2015

Alpine Lake, 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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University of Wisconsin-Stevens Point

Lake Management Plan for Alpine Lake, Waushara County, Wisconsin

The Alpine Lake Management Plan was developed with input from residents and lake users at a series of four public planning sessions held at the Marion Town Hall in Wautoma, Wisconsin in May, June, July and August 2015. 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 Alpine Lake Protection & Rehabilitation District on: January 27, 2016.
Date

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

The plan was adopted by Waushara County on: _____.
Date

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

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

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Overarching Vision for Alpine Lake

Alpine Lake will remain a quiet retreat known for its great swimming, fishing and serene landscape. It will continue to be a place of fond memories where people and wildlife congregate to enjoy this special place.

Introduction

Alpine Lake is a 56-acre impoundment of Bruce Creek. The lake is located in the township of Marion, east of the city of Wautoma, Wisconsin, in Waushara County. It receives most of its water from Bruce Creek and, to lesser extents, from surface and groundwater. The maximum depth in Alpine Lake is 18 feet. Alpine Lake has an irregular shape and its lakebed has a slope that varies from gentle to steep on the eastern side. Its bottom sediments are mostly muck with some rock and sand along the southeastern side. The surface watershed of Alpine Lake is comprised primarily of forested land and cultivated cropland and includes portions of the towns of Marion, Mount Morris, Dakota and Wautoma. There are roads and some development around its perimeter as well as forested land.

The purpose of this plan is to provide a framework for the protection and improvement of the lake. Implementing the content of this lake management plan (LMP) will enable citizens and other supporters to achieve the vision for Alpine 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 Alpine 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 Alpine 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 Alpine Lake can have the greatest influence on the lake by understanding and choosing lake-friendly options to manage their land and the lake.
- **Alpine Lake Protection & Rehabilitation District:** This plan provides the Alpine Lake 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 Alpine 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 fun.
- **The towns of Mount Morris, Marion, Wautoma, and Dakota and the city of Wautoma**: 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 funding from the State – 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 professionals at the Wisconsin Department of Natural Resources were also incorporated into the planning process to provide 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 Alpine 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, data used in the development of this plan were detailed in the report *Waushara County Lakes Study – Alpine Lake 2010-2012*, University of Wisconsin-Stevens Point.

The Planning Process

The planning process included a series of four public planning sessions held between May and August 2015 at the Marion Town Hall. The Alpine Lake Planning Committee consisted of lake district members and property owners. 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 mailed to Alpine Lake waterfront property owners and by press releases in local newspapers. In addition, members of the planning committee 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 F. Lake User Survey Results.

Implementing the content of this lake management plan will enable citizens and other supporters to achieve the vision for Alpine 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 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 Alpine Lake and members of the Alpine Lake Management Planning Committee, as well as the known science about Alpine Lake, its ecosystem and the landscape within its watershed. 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. Implementing and regularly updating the goals and actions in the Alpine Lake Management Plan will ensure that the vision is supported and that changes or new challenges are incorporated into the plan. **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, Alpine Lake Protection & Rehabilitation District

List of Goals

Goal 1. Alpine Lake will have the necessary elements to sustain a balanced fishery, which include sufficient habitat, water quality, and fishing regulations.

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

Goal 3. New aquatic invasive species will not become established in Alpine Lake. EWM/HWM and CLP will be controlled or eliminated.

Goal 4. Protect unique areas that are valuable to the water quality and habitat of Alpine Lake.

Goal 5. Minimize nutrient and sediment loading to the lake by improving land management practices near the lake and in the watershed.

Goal 6. Continue long term data collection on Alpine Lake to monitor trends such as declines and improvements over time.

Goal 7. Encourage shoreland property owners to preserve and restore healthy shorelands. To reach compliance with NR 115, 7499 feet of shoreland frontage are currently in need of shoreland restoration. Restore approximately 5% (350 feet) of the shoreline over the next 5 years.

Goal 8. Explore and utilize resources for healthy lake management.

Goal 9. Alpine Lake will retain its peaceful setting for people and nature while accommodating a variety of uses.

Goal 10. Increase participation in lake stewardship.

Goal 11. Review plan annually and update with partners as needed or every five years.

The following goals were identified as 'high priority':

New aquatic invasive species will not become established in Alpine Lake. EWM and CLP will be controlled or eliminated. (Aquatic Invasive Species (AIS)**)**

(see Alpine Lake Aquatic Plant Management Plan)

Maintain navigable water. (Alpine Lake Aquatic Plant Management Plan**)**

Improve fishing opportunities. (The Fish Community**)**

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
Alpine Lake Protection & Rehabilitation District	ALPRD
WDNR Citizen Lake Monitoring Network	CLMN
UWSP Center for Watershed Science and Education	CWSE
Wisconsin Department of Agriculture, Trade and Consumer Protection	DATCP
North Central Conservancy Trust	NCCT
USDA Natural Resources Conservation Service	NRCS
Golden Sands Resource Conservation & Development Council, Inc.	RC&D
UW- Extension	UWEX
University of Wisconsin-Stevens Point	UWSP
Waushara County Watershed Lakes Council	WCWLC
Wisconsin Department of Natural Resources	WDNR
Wisconsin Department of Transportation	WDOT
UWSP Water and Environmental Analysis Laboratory	WEAL
Waushara County Land Conservation Department	WLCD

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

In-Lake Habitat and a Healthy Lake

Many lake users value Alpine Lake for its solitude, scenery, fishing, and wildlife. 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 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.


Painted Turtles - A.B. Sheldon

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 Alpine Lake includes the aquatic plants, branches, and tree limbs above and below the water.

The 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.


Photo courtesy of Limnology Center, UW Madison

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.

Periodically, fish have been stocked to enhance populations in Alpine Lake. Between 1972 and 2015, over 256,950 walleye were reported to be stocked in Alpine Lake. Depending upon size and source, the cost per walleye ranged between $0.75 and $2.85; approximately 70% survive to become adults.

Table 1. History of fish stocking.

Year	Species	Age Class	Number Stocked	Average Length (inches)
1972	WALLEYE	FRY	250,000	1
1988	WALLEYE	FINGERLING	450	5
1989	WALLEYE	FINGERLING	5,400	7
1990	WALLEYE	FINGERLING	1,000	5
1995	WALLEYE	FINGERLING	350	10
1996	WALLEYE	FINGERLING	500	10
1998	WALLEYE	FINGERLING	500	10
2000	WALLEYE	FINGERLING	200	14.75
2002	WALLEYE	FINGERLING	750	8
2004	WALLEYE	FINGERLING	400	8
2006	WALLEYE	FINGERLING	750	8
2008	WALLEYE	FINGERLING	750	
2013	BLACK CRAPPIES		600	
2015	WALLEYE	FINGERLING	100	7
	WHITE SUCKERS		325 200	5 9
	MINNOWS		100 lbs.	2

Most of the survey responses and participants at the August 10, 2015 planning session felt the fishery had not changed significantly during their time at Alpine Lake, but that the density of aquatic plant beds (including invasives) has limited its potential. David Bartz, Fisheries Biologist with the WDNR, was in attendance at the session to present results of monitoring the lake's fishery in recent years. His strongest recommendation for improving the fishery was to enhance native shoreland vegetation and coarse woody habitat in shallow water.

The most recent comprehensive fishery surveys were conducted in Alpine Lake in 2014 by fisheries biologists with the WDNR. The 2014 surveys included an early spring (immediately after ice-out) fyke netting survey and a spring electrofishing survey. Survey results indicated panfish/bluegills were in somewhat high abundance (424/hr) with poor size structure (PSD6=17%, RSD7=6%, mean length 4.7"). Black crappies were in fair abundance with good growth. Many of the crappies were likely some of the 600 fish stocked in 2013 by We Really Kare fishing club. While black crappies should naturally reproduce in Alpine Lake, inadequate healthy near-shore habitat, including shoreland vegetation and woody habitat, is limiting their reproductive success. Largemouth bass were in slightly high abundance (149/hr > 8"), which had improved slightly from the overly abundant number (159/hr > 8") in a 2006 survey. Their size structure was fair (PSD12=56%, similar to 2006) with a mean length of 12 inches, which is average for lakes in the area. By the time boats were able to get onto the lake following ice-off, the northern pike had already moved into deeper water, which resulted in a small sample size, totaling 78. The fish that were captured indicated poor size structure with only one fish greater than 26 inches and a mean size of 17.8 inches. To help improve the overall fishery in Alpine Lake, the size limit for northern pike was removed from Alpine Lake beginning on January 1, 2015.

Guiding Vision for the Fish Community

The fishery in Alpine Lake will provide good fishing within a balanced lake ecosystem.

Goal 1. Alpine Lake will have the necessary elements to sustain a balanced fishery, which include sufficient habitat, water quality, and fishing regulations.

Objective 1.1. Improve the reproduction and size structure of the fishery through habitat improvements.

Actions	Lead person/group	Resources	Timeline
Inform property owners about the importance of habitat (aquatic vegetation, woody habitat, shoreland vegetation) to the fishery in Alpine Lake. (see also Shorelands section)	ALPRD	UWEX Lakes – educational materials	Ongoing 2016
Shoreland property owners will work together to ensure that sufficient near- shore habitat (including shoreland vegetation and woody habitat) is available to sustain a healthy fish community.	Shoreland property owners	WDNR Fishery Biologist WDNR Healthy Lakes Grants WCLCD	Ongoing
The County Parks Dept. will identify areas where healthy shoreland vegetation can be sustained and the addition of woody habitat would not negatively affect recreation.	WC Park Director WCLCD	ALPRD	2017
Work with WDNR Fishery Biologist on placement of woody habitat to avoid obstruction of recreation including use of shorter pieces, placing at angles, etc.	Shoreland property owners	WDNR Fishery Biologist WDNR Healthy Lakes Grants	Ongoing
Work with the county to determine how to improve management of the dike in a way that will provide better shoreland vegetation without compromising the structure.	ALPRD	WCLCD WDNR Healthy Lakes Grants WDNR Dam Safety Staff	2017

Aquatic Plants

Aquatic plants provide the forested landscape within Alpine 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. The aquatic plants that attract the animals to these areas contribute to the beauty of the shoreland and lake.

During the 2011 aquatic plant survey of Alpine Lake, ninety-nine percent (237) of 240 sampled sites had vegetative growth. Of the sampled sites within Alpine Lake, the average depth was 7.3 feet and the maximum depth with vegetation was 19 feet. Fourteen species of aquatic plants were found in Alpine Lake in 2011, with the greatest diversity located in the southern end of the lake. Figure 1 shows the number of species that were identified at each sampling site.

The dominant plant species in the survey was wild celery (*Vallisneria americana*), followed by common waterweed (*Elodea canadensis*) and muskgrass (*Chara* spp.). Wild celery is a premiere source of food for waterfowl, marsh birds and shore birds, and beds of this submersed plant also provide shade, shelter and feeding habitat for fish. Common waterweed offers shelter to fish and also provides food to waterfowl. Muskgrass is a favorite food source for a wide variety of waterfowl, and muskgrass beds offer cover and food to fish, especially young trout,

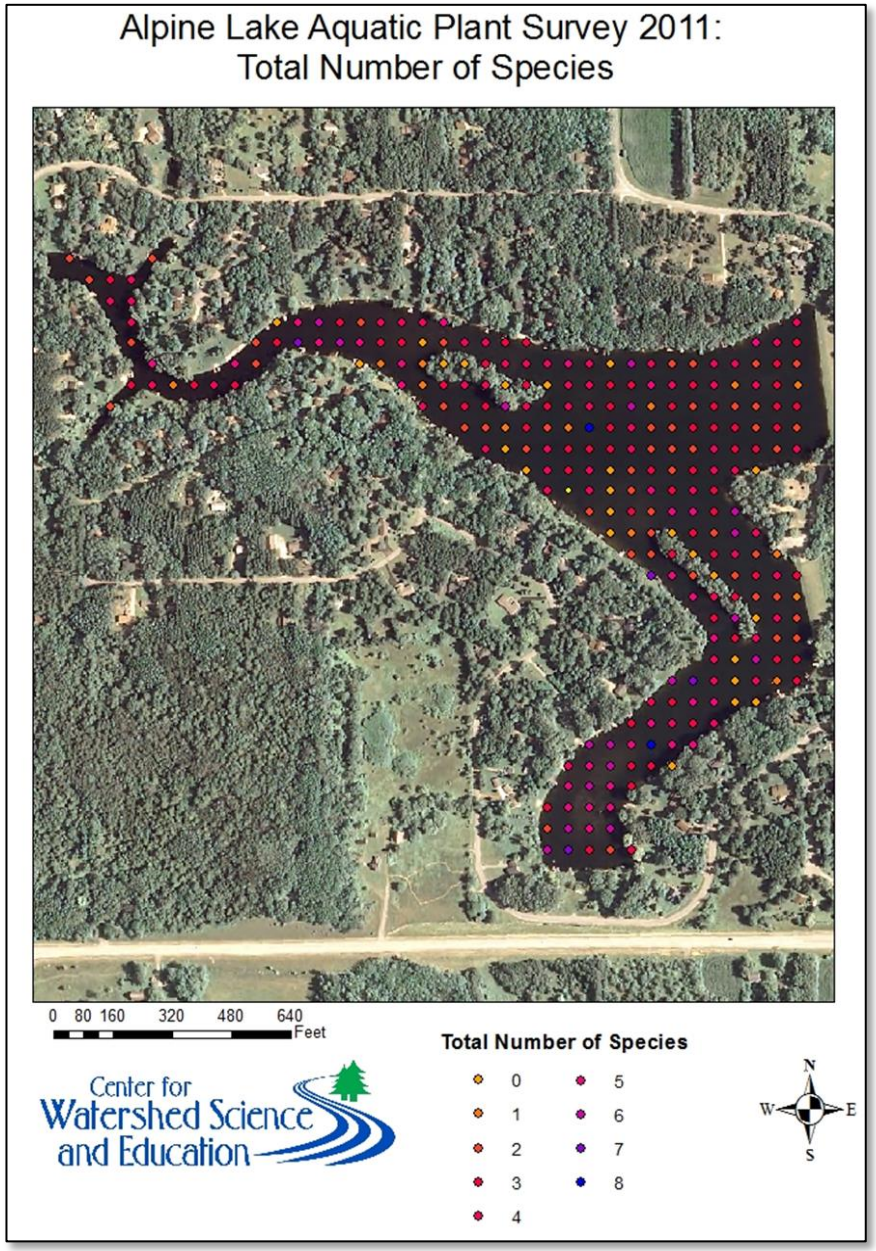


Figure 1. Total number of species at each site, 2011.

largemouth bass, and smallmouth bass (Borman et al., 2001). Two invasive species, curly-leaf pondweed and hybrid watermilfoil have been documented in the lake. More detailed information can be found in Appendix B. Aquatic Plants, the Alpine Lake Aquatic Plant Report, the Alpine Lake 2010-2012 Lake Study Report, or the Alpine Lake 2015 Aquatic Plant Management Plan.

Most survey respondents (92%) indicated aquatic plants, especially invasives and water lilies, are dense in Alpine Lake and affect their use of the lake. All survey respondents felt some degree of aquatic plant management was necessary. Participants at the planning session indicated that parts of the lake are commonly in a choked state. Some harvesting has been done in the past to create navigable areas, most recently in 2014.

As an impoundment, Alpine Lake receives most of its water via the Bruce Creek inlet on its western end. Soils within this watershed consist of sand and loamy sand interspersed with highly organic and tight clay soils that were likely drainage channels for melting glaciers just to the north. This results in a high, nutrient-rich, sediment load to the lake that periodically fills the inlet channel. The ALPRD has dredged this channel from time to time, most recently about 8 years ago. This work requires a permit, and costs of dredging limit the volume of sediment removed. Participants at the planning session indicated an interest in the placement of aerators in this area following the next dredging operation to try and reduce sedimentation. Putting good management practice on the landscape within the watershed would help to reduce the amount of sediment delivery to Alpine Lake.

Guiding Vision for Aquatic Plants in Alpine Lake

Alpine Lake will have a diverse native aquatic plant community that balances healthy habitat, good water quality, and recreational use.

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

Objective 2.1. Avoid disturbing 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, and at annual meeting.	ALPRD	UWEX Lakes WDNR Lake Manager WLCD WCWLC	Ongoing
Contact WDNR if water lilies become a significant obstruction in the main channel to discuss options.	ALPRD	WDNR Lake Manager	Ongoing
Refer to the Alpine Lake Aquatic Plant Management Plan, later in this section, for more detailed information and management options.	ALPRD	Consultants WDNR Lake Manager WLCD	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. In some lakes, aquatic invasive plant species can exist as a part of the plant community, while in other lakes populations explode, creating dense beds that can damage boat motors, make areas non-navigable, inhibit activities like swimming and fishing, and disrupt the lakes' ecosystems.

A special survey of Alpine Lake for curly-leaf pondweed (CLP) was conducted in June 2012. The life cycle of CLP can impact a lake's ecosystem. CLP grows under the ice during late winter and early spring, and when it dies back in late June/early July it releases phosphorus at a time when new plants and algae are beginning to grow. This phosphorus release may help fuel algae blooms and excessive plant growth. This seems to be the case in Alpine Lake, where participants indicated problems with filamentous algae during the summer months. During the 2012 CLP survey, CLP was found in numerous patches, some of which were relatively dense. A subsequent survey in 2013 yielded similar results (Figure 2).

Hybrid watermilfoil (HWM) was found in Alpine Lake during the 2011 aquatic plant survey. The lake was chemically treated for Eurasian watermilfoil (EWM) just before the survey was conducted in 2011, which likely impacted the distribution and density observed throughout the lake. The July 2013 survey revealed widespread EWM/HWM beds across the lake.

Continued monitoring of CLP and EWM/HWM is recommended to ensure that these populations are not growing or spreading to new locations within the lake.

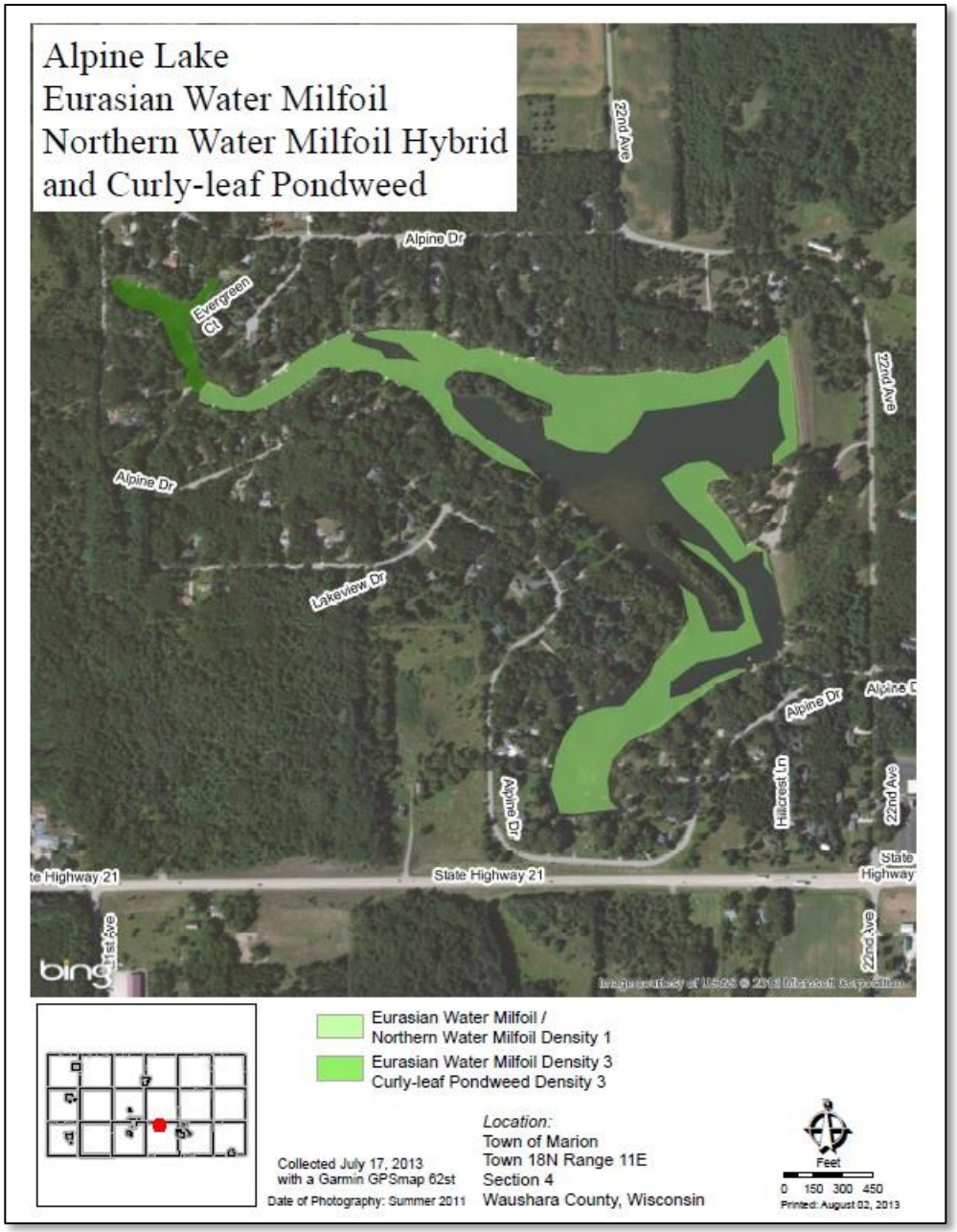


Figure 2. EWM and CLP in Alpine Lake, July 2013.

Originally documented in Alpine Lake in 2008, CLP can live in harmony with the rest of the aquatic plant community but may become invasive. The die-off of large beds of CLP in June can contribute to nuisance algae blooms throughout the summer. In Alpine Lake, CLP should be monitored annually in early June. Once the CLP is near the surface in late May or early June, harvesting it would help to remove nutrients from the lake.

Originally documented in Alpine Lake in 1992, 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. This plant produces viable seeds; however, it often spreads by fragmentation. Just a small fragment of the stem 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.

Each lake is different and the response to EWM control may differ 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 population should be evaluated using a 'point-intercept' method (accompanied by more thorough observations) before and after treatments to determine the effectiveness of an approach in a given year. Strategies for the subsequent year should be adjusted accordingly. EWM management involves evolving scientific knowledge; therefore, the management strategies for the management of EWM in Alpine Lake should be adapted as EWM populations in the lake change and as new information becomes available.

Hybrid watermilfoil (HWM) results from a hybridization of native watermilfoil with EWM. HWM tends to be more resilient and less affected by certain types of chemical treatment. HWM was formally listed as present in Alpine Lake by the WDNR in 2013. Since HWM has been confirmed, a *challenge test* should be conducted to determine which combination of chemicals will be effective in controlling that particular strain of HWM. Over 13 combinations of chemicals can potentially be used to treat HWM. 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 a more resilient strain in the lake, damage the native aquatic plant population, and waste money.

Japanese knotweed, a terrestrial invasive species, was documented near the inlet at Alpine Lake in 2013. Also known as Japanese or Mexican bamboo, it is an herbaceous perennial that forms large colonies of erect, arching stems resembling bamboo. Stems are round, smooth and hollow with reddish-brown blotches. Plants reach up to 10 feet high and the dead stalks remain standing through the winter. Japanese knotweed can cause the following problems (WDNR, 2015):

- New infestations of Japanese knotweed often occur when soil contaminated with rhizomes is transported or when rhizomes are washed downstream during flooding.
- Japanese knotweed poses a significant threat to shoreland areas where it prevents streamside tree regeneration and increases soil erosion.
- Root fragments as small as two inches can sprout, producing new infestations.
- Japanese knotweed can disrupt nutrient cycling in forested shoreland areas.
- Japanese knotweed contains allopathic compounds (chemicals toxic to surrounding vegetation).

There are manual and chemical options for controlling Japanese knotweed. Young plants can be hand-pulled. They should be pulled up by the root crown, while trying to remove the rhizomes, since remaining rhizomes can produce new plants. It is possible to eradicate small patches of knotweed with repeated and persistent cutting of the plants. Plant debris should be properly disposed of, as fragments as small as two inches can sprout and produce new infestations. Chemical use may be required to eradicate large, established plants. Plants are more susceptible to herbicides if they are cut when 4-5' tall and the regrowth treated around 3' tall. Large plants can be cut low to the ground and herbicide applied directly into the hollow stem.

Guiding Vision for Aquatic Invasive Species

Aquatic invasive species (AIS) will not significantly impact recreation or the fishery in Alpine Lake.

Goal 3. New aquatic invasive species will not become established in Alpine Lake. EWM/HWM and CLP will be controlled or eliminated.

Objective 3.1. Prevent the establishment of any new invasive species (AIS) in Alpine Lake.

Actions	Lead person/group	Resources	Timeline
Learn to identify AIS and routinely look for it.	ALPRD Board		2015, Ongoing
Use signs, newsletters, and other methods to inform lake visitors about AIS and removing aquatic hitchhikers.	ALPRD Board or Project Committee	RC&D	Annually

Inform property owners of the importance of aquatic vegetation and to refrain from removing native aquatic vegetation to diminish the possibility of new AIS colonization.	Individuals	UWEX Lakes (educational materials)	Ongoing

Objective 3.2. Reduce or eliminate populations of CLP in Alpine Lake.

The following table is a summary of actions associated with CLP management in Alpine Lake. It is not all-inclusive; please review the entirety of the Aquatic Plant Management Plan before choosing management options each year.

Actions	Lead person/group	Resources	Timeline
Map CLP beds in spring to assess the need for control, strategies to be employed, and to contribute to long-term assessment of CLP management.	ALPRD	Consultant WDNR Aquatic Plant Biologist	Annually – May/June
Prior to spring, review the results of the previous year's treatment and survey results, and develop a strategy (if needed) for the upcoming year.	ALPRD	Consultant WDNR Aquatic Plant Biologist	Annually in winter
Harvest CLP in late May/early June to reduce plant biomass/nutrient inputs to the lake and to increase navigation. Avoid areas where EWM is present in beds that are accessible to the harvester.	ALPRD	WDNR Aquatic Plant Biologist Consultant	Annually in spring
If needed, use herbicide treatments to reduce CLP populations.	ALPRD	Consultant WDNR Aquatic Plant Biologist	2016 and as needed
Consider skimming to remove filamentous algae and floating plants to reduce biomass/phosphorus inputs and improve navigation. Avoid areas where EWM is present.	ALPRD	WDNR Aquatic Plant Biologist Consultants	As needed
Consider a winter drawdown to kill CLP and compact the sediment.	ALPRD	WDNR Aquatic Plant Biologist Consultants	As needed

Objective 3.3. Reduce or eliminate populations of EWM in Alpine Lake.

The following table is a summary of actions associated with the management of EWM in Alpine Lake. It is not all-inclusive; please review the entirety of the Aquatic Plant Management Plan before choosing management options each year.

Actions	Lead person/group	Resources	Timeline
Learn to identify and properly remove EWM where it is present in small areas of Alpine Lake.	ALPRD Shoreland property owners	RC&D	2016 and ongoing
Continue to work to eradicate EWM in Alpine Lake. Prior to spring, review the survey results and choose the appropriate management options for the upcoming year.	ALPRD	Consultant WDNR Aquatic Plant Biologist	Annually in fall

Conduct a point-intercept (P.I.) survey of the aquatic plant community at least every 5 years Pre- and post-P.I. surveys are required to obtain a permit for chemical treatment and help to quantify changes over time. If chemical treatments are not conducted, conduct visual aquatic plant surveys in years between P.I. surveys. Use the survey results to develop management strategies for the upcoming year.	ALPRD	*P.I. Survey:* WDNR Water Resource Spec. Consultant *Visual Survey:* Golden Sands RC&D	*P.I. Survey:* Pre- and post-chemical treatments Every 5 years *Visual Survey:* Annually between P.I Surveys
Inform lake residents and lake users when chemical treatment is conducted.	ALPRD	WDNR Water Resource Spec. Consultant	As needed
If resistance of HWM to chemical treatment is observed, submit EWM samples to a lab for a challenge test to determine which chemicals will effectively treat it.	ALPRD	WDNR Water Resource Spec.	As needed
Where small populations exist, hand-pull EWM in shallows and/or hire divers to hand pull in less accessible areas.	ALPRD	RC&D	Ongoing
If hiring divers is appropriate for the level of infestation, work with other lakes to submit a WDNR AIS grant to make your request more competitive.	ALPRD	WDNR AIS grant WDNR Water Resource Spec. Golden Sands RC&D Local lakes with AIS	As needed
Consider a winter drawdown to kill HWM and compact the sediment.	ALPRD	WDNR Aquatic Plant Biologist Consultants	As needed
Consider the use of milfoil weevil populations as a control method for HWM in parts of Alpine Lake Helen. Weevil over-wintering habitat could be improved by establishing healthy shoreland vegetation.	ALPRD	Golden Sands RC&D UWSP – Dr. Ron Crunkilton WDNR Lakes Specialist	

Objective 3.4. Reduce or eliminate populations of Japanese Knotweed around Alpine Lake.

Actions	Lead person/group	Resources	Timeline
Distribute information about Japanese knotweed to residents around the lake.	ALPRD	UWEX Lakes RC&D	Ongoing
Organize training on the identification and proper removal of Japanese knotweed.	ALPRD	Consultant RC&D	As needed
Routinely survey and monitor areas around the lake for new populations of Japanese knotweed. Inform and work with property owner for any observed populations.	ALPRD	Consultant RC&D	Annually in spring

Alpine Lake Aquatic Plant Management Plan

Management strategies in Alpine Lake were designed to achieve a balance between healthy aquatic habitat, good water quality, and recreation. With a permit from the WDNR, aquatic plant management may occur in areas of the lake exhibiting heavy aquatic plant and/or algae growth that restricts boating and other recreational activities. A variety of management options were discussed during the development of this plan. Some options were rejected due to the nature of the lake. Each lake is different and the response to HWM control efforts may differ 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. Each year, the state of the aquatic plants in Alpine Lake should be assessed. During fall or winter, the results of the assessment (point-intercept survey, mapped marked with CLP beds, etc.) should be reviewed by the ALPRD with assistance from the WDNR Lake Manager, Golden Sands RC&D, and/or a consultant. Based on conditions, the strategy for the upcoming year should be developed. A strategy may include one or more of the following options, some of which require a permit from the WDNR.

Manual removal, target species: HWM/EWM, CLP, other AIS

Manual removal of AIS is focused on limited areas. This is commonly conducted by individual waterfront property owners who are trained in the identification and removal of EWM and other aquatic invasive species. Plants can be removed manually at any time of year, without a permit. Trained divers can be hired to manually remove HWM in deeper parts of the lake in areas less than 1 acre. This is most effective as a follow-up to chemical treatments, where HWM presence is spotty.

Individuals may hand-pull aquatic plants adjacent to their dock (thirty feet or less) without a permit for the purpose of clearing a channel for access. Any hand-pulled aquatic plants should be removed from the water and composted away from the lake. Property owners should diligently monitor any cleared areas for AIS.

Option**:** Provide a pick-up service for hand-pulled plants from docks with the harvester.

Herbicide treatment, target species: HWM and CLP

An annual permit is required. The target population of HWM or CLP 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. This information should guide subsequent management such as manual removal. Strategies for the subsequent year should be adjusted accordingly. HWM management involves

evolving scientific knowledge; therefore, the management strategies for HWM in Alpine Lake should be adapted as HWM populations in the lake change and as new information becomes available.

The use of herbicides to control aquatic invasive species is an evolving science. Results of recent studies of the effectiveness of chemical spot treatment suggest the treatment may be less effective than previously thought, and may actually promote chemically-resistant forms of HWM. While herbicides can have immediate effect on the target plant species, there can be unanticipated effects on other species. There are approximately 300 herbicides registered for use on land in the United States, but only 13 can be applied into or near aquatic systems. All herbicides must be applied according to the US Environmental Protection approved label rate and application requires a permit if "you are standing in socks and they get wet."

The toxicity tests that have been conducted are related to specific effects such as carcinogenicity. There may be as-yet unidentified consequences to aquatic ecosystems. Despite this, chemical spot treatments may still be appropriate in certain conditions. AIS species such as HWM are best treated early in the growing season – typically before June 1 when water temperatures are below 60 degrees F – to minimize the impacts of the herbicides on native plants that often emerge later in the growing season. Balancing the eradication of invasive species with the survival and flourishing of native species is essential to long-term success.

Herbicides can be divided into two main categories: contact herbicides that cause extensive cellular damage upon contact and systemic herbicides that act more slowly, often by speeding up cellular division. Systemic herbicides are taken up by the plant and transported throughout the entire plant, often resulting in complete mortality. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a sufficient amount of time.

Herbicides are applied directly to the water, either as a liquid or an encapsulated granular form. Factors such as water depth, water flow, treatment area size, retention time, lake stratification, and plant density play roles in determining the appropriate herbicide concentration. Application rates and exposure times are important considerations for aquatic herbicides. Herbicide costs vary greatly between about $400 and $1,500 per acre depending on the chemical used, who applies it, permitting procedures, and the size of the treatment area.

Herbicide Plan: Conduct herbicide spot treatments as appropriate to reduce populations of EWM/HWM. The type of chemical(s) used should be based on the specific type of HWM. If treating less than 5 acres, a contact herbicide such as endothall or diquat should be used. Treatment should occur early in the season, prior to emergence of native plants. To reduce the chance of developing resilient strains of HWM, different treatments should be used each year. Each application should coincide with pre- and post-treatment aquatic plant surveys to monitor impacts to native plants and measure the efficacy of the herbicide regime. Treatment should be supplemented with subsequent manual removal of HWM.

Mechanical harvesting, target species: CLP, dense native aquatic plants

A permit is required. Benefits of mechanically harvesting aquatic plants include the removal of nutrients and oxygen-demanding plant material from the lake system, and the temporary recreational relief from dense aquatic plant beds and filamentous algae. Harvesting may have negative effects on native aquatic plants that provide valuable habitat. Harvesting in depths less than 3 feet should be avoided to minimize impact on habitat and to reduce sediment disturbance. Areas where EWM/HWM is present should not be harvested since these plants spread by fragmentation.

CLP should be harvested in late May or early June when the plants surface. Removing the plant matter from the lake via harvester as opposed to chemical treatment will remove plant biomass and nutrients from the system.

Dense beds of native aquatic plants can be harvested as needed to provide navigation later in the summer. Areas of EWM should be avoided to prevent fragmentation and spread.

Mechanical Harvesting Plan: With a WDNR permit, harvesting in Alpine Lake may be conducted in depths of water greater than three feet, up to three times per year. A second pass with the harvester should be run on harvested areas to remove plant fragments and floaters. Based on the original lake bathymetry, these areas are shown in Figure 3. Since this map is outdated, it is recommended that the harvesting equipment have a depth finder with the transducer mounted on the cutting end to ensure that cutting is occurring in water depths greater than three feet. Alternatively, a new bathymetric map could be developed and the resulting geo-referenced map could be loaded into the depth finder for orientation.

Situations in which harvesting may occur:

1. Removal of CLP.
2. Nuisance aquatic plant beds and/or filamentous algae significantly impede recreation.
3. EWM is not present beyond isolated individual plants.

Skimming target: floating plant material including filamentous algae

Skimming of floating plant material can be conducted by mechanical or non-mechanical means. Skimming and removal of floating plant material could be conducted in areas where sediment and emergent plants would not be disturbed by this activity.

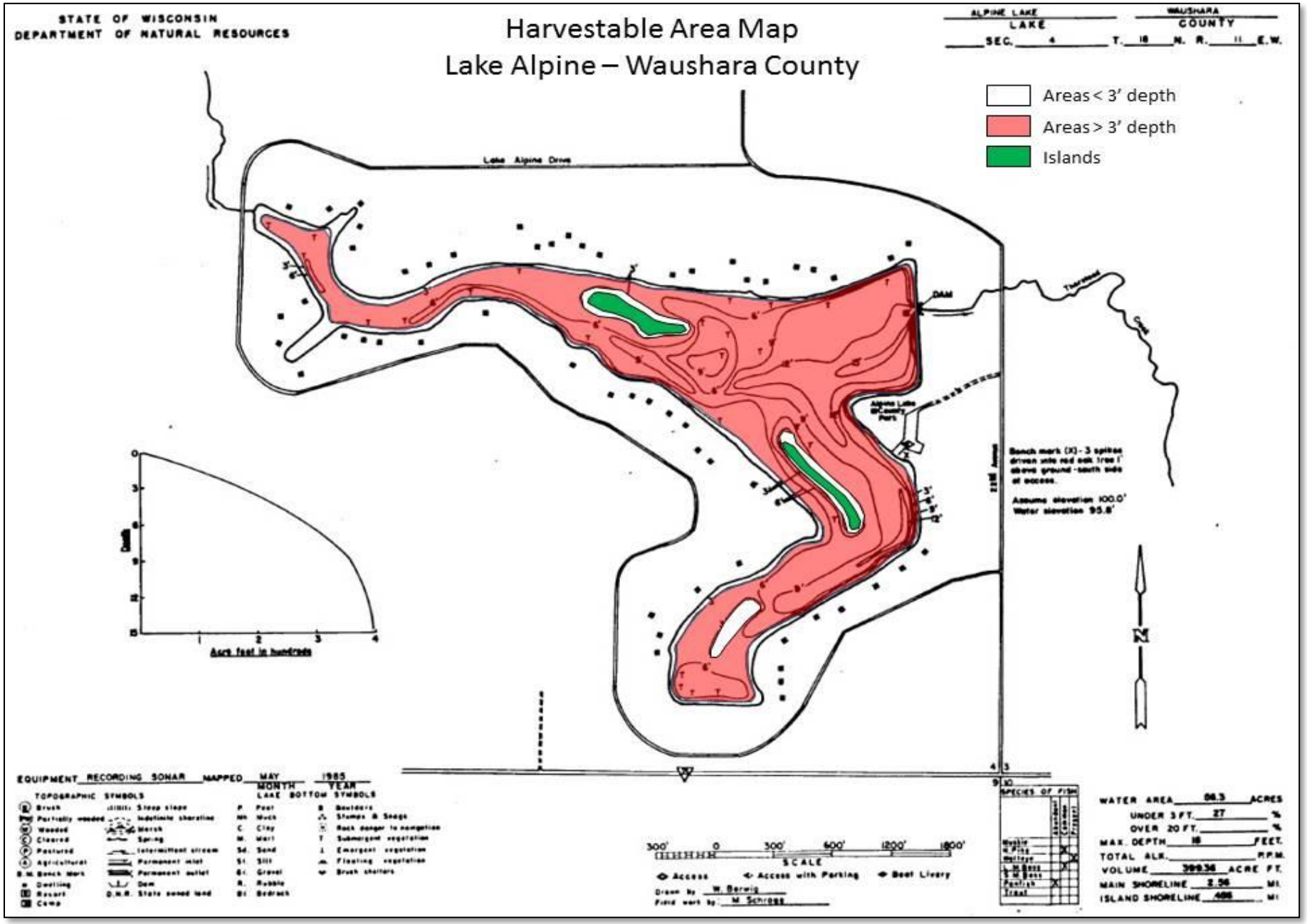


Figure 3. Potential areas for mechanical harvesting in Alpine Lake (water depths greater than 3 feet).

Water level manipulation (drawdown), target species: EWM/HWM, CLP

Temporary reduction of water levels in Alpine Lake can be used to reduce AIS populations and has the added benefit of compacting sediment. This technique has the greatest effect on vegetation located in the shallows. If done during the late fall and winter, the exposed plant crowns will desiccate and kill the plants. A permit is required. Consultation with WDNR lake and fisheries biologists is essential in determining the appropriate timing and duration needed for current conditions.

Weevils, target species: EWM/HWM

Milfoil weevils (*Euhrychiopsis lecontei*) are insects that are native to some Wisconsin lakes. They feed on both the native northern watermilfoil and the invasive EWM/HWM. They require unmowed shoreline vegetation nearby to overwinter and survive. Milfoil weevils are not commercially available in Wisconsin, so obtaining a starter population and rearing them in predator-free conditions is necessary to enhance the size of the population released into the lake. Professional assistance should be sought if stocking or if a survey of the existing population in Alpine Lake is pursued.

Plan: If use of weevils is desired, have a survey conducted to establish the presence and abundance of weevils in Alpine Lake. Weevils could be considered for keeping EWM/HWM in balance in the following circumstances:

a. Shallow water less than three feet in depth where harvesting is not occurring.
b. Areas not affected by chemical treatments.
c. Primarily minimally disturbed/unmowed shoreline.
d. Areas of concentrated HWM.

Aquatic Plant Management Plan Review

A good aquatic plant management plan strategy should reduce the amount of management activity that is needed as time goes on. In Alpine Lake, a succession of successful strategies should lead to a balance between healthy aquatic habitat, water quality and recreation with minimal annual management. To evaluate if management strategies are making progress, updates to aquatic plant point-intercept surveys should be conducted at least every five years. If chemical treatments are pursued, more frequent (pre- and post-treatment) surveys are necessary. Work with the Aquatic Plant Specialist with the WDNR and a consultant to update surveys.

Tracking historical conditions, changes in the lake, and how those changes have affected current conditions is very important in the development of management strategies for the lake. Progress or change that occurs due to management activities documented in a plan, aquatic plant surveys, and updates to both will support future strategic decision-making. The following documents contain additional information about aquatic plants and other aspects of the lake:

Alpine Lake Management Plan, 2015. Center for Watershed Science and Education. UW-Stevens Point. Report to Waushara County and WDNR.

Visual Survey of EWM and CLP in Alpine Lake, 2013. Golden Sands RC&D, Inc. http://www.goldensandsrcd.org

Alpine Lake Aquatic Plant Survey, 2012. McNelly, J. University of Wisconsin-Stevens Point. Report to Waushara County and WDNR.

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 Alpine Lake does not have an official critical habitat area designation, there are areas within Alpine 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 all elements of good quality habitat. Identifying 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.

Current and proposed critical habitat area designations and additional information can be found on the WDNR website.

Guiding Vision for Alpine Lake's Critical Habitat

Sensitive areas in and around Alpine Lake will remain intact and protected.

Goal 4. Protect unique areas that are valuable to the water quality and habitat of Alpine Lake.

Objective 4.1. Identify and inform others of quality habitat in and near Alpine Lake.

Actions	Lead person/group	Resources	Timeline
If critical habitat is designated on Alpine Lake, communicate to property owners, visitors, and Town Board as to why these areas are important.	ALPRD	WDNR Biologists and Lake Manager	TBD

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 Alpine 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 Alpine 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 Alpine Lake survey respondents felt that water quality had an impact on both the personal enjoyment value and economic value of their lake property. Most felt that swimming and aesthetic enjoyment was moderately-substantially reduced due to algal blooms. Half of the respondents and committee members felt that the conditions had deteriorated during their time at the lake, but a small percentage thought that it had improved. Fertilizers and septic systems were perceived to be the most likely culprits.

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

A variety of water chemistry measurements were used to characterize the water quality in Alpine 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 Alpine Lake's water quality.

Dissolved oxygen is an important measure in Alpine 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. In spring and fall, dissolved oxygen in Alpine Lake was fairly uniform from top to bottom. During the summer, dissolved oxygen concentrations increased in depths of 6-10 feet, likely due to algal blooms, and generally decreased at about 12 feet. Dissolved oxygen concentrations below 5 mg/L can stress some species of fish and other aquatic organisms. In February 2011, only the upper six feet of water had dissolved oxygen concentrations above 5 mg/L, which should provide sufficient area to support the fishery.

Water clarity measured in Alpine Lake during the study was considered fair, ranging from 5.5 feet to 13 feet. Alpine Lake has a robust water clarity dataset that dates back to 1986. When compared with historic data, the average water clarity measured during the study was better in April and October, similar in May, and was much poorer during the growing season months of June, July, August and September (Figure 4). The perception of the citizen who is monitoring Alpine Lake is that algal blooms impair the usability of the water for part of the summer. When chlorophyll-*a* (measure of algae) and water clarity data that were collected at the same time are plotted, a fairly strong relationship exists between the two measures in

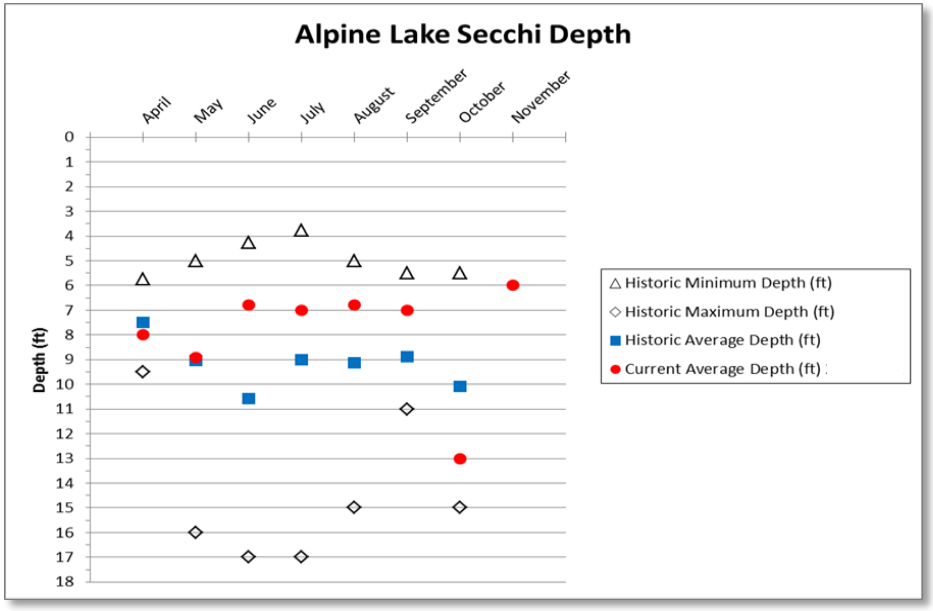


Figure 4. Water Clarity in Alpine Lake (2010-2012 is "current"; data prior to 2010 is "historic").

Alpine Lake. As concentrations of algae increase, water clarity is reduced (Figure 6). In addition, algal production was also related to phosphorus; as the concentrations of phosphorus increased so did concentrations of algae (Figure 5).

Phosphorus is an element that is essential in trace amounts to most living organisms, including aquatic plants and algae. Sources of phosphorus can include naturally-occurring phosphorus in soils and 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.

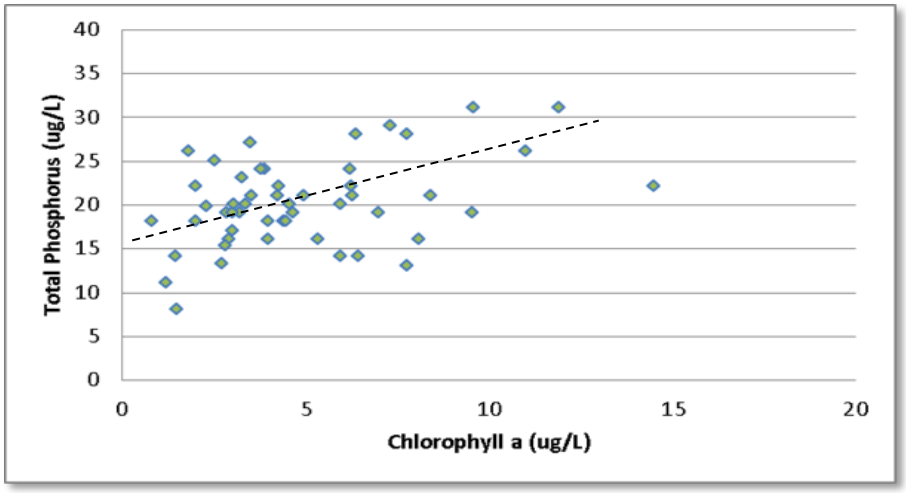


Figure 5. Total phosphorus and chlorophyll *a* (algae) concentrations in Alpine Lake

During the study, total phosphorus concentrations in Alpine Lake ranged from 9 ug/L in February 2011 to 37 ug/L in May 2012. The summer median total phosphorus concentrations were 21 ug/L and 24 ug/L in 2011 and 2012, respectively. These median concentrations were below Wisconsin's phosphorus standard of 40 ug/L for shallow impoundments. Summer monitoring of phosphorus concentrations has been conducted between 1995 and present. During this period of time, year to year variability has been observed. During the study, average spring inorganic nitrogen concentrations were 0.38 mg/L which is high enough to enhance algal blooms throughout the summer (Shaw et al., 2004).

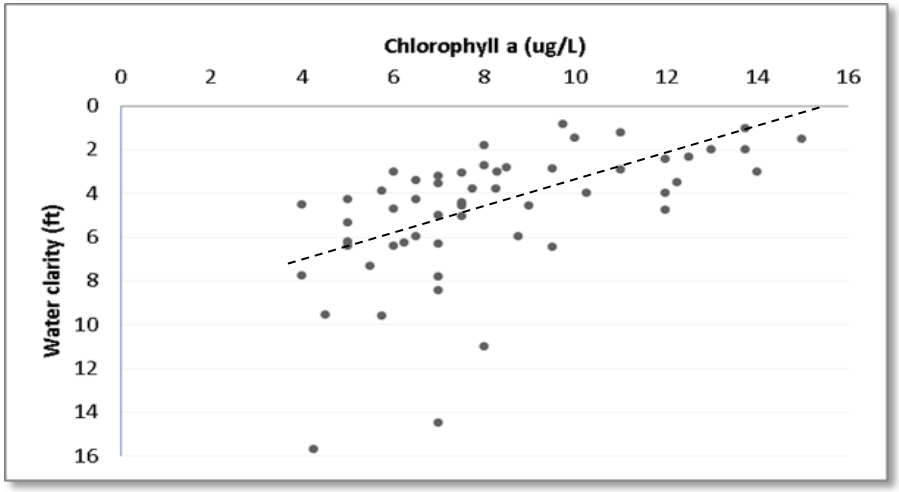


Figure 6. Water clarity depths and chlorophyll *a* (algae) concentrations in Alpine Lake.

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. Average concentrations of chloride, sodium and potassium in Alpine Lake were elevated. Although these elements are not detrimental to the aquatic ecosystem, they indicate that sources of contaminants such as road salt, fertilizer, animal waste and/or septic system effluent may be entering the lake from either surface runoff or via groundwater. Atrazine, an herbicide commonly used on corn, was below the detection limit (<0.01 ug/L DACT) in the two samples that were analyzed from Alpine Lake.

Managing nitrogen, phosphorus and soil erosion throughout the Alpine Lake watershed is one of the keys to protecting the lake itself. Near shore activities that may increase the input of phosphorus 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 Alpine 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.

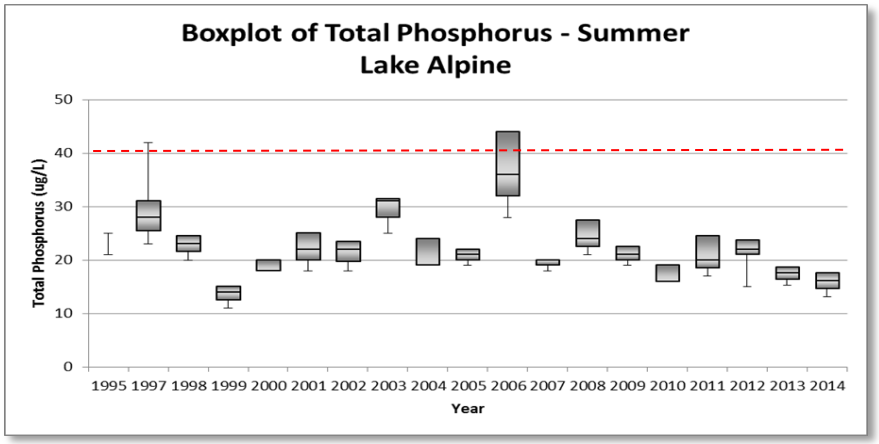


Figure 7. Summer phosphorus concentrations in Alpine Lake (red line indicates the WDNR phosphorus standard (40 ug/L)).

Guiding Vision for Water Quality in Alpine Lake

Alpine Lake will have good water quality that does not support excessive algal blooms or aquatic plant growth.

Goal 5. Minimize nutrient and sediment loading to the lake by improving land management practices near the lake and in the watershed.

Objective 5.1. Phosphorus concentrations will be maintained the same or better than the average measurements observed during the 2010-2012 study (summer median less than 22 ug/L). The goal for spring overturn inorganic nitrogen concentrations is less than 0.3 mg/L and showing a decreasing trend over the next 10 years.

Actions	Lead person/group	Resources	Timeline
Reduce nutrient inputs (P) to the lake by harvesting CLP in June and filamentous algae when it occurs, removing them from the aquatic system. See **Aquatic Plants** section.	ALPRD	WDNR Lake Manager	Annually, as needed
Improve shoreland areas where needed to reduce sediment and nutrient loading. See **Shorelands** section.	Shoreland property owners	UWEX Lakes	Ongoing
Work within the watershed to reduce runoff, increase infiltration and minimize the application of fertilizers and other chemicals. See **Watershed** section.	WCLCD		Ongoing

Inform others around the lake about the impacts of nutrients and land management on water quality through the distribution of an association newsletter and neighborly discussions. Consider including information on a lake sign.	ALPRD	UWEX Lakes (educational materials)	2016, Ongoing

Goal 6. Continue long term data collection on Alpine Lake to monitor trends such as declines and improvements over time.

Objective 6.1. Continue any current monitoring initiatives and begin collecting data that has not been routinely recorded.

Actions	Lead person/group	Resources	Timeline
Monitor water clarity (>5 times a summer).	ALPRD or volunteer	CLMN Coordinator	Ongoing – summer
Continue monitoring water chemistry (total phosphorus and chlorophyll-*a*).	ALPRD or volunteer	CLMN Coordinator	Ongoing - summer
Test for inorganic nitrogen in lake water during spring overturn.	ALPRD or volunteer	WEAL or other state-certified water testing lab (for N)	Ongoing - spring
Submit any collected data to WDNR for long term storage, interpretation, and use.	ALPRD or volunteer	CLMN Coordinator	As needed
Encourage homeowners to test their drinking water for nitrates and atrazine.	ALPRD or volunteer	WC UWEX WEAL or other state-certified water testing lab	Ongoing - annually

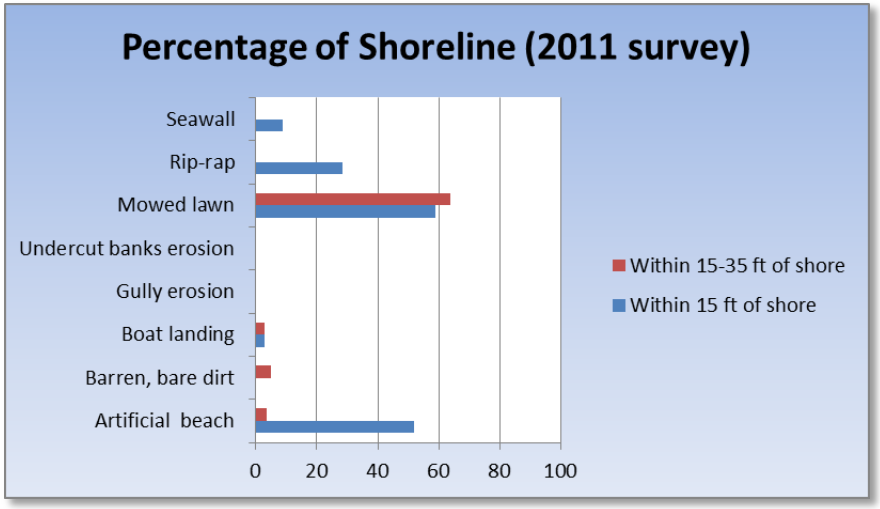
Shorelands

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. 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.

The summary of scores for shorelands around Alpine Lake is displayed on the map in Appendix D. Shoreland Survey – 2011. Alpine Lake's shorelands are in good shape, but some portions have challenges that should be addressed. Restoration would benefit the lake. There were no stretches of Alpine Lake shoreland ranked as poor.



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 viewing corridor for each shoreland lot. With a total of 85 lakefront lots, 2,550 feet (16%) of disturbed shorelands are permitted. Based on the 2011 shoreland inventory, 64% (10,395 feet) of Alpine Lake's shoreland was mowed lawn. Although some properties were grandfathered in when the ordinance was initiated in 1966, following this guidance will benefit the health of the lake and its inhabitants.

Guiding Vision for Alpine Lake's Shorelands

Alpine Lake will have a shoreland that provides aesthetic beauty, water quality benefits and wildlife habitat.

Goal 7. Encourage shoreland property owners to preserve and restore healthy shorelands. To reach compliance with NR 115, 7499 feet of shoreland frontage are currently in need of shoreland restoration. Restore approximately 5% (350 feet) of the shoreline over the next 5 years.

Objective 7.1. Inform lake residents of the importance of shoreland vegetation.

Actions	Lead person/group	Resources	Timeline
Host 'Garden Walk' open house to provide a social opportunity to view what others have done and get new healthy shoreland ideas and tips.	ALPRD	WCLCD WC UWEX UWEX Lakes	Summer
Encourage hesitant homeowners to 'start small' with shoreland	ALPRD	WCLCD	Ongoing

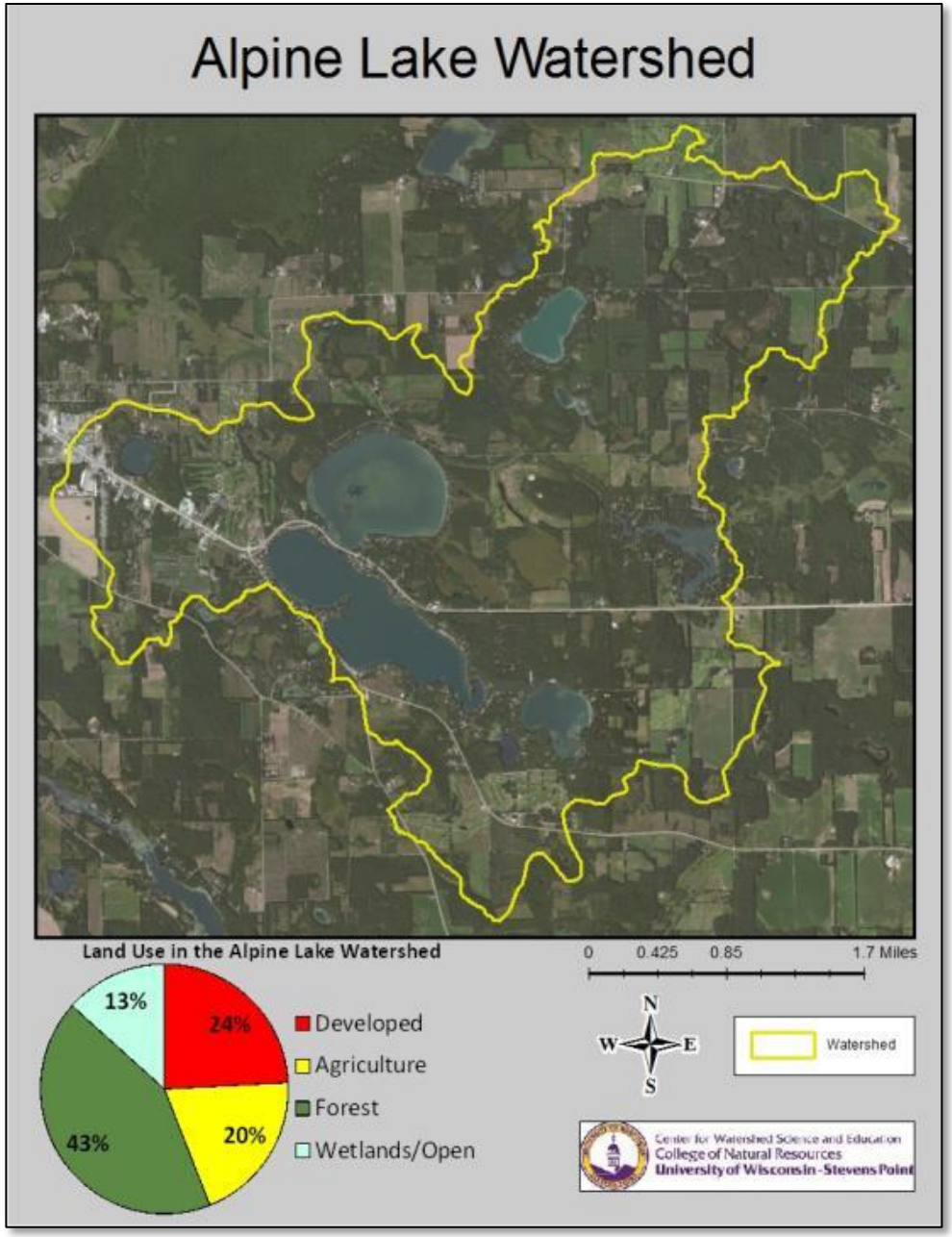
vegetation (such as 1' the first year).		WDNR Healthy Lakes Grant	Grant deadline Feb 1
Invite a speaker to come and discuss shoreland plantings at a lake event or other gathering.	ALPRD	UWEX Lakes-Patrick Goggin Consultant	
Contact staff from the WCLCD for suggestions about shoreland improvements (particularly those specific to Alpine Lake) and create handouts for members at the fall meeting.	Shoreland property owners	WCLCD WDNR Healthy Lakes Grant	As needed

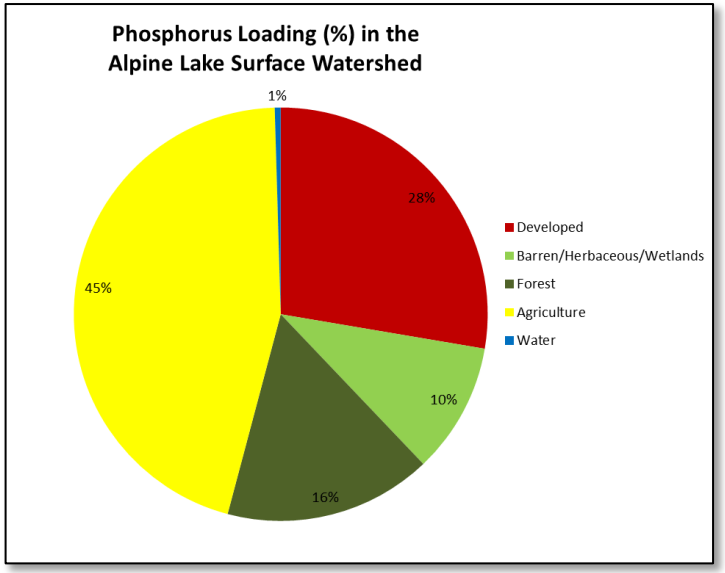
Watershed Land Use

It is important to understand where Alpine 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 Alpine 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 for Alpine Lake is 10,063 acres. Primary land uses are forested land and cultivated cropland. The lake's shoreland is surrounded primarily by roads and some development as well as forests and agriculture. In general, the land closest to the lake has the greatest immediate impact on water quality.

Estimates of phosphorus from the landscape can help to understand the phosphorus sources to Alpine 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, developed land and agriculture had the greatest percentages of phosphorus contributions from the watershed to Alpine Lake.

Guiding Vision for Alpine Lake's Watershed

Land within the Alpine Lake watershed will be managed in a way that improves the lake and drinking water quality.

Goal 8. Explore and utilize resources for healthy lake management.

Objective 8.1. Increase participation in healthy land management activities around Alpine Lake and throughout its watershed.

Actions	Lead person/group	Resources	Timeline
Consider initiating watershed gatherings to learn from one another and work together to solve water quality problems.	ALPRD	WCLCD WC UWEX	
Support property owners interested in testing their soil for needed amendments. Provide information to landowners on how and where to sample. Arrange for groups of samples.	ALPRD	WC UWEX	Fall
Conduct a water quality study to quantify nutrient sources from Bruce Creek, groundwater, and near shore runoff.	ALPRD	CWSE Consultant WDNR Lake grant	

The County will support and follow-up with water quality-based Best Management Practices (BMPs) within the watershed.	WCLCD	NRCS County Board Supervisors DATCP WDNR Lake Protection grants	Ongoing
Continue to use WCLCD as a resource for land management activities.	Shoreland and watershed property owners	WCLCD	As needed
Encourage subdivisions and other new developments to manage stormwater on-site and minimize septic system impacts to Alpine Lake.	Developers Town of Marion	Waushara Co. Planning and Zoning City of Wautoma Planning & Zoning	Ongoing
Encourage design of road and construction projects that will minimize impacts to Alpine Lake.	ALPRD Town of Marion	WCLCD NRCS Waushara Co. Highway Dept. WDOT	Ongoing, as applicable
Encourage and support the implementation of runoff reduction practices during new construction and replacement of infrastructure throughout the watershed.	ALPRD		Ongoing
Support landowners interested in the protection of their land via a conservation program such as a conservation easement, purchase of development rights, or sale of land for protection.	ALPRD	NCCT NRCS WDNR Lake Protection grants	As needed
Explore funding options for land purchase within the watershed for conservation, preservation, or restoration purposes.	ALPRD	WDNR Lake Protection grants Knowles-Nelson Stewardship Funds	Ongoing

People and the Lake

The people that 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 positive impacts on the lake and on those who enjoy this common resource. Collaborative efforts may have bigger positive impacts; therefore, communication and cooperation between the 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.

Photo courtesy of Waushara County

Recreation

Alpine Lake is enjoyed by people who live on and off of the lake. Popular activities enjoyed on the lake include fishing, swimming, canoeing/kayaking, motor boating, and ice skating. People also appreciate its beauty, its wildlife and enjoy its scenery and solitude. The eastern end of the flowage is home to the 15-acre Alpine Lake County Park. With more than 1,900 feet of shoreland, the park provides opportunities for swimming and picnicking, and a boat launch provides access to Alpine Lake. The launch is often congested with people fishing and launching boats, so the committee suggested the installation of a handicapped-access pier on the southern shore of the dike. From WDNR website: “The boarding dock is accessible but the route of travel to it is not (May 2014).” Additional facilities at the park include a shelter house, volleyball court, and a playground. Likely because of its *no wake* status, user conflicts were not identified in the survey or by committee members.

Guiding Vision for Recreation

Alpine Lake will provide recreational opportunities for families and lake users of all ages for generations to come.

Goal 9. Alpine Lake will retain its peaceful setting for people and nature while accommodating a variety of uses.

Objective 9.1. Ensure that the county park provides safe access for a variety of uses and users.

Actions	Lead person/group	Resources	Timeline
Place a handicap accessible pier on the southern shore of the dike. This will reduce congestion caused by fishing from the boat launch and would be located where there is better fishing.	ALPRD	WDNR Fisheries Biologist Local fishing clubs	
Install a No Parking sign on the boat launch.	Waushara County Parks	ALPRD	2015

Objective 9.2. Explore the use of dredging to remove sediments and increase the depth of Alpine Lake.

Actions	Lead person/group	Resources	Timeline
Hire a consultant to estimate the costs, permits, and tasks associated with dredging portions of Alpine Lake.	ALPRD	WDNR Fishery Biologist Consultants	

Dam

Alpine Lake is a 56-acre impoundment along the Bruce Creek. The dam, located at the eastern end of the lake along 22nd Avenue, was constructed in 1970 and is owned by Waushara County. Information about this dam can be found on the WDNR website (http://dnr.wi.gov/topic/dams/), in Appendix E. Dam Details, or by contacting the WDNR Dam Safety Program at 608-261-6401 dnrdamsafety@wisconsin.gov.

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 Alpine Lake enjoyed by many people. Working together on common values will help to achieve the goals that are outlined in this plan.

Guiding Vision for Communication

The Alpine Lake community will be connected and informed in lake stewardship.

Goal 10. Increase participation in lake stewardship.

Objective 10.1. Develop opportunities for education and outreach among full and part-time residents.

Actions	Lead person/group	Resources	Timeline
Maintain the ALPRD website to provide a common source of communication.	ALPRD		Ongoing
Maintain an email list of shoreland property owners and others interested in Alpine Lake.	ALPRD	WC Land Information	Ongoing
Continue to distribute a welcome packet/mailing to all new shoreland property owners with basic lake stewardship information/brochures.	Waushara County	WCWLC UWEX Lakes	As needed
Communicate updates to this LMP and management activities to residents and users of the lake via email list and/or newsletter.	ALPRD		Ongoing
Host an annual meeting to discuss lake management and opportunities for shoreland property owners.	ALPRD		Annually
Host gatherings to learn about topics identified in this LMP. Invite speakers or conduct demonstrations. Incorporate food (potlucks, etc.) to increase attendance and make them more fun.	ALPRD	WCWLC UWEX Lakes WDNR	

Objective 10.2. Achieve good communication with clubs, municipalities, agency staff, elected officials, and organizations interested in Alpine Lake or lake health.

Actions	Lead person/group	Resources	Timeline
Network with other lake groups in Waushara County by having an Alpine Lake representative on the WCWLC.	ALPRD	WC UWEX	Quarterly
Network with other lakes in the state to learn lake management strategies, etc. by having a representative attend the Wisconsin Lake Convention	ALPRD	UWEX Lakes	Annually
Consider sending an individual interested in Alpine Lake to the Lake Leaders Institute	ALPRD	UWEX Lakes	

Encourage shoreland property owners and stewards to obtain "Lake Tides", a quarterly newsletter about Wisconsin lakes.	ALPRD	UWEX Lakes	
Keep the contact information for the ALPRD commissioners current on the UWEX Lakes website.	ALPRD	UWEX Lakes	

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

Alpine Lake will have an accurate, relevant, comprehensive lake management plan that is reviewed annually and documents all management activities and results.

Goal 11. Review plan annually and update with partners as needed or every five years.

Objective 11.1. Communicate updates with community members and members of the District.

Actions	Lead person/group	Resources	Timeline
Review this LMP at the annual meeting and discuss accomplishments and identification of goals/objectives/actions for upcoming year. Ask partners for updates ahead of the meeting.	ALPRD		Annually
Formally update this LMP as needed or every 5 years.	ALPRD	WCWLC WC UWEX	2019

Governance

This section was prepared by Waushara County UW-Extension.

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

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

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Epping, Dillon, 2015. Aquatic Invasive Species and Clean Boats Clean Waters. Presentation given June 5, 2015 at the Marion Town Hall.

Haney, Ryan, 2015. How Is the Water in Alpine and Little Hills Lakes? Presentation given July 14, 2015 at the Marion Town Hall.

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. Klessing, 2000. *Understanding Lake Data*. University of Wisconsin-Extension, Stevens Point. 20 pp.

Turyk, Nancy, 2015. Aquatic Plants of Alpine and Little Hills Lakes. Presentation given June 5, 2015 at the Marion Town Hall.

Turyk, Nancy, 2015. Healthy Land = Healthy Water. Presentation given July 14, 2015 and the Marion Town Hall.

Turyk, Nancy, 2015. Healthy Shorelands. Presentation given August 10, 2014 at the Marion Town Hall.

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UW-Stevens Point Center for Watershed Science and Education, 2013. Waushara County Lake Study – Alpine 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 Lake 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

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.

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/

Conservation Easements (cont'd)
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/

Fertilizers/Soil Testing
Contact: Ken Williams
Waushara County UW- Extension
209 S St. Marie Street, 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

Groundwater Levels/Quantity (Cont'd)
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

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/

Lake Groups – Friends, Associations, Districts
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

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

Nutrient Management Plans (cont'd)
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 Street, 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

Table 1. Alpine Lake Aquatic Plant Survey Summary, 2011.

	Lake Average	Statewide Average	North Central Hardwood Forests Ecoregion Average
Littoral Frequency of Occurrence (%)	98.8	74.3	76
Maximum Depth of Plant Growth (ft)	19	15.3	15.9
Species Richness	14	16.8	16.2
Floristic Quality Index (FQI)	19.1	24.1	23.3

Table 2. Frequency of occurrence of aquatic plant species observed in Alpine Lake, 2011.

Scientific Name	Common Name	Coefficient of Conservatism Value (C Value)	2011 % Frequency of Occurrence
Emergent Species			
Typha augustifolia	narrow-leaved cattail	1	---
Floating Leaf Species			
Nymphaea odorata	white water lily	6	1.27
Submergent Species			
Chara spp.	muskgrass	7	64.14
Vallisneria americana	wild celery	6	57.81
Elodea canadensis	common waterweed	3	52.74
Ceratophyllum demersum	coontail	3	51.9
Najas flexilis	slender naiad	6	44.73
Stuckenia pectinata	sago pondweed	3	18.57
Potamogeton illinoensis	Illinois pondweed	6	13.92
Potamogeton zosteriformis	flat-stem pondweed	6	12.24
Myriophyllum spicatum	hybrid water-milfoil	0	8.86
Utricularia vulgaris	common bladderwort	7	7.2
Heteranthia dubia	water star-grass	6	4.64
Utricularia gibba	creeping bladderwort	9	0.84
Potamogeton crispus (2012 survey)	curly-leaf pondweed	0	---

Appendix C. Aquatic Plant Management Options

Summary of Aquatic Plant Management Planning Session Discussion – June 5, 2015

Residents have been attempting to manage the excessive aquatic plant growth, both native and invasive, for some time. A drawdown was conducted during the winter of 2011-2012; however, a mild winter led to limited success. A whole-lake treatment was conducted for CLP and EWM management in spring 2015 by Stantec. The future strategies will be based on the results of the post-treatment survey.

Management options will change depending upon the amount of EWM/HWM and CLP in Alpine Lake; therefore, routine annual monitoring of these species is essential. The presence of AIS will also define the type of aquatic plant management that could be conducted to address recreational impediments. The following aquatic plant management options were determined to be the most practical and effective options that would allow for recreational use of Alpine Lake and minimize impacts to native aquatic plant community:

- Manual removal. (target species: HWM or CLP) This is essentially being done by individual lake front property owners now. They are permitted to clear an area up to 30' around their dock for boat and swimming access to open water. Additionally, those trained to properly identify and remove EWM and other aquatic invasive species can remove those plants manually any time of year, without a permit. Trained divers can be hired to manually remove HWM in deeper parts of the lake in areas less than 1 acre. This is most effective as a follow-up to chemical treatments, where HWM presence is spotty.

- Chemical spot treatment. (target species: HWM) Results of recent studies of the effectiveness of chemical spot treatment suggest the treatment is less effective than previously thought and may actually promote chemically resistant forms of HWM. However, chemical spot treatments may still be appropriate in certain conditions to control HWM in the future. The type of chemical(s) used should be based on the specific type of hybrid. If treating less than 5 acres, a contact herbicide such as endothall or diquat should be used. To avoid developing resistant plant strains, systemic herbicides should be avoided. Treatment should occur early in the season, prior to emersion of native plants. To reduce the chance of developing resilient strains of HWM; different treatments should be used each year.

- Mechanical harvesting. (Native aquatic plants) A harvester could be purchased or hired to cut access lanes through dense vegetation to provide boating access and improve fish habitat. However, HWM can be spread through fragmentation so the EWM population may be increased by mechanical harvesting. Therefore, it is desirable to treat HWM (by manual removal or chemical treatment prior to use of mechanical harvesting. If this technique is considered in the future, a more detailed harvesting plan should be developed, and a permit should be sought.

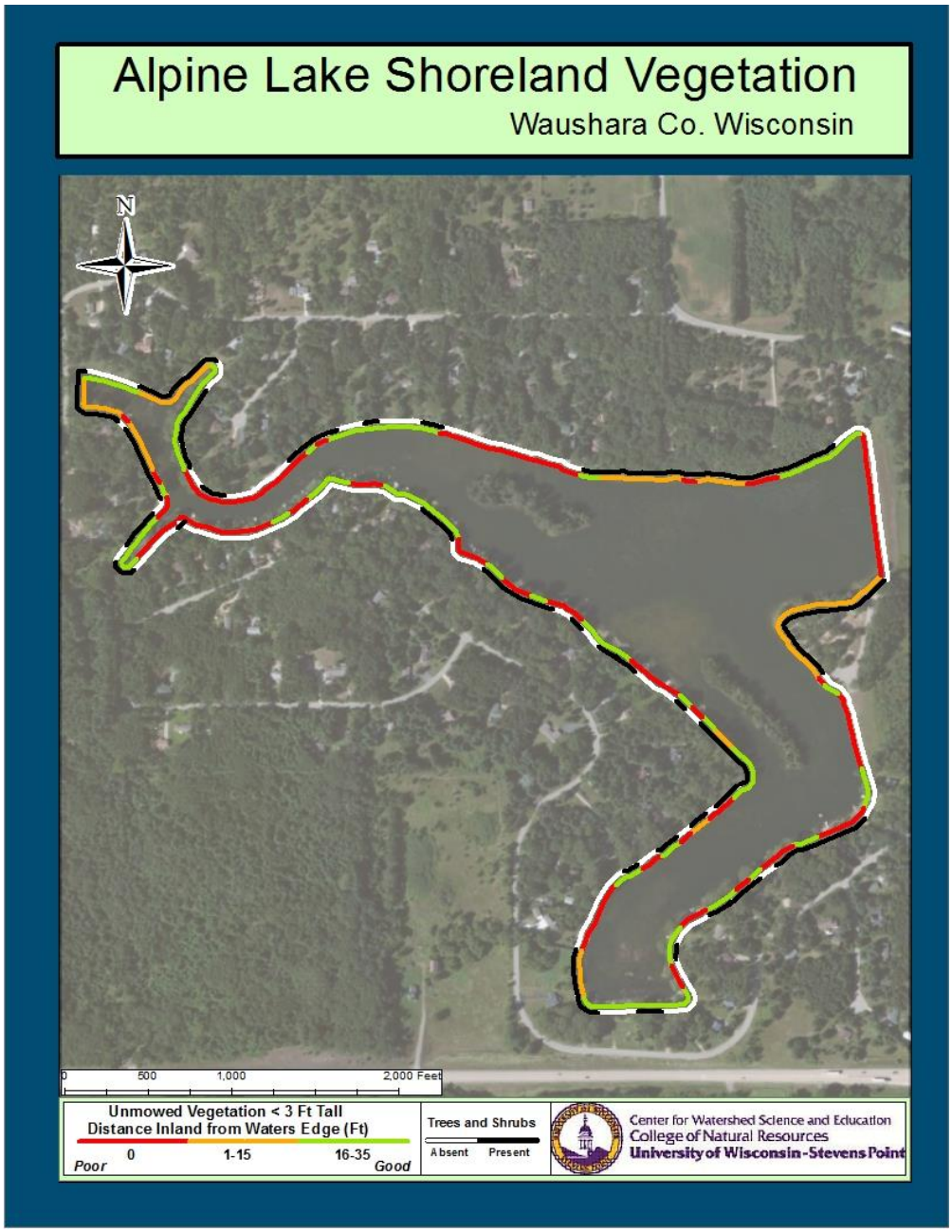
- Skimming. (Native aquatic plants and filamentous algae). Floating plant material that limits swimming during the later parts of summer may accumulate in some areas of the flowage and bays. Skimming and removal of this plant material could be conducted in areas deeper water depths where sediment and emergent plants would not be disturbed by this activity. Skimming can be conducted by mechanical or non-mechanical means.

- Milfoil weevils. (HWM) This option could be considered in areas of the lake with native or restored shorelines where harvesting and chemicals are not being used. Milfoil weevils are not commercially available so obtaining a starter population and rearing them in predator-free conditions can be desirable from a financial standpoint. Weevils cannot be used in conjunction with chemical application unless in a relatively isolated, untreated bay or lobe. Professional assistance should be sought if stocking or rearing is pursued.

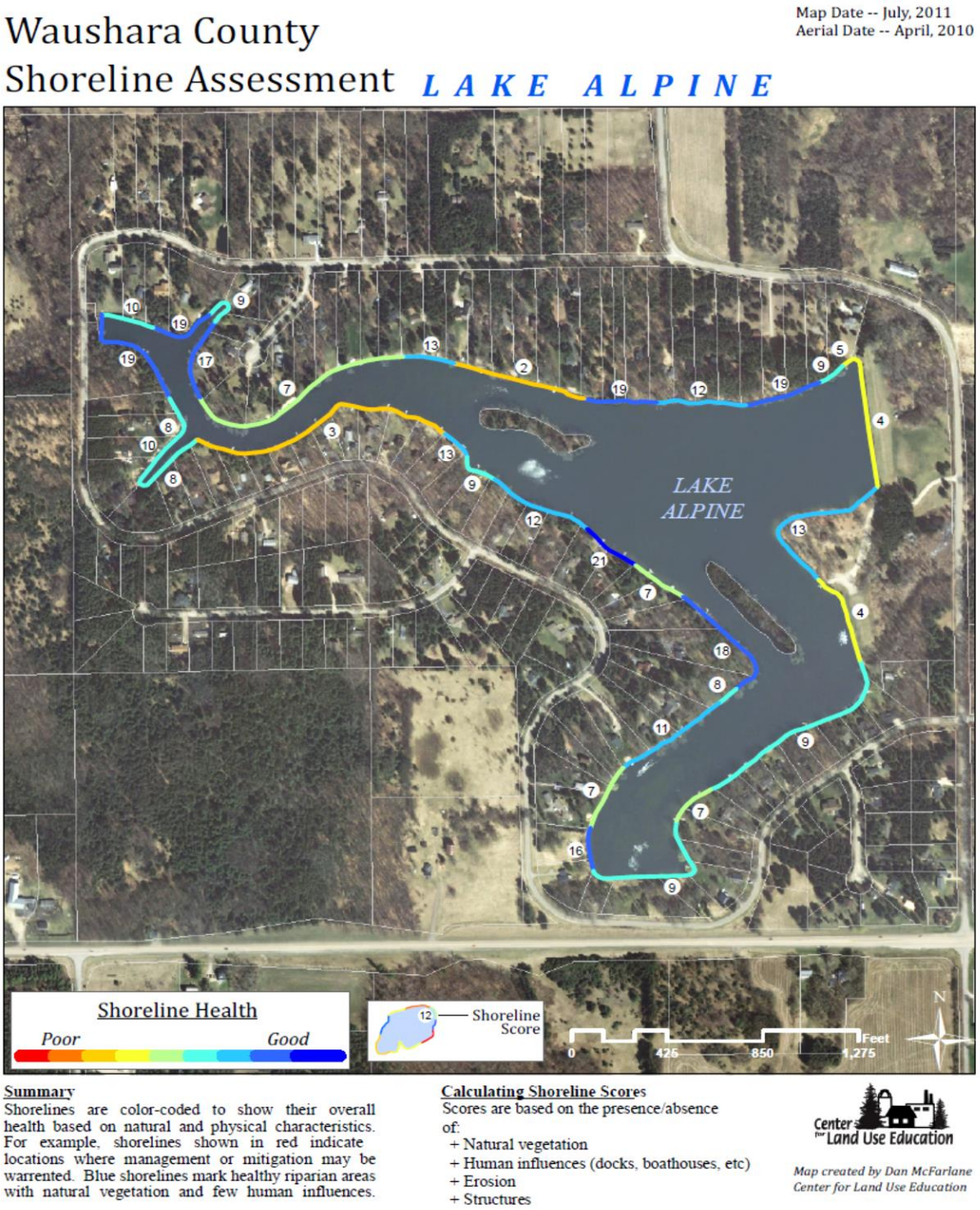
Techniques applied within the watershed and on shoreland property can reduce the nutrient loading responsible for aquatic plant growth in the lake. Good shoreland management practices are especially critical in problem areas of Alpine Lake. This is discussed further in the Shoreland and Watershed sections.

Appendix D. 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 Alpine Lake are displayed below. 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.



Overall shoreland health around Alpine Lake.

Appendix E. Dam Details

Detailed Information for Dam : ALPINE LAKE

Dam Key Seq No	60	Field File No	69.21
Size	LARGE	NID	
Popular Name		Former Name	

Location

County	Waushara		
Latitude	44.062270	Longitude	-89.188890
Permitted TRS		**Located TRS**	
QQQ:SE QQ:SE Q:NE - Sec:04 T:18N R:11E		QQ:NE Q:SE - Sec: 04 T: 18N R: 11E	

Contacts

Owner		**Alternate**	
Organization	WAUSHARA COUNTY	Organization	
Name		Name	
Address	P.O. BOX 300	Address	
	Wautoma		

Waterbody

Drainage Basin (sq mi)	3.50		
Stream		**Impoundment**	
Local Name	BRUCE (THORSTAD) CREEK	Local Name	ALPINE LAKE
Row and Official Name		Row and Official Name	
Navigable ?	Y	Size (acres)	80
When was navigability determined ?		Maximum Depth (ft)	17

Regulatory/Inspection

NR 333 Years	EAP:2012 IOM:2012 HYD:2006 STAB: ZONE:2007		
Auth Approval Desc	3WR471	Regulatory Agency	WDNR
Hazard Rating	L	Estimated Hazard Rating	L
Ferc No		Exempt Issue Date	
Ferc Inspection Year		License Expiration Year	

Construction Characteristics

Normal Storage (acre-ft)	460	Max Storage (acre-ft)	950
Structural Height (ft)	25	Hydraulic Height (ft)	19
Crest Length (ft)	600	Spillway Type	
Discharge Through Principal Spillway (cfs)	110	Width/Diameter of Pricipal Spillway (ft)	3
Total Discharge Through All Spillways (cfs)	110	Total Width/Diameter of all Spillways (ft)	
Core Type		Position	
Foundation Type		Foundation Certainty	
Purpose(s)		Structure Type(s)	

Water Levels

	Normal		Winter	
	MSL	Datum	MSL	Datum
Minimum	847			
Normal				
Maximum	847.50			

Construction History

Designer	Construction Firm	Complete Year
RICE AND URBAN LTD		1970

Outlet Gates

Appendix F. Lake User Survey Results

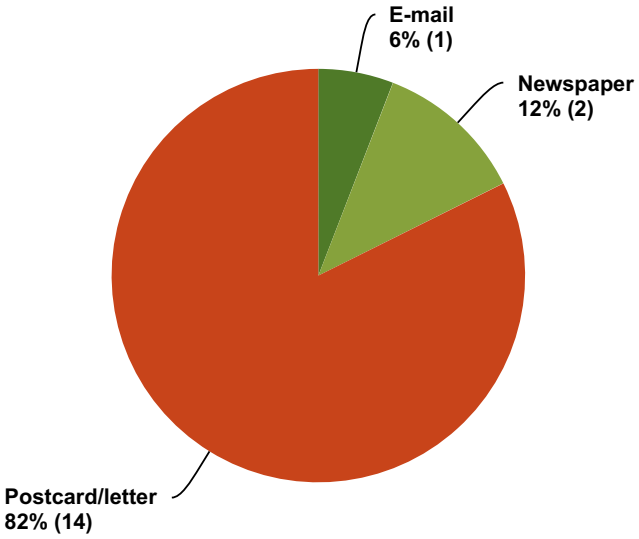
Q1 What is your Waushara County Lakes Survey ID?

Answered: 19 Skipped: 0

#	Responses	Date
1	[redacted]	5/4/2015 1:23 AM
2	[redacted]	4/30/2015 4:19 PM
3	[redacted]	4/29/2015 8:44 AM
4	[redacted]	4/27/2015 8:59 AM
5	[redacted]	4/27/2015 8:39 AM
6	[redacted]	4/27/2015 8:27 AM
7	[redacted]	4/27/2015 7:30 AM
8	[redacted]	4/25/2015 12:01 PM
9	[redacted]	4/24/2015 7:12 PM
10	[redacted]	4/23/2015 8:13 AM
11	[redacted]	4/22/2015 6:37 AM
12	[redacted]	4/21/2015 10:47 PM
13	[redacted]	4/21/2015 7:28 PM
14	[redacted]	4/21/2015 5:31 PM
15	[redacted]	4/21/2015 3:09 PM
16	[redacted]	4/21/2015 1:19 PM
17	[redacted]	4/20/2015 8:20 PM
18	[redacted]	4/20/2015 3:24 PM
19	[redacted]	4/20/2015 2:36 PM

Q2 How did you hear about this survey?

Answered: 17 Skipped: 2

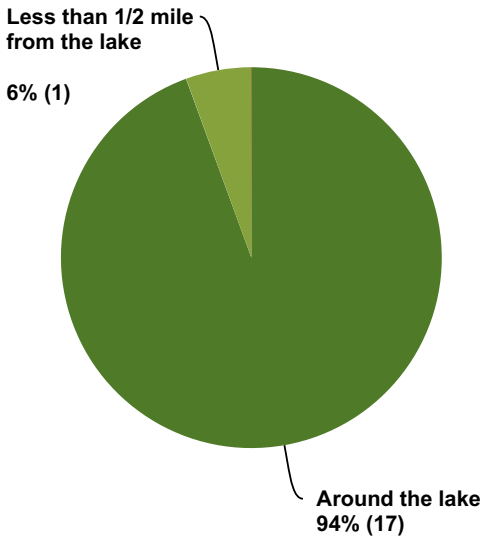


Answer Choices	Responses	
E-mail	6%	1
Newspaper	12%	2
Postcard/letter	82%	14
Facebook	0%	0
Radio	0%	0
Total		17

#	Other (please specify)	Date
1	US mail	4/21/2015 3:12 PM

Q3 Do you own or rent property...

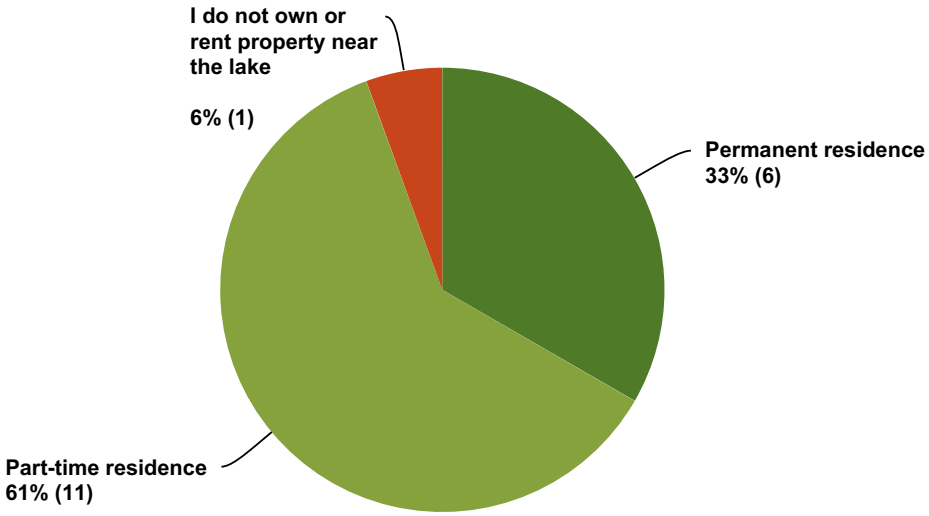
Answered: 18 Skipped: 1



Answer Choices	Responses	
Around the lake	94%	17
Less than 1/2 mile from the lake	6%	1
1/2 mile to 1 mile of the lake	0%	0
More than 1 mile from the lake	0%	0
I do not own or rent property near the lake	0%	0
Total		18

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: 18 Skipped: 1

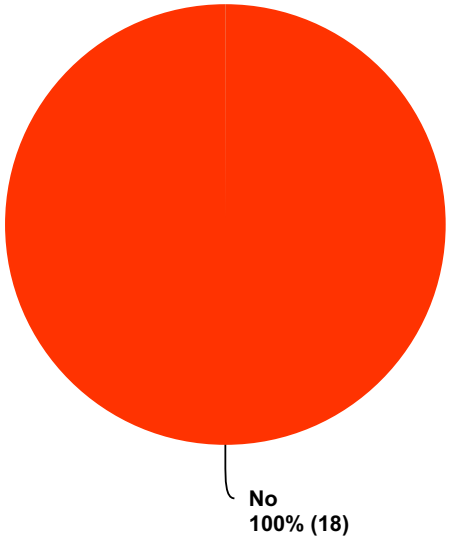


Answer Choices	Responses	
Permanent residence	33%	6
Part-time residence	61%	11
I do not own or rent property near the lake	6%	1
Total		18

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

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

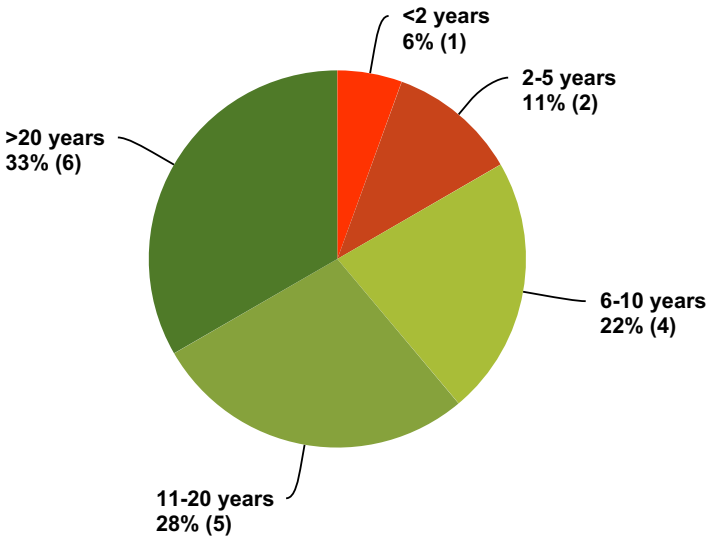
Answered: 18 Skipped: 1



Answer Choices	Responses	
Yes	0%	0
No	100%	18
Total		18

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

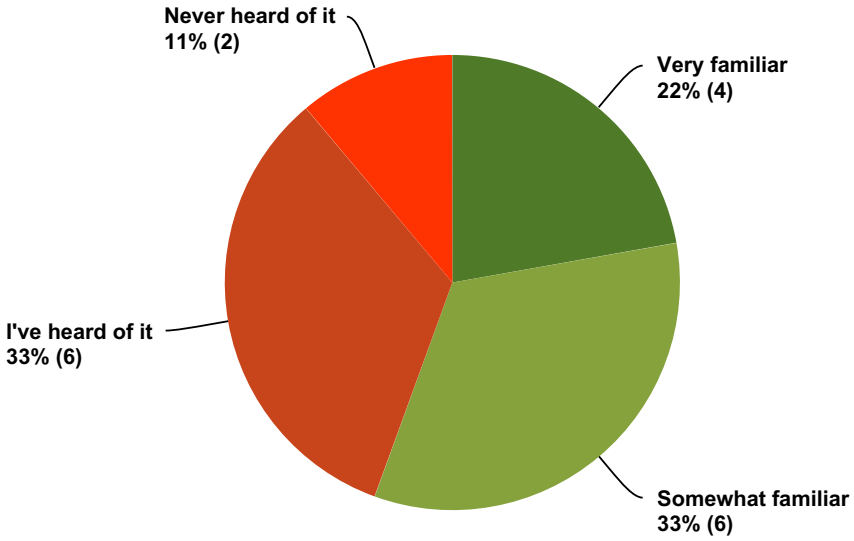
Answered: 18 Skipped: 1



Answer Choices	Responses	
<2 years	6%	1
2-5 years	11%	2
6-10 years	22%	4
11-20 years	28%	5
>20 years	33%	6
Total		18

Q7 Are you familiar with the Alpine Lake Protection & Rehabilitation District?

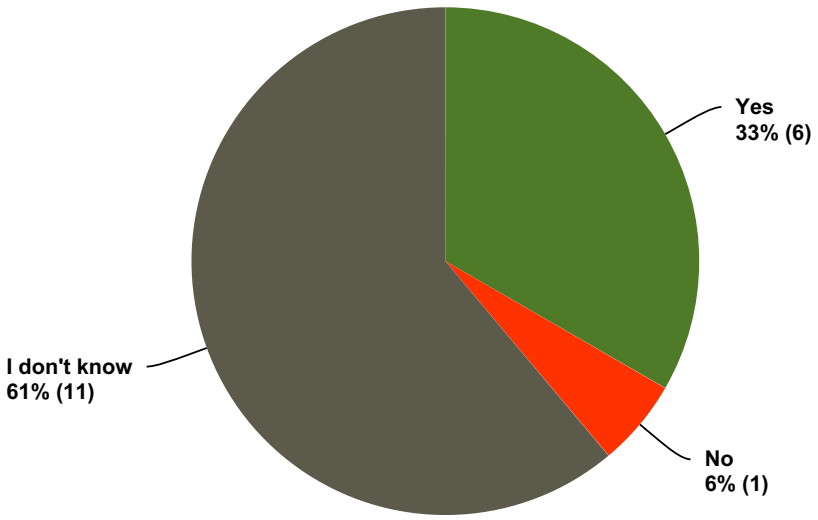
Answered: 18 Skipped: 1



Answer Choices	Responses	
Very familiar	22%	4
Somewhat familiar	33%	6
I've heard of it	33%	6
Never heard of it	11%	2
Total		18

Q8 Are you a member of the Alpine Lake Protection & Rehabilitation District?

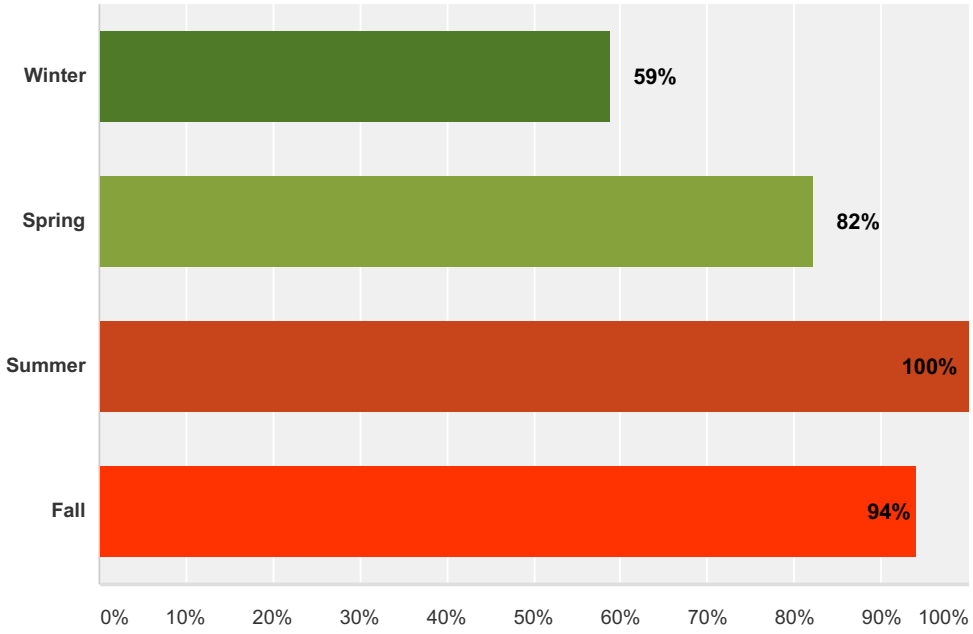
Answered: 18 Skipped: 1



Answer Choices	Responses	
Yes	33%	6
No	6%	1
I don't know	61%	11
Total		18

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

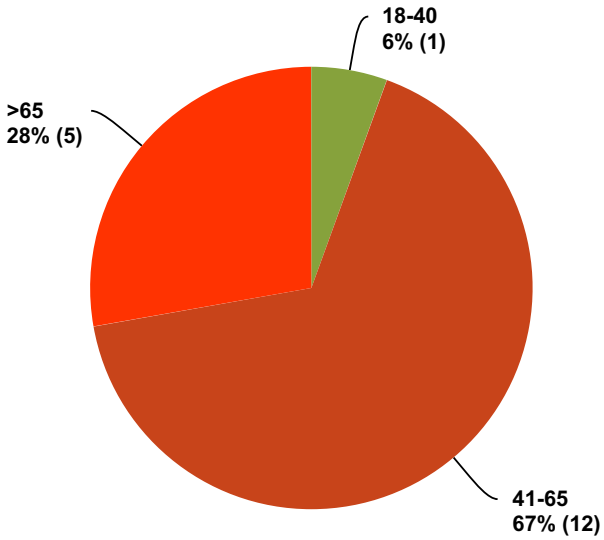
Answered: 17 Skipped: 2



Answer Choices	Responses	
Winter	59%	10
Spring	82%	14
Summer	100%	17
Fall	94%	16
Total Respondents: 17		

Q10 Which category below includes your age?

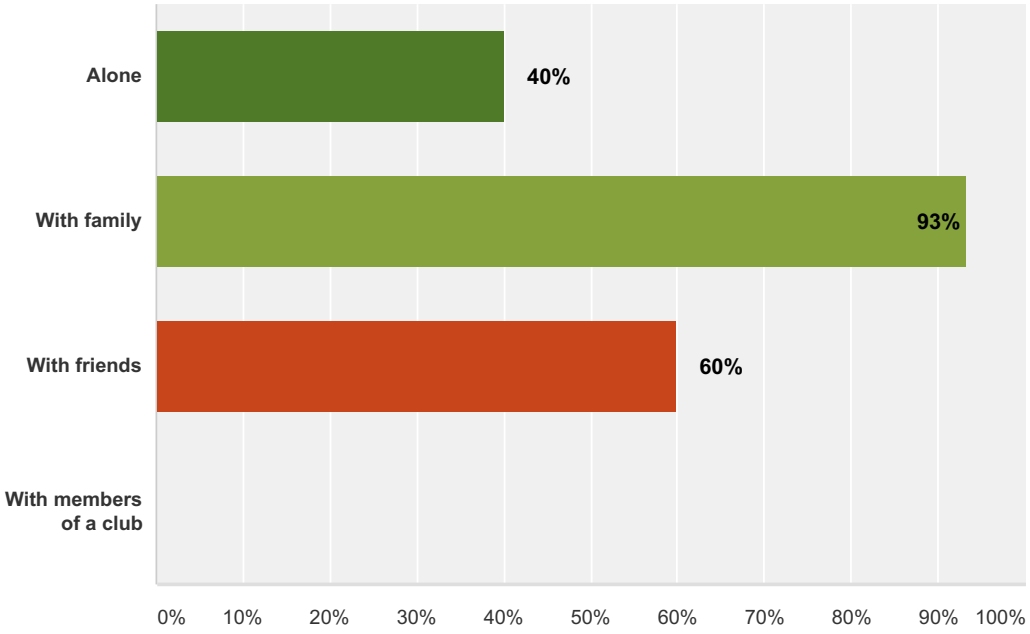
Answered: 18 Skipped: 1



Answer Choices	Responses	
Under 18	0%	0
18-40	6%	1
41-65	67%	12
>65	28%	5
Total		18

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

Answered: 15 Skipped: 4

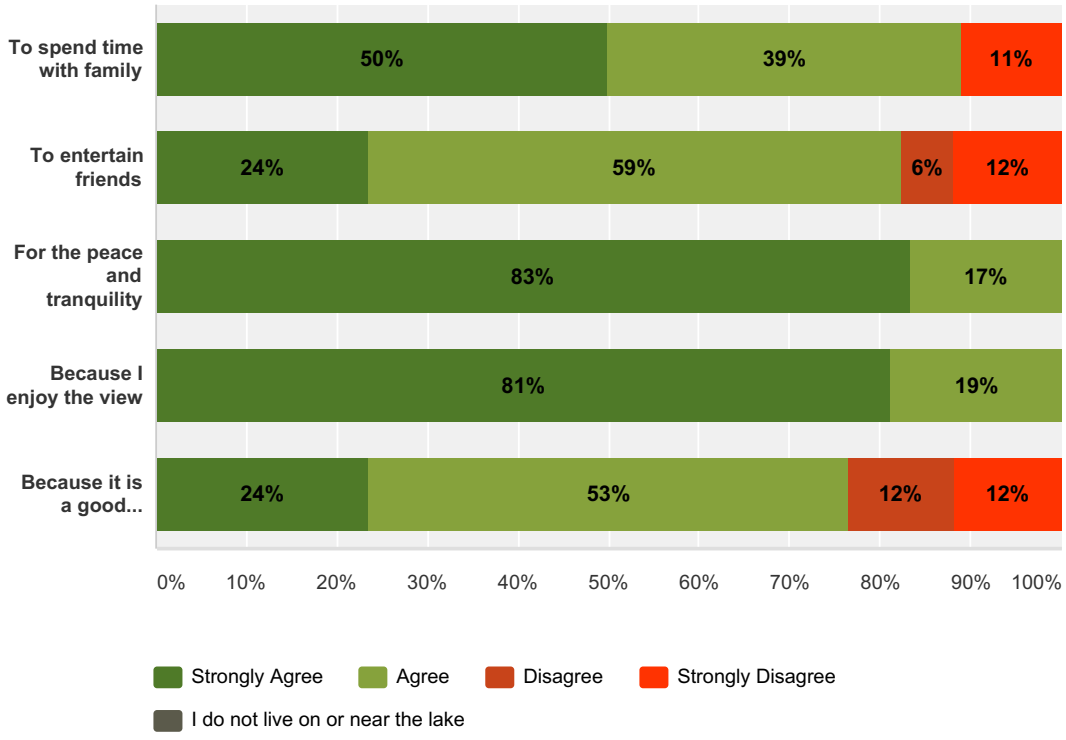


Answer Choices	Responses	
Alone	40%	6
With family	93%	14
With friends	60%	9
With members of a club	0%	0
Total Respondents: 15		

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

Q12 I live on or near the lake...

Answered: 18 Skipped: 1



	Strongly Agree	Agree	Disagree	Strongly Disagree	I do not live on or near the lake	Total
To spend time with family	**50%** 9	**39%** 7	**0%** 0	**11%** 2	**0%** 0	18
To entertain friends	**24%** 4	**59%** 10	**6%** 1	**12%** 2	**0%** 0	17
For the peace and tranquility	**83%** 15	**17%** 3	**0%** 0	**0%** 0	**0%** 0	18
Because I enjoy the view	**81%** 13	**19%** 3	**0%** 0	**0%** 0	**0%** 0	16
Because it is a good investment	**24%** 4	**53%** 9	**12%** 2	**12%** 2	**0%** 0	17

Q13 What do you value most about Alpine Lake?

Answered: 15 Skipped: 4

#	Responses	Date
1	Its small size and the good fishing. The Park and being able to take a swim.	5/4/2015 1:52 AM
2	its beauty and the fact that it is no wake, so it is quiet, fishing and swimming.	4/30/2015 4:22 PM
3	The beauty	4/29/2015 8:46 AM
4	fishing	4/27/2015 9:02 AM
5	quiet, weed free boating/fishing	4/27/2015 8:30 AM
6	Good value for my investment and a quiet sanctuary for me.	4/25/2015 12:05 PM
7	peacefulness, nature,just being on the water	4/24/2015 7:32 PM
8	The solitude	4/23/2015 8:16 AM
9	tranquility	4/22/2015 6:41 AM
10	Lately nothing, The presences of thick vegetation, low water levels, dirty muck bottom and poor fish quality has very much deterred our family from using the lake as much as we have in the past.	4/21/2015 11:01 PM
11	Beauty and quietness	4/21/2015 7:33 PM
12	The spacing of homes on the lake. Also the peace & tranquility. This applies to holiday weekends as well.	4/21/2015 3:12 PM
13	recreational opportunities	4/21/2015 1:23 PM
14	No wake, quiet. Up until recently, good fishing and just quietly cruising the lake. Now, too many weeds.	4/20/2015 8:24 PM
15	The fall of the year when everyone leaves and the lake is calm and quiet, great for canoeing.	4/20/2015 3:27 PM

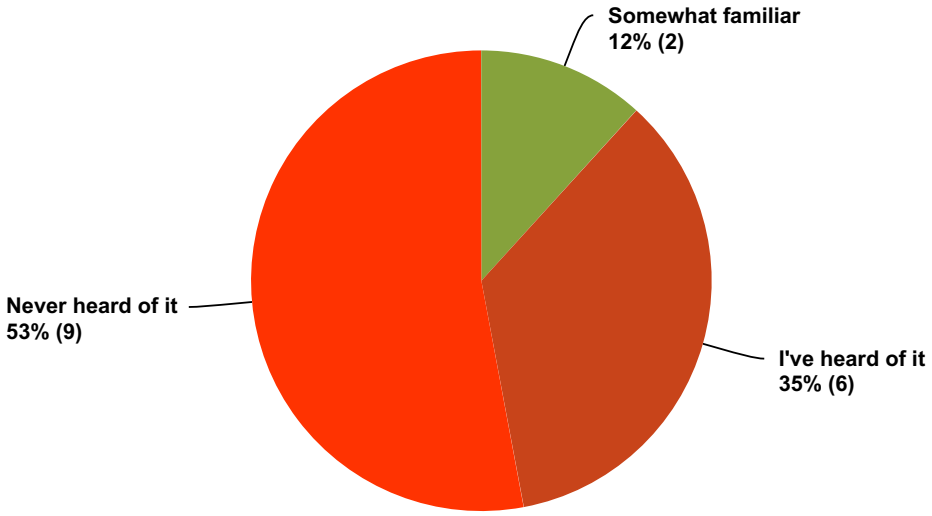
Q14 In your opinion, what should be done to restore, maintain, or improve Alpine Lake?

Answered: 17 Skipped: 2

#	Responses	Date
1	I think we should do control the weed problem. Next, improve the quality of the fish habitat, then stock more fish.	5/4/2015 1:52 AM
2	there is a terrible weed problem; the weeds need to be controlled	4/30/2015 4:22 PM
3	Dredge the lake!!!	4/29/2015 8:46 AM
4	improve the fishing to where it was in the late 80's	4/27/2015 9:02 AM
5	Control weeds to allow easier boating/fishing	4/27/2015 8:30 AM
6	Make the water cleaner and remove the weeds.	4/27/2015 7:33 AM
7	Aquatic Weed control and less regulation. I would like to put in and maintain a beach on my property or improve my shoreline but there is too much regulation and bureaucratic hoops to jump through. .	4/25/2015 12:05 PM
8	better control of the invasive aquatic plants, more people volunteering to make the lake better, more cooperation between the DNR and Lake Association.	4/24/2015 7:32 PM
9	Weed control and a good swimming area	4/23/2015 8:16 AM
10	maintain water quality	4/22/2015 6:41 AM
11	There are several rather costly steps or solutions that could be in acted, However, In our opinion until there is a boat launch fee for non lake association members, A stricter enforcement of catch and release policys (at least until quality fish population is in good numbers and the channel either dredged or the dam itself raised there is no reason to waste our neighbors monies on " band aid solutions" that do not work or only work temporarily.	4/21/2015 11:01 PM
12	Get weeds under control	4/21/2015 7:33 PM
13	Water clarity and lake weed control	4/21/2015 3:12 PM
14	Kill more weeds (both native and invasive) and Cut down some cotton wood trees that are close to lake	4/21/2015 1:23 PM
15	This being a man-made recreational LAKE, it should be maintained as such. Navigating it now is nearly impossible due to the weeds. Mucky bottoms will, if not maintained through controlled dredging, will cause it to fill into a swamp like bog. Not what I bought in to.	4/20/2015 8:24 PM
16	Control the Milfoil & Silt problem	4/20/2015 3:27 PM
17	Put it back to a stream and make a wild life area with a parkway around it	4/20/2015 2:40 PM

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

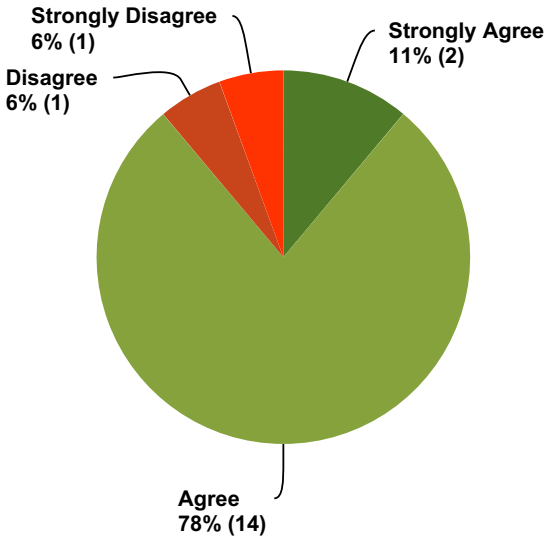
Answered: 17 Skipped: 2



Answer Choices	Responses	
Very familiar	0%	0
Somewhat familiar	12%	2
I've heard of it	35%	6
Never heard of it	53%	9
Total		17

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

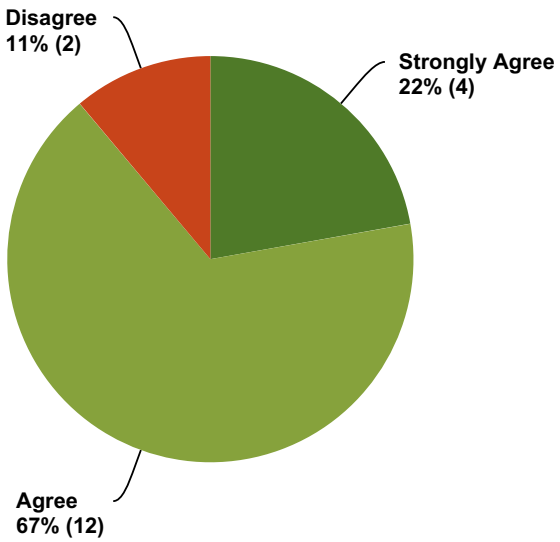
Answered: 18 Skipped: 1



Answer Choices	Responses	
Strongly Agree	11%	2
Agree	78%	14
Disagree	6%	1
Strongly Disagree	6%	1
Total		18

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

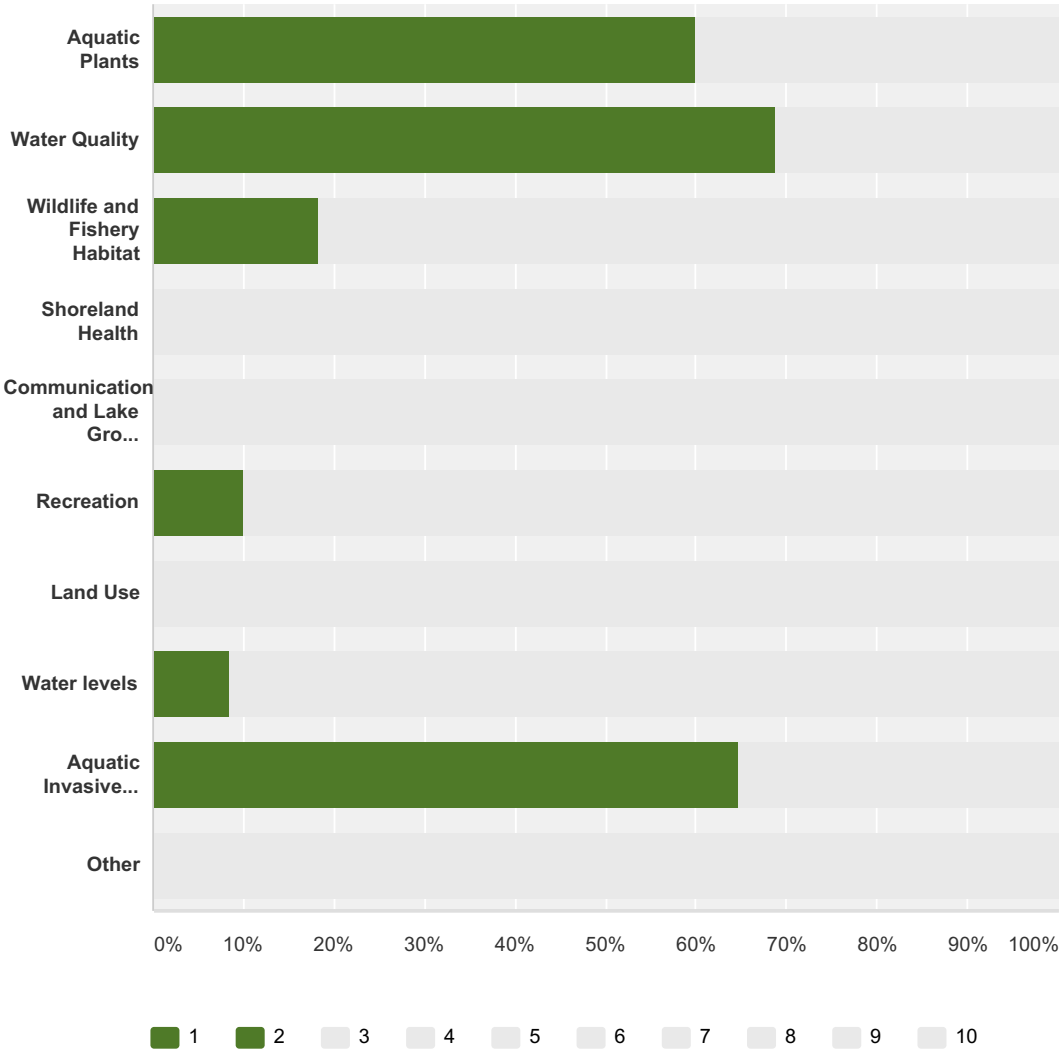
Answered: 18 Skipped: 1



Answer Choices	Responses	
Strongly Agree	22%	4
Agree	67%	12
Disagree	11%	2
Strongly Disagree	0%	0
Total		18

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

Answered: 18 Skipped: 1

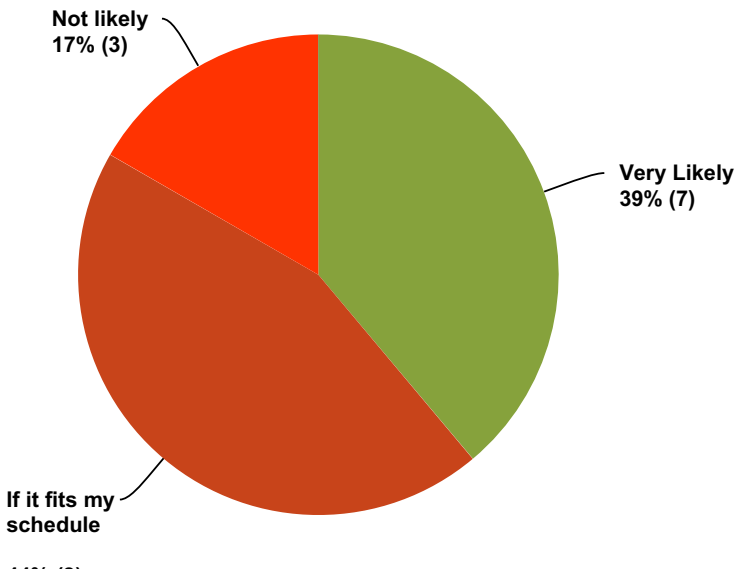


	1	2	3	4	5	6	7	8	9	10	Total	Score
Aquatic Plants	47% 7	13% 2	20% 3	7% 1	0% 0	7% 1	0% 0	7% 1	0% 0	0% 0	15	8.47
Water Quality	31% 5	38% 6	19% 3	6% 1	6% 1	0% 0	0% 0	0% 0	0% 0	0% 0	16	8.81
Wildlife and Fishery Habitat	0% 0	18% 2	18% 2	27% 3	9% 1	9% 1	18% 2	0% 0	0% 0	0% 0	11	6.73
Shoreland Health	0% 0	0% 0	20% 2	40% 4	0% 0	10% 1	10% 1	20% 2	0% 0	0% 0	10	5.90
Communication and Lake Group Support	0% 0	0% 0	9% 1	18% 2	18% 2	0% 0	0% 0	27% 3	27% 3	0% 0	11	4.45

Recreation	**0%** 0	**10%** 1	**10%** 1	**0%** 0	**0%** 0	**30%** 3	**0%** 0	**10%** 1	**30%** 3	**10%** 1	10	4.20
Land Use	**0%** 0	**0%** 0	**0%** 0	**9%** 1	**9%** 1	**9%** 1	**45%** 5	**9%** 1	**18%** 2	**0%** 0	11	4.09
Water levels	**0%** 0	**8%** 1	**33%** 4	**0%** 0	**33%** 4	**8%** 1	**17%** 2	**0%** 0	**0%** 0	**0%** 0	12	6.50
Aquatic Invasive Species	**35%** 6	**29%** 5	**6%** 1	**6%** 1	**12%** 2	**6%** 1	**0%** 0	**0%** 0	**6%** 1	**0%** 0	17	8.18
Other	**0%** 0	**0%** 0	**0%** 0	**0%** 0	**0%** 0	**17%** 1	**0%** 0	**0%** 0	**0%** 0	**83%** 5	6	1.67

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?

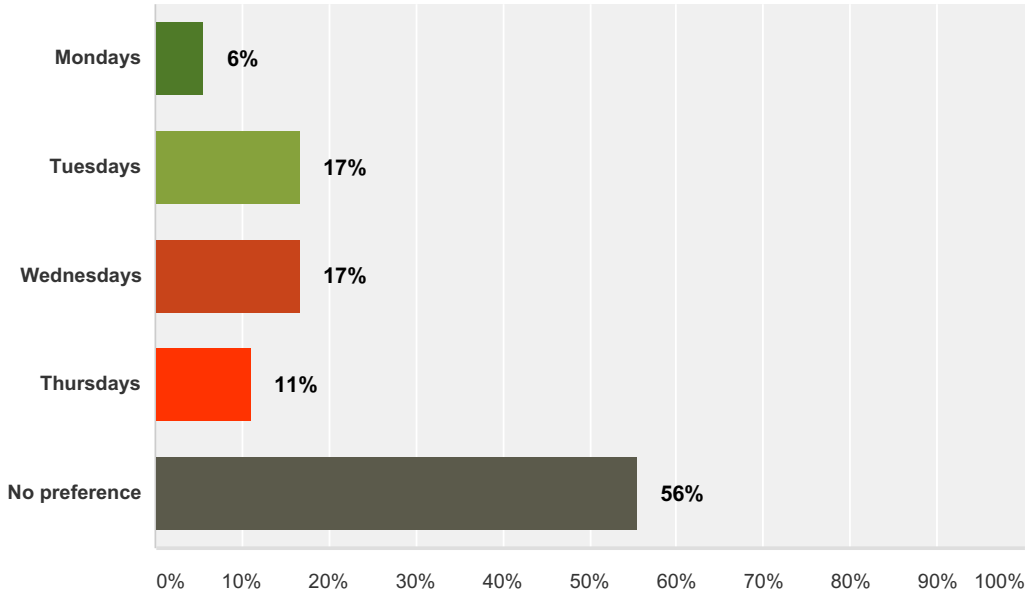
Answered: 18 Skipped: 1



Answer Choices	Responses	
Definitely	0%	0
Very Likely	39%	7
If it fits my schedule	44%	8
Not likely	17%	3
I won't attend any	0%	0
Total		18

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?

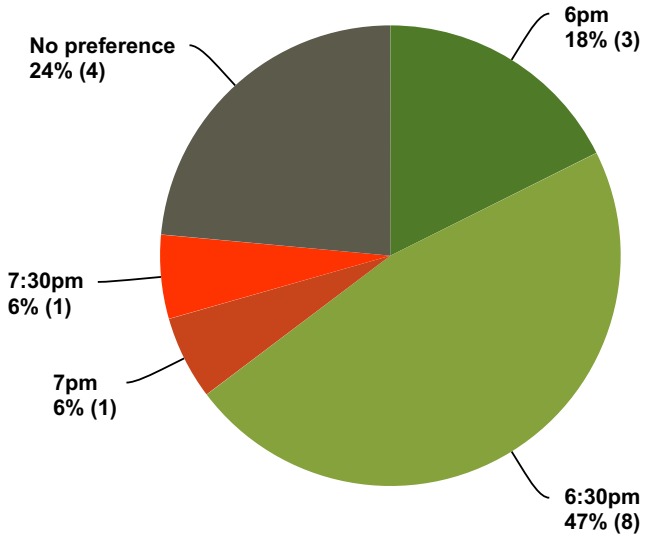
Answered: 18 Skipped: 1



Answer Choices	Responses	
Mondays	6%	1
Tuesdays	17%	3
Wednesdays	17%	3
Thursdays	11%	2
No preference	56%	10
Total Respondents: 18		

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

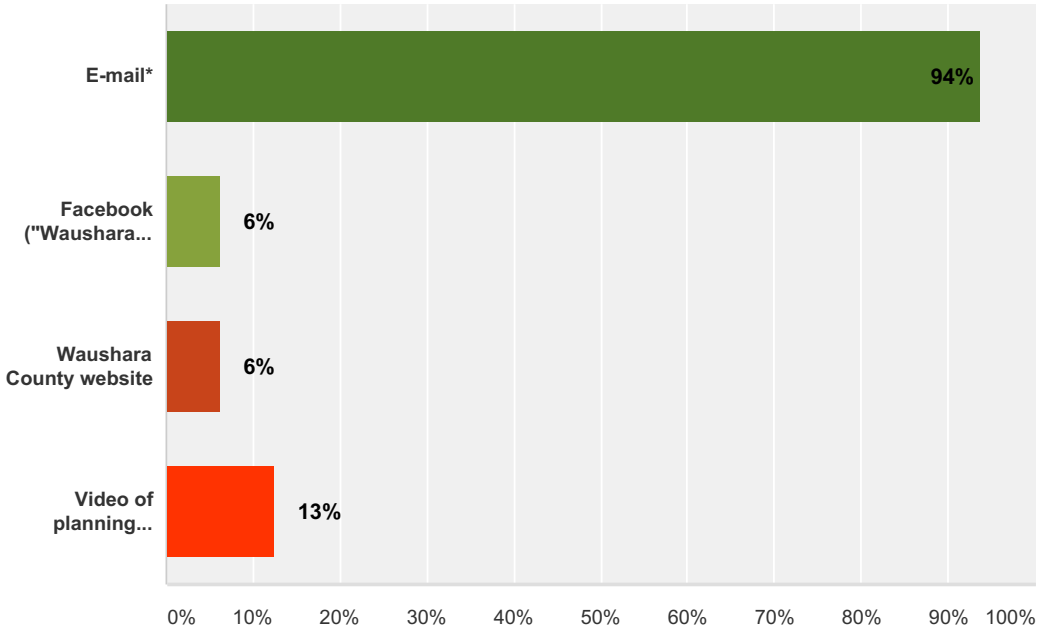
Answered: 17 Skipped: 2



Answer Choices	Responses	
6pm	18%	3
6:30pm	47%	8
7pm	6%	1
7:30pm	6%	1
No preference	24%	4
Total		17

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

Answered: 16 Skipped: 3



Answer Choices	Responses	
E-mail*	94%	15
Facebook ("Waushara County Lakes Project")	6%	1
Waushara County website	6%	1
Video of planning meeting posted on the web	13%	2
Total Respondents: 16		

#	Other (please specify)	Date
1	USPS	4/30/2015 4:26 PM
2	email- greg.dobratz@gmail.com	4/20/2015 3:31 PM

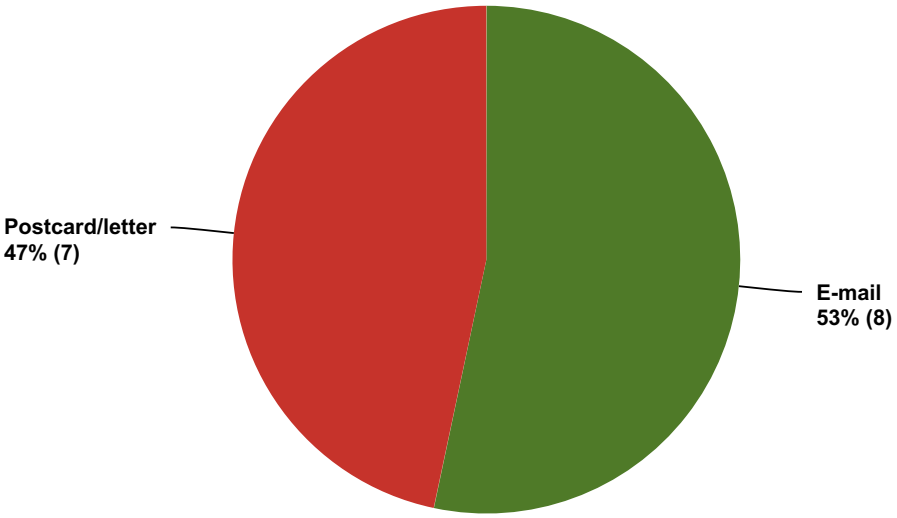
Q1 Enter your Waushara County Lakes Survey ID. If you've forgotten your ID or haven't created one yet, follow the instructions below.

Answered: 16 Skipped: 0

#	Responses	Date
1	[redacted]	6/5/2015 10:43 AM
2	[redacted]	6/4/2015 10:29 AM
3	[redacted]	6/3/2015 9:06 PM
4	[redacted]	6/1/2015 6:36 AM
5	[redacted]	5/28/2015 1:59 PM
6	[redacted]	5/28/2015 1:55 PM
7	[redacted]	5/28/2015 12:07 PM
8	[redacted]	5/27/2015 6:14 PM
9	[redacted]	5/27/2015 5:01 PM
10	[redacted]	5/27/2015 4:13 PM
11	[redacted]	5/27/2015 3:23 PM
12	[redacted]	5/27/2015 1:47 PM
13	[redacted]	5/27/2015 1:10 PM
14	[redacted]	5/27/2015 12:56 PM
15	[redacted]	5/27/2015 11:53 AM
16	[redacted]	5/26/2015 2:01 PM

Q2 How did you hear about this survey?

Answered: 15 Skipped: 1

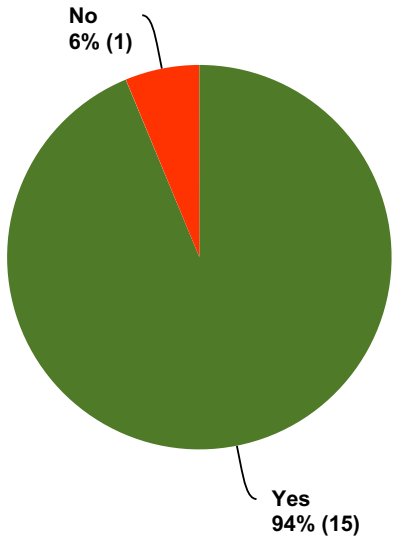


Answer Choices	Responses	
E-mail	53%	8
Newspaper	0%	0
Postcard/letter	47%	7
Facebook	0%	0
Radio	0%	0
Total		15

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

Q3 Were you aware of the importance of aquatic plants?

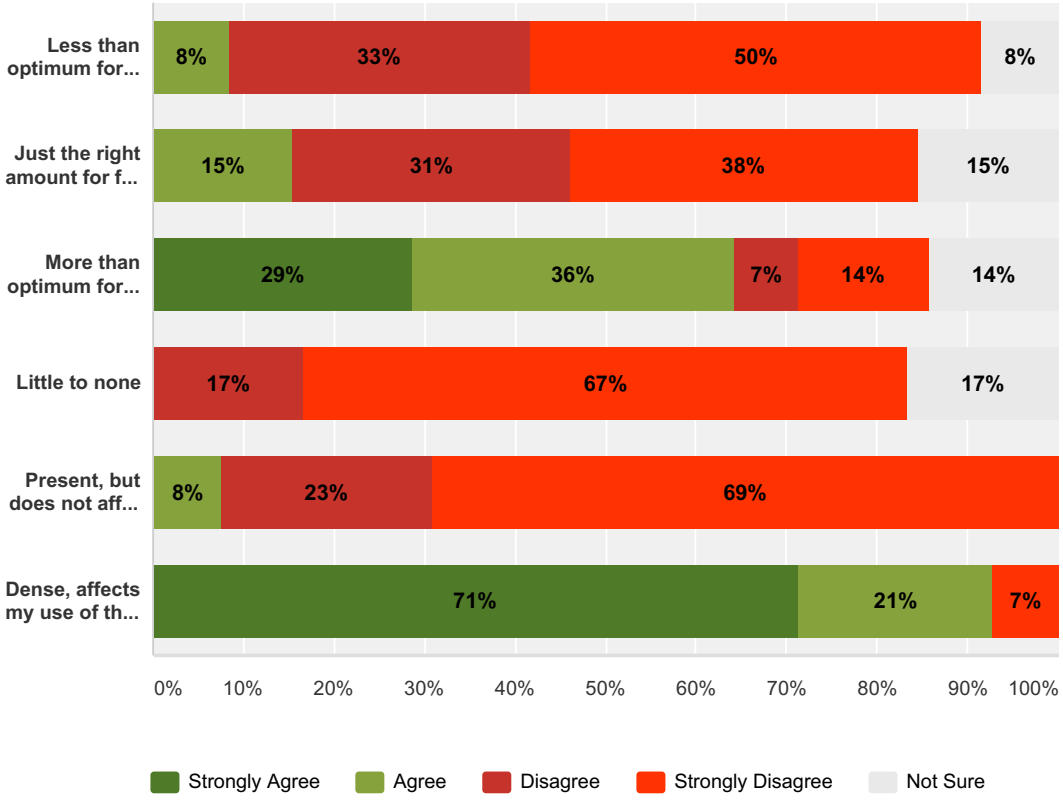
Answered: 16 Skipped: 0



Answer Choices	Responses	
Yes	94%	15
No	6%	1
Unsure	0%	0
Total		16

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

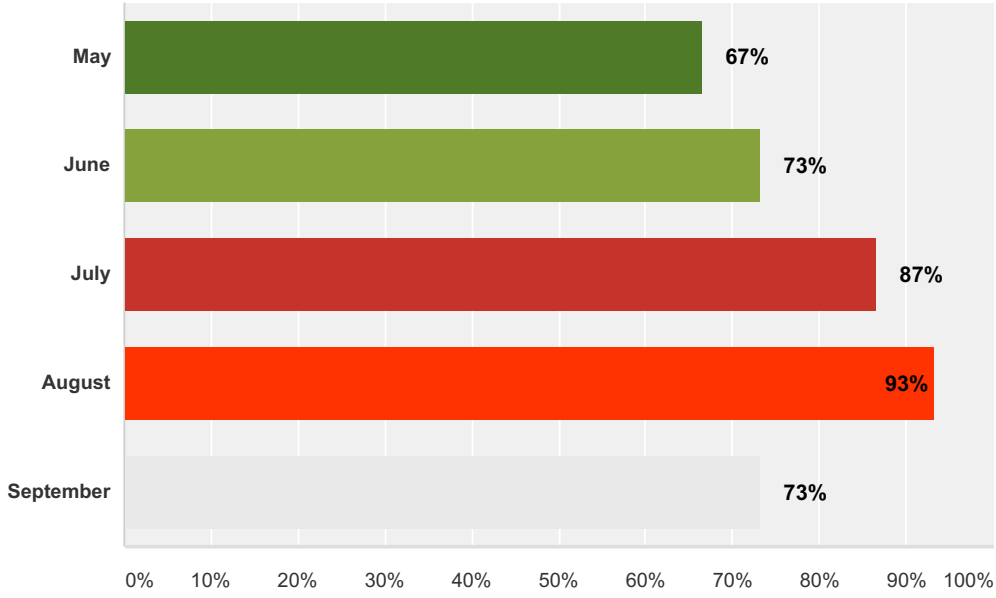
Answered: 16 Skipped: 0



	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure	Total
Less than optimum for fish and wildlife	0% 0	8% 1	33% 4	50% 6	8% 1	12
Just the right amount for fish and wildlife	0% 0	15% 2	31% 4	38% 5	15% 2	13
More than optimum for fish and wildlife	29% 4	36% 5	7% 1	14% 2	14% 2	14
Little to none	0% 0	0% 0	17% 2	67% 8	17% 2	12
Present, but does not affect my use of the lake	0% 0	8% 1	23% 3	69% 9	0% 0	13
Dense, affects my use of the lake	71% 10	21% 3	0% 0	7% 1	0% 0	14

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

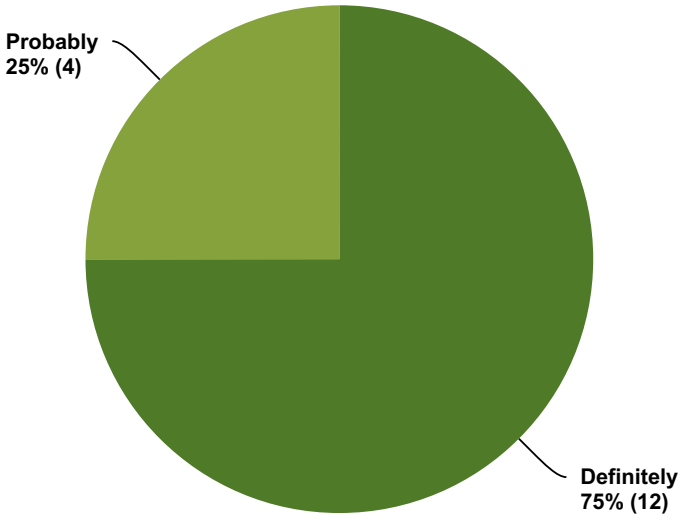
Answered: 15 Skipped: 1



Answer Choices	Responses	
May	67%	10
June	73%	11
July	87%	13
August	93%	14
September	73%	11
Total Respondents: 15		

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

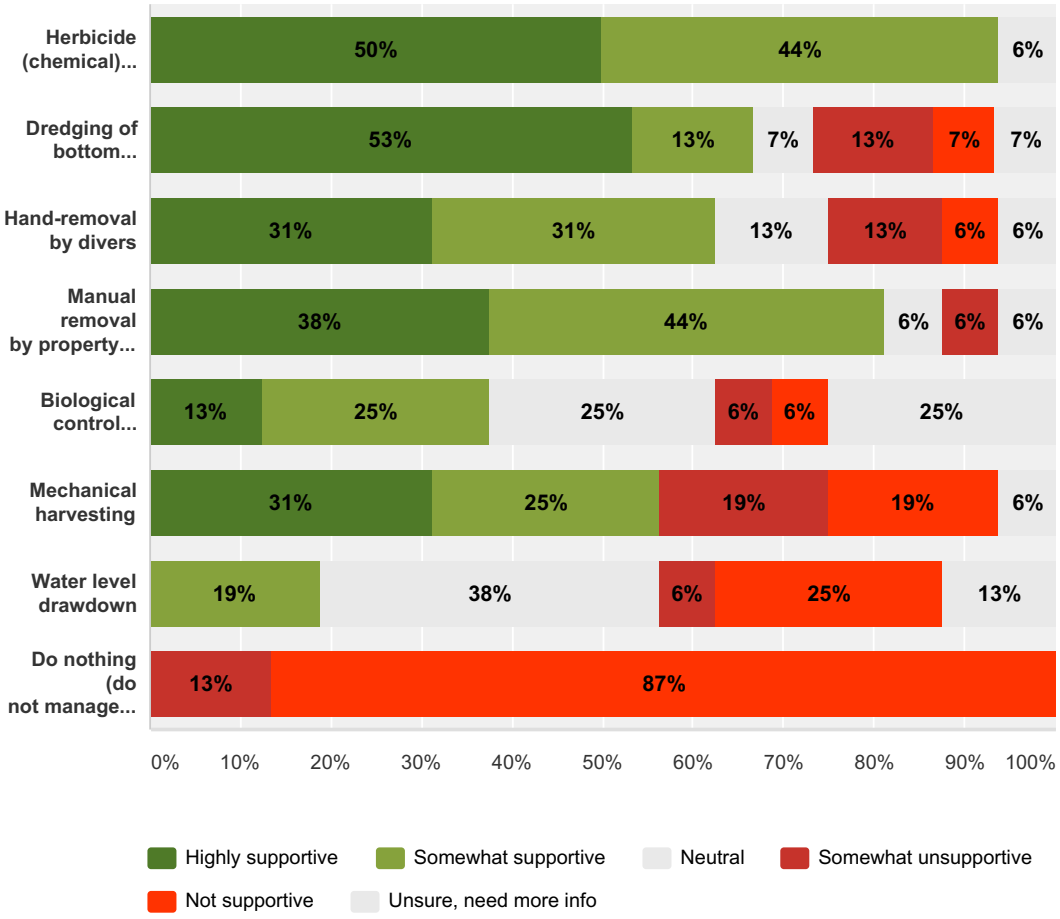
Answered: 16 Skipped: 0



Answer Choices	Responses	
Definitely	**75%**	12
Probably	**25%**	4
Unsure	**0%**	0
Probably not	**0%**	0
Definitely not	**0%**	0
Total		**16**

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

Answered: 16 Skipped: 0

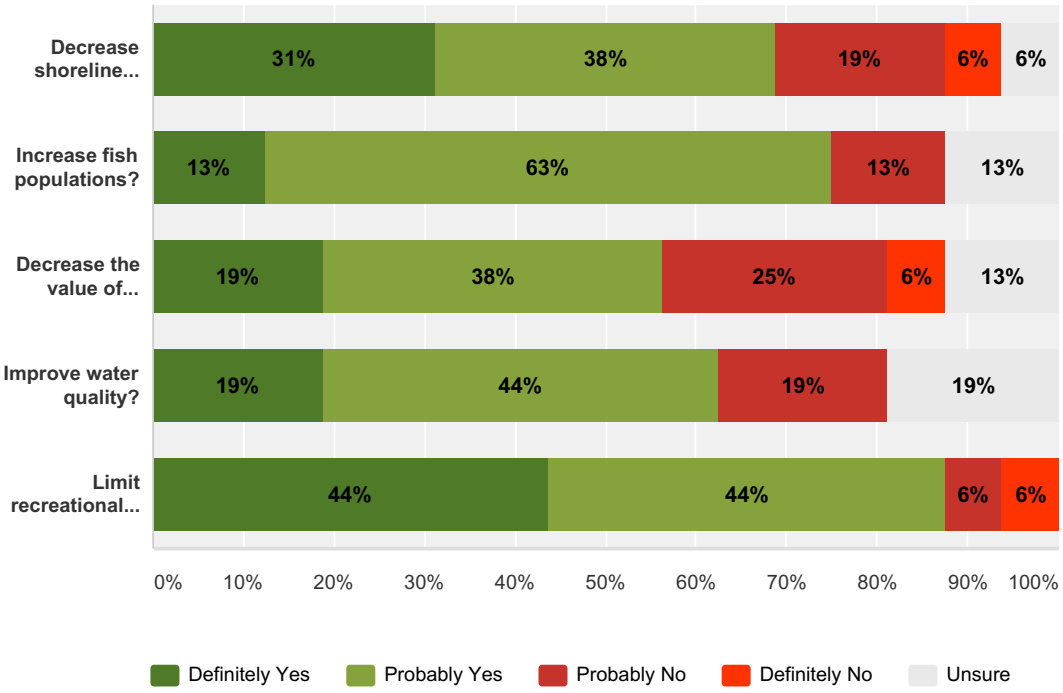


	Highly supportive	Somewhat supportive	Neutral	Somewhat unsupportive	Not supportive	Unsure, need more info	Total	Weighted Average
Herbicide (chemical) control	50% 8	44% 7	0% 0	0% 0	0% 0	6% 1	16	1.38
Dredging of bottom sediments	53% 8	13% 2	7% 1	13% 2	7% 1	7% 1	15	1.87
Hand-removal by divers	31% 5	31% 5	13% 2	13% 2	6% 1	6% 1	16	2.13
Manual removal by property owners	38% 6	44% 7	6% 1	6% 1	0% 0	6% 1	16	1.69
Biological control (milfoil weevil, loosestrife beetle, etc.)	13% 2	25% 4	25% 4	6% 1	6% 1	25% 4	16	1.94
Mechanical harvesting	31% 5	25% 4	0% 0	19% 3	19% 3	6% 1	16	2.50

Water level drawdown	**0%** 0	**19%** 3	**38%** 6	**6%** 1	**25%** 4	**13%** 2	16	3.00
Do nothing (do not manage plants)	**0%** 0	**0%** 0	**0%** 0	**13%** 2	**87%** 13	**0%** 0	15	4.87

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

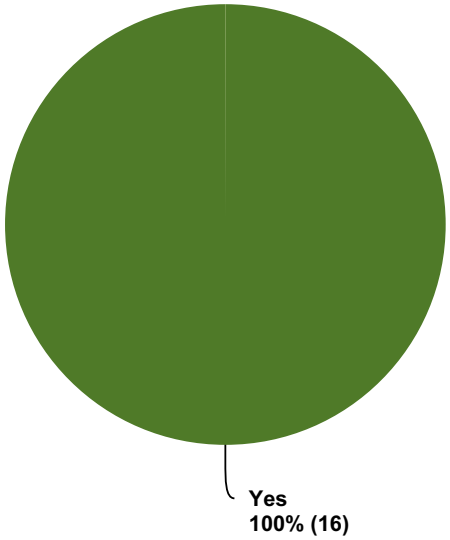
Answered: 16 Skipped: 0



	Definitely Yes	Probably Yes	Probably No	Definitely No	Unsure	Total
Decrease shoreline erosion?	**31%** 5	**38%** 6	**19%** 3	**6%** 1	**6%** 1	16
Increase fish populations?	**13%** 2	**63%** 10	**13%** 2	**0%** 0	**13%** 2	16
Decrease the value of shoreline property?	**19%** 3	**38%** 6	**25%** 4	**6%** 1	**13%** 2	16
Improve water quality?	**19%** 3	**44%** 7	**19%** 3	**0%** 0	**19%** 3	16
Limit recreational enjoyment?	**44%** 7	**44%** 7	**6%** 1	**6%** 1	**0%** 0	16

Q9 Have you ever heard of aquatic invasive species?

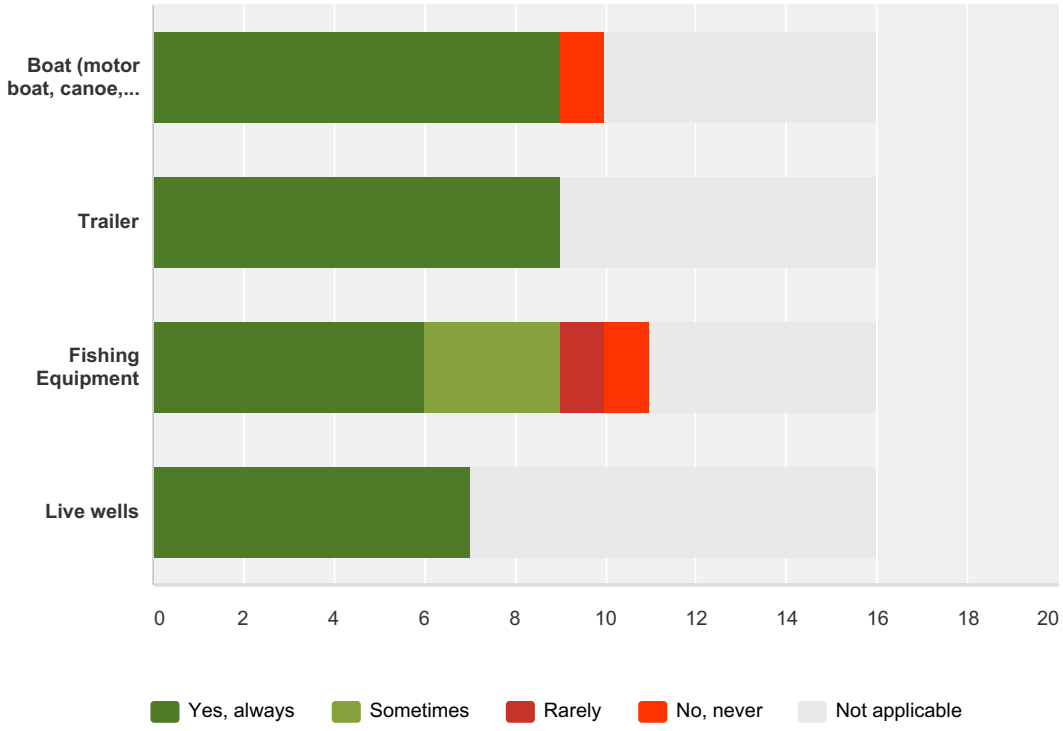
Answered: 16 Skipped: 0



Answer Choices	Responses	
Yes	**100%**	16
No	**0%**	0
Total		**16**

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

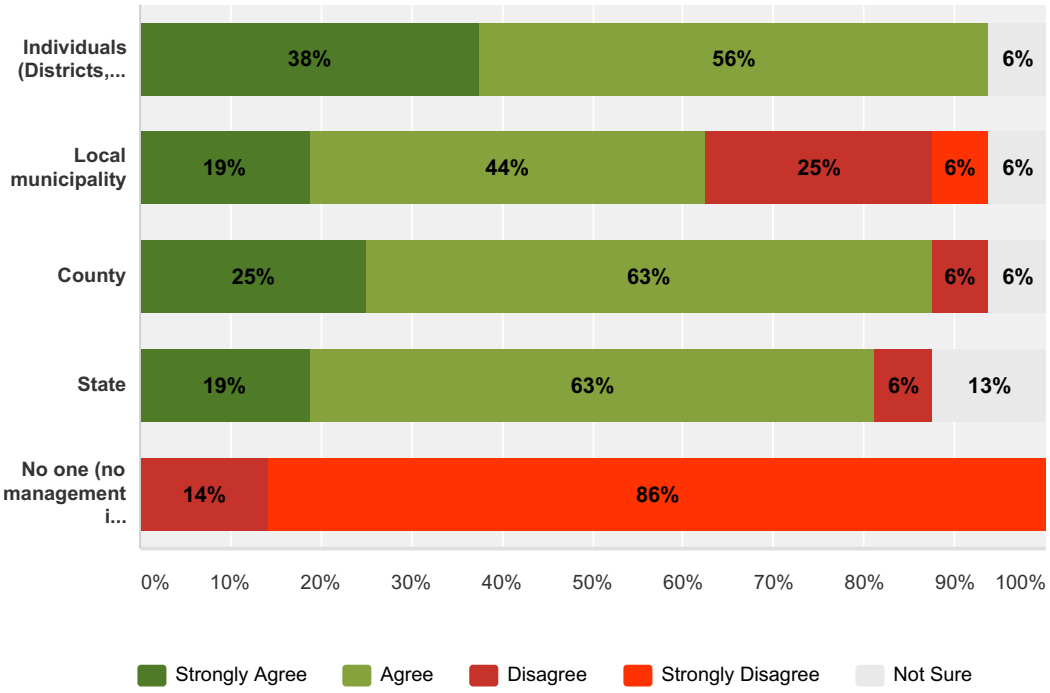
Answered: 16 Skipped: 0



	Yes, always	Sometimes	Rarely	No, never	Not applicable	Total Respondents
Boat (motor boat, canoe, kayak, etc.)	**56%** 9	**0%** 0	**0%** 0	**6%** 1	**38%** 6	16
Trailer	**56%** 9	**0%** 0	**0%** 0	**0%** 0	**44%** 7	16
Fishing Equipment	**38%** 6	**19%** 3	**6%** 1	**6%** 1	**31%** 5	16
Live wells	**44%** 7	**0%** 0	**0%** 0	**0%** 0	**56%** 9	16

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

Answered: 16 Skipped: 0

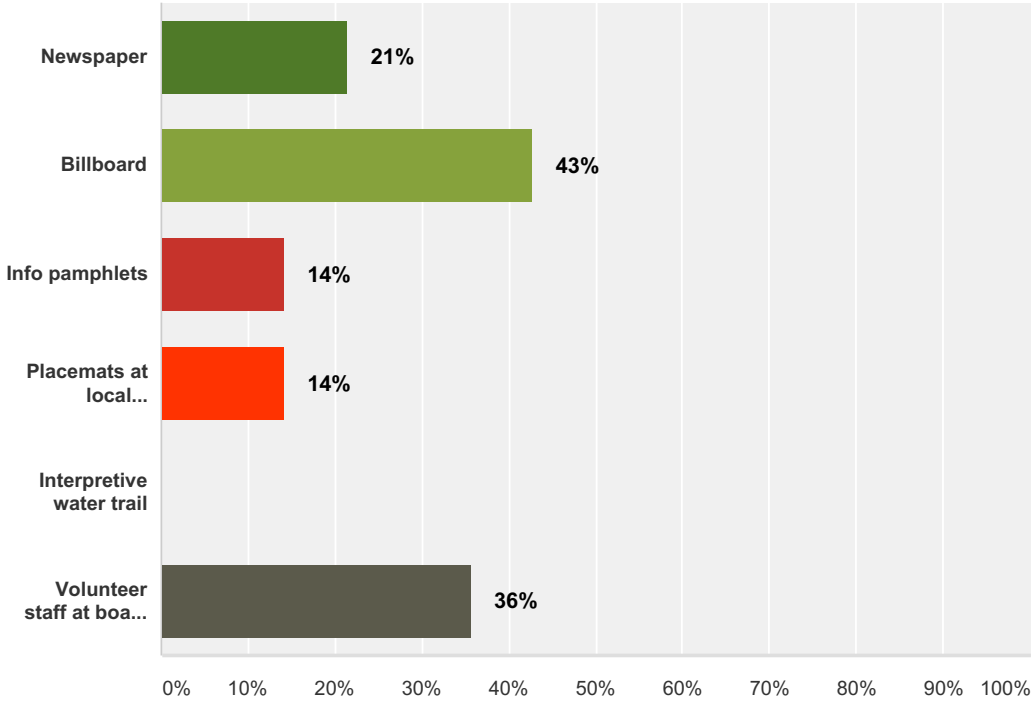


	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure	Total
Individuals (Districts, associations, lakefront property owners)	**38%** 6	**56%** 9	**0%** 0	**0%** 0	**6%** 1	16
Local municipality	**19%** 3	**44%** 7	**25%** 4	**6%** 1	**6%** 1	16
County	**25%** 4	**63%** 10	**6%** 1	**0%** 0	**6%** 1	16
State	**19%** 3	**63%** 10	**6%** 1	**0%** 0	**13%** 2	16
No one (no management is undertaken)	**0%** 0	**0%** 0	**14%** 2	**86%** 12	**0%** 0	14

#	Other (please specify)	Date
1	Depends on who owns the public access	6/4/2015 10:47 AM

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

Answered: 14 Skipped: 2

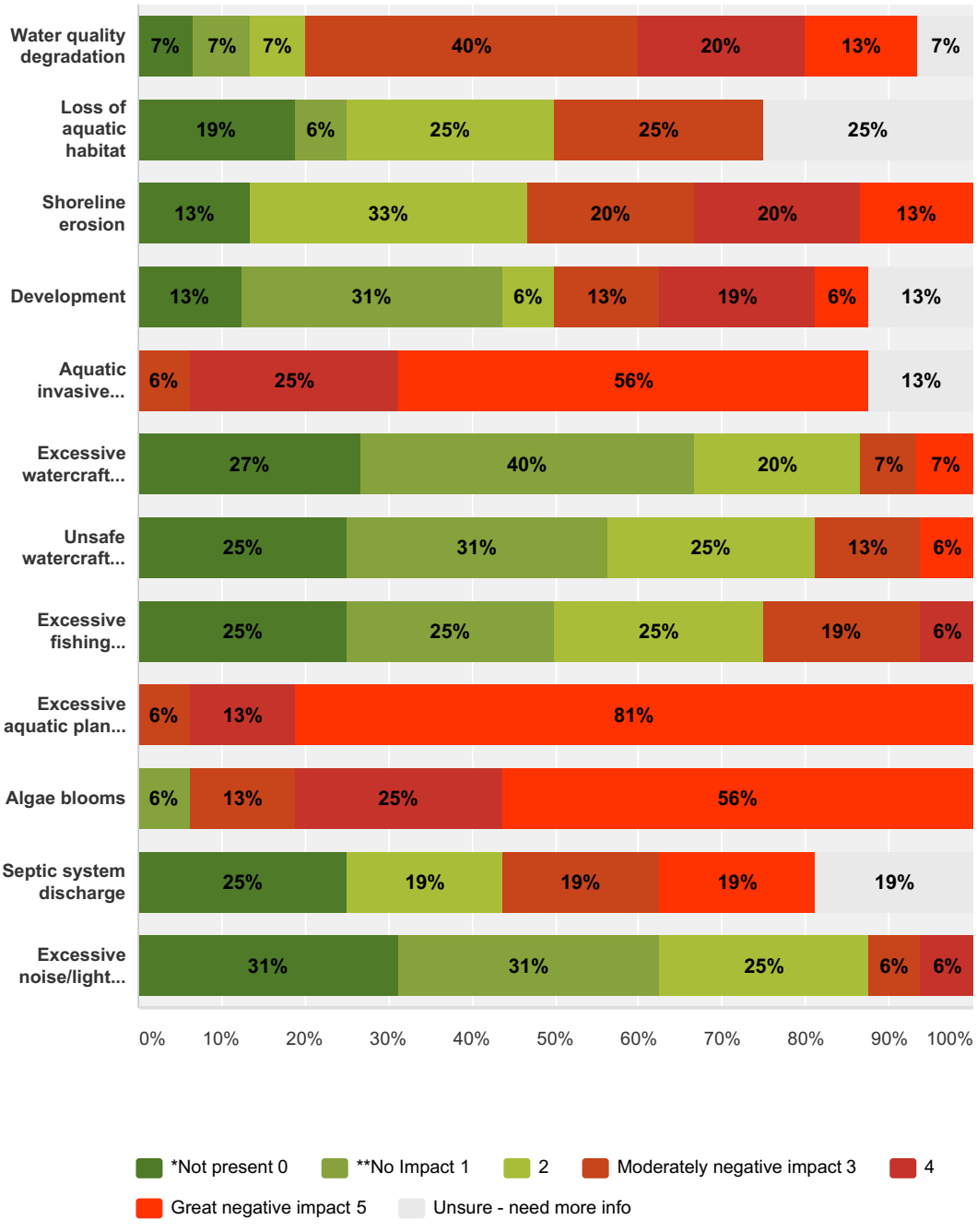


Answer Choices	Responses	
Newspaper	21%	3
Billboard	43%	6
Info pamphlets	14%	2
Placemats at local restaurants	14%	2
Interpretive water trail	0%	0
Volunteer staff at boat launch	36%	5
Total Respondents: 14		

#	Other (please specify)	Date
1	Large signs at boat launch	6/4/2015 10:47 AM
2	Notices placed at boat launch and entrance to park	6/3/2015 9:13 PM
3	Radio public service notices	5/27/2015 1:55 PM
4	Lake association Newsletters	5/27/2015 1:06 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 Alpine Lake? (Please rate 0 - 5)* Not Present means that you believe the issue does not exist on Alpine Lake.**No Impact means that the issue may exist on Alpine Lake but it is not negatively impacting the lake.

Answered: 16 Skipped: 0

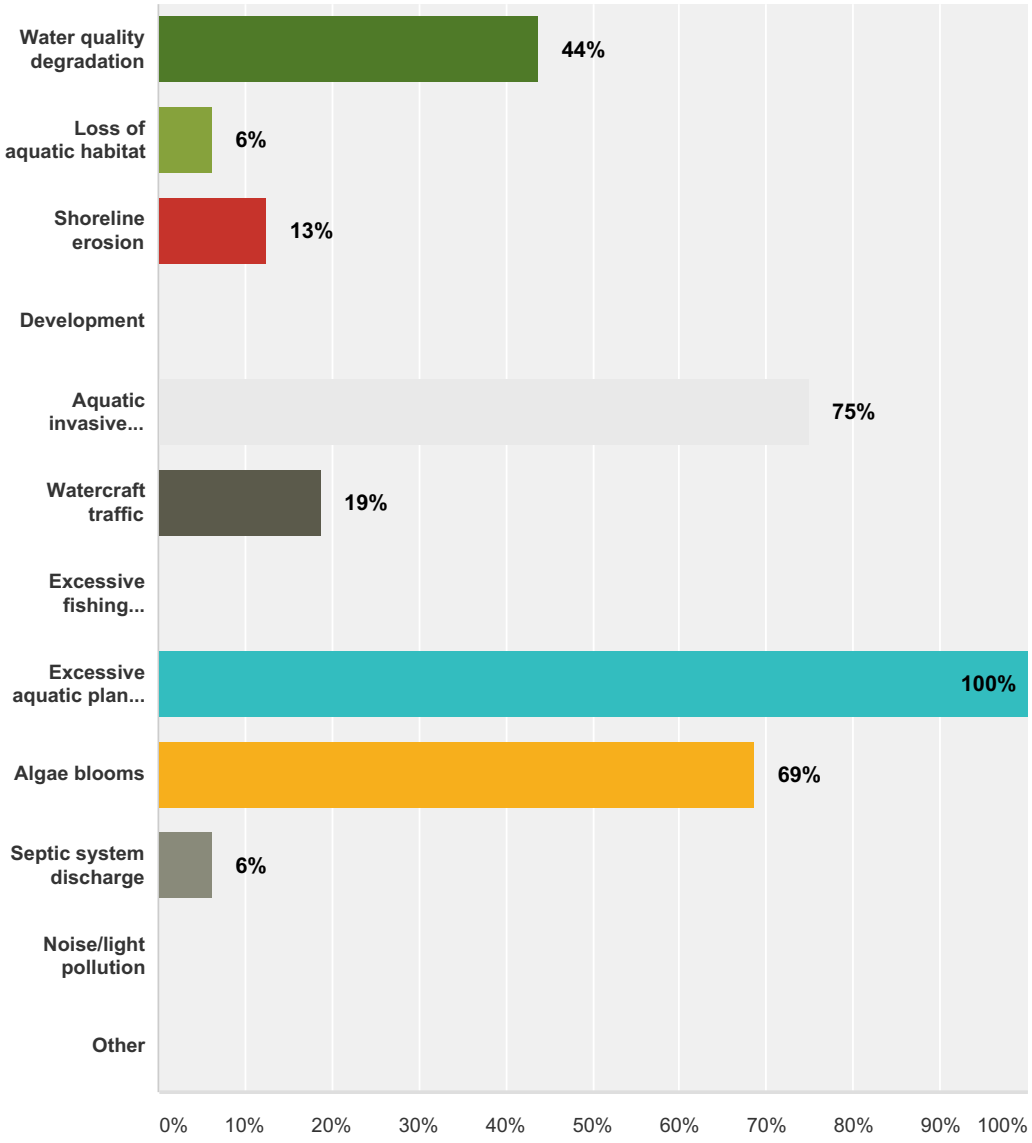


	*Not present 0	**No Impact 1	2	Moderately negative impact 3	4	Great negative impact 5	Unsure - need more info	Total	Weighted Average
Water quality degradation	7% 1	7% 1	7% 1	40% 6	20% 3	13% 2	7% 1	15	2.87
Loss of aquatic habitat	19% 3	6% 1	25% 4	25% 4	0% 0	0% 0	25% 4	16	1.31
Shoreline erosion	13% 2	0% 0	33% 5	20% 3	20% 3	13% 2	0% 0	15	2.73
Development	13% 2	31% 5	6% 1	13% 2	19% 3	6% 1	13% 2	16	1.88
Aquatic invasive species introduction	0% 0	0% 0	0% 0	6% 1	25% 4	56% 9	13% 2	16	4.00
Excessive watercraft traffic	27% 4	40% 6	20% 3	7% 1	0% 0	7% 1	0% 0	15	1.33
Unsafe watercraft practices	25% 4	31% 5	25% 4	13% 2	0% 0	6% 1	0% 0	16	1.50
Excessive fishing pressure	25% 4	25% 4	25% 4	19% 3	6% 1	0% 0	0% 0	16	1.56
Excessive aquatic plant growth (excluding algae)	0% 0	0% 0	0% 0	6% 1	13% 2	81% 13	0% 0	16	4.75
Algae blooms	0% 0	6% 1	0% 0	13% 2	25% 4	56% 9	0% 0	16	4.25
Septic system discharge	25% 4	0% 0	19% 3	19% 3	0% 0	19% 3	19% 3	16	1.88
Excessive noise/light pollution	31% 5	31% 5	25% 4	6% 1	6% 1	0% 0	0% 0	16	1.25

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

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

Answered: 16 Skipped: 0



Answer Choices	Responses	
Water quality degradation	**44%**	7
Loss of aquatic habitat	**6%**	1
Shoreline erosion	**13%**	2
Development	**0%**	0
Aquatic invasive species introduction	**75%**	12
Watercraft traffic	**19%**	3

Excessive fishing pressure	**0%**	0
Excessive aquatic plant growth (excluding algae)	**100%**	16
Algae blooms	**69%**	11
Septic system discharge	**6%**	1
Noise/light pollution	**0%**	0
Other	**0%**	0
Total Respondents: 16		

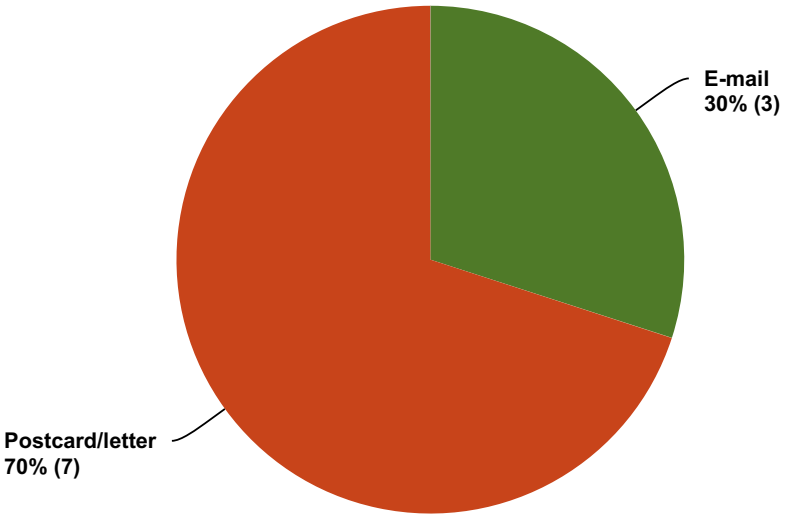
Q1 What is your Waushara County Lakes Study ID?

Answered: 10 Skipped: 0

#	Responses	Date
1	[redacted]	7/13/2015 11:37 AM
2	[redacted]	7/12/2015 2:15 PM
3	[redacted]	7/9/2015 4:31 PM
4	[redacted]	7/9/2015 8:52 AM
5	[redacted]	7/7/2015 8:18 AM
6	[redacted]	7/3/2015 5:07 PM
7	[redacted]	6/30/2015 7:44 PM
8	[redacted]	6/30/2015 6:53 AM
9	[redacted]	6/29/2015 7:10 PM
10	[redacted]	6/29/2015 3:50 PM

Q2 How did you hear about this survey?

Answered: 10 Skipped: 0

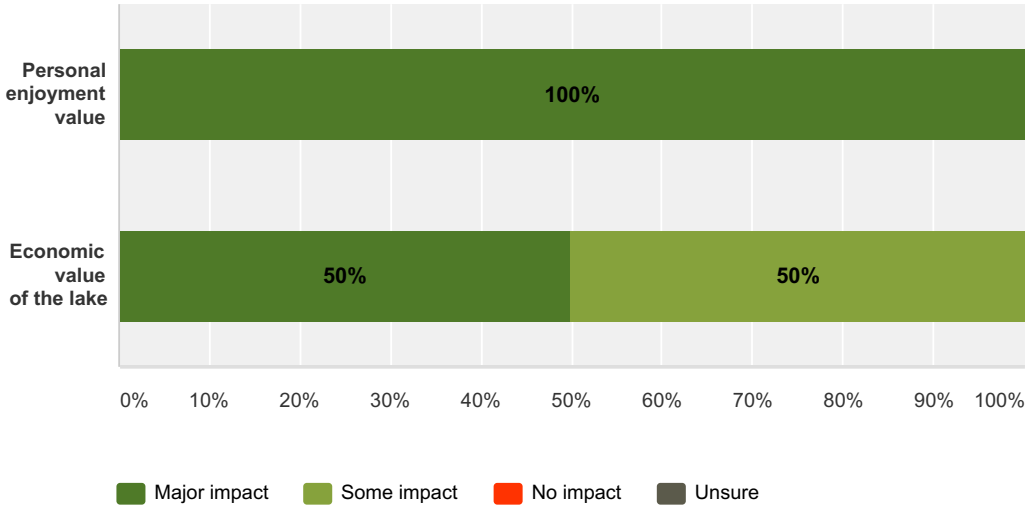


Answer Choices	Responses	
E-mail	30%	3
Newspaper	0%	0
Postcard/letter	70%	7
Facebook	0%	0
Radio	0%	0
Word of mouth	0%	0
Total		10

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

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

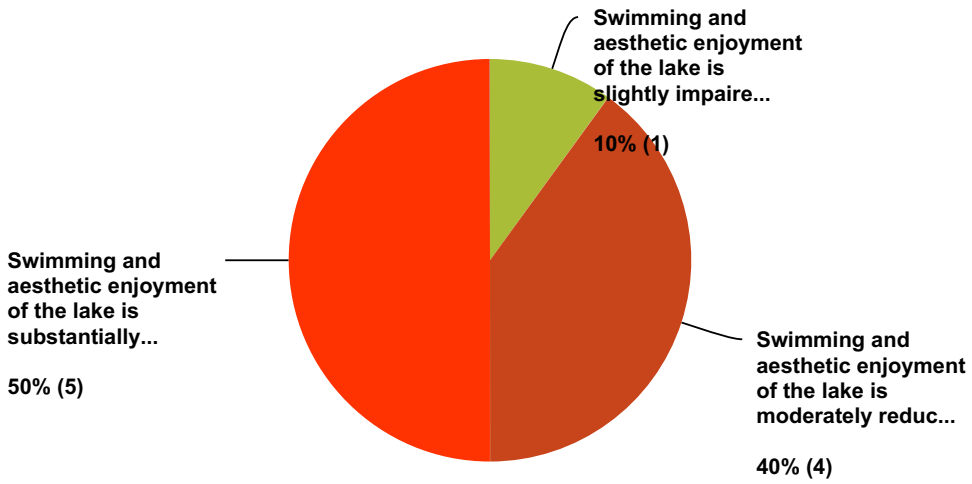
Answered: 10 Skipped: 0



	Major impact	Some impact	No impact	Unsure	Total
Personal enjoyment value	**100%** 10	**0%** 0	**0%** 0	**0%** 0	10
Economic value of the lake	**50%** 5	**50%** 5	**0%** 0	**0%** 0	10

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

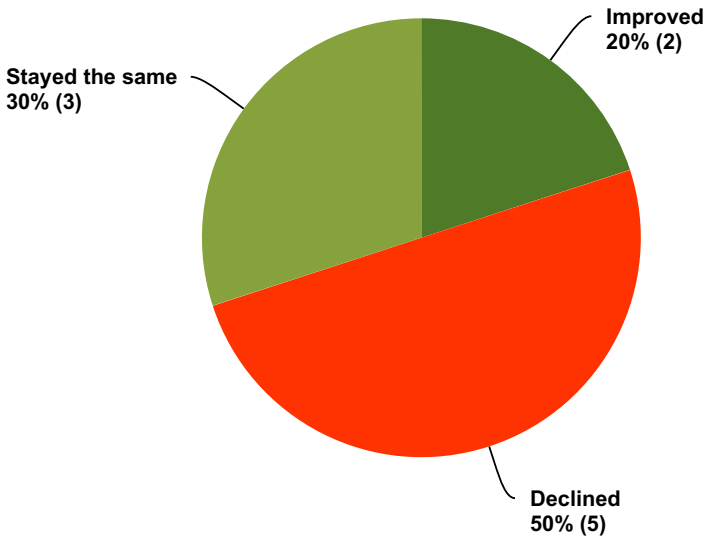
Answered: 10 Skipped: 0



Answer Choices	Responses	
Beautiful, could not be any nicer	0%	0
Very minor aesthetic problems; excellent for swimming and boating enjoyment	0%	0
Swimming and aesthetic enjoyment of the lake is slightly impaired because of algae	10%	1
Swimming and aesthetic enjoyment of the lake is moderately reduced because of algae	40%	4
Swimming and aesthetic enjoyment of the lake is substantially reduced because of algae	50%	5
None of the above	0%	0
Unsure	0%	0
Total		**10**

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

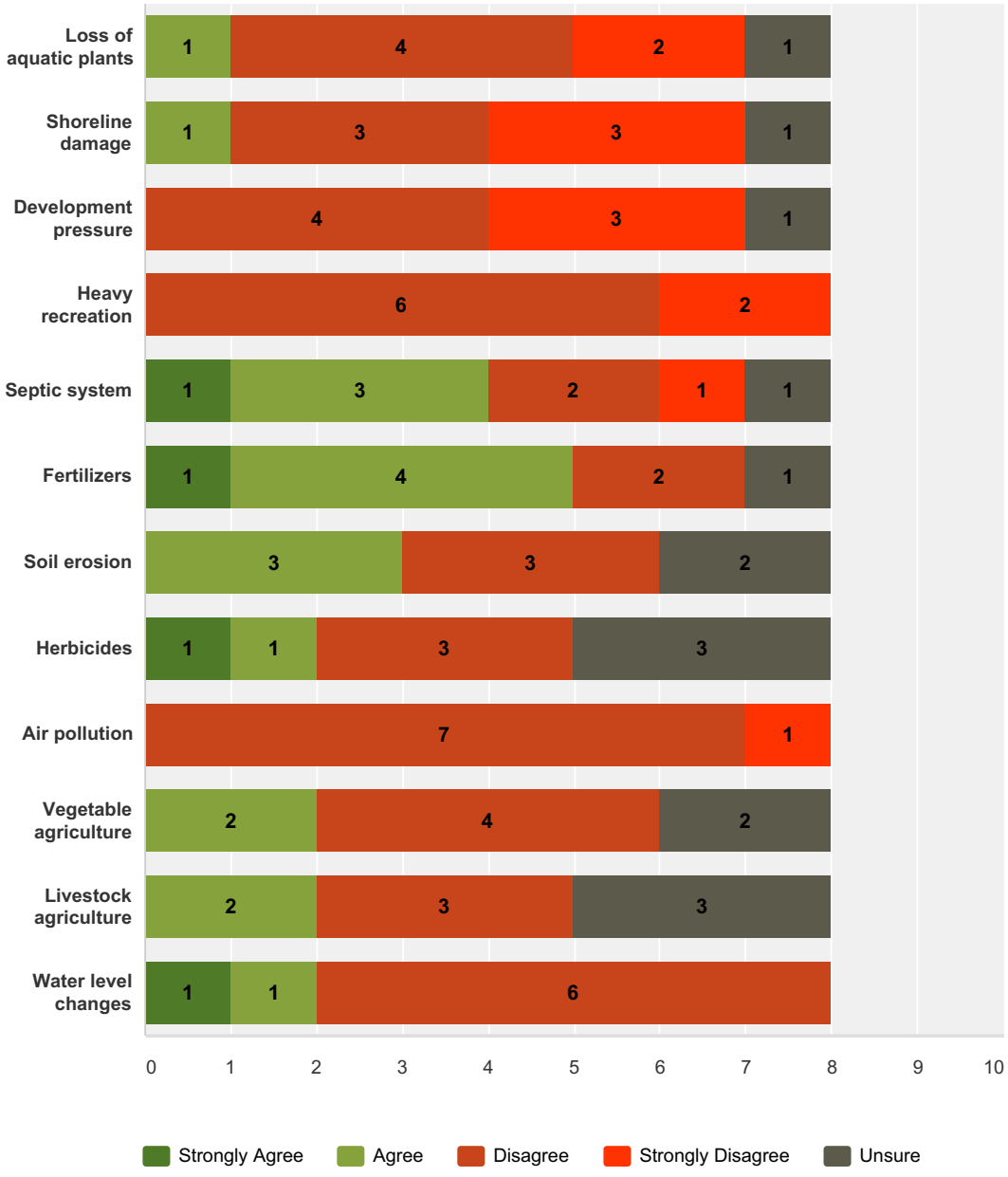
Answered: 10 Skipped: 0



Answer Choices	Responses	
Improved	20%	2
Declined	50%	5
Stayed the same	30%	3
Unsure	0%	0
Total		10

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

Answered: 8 Skipped: 2

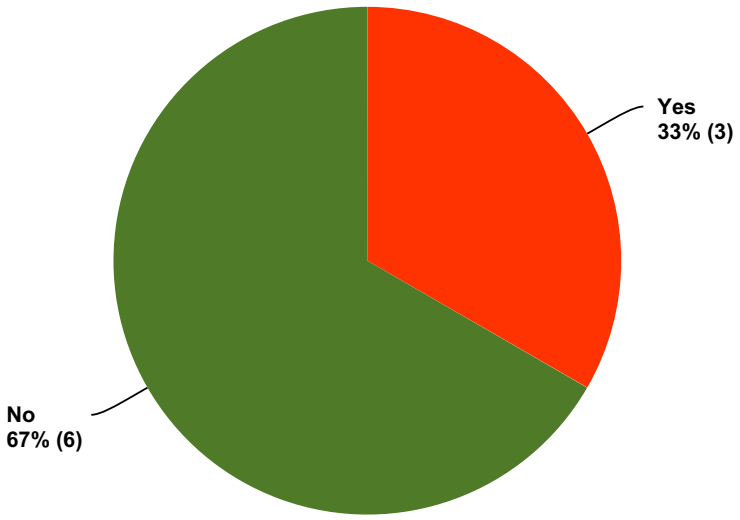


	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	Total Respondents
Loss of aquatic plants	0% 0	13% 1	50% 4	25% 2	13% 1	8
Shoreline damage	0% 0	13% 1	38% 3	38% 3	13% 1	8
Development pressure	0% 0	0% 0	50% 4	38% 3	13% 1	8
Heavy recreation	0% 0	0% 0	75% 6	25% 2	0% 0	8

Septic system	**13%** 1	**38%** 3	**25%** 2	**13%** 1	**13%** 1	8
Fertilizers	**13%** 1	**50%** 4	**25%** 2	**0%** 0	**13%** 1	8
Soil erosion	**0%** 0	**38%** 3	**38%** 3	**0%** 0	**25%** 2	8
Herbicides	**13%** 1	**13%** 1	**38%** 3	**0%** 0	**38%** 3	8
Air pollution	**0%** 0	**0%** 0	**88%** 7	**13%** 1	**0%** 0	8
Vegetable agriculture	**0%** 0	**25%** 2	**50%** 4	**0%** 0	**25%** 2	8
Livestock agriculture	**0%** 0	**25%** 2	**38%** 3	**0%** 0	**38%** 3	8
Water level changes	**13%** 1	**13%** 1	**75%** 6	**0%** 0	**0%** 0	8

Q7 Do you use herbicides or pesticides (i.e. "weed and feed") on your land? If selecting No, please skip to Question 11.

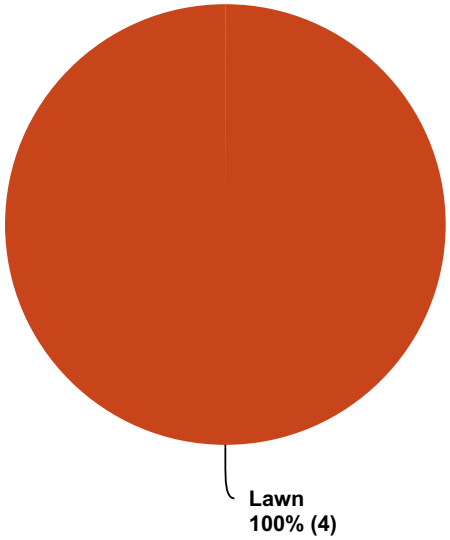
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	33%	3
No	67%	6
Total		9

Q8 Where do you apply herbicides and/or pesticides?

Answered: 4 Skipped: 6

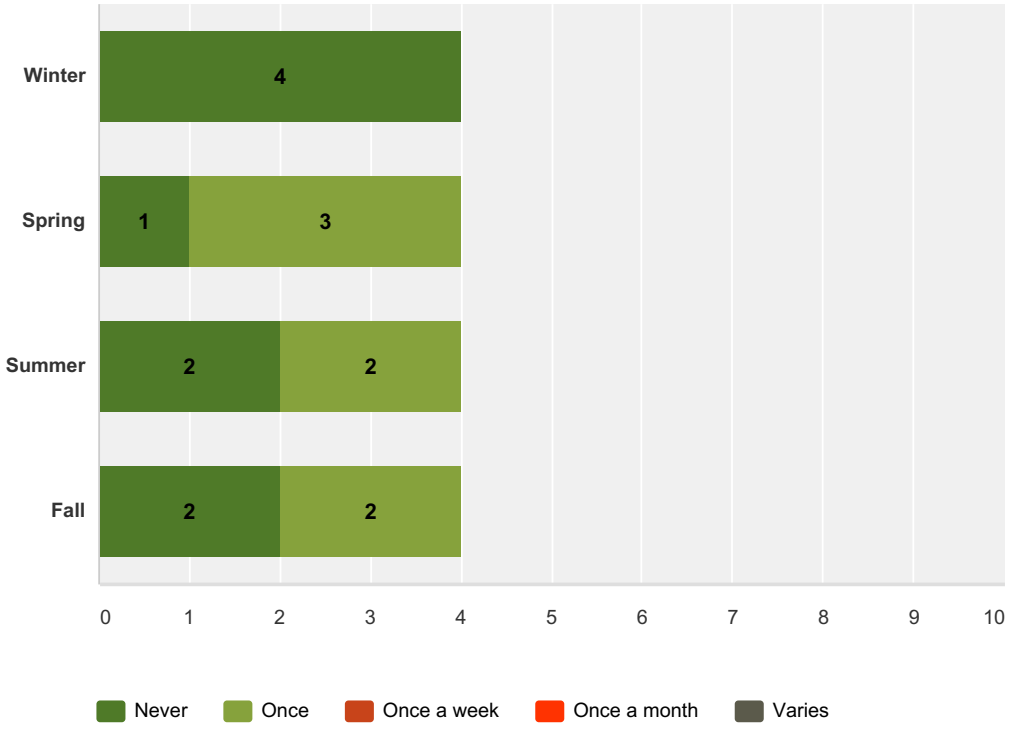


Answer Choices	Responses	
Agricultural fields	0%	0
Garden	0%	0
Lawn	100%	4
Total		4

#	Other (please specify)	Date
1	Don't	7/9/2015 4:34 PM
2	only 75 feet from lake	6/30/2015 7:49 PM

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

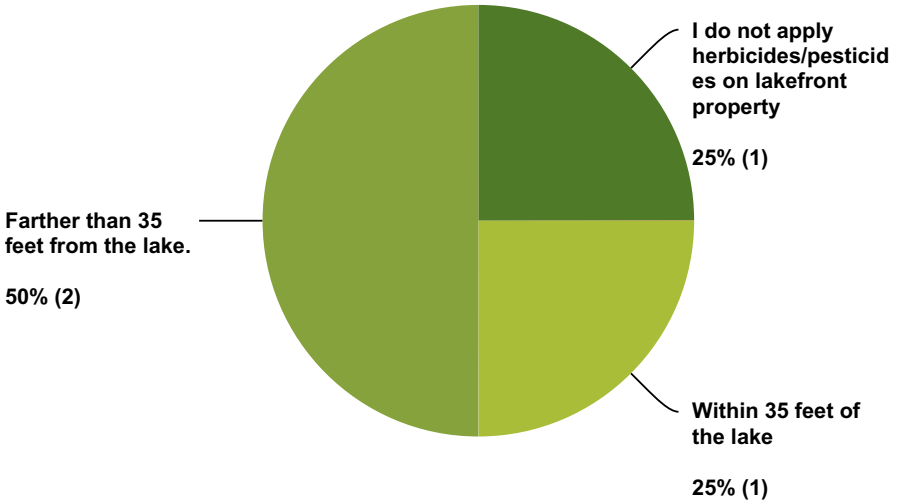
Answered: 4 Skipped: 6



	Never	Once	Once a week	Once a month	Varies	Total Respondents
Winter	**100%** 4	**0%** 0	**0%** 0	**0%** 0	**0%** 0	4
Spring	**25%** 1	**75%** 3	**0%** 0	**0%** 0	**0%** 0	4
Summer	**50%** 2	**50%** 2	**0%** 0	**0%** 0	**0%** 0	4
Fall	**50%** 2	**50%** 2	**0%** 0	**0%** 0	**0%** 0	4

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)?

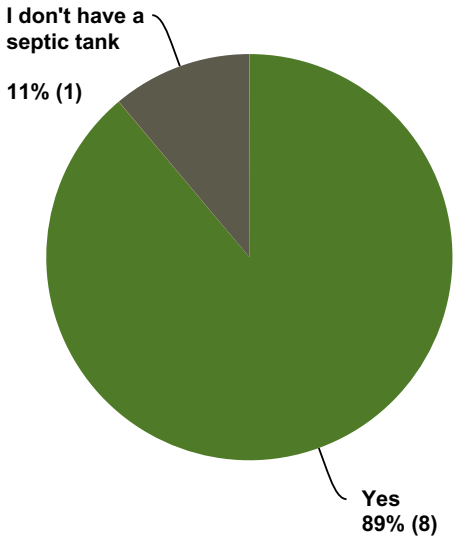
Answered: 4 Skipped: 6



Answer Choices	Responses	
I do not apply herbicides/pesticides on lakefront property	25%	1
Up to the lake	0%	0
Within 35 feet of the lake	25%	1
Farther than 35 feet from the lake.	50%	2
Total		4

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

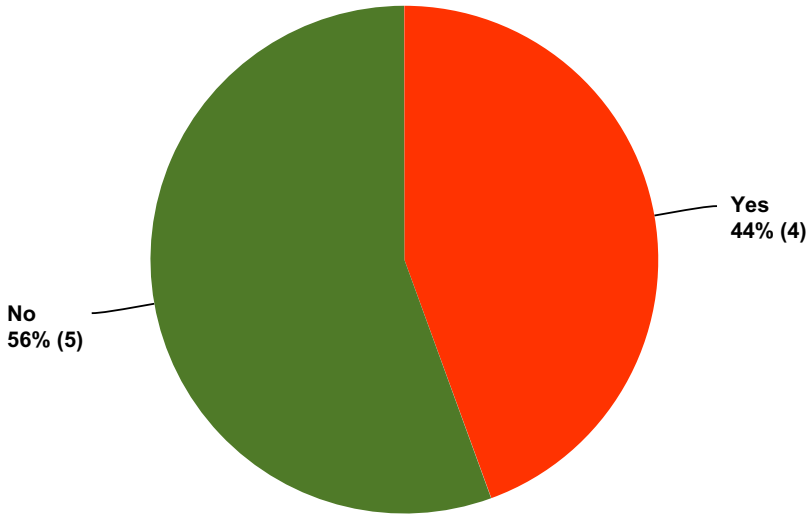
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	89%	8
No	0%	0
I don't have a septic tank	11%	1
Total		9

Q12 Do you use fertilizer on your land?

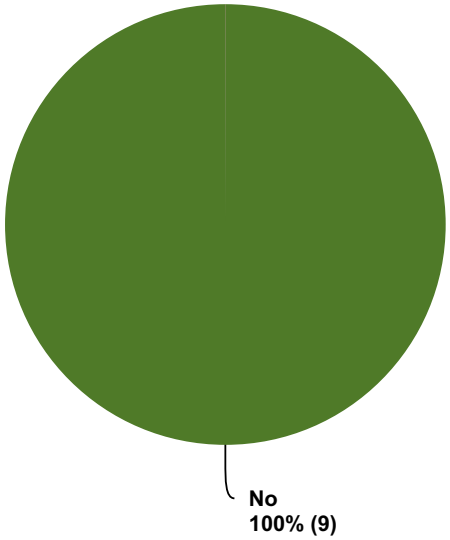
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	44%	4
No	56%	5
Total		9

Q13 Do you use fertilizer which contains phosphorus?

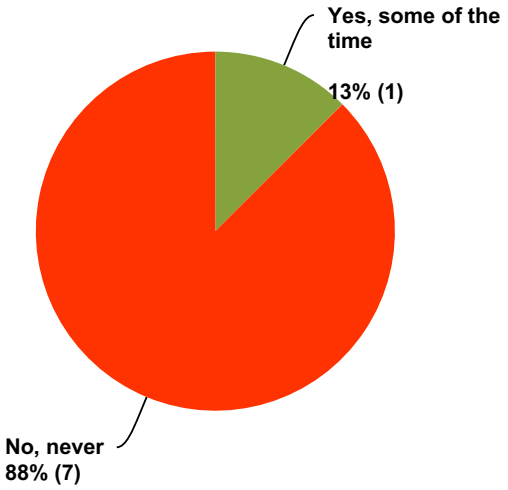
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	0%	0
No	100%	9
I don't know	0%	0
Total		9

Q14 Do you have your soil tested before applying fertilizer?

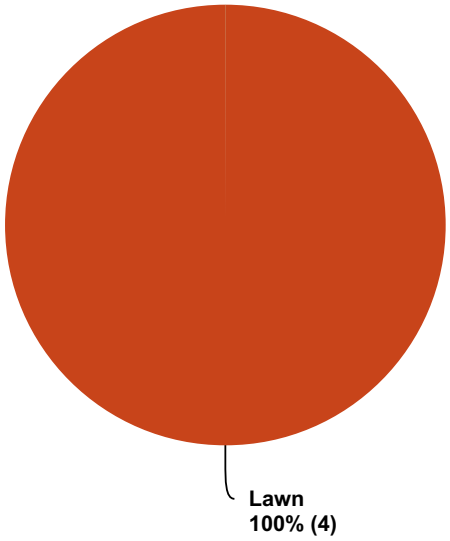
Answered: 8 Skipped: 2



Answer Choices	Responses	
Yes, all of the time	0%	0
Yes, some of the time	13%	1
No, never	88%	7
Total		8

Q15 Where do you apply fertilizer?

Answered: 4 Skipped: 6

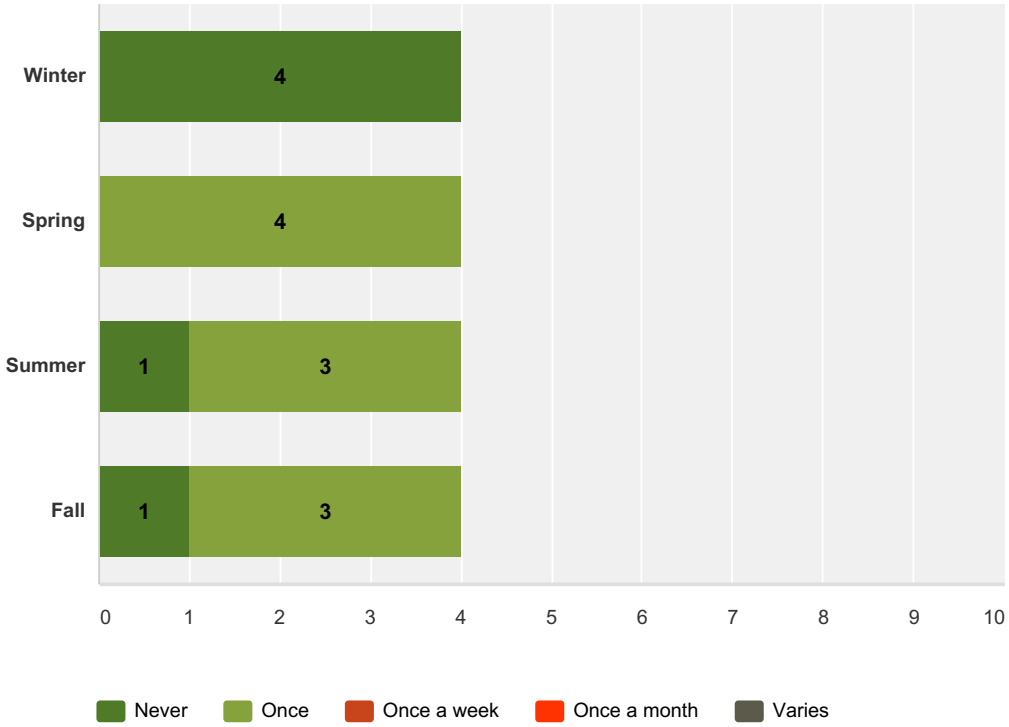


Answer Choices	Responses	
Agricultural fields	0%	0
Garden	0%	0
Lawn	100%	4
Total		4

#	Other (please specify)	Date
1	use only lake friendly fertilizer	7/7/2015 8:20 AM

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

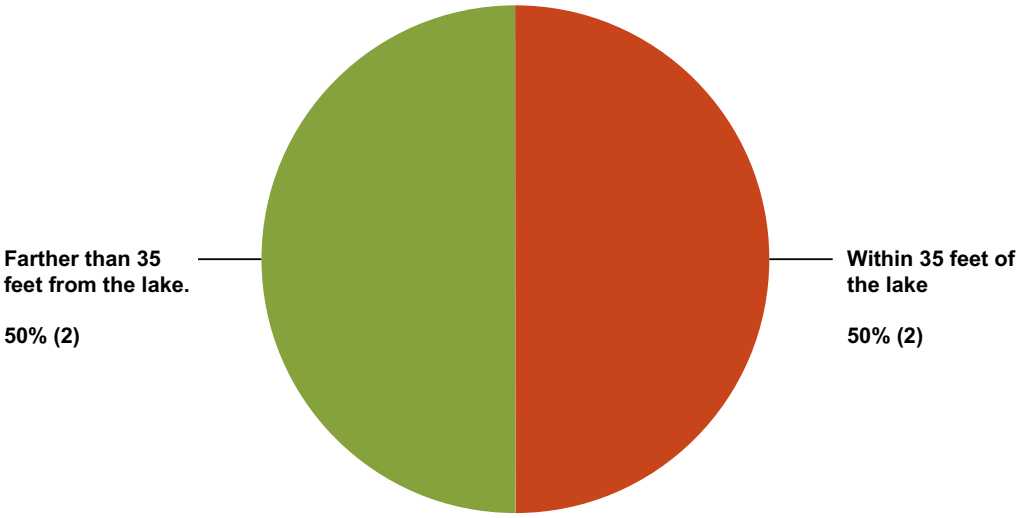
Answered: 4 Skipped: 6



	Never	Once	Once a week	Once a month	Varies	Total Respondents
Winter	**100%** 4	**0%** 0	**0%** 0	**0%** 0	**0%** 0	4
Spring	**0%** 0	**100%** 4	**0%** 0	**0%** 0	**0%** 0	4
Summer	**25%** 1	**75%** 3	**0%** 0	**0%** 0	**0%** 0	4
Fall	**25%** 1	**75%** 3	**0%** 0	**0%** 0	**0%** 0	4

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)?

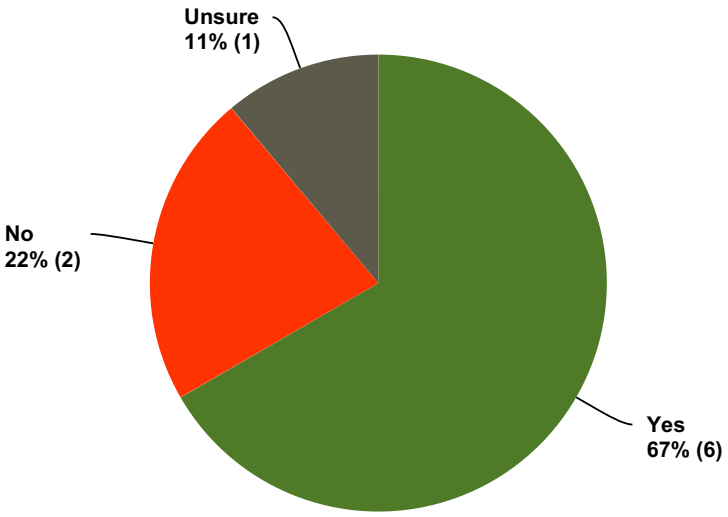
Answered: 4 Skipped: 6



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	50%	2
Farther than 35 feet from the lake.	50%	2
Total		4

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

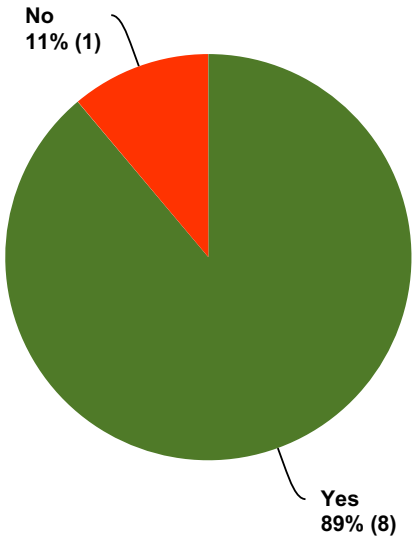
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	67%	6
No	22%	2
Unsure	11%	1
Total		9

Q19 Do you own shoreland property? If selecting No, please skip to the last page.

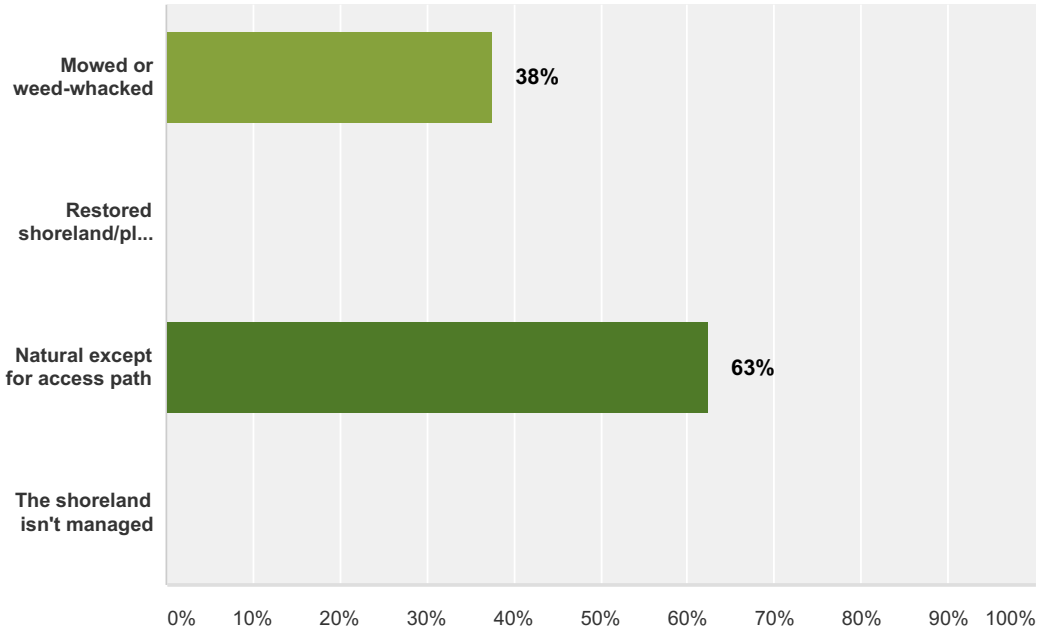
Answered: 9 Skipped: 1



Answer Choices	Responses	
Yes	89%	8
No	11%	1
Total		9

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

Answered: 8 Skipped: 2

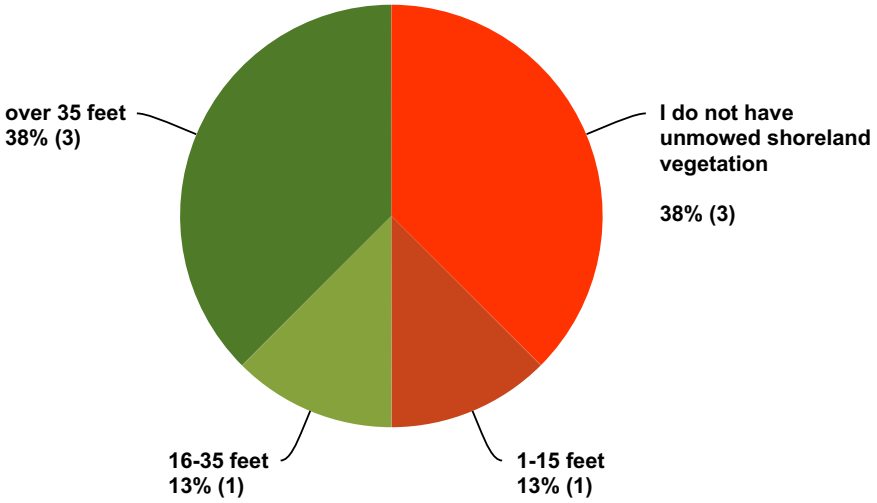


Answer Choices	Responses	
Mowed or weed-whacked	**38%**	3
Restored shoreland/planted	**0%**	0
Natural except for access path	**63%**	5
The shoreland isn't managed	**0%**	0
Total Respondents: 8		

#	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?

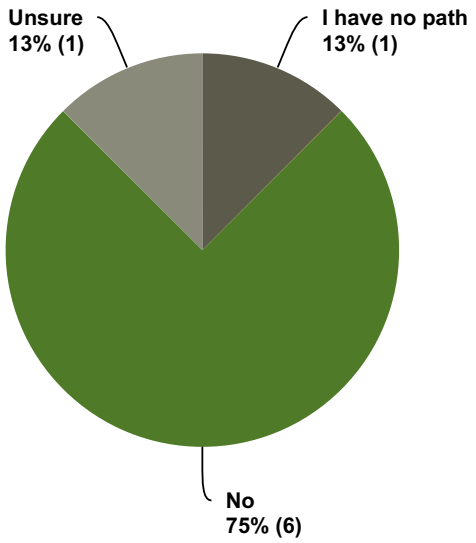
Answered: 8 Skipped: 2



Answer Choices	Responses	
I do not have unmowed shoreland vegetation	38%	3
1-15 feet	13%	1
16-35 feet	13%	1
over 35 feet	38%	3
Total		8

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

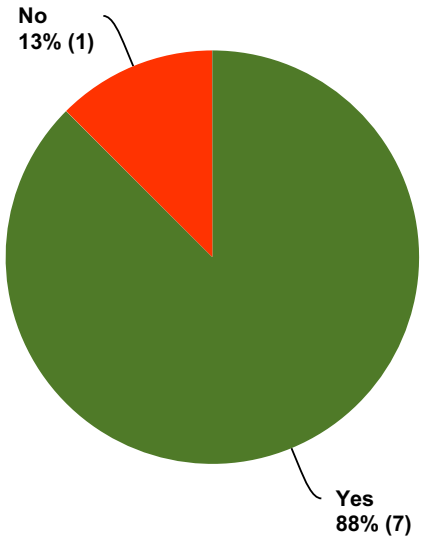
Answered: 8 Skipped: 2



Answer Choices	Responses	
I have no path	13%	1
Yes	0%	0
No	75%	6
Unsure	13%	1
Total		8

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

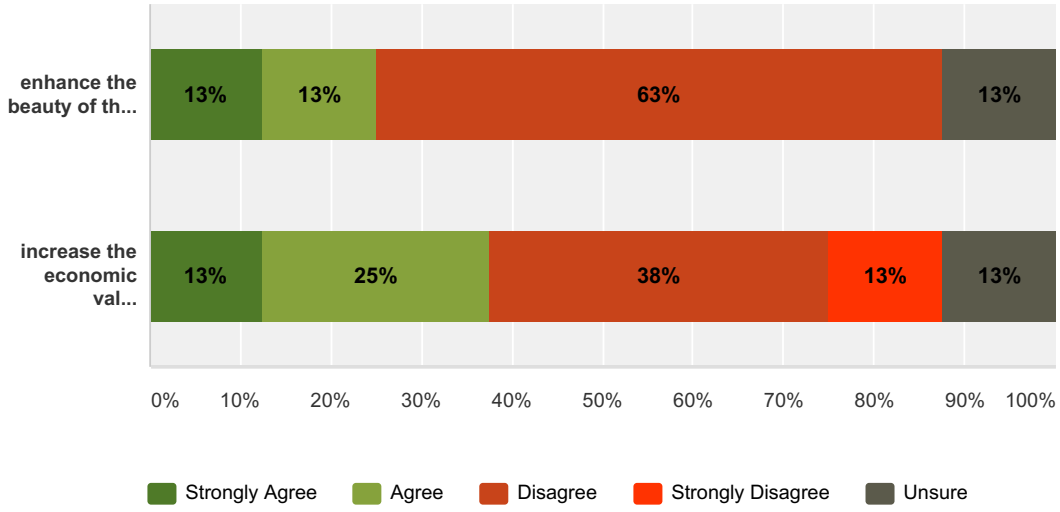
Answered: 8 Skipped: 2



Answer Choices	Responses	
Yes	88%	7
No	13%	1
Unsure	0%	0
Total		8

Q24 In your opinion, does shoreland vegetation...

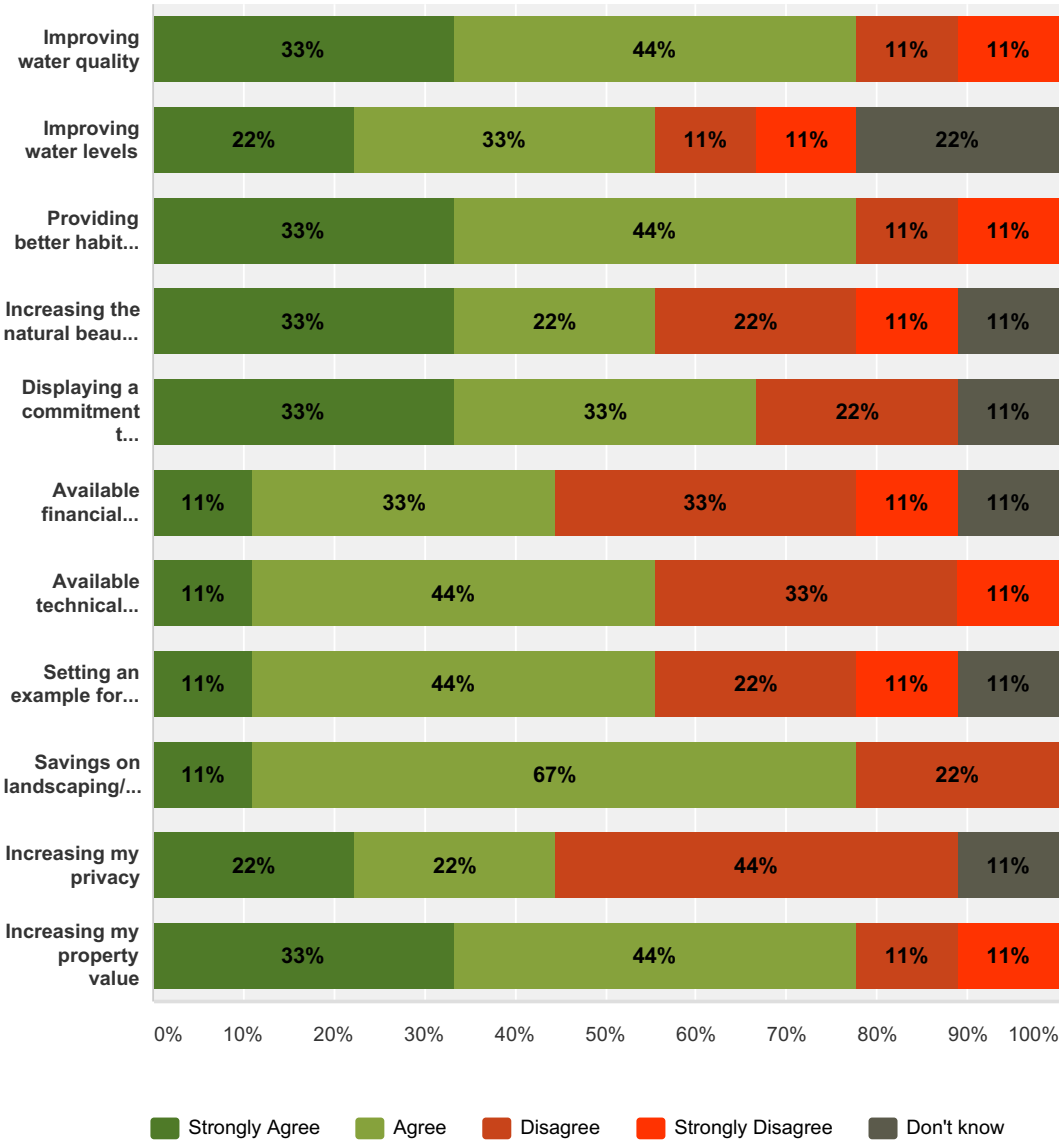
Answered: 8 Skipped: 2



	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure	Total
enhance the beauty of the property?	**13%** 1	**13%** 1	**63%** 5	**0%** 0	**13%** 1	8
increase the economic value of the property?	**13%** 1	**25%** 2	**38%** 3	**13%** 1	**13%** 1	8

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

Answered: 9 Skipped: 1



	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't know	Total
Improving water quality	33% 3	44% 4	11% 1	11% 1	0% 0	9
Improving water levels	22% 2	33% 3	11% 1	11% 1	22% 2	9
Providing better habitat for fish and wildlife	33% 3	44% 4	11% 1	11% 1	0% 0	9
Increasing the natural beauty of my property	33% 3	22% 2	22% 2	11% 1	11% 1	9
Displaying a commitment to the environment	33% 3	33% 3	22% 2	0% 0	11% 1	9

Available financial assistance	**11%** 1	**33%** 3	**33%** 3	**11%** 1	**11%** 1	9
Available technical assistance	**11%** 1	**44%** 4	**33%** 3	**11%** 1	**0%** 0	9
Setting an example for community members	**11%** 1	**44%** 4	**22%** 2	**11%** 1	**11%** 1	9
Savings on landscaping/maintenance costs	**11%** 1	**67%** 6	**22%** 2	**0%** 0	**0%** 0	9
Increasing my privacy	**22%** 2	**22%** 2	**44%** 4	**0%** 0	**11%** 1	9
Increasing my property value	**33%** 3	**44%** 4	**11%** 1	**11%** 1	**0%** 0	9

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

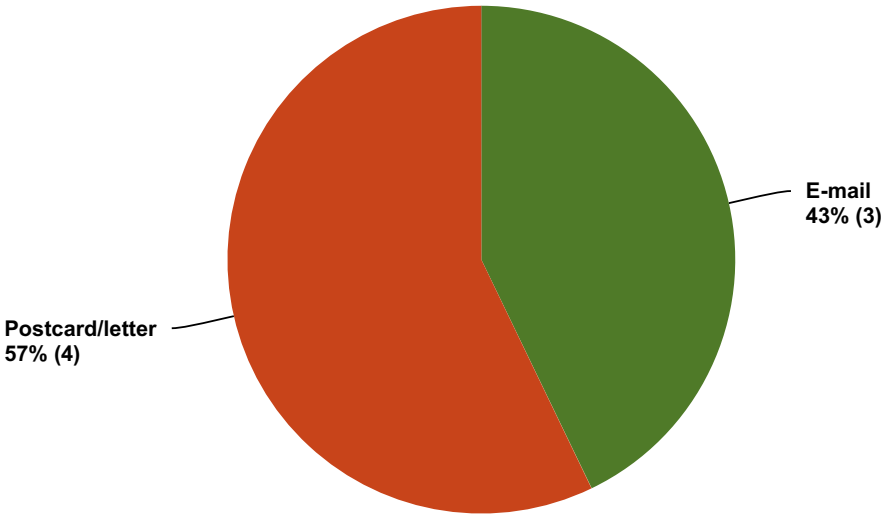
Q1 Enter your Waushara County Lakes Survey ID. Your survey cannot be processed without this information. If you've forgotten your ID or haven't created one yet, follow the instructions below.

Answered: 7 Skipped: 0

#	Responses	Date
1	[redacted]	8/6/2015 11:23 AM
2	[redacted]	8/5/2015 12:56 PM
3	[redacted]	8/3/2015 6:25 AM
4	[redacted]	8/1/2015 9:06 PM
5	[redacted]	8/1/2015 8:59 PM
6	[redacted]	7/31/2015 4:18 PM
7	[redacted]	7/30/2015 1:40 PM

Q2 How did you hear about this survey?

Answered: 7 Skipped: 0

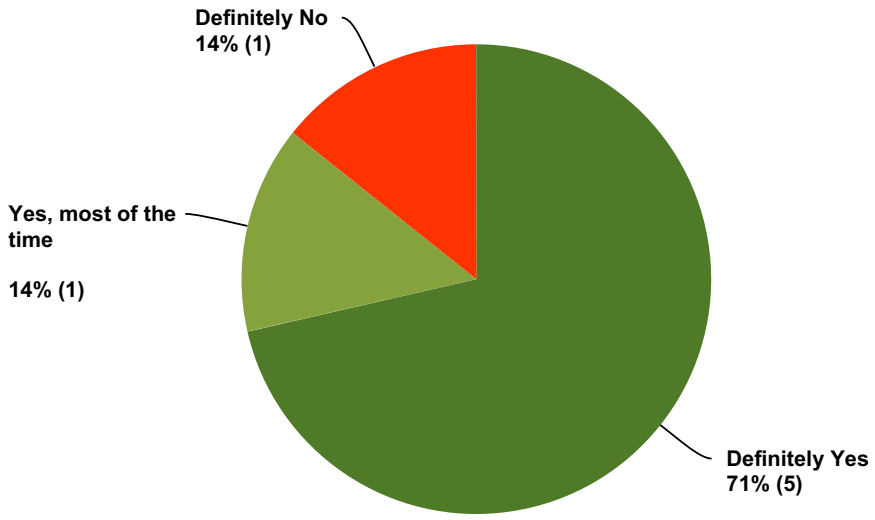


Answer Choices	Responses	
E-mail	43%	3
Newspaper	0%	0
Postcard/letter	57%	4
Facebook	0%	0
Radio	0%	0
Total		7

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

Q3 "No Wake" is allowed on Alpine Lake at any time. Do you like the current "No Wake" rules as they are? (If answering 'Definitely Yes', please skip to Question 18.)

Answered: 7 Skipped: 0



Answer Choices	Responses	
Definitely Yes	71%	5
Yes, most of the time	14%	1
No, not most of the time	0%	0
Definitely No	14%	1
Unsure	0%	0
Total		7

Q4 If you think the "No Wake" rules should be adjusted...in what way?

Answered: 1 Skipped: 6

#	Responses	Date
1	It would create more recreation on the lake.	8/3/2015 6:27 AM

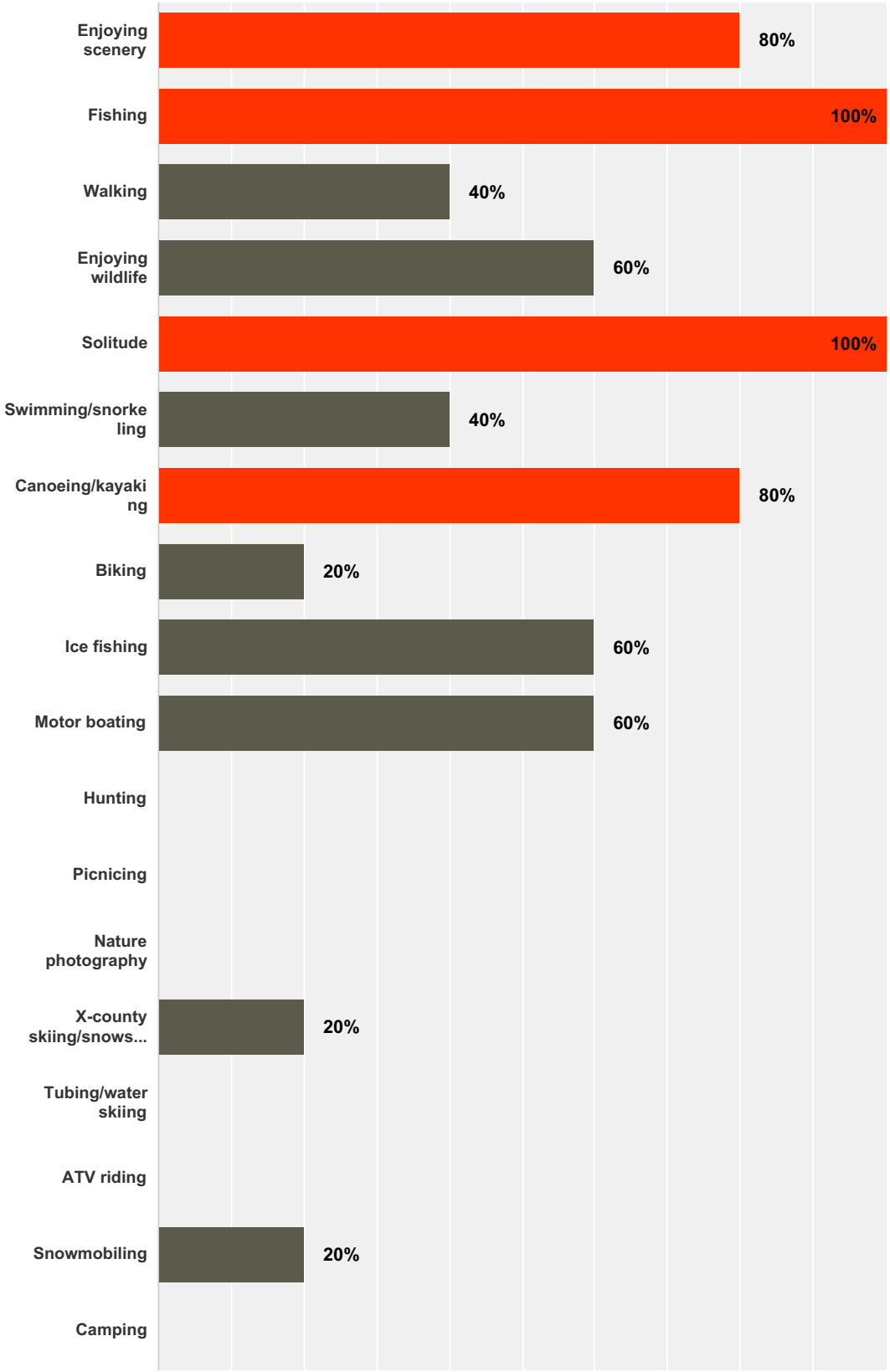
Q5 What could be done to improve your recreation experience on Alpine Lake?

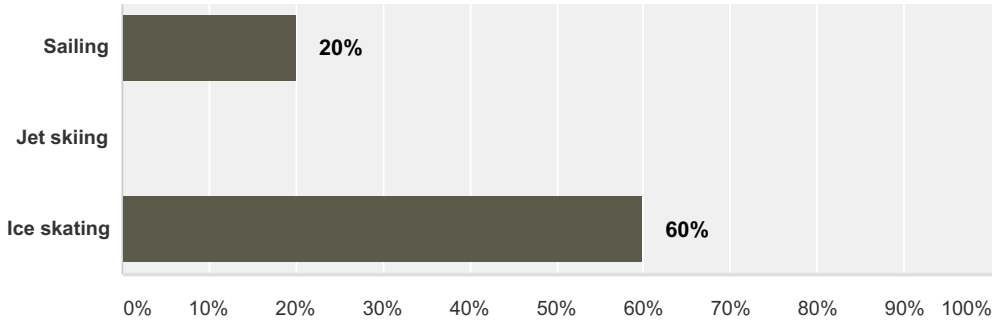
Answered: 3 Skipped: 4

#	Responses	Date
1	remove weeds	8/6/2015 11:25 AM
2	Allow a wake.	8/3/2015 6:27 AM
3	less weeds	8/1/2015 9:07 PM

Q6 What recreational activities do you partake in on Lake Alpine (check all that apply)?

Answered: 5 Skipped: 2



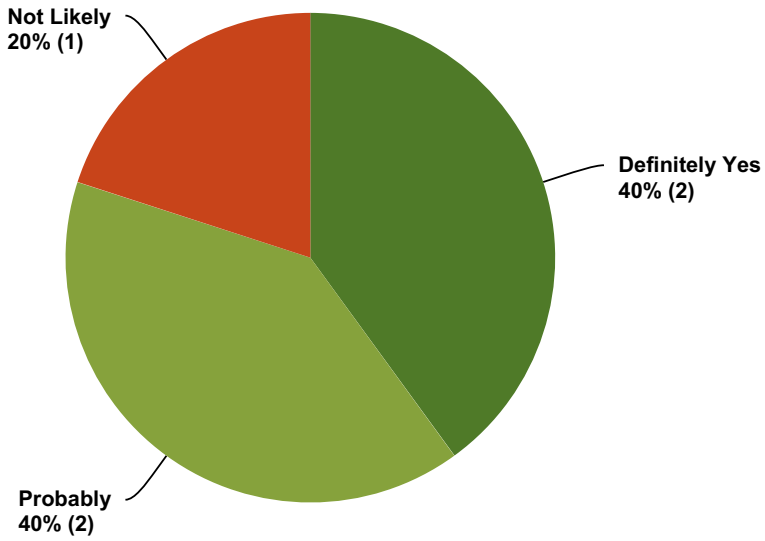


Answer Choices	Responses	
Enjoying scenery	**80%**	4
Fishing	**100%**	5
Walking	**40%**	2
Enjoying wildlife	**60%**	3
Solitude	**100%**	5
Swimming/snorkeling	**40%**	2
Canoeing/kayaking	**80%**	4
Biking	**20%**	1
Ice fishing	**60%**	3
Motor boating	**60%**	3
Hunting	**0%**	0
Picnicing	**0%**	0
Nature photography	**0%**	0
X-county skiing/snowshoeing	**20%**	1
Tubing/water skiing	**0%**	0
ATV riding	**0%**	0
Snowmobiling	**20%**	1
Camping	**0%**	0
Sailing	**20%**	1
Jet skiing	**0%**	0
Ice skating	**60%**	3
Total Respondents: 5		

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

Q7 Does a desire to provide better habitat for fish and wildlife motivate you to support (morally) efforts to improve Alpine Lake?

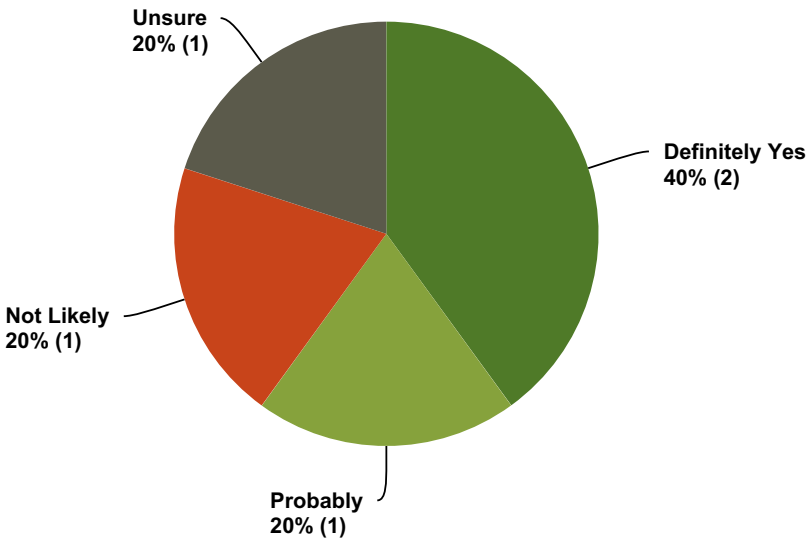
Answered: 5 Skipped: 2



Answer Choices	Responses	
Definitely Yes	40%	2
Probably	40%	2
Not Likely	20%	1
Definitely No	0%	0
Unsure	0%	0
Total		5

Q8 Does a desire to provide better habitat for fish and wildlife motivate you to support (by direct action) efforts to improve Alpine Lake?

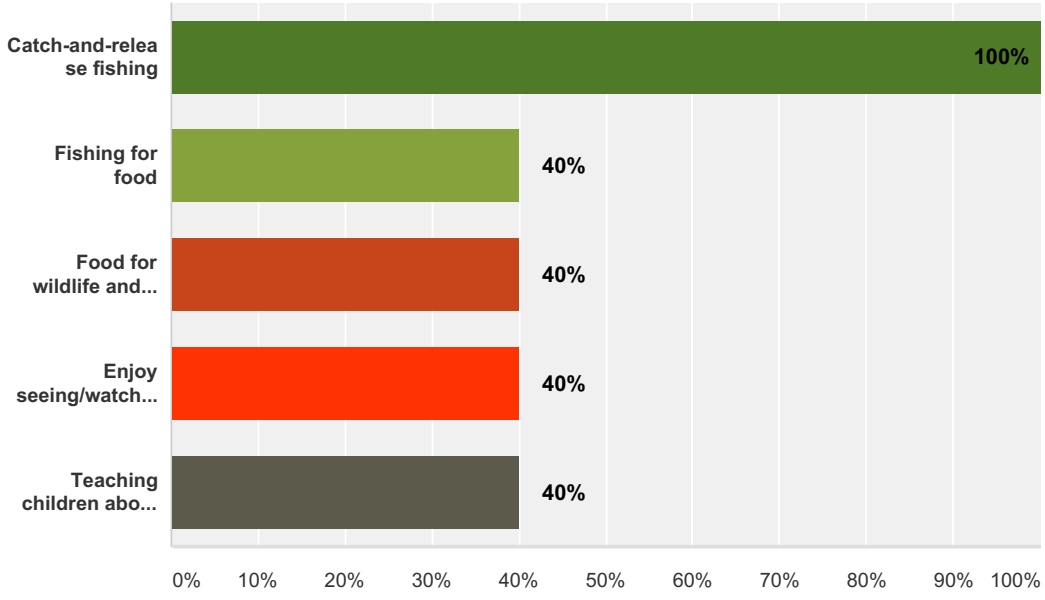
Answered: 5 Skipped: 2



Answer Choices	Responses	
Definitely Yes	40%	2
Probably	20%	1
Not Likely	20%	1
Definitely No	0%	0
Unsure	20%	1
Total		5

Q9 For what purposes do you value the fishery in Alpine Lake? (Check all that apply.)

Answered: 5 Skipped: 2

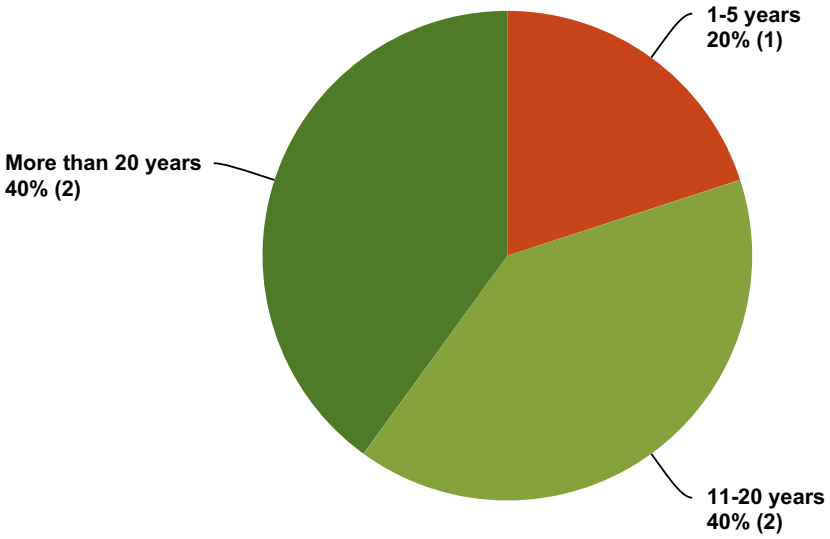


Answer Choices	Responses	
Catch-and-release fishing	100%	5
Fishing for food	40%	2
Food for wildlife and birds	40%	2
Enjoy seeing/watching fish	40%	2
Teaching children about fishing/lakes	40%	2
Total Respondents: 5		

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

Q10 How many years of fishing experience do you have on Alpine Lake? If you don't fish Alpine Lake, skip to Question 14.

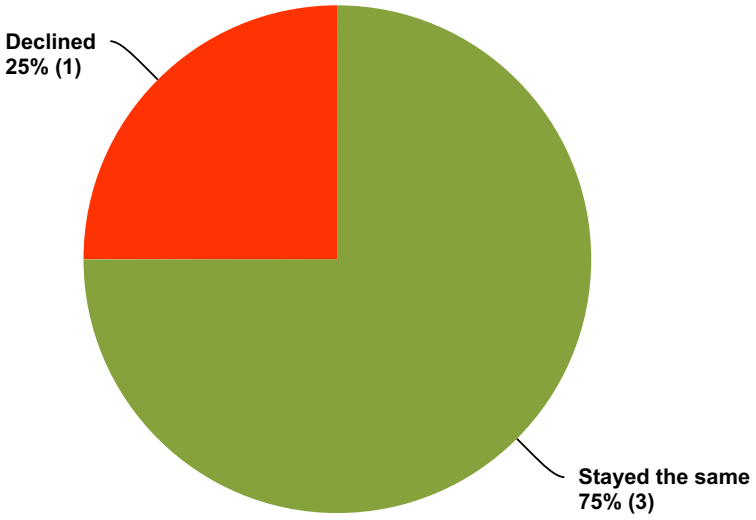
Answered: 5 Skipped: 2



Answer Choices	Responses	
I don't fish Alpine Lake	0%	0
1-5 years	20%	1
6-10 years	0%	0
11-20 years	40%	2
More than 20 years	40%	2
Total		**5**

Q11 In the years you have been fishing Alpine Lake, would you say the quality of fishing has... (If answering 'Stayed the same' or 'Not sure', skip to Question 9).

Answered: 4 Skipped: 3



Answer Choices	Responses	
Improved	0%	0
Stayed the same	75%	3
Declined	25%	1
Not sure	0%	0
Total		4

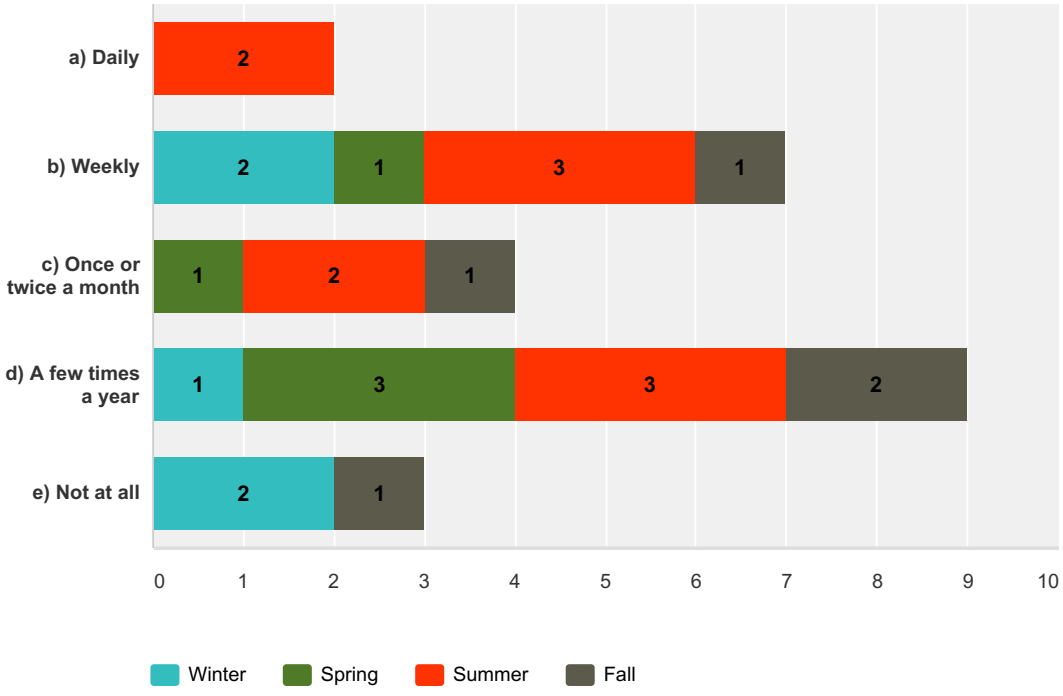
Q12 What factors do you feel have contributed to the change in fishing?

Answered: 1 Skipped: 6

#	Responses	Date
1	Too thick weed cover over too large area.	7/31/2015 4:25 PM

Q13 When and how often do you typically fish Alpine Lake?(Please answer a-e)

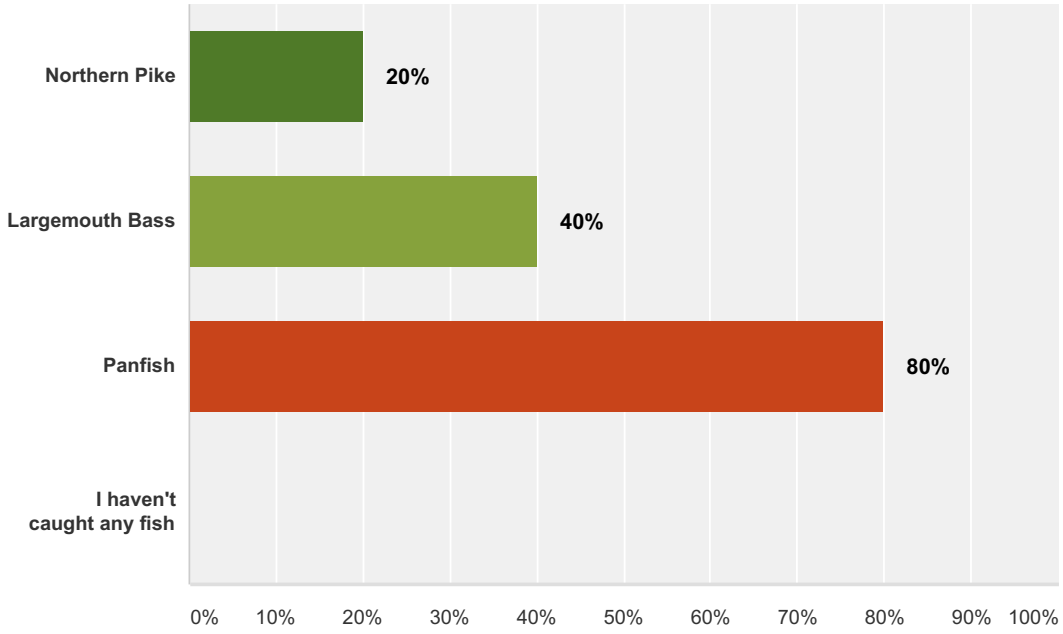
Answered: 5 Skipped: 2



	Winter	Spring	Summer	Fall	Total Respondents
a) Daily	0% 0	0% 0	100% 2	0% 0	2
b) Weekly	50% 2	25% 1	75% 3	25% 1	4
c) Once or twice a month	0% 0	50% 1	100% 2	50% 1	2
d) A few times a year	25% 1	75% 3	75% 3	50% 2	4
e) Not at all	67% 2	0% 0	0% 0	33% 1	3

Q14 What fish do you typically catch at Alpine Lake? Check all that apply.

Answered: 5 Skipped: 2

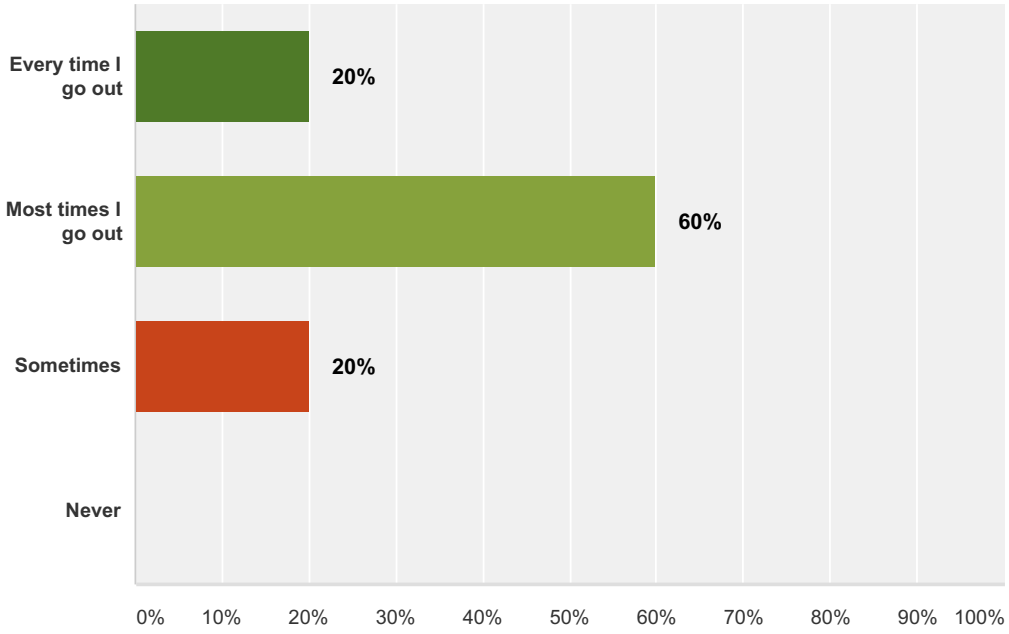


Answer Choices	Responses	
Northern Pike	20%	1
Largemouth Bass	40%	2
Panfish	80%	4
I haven't caught any fish	0%	0
Total Respondents: 5		

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

Q15 In general, how often do you catch fish on Alpine Lake?

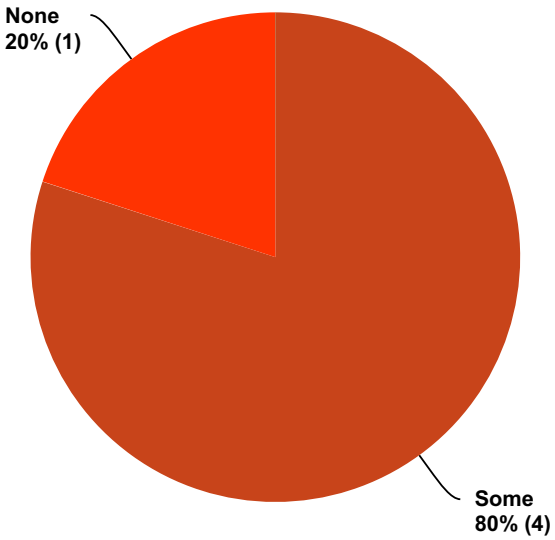
Answered: 5 Skipped: 2



Answer Choices	Responses	
Every time I go out	20%	1
Most times I go out	60%	3
Sometimes	20%	1
Never	0%	0
Total Respondents: 5		

Q16 In general, how many of the fish you catch are big enough to keep?

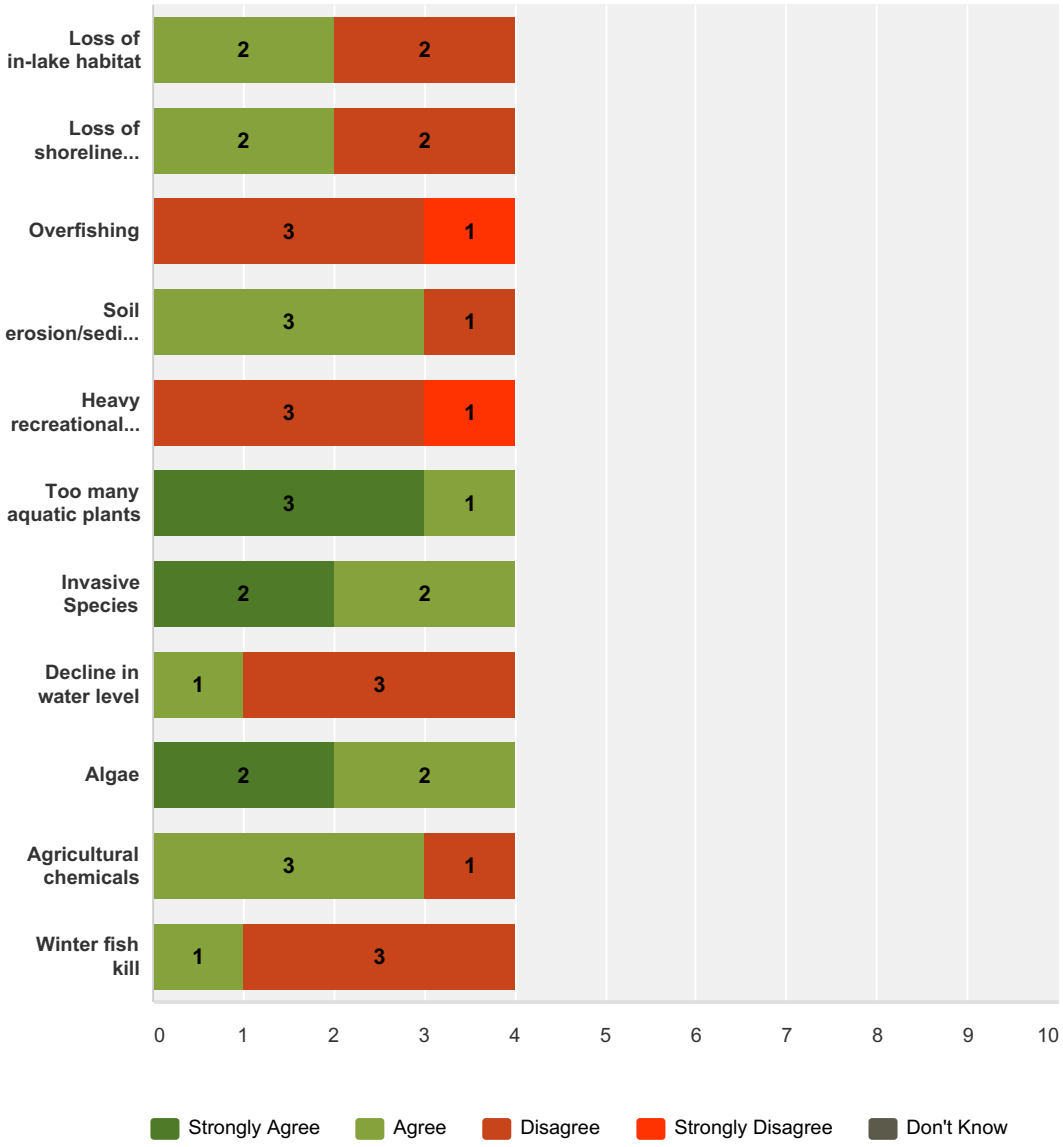
Answered: 5 Skipped: 2



Answer Choices	Responses	
All	0%	0
Most	0%	0
Some	80%	4
None	20%	1
Total		5

Q17 What do you believe is the greatest threat to the fishery in Alpine Lake in the next 10 years?

Answered: 4 Skipped: 3



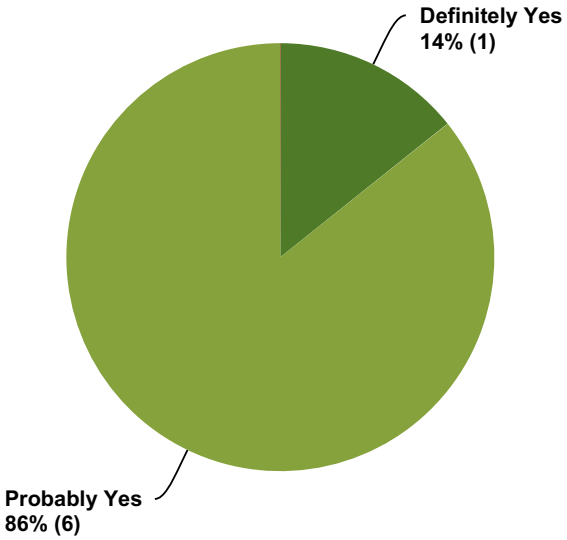
	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know	Total Respondents
Loss of in-lake habitat	0% 0	50% 2	50% 2	0% 0	0% 0	4
Loss of shoreline habitat	0% 0	50% 2	50% 2	0% 0	0% 0	4
Overfishing	0% 0	0% 0	75% 3	25% 1	0% 0	4
Soil erosion/sedimentation	0% 0	75% 3	25% 1	0% 0	0% 0	4

Heavy recreational use	**0%** 0	**0%** 0	**75%** 3	**25%** 1	**0%** 0	4
Too many aquatic plants	**75%** 3	**25%** 1	**0%** 0	**0%** 0	**0%** 0	4
Invasive Species	**50%** 2	**50%** 2	**0%** 0	**0%** 0	**0%** 0	4
Decline in water level	**0%** 0	**25%** 1	**75%** 3	**0%** 0	**0%** 0	4
Algae	**50%** 2	**50%** 2	**0%** 0	**0%** 0	**0%** 0	4
Agricultural chemicals	**0%** 0	**75%** 3	**25%** 1	**0%** 0	**0%** 0	4
Winter fish kill	**0%** 0	**25%** 1	**75%** 3	**0%** 0	**0%** 0	4

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

Q18 Do you believe fish from Alpine Lake are safe to eat?

Answered: 7 Skipped: 0



Answer Choices	Responses	
Definitely Yes	14%	1
Probably Yes	86%	6
Probably No	0%	0
Definitely No	0%	0
Unsure	0%	0
Total		7

Q19 Do you have any additional comments regarding the fishery in Alpine Lake?

Answered: 0 Skipped: 7

#	Responses	Date
	There are no responses.	

Waushara County Lakes Study

Alpine Lake

Spring 2014

University of Wisconsin-Stevens Point

University of Wisconsin
Stevens Point

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ALPINE 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 Alpine Lake between fall 2010 and fall 2012.

ABOUT ALPINE 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. Alpine Lake is located in the township of Marion, east of Wautoma and north of Highway 21. There is one public boat launch located on the lake's eastern side. Alpine Lake is a 56 acre impoundment of Bruce Creek. It receives most of its water from the creek, and to lesser extents, from surface and groundwater. The maximum depth in Alpine Lake is 18 feet. Alpine Lake has an irregular shape and its lakebed has a slope that varies from gentle to steep on the eastern side (Figure 1). Its bottom sediments are mostly muck with some rock and sand along the southeastern side.

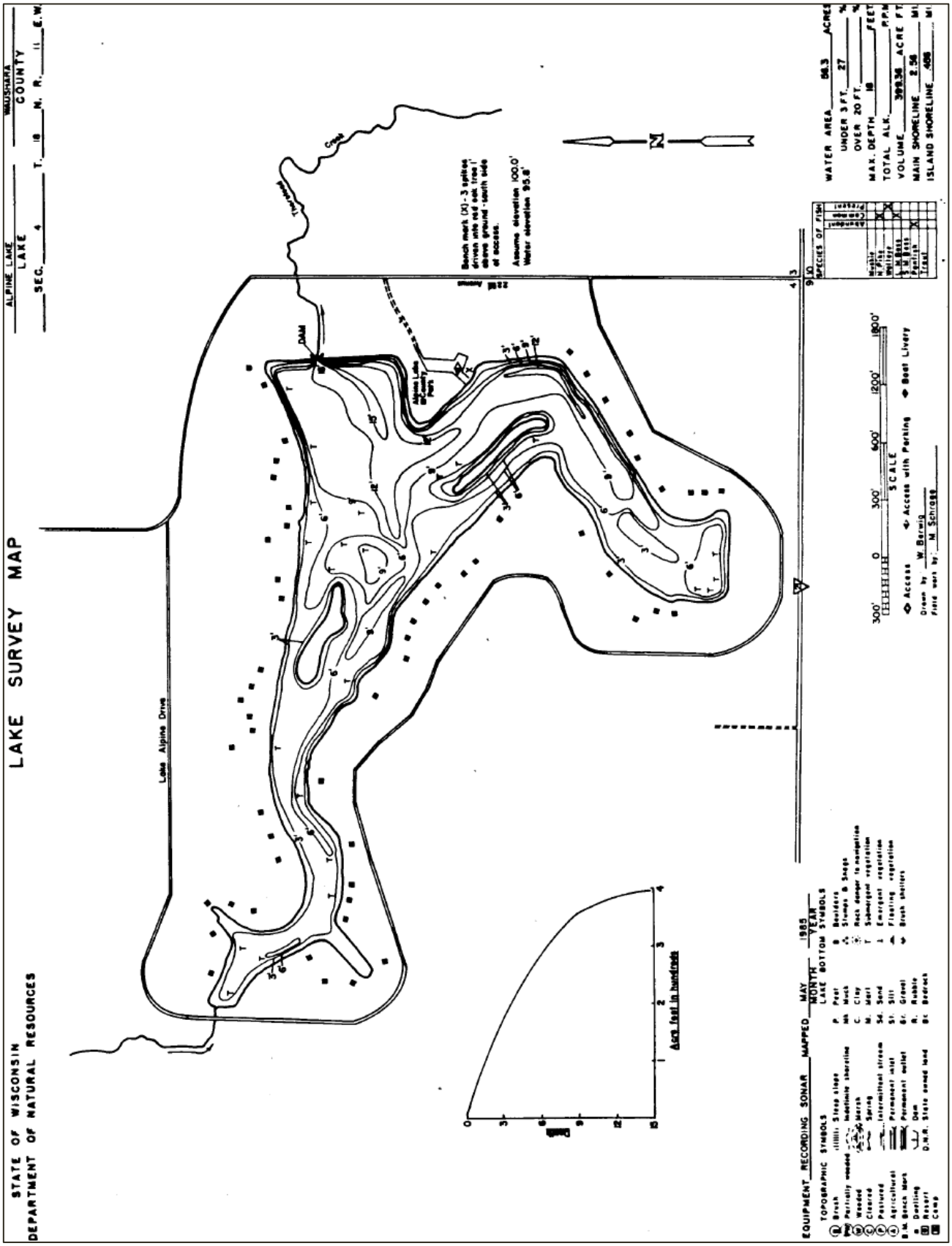


FIGURE 1. CONTOUR MAP OF THE ALPINE LAKE LAKEBED.

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

The water quality in Alpine 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 Alpine 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 Alpine Lake is called a surface watershed. Groundwater also feeds Alpine 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 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 use 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 and pesticides used on lawns, gardens and crops can contribute nutrients that enhance the growth of algae and aquatic plants, and affect animals that live in or near our lakes.

A variety of land management practices can be put in place to help reduce impacts to Alpine Lake. 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 and pesticides, 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.

ALPINE LAKE SURFACE WATERSHED

The surface watershed for Alpine Lake is approximately 10,063 acres (Figure 2). The dominant types of land use in the watershed are forests (43%), developed land (24%) and agriculture (20%). The land closest to the lake often has the greatest impact on water quality and habitat; Alpine Lake's shoreland is surrounded primarily by development and forests.

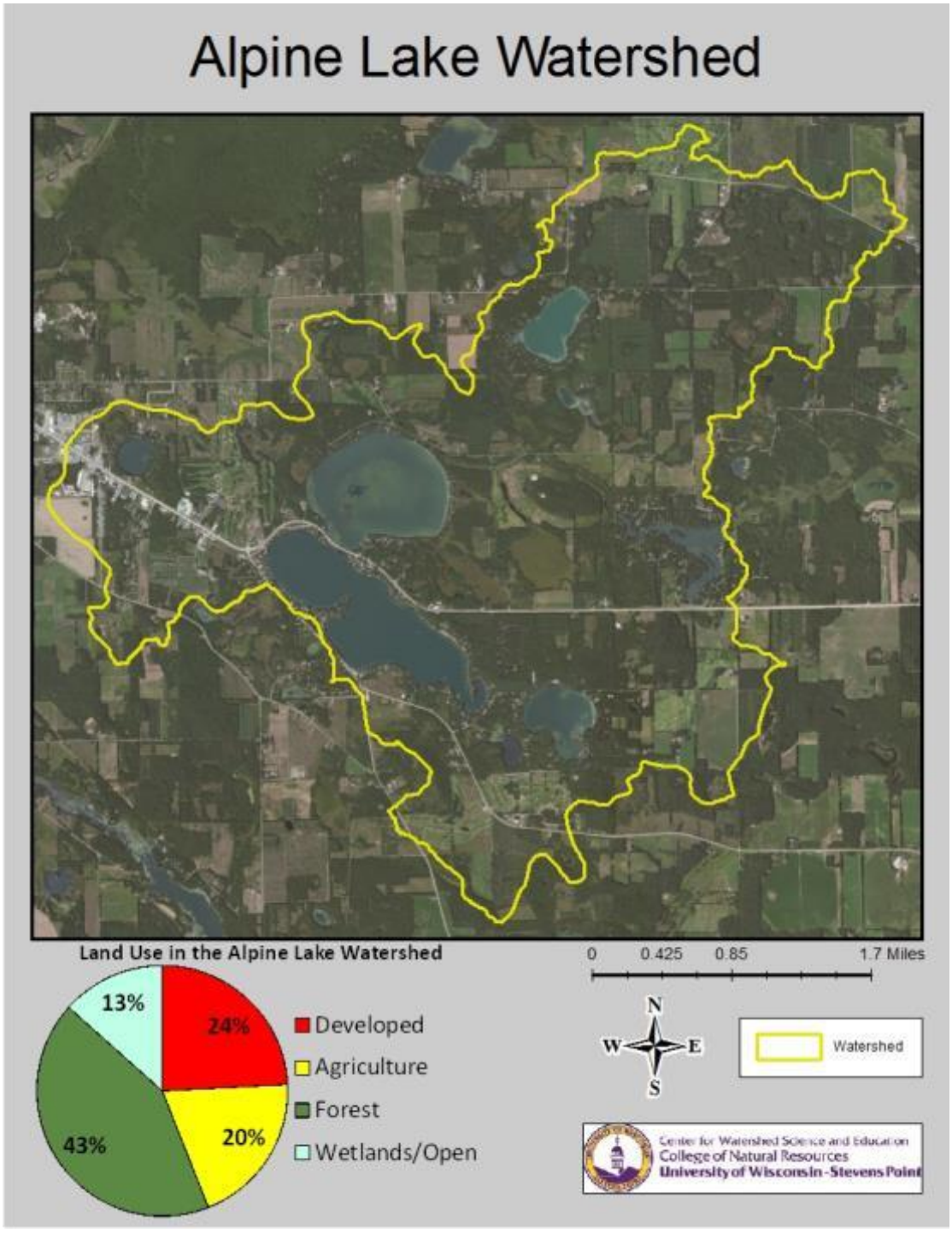


FIGURE 2. LAND USE IN THE ALPINE LAKE SURFACE WATERSHED.

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, so groundwater feeding Alpine Lake will help keep the lake water cooler during the summer and may keep ice from forming on parts of the lake during the winter.

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 Alpine Lake from the northwest.

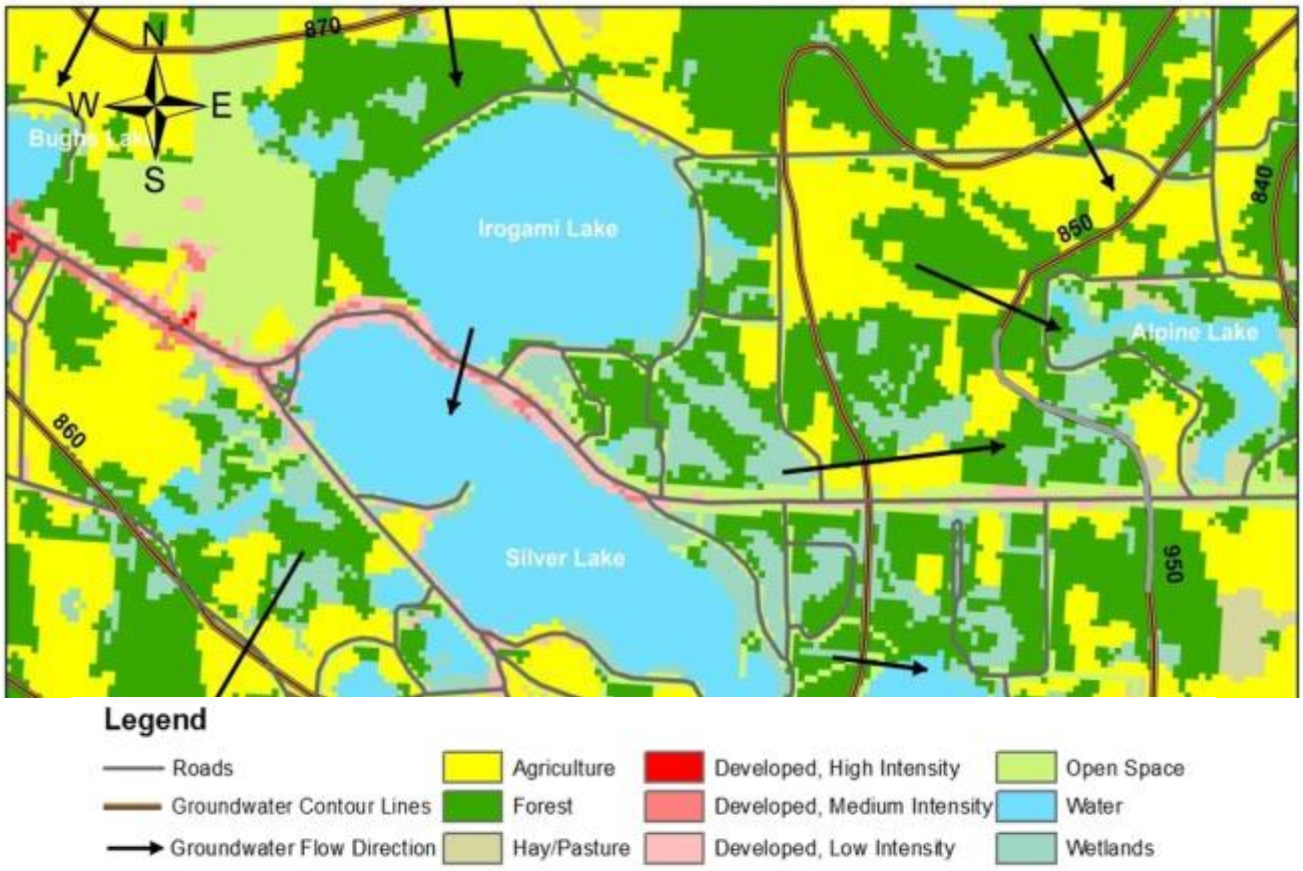
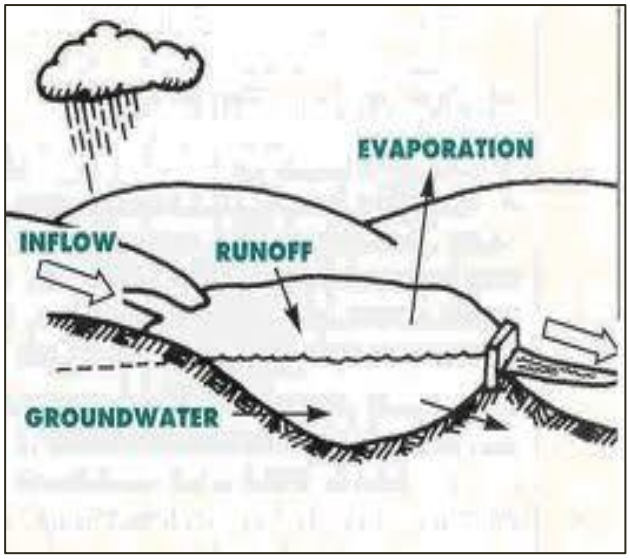


FIGURE 3. GROUNDWATER FLOW DIRECTION NEAR ALPINE LAKE.

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 Alpine Lake was assessed by measuring different characteristics including temperature, dissolved oxygen, water clarity, water chemistry, and algae.

Water enters Alpine Lake from Bruce Creek and via runoff, precipitation and groundwater. Alpine Lake is an impoundment, or manmade lake, created by a dam on Bruce Creek (Figure 4). The lake receives a fair amount of sediment and nutrients which can affect water quality. While the water remains in this type of lake for a relatively short period of time, the sediments and nutrients that are carried into the lake will build up over time and provide ideal growing conditions for aquatic plants and algae.



The geology that lies beneath a lake has the ability to influence the temperature, pH, minerals and other properties in the lake. As groundwater moves, some substances are filtered out, while other materials in the soil dissolve into the groundwater (Shaw et al., 2000). Minerals such as calcium and magnesium dissolve, making the water hard. The average hardness concentration for Alpine Lake during the study was 173 mg/L, which is considered hard (Table 1). Hard water provides calcium necessary for building bones and shells for animals in the lake. The average alkalinity was 156 mg/L. Higher alkalinity in inland lakes can support higher species productivity. Hardness and alkalinity also play roles in determining which types of aquatic plants might be found in a lake (Wetzel, 2001).

FIGURE 4. CARTOON SHOWING INFLOW AND OUTFLOW OF WATER IN AN IMPOUNDMENT LAKE.

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

Alpine Lake	Alkalinity (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Hardness (mg/L as $CaCO_3$)	Color (SU)	Turbidity (NTU)
Average	156	32	21	173	19	1.9

Chloride concentrations, and to a lesser degree 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. Average concentrations of potassium, chloride and sodium in Alpine Lake were elevated (Table 2). These concentrations are not harmful to aquatic organisms, but indicated that land management practices were influencing the water quality in Alpine Lake. Common sources of potassium, chloride and sodium include animal waste, septic systems

and road-salting chemicals. Atrazine (DACT), an herbicide commonly used on corn, was below the detection limit (<0.01 ug/L) in the samples that were analyzed from Alpine Lake.

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

Alpine Lake	Average Value			Reference Value		
	Low	Medium	High	Low	Medium	High
Potassium (mg/L)		1.0		<.75	0.75-1.5	>1.5
Chloride (mg/L)		7.6		<3	3.0-10.0	>10
Sodium (mg/L)			4.3	<2	2.0-4.0	>4

Dissolved oxygen is an important measure in aquatic ecosystems because a majority of animals in the water depend on oxygen to survive. Oxygen is dissolved into the water from contact with the atmosphere, which can be 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 can reduce oxygen in the lake. Some forms of iron and other metals can also consume oxygen.

In a lake, the water temperature changes throughout the year and may vary with depth. Dissolved oxygen concentrations below 5 mg/L can stress some species of fish and other aquatic organisms. Water temperature and dissolved oxygen were measured in Alpine Lake from the lake surface to the lake bottom at the time of sample collection. During most of the year, temperatures in Alpine Lake were similar top to bottom (Figure 5). Dissolved oxygen in Alpine Lake was more variable than temperature (Figure 6). In spring and fall, dissolved oxygen was fairly uniform from top to bottom. During the summer, dissolved oxygen concentrations increased in depths of 6-10 feet, likely due to algal blooms, and generally decreased at about 12 feet. In February 2011, only the upper six feet of water had dissolved oxygen concentrations above 5 mg/L.

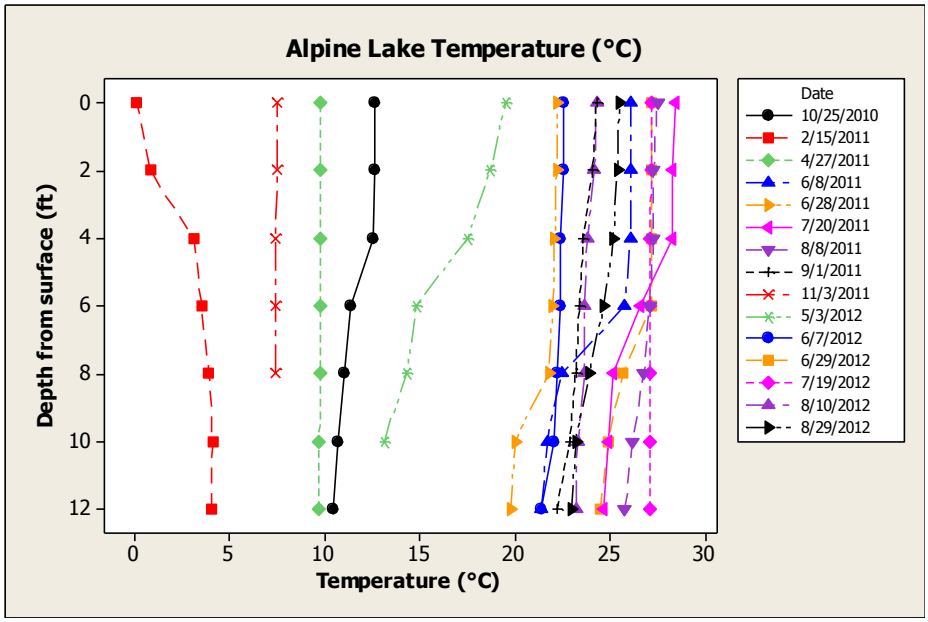


FIGURE 5. TEMPERATURE PROFILES IN ALPINE LAKE, 2010-2012.

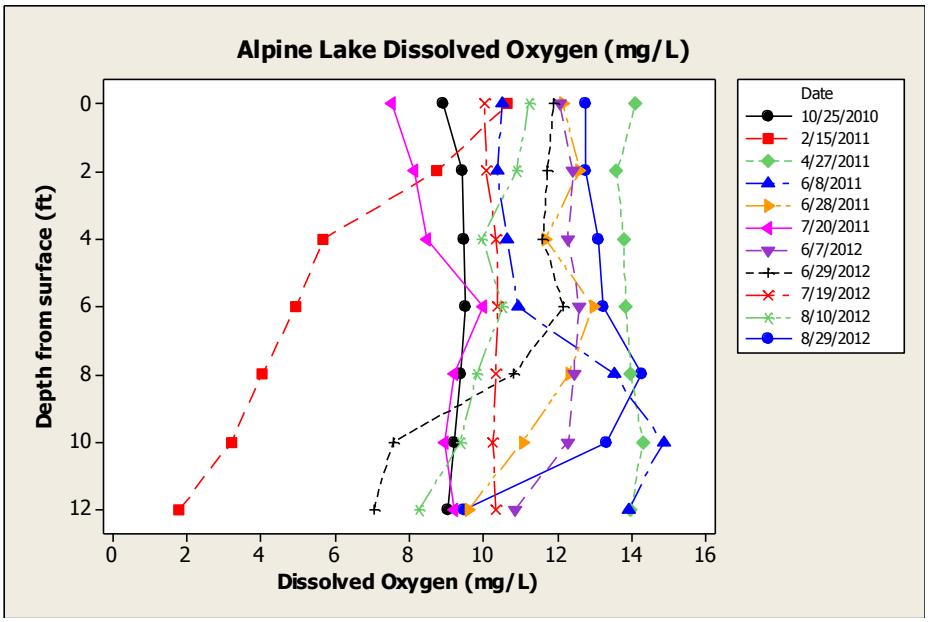
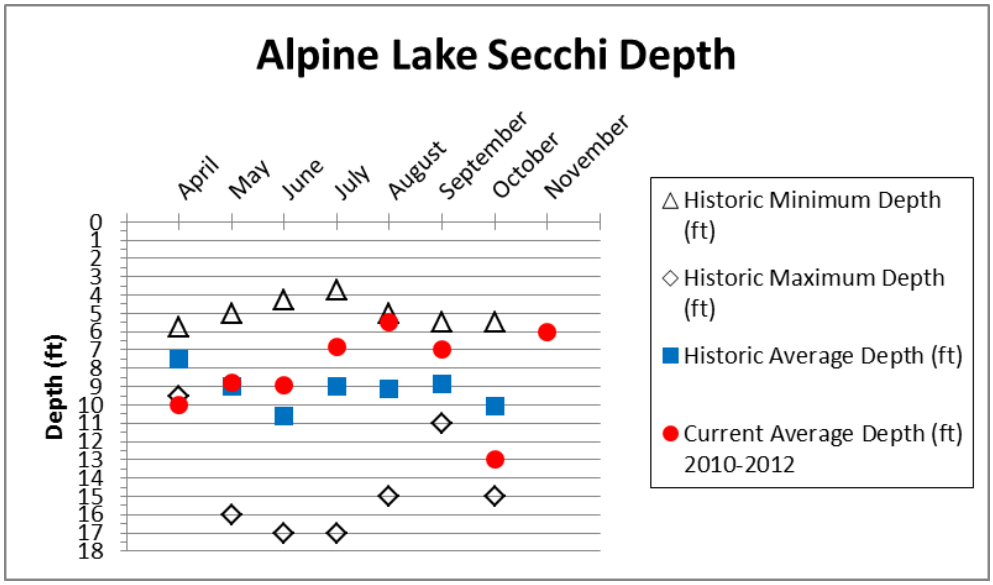


FIGURE 6. DISSOLVED OXYGEN PROFILES IN ALPINE LAKE, 2010-2012.

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 Alpine Lake, color was relatively low (Table 1), indicating that the variability in transparency throughout the year is primarily due to fluctuating algae concentrations and re-suspended sediment following storms and/or heavy boating.

The water clarity measured in Alpine Lake during the study was considered fair, ranging from 5.5 feet to 13 feet (Figure 7). Alpine Lake has a robust water clarity dataset that dates back to 1986. When compared with historic data, the average water clarity measured during the study was better in April and October, similar in May, and was much poorer during the growing season months of June, July, August and September. The perception of the citizen who is monitoring Alpine Lake is that algal blooms impair the usability of the water for part of the summer.



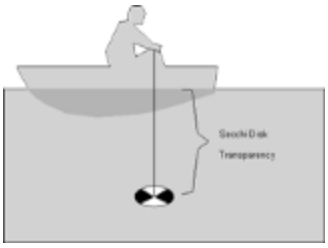


FIGURE 7. WATER CLARITY IN ALPINE LAKE, 2010-2012 AND HISTORIC.

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 in Alpine Lake ranged from 9 ug/L in February 2011 to 37 ug/L in May 2012. The summer median total phosphorus concentration was 21 and 24 ug/L in 2011 and 2012, respectively. These median concentrations are below Wisconsin's phosphorus standard of 40 ug/L for shallow impoundments; however, the maximum concentration measured was just below the standard. During the study, inorganic nitrogen concentrations were elevated (Table 3) and were high enough at spring turnover to enhance algal blooms throughout the summer (Shaw et al., 2004).

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

Alpine Lake	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	0.10	0.10	0.10	0.43	0.43	0.43	0.54	0.54	0.54	1	1	1	14	14	14
Spring	0.20	0.38	0.55	0.43	0.43	0.43	1.01	1.01	1.01	3	4	4	11	25	37
Summer													15	22	33
Winter	0.70	0.87	1.04	0.42	0.42	0.42	1.72	1.72	1.72	4	13	21	9	13	16

Chlorophyll *a* is a measurement of algae in the water. In Alpine Lake, chlorophyll *a* concentrations varied throughout the monitoring period, from a high of 8.4 ug/L in June 2012 to a low of 0.5 ug/L in June 2011. This variation was consistent with the variation observed in water clarity. Data collected from 1995 to 2014 by citizens participating in the Wisconsin Department of Natural Resources citizen lake monitoring program were examined for relationships between water clarity, chlorophyll *a*, and total phosphorus. In Alpine Lake, a relationship exists between water clarity and chlorophyll *a*; poorer water clarity was observed when elevated concentrations of chlorophyll *a* were present (Figure 8). A relationship between total phosphorus and chlorophyll *a* also exists in Alpine Lake; higher concentrations of chlorophyll *a* were associated with higher total phosphorus concentrations (Figure 9).

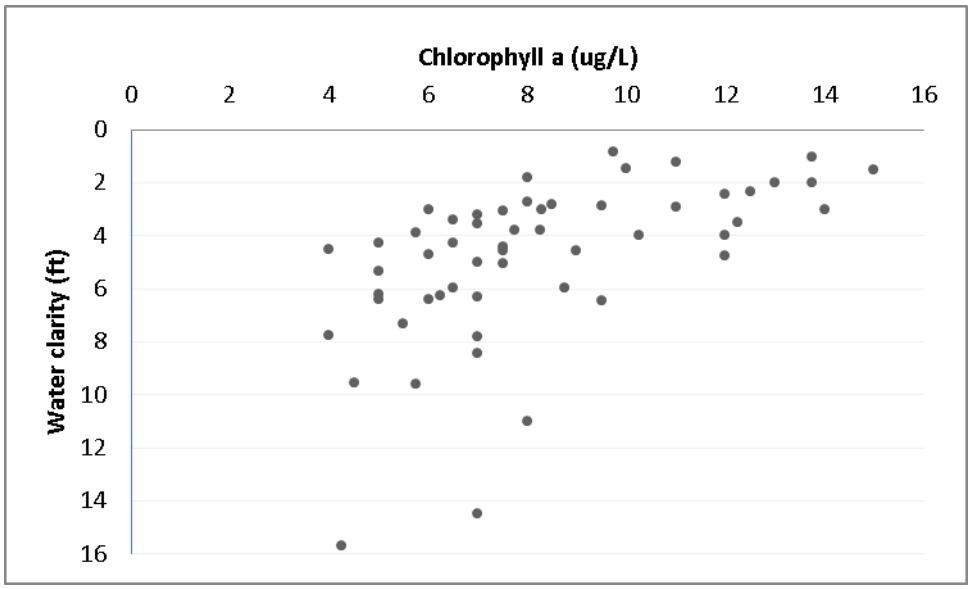


FIGURE 8. WATER CLARITY DEPTHS AND CORRESPONDING CHLOROPHYLL *A* CONCENTRATIONS IN ALPINE LAKE, 1995-2014 (CITIZEN MONITORING DATA, WISCONSIN DEPARTMENT OF NATURAL RESOURCES).

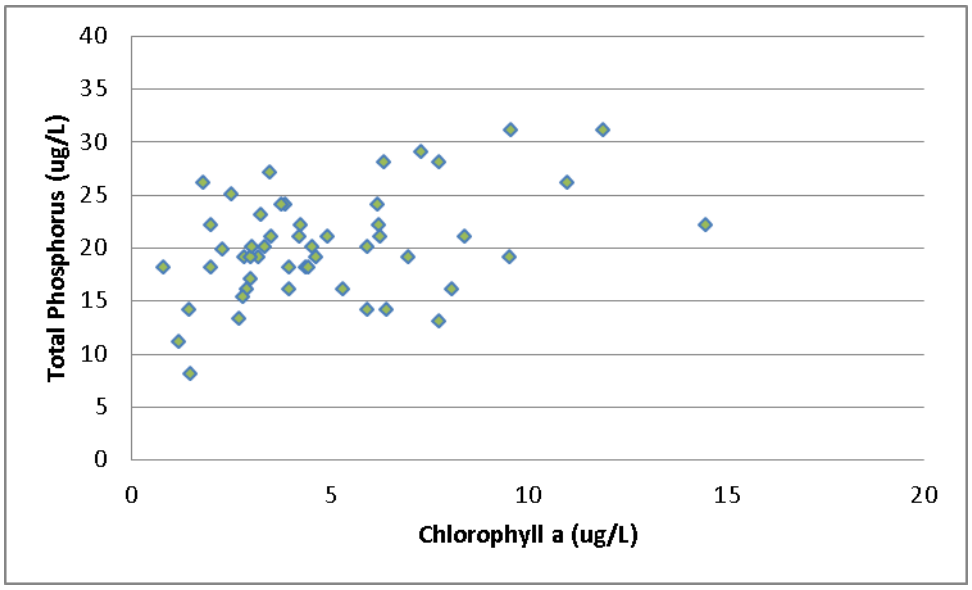


FIGURE 9. TOTAL PHOSPHORUS AND CORRESPONDING CHLOROPHYLL *A* CONCENTRATIONS IN ALPINE LAKE, 1995-2014 (CITIZEN MONITORING DATA, WISCONSIN DEPARTMENT OF NATURAL RESOURCES).

Estimates of phosphorus from the landscape can be help to understand the phosphorus sources to Alpine 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 differing amounts of phosphorus in runoff and through groundwater. The types of land management practices that are used and their distances from the lake or inflowing stream also affect the contributions to the lake from a parcel of land. Based on modeling results, agriculture and developed land had the greatest percentages of phosphorus contributions from the watershed to Alpine Lake (Figure 10). 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).

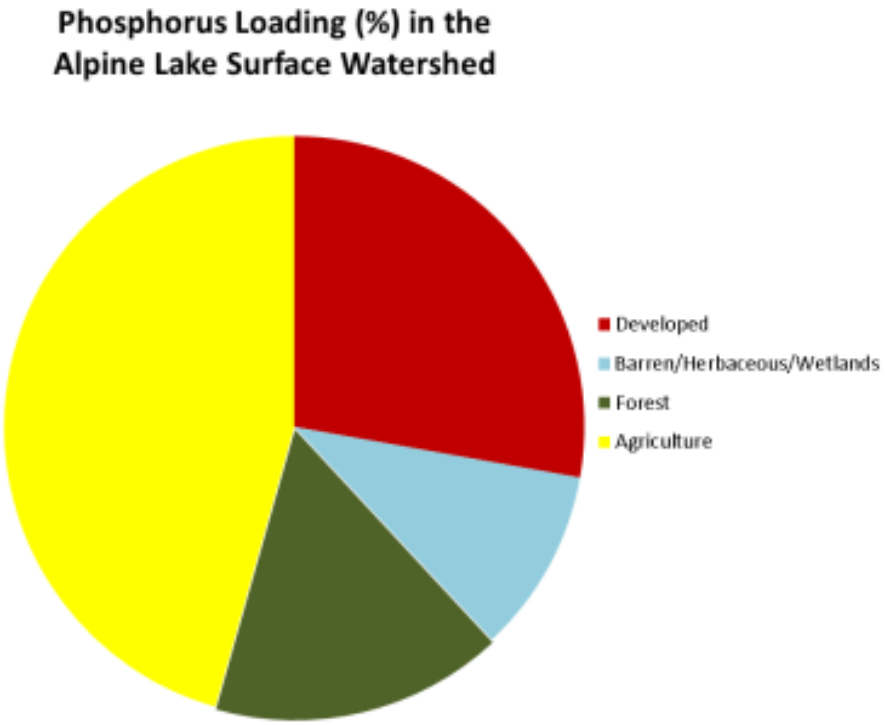


FIGURE 10. ESTIMATED PHOSPHORUS LOADS FROM LAND USES IN THE ALPINE LAKE WATERSHED.

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

Alpine Lake Watershed Land Use	Phosphorus Export Coefficient (lbs/acre-yr)	Land Use Area Within the Watershed		Estimated Phosphorus Load	
		Acres	Percent	Pounds	Percent
Water	0.10	822	**8**	5-15	**<1**
Developed	0.13	2235	**22**	299-996	**28**
Barren/Herbaceous/Wetland	0.09	1239	**12**	111-331	**10**
Forest	0.04	3934	**39**	176-315	**16**
Cultivated Agriculture	0.45	1834	**18**	491-1310	**46**
*Values are not exact due to rounding and conversion.					

Aquatic plants are the forested landscape within a lake. They provide food and habitat for a wide range of species, including fish, waterfowl, turtles, 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 which creates diversity that makes the aquatic plant community more resilient and can help to prevent the establishment of non-native aquatic species.

During the 2011 aquatic plant survey of Alpine Lake, fourteen species of aquatic plants were found (Table 5), with the greatest diversity located in the southern end of the lake (Figure 11). This number is low compared with other lakes in the Waushara County Lakes Study. Ninety-nine percent (237) of 240 sampled sites had vegetative growth. Of the sampled sites within Alpine Lake, the average depth was 7.3 feet and the maximum depth with vegetation was 19 feet.

TABLE 5. LIST OF AQUATIC PLANTS IDENTIFIED IN THE 2011 AQUATIC PLANT SURVEY AND 2012 CLP SURVEYOF ALPINE LAKE.

Scientific Name	Common Name	Coefficient of Conservatism Value
Emergent Species		
Typha augustifolia	narrow-leaved cattail	1
Floating Leaf Species		
Nymphaea odorata	white water lily	6
Submergent Species		
Ceratophyllum demersum	coontail	3
Chara spp.	muskgrass	7
Elodea canadensis	common waterweed	3
Heteranthia dubia	water star-grass	6
Myriophyllum spicatum	hybrid Eurasian water-milfoil	0
Najas flexilis	slender naiad	6
Potamogeton crispus (2012 survey)	curly-leaf pondweed	0
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton zosteriformis	flat-stem pondweed	6
Stuckenia pectinata	sago pondweed	3
Utricularia gibba	creeping bladderwort	9
Utricularia vulgaris	common bladderwort	7
Vallisneria americana	wild celery	6

The dominant plant species in the survey was wild celery (*Vallisneria americana.*), followed by common waterweed (*Elodea canadensis*) and muskgrass (*Chara* spp.). Wild celery is a premiere source of food for waterfowl, marsh birds and shore birds, and beds of this submersed plant also provide shade, shelter and feeding habitat for fish. Common waterweed offers shelter to fish and also provides food to waterfowl. Muskgrass is a favorite food source for a wide variety of waterfowl, and muskgrass beds offer cover and food to fish, especially young trout, largemouth bass, and smallmouth bass (Borman et al., 2001).

The Floristic Quality Index (FQI) evaluates the closeness of a plant community to undisturbed conditions. Each plant is assigned a coefficient of conservatism (C value) that reflects its sensitivity to disturbance. These numbers are used to calculate the FQI. C values range from 0 to 10. The higher the number, the more intolerant the plant is of disturbance. A C value of zero is assigned to exotic and most nonvascular species. The C values in Alpine Lake ranged from 1 to 9, with an average C value of 5.3 (Table 5). One high quality plant was observed in Alpine Lake: creeping bladderwort (*Utricularia gibba*), a carnivorous aquatic plant species with a C value of 9. The FQI for a lake is calculated using the C values. In 2011, the FQI for Alpine Lake was 19.1. This is below average compared with other lakes in the Waushara County Lakes Study.

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 zero to one. Values closer to one represent higher amounts of biodiversity. Alpine Lake had an SDI value of 0.86. This represents above average biodiversity when compared to all of the lakes in the Waushara County Lakes Study.

A special survey of Alpine Lake for curly-leaf pondweed (CLP) was conducted in June 2012. The life cycle of CLP can impact a lake's ecosystem. CLP grows under the ice during late winter/early spring, begins growing in spring before native plants, and dies back in late June/early July, releasing phosphorus at a time when the water is warm and new plants and algae are growing. The phosphorus released from the CLP can help fuel algal blooms and excessive plant growth. During the 2012 CLP survey, CLP was found in numerous patches, some of which were relatively dense (Figure 12).

Hybrid Eurasian water-milfoil was found in Alpine Lake during the 2011 aquatic plant survey; however, the lake was treated for Eurasian water-milfoil just before the 2011 survey was conducted, likely impacting its distribution and density throughout the lake (Figure 13).

Overall, the aquatic plant community in Alpine Lake can be characterized as healthy and having above average biodiversity when compared to other lakes in the Waushara County Lakes Study. The presence of curly-leaf pondweed and Eurasian water-milfoil within the lake is cause for concern and their populations and densities should continue to be monitored. The habitat, food source, and water quality offered by the plant community within Alpine Lake should be focal points of future lake management strategies.

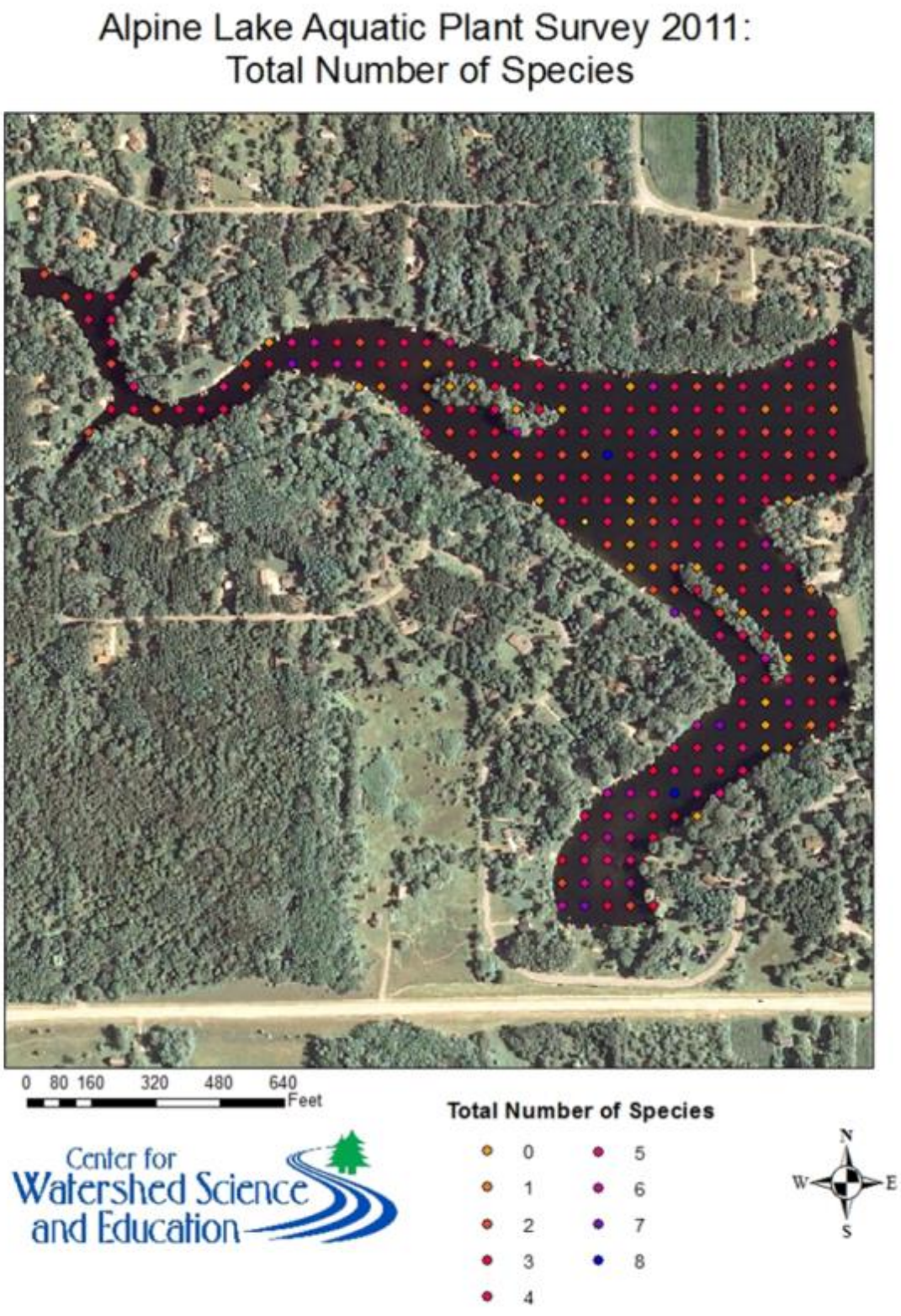


FIGURE 11. NUMBER OF AQUATIC PLANT SPECIES AT EACH SAMPLE SITE IN ALPINE LAKE, 2011.

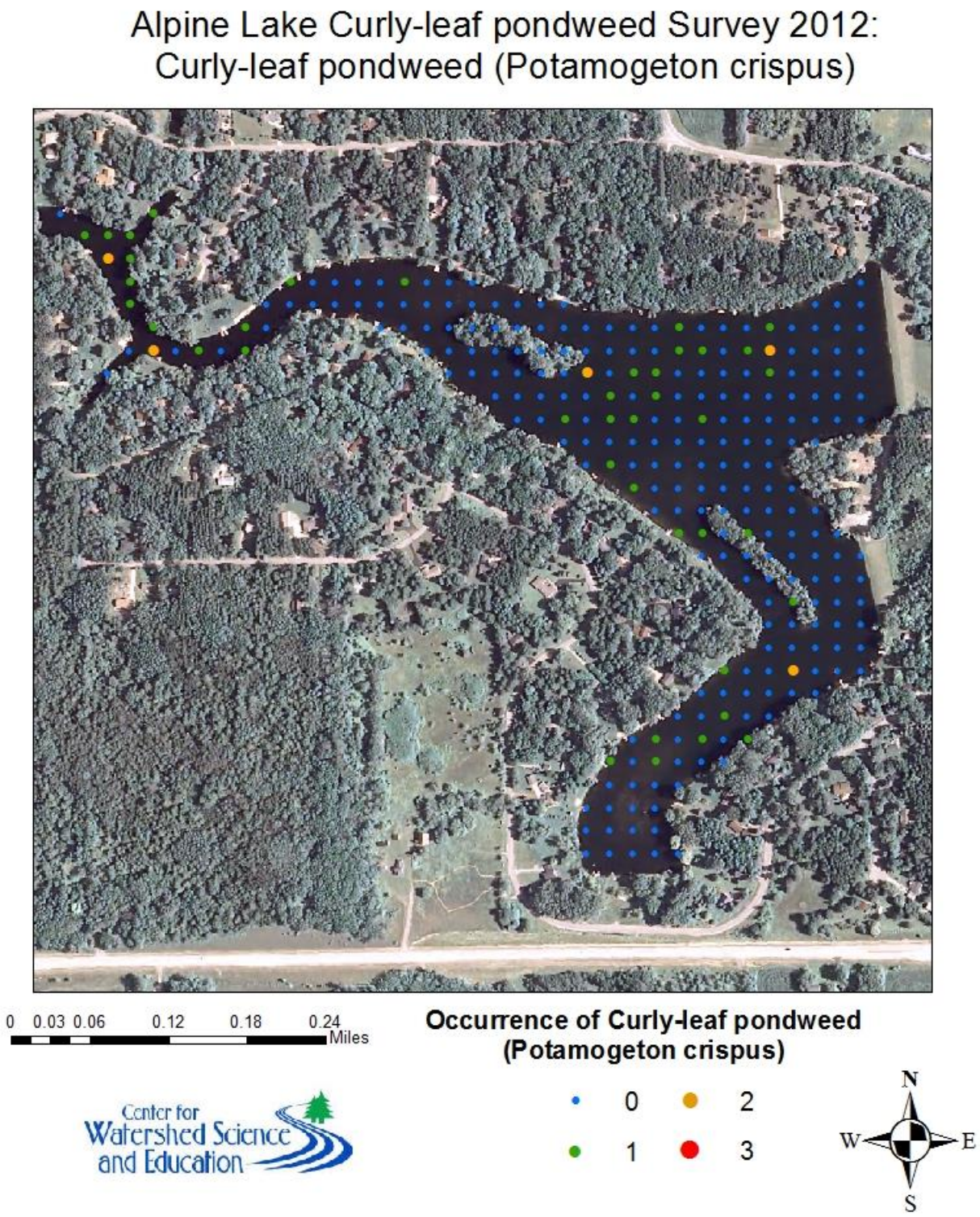


FIGURE 12. LOCATION AND DENSITY OF CURLY-LEAF PONDWEED AT EACH SAMPLE SITE IN ALPINE LAKE, JUNE 2012.

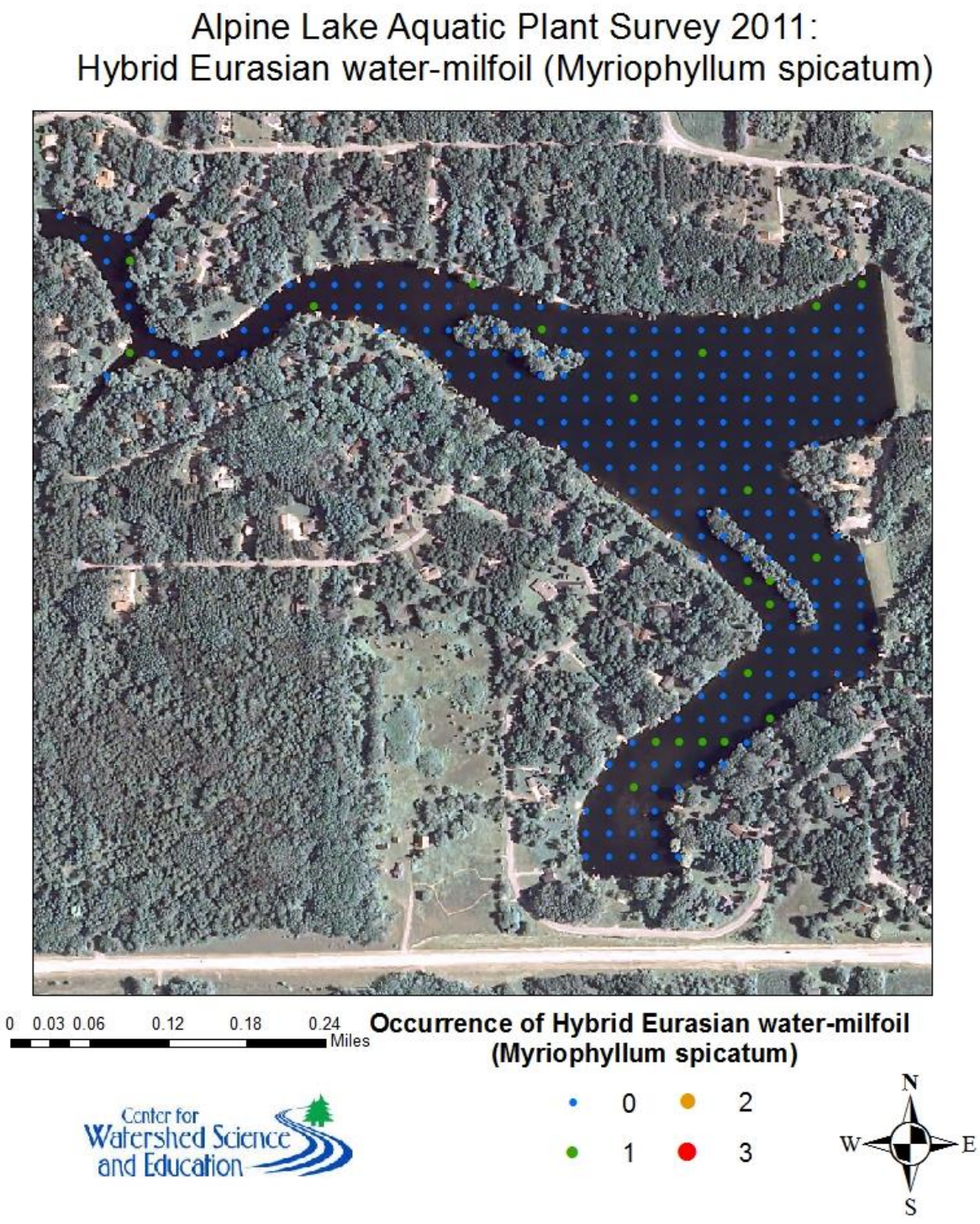


FIGURE 13. LOCATION AND DENSITY OF EURASIAN WATER-MILFOIL AT EACH SAMPLE SITE IN ALPINE LAKE, JULY, 2011.

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 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, seawalls, 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. Higher scores denote healthier shorelines with good land management practices. These are areas where protection and/or conservation should be targeted. On the other hand, lower scores signify ecologically unhealthy shorelines. These are areas where management and/or mitigation practices may be desirable for improving water quality.

The summary of scores for shorelands around Alpine Lake is displayed in Figure 14. 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 stretches of Alpine Lake's shorelands are in good shape, but some portions have challenges that should be addressed. There were no stretches of Alpine Lake shoreland ranked as poor. 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 ALPINE LAKE, 2011.

Disturbance	Length of Shoreline	
	Feet	Percent
Artificial beach	8487	52
Barren, bare dirt	0	0
Boat landing	446	3
Dock/pier at water	11804	72
Gully erosion	0	0
Undercut banks erosion	0	0
Mowed lawn	9590	59
Rip-rap	4637	28
Seawall	1464	9

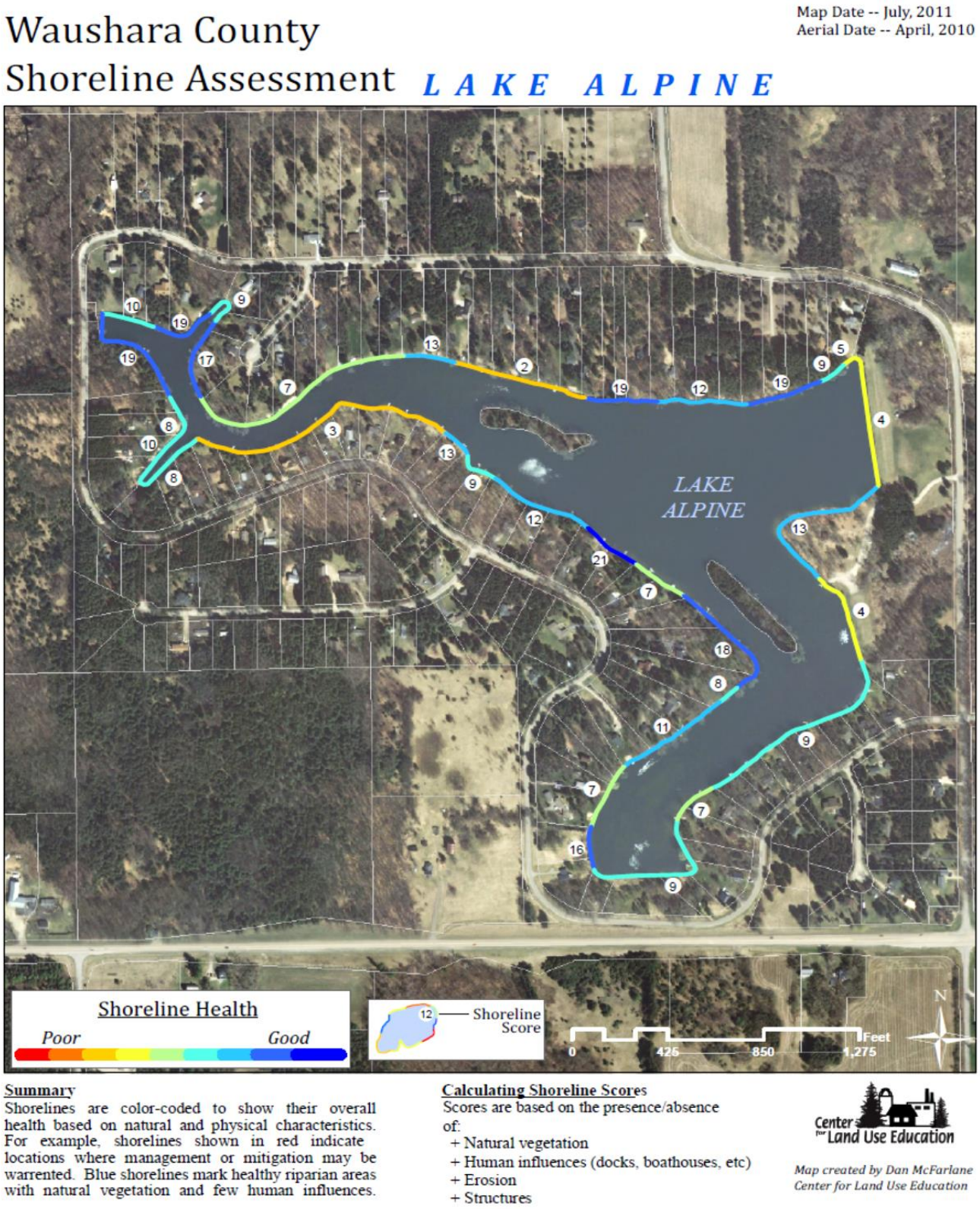


FIGURE 14. OVERALL SHORELAND HEALTH AROUND ALPINE LAKE.

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 water clarity measured in Alpine Lake during the study was considered fair. Alpine Lake has a robust water clarity dataset that dates back to 1986. When compared with historic data, the average water clarity measured during the study was better in April and October, similar in May, and was much poorer during the growing season months of June, July, August and September. The perception of the citizen who is monitoring Alpine Lake is that algal blooms impair the usability of the water during part of the summer.
- The citizen monitoring dataset that ranged from 1995-2014 was evaluated for relationships between water clarity, chlorophyll *a* (a measure of algae), and total phosphorus. In general, as chlorophyll *a* increased, water clarity decreased. Chlorophyll *a* increases were also associated with increases in total phosphorus. Therefore, to reduce algal blooms in Alpine Lake, efforts should be made to reduce the phosphorus being delivered to the lake from the watershed.
- During the study, total phosphorus concentrations for Alpine Lake ranged from 9 ug/L in February 2011 to 37 ug/L in May 2012. The summer median total phosphorus concentration was 21 ug/L and 24 ug/L in 2011 and 2012, respectively. These median concentrations are below Wisconsin's phosphorus standard for shallow impoundments of 40 ug/L; however, the maximum concentration measured was just below the standard.
- Identifying and taking steps to maintain or improve water quality in Alpine Lake depends upon understanding the sources of nutrients to the lake and identifying those that are manageable. Although forests and developed land comprise the greatest percentage of land in the Alpine Lake watershed, modeling results indicated that agriculture and developed land had the greatest percentages of phosphorus contributions from the watershed to Alpine Lake.
- Alpine Lake had elevated nitrate (NO2+NO3-N) concentrations. Sources of nitrate include fertilizers, septic systems, and animal waste. The nitrate is likely moving to the lake in groundwater.
    - Water users around and upgradient of the lake should have the water from their private wells tested to determine if they exceed the health standards for drinking water.
    - In a lake, nitrate can be readily used by aquatic plants and some types of algae, increasing their growth.
- 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.
- Continued monitoring of water quality should continue to be conducted to track changes in Alpine Lake. A monitoring plan should be designed and carried out.

Shoreland health is critical to a healthy lake's ecosystem. Alpine Lake's shoreland 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. Viewed separately, manmade disturbances may not pose a

problem for a lake, but the collective impact of these disturbances on developed lakes can be a problem for lake habitat and water quality.

  - Long stretches of Alpine Lake's shorelands are in good shape, but some portions have challenges that should be addressed.
    - Structures such as seawalls, rip-rap (rocked shoreline), and artificial beach result in habitat loss.
    - Unmanaged runoff from rooftops of structures contribute more runoff to the lake, often resulting in delivery of more sediment to the lake.
    - Docks result in altered in-lake habitat. Denuded lakebeds adjacent to docks 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 should be restored, and/or excess runoff should be 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.

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. Fourteen species of aquatic plants were found in Alpine Lake, which is low compared with other lakes in the Waushara County Lakes Study; however, Alpine Lake had above-average biodiversity (based on the number of species surveyed and the number of individuals per site) when compared with other lakes in the Waushara County Lakes Study.
- To ensure that a healthy diversity of native aquatic plant community continues to exist in Alpine Lake, disturbance of aquatic plants should be minimized.
- One high quality plant (C value of 9) was observed in Alpine Lake: creeping bladderwort, a sensitive, carnivorous aquatic plant species.
- Two invasive aquatic plant species were identified in Alpine Lake: curly-leaf pondweed (CLP*)* and hybrid Eurasian water-milfoil (HWM). The presence of these invasive species within the lake is cause for concern, and their populations and densities should continue to be monitored and/or controlled.
- Managing CLP may help to reduce the algal blooms that occur in Alpine Lake in late summer.
- 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.

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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."

Introduction

A healthy aquatic plant community is a vital component of a lake community. Aquatic plants play important roles in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species, and checking excessive growth of tolerant species that could out-compete sensitive species and reduce diversity.

Alpine Lake is a 56 acre impoundment located in Waushara County, east of Wautoma, Wisconsin.

Methods

The aquatic plant survey in Alpine Lake was conducted by UW-Stevens Point in July 2011, using the Wisconsin Department of Natural Resources (WDNR) point intercept sampling protocol (Hauxwell et al., 2010). The GPS coordinates for the sampling grid were provided by the WDNR. The survey included 261 sampling points throughout Alpine Lake (Figure 1).

The sampling grid was laid out with equal spacing (28 m) between all points. The shape of the lake and the size of the littoral zone determined the number of points and their spacing. The GPS points were uploaded onto an aerial photograph that was used in the field. A handheld GPS unit was used to locate sampling sites while in the field.

A pole-mounted rake was used to collect an aquatic plant sample at each accessible site. The rake had a double rake head with fourteen tines on each side with a width of 13.8 inches. After the rake was brought up, each species present was assigned a fullness rating. Ratings ranged from 0 (plants not present) to 3 (plants overflowing the rake tines) (Figure 2). Depth and dominant sediment type were also recorded at each site.

Results and Discussion

The survey was based on 261 sites that were assigned within Alpine Lake using the WDNR's point intercept protocol (Hauxwell et al., 2010). Of these points, 240 were sampled during this survey. Ninety-nine percent (237) of the 240 sampled sites had vegetative growth. The points that were not surveyed were too deep for plant growth, placed on land, or in water that was landlocked.

The average depth of the sampled sites was 7.3 feet and the deepest site in Alpine Lake that was sampled was 19 feet. The maximum depth that aquatic plants can grow is often limited by light penetration. In Alpine Lake, that is often determined by the depth of the lake.

During the 2011 aquatic plant survey, 14 species of submerged, emergent and floating leaf aquatic plants were identified (Table 1). Curly-leaf pondweed (*Potamogeton crispus*) was found

during a special curly-leaf pondweed survey in 2012. The most common plant species in the 2011 survey was muskgrass (*Chara* spp.). Plants grew to a maximum rooting depth of 19 feet.

The dominant sediment type was assessed at each site. Using the WDNR protocol for aquatic plant surveys (Hauxwell et al., 2010), the categories of sand, muck, or rock were given for dominant sediment type. Only one classification was allowed per site. Ninety-three percent of the sites had muck bottom, which provides ideal rooting conditions for aquatic plants. The remaining sites (7%) were comprised of rock.

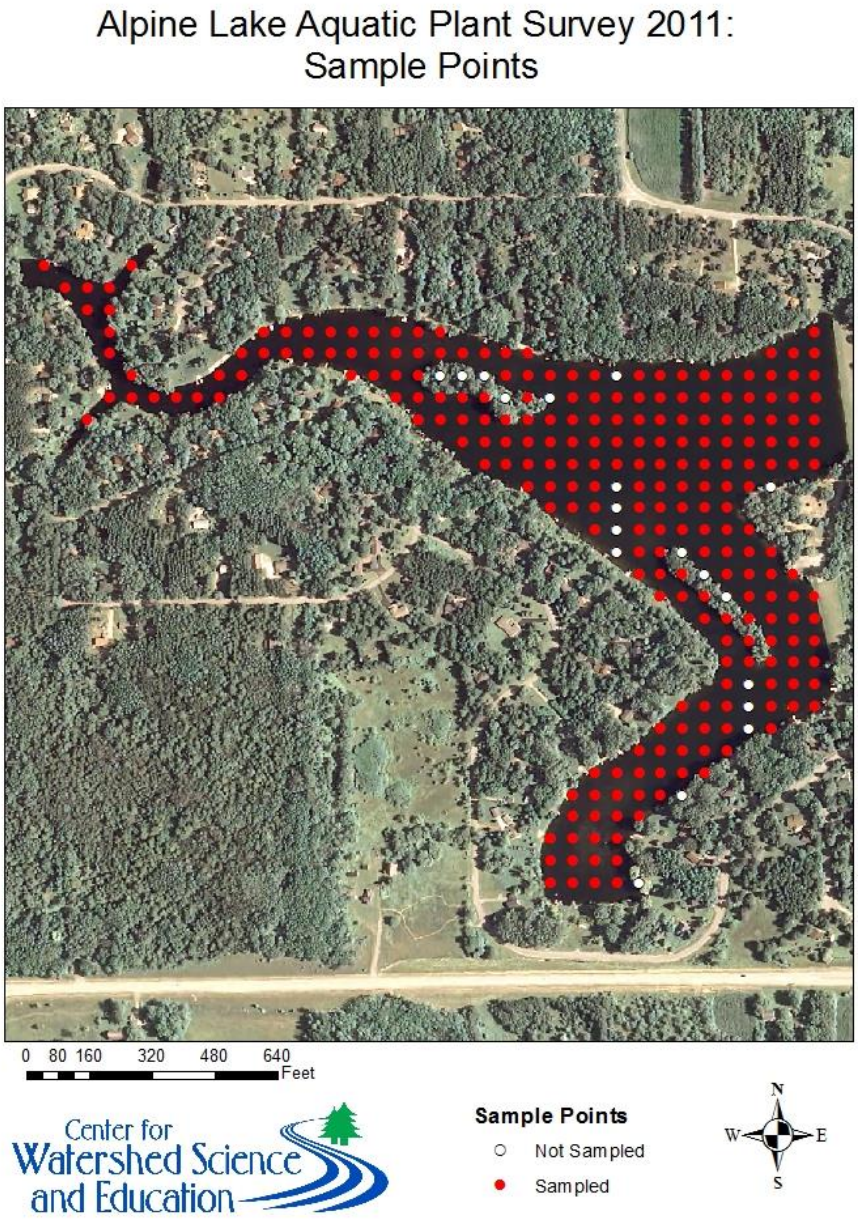

Figure 1. Sampling points on Alpine Lake, 2011.

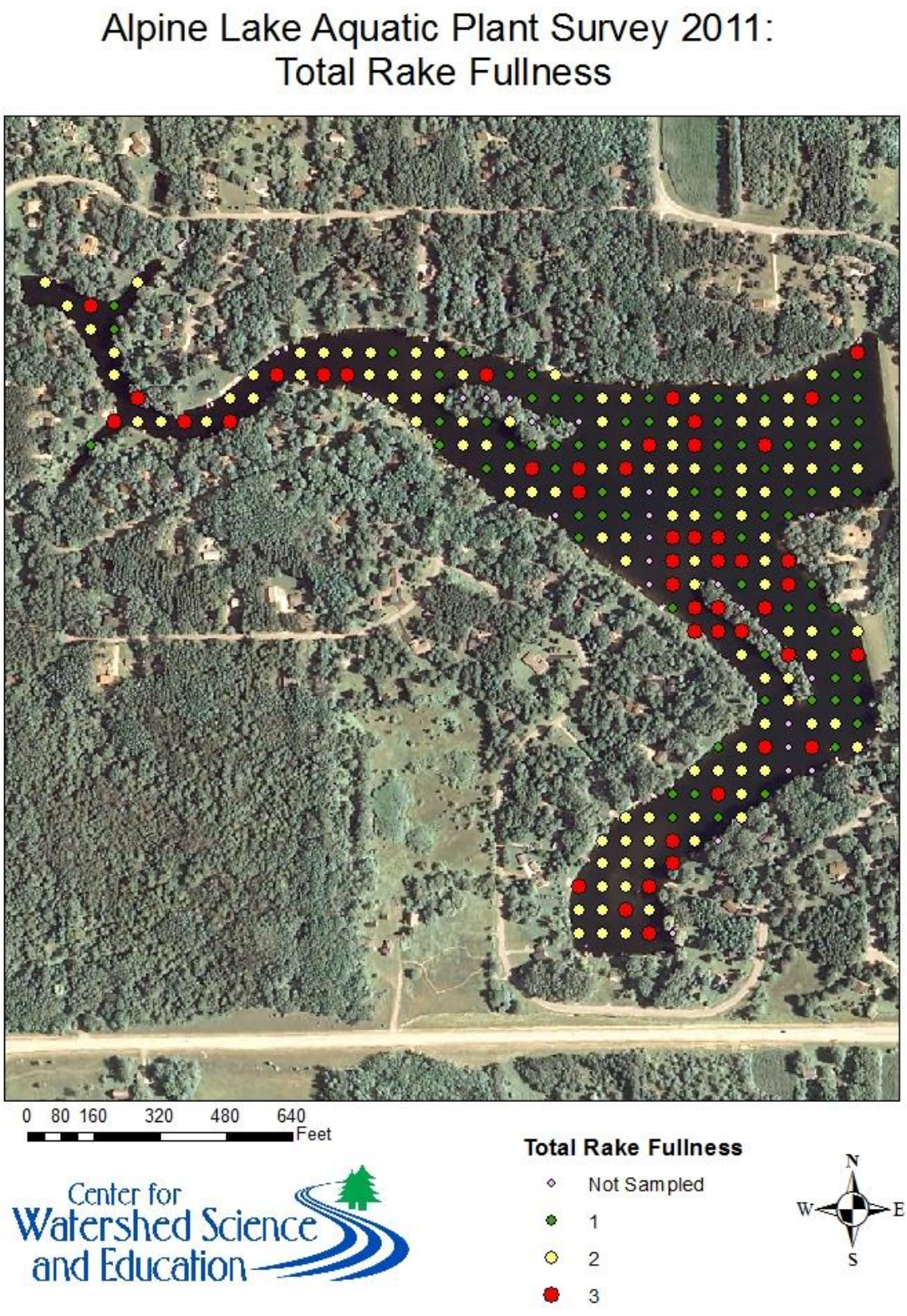

Figure 2. Rake fullness at sampled sites in Alpine Lake, 2011.
0 = absent, 1 = sparse, 2 = moderate, 3 = dense.

Table 1. List of aquatic plants identified in the 2011 aquatic plant survey and 2012 curly-leaf pondweed survey of Alpine Lake.

Scientific Name	Common Name	Coefficient of Conservatism Value
Emergent Species		
Typha augustifolia	narrow-leaved cattail	1
Floating Leaf Species		
Nymphaea odorata	white water lily	6
Submergent Species		
Ceratophyllum demersum	coontail	3
Chara spp.	muskgrass	7
Elodea canadensis	common waterweed	3
Heteranthia dubia	water star-grass	6
Myriophyllum spicatum	hybrid Eurasian water-milfoil	0
Najas flexilis	slender naiad	6
Potamogeton crispus (2012 survey)	curly-leaf pondweed	0
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton zosteriformis	flat-stem pondweed	6
Stuckenia pectinata	sago pondweed	3
Utricularia gibba	creeping bladderwort	9
Utricularia vulgaris	common bladderwort	7
Vallisneria americana	wild celery	6

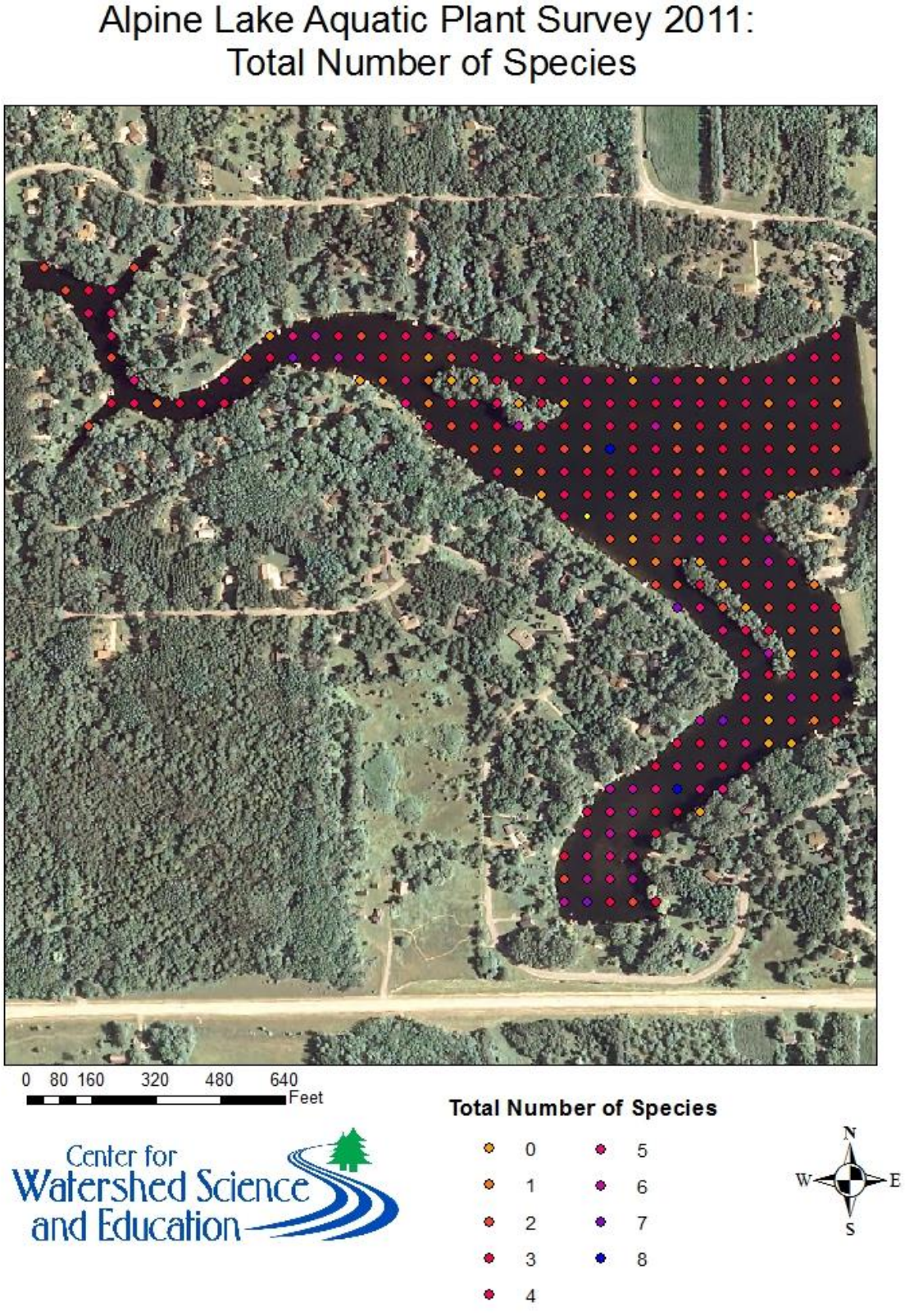

Figure 3. Number of aquatic plant species observed at each sample site in Alpine Lake, 2011.

Frequency of Occurrence

The frequency of occurrence (FO) value is the percent of sample points shallower than the maximum rooting depth that are vegetated. The FO for Alpine Lake was 98.75%. Of the sites that were vegetated, wild celery (*Vallisneria americana)* occurred at 58% of the vegetated sites, common waterweed (*Elodea canadensis*) occurred at 53% of the sites, and muskgrass (*Chara* spp.) was collected at 64% of the vegetated sites (Figures 4, 5 and 6).

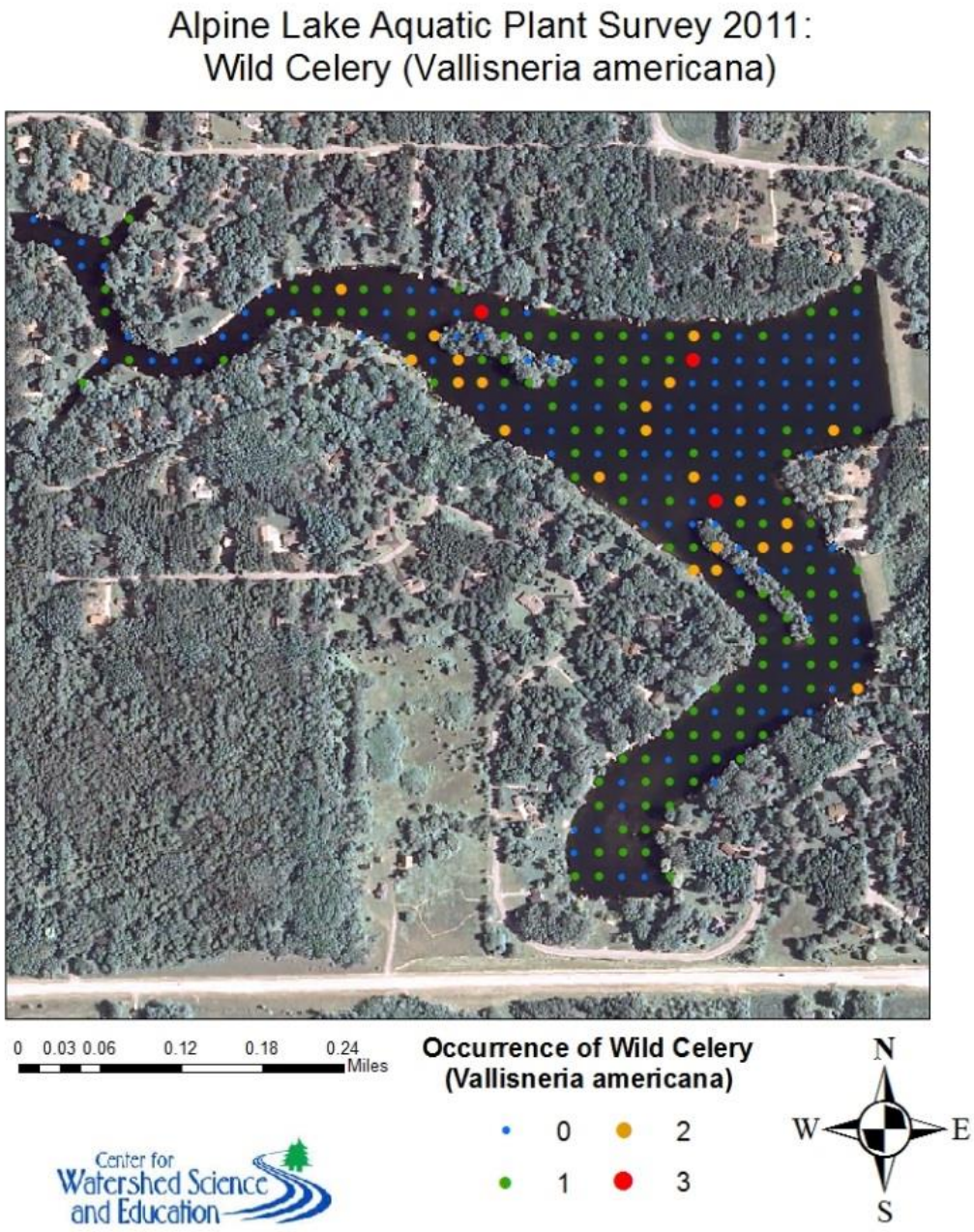

Figure 4. Occurrence and density of wild celery (*Vallisneria americana*) in Alpine Lake, 2011.

Wild celery, common waterweed, and muskgrass are all native species of aquatic plants. Wild celery (*Vallisneria americana)* is a long, limp, flat, grass-like plant with a visible green mid-ridge that grows under the water. Wild celery is an important source of food for animals, especially waterfowl. Muskgrass (*Chara* spp.*)* is a species of algae that resembles a plant. Muskgrass is rough to the touch because of deposited calcium salts on the cell wall. The metabolic processes associated with this deposition often give muskgrass the distinctive and unpleasant smell of hydrogen sulfide.

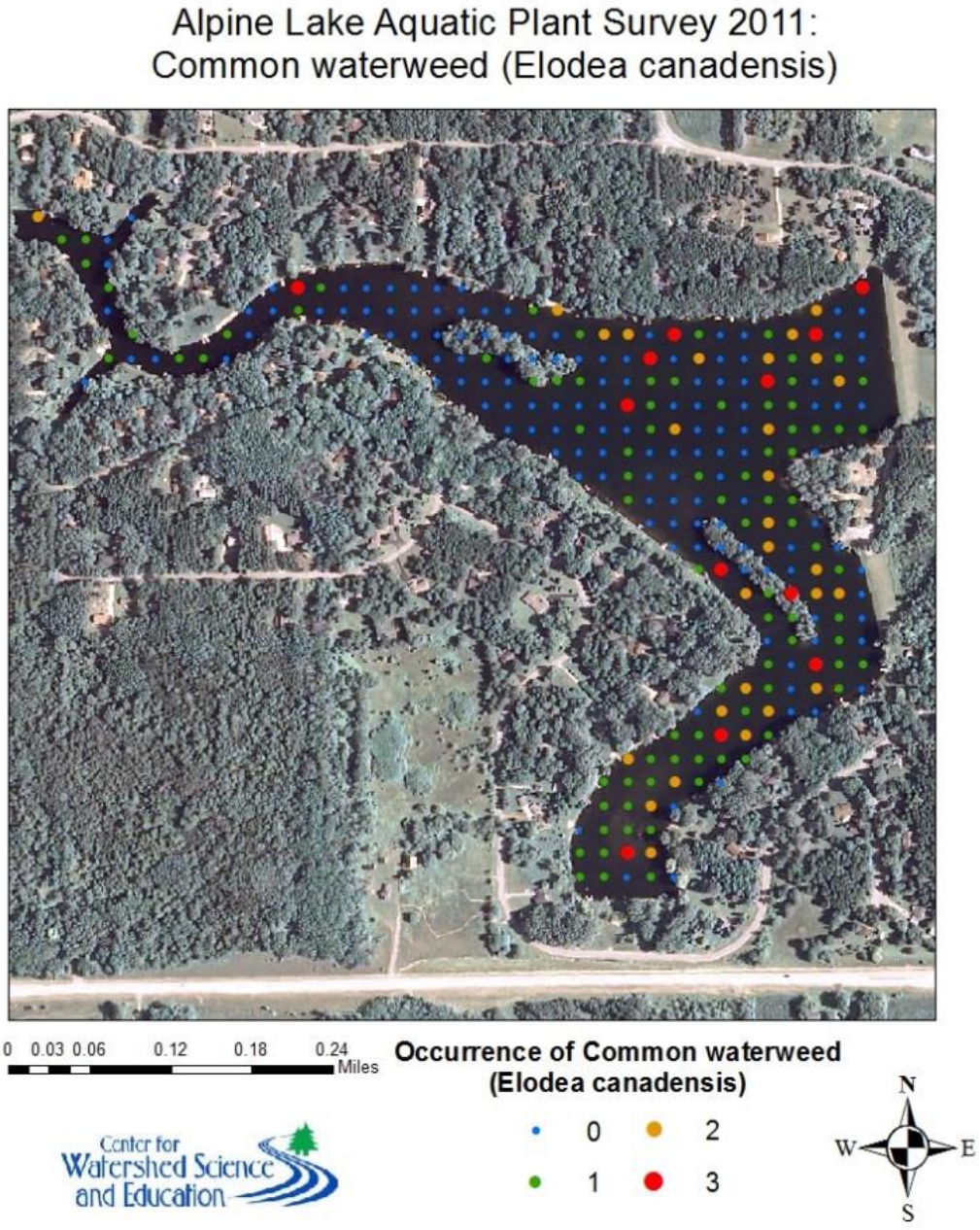

Figure 5. Occurrence and density of common waterweed (*Elodea canadensis*) in Alpine Lake, 2011.

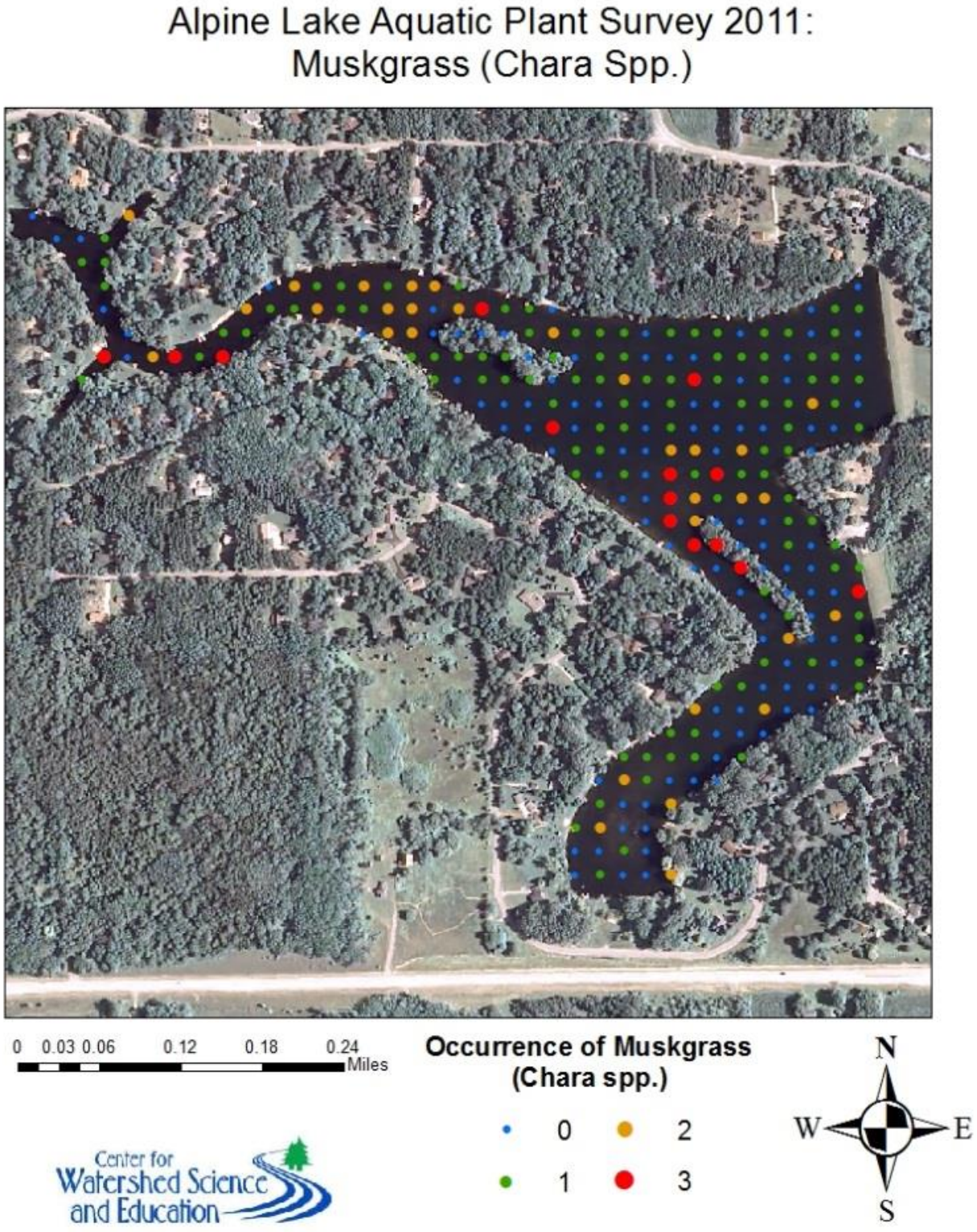

Figure 6. Occurrence and density of muskgrass (*Chara* spp.) in Alpine Lake, 2011.

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 represent higher amounts of biodiversity. Data collected from the 2011 Alpine Lake survey resulted in an SDI of 0.86. A diverse community of aquatic plants tends to be more stable and is desirable for a healthy lake ecosystem. Much of the diversity in Alpine Lake was found on the southern end of the lake.

Floristic Quality Index

The Floristic Quality Index (FQI) evaluates the closeness of a plant community to undisturbed conditions (Nichols, 1999). Each plant is assigned a coefficient of conservatism (C-value) that reflects its sensitivity to disturbance. These numbers are used to calculate the FQI. C-values range from 0 to 10. The higher the number, the more intolerant the plant is of disturbance. A C-value of zero is assigned to exotic and most nonvascular species; therefore, these species are not included in the calculation. The C-values in Alpine Lake ranged from 1 to 9, with an average C-value of 5.3 (Table 1).

The FQI for a lake is calculated by taking the average C-value for the lake times the square root of the number of species found in the lake. The 2011 FQI for Alpine Lake was 19.1. The average FQI for all lakes in the Waushara County Lakes Study was 23.2.

Aquatic Invasive Species

A special survey for curly-leaf pondweed was conducted in June 2012 (Figure 7). The survey was done using the WDNR point intercept sampling protocol (Hauxwell et al., 2010). Curly-leaf pondweed (CLP) can have an impact on a lake's ecosystem because of its life cycle. CLP grows under the ice during late winter/early spring and dies back from late June to early July, releasing phosphorus at a time when new plants and algae are beginning to grow. This phosphorus release can help fuel algae blooms and excessive plant growth. During the 2012 curly-leaf pondweed (CLP) survey, CLP was found in numerous patches, some of which were relatively dense. Further exploration may be needed to determine the impact of these plants on nutrient levels in Alpine Lake.

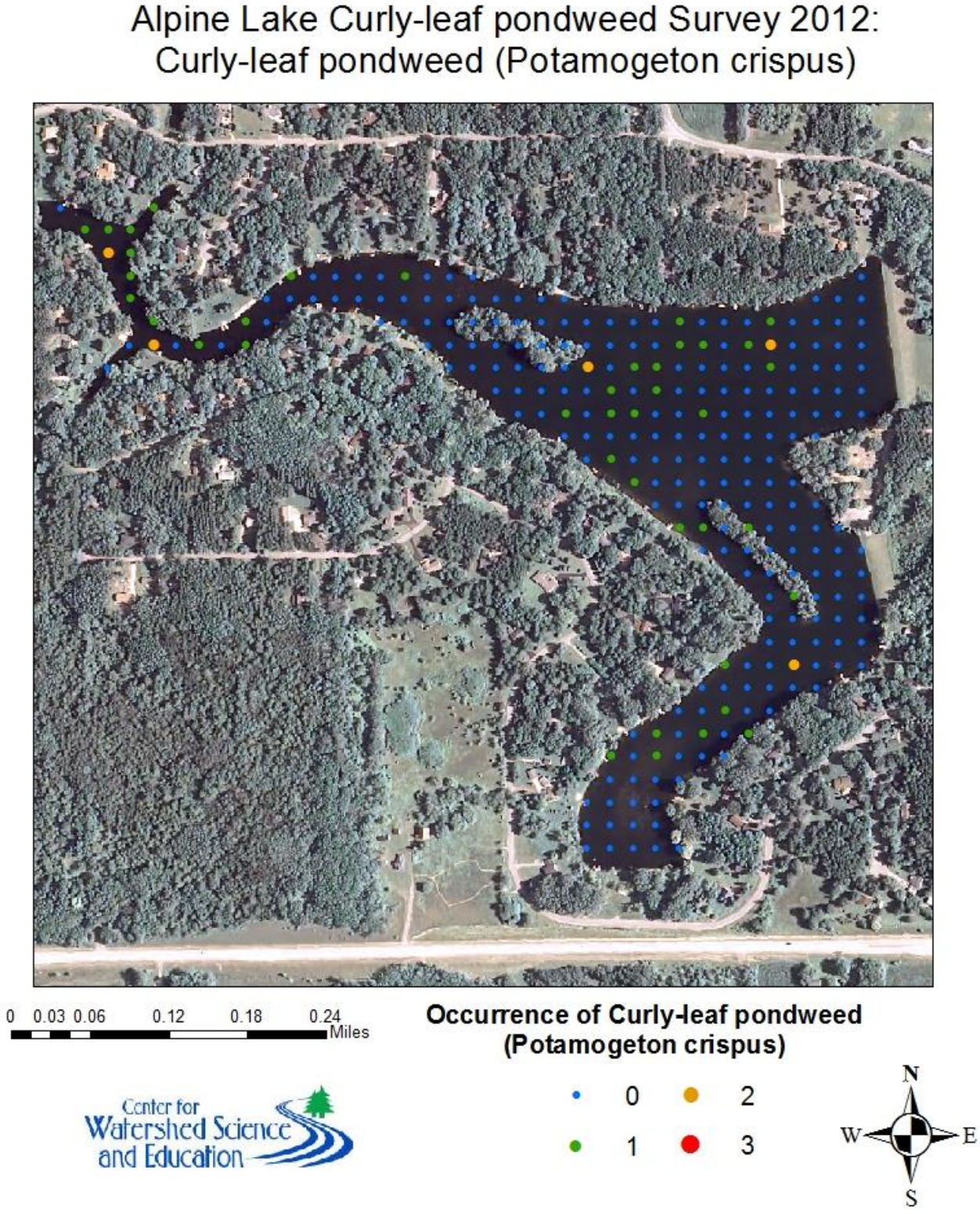

Figure 7. Occurrence and density of curly-leaf pondweed *(Potamogeton crispus)* in Alpine Lake, 2012.

Hybrid Eurasian water-milfoil (EWM) was found in Alpine Lake during the 2011 full aquatic plant survey (Figure 8); however, the lake was treated for EWM just before the survey was conducted in 2011, likely impacting its distribution and density throughout the lake. Northern water-milfoil (*Myriophyllum sibiricum*) and Eurasian water-milfoil easily hybridize and it can be difficult to distinguish between them.

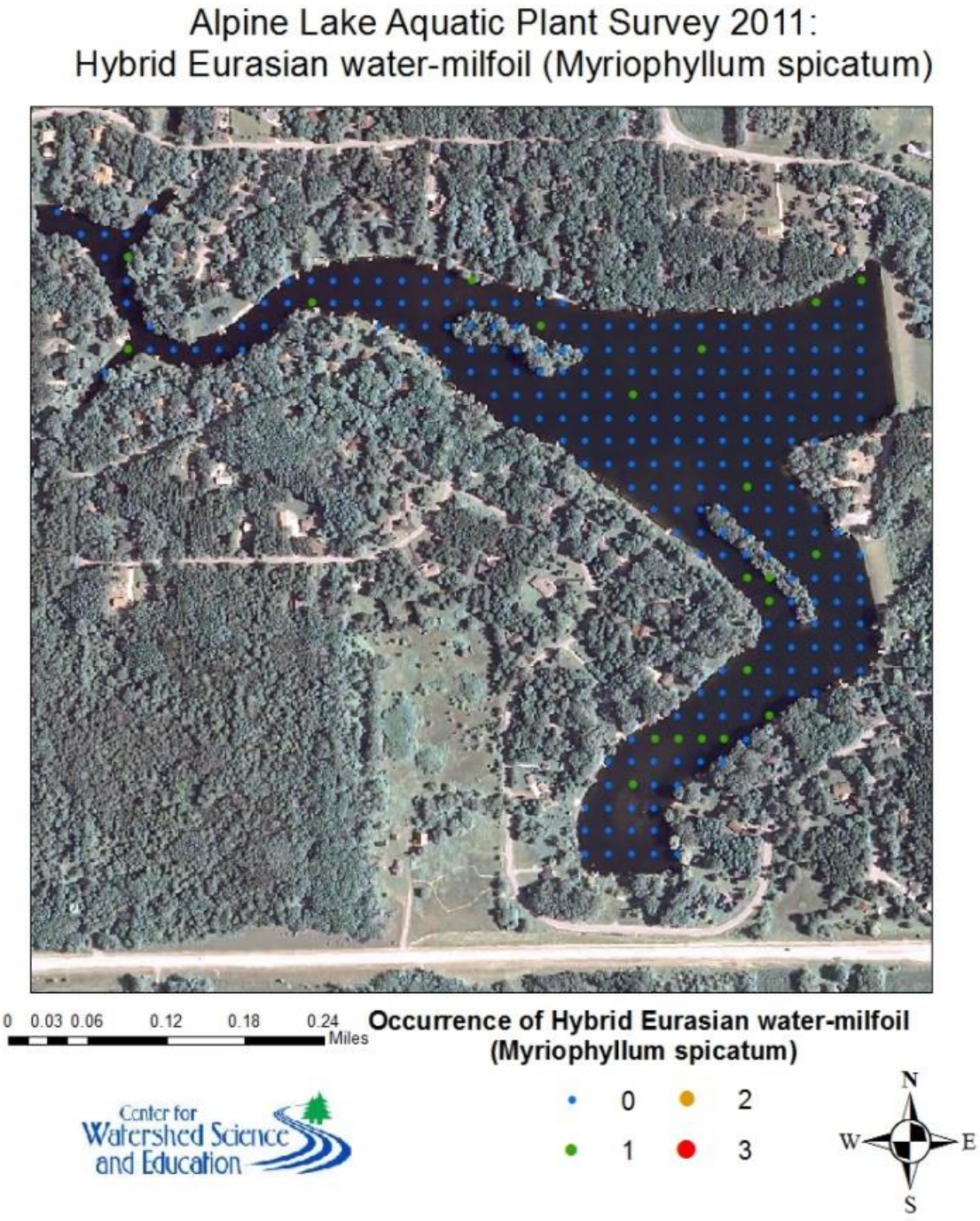

Figure 8. Occurrence and density of hybrid Eurasian water-milfoil *(Myriophyllum spicatum)* in Alpine Lake, 2011.

Conclusion

The aquatic plant community in Alpine Lake is characterized by healthy and relatively diverse plant species. Alpine lake has a fair amount of development on the shores, which can have an impact on the presence and diversity of plant species. There are healthy aquatic plants distributed throughout the littoral zone of the lake (98%), up to a maximum rooting depth of 19 feet in one location. Most plant growth occurred at 7 feet.

In 2011, the most common plant species was muskgrass (*Chara* spp.). Common waterweed (*Elodea canadensis*) and wild celery (*Vallisneria americana*) were also prevalent plant species occurring at more than the half the sites. The FQI value for Alpine Lake was 19.1.

Healthy aquatic plant communities provide many invaluable benefits to the lake ecosystem, including improved water quality, and fish and wildlife habitat. For these reasons, the native aquatic plant community of Alpine Lake should be protected.

References

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