Long Lake

Manitowoc County, Wisconsin

Aquatic Plant Management Planning Project

Revised January 2011

Sponsored by:

Long Lake Advancement Association
Town of Rockland
WDNR Aquatic Invasive Species Grant Program

AISEPP-103-08

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Lake Management Planning

Long Lake

Manitowoc County, Wisconsin

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December 2010

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Funded by: Long Lake Advancement Association
Wisconsin Dept. of Natural Resources
AEPP-103-08

Acknowledgements

This management planning effort was truly a team-based project and could not have been completed without the input of the following individuals:

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1.0 INTRODUCTION

Long Lake, Manitowoc County, is a 120 acre seepage lake with a maximum depth of 38 feet (Map 1). Previous studies have described the lake as being eutrophic due to its high phosphorus concentration, elevated algae levels and excessive aquatic plant growth. The lake is known to harbor two invasive plant species, Eurasian water milfoil (EWM) and Curly leaf pondweed (CLP). There are several lakes (Becker and Bullhead Lakes) within 2 miles of Long Lake that are known to contain both of these invasive plant species as well.

The Long Lake Advancement Association (LLAA) is concerned with increasing amounts of Eurasian water milfoil within Long Lake, Manitowoc County. The association has been involved in developing a management plan for the lake over the past 5 years and would like to continue that effort by developing an Aquatic Plant Management (APM) Plan for Long Lake The APM plan would follow the latest version of the WDNR draft document Aquatic Plant Management in Wisconsin (April 20, 2006). Considering the level of EWM that is reported to occur within the lake, it is anticipated that the Long Lake APM plan would be considered a Level 3 plan in the guidance document. The guidance document, in its entirety, is available for downloading, viewing, and printing at the University of Wisconsin Extension website (http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp).

2.0 STAKEHOLDER PARTICIPATION

Stakeholder participation is an important part of any management planning exercise. During this project, stakeholders were not only informed about the project and its results, but also introduced to important concepts in lake ecology. The objective of this component in the planning process is to accommodate communication between the planners and the stakeholders. The communication is educational in nature, both in terms of the planners educating the stakeholders and vice-versa. The planners educate the stakeholders about the planning process, the functions of their lake ecosystem, their impact on the lake, and what can realistically be expected regarding the management of the aquatic system. The stakeholders educate the planners by describing how they would like the lake to be, how they use the lake, and how they would like to be involved in managing it. All of this information is communicated through multiple meetings that involve the lake group as a whole or a focus group called a Planning Committee, the completion of a stakeholder survey, and updates within the lake group's newsletter.

The highlights of this component are described below in chronological order. Materials used during the planning process can be found in Appendix A.

Kick-off Meeting
On May 3, 2008, a project kick-off meeting was held at the Rockland Town Hall to introduce the project to the general public. The meeting was announced through a mailing and personal contact by LLAA board members. The approximately 21 attendees viewed a presentation given by Eddie Heath that started with an educational component regarding general lake ecology and ending with a detailed description of the project including opportunities for stakeholders to be involved. Mr. Heath's presentation was followed by a question and answer session.

Stakeholder Survey
During October 2009, an eight-page, 34-question survey was mailed to 191 riparian property owners in the Long Lake watershed. 49.7 percent of the surveys were returned and those results were entered into a spreadsheet by members of the Long Lake Planning Committee. The data were summarized and analyzed by Onterra for use at the planning meetings and within the management plan. The full survey and results can be found in Appendix B, while discussion of those results is integrated within the appropriate sections of the management plan.

Planning Committee Meeting I
On March 3, 2010, Tim Hoyman of Onterra met with eight members of the Long Lake Planning Committee for nearly 2 ½ hours. The primary focus of this meeting was the delivery of the study results and conclusions to the committee. Results from Eurasian water milfoil and Curly-leaf pondweed surveys and native aquatic plant inventories were presented and discussed. Many concerns were raised by the committee, including water quality degradation, ways of dealing with exotic plant species, and more.

Plan Acceptance Meeting
On June 26th, 2010, the LLAA met to discuss a draft version of the Implementation Plan. At this meeting, a vote was held and the group decided unanimously to continue forward with the Implementation Plan.

3.0 RESULTS

Aquatic Plants

Introduction

Although the occasional lake user considers aquatic macrophytes to be "weeds" and a nuisance to the recreational use of the lake, the plants are actually an essential element in a healthy and functioning lake ecosystem. It is very important that lake stakeholders understand the importance of lake plants and the many functions they serve in maintaining and protecting a lake ecosystem. With increased understanding and awareness, most lake users will recognize the importance of the aquatic plant community and their potential negative effects on it.

Diverse aquatic vegetation provides habitat and food for many kinds of aquatic life, including fish, insects, amphibians, waterfowl, and even terrestrial wildlife. For instance, wild celery (*Vallisneria americana)* and wild rice (*Zizania aquatica* and *Z. palustris*) both serve as excellent food sources for ducks and geese. Emergent stands of vegetation provide necessary spawning habitat for fish such as northern pike (*Esox lucius*) and yellow perch (*Perca flavescens*) In addition, many of the insects that are eaten by young fish rely heavily on aquatic plants and the *periphyton* attached to them as their primary food source. The plants also provide cover for feeder fish and *zooplankton*, stabilizing the predator-prey relationships within the system. Furthermore, rooted aquatic plants prevent shoreline erosion and the resuspension of sediments and nutrients by absorbing wave energy and locking sediments within their root masses. In areas where plants do not exist, waves can resuspend bottom sediments decreasing water clarity and increasing plant nutrient levels that may lead to algae blooms. Lake plants also produce oxygen through photosynthesis and use nutrients that may otherwise be used by *phytoplankton*, which helps to minimize nuisance algal blooms.

Under certain conditions, a few species may become a problem and require control measures. Excessive plant growth can limit recreational use by deterring navigation, swimming, and fishing activities. It can also lead to changes in fish population structure by providing too much cover for feeder fish resulting in reduced numbers of predator fish and a stunted pan-fish population. *Exotic* plant species, such as Eurasian water-milfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) can also upset the delicate balance of a lake ecosystem by out competing *native* plants and reducing *species diversity*. These *invasive* plant species can form dense stands that are a nuisance to humans and provide low-value habitat for fish and other wildlife.

When plant abundance negatively affects the lake ecosystem and limits the use of the resource, plant management and control may be necessary. The management goals should always include the control of invasive species and restoration of native communities through environmentally sensitive and economically feasible methods. No aquatic plant management plan should only contain methods to control plants, they should also contain methods on how to protect and possibly enhance the important plant communities within the lake. Unfortunately, the latter is often neglected and the ecosystem suffers as a result.

Aquatic Plant Management and Protection

Many times an aquatic plant management plan is aimed at only controlling nuisance plant growth that has limited the recreational use of the lake, usually navigation, fishing, and swimming. It is important to remember the vital benefits that native aquatic plants provide to lake users and the lake ecosystem, as described above. Therefore, all aquatic plant management plans also need to address the enhancement and protection of the aquatic plant community. Below are general descriptions of the many techniques that can be utilized to control and enhance aquatic plants. Each alternative has benefits and limitations that are explained in its description. Please note that only legal and commonly used methods are included. For instance, the herbivorous grass carp (*Ctenopharyngodon idella*) is illegal in Wisconsin and rotovation, a process by which the lake bottom is tilled, is not a commonly accepted practice. Unfortunately, there are no "silver bullets" that can completely cure all aquatic plant problems, which makes planning a crucial step in any aquatic plant management activity. Many of the plant management and protection techniques commonly used in Wisconsin are described below.

Important Note:
Even though most of these techniques are not applicable to Long Lake, it is still important for lake users to have a basic understanding of all the techniques so they can better understand why particular methods are or are not applicable in their lake. The techniques applicable to Long Lake are discussed in Summary and Conclusions section and the Implementation Plan found near the end of this document.

Permits

The signing of the 2001-2003 State Budget by Gov. McCallum enacted many aquatic plant management regulations. The rules for the regulations have been set forth by the WDNR as NR 107 and 109. A major change includes that all forms of aquatic plant management, even those that did not require a permit in the past, require a permit now, including manual and mechanical removal. Manual cutting and raking are exempt from the permit requirement if the area of plant removal is no more than 30 feet wide and any piers, boatlifts, swim rafts, and other recreational and water use devices are located within that 30 feet. Please note that a permit is needed in all instances if wild rice is to be removed. Furthermore, installation of aquatic plants, even natives, requires approval from the WDNR.

Permits are required for chemical and mechanical manipulation of native and non-native plant communities. Large-scale protocols have been established for chemical treatment projects covering >10 acres or areas greater than 10% of the lake littoral zone and more than 150 feet from shore. Different protocols are to be followed for whole-lake scale treatments (≥160 acres or ≥50% of the lake littoral area). Additionally, it is important to note that local and federal permits and regulations may also apply, specifically if water level manipulations are implemented or items are staked to the bottom of the lake bed. For more information on permit requirements, please contact the WDNR Regional Water Management Specialist or Aquatic Plant Management and Protection Specialist.

Native Species Enhancement

The development of Wisconsin's shorelands has increased dramatically over the last century and with this increase in development a decrease in water quality and wildlife habitat has occurred. Many people that move to or build in shoreland areas attempt to replicate the suburban landscapes they are accustomed to by converting natural shoreland areas to the "neat and clean" appearance of manicured lawns and flowerbeds. The conversion of these areas immediately leads to destruction of habitat utilized by birds, mammals, reptiles, amphibians, and insects (Jennings et al. 2003). The maintenance of the newly created area helps to decrease water quality by considerably increasing inputs of phosphorus and sediments into the lake. The negative impact of human development does not stop at the shoreline. Removal of native plants and dead, fallen timbers from shallow, near-shore areas for boating and swimming activities destroys habitat used by fish, mammals, birds, insects, and amphibians, while leaving bottom and shoreline sediments vulnerable to wave action caused by boating and wind (Jennings et al. 2003, Radomski and Goeman 2001, and Elias & Meyer 2003). Many homeowners significantly decrease the number of trees and shrubs along the water's edge in an effort to increase their view of the lake (. However, this has been shown to locally increase water temperatures, and decrease infiltration rates of potentially harmful nutrients and pollutants. Furthermore, the dumping of sand to create beach areas destroys spawning, cover and feeding areas utilized by aquatic wildlife (Scheuerell and Schindler 2004).

In recent years, many lakefront property owners have realized increased aesthetics, fisheries, property values, and water quality by restoring portions of their shoreland to mimic its unaltered state. An area of shore restored to its natural condition, both in the water and on shore, is commonly called a *shoreland buffer zone.* The shoreland buffer zone creates or restores the ecological habitat and benefits lost by traditional suburban landscaping. Simply not mowing within the buffer zone does wonders to restore some of the shoreland's natural function.

Enhancement activities also include additions of *submergent*, *emergent*, and *floating-leaf* plants within the lake itself. These additions can provide greater species diversity and may compete against exotic species.

Cost

The cost of native, aquatic and shoreland plant restorations is highly variable and depend on the size of the restoration area, planting densities, the species planted, and the type of planting (e.g. seeds, bare-roots, plugs, live-stakes) being conducted. Other factors may include extensive grading requirements, removal of shoreland stabilization (e.g., rip-rap, seawall), and protective measures used to guard the newly planted area from wildlife predation, wave-action, and erosion. In general, a restoration project with the characteristics described below would have an estimated materials and supplies cost of approximately $4,200.

- The single site used for the estimate indicated above has the following characteristics:
    - An upland buffer zone measuring 35' x 100'.
    - An aquatic zone with shallow-water and deep-water areas of 10' x 100' each.
    - Site is assumed to need little invasive species removal prior to restoration.
    - Site has a moderate slope.
    - Trees and shrubs would be planted at a density of 435 plants/acre and 1210 plants/acre, respectively.
    - Plant spacing for the aquatic zone would be 3 feet.
    - Each site would need 100' of biolog to protect the bank toe and each site would need 100' of wavebreak and goose netting to protect aquatic plantings.
    - Each site would need 100' of erosion control fabric to protect plants and sediment near the shoreline (the remainder of the site would be mulched).
    - There is no hard-armor (rip-rap or seawall) that would need to be removed.
    - The property owner would maintain the site for weed control and watering.

Advantages	***Disadvantages***
• Improves the aquatic ecosystem through species diversification and habitat enhancement. • Assists native plant populations to compete with exotic species. • Increases natural aesthetics sought by many lake users. • Decreases sediment and nutrient loads entering the lake from developed properties. • Reduces bottom sediment re-suspension and shoreline erosion. • Lower cost when compared to rip-rap and seawalls. • Restoration projects can be completed in phases to spread out costs. • Many educational and volunteer opportunities are available with each project.	• Property owners need to be educated on the benefits of native plant restoration before they are willing to participate. • Stakeholders must be willing to wait 3-4 years for restoration areas to mature and fill-in. • Monitoring and maintenance are required to assure that newly planted areas will thrive. • Harsh environmental conditions (e.g., drought, intense storms) may partially or completely destroy project plantings before they become well established.

Manual Removal

Manual removal methods include hand-pulling, raking, and hand-cutting. Hand-pulling involves the manual removal of whole plants, including roots, from the area of concern and disposing them out of the waterbody. Raking entails the removal of partial and whole plants from the lake by dragging a rake with a rope tied to it through plant beds. Specially designed rakes are available from commercial sources or an asphalt rake can be used. Hand-cutting differs from the other two manual methods because the entire plant is not removed, rather the plants are cut similar to mowing a lawn; however Wisconsin law states that all plant fragments must be removed. One manual cutting technique involves throwing a specialized "V" shaped cutter into the plant bed and retrieving it with a rope. The raking method entails the use of a two-sided straight blade on a telescoping pole that is swiped back and forth at the base of the undesired plants.

In addition to the hand-cutting methods described above, powered cutters are now available for mounting on boats. Some are mounted in a similar fashion to electric trolling motors and offer a 4-foot cutting width, while larger models require complicated mounting procedures, but offer an 8-foot cutting width. Please note that the use of powered cutters may require a mechanical harvesting permit to be issued by the WDNR.

When using the methods outlined above, it is very important to remove all plant fragments from the lake to prevent re-rooting and drifting onshore followed by decomposition. It is also important to preserve fish spawning habitat by timing the treatment activities after spawning. In Wisconsin, a general rule would be to not start these activities until after June 15th.

Cost

Commercially available hand-cutters and rakes range in cost from $85 to $150. Power-cutters range in cost from $1,200 to $11,000.

Advantages	***Disadvantages***
• Very cost effective for clearing areas around docks, piers, and swimming areas. • Relatively environmentally safe if treatment is conducted after June 15th. • Allows for selective removal of undesirable plant species. • Provides immediate relief in localized area. • Plant biomass is removed from waterbody.	• Labor intensive. • Impractical for larger areas or dense plant beds. • Subsequent treatments may be needed as plants recolonize and/or continue to grow. • Uprooting of plants stirs bottom sediments making it difficult to conduct action. • May disturb *benthic* organisms and fish-spawning areas. • Risk of spreading invasive species if fragments are not removed.

Bottom Screens

Bottom screens are very much like landscaping fabric used to block weed growth in flowerbeds. The gas-permeable screen is placed over the plant bed and anchored to the lake bottom by staking or weights. Only gas-permeable screen can be used or large pockets of gas will form under the mat as the result of plant decomposition. This could lead to portions of the screen becoming detached from the lake bottom, creating a navigational hazard. Normally the screens are removed and cleaned at the end of the growing season and then placed back in the lake the following spring. If they are not removed, sediments may build up on them and allow for plant colonization on top of the screen. Bottom screens require WDNR permits, especially when anchored to the lake bottom.

Cost

Material costs range between \$.20 and \$1.25 per square-foot. Installation cost can vary largely, but may roughly cost \$750 to have 1,000 square feet of bottom screen installed. Maintenance costs can also vary, but an estimate for a waterfront lot is about \$120 each year.

Advantages	*Disadvantages*
• Immediate and sustainable control. • Long-term costs are low. • Excellent for small areas and around obstructions. • Materials are reusable. • Prevents fragmentation and subsequent spread of plants to other areas.	• Installation may be difficult over dense plant beds and in deep water. • Not species specific. • Disrupts benthic fauna. • May be navigational hazard in shallow water. • Initial costs are high. • Labor intensive due to the seasonal removal and reinstallation requirements. • Does not remove plant biomass from lake. • Not practical in large-scale situations.

Water Level Drawdown

The primary manner of plant control through water level drawdown is the exposure of sediments and plant roots/tubers to desiccation and either heating or freezing depending on the timing of the treatment. Winter drawdowns are more common in temperate climates like that of Wisconsin and usually occur in reservoirs because of the ease of water removal through the outlet structure. An important fact to remember when considering the use of this technique is that only certain species are controlled and that some species may even be enhanced. Furthermore, the process will likely need to be repeated every two or three years to keep target species in check. An extensive permitting process usually encompasses a water level manipulation which may include an Environmental Assessment.

Cost

The cost of this alternative is highly variable. If an outlet structure exists, the cost of lowering the water level would be minimal; however, if there is not an outlet, the cost of pumping water to the desirable level could be very expensive. If a hydro-electric facility is operating on the system, the costs associated with loss of production during the drawdown also need to be considered, as they are likely cost prohibitive to conducting the management action.

Advantages	***Disadvantages***
• Inexpensive if outlet structure exists. • May control populations of certain species, like Eurasian water-milfoil for a few years. • Allows some loose sediment to consolidate, increasing water depth. • May enhance growth of desirable emergent species. • Other work, like dock and pier repair may be completed more easily and at a lower cost while water levels are down.	• May be cost prohibitive if pumping is required to lower water levels. • Has the potential to upset the lake ecosystem and have significant affects on fish and other aquatic wildlife. • Adjacent wetlands may be altered due to lower water levels. • Disrupts recreational, hydroelectric, irrigation and water supply uses. • May enhance the spread of certain undesirable species, like common reed (*Phragmites australis*) and reed canary grass (*Phalaris arundinacea*). • Permitting process may require an environmental assessment that may take months to prepare. • Unselective.

Mechanical Harvesting

Aquatic plant harvesting is frequently used in Wisconsin and involves the cutting and removal of plants much like mowing and bagging a lawn. Harvesters are produced in many sizes that can cut to depths ranging from 3 to 6 feet with cutting widths of 4 to 10 feet. Plant harvesting speeds vary with the size of the harvester, density and types of plants, and the distance to the off-loading area. Equipment requirements do not end with the harvester. In addition to the harvester, a shore-conveyor would be required to transfer plant material from the harvester to a dump truck for transport to a landfill or compost site. Furthermore, if off-loading sites are limited and/or the lake is large, a transport barge may be needed to move the harvested plants from the harvester to the shore in order to cut back on the time that the harvester spends traveling to the shore conveyor. Some lake organizations contract to have nuisance plants harvested, while others choose to purchase their own equipment. If the latter route is chosen, it is especially important for the lake group to be very organized and realize that there is a great deal of work and expense involved with the purchase, operation, maintenance, and storage of an aquatic plant harvester. In either case, planning is very important to minimize environmental effects and maximize benefits.

Costs

Equipment costs vary with the size and features of the harvester, but in general, standard harvesters range between $45,000 and $100,000. Larger harvesters or stainless steel models may cost as much as $200,000. Shore conveyors cost approximately $20,000 and trailers range from $7,000 to $20,000. Storage, maintenance, insurance, and operator salaries vary greatly.

Advantages	*Disadvantages*
• Immediate results. • Plant biomass and associated nutrients are removed from the lake. • Select areas can be treated, leaving sensitive areas intact. • Plants are not completely removed and can still provide some habitat benefits. • Opening of cruise lanes can increase predator pressure and reduce stunted fish populations. • Removal of plant biomass can improve the oxygen balance in the littoral zone. • Harvested plant materials produce excellent compost.	• Initial costs and maintenance are high if the lake organization intends to own and operate the equipment. • Multiple treatments are likely required. • Many small fish, amphibians and invertebrates may be harvested along with plants. • There is little or no reduction in plant density with harvesting. • Invasive and exotic species may spread because of plant fragmentation associated with harvester operation. • Bottom sediments may be re-suspended leading to increased turbidity and water column nutrient levels.

Chemical Treatment

There are many herbicides available for controlling aquatic macrophytes and each compound is sold under many brand names. Aquatic herbicides fall into two general classifications:

1. *Contact herbicides* act by causing extensive cellular damage, but usually do not affect the areas that were not in contact with the chemical. This allows them to work much faster, but does not result in a sustained effect because the root crowns, roots, or rhizomes are not killed.
2. *Systemic herbicides* spread throughout the entire plant and often result in complete mortality if applied at the right time of the year.

Both types are commonly used throughout Wisconsin with varying degrees of success. The use of herbicides is potentially hazardous to both the applicator and the environment, so all lake organizations should seek consultation and/or services from professional applicators with training and experience in aquatic herbicide use.

Applying herbicides in the aquatic environment requires special considerations compared with terrestrial applications. WDNR administrative code states that a permit is required if "you are standing in socks and they get wet." In these situations, the herbicide application needs to be completed by an applicator licensed with the Wisconsin Department of Agriculture, Trade and

Consumer Protection. All herbicide applications conducted under the ordinary high water mark require herbicides specifically labeled by the United States Environmental Protection Agency.

Herbicides that target submersed plant species are directly applied to the water, either as a liquid or an encapsulated granular formulation. Factors such as water depth, water flow, treatment area size, and plant density work to reduce herbicide concentration within aquatic systems. Understanding concentration exposure times are important considerations for aquatic herbicides. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a specific duration of time. Some herbicides are applied at a high dose with the anticipation that the exposure time will be short. Granular herbicides are usually applied at a lower dose, but the release of the herbicide from the clay carrier is slower and increases the exposure time.

Below are brief descriptions of the aquatic herbicides currently registered for use in Wisconsin.

<u>Fluridone</u> (Sonar®, Avast!®) Broad spectrum, systemic herbicide that is effective on most submersed and emergent macrophytes. It is also effective on duckweed and at low concentrations has been shown to selectively remove Eurasian water-milfoil. Fluridone slowly kills macrophytes over a 30-90 day period and is only applicable in whole lake treatments or in bays and backwaters were dilution can be controlled. Required length of contact time makes this chemical inapplicable for use in flowages and impoundments. Irrigation restrictions apply.

<u>Diquat</u> (Reward®, Weedtrine-D®) Broad spectrum, contact herbicide that is effective on all aquatic plants and can be sprayed directly on foliage (with surfactant) or injected in the water. It is very fast acting, requiring only 12-36 hours of exposure time. Diquat readily binds with clay particles, so it is not appropriate for use in turbid waters. Consumption restrictions apply.

<u>Endothall</u> (Hydrothol®, Aquathol®) Broad spectrum, contact herbicides used for spot treatments of submersed plants. The mono-salt form of Endothall (Hydrothol®) is more toxic to fish and aquatic invertebrates, so the dipotassium salt (Aquathol®) is most often used. Fish consumption, drinking, and irrigation restrictions apply.

<u>2,4-D</u> (Navigate®, DMA IV®, etc.) Selective, systemic herbicide that only works on broad-leaf plants. The selectivity of 2,4-D towards broad-leaved plants (dicots) allows it to be used for Eurasian water-milfoil without affecting many of our native plants, which are monocots. Drinking and irrigation restrictions may apply.

<u>Triclopyr</u> (Renovate®) Selective, systemic herbicide that is effective on broad leaf plants and, similar to 2,4 D, will not harm native monocots. Triclopyr is available in liquid or granular form, and can be combined with Endothal in small concentrations (<1.0 ppm) to effectively treat Eurasian water-milfoil. Triclopyr has been used in this way in Minnesota and Washington with some success.

<u>Glyphosate</u> (Rodeo®) Broad spectrum, systemic herbicide used in conjunction with a *surfactant* to control emergent and floating-leaved macrophytes. It acts in 7-10 days and is not used for submergent species. This chemical is commonly used for controlling

purple loosestrife (*Lythrum salicaria*). Glyphosate is also marketed under the name Roundup®; this formulation is not permitted for use near aquatic environments because of its harmful effects on fish, amphibians, and other aquatic organisms.

Imazapyr (Habitat®) Broad spectrum, system herbicide, slow-acting liquid herbicide used to control emergent species. This relatively new herbicide is largely used for controlling common reed (giant reed, *Phragmites*) where plant stalks are cut and the herbicide is directly applied to the exposed vascular tissue.

Cost

Herbicide application charges vary greatly between $400 and $1000 per acre depending on the chemical used, who applies it, permitting procedures, and the size of the treatment area.

Advantages	***Disadvantages***
• Herbicides are easily applied in restricted areas, like around docks and boatlifts. • If certain chemicals are applied at the correct dosages and at the right time of year, they can selectively control certain invasive species, such as Eurasian water-milfoil. • Some herbicides can be used effectively in spot treatments.	• Fast-acting herbicides may cause fishkills due to rapid plant decomposition if not applied correctly. • Many people adamantly object to the use of herbicides in the aquatic environment; therefore, all stakeholders should be included in the decision to use them. • Many herbicides are nonselective. • Most herbicides have a combination of use restrictions that must be followed after their application. • Many herbicides are slow-acting and may require multiple treatments throughout the growing season. • Overuse may lead to plant resistance to herbicides

Biological Controls

There are many insects, fish and pathogens within the United States that are used as biological controls for aquatic macrophytes. For instance, the herbivorous grass carp has been used for years in many states to control aquatic plants with some success and some failures. However, it is illegal to possess grass carp within Wisconsin because their use can create problems worse than the plants that they were used to control. Other states have also used insects to battle invasive plants, such as waterhyacinth weevils (*Neochetina spp.*) and hydrilla stem weevil (*Bagous spp.*) to control waterhyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata)*, respectively. Fortunately, it is assumed that Wisconsin's climate is a bit harsh for these two invasive plants, so there is no need for either biocontrol insect.

However, Wisconsin, along with many other states, is currently experiencing the expansion of lakes infested with Eurasian water-milfoil and as a result has supported the experimentation and use of the milfoil weevil (*Euhrychiopsis lecontei*) within its lakes. The milfoil weevil is a native weevil that has shown promise in reducing Eurasian water-milfoil stands in Wisconsin, Washington, Vermont, and other states. Research is currently being conducted to discover the best situations for the use of the insect in battling Eurasian water milfoil. Currently the milfoil weevil is not a WDNR grant-eligible method of controlling Eurasian water milfoil.

Cost

Stocking with adult weevils costs about $1.20/weevil and they are usually stocked in lots of 1000 or more.

Advantages	***Disadvantages***
• Milfoil weevils occur naturally in Wisconsin. • Likely environmentally safe and little risk of unintended consequences.	• Stocking and monitoring costs are high. • This is an unproven and experimental treatment. • There is a chance that a large amount of money could be spent with little or no change in Eurasian water-milfoil density.

Wisconsin has approved the use of two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) to battle purple loosestrife. These beetles were imported from Europe and used as a biological control method for purple loosestrife. Many cooperators, such as county conservation departments or local UW-Extension locations, currently support large beetle rearing operations. Beetles are reared on live purple loosestrife plants growing in kiddy pools surrounded by insect netting. Beetles are collected with aspirators and then released onto the target wild population. For more information on beetle rearing, contact your local UW-Extension location.

In some instances, beetles may be collected from known locations (*cella* insectaries) or purchased through private sellers. Although no permits are required to purchase or release beetles within Wisconsin, application/authorization and release forms are required by the WDNR for tracking and monitoring purposes.

Cost

The cost of beetle release is very inexpensive, and in many cases is free.

Advantages	***Disadvantages***
• Extremely inexpensive control method. • Once released, considerably less effort than other control methods is required. • Augmenting populations many lead to long-term control.	• Although considered “safe,” reservations about introducing one non-native species to control another exist. • Long range studies have not been completed on this technique.

Analysis of Current Aquatic Plant Data

Aquatic plants are an important element in every healthy lake. Changes in lake ecosystems are often first seen in the lake's plant community. Whether these changes are positive, like variable water levels or negative, like increased shoreland development or the introduction of an exotic species, the plant community will respond. Plant communities respond in a variety of ways; there may be a loss of one or more species, certain life forms, such as emergents or floating-leaf communities may disappear from certain areas of the lake, or there may be a shift in plant dominance between species. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide very useful information for management decisions.

As described in more detail in the methods section, multiple aquatic plant surveys were completed on Long Lake; the first looked strictly for the exotic plant, curly-leaf pondweed, while the others that followed assessed both native and non-native species. Combined, these surveys produce a great deal of information about the aquatic vegetation of the lake. These data are analyzed and presented in numerous ways; each is discussed in more detail below.

Primer on Data Analysis & Data Interpretation

Species List

The species list is simply a list of all of the species that were found within the lake, both exotic and native. The list also contains the life-form of each plant found, its scientific name, and its coefficient of conservatism. The latter is discussed in more detail below. Changes in this list over time, whether it is differences in total species present, gains and losses of individual species, or changes in life-forms that are present, can be an early indicator of changes in the health of the lake ecosystem.

Frequency of Occurrence

Frequency of occurrence describes how often a certain species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of Long Lake, plant samples were collected from plots laid out on a grid that covered the entire lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. In this section, two types of data are displayed: littoral frequency of occurrence and relative frequency of occurrence. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are less than the maximum depth of plant growth (littoral zone). Littoral frequency is displayed as a percentage.

Relative frequency of occurrence uses the littoral frequency for occurrence for each species compared to the sum of the littoral frequency of occurrence from all species. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 10%, it would mean that white water lily comprises 10% of the lake's population of plants.

In the end, this analysis indicates the species that dominate the plant community within the lake. Shifts in dominant plants over time may indicate disturbances in the ecosystem. For instance, low water levels over several years may increase the occurrence of emergent species while decreasing the occurrence of floating-leaf species. Introductions of invasive exotic species may result in major shifts as they crowd out native plants within the system.

Species Diversity

Species diversity is probably the most misused value in ecology because it is often confused with species richness. Species richness is simply the number of species found within a system or community. Although these values are related, they are far from the same because diversity also takes into account how evenly the species occur within the system. A lake with 25 species may not be more diverse than a lake with 10 if the first lake is highly dominated by one or two species and the second lake has a more even distribution.

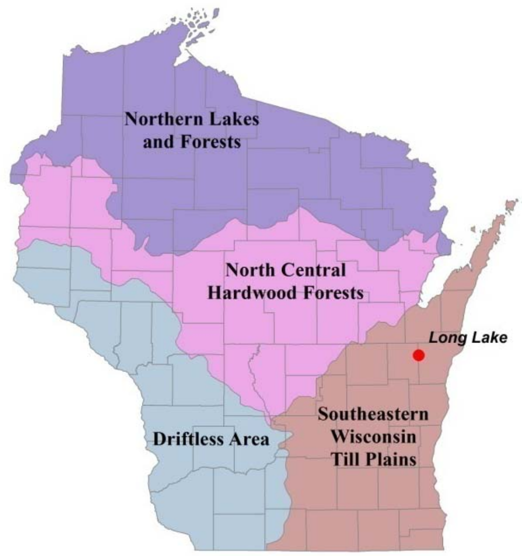

Figure 3.0-1. Location of Long Lake within the ecoregions of Wisconsin. After Nichols 1999.

A lake with high species diversity is much more stable than a lake with a low diversity. This is analogous to a diverse financial portfolio in that a diverse lake plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. For example, a lake with a diverse plant community is much better suited to compete against exotic infestation than a lake with a lower diversity.

Floristic Quality Assessment

Floristic Quality Assessment (FQA) is used to evaluate the closeness of a lake's aquatic plant community to that of an undisturbed, or pristine, lake. The higher the floristic quality, the closer a lake is to an undisturbed system. FQA is an excellent tool for comparing individual lakes and the same lake over time. In this section, the floristic quality of Long Lake will be compared to lakes in the same ecoregion and in the state (Figure 3.0-1).

Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems in the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states.

The floristic quality of a lake is calculated using its species richness and average species conservatism. As mentioned above, species richness is simply the number of species that occur in the lake, for this analysis, only native species are utilized. Average species conservatism utilizes the coefficient of conservatism values for each of those species in its calculation. A species coefficient of conservatism value indicates that species likelihood of being found in an undisturbed (pristine) system. The values range from one to ten. Species that are normally found in disturbed systems have lower coefficients, while species frequently found in pristine systems have higher values. For example, cattail, an invasive native species, has a value of 1, while common hard and softstem bulrush have values of 5, and Oakes pondweed, a sensitive and rare species, has a value of 10. On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality.

Community Mapping

A key component of the aquatic plant survey is the creation of an aquatic plant community map. The map represents a snapshot of the important plant communities in the lake as they existed during the survey and is valuable in the development of the management plan and in comparisons with surveys completed in the future. A mapped community can consist of submergent, floating-leaf, or emergent plants, or a combination of these life-forms. Examples of submergent plants include wild celery and pondweeds; while emergents include cattails, bulrushes, and arrowheads, and floating-leaf species include white and yellow pond lilies. Emergents and floating-leaf communities lend themselves well to mapping because there are distinct boundaries between communities. Submergent species are often mixed throughout large areas of the lake and are seldom visible from the surface; therefore, mapping of submergent communities is more difficult and often impossible.

Exotic Plants

Because of their tendency to upset the natural balance of an aquatic ecosystem, exotic species are paid particular attention to during the aquatic plant surveys. Two exotics, curly-leaf pondweed and Eurasian water milfoil are the primary targets of this extra attention.

Eurasian water-milfoil is an invasive species, native to Europe, Asia and North Africa, that has spread to most Wisconsin counties (Figure 3.0-2). Eurasian water-milfoil is unique in that its primary mode of propagation is not by seed. It actually spreads by shoot fragmentation, which has supported its transport between lakes via boats and other equipment. In addition to its propagation method, Eurasian water-milfoil has two other competitive advantages over native aquatic plants, 1) it starts growing very early in the spring when water temperatures are too cold for most native plants to grow, and 2) once its stems reach the water surface, it does not stop growing like most native plants, instead it continues to grow along the surface creating a canopy that blocks light from reaching native plants. Eurasian water-milfoil can create dense stands and dominate submergent communities, reducing important natural habitat for fish and other wildlife, and impeding recreational activities such as swimming, fishing, and boating.

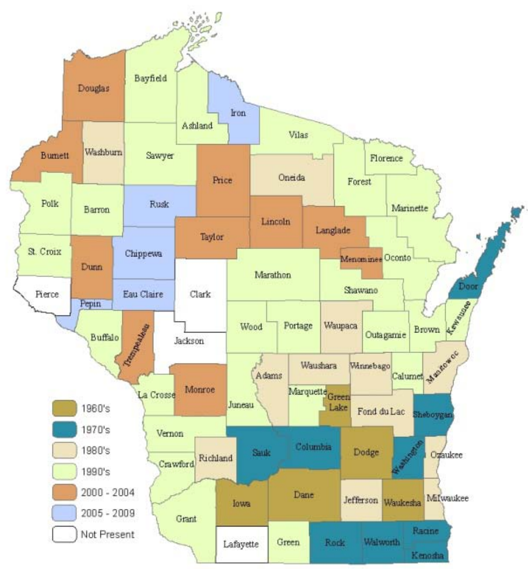

Figure 3.0-2. Spread of Eurasian water milfoil within WI counties. WDNR Data 2009 mapped by Onterra.

Curly-leaf pondweed is a European exotic first discovered in Wisconsin in the early 1900's that has an unconventional lifecycle giving it a competitive advantage over our native plants. Curly – leaf pondweed begins growing almost immediately after ice-out and by mid-June is at peak biomass. While it is growing, each plant produces many turions (asexual reproductive shoots) along its stem. By mid-July most of the plants have senesced, or died-back, leaving the turions in the sediment. The turions lie dormant until fall when they germinate to produce winter foliage, which thrives under the winter snow and ice. It remains in this state until spring foliage is produced in early May, giving the plant a significant jump on native vegetation. Like Eurasian water-milfoil, curly-leaf pondweed can become so abundant that it hampers recreational activities within the lake. Furthermore, its mid-summer die back can cause algal blooms spurred from the nutrients released during the plant's decomposition.

Because of its odd life-cycle, a special survey is conducted early in the growing season to inventory and map curly-leaf pondweed occurrence within the lake. Although Eurasian water milfoil starts to grow earlier than our native plants, it is at peak biomass during most of the summer, so it is inventoried during the comprehensive aquatic plant survey completed in mid to late summer.

Aquatic Plant Survey Results

As mentioned above, numerous plant surveys were completed as a part of this project. On June 26, 2008, a survey was completed on Long Lake that focused upon curly-leaf pondweed. Curly-leaf pondweed was previously documented in Long Lake, but this survey did not locate any occurrences of this plant, so the same survey was re-conducted the following year on June 11, 2009. This meander-based survey located numerous occurrences of curly-leaf pondweed in near-shore areas throughout most of the lake (Map 2). The possible reason for observing curly-leaf pondweed in 2009 and not in 2008 is explained below.

Median Value This is the value that roughly half of the data are smaller and half the data are larger. A median is used when a few data are so large or so small that they skew the average value to the point that it would not represent the population as a whole.

It is believed that Long Lake may be an algae-dominated system that at times has difficulty supporting significant amounts of rooted aquatic plants. High levels of nutrients and suspended sediments allow algae to flourish. The suspended sediments and increasing algae in the water column greatly reduce the light availability needed by aquatic plants, and they are no longer able to grow. Without aquatic plants to serve as areas of cover, zooplankton are increasingly predated upon by fish. Zooplankton feed on algae and if their populations are suppressed, algal populations can continue to grow.

It is believed that Long Lake was in or near an algae-dominated state in 2008 which greatly inhibited aquatic plant growth in the lake. Large precipitation events over short periods of time in the early summer of 2008 probably led to greater influxes of surface runoff into Long Lake. The dominant land cover type within Long Lake's watershed is agriculture, so this surface runoff was probably carrying high amounts of nutrients and sediments into the lake. This in combination with the suspension of lake-bottom sediments by common carp (*Cyprinus carpio*) led to greatly reduced water clarity that probably inhibited the growth of aquatic plants. This is likely why no curly-leaf pondweed or many native plants were observed during the 2008 survey.

The point intercept survey was conducted on Long Lake in July of 2008 by Onterra. Based on this survey, it was determined to suspend the native and exotic aquatic plant community mapping surveys which were planned for later that month due to the strangely turbid water and lack of aquatic plants. As noted above, the curly-leaf pondweed survey was repeated in 2009 and the native and exotic community maps were completed by Onterra during August of 2009 (Map 3). A reconnaissance survey was conducted during May of 2010 and field crews noted an increase in plant abundance compared with 2009 and based upon discussions with the LLAA and the WDNR, it was determined that the results of the 2008 point-intercept survey were not adequate to portrait the current condition of the lake. A repeat of the point-intercept survey was conducted by Onterra during mid-July 2010. Field crews noted in the 2009 and 2010 surveys that the water appeared significantly clearer and more aquatic plants were observed growing.

Compiling the data from the two point-intercept surveys (2008 and 2010) and aquatic plant mapping surveys (2009), 19 species of plants were located in Long Lake (Table 3.0-1), three are considered non-native species: Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife. Because of their importance, they will be discussed in a separate section.

Table 3.0-1. Aquatic plant species located in Long Lake during 2008, 2009, and 2010 surveys.

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	2008	2009	2010
Emergent	*Iris versicolor*	Northern blue flag	5	X	X	X
	Lythrum salicaria	Purple loosestrife	Exotic	X	X	X
	Schoenoplectus tabernaemontani	Softstem bulrush	4	X	X	X
	Typha spp.	Cattail spp.	1	X	X	X
FL	*Nuphar variegata*	Spatterdock	6	X	X	X
	Nymphaea odorata	White water lily	6	X	X	X
	Polygonum amphibium	Water smartweed	5	X	X	X
FL/E	*Sparganium eurycarpum*	Common bur-reed	5	X	X	X
Submergent	*Chara sp.*	Muskgrasses	7	X	X	X
	Ceratophyllum demersum	Coontail	3	X	X	X
	Heteranthera dubia	Water stargrass	6			X
	Myriophyllum sibiricum	Northern water milfoil	7	X		
	Myriophyllum spicatum	Eurasian water milfoil	Exotic	X	X	X
	Potamogeton strictifolius	Stiff pondweed	8		X	X
	Potamogeton crispus	Curly-leaf pondweed	Exotic		X	X
	Potamogeton foliosus	Leafy pondweed	6			X
	Stuckenia pectinata	Sago pondweed	3		X	X
	Vallisneria americana	Wild celery	6			X
FF	*Lemna minor*	Lesser duckweed	5	X	X	X

There were significantly less plants found in 2008, as only about 30% of the littoral zone (less than maximum depth of plant growth) contained aquatic plants compared with almost 50% in 2010. Aquatic plants were found growing to a maximum depth of 12 feet in 2008, with the average depth of point intercept locations containing plants around 5.6 feet (Figure 3.0-3). In 2010, plants were found growing a little less deep (9 feet) and the average water depth of point-intercept locations containing plants around 3.7 feet. It also needs to be mentioned that field crews reported the water level of Long Lake to be over a foot higher in 2010 due to recent heavy rains, leaving the pier at the public landing completely submerged.

It may seem contrary to earlier statements that plant growth was suppressed in 2008 due to turbid water, but plants were found growing in slightly deeper water than in 2010. This may be explained by the simple fact that every location that contained aquatic plants in 2008 contained coontail. Coontail is a disturbance-tolerant species that obtains the majority of its nutrients directly from the water column and is able to grow in low-light conditions. Lacking true roots, the location of coontail within a lake may not indicate adequate growing conditions (i.e. it was transported by waves from where it originally grew to where it was sampled). Coontail has the capacity to aggregate and form dense mats at the surface as they become entangled in rooted plants, rocks and other debris. During the 2008 point-intercept survey, thick mats of coontail were only observed in the extreme southern area of Long Lake.

As Figure 3.0-3 shows, it is presumed the aquatic plant community of Long Lake typically inhabits relatively shallow water (< 6 feet) due to the low light conditions. The conditions in 2008 were not favorable for the plant species that normally reside in these areas and coontail populations proliferated in their absence.

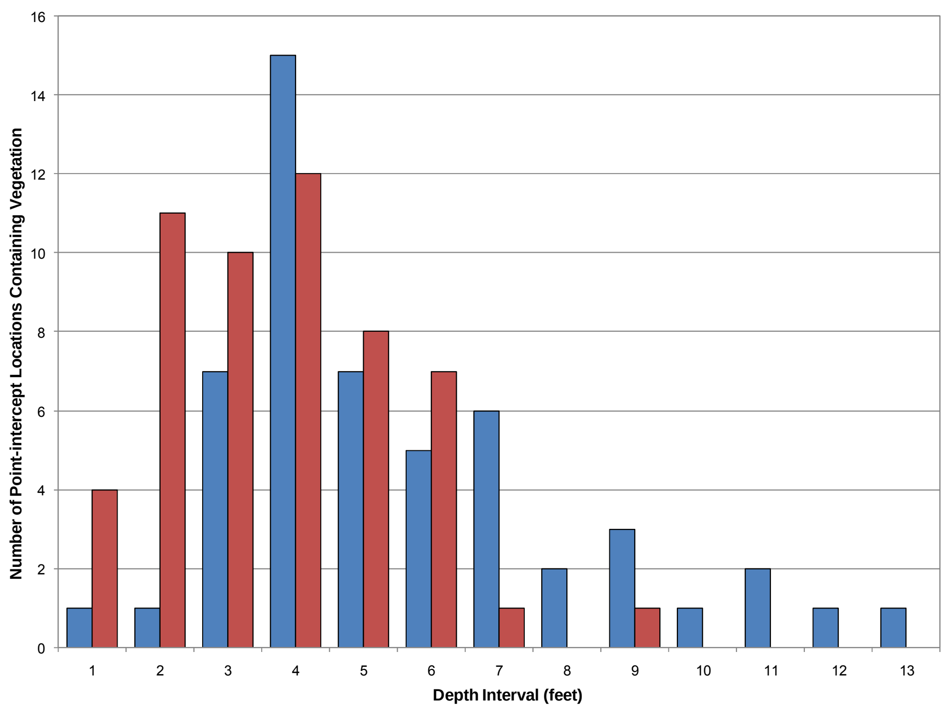

Figure 3.0-3 Long Lake aquatic plant depth distribution. Created using data from 2008 and 2010 point-intercept surveys.

Statistical analysis is used by scientists to determine if an observed difference is sufficient to be attributed to a particular factor or if the difference may have occurred randomly. If the difference is sufficient, it is considered to be *significantly different* or *statistically different*, if it is not sufficient, it is considered to be *insignificantly different*. In the end, a significant difference can be attributed to some factor, while an insignificant difference can only be attributed to random variation.

Aquatic plant frequencies were compared on Long Lake during the 2008 and 2010 point-intercept surveys (Table 3.0-2, Figure 3.0-4). Supported by these statistics, coontail populations were approximately 50% less in 2010 than in 2008. Sago pondweed, leafy pondweed, and white water lily were shown to increase over this period, along with an incredible increase in Eurasian water milfoil occurrence.

Table 3.0-2. Aquatic plant change in occurrence analysis on Long Lake during 2008 and 2010 surveys. Statistical significance is determined by Chi-square distribution analysis (alpha = 0.05).

Common Name	Scientific Name	Year 1 FOO	Year 2 FOO	Percent Change	Direction	Chi-square Analysis Significance	Chi-square Analysis p-value
Eurasian water milfoil	*Myriophyllum spicatum*	1.2	38.9	3,248.67	▲	Yes	0.000
Coontail	*Ceratophyllum demersum*	29.7	15.0	-49.26	▼	Yes	0.005
Sago pondweed	*Stuckenia pectinata*	0.0	10.6	100.00	▲	Yes	0.000
Leafy pondweed	*Potamogeton foliosus*	0.0	2.7	100.00	▲	Yes	0.032
White water lily	*Nymphaea odorata*	0.0	2.7	100.00	▲	Yes	0.032
Spatterdock	*Nuphar variegata*	1.7	2.7	52.21	▲	No	0.600
Muskgrasses	*Chara sp.*	0.6	0.9	52.21	▲	No	0.764
Curly-leaf pondweed	*Potamogeton crispus*	0.0	1.8	100.00	▲	No	0.080

FOO = Littoral Frequency of Occurrence; Chi-square statistical significance at α=0.05
▲ ▼ = Statisticaly Significant Difference, ▲ ▼ = Insignificant Difference

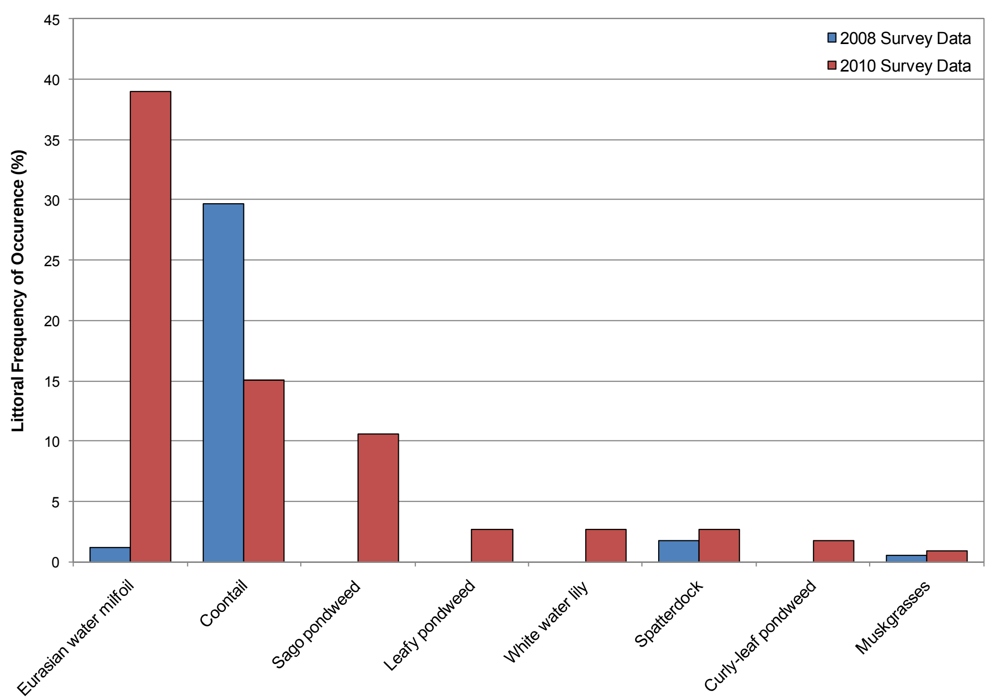

Figure 3.0-4 Long Lake aquatic plant occurrence analysis in 2008 and 2010. Created using data from 2008 and 2010 surveys.

Long Lake has a relatively low number of aquatic plant species, and because of this one may assume that the system would also have low diversity. As discussed earlier, how evenly the species are distributed throughout the system also influences the diversity. The diversity index (Simpson's Diversity Index) for Long Lake's plant community in 2008 was 0.20 showing that the lake had an extremely uneven distribution (relative frequency) of plant species throughout the lake. The left pie chart in Figure 3.0-4 shows that the aquatic plant community of Long Lake in 2010 was dominated by coontail. A slightly more even distributions was observed in 2010 (right pie chart in Figure 3.0-4) and the diversity of the lake was greater (0.67). However, both of these index values are quite low and show that the plant community of Long Lake is often dominated by one species, depending on environmental conditions at that time. Having a greater number of aquatic plant species and a more even distribution would likely insulate Long Lake from the extreme conditions observed in either survey years (2008 and 2010).

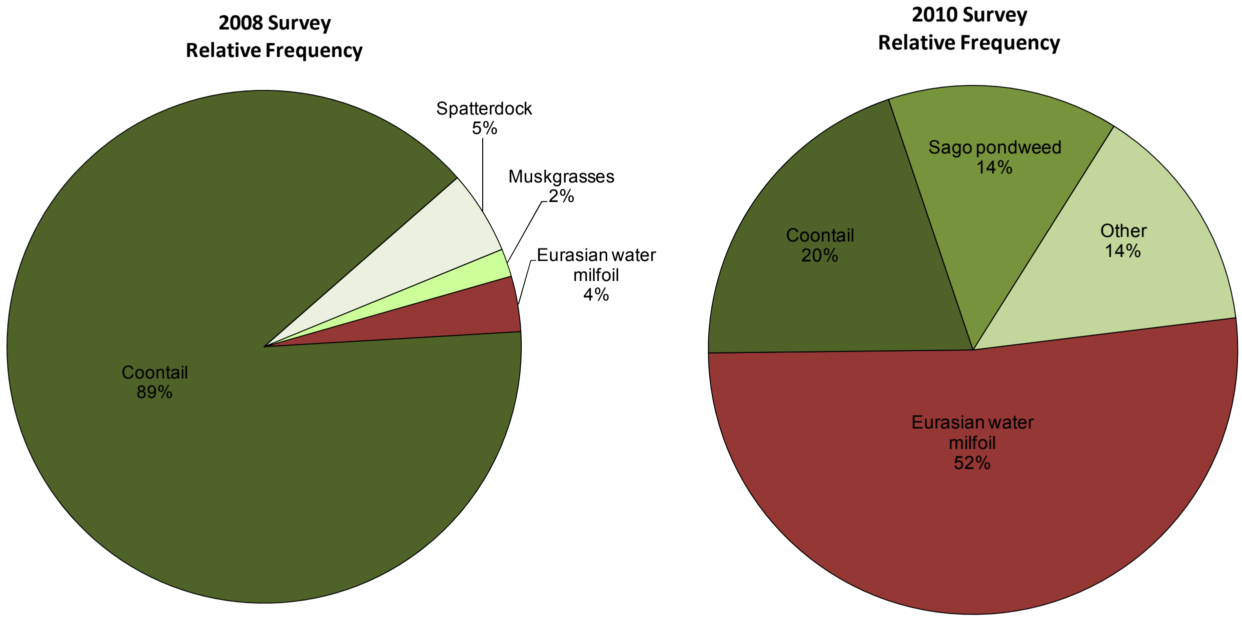

Figure 3.0-5 Long Lake aquatic plant relative frequency of occurrence in 2008 and 2010. Created using data from 2008 and 2010 aquatic plant point-intercept survey.

Data collected from the aquatic plant surveys indicate that the average conservatism value is well below the Southeastern Till Plains Ecoregion median and the state median (Figure 3.0-6). This illustrates that the aquatic plant community of Long Lake is indicative of a highly disturbed system. Specifically, this shows that the plant community is mainly comprised of species that are disturbance-tolerant.

Traditional forms of disturbance that often affect lakes include development of the lake's shoreline and motorboat traffic. A stakeholder survey sent to district members indicate that motor boats with a 25 horsepower or greater motor are the second most prevalent watercraft on the lake (Appendix B). Many studies have documented the adverse effects of motorboat traffic on aquatic plants (e.g. Murphy and Eaton 1983, Vermaat and de Bruyne 1993, Mumma et al. 1996, Asplund and Cook 1997). In all of these studies, lower plant biomass and/or declines and higher turbidity were associated with motorboat traffic. Eurasian water milfoil and curly-leaf pondweed infestation can also be viewed as a disturbance, and once established, will likely cause a shift of the aquatic plant community, particularly in respect away from those species with higher coefficients of conservatism (Table 3.0-1). In Long Lake, it appears that the major disturbances affecting aquatic plants are human development within the watershed, particularly runoff from agriculture and manicured lawns and aquatic invasive species.

Combining Long Lake's species richness and average conservatism values to produce its Floristic Quality Index (FQI) results in a relatively low value of 20.8 (equation shown below); again, well below the median values of the ecoregion and the state (Figure 3.0-6).

$$FQI = \text{Average Coefficient of Conservatism } (5.2) * \sqrt{\text{Number of Native Species } (16)}$$
$$FQI = 20.8$$

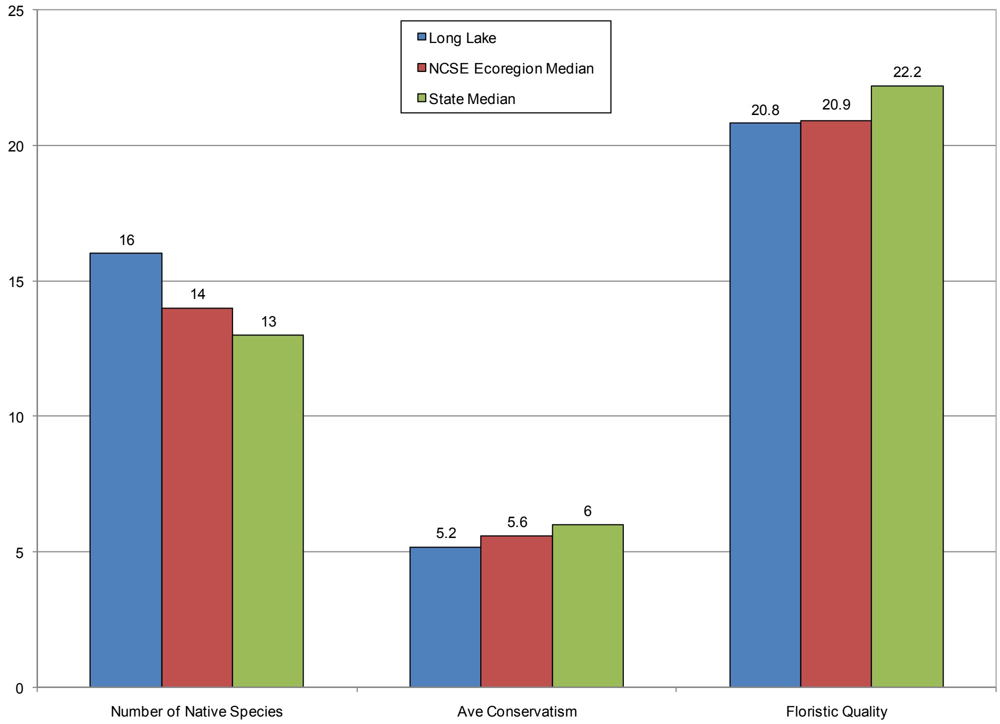

Figure 3.0-6. Long Lake Floristic Quality Assessment. Created using data from 2008 and 2009 surveys. Analysis following Nichols (1999).

Long Lake has a relatively low incidence of emergent and floating-leaf plant communities. The 2009 community map indicates that approximately 2.9 acres (2.4%) of the 120-acre lake contains these types of plant communities (Table 3.0-3, Map 3). The low occurrence of these species may be due to the combination of highly turbid waters of Long Lake and developed shorelines and manual removal. Six native species of emergent and floating-leaf species were located on Long Lake. These areas are valuable fish and wildlife habitat important to the ecosystem of the lake, and become particularly important for structural habitat in areas where fallen trees and other forms of coarse-woody debris are sparse or have been removed.

Table 3.0-3. Long Lake acres of plant community types from the 2009 community mapping survey.

Plant Community	Acres
Emergent	0.02
Floating-leaf	2.67
Mixed Floating-leaf and Emergent	0.17
Total	2.86

Continuing the analogy that the community map represents a 'snapshot' of the important plant communities, a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within Long Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development, as previously stated. Radomski and Goeman (2001) found a 66% reduction in vegetation coverage on developed shorelines when compared to undeveloped shorelines in Minnesota Lakes. Furthermore, they also found a significant reduction in abundance and size of northern pike (*Esox luciusi*), bluegill (*Lepomis macrochirus*), and pumpkinseed (*Lepomis gibbosus*) associated with these developed shorelines.

Exotic Plants in Long Lake

As described above, three exotic plant species were located within Long Lake during this project's aquatic plant surveys, Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife. All three of these species are a concern when found in any lake due to the possible negative ecological and recreational impacts they can cause.

Eurasian water milfoil was first documented in Long Lake in 2003. During the first year of the project, very little Eurasian water milfoil was located in Long Lake. Map 4 displays the locations of Eurasian water milfoil in Long Lake located during the 2009 community mapping survey. During this year, scattered Eurasian water milfoil was found growing in shallow areas throughout most of the lake. None of these areas contained Eurasian water milfoil at to a degree that would affect navigation on their own. But in some areas like along the northern shoreline of the eastern peninsula Eurasian water milfoil was mixed with sago pondweed and coontail that raised concern by some riparians with low tolerances of aquatic plants. In 2010, field crews noted more Eurasian water milfoil in this and other areas around the lake (Map 5). As can clearly be observed in Table 3.0-2 and Figures 3.0-4 and 3.0-5, Eurasian water milfoil populations greatly increased between 2008 and 2010. This data suggests that within a very short period of time, Eurasian water milfoil can increase greatly in Long Lake and will likely continue to do so in the absence of management.

Curly-leaf pondweed was first documented in Long Lake in 1988. Map 2 displays the locations of curly-leaf pondweed in Long Lake located during the 2009 curly-leaf pondweed and community mapping surveys. Like Eurasian water milfoil, scattered single plants and clumps of curly-leaf pondweed were found in near-shore areas throughout most of Long Lake, none of which seemed to show any indication of inhibiting navigation. Like Eurasian water milfoil, curly-leaf pondweed has the potential to displace native aquatic plant species.

Both Eurasian water milfoil and curly-leaf pondweed have been present in Long Lake for a significant period of time, but neither species presently appear to be at or near nuisance levels. As mentioned previously, there are some areas around the lake that have larger, denser colonies of Eurasian water milfoil. It is possible that these areas may reach nuisance levels in the near future, potentially interfering with navigation and other recreational activities. A detailed control strategy for Eurasian water milfoil and curly-leaf pondweed in Long Lake is discussed in the Implementation Plan Section.

Purple loosestrife (*Lythrum salicaria*), an invasive wetland plant, was found growing along the shoreline of Long Lake in four locations (Map 3). This perennial herbaceous plant is native to Europe and was likely brought over to North America as a garden ornamental. It escaped from its garden landscape into wetland environments where it is able to out-compete our native plants for space and resources. First detected in Wisconsin in the 1930s, it has now spread to 70 of the state's 72 counties. The infestation on Long Lake appears to be in its early stages. At this time, hand removal is likely the best option for controlling the purple loosestrife on Long Lake. Additional purple loosestrife monitoring would be required to ensure its eradication from the shores of Long Lake.

4.0 SUMMARY AND CONCLUSIONS

The design of this project was intended to fulfill two objectives;

1) Collect detailed information regarding invasive plant species within the lake, with the primary emphasis being on Eurasian water milfoil and curly-leaf pondweed.
2) Collect sociological information from Long Lake stakeholders regarding their use of the lake and their thoughts pertaining to the past and current condition of the lake and its management.

During the summer of 2008, Long Lake experienced incredible algal blooms that reduced water clarity and subdued aquatic macrophyte growth. In fact, crews from Onterra were not able to locate large amounts of native or non-native plants throughout the entire summer. This was contradictory to the antidotal information passed onto Onterra staff by lake residents based upon their 2008 observations. According to some riparian property owners, vast areas of Long Lake were inaccessible during the summer and fall of 2008 due to nuisance levels of what was believed to be Eurasian water milfoil. The lack of vascular plants during the 2008 growing season was certainly not in line with the riparian reports; therefore, the completion of the management plan was put on hold until additional surveys could be completed in 2009.

Onterra completed two additional surveys the first during the summer of 2009 and the second during the spring of 2010. Both surveys were conducted in search of native and non-native vascular plants. During those surveys, limited amounts of curly-leaf pondweed and Eurasian water milfoil were located throughout much of the lake in the form of single plants or small groupings of plants (or clumps). However, none of the occurrences were considered to be at nuisance levels. Nuisance levels of native plants were not found to occur either. Overall, the plant community in Long Lake was found to be of low diversity, low quality, and indicative a disturbed ecosystem.

As of May 2010, there appears to be more Eurasian water milfoil in Long Lake than curly-leaf pondweed, and with Eurasian water milfoil's tendency to spread in productive systems, it would be wise to focus the association's aquatic plant management efforts first on lake-wide control of Eurasian water milfoil, then after that exotic is under control, move on to curly-leaf pondweed. The control of Eurasian water milfoil is discussed in detail within the Implementation Plan below.

In some lakes, the July die back and subsequent decomposition of curly-leaf pondweed can release sufficient phosphorus into the lake to spur mid-summer algae blooms. This is likely not the case in Long Lake as the release of phosphorus from curly-leaf pondweed decomposition is probably negligible relative to background levels in the lake.

The stakeholder survey results indicate that many of the lake residence are concerned with algae blooms, aquatic invasive species, degraded water quality, and excessive aquatic plant growth (Appendix B, Questions #23 & 24). It is beyond the scope of this project to deal with the algae and water quality issues, but our experience on the lake does support the riparian thoughts that these are serious problems with Long Lake. However, based upon the aquatic plant surveys that were completed during the 2008 and 2009 growing seasons, there are no findings that support excessive growth of native plants; therefore, there are no management actions entailing native aquatic plant control on Long Lake that could be included in an implementation plan. However, management actions to deal with the non-native Eurasian water milfoil are outlined in the Implementation Plan.

Regarding the water quality and algae blooms: Long Lake has had numerous studies completed on it and during the early 2000's the LLAA initiated a management planning project. During that multi-phased planning project, Long Lake's water quality issues were documented along with likely sources within the lake's watershed. Figure 4.0-1 contains total phosphorus data collected on Long Lake during the earlier planning projects along with data collected prior to that time. Over the course of the dataset, the majority of Long Lake's total phosphorus values remained in the poor range, near the regional average and well above the state average. All-in-all, it is safe to say that one of the most prevalent issues facing Long Lake presently is its poor water quality. Further, it is likely that much of the phosphorus that occurs in Long Lake originates from its watershed; therefore, at least a portion of it could be mitigated from even entering the lake if corrective measures were taken.

To minimize the phosphorus load originating from the watershed, the LLAA should partner with the Manitowoc County Soil and Water Conservation Department, and possibly a private consultant, to create a watershed management plan. That management plan would determine best management practices (BMPs) that could be implemented within the watershed to minimize nutrient (and sediment) loading to Long Lake. The plan would also detail possible funding sources for each BMP proposed for the watershed within the plan. An additional study component that may be useful within the watershed management planning project would be one that would determine the extent of internal nutrient cycling within the lake, which could also be a significant source of phosphorus fueling algal growth. A likely source to fund the development of the watershed management plan would be the WDNR Lake Management Planning Grant Program.

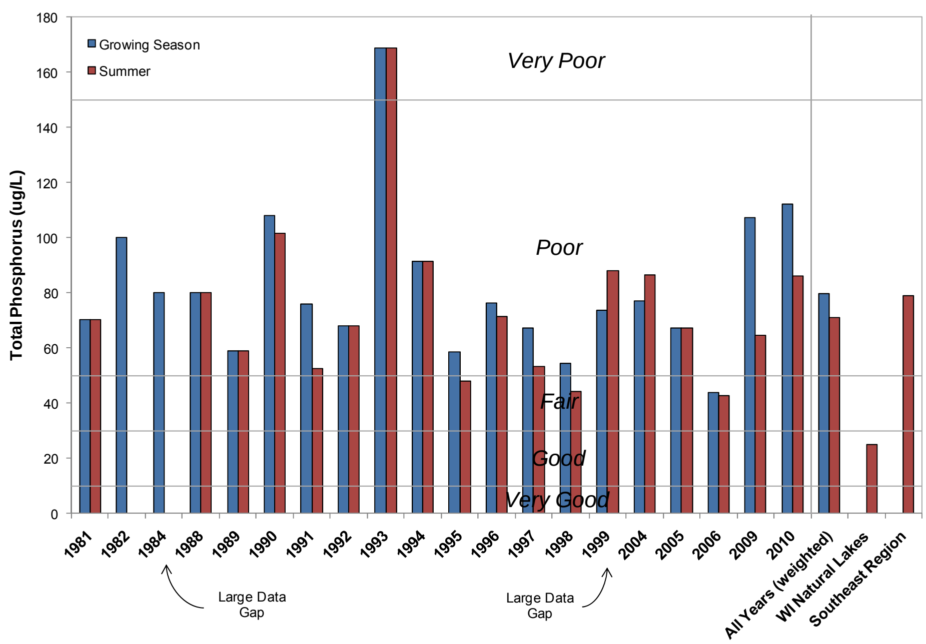

Figure 4.0-1 Long Lake, regional and state average total phosphorus values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from Lillie and Mason (1983).

5.0 IMPLEMENTATION PLAN

The Implementation Plan presented below was created through the collaborative efforts of the LLAA Planning Committee and ecologist/planners from Onterra. It represents the path the LLAA will follow in order to meet their lake management goals. The goals detailed within the plan are realistic and based upon the findings of the studies completed in conjunction with this planning project and the needs of Long Lake stakeholders as portrayed by the members of the Planning Committee, the returned stakeholder surveys, and numerous communications between Planning Committee members and the lake stakeholders. The Implementation Plan is a living document in that it will be under constant review and adjustment depending on the condition of the lake, the availability of funds, level of volunteer involvement, and the needs of the stakeholders.

Management Goal 1: Control Existing and Prevent Further Aquatic Invasive Species Infestations within Long Lake

Management Action: Initiate and Continue Clean Boats Clean Waters watercraft inspections at public landing

Timeframe: Start 2010 or 2011

Facilitator: Planning Committee

Description: Although Long Lake already contains aquatic invasive species, including purple loosestrife, Eurasian water milfoil and curly-leaf pondweed, it is still important to minimize the chance that other AIS be introduced into the system and that existing AIS are not transported to other waterbodies. To that end, the LLAA have initiated a volunteer based WDNR Clean Boats/Clean Waters watercraft inspection program at the Long Lake public access sites in 2010. Also, as a part of the Tri County Clean Boats program, paid inspectors through Glacierland Resource Conservation and Development, Inc. periodically monitor the Long Lake boat landing. While this is beneficial to Long Lake, it will be important that volunteerism does not lax knowing that paid monitors are aiding in the monitoring.

Action Steps:

1. Members of association attend Clean Boats Clean Waters training session during spring or summer 2010.
2. Training of additional volunteers completed by those trained during 2010.
3. Begin inspections during high-risk weekends
4. Report results to WDNR and LLAA.
5. Promote enlistment and training of new of volunteers to keep program fresh.

Management Action: Control Eurasian water milfoil infestations within Long Lake using herbicide applications.

Timeframe: Initiate 2011

Facilitator: Board of Commissioners with professional help as needed

Description: As described in the Aquatic Plant section, one of the most pressing threats to the health of Long Lake's aquatic plant community is Eurasian water milfoil.

During the planning process, LLAA stakeholders discussed the difference between the control of Eurasian water milfoil for nuisance relief or for ecological restoration. Applicable management actions for Long Lake aimed at alleviating the nuisance conditions caused by this plant would likely include the use of a mechanical harvester or possibly herbicides to create 30-foot access lanes in strategic locations around the lake.

LLAA would rather not pursue this form of a control program, and would like to attempt to impact Eurasian water milfoil on a whole-lake level in an effort to improve the health of their lake ecosystem. The LLAA understands that there is no *silver bullet* and an ecological restoration program will need to be ongoing and adaptable based on control successes and failures and additional management tools that become available in the future.

As stated above, the Eurasian water milfoil population in Long Lake is scattered throughout the littoral zone. It appears that at this time, the only way to address the Eurasian water milfoil on a lake-wide level in Long Lake is to treat this entire area which essentially would involve treating the entire lake. If Eurasian water milfoil was confined to colonies or certain parts of the lake, more targeted control efforts could be taken. At this time the use of liquid 2,4-D would be the most applicable option for a whole lake treatment on Long Lake. The responsible use of this technique is relatively supported by Long Lake stakeholders with only 22% of respondents being opposed to this technique (Appendix B, Question #27). It must be noted here, that the use us liquid 2,4-D in Wisconsin Lakes is still in an experimental phase as only a few treatments have been completed using this technique. Therefore; the association must remember that the treatment strategy outlined here may need to be altered based upon the findings of studies being conducted on lakes treated with liquid 2,4-D during 2010.

A current study by the WDNR and the United States Army Corps of Engineers (USACOE) is investigating the use of liquid 2,4-D; most specifically, the associated herbicide concentrations in the water column (residuals) at different locations and lengths of time after treatment. Preliminary findings indicate that the herbicide quickly (within a few days) diffuses through the system and reaches an equilibrium concentration within the entire volume of the lake. It appears that seasonal control is reached when residual concentrations are between 100 and 150 μg/L for 10-15 days and long-term control can be achieved at higher concentrations. WDNR and USACOE researchers have indicated that 2,4-D concentrations of greater than 300 μg/L for this duration provided exceptional control of the target species, but have had short-term, and undesirable impacts on the native plant community.

Short Term Control Plan

The LLAA is planning a chemical treatment of Eurasian water milfoil in the spring of 2011. The treatment would occur before June 1 and/or water temperatures reach 65°F.

Digitizing the lake survey map of Long Lake from 1973 and exporting the associated acreages in GIS, the lake's volume was calculated at approximately 1,508.8 acre-feet and an average depth of approximately 12 feet. At this time, it appears that the most prudent approach would be to apply liquid 2,4-D to the approximately 61 acres of Long Lake that are between the shoreline and the 10-foot contour (Map 5). Herbicide dose would likely be applied at between 1.0 ppm and 1.5 ppm to allow herbicide concentrations when mixed with the volume of the lake to reach the thresholds discussed above.

WDNR and USACOE researchers are also investigating whether 2,4-D residuals vertically mix between the epilimnion (top layer) and hypolimnion (bottom layer). The table on Map 5 also displays the calculated concentrations assuming that the 2,4-D only mixes within the epiliminion (upper 15 feet of water).

Further correspondence with the LLAA, their herbicide applicator, WDNR, and professional lake managers will yield specifics regarding dose and anticipated whole-lake residual concentrations. One of the most complex components of this discussion relates to exposure time and degradation of herbicide concentrations – areas that researchers continue to prioritize as missing pieces of the puzzle.

Qualitative monitoring of the herbicide treatment would be conducted by conducting Eurasian water milfoil peak biomass survey during the summer before the treatment (2010) and comparing against one completed the summer after the treatment 2011. Qualitatively, a successful treatment on Long Lake would include a reduction of exotic density as demonstrated by a decrease in density rating (e.g. dominant reduced to scattered).

Quantitative monitoring of the treatment would be completing the whole-lake point-intercept survey during the same timeframes as the qualitative monitoring (summer before and summer after). Quantitatively, a successful treatment would include a significant reduction in Eurasian water milfoil frequency following the treatments as exhibited by at least a 50% decrease in exotic frequency from the pre- and post treatment point-intercept survey. In other words, if the Eurasian water milfoil frequency of occurrence before the treatment was 50%, the post treatment frequency would need to be 25% or lower for the treatment to be considered a success. Further, there would be a noticeable decrease in rake fullness ratings within the fullness categories of 2 and 3.

This strategy would greatly benefit from having residual water samples taken in association with the 2011 treatment. This would allow for an understanding of whether the herbicide dose was high enough and sustained long enough to kill the Eurasian water milfoil. It would also be advantageous to understand if the dose was too high or sustained for too long in which unintended collateral damage to the lake's native plants occurs. Combining this information with the vegetation surveys completing on the lake, much information will be learned that would lead to an effective long-term control plan being developed for Long Lake. The LLAA would attempt to solicit a volunteer to collect these data and send the data to the laboratory for analysis.

Long-Term Control Plan

It should be noted that it is highly unlikely that any single herbicide treatment will completely control the Eurasian water milfoil in Long Lake. The objective is to bring the invasive species down to more easily controlled levels. In other words, the goal is to reduce the amount of Eurasian water milfoil to levels that would only require spot treatments to keep them under control. To complete this objective efficiently, a cyclic series of steps is used to plan and implement the treatment strategies. The series includes:

1. A lake-wide assessment of Eurasian water milfoil completed while the plant is at peak biomass.
2. Creation of treatment strategy for the following spring.
3. Verification and refinement of treatment plan immediately before treatments are implemented (not applicable to whole-lake treatments).
4. Completion of treatments.
5. Assessment of treatment results.

Once Step 5 is completed, the process would begin again that same summer with the completion of a peak biomass survey. The survey results would then be used to create the next spring's treatment strategy.

If Eurasian water milfoil populations are brought down to levels requiring smaller treatments of specific colonies, treatment monitoring activities would follow protocols currently being developed by the WDNR and in general, use guidance supplied in Aquatic Plant Community Evaluation with Chemical Manipulation (2010 Draft). This form of monitoring is required for all large scale herbicide applications (exceeding 10 acres in size or 10% of the area of the water body that is 10 feet or less in depth and treatment areas that are more than 150 feet from shore) and grant-funded projects where scientific and financial accountability are required.

As a part of the treatment monitoring, sub-sampling sites within the treatment areas at a resolution of approximately 4 points per acre would be visited before and after the treatments to produce the pre- and post treatment data. By comparing those data, it can be determined if there is differences in native and non-native plant abundances between the surveys. If there is a difference between the pre- and post treatment data, statistical analysis is used to determine if the difference is sufficient to be attributed to the treatment or if the difference may have occurred randomly. If the difference is sufficient, it is considered to be significantly different, if it is not sufficient, it is considered to be insignificantly different. In the end, a significant difference can be attributed to some factor, while an insignificant difference can only be attributed to random chance.

With guidance from WDNR Integrated Sciences, a Chi-square distribution analysis (alpha = 0.05) would be used to determine if the quantitative data collected before the treatment are statically different from the data collected after the treatment. The alpha value is set such that we consider the results statistically significant when the test is 95% confident that the results are truly different and non-random.

Action Steps:

1. Retain qualified professional assistance to develop a specific project design utilizing the cyclic series of steps discussed above.
2. Initiate control plan
3. Revisit control plan in 5-7 years
4. Update management plan to reflect changes in control needs and those of the lake ecosystem.

6.0 METHODS

Aquatic Vegetation

Curly-leaf Pondweed Survey

Surveys of curly-leaf pondweed were completed on Long Lake during field visits on June 26, 2008 and June 11, 2009 in order to correspond with the anticipated peak growth of the plant. Visual inspections were completed throughout the lake by completing a meander survey by boat.

Comprehensive Macrophyte Surveys

Comprehensive surveys of aquatic macrophytes were conducted on Long Lake to characterize the existing communities within the lake and include inventories of emergent, submergent, and floating-leaved aquatic plants within them. The point-intercept method as described Wisconsin Department of Natural Resources Bureau of Science Services, PUB-SS-1068 2010 was used to complete this study on July 28, 2008 and July 23, 2010. A point spacing of 40 meters was used resulting in approximately 317 points (Map 1).

Community Mapping

During the species inventory work, the aquatic vegetation community types within Long Lake (emergent and floating-leaved vegetation) were mapped using a Trimble GeoXT Global Positioning System (GPS) with sub-meter accuracy on August 5, 2009. Furthermore, all species found during the point-intercept surveys and the community mapping surveys were recorded to provide a complete species list for the lake.

7.0 LITERATURE CITED

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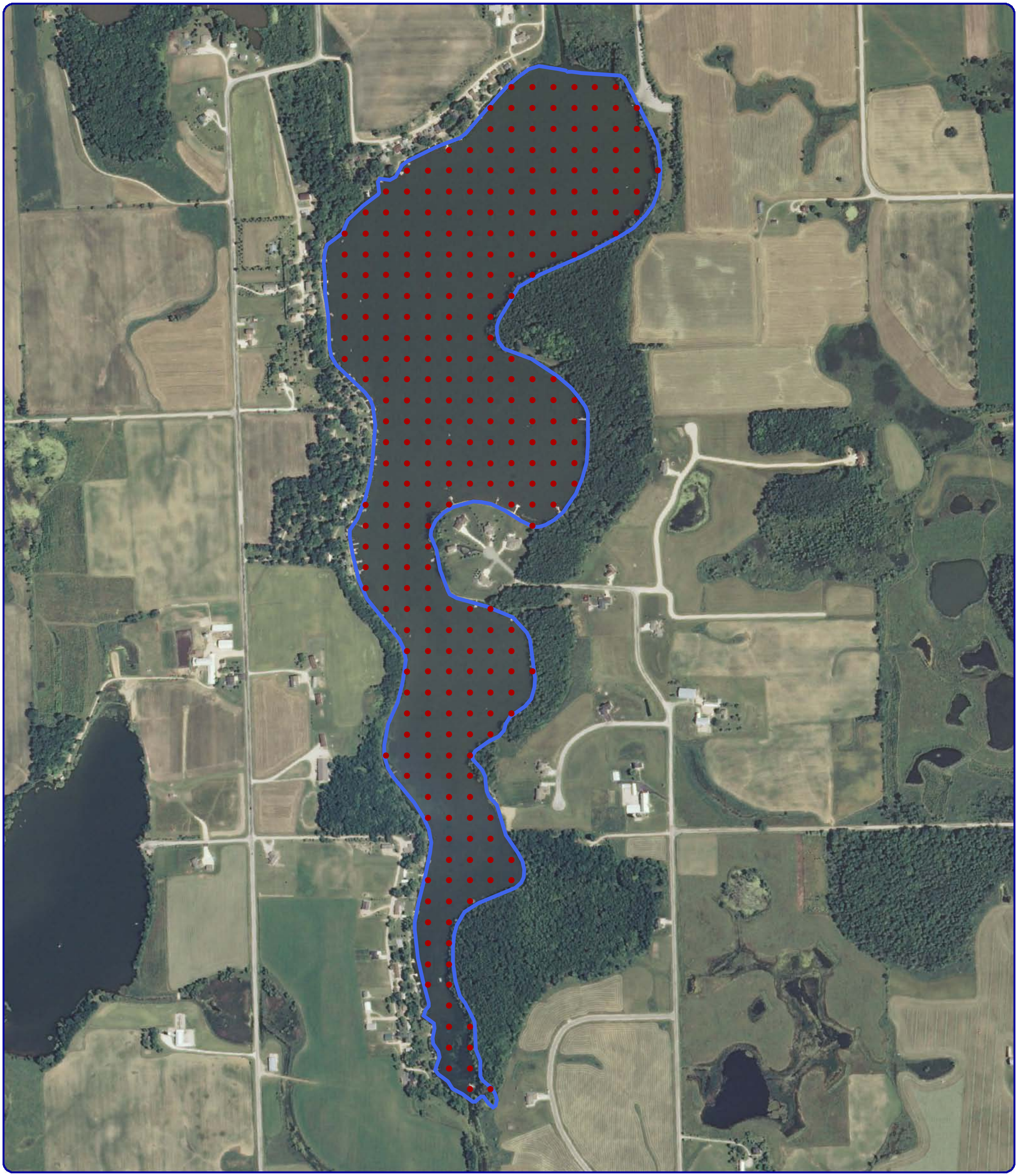

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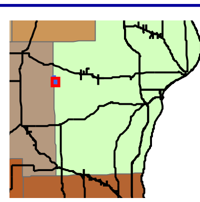


Extent of large map shown in red.

Legend

Long Lake ~ 120 acres
WDNR Definition

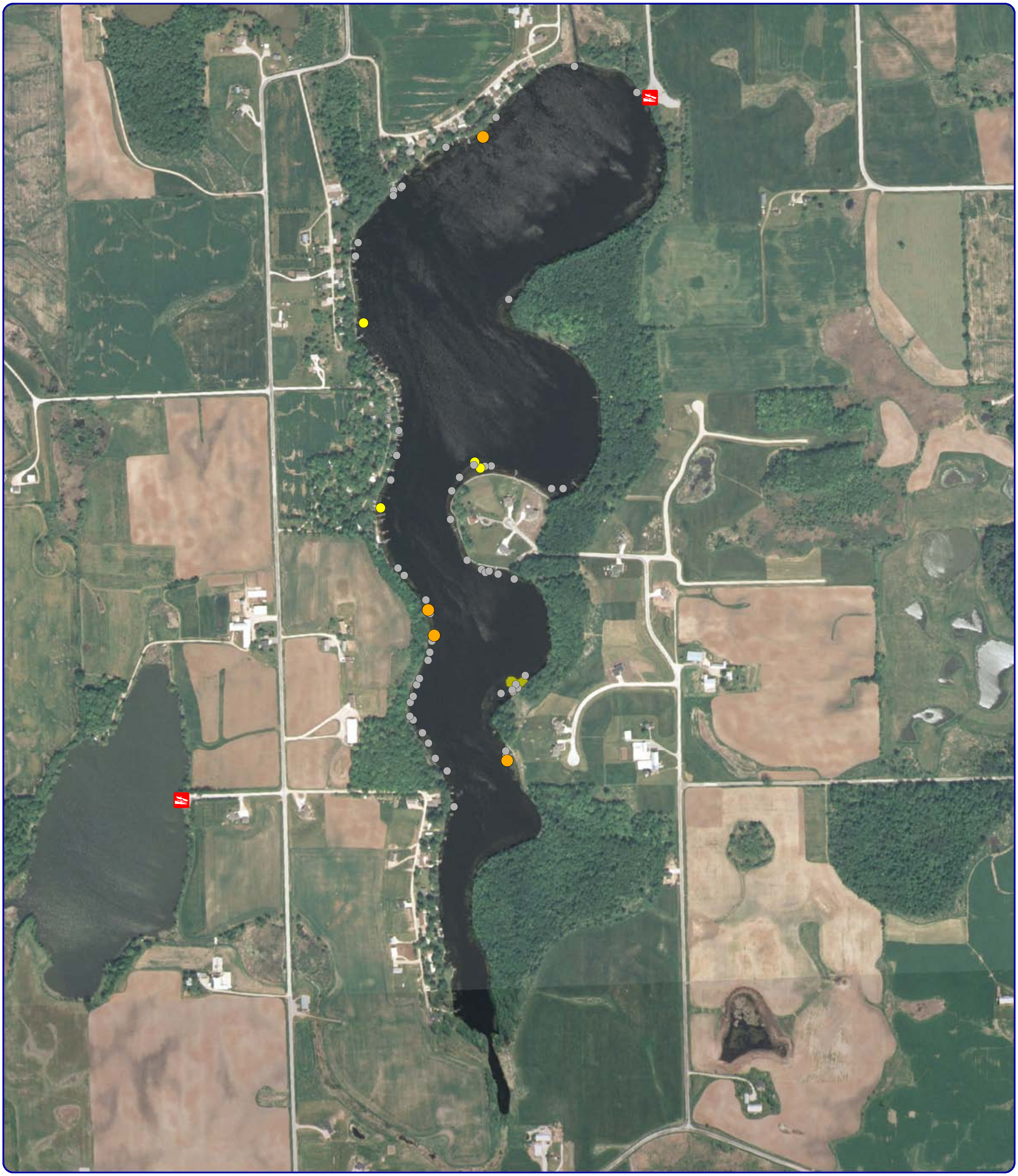
Point-intercept Survey Location
40-meter spacing - 317 total points

Map1
Long Lake
Manitowoc County, Wisconsin

Project Location & Lake Boundaries

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads & Hydro: WDNR
Orthophotography: NAIP, 2005
Map date: December 17, 2010



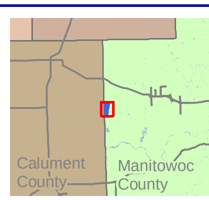
850

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra 2009
Orthophotography: NAIP, 2005

Map Date: March 3, 2010



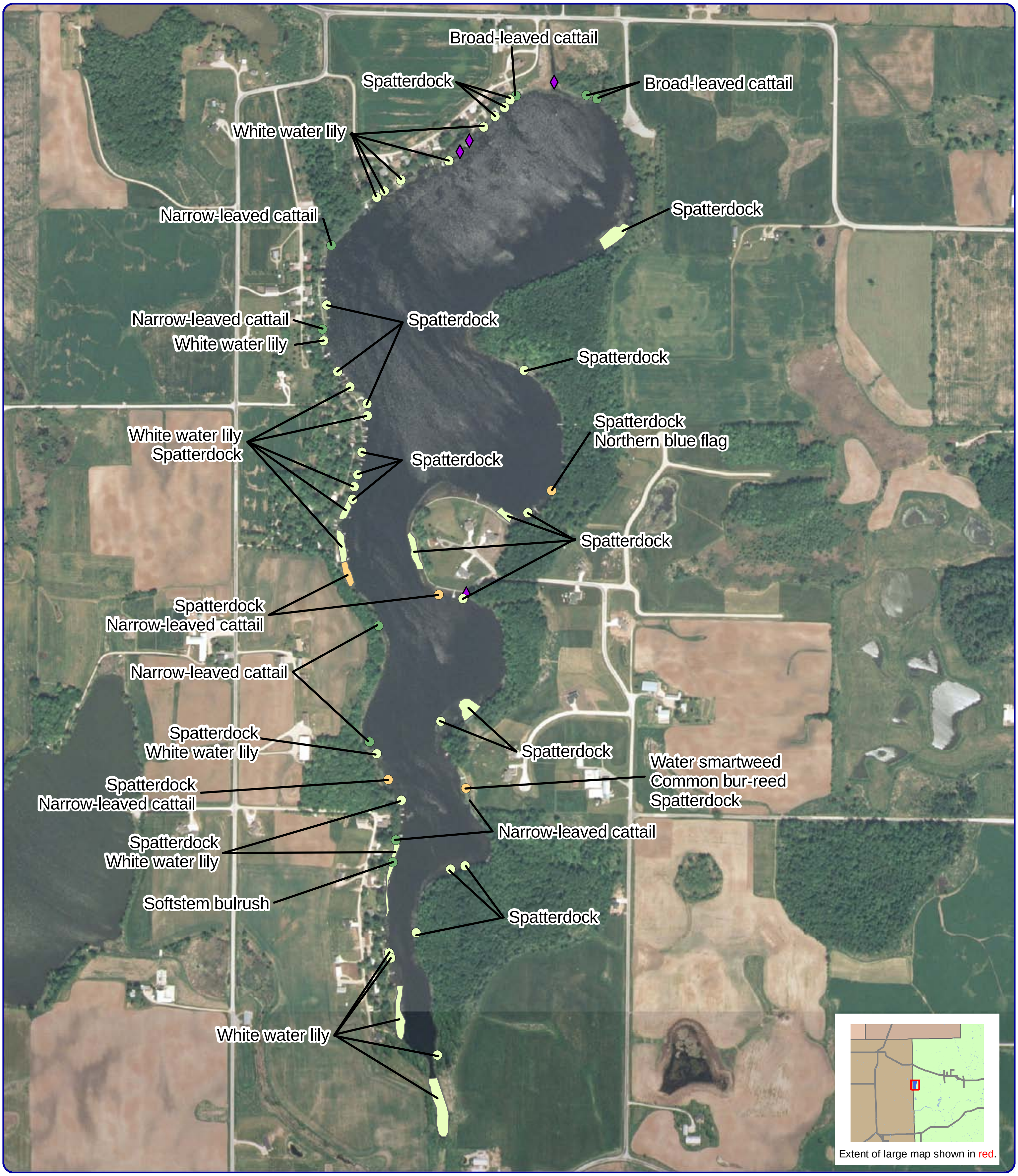
Extent of large map shown in red.

Legend

- CLP single or few plants
- CLP clump
- CLP small colony
- CLP scattered plants

Map 2
Long Lake
Manitowoc County, Wisconsin

2009 CLP Findings



N W E S

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Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra 2009
Orthophotography: NAIP, 2005

Map Date: February 9, 2010

Legend

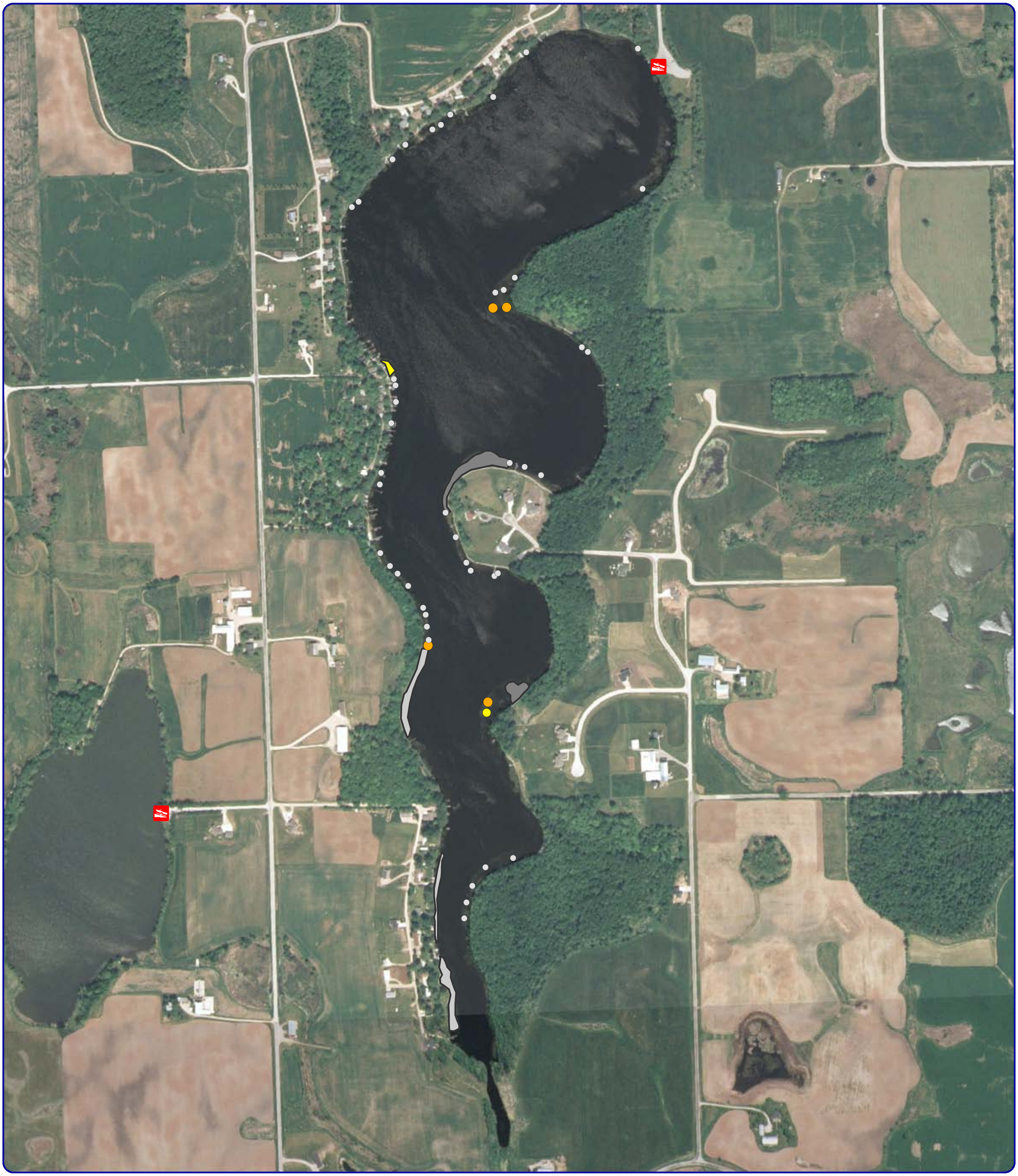
Large Plant Communities
- Emergent
- Floating-leaf
- Mixed floating-leaf & emergent

Exotic Plant Communities
- Purple Loosestrife

Small Plant Communities
- Emergent
- Floating-leaf
- Mixed floating-leaf & emergent

Map 3
Long Lake
Manitowoc County, Wisconsin

Aquatic Plant Communities



N
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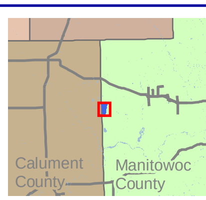
850

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra 2009
Orthophotography: NAIP, 2005

Map Date: December 8, 2009



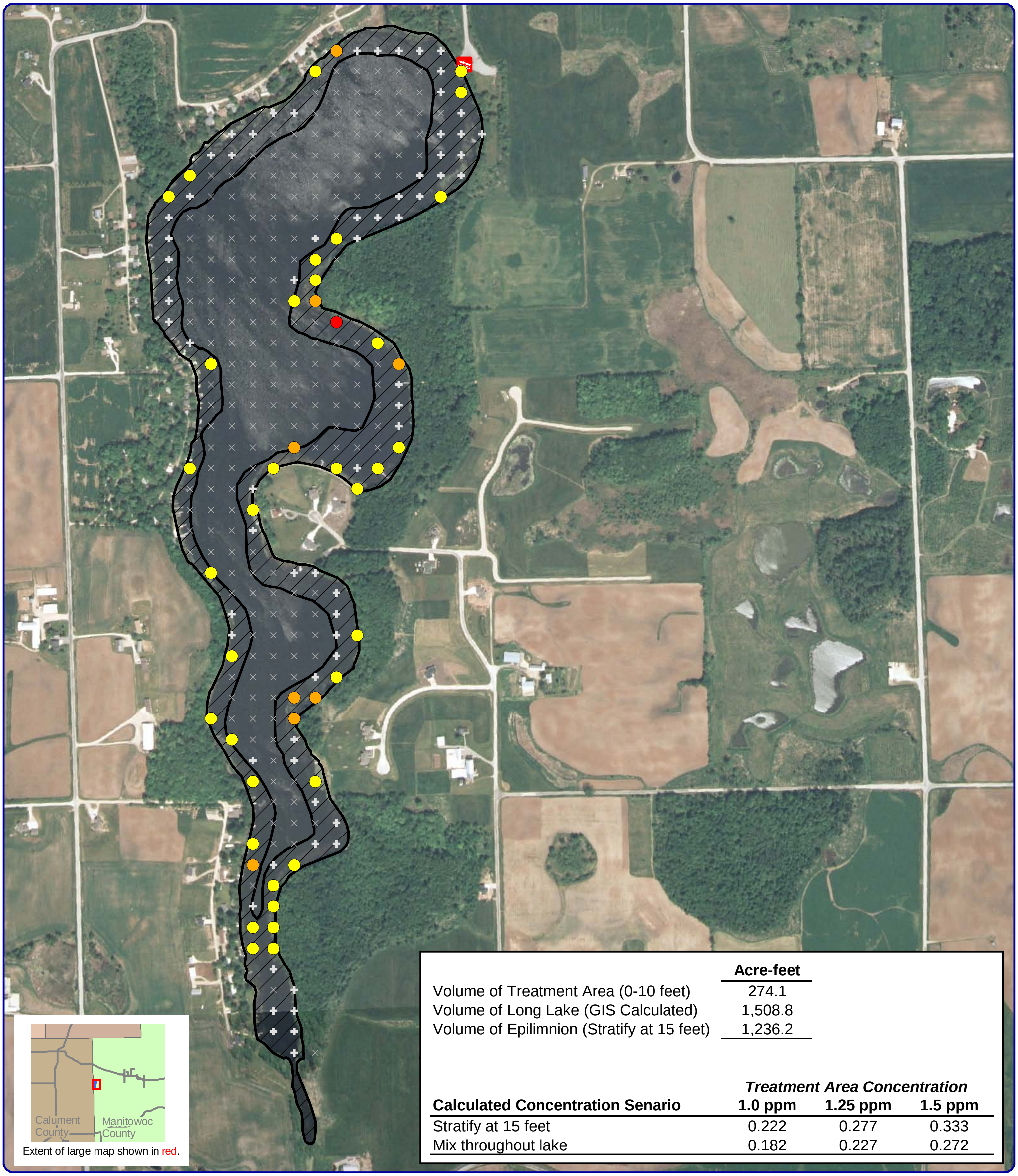
Extent of large map shown in red.

EWM Survey Results (August 2009)

- Single or Few Plants
- Many Plants or Clumps of Plants
- Small Plant Colony (<40 ft Diameter)
- Highly Scattered
- Scattered
- Dominant
- Highly Dominant *(none found)*
- Surface Matting *(none found)*

Map 4
Long Lake
Manitowoc County, Wisconsin

2009 EWM Findings



	Acre-feet
Volume of Treatment Area (0-10 feet)	274.1
Volume of Long Lake (GIS Calculated)	1,508.8
Volume of Epilimnion (Stratify at 15 feet)	1,236.2

	Treatment Area Concentration		
Calculated Concentration Senario	**1.0 ppm**	**1.25 ppm**	**1.5 ppm**
Stratify at 15 feet	0.222	0.277	0.333
Mix throughout lake	0.182	0.227	0.272

N W E S

800

Feet

Onterra LLC
Lake Management Planning
135 South Broadway Suite C
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra 2010
Orthophotography: NAIP, 2005

Map Date: October 19, 2010

Point-intercept Survey Results
Onterra, 2010

- Too Deep
- No EWM Found
- EWM Rake Fullness = 1
- EWM Rake Fullness = 2
- EWM Rake Fullness = 3

Proposed EWM Treatment Area
~ 61 Acres

Map 6
Long Lake
Manitowoc County, Wisconsin
2011 Proposed EWM Treatmen Areas

A

APPENDIX A

Public Participation Materials

Long Lake Aquatic Plant Management Planning Project

Project Kick-Off Meeting

May 3, 2008 10:00 AM

Town of Rockland Town Hall - Collins, WI

The Long Lake Advancement Association has received an Aquatic Invasive Species Grant from the Wisconsin Department of Natural Resources to partially fund the completion of a plant management plan for Long Lake. The project has two primary objectives, the first being the completion of an in-depth study including multiple plant surveys; the second being the completion of a realistic plant management plan for the lake. Most of the studies will be completed during this spring, summer and fall. The tasks associated with the analysis of the data will be completed during the fall and winter. The project will also incorporate opportunities for stakeholder education and input, which are both very important components of all lake management planning efforts. The first opportunity for your participation in the process will be at the Project Kick-off Meeting to be held on Saturday, May 3rd at 10:00 am at the Town of Rockland Town Hall in Collins, WI.

Onterra, LLC, a lake management planning firm out of De Pere, has been hired to lead the project. During the meeting Eddie Heath, an Aquatic Ecologist with Onterra, will describe the project and its importance. His presentation will include a description of the project's components, a quick course on general lake ecology, and a breakdown of how the Association's Planning Committee will be involved in the plan's completion. So, please plan on attending the meeting and do not hesitate to ask questions or make comments.

Eurasian Water Milfoil Crash in Long Lake

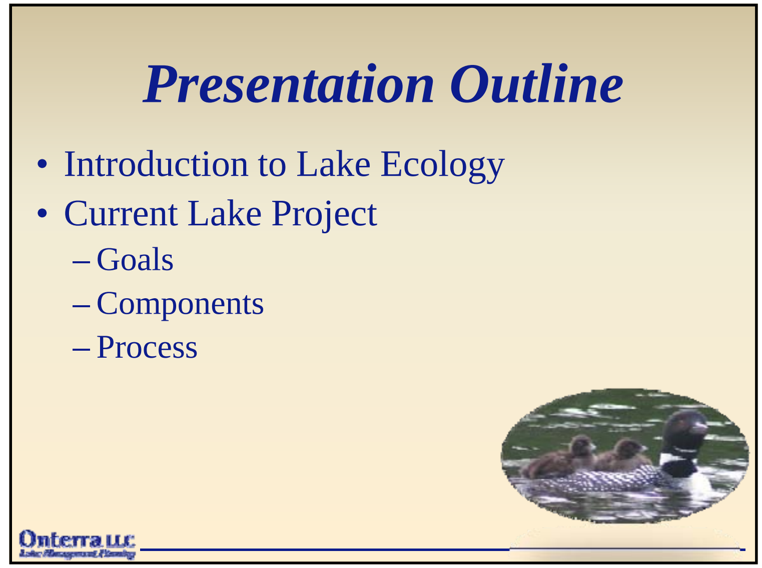
Submitted by:
Tim Hoyman
Aquatic Ecologist
Onterra, LLC

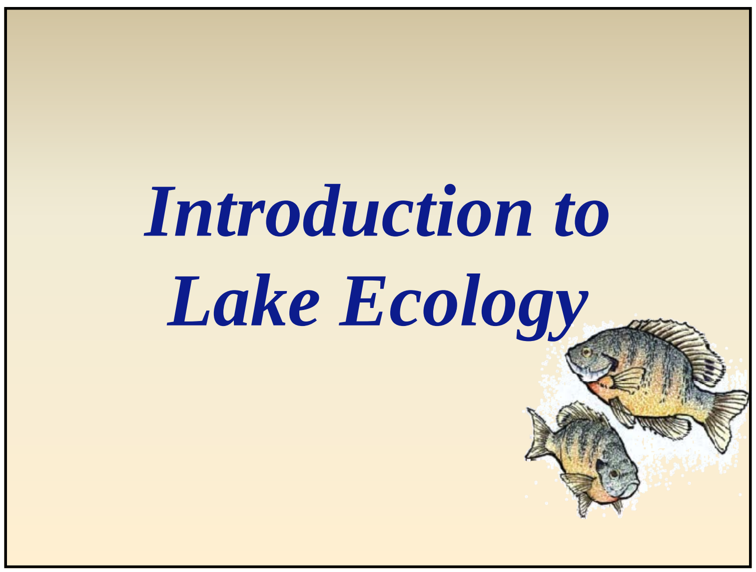
One of the primary reasons for undertaking the Long Lake Management Planning Project was to develop options to control the Eurasian water milfoil within the lake. Reportedly, the invasive plant was approaching nuisance levels during the summers of 2006 and 2007; however, during 2008, the troublesome plant has all but disappeared from the lake. In fact, only a few occurrences of Eurasian water milfoil were located within the lake during two surveys completed by Onterra staff this past summer.

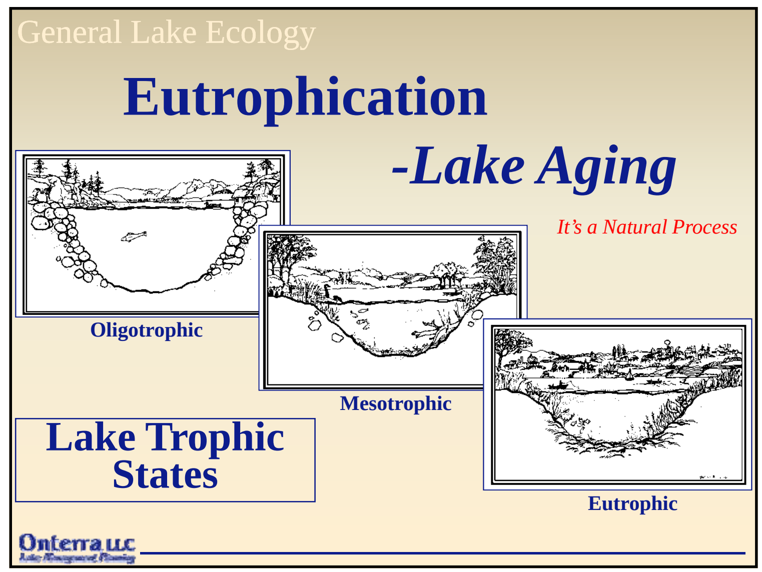
While all aquatic plants are cyclic in nature regarding their abundances from year to year, this kind of decrease in plant biomass is truly unheard of. Unfortunately, no plant surveys were completed in 2007 or 2006, so we are unable to quantify the decrease in anyway. Further, we really have no way of determining what changed within the lake to cause the Eurasian water milfoil population to decrease. The most likely possibility is a combination of effects caused by a late ice-out and a decrease in light penetration due to decreased water transparency. Data collected during the summer of 2008 indicates that water clarity was about half what it was during 2006, unfortunately, no water quality data is available for the summer of 2007. The decrease in water clarity is probably the result of increased algal abundance within the water column

Regrettably, we really have no way of knowing if this trend will continue or not. If the trend does continue, the original intent of the management planning project is moot because there will be no Eurasian water milfoil that requires management. At this time, any further actions regarding the management plan have been put “on-hold” until the summer of 2009 when the lake can be surveyed for Eurasian water milfoil. If Eurasian water milfoil occurs more frequently within the lake than during the summer of 2008, then the planning project will proceed. If Eurasian water milfoil remains to be infrequent within the lake, then a new scope of work will need to be developed in regards to the management plan.


Long Lake
Advancement Association
Long Lake Aquatic Plant
Management Planning Project
Kick-off Meeting
May 3, 2007
Eddie J. Heath
Aquatic Ecologist
Onterra LLC

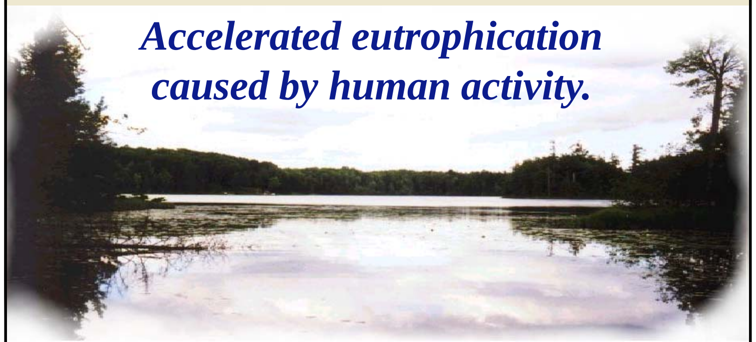

Presentation Outline
• Introduction to Lake Ecology
• Current Lake Project
– Goals
– Components
– Process
Onterra LLC


Introduction to
Lake Ecology


General Lake Ecology
Eutrophication
-Lake Aging
It's a Natural Process
Oligotrophic
Mesotrophic
Eutrophic
Lake Trophic
States
Onterra LLC

General Lake Ecology

Cultural Eutrophication



Accelerated eutrophication caused by human activity.

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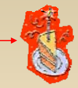
General Lake Ecology

Limiting Nutrient

2 Eggs
2 Cups Flour
2 Cups Sugar
2 Cups Water

2 Eggs
2 Cups Flour
2 Cups Sugar
2 Cups Water



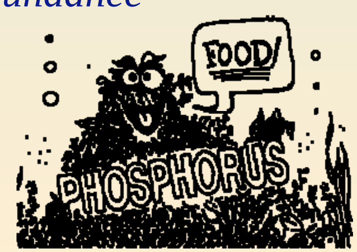
2 Eggs
2 Cups Flour
2 Cups Sugar
2 Cups Water

2 Eggs
2 Cups Flour
2 Cups Sugar
2 Cups Water

General Lake Ecology

Phosphorus

- *Limiting Nutrient*
- *Controls Plant Abundance (Productivity)*
  - *Algae*
  - *Macrophytes*

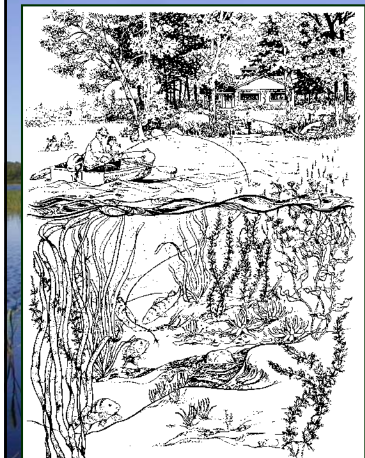


General Lake Ecology

Aquatic Plants (macrophytes)

- *Native Plants*
- *Exotic Plants (non-native)*

Native Aquatic Plants



- Base of the Food Web
- Cover (not only fish)
- Nursery
- Sediment Stabilization

General Lake Ecology

Non-native Aquatic Plants

Curly-leaf Pondweed

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General Lake Ecology

Non-native Aquatic Plants

Eurasian Water Milfoil

Onterra LLC

General Lake Ecology

Consequences of Exotics

- Competition with Natives
  - Monotypic Community
- Decreased Recreational Value
- Decreased Property Value

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Current Project

Study and Plan Goals

- Collect & Analyze Data
- Construct Long-Term & Useable Plan

A goal without a plan is just a wish.

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Current Project

Study Components

- Public Participation
- Aquatic Vegetation
  - Curly-leaf Survey
  - Comprehensive Survey
    - Point-intercept Survey
    - Native/Non-native Community Mapping
- Plan Development

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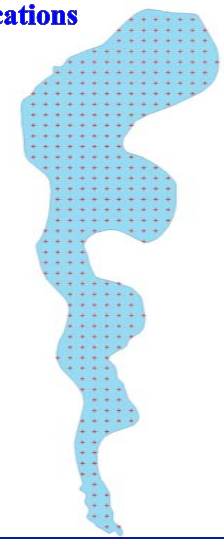
Point-intercept Locations



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Long Lake Planning Committee

- What is the *Planning Committee*?
  - Focus Group
  - Steering Committee
- Who should be on the *Planning Committee*?
  - 6-10 People
  - Cross-section
    - Age
    - Property Ownership
    - Perceptions & Interests
- What is expected of *Planning Committee* members?
  - Stakeholder Survey Mailing
  - 2-3 Meetings (1.5-3 hours each)

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Current Project

Planning Process

Planning Committee Meetings

- Study Results (including a stakeholder survey)
- Conclusions & Initial Recommendations
- Management Goals
- Management Actions
  - Timeframe
  - Facilitator(s)

Implementation Plan

Onterra LLC

Thank You

Eddie J. Heath **eheath@onterra-eco.com**

Many of the graphics used in this presentation were supplied by:

Wisconsin Lakes Partnership

UW Extension

Wisconsin Dept. of Natural Resources

Onterra LLC

Presentation Outline

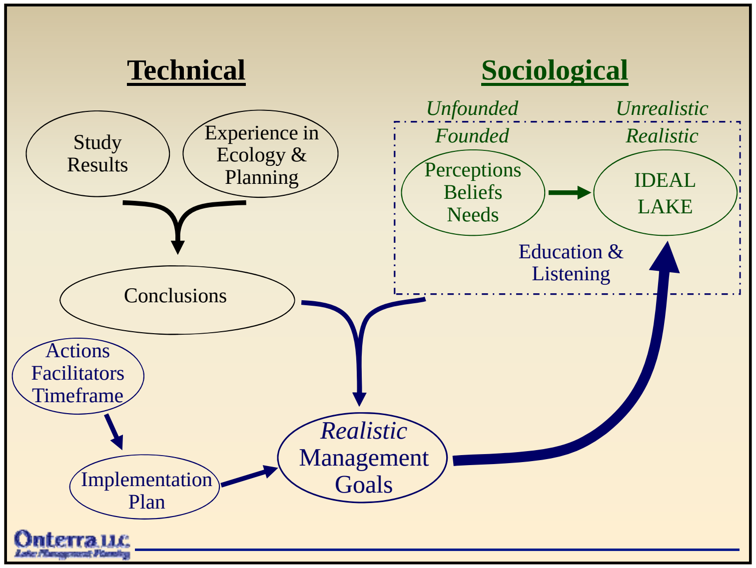
- Lake Management Planning Project Overview
- Study Results
  - Aquatic Plants
- “Big Picture”
- Goals and Actions Discussion

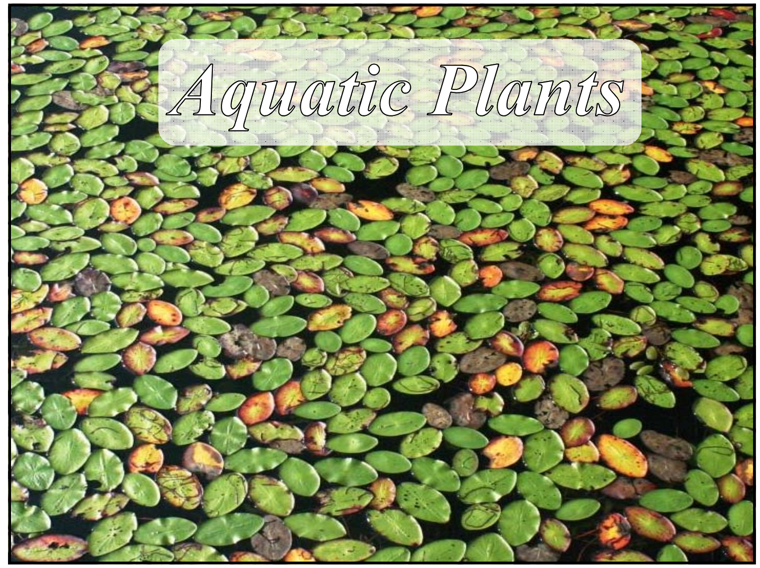
Study and Plan Goals

- Collect & Analyze Data
- Construct Long-Term & Useable Plan

The Planning Process

…it’s not as easy as you may think.



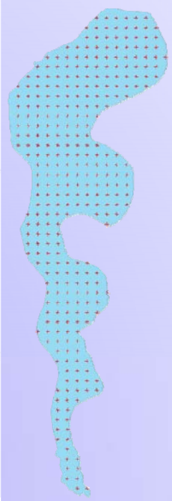


Point-Intercept Survey

Long Lake

40-meters

317 points



Species List

- 11 Total Species
  - 2 non-natives

Long Lake

Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)
E	*Typha latifolia**	Broad-leaved cattail	1
FL	*Nuphar variegata*	Spatterdock	6
	*Nymphaea odorata**	White water lily	6
Submergent	*Ceratophyllum demersum*	Coontail	3
	Chara sp.	Muskgrasses	7
	Myriophyllum sibiricum	Northern water milfoil	7
	Myriophyllum spicatum	Eurasian water milfoil	Exotic
	*Potamogeton crispus**	Curly-leaf pondweed	Exotic
	*Potamogeton strictifolius**	Stiff pondweed	8
	*Stuckenia pectinata**	Sago pondweed	3
FF	*Lemna minor**	Lesser duckweed	5

Note: P. crispus, P. strictifolius and S. pectinata found in summer 2009

E = Emergent

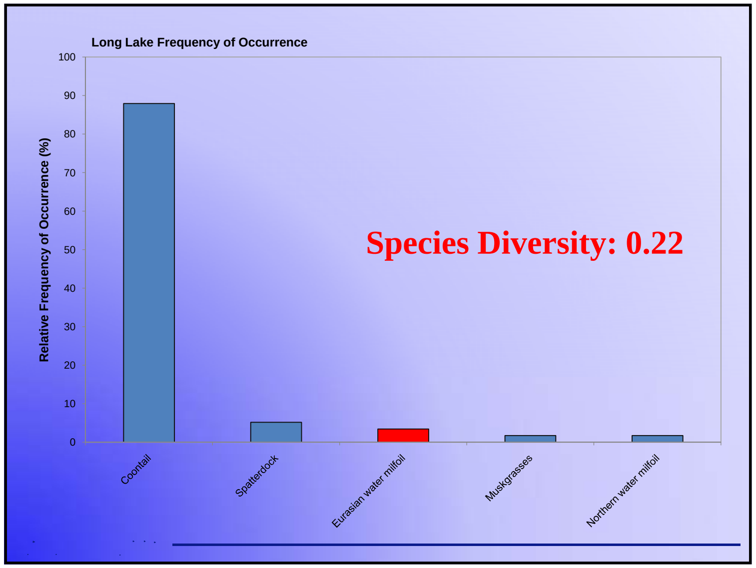
FL = Floating Leaf

FL/E = Floating Leaf and Emergent

S/E = Submergent and Emergent

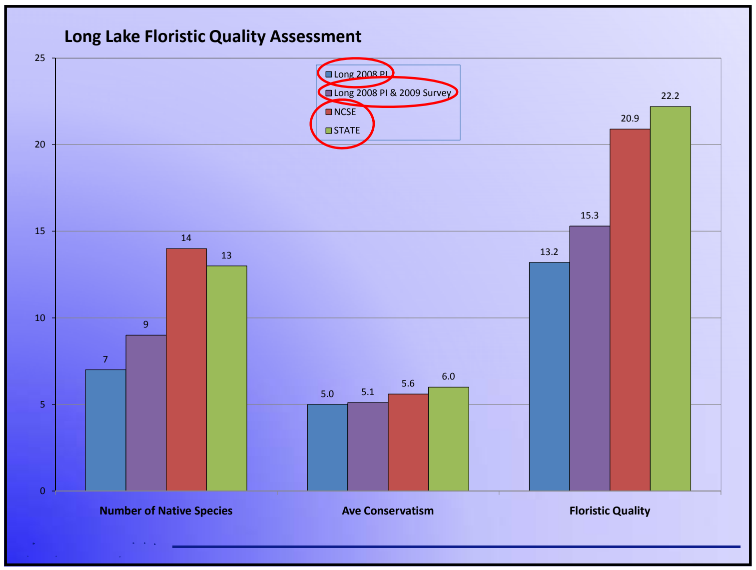
FF = Free Floating

* = Incidental



Aquatic Plants

Wisconsin Ecoregions



Aquatic Plant Community Mapping

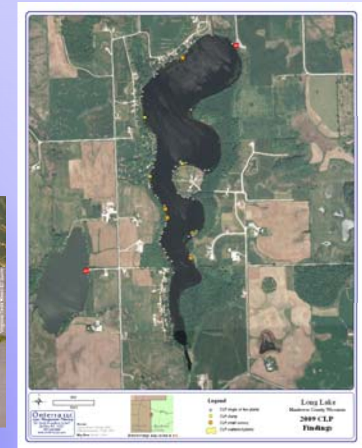
- Mapped Communities
  - Floating-leaf
  - Emergent
- Important Indicators
  - Vulnerable to ecosystem changes
    - Loss of species
    - Expansion or recession

Non-native Aquatic Plants

- **Exotic Surveys**
  - June 26, 2008 – *no exotics located.*
  - July 28, 2008 – *EWM found in very few point-intercept locations.*
  - October 2008 – *Management plan development put on hold.*
  - June 11, 2009 – *EWM and CLP mapped in moderate numbers around lake.*
  - August 5, 2009 – *EWM and CLP mapped in numerous areas around lake.*

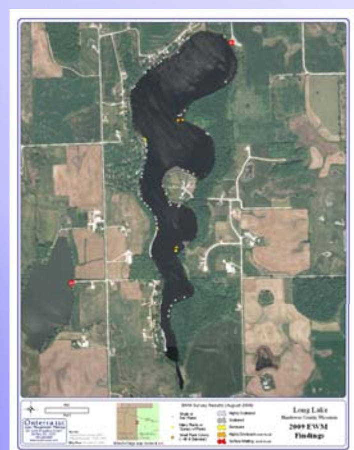
Non-native Aquatic Plants

Curly-leaf Pondweed



Non-native Aquatic Plants

Eurasian Water Milfoil



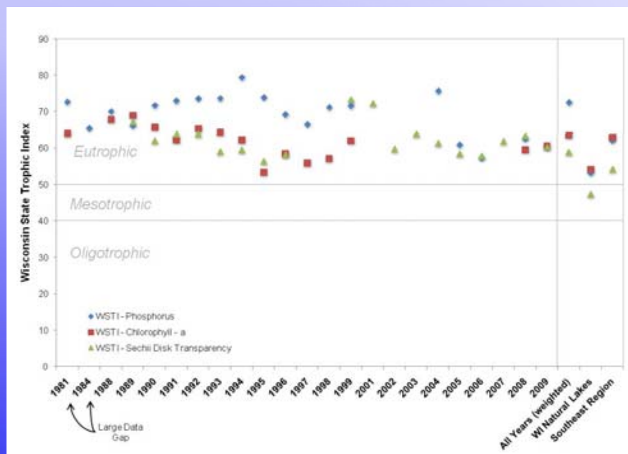
Conclusions

- Plant community is in poor condition
  - Very low species diversity
  - Poor species richness
  - Low floristic quality
  - Some areas may have nuisance plant levels on a seasonal basis
  - Relatively abundant exotic population (not too bad)
- This is a concern
  - Poor competition against algae population
  - Low grade aquatic habitat

Conclus

- Why is the … in such a poor condi…
  - Exceeding … rbance in lake and waters…
    - Leads t… d in-lake plant commu…

Conclusions



Conclusions


Thank You
Many of the graphics used in this presentation were supplied by:
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DEPT. OF NATURAL RESOURCES

B

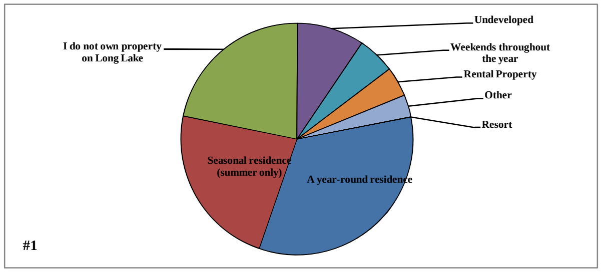
APPENDIX B

Stakeholder Survey Response Charts and Comments

Returned Surveys	95
Sent Surveys	191
Response Rate (%)	49.7

#1 What type of property do you own on Long Lake?

	Total	%
A year-round residence	32	*33.3*
Seasonal residence (summer only)	22	*22.9*
I do not own property on Long Lake	21	*21.9*
Undeveloped	9	*9.4*
Weekends throughout the year	5	*5.2*
Rental Property	4	*4.2*
Other	3	*3.1*
Resort	0	*0.0*
	96	*100.0*

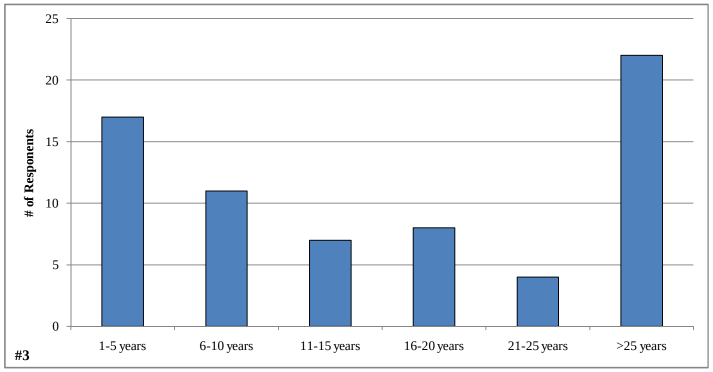


#2 If you are not a year-round resident, how many days each year is your property used by you or others?

Answered Question	35
Average	59.9
Standard deviation	53.9

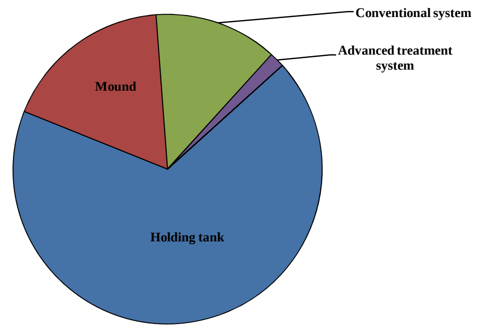
#3 How many years have you owned property on Long Lake?

	Total	%
1-5 years	17	*24.6*
6-10 years	11	*15.9*
11-15 years	7	*10.1*
16-20 years	8	*11.6*
21-25 years	4	*5.8*
>25 years	22	*31.9*
	69	*100.0*



#4 What type of septic system does your property utilize?

	Total	%
Holding tank	42	*67.7*
Mound	11	*17.7*
Conventional system	8	*12.9*
Advanced treatment system	1	*1.6*
Municipal Sewer	0	*0.0*
Do not know	0	*0.0*
	62	*100.0*



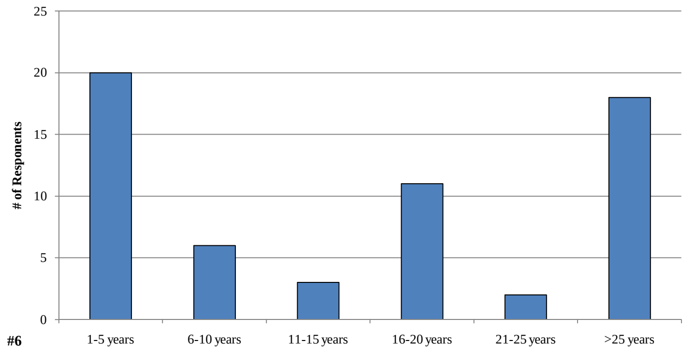
#4

#5 Have you personally fished on Long Lake in the past 3 years?

	Total	%
Yes	60	*63.8*
No	34	*36.2*
	94	*100.0*

#6 How many years experience do you have fishing on Long Lake?

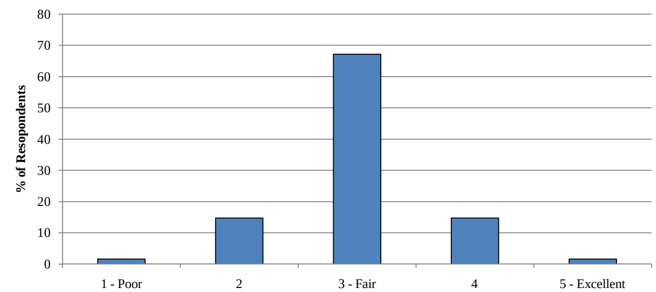
	Total	%
1-5 years	20	*29.0*
6-10 years	6	*8.7*
11-15 years	3	*4.3*
16-20 years	11	*15.9*
21-25 years	2	*2.9*
>25 years	18	*26.1*
	60	*87.0*



#6

#7 How would you describe the current quality of fishing on Long Lake?

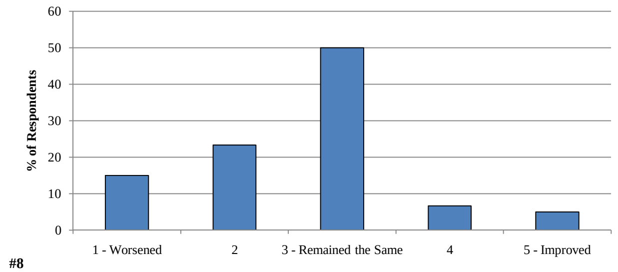
	Total	%
1 - Poor	1	*1.6*
2	9	*14.8*
3 - Fair	41	*67.2*
4	9	*14.8*
5 - Excellent	1	*1.6*
	61	*100.0*



#7

#8 How has the quality of fishing changed on Long Lake since you obtained your property?

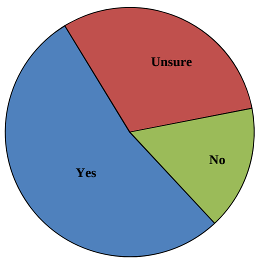
	Total	%
1 - Worsened	9	*15.0*
2	14	*23.3*
3 - Remained the Same	30	*50.0*
4	4	*6.7*
5 - Improved	3	*5.0*
	60	*100.0*



#8

#9 Are you in favor of stocking northern pike in Long Lake?

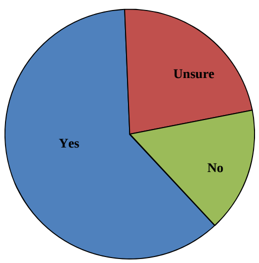
	Total	%
Yes	33	*53.2*
Unsure	19	*30.6*
No	10	*16.1*
	62	*100.0*



#9

#10 Are you in favor of stocking walleye in Long Lake?

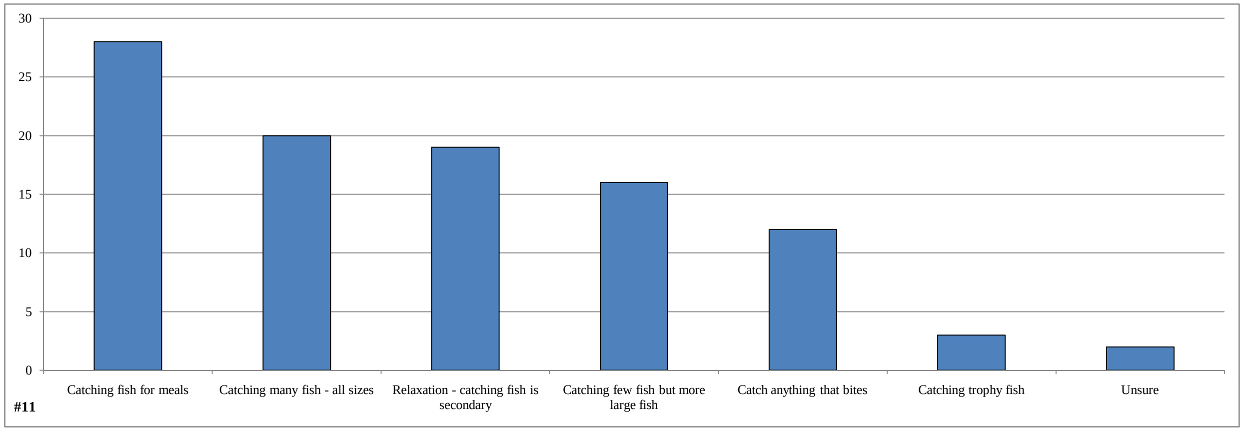
	Total	%
Yes	38	*61.3*
Unsure	14	*22.6*
No	10	*16.1*
	62	*100.0*



#10

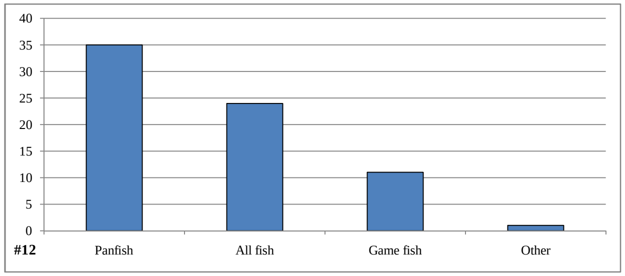
#11 What kind of fishing experience are you interested in on Long Lake?

	Total
Catching fish for meals	28
Catching many fish - all sizes	20
Relaxation - catching fish is secondary	19
Catching few fish but more large fish	16
Catch anything that bites	12
Catching trophy fish	3
Unsure	2
	100



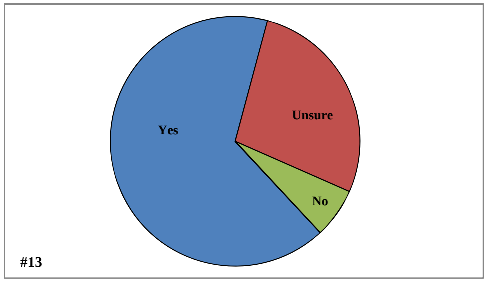
#12 What kind of fish do you like to catch on Long Lake?

	Total
Panfish	35
All fish	24
Game fish	11
Other	1
	71



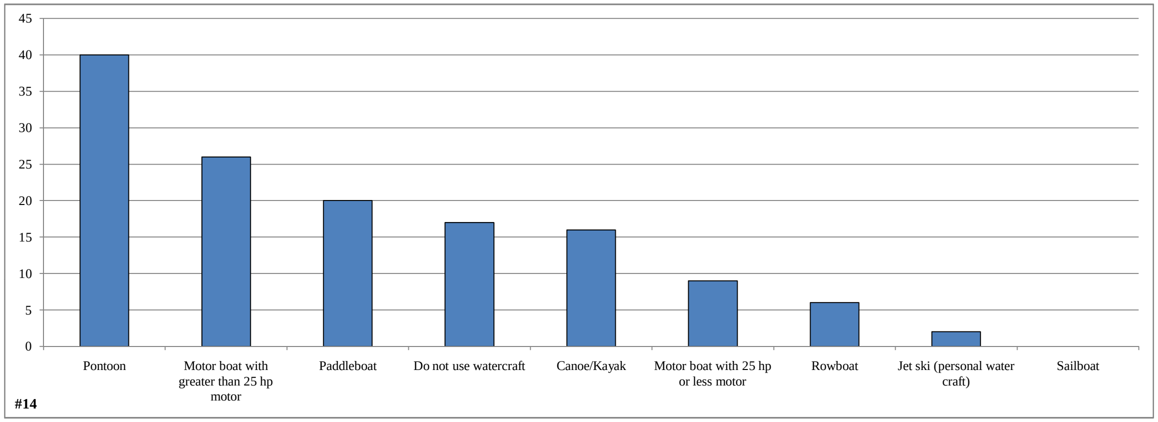
#13 Do you think that fish habitat should be improved on Long Lake?

	Total	%
Yes	41	*66.1*
Unsure	17	*27.4*
No	4	*6.5*
	62	*100.0*



#14 What types of watercraft do you currently use on the lake?

	Total
Pontoon	40
Motor boat with greater than 25 hp motor	26
Paddleboat	20
Do not use watercraft	17
Canoe/Kayak	16
Motor boat with 25 hp or less motor	9
Rowboat	6
Jet ski (personal water craft)	2
Sailboat	0
	136

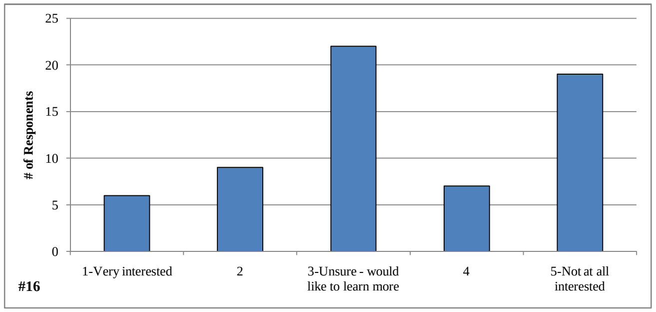


#15 Are you a riparian owner, that is, is your property waterfront property?

	Total	%
Yes	41	*91.1*
No	4	*8.9*
	45	*100.0*

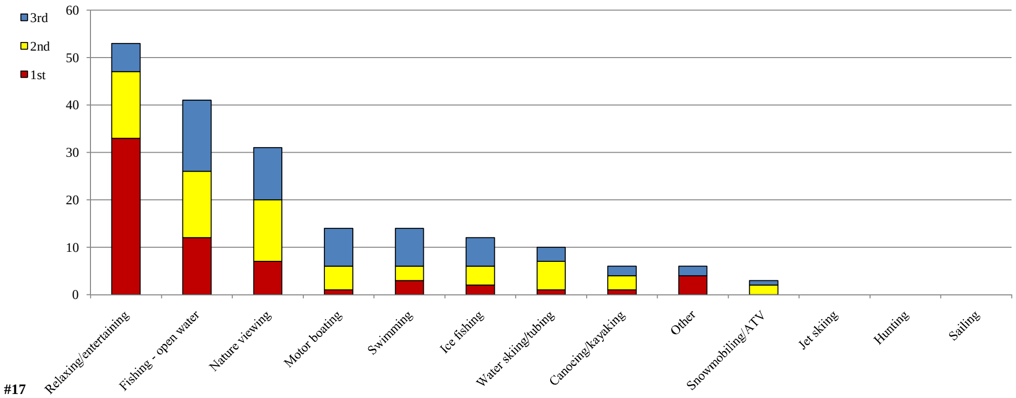
#16 How interested would you be in hosting a fish habitat improvement project on your shore?

	Total	%
1-Very interested	6	*9.5*
2	9	*14.3*
3-Unsure - would like to learn more	22	*34.9*
4	7	*11.1*
5-Not at all interested	19	*30.2*
	63	*100.0*



#17 Please rank up to three activities that are important reasons for owning your Long Lake property.

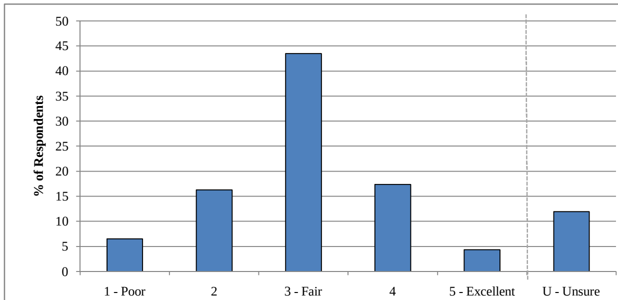
	1st	2nd	3rd	% ranked
Relaxing/entertaining	33	14	6	*27.9*
Fishing - open water	12	14	15	*21.6*
Nature viewing	7	13	11	*16.3*
Motor boating	1	5	8	*7.4*
Swimming	3	3	8	*7.4*
Ice fishing	2	4	6	*6.3*
Water skiing/tubing	1	6	3	*5.3*
Canoeing/kayaking	1	3	2	*3.2*
Other	4	0	2	*3.2*
Snowmobiling/ATV	0	2	1	*1.6*
Jet skiing	0	0	0	*0.0*
Hunting	0	0	0	*0.0*
Sailing	0	0	0	*0.0*
	64	64	62	*100.0*



#17

#18 How would you describe the current water quality of Long Lake?

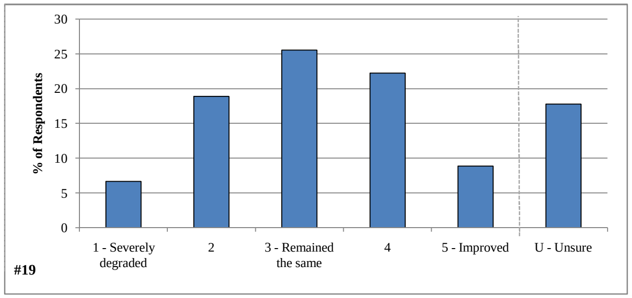
	Total	%
1 - Poor	6	*6.5*
2	15	*16.3*
3 - Fair	40	*43.5*
4	16	*17.4*
5 - Excellent	4	*4.3*
U - Unsure	11	*12.0*
	92	*100.0*



#18

#19 How has the water quality changed in Long Lake since you started using the lake?

	Total	%
1 - Severely degraded	6	*6.7*
2	17	*18.9*
3 - Remained the same	23	*25.6*
4	20	*22.2*
5 - Improved	8	*8.9*
U - Unsure	16	*17.8*
	90	*100.0*



#20 Have you ever heard of aquatic invasive species?

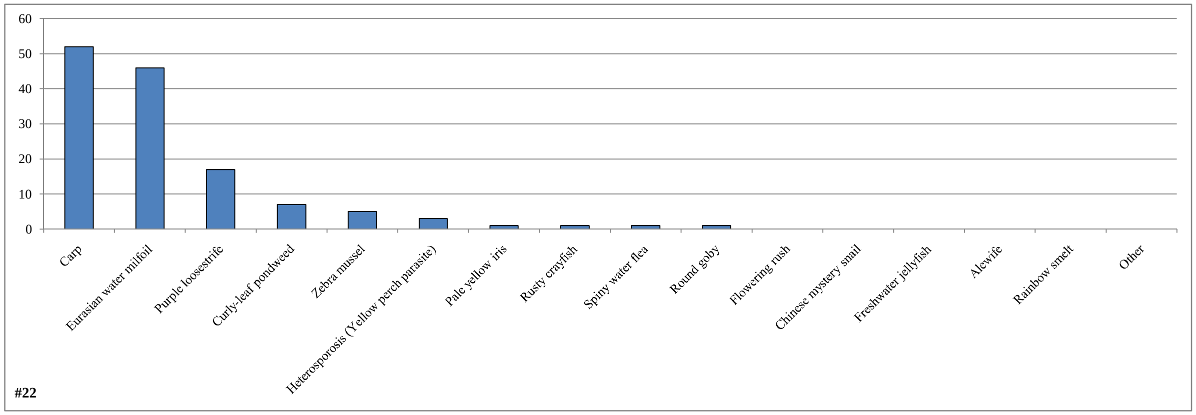
	Total	%
Yes	82	*89.1*
No	10	*10.9*
	92	*100.0*

#21 Are you aware of aquatic invasive species in Long Lake?

	Total	%
Yes	55	*60.4*
No	36	*39.6*
	91	*100.0*

#22 Which aquatic invasive species are you aware of in Long Lake?

	Total
Carp	52
Eurasian water milfoil	46
Purple loosestrife	17
Curly-leaf pondweed	7
Zebra mussel	5
Heterosporosis (Yellow perch parasite)	3
Pale yellow iris	1
Rusty crayfish	1
Spiny water flea	1
Round goby	1
Flowering rush	0
Chinese mystery snail	0
Freshwater jellyfish	0
Alewife	0
Rainbow smelt	0
Other	0

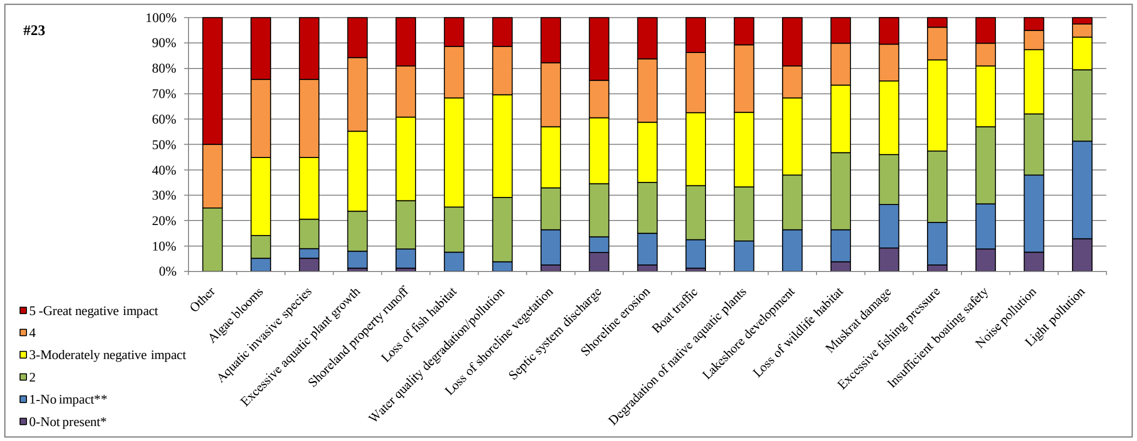


#23 To what level do you believe each the following factors may be negatively impacting Long Lake?

	0-Not present*	1-No impact**	2	3-Moderately negative impact	4	5 -Great negative impact	*Total*	*Average*
Other	0	0	1	0	1	2	*4*	*4.0*
Algae blooms	0	4	7	24	24	19	*78*	*3.6*
Aquatic invasive species	4	3	9	19	24	19	*78*	*3.4*
Excessive aquatic plant growth	1	5	12	24	22	12	*76*	*3.3*
Shoreland property runoff	1	6	15	26	16	15	*79*	*3.2*
Loss of fish habitat	0	6	14	34	16	9	*79*	*3.1*
Water quality degradation/pollution	0	3	20	32	15	9	*79*	*3.1*
Loss of shoreline vegetation	2	11	13	19	20	14	*79*	*3.1*
Septic system discharge	6	5	17	21	12	20	*81*	*3.1*
Shoreline erosion	2	10	16	19	20	13	*80*	*3.1*
Boat traffic	1	9	17	23	19	11	*80*	*3.0*
Degradation of native aquatic plants	0	9	16	22	20	8	*75*	*3.0*
Lakeshore development	0	13	17	24	10	15	*79*	*3.0*
Loss of wildlife habitat	3	10	24	21	13	8	*79*	*2.7*
Muskrat damage	7	13	15	22	11	8	*76*	*2.5*
Excessive fishing pressure	2	13	22	28	10	3	*78*	*2.5*
Insufficient boating safety	7	14	24	19	7	8	*79*	*2.4*
Noise pollution	6	24	19	20	6	4	*79*	*2.1*
Light pollution	10	30	22	10	4	2	*78*	*1.7*

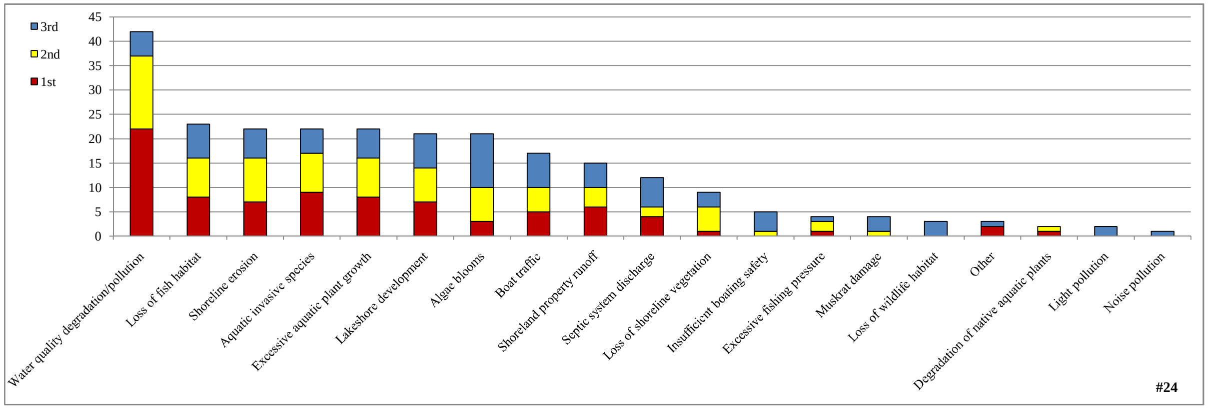
** Not present means that the issue does not exist on Long Lake*

*** No impact means that the issues may exist on Long Lake but it is not negatively impacting the lake*



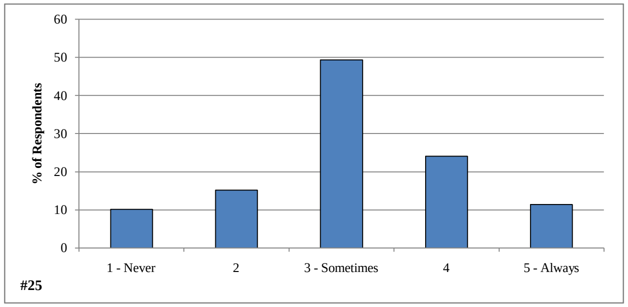
#24 Please rank your top three concerns regarding Long Lake

	1st	2nd	3rd	*% Ranked*
Water quality degradation/pollution	22	15	5	*16.8*
Loss of fish habitat	8	8	7	*9.2*
Shoreline erosion	7	9	6	*8.8*
Aquatic invasive species	9	8	5	*8.8*
Excessive aquatic plant growth	8	8	6	*8.8*
Lakeshore development	7	7	7	*8.4*
Algae blooms	3	7	11	*8.4*
Boat traffic	5	5	7	*6.8*
Shoreland property runoff	6	4	5	*6.0*
Septic system discharge	4	2	6	*4.8*
Loss of shoreline vegetation	1	5	3	*3.6*
Insufficient boating safety	0	1	4	*2.0*
Excessive fishing pressure	1	2	1	*1.6*
Muskrat damage	0	1	3	*1.6*
Loss of wildlife habitat	0	0	3	*1.2*
Other	2	0	1	*1.2*
Degradation of native aquatic plants	1	1	0	*0.8*
Light pollution	0	0	2	*0.8*
Noise pollution	0	0	1	*0.4*
	84	83	83	*100.0*



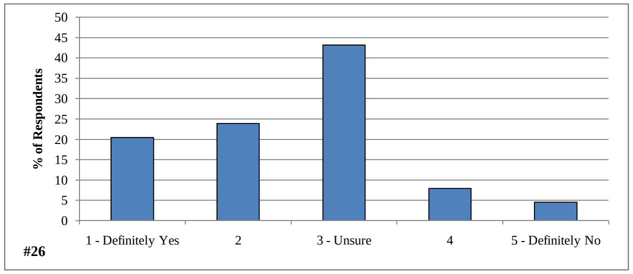
#25 How often does aquatic plant growth negatively impact your enjoyment of Long Lake?

	Total	%
1 - Never	8	*10.1*
2	12	*15.2*
3 - Sometimes	39	*49.4*
4	19	*24.1*
5 - Always	9	*11.4*
	79	*100.0*



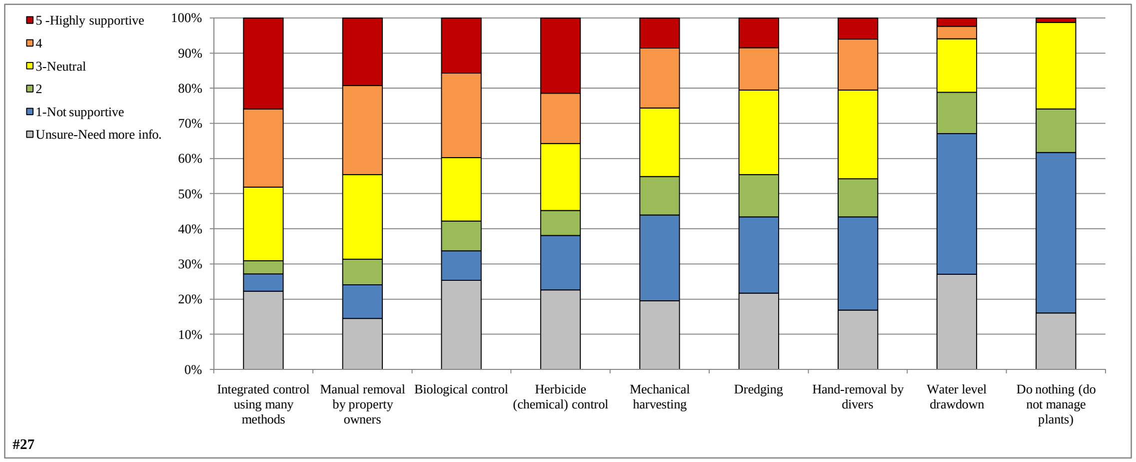
#26 Considering your answer to the question above, do you believe aquatic plant control is needed on Long Lake?

	Total	%
1 - Definitely Yes	18	*20.5*
2	21	*23.9*
3 - Unsure	38	*43.2*
4	7	*8.0*
5 - Definitely No	4	*4.5*
	88	*100.0*



#27 What is your level of support for the responsible use of the following techniques on Long Lake?

	1-Not supportive	2	3-Neutral	4	5 -Highly supportive	Unsure-Need more info.	*Total*	*Average*
Integrated control using many methods	4	3	17	18	21	18	*81*	*3.8*
Manual removal by property owners	8	6	20	21	16	12	*83*	*3.4*
Biological control	7	7	15	20	13	21	*83*	*3.4*
Herbicide (chemical) control	13	6	16	12	18	19	*84*	*3.2*
Mechanical harvesting	20	9	16	14	7	16	*82*	*2.7*
Dredging	18	10	20	10	7	18	*83*	*2.7*
Hand-removal by divers	22	9	21	12	5	14	*83*	*2.6*
Water level drawdown	34	10	13	3	2	23	*85*	*1.9*
Do nothing (do not manage plants)	37	10	20	0	1	13	*81*	*1.8*



#28 Before receiving this mailing, have you ever heard of the Long Lake Advancement Association?

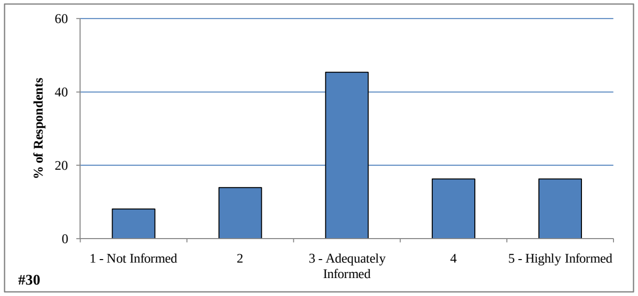
	Total	%
Yes	90	*96.8*
No	3	*3.2*
	93	*100.0*

#29 Are you currently a member of the Long Lake Advancement Association?

	Total	%
Yes	63	*71.6*
No	25	*28.4*
	88	*100.0*

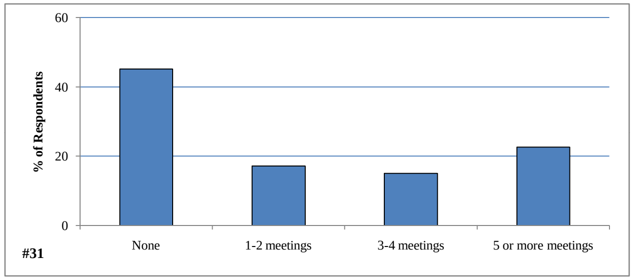
#30 How informed has the Long Lake Advancement Association kept you, regarding issues with Long Lake and its management?

	Total	%
1 - Not Informed	7	*8.1*
2	12	*14.0*
3 - Adequately Informed	39	*45.3*
4	14	*16.3*
5 - Highly Informed	14	*16.3*
	86	*100.0*



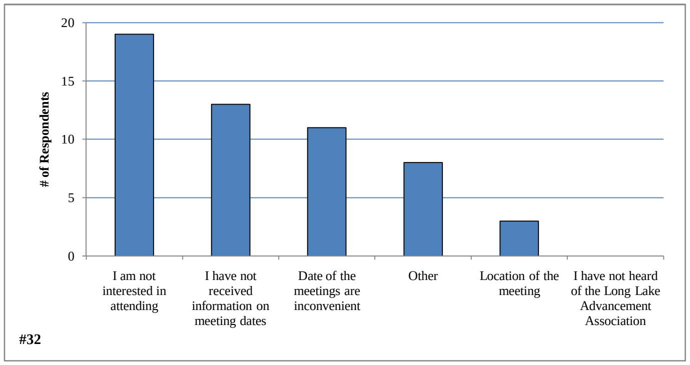
#31 How many Long Lake meetings have you attended?

	Total	%
None	42	*45.2*
1-2 meetings	16	*17.2*
3-4 meetings	14	*15.1*
5 or more meetings	21	*22.6*
	93	*100.0*



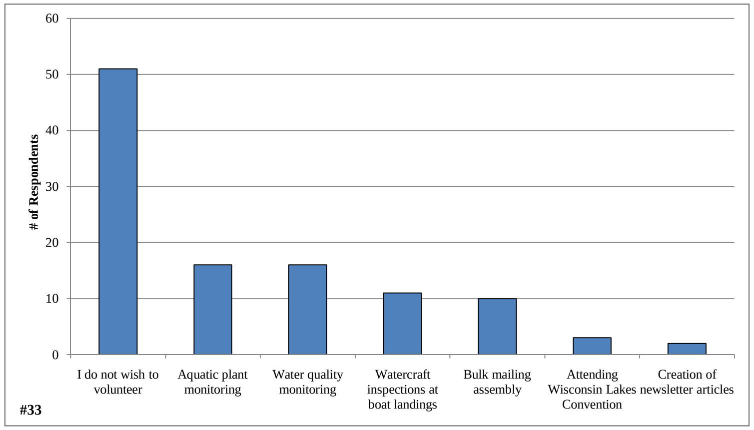
#32 If you have never attended a meeting, what is the reason you choose not to attend Long Lake Advancement Association meetings?

	Total	%
I am not interested in attending	19	*35.2*
I have not received information on meeting dates	13	*24.1*
Date of the meetings are inconvenient	11	*20.4*
Other	8	*14.8*
Location of the meeting	3	*5.6*
I have not heard of the Long Lake Advancement Association	0	*0.0*
	54	*100.0*



#33 Please circle the activities you would be willing to participate in if called upon.

	Total	%
I do not wish to volunteer	51	*46.8*
Aquatic plant monitoring	16	*14.7*
Water quality monitoring	16	*14.7*
Watercraft inspections at boat landings	11	*10.1*
Bulk mailing assembly	10	*9.2*
Attending Wisconsin Lakes Convention	3	*2.8*
Creation of newsletter articles	2	*1.8*
	109	*100.0*



Survey Number	Question 34	Additional Comments
1		
2		
3		# 24 All need attention
4		
5		# 32 Working
6		
7	We bought this property to enjoy some peaceful times. There are many speed boats and jet skis.also, the association pays to stock fish. Why can't there be a charge at the boat launch.	#23 Speed boat & jet ski
8		
9	I feel high powered boats and wave runners should not be allowed on long lake. It is too small a lake for that type of water craftand the waves wreck the shore. Not to mention effect to other boaters and fisherman.	Not specified: Had other commitments
10		
11	Severe shoreline erosion is a serious concern caused by wakes from power boats. A lake mgmt plan is needed for controlling eurasion water milfoil and other invasive weeds..	
12		
13		
14	I feel that a launch fee should be applied to help with costs..	
15		
16		
17		# 23 High speed boating, # 32 Too busy
18		#32 As long as you don't see me my wallet is safe. Times are tight. Haven't you noticed? I am not cocky just practical.
19	Do you think all the cottages and homes around the lake could be affecting the quality of the water.	
20	There should be a stricter regulation regarding lawn fertilizer…it is terrible…the expensive new homesuse it to extremeand the results are destructive. We need to put stop to it.	
21		#17 Paddle boat
22		
23		
24		
25		# 12 For eating
26		
27		
28		
29	Are there any things that can be done to keep the lake water level higher during the summer. Are there any things that can be done to remove and keep the silt off the bottom of the lake.	#27 Lake too shallow already
30		#17 Do not live on Long Lake..live on Boot Lake
31		

Survey Number	Question 34	Additional Comments
32		#32 Do not live near lake, Not specified: other more important issues and activities consuming time
33		
34	We are having difficulty using our cabin facilities the past few years. We have found that managing several propertys(home in Sheboygan) takes too much free time and physically the job has been demanding as I get older (77).	
35		#12 Northern, #32 Not member
36		
37		
38		#17 Pontooning
39		
40		
41		#1 Own trailer with addition on rented land
42		
43		
44		
45		
46		
47	Water levels keep going down. The lake thru the years seems to be better for clarity. Fishing is good in early summer but bad in late summer and fall.	
48	Bill me and I will gladly contribute more. Our association board members are doing a great job. We need to continue to raise money and push for donations. Any plan that does not reduce the entry of phosphorous into the water is short sighted…we need pressure on the farmers to reduce their use of fertilizers..the lack of no wake sign at outlet of lake is problem. I will pay for a sign. Shoreline erosion will be reduced.	
49		
50		
51		
52	First of all I own 20 acres on sunset ln since 1952. The shore line was all swamps about 20 ft back form the lake.there was a big steep hill about 120 ft back. So in 1964 I hired a cab and wheeler and a drag line to pull the bush out of the lake and then we buried the swamp with 8 ft of clay which sqeezed the juice out of the swamp ground. After that I made 10 lots of 80 x 100 ft and sold all but one. Since I was farming then I still built a cottage for our family to enjoy on Sundays. I was also on the long lake association board back then. I was also on the brillion watershed board where we got the permit to build the dam and open the ditch to beckers lake. We use to have high water which would come up nearly to the cottages. I also use top spray for algae with copper sulfate until the stupid guy from the dnr had us put too much on so we had a fish kill. After that the weed problem came back but we took them out ourselves with home made devices.we plan on selling our cottage in the near future since I am over 81 years old. None of our children want it due to the high taxes.	#1 Summer weekends

Survey Number	Question 34	Additional Comments
53		#17 Pontooning
54		
55		#17 Ice skating, #23 Nonpoint source discharge, #24 Agriculture
56		Not specified: Water to cover stone which was already down to look better. Went get permit. Tol not to. Then 1/2 mile of shore covered in stone. If you have money you can do anything you want.
57	I use to fish long lake as a child with my grandfather and a boat rented over 50 years ago. We would catch bullheads. Some were huge. As far as change on the lake I would have to say more permanent homes have been built. There are no longer cows in the lake or close to the lake. There are more motor boats. There is water skiing and jet skiing now. People enjoyed the lake then as they do now. As a home owner on the lake I feel like we should be stewards of the lake for generations to come. I love living on the lake. I wouldn't want to be anywhere else on earth. I especially love the seasons changing each year. I have fun keeping track of when the ice covers the lake and when it goes out. When the first robin arrives or when the first loon stops by. When we take out the pontoon boat and put it back in. I hope I can stay here until I pass on to a better place.	
58		
59		
60		
61		
62		#32 Meeting conflicts
63		
64		Not specified: Clean air
65		#19 Usually same water quality..always seems same..no way of knowing, not specified: Copty double sided next time for surveys to save paper/postage
66		
67		
68		
69		
70		

Survey Number	Question 34	Additional Comments
71	I feel there are a lot of property owners willing to spend time and money on lake water quality problems but I feel that there;s never a real concrete plan in place to make this happen causing people to not want to waste their time and money. I would be willing to spend the money if there was a realistic plan in place and would see some actual progress. I know that's it needed, but I feel that all we do is studies and no action.	
72		
73		
74	Why have the 75 ft law? When no one follows the rules. Should not allow to get a variance. So much for parks and planning. All they do there is run around with their coffee cups. Also, cat tail removal and filling in to piers. some have to take out when they fill in pathways and cutting trees down so they can see the lake. They built their house on the other side of woods.	
75		
76	Appreciate this project. Would like to see the clarity of the lake water to improve.	#32 Schedule conflicts
77		
78		
79		
80	I feel the high nutrient load, mainly due to phosphorous, is what is preventing long lake from being a lake with decent water quality. I have personally tested the water entering the lake on the north end and found phosphorous to be off the charts. While in the south end, it is much lower. To me, it seems as if diverting the inlet creek and returning it to its original state and flow where it passes west under the long lake rd would be a start. The canal entering the lake is not a natural waterway and is loading the lake with huge amounts of phosphorous. I don't think anyone has explored this option and I believe it at least needs to be looked at.Until phosphorous is dealth with there will always be excess weed and algae bloom issues.	#27 Whatever works best to remove non natives without removing natives
81		
82		
83	It is good to have an association to watch over the lake and address the big problems a lake can have. The lake use to be good for crappies, bluegills and bullheads. Now it is better for northern, bass and carp. The good or bad depending on what you fish for. I hope the association can even the fishery out for everyone. It is doing a good job and I hope they don't over-manage the lake which could hurt it o0	#12 Northern, bullheads
84	Form committee to do projects and have them report back to the board on a regular basis. What about the committee's that are already formed. Are they doing their job as we never hear of any committee reports at any meetings.	
85		
86		
87		
88		#17 For retirement
89		#17 Investment property

Survey Number	Question 34	Additional Comments
90	User fee at the boat landing and or park. Shallow body on hump in the middle of the lake. No wake buoy in channel at beginning of entrance..south end of lake..perhaps county needs to do a better, more thorough job of inspecting septic systems of year round and seasonal owners. We support the lake through taxes, long lake association memberships, raffles, donations..and many non residents of the lake use it for their recreation-for nothing!! Warn the public of the potential hazard(shallow hump), hopefully preventing anyone from getting hurt, and therefore, lessoning chances of lawsuit. County inspecting septics better would help to save shorelines in the area.	
91		#24 Low water levels
92		
93	No full treasurer report last year…no money from baot launch area. Get no money from town.No projects are ever done only studies with money to foth.	
94		#17 Peace & quiet
95		
96	i feel that some board members are mainly concerned with improving fish habitat and don’t heed listen to what most association members want. We want the money we are raising and spending to go toward weed control and lake clarity. Just because money is raised we don’t have to spend it. What are you democrats? Listen to the people. Change no wake limit from 11:00 to 6:00 to 10:30 to 7:00 from June 1st thru August. I think year round residents should have more weight in voting as some pay close to 10,000 in taxes and that is part of for living on lake..the farmers are a problem and know for a fact that even the farmers are aware of their neighbor farmers spraying excessive amount of manure and we don’t want to say anything but it is getting out of hand and even the roads are stuck in fall with 3 inches of manure. The liquid manure is running into low points under ground and ends up in ditches and the lake…	

C

APPENDIX C

2008 Aquatic Plant Survey Data

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
1	44.14206807	-88.04081238		5	M	P			1			
2	44.14170815	-88.04082428	No Vegetation	7	M	R						
3	44.14134823	-88.04083619	No Vegetation	7	M	R						
4	44.14098831	-88.0408481	No Vegetation	7	M	P						
5	44.14062839	-88.04086001		7	M	P			1			
6	44.14026847	-88.04087191	No Vegetation	7	M	P						
7	44.13990855	-88.04088382	No Vegetation	7	M	P						
8	44.14241942	-88.04030065	No Vegetation	6	M	P						
9	44.1420595	-88.04031256	No Vegetation	9	M	P						
10	44.14169958	-88.04032447	No Vegetation	11	M	R						
11	44.14133966	-88.04033638		13		R			1			
12	44.14097974	-88.04034829	No Vegetation	12		R						
13	44.14061982	-88.0403602	No Vegetation	13		R						
14	44.1402599	-88.04037211	Too Deep									
15	44.13989998	-88.04038402	No Vegetation	11	M	P						
16	44.13954006	-88.04039593	No Vegetation	8	M	P						
17	44.13738053	-88.04046738	No Vegetation	8	M	P						
18	44.13702061	-88.04047929		10	M	P			1	1		
19	44.13666069	-88.04049119	No Vegetation	12	M	P						
20	44.13630077	-88.0405031	No Vegetation	12	M	P						
21	44.13594085	-88.04051501	No Vegetation	3	M	P						
22	44.14277076	-88.03978892	No Vegetation	7	M	P						
23	44.14241084	-88.03980083	No Vegetation	11	M	P						
24	44.14205092	-88.03981275	No Vegetation	14		R						
25	44.141691	-88.03982466	Too Deep									
26	44.14133108	-88.03983657	Too Deep									
27	44.14097116	-88.03984848	Too Deep									
28	44.14061124	-88.0398604	Too Deep									
29	44.14025132	-88.03987231	Too Deep									
30	44.1398914	-88.03988422	Too Deep									
31	44.13953148	-88.03989613	No Vegetation	12	M	P						

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
32	44.13917156	-88.03990805	No Vegetation	10	M	P						
33	44.13881164	-88.03991996	No Vegetation	10	M	P						
34	44.13845172	-88.03993187	No Vegetation	13		R						
35	44.1380918	-88.03994378	Too Deep									
36	44.13773188	-88.03995569	Too Deep									
37	44.13737196	-88.0399676	Too Deep									
38	44.13701203	-88.03997951	Too Deep									
39	44.13665211	-88.03999142	Too Deep									
40	44.13629219	-88.04000333	Too Deep									
41	44.13593227	-88.04001524	Too Deep									
42	44.13557235	-88.04002715	No Vegetation	6	M	P						
43	44.13305291	-88.04011051		4	M	P			1			
44	44.1431221	-88.03927718	No Vegetation	5	M	P						
45	44.14276218	-88.0392891	No Vegetation	9	M	P						
46	44.14240226	-88.03930101	Too Deep									
47	44.14204234	-88.03931293	Too Deep									
48	44.14168242	-88.03932485	Too Deep									
49	44.1413225	-88.03933676	Too Deep									
50	44.14096258	-88.03934868	Too Deep									
51	44.14060266	-88.03936059	Too Deep									
52	44.14024274	-88.03937251	Too Deep									
53	44.13988282	-88.03938442	Too Deep									
54	44.1395229	-88.03939634	Too Deep									
55	44.13916298	-88.03940825	Too Deep									
56	44.13880306	-88.03942017	Too Deep									
57	44.13844314	-88.03943208	Too Deep									
58	44.13808322	-88.039444	Too Deep									
59	44.1377233	-88.03945591	Too Deep									
60	44.13736338	-88.03946783	Too Deep									
61	44.13700346	-88.03947974	Too Deep									
62	44.13664354	-88.03949165	Too Deep									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
63	44.13628361	-88.03950357	Too Deep									
64	44.13592369	-88.03951548	Too Deep									
65	44.13556377	-88.03952739	Too Deep									
66	44.13520385	-88.0395393		9	M	P			1			
67	44.13484393	-88.03955122	No Vegetation	4	M	P						
68	44.13448401	-88.03956313		1	M	P			1			
69	44.13412409	-88.03957504	No Vegetation	8	M	P						
70	44.13376417	-88.03958695		]13		R						
71	44.13340425	-88.03959886	Too Deep									
72	44.13304433	-88.03961077	Too Deep									
73	44.13268441	-88.03962268	No Vegetation	9	M	P						
74	44.14311352	-88.03877735	No Vegetation	7	M	P						
75	44.1427536	-88.03878927	No Vegetation	12	M	P						
76	44.14239368	-88.03880119	Too Deep									
77	44.14203376	-88.03881311	Too Deep									
78	44.14167384	-88.03882503	Too Deep									
79	44.14131392	-88.03883695	Too Deep									
80	44.140954	-88.03884887	Too Deep									
81	44.14059408	-88.03886079	No Vegetation	14		R						
82	44.14023416	-88.03887271	No Vegetation	10	M	P						
83	44.13987424	-88.03888463	Too Deep									
84	44.13951432	-88.03889655	Too Deep									
85	44.1391544	-88.03890846	Too Deep									
86	44.13879448	-88.03892038	Too Deep									
87	44.13843456	-88.0389323	Too Deep									
88	44.13807464	-88.03894422	Too Deep									
89	44.13771472	-88.03895613	Too Deep									
90	44.1373548	-88.03896805	No Vegetation	12	M	P						
91	44.13699488	-88.03897997	No Vegetation	3	M	P						
92	44.13663495	-88.03899188		3	M	P						
93	44.13627503	-88.0390038	No Vegetation	10	M	P						

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
94	44.13591511	-88.03901571	Too Deep									
95	44.13555519	-88.03902763	Too Deep									
96	44.13519527	-88.03903955	Too Deep									
97	44.13483535	-88.03905146	Too Deep									
98	44.13447543	-88.03906338	Too Deep									
99	44.13411551	-88.03907529	Too Deep									
100	44.13375559	-88.03908721	Too Deep									
101	44.13339567	-88.03909912	Too Deep									
102	44.13303575	-88.03911103	Too Deep									
103	44.13267583	-88.03912295	No Vegetation	13		R						
104	44.13231591	-88.03913486		7	M	P			1			
105	44.13195599	-88.03914677		5	M	P			1			
106	44.13087622	-88.03918251		6	M	P			1	1		
107	44.1305163	-88.03919443	No Vegetation	8	M	P						
108	44.13015638	-88.03920634		9	M	P			1			
109	44.12979646	-88.03921825	No Vegetation	10	M	P						
110	44.12943654	-88.03923016	No Vegetation	9	M	P						
111	44.12907662	-88.03924207		5	M	P			1			
112	44.14346485	-88.03826561	No Vegetation	4	R	P						
113	44.14310493	-88.03827753	No Vegetation	9	M	P						
114	44.14274501	-88.03828945	Too Deep									
115	44.14238509	-88.03830138	Too Deep									
116	44.14202517	-88.0383133	Too Deep									
117	44.14166525	-88.03832522	Too Deep									
118	44.14130533	-88.03833714	Too Deep									
119	44.14094541	-88.03834907	Too Deep									
120	44.14058549	-88.03836099	Too Deep									
121	44.14022557	-88.03837291	No Vegetation	10	M	P						
122	44.13986565	-88.03838483	Too Deep									
123	44.13950573	-88.03839675	Too Deep									
124	44.13914581	-88.03840867	Too Deep									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
125	44.13878589	-88.03842059	Too Deep									
126	44.13842597	-88.03843251	Too Deep									
127	44.13806605	-88.03844443	Too Deep									
128	44.13770613	-88.03845635	No Vegetation	5	R	P						
129	44.13734621	-88.03846827	On shore									
130	44.13554661	-88.03852787	No Vegetation	11	M	P						
131	44.13518669	-88.03853979	Too Deep									
132	44.13482677	-88.03855171	Too Deep									
133	44.13446685	-88.03856362	Too Deep									
134	44.13410693	-88.03857554	Too Deep									
135	44.13374701	-88.03858746	Too Deep									
136	44.13338709	-88.03859938	No Vegetation	13		R						
137	44.13302717	-88.03861129	No Vegetation	8	M	P						
138	44.13266725	-88.03862321	No Vegetation	12		R						
139	44.13230733	-88.03863513	No Vegetation	12	M	P						
140	44.13194741	-88.03864704	No Vegetation	11	M	P						
141	44.13158748	-88.03865896		11	M	P			1			
142	44.13122756	-88.03867088	No Vegetation	12	M	P						
143	44.13086764	-88.03868279	No Vegetation	12	M	P						
144	44.13050772	-88.03869471		8	M	P			1			
145	44.1301478	-88.03870662		4	M	P			1			
146	44.12978788	-88.03871854		4	M	P			2			
147	44.12942796	-88.03873045	On shore									
148	44.12906804	-88.03874237		4	M	P			2			
149	44.12870812	-88.03875428	No Vegetation	7	M	P						
150	44.1283482	-88.0387662		8	M	P			3			
151	44.12798828	-88.03877811		4	M	P			3			
152	44.12762836	-88.03879002		4	M	P			3			
153	44.14345627	-88.03776578	No Vegetation	9	M	P						
154	44.14309635	-88.03777771	Too Deep									
155	44.14273643	-88.03778963	Too Deep									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
156	44.14237651	-88.03780156	Too Deep									
157	44.14201659	-88.03781348	Too Deep									
158	44.14165667	-88.03782541	Too Deep									
159	44.14129675	-88.03783734	No Vegetation	14		R						
160	44.14093683	-88.03784926		12	M	P						
161	44.14057691	-88.03786118	No Vegetation	9	M	P						
162	44.14021699	-88.03787311	No Vegetation	3	M	P						
163	44.13985707	-88.03788503	Too Deep									
164	44.13949715	-88.03789696	Too Deep									
165	44.13913723	-88.03790888	Too Deep									
166	44.13877731	-88.03792081	Too Deep									
167	44.13841739	-88.03793273	Too Deep									
168	44.13805747	-88.03794465	Too Deep									
169	44.13769755	-88.03795658	No Vegetation	4	R	P						
170	44.13553803	-88.03802811	No Vegetation	6	M	P						
171	44.13517811	-88.03804003	No Vegetation	13		R						
172	44.13481819	-88.03805195	Too Deep									
173	44.13445826	-88.03806387	Too Deep									
174	44.13409834	-88.03807579	Too Deep									
175	44.13373842	-88.03808771	Too Deep									
175	44.1333785	-88.03809964	No Vegetation	13		R						
176	44.13301858	-88.03811156		3	M	P			1	1		
177	44.13265866	-88.03812348		3	M	P			1			
178	44.13229874	-88.03813539	No Vegetation	4	M	P						
179	44.13193882	-88.03814731		9	M	P			1			
180	44.1315789	-88.03815923	No Vegetation	10	M	P						
181	44.13121898	-88.03817115	No Vegetation	12	M	P						
182	44.13085906	-88.03818307	No Vegetation	12	M	P						
183	44.13049914	-88.03819499	No Vegetation	9	M	P						
184	44.12833961	-88.0382665		3	M	P			1			
185	44.12797969	-88.03827841	On shore									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
187	44.12761977	-88.03829033		4	M	P			3			
188	44.12725985	-88.03830225		6	M	P			3			
189	44.14416752	-88.03724209		4	M	P			1			
190	44.1438076	-88.03725402	No Vegetation	11	M	P						
191	44.14344768	-88.03726595	Too Deep									
192	44.14308776	-88.03727788	Too Deep									
193	44.14272784	-88.03728981	Too Deep									
194	44.14236792	-88.03730174	Too Deep									
195	44.142008	-88.03731367	Too Deep									
196	44.14164808	-88.0373256	No Vegetation	14		R						
197	44.14128816	-88.03733753	No Vegetation	9	M	P						
198	44.14092824	-88.03734945	No Vegetation	6	M	P						
199	44.14056832	-88.03736138	No Vegetation	2	M	P						
200	44.1402084	-88.03737331	No Vegetation	2	M	P						
201	44.13984848	-88.03738524	No Vegetation	11	M	P						
202	44.13948856	-88.03739716	Too Deep									
203	44.13912864	-88.03740909	Too Deep									
204	44.13876872	-88.03742102	Too Deep									
205	44.1384088	-88.03743294	Too Deep									
206	44.13804888	-88.03744487	Too Deep									
207	44.13768896	-88.0374568	No Vegetation	9	M	P						
208	44.13552944	-88.03752835		3	M	P			1			
209	44.13516952	-88.03754027	No Vegetation	10	M	P						
210	44.1348096	-88.0375522	No Vegetation	12		R						
211	44.13444968	-88.03756412	No Vegetation	13		R						
212	44.13408976	-88.03757605	No Vegetation	13		R						
213	44.13372984	-88.03758797	No Vegetation	5	M	P						
214	44.13336992	-88.03759989		3	M	P			1			
215	44.13193024	-88.03764758		4	M	P			1			
216	44.13157032	-88.03765951		7	M	P			1			
217	44.13121039	-88.03767143		11	M	P			1			

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
218	44.13085047	-88.03768335		7	M	P			1			
219	44.12725127	-88.03780256	On shore									
220	44.14451884	-88.03673033		5	M	P			1			
221	44.14415893	-88.03674226	No Vegetation	12	M	P						
222	44.14379901	-88.03675419	Too Deep									
223	44.14343909	-88.03676613	Too Deep									
224	44.14307917	-88.03677806	Too Deep									
225	44.14271925	-88.03678999	Too Deep									
226	44.14235933	-88.03680192	Too Deep									
227	44.14199941	-88.03681385	Too Deep									
228	44.14163949	-88.03682579	No Vegetation	11	M	P						
229	44.14127957	-88.03683772		5	M	P			1			
230	44.14091965	-88.03684965	On shore									
231	44.13983989	-88.03688544	No Vegetation	7	M	P						
232	44.13947997	-88.03689737	Too Deep									
233	44.13912005	-88.0369093	Too Deep									
234	44.13876013	-88.03692123	Too Deep									
235	44.13840021	-88.03693316	Too Deep									
236	44.13804029	-88.03694509	Too Deep									
237	44.13768037	-88.03695702	No Vegetation	13		R						
238	44.13732045	-88.03696895		4	M	P	1		1			1
239	44.13516093	-88.03704052	No Vegetation	7	M	P						
240	44.13480101	-88.03705244	No Vegetation	8	M	P						
241	44.13444109	-88.03706437	No Vegetation	8	M	P						
242	44.13408117	-88.0370763		7	M	P			1			
243	44.13372125	-88.03708822		3	M	P			1			
244	44.13120181	-88.03717171		5	M	P			1			
245	44.13084189	-88.03718363		4	M	P			2			
246	44.14451025	-88.03623049	No Vegetation	10	M	P						
247	44.14415033	-88.03624243	No Vegetation	18	-	R						
248	44.14379041	-88.03625436	Too Deep									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
249	44.14343049	-88.0362663	Too Deep									
250	44.14307057	-88.03627824	Too Deep									
251	44.14271065	-88.03629017		13		R						
252	44.14235073	-88.03630211	No Vegetation	13		R						
253	44.14199081	-88.03631404		12	M	P	1		1			
254	44.1416309	-88.03632598	No Vegetation	7	R	P						
255	44.14127098	-88.03633791	On shore									
256	44.13947138	-88.03639758	No Vegetation	14		R						
257	44.13911146	-88.03640951	Too Deep									
258	44.13875154	-88.03642144	Too Deep									
259	44.13839162	-88.03643338	Too Deep									
260	44.1380317	-88.03644531	Too Deep									
261	44.13767178	-88.03645724	Too Deep									
262	44.13731186	-88.03646917		7	M	P					1	
263	44.13695194	-88.0364811	On shore									
264	44.1344325	-88.03656462	On shore									
265	44.14450165	-88.03573066	No Vegetation	9	M	P						
266	44.14414174	-88.0357426	Too Deep									
267	44.14378182	-88.03575454	Too Deep									
268	44.1434219	-88.03576647	Too Deep									
269	44.14306198	-88.03577841	Too Deep									
270	44.14270206	-88.03579035		13		R						
271	44.14234214	-88.03580229	No Vegetation	12	M	P						
272	44.14198222	-88.03581423	No Vegetation	10	M	P						
273	44.1416223	-88.03582616	No Vegetation	7	M	P						
274	44.13946278	-88.03589779	No Vegetation	6	M	P						
275	44.13910286	-88.03590972	No Vegetation	10	M	P						
276	44.13874294	-88.03592166	No Vegetation	11	M	P						
277	44.13838302	-88.03593359	No Vegetation	12	M	P						
278	44.1380231	-88.03594553	No Vegetation	12	M	P						
279	44.13766318	-88.03595746	No Vegetation	10	M	P						

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
280	44.13730326	-88.0359694		6	M	P			1			
281	44.14449306	-88.03523082	No Vegetation	7	M	P						
282	44.14413314	-88.03524276	Too Deep									
283	44.14377322	-88.03525471	Too Deep									
284	44.1434133	-88.03526665	Too Deep									
285	44.14305338	-88.03527859	Too Deep									
287	44.14269346	-88.03529053	No Vegetation	11	M	P						
288	44.14233354	-88.03530247	No Vegetation	9	M	P						
289	44.14197362	-88.03531441		13		R						
289	44.1416137	-88.03532635		4	M	P			1			
290	44.13909427	-88.03540993		4	M	P			1			
291	44.13873435	-88.03542187	No Vegetation	5	M	P						
292	44.13837443	-88.03543381	No Vegetation	5	M	P						
293	44.13801451	-88.03544575	No Vegetation	6	M	P						
294	44.13765459	-88.03545769		2	M	P			1			
295	44.14448446	-88.03473099		5	M	P			1			
296	44.14412454	-88.03474293	No Vegetation	10	M	P						
297	44.14376462	-88.03475488	Too Deep									
298	44.1434047	-88.03476682	Too Deep									
299	44.14304478	-88.03477877	No Vegetation	12	M	P						
300	44.14268486	-88.03479071		11	M	P						
301	44.14232494	-88.03480266	No Vegetation	9	M	P						
302	44.14196502	-88.0348146		6	M	P			1			
303	44.14447585	-88.03423115		4	M	P			1			
304	44.14411593	-88.0342431	No Vegetation	8	M	P						
305	44.14375602	-88.03425505	No Vegetation	8	M	P						
306	44.1433961	-88.034267	No Vegetation	9	M	P						
307	44.14303618	-88.03427894	No Vegetation	9	M	P						
308	44.14267626	-88.03429089		8	M	P						
309	44.14231634	-88.03430284	No Vegetation	6	M	P						
310	44.14195642	-88.03431479	On shore									

Number	Latitude	Longitude	Notes	Depth (ft)	Sediment type (M=muck, S=Sand, R=Rock)	Rope (R); Pole (P); Visual (V)	Myriophyllum spicatum	Potamogeton crispus	Ceratophyllum demersum	Nuphar variegata	Chara sp.	Myriophyllum sibiricum
311	44.14410733	-88.03374327		3	M	P			1			
312	44.14374741	-88.03375522		4	M	P			1			
313	44.14338749	-88.03376717		6	M	P			1			
314	44.14302757	-88.03377912	No Vegetation	7	M	P						
315	44.14266765	-88.03379107	No Vegetation	5	M	P						
316	44.14230773	-88.03380302	No Vegetation	2	M	P						
317	44.14301897	-88.0332793	On shore									

D

APPENDIX D

2010 Aquatic Plant Survey Data

sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
1	44.1420681	-88.04081238	3	M	P	Filamentous algae	1		1					
2	44.1417082	-88.04082428	7	M	P	No Vegetation								
3	44.1413482	-88.04083619	8	M	P	No Vegetation								
4	44.1409883	-88.0408481	8	M	P	No Vegetation								
5	44.1406284	-88.04086001	7	M	P	No Vegetation								
6	44.1402685	-88.04087191	6	M	P									
7	44.1399086	-88.04088382	7	M	P	No Vegetation								
8	44.1424194	-88.04030065	6	M	P		1							
9	44.1420595	-88.04031256	9	M	P	No Vegetation								
10	44.1416996	-88.04032447				Too Deep								
11	44.1413397	-88.04033638				Too Deep								
12	44.1409797	-88.04034829				Too Deep								
13	44.1406198	-88.0403602				Too Deep								
14	44.1402599	-88.04037211				Too Deep								
15	44.1399	-88.04038402				Too Deep								
16	44.1395401	-88.04039593	8	M	P	No Vegetation								
17	44.1373805	-88.04046738	3	M	P		1				1			
18	44.1370206	-88.04047929				Too Deep								
19	44.1366607	-88.04049119				Too Deep								
20	44.1363008	-88.0405031				Too Deep								
21	44.1359409	-88.04051501				Too Deep								
22	44.1427708	-88.03978892	6	M	P	No Vegetation								
23	44.1424108	-88.03980083				Too Deep								
24	44.1420509	-88.03981275				Too Deep								
25	44.141691	-88.03982466				Too Deep								
26	44.1413311	-88.03983657				Too Deep								
27	44.1409712	-88.03984848				Too Deep								
28	44.1406112	-88.0398604				Too Deep								
29	44.1402513	-88.03987231				Too Deep								
30	44.1398914	-88.03988422				Too Deep								
31	44.1395315	-88.03989613				Too Deep								
32	44.1391716	-88.03990805	5	M	P		1			2				
33	44.1388116	-88.03991996	10	M	P	No Vegetation								
34	44.1384517	-88.03993187				Too Deep								
35	44.1380918	-88.03994378				Too Deep								
36	44.1377319	-88.03995569				Too Deep								
37	44.137372	-88.0399676				Too Deep								
38	44.137012	-88.03997951				Too Deep								
39	44.1366521	-88.03999142				Too Deep								
40	44.1362922	-88.04000333				Too Deep								
41	44.1359323	-88.04001524				Too Deep								
42	44.1355724	-88.04002715	3	M	P		1							
43	44.1330529	-88.04011051	3	M	P		1		1	1				
44	44.1431221	-88.03927718	6	M	P	No Vegetation								
45	44.1427622	-88.0392891	9	M	P	No Vegetation								
46	44.1424023	-88.03930101				Too Deep								
47	44.1420423	-88.03931293				Too Deep								

sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
48	44.1416824	-88.03932485				Too Deep								
49	44.1413225	-88.03933676				Too Deep								
50	44.1409626	-88.03934868				Too Deep								
51	44.1406027	-88.03936059				Too Deep								
52	44.1402427	-88.03937251				Too Deep								
53	44.1398828	-88.03938442				Too Deep								
54	44.1395229	-88.03939634				Too Deep								
55	44.139163	-88.03940825				Too Deep								
56	44.1388031	-88.03942017				Too Deep								
57	44.1384431	-88.03943208				Too Deep								
58	44.1380832	-88.039444				Too Deep								
59	44.1377233	-88.03945591				Too Deep								
60	44.1373634	-88.03946783				Too Deep								
61	44.1370035	-88.03947974				Too Deep								
62	44.1366435	-88.03949165				Too Deep								
63	44.1362836	-88.03950357				Too Deep								
64	44.1359237	-88.03951548				Too Deep								
65	44.1355638	-88.03952739				Too Deep								
66	44.1352039	-88.0395393				Too Deep								
67	44.1348439	-88.03955122	4	M	P				1					
68	44.134484	-88.03956313	3	M	P	No Vegetation								
69	44.1341241	-88.03957504	6	M	P		1							
70	44.1337642	-88.03958695				Too Deep								
71	44.1334043	-88.03959886				Too Deep								
72	44.1330443	-88.03961077				Too Deep								
73	44.1326844	-88.03962268	4	M	P		1		1					
74	44.1431135	-88.03877735	7	M	P	No Vegetation								
75	44.1427536	-88.03878927				Too Deep								
76	44.1423937	-88.03880119				Too Deep								
77	44.1420338	-88.03881311				Too Deep								
78	44.1416738	-88.03882503				Too Deep								
79	44.1413139	-88.03883695				Too Deep								
80	44.140954	-88.03884887				Too Deep								
81	44.1405941	-88.03886079				Too Deep								
82	44.1402342	-88.03887271				Too Deep								
83	44.1398742	-88.03888463				Too Deep								
84	44.1395143	-88.03889655				Too Deep								
85	44.1391544	-88.03890846				Too Deep								
86	44.1387945	-88.03892038				Too Deep								
87	44.1384346	-88.0389323				Too Deep								
88	44.1380746	-88.03894422				Too Deep								
89	44.1377147	-88.03895613				Too Deep								
90	44.1373548	-88.03896805				Too Deep								
91	44.1369949	-88.03897997	1	S	P					1				
92	44.136635	-88.03899188	2	S	P		1				1	1	1	
93	44.136275	-88.0390038	7	M	P	No Vegetation								
94	44.1359151	-88.03901571				Too Deep								

sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
95	44.1355552	-88.03902763				Too Deep								
96	44.1351953	-88.03903955				Too Deep								
97	44.1348354	-88.03905146				Too Deep								
98	44.1344754	-88.03906338				Too Deep								
99	44.1341155	-88.03907529				Too Deep								
100	44.1337556	-88.03908721				Too Deep								
101	44.1333957	-88.03909912				Too Deep								
102	44.1330358	-88.03911103				Too Deep								
103	44.1326758	-88.03912295				Too Deep								
104	44.1323159	-88.03913486	9	M	P	No Vegetation								
105	44.131956	-88.03914677	5	M	P		1		1					
106	44.1308762	-88.03918251	4	M	P		1							
107	44.1305163	-88.03919443	7	M	P		2							
108	44.1301564	-88.03920634	10	M	P	No Vegetation								
109	44.1297965	-88.03921825	1	M	P	No Vegetation								
110	44.1294365	-88.03923016	9	M	P		1							
111	44.1290766	-88.03924207	6	M	P		1							
112	44.1434649	-88.03826561	2	S	P	No Vegetation								
113	44.1431049	-88.03827753	10	M	P	No Vegetation								
114	44.142745	-88.03828945				Too Deep								
115	44.1423851	-88.03830138				Too Deep								
116	44.1420252	-88.0383133				Too Deep								
117	44.1416653	-88.03832522				Too Deep								
118	44.1413053	-88.03833714				Too Deep								
119	44.1409454	-88.03834907				Too Deep								
120	44.1405855	-88.03836099				Too Deep								
121	44.1402256	-88.03837291				Too Deep								
122	44.1398657	-88.03838483				Too Deep								
123	44.1395057	-88.03839675				Too Deep								
124	44.1391458	-88.03840867				Too Deep								
125	44.1387859	-88.03842059				Too Deep								
126	44.138426	-88.03843251				Too Deep								
127	44.1380661	-88.03844443				Too Deep								
128	44.1377061	-88.03845635				Too Deep								
129	44.1373462	-88.03846827	1	M	P		1						3	
130	44.1355466	-88.03852787				Too Deep								
131	44.1351867	-88.03853979				Too Deep								
132	44.1348268	-88.03855171				Too Deep								
133	44.1344669	-88.03856362				Too Deep								
134	44.1341069	-88.03857554				Too Deep								
135	44.133747	-88.03858746				Too Deep								
136	44.1333871	-88.03859938				Too Deep								
137	44.1330272	-88.03861129	10	M	P	No Vegetation								
138	44.1326673	-88.03862321				Too Deep								
139	44.1323073	-88.03863513				Too Deep								
140	44.1319474	-88.03864704				Too Deep								
141	44.1315875	-88.03865896				Too Deep								

sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
142	44.1312276	-88.03867088				Too Deep								
143	44.1308676	-88.03868279				Too Deep								
144	44.1305077	-88.03869471	8	M	P	No Vegetation								
145	44.1301478	-88.03870662	5	M	P	Filamentous algae	1							
146	44.1297879	-88.03871854	2	M	P	Filamentous algae	1		1					
147	44.129428	-88.03873045	3	M	P		1							
148	44.129068	-88.03874237	2	M	P	Filamentous algae	1		1					
149	44.1287081	-88.03875428	7	M	P	No Vegetation								
150	44.1283482	-88.0387662	10	M	P	No Vegetation								
151	44.1279883	-88.03877811	7	M	P	No Vegetation								
152	44.1276284	-88.03879002	7	M	P	No Vegetation								
153	44.1434563	-88.03776578	9	M	P	No Vegetation								
154	44.1430964	-88.03777771				Too Deep								
155	44.1427364	-88.03778963				Too Deep								
156	44.1423765	-88.03780156				Too Deep								
157	44.1420166	-88.03781348				Too Deep								
158	44.1416567	-88.03782541				Too Deep								
159	44.1412968	-88.03783734				Too Deep								
160	44.1409368	-88.03784926				Too Deep								
161	44.1405769	-88.03786118	8	M	P	No Vegetation								
162	44.140217	-88.03787311	4	S	P		1			1				
163	44.1398571	-88.03788503				Too Deep								
164	44.1394972	-88.03789696				Too Deep								
165	44.1391372	-88.03790888				Too Deep								
166	44.1387773	-88.03792081				Too Deep								
167	44.1384174	-88.03793273				Too Deep								
168	44.1380575	-88.03794465				Too Deep								
169	44.1376976	-88.03795658	3	S	P		2			1				
170	44.135538	-88.03802811	3	S	P					1				
171	44.1351781	-88.03804003				Too Deep								
172	44.1348182	-88.03805195				Too Deep								
173	44.1344583	-88.03806387				Too Deep								
174	44.1340983	-88.03807579				Too Deep								
175	44.1337384	-88.03808771				Too Deep								
176	44.1333785	-88.03809964	4	R	P		2			1				
177	44.1330186	-88.03811156	2	S	P	Filamentous algae	2							
178	44.1326587	-88.03812348	5	M	P	Filamentous algae								
179	44.1322987	-88.03813539	9	M	P	No Vegetation								
180	44.1319388	-88.03814731				Too Deep								
181	44.1315789	-88.03815923				Too Deep								
182	44.131219	-88.03817115				Too Deep								
183	44.1308591	-88.03818307				Too Deep								
184	44.1304991	-88.03819499	4	M	P	Filamentous algae	1							
185	44.1283396	-88.0382665	1	M	P	Filamentous algae								
186	44.1279797	-88.03827841	1	M	P				1			1		
187	44.1276198	-88.03829033	5	M	P	No Vegetation								
188	44.1272599	-88.03830225	3	M	P				1	1				

sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
189	44.1441675	-88.03724209	5	M	P		1							
190	44.1438076	-88.03725402				Too Deep								
191	44.1434477	-88.03726595				Too Deep								
192	44.1430878	-88.03727788				Too Deep								
193	44.1427278	-88.03728981				Too Deep								
194	44.1423679	-88.03730174				Too Deep								
195	44.142008	-88.03731367				Too Deep								
196	44.1416481	-88.0373256				Too Deep								
197	44.1412882	-88.03733753	9	M	P	No Vegetation								
198	44.1409282	-88.03734945	6	M	P		1							
199	44.1405683	-88.03736138	3	S	P	Filamentous algae	1		1	1				
200	44.1402084	-88.03737331	2	S	P		2							
201	44.1398485	-88.03738524				Too Deep								
202	44.1394886	-88.03739716				Too Deep								
203	44.1391286	-88.03740909				Too Deep								
204	44.1387687	-88.03742102				Too Deep								
205	44.1384088	-88.03743294				Too Deep								
206	44.1380489	-88.03744487				Too Deep								
207	44.137689	-88.0374568	10	M	P	No Vegetation								
208	44.1355294	-88.03752835	2	M	P	No Vegetation								
209	44.1351695	-88.03754027				Too Deep								
210	44.1348096	-88.0375522				Too Deep								
211	44.1344497	-88.03756412				Too Deep								
212	44.1340898	-88.03757605				Too Deep								

sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
213	44.1337298	-88.03758797	4	R	P					1	1	1		
214	44.1333699	-88.03759989	2	M	P		2							
215	44.1319302	-88.03764758	4	S	P		1							
216	44.1315703	-88.03765951	7	M	P	No Vegetation								
217	44.1312104	-88.03767143	10	M	P	No Vegetation								
218	44.1308505	-88.03768335	7	M	P	No Vegetation								
219	44.1272513	-88.03780256				No Vegetation								
220	44.1445188	-88.03673033	5	M	P		2		1		V			
221	44.1441589	-88.03674226	12	M	P	No Vegetation								
222	44.143799	-88.03675419				Too Deep								
223	44.1434391	-88.03676613				Too Deep								
224	44.1430792	-88.03677806				Too Deep								
225	44.1427193	-88.03678999				Too Deep								
226	44.1423593	-88.03680192				Too Deep								
227	44.1419994	-88.03681385				Too Deep								
228	44.1416395	-88.03682579				Too Deep								
229	44.1412796	-88.03683772	6	M	P	Filamentous algae	1							
230	44.1409197	-88.03684965				Too Deep								
231	44.1398399	-88.03688544	3	S	P		3			1			1	
232	44.13948	-88.03689737				Too Deep								
233	44.1391201	-88.0369093				Too Deep								
234	44.1387601	-88.03692123				Too Deep								
235	44.1384002	-88.03693316				Too Deep								
236	44.1380403	-88.03694509				Too Deep								
237	44.1376804	-88.03695702				Too Deep								
238	44.1373205	-88.03696895	4	S	P		1							
239	44.1351609	-88.03704052	7	M	P	No Vegetation								
240	44.134801	-88.03705244	8	M	P	No Vegetation								
241	44.1344411	-88.03706437	9	M	P	No Vegetation								
242	44.1340812	-88.0370763	8	M	P	No Vegetation								
243	44.1337213	-88.03708822	2	M	P	Filamentous algae	1			1				
244	44.1312018	-88.03717171	5	M	P	No Vegetation								
245	44.1308419	-88.03718363	5	M	P	No Vegetation								
246	44.1445103	-88.03623049	8	M	P	No Vegetation								
247	44.1441503	-88.03624243				Too Deep								
248	44.1437904	-88.03625436				Too Deep								
249	44.1434305	-88.0362663				Too Deep								
250	44.1430706	-88.03627824				Too Deep								
251	44.1427107	-88.03629017				Too Deep								
252	44.1423507	-88.03630211				Too Deep								
253	44.1419908	-88.03631404				Too Deep								
254	44.1416309	-88.03632598	7	M	P	No Vegetation								
255	44.141271	-88.03633791	2	M	P	No Vegetation								
256	44.1394714	-88.03639758				Too Deep								
257	44.1391115	-88.03640951				Too Deep								
258	44.1387515	-88.03642144				Too Deep								
259	44.1383916	-88.03643338				Too Deep								

sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
260	44.1380317	-88.03644531				Too Deep								
261	44.1376718	-88.03645724				Too Deep								
262	44.1373119	-88.03646917	7	M	P	No Vegetation								
263	44.1369519	-88.0364811	1	M	P		1							
264	44.1344325	-88.03656462	2	M	P		1							
265	44.1445017	-88.03573066	8	M	P	No Vegetation								

sampling point	Latitude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Notes	*Myriophyllum spicatum*	*Potamogeton crispus*	*Ceratophyllum demersum*	*Stuckenia pectinata*	*Nuphar variegata*	*Nymphaea odorata*	*Potamogeton foliosus*	*Chara sp.*
266	44.1441417	-88.0357426				Too Deep								
267	44.1437818	-88.03575454				Too Deep								
268	44.1434219	-88.03576647				Too Deep								
269	44.143062	-88.03577841				Too Deep								
270	44.1427021	-88.03579035				Too Deep								
271	44.1423421	-88.03580229				Too Deep								
272	44.1419822	-88.03581423				Too Deep								
273	44.1416223	-88.03582616	7	M	P	No Vegetation								
274	44.1394628	-88.03589779	4	S	P	Filamentous algae	1		1					
275	44.1391029	-88.03590972	10	M	P									
276	44.1387429	-88.03592166				Too Deep								
277	44.138383	-88.03593359				Too Deep								
278	44.1380231	-88.03594553				No Vegetation								
279	44.1376632	-88.03595746	10	M	P	Too Deep								
280	44.1373033	-88.0359694	5	M	P		1							
281	44.1444931	-88.03523082	7	M	P	No Vegetation								
282	44.1441331	-88.03524276	14		R	No Vegetation								
283	44.1437732	-88.03525471				Too Deep								
284	44.1434133	-88.03526665				Too Deep								
285	44.1430534	-88.03527859				Too Deep								
286	44.1426935	-88.03529053				Too Deep								
287	44.1423335	-88.03530247				Too Deep								
288	44.1419736	-88.03531441	9	M	P	No Vegetation								
289	44.1416137	-88.03532635	4	M	P	No Vegetation								
290	44.1390943	-88.03540993	5	M	P		2							
291	44.1387344	-88.03542187	5	M	P	Filamentous algae								
292	44.1383744	-88.03543381	6	M	P			1						
293	44.1380145	-88.03544575	7	M	P	No Vegetation								
294	44.1376546	-88.03545769	4	M	P	Filamentous algae	1							
295	44.1444845	-88.03473099	5	M	P	No Vegetation								
296	44.1441245	-88.03474293	10	M	P	No Vegetation								
297	44.1437646	-88.03475488				Too Deep								
298	44.1434047	-88.03476682				Too Deep								
299	44.1430448	-88.03477877				Too Deep								
300	44.1426849	-88.03479071				Too Deep								
301	44.1423249	-88.03480266	8	M	P	No Vegetation								
302	44.141965	-88.0348146	7	M	P	No Vegetation								
303	44.1444759	-88.03423115	4	M	P	Filamentous algae			1					1
304	44.1441159	-88.0342431	8	M	P	No Vegetation								
305	44.143756	-88.03425505	9	M	P	No Vegetation								
306	44.1433961	-88.034267	10	M	P	No Vegetation								
307	44.1430362	-88.03427894	9	M	P	No Vegetation								
308	44.1426763	-88.03429089	9	M	P	No Vegetation								
309	44.1423163	-88.03430284	7	M	P	No Vegetation								
310	44.1419564	-88.03431479	2	S	P	Filamentous algae	1		1					
311	44.1441073	-88.03374327	2	M	P	Filamentous algae	1		1					
312	44.1437474	-88.03375522	5	M	P		1		1					

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313	44.1433875	-88.03376717	7	M	P	No Vegetation								
314	44.1430276	-88.03377912	7	M	P	No Vegetation								
315	44.1426677	-88.03379107	6	M	P			1						
316	44.1423077	-88.03380302	2	S	P	Filamentous algae			1					
317	44.143019	-88.0332793	1	S	P	No Vegetation								