The Bearskin Lake Adaptive Management Plan

(Oneida County, Wisconsin)

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Bearskin Lake – White Water Associates photo.

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WHITE WATER
ASSOCIATES, INC.

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

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CHAPTER 1

What Is the Bearskin Lake Adaptive Management Plan?

The *Bearskin 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 Big Bearskin Lake Association (BBLA). White Water Associates, Inc., an independent ecological consulting firm and environmental laboratory, served as a consultant to the BBLA.

Project participants have embraced the concept of “adaptive management” in their approach to Bearskin 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 Bearskin Lake Stewardship Program and the BBLA. 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 Bearskin Lake Stewardship Program and the BBLA to plan that future monitoring will focus on tangible indicators.

It is appropriate that the BBLA is the lead organization in the implementation of this plan. BBLA is comprised of people who care very much about Bearskin 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 BBLA is a healthy, sustainable Bearskin 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 *Bearskin 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 Bearskin 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 Big Bearskin 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 Bearskin Lake and its surroundings. Ten appendices complete this document. Appendix A contains the *Literature Cited.* Appendix B contains the *Bearskin Lake Aquatic Plant Management Plan*. Appendix C presents the *Bearskin Lake Review of Water Quality*. Appendix D includes the *Bearskin Lake Watershed, Water Quality, and WiLMS Modeling*. Appendix E encompasses the *Bearskin Lake Conductivity Study*. Appendix F provides results of the *Bearskin Lake EPA Littoral and Shoreline Activities*. Appendix G is a description of the *Bearskin Lake Fisheries Report.* Appendix H provides information about the *Bearskin Lake Rusty Crayfish Efforts.* Appendix I consists of the *Review of Water Regulations and Planning Relevant to Bearskin Lake.* Finally, Appendix J reviews the *Lake User Survey* for Bearskin Lake.

CHAPTER 2

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

The title of Chapter 3 poses the question: “Why Have the *Bearskin 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 Bearskin 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 Bearskin Lake and its surroundings. People who care are also those who live beyond the watershed boundaries. Some of these people visit Bearskin 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 Bearskin 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 BBLA has interacted with the plan writers throughout the process and reviewed draft components of the plan. The BBLA 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 Bearskin 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 Bearskin Lake Adaptive Management Plan?

Why have the *Bearskin 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 Bearskin 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 Bearskin 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 Bearskin Lake. The long-term economic health of the municipality is tied to the health of Bearskin Lake and other lakes and streams in the area. At even larger scales yet, this applies to Hazelhurst and Cassian Townships, Oneida County, to the State of Wisconsin, and so on.

The Big Bearskin 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 BBLA and this plan endeavor to harness that energy and apply it to restoration and protection actions focused on Bearskin 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 Bearskin Lake landscape in some way. Because we feel a civic responsibility to care for the lake. Because we realize Bearskin 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 Bearskin Lake ecosystem for them to enjoy and use.

The adaptive management plan will be successful if it allows and organizes meaningful stewardship work for Bearskin 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 *Bearskin 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 Bearskin Lake and its surroundings are quite pristine, part of the Bearskin 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 Bearskin Lake biology in science curriculum of area schools. Every person that visits Bearskin 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 Bearskin 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 Bearskin 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 BBLA, Oneida County Land & Water Conservation Department, the Wisconsin Department of Natural Resources, and those living and recreating in the Bearskin 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 Bearskin 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 Bearskin 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 Bearskin 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 Bearskin 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 BBLA 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 Bearskin 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 - Bearskin Lake watershed analysis included delineating the Bearskin Lake watershed area, mapping land cover/use and soils of the watershed; and digital elevation models. This information is discussed further in the *Bearskin 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 Bearskin Lake in 2012 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 *Bearskin 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 Bearskin Lake. This involved interpreting and summarizing the Bearskin 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 Bearskin 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 Bearskin Lake, (2) analyze and summarize existing Bearskin Lake water quality data, (3) assess the existing regimen of water quality sampling for Bearskin Lake and determine appropriateness to lake conditions, and (4) revise (if need) the water quality sampling regimen for Bearskin 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 Bearskin 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 Bearskin Lake's watershed and water quality using the WiLMS modeling, see Appendix D.

White Water did a conductivity study on Bearskin Lake in 2013. Conductivity studies are used to determine a lake's levels of dissolved substances. A lake's natural conductivity is influenced by the geology and soils in the watershed, but areas of high conductivity can be indicators of pollution or faulty septic systems. For information about Bearskin Lake's conductivity levels, see Appendix E.

Littoral and Riparian Zones - Two assessments of Bearskin 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 2013. This survey was augmented with some components of the WDNR protocol for littoral zone and shoreline survey. Appendix F provides the results of this EPA survey.

Fisheries - As part of the adaptive management plan, White Water biologists gathered and summarized information about Bearskin Lake fisheries. This objective was fulfilled by reviewing WDNR and GLIFWC fisheries reports. White Water biologists summarized this information (Appendix G) for inclusion in this adaptive management plan.

Wildlife – Observations of wildlife have been made on Bearskin Lake by White Water biologists, WDNR biologists and residents of the lake. Information about loons, eagles and other rare species near Bearskin Lake are discussed in this Adaptive Management Plan.

Rusty crayfish have been a part of Bearskin Lake's ecosystem since 1961. They became such a nuisance on the lake that land owners began trapping the crayfish. For information about rusty crayfish trapping and other efforts, see Appendix H.

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 *Bearskin Lake Adaptive Management Plan* where appropriate. We also reviewed federal, state, and local regulations and ordinances that serve to protect water quality. See Appendix I for the *Review of Water Regulations and Planning Relevant to Bearskin Lake.*

Bearskin Lake Attributes and Risks – Another objective was to prepare a catalog of Bearskin 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 BBLA and other Bearskin 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 Bearskin Lake attributes. Bearskin Lake attributes and risks descriptions can be read in Chapter 5, Part 9 and 10 of this plan.

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

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

Adaptive Management Plan – A final project objective called for the creation of this initial adaptive management plan for Bearskin 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 Bearskin Lake and its watershed. This objective was guided by two basic tasks. The first task was to develop management recommendations for Bearskin 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 Bearskin Lake and its Watershed?

An understanding of the features and conditions of the Bearskin 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 Bearskin 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 Bearskin 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 Bearskin 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. Bearskin Lake and the Surrounding Area

Bearskin Lake is in Oneida County, Wisconsin about 5 miles southeast of the town of Hazelhurst, and about 35 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. Bearskin Lake has value and function in this larger landscape as well as its own watershed.

Bearskin Lake has a 5.59 mile shoreline with 403 acres of surface area. An area surrounding the public boat landing is owned by the American Legion State Forest. 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 Bearskin Lake area and identifies major landmarks.

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 Bearskin Lake. However, from 2001-2004 barley straw bales were placed in Bearskin Lake in attempts to lower phosphorus values and coinciding algae blooms (McComas, 2007). These efforts are described further in Appendix C. An aquatic plant survey was conducted on Bearskin Lake in 2012 by White Water Associates biologists. The point-intercept aquatic plant survey recorded fifteen species. The aquatic plant community was low in diversity and had a low floristic quality. The survey is discussed in more detail in the Bearskin Lake Aquatic Plant Management Plan, followed by tables and figures displayed in Appendix 2 of that plan.

Part 3. Bearskin Lake Water Quality

Water quality data in Bearskin Lake supports a eutrophic classification (WDNR, 2015b). Bearskin Lake has a maximum depth of 26 feet and a simple bathymetry (Exhibit 2). Existing water quality data comes from the WDNR SWIMS database from 1973, 1974, 1990, and from 1992 to 2014. The majority of the water quality data on Bearskin Lake comes from Citizen Lake Monitoring Network (CLMN) volunteers. Bearskin Lake water quality information is briefly summarized in this section, but more fully interpreted in Appendix C.

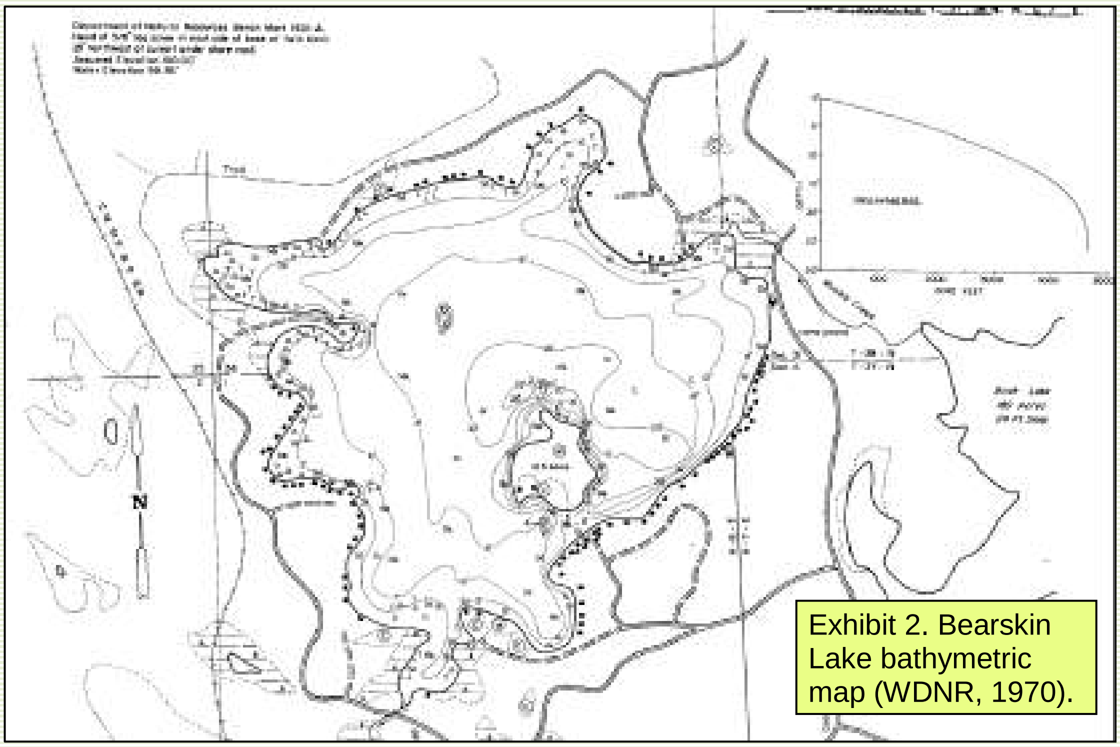

Exhibit 2. Bearskin Lake bathymetric map (WDNR, 1970).

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 Bearskin Lake. Water clarity is fair, with a 2014 average Secchi reading of 7 ft. The trophic state is 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 Bearskin 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. The average pH of Bearskin Lake is 7.6.

As mentioned previously, the *Wisconsin Lake Modeling Suite (WiLMS)* was used as a lake water quality planning and education tool for Bearskin 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 Bearskin Lake comes from forest cover. Appendix D provides results and analyses of WiLMS predictions on Bearskin Lake.

In September, 2013 White Water biologists conducted a shoreline conductivity study. This study was conducted to determine if areas of high conductivity were present around the lake. For summaries and results of these studies, see Appendix E.

Part 4. Bearskin 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 Bearskin Lake is 2.0. This number indicates that the lake has a relatively small 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 incorporating 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). For more information, see results of the *Bearskin Lake EPA Littoral and Shoreline Activities* in Appendix F.

Part 5. Bearskin Lake Fisheries

Historic fisheries data for Bearskin Lake dates back to 1956. Various fish surveys have been conducted on Bearskin Lake, including (but not limited to): electro shocking (1961, 1967, 2003, and 2015); fyke nets (2000, 2003 and 2015). All survey results were used to determine fisheries management for Bearskin Lake. For historical and recent information about Bearskin Lake's fishery, see Appendix G.

Part 6. Bearskin 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.

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, 2015). 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, 2015). 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., 2015). 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). In 2012, two territorial pairs of loons were observed on Bearskin Lake (LoonWatch). In 2013, one territorial pair was observed. This pair nested and reared two chicks (LoonWatch). In 2014, two territorial pairs were observed, and three “floater” loons were seen (non-territorial) (LoonWatch).

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, 2015a). 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, 2015b). This was an increase of 57 pairs from 2011, and an increase of 7 from 2012 (NHI, 2015b). In 2014, the WDNR observed 1,279 eagle nests occupied by breeding adults – a decrease of 65 pairs from 2013 (NHI, 2015b). Bearskin Lake, located in Oneida County, has one known territory with one known nest near it (Ron Eckstein, 2013). 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 Bearskin 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 Bearskin Lake.

Exhibit 4. Rare Species and Communities located near Bearskin Lake.			
Common Name	*Scientific Name*	*State Status**	*Group Name*
Predacious diving beetle	*Lioporeus trangularis*	SC/N	Beetle
Spruce grouse	*Falcipennis canadensis*	THR	Bird
Black tern	*Chlidonias niger*	END	Bird
Boreal chickadee	*Poecile hudsonicus*	SC/M	Bird
Cerulean warbler	*Setophaga cerulea*	THR	Bird
Ruby-crowned kinglet	*Regulus calendula*	SC/M	Bird
Northern wet forest		NA	Community
Black spruce swamp		NA	Community
Lake-deep, very soft, seepage		NA	Community
Northern dry-mesic forest		NA	Community
Northern mesic forest		NA	Community
Open bog		NA	Community
Mottled darner	*Aeshna clepsydra*	SC/N	Dragonfly
Pirate perch	*Aphredoderus sayanus*	SC/N	Fish
Northern flying squirrel	*Glaucomys sabrinus*	SC/P	Mammal
Small square-gilled mayfly	*Caenis hilaris*	SC/N	Mayfly
Bird rookery		SC	Other
Water-thread pondweed	*Potamogeton diversifolius*	SC	Plant
Calypso orchid	*Calypso bulbosa*	THR	Plant
Robbins' spike-rush	*Eleocharis robbinsii*	SC	Plant
American shoreweed	*Littorella uniflora*	SC	Plant
Algal-leaved pondweed	*Potamogeton confervoides*	THR	Plant
Wood turtle	*Glyptemys insculpta*	THR	Turtle
Blanding's Turtle	*Emydoidea blandingii*	SC/P	Turtle
*** END**=Endangered; **THR**=Threatened; **SC**=Special Concern; **SC/P**=fully protected; **SC/N**=no laws regulating use, possession or harvesting; **SC/H**=take regulated by establishment of open/closed seasons; **SC/FL**=federally protected as endangered or threatened, but not so designated by DNR; **SC/M**=fully protected by federal and state laws under Migratory Bird Act (WDNR, 2014).			

(NHI, 2015a)

Part 7. Bearskin Lake Aquatic Invasive Species

Bearskin Lake has had rusty crayfish (*Orconectes rusticus*) since 1961. The crayfish became such a nuisance that landowners began trapping the crayfish. For more information about trapping and other rusty crayfish efforts on Bearskin Lake, see Appendix H. The University of Wisconsin-Madison's Aquatic Invasive Species Smart Prevention Program has created a tool that classifies lakes by their susceptibility to invasive species. According to this tool, Bearskin Lake is considered "borderline suitable" for zebra mussels, based on calcium and conductivity levels (UW-Madison). For more information about zebra mussels and water quality parameters, see Appendix C, Review of Bearskin Lake Water Quality.

Part 8. Water Resource Regulations and Planning Relevant to Bearskin 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 I 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. Bearskin Lake Area Special Attributes

An objective for future iterations of the Bearskin 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, Bearskin 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 Bearskin Lake

As outlined in the previous part, the Bearskin Lake watershed ecosystem has numerous attributes of high ecological and aesthetic significance. These attributes combine to help make Bearskin Lake a unique and special place. Bearskin 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 Bearskin Lake plan.

Recreational pressure – Bearskin Lake is a 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 – Bearskin 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 Bearskin 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 Bearskin Lake. Bearskin Lake has fair water quality and a long record of water quality monitoring. Nevertheless, non-point source pollution (see next paragraph) represent an important threat to Bearskin Lake water quality.

Non-point source pollution – Surface runoff from the land, roadways, parking lots and other surfaces flows into Bearskin Lake. This runoff carries with it sediment, nutrients (for example, from fertilizers) and contaminants (for example, herbicides) that can have detrimental effects on the Bearskin 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 an important concern for the health of 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 Bearskin Lake increases. When it comes to non-native aquatic plant invaders, the best defense against establishment is a healthy community of native plants. The present plant community in Bearskin Lake is not very diverse but it does seem to be recovering from years of herbivory impacts perpetrated by rusty crayfish. Effective education and diligent monitoring are important factors in fostering a healthy native plant community and 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 Bearskin 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 Bearskin 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.

Habitat degradation of nearby aquatic and wetland habitats (ponds, streams) – The wetland habitats, streams, small lakes, and ponds in the vicinity of Bearskin 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 Bearskin Lake, input from the public is needed. This input helps us to understand the needs, knowledge base, concerns and desires of people who use Bearskin Lake. In this regard, a lake user survey was created and distributed to Bearskin Lake landowners. The results of this survey are available as Appendix J of this document.

CHAPTER 6

What Goals Guide the Bearskin 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 *Bearskin Lake Adaptive Management Plan* is to perpetuate the quality of Bearskin 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 *Bearskin 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 Bearskin 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 Bearskin 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 Bearskin 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 *Bearskin 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?

Bearskin Lake and its watershed are basically healthy and productive. Our challenge through this adaptive management plan is to perpetuate that condition into the future and to restore features that may have been degraded. The challenge will be met by a capable set of program partners that are prepared to devote themselves to Bearskin Lake stewardship. These partners include the members of The Big Bearskin 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 Bearskin 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 Bearskin 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 Big Bearskin 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 Bearskin Lake Adaptive Management Plan
Action #1 (Education): Work with WDNR to understand and manage the Bearskin Lake fishery. ***Objective:*** To support scientific and effective conservation of a quality Bearskin Lake fishery. ***Outcome:*** Document meetings and other contacts made to the WDNR and others. ***Status:*** Action included in *Adaptive Management Plan*.
Action #2 (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 Bearskin Lake and outline how such introductions can be minimized. ***Objective:*** Prevent new introductions of aquatic invasive species to Bearskin Lake. ***Outcome:*** Creates more informed and responsible recreational users of Bearskin Lake. BBLA should document that updated educational material is maintained. ***Status:*** Action included in *Adaptive Management Plan*.
Action #3 (Education): Host a 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 Bearskin Lake. ***Status:*** Action included in *Adaptive Management Plan*.
Action #4 (Research): Conduct a second point-intercept plan survey in 2017 (5 years after the first survey). Analyze and compare data to the 2012 survey to determine changes in the aquatic plant community. ***Objective:*** To understand the diversity and abundance of the native aquatic plant community in Bearskin Lake and understand how this community changes over time (especially the recovery of the plant community as rusty crayfish herbivory is less of a threat). ***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 Bearskin Lake Adaptive Management Plan
Action #5 (Research): Conduct annual assessments of Bearskin 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 (Appendix B)*.
Action #6 (Research): Because frogs and toads are crucial components of the Bearskin Lake ecosystem, and because they are highly sensitive to environmental changes, the BBLA should consider implementing a frog-toad survey for the wetland areas around Bearskin Lake. ***Objective:*** To understand the diversity and abundance of the frog-toad community in wetlands in the Bearskin Lake area determine how this community changes over time. ***Outcome:*** Create a report on the frog-toad monitoring in future versions of the Adaptive Management Plan. ***Status:*** Action included in *Adaptive Management Plan* and would be conducted in a future phases of the Bearskin Lake stewardship effort.
Action #7 (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 Bearskin Lake. ***Outcome:*** Monitor by general awareness of landowners and changes in shoreline maintenance behaviors. ***Status:*** Action included in *Adaptive Management Plan*.
Action #8 (Education): Create periodic (as frequently as resources allow) updates of the adaptive management plan. ***Objective:*** To incorporate most up-to-date information regarding Bearskin Lake and application of best stewardship practices. ***Outcome:*** Up-to-date management plan is available for ongoing implementation and stewardship of Bearskin Lake. ***Status:*** Action included in *Adaptive Management Plan*. This document is the first version of the adaptive management plan.

Recommended Actions for the Bearskin Lake Adaptive Management Plan
Action #9 (Protection): Develop a storm water and shoreland habitat plan. ***Objective:*** To maintain and improve the health of Bearskin Lake. ***Outcome:*** Protects the water quality of Bearskin Lake. ***Status:*** Action included in *Adaptive Management Plan* and would be conducted in a future phases of the Bearskin Lake stewardship effort.
Action #10 (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 Bearskin Lake, and reduce opportunities for introduction of aquatic invasive plant species. ***Outcome*:** A healthy, diverse Bearskin 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 2016.
Action #11 (Restoration): Continue rusty crayfish trapping program on Bearskin Lake. ***Objective*:** To keep number of this AIS as low as possible on the lake. ***Outcome*:** A healthy, diverse Bearskin Lake aquatic plant community and associated habitats and a human community that is actively engaged lake stewardship. ***Status*:** Ongoing.
Action #12 (Monitoring): Continue to monitor the rusty crayfish population in Bearskin Lake through collection of trapping records (in particular, rusty crayfish catch per unit effort so that comparisons to historical data are possible). ***Objective*:** To track the effectiveness of the rusty crayfish trapping program and the status of the rusty crayfish population. ***Outcome*:** Provides feedback on the trapping program and incentive to lake stewards to continue the control effort. ***Status*:** Ongoing.

Recommended Actions for the Bearskin Lake Adaptive Management Plan
Action #13 (Monitoring): Continue to monitor the rusty crayfish population in Bearskin Lake through collection of trapping records (in particular, rusty crayfish catch per unit effort so that comparisons to historical data are possible). ***Objective*:** To track the effectiveness of the rusty crayfish trapping program and the status of the rusty crayfish population. ***Outcome*:** Provides feedback on the trapping program and incentive to lake stewards to continue the control effort. ***Status*:** Ongoing.
Action #14 (Monitoring): Assess littoral zone habitat for quality and quantity of large woody habitat. ***Objective*:** Determine whether this important habitat component is present in sufficient quantity on Bearskin Lake. ***Outcome*:** Educates lake users on the importance of littoral zone habitat quality and provides data useful to determining if Bearskin Lake is a good candidate for a "fish sticks" activity. ***Status*:** Action included *Adaptive Management Plan*.

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

Bearskin 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.

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Appendix A
Literature Cited

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Literature Cited

Cairns, J. Jr. 1988. *Increasing diversity by restoring damaged ecosystems.* Pages 333-343 in E.O. Wilson, editor. Biodiversity. National Academy Press, Washington, DC.

Cornell Lab of Ornithology. *Common Loon*. Retrieved 2015. <http://www.allaboutbirds.org/guide/common_loon/lifehistory>

Eckstein, Ronald. Nov 2013. Regional DNR contact. *Eagle surveys*. E-mail communication.

Hassett, Scott, William H. Smith, Elizabeth Kluesner, Todd L. Ambs, Michael D. Staggs, and Jeff B. Bode. 2003. *Wisconsin Lake Modeling Suite*. Wisconsin DNR. Retrieved 2015. <http://dnr.wi.gov/lakes/Model/WiLMSDocumentation.pdf>

Lanoo, Michael J. 1996. *Okoboji Wetlands – A Lesson in Natural History*. University of Iowa Press. 156 pages.

Leopold, Aldo. 1948. *A Sand County Almanac and Sketches Here and There.* Oxford University Press, New York.

LoonWatch. *Wisconsin Loon Population Survey.* Retrieved 2014. <http://www.northland.edu/loon-population-survey.htm>

McComas, Steve. 2007. *Lake Conditions Through 2006 for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science. St. Paul, MN.

Minnesota Department of Natural Resources. 2015. *Common Loon (Gavia immer).* Retrieved 2015. <http://www.dnr.state.mn.us/birds/commonloon.html>

National Environmental Policy Act (NEPA). 1969. Public Law 91-190, 83 Stat. 852-856.

National Research Council. 1992. *Restoration of aquatic ecosystems: science, technology, and public policy.* National Academy Press, Washington, DC.

Natural Heritage Inventory (NHI). 2015a. *Elements of TownRange for Oneida County*. Retrieved 2015. <http://dnr.wi.gov/topic/NHI/data.asp?tool=township>

Natural Heritage Inventory (NHI). 2015b. *Wisconsin Bald Eagle and Osprey Surveys 2014.* Retrieved 2015. <http://dnr.wi.gov/topic/WildlifeHabitat/documents/reports/eagleospreysurv3.pdf>

North Central Wisconsin Regional Planning Commission (NCWRPC). December 2011. *Oneida County Land and Water Resource Management Plan 2012-2016.* Retrieved 2015. <http://www.co.oneida.wi.gov/docview.asp?docid=10421&locid=135>

Redding, Martin J. 1973. *Aesthetics in Environmental Planning.* Office of Research and Development. U.S. EPA EPA-600/5-73-009.

Shaw, B. Mechenich, C, and Klessig, L. 2004. *Understanding Lake Data (G3582).* Board of Regents of the University of Wisconsin System. Madison, WI.

The Loon Preservation Committee. 2015. *The Loon's Family and Social Life*. Retrieved 2015. <http://www.loon.org/loon-family.php>

University of Wisconsin-Madison, Center for Limnology, Vander Zanden Lab. *Aquatic Invasive Species Smart Prevention.* Retrieved 2015. <http://www.aissmartprevention.wisc.edu/>

U.S. Environmental Protection Agency (USEPA). 2009. *National Lakes Assessment: A Collaborative Survey of the Nation's Lakes. EPA 841-R-09-001*. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. Available on-line at: http://water.epa.gov/type/lakes/upload/nla_newlowres_fullrpt.pdf

Walters, C. 1986. *Objectives, constraints, and problem bounding.* In W.M. Getz, ed., Adaptive Management of Renewable Resources. Macmillan Publishing Company. New York. p. 13+.

Williams, Jack E., Christopher A. Wood, and Michael P. Dombeck, eds. 1997. *Watershed Restoration: Principles and Practices.* American Fisheries Society, Bethesda, Maryland.

Wisconsin Department of Natural Resources. Aug 1970. *Bearskin Lake Survey Map*. Retrieved 2015. <http://dnr.wi.gov/lakes/maps/DNR/1615900a.pdf>

Wisconsin Department of Natural Resources, Headwaters Basin Partnership Team and Stakeholders--DRAFT. 2002. *Headwaters Basin Integrated Management Plan*. Retrieved 2015. 259 pages. <http://dnr.wi.gov/water/basin/upwis/>

Wisconsin Department of Natural Resources. 2014. *Wisconsin natural heritage working list.* Retrieved 2015. <http://dnr.wi.gov/topic/NHI/WList.html#GRank>

Wisconsin Department of Natural Resources. 2015a. *Bald Eagle (Haliaeetus leucocephalus).* Retrieved 2015. <http://dnr.wi.gov/topic/endangeredresources/animals.asp?mode=detail&speccode=abnkc10010>

Wisconsin Department of Natural Resources. 2015b. *Bearskin Lake Water Quality*. Retrieved 2015. <http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=1523600&page=facts>

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Appendix B

Bearskin Lake Aquatic Plant Management Plan

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Bearskin Lake Stewardship Program

Aquatic Plant Management Plan – Bearskin Lake

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WHITE WATER
ASSOCIATES, INC.

Bearskin Lake Stewardship Program

Aquatic Plant Management Plan – Bearskin Lake

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

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WHITE WATER
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CHAPTER 1

Introduction

The ***Bearskin Lake Stewardship Program*** results from the efforts of the Big Bearskin Lake Association (BBLA). The Bearskin Lake Stewardship Program views stewardship of the lake as an ongoing endeavor that is integrated, coordinated, and administered by the BBLA. 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 (APMP) addresses Bearskin 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 ***Bearskin Lake Adaptive Management Plan*** (Premo et al., 2015) 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 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 plan is an adaptive plan (Walters, 1986). It will be modified as new information becomes available. The WDNR guidance document outlines three objectives that may influence preparation of an APMP. The motivation for this plan lies in all three objectives:

- ***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 (specifically, managing the rusty crayfish population to allow the recovery of native aquatic plants in Bearskin Lake).

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

During projects with the WDNR Planning Grant Program and through past efforts, the Big Bearskin 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 Bearskin Lake Water Quality*.

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CHAPTER 2

Study Area

Bearskin Lake is located in Oneida County, Wisconsin about 6 miles southeast of the town of Hazelhurst, Wisconsin. The water body identification code (WBIC) is 1523600. Exhibit 1 is an aerial view of the Bearskin Lake landscape showing the town of Hazelhurst, and a few other water features. This interconnected water landscape is a target for migrating and breeding waterfowl and other birds. Bearskin Lake has value and function in this larger landscape as well as its own watershed.

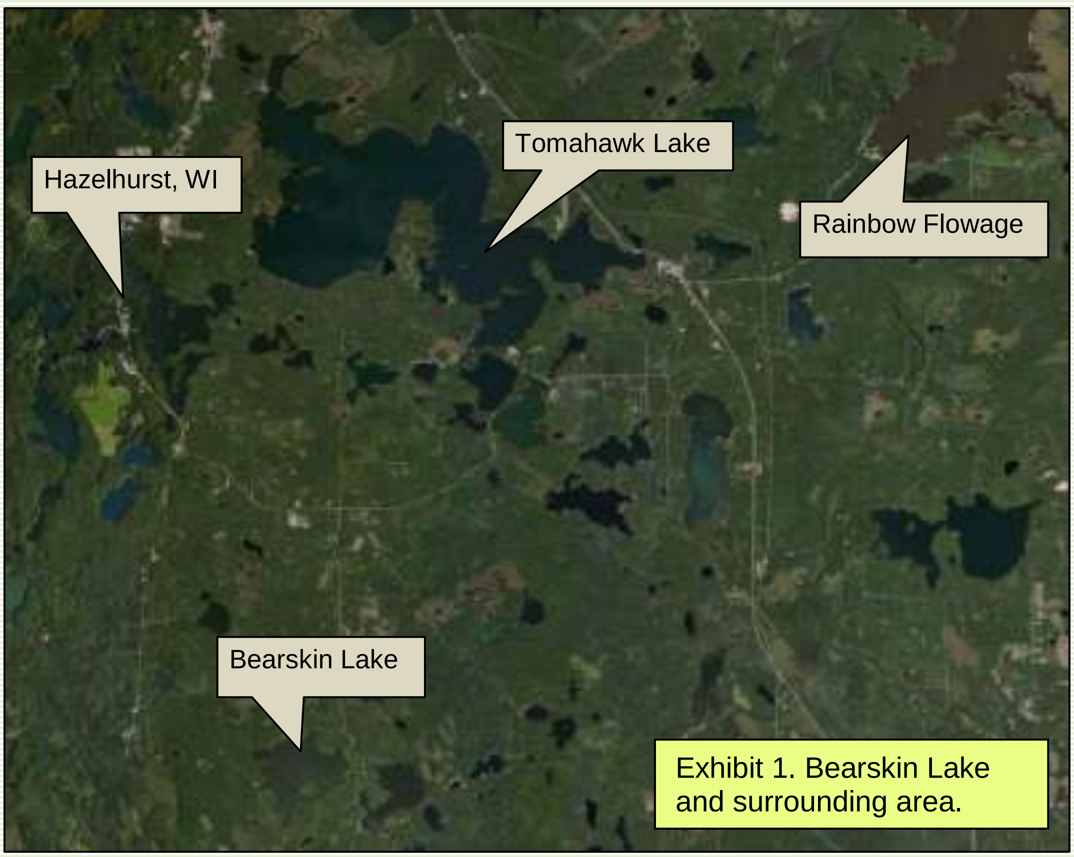

Exhibit 1. Bearskin Lake and surrounding area.

Bearskin 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 Bearskin Lake.

Descriptive parameters for Bearskin Lake are in Exhibit 3. It is a drainage lake (inlet and outlet are present) of about 403 acres and maximum depth of 26 feet. The stream that comes into the lake from the north drains extensive natural wetlands. Bearskin Lake has a shoreline development index of 2.0. 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	Bearskin
County	Oneida
Township/Range/Section	T37N-R6E-S1, T37N-R7E-S6, T38N-R6E-S36, T38N-R7E-S31
Water Body Identification Code	1523600
Lake Type	Drainage
Surface Area (acres)	403
Maximum Depth (feet)	26
Maximum Length (miles)	1.0
Maximum Width (miles)	0.95
Shoreline Length (miles)	5.6
Shoreline Development Index	2.0
Total Number of Piers (EPA study)	125
Number of Piers / Mile of Shoreline	22.4
Total Number of Homes (2013 aerial)	109
Number of Homes / Mile of Shoreline	19.5

Bearskin Lake has a public access site on the northeast end of the lake. We observed a total of 125 piers on the shoreline of Bearskin Lake from the 2013 EPA study or about 22.4 piers per mile of shoreline. The riparian area consists of both upland and wetland areas (Exhibit 4).

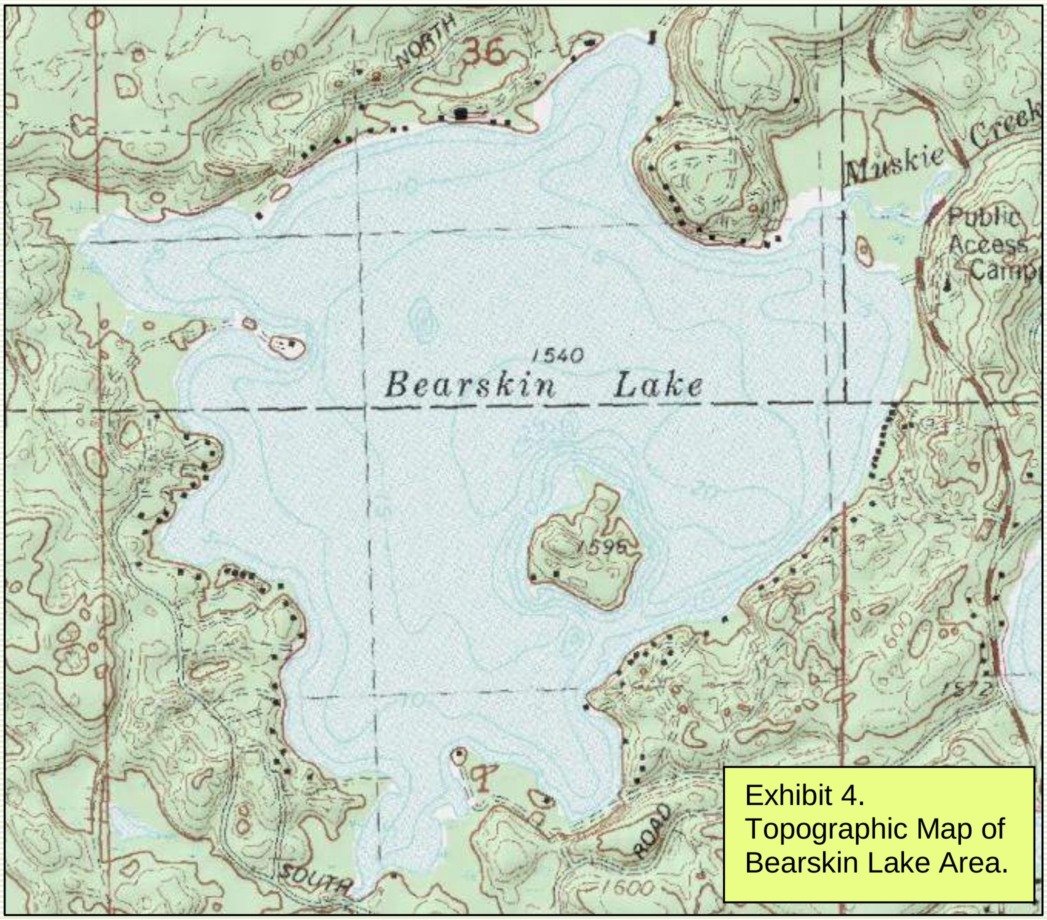

Exhibit 4. Topographic Map of Bearskin Lake Area.

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:

> ***Bearskin Lake has a native aquatic plant community that was documented by a point-intercept aquatic plant survey. This plant community is essential to, and part of, an aquatic ecosystem that benefits the human community with its recreational and aesthetic features. In the past, the plant community was negatively influenced by the presence of the non-native rusty crayfish. Aggressive removal of rusty crayfish has allowed the plant community to begin recovery. The purpose of this aquatic plant management plan is to foster the aquatic plant community so that it is able to play its natural role in the lake ecosystem.***

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;***
> ***(4) Continue to control and monitor the rusty crayfish population in an attempt to minimize its impact on native aquatic plants; and***
> ***(5) Educate riparian owners and lake users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.***

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

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CHAPTER 4

Information and Analysis

Our efforts in the Bearskin Lake Stewardship Program have compiled information about historical and current conditions of the Bearskin Lake ecosystem and its surrounding watershed. Of particular importance to this aquatic plant management plan is the aquatic plant survey that was conducted using 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

Bearskin 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. Bearskin 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 Bearskin 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. Bearskin Lake is located in the Middle Tomahawk River watershed (HUC#0707000109). Finally, the Middle Tomahawk River watershed is divided into federal hydrologic sub-watersheds, designated by 12-digit HUC codes. Bearskin Lake is located in the Bearskin Creek Sub-watershed (HUC#070700010906), which can be seen in Exhibit 8. Exhibit 9 shows the watershed boundary for Bearskin Lake.

Exhibit 5. United States watershed regions (USGS, 2014).

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

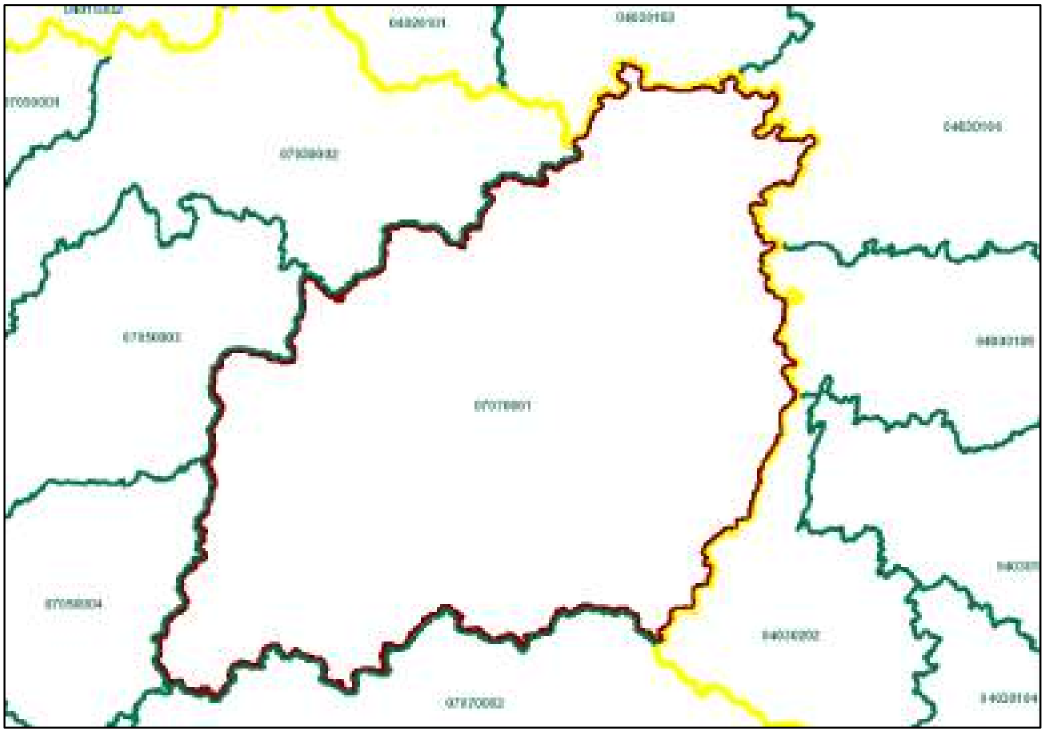

Exhibit 7. Upper Wisconsin sub-basin (red) lies on the border of the Upper Mississippi region (south of yellow line) and the Great Lakes region (north of line) (WDNR, 2015a).

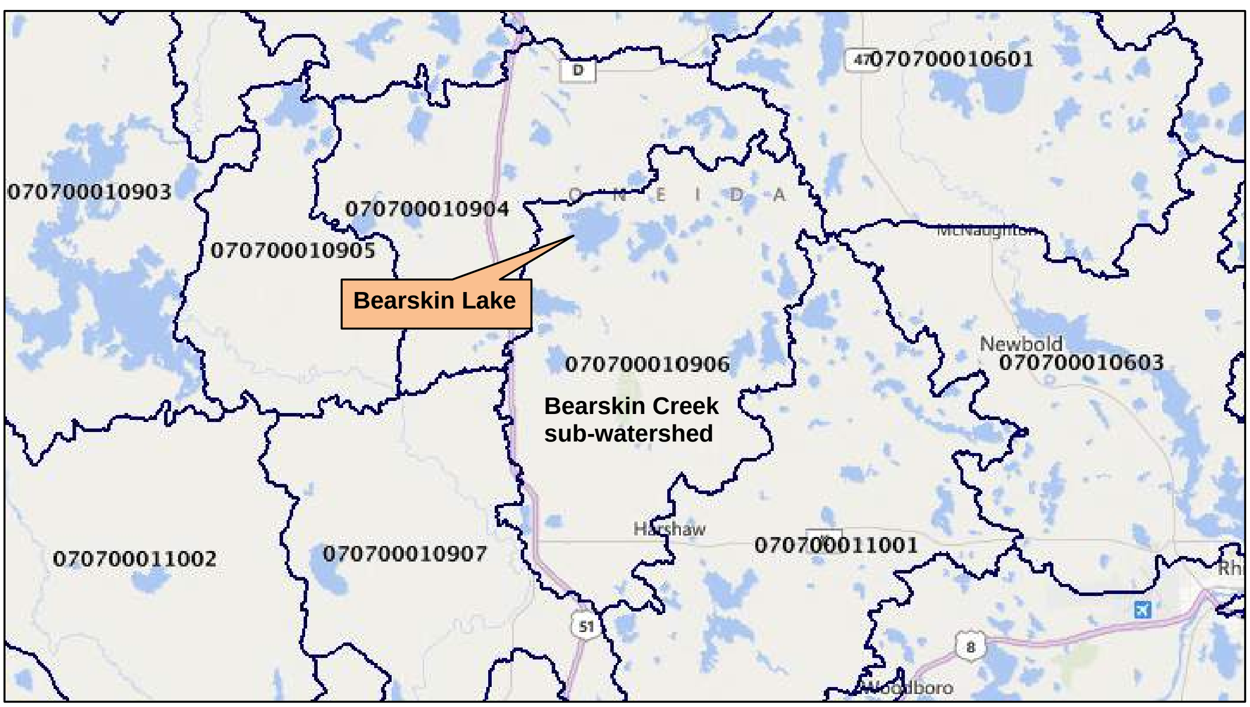

Exhibit 8. Bearskin Creek sub-watershed.

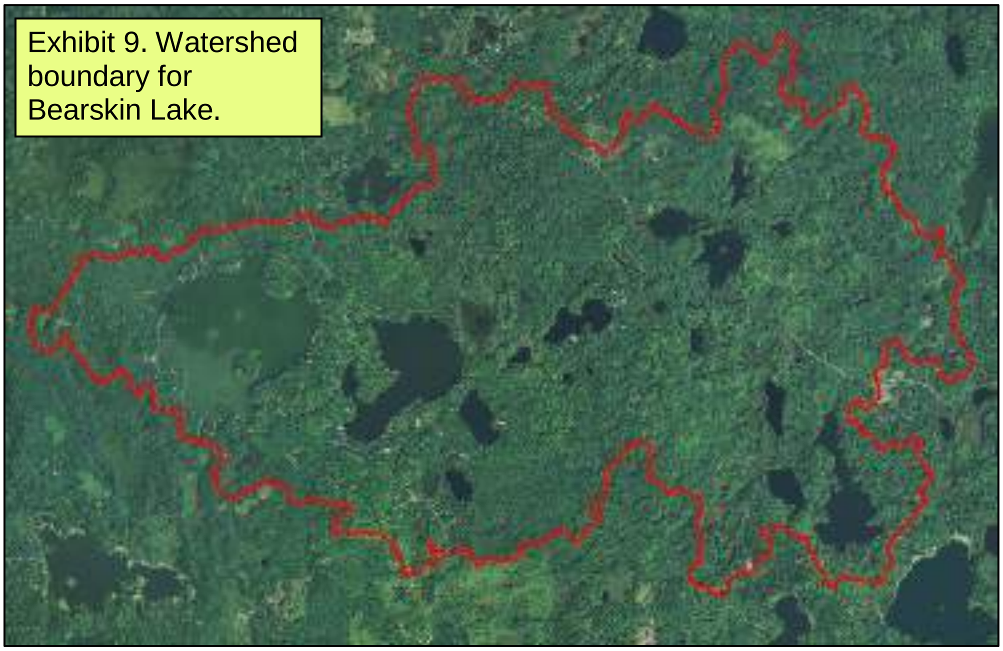

Exhibit 9. Watershed boundary for Bearskin Lake.

A digital elevation model is provided as Exhibit 10. It shows the relative elevations for the area with red areas being the highest elevations and blues being the lowest elevations. The area surrounding Bearskin Lake ranges from 1,510 feet above sea level to 1,740 feet above sea level.

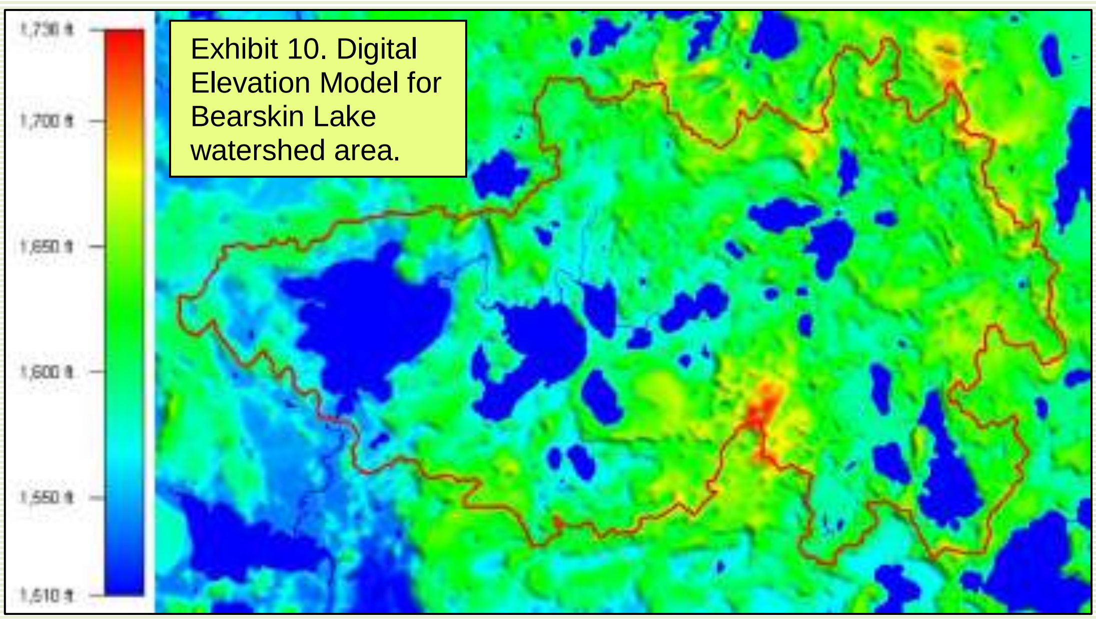

Exhibit 10. Digital Elevation Model for Bearskin Lake watershed area.

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 Bearskin Lake watershed is about 7,200 acres. The cover types in the watershed are presented in Exhibit 11.

Exhibit 11. Cover Types and Soil Groups of the Bearskin Lake Watershed.

Cover Type	Acres	Percent
Agriculture	0	0
Commercial	0	0
Forest	5160.3	71.7
Grass/Pasture	12.2	0.2
High-density Residential	1.4	0.02
Low-density Residential	239.2	3.3
Water	1782.5	24.8
Total	7195.6	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	1709.2	23.8	**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	3780.8	52.5	**Group B** is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
C	0	0	**Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
D	1705.6	23.7	**Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This soil has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

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

Forest and surface water comprise the largest components. Soil group B is the most common soil group the watershed; followed by group A, and D. 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 about 18:1. 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.

Part 2. Aquatic Plant Management History

As far as we can determine, no systematic or large-scale plant management activity has ever taken place in Bearskin Lake. However, from 2001-2004 barley straw bales were placed in Bearskin Lake in attempts to lower phosphorus values and coinciding algae blooms (McComas, 2007). These efforts are described further in Appendix C. Numerous aquatic plant surveys have been conducted on Bearskin Lake (1967, 1996, 1999, 2002, 2003, 2004, and 2006). The 2012 plant survey was the first point-intercept aquatic plant survey conducted on Bearskin Lake. Part 3 provides information about the 2012 point-intercept survey and a brief description of the previous aquatic plant survey 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.

Aquatic plant surveys have been conducted on Bearskin Lake in 1967, 1996, 1999, 2002, 2003, 2004, 2006 and 2012. In the 2012 survey, WDNR point-intercept protocol and methodology was followed. 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.

Because Bearskin Lake has been surveyed several times, we are able to hypothesize about apparent differences in the plant community that have resulted over the course of the years. 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 or submergent plants), and/or appearance of an AIS or change in its population size. Monitoring can track changes and provide valuable insight on which to base management decisions. In the remainder of this section (Part 3) we provide a report of the findings of the 2012 point-intercept aquatic plant survey, and provide a summary of the previously conducted aquatic plant surveys. Supporting tables and figures for the aquatic plant surveys are provided in Appendix 2.

Species richness refers to the total number of species recorded. We recorded 15 species of aquatic plants in Bearskin Lake. Of these, 9 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 106 sample points were found to have aquatic vegetation present. The average number of species encountered at these vegetated sites was 1.75. 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 13.5 feet (Table 1 and Figure 3). Rooted vegetation was found at 106 of the 265 sample sites with depth ≤ the maximum depth of plant colonization (40% 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 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 *Ceratophyllum demersum* (coontail) had the highest relative frequency followed by *Potamogeton friesii* (Fries' pondweed). The lowest relative frequencies are at the far right of the graph. Figure 7 displays the sites with emergent and floating aquatic plans. Figures 8-13 shows individual species distributions. We show the occurrences of a few of the most frequently and least frequently encountered plants in Bearskin Lake.

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

[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)."*

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 Bearskin Lake aquatic plants is 0.77 (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 Bearskin Lake FQI (18.7) compares to other lakes and regions. The statewide medians for number of species and FQI are 13 and 22.2, respectively. Bearskin Lake values are slightly low 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. Bearskin 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. Bearskin Lake data is slightly less than that find. Finally, the Bearskin Lake FQI (18.7) is lower than the median value for the Northern Lakes and Forests lakes group (24.3). These findings lead us to conclude that the Bearskin Lake plant community has relatively low species diversity and is comprised of species that are able to tolerate less-than-pristine conditions. We observed no aquatic plants in Bearskin Lake that would be considered a nuisance-level population density/distribution. We observed no state or federally listed species.

As stated previously, many aquatic plant studies have been conducted on Bearskin Lake. For many of these years, aquatic plant coverage has been estimated. The 1967 study reported the highest estimated aquatic plant coverage at 30% of the lake. The next study was in 1996, where coverage was only 8%. The 1999 study revealed the lowest aquatic plant coverage at 5%. After 1999, coverages have slowly increased: 2002, 12%; 2003, 8%; 2004, 14% and 2006, 19%. In these studies, transects were plotted perpendicularly to the lake's shoreline, and plants were sampled at points of varying depths along those transects (McComas, 2000). These study methods differ from the WDNR's point-intercept method therefore comparisons must be considered at a gross level. To estimate the aquatic plant coverage for the 2012 survey, we divide the number of sites that had aquatic vegetation present (106) by the total number of sites on the lake (539), which calculated a coverage of 19.6%. To see tables and figures of the historical aquatic plant data for Bearskin Lake, see Appendix 2 of this aquatic plant management plan.

The greatly reduced aquatic plant coverage in Bearskin Lake that was documented starting in 1996 coincided with an explosion of the invasive rusty crayfish. Appendix H of the Bearskin Lake Adaptive Management Plan reviews rusty crayfish biology and management, and summarizes the history of rusty crayfish management in Bearskin Lake. The rusty crayfish first appeared in Bearskin Lake in 1961, according to historic records. These invasive crayfish grew to a nuisance population by the 1980s and about this time concerned lake home owners began trapping efforts. Starting in 2000, the Bear Lake aquatic plant community began to demonstrate a recovery in the percent coverage. Aquatic vegetation may seem troublesome to some recreational users in Bearskin Lake, but is important to the lake's ecology. The plants provide important habitat for fish in the lake. They also take up nutrients that may otherwise cause algae blooms. Research has suggested that trapping rusty crayfish along with increasing the fish population will help to combat the invasive rusty crayfish and allow aquatic vegetation to recover. The BBLA has been doing just that and the plant community is showing this recovery.

Part 4. Fish Community

Fisheries data has been collected on Bearskin Lake since 1956. For further information about the fisheries of Bearskin Lake, see Appendix G of the *Bearskin Lake Adaptive Management Plan.*

Part 5. Water Quality and Trophic Status

Bearskin Lake is a 403 acre drainage lake with a maximum depth of 26 feet. Water quality data was retrieved from the WDNR SWIMS database in 1973, 1974, 1990, and from 1992 to

2014. The majority of the water quality data on Bearskin Lake has come from Citizen Lake Monitoring Network (CLMN) volunteers. A lake planning study was conducted in 1996 and additional work was conducted in 1999. A lake report was also completed in 2006. Water quality information is briefly summarized in this section, but more fully interpreted in Appendix 3.

Temperature and dissolved oxygen profiles showed very little stratification in Bearskin Lake. Water clarity was “fair”, with a mean Secchi reading of 7 feet in 2014. The trophic state is considered eutrophic. The average total phosphorus levels for July (32.95 µg/L) and August (42.17 µg/L) are higher than the average total phosphorus levels for Wisconsin natural lakes and lakes in the Northeast Region. Similarly, chlorophyll *a* (a measure of the amount of algae) was considered higher than Wisconsin natural lakes. For more information about Bearskin Lake’s water quality, see Appendix 3.

Part 6. Water Use

Bearskin Lake has one public access site, and is used by riparian owners and their guests for a variety of recreational activities. A small area surrounding the boat landing is under ownership of the American Legion State Forest.

Part 7. Riparian Area

Part 1 (Watershed) describes the larger riparian area context of Bearskin Lake. The near shore riparian area can be appreciated by viewing Exhibit 4. According to this figure, Bearskin Lake’s riparian appears to be 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 2013 aerial photography reveals 109 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 *Bearskin 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, frogs and toads, aquatic and semi-aquatic mammals, and invertebrate animals. Finally, it is essential to monitor Bearskin Lake for the presence of new aquatic invasive animal species (for example, spiny water flea, zebra mussels, and banded mystery snail, etc.). A description of Bearskin Lake efforts on reducing rusty crayfish can be viewed as Appendix H of the *Bearskin Lake Adaptive Management Plan.*

Bearskin Lake is currently designated as a *priority navigable waters* (PNW) (WDNR, 2015b). 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, 2015b). Bearskin Lake is considered a PNW with self-sustaining musky and walleye populations.

Bearskin Lake is also designated as an *area of special natural resource interest (ASNRI)* (WDNR, 2015b). A water body designated as an Area of Special Natural Resource Interest can be any of the following: WDNR trout streams; Outstanding or Exceptional Resource Waters (ORW/ERW); waters or portions of waters inhabited by endangered, threatened, special concern species or unique ecological communities; wild rice waters; waters in ecologically significant coastal wetlands along Lake Michigan and Superior; or federal or state waters designated as wild or scenic rivers (WDNR, 2015b). In the case of Bearskin Lake, it is designated as ASNRI because of it inhabits state or federally designated threatened or endangered species. See the *Bearskin Lake Adaptive Management Plan* for more information about rare species and communities found near Bearskin Lake.

Part 9. Stakeholders

At this juncture in the ongoing aquatic plant management planning process, the BBLA has represented the Bearskin 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 BBLA solicited input from all Bearskin 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 Appendix J of the *Bearskin Lake Adaptive Management Plan*.

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;
(4) Continue to control and monitor the rusty crayfish population in an attempt to minimize its impact on native aquatic plants; and
(5) Educate riparian owners and lake users on preventing AIS introduction, reducing nutrient inputs that potentially alter the plant community, and minimizing physical removal of native riparian and littoral zone plants.

Since Bearskin Lake is a relatively healthy and functioning ecosystem, we could simply recommend an alternative of "no action." In other words, Bearskin 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 Bearskin Lake Stewardship Program and the Big Bearskin Lake Association feels a great responsibility to minimize the threats and rehabilitate parts of the system that have become degraded. 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 Bearskin Lake. No aquatic invasive plant species are known to be present and no native plants exhibit nuisance population size or distribution. As previously stated, the evidence suggests that the diligent control of the rusty crayfish population has had a positive influence on the rehabilitation of the aquatic plant community. We recommend a continuation of the rusty crayfish removal program.

Recommended Actions for the Bearskin Lake Aquatic Plant Management 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 Big Bearskin Lake Association oversees activity and maintains the plan. ***Status:*** Planned for 2016.
Action #2: Monitor water quality. ***Objective***: Continue with collection and analysis of water quality parameters to detect trends. Expand monitoring to include parameters for which little information exists (see Appendix C for individual parameters). ***Monitoring:*** The Big Bearskin 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 Big Bearskin 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 Big Bearskin 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 Big Bearskin Lake Association coordinates activity. ***Status:*** Planned for 2016.
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:*** Big Bearskin Lake Association oversees and maintains data; copies to WDNR. ***Status:*** Anticipated in 2017.

Recommended Actions for the Bearskin Lake Aquatic Plant Management 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 BBLA 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 Big Bearskin Lake Association oversees activity and assesses effectiveness. ***Status:*** Anticipated to begin in 2017.
Action #10: Monitor the lake watershed for purple loosestrife. ***Objective:*** Identify purple loosestrife populations before they reach large size. ***Monitoring:*** The Big Bearskin Lake Association oversees activity. ***Status:*** Anticipated in 2016.

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

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

Exhibit 12 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

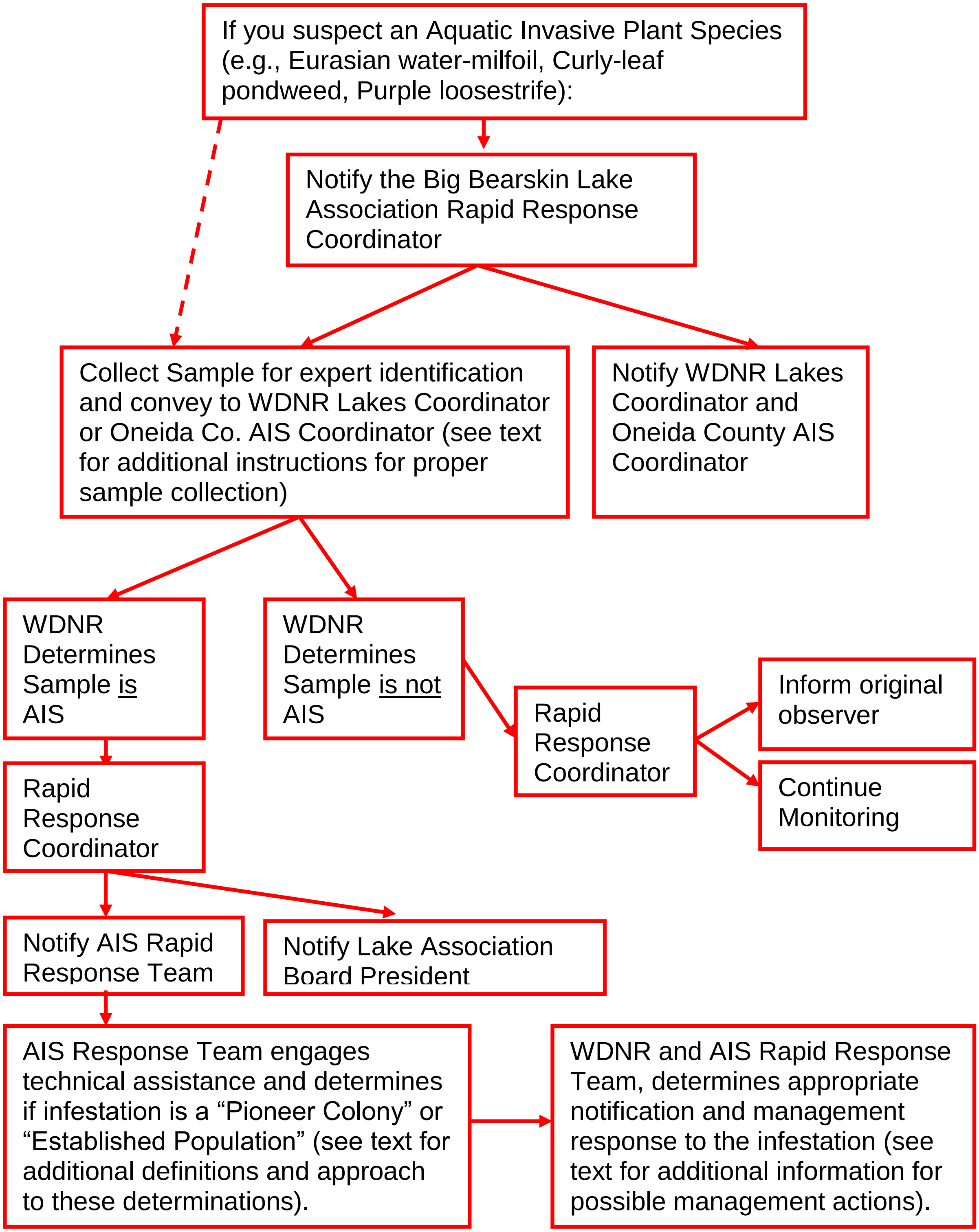
GPS is available). The sample should be placed on ice in a cooler or in a refrigerator. Deliver the sample to the WDNR Water Resources Management Specialist Kevin Gauthier or the WDNR Lakes Coordinator as soon as possible (at least within three days). The WDNR or their botanical expert(s) will determine 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, the WDNR Lakes Coordinator should be consulted in order 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 12. Aquatic Invasive Plant Species Rapid Response



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Appendix 1
Literature Cited

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Literature Cited

Hauxwell, J., S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky and S. Chase. 2010. *Recommended baseline monitoring of aquatic plants in Wisconsin: sampling design, field and laboratory procedures, data entry and analysis, and applications.* Wisconsin Department of Natural Resources Bureau of Science Services. Madison, WI.

McComas, Steve. 2000. *Comprehensive Lake Management Plan for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science. St. Paul, MN.

McComas, Steve. 2007. *Lake Conditions Through 2006 for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science. St. Paul, MN.

Nichols, Stanley A. 1999. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications.* Journal of Lake and Reservoir Management 15(2): 133-141.

Premo, Dean, Angie Stine, Caitlin Clarke, and Kent Premo. 2015. *The Bearskin Lake Adaptive Management Plan.* White Water Associates, Inc. Amasa, MI.

US Department of Agriculture, Natural Resources Conservation Service. June 1986. *Urban Hydrology for Small Watersheds.* Technical Release–55.

US Environmental Protection Agency. 2009. *A Watershed Perspective on Water Quality Impairments—A Working Draft Report*. Retrieved 2015. <http://www.epa.gov/sectors/sectorinfo/sectorprofiles/agribusiness/watershed.pdf>

US Geological Survey. 2014. *Locate your watershed.* Retrieved 2015. <http://water.usgs.gov/wsc/map_index.html>

Walters, C. 1986. *Objectives, constraints, and problem bounding.* In W.M. Getz, ed., Adaptive Management of Renewable Resources. Macmillan Publishing Company. New York. p. 13+.

Wisconsin Department of Natural Resources. 2015a. *About Designated Waters.* Retrieved 2015. <http://dnr.wi.gov/topic/SurfaceWater/swdv/documents/Designated%20Waters%20Workflow.pdf >

Wisconsin Department of Natural Resources. 2015b. *Surface Water Data Viewer*. Retrieved 2015. <http://dnrmaps.wi.gov/sl/?Viewer=SWDV>

Table 1. Summary statistics for the 2012 point-intercept aquatic plant surveys for Bearskin Lake.

Summary Statistic	Value	Notes
Total number of sites on grid	539	Total number of sites on the original grid (not necessarily visited)
Total number of sites visited	528	Total number of sites where the boat stopped, even if much too deep to have plants.
Total number of sites with vegetation	106	Total number of sites where at least one plant was found
Total number of sites shallower than maximum depth of plants	265	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	40.00	Number of times a species was seen divided by the total number of sites shallower than maximum depth of plants.
Simpson Diversity Index	0.77	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.)	13.50	The depth of the deepest site sampled at which vegetation was present.
Number of sites sampled with rake on rope	16	
Number of sites sampled with rake on pole	287	
Average number of all species per site (shallower than max depth)	0.70	
Average number of all species per site (vegetated sites only)	1.75	
Average number of native species per site (shallower than max depth)	0.70	Total number of species collected. Does not include visual sightings.
Average number of native species per site (vegetated sites only)	1.75	Total number of species collected including visual sightings.
Species Richness	9	
Species Richness (including visuals)	15	
Floristic Quality Index (FQI)	18.7	

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Appendix 2

Aquatic Plant Survey Tables and Figures

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Appendix 2

Aquatic Plant Survey Tables and Figures

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Table 2. Plant species recorded and distribution statistics for the 2012 Bearskin Lake aquatic plant survey[1].

Common name	Scientific name	Frequency of occurrence at sites less than or equal to maximum depth of plants	Frequency of occurrence within vegetated areas (%)	Relative Frequency (%)	Number of sites where species found	Number of sites where species found (including visuals)	Average Rake Fullness
Coontail	*Ceratophyllum demersum*	18.87	47.17	27.03	50	52	1.40
Fries' pondweed	*Potamogeton friesii*	17.74	44.34	25.41	47	48	1.11
Common waterweed	*Elodea canadensis*	16.23	40.57	23.24	43	43	1.16
Flat-stem pondweed	*Potamogeton zosteriformis*	13.21	33.02	18.92	35	37	1.97
White-stem pondweed	*Potamogeton praelongus*	1.51	3.77	2.16	4	4	1.00
Spatterdock	*Nuphar variegata*	1.13	2.83	1.62	3	5	1.00
Nitella	*Nitella* sp.	0.38	0.94	0.54	1	1	1.00
Large-leaf pondweed	*Potamogeton amplifolius*	0.38	0.94	0.54	1	2	1.00
Ribbon-leaf pondweed	*Potamogeton epihydrus*	0.38	0.94	0.54	1	1	1.00
Small duckweed	*Lemna minor*				Visual	4	
Creeping spikerush	*Eleocharis palustris*				Visual	2	
White water lily	*Nymphaea odorata*				Visual	1	
Swamp loosestrife	*Decodon verticillatus*				Boat Survey		
Pickerelweed	*Pontederia cordata*				Boat Survey		
Sago's pondweed	*Potamogeton pectinatus*				Boat Survey		
Clasping-leaf pondweed	*Potamogeton richardsonii*				Boat Survey		
Hardstem bulrush	*Schoenoplectus acutus*				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.

[1] Specimens were collected, pressed and sent to Dr. Robert Freckmann, UW-Stevens Point, for positive identification in October, 2012.

Figure 1. Number of plant species recorded at Bearskin Lake sample sites (2012).

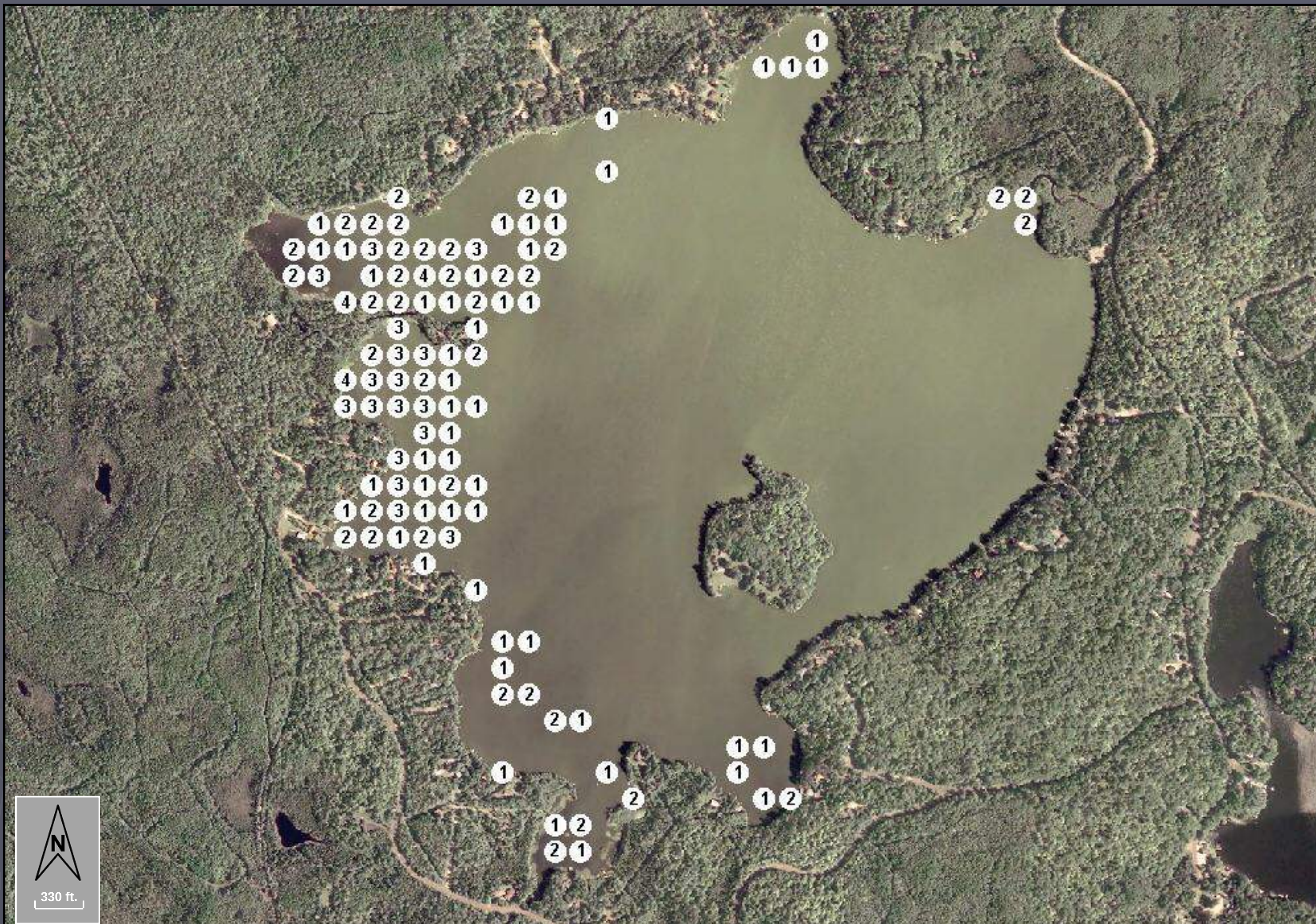
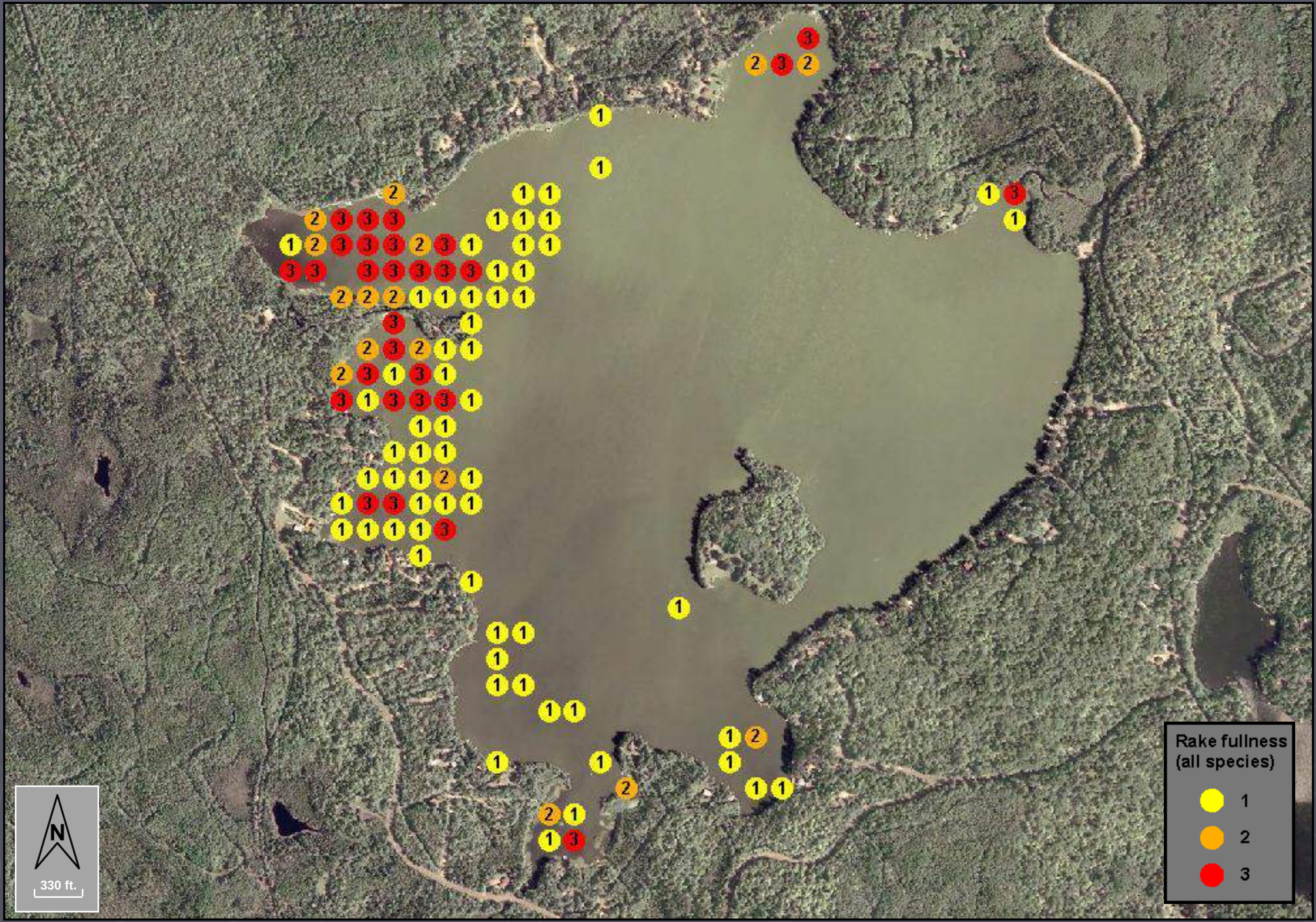


Figure 2. Rake fullness ratings for Bearskin Lake sample sites (2012).



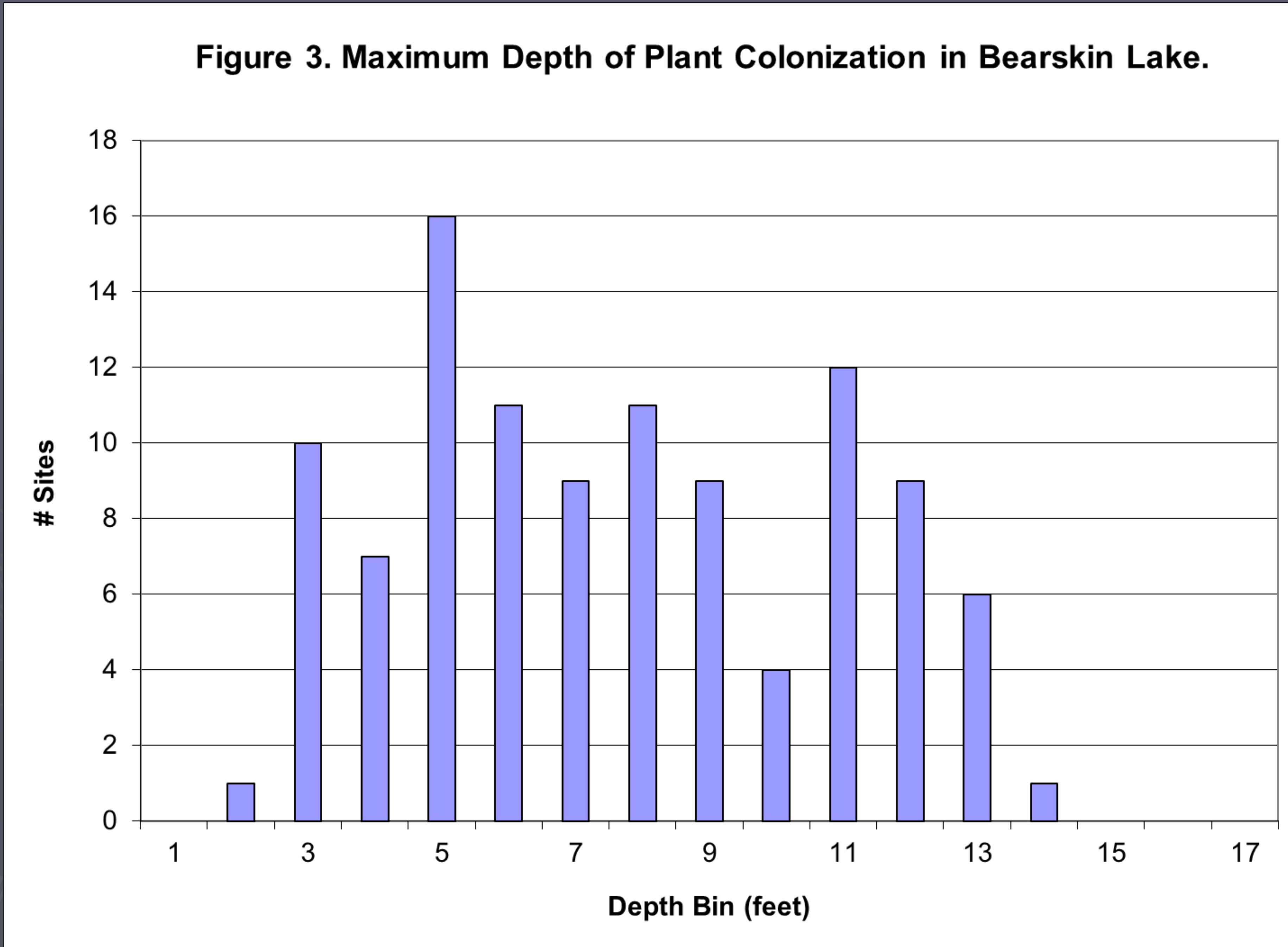


Figure 3. Maximum Depth of Plant Colonization in Bearskin Lake.
Sites
Depth Bin (feet)
0
2
4
6
8
10
12
14
16
18
1
3
5
7
9
11
13
15
17

Figure 4. Bearskin Lake sampling sites less than or equal to maximum depth of rooted vegetation (2012).

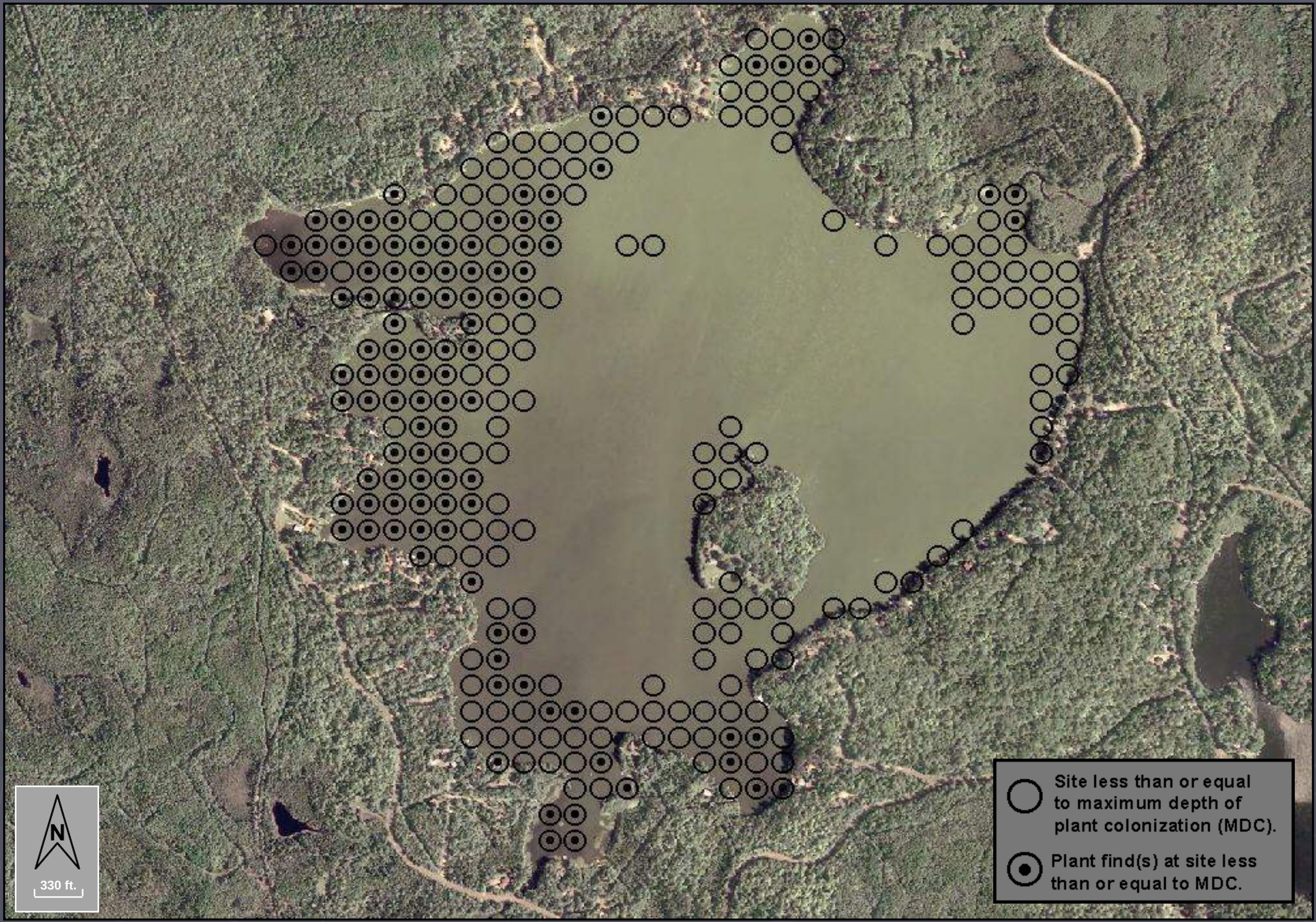
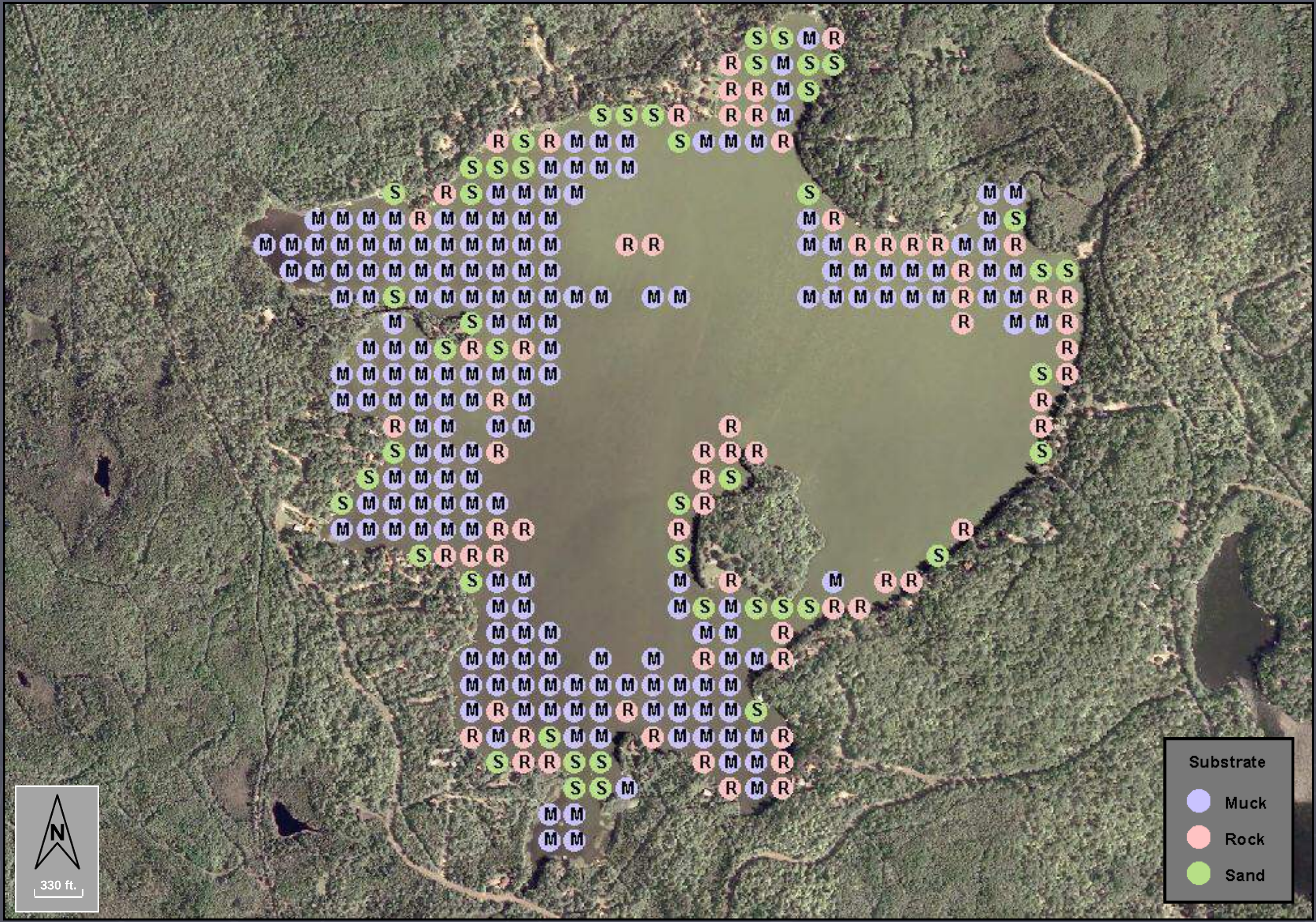


Figure 5. Bearskin Lake substrate encountered at point-intercept plant sampling sites (2012).



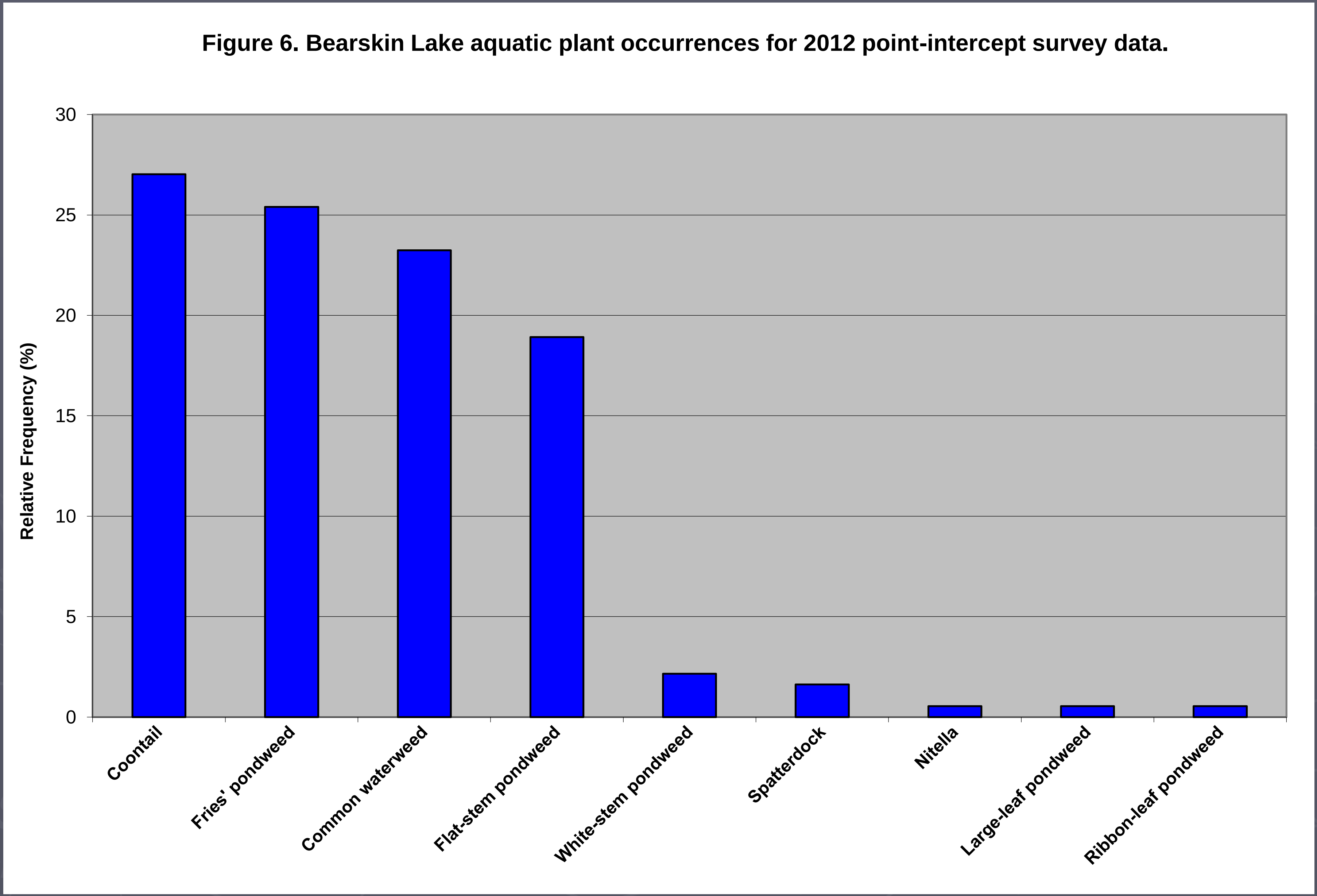


Figure 6. Bearskin Lake aquatic plant occurrences for 2012 point-intercept survey data.
Relative Frequency (%)
30
25
20
15
10
5
0
Coontail
Fries' pondweed
Common waterweed
Flat-stem pondweed
White-stem pondweed
Spatterdock
Nitella
Large-leaf pondweed
Ribbon-leaf pondweed

Figure 7. Bearskin Lake point-intercept plant sampling sites with emergent and floating aquatic plants (2012).

Figure 8. Distribution of plant species, Bearskin Lake (2012).

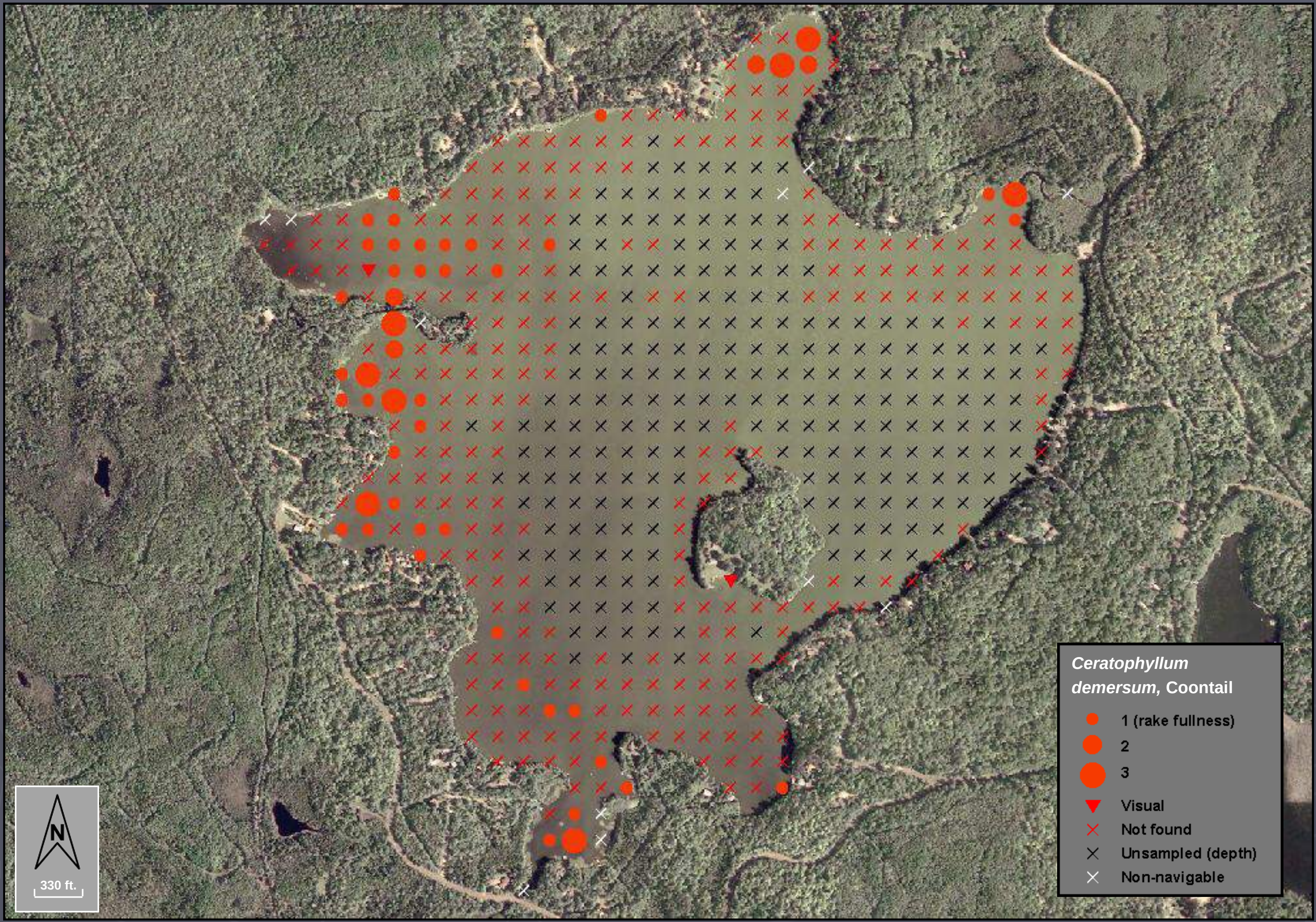


Figure 9. Distribution of plant species, Bearskin Lake (2012).

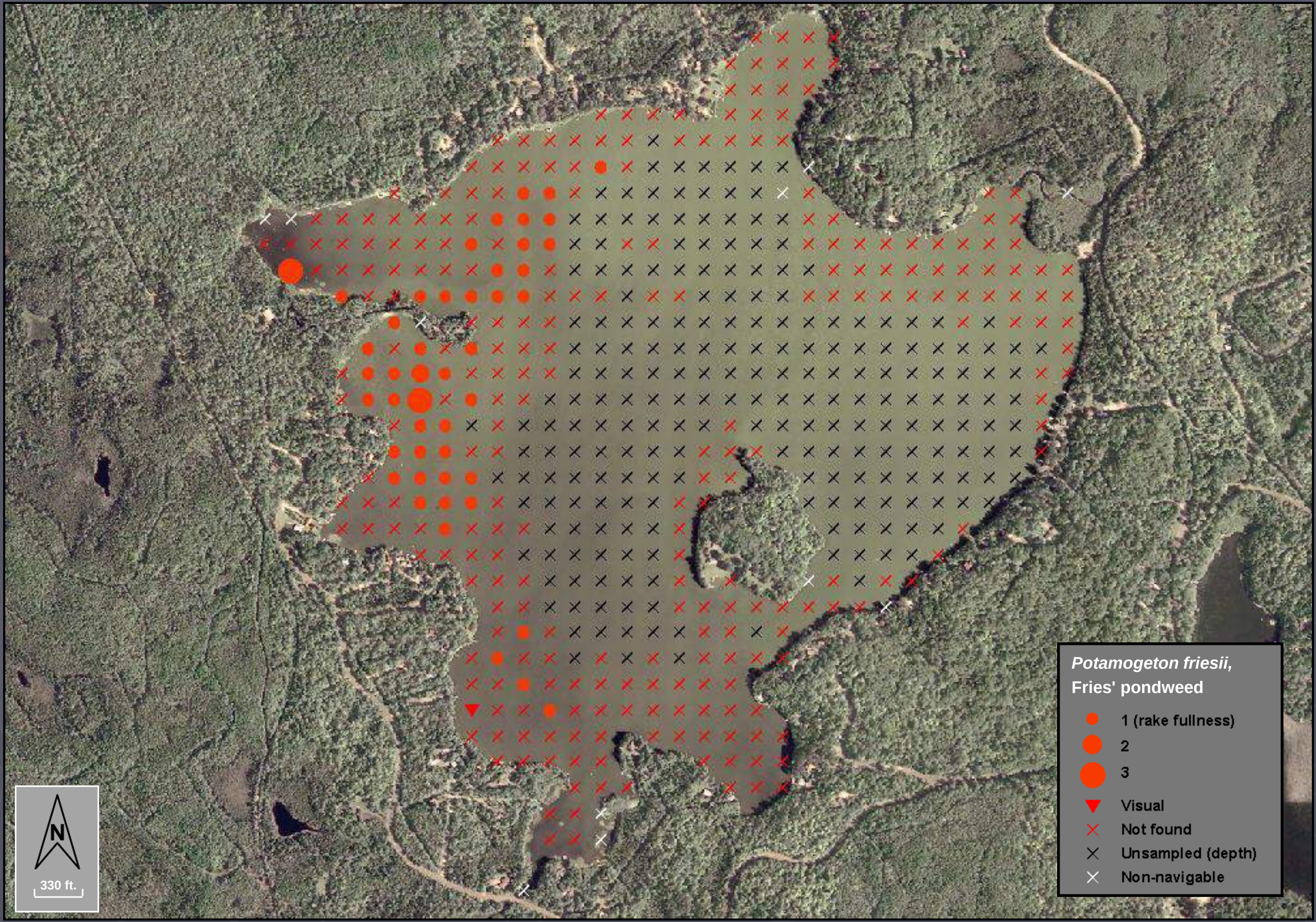


Figure 10. Distribution of plant species, Bearskin Lake (2012).

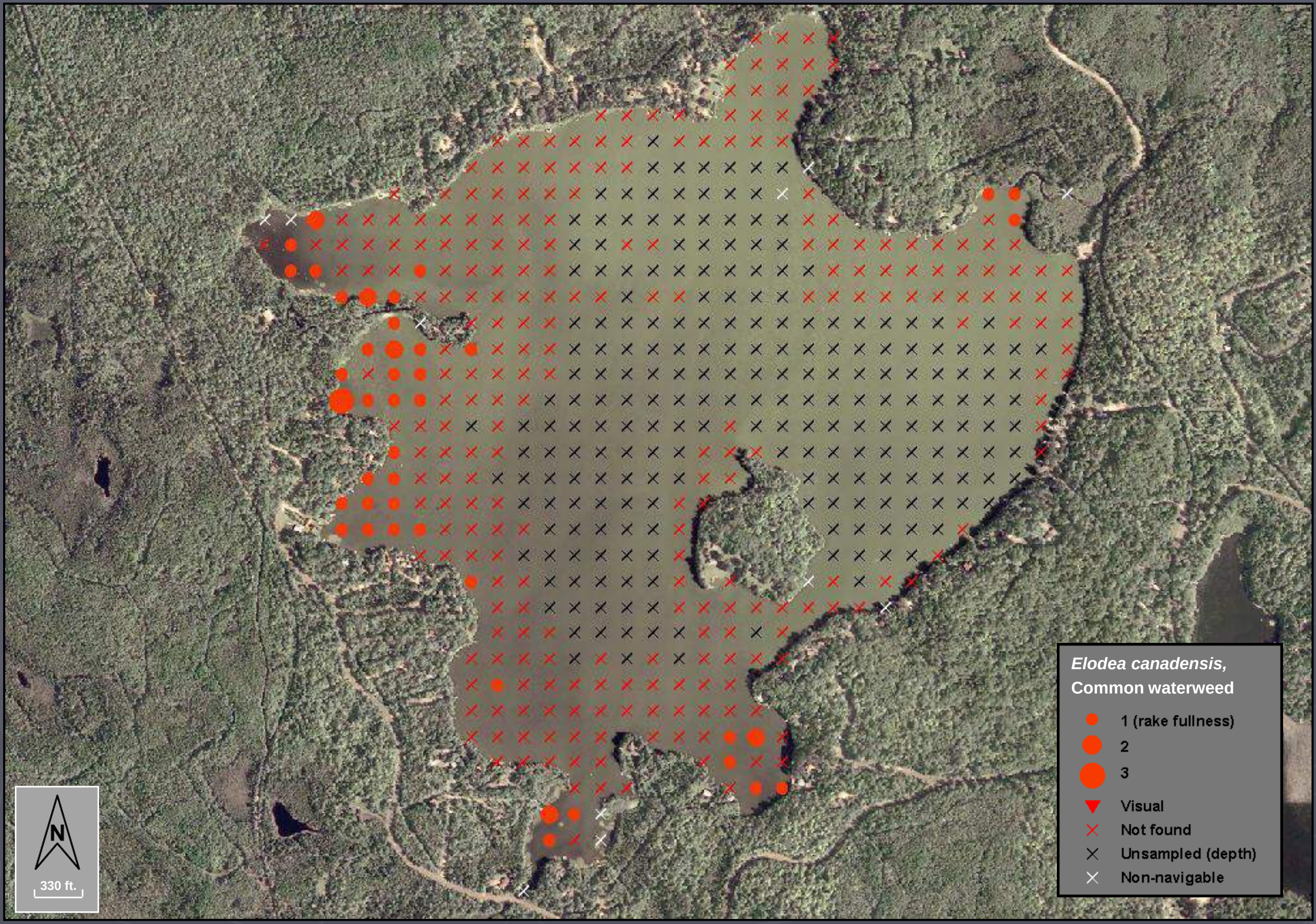


Figure 11. Distribution of plant species, Bearskin Lake (2012).

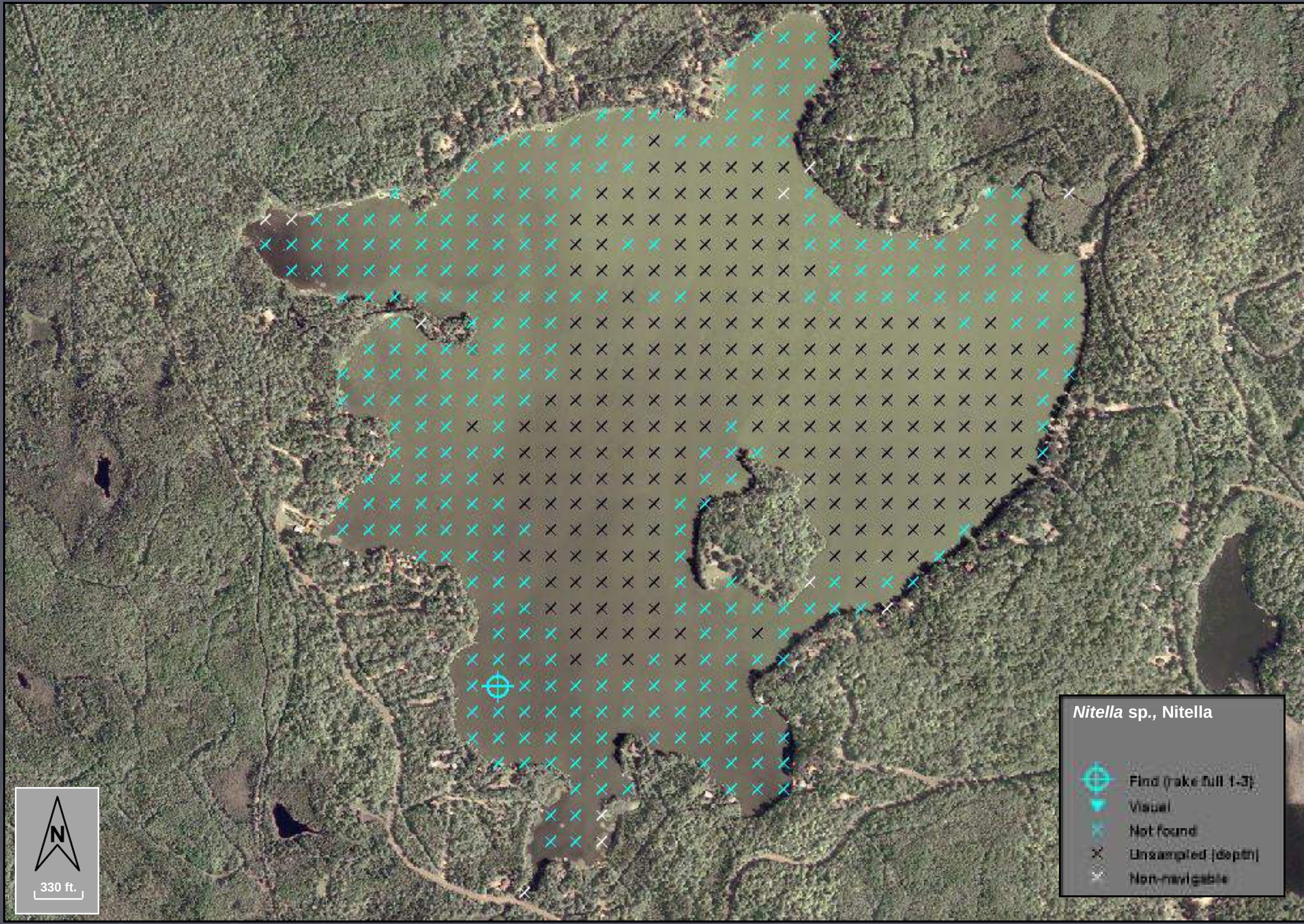


Figure 12. Distribution of plant species, Bearskin Lake (2012).

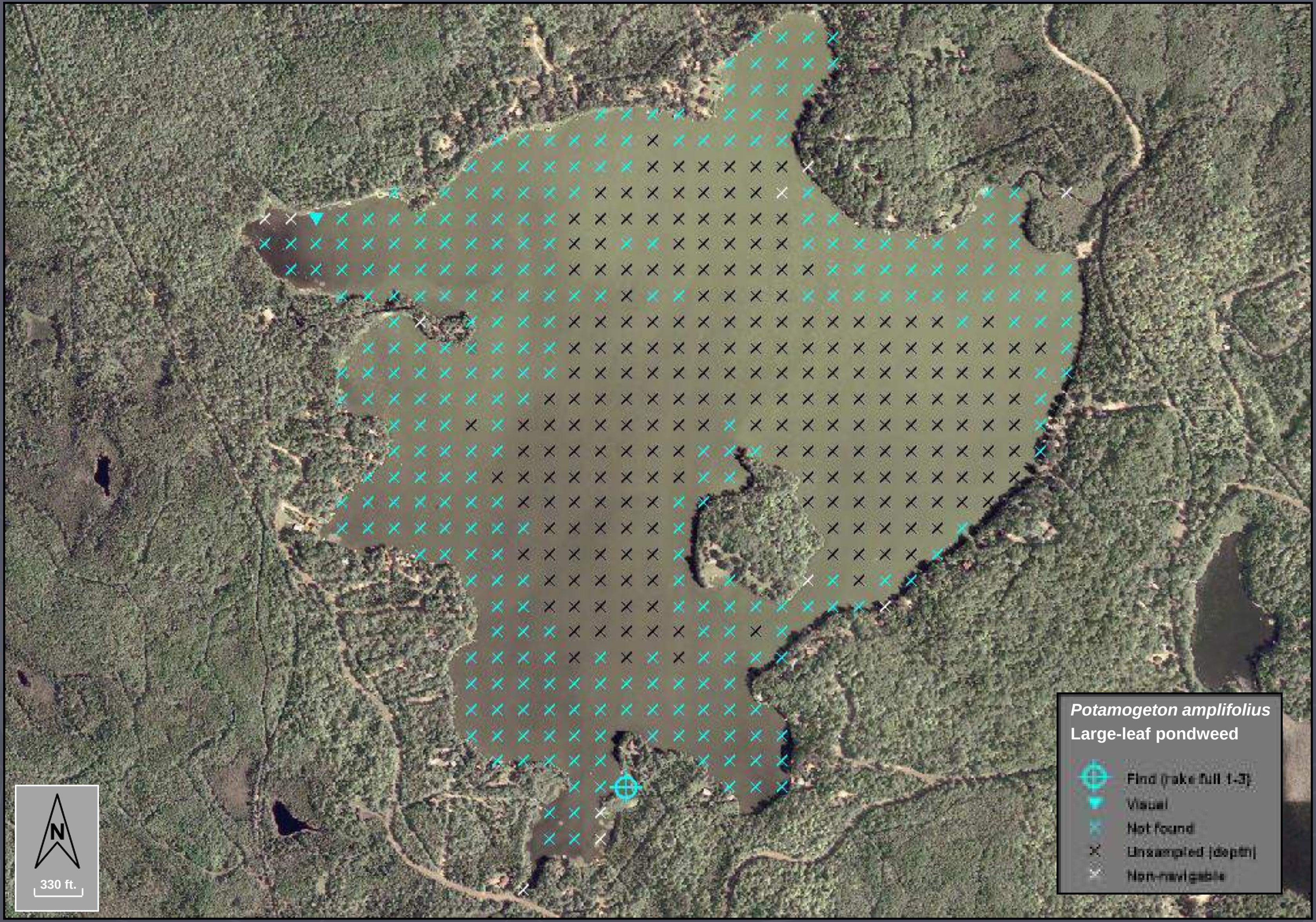
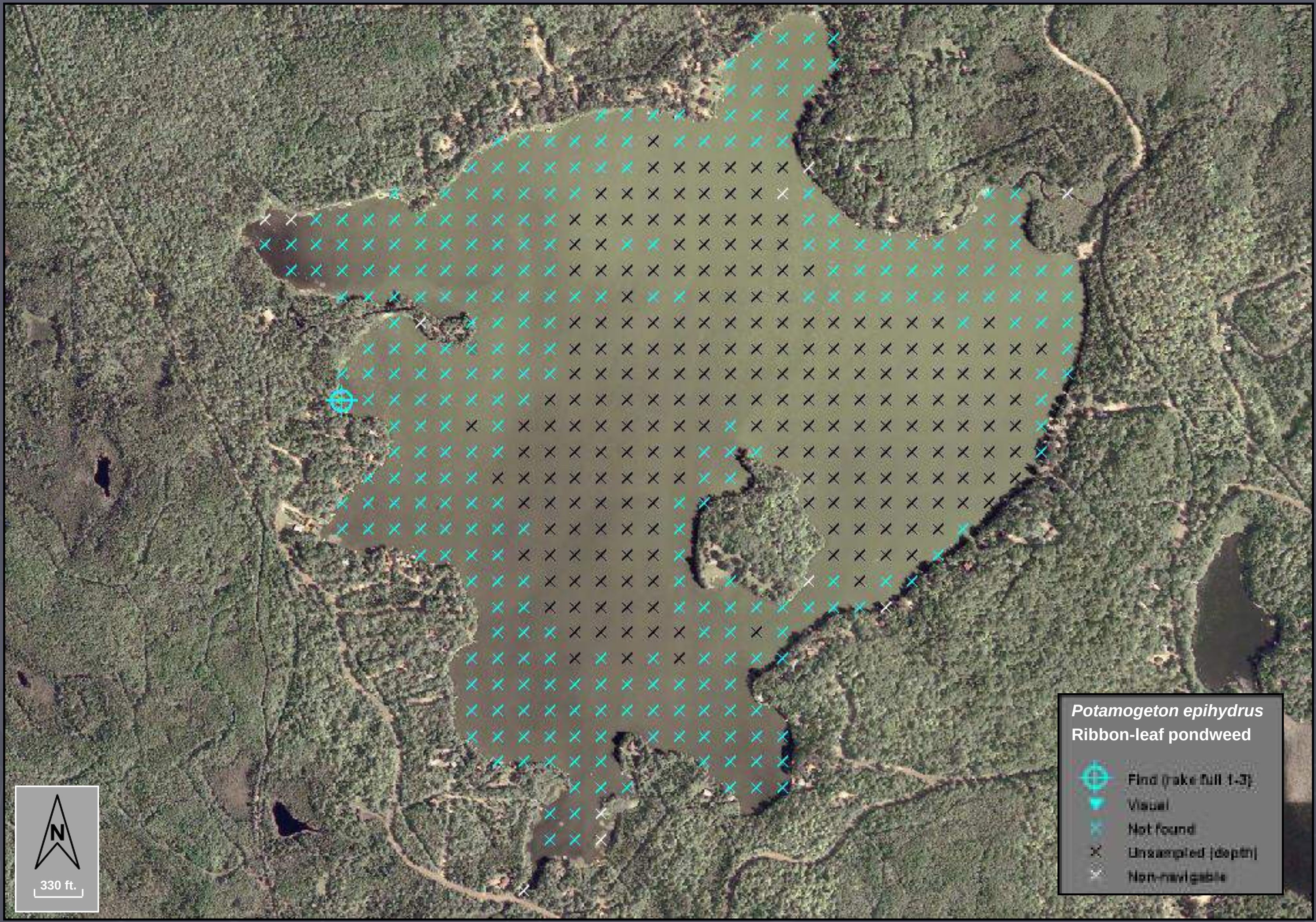


Figure 13. Distribution of plant species, Bearskin Lake (2012).



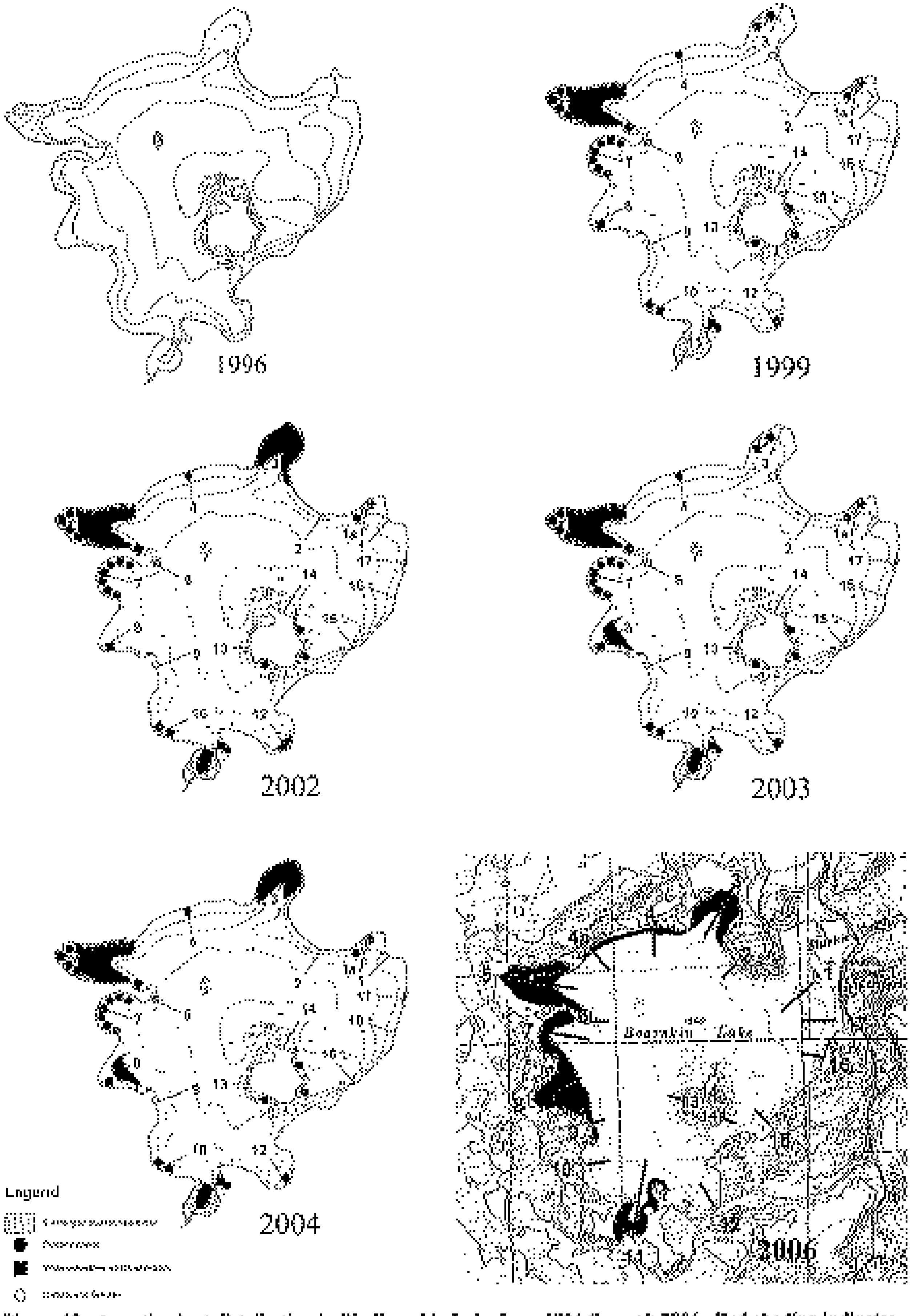


Figure 15. Aquatic plant distribution in Big Bearskin Lake from 1996 through 2006. Red shading indicates submerged plant coverage.

Table 5. Species list and the occurrence of aquatic plants found in Big Bearskin Lake in July 6, 7, 1967, July 25, 1996, August 10, 1999, August 3, 2002, July 27, 2004, and August 11, 2006.

Common Name	Scientific Name	1967 30% coverage	1996 8% coverage	1999 5% coverage	2002 12% coverage	2003 8% coverage	2004 14% coverage	2006 19% coverage
		Occurrence (number of times plant was found in sampling of 54 stations)						
Spikerush	*Eleocharis palustris*	X						
Duckweed	*Lemna sp*						2	
Little yellow waterlily	*Nuphar microphyllum*	X						
Spatterdock	*Nuphar variegatum*	X	X	3	7	X	12	9
White waterlily	*Nymphaea sp*	X	X	9	5	X	8	7
Pickerel plant	*Pontederia cordata*	X	X	3	5	X	6	2
Arrowhead	*Sagittaria sp*	X						
Bulrush	*Scirpus sp*	X	X	X	X	X	1	
Burreed	*Sparganium sp.*	X						
Cattails	*Typha sp*	X	X	X	X	X	2	
Water meal	*Wolffia columbiana*				1			
Coontail	*Ceratophyllum demersum*		X	1	1	1	5	7
Elodea	*Elodea canadensis*	X	X	2	11	4	9	9
Water milfoil	*Myriophyllum sp.*	X						
Water smartweed	*Polygonum amphibium*	X						
Cabbage	*Potamogeton amplifolius*	X	X				1	1
Ribbon-leaf pondweed	*P. epihydrus*						3	
Floatingleaf pondweed	*P. natans*							1
Claspingleaf pondweed	*P. richardsonii*	X	X					
Fern pondweed	*P. robbinsii*	X	X		2			
Flatstem pondweed	*P. zosteriformis?*					1	2	1
Narrowleaf pondweed	*P. sp*							1
Stringy pondweed	*P. sp*	X	X					2
Water buttercup	*Ranunculus sp.*	X						
Water celery	*Vallisneria americana*		X				1	
Number of Submerged Species		8	7	2	3	3	6	7

Appendix 3

Review of Bearskin Lake Water Quality

Note: This document is available as Appendix C of the

Bearskin Lake Adaptive Management Plan

(starts on following page)

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Appendix C
Review of Bearskin Lake Water Quality

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Appendix C

Review of Lake Water Quality

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Review of Bearskin Lake Water Quality

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

Introduction

Bearskin Lake is located in Oneida County, Wisconsin. It is a 400 acre drainage lake with a maximum depth of 26 feet. The Waterbody Identification Code (WBIC) is 1523600. The purpose of this study is to develop baseline data. Our goal is to collect existing water quality data to give us a starting point, and continue to monitor Bearskin Lake for a comparison of environmental and human changes. Water quality data was retrieved from the WDNR SWIMS database in 1973, 1974, 1990, and from 1992 to 2014. The majority of the water quality data on Bearskin Lake has come from Citizen Lake Monitoring Network (CLMN) volunteers. A lake planning study was conducted in 1996 and additional lake work was conducted in 1999. A lake report was also completed in 2006. Barley straw was added to Bearskin Lake from 2001-2004 in an attempt to control algae.

Comparison of Bearskin 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. Lake water temperature influences the rate of decomposition, nutrient recycling, lake stratification, and dissolved oxygen (D.O.) concentration. Temperature can also affect the distribution of fish species throughout a lake. The March-May temperature profiles are shown in Figure 2. There has been very little stratification during these months in Bearskin Lake. The June, July, August, and September temperature profiles are shown in Figures 3-5. In these months, Bearskin Lake shows more dates where the temperature was stratified, though there are still dates in July and August when the temperature did not change at deeper depths. The September and October temperature profiles (Figure 6) show fall mixing where the temperature was consistent from surface to bottom.

Figure 2. Bearskin Lake temperature profile, March-May.

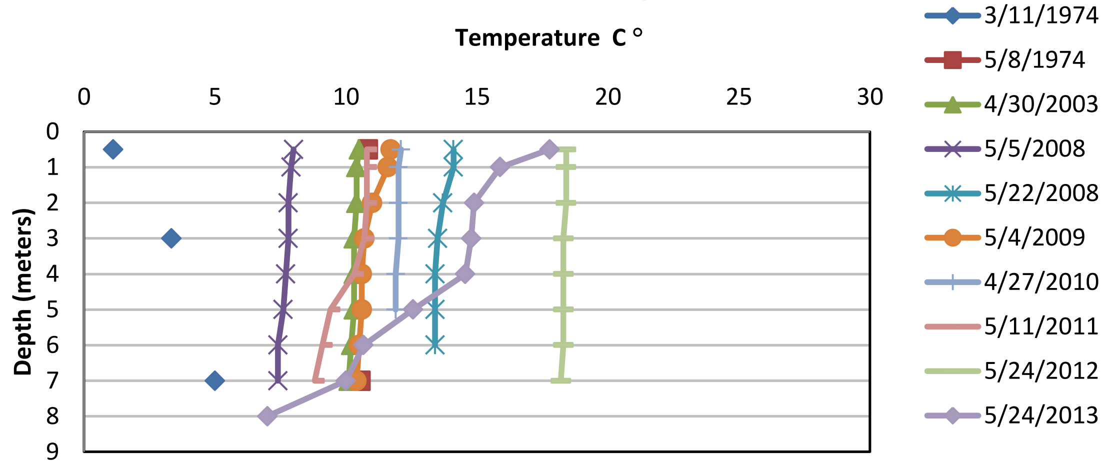


Figure 3. Bearskin Lake temperature profile, June.

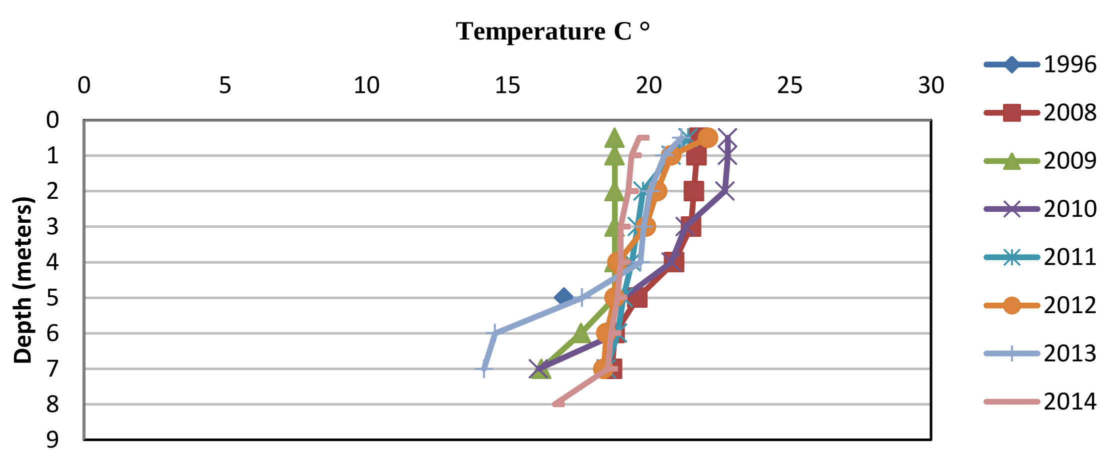


Figure 4. Bearskin Lake temperature profile, July.

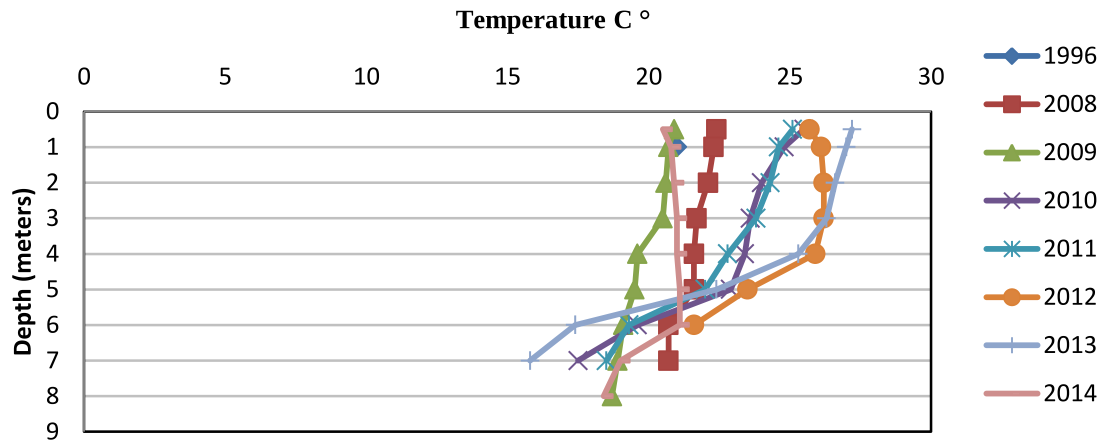
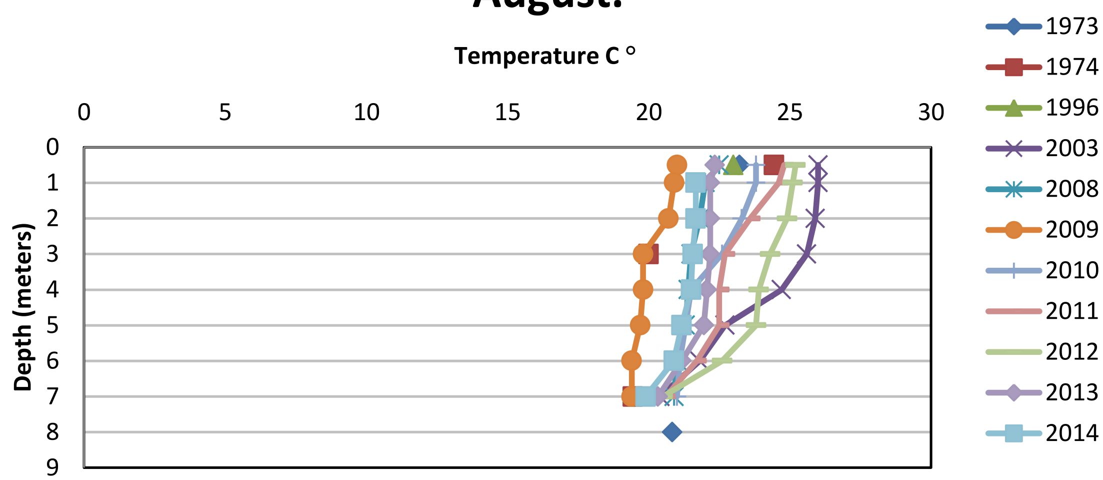
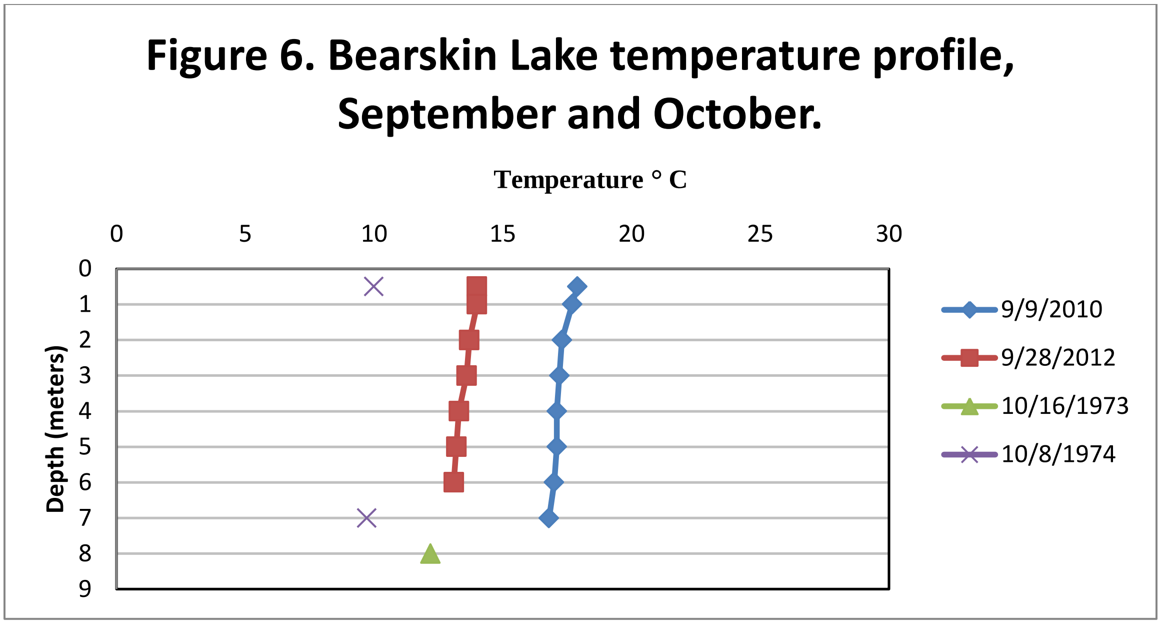


Figure 5. Bearskin Lake temperature profile, August.





Dissolved Oxygen

The dissolved oxygen (D.O.) content of lake water is vital in determining presence of fish species and other aquatic organisms. Dissolved oxygen also has a strong influence on the chemical and physical conditions of a lake. The amount of dissolved oxygen is dependent on the water temperature, atmospheric pressure, and biological activity. Oxygen levels are increased by aquatic plant photosynthesis, but reduced by respiration of plants, decomposer organisms, fish, and invertebrates. The amount of dissolved oxygen available in a lake, particularly in the deeper parts of a lake, is critical to overall health. Similar to the temperature profiles, the April and May D.O. levels rarely stratify (Figure 7). The June, July, August, September and October D.O. profiles all have varying degrees of stratification (Figures 8-11).

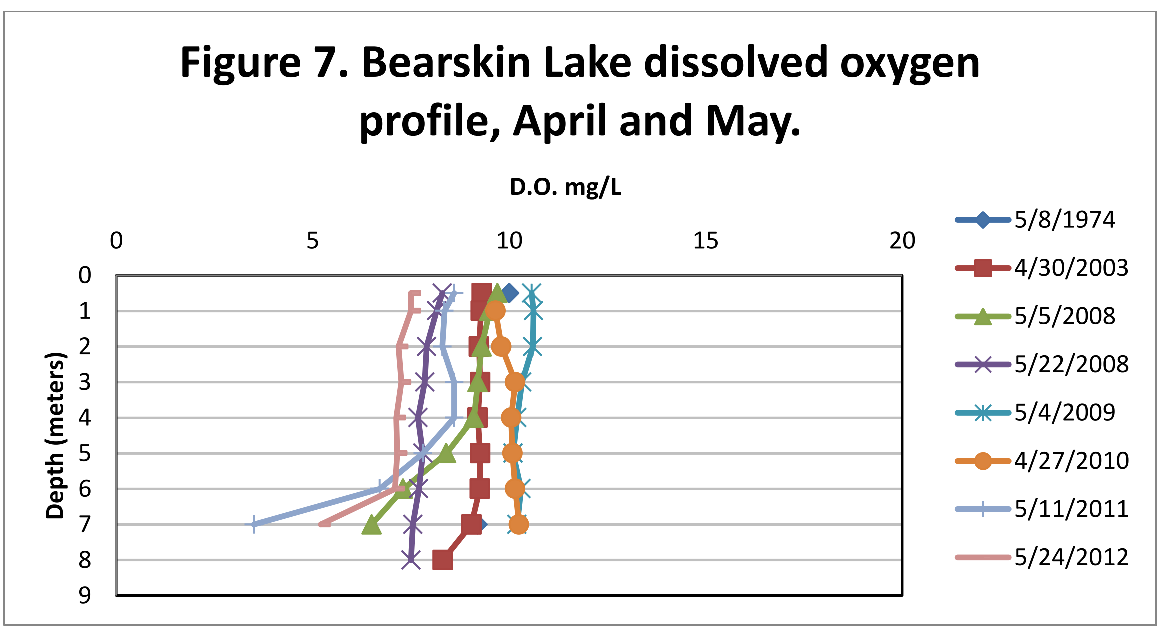


Figure 8. Bearskin Lake dissolved oxygen profile, June.

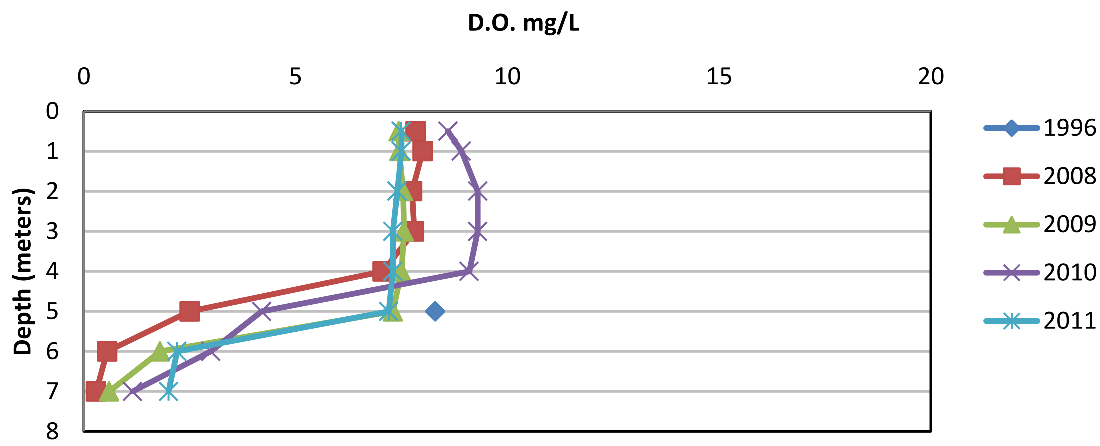
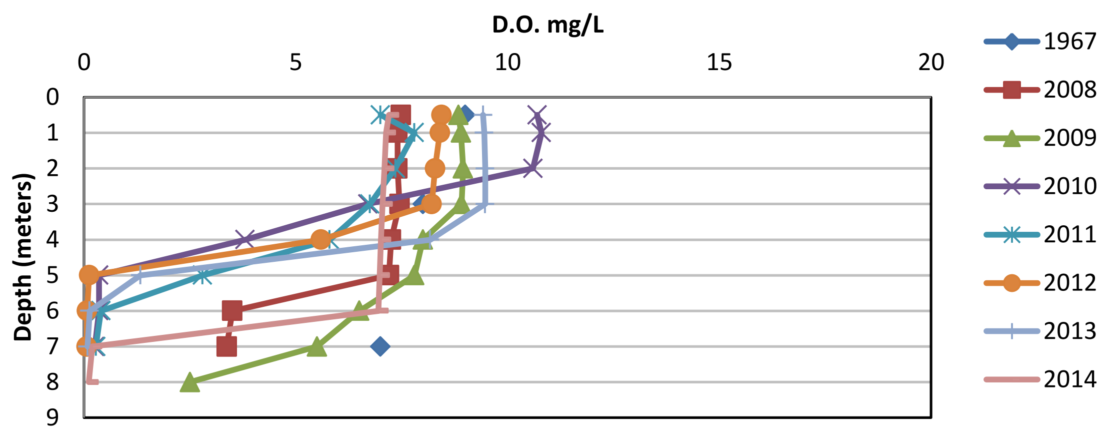
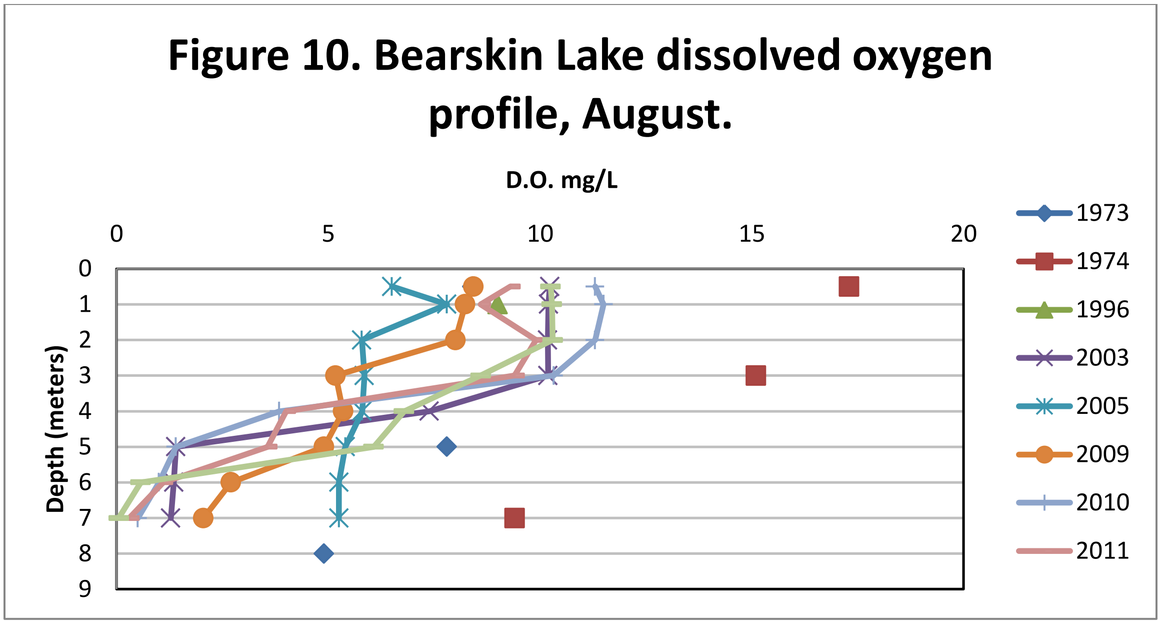
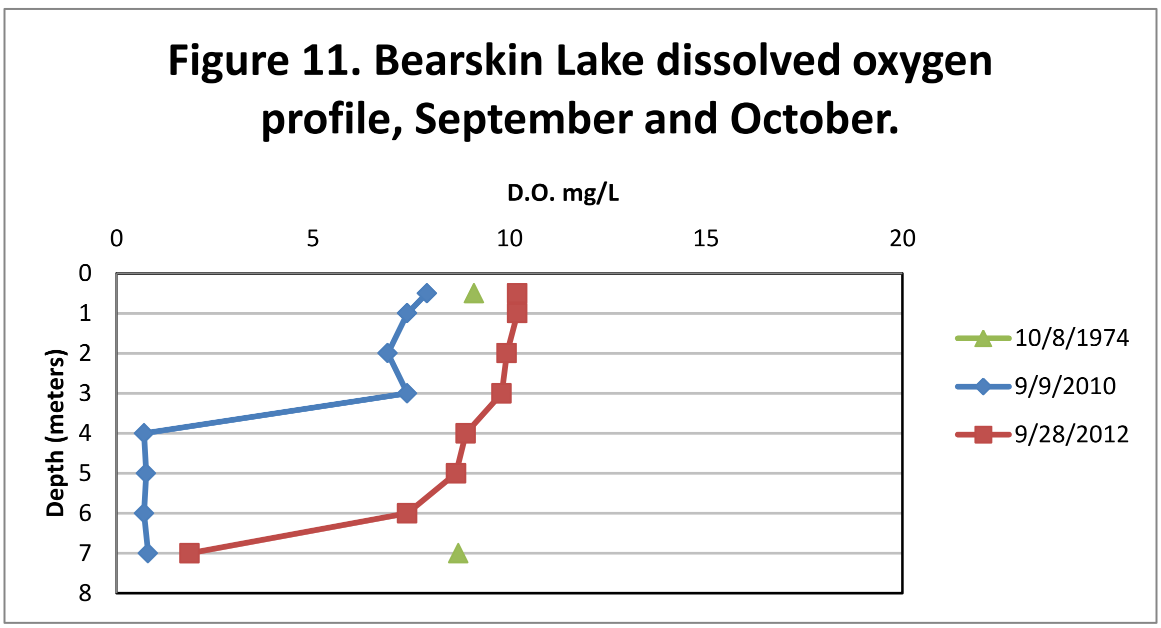


Figure 9. Bearskin Lake dissolved oxygen profile, July.





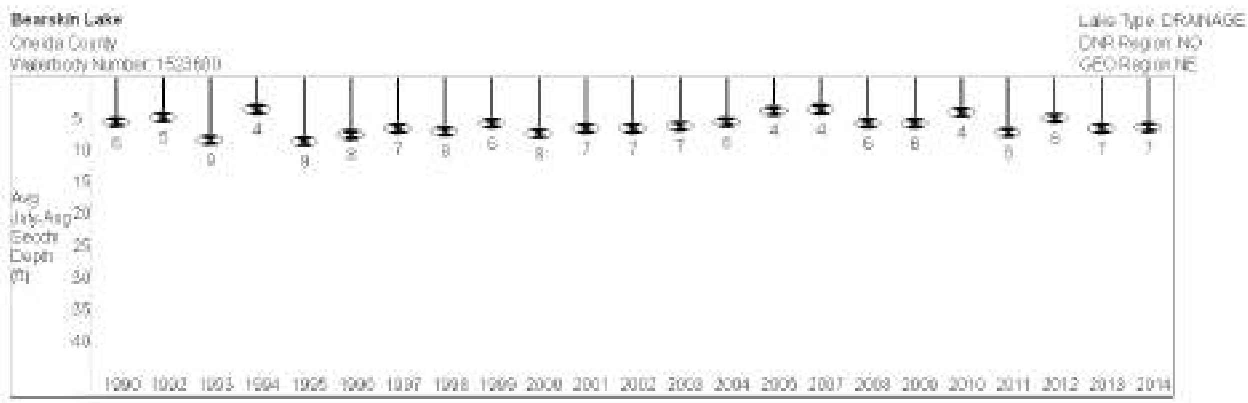


Water Clarity

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.

Figures 12 and 13 show the mean Secchi depths of Bearskin Lake from 1990 to 2014. The deepest Secchi measurement was 13 feet in 1996 and 2003, and the shallowest was 2.1 in 2012. According to Table 1, Bearskin Lake's 2014 Secchi depth is considered "fair" with respect to water clarity.

Figure 12. Bearskin Lake Secchi depth averages (July and August only).



(WDNR, 2015b)

Figure 13. Bearskin Lake's July and August Secchi Data: Mean, Min, Max, and Secchi Count (1990, 1992-2014).

Year	Secchi Mean	Secchi Min	Secchi Max	Secchi Count
1990	6.25	5.5	7.25	6
1992	5.36	4	7	7
1993	9	7.5	10.5	2
1994	4.17	2.5	5.5	3
1995	9.25	9	9.5	2
1996	8.24	5.9	13	5
1997	7.17	4.5	9.5	3
1998	7.5	3.5	11.5	2
1999	6.44	4.5	11	8
2000	8	6.5	9.5	2
2001	7.13	5.5	8.75	2
2002	7.13	7	7.25	2
2003	6.72	3.5	13	9
2004	6.25	4.1	9	10
2005	4.45	3.28	6.56	7
2006				4
2007	4.15	2.5	7.25	10
2008	6.4	4.5	8	5
2009	6.33	5.5	9	6
2010	4.5	4	5	2
2011	7.75	5	10	8
2012	5.51	2.1	7	8
2013	7.25	5	9	4
2014	7	6	8	5

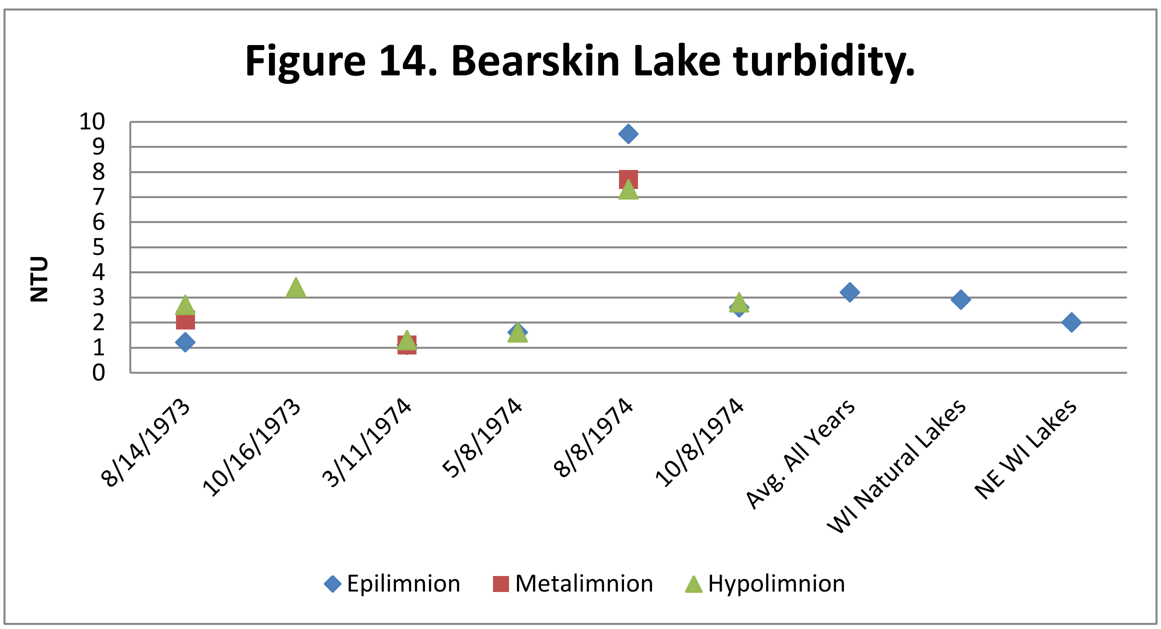
(WDNR, 2015b)

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

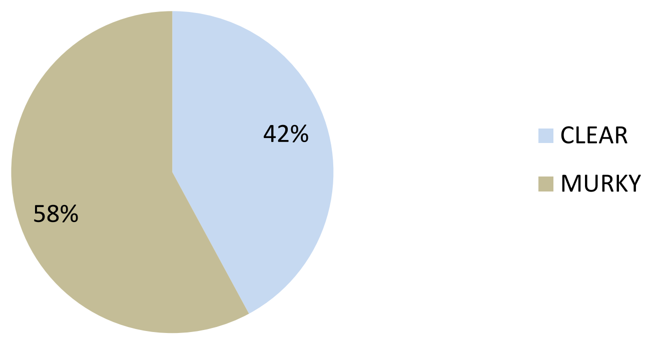
Turbidity

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. Bearskin Lake historically has low turbidity values (Figure 14).



While collecting Secchi samples, CLMN volunteers also rated the water clarity and describe it as “clear” or “murky.” From 1994 to 2014, 58% of volunteers rated the water as “murky” (Figure 15).

Figure 15. Bearskin Lake water column appearance, 1994-2014.

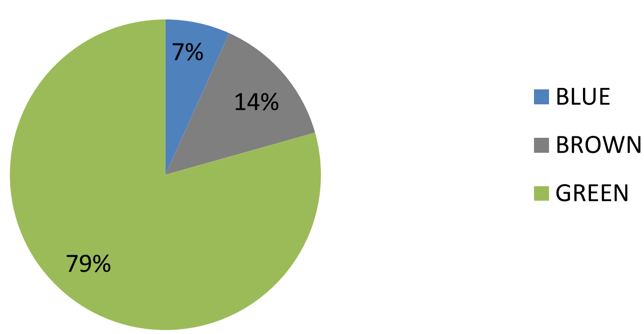


Water Color

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. Bearskin Lake had color samples collected on August 18, 2003 (10 Pt-Co) and July 26, 2013 (10 Pt-Co). The mean for Northeast Wisconsin lakes is 46 color units.

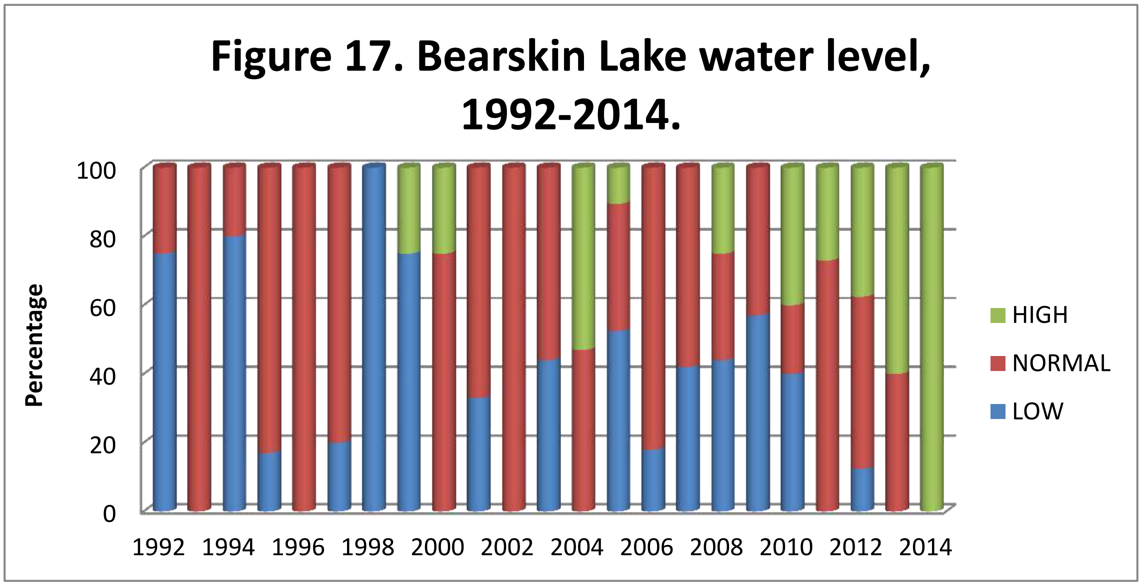
CLMN volunteers also recorded their opinion of the water color and recorded it as “brown,” “blue,” or “green.” The majority of volunteers viewed Bearskin Lake as “green” (Figure 16).

Figure 16. Bearskin Lake visual water color, 1990-2014.



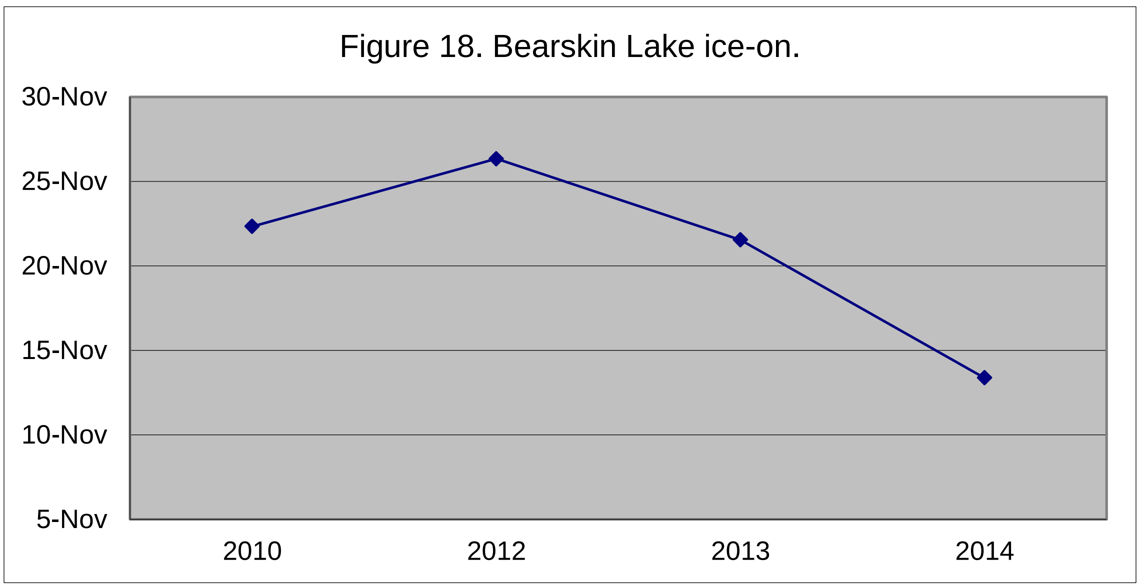
Water Level

CLMN volunteers also record the lake level as "high," "normal," or "low." Figure 17 shows that in 1996 and 2002, 100% of the volunteers viewed Bearskin Lake as having "normal" water levels. In 2014, 100% of volunteers viewed Bearskin Lake water level to be "high." In 1998, 100% of volunteers said the lake appeared "low."



Ice-on Dates

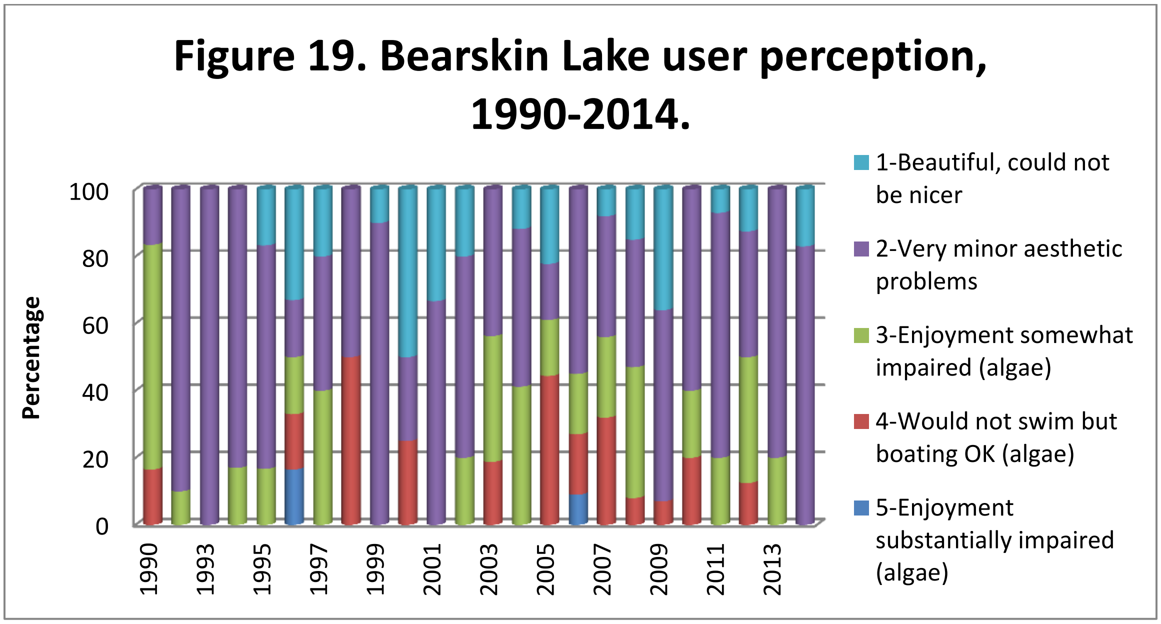
Citizen Lake Monitoring Network volunteers recorded the ice-on dates for Bearskin Lake (Figure 18). Since 2010, the ice-on date has been in the second or third week of November.



User Perceptions

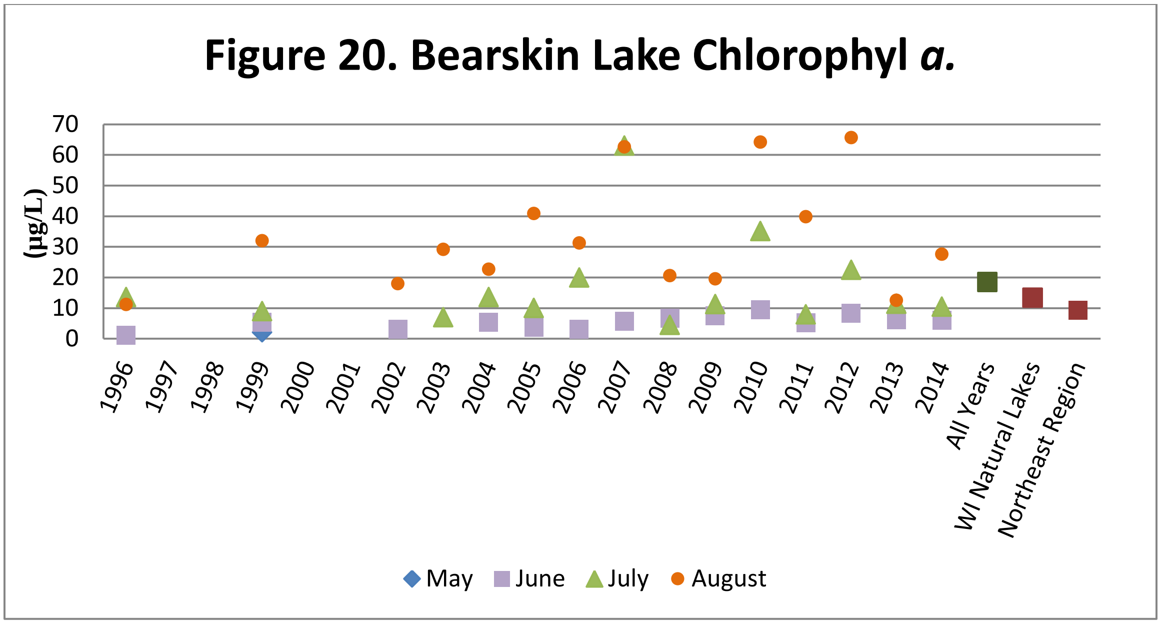
The CLMN also recorded their perceptions of the water, based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake user would experience the lake at that time. When interpreting the transparency data, we see that when the Secchi depth decreases, the rating of the lake's physical appearance also decreases. These perceptions of recreational suitability are displayed as a percentage by year in Figure 19.

In 1996 and 2006, a small percentage of CLMN volunteers thought the "enjoyment of the lake was substantially impaired due to algae." In the majority of years since 1995, only a small percentage of volunteers viewed the lake as "beautiful, could not be nicer." In just about every year, the majority of volunteers viewed Bearskin Lake as having "very minor aesthetic problems."



Chlorophyll *a*

Chlorophyll *a* is the photosynthetic pigment that makes plants and algae green. Chlorophyll *a* in lake water is 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* has been monitored in Bearskin Lake extensively (Figure 20). It can be observed that over the course of a summer, the chlorophyll *a* values increase each month.



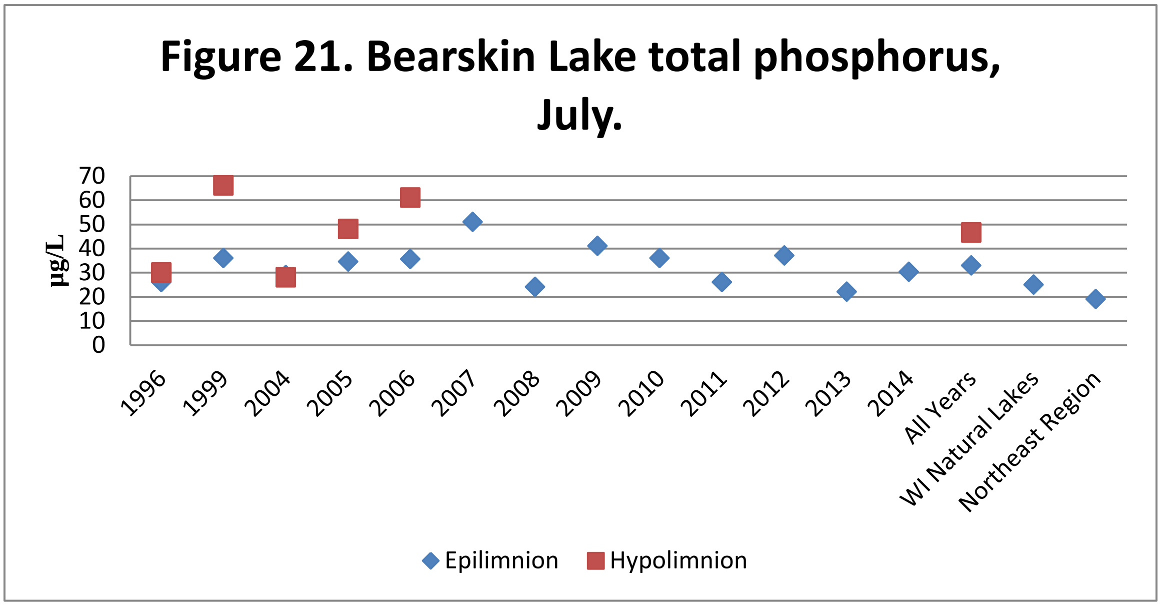
Phosphorus

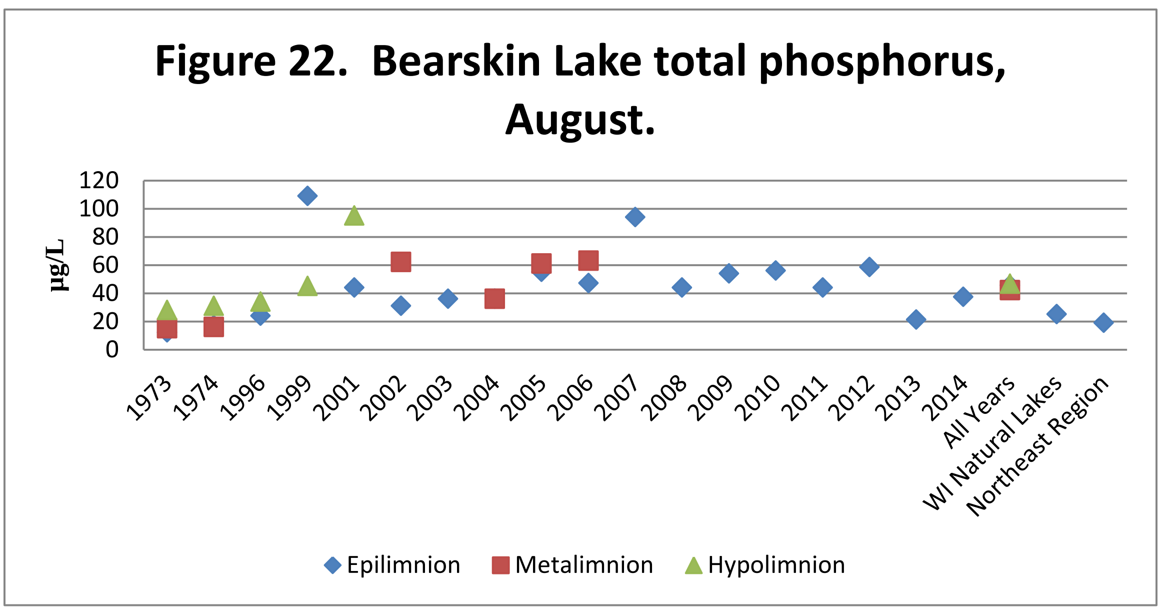
In more than 80% of Wisconsin's lakes, phosphorus is the key nutrient affecting the amount of algae and plant growth. If phosphorus levels are high, excessive aquatic plant growth can occur.

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).

The average total phosphorus levels for July (32.95 µg/L) and August (42.17 µg/L) are higher than the average total phosphorus levels for Wisconsin Natural Lakes and lakes in the Northeast Region (Figures 21 and 22). The total phosphorus value in July, 2013 is the lowest observed value, and is comparable to the Wisconsin lakes average in July and was below the average in August. The average August total phosphorus value (42.17 µg/L) classifies Bearskin Lake as "fair" with respect to phosphorus (Figure 23).

Due to high total phosphorus values, summer algae blooms have been prevalent in Bearskin Lake for many years. The summer algae blooms in Bearskin Lake have been caused from algae called *Gleotrichia*, a blue-green algae. Lake residents attempted to control this problem by introducing barley straw bales into the lake, from 2001-2004. An "adopt-a-bale" program was implemented by the association. The rate was 40 pounds of barley per lake-acre in 2001, and 20 pounds of barley per lake-acre in 2002, 2003, and 2004 (McComas 2006). It's believed that chemicals released during barley decomposition inhibit algal growth (Newman, 1997). McComas (2006) explained that the average clarity was slightly better in the span with barley compared to non-barley years of 2005 and 2006.





The Wisconsin DNR Impaired Waters web link states (2014): Bearskin Lake is on the impaired water list in 2012. The lake experiences some seasonal algae blooms during lake turnover and late summer, but the lake seems relatively stable. A sediment core was taken and the model predicted that pre-settlement TP levels were 17 µg/L, while current TP levels are 28 µg/L, indicating anthropogenic contributions. However, the watershed is all forested and current anthropogenic sources are unknown. Additional monitoring and investigation is recommended on what sources may be contributing to phosphorus levels. In 2014 listing cycle; chlorophyll sample data exceeded 2014 WisCalm listing thresholds for recreation use, however, total phosphorus data did **not** exceed the recreation use threshold. Total phosphorus and chlorophyll data do not exceed fish and aquatic life thresholds.

Figure 23. 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).

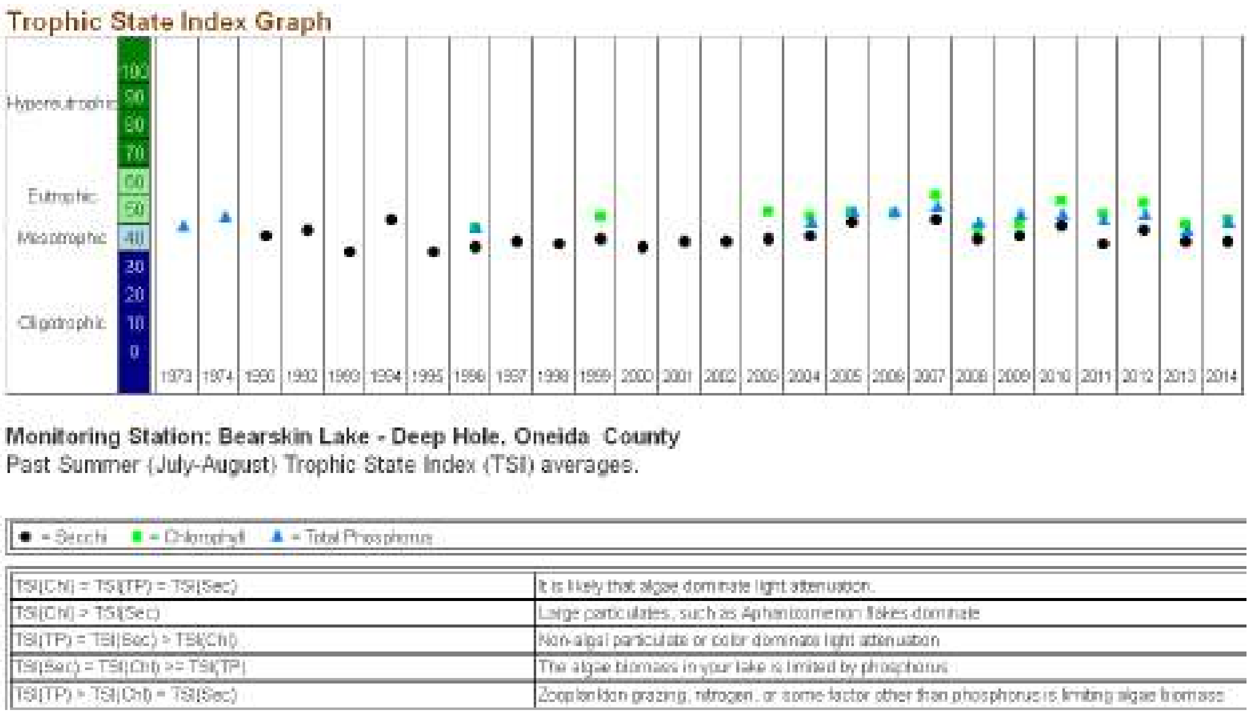
Researchers use various methods to calculate the trophic state of lakes. Common characteristics used to make the determination are: total phosphorus (important for algae growth), chlorophyll *a* concentration (a measure of the amount of algae present), and Secchi disk readings (an indicator of water 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 only Secchi measurements collected from CLMN volunteers. The July and August average TSI in the North Basin is shown from 1973 to 2014 (Figure 24), classifying Bearskin Lake as eutrophic in 2014 (Table 3). The average TSI for Secchi depth in 2014 was 46.6, the average TSI for total phosphorus was 53.7, and the average TSI for chlorophyll *a* was 53.7.

Figure 24. Bearskin Lake, North Basin Trophic State Index (1973-2014).



(WDNR, 2015b)

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 fish kill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

(WDNR, 2015b)

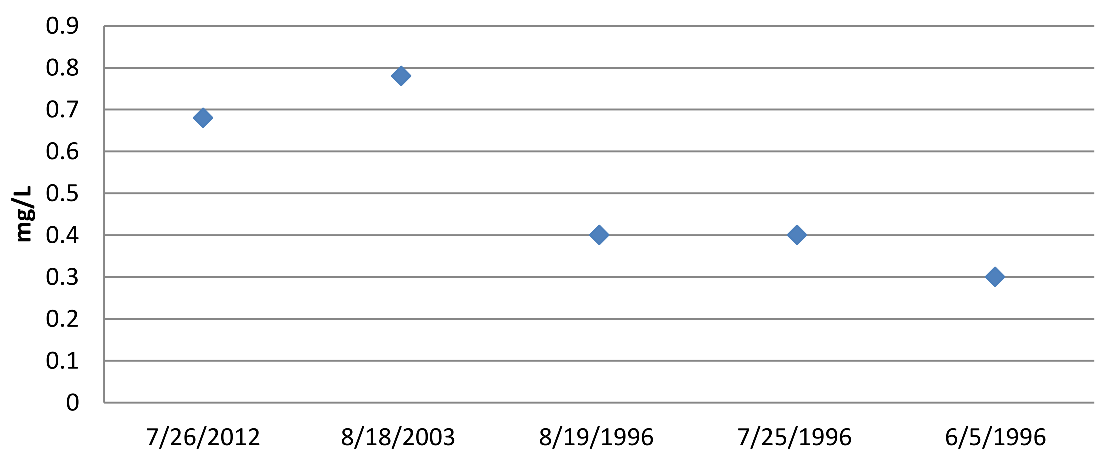
Nitrogen

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. Bearskin Lake was analyzed for total Kjeldahl nitrogen (Figure 25), organic nitrogen (Figure 26), total nitrogen (Figure 27), and ammonium (Figure 28). These figures show the forms of nitrogen collected a various depths during sampled years.

Nitrate-Nitrite was tested in June, July, and August 1996 and in August in 2003. It was undetectable in all samples, except on June 5, 1996 which had a value of 0.017 mg/L. 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).

Figure 25. Bearskin Lake total Kjeldahl nitrogen.



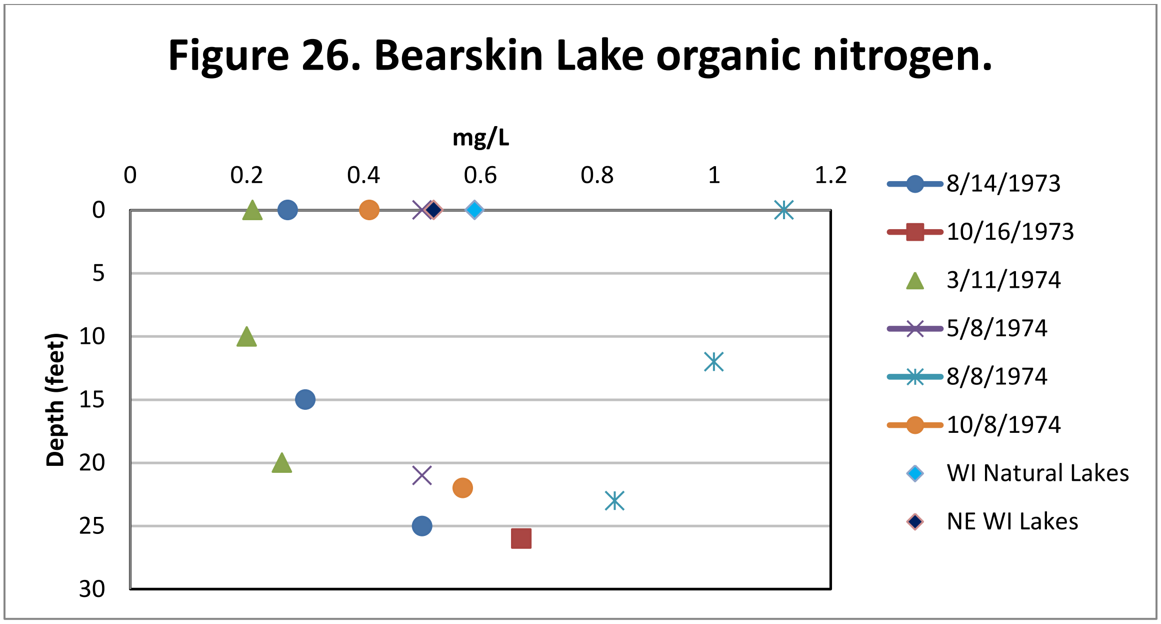


Figure 26. Bearskin Lake organic nitrogen.
mg/L
0
0.2
0.4
0.6
0.8
1
1.2
Depth (feet)
0
5
10
15
20
25
30
8/14/1973
10/16/1973
3/11/1974
5/8/1974
8/8/1974
10/8/1974
WI Natural Lakes
NE WI Lakes

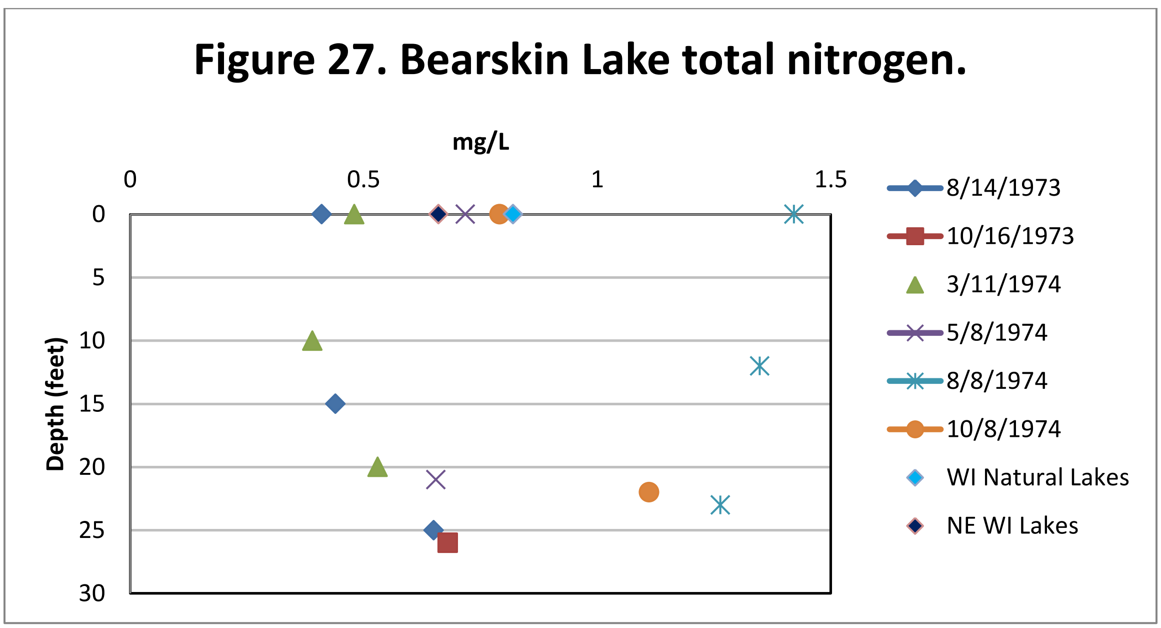
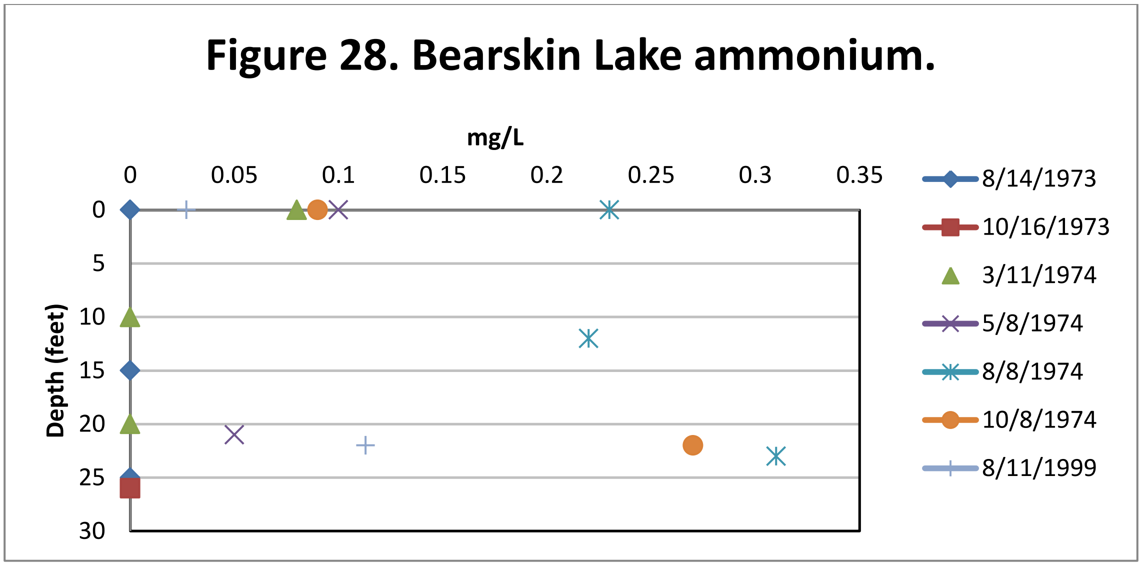
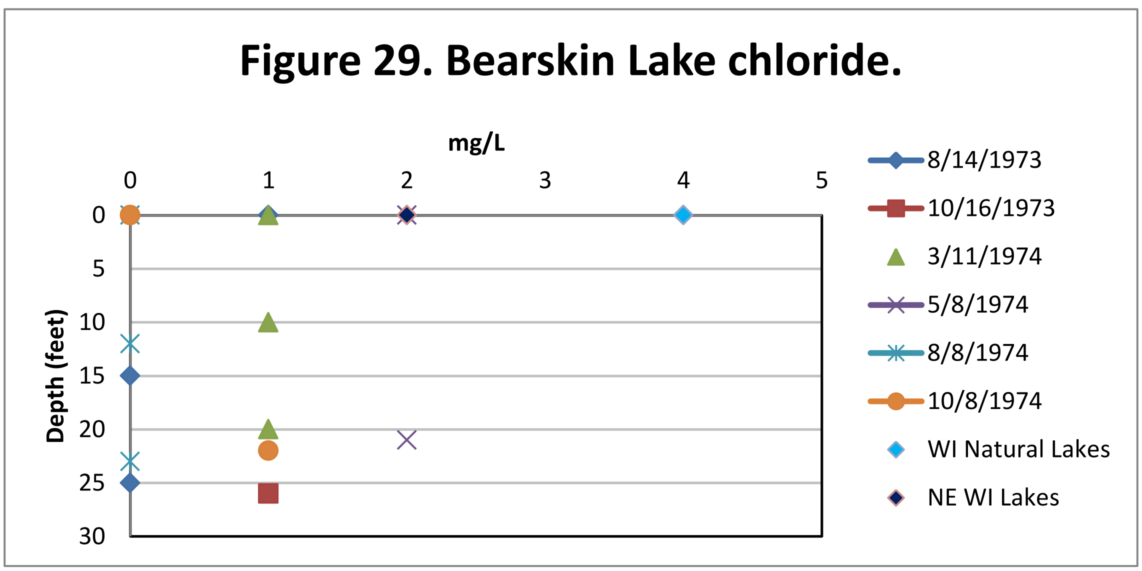


Figure 27. Bearskin Lake total nitrogen.
mg/L
0
0.5
1
1.5
Depth (feet)
0
5
10
15
20
25
30
8/14/1973
10/16/1973
3/11/1974
5/8/1974
8/8/1974
10/8/1974
WI Natural Lakes
NE WI Lakes



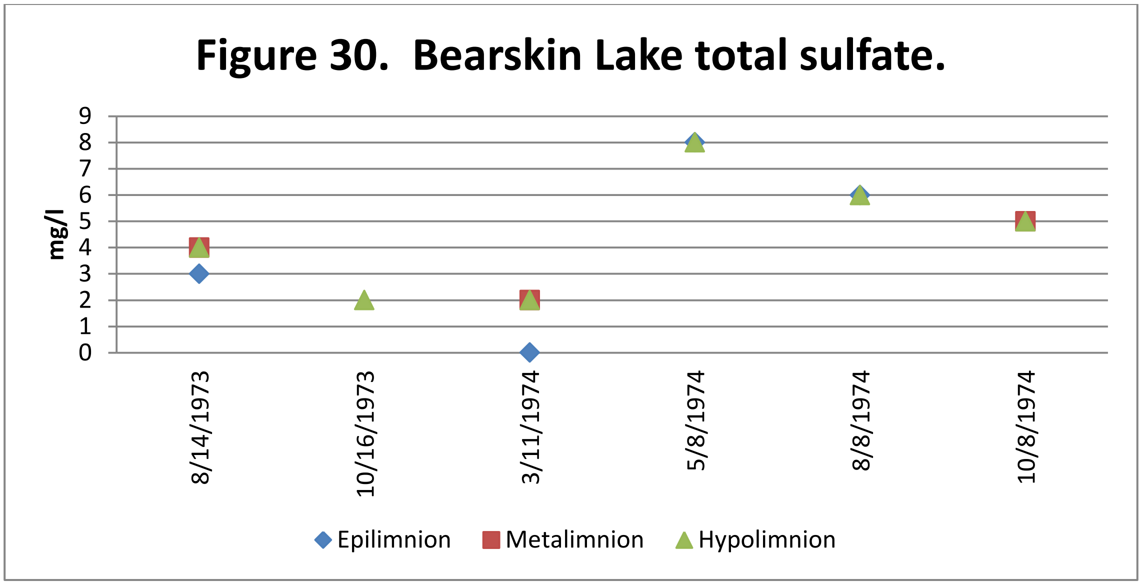
Chloride

The presence of chloride (Cl^-) where it does not occur naturally indicates possible water pollution (Shaw et al., 2004). Chloride does not affect plant and algae growth and is not toxic to aquatic organisms at most of the levels found in Wisconsin (Shaw et al., 2004). Chloride was analyzed in 1973 and 1974 at various depths (Figure 29). Chloride values were below Wisconsin natural lakes and the Northeast region.



Sulfate

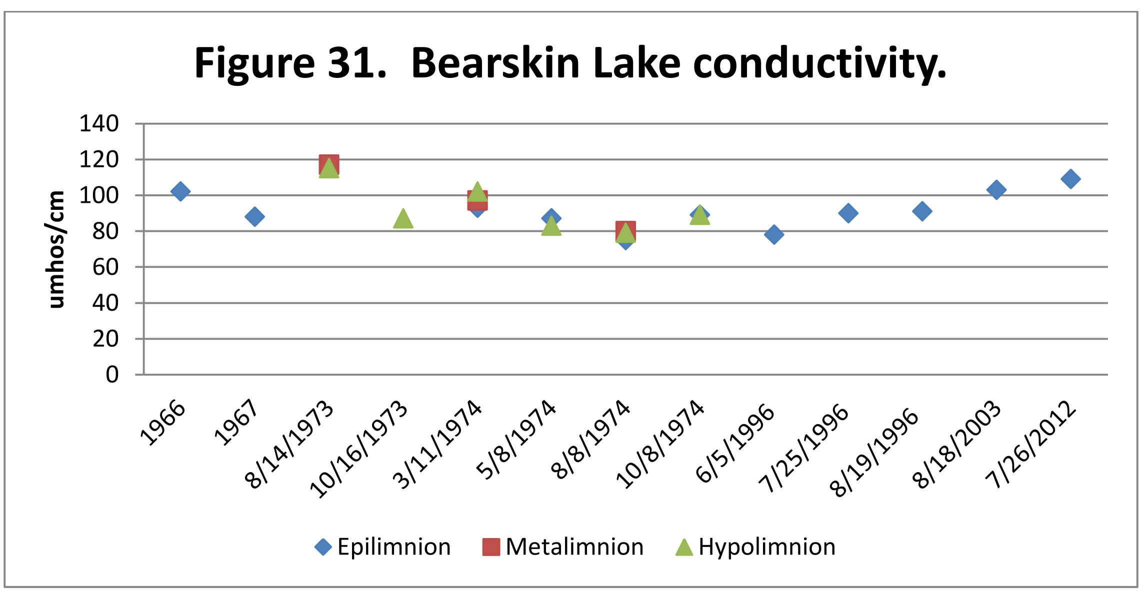
Sulfate in lake water is primarily related to the types of minerals found in the watershed, and to acid rain (Shaw et al., 2004). Sulfate was analyzed in 1973 and 74 for Bearskin Lake (Figure 30). New samples should be collected to better understand the current sulfate conditions in Bearskin Lake.



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). Figure 31 shows the conductivity values for Bearskin Lake collected at the deepest point of the lake.

A shoreline conductivity study was done on Bearskin Lake August 19, 1996. In 2013, White Water Associates conducted a shoreline conductivity study. For summaries and comparisons of these two studies, see Appendix E of the *Bearskin Lake Adaptive Management Plan.*



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. Figure 32 indicates that Bearskin Lake is alkaline. The average pH of Bearskin Lake is 7.6. It would be beneficial to monitor pH in the future to see if there are any trends.

Figure 32. Bearskin Lake pH.

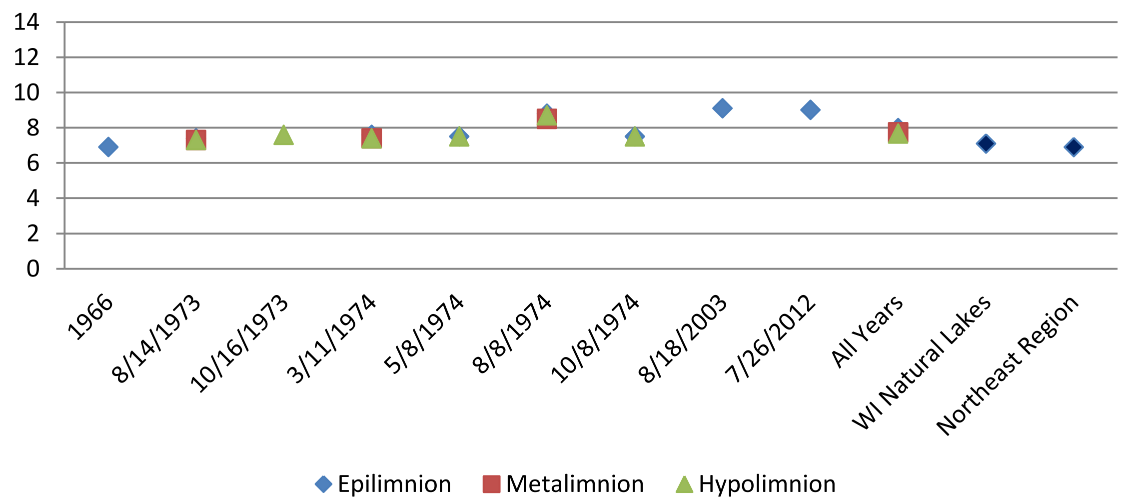


Table 4 indicates the effects pH levels less than 6.5 will have on fish. While moderately low pH does not usually harm fish, the metals that become soluble under low pH can be important. In low pH waters, aluminum, zinc, and mercury concentrations increase if they are present in lake sediment or watershed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

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. Figure 33 indicates alkalinity recorded for Bearskin Lake. Based on these values, Bearskin Lake is not sensitive to acid rain (Table 5).

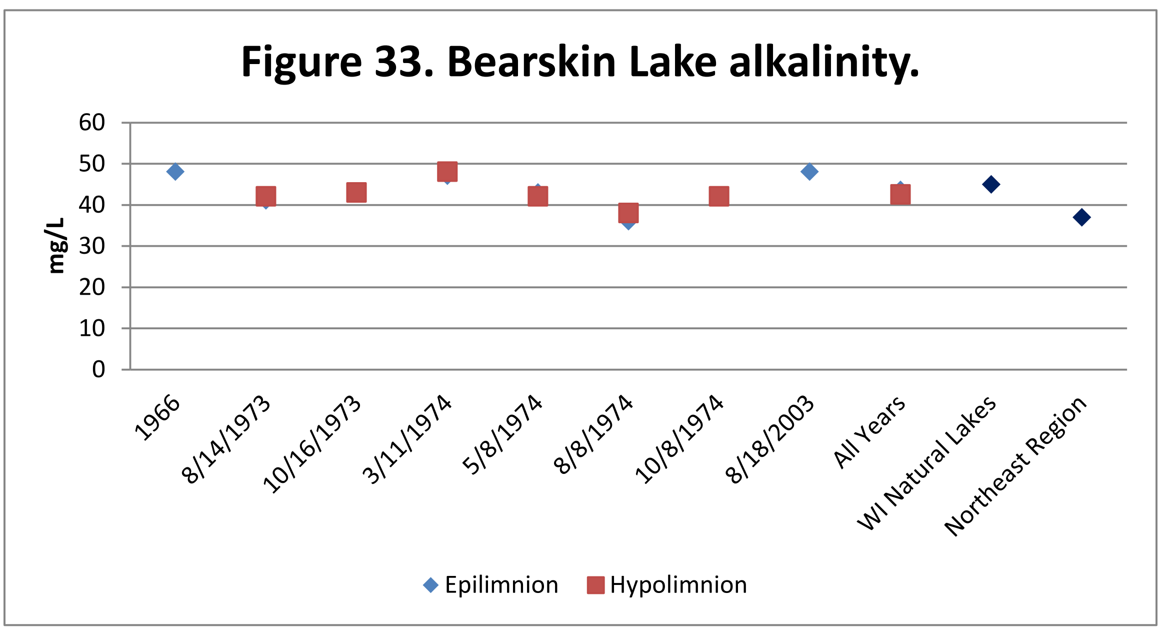


Table 5. Sensitivity of Lakes to Acid Rain (Shaw et al., 2004).	
Sensitivity to acid rain	***Alkalinity value (mg/L or ppm $CaCO_3$)***
High	0-2
Moderate	2-10
Low	10-25
Non-sensitive	>25

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 ($CaCO_3$) (Figure 34). Table 6 describes the hardness level of Bearskin Lake as "moderately hard water." New data should be collected to better understand Bearskin Lake's hardness level.

Figure 34. Bearskin Lake hardness.

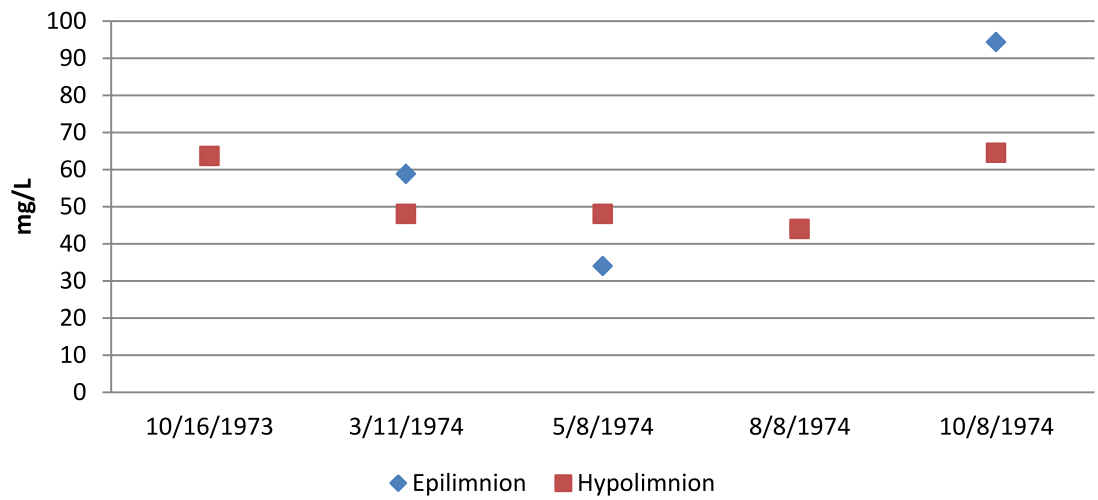
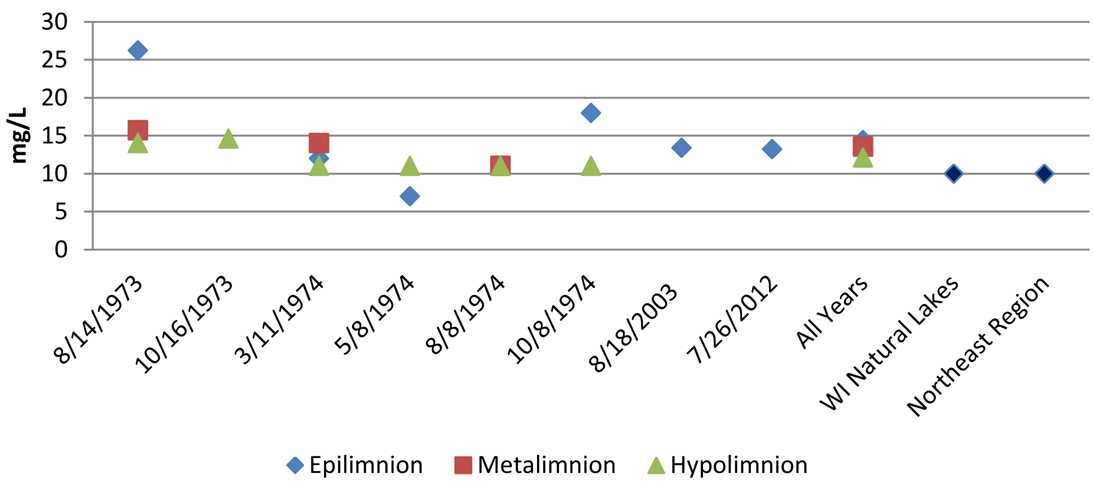


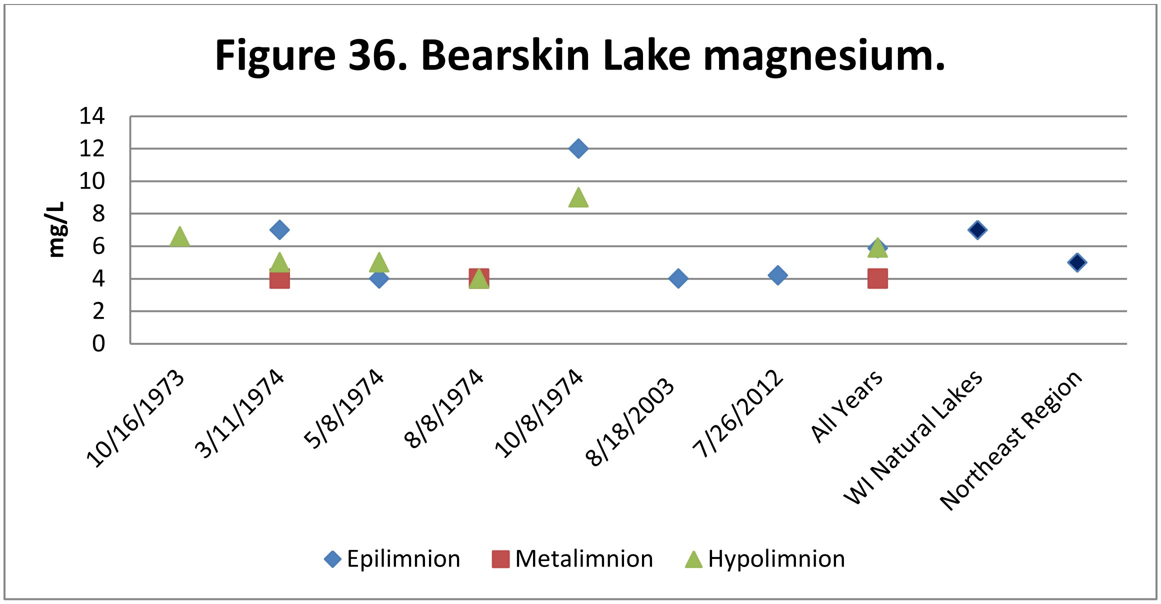
Table 6. Categorization of hardness (mg/L of calcium carbonate ($CaCO_3$)) (Shaw et al., 2004).	
Soft water	0-60
Moderately hard water	61-120
Hard water	121-180
Very hard water	>180

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. In lakes with calcium levels below 20 mg/L, it is still possible for mussels (native or invasive) to survive, however, successful reproduction and growth becomes difficult (Bartell et al., 2007). The average calcium level in Bearskin Lake is 12.1, which is an indication that zebra mussels could flourish if they were introduced to the lake (Figure 35). Magnesium levels are shown in Figure 36.

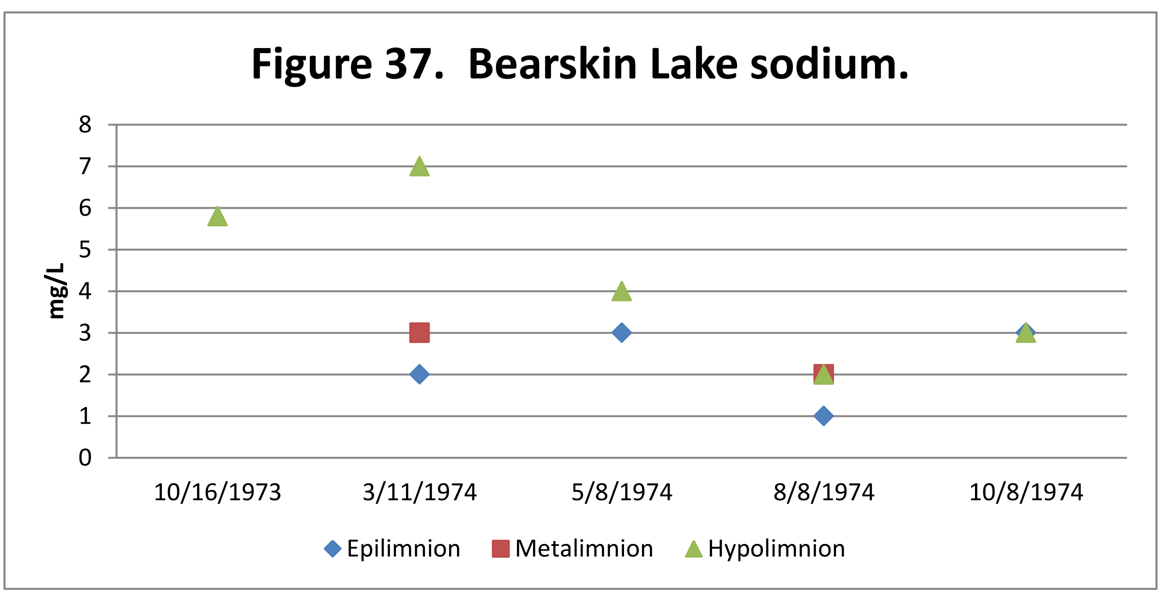
Figure 35. Bearskin Lake calcium.

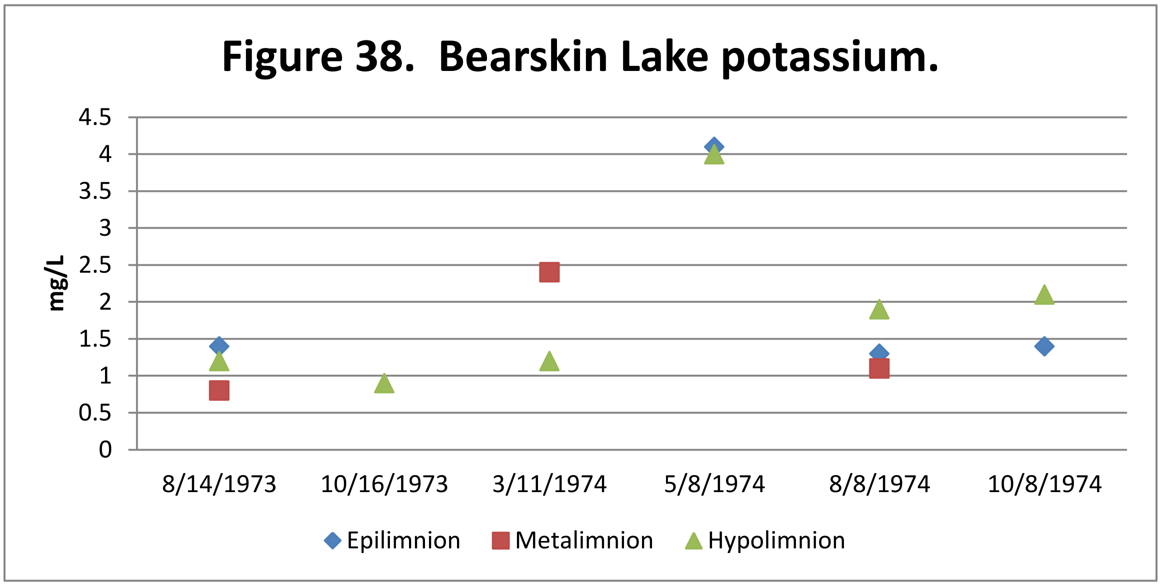




Sodium and Potassium

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). In 1973 and 1974 sodium (Figure 37) and potassium (Figure 38) were analyzed. New sodium and potassium data should be collected.





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. Base flow concentrations of DOC in undisturbed watersheds generally range from 1 to 20 mg/L carbon. A DOC level was collected in Bearskin Lake in August, 2013 and was 4.5 mg/L.

Silica

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

Aluminum

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

Iron

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

Manganese

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

Sediment

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

Aquatic Invasive Species

Bearskin Lake has two invasive species: rusty crayfish (observed 1961) and the Chinese mystery snail (2004).

Rusty crayfish are native to parts of Ohio, Tennessee, Kentucky and Indiana, and were likely introduced to Wisconsin waters by fishermen using the crayfish as bait (Gunderson, 2014). Rusty crayfish negatively affect other native crayfish species, cause destruction to aquatic plant beds, reduce fish populations by eating eggs, and cause shoreland owners recreational problems (Gunderson, 2014). It is illegal to possess both live crayfish and angling equipment simultaneously on any inland Wisconsin water (except Mississippi River) (WDNR, 2015a). It is also illegal to release crayfish into a water body without a permit (WDNR, 2015a). For more about rusty crayfish in Bearskin Lake, see Appendix H.

Chinese mystery snail was originally from Southeast Asia and Eastern Russia and was likely released to the Great Lakes from an aquarium between 1931 and 1942 (Kipp et al., 2015). The snail does not seem to have a significant impact on native species, but its ecological and anthropological threat comes from its potential to transmit parasites and diseases (Kipp et al., 2015). It is illegal to introduce the Chinese mystery snail into Wisconsin waters.

The University of Wisconsin-Madison's Aquatic Invasive Species Smart Prevention program classifies Bearskin Lake as "borderline suitable" for zebra mussels, based on calcium and conductivity levels found in the lake (UW-Madison).

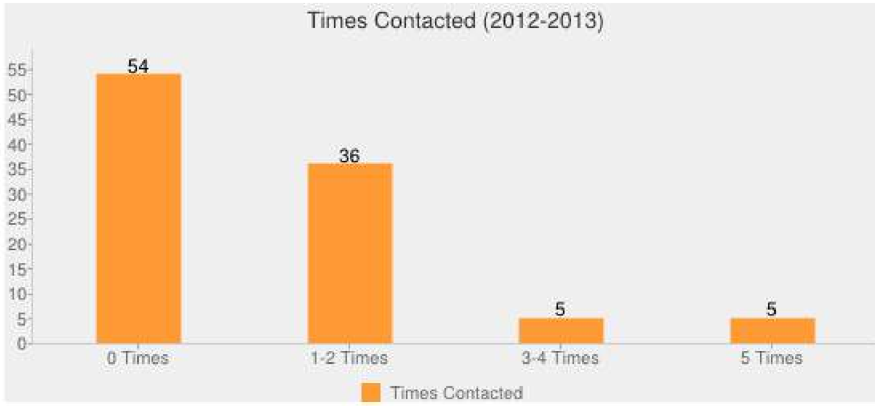
Zebra mussel veliger tows were conducted in 2003, 2004, 2010, and 2013 with no finds. In June, 2004 a search for Eurasian watermilfoil was conducted, but not found. In July, 2010 spiny water flea and fishhook water flea tows were conducted, and there were no finds.

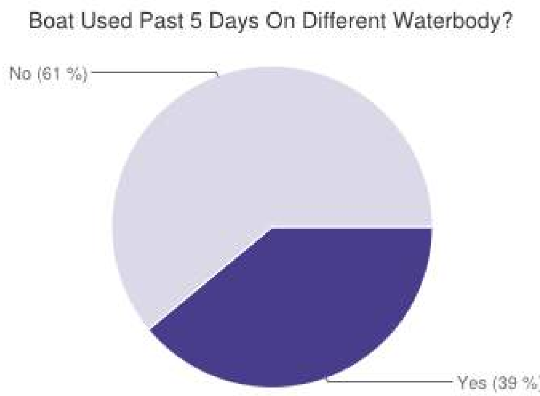
A volunteer should begin to monitor and record their search efforts into the SWIMS database for aquatic invasive species. It would be beneficial to educate someone living on the lake to identify aquatic invasive species and how to detect them and report them. Early detection is the key to many AIS.

Clean Boats Clean Waters (CBCW) is a program that inspects boats for aquatic invasive species and in the process educates the public on how to help stop the spread of these species. In 2007-2014, CBCW inspections took place at Bearskin Lake (Figures 39-44).

Figure 39. Clean Boats Clean Waters Bearskin Lake (WDNR, 2014).

Figure 40. Clean Boats Clean Waters Bearskin Lake (WDNR, 2014).





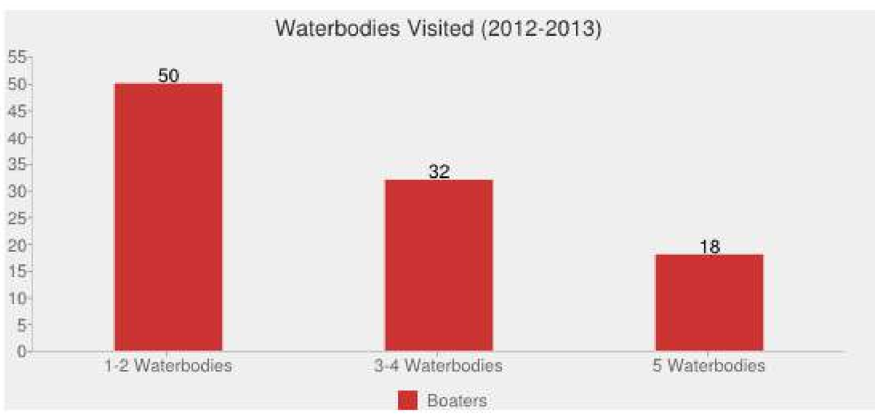


Figure 41. Clean Boats Clean Waters Bearskin Lake (WDNR, 2014).

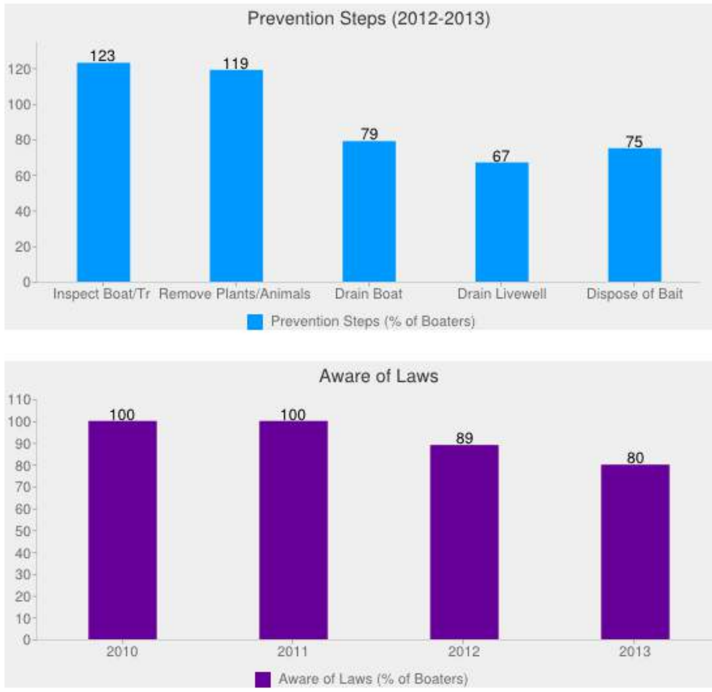


Figure 42. Bearskin Lake Clean Boats Clean Waters data (WDNR, 2014).

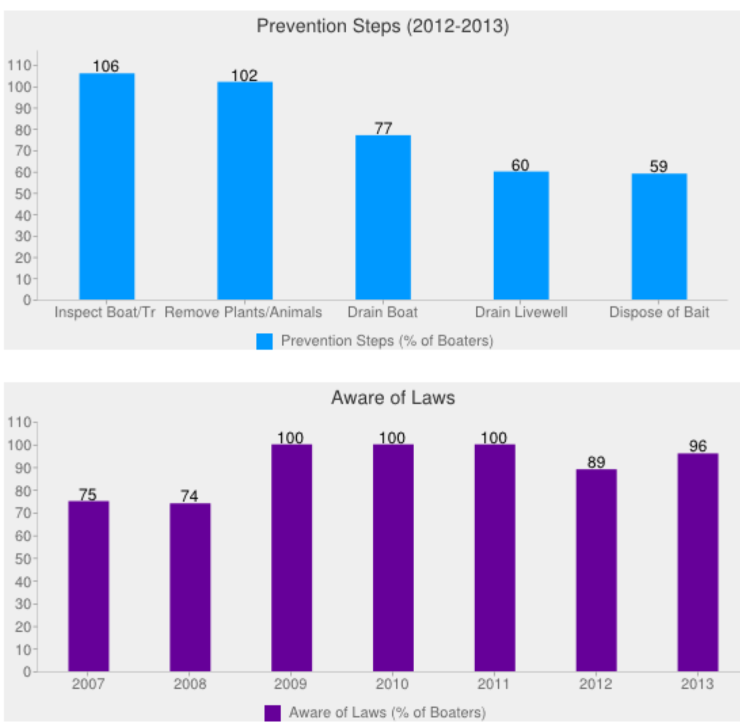


Figure 43. Bearskin Lake Clean Boats Clean Waters data (WDNR, 2014).

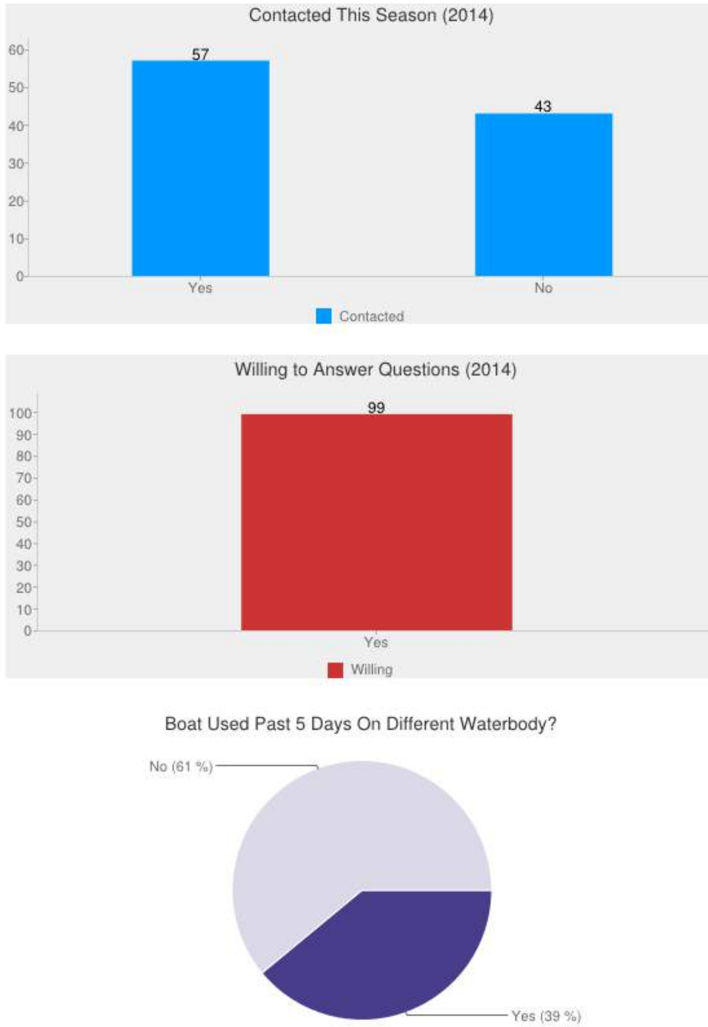
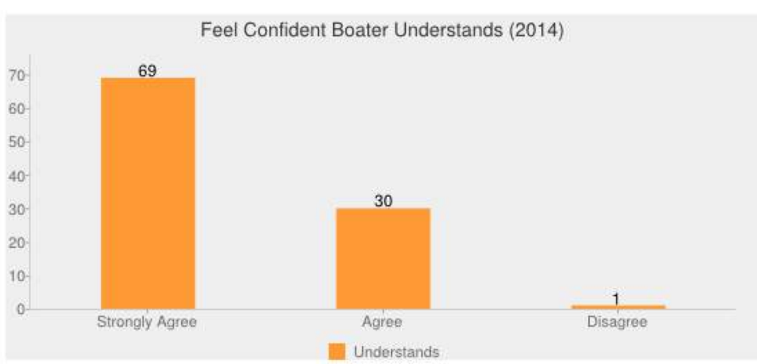


Figure 44. Bearskin Lake Clean Boats Clean Waters data (WDNR, 2014).



Literature Cited

Bartell, S.M., Y. Wu, S.K. Nair, J. Orr and J. Ragland. 2007. *Risk Assessment and Decision Analysis Support for Invasive Mussel Management for the St. Croix Basin and Adjacent Upper Mississippi River.* E2 Consulting Engineers, Inc. Maryville, TN and URS Group, Inc. Franklin, TN.

Camargo, Julio A., Álvaro Alonso (Lead Author); Raphael D. Sagarin (Topic Editor). 02 April 2007. *Inorganic nitrogen pollution in aquatic ecosystems: causes and consequences.* In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). Retrieved 2015. <http://www.eoearth.org/article/Inorganic_nitrogen_pollution_in_aquatic_ecosystems:_causes_and_consequences>

Carlson, R.E. 1977. *A Trophic State Index for Lakes.* Limnology and Oceanography. 22: 361-369.

Gunderson, Jeff. 2014. *Rusty Crayfish: A Nasty Invader*. Minnesota Sea Grant. Retrieved 2015. <http://www.seagrant.umn.edu/ais/rustycrayfish_invader>

Kipp, R.M., A.J. Benson, J. Larson, and A. Fusaro. 2015. *Cipangopaludina chinensis malleata*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved 2015. <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1045>

Kirchman, David L.; Suzuki, Yoshimi, Garside, Christopher, Ducklow, Hugh W. (15). 1991. *High turnover rates of dissolved organic carbon during a spring phytoplankton bloom.* Nature 352 (6336): 612–614. Doi:10.1038/352612a0. Retrieved 2015. <http://www.nature.com/nature/journal/v352/n6336/abs/352612a0.html.>

Lillie, R. A. and J. W. Mason. 1983. *Limnological Characteristics of Wisconsin Lakes.* Wis. Dept. of Natural Resources Tech. Bull. Page 138. Madison, WI.

McComas. 2006. *Lake Conditions through 2006 for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science, St. Paul, MN.

Newman, Dr. Jonathan. 1997. *Barley Straw Treatment of Algae*. IACR Centre for Aquatic Plant Management.

Olszyk, D. 1980. *Biological Effects of Acid Rain*. Testimony, Wis. Public Service Commission Docket No. 05-EP-2. 5 pp.

Shaw, B. Mechenich, C, and Klessig, L. 2004. *Understanding Lake Data (G3582).* Board of Regents of the University of Wisconsin System. Madison, WI.

University of Wisconsin-Madison, Center for Limnology, Vander Zanden Lab. *Aquatic Invasive Species Smart Prevention.* Retrieved 2015. <http://www.aissmartprevention.wisc.edu/>

Wisconsin Department of Natural Resources. 2014. *Clean Boats, Clean Waters*. Retrieved 2014. <http://dnr.wi.gov/lakes/cbcw/>

Wisconsin Department of Natural Resources. 2014. *Impaired Water Search*. Retrieved 2014. <http://dnr.wi.gov/water/impairedsearch.aspx>

Wisconsin Department of Natural Resources. 2015. *Rusty Crayfish-Round Lake*. Retrieved 2015. <http://dnr.wi.gov/lakes/invasives/AISDetail.aspx?roiseq=22705329>

Wisconsin Department of Natural Resources. 2015. *Surface Water Integrated Monitoring Systems (SWIMS) Database.* Retrieved 2015. <http://dnr.wi.gov/topic/surfacewater/swims/>

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

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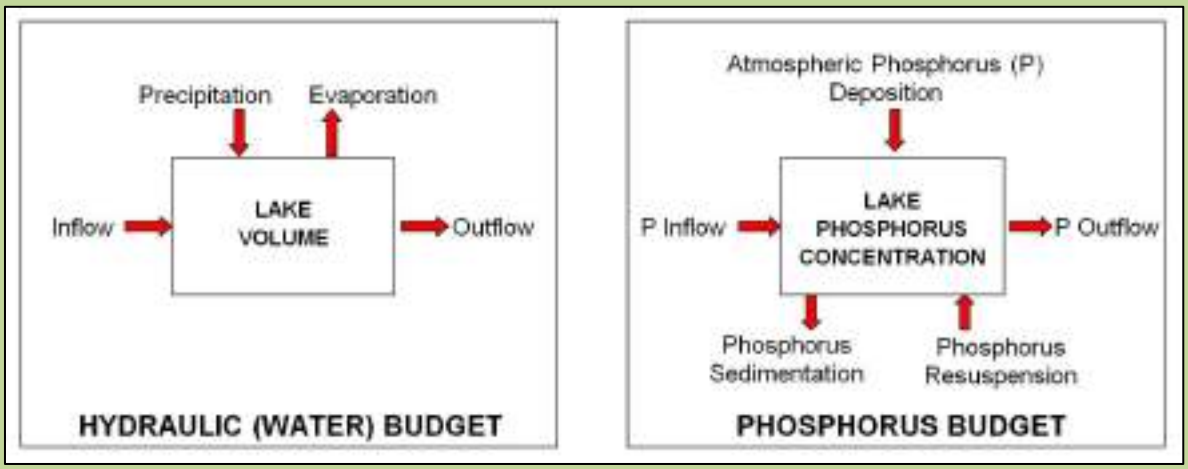
Watershed, Water Quality, and WiLMS Modeling

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.

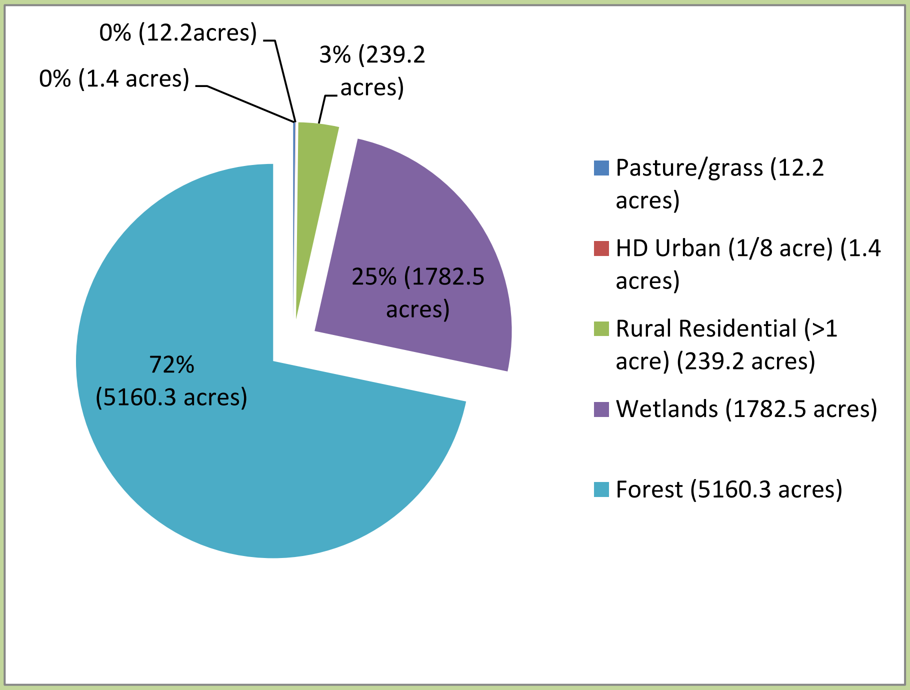
Internal loading refers to phosphorus (and other nutrients) that are present in the lake bottom sediment. Some of the phosphorus in a lake ecosystem continually falls to the bottom and becomes part of the sediment layer and is generally unavailable for plants. Under conditions of low dissolved oxygen, 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 Bearskin Lake. The 400.3 acre lake has a watershed of 7,195.6 acres and a drainage basin/lake area ratio of about 18 to 1. This is a relatively high ratio. Lakes with this size ratio combined with a mostly natural watershed cover type are likely to have lower quality (eutrophic) characteristics. This is the case with Bearskin Lake. The lake volume is 4636.8 acre-feet and the mean lake depth is 11.6 feet. The WiLMS model calculates the annual runoff volume as 7,315.5 acre-feet and the annual difference between precipitation and evaporation (precipitation minus evaporation) as 5.8 inches. The hydraulic loading for Bearskin Lake is 7,509 acre-feet per year and the areal water load is 18.8 feet per year. The WiLMS model calculates the annual lake flushing rate as 1.62 times per year and the water residence time (retention time) as 0.62 year.

The cover types in the Bearskin Lake watershed are shown in Figure 2 with their respective acreages. Forest cover type is the predominant land cover at 72%. Wetland cover is also important, comprising about 25% of the watershed.

Figure 2. Bearskin 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 Bearskin Lake. Non-point source phosphorus comes from many diffuse sources, and can be caused by rainfall or snowmelt moving over and through the ground (EPA, 2015). As the runoff moves, it picks up and carries away natural and human pollutants, finally depositing them into lakes, rivers, wetlands and ground waters (EPA, 2015). Point source pollutants, on the other hand, have a specific source. For example, pollution from industrial plants or sewage treatment plants is considered point source pollution. No point-source data is available for Bearskin Lake. The WiLMS model indicated that 321 kg (708 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 Bearskin Lake comes from forest 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	12.2	0.1	0.3	0.5	0.5	0	1	2
High Density Urban (1/8 acre)	1.4	1	1.5	2	0.3	1	1	1
Mid Density Urban (1/4 acre)	0	0.3	0.5	0.8	0	0	0	0
Rural Residential (>1 acre)	239.2	0.05	0.1	0.25	3	5	10	24
Wetlands	1782.5	0.1	0.1	0.1	22.5	72	72	72
Forest	5160.3	0.05	0.09	0.18	58.6	104	188	376
Lake Surface	400.3	0.1	0.3	1	15.2	16	49	162
				Totals	100.1	198	321	637

The WiLMS generated an estimate of internal loading of phosphorus. These data are presented in Table 2. The model predicts that about 708 pounds (321 kg) of phosphorus are released each year from Bearskin Lake sediments and available to algae and aquatic plants. The model calculates a predicted phosphorus retention coefficient as 0.63 (this represents the fraction of phosphorus entering the lake that is lost by settling to the sediment). The observed phosphorus retention coefficient is -0.37 indicating that phosphorus availability from the sediment is much higher than predicted. These data are consistent with other measures and observations that indicate that Bearskin Lake is eutrophic.

Table 2. WiLMS Method 1 – Complete Phosphorus Mass Budget	
Parameter	**Value**
Phosphorus Concentration of Lake (input into model)	47.4 mg/m^3
Phosphorus Inflow Concentration	34.6 mg/m^3
Areal External Loading	198 mg/m^2-year
Predicted Phosphorus Retention Coefficient *(the predicted fraction of phosphorus entering the lake that is lost by settling to the sediment)*	0.63
Observed Phosphorus Retention Coefficient	-0.37
Internal Load (amount released annually from the sediment)	708 pounds (321 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 pounds of phosphorus delivered to the lake from non-point source was calculated at 345.8 kg (compare to the 272.1 kg under the actual conditions in the watershed).

Literature Cited

Brylinsky, M. 2004 User's Manual for Prediction of Phosphorus Concentration In Nova Scotia Lakes: A Tool for Decision Making. Version 1.0. Prepared For The Nova Scotia Water Quality Objectives and Model Development Steering Committee, Nova Scotia Department of Environment and Labour. Prepared by Acadia Centre for Estuarine Research Acadia University Wolfville, Nova Scotia B4P 2R6 January 2004.

Environmental Protection Agency (EPA). 2015. *Polluted Runoff: Nonpoint Source Pollution.* Retrieved 2015. <http://www.epa.gov/polluted-runoff-nonpoint-source-pollution>

Shaw, B. Mechenich, C, and Klessig, L. 2004. Understanding Lake Data (G3582). Board of Regents of the University of Wisconsin System. Madison, WI.

WDNR. 2003. Wisconsin Lake Modeling Suite. PUBL-WR-363-94.

Appendix E

Bearskin Lake Conductivity Study

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Bearskin Lake Conductivity Study

Introduction

Conductivity (sometimes known as "specific conductance") is the measure of the water's ability to conduct an electric current (Shaw et al., 2004). It depends on ions (such as chloride, calcium, potassium or iron) in the water. The more ions present, the higher the conductivity. A lake's natural conductivity is influenced by the geology and soils in the watershed. Minerals that leach (dissolve) from the bedrock and soils enter the lake through runoff and contribute to conductivity. Human activities also affect lake water conductivity. When elevated or increasing conductivity is observed in a lake, it can be due to human activity such as road salting, faulty septic systems, urban runoff, or agricultural runoff. All these sources contribute dissolved substances (and therefore ions) to the water. New construction that alters runoff patterns and exposes new soil and bedrock areas can also contribute to elevated conductivity. Conductivity is also influenced by temperature. As water temperature increases, conductivity increases (EPA, 2012).

Shoreline conductivity studies are sometimes undertaken to determine if there are any faulty septic systems or other pollution sources present that could be delivering excess nutrients into the lake. Low values of conductivity are characteristic of high-quality, oligotrophic (low nutrient) lake waters (GVSU, 2014). High values of conductivity are observed in eutrophic lakes where plant nutrients (fertilizers) are in great abundance (GVSU, 2014). Very high values are indicators of possible pollution sites (GVSU, 2014). A shoreline study compares conductivity levels found along the shoreline with baseline levels found in the middle of the lake.

1996 Shoreline Conductivity Study

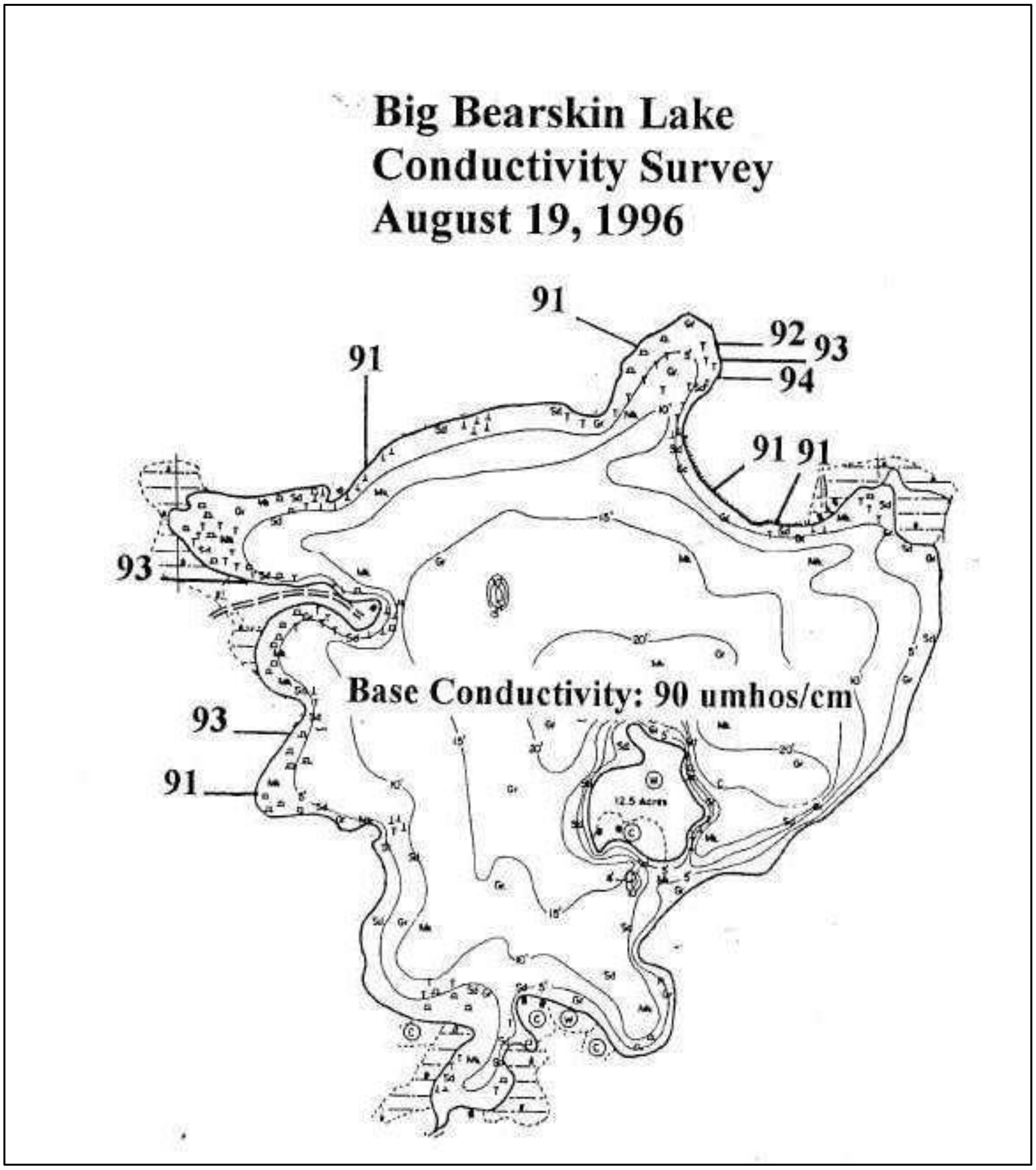
Procedure

On August 19, 1996, professional consultants conducted a shoreline conductivity study on Bearskin Lake. The object of this study was to observe any changes in conductivity around the lake (McComas, 2000). An increase or decrease of conductivity could indicate an inflow of groundwater, whether natural or from a septic tank (McComas, 2000). In the 1996 conductivity study, a Yellow Springs Instruments (YSI) conductivity meter with a probe was attached to the end of an eight foot pole. The entire shoreline was surveyed (McComas, 2000).

Results

The 1996 baseline conductivity value (taken from the center of the lake) was 90 µmhos/cm. As stated in the report, "Several areas around Bearskin Lake had readings above the baseline level. Because of a lack of homes or because the homes are far removed from the lakeshore, it does not appear that the elevated conductivity is from septic leachate discharges. Rather, the results suggest that the west and north ends of Bearskin Lake may be receiving groundwater inflows" (McComas, 2000). Figure 1 was taken from the previous Bearskin Lake management plan.

Figure 1. Areas of highest conductivity around Bearskin Lake, 1996 (McComas, 2000).



2013 Shoreline Conductivity Study

Procedure

White Water biologists conducted the shoreline conductivity study on September 5, 2013. Eight points were positioned in the middle of the lake to establish a baseline control value to compare to shoreline values. Samplers began at the boat landing and collected water samples for conductivity reading approximately every 100 feet around the shoreline. The coordinates for each perimeter point were plotted in a GPS prior to sampling, so that identifying sample points locations and navigation in the field was more efficient. Water conductivity samples were analyzed using a Myron Ultrameter II 6P conductivity meter. At each sample site the conductivity level was recorded along with any comment (e.g., site not accessible, fishermen, etc.).

Results

There was a total of 322 sample points around Bearskin Lake, plus the 8 control sites. Of the 322 sample points, 45 sites were not sampled (14%).

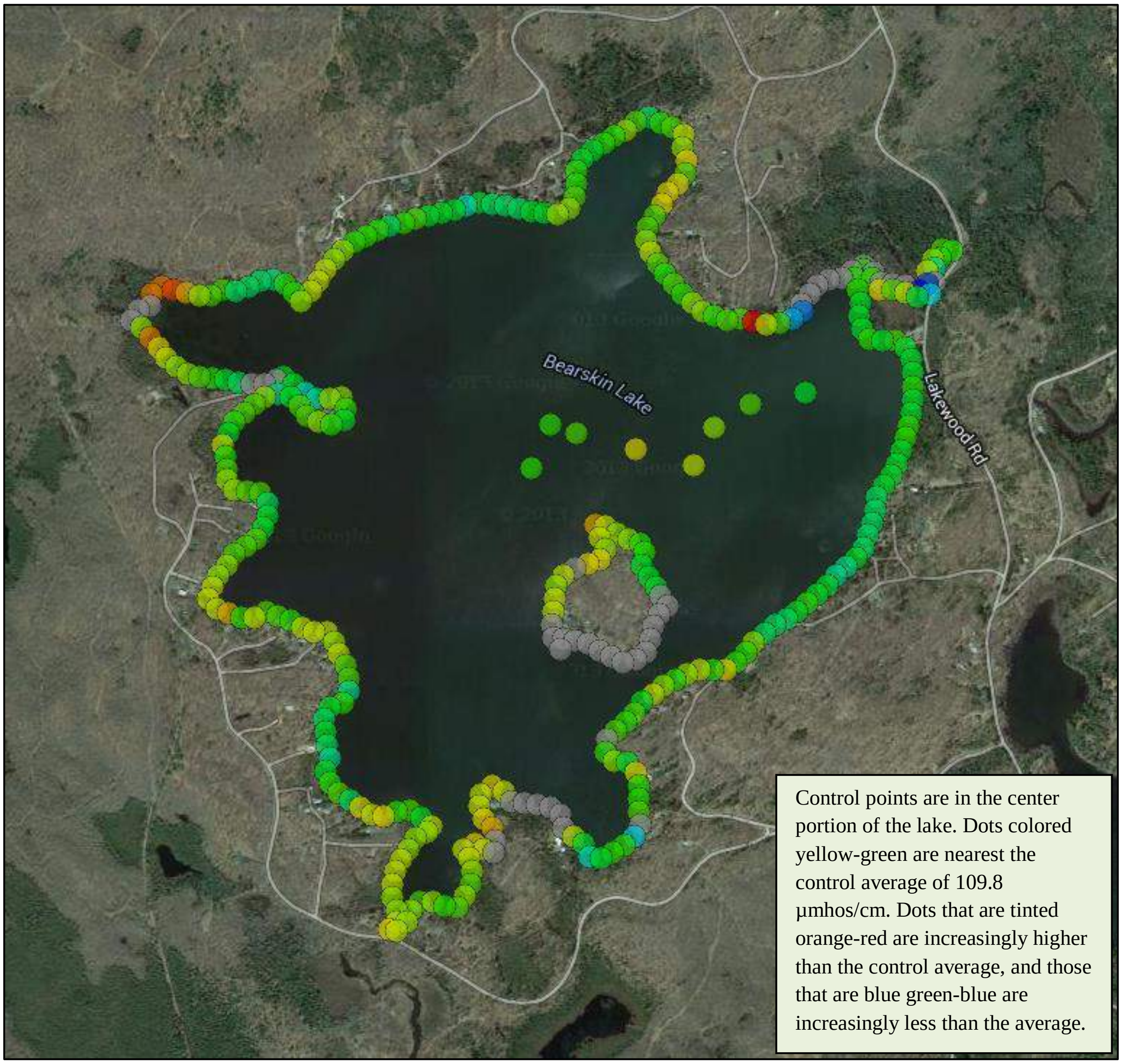
The conductivity levels ranged from 105.2 µmhos/cm to 110.9 µmhos/cm (a range of 5.7 µmhos/cm). The eight control points had an average conductivity of 109.8 µmhos/cm. The standard deviation of these points was very small, at 0.2. The confidence interval (at 95%) was ±0.1. Any shoreline-sampled value that was within the range of the confidence interval (109.8±0.1, or 109.7 to 109.9) was not statistically different than the control value mean. There were 81 sites that fell below the 95% confidence interval and 65 that were above it. The number of sites outside the confidence interval is high because the confidence interval range is very small.

Figure 2 displays the shoreline sample points of Bearskin Lake. The control values are seen in the center portion of the lake. Dots colored yellow-green are nearest the control average (109.8 µmhos/cm). Dots that are tinted orange-red are increasingly higher than the control average, and those that are blue green-blue are increasingly less than the average.

The majority of Bearskin Lake's shoreline appears to have similar conductivity levels to the eight control locations in the center of the lake. The conductivity values in lobe of the lake near the inlet of Muskie Creek (northeast) appear below the control average (green/blue dots).

A western bay of the lake appears to have slightly higher conductivity levels than the baseline levels (orange dots). One location along the northeast shoreline appears to have a higher conductivity level than the control average (red dot). It's possible this area with increased conductivity levels is caused by runoff of materials (for example, lawn fertilizers or road salts) into the lake. Although this value is technically higher than the control average, its true value (110.9 µmhos/cm) is not greatly higher than the control average (109.8 µmhos/cm).

Figure 2. Bearskin Lake conductivity levels.



Comparison of Results

In the 17 years since the 1996 study, conductivity levels have apparently increased slightly. This conclusion assumes, however, that the respective conductivity meters (1996 and 2013) were calibrated and accurate. The baseline conductivity level (taken from the center of the lake) was 90 µmhos/cm in 1996, and 109.8 µmhos/cm in 2013. In 1996, areas of Bearskin Lake where conductivity levels were highest were along the western and northeast shores of the lake, although their values were not significantly higher than the baseline value. In 2013, most areas along Bearskin Lake's shoreline had similar conductivity levels as the baseline average. Similar to 1996, a northwestern bay had slightly higher conductivity levels than the baseline level. Because of the precision of the 2013 control readings (that is, low variability and narrow confidence interval), the study was highly sensitive to either lower or higher readings. Despite this, most of the shoreline readings of conductivity were not distinguishable from the control levels. Even the couple areas of red-orange dots were only slightly above the background, although these areas might be examined closer for possible explanation.

Discussion

Elevated conductivity readings are typically due to human activity such as road salting, faulty septic systems, and agricultural runoff. The following are things riparian landowners can do to minimize the potential for increasing conductivity:

1. Limit soil disturbance and bedrock exposure on your property
2. Create vegetative buffers to filter and reduce the amount of storm water runoff from your property
3. Replace a conventional beach to a natural beach
4. Pump your septic system tank once every one to three years
5. Replace or upgrade a failing leach field immediately
6. Discuss alternatives to road salt use near the lake and its tributaries

Literature Cited

Environmental Protection Agency (EPA). 2012. *Water: Monitoring & Assessment, Conductivity*. Retrieved 2015. <http://water.epa.gov/type/rsl/monitoring/vms59.cfm>

Grand Valley State University (GVSU). 2014. *Annis Water Resources Institute: Conductivity*. Retrieved 2015. <https://www.gvsu.edu/wri/education/instructor-s-manual-conductivity-11.htm>

McComas, Steve. 2000. *Comprehensive Lake Management Plan for Big Bearskin Lake, Oneida County, Wisconsin.* Blue Water Science, St. Paul, Minnesota.

Shaw, B. Mechenich, C, and Klessig, L. 2004. *Understanding Lake Data (G3582).* Board of Regents of the University of Wisconsin System. Madison, WI.

Appendix F
Bearskin Lake Littoral and Shoreline Activities

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Bearskin Lake Littoral and Shoreline Activities

Introduction

Bearskin Lake's littoral and shoreline zones were assessed in 2013 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 Bearskin Lake will stand as a baseline against which future changes can be measured and can be used to compare Bearskin 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 site, 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 sites. A photo was also taken at each site.

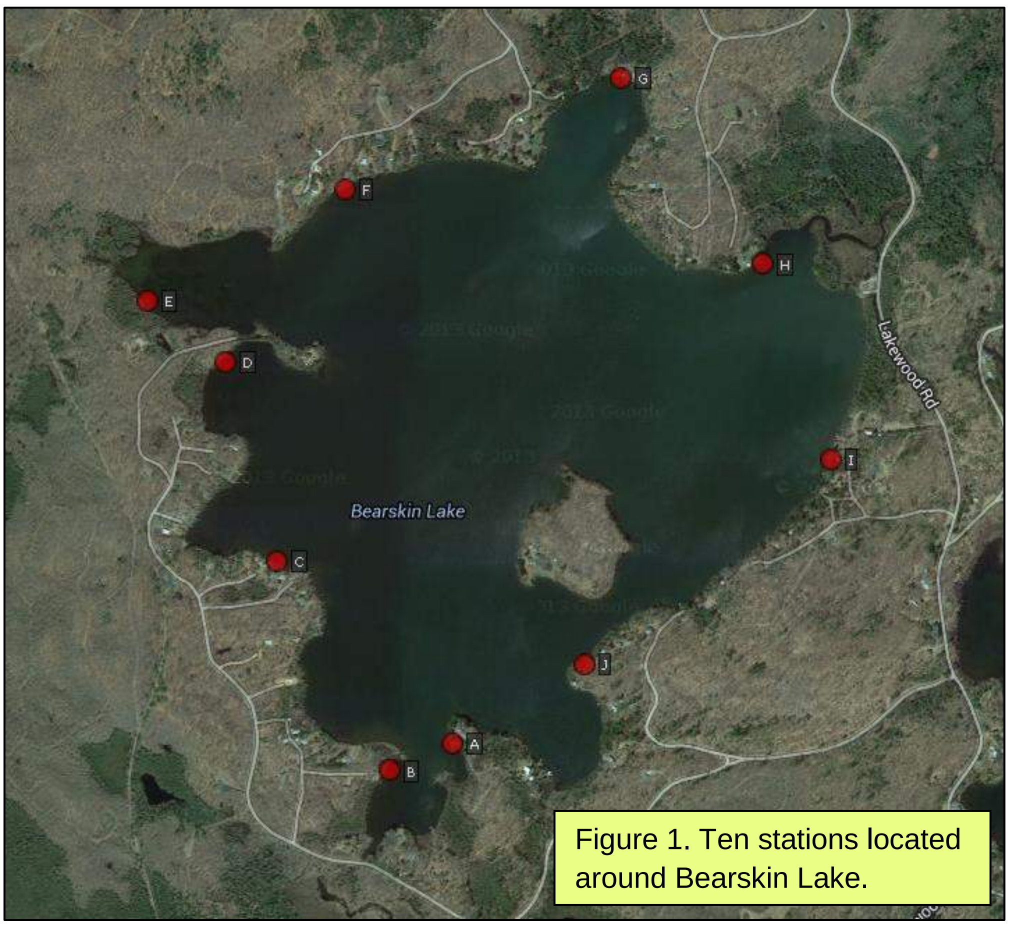

Figure 1. Ten stations located around Bearskin Lake.

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

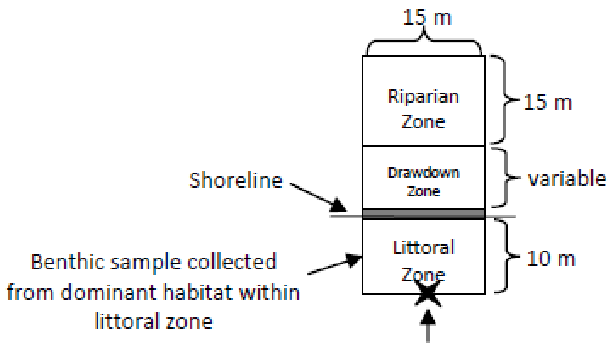

Figure 2. Dimensions and layout of a P-Hab station.

Results

The average depth of the ten stations was 2.75 feet (the range was from 2 to 4 feet). No surface film was observed at nine stations; however, pollen was present on the surface at one station. Table 1 contains the littoral zone bottom substrate data collected from the ten Bearskin Lake sampling stations. Bedrock was not observed as a bottom substrate at any station. Boulders were sparse at three stations. Cobble was present at five stations. Gravel was present at five stations. Sand was present at eight stations. Silt, clay, and muck were encountered at seven stations. Woody debris was present at eight stations. Brown sediment was encountered at all stations and no odor was associated with the bottom substrate at any of the 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	0	0	0	0	1	0	0	1	1
Cobble	2	0	2	0	0	3	0	0	3	3
Gravel	2	0	0	3	0	3	0	0	2	2
Sand	3	0	2	3	0	2	3	3	2	2
Silt, Clay, Muck	0	3	2	1	4	1	2	1	0	0
Woody Debris	1	1	1	1	0	1	1	0	2	1
Color	Brown	Brown	Brown	Brown	Brown	Brown	Brown	Brown	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 (plants) in the littoral zone. Submergent macrophytes were observed at three stations with moderate to heavy coverage.

Emergent macrophytes were observed at one station with heavy coverage. Four stations had floating macrophytes present with sparse and moderate coverage. Total macrophyte cover was sparse at one station, moderate at one station, and heavy at three stations. Macrophytes extended lakeward at four of the stations.

Table 2. USEPA Habitat Characterization – Littoral Zone Aquatic Macrophytes.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Submergent	0	0	2	3	3	0	0	0	0	0
Emergent	0	3	0	0	0	0	0	0	0	0
Floating	0	2	0	1	1	0	0	1	0	0
Total Aquatic Macrophyte Cover	0	3	2	3	3	0	0	1	0	0
Do macrophytes extend lakeward from plot?	No	Yes	Yes	Yes	Yes	No	No	No	No	No
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 were observed at three stations with sparse and moderate coverages. Woody debris and snags > 0.3 meters in diameter were observed at five stations. Woody brush/woody debris < 0.3 meters in diameter was found at seven stations. Inundated live trees (> 0.3 meters in diameter) were observed at two stations. Overhanging vegetation within one meter of the surface was observed at nine stations. Ledges or sharp drop-offs were observed at three stations. Boulders were observed at two stations. Finally, human structures (such as docks, landings, etc.) were observed as fish cover at four stations.

Table 3. USEPA Habitat Characterization – Littoral Zone Fish Cover.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Aquatic & Inundated Herbaceous Cover	0	2	0	0	1	0	0	1	0	0
Woody Debris/Snags >0.3 m dia.	2	0	2	1	0	2	0	0	2	0
Woody Brush/ Woody Debris <0.3 m dia.	0	1	1	2	0	1	0	1	2	1
Inundated Live Trees >0.3 m dia.	0	0	0	0	0	0	0	0	1	1
Overhanging veg. w/in 1 m of surface	3	4	1	1	1	2	0	2	2	2
Ledges or Sharp Drop-offs	2	0	0	2	0	0	0	0	0	3
Boulders	0	0	0	0	0	3	0	0	2	0
Human Structures (docks, landings, etc.)	0	0	1	0	0	2	4	0	2	0
0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)										

Table 4 presents observations made on the riparian zone canopy (> 5 meters high), understory (0.5 to 5 meters), and ground cover (<0.5 meters). Mixed canopy type (conifer and deciduous) was observed in eight stations. "No canopy" was observed at two stations. The coverage of big trees (>0.3 meters diameter) was sparse at two stations, moderate at four stations, heavy at one station, and very heavy coverage at one station. The coverage of small trees (<0.3 meters diameter) was sparse to moderate at four stations and heavy at three stations. Mixed (conifer and deciduous) understory type was observed at four stations and deciduous canopy type was observed at five stations. No understory was observed at one station. Coverage of understory woody shrubs and saplings was sparse (two stations), moderate (three stations), heavy (four stations), and very heavy (one station). Tall herbs, grasses, and forbs were present at two stations with sparse and moderate coverage. Woody shrubs and saplings were observed as ground cover at nine stations, five of which were sparse coverage, one had moderate coverage, and three had heavy coverage. Herbs, grasses, and forbs were observed as groundcover at all ten stations with coverages of sparse (three stations), moderate (two stations), heavy (one station), and very heavy (three stations). Standing water or inundated vegetation was observed at four stations. Barren, bare, dirt, or buildings were observed at three 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	Mix	Mix	Mix	Mix	None	None	Mix	Mix
Big Trees >0.3 m dia.	2	1	1	2	2	3	0	0	2	4
Small Trees <0.3 m dia.	1	1	3	2	3	3	0	0	0	2
UNDERSTORY (0.5 to 5 m high)										
Type	Dec	Dec	Dec	Dec	Mix	Mix	None	Dec	Mix	Mix
Woody Shrubs and Saplings	2	4	3	3	3	2	1	3	1	2
Tall Herbs, Grasses, Forbs	0	0	0	1	0	2	0	0	0	0
GROUND COVER (<0.5 m high)										
Woody Shrubs and Saplings	1	3	3	3	2	1	0	1	1	1
Herbs, Grasses and Forbs	2	3	2	4	1	4	4	2	1	1
Standing Water/ Inundated Veg.	0	2	0	1	2	0	0	4	0	0
Barren, Bare Dirt, or Buildings	0	0	2	1	0	0	0	0	2	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; BE = Broadleaf Evergreen										

Table 5 presents observations recorded on the riparian shoreline substrate zone. Bedrock was not observed at any of the stations. Boulders were observed at three stations with sparse (two stations) and very heavy (one station) coverage. Cobble was observed at five stations with sparse (four stations) and moderate (one station) coverage. Gravel was observed at two stations with sparse coverage. Sand was observed at one station with moderate coverage. Silt, clay, muck was observed at three stations with moderate (one station), heavy (one station), and very heavy (one station) coverages. Woody debris was observed at eight stations with sparse (seven stations) and very heavy (one station) coverages. Vegetation or other was observed at all stations with sparse (one station), moderate (one station), heavy (three stations), and very heavy (five stations) coverages.

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	0	0	0	0	0	1	4	0	1	0
Cobble	1	0	1	0	0	1	2	0	1	0
Gravel	0	0	1	0	0	1	0	0	0	0
Sand	0	0	0	0	0	0	0	2	0	0
Silt, Clay, Muck	0	4	0	0	3	0	0	2	0	0
Woody Debris	0	1	1	1	1	4	0	1	1	1
Vegetation or other	4	3	3	4	4	2	1	3	4	4
0=Absent (0%); 1=Sparse (<10%); 2=Moderate (10-40%); 3=Heavy (40-75%); 4=Very Heavy (>75%)										

Table 6 displays human influences in the riparian zone. Buildings were observed outside the plot at seven stations and inside the plot at five stations. Commercial facilities were observed inside and outside of the plot at one station. Docks were observed inside the plot at four stations and outside the plot at two stations. Walls, dykes, revetments were located within the plot at two stations and outside the plot at two stations. Roads were present outside the plot at one station. Lawn was observed inside the plot at two stations and outside at three stations. All other human influences (park facilities, manmade beaches, landfill, power lines, row crops, pasture, or orchards) were not observed.

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

Table 7 classifies littoral fish macrohabitat. Human disturbance was observed at five stations and was classified as low (three stations), moderate (one station), and high (one station). Cover class was recorded as patchy (five stations), no/little (three stations), and continuous (two stations). Cover type was recorded as woody (six stations), vegetation (six stations), artificial (three stations), and boulder (two stations). Dominant substrate was recorded as mud/muck (five stations), cobble/boulder (three stations), and sand/gravel (two stations).

Table 7. USEPA Habitat Characterization – Littoral Zone Macrohabitat Classification.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Human Disturbance	Low	None	Mod	None	None	None	High	None	Low	Low
Cover Class	Patchy	Cont	Patchy	No/Lit	Cont	No/Lit	Patchy	Patchy	Patchy	No/Lit
Cover Type	Woody Veg	Woody Veg	Art	Woody	Veg	Woody Veg	Art Bould	Woody Veg	Art Bould	Woody Veg
Dominant Substrate	C/B	M/M	M/M	M/M	M/M	S/G	S/G	M/M	C/B	C/B
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 flat at one station, gradual at four stations, steep at two stations, and near vertical at three stations. The vertical height from waterline to the high water mark varied at all stations. The horizontal distance from waterline to the high water mark was zero, except at one station where it was a 0.09 m.

Table 8. USEPA Habitat Characterization – Within Plot Bank Features.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Angle	Grad	Grad	Grad	NV	Flat	Steep	Steep	Grad	NV	NV
Vertical Height (m) to HWM	0.15	0.04	0.15	0.15	0.04	0.25	0.09	0.1	0.1	0.1
Horizontal Dist. (m) to HWM	0	0	0.09	0	0	0	0	0	0	0
HWM = High Water Mark; Flat = <5 degrees; Grad = Gradual (5-30 degrees); Steep (30-75 degrees)										

Table 9 shows the invasive plant and invertebrate species found. Rusty crayfish were present at three stations and the Chinese mystery snail was present at one station. No invasive species were observed in the shoreline/riparian plot.

Table 9. USEPA Habitat Characterization – Invasive Plant and Invertebrate Species.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Target Invasive Species in Littoral Plot	Rusty	Rusty	None	None	CMS	None	None	None	Rusty	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										

Table 10 shows the wood and invasive plant species data. 118 pieces of small woody material (>5cm) were counted at seven stations. Twenty-six pieces of large woody material (>10 cm) were counted at seven stations. None of the target invasive species was observed.

Table 10. WDNR Supplemental Methodology– Wood and Invasive Plant Species.										
Station	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Wood: >5cm diameter	0	3	31	20	0	38	18	4	4	0
Wood: >10cm diameter	0	1	8	8	1	4	2	0	2	0
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

Riprap (one station) and lawn (two stations) were found in at four stations in Bearskin Lake (Table 11). Seawalls and artificial beaches were not present. Residences were observed in the riparian plot at one station and in the upland plot of six stations. Commercial buildings were not observed. Structures such as sheds or boat houses were observed at one station in the riparian plot and at four stations in the upland plot. A boat lift was observed at one station. A swim raft was found at one station. Docks were observed at four stations. The WDNR protocol called for counting the number of piers between each of the ten stations. One hundred twenty-five piers were counted around the perimeter of Bearskin Lake.

Table 11. WDNR Supplemental Methodology– 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	0	0	0	0	4	4	0	0	0
Artificial beach	0	0	0	0	0	0	0	0	0	0
Lawn	1	0	0	0	0	0	0/4	0	1/1	0
Pavement	0	0	0	0	0	0	0	0	0	0
HUMAN DEVELOPMENT (1 number given for riparian plot; if 2 numbers, 1^{st} for riparian plot & 2^{nd} for upland plot)										
Residences	0/1	0	0/4	0	0	0	0/1	0/1	1/2	0/1
Commercial buildings	0	0	0	0	0	0	0	0	0	0
Structures (sheds/boat houses)	0/1	0	0/1	0	1	0/1	0/1	0	0	0
Boat lifts	0	0	0	0	0	0	1	0	0	0
Swim rafts	0	0	1	0	0	0	0	0	0	0
Docks	1	0	0	0	0	0	1	1	1	0
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	8	17	19	1	4	19	20	5	24	8

The USEPA 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 in the composite sample. A total of twenty-three taxa and 665 individual organisms were identified.

Table 12. Composite Benthic Macroinvertebrate Sample from Bearskin Lake.			
Taxon	**Count**	**Taxon**	**Count**
Annelida: Hirudinae (6), Oligochaeta (12)	18	Trichoptera (caddisflies): Lepidostomatidae (1), Leptoceridae (5), Polycentropodidae (2), Psychomyiidae (1), Sericostomatidae (1)	10
Crustacea: Amphipoda (39), Isopoda (29)	68	Coleoptera (aquatic beetles): Haliplidae (7 adults)	7
Arachnoidea: Hydracarina (11)	11	Diptera (true flies): Ceratopogonidae (4), Chironomidae (145)	149
Ephemeroptera (mayflies): Caenidae (59), and Ephemerellidae (1)	60	Mollusca: Gastropoda: Hydrobiidae (137), Planorbidae (11), Valvatidae (8), Viviparidae (1)	157
Zygoptera (damselflies): Coenagrionidae (8)	8	Mollusca: Pelecypoda: Sphaeriidae (175)	175
Hemiptera: Corixidae (1), Pleidae (1)	2	**Total Taxa**	**23**

Finally, the USEPA protocol called for a fecal indicator sample at the final sampling station (Station J). The collected sample was analyzed for *Escherichia coli* (*E. coli*). The *E. coli* analysis resulted in no detection of *E. coli.* The USEPA recommends a water quality advisory (for swimming) when a level of the indicator bacterium *E. coli* exceeds a limit is 235 CFU per 100 milliliters.

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. Bearskin Lake USEPA & WDNR Physical Habitat Locations.		
Station	*Latitude*	*Longitude*
A	45.7253	-89.6841
B	45.7248	-89.6860
C	45.7293	-89.6895
D	45.7336	-89.6911
E	45.7349	-89.6935
F	46.7373	-89.6874
G	45.7397	-89.6789
H	45.7357	-89.6745
I	45.7315	-89.6724
J	45.7271	-89.6800

Station A – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment

Photograph taken 6/4/2013, White Water Associates, Inc.

Station B – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
Photograph taken 6/4/2013, White Water Associates, Inc.

Station C – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
Photograph taken 6/4/2013, White Water Associates, Inc.

Station D – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment

Photograph taken 6/4/2013, White Water Associates, Inc.

Station E – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment

Photograph taken 6/4/2013, White Water Associates, Inc.

Station F – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
Photograph taken 6/4/2013, White Water Associates, Inc.

Station G – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
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Station H – Bearskin Lake

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Station I – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
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Station J – Bearskin Lake

USEPA & WDNR Physical Habitat Assessment
Photograph taken 6/4/2013, White Water Associates, Inc.

Literature Cited

United States Environmental Protection Agency (USEPA). 2009. National Lakes Assessment: A Collaborative Survey of the Nation's lakes. EPA 841-R-09-001. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. Retrieved 2014. <water.epa.gov/type/lakes/upload/nla_newlowres_fullrpt.pdf>

Appendix G
Review of Bearskin Lake Fishery

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Review of Bearskin Lake Fishery

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

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White Water Associates, Inc.

Introduction

Historic fish surveys were conducted in 1956, 1961, 1962, and 1967 on Bearskin Lake. Comprehensive fisheries surveys were conducted by the Wisconsin Department of Natural Resources (WDNR) in 1990, 1996, 2000, 2003, and 2015.

Bearskin Lake is located in the ceded territory. The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) conducted mark-recapture adult walleye population estimates in 1998, 2002, and 2014. GLIFWC also conducted fishery assessment surveys of ceded territory lakes, including Bearskin Lake, during the spring and fall of 1997 through 2011. These assessments were completed to improve understanding of spatial and temporal variability of fish populations in ceded territory waters of Northern Wisconsin (Luehring and Rose 2009). These studies add to an extensive body of information describing ceded territory walleye populations and associated biological parameters. They provide data needed to update recruitment codes, set harvest quotas, and monitor the impacts of a combined tribal and sport fishery on the walleye resource (Luehring and Rose 2009).

Creel surveys were conducted in 1990-91, 1996-97, 2000-01, 2003-04, and 2015. Fall young-of-year surveys were conducted in 1975, 76, 77, 78 by the WDNR and in 1988, 1990, 1996, 2000, 2003 and 2013 by the WDNR and GLIFWC (Kubisiak 2004). GLIFWC also conducted spring adult walleye population estimates in 2004, 2006, 2008, and 2010. Fall walleye recruitment surveys were completed in 2004 to 2008, 2010, 2011, and 2013. Walleye and musky spearing data were available from GLIFWC from 1998 to 2014.

History

WNDR Fisheries Biologist, John Kubisiak, explains some historic fishery information in the Comprehensive Fisheries Survey of Bearskin Lake during 2003. Walleyes were netted on Bearskin Lake May 1956. Based on a good walleye catch and moderate contribution of one stocked year (1951), it was recommended that Bearskin be dropped from walleye stocking quotas (Kubisiak 2004). Kubisiak (2004) describes a single electro-shocking run conducted in July, 1961 contained observations about panfish abundance, rusty crayfish and vegetation. A more thorough survey was performed in 1967 (Theis and McNight 1968). Walleyes were netted and an electro-shocking survey was performed. Also, a 50 foot seine was used. The authors noted an abundance of small (6-10 inch) walleyes and recommended no further walleye stocking. A “fair” muskellunge population was found and periodic stocking of muskellunge was recommended (Kubisiak 2004). From the description, it appears that largemouth bass were prevalent while smallmouth and northern pike are described as secondary species (Kubisiak 2004). A moderately stunted bluegill and pumpkinseed population was indicated (although panfish growth rates were not determined), and musky stocking was proposed as a solution (Kubisiak 2004).

In 1996, the WDNR conducted a length frequency survey for walleye, musky, smallmouth bass, northern pike, and largemouth bass. They said that Bearskin Lake had a good walleye population and that good natural reproduction was occurring (Kubisiak 2004). There were 149 musky caught in the spring of 1996 with the largest being 47 inches in length. Kubisiak (2004) also mentioned that there were good numbers of smallmouth bass present in 1996. They captured over 80 fish in spring of 1996 with the largest being 19 inches long and weighed 3 lbs. 13 oz. (Kubisiak 2004). Largemouth bass were present with only three being caught with the largest being 16 inches long and weighed 2 lbs. in 1996.

From June 3-7, 1999 bluegill and pumpkinseed sunfish were transferred from Bear Lake to Big Bearskin Lake (Table 1). Transfer of fish was conducted by volunteers from the Big Bearskin Lake Association. Permission and permit was granted from the Wisconsin DNR (McComas 2000).

Table 1. Summary of panfish stocked in Bearskin Lake 1996 (McComas 2000).

	Bluegills	Sunfish	**Total**
Number of fish transferred from Bear Lake to Bearskin Lake	1,169	2,677	**3,846**
Pounds of fish transferred from Bear Lake to Bearskin Lake	144	455	**599**
Average weight of fish transferred to Big Bearskin (in ounces)	2.0	2.7	

The WDNR also surveyed Bearskin Lake in 2000. Mike Vogelsang, WDNR Fisheries Biologist, explains their efforts as follows. He reported that Bearskin Lake had a good walleye population with sizes between 10 and 17 inches in length. They also captured a total of 60 musky in their nets. Most of these fish ranged from 31 to 37 inches. A total of 41 smallmouth bass were captured fyke netting and in the shocking surveys. Most smallmouths captured ranged from 9 to 12 inches with another size group averaging around 17 inches. Sixty-one northern pike were captured during fyke netting and shocking surveys that spring (Vogelsang 2000). A majority of those fish ranged from 19 to 22 inches in length.

A fair number of yellow perch, rock bass, bluegills, and white sucker were also observed during these surveys (Vogelsang 2000). A creel clerk was stationed on the lake to interview anglers during the summer and winter months of 2000.

A comprehensive fisheries survey was conducted on Bearskin Lake during 2003 by the WDNR. Fieldwork conducted on Bearskin Lake is as follows: Walleye netting, April 2003, Musky netting April – May, 2003, Panfish netting June, 2003, Mini-fyke netting August, 2003, and electro-shocking one time (entire shoreline) April, May, May, June and October, 2003.

The most recent fish surveys were conducted by the Wisconsin DNR right after ice out on Bearskin Lake in 2015. Fyke nets were used to catch and mark walleyes (fin clip) and other gamefish. Electro-fishing along the shoreline was used to recapture the marked fish. From the electro-fishing run, the ratio of marked to unmarked fish will be used to estimate the population (WDNR 2015). For example, if 1,000 walleye are given a left-ventral fin clip, 500 are captured during electrofishing, and 200 of these have the fin clip, then the estimated population = 1000 x 500/200 = 2,500 walleye (WDNR 2015). Additional sampling will be done to sample muskies using fyke nets and electrofishing to look at the bass population. Finally, additional electrofishing will be conducted in the fall to target young walleyes to assess the amount of reproduction that occurred the summer of 2015 (WDNR 2015).

Stocking

Muskellunge, crappie, smallmouth bass, yellow perch, and bluegill have been historically stocked in Bearskin Lake (Table 2).

Table 2. Fish stocking from 1979 to 2003 in Bearskin Lake (Kubisiak 2004).

Year	Species	Size	Number
1979	muskellunge	large fingerling (8-9")	800
1980	muskellunge	large fingerling (12")	500
1981	muskellunge	large fingerling (12")	309
1984	muskellunge	large fingerling	500
1985	muskellunge	large fingerling (10")	500
1987	muskellunge	large fingerling (12")	810
1989	crappie	adult (5-10")	1,000 (field transfer)
1989	bluegill	adult (4-6")	1,000 (field transfer)
1989	smallmouth bass	large fingerling (4-6")	300 (privately funded)
1990	smallmouth bass	large fingerling (4-6")	500 (privately funded)
1990	muskellunge	large fingerling (8-9")	307
1990	muskellunge	large fingerling (11")	493
1991	muskellunge	large fingerling (11.6")	400
1993	muskellunge	large fingerling	400
1994	smallmouth bass	fingerling	1,196 (privately funded)
1995	muskellunge	large fingerling	400
2003	bluegill	large fingerling (4.7")	2,000 (privately funded)
2003	yellow perch	large fingerling (4-10")	1,880 (privately funded)

Results

Multiple comprehensive surveys of gamefish and panfish were conducting on Bearskin Lake in spring, 2003. Please see Kubisiak 2004 for the full report. Table 3 displays the various sampling dates and the species observed. Netting rates are reported as number of fish per net night, while electrofishing catch rates are the number of fish per mile of shoreline. Panfish data were collected during all sampling events (Kubisiak 2004).

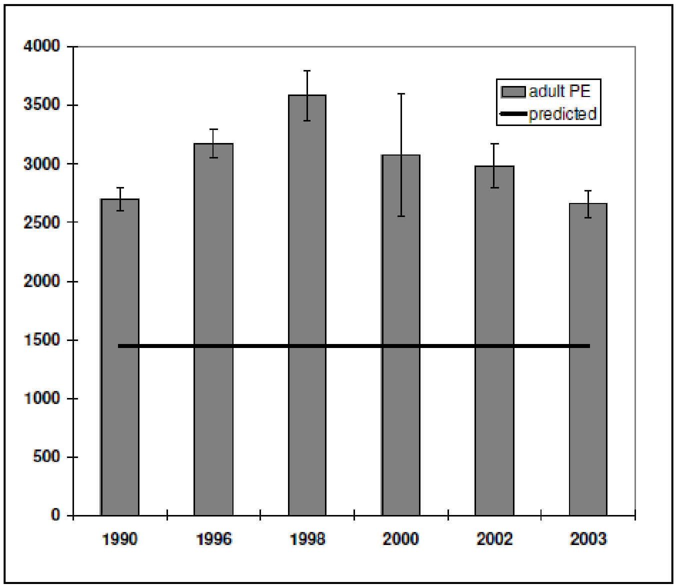
Table 3. Catch per unit effort of gamefish and panfish species during spring, 2003 (Kubisiak 2004).

species	walleye netting	April 28 shocking	musky netting	May 12 shocking	May 27 shocking	June 4 shocking	panfish netting
walleye	32.9	121.4	7.3	46.8	121.1	193.4	2.0
largemouth bass	0.08	0.9	0.5	0.5	0.7	0.7	1.0
smallmouth bass	1.4	9.1	1.4	8.0	19.5	15.5	0.6
muskellunge	0.8	3.0	2.3	1.4	0.7	0.7	0.2
hybrid muskellunge	0.02	0	0	0	0	0	0.03
northern pike	1.3	0.5	1.3	0.7	0.2	0.7	1.0
black crappie	1.1						0.4
bluegill	1.9						31.4
pumpkinseed	0						7.3
rock bass	2.8						13.5
yellow bullhead	0						0.03
yellow perch	8.4						3.5

Walleye

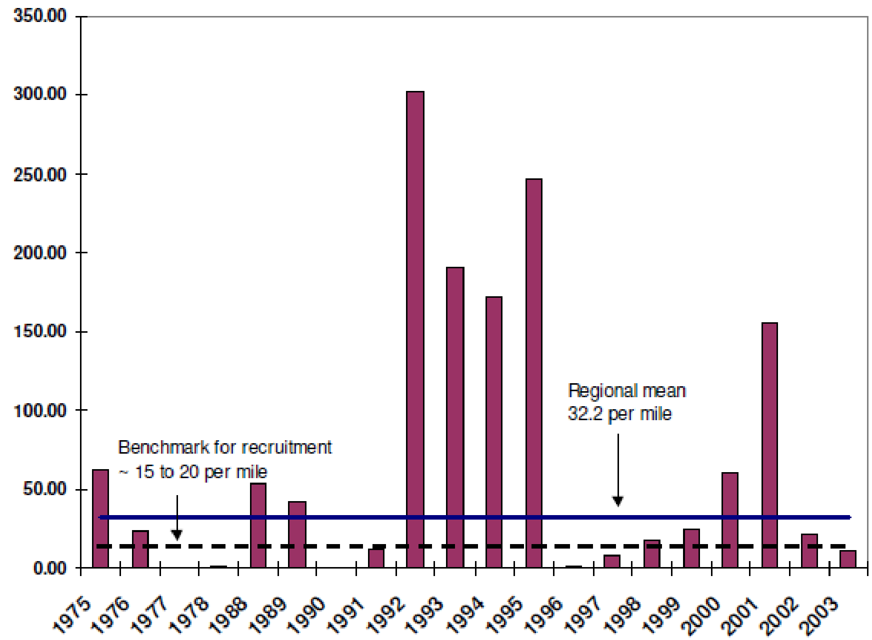
The mark-recapture population estimate (2003) of 2,658 adult walleyes, or 6.6 per acre, is somewhat below five previous population estimates since 1990 (Figure 1). However, it was 83% higher than the predicted population of 1,448 (from a regression model of naturally reproducing northern Wisconsin walleye populations) (Kubisiak 2004).

Figure 1. Adult walleye population estimates in Bearskin Lake, 2003 (Kubisiak 2004).



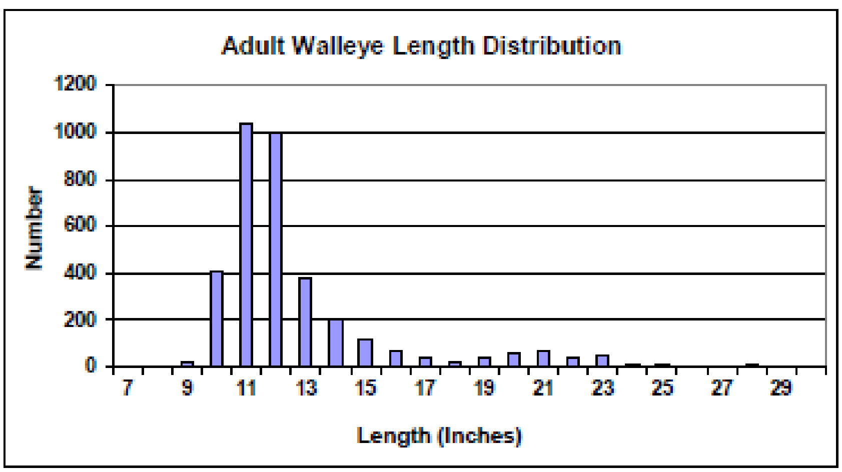
The total walleye population (all fish 7 inches and larger) is estimated at 12,449 (+/- 3,437 SD) in the 2003 survey. Fish less than 15 inches comprised 65% of adult walleyes and 73% of total walleyes estimated in Bearskin Lake, indicating strong recruitment. Fall surveys show strong recruitment with sporadic extremely high catch rates well over 100 young-of-year (YOY) per mile, as is typical of naturally-reproducing populations (Figure 2) (Kubisiak 2004). In 2013, GLIFWC noted 1,220 total walleye for 5.6 miles which would be 217.9 walleye per mile. In 2015, Wisconsin DNR estimated the walleye population to be 3,571 adult walleye (8.9/acre).

Figure 2. Fall walleye recruitment surveys from 1975 to 2003 in Bearskin Lake (Kubisiak 2004).



During four days of fyke netting in the 2015 survey, 1,242 adult walleye were captured and marked with a fin clip (Eslinger 2015). Two crews then sampled with electro-fishing boats and captured 416 adult walleye (Eslinger 2015). During electro-fishing, 45 of 416 of captured walleye bore the fin clip given during fyke netting (Eslinger 2015). The largest walleye captured was 28.2 inch female. In the 2015 survey Bearskin Lake was estimated to contain 3,571 walleye (8.9/acre) (Eslinger 2015). An estimated 15% of adult walleye were 15 inches or larger (Figure 3) (Eslinger 2015). Appendix A has length frequency data for walleye from 1998-2014.

Figure 3. Adult walleye length distribution 2015 (Eslinger 2015).

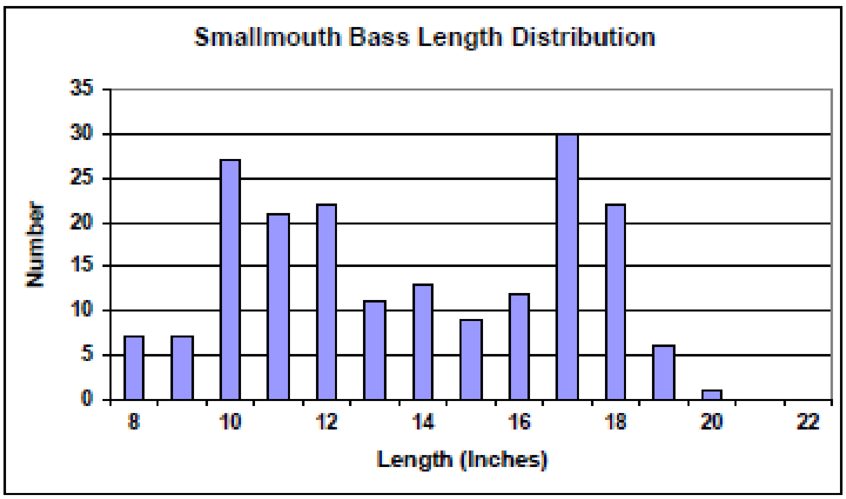


Smallmouth Bass

Trends in Bearskin Lake smallmouth size structure appear to be driven more by recruitment than the 18-inch minimum length regulations (Kubisiak 2004). Although some limited stocking of smallmouth bass occurred in 1989, 1990 and 1994, it is likely that the bass population was primarily supported by natural reproduction (Kubisiak 2004).

In the 2015 survey, crews were able to capture and mark a sufficient number of smallmouth bass from Bearskin Lake to estimate the population size (Eslinger 2015). During sampling conducted through May 12, 188 smallmouth bass eight inches or larger were captured (Eslinger 2015). Of those smallmouth captured, 49% were 14 inches long or larger and the largest captured was 20.1 inches long (Figure 4) (Eslinger 2015). The smallmouth population in Bearskin Lake (eight inches or larger) was estimated to be 587 fish (1.4/acre) in 2015 (Eslinger 2015).

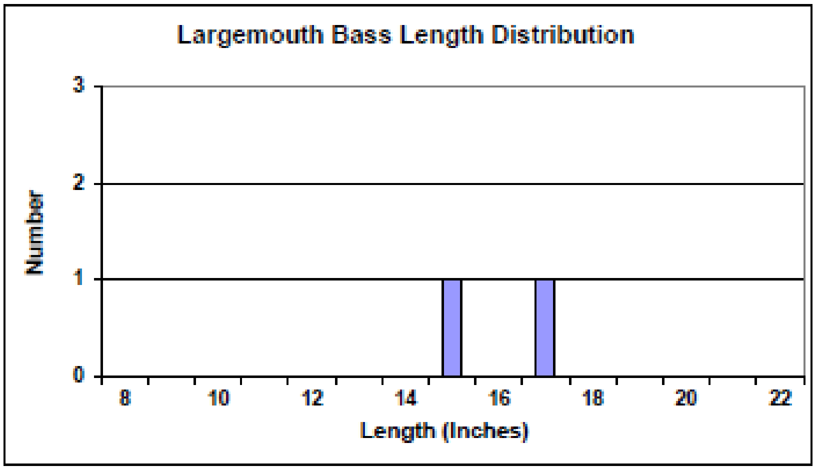
Figure 4. Smallmouth bass length distribution 2015 (Eslinger 2015).



Largemouth Bass

During the 2015 sampling, just two largemouth bass (15.5 and 17.1 inches long (Figure 5)) were captured (Eslinger 2015).

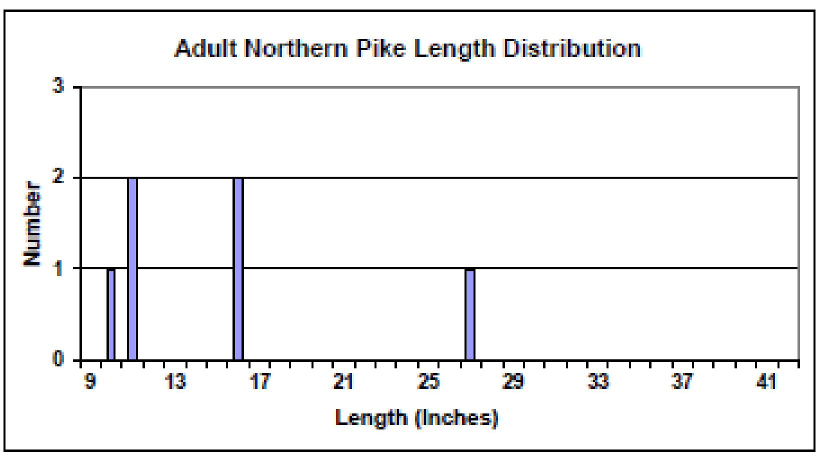
Figure 5. Largemouth bass length distribution (Eslinger 2015).



Northern Pike

In the 2003 sampling, the average size of adult northern pike was 20 inches, and good numbers of fish less than 30 inches in length were observed (Kubisiak 2004). The northern pike population was considered low-density (less than two fish per acre in 2003 (Kubisiak 2004). In 2015 just six pike were captured, with the largest being 27.1 inches in length (Figure 6).

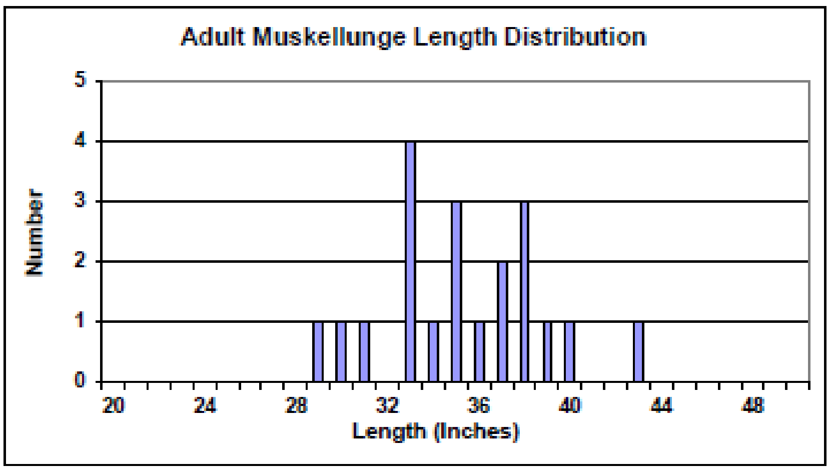
Figure 6. Adult northern pike length distribution (Eslinger 2015).



Muskellunge

Kubisiak (2004) stated that in 2003, 172 muskellunge were captured during all netting and shocking periods (including 33 recaptures), at a catch rate of 2.3 per net night during the musky netting period. Sizes were scattered between low-20 and mid-40 inch ranges (Kubisiak 2004). Size structure appears to have been fairly consistent in recent years, with 9% of captured muskies over 40 inches during 1990, 12% during 1996, 8% during 2000, 16% during 2003, and 10% during 2015. The capability to produce large fish is evident by one fish over 50 inches in 1967, one 50.5 inches in 1990 and one 50.5 inches in 2000 and one 43.3 inches in 2015 (Figure 7). Bearskin Lake has not been stocked with muskies since 1995(Kubisiak 2004). Presence of a variety of sizes and many small muskies collected during fall shocking surveys and summer mini-fyke nets show that natural reproduction is occurring in 1996 and 2015. Two tiger muskies (northern pike x muskellunge) were encountered, indicating that a small amount of hybridization is occurring (Kubisiak 2004). During the 2015 fyke netting and electro-fishing sampling of Bearskin Lake, 20 adult muskellunge were captured (Eslinger 2015).

Figure 7. Adult muskellunge length distribution (Eslinger 2015).



Panfish and other species

Kubisiak (2004) states that early netting and electrofishing showed good catches of yellow perch, while bluegill, rock bass and pumpkinseed dominated June panfish netting in 2003. Large numbers (several hundred per net) of 5 to 6 inch yellow perch were captured in spring, 2004 muskellunge nets, suggesting a strong 2002 year class. In 2015, electro-fishing survey their sizes ranges between 6 and 9.4 inches (Eslinger 2015). Black crappies were netted, indicating low abundance, and most were in the 11- inch size range (Kubisiak 2004). Panfish size structure was excellent, but catch rates were low compared to lakes with more vegetation (Kubisiak 2004). Natural reproduction appears to be adequate, but loss of aquatic vegetation to rusty crayfish and high abundance of predator fish keep panfish populations suppressed (Kubisiak 2004). Big Bearskin Lake Association replaced some lost habitat by installing cribs and brush, and stocked bluegills and perch in 2003 (Kubisiak 2004). However, with current predator populations it is unlikely that panfish survival and adult abundance will improve unless escape cover for juvenile panfish is restored (Kubisiak 2004). White sucker were common, while bluegill were captured at lower rates in

2015 (size during electro-fishing ranging between 6.5 and 8.4 inches) (Eslinger 2015). Other species sampled (2015) in low numbers included rock bass, black crappie, pumpkinseed, and yellow bullhead (Eslinger 2015).

Management Recommendations

Bearskin Lake supports a high-density walleye population and bass numbers are currently dominated by smallmouth bass, which show very good size structure (Kubisiak 2004). Abundant largemouths were found in the 1967 survey and were likely replaced by smallmouth as crayfish increased and vegetation declined (Kubisiak 2004). Muskellunge abundance is moderately high for a typically low-density species, with good growth and numbers of fish up to 44 inches in the last few surveys. The muskellunge population has been supported by natural reproduction since 1995. Northern pike were similar in abundance to muskellunge, but typically show much higher abundance and are considered low-density in Bearskin Lake (Kubisiak 2004). Panfish exhibited moderate abundance, but growth rates and size structure were above average. The strong predator populations and low amount of submerged vegetation for cover suppress panfish numbers. Rusty crayfish have had strong effects on Bearskin Lake and the fishery. Bearskin experiences annual midsummer blooms of blue-green algae (McComas 2003). Low panfish abundance and a shift from largemouth to smallmouth bass are fisheries changes attributable to rusty crayfish (Kubisiak 2004). Management recommendations include suppression of rusty crayfish to allow recovery of aquatic vegetation. Increased cover in the form of woody brush (e.g., tree drops) may replace some of the vegetation that has been lost (Kubisiak 2004). BBLA has been trapping rusty crayfish since the early 80s and the aquatic vegetation has been coming back.

Mark Kiepke (WDNR fisheries biologist), commented in an email (2015a) to the BBLA on some preliminary results from spring electrofishing. The WDNR indicates an adult walleye population estimate of about 8.9 per acre (about 3571 fish). He states that it is slightly lower than the over the years, but is still about 2 to 2.5 times the average adult walleye density per acre than other naturally reproducing lakes (Kiepke 2015a). Kiepke (2015a) comments that in his experience, Bearskin Lake is the most consistently prolific lakes in natural walleye production

Kiepke (2015b) discussed with BBLA that the tribe took 935 walleyes this year. They also took five muskies. There was a high adult walleye population density last spring (17 per acre – about 6900 adult walleyes) so that is the reason for the noticeably larger walleye harvest (Kiepke 2015b).

GLIFWC Research

As a Great Lakes Indian Fish and Wildlife Commission (GLIFIW) long-term study lake, Bearskin Lake is surveyed annually or biennially to collect trend and variability information on adult walleye populations. The continuing goal is to use adult estimates and fall recruitment data from long-term study lakes to develop and assess models for predicting population size (Luehring and Rose 2009). This estimate was obtained either from a previous population estimate survey, or when none existed, from a regression formula estimate for a lake of similar size and recruitment code (Luehring and Rose 2009).

Per agreement between GLIFWC and WDNR biologists, all unknown sex fish less than 15 inches in total length were assumed to be “immature fish” and excluded from the calculation of adult population estimates (Luehring and Rose 2009). In lakes where spearing occurred prior to the recapture survey; an adjustment was made by reducing the marking sample by the number of marked fish speared. Also, the total number of fish speared before the first recapture run (except for walleye of unknown sex less than 15 inches) was added to the estimate (Luehring and Rose 2009).

Spring Walleye Surveys

Fish were captured for marking with electrofishing gear soon after ice out. Walleye were measured (total length in inches) and sexed (male, female, or unknown). Crews were instructed to collect a scale or spine sample from ten male fish per half-inch group between 11.0 inches and 16.9 inches, and from five fish per half-inch group for males of other sizes and females. Generally, spines were taken from fish 10 inches and larger, and scales were taken from smaller fish. Spines and scales were analyzed at a later date for age determination. On long-term study lakes, fish were tagged with yellow, individually numbered tags prior to release. Fish on all other lakes were given a single caudal fin notch. After being tagged or notched, fish were released away from the capture area, typically near the middle of the lake (Luehring and Rose 2009).

During the spawning adult walleye population estimate period (1998 to 2010), a total of 8036 walleye were sampled from Bearskin Lake. The Report on Biological Issues (1988) listed several indicators of healthy reproducing walleye stocks agreed to by state and tribal biologists. Two indicators included: a) population density of three adult walleye per acre; and, b) the presence of five year classes of females in a sample or three year classes in a sample of 100 females that each contribute at least 15 percent of the sample. The estimated population density ranged from 6 to 10.87 (Table 5). Bearskin Lake proves to be a healthy lake with the exception of having only 4 female year classes in 1998 (Table 4).

Table 4. Bearskin Lake Walleye Population Densities.

	1998	2002	2004	2006	2008
Female Year Classes	4	7	7	6	7
Male Year Classes	6	9	7	8	8

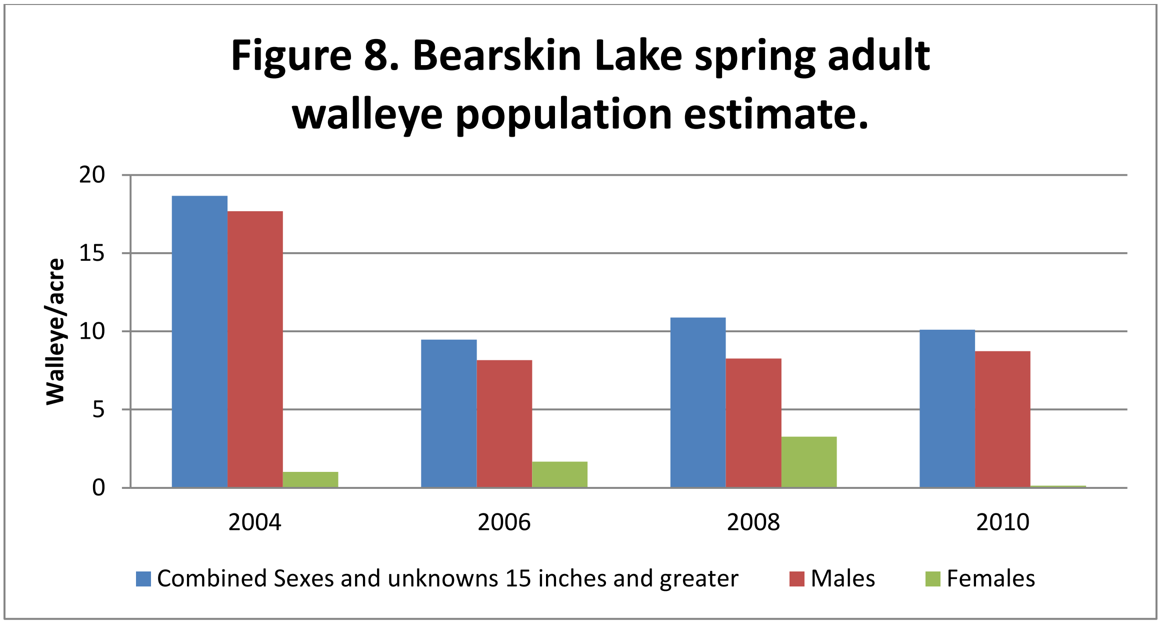
Bearskin Lake has a walleye recruitment code of NR, indicating natural reproduction was the only source of recruitment, for every year surveyed (Table 5). Male-to-female sex ratios (Table 5) were skewed in favor of males in Bearskin Lake. The reliability of these values is questionable as electrofishing may bias sampling in favor of males (Shively and Kmiecik 1991) because males spend more time in shallow water than females during the spawning period (Colby et al. 1979), and many females are out of effective capture range except during or after spawning. Table 6 is the spring 1998 Juvenile population estimate.

Table 5. Spring Adult Walleye Population Estimates by GLIFWC.								
Year	Population Estimate	Density	Coeff. of Variation (%)	Marking Gear	Recapture Gear	Fin Clip Applied	Male: Female ratio	Length regulation
2010	4039	10.1	11.03	E	E	YF	52:01	
2008	4349	10.87	8.44	E	E	YF	6:01	
2006	3787	6.4	9.47	E	E	YF	15:01	
2004	7467	10	18.67	E	E	YF	21:01	1 over 14"
2002	2984	6.4	7.46	E	E	BC/YF	13:01	1 over 14"
1998	3582	6	8.96	E	E	TCN/YF	243.0:1	1 over 14"
Gear Used: E=Electrofishing								
TCN = top caudal notch, YF = numbered yellow floy tag, BC = bottom caudal								
Sex ratio is calculated for walleye sampled during marking and recapture runs but excludes recaptu								

Table 6. Spring 1998 Juvenile Walleye Population Estimates, GLIFWC.					
Area	Schnabel PE	St. Dev. Of Schnabel PE	Schnabel Density	Age 1 PE	Age 2 PE
400	5835	1328	14.59	918	354

In 2002, 2004, 2006, 2008, and 2010 there were a total of 506 females, 7,075 males, and 455 unknown sex walleye measured (Table 7). Age-length tables were developed for subsets of female, male, and unknown sex walleye (Appendix A and B). Length frequency has increased in number and more fish of greater length are noticeable in 2008 compared with 1998. The numbers of walleye caught and the variation in age classes have increased since 1998. If there are five year classes, the lake is considered healthy. Bearskin Lake proves to be healthy in all of the years shown. The number of males in 2006, 2008 and 2010 were consistent year to year (Figure 8). Tribal and state biologists have identified a population density of 3.0 per acre for spawning adult walleye as a benchmark for a healthy, naturally reproducing walleye population (GLIFWC 2012).

Table 7. Lengths of Walleye During Spring Adult Walleye Population Estimates.										
Year	Female	Male	Unknown	Total	Female Min. Length	Female Max. Length	Male Min. Length	Male Max. Length	Unknown Min. Length	Unknown Max. Length
2010	30	1570	70	1670	12.5	26	9.5	19	9.5	16
2008	221	1359	115	1695	12	26	9.5	19.5	10	16.5
2006	89	1355	120	1564	12.5	26.5	10	20	10	16.5
2004	76	1620	20	1716	11.5	27	9	20	9	14
2002	90	1171	130	1391	13.5	26	9	20	5	15.5



Fall Recruitment Surveys

Fall electrofishing surveys were completed on Bearskin Lake to evaluate recruitment of age 0 (young of the year) and age 1 (yearling) walleye, and to assess whether recruitment codes were appropriate. The primary objective of this survey was to assess year class strength of stocked or naturally reproduced age 0 and age 1 walleye (GLIFWC 2012). Larger walleye and other game fish were of secondary priority and collected if this effort did not detract from the collection of juvenile walleye. Panfish and other species were collected as a third priority (GLIFWC 2012). Results of surveys were used to determine whether lake recruitment code changes were needed. Other uses included trend analysis of important mixed fishery lakes maintained by natural reproduction, and the development of a regional perspective of annual walleye year class strength (GLIFWC 2012). All fish were identified to species and length measured (total length in inches). For walleye only, a scale sample was collected from five fish per half-inch group between 5.5 and 12.0 inches to determine the length range and numbers of age 0 and age 1 walleye. The fall walleye recruitment data are summarized in Table 8.

Table 8. Fall Walleye Recruitment Surveys by GLIFWC Bearskin Lake, Oneida County.

Date Surveyed	Age 0 CPE	Age 0 Walleye	Age 0 Min Length	Age 0 Max Length	Age 0 Mean Length	Age 1 CPE	Age 1 Walleye	Age 1 Min Length	Age 1 Max Length	Age 1 Mean Length	Total Walleye	Hours Surveyed	Temp.	MUE	NOP	LMB	SMB	YEP	BLG
9/24/2013	146	817	4.2	6.8	5.6	43.4	243	7.1	10.4	9.2	1220	3.14	67						
9/27/2011	203	1139	4.3	7.6	6.2	3	17	8.1	9.4	9	1304	2.6	57						
9/28/2010	55.2	309	4.8	7.7	6.4	24.5	137	7.8	10.4	9.2	571	2.8	53				6	8	1
9/30/2009	55.9	313	3.8	6.4	5.1	75	420	6.5	8.9	8	875	2.5	43						
9/23/2008	132	662	3.4	7.3	5.6	36.4	182	7.7	10.6	9.5	978	1.87	65	2					
10/10/2007	87.1	488	4.6	7.9	6.5	72.5	406	8	10.3	9.3	1156	2.34	58						
10/2/2006	193	1083	3.8	7.6	5.6	22.3	125	7.8	9.7	9.2	1373	2.66	58						
9/20/2005	40.9	229	4.2	7.6	5.7	15.4	86	8	10.4	9.4	419	2.44	71						
9/20/2004	218	1218	4	6.9	5.6	14.8	83	7.7	10	9.2	1723	2.88	65						
10/16/2002	21.2	119	4.5	7.2	5.8	50.5	283	7.4	10.2	8.8	431	2.18	50						
9/26/2001	156	871	4.4	6.9	5.9	7	39	7.3	103	9.4	946	2.04	58						
9/9/1999	24.8	139	4.2	8	5.8	31.4	176	8.7	11.5	10.3	364	2.49	66	0	0	1	3		
9/29/1998	17.7	99	6.2	9.1	7.5	6	6	9.2	9.4	1.1	200	1.9	65						
9/15/1997	8.6	48	4.8	6.6		28.9	162	7.8	10		478	2.8	70				1		

NR= Natural reproduction provides the only source of recruitment to the adult population

and is consistent enough to result in an adult population with multiple year-classes present.

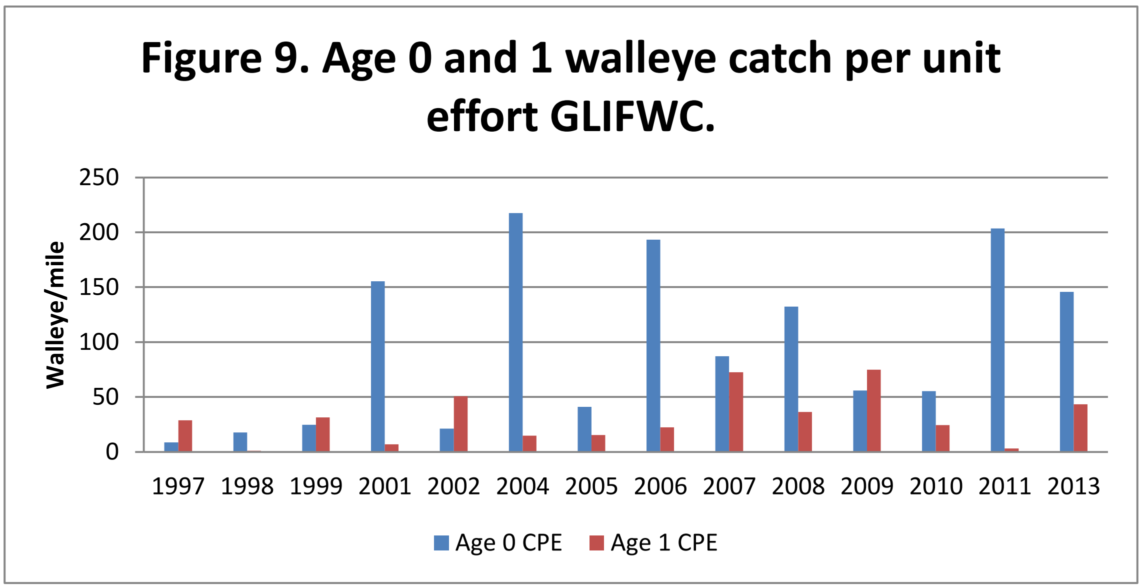
CPE = catch per unit effort (number of fish divided by shore miles surveyed).

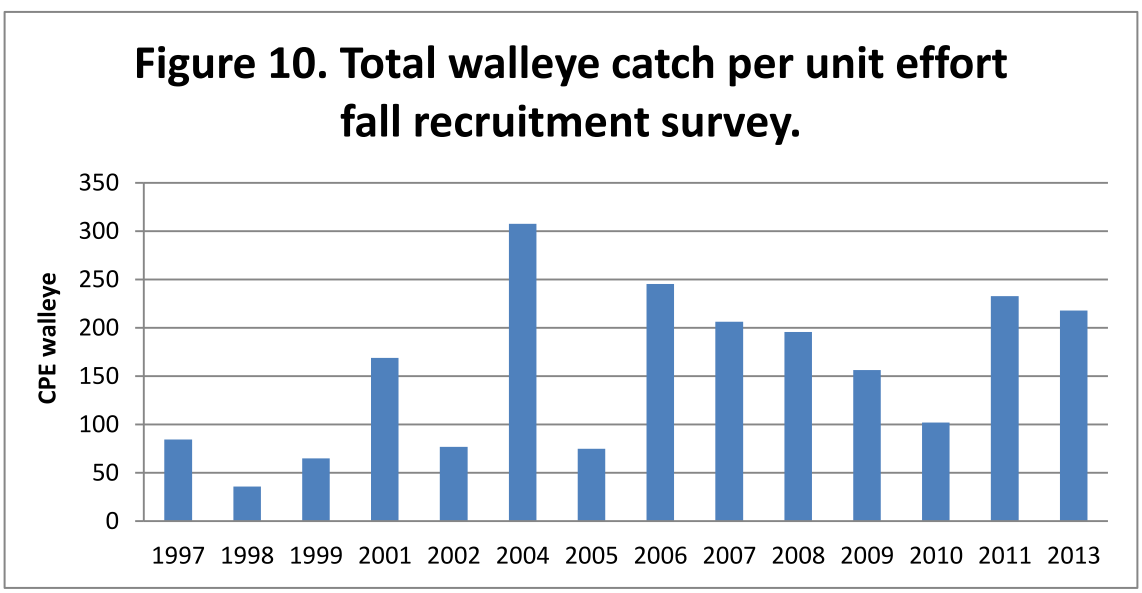
MUE = muskellunge, NOP = northern pike, LMB = largemouth bass, SMB = smallmouth bass, YEP= Yellow Perch, BLG= Bluegill

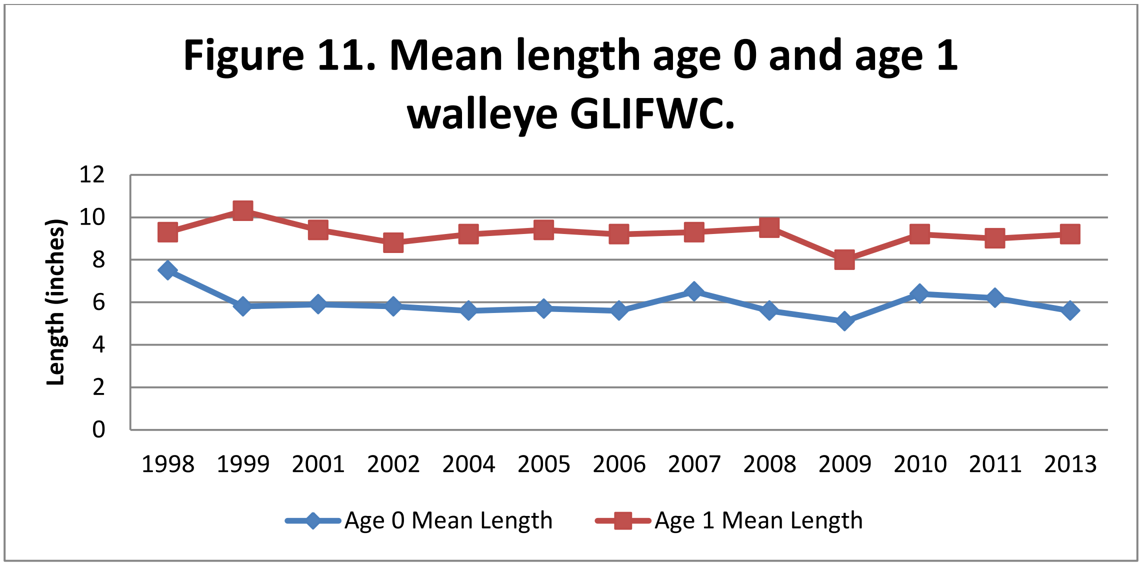
Surface Area (Acres) was 400 and the Walleye Code was NR for all dates surveyed.

Miles Surveyed and Shore Miles were 5.6.

Catch per unit of effort (CPE) statistics are generated by dividing the numbers of age 0 and age 1 walleye captured by the length of the shoreline surveyed, which gives the number of age 0 and age 1 walleye captured per mile of shoreline surveyed. These CPE statistics can easily be compared from lake to lake in order to evaluate recruitment. On lakes sustained primarily or entirely by natural reproduction, age 0 CPEs typically average between 20 and 30 age 0 walleye per mile, and age 1 CPEs typically average between 6 and 10 per mile (GLIFWC 2012). A total of 10,818 walleye have been sampled since 1997. In 2011, a total of 1,139 Age 0 and 17 Age 1 walleye were collected. Age 0 CPE ranged from 8.6 to 218 per mile and age 1 CPE ranged from 3 to 72.4 per mile (Figure 9 and 16). In 2004, 2006, and 2011 the Age 0 walleye were abundant (Figure 9). There has been a decline in Age 1 walleyes in 2011and also walleye abundance since 2004 but the CPE increased in 2011 (Figure 10). Figure 11 indicates the mean length of Age 0 and Age 1 walleyes.

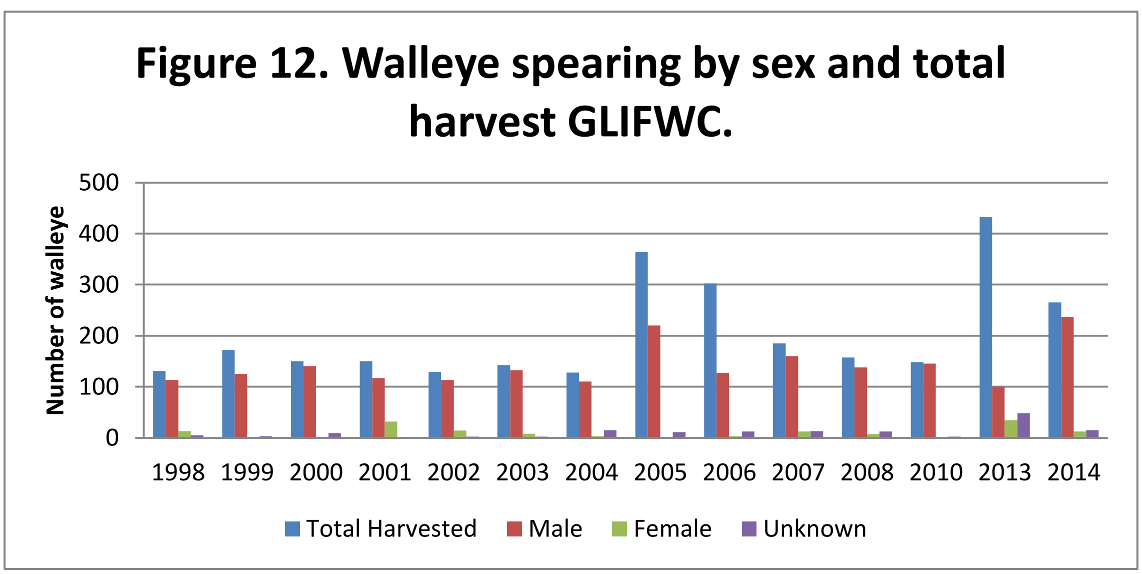






Spearing

The primary off-reservation tribal fishery is the spring spearing and gill-netting of walleye. Musky and other species of fish can also be harvested. This fishery is highly regulated and controlled with individual lake quotas, a nightly permitting system, a requirement that only specified boat landings be used, and the stationing of tribal creel clerks and wardens at every landing each night during the spring season to count all fish harvested (GLIFWC 2012). Quotas are adjusted daily based on the previous night's harvest to ensure that they are not exceeded. With such a system, a wealth of information for describing the tribal fishery and the impact of that fishery on individual walleye populations have been collected (GLIFWC 2012). Data is available for walleye and musky spearing on Bearskin Lake from 1998 to 2014 (Figures 12-15). Very few female walleye have been speared over the years (Figure 12). The tribal quota and total harvest have coincided every year (Figure 13). On average 6.6 boat hours are spent spearing on Bearskin Lake each year (Figure 14). The CPE of walleyes speared averaged 37.7 per hour (Figure 15).



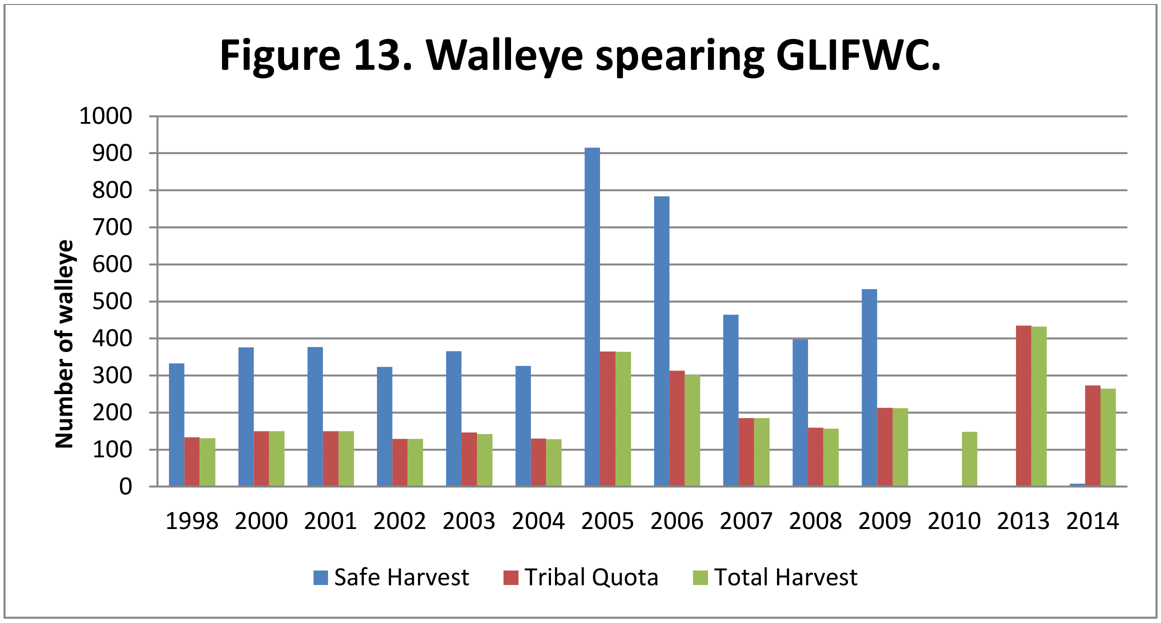


Figure 13. Walleye spearing GLIFWC.
Number of walleye
1000
900
800
700
600
500
400
300
200
100
0
1998 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2013 2014
Safe Harvest
Tribal Quota
Total Harvest

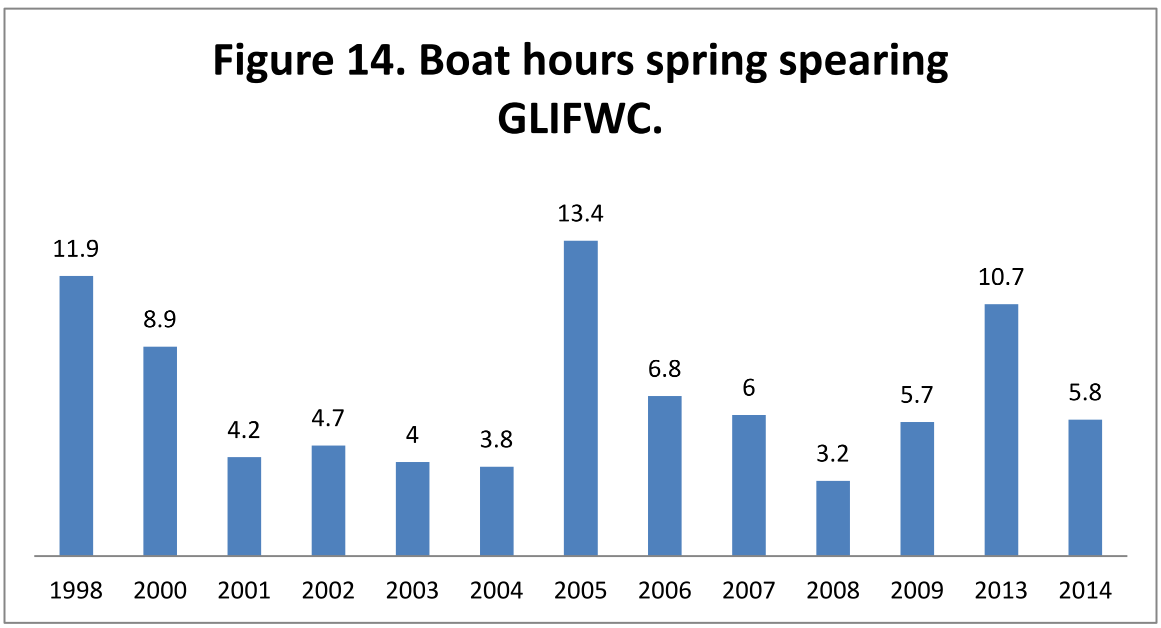
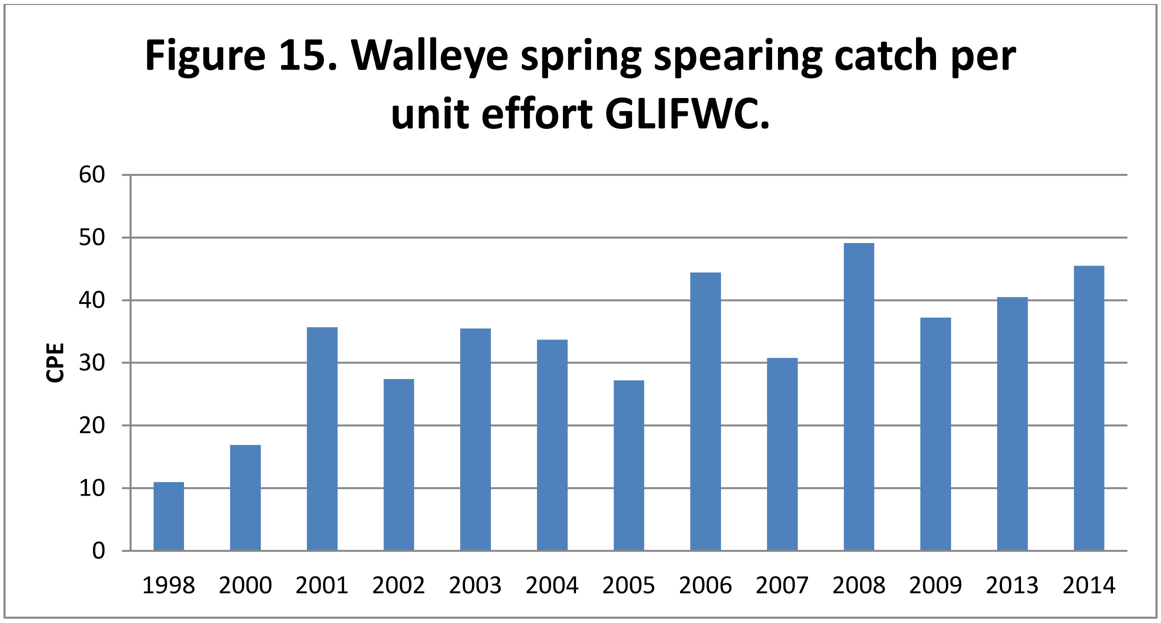


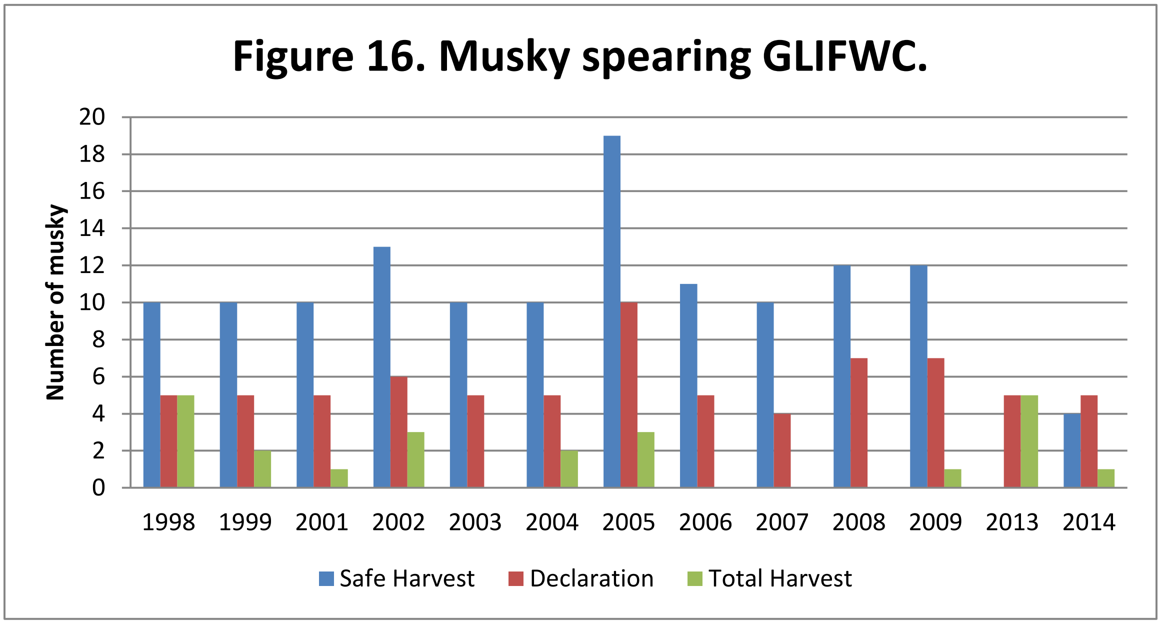
Figure 14. Boat hours spring spearing GLIFWC.
11.9
8.9
4.2
4.7
4
3.8
13.4
6.8
6
3.2
5.7
10.7
5.8
1998 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2013 2014

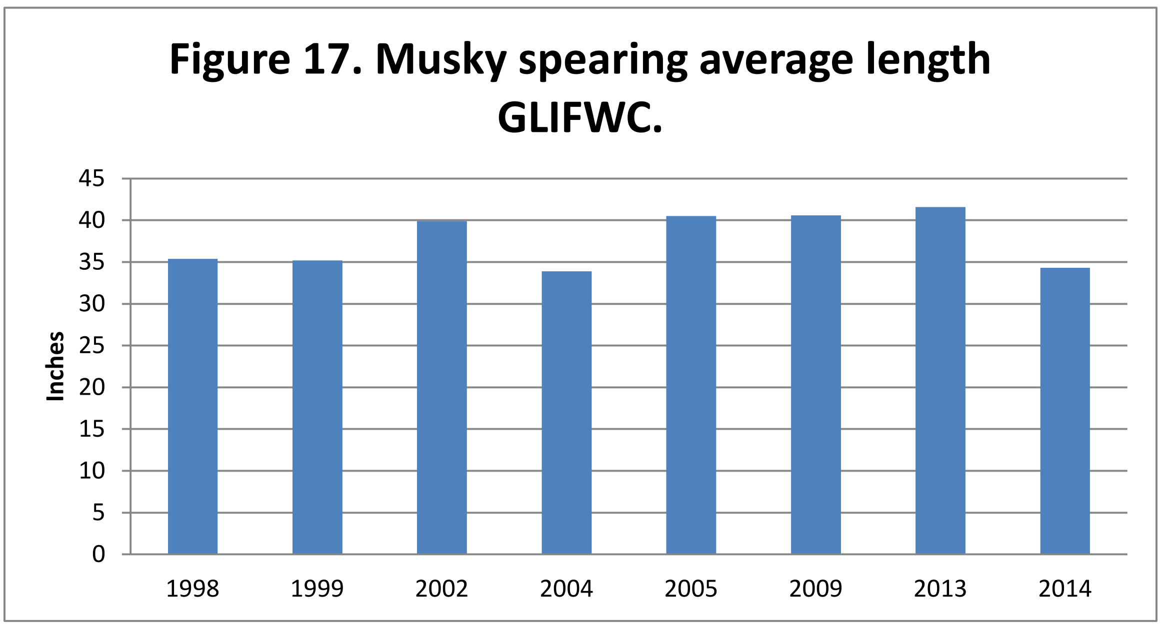


In 2015, a biologist from GLIFWC explained the spear harvest as follows (GLIFWC 2015):

> This spring's (2015) walleye spearing results for Bearskin Lake (935 walleye harvested) is above the average spear harvest for the lake. Tribal spear harvest quotas are determined from population estimates conducted by the WDNR and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC). Last year, GLIFWC completed a Bearskin Lake walleye population estimate, which resulted in an estimate of about 6,800 adult walleyes, or approximately 17 fish per acre, an extremely high number (most good walleye fisheries contain a density of about 3-5 adult walleyes per acre). As a result, walleye safe harvest, and the subsequent tribal quota for Bearskin Lake was declared at 935 fish, which was met. We will receive a report on the walleye spear harvest that occurred; this report provides information on all lakes where tribal spearing occurred. Please keep in mind that past angler creel surveys on Bearskin Lake have estimated anglers to have harvested 1,500+ walleyes annually since the no-minimum but only 1 fish over 14 inch regulation was implemented.
>
> In past years, walleye angler bag limits were adjusted before and after tribal spear harvest occurred. Starting this year, however, angler bag limits are not being adjusted. Instead, daily bag limits for walleye have been set at 3 fish for all Ceded Territory lakes. Therefore, regardless of tribal harvest, the angler bag limit for walleye on Bearskin Lake will be 3.
>
> Bearskin Lake contains one of the most productive walleye populations in our area, which makes it popular amongst recreational and tribal fisherman. High levels of natural walleye reproduction fuel this productive population/fishery. As long as that continues (which it has over the past 3 decades), good walleye fishing should continue, even in spite of relatively high harvest.

Musky spearing data was obtained from the GLIFWC on Bearskin Lake from 1998 to 2014. There have been only 23 musky harvested by spear since 1998, and the total harvest never exceeded the declaration and was always under the safe harvest (Figure 16). The average length ranged from 33.9 inches to 40.6 inches (Figure 17).





GLIFWC conducted creel surveys in 1938, 1990-91, 1996-97, 2000-01, and 2003-04 (Table 9). Largemouth bass, northern pike, and musky had low catch rates in the years described. Walleye catch/acre was the highest in 1996. Smallmouth bass catch per acre went up from the 90’s.

A nine-month angler creel survey will be conducted throughout the gamefish season for the 2015-16 seasons. The clerks will conduct counts of anglers to determine fishing pressure and also record information on harvested fish. The walleye sport harvest and exploitation information is critical to assure that the total harvest of adult walleyes, after tribal harvest is added in, does not exceed a safe level (WDNR 2015). The results will not be available until July 2016.

Table 9. Bearskin Lake Creel Data (GLIFWC).
LAKE ACRES: 400, SHORELINE MILES: 5.6

SPECIES	SURVEY YEAR	TOTAL ANGLER EFFORT/ACRE (HOURS)	DIRECTED EFFORT/ACRE (HOURS)	CATCH	CATCH/ ACRE	HARVEST	HARVEST/ ACRE	HOURS OF DIRECTED EFFORT/FISH CAUGHT	HOURS OF DIRECTED EFFORT/FISH HARVESTED
LARGEMOUTH BASS	1990	56.5	3.3	87	0.2	0	0	18.3	
	1996	42.8		15	0	0	0		
	2000	44	1.2	36	0.1	0	0	22.8	
	2003	50.4	2.2	229	0.6	0	0	21.5	
MUSKELLUNGE	1990	56.5	18.6	554	1.4	14	0	25	833.3
	1996	42.8	10.3	282	0.7	13	0	30.6	312.5
	2000	44	10	385	1	16	0	21.3	250
	2003	50.4	14.5	189	0.5	0	0	37.7	
NORTHERN PIKE	1990	56.5	1.2	54	0.1	10	0		
	1996	42.8	0.2	73	0.2	16	0		
	2000	44	1	240	0.6	25	0.1	8	
	2003	50.4	1.4	446	1.1	61	0.2	11.2	15.1
SMALLMOUTH BASS	1990	56.5	7.2	974	2.4	157	0.4	5.4	28.7
	1996	42.8	5.8	859	2.1	0	0	4.4	
	2000	44	7	2709	6.8	24	0.1	1.7	114.9
	2003	50.4	7.5	2446	6.1	0	0	1.7	
WALLEYE	1990	56.5	31.5	4931	12.3	538	1.3	2.6	23.4
	1996	42.8	31.1	15386	38.5	584	1.5	0.8	21.3
	2000	44	19.9	4750	11.9	1804	4.5	1.7	4.5
	2003	50.4	28	5281	13.2	1535	3.8	2.2	7.3

Literature Cited

Colby, P.J., McNicol, R.E. and Ryder, R.A., 1979. *Synopsis of biological data on the walleye Stizostedion v. vitreum (Mitchell 1818).* FAO Fisheries Synopsis 119.

Eslinger, Lawrence. 2015. *Wisconsin DNR Fisheries Information Sheet Bearskin Lake, Oneida County Wisconsin 2015.* Wisconsin Department of Natural Resources, Rhinelander, WI.

Great Lakes Indian Fish and Wildlife Commission (GLIFWC). 2012. *Great Lakes Indian Fish and Wildlife Commission Website*. Retrieved 2015. <Http://www.glifwc.org/fisheries/inland/inland.html.>

Great Lakes Indian Fish and Wildlife Commission (GLIFWC). 2015. Email correspondence with WDNR and Big Bearskin Lake Association, April 21.

Kubisiak, John. 2004. *Comprehensive Fisheries Survey of Bearskin Lake, Oneida County Wisconsin during 2003*. Wisconsin Department of Natural Resources, Rhinelander, WI. 15 pages.

Luehring, M. and J.D. Rose. 2009. *Fish Population Assessments of Ceded Territory Lakes in Wisconsin, Michigan and Minnesota During 2008*. Great Lakes Indian Fish and Wildlife Commission. 30 pages.

McComas, S. 2000. *Comprehensive Lake Management Plan for Big Bearskin Lake, Oneida County, Wisconsin, 2000.* Blue Water Science, St. Paul MN.

McComas, S. 2003. *Big Bearskin Lake report Oneida County, Wisconsin, 2003.* Annual report to Big Bearskin Lake Association. Blue Water Science, St. Paul MN. 18 pages.

Shively, J.D. and N. Kmiecik. 1991. *Fish population assessment of ceded territory lakes in Wisconsin during 1990*. Great Lakes Indian Fish and Wildlife Commission Administrative Report 91-2. Odanah, WI.

Theis, R. and T McNight. 1968. *General letter 102 – Lake Survey of Bearskin (Big Bearskin) Lake, Oneida County*.

Vogelsang, Mike. 2000. *Wisconsin DNR Fisheries Information Sheet.* Wisconsin Department of Natural Resources, Rhinelander, WI.

Wisconsin Department of Natural Resources. 2015. *Fish & Creel Info.* Email from Deb Brossard, April 14, 2015.

Kiepke, Marty. 2015a. Email correspondence with Deb Brossard. Wisconsin Department of Natural Resources. April 14.

Kiepke, Marty. 2015b. Email correspondence with Deb Brossard. Wisconsin Department of Natural Resources. April 22.

Appendix A
Length-Frequency Tables, GLIFWC

Figure A1. Length frequency of adult walleye, spring 1998.

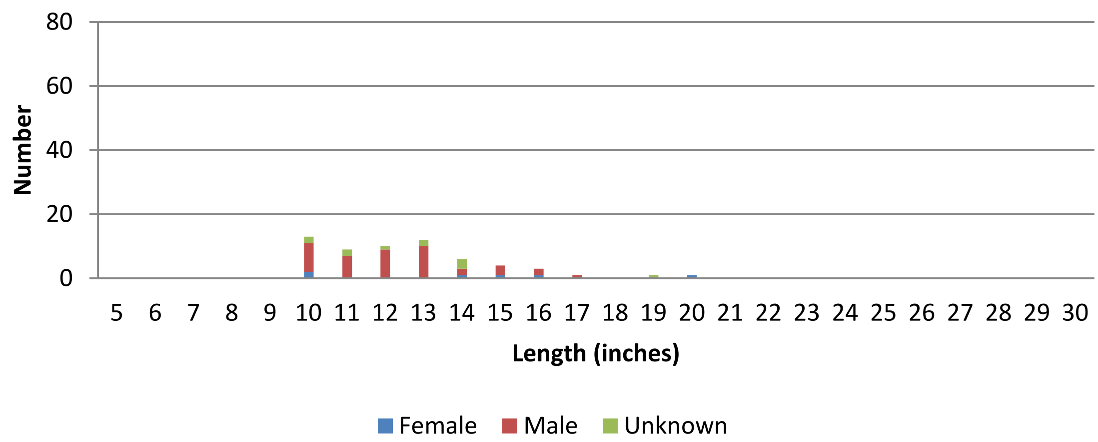
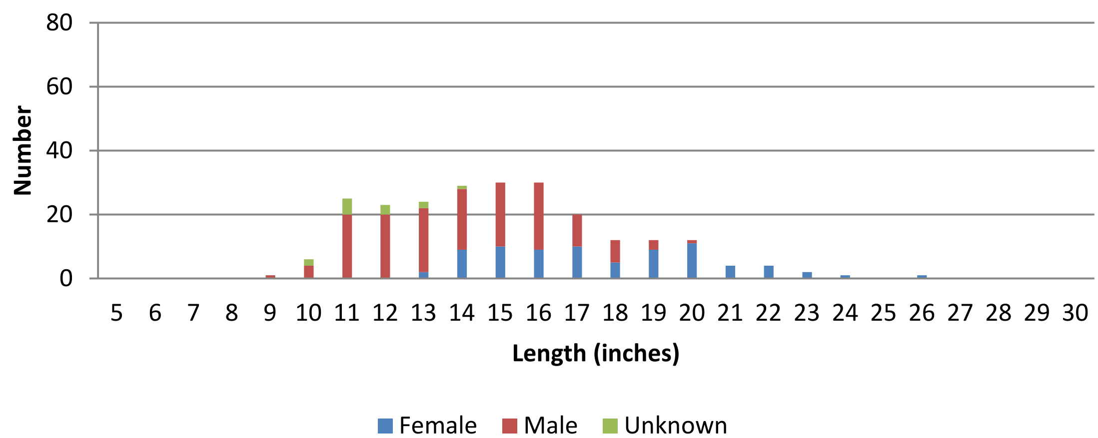


Figure A2. Length frequency of adult walleye, spring 2002.



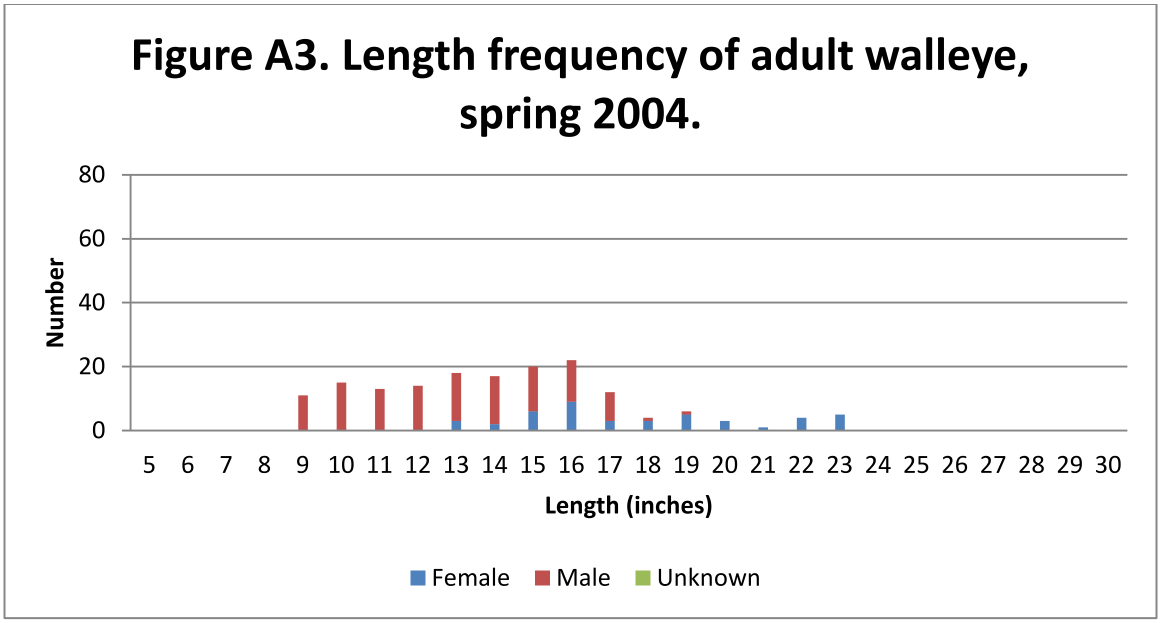


Figure A3. Length frequency of adult walleye, spring 2004.
Number
80
60
40
20
0
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)
Female
Male
Unknown

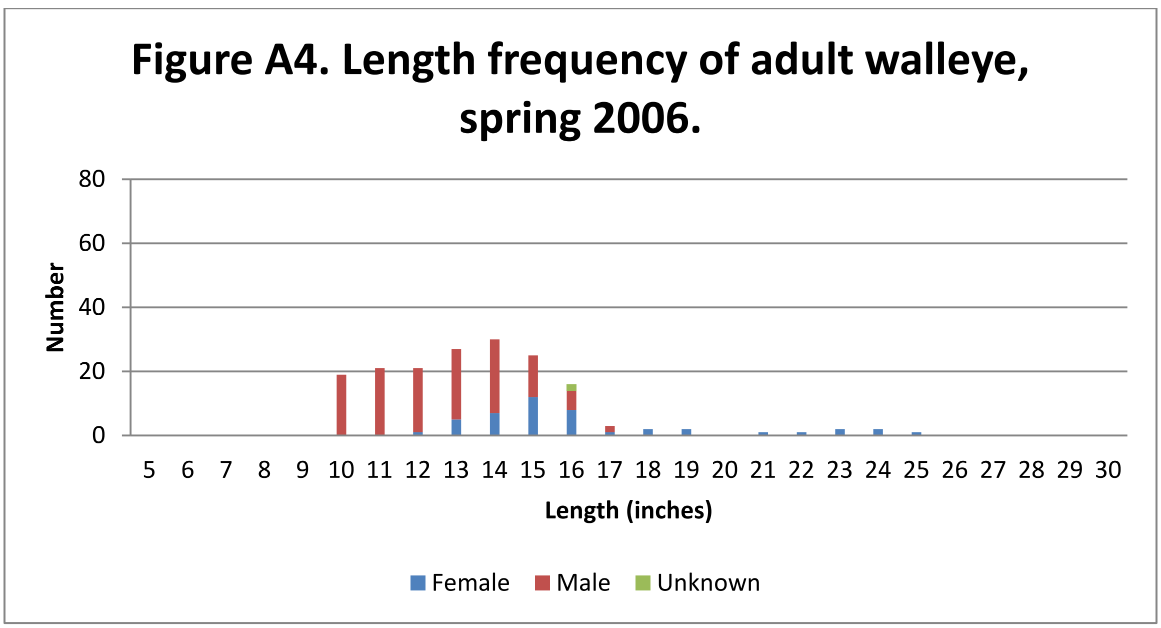


Figure A4. Length frequency of adult walleye, spring 2006.
Number
80
60
40
20
0
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)
Female
Male
Unknown

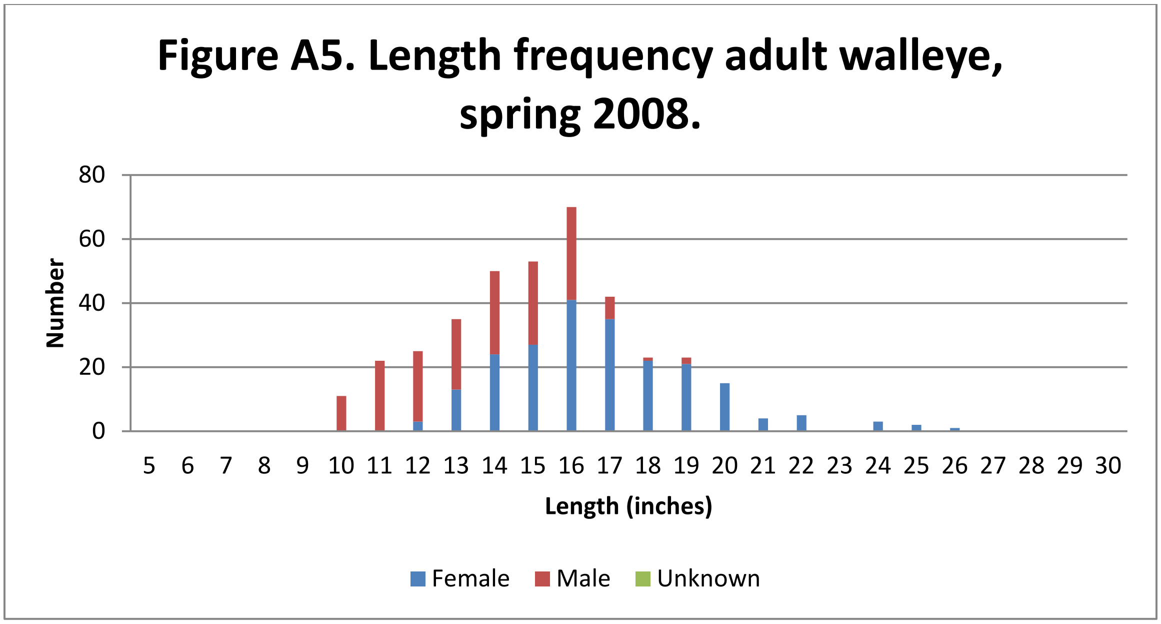


Figure A5. Length frequency adult walleye, spring 2008.
80
60
40
20
0
Number
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)
Female
Male
Unknown

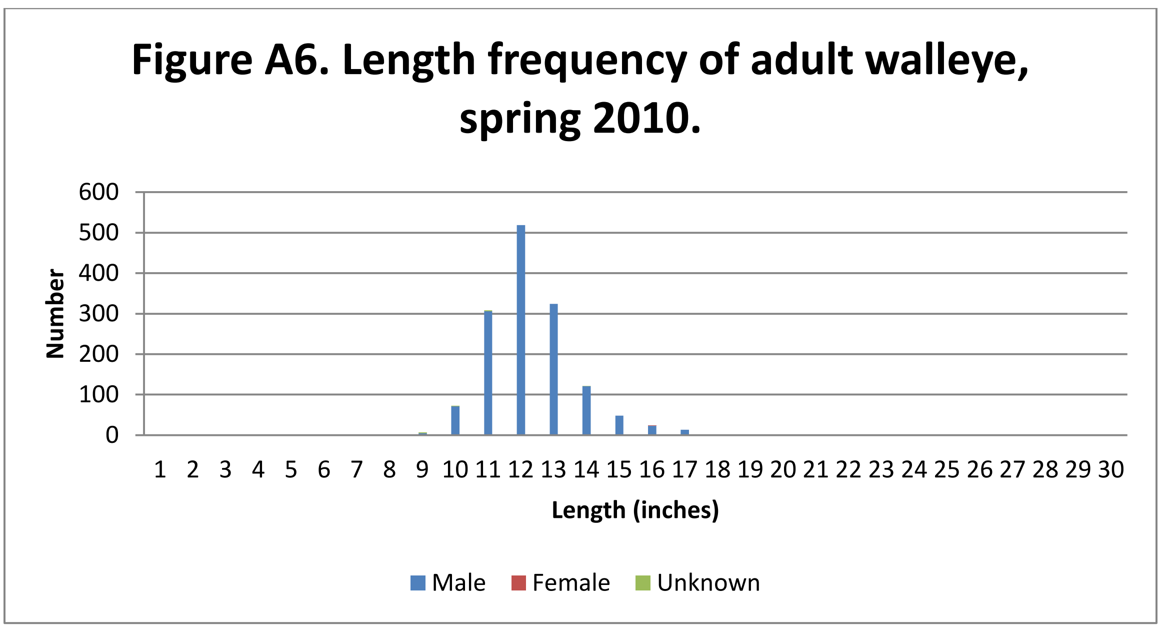


Figure A6. Length frequency of adult walleye, spring 2010.
600
500
400
300
200
100
0
Number
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)
Male
Female
Unknown

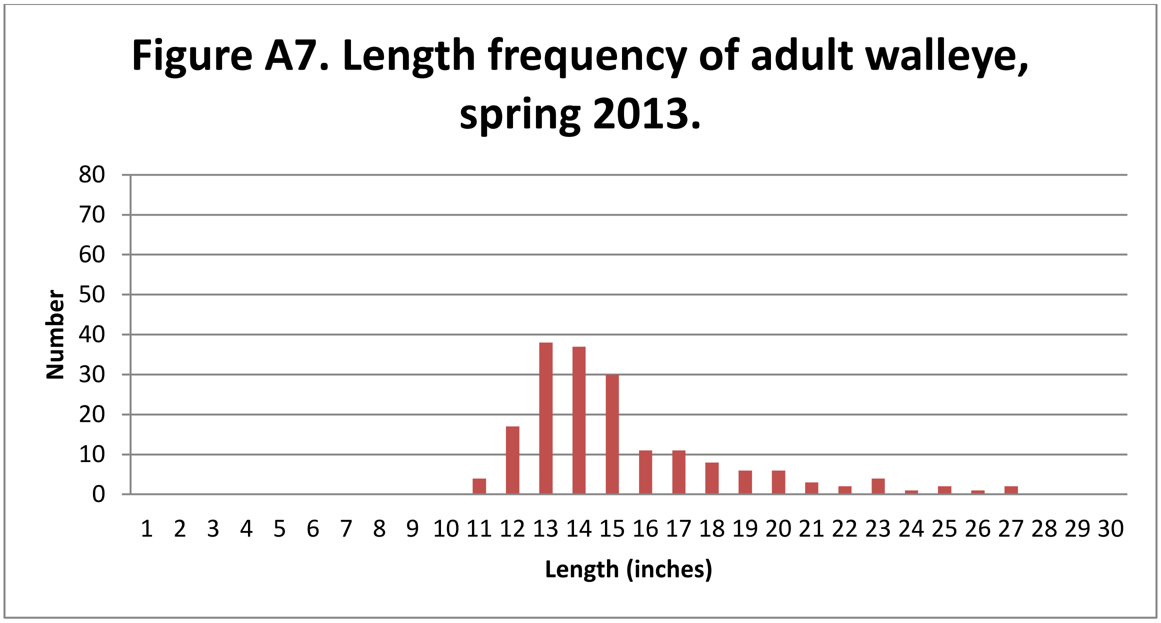


Figure A7. Length frequency of adult walleye, spring 2013.
Number
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)

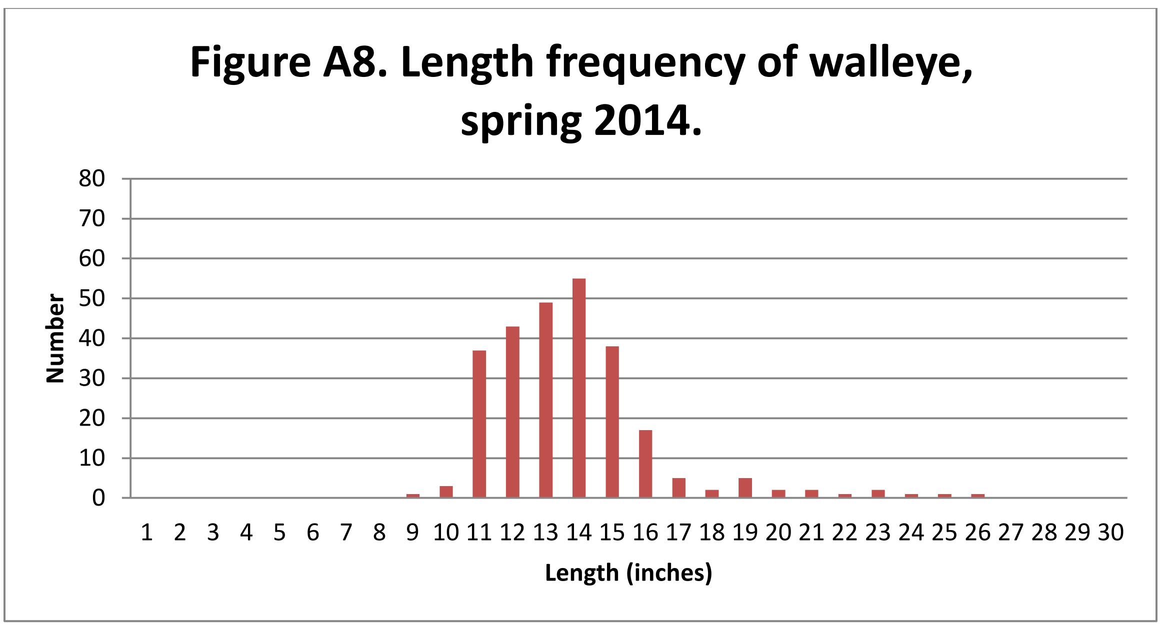
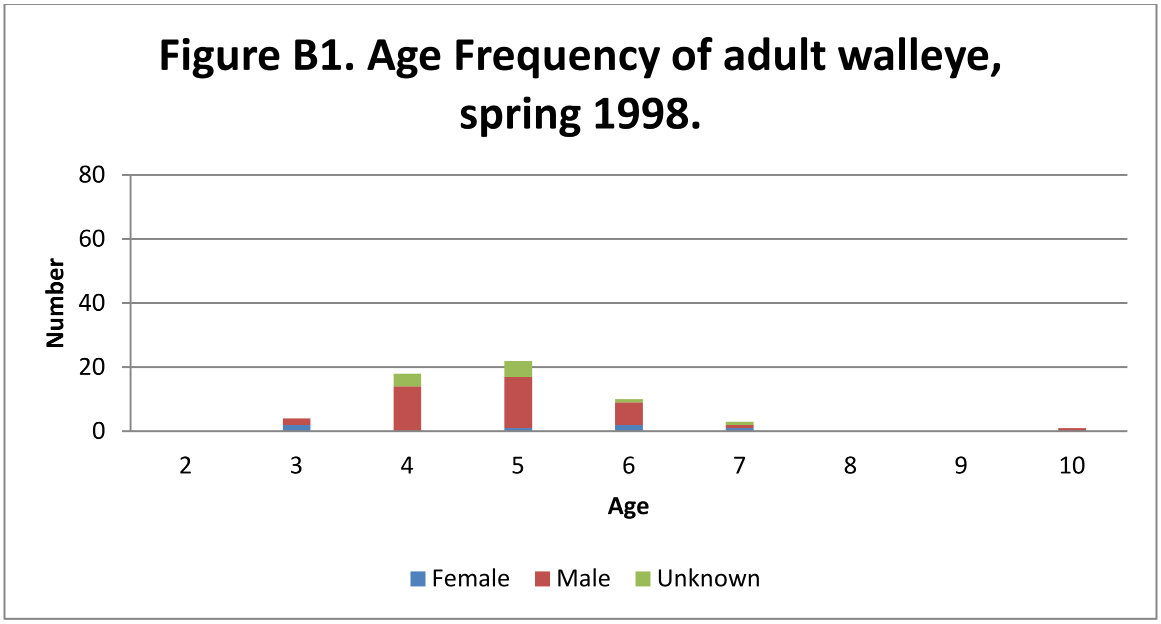
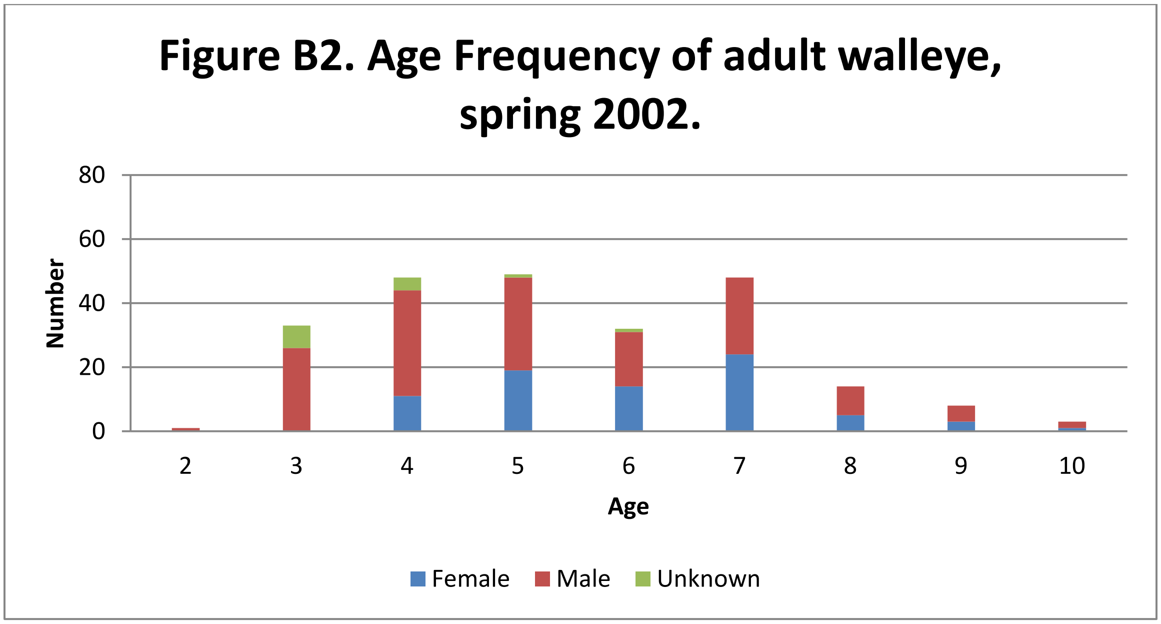


Figure A8. Length frequency of walleye, spring 2014.
Number
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Length (inches)

Appendix B
Age Frequency of Adult Walleyes, GLIFWC





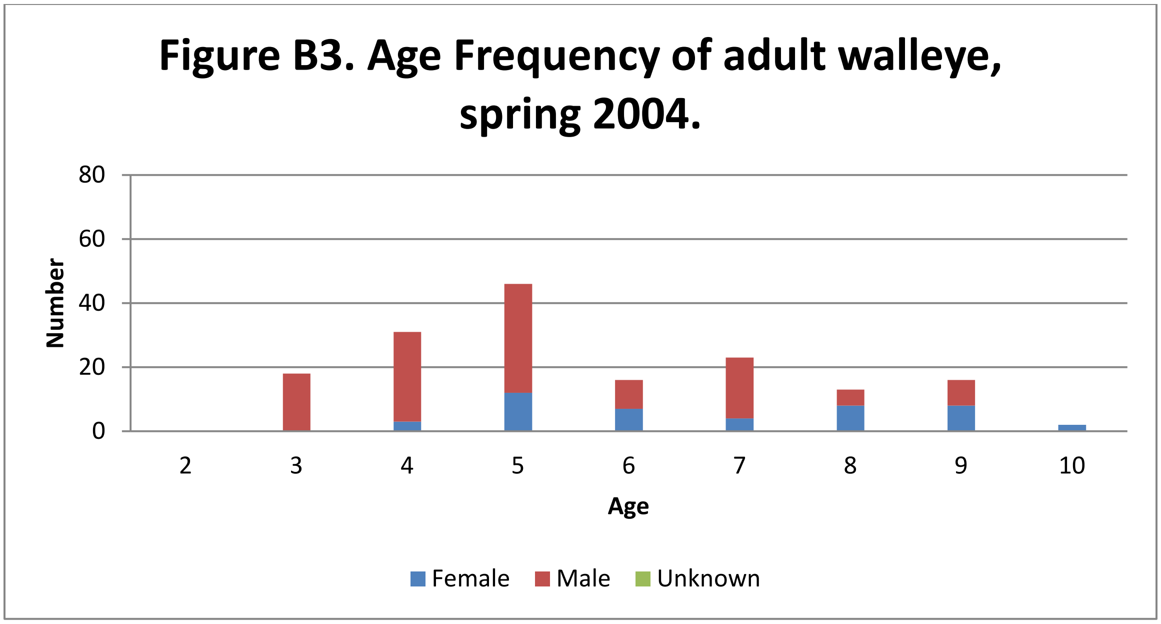


Figure B3. Age Frequency of adult walleye, spring 2004.
80
60
40
20
0
Number
2
3
4
5
6
7
8
9
10
Age
Female
Male
Unknown

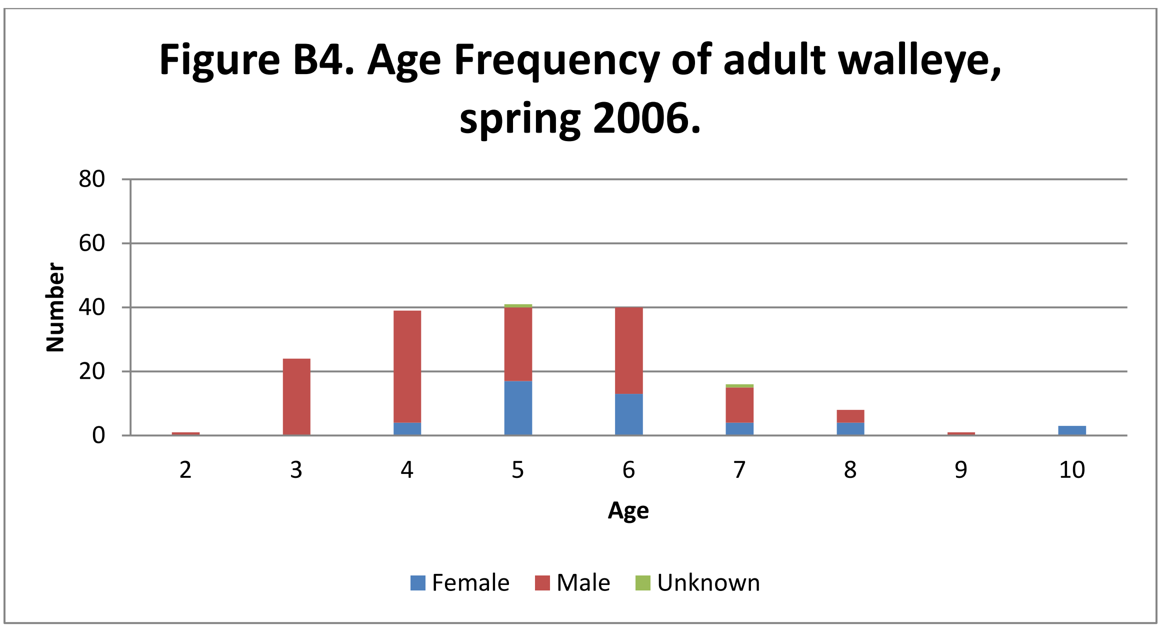


Figure B4. Age Frequency of adult walleye, spring 2006.
80
60
40
20
0
Number
2
3
4
5
6
7
8
9
10
Age
Female
Male
Unknown

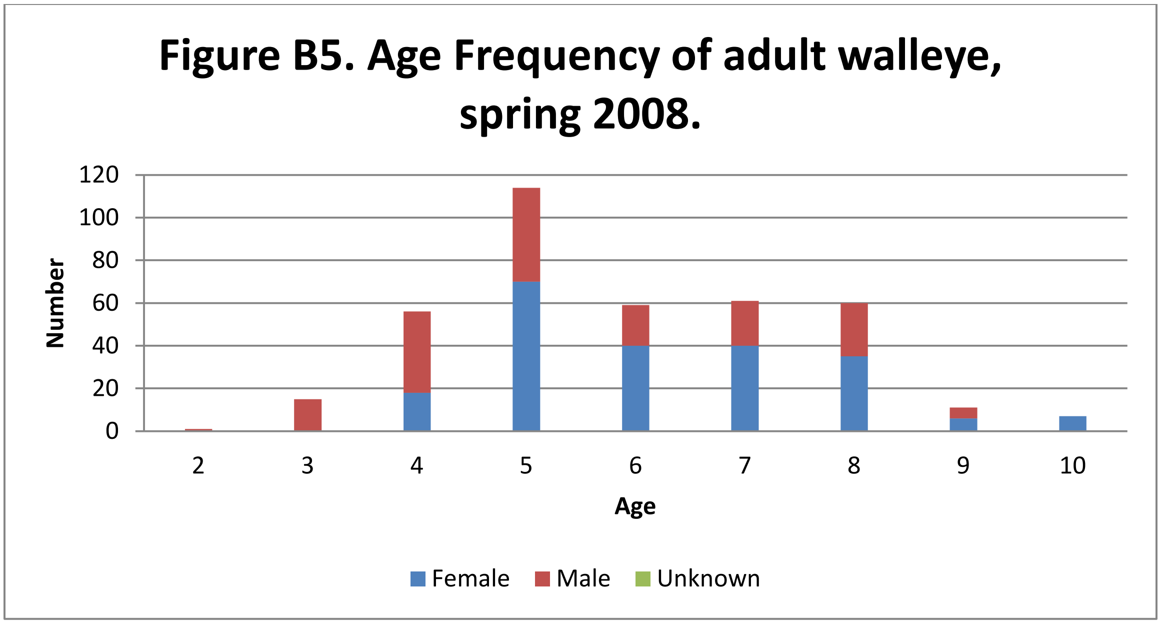


Figure B5. Age Frequency of adult walleye, spring 2008.
Number
120
100
80
60
40
20
0
2
3
4
5
6
7
8
9
10
Age
Female
Male
Unknown

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White Water Associates, Inc.

Appendix H
Bearskin Lake Rusty Crayfish Efforts

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Bearskin Lake Rusty Crayfish Efforts

By Angie Stine B.S., White Water Associates, Inc.

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WHITE WATER
ASSOCIATES, INC.

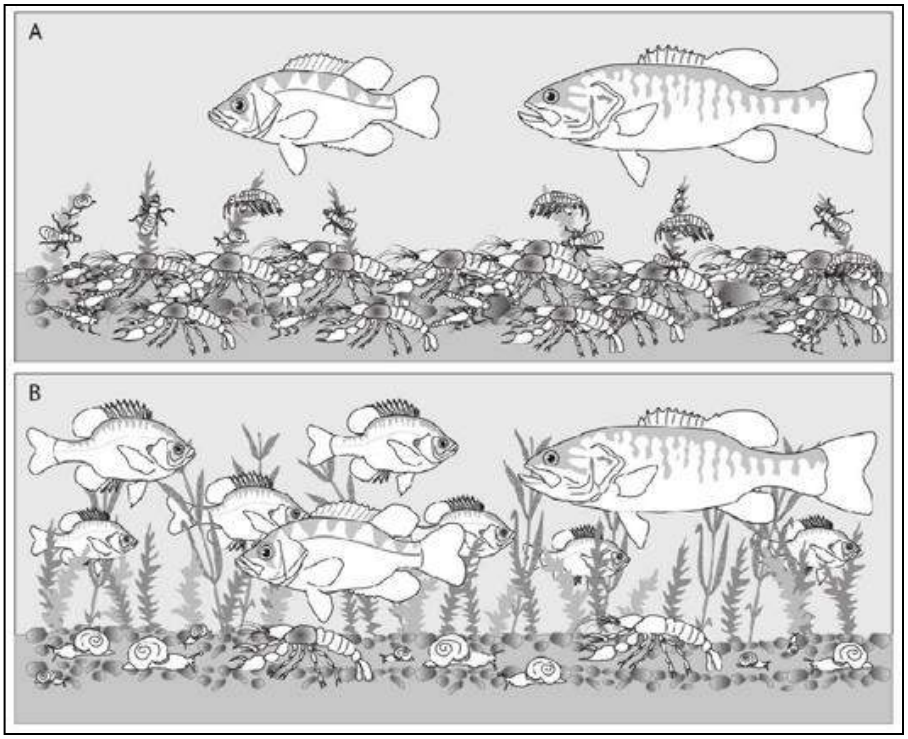
Introduction

Rusty crayfish (*Orconectes rusticus*) is an aquatic invasive species (AIS) that has been troublesome to many Wisconsin lakes. As voracious herbivores, a dense rusty crayfish population can decimate the native plant community. They also impact native invertebrates and fishes. Research has indicated that intensive trapping of rusty crayfish combined with the proper management of fish populations can be effective at reducing rusty crayfish populations and their impacts. The Big Bearskin Lake Association (BBLA) has diligently undertaken this approach to managing Bearskin Lake's population of rusty crayfish. BBLA volunteers have trapped rusty crayfish in a concerted program since the early 1980s. The BBLA has also created an annual event called CRAB-O-RAMA to recruit as many residents as possible to trap rusty crayfish around the July 4th holiday. Efforts from the Wisconsin Department of Natural Resources (WDNR) and the Big Bearskin Lake Association have created an improvement in the densities of rusty crayfish by using fish management and rusty crayfish trapping. This report documents those efforts.

Rusty Crayfish Research

When present, invasive rusty crayfish are a major driver of community composition in northern Wisconsin lakes where they extirpate native crayfish and reduce macrophyte, invertebrate, and fish populations (Sargent et al. 2012). Rusty crayfish populations exhibit low densities in some lakes where they have been introduced, but can reach "outbreak" densities in other lakes (Sargent et al. 2012). Understanding which factors are important in controlling crayfish density is essential for reducing their impacts (Sargent et al. 2012). Ecological interactions between abundances of fish predators, macrophytes, and crayfish may drive lake communities towards either high or low densities of crayfish (Sargent et al. 2012). Intensive trapping combined with management of fish populations has been effective at reducing rusty crayfish populations (Sargent et al. 2012). Exhibit 1 indicates how management/trapping can have an effect on a lake.

Exhibit 1. Illustration of a lake before (A) and after (B) management/trapping (Illustration by Bill Feeny) (Smith 2013).



Control of established invasive species can serve two purposes: (1) restoration of native biodiversity and ecosystem functions, and (2) quantification of the effects of food web interactions on ecosystem dynamics (Hansen et al. 2013). The graphic above illustrates how a lake invaded by rusty crayfish can change back to a healthy and diverse ecosystem. Successful control of an invasive species and restoration of ecosystem function does not necessarily require that 100% of the invasive population be eliminated (Hansen et al. 2013), although the long-term effectiveness of control is determined by the stock-recruitment relationship of the exploited species. If reproduction or juvenile survival increases at low adult densities, then attempts to control invasive species can backfire, resulting in greater abundance of the target species (Hansen et al. 2013).

A study of rusty crayfish trapping was conducted on Sparkling Lake in Vilas County, Wisconsin. Sparkling Lake is a 64 ha mesotrophic seepage lake with a maximum depth of 20 m. Rusty crayfish invaded the lake in the 1970s and reached high densities in the 1980s. A whole-lake manipulation was initiated in Sparkling Lake in 2001 to control rusty crayfish via trapping and fish predation. Rusty crayfish removal trapping was applied between 2001 and 2008. Monitoring trapping continued through 2012. Fishing regulations were changed in 2001 with the intent of reducing angler harvest and increasing fish predation on juvenile rusty crayfish. Length limits of smallmouth bass and walleye were increased. Bag limits were decreased to one for each species (Hansen et al. 2013).

The rusty crayfish management efforts at Sparkling Lake resulted in the removal of 91,930 crayfish with traps from 2001 to 2008. Rusty crayfish catch per unit effort decreased by two orders of magnitude from its peak of 11.8 trap in 2002 to 0.11 trap in the final year of harvest in 2008, and remained low through 2012 (Hansen et al. 2013). The percent cover of aquatic plants (a measure of plant density) was considerably higher in years of low rusty crayfish densities. The panfish (*Lepomis)* population increased substantially over the years of the rusty crayfish management. Early in the study, crayfish constituted approximately 25% and 20% by number of rock bass and smallmouth bass diets, respectively (Hein et al. 2007). At the end of the experiment, crayfish made up less than 1% of rock bass diets and just over 1% of smallmouth diets (Hansen et al. 2013).

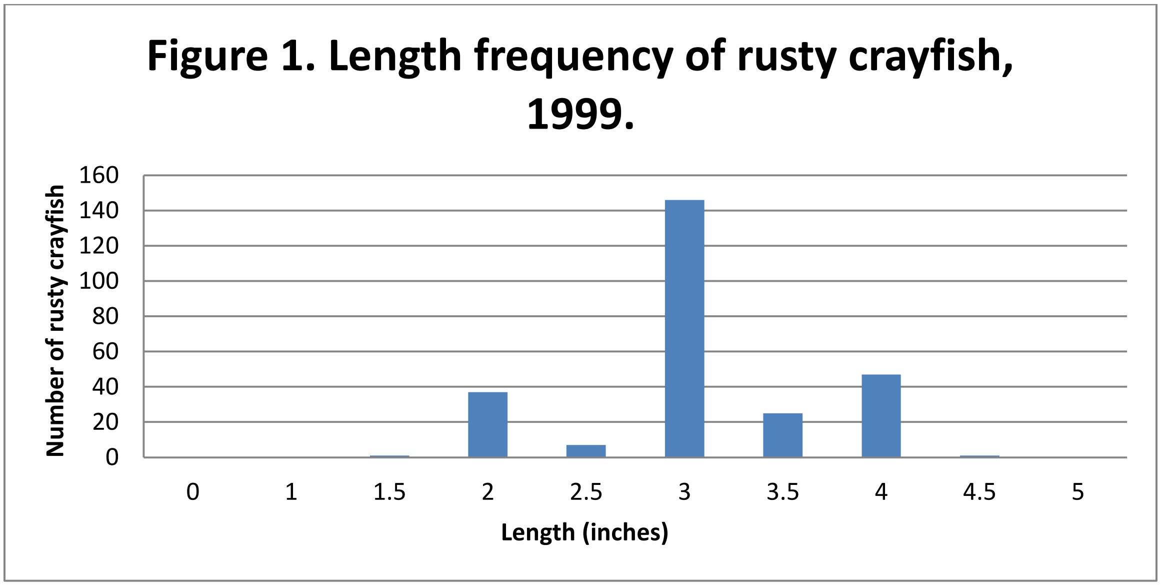
The Sparkling Lake case study demonstrates that it is possible to alleviate the negative effects of invasive rusty crayfish even in the absence of complete eradication (Hansen et al. 2013). Eradication or control of established invasive species is often viewed pessimistically by managers and scientists, and control via harvesting has been discounted as impossible for most species owing to the low probability of removing all individuals (Hansen at al. 2013). Furthermore, others have argued that controlling invasive species will require ongoing management to prevent recovery by the invader. In this study, however, rusty crayfish densities remained low 4 years after cessation of harvest (Hansen et al. 2013). Maintaining the rusty crayfish at low densities could sustain positive effects for many years. The Sparkling Lake experience is a unique example of successful control of an established aquatic invasive species leading to sustained changes in the native community of an inland lake (Hansen et al. 2013). Native virile crayfish (*Orconectes virilis*), macrophytes, gastropods (found in cobble), and panfish (*Lepomis*) densities all increased as rusty crayfish population was diminished. These positive changes continued in the 4 years following termination of rusty crayfish removal harvest (Hansen et al. 2013). As will be reported below, the Bearskin Lake experience demonstrates a similar outcome.

Bearskin Lake Rusty Crayfish Trapping

The rusty crayfish first appeared in Bearskin Lake in 1961, according to historic records. These invasive crayfish grew to a nuisance population by the 1980s and about this time concerned lake home owners began trapping efforts. Bearskin Lake resident and volunteer Roger Soletske spearheaded and coordinated the rusty crayfish trapping program through the years. He has been inquisitive and innovative about trapping techniques and has developed a thorough working knowledge on the subject. We reference Mr. Soletske throughout this report. In 1997, a consultant for the Big Bearskin Lake Association (BBLA) stated that harvesting the rusty crayfish may be having a small impact on the population but the best course of action is to wait to see if the fish community can adapt to feeding on them (McComas 1997). The BBLA continued to trap using an assortment of traps and bait. Over time, volunteers found that the most effective rusty crayfish traps were constructed from 5 gallon buckets. The bucket trap was made by cutting a circle out of the lid and placing a mesh wiring shaped into a cone for entrance and entrapment. There was a weight placed on one side of the bucket so the rusty crayfish could enter easier. Various baits (e.g. liver, cowhide, fish parts, and can of tuna) were used to entice the rusty crayfish to enter the trap. The traps had proper identification with a float attached on them and they were left in the water for 24 hours and then removed. Over time, BBLA provided bait for residents to use for trapping rusty crayfish.

Volunteer trapper Roger Soletske recalled that in 1981 approximately 26 gallons of rusty crayfish were caught per day in 25 traps (personal communication Soletske 2012). In 1987, Soletske mentions catching 8-10 gallons of crayfish per day with 25 traps. The BBLA brainstormed some ideas on how to combat the rusty crayfish along with trapping. In 1994, the BBLA worked with the WDNR, Conservation Congress and the Warm Water Fish Committee on changing the bass size and bag limit to one fish over 18 inches in length to help with the rusty crayfish problem (BBLA Newsletter 1995). Another effort of dealing with the rusty crayfish was to find commercial rusty crayfish trappers. The Association put an ad in the Midwest Outdoors and Outdoor Notebook looking for rusty crayfish trappers and also posted some flyers at local establishments.

In 1999, crayfish traps were placed at two specific depths: 3 and 8 feet. Rusty crayfish were counted and their length was measured. Figure 1 indicates that in 1999 the majority of rusty crayfish caught were 3 inches in length.



McComas (2000) stated that typically, a plant coverage of 40% or more is adequate to sustain clear water conditions. In 1999, it was estimated that the aquatic plant coverage in Bearskin Lake was less than 10 percent. The presence of both algae blooms and rusty crayfish negatively impacted the aquatic plant community.

Exhibit 2 displays pictures of rusty crayfish trapping efforts (McComas 2000). Notice the size variation in rusty crayfish. Roger Soletske began having people drop off their trapped crayfish in a homemade live well off his dock, if they did not want to dispose of them themselves (Exhibit 2). Mr. Soletske was able to sell rusty crayfish meat from larger individuals to restaurants and bait dealers.

Exhibit 2. Rusty Crayfish Trapping by Roger Soletske (McComas 2000 and 2006).

Float attached to rusty crayfish trap.

Fish can eat the small crayfish, but not the larger.

Frabill traps used for trapping rusty crayfish.

Homemade trap a five gallon pail with mesh.

Soletske examining his holding pens.

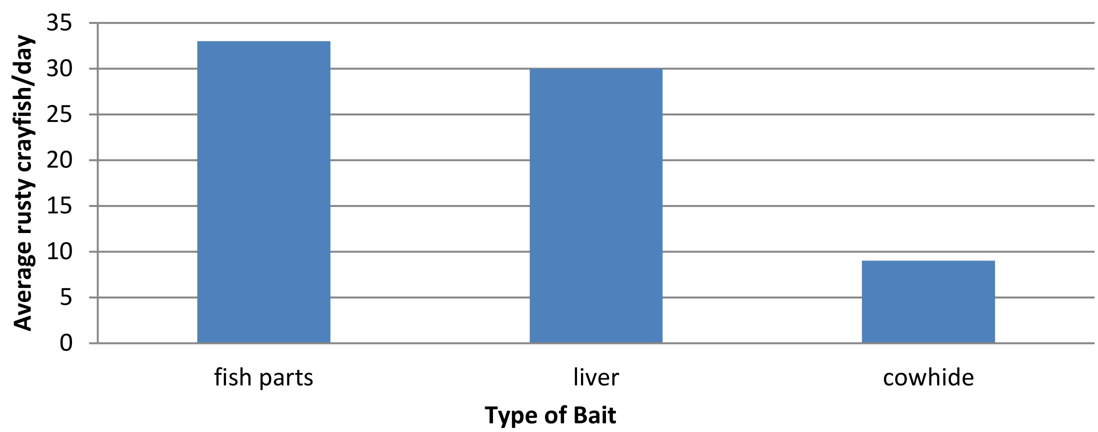
These crayfish will be sorted and the larger sized crayfish end up in a restaurant (BBLA 2000).

A WDNR grant was awarded to the BBLA from 2004-2006 to study how best to catch rusty crayfish. Trap location, type of bait, and type of trap were varied to determine the most effective method.

In 2004, Soletske placed 30 traps (in groups of six) at five locations, around the shoreline. In this fifteen-day trial, 682 pounds of crayfish were removed. He notes that the crayfish appeared to be different sizes at different locations around the lake. The smaller rusty crayfish were located in flat, rocky areas, while the larger, mature crayfish were near softer bottom that had aquatic plant growth (Soletske 2006).

In 2005, Soletske tested different baits. He used 20 traps per day over 22 days with three different bait types such as fish parts, liver, or cowhide (Figure 2). Traps with fish bait averaged 33 rusty crayfish per trap and those with liver averaged 30. Cowhide bait was not nearly as effective (Soletske 2006). Over the years of rusty crayfish trapping at Bearskin Lake, a variety of baits have been used. Poultry carcasses, beef and bones, punctured tuna cans, corn cobs, and other table scraps have had variable success as bait.

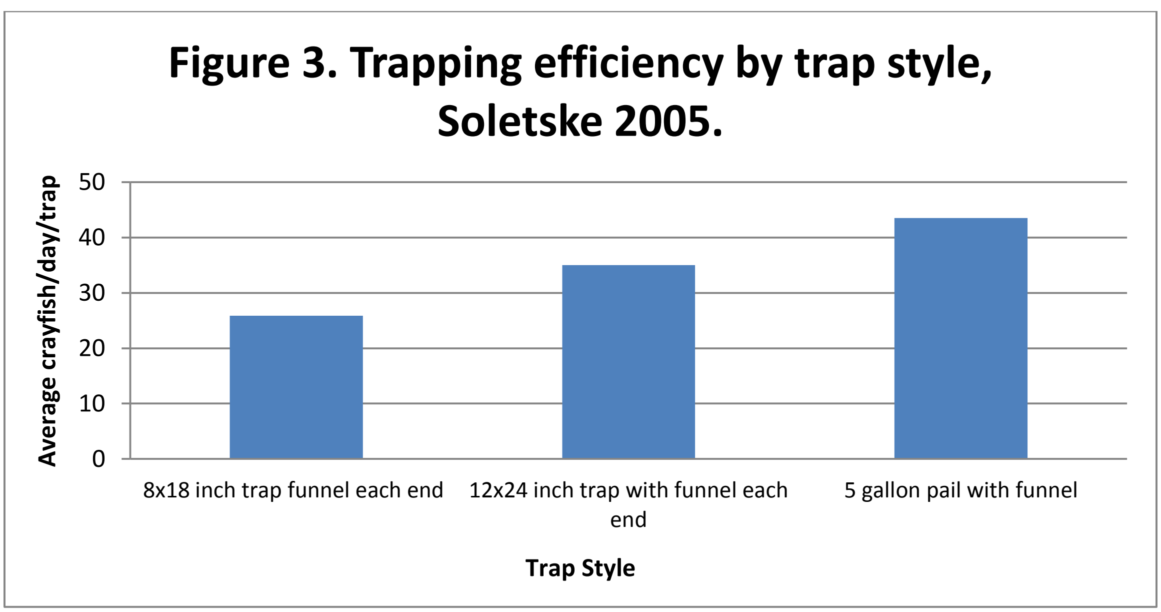
Figure 2. Trapping efficiency by bait trial, Soletske 2005.



Mr. Soletske was also interested in determining what trap type worked most effectively for rusty crayfish. Through direct experience, he had observed that when rusty crayfish populations were high, traps would fill to capacity within 8-12 hours. Because traps were typically checked once a day (ie, every 24 hours) many crayfish escaped capture. Exhibit 3 illustrates the three trap styles that Soletske used.

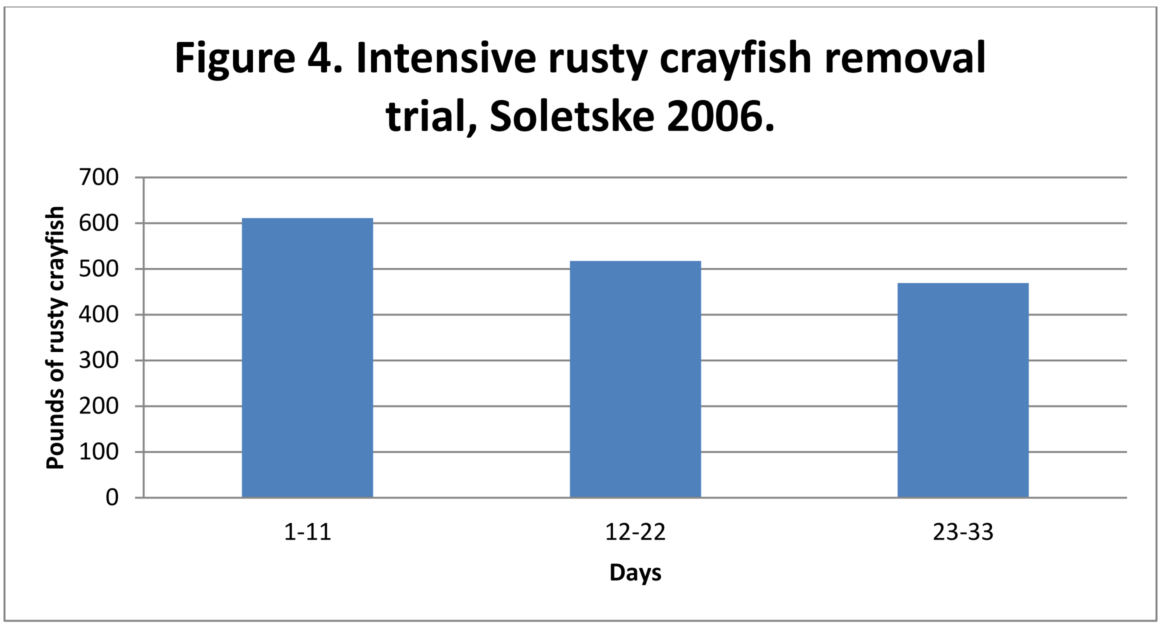
Exhibit 3. Roger Soletske with the three different trap styles (McComas 2006).

The first trap style was a purchased trap that was approximately 8x18 inches with a funnel at each end and was emptied by splitting in the middle (Exhibit 3, right). The average count for this trap was 25.9 crayfish per 24 hour period (Soletske 2006). This trap had the highest loss due to many crayfish being able to escape. The second trap was one that Soletske made out of hardware cloth, measuring 12x14 inches with a funnel on each end (Exhibit 3, middle). This trap averaged 35 crayfish per 24 hour period. The third trap style was a plastic 5 gallon pail with perforated holes and one mesh funnel end formed into the pail top (Exhibit 3, left). This style of trap averaged 43.5 crayfish per trap. Figure 3 displays the number of rusty crayfish captured/day by trap type.



With the new trap and bait information, Soletske decided to trap for 9 more days with the 5 gallon pail trap and the fish parts. He captured 396 pounds (9,036) of crayfish during this 9 day period. Considering the 1,519 rusty crayfish caught in the bait study, and the 1,055 rusty crayfish caught in the trap study, the total number of rusty crayfish removed by trapping in 2005 was 11,621(Soletske 2006).

Soletske's objectives in 2006 were to remove as many crayfish as possible and to determine if high trapping intensity in a specific area of the lake would dramatically decrease the number of rusty crayfish in that area. In this activity, he placed traps along 300 yards of shoreline and used the same traps and bait type for 33 days. Trapping results (total pounds of rusty crayfish per eleven day period) are illustrated in Figure 4. Days 1-11 produced 611 pounds (13,495) of crayfish. Days 12-22 produced 517 pounds (11,007). Days 23-33 produced 469 pounds (11,076). Not related to the test, Soletske trapped and additional 254 pounds (7,620) in other parts of Bearskin Lake.



Soletske removed a total of 76,134 crayfish during the 2005-2006 study. In addition, 25,000 crayfish were trapped by lake residents during that same period. Soletske made several integrative observations during the 2005-2006 rusty crayfish trapping seasons that draw from his extensive experience:

- Rusty crayfish can be trapped with almost any kind of bait.
- Trap styles will affect trapping success.
- Intensively trapping an area will decrease the size of rusty crayfish being caught more than numbers caught.
- Current trap designs allow rusty crayfish to escape (more effective trap design is needed).
- Bait is difficult to obtain.
- It is important to conduct intensive trapping to remove the larger crayfish.

- Lake residents/volunteers must continue and increase trapping efforts.
- Commercial trapping should be encouraged.

Soletske (2006) feels that it would be helpful to relax laws on the types of bait allowed for trapping. Currently only fish parts from fish harvested in the lake can be used to trap rusty crayfish because of concern for VHS disease (a fish disease). Soletske also advocates increased financial support for rusty crayfish trapping and stricter bag limits of predator fish that eat small crayfish.

Senior WDNR fisheries biologist, John Kubisiak (2004), states that low panfish abundance and a shift from largemouth bass to smallmouth bass are changes attributable to the presence of rusty crayfish in Bearskin Lake. Predation by fishes, especially smallmouth bass, may help regulate crayfish abundance (Kubisiak 2004). Kubisiak (2004) recommends continuing the suppression of rusty crayfish to allow recovery of aquatic vegetation.

Long time lake resident John Lietz (BBLA Newsletter 2012) reports an increase in aquatic plant growth and a large decrease in rusty crayfish. Roger Soletske recalls that in the early 1980s, he was catching 8-10 gallons of rusty crayfish per day in 25 traps, whereas nowadays he collects only 1/3 of a gallon in the same number of traps.

Roger Soletske (personal communication 2012) observes that the rusty crayfish season shortens every year and that it is currently more difficult to find crayfish in the spring. Soletske notices males after the water warms up to 60 degrees F (Soletske 2012). Shortly after that, Soletske will only catch females (69 degrees F). July is the best month of trapping (Soletske 2012).

In 2013, Roger Soletske and Angie Stine (White Water Associates) developed a data collection form for recording additional rusty crayfish trapping data. This system divided Bearskin Lake into twelve zones for purposes of recording geographic data. Exhibits 4 and 5 present the map of lake zones and the field data form. Crayfish size and gender was included in this form as well as habitat, type of bait, and depth where the trap was placed.

Exhibit 4. Rusty crayfish tapping data sheet (Soletske and Stine 2013).

Rusty Crayfish Trapping Data Sheet: Bearskin Lake 2014: Print Name ____________________________.

*The time the trap is in the water is assumed to be 24 hours. If more than one Area is used please record one Area per line.

+ Completed by "weigh in volunteer", Zones 1-16.

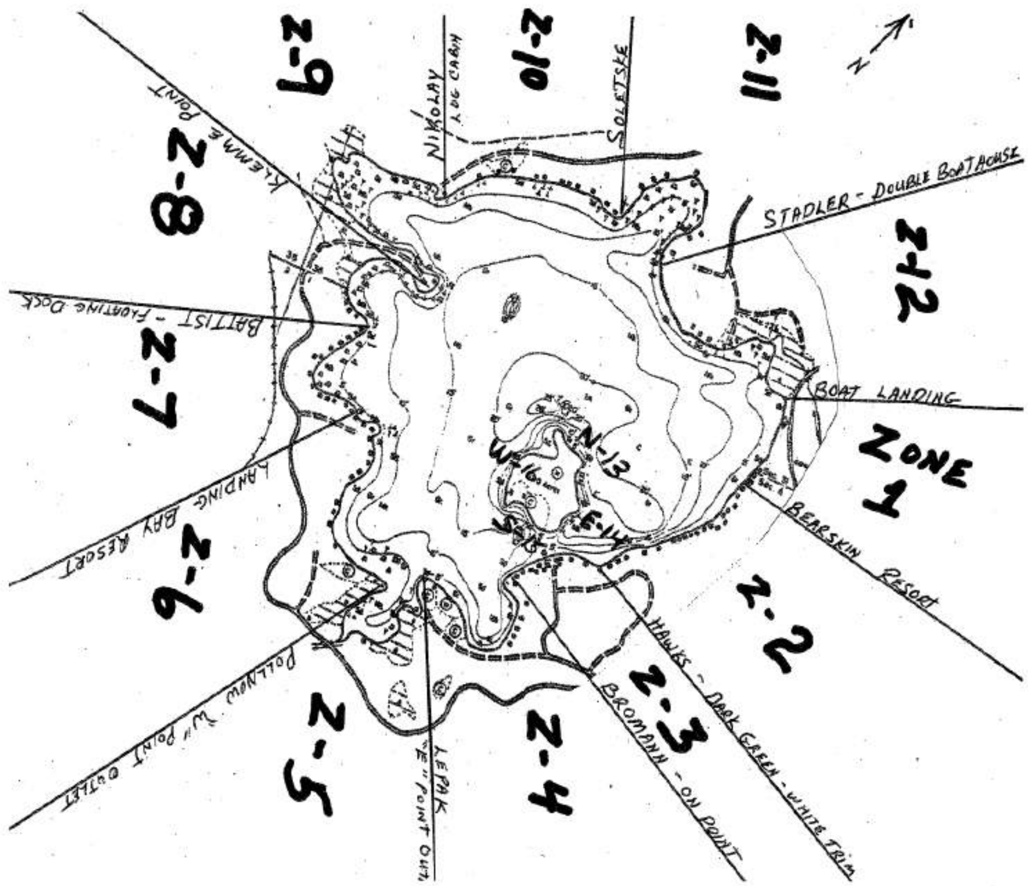
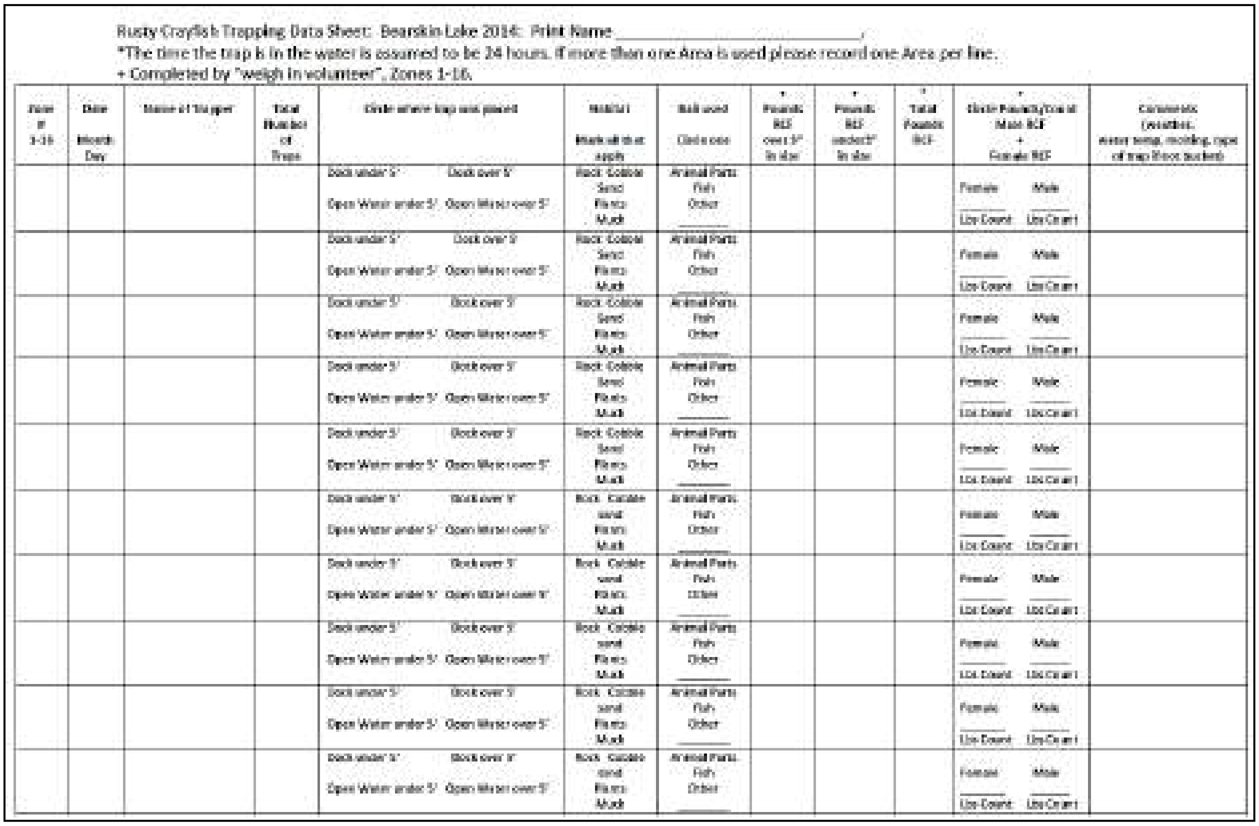


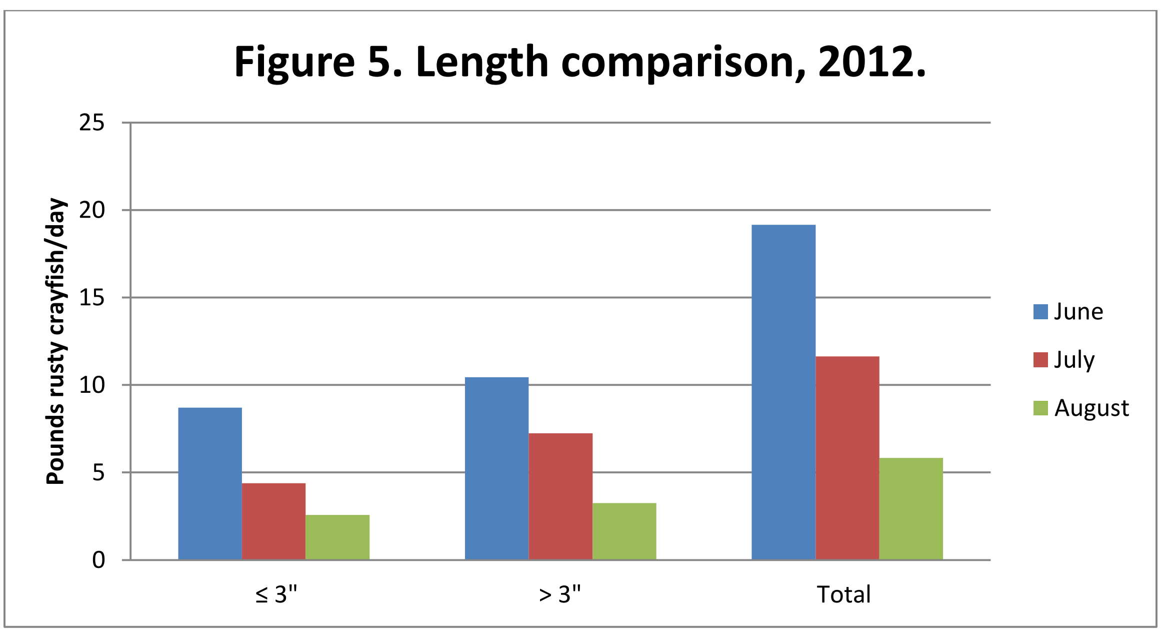
Exhibit 5. Rusty crayfish log in datasheet for Bearskin Lake (Soletske and Stine 2013).



Rusty Crayfish Trapping Data Sheet: Bearskin Lake 2014: Print Name ____________________.
*The time the trap is in the water is assumed to be 24 hours. If more than one Area is used please record one Area per line.
+ Completed by "weigh in volunteer", Zones 1-16.

Zone # 1-16	Date Month Day	Name of Trapper	Total Number of Traps	Circle where trap was placed	Habitat Mark all that apply	Bait used Circle one	+ Pounds RCF over 3" in size	+ Pounds RCF under 3" in size	+ Total Pounds RCF	+ Circle Pounds/Count Male RCF + Female RCF	Comments (weather, water temp, molting, type of trap (foot socket))
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	
				Dock under 5' Dock over 5' Open Water under 5' Open Water over 5'	Rock Cobble Sand Plants Muck	Animal Parts Fish Other ____				Female Male ____ ____ Lbs Count Lbs Count	

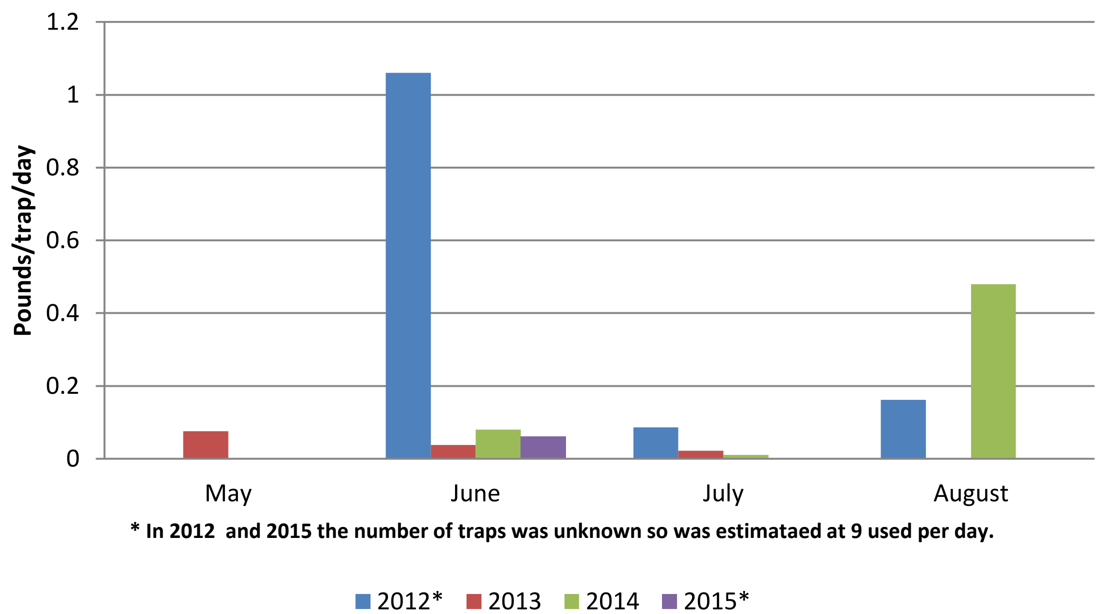
In 2012, a comparison was made for the pounds of rusty crayfish caught each day of trapping that were less than or equal to 3 inches and greater than 3 inches (Figure 5).

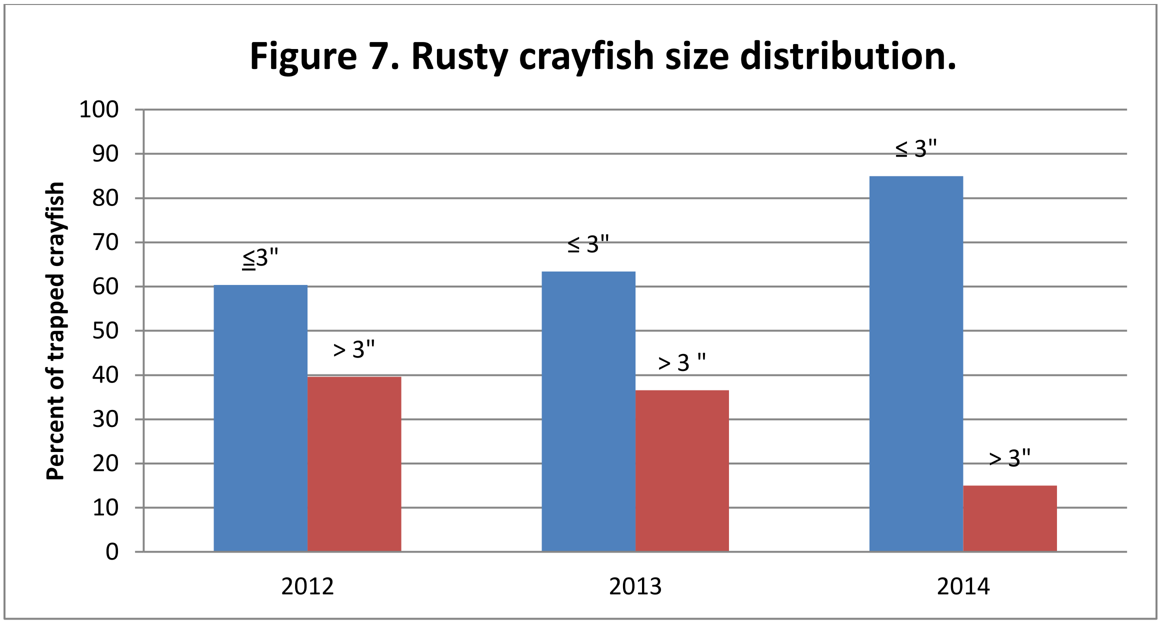


In 2013 and 2014, trapping was mostly accomplished using 5 gallon pails with a funnel attached to the cover. The pail was weighted so it lies on its side. Soletske (2013a) mentions how the rusty crayfish numbers were down and states that yellow perch may have made a great impact on the rusty crayfish after they were stocked (privately funded). Gender was not determined for all of the crayfish trapped because of the time involved in handling.

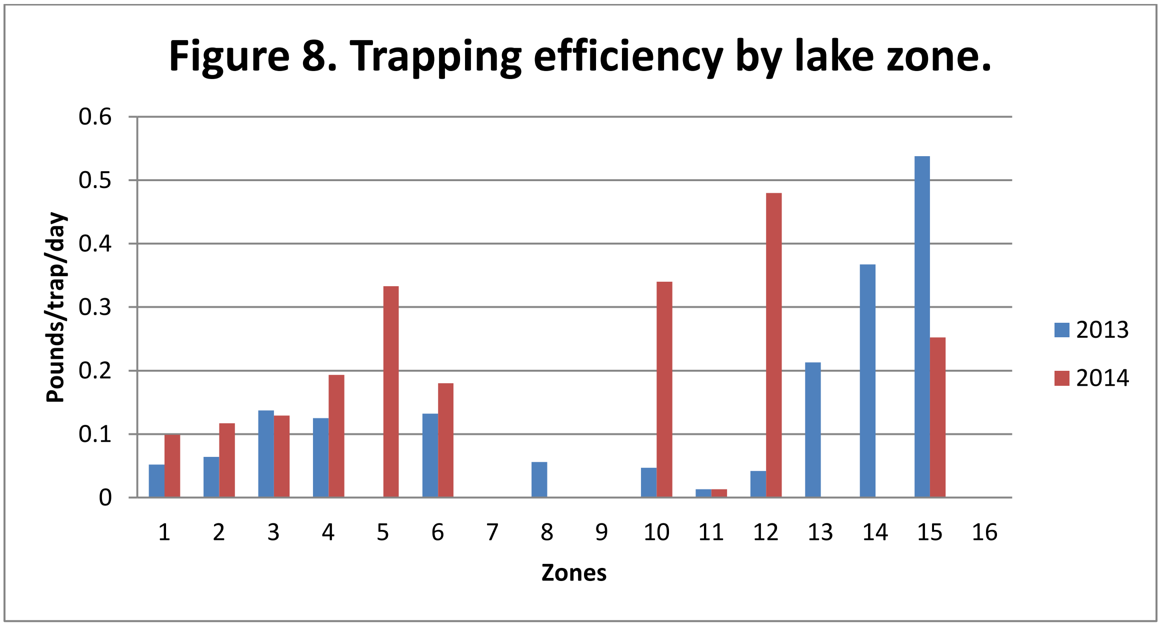
Figure 6 displays the 2012-2015 trapping season efforts. July tended to be the month with the most trapping data and is the more reliable month to compare changes in trapping efficiency over the years of trapping. It is possible to compare the size distribution (a surrogate for crayfish age) of trapped rusty crayfish over time using Bearskin Lake trapping data. Figure 7 illustrates the size distribution moving toward smaller crayfish between 2012 and 2015.

Figure 6. Trapping efficiency by month.





Also analyzed was the trapping efficiency (pounds of rusty crayfish per trap per day) in each zone on Bearskin Lake in 2013 and 2014 (Figure 8). Zone 15 had the highest trapping efficiency in 2013 and zone 12 in 2014.



Trapping efficiency by lake substrate was also analyzed. Traps placed on rock and cobble substrate generally had higher efficiency for trapping rusty crayfish (Figure 9).

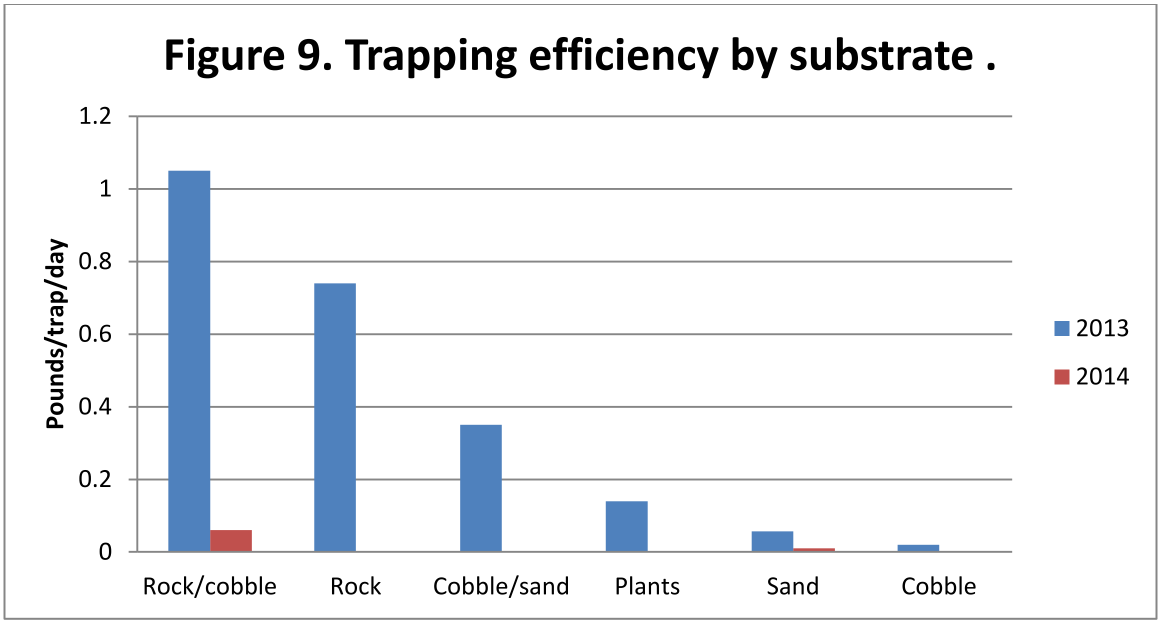
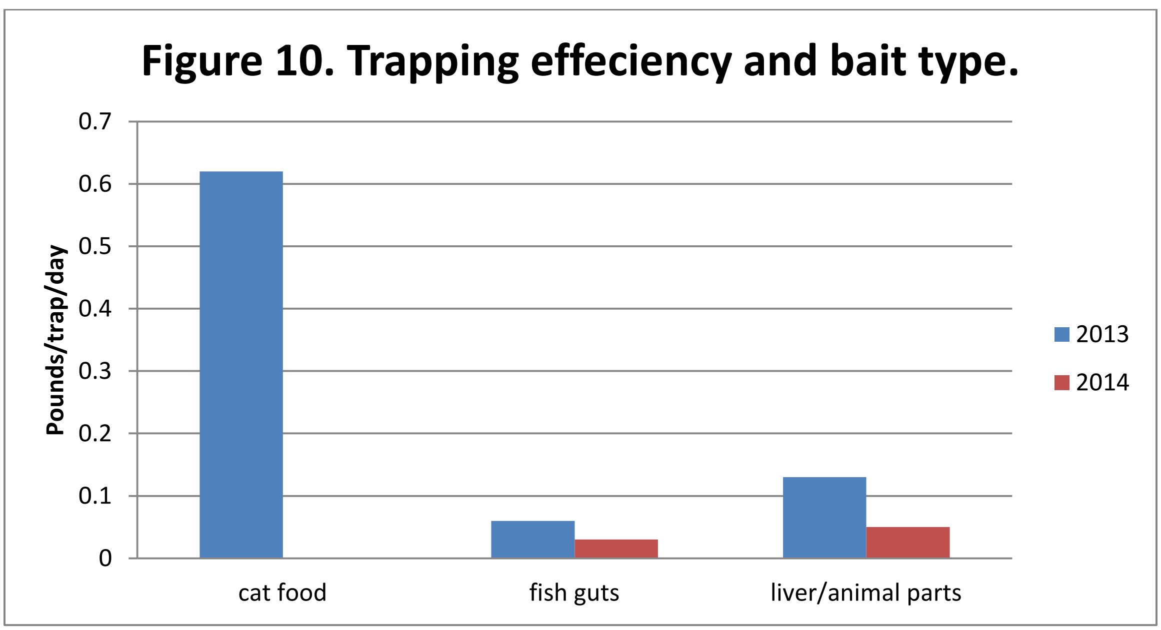


Figure 10 displays the type of baits used in 2013 and 2014 and analyzes trapping efficiency by bait type. Although cat food demonstrated the highest trapping efficiency for rusty crayfish, the sample size for this bait type was very small (one trapping outing).



In 2013 and 2014, trappers monitored how depth of the trap placement influenced trapping success (Figure 11). The deeper water traps (those in 6-10 feet) showed the highest trapping efficiency.

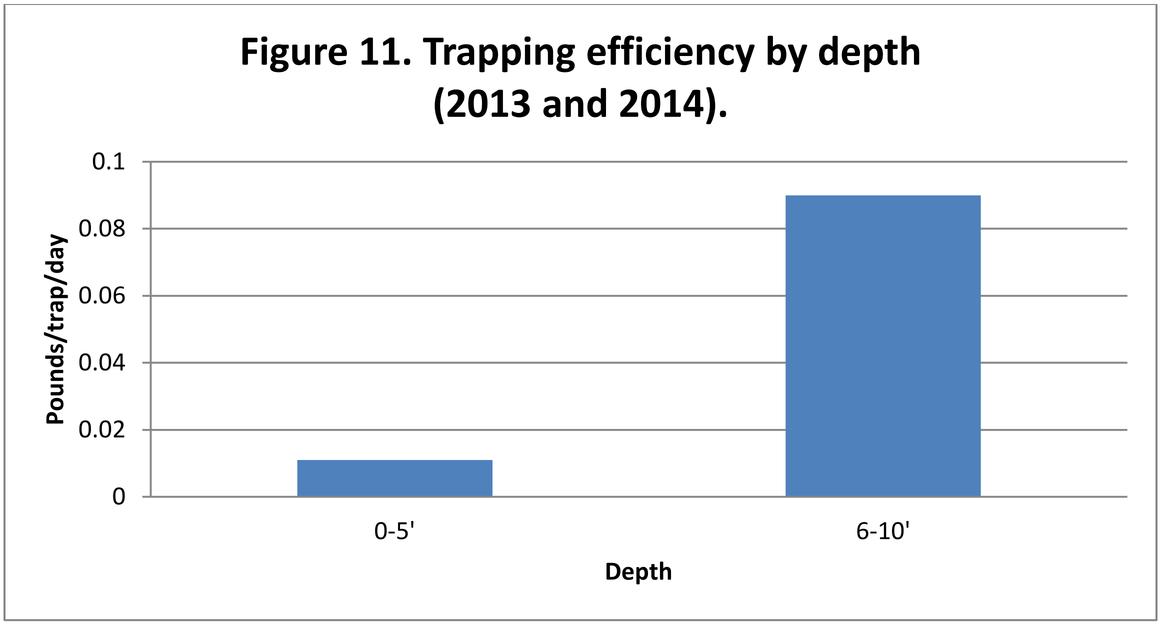


Figure 12 displays the total pounds of rusty crayfish caught in 1981, 1987, 2004-2006, and 2012-2015. The spike in 2006 was indicative of the strategy to catch as many rusty crayfish as possible in a given month. This graph also illustrates how over time the trapping efforts have sustained a low number of rusty crayfish.

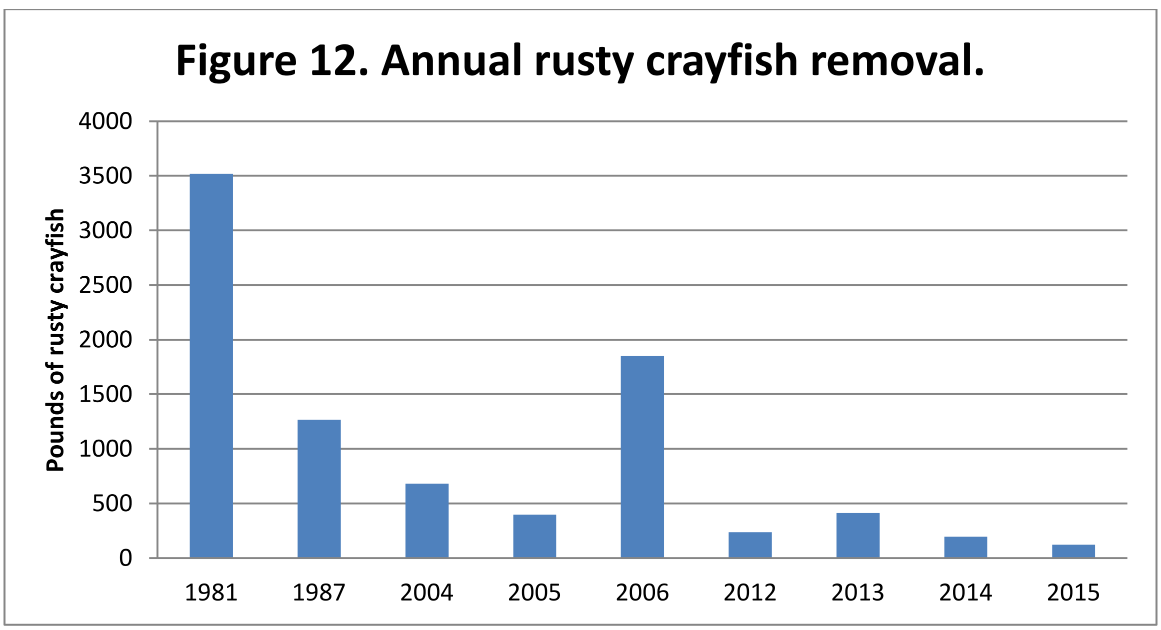
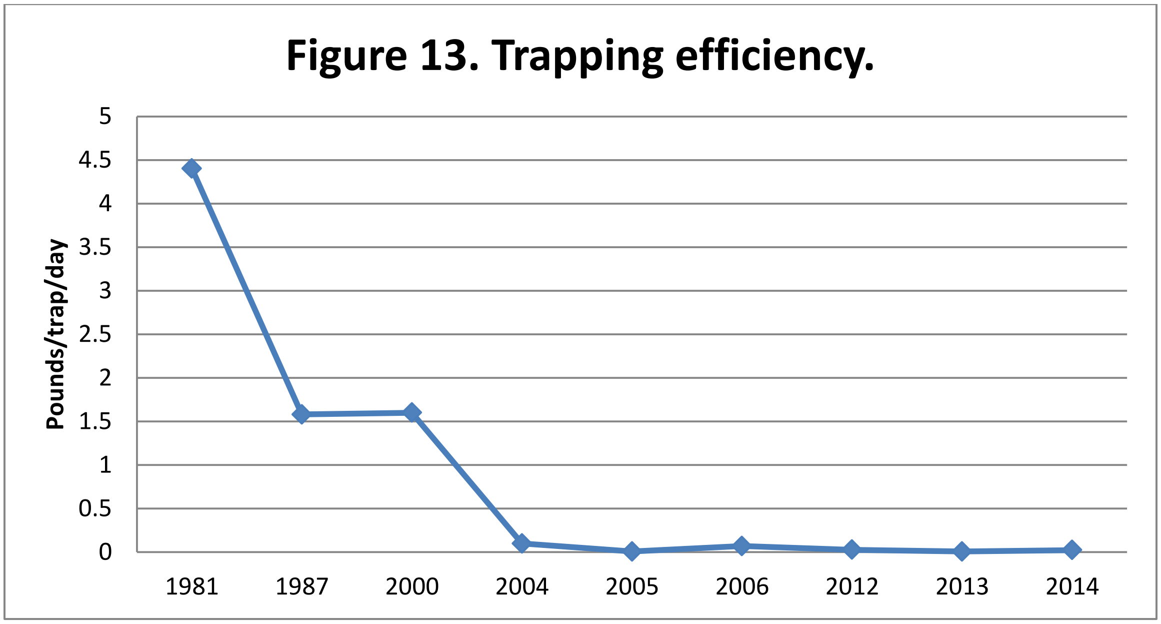
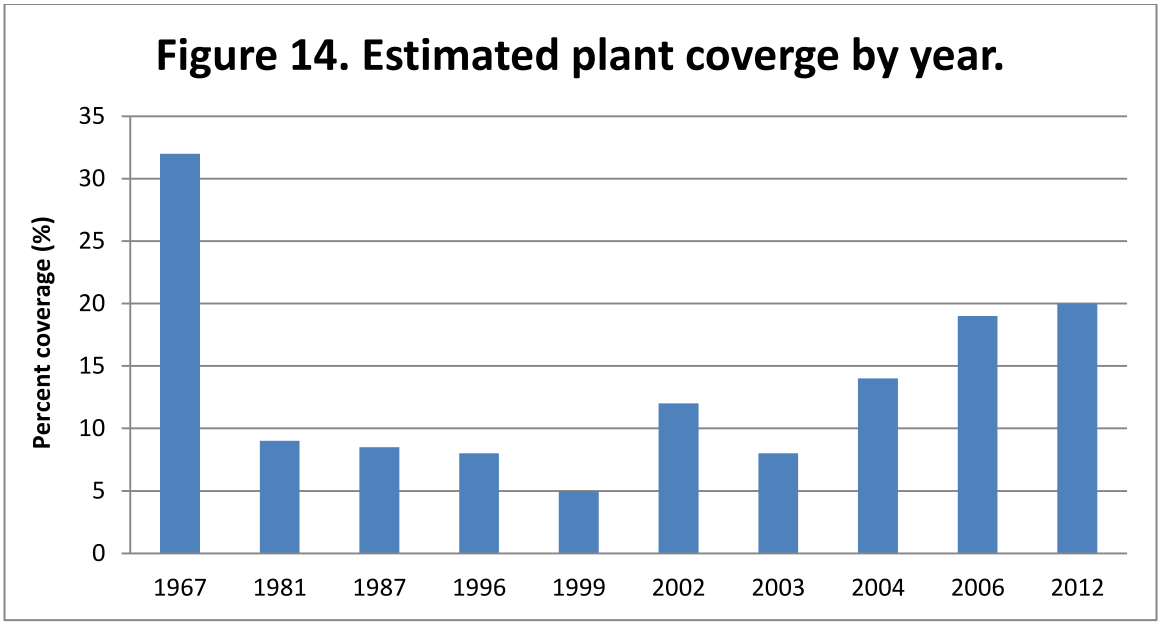


Figure 13 is a comparison of the pounds of rusty crayfish trapped per day per trap over time. Since similar techniques have been used throughout this time, the lower efficiency would seem to indicate a much lower rusty crayfish population. Trapping has proven to be effective in Bearskin Lake. The number of rusty crayfish trapped has decreased substantially from 1981 to 2014.



Historical records indicate the percent of plant coverage in Bearskin Lake. In 1967, Theis and McNight (1968) reported 2% aerial coverage by emergent aquatic plants and 30% coverage by submersed aquatic vegetation. McComas (2006) reported percent coverage of aquatic plants for 1996, 1999, 2002, 2003, 2004, and 2006. A point-intercept aquatic plant survey conducted by White Water Associates in 2012 estimates a percent coverage of aquatic plants at 20%. This various information on aquatic plant percent cover is graphed in Figure 14 to indicate the changes over time. The 1967 estimate can be considered the baseline prior to dramatic herbivory from rusty crayfish. The 1980s and 1990s showed the greatest impact by rusty crayfish on the aquatic plant community. Starting in 2000, the Bear Lake aquatic plant community begins to demonstrate a recovery in the percent coverage. Aquatic vegetation may seem troublesome to some recreational users in Bearskin Lake, but is important to the lake's ecology. The plants provide important habitat for fish in the lake. They also take up nutrients that may otherwise cause algae blooms. Research has suggested that trapping rusty crayfish along with increasing the fish population will help to combat the invasive rusty crayfish and allow aquatic vegetation to recover. The BBLA has been doing just that and the plant community is showing this recovery.



CRAB-O-RAMA

The Big Bearskin Lake Association (BBLA) started an annual, intensive trapping of rusty crayfish around the 4th of July holiday: Crab-O-Rama. They organized it as a family fun event starting in 2008. Crab-O-Rama has two trophy divisions: the Family Fun Division allows five or fewer traps and the Professional Division consists of six or more traps. Liver is available for use as bait and is kept in a nearby freezer. Signs are in place advertising the event along with email reminders (Exhibit 6).

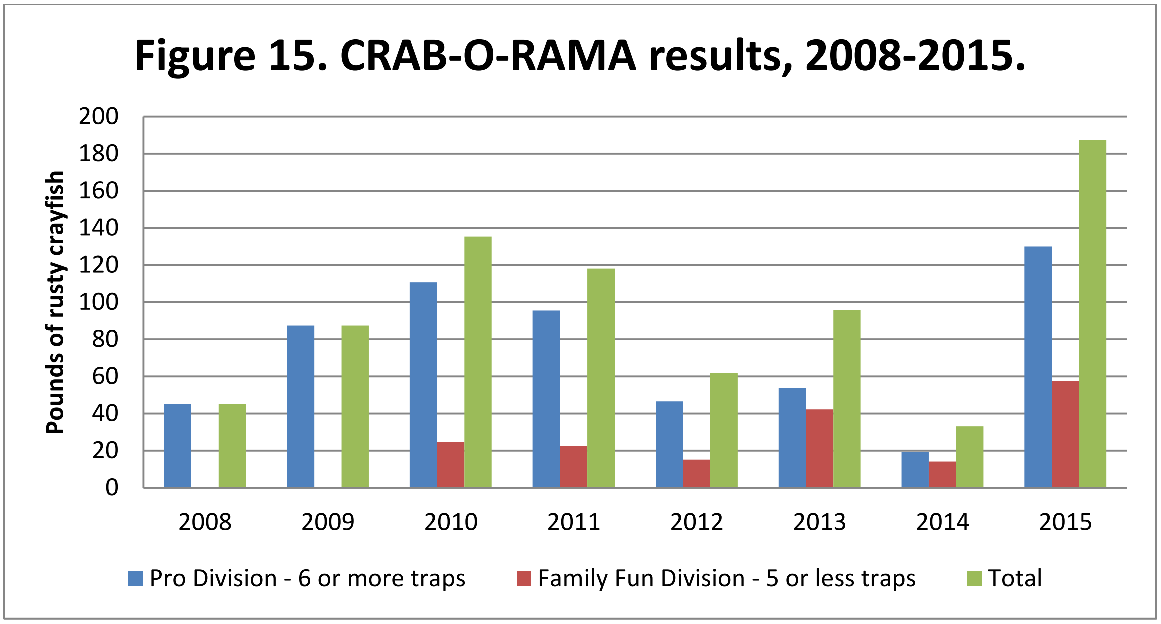
Exhibit 6. CRAB-O-RAMA participants.

Roger Soletske's home is one of the weigh-in points to keep track of who has trapped the most crayfish. Jerry Grulkowski also helps with the weigh-in and trapping. Prizes, donated from many local businesses, are awarded at the annual picnic. For every five pounds of rusty crayfish turned in, the trapper receives a ticket for a prize drawing. A wooden plaque was created to display the winners of each year's trapping success (Exhibit 7). Results are also placed in the BBLA newsletter.

Exhibit 7. Bearskin Lake Crab-O-Rama Plaques.

In 2013, there were thirteen families involved. During this three day event, 95.7 pounds of rusty crayfish were removed. The crayfish size ranged from 1 to 2.5 inches. In 2014, Soletske mentions sixteen families participated (Soletske 2014). There were 86.2 pounds of rusty crayfish removed. In 2015, fifteen families participated and 187.3 pounds of rusty crayfish were removed.

Soletske (2013b) states, "out of 100 homes on the lake, we are not accomplishing our goal of removing rusty crayfish from the lake." Soletske (2013b) goes on to write, "for those of you that don't remember the old days (90s) let me refresh the past. You could not fish live bait as the crayfish would attack it before a fish could get near it. When you walked on your dock the bottom would move which was actually 1000s of crayfish scurrying away." He goes on to explain that he would set 25 traps and would catch 8 five gallon pails full every day. The lake only had about 5% plant cover at the time which affected cover for the fish. Soletske explains that everyone has put a good dent in the crayfish population but to keep trapping in the next few years. The BBLA built over 75 bucket traps and distributed them to lake members. Figure 15 displays the pounds of rusty crayfish caught from 2008 to 2015 for the Family Fun and Professional Divisions.



Conclusion

With all the efforts the Big Bearskin Lake Association has put into trapping rusty crayfish, there is a noticeable decrease in captured crayfish numbers and an increase of aquatic plant coverage. It is important to continue the trapping of rusty crayfish as long as they are present in Bearskin Lake to keep their numbers at bay. Trapping on Bearskin Lake, along with scientific research of trapping on other lakes, has indicated that rusty crayfish trapping can make a difference. Will the current fish populations and the continuation of trapping on Bearskin Lake keep the rusty crayfish in check? Continued effort on behalf of the trappers and assistance from the Wisconsin DNR will help maintain the current rusty crayfish population.

Exhibit 8. Roger Soletske's trapping efforts (Stine 2013).

5 gallon pails used by Soletske to trap.

Boat with green 5 gallon traps.

5 gallon trap located on the bottom near dock.

5 gallon pail with rusty crayfish.

Soletske weighing rusty crayfish.

Rusty crayfish storage bin located by dock.

Literature Cited

Big Bearskin Lake Newsletter. *Lake Status Report*. 1995. BBLA Oneida County, Wisconsin.

Big Bearskin Lake Newsletter. *Lake Status Report*. 2000. BBLA Oneida County, Wisconsin.

Big Bearskin Lake Newsletter. *Lake Status Report*. 2012. BBLA Oneida County, Wisconsin.

Hansen, G.J.A., C.L. Hein, B.M. Roth, M.J. Vander Zanden, J.W. Gaeta, A.W. Latzka, and S.R. Carpenter. 2013. *Food web consequences of long-term invasive crayfish control.* Canadian Journal Fish aquatic Sciences: 70:1109-1122.

Hein, C.L., Vander Zanden, M.J., and Magnuson, J.J. 2007. *Intensive trapping and increased fish predation cause massive population decline of an invasive crayfish*. Freshwater Biology. 52(6): 1134-1146.

Kubisiak, John. 2004. *Comprehensive Fisheries Survey of Bearskin Lake, Oneida County Wisconsin during 2003.* Wisconsin Department of Natural Resources.

McComas, Steve. 1997. *Water Quality Report and Management for Big Bearskin Lake, Oneida County, WI.* Blue Water Science. St. Paul, MN.

McComas, Steve. 2000. *Comprehensive Lake Management Plan for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science. St. Paul, MN.

McComas, Steve. 2006. *Lake Conditions through 2006 for Big Bearskin Lake, Oneida County, Wisconsin*. Blue Water Science. St. Paul, MN.

Sargent, L., K. Towle, A. Baldridge, and D. Lodge. 2012. *Endoparasite impacts on rusty crayfish* (*Orconectes rusticus*). University of Notre Dame. Department of Biological Sciences.

Smith, Heather. 2013. *Lake of the Month: Sparkling Lake in Vilas County. Live From the Lakes: A Wisconsin Lakes Blog.* Department of Natural Resources. Retrieved March 2015 <http://lakes-l.blogs.govdelivery.com/2013/11/lake-of-the-month-sparkling-lake-in-vilas-county/>

Soletske, Roger. 2006. *Crayfish trapping grant results, 2004-2006*. E-mail communication.

Soletske, Roger. 2012. *Rusty Crayfish Trapping*. Personal communication.

Soletske, Roger. 2013a. *Rusty Crayfish Trapping*. Personal communication.

Soletske, Roger. 2013b. *CRABO-O-RAMA Summary*. Big Bearskin Lake Association Newsletter.

Soletske, Roger. 2014. *CRABO-O-RAMA Summary*. Big Bearskin Lake Association Newsletter.

Soletske, Roger and Angie Stine. *Rusty crayfish tapping data sheet and map.* Bearskin Lake.

Stine, Angie. 2013. Photographs of various Bearskin Lake rusty crayfish efforts.

Theis, R. and T McNight. 1968. *General letter 102 – Lake Survey of Bearskin (Big Bearskin) Lake, Oneida County*. 4 page memorandum with 17 pages of attached data.

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Appendix I
Review of Water Resource Regulations and Planning Relevant to Bearskin Lake

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Review of Water Resource Regulations and Planning Relevant to Bearskin Lake

In this appendix, we provide reviews of documents created to preserve and protect Wisconsin waters, including Bearskin 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 Bearskin Lake. Second is a review of the *Headwaters Basin Integrated Management Plan*. This plan describes issues of concern within the Headwaters Basin (where Bearskin 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 Bearskin 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, 2014).

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, 2015).

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, 2013).

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 Bearskin 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.

Local

Ordinance #98-6, as created by the Town of Hazelhurst, summarizes that on lakes less than 50 acres, and up to 100 acres, personal watercraft shall only be operated in a "slow-no-wake" manner. Additionally, PWC cannot be operated within 200 feet on a shoreline. This ordinance was created help protect the shoreline and water resources of smaller lakes.

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. 2013. *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. 2014. *WPDES Permits*. Retrieved 2015. <http://dnr.wi.gov/topic/wastewater/permits.html>

Wisconsin Department of Natural Resources. 2015. *Aquatic Plants*. Retrieved 2015. <http://dnr.wi.gov/lakes/plants/>

Review of *Headwaters Basin Integrated Management Plan* Relevant to Bearskin 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 Bearskin 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 Bearskin Lake is not considered an ORW, four lakes within 10 miles of Bearskin Lake are considered an ORW: Clear Lake, Tomahawk Lake, Two Sisters Lake and Willow Flowage. In contrast, twelve waterbodies within 10 miles of Bearskin Lake are listed as Impaired Waters (303 (d)): Bird Lake, Bass Lake, Currie Lake, Foster Lake, Gilmore Lake, Hemlock Lake, Hodstradt Lake, Long Lake, McGrath Lake, North Two Lakes, Upper Kaubashine Lake, and Willow Flowage. These waterbodies are considered impaired because of mercury contamination in fish tissues. Bearskin Lake is also listed as an Impaired Water. Bearskin Lake, however, is considered an Impaired Water due to "total phosphorus and chlorophyll sample data exceeding the WisCALM listing thresholds for recreation use" (WDNR, 2014a). Nearby Rainbow Flowage was previously listed as impaired because of mercury levels, but was delisted in 2006 (WDNR, 2014b). Because of Bearskin 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 Bearskin 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. 2013. *Outstanding and Exceptional Resource Waters*. Retrieved 2015. <http://dnr.wi.gov/topic/SurfaceWater/orwerw.html>

Wisconsin Department of Natural Resources. 2014a. *Impaired water-Bearskin Lake.* Retrieved 2015. < http://dnr.wi.gov/water/impairedDetail.aspx?key=128040>

Wisconsin Department of Natural Resources. 2014b. *Wisconsin's 2014 Impaired Waters List.* Retrieved 2015. < http://dnr.wi.gov/topic/ImpairedWaters/2014IR_IWList.html>

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March 1, 2013

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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 <u>Oneida County Land & Water Resource Management Plan</u>.[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.

<u>Organization</u>

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 <u>Content</u> section to follow.

[1] The <u>Oneida County Land & Water Resource Management Plan</u> 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 J
Lake User Survey

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WHITE WATER
ASSOCIATES, INC.

Bearskin Lake Aquatic Plant Management Plan – Lake User Survey

Technical assistance by White Water Associates, Inc.

Conducted August, 2013

Note: This public questionnaire was sent out as a six-page document with the first page being explanatory material (see text below). Here the original questionnaire is expanded to provide the analysis (primarily in bar graph form) of responses from 84 respondents.

We are writing to inform you about the Bearskin Lake planning process that will have important outcomes for Bearskin Lake and how you use and enjoy the lake. Please assist by completing this questionnaire and conveying your ideas. Please respond as soon as possible.

An aquatic plant survey was conducted in the summer of 2012 and it provided substantial information on plant presence and distribution in the lake. Bearskin 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 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, and rusty crayfish, spiny water flea, Chinese mystery snail, Eurasian water milfoil, purple loosestrife, and curly-leaf pondweed.

Bearskin Lake stakeholders want to maintain the high quality condition present in Bearskin 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 Bearskin 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 as soon as possible to the address provided on page 6.

A total of 120 surveys were given out and 84 were returned. The questions are as follows:

1. Please circle the response(s) that describes your affiliation with Bearskin 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

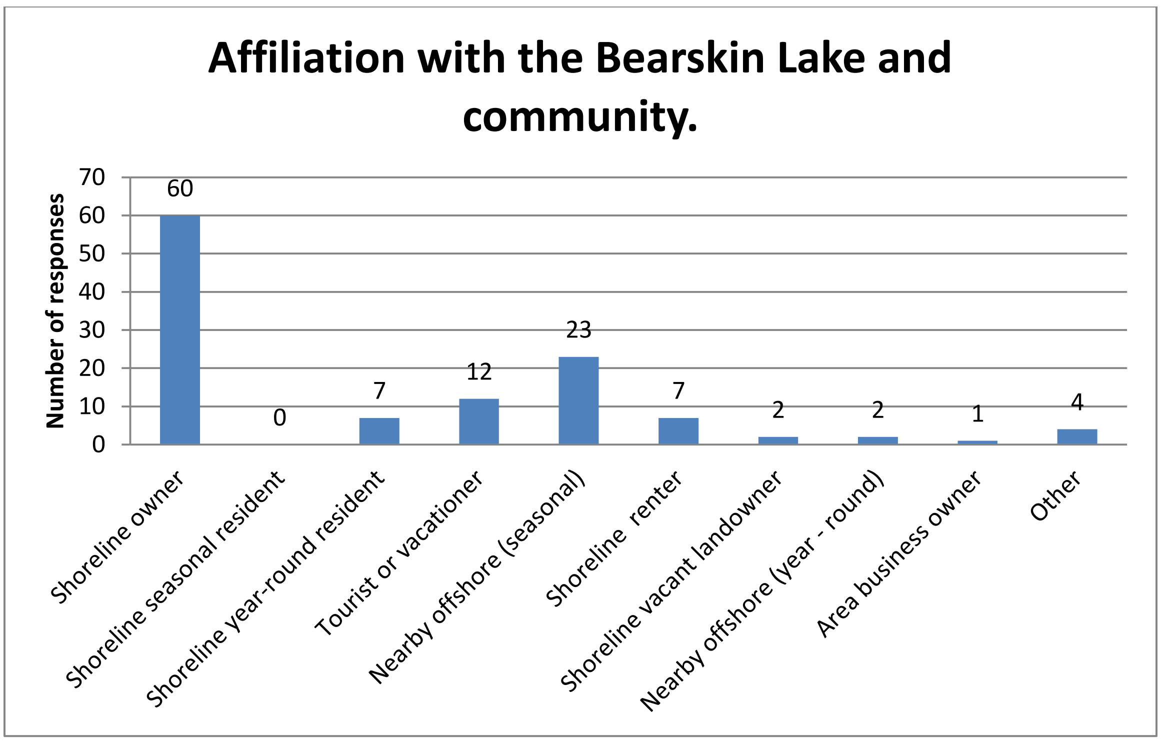
F. Nearby offshore resident (year-round)

G. Nearby offshore resident (seasonal)

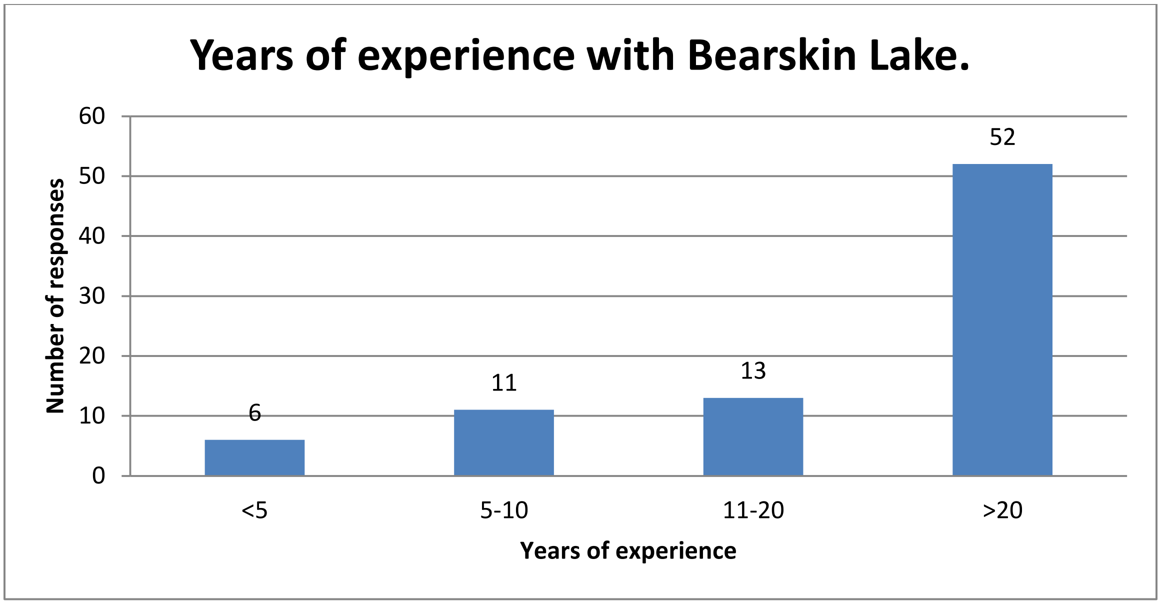
H. Area business owner

I. Tourist or vacationer

J. Other (specify)_______________________

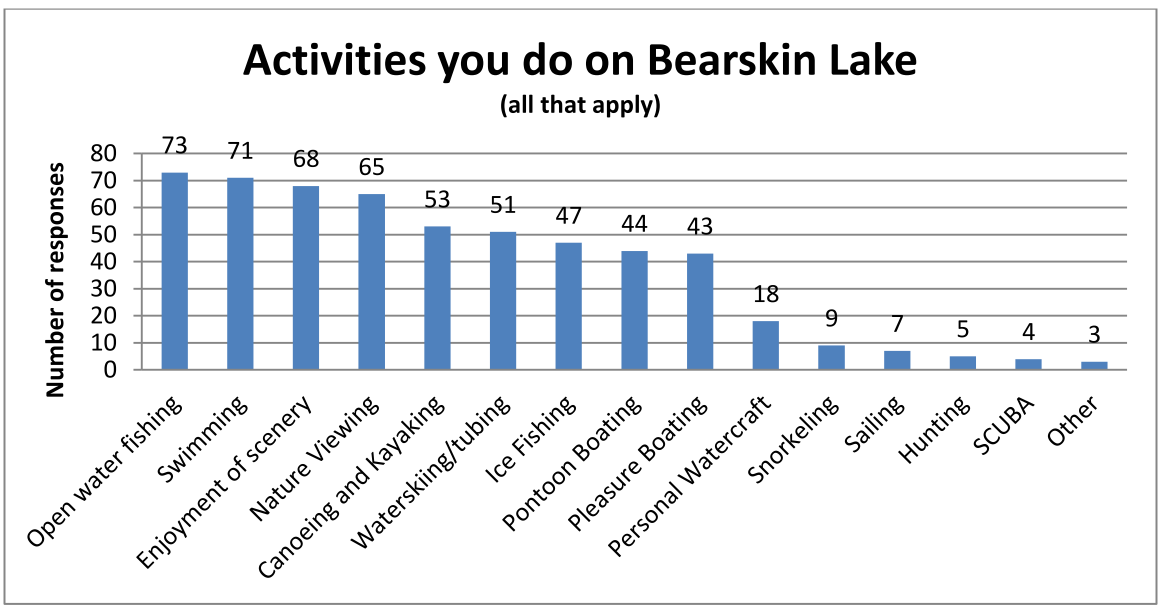


2. How many years of experience do you have with Bearskin Lake? There was a total of 2314 years of combined experience on Bearskin Lake with the lowest being one year of experience and 68 years being the highest and 28 years being the average.



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

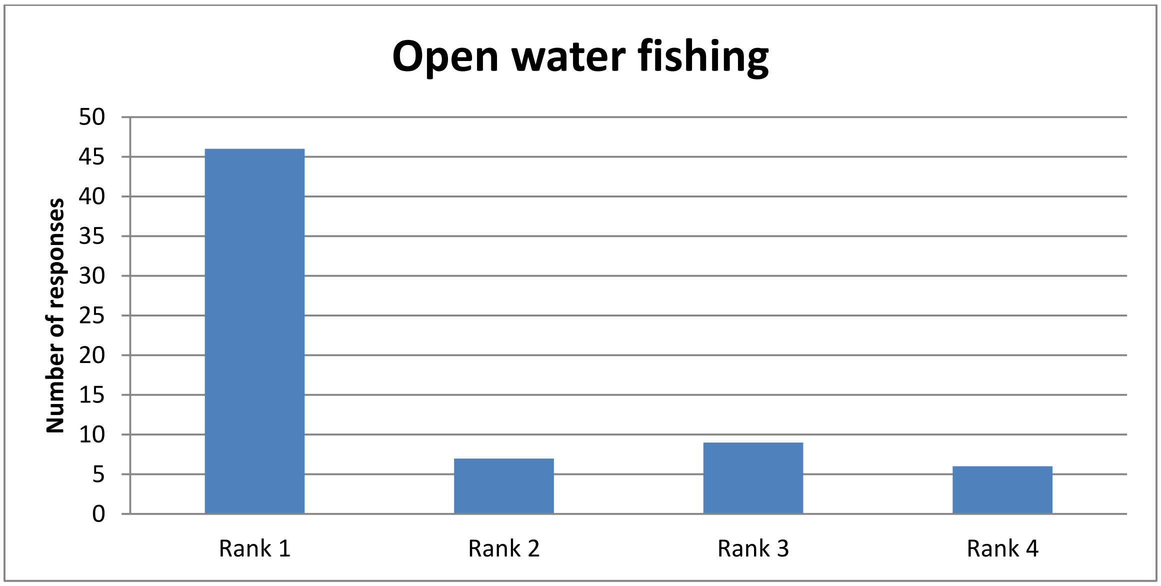
A. Open water fishing
B. Ice fishing
C. Waterskiing/tubing
D. Personal watercraft
E. Swimming
F. Pontoon boating
G. Sailing
H. Pleasure boating
I. SCUBA
J. Canoeing & kayaking
K. Nature viewing
L. Enjoyment of scenery
M. Hunting
N. Snorkeling
O. Other_______________
P. None of the above (skip to question 9)

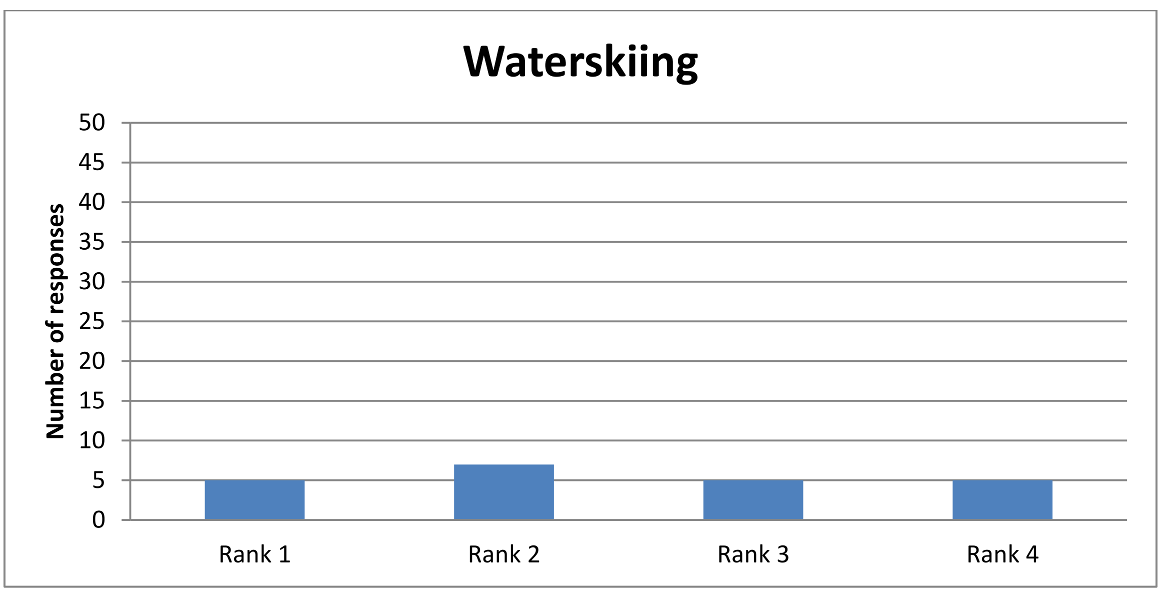


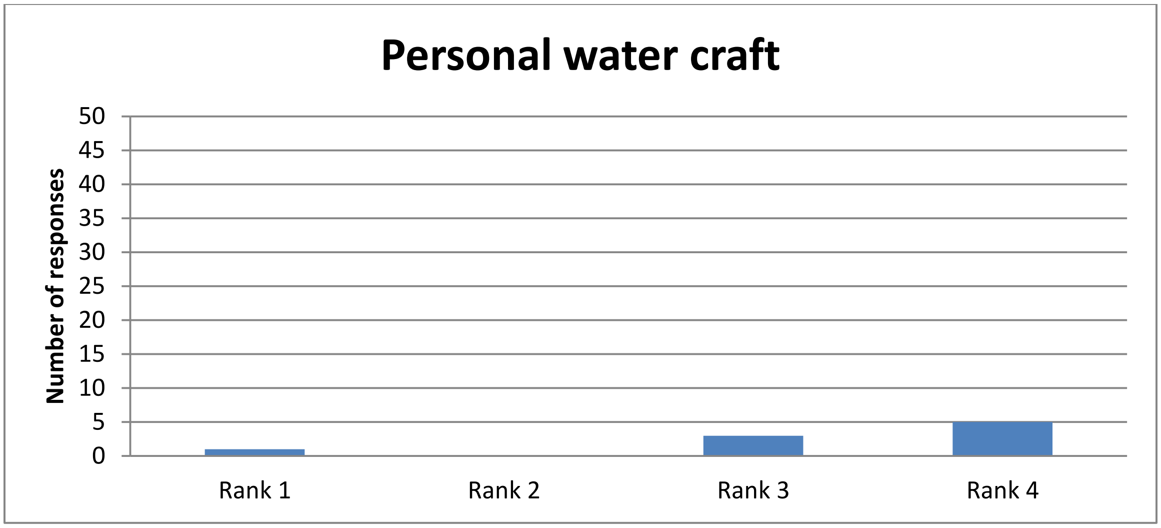
4. Please rank the four activities that are most important to you on Bearskin Lake. (Use "1" for the most important, "2" for your next choice and so on.)

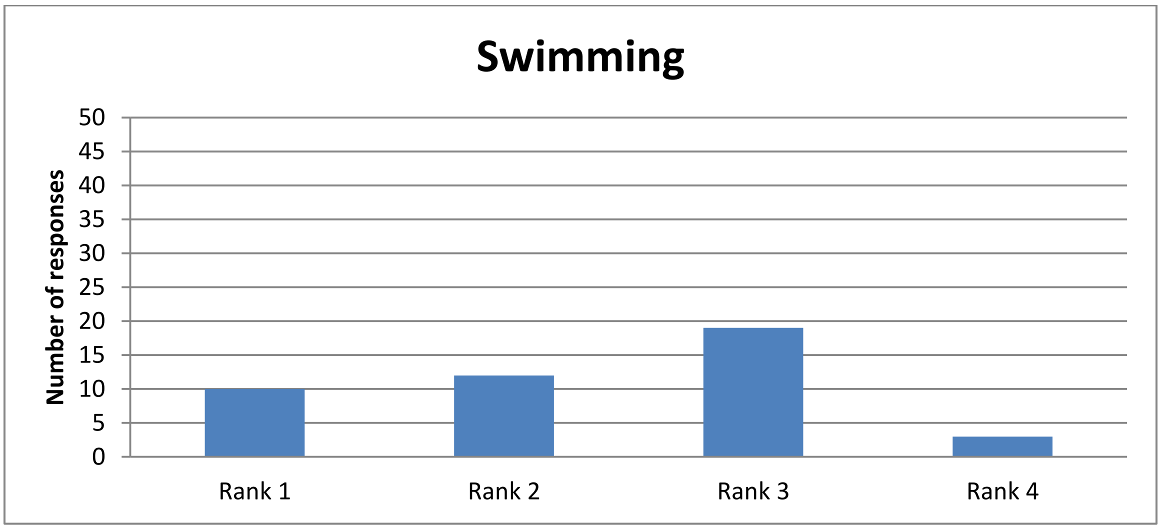
___ Open water fishing	___ Ice fishing
___Waterskiing	___Canoeing & kayaking
___Personal water craft	___Nature viewing
___Swimming	___Scenery
___Pontoon boating	___Hunting
___Sailing	___Snorkeling
___Pleasure boating	___SCUBA

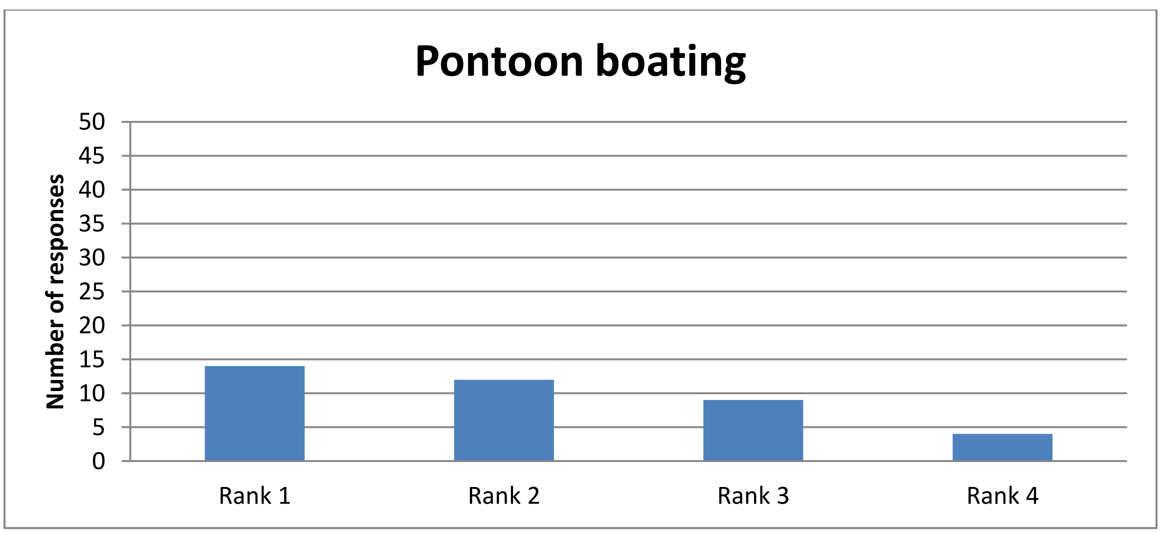
___Other (specify) ________________________________

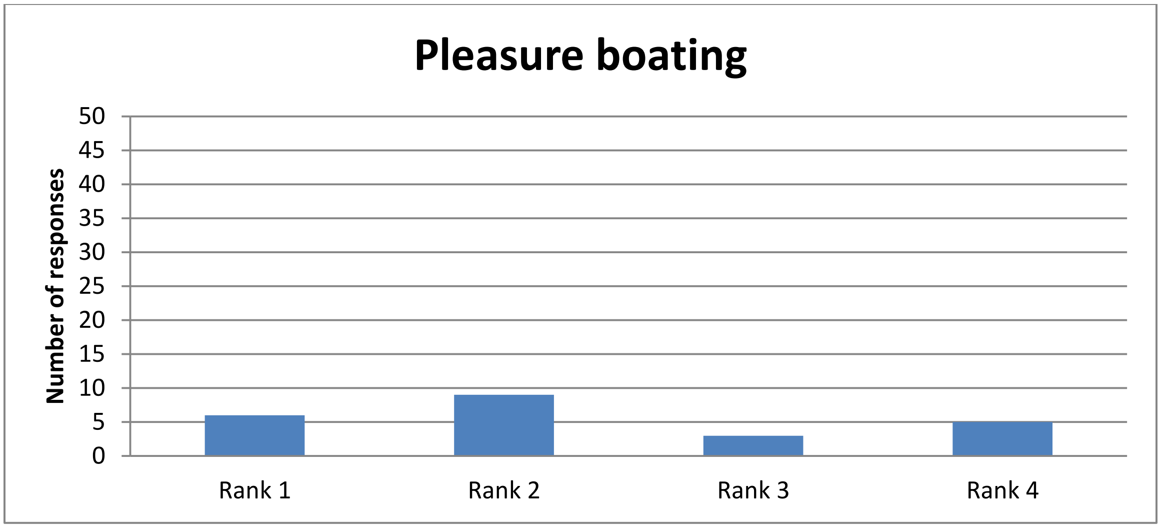


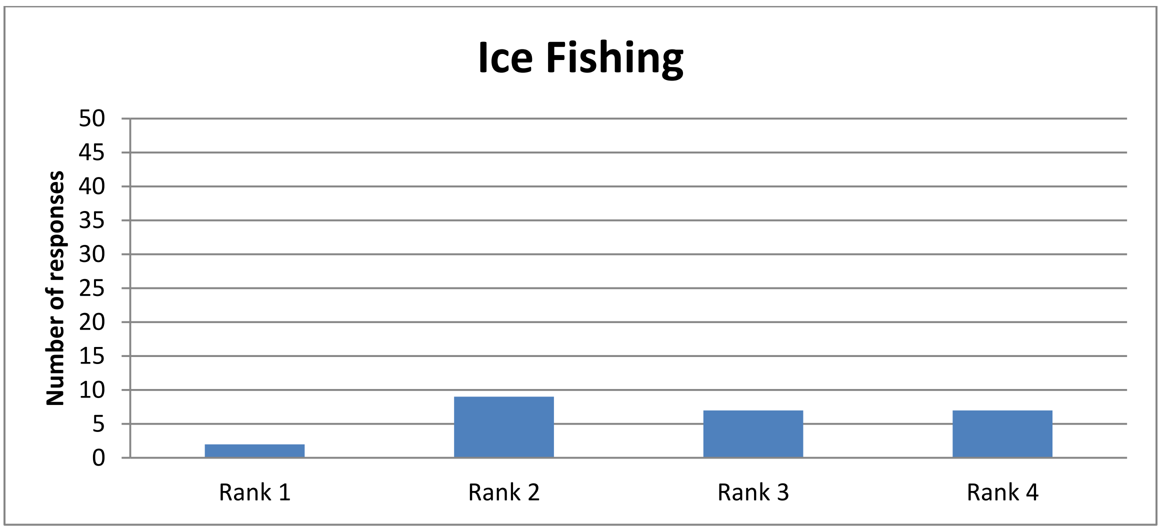


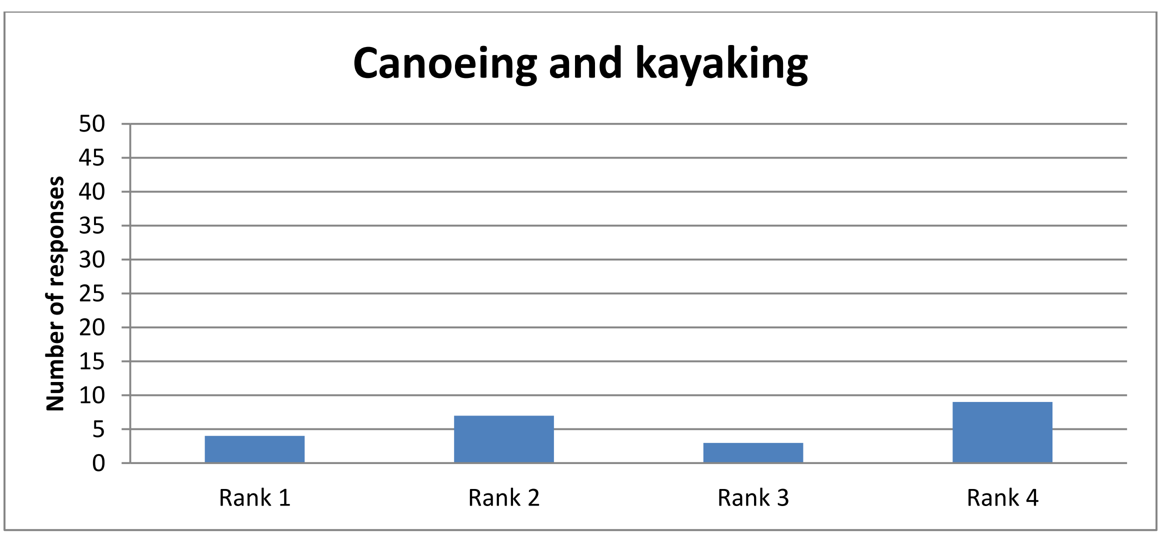

Personal water craft
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4

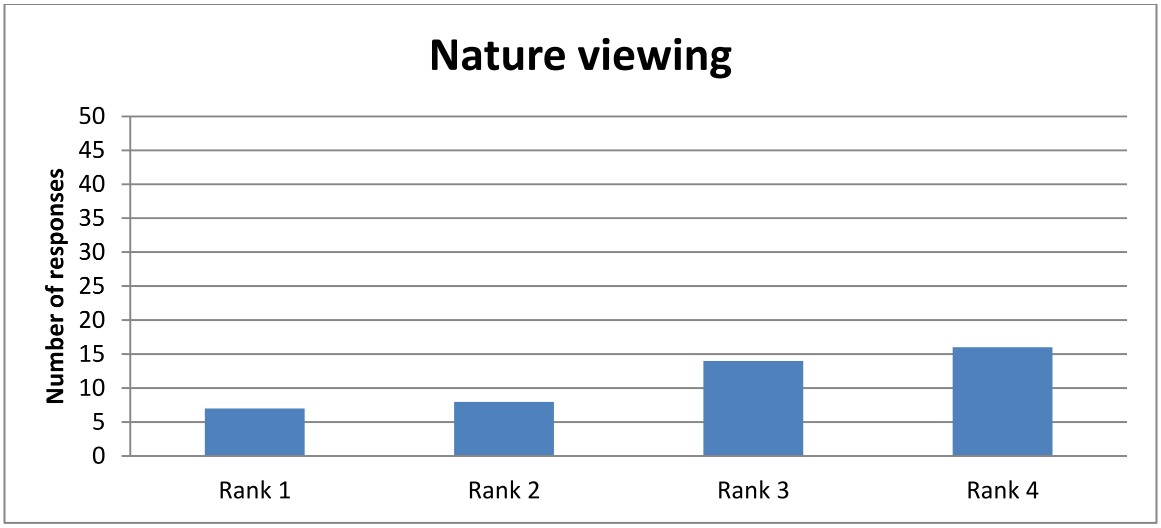

Swimming
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4

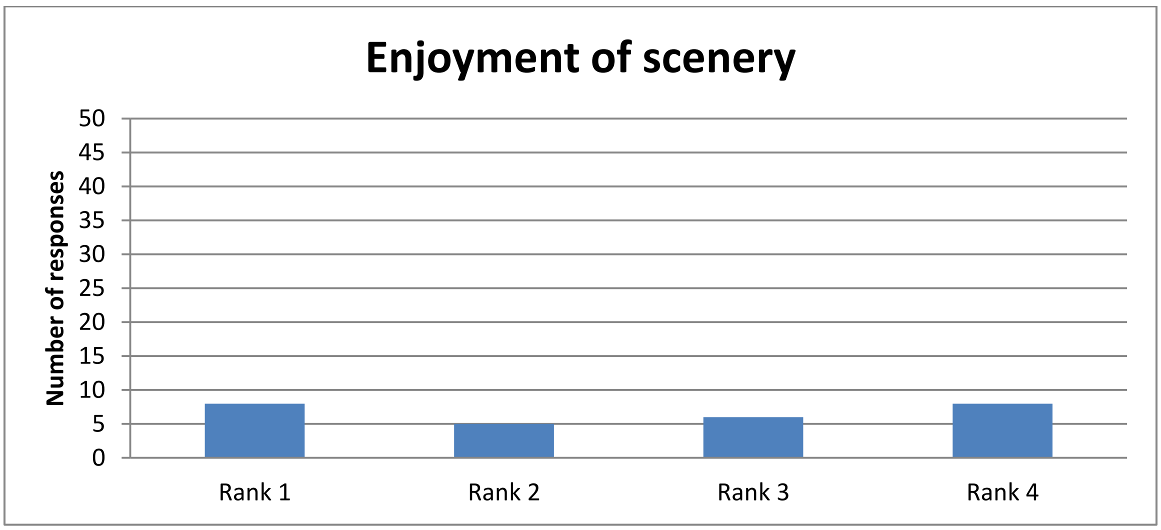

Pontoon boating
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4


Pleasure boating
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4


Ice Fishing
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4


Canoeing and kayaking
Number of responses
50
45
40
35
30
25
20
15
10
5
0
Rank 1
Rank 2
Rank 3
Rank 4

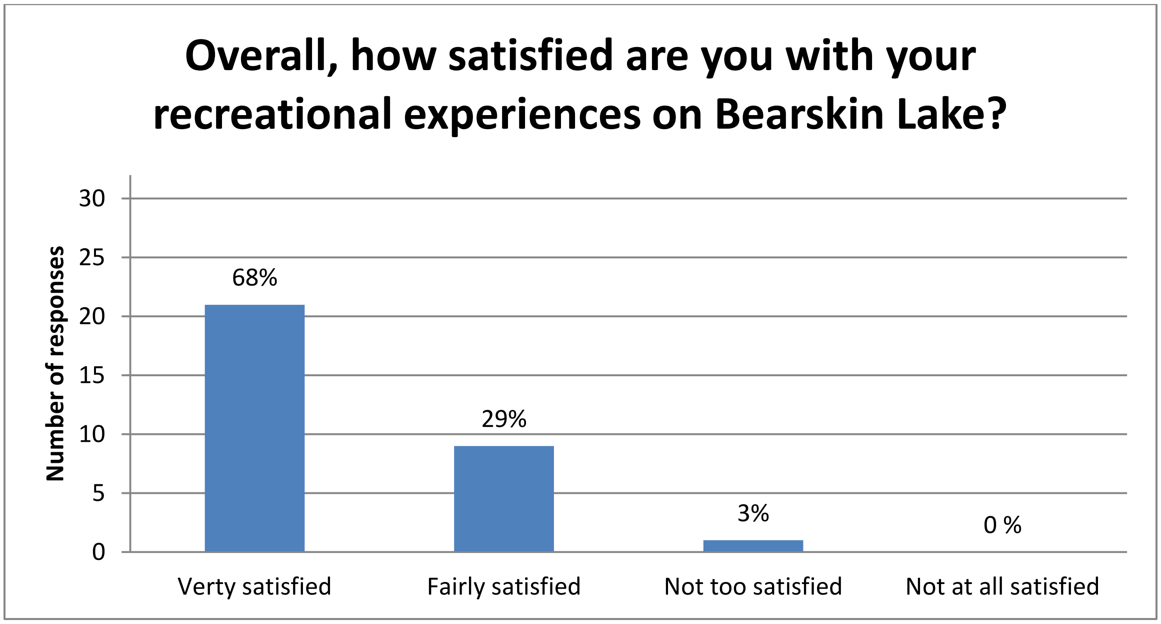




The following activities were ranked as 4 by one person (each): snorkeling, snowmobiling, SCUBA diving. Additionally, one person ranked sailing as a 3.

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

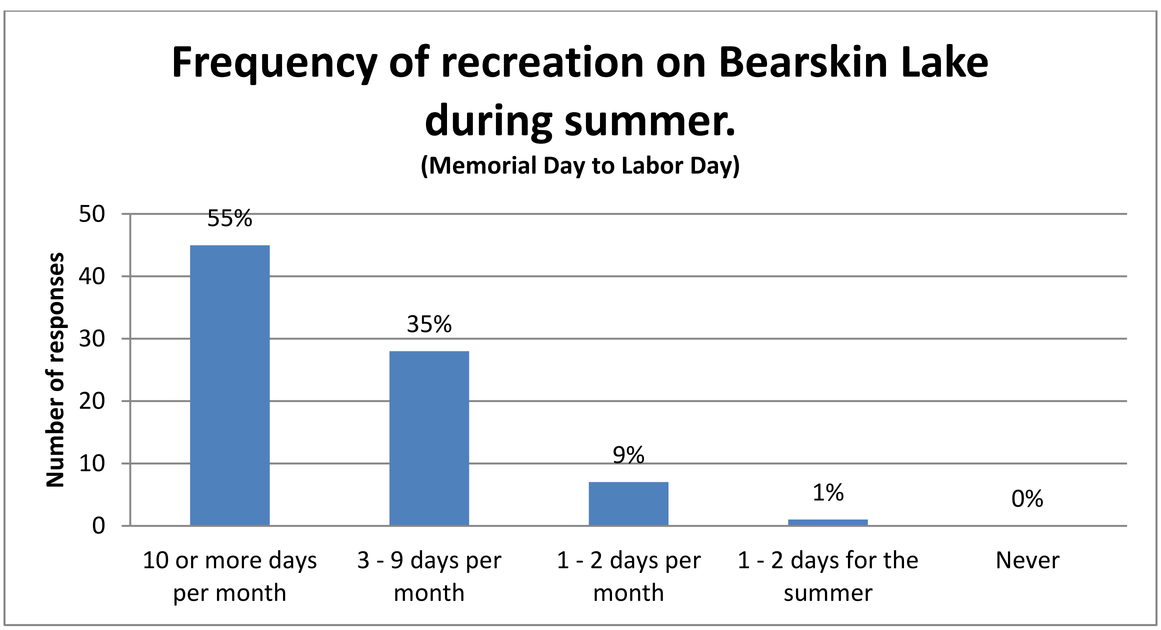
A. Very satisfied B. Fairly satisfied C. Not too satisfied D. Not at all satisfied



6. Please circle the statement that best describes how often you recreate on Bearskin 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 Bearskin Lake?

___Do not use watercraft (please skip to question 9)

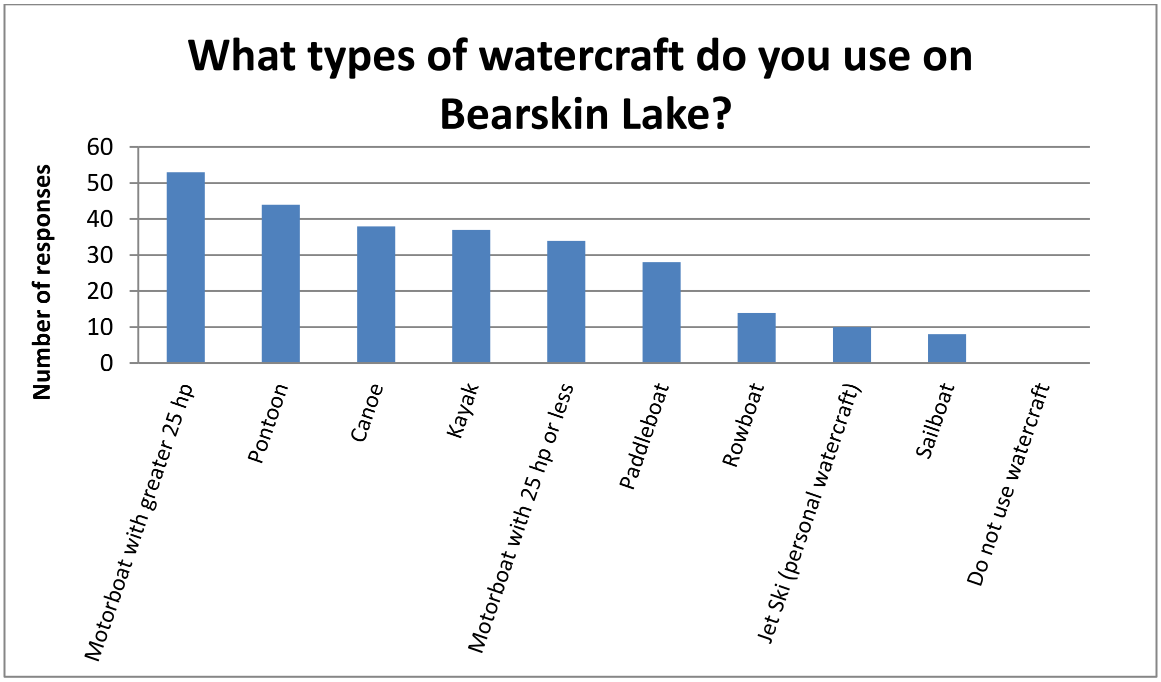
___Paddleboat ___Motorboat with 25 hp or less

___Sailboat ___Motorboat with greater than 25 hp

___Canoe ___Pontoon

___Rowboat ___Jet Ski (personal watercraft)

___Kayak

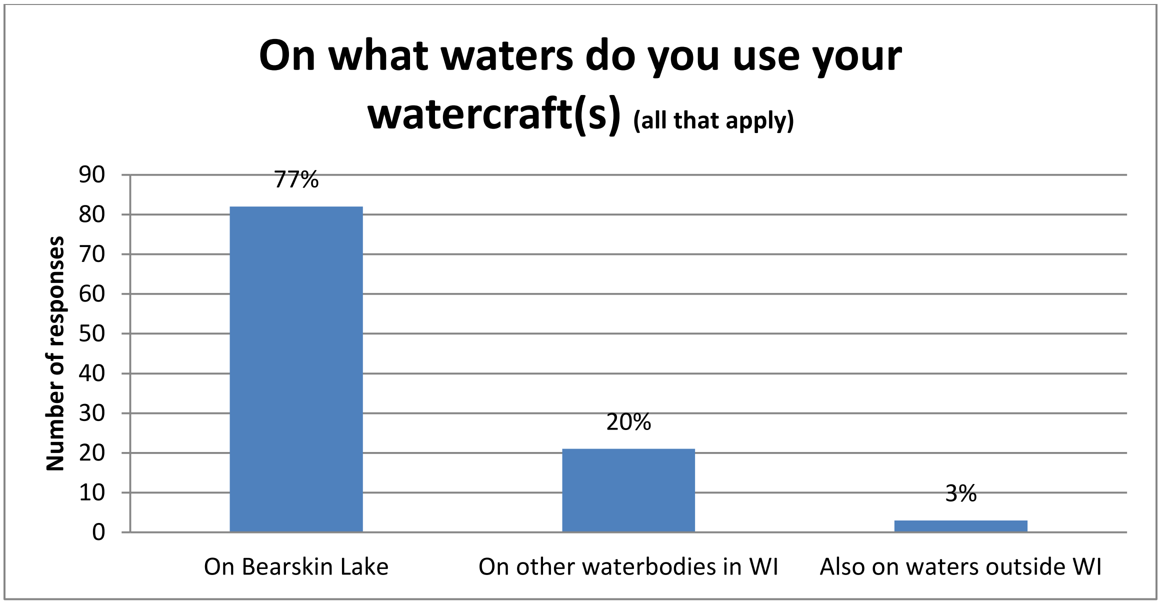


8. On what waters do you use your watercraft(s)?

___I use my watercraft on Bearskin Lake

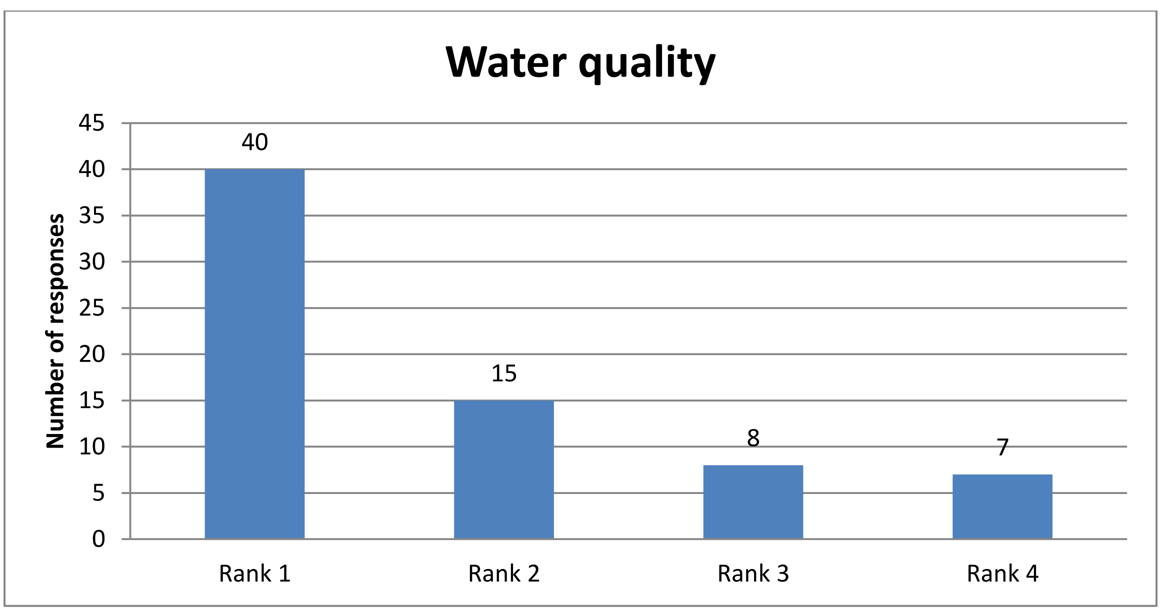
___I use my watercraft on other water bodies in Wisconsin

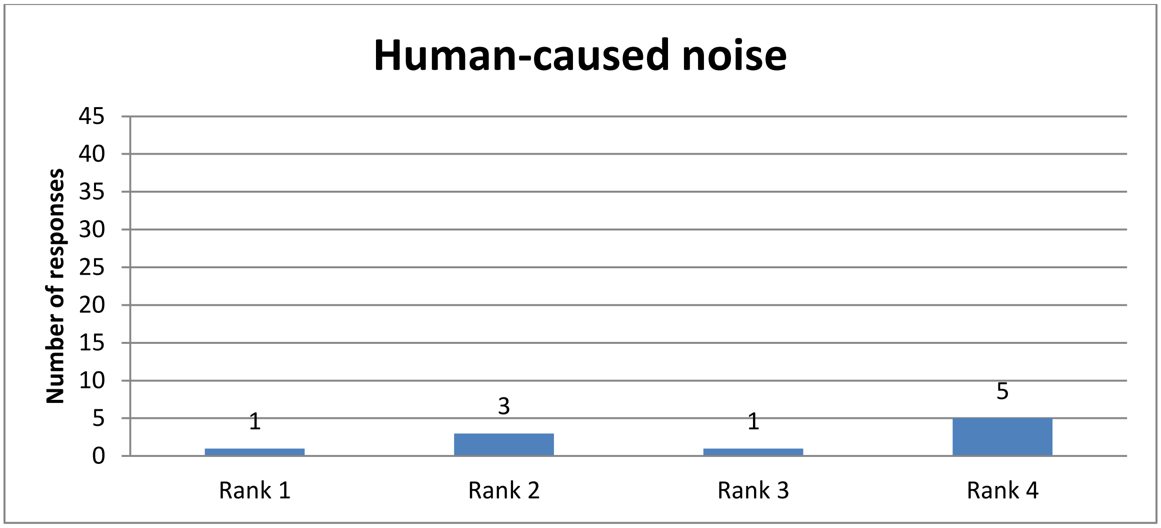
___I also use my watercraft on water bodies outside of Wisconsin

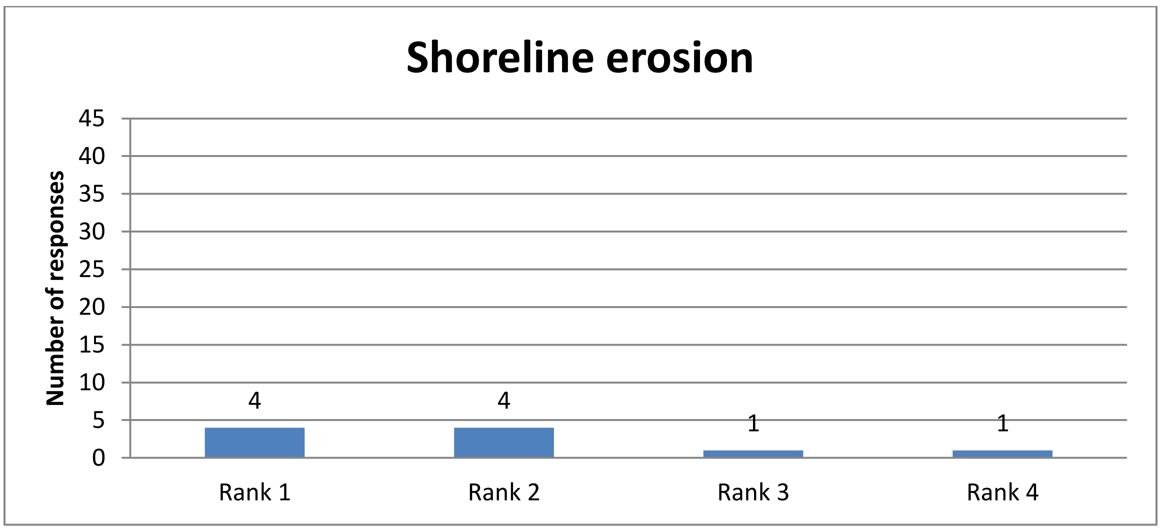


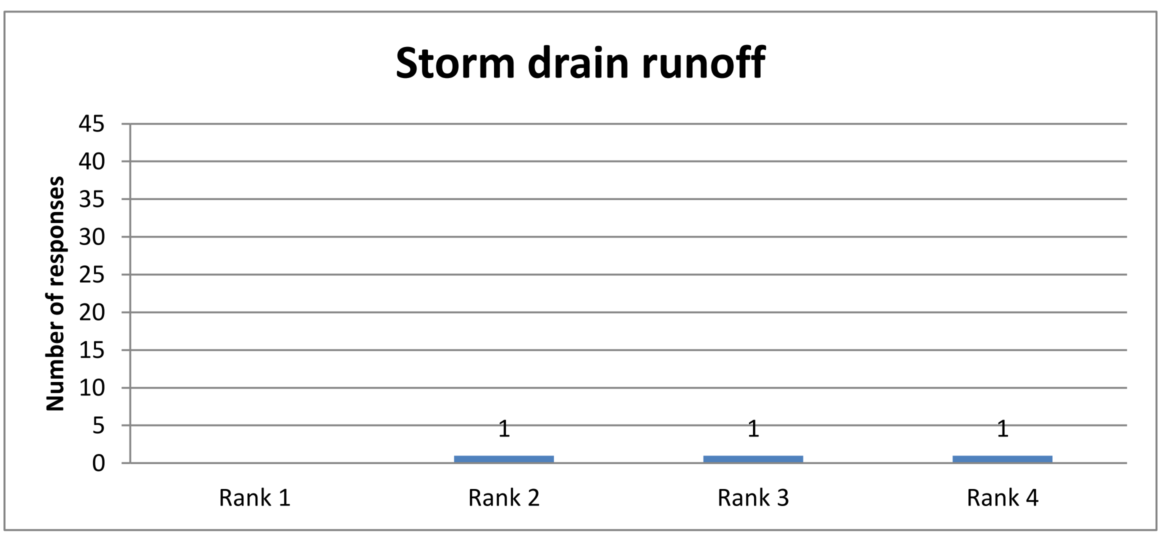
9. From the list below, please rank your top four (1, 2, 3, and 4) concerns for Bearskin Lake. Write a 1 for your primary (most important) concern.

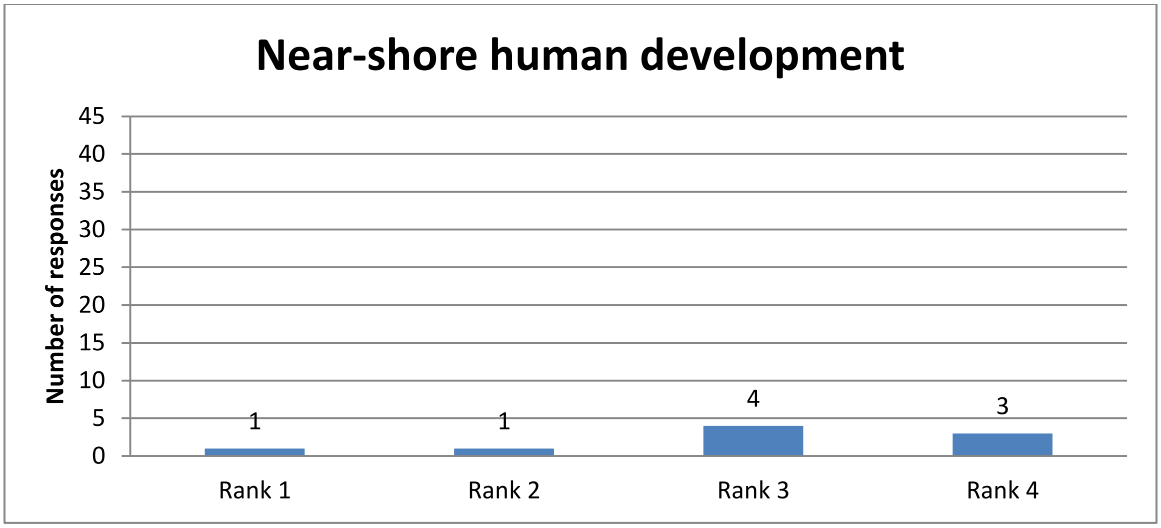
____ Water quality	____Quality of fish habitat
____ Human-caused noise	____ Aquatic plant growth
____ Shoreline erosion	____ Algae growth
____ Storm drain runoff	____Aquatic Invasive Species (AIS) introduction
____ Near-shore human development	____ Human development on the greater watershed
____Boat traffic	____ Shoreline vegetation removal
____Boating safety	____Other (explain________________________________)

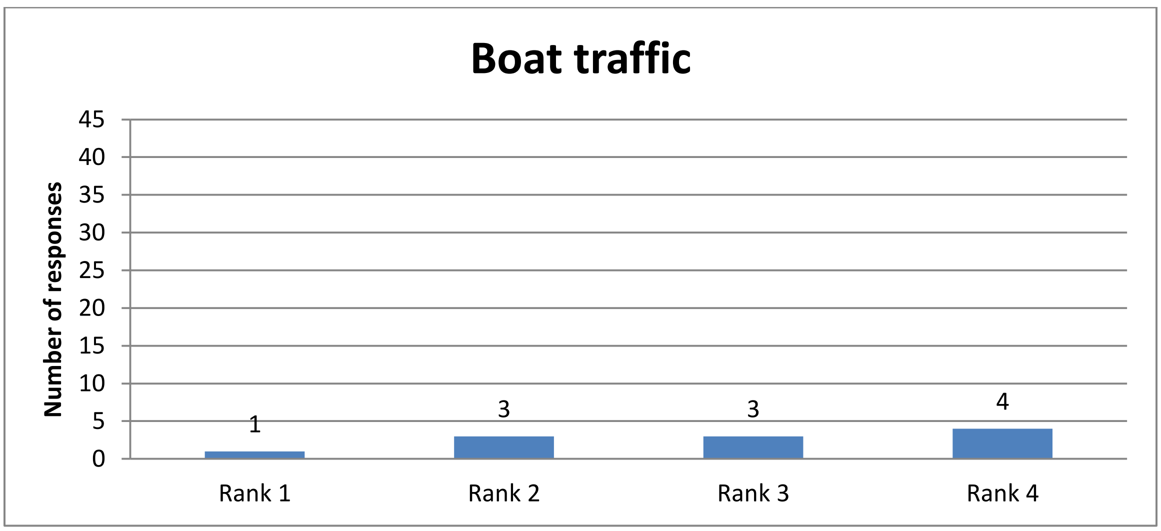


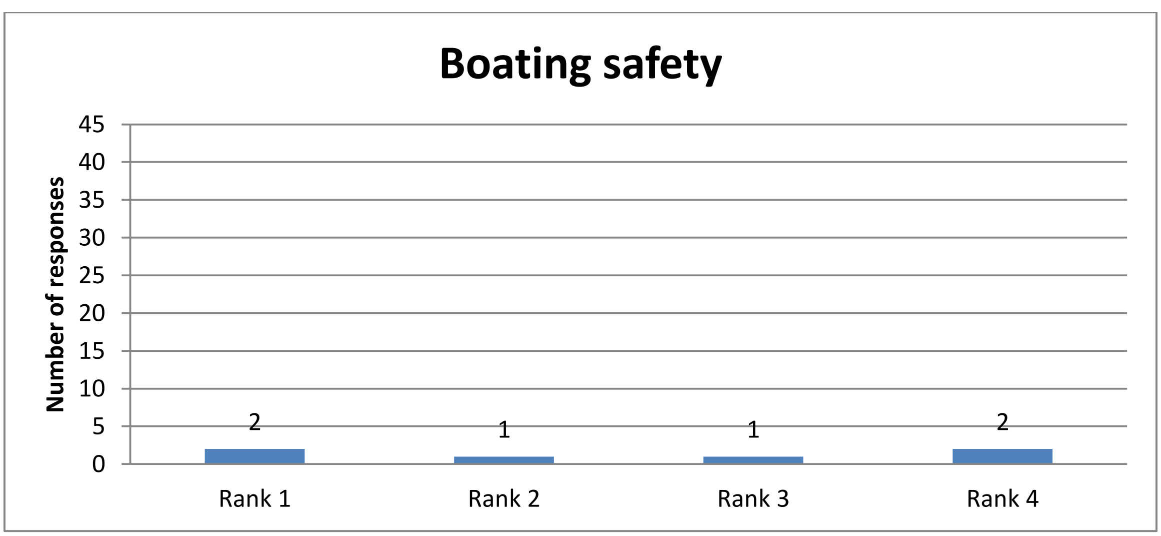

Human-caused noise
Number of responses
45
40
35
30
25
20
15
10
5
0
1
3
1
5
Rank 1
Rank 2
Rank 3
Rank 4

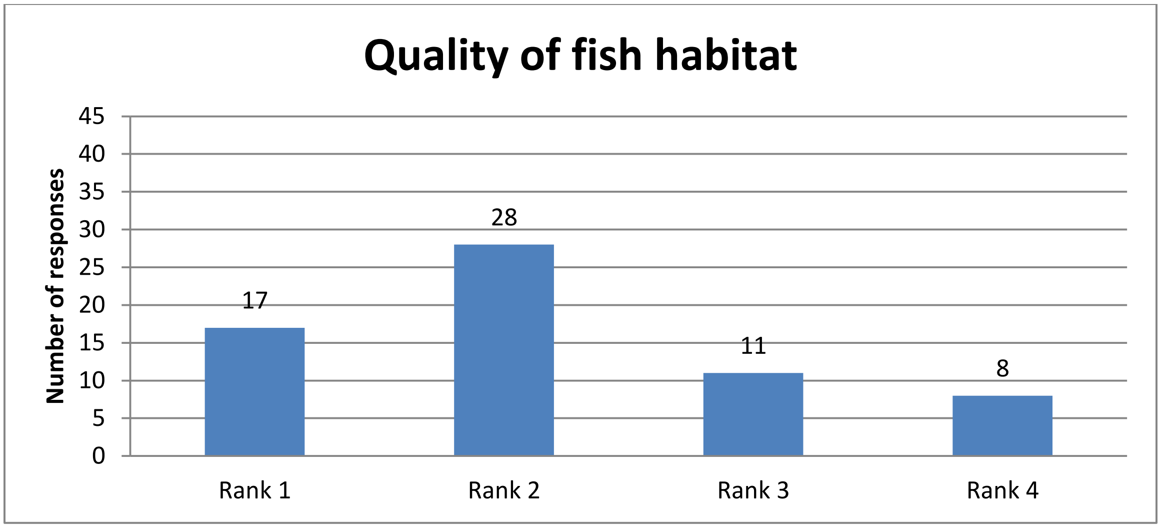

Shoreline erosion
Number of responses
45
40
35
30
25
20
15
10
5
0
4
4
1
1
Rank 1
Rank 2
Rank 3
Rank 4

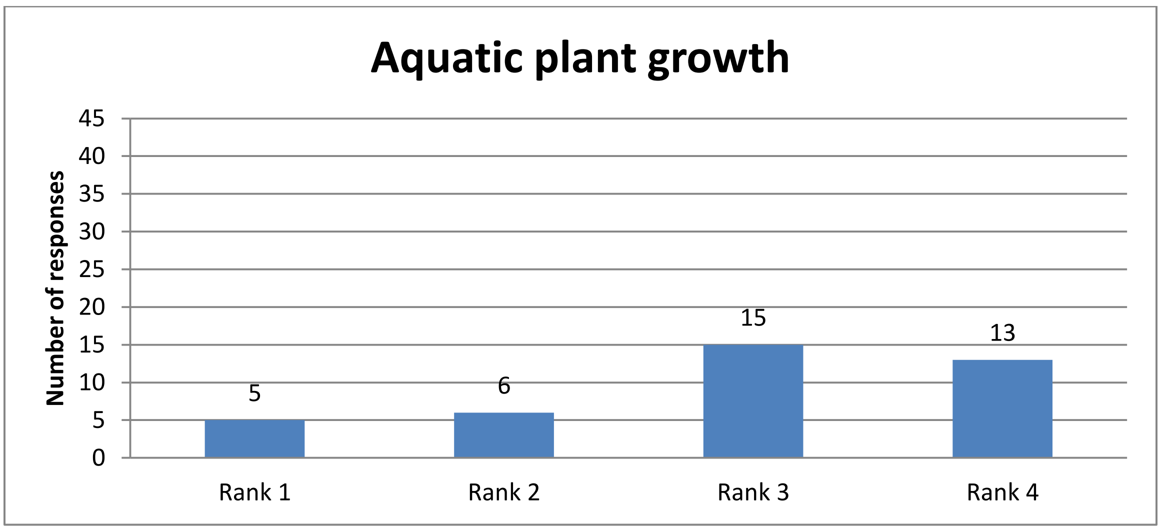

Storm drain runoff
Number of responses
45
40
35
30
25
20
15
10
5
0
1
1
1
Rank 1
Rank 2
Rank 3
Rank 4

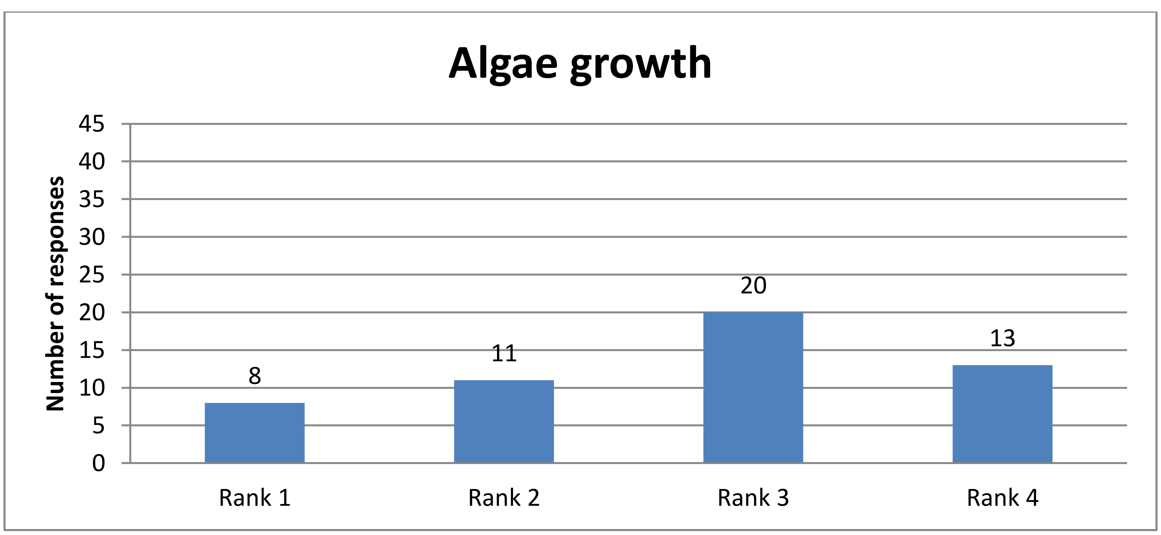

Near-shore human development
Number of responses
45
40
35
30
25
20
15
10
5
0
1
1
4
3
Rank 1
Rank 2
Rank 3
Rank 4

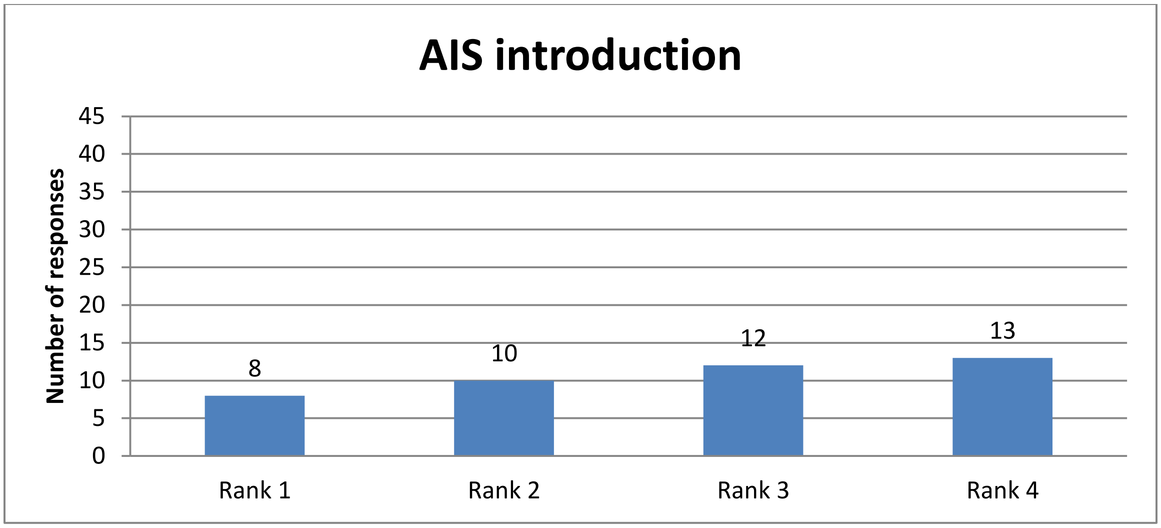

Boat traffic
Number of responses
45
40
35
30
25
20
15
10
5
0
1
3
3
4
Rank 1
Rank 2
Rank 3
Rank 4

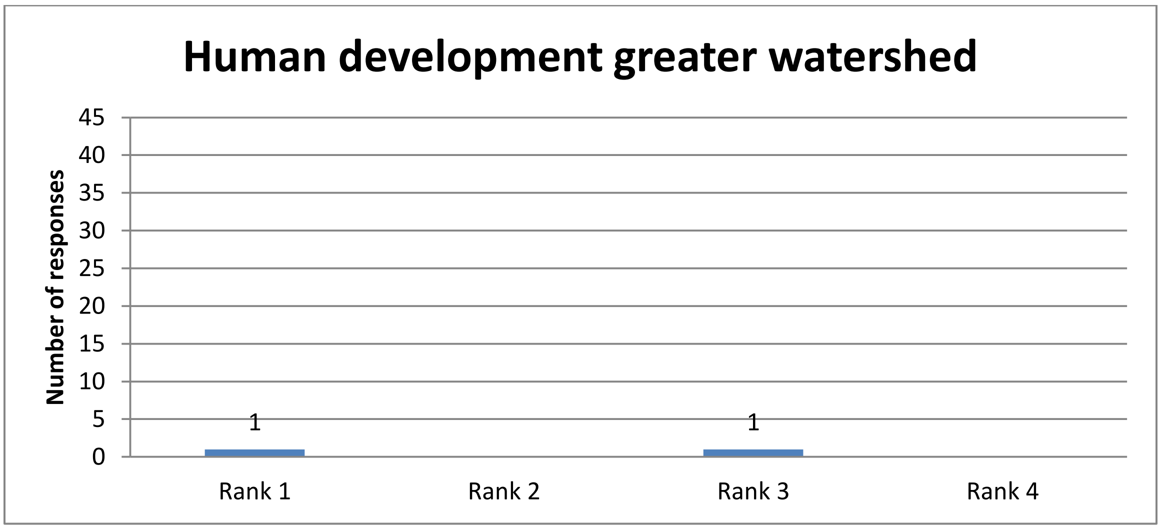

Boating safety
Number of responses
45
40
35
30
25
20
15
10
5
0
2
1
1
2
Rank 1
Rank 2
Rank 3
Rank 4

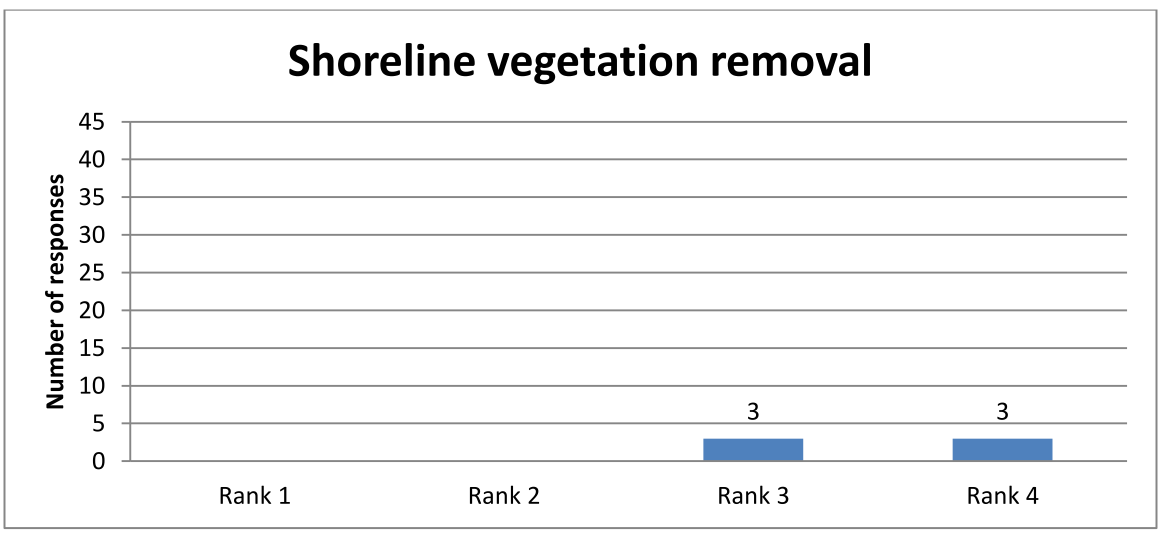

Quality of fish habitat
Number of responses
45
40
35
30
25
20
15
10
5
0
17
28
11
8
Rank 1
Rank 2
Rank 3
Rank 4

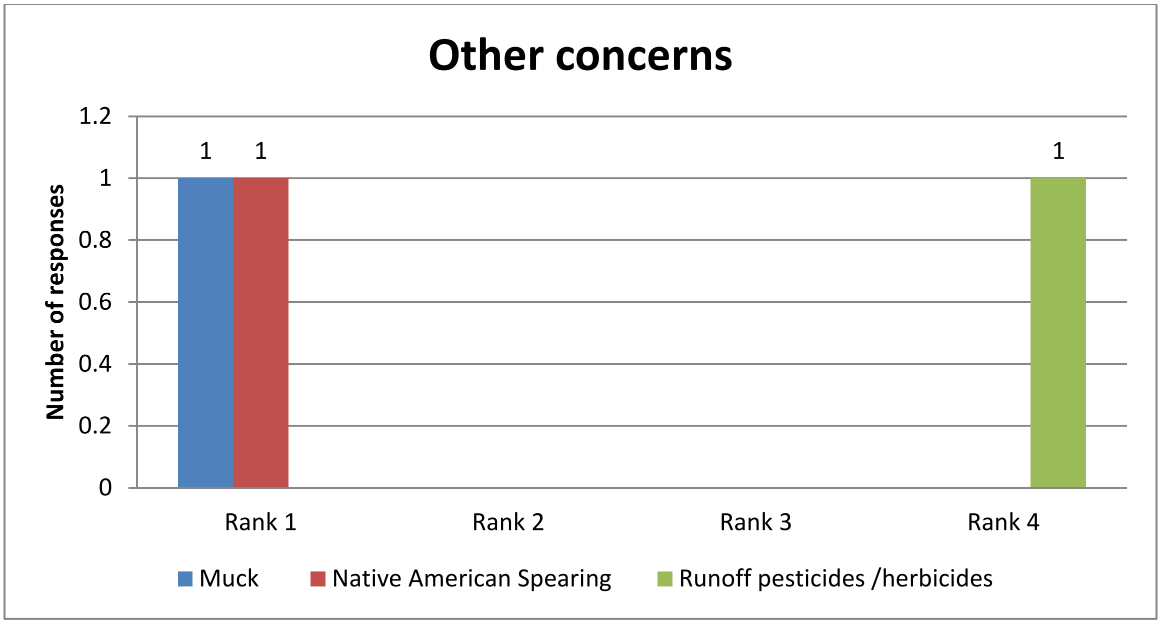

Aquatic plant growth
Number of responses
45
40
35
30
25
20
15
10
5
0
5
6
15
13
Rank 1
Rank 2
Rank 3
Rank 4


Algae growth
Number of responses
45
40
35
30
25
20
15
10
5
0
8
11
20
13
Rank 1
Rank 2
Rank 3
Rank 4


AIS introduction
Number of responses
45
40
35
30
25
20
15
10
5
0
8
10
12
13
Rank 1
Rank 2
Rank 3
Rank 4

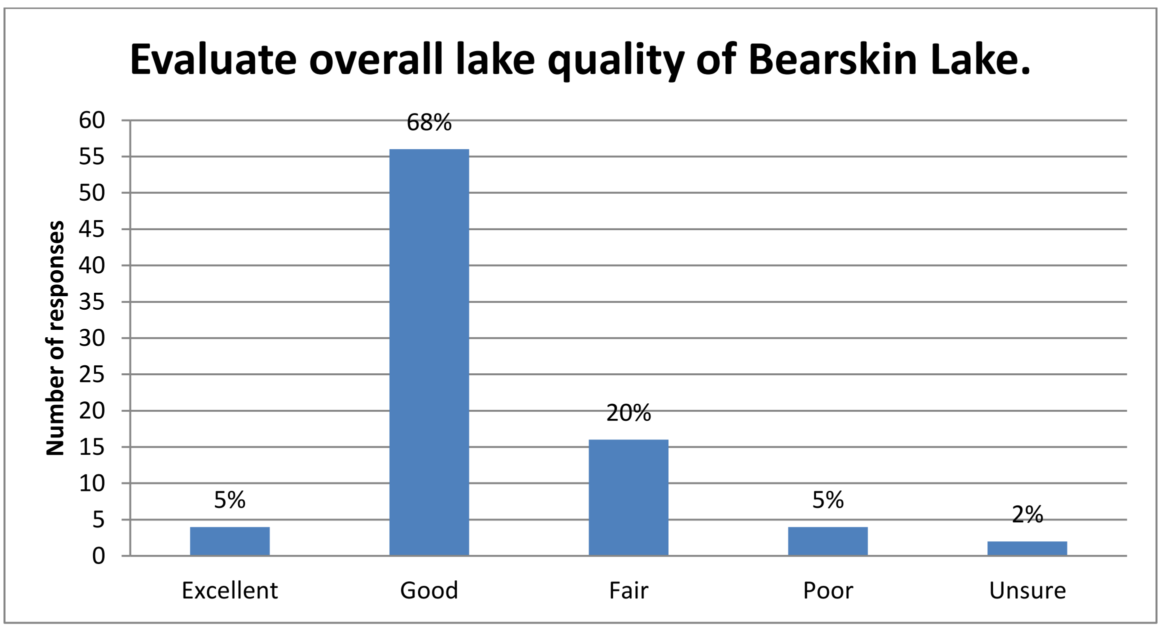

Human development greater watershed
Number of responses
45
40
35
30
25
20
15
10
5
0
1
1
Rank 1
Rank 2
Rank 3
Rank 4


Shoreline vegetation removal
Number of responses
45
40
35
30
25
20
15
10
5
0
3
3
Rank 1
Rank 2
Rank 3
Rank 4



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 Bearskin Lake, what changes have you seen in the aquatic plants? (cirlce all that apply)

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

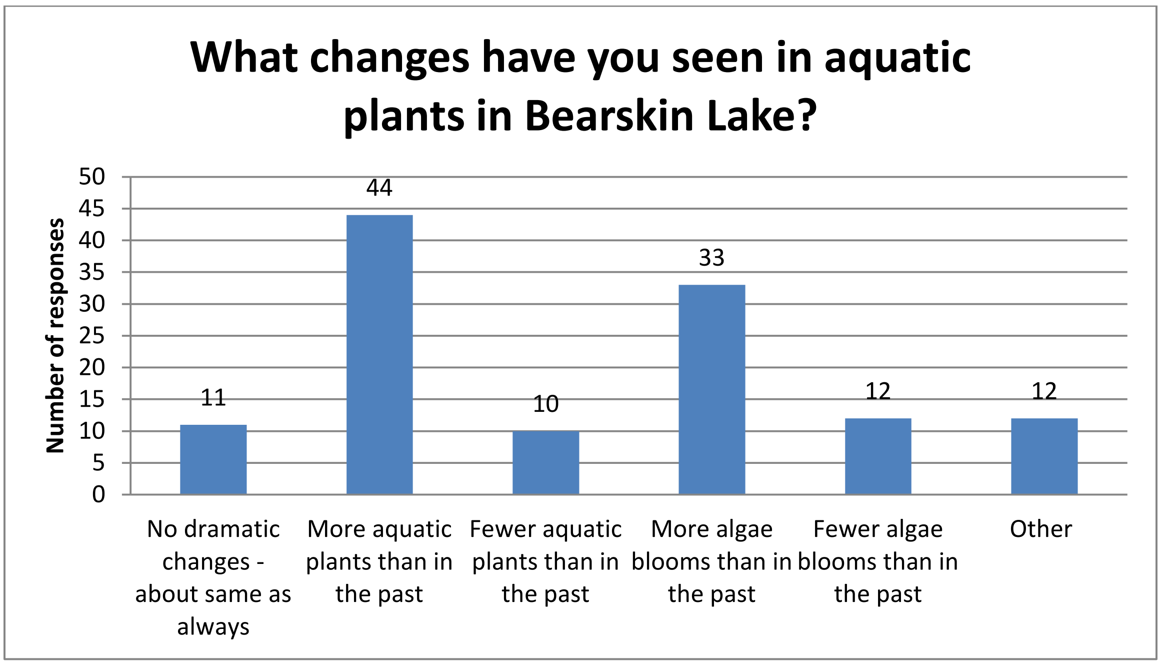
B. More aquatic plants than in the past.

C. Fewer aquatic plants than in the past.

D. More algal blooms than in the past.

E. Fewer algal blooms than in the past.

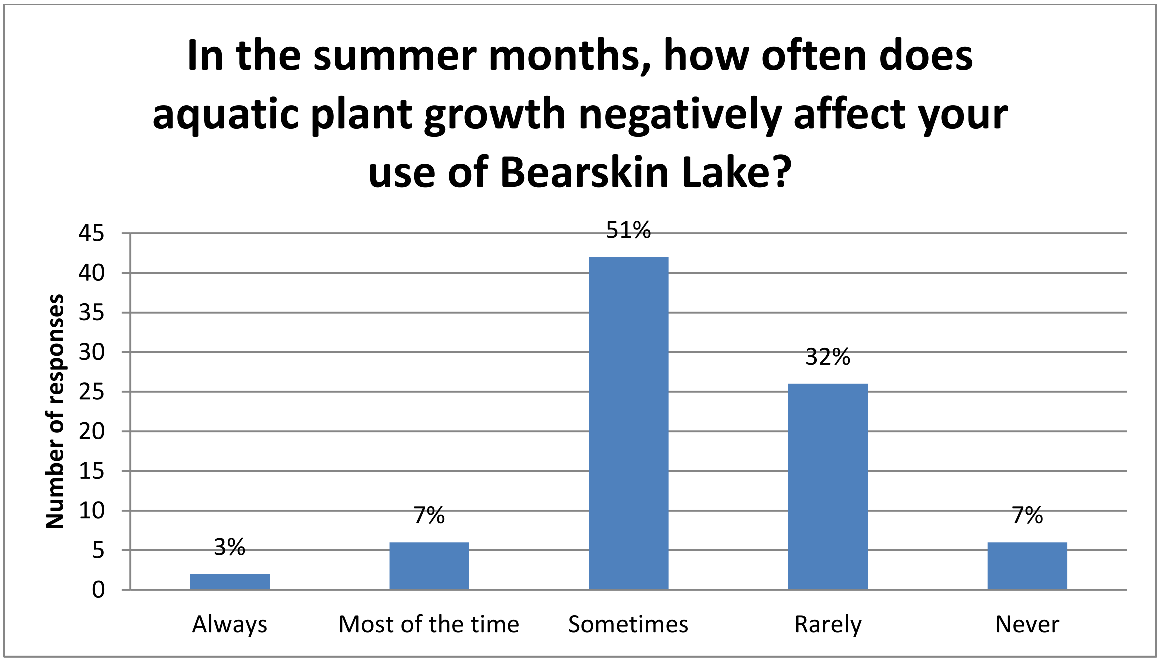
F. Other (describe :____)



Other: 1. "Out of control. 2. "More weeds in the bays and more fish." 3. "Change in types of aquatic plants." 4. "Last 15-20 years it has cycled from good amount of weeds to reduction (crayfish) to now more plant/weed growth." 5. "Less crayfish (by a lot)." 6. "Aside from crayfish outbreak, lake has cyclic plant and algae growth and absence." 7. "Remember – we saw it before the crabs and the worst period with no aquatic plants and now things are getting better." 8. "Thicker muck." 9. "Algae seem slight and very slight." 10. "Past 5 years more plants less than 25 years ago." 11. "In the 70's abundant aquatic plant life – rusty crayfish introduced and no plant life. Present day plant life and fishing are back." 13. "Every year is different." 14. "More algae in August and September."

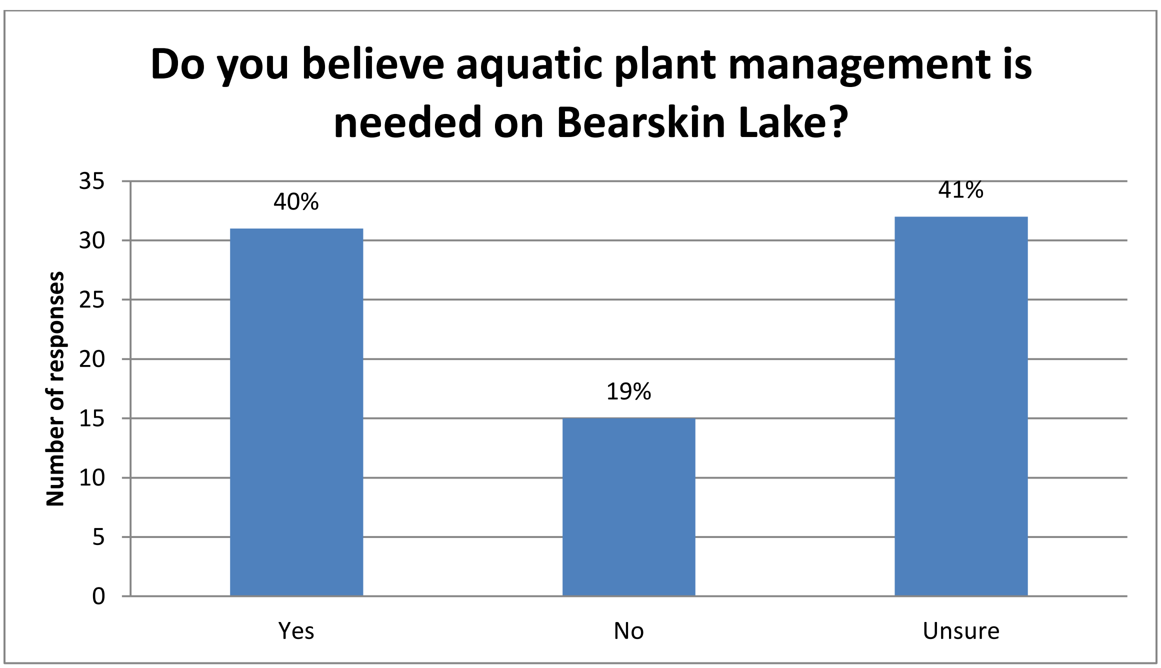
12. In the summer months (Memorial Day through Labor Day), how often does aquatic plant growth negatively affect your use of Bearskin Lake? (Circle one)

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

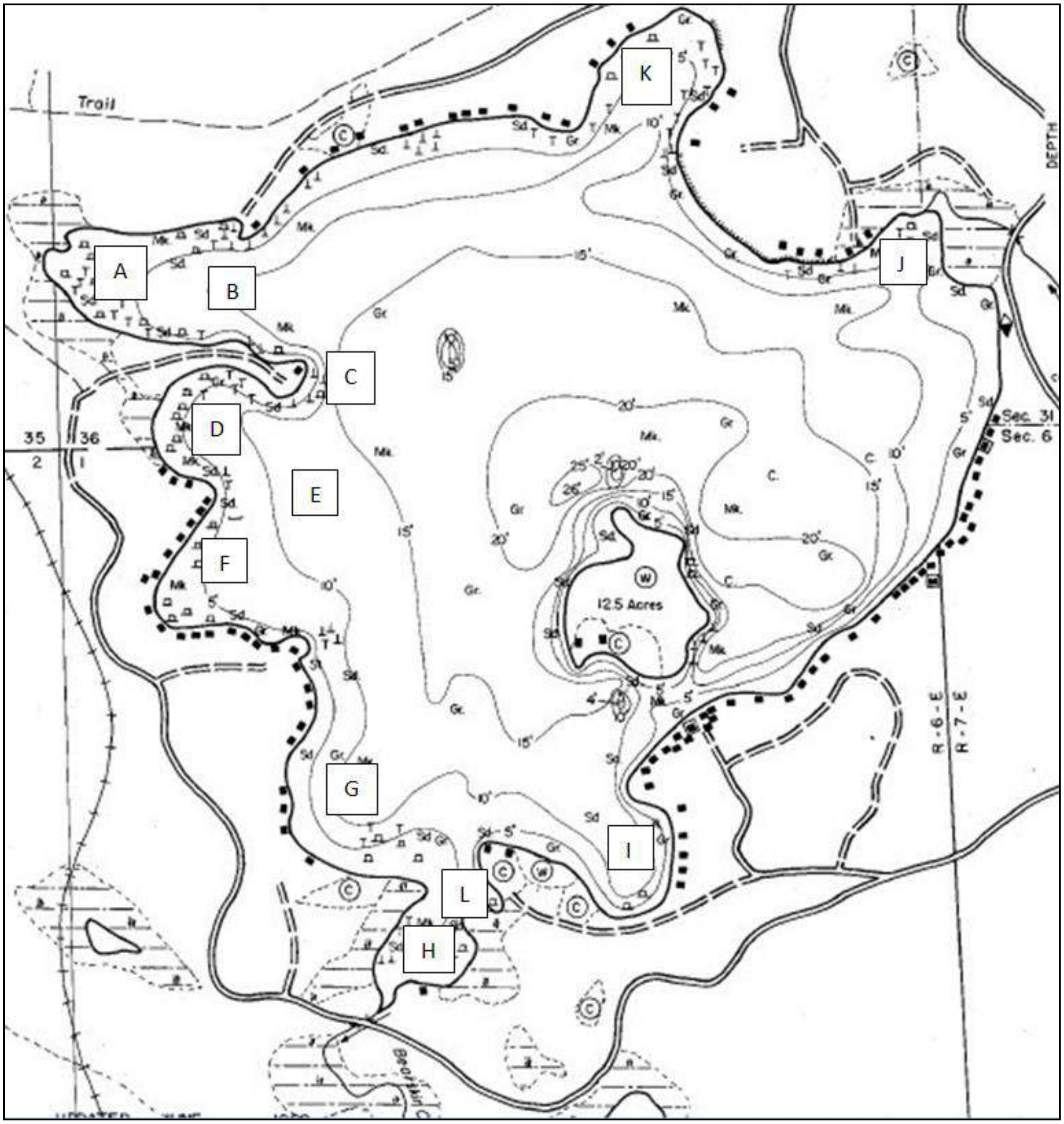


13. Do you believe that aquatic plant management is needed on Bearskin Lake? (Please circle only one)

A. Yes B. No C. Unsure



Question 14. Describe any problem on Bearskin Lake that you believe requires aquatic plant management by labeling with an “X” with a description to the right. Twenty-seven people marked areas on the map.



A – “Shallow do not use due to weeds.” “Area heavily choked with weed growth.” “Overgrowth.” “There are too many weeds to fish in bay.” “Excessive plant growth.” “Too many surface weeds – area difficult to access with boats – hopefully will not become worse.” “Excessive plant growth always gets caught in propeller.”

B – “Weeds are expanding out of bays. Also weeds are getting so thick you can’t get boat in even with prop skimming the surface. I can’t fish in the thick weeds.” “Shallow do not use due to weeds.” “Long, stringy weeds at entrance to mud bay seem to be a problem. I had not experienced until the last three to four years. This weed seems to have overtaken the coontail and cabbage that had grown here previously.” “Weeds are extending outright of bay into deeper water– area difficult to access with boats – hopefully will not become worse.” “Excessive growth in last ten years.”

C – No comments.

D – “Heavily choked with weed growth.” “Shallow do not use due to weeds.” “Weeds are expanding out of bays. Also weeds are getting so thick you can’t get boat in even with prop skimming the surface. I can’t fish in the thick weeds.” “Too much green slime algae, used to have nice cabbage weeds.” “Excessive plant growth always gets caught in propeller.” “Excessive growth in last ten years.”

E – No comments.

F – “Cannot get out of bay with boat without reversing motor to remove weeds. “Area heavily choked with weed growth.” “Weeds are expanding out of bays. Also weeds are getting so thick you can’t get boat in even with prop skimming the surface. I can’t fish in the thick weeds.” “I swim the shoreline for Triathlon Training. Weeds so thick nearly impossible to swim near shore.”

G – “We need to be diligent about introduction of invasive species.” “No weeds present in our first six years, now weeds growing these last two years. Very concerning!”

H – “Area heavily choked with weed growth.” “Shallow do not use due to weeds.” “Weeds are expanding out of bays. Also weeds are getting so thick you can’t get boat in even with prop skimming the surface. I can’t fish in the thick weeds.” “ Too many surface weeds – area difficult to access with boats – hopefully will not become worse.” “Used to be musky weeds coming back.” “Excessive growth in last ten years.”

I – “Blue green algae.”

J – “More algae than years ago.”

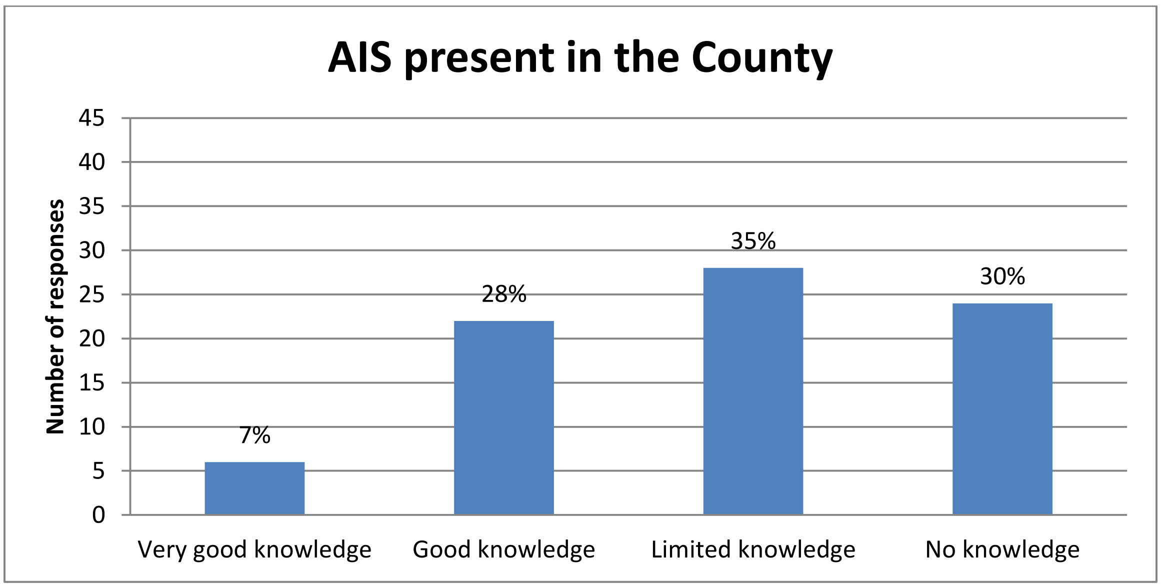
K – No comments.

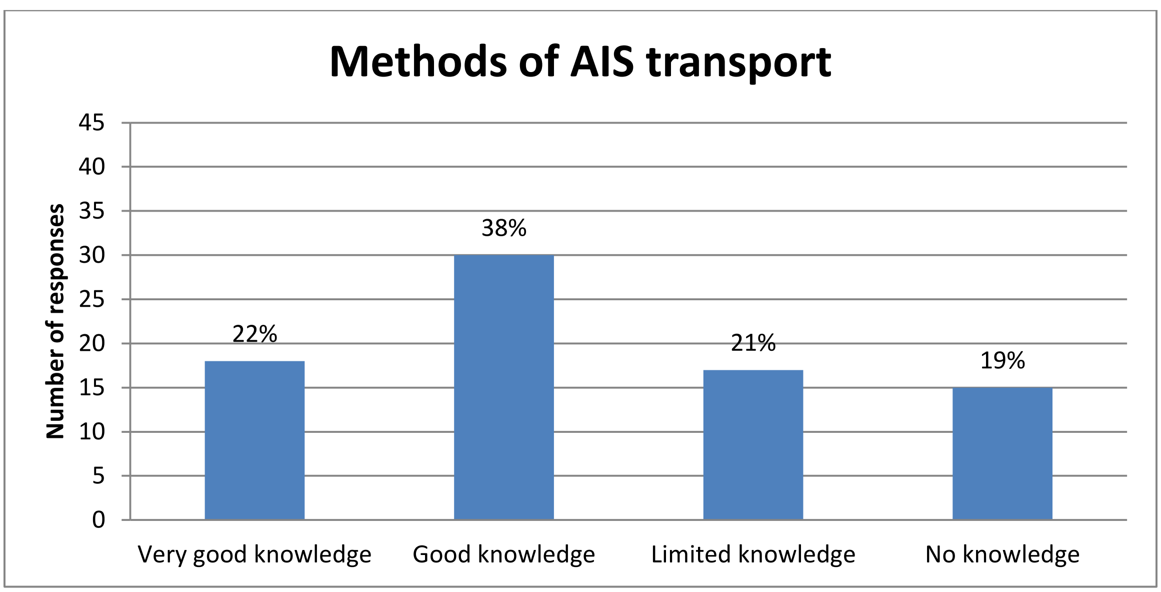
L – “Algae.”

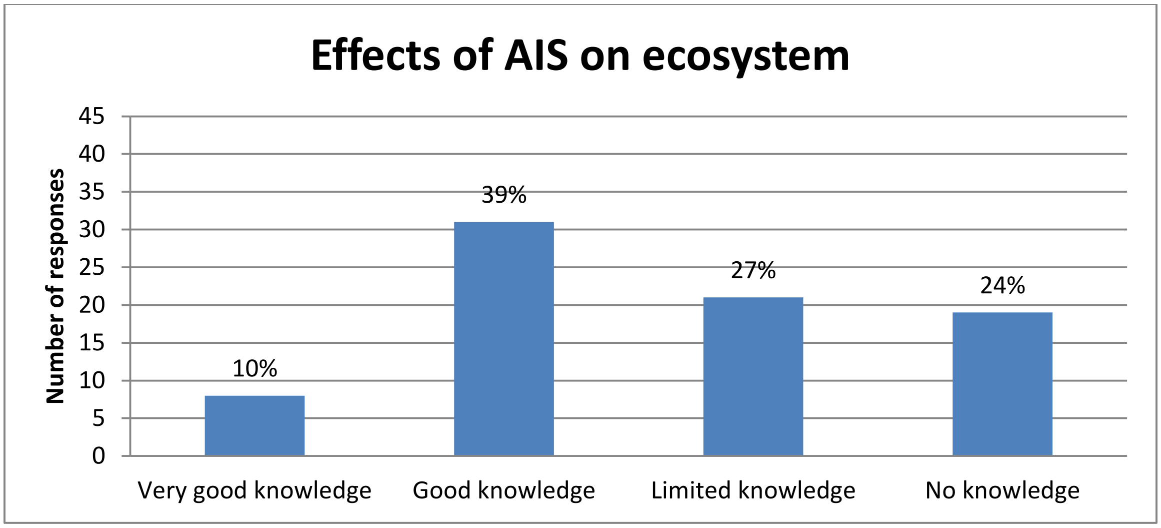
15. Education is a fundamental component of Aquatic Plant Management (APM) planning projects. Please use the following scale to rank your understanding of the aquatic invasive species (AIS) topics listed below. (For example if you have little or no knowledge about methods of AIS transport, place a 4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

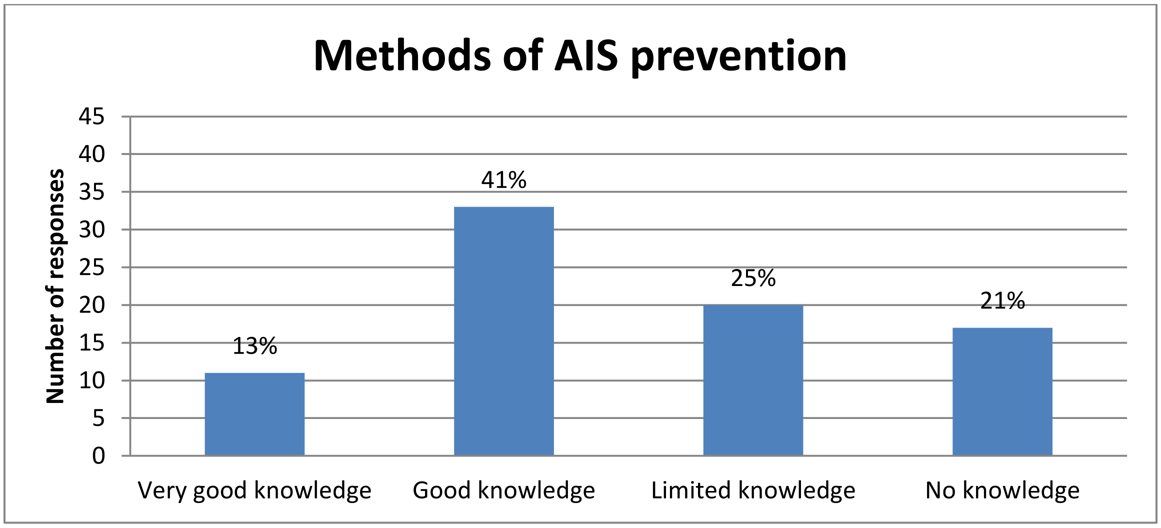
Scale 1. Very good knowledge of subject 2. Limited knowledge of subject
3. Good knowledge of subject 4. No knowledge of subject

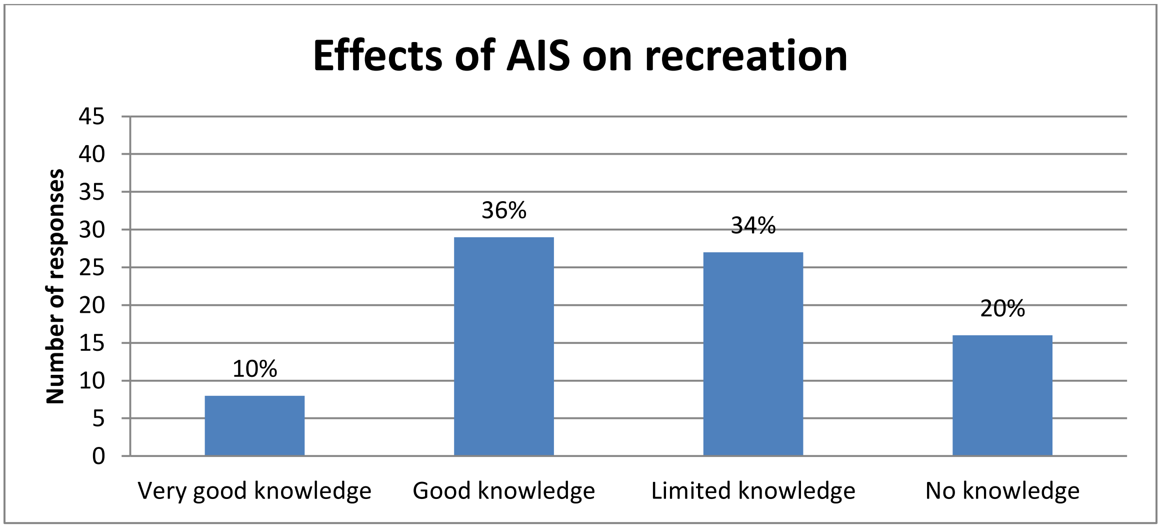
___ AIS present in the County
___ Methods of AIS transport
___ Effects of AIS on ecosystem
___ Methods of AIS prevention
___Effects of AIS on recreation
___ Long term results of AIS control
___ Methods of AIS control
___Able to identify AIS

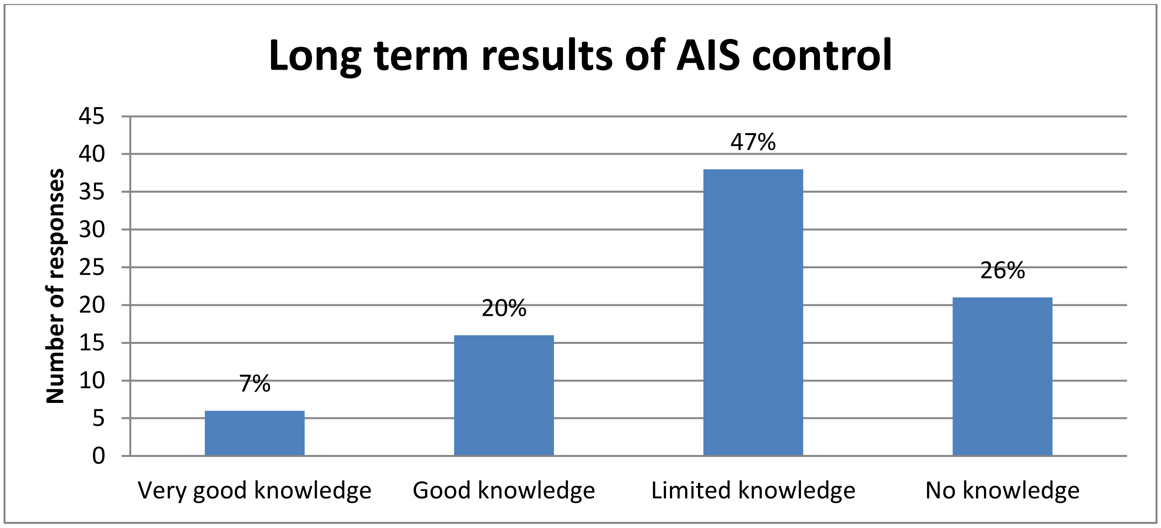


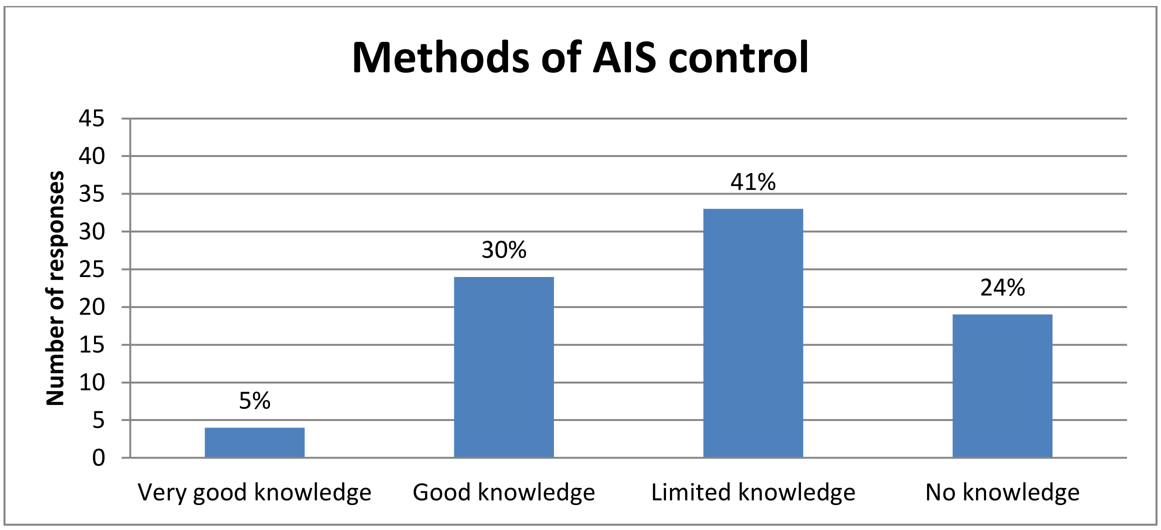


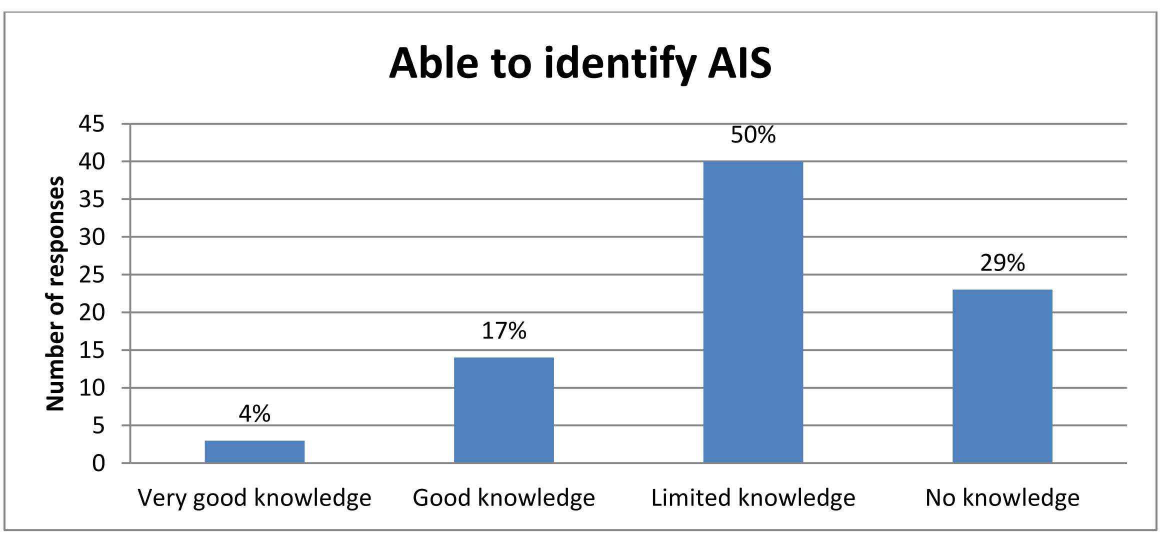

Effects of AIS on ecosystem
Number of responses
0
5
10
15
20
25
30
35
40
45
10%
39%
27%
24%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge


Methods of AIS prevention
Number of responses
0
5
10
15
20
25
30
35
40
45
13%
41%
25%
21%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

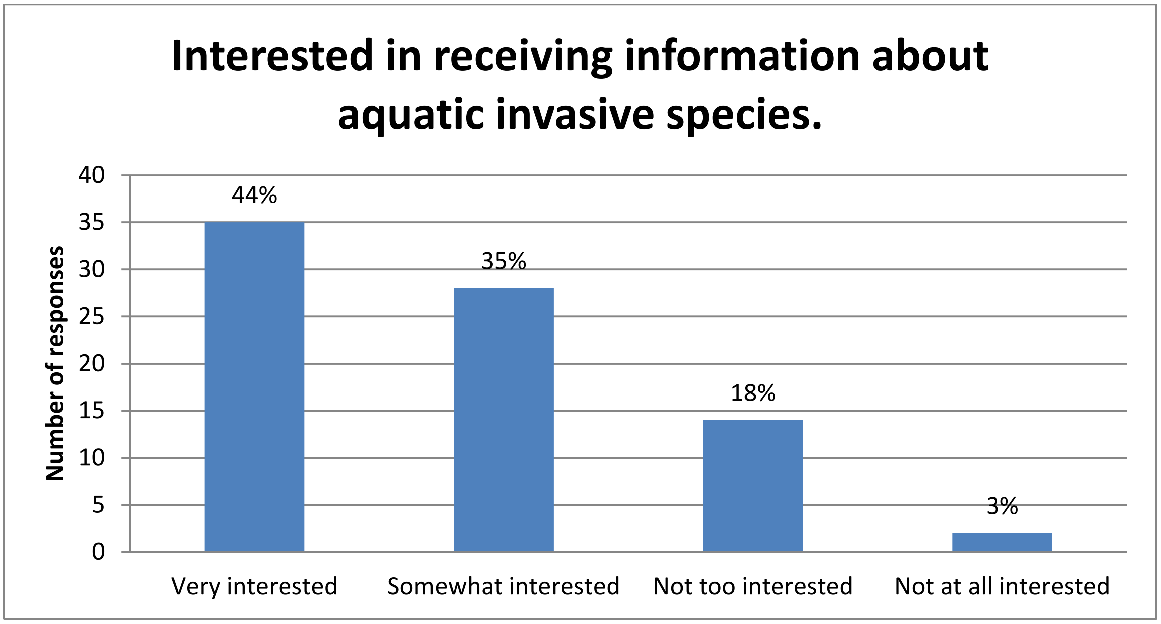

Effects of AIS on recreation
Number of responses
0
5
10
15
20
25
30
35
40
45
10%
36%
34%
20%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge


Long term results of AIS control
Number of responses
45
40
35
30
25
20
15
10
5
0
7%
20%
47%
26%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge


Methods of AIS control
Number of responses
45
40
35
30
25
20
15
10
5
0
5%
30%
41%
24%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

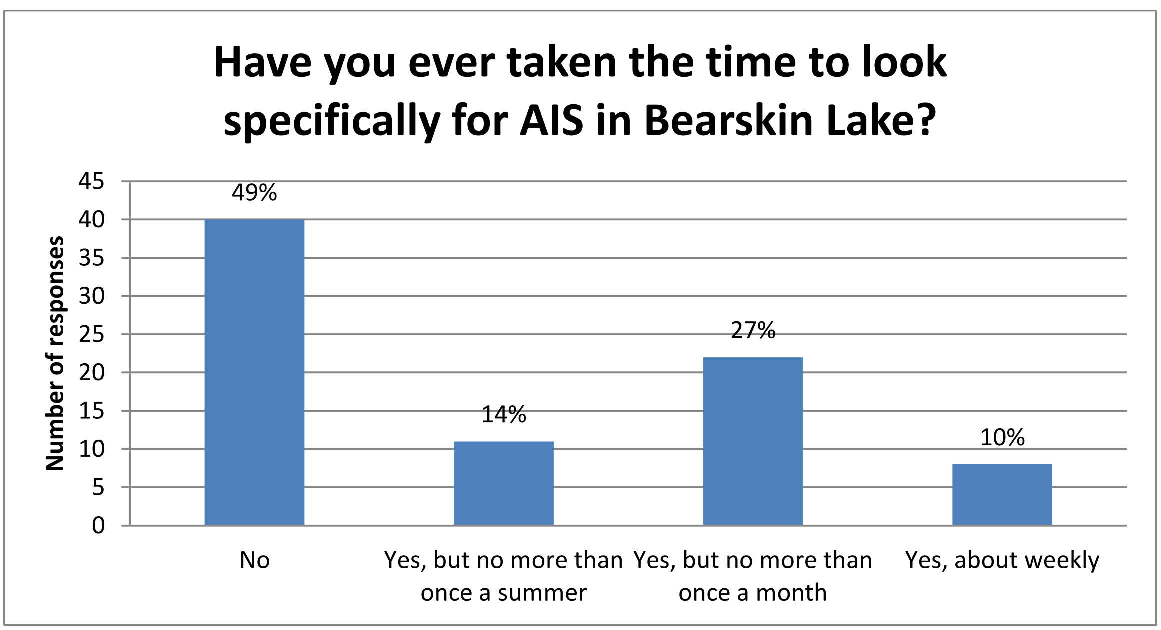

Able to identify AIS
Number of responses
45
40
35
30
25
20
15
10
5
0
4%
17%
50%
29%
Very good knowledge
Good knowledge
Limited knowledge
No knowledge

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 Bearskin 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

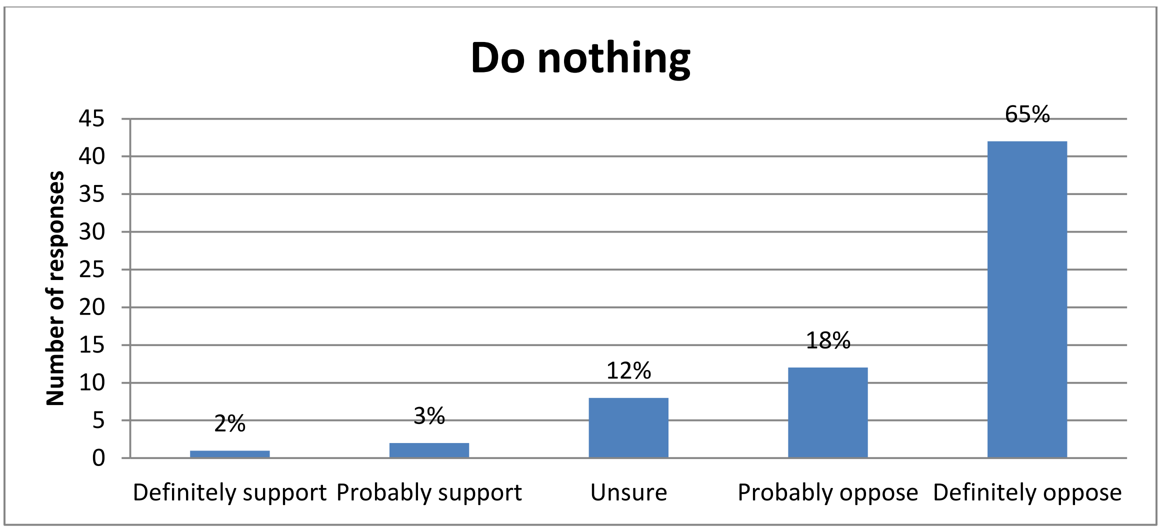
___Hand pulling and raking – use of SCUBA or Snorkeling

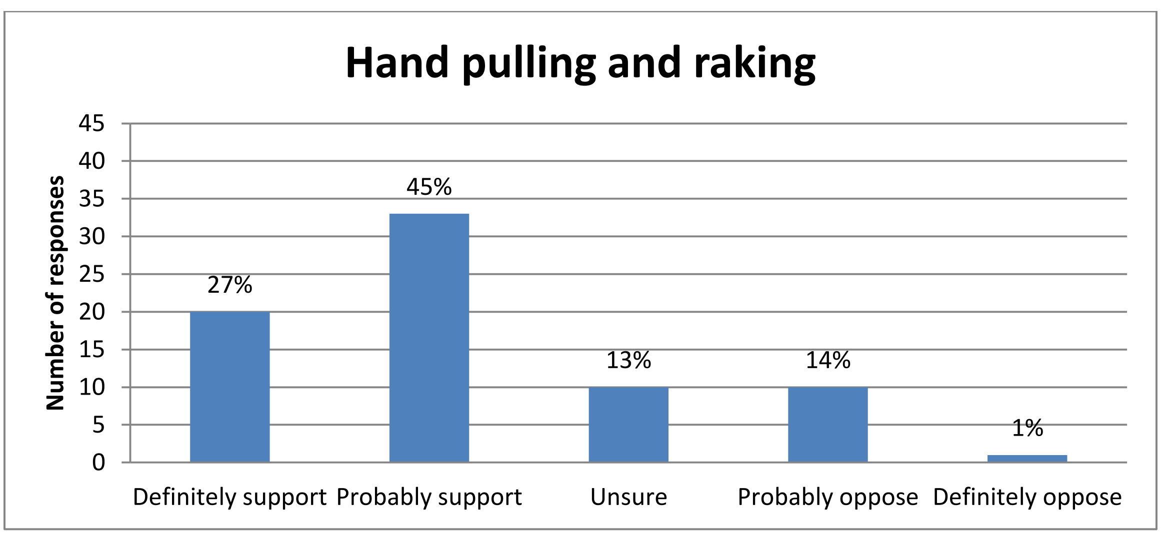
___Mechanical harvesting – use of a machine to eliminate invasive aquatic plants

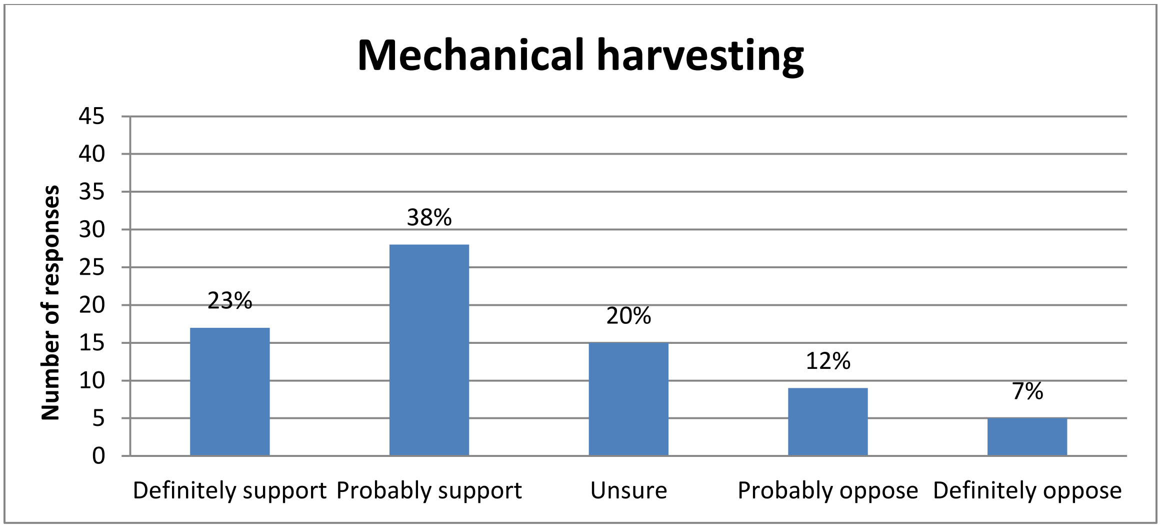
___Biological controls (native weevils) – placed in the lake to naturally control Eurasian watermilfoil

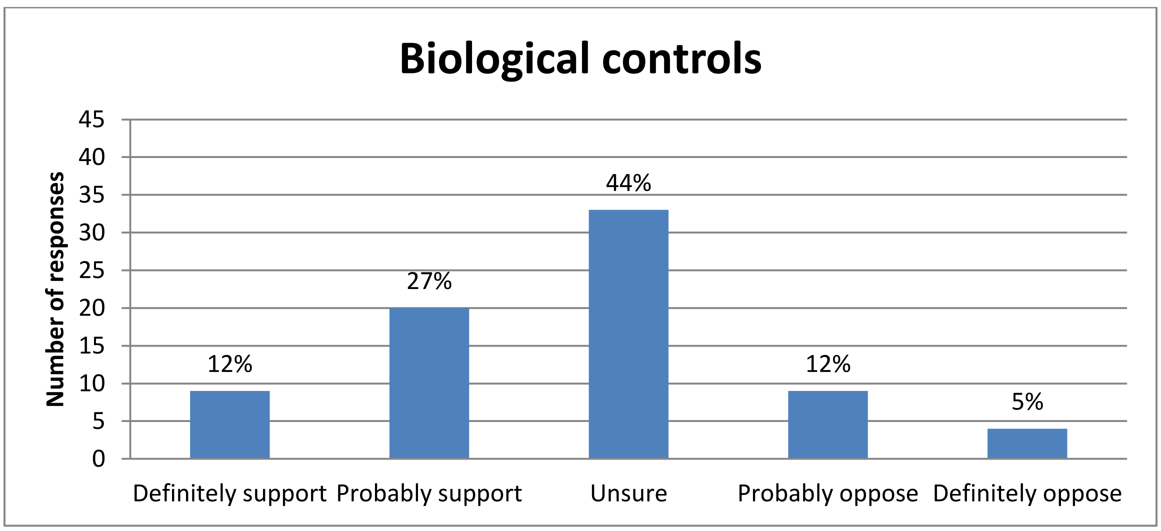
___Aquatic herbicides – applying herbicides to the AIS to control them

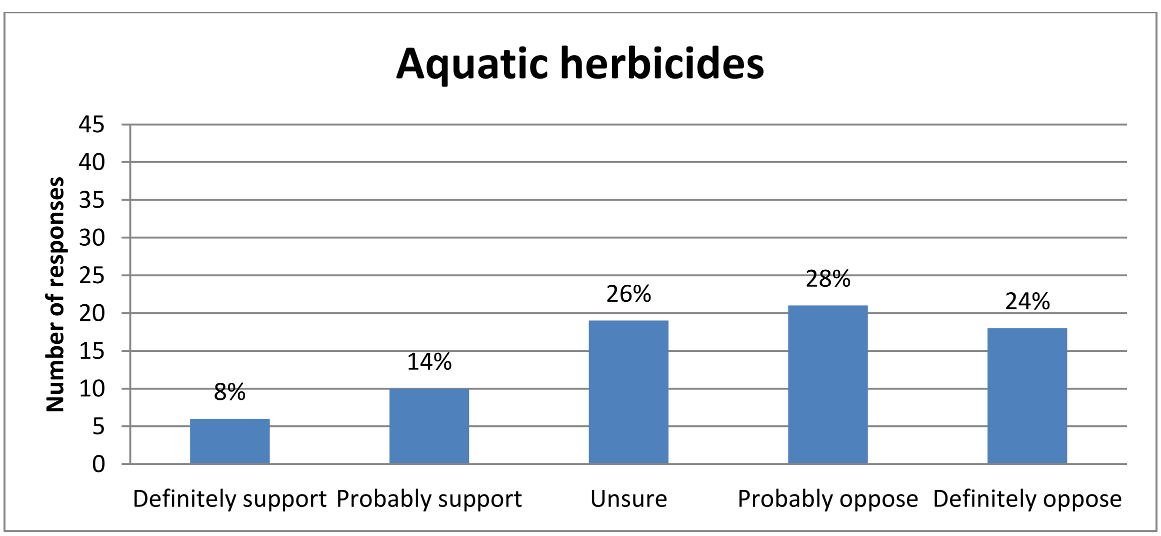
Other responses: (1) "Allow crayfish to reduce weeds – it worked during our first 6 years – no weeds by our cabin." (2) "Let crayfish control the weeds."






Mechanical harvesting
Number of responses
45
40
35
30
25
20
15
10
5
0
23%
38%
20%
12%
7%
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose

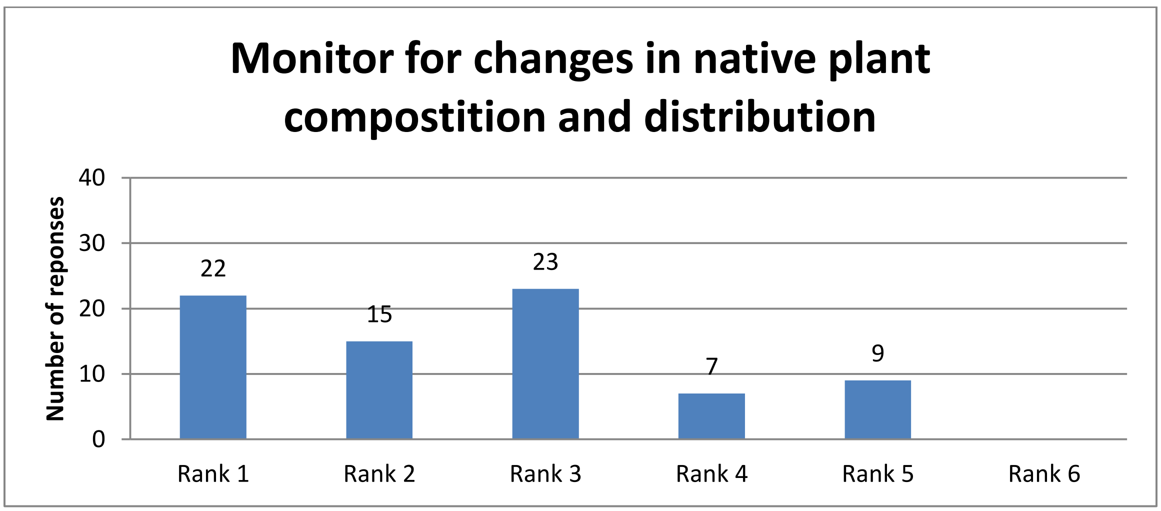

Biological controls
Number of responses
45
40
35
30
25
20
15
10
5
0
12%
27%
44%
12%
5%
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose

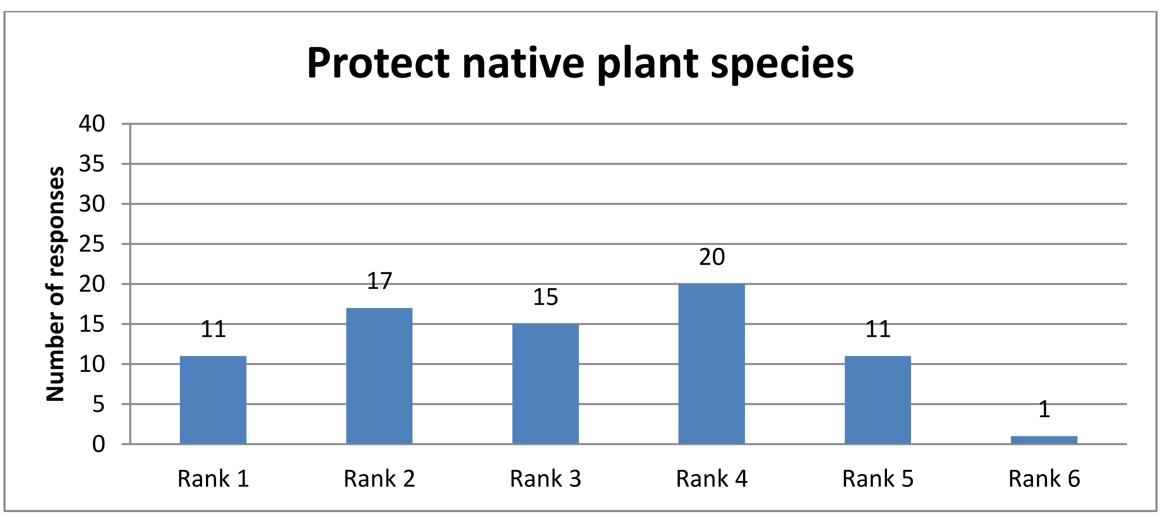

Aquatic herbicides
Number of responses
45
40
35
30
25
20
15
10
5
0
8%
14%
26%
28%
24%
Definitely support
Probably support
Unsure
Probably oppose
Definitely oppose

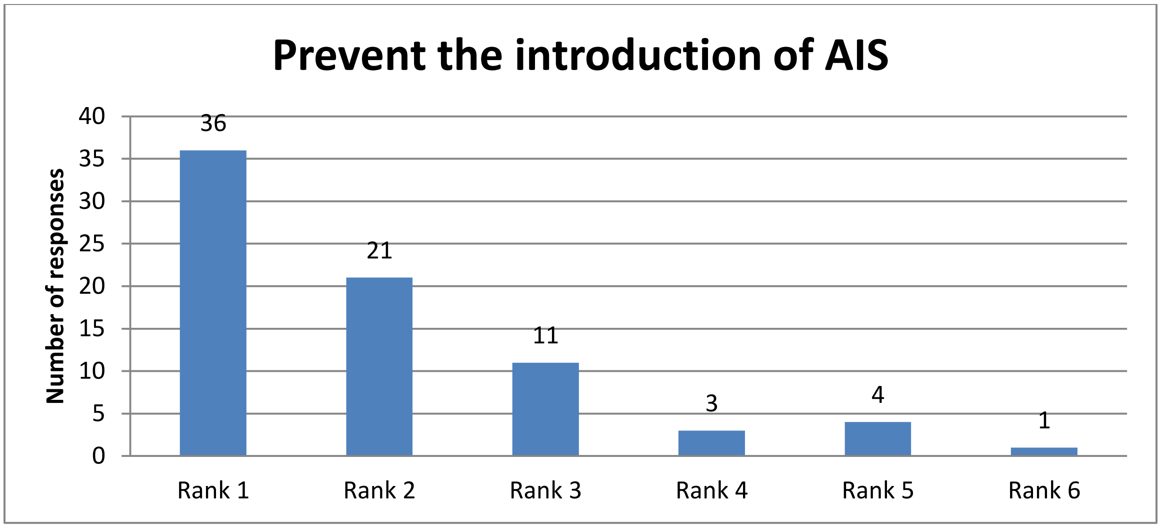
19. The Aquatic Plant Management (APM) Plan can have several goals. We would like to know where you think the Plan should place its emphasis. **Rank the following list of APM Plan goals** (“1” being the most important and “6” being the least important).

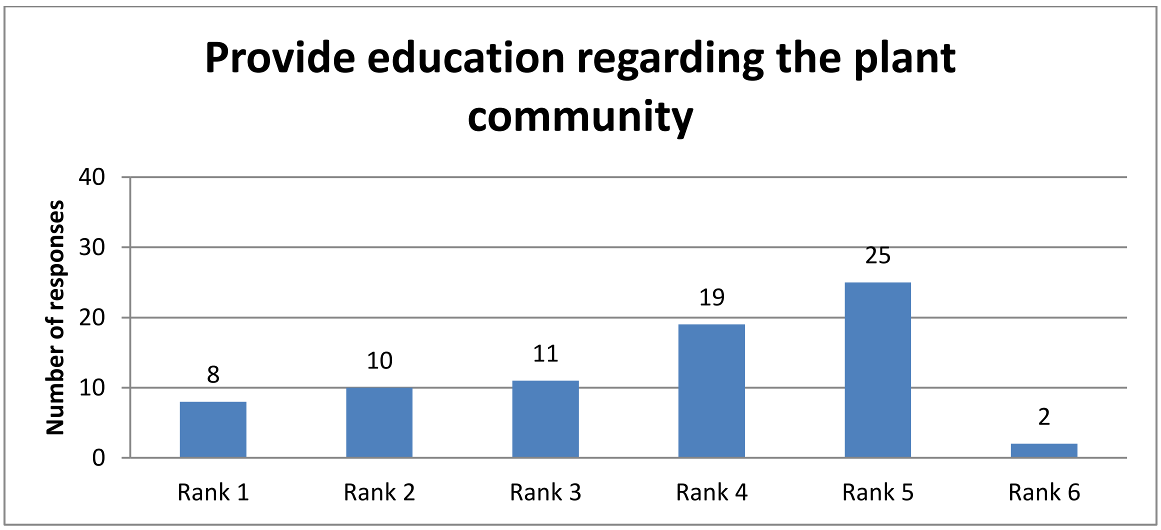
___Monitor Bearskin Lake for changes in native plant composition and distribution.
___Protect native plant species.
___Prevent the introduction of Aquatic Invasive Species.
___Provide education to Bearskin Lake stakeholders regarding the plant community.
___Monitor recreational users to minimize introduction of Aquatic Invasive Species.
___Other______________________________

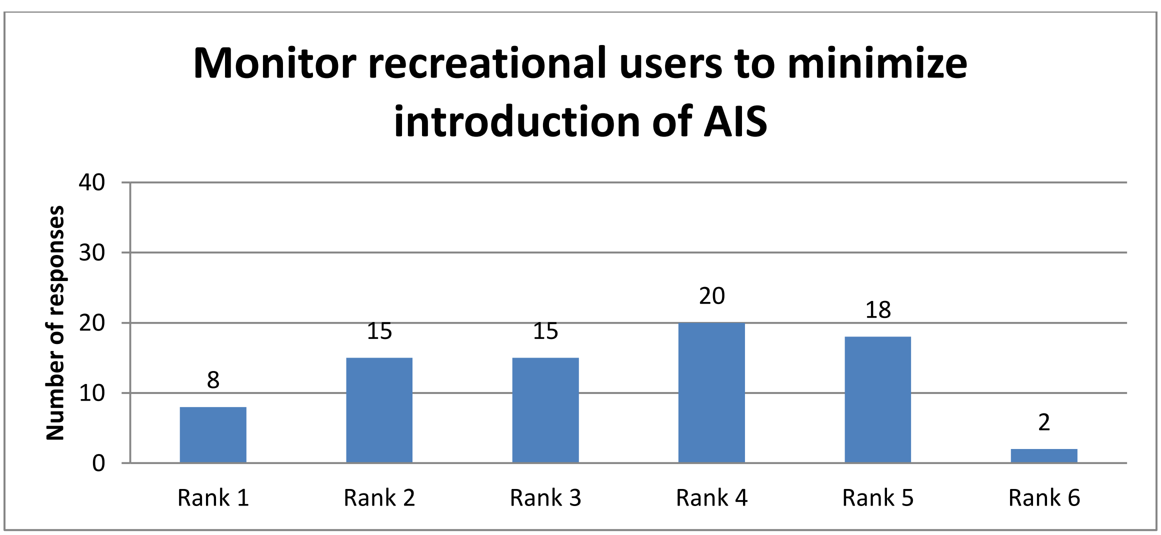
Other responses: (1) “Manage and harvest native plant species to keep them from spreading and choking the bays.” (2) “Get the muck out.” (3) “Stop the spread of weeds in the lake.” (4) “Limit or ban wake board boats, they chew up plant matter.”






Prevent the introduction of AIS
Number of responses
0
5
10
15
20
25
30
35
40
36
21
11
3
4
1
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6


Provide education regarding the plant community
Number of responses
0
10
20
30
40
8
10
11
19
25
2
Rank 1
Rank 2
Rank 3
Rank 4
Rank 5
Rank 6


Monitor recreational users to minimize introduction of AIS
Number of responses
0
10
20
30
40
8
15
15
20
18
2
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 Bearskin 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 Bearskin 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 Bearskin Lake
3. Temperature Profile
4. Use of your boat to help scientist or volunteer to monitor

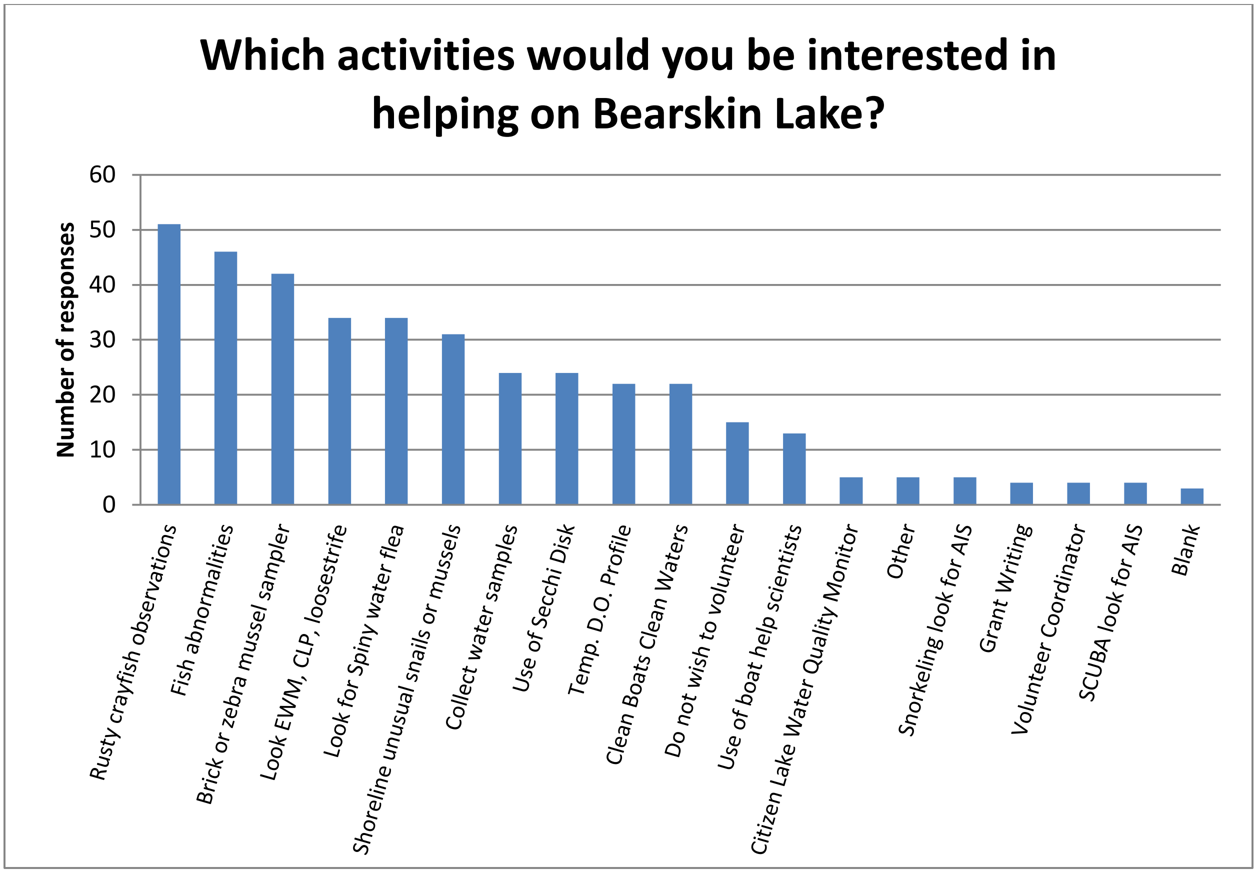
D. Clean Boats Clean Waters – educate the boaters on AIS and inspect boats

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

E. Other (specify :____)

F. Do not wish to volunteer

Other responses: (1) Kids fishery (2) Hand out = AIS educational material (3) Do Kids workshop – on birds and/or aquatic plants.



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

"Great work David!!"

"Property values will drop if the "good" weeds are also not managed and controlled."

"Video or You Tube training."

"Just to make sure that the studies are ongoing to help keep Bearskin beautiful and healthy."

"As past president and a stakeholder, I hope to pass our deep concern and our willingness to take action to the next generation – we need their help to continue to protect Bearskin Lake! John."

"First of all, thanks for the opportunity to weigh in. We are first and foremost, very avid water skiers. I also swim distances as I train for Triathlons. We are very concerned about the presence of weeds near our cabin, and the trend toward weed growth and expansion. One of the reasons we chose our cabin property and location was because of the firm bottom and a weed less bay. The first day I observed weeds growing off our pier about 2 years ago was very disturbing. We fish on occasion, and enjoy ice fishing, so fish population and habitat is also a concern. I feel we have sufficient weed cover now no need to choke out areas that are used for other purposes."

"Create no-wake zone through south shore channels."

"I have been doing water quality monitoring and loon watching for the last 7 years."

Thank you for taking time to complete this survey. Return completed survey to:
Big Bearskin Lake Association
President: David McDonald

1002 Shenandoah R.R.

Wausau, Wisconsin 54403

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___________________________________

45 of the respondents provided contact information.