SILVER LAKE PROTECTION ASSOCIATION

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Aquatic Plant Management Plan for Silver Lake, Kenosha County, WI

Silver Lake Protection Association

February 1, 2013

Revised March 19, 2013

Revised July 23, 2013 by Stantec Consulting

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With Input from:

SEWRPC

Stantec

Wisconsin Department of Natural Resources

The Silver Lake Community

Representatives from the Town of Salem

Representatives from the Village of Silver Lake

Introduction

This document summarizes the current state of Silver Lake's aquatic plant community and outlines proposed actions likely to be required in order to maintain a healthy population of native plants. The Silver Lake Protection Association (SLPA) is working with the Village of Silver Lake and Town of Salem to control the aquatic plants in Silver Lake. In addition, a partnership has been formed with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to draft this document.

This aquatic plant management plan contains the following sections:

- Goals and Objectives
- Lake and Watershed Characteristics
- Aquatic Plant Communities
- Adverse Effects of Nonnative Aquatic Plants
- Past and Current Aquatic Plant Management Practices
- Alternative Methods for Nonnative Aquatic Plant Control
- Recommended Aquatic Plant Management Plan.

Goals and Objectives

While there are many considerations that go into maintaining a healthy watershed and waterbody, the immediate focus of the SLPA is on Silver Lake's aquatic plants. Silver Lake has a diverse community of aquatic plants that contributes to maintaining the fish population, the overall health of the Silver Lake ecosystem, and the beauty of Silver Lake. The main goal of this aquatic plant management plan is to sustain a healthy level of native plants by targeting the nonnative plants in the lake. By reducing the presence of nonnative aquatic plants, the Silver Lake community aims to improve recreational opportunities, angling conditions, and ecosystem sustainability. It is important to consider these objectives with long-term results in mind, not just seasonal relief.

Any considerations made or actions taken in response to this management plan must be done so in an environmentally sustainable manner in compliance with the *Wisconsin Administrative Code*. This may include Chapters NR 107, "Aquatic Plant Management", and NR 109, "Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations", amongst others.

The Aquatic Plant Management Plan also upholds SLPA objectives, including those which seek to:

- protect our valuable lake for the enjoyment of all
- improve and protect the environment of Southeastern Wisconsin
- protect wildlife and its habitat
- prevent water pollution
- promote responsible zoning regulations
- promote water related safety regulations
- promote adequate sanitary codes and police protection
- cooperate with the Town Board of Salem and the Village of Silver Lake in any action which will benefit all property owners
- keep members informed on taxation and other pertinent matters
- plan meetings and social activities for the benefit and enjoyment of its members

Lake and Watershed Characteristics

Silver Lake is located in Southeastern Wisconsin, in Kenosha County, as shown in Figure 1. The lake is shared by the Village of Silver Lake and the Town of Salem. The total lake area is 516 acres and the maximum lake depth is 44 feet [1]. The drainage basin area is 3,699 acres, with agriculture as the largest land use, as shown in Table 1 [2]. The northeast portion of the lakeshore is public land managed by the DNR and by Kenosha County as part of their Parks Department. The remainder of the lakeshore is developed by private landowners or the Village of Silver Lake. Silver Lake is primarily fed by warm water seepage and runoff from the watershed, including inflow from the small streams and wetlands on the north end of the lake. Contaminant loads from the various nonpoint sources within the drainage area are shown on Table 2. The primary outlet is a dam, located in the southwest corner of the lake, which flows southwest into the Fox River as seen in Figure 2. A delineation of the watershed is shown in Figure 3, and riparian lands in Figure 4.

Silver Lake has three boat landing sites as shown in Figure 2: one on the north side of the lake managed by the Department of Natural Resources (DNR) with parking for up to 25 vehicles/trailers, one on the northwest side of the lake managed by the Village of Silver Lake, and one on the south side open to the public, managed by a private marina.

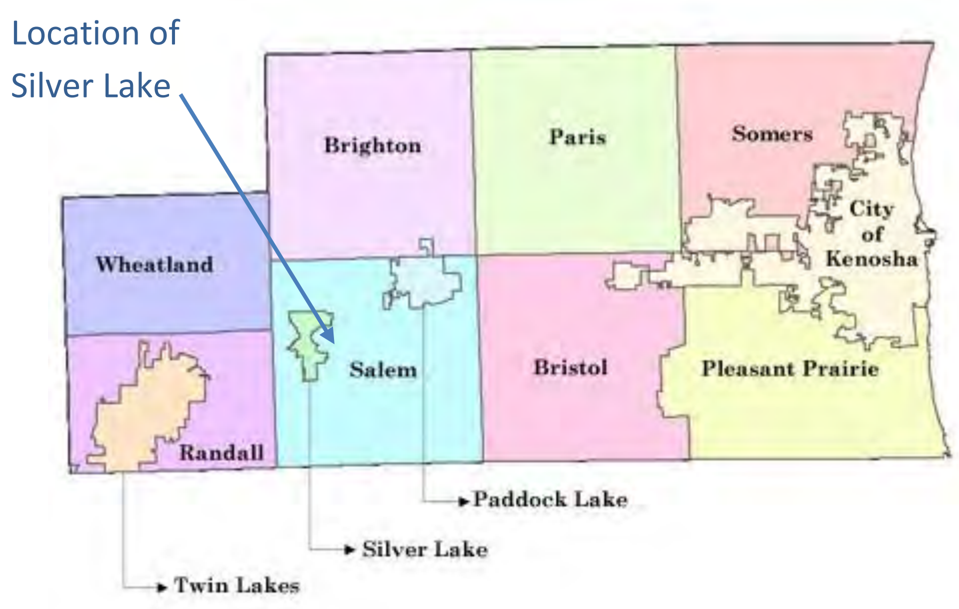


Figure 1: Location of Silver Lake in Kenosha County [3]

Table 1: Land use within the Silver Lake drainage area: 2010

Land Use Categories	2010	
	Acres	Percent of Tributary Area
Urban		
Residential	272.8	7.4
Commercial	23.3	0.6
Industrial	14.1	0.3
Governmental and Institutional	14.5	0.4
Transportation and Utilities	191.4	5.2
Recreational	39.7	1.1
Subtotal	555.8	15.0
Rural		
Agriculture and open Lands	1,651.1	44.7
Wetlands	411.3	11.1
Woodlands	521.8	14.1
Surface Water	559.1	15.1
Subtotal	3,143.3	85.0
Total	3,699.1	100.0

Source: SEWRPC.

Table 2: Nonpoint-sourced contaminant loads to Silver Lake by land use category: 2010

Land Use Categories	Pollutant Loads			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential	2.6	54.6	0.0	2.7
Commercial	0.1	27.8	5.1	34.6
Industrial	5.3	16.5	3.1	21.0
Governmental and Institutional	3.7	19.6	--	--
Transportation and Utilities	9.9	21.0	1.0	11.6
Recreational	0.5	10.7	--	--
Subtotal	22.1	150.2	9.2	69.9
Rural				
Agriculture and open Lands	371.5	1,419.9	--	--
Wetlands	0.8	16.5	--	--
Woodlands	1.0	20.9	--	--
Surface Water	52.5	72.7	--	--
Subtotal	425.8	1,530.0	--	--
Total	447.9	1,680.2	9.2	69.9

Figure 2: Location of the public boat landing sites and dam as signified by red squares [4]

88th Avenue Boat Launch

Landing Type: RAMP
Municipality: VILLAGE OF SILVER LAKE
Number of Launch Lanes: 2
Launch Surface: Paved
Number of Vehicle Stalls: 1-5
Number of Vehicle/Trailer Stalls: 21-25

Highway F Boat Ramp

Landing Type: RAMP
Municipality: VILLAGE OF SILVER LAKE
Number of Launch Lanes: 1
Launch Surface: Paved
Number of Vehicle Stalls: Unknown
Number of Vehicle/Trailer Stalls: Unknown

Cogswell Drive Boat Ramp

Landing Type: RAMP
Municipality: TOWN OF SALEM
Number of Launch Lanes: 2
Launch Surface: Paved
Number of Vehicle Stalls: 10
Number of Vehicle/Trailer Stalls: 15

Figure 3: Silver Lake Watershed Delineation

Figure 4: Silver Lake Riparian Properties

The Lake is well used for angling, with muskellunge, northern pike, walleye, and largemouth bass being described as being common. Smallmouth bass and catfish also are present, together with a range of panfish [5]. The Lake has reported populations of critical fish species, including pugnose shiner (a State threatened species) and lake chubsucker (a State special concern species) [6]. In addition, the wetlands adjacent to the northern shores of the lake have been noted as being valuable for a range of wildlife.

Silver Lake has a dedicated team of Citizen Lake Monitors who sample water quality data several times per year and send the collected information into the DNR. In 2012, the DNR gave Silver Lake a Trophic State Index (TSI) of 48, suggesting that Silver Lake was mesotrophic. Mesotrophic lakes typically have moderately clear water, but are at risk of having low dissolved oxygen in deeper water, especially in warmer months. The TSI is based on factors including chlorophyll, phosphorus, and secchi depth. A summary of this data collected at Silver Lake's Deep Hole location since 2000 is summarized in Charts 1-4 below.

Chart 1: Silver Lake Trophic State Index [7]

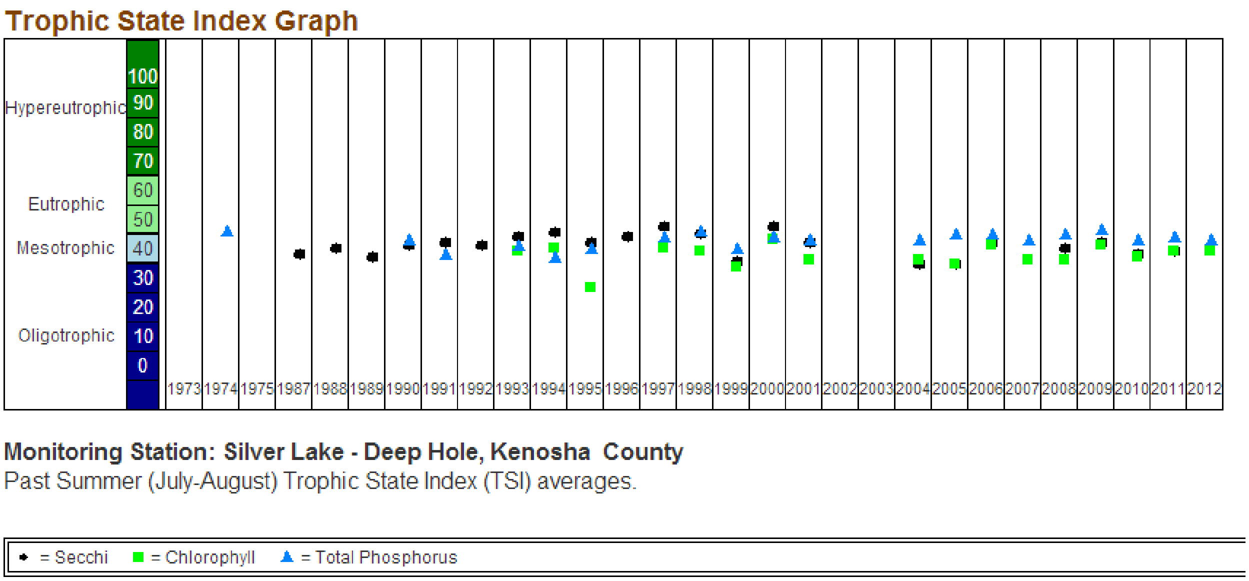


Chart 2: Silver Lake Summer Secchi Depth [8]

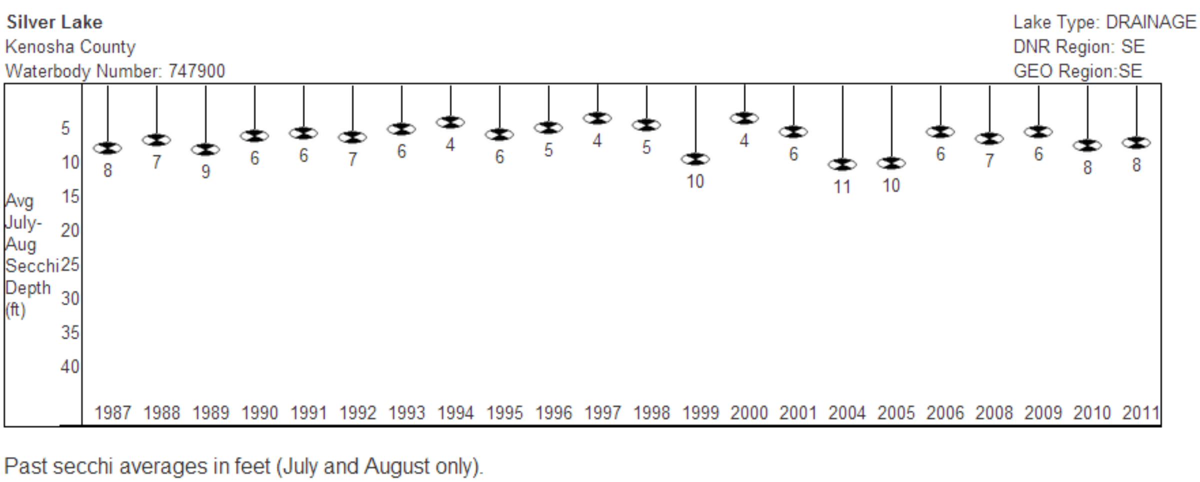


Chart 3: Silver Lake Chlorophyll Levels [9]

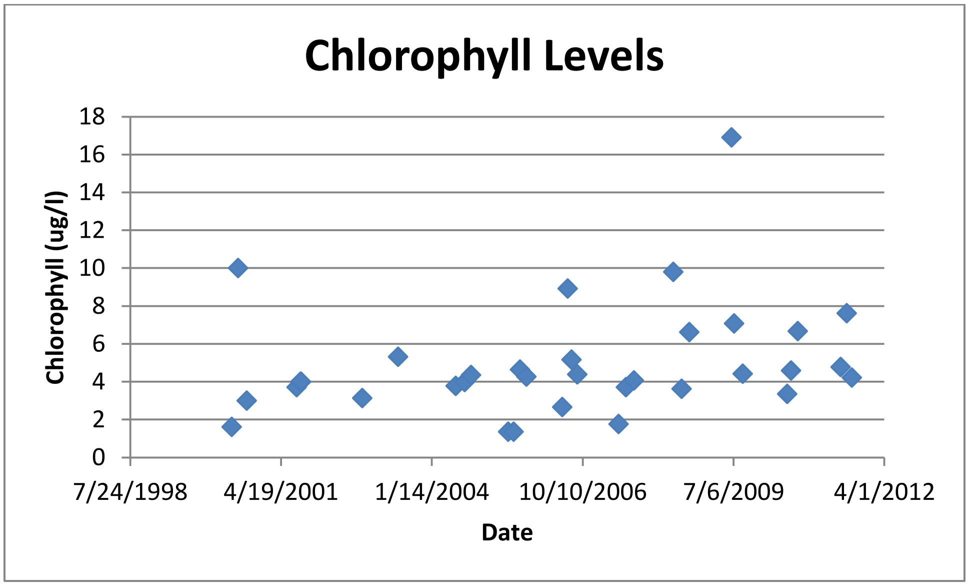
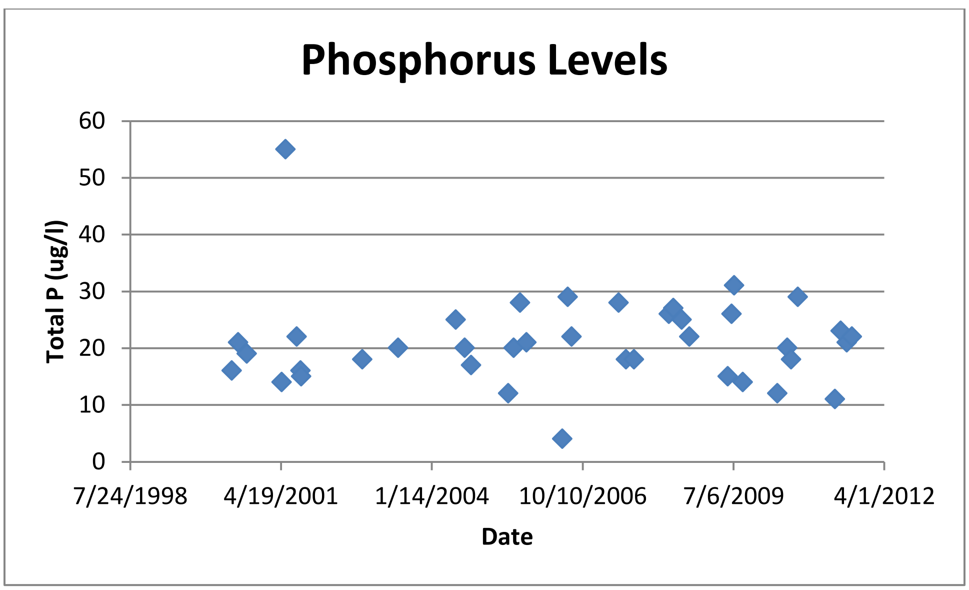


Chart 4: Silver Lake Phosphorus Levels [9]



Aquatic Plant Communities

In order to better understand the plant communities present in Silver Lake, two plant surveys have been conducted: one in 2006 by the DNR, and one in 2012 conducted by Lake and Pond Solutions Co at the request of the SLPA, funded by the Village of Silver Lake, and the Town of Salem. A grid-based point intercept (PI) method was used in both cases, in which a standardized rake or pole is used to collect plant samples at predetermined locations on the lake. The same 491 sampling locations were used in both plant surveys, as shown in Figure 5.

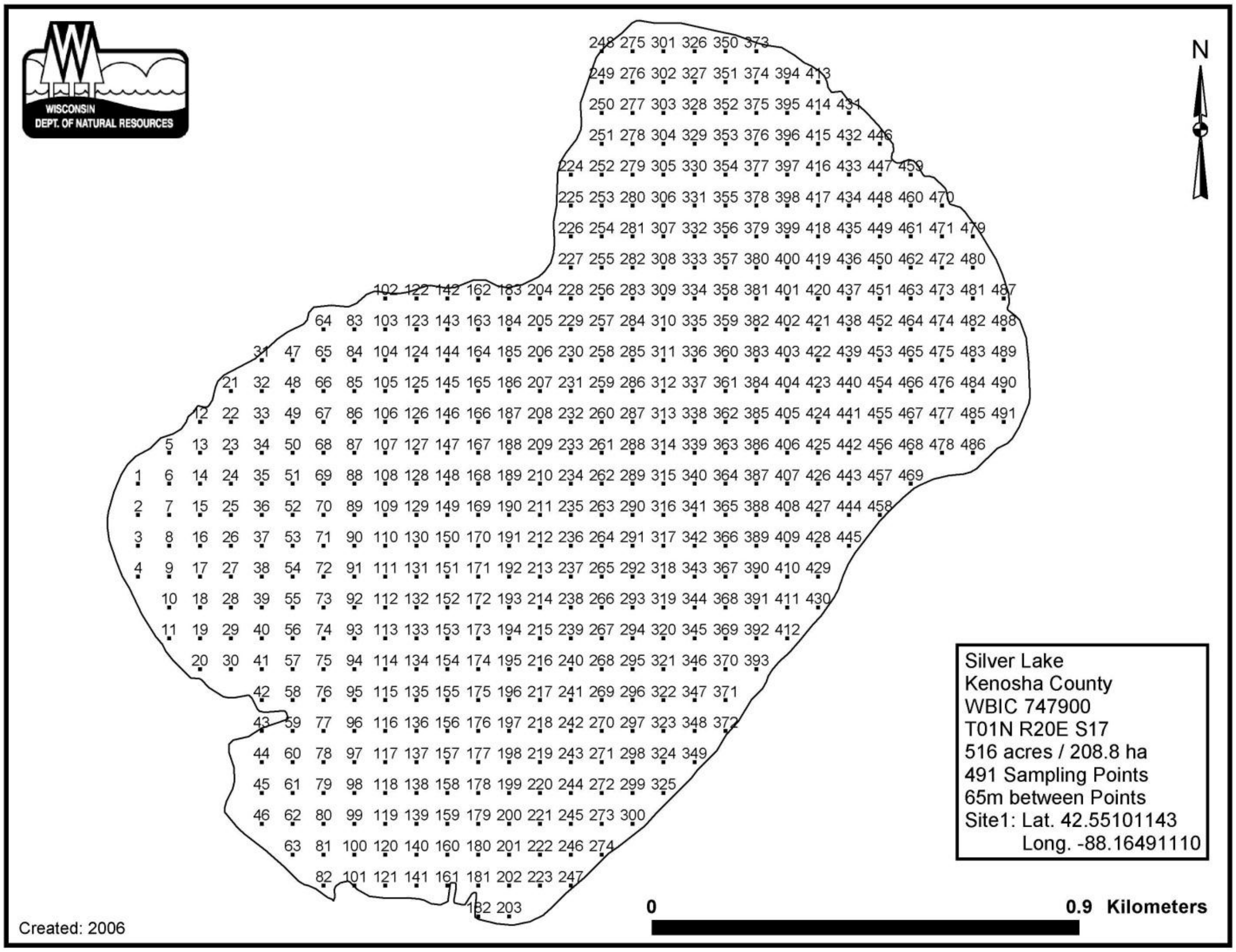


Figure 5: Silver Lake Aquatic Plant Sampling Points [10]

2006 Survey

In June 2006, 27 aquatic plant species were found in Silver Lake as outlined in Table 3. The frequency of occurrence of these plants within the vegetated areas of the Lake is also shown as a percentage, which is calculated by dividing the number of sites at which a particular species was detected by the number of sites with vegetation. *Chara* (muskgrass) was the most widespread plant found in Silver Lake in 2006, followed by *Potamogeton illinoensis* (Illinois pondweed), *Vallisneria americana* (Wild celery), and *Stuckenia pectinata* (Sago pondweed), all of which are native plants. Two nonnative, or invasive, species were found in the lake: *Myriophyllum spicatum* (Eurasian watermilfoil, EWM) and *Potamogeton crispus* (Curly-leaf pondweed). Historically, the two aquatic invasive species (AIS) discussed have been present in Silver Lake for many years. EWM was first recorded by the DNR in Silver Lake in 1994, and Curly-leaf pondweed was first recorded in 1976 [11]. The Floristic Quality (including visuals) was 29 in 2006, which is generally rated as a high native vegetative quality for an area.

Table 3: June 2006 Plant Survey Species and Frequencies Observed [12]; highlighted species are designated nonnative, invasive species.

Species	Frequency of occurrence within vegetated areas (%)
Chara, Muskgrasses	67.90
Potamogeton illinoensis, Illinois pondweed	26.42
Vallisneria americana, Wild celery	25.85
Stuckenia pectinata, Sago pondweed	23.86
Filamentous algae	23.30
Myriophyllum spicatum, Eurasian water milfoil	22.44
Najas flexilis, Slender naiad	11.65
Ceratophyllum demersum, Coontail	9.94
Myriophyllum sibiricum, Northern water milfoil	8.52
Heteranthera dubia, Water star-grass	7.95
Najas marina, Spiny naiad	6.82
Nitella sp., Nitella	2.84
Potamogeton richardsonii,Clasping-leaf pondweed	1.42
Utricularia resupinata, Small purple bladderwort	1.42
Potamogeton crispus, Curly-leaf pondweed	1.14
Potamogeton friesii, Frie's pondweed	1.14
Potamogeton pusillus, Small pondweed	1.14
Najas sp., Naiad	0.85
Potamogeton foliosus, Leafy pondweed	0.57
Brasenia schreberi, Watershield	0.28
Nymphaea odorata, White water lily	0.28
Pontederia cordata, Pickerelweed	0.28
Potamogeton gramineus, Variable pondweed	0.28
Potamogeton nodosus, Long-leaf pondweed	0.28
Utricularia minor, Small bladderwort	0.28
Utricularia vulgaris, Common bladderwort	0.28
Freshwater sponge	0.28
Nuphar variegata, Spatterdock	present
Schoenoplectus tabernaemontani, Softstem bulrush	present

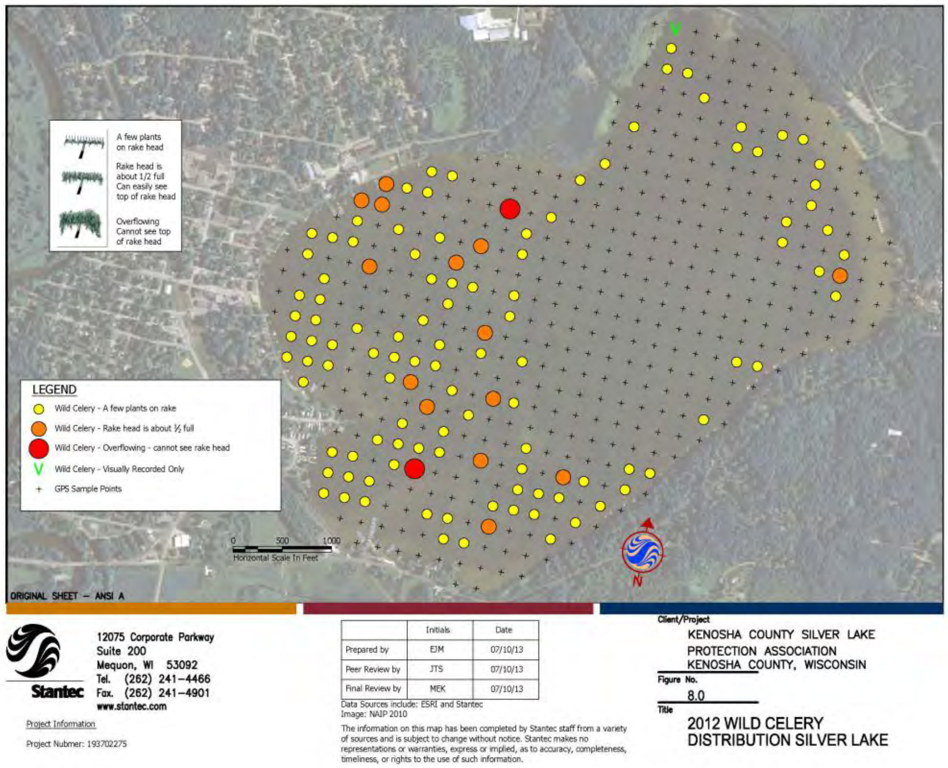
2012 Survey

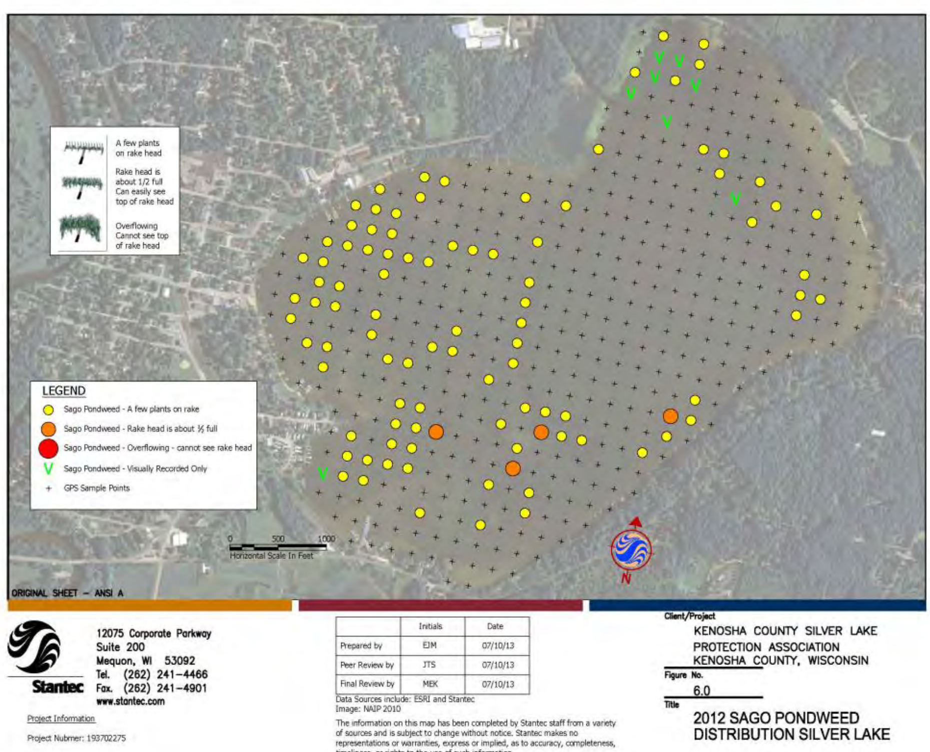
In September 2012, 20 plant species were sampled in Silver Lake, as outlined in Table 4. Non-native EWM was the most widespread plant observed, surpassing all native plants, including Chara, which is still the most frequently occurring native plant. Silver Lake had 260 acres of EWM in 2012. Samples of the EWM were sent to Grand Valley State University for testing, and it was concluded that Silver Lake does have a hybrid species. For data collection purposes, all EWM and possible hybrids were categorized as EWM. *Potamogeton crispus* was not found in 2012, but sampling was done later in the season than in 2006, and may have missed the peak season for this species. It is unknown whether Curly-leaf pondweed was present earlier in the season or not. The six most common native plants found, excluding chara, in Silver Lake are shown in Figures 6-11 below. The Floristic Quality (including visuals) was 27 in 2012, which is still a high native vegetative quality for an area, but showed a decrease from 2006 to 2012.

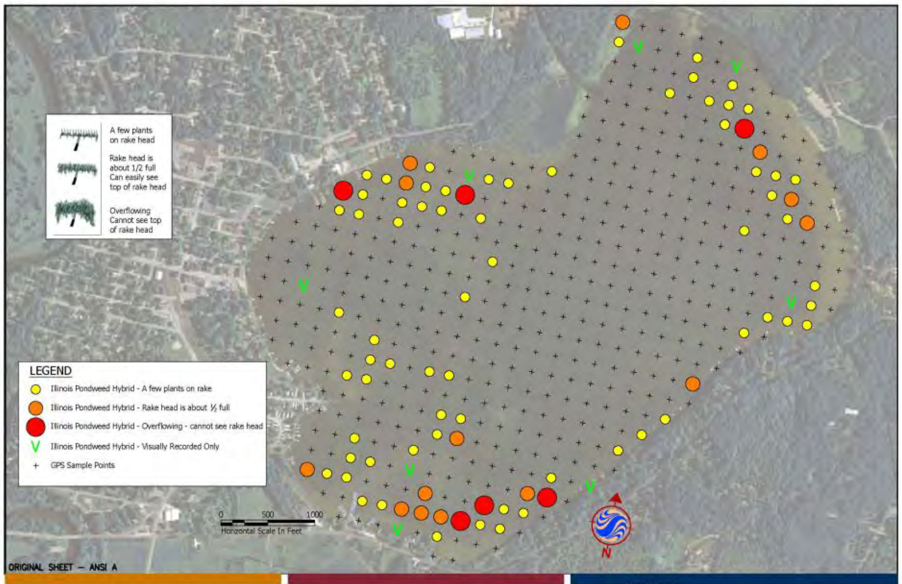
Table 4: September 2012 Plant Survey Species and Frequencies Observed [13]; highlighted species are designated nonnative, invasive species.

Species	Frequency of occurrence within vegetated areas (%) 2012
Myriophyllum spicatum, Eurasian water milfoil	60.86
Chara sp., Muskgrasses	57.14
Vallisneria americana, Wild celery	34.57
Stuckenia pectinata, Sago pondweed	27.71
Potamogeton illinoensis hybrid, Illinois pondweed hybrid	24.86
Ceratophyllum demersum, Coontail	21.14
Najas flexilis, Slender naiad	12.86
Najas marina, Spiny naiad	9.43
Heteranthera dubia, Water star-grass	8.86
Nitella sp., Nitella	2.29
Potamogeton nodosus, Long-leaf pondweed	2.29
Potamogeton praelongus, White-stem pondweed	2.00
Potamogeton friesii, Fries pondweed	1.14
Nymphaea odorata, White water lily	0.86
Potamogeton illinoensis, Illinois pondweed	0.86
Nuphar variegata, Spatterdock	0.57
Utricularia vulgaris, Common bladderwort	0.57
Elodea canadensis, Common waterweed	0.29
Pontederia cordata, Pickerelweed	0.29
Filamentous algae	0.29
Lemna minor, Small duckweed	present
Lythrum salicaria, Purple loosestrife	present
Myriophyllum verticillatum, Whorled water-milfoil	present
Phragmites australis, Common reed	present
Potamogeton natans, Floating-leaf pondweed	present
Sagittaria latifolia, Common arrowhead	present
Schoenoplectus tabernaemontani, Softstem bulrush	present
Wolffia columbiana, Common watermeal	present

Figures 6-11: 2012 Silver Lake Plant Survey- Five Most Common Native Species (excluding chara)







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Project Information

Project Nubmer: 193702275

	Initials	Date
Prepared by	EJM	07/10/13
Peer Review by	JTS	07/10/13
Final Review by	MEK	07/10/13

Data Sources include: ESRI and Stantec
Image: NAIP 2010

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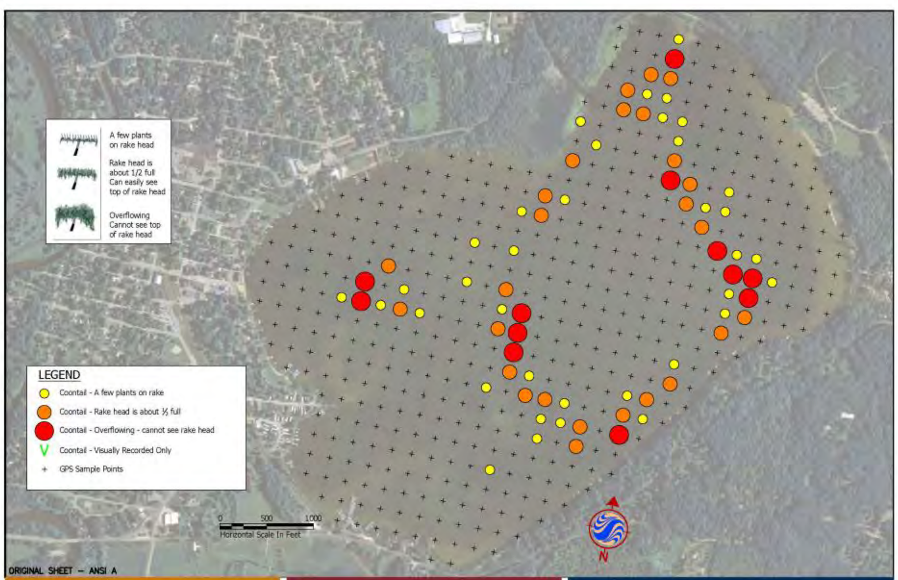
KENOSHA COUNTY SILVER LAKE PROTECTION ASSOCIATION
KENOSHA COUNTY, WISCONSIN

Figure No.
7.0

Title
2012 ILLINOIS PONDWEED HYBRID DISTRIBUTION SILVER LAKE



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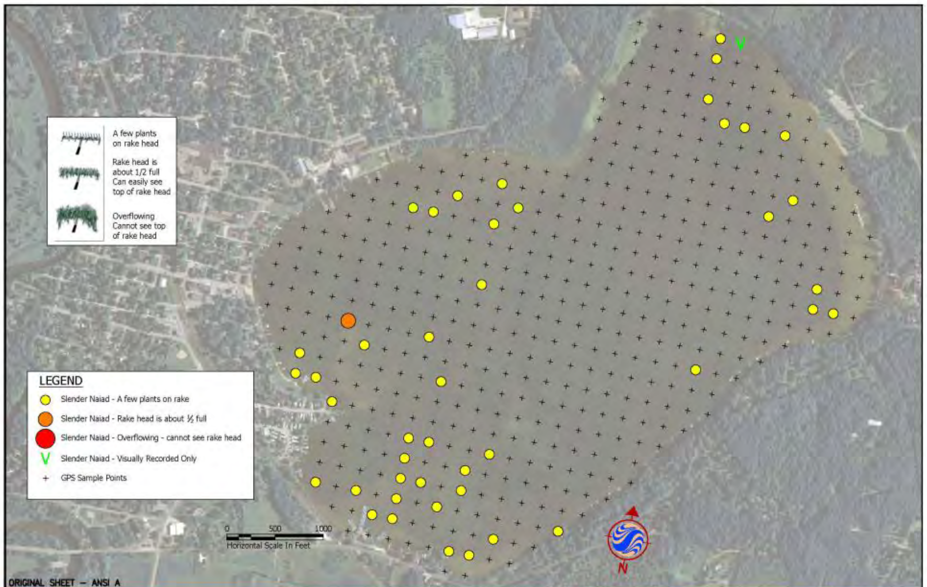
KENOSHA COUNTY, WISCONSIN

Figure No.
3.0

Title
2012 COONTAIL DISTRIBUTION SILVER LAKE



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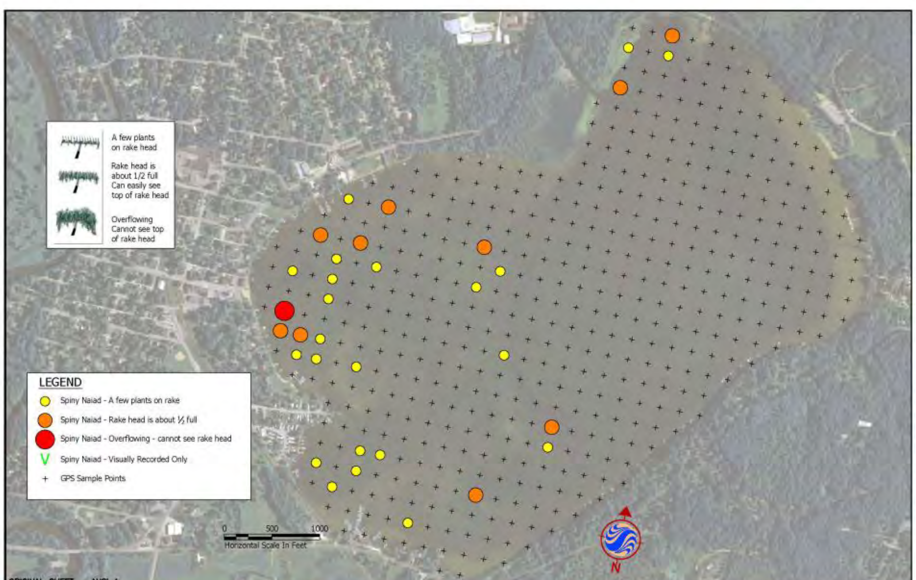
KENOSHA COUNTY, WISCONSIN
Figure No.
4.0
Title
2012 SLENDER NAIAD DISTRIBUTION SILVER LAKE



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KENOSHA COUNTY, WISCONSIN
Figure No.
5.0
Title
2012 SPINY NAIAD DISTRIBUTION SILVER LAKE

Chart 5: 2012 Silver Lake Plant Survey: Maximum Depth of Plant Colonization

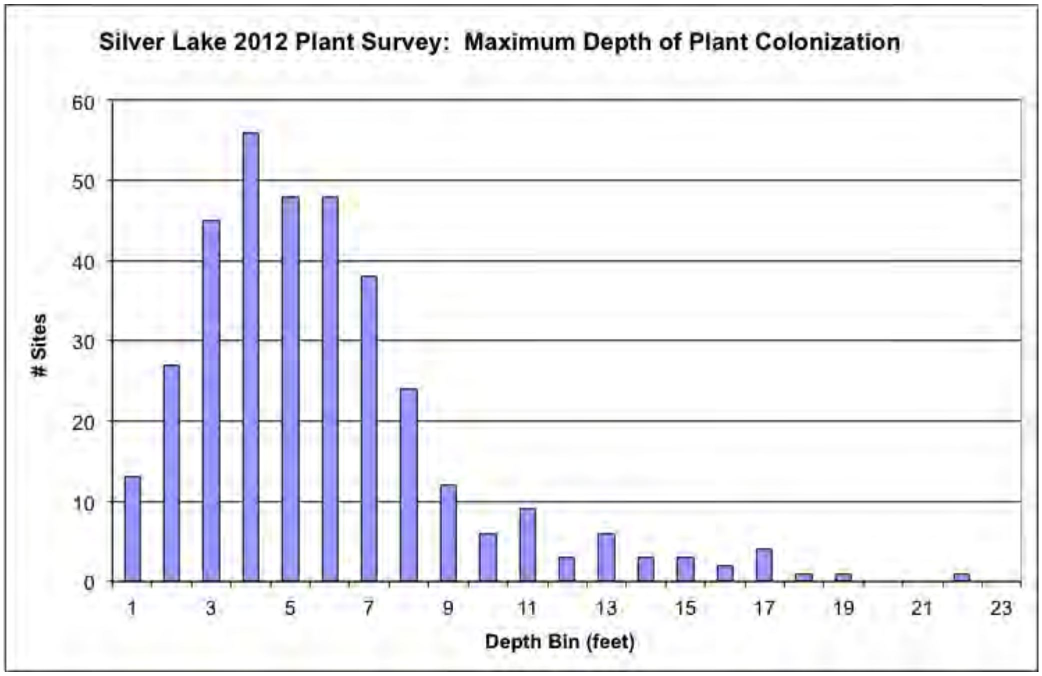


Table 5: 2012 FQI Without and Including Visuals

Species	Common Name	C
Ceratophyllum demersum	Coontail	3
Chara	Muskgrasses	7
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Najas flexilis	Slender naiad	6
Nitella	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	8
Potamogeton friesii	Fries' pondweed	8
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton nodosus	Long-leaf pondweed	7
Potamogeton praelongus	White-stem pondweed	8
Stuckenia pectinata	Sago pondweed	3
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6

		Including visuals
N	16	24
mean C	6.0625	5.54166
FQI	24.25	27.15

Observed changes

There was a significant increase in the amount of EWM found in Silver Lake between 2006 and 2012 as perceived by the Silver Lake community, and confirmed by a comparison of the plant surveys. In 2006, EWM was found at 22.44% of sampling sites with vegetation, and at 60.86% of sites in 2012. This increase is illustrated in Figure 6 where the dark green sites show where EWM was detected in 2006 and the light green areas show where EWM had spread to in 2012. The FQI (including visuals) decreased from 29 in 2006 to 27 in 2012 (Table 5).

Figure 12: Expansion of EWM from 2006 to 2012 [14]

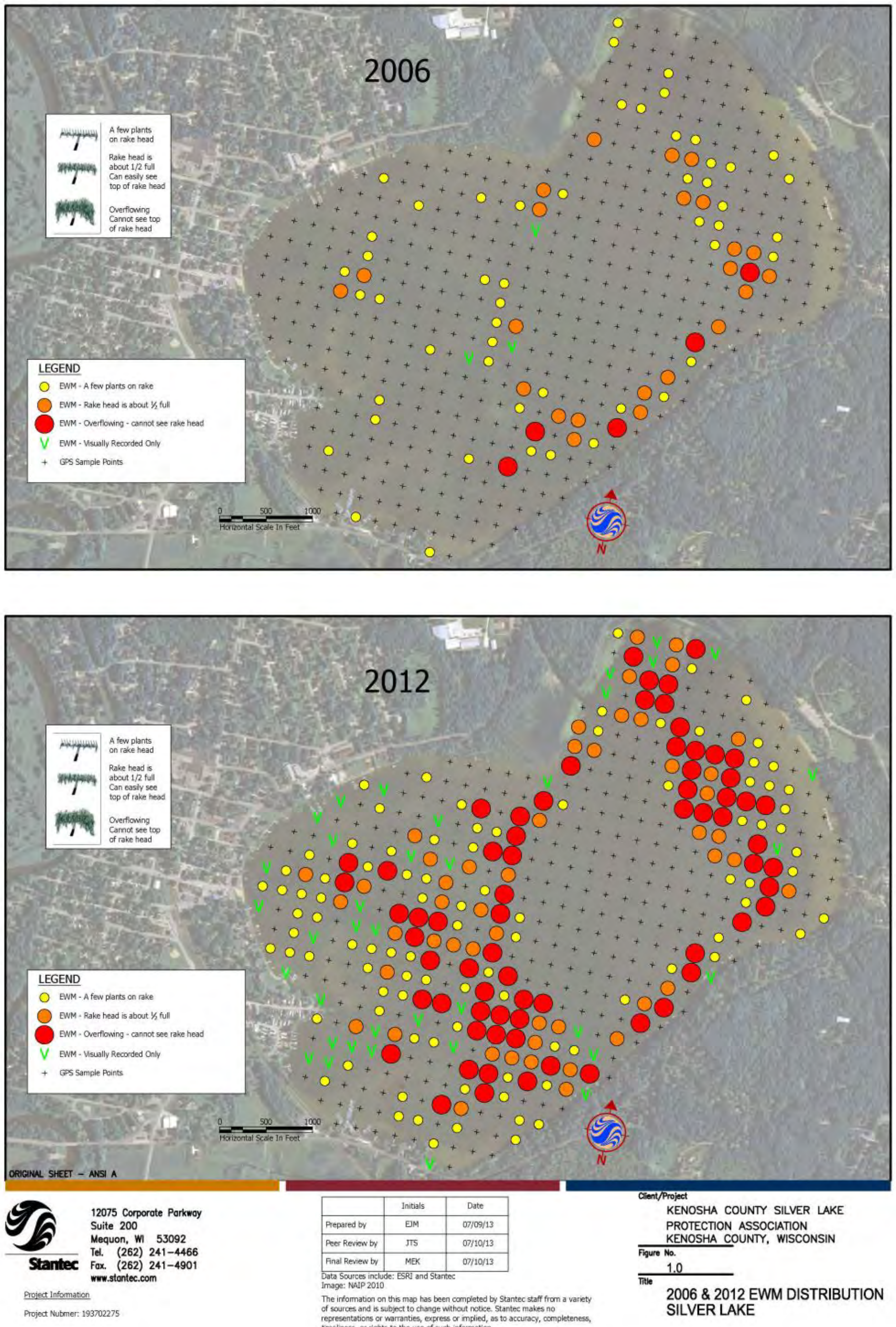
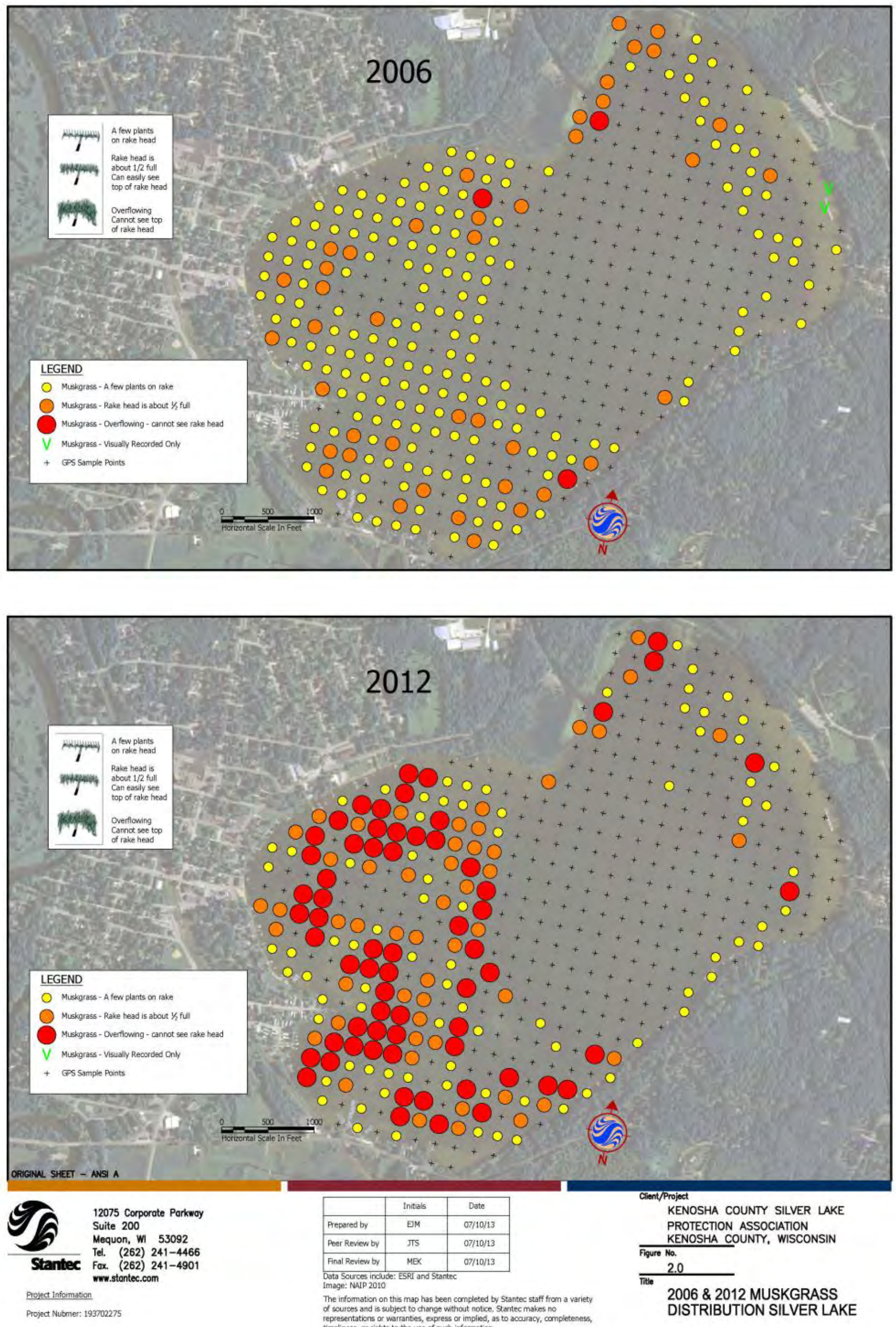


Table 6: Silver Lake Plant Survey Frequency of Occurrence Within Vegetated Areas- 2006 vs 2012

Species	Frequency of occurrence within vegetated areas (%) 2006	Frequency of occurrence within vegetated areas (%) 2012
Myriophyllum spicatum, Eurasian water milfoil	22.44	60.86
Chara sp., Muskgrasses	67.90	57.14
Vallisneria americana, Wild celery	25.85	34.57
Stuckenia pectinata, Sago pondweed	23.86	27.71
Potamogeton illinoensis hybrid, Illinois pondweed hybrid	-	24.86
Ceratophyllum demersum, Coontail	9.94	21.14
Najas flexilis, Slender naiad	11.65	12.86
Najas marina, Spiny naiad	6.82	9.43
Heteranthera dubia, Water star-grass	7.95	8.86
Nitella sp., Nitella	2.84	2.29
Potamogeton nodosus, Long-leaf pondweed	0.28	2.29
Potamogeton praelongus, White-stem pondweed	-	2.00
Potamogeton friesii, Fries pondweed	1.14	1.14
Nymphaea odorata, White water lily	0.28	0.86
Potamogeton illinoensis, Illinois pondweed	26.42	0.86
Nuphar variegata, Spatterdock	Visual only	0.57
Utricularia vulgaris, Common bladderwort	0.28	0.57
Elodea canadensis, Common waterweed	-	0.29
Pontederia cordata, Pickerelweed	0.28	0.29
Filamentous algae	23.30	0.29
Lemna minor, Small duckweed	-	Visual only
Lythrum salicaria, Purple loosestrife	-	Visual only
Myriophyllum verticillatum, Whorled water-milfoil	-	Visual only
Phragmites australis, Common reed	-	Visual only
Potamogeton natans, Floating-leaf pondweed	-	Visual only
Sagittaria latifolia, Common arrowhead	-	Visual only
Wolfia columbiana, Common watermeal	-	Visual only
Schoenoplectus tabernaemontani, Softstem bulrush	Visual only	Visual only

A decrease in the most common native plant, Chara, was observed. Chara had an observed frequency of 67.90% in 2006, which was reduced to 57.14% in 2012. The observed change for Chara is illustrated in Figure 7 below. The objective of this aquatic plant management plan is to reduce the amount of nonnative plants in the lake, in order to reestablish and maintain a healthy level of native plants in the lake.

Figure 13: Reduction of native Chara from 2006 to 2012 [14]



Adverse Effects of Nonnative Aquatic Plants

Not all aquatic plants are bad, and most should not be treated like weeds. Aquatic plants are necessary to stabilize sediments, support fish populations, and protect water clarity [15]. Invasive species become a problem when they are able to out compete native species for resources and are left unchecked and able to expand rapidly. For example, EWM begins growing earlier in the season than native plants, and can form a dense canopy on the water's surface in order to increase its access to light and cut off the resource for other plants. Invasive aquatic plants not only affect other plants, but can have a negative impact on fish and birds. Fish thrive in habitats with moderate plant populations because it provides the correct balance of habitat, food, and water chemistry. Homogeneous invasive plant communities are often dense and may decrease spawning and foraging productiveness and, upon decomposition, may deplete the dissolved oxygen to a level that is inhabitable, especially for larger fish [15]. A reduction in the availability of native plants may also adversely affect waterfowl because they feed on native plants. Silver Lake hosts a diverse group of migratory ducks in the spring and fall, which depend on a healthy diet of native plants.

Silver Lake is heavily used for recreation including swimming, angling, and waterskiing. Canopies formed by EWM have become a problem in Silver Lake and, especially in 2012, limit recreation on the lake. If this trend toward more abundant EWM populations continues or increases, it may reduce tourism to the area, and even deplete riparian property values. EWM and other AIS can be spread to surrounding waterbodies as fragments adhering onto boats, motors and personal watercraft, and an increase in these species in Silver Lake may increase the threat to other waterbodies in the area.

Common reed grass (*Phragmites australis*), also an invasive species, was identified as a visual only on private property during the 2012 aquatic plant survey growing in a small location along the shoreline. This species can spread rapidly within wetland areas by vegetative clones, becoming a monotypic stand and decreasing the quality and habitat within the wetland.

Past and Current Aquatic Plant Management Practices

In the past, Silver Lake has attempted to manage the aquatic plant population on a small scale, with primarily localized herbicide treatments. Two permits for the aquatic herbicide 2,4-D were issued for the 2012 season, one for a 1.12 acre area including the Silver Lake beach, public boat landing, and condominium development along the shoreline [16], and a 0.48 acre area at a private residence within the Village of Silver Lake [17]. In years past the Village of Silver Lake has cut the Eurasian Milfoil at their public beach located in the Village on the west side of the lake using a Hockney Underwater Weed Cutter. The public works employees would rake the cut weeds to shore and haul away in a village truck. More recently the Village has treated with diquat as noted at the beach and boat landing.

Both the Village of Silver Lake and the Town of Salem have ordinances prohibiting the use of phosphorus containing fertilizer on residential lawns that predate the State prohibition [18] [19]. Phosphorus is a necessary nutrient for aquatic plants but an abundance of phosphorus may cause algal blooms, amongst other problems. Several properties on the lake have restored portions of the shoreline to native vegetation in order to promote natural filtration of nutrients and pollutants from entering the lake.

To additionally protect the aquatic plant community within Silver Lake, Ordinance 307 was enacted by the Village of Silver Lake in 1989. This ordinance establishes the following restrictions:

1) Slow, no-wake within 200' of all shoreline
2) Slow no wake speed between 7:00 pm and 10:00 am

http://www.villageofsilverlakewi.com/wp-content/uploads/2011/08/Ordinance307.doc

In order to help reduce the exposure of invasive species to Silver Lake, the DNR has posted information at the public boat landings which outlines proper precautions that traveling boaters should take to prevent the spread of AIS.

Alternative Methods for Nonnative Aquatic Plant Control

There are many ways to attempt to control aquatic plants, including the following, which can be employed individually or in combination. This section will present and evaluate methods considered for Silver Lake's aquatic plant management plan. All of these methods require DNR permits under Chapter 30 of the Wisconsin Statutes and/or Chapters NR 107 and NR 109 of the Wisconsin Administrative Code.

Physical Control Measures

Physical control methods usually involve non-mechanical, non-chemical approaches to controlling the undesirable or nuisance aquatic plant populations [15]. One simple method of removing plants is hand pulling or raking. Pulling the plant out by the roots can be done by wading in shallow water, or using SCUBA gear in deeper water. One advantage to this method is that the person may be highly selective and only remove undesirable plants as opposed to removing all vegetation from an area. Some disadvantages are that it can be time consuming if treating a large or dense area, and that it will disturb sediments. Raking has similar results to hand pulling, but is less selective and may create more plant fragments by breaking up the plants.

Because of the additional costs associated with hand pulling of larger and/or deeper areas (purchase of equipment and possibly hiring SCUBA diver contractors), it would likely offer the most benefit from a control and economic standpoint for SLPA to hand pull utilizing local volunteers within isolated, shallow water beds (<3' deep) of EWM prior to 70 degree water temps while the plants are actively growing. These would be best identified during the annual PI surveys, focusing on high-use areas near boat landings, beaches, and marinas and notated on subsequent treatment maps for the following year. EWM harvested will be collected and deposited into collection bags for removal. Appendix A contains a how-to on creating collections bags along with an informational brochure on proper hand-pulling procedures. Given the substantial costs ($10,000/acre+), limited budget, and large area of infestation it appears that SCUBA hand removal is an unlikely scenario at this time and did not warrant further evaluation at this time, but may in the future if the infestation becomes small enough.

Another method of physical control is drawdown. This technique involves lowering the water level in fall so that undesirable plants are exposed overwinter and will dry out, and/or are exposed to harsh freezing conditions. Special care must be taken so that enough wet area is left to support native fish and plant communities. The water level is typically controlled by the outlet structure or pumping, and must remain at low levels for at least 12 weeks to be effective. Silver Lake has one small outlet with minimal head control which is fed through seepage and runoff, so it would be difficult to draw the water levels down low enough for this type of control to be effective. Other effects of drawdown are that, if repeated seasonally, it may compact the lake sediments.

Limiting exposure to sunlight, a necessary part of life for aquatic plants, is another way to reduce nuisance plant growth. Benthic barriers may be installed on the lake bottom to compress plants and cut off sunlight. These are usually small, local installments that are left in place for at least one to two months, but may be more permanent structures that would require maintenance. One advantage of benthic barriers is that they can be installed in swim areas and have little impact on the people using the swim area. A disadvantage of this method is that it is nonselective and cuts off the natural habitat required by other aquatic life including insects, fish, and amphibians.

Shading, or reducing the amount of sunlight available to plants, is another form of physical control. Dyes or surface covers may be used to prevent sunlight from getting to plants, although both methods are generally used on small ponds that are not heavily used for recreation. In a northern lake with ice cover in the winter, such as Silver Lake, natural shading may occur from heavy snow cover. Artificial covers may be used on the ice as well, such as fabric or rigid panels, but would require maintenance and would interfere with winter recreational activities. Another disadvantage to any form of shading is that it is nonselective.

Nitrogen and phosphorus are two other major requirements for plant life. One major theory for limiting plant growth is limiting nutrient availability to plants. Nutrient inactivation may be used in water bodies that have an excessive amount of nutrients and involves the addition of a substance that binds to the nutrients in order to make them unavailable to plants. Aluminum, lime, or iron salts are common substances used, with alum (aluminum sulfate) being the most common. This method is most frequently used to control algal blooms because the additives bind phosphorus. Nitrogen is the limiting nutrient in submersed plants, such as EWM, and there are currently no common compounds which bind with nitrogen, which is freely available from the atmosphere. One important thing to note with nutrient limitation is that it may increase water clarity, which is good for water quality, but also makes more sunlight readily available to plants.

Another effective way of reducing the amount of nutrients available to aquatic plants is by reducing the input of these nutrients through runoff. Fertilizers used on lawns and agricultural fields often contain phosphorus and nitrogen. These fertilizers can be expensive and are often over applied due to loss of nutrients from runoff. If better application and stormwater management practices are used, resources and the costs associated with them may be conserved as well as reducing the amount of nutrients introduced to the lake. To this end, use of vegetated buffer strips along shorelines and stream banks has proven extremely successful.

Mechanical

Mechanical aquatic plant control methods involve many different types of machinery, which are designed for many specific purposes [15]. These types of machines remove aquatic plants to increase the navigability of the waterway and to remove organic material that will eventually decompose and make more nutrients available. Because the equipment is used for a very specific purpose, the machinery can be quite expensive. Some equipment, such as cutter boats and shredding boats focus on clearing navigation channels, but typically create a lot of fragments from the plants, which may cause an expansion of plants such as EWM which can regrow from fragments. In this regard, it must be noted that, in Wisconsin, these plant fragments must be removed from the waterbody.

Harvesters are the most common type of mechanical equipment used to cut and collect aquatic plants. This machinery may be used in waters as shallow as 12 inches (although operating in less than 36 inches of water generally is not permitted) and can be controlled in order to harvest plants near piers and other fixed objects. Harvesters trim the plants down about 5 feet and collect the plants in order to remove them from the lake. Removing the plant matter from the lake helps reduce the amount of material that will decay and consume dissolved oxygen, and also removes the nutrients in use by the plants so that the nutrients are not available for other plants. Because the entire plant is not removed, it leaves the habitat near the bottom of the lake intact for fish and other aquatic creatures, but it does not eradicate the non-native plants. By reducing the canopy formed by some invasive species such as EWM, native plants have a better chance of reestablishing in the area. Cutting and removing large amounts of aquatic plant material may involve several pieces of equipment: a cutter/harvester, a transporter to move the material to shore, a shore conveyor, and a truck to transport the plants away from the lake if needed. This plant material may be useful on farms or in other applications, and revenues from these applications may offset the resources required to harvest the plants. Harvested plants will continue to grow back. By removing the EWM canopy, native species are able to out-compete the invasives. However, multiple harvests per season may be necessary to achieve a continued reduction in plant mass.

Biological

Biological controls involve introducing a predator of the plant, such as a bug or animal that will feed on the plant [15]. These predators may be a native species to the area, or may be another nonnative species that naturally feeds on the plant in its home environment. The decision to introduce another nonnative species should always be made carefully, because the introduced species may have unforeseen effects on the system, causing additional problems.

One native insect to North America, the milfoil weevil (*Eurychiopsis lecontei*), is a natural predator of the native milfoils, but has been shown to prefer the non-native Eurasian watermilfoil. The weevil may be naturally occurring in the lake, and may also be supplemented by purchasing and introducing more weevils to the lake in order to control the EWM. Although this option is very attractive because it uses a native insect to control a non-native plant, results of increasing the weevil population have varied and are unpredictable, and the costs are extremely high at $1.00 per weevil or more, and 6,000 to 8,000 weevils per acre are typically recommended as a colonization starting point.

Grass carp are a non-native species that have been used to control aquatic plants, including EWM. Unlike the common carp, the grass carp has several adaptations that allow it to be a very effective herbivore. These fish were brought to the US because they are able to consume so much aquatic plant mass for a very low cost. Grass carp are commonly artificially produced to be sterile so that they may be used in closed watersheds without the risk of overpopulation. Although these fish are effective at eating a lot of aquatic plants, they do not show a preference for EWM and may consume native plants as well. Grass carp are not legal for use in Wisconsin.

Chemical

There are several types of herbicides that are approved by the US Environmental Protection Agency (EPA) for aquatic use [15]. Treatments may involve small scale applications to target a specific area, or large scale to manage a whole lake. There are also options involving the delivery methods and concentrations used. The type of chemical, delivery method, and concentration must all be approached in a case-by-case basis for each lake and plant community.

Aquatic herbicides can be broken down into two main groups: contact and systemic. Contact herbicides work in much the same way as herbicides used on land to control weeds and generally take effect more quickly than systemic types. Contact herbicides must sustain a certain concentration in the water for a certain exposure period in order to be effective. This time period is on the order of hours or days (all degradation times are expressed as half-lives of the chemical), and is described as the concentration and exposure time relationship. Another important aspect to consider with contact herbicides is that the entire plant must be treated, and that most contact herbicides are selective. In order to minimize possible negative impacts on non-target native plants, the chemicals should be applied in the spring, before the lake has stratified. The treated plants usually die off in three to 14 days.

Copper is categorized as a contact herbicide, although it is a natural micronutrient. Copper is mainly used to control algae problems, but may be used for submersed plants. It is very fast acting and is safe for most humans, animals, and fish, even in drinking water sources. Copper applications may not be as effective in water with high alkalinity, and copper does not biodegrade, meaning that it may accumulate in the sediment. The required exposure time for copper treatments is hours to one day, and it generally is inactivated by ions in the water or sediment over a period of hours to one day.

Endothall, another contact herbicide, may be used either in small patches, or as a whole lake treatment using either granules or a liquid. Curly-leaf Pondweed may be targeted by Endothall by applying the herbicide early in the spring, before the native plants have begun to grow. Applications early in the season, which is true for many herbicides, is favorable for two main reasons: it minimizes the negative affect on native plants, and there is not as much biomass as will grow later in the summer, reducing the amount of plant matter that dies off and in turn reducing the risk of oxygen depletion. Endotholl should maintain a stable concentration for hours to days in order to effectively treat the plants. It is degraded in days to weeks by microbial action, and degrades slower in cooler water.

Diquat is another fast-acting contact herbicide which is applied in liquid form. Diquat attacks plants by inhibiting the photosynthesis process, making it a non-selective chemical. This type of herbicide is mainly used in small target areas for control of submersed plants. Diquat binds to particles in the water, which deactivates the chemical, causing the effectiveness to drop as turbidity increases. Once inactivated, Diquat usually degrades in under a week. The required exposure time is hours to days.

Systemic herbicides are a different class of treatment chemicals, which attack the plant by absorbing into the plant tissue and moving through the plant's vessels. Because the chemical must be absorbed into the plant and distributed, systemic herbicides usually take more time to show results, usually between two and three weeks. Because systemic herbicides attack the internal functions of the plant, some chemicals may be more specific to a type of plant. For example, auxin mimics such as 2,4-D and Triclopyr affect dicots more severely than monocots. There are also enzyme specific systemic herbicides that attack floating and emergent aquatic plants, and bleaching herbicides such as Fluridone.

2,4-D is a widely used systemic herbicide that has been used to target EWM, amongst other submersed, floating, and emergent plants. Because 2,4-D can affect native plants such as water lilies, care must be taken in order to minimize the negative impact on native plants. 2,4-D may be used in either liquid or granular form, for either whole lake treatments or small scale localized treatments. 2,4-D requires an exposure time of hours to days to properly absorb into the treated plants. Microbial degradation usually occurs in four days to three weeks, but is affected by water temperature.

Triclopyr is also a systemic herbicide that can be used either as a liquid or as a granule and is mainly used to treat EWM. Triclopyr shares many characteristics of 2,4-D, including the risk of harming native broad leaf plants. The required exposure time is also similar to 2,4-D, hours to days, but may degrade slightly faster than 2,4-D, in four days to two weeks.

Fluridone is a different form of systemic herbicide that attacks the chlorophyll or green pigment in plants, effectively damaging the photosynthesis process. Fluridone can be used either in granular or liquid form and is typically used in a whole lake application to control submersed plants. The plants will turn white and eventually die, although this may take months from the initial treatment. One benefit of this slow process is that there is not typically a sudden large amount of plant death, which reduces the risk of depleting the dissolved oxygen. Fluridone requires a long exposure time of over 60 days, and the half-life of degradation is only seven to 30 days via photolysis. Because it degrades more rapidly than the plants are affected, it is common to require another treatment in order to maintain a high enough concentration typically 4.0 – 8.0 PPB. Because the chemical must be established in the water column for an extended period of time, it is less selective due to the sheer exposer to more plants. Although the herbicide must maintain a presence in the water for an extended period of time, there are no specific restrictions on recreation. Fluridone is currently considered to be an experimental herbicide in Wisconsin.

Common reed is also readily controlled by herbicide applications (glyphosate or imazapyr or a combination of both products) applied at 1.5% solution directly to the plants in late summer in conjunction with mowing and or burning at least 2 weeks after treatment but prior to first frost. Multiple treatments/cuttings may be necessary to fully control the infestation. Since the current population is in a small, restricted area this may be the best option moving forward. However, the current size of infestation must be obtained prior to any action along with landowner permission (if on private property) to proceed.

It is recommended the SLPA or their consultant contact the property owner(s) and request permission to assess and map the current infestation and review written permission prior to management actions to assure consent if the infestation is above the ordinary high watermark of Silver Lake. If landowner consent is granted, management should commence in the fall of 2013 and be continued each year until the infestation is under control

Education, Prevention and Restoration

Education and the prevention of spreading invasive species are valuable tools in aquatic plant management. Ideally, prevention of spreading a nonnative species to a new location is the best management option. However, the spread is often inevitable, especially if there are no practices in place to contain and detect the nonnative species. Once an invasive species is established, it is important to contain it to spare other waterbodies the same fate.

Informing the community members about their watershed, including the aquatic plants, has many benefits. First, it fosters a sense of community and appreciation of the resource. If people understand how they can help restore their lake, they are more likely to do so. Small actions that riparian citizens and visitors can participate in may promote further education and bigger involvement. Second, if people can identify desirable native plants from nuisance nonnative, they can assist in monitoring changes in the plant community, including the introduction and spread of invasives. Third, familiarizing the public with what can be done by the community as a whole in order to manage invasive plants may generate more support, including financial support for the project. Generating interest and support for the project is important, because many of the selected management tools may require volunteer time.

Prevention is always the desired option, even if an invasive species is already established in a lake. It is important to prevent spreading the invasive species to other waterbodies that may not yet be affected, and to prevent other invasives from entering the lake. It is also desirable to prevent the addition of more of the established invasive species because it may cause further spread, or may be a hybrid species. Especially in a lake that is involved in an aquatic plant management program, the addition of more of an established invasive species is undesirable because it may reverse valuable steps taken to reduce the plant problem. One of the most common approaches to prevention is monitoring or posting signs at boat launches. Programs such as Clean Boats-Clean Waters can provide boaters with information on preventing the spread of invasives and assist in inspecting watercraft. Removing the plants by hand or with boat washing stations are easy preventative measures at the boat landing.

Another step in prevention is restoration of native plant communities as the invasive plants are brought under control. A plant that can be identified and moved by local volunteers within the lake and re-distributed is chara, a hardy, readily available in Silver Lake, and easily transplanted species. This will fill the void and prevent EWM reintroduction while providing additional, important spawning and feeding habitat for the State threatened species, pugnose shiner.

Other possibilities include transplanting of native pondweeds or wild celery from nursery stock. This technique has been tried in a few other areas with success of these projects not yet determined. Currently, Silver Lake has an already incredibly diverse plant community for the Southeast Wisconsin region with an above average FQI of 27. With this in mind, this option should be limited to plant species already present in the lake as the potential for increased diversity is low. Additionally, a high per-acre cost (potentially $25,000 an acre or higher depending on plant types and densities), possibility of inadvertent introduction of non-native species, hiring of subcontractors, and additional WDNR permitting outweighs benefits and SLPA's annual budget versus activities above that are based on volunteer labor. This management option is not currently feasible for Silver Lake.

Of note one of the species that experienced the greatest decline while EWM flourished was Chara; a hardy, readily available species in Silver Lake. Chara is easily transplanted from the densest growth of the lake into these areas barren areas. This will fill the void and prevent EWM reintroduction while providing additional, important spawning and feeding habitat for the pugnose shiner, a State threatened species. The costs for this option would be primarily in the form of volunteer labor and would focus on the specie most affected by the EWM infestation and appears to be the simplest, most cost effective and ecologically sound option for the Association.

Summary

The management practices discussed here are most effective when a combination of methods are used based on the individual characteristics of the water body. A general overview of the advantages and disadvantages of each method discussed are summarized in Table 7.

Table 7: Comparison of management options

		Advantages	Disadvantages
Physical	**Hand pulling, raking**	Selective	Time consuming, not feasible in large areas or deep water
	Drawdown	Targets submersed plants	Difficult to control water levels in Silver Lake, not enough head on the dam
	Benthic Barriers	No disruption to recreation	Non-selective, cuts off other natural habitat
	Shading	Effective in small areas	Non-selective, impairs recreation
	Nutrient Inactivation	Reduces algal blooms	Does not target submersed plants
	Nutrient Availability	Improves overall ecosystem health and water quality	Difficult to identify non-point sources
Mechanical	**Cutter and Shredding Boats**	Clears navigation channels	Increases plant fragments
	Rotovators	Removes a large amount of biomass	Disturbs sediments and bottom habitat
	Harvesters	Reduces the amount of vegetation and associated nutrients	Does not remove entire plant
Biological	**Milfoil Weevil**	Native species, selective	Inconsistent results & expensive
	Grass Carp	Effective at reducing overall aquatic plant biomass	Introduces another non-native species with uncertain results
Chemical	**Copper**	Considered safe for animals and immediate recreation	Accumulates in the sediment
	Endothall	A semi-selective contact herbicide	Acidic chemical affected by water chemistry, non-selective
	Diquat	Effective at killing most plants	Non-selective, mainly small target areas
	2,4-D	Targets dicots	May affect native broadleaf plants
	Triclopyr	Targets dicots	May affect native broadleaf plants
	Fluridone	Steady, effective decline of plants, shows promise on hybrid strains of EWM	Long exposure requirement, may require reapplication
	Glyphosate	Short contact time and fast acting towards Phragmites.	General, broad spectrum herbicide

	Imazapyr	Fast acting, long term control	Long, persistent residual in soil, may impact native re-establishment
Education, Prevention, and Restoration	**Education**	Increased appreciation of resource, many small changes may create large positive impact	Volunteer time requirement, reaching target audience
	Prevention	Limit spread of existing invasives to other waterways, limit exposure of new invasives to Silver Lake	Volunteer time requirement
	Restoration – Aquatic plant transplanting	Replace removed invasives with full-grown native species, increasing or maintaining diversity	Substantial labor, material, and permitting costs
	Restoration – Chara redistribution	Fill in void left by EWM removal with a readily available native specie	Volunteer time requirement, labor intensive

Recommended Aquatic Plant Management Plan

In the summer of 2012, the SLPA held several public informational and input meetings in order to determine the best course of action for restoring Silver Lake. Craig Helker, WDNR, attended a meeting on September 5, 2012, and spoke to over 100 concerned community members about possible options for restoring Silver Lake's native plant community. The SLPA quickly mobilized to conduct an aquatic plant survey and form an Executive Committee. The Executive Committee was charged with researching and writing an aquatic plant management plan with the input of professionals and community members with the goal of starting into action a treatment program in 2013. Through the process of several community meetings, including SLPA fundraisers, Silver Lake Sportsmen's Club meetings, Silver Lake Village meetings, Salem Township meetings, Rustic Shores Homeowners Association meetings, and SLPA Executive Committee meetings, this aquatic plant management plan was formed.

The main goal of this aquatic plant management plan is to reduce the amount of nonnative aquatic plants in Silver Lake, specifically Eurasian watermilfoil, and to promote the reestablishment of native plants as the major plant species in the lake. Any measures taken to control nonnative plants should first consider and minimize adverse impacts to native plants. The seasonal goal of this management plan is to reduce the presence of total nonnative plants by 50% each year either in density or total distribution, with a long term management goal of maintaining <10% nonnative plants. These rates are to be monitored and measured by plant survey data, using the frequency of occurrence in vegetated area profile. If these goals are not met because the hybrid strain of EWM present proves to be resistant to typical systemic herbicides, it would be recommended that the group discuss with the WDNR and their lake management consultant the possibility of either the use of a dual herbicide combination or the potential of a fluridone treatment on a lake-wide basis. Since a vast majority of the lake is within the littoral zone (22' or less in depth ~ 350 acres or 68%), control of EWM is essential on this lake to maintain navigation and recreation, rehabilitate native vegetation, improve fish and wildlife habitat, and decrease risk of spread of hybrid EWM to other water bodies.

Table 8: EWM Reduction Goals and Actions

Year	EWM (ac)	% Reduction from previous year	% of Littoral Zone with EWM	Management Actions
2013	260	---	74.30%	Whole lake liquid 2,4-d at 0.35 ppm, Iniate Clean Boats / Clean Waters
2014	45	80%	12.90%	Liquid 2,4-d within EWM beds at 3.0-4.0 ppm, Continue CB/CW, Chara redistribution
2015	27	60%	7.71%	Liquid 2,4-d within EWM beds at 3.0-4.0 ppm, Continue CB/CW, Chara redistribution
2016	13.5	50%	3.86%	Granular 2,4-d/triclopyr within EWM beds at 3.0-4.0 ppm, Continue CB/CW, Chara redistribution
2017	6.75	50%	1.92%	Granular 2,4-d/triclopyr within EWM beds at 3.0-4.0 ppm, Continue CB/CW, Chara redistribution, Hand-pull in near-shore locations
Total Reduciton from 2013		97.00%		

The above goals and respective management options are based on past management experiences and expectations from lakes with EWM infestations similar to Silver Lake. However, no matter how similar separate lakes may appear, there are many different environmental and ecosystem variables that may affect each year's management outcome and success. Because of these variables, an additional plan of attack for management based on the actual amount of EWM present within the littoral zone should be conducted regardless of the yearly outcome when compared to the goals above. A management approach by percent of EWM within the littoral zone is include in Table 9 below and will be referenced each year prior to the growing season based on the previous year's results.

Table 9: Management Actions by amount of EWM in Littoral Zone

% of Littoral Zone with EWM	Management Actions	
	Type	**Actvity**
>60%	Chemical	Whole-lake treatment with liquid 2,4-d at 0.350 ppm. If no whole-lake response, test for hybridity.
	Physical	Hand-pulling in shallow, near shore areas with focus on high use plots (boat landings, beaches, marinas, etc)
	Restoration	Chara redistribution 60 days after treatment into vacant areas, full point-intercept pre and post-treatment aquatic plant surveys
	Prevention	Clean Boats / Clean Waters, maintain signage and boat cleaning stations at landings
40-60%	Chemical	Treatment within EWM beds with liquid 2,4-d at 3.0-4.0 ppm
	Physical	Hand-pulling in shallow, near shore areas with focus on high use plots (boat landings, beaches, marinas, etc)
	Restoration	Chara redistribution 60 days after treatment into vacant areas, full point-intercept pre and post-treatment aquatic plant surveys
	Prevention	Clean Boats / Clean Waters, maintain signage and boat cleaning stations at landings
15-30%	Chemical	Treatment within EWM beds with liquid 2,4-d at 3.0-4.0 ppm
	Physical	Hand-pulling in shallow, near shore areas with focus on high use plots (boat landings, beaches, marinas, etc)
	Restoration	Chara redistribution 60 days after treatment into vacant areas, point-intercept pre and post-treatment aquatic plant surveys limited to treatment areas
	Prevention	Clean Boats / Clean Waters, maintain signage and boat cleaning stations at landings
5-10%	Chemical	Treatment of EWM with liquid 2,4-d at 3.0-4.0 ppm in beds >5.0 acres and/or granular 2,4-d/triclopyr in beds <5.0 acres at 3.0-4.0 ppm
	Physical	Hand-pulling in shallow, near shore areas with focus on high use plots (boat landings, beaches, marinas, etc)
	Restoration	Chara redistribution 60 days after treatment into vacant areas, point-intercept pre and post-treatment aquatic plant surveys limited to treatment areas
	Prevention	Clean Boats / Clean Waters, maintain signage and boat cleaning stations at landings
0-5%	Chemical	Treatment of EWM with granular 2,4-d/triclopyr at 3.0-4.0 ppm
	Physical	Hand-pulling in shallow, near shore areas with focus on high use plots (boat landings, beaches, marinas, etc)
	Restoration	Chara redistribution 60 days after treatment into vacant areas, point-intercept pre and post-treatment aquatic plant surveys limited to treatment areas
	Prevention	Clean Boats / Clean Waters, maintain signage and boat cleaning stations at landings

Based on a review of the various aquatic plant management measures available, as discussed above, the following actions are recommended for a restorative treatment approach. The long-term project will be completed through several project tasks. A structured program facilitates efficient project completion and limits overall cost. The project consists of the following major tasks and a timeline which are described in further detail below:

2013 Project Tasks

- Task 1.0 2013 Herbicide Treatment Permit Application & Educational Mailing
- Task 2.0 Pre-treatment Aquatic Plant Survey
- Task 3.0 Herbicide Treatment Targeting EWM
- Task 4.0 Post-Treatment Aquatic Plant Survey & Report
- Task 5.0 Install Boat Trailer Cleaning Equipment & Signage
- Task 6.0 Initiate Clean Boats / Clean Waters Campaign
- Task 7.0 Chara Redistribution

2014 Project Tasks

- Task 8.0 2014 Herbicide Treatment Permit Application & Educational Mailing
- Task 9.0 Pre-Treatment Aquatic Plant survey
- Task 10.0 Herbicide Treatment Targeting EWM
- Task 11.0 Post-Treatment Full Point-Intercept Aquatic Plant Survey & Report
- Task 12.0 Continue Clean Boats / Clean Waters Campaign
- Task 13.0 Chara Redistribution

2015 Project Tasks

- Task 14.0 2015 Herbicide Treatment Permit Application & Educational Mailing
- Task 15.0 Pre-Treatment Aquatic Plant survey
- Task 16.0 Herbicide Treatment Targeting EWM
- Task 17.0 Post-Treatment Full Point-Intercept Aquatic Plant Survey & Report
- Task 18.0 Continue Clean Boats / Clean Waters Campaign
- Task 19.0 Chara Redistribution

Physical Control Measures

Reducing nutrient availability to the waterbody is important for overall watershed health, but also for limiting algal blooms. In the initial stages of the aquatic plant management program, there will ideally be a reduction in the nonnative plant population, followed by a reestablishment of native plants as the dominant species. Because the current cover of EWM is so extensive, the overall plant biomass in the lake may be reduced overall, even after native plants reestablish. A reduction in plant biomass, whether temporary or permanent, will leave more phosphorus available in the water, which may result in algal blooms. Limiting the input of nutrients into the lake, specifically phosphorus, is integral in maintaining a healthy lake.

Some point sources of phosphorus are easily identifiable, but nonpoint sources are often significant contributors and are difficult to identify. The existing Citizen Lake Monitoring Program, which takes samples of Phosphorus levels in the lake, should continue so that changes in Phosphorus levels may be monitored. In addition, a phosphorus monitoring study should be conducted in order to aid in identifying nutrient sources. This study may be conducted either using historical satellite data, or data collected from an airplane. These aerial images can be used to identify where phosphorus levels are the highest, which will indicate where reduction efforts should be concentrated. One nonpoint source of nutrients is stormwater runoff into the lake. Promoting natural native shoreline vegetation has shown reduction in nutrient input levels, and should be incorporated wherever possible. This may require a county permit, and any applicable restrictions should be followed. A verity of pamphlets from the UW Extension such as “Shoreland Plants and Landscaping” publication number DNR WR-461-94 are planned to be delivered door to door to riparian property owners with help from the Silver Lake Junior Sportsman's Club, and Boy Scouts.

EWM within Silver Lake grows dense and crowds out more desirable, native aquatic macrophytes. After herbicide treatment targeting EWM, areas once dominated by it may be barren and provide ideal growing conditions for re-establishment due to lack of competition. In an effort to restore native plant communities as AIS are brought under control, Association members will identify any such areas and re-distribute chara, a hardy, readily available in Silver Lake, and easily transplanted species from the densest growth of the lake into these areas making sure to not leave the donor area barren. This will fill the void and prevent EWM reintroduction while providing additional, important spawning and feeding habitat for the State threatened species, pugnose shiner.

All areas of dense chara for redistribution and voids identified for redistribution will be identified during the post-treatment PI survey. Only those areas with a chara rake-density of 2 or greater and a depth of 4’ or shallower to ease in harvesting methods will be included as donor areas, focusing on locations where this condition exists on consecutive or neighboring PI locations. These locations will then be recorded via GPS by Association members and notated on full PI data to be monitored and compared separately from the full survey, allowing for a more complete assessment of this program year after year. Chara from the donor areas will be collected by either snorkel and hand pulling or by raking and harvesting assuring to maintain the presence of. Collected specimens will be deposited within containers on transport boats provided by SLPA and immediately transplanted to barren areas once a full load is reached. All hours completed by SLPA volunteers under this task are grant-match eligible.

In addition to chara redistribution, it is recommended SLPA hand harvest areas of EWM growing in shallow, high use areas. Volunteers trained within the CB / CW program and proper plant identification will hand pull and remove EWM from areas near boat landings, marinas, beaches, and other high-use, readily accessible locations. These locations will be located during pre and/or post-treatment point intercept surveys. Hand pulling will begin once plants are actively growing and continue at minimum of once month throughout the growing season.

Hand pulling in shallow areas will ensure that the plants are visible and easily identifiable to limit removal of native species. Additionally, hand pulling will limit or remove the need for chemical control in shallow, near shore areas where potential for native impact is greatest, protecting important, susceptible species for habitat (such as white-water lily). All hours completed by SLPA volunteers under this task are grant-match eligible.

Education, Prevention and Restoration

As previously discussed, preventing the spread of AIS is a requirement for any successful aquatic plant management plan. Participating in the Clean Boats-Clean Waters (CBCW) program is one way that Silver Lake will implement prevention. CBCW is a volunteer watercraft inspection program that helps train volunteers to inform boaters on how invasive species spread and how to check and clean their equipment. Erin McFarlane (erin.mcfarlane@uwsp.edu), the Aquatic Invasive Species Volunteer Coordinator at the UW-Extension, has already been contacted about starting a CBCW program on Silver Lake, and a program will be launched in 2013. A minimum of 3 volunteers from the SLPA will attend CBCW workshop in spring, 2013. 200 hours of boat landing monitoring will be completed by the association each summer, distributed across all public landings. All data collected will be entered into SWIMS according to CBCW requirements. The SLPA will install aides in the form of either a broom or soft-tipped hook (i.e. rubber coated to avoid scratching trailer/boats) to help boaters remove vegetation from under their trailer at all three public boat landings. Additional signage indicating the location of the nearest vehicle and trailer car-wash facilities to assist in additional boat and trailer cleaning will be posted at all public landings. Please note at the time this plan was submitted (July 22, 2013) over 160 hours have been spent at the boat landing so far in 2013 implementing CBCW and 14 citizen volunteers have been trained, on track to far exceed the 200 hour requirement. Depending on future volunteer labor availability the group may want to consider applying for a grant to cover a portion of CBCW costs.

An early detection plan should be formed so that nonnative species that may be introduced to Silver Lake in the future are less likely to become a widespread problem. Silver Lake already has a Citizen Lake Monitoring program, which documents specific water quality markers, which is important to continue. Citizen monitoring should also be expanded to include invasive species monitoring and reporting. New species or expansion of an existing invasive population may be reported by any lake users to the DNR. The DNR will offer identification courses to citizens to ensure proper identification. SLPA has gone through plant identification education and on-site training with the DNR in the past.

Informing the community and lake users of the proper steps to maintain a long-lasting, healthy lake is an important part of the management program. This should include information at all boat landings, which is also part of the CBCW program. This may be in the form of signs, such as the existing signs at the public boat landings, pamphlets, or volunteers talking to boaters. A community information day with a focus on appreciating and protecting our natural resources is suggested to inform riparian citizens and lake users of what steps they can take to help maintain a healthy waterbody. Based on past interest in the Silver Lake Protection Association, citizens are passionate about protecting Silver Lake and getting involved in the process. The SLPA will continue to hold public information meetings and to post information on the website in order to keep the community informed and to maintain a collaborative effort of restoration. The first plant redistribution is intended to be a combined effort between the SLPA, the Silver Lake Sportsman's Club and volunteer personal from the Camp, Center Lake Rehabilitation District (CCLRD) who have a history of preforming this technique successfully on their lake will assist the Silver Lake volunteers with the initial transplant effort.

Continuing plant surveys may be a requirement of permits, but is also important for Silver Lake to gauge progress in reducing the amount of invasive plants and restoring the native plants. It is also vital to an adaptive management program, so that proper decisions are made in reaction to actual changes in the plant community. Under this task, the consultant will conduct a post-treatment aquatic plant survey to determine treatment results and potential treatment areas for the following year. All data points established during the pre-treatment survey will be sampled with presence and density of all aquatic plant species recorded. Additionally, remaining areas of the lake will be surveyed for new growth of AIS and mapped, if found, to be included for future treatments. The post-treatment survey will follow established WDNR protocols. The post-treatment survey will be scheduled at least 60 days after the AIS treatment, but no later than September 1st to ensure any aquatic plants present can be collected and identified. The consultant will teach proper plant sampling identification technique, especially of AIS, during the post-treatment survey by offering ride-along to up to 4 SLPA members. These members will then use this knowledge for future lake surveillance. Data collected at each sample point will include species presence and density, depth, GPS location, and bottom substrate and will be compiled in the WDNR provided Wisconsin Aquatic Plant Management Spreadsheet (WiAPMS.xlsx) and submitted to the Association. Another useful resource is a sonar plant survey, in which the lake is mapped out three-dimensionally, and indicates areas and densities of plant growth. This may be used in combination with a modified plant survey in order to quantify the amount of each plant, both native and invasive.

If a suspected invasive species is found:

- Take a digital photo of the plant in the setting where it was found and mark with a GPS. Then collect 5 – 10 intact specimens. Try to get the root system, all leaves as well as seed heads and flowers where present. Place in a Ziplock bag with no water. Place on ice.
- Fill out form http:dnr.wi.gov/lakes/forms/3200-125-plantincident.pdf
- Contact the DNR Aquatic Invasive Species Contact (currently Heidi Bunk, WDNR Lakes Biologist) and deliver the specimens, report, digital photo, and coordinates. Do this as soon as possible; but no later than 4 days after the plant is discovered. A board member and current lake consultants should also be notified.
- Upon determination of species, a coordinated response plan should be developed in consultation with the DNR, the County, and lake consultants as needed.

Chemical

Silver Lake has a wide-spread Eurasian watermilfoil problem affecting over 50% of the littoral area of the lake. Chemical treatment appears to currently be the best option for Silver Lake to obtain a significant reduction in invasive plants in order to allow the growth of native plants. Chemical treatment of a waterbody requires a DNR permit in advance of any treatment and should be applied for by the April 1 deadline in order to have the option to treat in spring. Conducting a pretreatment survey may be required by the DNR permit, and is a useful benchmark to compare to a post-treatment survey in order to gauge the effectiveness of the treatment.

The consultant will selectively treat the 2013 permitted application areas on a whole-lake basis for EWM. To minimize impacts to more desirable, native aquatic plants selective aquatic herbicides will be applied for control of EWM. A liquid herbicide containing 2,4-D (DMA 4) will be applied to target EWM at a lake-wide rate of 0.35 ppm based on a lake volume of approximately 5000 acre-feet. This herbicide has been shown to selectively combat infestations of EWM and is approved by the Environmental Protection Agency and the WDNR for use in aquatic ecosystems. An early chemical treatment will occur before water temperatures reach 65°F. Timing of this application is critical to ensure project success and to minimize undesirable impacts to the native aquatic plants. The initial whole lake treatment was completed in May, 2013 and a follow up PI survey is scheduled for late summer of 2013 by WDNR staff.

Water samples were collected, post-treatment, in accordance with the following schedule, or as required by the permit, is suggested: one day after, three days after, one week after, and two weeks after treatment. This information is used to test for herbicide residuals in the water and to aid in calculating future treatment concentrations.

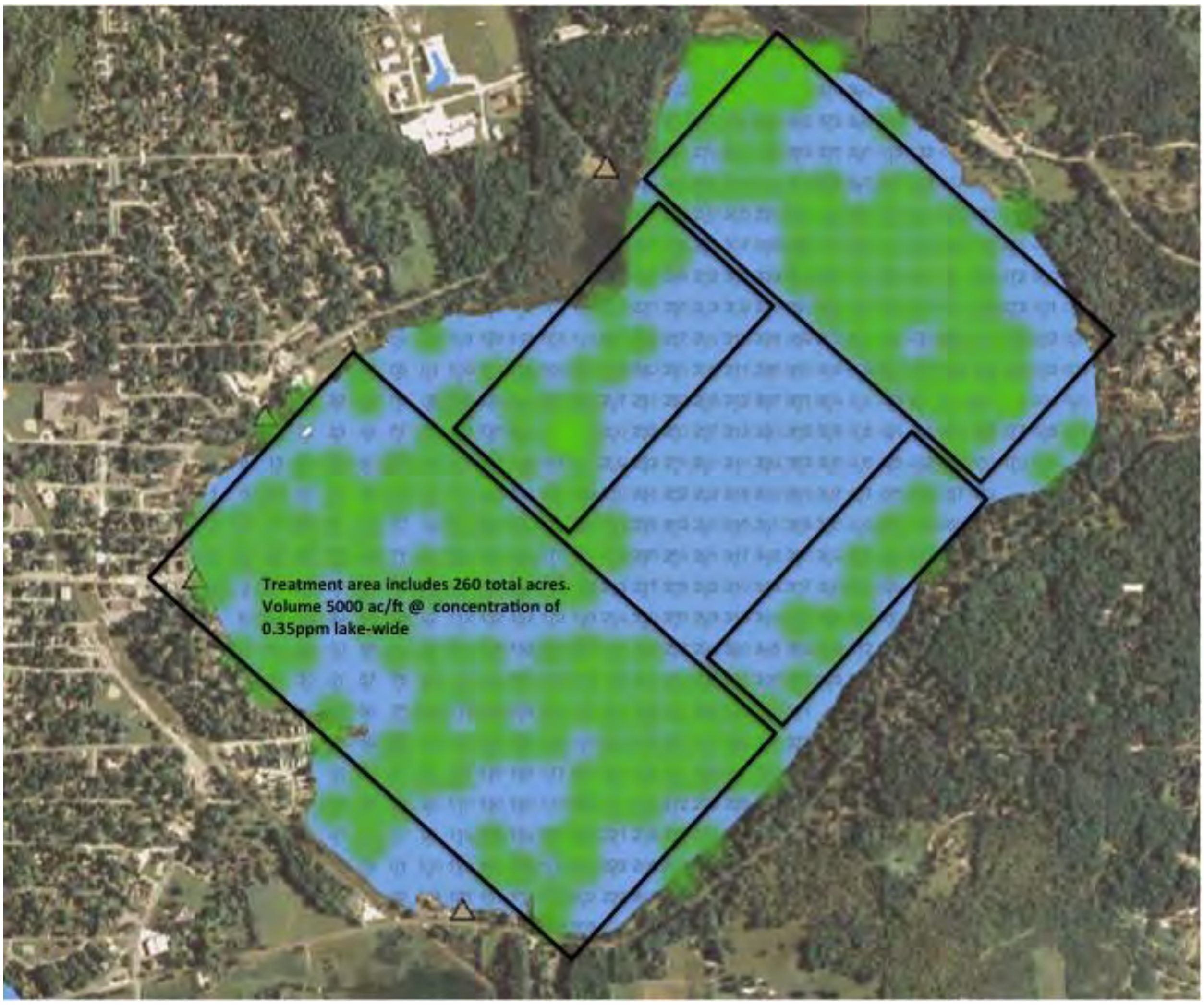


Figure 14: Silver Lake 2103 Proposed Treatment Area

Other Considerations

Some of the management tools suggested, specifically chemical treatment and mechanical harvesting, can be quite expensive. Soliciting grant funding under Chapters NR 198, "Aquatic Invasive Species Control Grants", is being actively pursued. This document may be used as supporting material for grant applications and has been prepared in accordance of the timeline set forth by the grant requirements.

Any actions should take into consideration the 2010 Silver Lake Integrated Sensitive Area Report prepared by DNR, as this may outline management restrictions for these sensitive areas [20]. Despite the issues with AIS within the lake, it is listed as an Area of Special Natural Resource Interest due to one NHI endangered species present, the pugnose shiner. The sensitive areas identified by the DNR are shown in Figure 5 below. The anticipated lake management practices, including chemical treatment, are not expected to have a negative impact on the sensitive areas; however any restrictions will be outlined in the chemical application permit from the DNR. On the contrary, all actions carried out in accordance with this aquatic plant management plan are expected to enhance and protect the sensitive areas designated by improving the conditions for native plants to thrive. Regarding restoration, one of the most important aspects will be to significantly decrease the pressure from invasive EWM, allowing the diverse native population of aquatic plants to better flourish. Silver lake has a diverse list of native species and FQI of 27, and the protection and promotion of Silver Lake's diversity is of utmost importance.

Figure 15: Sensitive areas designated by the DNR [20]

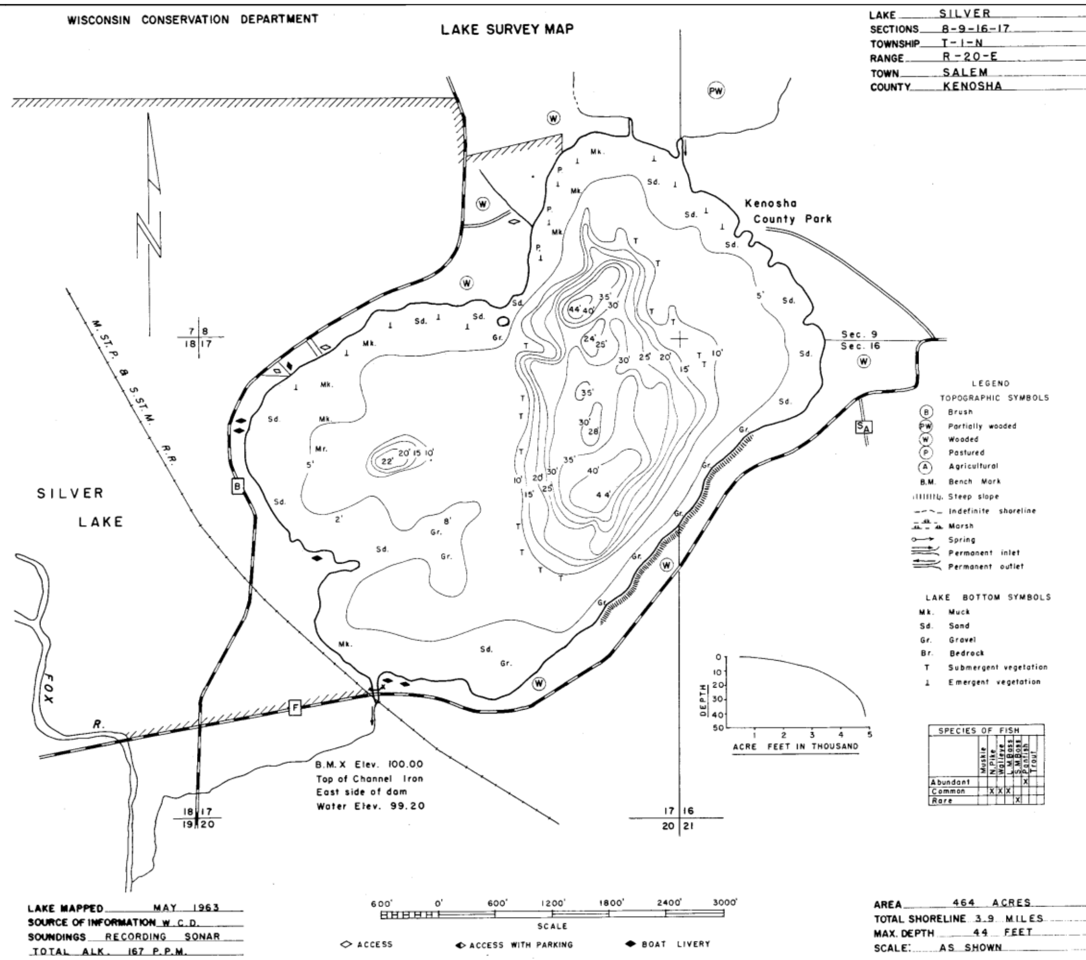


Figure 16: Silver Lake Bathymetry

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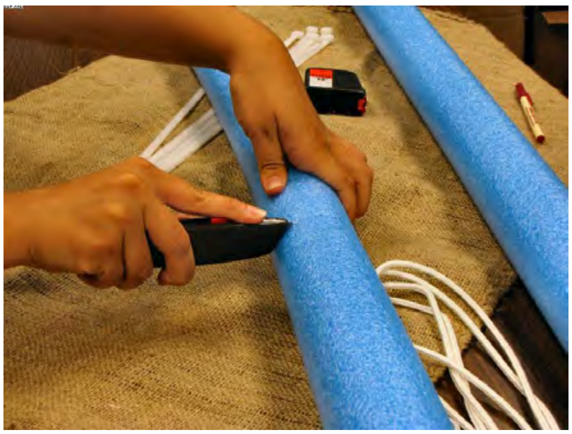
ATTACHMENT A – EWM Hand Pulling Information

Directions to make floating bags for containing EWM while hand-pulling

Contact Paul Skawinski, Golden Sands RC&D

Materials include:
6 - 24" zip ties
2 – 50" foam noodles
1 – 23" wide burlap sack
1 - short section of rope (~9ft)
Tape
Box cutter knife

Step 1) Cut foam noodles to correct size.



Step 2) Tape noodles into ring shapes. Then stack noodles and tape them together.

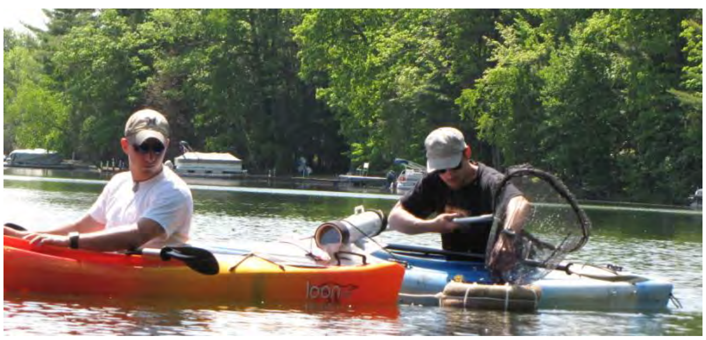
Step 3) Push open end of burlap sack downward through the rings, and pull edges back up. Fold them in around the inside of the noodles.

Step 4) Push zip ties through the burlap and around the noodles and zip tight.

Your bag should now look like this:

Step 5) Cut off excess zip-ties, and thread a section of rope underneath all of the zip ties.

Step 6) Tie a knot in the rope, leaving 5-6ft of extra rope. This rope will be tied to the boat, kayak, etc. These bags could be used by themselves without rope, or could be tied to just about anything. Anchoring them in a spot or tying them to a tree would also work (with more rope). I hope others will find this idea as helpful as we have!



Frequently asked questions

What do I do if I find EWM?

Collect a sample and mark the location where the specimen was found. Contact your local DNR and/or AIS Coordinator to assist in verifying the EWM, and offer advice before any action is taken. They can also inform you of other experts that are available.

How do I preserve the specimen?

Place the specimen in a zipper-style bag with a moist paper towel. Keep the specimen refrigerated until it is delivered or mailed to your local DNR Water Resource Specialist or AIS Coordinator.

What is manual removal? Is it legal? Do I need a permit?

Manual removal is pulling by hand or with hand-held devices that do not use external or auxiliary power sources (e.g. small rakes). It is legal if the native plant population is not excessively harmed. No permit is needed when following these guidelines. Contact with the local DNR is always recommended before starting.

What if EWM is mixed in with native plants, what should I do?

Try to target only the EWM. If native plants are accidently removed, dispose of them with the EWM. This prevents losing any EWM fragments that might be mixed in with the native plant material. The more native plants you can leave, the better chance they will spread and help prevent any EWM from becoming reestablished in that area.

Where do I dispose of EWM?

Contacting your local DNR Water Resources Specialist prior to the project is always recommended for the latest approved procedures. Transport the material away from the water body so that no parts escape, and dispose of it in a manner that prevents the establishment, introduction, or spread of the plants. All pulled EWM must be disposed of above the ordinary high water mark, preferably in a flat, vegetated area so the EWM fragments cannot wash back into a nearby water body. Compost piles, farm fields, gardens, and landfills are good places.

What kind of equipment do I need?

- (Optional) snorkeling gear: mask, fins, snorkel (a dive flag is needed if more than 150 feet from shore)
- Small rake, trowel or similar tools
- Container to put harvested EWM for transport & disposal (have a predetermined disposal place)
- Bag made with small mesh or burlap to put collected EWM while working away from the watercraft
- Watercraft to work out of & place harvested EWM
- Long-handled, small-mesh net for catching fragments
- Wetsuits aren't necessary but do keep divers warmer & allows them to work longer with more comfort
- Trailer or truck to haul the harvested EWM to a disposal site
- Record progress & what works best so information can be shared. Record time & people working for future reference & to document needed volunteer hours towards grant match funds.

EWM Collection

Making EWM Collection Bags

Materials:

- Mesh bags and/or burlap sacks
- 10 - 12 inch zip ties (amount varies on size of bag)
- Foam water noodles (wacky noodles)

Directions:

- Cut the foam water noodle to the diameter of the bag or sack being used.
- Making a circle with the foam, place the foam inside the bag at the open end and attach with the zip ties to create a floating lip at the opening of the bag (see above pictures). You now have a floating collection bag for the EWM that lets the water strain out when it is time to dispose of the EWM.

Eurasian Water Milfoil
Manual Removal

- ***What Is It?***
- ***How To Do It***
- ***Helpful Tips***

Rev. 5/11/2011

Sponsored by Lumberjack Resource Conservation & Development (RC&D) Council, Inc. & Golden Sands RC&D Council, Inc.
With assistance from the WDNR AIS Grants Program and UW Extension Lakes Program
Photos by Chris Hamerla, Paul Skawinski, Russ Robinson, & Tiffany Lyden

Identify and responding quickly to EWM is essential. On new, small colonies and scattered plants, hand removal can be a simple, effective way to control EWM. EWM is distinguished from northern water milfoil by having 12 to 21 pairs of leaflets on each leaf (see milfoil leaf pictures far right). Typically, EWM also has limp, pinkish stems, while northern water milfoil tends to have whitish stems, and leaves with 4 to 12 pairs of leaflets.

Manage EWM in spring. Generally, EWM will grow quicker than native plants so it is easier to locate and remove. At this time, most native plants are still dormant, so the EWM is more visible. Also, the plants are younger and stronger, so they don't break apart as easily as later in the season. Eliminating fragmentation is a top priority.

Mark EWM locations after finding it from a boat or by snorkeling so it can be found again quickly for removal. A GPS unit works great, as does a map of the lake marked with EWM locations. Mapping also helps for future reference to see if EWM is showing up in different places and how effective past removal efforts have been. This map can also assist a lake consultant brought in to perform more in-depth surveying.

Remove EWM carefully. All portions of the plant, including roots and pieces that break off, need to be removed. Grabbing numerous stems on the same plant reduces breaking from the roots. Bigger plants or firmer sediment require the person to work their fingers/hands into the sediment to help loosen the plant. Slowly remove the plant from the sediment and gently shake it to reduce sediments clouding the water. Carefully wind the plant around a hand to help eliminate lost fragments, and make for easier transition to the container.

In shallow water, a stable watercraft can be used to work from and minimize sediment disruption, especially when dealing with soft substrates like silt, mud, or marl. The removed plants can be transferred right into the watercraft or other container.

Snorkeling is a good option in shallow water. Using a watercraft is still helpful as it gives the diver a place to deposit removed EWM and to rest. The people in the watercraft can point out plants to the diver and help retrieve fragments (long-handled nets with a fine mesh work well).

The diver can put plants into a mesh or burlap bag that keeps fragments from escaping, or bring the plants directly to the watercraft. To maximize the time spent harvesting EWM, a bag or similar floating container should stay with the diver for depositing plants. Once it is full, it can be taken to the watercraft to be emptied. The watercraft needs to remain at a safe distance to give the diver room to work. Non-motorized watercraft work well since they aren't as likely to disrupt the sediment, and there isn't the danger from the propeller.

Calm, sunny days offer the best working conditions regardless of the removal technique. Visibility is greater, plus boat positioning and control is much easier.

Disposal of harvested plants should be planned in advance. Gardens, flower beds, and farm fields are great places, as aquatic plants make good fertilizer. Care needs to be taken to prevent escape and introduction of fragments into new areas. Drain excess water to reduce weight during transport.

Eurasian water milfoil

Watercraft assistants

Making a difference!

Eurasian water milfoil (left)
Northern water milfoil (right)

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Wisconsin Department of Natural Resources
www.dnr.wi.gov/invasives

UW Extension Lakes Program
www.uwsp.edu/cnr/uwexlakes/