2015

Pine Lake - Hancock, Waushara County, Wisconsin Lake Management Plan

Prepared by staff from the Center for Watershed Science and Education
University of Wisconsin-Stevens Point.

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Lake Management Plan for Pine Lake – Hancock, Waushara County, Wisconsin

The Pine Lake Management Plan was developed with input from residents and lake users at a series of four public planning sessions held at the Hancock Community Center in Hancock, Wisconsin in June-September 2014. The inclusive community sessions were designed to learn about and identify key community opportunities, assets, concerns, and priorities. Representatives of state and local agencies, as well as nonprofit organizations, also attended the planning sessions to offer their assistance to the group in developing a strategic lake management plan (LMP).

The plan was adopted by the Pine Lake Management District on: September 8, 2015.
Date

The plan was adopted by the Town of Hancock on: _____.
Date

The plan was adopted by the Town of Deerfield on: _____.
Date

The plan was adopted by the Village of Hancock on: _____.
Date

The plan was adopted by Waushara County on: January 6, 2016.
Date

The plan was approved by the Wisconsin Department of Natural Resources on: _____.
Date

A special thanks to all who helped to create the Pine Lake Management Plan and provided guidance during the plan's development.

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Overarching Vision for Pine Lake

Pine Lake will be a place of quiet natural beauty, family memories, and clear, abundant water. Fish, wildlife and native plants will be in balance, supplementing the quality recreational experiences offered by the lake.

Introduction

Pine Lake is a 104-acre seepage lake located in Hancock, Wisconsin. Land in the towns of Hancock and Deerfield and the village of Hancock are located in the Pine Lake watershed. The lake is bordered by shaded residential development, roads, and several wetland complexes. Pine Lake residents value the beauty, tranquility and quiet of the lake. They enjoy the no-wake activities the lake has to offer, such as viewing wildlife, swimming, fishing and kayaking. Their connection with the lake inspired the Pine Lake community to come together in partnership with local professionals and experts to develop this lake management plan (LMP).

The purpose of this plan is to provide a framework for the protection and improvement of Pine Lake. Implementing the content of this LMP will enable citizens and other supporters to achieve the vision for Pine Lake now and in the years to come. The plan was developed by community members who learned about the lake and identified features important to the Pine Lake community to help guide the fate of the lake. It is a dynamic document that identifies goals and action items for the purpose of maintaining, protecting and/or creating desired conditions in a lake and identifies steps to correct past problems, improve on current conditions, and provide guidance for future boards, lake users, and technical experts. Because many entities are involved in lake and land management, it can be challenging to navigate the roles, partnerships and resources that are available; the planning process and content of this plan have been designed to identify where some key assistance exists. The actions identified in this LMP can serve as a gateway for obtaining grant funding and other resources to help implement activities outlined in the plan.

Who can use the Pine Lake Management Plan, and how can it be used?

- **Individuals**: Individuals can use this plan to learn about the lake they love and their connection to it. People living near Pine Lake can have the greatest influence on the lake by understanding and choosing lake-friendly options to manage their land and the lake.
- **Pine Lake Management District:** This plan provides the District with a well thought out plan for the whole lake and lists options that can easily be prioritized. Annual review of the plan will also help the District to realize its accomplishments. Resources and funding opportunities for District management activities are made more available by placement of goals into the lake management plan, and the District can identify partners to help achieve their goals for Pine Lake.

- **Neighboring lake groups, sporting and conservation clubs**: Neighboring groups with similar goals for lake stewardship can combine their efforts and provide each other with support, improve competitiveness for funding opportunities, and make efforts more enjoyable.
- **The Towns of Hancock and Deerfield and the Village of Hancock**: The municipalities can utilize the visions, wishes, and goals documented in this lake management plan when considering town-level management planning or decisions within the watershed that may affect the lake.
- **Waushara County:** County professionals will better know how to identify needs, provide support, base decisions, and allocate resources to assist in lake-related efforts documented in this plan. This plan can also inform county board supervisors in decisions related to Waushara County lakes, streams, wetlands, and groundwater.
- **Wisconsin Department of Natural Resources**: Professionals working with lakes in Waushara County can use this plan as guidance for management activities and decisions related to the management of the resource, including the fishery, and invasive species. Lake management plans help the Wisconsin Department of Natural Resources to identify and prioritize needs within Wisconsin's lake community, and decide where to apply resources and funding. A well thought-out lake management plan increases an application's competitiveness for state funding– if multiple Waushara County lakes have similar goals in their lake management plans, they can join together when seeking grant support to increase competitiveness for statewide resources.

Background

One of the first steps in creating this plan was to gather and compile data about the lake and its ecosystem to understand past and current lake conditions. This was done alongside 32 other lakes as part of the Waushara County Lakes Project. The Waushara County Lakes Project was initiated by citizens in the Waushara County Watershed Lakes Council who encouraged Waushara County to work in partnership with personnel from UW-Stevens Point to assess 33 lakes in the county. This effort received funding from the Wisconsin Department of Natural Resources' Lake Protection Grant Program. There was insufficient data available for many of the lakes to evaluate current water quality, aquatic plant communities, invasive species, and shorelands. The data that were available had been collected at differing frequencies or periods of time, making it difficult to compare lake conditions. Professionals and students from UW-Stevens Point and the Waushara County Land Conservation Department conducted the Waushara County Lakes Study and interpreted data for use in the development of lake management plans. Data collected by citizens, consultants and Wisconsin Department of Natural Resources professionals were also incorporated into the planning process, helping to create a robust set of information from which informed decisions could be made. Sources of information used in the planning process are listed at the end of this document.

Several reports from the Pine Lake Study and the materials associated with the planning process and reports can be found on the Waushara County website: http://www.co.waushara.wi.us/ (select "Departments", "Zoning and Land Conservation", "Land Conservation", and "Lake Management Planning"). Unless otherwise noted, the data used in the development of this plan were detailed in the report *Waushara County Lakes Study – Pine Lake (Hancock) 2010-2012*, University of Wisconsin-Stevens Point.

The Planning Process

The planning process included a series of four public planning sessions held between June and September 2014 at the Hancock Community Center. The Pine Lake Planning Committee consisted of property owners, recreational users, and District members. Technical assistance during the planning process was provided by the Waushara County Conservationist, the Waushara County Community, Natural Resources and Economic Development Extension Agent, and professionals from the Wisconsin Department of Natural Resources (WDNR), Golden Sands Resource Conservation & Development Council, Inc. (RC&D), University of Wisconsin-Extension (UWEX), and the University of Wisconsin-Stevens Point Center for Watershed Science and Education (CWSE).

Participation in the planning process was open to everyone and was encouraged by letters sent directly to Pine Lake waterfront property owners and by press releases in local newspapers. In addition, planning committee members were provided with emails about upcoming meetings which could be forwarded to others. To involve and collect input from as many people as possible, a topic-specific survey related to the subject of each upcoming planning session was made available prior to each planning session. Property owners and interested lake users were notified about the surveys and how to access them (via postcards mailed to waterfront property owners and press releases in local newspapers). The surveys could be filled out anonymously online, or paper copies were available upon request. Survey questions and responses were shared at the planning sessions and can be found in Appendix E. Lake User Survey Results .

Implementing the content of this lake management plan will enable citizens and other supporters to achieve the vision for Pine Lake now and in the years to come.

Guest experts and professionals attended the planning sessions. They presented information and participated in discussions with participants to provide context, insight and recommendations for the lake management plan, including environmental and regulatory considerations. This information was organized with the survey results into discussion topics, which included: the fishery and recreation; the aquatic plant community; water quality and land use; shoreland health; and, communication. After learning about the current conditions of each topic, planning committee members identified goals, objectives and actions for the lake management plan that were then recorded by professionals from UW-Stevens Point. Planning session notes and presentations are available on the Waushara County website.

Goals, Objectives and Actions

The following goals, objectives and associated actions were derived from the values and concerns of citizens interested in Pine Lake and members of the Pine Lake Management Planning Committee, as well as the known science about Pine Lake, its ecosystem and the landscape within its watershed. Implementing and regularly updating the goals and actions in the Pine Lake Management Plan will ensure that the vision is supported and that changes or new challenges are incorporated into the plan. A lake management plan is a living document that changes over time to meet the current needs, challenges and desires of the lake and its community. **The goals, objectives and actions listed in this plan should be reviewed annually and updated with any necessary changes.**

Although each lake is different, the Wisconsin Department of Natural Resources requires that each comprehensive lake management plan address a specific list of topics affecting the character of a lake, whether each topic has been identified as a priority or as simply something to preserve. In this way, every lake management plan considers the many aspects associated with lakes. These topics comprise the chapters in this plan and have been grouped as follows:

In-Lake Habitat and a Healthy Lake

Fish Community—fish species, abundance, size, important habitat and other needs
Aquatic Plant Community—habitat, food, health, native species, and invasive species
Critical Habitat—areas of special importance to the wildlife, fish, water quality, and aesthetics of the lake

Landscapes and the Lake

Water Quality and Quantity—water chemistry, clarity, contaminants, lake levels
Shorelands—habitat, erosion, contaminant filtering, water quality, vegetation, access
Watershed Land Use—land use, management practices, conservation programs

People and the Lake

Recreation—access, sharing the lake, informing lake users, rules
Communication and Organization—maintaining connections for partnerships, implementation, community involvement
Updates and Revisions—continuing the process
Governance—protection of the lake, constitution, state, county, local municipalities, lake organizations

List of Goals

Goal 1. Pine Lake will host a healthy fish community with supportive lake conditions.

Goal 2. Protect native plants in and around Pine Lake.

Goal 3. EWM/HWM will be controlled at a level that does not prevent recreational enjoyment of Pine Lake.

Goal 4. Preserve and redevelop high quality habitat for fish and wildlife.

Goal 5. Maintain median summer total phosphorus concentrations below 15 ug/L. Reduce springtime inorganic nitrogen concentrations to 0.3 mg/L or below.

Goal 6. Collect long term data on Pine Lake to monitor trends over time and inform homeowners of drinking water quality.

Goal 7. Protect Pine Lake during times of low water.

Goal 8. Maintain and preserve healthy shoreland areas and encourage property owners to restore shorelands that need attention.

Goal 9. Property owners and land managers in the Pine Lake watershed will understand how the can reduce impacts to Pine Lake and who to contact for assistance.

Goal 10. Maintain the no-wake status on Pine Lake a no-wake lake, and encourage visitors and residents to abide by boating rules.

Goal 11. Pine Lake Management District members will be informed about lake health and activities to learn about and provide input for lake management.

Goal 12. LMP will be up to date by reviewing annually and updating every 5 years.

The following goals were identified as 'high priority':

Goal 3. EWM/HWM will be controlled at a level that does not prevent recreational enjoyment of Pine Lake.
(Aquatic Invasive Species (AIS)**)**

Objective 3.1. Reduce populations of EWM/HWM to less than 15% of the lake surface.

Continue whole-lake treatment for EWM as appropriate. Evaluate results and approach annually. Inform property owners about refraining from removing native aquatic vegetation. Investigate new herbicide treatments as they are developed.

Goal 6. Collect long term data on Pine Lake to monitor trends over time and inform homeowners of drinking water quality. **(**Water Quality**)**

Objective 6.1. Monitor water quality parameters in Pine Lake and drinking water. Initiate a water quality monitoring regiment consistent with WisCALM guidance, begin water clarity monitoring, submit all results to state database. Monitor ice-on and ice-off dates. Work with county to install water level monitoring well.

Goal 8. Maintain and preserve healthy shoreland areas and encourage property owners to restore shorelands that need attention. (Shorelands)

Objective 8.1. Restore approximately 664' (~25%) of unhealthy shoreline over the next 5 years.

Provide materials to property owners regarding shoreland buffer vegetation. Recognize property owners that maintain and restore shorelands, obtain grant to install a demonstration site.

Lead persons and resources are given under each objective of this plan. These individuals and organizations are able to provide information, suggestions or services to accomplish objectives and achieve goals. The following table lists organization names and their common acronyms used in this plan. This list should not be considered all-inclusive – assistance may also be provided by other entities, consultants and organizations.

Resource	Acronym
Clean Boats, Clean Waters	CBCW
WDNR Citizen Lake Monitoring Network	CLMN
UWSP Center for Watershed Science and Education	CWSE
Wisconsin Department of Agriculture, Trade and Consumer Protection	DATCP
Gathering Waters Conservancy	GWC
North Central Conservancy Trust	NCCT
USDA Natural Resources Conservation Service	NRCS
Pine Lake Management District	PLMD
Golden Sands Resource Conservation & Development Council, Inc.	RC&D
University of Wisconsin Extension	UWEX
University of Wisconsin-Stevens Point	UWSP
Waushara County Land Conservation Department	WCLCD
Waushara County Watershed Lakes Council	WCWLC
Wisconsin Department of Natural Resources	WDNR
UWSP Water & Environmental Analysis Lab	WEAL

Contact information for organizations and individuals who support lake management in Waushara County can be found in Appendix A. Waushara County Lakes Information Directory.

In-Lake Habitat and a Healthy Lake

Many lake users value Pine Lake for its fishing, wildlife, and water quality that allows enjoyable recreational experiences. These attributes are all interrelated; the health of one part of the lake system affects the health of the rest of the plant and animal community, the experiences of the people seeking pleasure at the lake, and the quality and quantity of water in the lake. Habitat is the structure for a healthy fishery and wildlife community. It can provide shelter for some animals and food for others.

Lake habitat occurs within the lake, along all of its shorelands, and even extends into its watershed for some species. Many animals that live in and near the lake are only successful if their needs – food, a healthy environment, and shelter – are met. Native vegetation including wetlands along the shoreline and adjacent to the lake provides habitat for safety, reproduction, and food, and can improve water quality and balance water quantity. Some lake visitors such as birds, frogs, and turtles use limbs from trees that are sticking out of the water for perches or to warm themselves in the sun. Aquatic plants infuse oxygen into the water and provide food and shelter for waterfowl, small mammals, and people. The types and abundance of plants and animals that comprise the lake community also vary based on the water quality, and the health and characteristics of the shoreland and watershed. Healthy habitat in Pine Lake includes the aquatic plants, branches, and tree limbs above and below the water.

Fish Community

A balanced fish community has a mix of predator and prey species, each with different food, habitat, nesting substrate, and water quality needs in order to flourish. Activities in and around a lake that can affect a fishery may involve disturbances to the native aquatic plant community or substrate, excessive additions of nutrients or harmful chemicals, removal of woody habitat, shoreline alterations, and/or an imbalance in the fishery. Shoreland erosion can cause sediment to settle onto the substrate, causing the deterioration of spawning habitat. Habitat can be improved by allowing shoreland vegetation to grow, minimizing the removal of aquatic plants, providing fallen trees or limbs in suitable areas, and protecting wetlands and other areas of critical habitat.

People are an important part of a sustainable fish community; their actions on the landscape and the numbers and sizes of fish taken out of the lake can influence the entire lake ecosystem. Putting appropriate fishing regulations in place and adhering to them can help to balance the fishery with healthy prey and predatory species, can be adjusted as the fish community changes, and can provide for excellent fishing.

Managing a lake for a balanced fishery can result in fewer expenses to lake stewards and the public. While some efforts may be needed to provide a more suitable environment to meet the needs of the fish, they usually do not have to be repeated on a frequently reoccurring basis. Protecting existing habitat such as emergent, aquatic, and shoreland vegetation, and allowing trees that naturally fall into the lake to remain in the lake are free of cost. Alternatively, restoring habitat in and around a lake can have an up-front cost, but the effects will often continue for decades. Costs in time, travel, and other expenses are associated with routine efforts such as fish stocking and aeration. Ideally, a lake contains the habitat, water quality, and food necessary to support the fish communities that are present within the lake and provide fishing opportunities for people without a lot of supplemental effort and associated expenses to maintain these conditions.

In 2010, a survey of the sport fish in Pine Lake was conducted by fisheries biologists with the WDNR. Northern pike, largemouth bass, and pumpkinseed were commonly caught during this survey, although bluegill abundance was low (likely due to a preceding winter kill). Pine Lake experiences frequent winter kills, likely related to low oxygen concentrations. The most recent was a severe winter kill during the winter of 2013-2014. The majority of lake user survey respondents indicated fishing in Pine Lake had declined with time, but reported they were still catching a variety of fish, including northern pike, largemouth bass, bullheads, small panfish, catfish, crappie and walleye.

On July 22, 2014, the Fisheries Biologist and Fisheries Technician from the WDNR presented information about the fish community to the Pine Lake planning committee. They also offered recommendations and answered questions. Recommendations included:

- Protect and restore near shore habitat. Pine Lake is currently in good shape regarding emergent vegetation and habitat, since much of the lake is surrounded by bulrushes. The planning committee did not express much concern with lake residents removing the bulrushes due to the mucky nature of the sediment.
- Refrain from the removing woody habitat (logs, sticks, stumps, branches, etc.). Committee members indicated there were few trees close enough to the water to fall into the lake naturally; however, aquatic plant growth is providing plentiful cover for fish in Pine Lake. The group was open to future habitat management or enhancement, but was not interested at the present time.
- If stocking fish occurs, consider choosing species more resistant to low oxygen concentrations, such as perch.

At the time of LMP formation, the Fisheries Biologist was awaiting the approval of requests for yellow perch and largemouth bass stocking in Pine Lake.

Guiding Vision for the Fish Community

Pine Lake will host a flourishing, year-round sport fish community.

Goal 1. Pine Lake will host a healthy fish community with supportive lake conditions.

Objective 1.1. Provide an environment in which the existing (and stocked) fish community can thrive year-round.

Actions	Lead person/group	Resources	Timeline
Explore the purchase and installation of an aerator. Contact WDNR Fisheries Biologist for more information and resources.	PLMD	WDNR Fisheries Biologist Local fishing clubs	2016
Consider the effects of an open water area caused by an aerator on the current snowmobile trail across the lake and explore options to assure safe recreation (barrier system around open water, cones, etc.).	PLMD	WDNR Fisheries Biologist	2016

If stocking, consider stocking species more resistant to low dissolved oxygen concentrations, such as perch.	PLMD	WDNR Fisheries Biologist Fish hatchery	As needed
Coordinate with the Fisheries Biologist to pursue another fish community survey to assess populations after the 2014 winter fish kill.	PLMD	WDNR Fisheries Biologist Local fishing clubs Consultant	2016

Objective 1.2. Protect or restore in-lake habitat.

Actions	Lead person/group	Resources	Timeline
Refrain from the removal of bulrush habitat around the lake. Provide information about the importance to shoreland property owners (at meetings, through newsletters, info sign near boat launch, etc.)	Shoreland property owners	UWEX Lakes (educational material)	Ongoing
Refrain from the removal of woody habitat (stumps, logs, branches, etc.) in the lake.	Shoreland property owners	UWEX Lakes (educational material)	Ongoing
Consider working with the fisheries biologist to recommend locations for enhancements of near shore woody habitat.	PLMD	WDNR Fisheries Biologist Local fishing clubs WDNR Healthy Shorelands grant	Ongoing
Identify a volunteer to monitor a groundwater monitoring well near Pine Lake to initiate the collection of water level data over time.	PLMD	WCLCD WDNR SWIMS database	2016

Aquatic Plant Community

Aquatic plants provide the forested landscape within Pine Lake. They provide food and habitat for spawning, breeding and survival for a wide range of inhabitants and lake visitors including fish, waterfowl, turtles, amphibians, as well as invertebrates and other animals. They improve water quality by releasing oxygen into the water and utilizing nutrients that would otherwise be used by algae. A healthy lake typically has a variety of aquatic plant species which creates diversity that makes the aquatic plant community more resilient and can help to prevent the establishment of non-native aquatic species. Aquatic plants near shore and in shallows provide food, shelter and nesting material for shoreland mammals, shorebirds and waterfowl. It is not unusual for otters, beavers, muskrats, weasels and deer to be seen along a shoreline in their search for food, water or nesting material.

An August 2013 aquatic plant survey conducted by staff from Golden Sands Resource Conservation & Development Council, Inc. (RC&D) documented twenty-three species of aquatic plants in Pine Lake. This was above-average compared with the other lakes in the Waushara County Lakes Study. The greatest depth at which aquatic plant growth was found was 13 feet. The greatest species diversity occurred in the shallows and scattered around the lake. The dominant plant species in Pine Lake was the aquatic invasive species, Eurasian watermilfoil (EWM), followed by muskgrasses and sago pondweed. EWM growth can begin in early spring when lake temperatures are too cold for other aquatic plants to grow, giving EWM an advantage. Another invasive species, spiny naiad, was found in Pine Lake during the 2013 survey.

More detailed information can be found in the Pine Lake (Hancock) Aquatic Plant Report, the Pine Lake (Hancock) 2010-2012 Lake Study Report and Appendix B. Aquatic Plants.

Guiding Vision for Aquatic Plants in Pine Lake

Pine Lake will have a healthy, well-balanced aquatic plant community that allows for recreational opportunities while providing adequate habitat and water quality benefits.

Goal 2. Protect native plants in and around Pine Lake.

Objective 2.1. Avoid disturbance of the native aquatic plant community.

Actions	Lead person/group	Resources	Timeline
Minimize removal and disturbance of native vegetation via educational materials provided in annual mailing, website re: mitigation methods available.	Shoreland property owners	UWEX Lakes (educational material)	Ongoing
If plants severely impede recreation, consider hand-pulling small areas around personal docks.	Shoreland property owners	WDNR Lakes Specialist	As needed
Inform property owners to refrain from using fertilizers on shoreland properties to reduce the growth of dense plant beds (see Shoreland Section of this plan).	PLMD	WC UWEX	Ongoing

Aquatic Invasive Species (AIS)

Aquatic invasive species are non-native aquatic plants and animals that are most often unintentionally introduced into lakes by lake users. This most commonly occurs on trailers, boats, equipment, and from the release of bait. The 2013 aquatic plant survey identified two aquatic invasive species in Pine Lake: spiny naiad and Eurasian watermilfoil (EWM). EWM was found at 84% of the vegetated sites and currently accounts for a large portion of the plant biomass in Pine Lake. A map of the locations and extent of EWM can be found in Appendix B. Aquatic Plants .

EWM can exist as part of the plant community or it can create dense beds that can damage boat motors, make areas non-navigable, and inhibit activities like swimming and fishing. EWM produces viable seeds; however, it often spreads by fragmentation. Just a small stem fragment is enough to start a new plant, so spread can occur quickly if plants are located near points of activity such as beaches and boat launches.

Eurasian watermilfoil.

Planning participants indicated Pine Lake had been treated with 2,4-D (Appendix B. Aquatic Plants) about three years prior to the planning process. The group received an Aquatic Invasives Control grant from the WDNR in 2004 to conduct a large-scale Eurasian Watermilfoil Control project on 48.9 acres of the affected area. 2,4-D was used to treat hybrid watermilfoil (HWM) in 2011.

Summary of Aquatic Plant Management Planning Session Discussion – September 23, 2014

Various aquatic plant management options for the control of aquatic invasive species (AIS) were discussed at the September 23, 2014 lake management planning meeting. Attendees considered the survey responses from residents and the public to questions about the control of Eurasian watermilfoil/hybrid watermilfoil (EWM/HWM). The presence of AIS was among the top three concerns of 86% of survey respondents. The favored options for controlling AIS were, in order of preference, chemical control (herbicides), biological control , dredging of bottom sediments, and mechanical harvesting. Less favored options were manual removal by property owners and hand-removal by divers. Mechanical harvesting was determined to be inappropriate for Pine Lake and was not elaborated on at the meeting.

Participants indicated chemical spot treatments have been ineffective for HWM found in Pine Lake. Ted Johnson, Water Resource Management Specialist with the WDNR, reported the WDNR has had success treating HWM with a combination of Endothal and 2,4-D that seemed to have a synergistic effect when both were used at lower concentrations. Johnson also suggested a granular form of Fluoridone may be effective, but warned against the liquid form as it is not plant-specific and 85% of the plant community would be susceptible. He also stated residents should not attempt to control aquatic plants by spraying Roundup around the shorelines, due to negative impacts on people and fish.

Coordinating volunteers or hiring someone to inform boaters about the spread of aquatic invasive species at boat launches raises awareness of AIS and can help prevent the entry of aquatic invasive plants into the lake. In addition to informing visitors, developing a program to monitor for AIS within the lake is an important way to identify and report new outbreaks before AIS become established.

Action: Work with RC&D to learn how to identify invasive species and coordinate volunteers or paid individuals to conduct boat launch inspections through the Clean Boats, Clean Waters (CBCW) program. If AIS are found, refer to Appendix D. Rapid Response Plan.

The following **management options** were determined to be the most practical and effective options to minimize impacts to Pine Lake as a whole. These options can be selected individually or together. A single strategy should not be used year after year; rather, the strategy each year should be selected based on conditions in the previous year.

Hand Pulling by Trained Citizens (Native plants or EWM)

This is being done by individual lakefront property owners who have been trained in removal techniques intended to be successful in removal and minimize fragmentation of the plants. Those trained to properly identify and remove EWM and other AIS can remove those plants manually any time of year, without a permit. Shoreland property owners are permitted to clear an area up to 30 feet around their docks for boat and swimming access to

open water; however, caution should be used to minimize the extent of cleared lakebed as this open habitat allows for easy establishment of many invasive species. Trained divers can be hired to manually remove AIS in deeper parts of the lake.

Chemical Spot/Whole-Lake Treatment

Studies of the effectiveness of chemical spot treatment for EWM/HWM control have been conducted in recent years. The results suggest chemical spot treatment is less effective at controlling EWM/HWM than previously thought. Although chemical spot treatment may not be as detrimental to the native aquatic plant population as a whole-lake treatment, studies showed there are negative effects to native vegetation (Johnson, 2014). Chemical treatments may kill AIS, but the decaying aquatic plant tissue remaining in the lake may create conditions ideal for algae blooms and other water quality problems, and can increase sediment. Although the chemicals used are approved for use in aquatic environments by the US Environmental Protection Agency and WDNR, the complete impacts to the aquatic ecosystem are still unknown (WDNR, 2012). More information can be found in Appendix B. Aquatic Plants .

The most recent information suggests that chemical spot treatments are effectively low-dose whole-lake treatments without the necessary contact time and concentrations. If chemical application is desired, an appropriate herbicide, chemical concentration, and contact time should be determined as part of the permit application process.

Each lake is different and the response to EWM/HWM control may vary from lake to lake. No single approach will be appropriate for all lakes. Often multiple approaches and adaptive year-to-year changes in approach are most successful. The EWM/HWM population should be evaluated using a 'point-intercept' method (accompanied by more thorough observations) before and after chemical treatments to determine the effectiveness of an approach in a given year. EWM/HWM plants that were not successfully killed by the chemical can be hand removed. Strategies for the subsequent year should be adjusted accordingly. EWM/HWM management involves evolving scientific knowledge; therefore, the management strategies for EWM/HWM in Pine Lake should be adapted as their populations in the lake change and as new information becomes available.

Hybrid watermilfoil (HWM) results from a hybridization of native watermilfoil with Eurasian watermilfoil. HWM tends to be more resilient and less affected by chemical treatment. HWM may be suspect in a lake if 1) the plants appearance is different than EWM; 2) management with chemicals becomes difficult or ineffective; and, 3) the lake is near other lakes with HWM. If these criteria are met, plant samples should be submitted to a lab for confirmation. Once HWM is confirmed, a *challenge test* should be conducted to determine which combination of chemicals will be effective in controlling that particular strain of HWM. Many combinations of chemicals can potentially be used to treat HWM, so the only way to know the appropriate combination is by sending samples to be *challenge tested*. Treating HWM without knowing the appropriate combination of chemicals can result in an even more resilient strain in the lake, damage to the native aquatic plant population, and a waste of money.

Chemical control of EWM beds that are less than 5 acres in size should be done using a contact herbicide (examples: endothall and diquat). Systemic herbicides should not be used. Treatment should occur early in the season, prior to emergence of native plants. To reduce the chance of developing resilient strains of EWM, different treatments should be used each year.

> **Action:** Monitor results of various manual removal techniques. If the EWM/HWM population exceeds a threshold of 5-10% of the lake surface area, consider chemical treatments. Following treatment, monitoring for the target species should be conducted that summer at least 30 days after the treatment, and the results of its effectiveness on target and non-target species should be documented.
>
> Follow guidelines to inform lake users of the use of chemicals in the lake and provide documentation about the chemical to all property owners around the lake. Work with WDNR Water Resource Specialist for specifics.
>
> When possible, use additional caution when applying chemicals to high quality aquatic plant species and species of special concern.

Milfoil Weevils (EWM, HWM, northern watermilfoil)

This option could be considered in areas of the lake with native or restored shorelines. Milfoil weevils are expensive to purchase, so obtaining a starter population and rearing them in predator-free conditions can be desirable from a financial standpoint. Professional assistance from RC&D staff should be sought if stocking or rearing is pursued. It is unknown if native milfoil weevil populations are present in Pine Lake. **This option is not viable if chemical treatment options are being pursued**.

No Action

This may be used in years leading up to a whole-lake chemical treatment.

Guiding Vision for Aquatic Invasive Species

Invasive species will have minimal adverse effect on Pine Lake.

Goal 3. EWM/HWM will be controlled at a level that does not prevent recreational enjoyment of Pine Lake.

Objective 3.1. Reduce populations of EWM/HWM to less than 15% of the lake surface.

Actions	Lead person/group	Resources	Timeline
Assess native and invasive plant community annually. Based on the results, work with an aquatic plant biologist to select the management strategy for the upcoming year.	PLMD	Consultant WDNR Aquatic Plant Specialist	Annually
An aquatic plant survey using point-intercept methods must be conducted prior to and after every chemical treatment and prior to the 5 year update of this LMP.	PLMD	Consultant WDNR Aquatic Plant Specialist	As needed
Submit HWM samples for challenge test to determine appropriate chemical cocktail for treatment.	PLMD	WDNR Aquatic Plant Specialist RC&D	2015 or prior to whole lake treatment
Inform property owners about refraining from removing native aquatic vegetation to diminish the possibility of invasive species colonization.	PLMD	RC&D WCWLC	Ongoing
Inform property owners about the hazards of attempting to control aquatic plants by spraying Roundup near the shoreline.	PLMD	UWEX	Ongoing

Objective 3.2. Prevent the establishment of any new invasive species in Pine Lake.

Actions	Lead person/group	Resources	Timeline
Use signs, newsletters, and other methods to inform lake visitors about invasives and removing aquatic hitchhikers.	PLMD	RC&D Town of Hancock Village of Hancock	Ongoing
Inform property owners of the importance of aquatic vegetation and to refrain from removing native aquatic vegetation to diminish the possibility of AIS colonization.	PLMD	RC&D CBCW WCWLC	Ongoing
Learn to identify AIS and routinely look for it.	Interested citizens	RC&D	Annually
Follow the steps in the Rapid Response Plan (Appendix D) if new AIS are found or suspected.	PLMD	RC&D	As needed

Critical Habitat

Special areas harbor habitat that is essential to the health of a lake and its inhabitants. In Wisconsin, critical habitat areas are identified by biologists and other lake professionals from the WDNR in order to protect features that are important to the overall health and integrity of the lake, including aquatic plants and animals. While every lake contains important natural features, not all lakes have official critical habitat designations. Designating areas of the lake as critical habitat enables these areas to be located on maps and information about their importance to be shared. Having a critical habitat designation on a lake can help lake groups and landowners plan waterfront projects that will minimize impact to important habitat, ultimately helping to ensure the long-term health of the lake.

Although Pine Lake does not have any official critical habitat area designations, there are areas within Pine Lake that are important for fish and wildlife. Natural, minimally impacted areas with woody habitat such as logs, branches, and stumps; areas with emergent and other forms of aquatic vegetation; areas with overhanging vegetation; and wetlands are elements of good quality habitat. Identifying other important areas around the lake that are important habitat and informing lake users of their value can help raise awareness for the protection of these areas.

Guiding Vision Pine Lake's Critical Habitat

Sensitive areas on Pine Lake will be enhanced and protected from degradation.

Goal 4. Preserve and redevelop high quality habitat for fish and wildlife.

Objective 4.1. Identify critical habitat on Pine Lake.

Actions	Lead person/group	Resources	Timeline
Identify and map areas of critical habitat in Pine Lake.	PLMD	Consultants WDNR biologists and lake managers	2016
Support landowners around the lake who express interest in placing undeveloped land into a conservation program (conservation easements, purchase of development rights, etc.).	PLMD	NCCT GWC NRCS Lake Protection grants Knowles-Nelson Stewardship Funds	As needed

Landscapes and the Lake

Land use and land management practices within a lake's watershed can affect both its water quantity and quality. While forests, grasslands, and wetlands allow a fair amount of precipitation to soak into the ground, resulting in more groundwater and good water quality, other types of land uses may result in increased runoff and less groundwater recharge, and may also be sources of pollutants that can impact the lake and its inhabitants. Areas of land with exposed soil can produce soil erosion. Soil entering the lake can make the water cloudy and cover fish spawning beds. Soil also contains nutrients that increase the growth of algae and aquatic plants. Development on the land may result in changes to natural drainage patterns and alterations to vegetation on the landscape, and may be a source of pollutants. Impervious (hard) surfaces such as roads, rooftops, and compacted soil prevent rainfall from soaking into the ground, which may result in more runoff that carries pollutants to the lake. Wastewater, animal waste, and fertilizers used on lawns, gardens and crops can contribute nutrients that enhance the growth of algae and aquatic plants in our lakes. Land management practices can be put into place that better mimic some of the natural processes, and reduction or elimination of nutrients added to the landscape will help prevent the nutrients from reaching the water. In general, the land nearest the lake has the greatest impact on the lake water quality and habitat.

Shoreland vegetation is critical to a healthy lake's ecosystem. It helps improve the quality of the runoff that is flowing across the landscape towards the lake. It also provides habitat for many aquatic and terrestrial animals including birds, frogs, turtles, and many small and large mammals. Healthy shoreland vegetation includes a mix of tall grasses/flowers, shrubs, and trees which extend at least 35 feet landward from the water's edge. Shorelands include adjacent wetlands, which also serve the lake by allowing contaminants to settle out, providing shelter for fish and wildlife, and decreasing the hazard of shoreline erosion by providing a shoreland barrier from waves and wind.

The water quality in Pine Lake is the result of many factors, including the underlying geology, the climate, and land management practices. Since we have little control over the climate and cannot change the geology, changes to land management practices are the primary actions that can have positive impacts on the lake's water quality. The water quality in Pine Lake was assessed by measuring different characteristics including temperature, dissolved oxygen, water clarity, water chemistry, and algae. All of these factors were taken into consideration when management planning decisions were made.

Water Quality

All of the respondents to the citizen survey indicated water quality had an impact on their personal enjoyment and the economic value of the lake. A large majority of the respondents also indicated the water quality had declined in the time they have been visiting Pine Lake, with the causes most often cited being water level changes and agriculture.

A variety of water chemistry measurements were used to characterize the water quality in Pine Lake. Water quality was assessed during the 2010-2012 lake study and involved a number of measures including temperature, dissolved oxygen, water chemistry, and nutrients (phosphorus and nitrogen). Nutrients are important measures of water quality in lakes because they are used for growth by algae and aquatic plants. Each of these interrelated

measures plays a part in the lake's overall water quality. In addition, water quality data collected in past years was also reviewed to determine trends in Pine Lake's water quality.

Dissolved oxygen is an important measure in Pine Lake because a majority of organisms in the water depend on oxygen to survive. Oxygen is dissolved into the water from contact with air, which is increased by wind and wave action. Algae and aquatic plants also produce oxygen when sunlight enters the water, but the decomposition of dead plants and algae reduces oxygen in the lake. During the study, dissolved oxygen concentrations fell near or below 5mg/L throughout the water column in February 2011 and February 2012. Concentrations below 5 mg/L can stress some species of cold water fish and over time can reduce the amount of available habitat for sensitive cold water species of fish and other aquatic organisms. According to planning session participants, Pine Lake experiences occasional to frequent winter fish kills.

For Pine Lake, water clarity ranged from 7 feet to 16 feet, with an average of 11.3 feet over the 2010-2012 monitoring period. When compared with historic data, the average water clarity measured during the study was similar in April and June, better in August, and poorer in May, July, and October. Past data used in this analysis ranged from 1991 to 2001.

Chloride, sodium and potassium concentrations are commonly used as indicators of how a lake is being impacted by human activity. The presence of these compounds where they do not naturally occur indicates sources of water contaminants. Concentrations of potassium and sodium in Pine Lake reflected natural sources. Chloride concentrations were slightly elevated, and while they were not harmful to aquatic organisms, they indicated pollutants may be entering the lake from either surface runoff or via groundwater. Chloride sources include animal waste, septic systems, fertilizer, and road-salting chemicals. Atrazine, an herbicide commonly used on corn, was detected (0.005 µg/L and 0.055 µg/L DACT) in the samples that were analyzed from Pine Lake. Some toxicity studies have indicated reproductive system abnormalities can occur in frogs at these levels (Hayes et al., 2001; Hayes et al., 2003).

Phosphorus is an element that is essential in trace amounts to most living organisms, including aquatic plants and algae. Sources of phosphorus include naturally-occurring phosphorus in soils, wetlands and groundwater. Common sources from human activities include soil erosion, animal waste, fertilizers and septic systems. Although a variety of compounds are important to biological growth, phosphorus receives attention because it is commonly the "limiting nutrient" in many Wisconsin lakes. Due to its relatively short supply compared to other substances necessary for growth, relatively small increases in phosphorus result in significant increases in aquatic plants and algae.

One pound of phosphorus entering a lake can result in up to 500 pounds of algal growth! (Vallentyne, 1974)

During the study, total phosphorus concentrations for Pine Lake ranged from a high of 23 ug/L in November 2010 to a low of 10 ug/L in August 2012. The summer median total phosphorus concentrations were 18 ug/L and 16 ug/L in 2011 and 2012, respectively. This is below Wisconsin's phosphorus standard of 20 ug/L for deep seepage lakes, but above the proposed flag value of 15 ug/L. During the study, inorganic nitrogen concentrations were high

enough in the spring to enhance algal blooms throughout the summer (Shaw et al., 2000). Both nitrates and atrazine have drinking water health standards. Their presence in the lake water also raises concern for drinking water in the Pine Lake watershed.

Estimates of phosphorus from the landscape can help to understand the phosphorus sources to Pine Lake. Land use in the surface watershed was evaluated and used to populate the Wisconsin Lakes Modeling Suite (WILMS) model. In general, each type of land use contributes different amounts of phosphorus in runoff and through groundwater. The types of land management practices that are used and their distances from the lake also affect the contributions to the lake from a parcel of land. Based on modeling results, agriculture had the greatest phosphorus contributions from the watershed to Pine Lake.

Managing nitrogen, phosphorus and soil erosion throughout the Pine Lake watershed is one of the keys to protecting the lake itself. Near shore activities that may increase phosphorus input to the lake include applying fertilizer, removing native vegetation (trees, bushes and grasses), mowing vegetation, and increasing the amount of exposed soil. Nitrogen inputs to Pine Lake can be controlled by using lake-friendly land management decisions, such as the restoration of shoreland vegetation, elimination/reduction of fertilizers, proper management of animal waste and septic systems, and the use of water quality-based management practices.

Guiding Vision for Water Quality in Pine Lake

Pine Lake will have water quality that supports a balanced fishery, great recreation, and reduces the growth of algae and aquatic plants.

Goal 5. Maintain median summer total phosphorus concentrations below 15 ug/L. Reduce springtime inorganic nitrogen concentrations to 0.3 mg/L or below.

Objective 5.1. Decrease runoff from shoreland properties and the watershed entering the lake.

Actions	Lead person/group	Resources	Timeline
Encourage the restoration of shoreland vegetation around the lake to slow water and filter out sediment and nutrients.	PLMD	WCLCD Consultants WDNR Healthy Lakes grant	Ongoing
Minimize impervious surfaces directly around the lake.	Shoreland property owners	WCLCD WDNR Healthy Lakes grant	Ongoing
Encourage the installation of rain barrels, rain gardens, and other lake-friendly storm water runoff management practices.	PLMD	WCLCD WDNR Healthy Lakes grant	Ongoing

Goal 6. Collect long term data on Pine Lake to monitor trends over time and inform homeowners of drinking water quality.

Objective 6.1. Monitor water quality parameters in Pine Lake and drinking water.

Actions	Lead person/group	Resources	Timeline
Encourage private well owners in the Pine Lake watershed to test their drinking water for nitrates and atrazine.	PLMD	WC UWEX State certified labs WEAL UWEX Groundwater Specialist	2015 and ongoing
Monitor water clarity (usually 5 times a summer). Connect with the CLMN Coordinator for Waushara County for training.	Interested citizen	CLMN Coordinator	Annually spring - fall
Monitor total phosphorus and chlorophyll-*a* during the summer.	Interested citizen	CLMN Coordinator	Annually – summer
Monitor inorganic nitrogen during spring overturn.	Interested citizen	State certified lab WEAL	Annually - spring
Monitor dissolved oxygen (DO) in late winter. Take readings every 2 feet. If DO is less than 3 mg/L in upper 5 feet of water, report to WDNR Fisheries Biologist.	Interested citizen	WCLCD WDNR Fisheries Biologist Local fishing club	Annually - winter
Conduct ice-on/ice-off monitoring.	Interested citizen	CLMN Coordinator	Annually spring and fall
Submit any monitored/collected data to WDNR.	Interested citizen PLMD	CLMN Coordinator WDNR SWIMS database	As needed
Work with County to install a groundwater monitoring well near Pine Lake to monitor groundwater levels over time.	PLMD	WCLCD	2016

Goal 7. Protect Pine Lake during times of low water.

Objective 7.1. Minimize impacts to Pine Lake during times of low water levels.

Actions	Lead person/group	Resources	Timeline
Inform shoreland property owners to refrain from the removal and disturbance of exposed vegetation and/or woody habitat (sticks, logs, etc.) from the exposed lakebed during times of low water.	PLMD	UWEX Lakes (educational material) WCWLC Municipalities (newsletters and websites)	As needed
Minimize disturbance to the lake bed during times of low water.	Shoreland property owners		As needed
Connect with other lake groups and organizations in the area focused on water level/groundwater issues in Central Wisconsin.	PLMD	Wisconsin Lakes UWEX Lakes WCWLC	Ongoing

Shorelands

Shoreland vegetation is critical to a healthy lake ecosystem. It provides habitat for many aquatic and terrestrial animals including birds, frogs, turtles, and small and large mammals. It also helps to improve the quality of the runoff that is flowing across the landscape towards the lake. Healthy shoreland vegetation includes a mix of unmowed grasses/flowers, shrubs, trees, and wetlands which extends at least 35 feet landward from the water's edge.

To better understand the health of the Waushara County lakes, shorelands were evaluated. The survey inventoried the type and extent of shoreland vegetation. Areas with erosion, rip-rap, barren ground, sea walls, structures and docks were also inventoried (Figure 1). A scoring system was developed for the collected data to provide a more holistic assessment. Areas that are healthy will need strategies to keep them healthy, and areas with potential problem areas and where management and conservation may be warranted may need strategies for improvement. The scoring system is based on the presence/absence and abundance of shoreline features, as well as their proximity to the water's edge. Values were tallied for each shoreline category and then summed to produce an overall score. Higher scores denote a healthier shoreline with good land management practices. These are areas where protection and/or conservation should be targeted. On the other hand, lower scores signify an ecologically unhealthy shoreline. These are areas where management and/or mitigation practices may be desirable for improving water quality and habitat.

Large portions of Pine Lake's shorelands are in good shape, but a few segments have challenges that should be addressed. One stretch of Pine Lake shoreland, along the southern shore, fell into the poorest category. The summary of scores for shorelands around Pine Lake is displayed on the map in Appendix C. Shoreland Survey – 2011.

Shoreland ordinances were enacted to improve water quality and habitat, and to protect our lakes. To protect our lakes, county and state (NR 115) shoreland ordinances state that vegetation should extend at least 35 feet inland from the water's edge, with the exception of an optional 30 foot access corridor for each shoreland lot. Villages can create their own ordinances for healthy vegetative shorelands, and state/county ordinances can be used as guidance to develop village ordinances. With a total of 49 lakefront lots, 1,470 feet (10%) of disturbed shoreland would be permitted as access corridors using the state/county ordinances. Based on the 2011 shoreland inventory, 30% (4,124 feet) of Pine Lake's shoreland was mowed to the water's edge. These areas provide minimal habitat and water quality benefits, so any improvements would be viewed as beneficial.

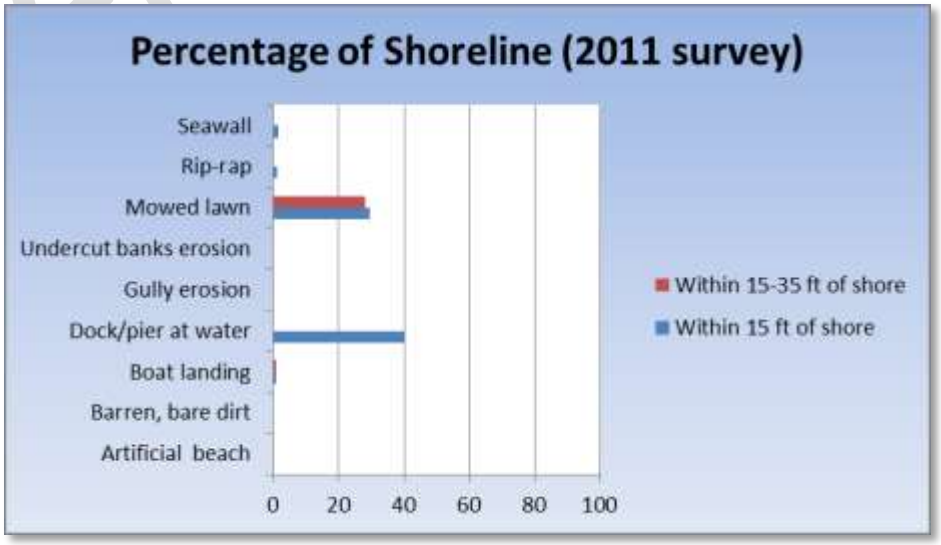


Figure 1. Percentage of shoreland with disturbances, 2011.

Guiding Vision for Pine Lake's Shorelands

Pine Lake will have shoreland that provides aesthetic beauty, water quality benefits and habitat.

Goal 8. Maintain and preserve healthy shoreland areas and encourage property owners to restore shorelands that need attention.

Approximately 25% (664 feet) of currently mowed shoreline will be restored over the next 5 years.

Objective 8.1. Restore approximately 664' (~25%) of unhealthy shoreline over the next 5 years.

Actions	Lead person/group	Resources	Timeline
Provide materials to property owners re: shoreland buffer vegetation in welcome packets, at the annual meeting, and on the website.	PLMD	WCLCD WDNR Healthy Shorelands grant	Ongoing
Maintain information and get assistance re: shoreland vegetation, help with restoration/plantings for interested property owners.	PLMD	WCLCD WDNR Healthy Shorelands grant Local incentives	Ongoing
Recognize property owners who maintain/restore shoreland vegetation.	PLMD	Wisconsin Lakes	Ongoing
Explore obtaining a grant to conduct a beginning phase of a demonstration shoreland restoration project. Continue project through stages if possible with grant/landowner permission.	PLMD	WCLCD WDNR Healthy Shorelands grant Local incentives Town of Hancock Village of Hancock	2016

Watershed Land Use

It is important to understand where Pine Lake's water originates in order to understand the lake's health. During snowmelt or rainstorms, water moves across the surface of the landscape (runoff) towards lower elevations such as lakes, streams, and wetlands. The land area that contributes runoff to a lake is called the surface watershed. Groundwater also feeds Pine Lake; its land area may be slightly different than the surface watershed.

The capacity of the landscape to shed or hold water and contribute or filter particles determines the amount of erosion that may occur, the amount of groundwater feeding a lake, and ultimately, the lake's water quality and quantity. Essentially, landscapes with greater capacities to hold water during rain events and snowmelt slow the delivery of the water to the lake. Less runoff is desirable because it allows more water to recharge the groundwater, which feeds the lake year-round - even during dry periods or when the lake is covered with ice.

A variety of land management practices can be put in place to help reduce impacts to our lakes. Some practices are designed to reduce runoff. These include protecting/restoring wetlands, installing rain gardens, swales, rain barrels, and routing drainage from pavement and roofs away from the lake. Some practices are used to help reduce nutrients from moving across the landscape towards the lake. Examples include manure management practices, eliminating/reducing the use of fertilizers, increasing the distance between the lake and a septic drainfield, protecting/restoring wetlands and native vegetation in the shoreland, and using erosion control practices.

The surface watershed of Pine Lake is approximately 5,667 acres. Primary land use is agriculture and forested land (Figure 2). The lake's shoreland is surrounded primarily by agriculture, developed land, and forest. In general, the land closest to the lake has the greatest immediate impact on water quality.

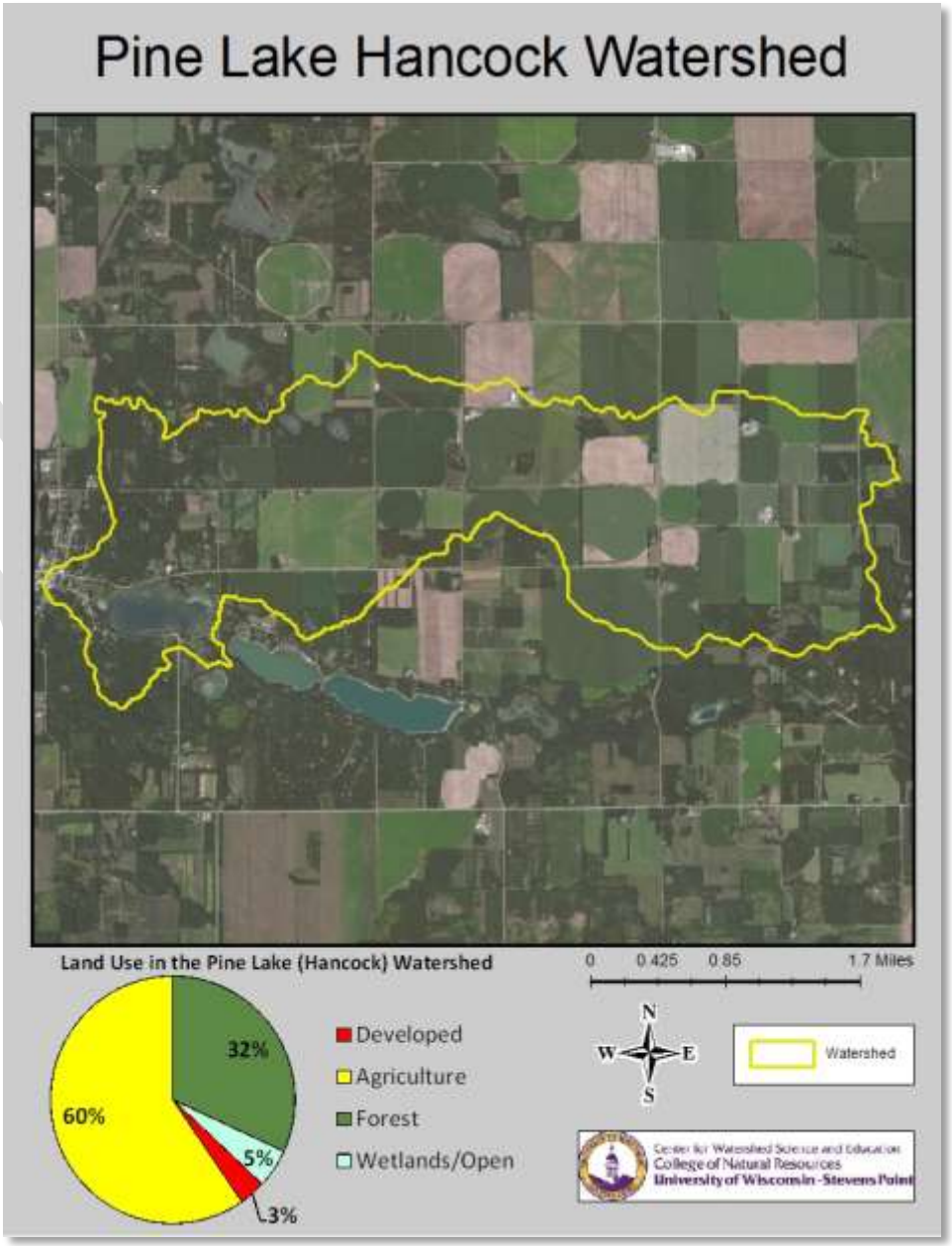


Figure 2. Surface watershed of Pine Lake.

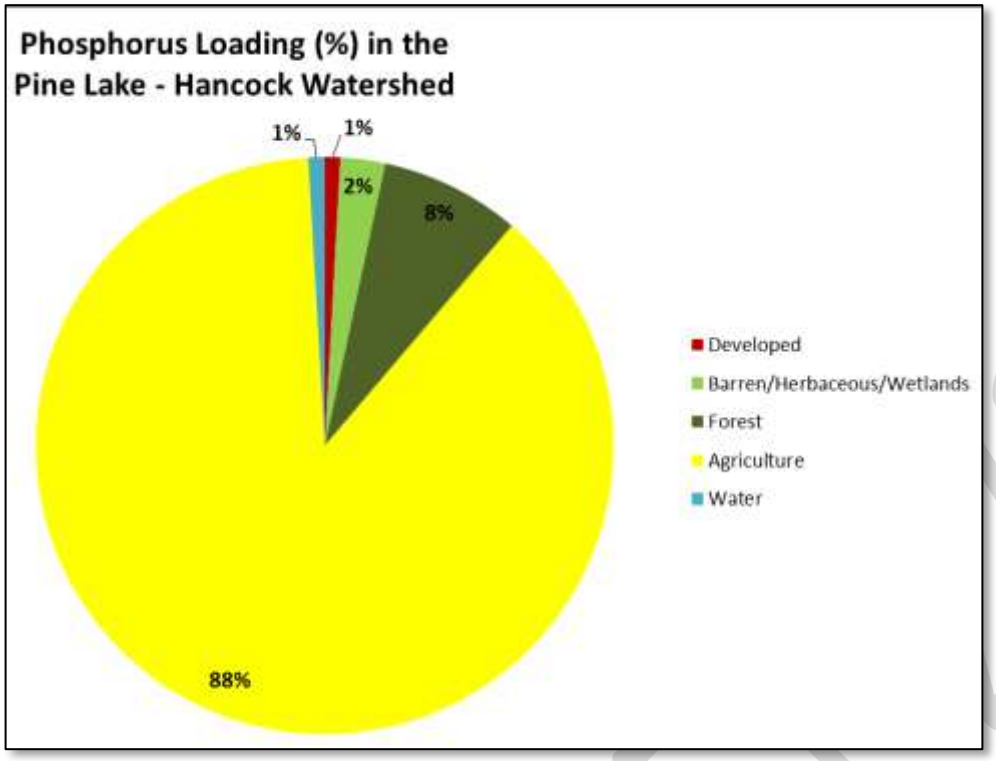


Figure 3. Estimated phosphorus loads from land uses in the Pine Lake watershed.

Estimates of phosphorus from the landscape can help to understand the phosphorus sources to Pine Lake. Land use in the surface watershed was evaluated and used to populate the Wisconsin Lakes Modeling Suite (WILMS) model. In general, each type of land use contributes different amounts of phosphorus in runoff and groundwater. The types of land management practices that are used and their distances from the lake also affect the contributions to the lake from a parcel of land. Based on modeling results, agriculture had the greatest percentage of phosphorus contributions from the watershed to Pine Lake (Figure 3). While modeling results indicated 88% of the phosphorus load entering the lake likely originates from agricultural sources within the watershed, the area closest to the lake can also help input phosphorus if shoreland properties contribute fertilizers, erosion, or septic seepage.

Guiding Vision for Pine Lake's Watershed

Land in the Pine Lake watershed will be managed in a way that supports clean water and a healthy lake.

Goal 9. Property owners and land managers in the Pine Lake watershed will understand how the can reduce impacts to Pine Lake and who to contact for assistance.

Objective 9.1. Provide support healthy land management activities in the Pine Lake watershed.

Actions	Lead person/group	Resources	Timeline
County will support and follow up with water quality-based Best Management Practices (BMPs) within the watershed, including strategies to reduce excess nitrogen leaching to groundwater.	WCLCD	NRCS DATCP WDNR Lake Protection grants	Ongoing
Continue to use WCLCD as a resource for land management activities.	Watershed land managers	WCLCD	As needed
Support any landowners interested in the protection of their land via a conservation program (i.e. conservation easement or purchase of development rights) by referring them WCLCD.	Interested property owners	GWC NCCT NRCS WDNR Lake Protection grants Knowles-Nelson Stewardship Funds	As needed

People and the Lake

The people who interact with the lake are a key component of the lake and its management. In essence, a lake management plan is a venue by which people decide how they would like people to positively impact the lake. The plan summarizes the decisions of the people to take proactive steps to improve their lake and their community. Individual decisions by lake residents and visitors can have a positive impact on the lake and on those who enjoy this common resource. Collaborative efforts may have a bigger positive impact; therefore, communication and cooperation between a lake district, community, and suite of lake users are essential to maximize the effects of plan implementation.

Boating hours, regulations, and fishing limits are examples of principles that are put into place to minimize conflicts between lake users and balance human activities with environmental considerations for the lake.

Recreation

The lake is enjoyed year-round. Depending on the season, activities include swimming, boating, fishing, ice skating, and appreciating the lake's beauty and peace. Pine Lake provides a place for family to be together, enjoy nature, and create and reminisce about memories. The views, scents, and sounds were noted as important experiences to the people of Pine Lake.

There are two public accesses to the lake. A boat launch on the eastern side of the lake is owned by the Town of Hancock, and a carry-in canoe launch on the northern end is owned by the Village of Hancock. Pine Lake is a 'no wake' lake. The majority of 17 survey respondents and planning session participants prefer that Pine Lake remain 'no wake'.

Guiding Vision for Recreation

Pine Lake will remain a peaceful, quiet respite to enjoy alone, with family, and friends.
The lake will provide swimming, fishing and other recreational opportunities with limited noise and boat activity.

Goal 10. Maintain the no-wake status on Pine Lake a no-wake lake, and encourage visitors and residents to abide by boating rules.

Objective 10.1. Explore enforcement options for boating rules.

Actions	Lead person/group	Resources	Timeline
Contact the county or WDNR Conservation warden with concerns regarding compliance with boating regulations.	PLMD	County Sheriff WDNR Conservation Warden (See Appendix A)	Ongoing

Communication and Organization

Many of the goals outlined in this plan focus on distributing information to lake and watershed residents and lake users in order to help them make informed decisions that will result in a healthy ecosystem in Pine Lake enjoyed by many people. Working together on common values will help to achieve the goals outlined in this plan.

At the time of plan formation, Pine Lake had formed a Lake District the prior year. Previously, the organizations involved with Pine Lake included the Pine Lake Association and the Village of Hancock.

Guiding Vision for Communication

Communications related to the health of Pine Lake will occur within the District as well as with the community.

Goal 11. Pine Lake Management District members will be informed about lake health and activities to learn about and provide input for lake management.

Objective 11.1. Provide opportunities for members of the Lake District to stay informed.

Actions	Lead person/group	Resources	Timeline
Develop and maintain ways to communicate with PLMD members (email list, website, mailing list, etc.).	PLMD	UWEX Lakes	2016
Host an annual meeting to inform and hear from membership.	PLMD		Annually
Continue the distribution of a welcome packet to all new and current residents of Pine Lake via the WCWLC.	WC	WCWLC UWEX (educational materials)	Ongoing

Objective 11.2. Communication will occur with others with a vested interest in the lake.

Actions	Lead person/group	Resources	Timeline
Learn about lake-related topics in Waushara County by sending a PLMD representative to WCWLC.	PLMD	WCWLC	Ongoing
Meet with elected officials from local municipalities to keep them up to date with Pine Lake management efforts and any concerns.	PLMD	Towns and Village	Annually or as needed
Inform members about opportunities offered statewide such as the annual Wisconsin Lakes Convention and semi-annual Lake Leaders Institute.	PLMD	WCWLC UWEX Lakes	Annually

Updates and Revisions

A management plan is a living document that changes over time to meet the current needs, challenges and desires of the lake and its community. The goals, objectives and actions listed in this plan should be reviewed annually and updated with any necessary changes.

Guiding Vision for Updates and Revisions

Pine Lake will have a regularly updated plan in place to adaptively protect and improve lake health.

Goal 12. LMP will be up to date by reviewing annually and updating every 5 years.

Objective 12.1. Receive input from and communicate updates with community members.

Actions	Lead person/group	Resources	Timeline
Review the LMP at the annual meeting to celebrate achievements and plan for the upcoming year.	PLMD	WDNR Waushara County Towns of Hancock and Deerfield Village of Hancock	Annually
Inform those that have adopted this LMP of proposed changes.	PLMD	WDNR Waushara County Towns of Hancock and Deerfield Village of Hancock	As needed

Governance

Written by Patrick Nehring, Community Agent, UW-Extension Waushara County.

Lake Management Plan Approval

The draft lake management plan will be completed by the lake association/district board, a committee, or a committee of the whole. The final draft of the lake management plan will be approved through a vote of the lake association/district membership or board. The final draft will be approved by the Wisconsin Department of Natural Resources (DNR) to have met the lake management plan requirements and grant requirements. If the DNR requires modifications or additional information before approving the plan, the plan will be changed to meet DNR requirements that are acceptable to the lake association/district. The completed plan that has been approved by the lake association/district and the DNR will be presented to the municipalities containing the lake and Waushara County. The municipality may reference the lake management plan or parts of the plan in their comprehensive plan to guide municipal or county decisions.

Lake Assistance

The lake management plan will enhance the ability of the lake to apply for financial assistance. The lake management plan will be considered as part of the application for grants through the Wisconsin Department of Natural Resources. Current listings of grants available from the DNR can be found at http://dnr.wi.gov/aid/. Waushara County offers technical and financial assistance through the Land Conservation and Zoning Department and University of Wisconsin-Extension Department. Additional assistance may be available from other agencies and organizations, including DNR, UW-Extension Lakes Program, Golden Sands RC&D, Wisconsin Wetlands Association, and Wisconsin Trout Unlimited.

Lake Regulations

The lake management plan is superseded by federal, state, county, and municipal laws and court rulings. However, the lake management plan may influence county and municipal ordinances and enforcement, which is why the lake management plan will be reviewed and included or referenced in the county and related municipal comprehensive plans. Federal laws contain regulations related to water quality, wetlands, dredging, and filling. State laws contain regulations related to water quality, water and lake use, aquatic plants and animals, shoreline vegetation, safety, and development. County laws contain regulations related to development, safety, use, and aquatic plants and animals. Municipal laws contain regulation of use and safety. The court system interprets these rules and regulations. The rules and regulations are primarily enforced by the US Army Corps of Engineers, the Wisconsin Department of Natural Resources, the Waushara County Sheriff Department, and the Waushara County Land Conservation and Zoning Office. If considering development near or on a lake, addressing problem plants or animals, or changing the lake bottom contact the Waushara County Land Conservation & Zoning Department at the Waushara County Courthouse (920) 787-0443 and/or the Wisconsin Department of Natural Resources (888) 936-7463.

Comprehensive Plans

The lake management plan and changes to the plan will be presented to the County and the Municipality for review and possible incorporation into their comprehensive plans. The comprehensive plan is intended to be used to guide future decision. Zoning, subdivision, and official mapping decisions must be consistent with the comprehensive plan.

Process for Inclusion in the Municipal Comprehensive Plan

The Municipal Plan Commission will review the lake management plan to determine if it is consistent with the municipality's comprehensive plan. If the lake management plan is found by the Municipal Plan Commission to not be consistent with the municipality's comprehensive plan, the plan commission may (a) recommend changes to the comprehensive plan or (b) ask that an aspect of the lake management plan be revisited. When the Municipal Plan Commission has reached a consensus that the lake management plan aligns with the municipality's vision, the Municipal Plan Commission will develop an amendment to the comprehensive plan referencing the lake management plan. This could include a reference to the lake management plan under local policies in the agricultural, natural and cultural resources background information and the addition of a recommendation to support the lake management plan and to implement the applicable recommendations contained in the lake management. The Municipal Plan Commission will recommend by resolution that the amendment to the comprehensive plan be adopted by the Municipal Board. A public hearing on the changes to the comprehensive plan will be held with a thirty-day class one notice. The Municipal Board will consider the recommendations from the Municipal Plan Commission. The Municipal Board may (a) adopt the recommendations to the comprehensive plan by ordinance, (b) adopt by ordinance the recommendations with changes, or (c) request the plan commission revisit the changes to the comprehensive plan.

Process for Inclusion in the County Comprehensive Plan

Waushara County Land Use Committee will review the updates to the municipality's comprehensive plan and the lake management plan as referenced by the municipality's comprehensive plan to determine if they are consistent with the County's comprehensive plan. If they are found by the land use committee to not be consistent with the municipality's comprehensive plan, the land use committee may (a) recommend changes to the County's comprehensive plan or (b) ask that an aspect of the lake management plan or municipality's comprehensive plan be revisited. When the Land Use Committee has reached a consensus that the updates to the municipality's comprehensive plan and the lake management plan aligns with the county's vision, and if it is not already consistent, it will develop an amendment to the County's comprehensive plan. The amendment may be include a reference to the lake management plan under local policies in the agricultural, natural and cultural resources background information and the addition of a recommendation to support the lake management plan and to implement the applicable recommendations contained in the lake management. The Land Use Committee will recommend the amendment to the comprehensive plan to the Land, Water, and Education Committee.

The Land, Water, and Education Committee will review the amendment and if it concurs with the recommendation from the Land Use Committee, it will make a recommendation to the Planning & Zoning Committee. The Planning & Zoning Committee will hold a public hearing with a thirty-day class one

notice. The Planning & Zoning Committee will recommend by resolution the amendment to the comprehensive plan or the amendment with changes be adopted by the County Board.

The County Board will consider the recommendations from the Planning & Zoning Committee. The County Board may (a) adopt the amendment to the comprehensive plan by ordinance, (b) adopt the amendment with changes, or (c) request the Land Use Committee or Planning & Zoning Committee revisit the changes to the comprehensive plan.

Use of the Comprehensive Plan

The lake management plans as referenced in the comprehensive plans will be used by the County and the Municipality to consider certain actions or in the implementation of zoning and other applicable regulations. The County Board of Adjustments and the County Planning and Zoning Committee may reference the lake management plans as referenced in the comprehensive plan when considering zone changes, variances, conditional uses, and suitable mitigation measures. The Municipality and County may take action as called for in the lake management plan as referenced in the comprehensive plan, including changes to zoning and other applicable regulations, shortly after the County's comprehensive plan has been updated or may take action as needed.

The lake organization, lake residents, riparian property owners, or other citizens may request that the Municipality or County take a specific action to implement aspects of the lake management plan as referenced in the comprehensive plan. The lake organization lake residents, riparian property owners, or other citizens may provide written or oral support to encourage the Municipality and County to reference the lake management plan when considering regulation or action that may impact the lake. The lake organization will inform the Municipality and the County when the lake management plan is updated and allow the Municipality and County an opportunity to participate in the update process.

References

Bartz, David, 2014. Fisheries of Fish and Pine Lakes. Presentation given at the Hancock Community Center on July 22, 2014.

Boat Ed, 2013. The Handbook of Wisconsin Boating Laws and Responsibilities. Approved by Wisconsin Department of Natural Resources. www.boat-ed.com

Borman, Susan, Robert Korth, and Jo Temte, 2001. Through the looking glass, a field guide to aquatic plants. Reindl Printing, Inc. Merrill, Wisconsin.

Haney, Ryan, 2014. Water Quality in Fish and Pine Lakes. Presentation given at the Hancock Community Center on August 21, 2014.

Hayes, T., K. Haston, M. Tsui, A. Hoang, C. Haeffele and A. Vonk. 2003. *Atrazine-Induced Hermaphroditism at 0.1 PPB in American Leopard Frogs (Rana pipiens): Laboratory and Field Evidence*. Environmental Health Perspectives 111: 568-575.

Hayes, T.K. A. Collins, M, L,, Magdelena Mendoza, N. Noriega, A. A. Stuart, and A. Vonk. 2001. *Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses*. National Academy of Sciences vol. 99 no. 8, 5476–5480.

Kraft, George, 2014. Groundwater Pumping and Lake Water Levels. Presentation given at the Hancock Community Center on September 23, 2014.

Panuska and Lillie, 1995. Phosphorus Loadings from Wisconsin Watershed: Recommended Phosphorus Export Coefficients for Agricultural and Forested Watersheds. Bulletin Number 38, Bureau of Research, Wisconsin Department of Natural Resources.

Shaw, B., C. Mechenich, and L. Klessig, 2000. *Understanding Lake Data*. University of Wisconsin-Extension, Stevens Point. 20 pp.

Stushek, Kaycie, 2014. AIS in Fish and Pine Lakes. Presentation given at the Hancock Community Center on September 23, 2014.

Turyk, Nancy, 2014. Healthy Land = Healthy Water. Presentation given at the Hancock Community Center on August 21, 2014.

Turyk, Nancy, 2014. The Aquatic Plants of Fish and Pine Lakes. Presentation given at the Hancock Community Center on September 23, 2014.

UW-Stevens Point Center for Watershed Science and Education, 2014. Waushara County Lake Study - Pine Lake 2010-2012. Final Report to Waushara County and Wisconsin Department of Natural Resources.

UW-Stevens Point Center for Watershed Science and Education, 2013. Waushara County Lake Study - Pine Lake 2010-2012 Mini-Report. Report to Waushara County and Wisconsin Department of Natural Resources. Planning Meeting Presentations

Vallentyne, J.R., 1974. The Algal Bowl-Lakes and Man. Ottawa Department of the Environment.

Wetzel, R.G., 2001. Limnology, Lake and River Ecosystems, Third Edition. Academic Press. San Diego, California.

Appendices

Appendix A. Waushara County Lakes Information Directory

Algae - Blue-Green

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/lakes/bluegreenalgae/

Contact: Wisconsin Department of Health Services
1 West Wilson Street, Madison, WI 53703
Phone: 608-267-3242
Website:
http://www.dhs.wisconsin.gov/eh/bluegreenalgae/contactus.htm

Aquatic Invasive Species/Clean Boats Clean Water

Contact: Golden Sands RC&D
1100 Main St., Suite 150, Stevens Point, WI 54481
Phone: 715-343-6215
Websites: www.goldensandsrcd.org
http://dnr.wi.gov/invasives/

Aquatic Plant Management (Native and Invasive)

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/lakes/plants/

Aquatic Plant Identification

Contact: Golden Sands RC&D
1100 Main St., Suite 150, Stevens Point, WI 54481
Phone: 715-343-6215
Website: www.goldensandsrcd.org

Contact: Dr. Emmet Judziewicz
UWSP Freckmann Herbarium
TNR 301, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-4248
E-mail: ejudziew@uwsp.edu

Aquatic Plant Identification (cont'd)

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov

Aquatic Plant Surveys/Management

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/lakes/plants/

Best Management Practices (rain gardens, shoreland buffers, agricultural practices, runoff controls)

Contact: Ed Hernandez
Waushara County Land Conservation Department
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Boat Landings, Signage, Permissions (County)

Contact: Scott Schuman
Waushara County Parks
PO Box 300, Wautoma, WI 54982
Phone: 920-787-7037
E-mail: wcparks.parks@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/parks.htm

Boat Landings (State)

Contact: Dave Bartz
Wisconsin Department of Natural Resources
Hwy 22N, Box 430, Montello, WI 53949
Phone: 608-635-4989
E-mail: David.Bartz@wisconsin.gov
Website:
http://dnr.wi.gov/org/land/facilities/boataccess/

Boat Landings (Town)

Contact the clerk for the specific town/village in which the boat landing is located.

Citizen Lake Monitoring Network

Contact: Brenda Nordin, Wisconsin Department of Natural Resources
Phone: 920-662-5141
E-mail: brenda.nordin@wisconsin.gov

Conservation Easements

Contact: Gathering Waters Conservancy
211 S. Paterson St., Suite 270, Madison, WI 53703
Phone: 608-251-9131
E-mail: info@gatheringwaters.org
Website: http://gatheringwaters.org/

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov

Contact: Patrick Sorge
Wisconsin Department of Natural Resources
PO Box 4001, Eau Claire, WI 54702
Phone: 715-839-3794
E-mail: Patrick.Sorge@wisconsin.gov

Contact: North Central Conservancy Trust
PO Box 124, Stevens Point, WI 54481
Phone: 715-344-1910
E-mail: info@ncctwi.org
Website: http://www.ncctwi.org/

Contact: NRCS Stevens Point Service Center
1462 Strongs Ave., Stevens Point, WI 54481
Phone: 715-346-1325

Critical Habitat and Sensitive Areas

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/lakes/criticalhabitat/

Dams

Contact: Joe Behlen
Wisconsin Department of Natural Resources
473 Griffith Ave., Wisconsin Rapids, WI 54494
Phone: 715-421-9940
E-mail: joseph.behlen@wisconsin.gov
Website: http://dnr.wi.gov/org/water/wm/dsfm/dams/

Enforcement (boating, fishing, etc.)

Contact: Jeff Nett
Waushara County Sheriff
Phone: 920-787-3321

Contact: Ben Mott
Conservation Warden
Wisconsin Department of Natural Resources
Phone: 920-896-3383

Fertilizers/Soil Testing

Contact: Ken Williams
Waushara County UW- Extension
209 S St. Marie St, PO Box 487, Wautoma, WI 54982
Phone: 920-787-0416
E-mail: ken.williams@ces.uwex.edu
Website:
http://waushara.uwex.edu/agriculture/services

Fisheries Biologist (management, habitat)

Contact: Dave Bartz
Wisconsin Department of Natural Resources
Hwy 22N, Box 430, Montello, WI 53949
Phone: 608-635-4989
E-mail: David.Bartz@wisconsin.gov
Website: http://dnr.wi.gov/fish/

Frog Monitoring—Citizen Based

Contact: Andrew Badje
Wisconsin Department of Natural Resources
Phone: 608-266-3336
E-mail: Andrew.badje@wisconsin.gov
E-mail: WFTS@wisconsin.gov

Grants

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/Aid/Grants.html#tabx8

Contact: Ed Hernandez
Waushara County Land Conservation Department
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Groundwater Quality

Contact: Kevin Masarik
UWSP Center for Watershed Science & Education
TNR 224, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-4276
E-mail: kmasarik@uwsp.edu
Website: http://www.uwsp.edu/cnr/watersheds/

Groundwater Levels/Quantity

Contact: Ed Hernandez
Waushara County Land Conservation Department
Address: PO Box 1109 Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us

Contact: George Kraft
UWSP Center for Watershed Science & Education
TNR 224, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-2984
E-mail: george.kraft@uwsp.edu

Contact: Scott Provost
Wisconsin Department of Natural Resources
473 Griffith Ave., Wisconsin Rapids, WI 54494
Phone: 715-421-7881
E-mail: scott.provost@wisconsin.gov
Website:
http://prodoasext.dnr.wi.gov/inter1/hicap$.startup

Informational Packets

Contact: UWSP Center for Watershed Science & Education
TNR 224, 800 Reserve St. Stevens Point, WI 54481
Phone: 715-346-2497
E-mail: pclakes@uwsp.edu

Lake Groups – Friends, Associations, Districts

Contact: Patrick Nehring
UWEX Economic Resource Development Agent
PO Box 487, Wautoma, WI 54982
Phone: 920-787-0416
E-mail: Patrick.nehring@ces.uwex.edu

Lake Groups – Friends, Associations, Districts (cont'd)

Contact: Patrick Goggin
UWEX Lakes
TNR 203, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-365-8943
E-mail: pgoggin@uwsp.edu
Website:
http://www.uwsp.edu/cnr/uwexlakes/organizations/

Contact: Eric Olson
UWEX Lakes
TNR 206, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-2192
E-mail: eolson@uwsp.edu
Website:
http://www.uwsp.edu/cnr/uwexlakes/organizations/

Contact: Susan Tesarik
Wisconsin Lakes
4513 Vernon Blvd., Suite 101, Madison, WI 53705
Phone: 1-800-542-5253
E-mail: lakeinfo@wisconsinlakes.org
Website: http://wisconsinlakes.org/

Lake Levels

See: Groundwater

Lake-Related Law Enforcement (no-wake, transporting invasives, etc.)

Contact: Ben Mott
State Conservation Warden
Wisconsin Department of Natural Resources
427 E. Tower Drive, Suite 100, Wautoma, WI 54982
Phone: 920-896-3383
Website: http://www.wigamewarden.com/

Land Use Plans and Zoning Ordinances

Contact: Terri Dopp-Paukstat
Waushara County Planning and Zoning
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Land Use Plans and Zoning Ordinances (cont'd)

Contact: UWSP Center for Land Use Education
TNR 208, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-3783
E-mail: Center.for.Land.Use.Education@uwsp.edu
Website: http://www.uwsp.edu/cnr/landcenter/

Nutrient Management Plans

Contact: Ed Hernandez
Waushara County Land Conservation Department
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Contact: NRCS Stevens Point Service Center
1462 Strongs Ave., Stevens Point, WI 54481
Phone: 715-346-1325

Parks (County)

Contact: Scott Schuman
Waushara County Parks
PO Box 300, Wautoma, WI 54982
Phone: 920-787-7037
E-mail: wcparks.parks@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/parks.htm

Purchase of Development Rights

Contact: North Central Conservancy Trust
PO Box 124, Stevens Point, WI 54481
Phone: 715-341-7741
E-mail: info@ncctwi.org
Website: http://www.ncctwi.org/

Purchase of Land

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov
Website: http://dnr.wi.gov/topic/stewardship/

Rain Barrels – Order

Contact: Golden Sands RC&D
1100 Main St., Suite 150, Stevens Point, WI 54481
Phone: 715-343-6215
Website: http://www.goldensandsrcd.org/store

Rain Gardens and Stormwater Runoff

Contact: Ed Hernandez
Waushara County Land Conservation Department
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Septic Systems/Onsite Waste

Contact: Terri Dopp-Paukstat
Waushara County Planning and Zoning
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Shoreland Management

Contact: Ed Hernandez
Waushara County Land Conservation Department
PO Box 1109, Wautoma, WI 54982
Phone: 920-787-0453
E-mail: lcdzoning.courthouse@co.waushara.wi.us
Website: http://www.co.waushara.wi.us/zoning.htm

Shoreland Vegetation

http://dnr.wi.gov/topic/ShorelandZoning/

Shoreland Zoning Ordinances

See: Land Use Plans and Zoning Ordinances

Soil Fertility Testing

Contact: Ken Williams
Waushara County UW- Extension
209 S St. Marie St, PO Box 487, Wautoma, WI 54982
Phone: 920-787-0416
E-mail: Ken.williams@ces.uwex.edu
Website: http://waushara.uwex.edu/index.html

Water Quality Monitoring

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov

Water Quality Problems

Contact: Ted Johnson
Wisconsin Department of Natural Resources
Phone: 920-424-2104
E-mail: TedM.Johnson@wisconsin.gov

Contact: Nancy Turyk
UWSP Center for Watershed Science and Education
TNR 216, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-4155
E-mail: nturyk@uwsp.edu

Wetlands

Contact: Keith Patrick
Wisconsin Department of Natural Resources
5301 Rib Mountain Drive, Wausau, WI 54401
Phone: 715-241-7502
E-mail: keith.patrick@wisconsin.gov
Website: http://dnr.wi.gov/wetlands/

Contact: Wisconsin Wetlands Association
214 N. Hamilton Street, #201, Madison, WI 53703
Phone: 608-250-9971
Email: info@wisconsinwetlands.org

Wetland Inventory

Contact: Dr. Emmet Judziewicz
UWSP Freckmann Herbarium
TNR 301, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-4248
E-mail: ejudziew@uwsp.edu

Woody Habitat

Contact: Dave Bartz
Wisconsin Department of Natural Resources
Phone: 608-635-4989
Address: Hwy 22N Box 430, Montello, WI 53949
E-mail: David.Bartz@wisconsin.gov

If you are looking for any information that is not listed in this directory, please contact:
Ryan Haney (wclakes@uwsp.edu)
UWSP Center for Watershed Science and Education
TNR 224, 800 Reserve St., Stevens Point, WI 54481
Phone: 715-346-2497

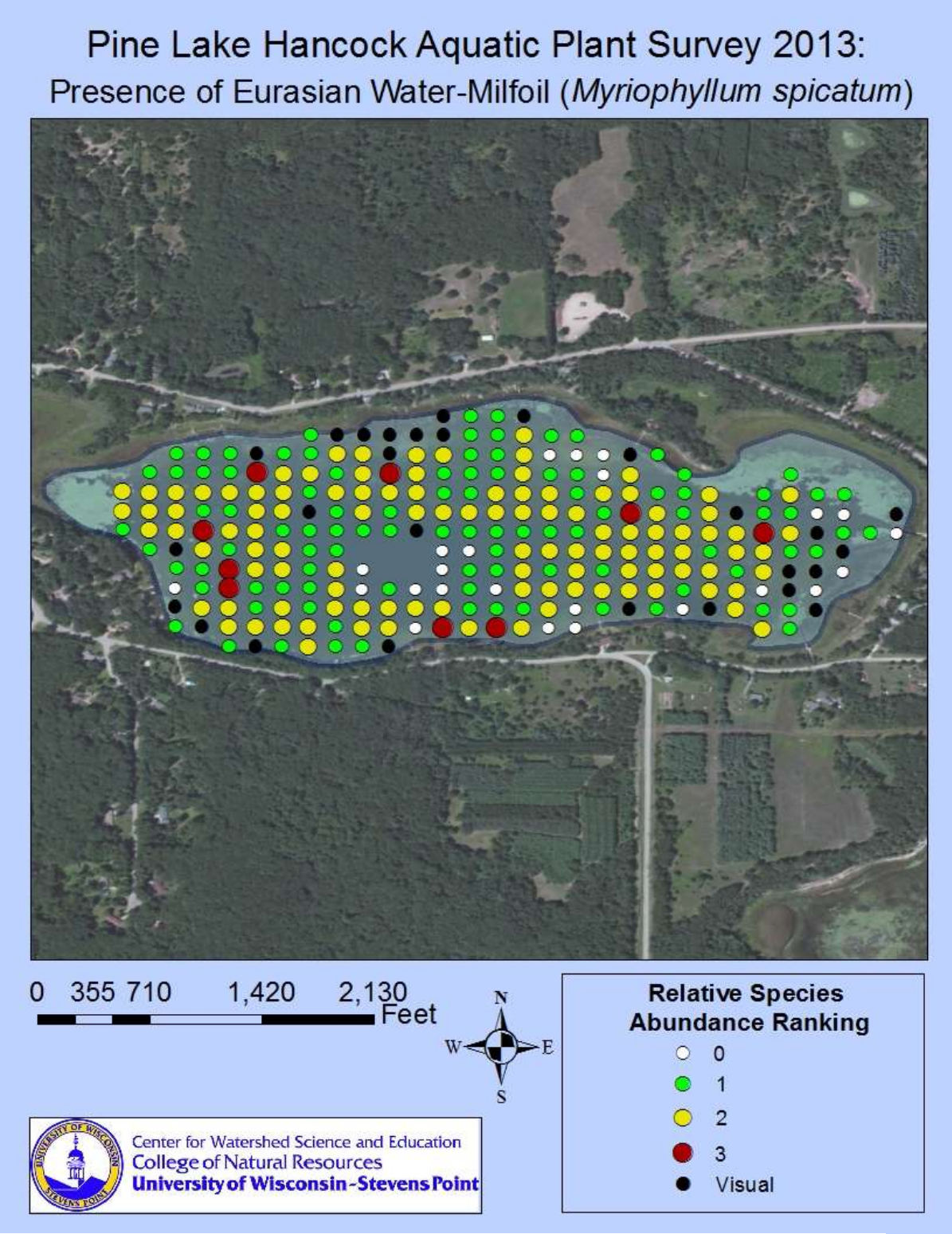
Appendix B. Aquatic Plants

Pine Lake-Hancock aquatic plant survey summary, 2013.

	Lake Average	Statewide Average	North Central Hardwood Forests Ecoregion Average
Littoral Frequency of Occurrence (%)	96.95	74.3	76
Maximum Depth of Plant Growth (ft)	13.25	15.3	15.9
Species Richness (Including visuals)	23	16.8	16.2
Floristic Quality Index (FQI)	27.1	24.1	23.3

Frequency of occurrence of aquatic plant species observed in Pine Lake-Hancock, 2013.

Scientific Name	Common Name	Coefficient of Conservatism Value (C Value)	2013 % Frequency of Occurrence
Emergent Species			
Nymphaea odorata	White water lily	6	5.12
Typha angustifolium	Narrow-leaved cattail	1	0.39
Submergent Species			
Myriophyllum spicatum	Eurasian water-milfoil	0	83.86
Chara	Muskgrasses	7	35.83
Stuckenia pectinata	Sago pondweed	3	27.17
Najas flexilis	Slender naiad	6	11.02
Najas guadalupensis	Southern naiad	8	9.06
Potamogeton gramineus	Variable pondweed	7	5.91
Potamogeton strictifolius	Stiff pondweed	8	5.91
Potamogeton zosteriformis	Flat-stem pondweed	6	5.91
Myriophyllum sibiricum	Northern water-milfoil	6	5.51
Potamogeton illinoensis	Illinois pondweed	6	5.51
Utricularia vulgaris	Common bladderwort	7	3.94
Potamogeton foliosus	Leafy pondweed	6	1.18
Potamogeton friesii	Fries' pondweed	8	0.79
Schoenoplectus acutus	Hardstem bulrush	6	0.79
Ceratophyllum demersum	Coontail	3	0.39
Nitella	Nitella	7	0.39
Nuphar variegata	Spatterdock	6	0.39
Potamogeton amplifolius	Large-leaf pondweed	7	0.39
Potamogeton pusillus	Small pondweed	7	0.39



Occurrences of Eurasian watermilfoil in Pine Lake, 2013.

Wisconsin Department of Natural Resources

January 2012

2,4-D Chemical Fact Sheet

Formulations

2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-964 2012

General recommendations:

- Reduce nutrients traveling to the lake from the landscape.
- Avoid increasing algal blooms by maintaining a healthy amount of aquatic plants.
- Don't denude the lakebed.
    - Increases potential for aquatic invasive species establishment.
    - Sediments can add phosphorus to the water which may lead to increased algal growth.
- Choose options that are appropriate for your lake's situation.
- Monitor and adjust your strategies if you are not making headway!

List of Aquatic Plant Management Options (selection of options varies with situation):

No Action

ADVANTAGES	LIMITATIONS
∗ No associated cost. ∗ Least disruptive to lake ecosystem.	∗ May not be effective in achieving aquatic plant management objectives.

Hand Pulling

ADVANTAGES	LIMITATIONS
∗ Can be used for thinning aquatic plants around docks. ∗ Can target specific plants - with proper training. ∗ Can be effective in controlling small infestations of aquatic invasive species. ∗ No associated cost.	∗ Removes near-shore wildlife and fish habitat. ∗ Opens up areas where invasives to become established. ∗ If aquatic invasive species are not pulled properly, could worsen the problem.

Hand Pulling Using Suction

ADVANTAGES	LIMITATIONS
∗ Can be used for thinning plants around docks. ∗ Can be used in deeper areas (with divers). ∗ Can target specific plants with proper training. ∗ Can be effective in controlling small infestations of aquatic invasive species. ∗ May be useful in helping to remove upper root mass of aquatic invasive species.	∗ Costs associated with hiring a diver may be comparable to chemical treatment expenses. ∗ Currently an experimental treatment – not readily available. ∗ If aquatic invasive species are not pulled properly, could worsen the problem.

Mechanical Harvesting

ADVANTAGES	LIMITATIONS
∗ Removes plant material and nutrients. ∗ Can target specific locations. ∗ Used to manage larger areas for recreational access or fishery management.	∗ Not used in water depths less than 3 feet. ∗ Some harm to aquatic organisms. ∗ Is a temporary control. ∗ Risk of introduction of new aquatic invasive species (on a hired harvester) or spread of some existing invasive species. ∗ Hired cost at least $150/hr.

Water Level Manipulation

ADVANTAGES	LIMITATIONS
∗ Controls aquatic plants in shallower, near-shore areas. ∗ Can be low cost.	∗ Requires a controlling structure on the lake. ∗ May cause undesired stress on ecosystem. ∗ Cannot be used frequently.

Milfoil Weevils

ADVANTAGES	LIMITATIONS
∗ Natural, native maintenance of native and exotic milfoils. ∗ Prefers the aquatic invasive Eurasian Watermilfoil. ∗ Some lakes may already have a native populations; need a professional stem count and assessment of shoreland health, structure of fishery, etc. ∗ Doesn't harm lake ecosystem.	∗ Require healthy shoreline habitat for overwintering. ∗ Cannot survive in areas of mechanical harvesting or herbicide application. ∗ Effectiveness highly variable between lakes (only works well for some lakes). ∗ Limited access to weevils for purchase in WI. ∗ Still considered experimental.

Chemical Treatment: Spot

ADVANTAGES	LIMITATIONS
∗ May be less destructive to lake ecosystem than lake-wide treatment.	∗ Only considered in lakes with aquatic invasive plants. ∗ Usually not fully effective in eradicating target species. ∗ Contaminants may remain in sediment. ∗ Effects on lake ecosystem not fully understood. ∗ Does not remove dead vegetation, which depletes oxygen, releases nutrients, adds to muck build-up. ∗ Extra nutrients may spur additional aquatic plant and algae growth.

Chemical Treatment: Lake-wide

ADVANTAGES	LIMITATIONS
∗ May reduce aquatic invasives for a time. ∗ Treatment not needed as frequently.	∗ Only considered in lakes with AIS. ∗ Usually not fully effective in eradicating target species. ∗ Contaminants may remain in sediment. ∗ Does not remove dead vegetation, which depletes oxygen and releases nutrients, adds to build-up of muck. ∗ Extra nutrients may spur additional aquatic plant and algae growth. ∗ Negatively affects native vegetation. ∗ Effects on lake ecosystem not fully understood. ∗ Opens up space once taken up by natives for invasive species to colonize once again. ∗ ~$4000 per 5 acres.

Appendix C. Shoreland Survey – 2011

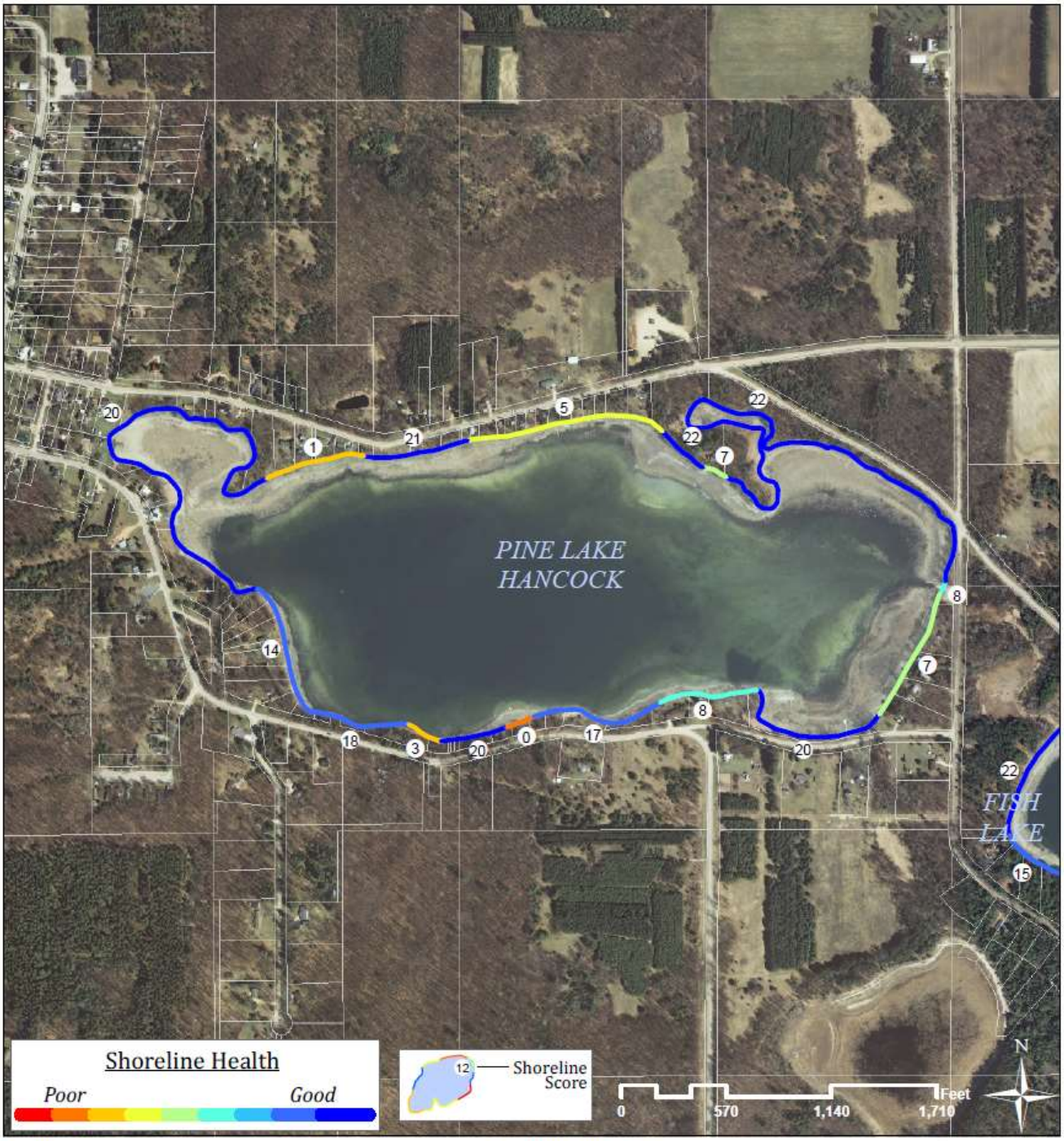
A scoring system was developed for the collected data to provide a more holistic assessment. Areas that are healthy will need strategies to keep them healthy, and areas with potential problem areas and where management and conservation may be warranted may need a different set of strategies for improvement. The scoring system is based on the presence/absence and abundance of shoreline features, as well as their proximity to the water's edge. Values were tallied for each shoreline category and then summed to produce an overall score. Higher scores denote a healthier shoreline with good land management practices. These are areas where protection and/or conservation should be targeted. On the other hand, lower scores signify an ecologically unhealthy shoreline. These are areas where management and/or mitigation practices may be desirable for improving water quality.

The summary of scores for shorelands around Pine Lake are displayed in the figure on the next page. The shorelands were color-coded to show their overall health based on natural and physical characteristics. Blue shorelands identify healthy shorelands with sufficient vegetation and few disturbances. Red shorelands indicate locations where changes in management or mitigation may be warranted. Large portions of Pine Lake's shorelands are in good shape, but a few segments have challenges that should be addressed. One stretch of Pine Lake shoreland, along the southern shore, fell into the poorest category. For a more complete understanding of the ranking, an interactive map showing results of the shoreland surveys can be found on Waushara County's website at http://gis.co.waushara.wi.us/ShorelineViewer/.

Map Date -- July, 2011
Aerial Date -- April, 2010

Waushara County Shoreline Assessment

PINE LAKE



Summary

Shorelines are color-coded to show their overall health based on natural and physical characteristics. For example, shorelines shown in red indicate locations where management or mitigation may be warrented. Blue shorelines mark healthy riparian areas with natural vegetation and few human influences.

Calculating Shoreline Scores

Scores are based on the presence/absence of:

+ Natural vegetation
+ Human influences (docks, boathouses, etc)
+ Erosion
+ Structures

Center for Land Use Education

Map created by Dan McFarlane
Center for Land Use Education

Appendix D. Rapid Response Plan

SURVEY/MONITOR

1. Learn how to survey/monitor the lake.	**Contacts:** **Water Resource Management Specialist** Wisconsin Department of Natural Resources Phone: 920-424-2104 E-Mail: TedM.Johnson@wisconsin.gov **Regional Aquatic Invasive Species (AIS) Coordinator** Golden Sands RC&D 1100 Main St., Suite #150 Stevens Point, WI 54481 Phone: 715-343-6278 E-Mail: info@goldensandsrcd.org
2. Survey/monitor the lake monthly/seasonally/annually.	If you find a suspected invasive species, report it as soon as possible using the procedure below.

REPORTING A SUSPECTED INVASIVE SPECIES

1. Collect specimens or take photos. Regardless of the method used, provide as much information as possible. Try to include flowers, seeds or fruit, buds, full leaves, stems, roots and other distinctive features. In photos, place a coin, pencil or ruler for scale. Deliver or send specimen ASAP.	Collect, press and dry a complete sample. This method is best because a plant expert can then examine the specimen. **-OR-** Collect a fresh sample. Enclose in a plastic bag with a moist paper towel and refrigerate. **-OR-** Take detailed photos (digital or film).
2. Note the location where the specimen was found. If possible, give the exact geographic location using a GPS (global positioning system) unit, topographic map, or the Wisconsin Gazetteer map book. If using a map, include a photocopy with a dot showing the plant's location. You can use TopoZone.com to find the precise location on a digital topographic map. Click the cursor on the exact collection site and note the coordinates (choose UTM or Latitude/Longitude).	Provide one or more of the following: • Latitude & Longitude • UTM (Universal Transverse Mercator) coordinates • County, Township, Range, Section, Part-section • Precise written site description, noting nearest city & road names, landmarks, local topography

3. Gather information to aid in positive species identification.	• Collection date and county • Your name, address, phone, email • Exact location (Latitude/Longitude or UTM preferred, or Township/Range/Section) • Plant name (common or scientific) • Land ownership (if known) • Population description (estimated number of plants and area covered) • Habitat type(s) where found (forest, field, prairie, wetland, open water)
4. Mail or bring specimens and information to any of the following locations: Digital photos may be emailed.	**Wisconsin Dept. Natural Resources** 427 E. Tower Drive, Suite 100 Wautoma, WI 54982 Phone: (920) 787-4686 **Regional AIS Coordinator** Golden Sands RC&D 1100 Main St., Suite #150 Stevens Point, WI 54481 Phone: 715-343-6214 E-Mail : info@goldensandsrcd.org **UW-Stevens Point Herbarium** 301 Trainer Natural Resources Building 800 Reserve Street Stevens Point, WI 54481 Phone: 715-346-4248 E-Mail: ejudziew@uwsp.edu **Wisconsin Invasive Plants Reporting & Prevention Project** Herbarium-UW-Madison 430 Lincoln Drive Madison, WI 53706 Phone: (608) 267-7612 E-Mail: invasiveplants@mailplus.wisc.edu
5. Once the specimen is dropped off or sent for positive identification, be sure to contact:	**Regional AIS Coordinator** Golden Sands RC&D 1100 Main St., Suite #150 Stevens Point, WI 54481 Phone: 715-343-6214 E-Mail : info@goldensandsrcd.org

If an invasive species is confirmed, the Regional AIS Coordinator will make the following public information contacts:

- **Wisconsin Department of Natural Resources**
  427 E. Tower Drive, Suite 100
  Wautoma, WI 54982
  Phone: (920) 787-4686

  The municipal board(s) in which the water body is located

  Town of:

  Town of:

- **The Lake District/Association** in which the waterbody is located.
  Contact:
  Phone:

- **University of Wisconsin-Stevens Point**
  Water Resource Scientist
  Nancy Turyk
  Trainer Natural Resources Building
  800 Reserve Street
  Stevens Point, WI 54481Telephone: 715-346-4155
  E-mail: nturyk@uwsp.edu

- **Local Residents**

If an invasive species is confirmed secretary of the Pine Lake Management District will make the following public information contacts:

- **Newspapers**: Argus, Resorter

Contact the WDNR to post notice(s) at the access point(s) to the water body.

Appendix E. Lake User Survey Results

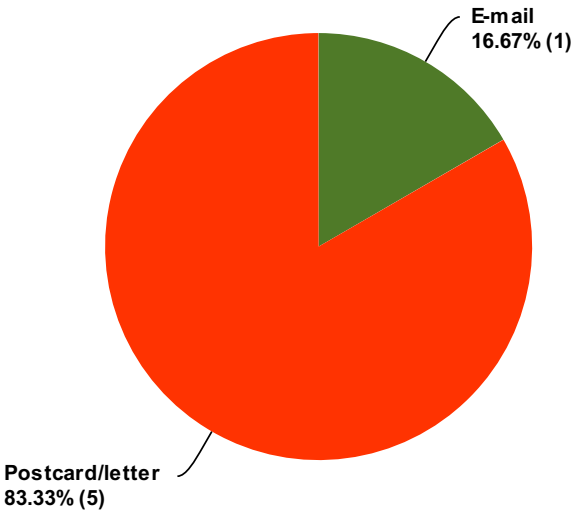
Q1 What is your Waushara County Lakes Survey ID?

Answered: 6 Skipped: 0

#	Responses	Date
1	[redacted]	6/24/2014 11:52 AM
2	[redacted]	6/23/2014 4:34 PM
3	[redacted]	6/17/2014 8:47 PM
4	[redacted]	6/16/2014 10:03 PM
5	[redacted]	6/16/2014 8:25 AM
6	[redacted]	6/14/2014 8:55 AM

Q2 How did you hear about this survey?

Answered: 6 Skipped: 0

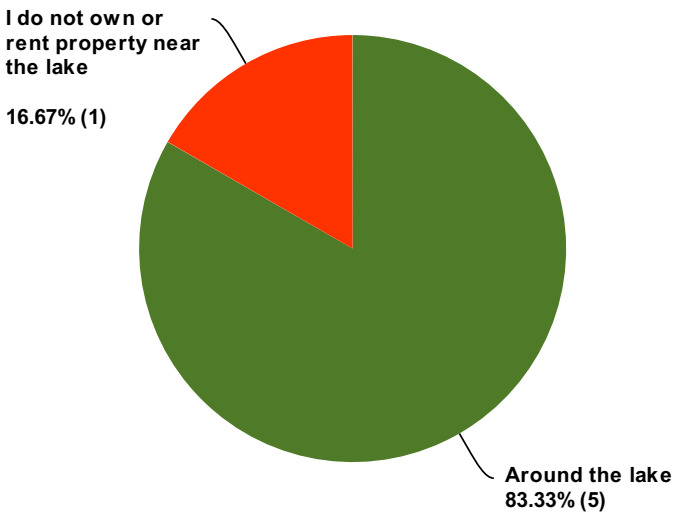


Answer Choices	Responses	
E-mail	**16.67%**	1
Newspaper	**0.00%**	0
Postcard/letter	**83.33%**	5
Facebook	**0.00%**	0
Radio	**0.00%**	0
Total		**6**

#	Other (please specify)	Date
	There are no responses.	

Q3 Do you own or rent property...

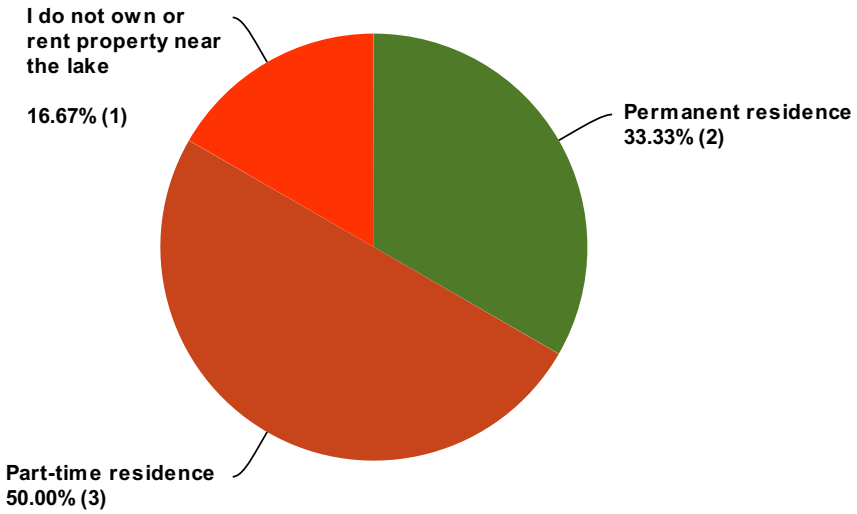
Answered: 6 Skipped: 0



Answer Choices	Responses	
Around the lake	83.33%	5
Less than 1/2 mile from the lake	0.00%	0
1/2 mile to 1 mile of the lake	0.00%	0
More than 1 mile from the lake	0.00%	0
I do not own or rent property near the lake	16.67%	1
Total		**6**

Q4 If you own or rent property near the lake, is this property your permanent residence, a part-time residence (such as a vacation home, rental, etc.), or other?

Answered: 6 Skipped: 0

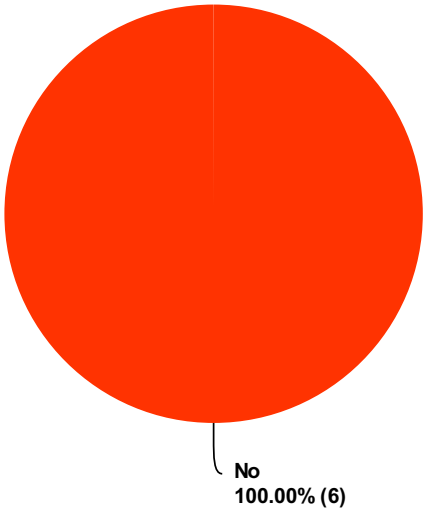


Answer Choices	Responses	
Permanent residence	33.33%	2
Part-time residence	50.00%	3
I do not own or rent property near the lake	16.67%	1
Total		6

#	Other (please specify)	Date
	There are no responses.	

Q5 I own property on or near the lake because I inherited it.

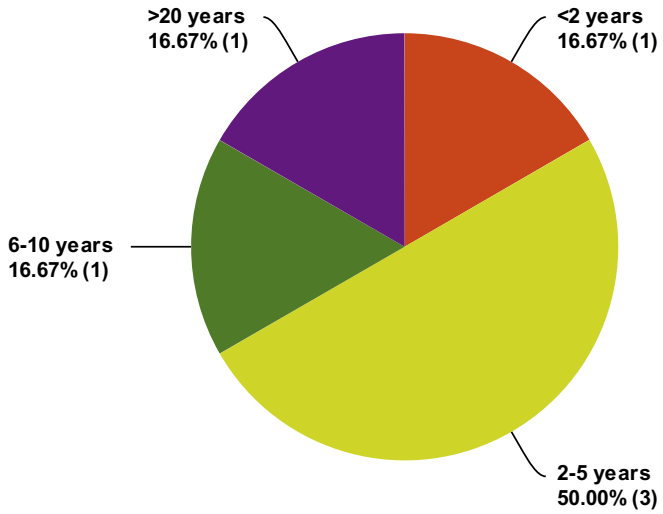
Answered: 6 Skipped: 0



Answer Choices	Responses	
Yes	0.00%	0
No	100.00%	6
Total		6

Q6 How long have you lived on, visited or recreated on the lake?

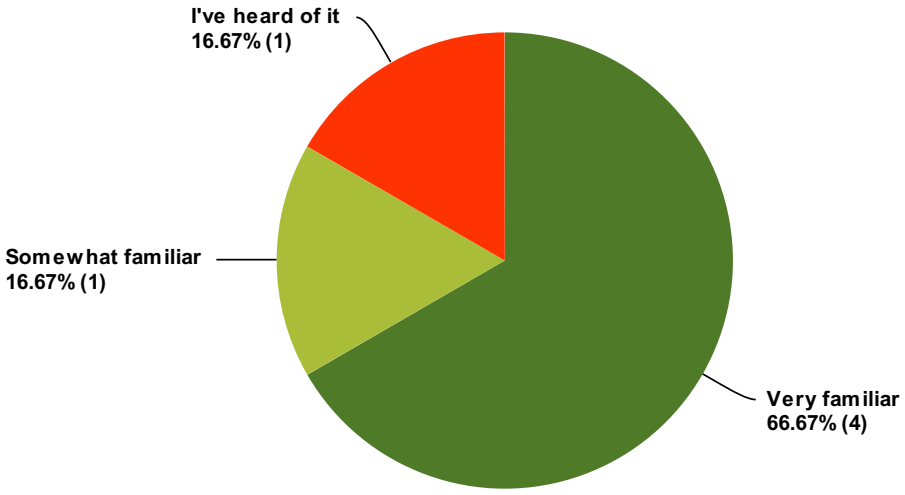
Answered: 6 Skipped: 0



Answer Choices	Responses	
<2 years	16.67%	1
2-5 years	50.00%	3
6-10 years	16.67%	1
11-20 years	0.00%	0
>20 years	16.67%	1
Total		6

Q7 Are you familiar with the Hancock Pine Lake Association?

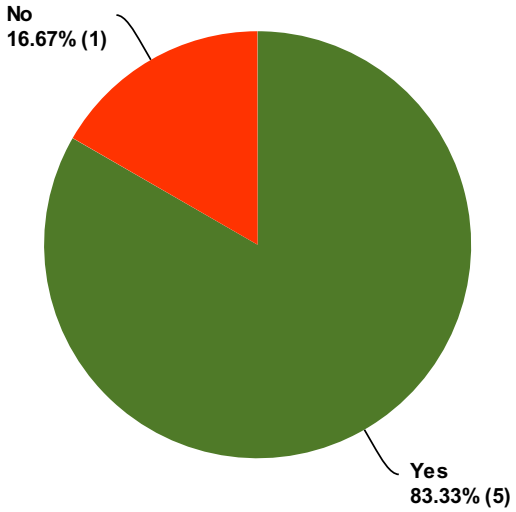
Answered: 6 Skipped: 0



Answer Choices	Responses	
Very familiar	66.67%	4
Somewhat familiar	16.67%	1
I've heard of it	16.67%	1
Never heard of it	0.00%	0
Total		6

Q8 Are you a member of the Hancock Pine Lake Association?

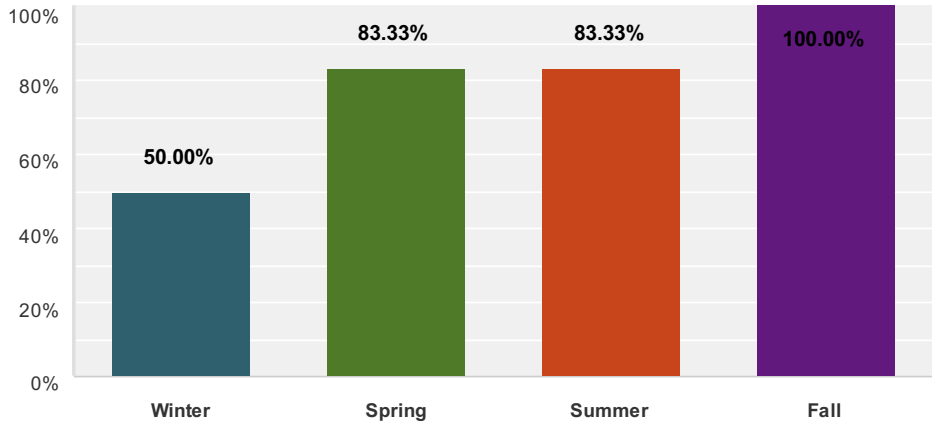
Answered: 6 Skipped: 0



Answer Choices	Responses	
Yes	83.33%	5
No	16.67%	1
I don't know	0.00%	0
Total		6

Q9 What time of year do you generally use the lake? Select all that apply.

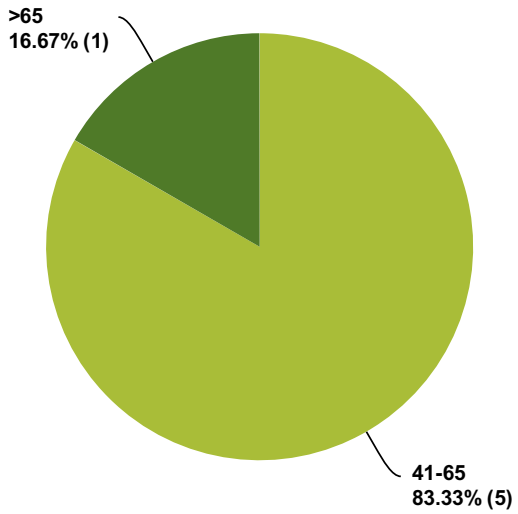
Answered: 6 Skipped: 0



Answer Choices	Responses	
Winter	50.00%	3
Spring	83.33%	5
Summer	83.33%	5
Fall	100.00%	6
Total Respondents: 6		

Q10 Which category below includes your age?

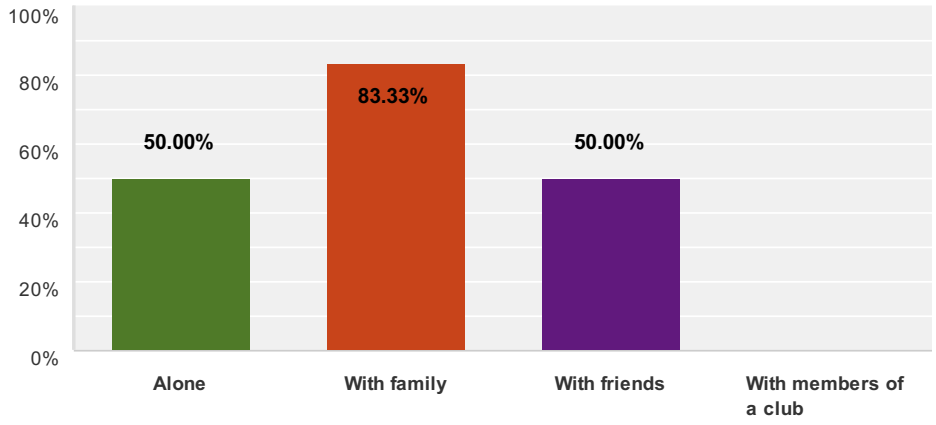
Answered: 6 Skipped: 0



Answer Choices	Responses	
Under 18	0.00%	0
18-40	0.00%	0
41-65	83.33%	5
>65	16.67%	1
Total		6

Q11 When you visit Pine Lake, are you typically...(check all that apply)

Answered: 6 Skipped: 0

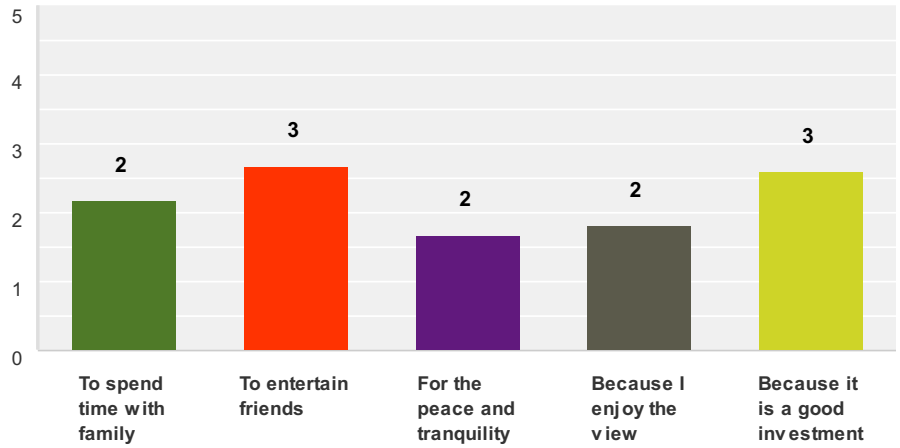


Answer Choices	Responses	
Alone	50.00%	3
With family	83.33%	5
With friends	50.00%	3
With members of a club	0.00%	0
Total Respondents: 6		

#	Other (please specify)	Date
	There are no responses.	

Q12 I live on or near the lake...

Answered: 6 Skipped: 0



	Strongly Agree	Agree	Disagree	Strongly Disagree	I do not live on or near the lake	Total
To spend time with family	**50.00%** 3	**16.67%** 1	**16.67%** 1	**0.00%** 0	**16.67%** 1	6
To entertain friends	**0.00%** 0	**66.67%** 4	**16.67%** 1	**0.00%** 0	**16.67%** 1	6
For the peace and tranquility	**83.33%** 5	**0.00%** 0	**0.00%** 0	**0.00%** 0	**16.67%** 1	6
Because I enjoy the view	**66.67%** 4	**16.67%** 1	**0.00%** 0	**0.00%** 0	**16.67%** 1	6
Because it is a good investment	**20.00%** 1	**40.00%** 2	**20.00%** 1	**0.00%** 0	**20.00%** 1	5

Q13 What do you value most about Pine Lake?

Answered: 5 Skipped: 1

#	Responses	Date
1	Previous Quality of the lakes fish and habitat. Does no longer exist!	6/23/2014 4:41 PM
2	Fishing, swimming, and the wildlife.	6/17/2014 8:55 PM
3	Quite and Tranquil	6/16/2014 10:12 PM
4	Its beauty	6/16/2014 8:31 AM
5	all of the activities that could be done on the lake...kayaking, fishing, swimming, etc	6/14/2014 9:03 AM

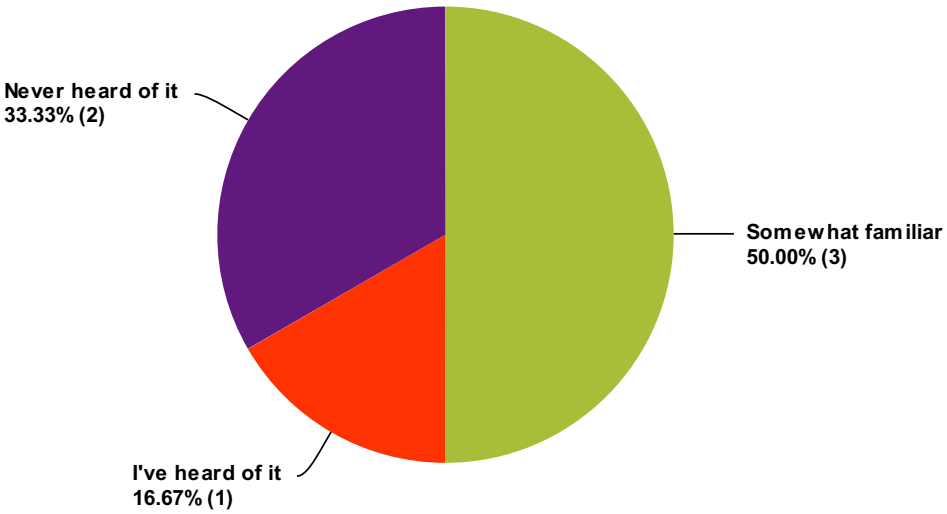
Q14 In your opinion, what should be done to restore, maintain, or improve Pine Lake?

Answered: 6 Skipped: 0

#	Responses	Date
1	remove the eurasion water milfoil	6/24/2014 11:54 AM
2	Remove the entire invasive weed species. Restock the lake. Allow shoreline owners to do individual cleanup to improve the shoreline.	6/23/2014 4:41 PM
3	Restock fish. limit local irrigation, possible aeration, control invasive vegetation.	6/17/2014 8:55 PM
4	reduce milfoil growth & Improve fish habitat	6/16/2014 10:12 PM
5	Treat milfoil and other weeds. Treat vegitation	6/16/2014 8:31 AM
6	First, kill the invasive plants in lake. Second, make it deeper (or some other method) to make it more resistant to winter freeze . Third, restock lake with fish since all the fish were killed by the 2013/2014 winter.	6/14/2014 9:03 AM

Q15 How familiar are you with Wisconsin's Public Trust Doctrine?

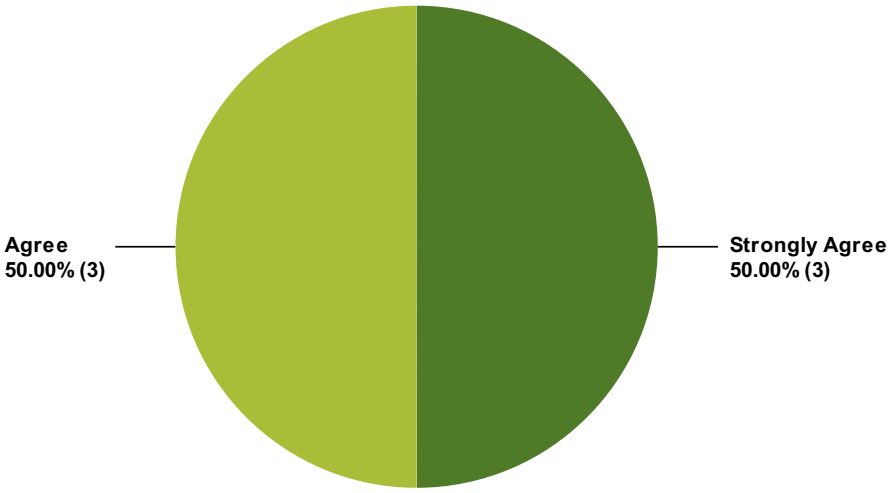
Answered: 6 Skipped: 0



Answer Choices	Responses	
Very familiar	0.00%	0
Somewhat familiar	50.00%	3
I've heard of it	16.67%	1
Never heard of it	33.33%	2
Total		6

Q16 How I recreate in and around the lake can affect other lake users.

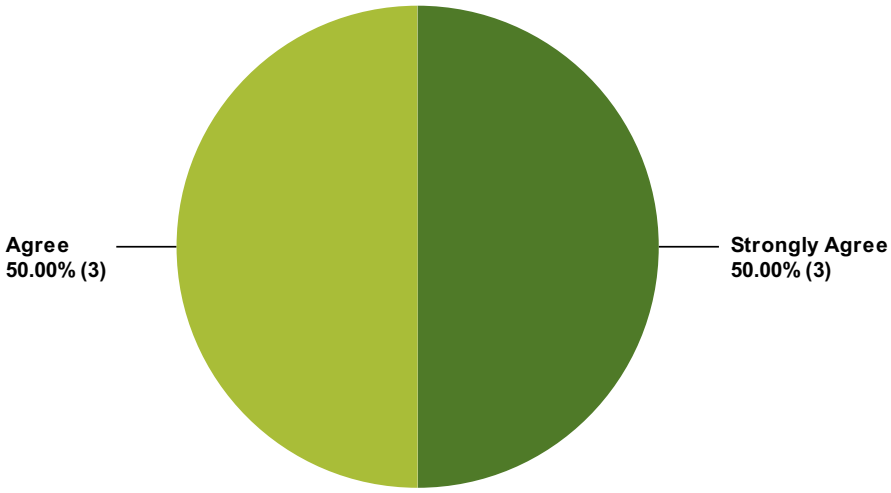
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly Agree	50.00%	3
Agree	50.00%	3
Disagree	0.00%	0
Strongly Disagree	0.00%	0
Total		6

Q17 How I manage my land can affect other lake users.

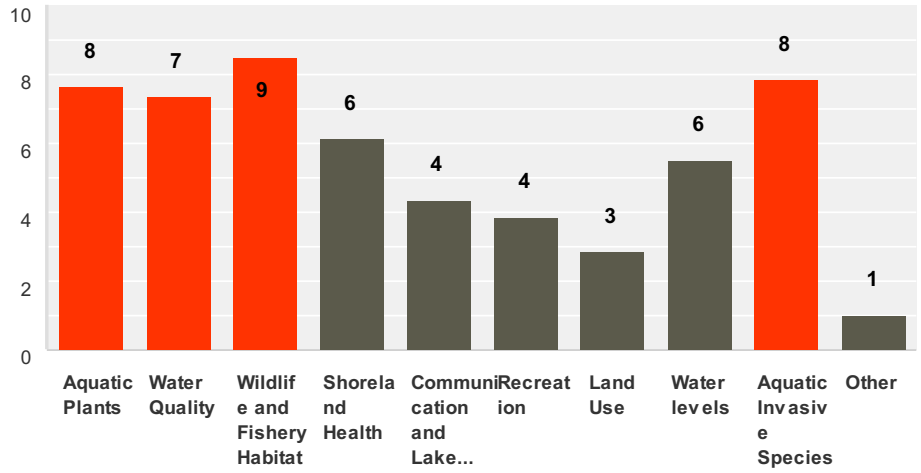
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly Agree	50.00%	3
Agree	50.00%	3
Disagree	0.00%	0
Strongly Disagree	0.00%	0
Total		6

Q18 Which of the following meeting topics, in your opinion, are the most important to talk about regarding Pine Lake? (Please rank at least your top three.)

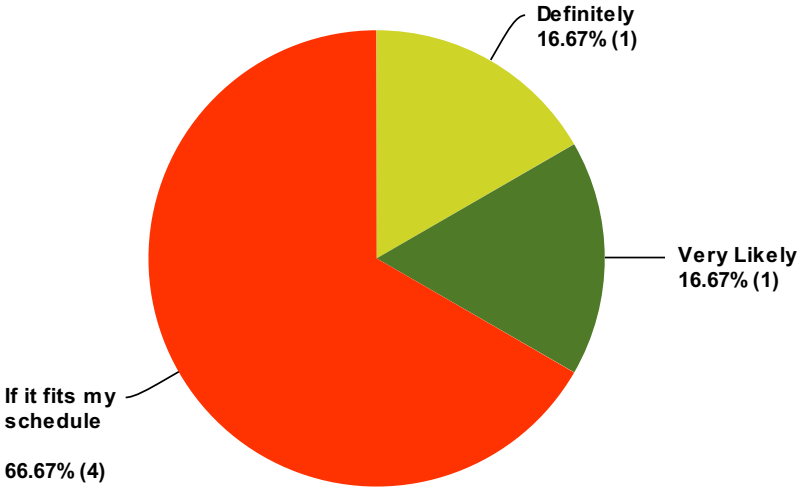
Answered: 6 Skipped: 0



	1	2	3	4	5	6	7	8	9	10	Total	Average Ranking
Aquatic Plants	16.67% 1	16.67% 1	16.67% 1	16.67% 1	33.33% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	6	7.67
Water Quality	0.00% 0	16.67% 1	16.67% 1	50.00% 3	16.67% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	6	7.33
Wildlife and Fishery Habitat	16.67% 1	50.00% 3	16.67% 1	0.00% 0	16.67% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	6	8.50
Shoreland Health	0.00% 0	16.67% 1	0.00% 0	16.67% 1	16.67% 1	50.00% 3	0.00% 0	0.00% 0	0.00% 0	0.00% 0	6	6.17
Communication and Lake Group Support	0.00% 0	0.00% 0	0.00% 0	0.00% 0	16.67% 1	33.33% 2	33.33% 2	0.00% 0	16.67% 1	0.00% 0	6	4.33
Recreation	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	16.67% 1	50.00% 3	33.33% 2	0.00% 0	0.00% 0	6	3.83
Land Use	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	16.67% 1	50.00% 3	33.33% 2	0.00% 0	6	2.83
Water levels	16.67% 1	0.00% 0	33.33% 2	0.00% 0	0.00% 0	0.00% 0	0.00% 0	16.67% 1	33.33% 2	0.00% 0	6	5.50
Aquatic Invasive Species	50.00% 3	0.00% 0	16.67% 1	16.67% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	16.67% 1	0.00% 0	6	7.83
Other	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 6	6	1.00

Q19 Many of the decisions determining the final lake management plan will be made at the planning sessions. Sessions will typically take place monthly on weeknights. How likely is it that you will attend one or more of the planning sessions?

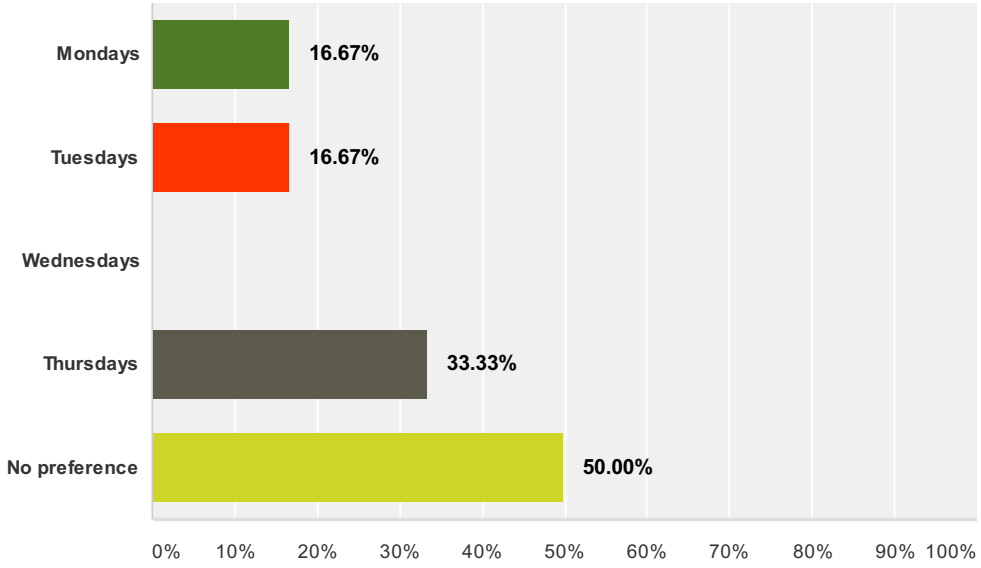
Answered: 6 Skipped: 0



Answer Choices	Responses	
Definitely	16.67%	1
Very Likely	16.67%	1
If it fits my schedule	66.67%	4
Not likely	0.00%	0
I won't attend any	0.00%	0
Total		6

Q20 Previous experience has shown that weekday evenings work best for most people. If you will attend the planning sessions, which weeknights do you prefer?

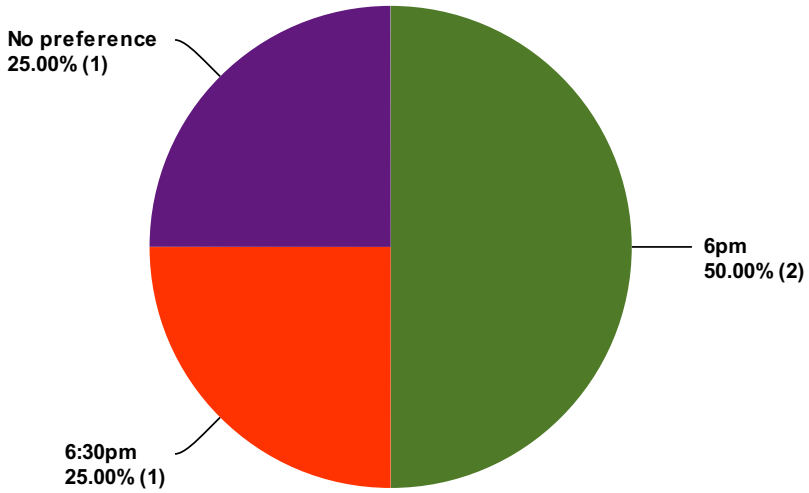
Answered: 6 Skipped: 0



Answer Choices	Responses	
Mondays	16.67%	1
Tuesdays	16.67%	1
Wednesdays	0.00%	0
Thursdays	33.33%	2
No preference	50.00%	3
Total Respondents: 6		

Q21 Most sessions will last around 2 hours. If you will attend the planning sessions, which times do you prefer to start?

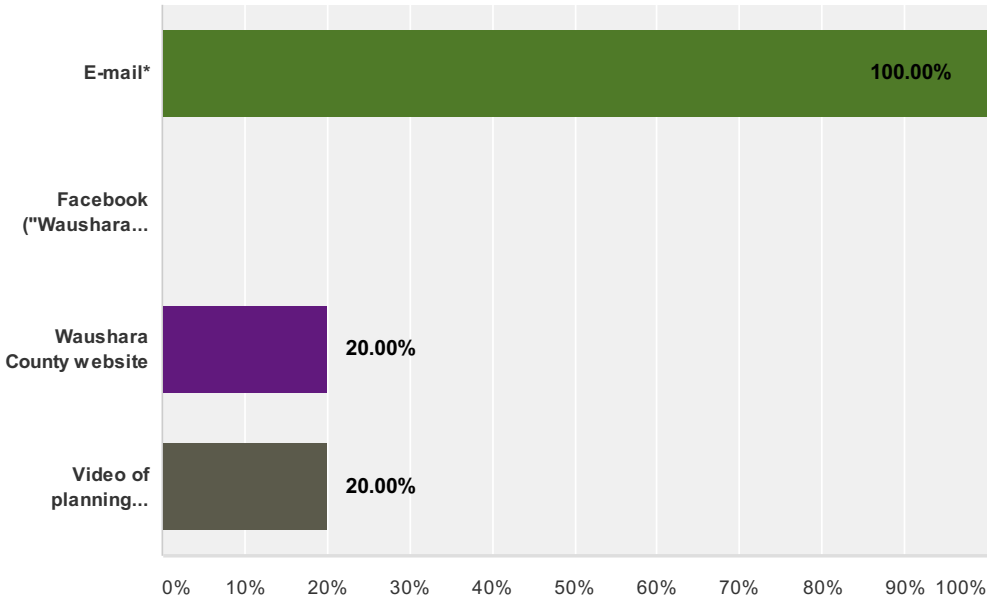
Answered: 4 Skipped: 2



Answer Choices	Responses	
6pm	50.00%	2
6:30pm	25.00%	1
7pm	0.00%	0
7:30pm	0.00%	0
No preference	25.00%	1
Total		4

Q22 How would you like to receive information about meetings (agendas, minutes), the planning process, and updates? (Select all that apply)

Answered: 5 Skipped: 1



Answer Choices	Responses	
E-mail*	100.00%	5
Facebook ("Waushara County Lakes Project")	0.00%	0
Waushara County website	20.00%	1
Video of planning meeting posted on the web	20.00%	1
Total Respondents: 5		

#	Other (please specify)	Date
	There are no responses.	

Pine Lake Hancock Survey #2

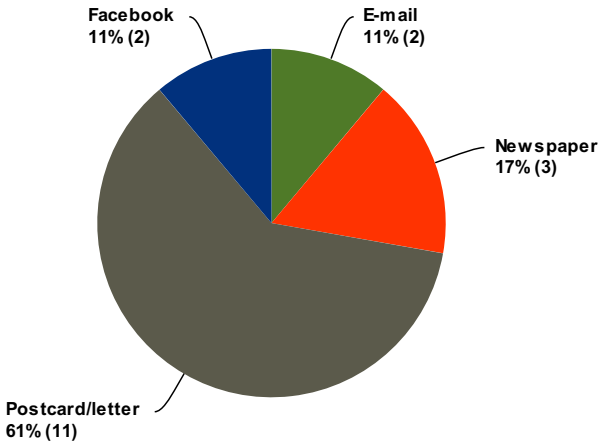
Q1 Enter your Waushara County Lakes Survey ID. Your survey cannot be processed without this information. If you've forgotten your ID or haven't created one yet, follow the instructions below.

Answered: 18 Skipped: 0

#	Responses	Date
1	[redacted]	7/22/2014 8:21 PM
2	[redacted]	7/20/2014 11:18 PM
3	[redacted]	7/19/2014 2:10 PM
4	[redacted]	7/18/2014 8:21 PM
5	[redacted]	7/17/2014 3:17 PM
6	[redacted]	7/17/2014 12:49 PM
7	[redacted]	7/16/2014 11:24 PM
8	[redacted]	7/16/2014 10:18 PM
9	[redacted]	7/16/2014 10:08 PM
10	[redacted]	7/16/2014 10:03 PM
11	[redacted]	7/16/2014 8:01 PM
12	[redacted]	7/16/2014 3:08 PM
13	[redacted]	7/16/2014 12:27 PM
14	[redacted]	7/16/2014 12:13 PM
15	[redacted]	7/16/2014 10:53 AM
16	[redacted]	7/16/2014 10:23 AM
17	[redacted]	7/16/2014 7:55 AM
18	[redacted]	7/14/2014 7:14 PM

Q2 How did you hear about this survey?

Answered: 18 Skipped: 0

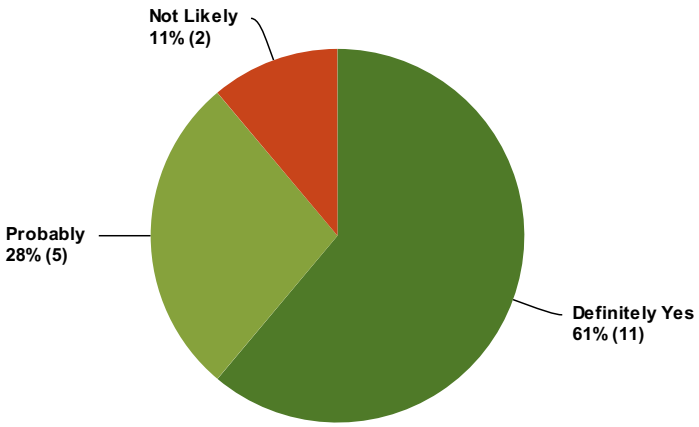


Answer Choices	Responses	
E-mail	11%	2
Newspaper	17%	3
Postcard/letter	61%	11
Facebook	11%	2
Radio	0%	0
Total		18

#	Other (please specify)	Date
	There are no responses.	

Q3 Does a desire to provide better habitat for fish and wildlife motivate you to support (morally) efforts to improve Pine Lake?

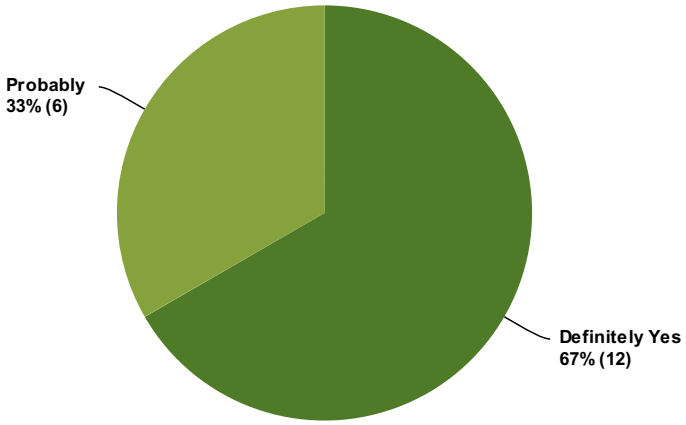
Answered: 18 Skipped: 0



Answer Choices	Responses	
Definitely Yes	61%	11
Probably	28%	5
Not Likely	11%	2
Definitely No	0%	0
Unsure	0%	0
Total		18

Q4 Does a desire to provide better habitat for fish and wildlife motivate you to support (by direct action) efforts to improve Pine Lake?

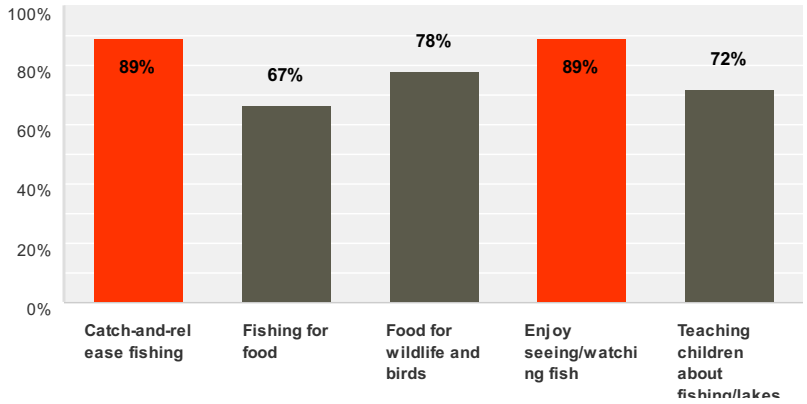
Answered: 18 Skipped: 0



Answer Choices	Responses	
Definitely Yes	67%	12
Probably	33%	6
Not Likely	0%	0
Definitely No	0%	0
Unsure	0%	0
Total		18

Q5 For what purposes do you value the fishery in Pine Lake? (Check all that apply.)

Answered: 18 Skipped: 0

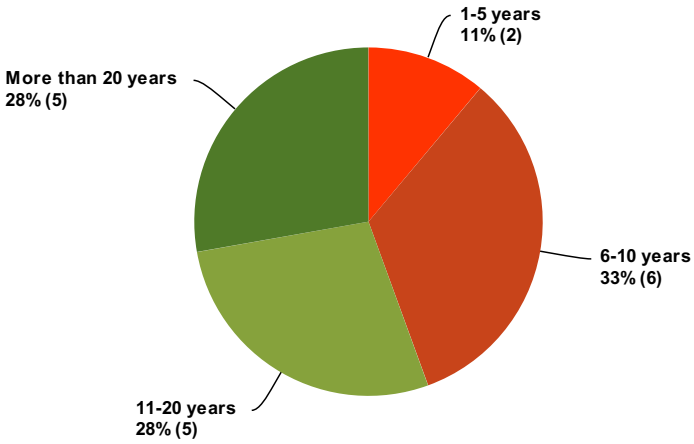


Answer Choices	Responses	
Catch-and-release fishing	89%	16
Fishing for food	67%	12
Food for wildlife and birds	78%	14
Enjoy seeing/watching fish	89%	16
Teaching children about fishing/lakes	72%	13
Total Respondents: 18		

#	Other (please specify)	Date
1	The local economy needs help attracting tourists. Having a nice swimming lake stocked with fish is a good start.	7/16/2014 3:13 PM
2	lake property value	7/16/2014 12:29 PM

Q6 How many years of fishing experience do you have on Pine Lake?

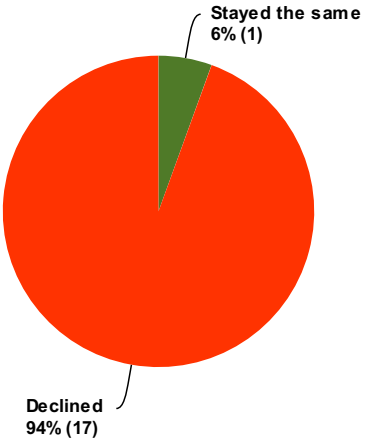
Answered: 18 Skipped: 0



Answer Choices	Responses	
I don't fish Pine Lake	0%	0
1-5 years	11%	2
6-10 years	33%	6
11-20 years	28%	5
More than 20 years	28%	5
Total		18

Q7 In the years you have been fishing Pine Lake, would you say the quality of fishing has...

Answered: 18 Skipped: 0



Answer Choices	Responses	
Improved	0%	0
Stayed the same	6%	1
Declined	94%	17
Not sure	0%	0
Total		18

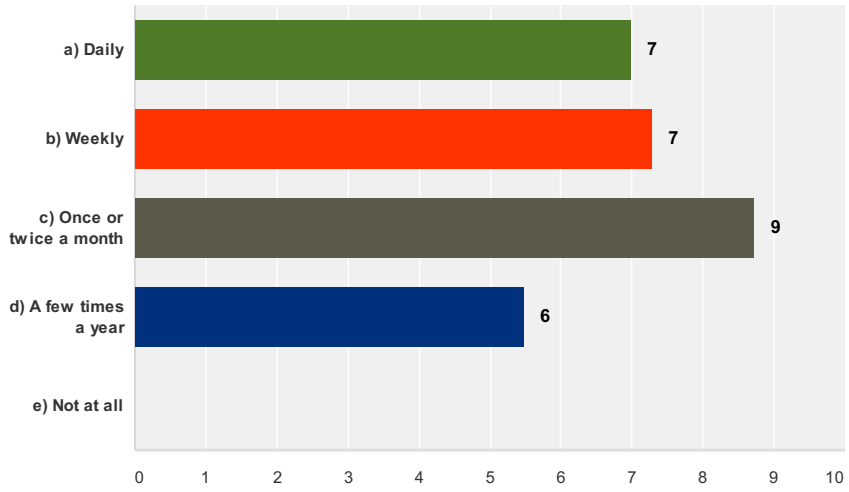
Q8 What factors do you feel have contributed to the change in fishing?

Answered: 17 Skipped: 1

#	Responses	Date
1	People keeping to many fish at one time. disobeying state size limits No stocking program We need to set our own slot size and limits and enforce them	7/22/2014 8:25 PM
2	Winter fish kill	7/20/2014 11:19 PM
3	weeds	7/19/2014 2:11 PM
4	Low water levels and winter kill.	7/18/2014 8:25 PM
5	Low lake levels and weeds	7/17/2014 3:19 PM
6	Lake taken over by weeds.	7/17/2014 2:05 PM
7	This lake has very low water levels I'm afraid that if something isn't done to manage this the community and vacation homes will lose the lake completely and turn into just a grassy marsh field. Then the homeowners will complain the taxes are no longer water frontage and will need to be reduced. Property values will drop and Hancock will suffer. If the lake could be saved and maintained the community will grow and flourish. People will want to spend money and visit if fishing and boating are worth while activities. Right now the lake is drying up and loaded with thick milfoil weeds. Few fish can survive. Turtles get tangled in the thick weeds. Can't this lake be cleared out or dredged? Obviously milfoil needs treatment yearly. Why are we letting farmers spray fields constantly with our precious well water causing water table to lower and lakes disappearing. Why does Hancock only have 2 bars open in town? Why promote just drinking and smoking ???? No nutrition in this town??? No grocery store ?? No reason to bring in revenue to the public?? Hancock and pine lake need attention desperately. I'm afraid this lake will fade away if things sent taken more seriously to preserve the wild life and fishing and water levels.	7/16/2014 11:41 PM
8	fish die off and freeze in winter due to low water level	7/16/2014 10:19 PM
9	Too many high capacity wells are draining lake soon it will be gone and just grassy field. milfoil has taken over, wild life has declined and few fish. the lake has not been maintained. years ago they cleared out the weeds and opened a spring that raised level of lake significantly. appears the town has declined as well many businesses closed up. streets and sidewalks old and crumbly. no updates in town or on lake.	7/16/2014 10:13 PM
10	The water levels are low on pine lake then ever before. high capacity wells are decreasing water tables and Waushara county is not fighting to protect dangerous low lake levels. There should be restrictions on high capacity wells and limit usage andstop drilling of new wells. Pine lake should also be dredged out and allow nearby springs to flow back in to help rise levels. Hancock is also poor at bringing in tourism to increase revenue to help the lake . the town looks poverty like most of the buildings are collapsing and vacant. What is going on in Hancock? surely taxes are high enough why cant they open some businesses? or even a simple grocery store? Who ever is the mayor should probably step down and let a more educated person take over to save the town and Pine Lake.	7/16/2014 8:11 PM
11	No fish being stocked coupled with a steadily declining water level and increasng weed level. Ground water level lowering due to wells being installed by local farmers for crop irrigation.	7/16/2014 3:13 PM
12	mucky, weedy and low lake levels. High capacity wells from local farmlands draining the water table.	7/16/2014 12:29 PM
13	Weeds and shrinking water levels.	7/16/2014 12:15 PM
14	The Lake is drying up. Its a valuable economic tourist resource not being taken care of properly by Hancock.	7/16/2014 10:56 AM
15	low water levels and too many people keeping fish. the natural springs feeding the lake need to be dredged like they did many years ago when the water levels dropped. the northeast corner and north central sides of the lake have springs.	7/16/2014 10:26 AM
16	Extremely low lake levels (possibly caused by high capacity wells in area and poor watershed management by town of Hancock). Milfoil invasion and Very cold winter.	7/16/2014 8:01 AM
17	Excessive Milfoil growth	7/14/2014 7:27 PM

Q9 When and how often do you typically fish Pine Lake? (Please answer a-e)

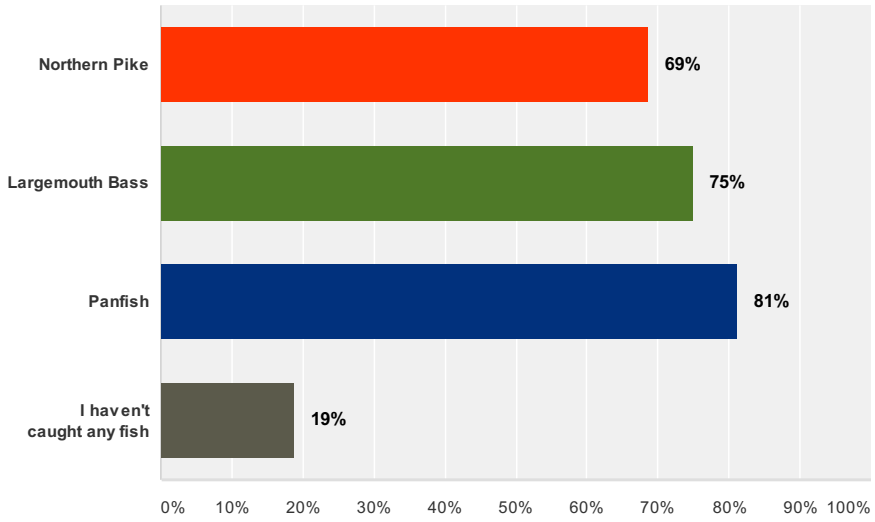
Answered: 17 Skipped: 1



	Winter	Spring	Summer	Fall	Total Respondents
a) Daily	**100%** 2	**50%** 1	**100%** 2	**50%** 1	2
b) Weekly	**43%** 3	**71%** 5	**86%** 6	**71%** 5	7
c) Once or twice a month	**64%** 7	**100%** 11	**82%** 9	**91%** 10	11
d) A few times a year	**100%** 2	**50%** 1	**50%** 1	**50%** 1	2
e) Not at all	**0%** 0	**0%** 0	**0%** 0	**0%** 0	0

Q10 What fish do you typically catch at Pine Lake? Check all that apply.

Answered: 16 Skipped: 2

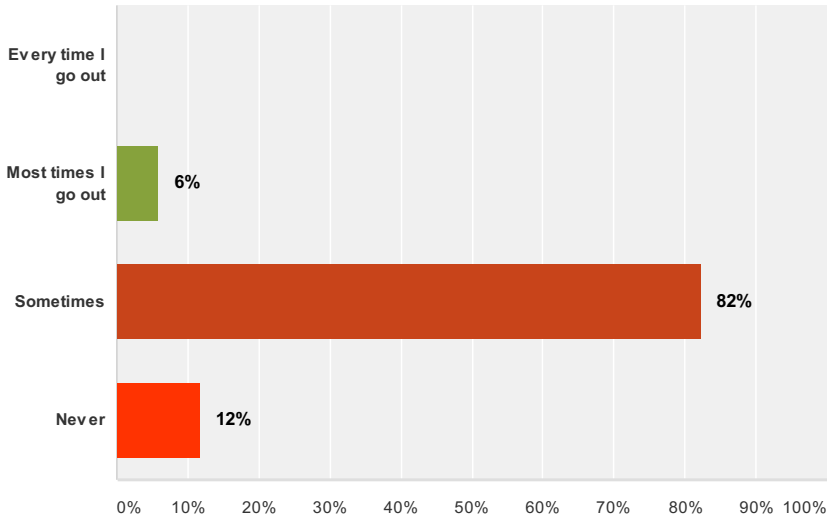


Answer Choices	Responses	
Northern Pike	69%	11
Largemouth Bass	75%	12
Panfish	81%	13
I haven't caught any fish	19%	3
Total Respondents: 16		

#	Other (please specify)	Date
1	There are no panfish available anymore.	7/22/2014 8:29 PM
2	no longer able to catch any fish	7/19/2014 2:17 PM
3	bullheads	7/17/2014 3:24 PM
4	bullheads	7/17/2014 2:40 PM
5	use to catch these but now mostly small panfish if any	7/16/2014 10:16 PM
6	garr fish	7/16/2014 3:20 PM
7	turtles	7/16/2014 12:31 PM
8	catfish	7/16/2014 12:19 PM
9	crappie	7/16/2014 10:59 AM
10	walleye, no fish in 2014 due to winter fish kill	7/16/2014 10:29 AM
11	bullheads	7/16/2014 8:14 AM

Q11 In general, how often do you catch fish on Pine Lake?

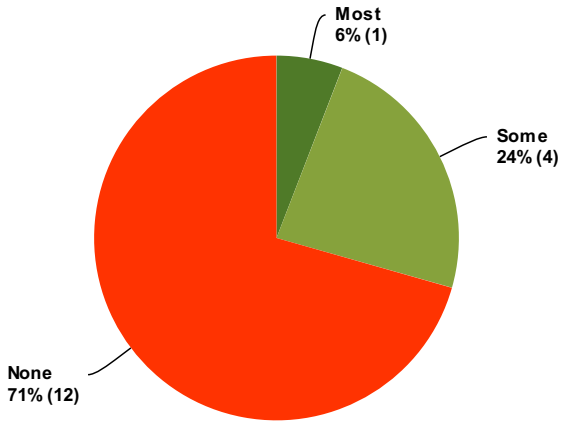
Answered: 17 Skipped: 1



Answer Choices	Responses	
Every time I go out	0%	0
Most times I go out	6%	1
Sometimes	82%	14
Never	12%	2
Total Respondents: 17		

Q12 In general, how many of the fish you catch are big enough to keep?

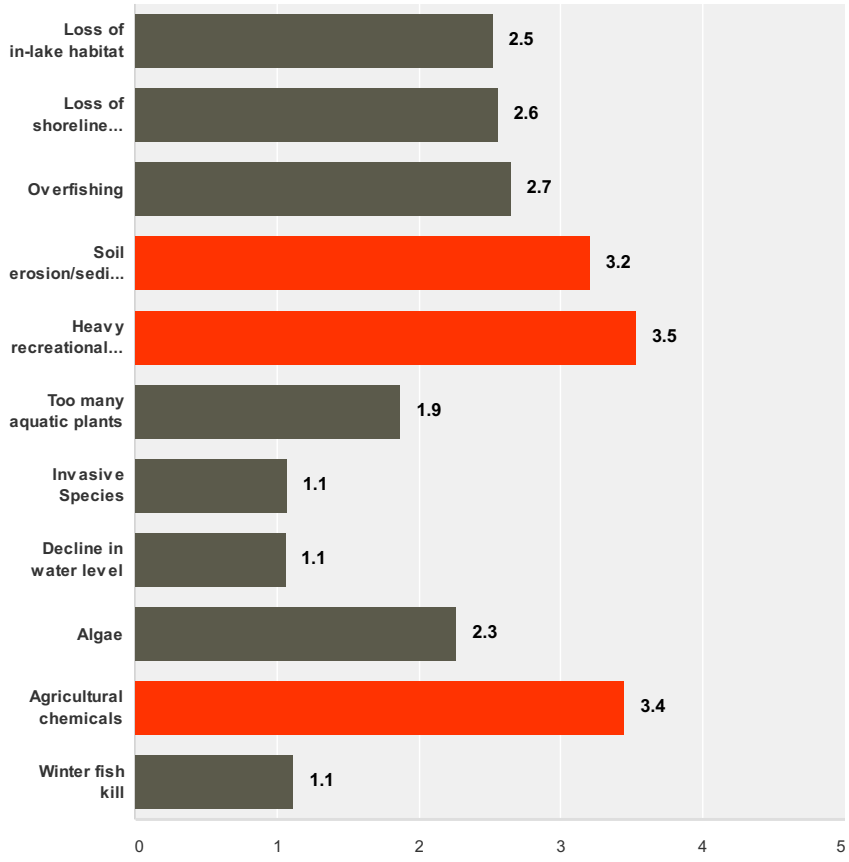
Answered: 17 Skipped: 1



Answer Choices	Responses	
All	0%	0
Most	6%	1
Some	24%	4
None	71%	12
Total		17

Q13 What do you believe is the greatest threat to the fishery in Pine Lake in the next 10 years?

Answered: 17 Skipped: 1



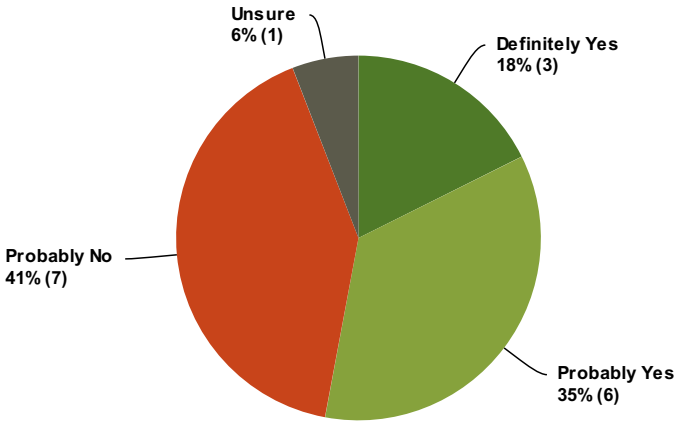
	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know	Total Respondents
Loss of in-lake habitat	**40%** 6.0	**7%** 1.0	**13%** 2.0	**40%** 6.0	**0%** 0.0	15
Loss of shoreline habitat	**38%** 6.0	**13%** 2.0	**6%** 1.0	**44%** 7.0	**0%** 0.0	16
Overfishing	**18%** 3.0	**35%** 6.0	**12%** 2.0	**35%** 6.0	**0%** 0.0	17
Soil erosion/sedimentation	**0%** 0.0	**20%** 3.0	**40%** 6.0	**40%** 6.0	**0%** 0.0	15
Heavy recreational use	**0%** 0.0	**7%** 1.0	**33%** 5.0	**60%** 9.0	**0%** 0.0	15
Too many aquatic plants	**47%** 7.0	**20%** 3.0	**33%** 5.0	**0%** 0.0	**0%** 0.0	15
Invasive Species	**93%** 14.0	**7%** 1.0	**0%** 0.0	**0%** 0.0	**0%** 0.0	15
Decline in water level	**94%** 16.0	**6%** 1.0	**0%** 0.0	**0%** 0.0	**0%** 0.0	17
Algae	**27%** 4.0	**40%** 6.0	**13%** 2.0	**20%** 3.0	**0%** 0.0	15
Agricultural chemicals	**0%** 0.0	**25%** 4.0	**38%** 6.0	**38%** 6.0	**6%** 1.0	16
Winter fish kill	**88%** 15.0	**12%** 2.0	**0%** 0.0	**0%** 0.0	**0%** 0.0	17

#	Other (please specify)	Date
1	muskrats digging holes	7/17/2014 3:24 PM
2	Low lake levels	7/17/2014 2:40 PM

3	Loca farmers stealing ground water from high capacity well use.	7/16/2014 3:20 PM
4	extreme low lake level and milfoil weeds	7/16/2014 12:31 PM
5	Needs to be dredged out so spring can feed lake water.	7/16/2014 10:59 AM
6	remove the "NO-WAKE" from the lake to increase oxygen levels to reduce aquatic plants.	7/16/2014 8:14 AM

Q14 Do you believe fish from Pine Lake are safe to eat?

Answered: 17 Skipped: 1



Answer Choices	Responses	
Definitely Yes	18%	3
Probably Yes	35%	6
Probably No	41%	7
Definitely No	0%	0
Unsure	6%	1
Total		17

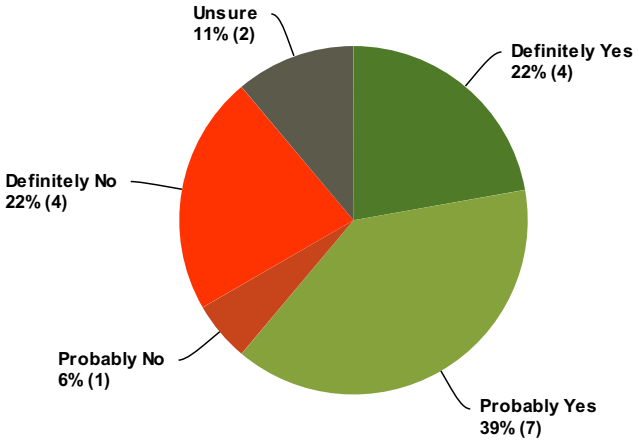
Q15 Do you have any additional comments regarding the fishery in Pine Lake?

Answered: 13 Skipped: 5

#	Responses	Date
1	was able to catch fish each time i fished, but no longer. fishing has declined as the milfoil and cattails have over taken the lake.	7/19/2014 2:17 PM
2	Needs aeration and restocking. Less irrigation!	7/18/2014 8:32 PM
3	milfoil weeds too thick, mucky bottom needs to be dug out, lake levell way too shallow for hearty fish populations.	7/17/2014 3:24 PM
4	Many Muskrats digging deep burrows possibly slowly draining Pine lake.	7/17/2014 2:40 PM
5	please save pine lake from disappearing	7/16/2014 10:16 PM
6	There are very few if any fish in this low level weedy milfoil lake	7/16/2014 10:05 PM
7	the invasive milfoil is taking over the fish habitat and turning it into swampy unsafe consitions. treatment needs to be done every year without question	7/16/2014 8:14 PM
8	This lake is one of the poorest uses of a natural resource I have ever seen by the local community. Hancock should be more proactive in its resoration.	7/16/2014 3:20 PM
9	If something is done soon about the declining lake level and the invasive weeds, the lake will be dry in 5 years.	7/16/2014 12:31 PM
10	There has been talk in the community that the Pine Lake is not being taken advantage of as far as bring in money from tourists (ex. Boat launch fee: making motor sports available; fishing tournaments; conoe races) Lake needs a nice public beach for swimmers/fishers to access.	7/16/2014 12:19 PM
11	Maybe add plant eating carp to controll milfoil.	7/16/2014 10:59 AM
12	the lake needs to be stocked like they stock Fish Lake every year. but first the invasive milfoil weeds need to be treated, then the spring fed areas need to be dredged.	7/16/2014 10:29 AM
13	Charge an access fee to launch boats and use the money to improve lake. When it rains have the town of Hancock make sure water is directed into the lake. This lake is about 10 feet below where it used to be. at the rate its declining, it will be a dry lakebed in 10 years.	7/16/2014 8:14 AM

Q16 There are currently no designated boating hours on Pine Lake. Do you like the rules as they are?

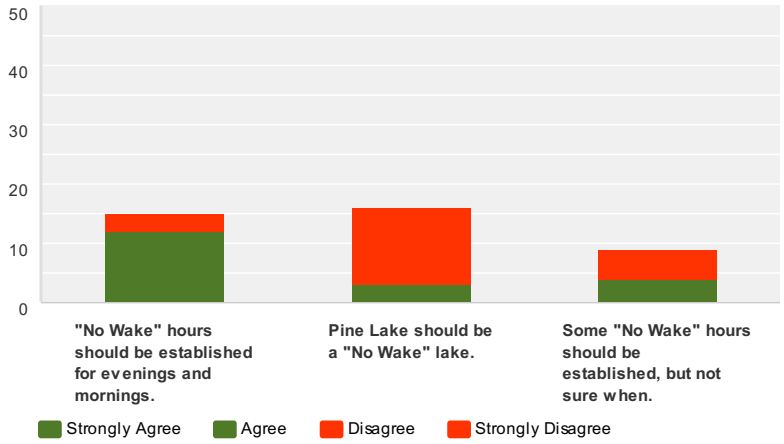
Answered: 18 Skipped: 0



Answer Choices	Responses	
Definitely Yes	22%	4
Probably Yes	39%	7
Probably No	6%	1
Definitely No	22%	4
Unsure	11%	2
Total		**18**

Q17 If you think the boating regulations should be adjusted...in what way?

Answered: 17 Skipped: 1

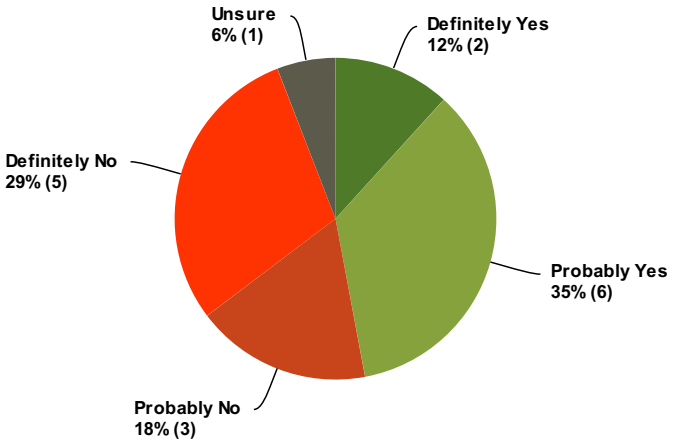


	Strongly Agree	Agree	Disagree	Strongly Disagree	Total Respondents
"No Wake" hours should be established for evenings and mornings.	**53%** 8.0	**27%** 4.0	**13%** 2.0	**7%** 1.0	15
Pine Lake should be a "No Wake" lake.	**19%** 3.0	**0%** 0.0	**25%** 4.0	**56%** 9.0	16
Some "No Wake" hours should be established, but not sure when.	**22%** 2.0	**22%** 2.0	**44%** 4.0	**11%** 1.0	9

#	Other (please specify)	Date
1	This lake needs to allow more recreation. Few grumpy land owners ruin the lake recreation.	7/17/2014 3:28 PM
2	make the public launch better by charging a "launch fee"!	7/16/2014 3:25 PM
3	Most people who I know on Pine Lake would like to see recreation boating allowed such as jet-ski or faster boating.	7/16/2014 12:34 PM
4	Pine lake should allow faster boats to help water flow.	7/16/2014 11:02 AM

Q18 Do you think there should be a boating speed limit on Pine Lake?

Answered: 17 Skipped: 1



Answer Choices	Responses	
Definitely Yes	12%	2
Probably Yes	35%	6
Probably No	18%	3
Definitely No	29%	5
Unsure	6%	1
Total		17

Q19 What could be done to improve your recreation experience on Pine Lake?

Answered: 16 Skipped: 2

#	Responses	Date
1	If water levels ever return to normal allow water skiing and water craft same as fish lake, it might get rid of all the dam muck, and increase property values.	7/22/2014 8:34 PM
2	Weed control	7/20/2014 11:23 PM
3	get rid of the overwelming weeds	7/19/2014 2:18 PM
4	Higher water and more fish.. Lake should be catch and release until fishery recovers.	7/18/2014 8:34 PM
5	Get the water level deeper and remove the "no Wake" during the day time! This lake could become a gold mine for the residents of Hancock.	7/17/2014 3:28 PM
6	Clean up this lake get rid of weeds. Bring water levels back. Improve the town bring in revenue with businesses and attractions. Enough with the bars booze and cigarettes turn this town around. Get a new town leader who has fresh ideas and cares about keeping property values! The streets need work the buildings are delapataded Pine lake needs to be properly managed !	7/16/2014 11:49 PM
7	get rid of the muskrats that are destroying the shoreline habitat	7/16/2014 10:23 PM
8	low water levels, weeds , no wake lake nothing to attract tourism	7/16/2014 10:17 PM
9	stock lake with fish and treat milfoil twice a year	7/16/2014 10:07 PM
10	dredge it out, open up springs, treat mill foil, make it a "wake" lake. charge boat launch fee, make a small beach. add fish to lake, improve town add shops and tourism.	7/16/2014 8:17 PM
11	clear out the muck on the outside edge of the lake to let the boaters use whole lake.	7/16/2014 3:25 PM
12	Do whatever it takes to increase the water level. The Village of Hancock should contribute money to help this Lake recover. Aslo, who is in charge of the down town area? What a dump it has become.	7/16/2014 12:34 PM
13	Allowing boats to drive faster on Pine Lake will help increse revenue and awareness to this almost "dead" lake. Dredge out old spring in bay to allow the lake to fill up again. This was done many years ago with success.	7/16/2014 12:22 PM
14	Help the Lake become deeper once again. Have the village add a public swimm area with groomed sany beach.	7/16/2014 11:02 AM
15	Remove the "No Wake" from the Lake.	7/16/2014 8:17 AM
16	Control milfoil growth	7/14/2014 7:28 PM

Pine Lake Hancock Survey #3

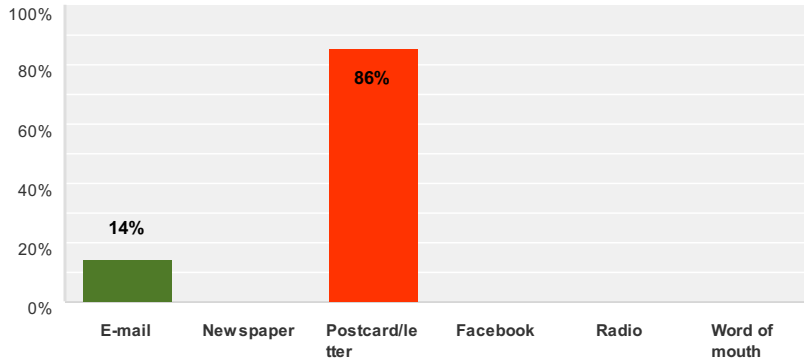
Q1 What is your Waushara County Lakes Study ID?

Answered: 7 Skipped: 0

#	Responses	Date
1	[redacted]	8/19/2014 10:08 AM
2	[redacted]	8/18/2014 9:34 PM
3	[redacted]	8/18/2014 12:37 PM
4	[redacted]	8/13/2014 3:21 PM
5	[redacted]	8/12/2014 5:56 PM
6	[redacted]	8/11/2014 1:20 PM
7	[redacted]	8/2/2014 10:07 AM

Q2 How did you hear about this survey?

Answered: 7 Skipped: 0

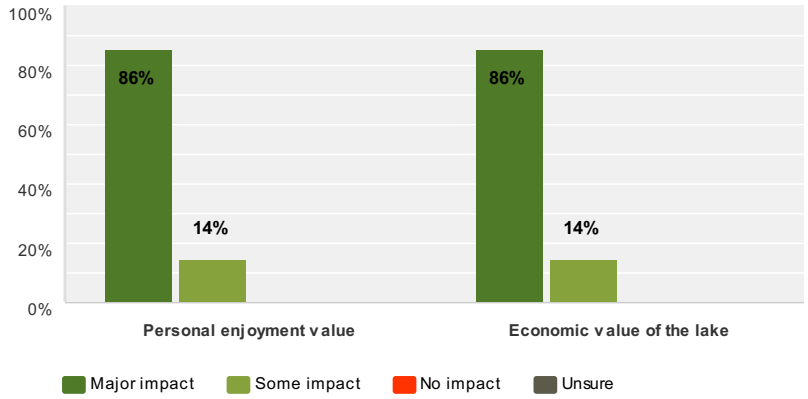


Answer Choices	Responses	
E-mail	14%	1
Newspaper	0%	0
Postcard/letter	86%	6
Facebook	0%	0
Radio	0%	0
Word of mouth	0%	0
Total		7

#	Other (please specify)	Date
	There are no responses.	

Q3 How much impact does the water quality of Pine Lake have on the following?

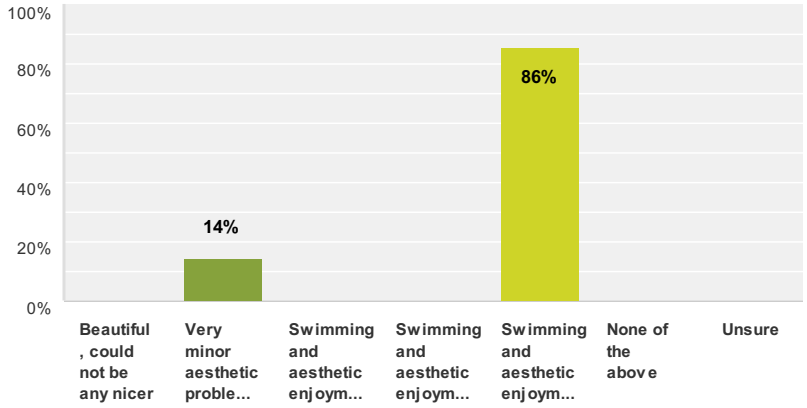
Answered: 7 Skipped: 0



	Major impact	Some impact	No impact	Unsure	Total
Personal enjoyment value	**86%** 6	**14%** 1	**0%** 0	**0%** 0	7
Economic value of the lake	**86%** 6	**14%** 1	**0%** 0	**0%** 0	7

Q4 Which statement best describes water clarity during the times you spend most on the lake?

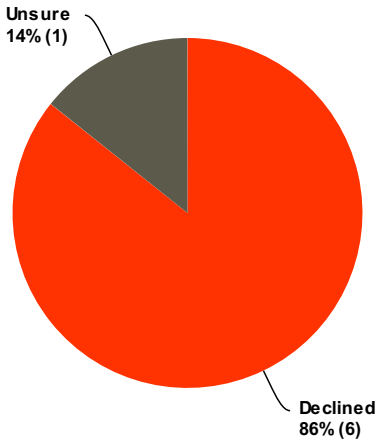
Answered: 7 Skipped: 0



Answer Choices	Responses	
Beautiful, could not be any nicer	0%	0
Very minor aesthetic problems; excellent for swimming and boating enjoyment	14%	1
Swimming and aesthetic enjoyment of the lake is slightly impaired because of algae	0%	0
Swimming and aesthetic enjoyment of the lake is moderately reduced because of algae	0%	0
Swimming and aesthetic enjoyment of the lake is substantially reduced because of algae	86%	6
None of the above	0%	0
Unsure	0%	0
Total		**7**

Q5 During the time that you have lived on, visited, or recreated on the lake, how would you say the water quality has changed?

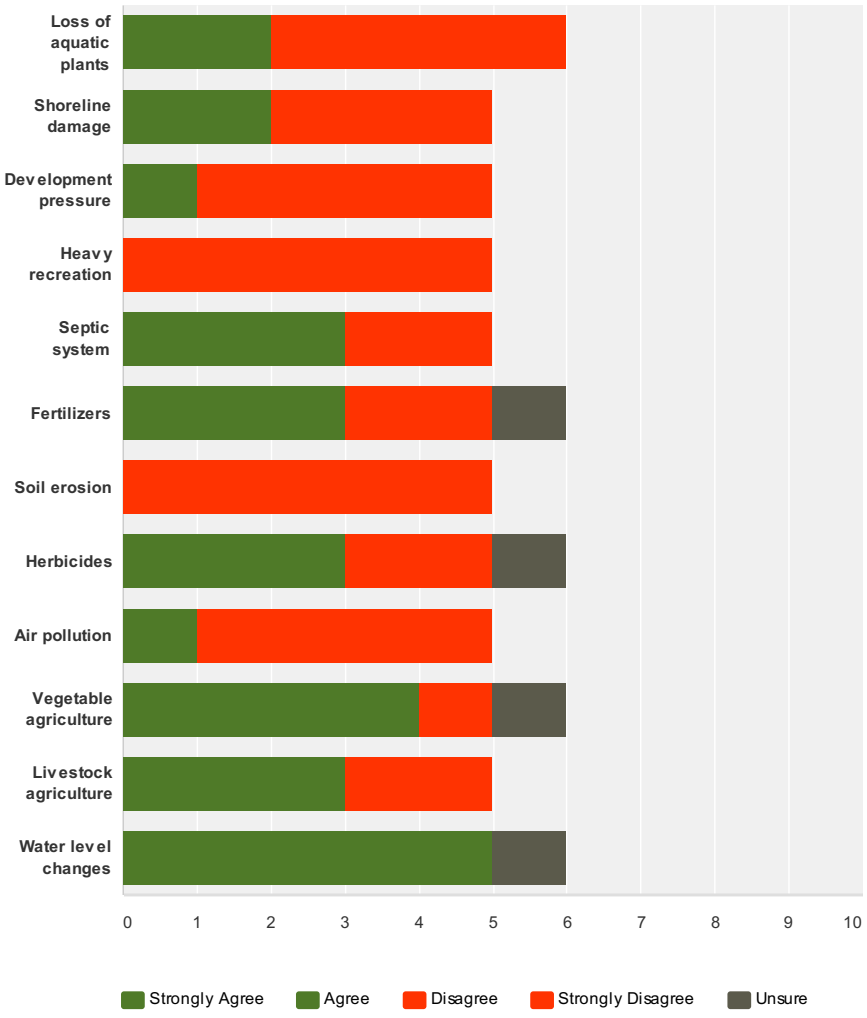
Answered: 7 Skipped: 0



Answer Choices	Responses	
Improved	0%	0
Declined	86%	6
Stayed the same	0%	0
Unsure	14%	1
Total		7

Q6 If it has declined, in your opinion, what are the primary causes?

Answered: 6 Skipped: 1

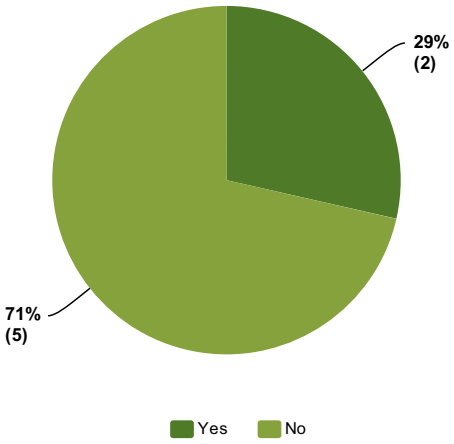


	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	Total Respondents
Loss of aquatic plants	33% 2.0	0% 0.0	17% 1.0	50% 3.0	0% 0.0	6
Shoreline damage	0% 0.0	40% 2.0	40% 2.0	20% 1.0	0% 0.0	5
Development pressure	20% 1.0	0% 0.0	40% 2.0	40% 2.0	0% 0.0	5
Heavy recreation	0% 0.0	0% 0.0	40% 2.0	60% 3.0	0% 0.0	5
Septic system	20% 1.0	40% 2.0	20% 1.0	20% 1.0	0% 0.0	5
Fertilizers	17% 1.0	33% 2.0	17% 1.0	17% 1.0	17% 1.0	6
Soil erosion	0% 0.0	0% 0.0	80% 4.0	20% 1.0	0% 0.0	5
Herbicides	33% 2.0	17% 1.0	17% 1.0	17% 1.0	17% 1.0	6
Air pollution	0% 0.0	20% 1.0	60% 3.0	20% 1.0	0% 0.0	5
Vegetable agriculture	67% 4.0	0% 0.0	17% 1.0	0% 0.0	17% 1.0	6
Livestock agriculture	60% 3.0	0% 0.0	20% 1.0	20% 1.0	0% 0.0	5

Water level changes	**83%** 5.0	**0%** 0.0	**0%** 0.0	**0%** 0.0	**17%** 1.0	6

Q7 Do you use herbicides or pesticides (i.e. "weed and feed") on your land?

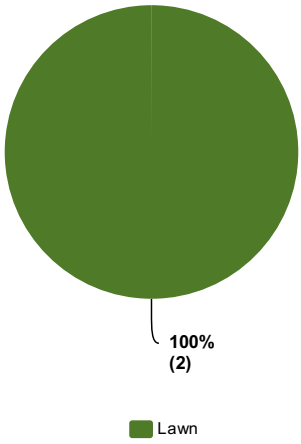
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	29%	2
No	71%	5
Total		7

Q8 Where do you apply herbicides and/or pesticides?

Answered: 2 Skipped: 5

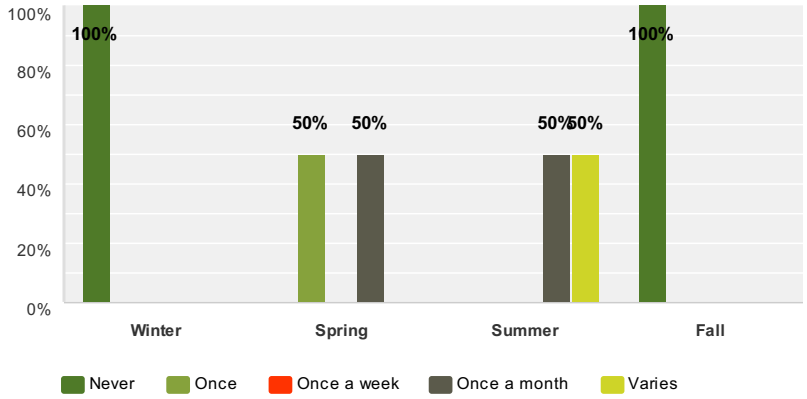


Answer Choices	Responses	
Agricultural fields	0%	0
Garden	0%	0
Lawn	100%	2
Total		2

#	Other (please specify)	Date
	There are no responses.	

Q9 In a typical year, how often do you apply herbicides and/or pesticides?

Answered: 2 Skipped: 5



	Never	Once	Once a week	Once a month	Varies	Total Respondents
Winter	**100%** 2	**0%** 0	**0%** 0	**0%** 0	**0%** 0	2
Spring	**0%** 0	**50%** 1	**0%** 0	**50%** 1	**0%** 0	2
Summer	**0%** 0	**0%** 0	**0%** 0	**50%** 1	**50%** 1	2
Fall	**100%** 2	**0%** 0	**0%** 0	**0%** 0	**0%** 0	2

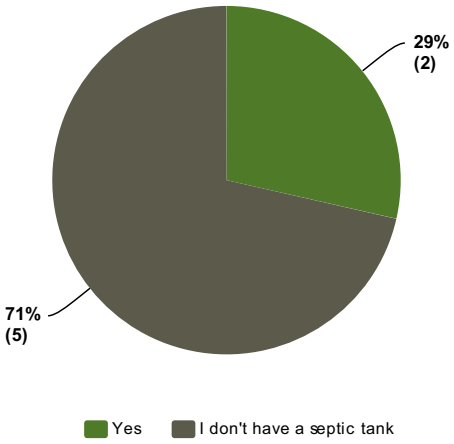
Q10 If you apply herbicides and/or pesticides on lakefront property, how close to the lake are they applied (select the closest distance to the lake where herbicides/pesticides are applied)?

Answered: 2 Skipped: 5

Answer Choices	Responses	
I do not apply herbicides/pesticides on lakefront property	0%	0
Up to the lake	0%	0
Within 35 feet of the lake	0%	0
Farther than 35 feet from the lake.	100%	2
Total		2

Q11 Do you have your septic tank pumped at least every 3 years?

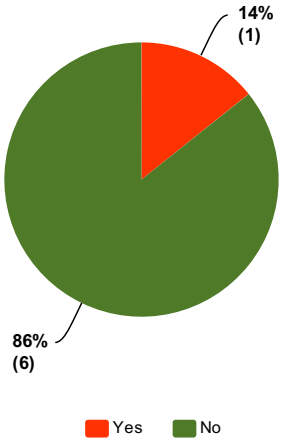
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	29%	2
No	0%	0
I don't have a septic tank	71%	5
Total		7

Q12 Do you use fertilizer on your land?

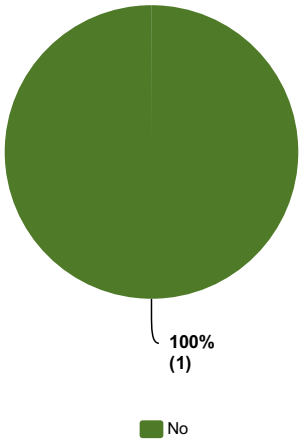
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	14%	1
No	86%	6
Total		7

Q13 Do you use fertilizer which contains phosphorus?

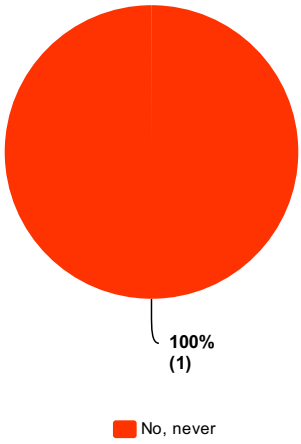
Answered: 1 Skipped: 6



Answer Choices	Responses	
Yes	0%	0
No	100%	1
I don't know	0%	0
Total		1

Q14 Do you have your soil tested before applying fertilizer?

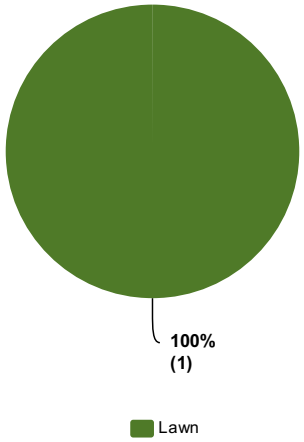
Answered: 1 Skipped: 6



Answer Choices	Responses	
Yes, all of the time	0%	0
Yes, some of the time	0%	0
No, never	100%	1
Total		1

Q15 Where do you apply fertilizer?

Answered: 1 Skipped: 6

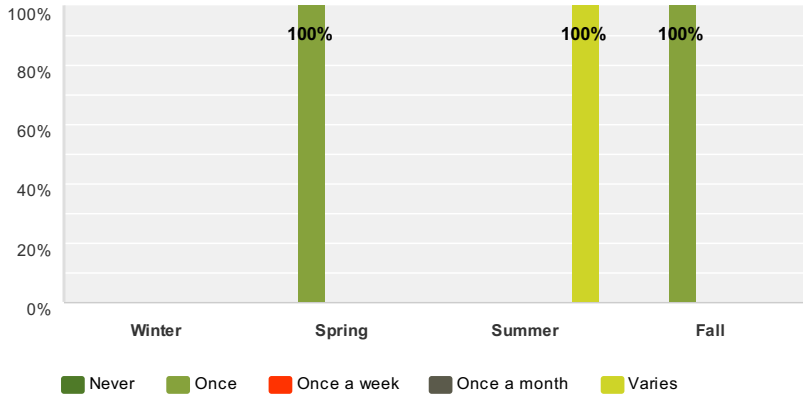


Answer Choices	Responses	
Agricultural fields	0%	0
Garden	0%	0
Lawn	100%	1
Total		1

#	Other (please specify)	Date
	There are no responses.	

Q16 In a typical year, how often do you apply fertilizer?

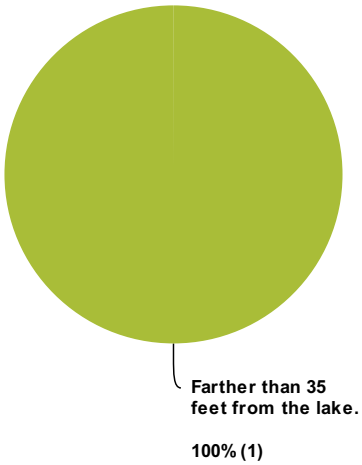
Answered: 1 Skipped: 6



	Never	Once	Once a week	Once a month	Varies	Total Respondents
Winter	0% 0	0% 0	0% 0	0% 0	0% 0	0
Spring	0% 0	100% 1	0% 0	0% 0	0% 0	1
Summer	0% 0	0% 0	0% 0	0% 0	100% 1	1
Fall	0% 0	100% 1	0% 0	0% 0	0% 0	1

Q17 If you apply fertilzer on lakefront property, how close to the lake is it applied (select the closest distance to the lake where fertilzer is applied)?

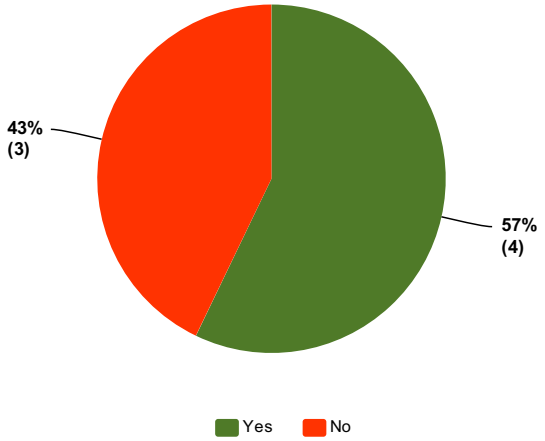
Answered: 1 Skipped: 6



Answer Choices	Responses	
I do not apply fertilizer on lakefront property	0%	0
Up to the lake	0%	0
Within 35 feet of the lake	0%	0
Farther than 35 feet from the lake.	100%	1
Total		1

Q18 Before reading the previous paragraph, did you know about the effects of phosphorus on lakes?

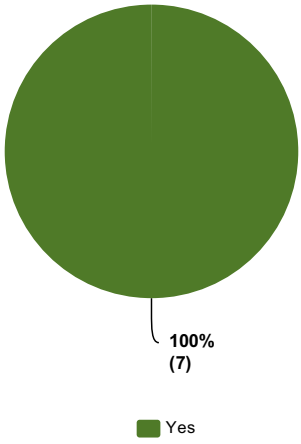
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	57%	4
No	43%	3
Unsure	0%	0
Total		7

Q19 Do you own shoreland property?

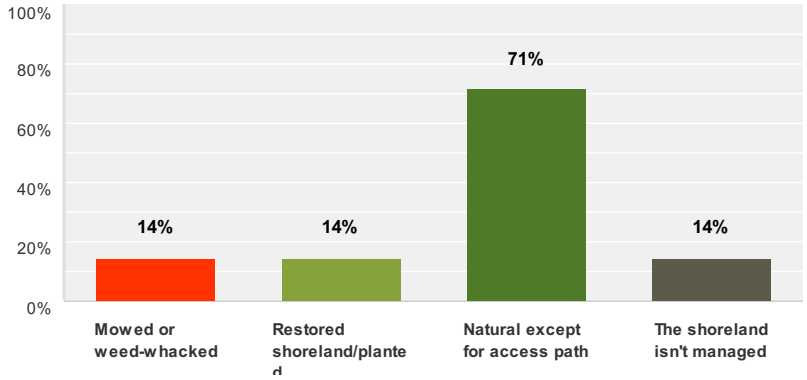
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	100%	7
No	0%	0
Total		7

Q20 How do you currently manage the majority of your property within 35 feet of the lake? Check all that apply.

Answered: 7 Skipped: 0

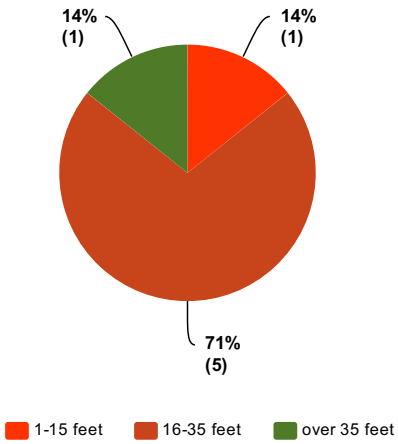


Answer Choices	Responses	
Mowed or weed-whacked	14%	1
Restored shoreland/planted	14%	1
Natural except for access path	71%	5
The shoreland isn't managed	14%	1
Total Respondents: 7		

#	Other (please specify)	Date
	There are no responses.	

Q21 If you have unmowed shoreland vegetation, how far inland from the water's edge does it extend?

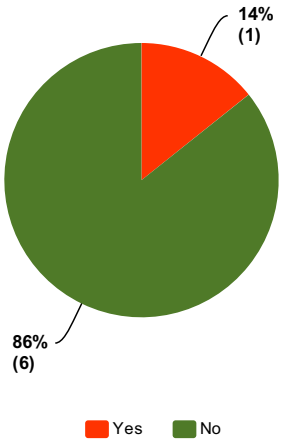
Answered: 7 Skipped: 0



Answer Choices	Responses	
I do not have unmowed shoreland vegetation	0%	0
1-15 feet	14%	1
16-35 feet	71%	5
over 35 feet	14%	1
Total		7

Q22 Have you observed erosion from your path to the lake?

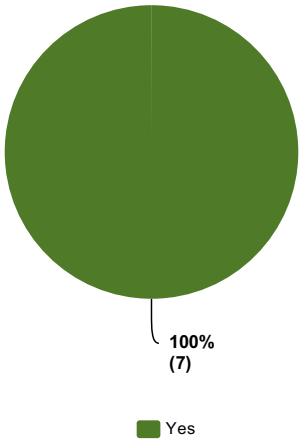
Answered: 7 Skipped: 0



Answer Choices	Responses	
I have no path	0%	0
Yes	14%	1
No	86%	6
Unsure	0%	0
Total		**7**

Q23 Did you understand the importance of shoreland vegetation before reading this?

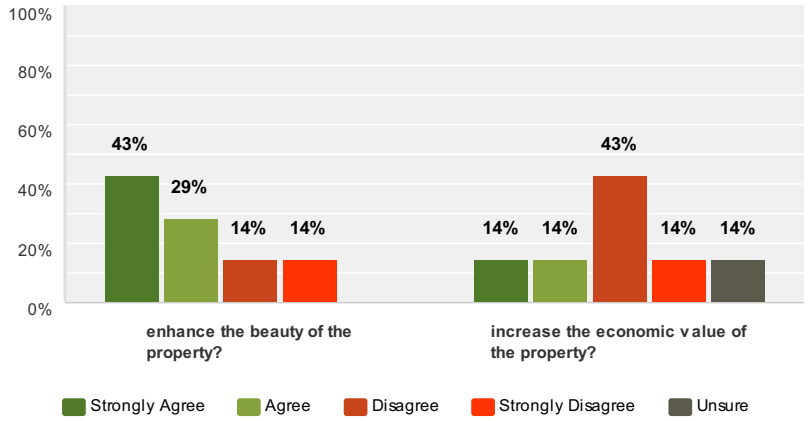
Answered: 7 Skipped: 0



Answer Choices	Responses	
Yes	100%	7
No	0%	0
Unsure	0%	0
Total		7

Q24 In your opinion, does shoreland vegetation...

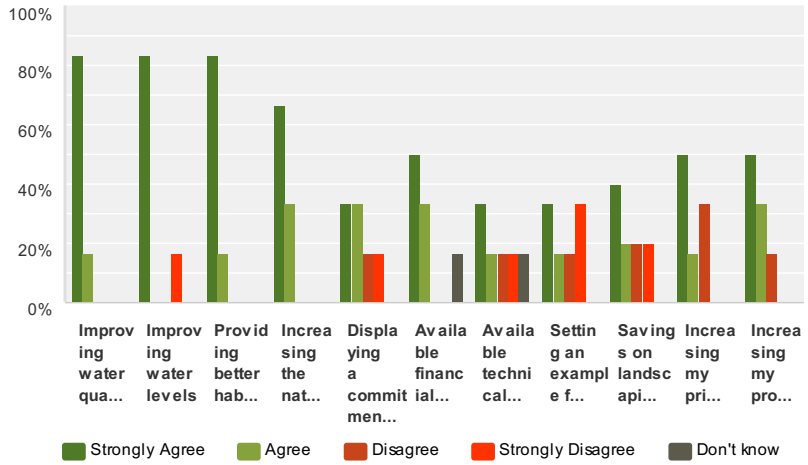
Answered: 7 Skipped: 0



	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	Total
enhance the beauty of the property?	43% 3	29% 2	14% 1	14% 1	0% 0	7
increase the economic value of the property?	14% 1	14% 1	43% 3	14% 1	14% 1	7

Q25 What might motivate you to change how you manage your land?

Answered: 6 Skipped: 1



	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't know	Total
Improving water quality	83% 5	17% 1	0% 0	0% 0	0% 0	6
Improving water levels	83% 5	0% 0	0% 0	17% 1	0% 0	6
Providing better habitat for fish and wildlife	83% 5	17% 1	0% 0	0% 0	0% 0	6
Increasing the natural beauty of my property	67% 4	33% 2	0% 0	0% 0	0% 0	6
Displaying a commitment to the environment	33% 2	33% 2	17% 1	17% 1	0% 0	6
Available financial assistance	50% 3	33% 2	0% 0	0% 0	17% 1	6
Available technical assistance	33% 2	17% 1	17% 1	17% 1	17% 1	6
Setting an example for community members	33% 2	17% 1	17% 1	33% 2	0% 0	6
Savings on landscaping/maintenance costs	40% 2	20% 1	20% 1	20% 1	0% 0	5
Increasing my privacy	50% 3	17% 1	33% 2	0% 0	0% 0	6
Increasing my property value	50% 3	33% 2	17% 1	0% 0	0% 0	6

#	Other (please specify)	Date
	There are no responses.	

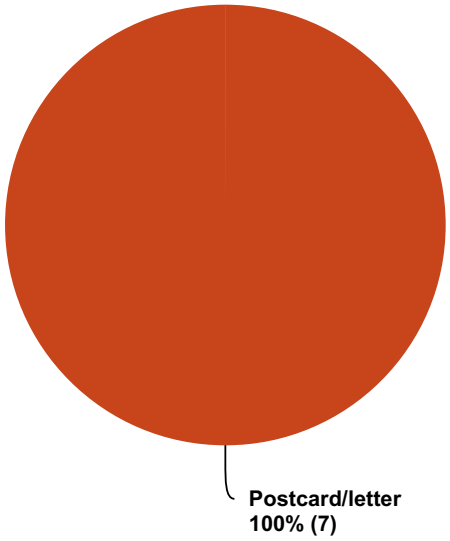
Q1 Enter your Waushara County Lakes Survey ID. If you've forgotten your ID or haven't created one yet, follow the instructions below.

Answered: 8 Skipped: 0

#	Responses	Date
1	[redacted]	9/22/2014 10:06 PM
2	[redacted]	9/21/2014 11:49 AM
3	[redacted]	9/20/2014 12:36 AM
4	[redacted]	9/18/2014 1:45 PM
5	[redacted]	9/15/2014 12:30 PM
6	[redacted]	9/13/2014 5:28 PM
7	[redacted]	9/13/2014 5:15 PM
8	[redacted]	8/2/2014 10:12 AM

Q2 How did you hear about this survey?

Answered: 7 Skipped: 1

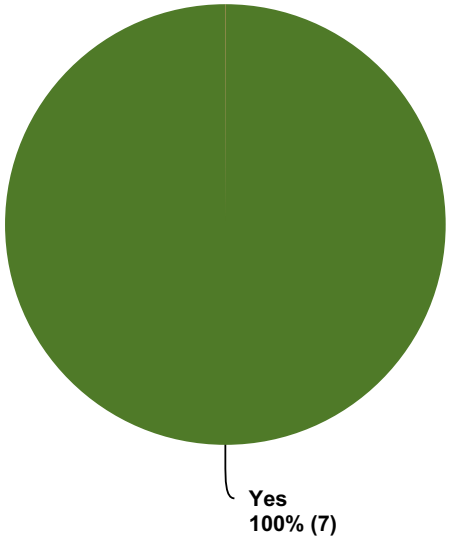


Answer Choices	Responses	
E-mail	0%	0
Newspaper	0%	0
Postcard/letter	100%	7
Facebook	0%	0
Radio	0%	0
Total		7

#	Other (please specify)	Date
1	property owner	9/18/2014 1:45 PM

Q3 Were you aware of the importance of aquatic plants?

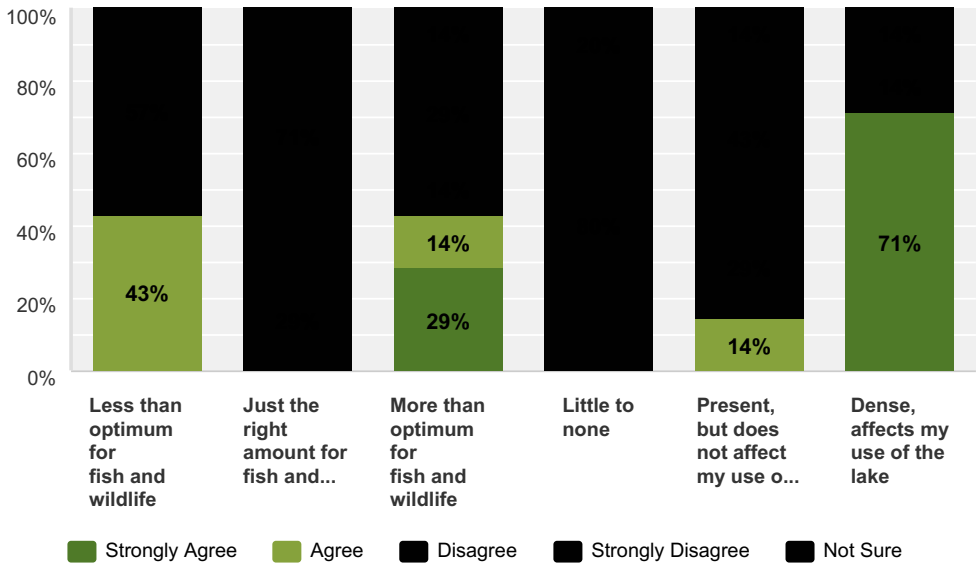
Answered: 7 Skipped: 1



Answer Choices	Responses	
Yes	100%	7
No	0%	0
Unsure	0%	0
Total		7

Q4 In your opinion, which statement best describes the amount of aquatic plant growth in Pine Lake?

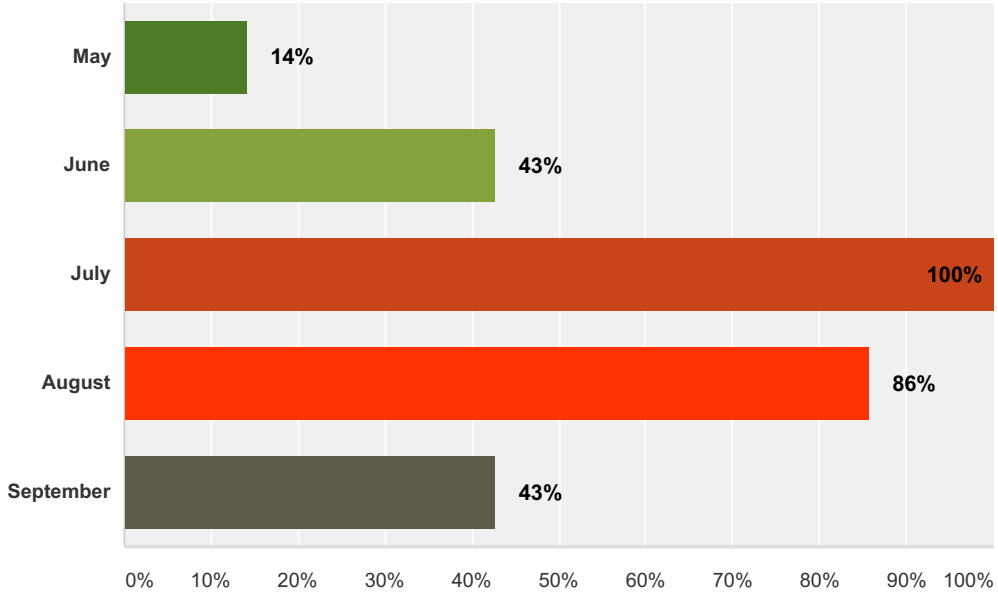
Answered: 7 Skipped: 1



	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure	Total
Less than optimum for fish and wildlife	0% 0	43% 3	0% 0	57% 4	0% 0	7
Just the right amount for fish and wildlife	0% 0	0% 0	29% 2	71% 5	0% 0	7
More than optimum for fish and wildlife	29% 2	14% 1	14% 1	29% 2	14% 1	7
Little to none	0% 0	0% 0	0% 0	80% 4	20% 1	5
Present, but does not affect my use of the lake	0% 0	14% 1	29% 2	43% 3	14% 1	7
Dense, affects my use of the lake	71% 5	0% 0	0% 0	14% 1	14% 1	7

Q5 If you selected dense or choked, what month(s) do the problems occur? Check all that apply.

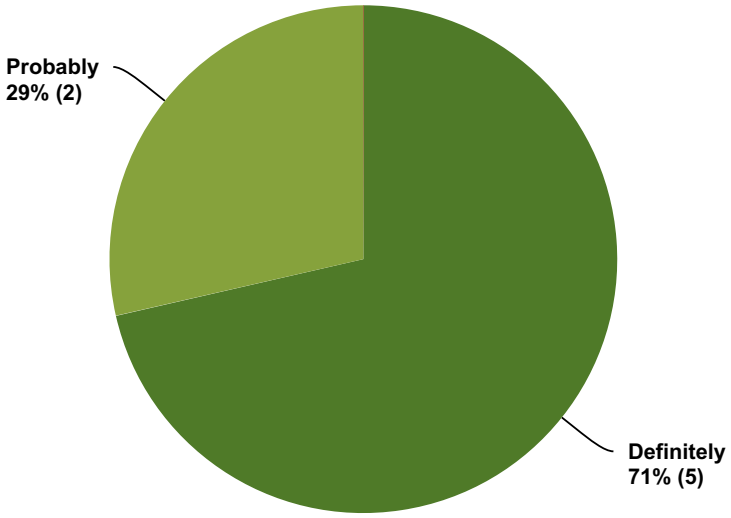
Answered: 7 Skipped: 1



Answer Choices	Responses	
May	14%	1
June	43%	3
July	100%	7
August	86%	6
September	43%	3
Total Respondents: 7		

Q6 Do you believe aquatic plant control is needed on Pine Lake?

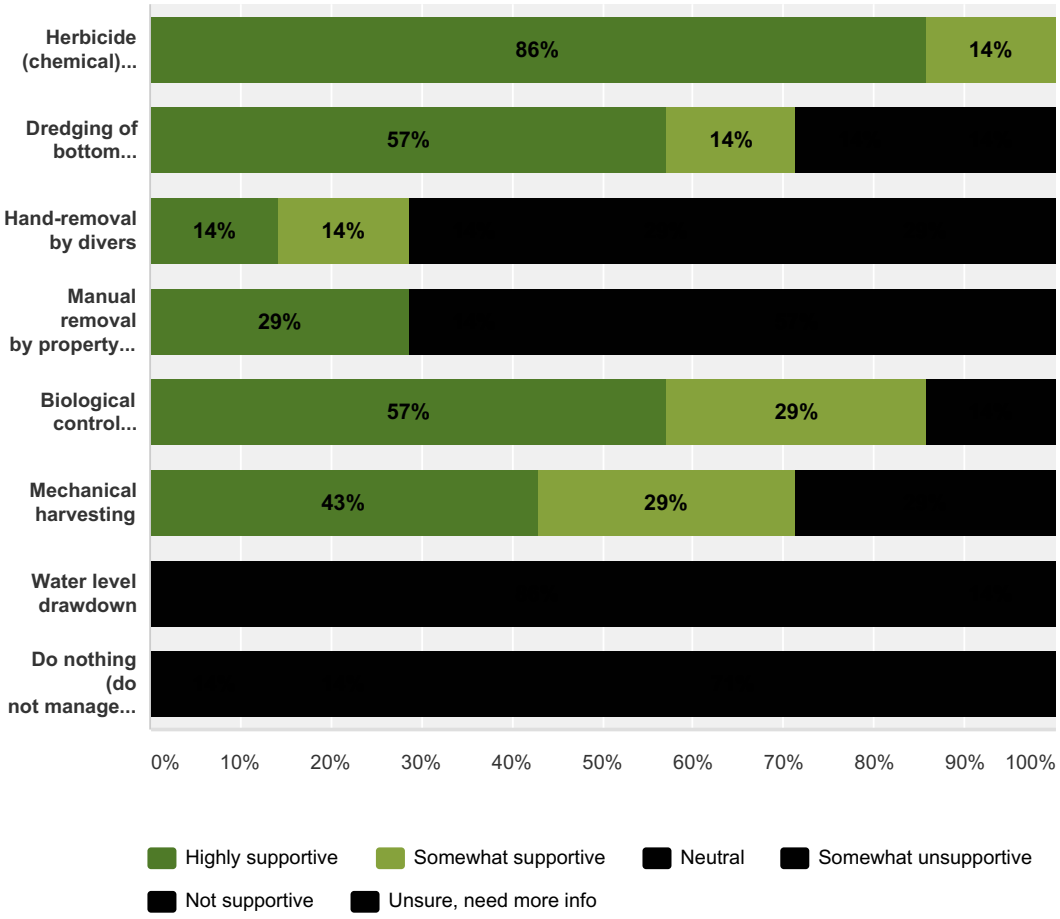
Answered: 7 Skipped: 1



Answer Choices	Responses	
Definitely	71%	5
Probably	29%	2
Unsure	0%	0
Probably not	0%	0
Definitely not	0%	0
Total		7

Q7 What is your level of support for the responsible use of the following techniques TO MANAGE AQUATIC PLANTS on Pine Lake?

Answered: 7 Skipped: 1

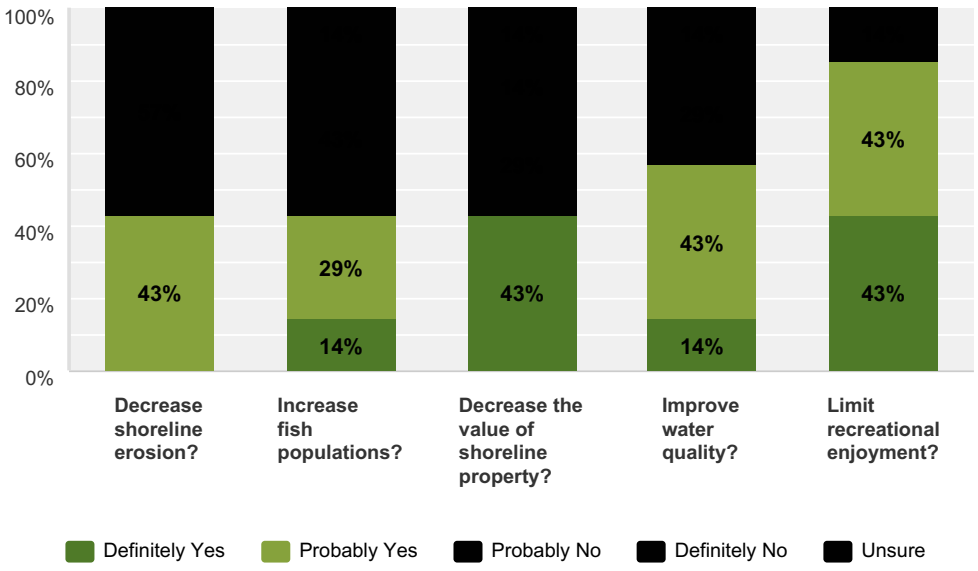


	Highly supportive	Somewhat supportive	Neutral	Somewhat unsupportive	Not supportive	Unsure, need more info	Total	Average Rating
Herbicide (chemical) control	86% 6	14% 1	0% 0	0% 0	0% 0	0% 0	7	1.14
Dredging of bottom sediments	57% 4	14% 1	0% 0	0% 0	14% 1	14% 1	7	1.57
Hand-removal by divers	14% 1	14% 1	0% 0	14% 1	29% 2	29% 2	7	2.43
Manual removal by property owners	29% 2	0% 0	0% 0	14% 1	57% 4	0% 0	7	3.71
Biological control (milfoil weevil, loosestrife beetle, etc.)	57% 4	29% 2	0% 0	0% 0	14% 1	0% 0	7	1.86
Mechanical harvesting	43% 3	29% 2	0% 0	0% 0	29% 2	0% 0	7	2.43

Water level drawdown	**0%** 0	**0%** 0	**0%** 0	**0%** 0	**86%** 6	**14%** 1	7	4.29
Do nothing (do not manage plants)	**0%** 0	**0%** 0	**14%** 1	**14%** 1	**71%** 5	**0%** 0	7	4.57

Q8 In your opinion, does establishing or maintaining native vegetation IN THE WATER in the near-shore area…

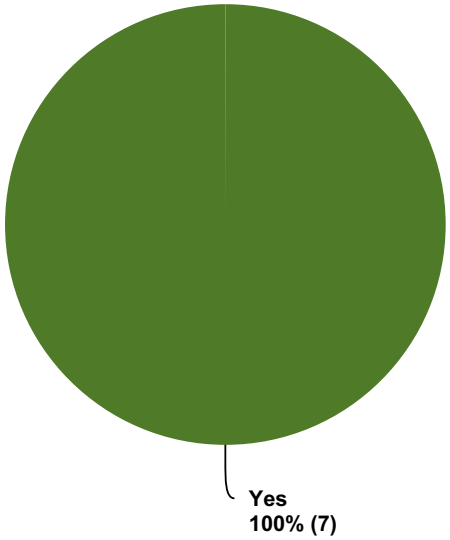
Answered: 7 Skipped: 1



	Definitely Yes	Probably Yes	Probably No	Definitely No	Unsure	Total
Decrease shoreline erosion?	0% 0	43% 3	57% 4	0% 0	0% 0	7
Increase fish populations?	14% 1	29% 2	43% 3	0% 0	14% 1	7
Decrease the value of shoreline property?	43% 3	0% 0	29% 2	14% 1	14% 1	7
Improve water quality?	14% 1	43% 3	29% 2	14% 1	0% 0	7
Limit recreational enjoyment?	43% 3	43% 3	14% 1	0% 0	0% 0	7

Q9 Have you ever heard of aquatic invasive species?

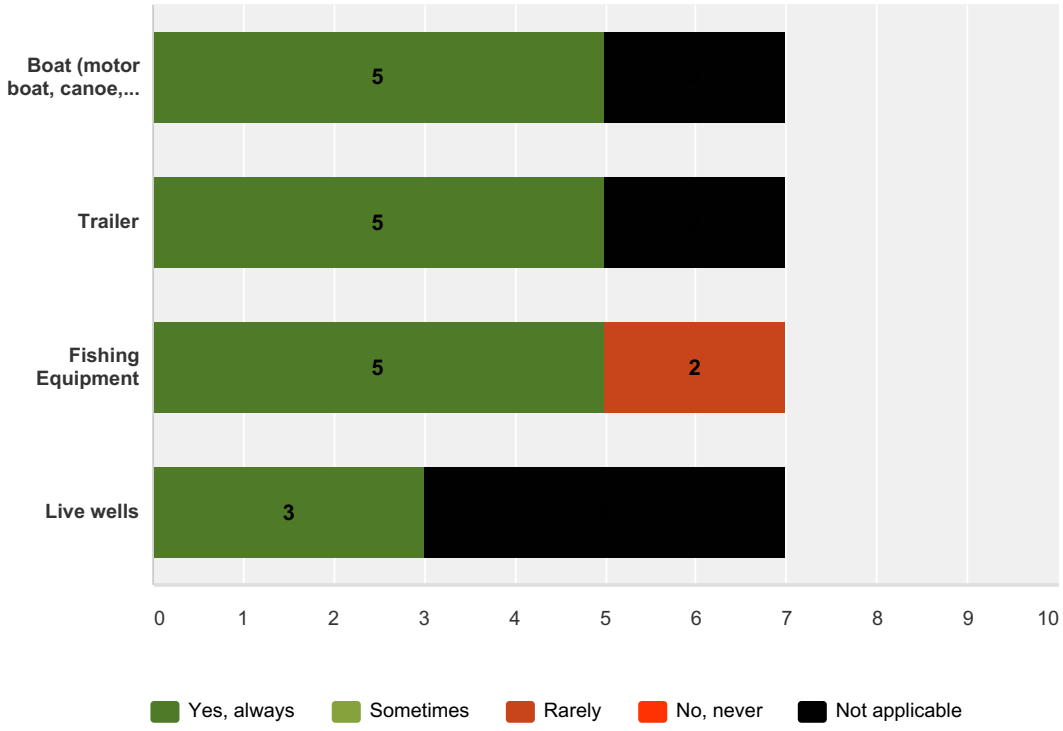
Answered: 7 Skipped: 1



Answer Choices	Responses	
Yes	100%	7
No	0%	0
Total		7

Q10 After you have been to another lake, do you clean your ... before bringing it back to Pine Lake?

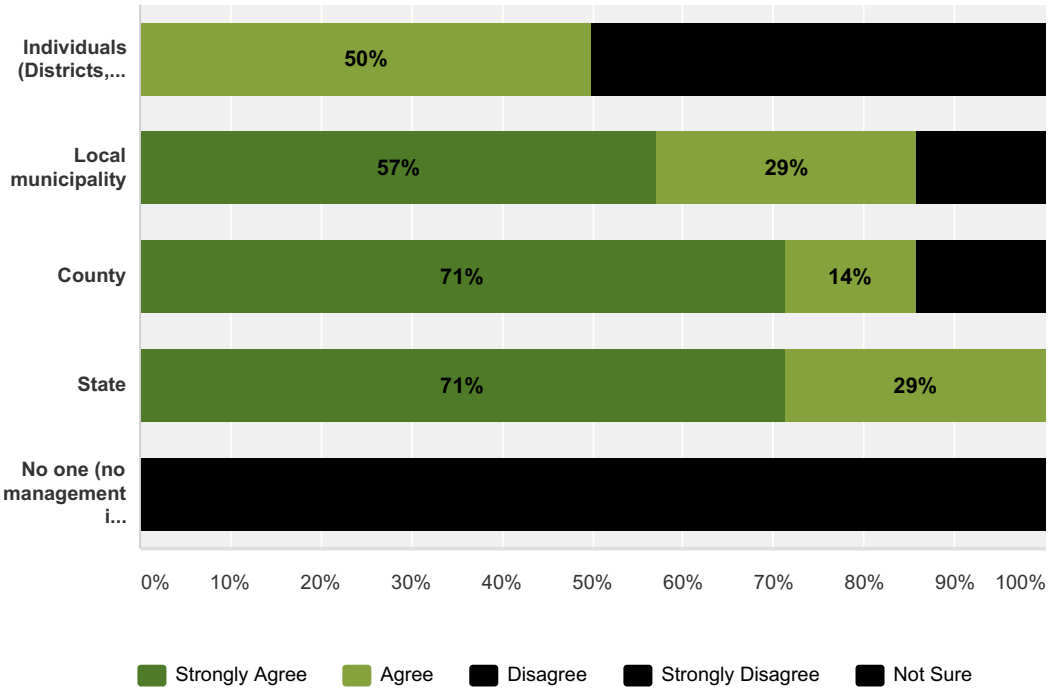
Answered: 7 Skipped: 1



	Yes, always	Sometimes	Rarely	No, never	Not applicable	Total Respondents
Boat (motor boat, canoe, kayak, etc.)	**71%** 5	**0%** 0	**0%** 0	**0%** 0	**29%** 2	7
Trailer	**71%** 5	**0%** 0	**0%** 0	**0%** 0	**29%** 2	7
Fishing Equipment	**71%** 5	**0%** 0	**29%** 2	**0%** 0	**0%** 0	7
Live wells	**43%** 3	**0%** 0	**0%** 0	**0%** 0	**57%** 4	7

Q11 Who should pay for the cost of managing invasive aquatic plants? Check all that apply.

Answered: 7 Skipped: 1

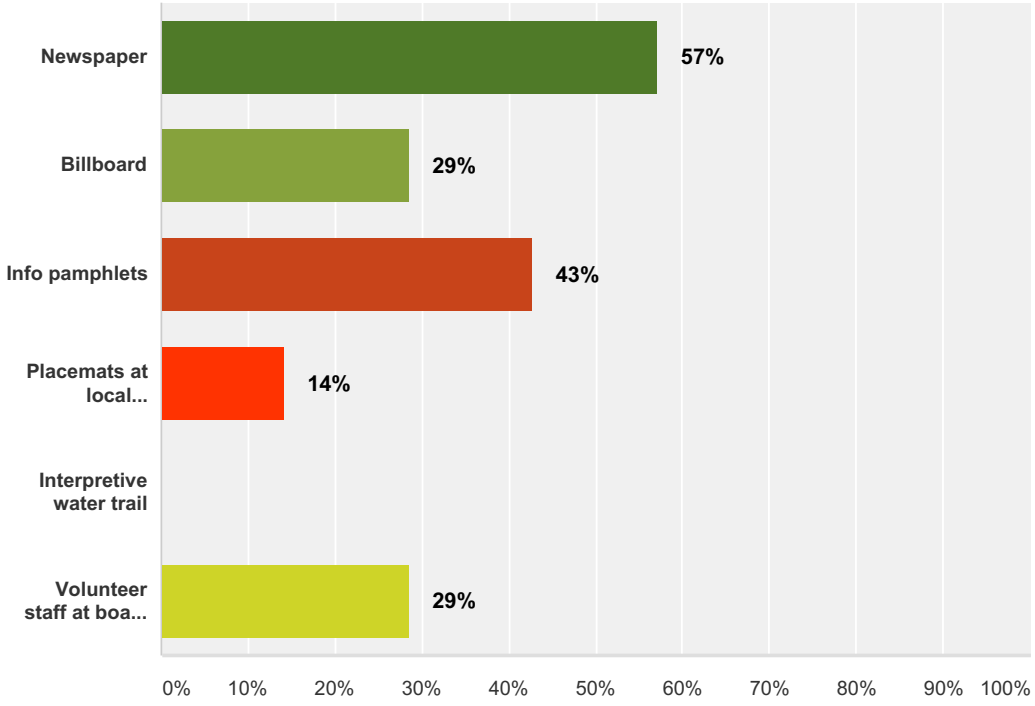


	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure	Total
Individuals (Districts, associations, lakefront property owners)	**0%** 0	**50%** 3	**17%** 1	**33%** 2	**0%** 0	6
Local municipality	**57%** 4	**29%** 2	**14%** 1	**0%** 0	**0%** 0	7
County	**71%** 5	**14%** 1	**14%** 1	**0%** 0	**0%** 0	7
State	**71%** 5	**29%** 2	**0%** 0	**0%** 0	**0%** 0	7
No one (no management is undertaken)	**0%** 0	**0%** 0	**0%** 0	**75%** 3	**25%** 1	4

#	Other (please specify)	Date
1	Boat launch fees	9/20/2014 12:41 AM
2	managing the weeds is a waste of time and resources if the lake dries up.	8/2/2014 10:20 AM

Q12 What is the most effective way to inform others about aquatic invasive species?

Answered: 7 Skipped: 1

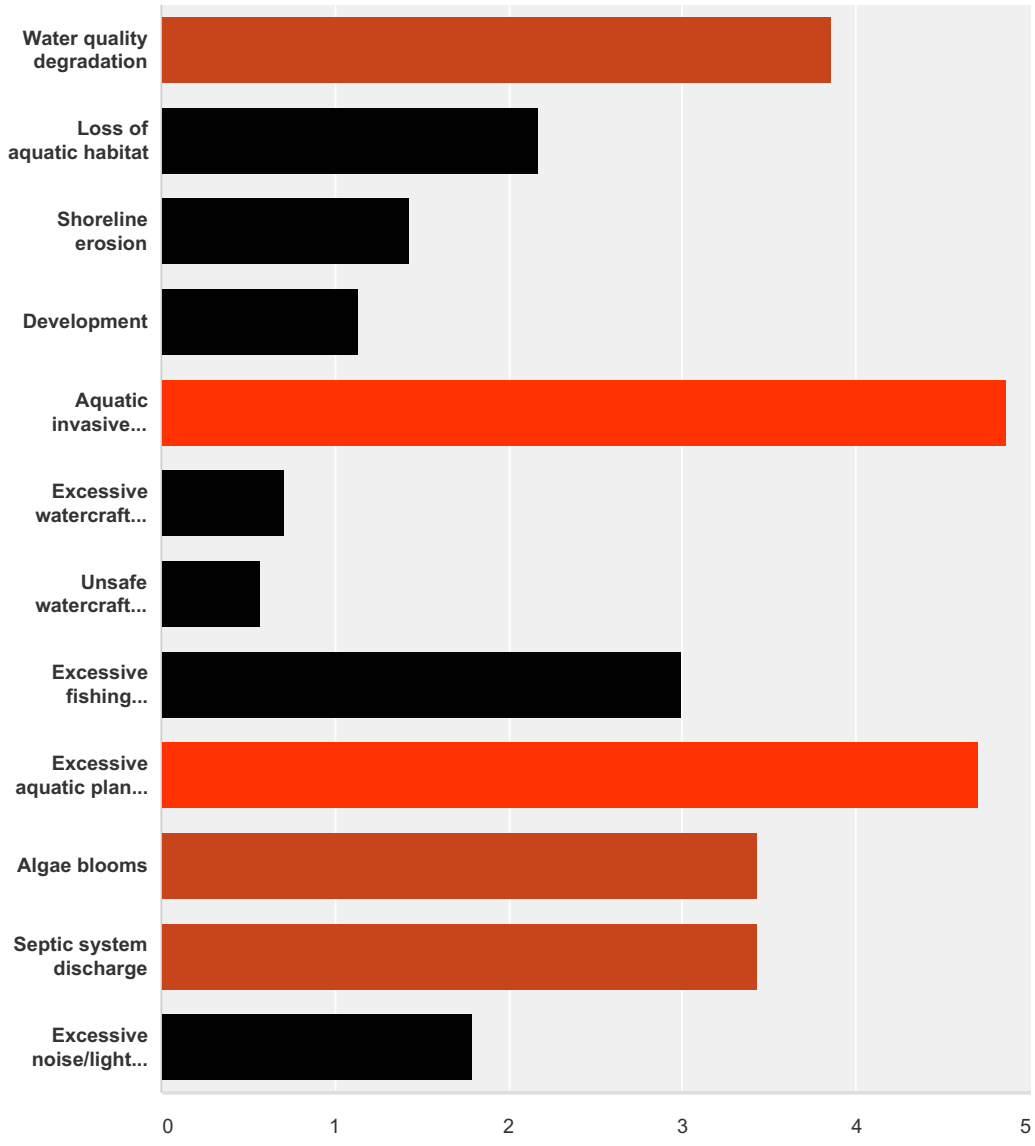


Answer Choices	Responses	
Newspaper	57%	4
Billboard	29%	2
Info pamphlets	43%	3
Placemats at local restaurants	14%	1
Interpretive water trail	0%	0
Volunteer staff at boat launch	29%	2
Total Respondents: 7		

#	Other (please specify)	Date
1	Boat License Applications	9/22/2014 10:33 PM

Q13 Below is a list of possible negative impacts commonly found in Wisconsin lakes. To what level do you believe each of the following factors may be impacting Pine Lake? (Please rate 0 - 5)* Not Present means that you believe the issue does not exist on Pine Lake.**No Impact means that the issue may exist on Pine Lake but it is not negatively impacting the lake.

Answered: 7 Skipped: 1



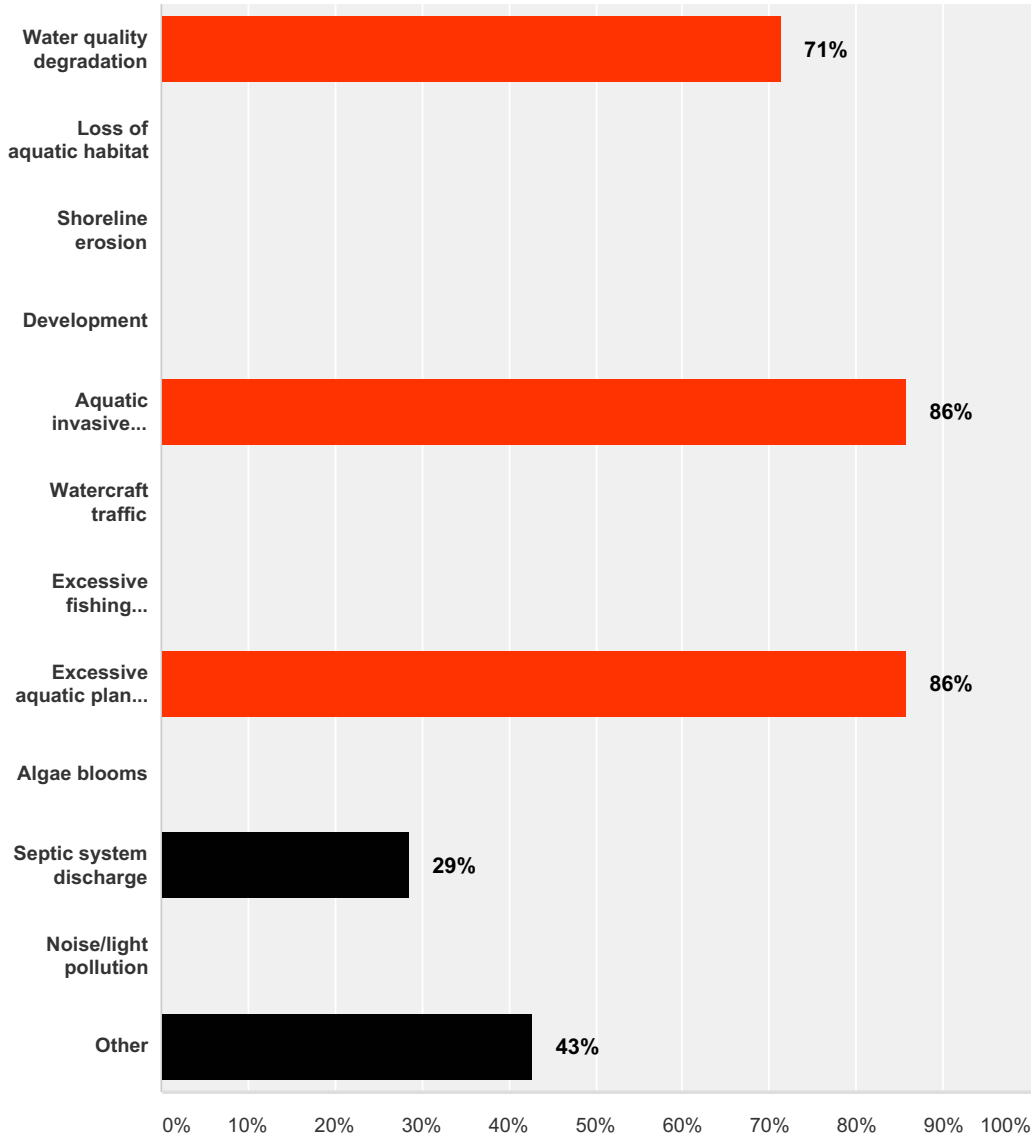
	*Not present 0	**No Impact 1	2	Moderately negative impact 3	4	Great negative impact 5	Unsure - need more info	Total	Average Rating

Water quality degradation	**0%** 0	**0%** 0	**14%** 1	**29%** 2	**14%** 1	**43%** 3	**0%** 0	7	3.86
Loss of aquatic habitat	**17%** 1	**17%** 1	**17%** 1	**33%** 2	**17%** 1	**0%** 0	**0%** 0	6	2.17
Shoreline erosion	**14%** 1	**57%** 4	**0%** 0	**29%** 2	**0%** 0	**0%** 0	**0%** 0	7	1.43
Development	**29%** 2	**43%** 3	**14%** 1	**14%** 1	**0%** 0	**0%** 0	**0%** 0	7	1.14
Aquatic invasive species introduction	**0%** 0	**0%** 0	**0%** 0	**0%** 0	**14%** 1	**86%** 6	**0%** 0	7	4.86
Excessive watercraft traffic	**57%** 4	**14%** 1	**29%** 2	**0%** 0	**0%** 0	**0%** 0	**0%** 0	7	0.71
Unsafe watercraft practices	**71%** 5	**14%** 1	**0%** 0	**14%** 1	**0%** 0	**0%** 0	**0%** 0	7	0.57
Excessive fishing pressure	**14%** 1	**29%** 2	**0%** 0	**0%** 0	**14%** 1	**43%** 3	**0%** 0	7	3.00
Excessive aquatic plant growth (excluding algae)	**0%** 0	**0%** 0	**0%** 0	**14%** 1	**0%** 0	**86%** 6	**0%** 0	7	4.71
Algae blooms	**0%** 0	**14%** 1	**14%** 1	**29%** 2	**0%** 0	**43%** 3	**0%** 0	7	3.43
Septic system discharge	**0%** 0	**29%** 2	**0%** 0	**14%** 1	**14%** 1	**43%** 3	**0%** 0	7	3.43
Excessive noise/light pollution	**60%** 3	**0%** 0	**0%** 0	**0%** 0	**20%** 1	**20%** 1	**0%** 0	5	1.80

#	Other (please specify)	Date
1	Irresponsible agricultural practices	9/21/2014 11:58 AM
2	The biggest effect to Hancock Lake is low water levels from nearby irrigation. The DNR needs to be involved in controlling the amount of water that is wasted by farmers.	9/13/2014 5:26 PM

Q14 From the list below, please mark your top three concerns regarding Pine Lake.

Answered: 7 Skipped: 1



Answer Choices	Responses	
Water quality degradation	71%	5
Loss of aquatic habitat	0%	0
Shoreline erosion	0%	0
Development	0%	0
Aquatic invasive species introduction	86%	6
Watercraft traffic	0%	0

Excessive fishing pressure	**0%**	0
Excessive aquatic plant growth (excluding algae)	**86%**	6
Algae blooms	**0%**	0
Septic system discharge	**29%**	2
Noise/light pollution	**0%**	0
Other	**43%**	3
Total Respondents: 7		

Waushara County Lakes Study

Pine Lake

Spring 2014

University of Wisconsin-Stevens Point

University of Wisconsin
Stevens Point

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PINE LAKE STUDY RESULTS

WAUSHARA COUNTY LAKES STUDY BACKGROUND

Lakes and rivers contribute to the way of life in Waushara County. Local residents and visitors alike enjoy fishing, swimming, boating, wildlife viewing, and the peaceful nature of the lakes. Healthy lakes add value to our communities. They provide places to relax and recreate, and they can stimulate tourism. Like other infrastructure in our communities, lakes require attention and good management practices to remain healthy in our developing watersheds.

Thirty-three lakes in Waushara County were selected for this study. The study focused on learning about the lakes' water quality, aquatic plant communities, shoreland habitats, watersheds and histories in order to help people make informed lake management decisions. This report summarizes data collected for Pine Lake between fall 2010 and fall 2012.

ABOUT PINE LAKE

To understand a lake and its potential for water quality, fish and wildlife, and recreational opportunities, we need to understand its physical characteristics and setting within the surrounding landscape. Pine Lake is located in the southwestern corner of the township of Hancock, south of County Highway V, with one public boat launch located on its eastern side. Pine Lake is a 104 acre seepage lake with surface runoff and groundwater contributing most of its water. The maximum depth in Pine Lake is 21 feet; the lakebed has a gradual to moderate slope (Figure 1). Its bottom sediments are mostly muck with a small amount of sand on its southern edge.

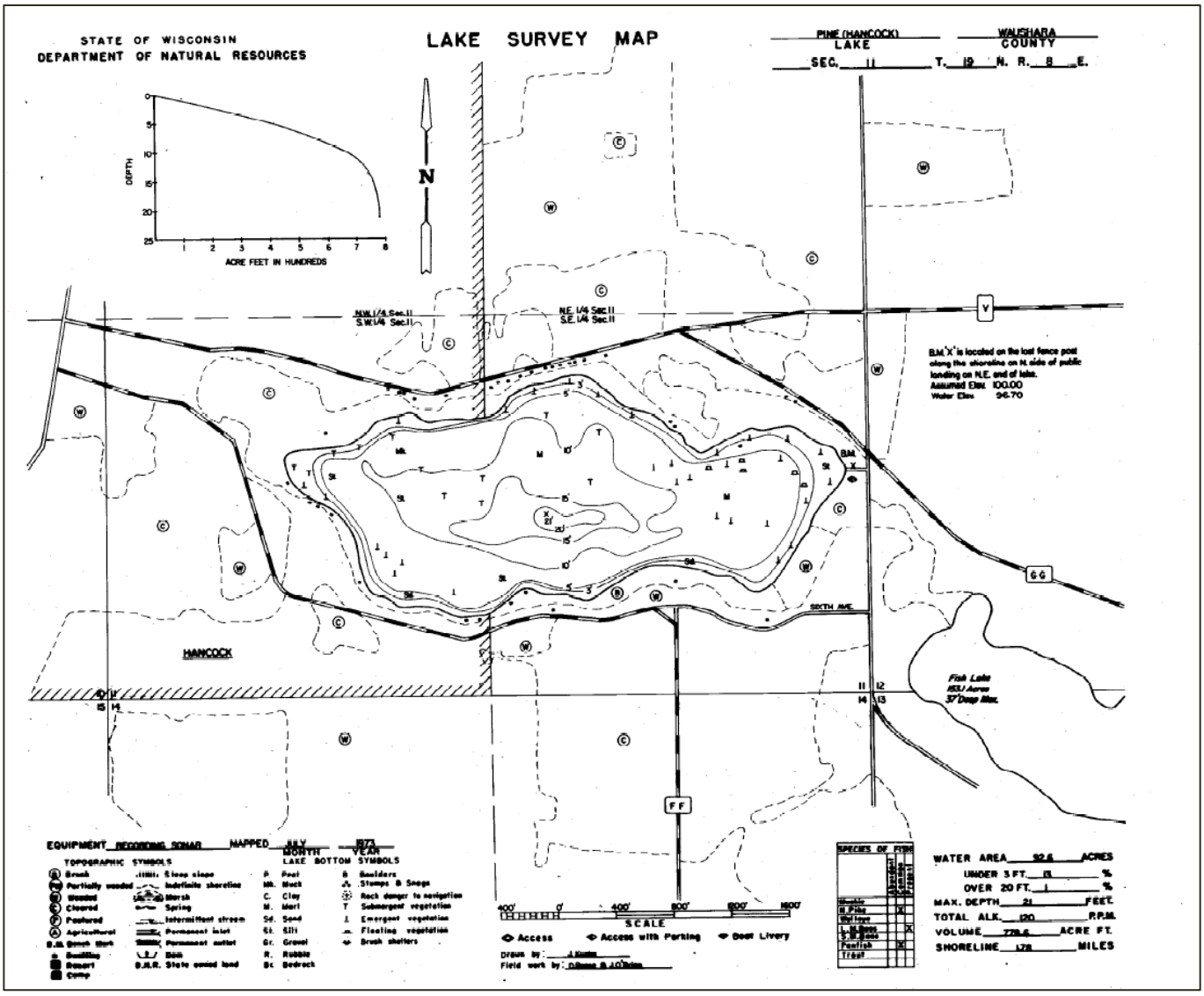


FIGURE 1. CONTOUR MAP OF THE PINE LAKE LAKEBED.

WHERE IS THE WATER COMING FROM? - WATERSHEDS AND LAND USE

The water quality in Pine Lake is a reflection of the land that drains to it. The water quality, the amount of algae, aquatic plants, the fishery and other animals in the lake are all affected by natural and manmade characteristics. Natural characteristics that affect a lake include the amount of land that drains to the lake, the hilliness of the landscape, types of soil, extent of wetlands, and the type of lake. Within the lake's watershed, alterations to the landscape, the types of land use, and the land management practices are examples of how people may affect the lake.

It is important to understand where Pine Lake's water originates in order to understand the lake's health. During snowmelt or a rainstorm, water moves across the surface of the landscape (runoff) towards lower elevations such as lakes, streams, and wetlands. The land area that contributes runoff to Pine Lake is called a surface watershed. Groundwater also feeds Pine Lake; its land area may be slightly different than the surface watershed. The surface watershed is shown in Figure 2.

The capacity of the landscape to shed or hold water and contribute or filter particles determines the amount of erosion that may occur, the amount of groundwater feeding a lake, and ultimately, the lake's water quality and quantity. Essentially, landscapes with a greater capacity to hold water during rain events and snowmelt help to slow the delivery of the water to the lake. Minimizing excess runoff is desirable because it allows more water to recharge the groundwater, which feeds the lake year-round - even during dry periods or when the lake is covered with ice.

Land use and land management practices within a lake's watershed can affect both its water quantity and quality. While forests and grasslands allow a fair amount of precipitation to soak into the ground, resulting in more groundwater and better water quality, other types of land uses may result in increased runoff and less groundwater recharge, and may be sources of pollutants that can impact the lake and its inhabitants. Areas of land with exposed soil can produce soil erosion. Soil entering the lake can make the water cloudy and cover fish spawning beds. Soil also contains nutrients that increase the growth of algae and aquatic plants. Development on the land often results in changes to natural drainage patterns, alterations to vegetation on the landscape, and may be a source of pollutants. Impervious (hard) surfaces such as roads, rooftops, and compacted soil prevent rainfall from soaking into the ground, which may result in more runoff that carries pollutants to the lake. Wastewater, animal waste, and fertilizers used on lawns, gardens and crops can contribute nutrients that enhance the growth of algae and aquatic plants in our lakes.

A variety of land management practices can be put in place to help reduce impacts to our lakes. Some practices are designed to reduce runoff. These include protecting/restoring wetlands, installing rain gardens, swales, rain barrels, and routing drainage from pavement and roofs away from the lake. Some practices are used to help reduce nutrients from moving across the landscape towards the lake. Examples include manure management practices, eliminating/reducing the use of fertilizers, increasing the distance between the lake and a septic drainfield, protecting/restoring native vegetation in the shoreland, and using erosion control practices. Waushara County staff and other professionals can work with landowners to determine which practices are best suited to a particular property.

The surface watershed for Pine Lake is approximately 5,667 acres (Figure 2). The dominant types of land use in the watershed are agriculture (60%) and forests (32%). The land closest to the lake often has the greatest impact on water quality and habitat; Pine Lake's shoreland is surrounded primarily by agriculture, developed land, and forests.

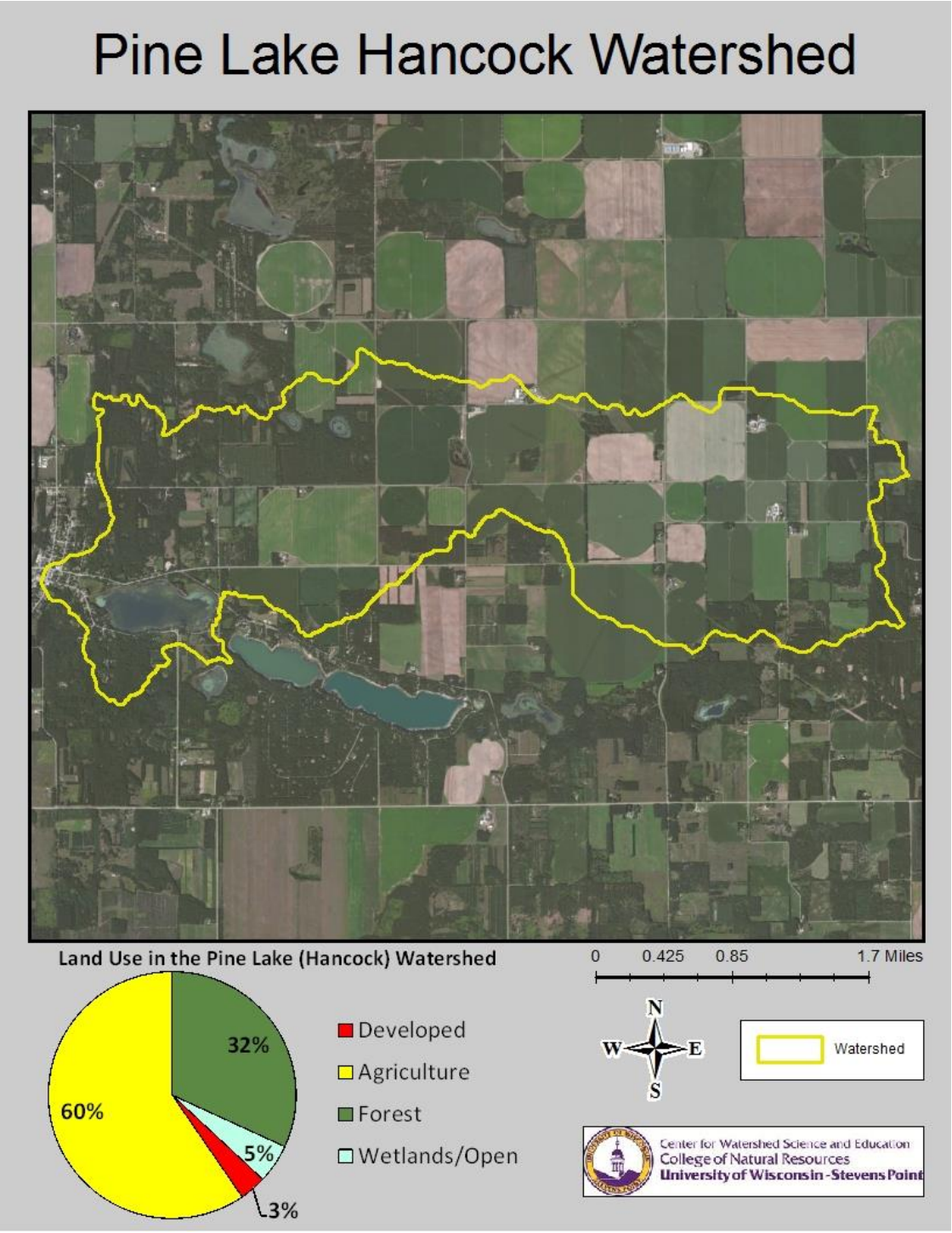


FIGURE 2. LAND USE IN THE PINE LAKE SURFACE WATERSHED.

The more the lake's water interacts with groundwater, the more influence the geology has on the lake. The length of time water remains below ground affects the temperature and chemistry of the groundwater. Groundwater temperature is near constant year round; during the summer, groundwater feeding Pine Lake will help keep the lake water cooler.

Groundwater flows below ground from higher to lower elevations, discharging into wetlands, streams, and lakes. The groundwater feeding the lakes in Waushara County originates nearby. The black arrows in Figure 3 indicate the general direction of groundwater flow. Much of the groundwater enters Pine Lake from the north.

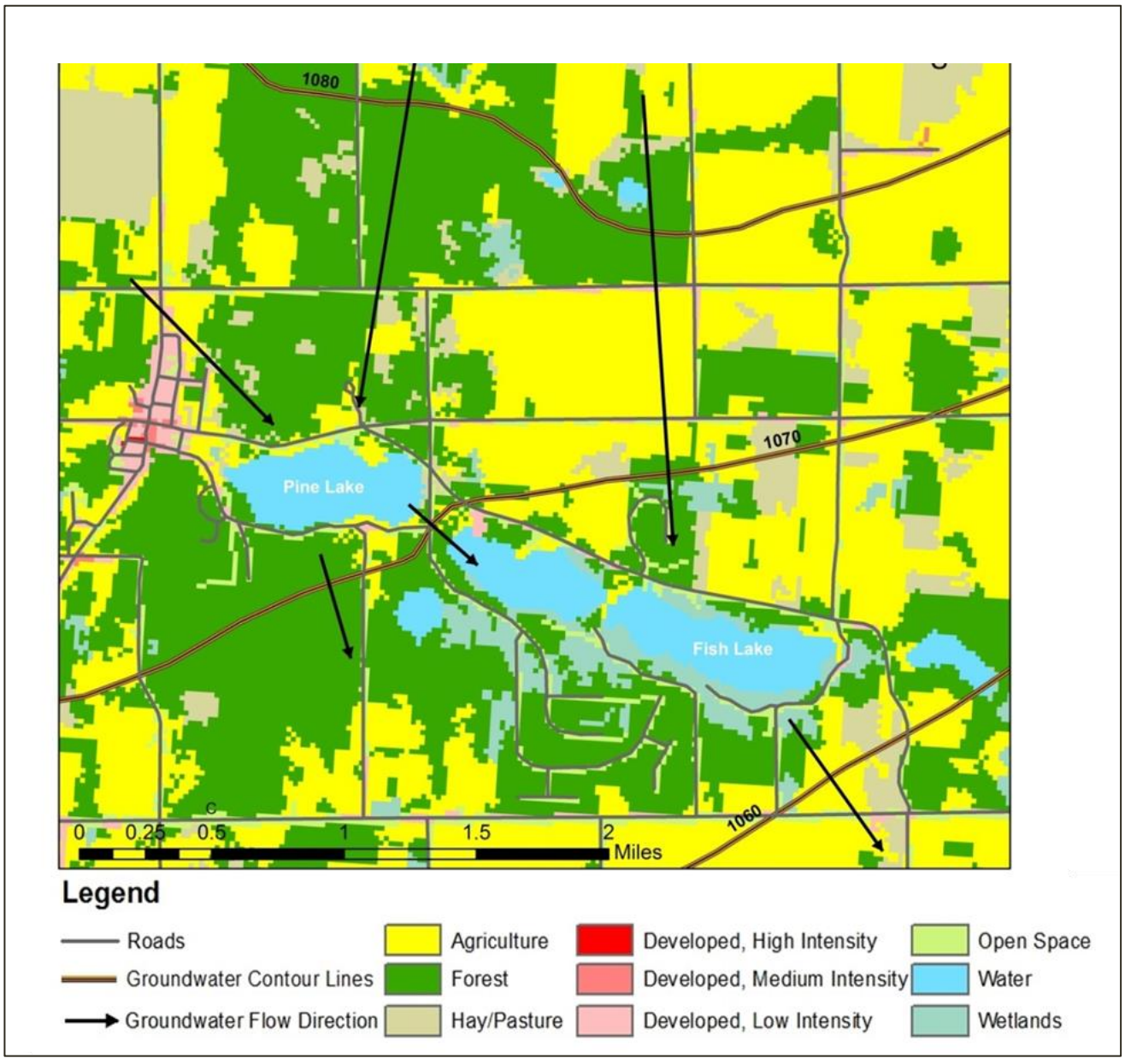
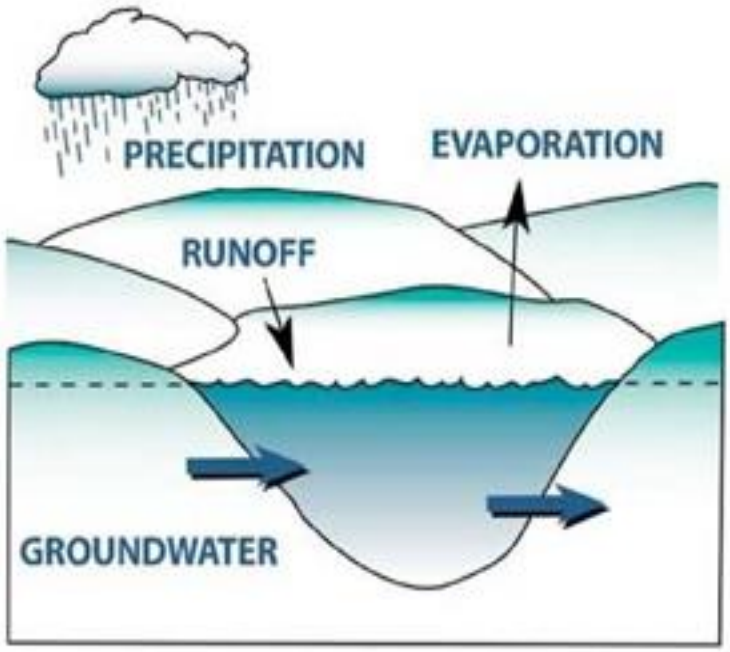


FIGURE 3. GROUNDWATER FLOW DIRECTION NEAR PINE LAKE.

Lake water quality is a result of many factors including the underlying geology, the climate, and land management practices. Assessing lake water quality allows us to evaluate current lake health and changes from the past. We can then identify what is needed to achieve a more desirable state or preserve an existing state for aesthetics, recreation, wildlife and the fishery. During this study, water quality in Pine Lake was assessed by measuring different characteristics including temperature, dissolved oxygen, water clarity, water chemistry, and algae.



The source of a lake's water supply is important in evaluating its water quality, quantity, and in choosing management practices to preserve or influence that quality or quantity. Pine Lake is classified as a seepage lake. Water enters and leaves seepage lakes primarily through groundwater; water may also enter the lake via surface runoff and direct precipitation (Figure 4). Seepage lakes generally have a longer retention time (length of time water remains in the lake), which affects contact time with nutrients that feed the growth of algae and aquatic plants. These lakes are vulnerable to contaminants moving towards the lake in the groundwater. Sources of contaminants for Pine Lake may include septic systems, agriculture, road salt, and contributions from other activities.

FIGURE 4. CARTOON SHOWING INFLOW AND OUTFLOW OF WATER IN A SEEPAGE LAKE.

The geologic composition that lies beneath a lake has the ability to influence the lake's temperature, pH, minerals, and other properties. As groundwater moves, some substances are filtered out, but other materials in the soil dissolve into the groundwater. Minerals such as calcium and magnesium in the soil around Pine Lake are dissolved in the water, making the water hard (Shaw et al., 2000). The average hardness for Pine Lake during the 2010-2012 sampling period was 148 mg/L, which is considered hard (Table 1). Hard water provides the calcium necessary for building bones and shells of animals in the lake. The average alkalinity was 141 mg/L; higher alkalinity in inland lakes can support higher species productivity. Hardness and alkalinity also play roles in the types of aquatic plants that are found in a lake (Wetzel, 2001).

TABLE 1. MINERALS AND PHYSICAL MEASUREMENTS IN PINE LAKE, 2010-2012.

Pine Lake	Alkalinity (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness (mg/L as $CaCO_3$)	Color (SU)	Turbidity (NTU)
Average Value	141	22.7	17.9	148	32.7	2.1

Chloride concentrations, and to lesser degrees sodium and potassium concentrations, are commonly used as indicators of how strongly a lake is being impacted by human activity. The presence of these compounds where they do not naturally occur indicates sources of water contaminants.

Concentrations of potassium and sodium in Pine Lake reflected natural sources. Chloride concentrations were slightly elevated (Table 2). These concentrations are not harmful to aquatic organisms, but indicate that pollutants are entering the lake. Chloride sources include animal waste, septic systems, fertilizer, and road-salting chemicals. Atrazine (DACT), an herbicide commonly used on corn, was detected (0.005 µg/L and 0.055 µg/L) in the samples that were analyzed from Pine Lake. Some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels (Hayes et al., 2001 and Hayes et al., 2003). The presence of this chemical indicates that agricultural or other human activities are influencing the water quality in Pine Lake.

TABLE 2. PINE LAKE AVERAGE WATER CHEMISTRY, 2010-2012.

Pine Lake (Hancock)	Average Value			Reference Value		
	Low	Medium	High	Low	Medium	High
Potassium (mg/L)	0.63			<.75	0.75-1.5	>1.5
Chloride (mg/L)		1.3		<3	3.0-10.0	>10
Sodium (mg/L)	1.7			<2	2.0-4.0	>4

Dissolved oxygen is an important measure in aquatic ecosystems because a majority of organisms in the water depend on oxygen to survive. Oxygen is dissolved into the water from contact with the air, which is increased by wind and wave action. Algae and aquatic plants also produce oxygen when sunlight enters the water, but the decomposition of dead plants and algae reduces oxygen in the lake. Some forms of iron and other metals carried by groundwater can also consume oxygen when the groundwater discharges to the lake.

In a lake, the water temperature changes throughout the year and may vary with depth. During winter and summer when lakes stratify (layer), the amount of dissolved oxygen is often lower towards the bottom of the lake. Dissolved oxygen concentrations below 5 mg/L can stress some species of cold water fish and over time can reduce the amount of available habitat for sensitive cold water species of fish and other aquatic organisms.

Water temperature and dissolved oxygen were measured in Pine Lake from the lake surface to the bottom at the time of sample collection. Temperature data followed a common cycle of mixing during spring and fall and stratification (layering) during summer and winter. Temperature data illustrated a typical late winter profile in February 2011 and 2012 with freezing temperatures at the surface and gradual warming with depth (Figure 5). The water in Pine Lake was mixed throughout the water column during spring and fall overturn. In summer months, weak thermal stratification developed by June and remained until fall overturn. The data showed decreasing temperatures with depth ranging from a high of 27C (81°F) at the surface to 13C (55°F) near the bottom in mid-summer. Dissolved oxygen concentrations followed patterns similar to temperature (Figure 6). During the summer, it was typical for dissolved oxygen to drop to low concentrations at depths below 7 feet.

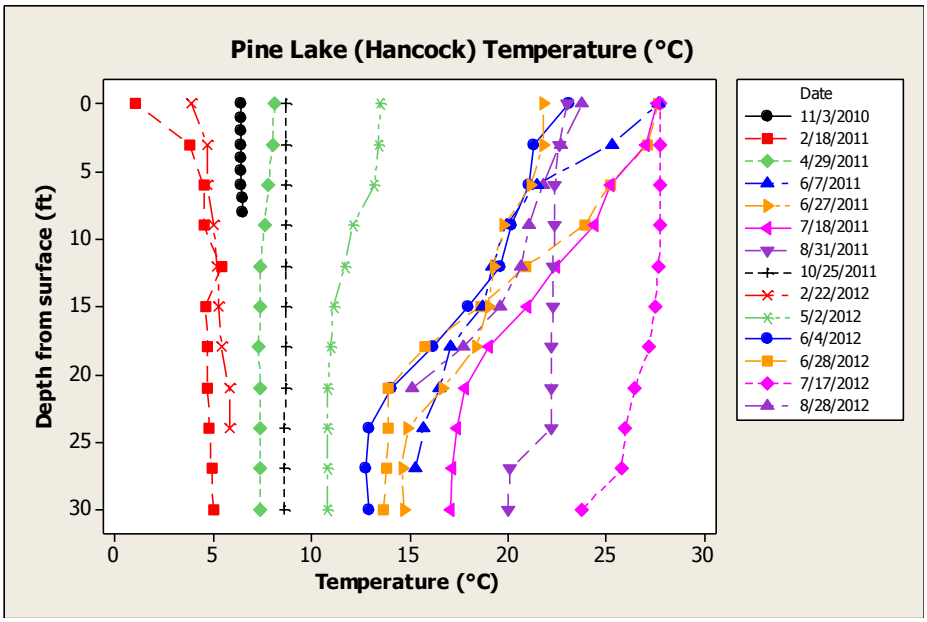


FIGURE 5. TEMPERATURE PROFILES IN PINE LAKE, 2010-2012.

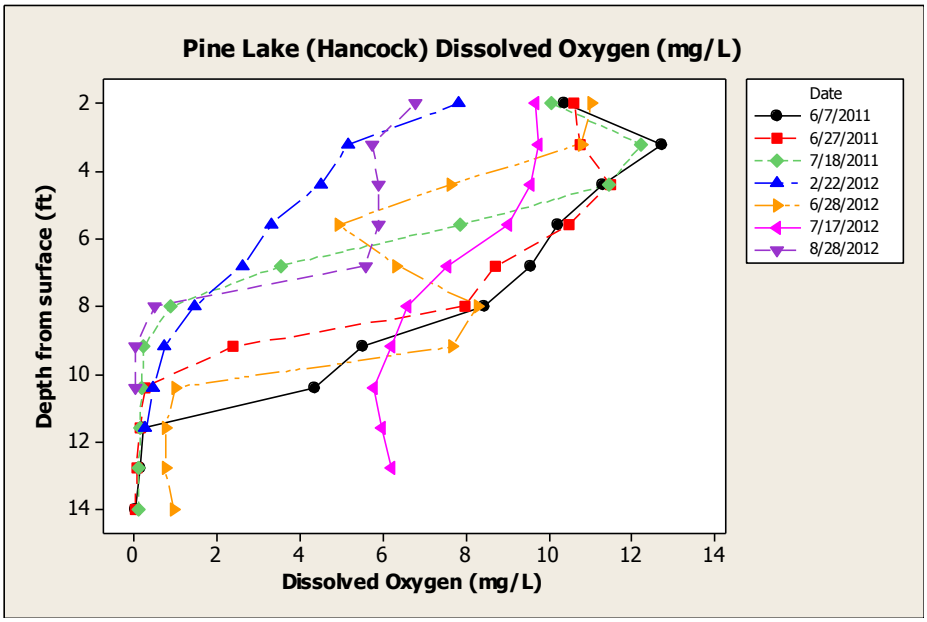


FIGURE 6. DISSOLVED OXYGEN PROFILES IN PINE LAKE, 2010-2012.

Water clarity is a measure of the depth that light can penetrate into the water. It is an aesthetic measure and is also related to the depth that rooted aquatic plants can grow. Water clarity is affected by water color, turbidity (suspended sediment), and algae, so it is normal for water clarity to change throughout the year and from year to year. In Pine Lake, color (staining) was low (Table 1), indicating that the variability in transparency throughout the year is primarily due to fluctuating algal concentrations and re-suspended sediment following storms and/or heavy boating activity.

For Pine Lake, water clarity ranged from 7 feet to 16 feet, with an average of 11.3 feet over the 2010-2012 monitoring period (Figure 7). When compared with historic data, the average water clarity measured during the study was similar in April and June, better in August, and poorer in May, July, and October. Past data used in this analysis ranged from 1991 to 2001.

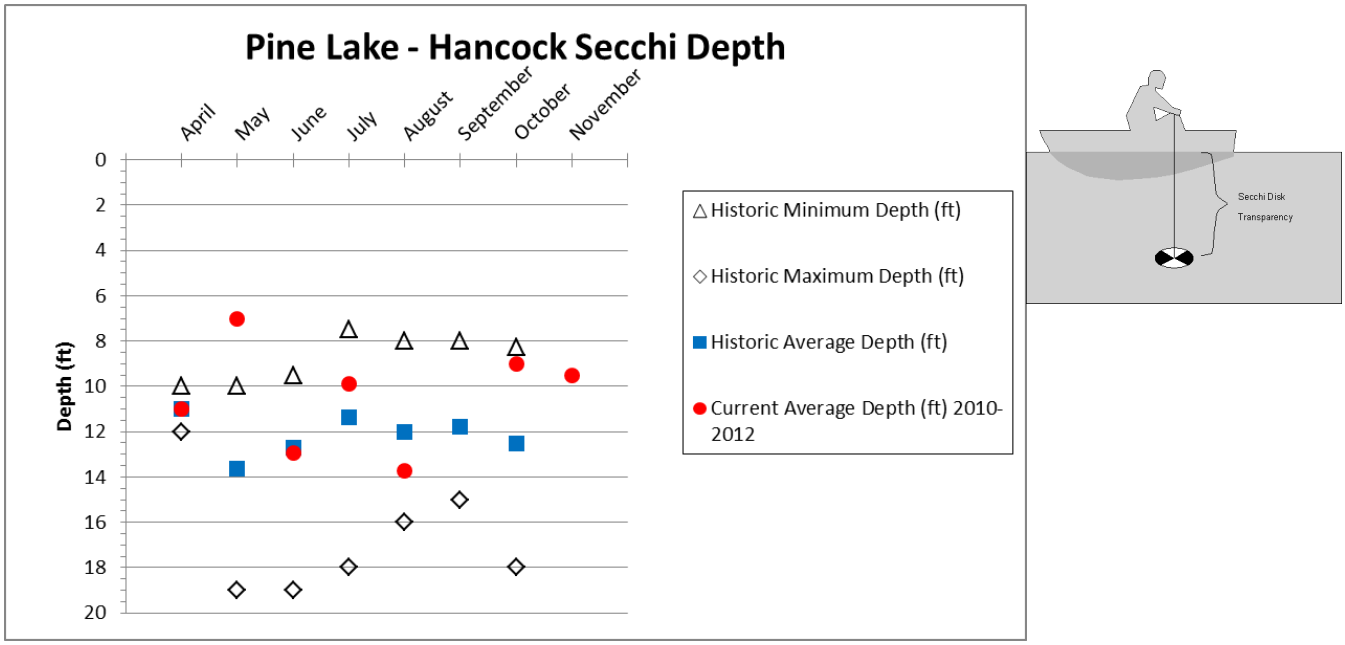


FIGURE 7. WATER CLARITY IN PINE LAKE, 2010-2012 AND HISTORIC.

Nutrients (phosphorus and nitrogen) are used by algae and aquatic plants for growth. Phosphorus is present naturally throughout the watershed in soil, plants, animals and wetlands. Common sources from human activities include soil erosion, animal waste, fertilizers and septic systems.

It is most common for phosphorus to move from the land to the water through surface runoff, but it can also travel to the lake in groundwater. Once in a lake, a portion of the phosphorus becomes part of the aquatic system in the form of plant and animal tissue, and sediment. The phosphorus continues to cycle within the lake for many years.

During the study, total phosphorus concentrations for Pine Lake ranged from a high of 23 ug/L in November 2010 to a low of 10 ug/L in August 2012, with an average concentration of 16.7 ug/l over the monitoring period (Table 3). The summer median total phosphorus concentrations were 18 ug/L and 16 ug/L in 2011 and 2012, respectively. This is below Wisconsin's phosphorus standard of 20 ug/L for deep seepage lakes, but above the proposed flag value of 15 ug/L. During the study, inorganic nitrogen concentrations were high enough in the spring to enhance algal blooms throughout the summer (Shaw et al., 2000).

Chlorophyll *a* is a measure of algae in the water. Chlorophyll *a* concentrations in Pine Lake varied throughout the 2012 monitoring season, ranging from a high of 9 ug/L in July 2011 to a low of 0.5 ug/L in August 2011. The average for the monitoring period was 2.8 ug/L, which is considered low.

TABLE 3. SEASONAL SUMMARY OF NUTRIENT CONCENTRATIONS IN PINE LAKE, 2010-2012

Pine Lake (Hancock)	Inorganic Nitrogen (mg/L)			Organic Nitrogen (mg/L)			Total Nitrogen (mg/L)			Soluble Reactive Phosphorus (ug/L)			Total Phosphorus (ug/L)		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Fall	0.01	0.01	0.01	0.79	0.79	0.79	0.82	0.82	0.82	6	6	6	23	23	23
Spring	0.03	0.46	1.29	0.57	0.62	0.67	0.72	1.30	1.87	1	3	4	12	18	22
Summer													10	17	21
Winter	0.05	0.06	0.07	0.83	0.83	0.83	1.31	1.31	1.31	0	3	6	11	12	13

Estimates of phosphorus from the landscape can help to understand the phosphorus sources to Pine Lake. Land use in the surface watershed was evaluated and used to populate the Wisconsin Lakes Modeling Suite (WILMS) model. In general, each type of land use contributes different amounts of phosphorus in runoff and through groundwater. The types of land management practices that are used and the distance from the lake also affect the contributions to the lake from a parcel of land. Based on modeling results, agriculture had the greatest phosphorus contributions from the watershed to Pine Lake (Figure 8). The phosphorus contributions by land use category, called phosphorus export coefficients, are shown in Table 4. The phosphorus export coefficients have been obtained from studies throughout Wisconsin (Panuska and Lillie, 1995).

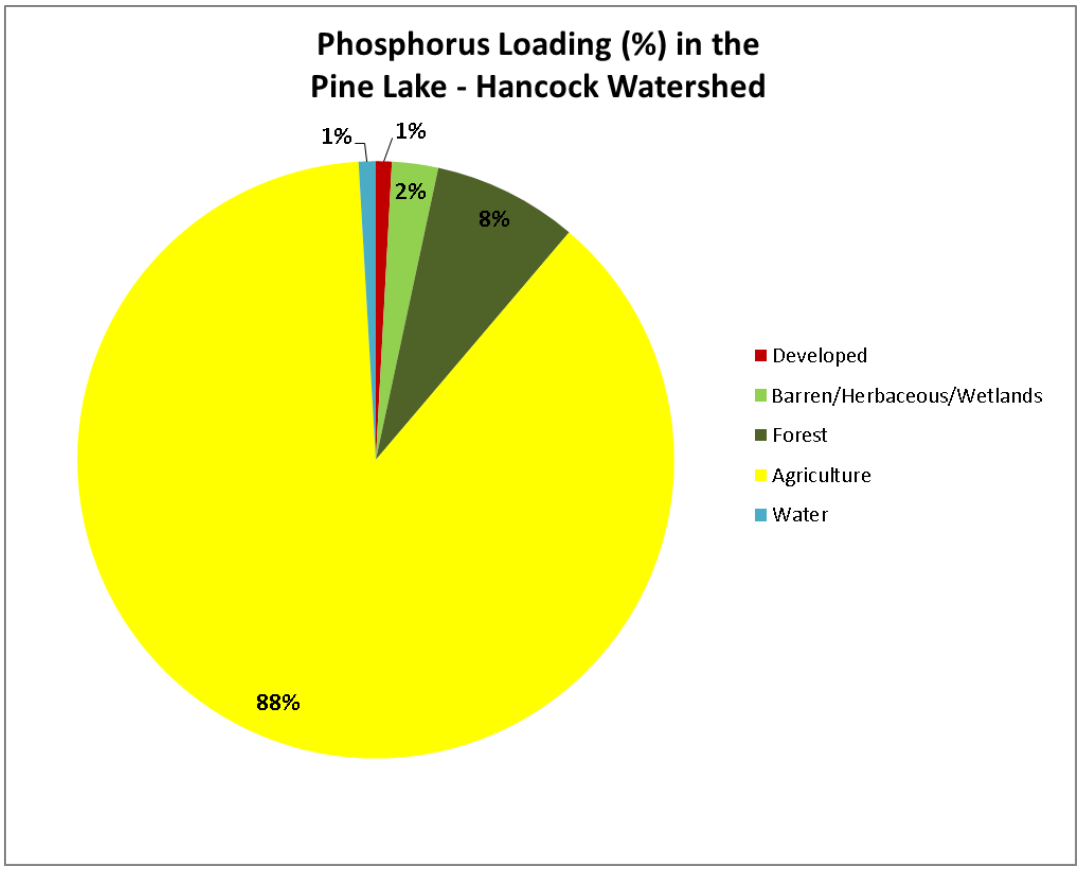


FIGURE 8. ESTIMATED PHOSPHORUS LOADS FROM LAND USES IN THE PINE LAKE WATERSHED.

TABLE 4. MODELING DATA USED TO ESTIMATE PHOSPHORUS INPUTS FROM LAND USES IN THE PINE LAKE WATERSHED (LOW AND MOST LIKELY COEFFICIENTS USED TO CALCULATE RANGE IN POUNDS).

Pine Lake-Hancock Land Use	Phosphorus Export Coefficient (lbs/acre-yr)	Land Use Area Within the Watershed		Estimated Phosphorus Load	
		Acres	Percent	Pounds	Percent
Water	0.1	112	**2**	9-29	**1**
Developed	0.04	194	**3**	9-18	**1**
Barren/Herbaceous/Wetland	0.09	283	**5**	25-75	**3**
Forest	0.04	1773	**31**	79-143	**8**
Cultivated Agriculture	0.45	3306	**58**	885-2359	**88**

*Values are not exact due to rounding and conversion.

(Based on contributions from Golden Sands Resource Conservation & Development Council, Inc., 2014)

Aquatic plants play important roles in a lake's ecosystem. They provide habitat for the fishery and other aquatic organisms, stabilize the sediment, reduce erosion, buffer temperature changes and waves, and infuse oxygen into the water. Aquatic plants near shore provide food, shelter and nesting material for shoreland mammals, shorebirds and waterfowl. It is not unusual for otters, beavers, muskrats and deer to be seen along a shoreline in their search for food or nesting material. The aquatic plants that attract the animals to these areas contribute to the beauty of the shoreland and lake.

The rapid and dominant growth of aquatic invasive plants, such as Eurasian watermilfoil (EWM), can reduce the recreational value of a lake. Aquatic invasive plants may also outcompete and cause a decline in native vegetation, which degrades habitat diversity and can alter the aquatic ecosystem. Denuding a lakebed by raking or using chemicals on native aquatic plants can provide ideal habitat for invasive species to become established in a lake.

An aquatic plant survey was conducted in Pine Lake (Hancock) in August 2013 by Golden Sands RC&D. Ninety-six percent (254 of 264) of the sites visited had vegetative growth. The greatest depth at which aquatic plant growth was found was 13 feet. Twenty-one species of aquatic plants were found in Pine Lake (Hancock), with an additional two species observed visually (Table 5). The total number of species in Pine Lake (Hancock) is above-average when compared with the other lakes in the Waushara County Lakes Study. Greater species diversity mostly occurred in the shallows of Pine Lake, but were scattered around the lake (Figure 9).

The dominant plant species found in Pine Lake (Hancock) was EWM, followed by muskgrass (*Chara* spp.) and sago pondweed (*Stuckenia pentinata*). Growth of EWM can begin early in the spring when lake temperatures are too low for other aquatic plants to grow, giving it an advantage over other aquatic plants. EWM provides habitat for fish and other aquatic organisms. *Chara* spp. beds offer cover and food for young trout, and provide habitat for algae and invertebrates that are food sources for waterfowl. Sago pondweed provides food and shelter for young trout (Borman et al., 2001).

The Floristic Quality Index (FQI) evaluates how close a plant community is to undisturbed conditions. Each plant is assigned a coefficient of conservatism value (C-value) that reflects its sensitivity to disturbance, and these numbers are used to calculate the FQI. C-values range from 0 to 10. The lower the number, the more tolerant the plant is of disturbance. Having more plants with low C-values than high C-values is an indicator of disturbance, as the lower C-value plants better tolerate stresses caused by disturbance. A C-value of 0 is assigned to exotic species. The FQI for Pine Lake (Hancock) was 27, which is above-average compared with the lakes in the Waushara County Lakes Study.

In Pine Lake (Hancock), C-values ranged from 0 to 8 (Table 5). One invasive plant species was sampled, EWM, which has a C-value of 0. Three of the species found in Pine Lake (Hancock) had a C-value of 8, indicating good health in the aquatic plant community. They were southern naiad (*Najas guadalupensis*), Fries' pondweed (*Potamogeton friesii*), and stiff pondweed (*Potamogeton strictifolius*).

Invasive species are present in Pine Lake (Hancock). EWM was found at 84% of the vegetated sites and currently accounts for a large portion of the plant biomass in Pine Lake (Hancock). EWM can create dense beds that can damage boat motors, make areas non-navigable, stunt or alter the fishery, create problems with dissolved oxygen, and prevent activities like fishing and swimming. This plant can

produce a viable seed; however, its primary mode of reproduction and spread is fragmentation. A one-inch fragment is enough to start a new plant, making EWM very successful at reproducing.

The Simpson Diversity Index (SDI) quantifies biodiversity based on a formula that uses the number of species surveyed and the number of individuals per site. The SDI uses a decimal scale from 0 to 1. Values closer to one represent higher amounts of biodiversity. The SDI of Pine Lake (Hancock) for the 2013 survey was 0.78. This represents an average biodiversity when compared to the other lakes in the Waushara County Lakes Study.

Aquatic plants play another critical role in the lake's ecosystem by using nutrients that would otherwise be available to algae. Any management activities should be planned to minimize the disturbance of native species in the water and on shore in order to maintain the balance between aquatic plants and algae. In addition, care should be taken to minimize raking the lakebed and pulling plants, since disturbing these valuable open spaces may allow invasive aquatic plants such as EWM to become established.

TABLE 5. LIST OF AQUATIC PLANT SPECIES IDENTIFIED IN THE 2013 AQUATIC PLANT SURVEY OF PINE LAKE.

Scientific Name	**Common name**	**Sampled**	**Visuals**	**C-value**
Ceratophyllum demersum	coontail	x		3
Chara spp.	muskgrasses (an algae)	x	x	7
Myriophyllum sibiricum	northern watermilfoil	x	x	6
Myriophyllum spicatum	Eurasian watermilfoil	x	x	0
Najas flexilis	slender naiad	x	x	6
Najas guadalupensis	southern naiad	x	x	8
Najas marina	spiny naiad		x	0
	stoneworts	x		7
Nuphar variegata	bullhead pond lily	x	x	6
Nymphaea odorata	white water lily	x	x	6
Polygonum amphibium	amphibious smartweed		x	6
Potamogeton amplifolius	large-leaf pondweed		x	7
Potamogeton friesii	Fries' pondweed	x	x	8
Potamogeton gramineus	variable pondweed	x	x	7
Potamogeton illinoensis	Illinois pondweed	x	x	6
Potamogeton natans	floating-leaf pondweed		x	5
Potamogeton pusillus	small pondweed	x	x	7
Potamogeton strictifolius	stiff pondweed	x	x	8
Potamogeton zosteriformis	flat stem pondweed	x	x	6
Schoenoplectus acutus	hard stem bulrush		x	6
Stuckenia pectinata	sago pondweed	x	x	3
Typha angustifolia	narrow-leaf cattail		x	1
Utricularia macrorhiza	common bladderwort	x	x	7
	freshwater sponges	x	x	-

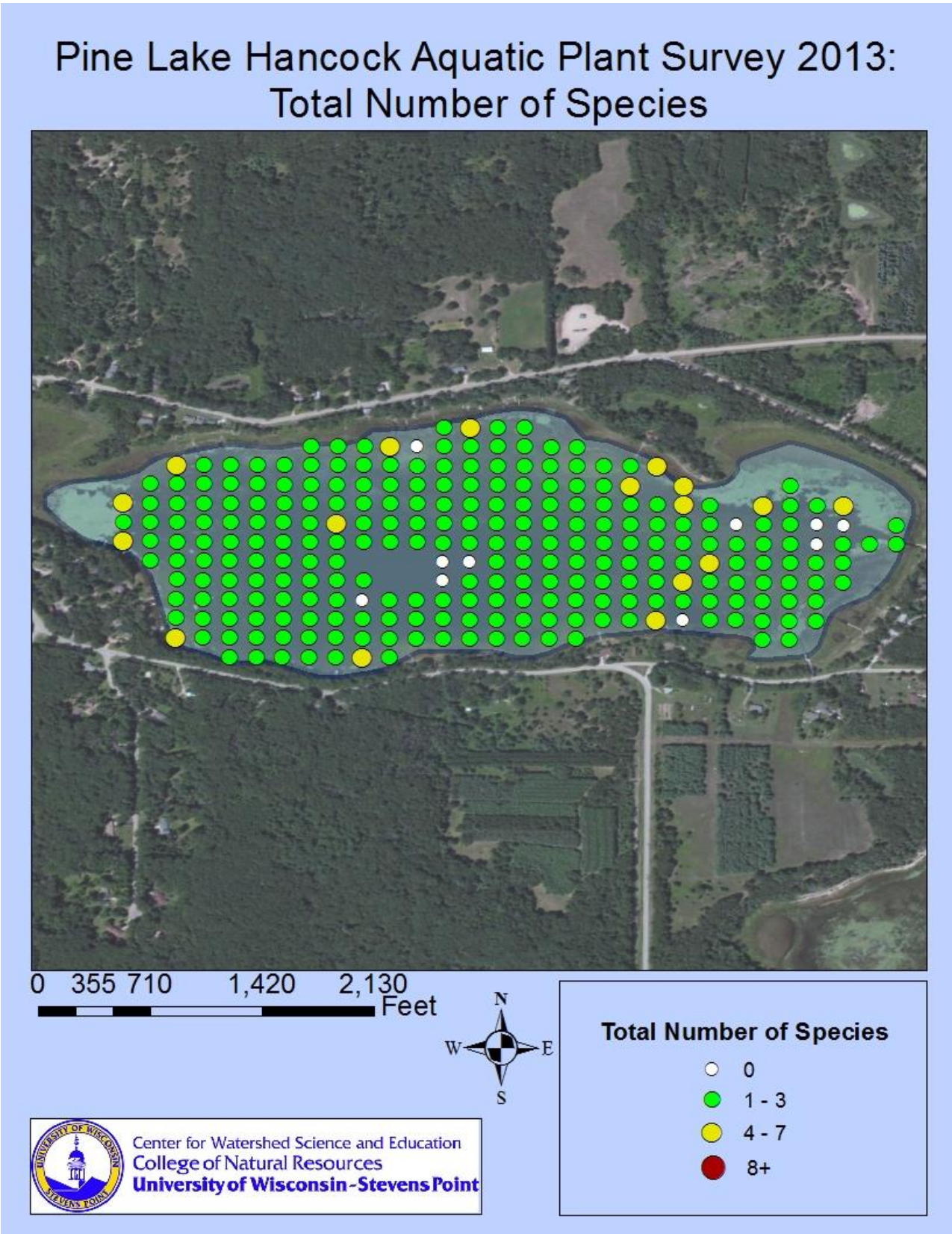


FIGURE 9. NUMBER OF AQUATIC PLANT SPECIES OBSERVED AT EACH SAMPLE SITE IN PINE LAKE (HANCOCK), 2013.

SEDIMENT CORES

Questions often arise concerning how a lake's water quality has changed over time related to changes in land use in the watershed, the abundance and diversity of its aquatic plant communities, and the state of its shoreland vegetation. The analysis of a lake's sediment core is an effective means to reconstruct some of the changes that may have occurred over time. Lakes act as sediment traps for particles that are either delivered to the lake from the surrounding landscape, the atmosphere, or occur in the lake itself. The chemical composition of the sediment can help decipher the composition of the past chemical environment in the lake. Lake sediment contains remains such as diatom skeletons, cell walls of algal species, and the partially preserved remains of aquatic plants. By examining remains trapped in the sediment, changes in the lake's ecosystem can be inferred

Seven lakes in the Waushara County lakes study were chosen for sediment core analysis. A single sediment core approximately 31 inches in length was collected for analysis from Pine Lake's deep area in 14 feet of water in November 2012. It is estimated that the bottom portion of this core was deposited at least 150 years ago.

BIOLOGICAL COMPONENTS IN THE SEDIMENT CORE

Aquatic organisms can be good indicators of water chemistry because they live in direct contact with the water and are strongly affected by the chemical composition of their surroundings. Most indicator groups grow rapidly and are short-lived, so the community composition responds rapidly to changing environmental conditions. Diatoms, a type of algae, are especially useful because they are usually abundant, are ecologically diverse and their ecological tolerances are well known. In addition, the cell walls of diatoms are made of silica, which enables them to be highly resistant to degradation and able to be well-preserved in sediments (Figure 10).

THE FIRST FOUR DIATOMS, FRAGILARIA CROTONENSIS (A), AULACOSEIRA AMBIGUA (B), DISCOTELLA STELLIGERA (C), AND CYCLOTELLA MICHIGANIANA (D) TYPICALLY ARE FOUND IN OPEN WATER ENVIRONMENTS. STAUROSIRA CONSTRUENS (F) AND STAUROSIRA CONSTRUENS VAR. VENTER (G) ARE COMMONLY FOUND ATTACHED TO SUBSTRATES SUCH AS AQUATIC PLANTS, OTHER FILAMENTOUS ALGAE OR GROWING ON THE SEDIMENTS AND ARE OFTEN ASSOCIATED WITH HIGHER NUTRIENT CONCENTRATIONS. NAVICULA VULPINA (E) GROWS ON AQUATIC PLANTS AND IS USUALLY FOUND IN LOW NUTRIENT ENVIRONMENTS.

FIGURE 10. PHOTOMICROGRAPHS OF THE COMMON DIATOMS FOUND IN WAUSHARA COUNTY LAKE SEDIMENT CORES.

The diatom community was analyzed in top and bottom samples from Pine Lake's sediment core. The bottom of the core was dominated by benthic (bottom feeding) *Fragilaria*, which is associated with submerged aquatic plants and filamentous soft-bodied algae (Figure 11). This species' presence at the bottom of the core indicates that Pine Lake has historically had a high abundance of aquatic plants. There were also small amounts of planktonic diatom species present at the bottom of the core, which indicated lower nutrient levels in Pine Lake in the past. In contrast, the top of the core had almost no planktonic diatom species, which indicated higher nutrient levels in recent years. Species richness and diversity were greater at the bottom of the core than at the top. This further suggested an increase in nutrient levels in recent years.

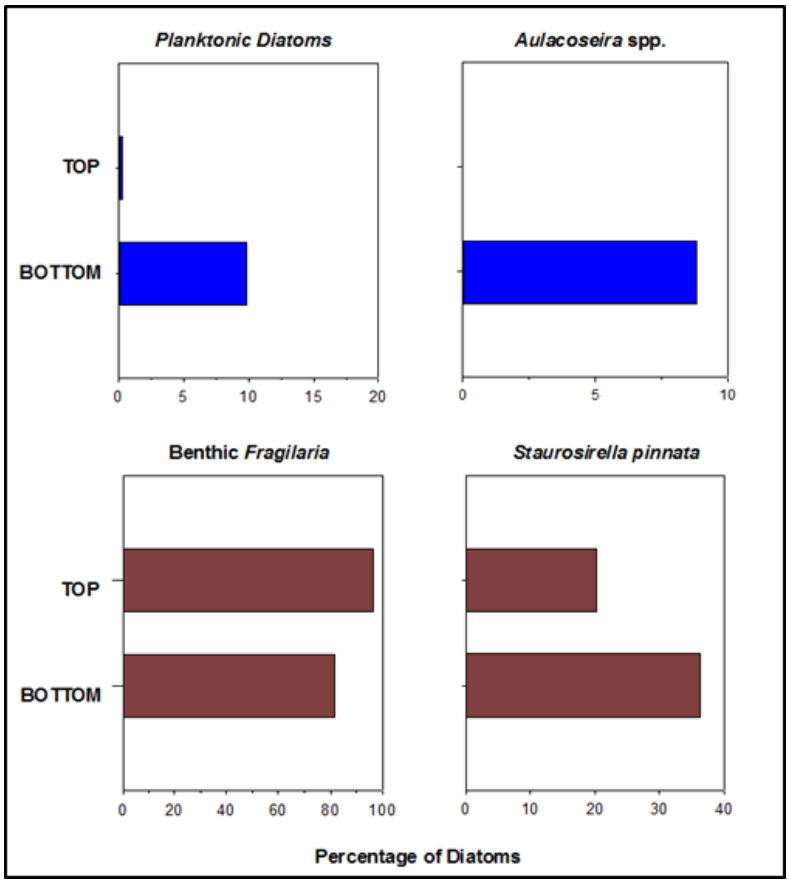


FIGURE 11. CHANGES IN ABUNDANCE OF IMPORTANT DIATOMS FOUND AT THE TOP AND BOTTOM OF THE SEDIMENT CORE IN PINE LAKE.

Relative dating techniques were used to provide chronological control of the sedimentary record of lake events. A spike in ragweed pollen (*Ambrosia* spp.) serves as a strong indicator of initial land clearance. When combined with historical maps, tax records and other documentation, an accurate date can be ascribed to the onset of these settlement activities, and thus to the depth of the ragweed spike in the lake sediment. Most of the seven lakes in the Waushara County sediment core study had ragweed spikes between depths of 20-40 cm, depending upon the rate of sedimentation.

Pine Lake's sediment ranged in color from lighter olives and browns at the bottom to darker colors of olive and brown toward the top of the core. The dark color at the top was likely the result high amounts of organic matter or iron staining of the sediment. As microbes and other organisms decompose in a lake, dissolved oxygen in th e overlying water decreases and the sediment is altered by the production of iron compounds. Although this typically occurs seasonally, it becomes more pronounced with an increase in nutrients, algae, and aquatic plants. Lighter colors in the middle and the bottom of the core indicated higher amounts of sand and silt.

Textural changes could also be seen throughout the sediment core in addition to changes in color. Coarse silt and fine sand were seen from 7.9 -15.7 inches as well as in the top 4.6 inches of the core, and were most likely introduced to the lake by shoreland erosion caused by land clearing and storm events.

In order to determine the composition of Pine Lake's sediment core, a test was conducted known as loss on ignition (LOI). Various components that make up the lake's sediment core such as organic matter, marl (carbonate), and silica (sand, silt, and clay) are burned away during this analysis to provide more specifics about the core's composition in addition to color and textural analysis (Figure 12). LOI data indicated that organic matter increased over the length of the core, and was most abundant from 25.5 inches to the top. Sand increased in the core at 15.7 inches, which was where carbonates begin to decrease. This may indicate a slight increase shoreland disturbance, such as erosion and land clearing. The abundance in organic matter towards the top of the core indicated a decrease in disturbance in recent years.

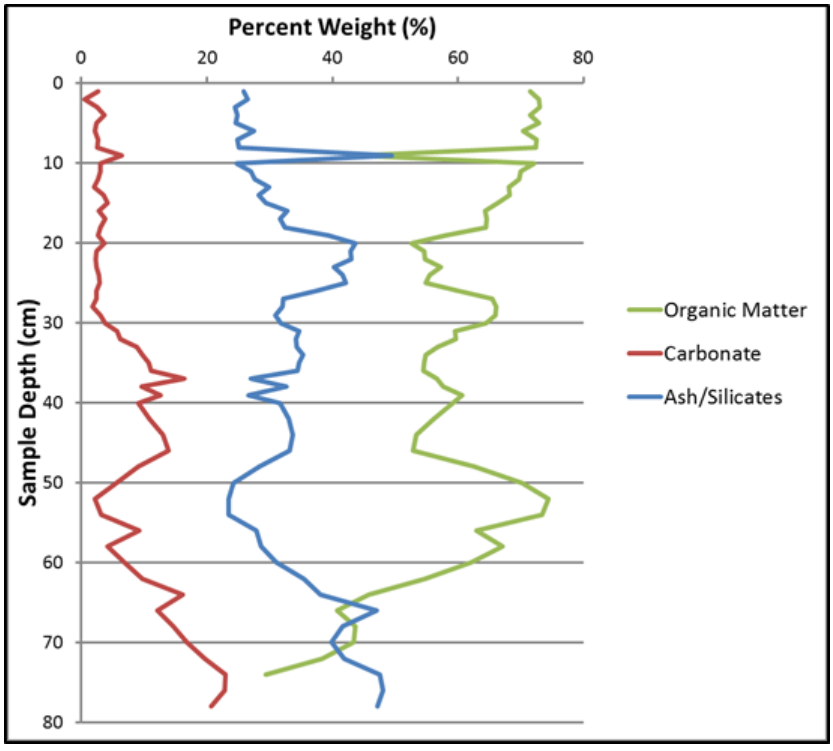


FIGURE 12. LOSS ON IGNITION RESULTS FOR PINE LAKE.

SEDIMENT CORE RESULTS SUMMARY

Analysis of biological components and physical properties of Pine Lake's sediment core indicated an increase in erosion-induced processes, such as land clearing, storm events, and shoreland disturbance since the time of land settlement around the lake. The analyses indicated these activities occurred more frequently in recent decades, but appear to have been minimized in recent years. There was likely an increase in nutrient delivery, including phosphorus, to the lake over this time period. While the diatom communities and the physical properties of the sediment did not directly show this increase in phosphorus, they did show an increase in aquatic plants and algae toward the top of the core. The increase in aquatic plants and algae resulted in a loss in water clarity since the last century.

Shoreland vegetation is critical to a healthy lake's ecosystem. It provides habitat for many aquatic and terrestrial animals including birds, frogs, turtles, and many small and large mammals. It also helps to improve the quality of the runoff that is flowing across the landscape towards the lake. Healthy shoreland vegetation includes a mix of tall grasses/flowers, shrubs and trees which extend at least 35 feet landward from the water's edge.

To better understand the health of the Waushara County lakes, shorelands were evaluated by professionals from the Center for Land Use Education and Waushara County as a part of the Waushara County Lakes Study. The survey inventoried the type and extent of shoreland vegetation. Areas with erosion, rip-rap, barren ground, sea walls, structures and docks were also inventoried.

A scoring system was developed for the collected data to provide a more holistic assessment. Areas that are healthy will need strategies to keep them healthy, and areas with potential problem areas and where management and conservation may be warranted may need a different set of strategies for improvement. The scoring system is based on the presence/absence and abundance of shoreline features, as well as their proximity to the water's edge. Values were tallied for each shoreline category and then summed to produce an overall score. Larger scores denote a healthier shoreline with good land management practices. These are areas where protection and/or conservation should be targeted. On the other hand, lower scores signify an ecologically unhealthy shoreline. These are areas where management and/or mitigation practices may be desirable for improving water quality.

The summary of scores for shorelands around Pine Lake (Hancock) is displayed in Figure 13. The shorelands were color-coded to show their overall health based on natural and physical characteristics. Blue shorelands identify healthy shorelands with sufficient vegetation and few human disturbances. Red shorelands indicate locations where changes in management or mitigation may be warranted. Large portions of Pine Lake's shorelands are in good shape, but a few segments have challenges that should be addressed. One stretch of Pine Lake shoreland, along the southern shore, fell into the poorest category. A summary of shoreland disturbances is displayed in Table 6. For a more complete understanding of the ranking, an interactive map showing results of the shoreland surveys can be found on Waushara County's website at http://gis.co.waushara.wi.us/ShorelineViewer/.

TABLE 6. DISTURBANCES WITHIN 15 FEET OF SHORE AROUND PINE LAKE, 2011.

Disturbance	**Length of Shoreline**	
	Feet	**Percent**
Artificial beach	0	0
Barren, bare dirt	0	0
Boat landing	86	1
Dock/pier at water	5666	40
Gully erosion	0	0
Undercut banks erosion	0	0
Mowed lawn	4124	29
Rip-rap	156	1
Seawall	203	1

FIGURE 13. OVERALL SHORELAND HEALTH AROUND PINE LAKE (HANCOCK).

CONCLUSIONS & RECOMMENDATIONS

Some of the water quality results for Pine Lake suggested that the lake may be transitioning to a lake with poorer water quality, which often leads to changes in the fishery and aquatic plant community. If positive changes are employed on the landscape within the Pine Lake watershed, it is quite possible to improve conditions in the lake. In general, each type of land use contributes different amounts of phosphorus, nitrogen, and pollutants in runoff and through groundwater. The types of land management practices that are used and their distances from the lake affect the contributions to the lake from a parcel of land. The health of Pine Lake is a reflection of the cumulative positive and negative impacts on the land, so each property owner in the watershed has a role to play.

- The summer median total phosphorus concentrations were 18 ug/L and 16 ug/L in 2011 and 2012, respectively. This is below but approaching Wisconsin's phosphorus standard of 20 ug/L for deep seepage lakes, and is above the proposed flag value of 15 ug/L. Pine Lake had the highest median phosphorus concentrations when compared with other deep seepage lakes in the Waushara County Lakes Study.
- Identifying and taking steps to maintain or improve water quality in Pine Lake depends upon understanding the sources of nutrients to the lake and identifying those that are manageable. While agriculture and forests comprised the greatest acreage of land in the Pine Lake watershed, agricultural land was estimated to contribute the greatest amount of phosphorus to the lake.
- During the study, inorganic nitrogen concentrations were high enough in the spring to enhance algal blooms throughout the summer. Sources of inorganic nitrogen include fertilizers, septic systems, and animal waste.
- Atrazine (DACT), an herbicide commonly used on corn, was detected (0.005 µg/L and 0.055 µg/L) in the samples that were analyzed from Pine Lake. Some toxicity studies have indicated that reproductive system abnormalities can occur in frogs at these levels. The presence of this chemical indicates that agricultural practices are influencing the water quality in Pine Lake.
- The water in Pine Lake followed a pattern of mixing and stratification (layering) throughout the year. During the summer, it was typical for dissolved oxygen to drop to low concentrations at depths below 7 feet.
- Over-application of chemicals and nutrients should be avoided. Landowners in the watershed should be made aware of their connection to the lake and should work to reduce their impacts through the implementation of water quality-based best management practices.
- Routine monitoring of water quality can help to track changes in Pine Lake. The monitoring that is being conducted in Pine Lake should be reviewed and continued to evaluate changes in lake health.

Shoreland health which is critical to a healthy lake's ecosystem was assessed for the extent of vegetation and disturbances. Shoreland vegetation provides habitat for many aquatic and terrestrial animals, including birds, frogs, turtles, and many small and large mammals. Vegetation also helps to improve the quality of the runoff that is flowing across the landscape towards the lake. Healthy shoreland vegetation includes a mix of tall grasses/flowers, shrubs and trees extending at least 35 feet inland from the water's edge. Alone, each manmade disturbance may not pose a problem for a lake, but on developed lakes, the collective impact of these disturbances can be a problem for lake habitat and water quality.

- Large portions of Pine Lake's shorelands are in good shape, but a few segments have challenges that should be addressed. One stretch of Pine Lake shoreland, along the southern shore, ranked in the poorest category.
    - Structures such as seawalls, rip-rap (rocked shoreline), and artificial beach can result in habitat loss.
    - Docks and artificial beaches can result in altered in-lake habitat. Denuded lakebeds provide opportunities for invasive species to become established and reduce habitat that is important to fish and other lake inhabitants.
- Strategies should be developed to ensure that healthy shorelands remain intact and efforts should be made to improve shorelands that have disturbances. Depending upon the source of the disturbances, erosion should be controlled, vegetation restored, and/or excess runoff minimized.
- Dissemination of relevant information to property owners is the recommended first step towards maintaining healthy shorelands.

- The Waushara County Land Conservation Department and Natural Resources Conservation Service (NRCS) have professional staff available to assist landowners interested in learning how they can improve water quality through changes in land management practices.

Analysis of biological components and physical properties of Pine Lake's sediment core indicated an increase in erosion-induced processes such as land clearing, storm events, and shoreland disturbance since the time of land settlement around the lake. The analyses indicated these activities occurred more frequently in recent decades, but appear to have been minimized in recent years.

- There has likely been an increase in nutrient delivery, including phosphorus, to the lake over this time period. While the diatom communities and the physical properties of the sediment did not directly show this increase in phosphorus, they did show an increase in aquatic plants and algae toward the top of the sediment core.
- The increase in aquatic plants and algae has resulted in a loss in water clarity since the last century.

Aquatic plants are the forested landscape within a lake. They provide food and habitat for a wide range of species including fish, waterfowl, turtles, and amphibians, as well as invertebrates and other aquatic animals. They improve water quality by releasing oxygen into the water and utilizing nutrients that would otherwise be used by algae. A healthy lake typically has a variety of aquatic plant species that creates the diversity needed to make the aquatic plant community more resilient and help prevent the establishment of non-native aquatic species.

- The diversity of an aquatic plant community is defined by the type and number of species present throughout the lake. Twenty-three species of aquatic plants were found in Pine Lake, which is above-average when compared with the other lakes in the Waushara County Lakes Study.
- Three of the species found in Pine Lake were considered high quality plant (with a C-value of 8). They were southern naiad, Fries' pondweed, and stiff pondweed.
- One carnivorous plant, common bladderwort, was also present in Pine Lake.
- Invasive species are present in Pine Lake. Eurasian watermilfoil (EWM) was found at 84% of the vegetated sites and currently accounts for a large portion of the plant biomass in Pine Lake. EWM can create dense beds that can damage boat motors, make areas non-navigable, stunt or alter the fishery, create problems with dissolved oxygen, and prevent activities like fishing and swimming.

This plant can produce a viable seed; however, its primary mode of reproduction and spread is fragmentation. A one-inch fragment is enough to start a new plant, making EWM very successful at reproducing

- The amount of disturbed lakebed from raking or pulling plants should be minimized, since these open spaces are "open real estate" for aquatic invasive plants to establish.
- Early detection of aquatic invasive species (AIS) can help to prevent their establishment should they be introduced into the lake. Boats and trailers that have visited other lakes can be a primary vector for the transport of AIS.
- Programs are available to help volunteers learn to monitor for AIS and to educate lake users at the boat launch about how they can prevent the spread of AIS.

REFERENCES

Borman, Susan, Robert Korth, Jo Temte, 2001. *Through the looking glass, a field guide to aquatic plants*. Reindl Printing, Inc. Merrill, Wisconsin.

Golden Sands Resource Conservation & Development Council, Inc., 2014. Aquatic Macrophyte Survey of Pine Lake, Waushara County, Wisconsin, Waushara County Lake Study.

Hayes, T., K. Haston, M. Tsui, A. Hoang, C. Haeffele and A. Vonk. 2003. *Atrazine-Induced Hermaphroditism at 0.1 PPB in American Leopard Frogs (Rana pipiens): Laboratory and Field Evidence*. Environmental Health Perspectives 111: 568-575.

Hayes, T.K. A. Collins, M, L,, Magdelena Mendoza, N. Noriega, A. A. Stuart, and A. Vonk. 2001. *Hermaphroditic, demasculinized frogs after exposure to the herbicide atrazine at low ecologically relevant doses*. National Academy of Sciences vol. 99 no. 8, 5476–5480.

Panuska and Lillie, 1995. *Phosphorus Loadings from Wisconsin Watershed: Recommended Phosphorus Export Coefficients for Agricultural and Forested Watersheds*. Bulletin Number 38, Bureau of Research, Wisconsin Department of Natural Resources.

Shaw, B., C. Mechenich, and L. Klessig. 2000. *Understanding Lake Data*. University of Wisconsin-Extension, Stevens Point. 20 pp.

Wetzel, R.G. 2001. *Limnology, Lake and River Ecosystems, Third Edition*. Academic Press. San Diego, California.

GLOSSARY OF TERMS

Algae: One-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species occur. Algae are an essential part of the lake ecosystem and provide the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

Atrazine: A commonly used herbicide. Transports to lakes and rivers by groundwater or runoff. Has been shown to have toxic effects on amphibians.

Blue-Green Algae: Algae that are often associated with problem blooms in lakes. Some produce chemicals toxic to other organisms, including humans. They often form floating scum as they die. Many can fix nitrogen (N2) from the air to provide their own nutrient.

Calcium (Ca++): The most abundant cation found in Wisconsin lakes. Its abundance is related to the presence of calcium-bearing minerals in the lake watershed. Reported as milligrams per liter (mg/1) as calcium carbonate (CaCO3), or milligrams per liter as calcium ion (Ca++).

Chloride (Cl-): The chloride ion (Cl-) in lake water is commonly considered an indicator of human activity. Agricultural chemicals, human and animal wastes, and road salt are the major sources of chloride in lake water.

Chlorophyll *a*: Green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae, and is therefore used as a common indicator of algae and water quality.

Clarity: See "Secchi disk."

Color: Color affects light penetration and therefore the depth at which plants can grow. A yellow-brown natural color is associated with lakes or rivers receiving wetland drainage. Measured in color units that relate to a standard. The average color value for Wisconsin lakes is 39 units, with the color of state lakes ranging from zero to 320 units.

Concentration units: Express the amount of a chemical dissolved in water. The most common ways chemical data is expressed is in milligrams per liter (mg/l) and micrograms per liter (ug/l). One milligram per liter is equal to one part per million (ppm). To convert micrograms per liter (ug/l) to milligrams per liter (mg/l), divide by 1000 (e.g. 30 ug/l = 0.03 mg/1). To convert milligrams per liter (mg/l) to micrograms per liter (ug/l), multiply by 1000 (e.g. 0.5 mg/l = 500 ug/l).

Cyanobacteria: See "Blue-Green Algae."

Dissolved oxygen: The amount of oxygen dissolved or carried in the water. Essential for a healthy aquatic ecosystem in Wisconsin lakes.

Drainage basin: The total land area that drains runoff towards a lake.

Drainage lakes: Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems, but generally have shorter residence times than seepage lakes.

Emergent: A plant rooted in shallow water and having most of its vegetative growth above water.

Eutrophication: The process by which lakes and streams are enriched by nutrients, and the resulting increase in plant and algae. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Groundwater drainage lake: Often referred to as a spring-fed lake, it has large amounts of groundwater as its source and a surface outlet. Areas of high groundwater inflow may be visible as springs or sand boils. Groundwater drainage lakes often have intermediate retention times with water quality dependent on groundwater quality.

Hardness: The quantity of multivalent cations (cations with more than one +), primarily calcium (Ca++) and magnesium (Mg++) in the water expressed as milligrams per liter of CaCO3. Amount of hardness relates to the presence of soluble minerals, especially limestone or dolomite, in the lake watershed.

Intermittent: Coming and going at intervals, not continuous.

Macrophytes: See "Rooted aquatic plants."

Marl: White to gray accumulation on lake bottoms caused by precipitation of calcium carbonate (CaCO3) in hard water lakes. Marl may contain many snail and clam shells. While it gradually fills in lakes, marl also precipitates phosphorus, resulting in low algae populations and good water clarity. In the past, marl was recovered and used to lime agricultural fields.

Mesotrophic: A lake with an intermediate level of productivity. Commonly clear water lakes and ponds with beds of submerged aquatic plants and mediums levels of nutrients. See also "eutrophication".

Nitrate (NO3-): An inorganic form of nitrogen important for plant growth. Nitrate often contaminates groundwater when water originates from manure, fertilized fields, lawns or septic systems. In drinking water, high levels (over 10 mg/L) are dangerous to infants and expectant mothers. A concentration of nitrate-nitrogen (NO3-N) plus ammonium-nitrogen (NH4-N) of 0.3 mg/L in spring will support summer algae blooms if enough phosphorus is present.

Oligotrophic: Lakes with low productivity, the result of low nutrients. Often these lakes have very clear waters with lots of oxygen and little vegetative growth. See also "eutrophication".

Overturn: Fall cooling and spring warming of surface water increases density, and gradually makes lake temperatures and density uniform from top to bottom. This allows wind and wave action to mix the entire lake. Mixing allows bottom waters to contact the atmosphere, raising the water's oxygen content. Common in many lakes in Wisconsin.

Phosphorus: Key nutrient influencing plant growth in more than 80% of Wisconsin lakes. Soluble reactive phosphorus is the amount of phosphorus in solution that is available to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Rooted aquatic plants (macrophytes): Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects and provide food for many aquatic and terrestrial animals. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Secchi disk: An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration).

Sedimentation: Materials that are deposited after settling out of the water.

Stratification: The layering of water due to differences in density. As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 20 feet. The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion. Common in many deeper lakes in Wisconsin.

Watershed: See "Drainage basin."

Aquatic Macrophyte Survey
of
Pine (Hancock) Lake
Town of Hancock
Waushara County, Wisconsin

Flower of common bladderwort (*Utricularia macrorhiza*), a carnivorous aquatic plant found in Hancock Lake. Photo by Paul Skawinski

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INTRODUCTION

A point-intercept survey of aquatic plants was conducted on Pine Lake on August 6-7, 2013. The information in the survey was obtained to evaluate the aquatic plant community and can be used as baseline information for the development of an aquatic plant management plan. Pine Lake is a 104-acre, hard-water lake. The maximum depth of rooted vegetation we recorded during our survey was 13.25 feet.

Aquatic plants play an important role in a lake's ecosystem. They provide habitat for the fishery and other aquatic organisms, stabilize the sediment, reduce shoreline erosion, buffer temperature changes and waves, and infuse oxygen into the water. Rapid and dominant growth of aquatic invasive plants, such as Eurasian watermilfoil (EWM), can outcompete and cause a decline in native vegetation, which degrades habitat diversity and recreational value. In Wisconsin, aquatic invasive species (AIS) have spread quickly via transport on boats, trailers, and equipment. One invasive plant species was found in our survey: EWM.

METHODS

The aquatic plant survey in Pine Lake was conducted by Golden Sands RC&D Council, Inc. from August 6-7, 2013. The survey was accomplished using the Wisconsin Department of Natural Resources (WDNR) point-intercept sampling protocol. The GPS coordinates for the grid, which consisted of 300 sampling sites, was provided by WDNR (Figure 1). The grid was laid out with equal spacing between all points to ensure future replication and thorough coverage of the lake. The shape of the lake and the size of the littoral zone are the two factors used to determine the number of points and their spacing. The GPS points were first overlaid onto an aerial photograph that was used in the field. A handheld GPS unit was also used to navigate to sampling sites in the field.

For aquatic plant sampling, a pole-mounted rake was used at each accessible site by dropping the rake straight down, turning it 360°, then pulling it straight back up. The rake had a double rake head with fourteen teeth on each side with a width of 13.8 inches. The pole rake method was usable to a depth of 13.5 feet. At depths greater than this, a rake on a rope was used by towing the rake 0.75 meters then pulling it straight up. The rope and pole were marked in 1-foot increments so depth could be measured as sampling took place. After the rake was retrieved, each species present was

A canoe with a crew of three was used during this survey. One person paddled the canoe, while another recorded data, and the third sampled and identified aquatic plants. There were a number of points that were inaccessible by canoe. If the water was too shallow or the surface was a tangle of vegetation, the points were deemed "non-navigable". If an aquatic plant was seen at a site but not pulled up on the rake, it was noted with a "V" on the data sheets and included in the plant list on Table 1 of this report.

RESULTS & DISCUSSION

The survey was based on 300 sites that were assigned using WDNR's point-intercept protocol; 264 of these points were accessible to sample during this survey. Some points were inaccessible due to dense, matted vegetation or because points were placed on shore. In addition, some points were too deep and were unlikely to have aquatic plants. 254 (96%) of the 264 sampled sites had vegetation present.

The greatest depth at which aquatic plant growth was found was 13.25 ft. In Pine Lake, aquatic plants are capable of growing this deep due to the level of water clarity; plant growth at such depths is fairly common in Wisconsin lakes. 67% of the sites sampled had a depth of 6 feet or less; many of these sites occur in the eastern half of the lake. Figure 3 also shows that the diversity in the eastern one-third of the lake is very low in open water. It is possible that EWM is shading out native species. Pine Lake's vegetated area was 96.9%, which is very high compared to many lakes in the Central Sands region of Wisconsin. Pine Lake had a species richness of 21; 23 if visuals are included. Freshwater sponges were also observed.

Dominant sediment type was assessed at each site. Following WDNR protocol, the dominant sediment type was recorded as sand, muck, or rock; only one classification was allowed per site. Muck was the dominant sediment type throughout the lake (96%). Of the remaining sites, 2% were sand and 2% of the sites had rocky substrate.

Frequency of Occurrence

The frequency of occurrence (FO) value is a measure of the frequency at which a species occurs in the lake. The most frequently occurring aquatic plant species found in Pine Lake was EWM, which occurred at 84% of vegetated sites (Figure 4). The second most abundant aquatic species was muskgrasses (*Chara* spp., which are macroalgae), found at 36% of vegetated sites (Figure 5), followed by sago pondweed (*Stuckenia pectinata*) at 27% (Figure 6). Freshwater sponges occurred at 10% of vegetated sites. Freshwater sponges are actually a primitive animal, not a plant, but were noted because they are excellent water quality indicators (Figure 7).

Although northern watermilfoil, (*Myriophyllum sibiricum*) (NWM), ranked ninth for frequency of occurrence (6%), it is one of the more important species to know in the lake. NWM can look very similar to its invasive counterpart EWM; however, it tends to be less abundant. There were a number of points in the lake which had NWM present, but the plants were in low abundance. This native milfoil can easily be misidentified as EWM which may prompt unnecessary action.

Simpson Diversity Index

The Simpson Diversity Index (SDI) quantifies biodiversity based on a formula that uses the number of species surveyed and the number of individuals per site. The SDI uses a decimal scale; values closer to one represents higher biodiversity. The SDI of Pine Lake for the 2013 survey was 0.78. This is slightly higher than Big Hills Lake, which is similar in depth and surface area size, has an SDI of 0.77, and was surveyed in August 2013.

Floristic Quality Index

The Floristic Quality Index (FQI) evaluates the similarity of a plant community to undisturbed conditions. Each plant is assigned a coefficient of conservatism value ("C-value") that reflects its sensitivity to disturbance and these numbers are used to calculate the FQI. C-values range from 0 to 10, the higher the number, the more intolerant of disturbance. A C-value of 0 is assigned to non-native species.

In Pine Lake, the C-value ranged from 0 to 8 (Table 2). EWM has a C-value of 0. 3 out of 23 of the species found in Pine Lake had a C-value of 8 or greater (Stiff pondweed, Fries' pondweed, and southern naiad), indicating the health of the aquatic plant community may be impacted by EWM (Table 2). The species with the highest frequency of occurrence was EWM, which has a C-value of 0. Figure 8 shows the highest C-value at each sampling site. Many of the sites have a C-value of 8 which in many cases is associated with southern naiad. The calculated FQI for Pine Lake was 27.0; this is higher than the average FQI for statewide lakes. The FQI, FO, and species richness for Pine Lake are above the statewide lake averages.

AIS

EWM was first identified in Pine Lake in 2003, and at the time of our survey, was abundant. In 2004, a grant was approved for the use of granular 2,4-D to treat 48.9 acres of EWM at a rate of 150 lbs/acre. EWM was found at 84% of the sampled points during our 2013 survey. It was in moderate to high abundance at the center of the lake, and is present in varying abundance at most of the other sites in the lake.

CONCLUSIONS

Pine Lake has a moderately diverse aquatic plant community. Pine Lake is designated "no-wake", which allows for more stable conditions for aquatic plants and in some cases may increase the possibility for the presence of rare species that may be less tolerant of disturbance. Aquatic plant growth is abundant in the lake due to the shallow depth of water, and nutrient-rich sediments.

In August, spiny naiad (*Najas marina*) could be found in a north central bay. While it may have been introduced and could potentially become problematic, this plant usually does not become a nuisance. Spiny naiad should be periodically monitored.

EWM currently accounts for a large portion of the plant biomass in Pine Lake. While EWM exists throughout most of the lake, it is especially high in some areas. The western half of the lake contains the most sites with high abundance ratings (Figure 4). The near-shore areas, however, contain low densities or none. EWM can create dense beds which can stall or burn up boat motors, make areas non-navigable, and prevent activities like swimming and fishing. This plant can produce viable seed; however, its primary mode of spread is fragmentation. A one-inch stem fragment is enough to start a new plant.

Boats and trailers that have visited other lakes can be a primary vector for the transport of AIS. Volunteer boat inspectors at the boat landing, trained through the Clean Boats, Clean Waters (CBCW) program, can help prevent new invasive species introductions. The lack of intense high speed boating helps preserve the integrity of Pine Lake by reducing disturbance to the lakebed, which can favor AIS. Monitoring for AIS should be conducted routinely on the lake by either trained citizen volunteers or paid personnel. Free training for volunteers for both CBCW and AIS monitoring is available through the Regional AIS Program at Golden Sands RC&D Council, Inc. Contact Golden Sands RC&D at 715-343-6215 or www.goldensandsrcd.org.

Aquatic plants play a critical role in the aquatic ecosystem by providing quality habitat and food for fish, invertebrates, birds, and mammals. The plants tie up nutrients which would otherwise be available to algae. Any management activities should be planned to minimize disturbance of the native species in the water and on shore and maintain the balance between aquatic plants and algae. In addition, care should be taken to minimize the amount of disturbed lake bed from raking or pulling of plants, as these open spaces are simply “open real estate” for aquatic invasive plants to establish.

Sedimentation and excessive nutrient inputs accelerate algae and aquatic plant growth in the lake. Some erosion and sedimentation occurs naturally in the watershed, but it is commonly increased by shoreline disturbance and fertilizer applications. A minimum 35-foot vegetative buffer is recommended to provide sufficient filtering of runoff. Healthy vegetated shoreline buffers are comprised of native, unmown grasses, forbs, shrubs, and trees. Riparian property owners looking to add native plants to their shorelines can find several local sources, including:

- Prairie Nursery of Westfield, WI
- J&J Aquatic Nursery of Wild Rose, WI
- Marshland Transplant of Berlin, WI

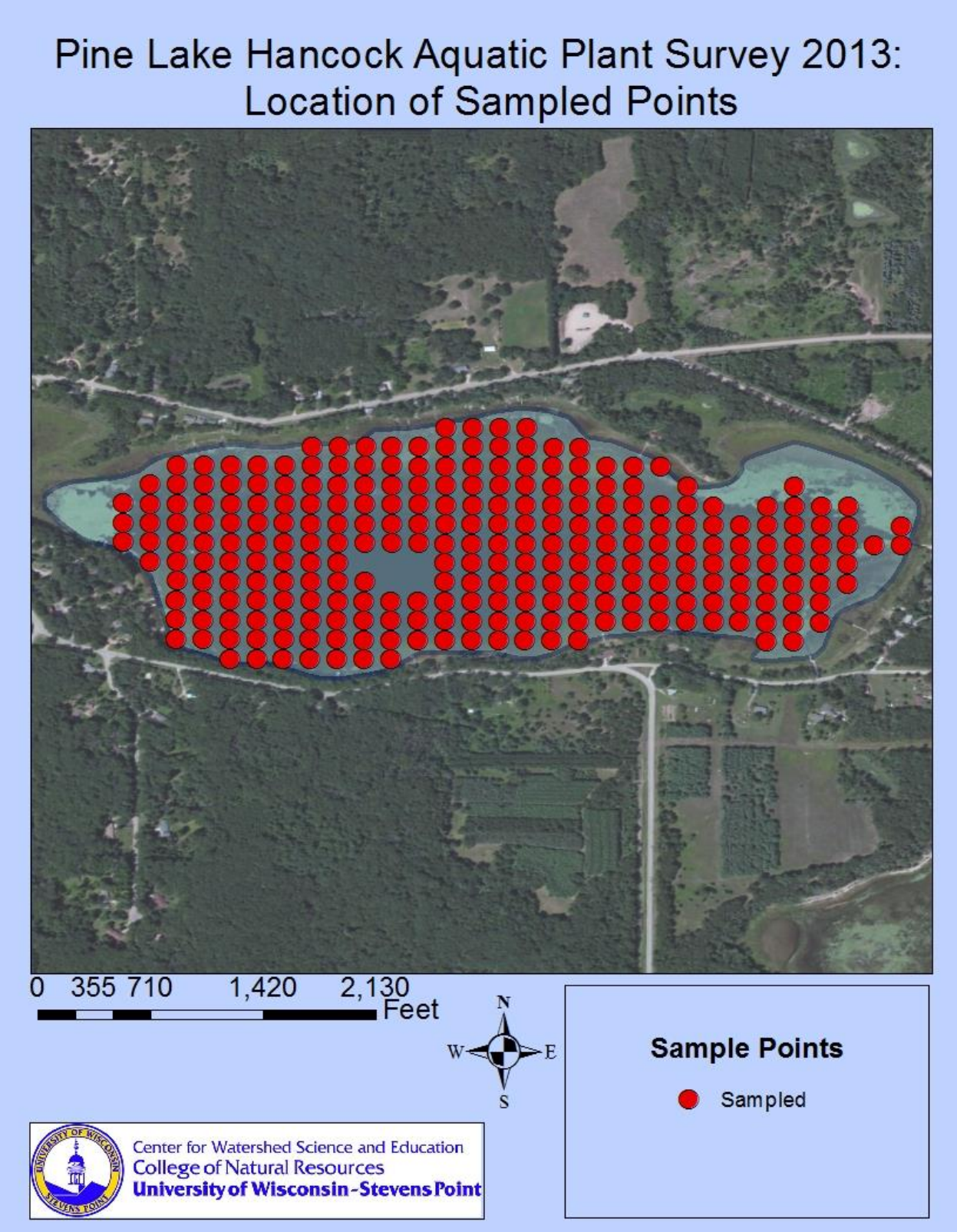

Figure 1. Survey points for an aquatic macrophyte survey of Pine Lake using the Wisconsin DNR point-intercept method.

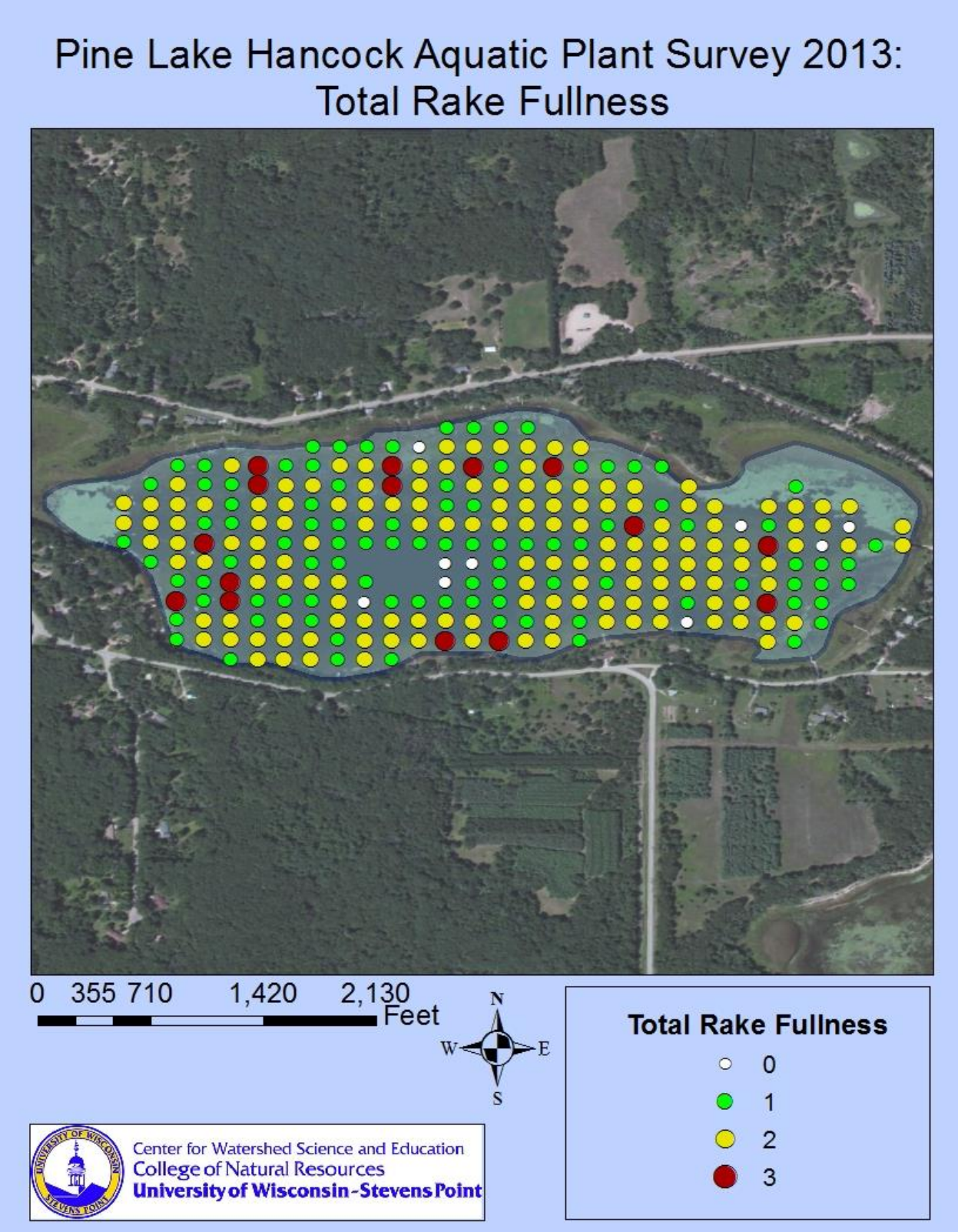

Figure 2. Total rake fullness of each sample point in Pine Lake, August 6-7, 2013.

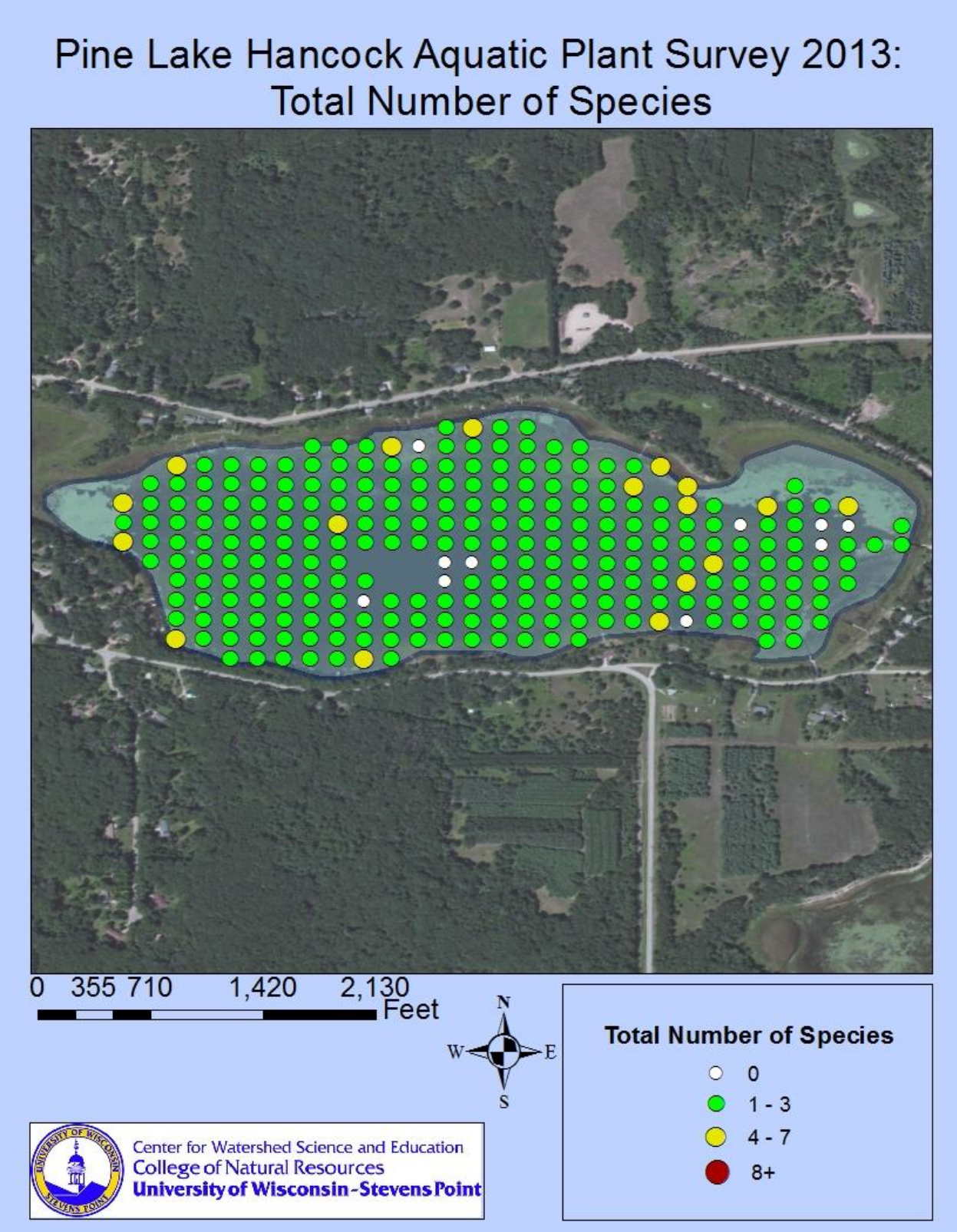

Figure 3. Total number of species found at each point in Pine Lake, August 6-7, 2013.

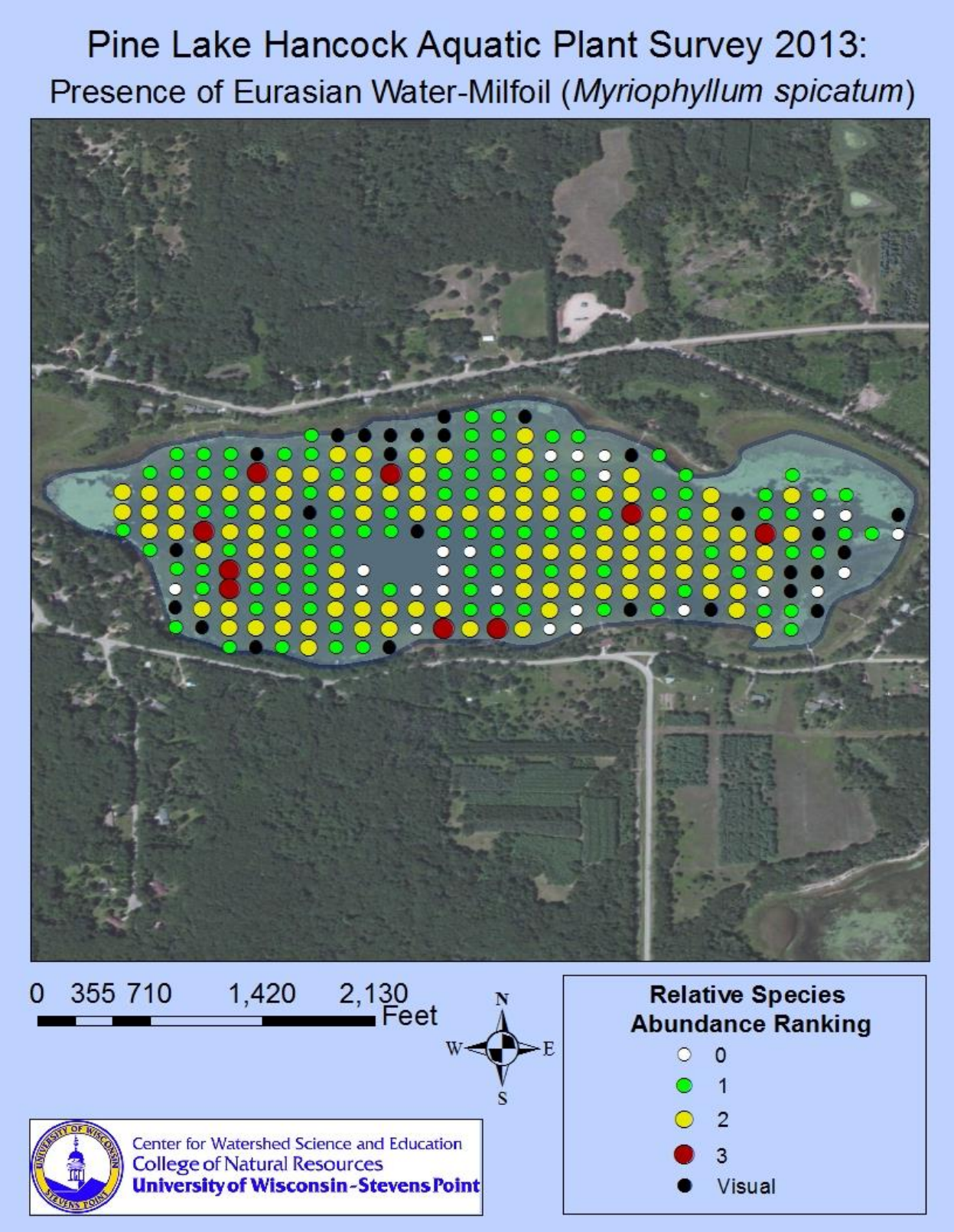

Figure 4. Location and relative abundance of Eurasian watermilfoil in Pine Lake, August 6-7, 2013.

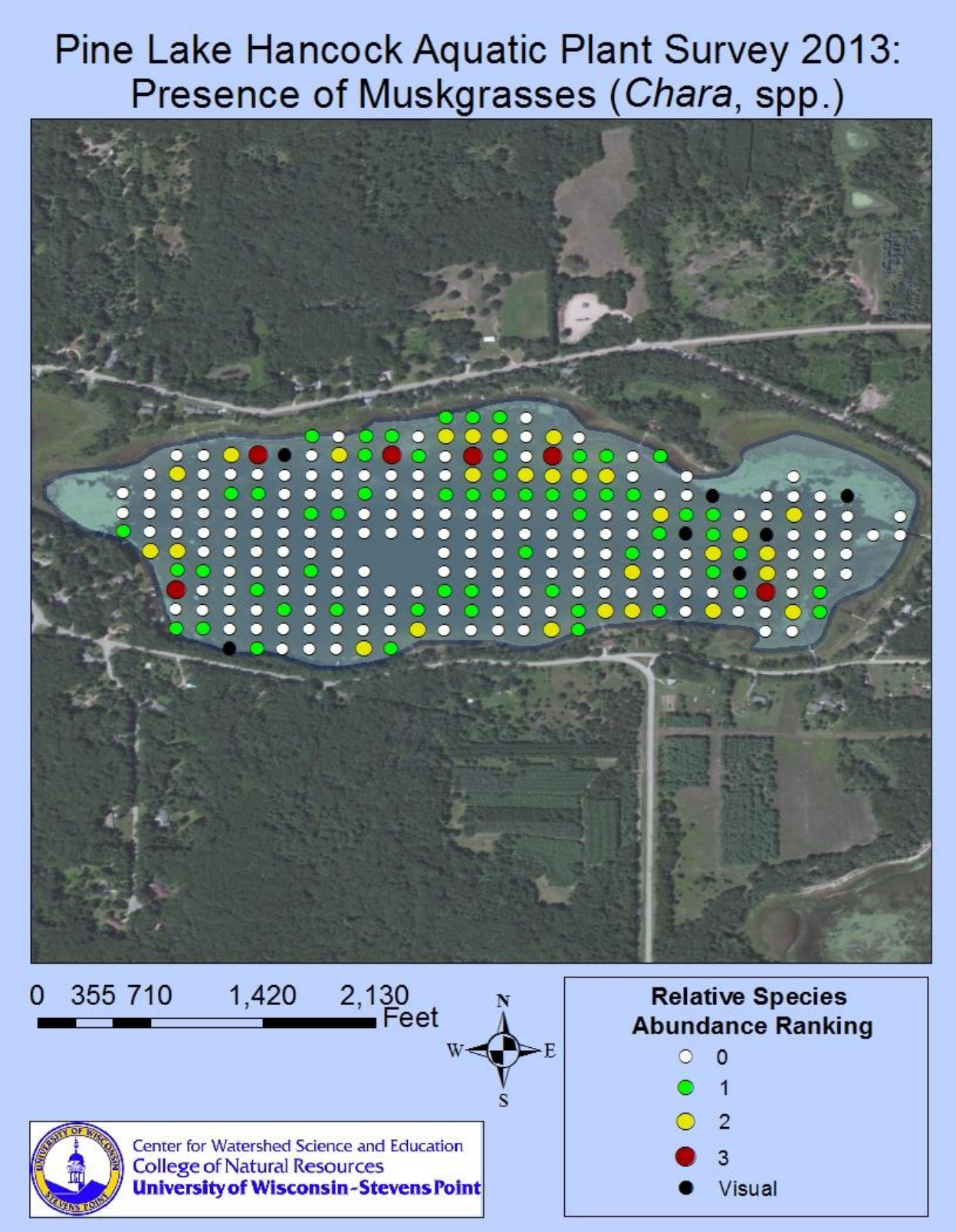

Figure 5. Location and relative abundance of muskgrasses in Pine Lake, August 6-7, 2013.

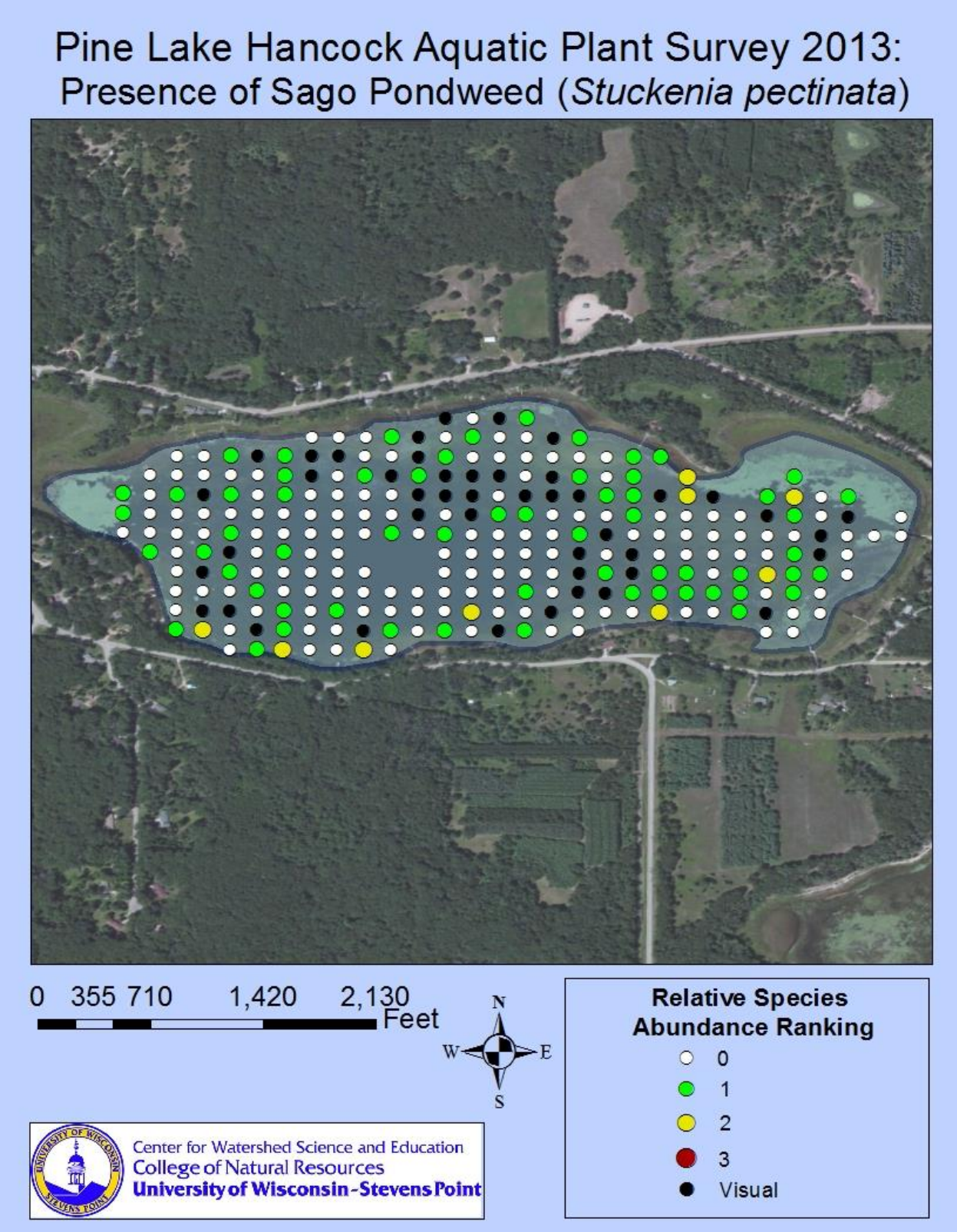

Figure 6. Location and relative abundance of sago pondweed in Pine Lake, August 6-7, 2013.

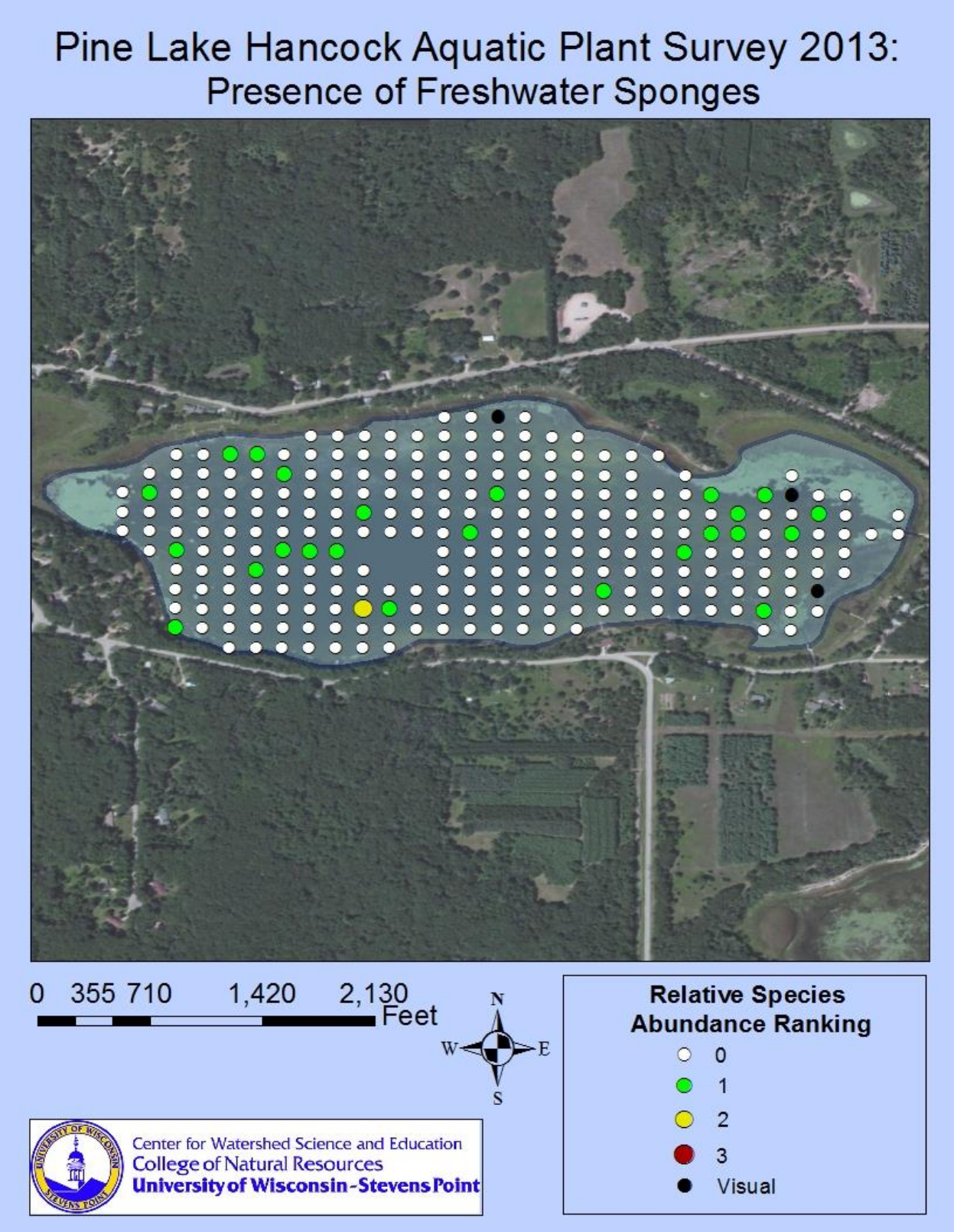

Figure 7. Location and relative abundance of freshwater sponges in Pine Lake, August 6-7, 2013.

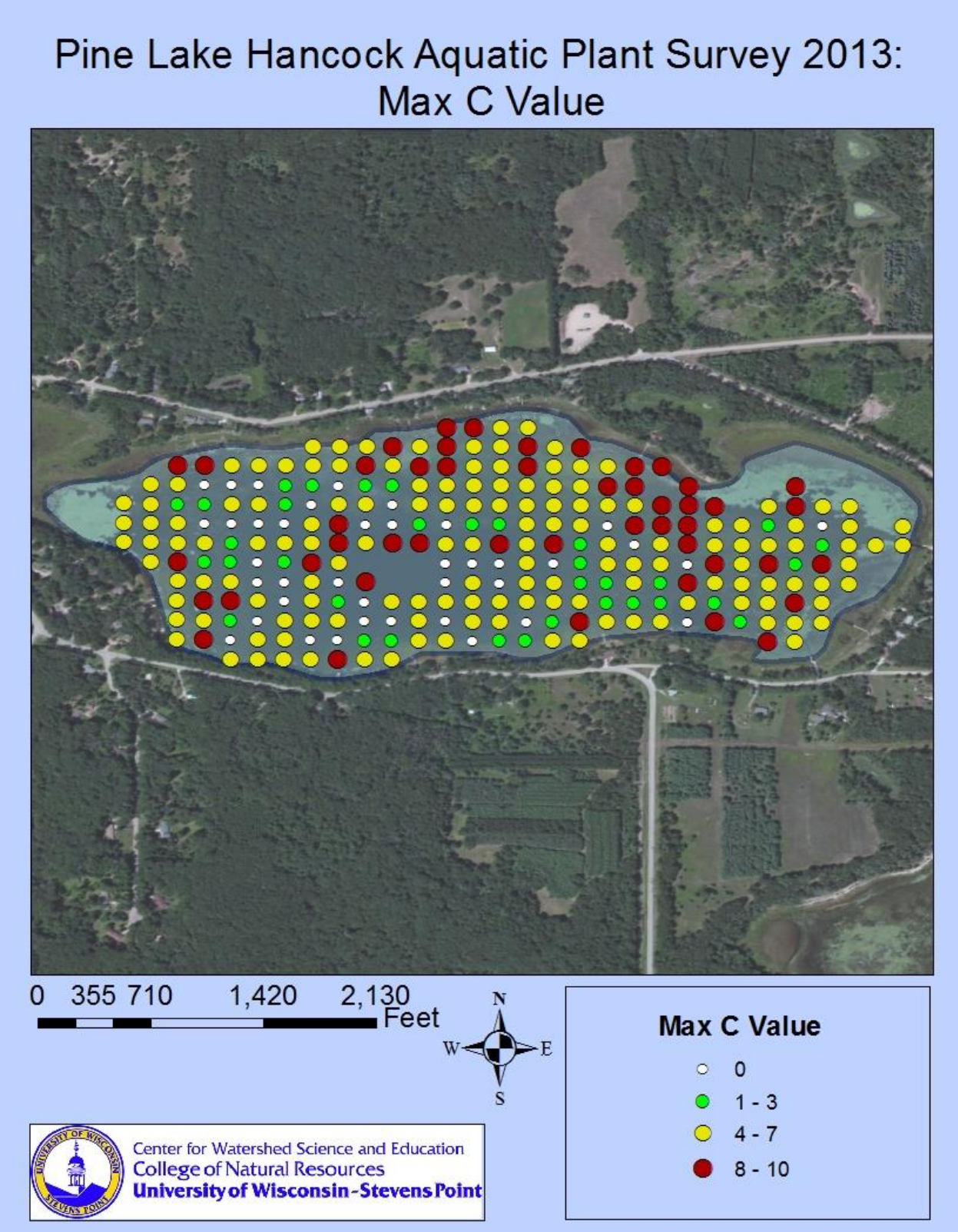

Figure 8. Maximum Coefficient of Conservatism value at each sample site in Pine Lake, August 6-7, 2013.

Table 1. Plants observed at Pine Lake in August 6-7, 2013.

Genus & species	Common name	Sampled	Visuals
Ceratophyllum demersum	Coontail	x	
Chara spp.	Muskgrasses	x	x
Myriophyllum sibiricum	Northern watermilfoil	x	x
Myriophyllum spicatum	Eurasian watermilfoil	x	x
Najas flexilis	Slender naiad	x	x
Najas guadalupensis	Southern naiad	x	x
Najas marina	Spiny naiad		x
	Stoneworts	x	
Nuphar variegata	Bullhead pond lily	x	x
Nymphaea odorata	White water lily	x	x
Polygonum amphibium	Amphibious smartweed		x
Potamogeton amplifolius	Large-leaf pondweed		x
Potamogeton friesii	Fries' pondweed	x	x
Potamogeton gramineus	Variable pondweed	x	x
Potamogeton illinoensis	Illinois pondweed	x	x
Potamogeton natans	Floating-leaf pondweed		x
Potamogeton pusillus	Small pondweed	x	x
Potamogeton strictifolius	Stiff pondweed	x	x
Potamogeton zosteriformis	Flat stem pondweed	x	x
Schoenoplectus acutus	Hard stem bulrush		x
Stuckenia pectinata	Sago pondweed	x	x
Typha angustifolia	Narrow leaf cattail		x
Utricularia macrorhiza	Common bladderwort	x	x
	Freshwater sponges	x	x

Table 2. Coefficient of Conservatism values for plant species present in Pine Lake, August 6-7, 2013.

Genus and Species	Common Name	C-value
Ceratophyllum demersum	Coontail	3
Chara spp.	Muskgrasses	7
Myriophyllum sibiricum	Northern watermilfoil	6
Myriophyllum spicatum	Eurasian watermilfoil	0
Najas flexilis	Slender naiad	6
Najas guadalupensis	Southern naiad	8
Najas marina	Spiny naiad	0
Nitella spp.	Stoneworts	7
Nuphar variegata	Bullhead pond lily	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Amphibious smartweed	6
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton pusillus	Small pondweed	7
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Schoenoplectus acutus	Hard-stem bulrush	6
Stuckenia pectinata	Sago pondweed	3
Typha angustifolium	Narrow-leaved cattail	1
Utricularia macrorhiza	Common bladderwort	7
	Freshwater sponges	-