Mable Lake Stewardship Program

Aquatic Plant Management Plan – Mable Lake

Prepared for:
Mable Lake Association
Contact: Rachel Heldt
203 Water Street
Mosinee, Wisconsin 54455

Prepared by:
White Water Associates, Inc.
Dean Premo, Ph.D.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903

Mable Lake (looking west to east)
Dean Premo photo, 2011

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WHITE WATER ASSOCIATES, INC.

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This plan is a product of a WDNR Lake Planning Grant awarded to:

Mable Lake Association
Contact: Rachel Heldt
203 Water Street
Mosinee, Wisconsin 54455
Phone: (715)571-6189; Email: heldtrat@gmail.com

Submitted to:

Wisconsin Department of Natural Resources
Attention: Carol Warden
3110 Trout Lake Station Dr.
Boulder Junction, Wisconsin 54512
Phone: 715-356-9494; Email: warden@wisc.edu

Prepared by:

White Water Associates, Inc.
Dean Premo, Ph.D., Angie Stine, B.S., Caitlin Hoenig, B.S., and Kent Premo, M.S.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903
Phone: (906) 822-7889; E-mail: dean.premo@white-water-associates.com

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CHAPTER 1 Introduction

The ***Mable Lake Stewardship Program*** results from the efforts of the Mable Lake Association (MLA), an organization that has been active since 2008. In 2011, the Mable Lake Association was awarded a small-scale planning grant from the Wisconsin Department of Natural Resources (WDNR). At that time, the Association was in the early stages of identifying and clarifying issues of management concern for Mable Lake and felt it would benefit from a project phase that allowed them to solidly establish an organizational footing. A 2010 discovery of Eurasian water-milfoil motivated a heightened concern for the lake's long-term well being. The product that resulted from the small-scale planning grant was a stewardship prospectus entitled *The Mable Lake Association: Stewardship for a High Quality Lake in Lincoln County, Wisconsin* (Premo 2011). The stewardship prospectus summarized the first steps taken by the Mable Lake Association along the path of lake stewardship and set the stage for the serious undertaking of long-term care of a healthy lake. An *early detection and response grant* awarded to the MLA in 2015 has allowed significant lake stewardship activities including a point-intercept plant survey, manual control of Eurasian water-milfoil, and the creation of this ***Aquatic Plant Management Plan (APMP)*** for Mable Lake

The Mable Lake Stewardship Program views stewardship of the lake as an ongoing endeavor that is integrated, coordinated, and administered by the MLA. This broader perspective accommodates the appropriate range of geographic scales from which to approach lake stewardship: a discrete "lake specific" focus that goes hand-in-hand with waterscape-wide awareness.

This APMP addresses Mable Lake. Despite this specificity, it maintains the waterscape perspective crucial to effective lake stewardship. This is especially important when it comes to preventing introduction and establishment of aquatic invasive species (AIS). This APMP also addresses a population of an aquatic invasive species (AIS). The aquatic invasive plant Eurasian water-milfoil was first documented in Mable Lake in 2010.

Systematic survey of aquatic plants using the Wisconsin Department of Natural Resources (WDNR) "point-intercept" method was an important underpinning of this aquatic plant management plan. In fact, two point-intercept surveys have been conducted on Mable Lake allowing some comparison over time of the aquatic plant community. An analysis of the plant data along with water quality and other lake information allowed the preparation of this APMP.

Aquatic plants rarely get the respect they merit, although this is slowly changing. We still call an aquatic plant bed a "weed bed." Many aquatic plants have "weed" in their names (e.g., duckweed, pondweed, or musky weed). Likely this term was borrowed from "seaweed" and not intended as derogatory, but in today's use, "weed" connotes an unwanted, aggressively growing plant. Such is not the case for the vast majority of aquatic plants. In fact, aquatic plants are a vital part of a lake ecosystem, recycling nutrients, providing vertical and horizontal structure, and creating habitat for animal life. Invertebrates, including crustaceans and insects, live on or within this "aquatic forest." Fish find food and shelter within aquatic plant beds. Waterfowl eat parts of plants directly as well as feed on invertebrates associated with the plants. Muskrats eat aquatic plants and particularly love cattails and bulrushes. Otter and mink hunt invertebrates and small vertebrates within the shelter of submergent and emergent beds. In shallow water, great blue herons find fishes among the plants.

In lakes that receive an excess of nutrients (particularly from fertilizers or leaking septic tanks), plant growth can become too lush or dominated by only a few species. As these abundant plants die, their decomposition can depress dissolved oxygen levels and diminish suitability for fish. Algae can respond rapidly to nutrient influxes and create nuisance conditions. These phenomena can cause humans to view all aquatic plants in a negative light.

On another negative front, non-native plant species, transported on boats and trailers or dumped from home aquariums, private ponds and water gardens may come to dominate a water body to the exclusion of a healthy diversity of native species. Eurasian water-milfoil (*Myriophyllum spicatum*) is one of the better known examples of aquatic invasive plant species.

For most lakes, native aquatic plants are an overwhelmingly positive attribute, greatly enhancing the aesthetics of the lake and providing good opportunities for fishing, boating, swimming, snorkeling, sight-seeing, and hunting.

When it comes to aquatic plant management, it is useful to heed the mantra of the medical profession: "First, do no harm." It is both a social and scientific convention that aquatic plant management is more effective and beneficial when a lake is considered as an entire and integrated ecosystem. Anyone involved in aquatic plant management should be aware that a permit may be required to remove, add, or control aquatic plants. In addition, anyone using Wisconsin's lakes must comply with the "Boat Launch Law" that addresses transport of aquatic plants on boat trailers and other equipment. A good review of the laws, permits, and regulations that affect management and behavior surrounding aquatic plants can be found in the WDNR guidelines called ***Aquatic Plant Management in Wisconsin***.[1]

In preparing this plan, we followed guidelines in ***Aquatic Plant Management in Wisconsin***. The resulting plan is an adaptive plan (Walters, 1986). Simply put, it will be modified as new information becomes available. The WDNR Guidance document outlines three objectives that may influence preparation of an aquatic plant management plan:

- ***Protection*** - preventing the introduction of nuisance or invasive species into waters where these plants are not currently present;
- ***Maintenance*** - continuing the patterns of recreational use that have developed historically on and around a lake; and
- ***Rehabilitation*** - controlling an imbalance in the aquatic plant community leading to the dominance of a few plant species, frequently associated with the introduction of invasive non-native species.

The motivation for this APMP lies in all three objectives. Mable Lake is a mesotrophic lake with a diverse and interesting community of aquatic plants. It also has a recreational history and current human use that riparian owners desire to continue. Currently, a population of the AIS Eurasian water-milfoil is present and is being targeted with manual removal control action.

Through the small-scale planning grant project, the early detection-rapid response project, and through past efforts, the Mable Lake Association has accomplished the first five steps in the seven-step plan outlined in the Guidance Document for developing an aquatic plant management plan:

1. Goal setting – Getting the effort organized, identifying problems to be addressed, and agreeing on the goals;
2. Inventory – Collecting baseline information to define the past and existing conditions;
3. Analysis – Synthesizing the information, quantifying and comparing the current conditions to desired conditions, researching opportunities and constraints, and setting directions to achieving the goals;
4. Alternatives – Listing possible management alternatives and evaluating their strengths, weaknesses and general feasibility;
5. Recommendations – Prioritizing and selecting preferred management options, setting objectives, drafting the plan;

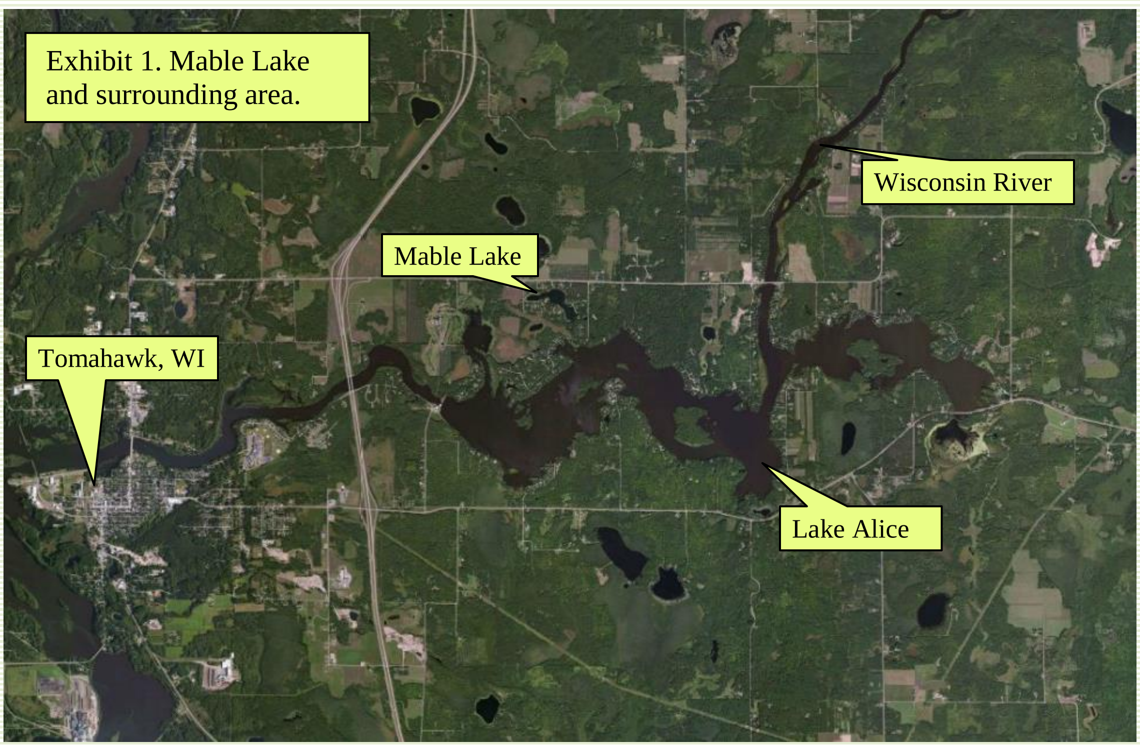
[1] *http://www4.uwsp.edu/cnr/uwexlakes/ecology/APM/APMguideFull2010.pdf*

6. Implementation – Formally adopting the plan, lining up funding, and scheduling activities for taking action to achieve the goals;
7. Monitor & Modify – Developing a mechanism for tracking activities and adjusting the plan as it evolves.

Besides this introductory chapter, this plan is organized in six chapters. The study area is described in Chapter 2. Chapter 3 states the purpose and goals for the plan. Chapter 4 presents an inventory and analysis of information that pertain to the plan including the results of the aquatic plant survey. Chapter 5 provides recommendations that support the overall goals and establish the stewardship component of plan. Finally, Chapter 6 presents actions and objectives for implementing the plan. Three appendices complete this document. Appendix 1 contains literature cited, Appendix 2 contains tables and figures for the aquatic plant surveys, and Appendix 3 contains a *Review of Mable Lake Water Quality*.

CHAPTER 2	Study Area

Mable Lake is located in Lincoln County, Wisconsin about three miles northeast of the town of Tomahawk. The water body identification code (WBIC) is 995300. Exhibit 1 is an aerial view of the Mable Lake landscape showing the town of Tomahawk, and a few other water features. This interconnected water landscape is a target for migrating and breeding waterfowl and other birds. Mable Lake has value and function in this larger landscape as well as its own watershed.



Mable Lake is located in a region that is rich in surface waters. The immediate Mable Lake landscape has numerous water bodies including the Wisconsin River, Green Meadow Creek, Big

Pine Creek, Lake Alice, Bass L., Clark L., Sump L., Twin Lakes, Lake Clara, Round L., Perch L., Mud L., Extrom L., Gerbick L., Pickerel L., and Reno L., all within a three mile radius. This complex of aquatic habitats forms an abundance of riparian habitats for birds, mammals, amphibians, reptiles, and invertebrates. Some lakes in this region are hydrologically connected with other surface waters while others are isolated. Most are shared by the many recreationists that enjoy them for boating, fishing, wildlife watching, and other outdoor activities.

Exhibit 2 is an aerial photograph of Mable Lake. Descriptive parameters for Mable Lake are in Exhibit 3.The lake is just under one-half mile long and is about 0.2 mile wide (at the widest point). It has a surface area of about 25 acres. Its shoreline is about one mile in length. Mable Lake is most easily characterized as a groundwater seepage lake with no inlet or outlet although a small intermittent stream does exit the lake at the southeastern-most point and during times of high water drains southwardly into a large wetland that is connected by surface water to Lake Alice. Mable Lake is at an elevation of 1,467 feet above sea level (10 feet higher than Lake Alice). The watershed for Mable Lake is quite small. The topographic relief in the vicinity of the lake is low (see Exhibit 4 for a topographic map of the Mable Lake vicinity).

Exhibit 2. Aerial photo of Mable Lake.

The shoreline development index is a quantitative expression derived from the shape of the lake. It is defined as the ratio of the shoreline length to the length of the circumference of a circle of the same area as the lake. A perfectly round lake would have an index of 1. Increasing irregularity of shoreline development in the form of bays and projections of the shore is shown by numbers greater than 1. For example, fjord lakes with extremely irregularly shaped shorelines sometimes have SDI's exceeding 5. Mable Lake has a low shoreline development index. A higher shoreline development index indicates that a lake has relatively more productive littoral zone habitat.

Exhibit 3. Water Body Parameters.	
Water Body Name	Mable
County	Lincoln
Township/Range/Section	T35N-R7E-S30
Water Body Identification Code	995300
Lake Type	Seepage
Surface Area (acres)	25
Reported Maximum Depth (feet)	25*
Maximum Length (miles)	0.2
Maximum Width (miles)	0.3
Shoreline Length (miles)	1.65
Shoreline Development Index	2.4
Total Number of Piers (aerial photo)	14
Number of Piers / Mile of Shoreline	8.5
Total Number of Homes (aerial photo)	24
Number of Homes / Mile of Shoreline	14.5

** A depth of 32 feet was documented during a 2011 WDNR-conducted point-intercept aquatic plant survey in Mable Lake.*

Mable Lake has no public access site. We observed a total of 14 piers on the shoreline of Mable Lake (from an aerial photo) or about 8.5 piers per mile of shoreline. The riparian area consists of both upland and wetland areas (Exhibit 4).

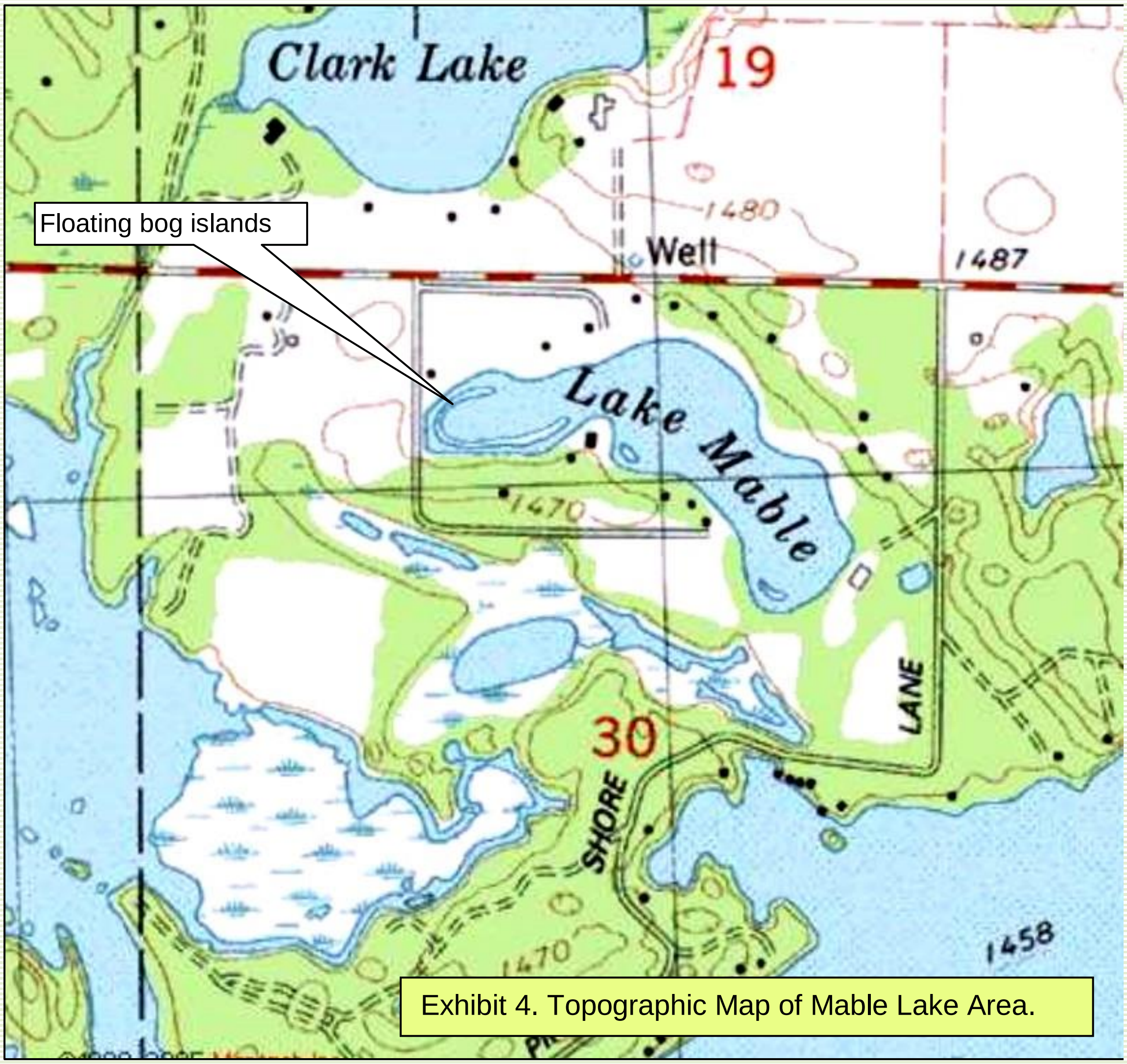


Exhibit 4. Topographic Map of Mable Lake Area.

CHAPTER 3

Purpose and Goal Statements

This plan approaches aquatic plant management with a healthy dose of humility. We do not always understand the causes of environmental phenomena or the effects of our actions to manage the environment. With that thought in mind, we have crafted a statement of purpose and goals for this plan:

> *Mable Lake has a healthy and diverse aquatic plant community that has been documented by two point-intercept aquatic plant surveys. The AIS Eurasian water-milfoil is present and represents a threat to the long term quality of the Mable Lake plant community. This plant community is essential to, and part of, an aquatic ecosystem that provides recreational and aesthetic benefits to humans.* ***The purpose of this aquatic plant management plan is to maintain the aquatic plant community in a high quality state.***

Supporting this purpose, the goals of this aquatic plant management plan are:

> ***(1) Monitor and protect the native aquatic plant community;***
> ***(2) Prevent establishment of new AIS and nuisance levels of native plants;***
> ***(3) Manage the distribution and abundance of Eurasian water-milfoil through manual hand-pulling.***
> ***(4) Promote and interpret aquatic plant management efforts; and***
> ***(5) Educate riparian owners and lake users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.***

The purpose and goals are the foundation for the aquatic plant management plan presented in this document. They inform the objectives and actions outlined in Chapter 5 and are the principal motivation of Mable Lake stewards.

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CHAPTER 4

Information and Analysis

Our efforts in the Mable Lake Stewardship Program have compiled information about historical and current conditions of the Mable Lake ecosystem and its surrounding watershed. Of particular importance to this aquatic plant management plan are the aquatic plant surveys (conducted in 2011 and 2015) that followed the ***WDNR Protocol for Aquatic Plant Survey, Collecting, Mapping, Preserving, and Data Entry*** (Hauxwell et al., 2010). The results of these comprehensive "point-intercept" surveys along with relevant components of other information are presented in this chapter under nine respective subheadings: watershed, aquatic plant management history, aquatic plant community description, fish community, water quality and trophic status, water use, riparian area, wildlife, and stakeholders.

Part 1. Watershed

Mable Lake and its watershed are very small components of a large-scale watershed landscape. The continental United States is divided into 18 watershed regions (Exhibit 5). Two watershed regions lie within Wisconsin: the Upper Mississippi and Great Lakes regions. Mable Lake is located in the Upper Mississippi region, but is very close to the Great Lakes regional border. The Upper Mississippi region is made up of many sub-regions and basins. The Wisconsin sub-region (HUC#0707), and the Wisconsin Basin (HUC#070700) (Exhibit 6) contain Mable Lake. Within the Wisconsin Basin is the Upper Wisconsin sub-basin (HUC#07070001) (Exhibit 7), which can be further divided into watersheds and sub-watersheds. Mable Lake is located in the Lake Mohawksin-Lake Alice-Wisconsin River watershed (HUC#0707000113). Finally, the Lake Mohawksin-Lake Alice-Wisconsin River watershed is divided into federal hydrologic sub-watersheds, designated by 12-digit HUC codes. Mable Lake is located in the Lake Alice-Wisconsin River Sub-watershed (HUC#070700011305), which can be seen in Exhibit 8. The Mable Lake watershed can be viewed in the Digital Elevation Model in Exhibit 9.

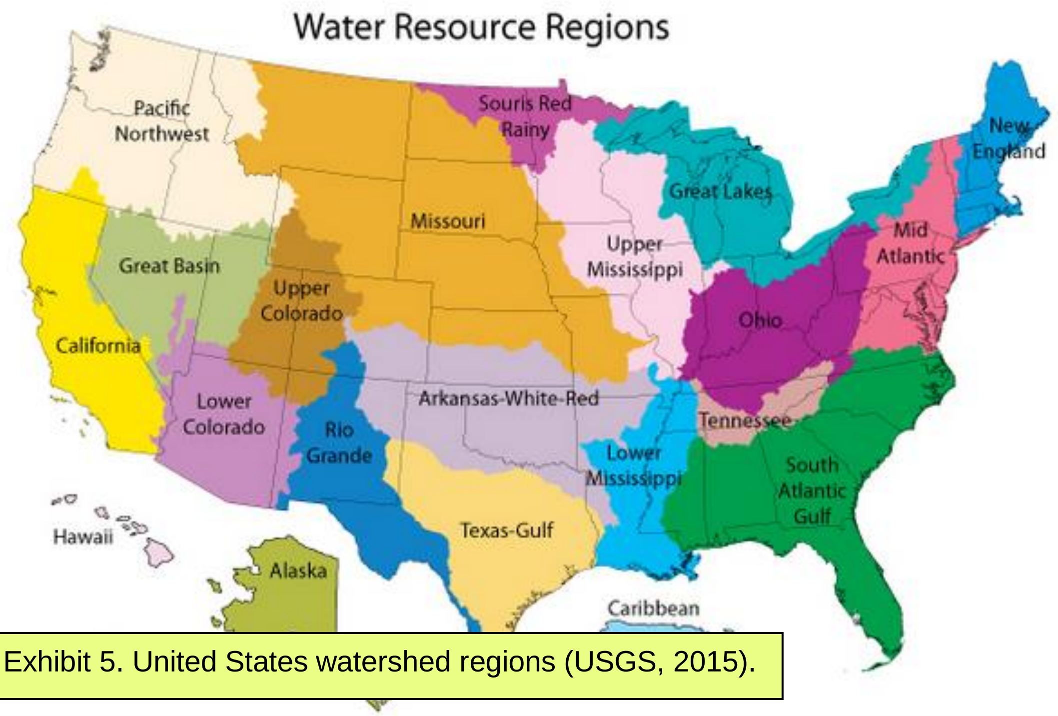


Exhibit 5. United States watershed regions (USGS, 2015).

Exhibit 6. Wisconsin Basin (HUC#070700). The Upper Wisconsin sub-basin is also visible (USEPA, 2009).

Exhibit 7. Upper Wisconsin sub-basin (red) lies on the border of the Upper Mississippi region (south of yellow line) and the Great Lakes region (north of line) (WDNR, 2013a).

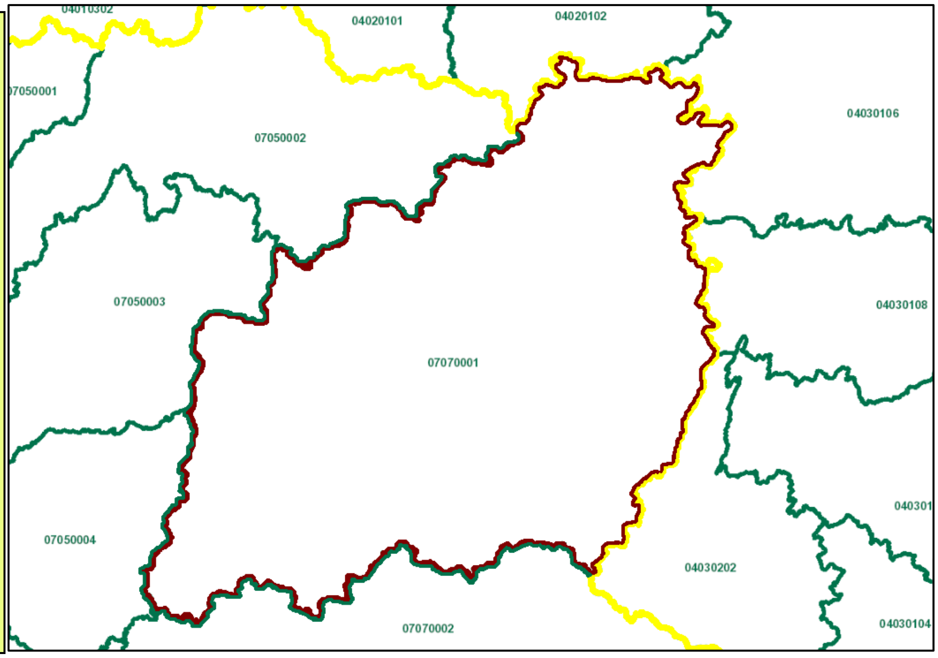


Exhibit 8. Lake Alice-Wisconsin River sub-watershed and surrounding sub-watersheds (USGS, 2016).

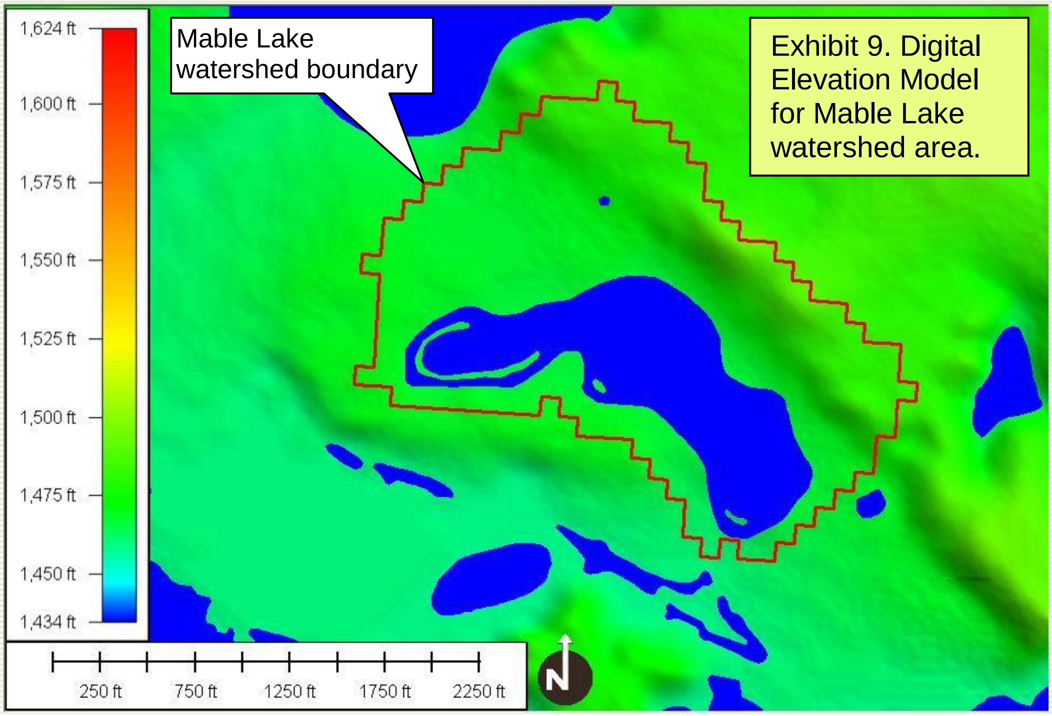


Exhibit 9. Digital Elevation Model for Mable Lake watershed area.

A digital elevation model is provided as Exhibit 9. It shows the relative elevations for the area with red to yellow areas being the highest elevations and greens and blues being the lowest elevations. The digital elevation model shows that there is relatively little variation in elevation within the Mable Lake watershed.

The watershed (drainage basin) is all of the land and water areas that drain toward a particular river or lake. A water body is greatly influenced by its watershed. Watershed size, topography, geology, land use, soil fertility and erodibility, and vegetation are all factors that influence water quality. The Mable Lake watershed is about 91 acres. The type of land cover (for example, forest, grassland, row crops, or human development) is also an important variable in determining amounts and kinds of materials (like nutrients and sediment) that are carried off the land and into the water. Certain kinds of agriculture (tilled row crops) and urban areas (with their impervious surfaces) have a tendency to give up sediments and nutrients to runoff. In contrast, native vegetation (forests, wetlands, and grasslands), tend to slow runoff of water and nutrients, allowing the soil to absorb them. The cover types in the watershed are presented in Exhibit 10.

Exhibit 10. Cover Types and Soil Groups of the Mable Lake Watershed.

Cover Type	Acres	Percent
Agriculture	0	0.0
Open Space/Park	8.89	9.8
Commercial	0	0.0
Deciduous Forest	3.11	3.4
Evergreen Forest	14.01	15.4
Mixed Forest	5.12	5.6
Grassland; Herbaceous	1.56	1.7
High-density Residential	0	0.0
Low-density Residential	5.12	5.6
Woody Wetlands	3.56	3.9
Emergent Wetlands	24.25	26.7
Water	25.13	27.7
Total	90.75	100.0

Soil Group	Acres	Percent	**Hydrologic Soil Groups** - Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups* based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Where A has the smallest runoff potential and D the greatest.
A	63.0	69.4	**Group A** is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
B	27.8	30.6	**Group B** is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
C	0	0	**Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	0	0	**Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This soil has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

* *(USDA, Natural Resources Conservation Service, 1986)*

Forest, wetlands, and surface water comprise the largest components of the overall watershed. Soil group A is the most common soil group the watershed; followed by group B. Soil group A has the highest infiltration capacity, and the lowest runoff potential. Soil group B has good infiltration capacity and little runoff potential. The watershed to lake area ratio is 2.6:1. This is a very low number and indicates a low potential for runoff into the lake. Water quality often decreases with an increasing ratio of watershed area to lake area. As the watershed to lake area increases there are more sources and amounts of runoff. In larger watersheds, runoff water can leach more minerals and nutrients and carry them to the lake. The runoff to a lake (such as after a rainstorm or snowmelt) differs greatly among land uses. Forest cover is the most protective as it exports much less soil (via erosion) and nutrients (such as phosphorus and nitrogen) to the lake than agricultural or urban land use. Wetlands are also highly protective of the lake.

Part 2. Aquatic Plant Management History

As far as can be determined, prior to 2010, no plant survey or large-scale plant management activity had ever taken place in Mable Lake. Over the years, no particular nuisance issues demanded control action, although some riparian owners expressed concern about the navigational challenges in shallow water areas between the shore and the floating bog islands in the west part of the lake. A few also were concerned about abundance of some native aquatic plants (Premo 2011).

In August 2010, Chris Hamerla (AIS Coordinator for Lincoln, Langlade, and Forest Counties) discovered Eurasian water-milfoil in an area along the northern shore of Mable Lake. He hand-pulled the specimens he observed at that time. As result of this aquatic invasive plant discovery, the WDNR conducted a point-intercept aquatic plant survey on Mable Lake in the summer of 2011. This data was available for analysis in this APMP. In early September 2011, Hamerla snorkeled Mable Lake and removed four smaller Eurasian water-milfoil plants from the known area of establishment.

MLA member Jim Norman provided the following history. In 2011, the MLA applied for and received a small-scale lake planning grant from the WDNR. During that survey in the summer of 2011 White Water Associates located the Eurasian water-milfoil in Mable Lake. With the help of the Lumberjack Aquatic Invasive Coordinator John Preuss, we were able to hand pull the first 15 or so plants we found. After that we progressed to using volunteers to pull the Eurasian water-milfoil using snorkels for the next two years. In the summer of 2014 a volunteer diver came in to help, but the job was too big for just one diver. It was in late 2014 that

MLA applied for a rapid response grant from the WDNR. The rapid response project began in 2015. White Water Associates (the MLA consultant) provided divers for manual control (hand-pulling) of the Eurasian water-milfoil. Two divers were used during the first dive of each year. In the second dive of the year, one diver was able to handle the effort.

The rapid response grant also allowed MLA to undertake a second point-intercept aquatic plant survey. This was conducted by White Water Associates staff in 2015. Findings from the 2011 and 2015 surveys are discussed in the next section (Part 3).

Part 3. Aquatic Plant Community Description

Why do lakes need aquatic plants? In many ways, they are underwater forests. Aquatic plants provide vertical and horizontal structure in the lake just like the many forms and variety of trees do in a forest. Imagine how diminished a forest's biodiversity becomes in the advent of a clear-cut. Similarly, a lake's biodiversity in large part depends on a diversity of plants.

Aquatic plants are beneficial in many ways. Areas with plants produce more food for fish (insect larvae, snails, and other invertebrates). Aquatic vegetation offers fish shelter and spawning habitat. Many submerged plants provide food for waterfowl and habitat for insects on which some waterfowl feed. Aquatic plants further benefit lakes by producing oxygen and absorbing nutrients (phosphorus and nitrogen) from runoff. Aquatic plants also protect shorelines and lake bottoms by dampening wave action and stabilizing sediments.

The distribution of plants within a lake is generally limited by light availability, which is, in turn, controlled by water clarity. Aquatic biologists often estimate the depth to which rooted aquatic plants can exist as about two times the average Secchi clarity depth. For example, if the average Secchi depth is eight feet then it is fairly accurate to estimate that rooted plants might exist in water as deep as sixteen feet. At depths greater than that (in our hypothetical example), light is insufficient for rooted plants to grow. In addition to available light, the type of substrate influences the distribution of rooted aquatic plants. Plants are more likely to be found in muddy or soft sediments containing organic matter, and less likely to occur where the substrate is sand, gravel, or rock. Finally, water chemistry influences which plants are found in a body of water. Some species prefer alkaline lakes and some prefer more acidic lakes. The presence of nutrients like phosphorous and nitrogen also influence plant community composition.

As mentioned earlier, non-native invasive plant species can reach high densities and wide distribution within a lake. This diminishes the native plant community and the related habitat. At times, even a native plant species can reach nuisance levels with respect to certain kinds of human recreation. These cases may warrant some kind of plant management.

Systematic aquatic plant surveys have been conducted on Mable Lake in 2011 and in 2015. In each of these surveys, WDNR point-intercept protocol and methodology was followed. This formal survey assesses the plant species composition on a grid of points distributed evenly over the lake. Using latitude-longitude coordinates and a handheld GPS unit, scientists navigate to the points and use a rake mounted on a pole or rope to sample plants. Plants are identified, recorded and put into a dedicated spreadsheet for storage and data analysis. This systematic survey provides baseline data about the lake. The strict methodology allows for comparisons to be made between the 2011 and 2015 surveys.

During the point-intercept field work, a water depth is recorded for the sample points. This allowed us to create a bathymetric (depth contour) map of Mable Lake. This map is shown in Exhibit 11. For its size, Mable Lake has a fairly complex depth structure.

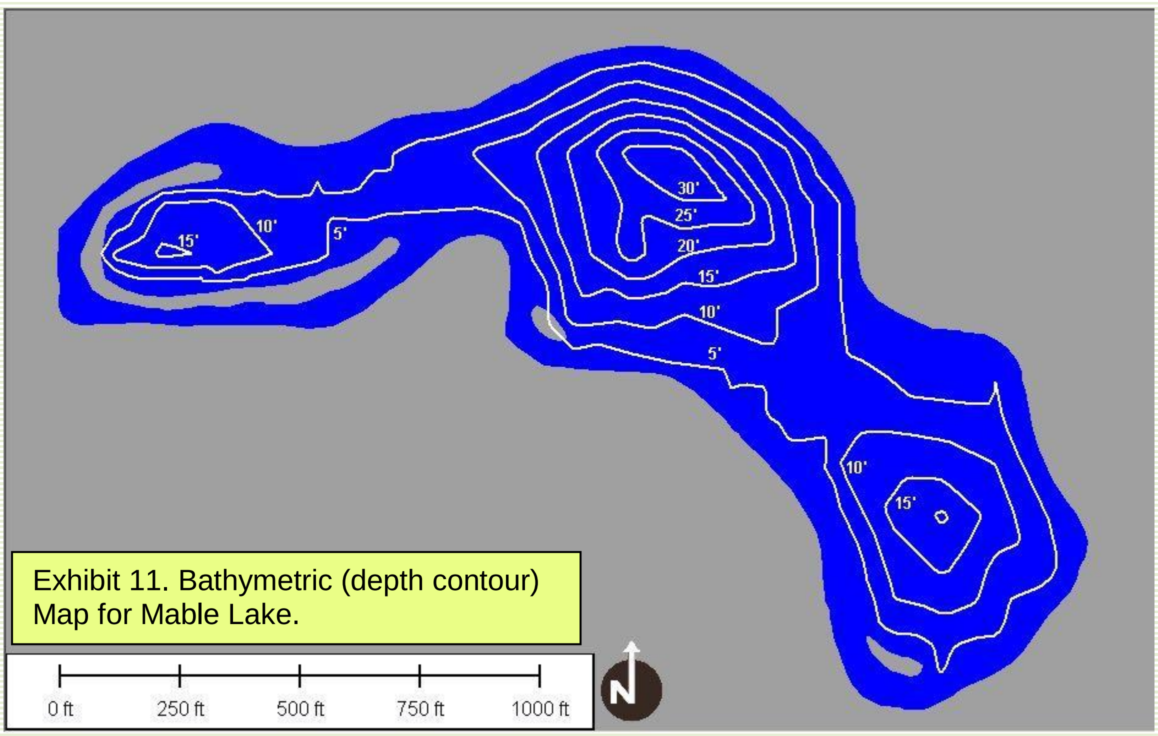


Exhibit 11. Bathymetric (depth contour) Map for Mable Lake.

Because Mable Lake has been surveyed twice, we are able to identify differences in the plant community that have resulted over the course of the four year interval between surveys.

Changes in a lake environment might manifest as loss of species, change in species abundance or distribution, difference in the relative composition of various plant life forms (emergent, floating leaf, or submergent plants), and/or appearance of an AIS or change in its population size. Monitoring can track changes and provide valuable insight on which to base management decisions. In the remainder of this section (Part 3) we provide a report of the findings of the 2015 and 2011 point-intercept aquatic plant surveys. Supporting tables and figures for the aquatic plant surveys are provided in Appendix 2. Tables 1-5 provide summary statistics and comparisons for the 2015 and 2011 surveys. Figures 1-13 present 2015 data and Figures 14-26 present the 2011 data.

Species richness refers to the total number of species recorded. Eighteen species of aquatic plants were observed. Of these, seventeen were collected at sampling sites and the others were observed from the boat while traveling between sites or along the lake's margin. Tables 1 and 2 provide summary statistics for the 2015 and 2011 surveys. Tables 3 and 4 provide a list of the species encountered, including common and scientific name along with summarizing statistics[2] for the 2015 and 2011 surveys. Table 5 provides a comparison of 2015 and 2011 statistics.

In 2015, the number of species encountered at any given sample point ranged from 0 to 7 and 63 sample points were found to have aquatic vegetation present (Table 1). The average number of species encountered at these vegetated sites was 2.21. The actual number of species encountered at each of the vegetated sites is graphically displayed on Figures 1 (2015) and 14 (2011). Plant density is estimated by a "rake fullness" metric (3 being the highest possible density). These densities (considering all species) are displayed for each sampling site on Figures 2 (2015) and 15 (2011).

The maximum depth of plant colonization in 2015 was 18.5 feet (Table 1 and Figure 3). Rooted vegetation was found at 63 of the 71 sample sites with depth ≤ the maximum depth of plant colonization (88.7% of sites). These sites are displayed as a black dot within a circle on Figure 4 (2015 data). This indicates that although availability of appropriate depth may limit the distribution of plants, it is not the only habitat factor involved. Substrate is another feature that influences plant distribution (e.g., soft substrate often harbors more plants than hard substrate). Figure 5 presents the substrates encountered during the 2015 aquatic plant survey (mud, sand, or rock). Figure 6 displays distribution of emergent and floating aquatic plants in 2015. Corresponding data for the 2011 survey are illustrated in Figures 16, 17, 18, and 19.

[2] *If you are interested in learning more about the plant species found in the lake, visit the University of Wisconsin Steven Point Freckmann Herbarium website at: http://wisplants.uwsp.edu/ or obtain a copy of "Through the Looking Glass (A Field Guide to the Aquatic Plants in Wisconsin)."*

Tables 3 and 4 provide information about the frequency of occurrence of the plant species recorded in the lake in 2015 and 2011. Several metrics are provided, including total number of sites in which each species was found and frequency of occurrence at sites ≤ the maximum depth of rooted vegetation. This frequency metric is standardized as a "relative frequency" by dividing the frequency of occurrence for a given species by the sum of frequency of occurrence for all plants and multiplying by 100 to form a percentage. The resulting relative frequencies for all species total 100%. The relative frequencies for the plant species collected with a rake are graphically displayed in descending order on Figure 7 (2015 data) and Figure 20 (2011 data). This 2015 display (Figure 6) shows that large-leaf pondweed (*Potamogeton amplifolius*) had the highest relative frequency followed by water bulrush (*Schoenoplectus subterminalis*) and fragile stonewort (*Chara globularis*), which had the same relative frequency. The lowest relative frequencies are at the far right of the graph. As examples of individual species distributions, we show the occurrences of a few of the most frequently and least frequently encountered plants in 2015 in Figures 8-13. Figures 21-26 present the corresponding distributions for the 2011 data.

Species richness (total number of plants recorded at the lake) is a measure of species diversity, but it doesn't tell the whole story. As an example, consider the plant communities of two hypothetical ponds each with 1,000 individual plants representing ten plant species (in other words, richness is 10). In the first pond each of the ten species populations is comprised of 100 individuals. In the second pond, Species #1 has a population of 991 individuals and each of the other nine species is represented by one individual plant. Intuitively, we would say that first pond is more diverse because there is more "even" distribution of individual species. The "Simpson Diversity Index" takes into account both richness and evenness in estimating diversity. It is based on a plant's relative frequency in a lake. The closer the Simpson Diversity Index is to 1, the more diverse the plant community. The Simpson Diversity Index for Mable Lake aquatic plants is 0.88 in 2015 (Table 1) which indicates a highly diverse aquatic plant community.

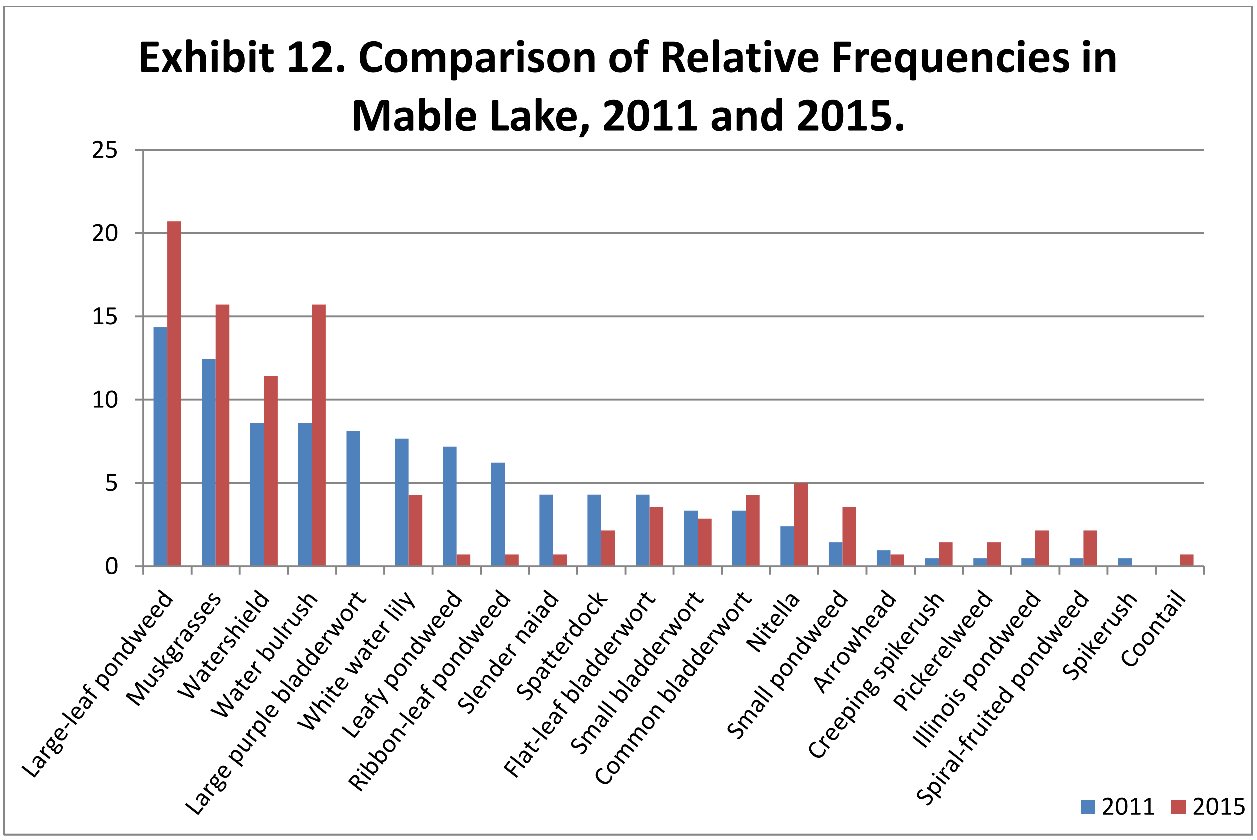
Another measure of floristic diversity and quality is the *Floristic Quality Index* (FQI). Floristic quality is an assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions (Nichols, 1999). Among other applications, it forms a standardized metric that can be used to compare the quality of different lakes (or different locations within a single lake) and monitor long-term changes in a lake's plant community (an indicator of lake health). The FQI for a lake is determined by using the average *coefficient of conservatism* times the square root of the number of native plant species present in the lake. Knowledgeable botanists have assigned to each native aquatic plant a *coefficient of conservatism* representing the probability that a plant is likely to occur in pristine environments (relatively unaltered from presettlement conditions). The coefficients range from 0 to 10, with 10 being assigned to those species most sensitive to disturbance. As more environmental disturbance occurs, the less conservative species become more prevalent.

Nichols (1999) analyzed aquatic plant community data from 554 Wisconsin Lakes to ascertain geographic (ecoregional) characteristics of the FQI metric. This is useful for considering how the Mable Lake FQI (28.3 in 2015) compares to other lakes and regions. The statewide medians for number of species and FQI are 13 and 22.2, respectively. Mable Lake values are higher than these statewide values. Nichols (1999) determined that there are four ecoregional-lake types groups in Wisconsin: (1) Northern Lakes and Forests lakes, (2) Northern Lakes and Forests flowages, (3) North Central Hardwoods and Southeastern Till Plain lakes and flowages, and (4) Driftless Area and Mississippi River Backwater lakes. Mable Lake is located in the Northern Lakes and Forests lakes group. Nichols (1999) found species numbers for the Northern Lakes and Forests lakes group had a median value of 13. Mable Lake data is higher than that find (18). Finally, the Mable Lake FQI (28.3) is higher than the median value for the Northern Lakes and Forests lakes group (24.3). These findings support the contention that the Mable Lake plant community is healthy and diverse.

It should be noted that Eurasian water-milfoil, although present in the lake, was not found at any of the sample points in either the 2011 or 2015 surveys. These findings indicate it has very low abundance in the lake. Eurasian water-milfoil was observed as part of the “boat survey” during the 2015 plant survey. Eurasian water-milfoil is considered a *Restricted* species in Wisconsin. A *Restricted* species is one that has already been established in the state and causes or has the potential to cause significant environmental or economic harm or harm to human health. Restricted species may be possessed, but may not be transported, transferred or introduced without a permit (WDNR, 2012). The discovery of Eurasian water-milfoil and subsequent removal efforts are described at the end of this section (Part 3).

As stated earlier, in the 2015 aquatic plant survey, 18 species were observed, with an average of 2.21 species per site. These values are somewhat lower than what was observed in 2011 (23 species, 3.07 species per site) (see Table 5 for comparisons). The maximum depth of plants in 2015 was 18.5 feet and was 20.0 feet in 2011. The frequency of occurrence of plants at sites shallower than the maximum depth of plants in 2015 was 88.7% which is comparable to 2011 (85.0%). In 2011, large-leaf pondweed (*Potamogeton amplifolius)* and muskgrasses (*Chara* sp.*)* had the highest relative frequencies. In 2015, large-leaf pondweed was again the most dominant plant. In 2011, the second most frequent species was *Chara* sp., and in 2015 one of the second most frequent species was fragile stonewort (*Chara globularis*) (the other was water bulrush (*Schoenoplectus subterminalis*). It is possible that that unknown stonewort from 2011 was fragile stonewort. The Simpson Diversity Index, which takes into account both richness and evenness in estimating diversity, was 0.92 in 2011, meaning the lake had a highly diverse and evenly distributed aquatic plant community. The 2015 SDI value was slightly lower at 0.88 (although this is still a high value). In 2011, the FQI was 31.7; higher than state and regional averages, and slightly higher than what was observed in the 2015 survey (28.3). A comparison of 2011 and 2015 aquatic plant statistics can be viewed in Appendix 2, Table 5.

Exhibit 12 displays the relative frequency of plants found in 2011 and 2015. We can see that the relative frequency of the first four species increased from 2011 to 2015.



Although the plant community of Mable Lake is generally healthy, Eurasian water-milfoil (*Myriophyllum spicatum*) has been documented in the lake since 2010 and presumably present for some time prior to the first detection. At this time, Chris Hamerla, Aquatic Invasive Species Coordinator for Lincoln, Langlade, and Forest Counties discovered Eurasian water-milfoil in an area along the northern shore of Mable Lake. Upon this discovery, he hand-pulled the plants observed at that time. As a result of this aquatic invasive species (AIS) discovery, the WDNR conducted a point-intercept aquatic plant survey on Mable Lake in the summer of 2011 (results discussed previously in this plan). In early September 2011, Hamerla snorkeled Mable Lake and removed four Eurasian water-milfoil plants from the original area of establishment (Premo 2011).

On July 15, 2015 working under the rapid response grant awarded to the MLA, White Water Associates scientists, Angie and Tracey Stine, met MLA volunteers (Rachel and Ted Heldt, Jim and Paula Norman, and Norman children) to begin a manual control effort of Eurasian water-milfoil plants (Exhibit 13). White Water scientists dove with SCUBA gear to reach the base of the plants in order to pull them out by the roots. Any pulled plants were placed in mesh bags for containment and for measurements. MLA members kayaked near the divers and collected any floating Eurasian water-milfoil fragments. They also collected filled bags from the divers and brought them to shore to be measured. Angie Stine describes the area of Eurasian water-milfoil as sporadic in places, but larger patches were also present. At the end of the day, the team collected 137 pounds of Eurasian water-milfoil from the lake.

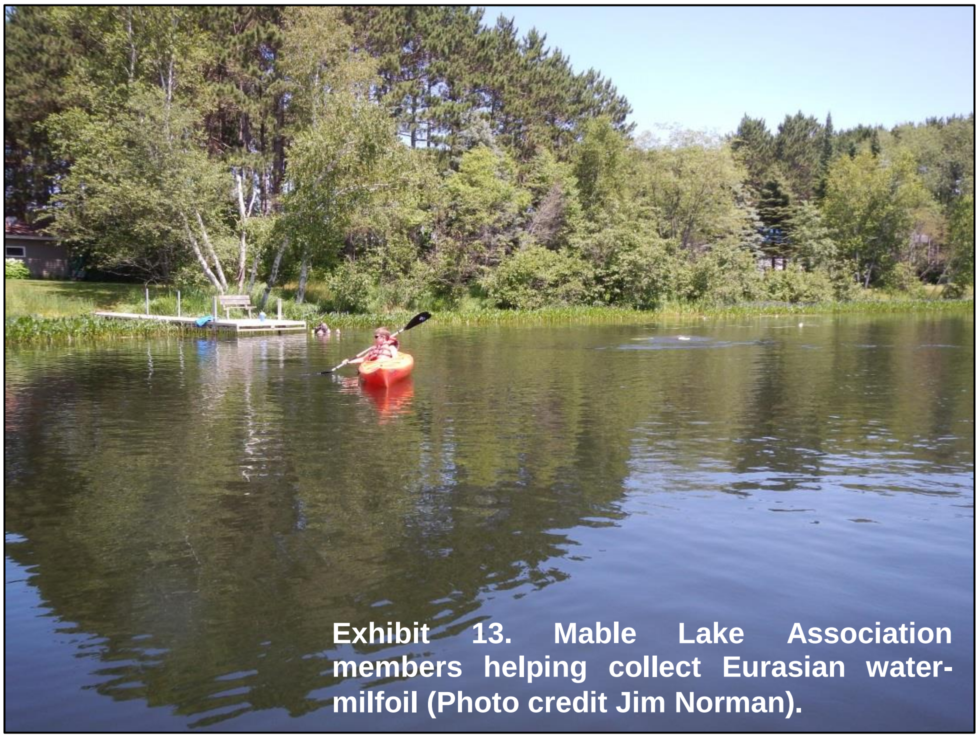


Exhibit 13. Mable Lake Association members helping collect Eurasian water-milfoil (Photo credit Jim Norman).

Hand-pulling continued on July 24, 2015. At that time, White Water biologist Angie Stine and MLA members, Jim Norman and Rachel Heldt collected 10 pounds of Eurasian water-milfoil.

On June 10, 2016, Jim Norman and Ted Heldt met with Tracey and Angie Stine for SCUBA diving hand-pulling efforts. They collected 185.6 pounds of Eurasian water-milfoil at that time. On June 14, 2016, Jim Norman, Angie Stine, and Riley Stine returned and pulled 14 pounds. Jim Norman was in contact via email with Angie in regards to the Eurasian water-milfoil growth in early September. He suggested coming back again to hand-pull. Angie Stine used Rachel Heldt's paddle boat to visually search for Eurasian water-milfoil September 14, 2016. She pulled 2.6 pounds using a rake. It was determined at that time that another trip to SCUBA dive was necessary to remove additional Eurasian water-milfoil. On September 27, 2016 Rachel met Tracey and Angie Stine and 24.7 pounds of Eurasian water-milfoil were removed. A total of 227 pounds was pulled in 2016. A total of 364 pounds of Eurasian water-milfoil was hand-pulled for the Mable Lake Rapid Response Grant over the two years of effort (2015 and 2016).

Biologist Angie Stine reflected that, "when we first dove I was surprised at the amount of Eurasian water-milfoil growth and how in certain areas it took over the native plants. When these areas were hand-pulled areas of substrate was left barren of plants." The hand-pulling efforts, however, have been effective in controlling the Eurasian water-milfoil in Mable Lake. Nevertheless, continued efforts of hand removal are necessary for Mable Lake in order to prevent Eurasian water-milfoil from growing into large patches again.

Part 4. Fish Community

Mable Lake has a variety of fish species including smallmouth bass, largemouth bass, bluegill, pumpkinseed, black crappie, walleye, northern pike, and bullhead. Occasional winter-time fish kills have been reported on Mable Lake. According to residents, this has kept the maximum size of largemouth bass rather small. They also report a large population of stunted bluegills. Fishing pressure on the lake is light and most of this is by riparian owners. There is a low amount of boat traffic in and out of the lake via an unimproved access site on township land.

Part 5. Water Quality and Trophic Status

Mable Lake is a 25 acre seepage lake with a reported maximum depth of 25 feet, according to WDNR lake maps. A depth of 32 feet was measured during the 2015 plant survey. Secchi depths have been measured in Mable Lake since 2009. In 2015, the Secchi depth was 10 feet. Although Secchi depths have been monitored, many water quality parameters have not been measured in Mable Lake. Actions listed in this *Aquatic Plant Management Plan* recommend expansion of water quality monitoring to include parameters for which little or no information exists. Descriptions of these parameters can be found in Appendix 3 of this plan.

Part 6. Water Use

Mable Lake has no developed public access site. A township road (Mable Highland Drive) right-of-way contacts the west end of the lake providing unimproved access for small watercraft. The lake is used by riparian owners for a variety of recreational activities. There is no State of Wisconsin ownership around the lake.

Part 7. Riparian Area

Part 1 (Watershed) describes the larger riparian area context of Mable Lake. The near shore riparian area can be appreciated by viewing Exhibits 2 and 4. These images give the impression that the lake is moderately developed with a fairly intact forested riparian zone that extends for hundreds of feet back from the lake. The riparian area is a mixture of wetlands and forest. This intact riparian area provides numerous important functions and values to the lake. It effectively filters runoff to the lake. It provides excellent habitat for birds and mammals. Trees that fall into the lake from the riparian zone contribute important habitat elements to the lake. Educating riparian owners as to the value of riparian areas is important to the maintenance of these critical areas. Our review of aerial photography reveals less than thirty houses on the lake.

Part 8. Wildlife

For many reasons, lakes attract wildlife species. Some of these require a lake as a prime habitat component. Some live in or near the lake permanently, while others visit only at times in order to obtain crucial resources. Lakes provide food in the form of plants, insects, fishes, and other organisms. Lakes provide breeding and nesting sites. Lakes provide shelter and protection. Some of the wildlife species that use lakes are common (for example, green frogs, painted turtles, tree swallows, belted kingfishers, mink, and raccoons). In contrast, other lake-dependent wildlife species are relatively rare (for example, common loons, bald eagles, and osprey).

Mable Lake's riparian area is used by songbirds and other vertebrates allowing canoeists and kayakers an opportunity to see and hear these animals. Lake residents report common loons use the lake for fishing, but not nesting. Appropriate habitat for common loon nesting does appear to be present. Bald Eagles are also seen on the lake. Great blue herons, Canada geese, and a variety of ducks nest and/or feed in Mable Lake. Western painted turtles and snapping turtles reside in Mable Lake and the surrounding wetlands as well as a variety of anurans (frog and toads). The Lake Alice Association conducts a frog and toad survey that includes some listening sites in wetlands near Mable Lake.

Other rare species and communities exist near Mable Lake. The Wisconsin Natural Heritage Inventory (NHI) lists rare species and communities and Exhibit 14 shows those found in the same township(s) as Mable Lake.

Exhibit 14. Rare Species and Communities located near Mable Lake.

Common Name	*Scientific Name*	*State Status**	*Group Name*
Emergent marsh		NA	Community
Ephemeral Pond		NA	Community
Floodplain forest		NA	Community
Lake-shallow, soft, seepage		NA	Community
Northern mesic forest		NA	Community
Open bog		NA	Community
Stream-slow, soft, warm		NA	Community
Algae-leaved pondweed	*Potamogeton confervoides*	THR	Plant
Autumnal water-starwort	*Callitriche hermaphroditica*	SC	Plant
Missouri rock-cress	*Boechera missouriensis*	SC	Plant
Northeastern bladderwort	*Utricularia resupinata*	SC	Plant
Wood turtle	*Glyptemys insculpta*	THR	Turtle

*** END**=Endangered; **THR**=Threatened; **SC**=Special Concern; **SC/P**=fully protected; **SC/N**=no laws regulating use, possession or harvesting; **SC/H**=take regulated by establishment of open/closed seasons; **SC/FL**=federally protected as endangered or threatened, but not so designated by DNR; **SC/M**=fully protected by federal and state laws under Migratory Bird Act (WDNR, 2014b).

Mable Lake is currently designated as a *priority navigable waters* (PNW) (WDNR, 2012). Priority Navigable Waters meet any of these standards: navigable waterways, or portions thereof, that are considered OWR/EWR or trout streams; lakes less than 50 acres in size; tributaries and rivers connecting to inland lakes containing naturally-reproducing lake sturgeon populations; waters with self-sustaining walleye populations in ceded territories; waters with self-sustaining musky populations; or perennial tributaries to trout streams (WDNR, 2012). Mable Lake is considered a PNW as a lake less than 50 acres in size.

Part 9. Stakeholders

On September 27, 2008, seventeen residents of the Mable Lake area gathered to discuss their concerns about the lake. They decided that the best way to protect the lake and bring about needed improvements was to form an association: the Mable Lake Association was established and became incorporated on December 2, 2008 as a non-stock corporation. The purpose as stated in the Articles of Incorporation "is to protect, preserve, and improve the ecosystems of Mable

Lake and its surroundings, and to enhance the water quality, fishery, boating safety, and aesthetic values of Mable Lake as a public recreational facility for today and for future generations. This purpose will be accomplished through education of and communication among concerned citizens."

Since its establishment, the Mable Lake Association has met annually on the last Saturday of September. It has succeeded in recruiting a sufficient number of members to exceed the 25 required by the WDNR and elected officers according to the by-laws. The Association has held one fund-raiser, a brat fry, and continues to notify all residents on the lake of meetings and activities. All residents are encouraged to join the Association and share their concerns about the lake.

Five Association members were trained in performing Secchi disc readings to monitor the clarity of the water in Mable Lake, beginning in 2008. They continue to take readings.

At this juncture in the ongoing aquatic plant management planning process, the MLA has represented the Mable Lake stakeholders. Additional stakeholders and interested citizens are invited to participate as the plan is refined and updated in order to broaden input, build consensus, and encourage participation in stewardship. No contentious plant management actions (for example, mechanical harvesting or use of herbicides) are a component of the current plan.

As part of a small-scale lake planning grant the Mable Lake Association, working with White Water Associates drafted a Stewardship Prospectus (Premo 2011). The prospectus states the following overarching goal statement for its stewardship undertaking:

> ***"The goal of the Mable Lake Association is to protect, preserve, and improve Mable Lake and surroundings. The Association endeavors to maintain or enhance water quality, fisheries, biodiversity, and aesthetic values of Mable Lake for today and the future. The Association seeks to minimize opportunities for aquatic invasive species."***

To support that overarching goal, the prospectus outlined 22 objectives. These are listed below with a check mark by those that have already been initiated or accomplished.

✓ 1. Gather, review, and summarize existing information about Mable Lake;
✓ 2. Analyze point-intercept aquatic plant survey data;
3. Develop and establish a program of water chemistry monitoring;
✓ 4. Delineate and characterize the watershed;
✓ 5. Prepare an aquatic plant management plan;
✓ 6. Monitor and manage Eurasian watermilfoil;

7. Monitor dissolved oxygen-temperature profiles at critical periods of the year;
8. Establish lake level monitoring program;
9. Implement a volunteer angler journal as means to track fish community dynamics;
10. ✓ Characterize rare plant and animal species' use of the lake and riparian habitats;
11. Characterize riparian vegetation;
12. Characterize bog island habitats and vegetation;
13. Conduct lake user survey;
14. ✓ Create bathymetric model (map) of the lake;
15. Develop and institute native plant bed monitoring for potential nuisance level plants;
16. Create photo archive of shoreline and near-shore riparian area;
17. Conduct qualitative assessment of shoreline and near-shore riparian area;
18. Conduct USEPA/WDNR habitat assessment littoral zone and riparian area;
19. Identify areas of protection, restoration, or enhancement in littoral and riparian zones;
20. Create the Mable Lake Stewardship Program Adaptive Management Plan;
21. ✓ Provide education that increases support, capacity, and involvement of lake stewards;
22. ✓ Engage Mable Lake stewards with the water stewardship community in the area.

The 2015 rapid response grant also allowed for a gathering of stakeholders with the MLA consultant White Water Associates to discuss various topics regarding Mable Lake. On September 26, 2015 lake association members met with White Water scientist Caitlin Hoenig. She presented information on the (1) point intercept survey, (2) a summary of EWM hand-pulling to date, (3) ways to identify EWM and other native milfoils, and (4) ways to prevent spreading AIS. Many of the members present at this meeting also participated in the field efforts.

CHAPTER 5

Recommendations, Actions, and Objectives

In this chapter we provide recommendations for specific objectives and associated actions to support the APM Plan's goals stated in Chapter 3 and re-stated here for convenient reference:

(1) Monitor and protect the native aquatic plant community;
(2) Prevent establishment of new AIS and nuisance levels of native plants;
(3) Manage the distribution and abundance of Eurasian water-milfoil through manual hand-pulling.
(4) Promote and interpret aquatic plant management efforts; and
(5) Educate riparian owners and lake users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.

Since Mable Lake is currently healthy and diverse ecosystem, we could simply recommend an alternative of "no action." In other words, Mable Lake continues without any effort or intervention on part of lake stewards. Nevertheless, we consider the "no action" alternative imprudent. Many forces threaten the quality of the lake and Mable Lake Stewardship Program and the Mable Lake Association feels a great responsibility to minimize the threats. The most proximate threat is the Eurasian water-milfoil already present in Mable Lake. Its presence motivates the MLA toward action. We therefore outline in this section a set of actions and related management objectives that will actively engage Mable Lake stewards in the process of management.

The actions are presented in tabular form. Each "action" consists of a set of four statements: (1) a declarative "action" statement that specifies the action (2) a statement of the "objective" that the action serves, (3) a "monitoring" statement that specifies the party responsible for carrying out the action and maintaining data, and (4) a "status" statement that suggests a timeline/calendar and indicates status (not yet started, ongoing, or completed).

Recommended Actions for the Mable Lake APM Plan
Action #1: Formally adopt the Aquatic Plant Management Plan. ***Objective:*** To provide foundation for long-term native plant community conservation, control the Eurasian water-milfoil, and prepare for response to new AIS introductions. ***Monitoring:*** The Mable Lake Association oversees activity and maintains the plan. ***Status:*** Planned for 2016.
Action #2: Continue with annual Eurasian water-milfoil hand-pulling efforts. ***Objective***: To prevent the existing population of Eurasian water-milfoil from expansion in terms of distribution in the lake and density. ***Monitoring:*** The Mable Lake Association oversees activity and maintains data. ***Status:*** Commence in 2017.
Action #3: Educate riparian owners and other lake users to identify Eurasian water-milfoil and report new colonies to Mable Lake Rapid Response coordinator. ***Objective***: To prevent the existing population of Eurasian water-milfoil from expansion in terms of distribution in the lake and density. ***Monitoring:*** The Mable Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #4: Monitor the lake for new infestations of aquatic invasive plant species. ***Objective***: To understand the lake's biotic community, provide for early detection of AIS and continue monitoring any existing populations of AIS. ***Monitoring:*** The Mable Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #5: Monitor the lake for aquatic invasive animal species. ***Objective***: To understand the lake's biotic community, provide for early detection of AIS and continue monitoring any existing populations of AIS. ***Monitoring:*** The Mable Lake Association oversees activity and maintains data. ***Status:*** Ongoing.

Recommended Actions for the Mable Lake APM Plan
Action #6: Monitor water quality. ***Objective***: Continue the collection and analysis of water quality parameters to detect trends. Expand monitoring to include parameters for which little or no information exists (see Appendix 3 for individual parameters). ***Monitoring:*** The Mable Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #7: Form an Aquatic Invasive Species Rapid Response Team and interface with the AIS Rapid Response Coordinator. See Chapter 6 for details. ***Objective:*** To be prepared for AIS discovery and efficient response. ***Monitoring:*** The Mable Lake Association coordinates activity. ***Status:*** Planned for 2017.
Action #8: Conduct quantitative plant surveys every five years using WDNR Point-Intercept Methodology. ***Objective:*** Watch for changes in native species diversity, floristic quality, plant abundance, plant distribution, and to check for the occurrence of non-native, invasive plant species. ***Monitoring:*** Mable Lake Association with assistance from consultant oversees and maintains data; copies to WDNR. ***Status:*** Anticipated in 2020.
Action #9: Update the APM plan approximately every five years or as needed to reflect new plant information from plant surveys and monitoring. ***Objective:*** To have current information and management science included in the plan. ***Monitoring:*** The MLA oversees and maintains data; copies to WDNR. ***Status:*** Ongoing.
Action #10: Characterize bog island habitats and vegetation. ***Objective:*** To document the diversity and importance of these islands to the Mable Lake ecosystem. ***Monitoring:*** Mable Lake Association with assistance from consultant oversees and maintains data; copies to WDNR. ***Status:*** Anticipated in 2020.

Recommended Actions for the Mable Lake APM Plan
Action #11: Create an education plan for the property owners and other stakeholders that will address issues concerning aquatic and riparian plant communities. ***Objective:*** To educate stakeholders about issues and topics that affect the lake's aquatic and riparian plant communities, including topics such as: (1) the importance of the aquatic plant community; (2) no or minimal mechanical removal of plants along the shoreline is desirable and that any plant removal should conform to Wisconsin regulations; (3) the value of a natural shoreline in protecting the aquatic plant community and lake health; (4) nutrient sources to the lake and the role excess nutrients play in degradation of the aquatic plant community; (5) the importance of reducing or eliminating use of fertilizers on lake front property; (6) the importance of minimizing transfer of AIS to the lake by having dedicated watercraft and cleaning boats that visit the lake. ***Monitoring:*** The Mable Lake Association oversees activity and assesses effectiveness. ***Status:*** Anticipated to begin in 2017.
Action #12: Monitor the lake watershed for purple loosestrife. ***Objective:*** Identify purple loosestrife populations before they reach large size. ***Monitoring:*** The Mable Lake Association oversees activity. ***Status:*** Anticipated in 2017.

CHAPTER 6 Contingency Plan for AIS

Unfortunately, sources of aquatic invasive plants and other AIS are numerous in Wisconsin. Some infested lakes are quite close to Mable Lake. There is an increasing likelihood of accidental introduction of AIS through conveyance of life stages by boats, trailers, and other vectors. It is important for the Mable Lake Association and other lake stewards to be prepared for the contingency of aquatic invasive plant species colonization in Mable Lake.

For riparian owners and users of a lake ecosystem, the discovery of AIS invokes a sense of tragedy that elicits an immediate desire to "fix the problem." Although strong emotions may be evoked by such a discovery, a deliberate and systematic approach is required to appropriately and effectively address the situation. An aquatic plant management plan (one including a contingency plan for AIS) is the best tool by which the process can be navigated. In fact the APM plan is a requirement in Wisconsin for some kinds of aquatic plant management actions. One of the actions outlined in the previous chapter was to establish an Aquatic Invasive Species Rapid Response Team. This team and its coordinator are integral to the management process. It is important for this team to be multi-dimensional (or at least have quick access to the expertise that may be required). AIS invade not just a single lake, but an entire region since the new infestation is an outpost from which the AIS can more easily colonize other nearby water bodies. For this reason it is strategic for the Rapid Response Team to include representation from regional stakeholders.

Exhibit 15 provides a flowchart outlining an appropriate rapid response to the suspected discovery of an aquatic invasive plant species. The response will be most efficient if an AIS Rapid Response Team has already been established and is familiar with the contingency plan. In the remainder of this chapter we further describe the approach.

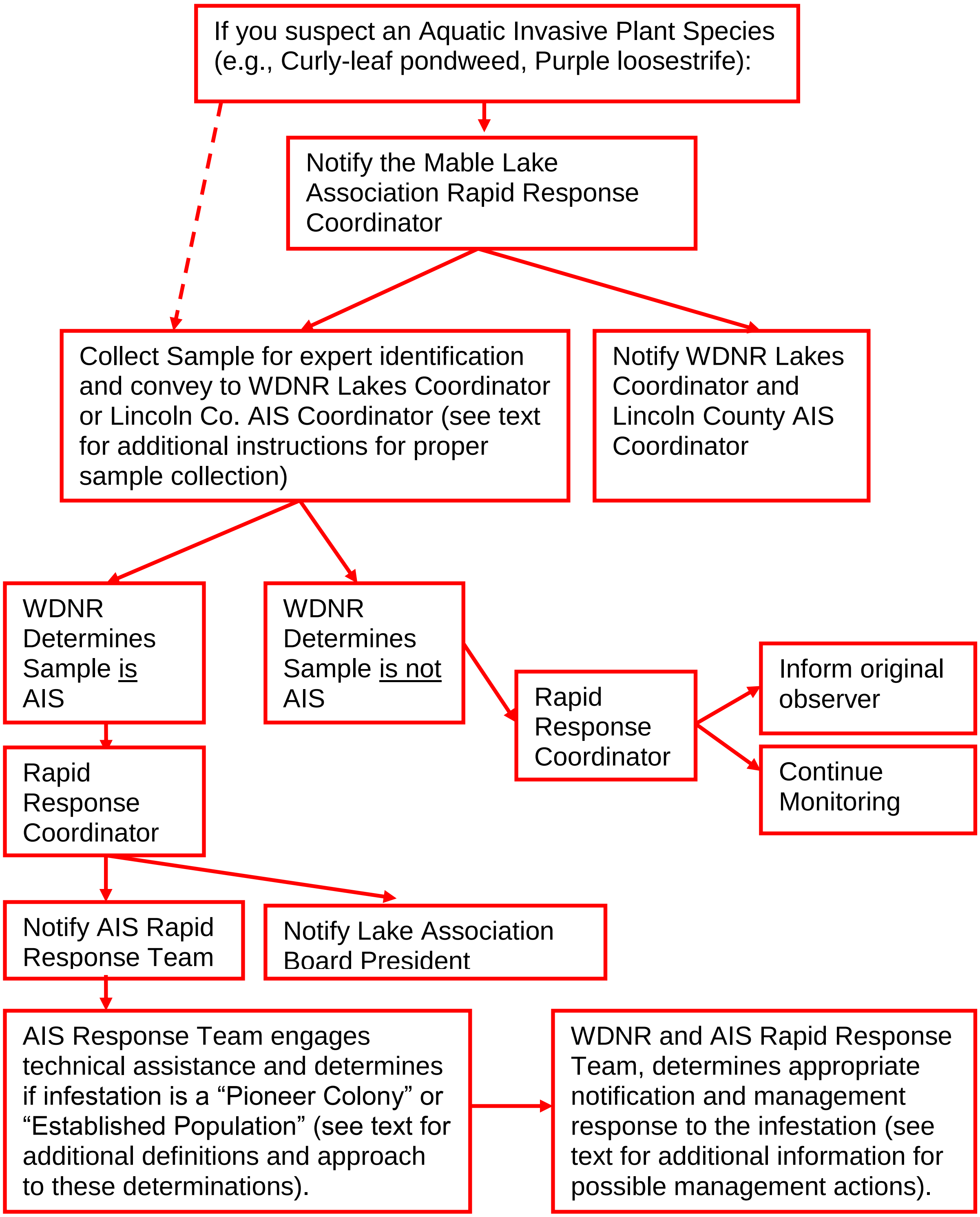
When a suspect aquatic invasive plant species is found, either the original observer or a member of the Rapid Response Team (likely the coordinator) should collect an entire plant specimen including roots, stems, and flowers (if present). The sample should be placed in a sealable bag with a small amount of water to keep it moist. Place a label in the bag written in pencil with date, time, collector's name, lake name, location, town, and county. Attach a lake map to the bag that has the location of the suspect AIS marked and GPS coordinates recorded (if GPS is available). The sample should be placed on ice in a cooler or in a refrigerator. Deliver the sample to the WDNR Water Resources Management Specialist as soon as possible (at least within three days). The WDNR or their botanical expert(s) will determine the species and confirm whether or not it is an aquatic invasive plant species.

If the suspect specimen is determined to be an invasive plant species, the next step is to determine the extent and density of the population since the management response will vary accordingly. The Rapid Response Team should conduct (or have its consultant conduct) a survey to define the colony's perimeter and estimate density. If less than five acres (or <5% of the lake surface area), it is designated a "Pioneer Colony." If greater than five acres (or >5% of the lake surface area) then it is designated an "Established Population." Once the infestation is characterized, "at risk" areas should also be determined and marked on a map. For example, nearby boat landing sites and areas of high boat traffic should be indicated.

When "pioneer" or "established" status has been determined, it is time to consult with the WDNR Lakes Coordinator to determine appropriate notifications and management responses to the infestation. Determining whether hand-pulling or chemical treatment will be used is an important and early decision. Necessary notifications of landowners, governmental officials, and recreationists (at boat landings) will be determined. Whether the population's perimeter needs to be marked with buoys will be decided by the WDNR. Funding sources will be identified and consultants and contractors will be contacted where necessary. The WDNR will determine if a further baseline plant survey is required (depending on type of treatment). A post treatment monitoring plan will be discussed and established to determine the efficacy of the selected treatment.

Once the Rapid Response Team is organized, one of its first tasks is to develop a list of contacts and associated contact information (phone numbers and email addresses). At a minimum, this contact list should include: the Rapid Response Coordinator, members of the Rapid Response Team, County AIS Coordinator, WDNR Lakes Management Coordinator, Lake Association Presidents (or other points of contact), local WDNR warden, local government official(s), other experts, chemical treatment contractors, and consultant(s).

Exhibit 15. Aquatic Invasive Plant Species Rapid Response



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Appendix 1
Literature Cited

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WHITE WATER
ASSOCIATES, INC.

Appendix 2

Aquatic Plant Survey Tables and Figures

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Table 1. Summary statistics for the 2015 point-intercept aquatic plant survey for Mable Lake.

Summary Statistic	Value	Notes
Total number of sites on grid	**93**	Total number of sites on the original grid (not necessarily visited)
Total number of sites visited	**82**	Total number of sites where the boat stopped, even if much too deep to have plants.
Total number of sites with vegetation	**63**	Total number of sites where at least one plant was found
Total number of sites shallower than maximum depth of plants	**71**	Number of sites where depth was less than or equal to the maximum depth where plants were found. This value is used for Frequency of occurrence at sites shallower than maximum depth of plants.
Frequency of occurrence at sites shallower than maximum depth of plants	**88.73**	Number of times a species was seen divided by the total number of sites shallower than maximum depth of plants.
Simpson Diversity Index	**0.88**	A nonparametric estimator of community heterogeneity. It is based on Relative Frequency and thus is not sensitive to whether all sampled sites (including non-vegetated sites) are included. The closer the Simpson Diversity Index is to 1, the more diverse the community.
Maximum depth of plants (ft.)	**18.50**	The depth of the deepest site sampled at which vegetation was present.
Number of sites sampled with rake on rope	**19**	
Number of sites sampled with rake on pole	**63**	
Average number of all species per site (shallower than max depth)	**1.96**	
Average number of all species per site (vegetated sites only)	**2.21**	
Average number of native species per site (shallower than max depth)	**1.96**	Total number of species collected. Does not include visual sightings.
Average number of native species per site (vegetated sites only)	**2.21**	Total number of species collected including visual sightings.
Species Richness	**17**	
Species Richness (including visuals)	**18**	
Floristic Quality Index (FQI)	**28.3**	An assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions.

Table 2. Summary statistics for the 2011 point-intercept aquatic plant survey for Mable Lake.

Summary Statistic	Value	Notes
Total number of sites on grid	**93**	Total number of sites on the original grid (not necessarily visited)
Total number of sites visited	**88**	Total number of sites where the boat stopped, even if much too deep to have plants.
Total number of sites with vegetation	**68**	Total number of sites where at least one plant was found
Total number of sites shallower than maximum depth of plants	**80**	Number of sites where depth was less than or equal to the maximum depth where plants were found. This value is used for Frequency of occurrence at sites shallower than maximum depth of plants.
Frequency of occurrence at sites shallower than maximum depth of plants	**85.00**	Number of times a species was seen divided by the total number of sites shallower than maximum depth of plants.
Simpson Diversity Index	**0.92**	A nonparametric estimator of community heterogeneity. It is based on Relative Frequency and thus is not sensitive to whether all sampled sites (including non-vegetated sites) are included. The closer the Simpson Diversity Index is to 1, the more diverse the community.
Maximum depth of plants (ft.)	**20.00**	The depth of the deepest site sampled at which vegetation was present.
Number of sites sampled with rake on rope	**14**	
Number of sites sampled with rake on pole	**74**	
Average number of all species per site (shallower than max depth)	**2.61**	
Average number of all species per site (vegetated sites only)	**3.07**	
Average number of native species per site (shallower than max depth)	**2.61**	Total number of species collected. Does not include visual sightings.
Average number of native species per site (vegetated sites only)	**3.07**	Total number of species collected including visual sightings.
Species Richness	**21**	
Species Richness (including visuals)	**23**	
Floristic Quality Index (FQI)	**31.7**	An assessment metric designed to evaluate the closeness that the flora of an area is to that of undisturbed conditions.

Table 3. Plant species recorded and distribution statistics for the 2015 Mable Lake aquatic plant survey[1].

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Large-leaf pondweed	*Potamogeton amplifolius*	40.85	46.03	20.86	29	30	1.10
Water bulrush	*Schoenoplectus subterminalis*	30.99	34.92	15.83	22	22	1.05
Fragile stonewort	*Chara globularis*	30.99	34.92	15.83	22	22	1.73
Watershield	*Brasenia schreberi*	22.54	25.40	11.51	16	24	1.00
Slender naiad	*Najas flexilis*	14.08	15.87	7.19	10	10	1.10
White water lily	*Nymphaea odorata*	8.45	9.52	4.32	6	28	1.00
Common bladderwort	*Utricularia vulgaris*	8.45	9.52	4.32	6	8	1.00
Berchtold's pondweed	*Potamogeton berchtoldii*	7.04	7.94	3.60	5	5	1.20
Flat-leaf bladderwort	*Utricularia intermedia*	7.04	7.94	3.60	5	5	1.00
Creeping bladderwort	*Utricularia gibba*	5.63	6.35	2.88	4	5	1.00
Spatterdock	*Nuphar variegata*	4.23	4.76	2.16	3	5	1.00
Pickerelweed	*Pontederia cordata*	4.23	4.76	2.16	3	9	1.00
Illinois pondweed	*Potamogeton illinoensis*	4.23	4.76	2.16	3	3	1.00
Bald spikerush	*Eleocharis erythropoda*	2.82	3.17	1.44	2	3	1.00
Spiny hornwort	*Ceratophyllum echinatum*	1.41	1.59	0.72	1	1	1.00
Ribbon-leaf pondweed	*Potamogeton epihydrus*	1.41	1.59	0.72	1	1	1.00
Leafy pondweed	*Potamogeton foliosus*	1.41	1.59	0.72	1	1	1.00
Bur-reed	*Sparganium* sp.				Visual	1	
Broad-leaved cattail	*Typha latifolia*				Boat Survey		
Three-way sedge	*Dulichium arundinaceum*				Boat Survey		
Water horsetail	*Equisetum fluviatile*				Boat Survey		
Woolgrass	*Scirpus cyperinus*				Boat Survey		
Common duckweed	*Lemna minor*				Boat Survey		
Dock	*Rumex* sp.				Boat Survey		

Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

[1] Plant specimens were verified by Dr. Robert Freckmann, University of Wisconsin-Stevens Pointe, on 10/21/2015.

Table 3. Continued.

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Needle spikerush	*Eleocharis acicularis*				Boat Survey		
Brown-fruited rush	*Juncus pelocarpus*				Boat Survey		
Sedge	*Carex* sp.				Boat Survey		
Water lobelia	*Lobelia dortmanna*				Boat Survey		
Eurasian water-milfoil	*Myriophyllum spicatum*				Boat Survey		

Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

Eurasian water-milfoil is considered a Restricted species in Wisconsin.

Table 4. Plant species recorded and distribution statistics for the 2011 Mable Lake aquatic plant survey[1].

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Large-leaf pondweed	*Potamogeton amplifolius*	37.5	44.12	14.35	30	33	1.33
Muskgrass	*Chara* sp.	32.5	38.24	12.44	26	26	1.85
Watershield	*Brasenia schreberi*	22.5	26.47	8.61	18	29	1.72
Water bulrush	*Schoenoplectus subterminalis*	22.5	26.47	8.61	18	19	1.33
Large purple bladderwort	*Utricularia purpurea*	21.25	25.00	8.13	17	32	1.18
White water lily	*Nymphaea odorata*	20	23.53	7.66	16	32	1.13
Leafy pondweed	*Potamogeton foliosus*	18.75	22.06	7.18	15	15	1.00
Ribbon-leaf pondweed	*Potamogeton epihydrus*	16.25	19.12	6.22	13	17	1.15
Slender naiad	*Najas flexilis*	11.25	13.24	4.31	9	9	1.00
Spatterdock	*Nuphar variegata*	11.25	13.24	4.31	9	17	1.00
Flat-leaf pondweed	*Utricularia intermedia*	11.25	13.24	4.31	9	12	1.00
Small pondweed	*Potamogeton pusillus*	8.75	10.29	3.35	7	7	1.14
Common bladderwort	*Utricularia vulgaris*	8.75	10.29	3.35	7	11	1.29
Nitella	*Nitella* sp.	6.25	7.36	2.39	5	5	1.40
Small bladderwort	*Utricularia minor*	3.75	4.41	1.44	3	8	1.00
Arrowhead	*Sagittaria* sp.	2.5	2.94	0.96	2	4	1.00
Creeping spikerush	*Eleocharis palustris*	1.25	1.47	0.48	1	1	1.00
Pickerelweed	*Pontederia cordata*	1.25	1.47	0.48	1	8	1.00
Illinois pondweed	*Potamogeton illinoensis*	1.25	1.47	0.48	1	1	1.00
Spiral-fruited pondweed	*Potamogeton spirillus*	1.25	1.47	0.48	1	2	1.00
Spikerush	*Eleocharis* sp.	1.25	1.47	0.48	1	1	1.00
Bur-reed	*Sparganium* sp.				Visual	5	
Three-way sedge	*Dulichium arundinaceum*				Visual	1	
Vasey's pondweed	*Potamogeton vaseyi*				Boat Survey		

Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

[1] Information was not available as to whether the listed plant species were verified by an expert botanist.

Table 4. Continued.

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Cattail	*Typha* sp.				Boat Survey		
Rush	*Juncus* sp.				Boat Survey		
Sedge	*Carex* sp.				Boat Survey		

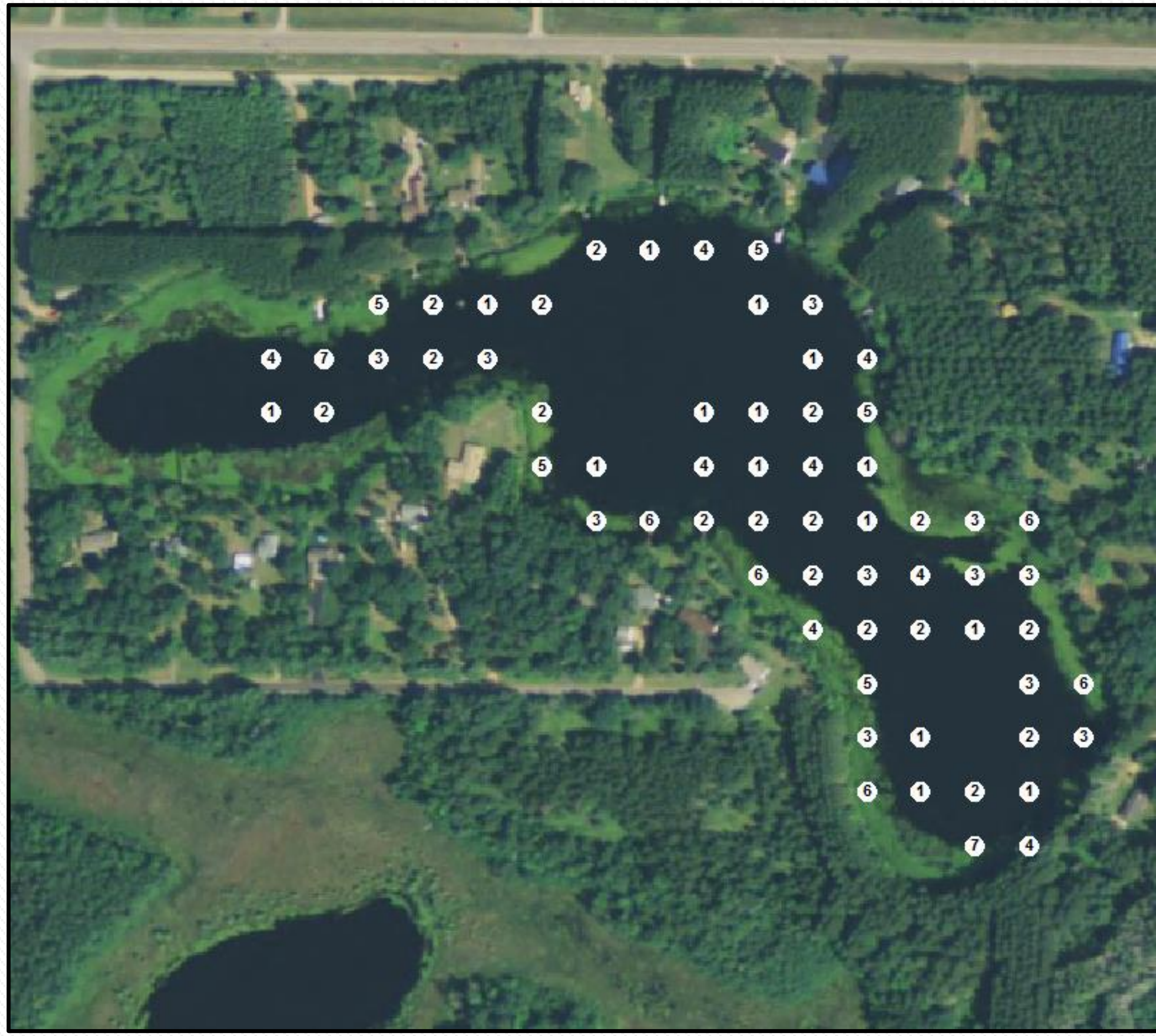
Frequency of occurrence within vegetated areas (%): Number of times a species was seen in a vegetated area divided by the total number of vegetated sites.

Vasey's pondweed (*Potamogeton vaseyi*) is considered a Special Concern species in Wisconsin.

Table 5. Comparison of summary statistics for 2011 and 2015 point-intercept aquatic plant surveys in Mable Lake.

Summary Statistic	2011	2015
Total number of sites on grid	93	93
Total number of sites visited	88	82
Total number of sites with vegetation	68	63
Total number of sites shallower than maximum depth of plants	80	71
Frequency of occurrence at sites shallower than maximum depth of plants	85.0	88.73
Simpson Diversity Index	0.92	0.88
Maximum depth of plants (ft.)	20.0	18.50
Number of sites sampled with rake on rope	14	19
Number of sites sampled with rake on pole	74	63
Average number of all species per site (shallower than max depth)	2.61	1.96
Average number of all species per site (vegetated sites only)	3.07	2.21
Average number of native species per site (shallower than max depth)	2.61	1.96
Average number of native species per site (vegetated sites only)	3.07	2.21
Species Richness	21	17
Species Richness (including visuals)	23	18
Floristic Quality Index (FQI)	31.7	28.3

Figure 1. Number of plant species recorded at Mable Lake sample sites (2015).



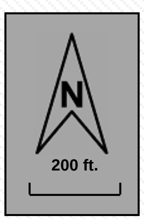


Figure 2. Rake fullness ratings for Mable Lake sample sites (2015).

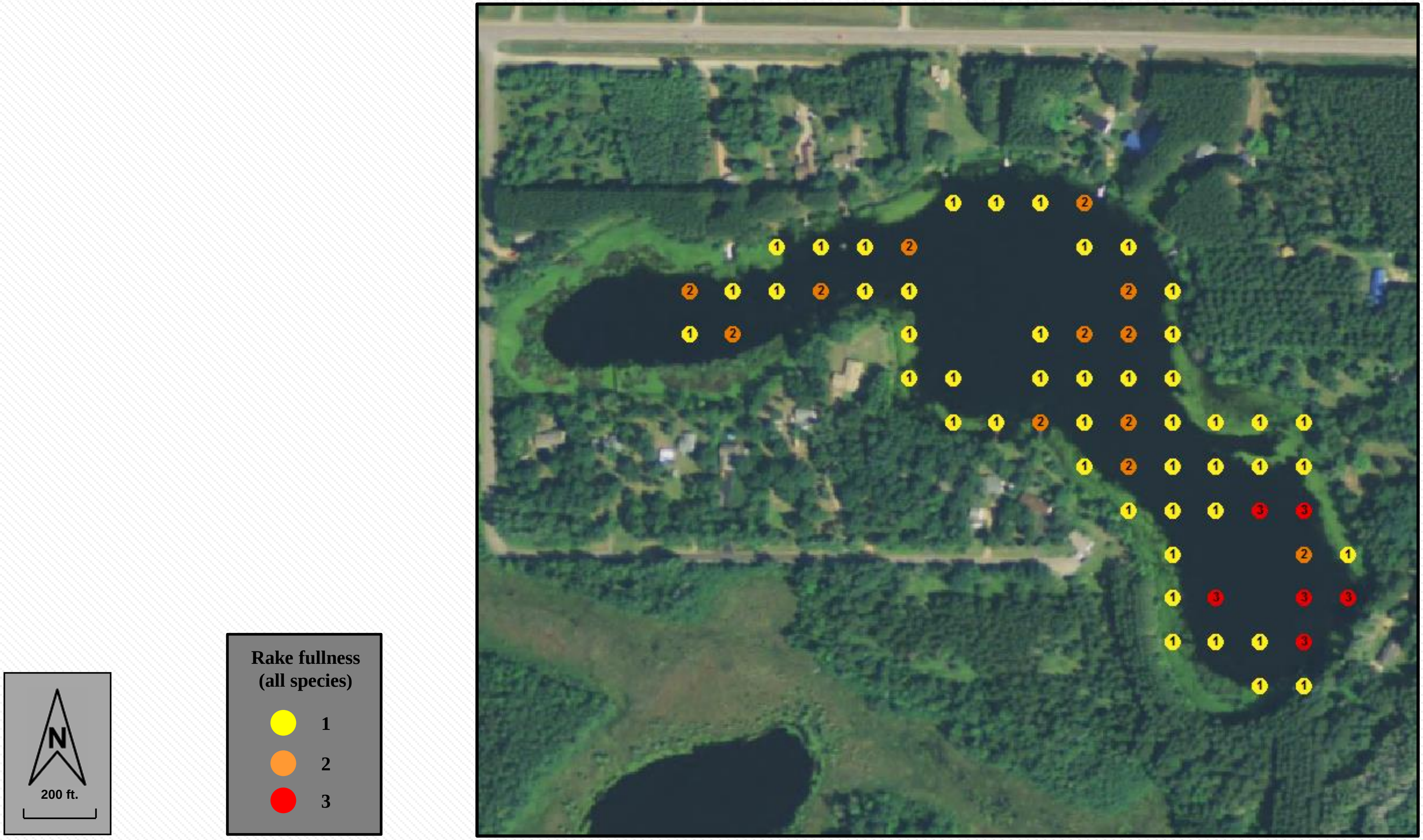


Figure 3. Maximum Depth of Plant Colonization of Mable Lake, 2015.

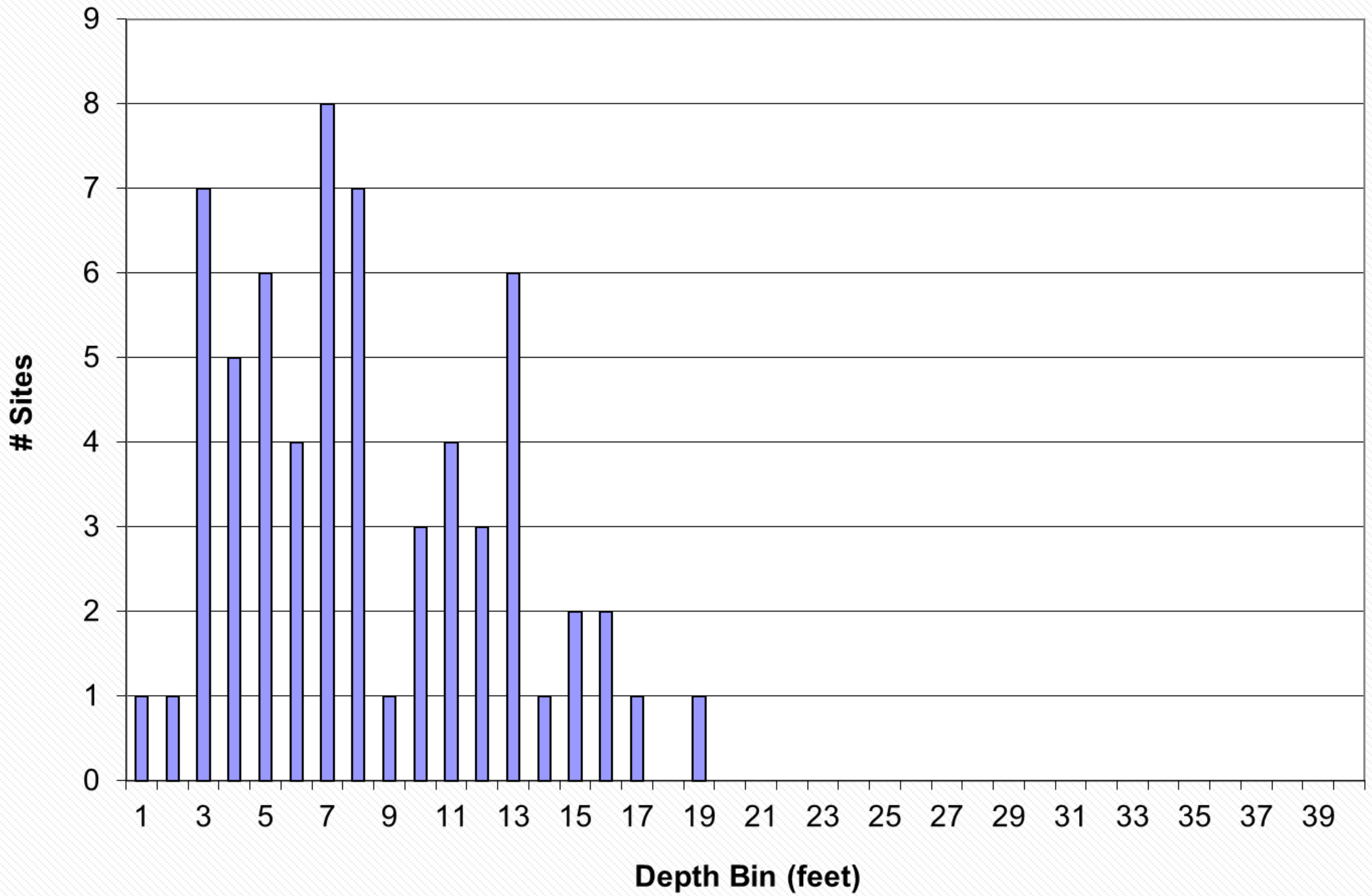


Figure 4. Mable Lake sampling sites less than or equal to maximum depth of rooted vegetation (2015).

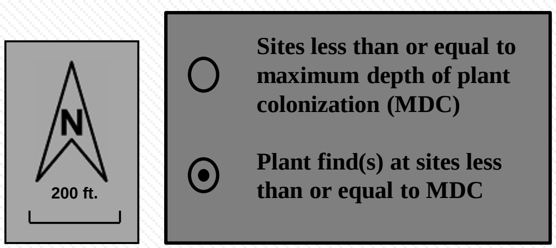
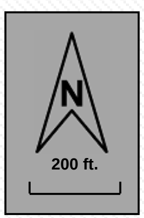


Figure 5. Mable Lake substrate encountered at point-intercept plant sampling sites (2015).



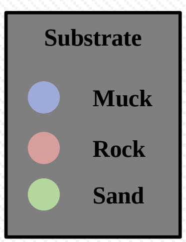
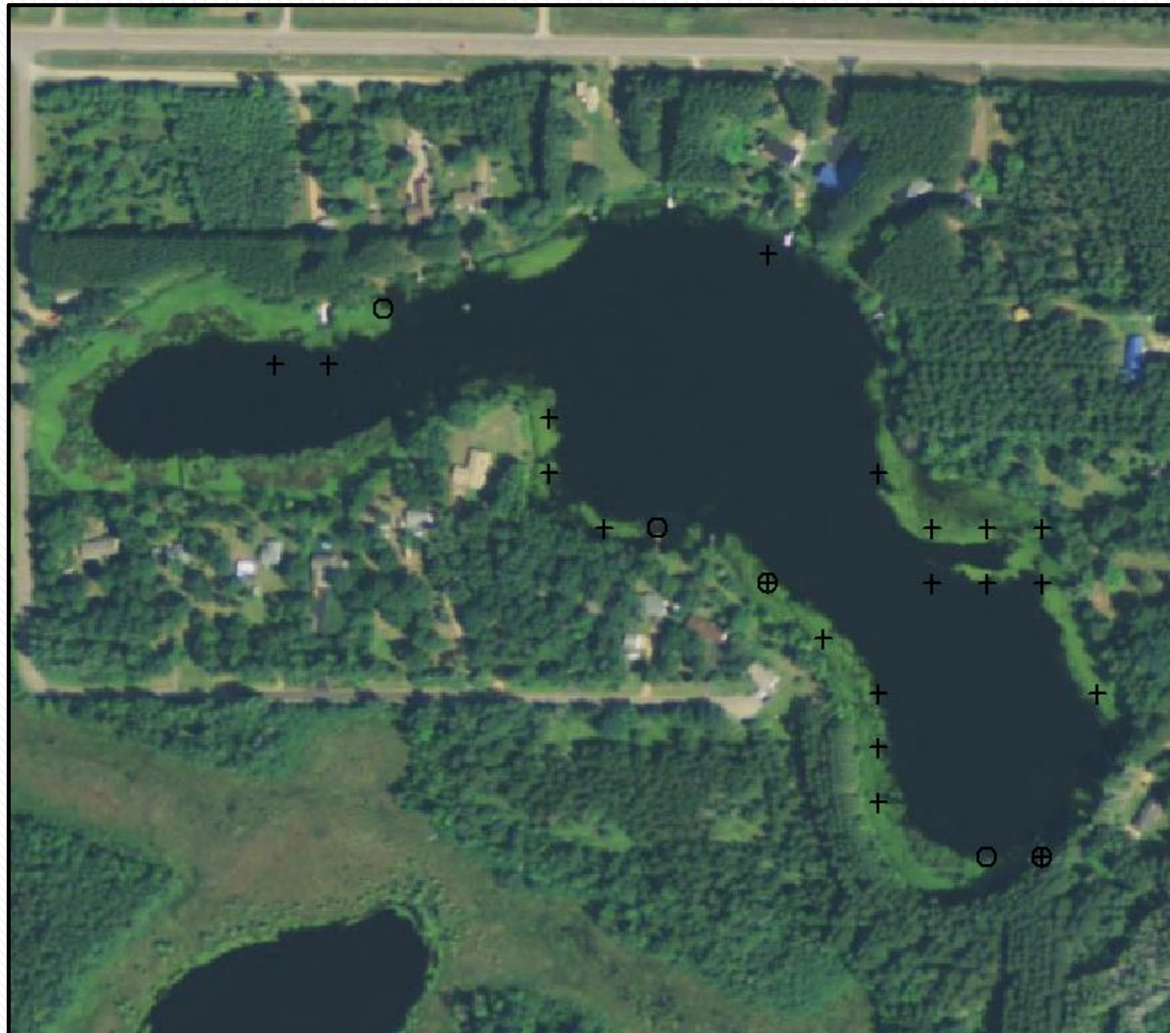
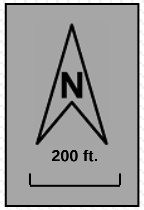


Figure 6. Mable Lake sampling sites with emergent and floating aquatic plants (2015).





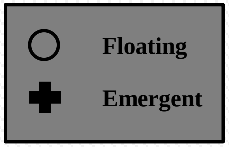


Figure 7. Mable Lake aquatic plant occurrences for 2015 point-intercept survey data.

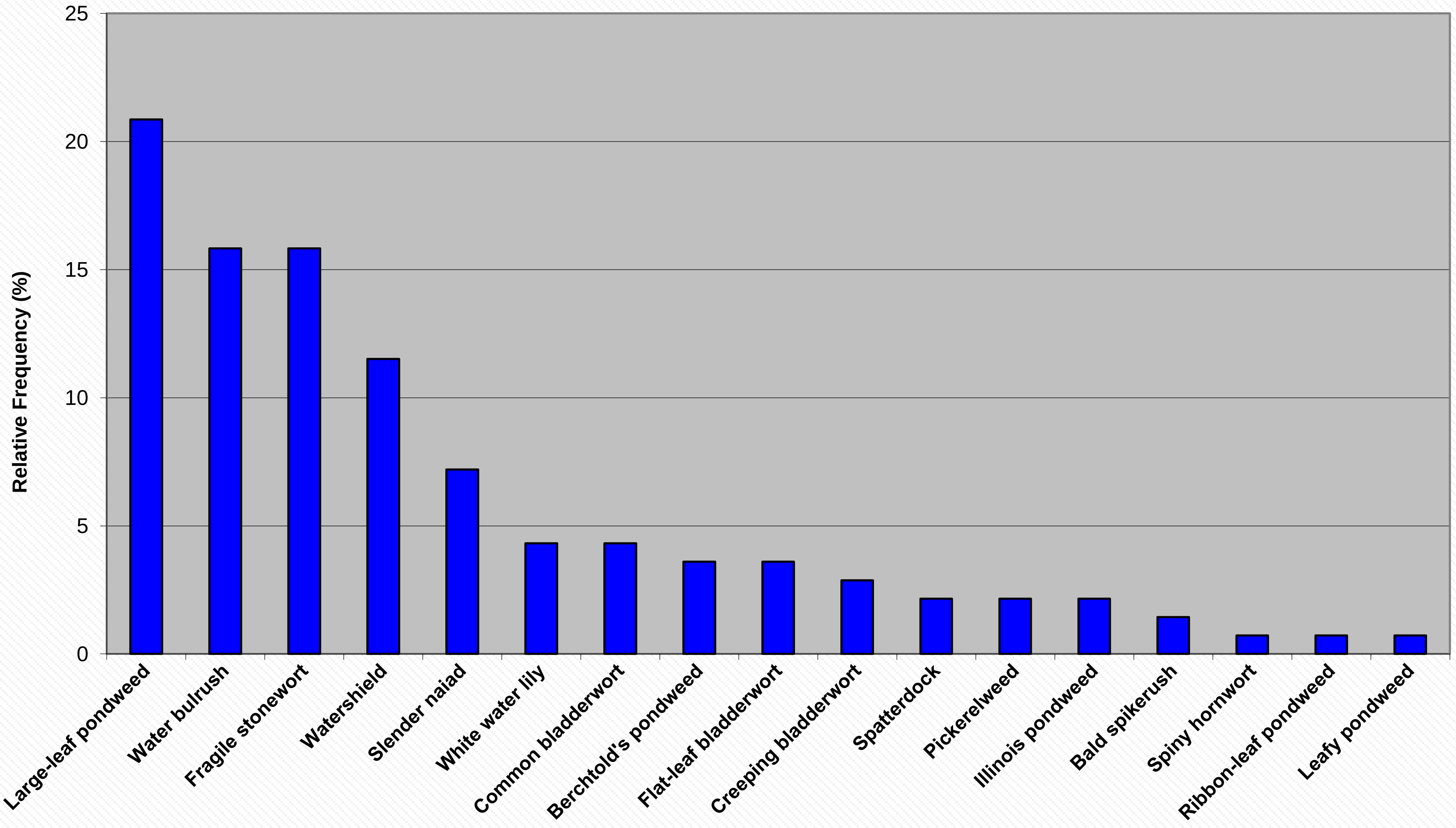
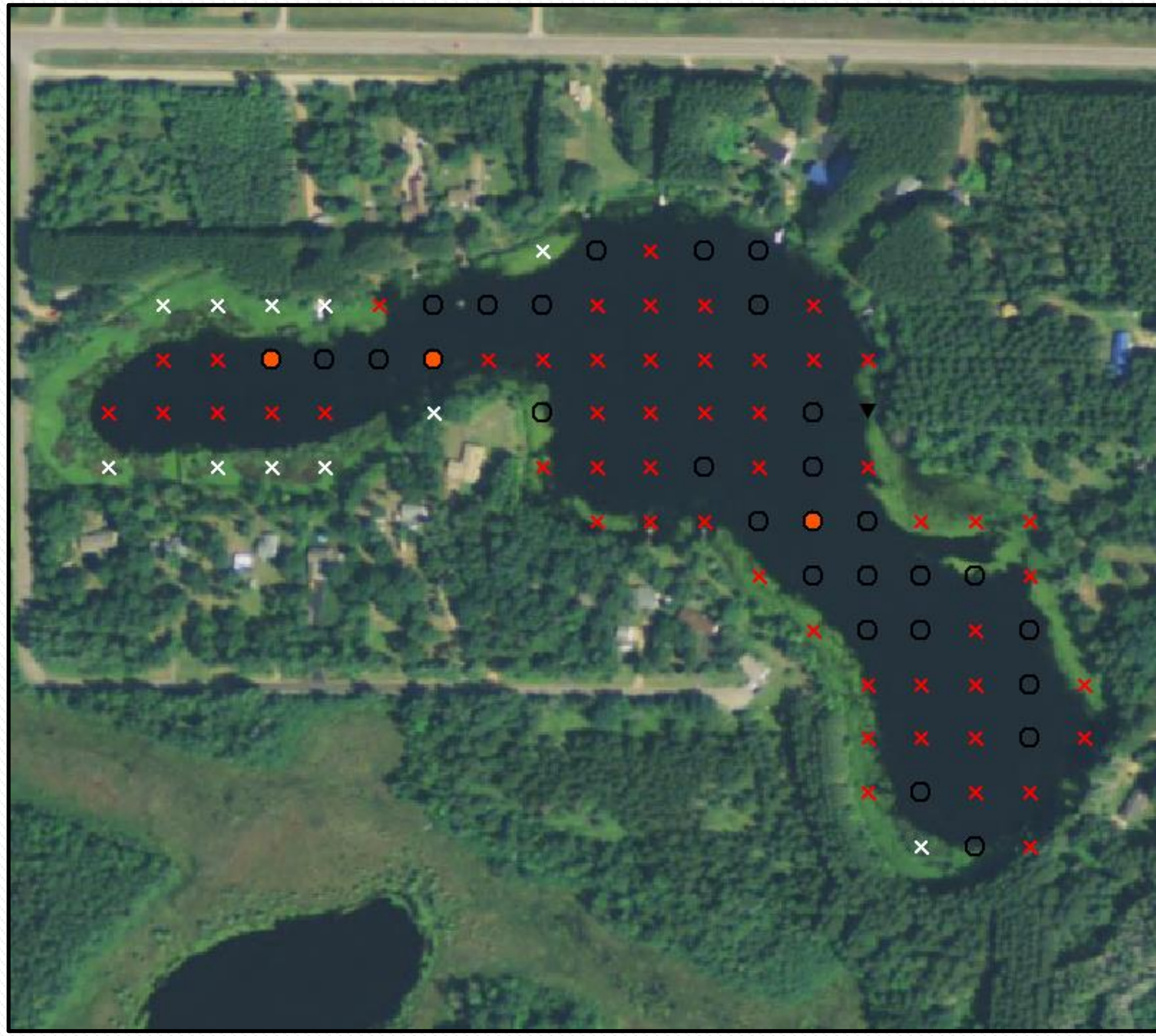


Figure 8. Distribution of plant species, Mable Lake (2015).



Potamogeton amplifolius, **Large-leaf pondweed**

- **1 (Rake fullness)**
- **2**
- **3**
- **Visual**
- **Not found**
- **Unsampled (depth)**
- **Non-navigable**

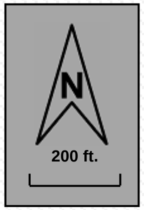


Figure 9. Distribution of plant species, Mable Lake (2015).

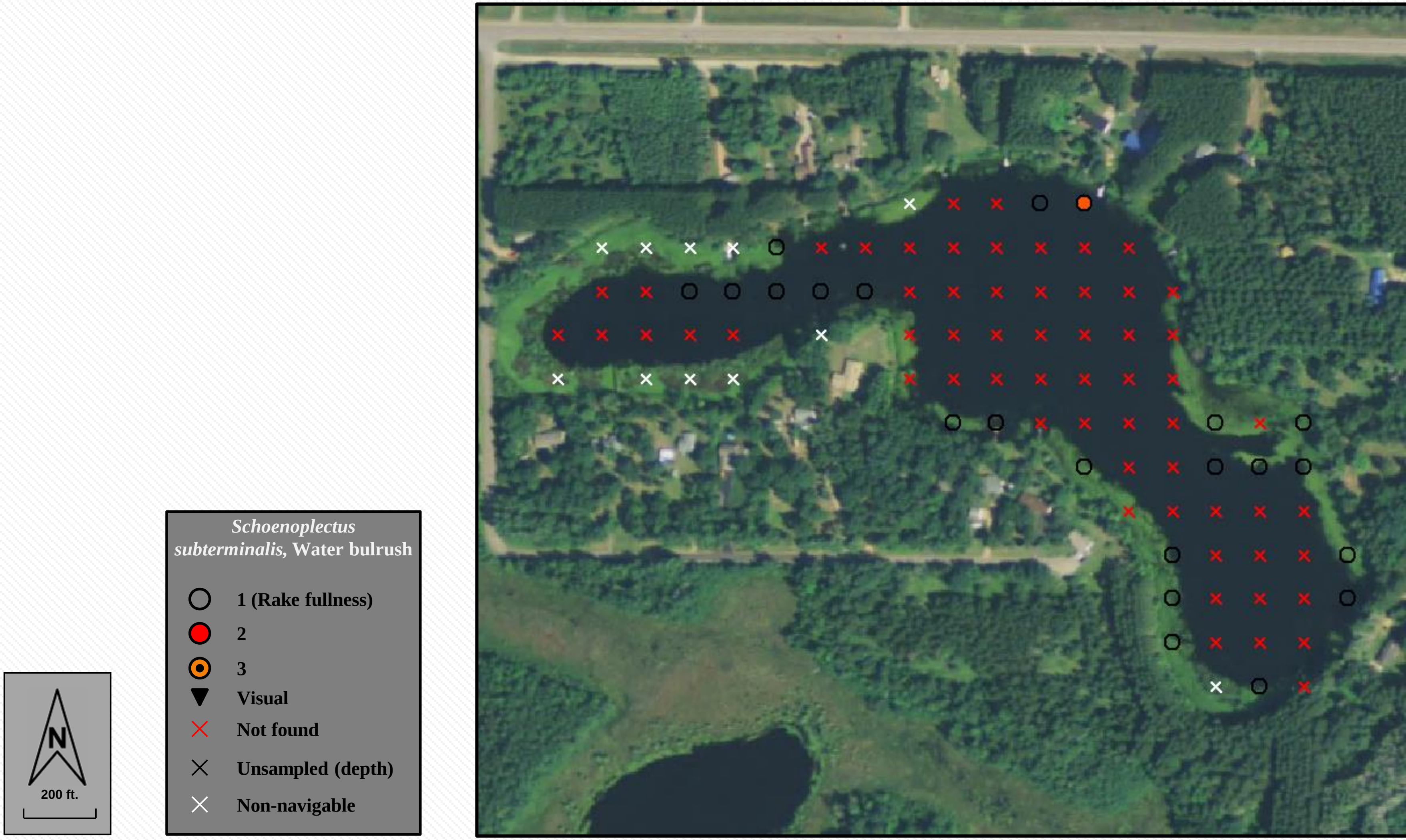


Figure 10. Distribution of plant species, Mable Lake (2015).

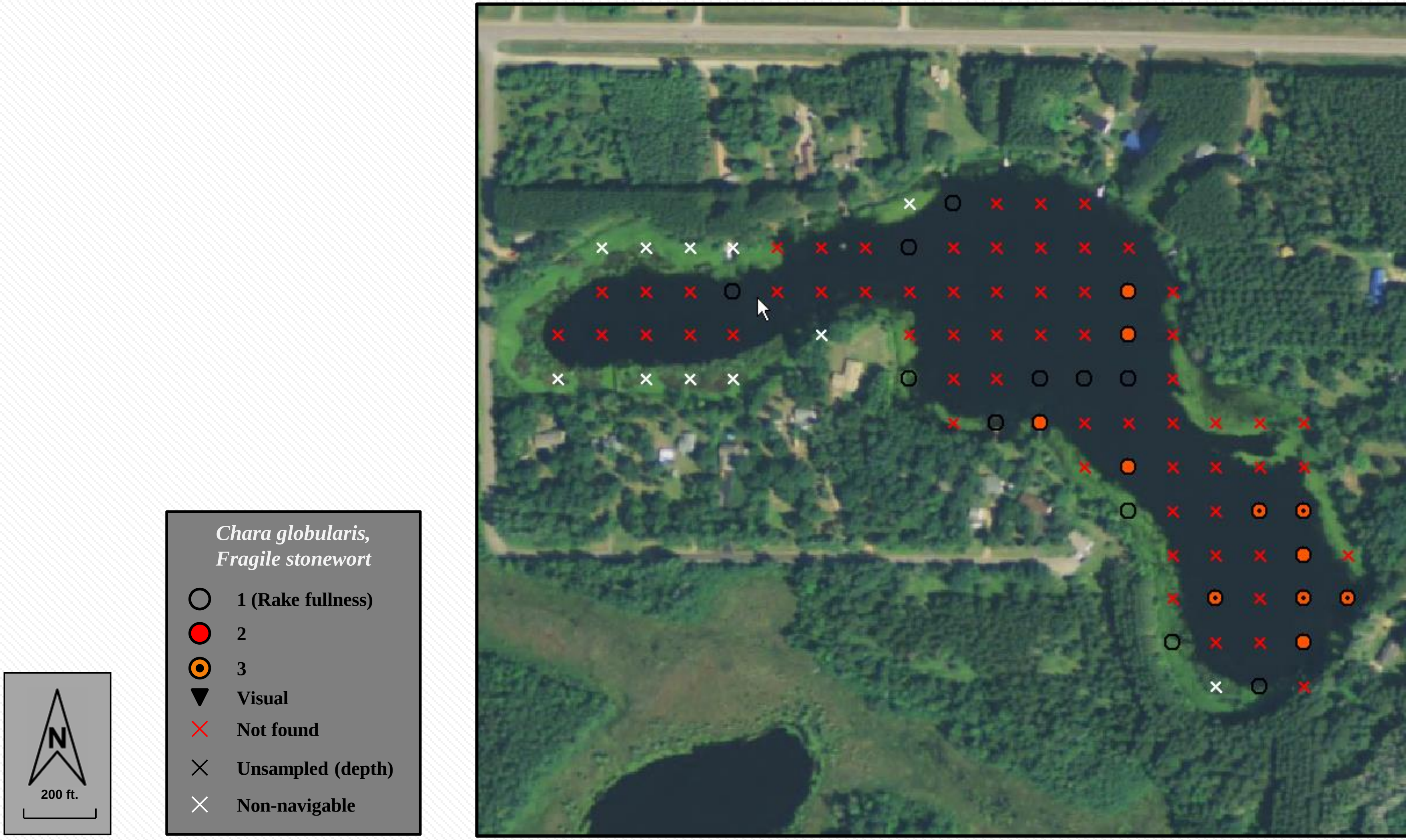
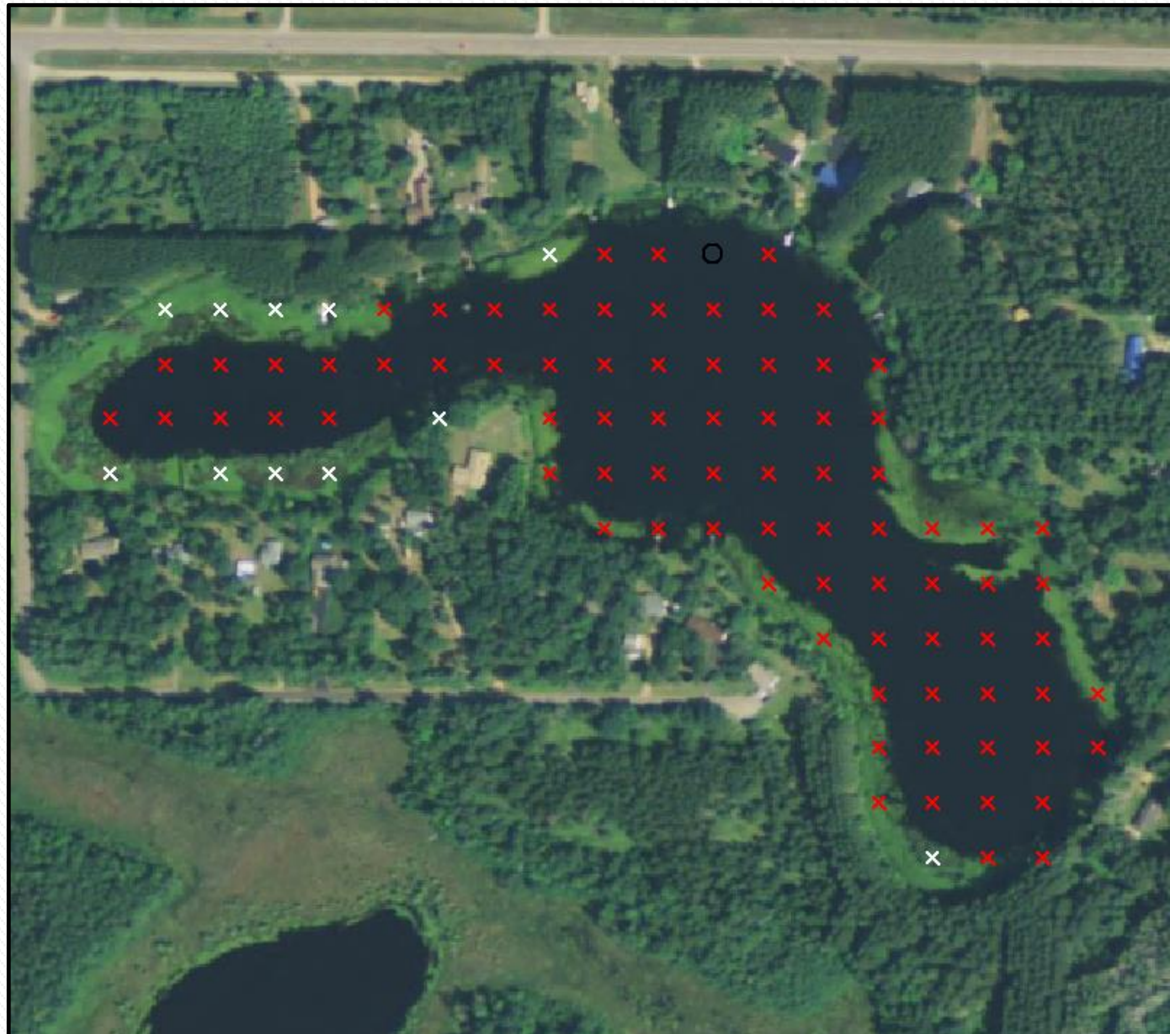
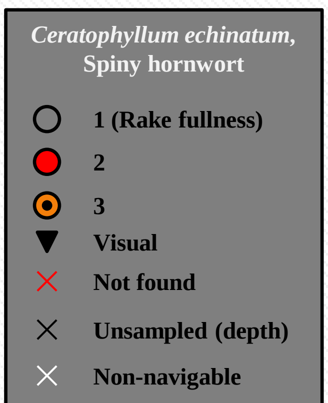


Figure 11. Distribution of plant species, Mable Lake (2015).





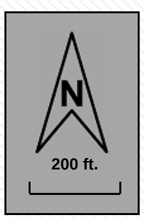


Figure 12. Distribution of plant species, Mable Lake (2015).

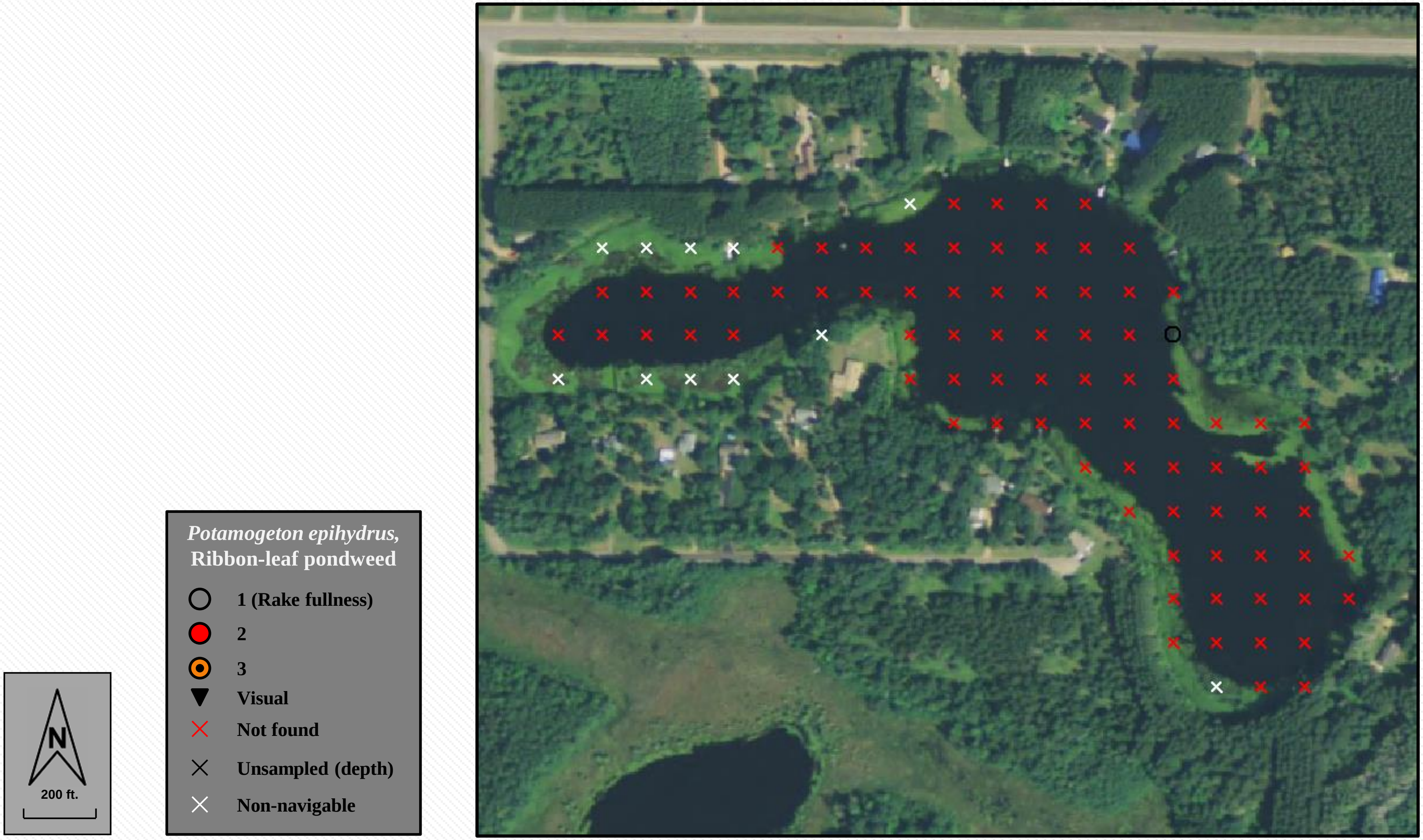
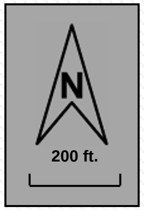
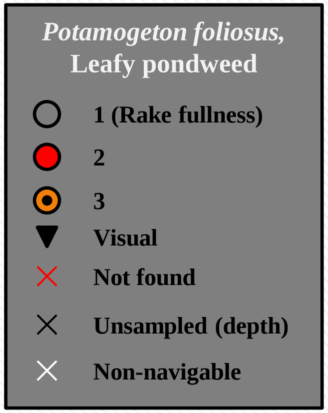


Figure 13. Distribution of plant species, Mable Lake (2015).





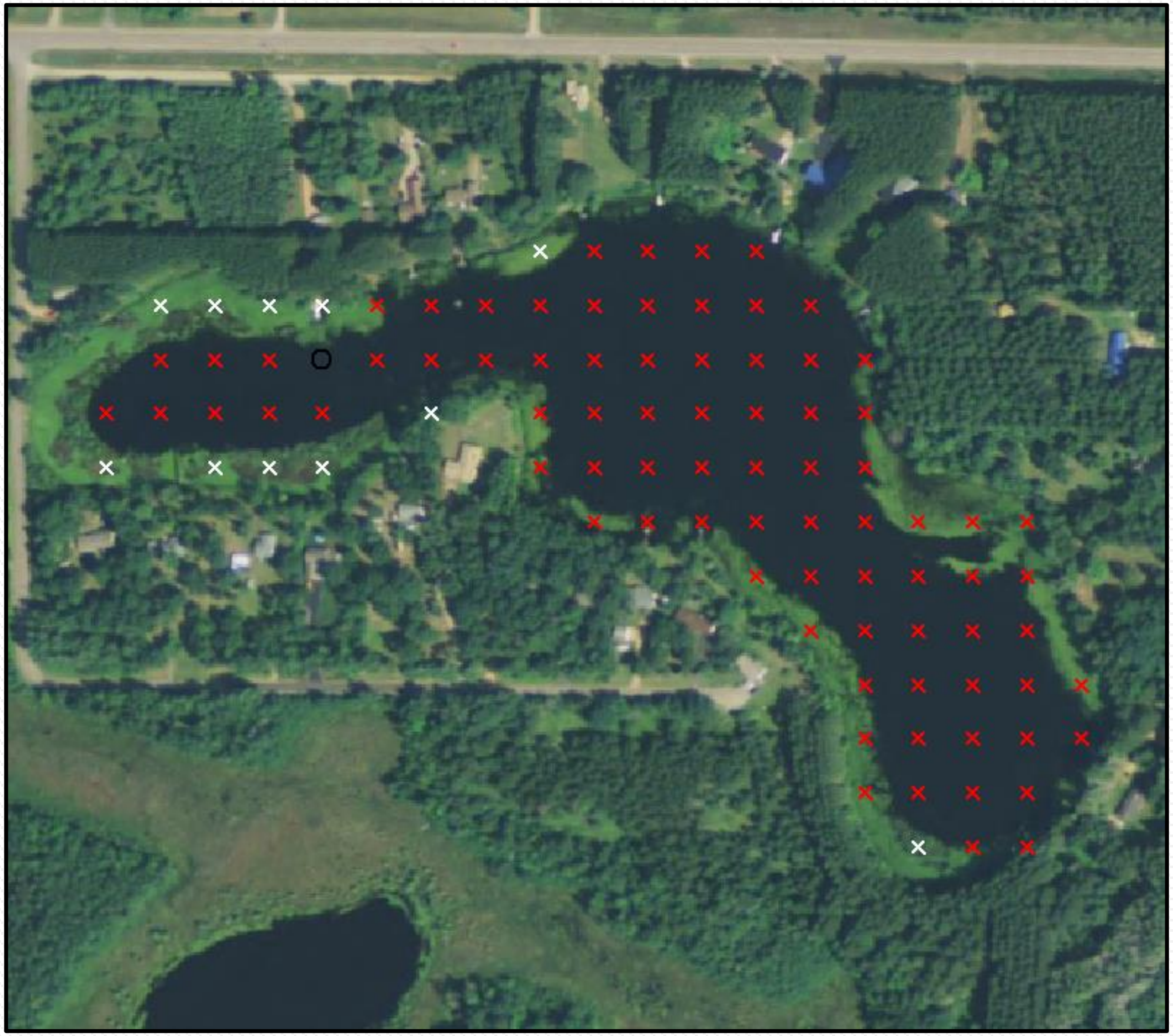
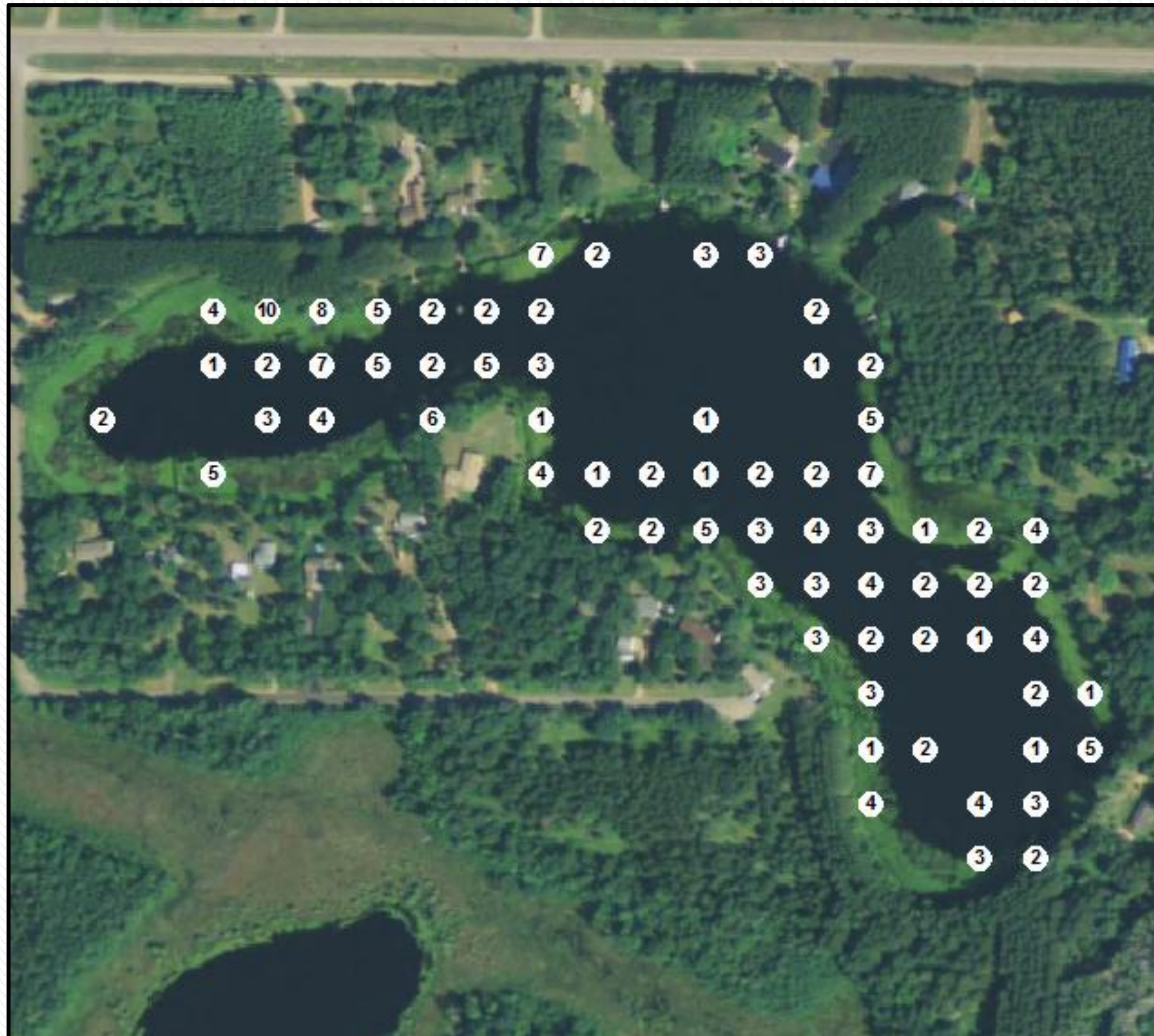


Figure 14. Number of plant species recorded at Mable Lake sample sites (2011).



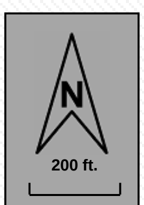


Figure 15. Rake fullness ratings for Mable Lake sample sites (2011).

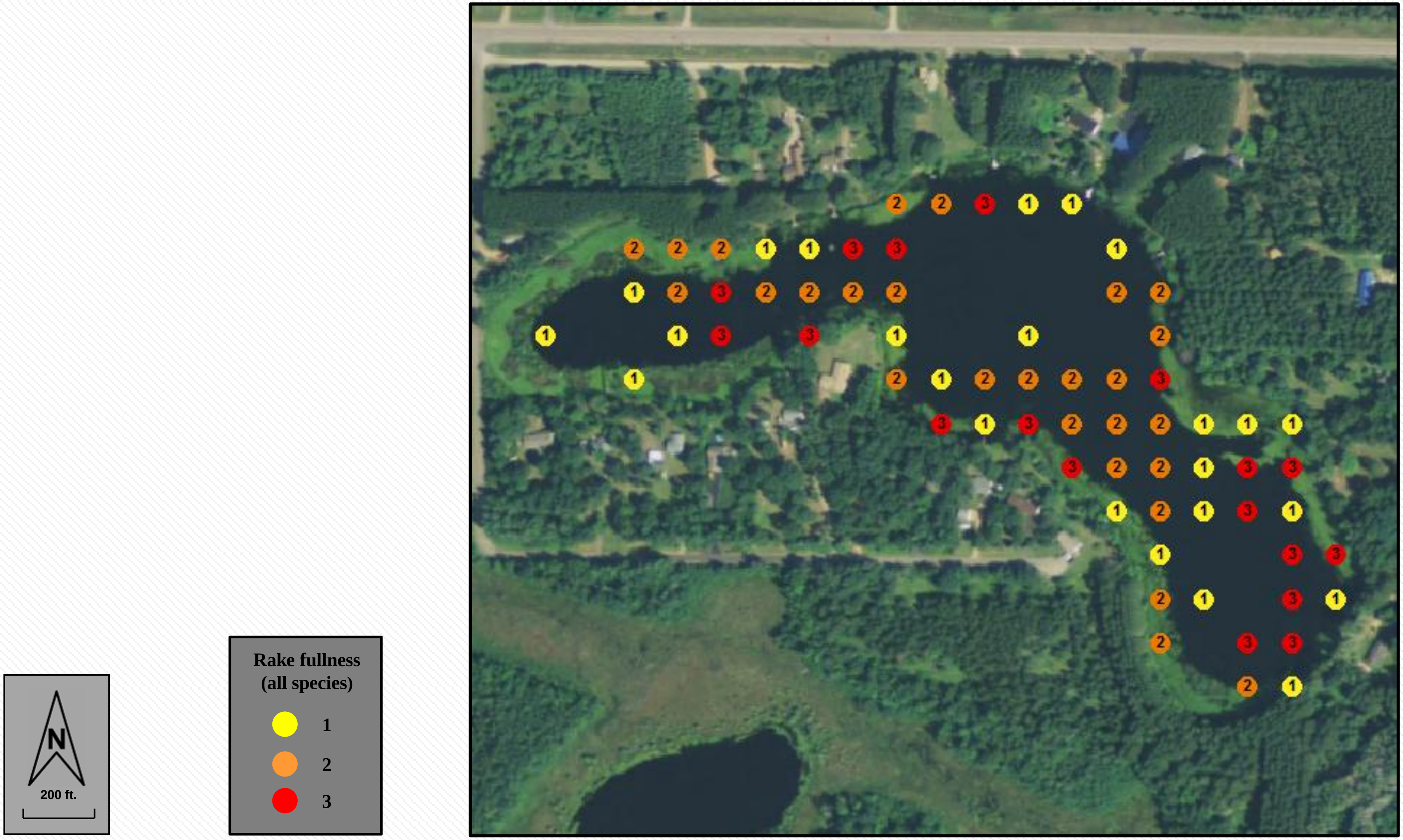


Figure 16. Maximum Depth of Plant Colonization in Mable Lake (2011).

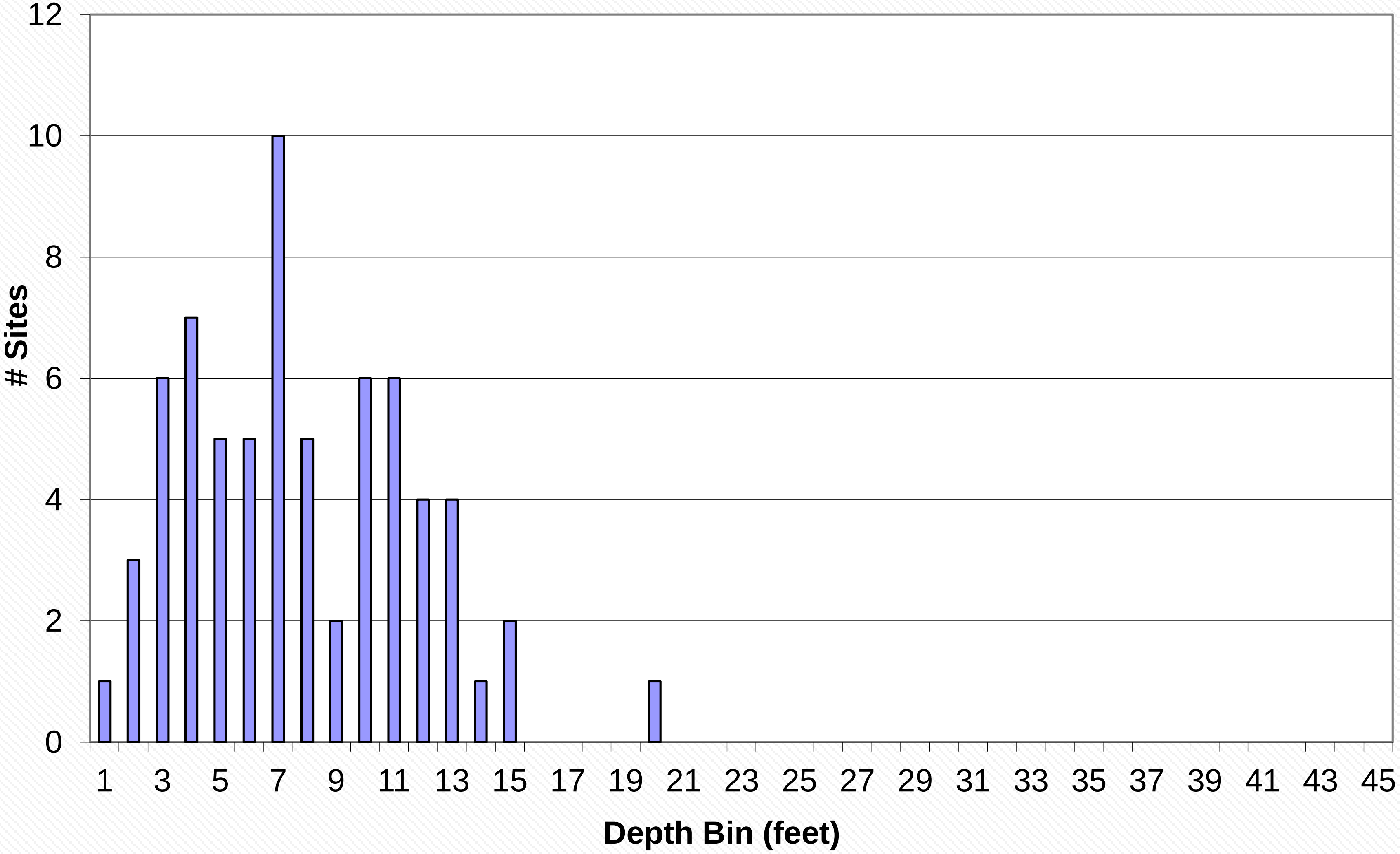
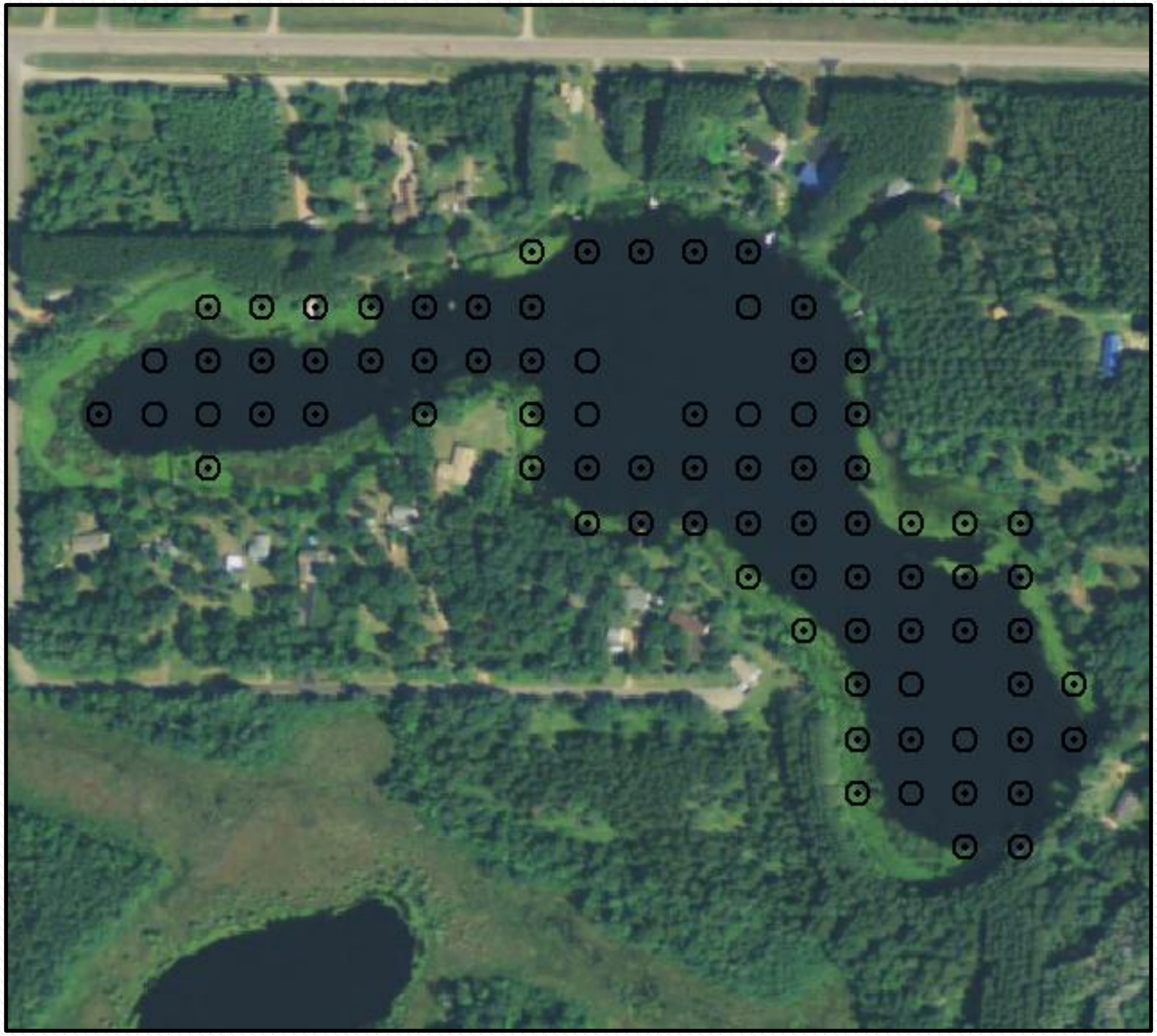
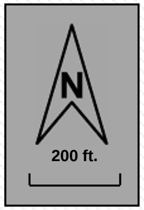


Figure 17. Mable Lake sampling sites less than or equal to maximum depth of rooted vegetation (2011).





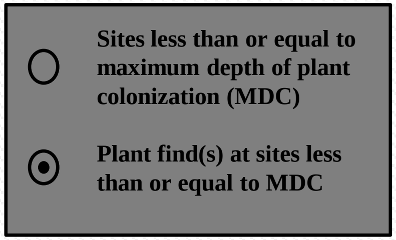
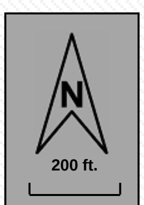


Figure 18. Mable Lake substrate encountered at point-intercept plant sampling sites (2011).



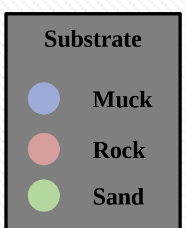
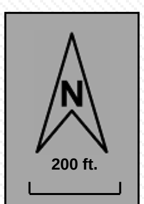


Figure 19. Mable Lake sampling sites with emergent and floating aquatic plants (2011).



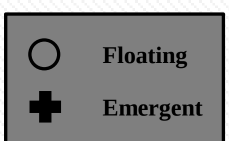


Figure 20. Mable Lake aquatic plant occurrences for 2011 point-intercept survey data.

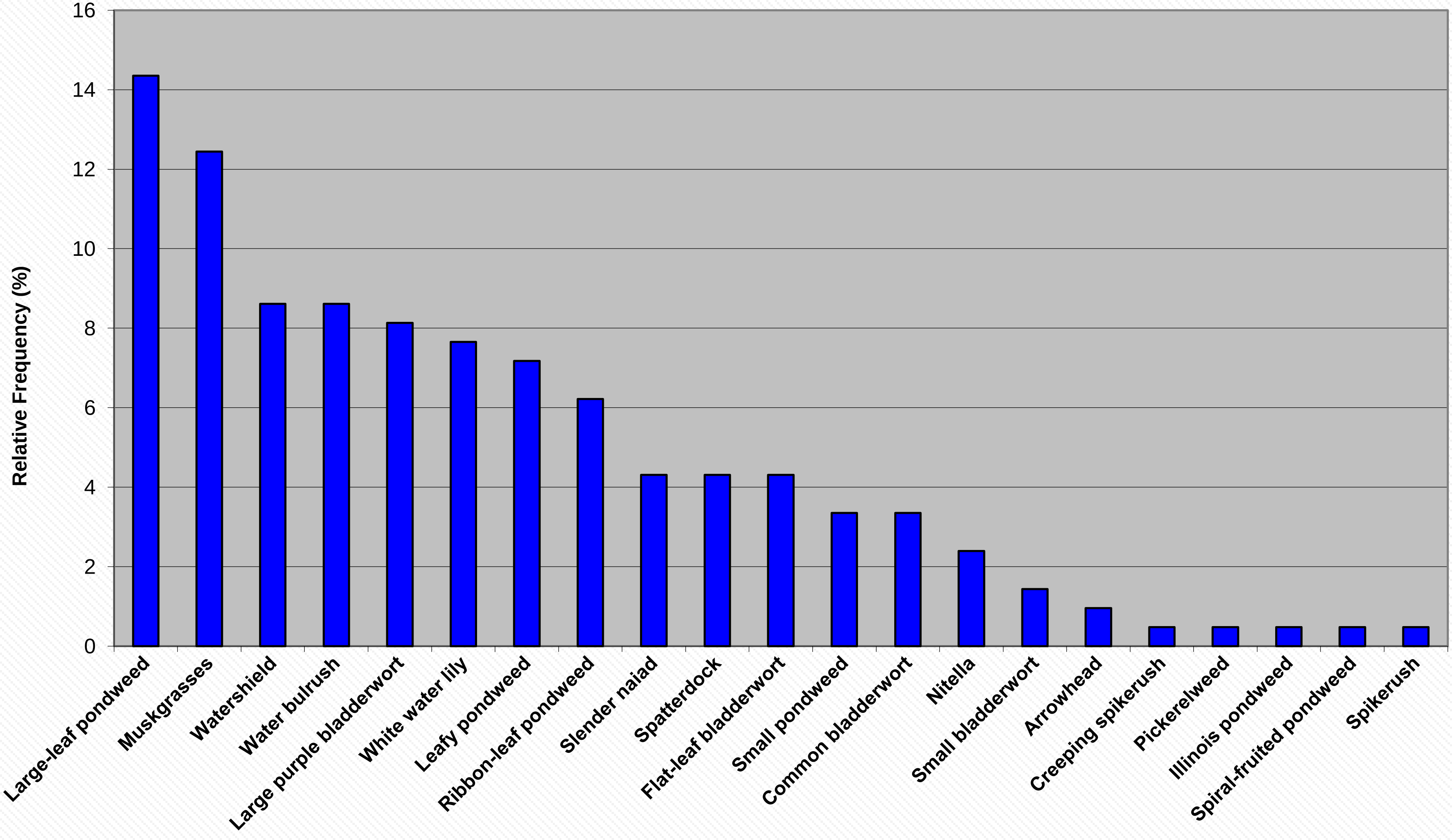


Figure 21. Distribution of plant species, Mable Lake (2011).

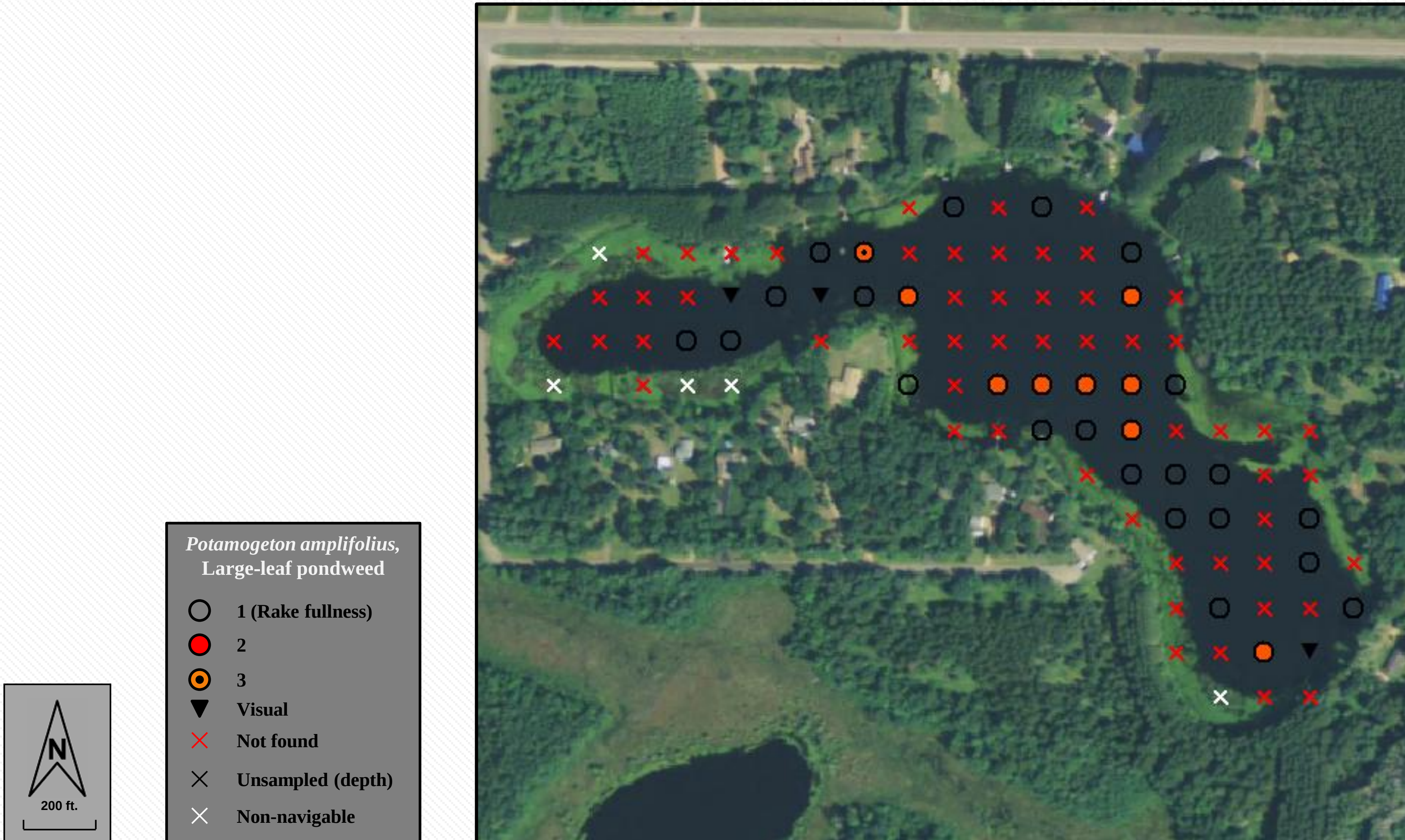
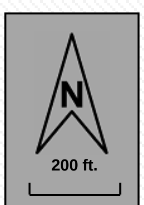


Figure 22. Distribution of plant species, Mable Lake (2011).



Chara sp., Stonewort

- 1 (Rake fullness)
- 2
- 3
- Visual
- Not found
- Unsampled (depth)
- Non-navigable

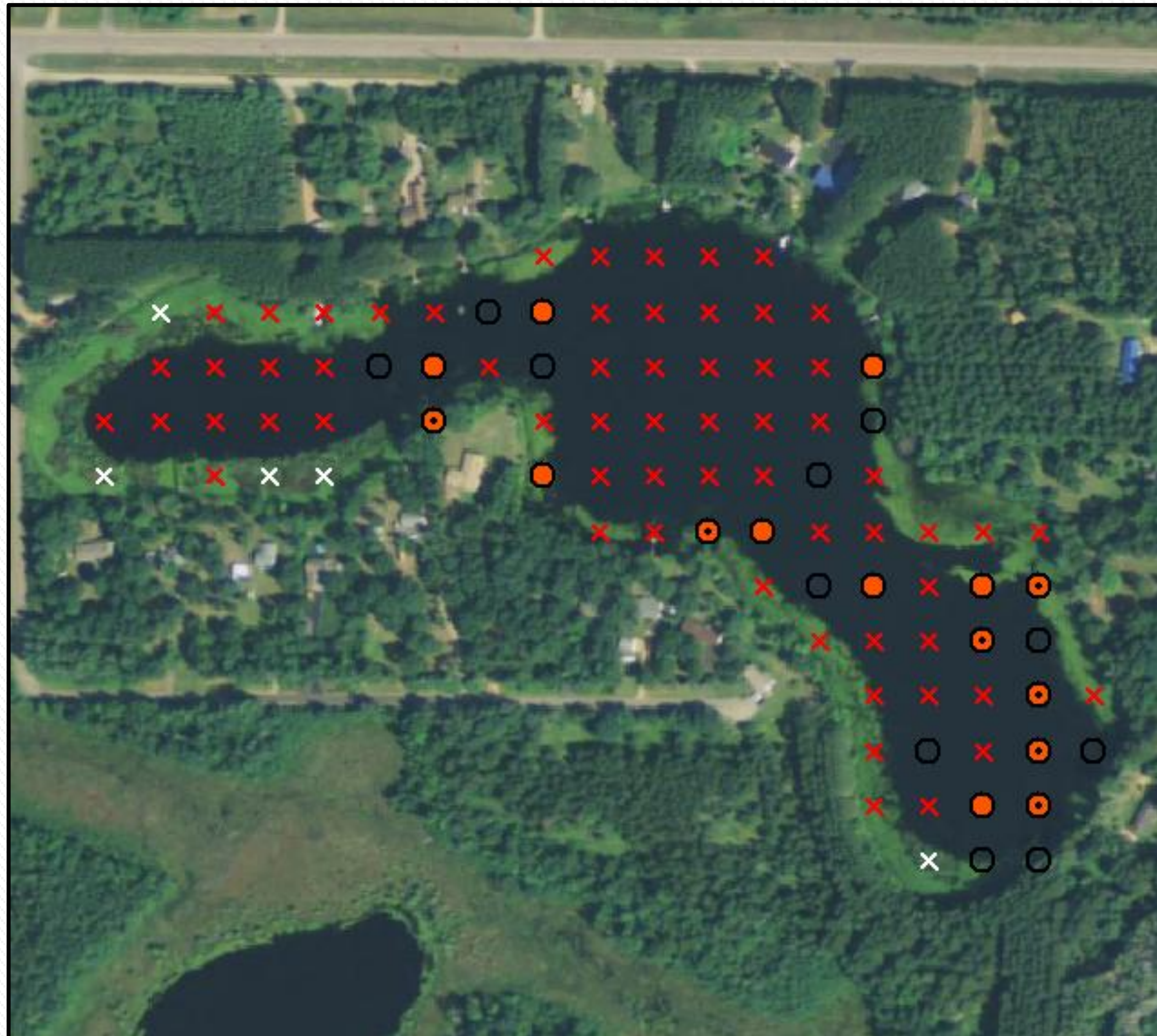


Figure 23. Distribution of plant species, Mable Lake (2011).

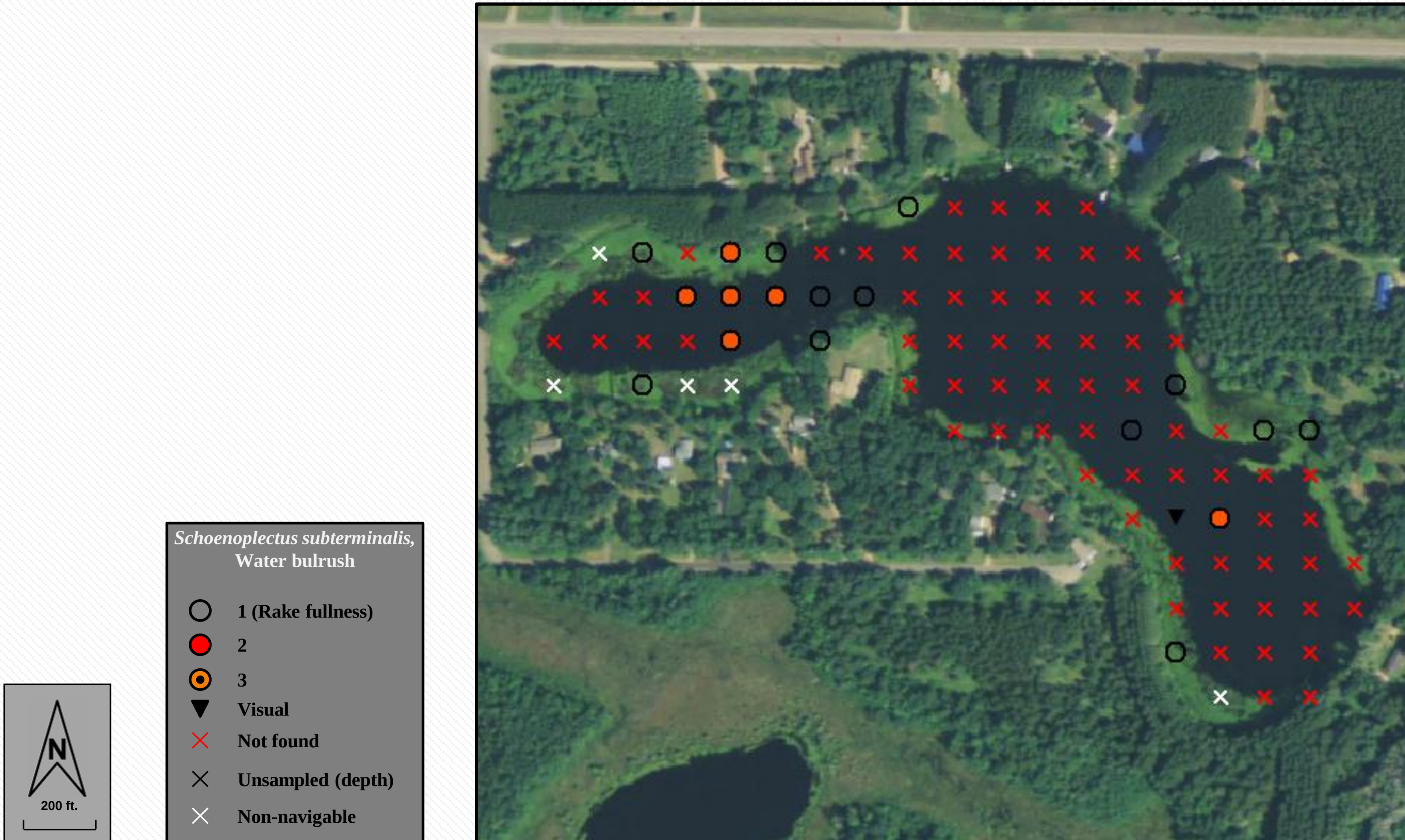


Figure 24. Distribution of plant species, Mable Lake (2011).

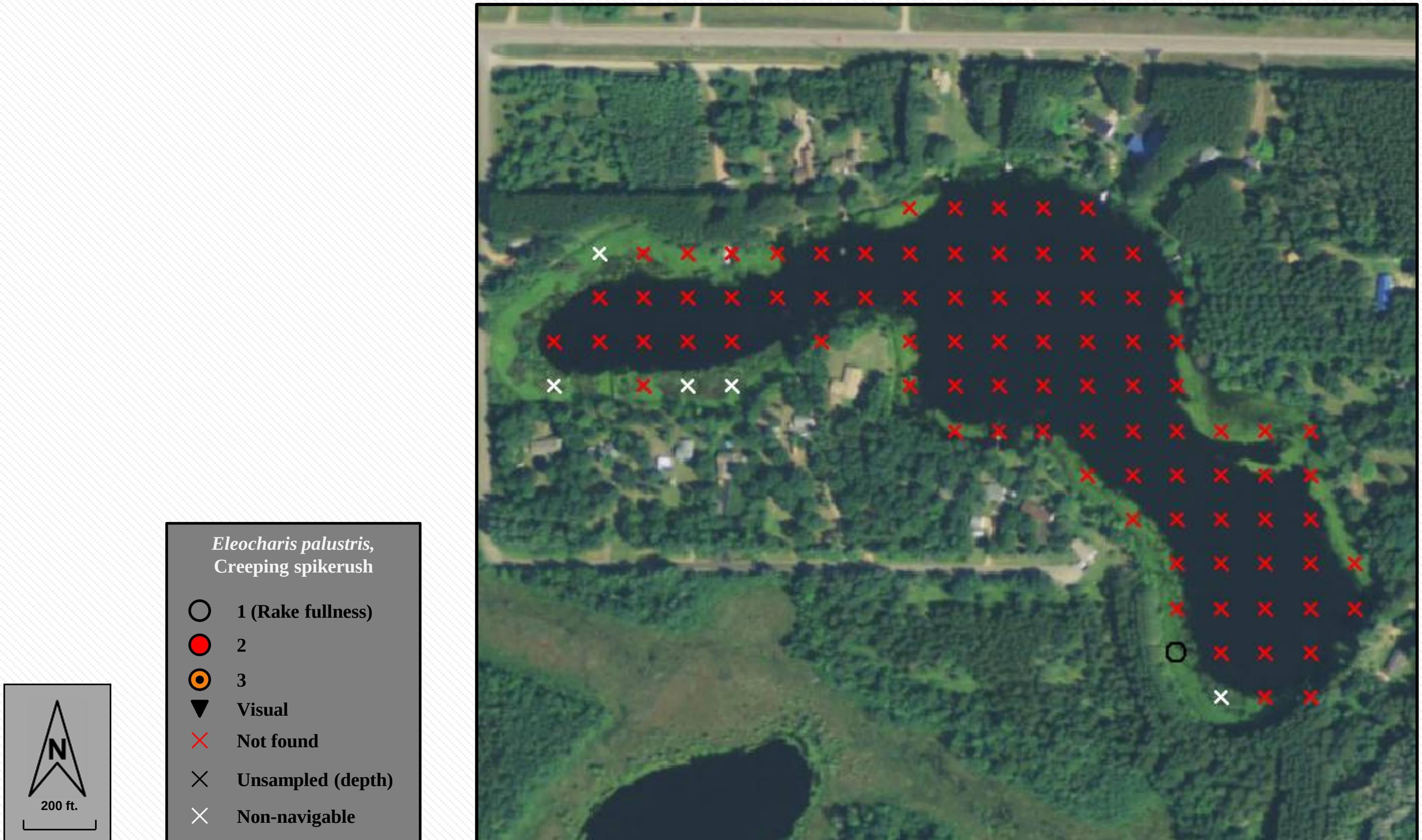


Figure 25. Distribution of plant species, Mable Lake (2011).

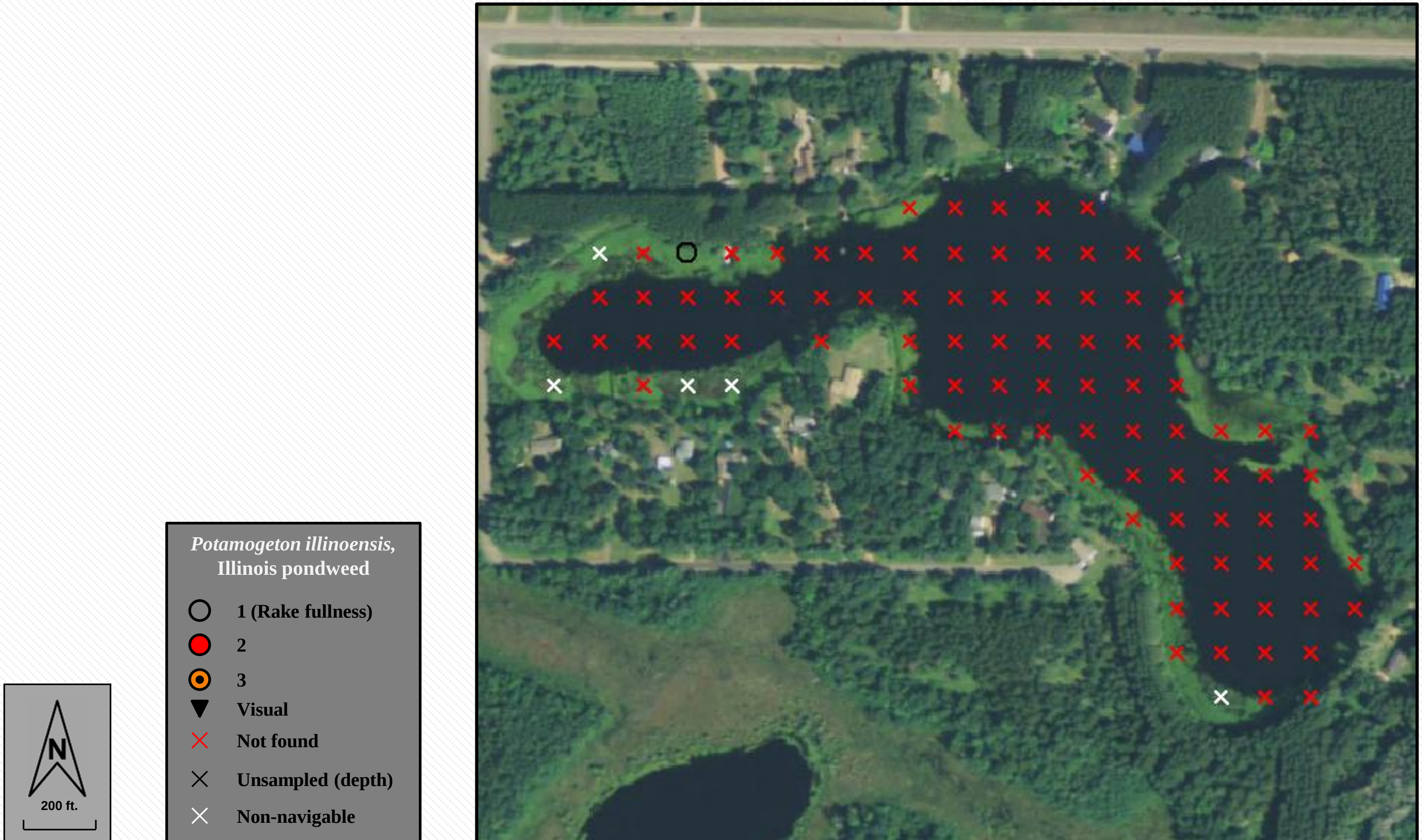
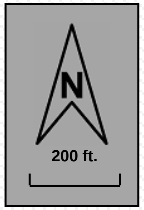
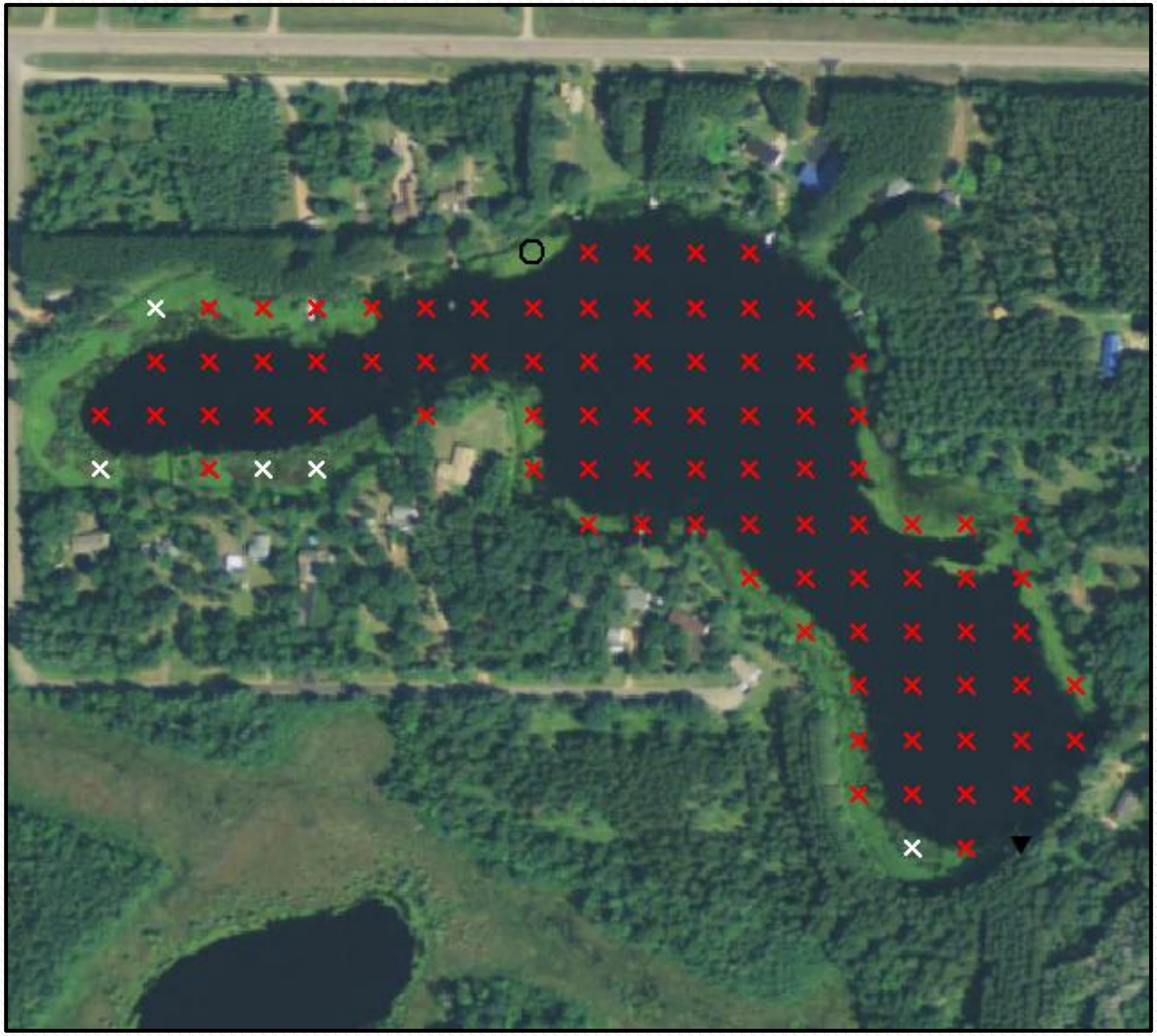


Figure 26. Distribution of plant species, Mable Lake (2011).



Potamogeton spirillus, Spiral-fruited pondweed

- 1 (Rake fullness)
- 2
- 3
- Visual
- Not found
- Unsampled (depth)
- Non-navigable



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Appendix 3

Review of Lake Water Quality

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Review of Mable Lake Water Quality

Prepared by Angie Stine, B.S., and Caitlin Clarke, B.S., White Water Associates, Inc.

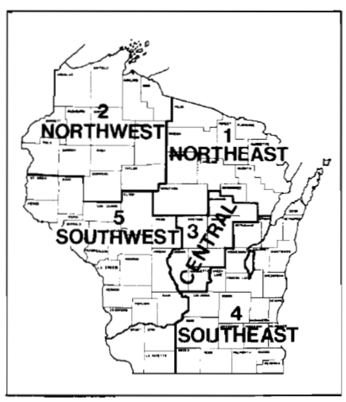
Introduction

Mable Lake is located Lincoln County, Wisconsin. It is a 25 acre seepage lake with a maximum depth of 25 feet. The Waterbody Identification Code (WBIC) is 995300. The purpose of this study is to develop baseline data. Our goal is to collect existing water quality data and continue to monitor Mable Lake for a comparison of environmental and human changes. Existing water quality information includes data from the WDNR SWIMS database from 2009 to present, with the water quality data coming from Citizen Lake Monitoring Network (CLMN) volunteers.

Comparison of Mable Lake with other datasets

Lillie and Mason's *Limnological Characteristics of Wisconsin Lakes* (1983) is a great source to compare lakes within our region to a subset of lakes that have been sampled in Wisconsin. Wisconsin is divided into five regions of sampling lakes. Mable Lake is in the Northeast Region (Figure 1) and was among 243 lakes randomly selected and analyzed for water quality.

Figure 1. Wisconsin regions in terms of water quality.



Temperature

Measuring the temperature of a lake at different depths will determine the influence it has on the physical, biological, and chemical aspects of the lake. Lake water temperature influences the rate of decomposition, nutrient recycling, lake stratification, and dissolved oxygen (D.O.) concentration. Temperature can also affect the distribution of fish species throughout a lake. Because temperature data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Dissolved Oxygen

The dissolved oxygen (D.O.) content of lake water is vital in determining presence of fish species and other aquatic organisms. Dissolved oxygen also has a strong influence on the chemical and physical conditions of a lake. The amount of dissolved oxygen is dependent on the water temperature, atmospheric pressure, and biological activity. Oxygen levels are increased by aquatic plant photosynthesis, but reduced by respiration of plants, decomposer organisms, fish, and invertebrates. The amount of dissolved oxygen available in a lake, particularly in the deeper parts of a lake, is critical to overall health. Because dissolved oxygen data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Water Clarity

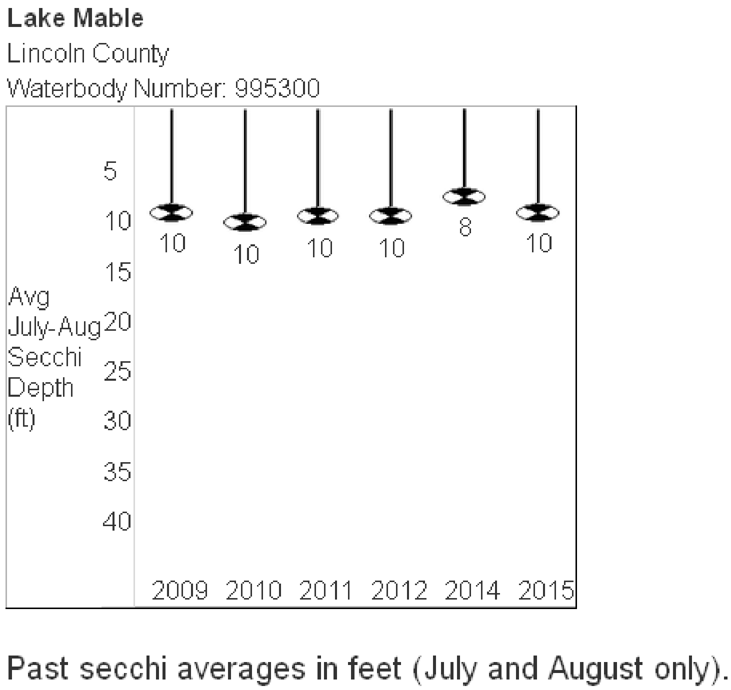
Water clarity has two main components: turbidity (suspended materials such as algae and silt) and true color (materials dissolved in the water) (Shaw et al., 2004). Water clarity gives an indication of the overall water quality in a lake. Water clarity is typically measured using a Secchi disk (black and white disk) that is lowered into the water column on a tether. In simple terms, the depth at which the disk is no longer visible is recorded as the Secchi depth.

Figure 2 shows the July and August mean Secchi depths from 2009 to 2015. The shallowest mean Secchi depth was 8 feet in 2014, and the deepest mean depth was at 10.5 feet in 2010 (Figure 3). According to Table 1, Mable Lake is considered "good" with respect to 2015 water clarity. For Northeastern Wisconsin Lakes the average Secchi depth was 8.86 feet and for Wisconsin natural lakes it was 7.87 feet.

Table 1. Water clarity index (Shaw et al., 2004).

Water clarity	Secchi depth (ft.)
Very poor	3
Poor	5
Fair	7
Good	10
Very good	20
Excellent	32

Figure 2. Mable Lake Secchi depth averages (July and August only).



Past secchi averages in feet (July and August only).

(WDNR, 2016)

Figure 3. Mable Lake's July and August Secchi Data (2009-2015).

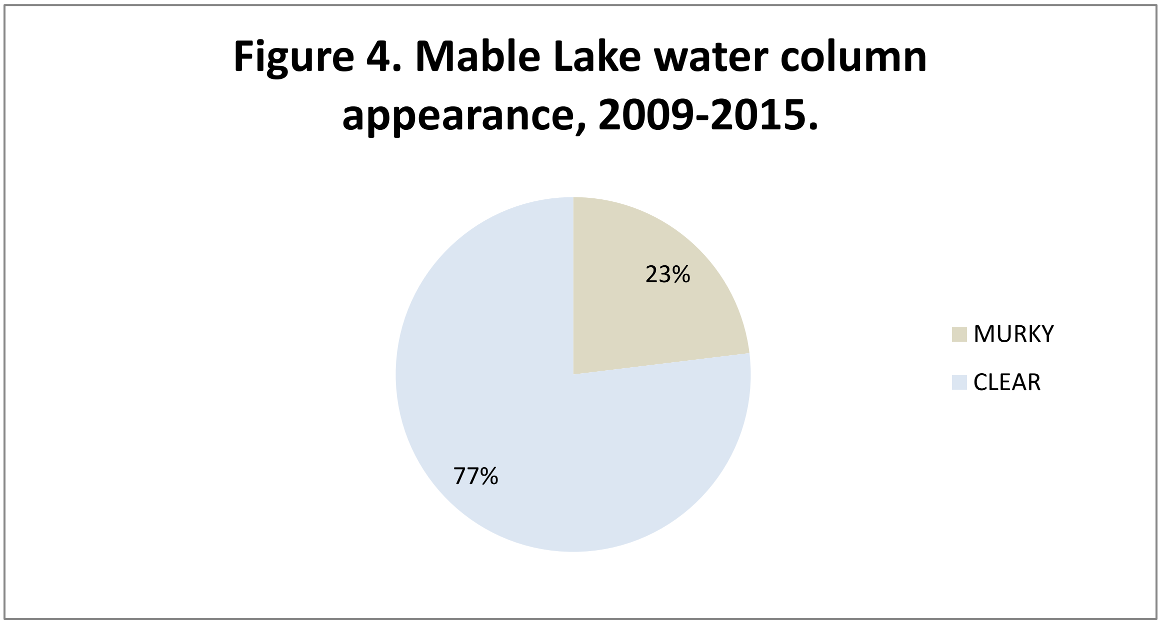
Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
2009	9.67	9.25	10.25	3
2010	10.5	10.25	11	3
2011	10	10	10	1
2012	10	10	10	1
2014	8	8	8	1
2015	9.67	9	10	3

(WDNR, 2016)

Turbidity

Turbidity is another measure of water clarity, but is caused by suspended particulate matter rather than dissolved organic compounds (Shaw et al., 2004). Particles suspended in the water dissipate light and reduce the depth at which the light can penetrate. This affects the depth at which plants can grow. Turbidity also affects the aesthetic quality of water. Water that runs off the watershed into a lake can increase turbidity by introducing suspended materials. Turbidity caused by algae is the most common reason for low Secchi readings (Shaw et al., 2004). In terms of biological health of a lake ecosystem, measurements less than 10 Nephelometric Turbidity Units (NTU) represent healthy conditions for fish and other organisms. Because turbidity data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

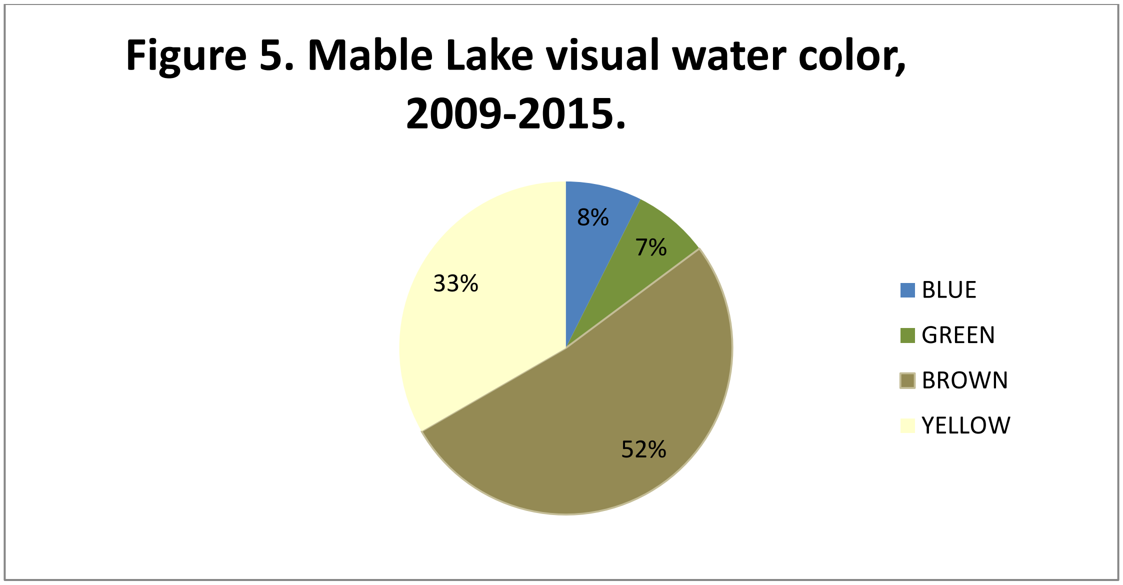
CLMN volunteers rated water clarity and described the water as “clear” or “murky.” Since 2009, 77% of volunteers described the water as “clear” (Figure 4).



Water Color

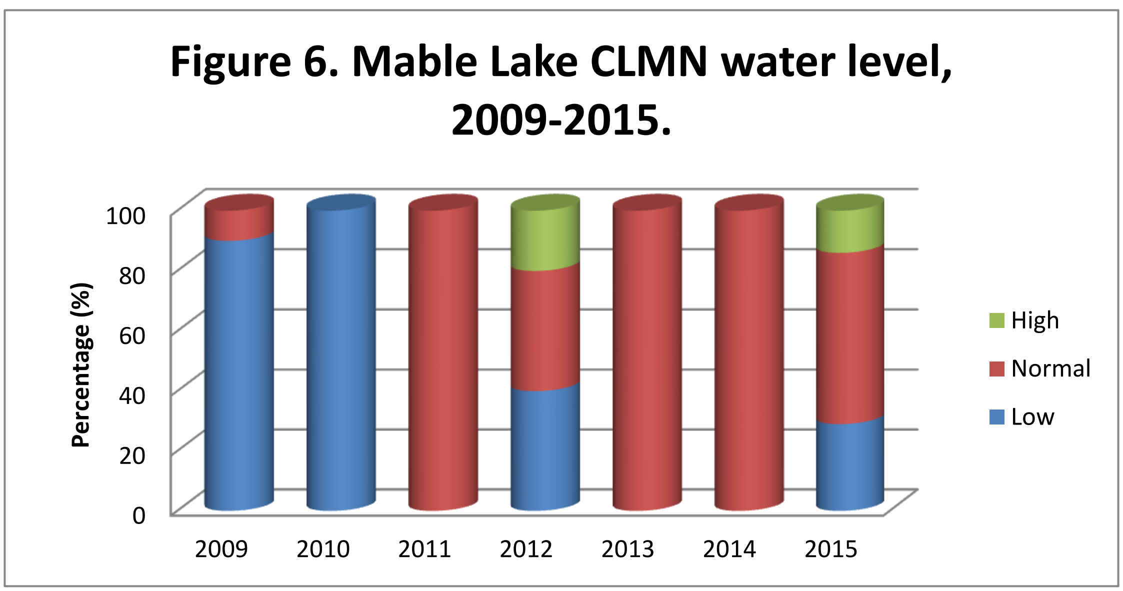
Color of lake water is related to the type and amount of dissolved organic chemicals. Its main significance is aesthetics, although it may also influence light penetration and in turn affect aquatic plant and algal growth. Many lakes have naturally occurring color compounds from decomposition of plant material in the watershed (Shaw et al., 2004). Units of color are determined from the platinum-cobalt scale and are therefore recorded as Pt-Co units. Shaw states that a water color between 0 and 40 Pt-Co units is low. Because water color data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

CLMN volunteers also provided their opinion on the water color and recorded it as “blue,” “green,” “brown,” or “yellow.” The majority of volunteers viewed Mable Lake water as “brown” (Figure 5).



Water Level

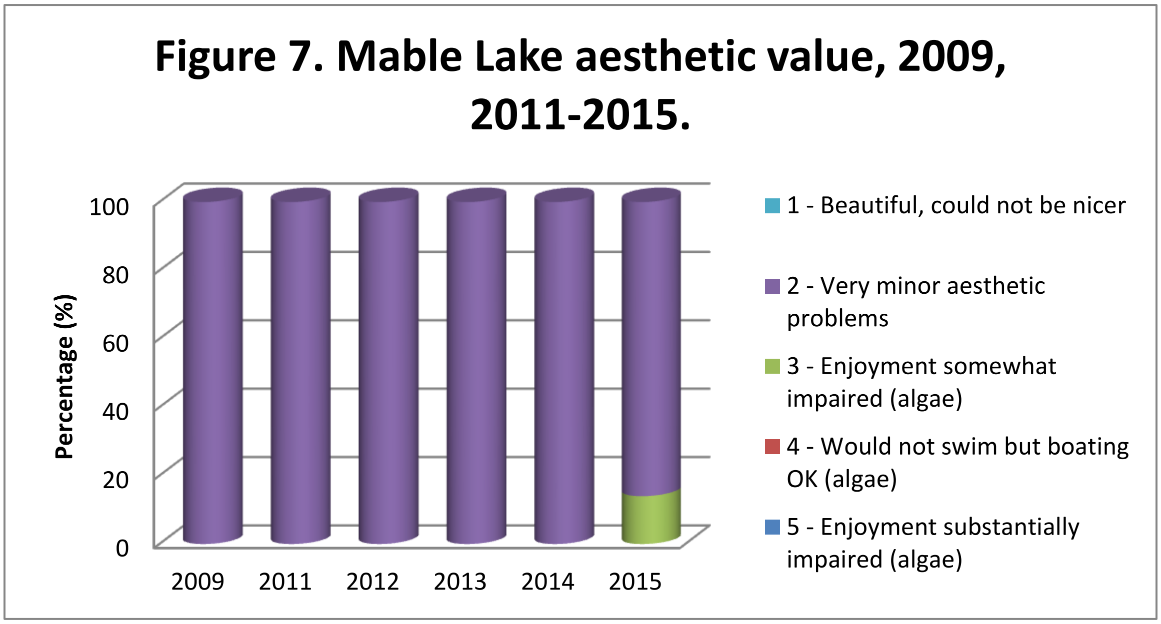
CLMN volunteers also recorded their perception of lake level. Figure 6 shows that in 2011, 2013, and 2014, 100% of volunteers viewed Mable Lake as having "normal" water levels. In 2010, all volunteers viewed the water levels as "low."



User Perceptions

CLMN also recorded their perceptions of the water, based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake user would experience the lake at that time. These perceptions of recreational suitability are displayed by year in

Figure 7. From 2009-2014, 100% of CLMN volunteers recorded Mable Lake as having "very minor aesthetic problems."



Chlorophyll *a*

Chlorophyll *a* is the photosynthetic pigment that makes plants and algae green. Chlorophyll *a* in lake water is an indicator of the amount of algae. Chlorophyll *a* concentrations greater than 10 µg/L are perceived as a mild algae bloom, while concentrations greater than 20 µg/L are perceived as a nuisance. Because chlorophyll *a* data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Phosphorus

In more than 80% of Wisconsin's lakes, phosphorus is the key nutrient affecting the amount of algae and plant growth. If phosphorus levels are high, excessive aquatic plant growth can occur.

Phosphorus originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland or lawns (Shaw et al., 2004). Phosphorus provokes complex reactions in lakes. An analysis of phosphorus often includes both soluble reactive phosphorus and total phosphorus. Soluble reactive phosphorus dissolves in the water and directly influences plant growth (Shaw et al., 2004). Its concentration varies in most lakes over short periods of time as plants take it up and release it. Total phosphorus is considered a better indicator of a lake's nutrient status than soluble reactive phosphorus because its levels remain more stable (Shaw et al., 2004). Total phosphorus includes soluble phosphorus and the phosphorus in plant and animal fragments suspended in lake water. Ideally, soluble reactive phosphorus concentrations should be 10 µg/L or less at spring turnover to prevent summer algae blooms (Shaw et al., 2004). A concentration of total phosphorus below 20 µg/L for lakes should be maintained to prevent nuisance algal blooms (Shaw et al., 2004). Because phosphorus data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Trophic State

Trophic state is another indicator of water quality (Carlson, 1977). Lakes can be divided into three categories based on trophic state – oligotrophic, mesotrophic, and eutrophic. These categories reflect a lake's nutrient and clarity levels (Shaw et al., 2004).

Researchers use various methods to calculate the trophic state of lakes. Common characteristics used to make the determination are: total phosphorus (important for algae growth), chlorophyll *a* concentration (a measure of the amount of algae present), and Secchi disk readings (an indicator of water clarity) (Shaw et al., 2004) (Table 2).

Table 2. Trophic classification of Wisconsin Lakes based on chlorophyll *a*, water clarity measurements, and total phosphorus values (Shaw et al., 2004).

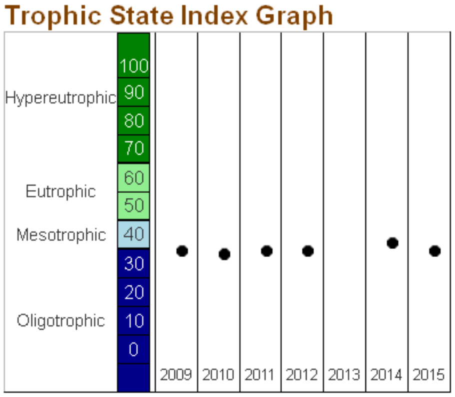
Trophic class	Total phosphorus µg/L	Chlorophyll *a* µg/L	Secchi Disk (ft.)
Oligotrophic	3	2	12
	10	5	8
Mesotrophic	18	8	6
	27	10	6
Eutrophic	30	11	5
	50	15	4

Trophic State Index (TSI) was calculated by the WDNR using only Secchi measurements collected from the CLMN. The July and August average TSI were consistent in sampled years (Figure 8), classifying Mable Lake as "mesotrophic" (Table 3).

Table 3. Trophic State Index.	
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

(WDNR, 2016)

Figure 8. Mable Lake, Trophic State Index (2009-2015).



Monitoring Station: Lake Mable - Deep Hole, Lincoln County
Past Summer (July-August) Trophic State Index (TSI) averages.

● = Secchi ■ = Chlorophyll ▲ = Total Phosphorus

TSI(Chl) = TSI(TP) = TSI(Sec)	It is likely that algae dominate light attenuation.
TSI(Chl) > TSI(Sec)	Large particulates, such as Aphanizomenon flakes dominate
TSI(TP) = TSI(Sec) > TSI(Chl)	Non-algal particulate or color dominate light attenuation
TSI(Sec) = TSI(Chl) >= TSI(TP)	The algae biomass in your lake is limited by phosphorus
TSI(TP) > TSI(Chl) = TSI(Sec)	Zooplankton grazing, nitrogen, or some factor other than phosphorus is limiting algae biomass

(WDNR, 2016)

Nitrogen

Nitrogen is second only to phosphorus as an important nutrient for aquatic plant and algae growth (Shaw et al., 2004). Human activities on the landscape greatly influence the amount of nitrogen in a lake. Nitrogen may come from lawn fertilizer, septic systems near the lake, or from agricultural activities in the watershed. Nitrogen may enter a lake from surface runoff or groundwater sources.

Nitrogen exists in lakes in several forms. Nitrogen is a major component of all organic (plant and animal) matter. Decomposing organic matter releases ammonia, which is converted to nitrate if oxygen if present (Shaw et al., 2004). All inorganic forms of nitrogen can be used by aquatic plants and algae (Shaw et al., 2004). If these inorganic forms of nitrogen exceed 0.3 mg/L (as N) in spring, there is sufficient nitrogen to support summer algae blooms (Shaw et al., 2004). Elevated concentrations of ammonium, nitrate, and nitrite, derived from human activities, can stimulate or enhance the development, maintenance and proliferation of primary producers (phytoplankton, benthic algae, marcrophytes), contributing to the widespread phenomenon of the cultural (human-made) eutrophication of aquatic ecosystems (Camargo et al., 2007). The nutrient enrichment can cause important ecological effects on aquatic communities, since the overproduction of organic matter, and its subsequent decomposition, usually lead to low dissolved oxygen concentrations in bottom waters, and sediments of eutrophic and hypereutrophic aquatic ecosystems with low turnover rates (Camargo et al., 2007). Because nitrogen data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Chloride

The presence of chloride (Cl^-) where it does not occur naturally indicates possible water pollution (Shaw et al., 2004). Chloride does not affect plant and algae growth and is not toxic to aquatic organisms at most of the levels found in Wisconsin (Shaw et al., 2004). Because chloride data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Sulfate

Sulfate in lake water is primarily related to the types of minerals found in the watershed, and to acid rain (Shaw et al., 2004). Sulfate concentrations are noted to be less than 10 mg/L in the Northeast region (Lillie and Mason, 1983). Because sulfate data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Sodium and Potassium

Sodium and potassium are possible indicators of human pollution in a lake, since naturally occurring levels of these ions in soils and water are very low. Sodium is often associated with chloride, and gets into lakes from road salting, fertilizations, and human and animal waste (Shaw et al., 2004). Potassium is the key component of commonly-used potash fertilizer, and is abundant in animal waste. Both of these elements are held by soils to a greater extent than is chloride or nitrate; therefore, they are not as useful as indicators of pollution impacts (Shaw et al., 2004). Although not normally toxic themselves, they provide a strong indication of possible contamination by more damaging compounds (Shaw et al., 2004). Because sodium and potassium data are unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Conductivity

Conductivity is a measure of the ability of water to conduct an electric current. Conductivity is reported in micromhos per centimeter **(**µmhos/cm) and is directly related to the total dissolved inorganic chemicals in the water. Usually, values are approximately two times the water hardness, unless the water is receiving high concentrations of human-induced contaminants (Shaw et al., 2004). Because conductivity data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

pH

The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is considered neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid, bog lakes to 8.4 in hard water lakes (Shaw et al., 2004). Natural rainfall in Wisconsin averages a pH of 5.6. Some minerals become available under low pH (especially aluminum, zinc, and mercury) and can inhibit fish reproduction or survival. Mercury and aluminum are not only toxic to many kinds of wildlife, but also to humans (especially those that eat tainted fish). The pH scale is logarithmic, so every 1.0 unit change in pH increases the acidity tenfold. Water with a pH of 6 is 10 times more acidic than water with pH of 7. A lake's pH level is important for the release of potentially harmful substances and affects plant growth, fish reproduction and survival. A lake with neutral or slightly alkaline pH is a good lake for fish and plant survival. Because pH data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Table 4 indicates the effects pH levels less than 6.5 will have on fish. While moderately low pH does not usually harm fish, the metals that become soluble under low pH can be important. In low pH waters, aluminum, zinc, and mercury concentrations increase if they are present in lake sediment or watershed solids (Shaw et al., 2004).

Table 4. Effects of acidity on fish species (Olszyk, 1980).

Water pH	*Effects*
6.5	Walleye spawning inhibited
5.8	Lake trout spawning inhibited
5.5	Smallmouth bass disappear
5.2	Walleye & lake trout disappear
5	Spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	Perch spawning inhibited
3.5	Perch disappear
3	Toxic to all fish

Alkalinity

Alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water and these materials (Shaw et al., 2004). Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. Acid rain has long been a problem with lakes that have low alkalinity levels and high potential sources of acid deposition. Because alkalinity data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter. Table 5 is the sensitivity of lakes to acid rain.

Table 5. Sensitivity of Lakes to Acid Rain (Shaw et al., 2004).

Sensitivity to acid rain	***Alkalinity value (mg/L or ppm $CaCO_3$)***
High	0-2
Moderate	2-10
Low	10-25
Non-sensitive	>25

Hardness

Hardness levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water and these materials (Shaw et al., 2004). One method of evaluating hardness is to test for calcium carbonate ($CaCO_3$). Hardness data is unknown for Mable Lake, so future water quality sampling should include measurement of this parameter.

Calcium and Magnesium 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 (Shaw et al., 2004). Calcium is the most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-bearing minerals in the lake watershed (Shaw et al., 2004). Aquatic organisms such as native mussels use calcium in their shells. The aquatic invasive zebra mussel tends to need calcium levels greater than 20 mg/L to maintain shell growth and is borderline suitable at >10 mg/L. Because calcium and magnesium data is unknown for Mable Lake, future water quality sampling could include measurement of this parameter.

Sodium and Potassium

Sodium and potassium are possible indicators of human pollution in a lake, since naturally occurring levels of these ions in soils and water are very low. Sodium is often associated with chloride and gets into lakes from road salting, fertilizations, and human and animal waste (Shaw et al., 2004). Potassium is the key component of commonly-used potash fertilizer, and is abundant in animal waste. Both of these elements are held by soils to a greater extent than is chloride or nitrate; therefore, they are not as useful as indicators of pollution impacts (Shaw et al., 2004). Although not normally toxic themselves, they provide a strong indication of possible contamination by more damaging compounds (Shaw et al., 2004). Because sodium and potassium data are unknown for Mable Lake, future water quality sampling should include measurement of this parameter.

Dissolved Organic Carbon

Dissolved Organic Carbon (DOC) is a food supplement, supporting growth of microorganisms, and plays an important role in global carbon cycle through the microbial loop (Kirchman et al., 1991). In general, organic carbon compounds are a result of decomposition processes from dead organic matter such as plants. When water contacts highly organic soils, these components can drain into rivers and lakes as DOC. DOC is also extremely important in the transport of metals in aquatic systems. Metals form extremely strong complexes with DOC, enhancing metal solubility while also reducing metal bioavailability. Baseflow concentrations of DOC in undisturbed watersheds generally range from 1 to 20 mg/L carbon. Mable Lake DOC has not been tested, and should be included in future water quality sampling.

Silica

The earth's crust is abundant with silicates or other compounds of silicon. The water in lakes dissolves the silica and pH can be a key factor in regulating the amount of silica that is dissolved. Silica concentrations are usually within the range of 5 to 25 mg/L. Generally lakes that are fed by groundwater have higher levels of silica. Because silica data is unknown for Mable Lake, future water quality sampling should include measurement of this parameter.

Aluminum

Aluminum occurs naturally in soils and sediments. In low pH (acidic) environments aluminum solubility increases greatly. With a low pH and increased aluminum values, fish health can become impaired. This can have impacts on the entire food web. Aluminum also plays an important role in phosphorus cycling in lakes. When aluminum precipitates with phosphorus in lake sediments, the phosphorus will not dissolve back into the water column as readily. Because aluminum levels are unknown in Mable Lake, future water quality sampling should include measurement of this parameter.

Iron

Iron also forms sediment particles that store phosphorus when dissolved oxygen is present. When oxygen concentration gets low (for example, in winter or in the deep water near sediments) the iron and phosphorus dissolve in water. This phosphorus is available for algal blooms. Mable Lake iron levels have not been tested, and should be included in future water quality sampling.

Manganese

Manganese is a mineral that occurs naturally in rocks and soil. In lakes, manganese is usually in particulate form. When the dissolved oxygen levels decrease, manganese can convert from an insoluble form to soluble ions. A manganese concentration of 0.05 mg/L can cause color and staining problems. Manganese data is unknown for Mable Lake, so future water quality sampling should include this parameter.

Sediment

Lake bottom sediments are sometimes analyzed for chemical constituents that they contain. This is especially true for potentially toxic metals such as mercury, chromium, selenium, and others. Lake sediments also tend to record past events as particulates settle down and become part of the sediment. Biological clues for the historic conditions in the lake can be gleaned from sediment samples. Examples include analysis of pollen or diatoms that might help understand past climate or trophic states in the lake. Sediment data was not collected for Mable Lake, and future sampling should include this parameter.

Total Suspended Solids

Total suspended solids are all particles suspended in lake water. Silt, plankton, and wastes are examples of these solids and can come from runoff of agricultural land, erosion, and can be produced by bottom-feeding fish. As the suspended solid levels increase, they absorb heat from sunlight which can increase the water temperature. They can also block the sunlight that plants need for photosynthesis. These events can in turn affect the amount of dissolved oxygen in the lake. Lakes with total suspended solids levels less than 20 mg/L are considered “clear,” while levels between 40 and 80 mg/L are “cloudy.” Because total suspended solids data is unknown for Mable Lake, future water quality sampling should include measurement of this parameter.

Aquatic Invasive Species

As described in the *Mable Lake Aquatic Plant Management Plan*, Eurasian water-milfoil (EWM) was discovered in Mable Lake in 2010. In summer 2011, the WDNR conducted a point-intercept study to record plants found in the lake's plant community. In fall 2011, four EWM plants were removed by hand-pulling. The Mable Lake Association applied for and received a Rapid Response Grant which allowed for a second point-intercept study and additional EWM hand-removal efforts. This work was conducting in 2015 and will continue in subsequent seasons. For more information about the Eurasian water-milfoil found in Mable Lake, see the *Mable Lake Aquatic Plant Management Plan*.

The University of Wisconsin-Madison's Aquatic Invasive Species Smart Prevention program classifies Mable Lake as "borderline suitable" for zebra mussels, based on calcium and conductivity levels found in the lake (UW-Madison). No zebra mussels have been found in Mable Lake.

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