Silver Lake
2019 Aquatic Plant Survey Report

December 11, 2019

Prepared for:
Silver Lake Protection Association

Prepared by:

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INTRODUCTION / SUMMARY

The Silver Lake Protection Association (SLPA or the Association) is a group responsible for the management of Silver Lake's aquatic invasive species (AIS), particularly hybrid Eurasian water-milfoil (Myriophyllum spicatum x sibiricum – HWM). Wisconsin Lake & Pond Resource, LLC (WLPR) was contracted by the Association to provide aquatic plant surveys and a report summarizing results and historical comparisons for the Lake. WLPR furnished all labor, materials, tools and equipment necessary to perform all operations. This report provides a summary of observations and conclusions for the management of AIS as recommendations for the upcoming 2020 season.

Waterbody Morphology

Silver Lake is a 516-acre drainage lake located in the Town of Salem, Kenosha County, Wisconsin. Silver Lake has a maximum depth of 43 feet with a mean depth of 9.3 feet. The Silver Lake Protection Association is an active lake Association that has been managing aquatic plants on the lake through chemical treatments. Hybrid water-milfoil and curly-leaf pondweed (CLP), both AIS, are present within the waterway, with only HWM actively managed for control.

Aquatic Plant Management Background

The aquatic plant community of Silver Lake has been healthy, though periodically dense. However, introduction of aquatic invasive species caused an expanding problem with excessive aquatic plant growth. Eurasian water-milfoil, now confirmed as hybrid water-milfoil, has caused the most significant problem within Silver Lake, requiring active management through herbicide applications. However, it still grew dense, choking out native species and hampering navigation while compromising a large percentage of the Lake's surface area.

Of particular note, the strain of EWM present within the Lake was confirmed as a hybrid between native water-milfoil and Eurasian water-milfoil. Often times hybrid EWM strains show resistance to typical systemic herbicides used for management, primarily 2,4-D in the State of Wisconsin. This can make meaningful reductions of HWM populations difficult. Past management of HWM in Silver Lake included multiple whole-lake volume dosed herbicide applications, primarily with 2,4-D, and with little results.

Continued management of HWM within Silver Lake is a great financial burden for the Association. In turn, the Association applied for and was awarded a DNR aquatic invasive species control grant in the winter of 2013 for management of HWM from 2014-2016. This grant allowed for a whole-lake fluridone application in 2015 and follow-up monitoring to gauge results. For further information regarding these applications, please reference the *Silver Lake 2016 Aquatic Plant Management Report*.

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2018 Aquatic Plant Management

Following a whole-lake fluridone application for HWM control in 2015, no direct management for HWM was completed in 2016-17. The 2017 aquatic plant survey found HWM at only five sample locations with a small, 3.0-acre bed located in the northern portion of the lake. This area was designated for treatment in 2018 with a brand-new herbicide, ProcellaCOR (Figure 1).

Application of ProcellaCOR to control HWM growth was completed on July 10, 2018. At this time, the HWM was topped out and had expanded outside the area mapped in late 2017. Initial results were positive with good control of HWM while limiting non-target impacts to native species present. For a complete detail of management action in 2018, please see *2018 Selective, Spot Management of Hybrid Eurasian Watermilfoil with ProcellaCOR Aquatic Herbicide: Silver Lake – Kenosha County, Wisconsin* (Heilman – 2018).

Aquatic Plant Surveys

Prior to whole-lake fluridone treatment, the entire aquatic plant community of the lake was surveyed in 2012 by the Association's consultant. The survey was completed according to the point-intercept sampling method described by Madsen (1999) and as outlined in the WDNR draft guidance entitled "Aquatic Plant Management in Wisconsin" (WDNR, 2005) and was used to map and verify areas of AIS growth prior to management. This survey was repeated in 2013-2017 and 2019 by WLPR.

In total, 491 individual locations were created to be sampled and spaced on a 65-meter grid. Latitude and longitude coordinates and sample identifications were assigned to each intercept point. Geographic coordinates were uploaded into a global positioning system (GPS) receiver. The GPS unit was then used to navigate to intercept points. At each intercept point, plants were collected by either tossing a specialized rake on a rope in depths 15' or greater or by using a specialized rake on a pole in depths less than 15' by dragging the rake along the bottom sediments. All collected plants were identified to the lowest practicable taxonomic level (e.g., typically genus or species) and recorded on field data sheets. Visual observations of aquatic plants were also recorded. Water depth and, when detectable, sediment types at each intercept point were also recorded on field data sheets. Further description of methods used and data calculated from these surveys are included in Appendix A.

2019 AQUATIC PLANT SURVEY

The entire aquatic plant community was surveyed on June 29 & 31, 2019 by WLPR and repeated sampling at the same 491 sample points from past surveys. Curly-leaf pondweed is an AIS present in Silver Lake that dies back in mid-summer and is often under-represented by point-intercept surveys in July or later when whole-lake surveys take place. It's likely that all surveys on Silver Lake may not accurately capture the abundance of CLP in the lake. However, CLP has not been noted to be found at nuisance levels during field visits by WDNR or WLPR staff or by members of the SLPA.

In 2019 vegetation was identified to a maximum depth of 18 feet (photic zone). The photic zone was again primarily vegetated with aquatic vegetation detected at 94.3 percent (%) of it.

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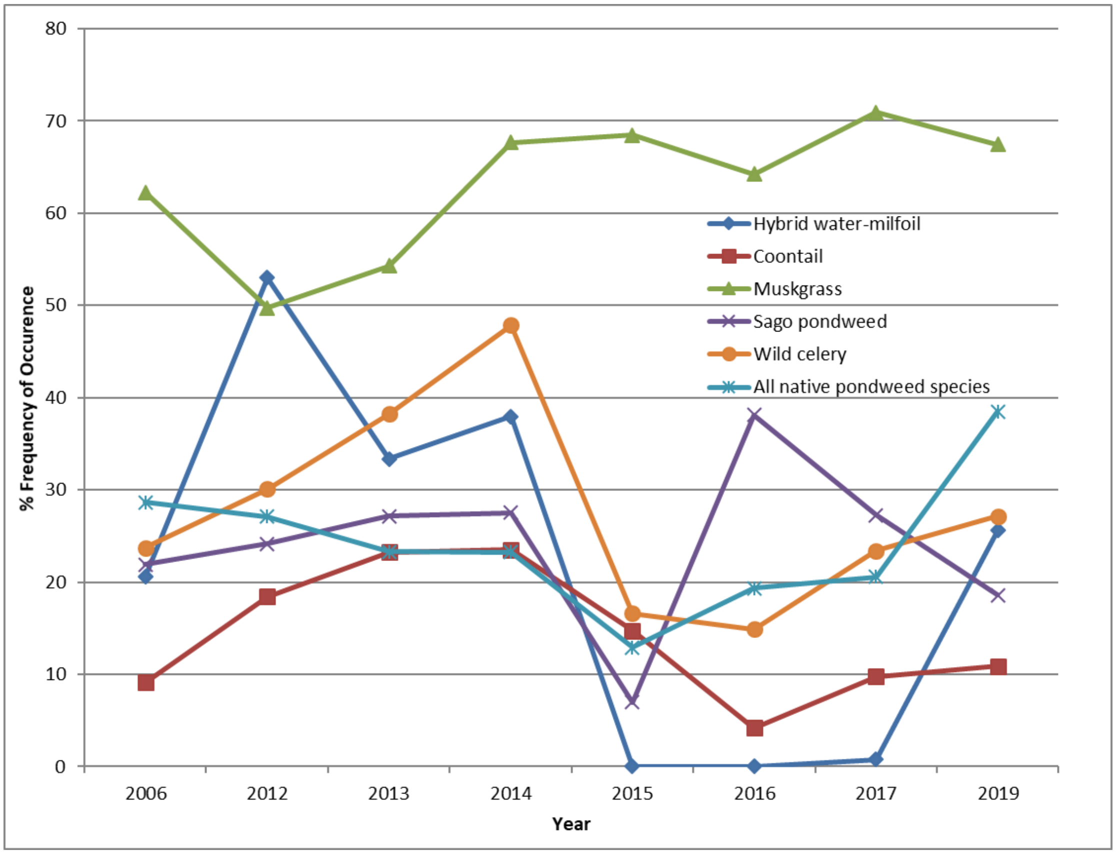
The aquatic plant community showed recovery with no visible continued impact from 2015 HWM management. All aquatic plant community indicators are increasing from the 2016-17 surveys and above pre-treatment levels. The Simpson Diversity Index (SDI) value of the community was 0.86 with an average of 2.12 native species identified at points with vegetation. Table 1 below summarizes the overall aquatic plant community statistics along with historical results.

	2006	2012	2013	2014	2015	2016	2017	2019
Number of sites sampled	400	488	424	384	489	487	488	482
Number of sites with vegetation	352	350	348	350	320	345	357	465
Number of sites shallower than maximum depth of plants	384	402	387	374	387	383	389	387
Frequency of occurrence at sites shallower than maximum depth of plants (%)	91.67	87.06	89.41	93.58	82.69	90.08	91.77	94.32
Simpson Diversity Index	0.87	0.86	0.88	0.86	0.69	0.8	0.82	0.86
Maximum Depth of Plants (Feet)	21	22	16.5	16	16	15	16.5	18
Taxonomic Richness (Number Taxa - includes visuals)	29	28	26	23	15	25	28	28
Average Number of Species per Site (less than max depth of plant growth)	2.27	2.34	2.51	2.69	1.34	1.77	2.01	2.35
Average Number of Species per Site (sites with vegetation)	2.47	2.69	2.81	2.87	1.62	1.97	2.19	2.49
Average Number of Native Species per Site (less than max depth of plant growth)	1.84	1.73	2.01	2.18	1.34	1.51	1.8	2
Average Number of Native Species per Site (sites with vegetation)	2.29	2.06	2.28	2.35	1.62	1.68	1.96	2.12
Floristic Quality Index	30.44	26.13	28.78	28.59	23.24	30.06	31.2	31.4
Average Coefficient of Conservatism	6.35	5.33	6.14	6.24	6.00	6.41	6.24	6.28

Table 2 in Appendix B includes the abundance statistics for each species from each survey. The following chart displays frequency of occurrence for the most common species sampled over time.



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The most abundant aquatic plant identified during the 2019 aquatic plant survey was again muskgrass (*Chara sp.*) It exhibited a 67.4% frequency of occurrence (percent of photic zone intercept points at which the taxa were detected) and had a 28.7% relative frequency of occurrence. Muskgrass has been found at a high frequency for each survey and is most often the most abundant species. This species is found in many hard water lakes throughout southeastern Wisconsin typically occupying depths of 0-10 feet. In some instances it can grow to nuisance levels.

Wild celery (*Vallisneria americana*) was the next abundant species, occurring at 27.1% of photic zone sample points and had a 11.6% relative frequency of occurrence. Wild celery is a very common species throughout Wisconsin and has been one of the most common species found in past surveys of Silver Lake. The roots and tubers produced by wild celery are an important food source for waterfowl in many lakes.

The third most abundant aquatic plant identified in 2019 was hybrid Eurasian water-milfoil. HWM was sampled at 25.6% of photic zone points with a 10.9% relative frequency of occurrence (Figure 2). Prior to 2015 management, HWM was sampled at 38% of points in 2014 and likely higher the year of treatment in 2015. Since then it had been greatly reduced to not being found in 2015-2016. Signs of recovery were noted in 2017 as it was found at 0.8% of locations and increased more in 2018. Locations in 2018 were dense enough to require active management using ProcellaCOR (Figure 1).

Floristic Quality Index

Higher FQI numbers indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. FQI varies around the state of Wisconsin and ranges from 3.0 to 44.6 with the average FQI of 22.2 (WDNR, 2005). Calculation allows for the comparison of waterbodies to one another within the same eco-region of the State. Silver Lake lies within the Southeastern Till Plain Lakes eco-region.

Lakes within the Southeastern Till Plains are typically natural lakes that, due to higher population density in this area of the State, have developed shoreline. Increased development around the lake and overall use of these lakes leads to more disturbance from an expected natural condition, which leads to lower plant community metrics like FQI and coefficient of conservatism. Both of these are below the average for all Wisconsin lakes due to this.

Aquatic plant communities are impacted slightly by this level of nearshore development, with both the average Coefficient and FQI for lakes within the region below State averages, showing a more disturbed community. For Silver Lake, however, the 2019 average coefficient (6.28) is above the State average and above the eco-region upper quartile. This indicates a plant community typically associated with lower disturbance levels and of high quality, especially for the amount of disturbance from management, watercraft, and development along the shoreline. The 2019 average coefficient is near the recorded high for Silver Lake and shows maintained recovery of the native plant community from whole-lake HWM management in 2015.

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Floristic quality index for Silver Lake has historically been high for the eco-region, falling within the upper quartile. The FQI calculated from the 2019 aquatic plant survey data was 31.4, the highest recorded value from past surveys. This value is above the upper quartile values for State wide and eco-region and indicates a tremendously healthy native plant community and recovery from 2015 HWM management. Table 4, Appendix B displays the expanded breakdown of FQI by species.

Table 3: FQI and Average Coefficient of Silver Lake Compared to Wisconsin and Southeastern Till Plain lakes.

	Average Coefficient of Conservatism			Floristic Quality			Number of Species		
Quartile*	Lower	Mean	Upper	Lower	Mean	Upper	Lower	Mean	Upper
Wisconsin Lakes	5.5	6	6.9	16.9	22.2	27.5	8	13	20
Southeastern Till Plain Lakes	5.2	5.6	5.8	17	20.9	24.4	10	14	19
2019	6.28			31.4			25		
2017	6.24			31.2			25		
2016	6.41			30.06			22		
2015	6.00			23.24			15		
2014	6.24			28.59			21		
2013	6.14			28.78			22		
2012	5.33			26.13			24		
2006	6.35			30.44			23		

* - Values indicate highest value of the lowest quartile, mean, and lowest value of the upper quartile

Native Aquatic Plant Species

To assess changes between 2019 and previous surveys, statistical analysis was completed using a Chi-square test with a 5% Type-I error rate. This error rate is standard in ecological studies and equals that there is a 5% chance of claiming statistically significant change when no real change occurred. Only those species that display a p-value of 0.05 or lower changed significantly population-wise between years. To calculate these values, the total number of sample locations each species was found at is compared between years. Table 5 displays statistical changes, if any, for each species sampled in 2019 versus 2014-2017 surveys.

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Table 5: Statistical Significance of Species between Sampling Events, Silver Lake, Kenosha County, Wisconsin.

Species	2019 v 2014			2019 v 2015			2019 v 2016			2019 v 2017		
	P-value	Significance	+ / -	P-value	Significance	+ / -	P-value	Significance	+ / -	P-value	Significance	+ / -
Hybrid water-milfoil	**0.001526253**	**	-	**5.05395E-30**	***	+	**9.38136E-30**	***	+	**9.97255E-27**	***	+
Curly-leaf pondweed	0.163895687	n.s.	+	0.156762546	n.s.	+	0.645277401	n.s.	-	0.995876556	n.s.	+
Filamentous algae	**0.002141299**	**	-	0.156762546	n.s.	-	---	---	---	---	---	---
Watershield	---	---	---	0.316997682	n.s.	-	0.314482084	n.s.	-	0.318245762	n.s.	-
Coontail	**3.39765E-06**	***	-	0.106455916	n.s.	-	**0.000449453**	***	+	0.619499861	n.s.	+
Muskgrass	0.949591278	n.s.	-	0.817055962	n.s.	-	0.309501002	n.s.	+	0.326129437	n.s.	-
Common waterweed	0.077500037	n.s.	-	---	---	---	---	---	---	---	---	---
Water star-grass	**4.43657E-11**	***	+	**1.15467E-16**	***	+	**1.77395E-16**	***	+	0.001258057	**	+
Small duckweed	0.163895687	n.s.	+	0.156762546	n.s.	+	0.158918963	n.s.	+	0.155696834	n.s.	+
Northern water-milfoil	---	---	---	---	---	---	---	---	---	0.318245762	n.s.	-
Slender naiad	**0.003517263**	**	+	**8.01657E-10**	***	+	**3.92083E-05**	***	+	0.882898771	n.s.	+
Southern naiad	**5.74774E-14**	***	-	0.156762546	n.s.	+	0.158918963	n.s.	+	0.155696834	n.s.	+
Spiny naiad	**0.023300502**	*	-	**7.57974E-09**	***	+	**3.85931E-10**	***	-	**3.83603E-06**	***	-
Nitella	**0.003009386**	**	+	**0.033525011**	*	+	**0.011409169**	*	+	0.159163499	n.s.	+
Spatterdock	0.16617587	n.s.	-	0.316056774	n.s.	-	0.31104204	n.s.	-	0.56596866	n.s.	-
White water lily	0.290203774	n.s.	-	0.314480441	n.s.	-	0.306976898	n.s.	-	0.481772369	n.s.	-
Pickerelweed	0.583056916	n.s.	+	1	n.s.	n.c.	0.991688712	n.s.	-	0.995876556	n.s.	+
Leafy pondweed	---	---	---	---	---	---	---	---	---	0.083462176	n.s.	-
Frie's pondweed	**1.78991E-14**	***	+	**1.33005E-15**	***	+	**8.6992E-12**	***	+	1.56739E-12	***	+
Variable pondweed	**0.000173123**	***	+	0.206024242	n.s.	-	**0.031190354**	*	-	0.569085114	n.s.	-
Illinois pondweed	**0.001025733**	**	-	**8.01657E-10**	***	+	**4.48883E-09**	***	+	0.136690095	n.s.	+
Floating-leaf pondweed	0.163895687	n.s.	+	0.156762546	n.s.	+	0.569036741	n.s.	+	0.559930887	n.s.	+
Long-leaf pondweed	0.388758877	n.s.	-	0.562945207	n.s.	+	0.991688712	n.s.	-	0.559930887	n.s.	+
White-stem pondweed	0.972669249	n.s.	-	0.156762546	n.s.	+	0.158918963	n.s.	+	0.995876556	n.s.	+
Clasping-leaf pondweed	**0.022482989**	*	-	---	---	---	---	---	---	---	---	---
Flat-stem pondweed	**0.014050051**	*	+	**0.003621315**	**	+	0.228339315	n.s.	+	**0.030205844**	*	+
Rigid arrowhead	0.325259498	n.s.	+	0.316997682	n.s.	+	0.31104204	n.s.	-	0.56596866	n.s.	-
Hardstem bulrush	0.980697827	n.s.	-	0.316997682	n.s.	+	0.994130636	n.s.	-	0.56596866	n.s.	-
Three-square bulrush	0.325259498	n.s.	+	1	n.s.	n.c.	0.319510045	n.s.	+	0.997088048	n.s.	+
Sago pondweed	**0.00199238**	**	-	**1.279E-06**	***	+	**1.85419E-09**	***	-	**0.004185216**	**	-
Small purple bladderwort	0.543036827	n.s.	-	0.316997682	n.s.	+	0.994130636	n.s.	-	0.997088048	n.s.	+
Common bladderwort	0.16617587	n.s.	-	**0.018924305**	*	-	0.31104204	n.s.	-	0.31575122	n.s.	+
Common watermeal	0.325259498	n.s.	+	0.316997682	n.s.	+	0.319510045	n.s.	+	0.997088048	n.s.	+
Wild celery	**8.97402E-10**	***	-	0.113178827	n.s.	+	**3.05045E-05**	***	+	0.2307497	n.s.	+
Illinois/Variable/Hybrid combined^	0.612395009	n.s.	-	**0.013347868**	*	+	0.140405425	n.s.	+	0.552634032	n.s.	+

* - somewhat significant change, ** - moderatly significant change, *** - very significant change

n.s. - Change not significant, n.c - no change

--- - Species was not sampled in both comparison years

The 2019 survey was completed following past procedures to further assess the aquatic plant community's impact from a whole-lake fluridone application and showed continued recovery with a mixed impact to native species. Seven native species saw a statistically significant decline from 2014 to 2019; coontail, southern naiad, spiny naiad, Illinois pondweed, clasping-leaf pondweed, sago pondweed, and wild celery. All these species experienced the largest decline from 2014 to the year of treatment in 2015. For a complete review of the lake's aquatic plant community changes from pre-fluridone treatment through 2016 please see *Silver Lake 2016 Aquatic Plant Management Report* (Kordus & Scharl – 2016).

Of the species that declined after treatment many saw a marked recovery from 2015 to 2019 with only one species, common bladderwort, having declined over this period. Many of the species that declined initially reproduce by seeds. The fluridone application in 2015 reduced the vegetation present that year, but plants re-grew from seeds within the lake sediment and increased significantly after application. These included naiad species.

Significant reduction of naiad species has been noted in other lakes where fluridone was used for E/HWM control. Reduced populations have occurred the year-of and one-year post application for naiads. However, naiads were noted to have returned in year 2 post-application. This same trend was noted for Silver Lake, which saw slender and southern naiad increase significantly from 2015 levels. Fluridone takes an extended time to breakdown and dissipate in lakes when applied. Recovery of naiad species is tied to remaining residual fluridone levels and, once low enough, naiad repopulate themselves. Positively, six native species increased significantly from pre-treatment 2014 levels; water star-grass, slender naiad, nitella, Frie's pondweed, variable pondweed, and flat-stem pondweed.

When completing management of AIS on a whole-lake basis it is impossible to have no non-target impacts to native vegetation. Impact to native species can only be mitigated based on application rates, timing, and the active ingredient applied. A balance must be reached between an acceptable level of target AIS reduction and non-target impacts. In Silver Lake, a significant reduction of HWM was achieved. It is important to note that the plant community's health as a whole has increased significantly from 2014 pre-treatment levels as noted by increased FQI, average coefficient of conservancy, species diversity, and SDI.

In addition, though some species have reduced abundances, the overall evenness of the spread of the most common native species has leveled out. This shows increased diversity and health. In the past, Silver Lake was dominated by AIS. However, now many species have returned to pre-treatment levels with an excellent population of native pondweeds present. Pondweed species are vital for the health of a lake and create excellent fisheries habitat. The total combined abundance of all pondweed species was found at an all-time high in 2019, 38.47%, higher than even much earlier surveys found. The reduction of a few is outweighed by the increase of native pondweed species distribution, overall species diversity, and increased evenness in distribution of all species present as noted in the increased SDI.

Aquatic Invasive Species

HWM management within Silver Lake continues to shows recovery and results should be viewed as a successful outcome following the 2015 fluridone application. However, HWM populations are increasing in Silver Lake and increased significantly from 2017 to 2019. Tolerance of some HWM strains to 2,4-D is a known problem and was created by repetitive management regimes of 2,4-D that merely injured a Lakes population of EWM/HWM by killing the most susceptible plants and leaving behind more resistant strains. This same scenario may occur in Silver Lake with a potential resistance to low levels of fluridone.
Even after a successful application was completed in 2015, a higher dose of fluridone may be required in Silver Lake for future control, if necessary.

Curly-leaf pondweed has continued to remain background levels and a very low frequency of under 1%. Though an AIS and often aggressive in other lakes, CLP is being held in check by the robust native plant community of Silver Lake and has simply become part of it. It has remained at low rake-density when sampled and no mono-typic beds have been found yet. CLP reproduces by seed-like structures called turions. When left unmanaged, turions can accumulate in the sediment and cause significant growth of plants in early-season and become difficult to manage, requiring multiple years of management to reduce turion seed banks.

2020 MANAGEMENT RECOMMENDATIONS

Management of aquatic plants can take many facets, depending on each lake's unique condition and desire by the community. To be successful, a management option must be accepted by its users. Herbicide use has been done in the past within Silver Lake at varying scales. Herbicides for aquatic plant management can have negative connotations and can be misunderstood by some users, making it potentially controversial. However, the combinations of periodic large-scale whole lake type treatments for AIS have shown to reduce the need and frequency of management in following years.

It is important that appropriate management actions continue on a yearly basis to ensure that nuisance invasive aquatic plant growth does not reach unmanageable levels. Though HWM is increasing within Silver Lake, results of the fluridone application have been highly successful. The native plant community was expected to see some impact, as seen by the above data. However, the gains in diversity and distribution of the native species outweigh the non-target impacts to select species.

Management of aquatic plants, specifically AIS, within Silver Lake can take on many facets in 2020. AIS have the biggest impact to a lake's ecosystem and should be the main target for active management. Though the population of HWM within Silver Lake has increased, it is still below pre-treatment levels found in 2014. Therefore, we recommend management in 2020 that focuses continued monitoring and planning for 2021. For 2020 management, we recommend the following course of action:

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- July/August 2020: whole-lake point intercept aquatic plant survey to assess the HWM population
- September/October 2020: Complete an assessment of HWM present for 2021 planning
  - Update and submit management report and recommendations to the Association
  - Future planning may involve any of the following actions:
    - Large-scale HWM control in 2021
    - WDNR AIS Grant application to assist in 2021 funding
    - Continued monitoring
    - Small-scale control of HWM in select areas

Though HWM has been reduced from historical levels, complete extirpation of this AIS from the lake is extremely difficult. Current populations of all aquatic plant species will fluctuate yearly and control actions should be altered accordingly. It is possible, as AIS populations are reduced and come under control to a small and more manageable size, that Association members can monitor the lake for historic and new AIS infestations and contract with a qualified consultant on an as-needed basis for removal or management, as a cost saving measure.

Because of the Association's proactive approach in dealing with AIS, the current populations of HWM within the Lake have significantly decreased, improving the health and overall ecosystem. However, the Silver Lake Protection Association should continue to be involved in some type of aquatic plant management program to help monitor and manage nuisance aquatic plant growth of AIS, if present, posing recreational impediments to riparian property owners and lake users. AIS are extremely opportunistic plants and can grow to nuisance levels in a very short period of time. Continued monitoring and possible management actions must occur to ensure that the health, aesthetic and recreational value of the lake is not degraded.

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Appendix A

Supporting Aquatic Plant Survey Methods and Documentation

The point-intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

- **Taxonomic richness** - the total number of taxa detected
- **Maximum depth of plant growth**
- **Community frequency of occurrence** - number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth
- **Mean intercept point taxonomic richness** - the average number of taxa per intercept point
- **Mean intercept point native taxonomic richness** - the average number of native taxa per intercept point
- **Taxonomic frequency of occurrence within vegetated areas** - the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present
- **Taxonomic frequency of occurrence at sites within the photic zone** - number of intercept points where a particular taxon was detected divided by the total number of points which are equal to or shallower than the maximum depth of plant growth
- **Relative taxonomic frequency of occurrence** – the number of intercept points where a particular taxon was detected divided by the sum of all species' occurrences
- **Mean density** - the sum density values for a particular species divided by the number of sampling sites
- **Simpson Diversity Index (SDI**) - an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.

Floristic Quality Index (FQI) - This method uses a predetermined Coefficient of Conservatism (C) that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present, with a measure of the species richness of the site.

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Appendix B

Tables

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Table 2: Frequency of Occurrence of Aquatic Plant Species by Year, Silver Lake, Kenosha County, Wisconsin.

Species	Frequency of Occurrence by Year							
	2006	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2019**
Hybrid water-milfoil	20.57	52.99	33.33	37.97	---	---	0.77	25.58
Curly-leaf pondweed	1.04	---	0*	---	---	0.78	0.51	0.52
Filamentous algae	21.35	0.25	2.84	2.41	0.52	---	---	---
Watershield	0.26	---	---	---	0.26	0.26	0.26	---
Coontail	9.11	18.41	23.26	23.53	14.73	4.18	9.77	10.85
Muskgrass	62.24	49.75	54.26	67.65	68.48	64.23	70.95	67.44
Common waterweed	---	0.25	0.26	0.53	---	---	---	---
Water star-grass	7.29	7.71	5.43	5.35	2.58	2.61	13.37	22.22
Small duckweed	---	0*	---	---	---	---	---	0.52
Purple loosestrife	---	0*	---	---	---	---	---	---
Northern water-milfoil	7.81	---	---	---	---	---	0.26	---
Whorled water-milfoil	---	0*	---	---	---	---	---	---
Slender naiad	10.68	11.91	10.34	4.01	---	2.35	9	9.3
Southern naiad	---	---	16.8	14.97	---	---	---	0.52
Spiny naiad	6.25	8.21	16.8	13.37	---	25.07	19.79	8.27
Nitella	2.6	1.99	---	---	0.52	0.26	1.03	2.33
Spatterdock	0*	0.5	0.26	0.53	0.78	0.78	0.51	0.26
White water lily	0.26	0.75	0.78	0.8	1.55	1.57	1.29	0.78
Common reed	---	0*	---	---	---	---	---	---
Pickerelweed	0.26	0.25	0*	0*	0.52	0.52	0.51	0.52
Leafy pondweed	0.52	---	---	---	---	---	0.77	---
Frie's pondweed	1.04	1	1.03	0.27	---	1.57	1.29	15.25
Variable pondweed	0.26	---	0.78	2.94	12.4	14.62	10.8	9.56
Illinois pondweed	24.22	0.75	3.62	16.84	---	0.26	5.91	9.3
Floating-leaf pondweed	---	0*	0*	---	---	0.26	0.26	0.52
Long-leaf pondweed	0.26	1.99	1.81	0.8	0.26	0.52	0.26	0.52
White-stem pondweed	---	1.74	0.26	0.53	---	---	0.51	0.52
Small pondweed	1.04	---	---	---	---	---	---	---
Clasping-leaf pondweed	1.3	---	2.33	1.34	---	---	---	---
Stiff pondweed	---	---	---	---	---	0.52	---	---
Flat-stem pondweed	---	---	0*	0.53	0.26	1.57	0.77	2.8
Common arrowhead	---	0*	---	---	---	---	---	---
Rigid arrowhead	---	---	---	---	---	0.78	0.51	0.26
Hardstem bulrush	---	---	---	0*	---	0.26	0.26	0*
Three-square bulrush	---	---	0.26	---	0.26	---	0.26	0.26
Softstem bulrush	0*	0*	---	---	---	---	---	---
Sago pondweed	21.88	24.13	27.13	27.54	6.98	38.12	27.25	18.6
Narrow-leaved cattail	---	0*	---	---	---	---	---	---
Small bladderwort	0.26	---	---	---	---	---	---	---
Small purple bladderwort	1.3	---	0.26	0.53	---	0.26	0.26	0.26
Common bladderwort	0.26	0.5	0.52	1.07	1.5	0.78	---	0.26
Common watermeal	---	0*	---	---	---	---	0.26	0.26
Wild celery	23.7	30.1	38.24	47.86	16.6	14.88	23.39	27.13
Illinois x variable pondweed hybrid	---	21.64	13.44	---	---	---	---	---
Illinois / Variable / Hybrid data combined^	24.48	22.39	17.84	19.78	12.4	14.88	16.71	18.86

* - recorded as visual only

--- - species not sampled

^ - due to difficulty identifying between three species and drastic changes between years data for Illinois, variable, and Illinois x variable hybrid pondweed species is combined

Table 4: Historical Floristic Quality Index, Silver Lake, Kenosha County, WI

	Coefficient of Conservatism							
Common Name	**2006**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2019**
Watershield	6	---	---	---	6	6	6	---
Coontail	3	3	3	3	3	3	3	3
Muskgrass	7	7	7	7	7	7	7	7
Common waterweed	---	3	3	3	---	---	---	---
Water star-grass	6	6	6	6	6	6	6	6
Small duckweed	---	4	---	---	---	---	---	4
Northern water-milfoil	6	---	---	---	---	---	6	---
Whorled water-milfoil	---	8	---	---	---	---	---	---
Slender naiad	6	6	6	6	---	6	6	6
Southern naiad	---	---	8	8	---	---	---	8
Nitella	7	7	---	---	7	7	7	7
Spatterdock	6	6	6	6	6	6	6	6
White water lily	6	6	6	6	6	6	6	6
Common reed	---	1	---	---	---	---	---	---
Pickerelweed	8	8	8	8	8	8	8	8
Leafy pondweed	6	---	---	---	---	---	6	---
Frie's pondweed	8	8	8	8	---	8	8	8
Variable pondweed	7	---	7	7	7	7	7	7
Illinois pondweed	6	6	6	6	---	6	6	6
Floating-leaf pondweed	---	5	5	---	---	5	5	5
Long-leaf pondweed	7	7	7	7	7	7	7	7
White-stem pondweed	---	8	8	8	---	---	8	8
Stiff pondweed	---	---	---	---	---	8	---	---
Small pondweed	7	---	---	---	---	---	---	---
Clasping-leaf pondweed	5	---	5	5	---	---	---	---
Flat-stem pondweed	---	---	6	6	6	6	6	6
Common arrowhead	---	3	---	---	---	---	---	---
Rigid arrowhead	---	---	---	---	---	8	8	8
Hardstem bulrush	---	---	---	6	---	6	6	6
Three-square bulrush	---	---	5	---	5	---	5	5
Softstem bulrush	4	4	---	---	---	---	---	---
Sago pondweed	3	3	3	3	3	3	3	3
Narrow-leaved cattail	---	1	---	---	---	---	---	---
Small bladderwort	10	---	---	---	---	---	---	---
Small purple bladderwort	9	---	9	9	---	9	9	9
Common bladderwort	7	7	7	7	7	7	---	7
Common watermeal	---	5	---	---	---	---	5	5
Wild celery	6	6	6	6	6	6	6	6
Total Species	23	24	22	21	15	22	25	25
Mean C	6.35	5.33	6.14	6.24	6.00	6.41	6.24	6.28
Floristic Quality Index (FQI)	**30.44**	**26.13**	**28.78**	**28.59**	**23.24**	**30.06**	**31.20**	**31.40**

Appendix C

Figures

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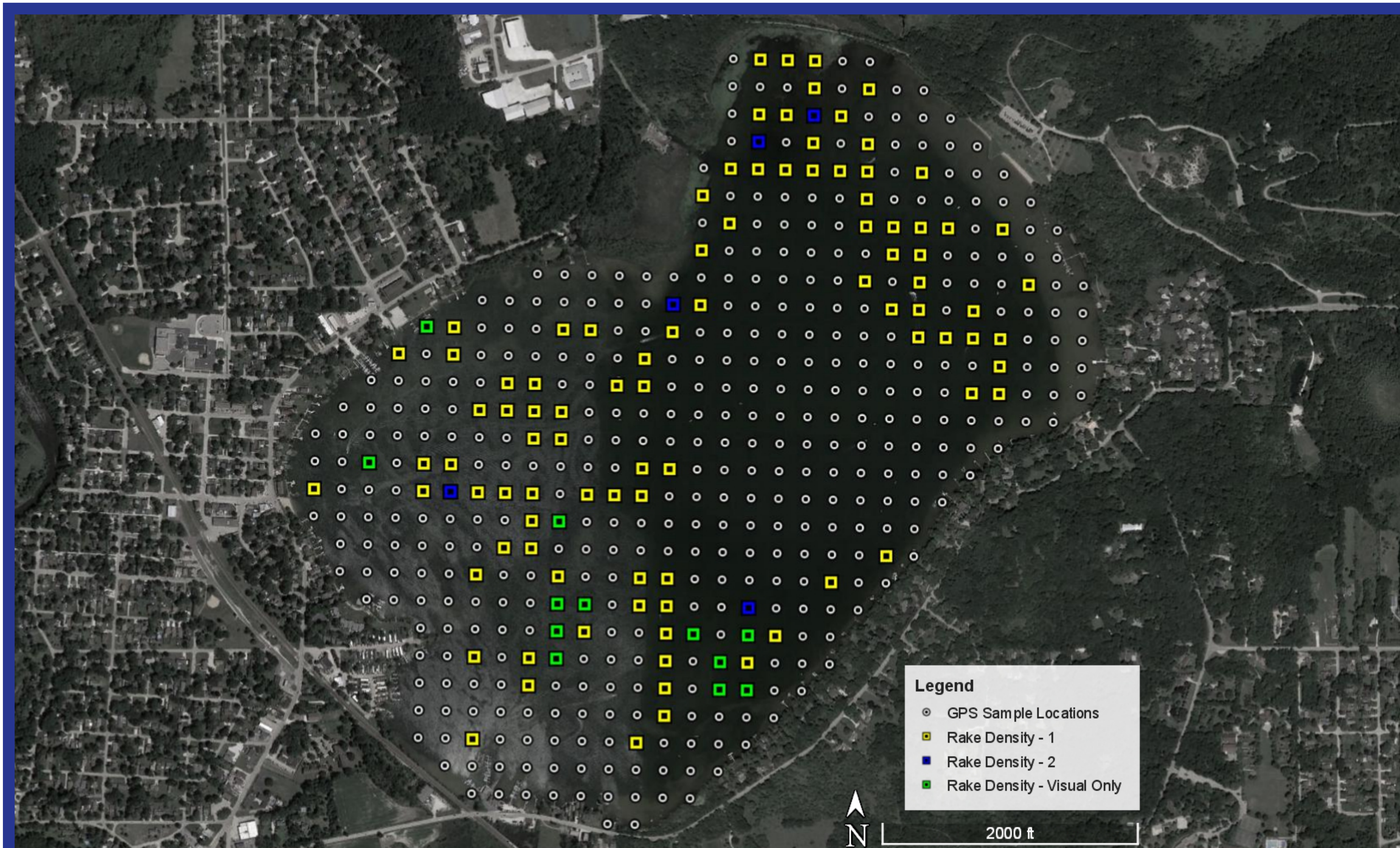
2018 HWM Management Location

Silver Lake, Kenosha County
Surveyed: September 6, 2017
Figure 1



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2019 HWM Locations

Silver Lake, Kenosha County
Surveyed: July 29 & 31, 2019
Figure 2