The Limnological Institute

A conservation organization providing research and solutions for the preservation of our inland waters.

2008 Silver Lake Aquatic Plant Management Plan

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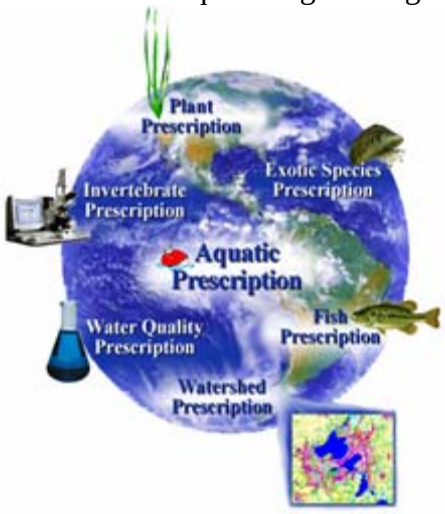

2008 Silver Lake Aquatic Plant Management Plan

December 2008

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In cooperation with the Wisconsin Department of Natural Resources and the City of Portage, WI.

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Acknowledgements

The 2008 Silver Lake Aquatic Plant Management Plan was completed based largely on information gathered through two Department of Natural Resource (WDNR) administered Lake Planning Grants (LPL-1101-06A and LPL-1101-06), which provided funding for 75% of the plant and water quality monitoring costs. This plan was funded through a third grant (LPL-1123-07). A special thanks to the following individuals for their help throughout the project:

City of Portage, WI

Jeff Grothman	City of Portage Mayor
Kay Messer	City of Portage Treasurer
Sharon Pyrek	City of Portage Secretary
Timothy Raimer	City of Portage Parks, Recreation, and Forestry Manager

Wisconsin Department of Natural Resources

Susan Graham	Regional APM Coordinator, Lake Coordinator
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Executive Summary

Silver Lake is located in the city of Portage in Columbia County, Wisconsin (WBIC 107700; T12N R9E S6). Silver Lake is a 74-acre spring-fed lake with two distinct basins divided by a public road. The basins are connected by a narrow channel that runs under the road. The two basins will be described as the east basin and the west basin for the remainder of this report. The west basin has a maximum depth of 42 feet and a mean depth of 20 feet while the east basin has a maximum depth of 13 feet and a mean depth of 5 feet.

During the summer of 2006, Aquatic Engineering, Inc. biologists assessed several key aspects of the Silver Lake ecosystem. Aquatic macrophytes, sediments, various water quality parameters, watershed, and riparian land use were analyzed. Plant sampling was performed twice during the aquatic plant growing season in 2006. Water quality parameters were sampled in each basin from May through October.

This report is an Aquatic Plant Management Plan (APMP) for Silver Lake. The plan includes a summary of the aquatic plant assessment and water quality activities that took place during 2006 and compares the objective data to subjective public perceptions. Management goals are based on ecological principles and are guided by public perception and input.

Deliverables listed in the grant and covered in this report include:

- Public use survey
- Organizational components
- Management history review
- Aquatic Plant Management Plan

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1.0 Introduction

In the summer of 2006, Aquatic Engineering, Inc. (AEI) performed water quality and aquatic plant monitoring activities on Silver Lake (Columbia County, WI). Analyses included in the water quality report included baseline water chemistry, Secchi depths, chlorophyll *a*, and TSI calculations.

Results of the water quality monitoring and analysis show that the west basin of Silver Lake is eutrophic while the east basin is mesotrophic. These terms can be misleading in that they do not assess trophic conditions such as standing vascular plant biomass. It is likely that the abundant submersed aquatic plant growth in the eastern basin helps maintain water quality indicative of a mesotrophic system though it may in fact be eutrophic. A complete summary of the water quality monitoring activities can be found in the "2006 Silver Lake Water Quality Monitoring Technical Report".

Aquatic plant monitoring activities in 2006 included whole lake qualitative and quantitative surveys. In addition to sampling the plant community, the surveys also included analyses of sediment type and riparian land use.

Results of the plant surveys show that Silver Lake has a plant community dominated by species tolerant of disturbance conditions. Two of the plant species are not native to Wisconsin, Eurasian water-milfoil (EWM) and curly-leaf pondweed (CLP). CLP is found at low densities while EWM is found throughout the lake and frequently at high densities. EWM causes nuisance conditions in localized areas. Simpson's Diversity index shows that the plant community within Silver Lake is in the lower quartile for lakes in the state and region (i.e., at least 75% of lakes in the state and region have more diversity in their plant community).

This document compiles information regarding the Silver Lake ecosystem and outlines an Aquatic Plant Management Plan. The plan considers objective information regarding inventory data, public input, historical conditions, and current plant and water quality conditions. The plan reviews management options and follows WDNR recommendations

for managing aquatic plants within Wisconsin. The APMP can be incorporated into a future or existing Lake Management Plan (LMP).

Purpose Statement

The City of Portage is committed to preserving the Silver Lake ecosystem. The Silver Lake Association, Association to Solve Silver Lake's Environmental Problems (A.S.S.E.T.), and the City's Municipal Services Committee are integral partners in this mission. The City's responsibility in this partnership is to provide direction, funding, and management for the City's natural resources.

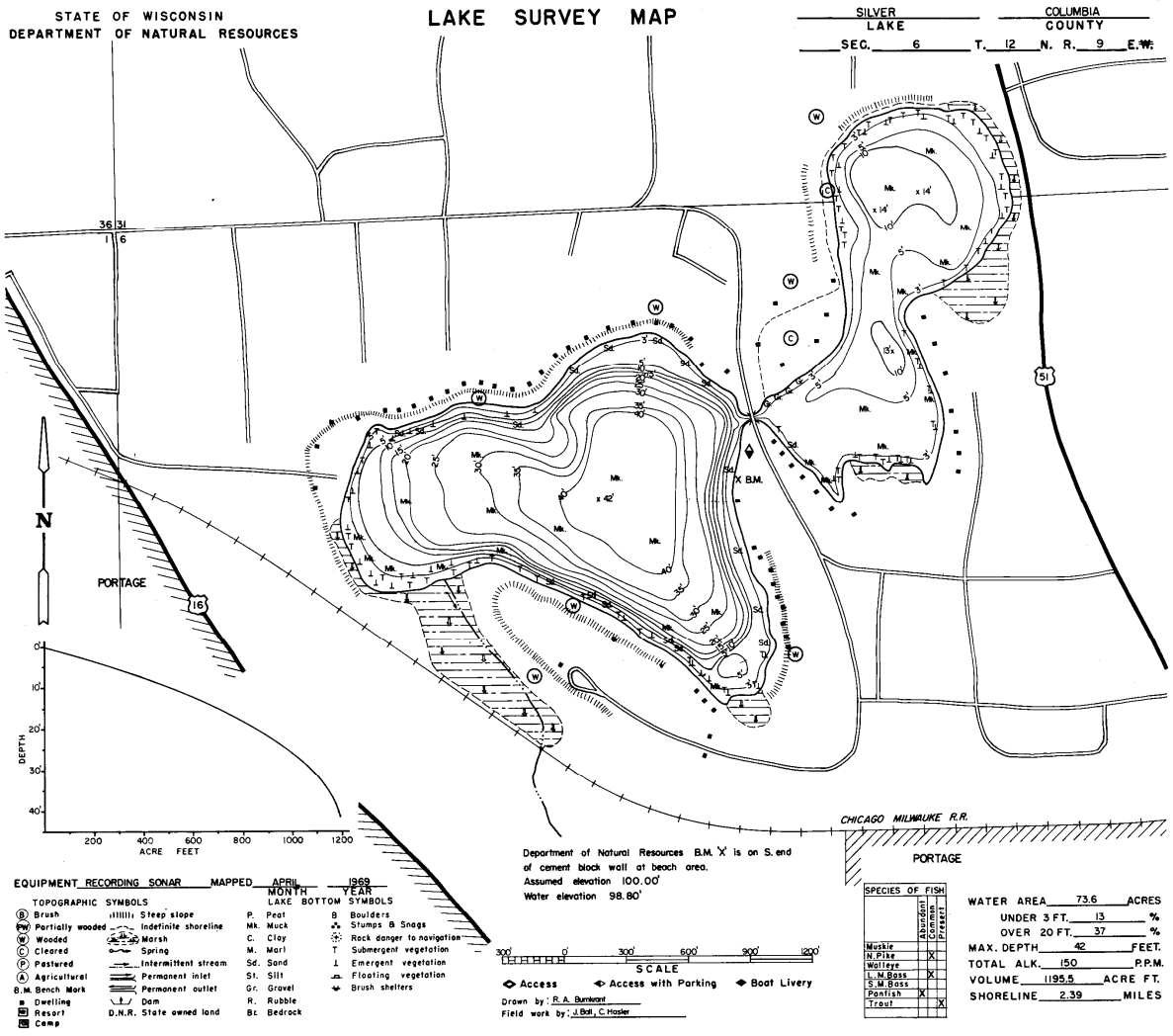


Figure 1. Bathymetry of Silver Lake (Portage, WI)

2.0 Description of Problems

Water Quality

The findings of the 2006 water quality monitoring show that the west basin of Silver Lake is eutrophic while the east basin is mesotrophic. The west basin experiences nuisance algal blooms and localized nuisance plant growth while the east basin experiences widely distributed nuisance vegetation and clear water. Results of the public use survey show the public believes water clarity is an important aspect of the ecosystem and needs to be managed. Respondents indicated that water clarity is clear or better (61%) or cloudy or worse (39%). The same survey shows that the public is divided on whether water clarity has remained unchanged or become worse.

Both basins contain elevated nutrient levels. The source of nutrients has not yet been identified, but it is likely that surface runoff plays the largest role. Internal loading may also be contributing nutrients, but the amount of contribution is unknown. A complete hydrologic budget and hypolimnetic study are needed in order to create a detailed nutrient budget. A detailed nutrient budget would reveal the source of hypolimnetic phosphorus concentrations.

Aquatic Vegetation

The findings of the 2006 aquatic plant monitoring show that Silver Lake has a disturbed macrophyte community that is dominated by EWM in the east basin and has a mix of native species in addition to EWM and CLP in west basin. The entire eastern bay is shallow and contains submersed macrophytes. In most areas of the east basin, EWM impedes navigation, swimming, fishing, and other recreational opportunities. Most of the west basin shoreline has steep contours, and the littoral zone is limited to near shore areas (Figure 1). Some areas of the west basin experience nuisance conditions caused by EWM.

Public Perception

Popular public opinion is that excessive weed growth inhibits enjoyment of the lake, is worse in some areas than others, and is not being managed effectively. The public survey

also revealed only a small portion of the public (15%) believes little to no aquatic vegetation should be the number one concern regarding the lake. The public survey revealed most people believe fluctuating water levels, inappropriate management efforts, and fertilizer and pesticide use are causing undesirable conditions within the lake. Regardless of the perceived causes, approximately half of respondents (61%) feel they have a voice in making decisions regarding lake management activities. It is clear that in order for their management plan to be successful the City will want to solicit public opinions and gain public support for their APMP.

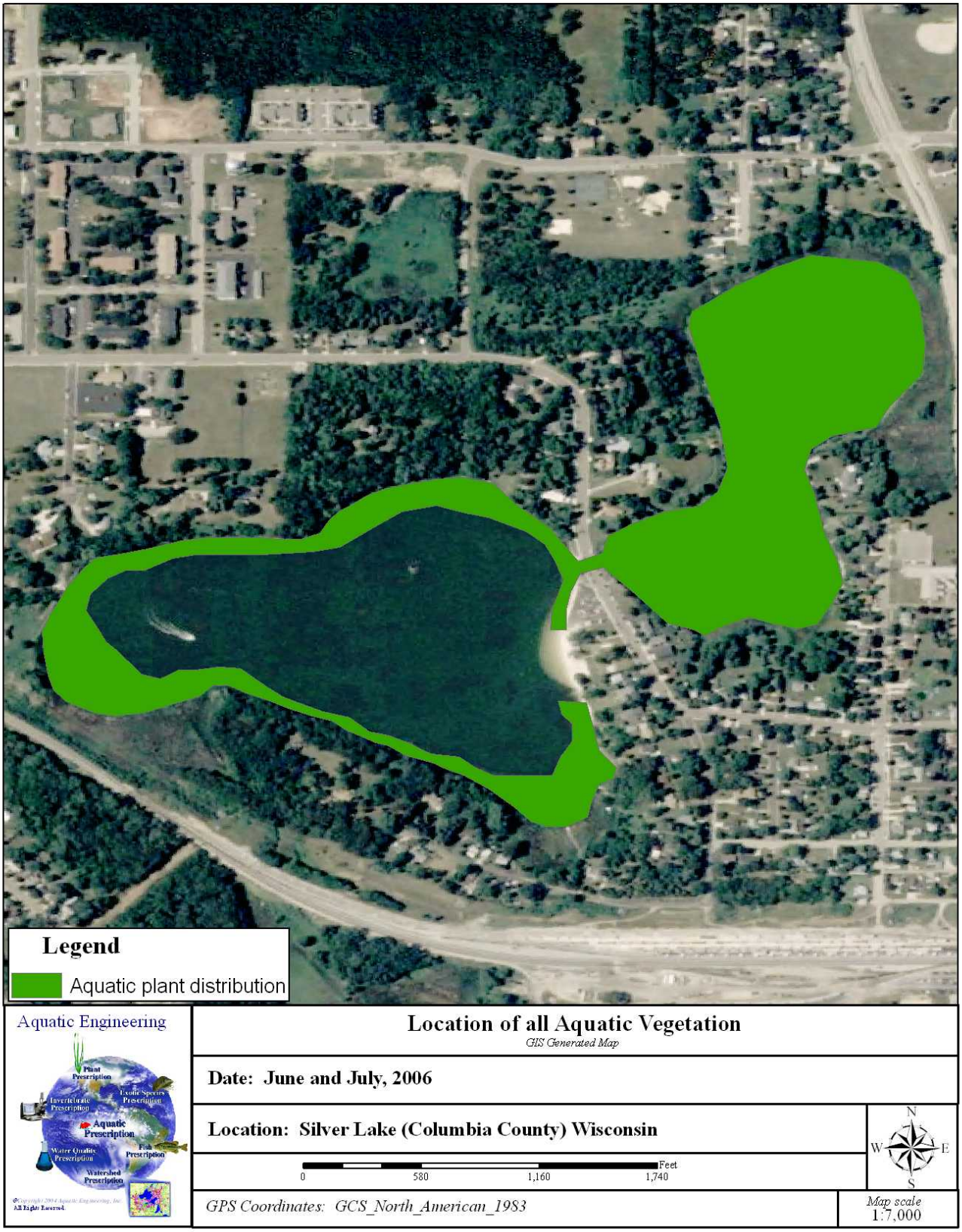


Figure 2. Distribution of submersed macrophytes in Silver Lake (Columbia County, WI).

3.0 Review of Existing Information

3.1 Aquatic Plants

Aquatic Engineering, Inc. performed a review of existing management information with regards to Silver Lake's aquatic plant community, plan management, and water quality monitoring. The following subsections outline the information reviewed.

3.1.1 Aquatic Plant Management History

Chemical treatment in near shore areas occurred from 1991 through 1995. The City of Portage began harvesting aquatic plants within Silver Lake in 1994. The harvesting program was initiated as a service for hire. The City contracted specific harvesting days and spent approximately $5,000 per year from 1994 to 1996 on their harvesting effort. No estimates are available regarding time spent harvesting or loads of plants harvested during those years. The City has since purchased their own harvesting equipment and now runs their program through the City's department of Parks, Recreation and Forestry.

The City pays for the operation and maintenance of all harvesting activities which totals approximately $7,000 per year. In 2005, a total of 141,600 pounds of wet plant material were removed but the amount of time required was not recorded. In 2006, 194,000 pounds of wet plant material were removed with a total harvesting time of 61.4 hours. This effort demonstrates the ability to harvest approximately 3,000 pounds of wet plant material per hour.

3.1.2 Plant Surveys

A review of past plant surveys revealed three surveys that took place in 1994, 1996, and 2002. While all three surveys employed a transect method, the 1994 and 2002 surveys were conducted by the DNR while the 1996 survey was conducted by Northern Environmental.

The 1994 survey was not available but was referenced in the 2002 survey report. The methods of the 1994 survey were not quantitative but the density and distribution of

dominant plant species were noted. The 2002 survey used quantitative transect and depth zone methods but no statistical or biological matrices were presented in the report.

The 1996 survey by Northern Environmental also used a transect method but only selected plants at the most vegetated site along each transect. The points sampled during this survey were not the same points surveyed by the DNR in 1994 and 2002. General plant distribution and dominant species were noted during this survey but no community assessment was made.

All three previous plant surveys documented nuisance levels of Eurasian water-milfoil in the eastern bay. All three surveys provide qualitative data which can be used to compare past plant communities to the present community. A comparison of the 1996 and 2002 qualitative survey results show a slightly different community from one survey to the next (Table 1). These differences are likely the result of changes in methods, personnel, and annual variance in the plant community.

3.2 Fish and wildlife community assessement[1]

The following information is in reference to threatened or endangered species occurring in or around Silver Lake. The WDNR database contains no records of listed or rare species or sensitive natural communities occurring in Silver Lake, however there are historic records for the following wetland associated plants from the area around the lake. It is unknown whether these species still occur in the area, but it is unlikely that management activates within the lake would disturb habitats where these species could occur, therefore impacts to these species would be avoided if wetlands around the lake are not disturbed by the proposed actions.

Slenderleaf Sundew (*Drosera linearis*) State Threatened
Slim-stem Small-reedgrass (*Calamagrostis stricta*) Special Concern
Whip Nutrush (*Scleria triglomerata*) Special Concern

[1] Provided by the Wisconsin Department of Natural Resources

Special Concern species are species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become endangered or threatened.

Comprehensive endangered resource surveys have not been completed for the project area and therefore there are no records in the Natural History Inventory database of endangered resources occurring in Silver Lake. As a result, the WDNR data files may be incomplete. However, given the nature of the proposed project it is the WDNR's opinion that further endangered resource surveys are not warranted.

Table 1. Comparison of plant species found in Silver Lake during 1996, 2002, and 2006 surveys.

Plant name	**1996 survey**	**2002 survey**	**2006 survey**
Water shield	Yes	Yes	Yes
Coontail	Yes	Yes	Yes
Muskgrass	Yes	No	Yes
Common waterweed	Yes	Yes	Yes
Common duckweed	Yes	No	Yes
Eurasian water-milfoil	Yes	Yes	Yes
Slender naiad[1]	Yes	No	No
Yellow water-lily[2]	Yes	No	No
White water-lily	Yes	Yes	Yes
Curly-leaf pondweed	Yes	Yes	Yes
Leafy pondweed	Yes	No	No
Common pondweed	Yes	No	No
White stem pondweed	Yes	No	No
Filamentous algae	Yes	Yes	NR[3]
Narrow leaved cattails	Yes	Yes	Yes
Spatterdock	No	Yes	Yes
Bushy naiad[1]	No	Yes	No
Bulrush	No	Yes	Yes
Illinois pondweed	No	Yes	No
Common bladderwort	No	Yes	Yes
Clasping leaf pondweed	No	Yes	No
Stoneworts	No	Yes	No
Sago pondweed	No	Yes	Yes
Large leaf pondweed	No	Yes	Yes
Water stargrass	No	No	Yes
Star duckweed	No	No	Yes
Southern naiad	No	No	Yes

1=1996 and 2002 survey likely misidentified southern naiad as slender naiad
2=1996 survey likely misidentified spatterdock as yellow lily
3=2006 survey did not record presence or absence of filamentous algae

4.0 Review of Management Options

4.1 Options for Managing Aquatic Macrophytes

The following subsections provide an overview of management strategies that are commonly used to manage eutrophic effects on lakes. The purpose of this section is to provide a general introduction to popular management strategies for future reference and consideration. Methods described are derived from the Managing Lakes and Reservoirs manual prepared by the North American Lake Management Society. Practices that are relevant to Silver Lake are described in more detail in the following sections.

Mechanical weed harvesting can be used to remove the upper portion of rooted vegetation. Weed harvesters are low-draft barges that cut and remove vegetation growing at or near the water surface. A harvester can generally operate at a rate of approximately 0.2 to 0.6 acres per hour, depending on equipment. Once cut, the plants are moved via conveyer to a holding area on a barge until the cut plants can be unloaded, via a second conveyer, at the shore. Plants are usually transported away from the lake to a compost site or a landfill. The physical removal of plant material means that the nutrients trapped in the plants are also removed from the lake ecosystem.

Harvesting is most effective to remove plants in three to six feet of water growing in dense beds. Harvesting can be used to open navigational channels, remove weedy obstructions from highly used recreational areas, or to produce relief for fish in weed-choked areas of a lake. Harvesting is non-specific and will remove all plants within the harvested area. Sometimes fish become trapped in harvested plants and end up being removed from the lake as well. Harvesting equipment is usually expensive, and operational costs vary depending on the harvesting effort required. Effects of harvesting are immediate, and there is no use restriction during operations. Wisconsin Department of Natural Resources permits are required for mechanical harvesting. Contact the local APM coordinator for more information regarding permitting requirements.

Manual weed harvesting is a scaled-down method of mechanical harvesting. In manual

weed harvesting, weeds can be uprooted completely or simply cut close to the sediment using a variety of equipment from drag lines and garden rakes to specially designed weed cutters. This method is the most species-specific mechanical method of plant removal since an individual can physically see which plants are going to be removed and which will be missed. This method, however, is also the most labor-intensive means of controlling plants, and its feasibility is directly affected by the available labor force. This method is most applicable to individual property owners who wish to maintain clear areas for swimming, fishing, and for boat access to their dock. Since many times plants are not removed from the root, repeated efforts are needed to maintain the benefits. Wisconsin Department of Natural Resources permits may be required for manual harvesting. Contact the local APM coordinator for more information regarding permitting requirements.

Sediment screens range from fiberglass or plastic mesh screens to simply sand or gravel, and are placed on the existing sediment and plants to block light and suppress growth. While the synthetic barriers make better screens, they are the most difficult to install and maintain. The screens must be installed early in the year and securely anchored to the sediment to prevent them from being disturbed. The screens must be removed and cleaned periodically to prevent sediment from building up on top of them.

Sand and gravel are more natural means of suppressing aquatic vegetation and are less expensive, but they also require maintenance on an annual basis and are less effective. Wisconsin Department of Natural Resources permits are required for sediment screening. Contact the local APM coordinator for more information regarding permitting requirements.

Water level manipulation, commonly referred to as “draw-down”, is a useful way to control nuisance vegetation that occurs in the shallow regions of a lake. This method is typically applied in the fall and over winter. Cold, dry conditions are best for a draw-down event, because frozen sediments will kill most of the seed bank and compress soft sediments. Both of these conditions prevent plant growth in the following spring when the water level is brought back up to normal conditions. This method severely impacts

recreational uses while the water level is lowered and has the potential to trap fish and other wildlife in shallow areas that may not become completely dry but do freeze from top to bottom over the winter.

Drawing the water level down in the summer has the opposite effect on plant growth. Lowering the water level generally increases the wetland area, and the littoral zone of a lake becomes larger. This provides more habitat for plants to become established. This is a low-labor option but can become expensive if power is generated at a dam. The power company may be entitled to compensation for loss of power generated during the draw-down.

Raising the water level in the summer can also suppress aquatic vegetation by limiting the amount of light penetrating to the bottom thereby making the littoral zone smaller.

Wisconsin Department of Natural Resources permits are required for water-level manipulations. Contact the local APM coordinator for more information regarding permitting requirements.

Dredging sediments and plants is usually only performed when an increase in depth is a required part of the management outcome. If the depth is increased sufficiently, light penetration is limited in the dredged area and plant growth is suppressed. Dredging an entire lake bed is very rarely performed. Dredging small areas for boat access and other recreational uses is a cheaper and more applicable compromise. Wisconsin Department of Natural Resources permits are required for dredging. Contact the local APM coordinator for more information regarding permitting requirements.

Chemical control of aquatic plants and algae is often used in areas where vegetation has created nuisance conditions. Herbicides and algaecides are used to control a wide variety of plant and algae species. Some herbicides and application methods are very specific for which plants they will control. Others control a wide variety of vegetation. In some cases, the precision and concentration of herbicide applied will also determine which species are controlled. Control is generally gained in one to two weeks and can last

several weeks up to an entire season.

Chemical applications are designed to control vegetation which is already present and rarely address the underlying nutrient problem associated with nuisance plants and algae. Treating dense vegetation in large areas of a lake can cause oxygen depletion due to the increased amount of decomposition. Wisconsin Department of Natural Resources permits are required for aquatic herbicide applications. Contact the local APM coordinator for more information regarding permitting requirements.

Biomanipulation refers to altering a food web in order to obtain a desired end result. In the case of controlling algae, a "top-down" approach is taken. Promoting top-level predator fish like muskellunge, walleye, largemouth bass, and northern pike naturally reduces the panfish population. Panfish typically graze on zooplankton (algae eaters) and when zooplankton reach high numbers, more algae is consumed and the water clarity is increased. This method is generally used only to improve water clarity, however improved water clarity has a significant impact on plant distribution within the lake. Wisconsin Department of Natural Resources permits are required for biomanipulation. Contact the local APM coordinator for more information regarding permitting requirements.

Biological Control Agents is a term used to describe organisms capable of controlling other organisms within their ecosystem by various methods. For example, loosestrife weevils have been used to control the exotic plant purple loosestrife. The weevils are tiny insects that use the plants for food, shelter and to reproduce. The weevil larvae consume plant material and make growth and reproduction difficult, if not impossible, for the plant. A similar situation is suggested to occur for the aquatic exotic plant EWM. There are no known biological control agents that would improve conditions within Silver Lake with respect to CLP and nuisance natives.

No management means that the lake resources are not actively managed but are monitored on a regular basis. Monitoring results are tracked and compared from year to year. When conditions that warrant management are discovered, a management tool is

selected. In some cases, the plant community will face a natural obstruction and balance is regained naturally.

4.2 Discussion of Management Options

Of the listed management options, no management, biomanipulation, and sediment screens are methods that will not meet the recreational needs of the City or improve or protect conditions within the lake. Water level manipulation is not possible due to the lack of an outflow control structure.

The four most applicable management options for the issues facing Silver Lake are (1) manual and mechanical weed harvesting; (2) biological control agents (milfoil weevils); (3) dredging and; (4) chemical control. Watershed BMPs (not listed) would also address nutrient inputs and urban pollution issues.

Mechanical weed harvesting is a proven method for Silver Lake. The City has invested resources in establishing the ability to run their own harvesting program. This method results in immediate relief and the cost is relatively low. The duration of relief is not typically long, however. Repeat cutting is needed to maintain desired conditions.

The history of manual harvesting is not known but it is clear that some property owners rake their own shoreline for private recreational use. Riparian property owners are allowed to manually remove plants provided under state statutes NR 107 and NR 109. This method is not specific to the plant causing nuisance conditions and is therefore not an ideal method for the long term management of the plant community. Residents should contact the regional APM coordinator before performing any plant management activities.

Biological control agents, mainly the milfoil weevil, have the potential to improve conditions within the east basin with regards to EWM. The weevil feeds on the tips of EWM plants and can noticeably reduce the growth of EWM. Once established, weevils could provide years of control of EWM.

The use of weevils is not without drawbacks. Weevils do not eliminate EWM but rather slow or stop their growth. Weevils need to be maintained at a certain stem density in order for adequate control to occur. Weevils don't typically do well in low density EWM beds so nuisance conditions are almost necessary for any degree of success to occur. Little or no control would be expected in the western basin of the lake due to the sporadic growth of EWM. A thick duff is required for the weevils to over-winter. Local conditions within and around the lake will determine the success of the weevils. Additional research and development is needed before biological control with weevils can be considered an effective management tool (WDNR 2004). A weevil population assessment for Silver Lake is needed to determine the feasibility of this particular method.

Dredging is also a reasonable method for control in the eastern basin but not the western. The shallow profile and nutrient rich sediments of the eastern basin favor nuisance plant growth. Removing that sediment and deepening the basin would help reduce plant growth. Effects would be immediate and long lasting. Depending on the underlying substrates, an improvement in the benthic invertebrate community may also occur.

Dredging is very disruptive to the lake ecosystem. The bay would likely experience increased turbidity from suspended sediments during and immediately after dredging. Reducing plant growth in the bay would also make more nutrients available for algae which could result in increased algae blooms.

Herbicide applications can provide relief for several weeks up to a full season or longer. The City should consider chemical management in areas not able to be harvested. These areas are usually shallow bays or around obstacles (fallen trees, stumps, rock piles, etc.).

In most cases, integrated approaches produce the best results. Regardless of the selected management activities, the goal of the plan should be to enhance the native plant community and protect valuable habitat while limiting growth and distribution of non-native plants. When integrating management techniques, the limitations of each need to be addressed to make sure all needs are being met and that no conflicts among selected

methods exists.

4.3 Public Use Survey

The public use survey was created by TLI and included questions regarding demographics, public use, and lake management opinions (Appendix A). The survey was sent to 61 riparian property owners via US postal service (USPS) on January 9, 2007. The survey was sent with return postage pre-paid (i.e., there was no cost to residents for completing and returning the surveys).

Completed surveys were due back by February 1, 2007. AEI processed the surveys on February 10, 2007 allowing for surveys arriving late. Of the 67 surveys distributed, 27 were completed and returned and 3 were returned by the USPS as undeliverable. Some respondents completed the entire survey while others skipped certain questions. The number of respondents was reported for each question rather than for the survey as a whole.

5.0 Aquatic Plant Management Overview

A complete aquatic macrophyte management plan follows a series of steps. A plan organizes labor and resources for a clearly defined mission and outlines a way to measure success. The WDNR has created a "manual" for aquatic plant management in Wisconsin. The manual outlines a seven-step process for managing aquatic plants. The steps to completing a plant management plan are:

- Setting Goals. . .Why are We Doing This?
- Inventory. . .Gather Information
- Analysis. . .Synthesis of the Information
- Alternatives. . .Providing Choices
- Recommendations. . .Completing the Plan for a Formal Decision
- Implementation. . .Taking Action
- Monitor and Modify. . .So How are We Doing?

The purpose of the following sub-sections is to provide the city of Portage with an overview of each step, explain what measures the City has already taken towards completing the step, and explain what, if any, additional action the City must take to complete the step.

5.1 Setting Goals

Overview

In order to set goals for aquatic plant management, a group must identify problems facing lake users and what endpoint is desired through management efforts. Setting goals involve the following three steps: 1) Develop a goal statement; 2) Create a plan of work; 3) Create a communication and education strategy.

Completed

Public interest in improving conditions is high, and a finished APMP will reflect the interests of the City and property owners while taking into consideration the best action for the resource.

The City will continue to hold regular meetings throughout the planning and implementation of the APMP. Special meetings may be called when certain topics

warrant immediate attention. These meetings may include the Association or Municipal Service Committee.

In addition, TLI will provide sources for educational materials and an informal presentation of the preliminary findings of the plant and water quality monitoring activities so that the City may make a well-informed decision regarding future management.

Goal Statement

The goal of the Silver Lake APM Plan is to organize City resources, inform citizens of current lake management issues, and take action to manage nuisance aquatic plant growth within Silver Lake while protecting native plants and water clarity.

Additional Action

There is no additional goal setting action required by the City in order to implement their APMP.

5.2 Inventory

Overview

In this step of the plan, information regarding several aspects of the lake and surrounding area need to be collected and analyzed. Examples of information that should be gathered include:

- Existing plans and studies
- Data regarding plants, fish, wildlife, and water quality within the lake
- Maps and historical documentation that describes past conditions of the lake
- Aerial photographs of the lake
- State and local regulations and ordinances
- Technical information or research on the topics of concern to the City
- Examples of other lake APM plans

Additional information may have to be reviewed depending on the goals of the City. The WDNR, UW-Extension, and regional resources such as county zoning, city clerk, and

planning offices are great places to gather most of this information. Past consulting firms may also be able to provide some information specific to their findings.

Completed

As part of this study, AEI has collected and organized historical data regarding the aquatic plant community, fishery and wildlife, and water quality of Silver Lake. Some information was found regarding past aquatic plant surveys and management efforts. The information collected isn't quantitative which makes it hard to objectively determine whether certain conditions have improved or declined. A current plant community inventory was collected in 2006 as part of this study in addition to water quality data and public opinion. That data will greatly improve the baseline inventory data available for Silver Lake.

Additional Action

The City will create a single location for storing all information regarding their lake management activities. The Municipal Services Committee is currently responsible for harvesting operations and overseeing general lake maintenance issues. The committee will decide what information will be kept, how it will be organized and stored, who will be responsible for organizing and storing the information, and where the information will be kept. Examples of this information include:

- Past Management Plans
- Public Surveys
- Contracts/Agreements with Consulting Firms
- Management Activity Reports

5.3 Analysis

Overview

The analysis step is the most critical step in the management process. It is during this step that the information gathered in the previous step is thoroughly analyzed and compared to the initial issues voiced. The information should provide an objective view of the perceived problems and be summarized in an "Analysis Report". Individuals dedicated to completing this step need to approach the analysis with open and objective

minds so that decisions are based on fact and not emotion or public pressure. To create an objective Analysis Report, consider these three variables: (1) What is the nature of people's concerns; (2) Where do conflicts occur; and (3) Has the problem changed over time?

(1) Considering the nature of people's concerns involves dissecting public input to decide if opinions genuinely have the health of the resource in mind. People must understand that not all plants are nuisances and that a certain amount of vegetation is necessary to sustain fish and wildlife and that it helps improve water quality and general aesthetics.

(2) Identifying areas where conflicts regarding lake use and proposed management may occur will help create a more detailed management plan. Areas that will have restricted use based on management activities need to be identified and management activities timed according to expected lake use. For example, one would not propose to perform a large scale herbicide treatment prior to the 4th of July when use restrictions may prevent activities such as swimming or fishing over the holiday weekend.

(3) Determining whether the problem has changed over time involves reviewing objective information gathered regarding the problem. A previous study or plan may contain objective findings regarding the problem and can be used to compare past conditions to the current state.

Completed – Analysis Report

Public opinion supports objective aquatic plant survey findings of localized impaired recreation in the eastern bay and sporadic invasive stands throughout the littoral zone of the western basin (Figure 3). However, the popular public opinion is that water clarity is the most important aspect of the lake resource. To balance recreational need with water quality protection, the City will focus on managing nuisance vegetation within the eastern basin and protecting water quality throughout the lake.

Level III management is needed in the eastern basin to meet the City’s goals while level

II management will currently suffice for the western basin. Level III management means the plant community will be manipulated on a large scale. The goal of the management program will be to maintain recreational use of the lake while promoting high value native plant growth and maintaining good water clarity.

The western basin will be monitored annually to determine the density and distribution of EWM. If management actions should be needed to meet the City's goals, they will likely include harvesting during the summer. Other management options will be considered prior to implementing management activities in the western basin.

The nature of peoples' concerns is genuine and in the best interest of the lake resource. The City is unified in its efforts, but some use conflicts are apparent. One use conflict is that some residents feel motorboat and personal watercraft traffic has increased over the last several years and that the increased traffic and the noise that comes with it negatively impacts their use and enjoyment of the lake. Only half of respondents would be in favor of expanding no-wake zones and times. The use conflict will be getting motorboat and personal watercraft users to agree on no-wake zones and times.

Additional Action

There is no additional action required of the City regarding the analysis step other than to hold regular City meetings and participate in the development of the APM Plan.

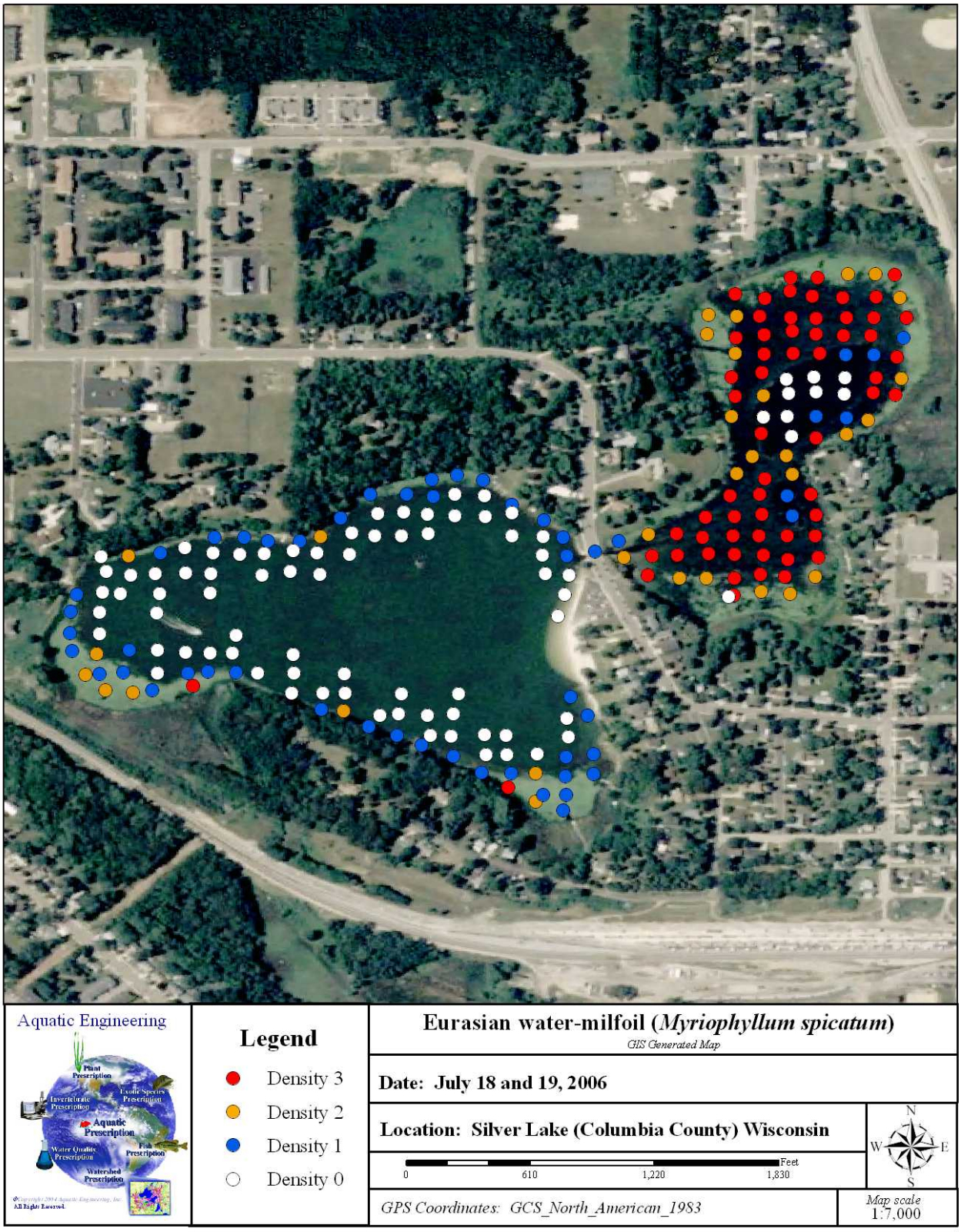


Figure 3. Distribution of EWM within Silver Lake (Portage, WI) in 2006.

5.4 Alternatives

Overview

It is difficult to conduct an analysis without simultaneously considering alternative management techniques. So, these portions of the plan may become merged into an "Alternatives Analysis". However, it is important that the need for and level of control be established independent of choosing the control method. The amount of discussion on alternatives will correspond with the level of control proposed.

Completed

The City has been presented with alternatives suitable for Silver Lake and is aware of the costs and benefits associated with each. City members have reviewed the table on the following page and have a clear understanding of the problems facing Silver Lake.

The City also acknowledges the need to protect valuable areas of the lake and high value aquatic vegetation throughout the lake. Throughout the implementation of this plan, all efforts will be made to protect and enhance valuable plants, fish, and wildlife within and surrounding the lake. Management techniques will be selected in a manner consistent with this goal and implementation of those techniques will be modified in the event adverse impacts are expected or encountered. Monitoring and public education will help enhance awareness of these resources and ultimately lead to their protection and enhancement.

Additional Action

There is no additional action required of the City regarding this step other than to regularly review all management options and make adjustments based on the success of implemented alternatives and the need for management.

Table 2. Comparison of management activities costs and benefits.

	Benefits	Drawbacks	Applicable	Recommended	Costs[2]	Longevity
Mechanical Harvesting	Removes plants and nutrients	High equipment capital investment costs	Yes	Yes	$200,000 equipment and $200-600 per acre	1-3 Weeks
	Immediate relief	Can not reach shallow areas				
	No use restrictions	Not species selective				
	No potentially harmful chemicals	Can promote spread of opportunistic plants				
Manual Harvesting	Species specific	Labor intensive	Yes	Yes	$100-? per acre	1-3 Weeks
	Shallow areas affected	Very small areas controlled				
	No chemicals	Slow				
	Removes plants and nutrients	Correct plant ID required				
Sediment Screens	Little negative impact to whole lake	Harms benthic invertebrates	No	No	$20,000-50,000 per acre	Months to Years
	No chemicals	Permit required				
	Site specific control	Difficult to install				
	Reversible	Expensive				
Water Level Manipulation	Controls plants in shallows	Restricts recreational use during	No	No	$1,000-2,000+ per acre	1-2 Years
	Sediment compaction	Perfect weather conditions required				
	2 years of control	Disrupts wildlife				
	Inexpensive (maybe)	Expensive (maybe)				
Dredging	Improves navigation	Increases turbidity	Yes	Yes	$20,000-80,000 per acre	Depends on sedimentation rate
	Removes plants and nutrients	Releases toxic contaminants				
		Destroys habitat				
		Very expensive				
Chemical Control	Quick relief	Repeat treatments required	Yes	Yes	$50-2,000 per acre	Months to Years
	Species specific	Does not remove nutrients				
	2 months of relief	Promotes aggressive species				
	Cost effective	Can increase algal blooms				
Biological control agents	Cost effective over the long term	Oscillating cycle of control	Yes	Yes	$300 - $3,000 per acre	Years
	Long term relief	Does not address nuisance natives				
	EWM specific	Susceptible to shoreline developments				
Biomanipulation	Long lasting	Hard to start	No	No	Varies	Varies
	Self sustaining	Alters habitat				
	No chemicals	May have negative impacts on habitat				

[2] Cost range per acre treated without consideration of longevity of effects (Holdren et al. 2001)

	Improves water quality	Can be irreversible				
	Improves fishery					

5.5 Recommendations

Overview

In this step of the plan, a preferred management tool is selected. This requires reviewing the goals and objectives set in step one, reviewing existing conditions from step two, reviewing the level of management decided in step three, and reviewing management alternatives from step four. The next step in the recommendations is to evaluate the action plan, organize resources, such as volunteer time and City budget, and identify and meet legal obligations prior to implementing the plan. Such legal obligations may be obtaining state permits for managing plants or informing the public of herbicide applications. Many of the requirements are listed in Wisconsin state statutes NR107 and NR109.

Completed

Primary Management Tool Selected[3]

The primary management tools selected by the City of Portage are mechanical harvesting, selective AIS herbicide applications and ongoing monitoring. Prioritized management within the eastern basin will occur from spring to fall depending on seasonal conditions and growth of aquatic plants. Limited management in the western basin may occur as exotic plants and public need is identified. Other management techniques will be considered when harvesting and herbicide applications are not feasible.

Eurasian water-milfoil is present in both basins of Silver Lake. In past years it has created a nuisance for recreational activity in the entire eastern basin and has occurred around the lake perimeter of the western basin. Management efforts will therefore focus on EWM and will improve conditions within the eastern bay and maintain recreational use of both basins.

The City has chosen these tools over other management options for the following reasons:

- There is no danger of this management practice worsening conditions within the eastern basin or the distribution of EWM in the west basin.

[3] Prepared by the City of Portage in 2006

- We feel these strategies is less likely to exacerbate algae blooms which decrease water clarity and aesthetic value.
- The method can be selective and does not rely on unpredictable performance of biological control agents.
- We believe this integrated management approach has the potential of providing long range, lasting reduction of the Eurasian water milfoil problem by promoting native plant growth.
- The integrated management techniques can improve conditions for predator fish which may improve water clarity in the long run.
- The major cost for the harvesting operations has already been covered and operational experience has been gained.

We will closely monitor the results of our integrated plan annually to determine its effectiveness and will determine if and when additional management techniques are needed or if current strategies require modification.

The Municipal Service Committee will also form an advisory taskforce responsible for gathering information regarding the feasibility of biological control agents to help control EWM. The advisory taskforce will prepare a summary of their findings and will include recommendations. The summary and recommendations will be presented to the committee before December 31, 2010 and will be incorporated into the APMP update in 2011.

Additional Action

No additional recommendations are needed prior to implementing the current APMP. Future recommendations will come as harvesting efforts are tracked and biological control options are evaluated.

5.6 Implementation

Overview

Implementation can be broken down into three steps. The first step is to adopt the plan. The plan will be adopted by the City first. The City will then present the adopted plan to the DNR for additional support.

The second step to implementation is to prioritize and schedule actions. Actions will be prioritized as immediate (2007-08, short-range (2007-09), medium-range (2007-10), and

long-range (indefinite).

The final step of implementation is to assign roles and responsibilities for the various agencies involved in the management activities. The responsibilities need to be clearly defined and recognized by the individuals and organizations responsible for carrying them out. Formal resolutions and contracts are usually adequate in covering these responsibilities.

Completed

Plan Adoption

Planning sessions have been held throughout the entire plan development process. The first open public planning session was held by the City Council on March 1st, 2007 with the purpose of providing the results from the extensive Water Quality and Aquatic Plant monitoring events. Following the meeting, copies of the Water Quality and Aquatic Plant Survey Technical Reports were proved to the WDNR for review. Comments from the WDNR were received on October 16th, 2007 and were addressed on November 14th, 2007. The second planning session was held with the WDNR and City Council members to discuss comments and the specific goals within the proposed Aquatic Plant Management Plan on February 13th, 2008. The City has arranged for TLI to distribute a draft version of this document, including the APM Plan in sections 6 and 7, to the vested parties for review. The vested parties have the opportunity to make suggestions for revisions to TLI. The document will then be revised and a final draft will be distributed to the City and WDNR. The APM plan is expected to be completed in 2008 and submitted to the WDNR shortly thereafter. The City will adopt the plan and request support from Columbia County and the WDNR. Once the WDNR approves the plan, the City will proceed to implement their plan.

Immediate Implementation Actions

Educational campaigns designed to inform property owners about the value of aquatic plants and what they can do to help improve the water quality will start immediately. The City will appoint a person responsible for carrying out the educational campaign. Information on how property owners and lake patrons can help protect water quality and

natural resources will be gathered from the WDNR, Columbia County, and local UW-extension office. That information will be typed and made available at the public library. The City will also create a space on their website for posting information related to Silver Lake. Links to other agencies and electronic copies of informational material will be included on the website. The purpose of the campaign is to raise awareness, solicit involvement, and promote action in the community.

A second immediate action is to continue with the current management program and seek ways to improve the efficiency and results of future efforts. Results will be measurable and tracked on a daily basis during each year. A summary of each year's data will be created at the end of each season. Multiple years will be compared and better estimates of future efforts and costs will be made. Ways to improve efficiency will be considered on an annual basis.

A third immediate action is to recruit and train volunteers to participate in Self-help Secchi monitoring and Clean Boats, Clean Waters programs. Citizen monitoring began in 2006 and will be promoted throughout the implementation of this plan. Training is available through the DNR and UW-Extension offices and will be paid for by the City of Portage. Volunteers will be responsible for reporting monitoring results to the City and DNR.

Short-term Implementation Actions

Short-term plant management actions will include mechanical harvesting and selective herbicide applications. The City will consider managing areas not able to be harvested using selective aquatic herbicides, biological control agents, or manual removal. Integrated management strategies provide the flexibility to manage different areas of the lake in different ways. Manual harvesting could be used to create relief for individual property owners. Herbicide treatments can also provide relief for individual property owners in areas too shallow to harvest and dense areas of EWM. Biological control agents can reduce EWM growth on a large scale and could prove particularly useful in the eastern basin. An integrated approach would include all three management practices and would result in clear navigation, access to private piers and docks, and broad control

of EWM.

Another short-term action is to protect valuable aquatic habitat by promoting the growth of high-value native plant species and protect certain areas by minimizing impacts from management practices as well as recreationists. The City will request that the WDNR designate sensitive areas of the lake. The City can then consider those areas when planning their management activities. Creating no-wake zones to include sensitive areas would help protect plants and wildlife within them.

A third short-term action will include protecting/improving water quality (gauged by annual average Secchi depth) by implementing BMPs throughout the watershed and implementing management techniques that minimize nutrient inputs. Protecting water quality is a fundamental aspect of lake improvement projects and reflects the public's opinion that water clarity should be the most important aspect of the plan.

The City will help educate residents on protecting water quality by establishing two demonstration areas at the public beach and shelter site. The City will be renovating the parking lot and will be creating a demonstration area of natural vegetative buffer strip between the pavement and water edge. Signage will be placed facing the parking lot and will provide basic vegetative buffer strip educational material and encourage residents to promote similar buffers on their water front property. The second demonstration area will be near the shelter and outbuildings. The City will create a rain garden demonstration area which will also have signage for education and encouragement to create similar structures throughout the watershed.

Mid-term Implementation Actions

The one mid-term action is to evaluate the possibility of biological control of EWM (weevils) within the eastern basin of Silver Lake. The Municipal Services Committee will create a taskforce which will investigate the possibility and prepare a set of recommendations with regard to milfoil weevil control for Silver Lake. The recommendations will be made prior to the next revision of the APMP planned in 2011.

Long-term Implementation Actions

The one long-term action is to protect and monitor the lake ecosystem. Water quality monitoring will be an ongoing process and the plant community will be monitored professionally every three to five years.

The City plans to address long-term (on-going) actions as needs are identified. We plan to achieve long-term actions by managing nuisance plant growth, monitor and protect water quality, plan and budget for a professional analysis of the lake every three to five years, find assistance to help fund implementation by applying for grants, and by promoting growth of high value native plants.

Additional Action

The City needs to evaluate the need for management every year and update the plan budget accordingly. The City will also solicit public support through various educational opportunities.

Funding Sources and City Budget

The City will budget for each management season and will cover costs for harvesting, education, public involvement, and future professional monitoring and planning. The current cost of harvesting is approximately $7,000 per year which will be increased to approximately $8,500 per year to accommodate public education, involvement and professional services.

The City will also apply for planning and implementation grants as applicable to the selected management activities. Aquatic Invasive Species grant funding may be available to help manage invasive species throughout the lake.

5.7 Monitor and Modify

Overview

Monitoring the plant community with methods outlined by the WDNR will ensure objective values are obtained and management activities are evaluated without bias.

Future decisions concerning the plant community will be based on objective data gathered annually throughout implementation of the plan. It is important to realize that effective monitoring will be the result of clearly defined performance objectives.

The WDNR APM guidelines outline the necessary monitoring and background information needed to perform Level I through III aquatic plant management activities in Wisconsin lakes. This report has been written to satisfy the requirements for the highest level of management described in the WDNR APM guidelines – Level III. Methods for monitoring and tracking management progress occur annually. The guidelines also recommend calculating the FQI every 5 years. The FQI should increase if the frequency of exotic species decreases and/or the frequency of native species, especially those designated as "sensitive species", increases. Calculating the FQI is explained in the WDNR's Aquatic Plant Management in Wisconsin guidelines.

Specific monitoring is required for herbicide applications and harvesting while other recommendations exist for monitoring current exotic species and preventing others. The City insists that all management and monitoring activities follow recommendations within the current draft of the manual.

Completed

Future monitoring will be dependent on the management activities that are performed. The minimum requirements are outlined in section 6 of this report and include plant and water quality monitoring. Additional monitoring may be required by the regional DNR aquatic plant management coordinator as part of the permitting process for mechanical harvesting of aquatic plants.

Additional Action

No additional action is required in order to implement the plan outlined in Sections 6 and 7 of this document.

6.0 Silver Lake APM Plan

6.1 Specific Elements of the Silver Lake APM Plan

This section lists the specific recommendations of the WDNR for Level III management. The recommendations have either been satisfied based on information gathered during the 2006 Aquatic Engineering, Inc., study (black items) or still need to be fulfilled (red items).

Goals

- ✓ Purpose Statement (Section 1.0)
- ✓ Goal Statement (Section 5.1)

Management History

- ✓ Summary of past management activities (Section 3.0)

Plant Community

- ✓ Comprehensive species list and review growth cycles of dominant species
- ✓ (Section 5.1 Aquatic Plant Survey Technical Report)
- ✓ Total surface area covered by aquatic vegetation (Section 2.0)
- ✓ Highlight rare, threatened or endangered species and species of concern (Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Highlight invasive and non-native species, map, and compare to native community (Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Describe beneficial use of plants as well as nuisance or use conflicts associated with plant community (Section 2.0 Aquatic Plant Survey Technical Report)
- ✓ Describe vegetative characteristics of near shore or shoreland areas (Section 5.4 Aquatic Plant Survey Technical Report)
- ✓ Collect quantitative data of the lake's aquatic plant community (Section 5.1 Aquatic Plant Survey Technical Report)
- ✓ Determine the percent frequency of each species present (Section 5.1 Aquatic Plant Survey Technical Report)
- ✓ Determine the lake's FQI (Section 5.1 Aquatic Plant Survey Technical Report)
- ✓ Collect three samples of each species for herbarium specimens (AEI 2006)
- ✓ Label sites where rare, threatened, endangered, special concern, invasive, and non-native plants were found (Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Map areas to show dominant species type and aquatic invasive species (AIS)(Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Maintain plant information in database or GIS including species name, location, and date sampled (Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Create map depicting proposed management areas and affects of management (Section 6.2)
- ✓ Map coordinates to be recorded on GIS map

Lake Map

- ✓ Obtain map with accurate scale (Appendix A&C of Aquatic Plant Survey Technical Report)
- ✓ Determine township, range and section of lake (Executive Summary)
- ✓ Tabulate lake surface area, and maximum and mean depths (Section 1.0 Aquatic Plant Survey Technical Report)
- ✓ Find Water Body Identification Code (WBIC) assigned by WDNR (Executive Summary)
- ✓ Obtain aerial photos of lake (Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Obtain bathymetric map of lake (Section 1.0)
- ✓ Identify sediment characteristics (Section 5.3 Aquatic Plant Survey Technical Report)
- ✓ Use GPS to record locations of specific sites of interest such as plant sampling locations (Section 4.0 and Appendix A&C Aquatic Plant Survey Technical Report)

Fishery & Wildlife

- ✓ Prepare a narrative describing the fish and wildlife community and its relationship to the plant community (Section 2.0 and 3.4 Aquatic Plant Survey Technical Report)
- ✓ Identify any areas designated as "Sensitive Areas" by the WDNR (Section 3.8 Aquatic Plant Survey Technical Report)
- ✓ Identify areas where rare, threatened, or endangered species or species of special concern exist (Section 5.1 and Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Conduct specific surveys as required (NA)

Water Quality

- ✓ Obtain one year of current water quality, including a minimum of five Secchi disk readings from June 1 to August 31 (This is planned to be completed as part of citizen lake monitoring program)
- ✓ Prepare summary of historical data (Section 2.0 Water Quality Monitoring Technical Report)
- ✓ Measure the temperature and dissolved oxygen at one-meter intervals at the deepest point of the lake during the summer (Section 4.4 Water Quality Monitoring Technical Report)
- ✓ Measure nutrient levels for TP, TKN, nitrate, ammonium and nitrite throughout the summer and obtain nutrient budget if available (Section 4.0 Water Quality Monitoring Technical Report)
- ✓ Measure chlorophyll-a concentrations, turbidity, alkalinity, and pH throughout the summer (Section 4.0 Water Quality Monitoring Technical Report)

Water Use

- ✓ Note primary human use patterns in the lake and on shore (Section 6.4)
- ✓ Note areas where use is restricted for any reason (Figure 4.)
- ✓ Collect public survey to gather opinions and perceptions on plant and water conditions (Section 4.3)

- ✓ Note water intakes for public water supply or irrigation (none known)
- ✓ Include the above information on GIS map (Figure 4.)

Watershed Description

- ✓ Provide topographical map showing watershed boundaries, inflows and outflows (Section 1.0 Aquatic Plant Survey Technical Report)
- ✓ Determine watershed area (Section 4.5 Water Quality Monitoring Technical Report)
- ✓ Quantify land use areas within watershed (Section 4.5 Water Quality Monitoring Technical Report)
- ✓ Calculate nutrient loading by area (Section 4.5 Water Quality Monitoring Technical Report)
- ✓ Locate all inputs into lake including streams, drainage ditches, drain tile, etc. (2008 City of Portage Stormwater Management Plan)
- ✓ Include the above information on GIS map (Section 4.5 Water Quality Monitoring Technical Report)
- ✓ Model the lake and watershed to develop annual nutrient budget (Section 4.5 Water Quality Monitoring Technical Report)

Analysis

- ✓ Identify management objectives needed to maintain and restore beneficial uses of the lake (Sections 6.2 through 6.8)
- ✓ Create maps and overlays of the information from the inventory and interpret the results (Section 5.0 and Appendix A&C Aquatic Plant Survey Technical Report)
- ✓ Identify target levels or intensity of manipulations (Section 5.3)
- ✓ Map areas proposed for management (Section 6.2)
- ✓ Mapping coordinates should be recorded on a GIS map

Alternatives

- ✓ Plans should include measures to protect the valuable elements of the aquatic plant community as well as measures to control nonnative and invasive plants, plants that interfere with beneficial lake uses, and plants that enhance habitat for fish and aquatic life (Section 6.2 through 6.8)
- ✓ Discuss most common plant control techniques, benefits, drawbacks with vested parties (Sections 4.1 and 4.2)
- ✓ Provide sufficient information regarding the feasibility, costs, and duration of control expected of each alternative (Sections 4.1, 4.2, and 5.4)
- ✓ Discuss the potential adverse impacts of each alternative (Sections 4.1, 4.2, and 5.4)

Recommendations

- ✓ Develop an invasive species prevention program including education and monitoring (Sections 6.3 and 6.8)
- ✓ Implement "Clean Boats, Clean Waters" program (Section 5.6)
- ✓ Involve the public in keeping the lake healthy by finding ways to decrease harmful watershed inputs (Section 6.5 and 6.8)
- ✓ List proposed control actions beyond those strictly necessary for aquatic plant management that will be implemented to achieve desired level of control

(Sections 6.3 through 6.8)

- ✓ Identify specific areas for control on a map and list the level of proposed management (Section 5.5)

Implementation

- ✓ Describe education or prevention strategies needed to maintain and protect the plant community (Section 6.8)
- ✓ Describe how all the management recommendations will be implemented, the methods and schedules applicable to the operation, including, timing, capital, operational cost estimates, and maintenance schedules if applicable. Describe the roles and responsibilities of the persons and/or organizations involved in the management process (In each appropriate section 6.2 through 6.8 and 7.0)
- ✓ Describe how the public will be involved (Section 6.8)
- ✓ Prepare a budget and identify funding sources, including plans for grant application (Section 5.7)
- ✓ Describe the process by which the plan will be adopted, revised, and coordinated, with WDNR approval (Section 5.6)

Monitoring and Evaluation (Lakes with Known Invasive Populations and Following Management Actions)

- ✓ Monitor for invasive aquatic plants in early spring and twice in the summer Perform quantitative plant survey at least once every five years (Section 6.7)
- ✓ Track diversity indices such as FQI for early warning signs of decreasing diversity or water quality (Section 6.7)
- ✓ Contract for a professional survey every 3 to 5 years for the presence of exotic species and for updating the native plant list (Section 6.7)
- ✓ For lakes with known exotics, sample more often, use the rake method, and sample areas of know infestation, major inlets, and boat launches (Section 6.7)
- ✓ Following management activities collect basic water chemistry and physical parameters such as TP, TKN, temperature, pH, dissolved and dissolved oxygen at a mid lake site and within each management zone (Section 6.2)

6.2 Annual Integrated Aquatic Plant Management Program

The City of Portage will continue with its current aquatic plant harvesting program. At this time, plant management is for nuisance relief rather than large-scale restoration. The Municipal Services Committee will be responsible for overseeing the program and will present annual reports to the City. The reports will contain the following information:

- ➢ Start and end dates for management activities
- ➢ Total area managed
- ➢ Total tons of wet plant material removed
- ➢ Total cost of operations
- ➢ Most common plants targeted
- ➢ List and map of areas managed with total number of events in each area

The City of Portage will appropriate annual funding and a final budget will be provided to the committee no later than December 31 for the upcoming management season. Mechanical harvesting and selective herbicide applications will all play an important role in future management strategies and need to be used when best suited for particular situations. Herbicide applications will control EWM in areas of new, isolated infestation or when control is required in areas not safe for harvesting. Harvesting EWM should be limited. Harvesting efforts should focus on maintaining navigational channels and not control. When control of EWM is required selective herbicides should be used early in the season.

Mechanical Removal Plan

The City will follow a set of guidelines when implementing mechanical harvesting activities. Management efforts will focus on the using harvesting as the primary management tool to achieve adequate and clear navigation. Harvesting will be limited to areas no less than 3' deep to minimize bottom sediment disturbance and protect fish spawning habitat. The harvester may be equipped with a GPS guidance system and navigational channels will be pre-determined by the City prior to harvesting. The GPS guidance system will also have the capability to record and store the path of the harvester while harvesting. General guidelines are broken down based on the target plant species and are as follows:

EWM

Harvesting EWM should be avoided when harvesting other target plants, especially in the west basin. The rationale is that at this concentration and distribution harvesting will not create any more fragmentation than what would naturally occur in the east basin. Annual monitoring of EWM should be followed in order to prevent the further establishment of fragmented EWM in the western basin. EWM found within the western basin should be removed by hand or treated with a selective herbicide and not mechanically harvested. All EWM areas should be mapped and recorded with GPS.

Nuisance Natives

Specifically, Coontail has posed navigational problems historically. Each summer this native plant can become overgrown and impede recreation in the east basin. Harvesting nuisance natives within the designated navigational areas is should be used as needed and assessed on an annual basis.

CLP

Any management efforts for controlling CLP will be focus on control before turion production and release occurs. CLP beds should be monitored and mapped in the spring and compared to the previous CLP beds. It is critical to harvest the CLP as it nears the surface, but before the turions are ready to be released. Monitoring will be instrumental as there is only approximately a two week window between CLP reaching the surface and the turion release phase. CLP management sites may be added or removed based on the City's needs and seasonal variation in plant growth. Presently CLP does not warrant management.

The harvester may also be equipped with a GPS device which can be used to track the harvester's path. GPS information will be useful when reporting plant management activities in annual reports. GPS integrated harvesters can also be set up prior to harvesting with the selected harvesting zones which would help the harvester operator navigate within selected management zones. Grant funding for outfitting the harvester with GPS guidance system should be applied for each grant period until funding is approved.

Selective Herbicide Plan

The City has selected to implement selective herbicide applications as part of their integrated approach when the focus changes to restoration or when harvesting activities are limited due to water depth. The City will solicit bids from professional application firms on an annual basis. The applications should be performed using precision pesticide application methods and technology (GPS/GIS) to ensure accurate application of herbicides within the lake. The City will collect GIS files recorded during herbicide

treatments for their records.

For selective **Eurasian water-milfoil** *(EWM)* herbicide applications, Triclopyr and 2,4-D products should be applied to the water with precision GPS guided application systems. A detailed area map of the application area*(s)* will be generated during the initial aquatic plant survey*(s)* that will allow accurate calculation of the total product required. Granular 2,4-D should be applied at a rate of 200lbs per surface acre in all areas greater than 8 feet in average depth. Where the average depth is less than 8 feet, an application rate of 150lbs per surface acre should be used. Where the average depth is less than 4 feet an application rate of 100lbs per surface acre should be used. Triclopyr products such as Renovate can be applied sub-surface in dosages of 1.5ppm. Product labels should be carefully monitored as recent changes to the label may require extensive set-back distances from water intakes which are loosely defined by regulatory officials. For all selective chemical applications the City should have a residual chemical concentration bioassay performed. Pursuant to chemical label restrictions, an approved assay must indicate a concentration for irrigation and for potable water use below label specifications. Samples should be gathered from within the center of each management zone, at any discharge downstream of an application and at a minimum of one non-treated control site.

The City may also have the need to treat **nuisance native species**, like coontail, filamentous algae, and elodea, for navigational and recreational purposes. The treatments are designed to provide a clear navigation and clean swimming areas. These treatments should be limited to high use recreational areas only and evaluated on an annual basis.

Selective **curly-leaf pondweed** *(CLP)* herbicide applications should occur after ice out ideally when the water temperature is between 50 and 58 degrees Fahrenheit, within each of the predetermined management zones. Liquid Aquathol K will be injected into the water at a concentration of 1.0 to 1.5 ppm. In the small areas require management, granular Aquathol K will be substituted for the liquid formula. If CLP plant densities are greater than 60%, neither liquid nor granular Aquathol K should be used to control plants and the areas should be harvested.

Eurasian water-milfoil and **curly-leaf pondweed** can be treated when occupying the same management zones. This option is best deployed when CLP and EWM are both actively growing in mid-spring. If the situation were to arise, the City will have CLP treated with Aquathol K applied at 1-2 ppm which will control CLP and EWM. Some application systems may have the ability to dispense two different herbicides simultaneously and at different rates. If control of both CLP and EWM is required, an alternative to high Aquathol K concentrations will be to apply Aquathol K at 0.5-1.5 ppm for CLP and granular 2,4-D at appropriate concentrations for EWM based on water volume and plant densities. This herbicide mixture will control both invasive species and should be reviewed annually during pre-management monitoring efforts when both species warrant management.

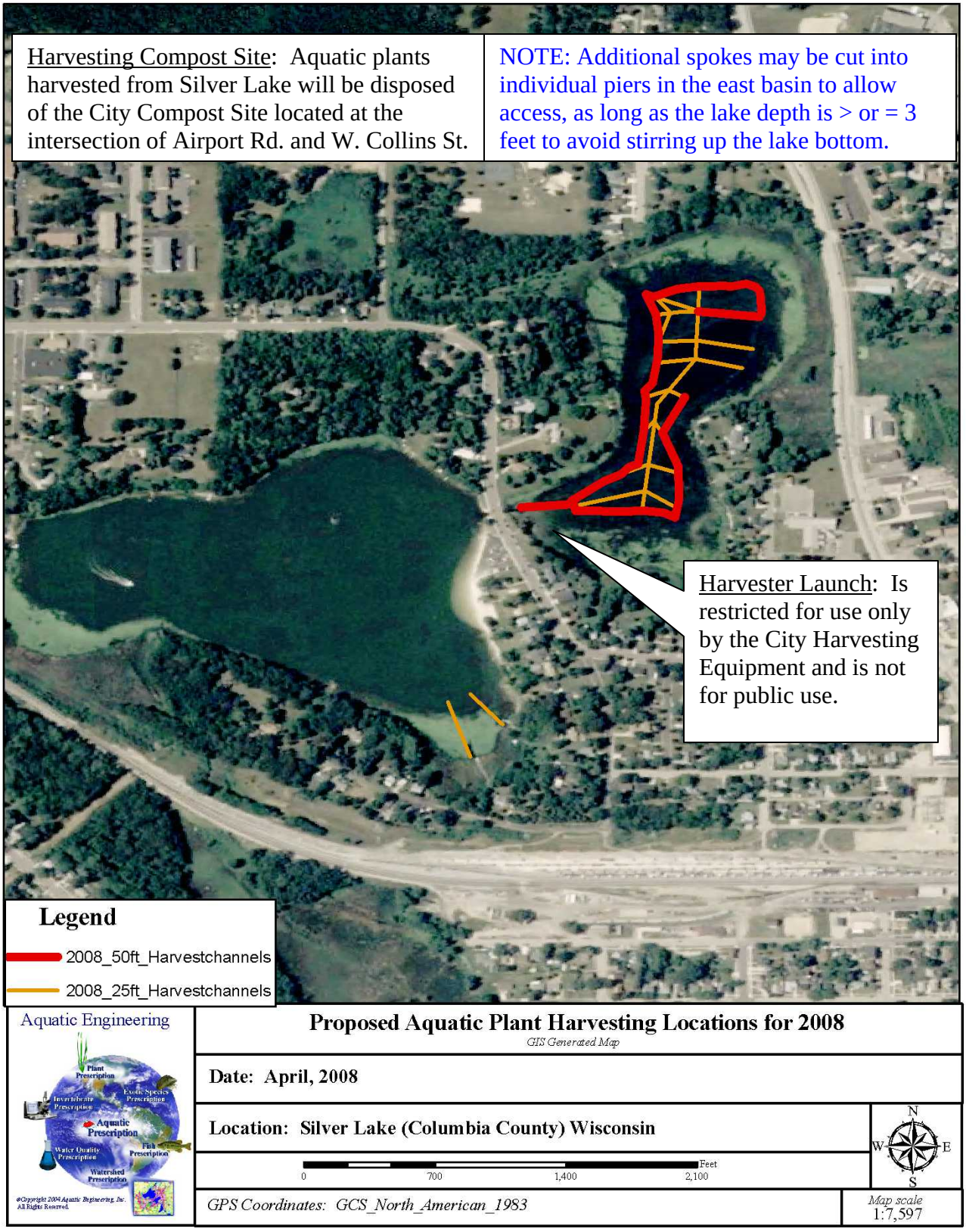


Figure 4. Proposed 2008 mechanical harvesting management map.

6.3 AIS Prevention Program

In addition to mechanical harvesting, the City will monitor for all non-native species. It is important to prevent the spread of invasive species both into and out of the lake. The City will attempt recruit volunteers, organize training sessions, and schedule monitoring events. Volunteers will report monitoring results to the Municipal Services Committee. Monitoring at boat launches should be conducted by volunteers on a weekly basis throughout the growing season (approximately Memorial Day through Labor Day). Volunteer training will be gained through the WDNR's Clean Boats, Clean Waters program. A list of monitors with addresses and phone numbers will be available to each person monitoring the launches in case of an invasive occurrence. The invasive species identified will be verified by two or more monitors and preferably by a DNR APM coordinator. The contact information for the local WDNR warden and regional APM coordinator will also be provided to each volunteer.

Monitoring the lake for CLP should occur in early spring and monitoring for EWM will occur throughout the summer. Such exotic species like: Purple Loosestrife, Flowering Rush, Hydrilla, Silver Carp, Zebra Mussels and Spiny waterflea and many others pose a significant threat to the aquatic ecosystem. Monitoring for present and threatening exotic species will follow WDNR recommendations for monitoring in lakes with known exotics. Areas of previous infestation (Figure 2), inlets, outlets, and boat launches are areas of special concern and will be sampled according to the current guidelines. The recommendations for monitoring can be found at the University of Wisconsin-Extension website: http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp. Information on exotic and invasive plant and animal species that pose a threat to Silver Lake can be found through the Midwest Invasive Plant Network at: http://mipn.org and http://dnr.wi.gov/invasives/index.htm.

6.4 High Recreational Use Area Management

Silver Lake's recreational use is primarily fishing in the east basin and swimming in the west basin. In addition to mechanical harvesting, near-shore areas of high recreational use (around piers, docks and swimming areas) can be managed for nuisance native aquatic vegetation. Riparians may also manage their private shorelines as legally defined

in state statutes NR 107 and NR 109. The only time a permit is not required to control aquatic plants is when a riparian land owner manually removes (i.e. hand-pulls or rakes), or gives permission to someone to manually remove, plants (except wild rice) from his/her shoreline in an area that is 30 feet or less in width along the shore and is not within a Designated Sensitive Area. Riparian property owners can also contract professional aquatic herbicide applicators to manage their nuisance plants. Management within areas containing high value vegetation and areas designated as sensitive should be avoided and will likely be limited by the WDNR. Contact your regional APM coordinator prior to any plant management.

6.5 Water Quality Management

For nuisance releif, Secchi depth, total phosphorus and chlorophyll a should be monitored during the growing season. The City will follow WDNR guidelines, which recommend a full water quality analysis one year out of every three. This will include Secchi depth monitoring, depth profiles for temperature and dissolved oxygen and water quality laboratory analysis for TP, TKN, TSS and chlorophyll *a*. Samples will be collected in a manner consistent with the 2006 sampling protocols. Participation in the DNR citizen based monitoring program will also occur each year. Secchi depth will be collected by a volunteer every other week through the growing season. Results will be reported to the DNR annually.

For any large scale restoration management activities, the City should collect basic water chemistry and physical parameters such as TP, TKN, temperature, pH, and dissolved oxygen at a mid lake site and within each management zone. These parameters are important aspects of the lake ecosystem and may be impacted as a result of mechanical harvesting. The regional APM coordinator may request other specific monitoring as part of the permitting process for aquatic plant management. The City will conduct the monitoring themselves, enlist the help of volunteers, or contract a professional management firm to perform necessary water quality monitoring.

The City should have a complete hydrologic budget, nutrient budget, and nutrient response modeling performed for Silver Lake in conjunction with stormwater planning

efforts. Efforts will focus on determining the source of nutrients and specifically identify the amount of internal loading occurring each year. The information will help the City select management practices that get the most results for their costs.

6.6 Fishery Management

The WDNR will continue to manage fish populations within Silver Lake through monitoring and stocking. Stocking efforts will be required if the lake experiences frequent fish kills, over fishing or poor reproductive success. Panfish may become stunted in the absence of predator fish, so predator fish populations should be assessed regularly to determine the need for fishery management. Predator fish will also help keep carp and other rough fish species in check.

Besides stocking efforts, size and daily bag limitations can help fish populations that are suffering from high fishing pressure. The WDNR and some private consulting firms are properly equipped to perform thorough surveys and will be contacted to perform such surveys at the discretion of the City.

6.7 Plant Monitoring

The City of Portage will continue to monitor the aquatic macrophyte community qualitatively every year and quantitatively every five years. The purpose of qualitative surveys will be to monitor the locations of exotic species (CLP and EWM), locate and map areas where aquatic plants create nuisance conditions, and maintain a current inventory of aquatic species. The FQI will be calculated after each qualitative survey and compared to previous values. This assessment will give the City a strong record of baseline plant community data which will be used in the future to objectively determine an improvement or decline in the general “disturbance” of the lake ecosystem. Although the FQI is a quick indicator of disturbance, quantitative surveys should be used as the indicator of a changing plant community.

Quantitative surveys will occur every three to five years and will be performed concurrently with qualitative surveys. These surveys will provide objective values the City will use to evaluate the condition of the aquatic plant community within the lake.

Only the quantitative surveys will be used to determine if a shift in the aquatic plant community has occurred.

6.8 Public Outreach

Public involvement will be solicited through the following methods

- Implementing the public education campaign (section 5.6 and 6.3)
- Partnering with the River Crossing School
- Participation with the Columbia County Lakes and Rivers Association
- Present the Aquatic Plant Management Plan to County and DNR for support
- Schedule expert speakers for membership meetings
- Compose a series of educational articles and links which will be located on the City's website

7.0 Implementation Responsibilities, Tasks, and Deadlines

Responsibility	Task	Deadline
Annual Harvesting Program		
	City Budget Appropriations	December 31, annually
	Harvester operator hiring/training	May 1, annually
	Begin harvesting date	June 1, annually
	Record harvesting information	Daily
	End harvesting date	September 1, annually
	Annual harvesting report	October 31, annually
	Harvester maintenance	Weekly
AIS Prevention		
	CBCW Recruiting volunteers	April 15, annually
	CBCW Training volunteers	June 1, annually
	CBCW Scheduling volunteers	June 1, annually
	Organizing data gathered by volunteers	Weekly
	Organizing volunteer and DNR contact lists	June 1, annually
	Contracting professional monitoring	June 1, annually
High Recreational Use Area Management		
	Land owner management	Annually, as needed
	Professional management	June 1, annually
	Tracking management data	October 31, annually
Water Quality Management		
	Citizen based monitoring program	June 1, annually
	Recruiting volunteers	April 15, annually
	Training volunteers	June 1, annually
	Scheduling volunteers	June 1, annually
	Professional water quality monitoring	June 1, annually
	Watershed BMP's	Annual, annually
	Professional hydrologic budget, nutrient budget, and nutrient modeling	2009-2010

Fishery Management		
	DNR fish survey request	Every 3-5 years
Plant Monitoring		
	Annual qualitative survey	June-August, annually
	Annual FQI calculation	Every 3-5 years
	Professional survey every 3 to 5 years	Every 3-5 years
Public Outreach		
	Invasive species prevention	See above
	Water quality management	See above
	Volunteer recruitment	April 15, annually
	City website development	October 31, 2009
APMP Update		
	City updates their current APMP plan	2012

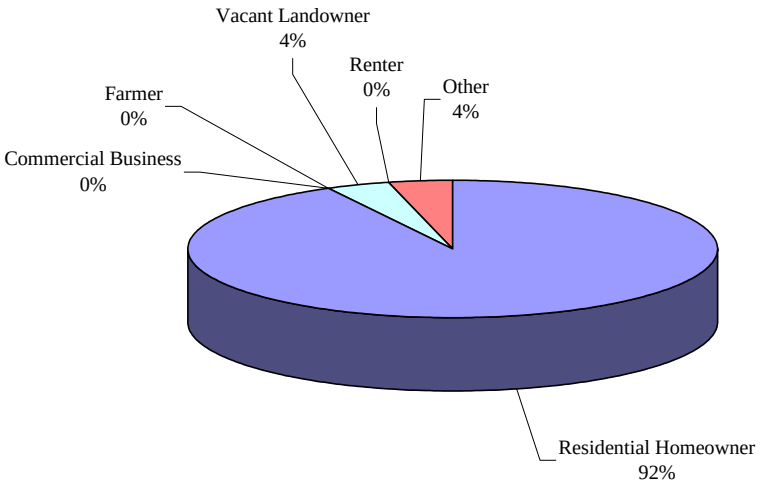
8.0 References

Holdren, C., W. Jones, and J. Taggart. 2001. Managing Lakes and Reservoirs. N. Am. Lake Manage. Soc. And Terrene Inst., in coop. with Off. Water Assess. Watershed Prot. Div. U.S. Environ. Prot. Agency, Madison, WI.

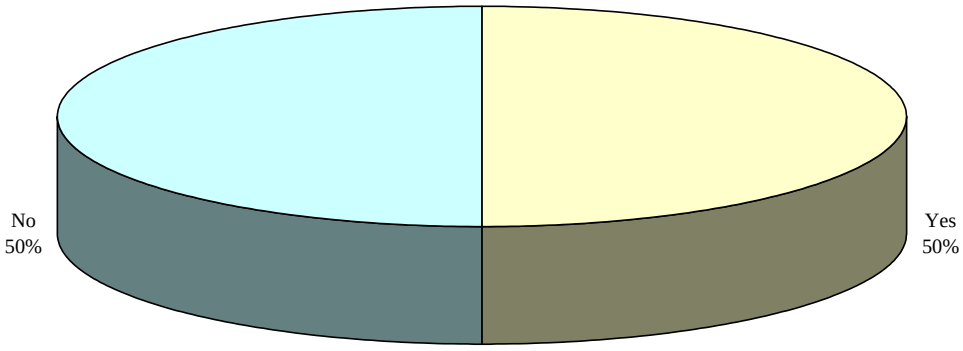
Wisconsin Department of Natural Resources. 2004. Eurasian water-milfoil brochure (PUB-WT-781 2004).

Appendix A – Public Use Survey Results

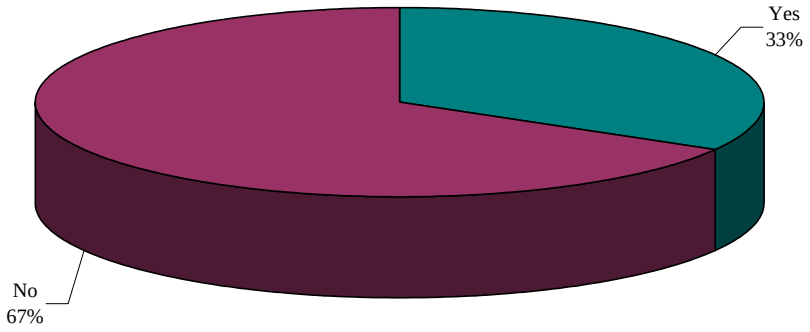
1. What type of property owner are you?
(26 of 27 responded)



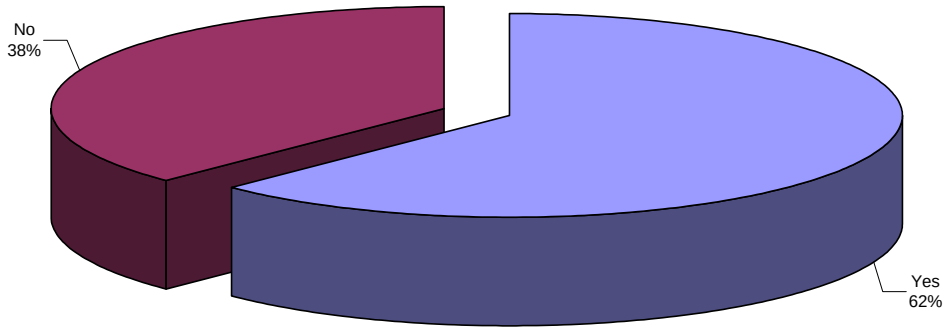
2A. Are you opposed to paying a special assessment fee on your property taxes as a way for the City of Portage to raise money for lake management activities?
(24 of 27 responded)



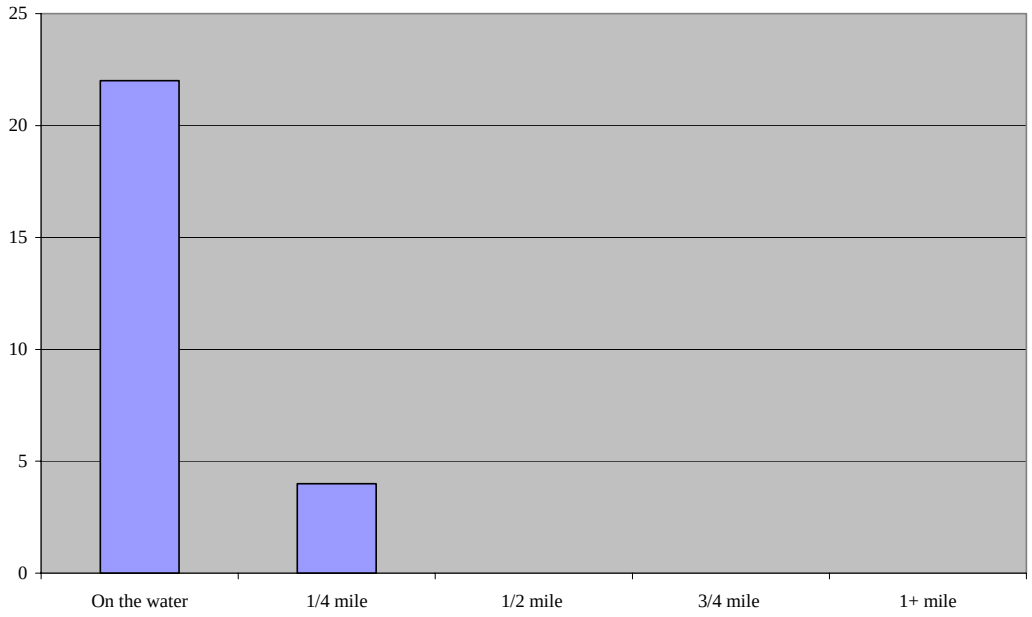
2B. Are you a dues-paying resident of a Lake Association?
(24 of 27 responded)



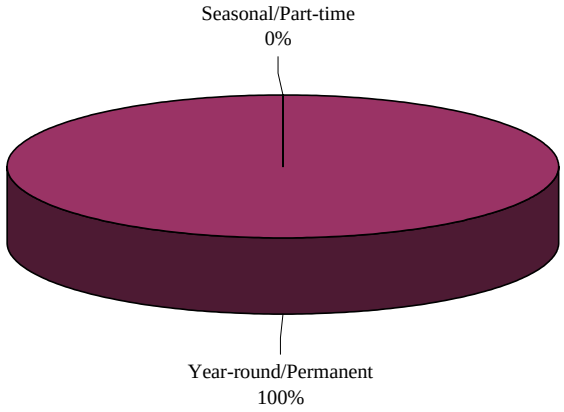
2C. Would you be interested in forming a Lake Association?
(24 of 27 responded)



3. Approximately what distance from the lake is your property located?
(26 of 27 responded)



4. Which of the following best describes your residency status?
(27 of 27 responded)



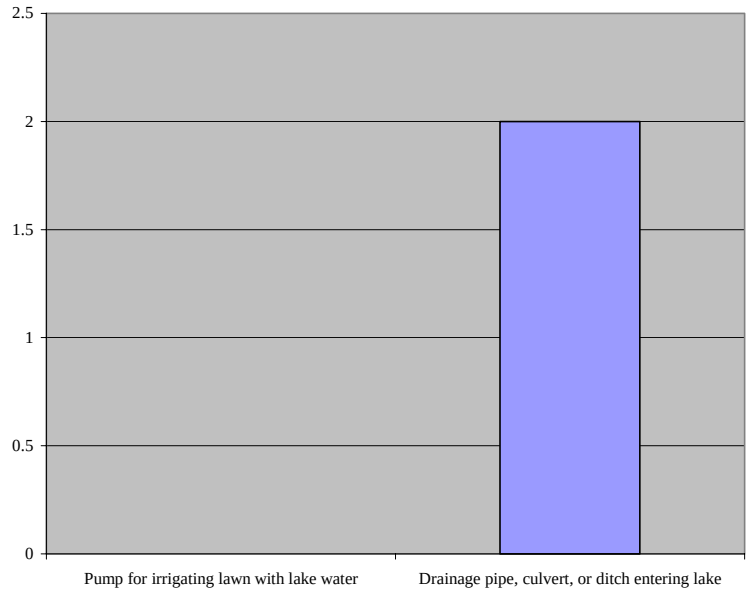
5. What is the average number of people living at your residence? (27 of 27 responded)

2.4 persons

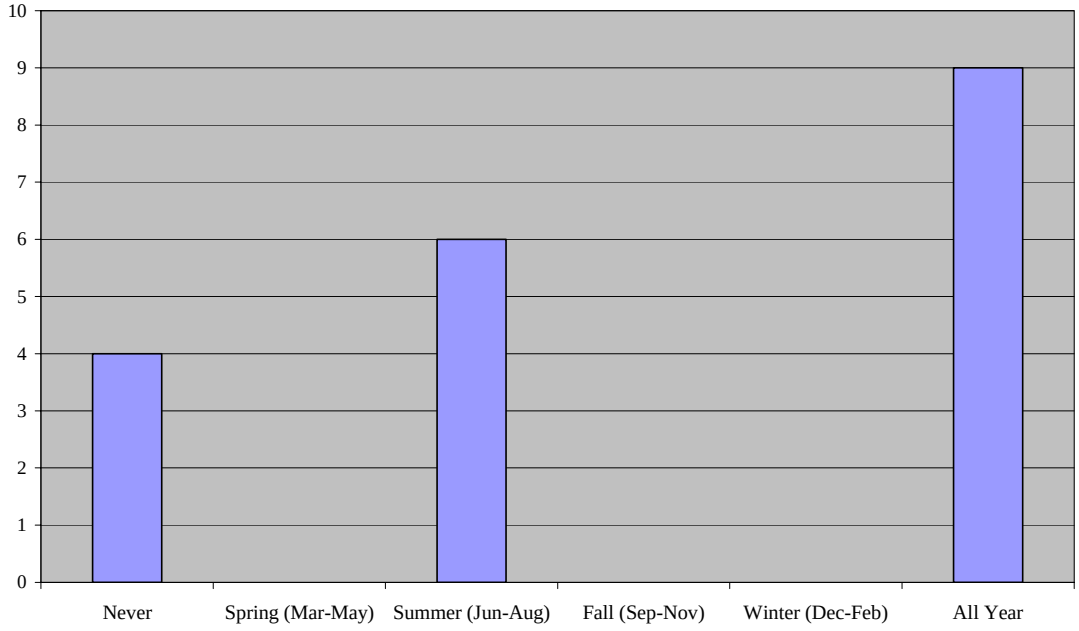
6. What is the average number of days per year you are at your residence? (26 of 27 responded)

363 days

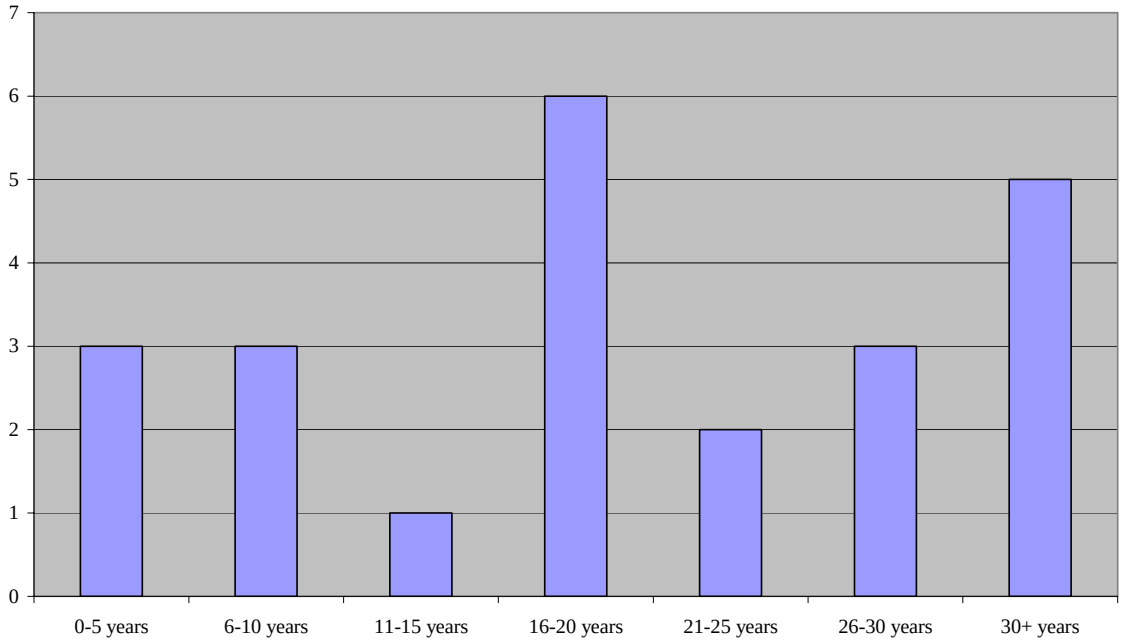
7. Do you have any of the following at your residence?
(2 of 27 responded)



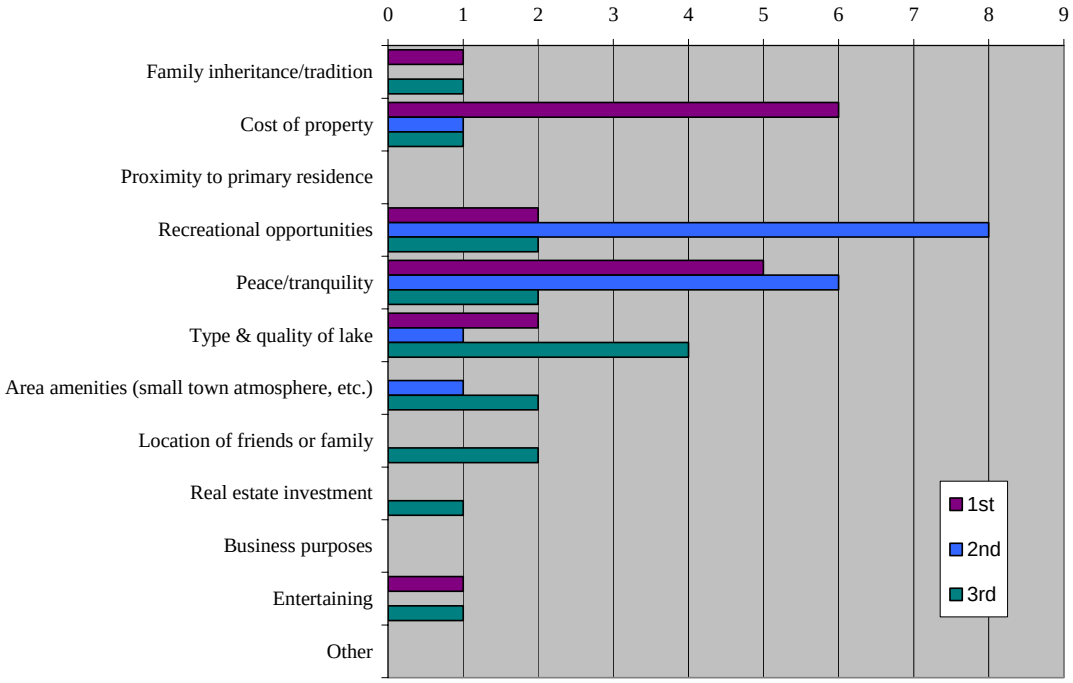
8. When do you most often spend time recreating on your lake?
(19 of 27 responded)



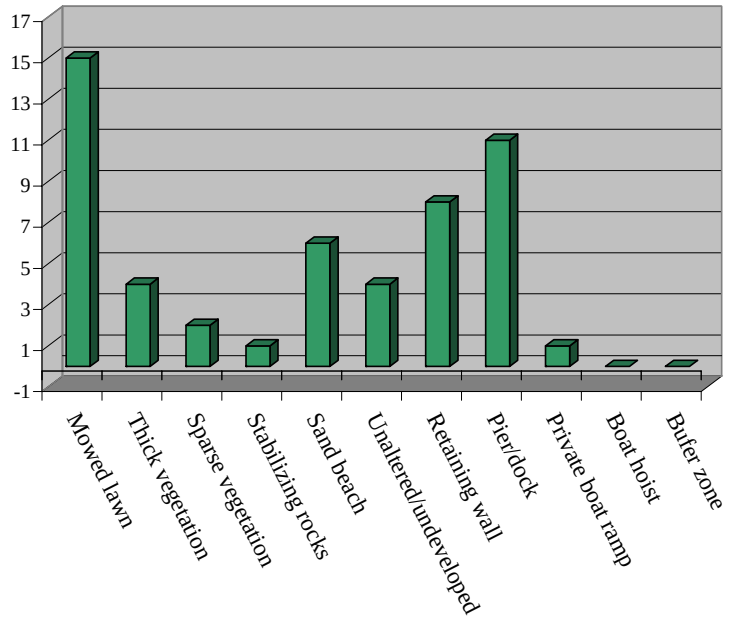
9. How many years have you owned property in your lake District?
(23 of 27 responded)



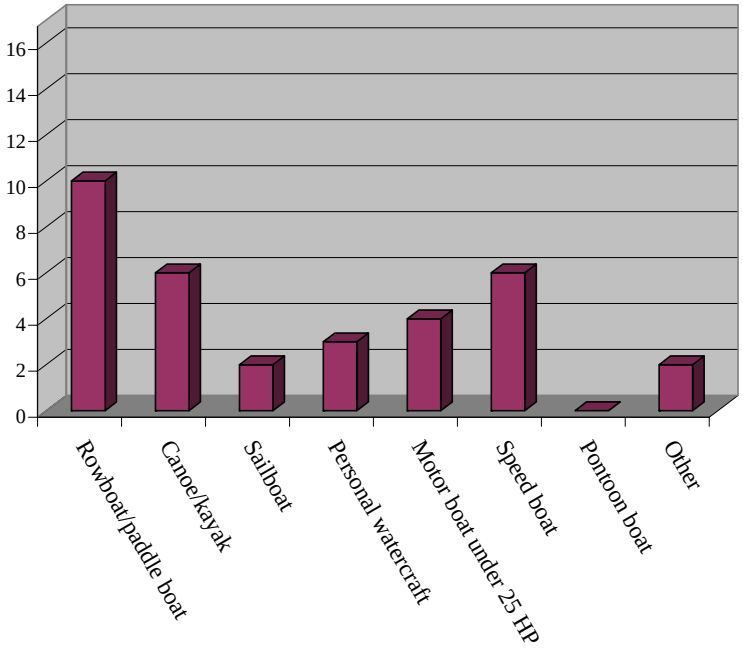
10. List the top three reasons why you chose to own property on or near your lake?
(17 of 27 responded)



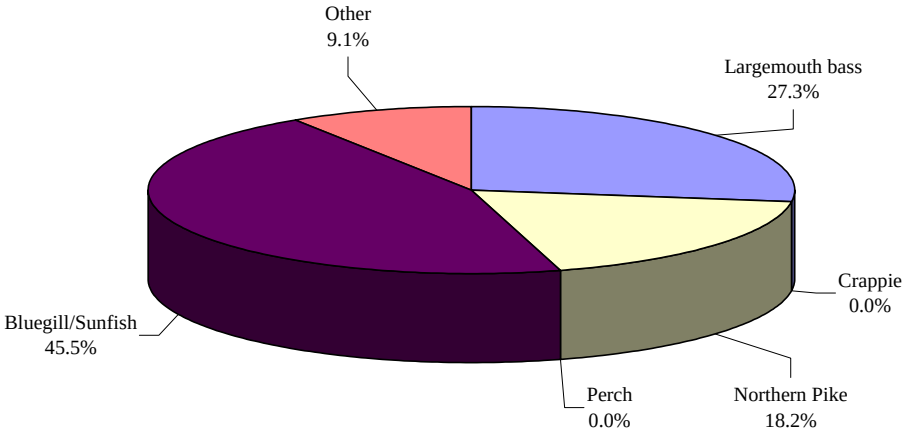
11. If you own lakefront property, which of the following describes your lake frontage within 25 feet of the water's edge? (Check all that apply.)
(17 of 27 responded)



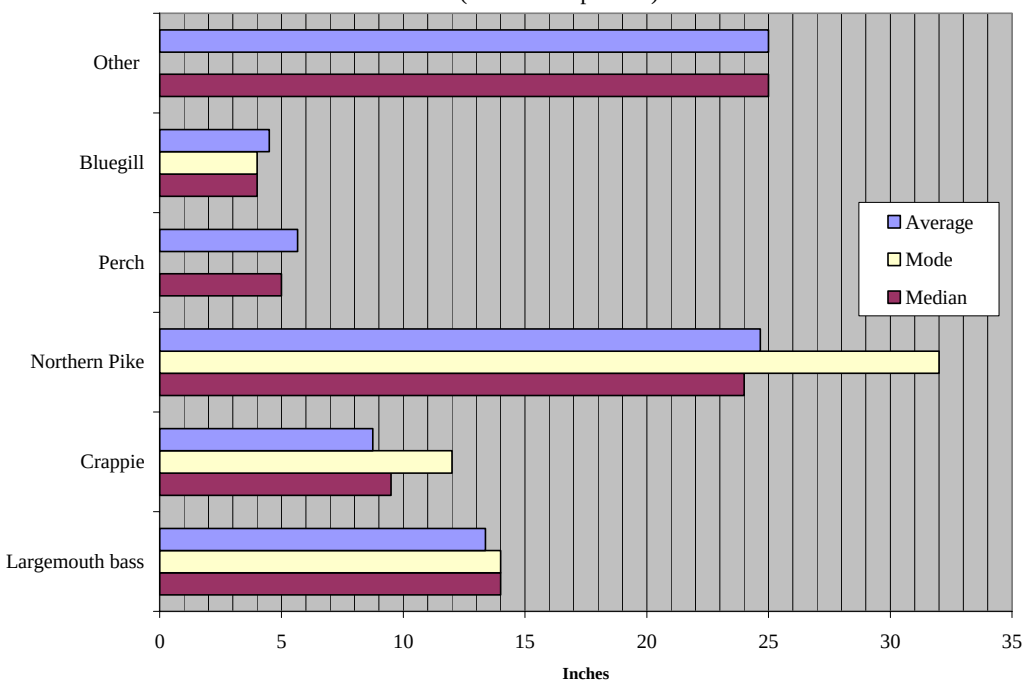
12. What types of watercraft do you routinely use on your lake? (Check all that apply.)
(17 of 27 responded)



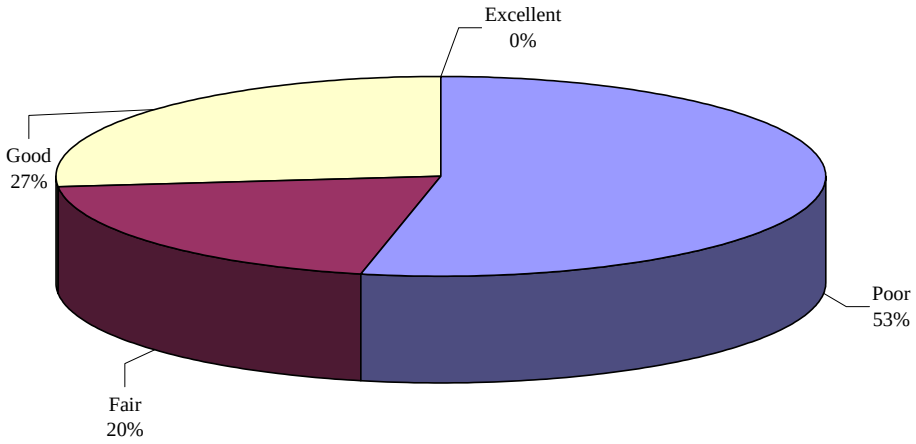
13A. Rank the following fish species that you prefer to catch on your lake?
(shows % of people that ranked each species #1)
(11 of 27 responded)



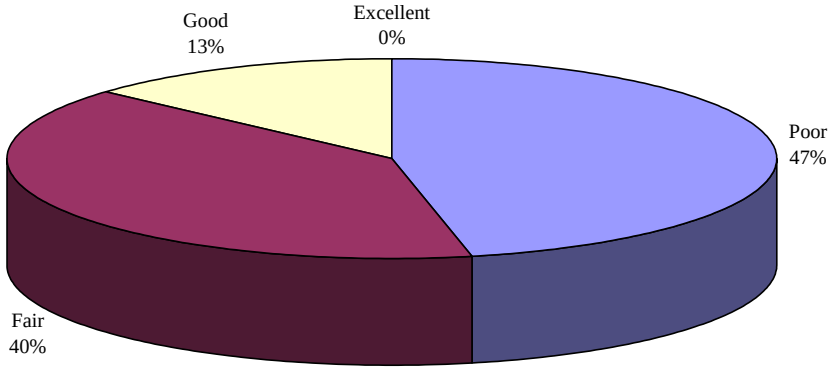
13B. What is the average size of each type of fish that can be caught on your lake?
(10 of 27 responded)



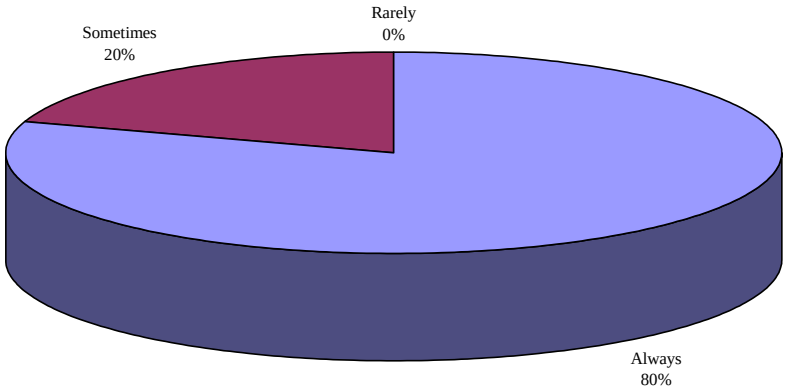
13C. How would you rate the quality of fishing on your lake in terns of fish SIZE?
(15 of 27 responded)



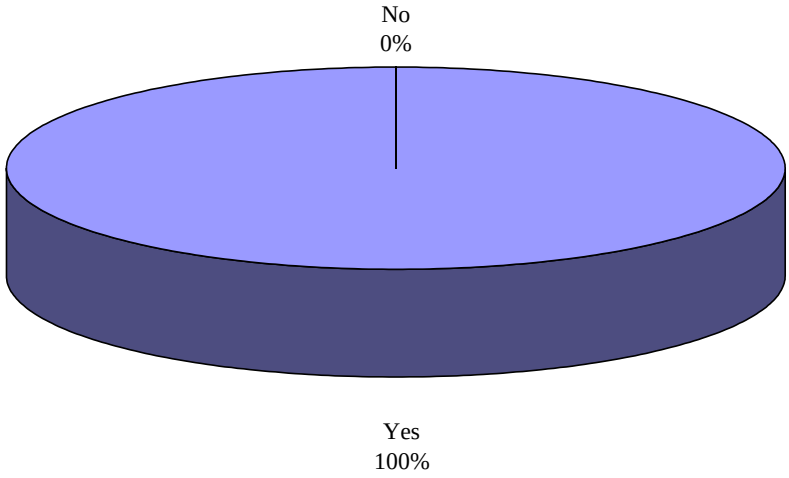
13D. How would you rate the quality of fishing on your lake in terns of fish NUMBERS?
(15 of 27 responded)



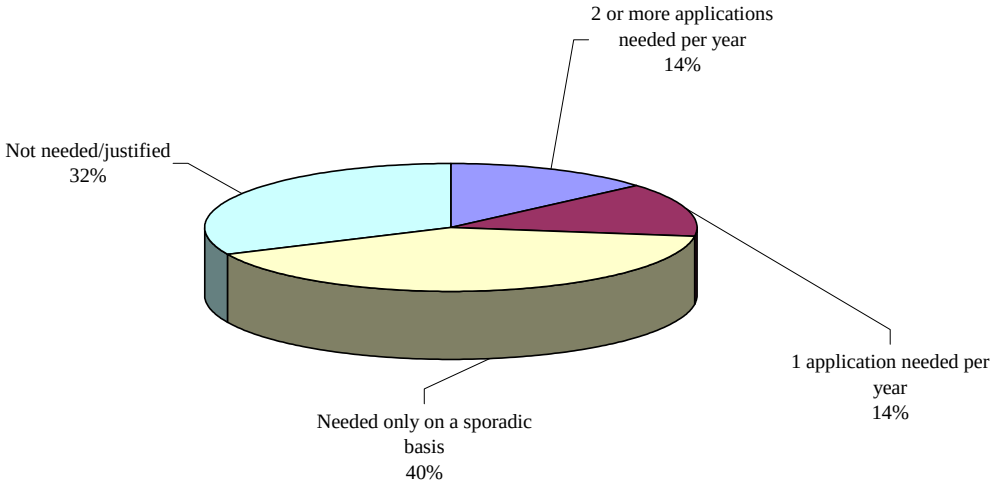
13E. Do you voluntarily practice "catch and relaese" when fishing for species other than panfish?
(15 of 27 responded)



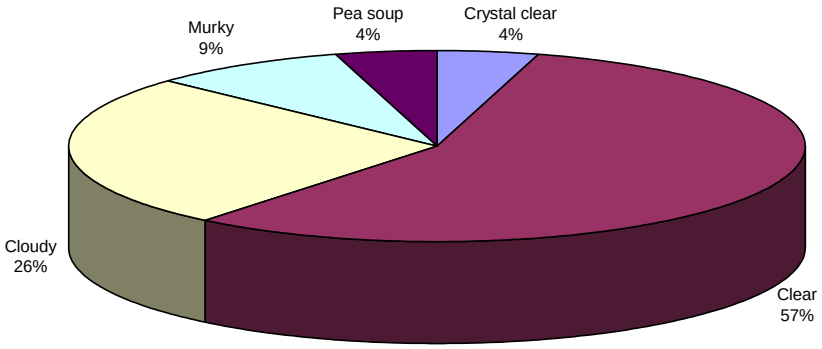
14. Do you feel your lake has more than adequate public access?
(21 of 27 responded)



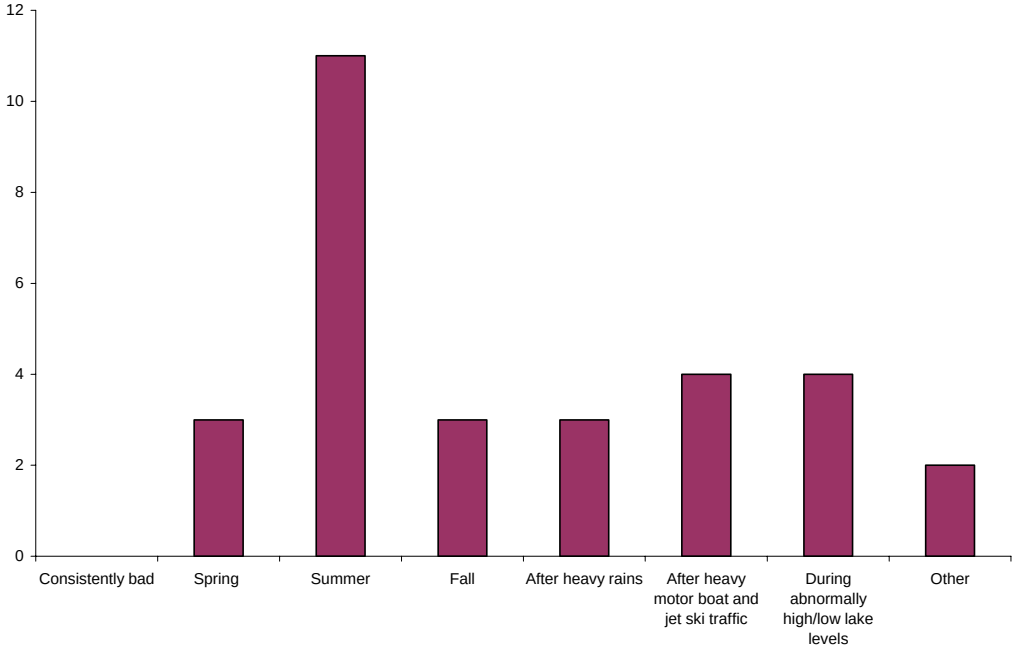
15. What is your opinion regarding the use of fertilizers and/or weed killer to maintain lawns around your lake (check all that apply)
(22 of 27 responded)



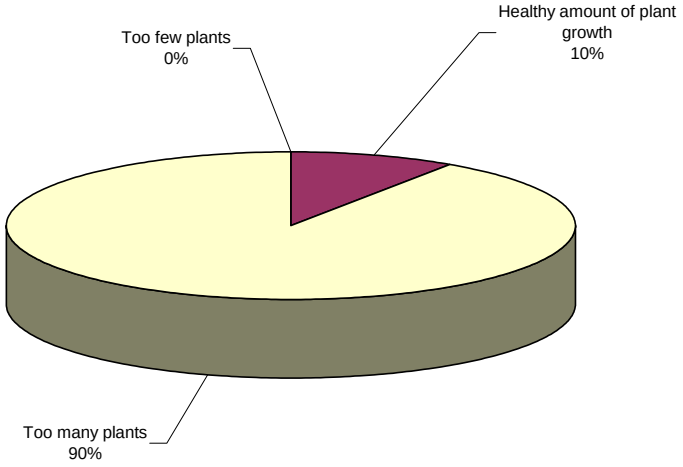
16. Overall, how would you descibe the water clarity in your lake during the winter months?
(23 of 27 responded)



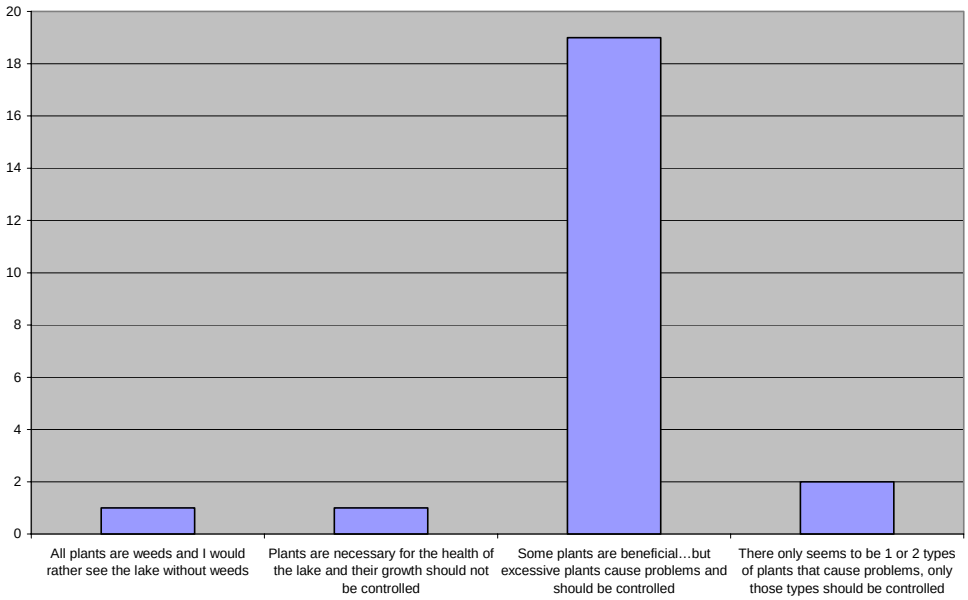
17. When is water clarity at its worst? (check all that apply)
(18 of 27 responded)



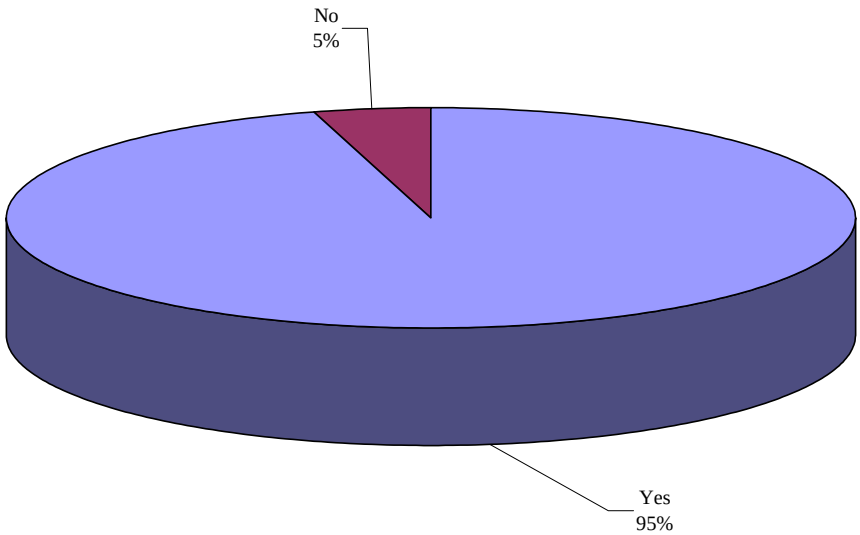
18. Overall, how would you describe your lake's aquatic plant growth?
(21 of 27 responded)



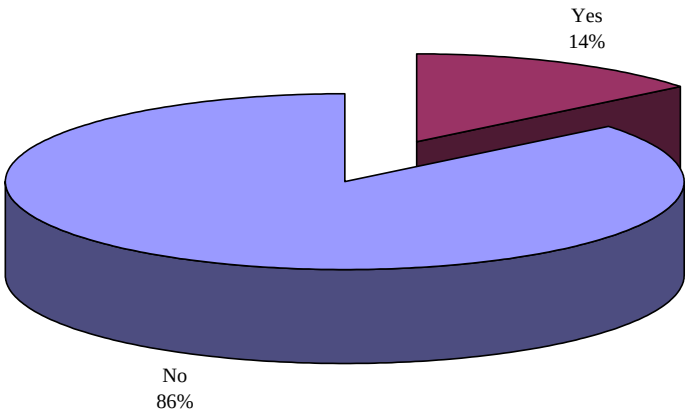
19. Which best describes your attitude toward aquatic vegetation within the lake?
(23 of 27 responded)



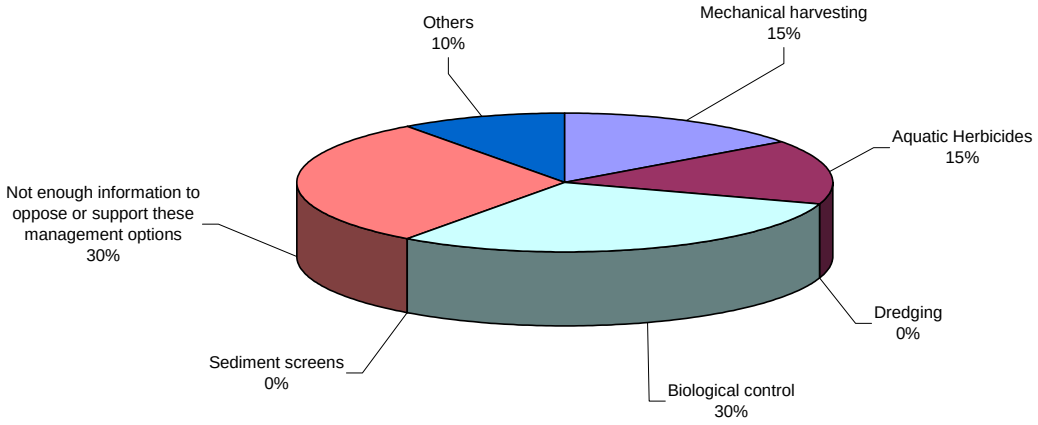
20. Are there areas on the lake where aquatic plant growth becomes especially problematic?
(22 of 27 responded)



21A. Do you feel the current weed management program is effectively controlling nuisance plant growth?
(21 of 27 responded)

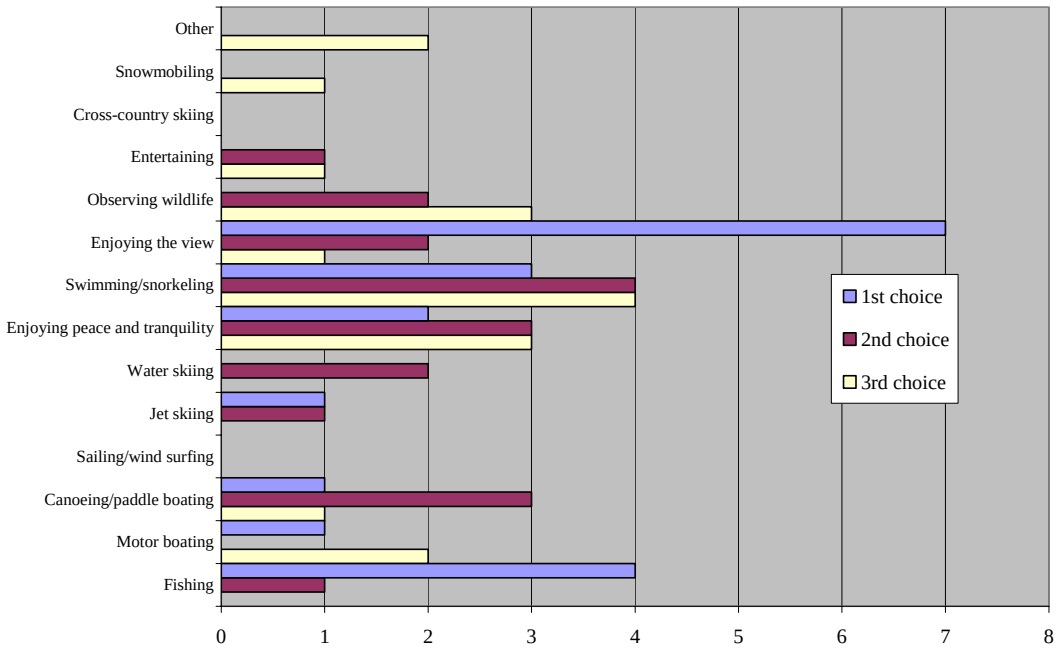


21B. Check any of the following plant management technicques you would NOT support:
(20 of 27 responded)



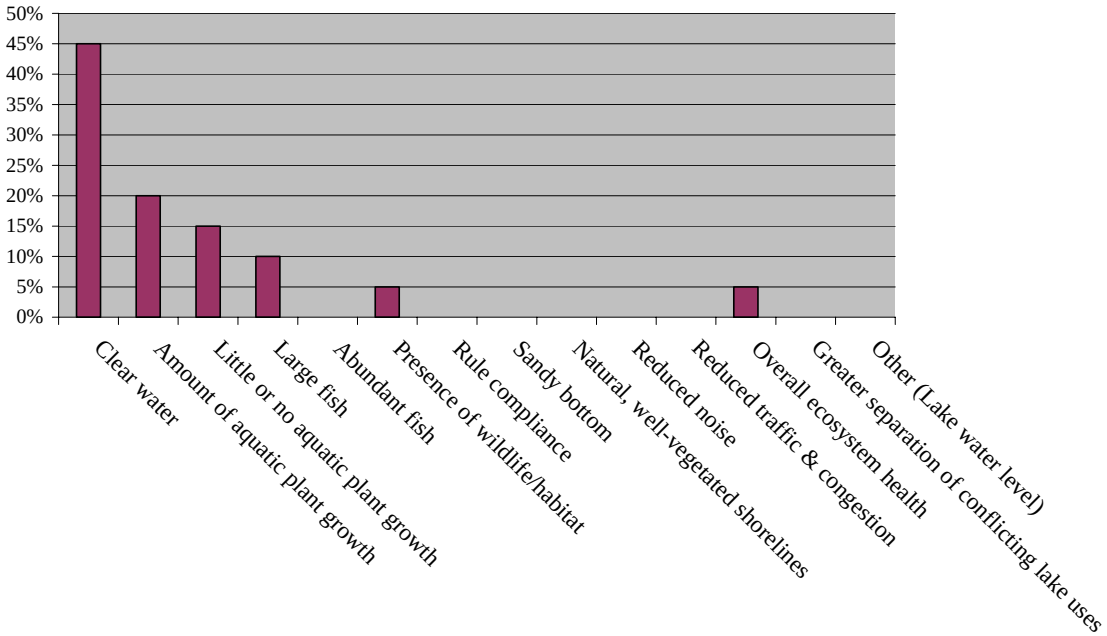
22. What activities do you and the members of your household most enjoy while recreating on your lake? (List the letters of your top three choices)

(19 of 27 responded)

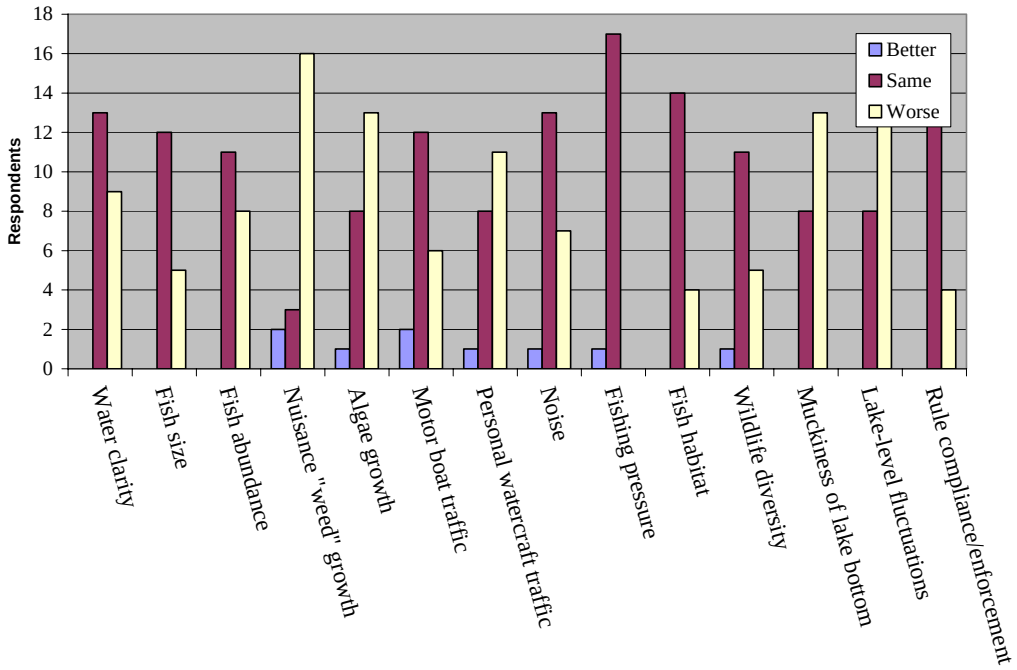


23. Rank the following according to their level of importance to you. (% ranked #1)

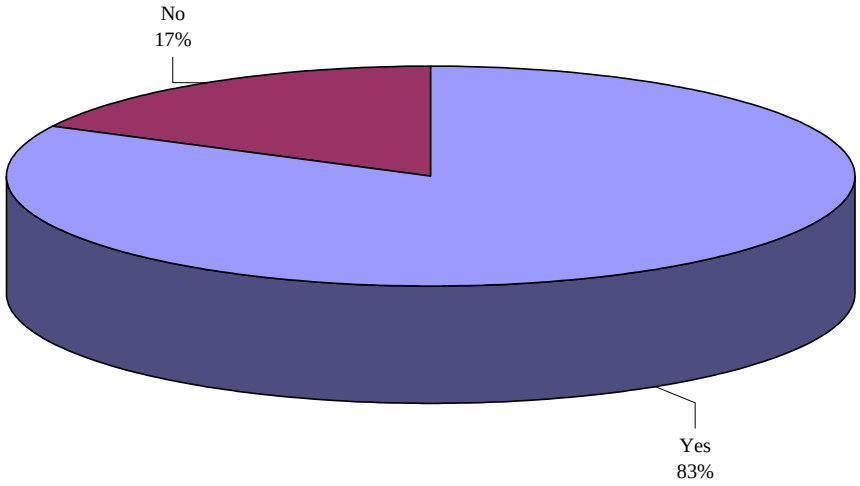
(20 of 27 responded)



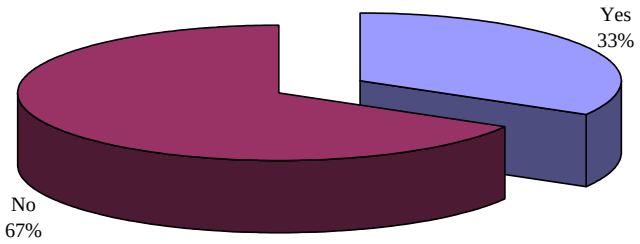
24. How have the following changed since you've lived on or near your lake?
(22 of 27 responded)



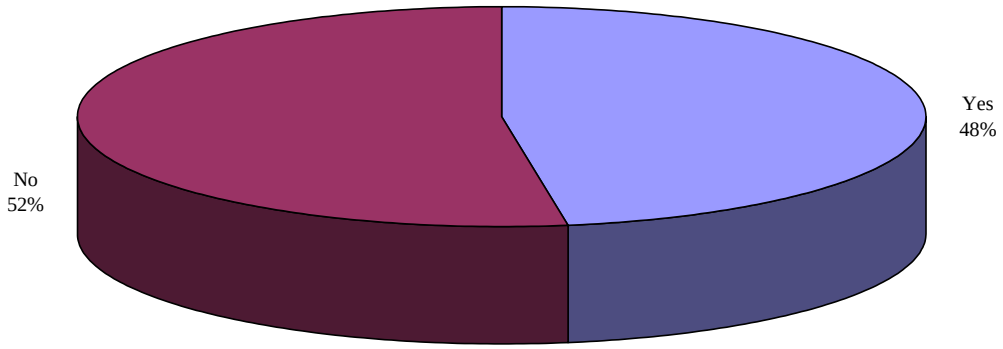
25. Do you feel that there is an adequate law enforcement presence on your lake?
(23 of 27 responded)



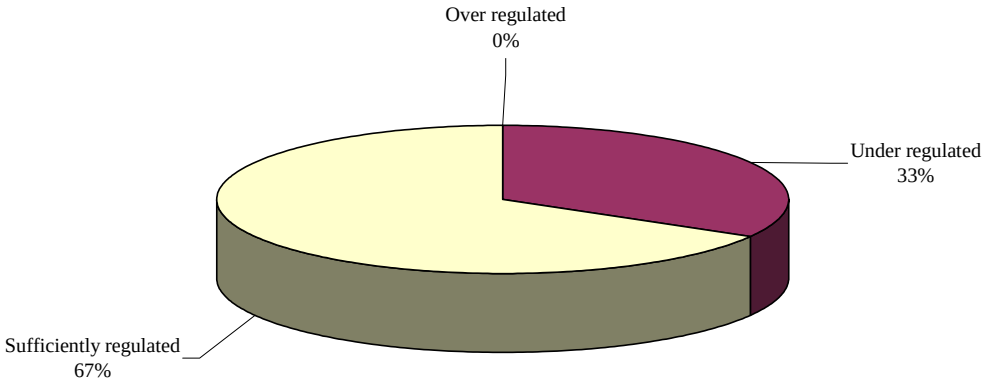
26. Are there any types of behavior, recreational activities or lake uses that you believe are seriously jeopardizing the health and safety of the lake?
(21 of 27 responded)



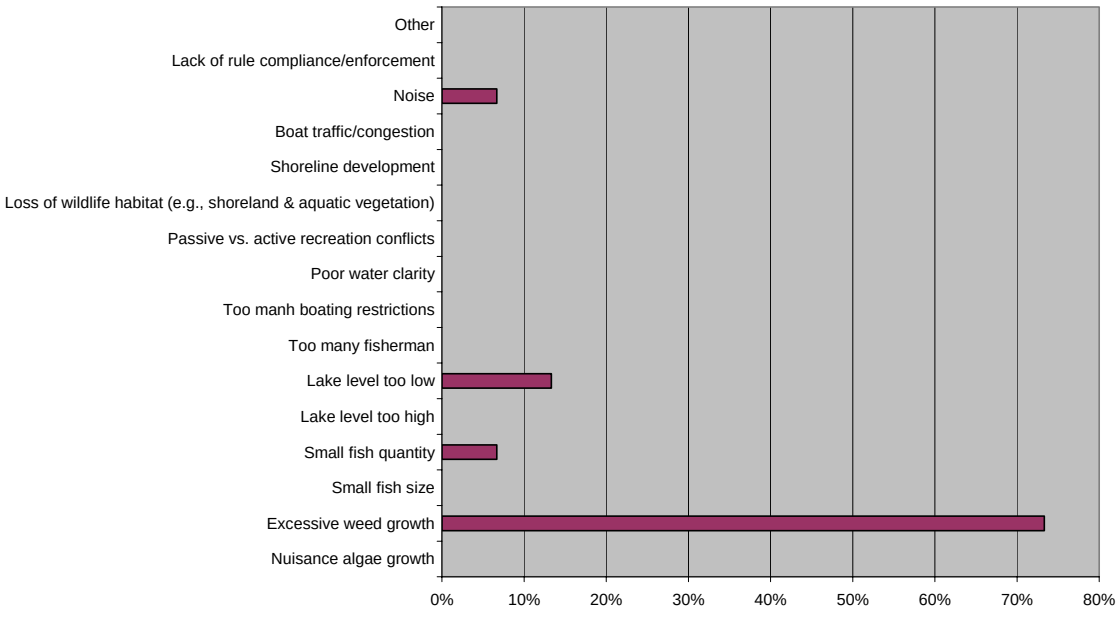
27. Would you be in favor of expanding "slow-no-wake" times and/or locations to promote safety and protect sensitive habitat areas on your lake?
(21 of 27 responded)



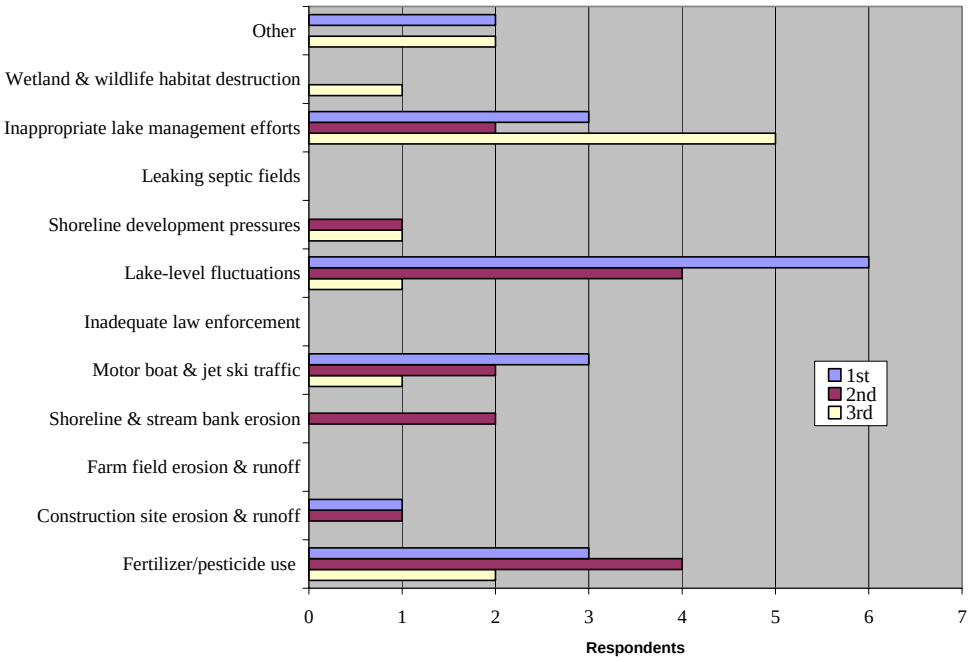
28.What is your opinion regarding lake-use regulations on your lake in general?
(21 of 27 responded)



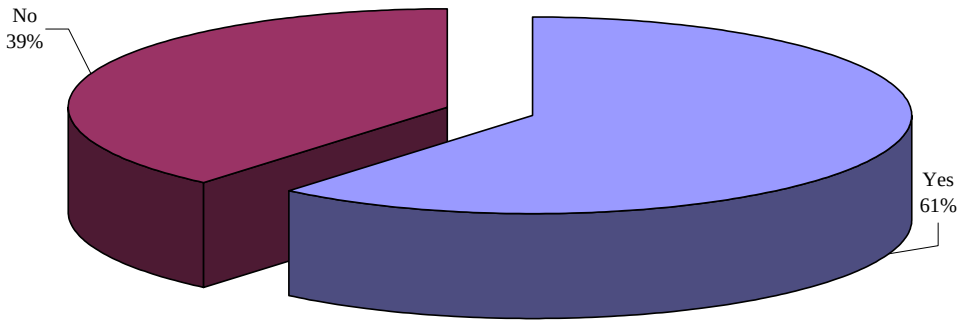
29. Rank the following according to the degree each condition negatively impacts your use or enjoyment of your lake? (Shows % of people who ranked each category #1)
(15 of 27 responded)



30. What do you feel are the top three factors that contribute to problems an your lake? (list the letters of your top three choices) (18 of 27 responded)



31. Do you feel that you have a voice in decision-making matters regarding the management of your lake?
(18 of 27 responded)



32. Can you identify the non-native species? (27 of 27 responded)