Results of the

2012 Aquatic Plant Study

on Silver Lake, Waupaca County, Wisconsin

Prepared for:

Scandinavia Silver Lake District
c/o Judy Watson
PO Box 24
Scandinavia, WI 54977

Prepared by:

Cason & Associates, LLC
Lake & Pond Managers

P.O. Box 230
Berlin, WI 54923-0230
920-361-4088

Prepared:
January, 2013

Introduction

Silver Lake is located in west-central Waupaca County within the Village of Scandinavia (**Figure 1**). Silver Lake has a surface area of approximately 70 acres (**Figure 2**) and a maximum depth of 17 feet. It is a groundwater seepage lake with an outlet through a 16" culvert into a wooded area with eventual drainage into the South Branch of the Little Wolf River.

Silver Lake Park and a newly established Jorgen's Park make up 48% of the shoreline with the remainder approximately equally divided between residential properties and Silver Lake Road. A small-scale aeration system has been operation on Silver Lake for a number of years. It is used primarily during the winter to provide a refuge for the lake's fishery.

There is one public boat launch located in Silver Lake Park along the western shore of the lake with approximately 100 feet of access. Silver Lake receives modest recreational use from local anglers which fish primarily for a variety of panfish, largemouth bass and northern pike. The lake also receives additional recreational boating and paddling use. However, in recent years, excessive plant growth, both native and exotic, has made it difficult to recreate on Silver Lake. Two submergent aquatic invasive species, Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*) have been found in Silver Lake. Curly-leaf pondweed was first confirmed in Silver Lake in 1992. Eurasian watermilfoil was confirmed a year later in 1993. Since their introductions, both species, along with a small number of native species have contributed to nuisance conditions in the lake. In 2005 milfoil growth became a particular concern for the Village. As the area of infestation grew, two of the lake property owners became qualified to apply herbicides. Small herbicide applications were made in 2007 and 2008 as permitted by the Wisconsin Department of Natural Resources (WDNR). These treatments did not provide the desired results and were discontinued. In subsequent years, Eurasian watermilfoil and curly-leaf pondweed became established throughout the lake.

Since 1988 Silver Lake has been part of an ongoing study related to water quality. This study has focused primarily on nutrient and chlorophyll levels and water clarity.

The Scandinavia Silver Lake District is the principle management unit representing the interests of riparian property owners and other lake users. Members of the District are particularly concerned about invasive species proliferation and the impact of this on lake ecology and recreational use of the lake. The current study is intended to enhance the ability of the District to develop and implement an effective long-range plan to protect Silver Lake. This report presents the results of these efforts. It also includes interpretation and implications of these results, as well as an analysis of management options. With the knowledge gained by this project, the District hopes to take the appropriate actions needed to best manage the aquatic plants for lake users and the biotic community alike.

Figure 1. The area surrounding Silver Lake, Waupaca County, Wisconsin.

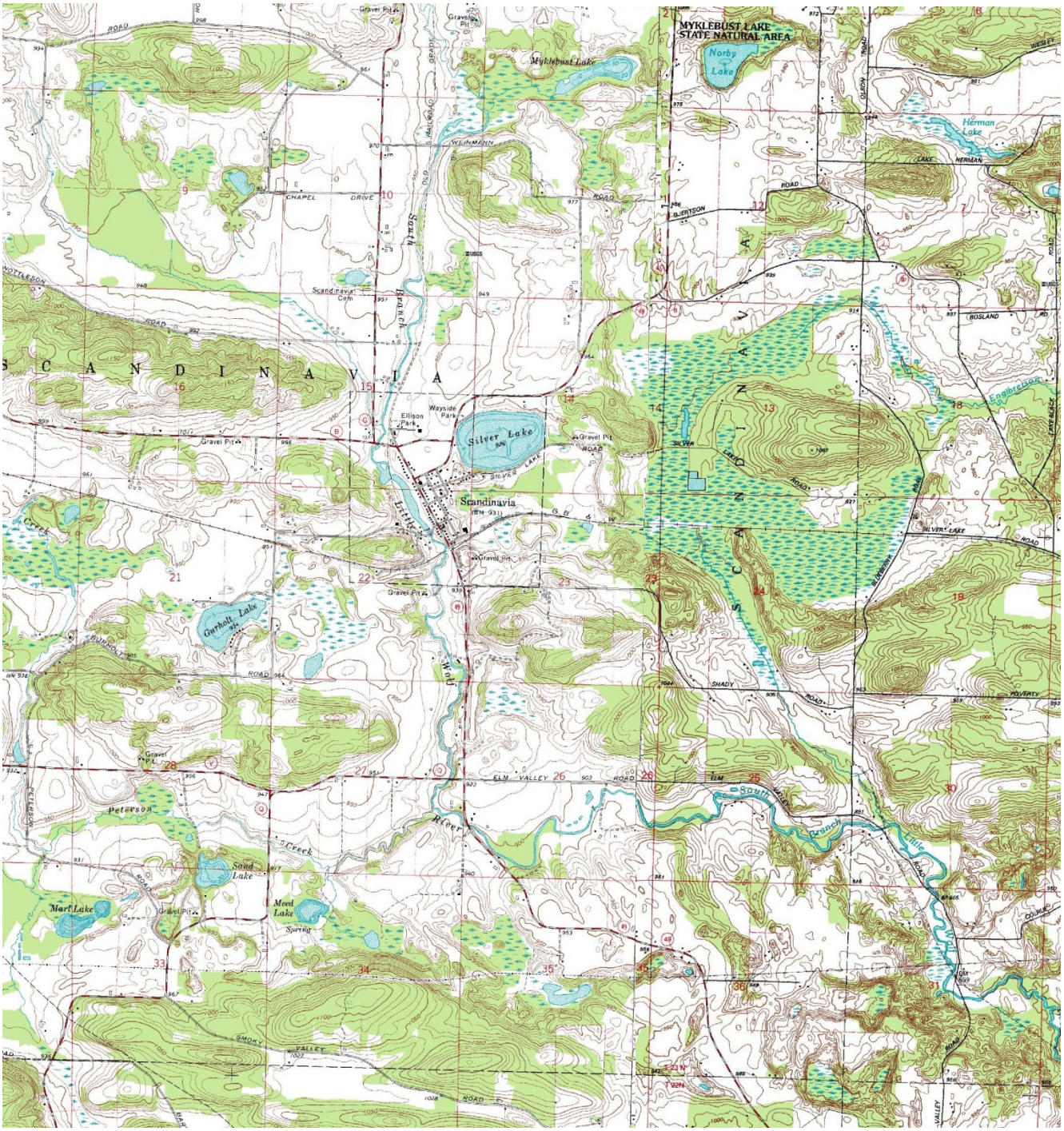
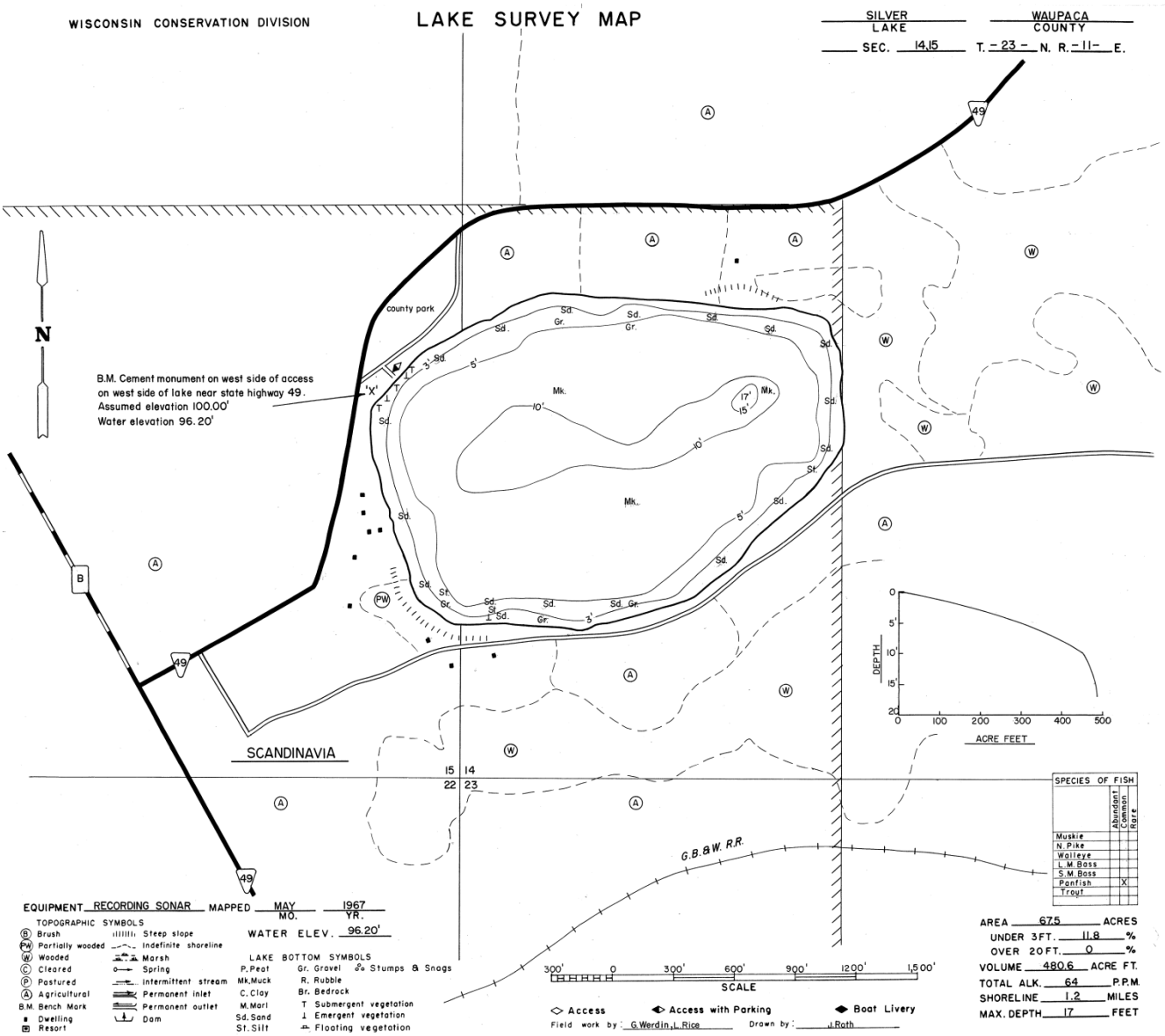


Figure 2. Bathymetric map of Silver Lake, Waupaca County, Wisconsin (1967).



Project Goals

The primary goals of this study are 1) to gather baseline information on the aquatic plant community of Silver Lake, 2) to address the presence of nuisance exotic and beneficial native aquatic plant species through lake surveys, 3) survey property owners and lake users regarding the management of Silver Lake and 4) to provide information needed to make informed decisions regarding the future management of the lake both ecologically and sociologically.

Methods for Field Studies

Aquatic Plant Assessment

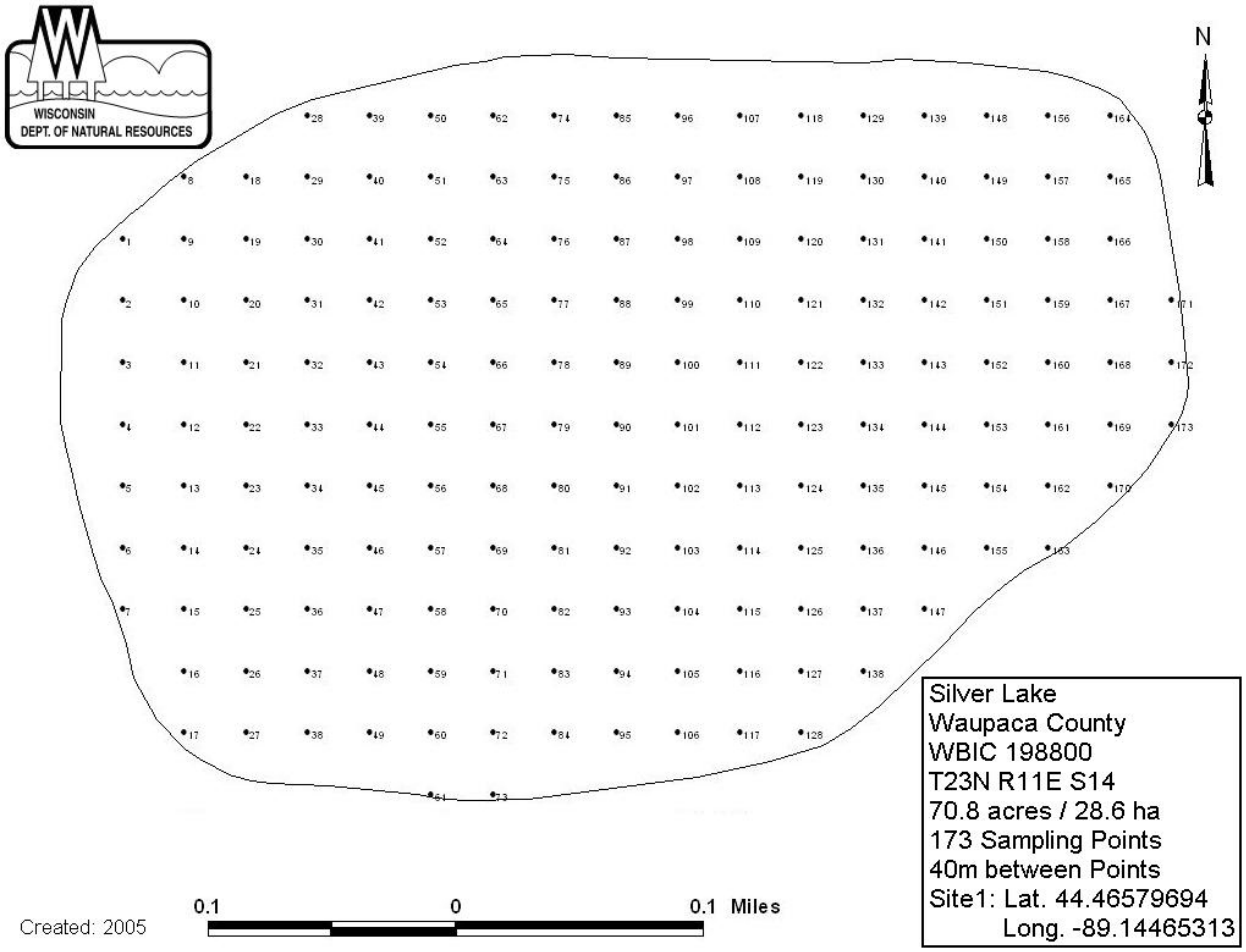
On June 25, 2012, a submergent aquatic plant survey was conducted utilizing methods developed by the WDNR. The Department's Bureau of Research developed the plant survey map for Silver Lake in 2005 (**Figure 3**). A series of grid points were mapped across the lake. At each of these locations, aquatic plant samples were collected from a boat with a single rake tow. Following WDNR guidelines, the rake used consisted of two short-toothed garden rake heads welded together. At each sample point, the rake was briefly dragged along the bottom to collect plants. All plant samples collected were identified to *genus* and *species* whenever possible, and recorded. An abundance rating was given to each species collected using the criteria established by the DNR. This rating was used as a tool to map plant abundance within Silver Lake. Data collected has been used to determine species composition and diversity, percent frequency, and floristic quality.

Exotic Species Distribution Mapping

In order to best manage aquatic invasive species in Silver Lake, surveys focusing on these species, namely curly-leaf pondweed (*Potamogeton crispus*) and Eurasian watermilfoil (*Myriophyllum spicatum*) took place. The Golden Sands RC&D Council conducted these surveys to identify and map these exotic plant species. A spring 2012 survey of the lake focused on curly-leaf pondweed, while a July 2012 survey focused on Eurasian watermilfoil. Curly-leaf pondweed is a cold-water species that grows quickly in the spring but dies back during the warmest times of the year. As a result, spring is the best time of the year to identify curly-leaf pondweed.

An additional exotic species mapping effort was made at the time of the submergent aquatic plant survey in June, 2012. During this survey, the extent and locations of exotic plant species found in Silver Lake were determined from surface observations and rake tows. This survey utilized the point-intercept map and corresponding coordinates provided by the Wisconsin DNR as a guide.

Figure 3. Point-intercept survey map for Silver Lake, Waupaca County, WI.



Property Owners and Lake Users Input

The Wisconsin DNR wants assurance that the project elements and management recommendations which come from this type of project fit the concerns of the lake residents and lake users. A property owner survey was used to gain an accurate understanding of the issues that property owners find most important. Because only a small number of individuals and families live on the shores of Silver Lake, surveys were distributed to a larger group of people which included frequent lake users and members of the Village and District Boards. Results of the 23 survey responses have been tabulated.

Results and Discussion

Aquatic Plant Communities

Results of the June 25, 2012 plant survey on Silver Lake can be found in **Appendix A.**

A total of 14 aquatic plant species were found during the 2012 survey (**Table 1**). This is above the state-wide average of 13 species. Silver Lake is within the Northern Central Hardwood Forests region of Wisconsin (**Figure 4**). The average number of species found in lakes in these regions is also 14 species (Nichols, 1999). The most abundant plant species encountered in Silver Lake were coontail (*Ceratophyllum demersum*), common waterweed (*Elodea canadensis*) and Eurasian watermilfoil (*Myriophyllum spicatum*). These species were found at 83.8%, 72.3% and 61.9% of the sites within vegetated areas, respectively. **Figures 5-15** show the distribution and density of these species across Silver Lake at the time of the survey. Along with Eurasian watermilfoil, curly-leaf pondweed and another exotic plant species, purple loosestrife (*Lythrum salicaria*) were found during this survey. At the time purple loosestrife was found in one clump along the shore, which was hand-pulled soon after.

Figure 4. Ecoregions of Wisconsin (after Omernick and Gallant, 1988)

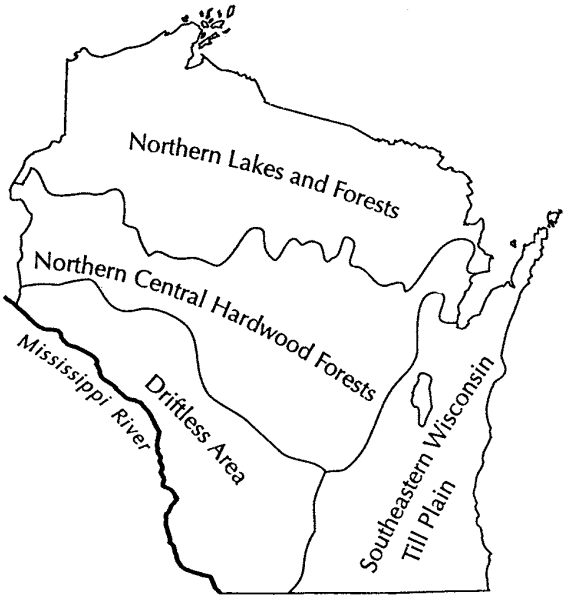


Table 1 shows the frequency of occurrence for plant species in the lake. Percent frequency values reflect the relationship between the number of locations where a particular species was found versus the total number of locations sampled. Relative frequency values reflect the abundance of a particular species in relation to all other species found.

Table 1 also includes a summary of the plant survey data collected in 2005. The two data sets can be used to make some inferences regarding the numbers and relative abundance of species in the lake. As in 2012, the species with the highest frequencies of occurrence in 2005 were coontail, common waterweed and Eurasian watermilfoil. Four additional species were found in both 2005 and 2012 at similar frequencies of occurrence.

The relative abundance of aquatic plants in Silver Lake can be found in **Figure 16**.

Table 1. Summary of aquatic plant survey data collected on June 25, 2012 and the summer of 2005 on Silver Lake, Waupaca County, WI.

		2012		2005	
Species common name	**scientific name**	**Percent Frequency**	**Relative Frequency**	**Percent Frequency**	**Relative Frequency**
Coontail	*Ceratophyllum demersum*	83.82	31.5	93.57	48.3
Common waterweed	*Elodea canadensis*	72.25	27.1	44.44	23.0
Eurasian water-milfoil	*Myriophyllum spicatum*	61.85	23.2	42.11	21.8
filamentous algae	--	23.70	8.9	--	--
Bushy pondweed	*Najas flexilis*	9.83	3.7	--	--
Sago pondweed	*Stuckenia pectinata*	5.20	2.0	5.85	3.0
Curly-leaf pondweed	*Potamogeton crispus*	3.47	1.3	--	--
White-stem pondweed	*Potamogeton praelongis*	3.47	1.3	2.34	1.2
Muskgrasses	*Chara spp.*	1.73	0.7	0.58	0.3
Flat-stem pondweed	*Potamogeton zosteriformis*	0.58	0.2	1.17	0.6
Large Duckweed	*Spirodela polyrhiza*	0.58	0.2	--	--
Marsh milkweed	*Asclepias incarnata,*	visual	visual	--	--
Purple loosestrife	*Lythrum salicaria*	visual	visual	--	--
Hardstem bulrush	*Schoenoplectus acutus*	visual	visual	--	--
Needle spikerush	*Eleocharis acicularis*	--	--	1.17	0.6
Northen watermilfoil	*Myriophyllum sibircum*	--	--	0.59	0.3
Broad-leaved cattail	*Typha latifolia*	--	--	0.59	0.3
Common watermeal	*Wolffia columbiana*	--	--	0.59	0.3
	Species richness	14		12	
	Sites with vegetation	171		168	
	Simpson Diversity Index	0.82		0.71	
	Coefficient of Conservatism	5.1		4.8	
	Floristic Quality Index	15.3		15.2	
	(WI ave. 22.2, Region ave. 20.9)				

Figure 5. Locations of coontail (*Ceratophyllum demersum*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

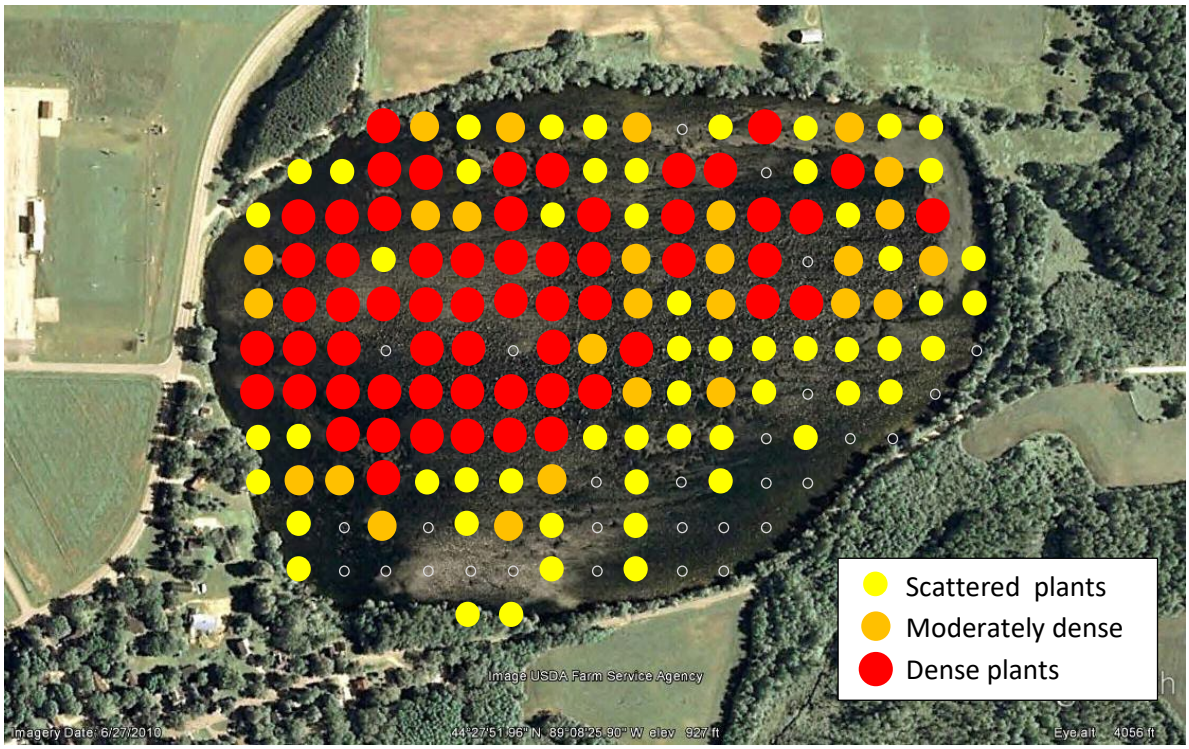


Figure 6. Locations of common waterweed (*Elodea canadensis*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

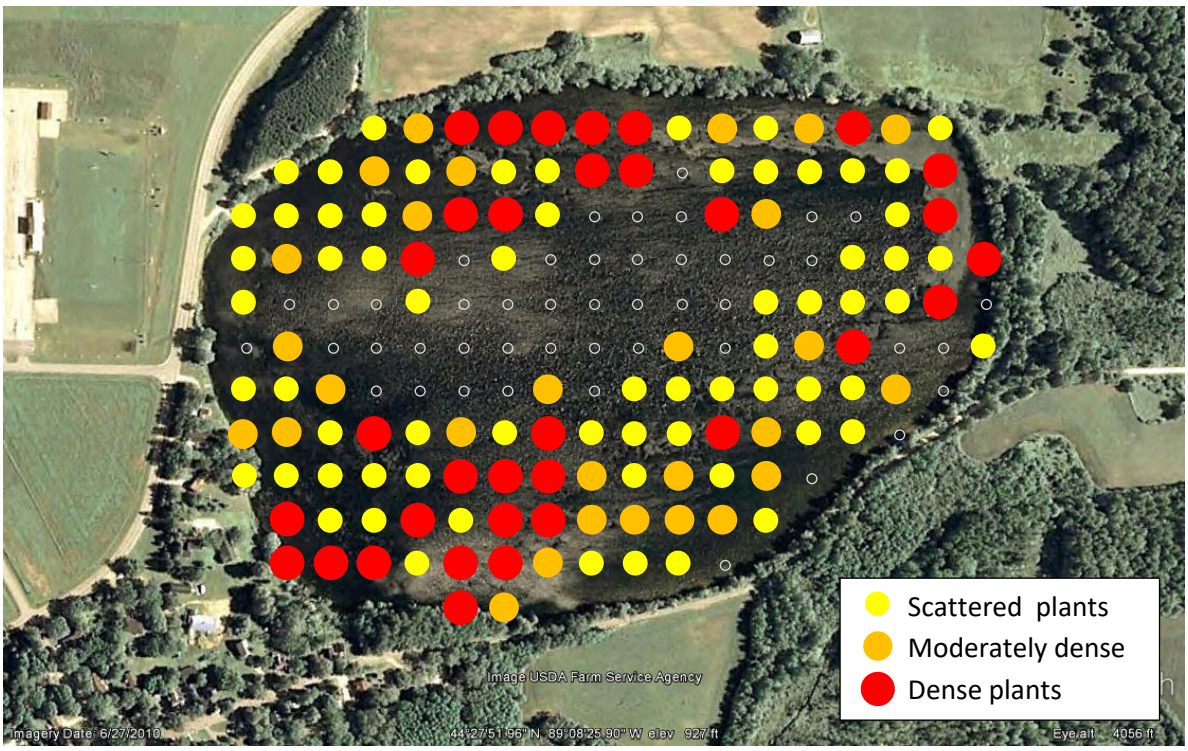


Figure 7. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

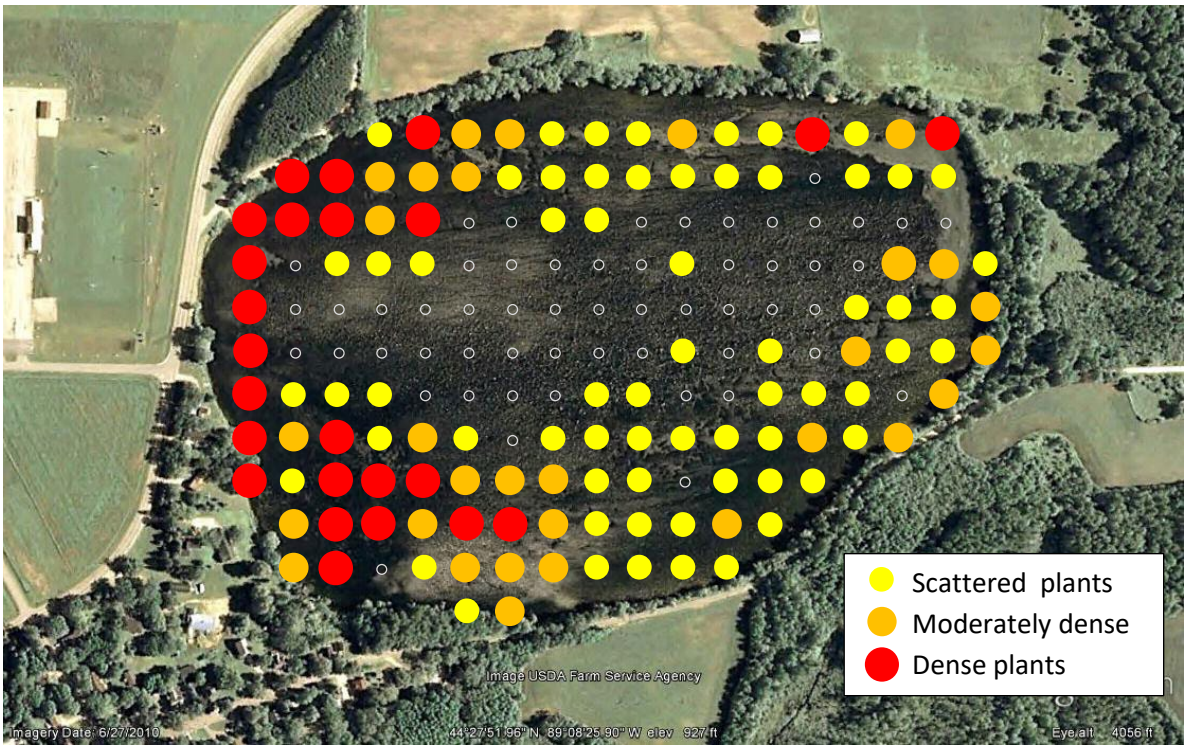


Figure 8. Locations of filamentous algae found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

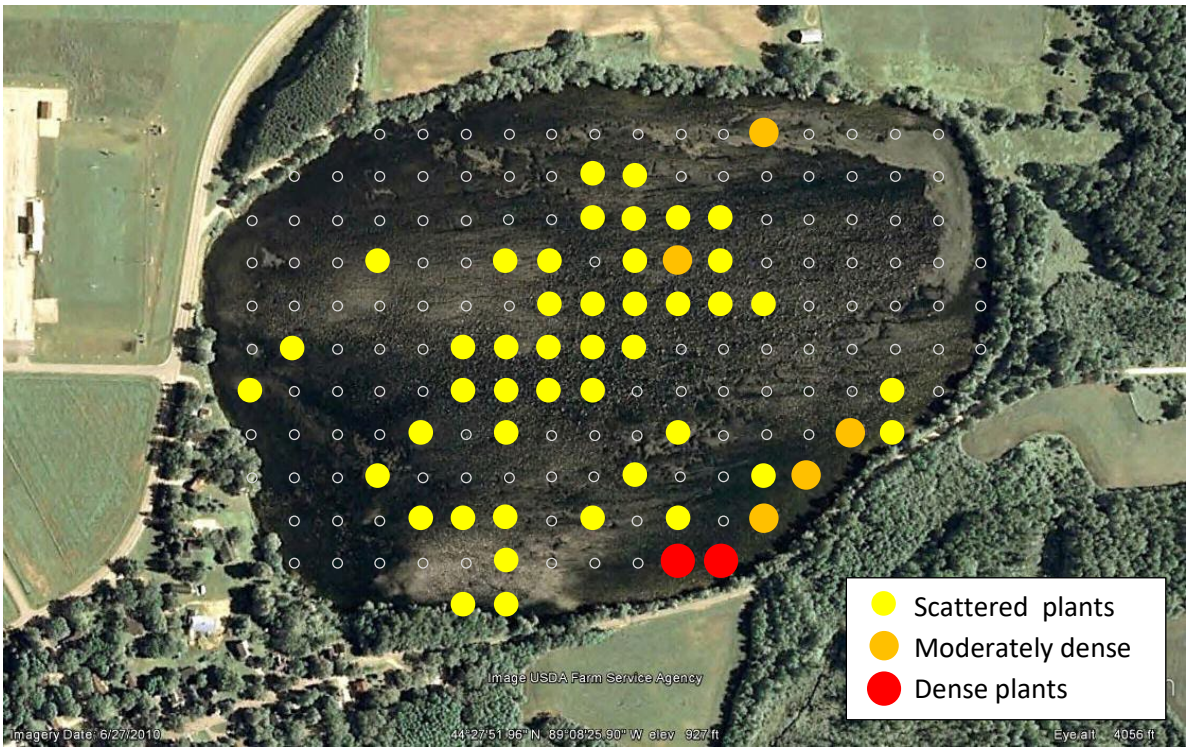


Figure 9. Locations of bushy pondweed (*Najas flexilis*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

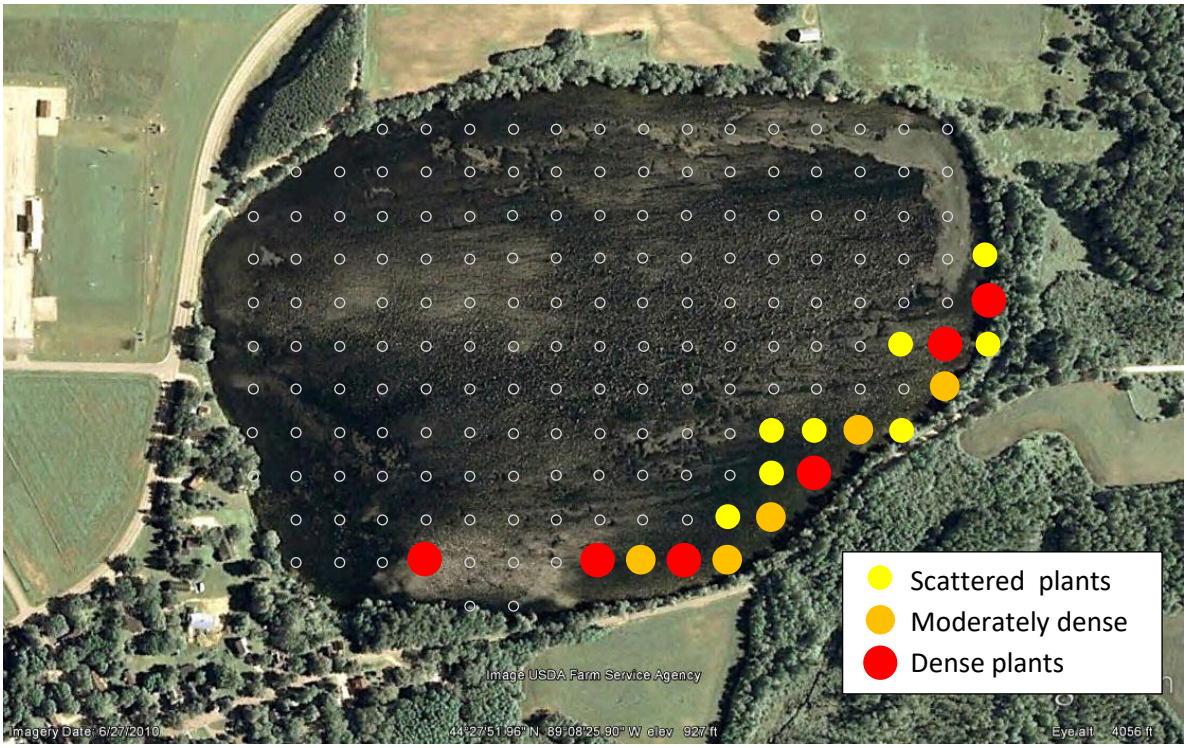


Figure 10. Locations of sago pondweed (*Stuckenia pectinata*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

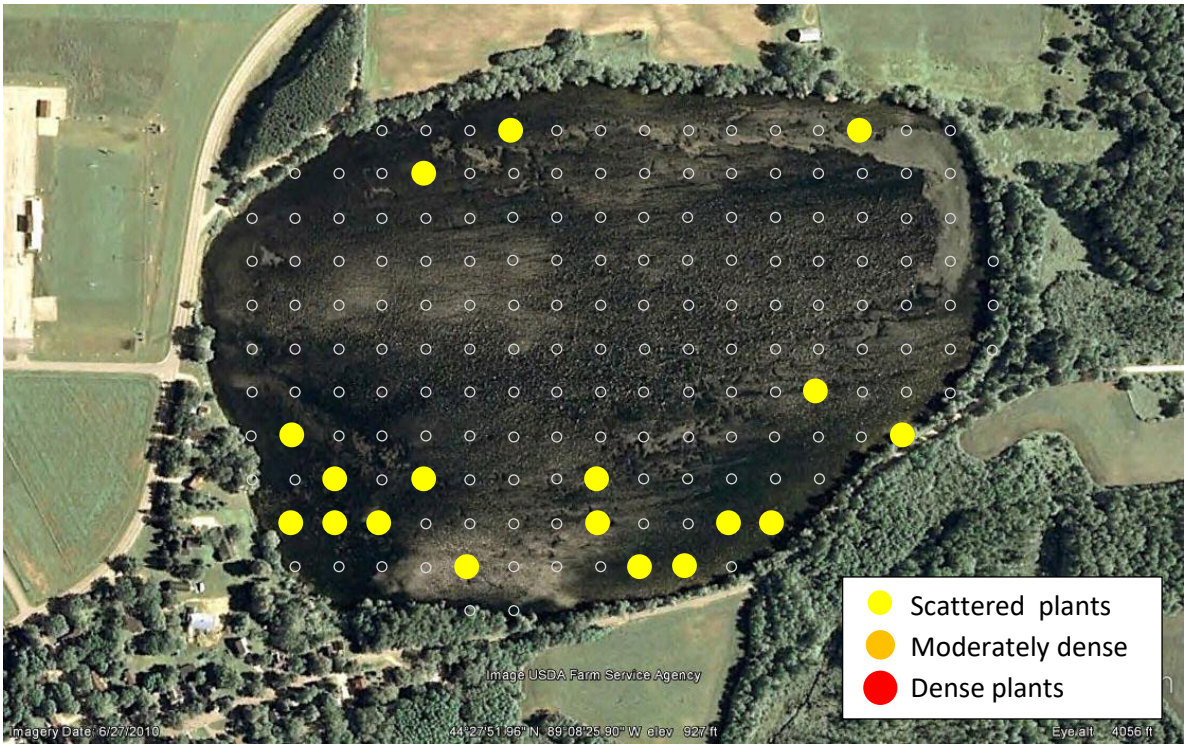


Figure 11. Locations of curly-leaf pondweed (*Potamogeton crispus*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

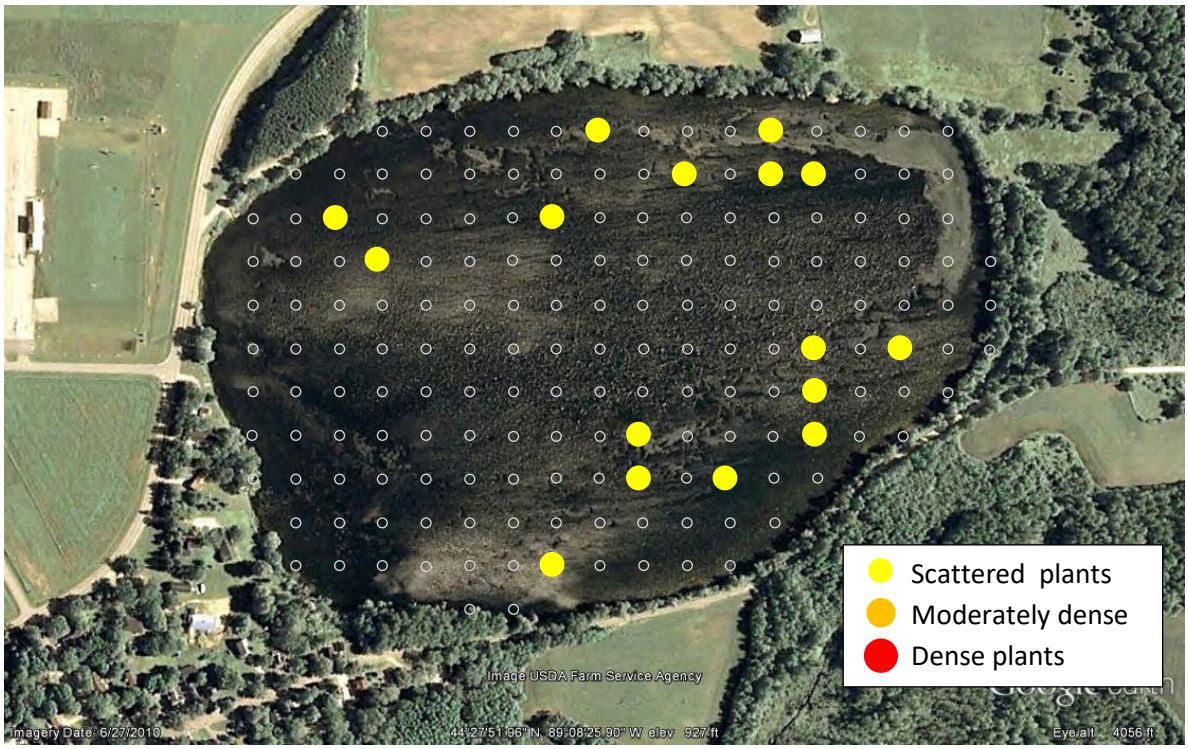


Figure 12. Locations of white-stem pondweed (*Potamogeton praelongis*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

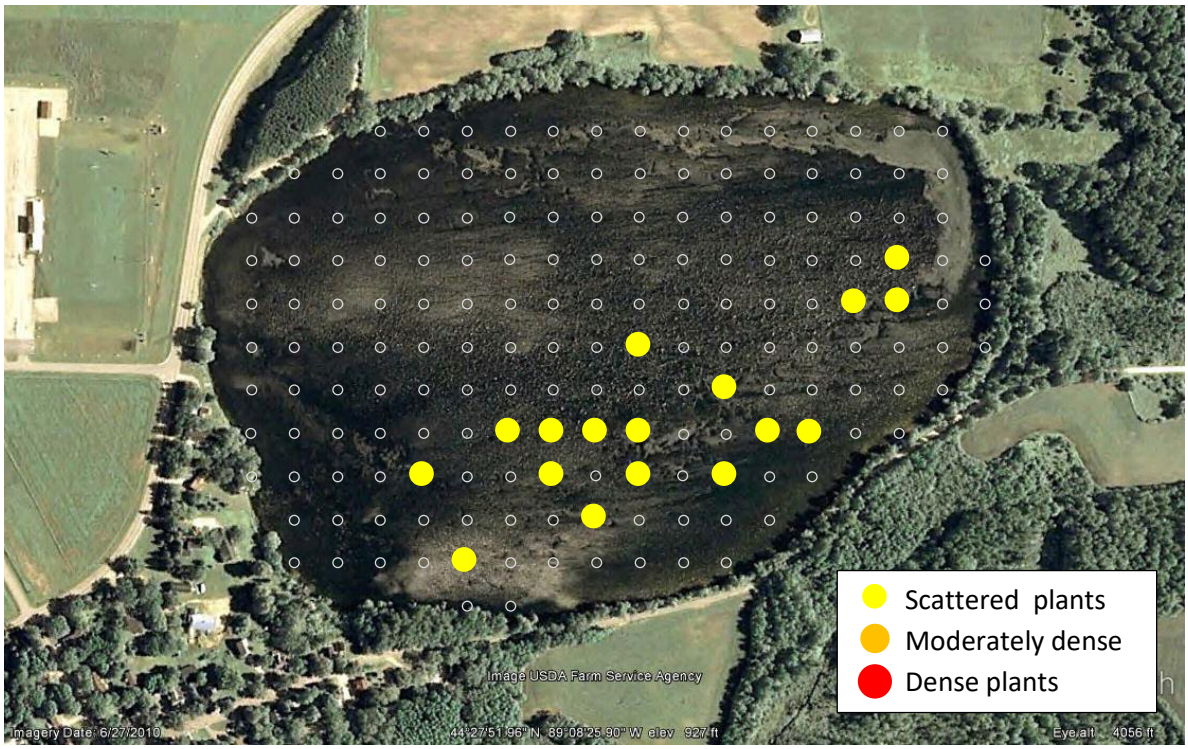


Figure 13. Locations of muskgrass (*Chara* spp.) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

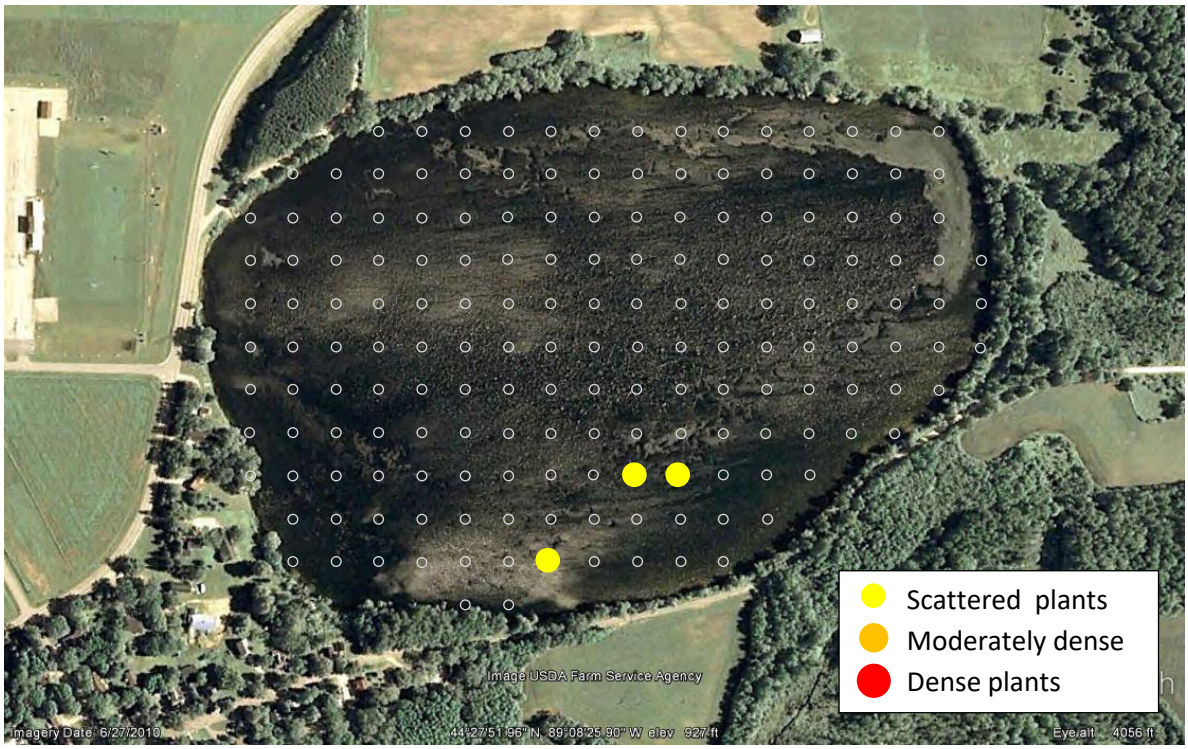


Figure 14. Locations of large duckweed (*Spirodela polyrhiza*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

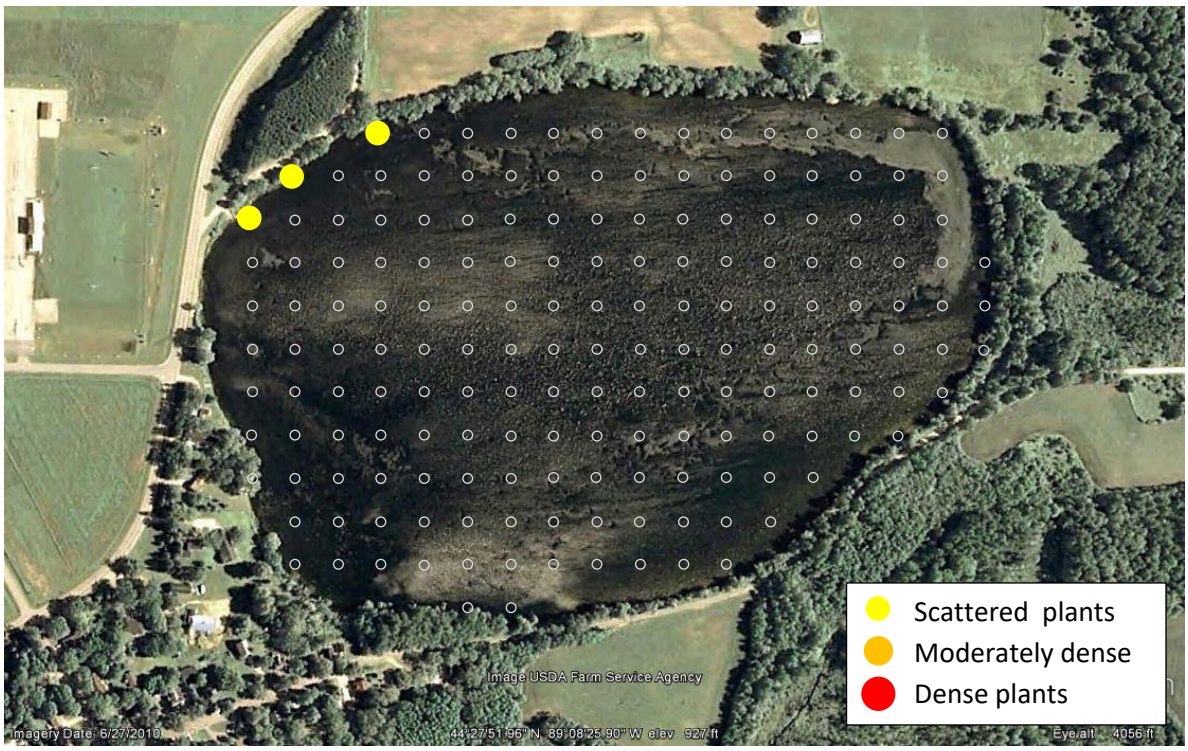


Figure 15. Locations of flat-stem pondweed (*Potamogeton zosteriformis*) found on June 25, 2012 on Silver Lake, Waupaca County, Wisconsin.

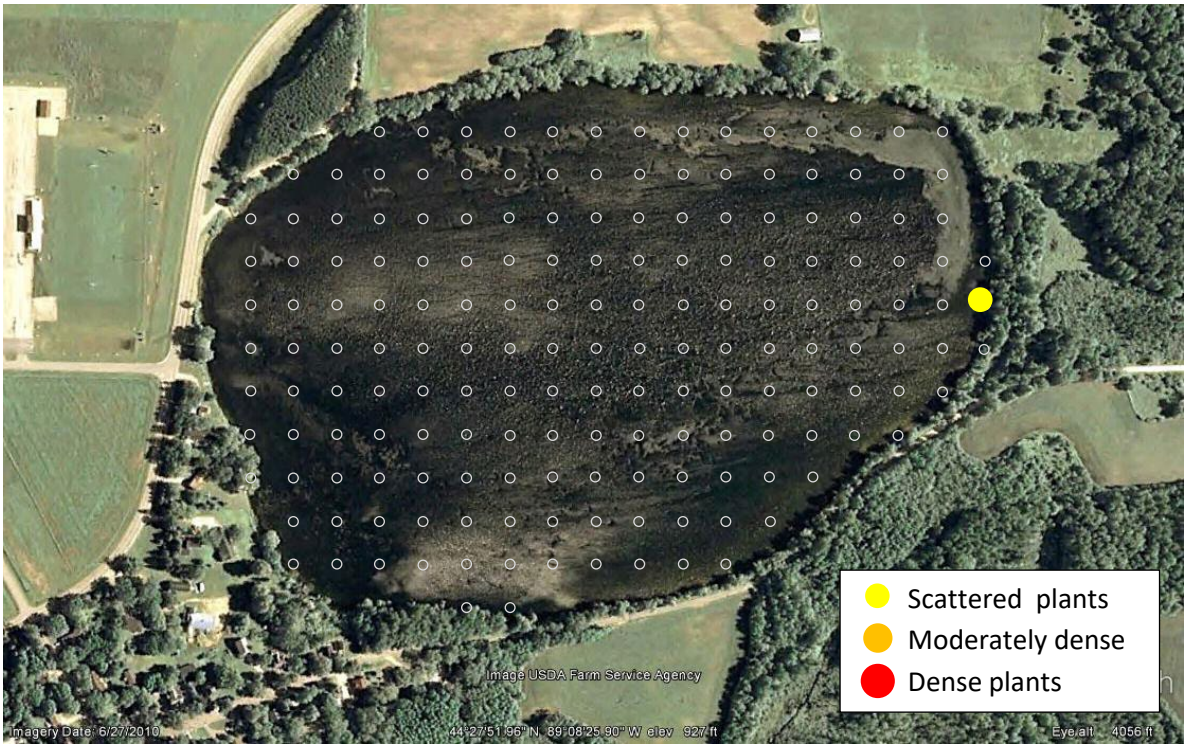
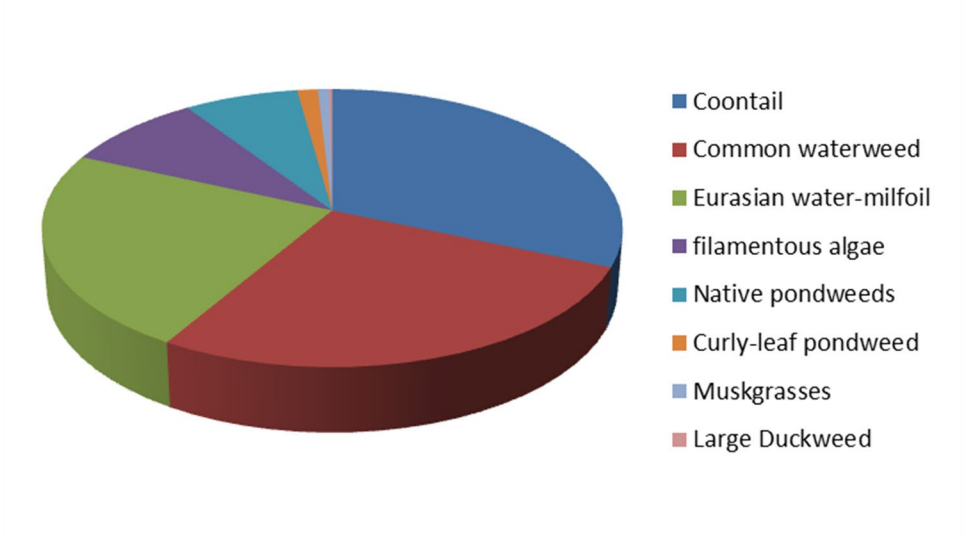


Figure 16. Submergent aquatic plant community composition from August 19-20, 2010 in Silver Lake, Waupaca County, WI.



Simpson Diversity Index

The plant data collected from Silver Lake were used to calculate the Simpson Diversity Index. In order to estimate the diversity of the aquatic plant community, this index takes in account both the number of species identified (richness) and the distribution or relative abundance of each species. As these parameters increase, so does the overall diversity. With the Simpson Diversity Index (D), 1 represents infinite diversity and 0, no diversity. That is, the bigger the value of D, the higher the diversity. The value of D calculated for Silver Lake based on the 2012 data was 0.82. Although State-wide or regional averages for diversity are not available, data from lakes surveyed in neighboring counties have yielded values between 0.70 and 0.90.

Assessment of Floristic Quality

Plant survey data were also used to assess the "floristic quality" of Silver Lake. The method used assigns a value to each *native* plant species called a Coefficient of Conservatism (C). It does not take in account the presence of exotic species, mosses, sponges, or filamentous algae. Coefficient values range from 0 - 10 and reflect a particular species' likelihood of occurring in a relatively undisturbed landscape. Species with low coefficient values, such as coontail (*Ceratophyllum demersum*) (C = 3), are likely to be found in a variety of habitat types and can tolerate high levels of human disturbance. On the other hand, species with higher coefficient values, such as white-stem pondweed (*Potamogeton praelongus*) (C = 8), are much more likely to be restricted to high quality, natural areas. By averaging the coefficient values available for the submergent and emergent species found in Silver Lake, a lake-wide value of 5.1 (**Table 1**) was calculated. The average value for lakes in Wisconsin is 6.0 while the average for lakes in the Northern Central Hardwood Forests region of Wisconsin is 5.6 (Nichols, 1999).

By utilizing the Coefficients of Conservatism for the plant species found in Silver Lake, further assessment of floristic quality can be made. By multiplying the average coefficient values by the square root of the number of plant species found, a Floristic Quality Index (FQI) of 15.3 was calculated for Silver Lake (**Table 1**). In general, higher FQI values reflect higher lake quality. The average for lakes in the Northern Central Hardwood Forests region is 20.9 (Nichols, 1999). Both Coefficient of Conservatism and the Floristic Quality Index values suggest the quality of the Silver Lake, specifically in terms of the plant community, is below average.

Aquatic plants serve an important purpose in the aquatic environment. They play an instrumental role in maintaining ecological balance in ponds, lakes, wetlands, rivers, and streams. Native aquatic plants have many values. They serve as buffers against nutrient loading and toxic chemicals, act as filters that capture runoff-borne sediments, stabilize lakebed sediments, protect shorelines from erosion, and provide critical fish and wildlife habitat. Therefore, it is essential that the native aquatic plant community within the District be protected. **Appendix B** provides a list of the more abundant native aquatic plant species that were found during the 2012 survey. Ecological values and a description are given for each species.

Appendix C contains information regarding the exotic species found in Silver Lake (Eurasian watermilfoil, curly-leaf pondweed and purple loosestrife) as well as information regarding additional threats from other exotic plants and animals more commonly identified in Wisconsin.

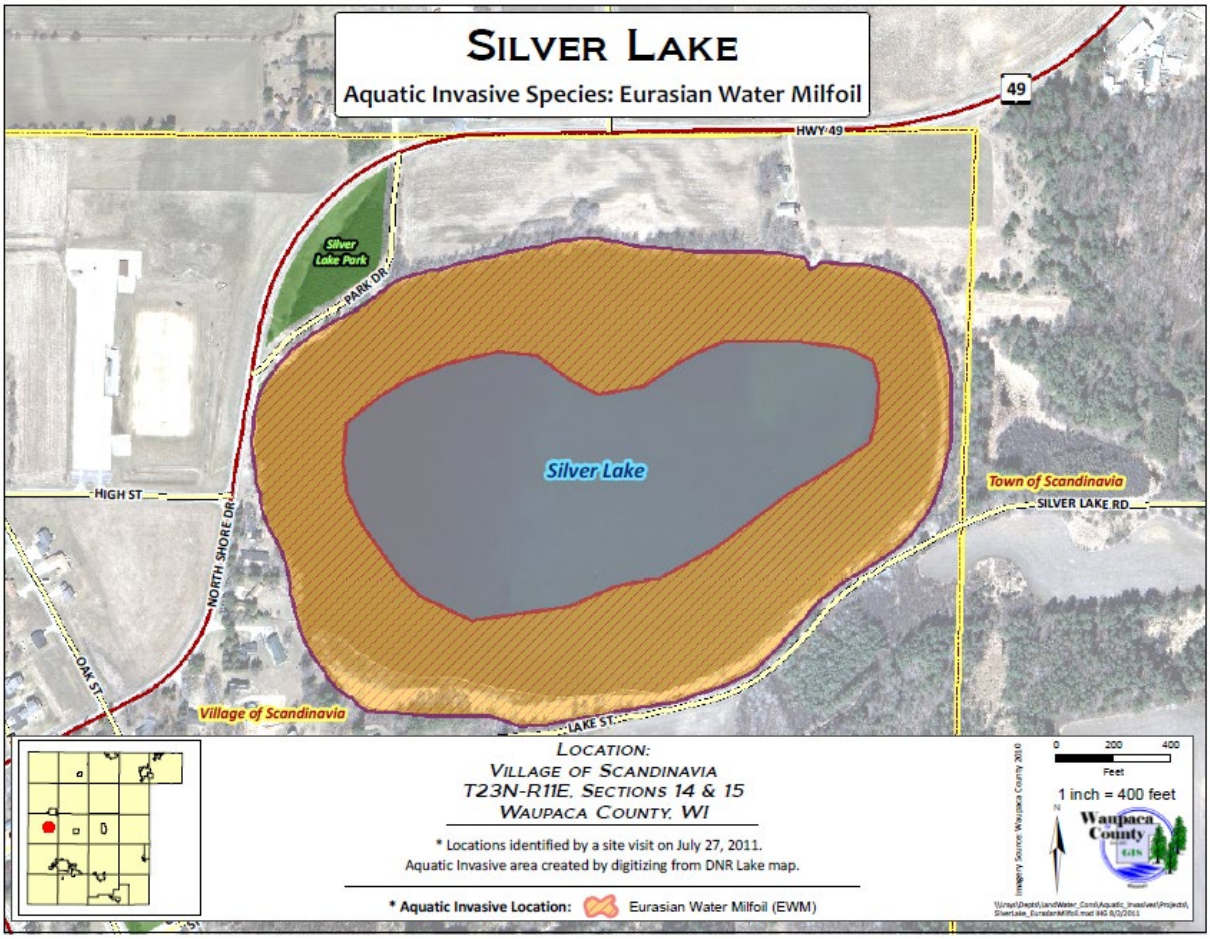
Exotic Species Surveys

In 2011 and 2012, Silver Lake was surveyed twice by Kaycie Stushek, Regional AIS Specialist with the Golden Sands RC&D Council. On July 27, 2011, Ms. Stushek surveyed the lake to map Eurasian watermilfoil. The results of this survey are found in **Figure 17**. This map shows Eurasian watermilfoil throughout much of the lake (approximately 57 acres). Although it does not indicate densities, Ms. Stushek noted at the time that Eurasian watermilfoil was one of the species impeding navigation and recreational use of the lake. This wide-spread distribution of Eurasian watermilfoil is fairly common in lakes after years of infestation with little or no management. In addition, this distribution is very similar to the occurrence mapped by Cason & Associates staff in 2012 (Figure X).

In the spring of 2012, Ms. Stushek conducted a survey of Silver Lake for curly-leaf pondweed. This survey took place at the same time District volunteers were being trained to identify aquatic invasive species. A map was not developed at the time, because the abundance of native vegetation and distribution of curly-leaf pondweed made accurate mapping of curly-leaf pondweed very difficult. Curly-leaf pondweed was found scattered throughout the lake but not in discernible beds.

Eurasian watermilfoil continues to be the main exotic species of concern in Silver Lake. It should be noted that both Ms. Stushek and Cason & Associates staff members feel there is a likelihood that a hybrid watermilfoil exists in Silver Lake. Hybrid watermilfoil is a cross between the exotic Eurasian watermilfoil and the native northern watermilfoil (*M. sibiricum*). Hybrid watermilfoil is generally lumped in with Eurasian watermilfoil when it comes to management of aquatic invasive species. Because hybrid watermilfoil shares characteristics with its exotic parent, it has the same potential to reach nuisance levels and cause ecological harm. In order to properly identify if a plant is indeed a hybrid, DNA analysis is required. To date, it is not believed this analysis has been conducted on plants from Silver Lake.

Figure 17. Locations of Eurasian watermilfoil (*Myriophyllum spicatum*) on July 27, 2011 on Silver Lake, Waupaca County, Wisconsin.



Lake Management Alternatives

Management of Aquatic Vegetation

Manual removal of vegetation

Manual removal options include raking or hand-pulling aquatic plants. Individuals can remove aquatic vegetation in front of their homes, however, there are limitations as to where plants can be hand-pulled and how much can be removed. In most instances, control of native aquatic plants is discouraged and is limited to areas next to piers and docks. When aquatic vegetation is manually removed it is restricted to an area that is 30 feet or less in width along the shore. Exotic species (Eurasian watermilfoil, curly-leaf pondweed, and purple loosestrife) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed. Manual removal beyond the 30 foot area would require a Chapter 109 (Wisconsin Administrative Code - NR 109) permit. Benefits of manual removal include low cost compared to other control methods. However, this approach is often labor intensive.

Herbicide treatment of navigation lanes

In areas where native plant growth interferes with navigation, and other management options are ineffective at reducing this nuisance, herbicide treatment of navigation lanes may be considered. A broad spectrum herbicide or mixture of herbicides can be used to target all plant species in a treatment area. In some cases, if individual species are targeted, a more selective herbicide may be applied in a manner that would target that particular species. Herbicide treatment of native plants may be a less desirable option when exotic species are a threat. Because the herbicides kill plants instead of merely cutting them, more opportunistic exotic plants may be better able to colonize the treated areas. And as with any herbicide treatment, the risk of dilution exists.

The method used for this type of treatment involves spraying herbicides to the surface of the water within the treatment area. Only those chemicals registered with the U.S. EPA and the Wisconsin Department of Agriculture, Trade, and Consumer Protection may be used. Herbicides registered for use in Wisconsin undergo a strict registration process. Before they are labeled for aquatic use, the data must demonstrate that they pose minimal risk to human health or the environment when used according to label requirements. Often a mixture of three chemicals (copper, endothall and diquat), is used to target all plants and algae present. This approach is often used when the likelihood of nuisance growth becomes apparent. If these treatments can take place early in the season, applications on low-growing plants can minimize the amount of biomass dying off at once. However, sometimes a later season follow-up treatment is needed to maintain open water. If this approach is used, it is likely that annual treatments would be needed to maintain effective control. Any treatment of this type would require a Chapter 107 permit. Impediments to navigation on Silver Lake have become more and more apparent in recent years. Treatment costs for navigation lanes range from $50 to $870 per acre depending upon the size of the treatment.

Herbicide treatment of shorelines

As with manual removal, herbicide treatment of near-shore vegetation is an option with certain restraints. Individuals must obtain a Chapter 107 permit from the WDNR to chemically treat aquatic plants in a 30-foot strip along their property extending out 150 feet if necessary. If native plant species are targeted, the same three chemicals used in treating navigation lanes would be used in this approach as well. Herbicides are able to provide control in shallow confined areas such as around docks. However, there is a negative public perception of chemicals. In addition, care must be taken to minimize the effect to non-target plant species. Water-use restrictions after application are often necessary. Often the affected property owners are expected to cover the costs of these treatments. Individual property treatments cost approximately $500 per property per treatment.

Aquatic Plant Harvesting

Mechanical harvesting involves the removal of aquatic plants from a lake using a machine that cuts and collects the plants for transport to an off-shore disposal site. Generally, harvesting equipment can be adjusted to cut to a desired depth up to five or six feet. Harvesting operations can include equipment, such as a barge, to transport plant materials from a harvester to the shore where a conveyor is used to transfer the materials to a waiting truck. Sometimes, the cutter is able to unload the materials directly into a truck or trailer. Harvesting is often used for areas where dense native plant growth significantly interferes with navigation. Harvesting produces fast results, and a removal of plant biomass from a lake. However, this method is limited. Harvesting is not used to restore aquatic plant communities. It is a maintenance approach used primarily for navigational issues. Harvesting can complicate the management of Eurasian watermilfoil. Because milfoil spreads efficiently through fragmentation, and harvesting results in a large number of fragments, the two are incompatible. Harvesting has been used on lakes containing curly-leaf pondweed to harvest plants prior to the production of turions. Harvesting also comes with high initial equipment costs, as well as relatively high maintenance, labor, and insurance costs, disposal site requirements, and a need for trained staff. A WDNR permit is also required by NR 109 for aquatic plant harvesting.

Exotic Species Management

Because Eurasian watermilfoil and curly-leaf pondweed exist in Silver Lake, control options for these species should be considered. Exotic aquatic plant species have interfered with recreational activities including swimming, pleasure boating, hunting, and fishing in numerous lakes throughout Wisconsin. Communities of native aquatic plants, as well as fish and wildlife, have also suffered as a result of these aquatic invaders. In terms of exotic species, Eurasian watermilfoil is currently the most abundant in Silver Lake, and poses the greatest threat to the District.

Herbicide treatment of exotics

Herbicides have been the most widely used and often most successful tools for controlling Eurasian watermilfoil. The most commonly employed herbicide to treat Eurasian watermilfoil in Wisconsin is 2,4-D (e.g. Navigate®, Sculpin®, DMA4 IVM®, Weedar 64®). Herbicides

containing 2,4-D have been effective at managing Eurasian watermilfoil in hundreds of Wisconsin lakes. When applied at labeled rates, 2,4-D has been shown to be an effective tool at selectively controlling Eurasian watermilfoil. Aquatic herbicides containing 2,4-D are labeled with application rates based on volume. In most cases, the recommended rates for control of Eurasian watermilfoil beds range from 2 ppm to 4 ppm, depending upon conditions. Recent research by the US Army Corps of Engineers and the WDNR has shown that a low-dose whole-lake treatment approach may also be effective at controlling Eurasian watermilfoil. Different concentrations have been tested. Currently it is believed that a whole-lake target concentration of 0.25 ppm to 0.40 ppm is effective at controlling Eurasian watermilfoil throughout a lake. Depending upon the volume of a lake, this may or may not be a more cost effective way to treat Eurasian watermilfoil when compared to treating individual beds. It is estimated this approach would cost the District approximately $7,500 to treat Silver Lake.

The herbicide most often used to control curly-leaf pondweed is endothall (e.g. Aquathol®). While endothall herbicides are effective on a broad range of aquatic monocots, early season applications made at low rates are highly species-selective for curly-leaf pondweed. Endothall herbicides effectively kill the parent plant, but the turions, which mature plants produce, are resistant to herbicides, allowing curly-leaf pondweed to regenerate annually. The labeled rate for whole-lake treatment of curly-leaf pondweed with Aquathol® is 0.75 ppm to 1.5 ppm. Curly-leaf pondweed treatments are more costly than Eurasian watermilfoil treatments because higher concentrations of herbicides are needed and the unit cost of the product is higher. The application rates forwhole-lake treatments of curly-leaf pondweed would likely cost over $25,000. In addition, because of the need for repeated annual treatments (three to five years), this would not be a one-time expense.

Studies conducted by the Army Corps of Engineers have found that conducting treatments of curly-leaf pondweed using Aquathol® when water temperatures are in the 50-60° F range will kill plants before turions form, thus providing long-term control. Researchers found that conducting repeated treatments over consecutive seasons for established curly-leaf pondweed populations will target both the standing crop of the pondweed as well as the resulting regrowth from the turions (Skogerboe and Poovey, 2002). In many cases three to five years of treatments are needed to gain significant control over this species.

Both endothall and 2,4-D are herbicides which break down microbially and do not persist in the environment. When applied at the labeled rates, herbicides are an effective management tool for control of many aquatic plant species. While no control method could be considered cheap, herbicide treatments are among the most feasible of methods. This is in part due to the relatively low labor costs in comparison to measures such as hand-pulling, mechanical harvesting, etc. Perhaps the greatest consideration is that these herbicides often produce long-term control of exotics. The greatest disadvantage of herbicide treatments is that they rarely produce 100% control. Unnoticed and untreated plants may eventually grow to dense beds if left unchecked. Factors such as pH and plant maturity may also reduce treatment efficacy. Several follow-up treatments, whether in-season or in subsequent years, may be needed to reduce exotic species to target levels.

Hybrid milfoil management

Research into control options for hybrid milfoil are currently being researched by the Army Corps of Engineers and staff at Mississippi State University. Preliminary results suggested hybrid milfoil responds to herbicide treatments similarly to Eurasian watermilfoil. However, more recent studies have found hybrid milfoil may be more difficult to control than Eurasian watermilfoil. DNA analysis has shown that there are multiple strains of Eurasian watermilfoil, northern watermilfoil and hybrid watermilfoil. Each strain likely responds differently to environmental conditions and control efforts. Research into herbicide effectiveness and treatment alternatives is ongoing. Management of hybrid watermilfoil is a relatively new focus. Currently, the same approach to managing Eurasian watermilfoil, primarily with 2,4-D, is being used to manage most populations of hybrid watermilfoil.

Biological control - milfoil weevils

There has been considerable research on biological vectors, such as insects, and their ability to affect a decline in Eurasian watermilfoil populations. Of these, the milfoil weevil (*Euhrychiopsis lecontei*) has received the most attention. Native milfoil weevil populations have been associated with declines in Eurasian watermilfoil in natural lakes in Vermont (Creed and Sheldon, 1995), New York (Johnson et al., 2000) and Wisconsin (Lilie, 2000). While numerous lakes have attempted stocking milfoil weevils in hopes of controlling milfoil in a more natural manner, this method has not proven consistently successful in Wisconsin. A twelve-lake study called "The Wisconsin Milfoil Weevil Project" (Jester et al. 1999) conducted by the University of Wisconsin, Stevens Point in conjunction with the WDNR researched the efficacy of weevil stocking. This report concluded that milfoil weevil densities were not elevated, and that Eurasian watermilfoil was unaffected by weevil stocking in any of the study lakes. Recently, however, work carried out on a number of Portage County lakes has shown some promise at enhancing milfoil weevil populations. In order for weevils to be successful in reducing the extent of Eurasian watermilfoil, a number of environmental criteria are needed, including the availability of proper year-round habitat. Stocking weevils costs over $1.00 per weevil (larvae). Often thousands of larvae need to be stocked to be effective.

Management of Purple Loosestrife

There are several methods that are commonly used for purple loosestrife control including digging or hand pulling, cutting, herbicide treatments and biological controls.

Manual removal

Digging and hand pulling of purple loosestrife plants are most effective for small infestations. Individual property owners are encouraged to use this method if they are able. Cutting involves removal and destruction of flowers and seed heads to inhibit plant propagation. Since cut plants tend to re-grow and since seeds present in the soil can sprout new plants, this method may need to be done for a number of years before desired control is achieved.

Herbicides

Herbicide treatments are the least labor intensive of methods. The preferred herbicide is glyphosate (ShoreKlear®, Rodeo®). This compound rapidly biodegrades upon contact with soil

or water. As a result, there are no water-use restrictions following treatment. Because it is non-selective, each individual plant must be sprayed, as opposed to broadcast applications. Glyphosate is extremely effective in controlling purple loosestrife at a very low cost of treatment. The biggest disadvantage is that seeds in the soil will sprout new plants, requiring annual treatments for a number of years before desired control is achieved. A WDNR permit is required for treatment; however the fee is waived. This option should be considered if the distribution of purple loosestrife increases significantly. It is difficult to estimate treatment costs for purple loosestrife without knowing the area to be treated. At a minimum, the cost to treat a small location would be at least $500 to $750.

Biological control - loosestrife beetles

Two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) are currently available from the WDNR in an effort to control purple loosestrife by biological means. Research has shown that these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants. Although, as with most biological control agents, these insects will not eradicate loosestrife, they may significantly weaken the population and allow native species to reclaim infested areas. According to the WDNR, tests have shown significant declines in loosestrife as a result of biological control. The purple loosestrife control program established through the WDNR provides a parent stock of beetles to individuals who are willing to raise the insects in a controlled environment until they are able to reproduce. Once the young have matured, they are released and are able to begin control of the purple loosestrife. As with other exotic plant control projects, annual monitoring should be employed to assess the success of control measures. If significant progress is not made, alternative management options can be considered to control purple loosestrife. The WDNR has a program for individuals to raise beetles on their own. More information can be obtained through the WDNR's website.

Property Owners and Lake Users Input

The results of the property owners' survey are tabulated in **Appendix D.** The following results were determined:

- A majority of respondents are year-round/permanent residents who have owned their residences for over 21 years.
- The most important factors for selecting property on Silver Lake were the peace and tranquility of the area, water quality, quality of the property itself and recreational opportunities.
- The best features of Silver Lake are the aesthetics and recreational opportunities (fishing and boating).
- The biggest change respondents would like to see in regards to Silver Lake is a reduction in the excessive weed growth.
- The most common activities on Silver Lake are enjoying the view, observing wildlife and fishing.
- Most respondents have non-motorized boats or boats with low-horsepower motors.

- Most respondents do not know if there is adequate law enforcement on Silver Lake but feel it is sufficiently regulated.
- The biggest potential impacts to the future of Silver Lake are shoreline development and weed growth.
- Respondents were inconsistent in their response to whether overall management of Silver Lake is satisfactory.
- Most respondents have not attended a District meeting, but feel they *can* offer input regarding management of the lake.
- A majority of respondents would like to see improvements made to the lake, primarily through managing aquatic plants and enhancing the lake's fishery.

Conclusions and Recommendations

Aquatic Plant Management

Aquatic plant community

Results of the property owner survey indicated that the aesthetics and recreational use of Silver Lake are very important to residents but are highly impeded but the aquatic plant growth. For some time now, Silver Lake has had a below average submergent aquatic plant community. Abundant growth of native plants (coontail, common waterweed) and exotic plants (primarily Eurasian watermilfoil) contribute to this problem.

Management of Eurasian watermilfoil

Only two small treatments of Eurasian watermilfoil have taken place on Silver Lake (2007 and 2008). The immediate results of these treatments are unclear. However, since that time, Eurasian watermilfoil has contributed significantly to the nuisance plant growth in Silver Lake. Given Silver Lake is relatively small in volume, a liquid whole-lake treatment approach seems most logical. This treatment would target all Eurasian watermilfoil in the lake. Because of the concern over the possible presence of hybrid watermilfoil in Silver Lake, a more concentrated treatment (0.4 ppm) is recommended. A higher rate should maintain a desired concentration of herbicide in the treatment area as long as possible.

The District should also stay informed on other alternative treatment approaches being researched for control of Eurasian watermilfoil and hybrid watermilfoil. If other treatment options are found to be ecologically and economically feasible, the District should consider them as well. This information would most likely come from conversations with the WDNR and the applicator firm, or through presentations at conferences.

Management of curly-leaf pondweed

Currently, curly-leaf pondweed is a lower priority for the District because it is less dense in Silver Lake than Eurasian watermilfoil and some of the native plant species. It is unlikely the District or Village of Scandinavia would be able to financially support the costs of repeated herbicide treatments for curly-leaf pondweed without significant outside funding.

Management of Purple loosestrife

Because purple loosestrife was found in only one location, it is unlikely to be found widespread in the Silver Lake area in the near future. District members should be on the lookout for this species and hand-pull any plants found before they produce seeds. It will be important to get the entire root system as well. Plants should be placed in large garbage bags and disposed of in the trash. It is not recommended the plants be composted due to the risk of seeds spreading. If the population of purple loosestrife expands quickly, the District should consider either spraying the plants with herbicides or releasing loosestrife beetles in the area for control.

Exotic species monitoring

Survey results confirm that Eurasian watermilfoil, and to a lesser extent curly-leaf pondweed, continue to infest Silver Lake. Regardless of management efforts, annual surveys for exotic species should take place. Presumably, the AIS Specialists with Golden Sands RC&D will be able to continue to offer this service free of charge. If two surveys per year are possible, one survey should take place in the early spring when curly-leaf pondweed will be most prevalent. A second survey in late summer would be ideal to be able to identify the full distribution of Eurasian watermilfoil and to locate any additional purple loosestrife plants found along shore. If only one annual survey is possible, it would be best to conduct this survey in the early summer when curly-leaf pondweed-leaf pondweed would still be visible, but also when Eurasian watermilfoil is easily found. Surveys of this type will be important to determine the needs for future management. If the distribution of Eurasian watermilfoil is reduced to more manageable levels, it may be in the District's interest to switch its attention to curly-leaf pondweed. Or if curly-leaf pondweed begins to expand significantly in Silver Lake, the District should consider implementing a control strategy for this species as well.

Clean Boats, Clean Waters

The Silver Lake Protection and Rehabilitation District does not have an active Clean Boats, Clean Waters (CBCW) program. However, a handful of individuals have been trained. Silver Lake does not receive a high level of recreational use. The WDNR in cooperation with the UW-Extension Lakes Program has developed this volunteer watercraft inspection program designed to educate motivated lake organizations in preventing the spread of exotic plant and animal species in Wisconsin lakes. This program would be particularly useful to Silver Lake during the highest boat-traffic times, primarily holidays. Since Eurasian watermilfoil and curly-leaf pondweed are both present, it is in the District's best interested to attempt to not allow additional invasive species into the lake, and also stop the spread out of the lake. Through the Clean Boats, Clean Waters program, volunteers are trained to organize and conduct a program to monitor and stop the spread of exotic plants and animals both into and out of Silver Lake.

For more information, contact:
Erin (Henegar) McFarlane
Aquatic Invasive Species Volunteer Coordinator
Phone: 715-346-4978
E-mail: erin.henegar@uwsp.edu

Education should play a big part in the Clean Boats, Clean Waters program. All individuals willing to participate should be taught to identify exotic species. The District should make it a priority to include such measures during all normally scheduled meetings whenever possible. In addition, special meetings should be considered to focus primarily on the identification of these species for riparian property owners and frequent lake users. The native plant, northern watermilfoil has historically been found in Silver Lake. Because it superficially looks much like Eurasian watermilfoil, care should be taken to specifically learn to differentiate between the two species. In addition to Eurasian watermilfoil, it would behoove members of the District to become familiar with the identification of other exotic species that pose a threat to Wisconsin lakes (see Appendix C). Additional information and education materials are available through the WDNR and the local UW-Extension office.

If a lake user locates what he or she believes to be a new exotic species in Silver Lake, its location should be documented by recording GPS coordinates. In addition, a sample should be collected and taken to a member of the District's Board or the coordinator of the monitoring program if such a program is implemented. Any suspicious material should be sent to the nearest WDNR office for verification. If the identification is confirmed to be an exotic species, it will be important to initiate management measures as quickly as possible. The extent of an exotic species infestation often dictates which management option is most likely to result in successful control. As always, education should be a key component of any exotic species management effort.

Grant opportunities

The WDNR has a number of grant opportunities to assist organizations with a variety of lake management activities.

The Aquatic Invasive Species (AIS) Control Grant program is designed to help prevent and control the spread of aquatic invasive species in the waters of the State. These grants can be used for education, prevention, planning, early detection, rapid response and established infestation control projects. The WDNR also has an AIS grant option to assist with payment of Clean Boats, Clean Waters activities. Under this program, the State reimburses the grant recipient 75% of the project costs.

The Lake Classification and Lake Protection Grant program is designed to improve or protect the quality of water in lakes or the quality of natural ecosystems, implement protection activities for the lakes based on their classification and implement the recommendations of a lake management plan. This is also a 75%/25% cost-share program.

The Lake Management Planning grant program provides funding for qualifying lake districts, local governments and tribes to collect and analyze information needed to protect and restore lakes and their watersheds. There are two categories in this program for large-scale and small-scale projects. This program is a 67%/33% cost-share program.