An Aquatic Plant Survey and Aquatic Plant Management Plan Update for Little Elkhart Lake– Sheboygan County

March, 2022

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Introduction

The aquatic plant community of Little Elkhart Lake , Sheboygan County has been the subject of numerous investigations. This document includes a summary of the most recent investigations, surveys conducted by Stantec, Inc. (2012) and by the WI DNR (2019 and 2020).

Following this summary is an Update to the Little Elkhart Lake Management Plan, which was last completed in 2014.

Methodology

The protocol for the aquatic plant surveys called for the sampling of vegetation at 232 pre-determined sites within the lake. These locations were spaced apart by approximately 30 meters in general north-south and east-west transects across Little Elkhart Lake using waypoints (longitude and latitude coordinates) provided by the Wisconsin Department of Natural Resources (Figure. #1).

While the location of these sites was the same for all three surveys, the total number of sites visited and locations changed survey-to-survey according to navigability, with water depth (too shallow) and/or density of plants being limiting factors. Furthermore, a few sites fell upon dry land, such as the island. Figure #2 (page 3) shows the location of the actual points sampled on the survey dates.

After downloading of a base map and the waypoint coordinates onto an on -board laptop computer, the sampling crew navigated to each of the waypoints with the assistance of a Global Positioning System. At each point, water depth was collected and recorded. Finally, a double-side rake head attached to Pole (P) or Rope (R) was lowered to the bottom (or cast) and retrieved. Plants collected were identified to genus with species (if known). Individual plant species density (rake fullness for a single plant type) along with total plant density (rake fullness for all plants) was determined. This data was then recorded for each site. The rake fullness rating was as follows:

Fullness Rating	Coverage	Description
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.
3		The rake is completely covered and tines are not visible.

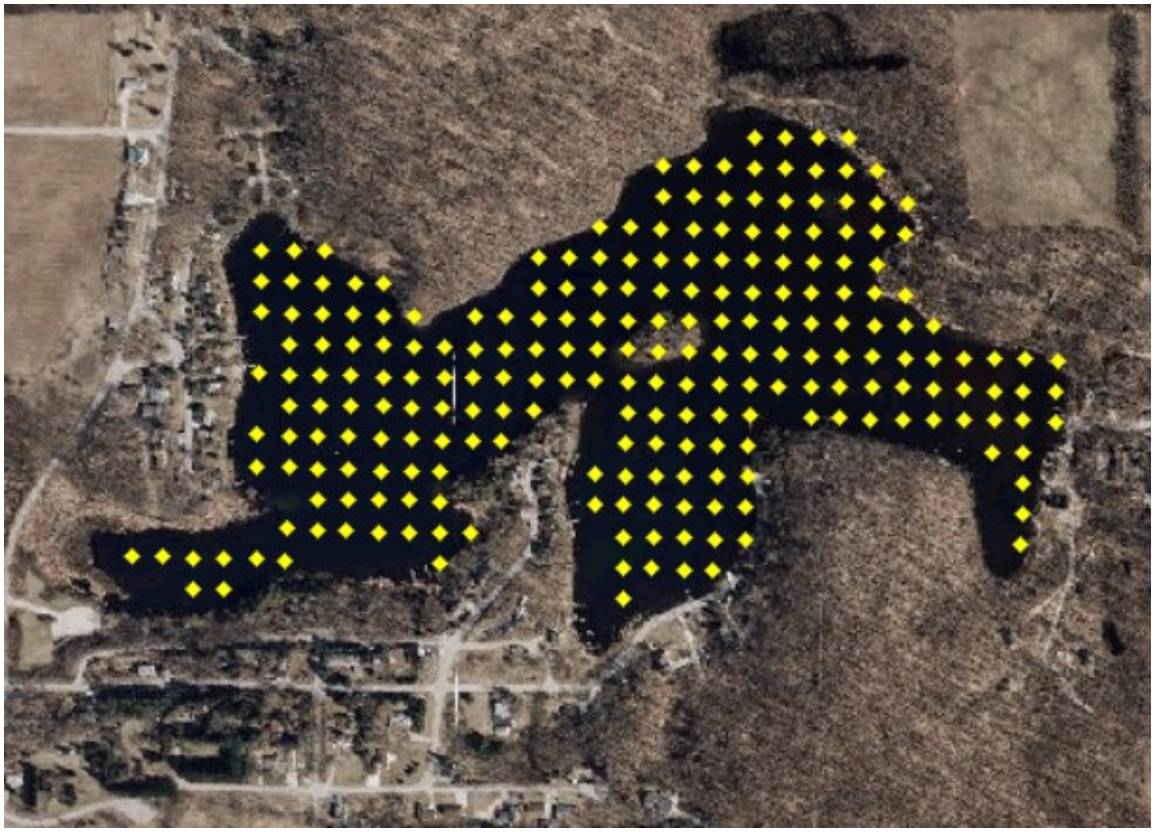
NOTE: Plants not collected by rake, but observed within a six-foot radius of a data collection site are recorded as Visual (V).

Text continued on page 4

Figure 1

Location of WI DNR Sampling Waypoints

Little Elkhart Lake — Sheboygan County, WI



Total # of Sampling Points : 232

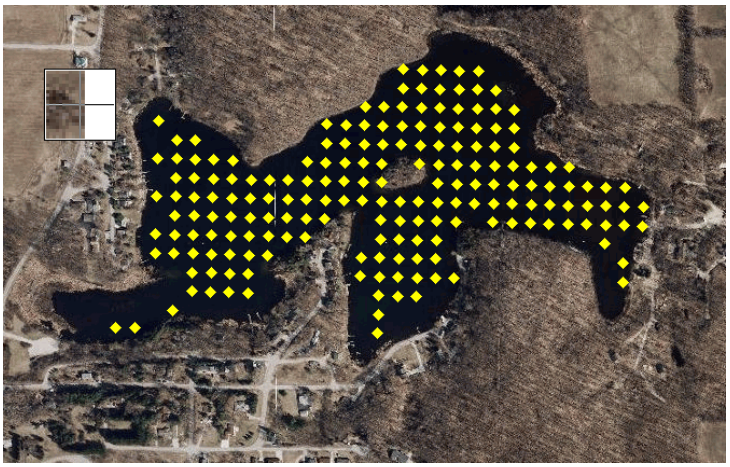
Sampling Interval: 30 meters

Figure 2

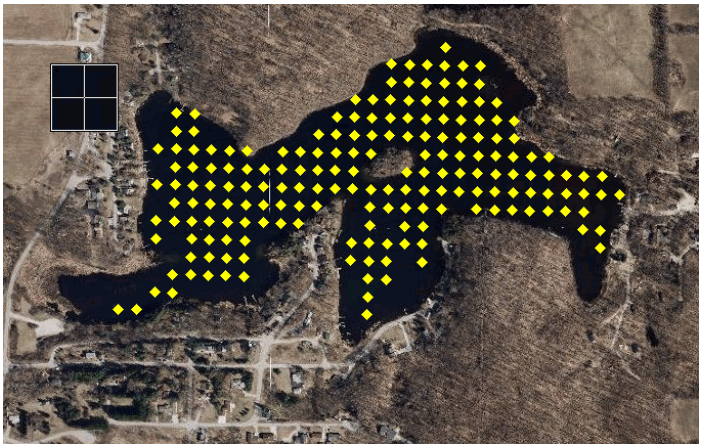
Location of Sampling Waypoints Visited

Little Elkhart Lake — Sheboygan County, WI

2020 Survey
Number of Sites Visited: 187



2019 Survey
Number of Sites Visited: 185



2012 Survey
Number of Sites Visited: 220

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Aquatic Plant Survey Results

Being a relatively shallow lake (maximum depth found, 29 ft.), Little Elkhart Lake has an abundant aquatic plant community, with plants located at sites up to 21 ft. deep (2021). This compares with 18 ft. in 2012 and 15 ft. in 2019. Table 1 (Below) shows a comparison of the plant species present, number of locations found, and average density.

Table 1

Species Presence—Little Elkhart Lake, Sheboygan County

		August, 2020			September, 2019			July, 2012		
Scientific Name	Common Name	# sites	Freq. %	Avg. Density	# sites	Freq. %	Avg. Density	# sites	Freq. %	Avg. Density
Myriphyllum spicatum	Eurasian water-milfoil	12	7.06	1.33	11	7.14	1.09	12	5.97	1.00
Brasenia schreberi	Watershield	present			Present			21	10.45	1.19
Ceratophyllum demersum	Coontail	18	10.59	1.33	15	9.74	1.53	70	34.83	1.29
Chara, sp.	Chara	93	54.71	2.74	122	79.22	2.17	120	59.70	1.43
Eleocharis acicularis	Needle spikerush							1	0.50	1.00
Elodea canadensis	Common waterweed	3	1.76	1.00	1	0.65	2.00	18	8.96	1.00
Iris versicolor	Northern Blue flag							1	0.50	1.00
Lemna triscula	Forked duckweed							41	20.40	1.00
Megalodonta beckii	Water marigold							3	1.49	1.00
Myriphyllum sibiricum	Northern watermilfoil	1	0.59	1.00	1	0.65	1.00	11	5.47	1.00
Najas flexilis	Bushy pondweed	6	3.53	1.67	1	0.65	1.00	26	14.43	1.10
Nitella, sp.	Nitella	54	31.76	2.24	7	4.55	1.29	16	7.96	1.25
Nuphar variegata	Spatterdock	1	0.59	1.00	Present			8	3.98	1.00
Nymphae odorata	White water lily	8	4.71	1.13	16	10.39	1.00	68	33.83	1.07
Polygonum amphibum	Water smartweed							2	1.00	1.00
Potamogeton amplifolious	Large-leaf pondweed	present						82	40.80	1.10
Potamogeton gramineus	Variable Leaf pondweed							8	3.98	1.00
Potamogeton illoensis	Illinois pondweed	Present			1	0.65	1.00			
Potamogeton strictifolious	Stiff pondweed				1	0.65	1.00			
Potamogeton zosteriformes	Flat-stem pondweed							49	24.38	1.18
Sagittaria, sp.	Arrowhead				1	0.65	1.00			
Schoenoplectus acutus	Hardstem bulrush							5	2.49	1.00
Schoenoplectus tabernaemontani	Softstem bulrush	1	0.59	1.00	present					
Stuckenia pectinata	Sago pondweed	1	0.59	3.00				1	0.5	1.00
Typha latifolia	Broad-leaved cattail				Present			1	0.5	1.00
Utricularia minor	Small bladderwort	23	13.53	1.17						
Utricularia vulgaris	Common bladderwort	14	8.24	1.43	43	27.92	1.56	14	6.97	1.14
	Filamentous algae	23	13.53	1.26	79	45.45	1.97	4	1.99	1.00

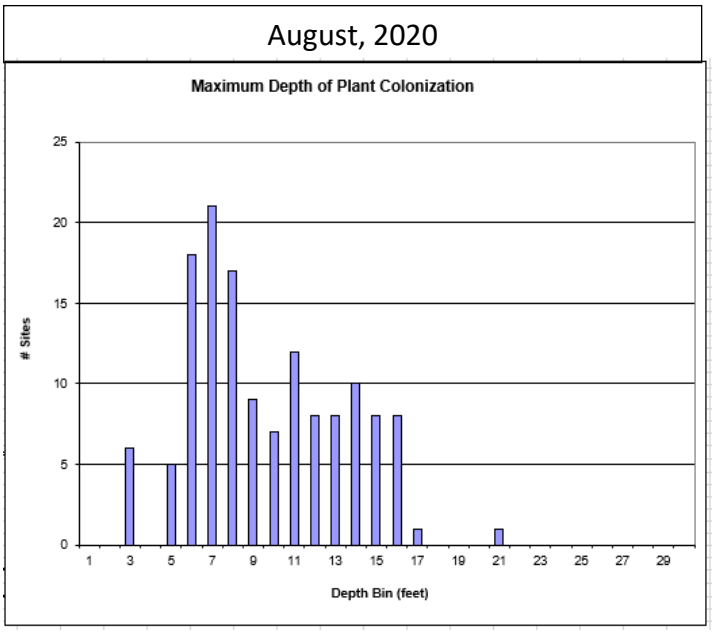
Figures #3 (following page) details the relationship between water depth and the number of sites where aquatic vegetation was found in Graph forms. Figure 4 (page 6) provides the location of sites with aquatic vegetation during the 2020 survey. Figure 5 is a map that shows the locations where Eurasian water-milfoil (EWM) was found.

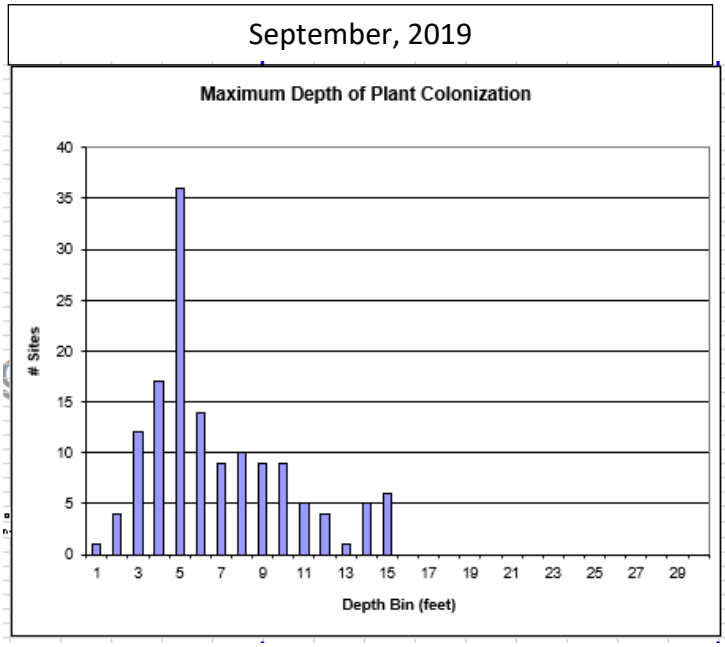
While Curly-leaf Pondweed has been observed previously in the lake, none was observed during the three surveys due to timing. This species typically reaches a maximum biomass in late-May/mid-June, then dies back after the 4th of July. It may re-develop once again somewhat in late Fall once water temperatures have cooled.

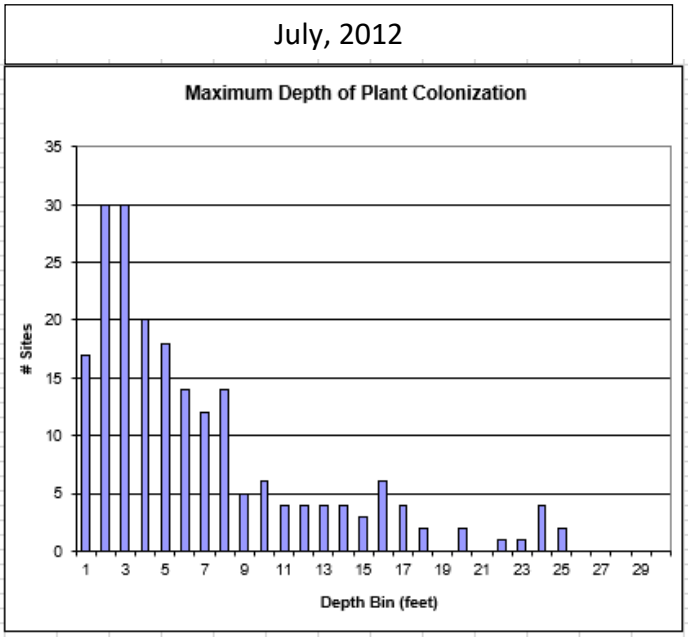
Figure 3

Depth of Plant Colonization - Little Elkhart Lake, Sheboygan County, WI

2012, 2019 and 2020 Survey







Figures 6-13 detail the location ofwith the Top Seven Ranked Native Plant Species and filamentous algae sites in Little Elkhart Lake during the 2020 survey. Also provided is the data for the same species collected during the earlier surveys as a comparison.

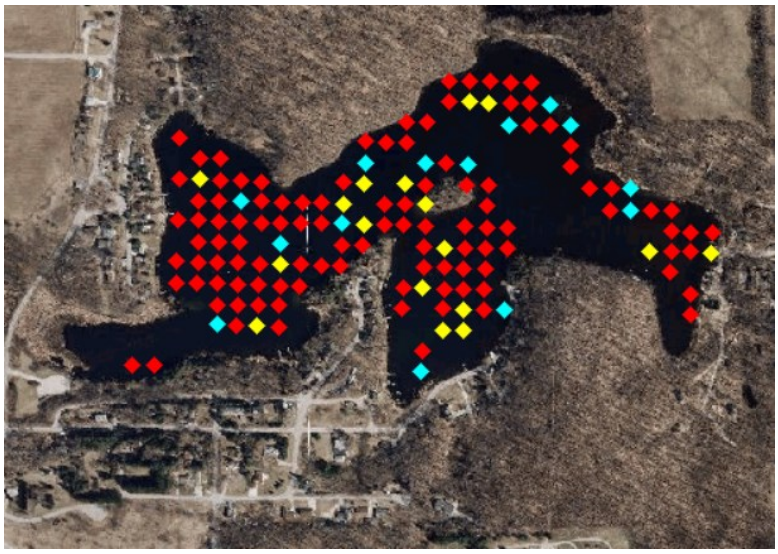
Further discussion of the Results and Comparison with prior surveys continues after the species maps on page 16.

Figure 4

Little Elkhart Lake, Sheboygan County, WI

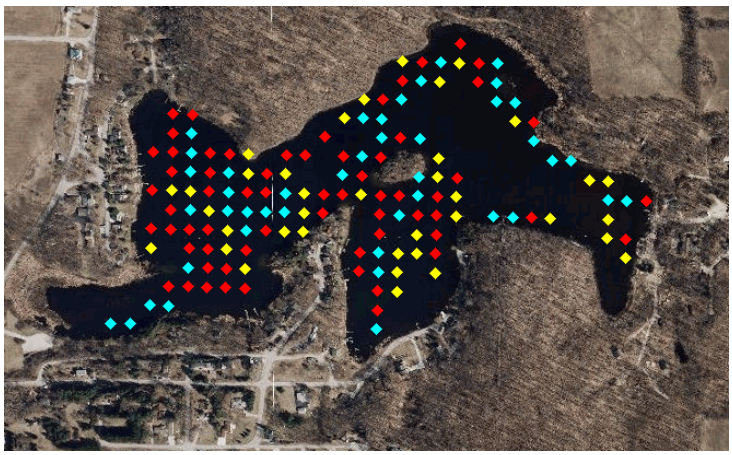
Sites with Aquatic Vegetation (all species)

August, 2020



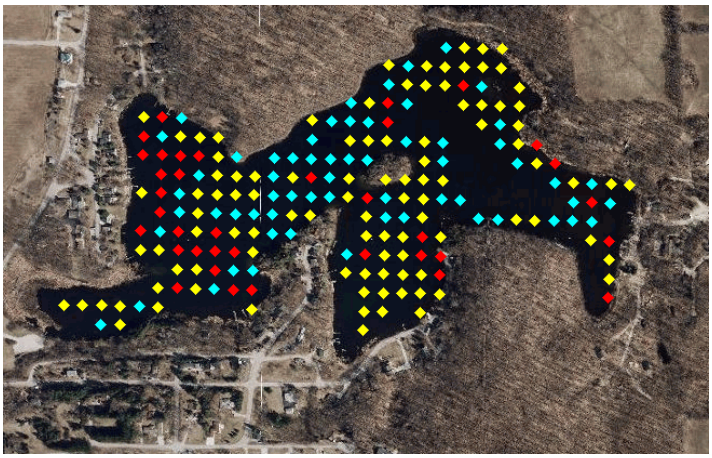
No. of Vegetated Sites: 139 Sites Visited: 187

Sept., 2019



No. of Vegetated Sites: 142 Sites Visited: 185

July, 2012



No. of Vegetated Sites: 199 Sites Visited: 220

Rake Fullness : 1
2
3
Visual

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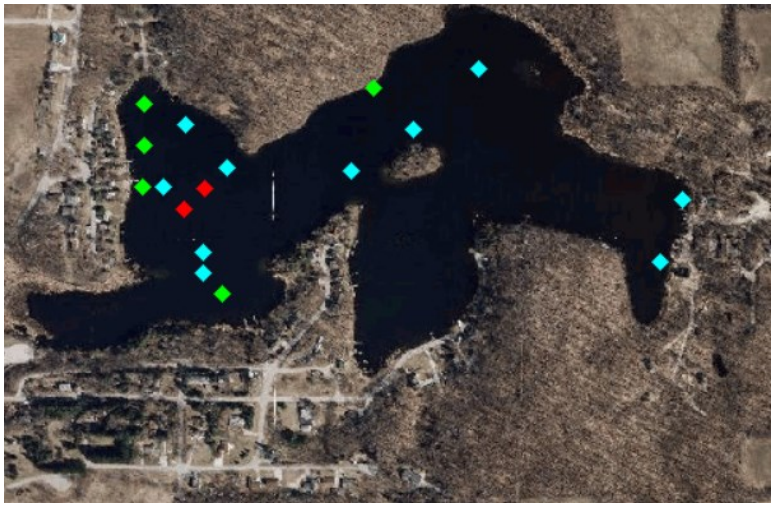
Figure 5

Little Elkhart Lake, Sheboygan County, WI

Sites with Eurasian/Hybrid Milfoil

August, 2020



Sites Present: 12 Visuals: 5

Rake Fullness : 1
2
3
Visual

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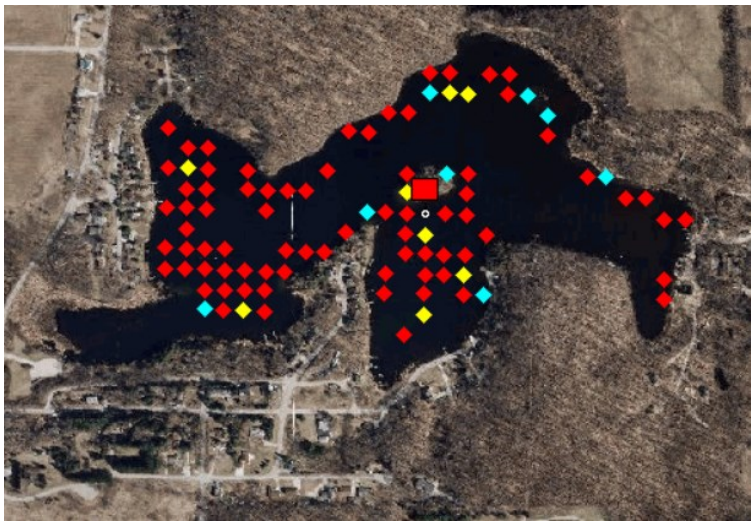
Figure 6

Little Elkhart Lake, Sheboygan County, WI

Sites with Chara (*Chara, spp*.)

August, 2020



Sites Present: 93

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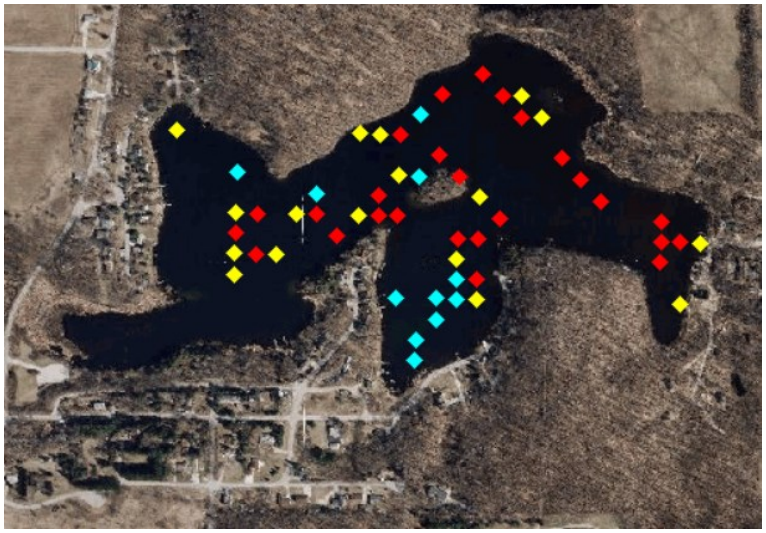
Figure 7

Little Elkhart Lake, Sheboygan County, WI

Sites with Nitella (*Nitella*, *spp*.)

August, 2020



Sites Present: 54

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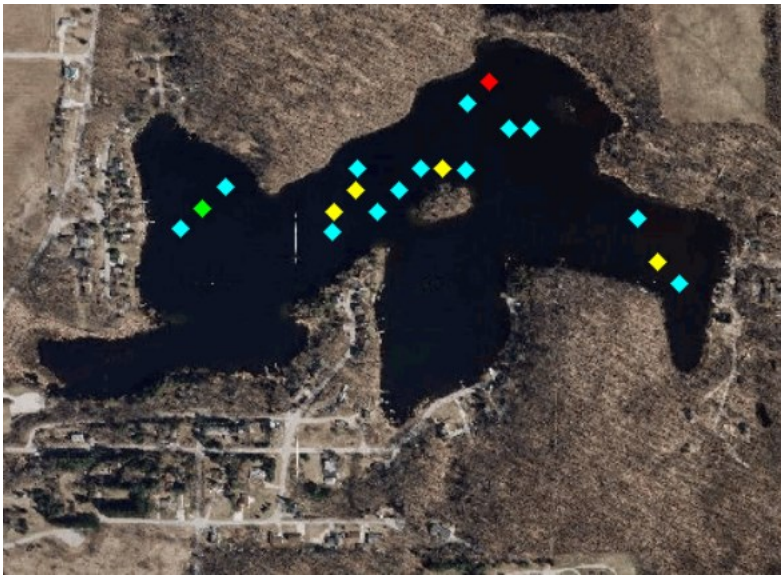
Figure 8

Little Elkhart Lake, Sheboygan County, WI

Sites with Coontail (*Ceratophyllum demersum*)

August, 2020



Sites Present: 18 Visuals: 1

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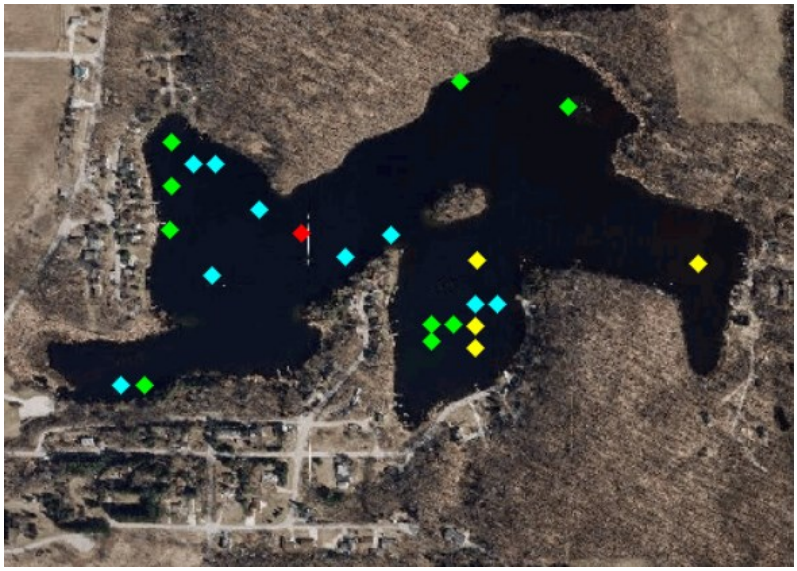
Figure 9

Little Elkhart Lake, Sheboygan County, WI

Sites with Common Bladderwort (*Utricularia vulgaris*)

August, 2020



Sites Present: 14 Visuals: 9

Rake Fullness : 1
2
3
Visual

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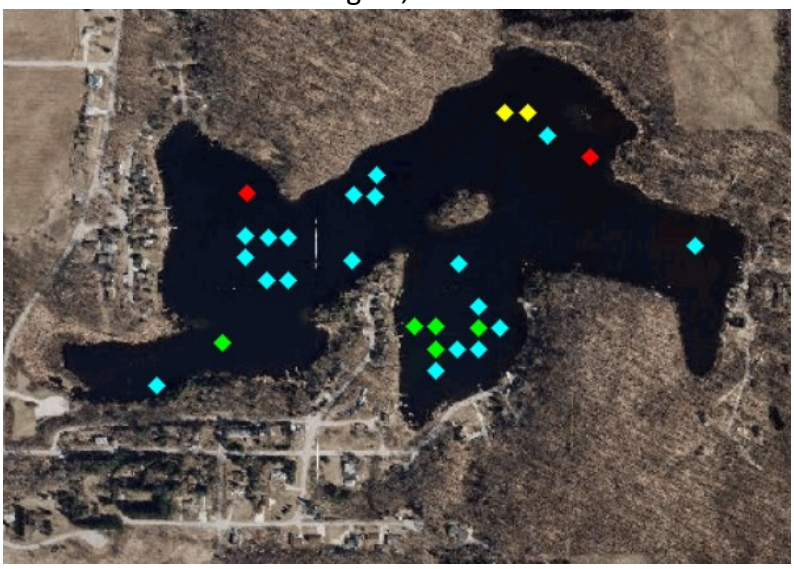
Figure 10

Little Elkhart Lake, Sheboygan County, WI

Sites with Small Bladderwort (*Utricularia minor*)

August, 2020



Sites Present: 23 Visuals: 5

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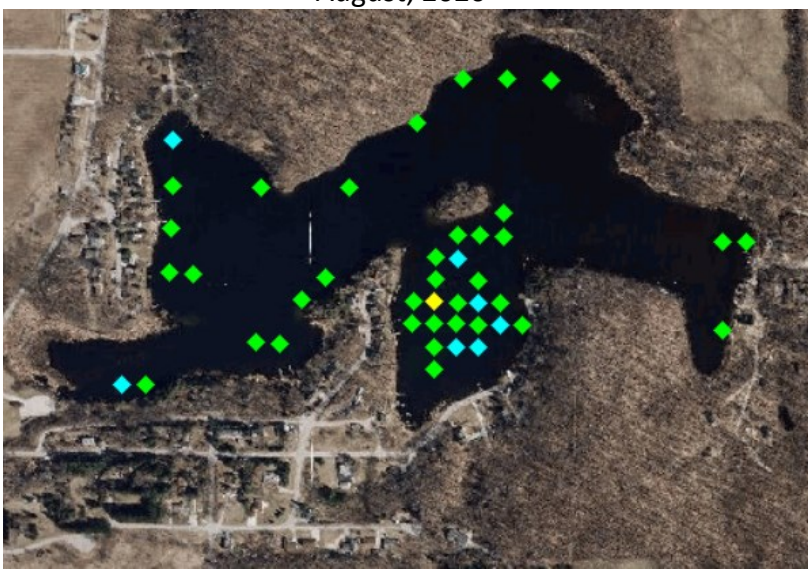
Figure 11

Little Elkhart Lake, Sheboygan County, WI

Sites with White Water Lily (*Nymphaea odorata*)

August, 2020



Sites Present: 8 Visuals: 35

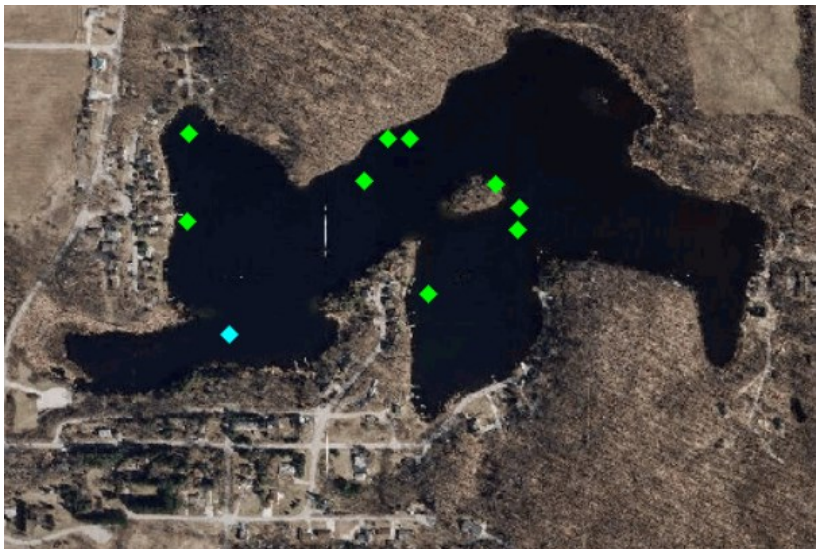
Rake Fullness : 1
2
3
Visual

Figure 12

Little Elkhart Lake, Sheboygan County, WI

Sites with Spatterdock (*Nuphar variegata*)

August, 2020



Sites Present: 1 Visuals: 9

Rake Fullness : 1
2
3
Visual

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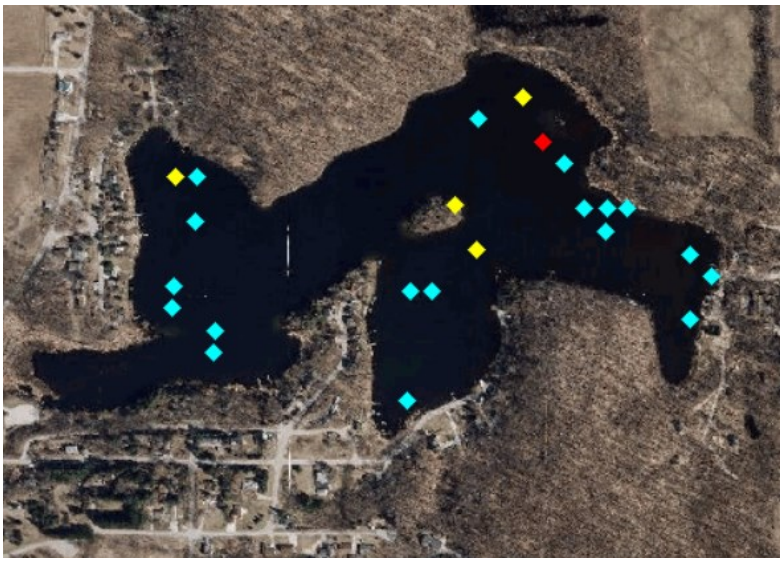
Figure 13

Little Elkhart Lake, Sheboygan County, WI

Sites with Filamentous Algae

August, 2020



Sites Present: 23

Rake Fullness : 1
2
3
Visual

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Aquatic Plant Survey Results cont'd

Figure 14 (following page) provides a Summary of Statistics for each species present at the 2020 survey, and Figure 15 (page 20), a Table of the Floristic Quality Index (FQI) for the 2020 survey, with FQI's for the 2012 and 2019 surveys provided as well. Figure 16 (page 21) lists the Summary Statistics for the 2020 Survey, for which a brief discussion follows.

Total # of Sites w/ Vegetation

The number of sites having vegetation in Little Elkhart Lake during the 2020 and 2019 surveys were very similar in number. (139 vs. 142) The l# Sites with Vegetation in 2012 was much higher (199). The primary reason for this significant difference is the Total # of Sites Visited - 220 in 2012 vs. 185 in 2019 and 187 in 2020.

Shallow water and/or dense vegetation interfered with navigation to these sites. Figured 4 (page 6) provides a side-by-side comparison of the location of vegetated sites during each of the three surveys.

Total # Sites Shallower Than Maximum Depth of Plants

The number of sites shallower than the maximum depth of plants for the 2020 survey was 170. During the 2019 Survey the number was 154 and in 2012, 201. Factors affecting a difference in these numbers include the total # sites being visited (highest in 2012) and changes in water clarity. Any changes in water clarity can increase/decrease the Maximum Rooting Depth.

Relative Frequency of Occurrence

Relative Frequency of Occurrence, presented as a percentage, is the number of sites shallower than the maximum depth that contained vegetation. The data for this statistic is provided below:

	Sept.,, 2020	Aug., 2019	July, 2012
Frequency of occurrence at sites shallower than maximum depth of plants	81.76	92.21	99.00

All three values indicate that aquatic vegetation is abundant throughout Little Elkhart Lake, with ample nutrients available in the bottom sediments to support aquatic growth..

It is important to note that the survey year with the greatest Maximum Rooting Depth (2020 at 21 feet) had the lowest Frequency of Occurrence. A single plant, located at this depth can have a significant (negative) impact in this percentage. The majority of vegetation in Little Elkhart Lake lies within a depth of 15 feet or less (see figure 3, page 5).

Simpson Diversity Index

The Simpson Diversity Index (SDI) measures the diversity of a plant population, using the number of species surveyed and the number of species per site. The decimal scale ranges from 0 (low diversity) to 1 (high diversity). The SDI for the surveys were 0.77 (Sept., 2020), 0.64 (Aug., 2010) and 0.89 (July, 2012). The lower values obtained during the 2019 and 2020 are indicative of either a fewer number of species being present and/or greater dominance by a limited number of species, such as Chara. The fewer number of sites visited in shallow water, where Chara is less dominant, and other species such as Bladderwort, White Lilly and Spatterdock, more prevalent, explains at least, in part, the discrepancy in the SDI Values..

Maximum Depth of Plants

Maximum depth of plants has ranged from 15 ft. (2019) to 21 ft.. (2020), with 2012 (18 ft.) falling in between. Water clarity is the primary factor in determining the depth to which plants will grow, providing that suitable substrate/nutrients are available as well.

Figure 14

Summary of Little Elkhart Lake 2020 PI Survey Plant Data

Common Name	Species	Freq. of Occurrence within vegetated areas (%)	Average Rake Fullness	# sites where species found (does not include visuals)	# of visual sightings
Eurasian Watermilfoil	*Myriophyllum spicatum*	8.63	1.33	12	5
Watershield	*Brasenia schreberi*	0.0	na	0	1
Coontail	*Ceratophyllum demersum*	12.95	1.33	18	1
Muskgrasses	*Chara*	66.91	2.74	93	0
Water star-grass	*Heteranthera dubia*	1.5	1.80	5	0
Elodea	*Elodea canadensis*	2.16	1.00	3	0
Northern water-milfoil	*Myriophyllum sibiricum*	0.72	1.00	1	0
Slender naiad	*Najas flexilis*	4.32	1.67	6	0
Nitella	*Nitella*	38.85	2.24	54	0
Spatterdock	*Nuphar variegata*	0.72	1.00	1	9
White water lily	*Nymphaea odorata*	5.76	1.13	8	35
Large-leaf pondweed	*Potamogeton amplifolius*	0.00	na	0	1
Illinois pondweed	*Potamogeton illinoensis*	0.00	na	0	1
Large-leaf pondweed	*Potamogeton amplifolius*	5.41	1.39	18	1
Hardstem bullrush	*Schoenoplectus tabemnaemontani*	0.72	1.00	1	0
Sago pondweed	*Stuckenia pectinata*	0.72	3.00	1	0
Small bladderwort	*Utricularia minor*	16.55	1.17	23	5
Common bladderwort	*Utricularia vulgaris*	10.07	1.43	14	9
Filamentous algae		16.55	1.26	23	0

Aquatic Plant Survey Results cont'd

Average # of Species Per Site (Shallower than maximum depth) and Average # of Species (vegetated sites only)

The values for the surveys are highlighted below:

	Aug., 2020	Sept., 2019	July,2012
Average number of all species per site (shallower than max depth)	1.38	1.43	2.91
Average number of all species per site (veg. sites only)	1.69	1.55	2.94

The values for the 2019/2020 surveys are significantly lower than the survey conducted in 2012. The difference between these surveys is due to the lower number of species (Species Richness) being found in the later surveys. It has already been hypothesized that part of this is due to Methodology, that is, more sites (in shallow water) being visited during the 2012 survey. Changes in dominance of a one or two species (whether native or non-native) in a given year can cause fluctuations in this statistic.

Avg. # of Native Species/Site (shallower than max. depth) and Avg. # of Native Species/ Site (vegetated sites only)

The values for these statistics are also provide below in Table form as a reference:

	Aug., 2020	Sept., 2019	July,2012
Average number of native species per site (shallower than max depth)	1.31	1.36	2.83
Average number of native species per site (veg. sites only)	1.62	1.47	2.88

These values for 2019/2020 are also much lower due to the lower number of species found in these surveys,.

Species Richness

Species richness is simply the number of species observed in the lake during the surveys. Species Richness (number of species collected by Rake), along with Richness, - including Visuals is located in the Table below.

	Aug., 2020	Sept., 2019	July,2012
Species Richness	16	12	23
Species Richness, including Visuals	16	16	23

The lower totals for 2020 and 2019 are quite obvious. The author has postulated that this difference is due in part to due to difference in methodology used (number of sites visited in 2019/2020 vs. the 2012) between surveys.

A visual survey of the Data (P.I.) Points not surveyed in 2019/20, but surveyed in 2012 was conducted in May and September, 2021 in order to determine what species "missing" in 2019/2020, but present in 2012, may have been overlooked. A series of photos, documenting their presence is found on pages 22-23.

Aquatic Plant Survey Results cont'd

Floristic Quality of Index

The Floristic Quality Index (FQI) is a measure of a plant community's closeness to an undisturbed condition. Urban lakes, or those with a high level of boat traffic have lower FQI's, meaning fewer species or lacking specific native species that are often associated with undisturbed conditions. The FQI for the surveys are as follows:

Sept.,2020	Aug., 2019	July,2012
19.63	18.66	25.27

FQI's for any particular lake are often compared to regional or state-wide averages in order to provide perspective. FQI values representing the highest value of the lowest quartile, mean and bottom of the highest quartile of all Wisconsin lakes are 16.9, 20.9, and 27.5. This places Little Elkhart Lake in the average category in terms of disturbance. For additional perspective, the lowest FQI measured 3.0 (most disturbed), and the highest, 44.6 (most undisturbed).

The fewer number of species present during the 2019/20 surveys, relative to the 20212 survey is the reason for the decrease in the FQI.

This concludes the presentation and discussion of the Data collected from the 2012, 2019 and 2020 Surveys The results of additional Surveys, completed on May 25 and September 1 will be discussed next.

May and September, 2021 Aquatic Plant Surveys

On May 25, 2021 a Pre Treatment Plant Survey was conducted on Little Elkhart Lake (LEL). While the primary purpose of this survey was to identify areas requiring treatment of EWM and CLP, additional time was spent looking for plant species that had not been determined to be "Present" during the 2019/20 Surveys. Some of these omissions were fairly obvious— it "just so happened" that no Waypoint fell upon/close to an area known to have a particular species. This is the case for Eleocharis sp., (Spikerush). It is an emergent plant that grows in shallow water. It is found along a significant portion of the shoreline in water that is too shallow for navigation. Thus, it can be overlooked rather easily. Other plants were located by slowly "drifting" the shallows, intently looking for species that were "Missing" from the 2019/20 surveys.

Figures 17 and 18 (pgs. 22-23) includes a series of photos taken during the May 25, 2021 survey. Names of the plant (genus and or species, along with common name) are also provided. Figure 19 is Raw Data collected (on September 1, 2021) from the 44 sites that were not sampled during the 2019/20 surveys.

Below is a Summary of the Data Collected during the September 1, 2021 survey:

Total # Waypoints	44
Visited	33
Vegetated	33

Species	# Sites
Chara	18
Nitella	6
Watershield	8
Spatterdock	2
White water lily	24
Bladderwort	8
Eurasian water-milfoil	1
Coontail	1
Illinois pondweed	2

Figures 20-22 (pages 25 -27) include Floristic Quality Indices, Summary Statistics and Plant Species Statistics reported earlier (figures 14-16) with data collected in 2021 added to the original 2020 Survey Workbook. With the 2021 data included, survey results are more consistent to those detailed at the time of the 2012 survey.

Figure 15

Floristic Quality Index (FQI) Little Elkhart Lake, Sheboygan County WI

Aquatic Plant Surveys

Species present=1

Species	Common Name	C	2020	2019	2012
Acunus americana	Sweet flag	7	0	0	1
Bidens beckii	Water marigold	8	0	0	1
Brasenia schreberi	Watershield	6	0	0	1
Ceratophyllum demersum	Coontail	3	1	1	1
Chara	Muskgrasses	7	1	1	1
Eleocharis acicularis	Needle spikerush	5	0	0	1
Elodea canadensis	Common waterweed	3	1	1	1
Lemna triscula	Forked duckweed	6	0	0	1
Myriophyllum sibiricum	Northern water-milfoil	6	1	1	1
Najas flexilis	Slender naiad	6	1	1	1
Nitella	Nitella	7	1	1	1
Nuphar variegata	Spatterdock	6	1	0	1
Nymphaea odorata	White water lily	6	1	1	1
Polygonum amphibum	Water smartweed	5	0	0	1
Potamogeton amplifolius	Large-leaf pondweed	7	0	0	1
Potamogeton gramineus	Variable pondweed	7	0	0	1
Potamogeton illinoensis	Illinois pondweed	6	0	1	0
Potamogeton strictifolious	Stiff pondweed	8	0	1	0
Potamogeton zosteriformis	Flat-stem pondweed	6	0	0	1
Schoenoplectus acutus	Hardstem bullrush	6	0	0	1
Schoenoplectus tabernaaemontani	Softstem bulrush	4	1	0	0
Stuckenia pectinata	Sago pondweed	3	1	0	1
Typha latifolia	Broad-leaved cattail	1	0	0	1
Utricularia minor	Small bladderwort	10	1	0	0
Utricularia vulgaris	Common bladderwort	7	1	1	1
N = # of of species			12	10	20
mean C			5.67	5.90	5.65
FQI			19.63*	18.66	25.27

* FQI for 2020 Survey with 2021 data included is 24.01 FQI is based upon presence of native aquatic plant species only

Note: "C" is a Coefficient of Conservatism assigned to individual plant species, with higher ranking species more representative of a more natural, undisturbed condition. See Citations for additional information.

CITATION: **Nichols, SA. 1999. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management, 15(2):133-141.**

CITATION: **University of Wisconsin-Madison, 2001. Wisconsin Floristic Quality Assessment (WFQA). Retrieved October 27, 2009 from: http://www.botany.wisc.edu/WFQA.asp**

Figure 16

Summary Statistics

Little Elkhart Lake, Sheboygan County, WI

Aquatic Plant Surveys (2012, 2019, 2020)

	August, 2020	Sept., 2019	July, 2012
Total number of sites visited	187	185	220
Total number of sites with vegetation	139	142	199
Total number of sites shallower than maximum depth of plants	170	154	201
Frequency of occurrence at sites shallower than maximum depth of plants	81.76	92.21	99.0
Simpson Diversity Index	0.77	0.64	0.89
Maximum depth of plants (ft)**	21.0	15.0	18.0
Number of sites sampled using rake on Rope (R)	31	62	54
Number of sites sampled using rake on Pole (P)	145	123	166
Average number of all species per site (shallower than max depth)	1.38	1.43	2.91
Average number of all species per site (veg. sites only)	1.69	1.55	2.94
Average number of native species per site (shallower than max depth)	1.31	1.36	2.83
Average number of native species per site (veg. sites only)	1.62	1.47	2.88
Species Richness	13	12	23
Species Richness (including visuals)	16	16	23

Figure 17
Little Elkhart Lake—Sheboygan County, WI
Photos taken during May 25, 2021 Visual Aquatic Plant Survey

Identification: Likely *Potamogeton zosteriformes*, or Flat-stem pondweed.

Identification: Likely the native milfoil, *Myriophyllum sibiricum*, or Northern water-milfoil. Note: Leaves are rigid, remain erect out of water (Close Up of leaf Left), entire stem (right).

Identification: Upper specimen likely *Myriophyllum verticillatum* or Whorled water-milfoil (native). Note densely-stacked whorls of leaves. Bottom specimen may be *M. sibiricum* or a native x Eurasian hybrid.

Identification Eleocharis sp., in foreground. Short emergent plant growing in shallow water. Fairly ubiquitous in Little Elkhart Lake, it can be overlooked. This photo was taken directly oppositive of the Boat Launch. Caattails (Typha, sp.) present in background (note dried stems).

continued on following page

Figure 18
Little Elkhart Lake—Sheboygan County, WI
Photos taken during May 25, 2021 Visual Aquatic Plant Survey

Continued from preceding page

Identification:

Top: *Brasenia schreberi or Watershield. Present in earlier surveys.*

Center: Currently unknown. Appearance similar to Watershield, except for notch in leaf. Floating leaves rather small-about the size of a half-dollar. No flowers apparent on survey date. Possibly *Nymphaea leibergii* (Pygmy water lily)

Bottom: Likely *Myriophyllum verticillatum* or Whorled water-milfoil (native).

Figure 19
Plant Survey Data—September 1, 2021

Rake Fullness Ratings for Species Presence

Waypoint #	Depth (ft.)	Chara	Nitella	Watershield	Spatterdock	White water lily	Bladderwort	EWM	Coontail	Illinois Pondweed
1	3.5					3	2			
2	2.5					3	2			
3	3			1		3	1			
5	3			1		3	1			
8	4	1			V	3				
13	5		1			3				
14	3		2	2		V	2			
22	4					2				
24	3	3				1				
34	7	3				1				
43	2	3				1				
52	2	2								
65	2	2			1	1				
66	2	2			V	2	1			
67	2	2				1	1	1		
68	8	3				V				
73	2					3	1			
116	island									
117	2	1				2				
124	shallow									
131	5	3				2				
138	shallow									
151	bog									
152	bog									
153	8								3	
163	shallow									
164	shallow									
166	bog									
167	5	2				3				
176	4		2		1	3				
177	4		3			2				
186	2		1			2				
187	4			V		2				
188	1.5	1		1						
196	cattails									
197	2		2	2		2				
198	3.5			1		2				
199	2	2		1		V				
200	1	2								1
205	land									
206	land									
207	3	2		1						1
229	3	1				3				
230	2.5	2				V				

Marine Biochemists
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www.marinebiochemists.com

Figure 20

Floristic Quality Index (FQI) Little Elkhart Lake, Sheboygan County WI

Aquatic Plant Surveys 2012-2020*

Notes: 2020 data includes data from 2021 observations/data collection

FQI is based upon presence of native aquatic plant species only

Species	Common Name	C	2020 w/ 2021 data inc.	2020	2019	2012
*Acunus americana**	Sweet flag	7	0	0	0	1
*Bidens beckii***	Water marigold	8	0	0	0	1
Brasenia schreberi	Watershield	6	1	0	0	1
Ceratophyllum demersum	Coontail	3	1	1	1	1
Chara	Muskgrasses	7	1	1	1	1
Eleocharis acicularis	Needle spikerush	5	1	0	0	1
Elodea canadensis	Common waterweed	3	1	1	1	1
Lemna triscula	Forked duckweed	6	0	0	0	1
Myriophyllum sibiricum	Northern water-milfoil	6	1	1	1	1
Myriophyllum verticillatum	Whorled water-milfoil	8	1	0	0	0
Najas flexilis	Slender naiad	6	1	1	1	1
Nitella	Nitella	7	1	1	1	1
Nuphar variegata	Spatterdock	6	1	1	0	1
Nymphaea odorata	White water lily	6	1	1	1	1
Polygonum amphibum	Water smartweed	5	0	0	0	1
Potamogeton amplifolius	Large-leaf pondweed	7	0	0	0	1
Potamogeton gramineus	Variable pondweed	7	0	0	0	1
Potamogeton illinoensis	Illinois pondweed	6	1	0	1	0
Potamogeton strictifolious	Stiff pondweed	8	0	0	1	0
Potamogeton zosteriformis	Flat-stem pondweed	6	1	0	0	1
Schoenoplectus acutus	Hardstem bullrush	6	0	0	0	1
Schoenoplectus tabernaaemontani	Softstem bulrush	4	1	1	0	0
Stuckenia pectinata	Sago pondweed	3	1	1	0	1
Typha latifolia	Broad-leaved cattail	1	0	0	0	1
Utricularia minor	Small bladderwort	10	1	1	0	0
Utricularia vulgaris	Common bladderwort	7	1	1	1	1
	N = # of of species		17	12	10	20
	mean C		5.82	5.67	5.90	5.65
	FQI		24.01	19.63	18.66	25.27

Figure 21

Summary Statistics

Little Elkhart Lake, Sheboygan County, WI

Aquatic Plant Surveys (2012, 2019, 2020)

Note: 2020 data includes data from 2021 observations/data collection

	August,. 2020 w 2021 data inc.	August, 2020	Sept., 2019	July, 2012
Total number of sites visited*	221	187	185	220
Total number of sites with vegetation	171	139	142	199
Total number of sites shallower than maximum depth of plants	204	170	154	201
Frequency of occurrence at sites shallower than maximum depth of plants	83.82	81.76	92.21	99.0
Simpson Diversity Index	0.80	0.77	0.64	0.89
Maximum depth of plants (ft)**	21.0	21.0	15.0	18.0
Number of sites sampled using rake on Rope (R)	30	31	62	54
Number of sites sampled using rake on Pole (P)	191	145	123	166
Average number of all species per site (shallower than max depth)	1.51	1.38	1.43	2.91
Average number of all species per site (veg. sites only)	1.80	1.69	1.55	2.94
Average number of native species per site (shallower than max depth)	1.45	1.31	1.36	2.83
Average number of native species per site (veg. sites only)	1.74	1.62	1.47	2.88
Species Richness	18	13	12	23
Species Richness (including visuals)	19	16	16	23

Figure 22

Species Presence-2020*

Note: Data in parenthesis ( ) includes 2021 survey data

Common Name	Species	Freq. of Occurrence within vegetated areas (%)	Average Rake Fullness	# sites where species found (does not include visuals)	# of visual sightings
Eurasian Watermilfoil	*Myriophyllum spicatum*	8.63 (7,60)	1.33 (1.31)	12 (13)	5 (5)
Watershield	*Brasenia schreberi*	0.0 (4.68)	na (1,25)	0 (8)	1 (2)
Coontail	*Ceratophyllum demersum*	12.95 (11.11)	1.33 (1.42)	18 (19)	1 (1)
Muskgrasses	*Chara*	66.91 (65.50)	2.74 (2.62)	93 (112)	0 (0)
Needle spikerush	*Eleocharis acicularis*	0 (0.58)	na (1.00)	0 (1)	0 (0)
Elodea	*Elodea canadensis*	2.16 (1.75)	1.00 (1.00)	3 (3)	0
Northern water-milfoil	*Myriophyllum sibiricum*	0.72 (1.17)	1.00	1 (2)	0 (0)
Whorled water-milfoil	*Myriophyllum verticillatum*	0.00 (0.58)	na (1,00)	0 (1)	0 (0)
Slender naiad	*Najas flexilis*	4.32 (3.51)	1.67 (1.67)	6 (6)	0 (0)
Nitella	*Nitella*	38.85 (35.09)	2.24 (2.20)	54 (60)	0 (0)
Spatterdock	*Nuphar variegata*	0.72 (1.75)	1.00 (1.00)	1 (3)	9 (11)
White water lily	*Nymphaea odorata*	5.76 (17.54)	1.13 (1.97)	8 (30)	35 (39)
Large-leaf pondweed	*Potamogeton amplifolius*	0.00 (0.00)	na (na)	0 (0)	1 (1)
Illinois pondweed	*Potamogeton illinoensis*	0.00 (1.17)	na (1.00	0 (2)	1 (1)
Flat-stem pondweed	*Potamogeton zosteriformes*	0.00 (0.58)	0.00 (1.00)	0 (1)	0 (0)
Hardstem bullrush	*Schoenoplectus tabemnaemontani*	0.72 (),72)	1.00 (1.00)	1 (1)	0 (0)
Sago pondweed	*Stuckenia pectinata*	0.72 (0.58)	3.00 (3.00)	1(1)	0 (0)
Small bladderwort	*Utricularia minor*	16.55 (13.45)	1.17 (1.17)	23 (23)	5 (5)
Common bladderwort	*Utricularia vulgaris*	10.07 (12.87)	1.43 (1.45)	14 (22)	9 (9)
Filamentous algae		16.55 (13.45)	1.26 (1.26)_	23 (23)	0 (0)

Note: Frequency of Occurrence is based upon the number of sites where species were sampled by rake, and does not include Visual observations. These are listed separately.

An Update to the Little Elkhart Lake Aquatic Plant Management Plan

March, 2022

Introduction

In December, 2014 a document entitled "Aquatic Plant Management Plan Little Elkhart Lake" was published by Stantec, and adopted by the Little Elkhart Lake Protection & Rehabilitation District (LELPRD). In addition to the results of the aquatic plant survey, other topics, including an inventory of the watershed, and review of water quality were discussed. Sections 6 and 7 (beginning on pages 27 and 33, respectively), provided a list and discussion of potential plant management alternatives, concluding in a Recommended Action Plan (pages 32- 33).

In October of 2020 a series of discussions were held between representatives of the WI DNR and the LELPRD in regards to the requirements for this update to the existing (2014) Aquatic Plant Management Plan. In addition to the discussion of the 2019/2020 Aquatic Plant Surveys, the final document was to include the following items, taken directly from the October, 2020 correspondence to the LELPRD from the WI DNR:

- 6) A discussion of historical plant management activities on LEL and purpose.
- 7) A description of existing plant management tools (herbicides/DASH/harvesting equipment).
- 8) A discussion or statement on LELs Goal(s) for Plant Management. If a resident survey is conducted, would be a good place to include.
- 9) A summary and table proscribing the APM actions and tools that LEL will employ in 2021-2025, having considered #7 and #8 above.
- 9a) A map imposed on an air photo denoting proposed (**if proposed under #9**) herbicide navigation lanes (in color). Any proposed changes by the lake group should be placed in the **draft** report for DNR consideration.
- 9b) A map imposed on an air photo denoting proposed (**if proposed under #9**) DASH/Harvester navigation lanes (in color).

Statement of Goals and Objectives

The current APM Plan (2014) identifies the LELPRD's aquatic plant management objectives (page 11, section 3.6) as follows:

- Effectively manage all AIS, currently EWM (Eurasian water-milfoil) and CLP (Curly-leaf pondweed).
- Conduct pre and post treatment monitoring of APM Management activities, if any.
- Maintain and improve recreational/navigational activities.
- Protect and improve fish and wildlife habitat.
- Preserve native aquatic plants.
- Prevent the spread of existing AIS and prevent the introduction of new AIS.
- Identify and protect sensitive areas.
- Educate the Little Elkhart Lake community on proper AIS identification and prevention efforts.
- Gather Little Elkhart Lake users input.

Historical Plant Management Activities

For this portion of the Plan a review of literature available through the WI DNR was conducted. In addition to the earlier (2014) Plan, cited previously, a 2003 Report entitled, "A Limnological Study and Aquatic Plant Management Plan, Little Elkhart Lake", prepared by Northern Environmental Technologies, Inc. (hereinafter referred to as "N.E.T.") was found to be quite helpful. Section 2,1 (page 2), provides a detailed historical review on lake management activities, including water level investigations, fisheries, water quality, land use/nutrient management to aquatic plants.

Since the scope of this Historical Review is limited to Aquatic Plant Management related activities, individuals interested in investigating this history in more detail are directed to the 2002 and 2014 Plans, available via the WI DNR website.

The N.E.T. Report indicates that a formal investigation of the aquatic plant community was conducted in 1977 (Section 6.2, page 14). A Point Intercept methodology was used, conducted by Environmental Resource Assessments., and indicated that of 30 aquatic plant species present (including emergent), Eurasian water-milfoil (*Myriophyllum spicatum*) was most dominant, "with a 60% frequency of occurrence".

The two aquatic plant surveys in 2002 were conducted in June and August using a different methodology referred to as the "Line-Transect Method" (Jensen and Lound). It utilized a total of seven transects, laid perpendicular to the shoreline at different locations of the lake. Additional information on this methodology is found in Section 3.4 (page 4) of the N.E.T. Report. It should be noted that only floating and submersed species were surveyed (emergent not included) due to limited access in extremely shallow waters (page 5).

The N.E.T. Report (Section 6.2.2, page 15) that a total of 21 submersed and floating leaf plant species were identified during the 2002 surveys. Northern water-milfoil (*Myriophyllum sibiricum*) was most dominant with a maximum frequency of occurrence (FOQ) of 75% (June), while Eurasian water-milfoil ("EWM") had a maximum FOQ in June at 17%.

The 2009 Survey referenced by Stantec in their 2013 Report indicated that a total of 30 plant species had been observed (page 29). EWM had an FOQ of 23.98% During the 2012 survey, Stantec reported that 21 species had been observed abd EWM had been reduced to 5.96%.

According to the N.E.T. Report, Mechanical Harvesting was reported to have been used for aquatic plant control in 1977, and may have been conducted in other years (1970's—early 1980's). Permits for Mechanical Harvesting were not required by the DNR at this time, making it difficult to determine exactly when and where this method was used.

Chemical controls on Little Elkhart Lake began in the mid-to-late 1980's (personal recollection). N.E.T. reported that treatment was discontinued in 1998 and this continued through the year 2002 (page 16).

The Table below lists the chemicals used, amounts, concentration and/or rates used and acreage treated during the years 2017-21. The majority of acreage during this period consisted of treatment for EWM (using 2,4-D) and/or CLP (using Aquathol-K). Treatment acreage listed under "Navigation" were for more broad-spectrum control of most native species using the active ingredient diquat dibromide under a variety of trade names. Treatment was limited to narrow (30 ft. wide) channels where a significant impediment to navigation ("Topped Out Beds") were present.

Little Elkhart Lake Treatment History 2017-2021

	Treatment Acres			Product , Amount (gal) and Concentration (ppm) *		
Year	EWM	CLP	Navigation	Liquid 2,4-D**	Aquathol-K	Diquat***
2021	8.8	5.6	2.2	77.0/2.0	16.5/1.0	3.0/1.4
2020	7.7	6.3		67.5/2.0	23.5/1.0	
2019	14.1	5.7	1.25	123.25/2.0	22.5/1.0	1.3/1.0
2018	10.0	5.8	2.0	87.25/2.0	16.5/1.0	2.0/1.0
2017	8.3	7.3	2.0	5705/2.0	20.8/1.0	2.6/1.25

* Diquat values are Rates, listed in gallons/acre. **Includes trade names DMA4-IVM (2017) and Weedar 64 (2018-2021).

*** Trade names Tribune (2017-19) and Littora (2021).

Review of Aquatic Plant Control Options Currently Available

As indicated in the Introduction, the primary intent of the 2019-20 surveys was to document the aquatic plant community of Little Elkhart Lake and monitor it for any changes. As has been discussed earlier, there has been concern by some that the native aquatic plant community may have been adversely impacted over the past several years by the current treatment program. This concern will be addressed in a later section of this report.

Once it has been determined that plants, whether by species (native and/or non-native), abundance, or location within high-use recreational waters are causing a nuisance, an evaluation of control alternatives should be completed. These alternatives can be selected based upon the degree of control desired, species present, growth habits of the nuisance plant, location in the lake, size and/or depth of the proposed control area, as well as applicable regulations. Several control methods are currently available to lake residents or organizations within the State of Wisconsin. These include:

1. *Manual (physical) Removal*, including hand-pulling, raking, or cutting. Labor intensive, these are best suited for relatively shallow, near-shore areas. State regulations currently allow residents to manually cut/pull and remove aquatic vegetation along their shoreline *without a state (DNR) permit* providing that the activity occurs along *no more than thirty (linear) feet of shoreline* if the vegetation targeted consists of *native aquatic plant species.*

   If *more than thirty feet of shoreline is to be managed*, a permit is required except for instances *where the target species is non-native (invasive)*, such as the case of Eurasian water-milfoil and/or Curly-leaf pondweed. Finally, when the frontage is within a WI DNR designated Sensitive Area a NR109 permit is required for hand removal.

2. Diver Assisted Suction Harvesting, or D.A.S.H. This technique, typically employed in deeper waters (greaer than 4-5 feet) utilizes a team of SCUBA divers to hand pull targeted plants. A mechanical suction device (dredge) is used to transport harvested plants to a barge (or small pontoon) at the lake surface. This approach is relatively new, having been developed since the last APM Plan Update (2013) was developed.

   The primary disadvantage of this method is cost due to the labor intensity of this technique. It is most cost-effecttive on small (<5000 sq. ft.) or irregularly shaped beds along steep drop-offs where herbicides are less effective. While this technique can provide season-long control under certain situations (scattered growth on fairly inorganic soils), more than one harvest per season may be required on fast-growing species such as EWM, particularly if growing on nutrient-rich, organic soils.

   Areas of Little Elkhart Lake that may be suited for this technique include the Plymouth Rock Swim/Pier area, where a very narrow bed of EWM develops occasionally, immediately adjacent to shore. This area has a substantial drop-off, thereby limiting the width of the bed to more than 20 feet. The high use areas adjacent to Camp Anokijig may be suitable for this technique as well in the event that nuisance plant conditions develop in the future.

3. H*abitat Manipulation* can include temporary activities, such as the installation of bottom-barriers, or more permanent, such as the deposition of sand on the lake bottom . In either event a permit is required. Dredging on any significant scale (permit required), may also be an option for plant control under some limited circumstances.

   Note that riparian owners may be exempt from obtaining a dredging if the project qualifies under the "Manual Dredging Conditions". Among these requirements is that the proposed dredging site be no more than 100 square feet in size and one foot in depth in any calendar year. A complete list of conditions can be found online at the DNR website, listed on the Manual Dredging Exemption Checklist #14 (R 06/19).

4. *Biological Controls,* include plant eating fish (White Amur or Grass Carp), and insects . It is important to note that the import of the White Amur is banned within the State of Wisconsin. Milfoil Weevils, once popular, are currently not commercially available. Their introduction of any biological control into a lake requires an approved WI DNR permit.

Review of Aquatic Plant Control Options Currently Available (cont'd.)

5. *Public Information and Education,* includes informing the public about the benefits of native plant population, how to identify aquatic invasive species, preventing their spread, and the tools available for control, along with regulations pertaining to their use. This includes the Clean Boats Clean Waters program for boaters.

6. *Aquatic Herbicides and/or Algaecides* are chemical compounds specifically formulated to control excessive plant and/or algae growth. These products may be used for aquatic plant control only if they are registered for use by the United States Environmental Protection Agency (USEPA) and the Wisconsin Department of Agriculture (DATCP) in lakes, ponds, etc. Their application is regulated under a permit system by the WI DNR. Further, the type of product that can be applied to a public body of water by individuals is limited to granular formulations to sites under 0.25 acres in size, unless it is applied by an certified applicator (WDATCP).

   Herbicides may be categorized as either selective (narrow spectrum) or non-selective (broad spectrum). They may also be categorized by their activity, either Contact or Systemic, whereby the latter type is taken up by the plant and translocated throughout.

   Finally, treatments can be conducted on isolated beds or a portion of a water body ("Spot-Treatments") or they may be targeted at specific species throughout the entire body. These are referred to as "Whole-Lake" Treatments.

   These topics will be discussed in greater detail in the next Section of this report.

7. *Mechanical harvesting* involves the cutting and collection of aquatic plants using a single large piece of equipment mounted on a pontoon-type barge. Once full of plants, the harvester returns to shore to off-load the plants. On larger lakes, transport barges are used to collect plants from the harvester for transport to and unloading site. Harvesters are available in a number of sizes. The largest can cut swaths of vegetation up to 10 feet wide at depths of 0-6 feet deep.

   Little Elkhart Lake has used this technique previously, so the advantages and disadvantages of this technique are fairly well known. It is worth mentioning since their last use on Little Elkhart Lake (1970's) the WI DNR has developed a permitting system with conditions that may or may not impact their cost/effectiveness on Little Elkhart Lake.

   Recommendations on Mechanical Harvesting will be addressed be addressed in the next section of this report.

Recommended Aquatic Plant Control Activities for Little Elkhart Lake

The following recommended activities are based upon the existing Goals and Objectives of the Little Elkhart Lake Protection and Rehabilitation District. Any changes in the stated Goals may necessitate an update to these recommendations as well. Recommended Aquatic Plant Control activities for Little Elkhart Lake include the following:

I. Small Scale Control Options for Individuals : Manual Removal, Dredging or D.A.S.H. may be conducted in accordance with all state regulations discussed previously in this report. This will achieve a quicker and higher degree of control (where needed) that can be achieved by chemical means alone .

   It is important to mention that if mechanical dredging is undertaken (in accordance with a WI DNR permit, of course), that any benefit derived in the way of plant control will be relatively short-lived (generally one season). As long as any organic material and/or nutrients remain at the dredged site, vegetation will re-colonize the site within a year or two.

   Individuals considering D.A.S.H. should investigate not only the potential cost, but also the number of harvests expected. As with dredging, aquatic vegetation should be expected to return within a year, in most circumstances. Longer control may be achieved at sites with bottom sediments consisting of relatively infertile sand/gravel, etc.

I.

Recommended Aquatic Plant Control Activities for Little Elkhart Lake (cont'd)

II. Large Scale Activities

A. Mechanical Harvesting or Skimming

Mechanical Harvesting on a Large Scale is not recommended. While it can be an extremely effective tool for con trolling excessive native plant populations, it may exacerbate problems related to invasive species, such as Curly-leaf pondweed (CLP) and Eurasian-watermilfoil (EWM). Unless harvesting is completed prior to turion formation (reproductive structure on CLP), these will build-up in bottom sediments can over time and lead to severe infestations.

A major mode of reproduction for EWM is via fragmentation. This fragmentation may be caused by boat traffic, mechanical harvesting, and/or "auto-fragmentation" by the plants themselves. Since EWM has the capacity to out-grow other plants (can grow more than an inch a day), and is a "canopy-former" (blocks sunlight from reaching other plants), repeated and frequent harvesting may lead to an ever increasing amount of milfoil at the expense of native species. The 60% Frequency of Occurrence for EWM during the 1977 Plant Survey should be seen as an example of what can be expected to occur in Little Elkhart Lake when this species is not properly managed.

Whether harvesting was directly responsible, or this species was just left to grow unmanaged and spread via fragmentation caused by boat traffic is unclear, this species was very much more prevalent in 1977 than it is today under active management.

While harvesting on a large scale is not recommended, it does have an advantage when it comes to broad-spectrum control of all species in high use areas. While herbicides have been used to create navigational channels, results are more immediate with harvesting. However, this benefit may be offset by the need to harvest repeatedly, as many as 3-4 times a year in shallow water.

The relatively small (total) acreage of the current channels for navigation may make the cost per acre prohibitive. Many harvesting contractors have a minimum charge in the several thousand dollar range. This may or may not be economically feasible for the District.

Finally, DNR permits conditions may require that harvesting take place in waters no less than three feet deep, as larger Harvesters can disturb bottom sediments significantly. Smaller harvesting equipment requiring less operating depth may be available and may fulfill harvesting requirements. This benefit may be off-set by reduced efficiency as they have less storage capacity, thus increasing the frequency at which they must unload harvested plants.

Finally, It should be noted that quite a few lakes have either purchased aquatic skimmers, or simply use their harvesting equipment for "skimming" floating plant fragments. Being mechanical devices, their use most likely re quires a permit. In the event that small enough equipment is available to access the shallows in Wehrmeyer Bay (and elsewhere), they may assist with removal of the large floating water lilly tuber "Bog" that forms every summer.

II. Large Scale Activities

B. Chemical Controls

A wide range of herbicides/algaecides are registered for use in the state of Wisconsin. Furthermore, the use of these products are regulated by the WI DNR under an Aquautic Plant Management Permit System. While a comprehensive list of active ingredients/tradenames is located in the Appendix, the discussion here will be limited to those products that may be of benefit to the primary aquatic nuisances present, EWM and CLP, and also in regards to maintenance of the navigational channels

Since there has been some questions raised in regards to the impact that the existing herbicide program (utilizing 2,4-D for control of EWM) may be having on the native plant community, a worthwhile exercise may for all those interested parties to gain a basic understanding of the products available, mode of action, available use patterns and degree of selectivity. A brief discussion of these topics follow:

Mode of Action—Systemic vs. Contact

Systemic herbicides are those in which are absorbed by plants from the water column and are transported throughout the entire plant. Contact herbicides are those that cause direct injury to the site of a plant by contact.

Liquid and/or granular 2,4-D, along with triclopyr are some of the active ingredients products that have been used for control of EWM in Little Elkhart Lake within the last ten years that are examples of systemic herbicides. Aquathol-K, active ingredient dipotassium salt of endotholl, is a contact-type herbicide that has been used for control of CLP in Little Elkhart Lake. Diquat (active ingredient), under the trade names Littora and Tribune, along with others is another contact herbicide that has been used for control of aquatic vegetation in the navigational channels for control of native species, as well as EWM and CLP.

While contact-type herbicides are generally considered to be taken up more quickly (matter of hours) by plants and provide control sooner than systemic herbicides, there are exceptions to this that will be discussed a little later. Systemic herbicides on the other hand, certainly appear to provide longer lasting control than contact herbicides on EWM. For example, at a minimum , 2,4-D (a systemic) has provided a fairly high degree of seasonal control of EWM. Products containing diquat (a contact), by contrast may require multiple treatments to maintain the same level of control.

Use Patterns—"Spot Treatment" vs. "Whole-Lake"

As the name implies—"Spot Treatments" are simply that. This "Spot" may be relatively small, such as an area surrounding a pier, or a fairly large area, such as an entire bay. It may also include a relatively narrow treatment area bordered by the shoreline on one side and a steep drop-off and deep water on the other.

"Whole Lake" treatments are aptly named as well. In shallower lakes (that do not stratify) the entire lake may be treated, either directly by applying material across the entire surface or indirectly by allowing natural currents or winds to thoroughly "mix" the lake over time. With sufficient time (generally days to a few weeks) and slow enough break-down of herbicide residues, herbicide concentration monitoring data has shown that this can occur. In the case of lakes that stratify, only the upper layer of water above the thermocline receives treatment. This is known as an Epilimnetic Treatment. The size and depth of the lake, depth at which the lake stratifies, susceptibility to mixing (by winds or currents) or dilution (flow-through impoundments) , location of treatment area(s) and the herbicide(s) used will all have a bearing on whether treatments will result in a high degree of control throughout an entire lake or very unsatisfactory and/or short term results. Please note that some products (for example, Aquathol-K), are much more dense than water and are able to "break through" thermoclines.

Unlike some impoundments that have a short Retention Period (approximate length of time to re-fill a lake under normal conditions), Little Elkhart Lake has very little water outflow, which makes it a plausible candidate for a whole lake treatment. This Retention Period also explains why treatments with 2,4-D have been very successful at significantly reducing EWM populations as compared to lakes with shorther Retention Periods. Finally, this factor may be another to carefully consider when selecting herbicides and concentrations—too high a concentration for too long of time may have an impact upon non-target ("native" species.

Recommended Aquatic Plant Control Activities for Little Elkhart Lake (cont'd)

II. Large Scale Activities

B. Chemical Controls

Selectivity—Broad or Narrow Spectrum

Some herbicides, such as those containing the active ingredient diquat, control a wide array of plant species and are considered "Broad Spectrum". Others, such as formulations of 2,4-D are narrow spectrum. In the case of 2,4-D the product label lists species that are able to be controlled—these are largely broad-leaved species (or "dicots"), whereas narrow-leaved species (or "monocots") are either difficult-to-control or are not controlled at typical herbicide use rates.

While the above concept may appear straight-forward—it is not. While laboratory conditions can be tightly controlled and replicated, nature cannot. While selectivity may be based upon the chemistry and it's action, selectivity can also be dependent upon treatment timing (are non-target plants present at time of treatment?) and a combination of treatment concentration and exposure time (referred to as "C.E.T.). Furthermore, exposure time can be influenced by a variety of factors, including Retention Time of the water body, water temperature and water quality, fertile vs. infertile, "hard" water vs. "soft". As a general rule, herbicide break-down (or half life) is shorter in warmer, more fertile waters with greater hardness.

While a great deal of research has been done by the WI DNR in terms of effectiveness of whole-lakes treatments using 2,4-D, and it appears as though a significant number may have had a negative impact upon some native species, it is a mistake to extrapolate this correlation into causation too quickly. After all, the product label, based upon a preponderance of evidence after many studies concludes which plant species will be controlled and which ones will not. Conversely, it is also well known that a substance can become toxic to a non-target organism, even at a very low concentration given a long enough exposure time.

In order to give the reader's more perspective on what this means to the plant population within Little Elkhart Lake, the table below provides a list of all submersed and floating leaved species observed during the five previous surveys (1977, 2002, 2012, 2019-20) , indicates whether they are monocots and/or dicots and if they are susceptible to 2,4-D on the product label.

Dicots (Broad-Leaved)

Species	Common	2021 (Visual)	2020	2019	2012	Susceptible to 2,4-D
*Bidens beckii***	Water marigold				X	X
Brasenia schreberi	Watershield	V				1
Ceratophyllum demersum	Coontail		X	X	X	X
Myriophyllum sibiricum	Northern water-milfoil		X	X	X	X
Myrioohyllum verticillarum	Whorled water-milfoik	V				X
Nuphar variegata	Spatterdock		X		X	1
Nymphaea odorata	White water lily		X	X	X	1
Utricularia minor	Small bladderwort		X			X
Utricularia vulgaris	Common bladderwort		X	X	X	X

Key: X in Year Column = Present

Susceptibility: X = Yes 1 = Susceptible if herbicide directly applied to leaf surface

Table continued on following page

Submersed and Floating-Leaved Plants in Little Elkhart Lake

Monocots (Narrow-Leaved)

Species	Common Name	2021 (Visual)	2020	2019	2012	Susceptibile to 2,4-D
Elodea canadensis	Common waterweed		1	1	1	?
Lemna triscula	Forked duckweed		0	0	1	
Najas flexilis	Slender naiad		1	1	1	?
Potamogeton amplifolius	Large-leaf pondweed		0	0	1	
Potamogeton gramineus	Variable pondweed		0	0	1	
Potamogeton illinoensis	Illinois pondweed		0	1	0	
Potamogeton strictifolious	Stiff pondweed		0	1	0	
Potamogeton zosteriformis	Flat-stem pondweed	V	0	0	1	
Stuckenia pectinata	Sago pondweed		1	0	1	

Edit to include sources of information

The above data appears to indicate that with the exception of *Bidens Becki* (Water marigold), there appears to be very little change in the presence of native dicot species since 2012, those that are most susceptible to herbicides containing 2,4-D. There are however, significant changes amongst the monocots—those that are typically considered to be rather tolerant to 2,4-D. Whether these changes are due to other factors, such as interspecies competition, some other disturbance, with or without "sub-lethal" herbicidal effects are very difficult to determine.

Chara and Nitella, being forms of alga, are not included in the above plant lists. Neither of these are affected by 2,4-D. While many of the native emergent species present in Little Elkhart Lake are dicots, they are not affected by 2,4-D being applied to the water. Instead, 2,4-D must be applied directly to the stem and leaves for control to be achieved.

Chemical Control Alternatives for Little Elkhart Lake

A. Eurasian Water-Milfoil (EWM) Control Alternatives

In addition to 2,4-D, whether applied on a "Spot" or "Whole Lake" basis, there are a number of other herbicides available, some of which have been mentioned in prior Plans, or in the case of Trichlopyr (under the trade name, Renovate), have been used previously in Little Elkhart Lake. Some of these are rather selective on EWM, others may control Curly-leaf pondweed as well. While some may be used on a "Spot" treatment basis, others can only be used when applied on a low concentration, whole-lake basis.

Since oftentimes the list of options available are narrowed down by cost, a review of costs associated with the EWM control options available for Little Elkhart Lake is found in the Table below:

Whole Lake

Product(s)	Treatment Cost	Permit (Entire Lake)	Herbicide Monitoring
SonarOne	$ 17,500.00	$ 1,270.00	$ 2,500.00
Sonar A.S/SonarOne	$ 16,000.00	$ 1,270.00	$ 2,500.00
Weedar 64	$ 7,532.00	$ 1,270.00	Not Required

Spot Treatment

Product(s)	Treatment Cost (10 Acres)	Permit	Herbicide Monitoring
Weedar 64	$ 4,370,00 *	$ 250.00	Not Required
ProcellaCOR	$ 13,000.00 **	$ 250.00	Not Required

* Cost based on 2.0 ppm concentration at 6 ft. depth.

** Cost based on 3.0 PDU (Prescription Dose Units) at 6 ft. depth.

It should be noted that EWM control utilizing Sonar A.S./SonarOne requires multiple treatments in order to maintain sufficient herbicide concentrations over an extended period of time (90-120 days). This requires sampling/ monitoring of lake water every three weeks after treatment (WAT). The results of these tests are used to determine timing of subsequent treatments, and concentration required. Cost listed include up to three treatments using Sonar A.S. and/or SonarOne Herbicides, along with lab fees .collection of sampling and freight available at additional cost.

The primary disadvantage of this type of treatment is the long period of time it takes to achieve full control (up to 10 weeks). This is due to the very low concentration used, along with it's slow uptake by plants. Treating very early in the season (early May) will partially offset this disadvantage, as well as using the liquid form (Sonar A.S.) for the initial treatment.

Finally it should be noted that Sonar A.S./SonarOne will control *both* EWM and CLP. While EWM control may last more than one year, CLP may require treatment the following year. This is due to the way in which CLP reproduces. These reproductive structures, called turions, remain viable in bottom sediments for many years and are not controlled in any way following treatments. If present the year following treatment, an additional "bump" treatment using a low concentration of Sonar can be used for control of CLP. Spot treatment with Aquathol-K is another option.

In the event that 2,4-D is used on a lake-wide basis, the District may wish to include a herbicide concentra- tion monitoring component. Thought not required, it may help establish how long herbicides remain, both inside and outside of direct treatment areas. Sampling may be available through the WI DNR at additional cost (up ro a maximum of $2,000.00). The District's WI DNR APM Supervisor will be able to better define the availability of these tests, their costs, and if cost-sharing is available.

Spot treatment of EWM with 2,4-D continues to be an available option for the District. However, the DNR has expressed some concern that the repeated use of 2,4-D may have the following negative impacts:

1) Non target damage to native plants— this was addressed earlier in this report.
2) Development of 2,4-D tolerant strains of EWM, and/or "Hybridized" EWM, which is a form of milfoil resulting from a cross of Eurasian water-milfoil and dnative milfoil species, including Northern water- milfoil.

As an option, the District could utilize a PrcellaCOR Herbicide, a relatively new, highly effective, quick-acting, systemic herbicide for control of EWM. It's primary advantage over 2,4-D (and Sonar herbicides) is it's rapid uptake and quick action, with a very high level of control (>90%) being achieved in one to two weeks. Treatments elsewhere indicate that up to three years of control may be achieved with a single treatment. The product manufacturer provides a three year guarantee on treatments 10 acres and larger in size).

It should be noted that ProcellaCOR, unlike Sonar will not control Curly-leaf pondweed.

B. Curly-leaf Pondweed Control Alternatives

As indicated previously, CLP will be controlled on a lake-wide basis in the event that Sonar A.S. and/or SonarOne herbicides are used. It was also mentioned that CLP may develop the year following and require additional treatment. CLP may be treated in one of the following manners:

1. Spot Treatment with Aquathol-K: $900.00/acre (maximum). Based on 7 ft. avg. depth at 1.0 parts per million (ppm) or 4.2 gal/acre. Pemit fees will be dependent upon the acreage ($385.00), plus processing.
2) Whole Lake Treatment with Sonar A.S.: $7200.00. Based on a single treatment of 4 parts per billion (ppb). Upon ice-out, water sampling ($500.00) will be conducted to determine what concentrations, if any remain from the previous year. In the event residues are present, less material will be required and final treatment cost reduced. A permit covering the entire lake will be required ($1,270.00).

continued on following page

C.. Treatment for Maintenance of Navigational Channels

If desired by the District, maintenance of the channels for navigation can continue. This includes control of both non-native and native species, including Water Lily. Herbicides containing diquat (Littora herbicide) and/or endotholl (Aquathol-K) can be conducted for control of most submersed species. Water Lilies may be controlled adequately using 2,4-D, or if a higher degree of control is desired, treated with the active iingrediemts imazapyr and/or glyphosate.

These treatments are intended to minimize any vegetation causing a significant impediment to navigation. Channels should be maintained to an approximate (maximum) width of 40 ft., sufficient to maintain safe navigation by opposing boat traffic. Water Lilies within the channel leading to/from the boat launch have reduced the area suitable for navigation to less than 10 feet in width.

A map detailing the location of established navigation channels (taken from APM Permits) is located on the fol-

III. Aquatic Plant Monitoring

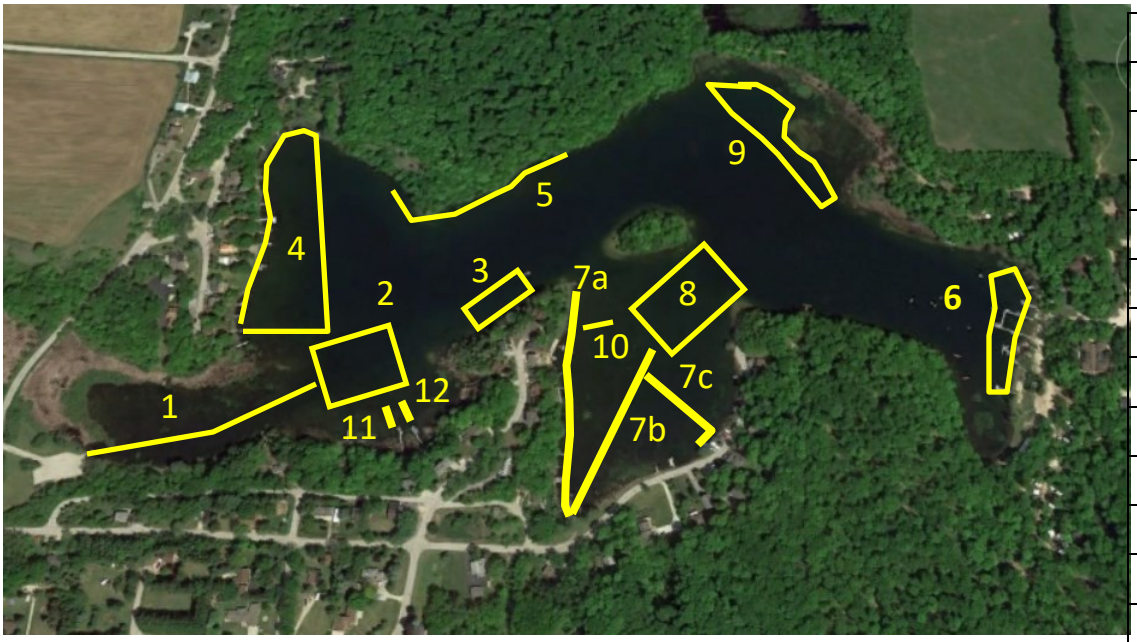
While currently not required by the WI DNR, periodic surveys of the aquatic plant population in Little Elkhart Lake are recommended. While these may consist of formal Point-Intercept Surveys as conducted in 2012, 2019 and 2020, they may be tailored based upon the existing need. For example, the Point-Intercept methodology may be required to fully access the plant population in a statistical manner, certain species may be unintentionally overlooked due to a combination of their low Frequency of Occurrence or location within the lake (outside of an immediate sampling location). Under these circumstances, a very thorough, but less time consuming Visual ("Meander") Survey may suffice if conducted under ideal (clear) water conditions. A GPS can be used to document the location of any exotic species, along with any less common, or previously undocumented native species.

This Aquatic Plant Management Plan Update concludes with a Summary Table describing the Aquatic Plant Management (APM) activities that the Little Elkhart Lake Management District will employ in the years 2022-202 (page 39).

Figure 22

Little Elkhart Lake — Sheboygan County, WI

Proposed APM Treatment Area*



*Note. Area #1, 7a-c, and 10-12 are navigation channels

Area	Acres	Depth (ft.)
1	0.5	4
2	1.1	7
3	0.9	7
4	4.6	7
5	1.0	6
6	1.0	5
7a	0.5	3
7b	0.5	4
7c	0.3	4
8	1.9	7
9	2.4	7
10	.1	3
11	.1	3
12	.1	3

Figure 23

Summary of the Little Elkhart Lake - Sheboygan County, WI

Aquatic Plant Management Plan—Recommended Activities

Information and Education	Ongoing. Informing the membership and general public about the benefits of native plant population, how to identify aquatic invasive species, prevent their spread, and the tools available for control, along with regulations pertaining to their use.
Physical Removal	Educate and promote removal in pier/swim areas, by property owner. Thirty feet of shoreline may be maintained by manual means w/o WI DNR permit approval. Removal along greater than 30 ft. of shore requires WI DNR Permit (Exception for non-native species). DNR Permit is required if property is within Sensitive Area for any removal activity. Physical removal of floating mats of Chara and or Lily tubers, etc., not attached to lake bottom may be removed by hand.
DASH and Mechanical Harvesting	D.A.S.H. may be contracted by riparians for a higher degree of control of control of plants in high use areas. DNR permit required. Mechanical harvesting and/or Skimming of plants may be considered in the future, either for maintenance of navigational channels or removal of unattached, floating vegetation. Equipment to be used must be capable of operating in shallow water (3 ft. or less) to minimize disruption of bottom sediments. DNR permit required. Application includes map of areas to be harvested and location where plants will be disposed of, along with travel route.
Herbicide Treatments	Annual "Spot" treatments (1-2x/yr.) for selective control of Aquatic Invasive Species (AIS) and/or native species in established navigation lanes. Evaluate lake-wide treatment options when distribution (extent) of EWM &/or CLP warrants. Objective: To minimize formation of plant beds dominated by AIS and impacts upon recreation in accordance with District's APM Goals/Objectives (page 28).
Aquatic Plant Monitoring	Annual Pre Treatment Survey (Visual) for EWM/CLP and/or native species (in navigational channels). Consider periodic Visual (Meander) Surveys periodically to identify all species present (maintain Species List) and to document location of AIS and/or document location of species with a low Frequency of Occurrence in lake, and emergent species. Full PI Survey as recommended by WI DNR.