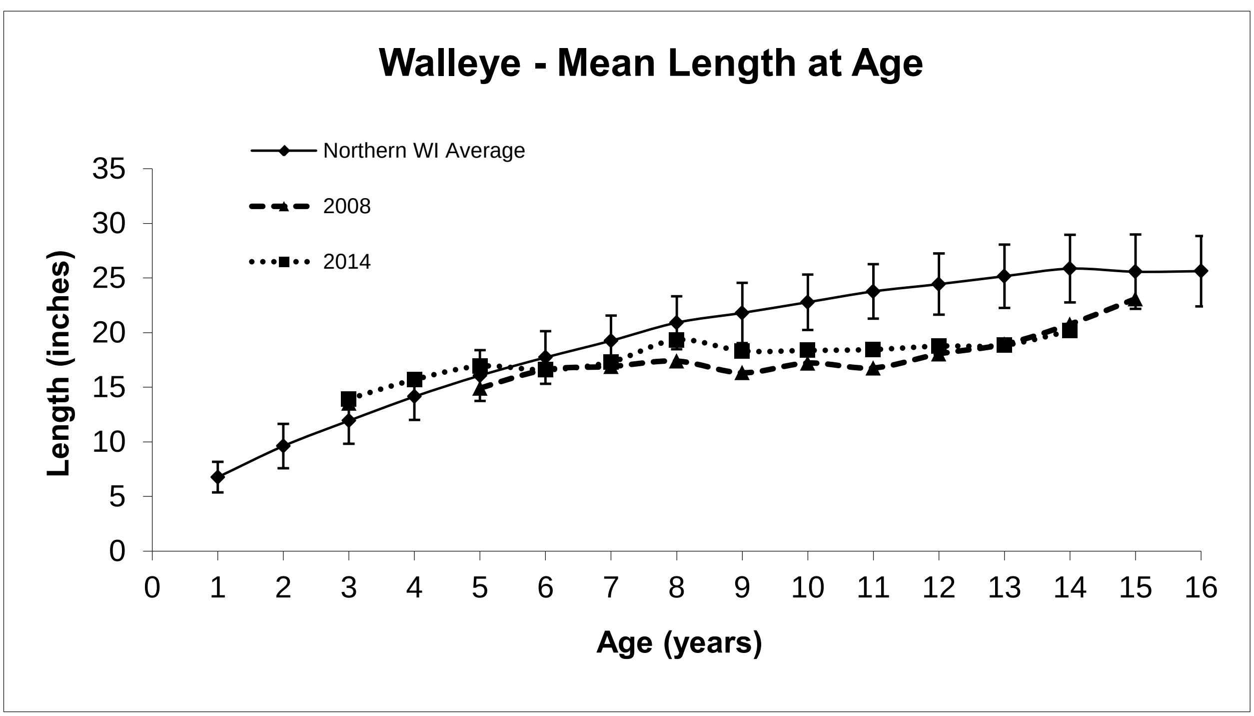


Figure 9. Walleye mean length at age comparison from Wheeler Lake; Oconto County, WI.

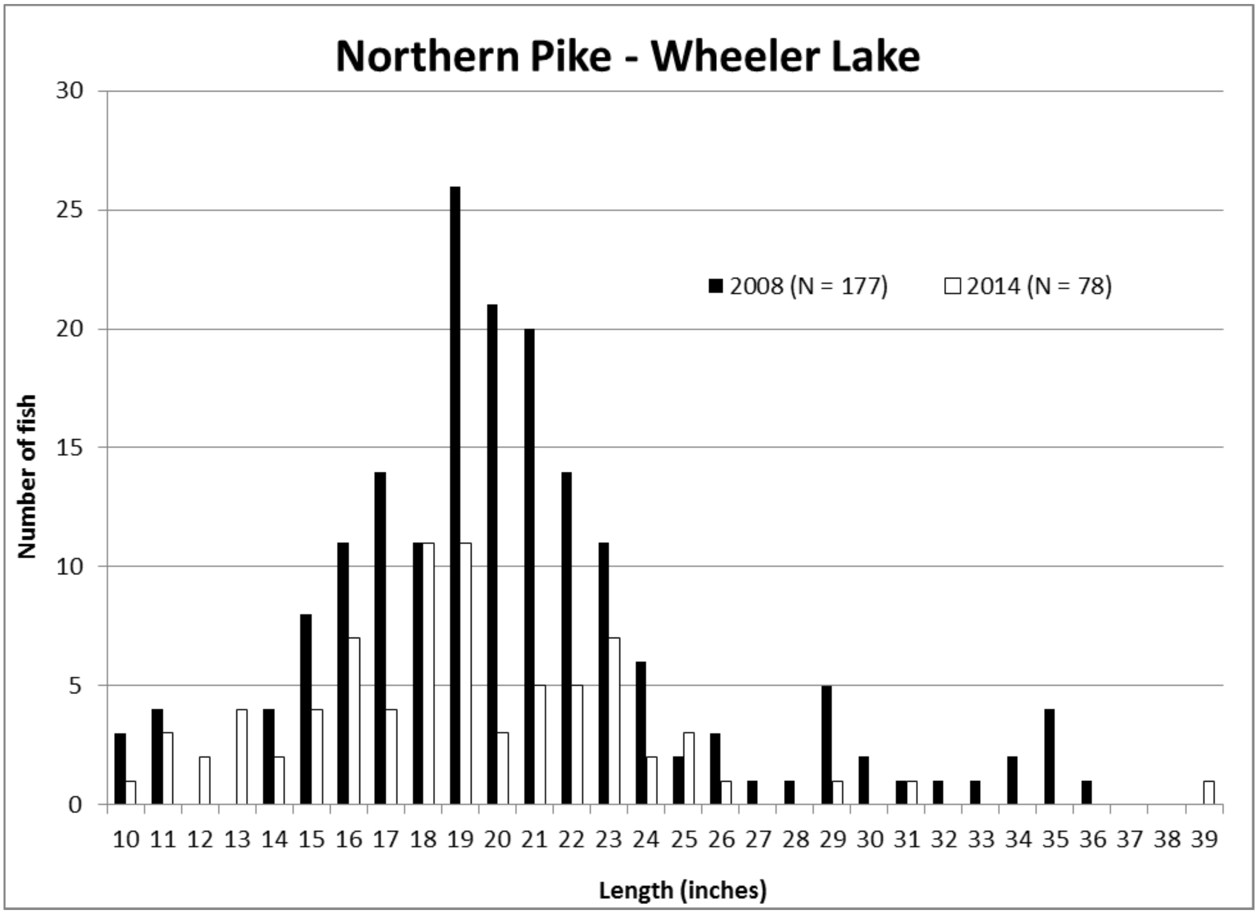


Figure 10. Northern pike length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

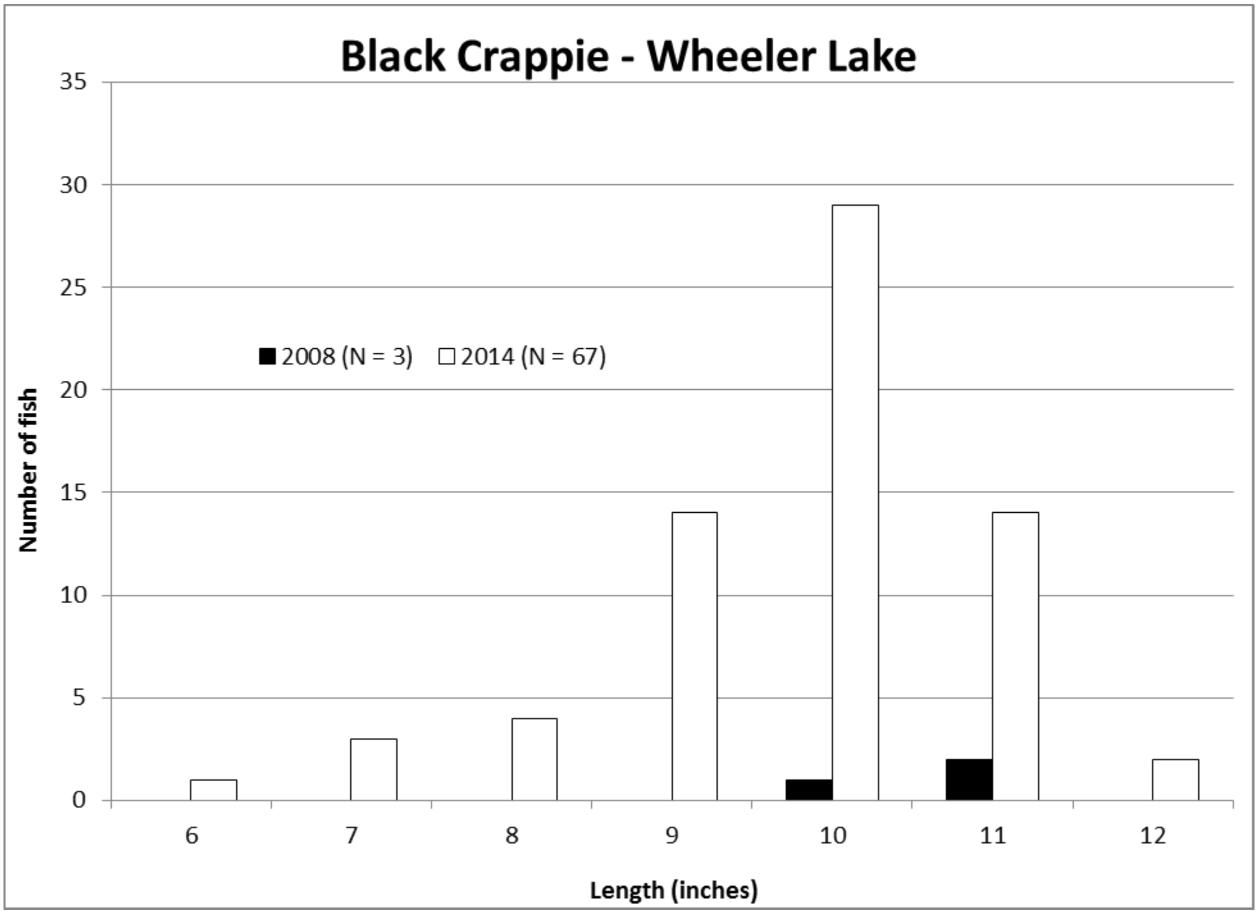


Figure 11. Black crappie length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

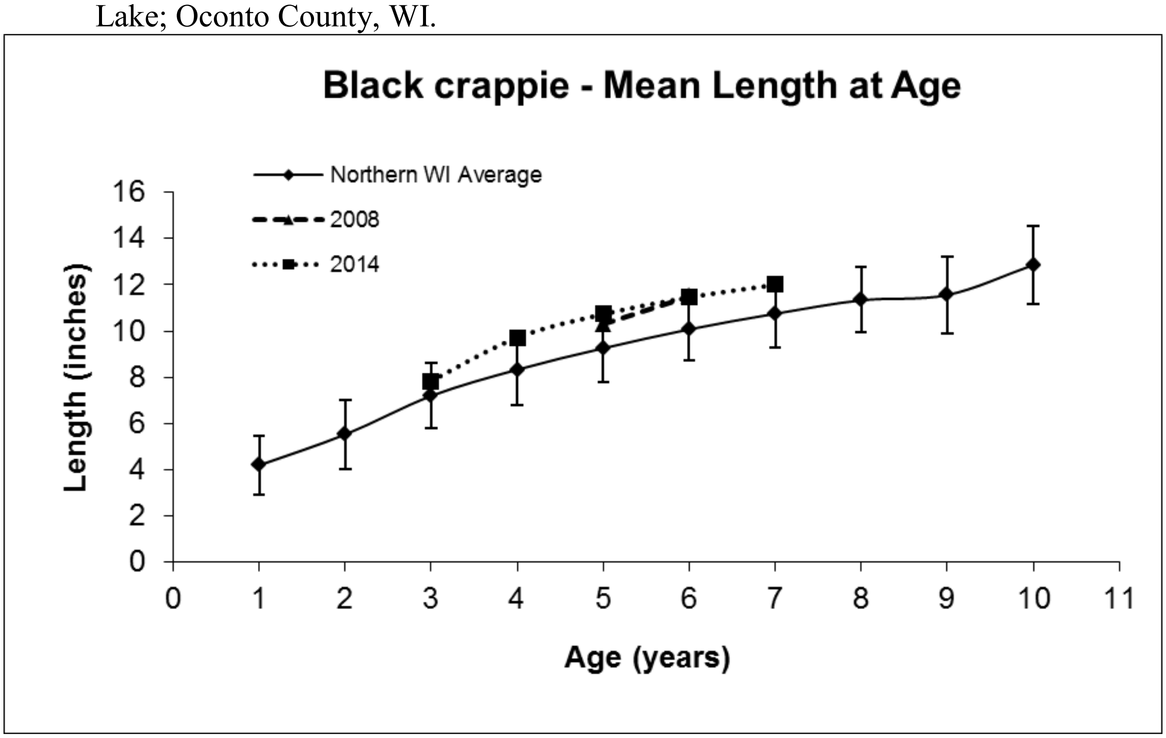


Figure 12. Black crappie mean length at age comparison from Wheeler Lake; Oconto County, WI.

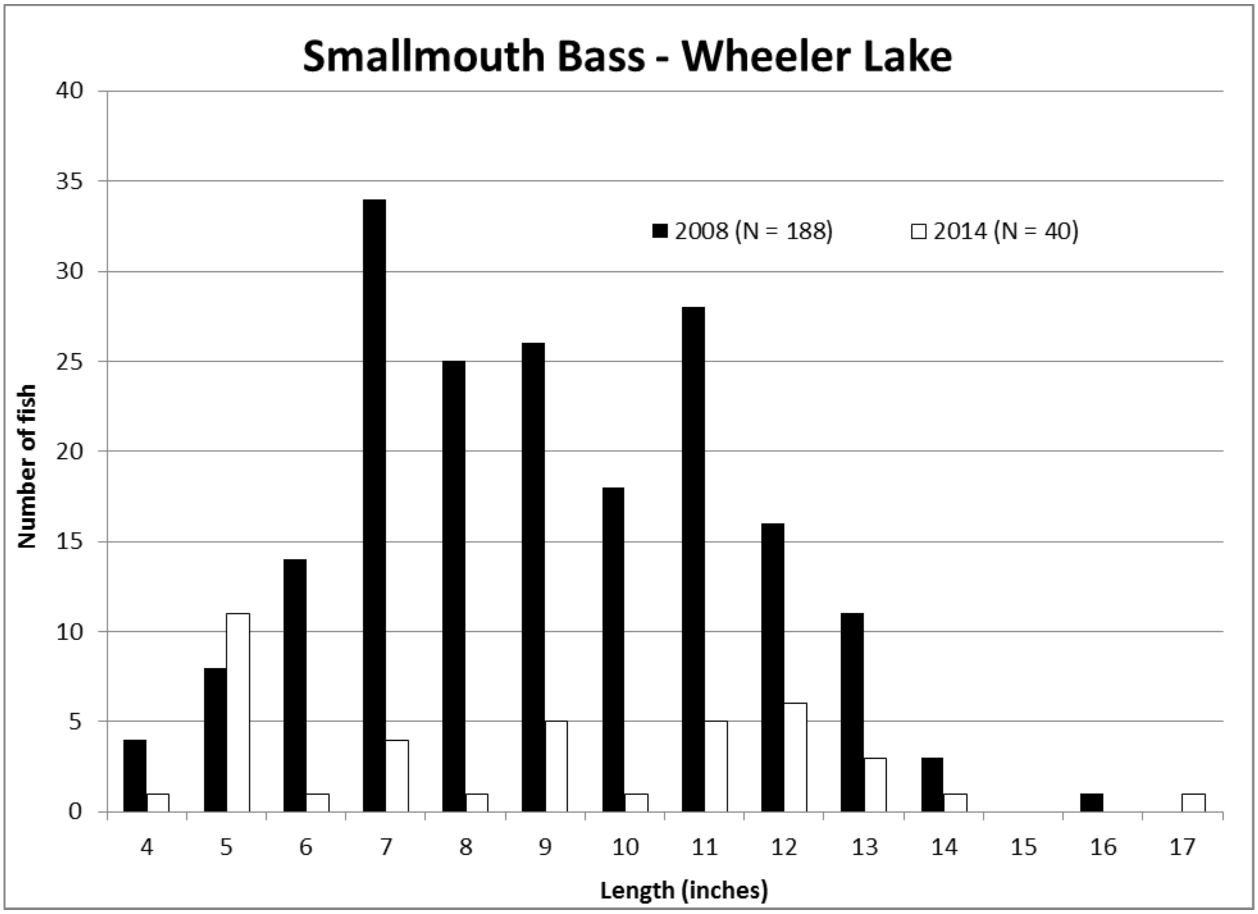


Figure 13. Smallmouth bass length frequency from 2008 and 2014 fisheries surveys at Wheeler Lake; Oconto County, WI.

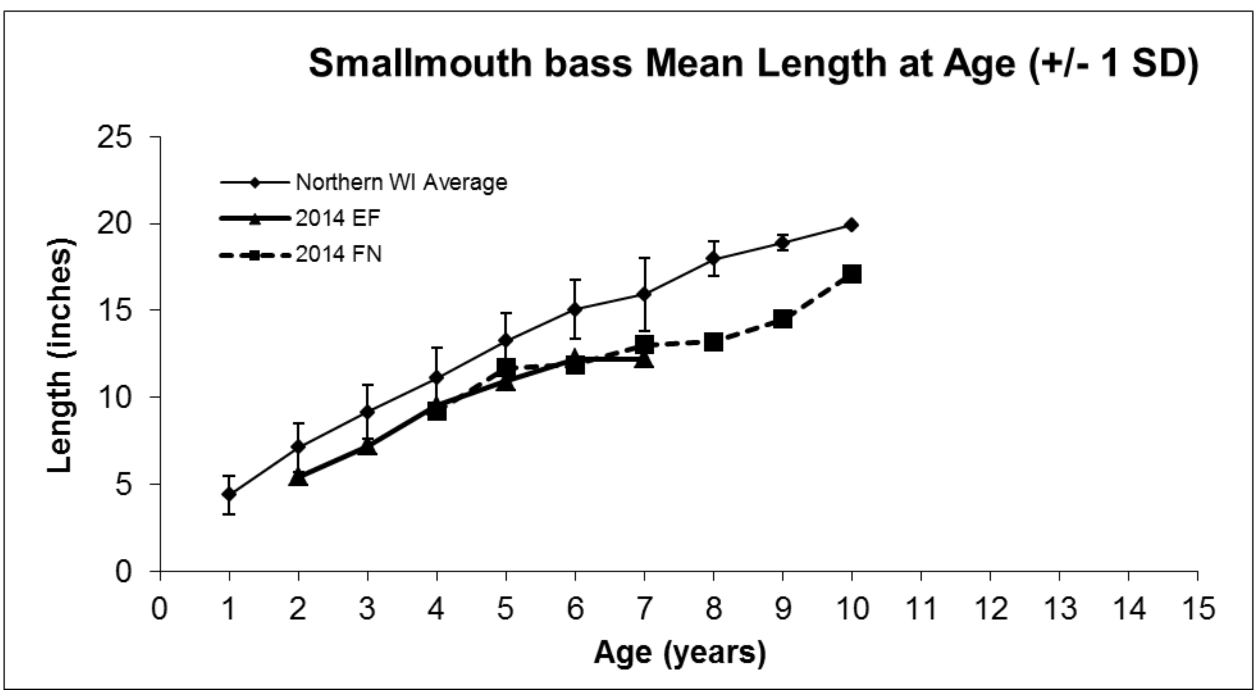


Figure 14. Smallmouth bass mean length at age comparison from Wheeler Lake; Oconto County, WI.

APPENDIX III – SAMPLING LOCATIONS

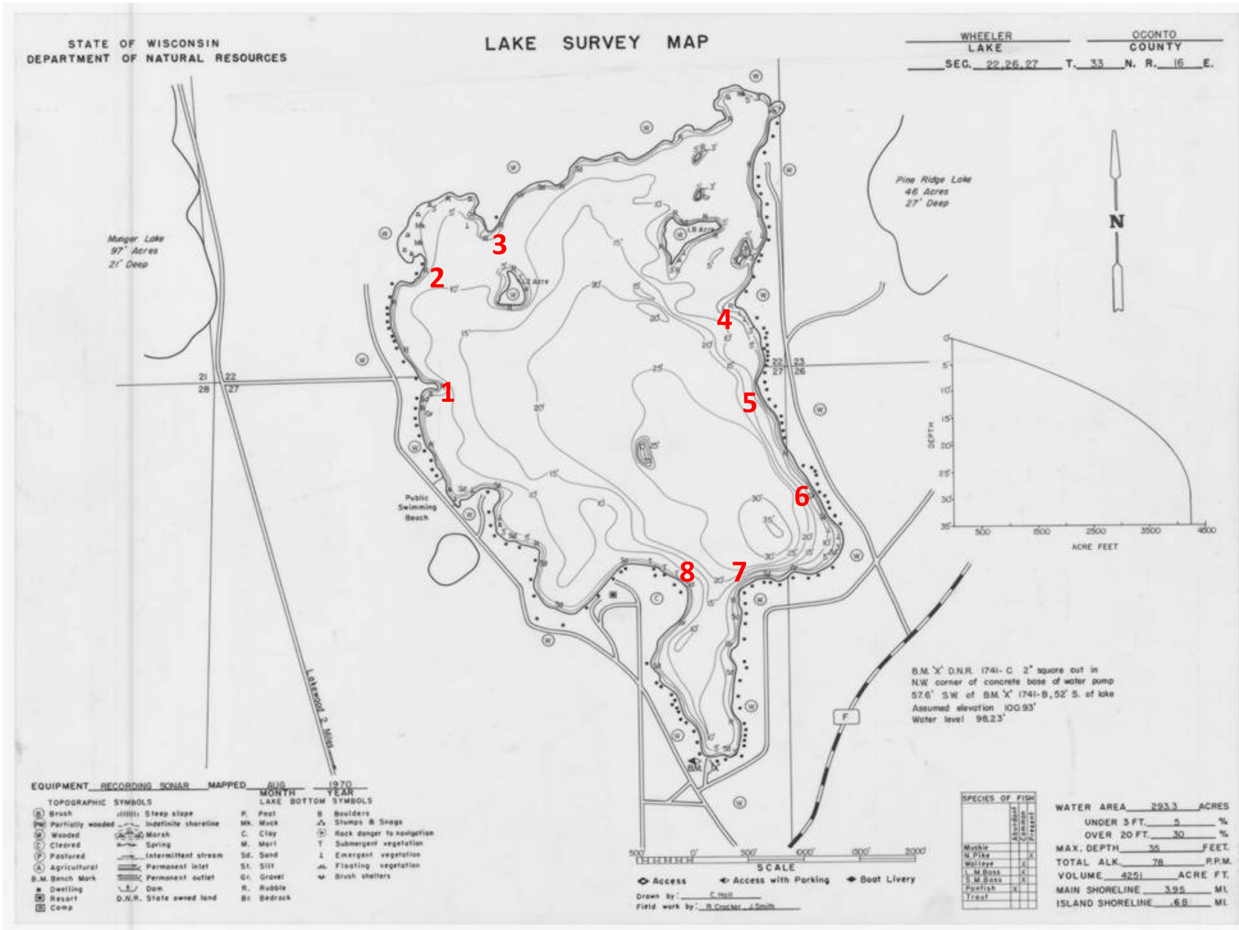


Figure 15. Fyke net locations during 2014 comprehensive survey of Wheeler Lake; Oconto County,WI.

APPENDIX III – FISH CRIB MAP

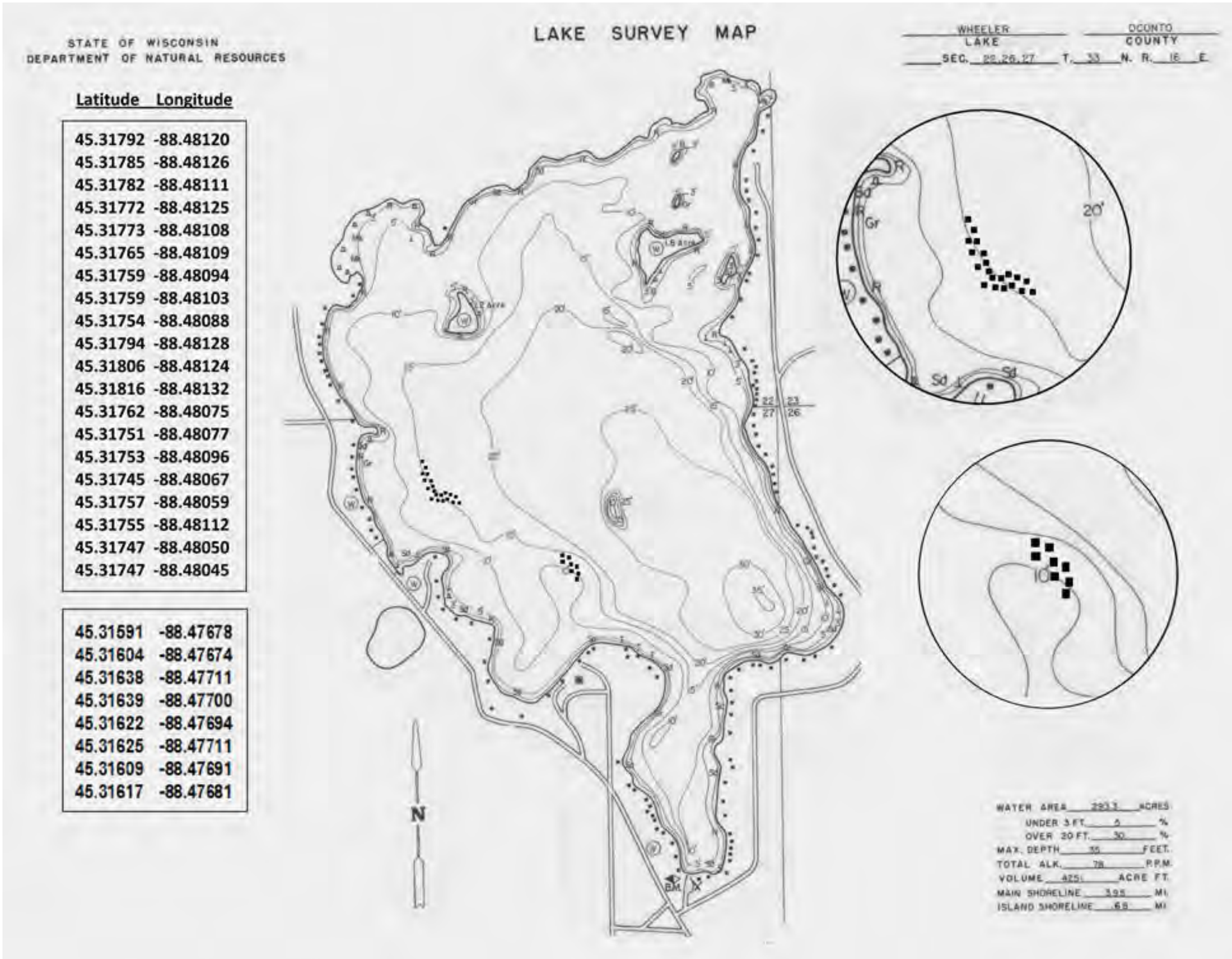


Figure 16. Locations of fish cribs placed in Wheeler Lake during 2012, 2013 and 2014.

Appendix J – Shoreland Assessment and Restoration

- Lakeshore Septic System Brochure
- Owning Waterfront Property

FALL 2004
Vol. 15, No. 4

Pipeline

Small Community Wastewater Issues Explained to the Public

NESC

Maintaining Your Septic System—A Guide For Homeowners

This issue of Pipeline is an update to the Fall, 1995 issue, Vol. 6, No. 4.

Buried beneath your back yard, it is out there—constantly working. When you're at work, it is working. When you're eating dinner, it continues working. And when you're sleeping, it's still out there in the dark—working. What is it? Your septic system. It may be the most overlooked and undervalued utility in your home; but with proper care and maintenance, your septic system can continue to work for you for at least 25 to 30 years.

If you are like most homeowners, you probably never give much thought to what happens when waste goes down your drain. But if you rely on a septic system to treat and dispose of your household wastewater, what you don't know *can* hurt you.

Proper operation and maintenance of your septic system can have a significant impact on how well it works and how long it lasts, and in most communities, septic system maintenance is the responsibility of the homeowner.

Preventing groundwater pollution from failing septic systems should be a priority for every community and every homeowner. Contamination of the groundwater source can lead to the pollution of local wells, streams, lakes, and ponds—exposing family, friends, and neighbors to waterborne diseases and other serious health risks.

When a septic system fails, inadequately treated domestic waste can reach the groundwater. Bacteria and viruses from human waste can cause dysentery, hepatitis, and typhoid fever. Many serious outbreaks of these diseases have been caused by contaminated drinking water.

Nitrates and phosphates, also found in domestic wastewater, can cause excessive algae growth in lakes and streams called algal blooms. These blooms cause aesthetic problems and impair other aquatic life. Nitrate is also the cause of methemoglobinemia, or blue baby syndrome, a condition that prevents the normal uptake of oxygen in the blood of young babies.

In addition, a failing septic system can lead to unpleasant symptoms, such as pungent odors and soggy lawns.

Why Maintain Your System

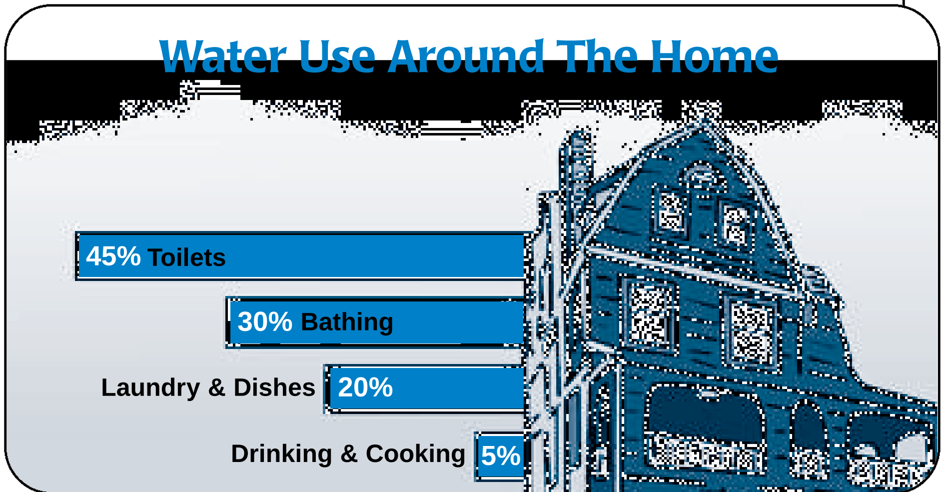
There are three main reasons why septic system maintenance is so important. The first reason is money. Failing septic systems are expensive to repair or replace, and improper maintenance by homeowners is a common cause of early system failure. The minimal amount of preventative maintenance that septic systems require costs very little in comparison to the cost of a new system. For example, it typically costs from $3,000 to $10,000 to replace a failing septic system, compared to $100 to $300 average per year costs to have a septic system routinely pumped and inspected.

The second and most important reason to properly maintain your system is the health of your family, your community, and the environment. When septic systems fail, inadequately treated household wastewater is released into the environment. Any contact with untreated human waste can pose a significant risk to public health. Untreated wastewater from failing septic systems can contaminate nearby wells, groundwater, and drinking water sources.

What's Inside...

Chemicals improperly disposed of through a septic system also can pollute local water sources and can contribute to early system failures. For this reason it is important for homeowners to educate themselves about what can and what cannot be disposed of through a septic system.

A third reason to maintain your septic system is to maintain the economic health of your community. Failing septic systems can cause property values to decline. Sometimes building permits cannot be issued for these properties. Also, failing septic systems may contribute to the pollution of local rivers, lakes, and shoreline that your community uses for commercial or recreational activities.



How to Maintain Your System

Septic system maintenance is often compared to automobile maintenance because only a little effort on a regular basis can save a lot of money and significantly prolong the life of the system.

Annual inspections of your septic system are recommended to ensure that it is working properly and to determine when the septic tank should be pumped. Systems that have moving parts may require more frequent inspections. By having your system inspected and pumped regularly, you can prevent the high cost of septic system failure.

A professional contractor can do a thorough inspection of the entire system and check for cracked pipes and the condition of the tees or baffles and other parts of the system.

A thorough septic system inspection will include the following steps:

1. Locating the system.
Even a professional may have trouble locating the system if the access to your tank is buried. One way to start looking is to go in the basement and determine the direction the sewer pipe goes out through the wall. Back outside, the inspector will use an insulated probe inserted into the soil to locate the buried piping. Once the system components are found, be sure to sketch a map and keep it on hand to save time on future service visits.

2. Uncovering the manhole and inspection ports.
This may require some digging in the yard. If they are buried, it will help future inspections if elevated access covers or risers are installed to make it easier to access the ports and manhole.

3. Checking connections.
Flushing the toilets, running water in the sinks, running the washing machine through a cycle will help to determine if the household plumbing is all going to the system and working correctly.

4. Measuring the scum and sludge layers.
The inspector will measure the scum and sludge layers with special tools inserted through the inspection port. A proper inspection will also include a visual observation of the scum and sludge layers. (The sludge layer is the heavier solids that have settled down to the bottom of the tank. The scum layer is made up of grease and light solids that float near the top of the tank.)

If the sludge depth is equal to one third or more of the liquid depth, the tank should be pumped. Also, the tank needs to

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be pumped when it is 1/3 full. See the table below for estimated pumping frequencies. But be aware it is most prudent to conduct regular inspections and pump when the inspection says the tank needs to be pumped.

Remember that toxic gases are produced by the natural treatment processes in septic tanks and can kill in minutes. Even looking into the tank can be dangerous. Leave inspections to the trained professionals.

5. Checking the tank and the drainfield.
The inspector will check the condition of the baffles or tees, the walls of the tank for cracks, and the drainfield for any signs of failure. If the system includes a distribution box, drop box, or pump, these need to be checked too.

How often the tank needs to be pumped depends on the tank size, the number of people living in your home, and the habits of your particular household. Garbage disposals and high-water-use appliances, such as a hot tub or whirlpool, also affect the pumping frequency.

When it's time to pump, be sure to hire a licensed contractor. He or she will have the appropriate equipment and will dispose of the sludge at an approved treatment site. You can find listings for licensed pumpers and haulers in the yellow pages, or contact your local health department or permitting agency for assistance.

It's a good idea to be present when your tank is being pumped. Make sure that the contractor uses the manhole, not the inspection ports, to pump the tank to avoid damaging the baffles or tees. Also make sure all of the material in the tank is removed. It is not necessary to leave anything in the tank to "restart" the biological processes, but it is also not necessary to scrub or disinfect the tank.

Pumping your septic tank is probably the single most important thing that you can do to protect your system. If the buildup of solids in the tank becomes too high and solids move to the drainfield, this could clog and strain the system to the point where a new drainfield will be needed.

Figure 1.
Estimated septic tank pumping frequencies in years. These figures assume there is no garbage disposal unit in use. If one is in use, pumping frequency may need to be increased.
(Source: Pennsylvania State University Cooperative Extension Service.)

Tank Size (gals.)	Household Size (number of people)					
	1	2	3	4	5	6
500	5.8	2.6	1.5	1.0	0.7	0.4
750	9.1	4.2	2.6	1.8	1.3	1.0
900	11.0	5.2	3.3	2.3	1.7	1.3
1000	12.4	5.9	3.7	2.6	2.0	1.5
1250	15.6	7.5	4.8	3.4	2.6	2.0
1500	18.9	9.1	5.9	4.2	3.3	2.6
1750	22.1	10.7	6.9	5.0	3.9	3.1
2000	25.4	12.4	8.0	5.9	4.5	3.7
2250	28.6	14.0	9.1	6.7	5.2	4.2
2500	31.9	15.6	10.2	7.5	5.9	4.8

Recordkeeping
It is very important to keep a detailed record of all inspections, pumpings, permits, repairs, and any other maintenance to your system along with a sketch of where your septic system is located. Having this information on hand for service visits can save you both time and money.

Learn the location of your septic system, and keep a diagram or sketch of it with your maintenance records.

Inspecting your septic system annually is a good way to monitor your system's health. Inspections can reveal problems before they become serious, and by checking the levels of sludge and scum in your tank, you can get a more accurate idea of how often it should be pumped.

Protect the tank and drainfield
Protect your septic system from potential damage. Don't plant anything but grass near your septic system—roots from shrubs and trees can cause damage—and don't allow anyone to drive or operate heavy machinery over any part of the system. Also, don't build anything over the drainfield. Grass is the most appropriate cover for the drainfield.

Sound septic system operation and maintenance practices include conserving water, being careful that nothing harmful is disposed of through the system, and having the system inspected annually and pumped regularly.

By educating everyone in your household about what is and what isn't good for septic systems, they can begin to develop good maintenance habits.

What Not To Flush

What you put into your septic system greatly affects its ability to do its job. Remember, your septic system contains living organisms that digest and treat waste. As a general rule of thumb, do not dispose of anything in your septic system that can just as easily be put in the trash. Your system is not designed to be a garbage can and solids build up in the septic tank that will eventually need to be pumped. The more solids that go into the tank, the more frequently the tank will need to be pumped, and the higher the risk for problems to arise.

In the kitchen, avoid washing food scraps, coffee grinds, and other food items down the drain. Grease and cooking oils contribute to the layer of scum in the tank and also should not be put down the drain.

The same common-sense approach used in the kitchen should be used in the bathroom. Don't use the toilet to dispose of plastics, paper towels, facial tissues, tampons, sanitary napkins, cigarette butts, dental floss, disposable diapers, condoms, kitty litter, etc. The only things that should be flushed down the toilet are wastewater and toilet paper.

When used as recommended by the manufacturer, most household cleaning products will not adversely affect the operation of your septic tank. Drain cleaners are an exception, however, and only a small amount of these products can kill the bacteria and temporarily disrupt the operation of the tank.

Household cleaners such as bleach, disinfectants, and drain and toilet bowl cleaners should be used in moderation and only in accordance with product labels. Overuse of these products can harm your system. It makes sense to try to keep all toxic and hazardous chemicals out of your septic tank system.

To avoid disrupting or permanently damaging your septic system, do not use it to dispose of hazardous household chemicals. Even small amounts of paints, varnishes, paint thinners, waste oil, anti-freeze, photographic solutions, pharmaceuticals, antibacterial soaps, gasoline, oil, pesticides, and other organic chemicals can destroy helpful bacteria and the biological digestion taking place within your system. These chemicals also pollute the groundwater.

Even latex paint is unhealthy for your septic system. To reduce the cleanup of these products, squeeze all excess paint and stain from brushes and rollers on several layers of newspaper before rinsing.

To help prevent groundwater pollution, be sure to dispose of leftover hazardous chemicals by taking them to an approved hazardous waste collection center. For more information, contact your local health department.

Additives/System Cleaners

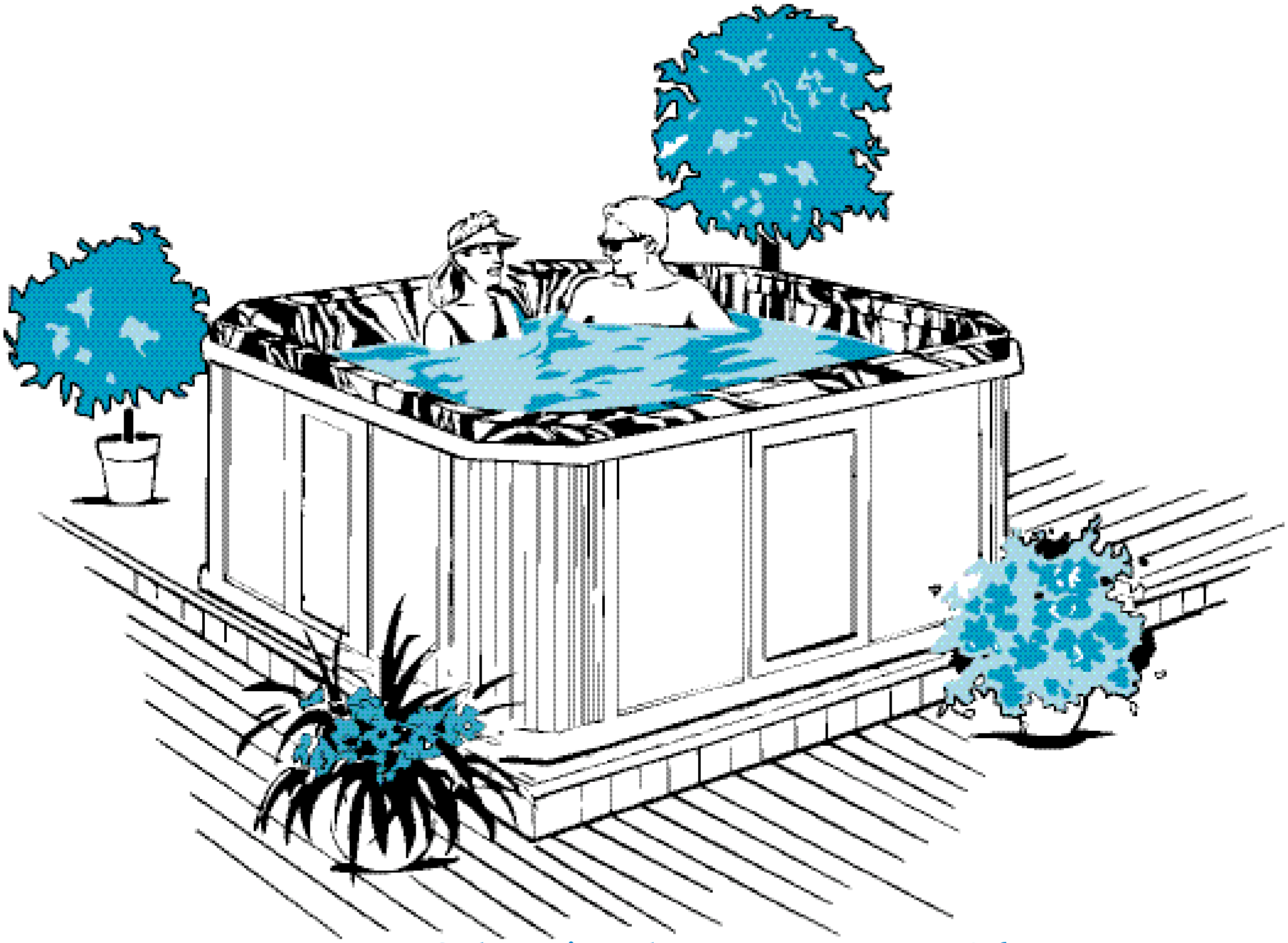
While many products on the market claim to help septic systems work better, the truth is there is no magic potion to cure an ailing system. In fact, most engineers and sanitation professionals believe that commercial septic system additives are, at best, useless, and at worst, harmful to a system.

There are two types of septic system additives: biological (like bacteria, enzymes, and yeast) and chemical. The biological additives are harmless but some chemical additives can potentially harm the soil in the drainfield and contaminate the groundwater.

While there hasn't been extensive study on the effectiveness of these products, the general consensus among septic system experts is that septic system additives are an unnecessary evil.

Be aware that the extended use of strong pharmaceuticals and personal care products may harm the working bacteria population in the tank. The total effects are unknown at this time.

Modern Appliances May Affect Your Septic Tank



Hot Tubs/Whirlpools

Hot tubs and whirlpools have become more common today in the home as a source of relaxation and therapy. While the soothing, swirling waters of a spa may be good for a homeowner, unfortunately, the large amounts of water that drain from the hot tub are not good for your septic system.

Emptying large quantities of water from a hot tub into your septic system can overload a system and stir the solids in the tank, pushing them into the drainfield, eventually causing it to fail.

Hot tub water should instead be cooled and then drained onto turf or landscaped areas of your property well away from the septic tank, drainfield, and house in accordance with local regulations.

Garbage Disposals

Garbage disposals can increase the amount of solids in the tank up to 50 percent and should not be used. Eliminating a garbage disposal can greatly reduce the amount of grease and solids that enter the drainfield.

Because a garbage disposal grinds kitchen scraps into small pieces, once they reach the septic tank, they are suspended in the water. Some of these materials are broken down by bacterial action, but most of the grindings must be pumped out of the tank.

As a result, use of a garbage disposal will significantly increase the amount of sludge and scum in your septic tank. Therefore, many states require a larger minimum size septic tank if there will be a garbage grinder/disposal unit in operation in the house.

Water Softeners

Some freshwater purification systems, including water softeners, needlessly pump hundreds of gallons of water into the septic system all at once. This can agitate the solids and allow excess to flow into the drainfield. Consult a plumbing professional about alternative routing for such freshwater treatment systems.

Water softeners remove hardness by using a salt to initiate an ion exchange. The backwash to regenerate the softener flushes pounds of this used salt into the septic system. There is some concern that these excess salts can affect the digestion in the septic tank or reduce the permeability in the soil dispersal system.

The Winter 2001 issue of *Pipeline* gives additional information about water softener use.

How Your Septic System Works

There are two main parts to the basic septic system: the septic tank and the drainfield.

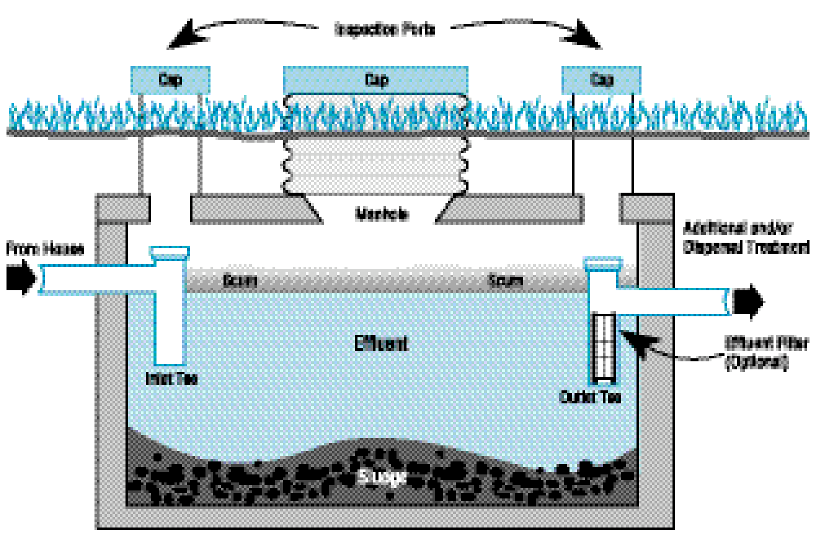
Household wastewater first flows into the septic tank where it should stay for at least a day. In the tank, heavy solids in the wastewater settle to the bottom forming a layer of sludge, and grease and light solids float to the top forming a layer of scum.

The sludge and scum remain in the tank where naturally occurring bacteria work to break them down. The bacteria cannot completely break down all of the sludge and scum, however, and this is why septic tanks need to be pumped periodically.

The separated wastewater in the middle layer of the tank is pushed out into the drainfield as more wastewater enters the septic tank from the house. If too much water is flushed into the septic tank in a short period of time, the wastewater flows out of the tank before it has had time to separate. This can happen on days when water use is unusually high, or more often if the septic tank is too small for the needs of the household. Homeowners should stagger their laundry throughout the week and try to do no more than two wash loads per day.

When wastewater leaves a septic tank too soon, solids can be carried with it to the drainfield. Drainfields provide additional treatment for the wastewater by allowing it to trickle from a series of perforated pipes, through a layer of gravel, and down through the soil. The soil acts as a natural filter and contains organisms that help treat the waste. Solids damage the drainfield by clogging the small holes in the drainfield pipes, and excess water strains the system unnecessarily.

Conventional septic systems are a very simple way to treat household wastewater. They contain no moving parts and are easy to operate and maintain. Although homeowners must take a more active role in maintaining septic systems, once they learn how their systems work, it is easy for them to appreciate the importance of a few sound operation and maintenance practices.



Use Water Wisely All Around The House

Water conservation is very important for septic systems because continual saturation of the soil in the drainfield can affect the quality of the soil and its ability to naturally remove toxics, bacteria, viruses, and other pollutants from the wastewater.

The most effective way to conserve water around the house is to first take stock of how it is being wasted. Immediately repair any leaking faucets or running toilets, and use dishwashers only when full.

Laundry

You can also cut down on water use by selecting the proper load size for your washing machine. Washing small loads of laundry with large quantities of water is a waste of both water and energy.

Also doing laundry all in one day might seem like a good use of time, but it could be harmful to your septic system. By doing several loads in succession, the septic system does not have time to adequately treat wastes. You might be hydraulically overloading your septic system, causing it to pass solids into the drainfield.

Newer energy-efficient clothes washers use 35 percent less energy and 50 percent less water than a standard model. Look for appliances that display the Energy Star symbol. This indicates they meet strict energy efficiency guidelines set by the EPA and the U.S. Department of Energy.

Use only nonphosphate or low phosphate laundry detergents. Powder detergents with low inert (clay) content are also easier on the septic system.

Bathrooms

In a typical household, most of the water used indoors is used in the bathroom, and there are several little things that can be done to conserve water there.

For example, try to avoid letting water run while washing hands and brushing teeth. Avoid taking long showers and install water-saving features in faucets and shower heads. These devices can reduce water use by up to 50 percent. Low-flush toilets use 1.6 gallons per flush compared to the three to five gallons used by conventional toilets. Even using a toilet dam or putting a container filled with rocks in the toilet tank can reduce water use by 25 percent.

It is also important to avoid overtaxing your system by using a lot of water in a short time period, or by allowing too much outside water to reach the drainfield. Try to space out activities requiring heavy water use over several days. Also, divert roof drains, surface water, and sump pumps away from the drainfield.

Reprint Info

Readers are encouraged to reprint *Pipeline* articles in local newspapers or include them in flyers, newsletters, or educational presentations. Please include the name and phone number of the National Environmental Service Center (NESC) on the reprinted information and send us a copy for our files. If you have any questions about reprinting articles or about any of the topics discussed in this newsletter, please contact the NESC at (800) 624-8301.

Septic System Dos and Don'ts

***Do** learn the location of your septic tank and drainfield. Keep a sketch of it handy with your maintenance record for service visits.

***Do** have your septic system inspected annually.

***Do** have your septic tank pumped out by a licensed contractor, approximately every three to five years, or as often as is appropriate for your system

***Do** keep your septic tank cover accessible for inspections and pumping. Install risers if necessary.

***Do** call a professional whenever you experience problems with your system, or if there are any signs of system failure.

***Do** keep a detailed record of repairs, pumping, inspections, permits issued, and other maintenance activities.

***Do** conserve water to avoid overloading the system. Be sure to repair any leaky faucets or toilets.

***Do** divert other sources of water, like roof drains, house footing drains, and sump pumps, away from the septic system. Excessive water keeps the soil in the drainfield from naturally cleansing the wastewater.

***Don't** go down into a septic tank. Toxic gases are produced by the natural treatment processes in septic tanks and can kill in minutes. Extreme care should be taken when inspecting a septic tank, even when just looking in.

***Don't** allow anyone to drive or park over any part of the system.

***Don't** plant anything over or near the drainfield except grass. Roots from nearby trees or shrubs may clog and damage the drain lines.

***Don't** dig in your drainfield or build anything over it, and don't cover the drainfield with a hard surface such as concrete or asphalt. The area over the drainfield should have only a grass cover. The grass will not only prevent erosion, but will help remove excess water.

***Don't** make or allow repairs to your septic system without obtaining the required health department permit. Use professional licensed onsite contractors when needed.

***Don't** use septic tank additives. Under normal operating conditions, these products usually do not help and some may even be harmful to your system.

***Don't** use your toilet as a trash can or poison your septic system and the groundwater by pouring harmful chemicals and cleansers down the drain. Harsh chemicals can kill the beneficial bacteria that treat your wastewater.

***Don't** use a garbage disposal without checking with your local regulatory agency to make sure that your septic system can accommodate this additional waste.

***Don't** allow backwash from home water softeners to enter the septic system.

The Summer 2004 issue of *Pipeline* provides more information about septic tanks for homeowners.

NESC Products related to Septic Systems

Conventional Onsite Sewage Disposal System: Your Septic System, What it is and how to take care of it. Video.
WWVTPE61 ....$10.00

Your Septic System: A Guide for Homeowners. Video.
WWVTPE16 ....$10.00

Pumping Your Septic Tank. Brochure.
WWBRPE71 ....$0.40

Septic System Maintenance.
Fact sheet.
WWFSPE73 ....$0.80

Onsite Wastewater Treatment Systems: Operation and Maintenance.
Fact sheet.
WWFSOM45................................$1.00

Homeowner's Manual for the Operation, Monitoring, and Maintenance of a Gravity Onsite Sewage Treatment and Disposal System Manual.
WWBLOM47..............................$13.00

Homeowner's Manual for the Operation, Monitoring, and Maintenance of a Proprietary Device Onsite Sewage Treatment and Disposal System Manual.
WWBLOM48 .... $13.00

Homeowner's Manual for the Operation, Monitoring, and Maintenance of a Pressure Distribution Onsite Sewage Treatment and Disposal System Manual.
WWBLOM49..............................$13.00

Homeowner's Septic Tank Information Package.
WWPKPE28 ....$2.25

Homeowner Onsite System Recordkeeping Folder.
WWBLPE37 ....$0.45

These products may be ordered by calling us at (800) 624-8301.

National Environmental Services Center
WVU Research Corporation
West Virginia University
P.O. Box 6064
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ADDRESS SERVICE REQUESTED

Protecting Your Waterfront Investment

10 Simple

Shoreland Stewardship Practices

HEALTHY WATERSHEDS MAKE HEALTHY LAKES
and higher property values

The quality of our lakes and streams is ultimately a reflection of how we take care of our land.

A watershed is the land area that drains to a lake or stream. Waterfront property owners, inland residents, recreational users, agricultural producers and other businesses all can play a positive role in maintaining and improving the water quality of our lakes and streams.

How will shoreland stewardship practices affect your pocketbook?

A recent study of over 1,000 waterfront properties in Minnesota found that when all other factors were equal, properties on lakes with clearer water commanded significantly higher property prices.[1] Similarly, higher property values were found on lakes without Eurasian Water-Milfoil.[2] What you and your neighbors do to sustain or improve water quality will improve resale potential. On the other hand, if water quality is degraded, lower property values could result.

This publication was developed for people who live on developed waterfront lots. It describes three types of opportunities to protect your property investment:

Curb Pollutants

Curb pollutants at their source – fertilizers, household toxins, eroding soils, malfunctioning septic systems.

Cut Runoff

Cut the amount of runoff that picks up pollutants and carries them to the waterway by minimizing the hard surfaces that create runoff.

Capture & Cleanse

Capture and cleanse pollutant-carrying runoff before it reaches the waterway – with shoreland buffers, rain barrels or rain gardens.

Simple Step 1

Choose zero-phosphorus fertilizer

If you must fertilize, avoid fertilizers that contain phosphorus. Remember, it's phosphorus that accelerates algae growth in our lakes and rivers. Most lawns and gardens already contain adequate – and often excessive – amounts of phosphorus. Based on a study of 236 lawns sampled in Dane County, the average available soil phosphorus concentration was approximately four times higher than the amount needed to maintain a healthy lawn.[3] Consider this – one pound of phosphorus in runoff can result in 500 pounds of algae growth![4]

Phosphorus is an essential nutrient for plants. However, when too much phosphorus makes its way into our lakes and streams it promotes the rapid growth of weeds and algae and decreases water clarity, often turning lakes green. Decaying algae also depletes oxygen in the water, so that fish can no longer thrive. Human activities contribute a great deal to the amount of phosphorus that enters a lake or stream.

WHEN YOU'RE FERTILIZING THE LAWN, REMEMBER, YOU'RE NOT JUST FERTILIZING THE LAWN.

Photo courtesy of Washington State Department of Ecology, King County,and the cities of Bellevue, Seattle, and Tacoma

If you follow the instructions on a bag of fertilizer containing phosphorus, you may be adding over 50 pounds of phosphorus to a half-acre lot each year.[5]

Beginning April 1, 2010, fertilizer that is labeled as containing phosphorus or available phosphate cannot be applied to lawns or turf in Wisconsin unless the fertilizer application qualifies under certain exemptions.[6]

Check local ordinances.

Simple Step 2

Properly dispose of household hazardous wastes

Do not pour old oil or pesticides into the ditch or wash paint brushes at the end of your driveway. Where do these pollutants end up? In our groundwater, lakes and streams![7] Gasoline, oil, solvents, old paints, thinners, fertilizers, pesticides, cleaners and many other products need to be disposed of properly. Some counties offer Clean-Sweep programs where you can take these products for safe disposal. To find out about local options, contact your county Land and Water Conservation Department. You can find their contact information at **www.wlwca.org** or in the phonebook.

IF YOU WOULDN'T DRINK IT, DON'T DUMP IT!

EVEN BETTER, MINIMIZE YOUR USE OF TOXIC PRODUCTS.

See your county UW-Extension family living educator for alternatives to toxic household products.

Sediment fences serve as a last resort for preventing construction site erosion, but the best policy is to leave the natural shoreline intact.

Simple Step 3

Minimize erosion during construction

During construction is **the** time that soil with its algae-feeding nutrients washes into a nearby lake or stream unless the builder uses erosion controls. When you're planning a construction project, follow these steps to protect the lake:

- ***DEVELOP AN EROSION CONTROL PLAN.*** These publications will help you: *Erosion Control for Home Builders* **clean-water.uwex.edu/pubs/pdf/storm.erosio.pdf**

  civicplus.com/DocumentView.aspx?DID=119 They describe how to preserve existing vegetation, build an access drive, install a sediment fence, protect soil piles, clean up sediment and replant the area.

- ***FENCE THE CONSTRUCTION AREA TO LIMIT CONSTRUCTION ACTIVITY TO THE NECESSARY AREA OF THE SITE.*** This approach reduces erosion and soil compaction. In fact, this approach can reduce the amount of sediment and phosphorus delivered to a lake by 18-fold.[8]

- ***DIVERT RUNOFF AROUND DISTURBED AREAS TO MINIMIZE EROSION.***

- ***AFTER CONSTRUCTION, ESTABLISH VEGETATION RIGHT AWAY.*** The less time bare soil is exposed, the less erosion you will create.

Curb Pollutants

Simple Step 4

Inspect and maintain your septic system regularly

- ***PUMP OR INSPECT YOUR SEPTIC SYSTEM ONCE EVERY THREE YEARS.***[9] Just like owning a car, there is maintenance, inspection and service required for septic systems in order to prevent premature failure. Inspection and pumping costs ($50-100) are minor compared to the cost for installing a new system ($3,000-$8,500).[10] Hire a licensed pumper, plumber or plumbing inspector.

- ***DIVERT SURFACE WATER AWAY FROM THE DRAIN FIELD.***

- ***AVOID DRIVING OR PARKING ON THE DRAIN FIELD TO PREVENT COMPACTION OF THE SOIL.***

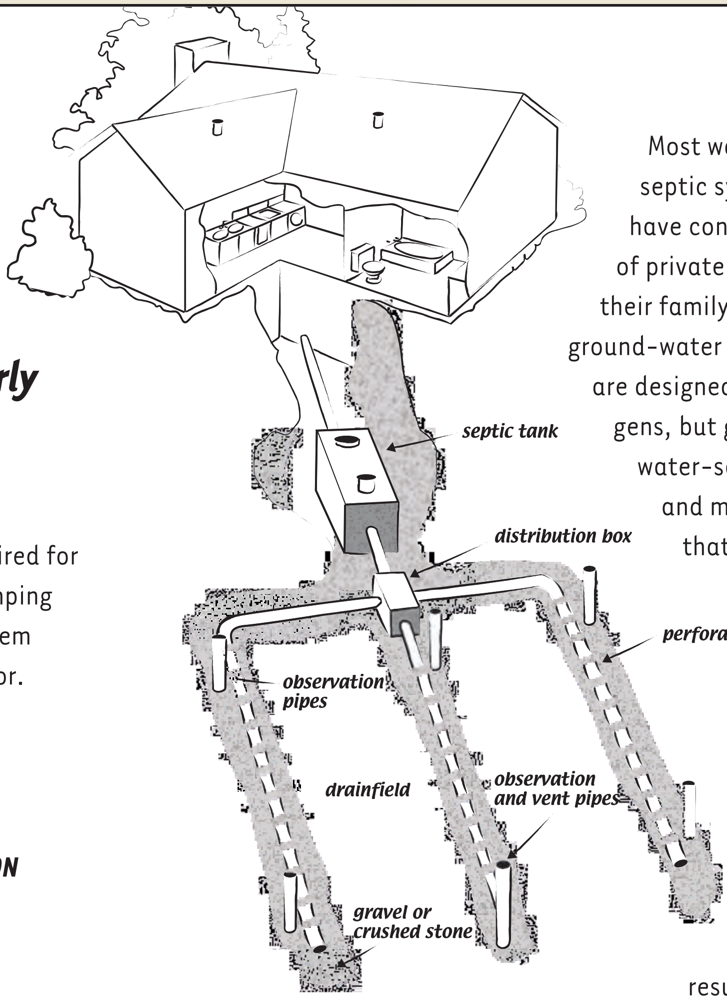
- ***KEEP THE ROOTS OF TREES AND SHRUBS AWAY FROM THE DRAIN FIELD PIPES TO AVOID OBSTRUCTED DRAIN LINES.***

- ***WHEN A REPLACEMENT SYSTEM IS NEEDED, CONSIDER AEROBIC DIGESTERS, RECIRCULATING SAND FILTERS*** and other effluent filtration systems that may do a better job of treating wastes and may be designed to remove nutrients and other contaminants.

- ***AVOID PUTTING ANY OF THE FOLLOWING MATERIALS DOWN THE DRAIN OR TOILET BECAUSE THEY MAY CLOG THE DRAIN FIELD:*** Cooking grease, oils, coffee grounds, cigarettes, facial tissues, paper towels, sanitary napkins, tampons or disposable diapers.[11]

- ***AVOID USING A GARBAGE DISPOSAL.*** Compost your vegetable scraps instead.

- ***CONSERVE WATER.*** Use low-flow toilets, faucets and showerheads to reduce the volume of water the system must filter and absorb.



Most waterfront homeowners in Wisconsin utilize a septic system, although some densely developed lakes have converted to public sanitary sewer systems. Owners of private septic systems have a responsibility to protect their family's health, as well as to protect the surface and ground-water from contamination. Properly functioning systems are designed to remove most disease-causing human pathogens, but generally are NOT designed to remove or treat water-soluble nutrients or pollutants.[12] The more water and material that goes into your septic system, the more that comes out into your drain field. Recent research at the University of Wisconsin-Stevens Point on septic systems located in sandy soils has found both phosphorus and nitrates migrated underground over 150 feet from drain fields. If these nutrients seep underground into the lake, aquatic plant growth and algae blooms are likely results.

Malfunctioning systems are especially harmful. Effluent from failed systems can result in direct contamination of well or surface water and could cause serious human health risks. Reasons for septic system failure may include advanced age, overloading, poor site placement and/or poor maintenance.

EVIDENCE OF A MALFUNCTIONING SEPTIC SYSTEM:

- Sewage backing up in the basement or drains.
- Ponded water or wet areas over the drain field.
- Bright green grass over the drain field.
- A dense stand of aquatic plants along only your shoreland.
- Sewage odors.
- Bacteria or nitrate in nearby well water.
- Biodegradable dye flushed through your system is detectable in the lake.

Cut Runoff

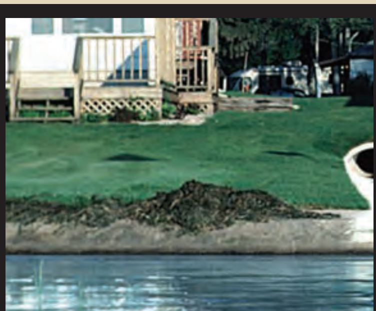
Runoff is excess water that comes from hard surfaces like roof tops, driveways, parking areas, sidewalks, decks and compacted soils. Runoff water washes fertilizer, eroded soil, car fluids and other pollutants into our lakes and streams. To reduce runoff, let water soak into the ground.

Simple Step 5

Reduce the hard surfaces like rooftops and driveways on your property

When considering additions, decide whether the extra space is really needed. Perhaps you could build up instead of out. Also consider runoff from decks, sidewalks and parking areas. Gravel areas quickly become compacted and are nearly as impervious as paved surfaces. Pervious pavers are an option for areas that do not have heavy traffic.

WHICH LOTS WILL CREATE MORE RUNOFF?



Simple Step 6

Plant trees and shrubs or protect your wooded areas

Wooded areas develop a thick understory of small shrubs and plants and a duff layer. This duff protects soil from rain impact and absorbs water. Root systems keep the duff in place, not in the lake. Lawns absorb little rainfall. A recent Wisconsin study found that lawns created much more runoff than wooded areas. As a consequence, the runoff from lawns carried eight times more phosphorus to the lake than the runoff from similar sized wooded areas.[13]

LAWNS CREATE MORE RUNOFF BECAUSE:

- Grading a lot removes the natural divots where water naturally ponds and has time to soak in.
- Heavy equipment, vehicles, lawn mowers and foot traffic compact the soils during and after construction.
- Removal of trees and shrubs causes more rain to hit the ground and run off rather than landing on leaves and branches.

Allowing water to soak in rather than run off your property filters out pollutants and replenishes our groundwater.

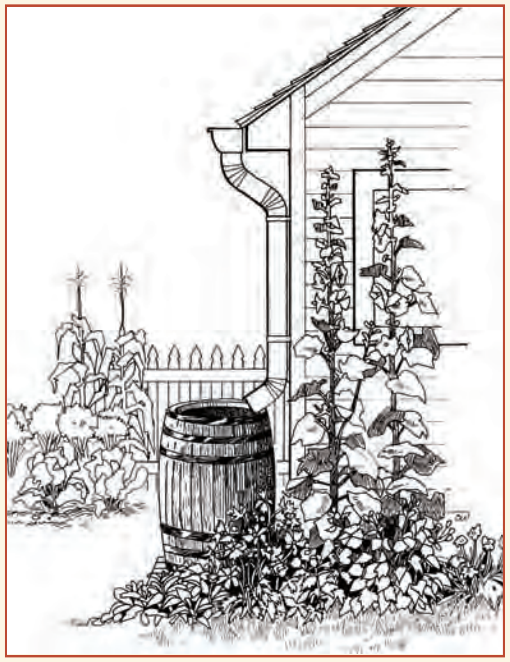
Simple Step 7

Direct downspouts onto your lawn or landscaping, not onto hard surfaces

Simple Step 8

Install a rain barrel

Collect water from your rooftop to water your yard during dry periods. The barrel should be covered to keep out silt, leaves and insects.



Simple Step 9

Build a rain garden

Rain Gardens: A How-To Manual for Homeowners provides easy-to-follow instructions to create a rain garden providing guidance on the following questions:

- ***Where is a good spot in my yard for a rain garden?***
- ***How big should it be?***
- ***What plants would work well?***
- ***What do I need to do after it's planted?***

This publication is available through county UW-Extension offices, and at: **learningstore.uwex.edu/assets/pdfs/GWQ037.pdf**

Rain Gardens
a beautiful solution to water pollution

HOW DOES A RAIN GARDEN WORK?

Rain gardens are just what they sound like — areas that soak up rain water during wet times and serve as a beautiful garden all the time. They are landscaped areas planted to wildflowers and other native vegetation to replace areas of lawn. The gardens fill with a few inches of water and allow the water to slowly filter into the ground.[14] The plants in the rain garden act as filters for the rain water, helping to slow the runoff and allowing it to soak into the ground rather than flowing out into storm sewers, ditches, or drainage ways on the way to lakes and streams. Keeping rain on your property, where it naturally belongs, will help solve some of our water pollution problems.

In addition to the benefits they provide to our water supply, rain gardens also provide wildlife habitat for birds, butterflies and dragonflies and are an aesthetically pleasing addition to any property.

Simple Step 9

Protect or restore your shoreland buffer

- ***If you have native vegetation along your shoreline***, consider yourself and the local wildlife fortunate. A mature native buffer represents many years of nature at work and discourages undesirable, exotic plants and animals while attracting songbirds, butterflies, turtles and frogs.

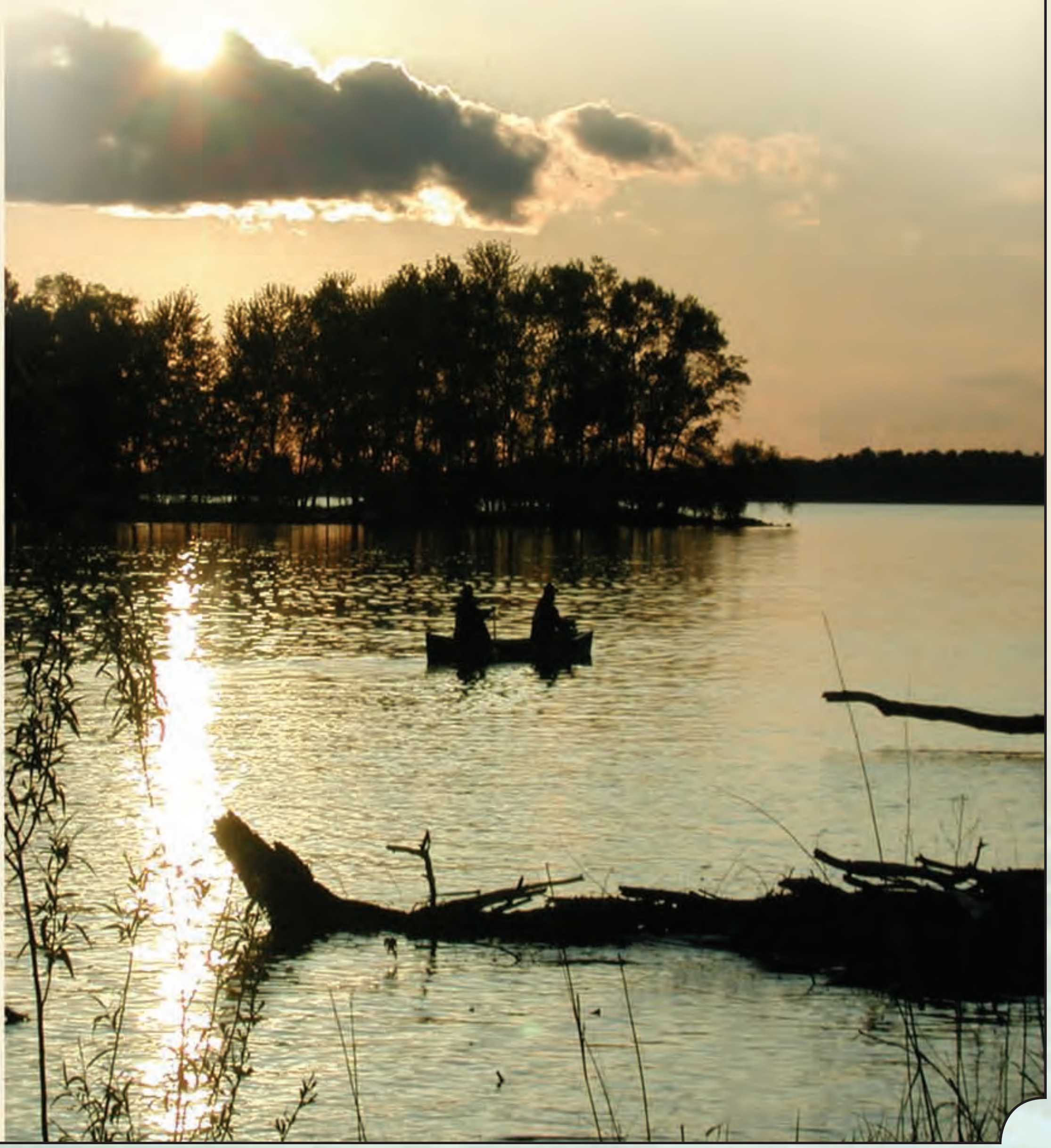
- ***If you have lawn to the water's edge***, a simple, no-cost way to get started in restoring your shoreland is to stop mowing next to the water. Seeds in the soil will germinate and valuable native plants will begin to reappear.

- ***If you have lawn to the water's edge and would like to play a more active role in restoring your shoreland***, you can replant native trees, shrubs, grasses and wildflowers to attract songbirds and butterflies. The main area where water runs off your property is the best location to start planting to improve water quality. You can create a natural, appealing waterfront landscape while eliminating expensive and time-consuming lawn care. The publication ***Protecting and Restoring Shorelands*** (**learningstore.uwex.edu/Assets/pdfs/GWQ038.pdf**) will help you think about what benefits you want from your buffer and the size needed to achieve these. For help designing and planting a natural shoreland, contact your County Land and Water Conservation Department listed at **www.wlwca.org** or a local nursery that specializes in native landscapes. Some counties have cost-share programs to help restore your shoreland.

Natural shorelands contain a lush mixture of native grasses, flowers, shrubs and trees that help to filter polluted runoff and provide important habitat for animals in the water and on the land. The trees, shrubs and plants not only help shelter and create privacy for both the homeowner and the lake user, but may also act as a noise buffer. Larger areas of natural shoreline provide more benefits. However, any amount of natural shoreline is better than none.

Flourishing shorelands provide some of the most effective protection for the lakes and streams of Wisconsin.

When trees and branches fall in the water, they form critical habitat for tiny aquatic organisms that feed bluegills, turtles, crayfish and other critters. Additionally, a fallen tree is like a dock for ducks and turtles, as well as serving as a perch for kingfishers, osprey and songbirds.



Endnotes

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2. Horsch, Eric J. et al. 2009. The Effects of Aquatic Invasive Species on Property Values: Evidence from a Quasi-Experiment. Land Economics, 85(3):391-409. http://171.66.125.237/cgi/content/abstract/85/3/391

3. Bennett, E.M. 2003. Soil phosphorus concentrations in Dane county, Wisconsin, USA: An evaluation of the urban-rural gradient paradigm. Environmental Management 32, no. 4: 476-487 and Bennett, E.M. personal communication 4/13/05.

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6. Turf Fertilizer: Restrictions on Use, Sale & Display for Homeowners http://datcp.wi.gov/Environment/Fertilizer/Turf_Fertilizer/

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8. Wisconsin Department of Natural Resources memo from John Panuska 11/6/94. Graphic by Wisconsin Lakes Partnership

9. Department of Commerce, COMM 83

10. Portage County Onsite Waste Specialist, personal communication 8/5/04.

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12. Pierce, Bryan; Kraft, George and Paul McGinley. August 2003. Guarding Our Groundwater. UW-Extension. www.uwex.edu/ces/shoreland/modules.htm

13. Graczyk, David J. et al. 2003. Hydrology, Nutrient Concentrations, and Nutrient Yields in Nearshore Areas of Four Lakes in Northern Wisconsin, 1999–2001. p 41, USGS Water Resources Investigation Report 03-4144. water.usgs.gov/pubs/wri/wrir-03-4144/

14. Rain Gardens: A Household Way To Improve Water Quality in Your Community by University of Wisconsin-Extension, publication GWQ034, and Wisconsin Department of Natural Resources publication WT 731-2002, learningstore.uwex.edu/assets/pdfs/GWQ034.pdf

In addition to this booklet and the resources below, we encourage you to join your local lake or river association, Wisconsin Association of Lakes, River Alliance of Wisconsin or other conservation groups. Additional resources, training and workshops may also be available through your county UW-Extension or Land and Water Conservation office, or local DNR office.

Additional Information:

GENERAL REFERENCES:

The Living Shore. A 17-minute video showing the importance of leaving a natural 'buffer zone' between the lake and lake owners' dwellings, and providing information about selecting and planting shoreline plants. UW-Extension and University of Minnesota Extension. Phone: 888-936-7463 http://cyfernet.extension.umn.edu/distribution/naturalresources/DD8307.html

Life on the Edge... Owning Waterfront Property. UW-Extension Lakes Program. Comprehensive guide for waterfront property owners.112 pages. Phone: 715-346-2116 or email *uwexlakes@uwsp.edu*

PHOSPHORUS:

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Brown Water, Green Weeds. 2001. UW-Extension (GWQ003) and Wisconsin DNR (WT-459-92) learningstore.uwex.edu/Assets/pdfs/GWQ003.pdf

FERTILIZER:

Lawn & Garden Fertilizer. 2008. UW-Extension (GWQ002) and Wisconsin DNR (WT-528-99) learningstore.uwex.edu/Assets/pdfs/GWQ002.pdf

Rethinking Yard Care. 2008. UW-Extension (GWQ009) and Wisconsin DNR (WT-526-99) learningstore.uwex.edu/Assets/pdfs/GWQ009.pdf

EROSION CONTROL AND RUNOFF

Erosion Control for Homebuilders. 1999. UW-Extension (GWQ001) and Wisconsin DNR (WT-457-96) learningstore.uwex.edu/Assets/pdfs/GWQ001.pdf

Controlling Runoff and Erosion from Your Property: A Landowner's Guide. 2008. Burnett County Land and Water Conservation Department and partners. www.burnettcounty.com/DocumentView.aspx?DID=119

SEPTIC SYSTEMS

Care and Maintenance of Residential Septic Systems. 2006. UW-Extension (B3583) learningstore.uwex.edu/assets/pdfs/B3583.pdf

STORMWATER RUNOFF

A Storm on the Horizon: An Educational Video on the Effects of Stormwater on Our Rivers. 18 minute video by Trout Unlimited.
Phone: 715-386-7568 or email *andrewlamberson@hotmail.com*

RAIN GARDENS

Rain Gardens … A Household Way To Improve Water Quality in Your Community. 2002. UW-Extension (GWQ034) and Wisconsin DNR (WT-731-2002) learningstore.uwex.edu/Assets/pdfs/GWQ034.pdf

Rain Gardens: A How-To Manual for Homeowners. 2003. UW-Extension (GWQ037) and Wisconsin DNR (WT-776 2003) Phone: 608-267-7694 learningstore.uwex.edu/assets/pdfs/GWQ037.pdf

Wisconsin Native Plants for Rain Gardens. dnr.wi.gov/runoff/rg/plants/PlantListing.htm

Wisconsin Native Plants for Shady Rain Gardens. dnr.wi.gov/runoff/rg/plants/shady/shady.htm

SHORELAND BUFFERS

The Waters Edge: Helping Fish and Wildlife on Your Waterfront Property. 2000. Wisconsin DNR (PUB-FH-428 00). learningstore.uwex.edu/Assets/pdfs/GWQ040.pdf

Shoreland Restoration: A Growing Solution. 2001. A 15 minute how-to guide. UW-Extension (GWQ032) Phone: 877-947-7827. http://cyfernet.extension.umn.edu/distribution/naturalresources/DD8307.html

Restoration Stories. 2003. UW-Extension and Wisconsin DNR. www.burnettcounty.com/DocumentView.aspx?DID=120

Protecting Our Living Shores – UWEX (GWQ039) DNR (WT-764-2003) learningstore.uwex.edu/Assets/pdfs/GWQ039.pdf

Protecting and Restoring Shorelands – UWEX (GWQ038) DNR (WT-748-2003) learningstore.uwex.edu/Assets/pdfs/GWQ038.pdf

A Fresh Look at Shoreland Restoration – UWEX (GWQ027) DNR (FH-429-2003) learningstore.uwex.edu/Assets/pdfs/GWQ027.pdf

Lakescaping for Wildlife and Water Quality. Minnesota Department of Natural Resources. The best detailed planning guide available for shoreland restoration in Wisconsin.180 pages. Phone: 800-675-3757

Wisconsin Native Plant Sources. 2004. UW-Extension (GWQ041) and Wisconsin DNR (WT-802). learningstore.uwex.edu/Assets/pdfs/GWQ041.pdf

INVASIVE SPECIES

We all have an important role to play in keeping our lakes, streams, and landscapes free of invasive species. The main way aquatic invasives spread to new waters is by hitching a ride on the boats and equipment of the very people who enjoy the water the most.

NEW LEAF PAPER®

ENVIRONMENTAL BENEFITS STATEMENT *of using post-consumer waste fiber vs. virgin fiber*

UW-Extension & DNR saved the following resources by using Reincarnation Matte (FSC), made with an average of 100% recycled fiber and an average of 60% post-consumer waste, processed chlorine free, designated Ancient Forest Friendly™ and manufactured with electricity that is offset with Green-e® certified renewable energy certificates.

trees	water	energy	solid waste	greenhouse gases
13 fully grown	6100 gallons	4 Million BTUs	370 pounds	1267 pounds

Calculations based on research by Environmental Defense and other members of the Paper Task Force.

www.newleafpaper.com

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WISCONSIN DEPT. OF NATURAL RESOURCES

UW-Extension Center for Land Use Education

Center for Land Use Education

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UW Extension

Services

County Cost Share Program

Purpose:
To reduce erosion & nutrient delivery to water bodies of Oconto County by using practices such as diversions, shoreline restoration, native buffers, rain gardens etc.

Cost Share:
The County sets aside $20,000.00 per year for various county-wide cost share practices. Eligible practices are cost shared @ 70%, total cost sharing per cooperator not to exceed $2,500.00.
Cost share applications will be accepted after January 1st of each year until funding is exhausted.
Applicants must be aware that funds are limited and approval is subject to ade

Some of the Eligible Projects Include:

- Erosion Control
- Lake Restoration & Protection Programs
- Stream Bank & Shoreline Restoration
- Wetland Development or Restoration
- AIS Education & Early Detection
- Aquatic Plan Management Plan
- Rain Gardens
- Shoreline Buffers

See the full list of projects below

Documents:
County Cost Share Policy- Download
County Cost Share Practices & Cost Share Rates- Download

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