The Margaret Lake Adaptive Management Plan

(Piehl Township, Oneida County, Wisconsin)

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Margaret Lake (looking north from boat landing) - Dean Premo photo.

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WHITE WATER ASSOCIATES, INC.

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TABLE OF CONTENTS

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CHAPTER 1

What Is the Margaret Lake Adaptive Management Plan?

The *Margaret Lake Adaptive Management Plan* results from a large-scale project funded by a Wisconsin Department of Natural Resources (WDNR) Lake Planning Grant. The project was submitted by the Margaret Lake Association (MLA). White Water Associates, Inc., an independent ecological consulting firm and environmental laboratory, served as a consultant to the MLA.

Project participants have embraced the concept of "adaptive management" in their approach to Margaret Lake stewardship. Simply stated, adaptive management uses findings from planned monitoring activities to inform future management actions and periodic refinement of the plan. An adaptive management plan accommodates new findings by integrating this information into successive iterations of the comprehensive plan. The plan will therefore be a dynamic entity, successively evolving and improving to fit the needs of Margaret Lake Stewardship Program and the MLA. A central premise of adaptive management is that scientific knowledge about natural ecosystems is uncertain and incomplete. It follows that a practical management plan allows for ongoing adjustments in management designed to "adapt" to changing conditions and new information or understanding. Monitoring the outcomes of plan implementation is essential to the process of adaptive management. It is the goal of the Margaret Lake Stewardship Program and the MLA to plan that future monitoring will focus on tangible indicators.

It is appropriate that the MLA is the lead organization in the implementation of this plan. MLA is comprised of people who care very much about Margaret Lake. Successful implementation of the plan depends on a coalition of participants, each carrying out appropriate tasks and communicating needs and findings to other team members. Future projects and ongoing monitoring results will inspire updates to the plan. The overall vision of the MLA is a healthy, sustainable Margaret Lake. This plan is an important tool to realize that vision.

Besides this introductory chapter, this plan is organized in seven additional chapters. Chapter 2 describes the audience for the *Margaret Lake Adaptive Management Plan*. Chapter 3 addresses why there should be a plan and discusses adaptive management and the underlying assumptions of the approach. Chapter 4 details how the plan was created, including the

methodology used. Chapter 5 presents the findings from efforts to gather existing and new information about Margaret Lake and its environs by providing summaries of information in eleven subsections. Chapter 6 (*What Goals Guide the Plan?*) presents the desired future condition and goals established by the Margaret Lake Association and the plan writers. Chapter 7 (*What Objectives and Actions Move Us Toward the Goals?*) offers a logical menu of practical management actions ready to be adopted and adapted by those interested in taking an active role in caring for Margaret Lake and its surroundings. Eleven appendices complete this document. Appendix A contains the *Literature Cited.* Appendix B contains the *Margaret Lake Aquatic Plant Management Plan*. Appendix C presents the *Margaret Lake Review of Water Quality*. Appendix D includes the *Margaret Lake Watershed, Water Quality, and WiLMS Modeling*. Appendix E encompasses the *Margaret Lake EPA Littoral and Shoreline Survey*. Appendix F is the *Summary of Margaret Lake Shoreline Photo Survey*. Appendix G presents the *Margaret Lake Fisheries Report.* Appendix H is a description of the *Margaret Lake Stewardship Program Volunteer Anglers' Journal Report.* Appendix I provides information about the *Margaret Lake Frog and Toad Survey.* Appendix J consists of the *Review of Water Regulations and Planning Relevant to Margaret Lake.* Finally, Appendix K reviews the *Lake User Survey* for Margaret Lake.

CHAPTER 2

Who Is the Audience for the Margaret Lake Adaptive Management Plan?

The title of Chapter 3 poses the question: "Why Have the *Margaret Lake Adaptive Management Plan*?" The short answer is "Because we care!" We believe that people working together in the stewardship of this lake can make a difference. We can protect and restore a healthy ecosystem if we take a long-term, strategic approach. That approach is presented in this adaptive plan. It is an adaptive plan in the sense that it will grow and evolve. Implemented actions will be monitored. The plan will be evaluated. It will be reviewed and refined as years go by – as new generations take up their stewardship responsibility.

People who care about the Margaret Lake Watershed are the most direct audience for this plan. They will be the implementers and evaluators. They will be the reviewers and future plan writers. Many of them live in or near the watershed. These are the "grassroots" – the constituency most connected to Margaret Lake and its surroundings. People who care are also those who live beyond the watershed boundaries. Some of these people visit Margaret Lake for recreation and enjoyment. But the audience also includes foundations and other funding agencies, resource and regulatory agencies concerned with environmental quality, and other citizens that are working on their watersheds.

For those in the "grassroots" camp, this plan is intended to provide a practical approach to carrying out protection and restoration of Margaret Lake and other regional waters. The plan does not have all the answers (it doesn't even have all the questions). It does not recommend every conceivable rehabilitation or protection action. But the plan does provide plenty with which to get started and it leaves room for ideas and contributions from others. Our recipe mixes a pinch of the theoretical with a cupful of the practical. Those of you who are "hands-on" have plenty to do.

The mixed audience of this plan challenges the authors to present a plan that is scientifically grounded and technically oriented, but at the same time accessible and understandable by the public who will in large part be responsible for its implementation. Although scientists are the primary authors of the plan, the writing is aimed at non-scientists. We define terms where clarity is needed and cite other literature for those interested in the source of a statement, or in learning more about the topic. The MLA has interacted with the plan writers

throughout the process and reviewed draft components of the plan. The MLA has encouraged our practical approach so that applications of the plan are conspicuous.

We will end this chapter with our strongest management recommendation:

Approach lake and watershed management with humility.

Lake and watershed ecosystems are enormously complex. Our understanding of how they work is not complete. This is even truer when aquatic invasive species are part of the mix. Our ability to predict outcomes from specific actions is uncertain. New discoveries are made every day that have important implications for future watershed management. We may never know all we need, but that fact can't stop us from starting work on Margaret Lake today. The fact that ecosystems are inherently resilient is to our great advantage. They are able to rebound from disturbance and repair themselves from injury. In fact, some of today's best watershed managers state that "...successful restoration usually has less to do with skillful manipulation of ecosystems than it does with staying out of nature's way" (Williams et al., 1997). This plan is intended to complement nature's own processes.

CHAPTER 3

Why Have the Margaret Lake Adaptive Management Plan?

Why have the *Margaret Lake Adaptive Management Plan*? The gut-level answer ("because we care") was offered in Chapter 2, but the question deserves more thoughtful reflection – the focus of this chapter. This requires consideration of environment, economy, history, and culture. This chapter also defines some important terms and presents the process and underlying assumptions.

Part 1 - Why Should We Care?

The health of a watershed and the health of local economies like those that exist in the Margaret Lake Watershed are highly integrated. A sustainable economy depends on a healthy environment. In fact all social and economic benefits are based on the biological and physical properties of watersheds (Williams et al., 1997). In fact, our economy should be viewed as being nested inside our environment (Lanoo, 1996).

This link between a healthy environment and the economy is true at several scales. For example, most property owners on Margaret Lake have invested in an ecosystem. The reasons that they have purchased the property are typically linked to the quality of the environment. The economic value of their investment is linked to the health of lake and surroundings. If ecological health declines, so does the value of the property.

At a slightly larger scale, this same principal linking the environment and economy applies to municipalities. The community is caretaker of many ecosystems including Margaret Lake. The long-term economic health of the municipality is tied to the health of Margaret Lake and other lakes and streams in the area. At even larger scales yet, this applies to Piehl Township, Oneida County, to the State of Wisconsin, and so on.

The Margaret Lake Association and this plan aspire to cultivate a deep connection to the lake and its surroundings. It is the people of the watershed that will make the management plan work. Lake and watershed stewardship must be a cultural imperative. In some ways, watershed restoration is about cultural restoration – rejuvenating citizens' civic responsibility to care for the environment in which they live. This is what Aldo Leopold referred to as "...the oldest task in human history: to live on a piece of land without spoiling it" (Leopold, 1948).

People need to feel vital by working to improve, beautify, or build. Sometimes that need is expressed by gardening, caring for a lawn, or volunteering on civic projects. The MLA and this plan endeavor to harness that energy and apply it to restoration and protection actions focused on Margaret Lake and its landscape. Education, rehabilitation, and protection become outlets for this creative energy.

Why should you care about creating and implementing a practical resource plan? Because we realize the economy and the economic options available to citizens in the watershed are tied to a healthy environment. Because we are all connected to the Margaret Lake landscape in some way. Because we feel a civic responsibility to care for the lake. Because we realize Margaret Lake potentially affects other lakes. Because we can feel vital by doing meaningful work in the watershed. Because future generations depend on us to hand down a healthy Margaret Lake ecosystem for them to enjoy and use.

The adaptive management plan will be successful if it allows and organizes meaningful stewardship work for Margaret Lake. It needs to make provision for different kinds of approaches and different kinds of people who want to be part of the process. It has to be strategic and integrated so that various actions complement one another, and are consistent with the lake's natural processes. The plan should help avoid management actions that work at cross-purposes or whose outcomes are undesirable.

Part 2 - What Is an Adaptive Management Plan?

An adaptive management process (Walters, 1986) is an appropriate model to use in lake and watershed management. In adaptive management, a plan is made and implemented based on the best available information and well-defined goals and objectives. Outcomes of management actions are monitored to ascertain whether they are effective in meeting stated goals and objectives. Based on this evaluation the plan is adapted (modified) in a process of continuous learning and refining.

Adaptive management concedes and confronts a truth that resource managers are sometimes reluctant to acknowledge – uncertainty. Because natural systems are so diverse, so complex, and so variable, almost all management actions will have uncertain outcomes. An adaptive management approach essentially takes a position that says, "We will make our best attempt and get better as we go along. We'll listen to what the natural system tells us." In adaptive management, monitoring is crucial. Adaptive management uses information from monitoring to continually evaluate and refine management practices. Monitoring measures the success of restoration or management. Well-designed monitoring should indicate how effectively

management measures are working and give us new insights into ecosystem structure and function. Monitoring should provide needed information to adapt management goals.

The *Margaret Lake Adaptive Management Plan* can be implemented through five kinds of management actions: protection, rehabilitation, enhancement, education, and research. Research actions have a special subset called "monitoring actions" that serve all of the management actions. Each kind of action is summarized in the following bullets.

- Protection actions are used when high quality areas or ecosystem elements are identified and need to be safeguarded. Since aspects of Margaret Lake and its surroundings are quite pristine, part of the Margaret Lake adaptive management could fall under this kind of action. There are numerous forms that protection actions can take including protecting water quality, conservation easements, buffer zones to prevent runoff into the lake, etc.
- Rehabilitation actions are those that manipulate site-specific elements of ecosystems in order to repair some past impact. Examples include planting lakeside natural vegetation in areas of erosion, placing fish structure where large woody material has been removed from the lake, or healing an area of active erosion. Individual rehabilitation actions contribute to overall lake and watershed restoration.
- Enhancement actions are intended to improve some function or value of the ecosystem. In some cases, these actions are meant to benefit human users of the lake (for example, enhancing recreation values by planting fish or creating new fish habitat).
- Education actions are those activities that promote lake stewardship and inform people about natural ecosystems. This can include this management plan as an education piece. These actions also include installation of interpretive kiosks or incorporation of Margaret Lake biology in science curriculum of area schools. Every person that visits Margaret Lake is an opportunity for education about healthy ecosystems and impacts to them.
- Research actions are employed to learn about the system being managed. Often we know very little about the plants, animals, habitats, ecosystems, and processes that our management actions are affecting. Research actions on water quality began at Margaret Lake years ago with basic water quality measures and are ongoing today. More recently, surveys for aquatic plants have contributed to our understanding of the Margaret Lake ecosystem. Monitoring actions (a subset of research actions) are those that serve to evaluate the outcomes of protection, rehabilitation, enhancement, and education actions. Monitoring actions guide future management.

One word of caution is warranted. Our society typically thinks a long-term planning horizon is twelve months. Unfortunately, this is out of synchrony with the way an ecosystem functions. An ecological clock ticks off time in years, decades, centuries, and even millennia. Lake and watershed management and restoration must be viewed from this perspective. In fact, the final outcomes of some of the good work put in place today might not be apparent until a new generation of lake stewards is on the scene.

Part 3 - What Are the Plan's Underlying Assumptions?

As an adaptive plan, a basic assumption is that the management actions will change over time under the influence of stakeholders. Through iterative refinement, the plan will more closely reflect the needs of the lake and the people who care about it. This plan has assumed a desired condition of sustainable lake health. The plan attempts to reflect the collective vision of the people and organizations that are concerned with the lake and the surroundings. The MLA, Oneida County Land & Water Conservation Department, the Wisconsin Department of Natural Resources, and those living and recreating in the Margaret Lake watershed are among these stakeholders.

The Oneida County Land & Water Conservation Department provides a variety of land information and related services including: natural resource and water quality protection information, AIS information and assistance, geographic information, rural addressing, Public Land Survey System and surveying data, property ownership and tax assessment information and mapping products. This office can provide important assistance in during subsequent phases of Margaret Lake stewardship.

At a larger geographic scale, the WDNR published the *Headwaters Basin Integrated Management Plan* (WDNR et al., 2002) that provides a snapshot of current conditions of resources in the larger drainage basin that includes Margaret Lake. The Plan outlines nineteen issues of concern to the basin, including control of exotic species, shoreline development, resource inventory and monitoring, habitat loss, user conflicts, and protection of endangered, special concern, or unique species.

The integrating feature of this lake management plan is Margaret Lake and its surroundings. The plan assumes that proper planning in the beginning of the process will save time and money throughout the life of the program and that this can be accomplished by managing the causes rather than (or at least, in addition to) managing the symptoms of any impairments.

CHAPTER 4

How Was the Margaret Lake Management Plan Made?

In this chapter, we describe the methods that were employed to accomplish these tasks and objectives. A team of consulting scientists (White Water) in consultation with the MLA prepared this adaptive management plan. The methods that were used followed closely the goals, objectives, and tasks that were described in the grant proposal submitted to the WDNR. We describe these methods in this section under descriptive paragraph headings.

The effort included gathering, reviewing, and summarizing existing information pertaining to Margaret Lake biota and water quality. Existing information is found in many repositories and forms: anecdotal accounts of residents, resource agency reports and memos, municipal planning and zoning documents, scientific reports, old and new photographs, best guesses of knowledgeable people, and government land office records. Not all of the existing information is of equivalent value in the planning process. Some is not verifiable or the methods by which it was collected are unknown.

Watershed - Margaret Lake watershed analysis included delineating the Margaret Lake watershed area, mapping land cover/use and soils of the watershed; and digital elevation models. This information is discussed further in the *Margaret Lake Aquatic Plant Management Plan*. We used existing layers of geographic information available from the WDNR and other sources and manipulated these data using geographical information system technology. We reviewed and summarized existing institutional programs that influence water quality (for example the *Headwaters Basin Integrated Management Plan*, the *Oneida County Land & Water Resources Management Plan*, and various township zoning ordinances).

Aquatic Plants - An aquatic plant survey was conducted on Margaret Lake in 2011 by White Water Associates using a point-intercept protocol. Collected data were analyzed and summarized in this plan. The data allow calculation of ecological metrics such as number of sites where a plant species is found, relative percent frequency of species occurrence, frequency of occurrence within vegetated areas, frequency of occurrence at all sites, and maximum depth at which plants are found. The data also allow calculation of metrics such as total number of points sampled,

total number of sites with vegetation, total number of sites shallower than maximum depth of plants, frequency of occurrence at sites shallower than maximum depth of plants, Floristic Quality Index, maximum depth of plants (feet), average number of all species per site, average number of native species per site, and species richness. This data and the subsequent analyses were used in the creation of the *Aquatic Plant Management Plan* component of the *Margaret Lake Adaptive Management Plan*.

Aquatic Plant Management Plan - An important component of this project was our objective to prepare an *Aquatic Plant Management Plan* (APMP) for Margaret Lake. This involved interpreting and summarizing the Margaret Lake aquatic plant data for inclusion in the plan. We created an APMP that includes goals, objectives, historical plant management, monitoring, evaluation, plant community, nuisance species or AIS, management alternatives, and recommendations. Because of the relative size of the APMP, it is included as Appendix B of this adaptive management plan.

Water Quality - One of our objectives was to gather, consolidate, assess, and manage information about Margaret Lake water quality and potential risks to water quality. Four tasks were applied to achieving this objective: (1) collect and review existing limnological information about Margaret Lake, (2) analyze and summarize existing Margaret Lake water quality data, (3) assess the existing regimen of water quality sampling for Margaret Lake and determine appropriateness to lake conditions, and (4) revise (if need) the water quality sampling regimen for Margaret Lake as dictated by current information needs. This water quality data provides insight into lake water quality and is a useful starting point for adaptive lake management.

To develop additional baseline material pertaining to Margaret Lake water quality, we applied the water quality-planning tool known as the *Wisconsin Lake Modeling Suite* (WiLMS). The model is comprised of four parts: the model setup, phosphorus prediction, internal loading and trophic response (Hassett et al., 2003). To see analyses of Margaret Lake's watershed and water quality using the WiLMS modeling, see Appendix D.

Littoral and Riparian Zones - Two assessments of Margaret Lake's littoral and riparian habitats (one quantitative and one qualitative) were conducted as part of this project. White Water Associates staff conducted a U.S. Environmental Protection Agency (EPA) quantitative littoral zone and shoreline survey in 2012. This survey was augmented with some components of the WDNR protocol for littoral zone and shoreline survey.

With training from White Water staff, Margaret Lake volunteers conducted a qualitative assessment of the lake shoreline. This effort included survey of the human development and impacts as well as the natural setting. A photographic documentation of the Margaret Lake shoreline was also completed and integrated with other data to document the current conditions of the lake. A summary of this information is available in Appendix F. The complete data and photos are available as a CD-ROM.

Fisheries - As part of the adaptive management plan, White Water biologists gathered and summarized information about Margaret Lake fisheries. This objective was fulfilled by reviewing WDNR fisheries reports and interviewing Oneida County area WDNR fisheries biologists. White Water biologists summarized this information for inclusion in this adaptive management plan.

Another component of the adaptive management plan is to create a volunteer journal program. Volunteer anglers' journals can be used to collect meaningful fisheries data to augment WDNR fisheries surveys. It is the objective of the anglers' journal to engage Margaret Lake anglers in collecting fish data and to help understand the dynamics of fish populations. In 2011, 67 angler journals were completed, and 11 people participated. Results of the anglers' journals are in Appendix H.

Wildlife - As part of this project, frog and toad surveys were conducted near Margaret in 2011 and 2013. Volunteers were trained to monitor for frog and toad species. Design and procedure of the frog and toad monitoring can be read in the *Margaret Lake Frog and Toad Survey*, Appendix I of this plan.

Other Related Plans - Because other organizations are involved with water resources planning and management in northern Wisconsin, an objective of the planning component of the project was to review recommendations from existing plans (for example, *Headwaters Basin Integrated Management Plan* and/or *Oneida County Land & Water Resources Management Plan*) and review these in the *Margaret Lake Adaptive Management Plan* where appropriate. We also reviewed federal, state, and local regulations and ordinances that serve to protect water quality.

Margaret Lake Attributes and Risks – Another objective was to prepare a catalog of Margaret Lake environmental, cultural, and aesthetic attributes with a qualitative evaluation of the quality and associated potential threats. This objective included three tasks: (1) Through collaboration

with the MLA and other Margaret Lake area stakeholders, list water-related environmental, cultural, and aesthetic attributes and describe each; (2) qualitatively evaluate each of the attributes; (3) identify and describe potential threats to the Margaret Lake attributes.

Educational Outreach - A planning objective was to support the educational program efforts where related to Margaret Lake and other management elements. Toward this end, White Water staff will be available for phone consultation with members of the MLA and other stakeholders. We endeavored to increase support, capacity, and involvement of the MLA and other stakeholders in long-term stewardship of Margaret Lake through communication of project progress and findings. Finally, White Water staff attended public meetings that report and discuss Margaret Lake planning process and other project-related issues.

Lake User Survey – White Water staff in consultation with MLA and WDNR prepared a lake user survey. The MLA distributed the survey and White Water staff analyzed the returned data. These results are presented as Appendix K of this document.

Adaptive Management Plan – A final project objective called for the creation of this initial adaptive management plan for Margaret Lake that will help ensure high quality lake management and will serve as a firm foundation for future iterations of the plan. The adaptive management plan integrates the APMP with other information about Margaret Lake and its watershed. This objective was guided by two basic tasks. The first task was to develop management recommendations for Margaret Lake. These recommendations include topics such as water quality, fish habitat, special species habitat (rare plants and animals), sensitive areas, non-native species, and ecological threats. The second task was to prepare a practical written plan, grounded in science that includes sections on implementation, monitoring, and adaptive management. The plan will lay the basis for its expansion in future phases. It will identify where more information is required. White Water scientists carried out tasks under this objective.

CHAPTER 5

What is the State of Margaret Lake and its Watershed?

An understanding of the features and conditions of the Margaret Lake and its landscape is the foundation for developing and implementing strategies that seek to protect and restore the biological health of the area. We have sought information useful to devising the lake's adaptive management plan. Future project phases will collect and incorporate additional information.

This chapter is intended to teach us about Margaret Lake. What is the lake like? What is the surrounding landscape? What organisms live here? How healthy is the lake? How have humans contributed (or detracted) from that health? Do threats to watershed health exist? This chapter identifies and organizes existing information and reports on new findings

If you are new to Margaret Lake and its surroundings, this chapter will make you familiar with features and conditions that exist here and provide some insight as to why things are the way they are. If you are a life-long resident of the Margaret Lake area, you may be familiar with parts of the discussion in this chapter. You may have things to contribute or correct. This would be a welcome response. Become engaged! Improve the understanding of the watershed by adding your knowledge in future iterations of this plan.

We present Chapter 5 in eleven Parts, each part reflecting the following topics: the lake and surroundings; aquatic plants; water quality; littoral and riparian zones; fisheries; wildlife; non-native invasive species; regional plans, special attributes, environmental threats, and the lake user survey. Various appendices are referenced from the text.

Part 1. Margaret Lake and the Surrounding Area

Margaret Lake is in Oneida County, Wisconsin about 6 miles southeast of the town of Three Lakes, and about 28 miles south of the Michigan-Wisconsin border. Other lakes, both large and small, are in this landscape. This interconnected water landscape is a target for migrating and breeding waterfowl and other birds. Margaret Lake has value and function in this larger landscape as well as its own watershed.

Margaret Lake has a 1.7 mile shoreline with 86 acres of surface area. No state or federal land surrounds the lake, however the island is owned by the State of Wisconsin. An improved boat ramp allows public access. The lake is fairly developed with permanent homes and cottages,

although areas of more natural riparian area also exist. Exhibit 1 shows the Margaret Lake area and identifies major landmarks.

Exhibit 1. Margaret Lake and surrounding area.

Part 2. Aquatic Plants and Aquatic Plant Management Plan

As far as we can determine, no systematic or large-scale plant management activity has ever taken place in Margaret Lake. Over the years, no particular aquatic plant nuisance issues have demanded control action. An aquatic plant survey was conducted on Margaret Lake in 2011 by White Water Associates biologists. The point-intercept aquatic plant survey recorded twenty-nine species. The aquatic plant community was diverse and had high floristic quality. These findings support the contention that the Margaret Lake plant community is healthy and diverse. One Special Concern species was observed: Vasey's pondweed (*Potamogeton vaseyi*). The

survey is discussed in more detail in the Margaret Lake APMP, followed by tables and figures displayed in Appendix 2 of that plan.

Part 3. Margaret Lake Water Quality

Water quality data in Margaret Lake supports a eutrophic classification (WDNR, 2014a). Margaret Lake has a maximum depth of 14 feet and a simple bathymetry (Exhibit 2). The water body identification code (WBIC) is 1615900.

Existing water quality data has been collected since 1985 by the WDNR. Citizen Lake Monitoring Network (CLMN) volunteers have collected water quality data since 1993 and White Water Associates biologists took water samples in 2011, 2012 and 2013. That water quality information is briefly summarized in this section, but more fully interpreted in Appendix C.

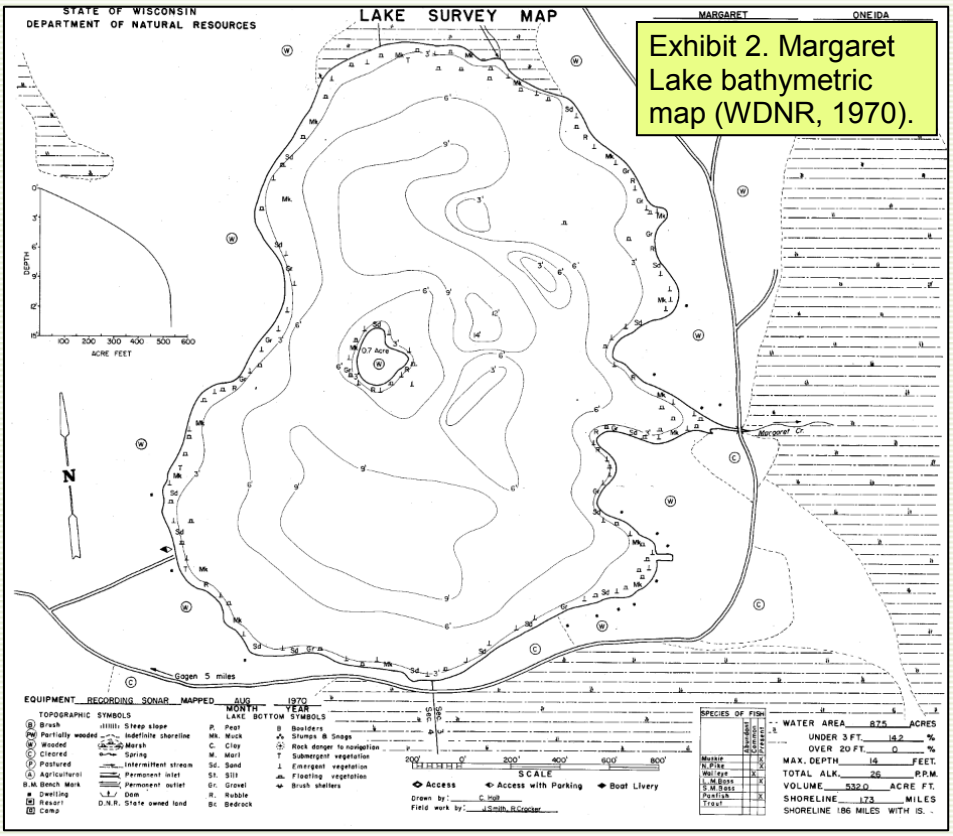

Exhibit 3. Trophic Status

Trophic state *of a lake is an indicator of water quality. Lakes are typically divided into three categories of trophic state: oligotrophic, eutrophic, and mesotrophic.*

Oligotrophic *lakes are clear, deep, and free of weeds or large algal blooms. They are low in nutrients and do not support large fish populations, but they can develop a food web capable of sustaining a desirable fishery.*

Eutrophic *lakes are high in nutrients and support large biomass (plants and animals). They are usually either weedy or subject to large algal blooms or both. Eutrophic lakes can support large fish populations, but are also susceptible to oxygen depletion. Small, shallow, eutrophic lakes are especially vulnerable to winterkill.*

Mesotrophic *lakes are intermediate between the oligotrophic and eutrophic. The deepest levels become devoid of oxygen in late summer and limit coldwater fish. Anoxic conditions at the water-sediment interface causes phosphorus to be released from the sediments.*

Over long periods of time, lakes go through natural aging from oligotrophic through mesotrophic to eutrophic. As part of this process, they begin to fill in. This aging process can be sped up by introductions of sediments and nutrients. (Shaw et al., 2004).

Temperature and dissolved oxygen samples show stratification in Margaret Lake in the ice-free season. Water clarity is very poor, with an average summer Secchi reading of 3.7 ft. The trophic state is mildly eutrophic. Such lakes (Exhibit 3) typically have a high amount of nutrients. They can support large fish populations, but are susceptible to oxygen depletion. Eutrophic lakes are usually small, shallow and are weedy or subject to large algal blooms. Water quality in Margaret Lake can be classified as fair with respect to phosphorus concentrations. Chlorophyll *a* (a measure of the amount of algae in a lake) was considered higher than Wisconsin natural lakes. Nitrogen, chloride, sulfate, hardness, conductivity, calcium, magnesium, sodium, and potassium would all be considered low. Alkalinity (a measure of a lake's buffering capacity against acid rain) was also low. The pH of Margaret Lake was slightly acidic with an average pH of 6.8.

As mentioned previously, the *Wisconsin Lake Modeling Suite (WiLMS)* was used as a lake water quality planning and education tool for Margaret Lake. WiLMS is a computer program into which the user enters information about the lake (e.g., surface area, depth, and nutrient measures) and the watershed (e.g., acreage and cover types). The model also has information about average rainfall, aerial deposition of materials, and cover type characteristics that it uses to help predict nutrient (phosphorus) loading scenarios to the lake. WiLMS predicted that most of the phosphorus delivered to Margaret Lake comes from wetland cover, the most common cover type in the watershed. Appendix D provides results and analyses of WiLMS predictions on Margaret Lake.

Part 4. Margaret Lake Littoral Zone and Riparian Area

The littoral zone is a critical part in maintaining a healthy lake ecosystem. This zone can be generally defined as the area nearest to a lake's shore in which it is usually shallowest, warmest and where sunlight can penetrate to the bottom. These factors usually allow for aquatic plants to grow. Aquatic plants provide habitat for invertebrates and fish in lakes, provide a food source for wildlife species, dampen the impact of waves, and absorb nutrients that would otherwise be used by algae. Bottom substrates also play an important role in the littoral zone. Substrates can include bedrock, cobble, sand, muck and woody material. These substrates provide habitat for invertebrates, amphibians, crustaceans and fish. The shoreline development index is one calculation used to indicate the amount of potentially productive littoral zone habitat relative to the overall acreage of the lake.

The shoreline development index is a quantitative expression derived from the shape of a 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 embayments 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. The Shoreline development index for Margaret Lake is 1.3. This number indicates that the lake has a minimal amount of potentially productive littoral zone habitat relative to the overall acreage of the lake.

Riparian zones make up the area where aquatic ecosystems converge with terrestrial ecosystems. It is one of the most structurally diverse and naturally dynamic ecosystems making it sensitive to environmental or human-cause changes. Like the littoral zone, the riparian zone provides shelter and food sources for wildlife, and improves water quality by retarding runoff, reducing erosion and absorbing pollutants. Riparian areas are so important that the Wisconsin Administrative Code requires at least 35 feet of land inland from the ordinary high water mark (OHW) be a vegetative buffer (State of Wisconsin Legislature).

In a national assessment of lakes, the United States Environmental Protection Agency (USEPA) evaluated hundreds of lakes across the United States assessing water quality, recreational suitability, and ecological integrity (USEPA, 2009). Important findings of that assessment included (1) poor lakeshore habitat (riparian vegetation) is the number one stressor of lake ecosystems nation-wide and (2) poor shallow water (littoral zone) habitat is the number two stressor. For the lake steward, by managing for sound lakeshores (both littoral and riparian components), we can make a difference in lake biological integrity (lake health). This means both development standards (e.g., NR115 and county shoreland ordinances) as well as best

management practices (e.g., leave wood in place and minimize clearing of aquatic vegetation). See results of the *Margaret Lake EPA Littoral and Shoreline Survey* in Appendix E.

In 2012, Margaret Lake volunteers conducted a qualitative assessment and photographic documentation of the entire lake shoreline. This information has been integrated and made available as a CD-ROM deliverable of this project. A summary of the qualitative results is provided in Appendix F.

Part 5. Margaret Lake Fisheries

Historic fisheries data for Margaret Lake dates back to 1955. Various fish surveys have been conducted on Margaret Lake: electro shocking (1963); seine haul and fyke nets (1970); trap nets (1974), and boom shocking (1996 and 2012). All survey results were used to determine fisheries management for Margaret Lake. Historically, fish species present in Margaret Lake have been: musky, walleye, northern pike, largemouth bass, rock bass, yellow perch, bluegill, black crappie, pumpkinseed, black bullheads, yellow bullheads, bluegill x pumpkinseed hybrid, white sucker, and golden shiner. Stocking in Margaret Lake has consisted of musky (1955, 1957, 1958, 1972, and 1996), walleye (1968, 1971, 1973, 1976, and 1996), pumpkinseed (1996 and 1997), and bluegill (1997). The most current WDNR survey from 2012 shows bluegill was caught at 122.77 CPE/Hour, pumpkinseed at 29.54 CPE/hour, and black crappie at 28.62 CPE/Hour. For more information about fisheries reports in Margaret Lake see Appendix G.

Volunteer Anglers' Journals can be used to collect meaningful fisheries data to augment WDNR fish surveys. Margaret Lake's volunteer angler journal program was designed so that anglers can systematically record their fishing experiences. It is hoped that this activity will engage anglers in collecting fish data and understanding the dynamics of fish populations. The objectives for the angler journal program include providing information on:

- Species of fish caught while angling on Margaret Lake;
- Size distribution of fishes caught on Margaret Lake;
- Fishing emphases of Margaret Lake anglers (time spent on panfish, walleyes, bass, etc.);
- Fishing techniques used on Margaret Lake (trolling, bait fishing, spin fishing, etc.);
- Relative amount of catch and release fishing; and
- Catch-per-effort (CPE) for various Margaret Lake fish species.

A field data form was provided for Margaret Lake anglers to fill out. In 2011, 67 angler journals were completed by 11 participants. For results of the anglers' journals, see Appendix H.

Part 6. Margaret Lake Wildlife

For many reasons, lakes attract a variety of wildlife species. Some of these species 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). In this section, we focus on two species (common loon and bald eagle) that in many ways represent the quintessential image of a northern Wisconsin lake. These species, when present also provide a strong indication of a healthy lake. This section also references the frog and toad survey conducted by Margaret Lake volunteers.

The common loon (*Gavia immer*) has one of the most distinct plumages of North American birds. It is a large bird with spotted black and white body, and a black/iridescent green head. The loon has many distinct calls for guarding territories, communicating with other loons, and warding of threats. Loons spend most of their life in the water. Unlike most birds, loons have solid bones allowing them to dive as deep as 250 feet in search of food (MNDNR, 2014). With legs positioned fairly far back on their body, loons are good swimmers. The position of the legs, however, means that walking on land is difficult. Perhaps because of their awkwardness on land, loon nests are built close to shore (Cornell, 2014). Loon nests are made of grasses, rushes, and twigs. Loons often place their nests on a small island or isolated point in an attempt to avoid predators. They sometimes will use artificial nest platforms. Loons are quite territorial during the breeding and nesting period. A small lake (12-125 acres) can accommodate only a single pair of breeding loons. Larger lakes may have more than one pair, with each pair occupying a bay or different section of the lake (Loon Pres. Comm., 2014). LoonWatch, a program of the Sigurd Olson Environmental Institute, has hundreds of volunteers monitoring loon nests and territories throughout Wisconsin. In 2010, volunteers observed approximately 3,373 adult loons and 805 chicks throughout surveyed Wisconsin lakes (LoonWatch). No information was available for loon nests and territories on Margaret Lake.

The bald eagle (*Haliaeetus leucocephalus*) is listed as a Special Concern species in Wisconsin, and is federally protected by the Bald & Golden Eagle Act (WDNR, 2013). Bald eagles live near water and eat small animals, carrion, and fish (preferring fish). They are believed to mate for life. Eagles create their nests in tall trees, using sticks and other debris. Eagle territories can be 1 to 2 square miles. In Wisconsin, bald eagle nest and territory surveys are

conducted by plane. In 2013, there were 1,344 known bald eagle nest territories occupied by breeding adults (NHI, 2014). This was an increase of 57 pairs from 2011, and an increase of 7 from 2012 (NHI, 2014). Margaret Lake, located in Oneida County, has no known nests or territories (Ron Eckstein, email). The Wisconsin Natural Heritage Inventory (NHI) assesses the rarity of species by using State and Global ranks. The State and Global ranks of the bald eagle can be described as: "Apparently secure in Wisconsin, with many occurrences (Breeding and Non-breeding)," and "Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery."

Other rare species and communities exist near Margaret Lake. The Wisconsin Natural Heritage Inventory (NHI) lists these rare species and communities and Exhibit 4 shows those found in the same township(s) as Margaret Lake.

Exhibit 4. Rare Species and Communities located near Margaret Lake.

Common Name	*Scientific Name*	*State Status**	*Group Name*
Long-eared owl	*Asio otus*	SC/M	Bird
Black tern	*Chlidonias niger*	SC/M	Bird
Bald eagle	*Haliaeetus leucocephalus*	SC/P	Bird
Boreal chickadee	*Poecile hudsonicus*	SC/M	Bird
American marten	*Martes americana*	END	Mammal
Black spruce swamp		NA	Community
Emergent marsh-wild rice		NA	Community
Lake-shallow, soft, drainage		NA	Community
Muskeg		NA	Community
Northern mesic forest		NA	Community
Northern sedge meadow		NA	Community
Northern wet forest		NA	Community
Poor fen		NA	Community
Springs and spring runs, soft		NA	Community
Stream-slow, soft, warm		NA	Community

*** 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).

(NHI, 2013)

Frog and toad surveys were conducted near Margaret Lake in 2011 and 2013. Working in consultation with lake stewardship volunteers with local knowledge of area wetlands, Dean Premo (a trained herpetologist) selected ten sites in the immediate landscape of Margaret Lake as

prospective frog and toad survey wetlands. Volunteers then surveyed these sites and record species and count. The field data was then conveyed to White Water Associates for analysis and reporting. Results of the Margaret Lake frog and toad survey can be viewed in Appendix I of the *Margaret Lake Adaptive Management Plan*.

Part 7. Margaret Lake Aquatic Invasive Species

Margaret Lake was monitored for banded mystery snail, rusty crayfish, Chinese mystery snail, curly-leaf pondweed, Eurasian water-milfoil, purple loosestrife, and zebra mussels in July, 2011. There is no report of invasive species found in Margaret Lake. The University of Wisconsin-Madison's Aquatic Invasive Species Smart Prevention program classifies Margaret Lake as "not suitable" for zebra mussels, based on calcium and conductivity levels (UW-Madison).

Part 8. Water Resource Regulations and Planning Relevant to Margaret Lake

For the purposes of this plan we reviewed documents of other organizations involved with water resources regulations, planning, and management in northern Wisconsin. Appendix J contains our documentation of these reviews and provides substantive information on (1) federal, state, and county regulations and ordinances that influence water quality, (2) WDNR programs that strive to preserve and restore land and water resources (including Fisheries Management and Habitat Protection, Watershed, Wastewater, Nonpoint Source Pollution Abatement, Drinking and Groundwater, Wildlife, Endangered Resources, and Forestry), and (3) a review of the *Oneida County Land & Water Resource Management Plan* (NCWRPC, 2011). These reviews discuss federal, state, and local agencies and the mechanisms by which they protect water resources. The discussion ranges from the federal Clean Water Act of 1972 to Wisconsin's NR115 to Oneida County ordinances.

Part 9. Margaret Lake Area Special Attributes

An objective for future iterations of the Margaret Lake Adaptive Management Plan will be to develop a description of specific environmental, cultural, and aesthetic attributes along with an assessment of the threats to the quality of these attributes. Environmental quality attributes can be organized in three categories: (1) environmental (ecological), (2) cultural and (3) aesthetic (Redding, 1973). Some resources may display all three conditions and others may contain only one. More complete definitions (Redding, 1973) of the three categories are as follows:

1. Environmental (ecological) attributes are components of the environment and the interactions among all its living and nonliving components that directly or indirectly sustain dynamic, diverse, and viable ecosystems. Included are functional and structural aspects of the environment.
2. Cultural attributes are evidence of past and present habitation that can be used to reconstruct or preserve human lifeways. Included are structures, sites, artifacts, and environments.
3. Aesthetic attributes are perceptual stimuli that provide diverse and pleasant surroundings for human annulment and appreciation. Included are sights, sounds, scents, tastes, and tactile impressions.

The first two attributes (ecological and cultural) are more tangible than the third but aesthetic attributes are important when it comes to how people feel about a feature and are compelled to protect a feature or otherwise act as stewards. The importance of preserving aesthetic resources is emphatically expressed in the National Environmental Policy Act 1969 that requires the "Federal Government to use all practicable means ….. (to) …. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings… and to… preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice" (NEPA Sec. 101 (b) (2, 4)). Aesthetic quality is a subjective attribute. Something that has high aesthetic value for one person may not receive the same consideration from another. Some hold high aesthetic value in a manicured lawn where others prefer a more natural ground cover. Aldo Leopold (1948) expresses his love for nature and its beauty and the need for a land ethic to protect natural beauty and "quality of life."

As has been outlined in various parts of this Adaptive Management Plan, Margaret Lake is a high quality ecosystem with respect to components of water quality, aquatic plants, fish community, and wildlife habitat. These attributes combine to influence a high aesthetic quality. The next part outlines some of the potential environmental threats to this high quality.

Part 10. Environmental Threats to Margaret Lake

As outlined in the previous part, the Margaret Lake watershed ecosystem has numerous attributes of high ecological and aesthetic significance. These attributes combine to help make Margaret Lake a unique and special place. Margaret Lake and its surroundings, however, are subject to environmental threats from a variety of sources. We outline some of these threats in this part of the Margaret Lake plan.

Recreational pressure – Margaret Lake is a light to moderately-used fishing and recreational lake for people from near and far. An expanding base of admirers will result in increasing recreational pressures. Increased traffic in and out of the lake increases opportunities for AIS.

Development pressure – Margaret Lake has some areas of residential development as well as areas with predominantly natural vegetation and broad and diverse riparian areas. In some areas of the lake, old-style lawns, cropped short and in close proximity to the shore indicate a need for some educational effort to inform residents about more ecologically friendly waterfront vegetation. Likewise, well-intended activities meant to "clean up" the shoreline or shallow water zone of the lake diminish the habitat quality for invertebrates and fish and could be addressed with some targeted education.

Water quality inputs – The water quality and aquatic ecosystem functioning of Margaret Lake is affected by all inputs of water (groundwater, precipitation, and overland runoff). All of these sources have potential to carry pollutants of various kinds to Margaret Lake. Margaret Lake has excellent water quality and a long record of water quality monitoring. Nevertheless, non-point source pollution (see next paragraph) represent an important threat to Margaret Lake water quality.

Non-point source pollution – Surface runoff from the land, roadways, parking lots and other surfaces flows into Margaret Lake. This runoff carries with it sediment, nutrients (for example, from fertilizers) and contaminants (for example, herbicides) that can have detrimental effects on the Margaret Lake ecosystem. Known as non-point source pollution (because it does not emanate from a discrete point like an effluent pipe from a paper mill), this kind of runoff can come from lawns, agricultural fields, clear-cuts, and impervious surfaces (for example, roads and paved parking lots). Sometimes the impact is physical, such as sediment covering gravel spawning areas. Sometimes it is chemical such as excess phosphorus from lawn fertilizers that might invoke an algal bloom. This type of pollution can be best controlled through education and protection of riparian buffers (natural vegetation near the waterways that absorb the pollutants before they reach the water).

Aquatic invasive species – Non-native plant and animal species have become a grave concern for aquatic, wetland, and terrestrial ecosystems. As more populations of aquatic plant and animal invasive species become established in lakes and streams in the region, the likelihood of AIS

coming to Margaret Lake increases. When it comes to non-native aquatic plant invaders, the best defense against establishment is a healthy community of native plants. A diverse native plant community presently exists. Effective education and diligent monitoring are important factors in avoiding establishment of aquatic invasive species.

Riparian ecosystem integrity – Healthy riparian areas (the naturally vegetated land near the water) provide numerous important functions and values to Margaret Lake. For example, they serve as habitat for many species, contribute important habitat to the lake (e.g., large wood), filter out non-point source pollution from entering the lake, and armors the shores against erosion. Educating riparian owners around Margaret Lake as to the importance of riparian areas is crucial to the maintenance of these critical areas.

Littoral zone ecosystem quality – Much of the productivity of a lake comes from the shallow water areas known as the littoral zone. This is where plants grow, invertebrates live, fishes spawn, and aquatic birds and mammals spend much of their time. The presence of good aquatic vegetation, diverse substrate, and dead woody material (logs and branches) is crucial to this littoral zone ecosystem. Sometimes the human temptation is to "clean up" these areas, but in fact this process diminishes the habitat quality greatly. It is important to educate landowners and others about how to protect the littoral zone from degradation. Piers and swimming areas impact the littoral zone as well, but can coexist with a quality shallow water habitat if kept to a reasonable level.

Habitat degradation of nearby aquatic and wetland habitats (ponds, streams) – The wetland habitats, streams, small lakes, and ponds in the vicinity of Margaret Lake all potentially contribute to the high quality of the lake. These smaller ecosystems can be overlooked in terms of their importance and therefore deserve some special attention. One of the first protective measures to take is to identify where these features are and characterize their size and ecological composition. This informs future protection and restoration efforts.

Part 11. Lake User Survey

In order to maintain the high quality condition of Margaret Lake, input from the public is needed. This input helps us to understand the needs, knowledge base, concerns and desires of people who use Margaret Lake. In this regard, a lake user survey was created and distributed to Margaret Lake landowners. The results of this survey are available as Appendix K of this document.

CHAPTER 6

What Goals Guide the Margaret Lake Adaptive Management Plan?

"Protect the Best and Restore the Rest" has become the credo of successful watershed managers across the country. This simple phrase acknowledges that watershed management is more than identifying the worst areas and trying to rehabilitate them. It recognizes that of equal or greater importance is identifying those areas that are of high or moderate quality in the watershed and establishing mechanisms to maintain that quality. "Protect the Best and Restore the Rest" also implies the importance of identifying imminent threats to watershed health and working to eliminate them. This simple principal is founded on the restoration ecology fact that the most certain way to successfully restore the structure and function of part of a broken watershed ecosystem is to rely on intact areas of the watershed to serve as the donors of healthy "parts" (such as aquatic insect species or good quality water). "Protecting the Best" allows us to "Restore the Rest" more effectively and economically. But, protecting the best is prerequisite.

The primary goal of the *Margaret Lake Adaptive Management Plan* is to perpetuate the quality of Margaret Lake and its watershed ecosystem into the future. Sometimes this will mean protecting what is good about the lake and its surroundings and sometimes it may mean restoring some feature that has been degraded. Restoration is reestablishment of the structure and function of an ecosystem including its natural diversity (Cairns, 1988; National Research Council, 1992). It implies rehabilitating and protecting sufficient components of the ecosystem so that it functions in a more or less natural way, provides habitat for native plants and animals, and supports reasonable human uses.

The *Margaret Lake Adaptive Management Plan* offers several supporting goals. In an adaptive plan, new goals can be adopted as the plan evolves. We conclude this chapter by presenting these goals organized under topical headings.

Restoration – Apply rehabilitation, protection, and education actions under the direction of specific objectives identified specific areas in the Margaret Lake watershed.

Research – Gather information that is useful in planning and monitoring restoration actions and devising education programs.

Monitoring – Establish a monitoring system in the Margaret Lake watershed that will provide data that reveals the quality of the system and establishes methods to evaluate the effectiveness of management efforts.

Cultural Climate – Encourage a cultural and political atmosphere that allows and promotes good watershed stewardship including cooperation between citizens, businesses, public agencies, and municipalities.

Sustainable Economy – Foster an environment that promotes a sustainable economy, provides a diversity of economic options for the residents of the watershed, and does not diminish opportunities for future generations of watershed residents.

Recreation – Promote a sustainable recreation in Margaret Lake where all citizens (now and in the future) can enjoy the opportunities of the natural and human-sustained environment while respecting the environment and the rights of fellow citizens.

Program Maintenance – Foster a stewardship culture that engages people to donate time, talent, and money sufficient to support the implementation and periodic update of the *Margaret Lake Adaptive Management Plan*.

In the final chapter of this plan, we present possible objectives and actions that will serve to move toward these goals. This is not an exhaustive treatment, but a starting point, integrated with monitoring so that adaptive management can take place in subsequent years.

CHAPTER 7

What Objectives and Actions Move Us Toward Our Goals?

The Margaret Lake watershed is healthy, diverse, and productive. Our challenge through this adaptive management plan is to perpetuate that condition into the future. The challenge will be met by a capable set of program partners that are prepared to devote themselves to Margaret Lake stewardship. These partners include the members of The Margaret Lake Association, the Oneida County Land and Water Conservation Department, the ecological scientists of White Water Associates, Inc., the WDNR, and others who care about Margaret Lake.

Abraham Lincoln is attributed with the following wisdom: "If I had an hour to cut down a tree, I'd spend the first 45 minutes sharpening my ax." Planning and preparation are important for any task, but especially when working with a system as complex as a lake or watershed. The vision and goals described in the previous chapter provide the basis for developing objectives and actions to achieve the desired future for the Margaret Lake watershed. In keeping with the spirit of an adaptive management plan, we present several actions and associated objectives that can be undertaken as human and financial resources allow in subsequent phases of the program. Desired outcomes of each action are also stated. The actions, objectives, and outcomes each need to be further developed so that appropriate methodology and accurate estimates of required effort can be described. The Margaret Lake Association is in control of the plan. The plan is flexible and allows the insertion of new actions at any point along the path of lake management. The pace of implementation of the plan is also flexible and will be influenced by availability of volunteer time, grant monies, and other factors.

Recommended Actions for the Margaret Lake APM Plan
Action (Education): Work with WDNR to understand and manage the Margaret Lake fishery. ***Objective:*** To support scientific and effective restoration of a quality Margaret Lake fishery. ***Outcome:*** Document meetings and other contacts made to the WDNR and others. ***Status:*** Action included in *Adaptive Management Plan*.
Action (Education): Maintain kiosk and/or other education structure at the public boat launch that provides information on the threats of aquatic invasive species introductions to Margaret Lake and outline how such introductions can be minimized. ***Objective:*** Prevent new introductions of aquatic invasive species to Margaret Lake. ***Outcome:*** Creates more informed and responsible recreational users of Margaret Lake. MLA should document that updated educational material is maintained. ***Status:*** Action included in *Adaptive Management Plan*.
Action (Education): Host a half-day field trip on littoral zone and riparian ecology. ***Objective:*** Inform lake users of the importance of these ecosystems to lake health. ***Outcome:*** Creates more informed and responsible recreational users and property owners of Margaret Lake. ***Status:*** Action included in *Adaptive Management Plan*.
Action (Research): Conduct a second point-intercept plan survey in 2016 (5 years after the first survey). Analyze and compare data to the 2011 survey to determine changes in the aquatic plant community. ***Objective:*** To understand the diversity and abundance of the native aquatic plant community in Margaret Lake and understand how this community changes over time. ***Outcome:*** Updated *Aquatic Plant Management Plan*. ***Status:*** Action included in *Adaptive Management Plan* and would be conducted in a future phase of the stewardship effort.

Recommended Actions for the Margaret Lake APM Plan
Action (Research): Conduct annual assessments of Margaret Lake for aquatic invasive plants. ***Objective:*** To provide an early warning of new introductions of aquatic invasive species to allow rehabilitation actions to occur when populations are still small. ***Outcome:*** Document the number and timing of surveys and maintain record of findings. ***Status:*** More specific guidance provided in the *Aquatic Plant Management Plan*.
Action (Research): Every 3-5 years (or more often if interest allows), repeat the frog-toad survey. ***Objective:*** To understand the diversity and abundance of the frog-toad community in wetlands in the Margaret Lake area determine how this community changes over time. ***Outcome:*** Updated report in Adaptive Management Plan. ***Status:*** Action included in *Adaptive Management Plan* and would be conducted in a future phases of the Margaret Lake stewardship effort.
Action (Education): Establish an award or recognition of riparian owners that preserve or rehabilitate "natural shoreline" habitat on their property. This could be recognized in the newsletter along with an article about the ecological benefits of natural shorelines. ***Objective:*** To encourage good shoreline stewardship by riparian owners and improve the riparian area quality of Margaret Lake. ***Outcome:*** Monitor by general awareness of landowners and changes in shoreline maintenance behaviors. ***Status:*** Action included in *Adaptive Management Plan*.
Action (Education): Create periodic updates of the adaptive management plan. ***Objective:*** To incorporate most up-to-date information regarding Margaret Lake and application of best stewardship practices. ***Outcome:*** Up-to-date management plan is available for ongoing implementation and stewardship of Margaret Lake. ***Status:*** Action included in *Adaptive Management Plan*. This document is the first version of the adaptive management plan.

Recommended Actions for the Margaret Lake APM Plan
Action (Protection): Develop a storm water and shoreland habitat plan. ***Objective:*** To maintain and improve the health of Margaret Lake. ***Outcome:*** Will be a future component of the Margaret Lake Adaptive Management Plan. ***Status:*** Action included in *Adaptive Management Plan* and would be conducted in a future phases of the Margaret Lake stewardship effort.
Action (Protection): Adopt and implement the *Aquatic Plant Management Plan* prepared as result of the current project. **Objective:** To protect and maintain a high quality aquatic plant community in Margaret Lake, and reduce opportunities for introduction of aquatic invasive plant species. **Outcome:** A healthy, diverse Margaret Lake aquatic plant community and a human community that is actively engaged in monitoring and protecting native aquatic plants. **Status:** Action included *Adaptive Management Plan*. The *Aquatic Plant Management Plan* is intended for adoption in 2014.

Future phases of Margaret Lake Stewardship will build on the foundation established in this *Adaptive Management Plan*. Additional aspects of the Margaret Lake watershed ecosystem will be explored. Future phases will include revisions to the lake management plan, and the aquatic plant management plan.

Margaret Lake and its watershed serve its human residents well. But, in order for future generations to enjoy all that the watershed can provide, this adaptive plan should be embraced, developed, and implemented. It may seem slow at first, but considerable momentum already exists because of the hard work that has already occurred.

Appendix A
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Appendix B
Margaret Lake Aquatic Plant Management Plan

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Margaret Lake Stewardship Program

Aquatic Plant Management Plan – Margaret Lake

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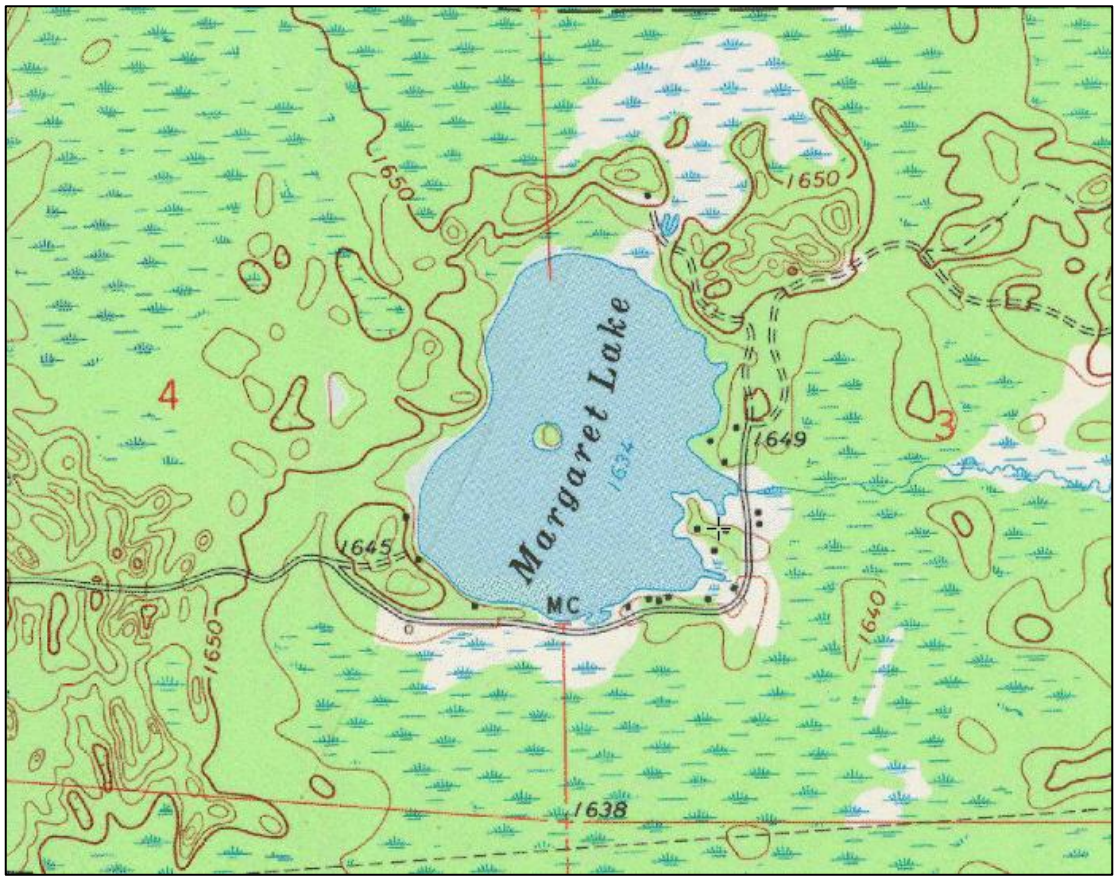

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Margaret Lake Stewardship Program

Aquatic Plant Management Plan – Margaret Lake

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

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TABLE OF CONTENTS

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CHAPTER 1 Introduction

The ***Margaret Lake Stewardship Program*** results from the efforts of the Margaret Lake Association (MLA), an organization that has been active since 2007. The Margaret 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 aquatic plant management plan addresses Margaret 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). The closely related ***Margaret Lake Adaptive Management Plan*** (Premo et al., 2014) provides additional overarching waterscape level examination that allows greater opportunity and efficiency in water resource management and education.

A 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. An analysis of the plant data along with water quality and other lake information allowed the preparation of the plan.

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 these so-called 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.

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

Currently, the motivation for this plan lies in the first two objectives. Margaret Lake is a eutrophic lake with a diverse and interesting community of aquatic plants. It also has a recreational history and current human use that has caused degradation to the ecosystem.

During projects with the WDNR Planning Grant Program and through past efforts, the Margaret Lake Association has followed 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;
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 survey, and Appendix 3 contains a *Review of Margaret Lake Water Quality*.

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CHAPTER 2

Study Area

Margaret Lake is located in Oneida County, Wisconsin about 14.5 miles northeast of the town of Rhinelander, and approximately 30 miles south of the Michigan-Wisconsin border. The water body identification code (WBIC) is 1615900. Exhibit 1 is an aerial view of the Margaret Lake landscape showing the town of Three Lakes, and a few other water features. This interconnected water landscape is a target for migrating and breeding waterfowl and other birds. Margaret Lake has value and function in this larger landscape as well as its own watershed.

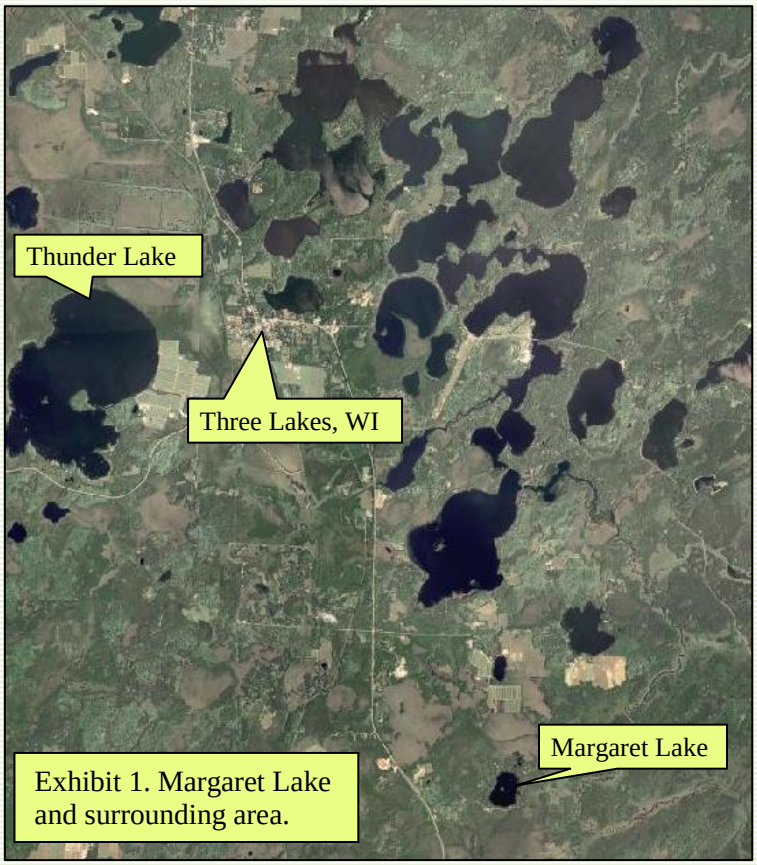

Exhibit 1. Margaret Lake and surrounding area.

Margaret Lake is located in a region that is marvelously rich in surface waters. Aerial photography reveals a concentration of lakes and streams that is unique in North America. This region could as easily be termed a "waterscape" as a "landscape." 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.

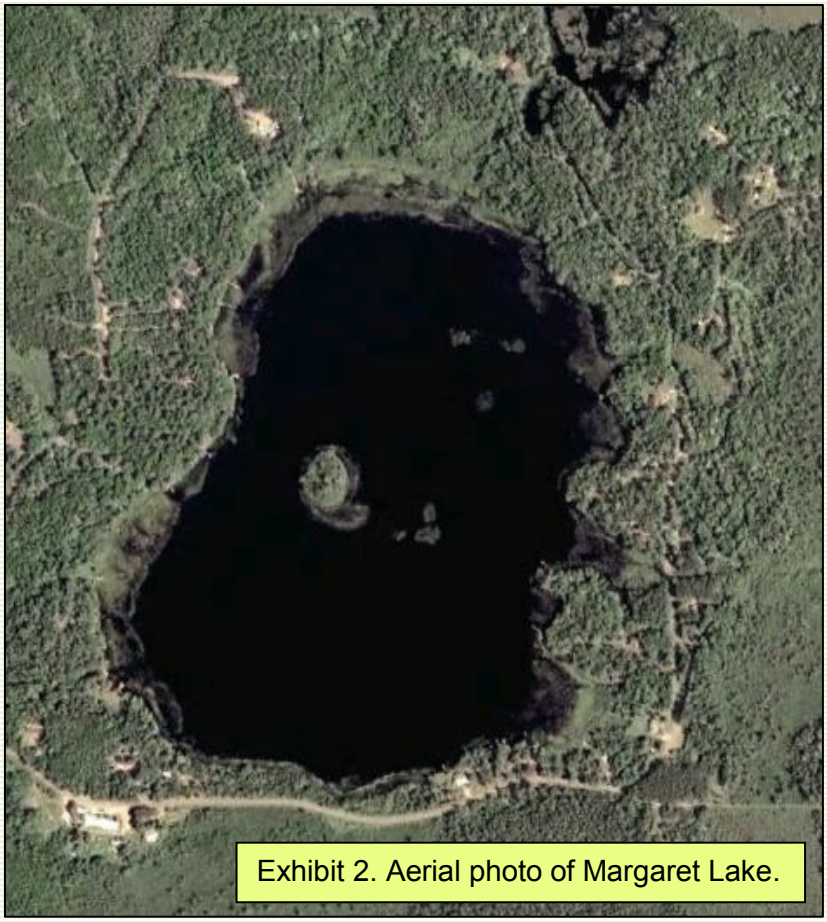

Exhibit 2. Aerial photo of Margaret Lake.

Descriptive parameters for Margaret Lake are in Exhibit 3. It is a drainage lake (inlet and outlet are present, but low flow) of about 86 acres and maximum depth of 14 feet. The stream that comes into the lake from the north drains extensive natural wetlands. Current watershed map

layers (as used in our analysis) show an area of commercial cranberry operation located about a mile to the north of the lake to be in a separate watershed from Margaret Lake. This is contrary to the understanding of some long-time residents of the area. Margaret Lake has a low shoreline development index. 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. A higher shoreline development index indicates that a lake has relatively more productive littoral zone habitat.

Exhibit 3. Water Body Parameters.	
Water Body Name	Margaret
County	Oneida
Township/Range/Section	T37N-R11E-S3,S4
Water Body Identification Code	1615900
Lake Type	Drainage
Surface Area (acres)	86
Maximum Depth (feet)	14
Maximum Length (miles)	0.4
Maximum Width (miles)	0.3
Shoreline Length (miles)	1.73
Shoreline Development Index	1.3
Total Number of Piers (EPA study)	29
Number of Piers / Mile of Shoreline	16.8
Total Number of Homes (2011 aerial)	25
Number of Homes / Mile of Shoreline	14.5

Margaret Lake has a public access site on the southwest end of the lake. We observed a total of 29 piers on the shoreline of Margaret Lake from the 2012 EPA study or about 16.8 piers per mile of shoreline. The riparian area consists of both upland and wetland areas (Exhibit 4).

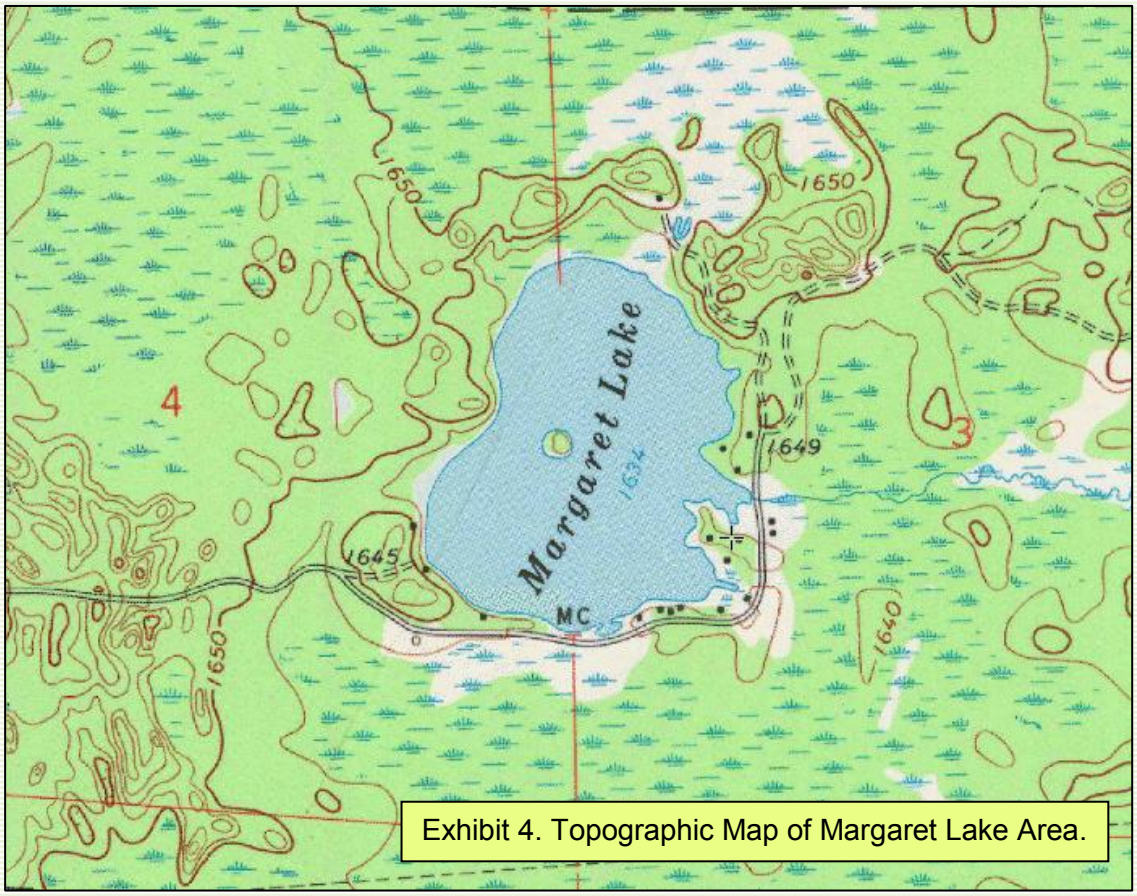

Exhibit 4. Topographic Map of Margaret Lake Area.

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:

> ***Margaret Lake has a healthy and diverse aquatic plant community that was documented by a point-intercept aquatic plant survey. This plant community is essential to, and part of, a high quality aquatic ecosystem that benefits the human community with its recreational and aesthetic features. The purpose of this aquatic plant management plan is to maintain the aquatic plant community in its present 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 AIS and nuisance levels of native plants;***
> ***(3) Promote and interpret APM efforts; and***
> ***(4) 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 Margaret Lake stewards.

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CHAPTER 4 Information and Analysis

Our efforts in the Margaret Lake Stewardship Program have compiled information about historical and current conditions of the Margaret Lake ecosystem and its surrounding watershed. Of particular importance to this aquatic plant management plan is the aquatic plant survey that followed the ***WDNR Protocol for Aquatic Plant Survey, Collecting, Mapping, Preserving, and Data Entry*** (Hauxwell et al., 2010). The results of this comprehensive "point-intercept" survey 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

Margaret 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. Margaret 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 River basin (HUC#070700) (Exhibit 6) contain Margaret Lake. Within the Wisconsin River basin is the Upper Wisconsin sub-basin (HUC#07070001) (Exhibit 7), which can be further divided into watersheds and sub-watersheds. Margaret Lake is located in the Eagle River watershed (HUC#0707000102). Finally, the Eagle River watershed is divided into federal hydrologic sub-watersheds, designated by 12-digit HUC codes. Margaret Lake is located in the Headwaters-Eagle River Sub-watershed (HUC#070700010201), which can be seen in Exhibit 8. The Margaret Lake watershed can be viewed in the Digital Elevation Model in Exhibit 9.

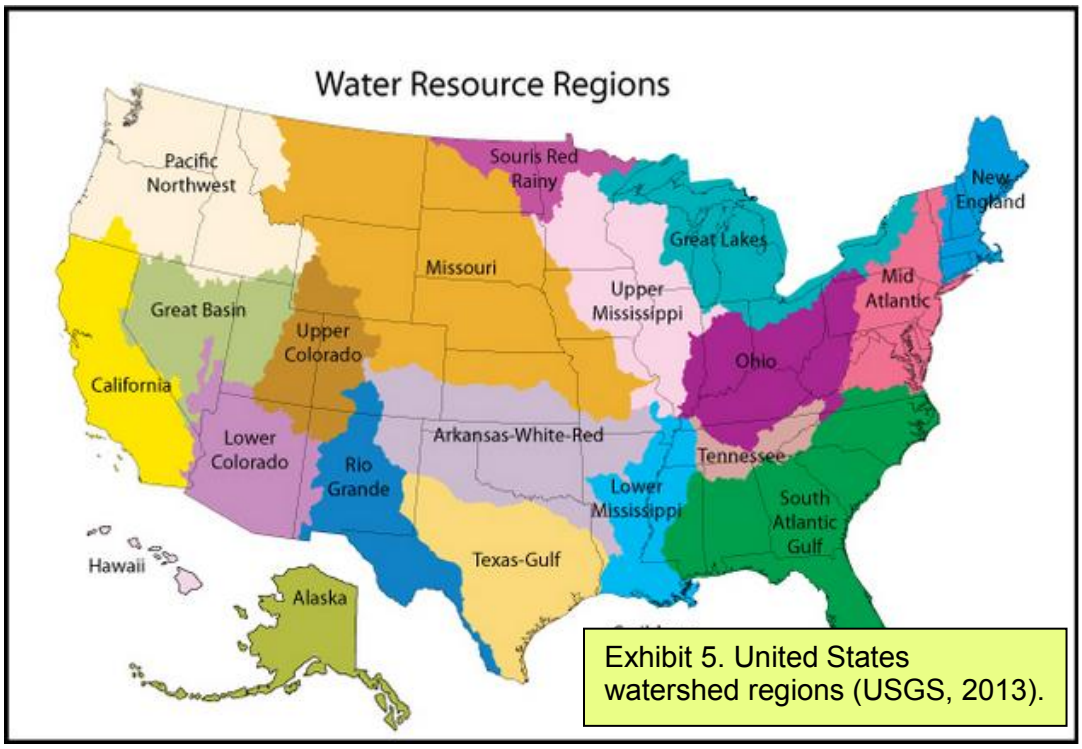


Exhibit 5. United States watershed regions (USGS, 2013).

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

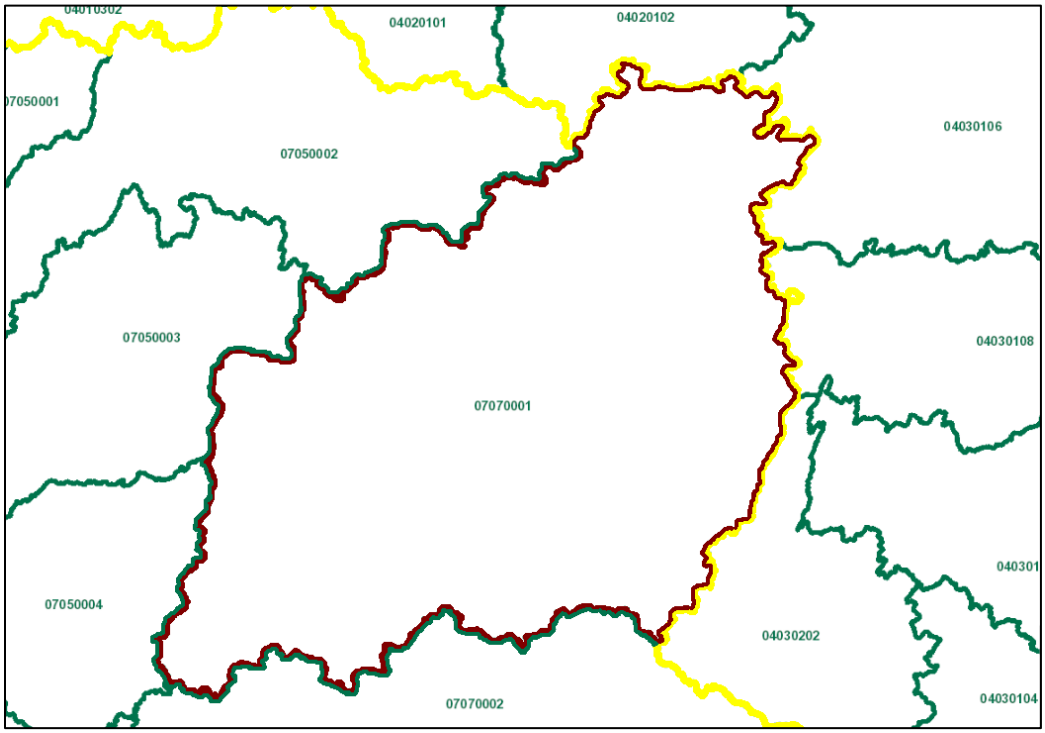


Exhibit 7. Upper Wisconsin sub-basin (red) lies on the border of the Upper Mississippi region (south of yellow line) and the Great Lakes region (north of line) (WDNR, 2013a).

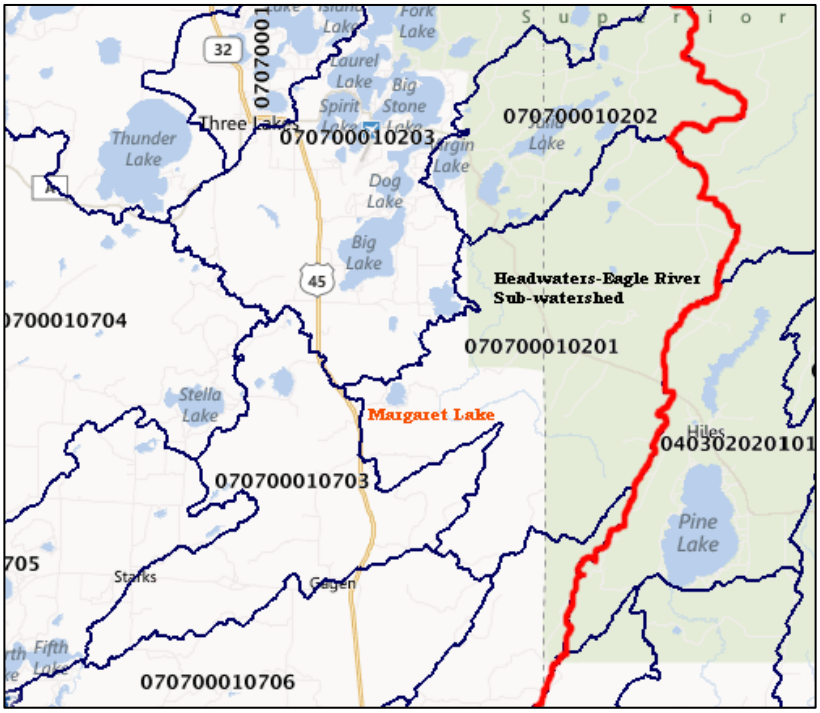


Exhibit 8. Headwaters-Eagle River sub-watershed. The red line delineates the Great Lakes Region (east of line) from the Upper Mississippi Region (west of line) (USEPA, 2013).

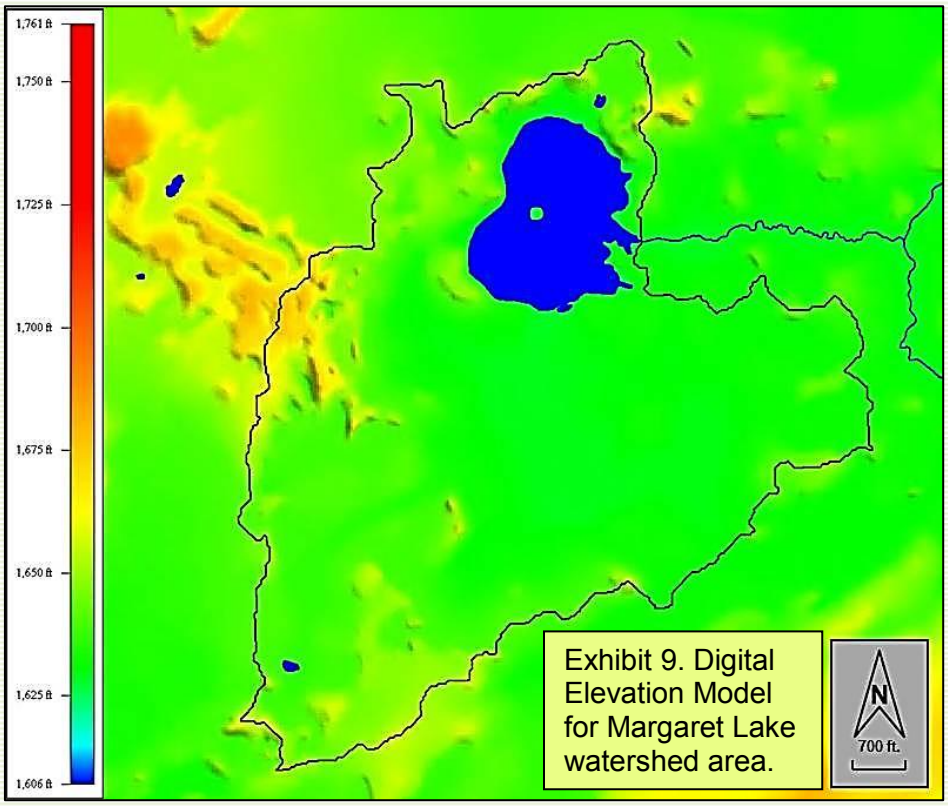


Exhibit 9. Digital Elevation Model for Margaret Lake watershed area.

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 elevation surrounding Margaret Lake ranges from around 1,625 feet above sea level to 1,680 feet above sea level.

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 Margaret Lake watershed is about 1,000 acres. The cover types in the watershed are presented in Exhibit 10. Forest and surface water comprise the largest components. Soil group D is the most common soil group the watershed; followed by group B, A, and C. Soil group D has the lowest infiltration capacity, and the highest runoff potential. Conversely, soil group A has the highest infiltration capacity, and the lowest runoff potential. The watershed to lake area ratio is 12:1. 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.

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

Cover Type	Acres	Percent
Agriculture	0	0
Commercial	0	0
Forest	263.1	26.3
Grass/Pasture	7.7	0.8
High-density Residential	2.3	0.2
Low-density Residential	33.8	3.4
Water	693.1	69.3
Total	1000.0	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	124.6	12.5	**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	289.2	28.9	**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	37.1	3.7	**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	549.1	54.9	**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)*

Part 2. Aquatic Plant Management History

As far as we can determine, no systematic or large-scale plant management activity has taken place in Margaret Lake. Over the years, no particular nuisance issues have demanded control action. A qualitative aquatic plant survey was conducted as part of the 1970 Margaret Lake fish study. The 2011 point-intercept plant survey was the first comprehensive and quantitative aquatic plant survey conducted on Margaret Lake. Part 3 provides information about the 2011 point-intercept survey and a brief description of the 1970 aquatic plant data.

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.

We conducted a WDNR point-intercept aquatic plant survey on Margaret Lake in summer 2011. This formal survey assessed the plant species composition on a grid of several hundred points distributed evenly over the lake. Using latitude-longitude coordinates and a handheld GPS unit, we navigated to the points and used a rake mounted on a pole or rope to sample plants. These were identified, recorded, and put into a dedicated spreadsheet for storage and data analysis. This systematic survey provides baseline data about the lake. Future monitoring will be able to identify and track changes in the plant community. 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 report the findings of the point-intercept aquatic plant survey. The supporting tables and figures for the aquatic plant survey are provided in Appendix 2.

Species richness refers to the total number of species recorded. We recorded 29 species of aquatic plants in Margaret Lake. Of these, 21 were collected at sampling sites and the others were observed from the boat. Table 1 displays summary statistics for the survey. Table 2 provides a list of the species encountered, including common and scientific name along with summarizing statistics.[2] The number of species encountered at any given sample point ranged from 0 to 6 and 114 sample points were found to have aquatic vegetation present. The average number of species encountered at these vegetated sites was 1.83. The actual number of species encountered at each of the vegetated sites is graphically displayed on Figure 1. 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 Figure 2.

The maximum depth of plant colonization is 9 feet (Table 1 and Figure 3). Rooted vegetation was found at 114 of the 215 sample sites with depth ≤ the maximum depth of plant colonization (53% of sites). These sites are displayed as a black dot within a circle on Figure 4. 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 aquatic plant survey (mud, sand, or rock).

Table 2 provides information about the frequency of occurrence of the plant species recorded in the lake. Several metrics are provided, including total number of sites in which each

[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)."*

species was found and frequency of occurrence at sites ≤ the maximum depth of rooted vegetation. This frequency metric is standardized as a "relative frequency" (also shown in Table 2) 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 6. This display shows that *Potamogeton praelongus* (white-stem pondweed) had the highest relative frequency followed by *Elodea canadensis* (common waterweed). The lowest relative frequencies are at the far right of the graph. Upon reviewing aerial imagery of Margaret Lake during growing season months of 2005, 2006, 2008 and 2010, no significant changes of floating and emergent plant densities were observed. The amount of floating and emergent vegetation during these years was approximately 15% of the lake's total surface area. As examples of individual species distributions, we show the occurrences of a few of the most frequently and least frequently encountered plants in Figures 8-13.

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 Margaret Lake aquatic plants is 0.85 (Table 1) which indicates a 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 Margaret Lake FQI (28.4) compares to other lakes and regions. The statewide medians for number of species and FQI are 13 and 22.2, respectively. Margaret Lake values are high compared to 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. Margaret 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. Margaret Lake data is consistent with that find. Finally, the Margaret Lake FQI (28.4) is higher than the median value for the Northern Lakes and Forests lakes group (24.3). These findings support the contention that the Margaret Lake plant community is healthy and diverse.

We observed no aquatic plants in Margaret Lake that would be considered a nuisance-level population density/distribution. Vasey's pondweed (*Potamogeton vaseyi*) was observed in the boat survey portion of the aquatic plant survey. Vasey's pondweed is considered a *Special Concern* species in Wisconsin. Special concern species are those species about which some problem of abundance or distribution is suspected but not yet proved (WDNR, 2013b). The survey found no aquatic invasive plant species.

In 1970, a fish survey was conducted on Lake Margaret by the WDNR. As part of this survey, aquatic plants observed and estimates of their abundances were recorded. Common names were recorded and abundances were rated as "abundant," "common," or "scarce" (Wendt, 1971). It was noted that aquatic vegetation was common in the shoal areas and around the entire shoreline (Wendt, 1971). Plants observed in this survey along with their abundances include: yellow water lily (common), white water lily (common), bulrush (abundant), spikerush (abundant), arrowhead (abundant), sedge (common), coontail (abundant), big leaf pondweed (common), watershield (common), wild rice (abundance recorded as "P," however no explanation of "P" was given) and muskgrass (abundant). The max depth of rooted vegetation was 5 feet and 10% of the lake's surface had standing emergent vegetation (Wendt, 1971).

Part 4. Fish Community

Fisheries data has been collected on Margaret Lake since 1995. For further information about the fisheries of Margaret Lake, see Appendix G of the *Margaret Lake Adaptive Management Plan.* The WDNR Lake Pages website (http://dnr.wi.gov/lakes/lakepages/) indicates that the bottom is comprised of 50% sand, 10% gravel, 10% rock, and 30% muck.

Part 5. Water Quality and Trophic Status

Margaret Lake is an 86 acre drainage lake with a maximum depth of 14 feet. Existing water quality information includes data collected by a WDNR volunteer in 1985 for a variety of parameters at depths of 3 feet and 11 feet. Data was also collected by Citizen Lake Monitoring Network (CLMN) volunteers, from 1993 to 2012. White Water Associates collected data on July 12, 2011, September 8, 2011, and July 24, 2012. That water quality information is briefly summarized in this section, but more fully interpreted in Appendix 3.

Temperature and dissolved oxygen samples showed stratification in Margaret Lake in the ice-free season. Water clarity was very poor, with an average summer Secchi reading of 3.7 ft. The trophic state was mildly eutrophic. Water quality would be classified as fair with respect to phosphorus concentrations. Chlorophyll *a* (a measure of the amount of algae) was considered higher than Wisconsin natural lakes. Nitrogen, chloride, sulfate, hardness, conductivity, calcium, magnesium, sodium, and potassium would all be considered low. Alkalinity (a measure of a lake's buffering capacity against acid rain) was also low. The pH of Margaret Lake was slightly acidic with an average pH of 6.8.

Part 6. Water Use

Margaret Lake has one public access site, and is used by riparian owners and their guests for a variety of recreational activities. There is no State of Wisconsin ownership around the lake, however, the island located in the center of Margaret Lake is owned by the State of Wisconsin.

Part 7. Riparian Area

Part 1 (Watershed) describes the larger riparian area context of Margaret Lake. The near shore riparian area can be appreciated by viewing Exhibit 4. The lake is lightly developed with a fairly intact forested riparian zone that extends for hundreds of feet back from the lake. The forest is a mixture of coniferous and deciduous trees and shrubs. Our review of 2011 aerial photography reveals 25 houses on the lake. 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.

Part 8. Wildlife

Eagle and loon studies have been conducted by the Wisconsin Department of Natural Resources and by many volunteers as part of programs such as LoonWatch. Rare species and communities have also been identified by the WDNR. These data can be viewed in the *Margaret Lake Adaptive Management Plan.*

Frog and toad surveys were conducted near Margaret Lake in 2011 and 2013. Working in consultation with lake stewardship volunteers with local knowledge of area wetlands, Dean Premo (a trained herpetologist) selected ten sites in the immediate landscape of Margaret Lake as prospective frog and toad survey wetlands. Volunteers then surveyed these sites and record species and count. The field data was then conveyed to White Water Associates for analysis and reporting. Results of the Margaret Lake frog and toad survey can be viewed in Appendix I of the *Margaret Lake Adaptive Management Plan*.

In the future it would be desirable to monitor other wetland and water oriented wildlife such as waterfowl, fish-eating birds, aquatic and semi-aquatic mammals, and invertebrate animals. Also of special importance would be monitoring for the presence of aquatic invasive wildlife species (for example, rusty crayfish, spiny water flea, or zebra mussel) and fish species (for example, rainbow smelt or common carp).

Margaret 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). Margaret Lake is considered a PNW with self-sustaining musky and walleye populations.

Part 9. Stakeholders

At this juncture in the ongoing aquatic plant management planning process, the MLA has represented the Margaret 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 direct plant management actions (for example, harvesting or use of herbicides) are a component of the current plan. The MLA solicited input from all Margaret Lake residents to better understand the needs, knowledge

base, concerns and desires of the various water body users. The results of these lake user surveys are presented in the *Margaret Lake Adaptive Management Plan* (Premo et al., 2014).

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 AIS and nuisance levels of native plants;
(3) Promote and interpret APM efforts; and
(4) 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 Margaret Lake is a healthy and diverse ecosystem, we could simply recommend an alternative of "no action." In other words, Margaret 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 Margaret Lake Stewardship Program and the Margaret Lake Association feels a great responsibility to minimize the threats. We therefore outline in this section a set of actions and related management objectives that will actively engage 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).

At this time, we recommend no direct manipulation of plant populations in Margaret Lake. No aquatic invasive plant species are known to be present and no native plants exhibit nuisance population size or distribution.

Recommended Actions for the Margaret Lake APM Plan
Action #1: Formally adopt the Aquatic Plant Management Plan. ***Objective:*** To provide foundation for long-term native plant community conservation and stewardship and to be prepared for response to AIS introductions. ***Monitoring:*** The Margaret Lake Association oversees activity and maintains the plan. ***Status:*** Planned for 2014.
Action #2: Monitor water quality. ***Objective***: Continue with collection and analysis of water quality parameters to detect trends in parameters such as nutrients, chlorophyll *a*, and water clarity. ***Monitoring:*** The Margaret Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #3: Monitor the lake for 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 Margaret Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #4: 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 Margaret Lake Association oversees activity and maintains data. ***Status:*** Ongoing.
Action #5: Form an Aquatic Invasive Species Rapid Response Team and interface with the AIS Rapid Response Coordinator. ***Objective:*** To be prepared for AIS discovery and efficient response. ***Monitoring:*** The Margaret Lake Association coordinates activity. ***Status:*** Planned for 2014.
Action #6: 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:*** Margaret Lake Association oversees and maintains data; copies to WDNR. ***Status:*** Anticipated in 2016.

Recommended Actions for the Margaret Lake APM Plan
Action #7: 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 #8: Become familiar with and recognize the water quality and habitat values of ordinances and requirements on boating, septic, and property development. ***Objective:*** To protect native aquatic plants, water quality, and riparian habitat. ***Monitoring:*** Lake residents and other stakeholders. ***Status:*** Ongoing.
Action #9: 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 Margaret Lake Association oversees activity and assesses effectiveness. ***Status:*** Anticipated to begin in 2015.
Action #10: Monitor the lake watershed for purple loosestrife. ***Objective:*** Identify purple loosestrife populations before they reach large size. ***Monitoring:*** The Margaret Lake Association oversees activity. ***Status:*** Anticipated in 2015.

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 Margaret 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 Margaret Lake Association and other lake stewards to be prepared for the contingency of aquatic invasive plant species colonization in Margaret Lake.

For riparian owners and users of a lake ecosystem, the discovery of AIS is a 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 11 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

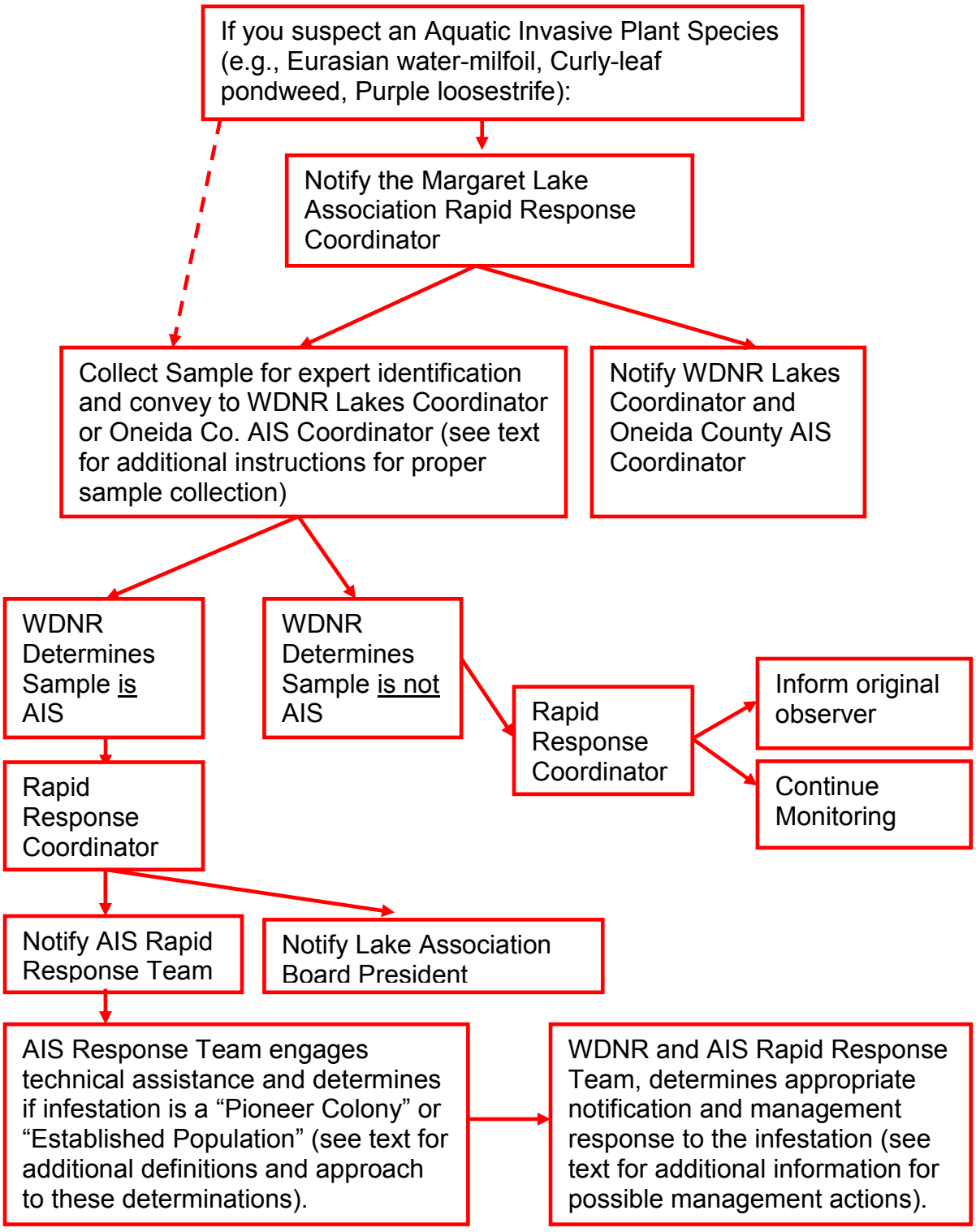
the sample to the WDNR Water Resources Management Specialist Kevin Gauthier and/or Michele Sadauskas (AIS Coordinator for Oneida County) as soon as possible (at least within three days). The WDNR or their botanical expert(s) will determine the species and confirm whether or not it is an aquatic invasive 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 11. Aquatic Invasive Plant Species Rapid Response



Appendix 1
Literature Cited

Literature Cited

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Appendix 2

Aquatic Plant Survey Tables and Figures

Table of Contents

Table 1. Summary statistics for the 2011 point-intercept aquatic plant surveys for Margaret Lake.

Summary Statistic	Value	Notes
Total number of sites on grid	282	Total number of sites on the original grid (not necessarily visited)
Total number of sites visited	268	Total number of sites where the boat stopped, even if much too deep to have plants.
Total number of sites with vegetation	114	Total number of sites where at least one plant was found
Total number of sites shallower than maximum depth of plants	215	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	53.0	Number of times a species was seen divided by the total number of sites shallower than maximum depth of plants.
Simpson Diversity Index	0.85	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.)	9.0	The depth of the deepest site sampled at which vegetation was present.
Number of sites sampled with rake on rope	0	
Number of sites sampled with rake on pole	268	
Average number of all species per site (shallower than max depth)	0.97	
Average number of all species per site (vegetated sites only)	1.83	
Average number of native species per site (shallower than max depth)	0.97	Total number of species collected. Does not include visual sightings.
Average number of native species per site (vegetated sites only)	1.83	Total number of species collected including visual sightings.
Species Richness	21	
Species Richness (including visuals)	29	
Floristic Quality Index (FQI)	28.4	

Table 2. Plant species recorded and distribution statistics for the 2011 Margaret Lake aquatic plant survey.

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
White-stem pondweed	*Potamogeton praelongus*	27.44	51.75	28.23	59	85	1.08
Common waterweed	*Elodea canadensis*	20.47	38.60	21.05	44	46	1.00
Flat-stem pondweed	*Potamogeton zosteriformis*	7.91	14.91	8.13	17	25	1.00
White water lily	*Nymphaea odorata*	6.51	12.28	6.70	14	29	1.14
Coontail	*Ceratophyllum demersum*	6.05	11.40	6.22	13	14	1.46
Nitella	*Nitella* sp.	4.65	8.77	4.78	10	10	1.00
Narrow-leaved bur-reed	*Sparganium angustifolium*	4.65	8.77	4.78	10	13	1.00
Spatterdock	*Nuphar variegata*	4.19	7.89	4.31	9	22	1.00
Watershield	*Brasenia schreberi*	3.72	7.02	3.83	8	32	1.00
Pickerelweed	*Pontederia cordata*	2.33	4.39	2.39	5	13	1.00
Small pondweed	*Potamogeton pusillus*	1.86	3.51	1.91	4	5	1.00
Muskgrasses	*Chara* sp.	1.40	2.63	1.44	3	3	1.00
Large-leaf pondweed	*Potamogeton amplifolius*	1.40	2.63	1.44	3	13	1.00
Variable pondweed	*Potamogeton gramineus*	0.93	1.75	0.96	2	6	1.00
Floating-leaf pondweed	*Potamogeton natans*	0.93	1.75	0.96	2	9	1.00
Creeping spikerush	*Eleocharis palustris*	0.47	0.88	0.48	1	4	1.00
Slender naiad	*Najas flexilis*	0.47	0.88	0.48	1	1	1.00
Crested arrowhead	*Sagittaria cristata*	0.47	0.88	0.48	1	1	1.00
Common bladderwort	*Utricularia vulgaris*	0.47	0.88	0.48	1	1	1.00
Bottle brush sedge	*Carex comosa*	0.47	0.88	0.48	1	1	1.00
Quillwort	*Isoetes* sp.	0.47	0.88	0.48	1	1	1.00
Three-way sedge	*Dulichium arundinaceum*				Visual	1	
Needle spikerush	*Eleocharis acicularis*				Visual	2	
Water horsetail	*Equisetum fluviatile*				Visual	3	

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.

Table 2. 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
Clasping-leaf pondweed	*Potamogeton richardsonii*				Visual	1	
Hardstem bulrush	*Schoenoplectus acutus*				Visual	1	
Softstem bulrush	*Schoenoplectus tabernaemontani*				Visual	1	
Floating-leaf bur-reed	*Sparganium fluctuans*				Visual	2	
Small bur-reed	*Sparganium natans*				Visual	1	
Water marigold	*Bidens beckii (*formerly *Megalodonta)*				Boat Survey		
Vasey's pondweed	*Potamogeton vaseyi*				Boat Survey		
Broad-leaved cattail	*Typha latifolia*				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.

Potamogeton vaseyi is considered a Special Concern species in Wisconsin.

Figure 1. Number of plant species recorded at Margaret Lake sample sites (2011).

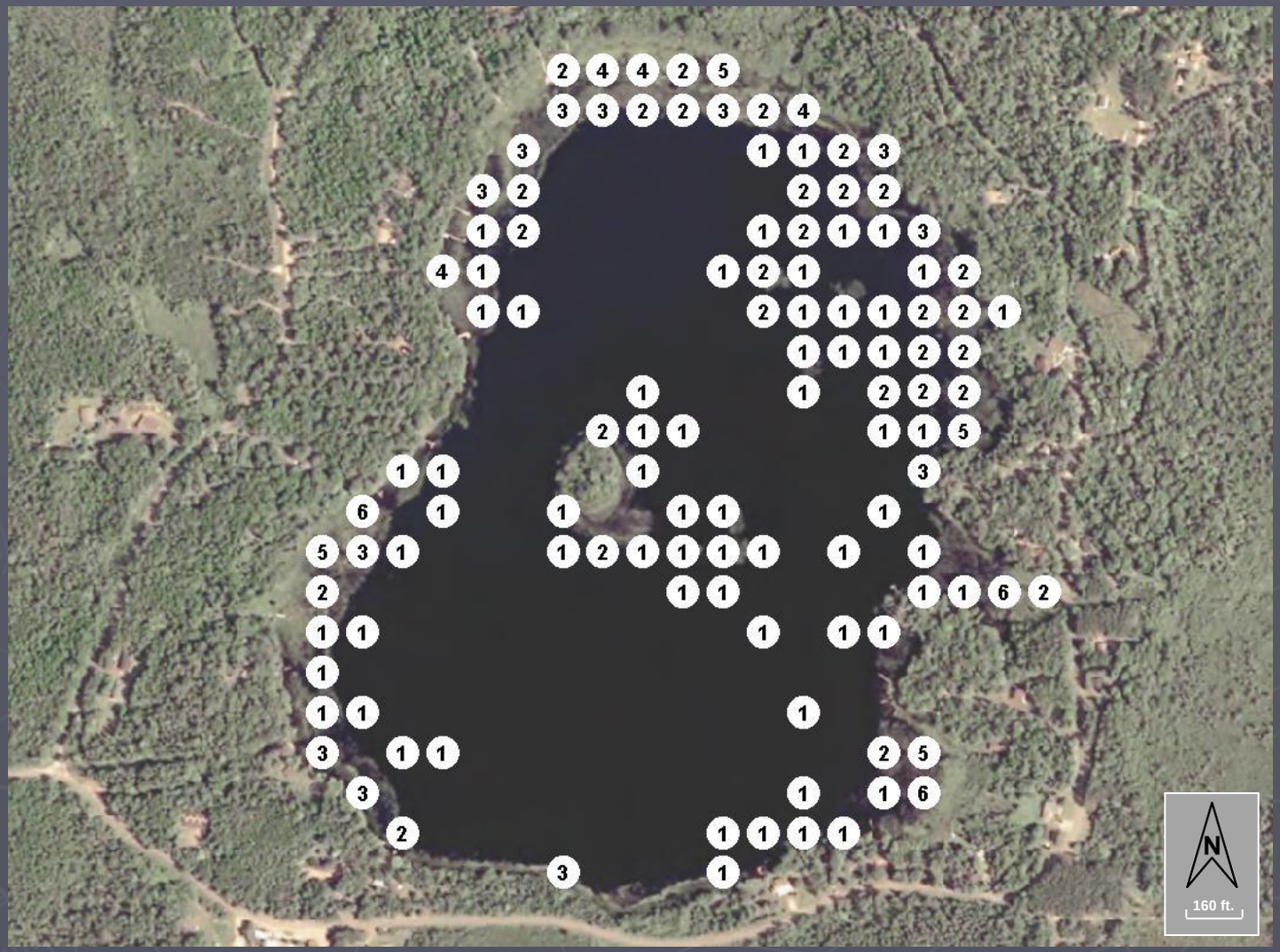


Figure 2. Rake fullness ratings for Margaret Lake sample sites (2011).

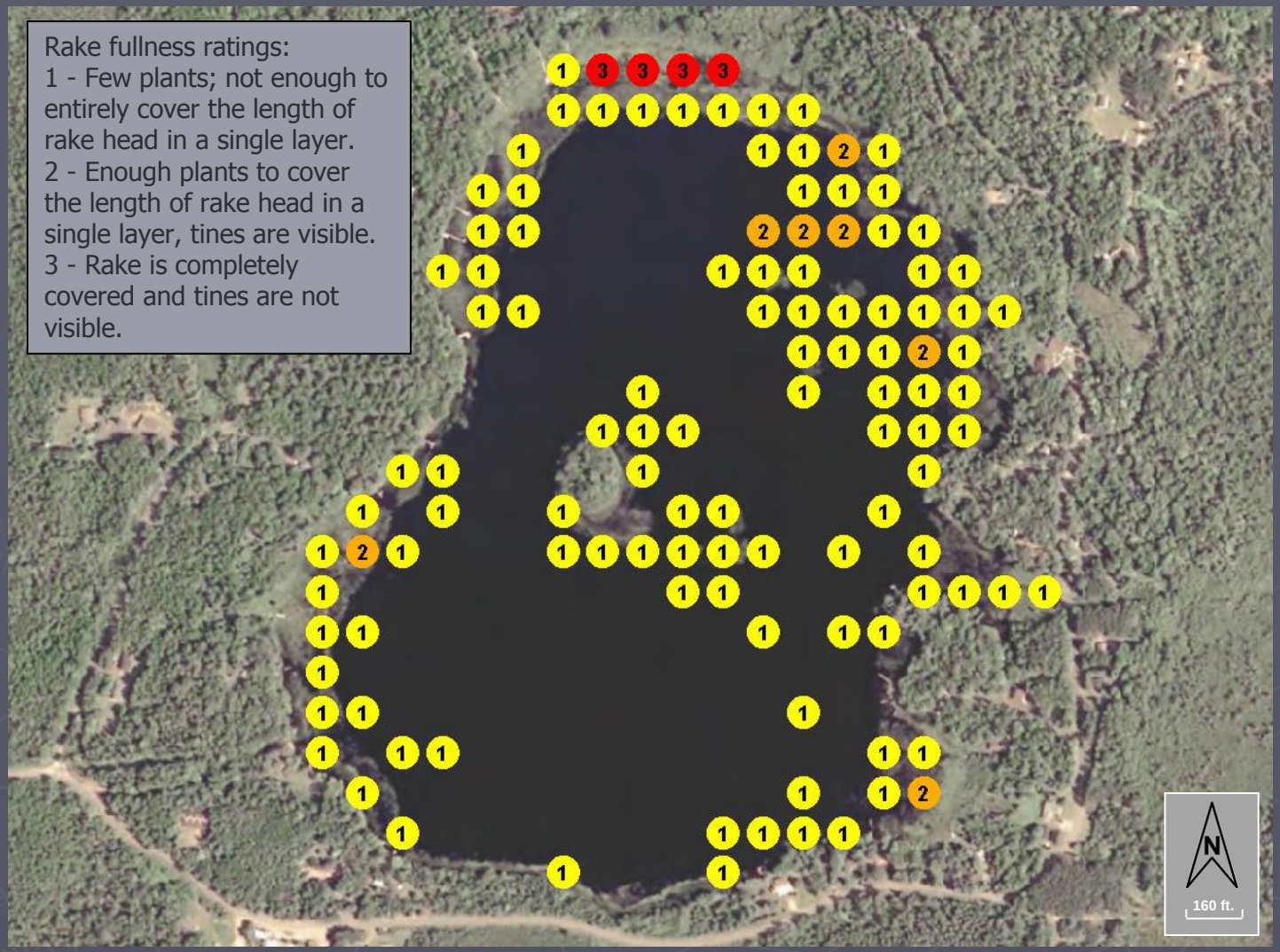


Figure 3. Maximum Depth of Plant Colonization in Margaret Lake.

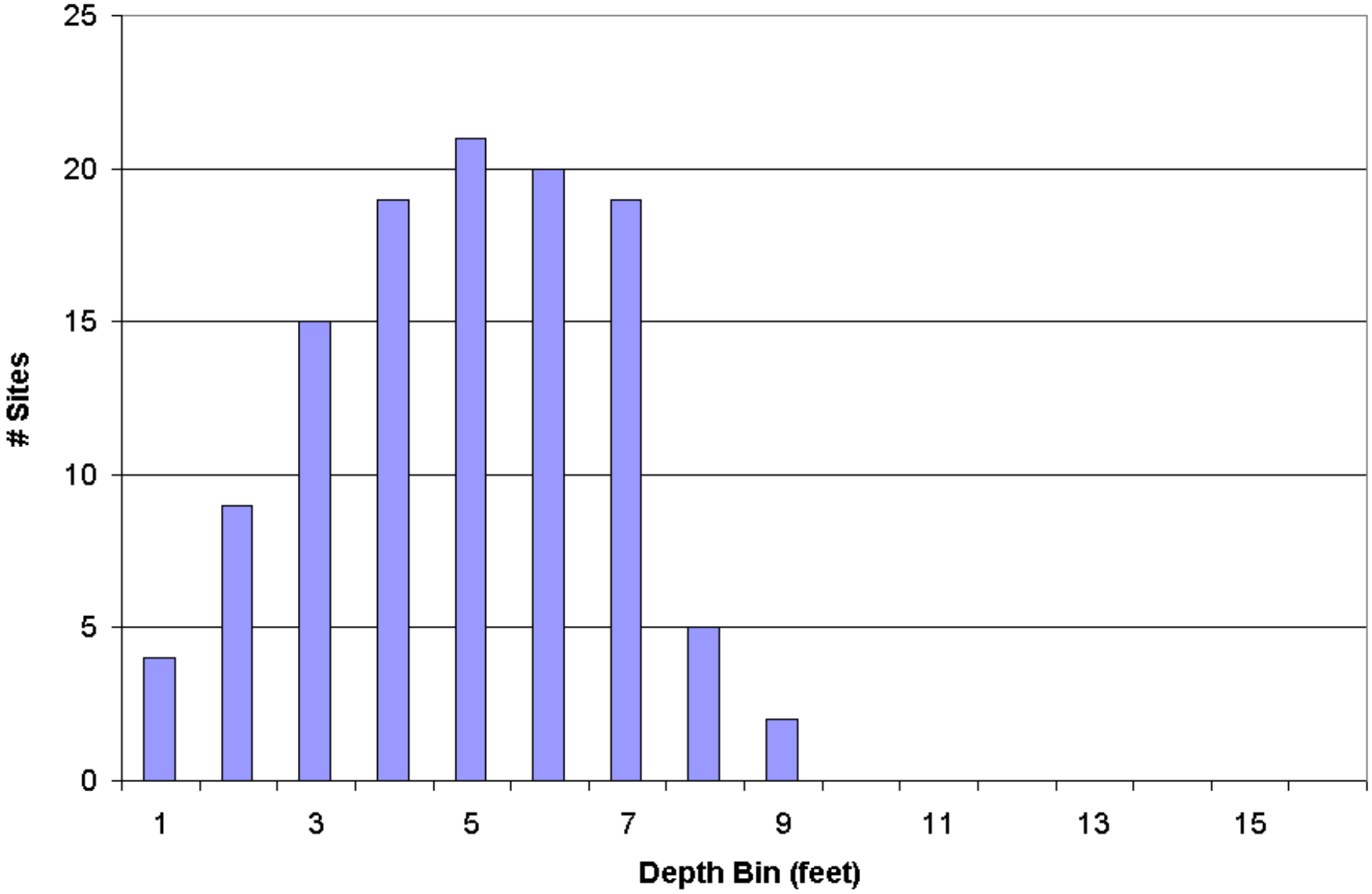


Figure 4. Margaret Lake sampling sites less than or equal to maximum depth of rooted vegetation (2011).

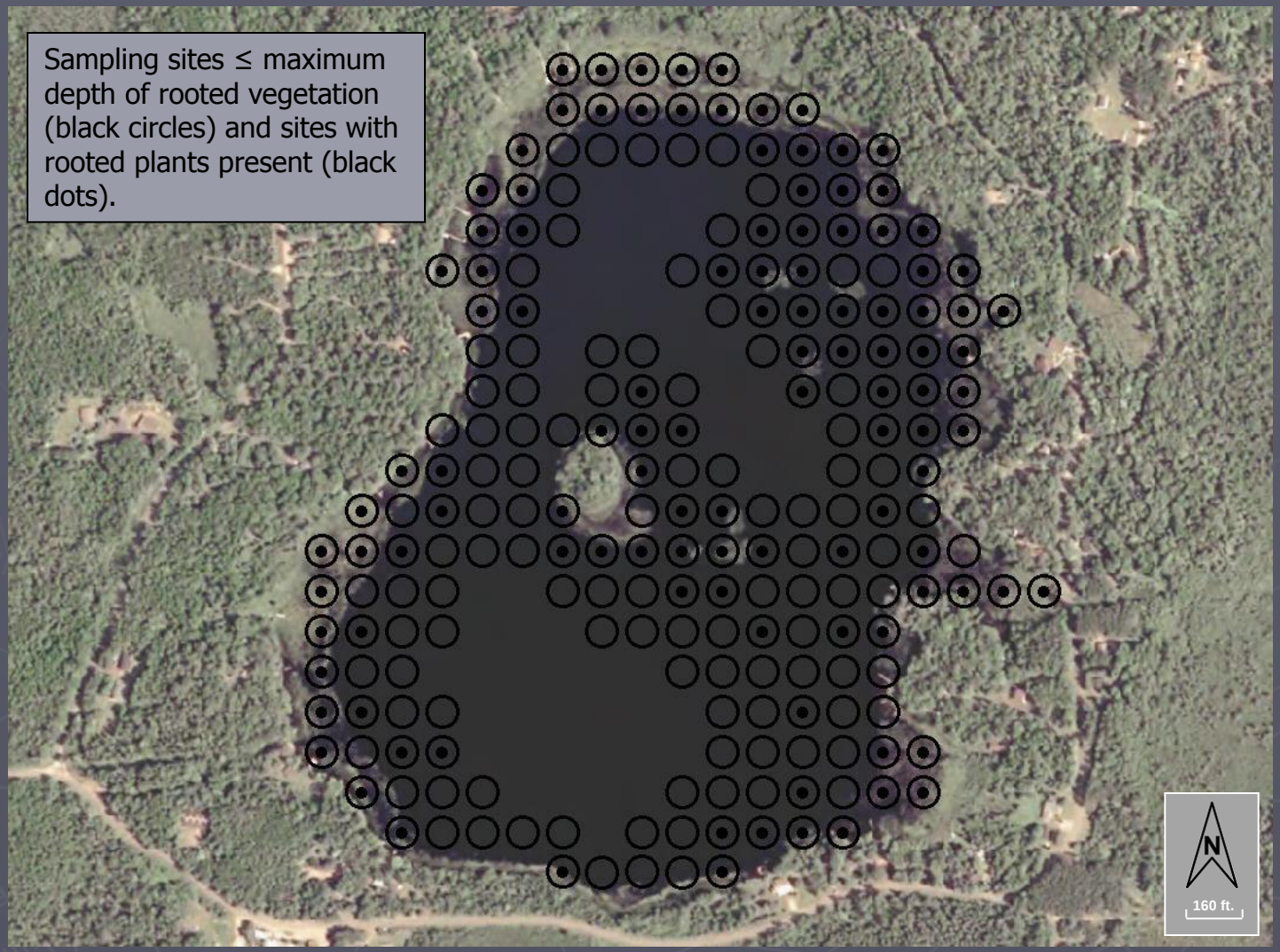


Figure 5. Margaret Lake substrate encountered at point-intercept plant sampling sites (2011).

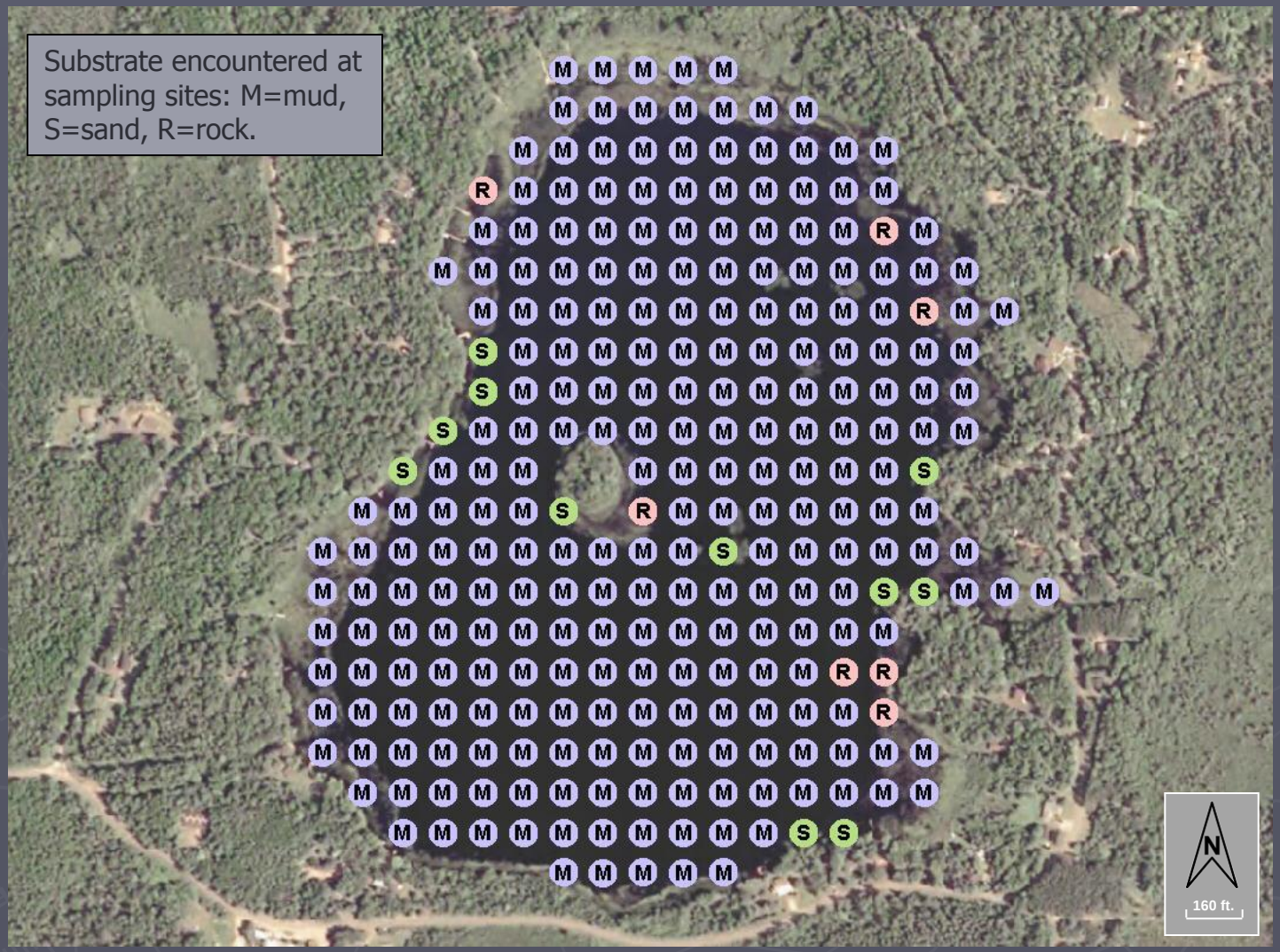


Figure 6. Margaret Lake aquatic plant occurrences for 2011 point-intercept survey data.

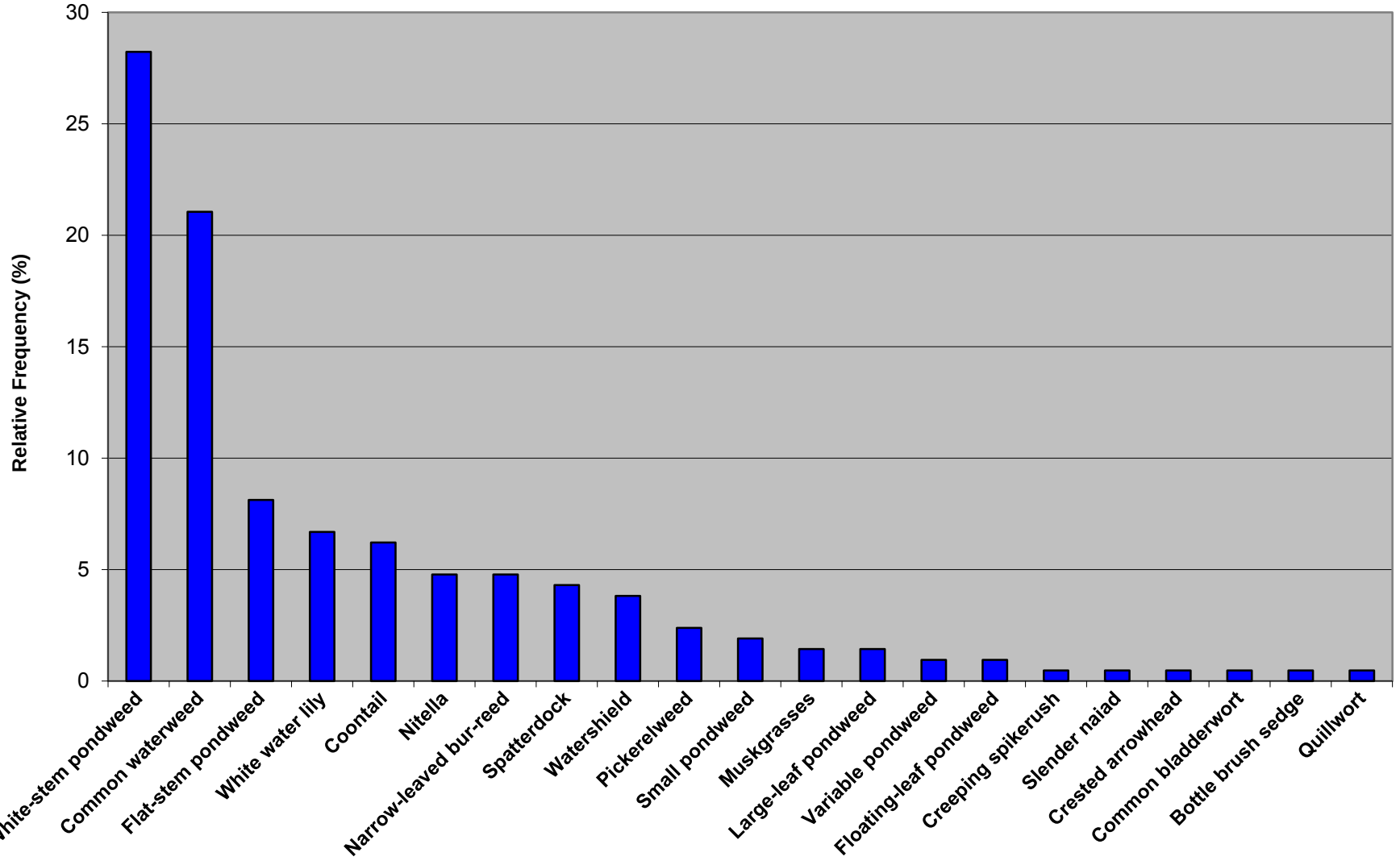


Figure 7. Margaret Lake point-intercept plant sampling sites with emergent and floating aquatic plants (2011).

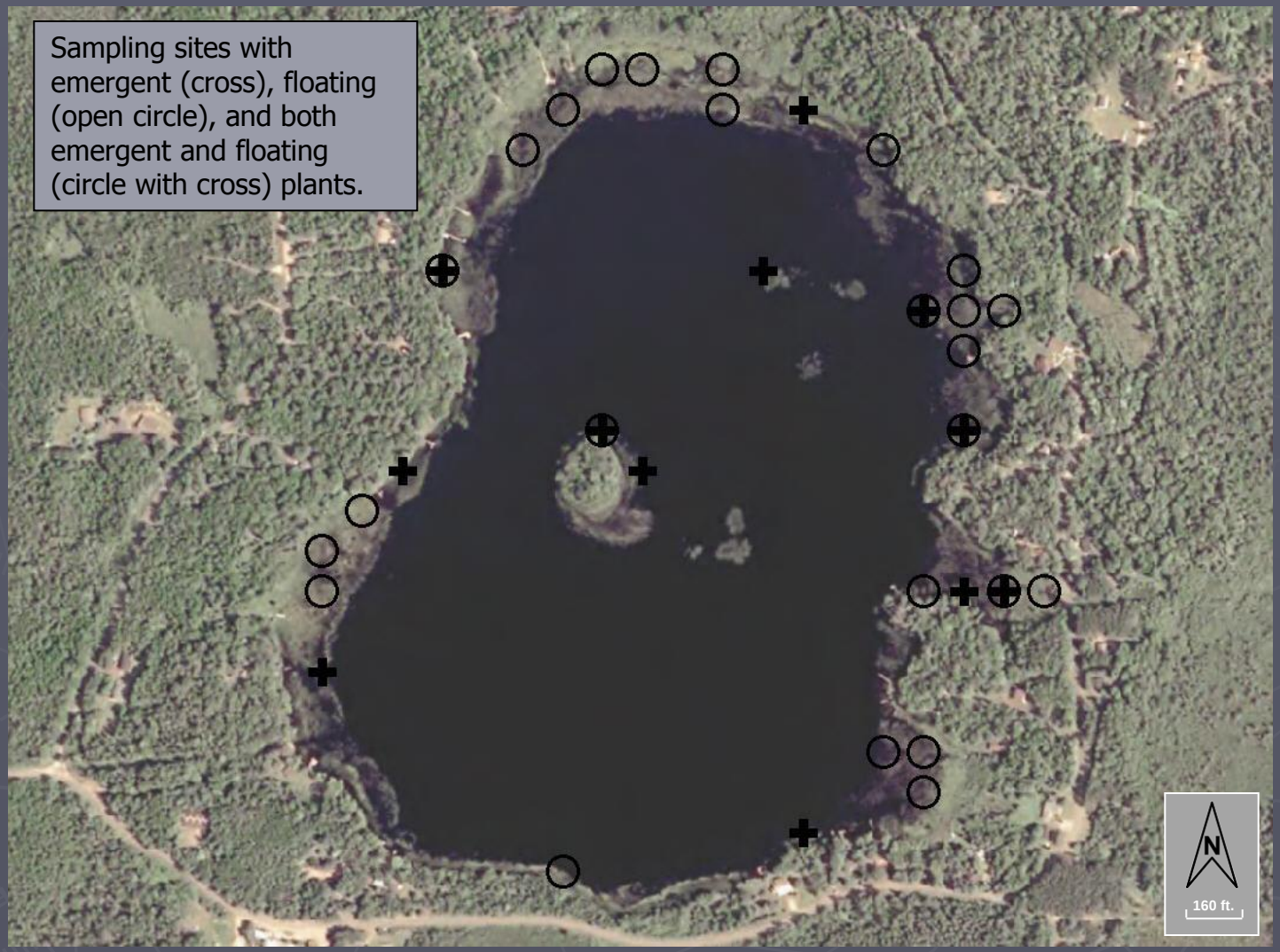
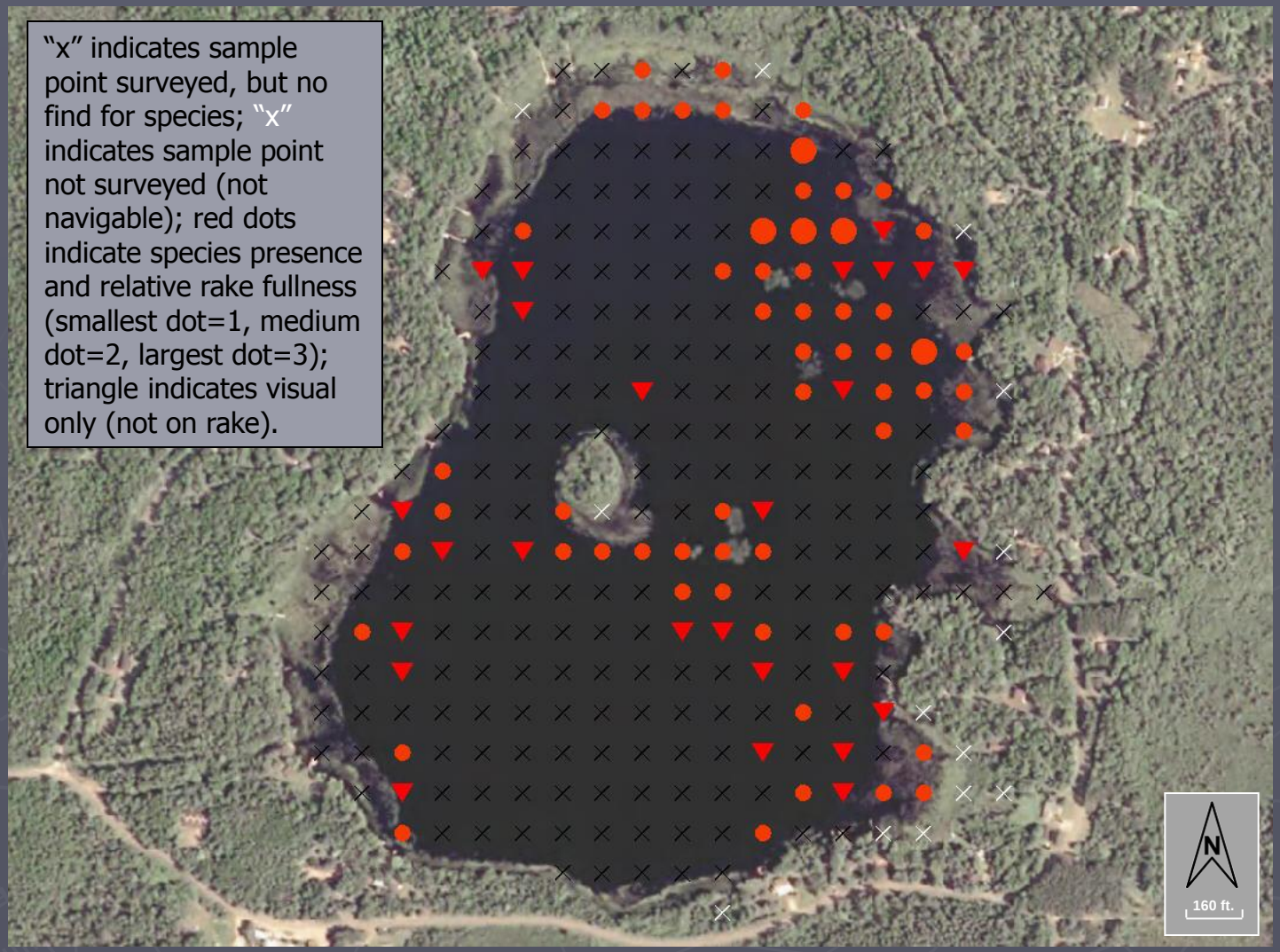
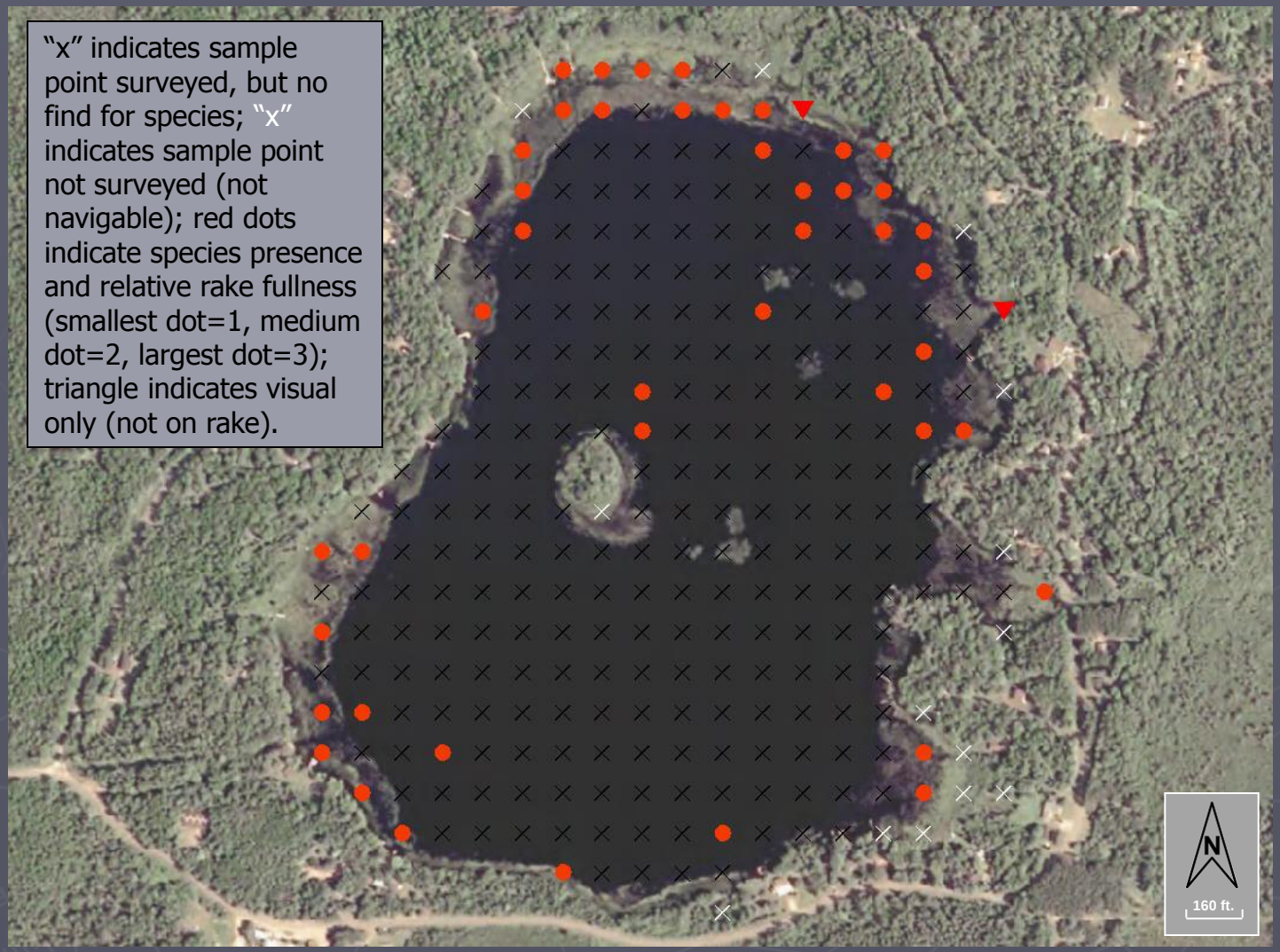


Figure 8. Distribution of plant species, Margaret Lake (2011).



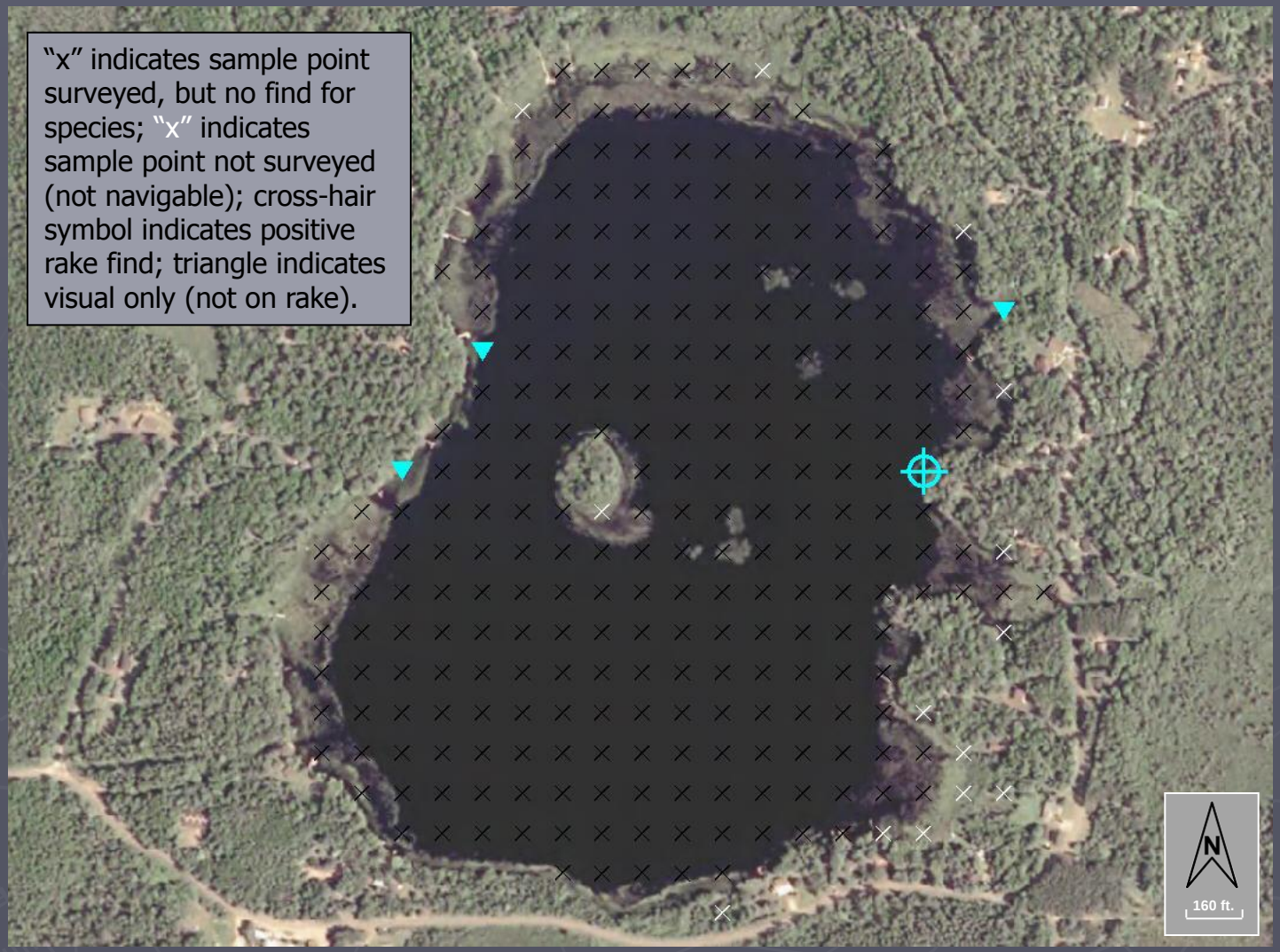
Potamogeton praelongus (White-stem pondweed)

Figure 9. Distribution of plant species, Margaret Lake (2011).



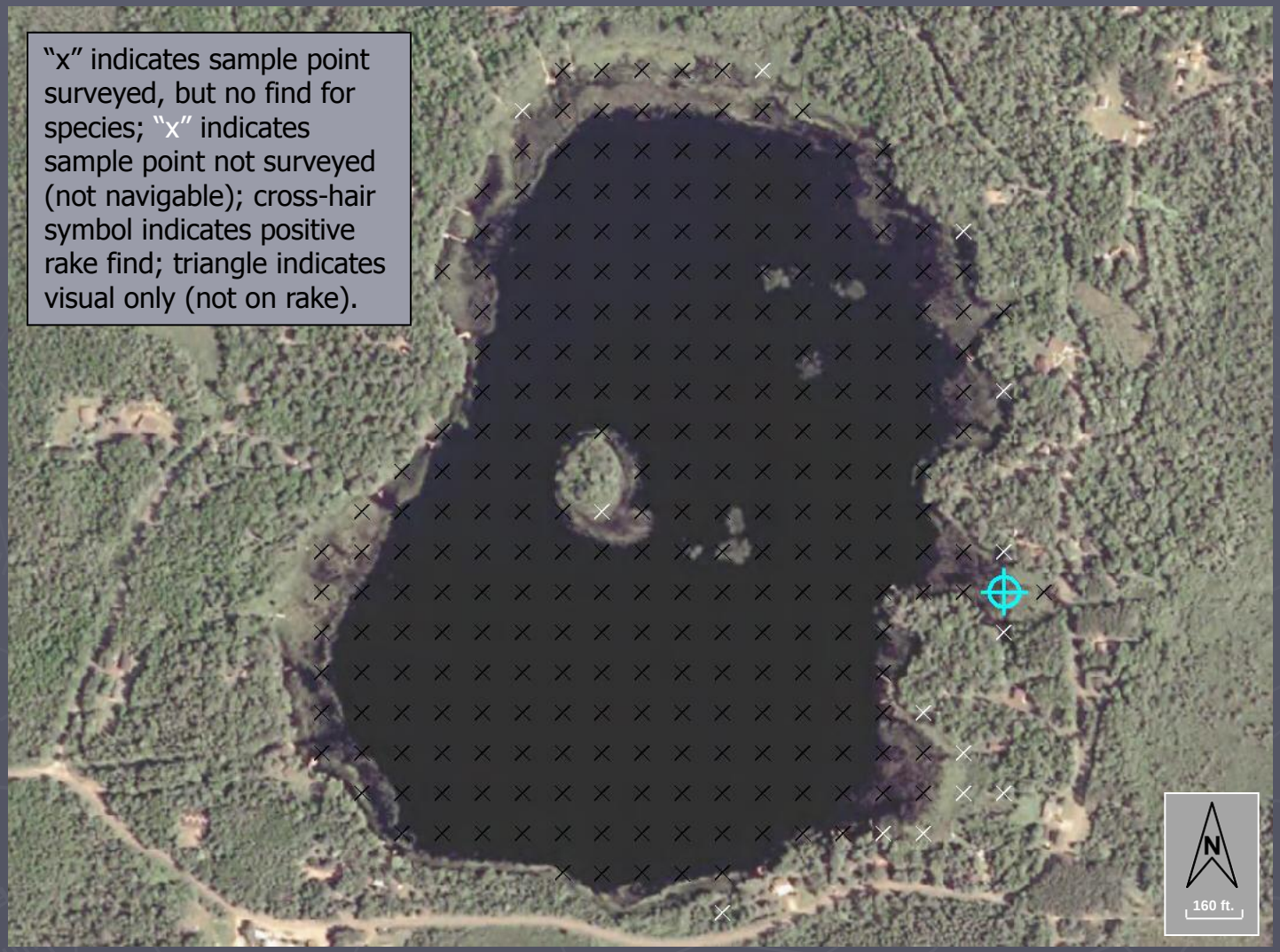
Elodea canadensis (Common waterweed)

Figure 10. Distribution of plant species, Margaret Lake (2011).



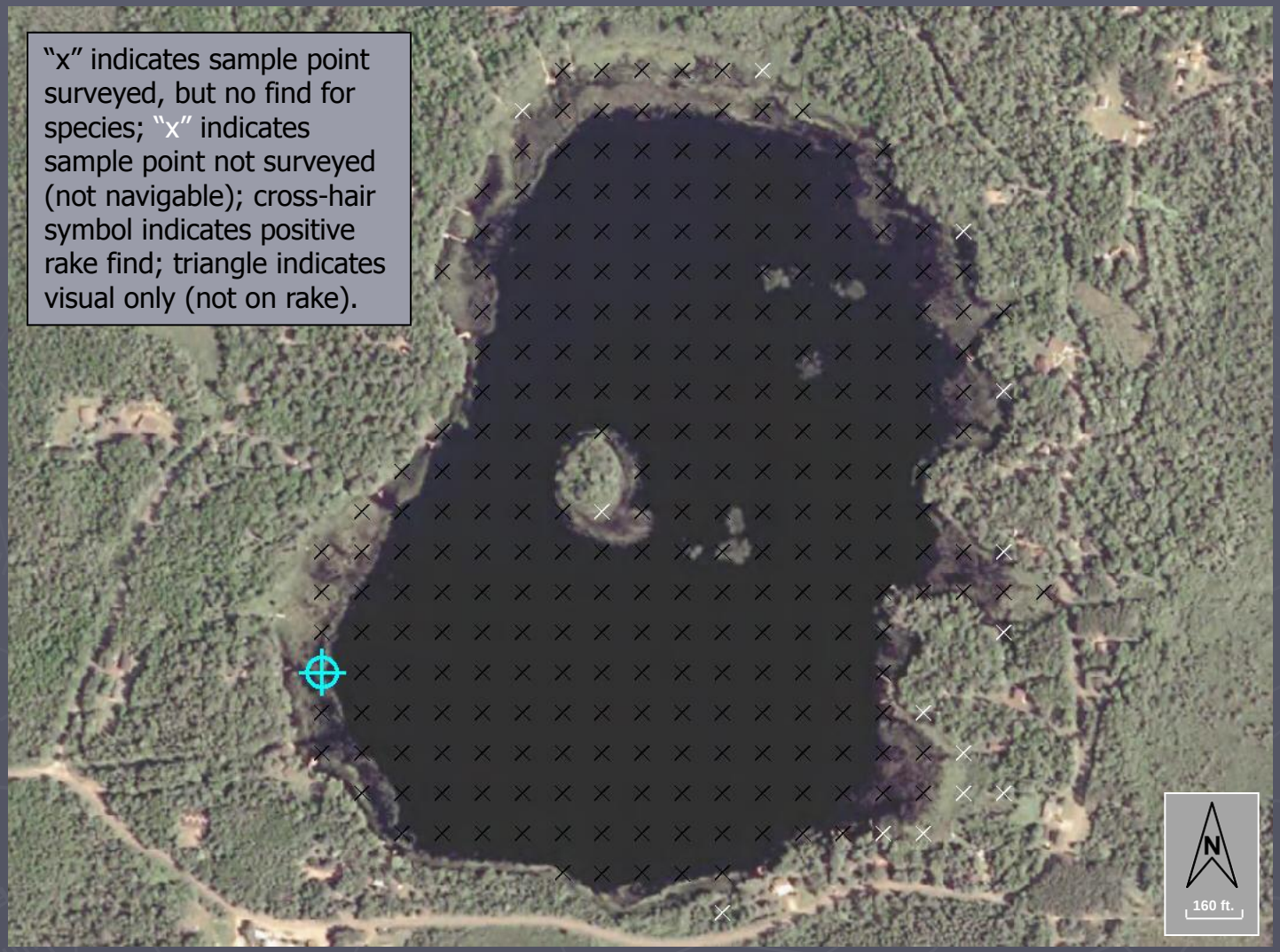
Eleocharis palustris (Creeping spikerush)

Figure 11. Distribution of plant species, Margaret Lake (2011).



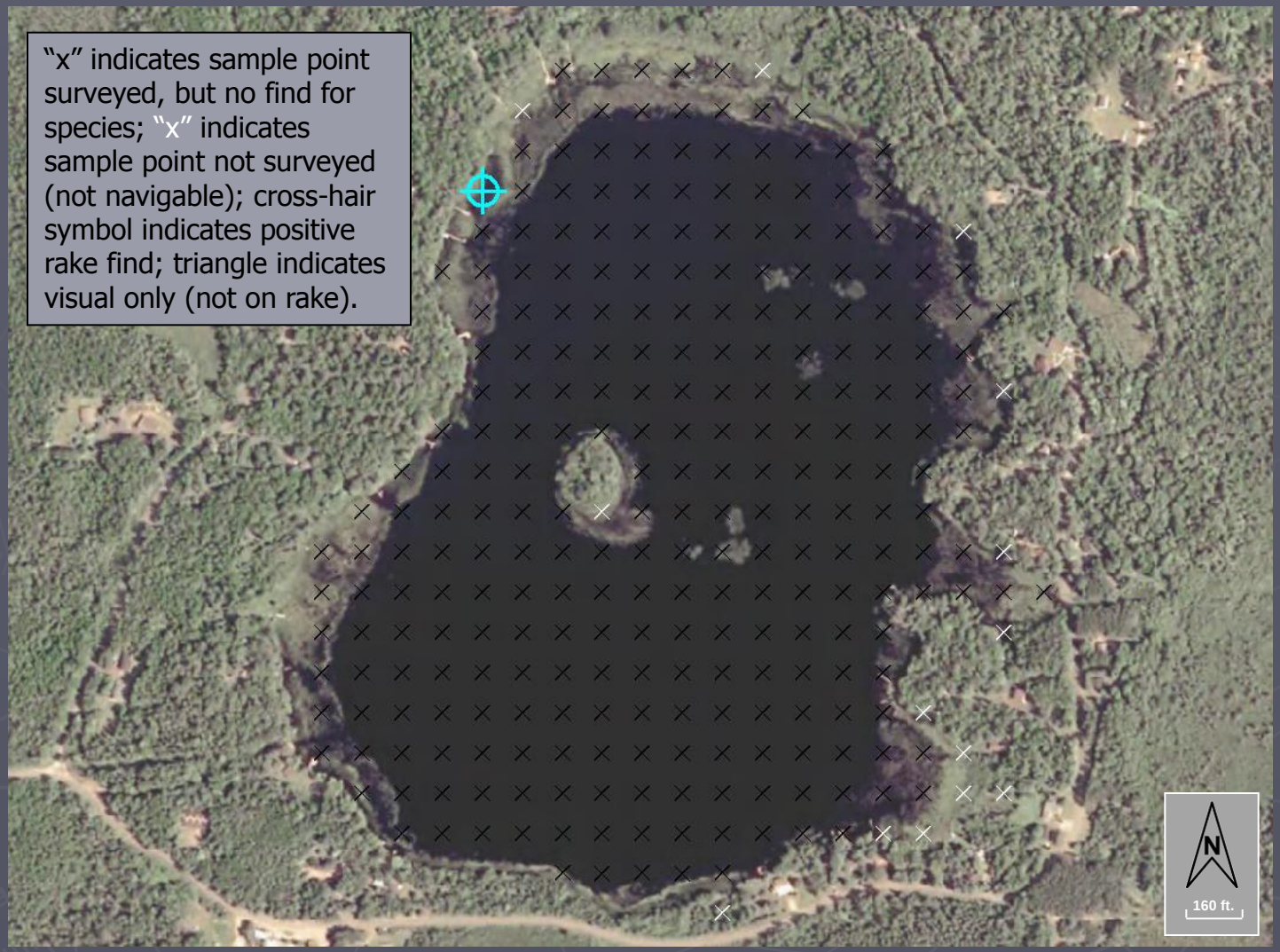
Najas flexilis (Slender naiad)

Figure 12. Distribution of plant species, Margaret Lake (2011).



Sagittaria cristata (Crested arrowhead)

Figure 13. Distribution of plant species, Margaret Lake (2011).



Utricularia vulgaris (Common bladderwort)

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Appendix 3

Review of Margaret Lake Water Quality

Note: This document is available as Appendix C of the

Margaret Lake Adaptive Management Plan

(starts on following page)

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Appendix C
Margaret Lake Review of Water Quality

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Appendix C

Review of Lake Water Quality

Table of Contents

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Review of Margaret Lake Water Quality

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

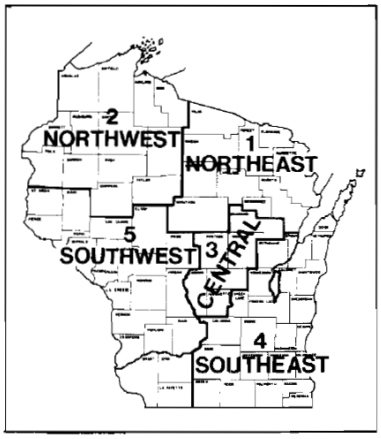
Introduction

Margaret Lake is an 86 acre drainage lake with a maximum depth of 14 feet. It is located in Oneida County, Wisconsin. There is a public boat landing on the southwest end of the lake. The Water Body Identification Code (WBIC) is 1615900, and the Station ID is 443314. In 1985, a volunteer with the WDNR collected data for a variety of parameters at depths of 3 feet and 11 feet. Data was also collected by Citizen Lake Monitoring Network (CLMN) volunteers from 1993 to 2012. White Water Associates collected data on July 12, 2011, September 8, 2011, July 24, 2012, and July 18, 2013.

Comparison of Margaret Lake with Other Datasets

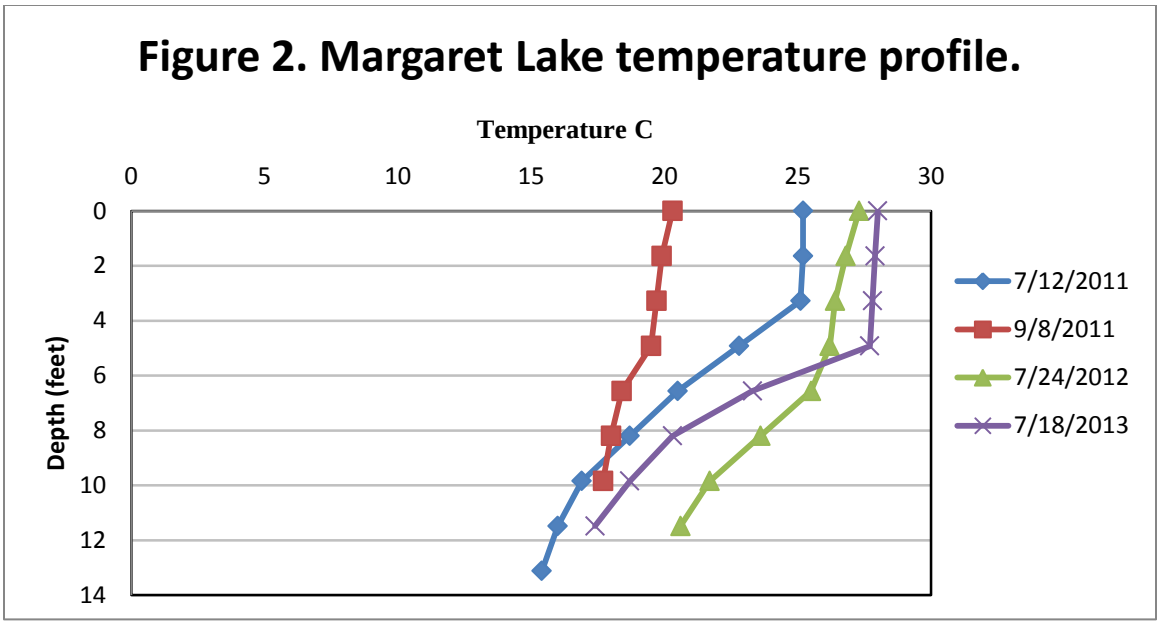
Lillie and Mason's *Limnological Characteristics of Wisconsin Lakes* (1983) is a great source to compare lakes within our region to a subset of lakes that have been sampled in Wisconsin. Wisconsin is divided into five regions of sampling lakes. Oneida County lakes are in the Northeast region (Figure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

Figure 1. Wisconsin regions in terms of water quality.



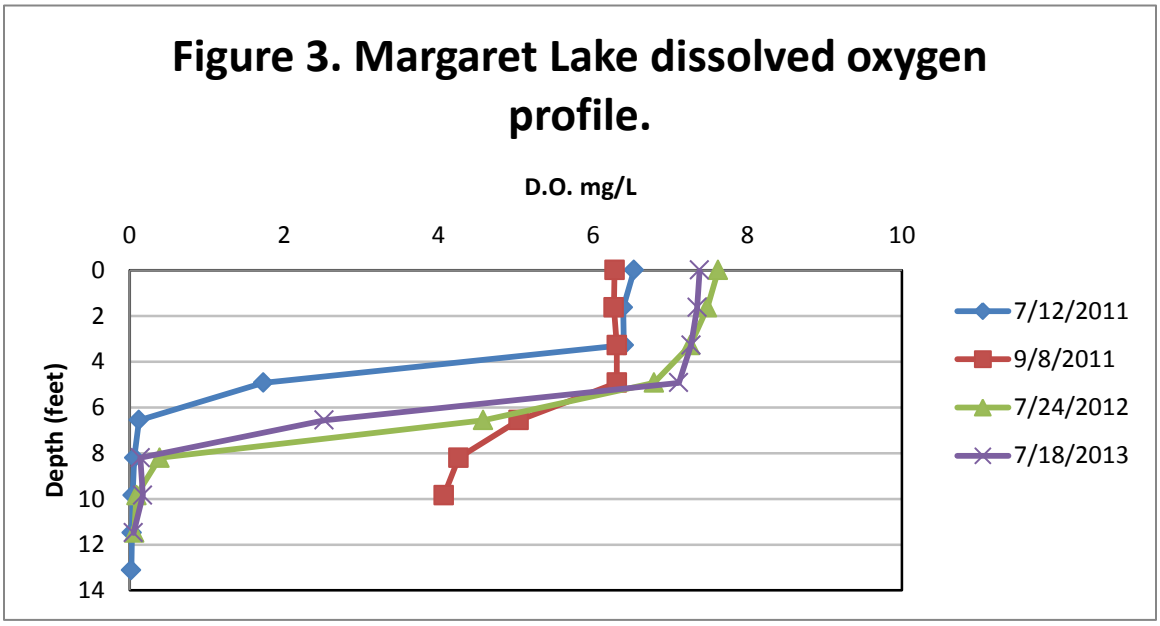
Temperature

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. 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 in a lake. In July, 2011, the lake stratified at 3.2 feet and in July, 2013 at 4.9 feet (Figure 2). In July, 2012, the lake stratified at 6.5 feet. September, 2011 indicates a fall turnover.



Dissolved Oxygen

The dissolved oxygen 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. In the month of July, oxygen levels are near zero at 6.5 to 8.2 feet deep (Figure 3). In September, oxygen levels remain between 4 and 6 mg/L up to 9.8 feet deep to fall turnover.



Water Clarity

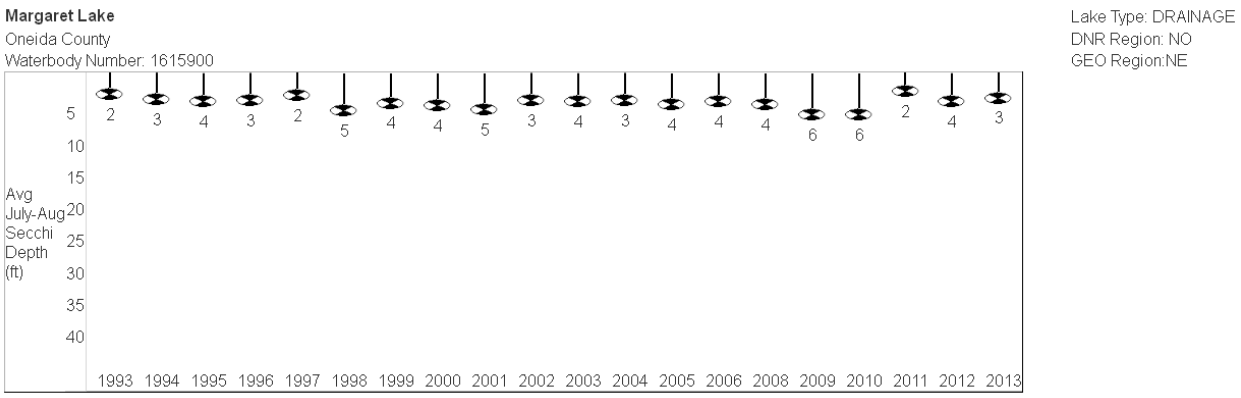
Water clarity has two main components: turbidity (suspended materials such as algae and silt) and true color (materials dissolved in the water) (Shaw et al., 2004). Water clarity gives an indication of the overall water quality in a lake. Water clarity is typically measured using a Secchi disk (black 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 4 displays the summer Secchi depths over several years on Margaret Lake. Since 1993, the average Secchi depth was 3.7 feet, which is "very poor" in regard to water clarity (Table 1). In comparison with other Wisconsin lakes, Margaret Lake tends to have low Secchi depths. In 2009, the Secchi reading was deepest at 7.5 feet, and in 2011 was lowest at 1.75 feet (Figure 5). The Secchi depth may have been mostly impacted by tannins—a stain from decaying matter. Tannins are natural and are not a result of pollution. Even though the water seems brown in color, it looks clear and appears like tea.

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 4. Secchi depth averages for Margaret Lake (July and August only).



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

(WDNR, 2013)

Figure 5. Margaret Lake's July and August Secchi Data: Mean, Min, Max, and Secchi Count.

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1993	2.3	2	2.5	5
1994	3.1	2	4	7
1995	3.5	3	4	5
1996	3.4	3	3.75	6
1997	2.5	2.5	2.5	3
1998	5	4.5	6	6
1999	3.8	3.5	4.5	6
2000	4.2	3.5	5.75	4
2001	4.8	4.25	5.5	5
2002	3.3	2.5	4	4
2003	3.5	3.5	3.5	2
2004	3.3	3	4	3
2005	4	4	4	3
2006	3.5	3	4	2
2008	4	3.5	4.5	4
2009	5.6	4.5	7.5	4
2010	5.6	4.5	7	4
2011	1.9	1.75	2.25	4
2012	3.5	3	4	4
2013	3	3	3	2

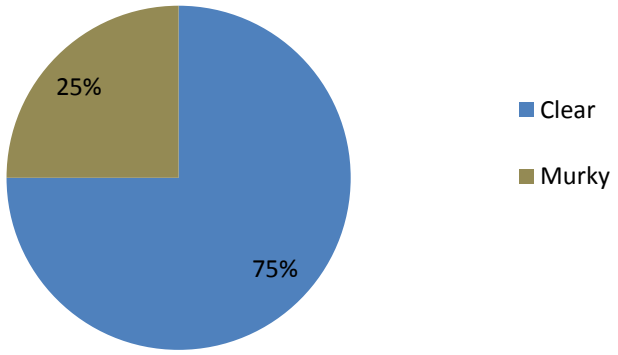
Report Generated: 10/31/2013

(WDNR, 2013)

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. Margaret Lake has not had turbidity sampled in the past, but since 1997, 75% of CLMN volunteers have noted that the water column was "clear" (Figure 6).

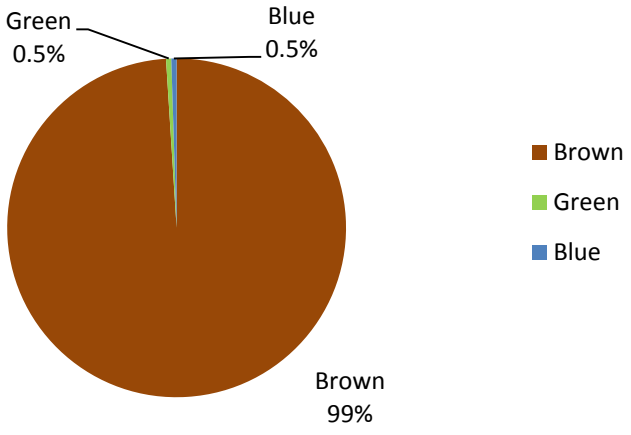
Figure 6. Margaret Lake water appearance, 1997-2012.



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. In July, 1985, the color was 125 Pt-Co, and in July, 2011, the color was 130 Pt-Co. From 1993 to 2012, 99% of CLMN volunteers viewed Margaret Lake as "brown," and 0.5% viewed it as each "green" and "blue" (Figure 7).

Figure 7. Margaret Lake visual water color, 1993-2012.



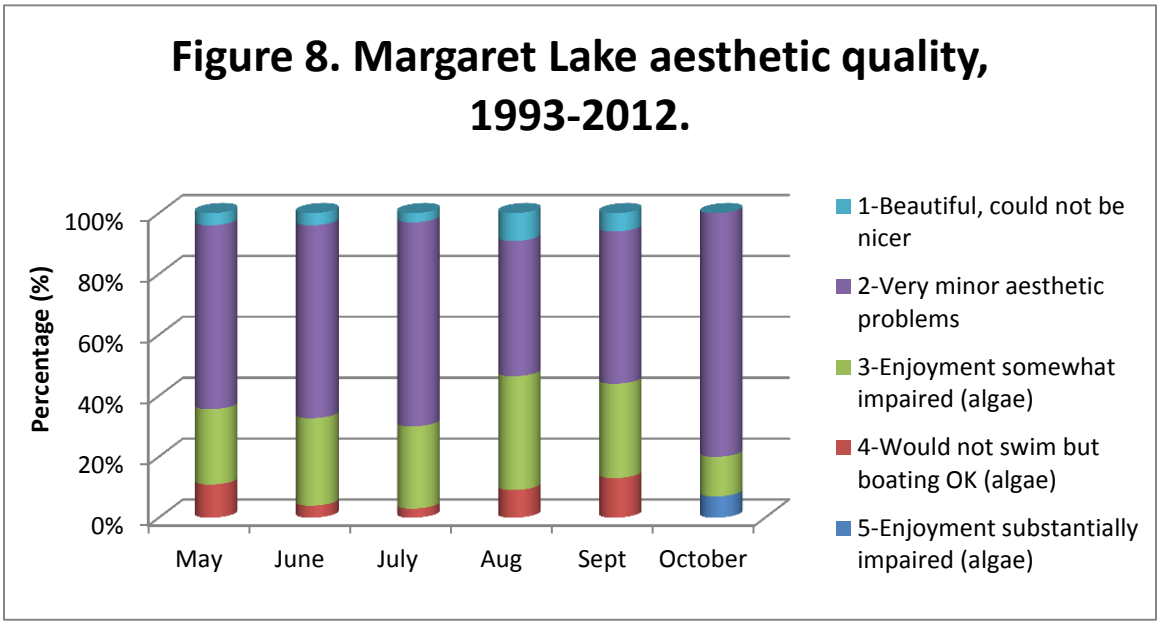
Water Level

When CLMN volunteers collect Secchi depth readings, they also record their perception of the lake level as "high," "normal," or "low." Lake level data was not collected for Margaret Lake.

User Perceptions

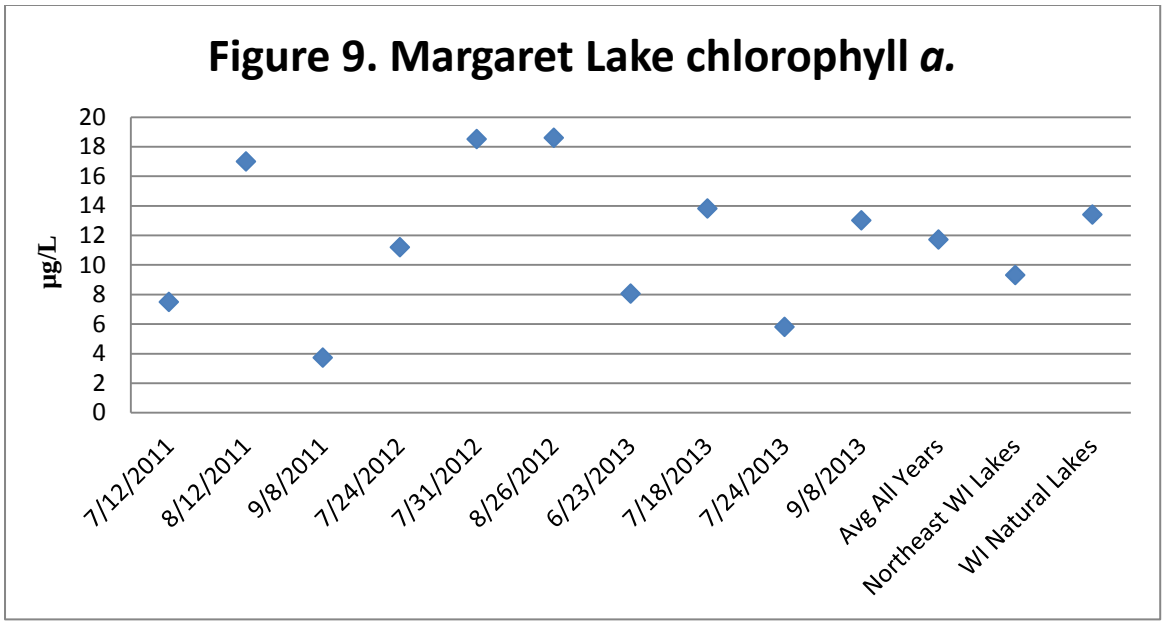
When Secchi depth readings are collected, the CLMN record their perceptions of the water, based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake user would experience the lake at that time. When interpreting the transparency data, we see that when the Secchi depth decreases, the rating of the lake's physical appearance also decreases.

These perceptions of recreational suitability from 1993 to 2012 are displayed by month in Figure 8. In May, June, July, and October, the majority of CLMN volunteers said there were "very minor aesthetic problems," and in October, a small percentage said the "enjoyment was substantially impaired (algae)."



Chlorophyll *a*

Chlorophyll *a* is the photosynthetic pigment that makes plants and algae green. Chlorophyll *a* in lake water is therefore 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. Chlorophyll *a* levels in Margaret Lake were below nuisance levels, but were higher certain times than the average for Wisconsin natural lakes (Figure 9).



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). Margaret Lake has high phosphorus values compared to other NE Wisconsin natural lakes (Figure 10). Figure 11 indicates the water quality index, under a range of phosphorus concentrations, and classifies Margaret Lake as "good," with respect to the average phosphorus concentration (30.3 µg/L).

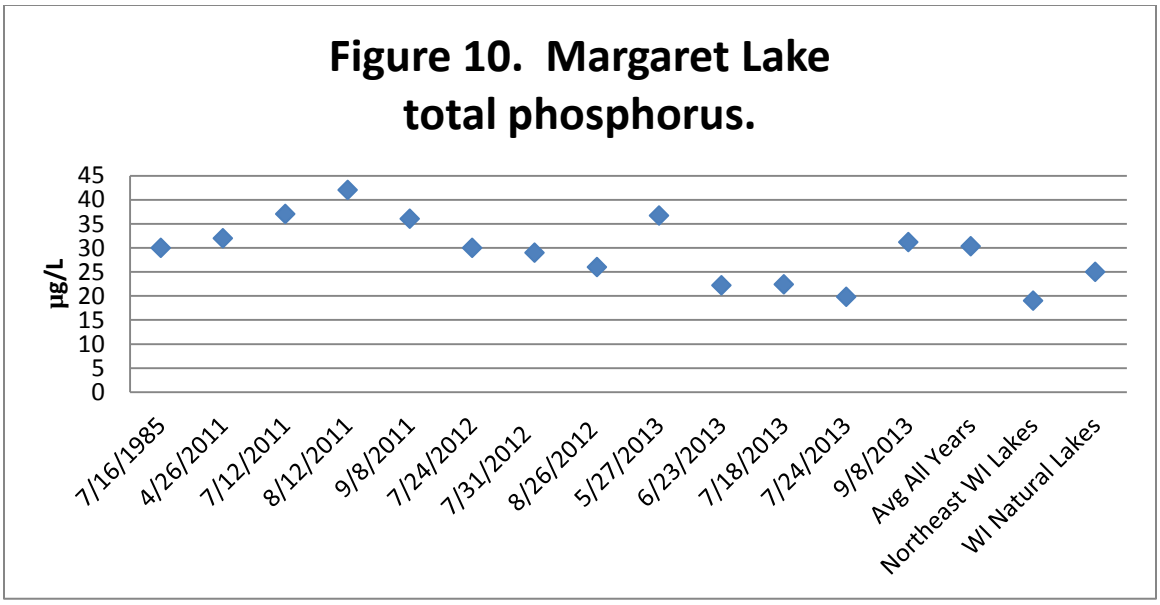
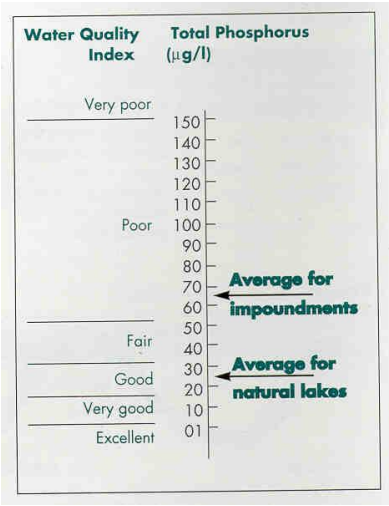


Figure 11. Total phosphorus concentrations for Wisconsin's natural lakes and impoundments (Shaw et al., 2004).



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).

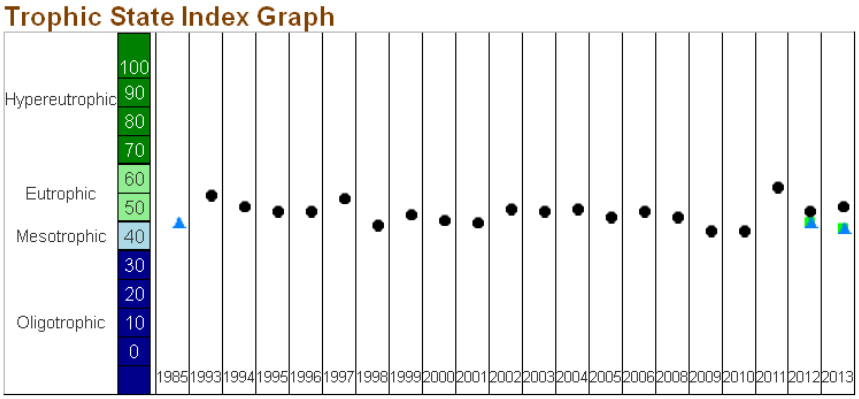
Researchers use various methods to calculate the trophic state of lakes. Common characteristics used to make the determination are: total phosphorus (important for algae growth), chlorophyll *a* concentration (a measure of the amount of algae present), and Secchi disk readings (an indicator of water 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 Secchi measurements, chlorophyll *a*, and total phosphorus values collected from the SWIMS database (Figure 12). The trophic state fluctuates over the years sampled, but the average TSI shows Margaret Lake to be "mildly eutrophic" (Table 3).

Figure 12. Margaret Lake Trophic State Index (1985-2013).



Monitoring Station: Margaret Lake - Deep Hole, Oneida 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, 2013)

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, 2012)

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. Margaret Lake was analyzed for total Kjeldahl nitrogen (0.7 mg/L in July, 1985 and 1.17 mg/L in July, 2011), nitrate/nitrite (0.02 mg/L in July, 1985, 0.069 mg/L in July, 2011; and not detected July, 2012); and ammonia (0.02 mg/L in July, 1985). 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).

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 levels found in Wisconsin (Shaw et al., 2004). Chloride concentrations in Margaret Lake were below the distribution gradient found in Wisconsin waters. In 1985, the chloride level was 1.2 mg/L.

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 Vilas County (Lillie and Mason, 1983). In 1985, the sulfate value was 3.7 mg/L.

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). Conductivity was measured July, 1985 (60 µmhos/cm), and July, 2011 (58.7 µmhos/cm).

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, marl 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 and/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. Margaret Lake was slightly acidic with a pH of 6.82 July, 1985, and a pH of 6.86 July, 2011.

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. The alkalinity in Margaret Lake was 22.6 mg/L $CaCO_3$ July, 2011. Based on this value, Margaret Lake has a low sensitivity to acid rain (Table 5).

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 ($CaCO_3$). Total hardness of Margaret Lake, 1985, was 32.33 mg/L. The surface water of Margaret Lake could be categorized as "soft water" (Table 6).

Table 6. Categorization of hardness (mg/L of calcium carbonate ($CaCO_3$)) (Shaw et al., 2004).	
Soft water	0-60
Moderately hard water	61-120
Hard water	121-180
Very hard water	>180

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. Margaret Lake appears to have a low calcium level. In 1985 the calcium level was 8 mg/L, in 2011 it was 7.6 mg/L, and in 2012 it was 9.9 mg/L. This is an indication that zebra mussels could not flourish. The magnesium levels appear low in comparison to the Northeast region of Wisconsin (5 mg/L) lakes, with values of 3 mg/L in 1985 and 3.1mg/L in 2011.

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). Sodium (1 mg/L) was tested in 1985. Potassium was also 1 mg/L, 1985.

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. Margaret Lake DOC was never tested, and could be included in the 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 is unknown for Margaret Lake, future water quality sampling could include measurements 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. In 1985, the aluminum level was 25 µg/L.

Iron

Iron also forms sediment particles that bind with and 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. Because iron levels are not known for Margaret Lake, future water sampling could include measurement of this parameter.

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. Because manganese levels are not known for Margaret Lake, future water sampling could include measurement of 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 Margaret Lake, and future sampling could 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." Total suspended solids have not been tested in Margaret Lake. Future water quality sampling could include this parameter.

Aquatic Invasive Species

Margaret Lake was monitored for banded mystery snail, rusty crayfish, Chinese mystery snail, curly-leaf pondweed, Eurasian water-milfoil, purple loosestrife, and zebra mussels on July 30, 2011. There is no report of invasive species found in Margaret Lake. The University of Wisconsin-Madison's Aquatic Invasive Species Smart Prevention program classifies Margaret Lake as "not suitable" for zebra mussels, based on calcium and conductivity levels found in the lake (UW-Madison).

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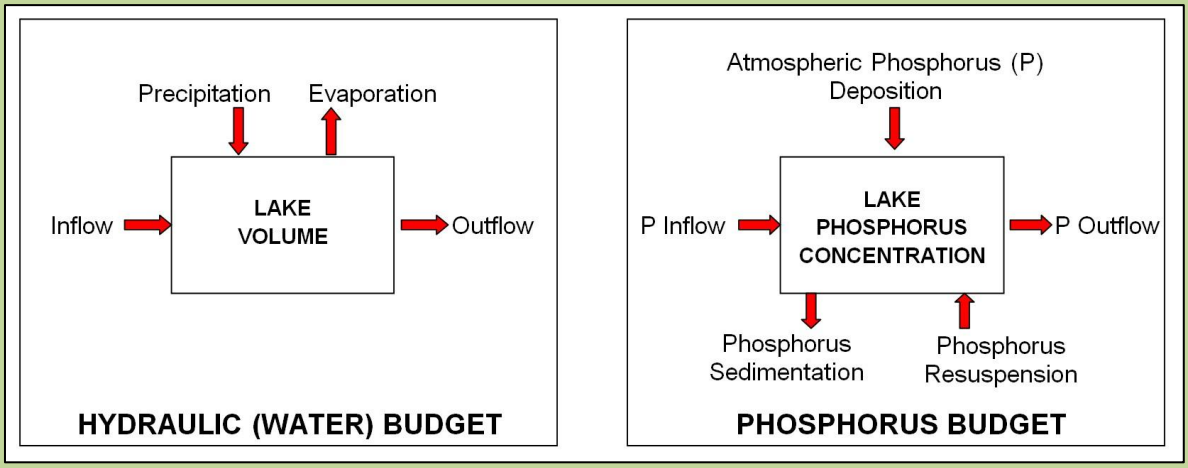
Appendix D
Margaret Lake
Watershed, Water Quality, and WiLMS Modeling

Margaret Lake Watershed, Water Quality, and WiLMS Modeling

Freshwater algae and rooted aquatic plants (macrophytes) require a number of nutrients in order to grow. Two of these nutrients, phosphorus and nitrogen, are often present in small amounts and limit algae and macrophyte growth. In fact, phosphorus is the nutrient that most often limits the growth of aquatic plants in freshwater systems and, when present in high concentrations, is most often responsible for algal blooms, rampant growth of rooted plants, and lake eutrophication. This is the reason that phosphorus is such a focus when it comes to concerns of lake water quality.

The water (hydraulic) budget of a lake is closely associated with the phosphorus budget (both illustrated in Figure 1). The graphics show in general terms the overall movement of water and phosphorus into and out of a lake ecosystem.

Figure 1. Hydraulic (water) and phosphorus budgets in lakes.



Modified from Brylinsky (2004)

Several interrelated factors are at play when it comes to the water quality of a lake. These include water source, watershed size, retention time, watershed cover types, and internal loading. Because each lake and its watershed have unique characteristics and interactions, no two lakes behave in exactly the same way. Nevertheless, being familiar with these factors and how they interrelate is helpful for lake planning and stewardship.

The sources of water for a lake strongly influence the lake's water quality because the water carries with it nutrients such as phosphorus. The four water sources include precipitation, runoff from

the surrounding land, upwelling groundwater, and inflow from a stream. The relative importance of each of these sources depends on several things. For example some lakes have no incoming stream, so these lakes depend on precipitation, runoff, and groundwater. A lake with a small drainage basin (watershed) receives relatively less water as runoff. Water can leave a lake through an outflow, evaporation, and groundwater seeping back into the aquifer (water table).

Water source is the factor that lake scientists use to classify lakes into four categories (Shaw et al., 2004). A "seepage lake" is fed by precipitation, limited runoff, and groundwater and has no inlet or outlet. A "groundwater drainage lake" is fed by groundwater, precipitation, and limited runoff and has a stream outlet. A "drainage lake" is fed by one or more streams, groundwater, precipitation, and runoff and has a stream outlet. Finally, an "impoundment" is a manmade lake formed by damming a stream and is also drained by a stream. When water comes into a lake from its various sources, it also carries other materials to the lake. Some of these are dissolved in the water (like phosphorus, nitrogen, and calcium). Some of the materials are suspended in the water (like silt and small bits of detritus). Precipitation (rain and snow) also carries with it dissolved and suspended materials to the lake (acid precipitation and dust are examples).

The size of a lake's watershed (drainage basin) relative to the lake's surface area is important in determining the amount of nutrients and other materials that come into the lake (Shaw et al., 2004). This ratio of drainage basin area to lake area is a measure of how important the watershed is as the lake's source of water, nutrients (like phosphorus), and other materials. A higher DB/LA ratio means the watershed is relatively more important and runoff contributes more water and nutrients to the lake. With their small watersheds, seepage lakes receive fewer nutrients from runoff than drainage lakes and tend to be higher in water quality.

Another important concept in a lake's water and nutrient "budget" (that is, inputs and outputs) is "retention time" (also called "water residence time"), the average length of time that water stays in the lake. This is determined by a lake's size (volume), water sources, and watershed size. For some lakes and impoundments, retention time can be quite short (days or weeks). In other lakes, retention time can be as long as decades or centuries. Retention time also indicates how long nutrients stay in the lake. In short retention time lakes, nutrients are flushed through the system rather quickly. In long retention time lakes, nutrients stay around a longer time and can move into the sediments where they become a long-term part of the lake's chemistry.

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. This is especially important close to the lake (the riparian

area), but the entire watershed is a contributor and we often map the cover types and measure their acreages to give us some idea of how at risk the lake might be to receiving unwanted materials. 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. When excessive nutrients and sediment reach a lake they can cause increased growth of aquatic plants, algal blooms, and reduced water clarity.

The DB/LA (drainage basin/lake area) ratio interacts in an interesting way with drainage basin cover type when it comes to nutrient runoff to a lake. For lakes where the ratio is relatively high (greater than 15:1), the role of drainage basin size in delivering water and nutrients to the lake tends to dominate the role of cover type. In small ratio lakes, the kind of cover type on the watershed has the greater influence than the absolute size of the watershed. For these small DB/LA ratio lakes maintaining or restoring good quality native cover type in the watershed will likely have a positive and observable influence on the lake.

Internal loading refers to phosphorus (and other nutrients) that are present in the lake bottom sediment. Some of the phosphorus in a lake ecosystem continually falls to the bottom and becomes part of the sediment layer and is generally unavailable for plants. Under conditions of low dissolved oxygen, however, this phosphorus can go back into the water column and be taken up by algae and macrophytes. The amount of phosphorus contained in the sediment can be quite high, resulting from centuries of deposition. The phenomenon of internal loading can therefore make available a large amount of phosphorus to the algae and plants of the lake and typically happens at spring and fall overturn periods. Even if sources of phosphorus outside of the lake are reduced, the internal loading can still enrich the lake and cause eutrophic conditions.

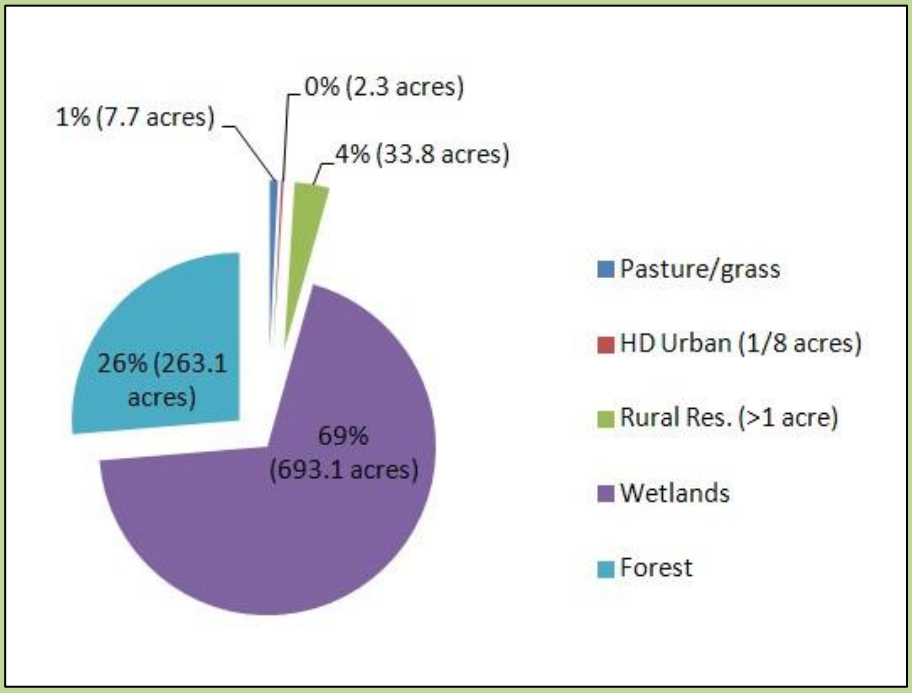
Because it is often challenging to work out how these several factors interact to influence the water quality of a specific lake, the Wisconsin Department of Natural Resources developed the "Wisconsin Lake Modeling Suite" (WiLMS) as a lake water quality planning tool (WDNR, 2003). WiLMS is a computer program into which the user enters information about the lake (e.g., surface area, depth, and nutrient measures) and the watershed (e.g., acreage and cover type). The model also has information about average rainfall, aerial deposition of materials, and cover type characteristics that it uses to help predict nutrient (phosphorus) loading scenarios to the lake.

In this project, we applied the WiLMS models to Margaret Lake. The 86 acre lake has a watershed of 1,000 acres and a drainage basin/lake area ratio of about 12 to 1. This is a relatively low ratio. Lakes with this size ratio combined with a mostly natural watershed cover type are likely to have

high quality (oligotrophic) characteristics, although this is not the case with Margaret Lake. The lake volume is 532 acre-feet and the mean lake depth is 6.2 feet. The WiLMS model calculates the annual runoff volume as 1,016.7 acre-feet and the annual difference between precipitation and evaporation (precipitation minus evaporation) as 5.8 inches. The hydraulic loading for Margaret Lake is 1,058.2 acre-feet per year and the areal water load is 12.3 feet per year. The WiLMS model calculates the annual lake flushing rate as 1.99 times per year and the water residence time (retention time) as 0.50 year.

The cover types in the Margaret Lake watershed are shown in Figure 2 with their respective acreages. Wetland cover type is the predominant land cover at 69%. Forest cover is also important, comprising about 26% of the watershed.

Figure 2. Margaret Lake watershed land cover types.



Note: the "wetlands" category also includes the surface area of the lake.

Table 1 presents output from the WiLMS model for non-point source phosphorus input to Margaret Lake. No point-source data is available for Margaret Lake. The WiLMS model indicated that 51 kg (112 pounds) of phosphorus are most likely delivered to the lake each year from watershed runoff and from direct deposition onto the lake surface (via precipitation and airborne particles). The WiLMS

model predicts that most of the phosphorus delivered to Margaret Lake comes from wetland cover type, the most prevalent cover type in the watershed.

Table 1. WiLMS estimated non-point source phosphorus loading based on watershed land use type and acres.

Land Use	Land Use Acres	Loading (kg/ha-year)				Loading kg/year		
		Low	Most Likely	High	Loading %	Low	Most Likely	High
Row Crop Ag.	0	0.5	1.0	3.0	0	0	0	0
Mixed Agricultural	0	0.3	0.8	1.4	0	0	0	0
Pasture/Grass	7.7	0.1	0.3	0.5	1.8	0	1	2
High Density Urban (1/8 acre)	2.3	1	1.5	2	2.7	1	1	2
Mid Density Urban (1/4 acre)	0	0.3	0.5	0.8	0	0	0	0
Rural Residential (>1 acre)	33.8	0.05	0.1	0.25	2.6	1	1	3
Wetlands	693.1	0.1	0.1	0.1	54.2	28	28	28
Forest	263.1	0.05	0.09	0.18	18.5	5	10	19
Lake Surface	86	0.1	0.3	1	20.2	3	10	35
				Totals	100.0	38	51	89

The WiLMS generated an estimate of internal loading of phosphorus. These data are presented in Table 2. The model predicts that about 52 pounds (24 kg) of phosphorus are released each year from Margaret Lake sediments and available to algae and aquatic plants. The model calculates a predicted phosphorus retention coefficient as 0.69 (this represents the fraction of phosphorus entering the lake that is lost by settling to the sediment). The observed phosphorus retention coefficient is 0.24 indicating that phosphorus is more readily available than predicted. These data are consistent with other measures and observations that indicate that Margaret Lake is mildly eutrophic.

Table 2. WiLMS Method 1 – Complete Phosphorus Mass Budget.	
Parameter	**Value**
Phosphorus Concentration of Lake (input into model)	30.33 mg/m^3
Phosphorus Inflow Concentration	39.7 mg/m^3
Areal External Loading	148.8 mg/m^2-year
Predicted Phosphorus Retention Coefficient *(the predicted fraction of phosphorus entering the lake that is lost by settling to the sediment)*	0.69
Observed Phosphorus Retention Coefficient	0.24
Internal Load (amount released annually from the sediment)	52 pounds (24 kg)

The WiLMS also allow us to manipulate the cover type acreages as an illustration of how watershed cover can influence the delivery of phosphorus to a lake. As an example, we re-ran the non-point source data model, but altered landscape composition to simulate the effect of converting 200 acres of the forest cover type to row crop agriculture. The results are dramatic as the most likely total kilograms of phosphorus delivered to the lake from non-point source was calculated at 124 kg (compare to the 51 kg under the actual conditions in the watershed).

Literature Cited

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Appendix E
Margaret Lake EPA Littoral and Shoreline Survey

Margaret Lake EPA Littoral and Shoreline Survey

Introduction

Margaret Lake's littoral and shoreline zones were assessed in 2012 by White Water field staff using the US Environmental Protection Agency's (EPA) National Lakes Assessment (NLA) protocol and the Wisconsin Department of Natural Resources (WDNR) Supplemental Lakeshore Assessment protocol. The intention of the National Lakes Assessment (NLA) project was to provide a comprehensive State of the Lakes assessment for lakes, ponds, and reservoirs across the United States (USEPA, 2009). This assessment at Margaret Lake will stand as a baseline against which future changes can be measured and can be used to compare Margaret Lake with other lakes measured using the same protocols.

Methods

Ten physical habitat (P-Hab) stations were spaced equidistantly around the lake (Figure 1 and 2). At each station (labeled "M-A," "M-B," etc.), White Water biologists recorded information about the littoral zone bottom substrate, littoral zone aquatic macrophytes (plants), littoral zone fish cover, riparian zone canopy, understory and ground cover, shoreline substrates, human influences, classification of fish habitat, bank features, any invasive species observed (terrestrial or aquatic), land cover, human development and the number of piers between stations.

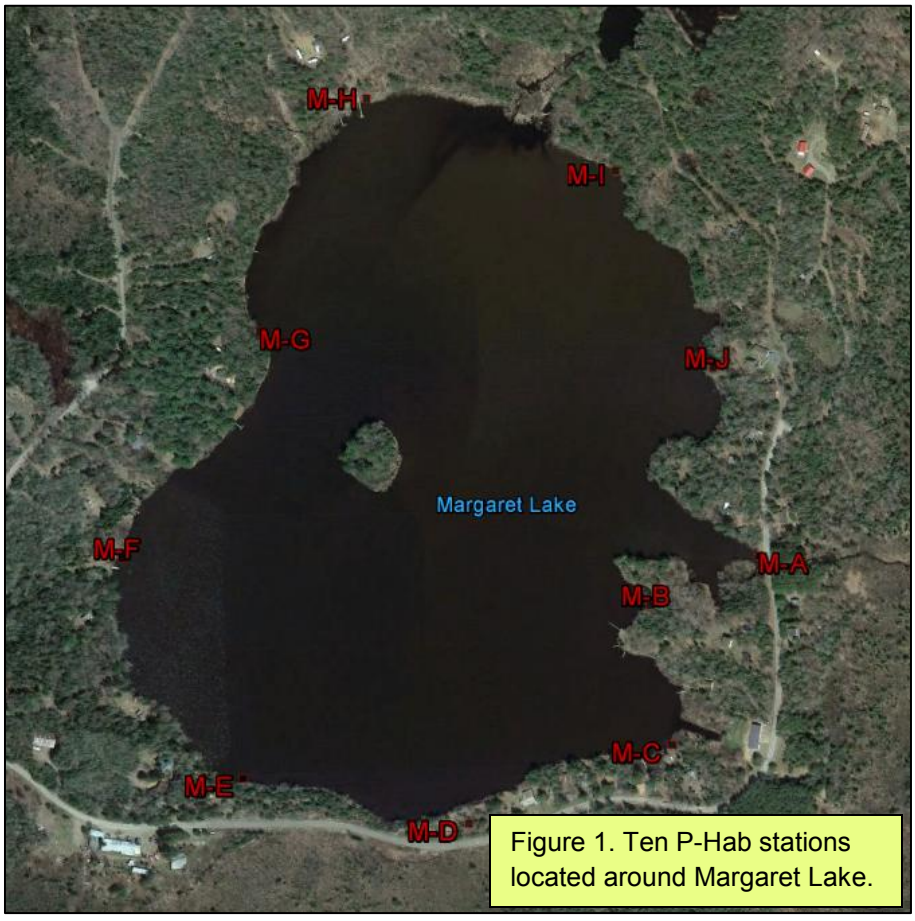

Figure 1. Ten P-Hab stations located around Margaret Lake.

At each P-Hab station, biologists collected macroinvertebrates for later identification. A fecal indicator sample was collected at one station to be analyzed for levels of *E. coli*.

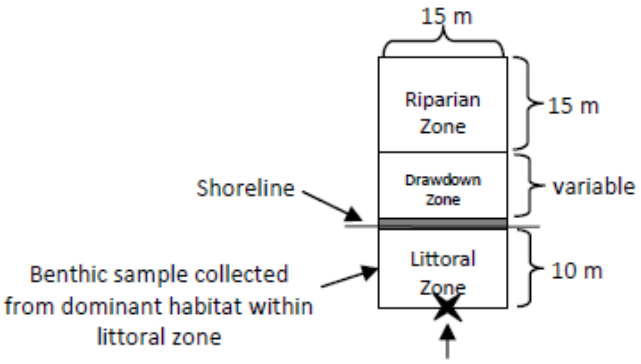

Figure 2. Dimensions and layout of a P-Hab station.

Results

Average depth of the ten stations was 2.3 feet (the range was from 1 to 4.5 feet). No surface film was observed at any of the ten stations.

Table 1 contains the littoral zone bottom substrate data collected from the ten Margaret Lake sampling stations. Bedrock was not observed at bottom substrate in any of the ten stations. Boulders were observed at two stations. Gravel was found at four stations. Sand was found at one station. Silt, clay, and muck were the most common substrate type (eight stations). Woody debris was encountered at two stations. No cobble or organic substrates were observed. Black colored sediment was encountered at six stations, while brown sediment was found at four. No odor was associated with the bottom substrate in any of the ten stations.

Table 1. USEPA Habitat Characterization – Littoral Zone Bottom Substrate.

Station	A	B	C	D	E	F	G	H	I	J
Bedrock	0	0	0	0	0	0	0	0	0	0
Boulders	0	2	0	0	0	0	0	0	0	1
Cobble	0	0	0	0	0	0	0	0	0	0
Gravel	2	3	0	0	0	0	3	0	0	4
Sand	4	0	0	0	0	0	0	0	0	0
Silt, Clay, Muck	0	1	4	4	4	4	2	4	4	0
Woody Debris	0	0	0	0	0	1	0	0	1	0
Organic	0	0	0	0	0	0	0	0	0	0
Color	Brown	Black	Black	Black	Black	Black	Brown	Black	Brown	Brown
Odor	None	None	None	None	None	None	None	None	None	None

Bedrock (>4000mm); Boulders (250-4000mm); Cobble (64-250mm); Gravel (2-64mm); Sand (0.02-2mm); Silt, Clay, or Muck (<0.06mm, not gritty). 0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)

Table 2 presents the observations made on aquatic macrophytes in the littoral zone. Submergent macrophytes were observed at eight of the ten stations. Emergent macrophytes, as well as floating macrophytes were observed all of the stations. Total macrophyte cover was considered sparse at one station, moderate at one station, heavy at one station, and very heavy at seven stations. Macrophytes extended lakeward from the stations in nine of the ten stations.

Table 2. USEPA Habitat Characterization – Littoral Zone Aquatic Macrophytes.

Station	A	B	C	D	E	F	G	H	I	J
Submergent	1	0	4	2	1	3	0	4	3	1
Emergent	1	2	4	4	4	3	4	2	3	2
Floating	1	1	4	2	2	4	1	4	3	1
Total Aquatic Macrophyte Cover	1	2	4	4	4	4	4	4	4	3
Do macrophytes extend lakeward from plot?	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)

Littoral zone fish cover observations are presented in Table 3. Aquatic and/or inundated herbaceous vegetation was observed at all of the stations, and was typically very heavy (> 75% cover). Woody debris and snags greater than 0.3 meters in diameter were observed at one station and was sparse in coverage. Woody brush/woody debris less than 0.3 meters in diameter was found at one station. Inundated live trees (greater than 0.3 meters in diameter) were not observed at any stations. Overhanging vegetation within one meter of the surface was observed at three stations. Ledges or sharp drop-offs and boulders were observed at two stations. Finally, human structures (such as docks) were observed as fish cover at one station.

Table 3. USEPA Habitat Characterization – Littoral Zone Fish Cover.

Station	A	B	C	D	E	F	G	H	I	J
Aquatic & Inundated Herbaceous Cover	2	2	4	4	4	4	4	4	4	3
Woody Debris/Snags >0.3 m dia.	0	0	0	0	0	1	0	0	0	0
Woody Brush/ Woody Debris <0.3 m dia.	0	0	0	0	0	0	0	0	1	0
Inundated Live Trees >0.3 m dia.	0	0	0	0	0	0	0	0	0	0
Overhanging veg. w/in 1 m of surface	0	0	0	0	4	0	3	0	1	0
Ledges or Sharp Drop-offs	1	0	0	0	4	0	0	0	0	0
Boulders	0	2	0	0	0	0	0	0	0	2
Human Structures (docks, landings, etc.)	1	0	0	0	0	0	0	0	0	0

0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)

Table 4 shows observations made on the riparian zone canopy (> 5 meters high), understory (0.5 to 5 meters high), and ground cover (<0.5 meters high). Mixed (conifer and deciduous) canopy type was observed in seven stations while deciduous canopy was observed at one station. One station had no canopy. The coverage of big trees (>0.3 meters diameter) ranged from sparse to heavy. Coverage of small trees (<0.3 meters diameter) also ranged from sparse to heavy. Mixed understory was observed at five stations; deciduous understory was observed at three stations; and no understory was observed at two stations. Coverage of understory woody shrubs and saplings was heavy at two stations, very heavy at two stations, moderate at two stations, and sparse at three stations. Tall herbs, grasses, and forbs were present at all of the stations with sparse coverage (one station), moderate coverage (two stations), heavy coverage (five stations), and very heavy coverage (two stations). Ground cover woody shrubs and saplings were observed at six stations with a coverage of sparse (two stations), moderate (three stations), and heavy (one station). Ground cover herbs, grasses, and forbs were observed at all ten stations with a coverage of sparse (one station), moderate (three stations), heavy (five stations), and very heavy (one station). Standing water or inundated vegetation was observed at two stations. Barren land, bare dirt, or buildings were not observed at any stations.

Table 4. USEPA Habitat Characterization – Riparian Zone.

Station	A	B	C	D	E	F	G	H	I	J
CANOPY (>5 m high)										
Type	Mix	Mix	None	Mix	Mix	Dec	Mix	None	Mix	Mix
Big Trees (Trunk >0.3 m dia.	1	1	0	1	2	0	3	0	3	1
Small Trees (Trunk <0.3 m dia.	1	1	0	1	3	2	3	0	3	3
UNDERSTORY (0.5 to 5 m high)										
Type	Dec	None	Mix	None	Mix	Dec	Mix	Dec	Mix	Mix
Woody Shrubs and Saplings	1	1	4	0	4	2	2	1	3	3
Tall Herbs, Grasses, Forbes	1	2	3	3	3	4	2	4	3	3
GROUND COVER (<0.5 m high)										
Woody Shrubs and Saplings	0	0	1	0	3	1	2	0	2	2
Herbs, Grasses and Forbes	1	2	3	3	3	3	2	4	2	3
Standing Water/ Inundated Veg.	0	0	2	0	0	0	0	3	0	0
Barren, Bare Dirt, or Buildings	0	0	0	0	0	0	0	0	0	0

0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%); Mix = Mixed conifer and deciduous; Dec = Deciduous

Table 5 presents observations recorded on the riparian shoreline substrate zone. Bedrock substrate was not observed at any of the stations. Boulders were observed at three stations and ranged from sparse to very heavy coverage. Cobble substrate was observed at two ten stations with moderate and heavy coverage. Neither gravel, sand, silt, clay, muck, nor woody debris was observed at any station. Organic (leaf pack, detritus) was observed at three of the stations. Vegetation was observed at every station and ranged from moderate (two stations), heavy (one station), to very heavy coverage (seven stations).

Table 5. USEPA Habitat Characterization – Riparian Zone – Shoreline Substrate Zone.

Station	A	B	C	D	E	F	G	H	I	J
Bedrock	0	0	0	0	0	0	0	0	0	0
Boulders	1	4	0	0	0	0	0	0	0	2
Cobble	2	0	0	3	0	0	0	0	0	0
Gravel	0	0	0	0	0	0	0	0	0	0
Sand	0	0	0	0	0	0	0	0	0	0
Silt, Clay, Muck	0	0	0	0	0	0	0	0	0	0
Woody Debris	0	0	0	0	0	0	0	0	0	0
Organic	0	1	0	0	3	0	0	0	1	0
Vegetation or other	2	2	4	4	3	4	4	4	4	4

0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)

Observations of human influence in the riparian zone are contained in Table 6. Human influence was quite low. Buildings were observed outside of the plot at four of the ten stations. Docks or boats were observed inside the plot at one station and outside the plot at eight stations. Walls, dykes, revetments were present within the plot at two stations. Lawn was observed inside the plot at four stations. No other human influences (commercial development, park facilities/ man-made beaches, landfill/trash, roads or railroads, powerlines, row crops, pasture/range/hayfield, or orchards) were observed at any of the stations.

Table 6. USEPA Habitat Characterization – Riparian Zone – Human Influence Zone.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Buildings	P	0	P	P	0	0	0	P	0	0
Commercial	0	0	0	0	0	0	0	0	0	0
Park Facilities/ manmade beach	0	0	0	0	0	0	0	0	0	0
Docks/Boats	C	P	P	P	P	P	P	P	0	P
Walls, dykes, revetments	C	C	0	0	0	0	0	0	0	0
Landfill/Trash	0	0	0	0	0	0	0	0	0	0
Roads or Railroad	0	0	0	0	0	0	0	0	0	0
Powerline	0	0	0	0	0	0	0	0	0	0
Rowcrops	0	0	0	0	0	0	0	0	0	0
Pasture/Range/Hayfield	0	0	0	0	0	0	0	0	0	0
Orchard	0	0	0	0	0	0	0	0	0	0
Lawn	C	C	0	C	0	C	0	0	0	0
0 = Not Present; P = Present outside plot; C = Present within plot										

Table 7 reports the observations made on littoral fish macrohabitat classification. Human disturbance was observed at two of ten stations and was considered either a low or moderate disturbance. Cover class was recorded as patchy at two of ten stations; as no/little at one station; and continuous at seven stations. Cover type was recorded as artificial at two of the stations; as woody at one station; as vegetation at all stations; and as boulders at two stations. Dominant substrate was recorded as mud/muck at six stations, sand/gravel at three stations, and cobble/boulder at one station.

Table 7. USEPA Habitat Characterization – Littoral Zone Macrohabitat Classification.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Human Disturbance	Mod	Low	None	None	None	None	None	None	None	None
Cover Class	No/Lit	Patchy	Cont	Cont	Cont	Cont	Cont	Cont	Cont	Patchy
Cover Type	Art Veg	Art Bould Veg	Veg	Veg	Woody Veg	Veg	Veg	Veg	Veg	Bould Veg
Dominant Substrate	S/G	C/B	M/M	M/M	M/M	M/M	S/G	M/M	M/M	S/G
Mod = Moderate; Cont = Continuous Cover; Art = Artificial; No/Lit = No or Little Cover; Bould = Boulder; Veg = Vegetation; M/M = Mud/Muck; C/B = Cobble/Boulder; S/G = Sand/Gravel										

Plot bank features are presented in Table 8. Bank angle was considered steep at three stations, gradual at four stations, and flat at three stations. The vertical height from waterline to the high water mark varied from 0.15 m to 0.31 m. The horizontal distance from waterline to the high water mark averaged 2 meters (range was 0.02 to 15 meters).

Table 8. USEPA Habitat Characterization – Within Plot Bank Features.

Station	A	B	C	D	E	F	G	H	I	J
Angle	Grad	Steep	Flat	Steep	Steep	Flat	Grad	Flat	Grad	Grad
Vertical Height (m) from water line to HWM	0.15	0.15	NA	0.15	0.15	0.15	0.31	0.0	0.15	0.15
Horizontal Distance (m) to HWM	0.0	0.15	NA	0.15	0.15	0.31	0.02	15	0.15	0.15

HWM = High Water Mark; Flat = <5 degrees; Grad = Gradual (5-30 degrees); Steep (30-75 degrees)

No target invasive species were observed in the littoral plot or the shoreline/riparian plot (Table 9).

Table 9. USEPA Habitat Characterization – Invasive Plant Species.

Station	A	B	C	D	E	F	G	H	I	J
Target Invasive Species in Littoral Plot	None	None	None	None	None	None	None	None	None	None
Target Invasive Species in Shore-line/Riparian Plot	None	None	None	None	None	None	None	None	None	None

Target Invasive Species include: Zebra or Quagga Mussel, Eurasian Water-milfoil, Hydrilla, Curly Pondweed, African Waterweed, Brazilian Waterweed, European Water Chestnut, Water Hyacinth, Parrot Feather, Yellow Floating Heart, Giant Salvinia, Purple Loosestrife, Knotweed (Giant or Japanese), Hairy Willow Herb, Flowering Rush

The Wisconsin Department of Natural Resources Supplemental Methodology observations are presented in Tables 10 and 11. Table 10 shows a total of 5 pieces of small woody material (>5cm diameter). No large woody material (>10 cm diameter) was found in the lake. None of the five target invasive species (Japanese stiltgrass, reed canary grass, Phragmites, cattails, or yellow iris) were observed at any of the stations.

Table 10. WDNR Supplemental Methodology to USEPA Habitat Characterization – Wood and Invasive Plant Species.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Wood: >5cm diameter	0	0	0	0	0	V	V	V	5	V
Wood: >10cm diameter	0	0	0	0	0	V	V	V	0	V
Invasive: Japanese stiltgrass	No	No	No	No	No	No	No	No	No	No
Invasive: Reed canary grass	No	No	No	No	No	No	No	No	No	No
Invasive: Phragmites	No	No	No	No	No	No	No	No	No	No
Invasive: Cattails	No	No	No	No	No	No	No	No	No	No
Invasive: Yellow Iris	No	No	No	No	No	No	No	No	No	No
V= Vegetation obscured visual assessment										

Table 11 tabulates that seawalls and pavements were not observed as landcover. Rip rap was observed at one station as very heavy coverage. An artificial beach was found at one station. Lawn was observed at four of the ten stations. Residences were observed in six of the ten stations. There was a structure (shed/boathouse) found at one station. Boat lifts were observed in the riparian plot of two stations and docks were observed in the riparian plot of eight stations. No commercial buildings or swim rafts were observed at any stations. The WDNR protocol calls for counting the number of piers between each of the ten stations (this amounts to a count of the total number of piers on Margaret Lake). Twenty-nine piers were counted on the perimeter of Margaret Lake.

Table 11. WDNR Supplemental Methodology to USEPA Habitat Characterization – Land cover, Human Development, and Piers.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
LANDCOVER Key: 0 (0-1%), 1 (>1-10%), 2 (>10-40%), 3 (>40-75%), 4 (>75%)										
Seawall	0	0	0	0	0	0	0	0	0	0
Rip Rap	0	4	0	0	0	0	0	0	0	0
Artificial beach	3	0	0	0	0	0	0	0	0	0
Lawn	3	2	0	2	0	1	0	0	0	0
Pavement	0	0	0	0	0	0	0	0	0	0
HUMAN DEVELOPMENT (1 number given for riparian plot; if 2 numbers, 1st for riparian plot & 2nd for upland plot)										
Residences	1	0	1	1	0	0	1	1	0	1
Commercial buildings	0	0	0	0	0	0	0	0	0	0
Structures (sheds/boat houses)	1	0	0	0	0	0	0	0	0	0
Boat lifts	0	0	0	0	0	1	0	1	0	0
Swim rafts	0	0	0	0	0	0	0	0	0	0
Docks	1	1	1	1	0	1	1	1	0	1
NUMBER OF PIERS BETWEEN STATIONS										
From:	A-B	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J	J-A
Count	4	5	5	0	5	2	5	0	1	2

The U.S.EPA protocol called for a composite sample of aquatic benthic macroinvertebrates, combining net sweeps from each station into one sample. Table 12 provides the identified invertebrate taxa and counts of individuals by taxa for the composite sample. A total of twenty-five taxa and 417 individual organisms were identified.

Table 12. Composite Benthic Macroinvertebrate Sample from Margaret Lake.				
Taxon	**Count**		**Taxon**	**Count**
Annelida: Hirudinea (leaches)	5		Trichoptera (caddisflies): Brachycentridae	2
Crustacea: Amphipoda (freshwater shrimp, scuds)	24		Trichoptera (caddisflies): Leptoceridae	7
Crustacea: Decapoda (crayfish)	1		Trichoptera (caddisflies): Molannidae	16
Crustacea: Isopoda (isopods)	24		Trichoptera (caddisflies): Phryganeidae	2
Arachnoidea: Hydracarina	6		Trichoptera (caddisflies): Polycentropodidae	11
Ephemeroptera (mayflies): Baetidae	21		Coleoptera (aquatic beetles): Elmidae	2
Ephemeroptera (mayflies): Caenidae	16		Diptera (true flies): Ceratopogonidae	6
Ephemeroptera (mayflies): Siphlonuridae	2		Diptera (true flies): Chironomidae (midges)	143
Anisoptera (dragonflies): Gomphidae	2		Gastropoda (snails): Bithyniidae	2
Anisoptera (dragonflies): Libelluiidae	4		Gastropoda (snails): Hydrobiidae	40
Zygoptera (Damselflies): Lestidae	25		Gastropoda (snails): Planorbidae	14
Hemiptera (aquatic bugs): Pleidae	2		Pelecypoda (mussels/clams): Sphaeriidae	28
Hemiptera (aquatic bugs): Salidae	12		**Total Taxa**	**25**

Finally, the U.S.EPA protocol called for a fecal indicator sample at the final sampling station (Station J). In the case of Margaret Lake, we analyzed the sample collected for *Escherichia coli* (*E. coli).* The *E. coli* analysis resulted in values of 1 and 0 CFU (Colony Forming Units) per 100 mL. To place this value in context, the EPA recommends a water quality advisory (for swimming) when the *E. coli* level exceeds 235 CFU per 100 mL of water.

Table 13 indicates the latitude and longitude of Stations A-J. A photo was taken at each of the ten stations. The station photos are displayed below.

Table 13. Margaret Lake USEPA & WDNR Physical Habitat Locations.		
Station	*Latitude*	*Longitude*
A	45.71559	-89.10517
B	45.71513	-89.10665
C	45.71380	-89.10635
D	45.71306	-89.10910
E	45.71349	-89.11216
F	45.71556	-89.11381
G	45.71770	-89.11192
H	45.71991	-89.11049
I	45.71921	-89.10712
J	45.71736	-89.10581

Station A – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station B – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station C – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station D – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station E – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station F – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station G – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station H – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station I – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

Station J – Margaret Lake

(USEPA & WDNR Physical Habitat Assessment) Photograph taken 8/17/2012, White Water Associates, Inc.

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Appendix F
Summary of Margaret Lake Shoreline Photo Survey

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Summary of Margaret Lake Shoreline Photo Survey

A photo survey was conducted on Margaret Lake In September, 2012. This survey was done to systematically document the littoral zone and riparian area condition of the lake. Documenting the shoreline condition of the lake helps to determine the extent of future changes and impacts, and asses the efficacy of regulatory programs intended to protect the riparian area and lake. Thirty-eight (38) shoreline segments (approximately 200 feet long) were assessed for a variety of shoreline parameters. Members of the Margaret Lake Association conducted the survey. The data and photographs of each segment are provided in CD-ROM format. This data will be a useful tool in identifying and planning restoration projects in the Margaret Lake riparian area and for monitoring long-term change. The following is a summary of the data collected. Some segments had more than one type recorded.

Margaret Lake Shoreline – Development		
Type	Number of records	% records
house	16	42%
shed	10	26%
garage	3	8%
gravel drive	0	0%
paved drive	1	3%
lawn	14	37%
other	0	0%

42% of records showed a house as part of the development.

Margaret Lake Shoreline – Structures		
Type	Number of records	% records
dock	22	58%
breakwater	0	0%
stormwall	0	0%
boathouse	0	0%
rip-rap	2	5%
other	1	3%

Docks were observed at 22 (58%) segments.

Margaret Lake Shoreline – Access		
Type	Number of records	% records
none	12	32%
unimproved path	9	24%
gravel path	1	3%
chip path	0	0%
paved path	0	0%
boardwalk	1	3%
stairs	0	0%
other	15	39%

In 12 segments, no access ("none") was noted (32%). "Other" was noted at 15 segments (39%).

Margaret Lake Shoreline – Beach		
Type	Number of records	% records
none	38	100%
natural	0	0%
artificial	0	0%
stable	0	0%
eroding	0	0%
other	0	0%

"None" (no beach) was recorded at all 38 segments (100%).

Margaret Lake Shoreline – Vegetation		
Type	Number of records	% records
upland	0	0%
wetland	18	47%
forested	38	100%
shrub	38	100%
natural openings	0	0%
stream	1	3%
other	0	0%

At all 38 sites, forested and shrub vegetation was seen. 18 of these segments also had wetland vegetation.

Margaret Lake Shoreline – Buffer		
Type	Number of records	% records
none	0	0%
1-3 ft	0	0%
4-10 ft	0	0%
above 10 ft	38	100%
type: herbaceous	38	100%
type: shrubs	37	97%
type: trees	37	97%
type: other	0	0%

All 38 segments had a buffer above 10 feet with herbaceous (100%), shrub (97%), and tree (97%) coverage.

Margaret Lake Shoreline – Erosion		
Type	Number of records	% records
none	38	100%
undercut banks/slumping	0	0%
furrows/gullies	0	0%
bare earth	0	0%
other	0	0%

Erosion was not observed along the Margaret Lake shoreline (100% of segments).

Margaret Lake Shoreline – Bank Height		
Type	Number of records	% records
none	4	11%
slight (< 2 ft)	26	68%
abrupt (2 ft or greater)	8	21%

The majority of segments had a slight (<2 ft.) bank height (68%), followed by abrupt and no bank height.

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Appendix G
Margaret Lake Fisheries Report

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Margaret Lake Fisheries Report

Historic fisheries data for Margaret Lake dates back to 1955. Fish species present in Margaret Lake are: musky, walleye, northern pike, largemouth bass, rock bass, yellow perch, bluegill, black crappie, pumpkinseed, black bullheads, yellow bullheads, bluegill x pumpkinseed hybrids, white sucker, and golden shiner.

Table 1 indicates the Margaret Lake stocking record of musky (1955, 1957, 1958, 1972, and 1996), walleye (1968, 1971, 1973, 1976, and 1996), pumpkinseed (1996 and 1997), and bluegill (1997).

Table 1. Margaret Lake, Oneida County Stocking Record (WDNR, 2012).

Date	*Species*	*Number Planted*	*Size*
1955	Musky	110	Fingerling
1957	Musky	300	Fingerling
1958	Musky	50	Fingerling
1968	Walleye	4,000	Fingerling
1971 – 9/3	Walleye	2,000	Fingerling
1972 – 9/22	Musky	173	Fingerling
1973 – 8/3	Walleye	2,000	Fingerling
1976 – 8/16	Walleye	3,000	Fingerling
1996 – 5/29	Walleye	100,000	Fry .3”
1996 – 6/3	Musky	50,000	Fry .5”
1996 – 9/25	Musky	180	Fingerling 10.7”
1996 – 6/28	Bluegill	4,710	Adult 4.6”
1996 – 6/28	Pumpkinseed	490	Adult 4.6”
1997	Bluegill	884	Adult
1997	Pumpkinseed	135	Adult

Beginning in the 1950’s, several small plantings of muskellunge fingerlings were made (Table 1). However, it remained that Margaret Lake had a poor fish population. With no predator species being captured, and as a lake with a measure of hardness (MOH) of 25 mg/L, Margaret Lake should have been capable of supporting a much larger fish population (Morehouse, 1963). Morehouse (1963) states that Margaret Lake should begin stocking the lake with walleye, since past muskellunge plantings were apparently not established (Morehouse, 1963).

On July 24, 1963 electro shocking was used to determine the present condition in order to make recommendations for future management. There were 2 rock bass (5.5 -5.7”), 4 perch (4.5 – 7.4”), 7 bluegill (4.8 – 7.1”), and 14 crappie (4.0 -10.7”) captured. They observed a moderate sucker population, one northern pike, and several walleye, and it was mentioned that there was a scarcity of forage species. The bottom sediment types were sand, gravel, rock, and a lot of muck. The aquatic plant growth was mentioned as medium, but was also heavy in spots.

In 1970, the DNR conducted seine net sampling and large and small fyke net sampling. Species observed from the siene net sampling are in Table 2. Young perch were the most common fish caught, followed by adult bluegills and pumpkinseeds. No adult largemouth bass

were captured, however a number of fingerlings were caught, and indicating adults are present. It was noted that black grubs were observed on perch, bluegill, and pumpkinseeds.

Table 2. WDNR Seine Net Sampling, August 12, 1970 (Wendt, 1971).		
Species	*Number*	*Model Size*
Perch	86	Young of year
Perch – adult	9	5.0" – 5.5"
Largemouth Bass	6	Young of year
Bluegills	10	Young of year
Bluegills – adult	33	5.0" – 5.5"
Pumpkinseeds	15	4.5" – 5.0"

As part of the fyke net sampling, crappies and bluegills were the most-caught species, and had the highest catch/unit rates (Table 3). Largemouth bass had the fewest caught, with sizes ranging from 3-3.4 inches.

Table 3. WDNR Large and Small Fyke Net Sampling, August 10-13, 1970 (Wendt, 1971).				
Species	*Number*	*Model Size(s)*	*Size Range*	*Catch/Unit per lift*
Walleye	16	15.5 – 16"	8.5 – 21.9"	0.66
Northern Pike	6	17.0 – 17.4"	15.0 – 20.9"	0.25
Largemouth Bass	3	3.0 – 3.4"	3.0 – 3.4"	0.12
Crappies – black	209	6.0 – 6.4"	4.0-13.5"	8.7
Bluegills	155	5.0 – 5.4"	2.0 -7.9"	6.4
Pumpkinseeds	42	4.5 – 4.9"	2.5 – 6.9"	1.7
Yellow Perch	7	5.0 – 5.4"	4.5 – 5.9"	0.39
Black bullheads	28	8.0 – 9.0"	5.0 – 9.4"	1.1
Yellow bullheads	7	9.0 -10.0"	9.0 – 11.4"	0.39
White suckers	12	9.0 - 9.4"	9.0 – 16.4"	0.5

From August 28-30, 1974 the WDNR set twelve trap nets at a depth of four to five feet. Table 4 is the size range and catch/unit of fish caught. If we compare the data from Table 3 (from 1970) to Table 4 data, the catch/unit data increased in all species except the northern pike, which remained the same.

Table 4. WDNR Fyke Net sampling, August 28-30, 1974 (WDNR, 1974).			
Species	*Number*	*Size Range*	*Catch/Unit per lift*
Northern Pike	3	16.0 – 19.4"	0.25
Crappie *	120	4.7 – 9.0	10.0
Bluegill *	131	2.3 – 7.7	11.0
Sunfish	39	3.2 – 6.5	3.25
Perch	6	3.7 – 6.5	0.50
Bullhead	52	2.0 – 9.4	4.33
*includes fish captured but not measured			

On September 23, 1996 the WDNR used a boom shocker to count Margaret Lake fish species. One largemouth bass (13.7"), four northern pike (12.0 – 24.3"), one muskellunge (40.5") and no walleye were captured (Gilbert, 1996).

The WDNR also used a boom shocker in May, 2012. Table 5 indicates the results of that survey. Compared to the 1996 boom shocking, walleye, largemouth bass, and northern pike numbers increased. There were 10 species of fish caught in this sample in Margaret Lake, but no muskies were caught (May, 2012). Largemouth bass were the most abundant gamefish (16) and bluegills (133) were the most abundant species caught (May, 2012). There were 31 black crappie captured, but most were smaller, suggesting some recent year classes (Kubisiak, 2012b). A complete summary can be found in the Margaret Lake Wisconsin DNR Fisheries Information Sheet, Margaret Lake, Oneida County, WI (Kubisiak, 2012b).

Table 5. WDNR Bass and Panfish Assessment Via Boom Shocker, May 9, 2012 (Kubisiak, 2012b).

Species	*Number*	*Model Size*	*Size Range*	*Catch/Unit per hour*
Walleye	10	11.7	10.0 – 13.9	9.23
Largemouth Bass	16		6.5 – 19.9	14.77
Northern Pike	5		12.5 – 21.8	4.62
Bluegill	133	5.2	2.5 – 7.4	122.77
Pumpkinseed	32	6.2	2.5 – 6.9	29.54
Black Crappie	31	4.7, 5.7	2.0 – 8.4	28.62
White Sucker	17	10.2	4.5 -17.9	15.69
Bluegill X Pump. Hybrid	14	4.2	3.5 – 7.9	12.92
Yellow Perch	5		4.0 - 6.9	4.62
Golden Shiner	5		2.5 – 6.9	4.62
Yellow Bullhead	3		7.0 – 9.9	2.77

John Kubisiak, Fisheries Biologist for Oneida County, stated that the walleye catch in spring (May 9, 2012) was puzzling because the DNR caught a fair number walleye in Margaret Lake. Kubisiak (2012a) didn't expect to see any walleye since Margaret Lake is a small, shallow lake without any spawning gravel in sight. The walleye caught were all similar size, with only one or two age-classes. Kubisiak (2012a) states it's possible the walleye found a way to navigate up from the Three Lakes Chain. He's seen similar situations; however he expected the route to be blocked by beaver dams during most of the years. It's also possible that someone purchased fish from a private grower without getting a stocking permit (Kubisiak, 2012a).

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Appendix H
Margaret Lake Stewardship Program
Volunteer Anglers' Journal Report

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Margaret Lake Stewardship Project
Volunteer Anglers' Journal Report

Table of Contents

Introduction

One component of the Margaret Lake Stewardship Program was to establish a means by which anglers could collect meaningful fisheries data. Members of the Margaret Lake Association (MLA) and their consultant (White Water Associates) worked with the Wisconsin Department of Natural Resources (WDNR) to develop the Volunteer Anglers' Journal. The goal of the journals (and the resulting data) is to augment the periodic WDNR fish surveys (including Fyke nets, electroshocking, and creel surveys) with continuously collected and annually reported fishing data from systematically recorded angler journals. This report documents the methods and findings for the first year of volunteer fish monitoring in Margaret Lake.

Methods

This volunteer angler journal program was designed so that volunteer anglers can systematically record their fishing experiences. The program was conceived and designed by White Water Associates although components of the program (and field form) were drawn from literature (similar programs have been established in other states). Review by WDNR fisheries staff (Dennis Scholl and David Seibel) and WDNR Water Resources Management Specialist (Kevin Gauthier) resulted in several meaningful modifications.

We hope that participating anglers will be engaged in the journaling process for at least a year (and hopefully more). Nevertheless, the system can also accommodate anglers who participate for one fishing trip only. It is hoped that this activity will engage anglers in collecting fish data and understanding the dynamics of fish populations. The objectives for the angler journal program include providing information on:

- Species of fish caught while angling on Margaret Lake;
- Size distribution of fishes caught on Margaret Lake;
- Fishing emphases of Margaret Lake anglers (time spent on panfish, walleyes, bass, etc.);
- Fishing techniques used on Margaret Lake (trolling, bait fishing, spin fishing, etc.);
- Relative amount of catch and release fishing; and
- Catch-per-effort for various Margaret Lake fish species

Volunteer anglers participating in the journal program were provided with field data forms and specific instructions on how to fill out the forms (Figure 1).

Figure 1. Volunteer Anglers' Journal field data form.

VOLUNTEER ANGLERS JOURNAL FIELD DATA FORM

Important Instructions (*see Angler Journal Description for details*)
Fill sheet out only for yourself (a partner fills out a separate sheet). Use new sheet for each fishing trip. Record unsuccessful trips too. Measure and record all gamefish caught and indicate if kept/released. For panfish, measure the length of the first ten of each species and indicate if kept or released. For additional panfish, count number kept and number released and record. Complete a journal form every time you fish.

Angler and Fishing Trip Data

Angler Name:	Phone:	Date:
Time start (actual fishing time):	Time end (actual fishing time):	Total time fishing (excluding lunch break, etc.):
List fish species sought and % time spent for each. If you are seeking all species listed during your entire outing, list "100%" by each.		
Watercraft (circle one): Ice Pontoon Fishing boat Canoe Kayak Other (specify):		
Fishing Style (circle 1 or more): Tip-up Jigging Trolling Casting Bait Fly Other (specify):		
Weather Conditions: Sunny _____ Partly Cloudy _____ Overcast _____	Air temp (°F) _____ Water temp (°F) _____ Rainy _____	Calm winds _____ Moderate winds _____ Strong winds _____ Wind Direction _____ Other weather notes:
Level of satisfaction (circle one): Low Medium High Explain:		

Record Fish Caught on Trip

Catch #	Fish Species Common Name	Length (nearest ¼ inch)	Check one: Kept	Check one: Released	Catch #	Fish Species Common Name	Length (nearest ¼ inch)	Check one: Kept	Check one: Released	Counts of unmeasured panfish
1					11					Bluegill
2					12					
3					13					Pumpkinseed
4					14					
5					15					Crappie
6					16					
7					17					Yellow Perch
8					18					
9					19					Other (specify)
10					20					

Data continued on second page? (circle one): YES NO Note: If you need more space, indicate by circling "YES" and then record data on back of this sheet or on a 2nd data form.

Important instructions to the volunteers were summarized on the data form and emphasized on a separate handout. These instructions included the following:

- Fill out the data form only for yourself (if they wish, a fishing partner should fill out his/her own);
- Use a new sheet for each fishing outing;
- Record all trips including unsuccessful trips (even if you have caught no or few fish);
- Record actual time spent fishing (boating to and from your fishing areas and time spent doing reconnaissance with sonar are considered fishing activities and you should include the time spent on these activities even though you may not have a line in the water). Don't include non-fishing activity such as a lunch break or time spent swimming);

- Measure all fish caught (even tiny ones) in inches from tip of the snout to tip of the tail. Measure to the nearest one-quarter (1/4) inch. We want to understand the population size structure;
- Indicate if the fish was kept or released;
- Be consistent; fill out a journal field data sheet every time you fish;
- List the fish species you are seeking during a fishing trip and estimate a percentage of time devoted to each. If you are seeking all species listed during your entire outing, record "100%" by each species;
- Measure and record all game fish species caught. For panfish species, measure the length of the first ten of each species and indicate if kept or released. For additional panfish (beyond 10), simply count (don't measure) the number kept and number released. Record these numbers;
- If you need additional space for recording fish, indicated "continued on another page" and then record on back of the Field Data Form or on a second Field Data Form.

As with any biological sampling (whether done by professionals or volunteers), appropriate scientific and resource management use of data must recognize possible limitations of the data. In the case of the Margaret Lake, data will be most valid and useful if volunteers: (1) carefully follow directions regarding data recording, (2) accurately identify fish and measure fish length, (3) honestly record all data (big fish, little fish, many fish, and few fish), (4) consistently use the journal on all fishing outings, and (5) participate for multiple years.

Results

General statistics

Margaret Lake is an 86 acre lake with a maximum depth of 14 feet. It is a eutrophic drainage lake. The volunteer anglers' journal efforts began with few participants, but we anticipate that this number will grow. The scientific value of the information collected will increase with a greater number of participants and participation over several years. In 2011, there were 67 angler journals completed and 11 people participated. The 67 completed journal entries represent 67 fishing trips (outings). The period of journal records in this report occurred from May 20, 2011 to October 2, 2011 (Table 1).

Table 1. Sport fishing effort summary, Margaret Lake, 2011 season.		
Month	*Total Angler Hrs. (Angler Journal)*	*Total Angler Hrs./Acre (Angler Journal)*
May	1.0	0.01
June	8.0	0.09
July	19.5	0.23
August	104.8	1.22
Sept.	21.3	0.24
October	4.0	0.05
Total	**158.5**	

Total angler hours are the estimated total number of hours that anglers spent fishing on Margaret Lake during each month surveyed. Total angler hours/acre is the total angler hours divided by the area of the lake in acres.

Figure 2 indicates the fishing effort hours on Margaret Lake by month. August had the most fishing effort hours at nearly 105 hours.

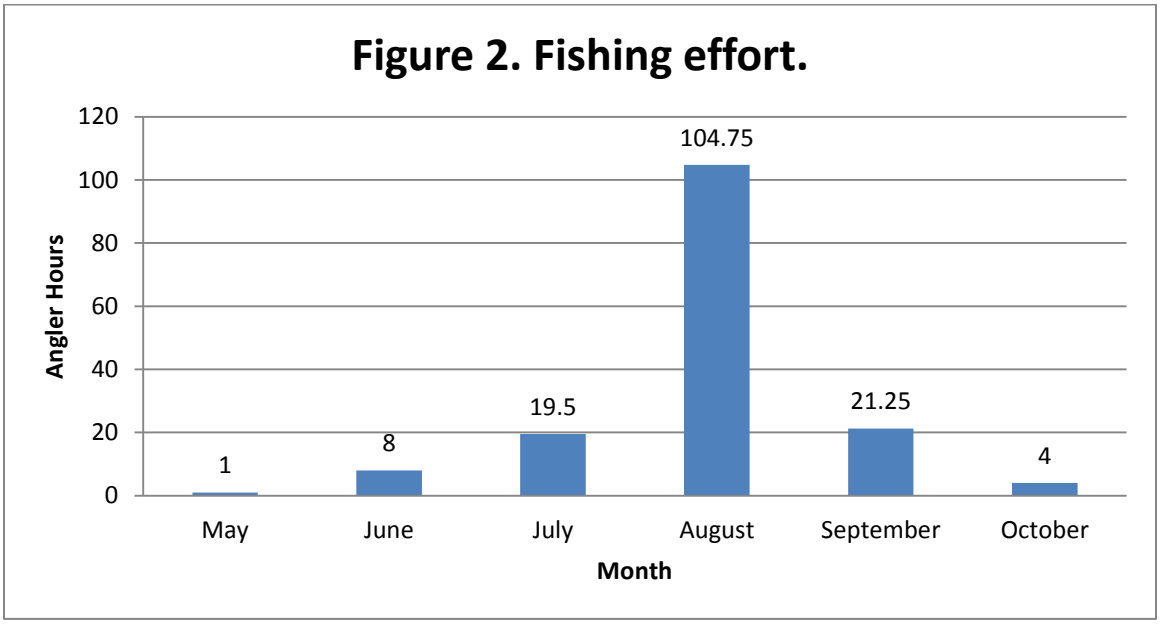
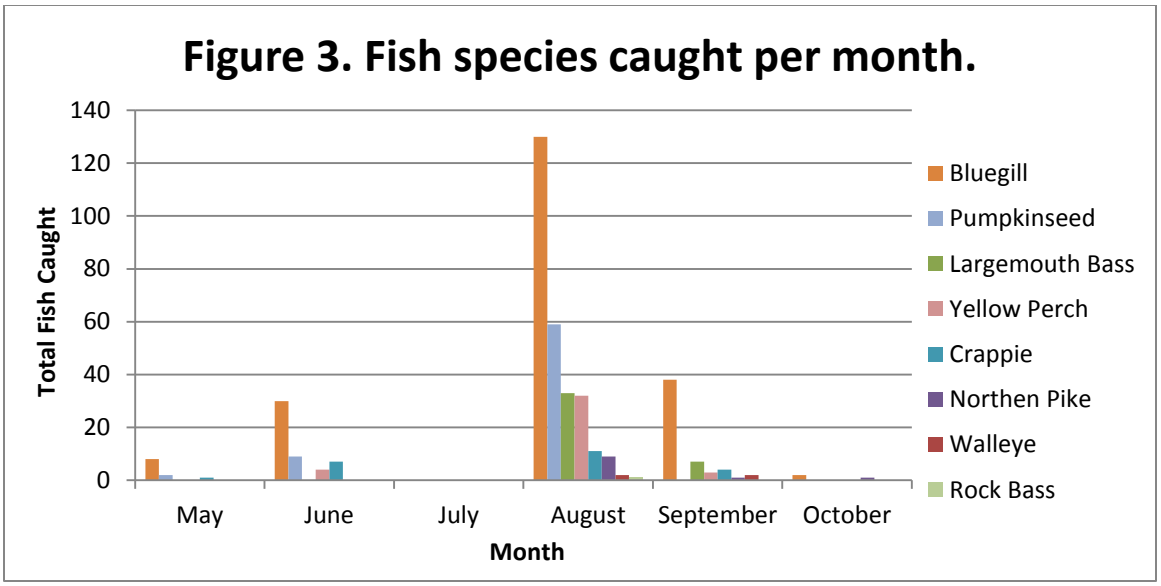


Figure 3 indicates the total fish caught per month. In each month, bluegills were the most caught fish.



Anglers indicated (with a percentage) what species of fish they were intending to catch. In some cases, it was recorded that anglers intended to catch three different species in the same outing. Panfish were the most noted fish intended to be caught and muskie was the second sought after fish species. Walleye, largemouth bass, northern pike, crappie, bluegill, pumpkinseed, and yellow perch were also fish sought after by anglers.

Anglers recorded the platforms from which they fished. The platforms noted were pier, shoreline, fishing boat, pontoon, or paddle boat. Their options also included canoe, kayak and ice fishing. The majority of fishing trips were conducted from a pier, while fishing boat was the second most common platform (Figure 4).

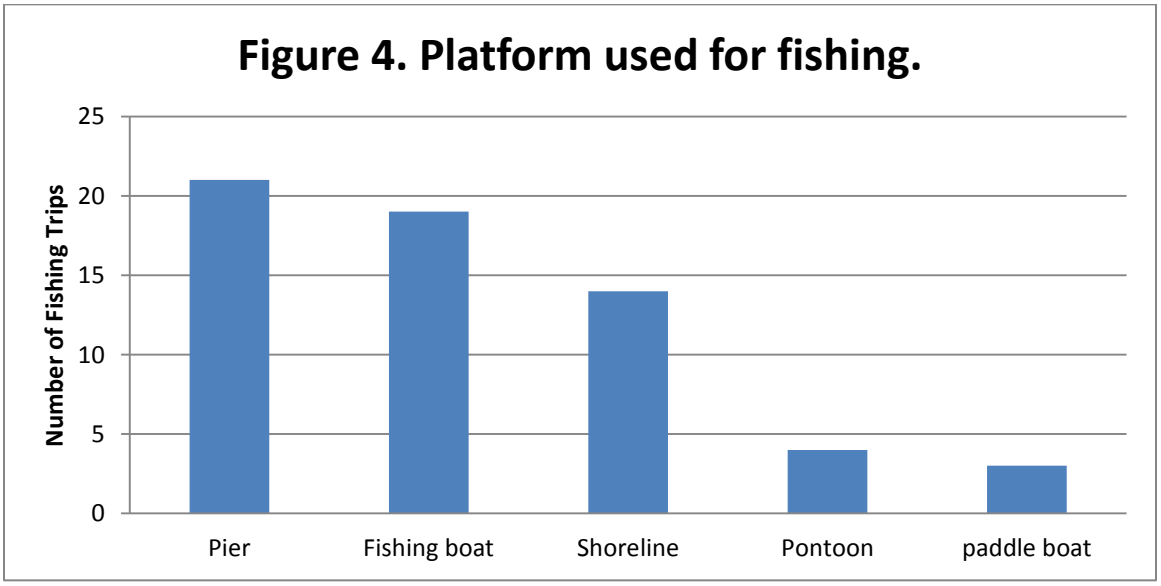
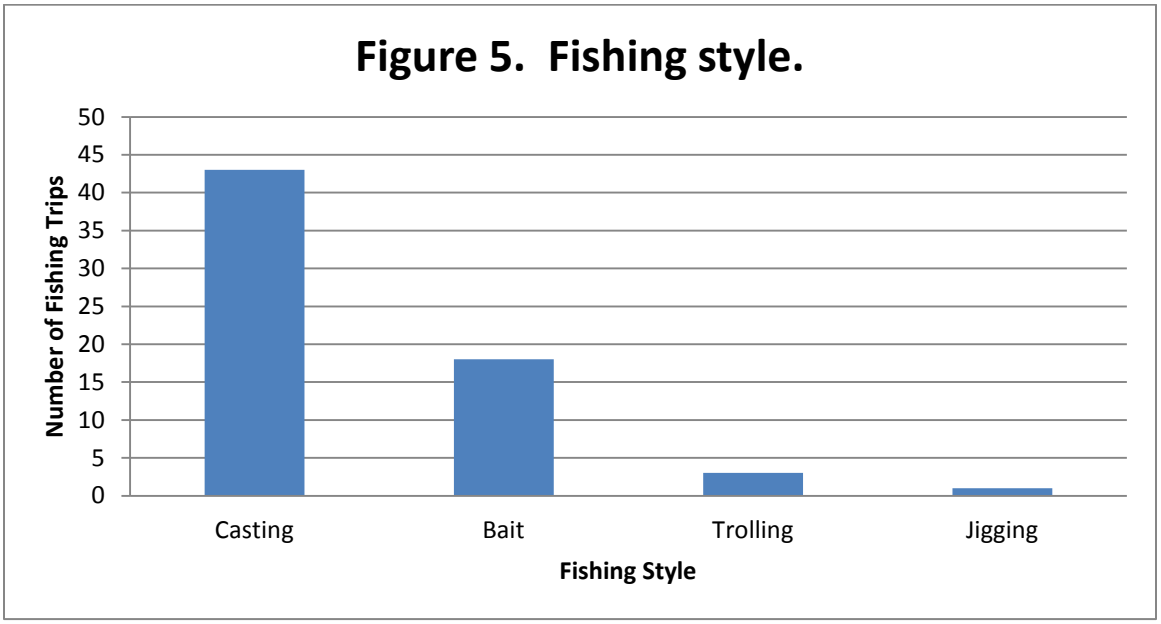
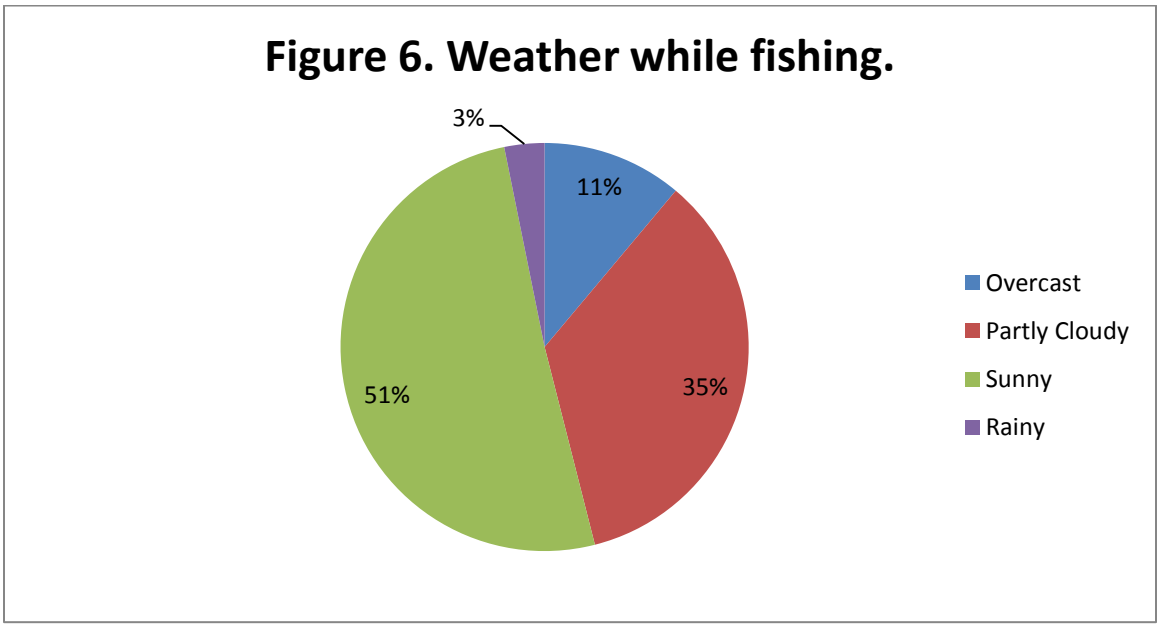
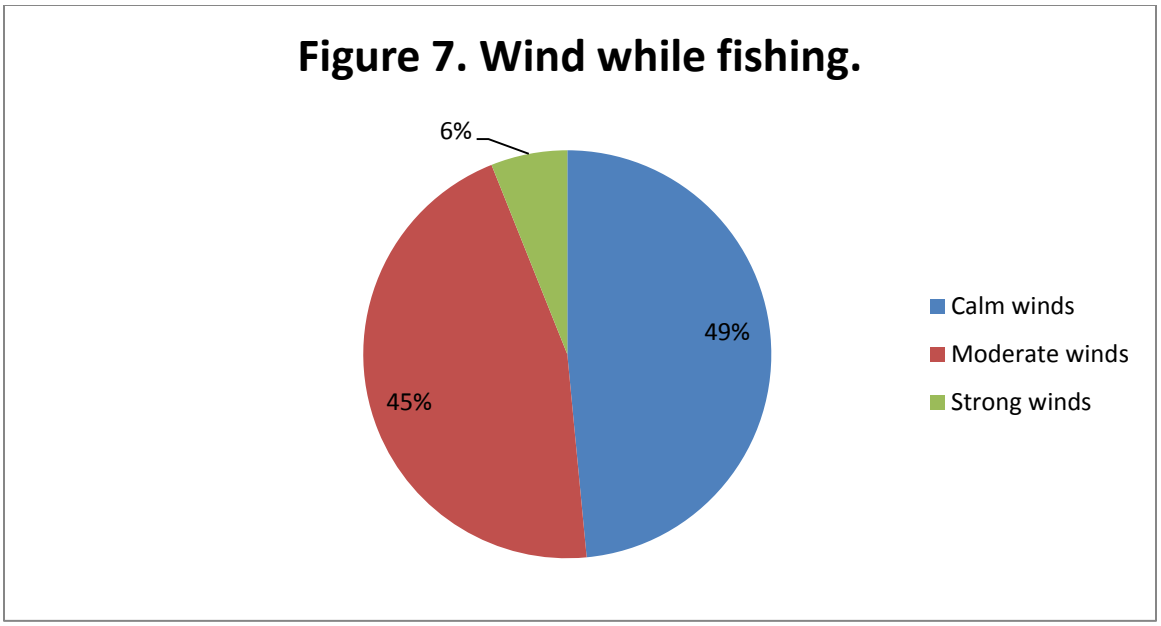


Figure 5 displays different techniques of fishing used by anglers. The most common technique was casting, followed by the use of bait. It would be expected that if angler journals were also recorded in the winter seasons, techniques and number of anglers might differ.

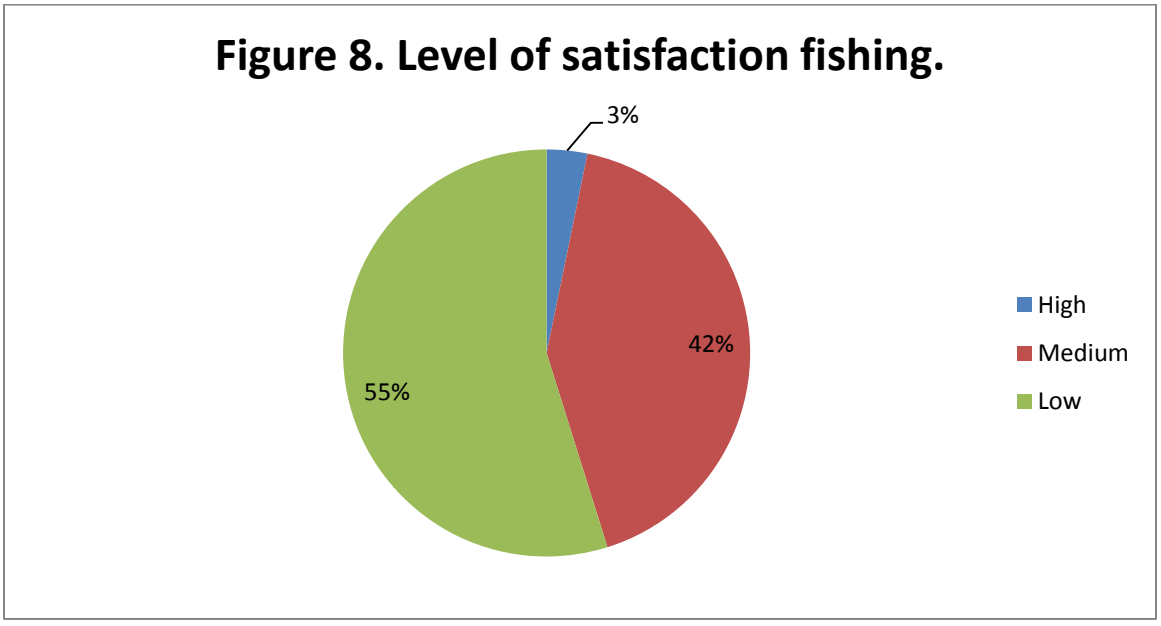


Weather and wind data was also recorded as part of the anglers' journals. The majority of anglers fished when it was sunny (Figure 6). Anglers fished in calm and moderate winds the most (Figure 7).

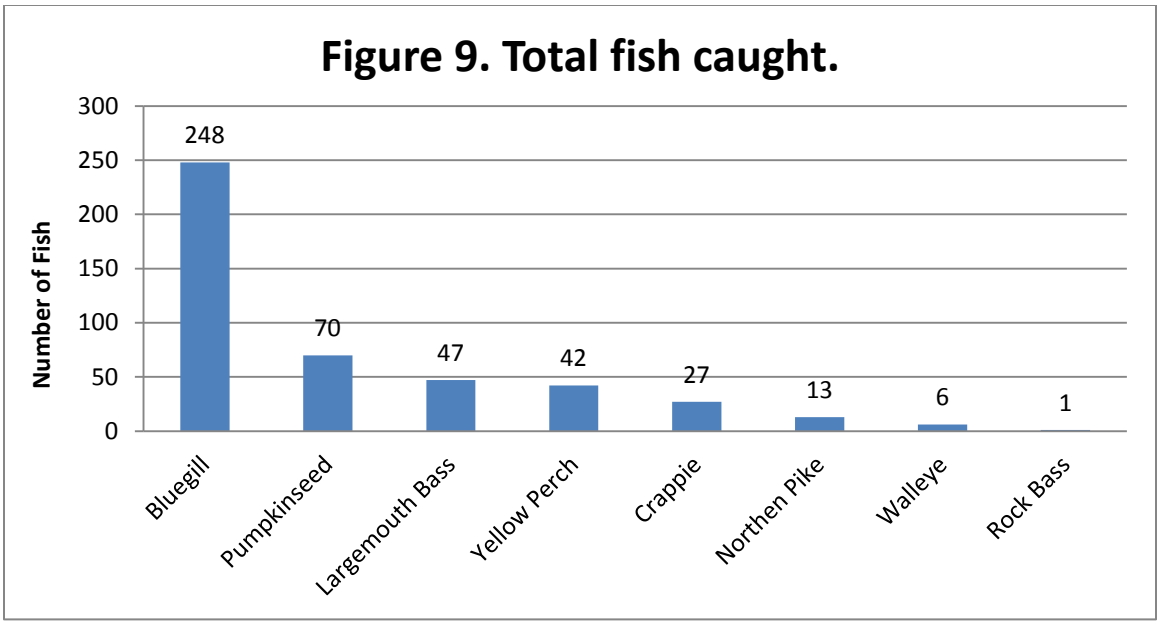




Anglers rated their level of satisfaction fishing as high, medium, or low (Figure 8). Over half (55%) of fishermen recorded a "low" satisfaction with their fishing experience.



A total of 396 fish were caught and recorded in the anglers' journals. Bluegill, pumpkinseed and largemouth bass were the top species caught (Figure 9). Other fish caught were yellow perch, crappie, northern pike, and rock bass. Muskie was also fished for, but there was no record of any being caught. One angler noted that they saw one rise to the surface.



Species-specific data

For each fish species caught in Margaret Lake, a number of statistics were recorded. These statistics include: number caught and harvested, length distributions, and average and longest length of fish both released and harvested. Catch and harvest numbers are the calculated number of fish (of the indicated species) caught regardless of targeted species. Length distribution is all fish of a species that were measured by the angler from May to October. Average and longest length of fish caught and harvested is the monthly longest and average length of fish caught and/or harvested fish species. Fish species with these data are: bluegill, pumpkinseed, largemouth bass, yellow perch, crappie, northern pike, walleye and rock bass.

BLUEGILL

In 2011, 208 bluegills were caught (Figure 10). The highest catch was in August (130 catches). The average length of bluegills was 4.7 inches; however the majority of fish were 4 inches (Figure 11). In August, the mean length was 4.6 inches, and in September the average was 7.7 inches (Figure 12). The largest bluegill recorded was 9 inches and was caught in September. Only one bluegill was caught in October making the average and longest length 3 inches.

Figure 10. Bluegill caught.

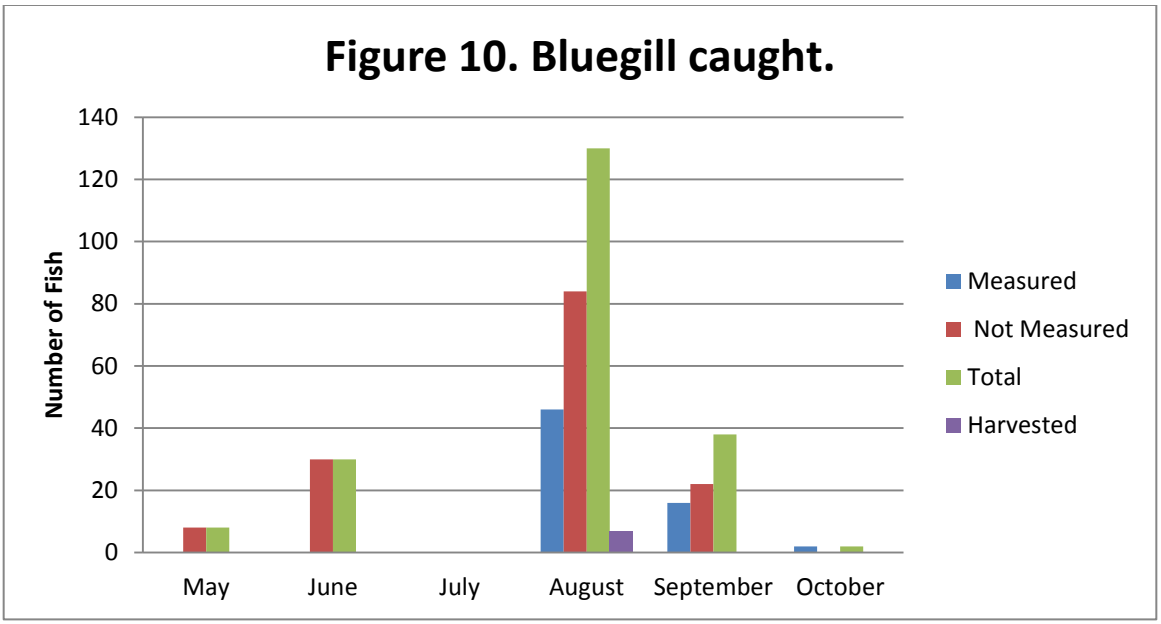
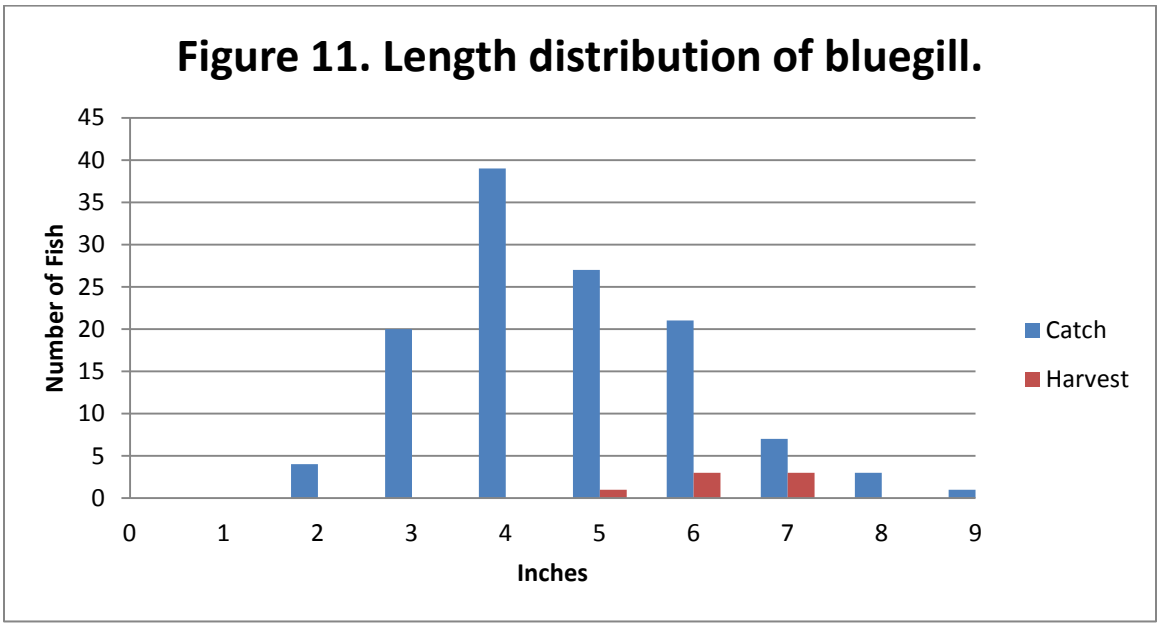
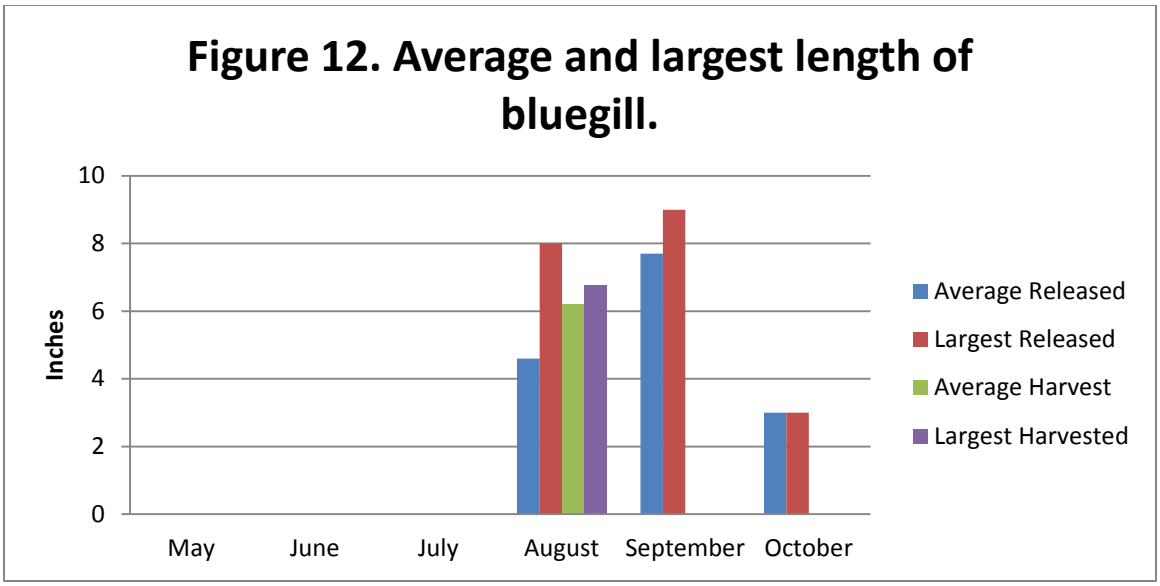


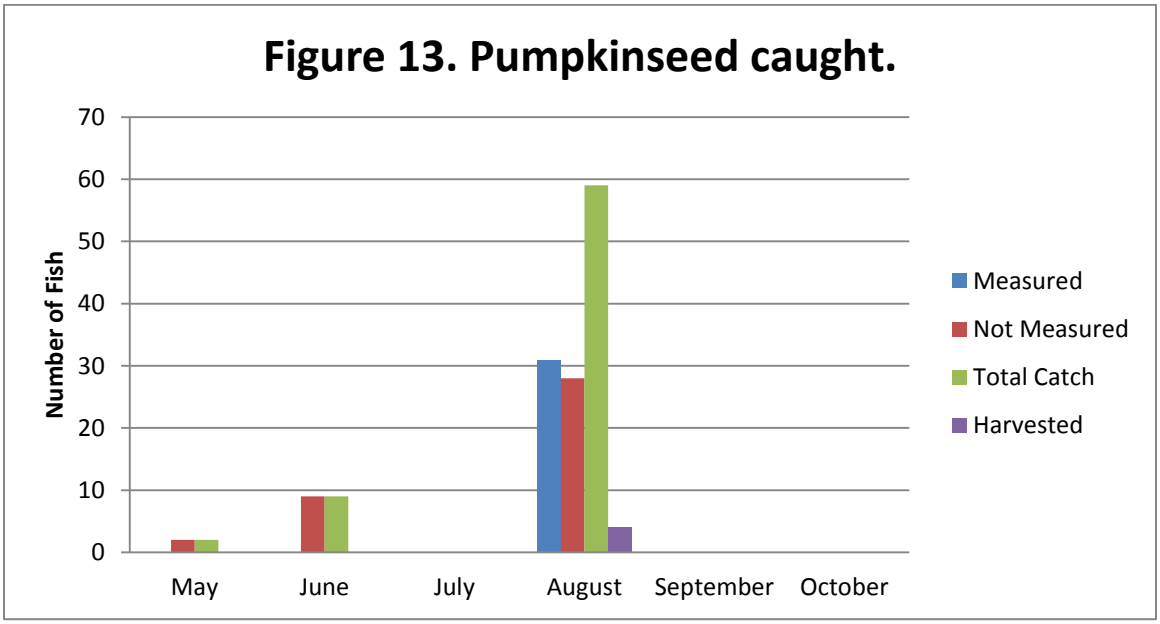
Figure 11. Length distribution of bluegill.

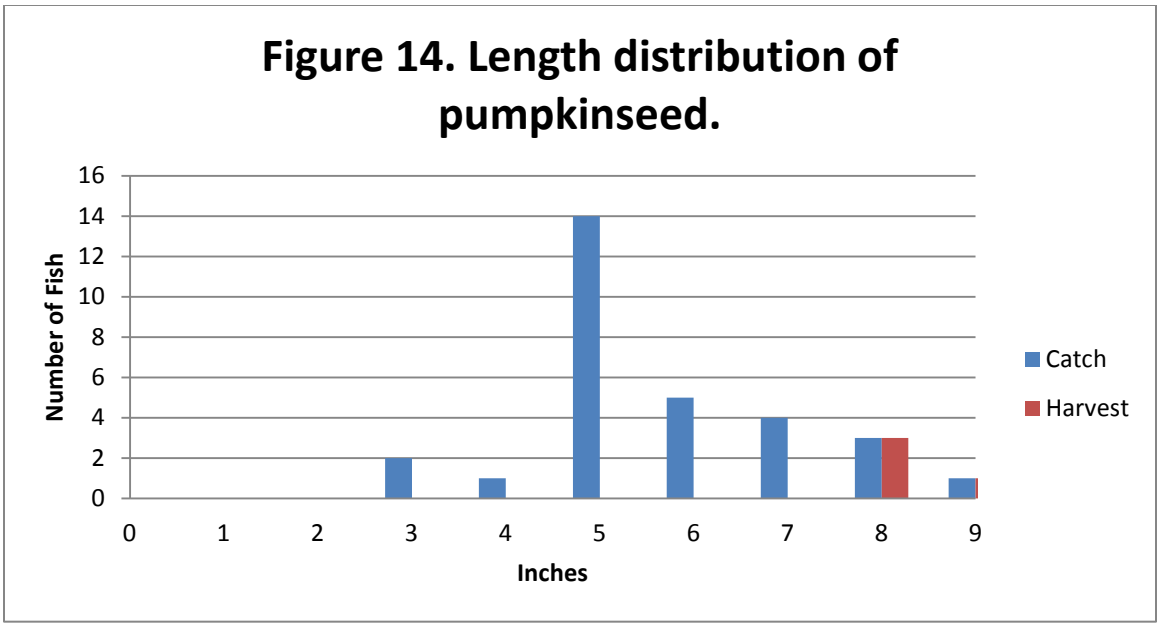


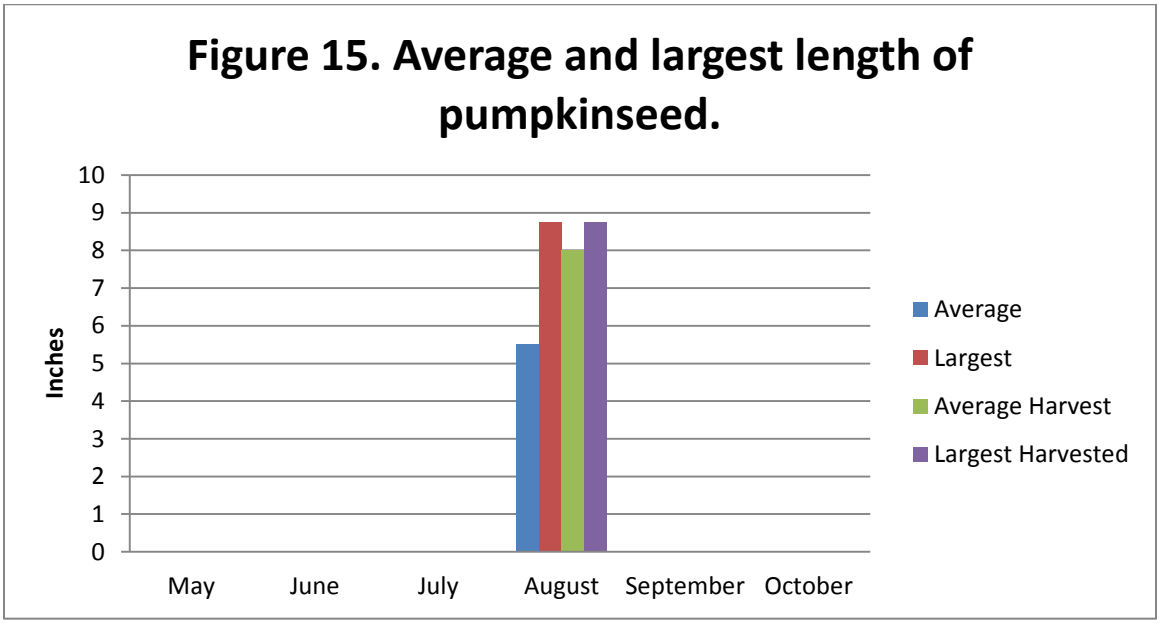


PUMPKINSEED

Pumpkinseed (70 fish) was the second most caught fish, with the most being caught in August (Figure 13). Fourteen fish measured 5 inches (Figure 14). Harvested pumpkinseeds were 8 inches long. The mean length of pumpkinseeds caught in August was 5.5 inches with the largest being 8.75 inches (Figure 15).







LARGEMOUTH BASS

Total catch of largemouth bass was 40 fish (Figure 16). The mean length of largemouth bass was 9.5 inches, and the majority of largemouth bass caught were 10 inches (Figure 17). The average length of largemouth bass was slightly larger in September (11.9 inches) than in August; however in both months the largest fish caught was 15 inches long (8.9 inches) (Figure 18).

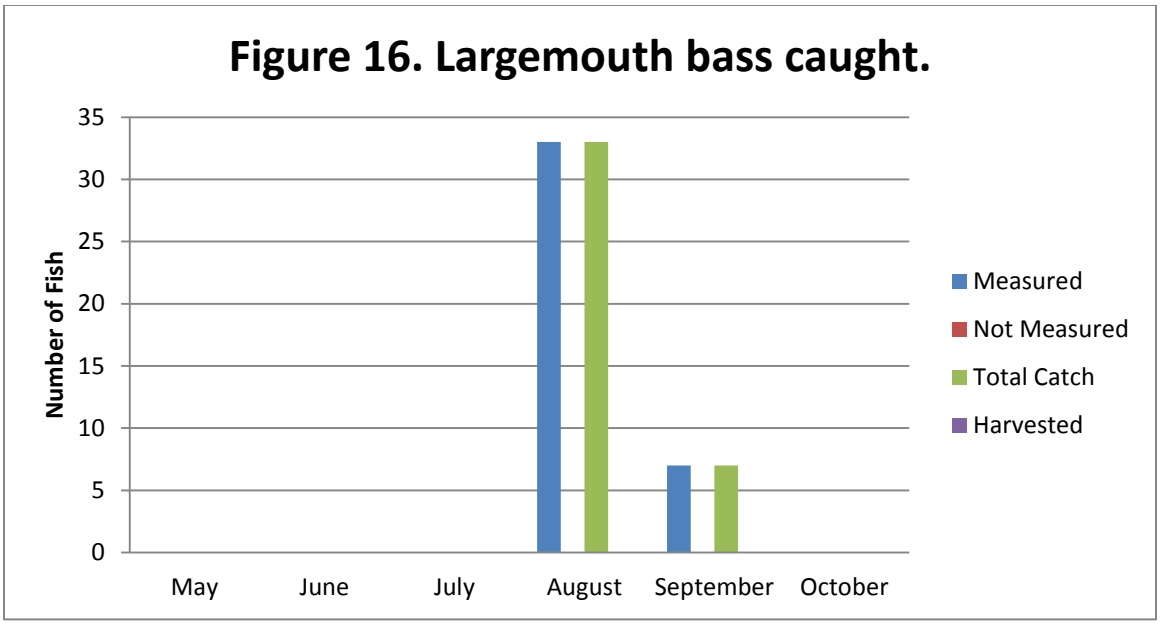


Figure 16. Largemouth bass caught.
Number of Fish
35
30
25
20
15
10
5
0
May
June
July
August
September
October
Measured
Not Measured
Total Catch
Harvested

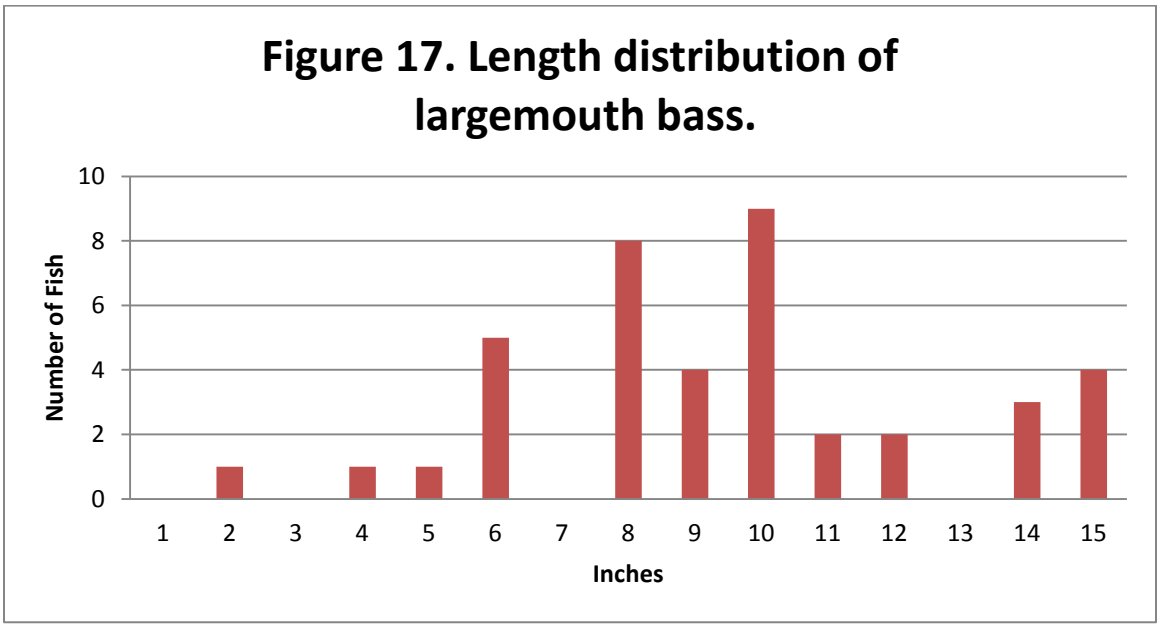
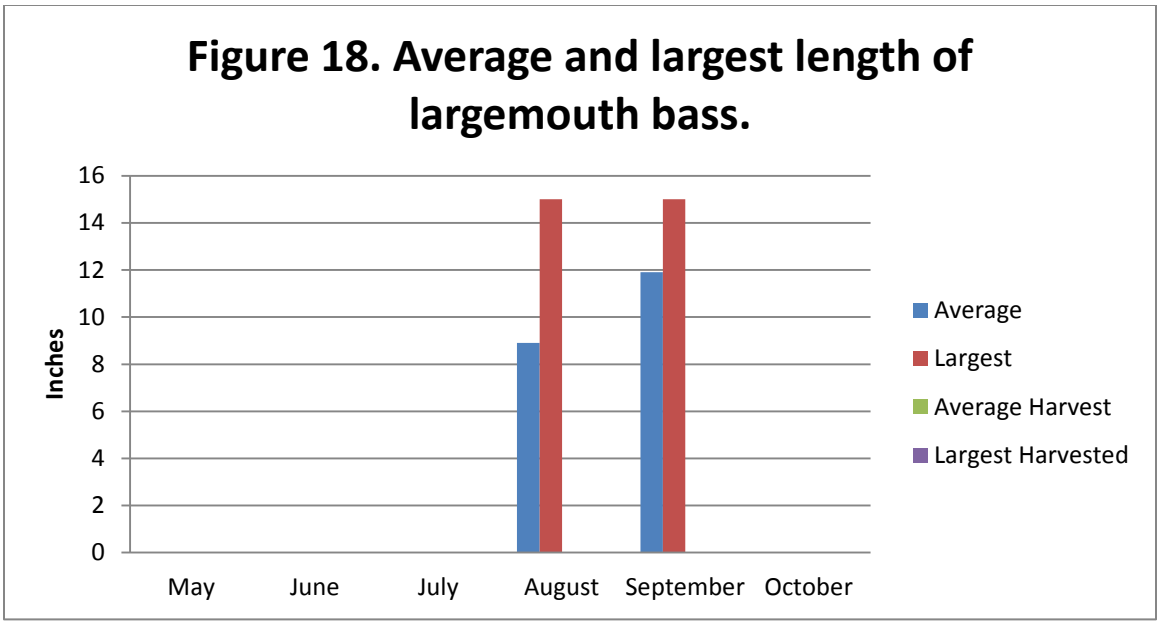
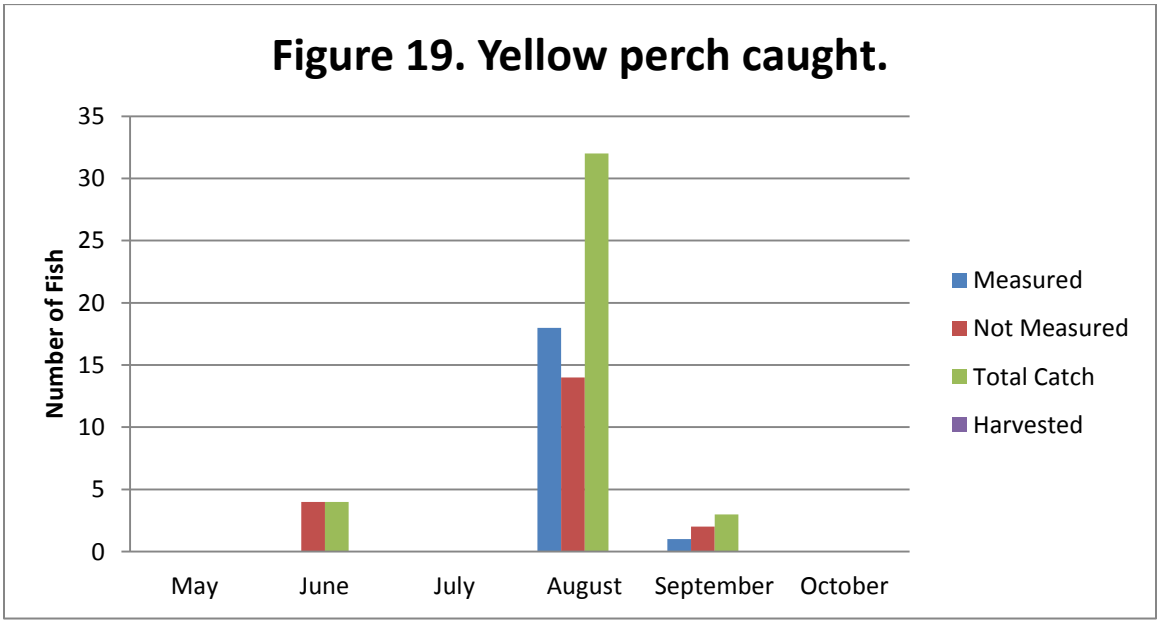


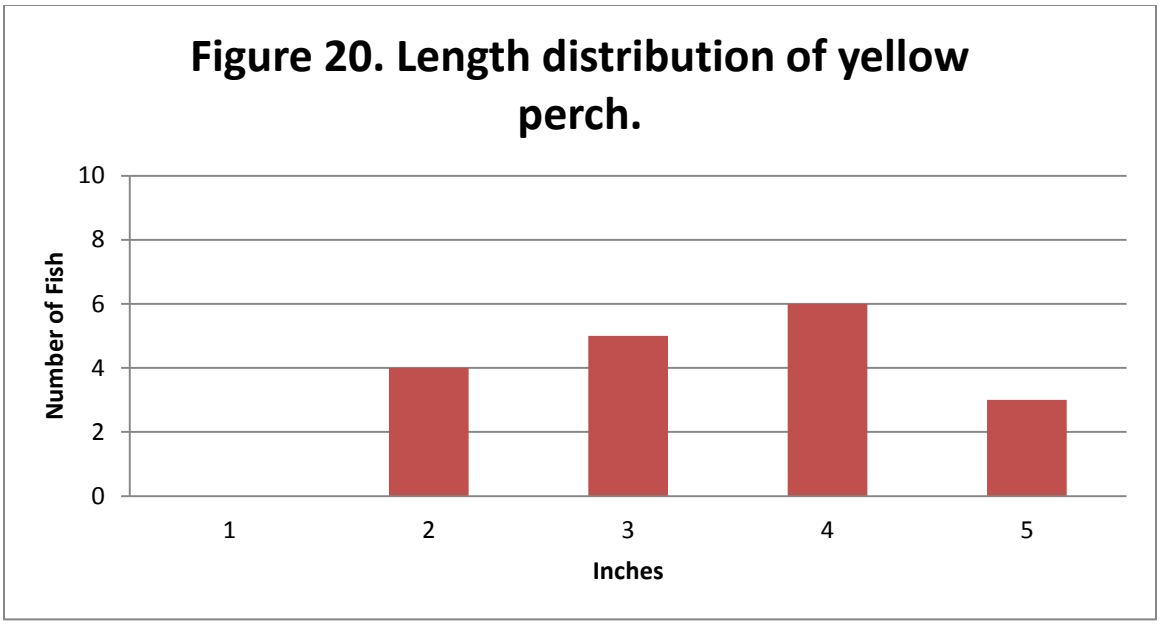
Figure 17. Length distribution of largemouth bass.
Number of Fish
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Inches

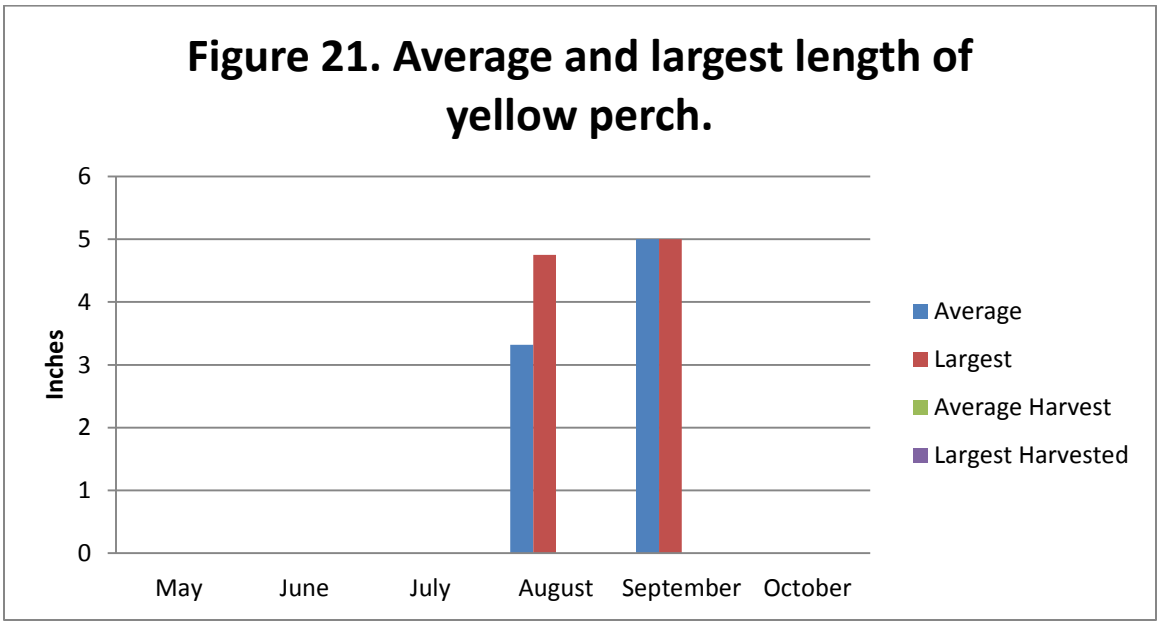


YELLOW PERCH

The total catch of yellow perch was 39 (Figure 19). The majority of perch caught were in August. The mean length of perch caught was 3.4 inches (Figure 20). The average length of perch in August was 3.2 inches, and the largest caught in August was 4.75 inches (Figure 21). In September, only one fish was caught, making the average and longest lengths 5 inches.







CRAPPIE

There were 23 crappie caught (Figure 22). The majority of crappies were caught in August. The mean length of crappies was 5.7 inches (Figure 23). The average length of crappies in August was 4.5 (Figure 24). Only one crappie was caught in September making the average and longest length 5 inches.

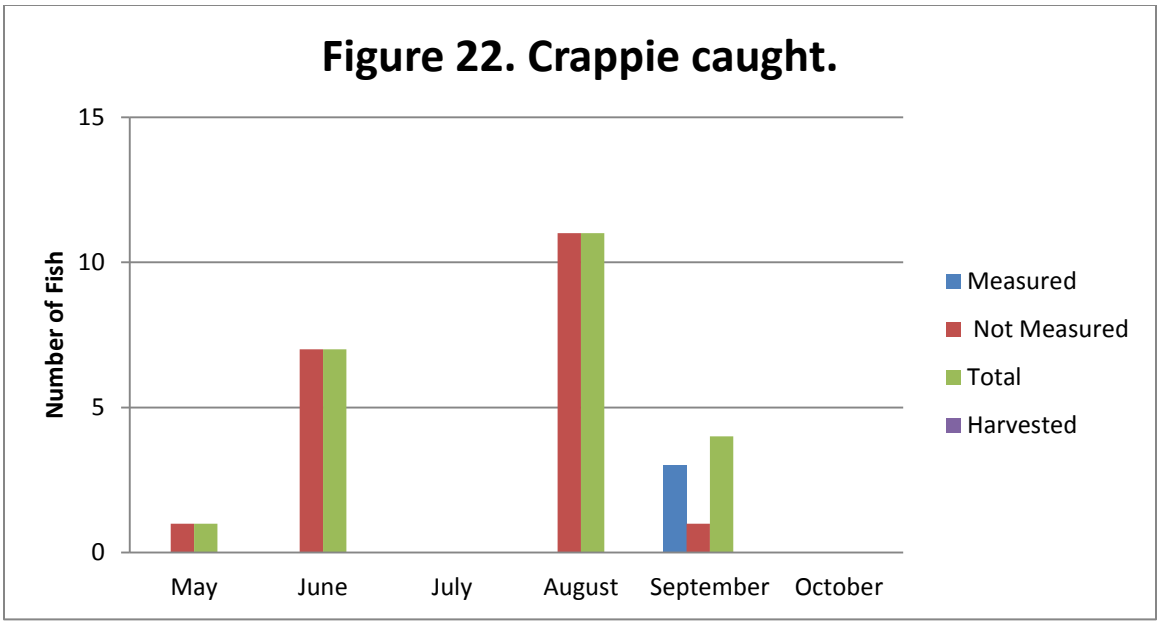


Figure 22. Crappie caught.
15
10
5
0
Number of Fish
May
June
July
August
September
October
Measured
Not Measured
Total
Harvested

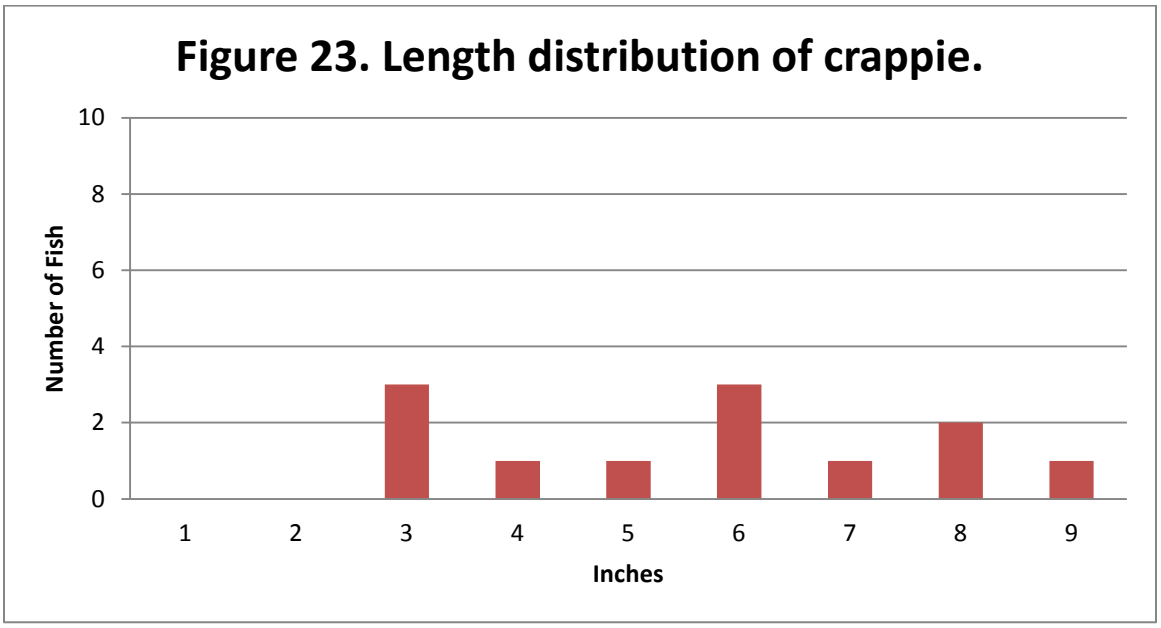
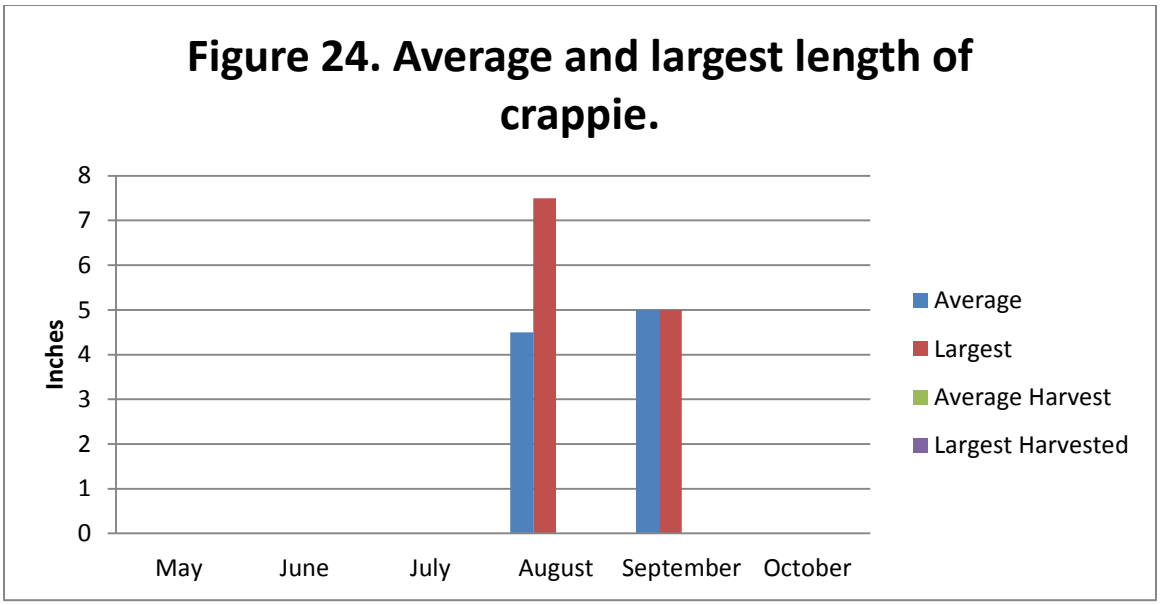
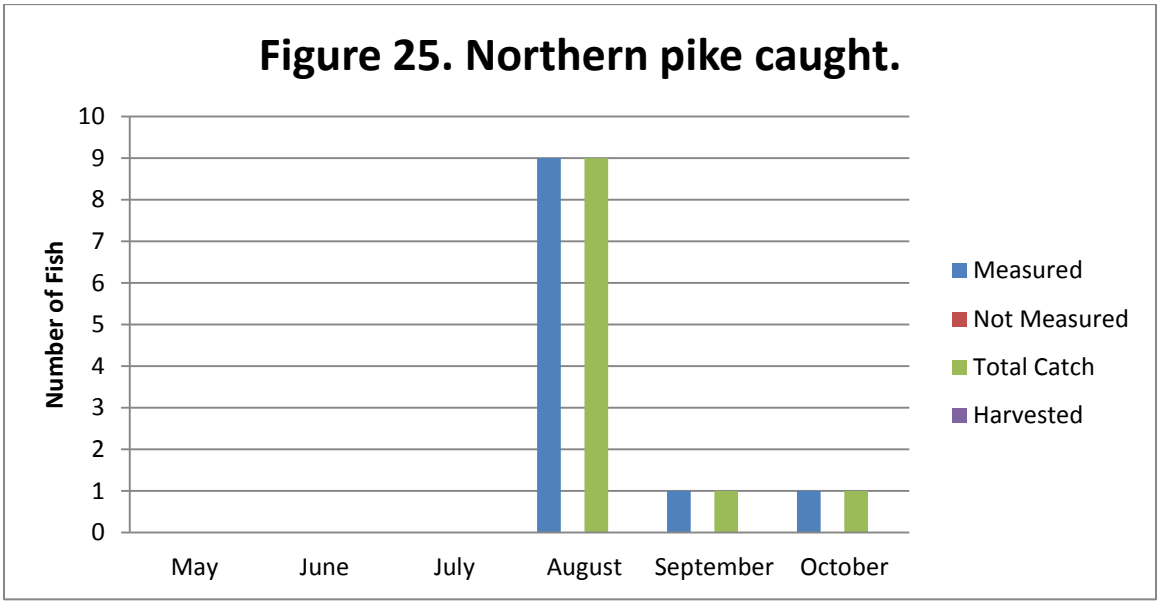


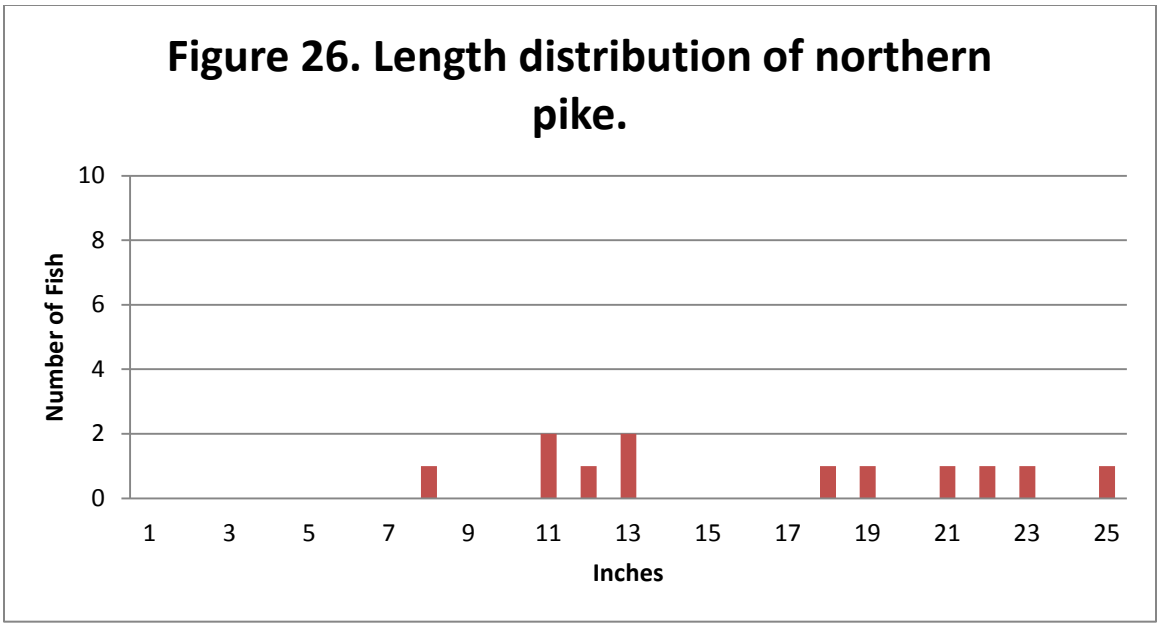
Figure 23. Length distribution of crappie.
10
8
6
4
2
0
Number of Fish
1
2
3
4
5
6
7
8
9
Inches

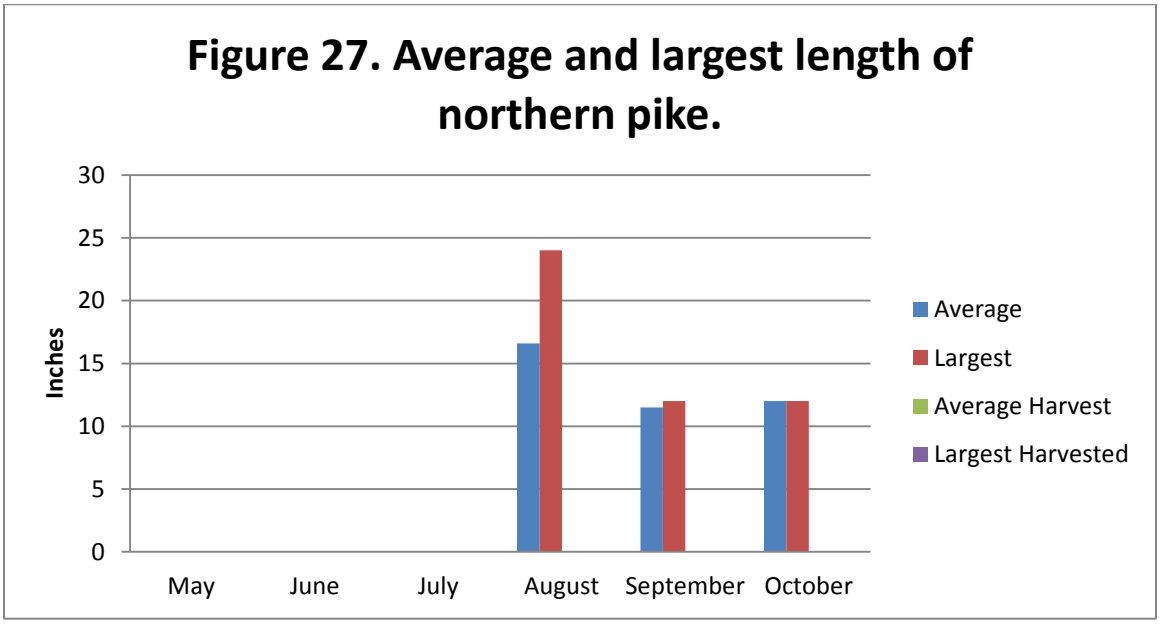


NORTHERN PIKE

There were 11 northern pike caught from August to October (Figure 25). The majority of pike caught were in August. The mean length was 16.3 inches (Figure 26). August had the highest average northern pike length (16.6 inches), while September had an average length of 11.5 inches (Figure 27). Only one pike was caught in October with the average and max lengths being 12 inches. The longest pike was caught in August, measuring 24 inches, followed by September and October both recording a longest pike of 12 inches.







WALLEYE

There were 4 walleye caught in August and September (Figure 28). The mean length was 9.8 inches (Figure 29). The average length of walleye caught in August was 9 inches, while the average length in September was 7 inches (Figure 30). The longest walleye caught in August was 9.5 inches. The longest walleye caught in September was 13 inches.

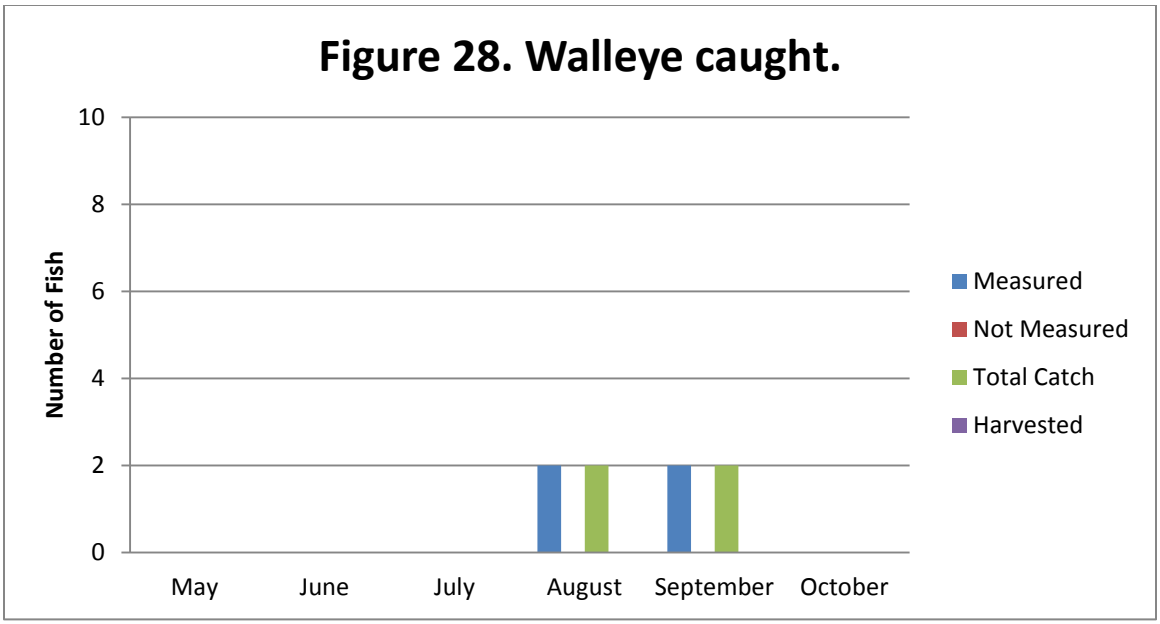


Figure 28. Walleye caught.
10
8
6
4
2
0
Number of Fish
May
June
July
August
September
October
Measured
Not Measured
Total Catch
Harvested

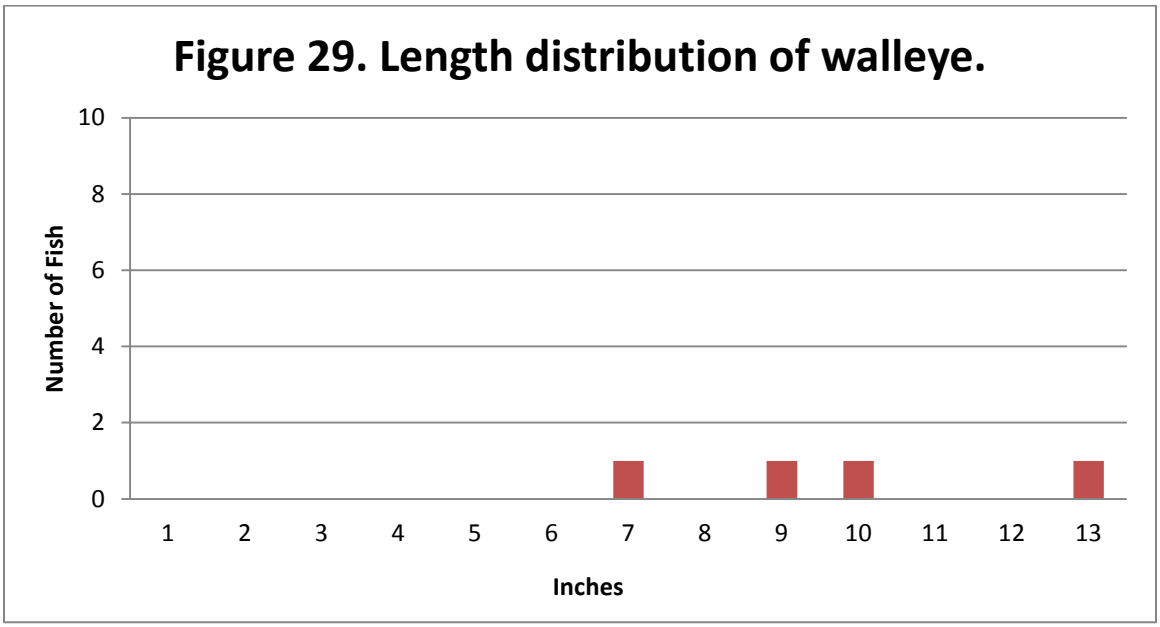
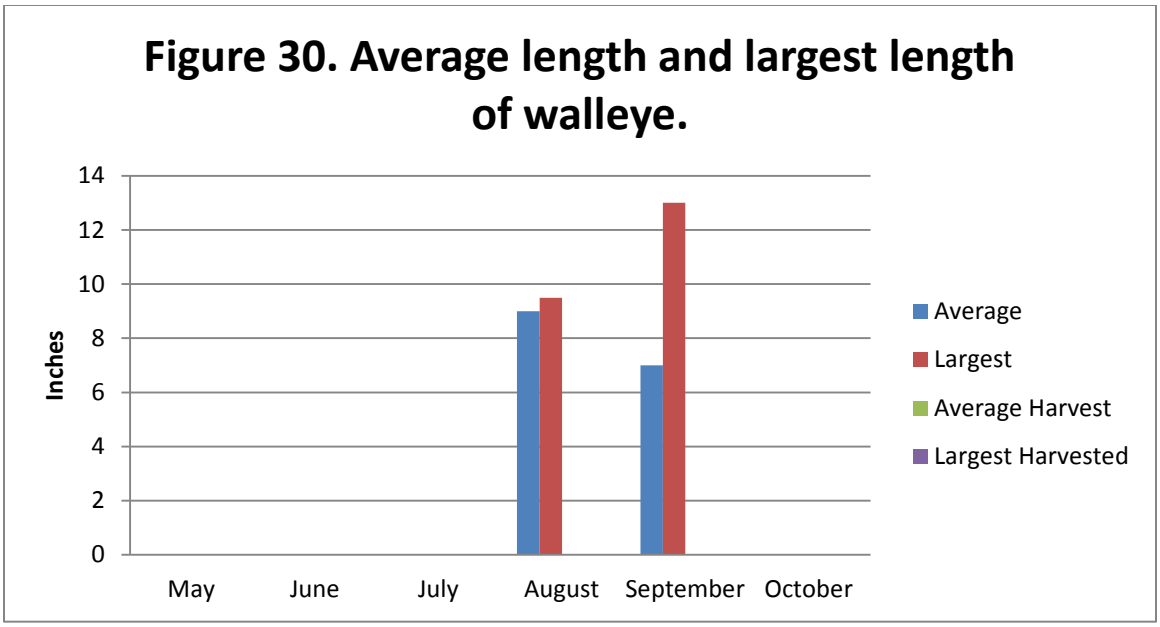


Figure 29. Length distribution of walleye.
10
8
6
4
2
0
Number of Fish
1
2
3
4
5
6
7
8
9
10
11
12
13
Inches



ROCK BASS

There was only one rock bass caught in August. It measured 6 inches.

Appendix I
Margaret Lake Frog and Toad Survey

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Margaret Lake Stewardship Program
Frog & Toad Survey

Northern Spring Peeper
(*Pseudacris crucifer*)
Photo by Dean Premo

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

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Date: March 2014

Introduction

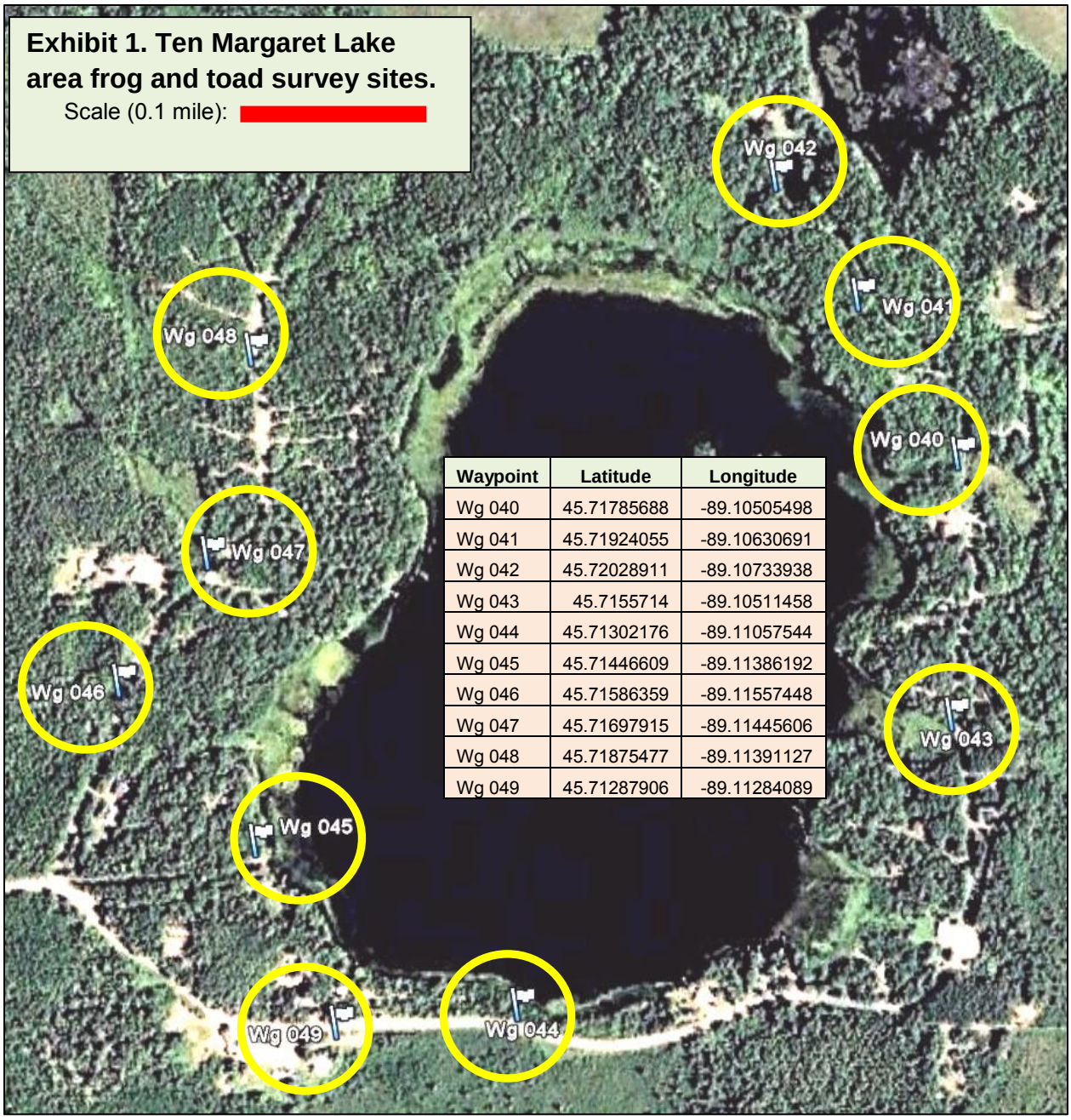
One component of the Margaret Lake Stewardship Program was to establish a volunteer frog and toad survey of habitats in the vicinity of Margaret Lake. The decline of amphibian populations in many areas in North America has prompted monitoring of local frog and toad populations. Many states (including Wisconsin) have developed frog and toad survey protocols for this purpose. This report documents the methods and findings for the frog and toad monitoring around Margaret Lake.

Methods

We followed the Wisconsin Frog and Toad Survey Manual[1] for site selection and field methodology. Working in consultation with lake stewardship volunteers with local knowledge of area wetlands, Dean Premo (a trained herpetologist) selected ten sites in the immediate landscape of Margaret Lake as prospective frog and toad survey wetlands. These sites are shown in Exhibit 1 and further described in the site summaries exhibits.

Lake steward volunteers offered their efforts for the "swing-shift" duty of surveying for frogs and toads (frog and toad monitoring typically starts after dark and may go late into the night). The volunteers were given instruction by Dean Premo and provided recordings of frog calls from which to study. All study wetlands were surveyed on the same three dates during the season. *First run*, *second run*, and *third run* dates are established in an attempt to capture the breeding phenology (seasonal timing) of all frog and toad species potentially present in the area. Monitoring was conducted under weather conditions conducive to frog/toad activity and to hearing the breeding males vocalize. This report covers the monitoring conducted during 2011 (two surveys conducted in first year) and 2013 (no survey was conducted in 2012).

[1] Paloski, R.A. T.L.E. Bergeson, M. Mossman, and R. Hay (eds). 2006. Wisconsin Frog and Toad Survey Manual PUB-ER-649. Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Madison, WI. 25 pp.



Waypoint	Latitude	Longitude
Wg 040	45.71785688	-89.10505498
Wg 041	45.71924055	-89.10630691
Wg 042	45.72028911	-89.10733938
Wg 043	45.7155714	-89.10511458
Wg 044	45.71302176	-89.11057544
Wg 045	45.71446609	-89.11386192
Wg 046	45.71586359	-89.11557448
Wg 047	45.71697915	-89.11445606
Wg 048	45.71875477	-89.11391127
Wg 049	45.71287906	-89.11284089

According to range maps in the scientific literature and the Frog and Toad Survey Manual, nine anuran (frogs and toads) species have been documented in Oneida County. Exhibit 2 provides this list. These species are the most likely anurans to be heard in the Margaret Lake watershed. The volunteers became familiar with their vocalizations.

Exhibit 2. Oneida County Frogs and Toads (Anurans).

Anurans for which Oneida County Records Exist

1. Eastern American Toad (*Bufo americanus*)
2. Western Chorus Frog (*Pseudacris triseriata*)
3. Northern Spring Peeper (*Pseudacris crucifer*)
4. Gray Treefrog (*Hyla versicolor*)
5. Bullfrog (*Lithobates catesbeiana*)*****
6. Green Frog (*Lithobates clamitans*)
7. Wood Frog (*Lithobates sylvatica*)
8. Northern Leopard Frog (*Lithobates pipiens*)*****
9. Mink Frog (*Lithobates septentrionalis*)*****

***** *Wisconsin's Natural Heritage Inventory current working list designates this species as SC/H=special concern/take regulated by establishment of open closed seasons*

Note: *Lithobates palustris* has not been documented in Oneida County but has been recorded from counties immediately south of Oneida.

Results

Field data collected is presented in the site data summary exhibits and the actual field data sheets provided at the end of this report. These site summary sheets also show the location of the wetland on an aerial photograph and describe the habitat.

A total of eight anuran species were detected during the auditory surveys of 2013. These species are listed in Exhibit 3. The Spring Peeper was the most widely distributed, occurring at 9 of 10 monitoring sites. Leopard frog was next, occurring at 7 of the 10 sites.

Exhibit 3. Anuran species detected in the Margaret Lake Watershed.

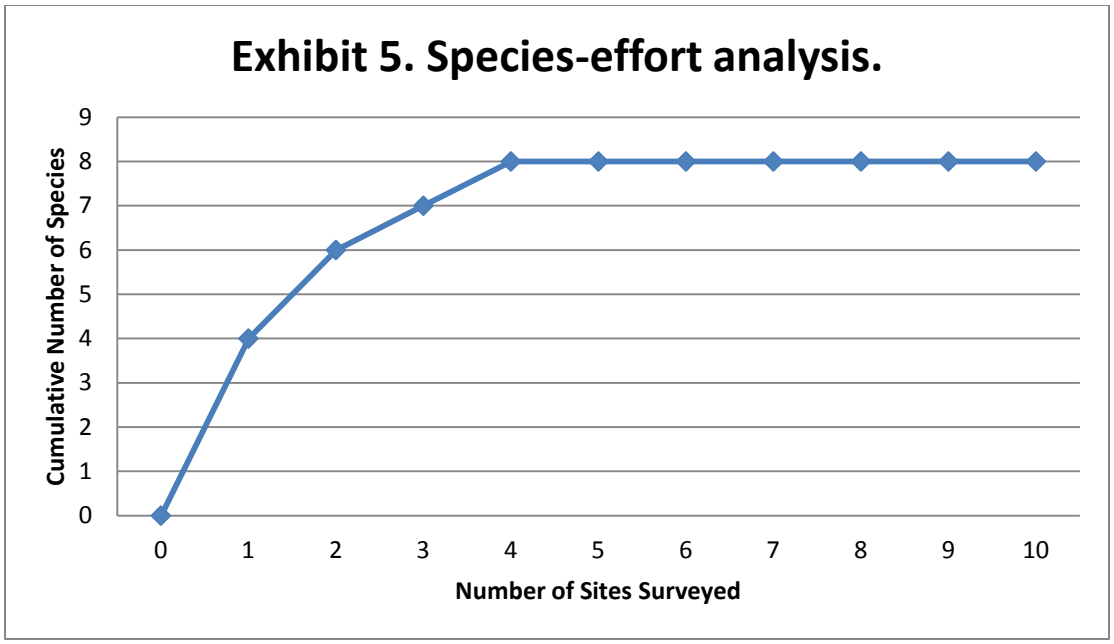
Anuran Species	Number of Sites Detected
Chorus Frog (*Pseudacris triseriata* or *maculata*)	3
Spring Peeper (*Pseudacris crucifer*)	9
Gray Treefrog (*Hyla versicolor*)	5
American Toad (*Anaxyrus americanus*)	4
Wood Frog (*Lithobates sylvatica*)	4
Leopard Frog (*Lithobates pipiens*)	7
Green Frog (*Lithobates clamitans*)	4
Bullfrog (*Lithobates catesbeiana*)	3

Exhibit 4 displays the species detected at each of the ten study sites. Site 8 had the highest number of species (eight). Sites 7 and 10 each had seven species detected. The mean number of species per site was 4.9 and the median number of species per site was 4.5.

Exhibit 4. Anuran species distribution across Margaret Lake watershed study sites.

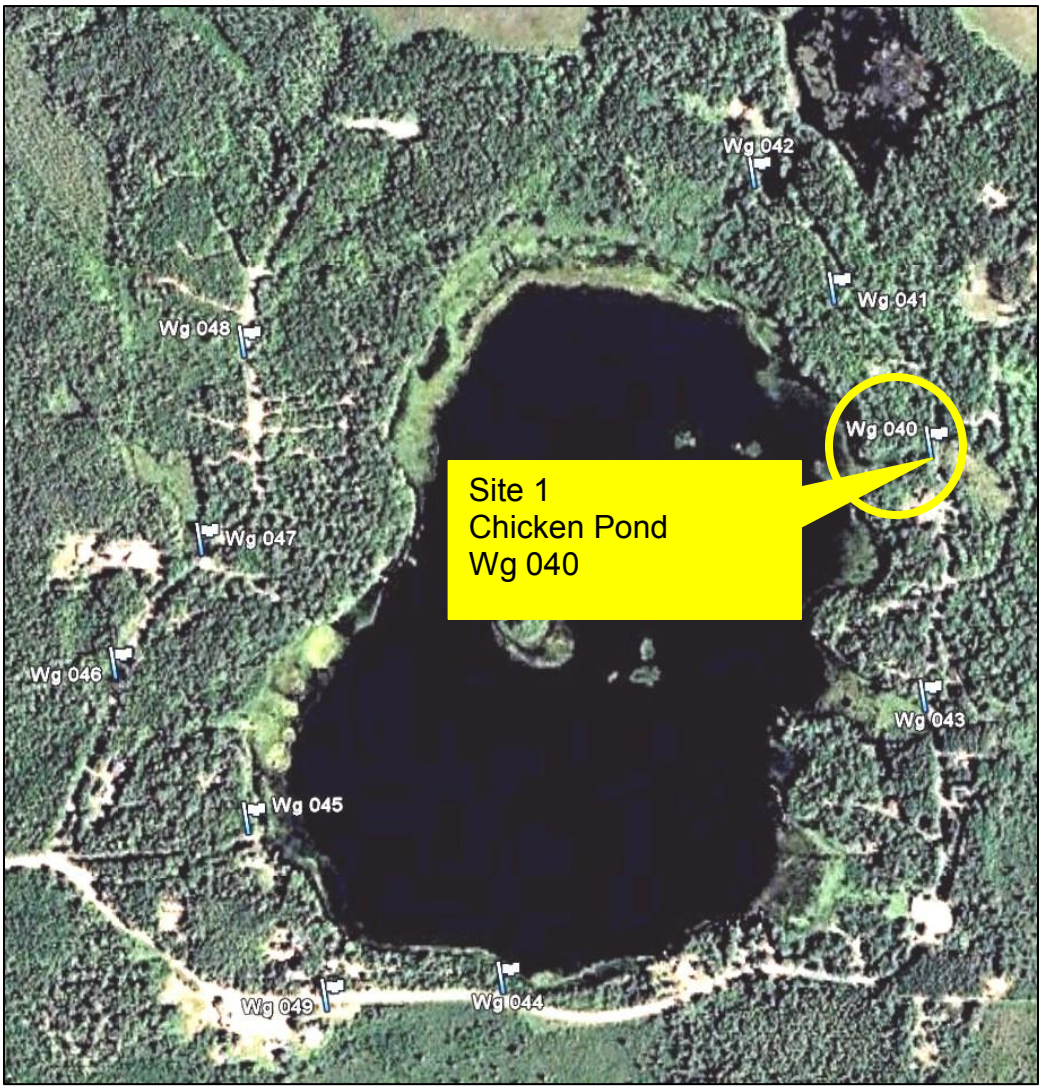
Site	Total Species	Wood Frog	Chorus Frog	Spring Peeper	Gray Treefrog	Leopard Frog	American Toad	Green Frog	Bullfrog
1	4			X	X	X		X	
2	4	X		X		X			X
3	2			X					X
4	5		X	X		X		X	X
5	5			X	X	X	X		X
6	4					X	X	X	X
7	7	X	X	X	X		X	X	X
8	8	X	X	X	X	X	X	X	X
9	3			X	X		X		
10	7	X	X	X	X	X	X	X	

Finally, as a measure of survey thoroughness, we present an analysis of species detected and effort expended (as measured by the number of sites surveyed). Exhibit 5 shows a graph of cumulative number of species plotted against number of sites visited. The actual site numbers were randomly arranged for this analysis. The curve has leveled off after four sites indicating our effort with regard to number of sites surveyed was adequate.



The habitats for each of the ten monitoring sites are described in Exhibits 6-15. Copies of the field data sheet is attached to the end of the document.

Exhibit 6. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 1

Site Location: Wg 040; Eagle Creek Road

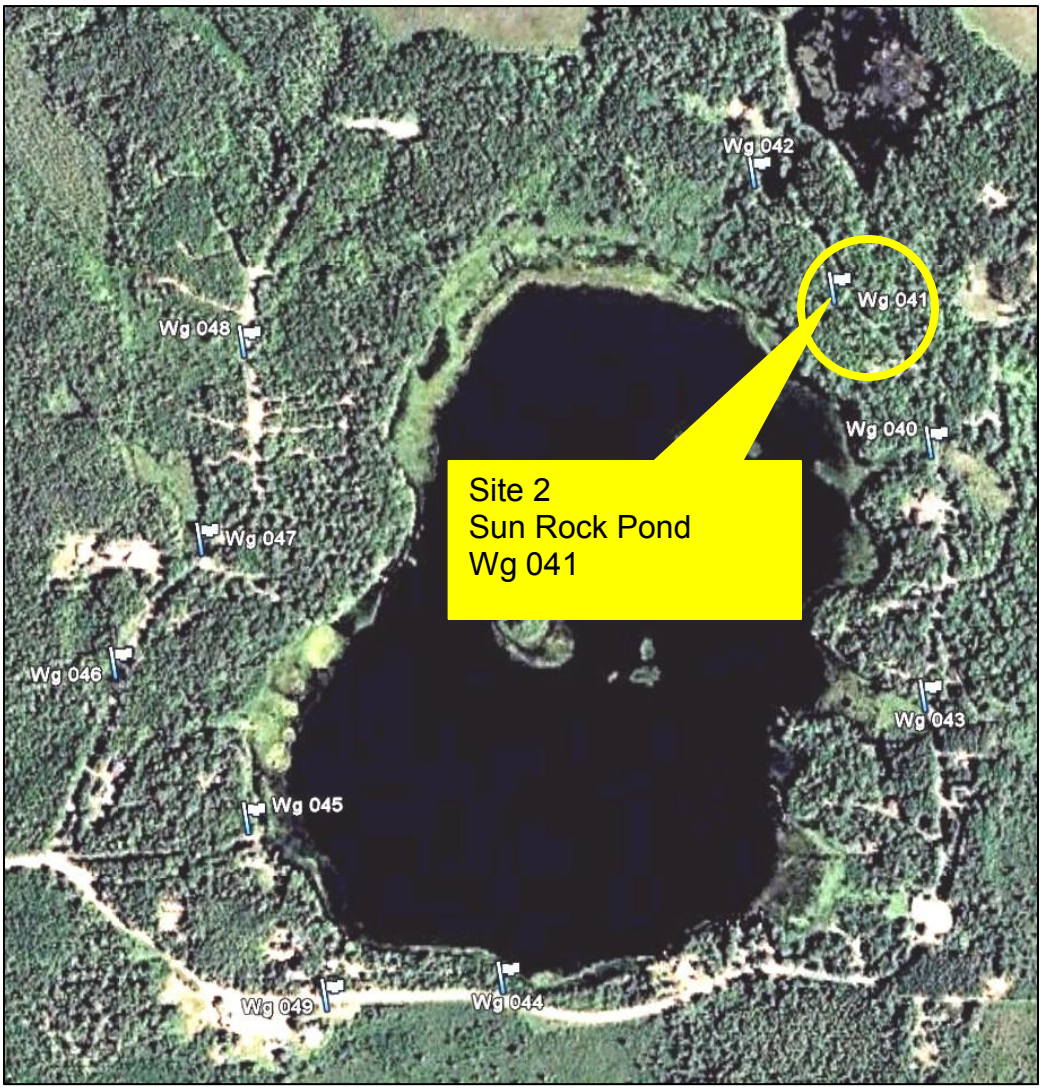
Site Coordinates: 45.71785688; -89.10505498

Habitat Description: Permanent pond with cattail fringe.

Species Detected:

- Spring peeper
- Gray treefrog
- Leopard frog
- Green frog

Exhibit 7. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 2

Site Location: Wg 041; Unnamed road off Eagle Creek Rd.

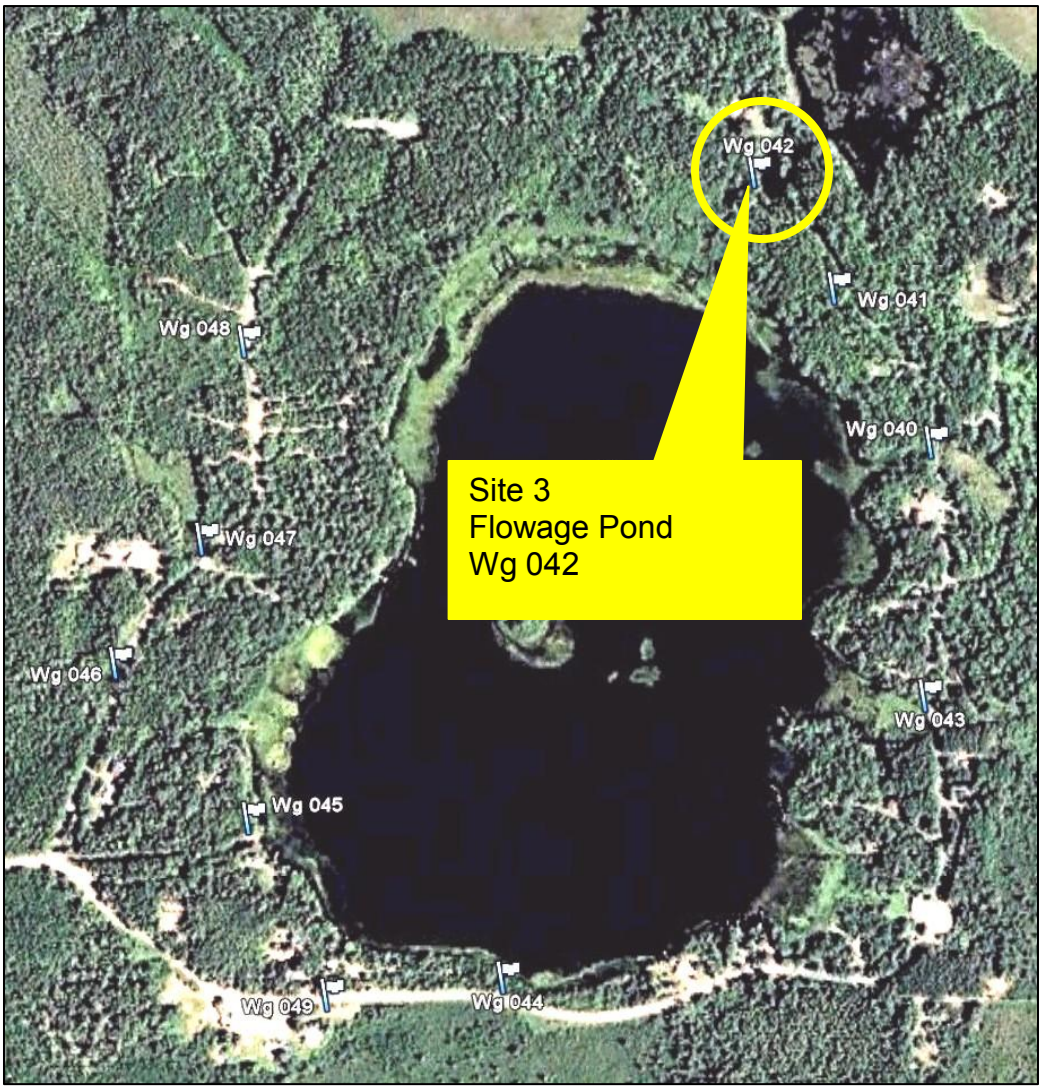
Site Coordinates: 45.71924055; -89.10630691

Habitat Description: Permanent pond with some cattail. Riparian area of balsam fir.

Species Detected:

- Wood frog
- Spring peeper
- Leopard frog
- Bullfrog

Exhibit 8. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 3

Site Location: Wg 042; Unnamed road of Eagle Creek Rd.

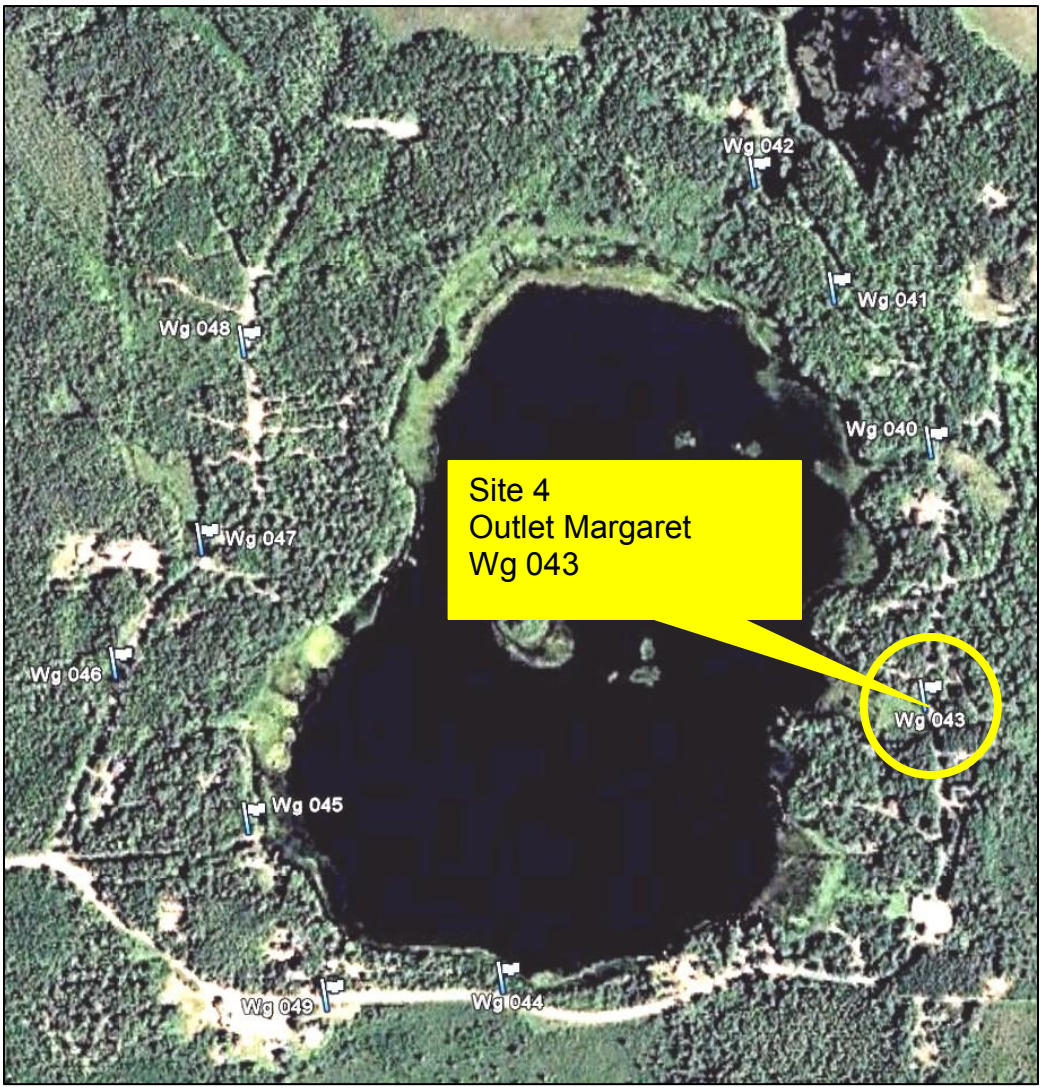
Site Coordinates: 45.72028911; -89.10733938

Habitat Description: Large permanent pond (impounded stream) with mixed hardwood-conifer forest riparian area.

Species Detected:

- Spring peeper
- Bullfrog

Exhibit 9. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 4

Site Location: Wg 043; Margaret Lake Road

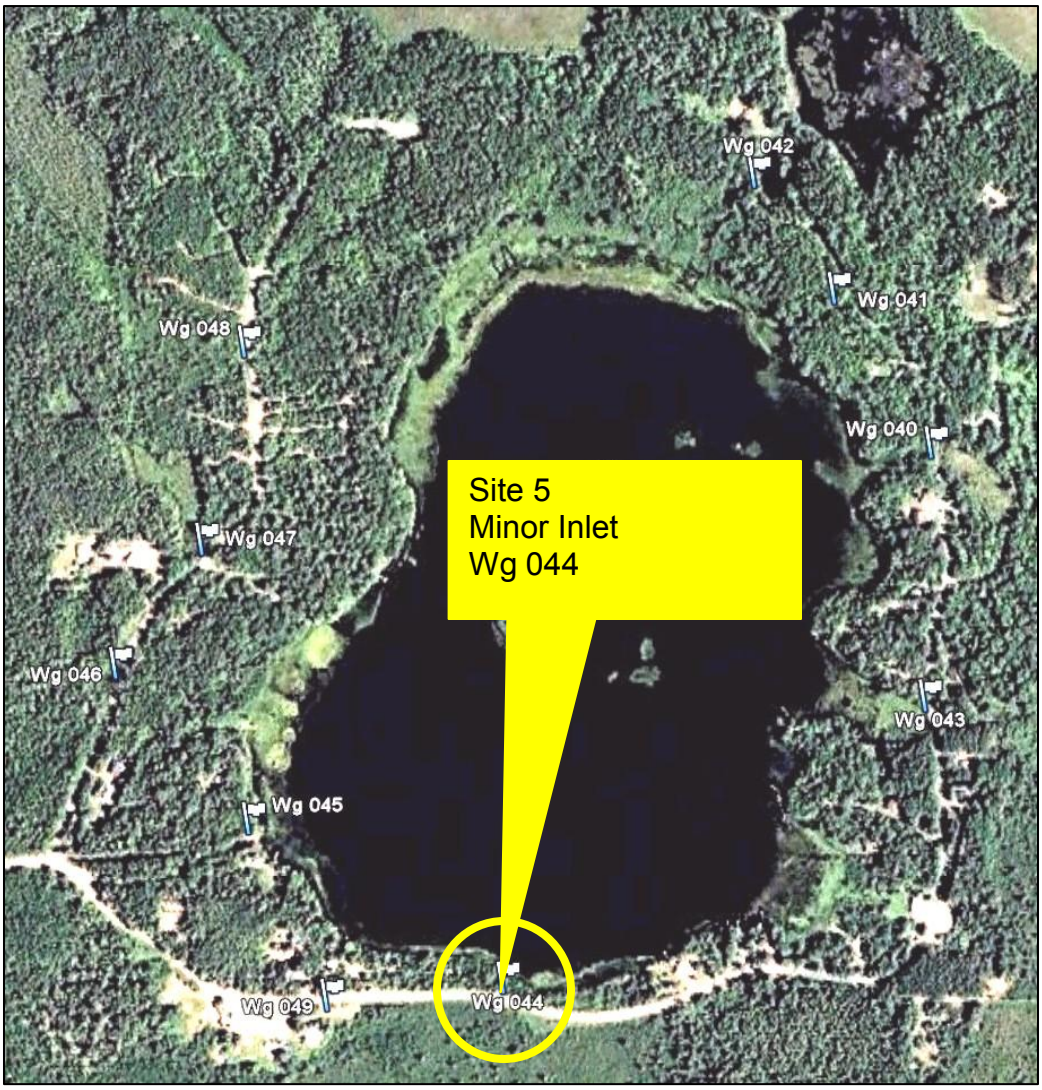
Site Coordinates: 45.7155714; -89.10511458

Habitat Description: Margaret Lake outlet. Sluggish water with lots of aquatic vegetation (floating and emergent). Cattaails are present. Tag alder also present.

Species Detected:

- Chorus frog
- Spring peeper
- Leopard frog
- Green frog
- Bullfrog

Exhibit 10. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 5

Site Location: Wg 044; Margaret Lake Road

Site Coordinates: 45.71302176; -89.11057544

Habitat Description: Small amount of permanent water. Flooded marshy swamp with light density conifer.

Species Detected:

- Spring peeper
- Gray treefrog
- Leopard frog
- American toad
- Bullfrog

Exhibit 11. Margaret Lake Frog & Toad Survey - Site Summary.

Site Number: 6

Site Location: Wg 045; end of Boat Landing Road

Site Coordinates: 45.71446609; -89.11386192

Habitat Description: Margaret Lake boat landing; permanent water; lots of aquatic vegetation (floating and emergent); riparian forest of mixed hardwoods and conifers.

Species Detected:

- Leopard frog
- Bullfrog
- American toad
- Green frog

Exhibit 12. Margaret Lake Frog & Toad Survey - Site Summary.

Site Number: 7

Site Location: Wg 046; Hansen Lane

Site Coordinates: 45.71586359; -89.11557448

Habitat Description: Seasonally wet swamp along road. This habitat includes willow balsam fir, cattails and large boulders.

Species Detected:

- Wood frog
- Spring peeper
- Gray treefrog
- American toad
- Chorus frog
- Green frog
- Bullfrog

Exhibit 13. Margaret Lake Frog & Toad Survey - Site Summary.

Site Number: 8

Site Location: Wg 047; Hansen Lane

Site Coordinates: 45.71697915; -89.11445606

Habitat Description: Approximately 2 acre emergent pond. Nice quality riparian forest.

Species Detected:

- Wood frog
- Chorus frog
- Spring peeper
- Gray treefrog
- Leopard frog
- American toad
- Green frog
- Bullfrog

Exhibit 14. Margaret Lake Frog & Toad Survey - Site Summary.

Site Number: 9

Site Location: Wg 048; Hansen Lane

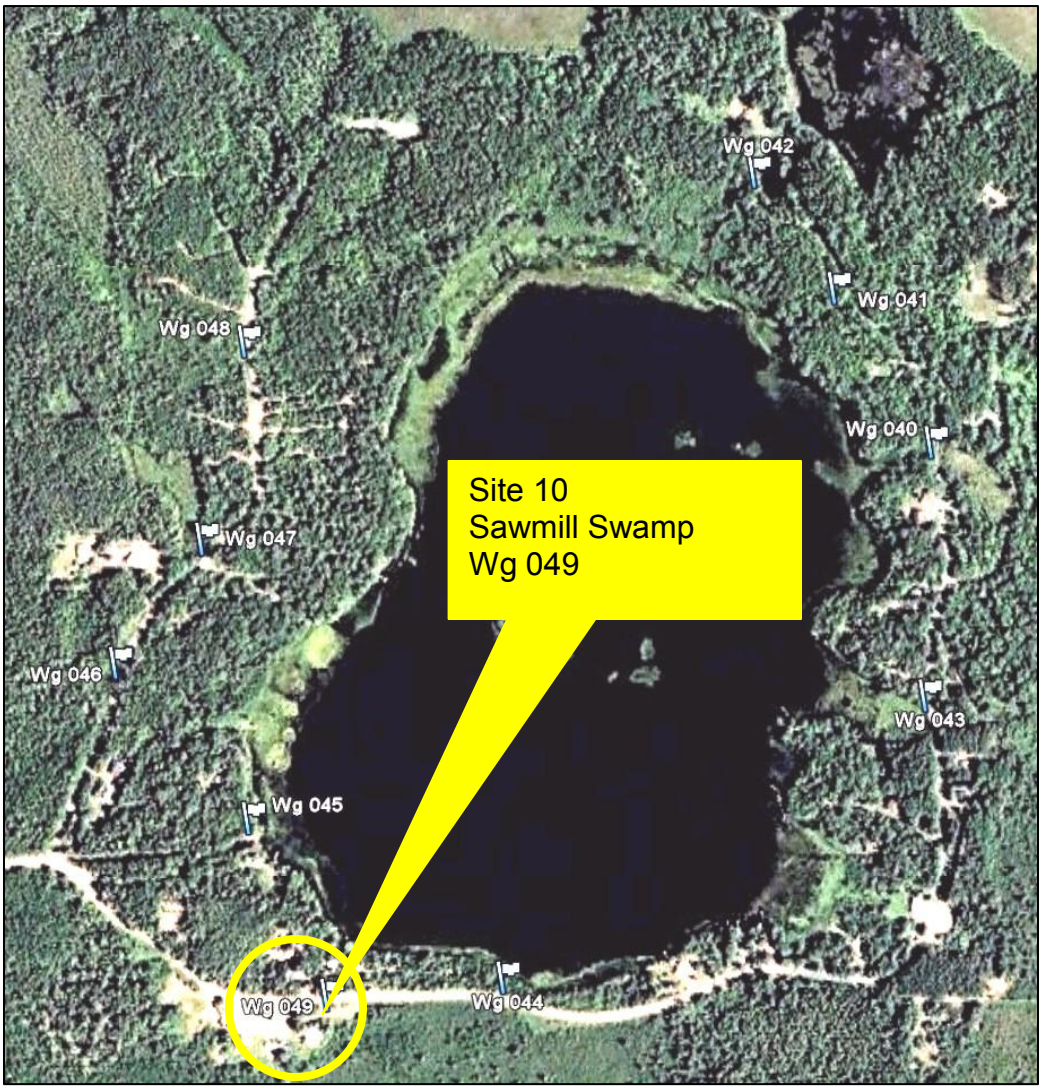
Site Coordinates: 45.71875477; -89.11391127

Habitat Description: Seasonally wet swamp with alder and black ash.

Species Detected:

- Spring peeper
- Gray treefrog
- American toad

Exhibit 16. Margaret Lake Frog & Toad Survey - Site Summary.



Site Number: 10

Site Location: Wg 049; Margaret Lake Road

Site Coordinates: 45.71287906; -89.11284089

Habitat Description: Seasonally wet alder swamp.

Species Detected:

- Wood frog
- Chorus frog
- Spring peeper
- Gray treefrog
- Leopard frog
- American toad
- Green frog

WISCONSIN FROG AND TOAD SURVEY (WFTS) -- Field Data Sheet

IMPORTANT -- Please return at the end of the season to:

Bureau of Endangered Resources
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707-7921

Observer name(s): Run 1: Gerrianne, Piersen & Marshall Rawoens
Run 2: Gerrianne, Piersen & Marshall Rawoens
Run 3: Gerrianne Rawoens Piersen & Marshall Rawoens

Route Number: _____
Year: 2011
County: Oneida

Instructions: Use this voluntary form to record data at each of the 10 listening points along a WFTS route. Surveys are repeated 3 times during the breeding season according to the minimum water temperature ranges of dates given below for each survey run. Conduct surveys after dark when wind speed is less than 12 mph. Listen for 5 minutes at each site and record a call index value of 1, 2, or 3 for each species calling. **See back of data sheet to obtain wind and sky codes and record additional comments.** Return data sheet to above address by **August 15th.**

	FIRST RUN	SECOND RUN	THIRD RUN
	Water Temp 50°F+; April 8-30	Water Temp 60°F+; May 20 - June 5	Water Temp 70°F+; July 1-15
DATE:	4/29/11	May 21, 2011	7/1/11
BEGIN: Time	8:00PM	8:15pm	8:00pm
Wind:	0	0	1
Sky:	0	2	0
Air Temp (°F):	61°	64	80°
END: Time	9:00PM	9:10pm	9:15pm
Wind:	1	0	1
Sky:	0	5	0
Air Temp (°F):	46°	60	76°

CALL INDEX*

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1. Chicken Pond	1			2										
2. Sun Rock	2		2	3										
3. Flowage	3			1										
4. Outlet	4			1	2									
5. Minor Inlet	5				1			1						
6. Boat Landing	6													
7. Carl Swamp	7			2	2									
8. Dandy Pond	8		1		3									
9. Blackish Swamp	9				3			1						
10. Sawmill "	10				3	2								

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1. Chicken Pond	1													
2. Sun Rock	2													
3. Flowage	3													
4. Outlet	4				2									
5. Minor Inlet	5				2		1							
6. Boat Landing	6				1									
7. Carl Swamp	7													
8. Dandy Pond	8				1									
9. Blackish Swamp	9						1	1						
10. Sawmill "	10				2	2								

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1. Chicken Pond	1							1					1	
2. Sun Rock	2													
3. Flowage	3													1
4. Outlet	4												2	1
5. Minor Inlet	5													1
6. Boat Landing	6												2	1
7. Carl Swamp	7							1						
8. Dandy Pond	8												1	
9. Blackish Swamp	9													
10. Sawmill "	10							1					2	

* The call index is a rough estimate of the number of calling males of a particular species, according to the following index values:
1 = Individuals can be counted; there is space between calls (no overlapping of calls).
2 = Calls of individuals can be distinguished but there is some overlapping of calls.
3 = Full chorus. Calls are constant, continuous, and overlapping; individual calls cannot be distinguished.

** The western and boreal chorus frogs are combined for WFTS calling surveys because their calls are nearly indistinguishable.

Form 1700-008
Revised June 2006

WISCONSIN FROG AND TOAD SURVEY (WFTS) -- Field Data Sheet

IMPORTANT -- Please return at the end of the season to:

Bureau of Endangered Resources
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707-7921

Observer name(s): Run 1: Gerrianne, Piersen & Marshall Rawoens
Run 2: Gerrianne, Piersen & Marshall Rawoens
Run 3: Gerrianne Rawoens Piersen & Marshall Rawoens

Route Number: ____
Year: 2011
County: Oneida

Instructions: Use this voluntary form to record data at each of the 10 listening points along a WFTS route. Surveys are repeated 3 times during the breeding season according to the minimum water temperatures and ranges of dates given below for each survey run. Conduct surveys after dark when wind speed is less than 12 mph. Listen for 5 minutes at each site and record a call index value of 1, 2, or 3 for each species calling. **See back of data sheet to obtain wind and sky codes and record additional comments.** Return data sheet to above address by **August 15th.**

	FIRST RUN	SECOND RUN	THIRD RUN
	Water Temp 50°F+; April 8-30	Water Temp 60°F+; May 20 - June 5	Water Temp 70°F+; July 1-15
DATE:	May 5, 2011	May 24, 2011	7/12/11
BEGIN: Time:	7:45 pm	7:30	7:40pm
BEGIN: Wind:	1	0	1
BEGIN: Sky:	1	0	0
BEGIN: Air Temp (°F):	61	70°	82°
END: Time:	8:30 pm	8:15	8:45pm
END: Wind:	2	0	1
END: Sky:	2	0	0
END: Air Temp (°F):	61°	68°	78°

FIRST RUN — CALL INDEX*

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1 Chicken Pond	1				3									
2. Sun Rock	2		2		3									
3. Flowage	3				2									
4. Outlet	4			2	3									
5. Minor Inlet	5				2				1					
6 Boat Landing	6					2								
7. Carl Swamp	7		1	2	2									
8. Dandy Pond	8		3		3	1								
9 Black Ash Pond	9				2			1						
10 Sawmill "	10				3	2								

SECOND RUN — CALL INDEX*

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1 Chicken Pond	1													
2. Sun Rock	2													
3. Flowage	3													
4. Outlet	4					2								
5. Minor Inlet	5					1			1					
6 Boat Landing	6					2								
7. Carl Swamp	7													
8. Dandy Pond	8					2								
9 Black Ash Pond	9								1					
10 Sawmill "	10					2								

THIRD RUN — CALL INDEX*

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
1 Chicken Pond	1								1					
2. Sun Rock	2													1
3. Flowage	3													1
4. Outlet	4												2	1
5. Minor Inlet	5								1					2
6 Boat Landing	6							1					2	2
7. Carl Swamp	7												1	1
8. Dandy Pond	8												1	2
9 Black Ash Pond	9							1	1					
10 Sawmill "	10												2	

* The call index is a rough estimate of the number of calling males of a particular species, according to the following index values:
1 = Individuals can be counted; there is space between calls (no overlapping of calls).
2 = Calls of individuals can be distinguished but there is some overlapping of calls.
3 = Full chorus. Calls are constant, continuous, and overlapping; individual calls cannot be distinguished.

** The western and boreal chorus frogs are combined for WFTS calling surveys because their calls are nearly indistinguishable.

Form 1700-008
Revised June 2006

WISCONSIN FROG AND TOAD SURVEY (WFTS) -- Field Data Sheet

IMPORTANT -- Please return at the end of the season to:

Bureau of Endangered Resources
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, Wisconsin 53707-7921

Observer name(s): Run 1: Suzanne Hansen
Run 2: Suzanne Hansen
Run 3: Suzanne Hansen

Route Number:
Year: 2013
County: Oneida

Instructions: Use this voluntary form to record data at each of the 10 listening points along a WFTS route. Surveys are repeated 3 times during the breeding season according to the minimum water temperatures and ranges of dates given below for each survey run. Conduct surveys after dark when wind speed is less than 12 mph. Listen for 5 minutes at each site and record a call index value* of 1, 2, or 3 for each species calling. **See back of data sheet to obtain wind and sky codes and record additional comments.** Return data sheet to above address by **August 15th.**

	FIRST RUN	SECOND RUN	THIRD RUN
	Water Temp 50°F+; April 8-30	Water Temp 60°F+; May 20 - June 5	Water Temp 70°F+; July 1-15
DATE:	5/13/2013	5/25/2013	7/7/2013
BEGIN: Time:	8:00 pm	8:15 pm	8:30
Wind:	0	1	1
Sky:	0	2	2
Air Temp (°F):	62	65	80
END: Time:	9:00 pm	9:20pm	9:30
Wind:	1	0	0
Sky:	0	2	4
Air Temp (°F):	50	60	75

CALL INDEX*

SITE NAME	Site Number	Water Temp (°F)	Wood frog	Chorus frogs**	Spring peeper	Leopard frog	Pickerel frog	American toad	(Eastern) gray treefrog	Cope's gray treefrog	Cricket frog	Mink frog	Green frog	Bullfrog
FIRST RUN														
1. Chicken Pond	1			2										
2. Sun Rock	2		2	3										
3. Flowage	3			3										
4. Outlet	4			2										
5. Minor Outlet	5			1				1						
6. Boat Landing	6													
7. Carl Swamp	7		2	3				1						
8. Dandy Pond	8		2	2	3									
9. Black Ash Sw	9			2										
10. Sawmill Pond	10		2	2	3									
SECOND RUN														
1. Chicken Pond	1				1									
2. Sun Rock	2				1									
3. Flowage	3													
4. Outlet	4				2									
5. Minor Outlet	5				2		1							
6. Boat Landing	6				1									
7. Carl Swamp	7						1							
8. Dandy Pond	8				1		1							
9. Black Ash Sw	9													
10. Sawmill Pond	10				2		2							
THIRD RUN														
1. Chicken Pond	1							1				1		
2. Sun Rock	2													
3. Flowage	3													
4. Outlet	4											2	1	
5. Minor Outlet	5												1	
6. Boat Landing	6												1	
7. Carl Swamp	7							1						
8. Dandy Pond	8							1				2		
9. Black Ash Sw	9													
10. Sawmill Pond	10							1				2		

* The call index is a rough estimate of the number of calling males of a particular species, according to the following index values:
1 = Individuals can be counted; there is space between calls (no overlapping of calls).
2 = Calls of individuals can be distinguished but there is some overlapping of calls.
3 = Full chorus. Calls are constant, continuous, and overlapping; individual calls cannot be distinguished.

** The western and boreal chorus frogs are combined for WFTS calling surveys because their calls are nearly indistinguishable.

Form 1700-008
Revised June 2006

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Appendix J
Review of Water Regulations and Planning Relevant to Margaret Lake

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Review of Water Resource Regulations and Planning Relevant to Margaret Lake

In this appendix, we provide reviews of documents created to preserve and protect Wisconsin waters, including Margaret Lake. These reviews were developed from documents created by a variety of sources, including: the Environmental Protection Agency, the Wisconsin Administrative Code, the Wisconsin Department of Natural Resources, the Oneida County Planning and Zoning Department, the North Central Wisconsin Regional Planning Commission, and the Oneida County Board.

The first part of this appendix is a review of the federal, state and county regulations and ordinances that influence the water quality of Margaret Lake. Second is a review of the *Headwaters Basin Integrated Management Plan*. This plan describes issues of concern within the Headwaters Basin (where Margaret Lake is located), and provides examples of how the WDNR strives to preserve and restore the land and water resources. The third part of this appendix is a letter sent to the North Central Wisconsin Regional Planning Commission, providing recommendations to enhance an already well-documented and comprehensive *Oneida County Land & Water Resource Management Plan.*

Regulations and Ordinances that Protect the Water Quality of Margaret Lake

Federal

The Army Corps of Engineers oversees projects that alter waterways-including discharges to wetlands, and the Environmental Protection Agency (EPA) regulates water quality pollution and drinking water standards. The EPA revised The Clean Water Act in 1972 in order to reduce pollutant discharges into waterways and mange polluted runoff. It has set waste water standards for industries, and for all contaminants in surface waters. The Clean Water Act deemed it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. You can view parts of the Clean Water Act at the EPA's website (http://www.epa.gov/npdes/pubs/cwatxt.txt).

State

For any given lake in Wisconsin, shoreland protection regulations can be set by the county, town or lake association; however, they must *at least* follow the regulations listed under the State of Wisconsin's Administrative Code, Chapter NR115: Wisconsin's Shoreland Protection Program. The purpose of this Program is to: "establish minimum shoreland zoning standards for ordinances…and to limit the direct and cumulative impacts of shoreland development on water quality; near—shore aquatic, wetland and upland wildlife habitat; and natural scenic beauty" (State of Wisconsin Legislature-a). This document states that a setback of 75 feet from the ordinary high-water mark (OHWM) of any navigable waters is required for all buildings and structures. It also states that the county will be in charge of establishing ordinances that consider the effect of vegetation removal on water quality, including soil erosion, and the flow of effluents, sediments and nutrients. Lastly, it says that a minimum of 35 feet vegetative buffer zone is required from the OHWM (State of Wisconsin Legislature-a).

Changes to the Wisconsin Administrative Code have limited the amount of phosphorus running off into waterbodies. Chapter 151 now restricts the amount of phosphorus farmers can have come off their fields. Moreover, in 2009-2010, Wisconsin legislatures passed laws so that fertilizers with phosphorus would be banned from use on lawns or turfs, and that phosphorus levels in dishwater detergent were reduced considerably (State of Wisconsin Legislature-b).

The Wisconsin Department of Natural Resources (WDNR) has developed the Wisconsin Pollutant Discharge Elimination System (WPDES) program. This program regulates the discharge of pollutants into waters. Types of permits issued are: individual, general (including ballast water discharge, pesticide pollutant discharge, etc.), storm water and agricultural (WDNR, 2012a).

The WDNR also requires permits for specific aquatic plant control techniques. Permits are required for aquatic plant control when: chemicals are used, biological controls are used, and physical techniques (such as barriers) are used; when wild rice is involved; when plants are mechanically removed, or when plants are removed from an area greater than 30 feet in width along a shoreline (WDNR, 2012b).

Personal Watercrafts (PWCs) are restricted to slow, to no-wake speed when within 200 feet of a shoreline, while boats must be at slow, to no-wake speed within 100 feet. These regulations can be more stringent under county or town ordinances (WDNR, 2011).

County

Regulations and ordinances set by Oneida County can be found in the Oneida County Zoning and Shoreland Protection Ordinance (Oneida County Zoning Department, 2012). This document provides detailed information about zoning and planning near shoreland and wetland areas. The following is a brief summary of some of these regulations that inherently protect the water quality of Margaret Lake.

According to the Ordinance, Shorelands are defined as lands within 1,000 feet from a lake, pond or flowage; and 300 feet from a river or stream (Oneida County Zoning, p. 9-1). In general, all structures are required to be 75 feet from the ordinary high-water mark (OHWM) of a navigable waterbody. Privies, dry wells and drain fields must be no less than 50 feet from the OHWM (Oneida County Zoning, p. 9-11). These regulations are set in place to prevent pollutants and contaminants from running off into the water.

To prevent erosion, Section 9.92 (Oneida County Zoning) states that "no grading or other land disturbing activities shall be permitted closer than 5 feet from the edge of a shoreland-wetland," and that "grading or other land disturbing activities less than 25 feet from a shoreland-wetland shall require silt fencing. Boathouses cannot be constructed where there is a slope of 20% or more, so that soils do not erode into the water (Oneida County Zoning, p. 9-12). In addition, stairs, walkways and lifts, if allowed by the zoning administrator, must avoid environmentally sensitive areas, and vegetation that stabilizes slopes cannot be removed. Likewise, removal of dead, diseased or dying vegetation must be replaced with other vegetation that is equally effective in retarding runoff, preventing erosion and preserving natural beauty (Oneida County Zoning, p. 9-14).

In general, on each lot, a vegetation protection area is established by the ordinary high-water mark, and a line 35 feet from the ordinary high-water mark (Oneida County Zoning, p. 9-15). By keeping this vegetation, soils are less likely to erode and pollutants and contaminants are less likely to enter the water.

Literature Cited

Oneida County Zoning Department. Amended Sept 2012. *Oneida County Zoning and Shoreland Protection Ordinance.* Retrieved 2014. <http://www.co.oneida.wi.gov/category.asp?linkcatid=427&linkid=1805&locid=135>

State of Wisconsin Legislature-a. NR 115. Wisc. Admin. Code § 115.01. *Wisconsin's Shoreland Protection Program, Purpose*. Page 145.

State of Wisconsin Legislature-b. NR 151. Wisc. Admin. Code § 151.001-151.32. *Runoff Management*. Pages 399-408.22.

Wisconsin Department of Natural Resources. 2011. *The Handbook of Wisconsin Boating Laws and Responsibilities*. Boat Ed., Kalkorney, Inc. Dallas, TX. Retrieved 2014. <http://dnr.wi.gov/files/PDF/pubs/LE/LE0301.pdf>

Wisconsin Department of Natural Resources. 2012a. *WPDES Permits*. Retrieved 2014. <http://dnr.wi.gov/topic/wastewater/permits.html>

Wisconsin Department of Natural Resources. 2012b. *Aquatic Plants*. Retrieved 2014. <http://dnr.wi.gov/lakes/plants/>

Review of *Headwaters Basin Integrated Management Plan* Relevant to Margaret Lake

The *Headwaters Basin Integrated Management Plan* provides information about the conditions of the land and water resources found in the basin, and addresses the programs that strive to preserve and restore those resources. In this section, we will discuss the programs that provide assistance and protection to the water quality of Wisconsin lakes, including Margaret Lake.

Of the 15,057 lakes in Wisconsin, 34% are located within the Headwaters Basin. The Basin spans Forest, Florence, Lincoln, Langlade, Oneida and Vilas Counties. There are 29 Outstanding Resource Waters (ORW) located within the Basin. Outstanding Resource Waters support valuable fisheries and wildlife habitats, have good water quality and are not significantly impacted by human activities (WDNR, 2012). Although Margaret Lake is not considered an ORW, one lake within 10 miles of Margaret Lake is considered an ORW: Little Rice Lake. In contrast, sixteen waterbodies within 10 miles of Margaret Lake are listed as Impaired Waters (303 (d)): Big Lake, Big Fork Lake, Big Stone Lake, Dog Lake, Fourmile Lake, Island Lake, Jennie Weber Lake, Julia Lake, Little Rice Lake, Long Lake, Moen Lake, Planting Ground Lake, Range Line Lake, Sugar Camp Lake, Thompson Lake and Whitefish Lake. These waterbodies are considered impaired because of mercury contamination in fish tissues. Nearby Medicine Lake and Pine Lake were previously listed as impaired because of mercury levels, but were delisted in 2006 (WDNR, 2013). Because of Margaret Lake's qualities, it is important to maintain that level of water quality and protect the lake from adverse impacts.

The Fisheries Management branch of the WDNR Water Division protects Wisconsin lakes by processing permits required for protecting shorelines, by helping interpret ordinances and regulations, and by providing biological and technical expertise to local units of government. They also help monitor lake levels, assist landowners in learning about lake ecology, process applications for lake management grants, and review licenses and inspections of dams (WDNR et al., 2002).

The Watershed Management branch of the WDNR Water Division, following the standards set by the Federal Clean Water Act, protects Wisconsin surface waters by writing plans for watersheds, such as: facilities plans, 305 (b) water quality reports to Congress, and aquatic

nuisance and exotic species reports. They also create water quality modeling, such as: streams and lakes water quality modeling, contaminated sediment monitoring, and wasteload allocations. The Watershed Program also proposes water quality standards and policies, such as: surface water quality classification and standards, contaminated sediment investigation, total maximum daily loads, and designation of 303 (d) water bodies (WDNR et al., 2002).

The Wastewater branch of the WDNR Water Division, following the standards set by the Federal Clean Water Act, protects Wisconsin surface waters by issuing Wisconsin Pollutant Discharge Elimination System (WDPES) permits, by reviewing industrial and municipal baseline and annual reports, and by providing information to communities about their program and its benefits (WDNR et al., 2002).

The Nonpoint Source Pollution Abatement Program, following the standards set by the Wisconsin Administrative Code, protects Wisconsin surface waters by encouraging landowners to minimize nonpoint pollution sources on their properties, by providing information about the best management practices for both rural and urban areas, and by assisting counties with implementing their land and water resource management plans (WDNR et al., 2002).

The Drinking Water and Groundwater branch of the WDNR Water Division, following the standards set by the federal Safe Drinking Water Act and the Wisconsin Administrative Code protects Wisconsin waters by enforcing standards for wells and pumps, by conducting surveys and inspections of water systems, and by reviewing water quality monitoring reports. They also provide assistance to well owners and the public (WDNR et al., 2002).

The Wildlife Management branch of the WDNR Land Division, following the standards set by the Wisconsin Administrative Code, protects Wisconsin waters by establishing State Wildlife and State Natural Areas, by conducting population and habitat surveys, developing wildlife management plans, monitoring threatened and endangered species, evaluating hunting and trapping regulations, and by educating and encouraging responsible management techniques (WDNR et al., 2002).

The Endangered Resources branch of the WDNR Land Division, following the standards set by the Wisconsin Administrative Code, protects Wisconsin waters by managing the Natural Heritage Inventory Program (NHI), which is used to determine the existence and location of

native plant and animal communities, and of Endangered or Threatened Species of Special Concern, and by providing permits for incidental take of these species (WDNR et al., 2002).

The Wisconsin Bureau of Forestry, following the standards set by the Wisconsin Administrative Code, protects Wisconsin waters by providing technical assistance to county, state and private forest lands. The Bureau helps each county forest by developing a Ten Year Comprehensive Plan, and by assisting with timber sale, reforestation, development of wildlife habitat, and protection of endangered and threatened species. On the state level, the Bureau assists with establishing the best management practices of sustainable forestry, reforestation, and timber harvesting. With private landowners, they help with establishing best management practices of sustainable forestry, help protect endangered and threatened species, and provide assistance with forest disease and insect problems (WDNR et al., 2002).

These programs have been put in place the help preserve, protect and restore the water quality of all Headwater Basin lakes, including Margaret Lake.

Literature Cited

Wisconsin Department of Natural Resources, Headwaters Basin Partnership Team and Stakeholders--DRAFT. 2002. *Headwaters State of the Basin Report*. Retrieved 2014. <http://dnr.wi.gov/water/basin/upwis/>

Wisconsin Department of Natural Resources. 24 April 2012. *Outstanding and Exceptional Resource Waters*. Retrieved 2014. <http://dnr.wi.gov/topic/SurfaceWater/orwerw.html>

Wisconsin Department of Natural Resources. 04 February 2013. *Wisconsin's 2012 Impaired Waters List.* Retrieved 2014. <http://dnr.wi.gov/topic/impairedwaters/2012IR_IWLIST.html>

White Water Associates, Inc.
429 River Lane, P.O. Box 27
Amasa, Michigan 49903
(906)822-7889

March 1, 2013

North Central Wisconsin Regional Planning Commission
210 McClellan Street
Wausau, WI 54403
(715)849-5510

To whom it may concern:

As ecological consultants, White Water Associates works with lake associations to conduct studies, review data, and create lake management plans. We have helped organizations like *Big Bearskin Lake Association, Sevenmile Lake Association* and *Margaret Lake Association* collect water quality data, fisheries data, and invasive species data, and prepare reports conveying these data. We have current projects with these associations that are funded by the Wisconsin Department of Natural Resources. One of our tasks in these projects was to review the Oneida County Land & Water Resource Management Plan.[1] The purposes of that review are to (1) determine where our lake management efforts integrate with the county plan and (2) provide input to the county for how future iterations of the plan might better address water resource issues. It is with those purposes in mind that we submit this summary of recommendations for your consideration to further improve an already comprehensive plan.

Organization

It may be beneficial to create two major categories: Land Resources and Water Resources, which would integrate the majority of subjects you covered in the plan. In the Land Resources section you could include: Geology & Soils, and Land Use. In the Water Resources section you could have the remaining subjects that are related to water resources. I also recommend discussing the major water types first: Basins & Watersheds, Groundwater, and Surface Waters (Lakes, Rivers and Streams, and Wetlands). After these sections, then address Impaired Water-303(d) Water, and Outstanding/Exceptional Resource Waters, since these subjects reflect a combination of lakes, rivers and wetlands.

As mentioned, I recommend creating sub-categories within Surface Waters for subjects like Lakes, Streams and Wetlands. I will give recommendations for these sub-categories in the Content section to follow.

[1] The Oneida County Land & Water Resource Management Plan used for this review was found at http://www.ncwrpc.org/oneida/lwrm.htm.

Lastly, I propose that Invasive Species becomes a new major category, placed after the Land and Water Resources sections. Since invasive species do not fall specifically under just one of these major categories, it merits a section of its own. It might be nice to create sub-sections for each Terrestrial and Aquatic Invasive Species.

Content

I recommend listing the total acreages for each type of land use, and then use a visual tool, like a pie chart, to show percent acreages of each land use category throughout Oneida County.

In the plan it is mentioned there was a 39.9% increase in cranberry farming land from 1997-2007. In a separate paragraph, I suggest describing the methods used for harvesting cranberries and the potentially harmful impacts it can have on water resources. Mentioning the NRCS Nutrient Management Conservation Practice Standard (the "590 Standard") would also be beneficial.

Also in the plan, it is stated that "There will be an additional 202 acres converted to residential use in the county by 2015." This might be a good place to describe the negative effects expanding residential areas can have on water quality.

Under the Forestry section, I recommend talking about forest management (including timber harvesting). Since soil erosion from cropland was discussed earlier in the plan, addressing the specific soil erosion concerns stemming from silvicultural activities might be beneficial in this section.

Within the new Lakes, Rivers and Streams and Wetlands sub-categories, you could provide information like: statistics, acreages, and address unique waterbodies, discuss the organizations/associates incorporated with the lakes and their efforts to maintain good water quality, and an overall statement regarding the quality waterbodies in these sub-categories. Additionally, within the Wetlands sub-category, you might take advantage of a nice educational opportunity to explain the importance of wetlands. For example, how they positively affect water quality and how wetland plants can take up and store pollutants, which results in cleaner waters.

Within the Rivers and Streams section, if there are any rivers associated with the Northern Rivers initiative (NRI), here would be a good place to inform the reader about NRI, and list the rivers involved.

Another educational opportunity you could take advantage of is to add more information to the Invasive Species section. In general, invasive species are detrimental to the native communities around them, but describing in detail how aquatic and terrestrial invasives species specifically affect the water quality of nearby waterbodies is also important. In each the Aquatic and Terrestrial Invasive Species sections, I recommend first speaking generally about these species, then list which are found in Florence County with a short paragraph describing how they arrived, how they are spread, how they affect the native community, and where they are found in Oneida County.

Within the Commercial & Industrial Development section, it would be useful to expand on the paragraph describing brownfields sites. They are a potential contributor to water resource pollution

and this should be addressed in this section. Providing sentences about restoration to these sites, and then adding that information to Goal 4 (Chapter 5) will help readers understand the detrimental effects these sites can have on water quality.

I suggest expanding Goal 5 by providing examples of how you will educate the public. I recommend highlighting these possible techniques: presentations, school field trips, classroom talks, posters, brochures, etc.

I was very impressed with the detail you have incorporated in this plan. It is thorough and comprehensive. I am sure it serves the residents of Iron County well. If you have questions or comments regarding my recommendations, please contact me at the phone number given above.

Sincerely,

Caitlin Clarke
Biologist

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Appendix K
Lake User Survey

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Margaret Lake

Lake User Survey

Technical assistance by White Water Associates, Inc., July 2012

A lake user survey was sent out to members of the Margaret Lake Association. A total of 20 surveys were sent out. This four-page questionnaire began with a single page of explanation (see italicized text below). In this report, we expand the original questionnaire in order to provide an analysis of results obtained from 18 respondents (a 90% return).

Introduction to the Survey

We are writing to inform you about the Margaret Lake planning process that will have important outcomes for Margaret Lake and how you use and enjoy the lake. Please assist by completing this questionnaire and conveying your ideas. Return the survey by Nov. 14, 2012.

An aquatic plant survey was conducted in the summer of 2011 and it provided substantial information on plant presence and distribution in the lake. Margaret Lake currently has a healthy and diverse community of native aquatic plants and does not harbor any aquatic invasive plant species.

An aquatic plant bed is often termed a "weed bed." In fact, many aquatic species have "weed" as part of their names (e.g., duckweed, pondweed, musky weed). This usage is not meant to be derogatory, but unfortunately "weed" also connotes an unwanted plant, often one that grows rampantly. Such is not the case for the vast majority of native plants in lakes. In fact, aquatic plants are a vital part of a lake ecosystem. They provide habitat for fish and other animals, filter runoff, stabilize the shoreline against erosion, offer fish spawning areas, produce oxygen, absorb nutrients (making them less available for nuisance algae), provide food for many animals, and make it difficult for aquatic invasive plant species to become established.

In lakes that receive an overabundance of nutrients (particularly from excessive fertilizers or leaking septic tanks), plant growth can become too lush and dominated by only a few species. This process of accelerated lake plant growth (often caused by human influences) can give aquatic plants a bad name. Aquatic invasive plant species can be transported on boat motors or dumped from home aquariums and establish in a lake. Sometimes, they may come to dominate a lake and exclude other native species.

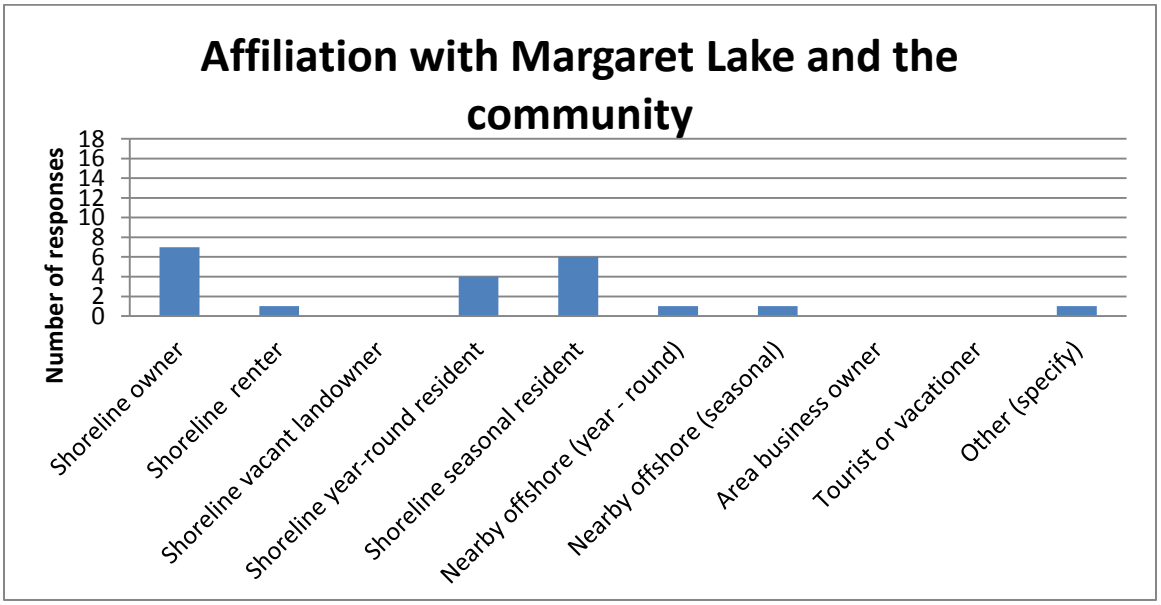
Aquatic invasive species (AIS) are non-native plants and animals that are introduced into our lakes and streams and can upset the natural balance of the ecosystem and decrease recreational opportunities. AIS examples include zebra mussels, carp, white perch, rusty crayfish, round goby, spiny water flea, Chinese mystery snail, Eurasian water milfoil, purple loosestrife, and curly-leaf pondweed.

Margaret Lake stakeholders want to maintain the high quality condition present in Margaret Lake and establish the foundation to conduct plant management should the need arise (for example if an aquatic invasive plant species is detected). An Aquatic Plant Management Plan is required by the WDNR prior to any plant management and Margaret Lake is in the process of creating such a plan. Public input is needed to refine the plant management goals and formulate reasonable management methods. Completing this survey will help guide the plan development and implementation. Please complete and return this form no later than November 14, 2012.

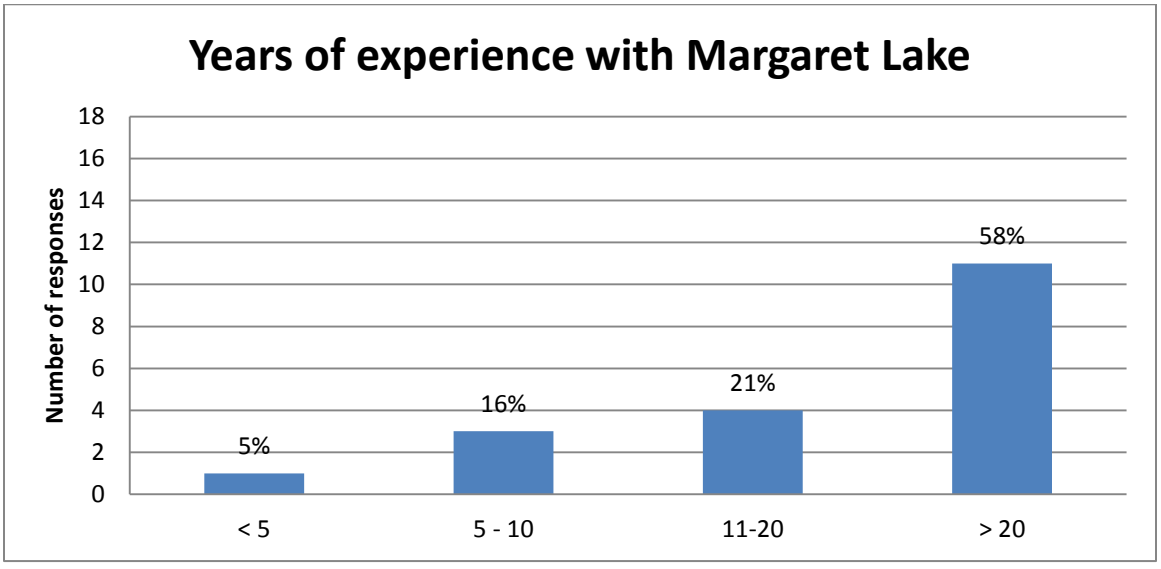
In the remainder of this document, each survey question is provided and an analysis of results immediately follows.

1. Please circle the response(s) that describes your affiliation with Margaret Lake and the community.

A. Shoreline home/cottage/apartment owner
B. Shoreline home/cottage/apartment renter
C. Shoreline vacant landowner
D. Shoreline year-round resident
E. Shoreline seasonal resident
F. Nearby offshore resident (year-round)
G. Nearby offshore resident (seasonal)
H. Area business owner
I. Tourist or vacationer
J. Other (specify) _____



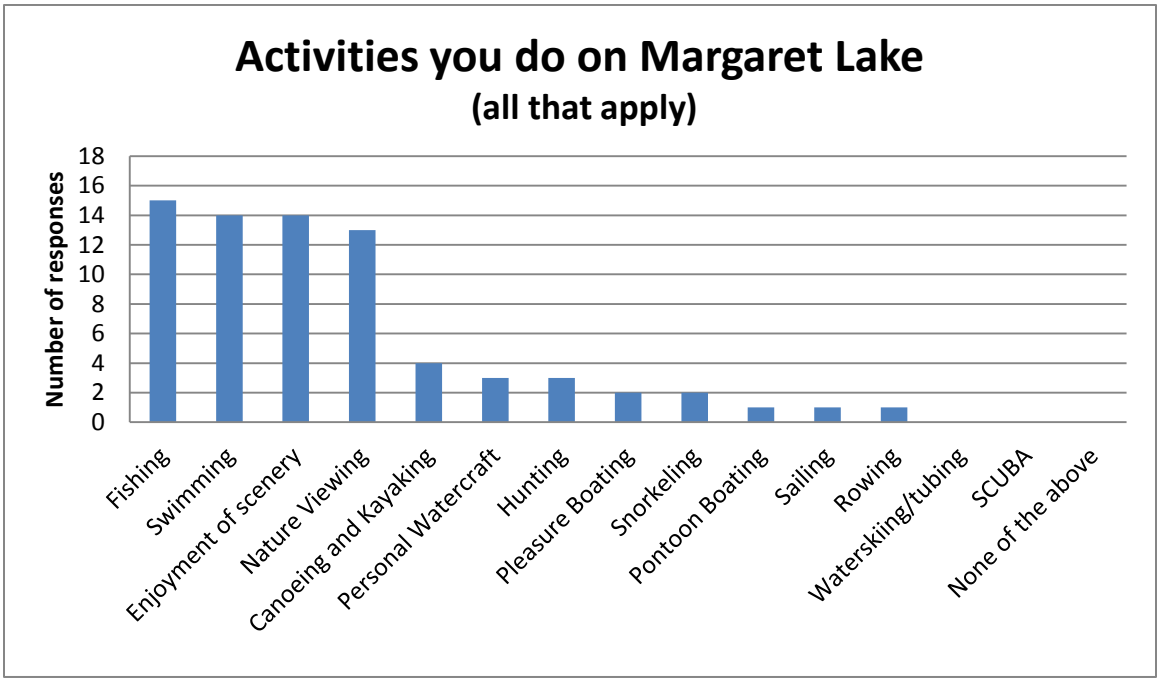
2. How many years of experience do you have with Margaret Lake?



There was a total of 550 years of combined experience on Margaret Lake with the lowest being three years of experience and 65 years being the highest and 29 years being the average.

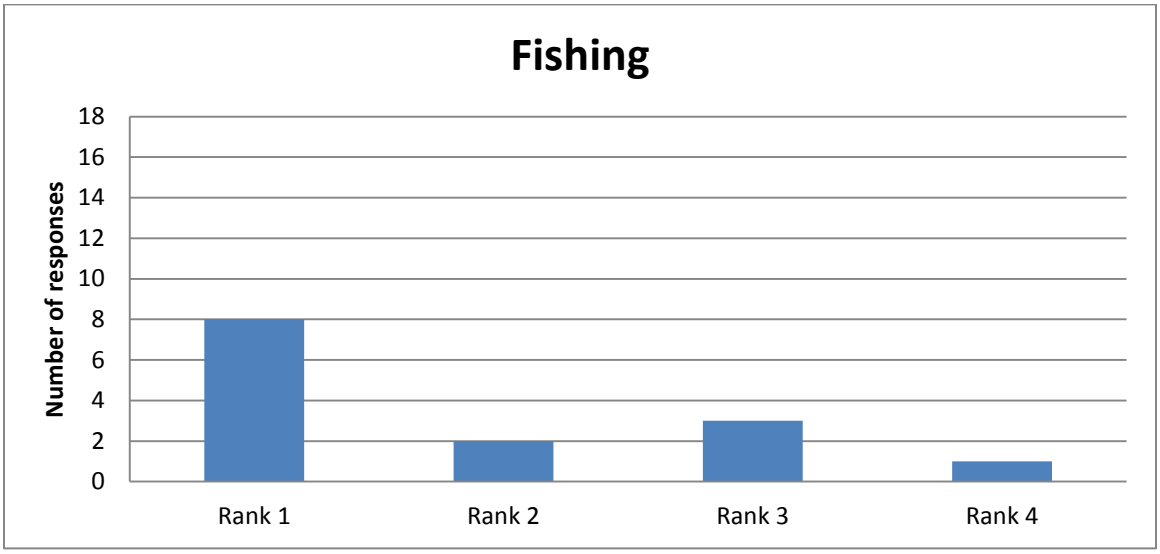
3. Please circle the activities that you do on Spectacle Lake. (Circle all that apply)

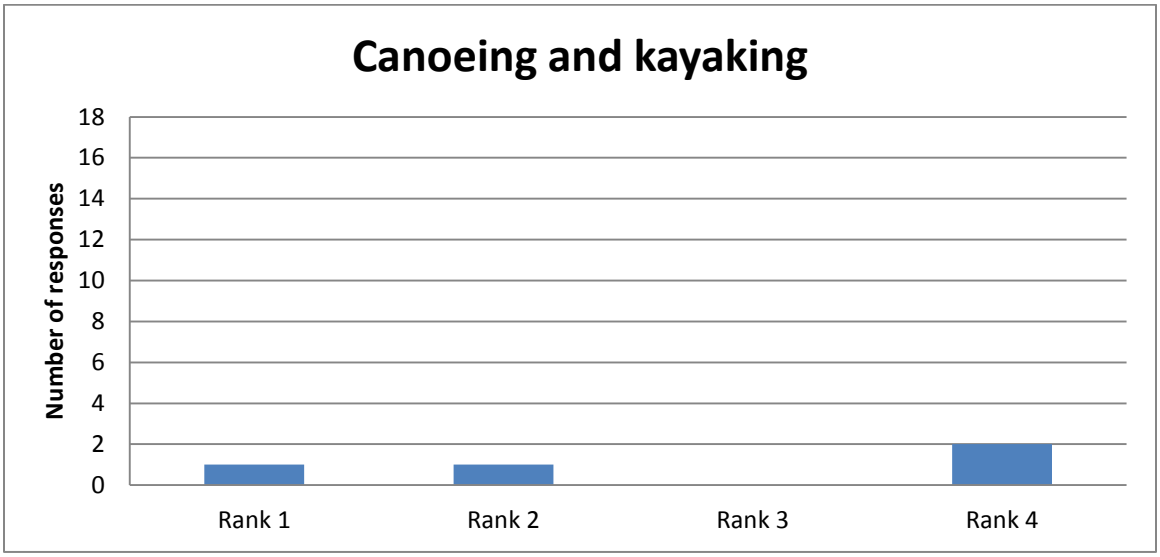
A. Fishing
B. Waterskiing/tubing
C. Personal watercraft
D. Swimming
E. Pontoon boating
F. Sailing
G. Pleasure boating
H. SCUBA
I. Canoeing & kayaking
J. Nature viewing
K. Enjoyment of scenery
L. Hunting
M. Snorkeling
N. Other_____

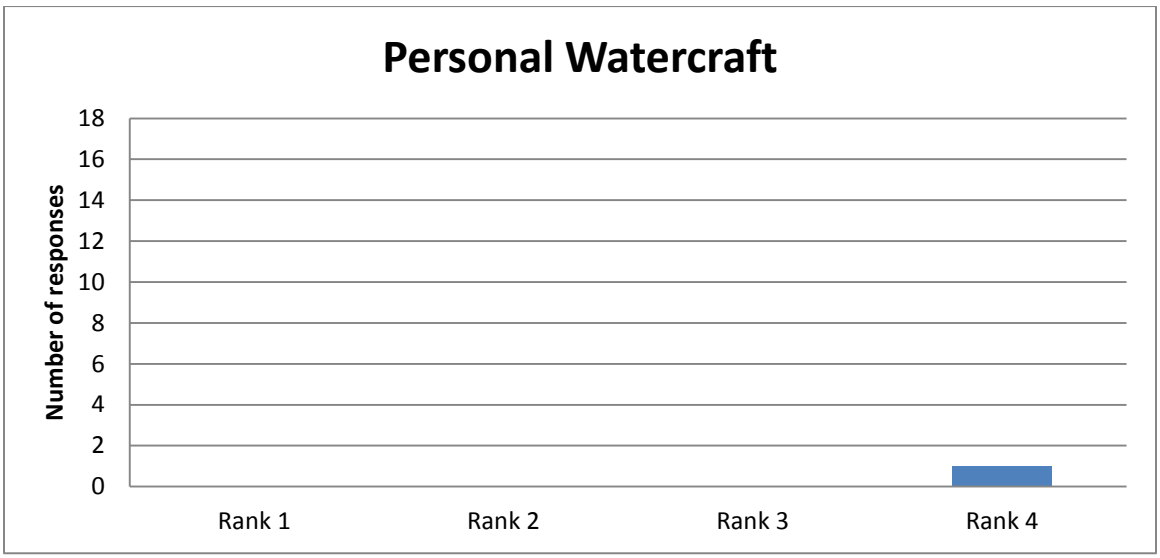


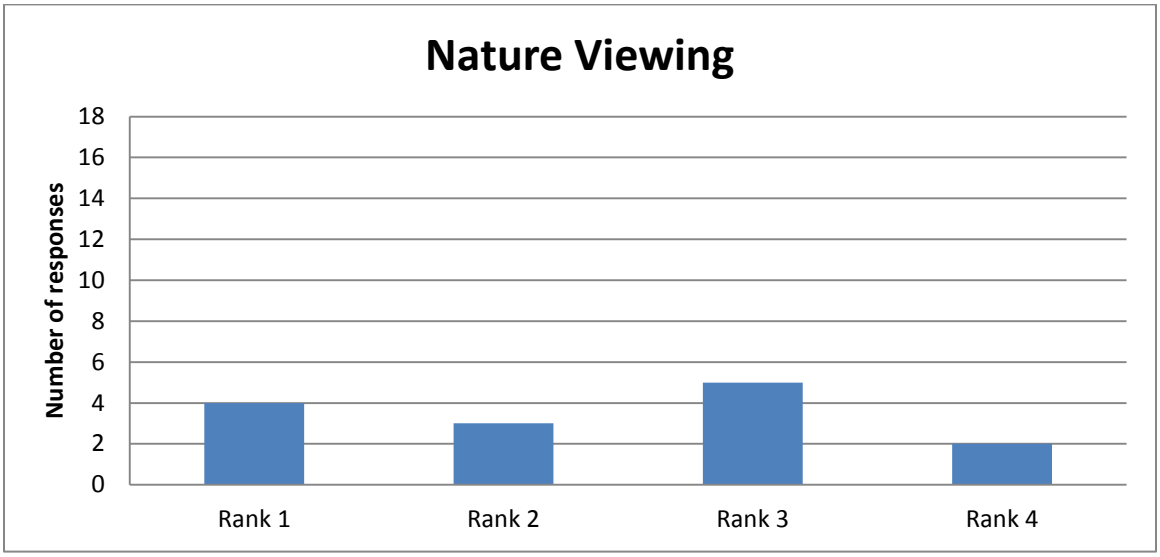
4. Please rank the four activities that are most important to you on Margaret Lake. (Use "1" for the most important, "2" for your next choice and so on.)

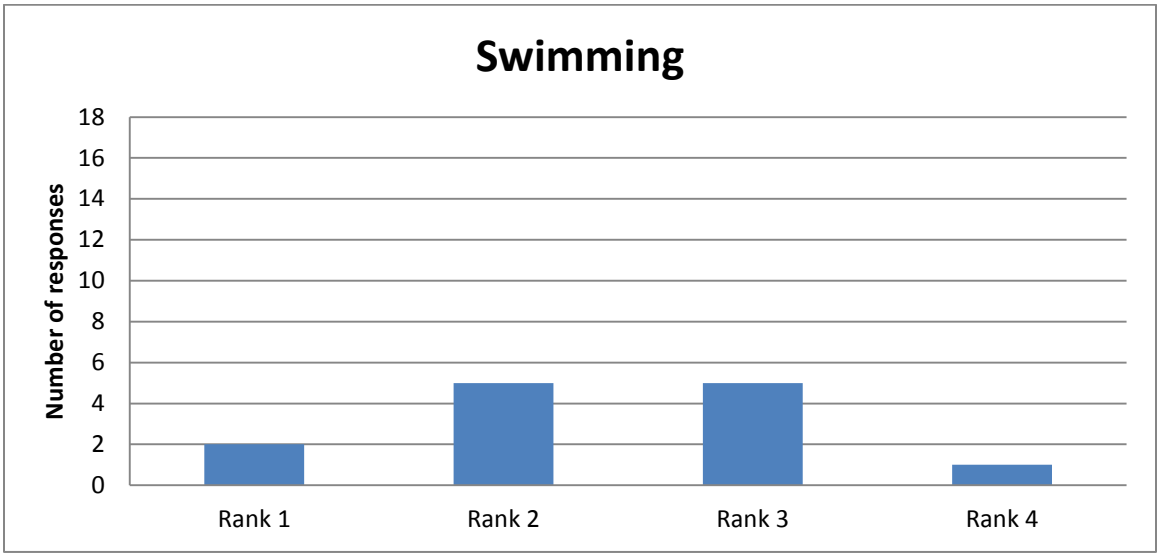
___Fishing
___SCUBA
___Waterskiing
___Canoeing & kayaking
___Personal water craft
___Nature viewing
___Swimming
___Scenery
___Pontoon boating
___Hunting
___Sailing
___Snorkeling
___Pleasure boating
___Other (specify) _____

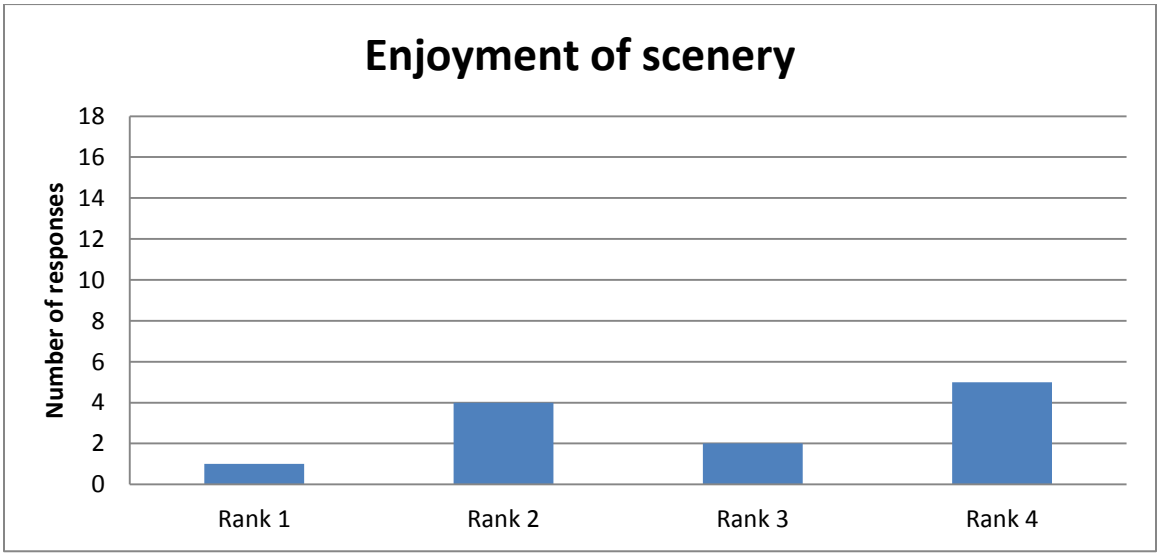

Fishing
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

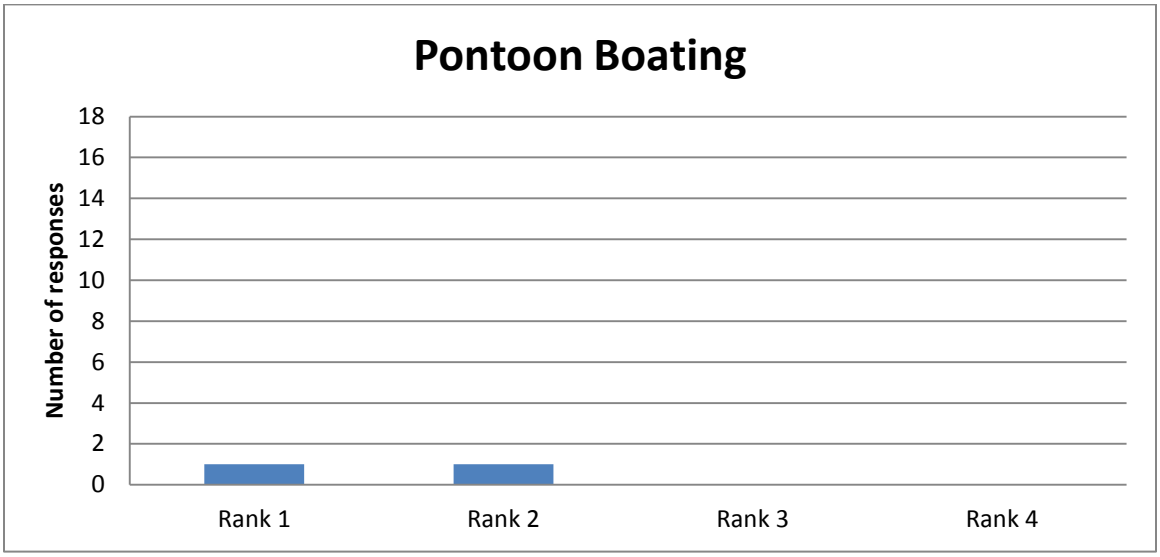

Canoeing and kayaking
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

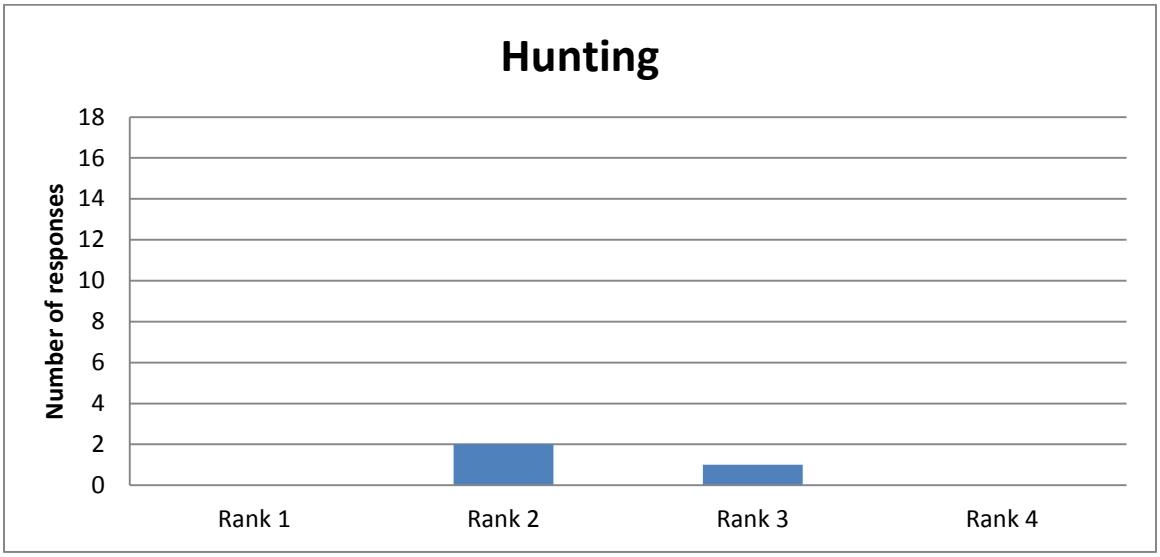

Personal Watercraft
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

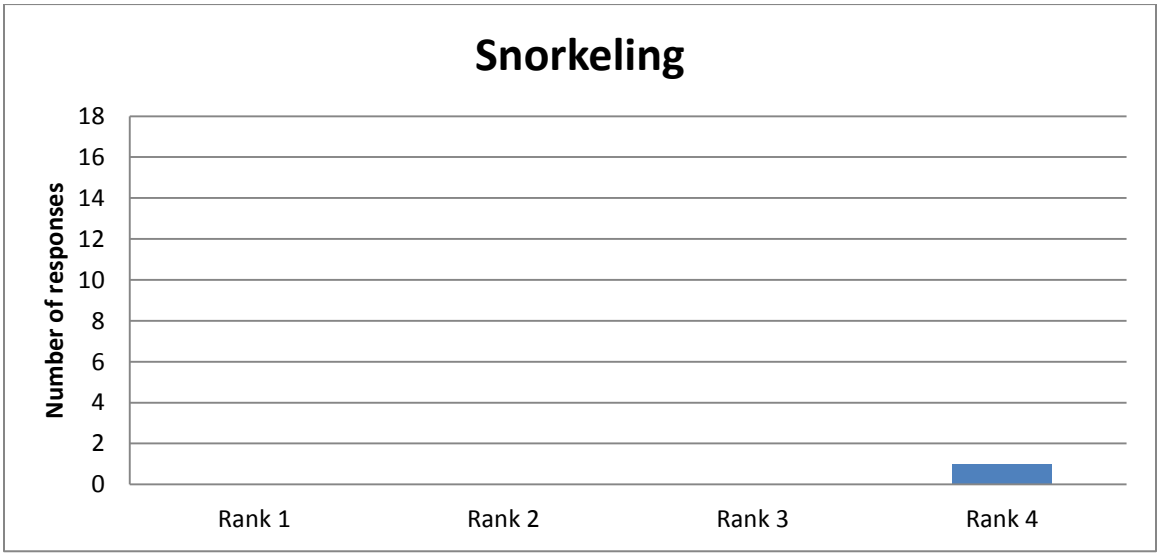

Nature Viewing
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

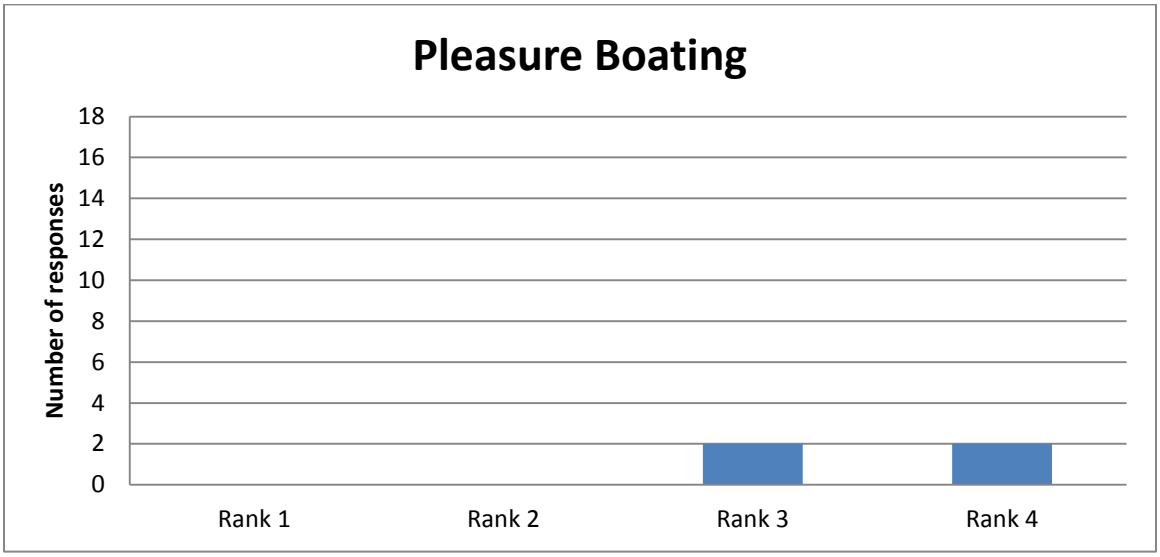

Swimming
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

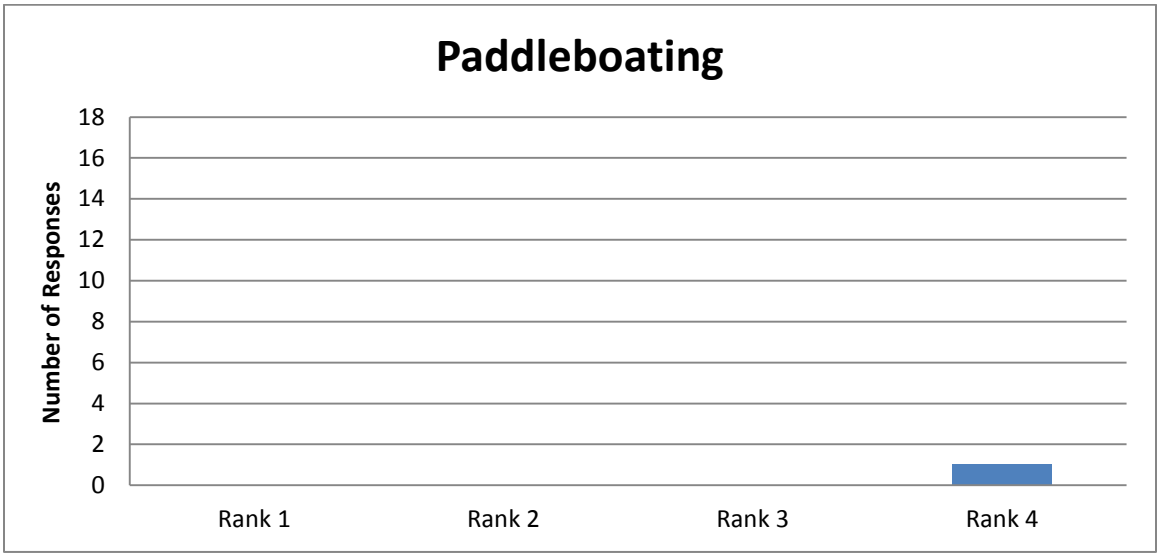

Enjoyment of scenery
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4


Pontoon Boating
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4


Hunting
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4


Snorkeling
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4

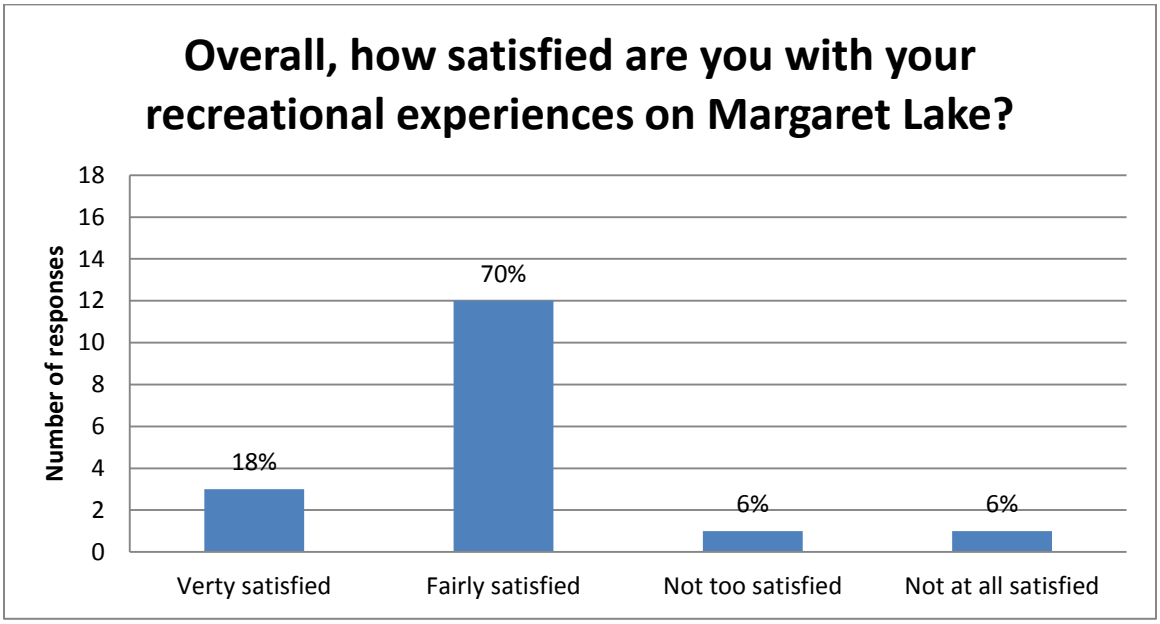




Waterskiing/tubing, sailing, SCUBA, ice fishing, and rowing were not ranked among the 18 people that filled out the survey.

5. Overall, how satisfied are you with your recreational experiences on Margaret Lake? Please circle only one.

A. Very satisfied B. Fairly satisfied C. Not too satisfied D. Not at all satisfied



6. Please circle the statement that best describes how often you recreate on Margaret Lake during the summer (between Memorial Day and Labor Day).

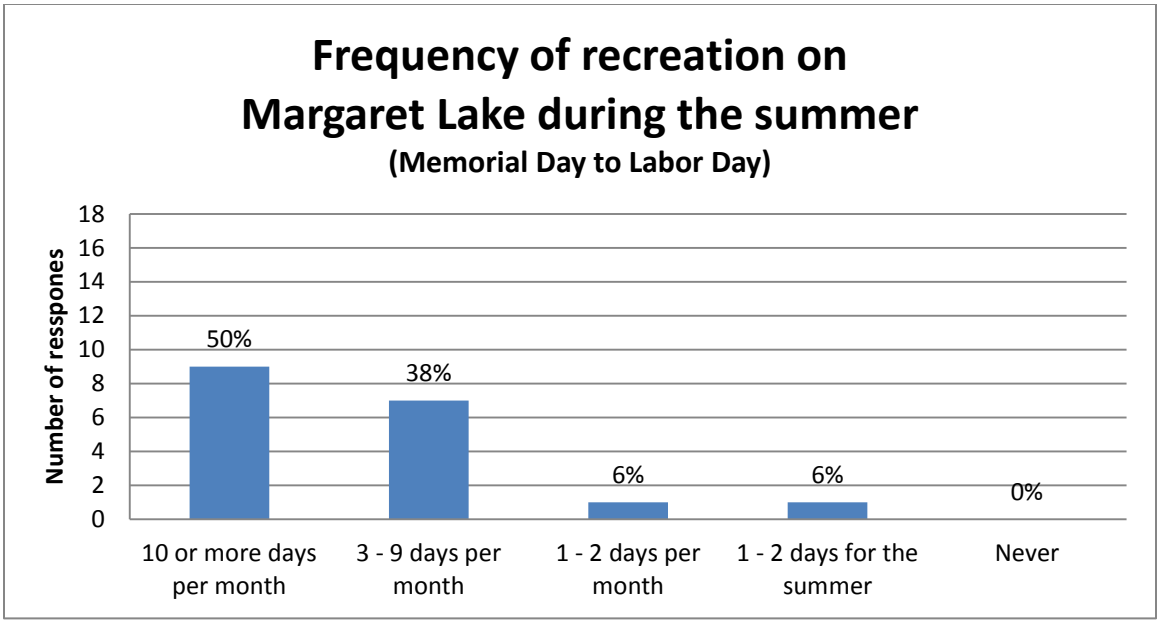
A. 10 or more days per month

B. 3-9 days per month

C. 1-2 days per month

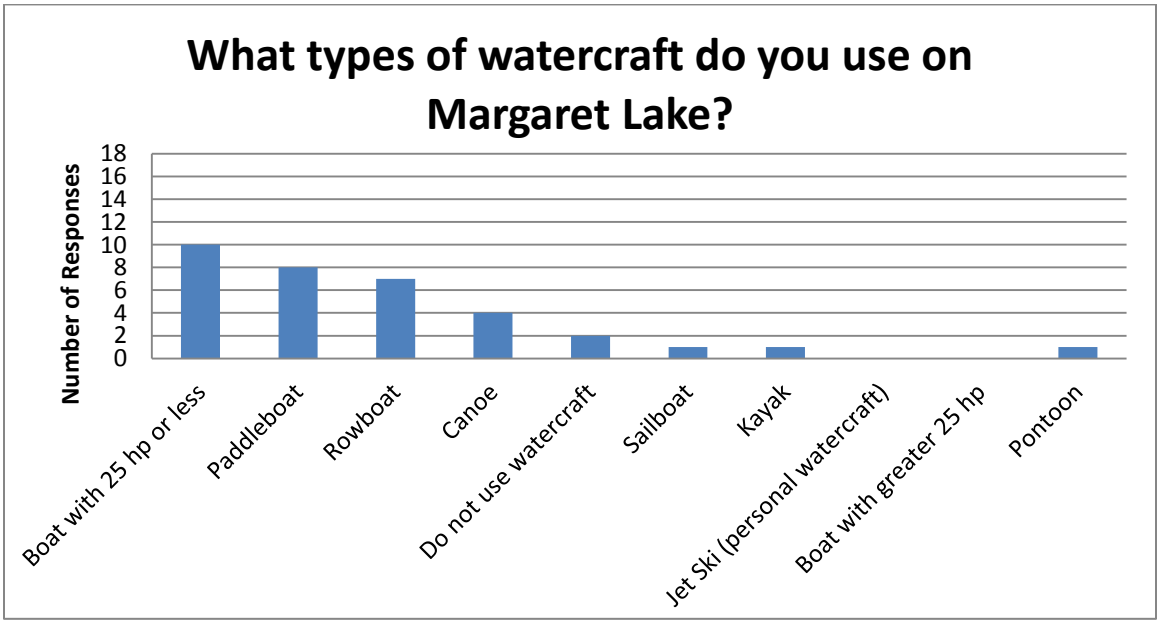
D. 1-2 days for the summer

E. Never



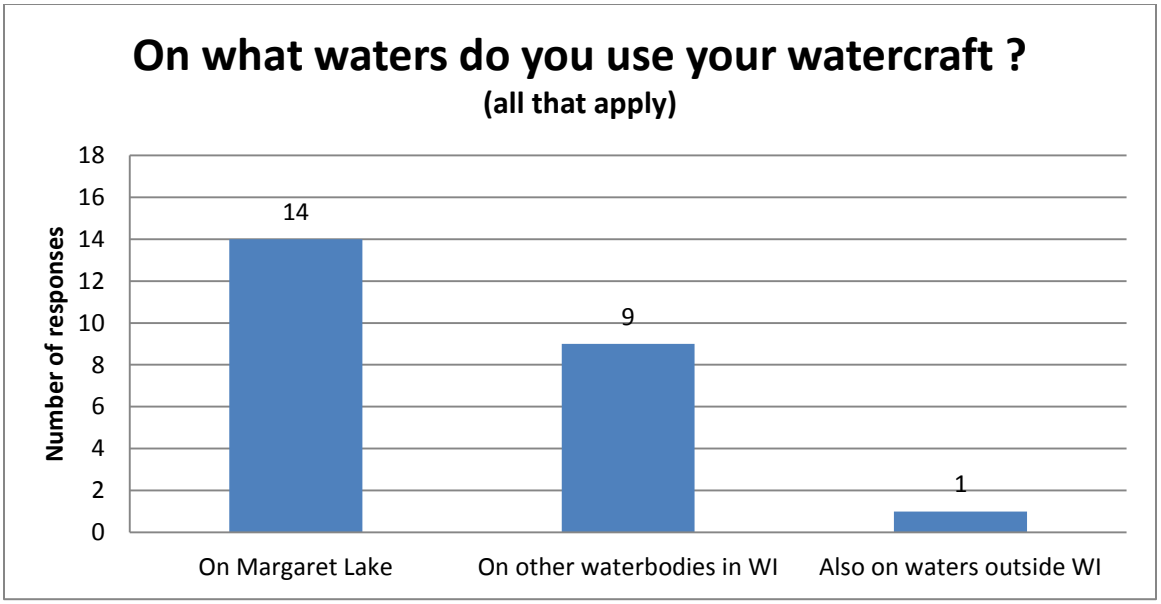
7. What types of watercraft do you use on Margaret Lake?

___Do not use watercraft (please skip to question 9)
___Paddleboat
___Motorboat with 25 hp or less
___Sailboat
___Motorboat with > 25 hp
___Canoe
___Pontoon
___Rowboat
___Jet Ski (personal watercraft)
___Kayak



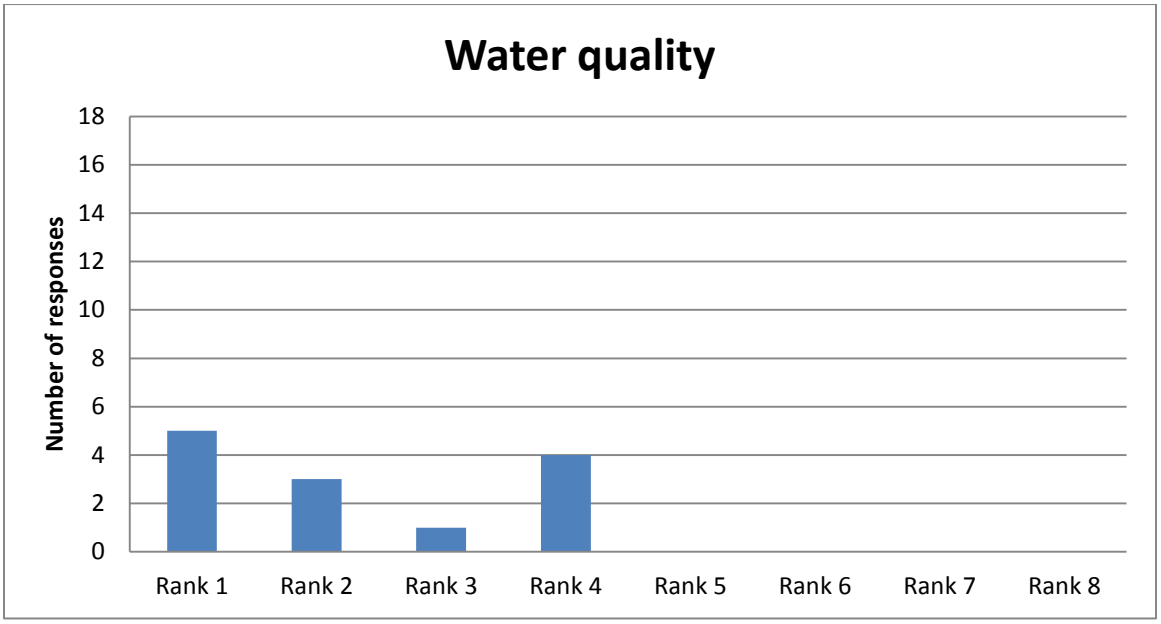
8. On what waters do you use your watercraft(s)?

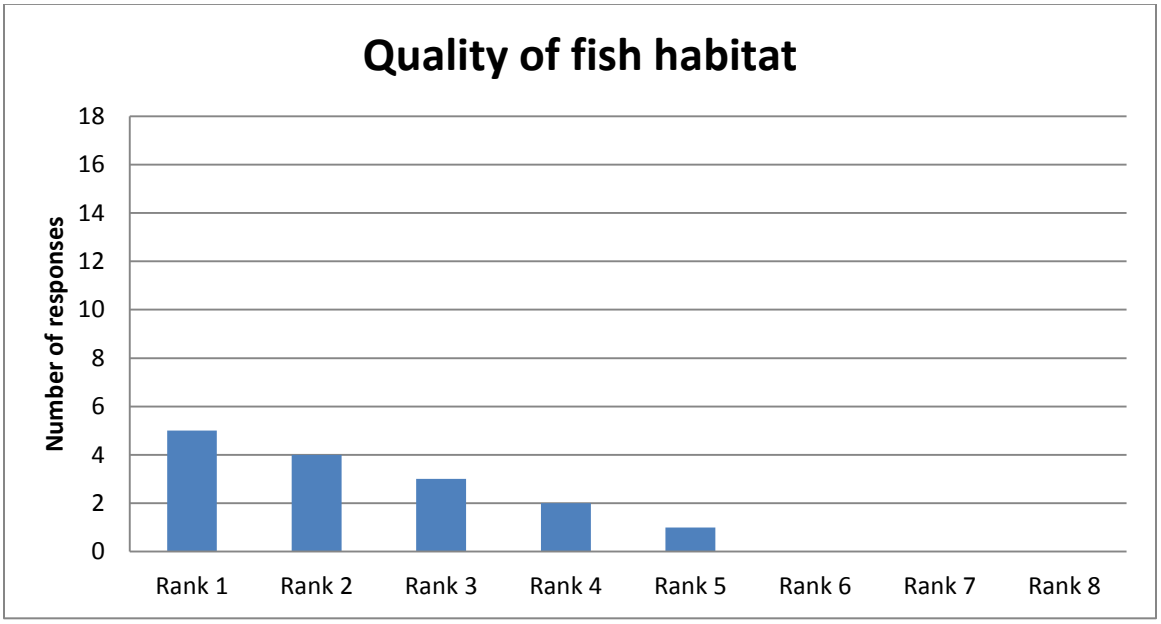
___I use my watercraft on Margaret Lake
___I use my watercraft on other water bodies in Wisconsin
___I also use my watercraft on water bodies outside of Wisconsin

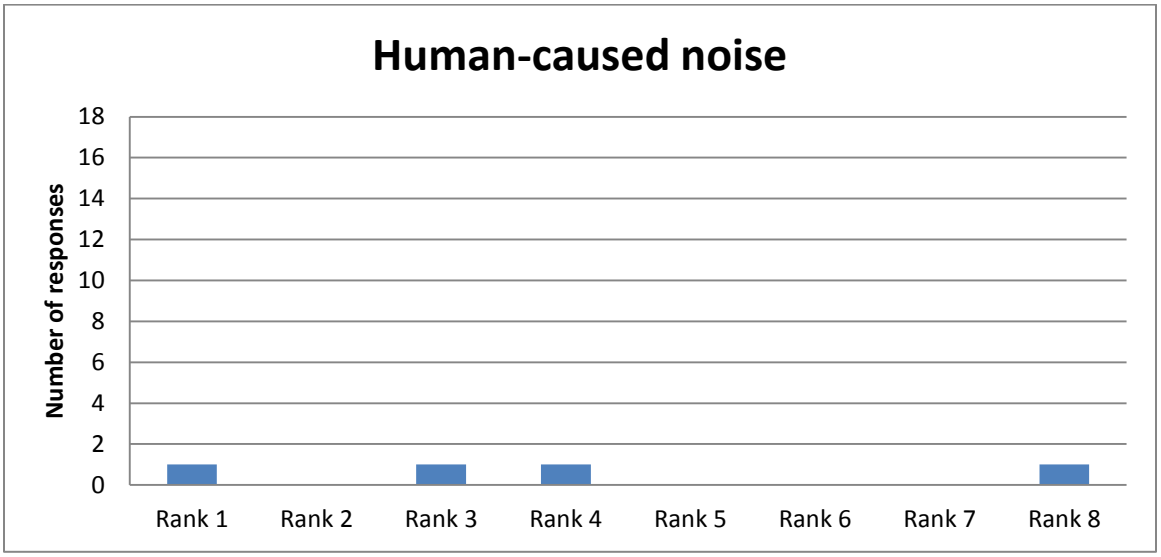


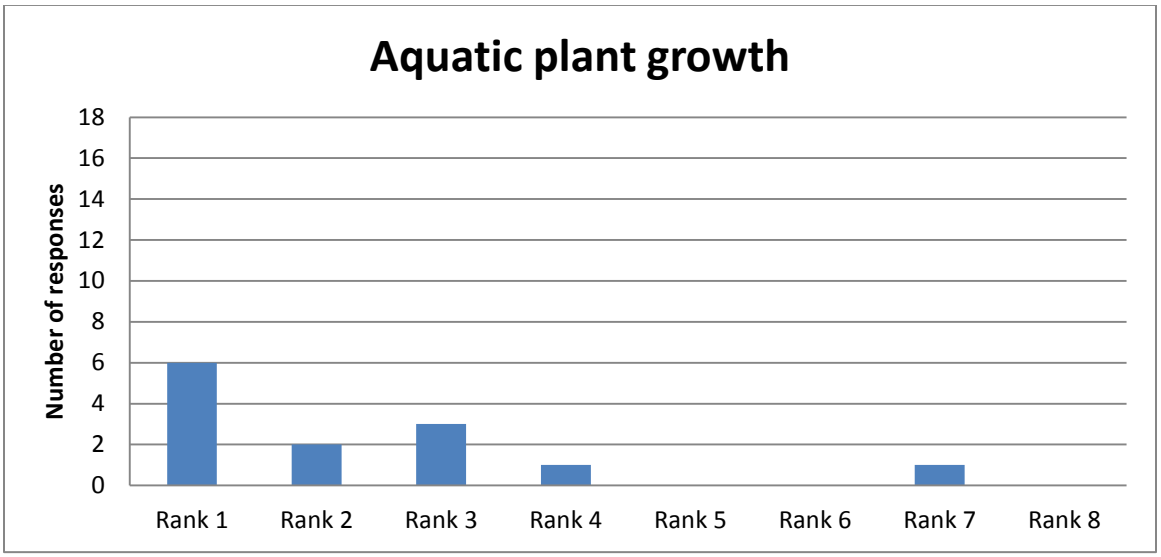
9. From the list below, please rank your top four (1, 2, 3, and 4) concerns for Margaret Lake. Write a 1 for your primary (most important) concern.

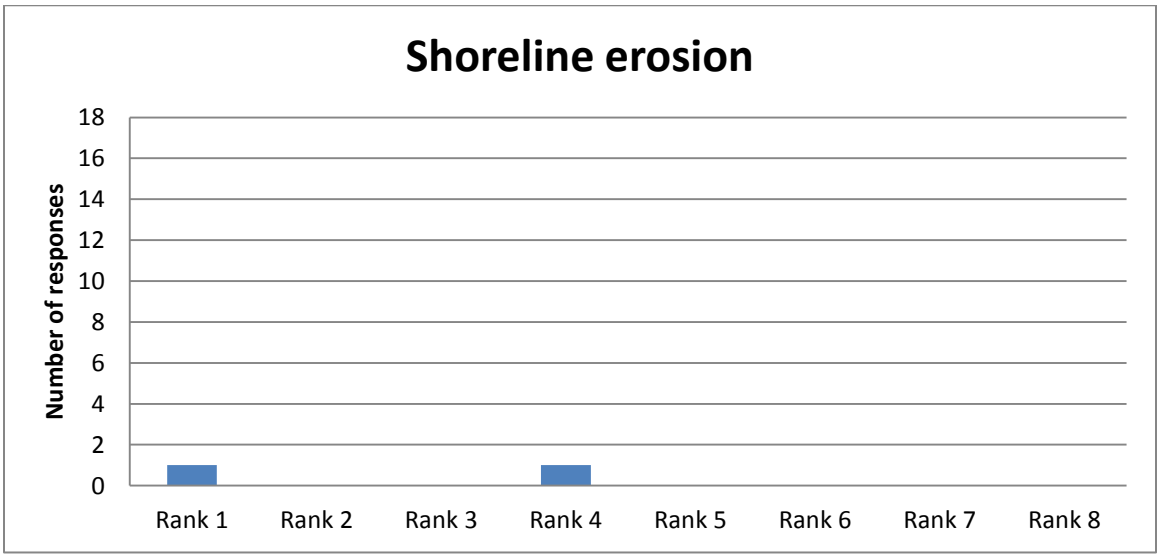
___Water quality
___Quality of fish habitat
___Human-caused noise
___Aquatic plant growth
___Shoreline erosion
___Algae growth
___Storm drain runoff
___Aquatic Invasive Species (AIS) introduction
___Near-shore human development
___Human development on the greater watershed
___Boat traffic
___Shoreline vegetation removal
___Boating safety
___Other (explain_____)

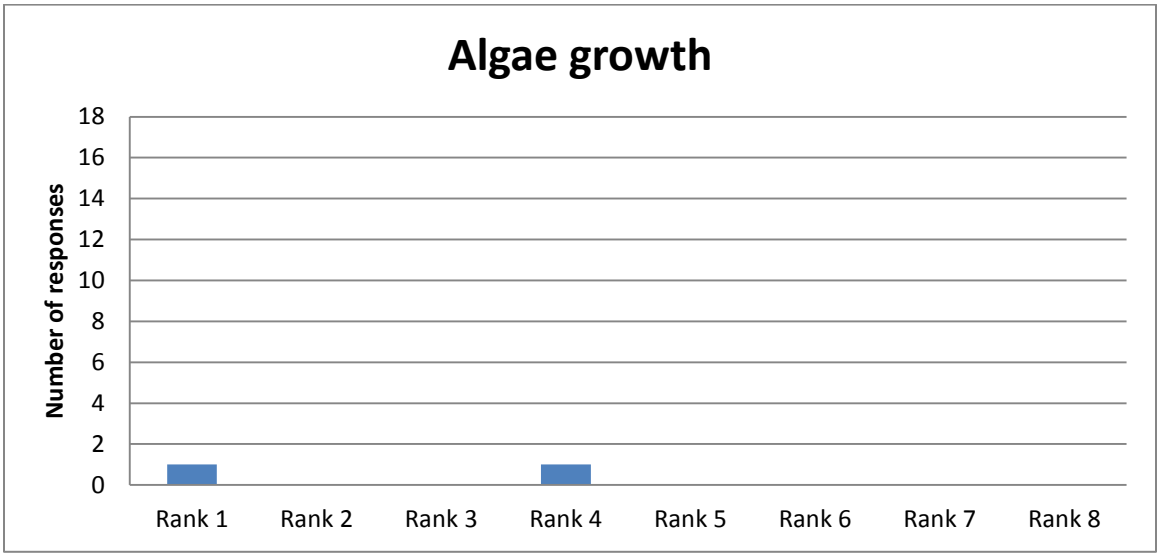


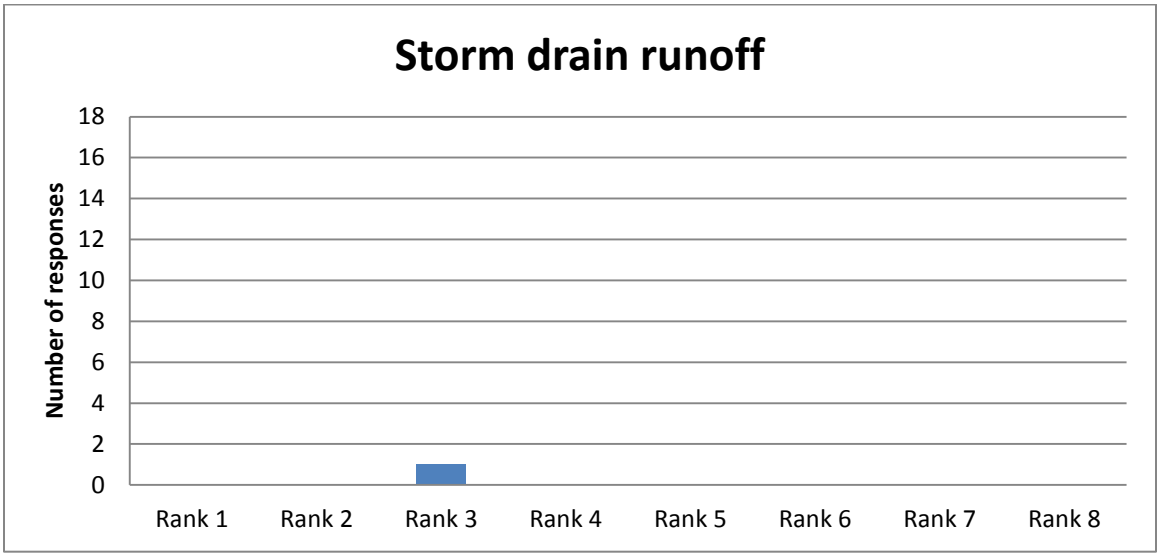


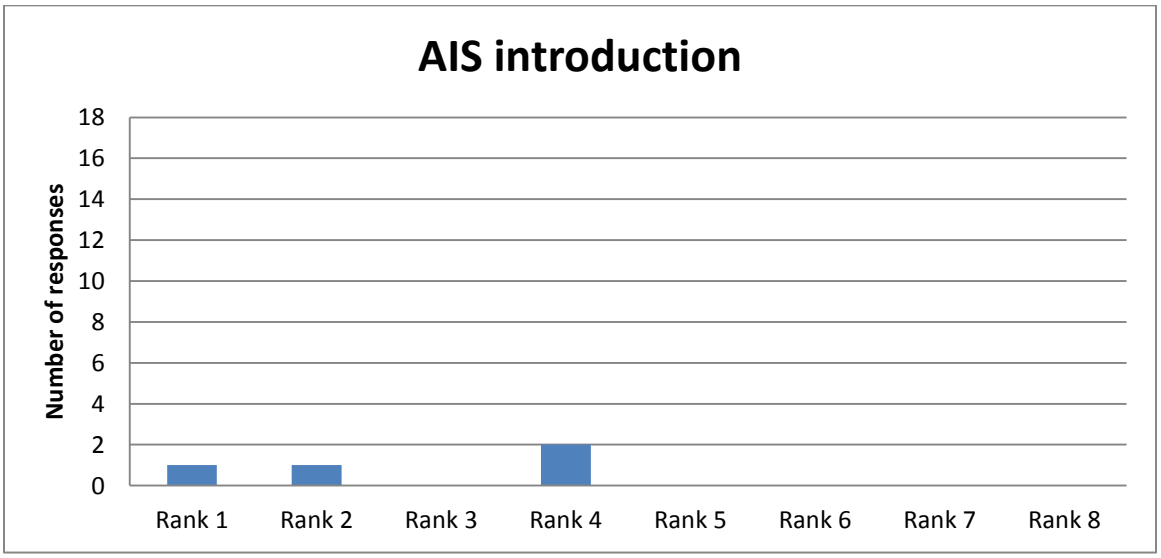

Human-caused noise
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

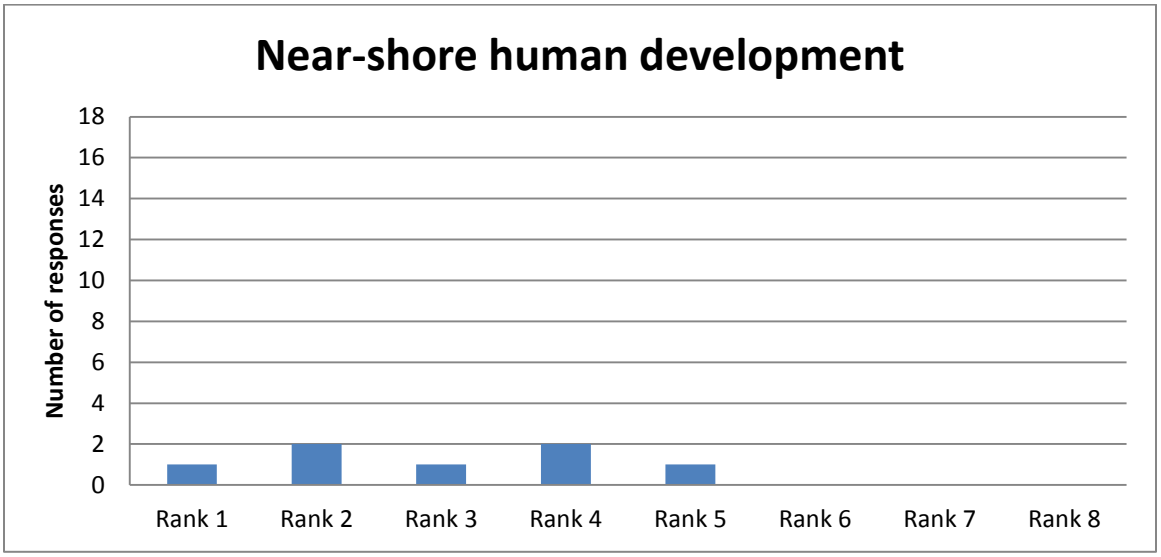

Aquatic plant growth
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

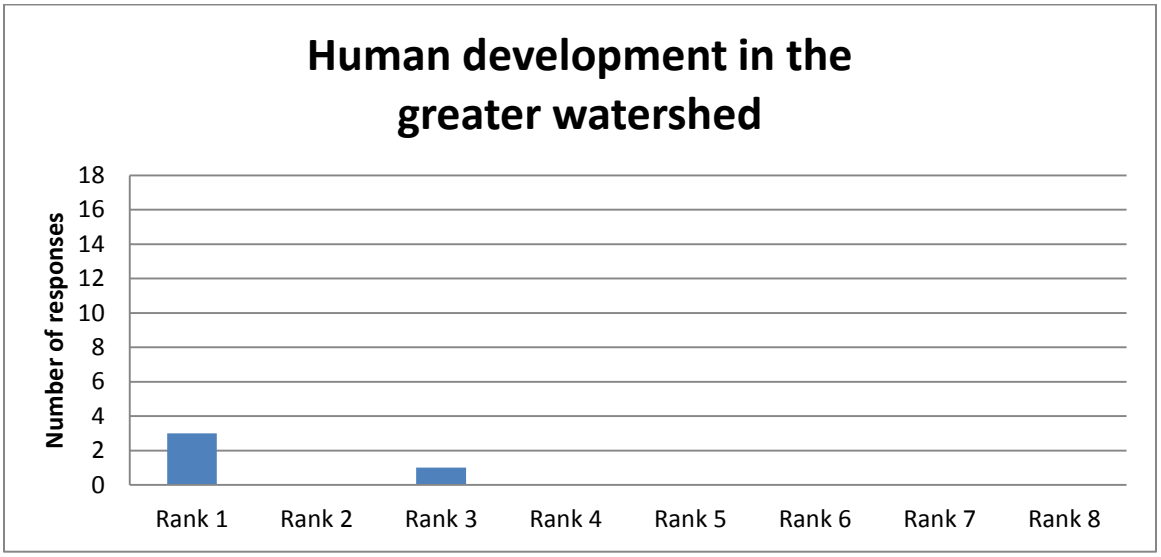

Shoreline erosion
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

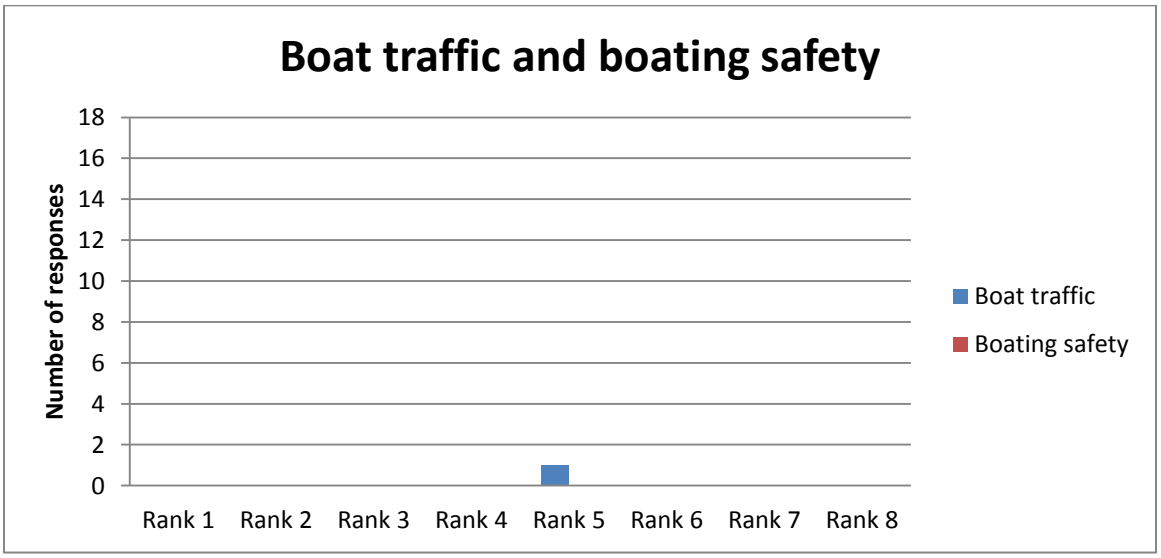

Algae growth
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

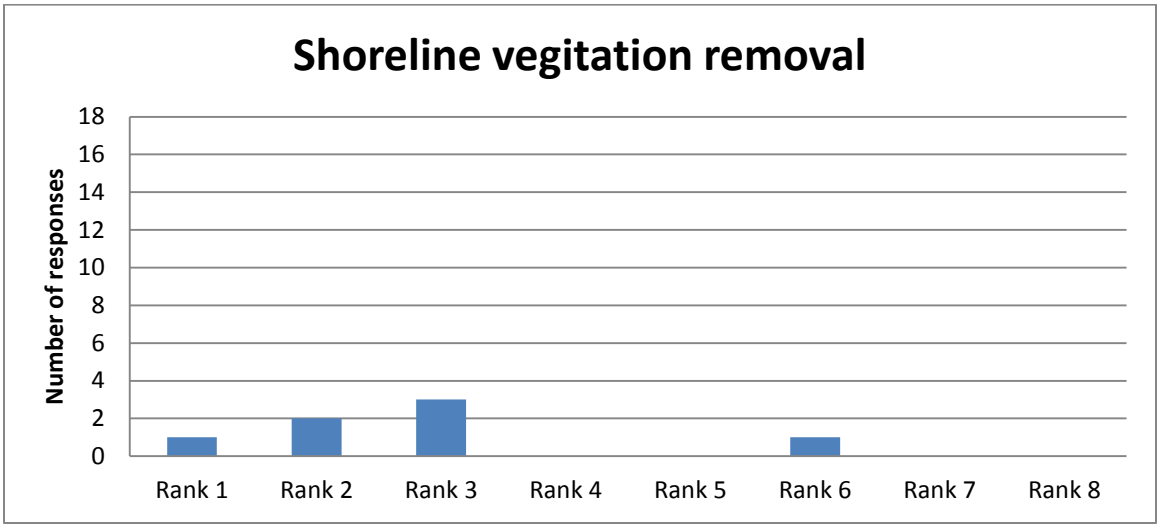

Storm drain runoff
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

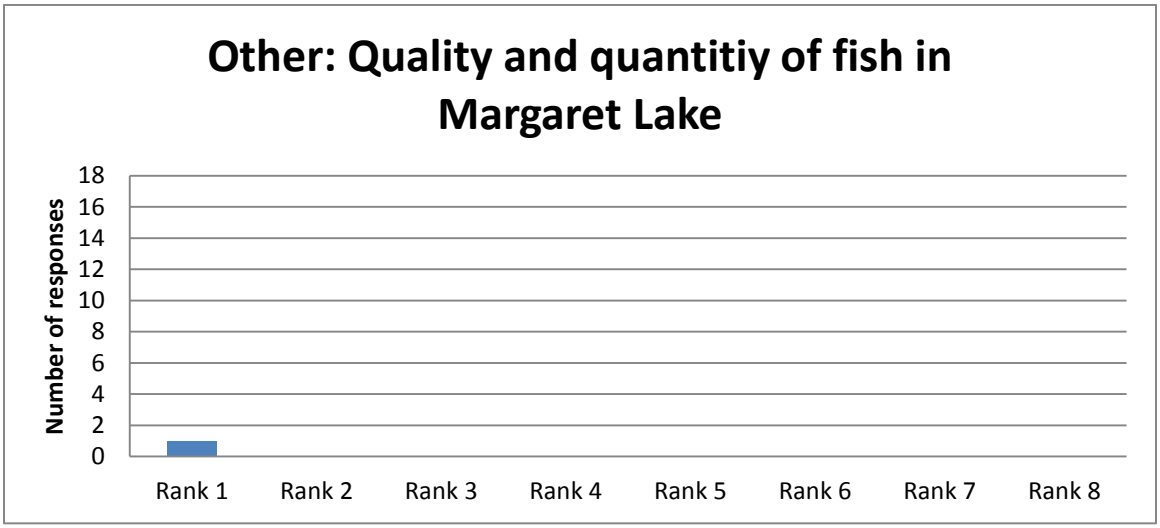

AIS introduction
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8


Near-shore human development
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8


Human development in the greater watershed
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8

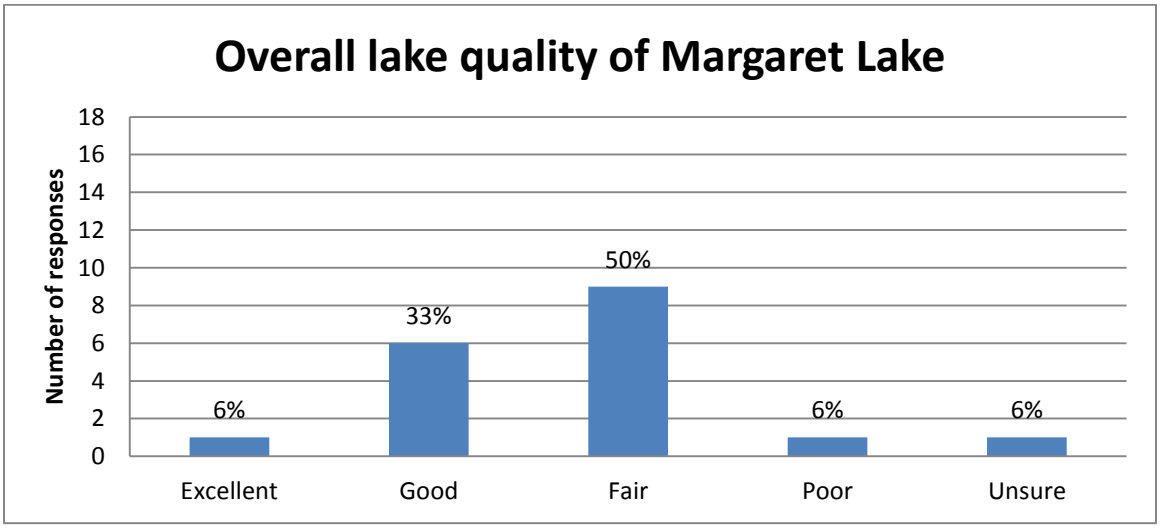

Boat traffic and boating safety
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6
Rank 7
Rank 8
Boat traffic
Boating safety





10. Considering the lake issues in question 9, please evaluate the overall lake quality. (Circle one).

A. Excellent B. Good C. Fair D. Poor E. Unsure



11. During the years you've been familiar with Margaret Lakes, what changes have you seen in the aquatic plants? (cirlce all that apply)

A. No dramatic changes – about the same as always.

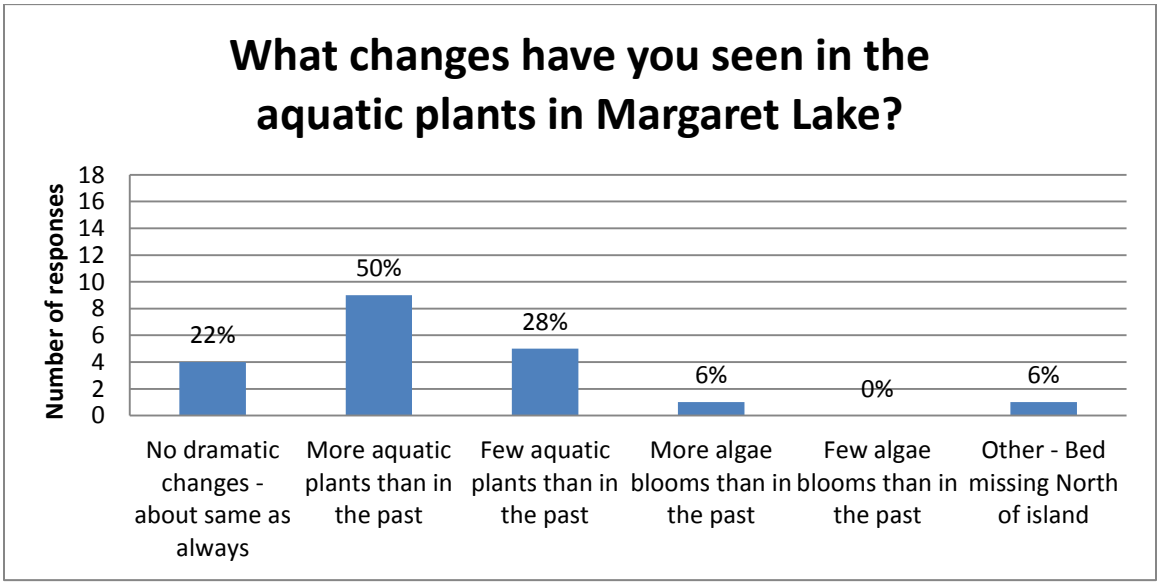
B. More aquatic plants than in the past.

C. Fewer aquatic plants than in the past.

D. More algal blooms than in the past.

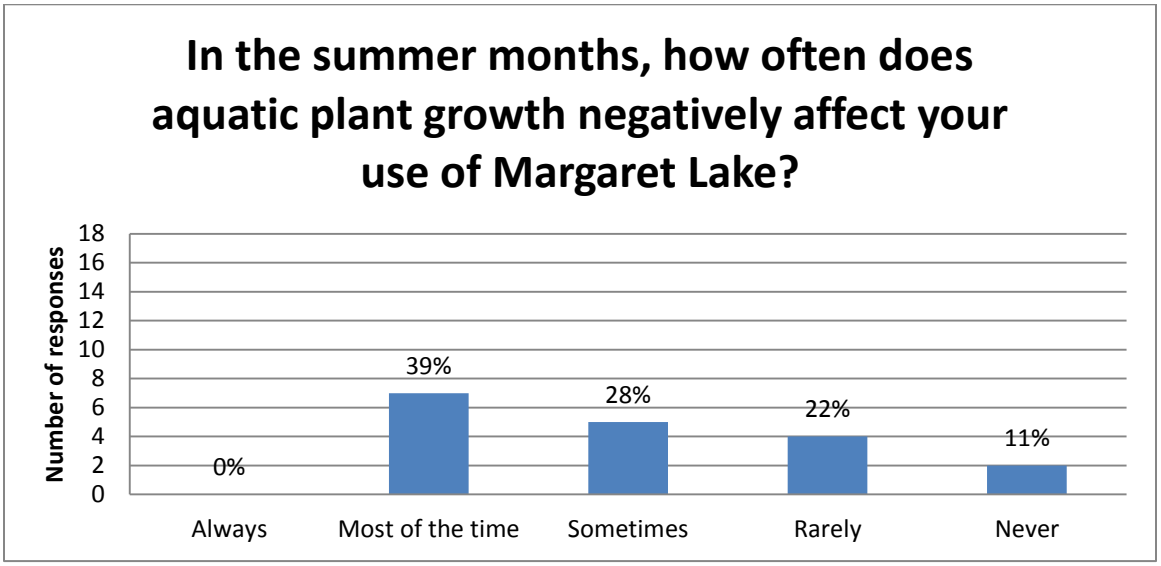
E. Fewer algal blooms than in the past.

F. Other (describe :_____)



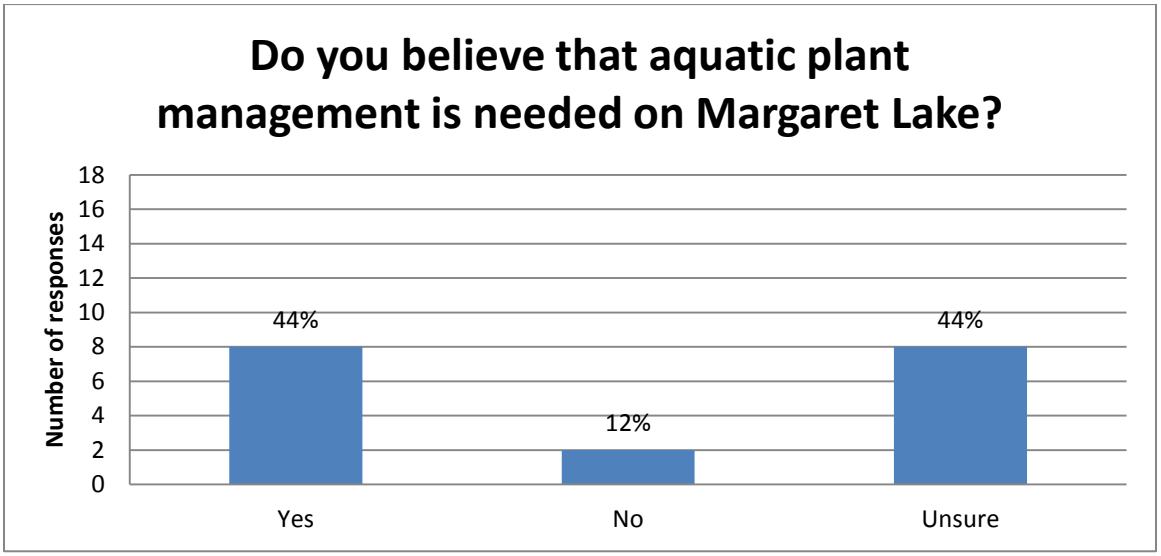
12. In the summer months (Memorial Day through Labor Day), how often does aquatic plant growth negatively affect your use of Margaret Lake? (Circle one)

A. Always B. Most of the time C. Sometimes D. Rarely E. Never



13. Do you believe that aquatic plant management is needed on Margaret Lake? (Please circle only one)

A. Yes B. No C. Unsure



Question 14 on the Margaret Lake Aquatic Plant Management Plan – Lake User Survey asked the lake user to describe any problem on Margaret Lake that you believe requires aquatic plant management by labeling with an "X" with a description to the right.

Figure 1 depicts the areas of aquatic plant issues viewed by lake users with the comments quoted beside. Areas 7, 12, and 15 were marked on the map where plant problems occurred, but no comment was provided.

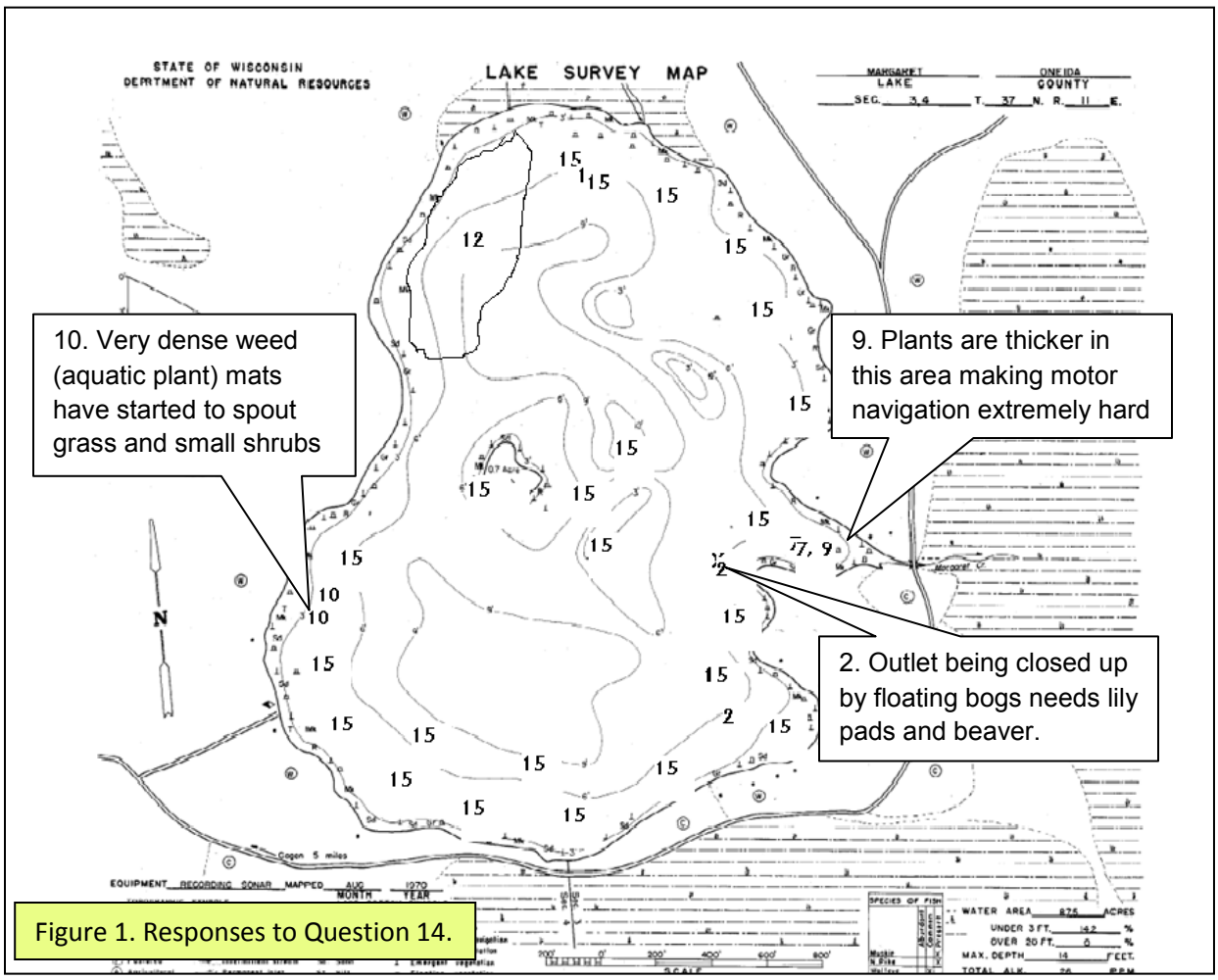
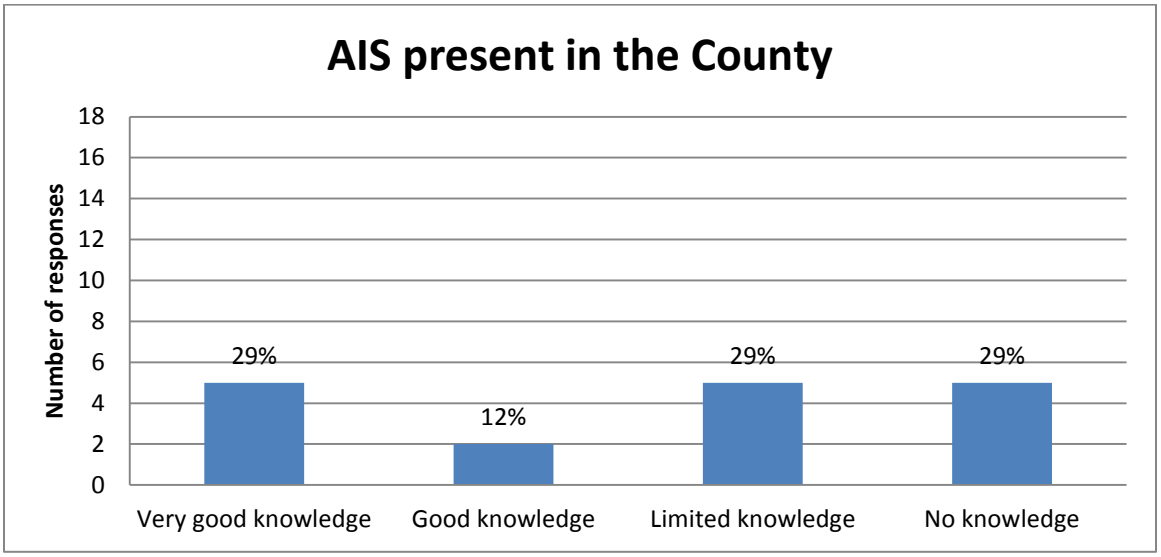


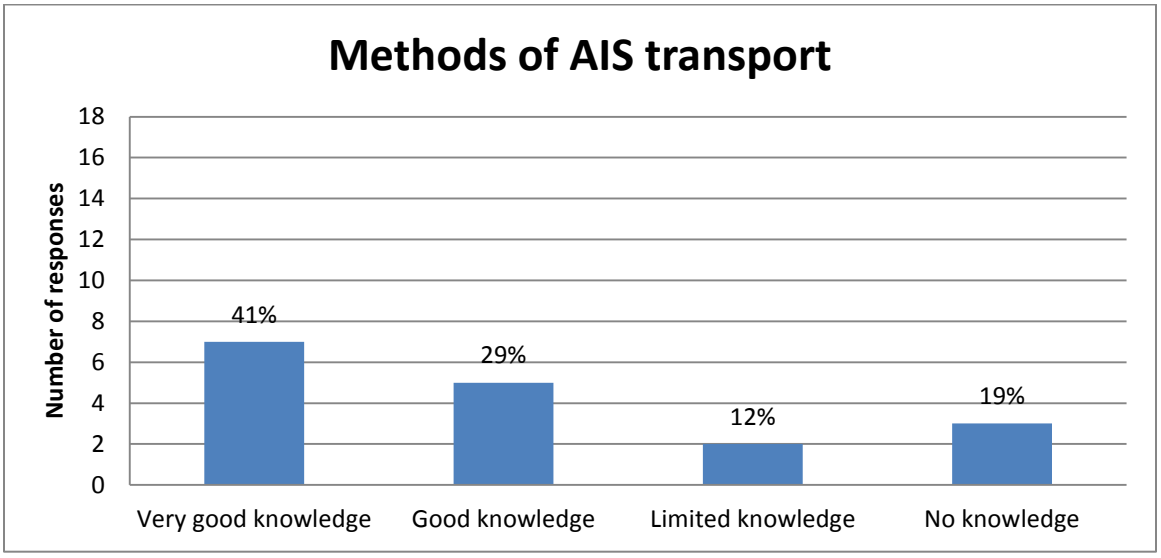
Figure 1. Responses to Question 14.

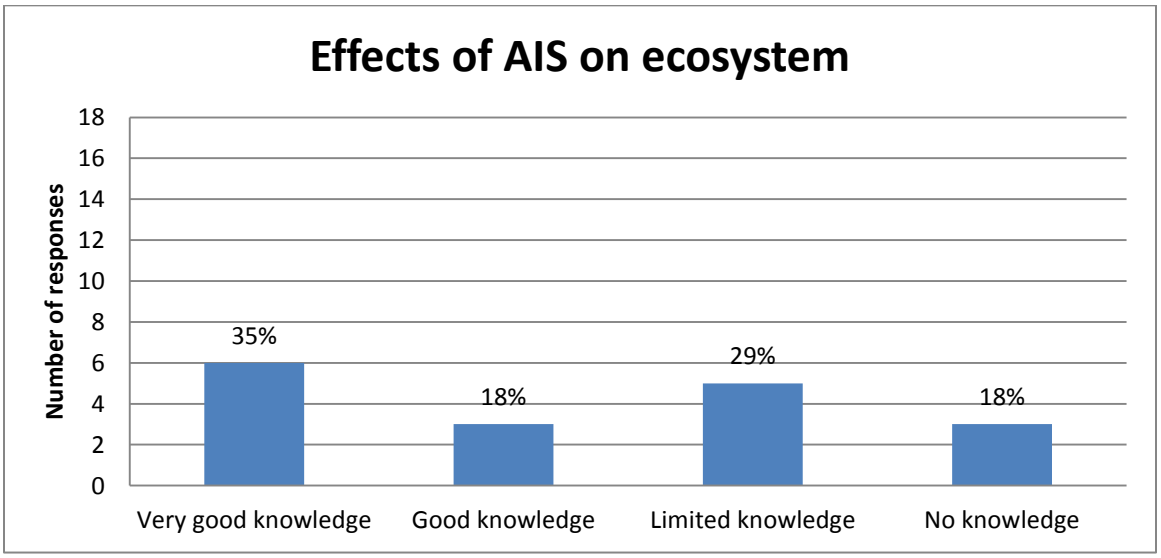
15. Education is a fundamental component of Aquatic Plant Management (APM) planning projects. Please use the following scale to rank your understanding of the aquatic invasive species (AIS) topics listed below. (For example if you have little or no knowledge about methods of AIS transport, place a 4 next to that choice).

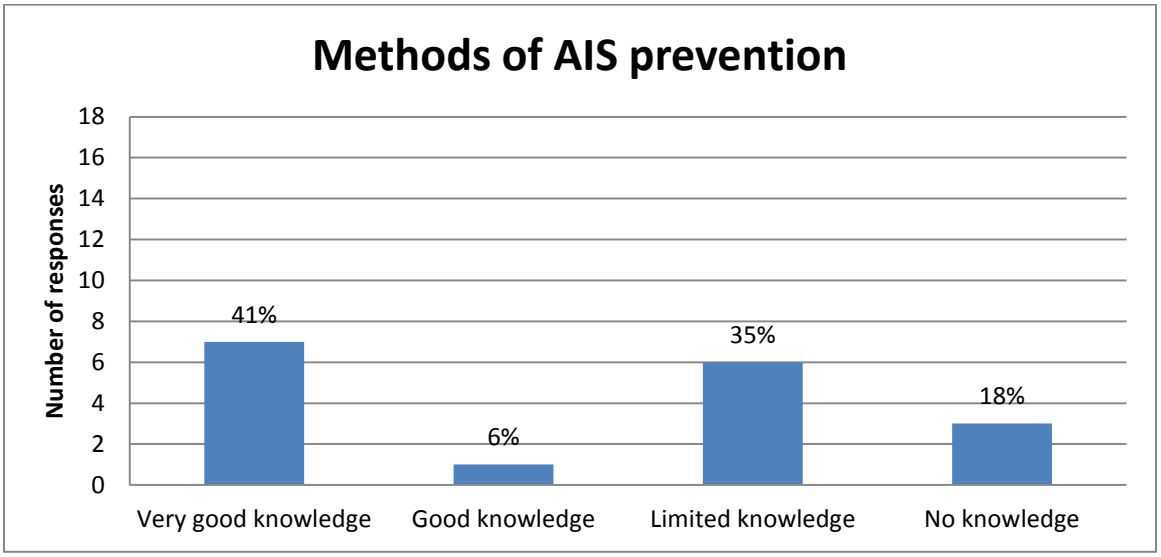
Scale 1. Very good knowledge of subject 2. Limited knowledge of subject
3. Good knowledge of subject 4. No knowledge of subject

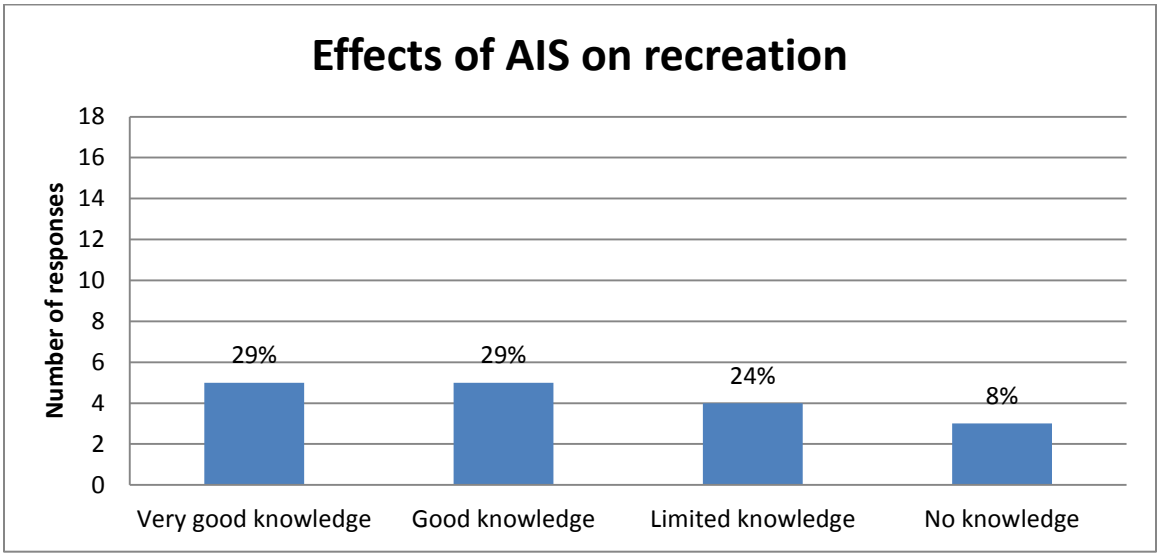
___ AIS present in the County
___ Methods of AIS transport
___ Effects of AIS on ecosystem
___ Methods of AIS prevention
___Effects of AIS on recreation
___ Long term results of AIS control
___ Methods of AIS control
___Able to identify AIS

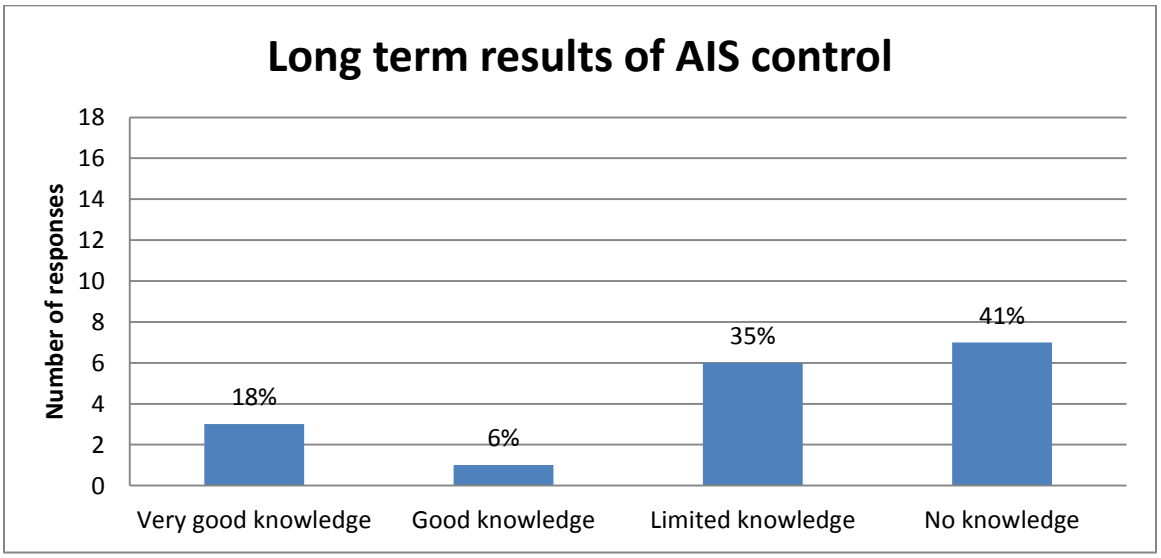

AIS present in the County
Number of responses
18
16
14
12
10
8
6
4
2
0
29%
12%
29%
29%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

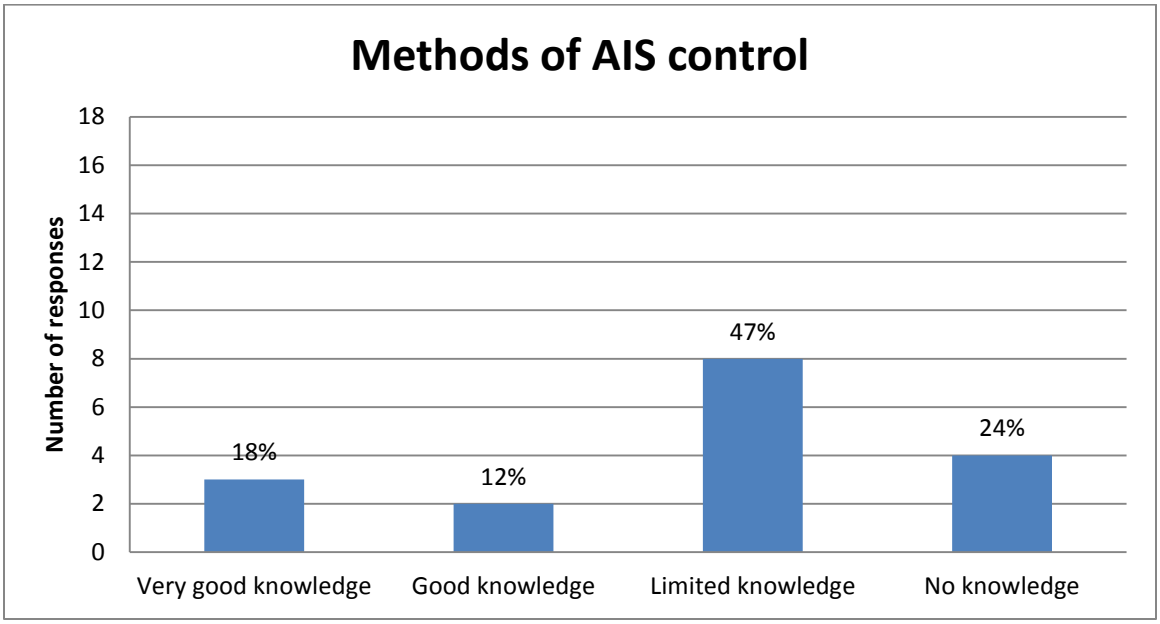

Methods of AIS transport
Number of responses
18
16
14
12
10
8
6
4
2
0
41%
29%
12%
19%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

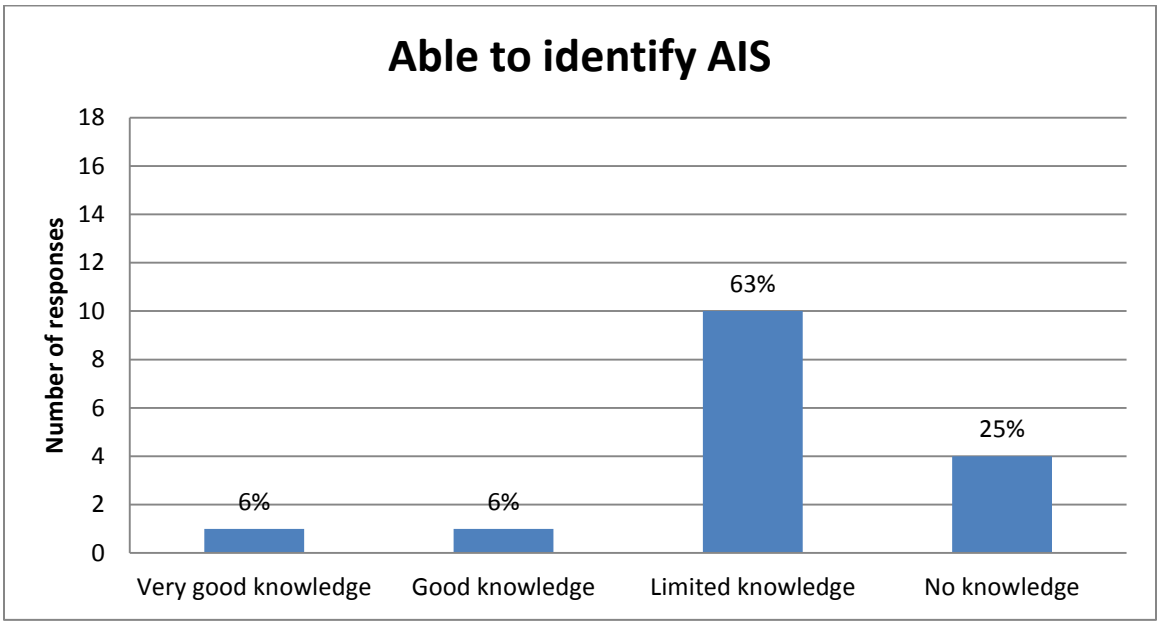

Effects of AIS on ecosystem
Number of responses
18
16
14
12
10
8
6
4
2
0
35%
18%
29%
18%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge


Methods of AIS prevention
Number of responses
18
16
14
12
10
8
6
4
2
0
41%
6%
35%
18%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge


Effects of AIS on recreation
Number of responses
18
16
14
12
10
8
6
4
2
0
29%
29%
24%
8%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

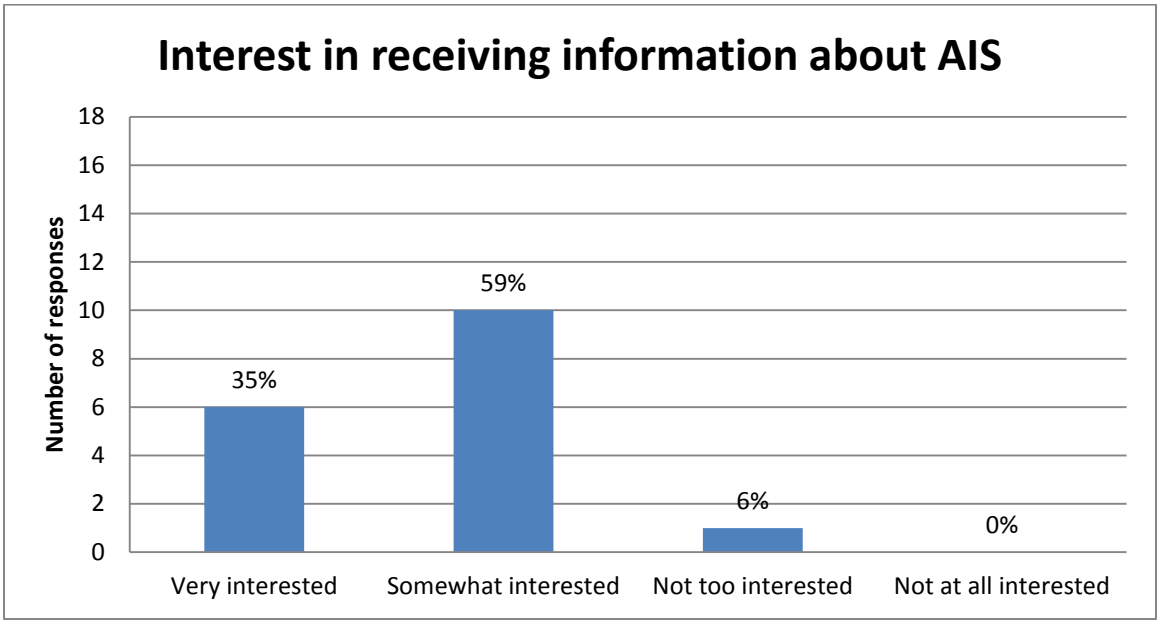

Long term results of AIS control
Number of responses
18
16
14
12
10
8
6
4
2
0
18%
6%
35%
41%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge





16. How interested would you be in receiving information about aquatic invasive species? (Circle one)

A. Very interested B. Somewhat interested C. Not to interested D. Not at all interested



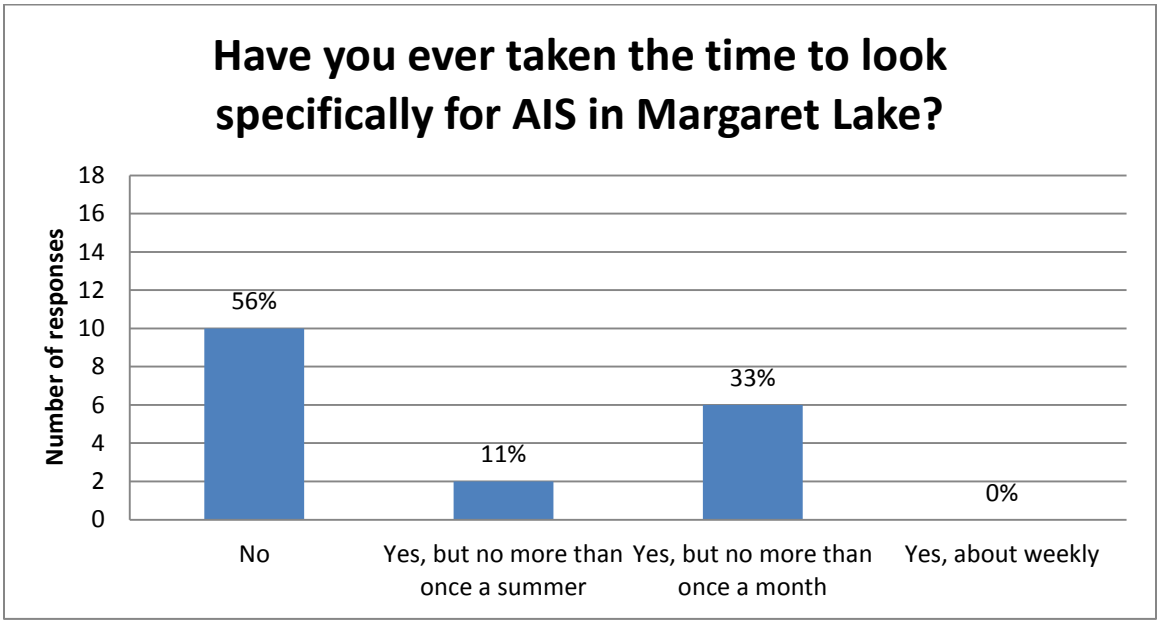
17. Have you ever taken the time to look specifically for aquatic invasive species in Margaret Lake?

A. No

B. Yes, but no more than once a summer

C. Yes, but no more than once a month

D. Yes, about weekly



18. Below are several methods used to manage aquatic invasive plant species. Using the following scale, please indicate your level of support or opposition for each control method.

A. Definitely support B. Probably support C. Unsure D. Probably oppose E. Definitely oppose

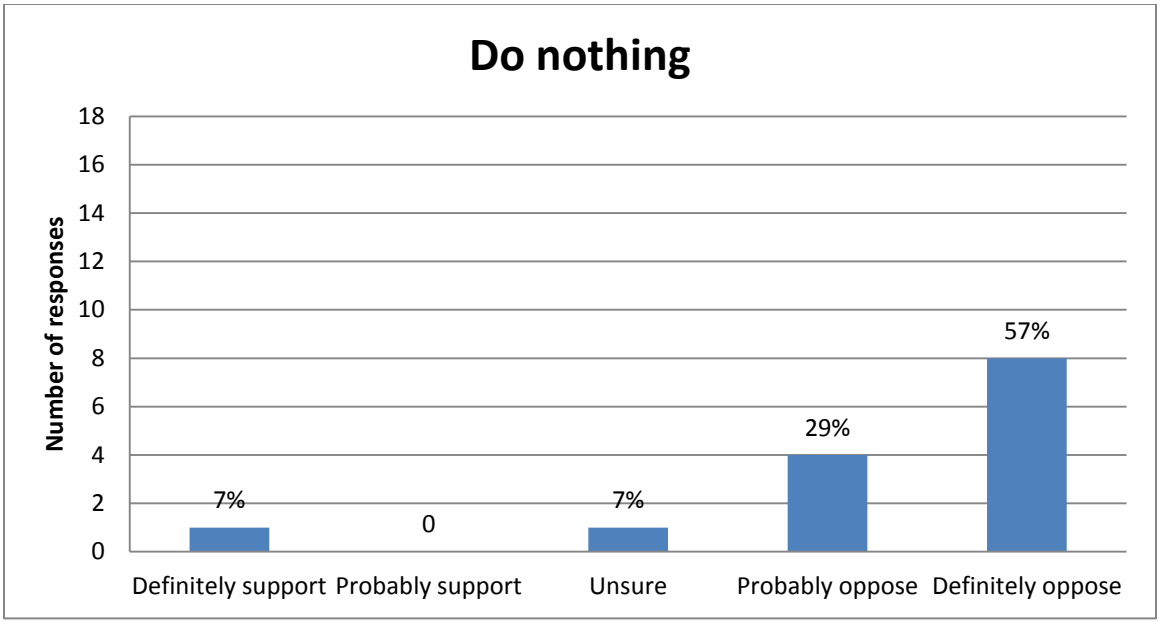
___Do nothing

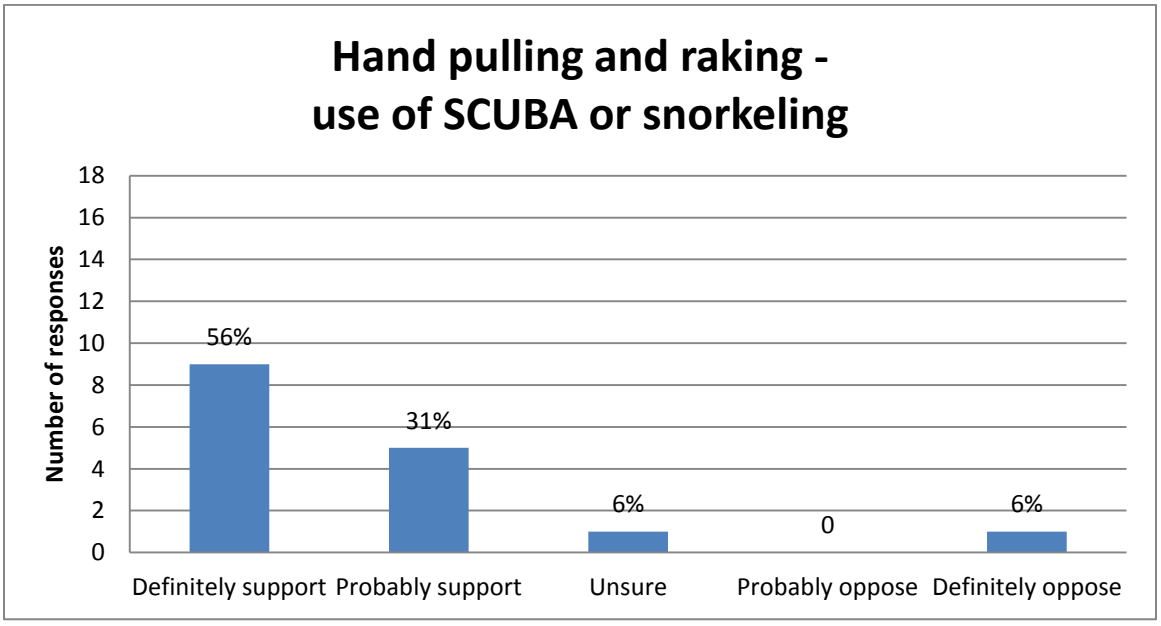
___Hand pulling and raking – use of SCUBA or Snorkeling

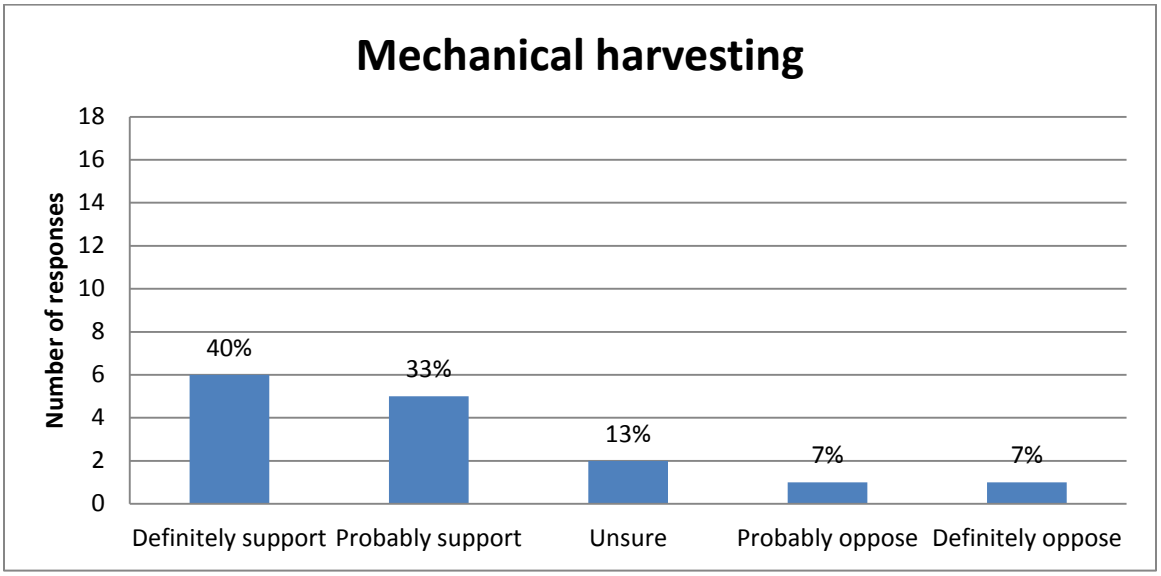
___Mechanical harvesting – use of a machine to eliminate invasive aquatic plants

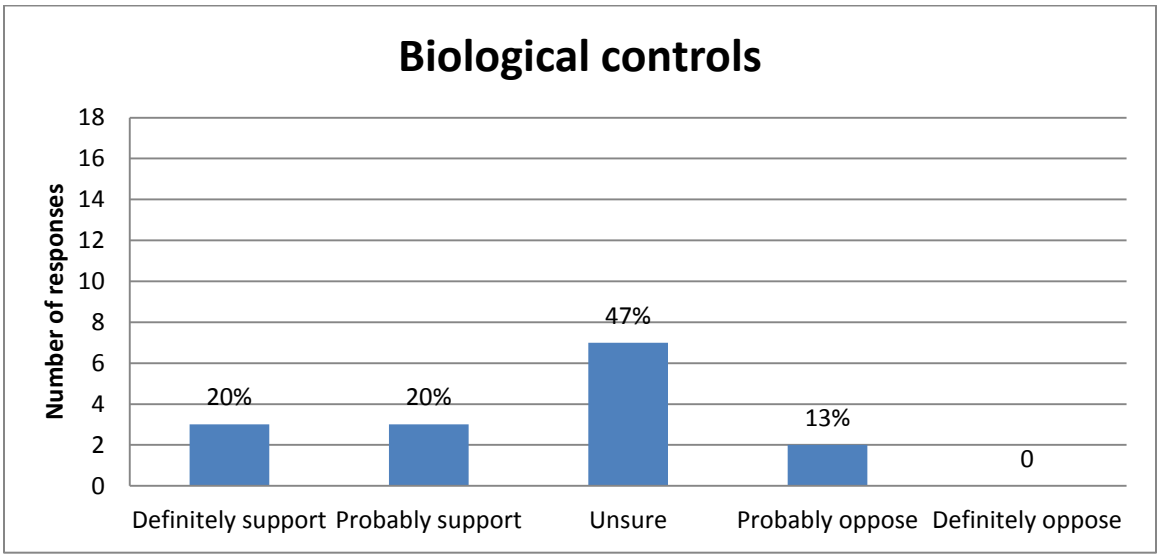
___Biological controls (native weevils) – placed in the lake to naturally control Eurasian water-milfoil

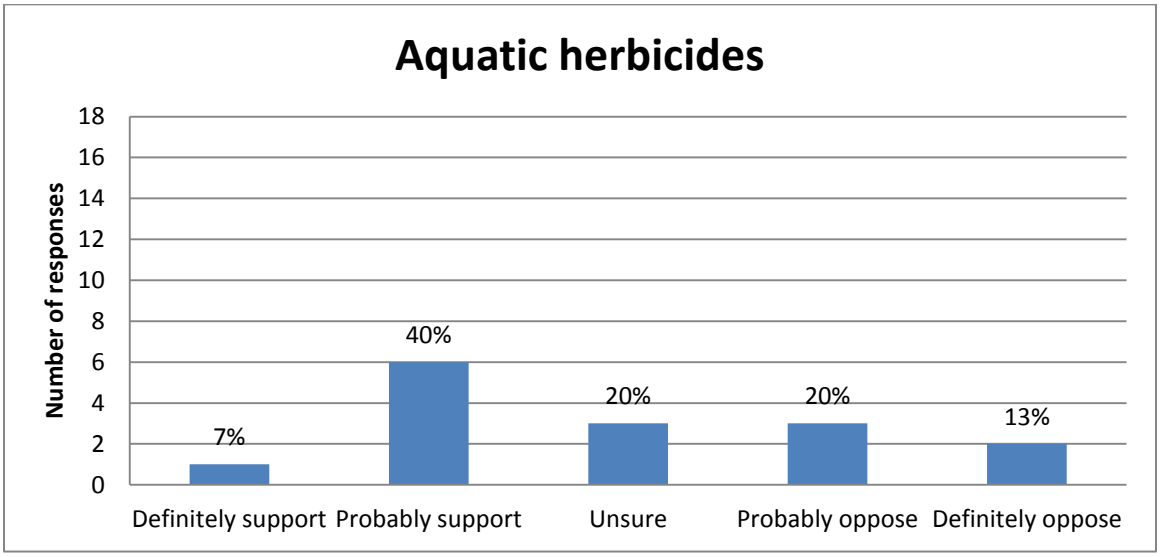
___Aquatic herbicides – applying herbicides to the AIS to control them






Mechanical harvesting
Number of responses
18
16
14
12
10
8
6
4
2
0
40%
33%
13%
7%
7%
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose


Biological controls
Number of responses
18
16
14
12
10
8
6
4
2
0
20%
20%
47%
13%
0
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose


Aquatic herbicides
Number of responses
18
16
14
12
10
8
6
4
2
0
7%
40%
20%
20%
13%
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose

19. The Aquatic Plant Management (APM) Plan can have several goals. We would like to know where you think the Plan should place its emphasis. ***Rank the following list of APM Plan goals*** *("1" being the most important and "6" being the least important).*

___Monitor Margaret Lake for changes in native plant composition and distribution.

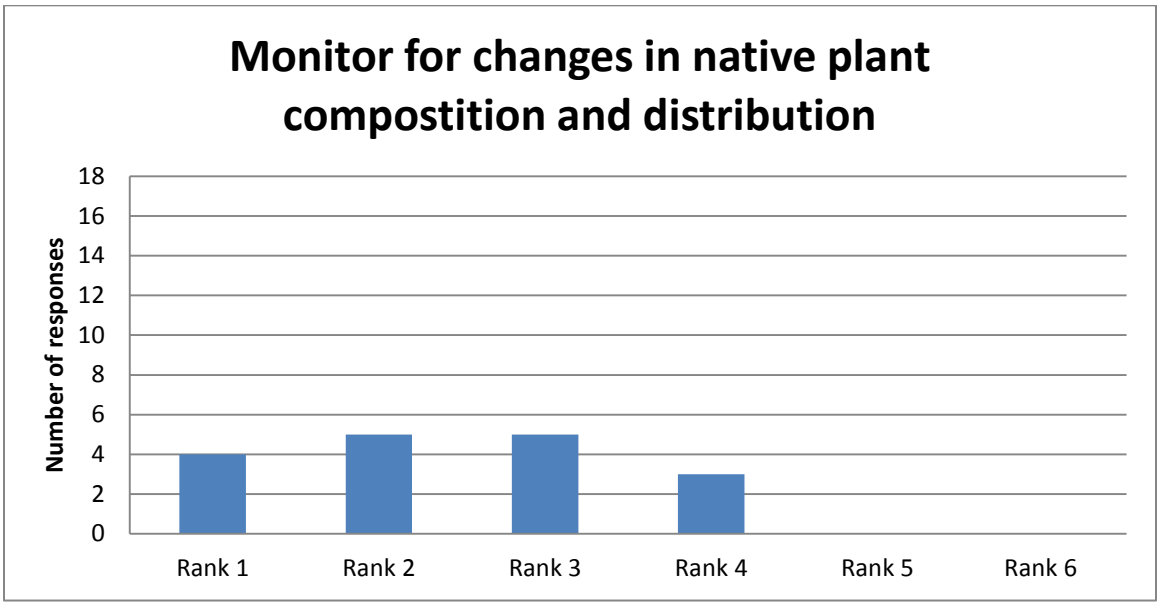
___Protect native plant species.

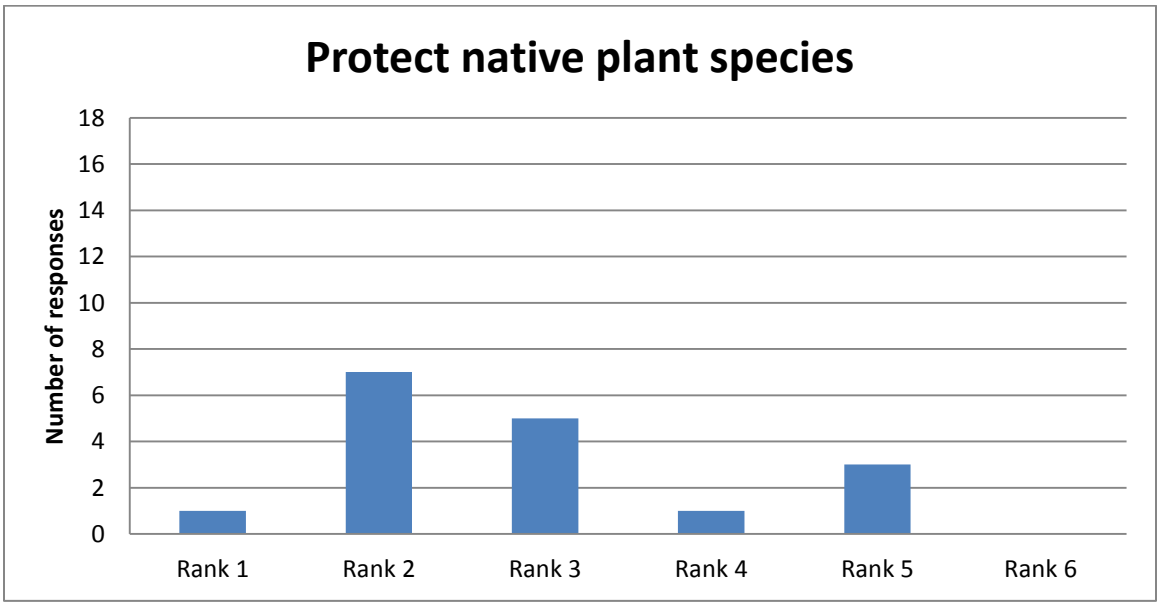
___Prevent the introduction of Aquatic Invasive Species.

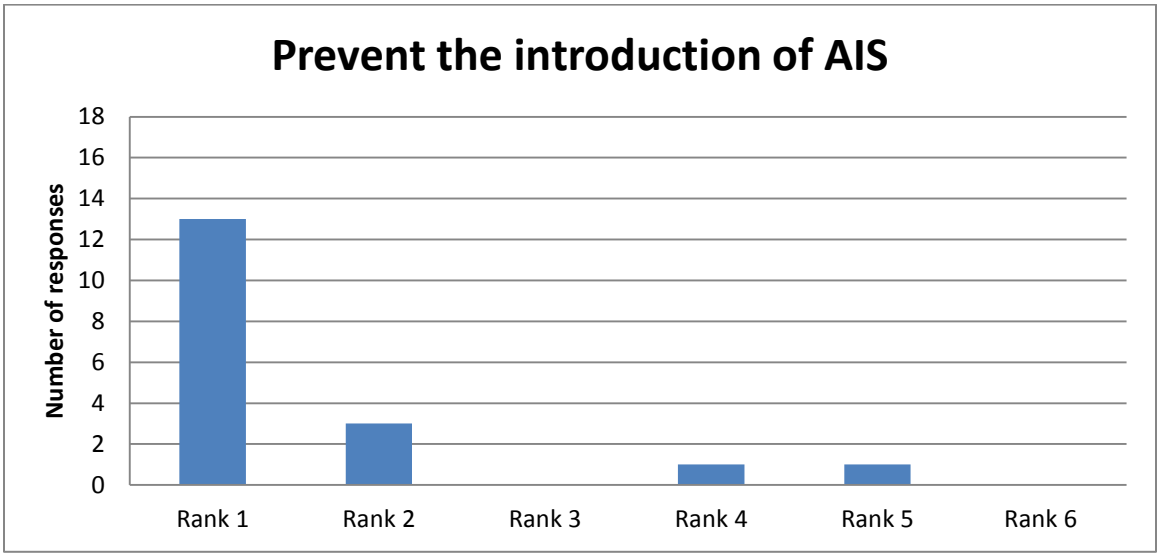
___Provide education to Margaret Lake stakeholders regarding the plant community.

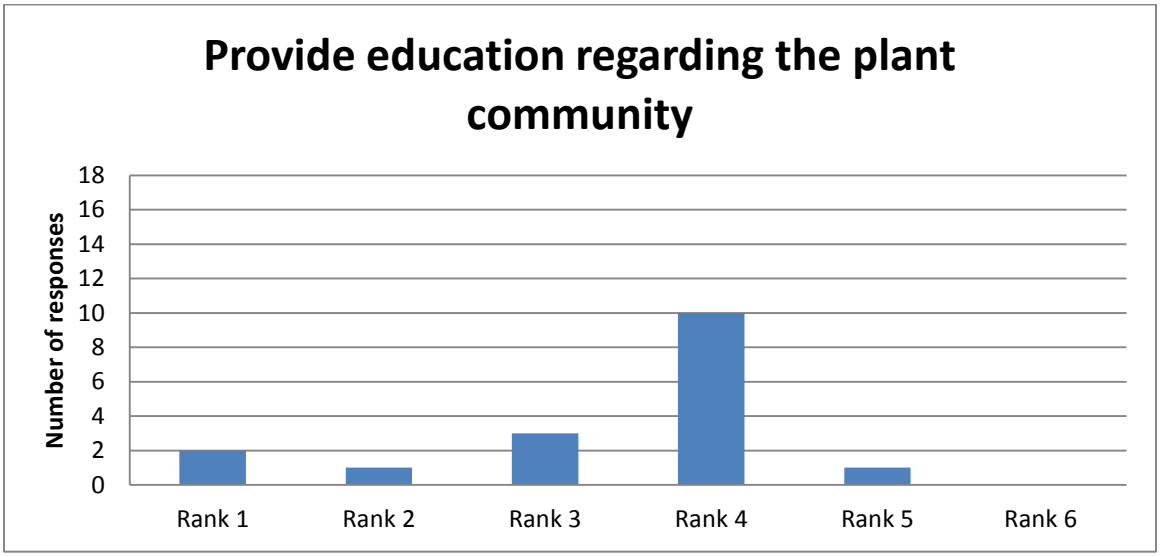
___Monitor recreational users to minimize introduction of Aquatic Invasive Species.

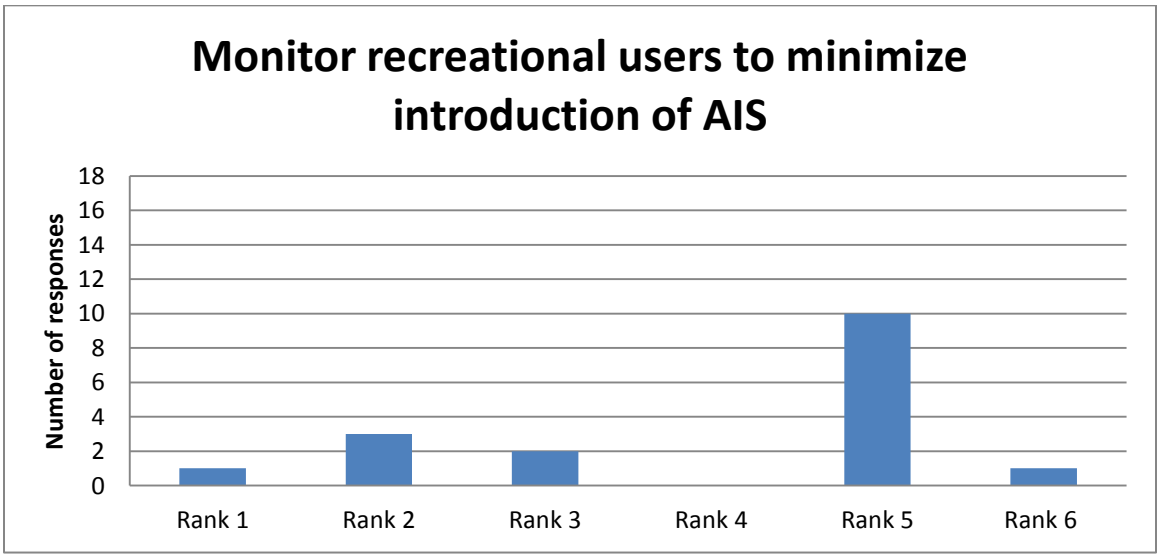
___Other_____






Prevent the introduction of AIS
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6


Provide education regarding the plant community
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6


Monitor recreational users to minimize introduction of AIS
Number of responses
18
16
14
12
10
8
6
4
2
0
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6

20. There are several opportunities for citizens to become actively involved in important roles during Aquatic Plant Management Plan implementation. From the list below, please identify which activities, if any, you would be interested in helping with. (Select all that apply)

A. Lake Aquatic Invasive Species Monitor – possibilities might include

1. Placing a brick or zebra mussel sampler off your dock and monitor for presence/absence
2. Scanning Margaret Lake looking for Eurasian water milfoil, curly-leaf pondweed, or purple loosestrife
3. Scanning the shoreline looking for any unusual snails or mussels
4. Observing the water for presence of the spiny water flea
5. Observing for the presence of the rusty crayfish
6. While fishing looking at the fish to see if there are any abnormalities or if you catch a fish you haven't seen before to report it

B. Grant writing – help in finding moneys for Margaret Lake

C. Citizen Lake Water quality Monitor

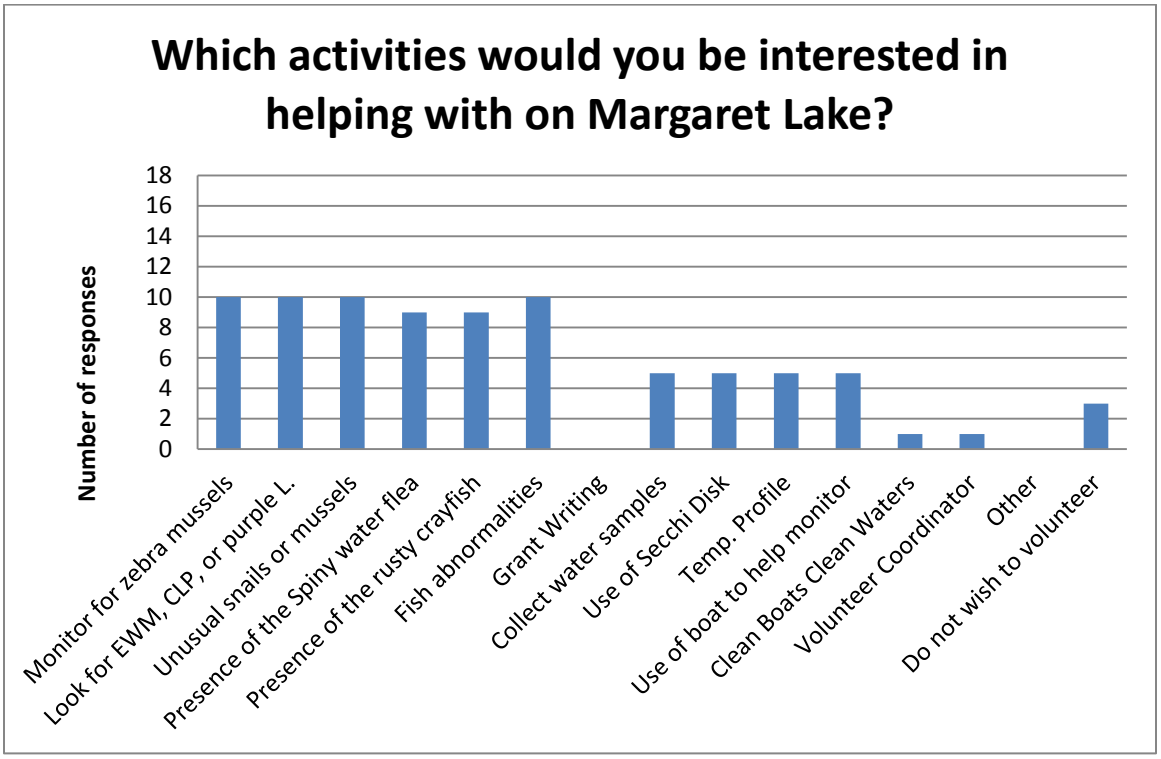
1. Collecting water samples
2. Using a Secchi disk (white and black disc dropped into the water to see how far down you can see determining the water clarity) – currently being done on Margaret Lake
3. Temperature Profile
4. Use of your boat to help scientist or volunteer to monitor

D. Clean Boats Clean Waters – educate the boaters on AIS and inspect boats

E. Volunteer Coordinator – organize volunteers for specific tasks on Margaret Lake

E. Other (specify :_____)

F. Do not wish to volunteer



NOTE: If you checked any of the volunteer opportunities or would like more information on AIS, please provide your contact information.

Name_____
Address_____
City _____ State_____ Zip Code_____
Phone_____ Email_____

14 of 18 respondents provided contact information

21. Please list any additional suggestions that you would like to see incorporated into the APM plan.

"See what the fish study shows and get a walleye planting."

"We would like to swim without getting tangled with weeds."

"Learn more about future grant, what is Phase 4? Plant fish (walleye)."

Thank you for taking time to complete this survey. Return completed survey to:

Margaret Lake Association
Eric Rady
988 Margaret Lake Road
Three Lakes, WI 54562