Silver Lake

Waushara County, Wisconsin

2021 Hybrid Watermilfoil Monitoring and Control Strategy Assessment Report

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EXECUTIVE SUMMARY

Executive Summary authored and submitted by Mark Magnusson – SLMD

Silver Lake Management District (SLMD) has been fighting Eurasian and Hybrid Water Milfoil (EWM/HWM) aquatic invasive species since the year 2000. SLMD has spent greater than $600K (not including DNR grants) to manage EWM/HWM at an acceptable level within the littoral zone of Silver Lake. Spot chemical treatment of 80 acres of EWM/HWM colonies largely with granular 2,4-D (Navigate) occurred from 2000 through 2013. In 2013 concerns that 2,4-D treatment was becoming less effective in EWM/HWM reduction. SLMD applied for a whole lake treatment in 2014 with granular Triclopyr (Renovate OTF). This treatment resulted in an EWM/HWM reduction to 7.8% of the littoral zone. EWM/HWM colonies however rebounded to 20% of the littoral zone in the lake during the spring/summer of 2015.

SLMD applied to the Wisconsin DNR (WI DNR) in 2015 for a whole lake treatment with pelletized fluridone (Sonar One). WI DNR approved the request and a whole lake treatment with Fluridone was performed by Clean Lakes Midwest during spring of 2016. Fluridone pellets were utilized during the initial and 2 bump treatments required which kept the concentration at 2-3 ppb throughout the entire 2016 open water season. A Point Intercept Survey (PIS) in 2017 indicated success with EWM/HWM being only 0.2% of the littoral zone. The districts strategy following the successful whole lake treatment was to maintain the EWM/HWM infestation with Diver Assisted Suction Harvesting (DASH).

DASH was effective in maintaining EWM/HWM as 0.2% of the littoral zone through the spring/summer seasons of 2017 through year 2020. Fox Tail Bay (FTB) had dense surface matting EWM/HWM colonies in 2018/2019. These dense colonies posed a risk to DASH divers and DASH was diverted from FTB to other areas within the lake. Onterra developed a detailed PIS grid in FTB to allow pre/post treatment monitoring and the district applied for a spot herbicide treatment with ProcellaCOR. WI DNR approved the permit and FTB was treated in June 2020. Results from the FTB treatment were excellent with only scattered plants noted on the north end and hand harvesting performed in FTB during 2020 and 2021 seasons.

The 2021 fall PIS survey indicated EWM was 2.5% of the littoral zone. This represents a statistically valid 10-fold increase over the prior years. Most of the problem areas are within the northwest bay by the highway 21 and 73 boat landing. This boat landing also receives most of our transient trailer boat traffic in/out of Silver Lake. Fifteen (15) small EWM/HWM colonies were also noted in other areas of the lake.

The district will maintain the recreation quality of Silver Lake with 7 weeks of DASH harvesting during the 2022 season. An optional 8th week if needed will be requested. The 15 designated small colonies will be harvested first, then focus will shift to the Northwest and Fox Tail Bay problem areas. The 2022 spring meandering survey by Onterra will update the DASH permit with any EWM/HWM colonies or scattered plant areas missed by the 2021 fall mapping survey. The acreage of EWM/HWM colonies and growth however is approaching what will be reasonable to manage with a DASH strategy. The 2022 strategy will be to develop a detailed sampling grid within four (4) northwest bay problem areas and harvest with DASH to prevent surface matting and large colonies. The district will apply for a spot chemical treatment to occur in 2023 within these problem areas with a short exposure time herbicide such as ProcellaCOR (a systemic herbicide).

1.0 INTRODUCTION

[Big] Silver Lake, Waushara County, is a seepage lake with a maximum depth of 48 feet and a mean depth of 21 feet. The lake area as determined through a heads-up digitization of the lake from a 2020 aerial photograph is approximately 360 acres, whereas the WDNR website lists the lake as 328 acres. This mesotrophic lake has a relatively small watershed when compared to the size of the lake (3.5:1). When water levels are near full pool, water exchange occurs with Irogami Lake via a culvert under State Hwy 21 (Figure 1.0-1). Four exotic species are known to exist in Silver Lake: banded mystery snail, curly-leaf pondweed (*Potamogeton crispus*, CLP), Eurasian water milfoil (*Myriophyllum* spicatum, EWM), and zebra mussels. Genetic analysis confirms that the invasive milfoil population is comprised of both EWM and hybrid water milfoil (*M. spicatum x sibiricum*, HWM). Subsequent discussion using "HWM" will represent the collective invasive milfoil population of Silver Lake unless specifically referenced otherwise.

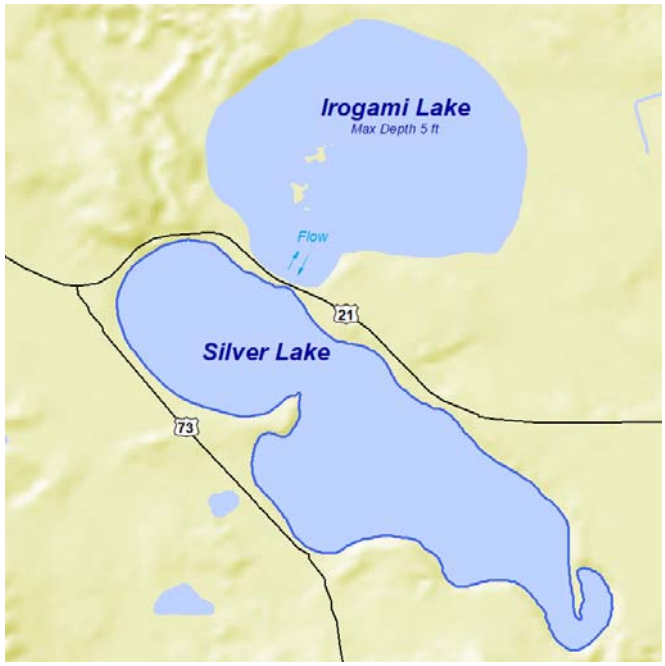


Figure 1.0-1. Silver Lake, Waushara County, Wisconsin.

The Silver Lake Management District (SLMD) is the local citizen-based organization leading the management of Silver Lake. The group has worked for years to protect and enhance the lake, including an increased effort in recent years to control HWM within the lake. The 2014 Aquatic Plant Management Plan recommended the SLMD initiate a large-scale (aka whole-lake) herbicide treatment targeting HWM in Silver Lake. A whole-lake granular triclopyr treatment occurred in June 2014 targeting 180-200 ppb acid equivalent (ae) lake-wide. Triclopyr concentrations fell short of achieving target levels in the main basin of the lake, but were found at higher concentrations in Foxtail Bay. A 20.0% frequency recorded in the 2015 point-intercept survey (*year after treatment*) indicates that the 2014 treatment resulted in only seasonal HWM control. Native plant impacts were relatively limited from the 2014 whole-lake triclopyr treatment.

1.1 2016 Fluridone Treatment Summary

The SLMD contracted with Onterra, LLC during May 2015 to provide technical direction as they pursued their goal to implement a large-scale herbicide treatment strategy during spring of 2016. Onterra developed a three-year control and monitoring strategy in which a large-scale herbicide treatment would occur in year two of the project. Following alternatives analysis, the SLMD decided to move forward with a pelletized fluridone treatment to target HWM in Silver Lake in 2016. Fluridone is a systemic herbicide that requires long exposure times (>90 days) to cause mortality to watermilfoils.

The 2016 treatment included application of pelletized fluridone over 86.4 acres of the littoral zone. The initial herbicide treatment was conducted on May 26, 2016. Based upon reviewing the measured herbicide concentration during the summer as well as technical advice from SePRO, 2 ppb bump

treatments of pelletized fluridone (Sonar One®) were conducted on July 21 and September 1. Herbicide concentration monitoring indicated that fluridone concentrations persisted at a consistent level during the winter months and were detectable as late as July 2017. More specific details related to the 2016 fluridone treatment have been reported on in recent annual reports as a part of this project.

1.2 Integrated Pest Management (2017-Current)

Many lake groups initiate a large-scale herbicide strategy with the intention of implementing smaller-scale control measures (e.g. herbicide spot treatments, hand-removal) when HWM begins rebounding. This is referred to as Integrated Pest Management (IPM) and the approach has shown promise on many lakes. However, the HWM population rebounds on many lakes in a lake-wide fashion that may not always lend well to implementing IPM.

The SLMD initiated a professional hand-harvesting strategy beginning in 2017 targeting the HWM as it begins to rebound following the fluridone treatment. Professional hand-harvesting efforts in 2017 likely aided in maintaining the HWM population at a relatively low level. Details of the 2017 HWM management and monitoring efforts were reported within the *2017 HWM Monitoring and Control Strategy Assessment Report* (January 2018).

The SLMD continued with an IPM HWM management strategy in 2018 that utilized an increased amount of professional DASH efforts. The professional DASH efforts in 2018 were able to effectively maintain or reduce the HWM population in all of the sites in which efforts were undertaken with the exception of Foxtail Bay. Details of the 2018 HWM management and monitoring efforts were reported within the *2018 HWM Monitoring and Control Strategy Assessment Report* (February 2019).

The SLMD was awarded a WDNR AIS-Established Population Control grant during the February 2019 grant cycle. The grant includes funding assistance for a three-year project (2019-2021) to aid in the implementation of an IPM strategy utilizing a combination of professional hand harvesting and spot herbicide treatment in Foxtail Bay with ProcellaCOR™.

During the first year of the project (2019), the SLMD contracted for 40 days of professional hand harvesting services at a cost that exceeded $100,000. During the course of the removal efforts, a total of 1,246 cubic feet of HWM was harvested from the permitted areas. The extended use of DASH was intended to help delay the need for herbicide control strategies in the future. The 2019 DASH efforts met or exceeded lake managers expectation in each of the five designated priority sites. However, the HWM population continued to expand within Foxtail bay and DASH removal efforts fell short of meeting expectations. Overall, the hand-harvesting efforts were effective at managing the HWM populations in most areas where it was applied, however some HWM population increases were observed in areas of the lake that were outside of the targeted areas. Additional details of the 2019 HWM management and monitoring efforts were reported within the *2019 HWM Monitoring and Control Strategy Assessment Report* (January 2020).

The SLMD continued to manage the lake-wide HWM population with a coordinated hand harvesting/DASH control strategy as well as a spatially targeted spot herbicide treatment in Foxtail Bay during the second year of the project in 2020. The 2020 herbicide treatment site showed promising results during the *year of treatment* with reductions in HWM demonstrated through comparative mapping surveys and point-intercept sub-sampling surveys. No significant impacts to the native plant

community were detected in the post-treatment point-intercept survey. It is suspected that the 2020 ProcellaCOR™ treatment likely resulted in some level of HWM control outside of the targeted area of Foxtail Bay. Some of the HWM reductions within the main portion of the lake towards the southern end of the lake were believed to be related to the treatment. The professional hand harvesting efforts that took place during 2020 contributed to the reduction of HWM around Silver Lake. All sites that were included in the 2020 hand harvesting strategy met the pre-determined success criteria. Reductions in the HWM population were observed in all of the 21 sites included on the hand harvesting strategy during 2020. Full details of the HWM monitoring and control activities completed during 2020 were reported within the *2020 HWM Monitoring and Control Strategy Assessment Report* (January 2021).

1.3 2021 HWM Monitoring and Management Strategy

No herbicide management was warranted to occur in 2021 based on the results of the 2020 Late-Summer HWM Mapping Survey. A preliminary HWM management strategy for 2021 included implementing a coordinated hand harvesting and DASH effort with the final strategy to be determined based upon the results of a June 2021 Early Season AIS Survey. A Late-Summer HWM Mapping Survey in 2021 would serve to assess the hand harvesting strategy while also understanding the lake-wide HWM population at its expected peak growth stage.

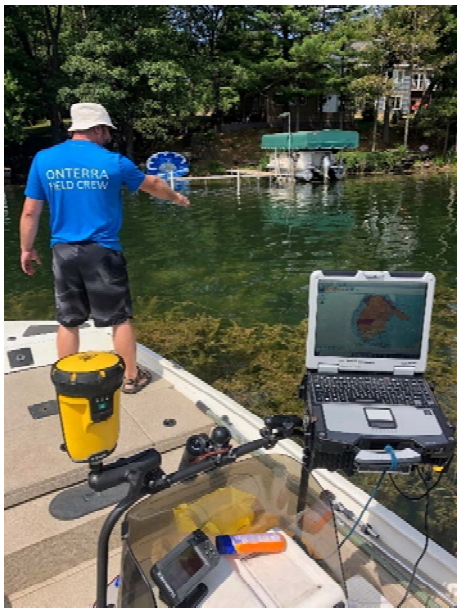
Additional monitoring in 2021 included a replication of the quantitative monitoring associated with the 2020 herbicide treatment in Foxtail Bay as well as a whole-lake point-intercept survey. The 2021 sub point-intercept data collected in Foxtail Bay represent the *year-after-treatment* and would be compared to the data collected during the year-before-treatment (2019) to determine whether the herbicide treatments met the HWM control expectations as well as to understand the potential impacts to the native aquatic plant species in the site.

2.0 2021 AQUATIC PLANT MONITORING RESULTS

It is important to note that two types of surveys are discussed in the subsequent materials: 1) point-intercept surveys and 2) HWM mapping surveys. The point-intercept survey provides a standardized way to gain quantitative information about a lake's aquatic plant population through visiting predetermined locations and using a rake sampler to identify all the plants at each location. The survey methodology allows comparisons to be made over time, as well as between lakes. The point-intercept survey can be applied at various scales. The point-intercept survey is most often applied at the whole-lake scale. The whole-lake point-intercept survey has been conducted on Silver Lake annually since 2012, with the exception of 2016.

If a smaller area is being studied, a modified and finer-scale point-intercept sampling grid may be needed to produce a sufficient number of sampling points for comparison purposes. This sub-sample point-intercept survey methodology is often applied over management areas such as herbicide application sites. This type of sampling is used within this project as a part of the Foxtail Bay herbicide treatment monitoring.

While the point-intercept survey is a valuable tool to understand the overall plant population of a lake, it does not offer a full account (census) of where a particular species exists in the lake. During the HWM mapping survey, the entire littoral area of the lake is surveyed through visual observations from the boat (Photograph 2.0-1). Field crews supplement the visual survey by deploying a submersible camera along with periodically doing rake tows. The HWM population is mapped using sub-meter GPS technology by using either 1) point-based or 2) area-based methodologies. Large colonies >40 feet in diameter are mapped using polygons (areas) and are qualitatively attributed a density rating based upon a five-tiered scale from *highly scattered* to *surface matting*. Point-based techniques were applied to AIS locations that were considered as *small plant colonies* (<40 feet in diameter), *clumps of plants*, or *single or few plants*.



Photograph 2.0-1. EWM mapping survey on a Waushara County, WI lake. Photo credit Onterra.

A pair of HWM mapping surveys were used to coordinate and monitor the professional hand-harvesting efforts in Silver Lake. An Early Season AIS Survey (ESAIS) is employed with the purpose of finalizing the hand-harvesting strategy for the summer. After hand-harvesting is completed, Onterra ecologists conduct the Late-Summer HWM Mapping Survey, the results of which serve as a post-harvesting assessment of the hand-removal efforts.

Overall, each survey has its strengths and weaknesses, which is why both are utilized in different ways as part of this project. A whole-lake point-intercept survey, a sub-sample point-intercept survey within Foxtail Bay, and two HWM mapping surveys (ESAIS and Late-Summer HWM Mapping Survey) occurred in 2021 on Silver Lake and are discussed within this report.

2.1 Early-Season AIS Survey (ESAIS)

The ESAIS survey was completed on Silver Lake on May 26, 2021. The main purpose of the survey was to assess the HWM population and then update the hand harvesting/DASH strategy for the rest of the summer. During the survey, the crews noted fair conditions with moderate wind and mostly sunny skies. The results of the mapping survey are displayed on Map 1.

Overall, the HWM population was found to have increased since the previous survey which was completed in September 2020. The HWM population mostly consisted of point-based occurrences, with the exception of a few *scattered* and *highly scattered* colonies on the northwest end of the lake. Minimal HWM was located in the southern half of the lake and just eight *single or few plant* occurrences were located in shallow waters within Foxtail Bay. The results of the survey were used to finalize the DASH sites to be included on the 2021 permit which included nine sites totaling 11.2 acres. A tenth site was subsequently added to the DASH permit following a July point-intercept survey resulting in 11.74 total permitted acres. All sites were given a prioritization as either first, second, or third priority for harvesting efforts based on the sites with the largest HWM population having the higher priority designation. Onterra provided the spatial data reflecting the ESAIS results to the professional harvesting firm in the form of a GPS compatible basemap.

2.2 Professional Hand-Harvesting Actions

The SLMD contracted with Aquatic Plant Management, LLC in 2021 to provide professional DASH and hand harvesting services. Diving activities spanned from June 14 to September 2, 2021. It total, 2,795 cubic feet of HWM were removed from Silver Lake in 2021 over the course of 183.8 underwater diving hours over 218 dives (Table 2.2-1). All of the 2021 DASH permitted sites saw harvesting efforts over the course of the season. Sites that saw the greatest amount of harvesting effort during 2021 include sites 21e-G, 21e-B, and 21e-H.

Minimal additional professional hand harvesting efforts took place with traditional harvesting methods (no DASH) including known isolated HWM occurrences in Foxtail Bay. Additional details related to the professional harvesting actions are included in a summary dive report created by APM, LLC as an appendix to this report.

Table 2.2-1. Silver Lake 2021 professional DASH and hand harvesting activities. Table extracted from APM, LLC EWM Removal Report – Appendix A

Dive Location	Avg. Water Depth	# of Dives	Underwater Dive Time	AIS Removed (cubic feet)
21e-g	8.8	53	43.2	725.0
21p-j	10.6	18	17.7	492.5
21e-b	7.5	35	32.5	400.5
21e-h	6.5	36	26.9	264.0
21e-d	7.1	22	17.8	246.5
21e-e	6.3	16	14.3	209.0
21e-a	12.5	14	11.3	170.0
21e-i	8.4	10	8.5	139.0
21e-f	6.9	9	8.5	123.5
21e-c	7.5	2	1.2	18.0
FTB	5.0	2	1.3	4.0
Ed's	6.0	1	0.8	3.0
Grand Total	8.1	218	183.8	2795.0

Months	Week Ending	Water Temp (F)	Underwater Dive Time (hrs)	AIS Removed (cubic ft)
Jun	20-Jun	77	19.1	129.0
	27-Jun	73	26.4	278.0
Jul	4-Jul	76	10.3	165.0
	11-Jul	78	4.5	75.0
	18-Jul	78	6.2	97.0
Aug	1-Aug	78	16.6	465.0
	8-Aug	76	23.4	346.0
	15-Aug	77	34.4	369.0
	22-Aug	76	19.4	474.0
	29-Aug	76	5.8	95.0
Sep	5-Sep	76	17.8	302.0
Grand Total			183.8	2795.0

2.3 Late-Summer HWM Mapping Survey

Onterra ecologists completed a late-summer HWM mapping survey on Silver Lake on September 10, 2021. Survey crews noted excellent conditions during the survey with mostly sunny skies and calm winds. A Secchi disk measurement of 15.1 feet confirmed high water clarity at the time of the survey. A submersible camera was not necessary during the survey as the majority of the HWM population was apparent and prominent within the water column. The results of the Late-Summer HWM Mapping Survey are displayed on Map 2. The HWM population was found to have expanded since the previous survey conducted in May 2021, with a nearly contiguous area of low density colonized HWM within

much of the northwestern end of the lake. Numerous *single plants*, *clumps of plants*, and *small plant colonies* were also mapped in littoral areas of the lake including isolated occurrences in the southern portions of the lake including Foxtail Bay.

A total of 13.7 acres of colonized HWM were mapped within the lake of which 6.44 acres were of the lowest density rating – *highly scattered*. A *highly scattered* colony does not always have a defined "edge" to the colony but is often rather a concentration of many individual HWM occurrences that are too numerous to account for each with point-based mapping methodologies. An additional 5.86 acres of HWM was delineated and designated as of a *scattered* density, and another 1.42 acres was delineated of a *dominant* density rating. No HWM colonies were described as either *highly dominant* or *surface matted*.

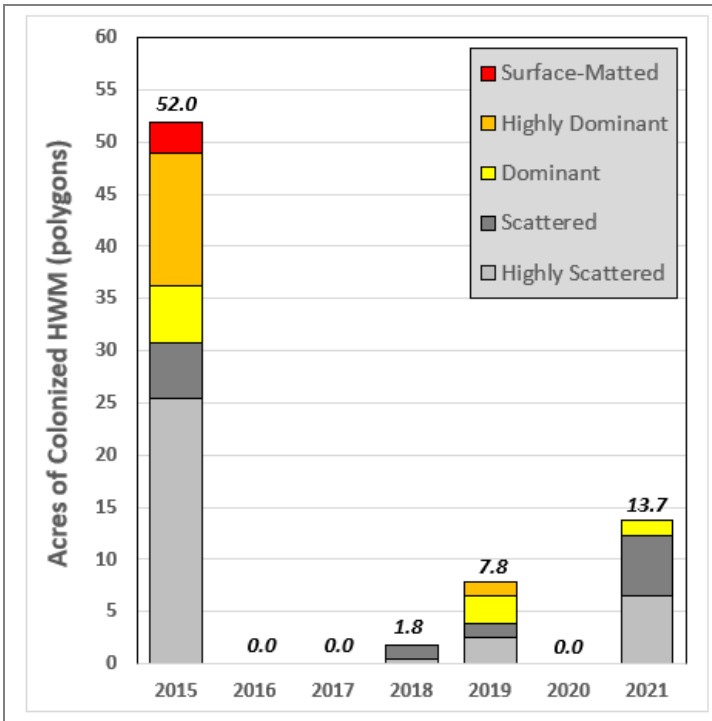


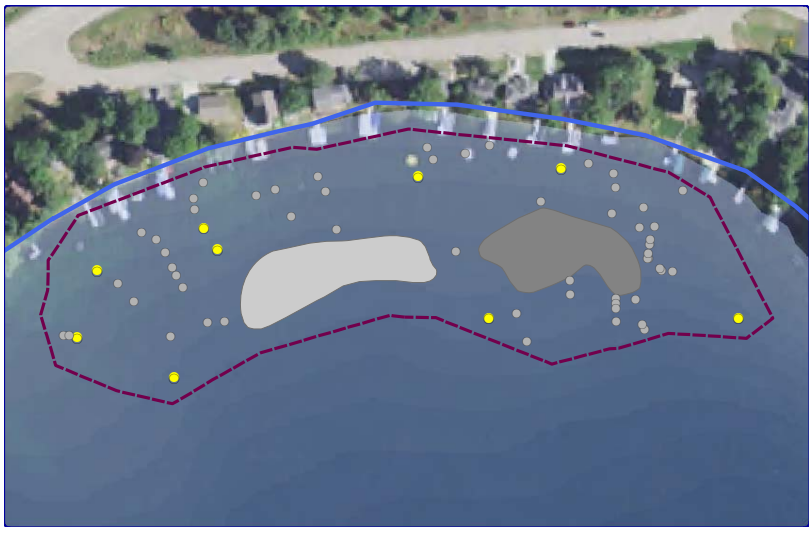
Figure 2.3-1. Acreage of HWM colonies in Silver Lake from 2015-2021. Data from annual Onterra Late-Summer HWM Mapping Surveys.

It is important to note that acreages of HWM only account for colonies mapped with area-based methodologies (polygons) and does not account for point-based HWM occurrences such as *single plants*, *clumps of plants*, or *small plant colonies*. The 13.7 acres of HWM mapped in the September 2021 survey is the largest amount of colonized HWM documented since 2015 which was the year prior to a whole-lake herbicide treatment; however, the 2021 HWM acreage totals remains far lower than the 52.0 acres mapped in 2015 (Figure 2.3-1).

Three sites were given first priority for professional hand harvesting removal efforts during 2021 based on the having the largest HWM population at the time of the June 2021 ESAIS survey. The figures below highlight the first priority DASH sites in 2021 along with site 21e-B which saw a substantial amount of DASH efforts and harvest. Comparisons of the HWM population in the remaining DASH work sites can be made by comparing Map 1 (May 2021 ESAIS) and Map 2 (September 2021 HWM mapping survey).

Site 21e-G was prioritized for harvesting efforts based on the presence of scattered and highly scattered HWM colonies as well as numerous *singles* or *clumps of plants* at the time of the May 2021 ESAIS survey (Figure 2.3-2, top frame). Professional DASH efforts in this site totaled 43.2 hours and yielded a harvest of 725 cubic feet of HWM (Table 2.2-1, appendix A). The September 2021 HWM mapping survey indicated an increase in HWM density within the site with most of the site containing colonized HWM of either *highly scattered*, *scattered*, or *dominant* densities (Figure 2.3-2, bottom frame). The 2021 DASH efforts in this site did not meet control expectations as the HWM population increased in size and density between the 2021 ESAIS and Late-Summer surveys.

May 2021 (Pre Hand-Harvesting)



Dive Time: 43.2 hours
HWM Harvest Total: 725.0 cubic feet

September 2021 (Post Hand Harvesting)

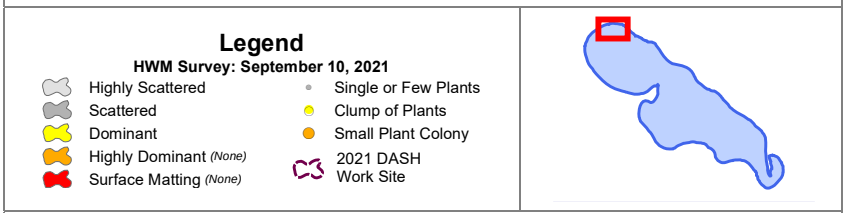


Figure 2.3-2. HWM populations from before (May 2021) and after (September 2021) professional hand-harvesting efforts at site 21e-G in Silver Lake.

Site 21e-H was included as a first priority DASH site based on the presence of a scattered HWM colony as well as small plant colonies, clumps of plants, and single plants identified in the site during the 2021 ESAIS survey (Figure 2.3-3, left frame). Professional DASH activities in the site totaled 26.9 hours of dive time and resulted in a harvest of 264 cubic feet of HWM. The September 2021 HWM mapping survey indicated an increase in the

HWM population within the site compared to the 2021 ESAIS survey with much of the site containing colonized HWM of variable densities (Figure 2.3-3, right frame). The 2021 DASH efforts in site 21e-H fell short of meeting the control success criteria.

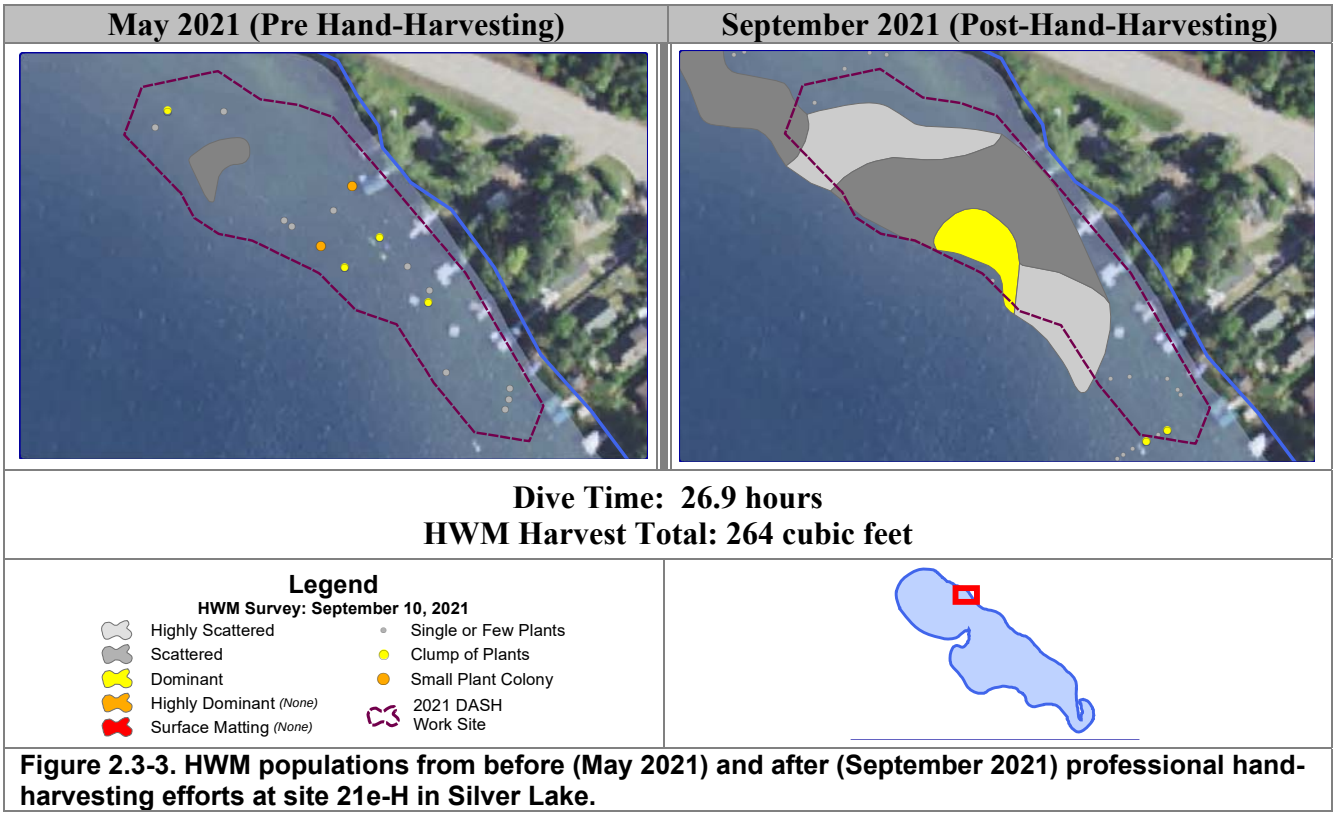
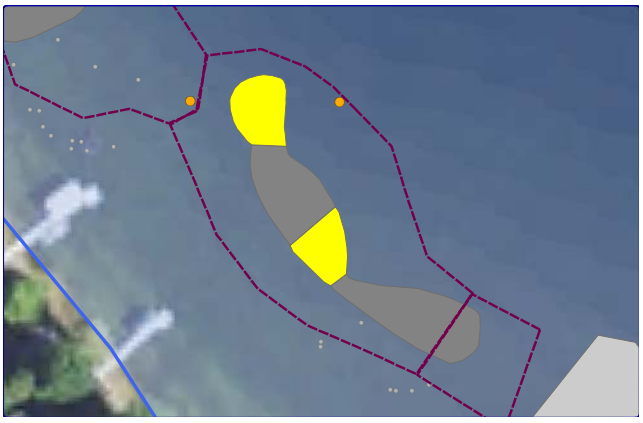


Figure 2.3-3. HWM populations from before (May 2021) and after (September 2021) professional hand-harvesting efforts at site 21e-H in Silver Lake.

Onterra staff identified a *dominant* density colony of HWM during a July whole-lake point-intercept survey in Silver Lake which was ultimately added to the 2021 DASH permit as site 21p-J and given first priority for removal (Figure 2.3-4, left frame). Professional DASH efforts in the site totaled 17.7 hours of dive time and resulted in a harvest of 492.5 cubic feet of HWM. The September 2021 HWM mapping survey showed a reduction in size of the colony along with a decrease in density from *dominant* to *scattered* within much of the original colony (Figure 2.3-4, right frame). The 2021 DASH efforts in site 21p-J resulted in a decreased HWM population in the site; however, fell short of meeting the pre-determined success criteria for the site.

Site 21e-B was given second priority for DASH removal efforts following the 2021 ESAIS survey which documented two *small plant colonies* and three *clumps* of HWM present in the site at the time (Figure 2.3-5, left frame). Professional DASH efforts in this site totaled 32.5 hours and resulted in the harvest of 400.5 cubic feet of HWM. The September HWM mapping survey indicated minimal HWM present in much of the site with the exception of the northern-most end of the site where a *highly scattered* colony was present in the vicinity (Figure 2.3-5, right frame). The 2021 DASH efforts in this site fell just short of meeting the success criteria; however, HWM appears to have been largely controlled within this site in 2021.

July 2021 (Pre Hand-Harvesting)	September 2021 (Post-Hand-Harvesting)
	

Dive Time: 17.7 hours
HWM Harvest Total: 492.5 cubic feet

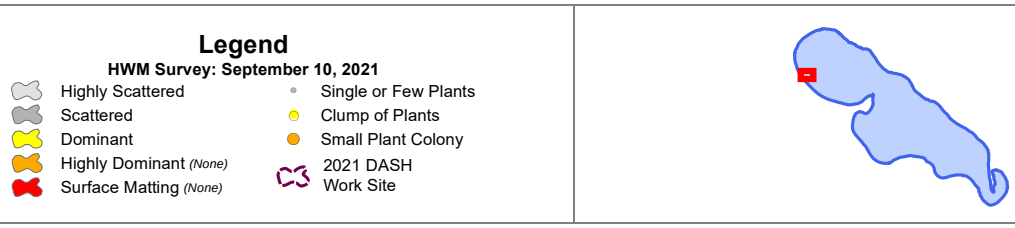


Figure 2.3-4. HWM populations from before (May 2021) and after (September 2021) professional hand-harvesting efforts at site 21p-J in Silver Lake.

May 2021 (Pre Hand-Harvesting)	September 2021 (Post-Hand-Harvesting)

Dive Time: 32.5 hours
HWM Harvest Total: 400.5 cubic feet

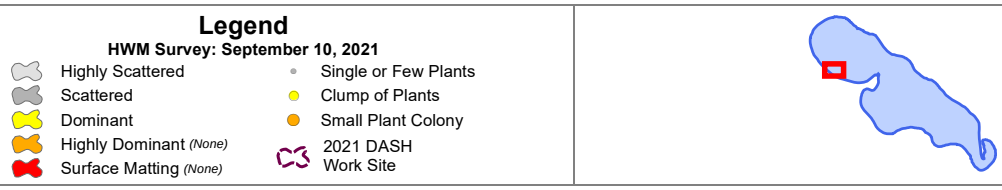


Figure 2.3-5. HWM populations from before (May 2021) and after (September 2021) professional hand-harvesting efforts at site 21e-B in Silver Lake.

The late-summer survey is used to evaluate the management efforts occurring on the system and also allows for an understanding of the full extent of the HWM distribution around Silver Lake. Defining control expectations for the hand harvesting program for 2021 would be done in two ways: a site-by-site basis as well as on a lake-wide basis, similar to the way in which the 2020 program was evaluated.

Site-by-Site Success Criteria: The 2021 DASH strategy would be evaluated on a site-by-site basis by comparing the pre-harvesting population mapped during the 2021 ESAIS survey to the late-summer 2021 post-harvesting survey. This evaluation would be specific to the priority areas that were included on the 2021 DASH permit.

1) Sites that contained colonized HWM in early summer 2021 would meet success criteria if the post-harvesting survey indicates that no colonized areas of HWM were present in the site and any remaining HWM in the site could be mapped using point-based mapping methods (i.e. *singles, clumps,* or *small plant colonies*).

2) The 2021 priority sites that contained *small plant colonies* or *clumps of plants* in the early-summer 2021 survey would meet control expectations by exhibiting a decrease in the HWM population as demonstrated by a reduction in the size or number of HWM *small plant colonies* or *clumps of plants* occurrences present in the site between the 2021 early-summer and late-summer surveys.

Lake-wide Success Criteria: The goal of the 2021 DASH strategy on a lake-wide scale is the same as was developed for the 2020 strategy which is to manage the HWM population in the main body of the lake at relatively low levels such that there is likely to be minimal negative impacts to the riparian's use of the lake for activities like boating or swimming. A realistic outcome for this goal may be met by suppressing the lake-wide population such that no HWM colonies reach a size over one acre and a density of *dominant* or greater by the time of the September 2021 survey.

Based on an evaluation of the HWM mapping surveys conducted in Silver Lake in 2021, the lake-wide professional hand harvesting program success criteria were approximately met. The September 2021 HWM mapping survey identified minimal dense HWM colonies characterized as either *dominant*, *highly dominant*, or *surface matted* in density. It is likely that for the majority of the 2021 growing season that HWM densities were maintained below density levels likely to contribute to any impacts to lake users' ability to recreate in the lake. Although 13.7 total acres of colonized HWM were mapped in the lake during the September 2021 survey, no contiguous areas of *dominant* or greater density exceeded one acre in size.

Table 2.3-1 displays the site-by-site success criteria evaluation for the sites that were included in the 2021 DASH permit. None of the ten sites included in the 2021 DASH strategy met the pre-determined success criteria threshold.

Table 2.3-1. 2021 Professional HWM Hand-Harvesting Summary & Success Criteria Evaluation

2021 HWM Hand-Harvest Control Strategy			DASH & Hand Harvesting Summary		May 2021 (Pre Hand-Harvest)	September 2021 (Post Hand-Harvest)	Success Criteria Met?
Site	Acres	Priority (SLMD)	Time (hours)	Harvest (cubic feet)	AIS Density	AIS Density	
21e-A	0.1	3rd	11.3	170.0	Pnt (C)	PG (Scattered)	No
21e-B	1.8	2nd	32.5	400.5	Pnts (SPC, C)	PG(Highly Scattered), Pnts (C,S)	No
21e-C	0.1	3rd	1.2	18.5	Pnt (C)	PG (Scattered)	No
21e-D	0.4	3rd	17.8	246.5	Pnts (C)	PG(Scattered), Pnts (SPC, S)	No
21e-E	0.4	2nd	14.3	209.0	Pnts (SPC, S)	PG(Scattered), Pnts (S)	No
21e-F	0.5	3rd	8.5	123.5	Pnts (S,C)	PGs(Scattered, Highly Scattered)	No
21e-G	5.1	1st	43.2	725.0	PGs(Scattered, Highly Scattered), Pnts (S,C)	PGs(Dominant, Scattered, Highly Scattered	No
21e-H	1.9	1st	26.9	264.0	PG (Scattered), Pnts (SPC,C,S)	PGs(Dominant, Scattered, Highly Scattered), Pnts (C,S)	No
21e-I	0.9	2nd	8.5	139.0	Pnts (SPC,C,S)	PG (Highly Scattered), Pnts (S)	No
21p-J	0.6	1st	17.7	492.5	Pnt (S)	PGs(Dominant, Scattered), Pnts (SPC,S)	No
Total			**181.9**	**2,788.5**	*Pnts= Only Point-Based Mapping, PGs = Includes Polygon-Based Mapping SPC = Small Plant Colony, CL = Clumps of Plants, S = Single or Few Plants*		

2.4 Whole-Lake Point-Intercept Survey

Aquatic Plants Primer

Native aquatic plants are an important element in every healthy aquatic ecosystem, providing food and habitat to wildlife, improving water quality, and stabilizing bottom sediments. Because most aquatic plants are rooted in place and are unable to relocate in wake of environmental alterations, they are often the first community to indicate that changes may be occurring within the system. Aquatic plant communities can respond in a variety of ways; there may be increases or declines in the occurrences of some species, or a complete loss. Or, certain growth forms, such as emergent and floating-leaf communities may disappear from certain areas of the waterbody. With periodic monitoring and proper analysis, these changes are relatively easy to detect and provide relevant information for making management decisions.

The point-intercept method as described in the WDNR publication (WDNR PUB-SS-1068 2010) was used to complete this study. A point spacing of 40 meters was used resulting in 826 total sampling locations, with between 447-564 sampling locations being located within the littoral zone during the period of study. This survey allows for a quantitative analysis of the aquatic plant community in the lake and is directly comparable to past or future surveys completed with the same methodology. Whole-lake point intercept surveys have been conducted on Silver Lake every year since 2012, with the exception of 2016, with the purpose of quantitatively monitoring the aquatic plant population during a period of active HWM management (Appendix B).

A pole-mounted rake was used to collect the plant samples, depth, and sediment information at point locations of 15 feet or less. A rake head tied to a rope (rope rake) was used at sites greater than 15 feet. Depth information was collected using graduated marks on the pole of the rake (at depths < 15 ft) or using an onboard sonar unit (at depths > 15 feet). Also, when a rope rake was used, information regarding substrate type was not collected due to the inability of the sampler to accurately "feel" the bottom with this sampling device. At each point that is sampled the surveyor records a total rake fullness (TRF) value ranging from 0-3 as a somewhat subjective indication of plant biomass (Figure 2.4-1). The

point-intercept survey produces a great deal of information about a lake's aquatic vegetation and overall health. These data are analyzed and presented in numerous ways; each is discussed in more detail the following section.

Figure 2.4-1. Total rake fullness (TRF) ratings.

Frequency of Occurrence

Frequency of occurrence describes how often a certain aquatic plant species is found within a lake. Obviously, all of the plants cannot be counted in a lake, so samples are collected from pre-determined areas. In the case of the whole-lake point-intercept surveys that have been completed; plant samples were collected from plots laid out on a grid that covered the lake. Using the data collected from these plots, an estimate of occurrence of each plant species can be determined. The occurrence of aquatic plant species is displayed as the *littoral frequency of occurrence*. Littoral frequency of occurrence is used to describe how often each species occurred in the plots that are within the maximum depth of plant growth (littoral zone), and is displayed as a percentage.

Littoral Zone is the area of a lake where sunlight is able to penetrate down to the sediment and support aquatic plant growth.

Relative frequency of occurrence uses the littoral frequency for occurrence for each species compared to the sum of the littoral frequency of occurrence from all species. These values are presented in percentages and if all of the values were added up, they would equal 100%. For example, if water lily had a relative frequency of 0.1 and we described that value as a percentage, it would mean that water lily made up 10% of the population.

Floristic Quality Assessment

The floristic quality of a lake's aquatic plant community is calculated using its native *species richness* and their *average conservatism*. Species richness is the number of native aquatic plant species that were physically encountered on the rake during the point-intercept survey. Average conservatism is calculated by taking the sum of the coefficients of conservatism (C-values) of the native species located and dividing it by species richness. Every plant in Wisconsin has been assigned a coefficient of conservatism, ranging from 1-10, which describes the likelihood of that species being found in an undisturbed environment. Species which are more specialized and require undisturbed habitat are given higher coefficients, while species which are more tolerant of environmental disturbance have lower coefficients.

On their own, the species richness and average conservatism values for a lake are useful in assessing a lake's plant community; however, the best assessment of the lake's plant community health is determined when the two values are used to calculate the lake's floristic quality. The floristic quality is calculated using the species richness and average conservatism value of the aquatic plant species that were solely encountered on the rake during the point-intercept surveys (equation shown below). This

assessment allows the aquatic plant community of Silver Lake to be compared to other lakes within the region and state.

FQI = Average Coefficient of Conservatism * √ Number of Native Species

Silver Lake falls within the North Central Hardwood Forests (NCHF) *ecoregion* (Figure 2.4-2), and the floristic quality of its aquatic plant community will be compared to other lakes within this ecoregion as well as the entire State of Wisconsin. Ecoregions are areas related by similar climate, physiography, hydrology, vegetation and wildlife potential. Comparing ecosystems within the same ecoregion is sounder than comparing systems within manmade boundaries such as counties, towns, or states. Ecoregional and state-wide medians were calculated from whole-lake point-intercept surveys conducted on 392 lakes throughout Wisconsin by Onterra and WDNR ecologists.

Figure 2.4-2. Location of Silver Lake within the ecoregions of Wisconsin. After Nichols 1999.

Species Diversity

Species diversity is often confused with species richness. As defined previously, species richness is simply the number of species found within a given community. While species diversity utilizes species richness, it also takes into account evenness or the variation in abundance of the individual species within the community. For example, a lake with 10 aquatic plant species that had relatively similar abundances within the community would be more diverse than another lake with 10 aquatic plant species were 50% of the community was comprised of just one or two species.

An aquatic system with high species diversity is more stable than a system with a low diversity. This is analogous to a diverse financial portfolio in that a diverse aquatic plant community can withstand environmental fluctuations much like a diverse portfolio can handle economic fluctuations. Some managers believe a lake with a diverse plant community is also better suited to compete against exotic infestations than a lake with a lower diversity. However, in a recent study of 1,100 Minnesota lakes, researchers concluded that more diverse communities were not more resistant or resilient to invaders (Muthukrishnan et al. 2018).

The diversity of a lake's aquatic plant community is determined using the Simpson's Diversity Index (1-D):

$$D = \sum (n/N)^2$$

where:
n = the total number of instances of a particular species
N = the total number of instances of all species
D is a value between 0 and 1

If a lake has a diversity index value of 0.90, it means that if two plants were randomly sampled from the lake there is a 90% probability that the two individuals would be of a different species. The Simpson's

Diversity Index value from the Silver Lake is compared to data collected by Onterra and the WDNR Science Services on 212 lakes within the North Central Hardwood Forests (lakes only, does not include flowages) Ecoregion and on 392 lakes throughout Wisconsin.

Onterra ecologists conducted the whole-lake point-intercept survey on Silver Lake on July 12 & 16, 2021. Figure 2.4-3 displays the littoral frequency of occurrence of aquatic plants located in the 2021 point-intercept survey. A total of 25 species were physically encountered on the survey rake during the 2021 survey of which two, Eurasian watermilfoil and curly-leaf pondweed, are non-native exotic species. The maximum depth of plant growth in the 2021 survey was 32 feet.

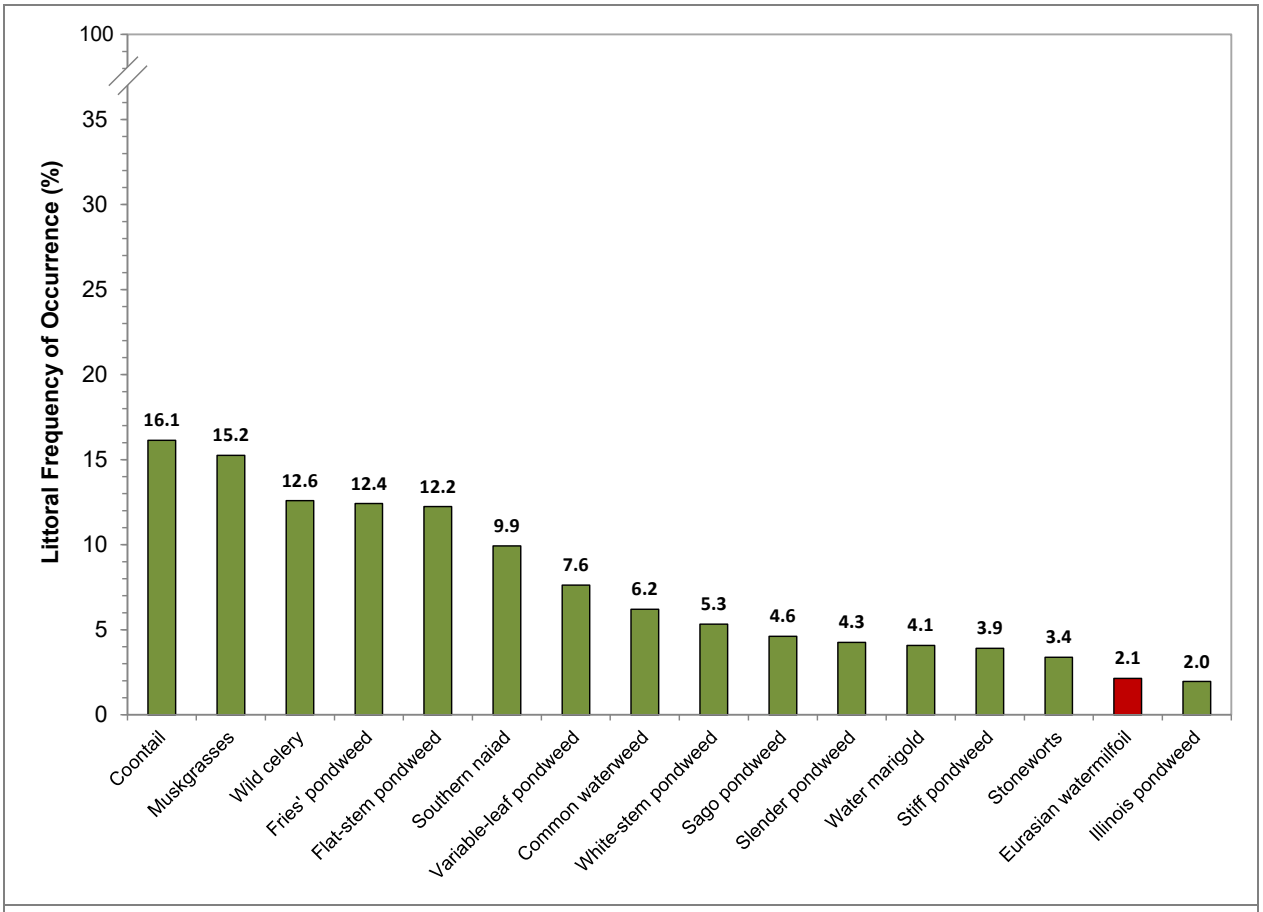


Figure 2.4-3. Littoral frequency of occurrence of aquatic plant species from a 2021 whole-lake point-intercept survey in Silver Lake.

Coontail was the most frequently encountered aquatic plant in Silver Lake in 2021 with a littoral frequency of occurrence of 16.1% (Figure 2.4-3). As its name indicates, the shape of this plant resembles the tail of a racoon. Coontail has whorls of leaves which fork into two to three segments, and provides ample surface area for the growth of periphyton and habitat for invertebrates. Unlike most of the submersed plants found in Wisconsin, coontail does not produce true roots and is often found growing entangled amongst other aquatic plants or matted at the surface. Because it lacks true roots, coontail derives most of its nutrients directly from the water (Gross, Erhard and Ivanyi 2003). This ability in combination with a tolerance for low-light conditions allows coontail to become more abundant in eutrophic waterbodies with higher nutrients and low water clarity. Coontail has the capacity to form dense beds that can float and mat on the water's surface. Coontail has consistently been one of the most

frequently encountered species in point intercept surveys dating back to 2012 (Figure 2.4-4). Coontail initially decreased in occurrence following the 2016 herbicide treatment and has remained at approximately the same levels in recent years.

According to a fluridone susceptibility analysis completed by the WDNR Science Services Department, common waterweed and coontail were shown to be particularly sensitive to fluridone treatments. The occurrence of common waterweed was reduced to 0% in 2017 after the fluridone treatments and has been slow to recover in recent years (Figure 2.4-4). The 6.2% occurrence of common waterweed in 2021 represented a statistically valid increase compared to the previous survey. The occurrence of common waterweed remains lower than was documented during 2012-2015 in Silver Lake.

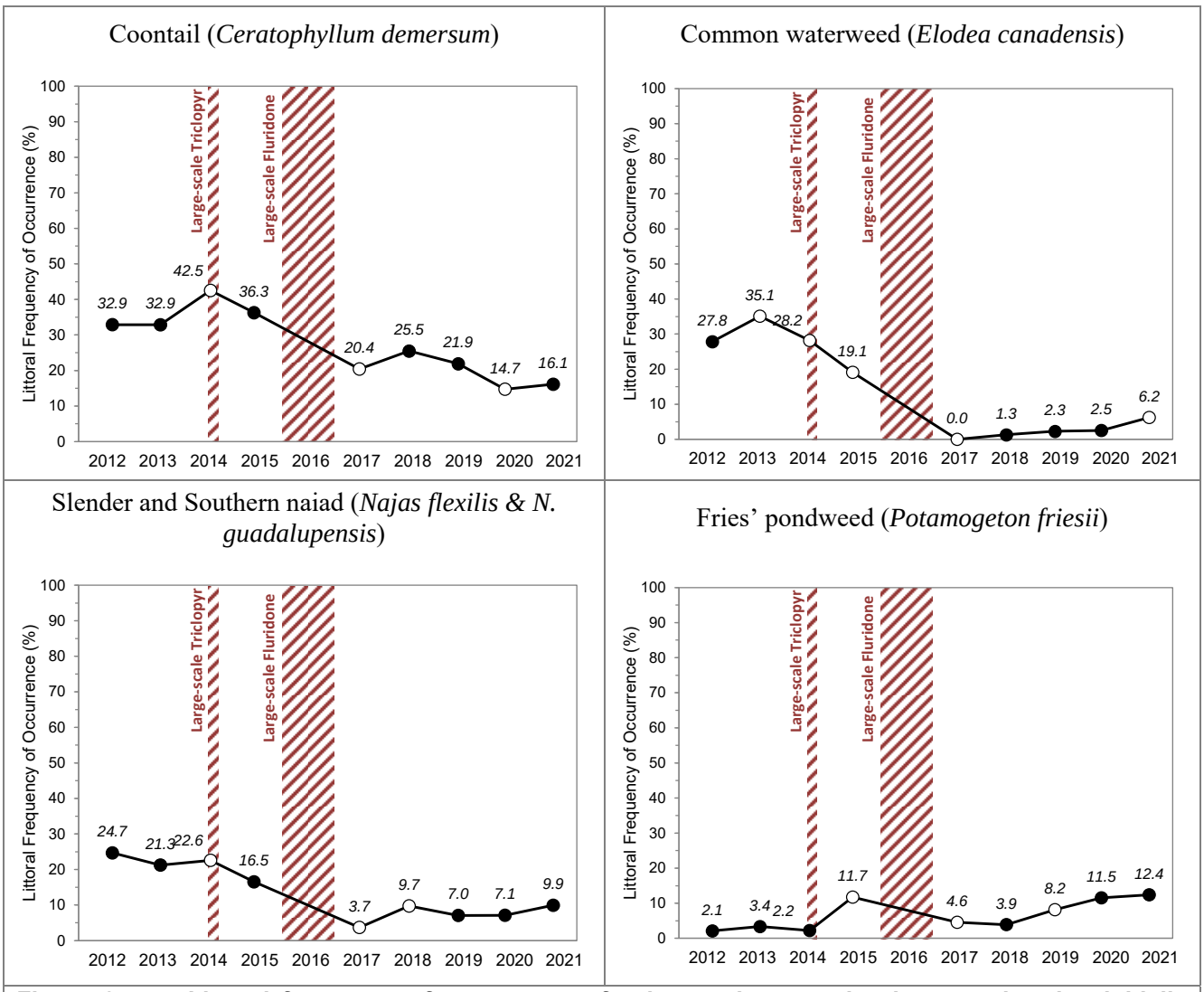


Figure 2.4-4. Littoral frequency of occurrence of select native aquatic plant species that initially decreased in occurrence following a 2016 fluridone treatment. Open circle represents statistically valid change in occurrence from previous survey.

Slender and southern naiad are morphologically similar, and distinguishing between them in the field is often difficult. Therefore, within the following analysis, the occurrences of slender and southern naiad are combined for analysis purposes. Slender naiad reproduces via a seed bank that is deposited into the lake sediments, therefore this species often decreases in the year of treatment before returning to

pretreatment levels by the year-after-treatment. After initially declining to 3.7% following the fluridone treatment, the occurrence increased in 2018 to 9.7% and has remained relatively in recent years (Figure 2.4-4). Fries' pondweed exhibited an occurrence of 12.4% in 2021, which is slightly above pre-treatment levels documented in 2015 (Figure 2.4-4). The occurrence of Fries' pondweed has shown an increasing trend in Silver Lake since 2018.

Muskgrasses were the second-most frequently encountered native plant in Silver Lake, being located in 2021 at 15.2% of the sampling points within the littoral zone (Figure 2.4-3). Muskgrasses and stoneworts are genera of macroalgae. These macroalgae require lakes with good water clarity, and their large beds stabilize bottom sediments. Studies have also shown that muskgrasses sequester phosphorus in the calcium carbonate incrustations which form on these plants, aiding in improving water quality by making the phosphorus unavailable to phytoplankton (Coops 2002). As macroalgae, they are typically resilient to most herbicide use-patterns. Due to their morphological similarity muskgrasses (*Chara* spp.) and stoneworts (*Nitella* spp.) were combined for the analysis as 'charophytes', but also shown separately on Figure 2.4-5. The populations of muskgrasses and stoneworts remained relatively stable between 2012 and 2018 but have trended slightly lower since 2018.

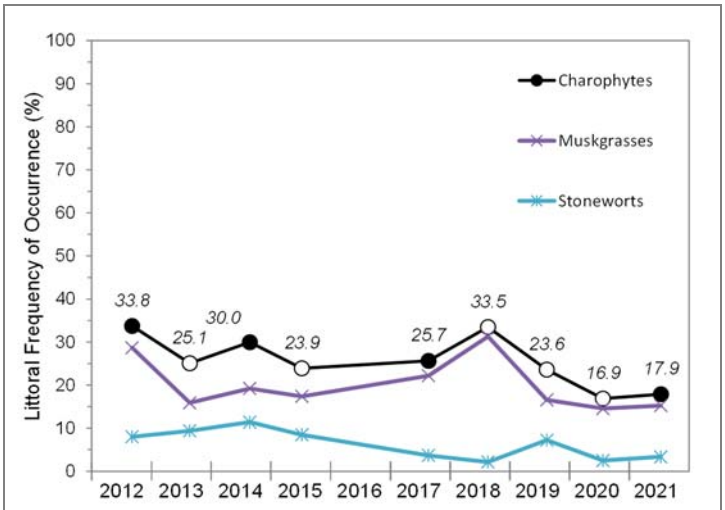


Figure 2.4-5. LFOO of muskgrasses (Chara spp.) and stoneworts (Nitella spp.) from 2012-2021 in Silver Lake.

Several genera of aquatic mosses may be found in Wisconsin of which *Fissidens*, *Drepanocladus*, and *Fontinalis* are some of the most commonly encountered in Wisconsin lakes. Aquatic mosses are relatively common in lakes, particularly in deeper water depths. In Silver Lake, aquatic mosses have often been the only species located at water depths beyond 30 feet, with some occurrences located as deep as 33 feet (Photo 2.4-1). The occurrence of aquatic moss has been variable in recent years with statistically valid changes in occurrence yearly since 2017 (Figure 2.4-6).

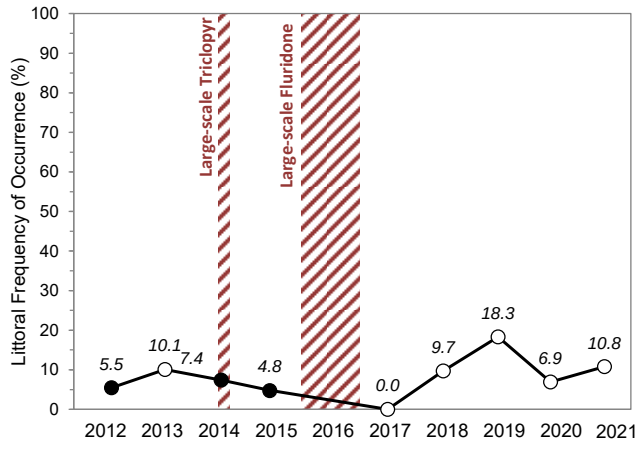


Figure 2.4-6. LFOO of aquatic moss from 2012-2021 in Silver Lake.

Photo 2.4-1. Aquatic moss. Photo credit Onterra.

Figure 2.4-7 highlights four additional native aquatic plant species that have been frequently encountered on point-intercept surveys in Silver Lake. Some species have shown very stable populations over time with few statistically valid changes from one survey to the next such as sago pondweed or wild celery. Variable-leaf pondweed populations have fluctuated over time and were lowest (3.5%) during 2017 after the whole-lake fluridone treatment. The occurrence of variable-leaf pondweed decreased following the fluridone treatment before recovering the following year to an occurrence of 15.1% in 2018. The occurrence of variable-leaf pondweed has been between 7.5-7.6% in 2020-2021. The occurrence of water marigold has increased in recent years from 0% in 2012 to 4.1% in 2021.

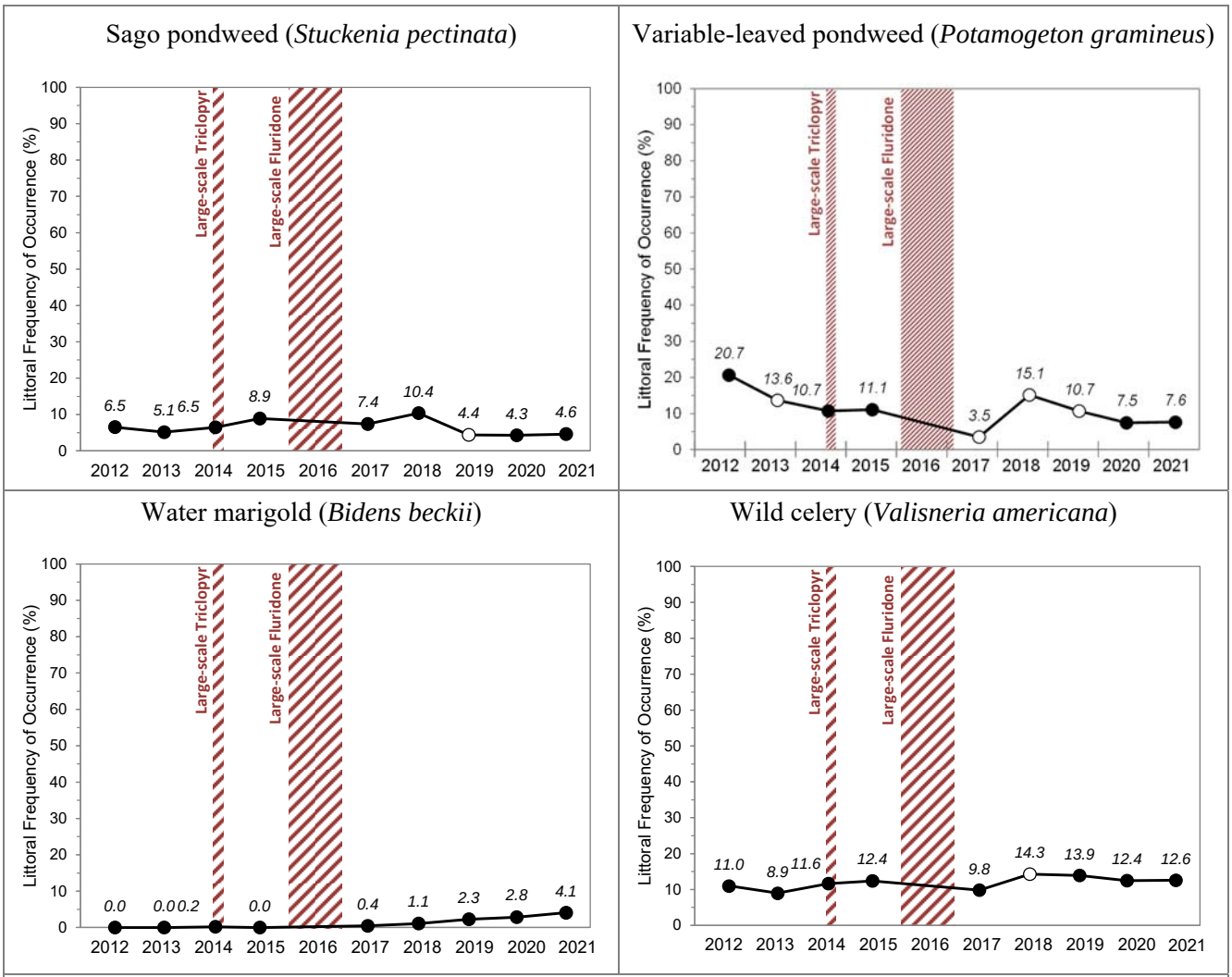


Figure 2.4-7. Littoral frequency of occurrence of select native aquatic plant species from 2012-2021 point-intercept surveys in Silver Lake. Open circle represents statistically valid change in occurrence from previous survey.

Because each sampling location may contain numerous plant species, relative frequency of occurrence is one tool to evaluate how often each plant species is found in relation to all other species found (composition of population). For example, while coontail was found at 16.1% of the littoral sampling locations in Silver Lake in 2021, its relative frequency of occurrence is 9.0%. Explained another way, if 100 plants were randomly sampled from Silver Lake, nine of them would be coontail. Figure 2.4-8 displays the relative frequency of occurrence of aquatic plant species from each of the point-intercept

surveys in Silver Lake. The occurrence of common waterweed was reduced to 0% in 2017 after treatment and from 2018-2021 has increased slightly; however, the occurrence remains lower than were documented before the treatment from 2012-2015. Eurasian watermilfoil comprised 9.1% of the relative frequency in 2012 and following a whole-lake fluridone treatment in 2016, was reduced to 0% in 2017. The relative frequency of HWM has remained below 2% in recent years and was 1.2% in 2021.

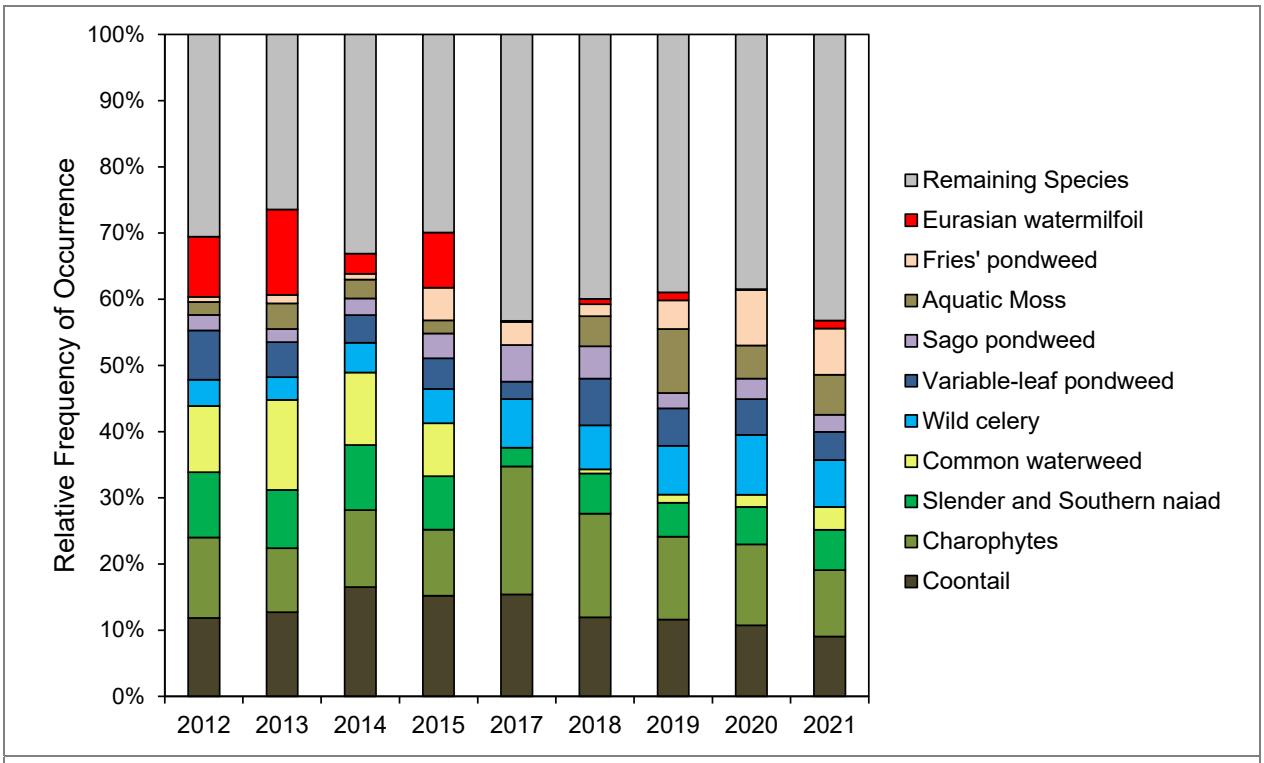


Figure 2.4-8. Relative frequency of occurrence of aquatic plants located in Silver Lake during point-intercept surveys.

Figure 2.4-9 displays the littoral frequency of occurrence of HWM in Silver Lake from 2012-2021. Following the 2016 fluridone treatment, the data show that the littoral frequency of HWM was initially reduced to 0.2% in 2017. The occurrence increased incrementally with a 1.7% occurrence in 2018 and 2.3% occurrence in 2019 before decreasing to 0.2% in 2020 following a ProcellaCOR™ spot treatment in Foxtail Bay. During the 2021 survey, HWM exhibited an occurrence of 2.1% which was a statistically valid increase in occurrence compared to the previous survey. The HWM population has been maintained at a relatively low level during the course of the last five years as the SLMD enacted an integrated pest management strategy

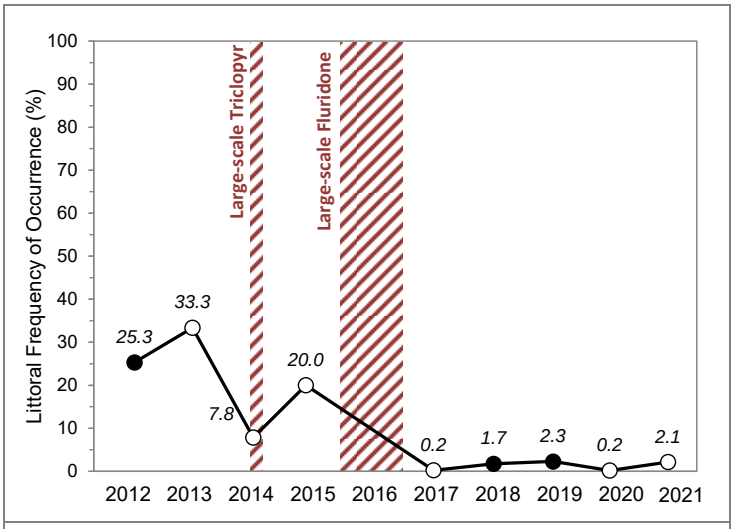


Figure 2.4-9. Littoral frequency of occurrence of HWM in Silver Lake. Open circle represents statistically valid change from previous survey (Chi-Square α = 0.05).

(coordinated hand harvesting and/or spot herbicide treatment) following the 2016 whole-lake fluridone treatment.

Figure 2.4-10 displays the number of point-intercept survey sampling locations that contained either native plants only, HWM plants only, or native plants and HWM plants from point-intercept surveys completed between 2012-2021 in Silver Lake. The figure illustrates the reduced footprint of the HWM population following the 2016 fluridone treatment with a comparatively lower number of sampling locations containing HWM from 2017-2021.

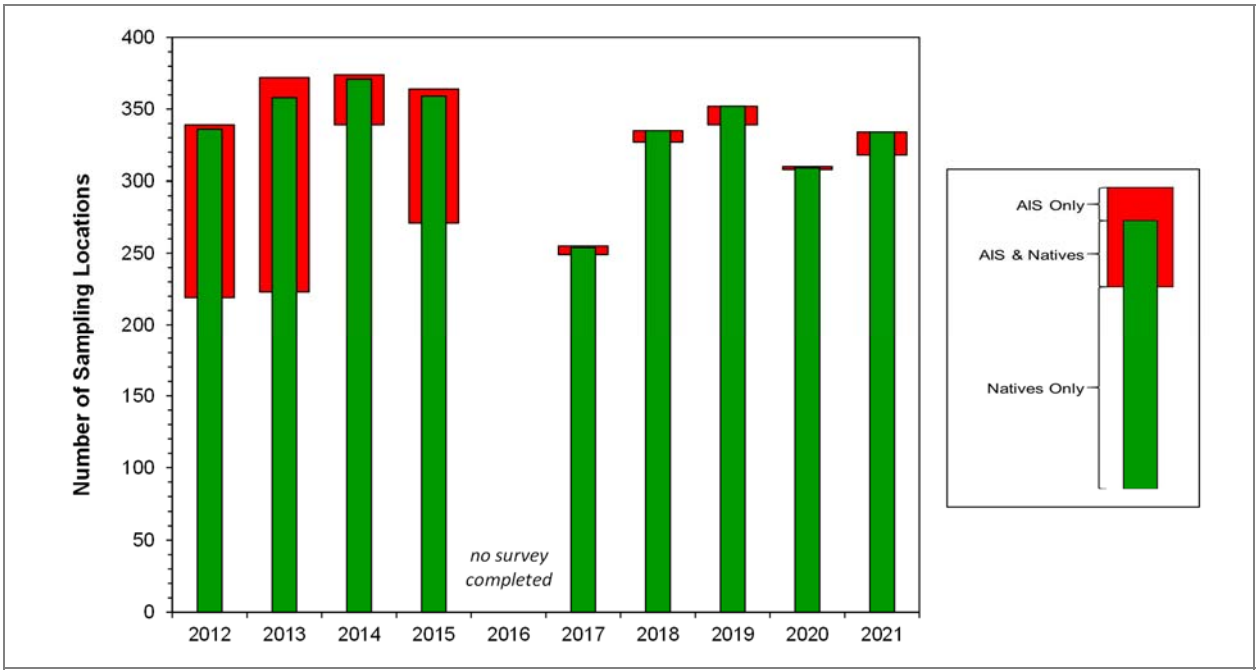
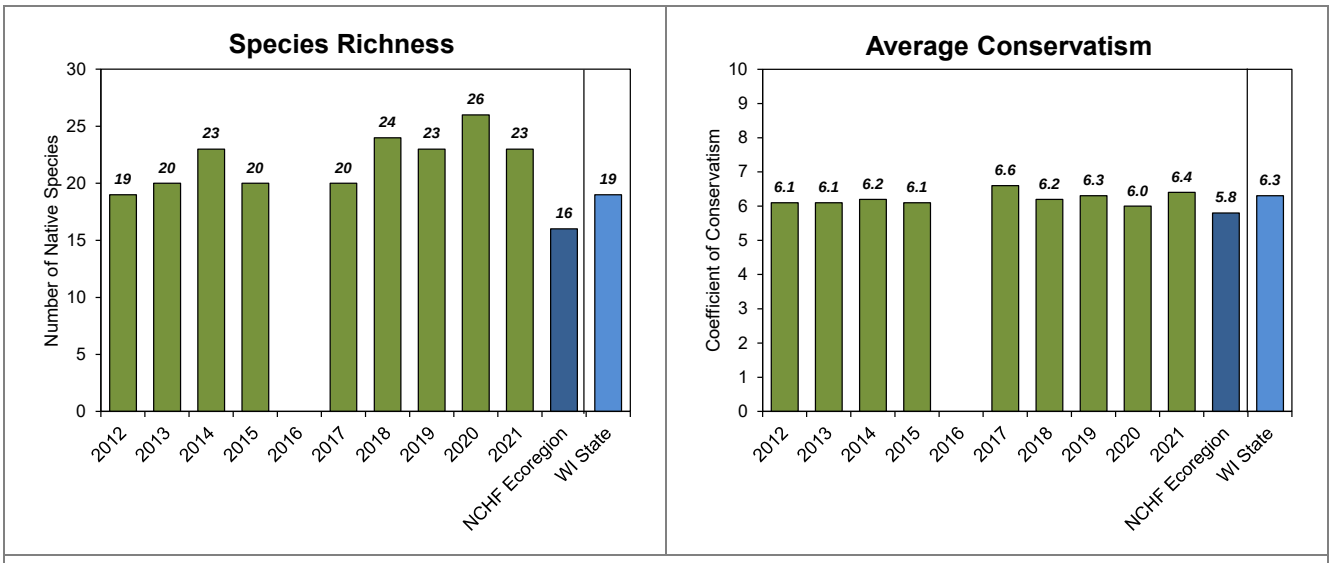


Figure 2.4-10. Number of sampling locations with native and non-native aquatic plant species from 2012-2021 point-intercept surveys in Silver Lake.

The calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. The native aquatic plant species located on the rake during the point-intercept surveys from 2012-2021 and their conservatism values were used to calculate the FQI for each year (Figure 2.4-11). Native species richness, or the number of native plant species recorded on the rake, has varied between 19 and 26 over the course of the surveys which are all at or above the ecoregion and state medians. Average conservatism values have ranged from 6.1-6.6 during the period of study. The average conservatism value of 6.4 in the 2021 survey is above the ecoregion and state median values. The floristic quality values have consistently fallen above ecoregion and state medians in recent years. The FQI value of 30.7 in 2021 was the highest value to date.



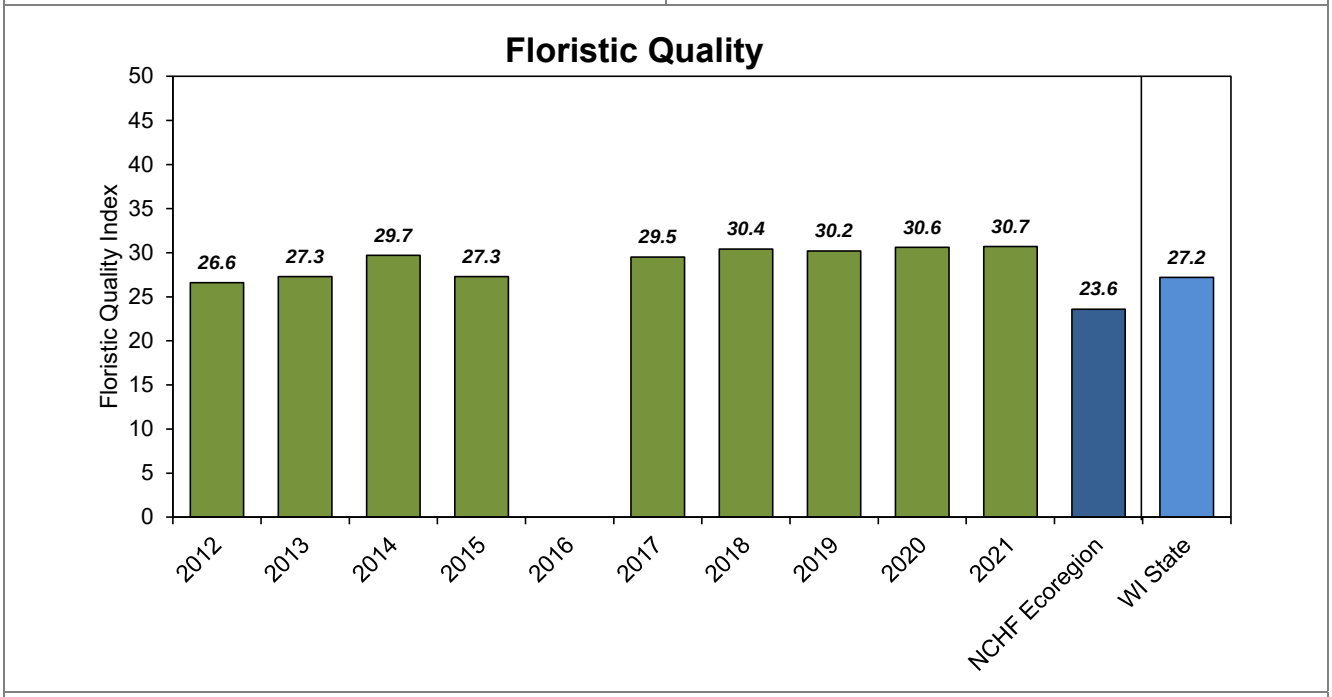


Figure 2.4-11. Silver Lake native aquatic plant species richness, average conservationism, and floristic quality. Includes native aquatic plant species physically encountered on the rake during the point-intercept survey and does not include incidentally-located species. No survey was conducted during 2016.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Silver Lake's diversity values rank. Using data collected by Onterra, quartiles were calculated for lakes within the NCHF Ecoregion (Figure 2.4-12). Using the data collected from the whole-lake point-intercept surveys, Silver Lake's aquatic plant species diversity has been relatively consistent over time with the exception of a 'dip' in 2017 corresponding to the first survey completed after a whole-lake herbicide treatment the previous year. In 2021, the Simpson's diversity value of 0.92 was the highest it has been during the period of study dating back to 2012.

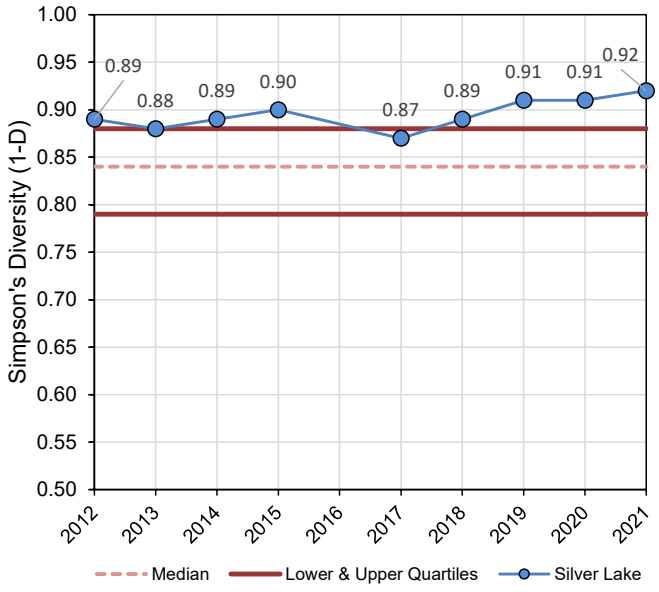


Figure 2.4-12. Silver Lake Simpson's Diversity Index. Created using data from whole lake-lake point intercept surveys.

3.0 2020 PROCELLACOR™ TREATMENT MONITORING (1-YEAR-AFTER-TREATMENT)

3.1 Qualitative Monitoring: Late-Summer EWM Mapping Survey

The HWM population mapped during September 2019 (pre-treatment), indicated that much of the Foxtail Bay contained colonized HWM including some particularly dense areas denoted as either *dominant* or *highly dominant* colonies (Figure 3.1-1- left frame). No HWM was located within Foxtail Bay during the 2020 Late-Summer HWM Mapping Survey. The reductions of HWM in the treatment site met control expectations for the year-of-treatment. The site was surveyed once again in September 2021 to determine whether the treatment met the control expectations with reductions in HWM extending through the *year-after-treatment*. A modest HWM population was mapped within Foxtail Bay during the 2021 survey (Figure 3.1-1 – right frame). The HWM population consisted of widely scattered individual plants throughout much of the bay, with one relatively small colony on the south end of the bay mapped with area-based methods and described as *scattered* in density.

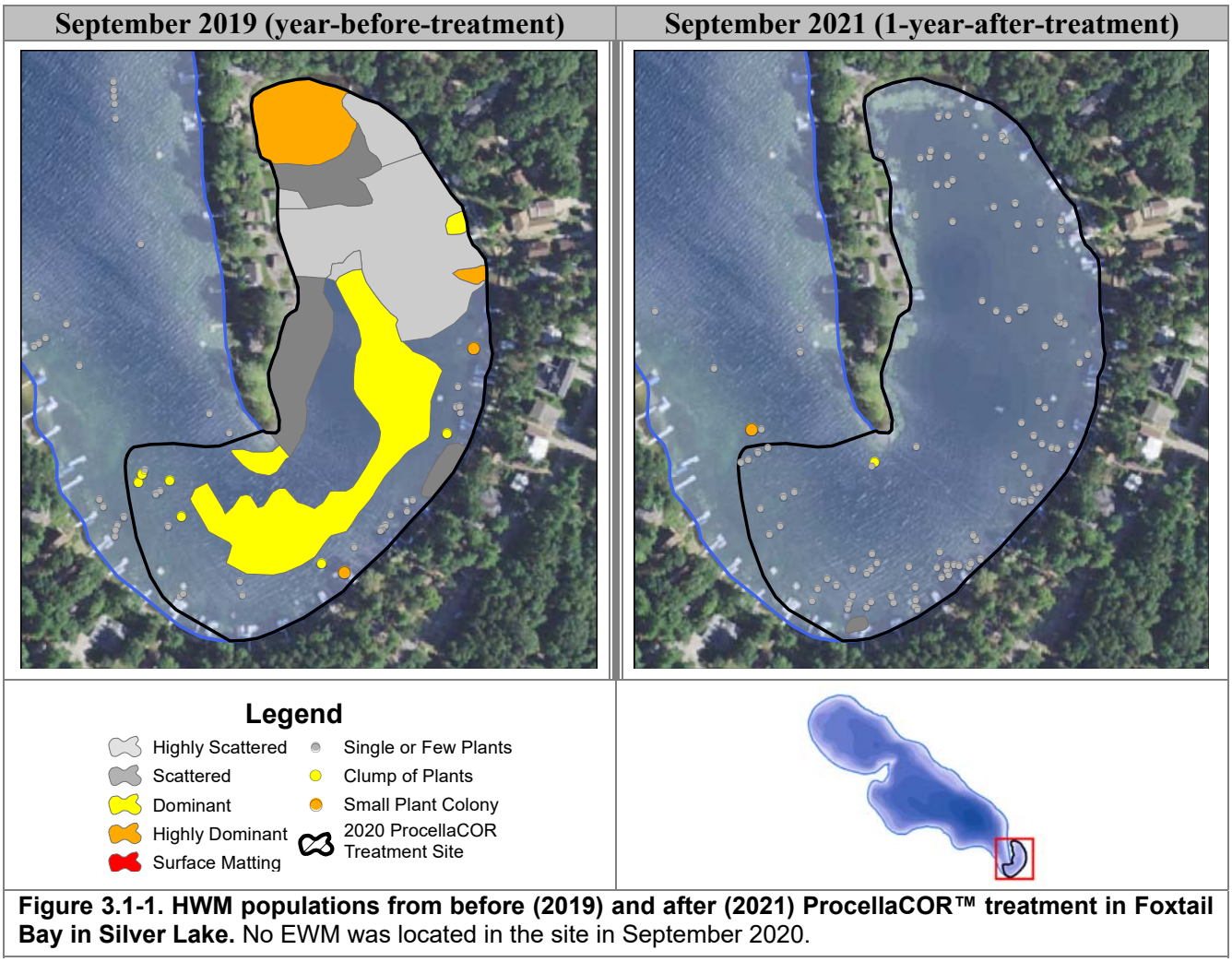


Figure 3.1-1. HWM populations from before (2019) and after (2021) ProcellaCOR™ treatment in Foxtail Bay in Silver Lake. No EWM was located in the site in September 2020.

3.2 Quantitative Monitoring: Sub-sample point-intercept Survey

A pretreatment sub-sample point-intercept survey was completed on September 27, 2019. The same sub-sample point-intercept survey was replicated on September 10, 2021 in order to understand the selectivity of the ProcellaCOR™ herbicide treatment one year after treatment. Figure 3.2-1 displays the sub-set sampling locations that are included in the following analysis. This dataset was intended to specifically monitor the HWM and native plant population dynamics during the pre and post treatment timeframe within the area where herbicide was directly applied (Appendix C).

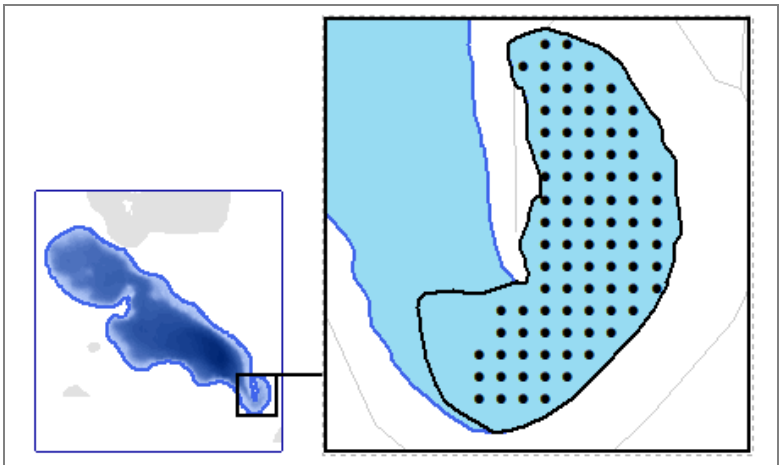


Figure 3.2-1. Sub-sample point-intercept survey sampling locations in Foxtail Bay of Silver Lake. (20-meter spacing, n=89)

Figure 3.2-2 displays the results of the sub-sample point-intercept surveys from before and after the herbicide treatment. Hybrid watermilfoil was not found at any of the 89 sampling locations during the 2020 post-treatment survey compared to a 36% occurrence in the pretreatment survey. Continued monitoring during the year-after-treatment (2021) indicated a modest HWM population in the study area with HWM being located at two sampling locations (2.3%). Hybrid watermilfoil exhibited a statistically valid 93.7% decrease in occurrence from the pre-treatment survey (2019) to the year-after-treatment (2021) indicating that reductions in the HWM populations extended through the *year-after-treatment*.

The native species response to the treatment is also displayed on Figure 3.2-2. Water stargrass (*Heteranthera dubia*), initially declined in occurrence by 100% during the year-of-treatment. This species has shown signs of recovery in the year-after-treatment (2021) with an occurrence of 6.8%. Muskgrasses initially decreased in occurrence from 24.7% in 2019 to 16.9% in 2020 and decreased further to 12.5% in the 2021 survey. The change in occurrence from 2019-2020 was not statistically valid; however, when comparing the 2019 to 2021 surveys, the 49.4% decrease in occurrence was statistically valid.

Common waterweed (*Elodea canadensis*) exhibited a statistically valid increase in occurrence from the pre- to post-treatment surveys. Most of the native species present in the study area did not show a statistically valid change in occurrence between the pre- and post-treatment surveys.

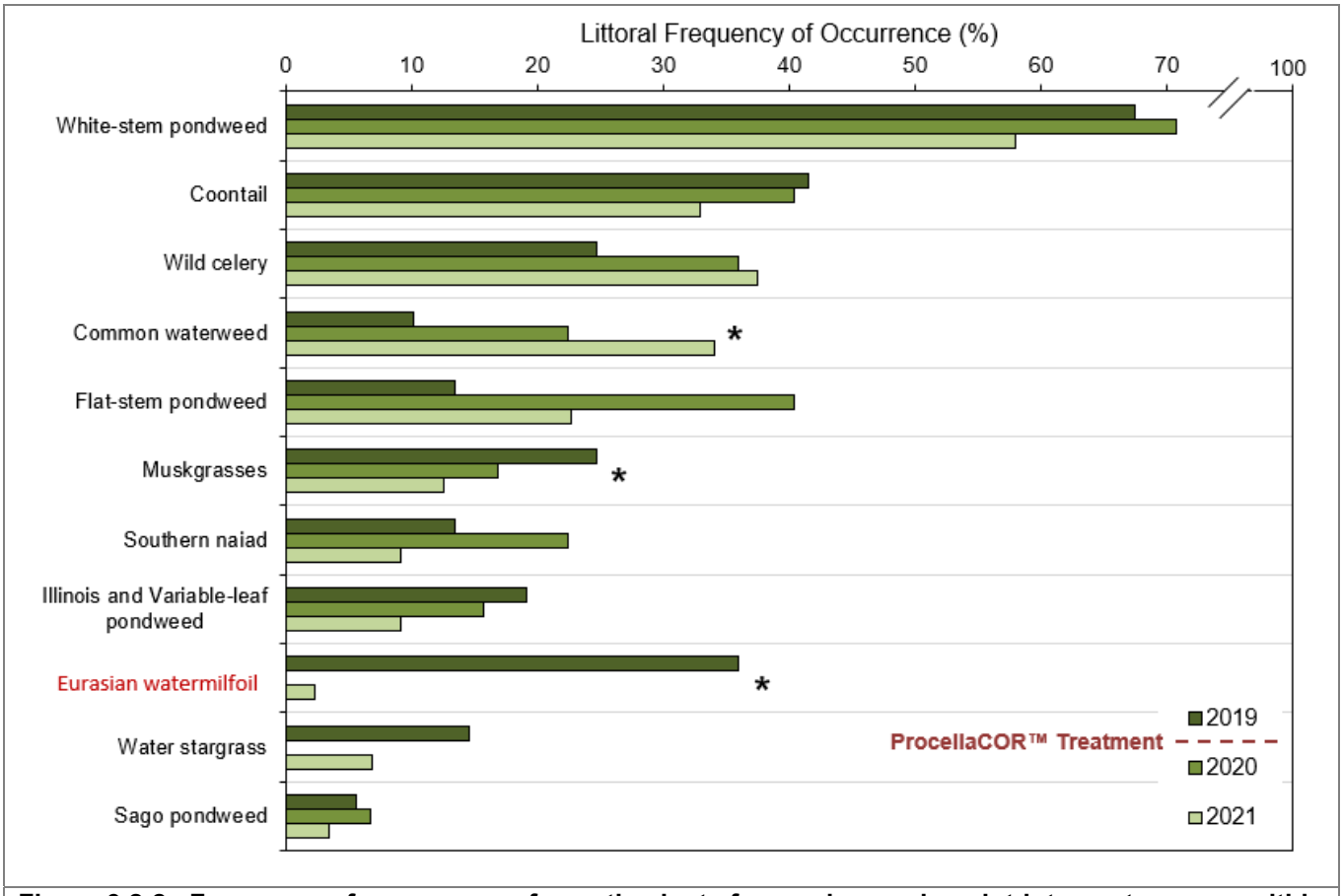


Figure 3.2-2. Frequency of occurrence of aquatic plants from sub-sample point-intercept surveys within a 2020 ProcellaCOR™ treatment area in Foxtail Bay. Asterisk represents statistically valid change from 2019 to 2021 surveys (Chi-Square α = 0.05).

4.0 CONCLUSIONS AND DISCUSSION

The native aquatic plant monitoring that was completed in 2021 within Foxtail Bay indicate minimal negative impacts following the 2020 herbicide treatment coupled with a high level of HWM control. The 2020 herbicide treatment in Foxtail Bay has exceeded the pre-determined quantitative and qualitative success criteria. The pre-determined quantitative success criteria were a 70% reduction in HWM occurrence between the pre-treatment survey (2019) and the year-after-treatment (2021). The sub point-intercept survey data indicate a 93.7% decrease in occurrence of HWM between the pre- and post-treatment surveys. Qualitative success criteria were for reductions in the HWM population to extend at least through the year-after-treatment. Comparative HWM mapping surveys conducted in late-summer 2019 (pre-treatment) and late-summer 2021 (post-treatment) indicate that this objective has been met.

Professional hand harvesting efforts in 2021 were met with marginal success. No individual sites met the pre-determined success criteria for 2021 as the HWM population expanded at a rate beyond what the harvesting efforts could accomplish. The lake-wide population management criteria were approximately achieved in that the HWM population was suppressed during 2021 to a level below where impacts to recreational activities including boating and swimming were likely. The harvesting efforts in 2021 likely resulted in seasonal HWM suppression in the targeted areas.

The 2021 whole-lake point-intercept survey indicates that Silver Lake continues to have a high quality native aquatic plant community as indicated by an FQI value of 30.7 in 2021, which is above the state and ecoregion median values. Hybrid watermilfoil exhibited an occurrence of 2.1% in 2021, which represents the fifth consecutive year during which the occurrence has been maintained at 2.3% or lower as the SLMD has implemented an IPM strategy in the years following the 2016 whole-lake treatment. The combination of an aggressive professional hand harvesting strategy coupled with a spot-herbicide treatment in Foxtail Bay have been instrumental in maintaining a lowered HWM population in recent years. The SLMD has learned a great deal about the applicability and associated expectations of various aquatic plant management strategies that have been utilized in managing HWM in Silver Lake in recent years.

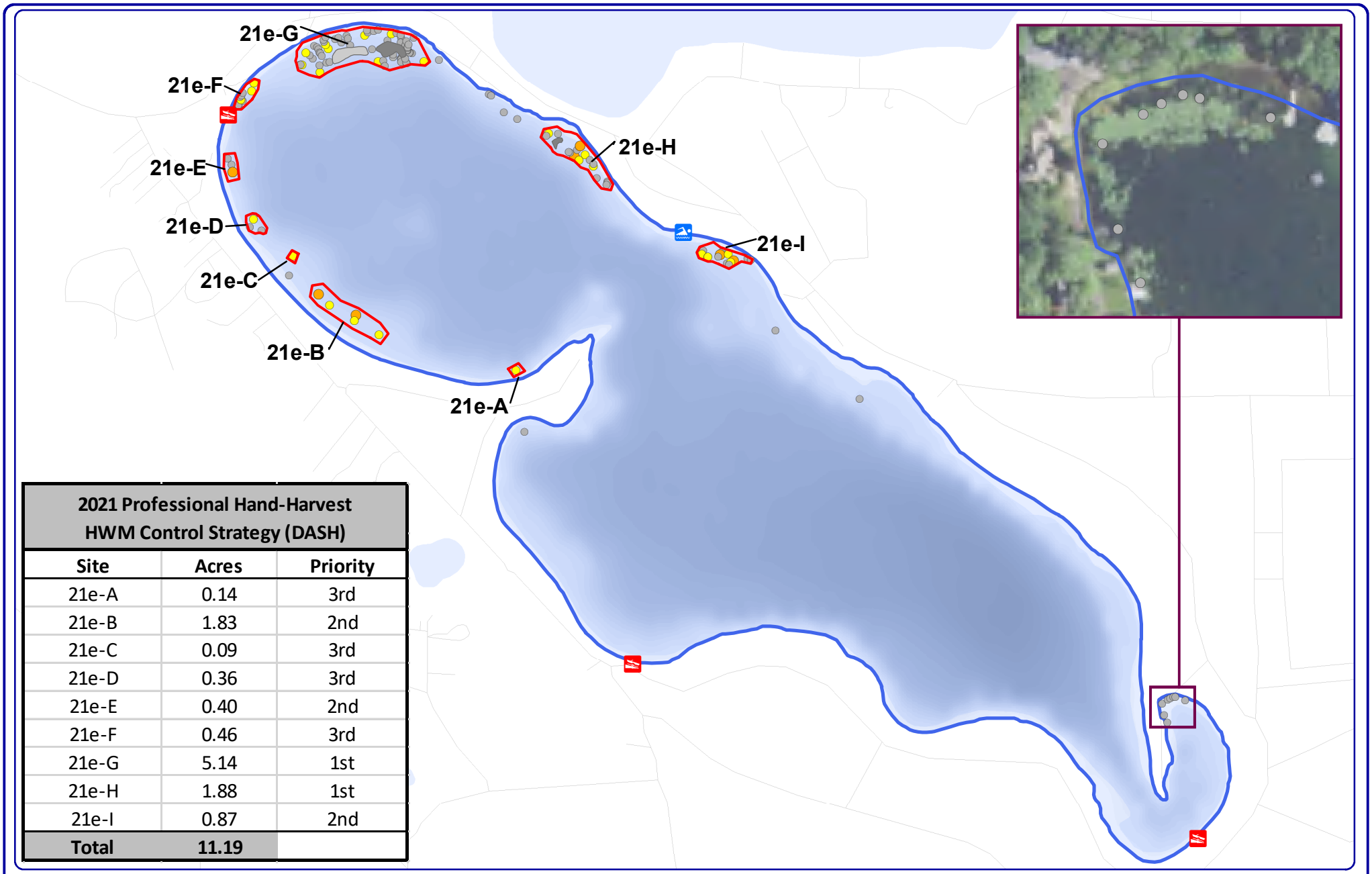
The SLMD has initiated a lake management planning project during 2022 that will be paid for without the aid of state grant funds. The project would serve to update the comprehensive management plan for the SLMD with analysis including the lake's water quality, watershed, shorelands, aquatic plants, and fisheries. Within the planning process, the SLMD will develop specific management goals and actions related to managing HWM in Silver Lake. The lake management planning process will build upon the knowledge and experience the SLMD has gained in recent years in managing HWM in the lake to develop realistic and implementable HWM management goals that align with the current understanding of best management practices.

The SLMD has also recently adopted the use of the ArcGIS Online platform to house spatial information related to past and current AIS management activities on Silver Lake (Click Here). This tool may have value for the SLMD and local lake riparian's ability in better understanding the management activities occurring on the system as well as take a more proactive role in developing future AIS management strategies.

4.1 2022 HWM Management Strategy Development

The SLMD has applied for a WDNR AIS Control Grant under the small-scale category during the November 2021 grant cycle. The prospective 2-year project would provide funding assistance for the SLMD to continue with their IPM approach to HWM management during 2022 and 2023. The project would include two annual HWM mapping surveys that would serve to guide and assess a professional hand harvesting/DASH program. The SLMD has developed a goal of these hand harvesting efforts of reducing the HWM population by one density level within areas where sufficient efforts take place. The SLMD have built an understanding of the expectations of implementing a DASH and hand harvesting control strategy in Silver Lake. The SLMD understands that hand harvesting at the current level of HWM present in the lake is likely to result in seasonal population suppression in most sites. By suppressing the growth of the HWM population by removing high amounts of biomass, the SLMD hopes to avoid the presence of nuisance HWM growth conditions in 2022 that would have the potential to impact recreational activities including boating or swimming. The SLMD acknowledges that if the HWM population continues to expand during 2022, an herbicide management strategy will likely be considered for implementation in 2023. During the late-summer of 2022, the SLMD will consider initiating the collection of pre-treatment sub point-intercept survey data in prospective 2023 herbicide management sites to align for the possibility of an herbicide control strategy the following year.

A preliminary DASH strategy developed based on the results of the 2021 Late-Summer HWM Mapping Survey is displayed on Map 3 and includes the majority of the HWM population. The final DASH strategy for 2022 will be created based upon the results of an Early Season AIS Survey scheduled to occur during June 2022. The exact timing of the 2022 ESAIS survey will be determined based on communications between the SLMD, Onterra, and APM, LLC to ensure that it falls at the most beneficial time to guide the ongoing hand harvesting program. A Late-Summer EWM Mapping Survey will occur during September 2022 which will be used to evaluate the hand harvesting strategy as well as to develop a preliminary management strategy for the following year.



2021 Professional Hand-Harvest HWM Control Strategy (DASH)		
Site	**Acres**	**Priority**
21e-A	0.14	3rd
21e-B	1.83	2nd
21e-C	0.09	3rd
21e-D	0.36	3rd
21e-E	0.40	2nd
21e-F	0.46	3rd
21e-G	5.14	1st
21e-H	1.88	1st
21e-I	0.87	2nd
Total	**11.19**	

N
W E
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900
Feet

Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2015
Aquatic Plants: Onterra, 2021
Map Date: June 7, 2021 TWH

Project Location in Wisconsin

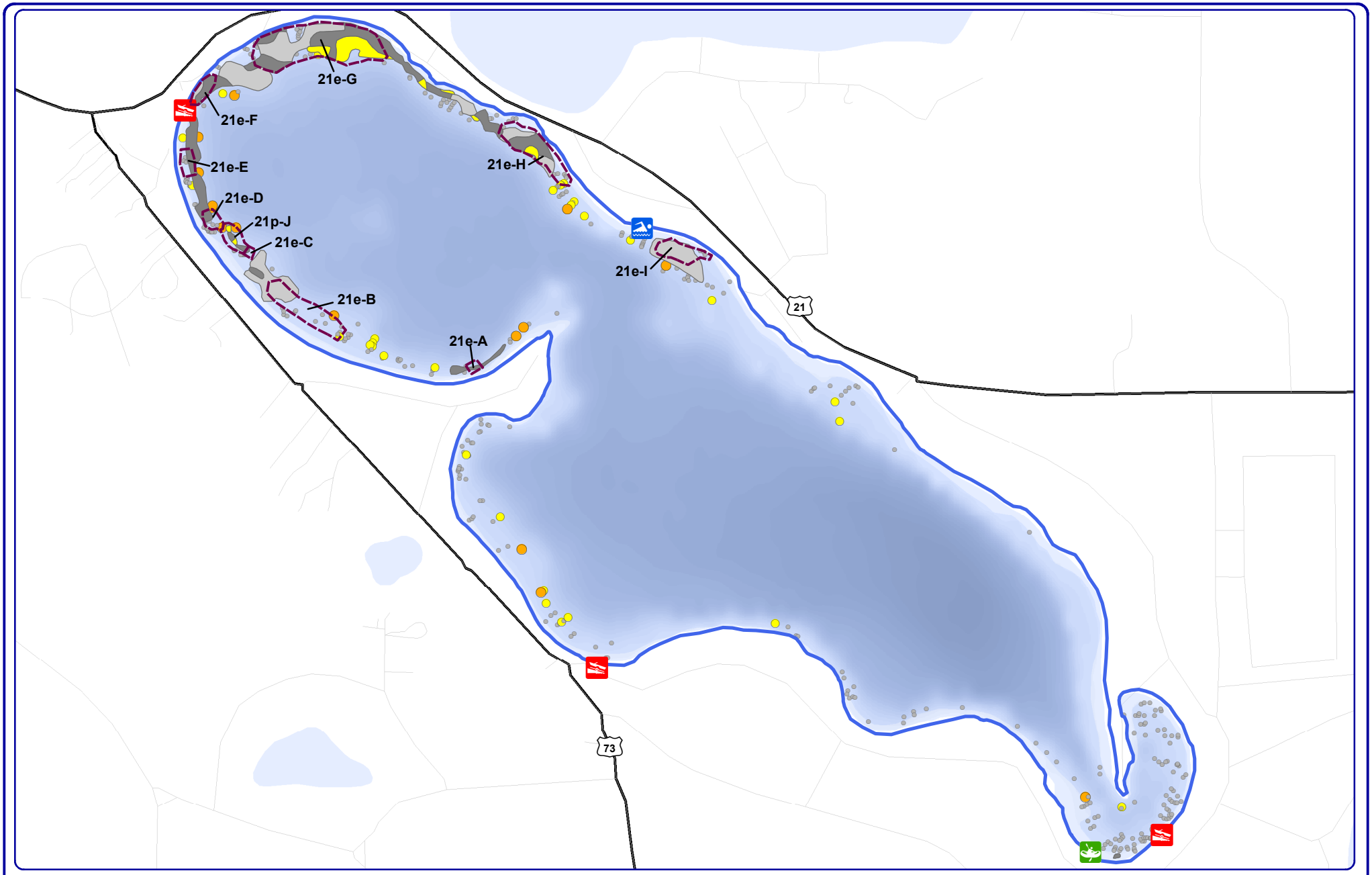
Legend

Hybrid/Eurasian Watermilfoil Survey: May 26, 2021

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- 2021 DASH HWM Sites

Map 1
Silver Lake
Waushara County, Wisconsin

May 2021 HWM Survey Results & Final DASH Strategy



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920.338.8860
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Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2015
Aquatic Plants: Onterra, 2021
Map Date: September 29, 2021 JMB

Project Location in Wisconsin

Legend

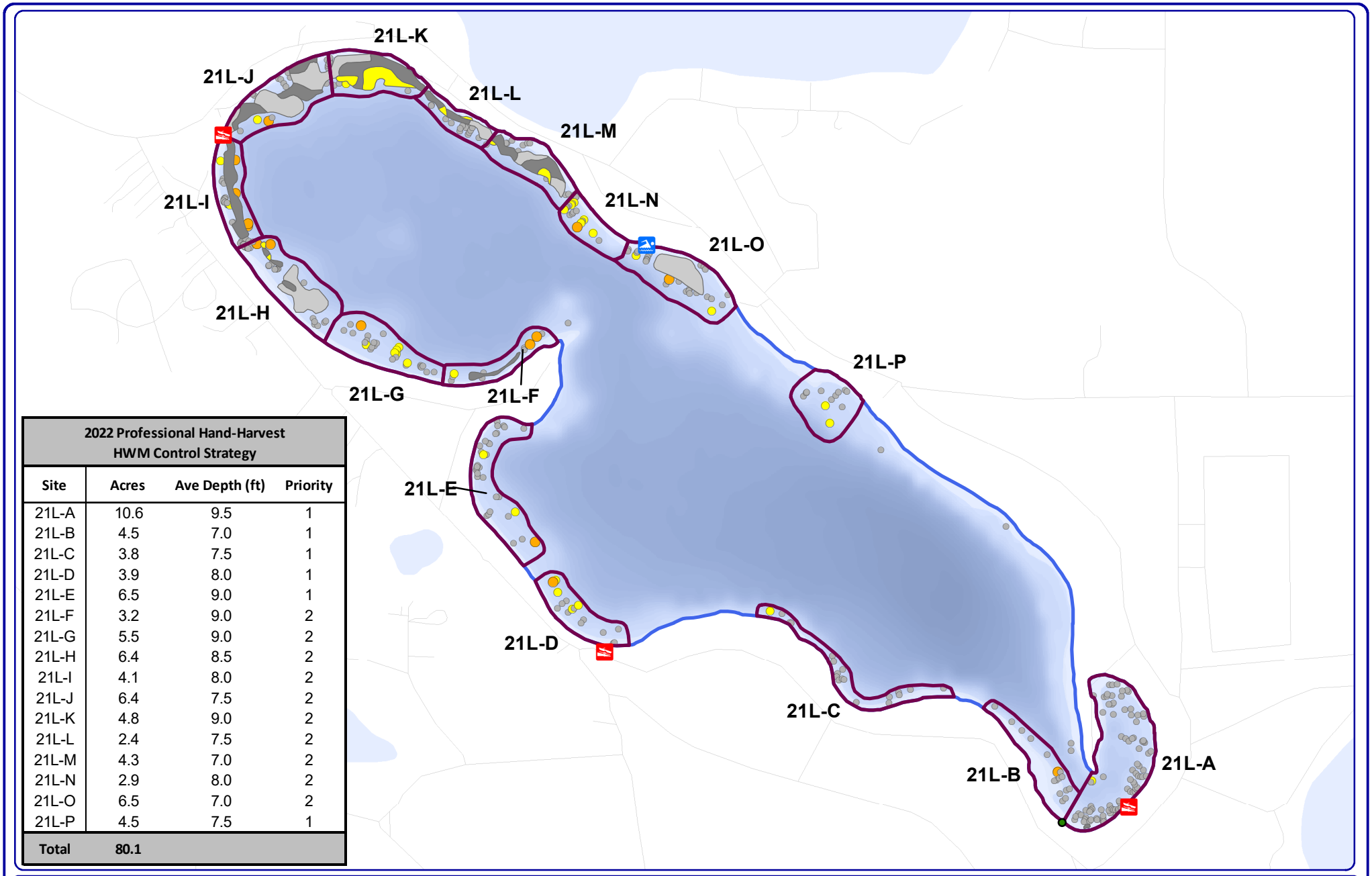
HWM Survey: September 10, 2021

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant *(None)*
- Surface Matting *(None)*
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- 2021 DASH Work Site

Map 2

Silver Lake
Waushara County, Wisconsin

Late-Season 2021 HWM Survey Results



2022 Professional Hand-Harvest HWM Control Strategy			
Site	**Acres**	**Ave Depth (ft)**	**Priority**
21L-A	10.6	9.5	1
21L-B	4.5	7.0	1
21L-C	3.8	7.5	1
21L-D	3.9	8.0	1
21L-E	6.5	9.0	1
21L-F	3.2	9.0	2
21L-G	5.5	9.0	2
21L-H	6.4	8.5	2
21L-I	4.1	8.0	2
21L-J	6.4	7.5	2
21L-K	4.8	9.0	2
21L-L	2.4	7.5	2
21L-M	4.3	7.0	2
21L-N	2.9	8.0	2
21L-O	6.5	7.0	2
21L-P	4.5	7.5	1
Total	**80.1**		

N W E S

900

Feet

Onterra LLC
Lake Management Planning
815 Prosper Road
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Roads and Hydro: WDNR
Bathymetry: Onterra, 2015
Aquatic Plants: Onterra, 2021
Map Date: January 11, 2022 AMS

Project Location in Wisconsin

Legend

Hybrid/Eurasian Watermilfoil Survey: Sept. 10, 2021

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting
- Single or Few Plants
- Clump of Plants
- Small Plant Colony
- 2022 Preliminary DASH Sites

Map 3
Silver Lake
Waushara County, Wisconsin

September 2021 HWM Survey Results & 2022 Preliminary DASH Strategy

A

APPENDIX A

Silver Lake 2021 HWM Manual Removal Summary Report – Aquatic Plant Management, LLC

Silver Lake
2021 EWM Manual Removal Report

Tuesday, September 14, 2021

Dive Summary

Silver Lake, Waushara County

Dates: 6/14 - 9/02

Dive Location	Avg. Water Depth	# of Dives	Underwater Dive Time	AIS Removed (cubic feet)
21e-g	8.8	53	43.2	725.0
21p-j	10.6	18	17.7	492.5
21e-b	7.5	35	32.5	400.5
21e-h	6.5	36	26.9	264.0
21e-d	7.1	22	17.8	246.5
21e-e	6.3	16	14.3	209.0
21e-a	12.5	14	11.3	170.0
21e-i	8.4	10	8.5	139.0
21e-f	6.9	9	8.5	123.5
21e-c	7.5	2	1.2	18.0
FTB	5.0	2	1.3	4.0
Ed's	6.0	1	0.8	3.0
Grand Total	**8.1**	**218**	**183.8**	**2795.0**

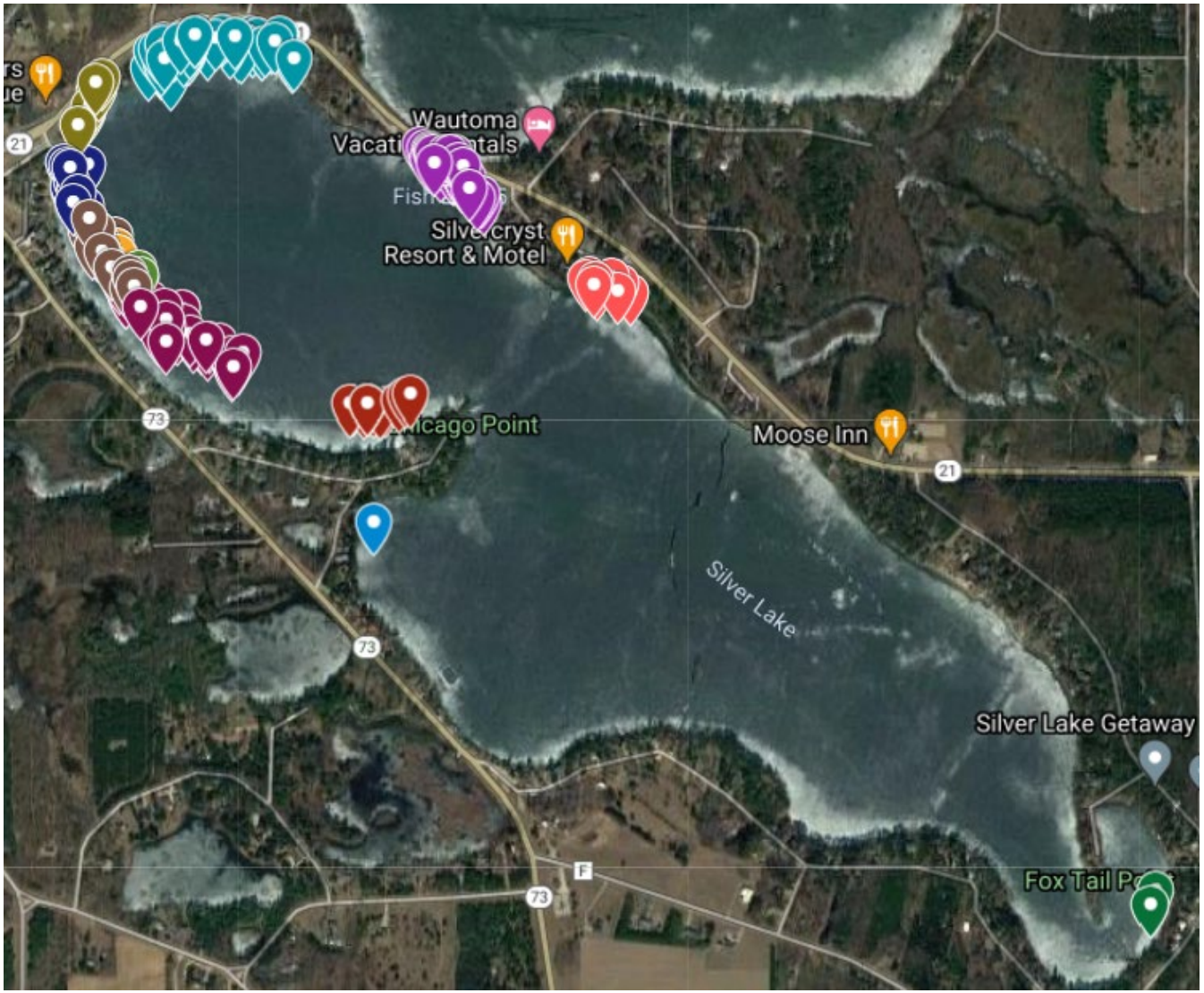
Months	Week Ending	Water Temp (F)	Underwater Dive Time (hrs)	AIS Removed (cubic ft)
Jun	20-Jun	77	19.1	129.0
	27-Jun	73	26.4	278.0
Jul	4-Jul	76	10.3	165.0
	11-Jul	78	4.5	75.0
	18-Jul	78	6.2	97.0
Aug	1-Aug	78	16.6	465.0
	8-Aug	76	23.4	346.0
	15-Aug	77	34.4	369.0
	22-Aug	76	19.4	474.0
	29-Aug	76	5.8	95.0
Sep	5-Sep	76	17.8	302.0
Grand Total			**183.8**	**2795.0**

Dive Map

Silver Lake, Waushara County

Link to interactive map

- 21e-g (53)
- 21e-h (36)
- 21e-b (35)
- 21e-d (22)
- 21p-j (18)
- 21e-e (16)
- 21e-a (14)
- 21e-i (10)
- 21e-f (9)
- 21e-c (2)
- FTB (2)
- Ed's (1)



Dive Detail

Silver Lake, Waushara County

Dates: 6/14 - 9/02

Date	Dive Location	Latitude	Longitude	Underwater Dive Time (hrs)	AIS Removed (cubic ft)	AIS Density	Avg Water Depth (ft)	Native Species	Native By-Catch	Substrate Type
6/14/2021	21e-h	44.05981	-89.23673	1.00	9.0	Small Plant Colony	7.0	Chara	1.0	Organic/Sand
6/14/2021	21e-h	44.05994	-89.23672	0.50	3.0	Clumps	7.0	Chara	0.5	Organic/Sand
6/14/2021	21e-h	44.05994	-89.23672	0.58	3.0	Scattered	7.0	Chara	0.5	Organic/Sand
6/14/2021	21e-h	44.05988	-89.23703	0.33	1.0	Small Plant Colony	7.5	Chara	0.5	Organic/Sand
6/14/2021	21e-h	44.06009	-89.23672	0.75	2.5	Clumps	6.0	Chara	0.5	Organic/Sand
6/14/2021	21e-h	44.06009	-89.23672	1.67	3.0	Clumps	6.0	Chara	1.0	Organic/Sand
6/14/2021	21e-h	44.05984	-89.23679	0.92	8.0	Small Plant Colony	8.5	Chara	1.5	Organic/Sand
6/15/2021	21e-h	44.06030	-89.23756	0.67	2.0	Single or Few	6.0	Chara	0.5	Organic/Sand
6/15/2021	21e-h	44.06022	-89.23743	1.08	6.0	Scattered	7.0	Chara	1.5	Organic/Sand
6/15/2021	21e-h	44.06021	-89.23729	0.42	6.0	Scattered	7.0	Chara	1.5	Organic
6/15/2021	21e-h	44.06020	-89.23733	1.25	5.5	Scattered	7.0	Chara	1.5	Organic
6/15/2021	21e-h	44.06005	-89.23735	1.17	6.0	Clumps	7.5	Chara	1.5	Organic/Gravel
6/15/2021	21e-h	44.06018	-89.23730	0.92	6.0	Clumps	6.0	Chara	2.0	Organic/Sand
6/15/2021	21e-h	44.06014	-89.23724	0.58	3.0	Clumps	7.0	Chara	1.0	Organic/Sand
6/16/2021	21e-h	44.05971	-89.23653	0.83	6.5	Scattered	6.0	Coontail	1.5	Organic/Sand
6/16/2021	21e-h	44.05986	-89.23666	1.08	9.5	Scattered	5.0	Elodea	1.0	Organic/Sand
6/16/2021	21e-h	44.06015	-89.23670	0.58	1.5	Scattered	4.0	Elodea	1.0	Organic/Sand
6/16/2021	21e-h	44.05985	-89.23647	0.83	9.0	Scattered	5.5	Elodea	4.0	Organic/Sand
6/16/2021	21e-h	44.05958	-89.23633	1.33	19.5	Scattered	9.0	Pondweeds	11.0	Organic/Gravel
6/16/2021	21e-h	44.05929	-89.23599	0.75	2.5	Highly Scattered	4.5	Pondweeds	0.5	Organic/Sand
6/16/2021	21e-h	44.05939	-89.23616	0.25	3.0	Scattered	8.0	Pondweeds	0.5	Organic/Sand
6/16/2021	21e-h	44.05939	-89.23616	1.17	10.5	Scattered	8.0	Pondweeds	1.0	Organic/Sand
6/17/2021	21e-h	44.05958	-89.23634	0.42	3.0	Highly Scattered	4.0	Chara	0.5	Organic/Gravel
6/21/2021	21e-h	44.05947	-89.23625	0.17	0.0	Highly Scattered	5.0	None	0.0	Organic/Sand
6/21/2021	21e-g	44.06189	-89.24397	0.83	9.0	Scattered	8.0	Chara	1.5	Organic
6/21/2021	21e-g	44.06170	-89.24386	0.25	3.0	Scattered	9.0	Chara	0.5	Organic/Sand
6/21/2021	21e-g	44.06170	-89.24386	0.33	2.0	Scattered	8.0	Pondweeds	0.5	Organic
6/21/2021	21e-g	44.06165	-89.24419	0.83	12.0	Scattered	8.0	Pondweeds	2.0	Organic
6/21/2021	21e-g	44.06213	-89.24377	0.58	7.5	Scattered	9.0	Pondweeds	2.5	Organic
6/22/2021	21e-g	44.06202	-89.24365	0.92	5.5	Scattered	4.0	Pondweeds	1.5	Organic/Sand
6/22/2021	21e-g	44.06209	-89.24372	0.42	2.0	Scattered	3.5	Pondweeds	0.0	Organic/Sand
6/22/2021	21e-g	44.06203	-89.24337	1.08	19.5	Scattered	9.5	Pondweeds	6.0	Organic/Sand
6/22/2021	21e-g	44.06202	-89.24342	0.33	3.0	Highly Scattered	9.5	Pondweeds	0.5	Organic/Sand
6/22/2021	21e-g	44.06191	-89.24359	0.42	6.0	Scattered	9.0	Pondweeds	1.5	Organic/Sand
6/22/2021	21e-g	44.06215	-89.24350	0.25	2.5	Scattered	3.0	Chara	0.5	Organic/Sand
6/22/2021	21e-g	44.06218	-89.24333	0.50	2.5	Scattered	3.0	Chara	0.5	Organic
6/22/2021	21e-g	44.06228	-89.24224	0.92	4.5	Scattered	6.5	Pondweeds	2.0	Organic/Sand
6/22/2021	21e-g	44.06224	-89.24188	0.33	4.5	Scattered	6.5	Pondweeds	2.0	Organic/Sand
6/22/2021	21e-g	44.06207	-89.24165	0.42	7.5	Scattered	6.5	Pondweeds	1.5	Organic/Sand
6/22/2021	21e-g	44.06225	-89.24168	0.17	1.5	Scattered	6.0	Chara	0.5	Organic/Sand
6/23/2021	21e-g	44.06181	-89.24067	0.50	4.0	Scattered	12.5	Pondweeds	0.5	Organic
6/23/2021	21e-g	44.06215	-89.24118	0.42	6.0	Scattered	9.0	Pondweeds	1.5	Organic/Sand
6/23/2021	21e-g	44.06223	-89.24152	0.42	7.5	Scattered	9.5	Pondweeds	2.5	Organic/Sand
6/23/2021	21e-g	44.06222	-89.24152	0.83	6.0	Scattered	9.5	Pondweeds	2.0	Organic
6/23/2021	21e-g	44.06202	-89.24142	0.42	3.5	Scattered	10.0	Pondweeds	0.5	Organic/Sand
6/23/2021	21e-g	44.06202	-89.24142	0.58	12.0	Scattered	11.0	Pondweeds	3.0	Organic/Sand
6/23/2021	21e-g	44.06219	-89.24317	0.33	9.0	Scattered	5.0	Pondweeds	2.5	Organic/Sand
6/23/2021	21e-g	44.06216	-89.24290	0.50	9.0	Scattered	7.0	Pondweeds	3.0	Organic/Sand
6/23/2021	21e-g	44.06227	-89.24291	0.50	4.5	Scattered	4.5	Pondweeds	1.0	Organic/Sand
6/23/2021	21e-g	44.06196	-89.24411	0.83	2.5	Scattered	9.0	Chara	0.0	Organic/Sand
6/23/2021	21e-g	44.06150	-89.24361	1.83	5.0	Scattered	13.0	Pondweeds	0.5	Organic/Sand
6/24/2021	21e-g	44.06210	-89.24184	1.33	17.5	Scattered	10.0	Pondweeds	6.0	Organic
6/24/2021	21e-g	44.06210	-89.24184	1.67	6.0	Scattered	10.0	Pondweeds	0.5	Organic
6/24/2021	21e-g	44.06197	-89.24193	0.83	9.0	Scattered	12.0	Pondweeds	2.5	Organic
6/24/2021	21e-h	44.05966	-89.23637	0.67	3.0	Highly Scattered	5.0	Pondweeds	0.5	Organic
6/24/2021	21e-h	44.05967	-89.23643	0.25	1.0	Highly Scattered	4.5	Chara	0.0	Organic
6/25/2021	21e-e	44.05982	-89.24597	1.25	21.0	Clumps	6.5	Chara	5.0	Organic
6/25/2021	21e-e	44.05953	-89.24591	1.42	24.0	Clumps	6.5	Chara	8.0	Organic
6/25/2021	21e-e	44.05972	-89.24608	0.92	6.0	Highly Scattered	6.0	Chara	1.0	Organic/Sand
6/25/2021	21e-b	44.05721	-89.24380	0.75	12.0	Clumps	7.5	Pondweeds	3.5	Organic
6/25/2021	21e-b	44.05680	-89.24288	1.42	17.0	Clumps	8.0	Pondweeds	5.0	Organic
7/1/2021	21e-b	44.05671	-89.24273	1.25	25.0	Clumps	8.0	Pondweeds	6.0	Organic
7/1/2021	21e-b	44.05634	-89.24213	1.08	17.0	Clumps	8.0	Pondweeds	4.0	Organic
7/1/2021	21e-a	44.05570	-89.23840	0.33	2.0	Highly Scattered	9.0	Pondweeds	0.0	Organic
7/1/2021	21e-a	44.05570	-89.23869	0.17	2.0	Highly Scattered	18.5	Pondweeds	0.0	Organic/Gravel
7/1/2021	21e-a	44.05566	-89.23852	0.17	3.0	Scattered	20.0	Pondweeds	0.5	Organic/Gravel
7/1/2021	21e-f	44.05872	-89.24551	1.33	21.0	Scattered	7.0	Pondweeds	7.0	Organic
7/1/2021	21e-d	44.05870	-89.24550	0.25	8.0	Scattered	8.0	Pondweeds	1.0	Sand
7/1/2021	21e-d	44.05870	-89.24500	0.42	8.0	Scattered	8.0	Pondweeds	1.0	Sand
7/1/2021	21e-d	44.05857	-89.24554	0.75	9.0	Scattered	8.0	Pondweeds	1.0	Sand
7/1/2021	21e-d	44.05846	-89.24541	0.25	6.0	Scattered	8.0	Pondweeds	1.0	Sand
7/2/2021	21e-d	44.05835	-89.24524	1.25	23.0	Clumps	8.0	Elodea	6.0	Organic
7/2/2021	21e-d	44.05853	-89.24535	0.67	12.0	Scattered	13.0	Pondweeds	2.0	Organic
7/2/2021	21e-d	44.05876	-89.24569	0.50	5.5	Scattered	5.0	Chara	0.0	Organic/Sand
7/2/2021	21e-f	44.06123	-89.24550	0.50	7.5	Scattered	7.0	Pondweeds	3.0	Organic
7/2/2021	21e-i	44.05785	-89.23279	0.92	10.0	Scattered	8.5	Pondweeds	2.0	Organic
7/2/2021	21e-i	44.05767	-89.23239	0.50	6.0	Scattered	8.5	Pondweeds	2.0	Organic
7/7/2021	21e-i	44.05784	-89.23262	1.08	12.0	Highly Scattered	7.0	Chara	3.0	Organic
7/7/2021	21e-i	44.05797	-89.23288	0.42	6.0	Highly Scattered	5.0	Elodea	2.0	Organic
7/7/2021	21e-i	44.05777	-89.23322	1.58	36.0	Small Plant Colony	7.0	Chara	14.0	Organic
7/7/2021	21e-i	44.05798	-89.23342	1.00	18.0	Scattered	12.0	Elodea	4.0	Organic
7/7/2021	21e-i	44.05792	-89.23348	0.42	3.0	Scattered	12.0	Elodea	0.5	Organic
7/12/2021	21e-b	44.05702	-89.24361	1.67	18.0	Scattered	8.0	Chara	6.0	Organic
7/12/2021	21e-b	44.05697	-89.24345	1.08	15.0	Scattered	8.0	Chara	5.0	Organic
7/12/2021	21e-b	44.05697	-89.24345	0.83	16.0	Scattered	8.0	Pondweeds	5.0	Organic
7/12/2021	21e-i	44.05770	-89.23272	1.33	20.0	Scattered	8.0	Pondweeds	6.0	Organic
7/12/2021	21e-i	44.05791	-89.23325	1.00	21.0	Scattered	8.0	Pondweeds	6.0	Organic
7/12/2021	21e-i	44.05782	-89.23329	0.25	7.0	Highly Scattered	8.0	Pondweeds	2.0	Organic
7/28/2021	21p-j	44.05793	-89.24438	0.58	18.5	Clumps	8.0	Elodea	3.0	Organic/Sand

Dive Detail

Silver Lake, Waushara County

Dates: 6/14 - 9/02

Date	Dive Location	Latitude	Longitude	Underwater Dive Time (hrs)	AIS Removed (cubic ft)	AIS Density	Avg Water Depth (ft)	Native Species	Native By-Catch	Substrate Type
7/28/2021	21p-j	44.05800	-89.24454	0.50	9.0	Clumps	10.0	Elodea	1.0	Organic/Sand
7/28/2021	21p-j	44.05812	-89.24486	2.58	86.0	Small Plant Colony	10.0	Elodea	8.0	Organic/Sand
7/28/2021	21p-j	44.05849	-89.24496	1.50	43.0	Small Plant Colony	11.0	Elodea	2.0	Organic/Sand
7/28/2021	21p-j	44.05849	-89.24496	1.50	30.0	Clumps	11.0	Elodea	2.0	Organic/Sand
7/29/2021	21e-f	44.06071	-89.24583	1.25	18.0	Highly Scattered	7.0	Pondweeds	9.0	Organic/Sand
7/29/2021	21e-f	44.06089	-89.24566	1.50	18.0	Scattered	7.0	Pondweeds	7.0	Organic/Sand
7/29/2021	21e-f	44.06100	-89.24562	1.00	12.0	Highly Scattered	7.0	Pondweeds	3.0	Organic/Sand
7/29/2021	21p-j	44.05808	-89.24472	2.00	62.0	Small Plant Colony	10.0	Pondweeds	3.0	Organic/Sand
7/29/2021	21p-j	44.05824	-89.24486	0.83	42.0	Small Plant Colony	10.0	Pondweeds	0.0	Organic/Sand
7/30/2021	21p-j	44.05845	-89.24501	0.75	33.0	Clumps	12.0	None	0.0	Organic/Sand
7/30/2021	21p-j	44.05829	-89.24484	0.58	18.0	Clumps	12.0	None	0.0	Organic/Sand
7/30/2021	21p-j	44.05847	-89.24518	0.33	24.0	Clumps	12.0	None	0.0	Organic/Sand
7/30/2021	21e-e	44.05922	-89.24568	1.17	42.0	Clumps	9.0	Elodea	1.0	Organic/Sand
7/30/2021	21e-e	44.05946	-89.24608	0.50	9.5	Clumps	4.0	Chara	1.0	Organic/Sand
8/2/2021	21p-j	44.05823	-89.24479	0.67	16.0	Scattered	12.0	Elodea	2.0	Organic/Sand
8/2/2021	21p-j	44.05831	-89.24484	0.42	15.0	Scattered	12.0	Elodea	2.0	Organic/Sand
8/2/2021	21p-j	44.05847	-89.24501	1.42	21.0	Clumps	12.0	Elodea	3.0	Organic/Sand
8/2/2021	21e-e	44.05994	-89.24566	0.42	7.0	Clumps	15.0	Pondweeds	0.5	Organic/Sand
8/2/2021	21p-j	44.05848	-89.24506	0.25	12.0	Highly Scattered	12.0	Pondweeds	0.5	Organic/Sand
8/2/2021	21p-j	44.05839	-89.24508	1.17	12.0	Scattered	12.0	Chara	1.0	Organic/Sand
8/3/2021	FTB	44.04712	-89.21964	0.75	2.5	Highly Scattered	5.0	Pondweeds	0.5	Organic/Sand
8/3/2021	FTB	44.04688	-89.21977	0.50	1.5	Highly Scattered	5.0	Pondweeds	0.5	Organic/Sand
8/4/2021	Ed's	44.05363	-89.23867	0.75	3.0	Highly Scattered	6.0	Pondweeds	0.0	Sand
8/4/2021	21e-a	44.05573	-89.23920	0.33	6.0	Highly Scattered	9.0	Pondweeds	0.5	Organic/Sand
8/4/2021	21e-a	44.05574	-89.23885	1.83	6.0	Small Plant Colony	14.0	None	0.0	Organic/Sand
8/4/2021	21e-a	44.05574	-89.23885	1.67	60.0	Small Plant Colony	12.0	Elodea	0.0	Organic/Sand
8/4/2021	21e-a	44.05568	-89.23891	0.75	9.0	Clumps	12.0	Elodea	0.0	Organic/Sand
8/4/2021	21p-j	44.05835	-89.24493	0.83	12.0	Scattered	9.0	Elodea	1.0	Organic
8/5/2021	21e-a	44.05571	-89.23927	0.67	12.0	Small Plant Colony	9.0	Elodea	1.0	Organic/Sand
8/5/2021	21e-d	44.05857	-89.24530	0.42	8.0	Highly Scattered	9.0	Pondweeds	1.0	Organic
8/5/2021	21e-f	44.06064	-89.24589	1.42	21.0	Clumps	10.0	Pondweeds	3.0	Organic
8/5/2021	21p-j	44.05838	-89.24491	0.67	9.0	Highly Scattered	9.0	Pondweeds	1.0	Organic
8/5/2021	21p-j	44.05776	-89.24474	1.08	30.0	Clumps	6.0	Pondweeds	0.5	Organic/Sand
8/5/2021	21e-b	44.05761	-89.24472	1.00	10.0	Clumps	6.0	Chara	0.5	Organic/Sand
8/5/2021	21e-b	44.05761	-89.24472	0.75	18.0	Clumps	6.0	Chara	1.0	Organic/Sand
8/5/2021	21e-f	44.06130	-89.24538	0.67	7.0	Scattered	9.0	Pondweeds	1.0	Organic
8/6/2021	21e-e	44.05997	-89.24624	1.00	6.0	Scattered	4.0	Pondweeds	0.5	Sand
8/6/2021	21e-e	44.05993	-89.24618	0.92	9.0	Scattered	4.0	Pondweeds	0.5	Sand
8/6/2021	21e-e	44.05968	-89.24608	1.00	9.0	Scattered	4.0	Pondweeds	2.0	Organic/Sand
8/6/2021	21e-e	44.05955	-89.24614	0.50	9.0	Scattered	4.0	Pondweeds	1.0	Organic/Sand
8/6/2021	21e-e	44.05924	-89.24593	1.50	15.0	Scattered	4.0	Pondweeds	1.0	Organic/Sand
8/10/2021	21e-e	44.05965	-89.24605	0.58	9.5	Small Plant Colony	7.0	Chara	3.0	Organic/Sand
8/10/2021	21e-e	44.05953	-89.24597	0.92	8.0	Scattered	7.0	Chara	2.0	Organic/Sand
8/10/2021	21e-e	44.05989	-89.24608	0.67	5.0	Scattered	7.0	Chara	2.0	Organic/Sand
8/10/2021	21e-d	44.05879	-89.24541	1.25	13.0	Small Plant Colony	7.0	Chara	2.0	Organic/Sand
8/10/2021	21e-d	44.05879	-89.24541	0.83	6.0	Small Plant Colony	7.0	Chara	2.0	Organic/Sand
8/11/2021	21e-d	44.05862	-89.24544	1.00	9.0	Scattered	7.0	Chara	3.0	Organic/Sand
8/11/2021	21e-d	44.05843	-89.24531	0.92	6.0	Scattered	7.0	Chara	2.0	Organic/Sand
8/11/2021	21e-d	44.05843	-89.24531	1.92	18.0	Clumps	7.0	Chara	4.0	Organic/Sand
8/11/2021	21e-d	44.05848	-89.24554	0.33	4.0	Scattered	5.0	Chara	2.0	Organic/Sand
8/11/2021	21e-a	44.05572	-89.23885	0.83	1.5	Clumps	15.0	None	0.0	Organic/Sand
8/11/2021	21e-a	44.05572	-89.23885	0.75	21.0	Clumps	15.0	None	0.0	Organic/Sand
8/11/2021	21e-b	44.05698	-89.24392	0.42	6.0	Highly Scattered	4.0	Chara	0.5	Organic/Sand
8/11/2021	21e-b	44.05708	-89.24371	0.42	3.0	Highly Scattered	4.0	Chara	0.5	Organic/Sand
8/11/2021	21e-b	44.05719	-89.24375	0.58	9.0	Highly Scattered	8.0	Pondweeds	0.5	Organic/Sand
8/11/2021	21e-b	44.05680	-89.24375	0.25	2.0	Highly Scattered	4.0	Chara	0.0	Organic/Sand
8/12/2021	21e-b	44.05740	-89.24334	1.42	27.0	Small Plant Colony	10.0	Elodea	8.0	Organic
8/12/2021	21e-b	44.05740	-89.24334	1.25	21.0	Small Plant Colony	10.0	Elodea	6.0	Organic
8/12/2021	21e-b	44.05703	-89.24357	0.83	6.0	Scattered	6.0	Chara	2.5	Organic
8/12/2021	21e-b	44.05684	-89.24308	1.17	8.0	Scattered	8.0	Coontail	2.0	Organic
8/12/2021	21e-b	44.05680	-89.24245	2.00	15.0	Clumps	8.0	Coontail	4.0	Organic
8/12/2021	21e-b	44.05653	-89.24200	0.67	9.0	Scattered	8.0	Coontail	3.0	Organic
8/12/2021	21e-b	44.05788	-89.24486	1.08	15.5	Scattered	5.0	Chara	0.5	Organic/Sand
8/12/2021	21e-a	44.05572	-89.23885	1.17	9.5	Scattered	15.0	Pondweeds	0.0	Organic/Sand
8/12/2021	21e-b	44.05773	-89.24456	0.58	6.0	Highly Scattered	5.0	Pondweeds	0.5	Organic/Sand
8/12/2021	21e-h	44.06014	-89.23693	0.50	4.0	Highly Scattered	5.0	Pondweeds	1.0	Organic/Sand
8/12/2021	21e-h	44.06014	-89.23680	0.92	15.0	Highly Scattered	5.0	Elodea	5.0	Organic/Sand
8/12/2021	21e-h	44.06002	-89.23663	0.50	12.0	Highly Scattered	5.0	Pondweeds	3.0	Organic/Sand
8/12/2021	21e-h	44.05991	-89.23649	1.00	6.0	Highly Scattered	6.0	Pondweeds	1.5	Organic/Sand
8/13/2021	21e-b	44.05738	-89.24365	0.75	16.0	Clumps	12.0	None	0.0	Organic/Sand
8/13/2021	21e-b	44.05747	-89.24429	0.42	8.0	Scattered	8.0	Chara	0.5	Organic/Sand
8/13/2021	21e-b	44.05756	-89.24413	1.00	6.0	Highly Scattered	6.0	Chara	1.0	Organic/Sand
8/13/2021	21e-b	44.05741	-89.24361	0.58	3.0	Highly Scattered	6.0	Chara	0.5	Organic/Sand
8/13/2021	21e-c	44.05809	-89.24441	0.67	9.0	Highly Scattered	7.0	Elodea	0.5	Organic/Sand
8/13/2021	21e-c	44.05798	-89.24435	0.50	9.0	Highly Scattered	8.0	Elodea	0.5	Organic/Sand
8/13/2021	21e-b	44.05714	-89.24332	0.58	6.0	Scattered	7.0	Elodea	2.0	Organic
8/13/2021	21e-b	44.05744	-89.24377	2.33	14.0	Clumps	10.0	Elodea	3.0	Organic
8/13/2021	21e-b	44.05696	-89.24314	0.67	2.0	Highly Scattered	8.0	Elodea	0.5	Organic
8/13/2021	21e-b	44.05658	-89.24213	1.50	12.0	Clumps	8.0	Chara	2.0	Organic
8/13/2021	21e-b	44.05662	-89.24187	0.67	9.0	Clumps	8.0	Chara	1.0	Organic
8/17/2021	21e-g	44.06209	-89.24133	1.33	27.0	Scattered	10.0	Pondweeds	1.0	Organic/Sand
8/17/2021	21e-b	44.05685	-89.24269	0.42	6.0	Scattered	10.0	Pondweeds	0.5	Organic/Sand
8/17/2021	21e-b	44.05658	-89.24226	0.42	6.0	Clumps	9.0	Pondweeds	0.5	Organic/Sand
8/17/2021	21e-h	44.05967	-89.23649	0.58	15.0	Scattered	6.0	Pondweeds	1.0	Organic/Gravel
8/17/2021	21e-h	44.05973	-89.23640	0.75	24.0	Scattered	6.0	Elodea	3.0	Organic/Gravel
8/17/2021	21e-h	44.05941	-89.23605	0.83	21.0	Scattered	6.0	Pondweeds	6.0	Organic/Gravel
8/17/2021	21e-g	44.06225	-89.24100	0.67	21.0	0	3.0	Pondweeds	0.0	0
8/18/2021	21e-g	44.06205	-89.24220	1.33	36.0	Scattered	12.0	Pondweeds	6.0	Organic/Gravel
8/18/2021	21e-g	44.06229	-89.24237	0.83	33.0	Scattered	12.0	Pondweeds	6.0	Organic/Gravel
8/18/2021	21e-g	44.06229	-89.24237	1.17	21.0	Scattered	12.0	Pondweeds	4.0	Organic/Gravel
8/18/2021	21e-g	44.06203	-89.24273	0.83	39.0	Clumps	12.0	Pondweeds	7.0	Organic
8/18/2021	21e-g	44.06219	-89.24255	0.33	18.0	Scattered	12.0	Pondweeds	4.0	Organic
8/18/2021	21e-g	44.06214	-89.24112	0.58	9.0	Scattered	4.0	Pondweeds	5.0	Organic/Sand
8/19/2021	21e-g	44.06190	-89.24331	0.92	21.0	Clumps	12.0	Pondweeds	1.0	Organic
8/19/2021	21e-g	44.06175	-89.24387	1.00	21.0	Clumps	12.0	Pondweeds	2.0	Organic
8/19/2021	21e-g	44.06201	-89.24398	0.92	15.0	Scattered	8.0	Pondweeds	2.0	Organic/Sand
8/19/2021	21e-g	44.06208	-89.24383	0.58	10.0	Scattered	8.0	Pondweeds	2.0	Organic/Sand

Dive Detail

Silver Lake, Waushara County

Dates: 6/14 - 9/02

Date	Dive Location	Latitude	Longitude	Underwater Dive Time (hrs)	AIS Removed (cubic ft)	AIS Density	Avg Water Depth (ft)	Native Species	Native By-Catch	Substrate Type
8/19/2021	21e-g	44.06184	-89.24379	0.75	12.0	Scattered	12.0	Pondweeds	1.0	Organic
8/20/2021	21e-e	44.05945	-89.24589	0.58	9.0	Scattered	7.0	Pondweeds	1.0	Organic
8/20/2021	21e-e	44.05928	-89.24600	0.92	20.0	Scattered	5.0	Pondweeds	1.0	Organic/Sand
8/20/2021	21e-f	44.06149	-89.24530	0.58	16.0	Scattered	4.0	Pondweeds	1.0	Organic/Sand
8/20/2021	21e-f	44.06140	-89.24544	0.25	3.0	Scattered	4.0	Pondweeds	0.0	Organic/Sand
8/20/2021	21e-g	44.06194	-89.24319	1.00	30.0	Clumps	10.0	Pondweeds	3.0	Organic
8/20/2021	21e-g	44.06194	-89.24319	0.75	21.0	Clumps	10.0	Pondweeds	2.0	Organic
8/20/2021	21e-g	44.06221	-89.24207	1.08	20.0	Scattered	6.0	Pondweeds	1.0	Organic/Sand
8/26/2021	21e-g	44.06183	-89.24065	1.17	21.0	Scattered	7.0	Pondweeds	1.0	Organic/Gravel
8/26/2021	21e-b	44.05683	-89.24278	0.67	16.0	Scattered	10.0	Pondweeds	1.0	Organic
8/26/2021	21e-b	44.05636	-89.24212	0.75	15.0	Scattered	9.0	Pondweeds	1.0	Organic
8/26/2021	21e-d	44.05776	-89.24461	1.00	15.0	Scattered	5.0	Chara	2.0	Organic/Sand
8/26/2021	21e-d	44.05777	-89.24469	0.42	5.0	Scattered	5.0	Chara	1.0	Organic/Sand
8/26/2021	21e-d	44.05792	-89.24460	1.33	18.0	Scattered	6.0	Pondweeds	1.0	Organic/Sand
8/26/2021	21e-d	44.05780	-89.24453	0.42	5.0	Scattered	5.0	Pondweeds	0.5	Organic
8/30/2021	21e-d	44.05900	-89.24561	1.50	31.0	Scattered	10.0	Pondweeds	1.0	Organic/Sand
8/30/2021	21e-d	44.05841	-89.24531	0.67	9.0	Highly Scattered	6.0	Pondweeds	0.5	Organic/Sand
8/30/2021	21e-d	44.05812	-89.24505	0.58	12.0	Highly Scattered	6.0	Chara	0.5	Organic/Sand
8/30/2021	21e-d	44.05801	-89.24464	1.08	16.0	Scattered	7.0	Pondweeds	1.0	Organic/Sand
8/30/2021	21e-a	44.05578	-89.23808	1.25	17.0	Scattered	8.0	Elodea	1.0	Organic/Sand
8/30/2021	21e-a	44.05586	-89.23790	0.75	15.0	Scattered	10.0	Elodea	0.5	Organic/Sand
8/31/2021	21e-a	44.05588	-89.23780	0.67	6.0	Clumps	9.0	None	0.0	Organic/Sand
8/31/2021	21e-h	44.05936	-89.23615	0.58	16.0	Scattered	8.0	Pondweeds	1.0	Organic
8/31/2021	21e-h	44.05954	-89.23635	0.75	15.0	Scattered	10.0	Pondweeds	3.0	Organic
8/31/2021	21e-h	44.05999	-89.23722	0.33	3.0	Scattered	12.0	Pondweeds	3.0	Organic
8/31/2021	21e-g	44.06204	-89.24315	0.83	23.0	Clumps	12.0	Pondweeds	1.0	Organic
8/31/2021	21e-g	44.06204	-89.24315	2.67	37.0	Clumps	12.0	Pondweeds	1.0	Organic
9/2/2021	21e-g	44.06215	-89.24339	0.92	24.0	Scattered	10.0	Pondweeds	0.5	Organic
9/2/2021	21e-g	44.06226	-89.24305	1.58	25.0	Scattered	6.0	Pondweeds	1.0	Organic
9/2/2021	21e-g	44.06226	-89.24305	0.83	21.0	Scattered	12.0	Pondweeds	1.0	Organic
9/2/2021	21e-g	44.06225	-89.24305	1.58	26.0	Clumps	12.0	Pondweeds	1.0	Organic
9/2/2021	21e-b	44.05743	-89.24438	1.25	6.0	Scattered	4.0	Chara	0.5	Sand
Total	**218**			**183.84**	**2795.0**				**422.0**	

B

APPENDIX B

Littoral Frequency of Occurrence of Aquatic Plants from whole-lake point-intercept surveys of Silver Lake from 2012-2021.

	Scientific Name	Common Name	LFOO (%)								
			2012	2013	2014	2015	2017	2018	2019	2020	2021
Dicots	*Ceratophyllum demersum*	Coontail	32.9	32.9	42.5	36.3	20.4	25.5	21.9	14.7	16.1
	Myriophyllum spicatum	Eurasian watermilfoil	25.3	33.3	7.8	20.0	0.2	1.7	2.3	0.2	2.1
	Bidens beckii	Water marigold	0.0	0.0	0.2	0.0	0.4	1.1	2.3	2.8	4.1
	Myriophyllum sibiricum	Northern watermilfoil	0.6	5.4	0.7	0.2	0.0	0.0	0.0	0.0	0.0
	Ranunculus aquatilis	White water crowfoot	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.5	1.4
	Nymphaea odorata	White water lily	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
	Myriophyllum verticillatum	Whorled watermilfoil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	Utricularia geminiscapa	Twin-stemmed bladderwort	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Non-dicots	*Chara & Nitella*	Charophytes	33.8	25.1	30.0	23.9	25.7	33.5	23.6	16.9	17.9
	Chara spp.	Muskgrasses	28.7	15.9	19.2	17.4	22.2	31.3	16.6	14.6	15.2
	Najas flexilis & N. guadalupensis	Slender and Southern naiad	27.4	22.8	25.3	19.3	3.7	13.0	9.7	7.8	10.8
	Najas guadalupensis	Southern naiad	24.7	21.3	22.6	16.5	3.7	9.7	7.0	7.1	9.9
	Elodea canadensis	Common waterweed	27.8	35.1	28.2	19.1	0.0	1.3	2.3	2.5	6.2
	Vallisneria americana	Wild celery	11.0	8.9	11.6	12.4	9.8	14.3	13.9	12.4	12.6
	Potamogeton gramineus	Variable-leaf pondweed	20.7	13.6	10.7	11.1	3.5	15.1	10.7	7.5	7.6
	Fissidens spp. & Fontinalis spp.	Aquatic Moss	5.5	10.1	7.4	4.8	0.0	9.7	18.3	6.9	10.8
	Potamogeton friesii	Fries' pondweed	2.1	3.4	2.2	11.7	4.6	3.9	8.2	11.5	12.4
	Potamogeton zosteriformis	Flat-stem pondweed	1.5	2.2	2.0	2.6	6.1	7.3	6.9	7.3	12.2
	Stuckenia pectinata	Sago pondweed	6.5	5.1	6.5	8.9	7.4	10.4	4.4	4.3	4.6
	Nitella spp.	Stoneworts	8.0	9.4	11.4	8.5	3.7	2.2	7.2	2.5	3.4
	Potamogeton praelongus	White-stem pondweed	4.6	4.0	8.5	4.8	1.5	4.1	4.2	4.1	5.3
	Potamogeton berchtoldii & P. pusillus	Slender and Small pondweeds	0.0	2.0	2.2	4.8	3.5	8.9	6.5	0.7	5.0
	Potamogeton foliosis & P. strictifolius	Leafy and Stiff pondweed	3.6	0.2	2.9	0.7	3.3	1.1	4.4	4.1	4.3
	Potamogeton pusillus	Small pondweed	0.0	2.0	2.2	4.8	3.5	8.9	6.5	0.7	0.7
	Potamogeton illinoensis	Illinois pondweed	4.6	2.7	4.7	5.4	1.5	0.6	1.5	1.1	2.0
	Najas flexilis	Slender naiad	3.2	1.8	3.8	3.0	0.0	3.2	3.0	0.7	1.1
	Potamogeton strictifolius	Stiff pondweed	0.0	0.0	0.0	0.0	1.5	0.9	1.9	3.9	3.9
	Heteranthera dubia	Water stargrass	0.6	0.2	0.2	0.0	2.4	4.3	1.7	0.2	1.4
	Potamogeton foliosus	Leafy pondweed	3.6	0.2	2.9	0.7	1.7	0.2	2.5	0.2	0.4
	Potamogeton berchtoldii	Slender pondweed	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	4.3
	Potamogeton natans	Floating-leaf pondweed	0.0	0.7	0.4	0.9	0.0	0.2	0.4	0.9	1.2
	Potamogeton crispus	Curly-leaf pondweed	0.2	0.0	0.0	0.2	1.1	0.0	0.2	0.2	0.7
	Potamogeton amplifolius	Large-leaf pondweed	0.6	0.0	0.7	0.0	0.0	0.6	0.2	0.2	0.5
	Eleocharis acicularis	Needle spikerush	0.0	0.0	0.2	0.7	0.4	0.2	0.0	0.2	0.0
	Spirodela polyrhiza	Greater duckweed	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
	Potamogeton spirillus	Spiral-fruited pondweed	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
	Potamogeton richardsonii	Clasping-leaf pondweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
	Elodea nuttallii	Slender waterweed	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Schoenoplectus pungens	Three-square rush	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
	Acorus americanus	Sweetflag	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0

C

APPENDIX C

Littoral Frequency of Occurrence of aquatic plants from sub point-intercept survey in Fox Tail Bay of Silver Lake from 2019-2021.

	Scientific Name	Common Name	LFOO (%)		
			2019	2020	2021
Dicots	*Ceratophyllum demersum*	Coontail	41.6	40.4	33.0
	Myriophyllum spicatum	Eurasian watermilfoil	36.0	0.0	2.3
	Nymphaea odorata	White water lily	4.5	3.4	1.1
	Bidens beckii	Water marigold	1.1	0.0	1.1
	Ranunculus aquatilis	White water crowfoot	0.0	1.1	0.0
Non-dicots	*Potamogeton praelongus*	White-stem pondweed	67.4	70.8	58.0
	Vallisneria americana	Wild celery	24.7	36.0	37.5
	Elodea canadensis	Common waterweed	10.1	22.5	34.1
	Potamogeton zosteriformis	Flat-stem pondweed	13.5	40.4	22.7
	Chara spp.	Muskgrasses	24.7	16.9	12.5
	Najas guadalupensis	Southern naiad	13.5	22.5	9.1
	Potamogeton illinoensis & P. gramineu	Illinois and Variable-leaf pondwee	19.1	15.7	9.1
	Potamogeton illinoensis	Illinois pondweed	19.1	6.7	5.7
	Heteranthera dubia	Water stargrass	14.6	0.0	6.8
	Stuckenia pectinata	Sago pondweed	5.6	6.7	3.4
	Potamogeton gramineus	Variable-leaf pondweed	0.0	10.1	4.5
	Potamogeton pusillus & P. berchtoldii	Small & Slender pondweeds	2.2	9.0	3.4
	Potamogeton pusillus	Small pondweed	2.2	0.0	3.4
	Potamogeton berchtoldii	Slender pondweed	0.0	9.0	0.0
	Potamogeton friesii	Fries' pondweed	1.1	6.7	0.0
	Potamogeton amplifolius	Large-leaf pondweed	0.0	3.4	2.3
	Potamogeton natans	Floating-leaf pondweed	2.2	2.2	1.1
	Potamogeton strictifolius	Stiff pondweed	0.0	3.4	0.0
	Potamogeton crispus	Curly-leaf pondweed	2.2	0.0	0.0
	Eleocharis acicularis	Needle spikerush	0.0	0.0	1.1
	Nitella spp.	Stoneworts	0.0	1.1	0.0
	Najas flexilis	Slender naiad	0.0	1.1	0.0