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SEWRPC Staff Memorandum

AN AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR FOWLER LAKE, WAUKESHA COUNTY, WISCONSIN: 2018

May 30, 2018

INTRODUCTION

This plan is the fifth in a series of aquatic plant management plans prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) for Fowler Lake,[1] and represents an important element of the ongoing commitment of the City of Oconomowoc and Fowler Lake Management District (FLMD) to sound environmental management of the Lake. The initial aquatic plant management plan element of the adopted Fowler Lake Management Plan was prepared by SEWRPC based upon field surveys conducted during 1984. Subsequently, the aquatic plant management plan element for Fowler Lake was further refined based upon the results of an aquatic plant reconnaissance conducted during June 1997, October 2007, and August 2011 (see Table 1). This memorandum refines the aquatic plant management plan for Fowler Lake based upon the results of a point-intercept aquatic plant survey carried out on Fowler Lake during August 2017.

Even though the Lake has a healthy aquatic plant community, the presence of Eurasian water milfoil and curly-leaf pondweed poses a risk to the plant community if it is not effectively managed and has been a consistent problem over the years. Dense beds of milfoil, along with some nuisance plant growth impedes Lake access, particularly in the central portions of the basin. Consequently, the City of Oconomowoc and the FLMD engage in aquatic plant management activities, including mechanical harvesting.

This memorandum report summarizes the information and recommendations needed to manage nuisance plant (i.e., Eurasian water milfoil and curly-leaf pondweed) growth in the Lake and is comprised of four main sections:

- Aquatic Plant Management Goals and Objectives
- Aquatic Plant Community Changes and Quality
- Alternative Methods For Aquatic Plant Control
- Recommended Aquatic Plant Management Plan

[1] *SEWRPC Community Assistance Planning Report No. 187,* A Management Plan for Fowler Lake, Waukesha County, Wisconsin*, March 1994; SEWRPC Memorandum Report No. 134, An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin, October 2000; SEWRPC Staff Memorandum, "An Aquatic Plant Management Plan Update for Fowler Lake, Waukesha County, Wisconsin: 2008," September 2008; and, SEWRPC Memorandum Report No. 134 (2nd Edition), An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin, July 2012.*

Table 1
Relative Frequency of Occurrence[a] of Submerged Aquatic Plant Species in Fowler Lake: 1984-2017

	Transect Survey[c]			Point-Intercept Survey[c]	
Aquatic Plant Species	1984	1997	2007[b]	2011	2017
Ceratophyllum demersum (coontail)	14.6	9.4	19.6	10.0	6.2
Chara spp. (muskgrass)	27.0	16.1	6.0	15.6	18.2
Elodea canadensis (waterweed)	--	4.8	0.9	1.6	2.2
Heteranthera dubia (water stargrass)	--	--	2.6	0.7	0.5
Myriophyllum sibiricum (northern watermilfoil)	--	--	18.8	2.3	0.3
Myriophyllum spicatum (Eurasian watermilfoil)	21.3	14.2	4.3	18.2	21.3
Najas flexilis (slender naiad)	--	8.5	6.0	5.6	1.3
Najas guadalupensis (southern naiad)	--	--	--	--	2.2
Najas marina (spiny naiad)	0.8	1.2	--	1.6	1.2
Nitella spp. (stonewort)	2.7	--	--	--	--
Potamogeton amplifolius (large-leaf pondweed)	--	0.6	1.7	--	0.7
Potamogeton crispus (curly-leaf pondweed)	2.2	3.6	3.4	0.4	0.7
Potamogeton foliosus (leafy pondweed)	--	--	1.8	0.9	--
Potamogeton gramineus (variable pondweed)	--	--	3.4	4.3	3.0
Potamogeton illinoensis (Illinois pondweed)	6.2	--	8.5	1.3	2.7
Potamogeton natans (floating-leaf pondweed)	--	--	--	--	Present[d]
Potamogeton praelongus (white-stem pondweed)	--	8.2	--	--	--
Potamogeton pusillus (small pondweed)	--	--	--	1.4	--
Potamogeton richardsonii (clasping-leaf pondweed)	1.8	0.6	5.1	2.6	3.7
Potamogeton zosteriformis (flat-stem pondweed)	--	7.0	0.9	0.3	1.0
Stuckenia pectinata (Sago pondweed)	8.4	7.0	8.5	6.7	4.0
Utricularia vulgaris (bladderwort)	4.8	6.4	4.3	4.9	7.1
Vallisneria americana (eel-grass/wild celery)	10.2	12.4	18.8	20.3	23.5
Total Number of Species	11	14	17	18	19

Note: Red text indicates nonnative and/or invasive species.

[a] *Relative frequency of occurrence is the frequency of a species divided by the total frequency of all species. This statistic presents an indication of how the plants occur throughout a lake in relation to each other.*

[b] *The 2007 data was collected as part of an aquatic plant reconnaissance utilizing an abbreviated number of sampling sites; sampling was done in the fall of the year rather than traditional summer sampling. Populations of many species of aquatic plants, most notably the pondweeds, regularly exhibit seasonal variation*

[c] *The 1984, 1997, and 2007 surveys were conducted using the WDNR modified Jesson and Lound transect methodology. The 2011 and 2017 surveys were conducted by SEWRPC staff using the point-intercept method.*

[d] *Species was observed but not quantified through rake pulls.*

Source: SEWRPC

This plan update presents a range of alternatives that could potentially be used, and provides specific recommendations related to each alternative. The measures discussed focus on those that can be implemented by the City of Oconomowoc and FLMD in collaboration with the Wisconsin Department of Natural Resources (WDNR) and Fowler Lake residents. The aquatic plant management component of this memorandum is limited to approaches that monitor and control nuisance aquatic plant growth in the Lake after growth has already occurred. The previous comprehensive lake management report describes other management strategies that can help prevent degradation of the Lake's water quality and aquatic plant community.[2] Examples of such management actions include strategies to reduce phosphorus loads to the Lake and measures to prevent accidental introduction of new invasive plants and animals. In short, this document helps interested parties understand the particular plant management measures to be used in and around Fowler Lake, and can be a valuable resource when developing future aquatic plant management efforts and requisite permit applications.

[2] *SEWRPC Community Assistance Planning Report No. 187, op. cit.*

AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

The goal of the aquatic plant management program being implemented in Fowler Lake by the City of Oconomowoc and the FLMD is to promote the multiple purpose use of Fowler Lake in a manner consistent with the maintenance of the integrity of the Lake's ecosystem. The objectives of the FLMD were developed in consultation with the City of Oconomowoc and WDNR. The objectives are to:

- Effectively control the quantity and density of aquatic plant growths in portions of Fowler Lake to improve the water-related recreation opportunities, to improve the aesthetic value of the resource to the community, and to enhance the resource value of the water body

- Manage the Lake in an environmentally sound manner, pursuant to the standards and requirements set forth in Chapters NR 103, "Water Quality Standards for Wetlands," NR 107, "Aquatic Plant Management," and NR 109, "Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations," of the *Wisconsin Administrative Code,* in order to preserve and enhance the Lake's water quality and biotic communities, their habitats, and essential structure and function in the water body and adjacent areas, as determined by the overall Lake management plan set forth in SEWRPC Community Assistance Planning Report No. 187, *A Management Plan for Fowler Lake, Waukesha County, Wisconsin*,[3] as amended

- Protect and maintain public health and promote public comfort, convenience, and welfare in concert with the natural resource through the environmentally sound management of native vegetation, fishes, and wildlife in and around Fowler Lake

- Promote a quality water-based experience for residents and visitors to Fowler Lake consistent with the policies and practices of the WDNR, as set forth in the regional water quality management plan, SEWRPC Planning Report No. 30, *A Regional Water Quality Management Plan for Southeastern Wisconsin -- 2000*, as amended[4]

AQUATIC PLANT COMMUNITY CHANGES AND QUALITY

Several surveys of aquatic plant communities in Fowler Lake have been conducted, beginning with the comprehensive survey of Sorge and Lowry, completed in 1984;[5] continuing through the surveys conducted by the Regional Planning Commission staff during June 1997, October 2007, and August 2011; and including the data gathered during the comprehensive aquatic plant survey conducted by the Commission staff during August of 2017. Species lists and percent relative abundances compiled from the results of these aquatic plant surveys are shown in Table 1.

Table 1 indicates that the total species richness of submerged aquatic plants has generally increased over time from 11 to eighteen species in 2011 and nineteen species in 2017, which is a good sign of increasing diversity of plants within Fowler Lake over the past 27 to 33 years, respectively. However, it is important to note that there was an important change in the sampling methodology from a transect-based method to a point-intercept method beginning in 2011.[6] So, this increase in species richness is likely partially influenced by this change in sampling, because a much larger surface area of the Lake is sampled with the point-

[3] *Ibid.*

[4] *SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin—2000, Volume One, Inventory Findings, September 1978, Volume Two, Alternative Plans, February 1979, Volume Three, Recommended Plan, June 1979, *and SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report*, March 1995.*

[5] *Patrick Sorge and Timothy Lowry,* Aquatic Plant and Sediment Survey on Fowler Lake*, 1984.*

[6] *R. Jesson, and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants*, 1962; as refined in the Memo from Stan Nichols to J. Bode, J. Leverence, S. Borman, S. Engel, and D. Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes Example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994; and, J. Hauxwell, S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase. Wisconsin Department of Natural Resources, Bureau of Science Services, Publication No. PUB-SS-1068 201, Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications, March 2010.*

intercept method, which makes it more likely to be able to capture rarer species of plants. Nonetheless, it has been well established that there is good agreement with respect to the dominant aquatic plant species and their relative areas of distribution indicated between the transect-based versus the point-intercept sampling methodologies, which is very important when assessing community changes over time.[7]

In general, from 1984 to 2017 the top four most abundant species within Fowler Lake have consistently been Eurasian watermilfoil (*Myriophullum spicatum*), wild celery (*Vallisneria americana*), muskgrass (*Chara* spp.), and coontail (*Ceratophyllum demersum*) (excluding the October 2007 sample date), which comprise between 52 to 73 percent of the entire plant community over that time period. The next three species that include bladderwort (*Utricularia vulgaris)*, Sago pondweed (*Stuckenia pectinata*), and slender naiad (*Najas flexilis*) do not dominate, but they on average consistently comprise between about 5 to 7 percent of the plant community. The number of Potamogeton species also has increased over time from three to seven species and this group of species has consistently made up at least 10 to 12 percent of the aquatic plant community. With the exception of one Potamogeton species, curly-leaf pondweed (*Potamogeton crispus*) which is an invasive species, this group of species contains some of the highest quality plants and their consistent presence is indicative of a healthy aquatic plant community in Fowler Lake. Finally, the remaining five species that includes waterweed (*Elodea canadensis*), southern naiad (*Najas guadalupensis*), spiny naiad (*Najas marina*), water stargrass (*Heteranthera dubia*), and northern watermilfoil (*Myriophyllum sibiricum*) generally comprise on average between one and two percent of the aquatic plant community.

2017 Versus 2011

During the 2017 survey, 19 species of submerged aquatic plants were observed. The distribution and raw data for each of these aquatic plant species is shown in Appendix A. Wild celery, muskgrass, and Eurasian watermilfoil continued to dominate the Fowler Lake aquatic plant community. As can be seen from the summaries in Tables 1 and 2, these three plant species, along with coontail and bladderwort made up more than 76 percent of the aquatic plant community in this most recent survey. Samples from waters as deep as 15 feet contained aquatic vegetation. The SEWRPC staff estimated that plants were present at greater depths, although limitations imposed by sampling apparatus did not allow for retrieval of samples beyond a depth of 15 feet. The average depth of water containing plants was 6.4 feet.

The 2017 survey also identified Southern naiad (*Najas guadalupensis*) and visual observation of floating leaf pondweed (*Potamogeton natans*) for the first time in Fowler Lake. In addition, large-leaf pondweed, which was present in earlier studies, but did not appear in 2011, was again identified in the 2017 survey. However, two species—leafy pondweed (*Potamogeton foliosus*) and small pondweed (*Potamogeton pusillus*)—have been present in earlier surveys, but were absent from plants observed in 2017.

As previously mentioned, the 2011 and 2017 surveys were accomplished using the point-intercept methodology. Consequently, the same grid points on Fowler Lake were sampled consecutively in each of these surveys, which allows for a more meaningful and detailed comparison of the abundance and distribution of aquatic plants as summarized below.

A critical key to the ability of an ecosystem, such as a lake, to maintain its ecological integrity is through biological diversity. Conserving the biological diversity, or biodiversity, of an ecosystem, based on the numbers of different species observed, not only helps to sustain the system, but preserves a spectrum of options for future decisions regarding the management of that system. This is particularly significant in the area of aquatic plant management.

The total numbers of aquatic plant species found in a lake, although important, are not the sole determinant of the degree of biodiversity in a lake. Aquatic plants in lakes and waterways have specific requirements for sunlight and substrate and, consequently, plant communities vary with depth, water quality, and other "drivers" that affect the ability of the plants to succeed in a specific locality. For these reasons, some areas of a lake may contain plant communities with very little diversity, while other areas of a lake may exhibit good diversity. In Fowler Lake, even though the overall total number of different plant species was high in both 2011 (18 species) and 2017 (19 species), no areas of the Lake actually contained all 18 or 19 species.

[7] *SEWRPC Memorandum Report No. 134 (2nd Edition), op. cit.*

Table 2
Abundance Data for Submerged Aquatic Plant Species Sampled in Fowler Lake: August 2017

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a]	Frequency of Occurrence Within Vegetated Areas[b]	Average Rake Fullness[c]	Relative Frequency of Occurence[d]	Visual Sightings[e]
Ceratophyllum demersum (coontail)	Native	37	19.17	1.73	6.22	0
Chara spp. (muskgrass)	Native	108	55.96	2.36	18.15	2
Elodea canadensis (waterweed)	Native	13	6.74	1.46	2.18	0
Heteranthera dubia (water stargrass)	Native	3	1.55	1.00	0.50	2
Myriophyllum sibiricum (northern watermilfoil)	Native	2	1.04	2.50	0.34	9
Myriophyllum spicatum (Eurasian watermilfoil)	Invasive	127	65.80	1.63	21.34	25
Najas flexilis (slender naiad)	Native	8	4.15	1.00	1.34	0
Najas guadalupensis (southern naiad)	Native	13	6.74	1.00	2.18	1
Najas marina (spiny naiad)[f]	Naturalized	7	3.63	1.43	1.18	3
Potamogeton amplifolius (large-leaf pondweed)[g]	Native	4	2.07	1.00	0.67	13
Potamogeton crispus (curly-leaf pondweed)	Invasive	4	2.07	1.00	0.67	3
Potamogeton gramineus (variable pondweed)	Native	18	9.33	1.11	3.03	6
Potamogeton illinoensis (Illinois pondweed)[g]	Native	16	8.29	1.06	2.69	8
Potamogeton natans (floating-leaf pondweed)	Native	0	--	--	--	1
Potamogeton richardsonii (clasping-leaf pondweed)[g]	Native	22	11.40	1.14	3.70	14
Potamogeton zosteriformis (flat-stem pondweed)	Native	6	3.11	1.33	1.01	5
Stuckenia pectinata (Sago pondweed)[g]	Native	24	12.44	1.13	4.03	3
Utricularia vulgaris (bladderwort)	Native	42	21.76	1.36	7.06	4
Vallisneria americana (eel-grass/wild celery)[g]	Native	140	72.51	1.83	23.53	10

Note: Sampling occurred at 193 sampling sites on August 22nd, 23rd, and 24th, 2017. All 193 of these sites had vegetation. Red text indicates non-native and/or invasive species. See Appendix A for distribution maps and identifying features

[a] *Number of Sites refers to the number of sites at which the species was retrieved and identified on the rake during sampling.*

[b] *Frequency of Occurrence, expressed as a percent, is the percentage of times a particular species occurred when there was aquatic vegetation present at the sampling site.*

[c] *Average rake fullness is the average amount, on a scale of 0 to 3, of a particular species at each site where that species was retrieved by the rake.*

[d] *Relative Frequency of Occurrence, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.*

[e] *Visual Sightings is the number of sites where that particular species was visually observed within six feet of the actual rake haul location, but was not actually retrieved on the rake and was not, therefore, assigned a rake fullness measurement for that site. At sites where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake.*

[f] *Spiny naiad was added to the NR 40 list as a restricted species in 2015, meaning it is not allowed to be transported, transferred, or introduced without a permit. Because the species is not native to Wisconsin and can become quite abundant, especially in lakes of poor water quality with hard water, it is currently considered a "naturalized" native species that can provide good habitat and food for fish and macroinvertebrates. Paul M. Skawinski, Aquatic Plants of the Upper Midwest 2nd Edition 2014; Through the Looking Glass: A Field Guide to Aquatic Plants 2nd Edition 2013.*

[g] *Considered a high-value aquatic plant species known to offer important values in specific aquatic ecosystems under Section NR 107.08 (4) of the Wisconsin Administrative Code.*

Source: Wisconsin Department of Natural Resources and SEWRPC

In fact, a review of the numbers of species found at each sampling point in the Lake that contained aquatic vegetation, revealed a range of from one to eight species in 2011 and one to seven species in 2017 at any given point. Figures 1 and 2 show the relative aquatic plant species richness at each grid point in Fowler Lake in year 2011 versus 2017, respectively. Comparison of these figures indicates that there were more grid sites with aquatic vegetation in 2017 (193) versus 2011 (175). However, the average numbers of all species per site and native species per site were lower by 0.90 (3.98-3.08) and 0.83 (3.26-2.43) species, respectively, in 2017 than compared to 2011. This can be also be seen visually in comparison of the species richness distribution in Figure 1 for 2011 versus species richness in Figure 2 for year 2017, which indicates smaller circles in 2017 corresponding to a slightly reduced lower species richness.

The total number of species also does not reflect the changes in frequency of occurrence that have been observed. Six native species—coontail, water stargrass, northern watermilfoil, slender naiad, variable pondweed, and Sago pondweed—have all decreased slightly in their frequency of occurrence from 2011 to 2017. However, eight native species have increased in frequency of occurrence. Eurasian watermilfoil and curly leaf pondweed have also increased in frequency of occurrence slightly since 2011, while spiny naiad has decreased (Table 1).

Although the total number of sites where Eurasian watermilfoil was observed was exactly the same for both the 2011 and 2017 surveys (127 sites), the percent frequency of occurrence decreased from 74.3 to 65.8 percent, due to an increase in the total number of sites were vegetation was found, and the average rake fullness decreased from 1.75 to 1.63 between these two sampling dates. Figure 3 shows changes in rake fullness of Eurasian watermilfoil from the 2011 to 2017 survey to help demonstrate the subtle shifts in the distribution and abundance of this invasive species. Increases in Eurasian watermilfoil are shown in red, decreases are shown in green, and no change is shown in yellow. These changes seem to indicate a general decrease in Eurasian watermilfoil (i.e., greater proportion of green sites) in the middle portions of the Lake and slight increase in some areas in the northern portion of the Lake.

Eurasian watermilfoil has been of particular concern in the Lake and has been one of the primary targets for control through an ongoing aquatic plant management program conducted by the City of Oconomowoc, and through the actions of riparian homeowners. Eurasian watermilfoil is one of eight milfoil species found in Wisconsin and the only one known to be exotic or nonnative. Because of its nonnative nature, Eurasian watermilfoil has few natural enemies that can inhibit its explosive growth under suitable conditions. The plant exhibits this characteristic growth pattern in lakes with organic-rich sediments, or where the lake bottom has been disturbed. In such cases, the Eurasian watermilfoil populations displace native plant species and interfere with the aesthetic and recreational use of the waterbodies.

Eurasian watermilfoil reproduces by the rooting of plant fragments. This plant has been known to cause significant recreational use problems in lakes within the Southeastern Wisconsin Region. Such conflicts can result in the expansion of Eurasian watermilfoil communities, especially when boat propellers fragment Eurasian watermilfoil plants. These fragments, as well as fragments that occur for other reasons such as wind-induced turbulence or fragmentation of the plant by fishes, are able to generate new root systems, allowing the plant to colonize new sites. Eurasian watermilfoil fragments can remain buoyant for two to three days in summer and two to six days in fall, with larger fragments remaining positively buoyant longer than smaller ones.[8] The fragments can also cling to boats, trailers, motors, and/or bait buckets, and can stay alive for weeks contributing to the transfer of milfoil to other lakes. For this reason, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

As previously mentioned, curly-leaf pondweed continues to be present in Fowler Lake. This plant, like Eurasian watermilfoil, also is identified in Chapter NR 109 of the *Wisconsin Administrative Code* as a nonnative invasive aquatic plant. While it is less likely to interfere with recreational boating activities in Southeastern Wisconsin Lakes, the plant can growth in dense stands that exclude other aquatic plants with a greater ecological value.

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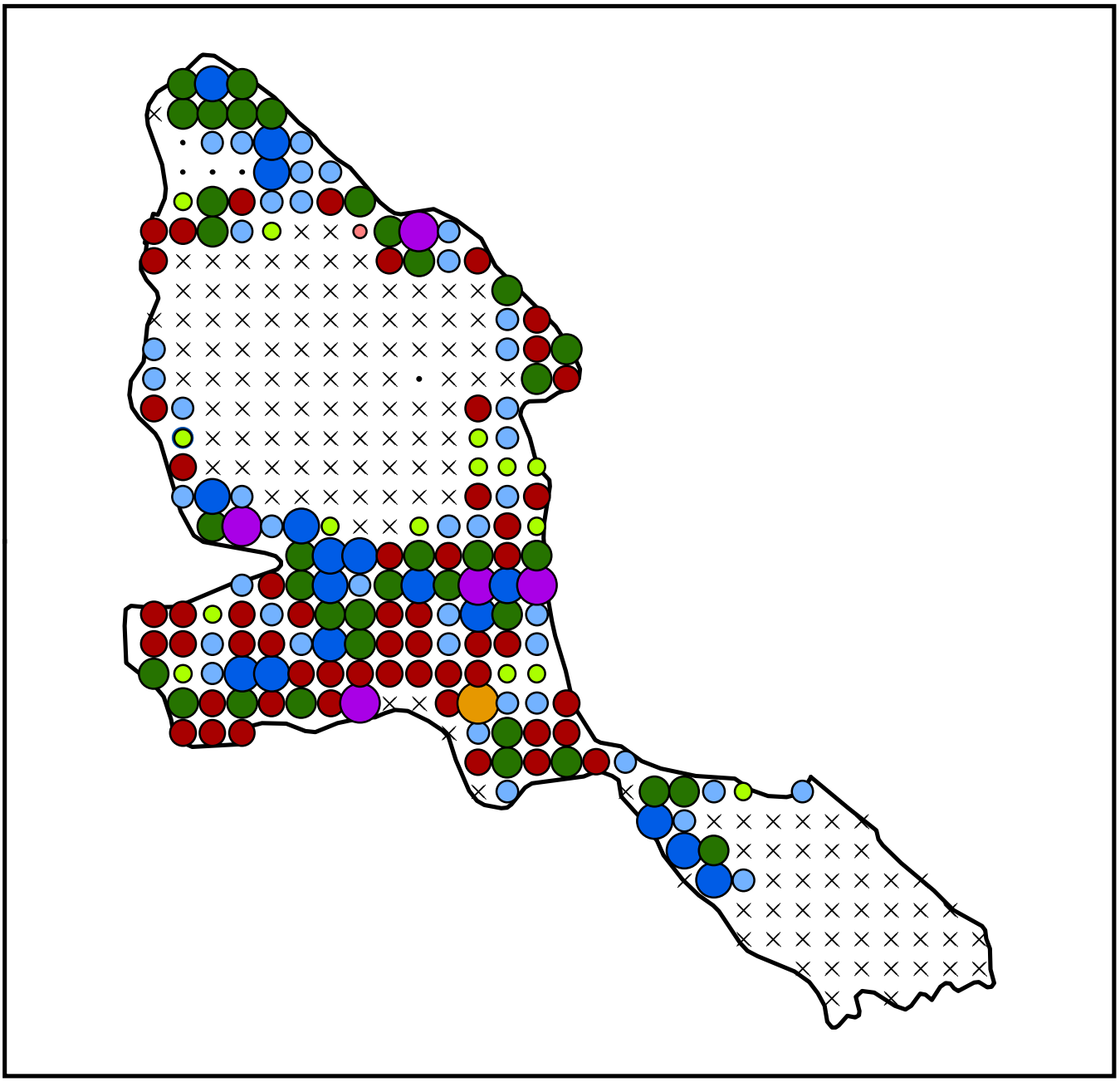
[8] *Joshua D. Wood and Michael D. Netherland, "How long do shoot fragments of hydrilla (Hydrilla verticillata) and Eurasian watermilfoil (Myriophyllum spicatum) remain buoyant?",* Journal of Aquatic Plant Management *Volume 55: Pages 76-82, July 2017.*

Figure 1
Aquatic Plant Survey Sites and Species Richness in Fowler Lake: August 2011



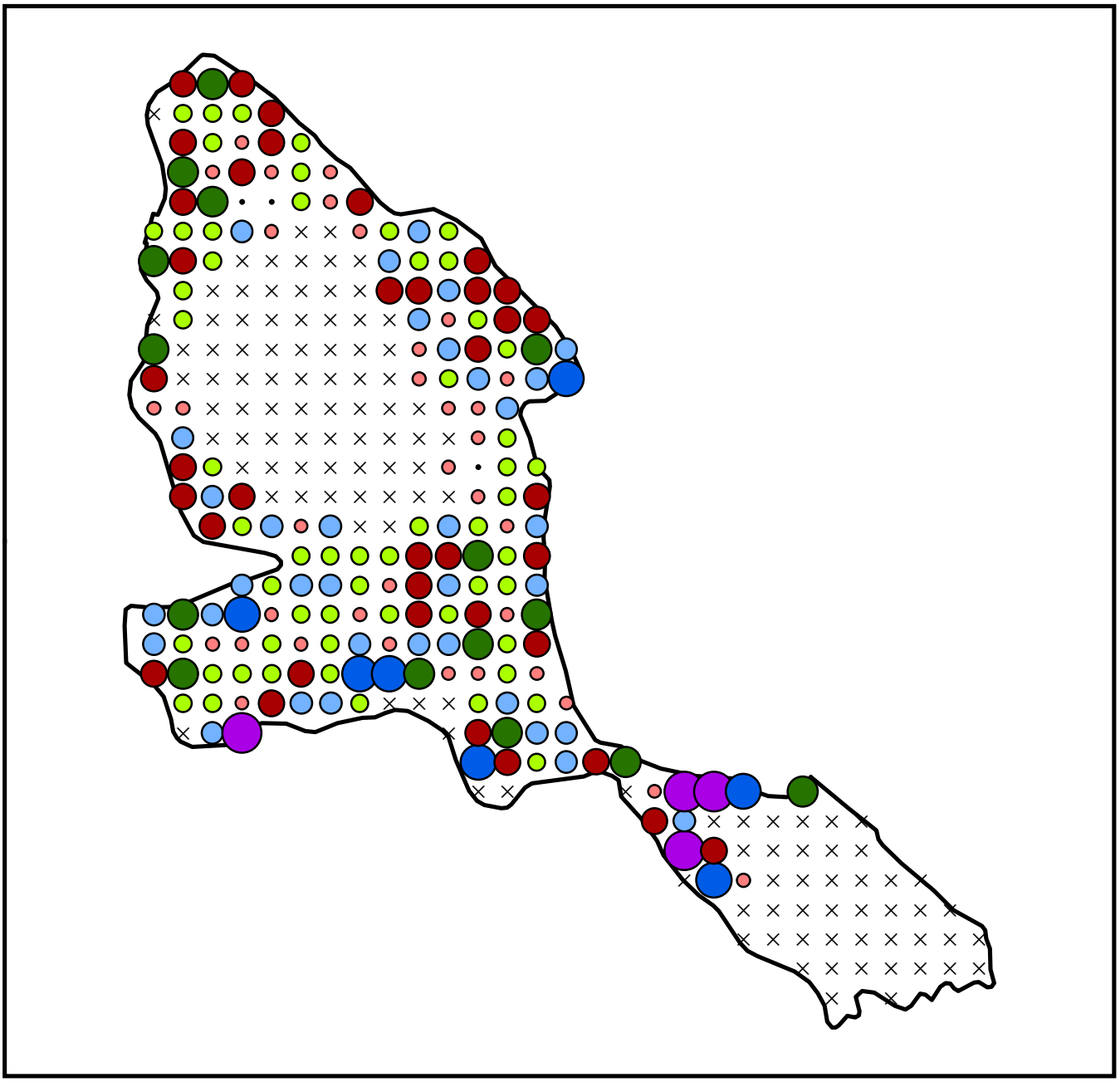
Note: Samples were collected in Fowler Lake on August 1, 2011.

NUMBER OF NATIVE SPECIES OBSERVED

1
2
3
4
5
6
7
8
NO PLANTS FOUND
NOT SAMPLED

Source: WDNR and SEWRPC

Figure 2
Aquatic Plant Survey Sites and Species Richness in Fowler Lake: August 2017



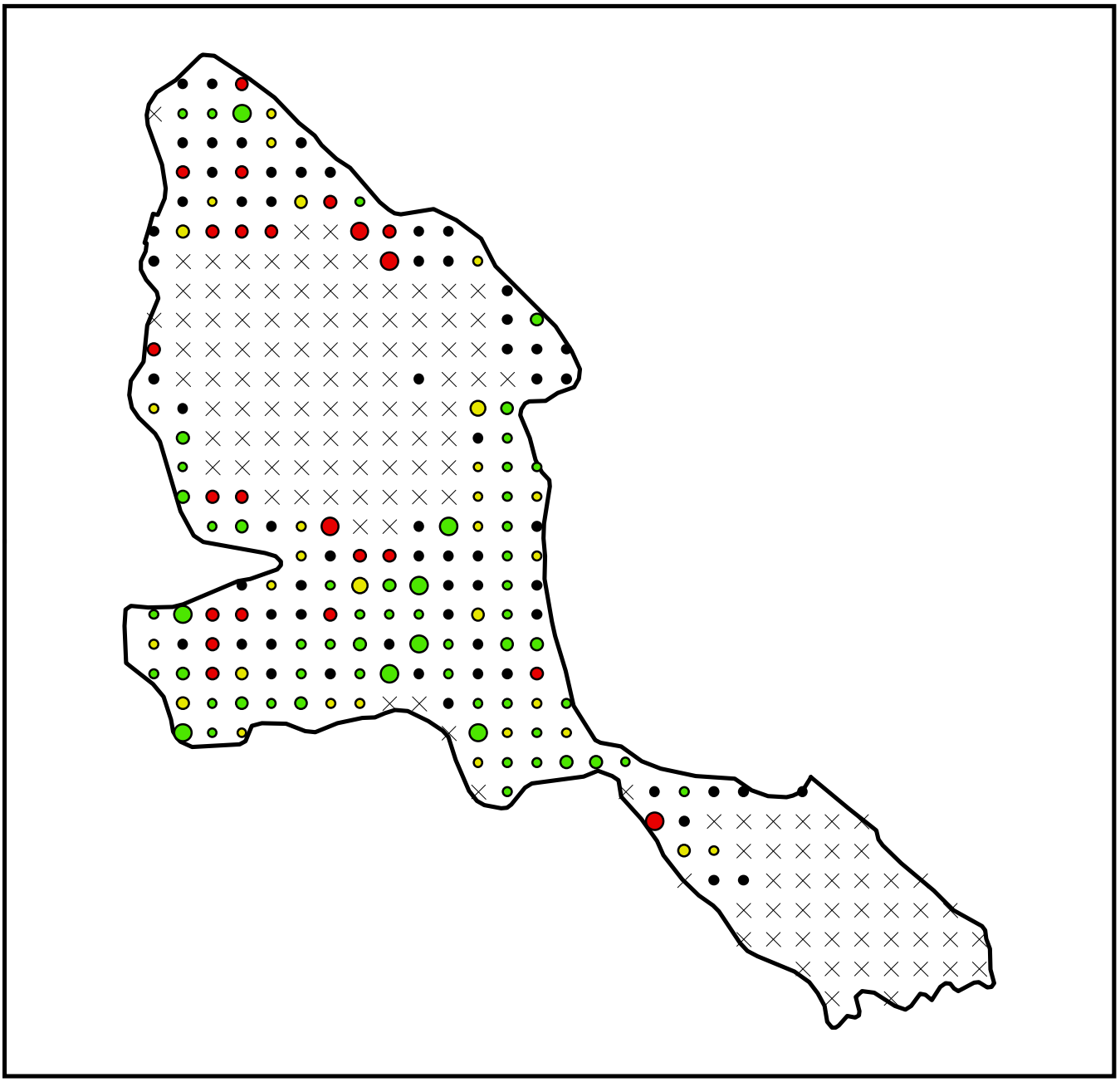
Note: Samples were collected in Fowler Lake between August 22 and August 24, 2017.

NUMBER OF NATIVE SPECIES OBSERVED

1
2
3
4
5
6
7
• NO PLANTS FOUND
× NOT SAMPLED

Source: WDNR and SEWRPC

Figure 3
Change in Rake Fullness of Eurasian Water Milfoil: 2011 to 2017



CHANGE IN RAKE FULLNESS OF EURASIAN WATER MILFOIL

- NOT SAMPLED
- NO EURASIAN WATER MILFOIL
- DECREASE OF 1
- DECREASE OF 2
- DECREASE OF 3
- NO CHANGE, RAKE FULLNESS OF 1
- NO CHANGE, RAKE FULLNESS OF 2
- NO CHANGE, RAKE FULLNESS OF 3
- INCREASE OF 2
- INCREASE OF 3

Source: WDNR and SEWRPC

PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

A WDNR-approved aquatic plant control program has been undertaken on Fowler Lake since the 1950s, when records of such control programs began to be kept by the WDNR. However, aquatic plant control programs on Fowler Lake probably predate the WDNR record-keeping system by several decades. This program initially involved the chemical treatment of aquatic plant growths with sodium arsenite. Fowler Lake was one of the ten most heavily dosed water bodies in Wisconsin, receiving more than 40 tons of sodium arsenite during the 20-year period from 1950 to 1969. Applications of sodium arsenite were discontinued in 1969 after arsenic accumulations were found in lacustrine sediments and concerns were expressed over possible human health impacts.

More recently, chemical treatments have consisted of systemic herbicides such as 2,4-D, as set forth in Table 3. All chemical treatments to Fowler Lake are applied by State-licensed applicators and conform to the requirements of the Chapter NR 107 permit held by the City of Oconomowoc. Chemical applications are normally made in late spring/early summer as the plants begin to grow, with occasional follow-up treatments being applied in midsummer. Copper-based algicides, such as Cutrine, have also been applied to Fowler Lake to control the growth of the macroscopic alga, *Chara* sp., and are listed in Table 3.

Since the mid-1980s, harvesting has been used in concert with an annual herbicide treatment to control aquatic plant growth in Fowler Lake. The City of Oconomowoc has purchased and operates an Aquamarine HM-420 harvester, MSC-23 Pier Conveyor, and T-12 Transport Barge on the Lake, removing an average of about 67,604 cubic feet (2,504 cubic yards) of plant material annually based on records from 2006 through 2017 (see Table 4). The equipment was purchased in 2004 and the City of Oconomowoc is considering replacing it in 2019, if grant funding is available. This dual control program has been viewed favorably by the public, although some concerns continue to be expressed on both sides of the issue. These concerns notwithstanding, the control program has reversed the opinion, widely held since the 1960s, that Fowler Lake was "gross."[9] The Lake is now viewed as an asset to the community and is a well-used recreational resource. Nevertheless, it is a goal of the Management Plan for Fowler Lake that aquatic herbicide use be minimized, synchronized with the aquatic plant harvesting operation to maximize its impact, and applied primarily in the nearshore areas to control nuisance plants such as Eurasian watermilfoil and curly-leaf pondweed.

ALTERNATIVE METHODS FOR AQUATIC PLANT CONTROL

Aquatic plant management techniques can be classified into five groups:

1. *Physical measures* – which include lake bottom coverings

2. *Biological measures* – which include the use of organisms, including herbivorous insects

3. *Manual measures* – which involve physical removal of plants by individuals using hand-held rakes or by hand

4. *Mechanical measures* – which include harvesting and removing aquatic plants with a machine known as a harvester or by suction harvesting

5. *Chemical measures* – which include the use of aquatic herbicides to kill nuisance and nonnative aquatic plants.

More information regarding these alternatives is provided in the following sections. All control measures are stringently regulated and most require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under Chapter NR 107, "Aquatic Plant Management," of the *Wisconsin Administrative Code*, while placing bottom covers (a physical measure) requires a WDNR permit under Chapter 30 of the *Wisconsin Statutes*. All other aquatic plant management practices are regulated under Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations," of the *Wisconsin Administrative Code*.

[9] Oconomowoc Enterprise*, June 2, 1983*.

Table 3
Chemical Controls on Fowler Lake: 1950-2017

	Algae Control		Macrophyte Control					
Year	Cutrine-Plus (gallons)	Copper Sulfate (pounds)	Sodium Arsenite (pounds)	2,4-D (gallons)	Hydrothol (gallons)	Diquat (gallons)	Glyphosate (gallons)	Endothall/ Aquathol (gallons)
1950-1969	--	2,506	87,456	--	--	--	--	--
1970-1979	20.0			28.0	20.0	124.8	--	194.0
1980-1989	40.3	--	--	285.5	4.5 + 610.0 pounds	68.0	--	137.5
1990	--	--	--	64.5	--	--	--	--
1992	--	--	--	47.8	--	--	--	--
1993	--	--	--	57.0	--	--	--	--
1994	--	--	--	2.5	--	--	--	--
1995	--	--	--	75.0	--	--	--	--
1996-2017[a]	--	--	--	--	--	--	--	--
Total	60.3	2,506	87,456	465.3	24.5 + 610.0 pounds	192.8	--	331.5

[a] *No chemical controls were used during these years.*

Source: Wisconsin Department of Natural Resources and SEWRPC

The aquatic plant management elements described below consider alternative management measures consistent with the provisions of Chapters NR 103, "Water Quality Standards for Wetlands," NR 107, and NR 109 of the *Wisconsin Administrative Code*. Furthermore, the alternative aquatic plant management measures are consistent with the requirements of Chapter NR 7, "Recreational Boating Facilities Program," and with the public recreational boating access requirements relating to eligibility under the State cost-share grant programs set forth in Chapter NR 1, "Natural Resources Board Policies," of the *Wisconsin Administrative Code*.

Table 4
Amount of Plant Material Harvested from Fowler Lake: 2006-2017

Year	Plant Material Removed (cubic feet)
2006	95,742
2007	89,308
2008	64,689
2009	96,379
2010	97,951
2011	54,999
2012	108,558
2013	39,809
2014	31,428
2015	50,023
2016	43,475
2017	38,892
Mean Per Year	67,604

Source: City of Oconomowoc

Physical Measures

Lake-bottom covers and light screens provide limited control of rooted plants by creating a physical barrier that reduces or eliminates plant-available sunlight. Various materials such as pea gravel or synthetics like polyethylene, polypropylene, fiberglass, and nylon can be used as covers. The longevity, effectiveness, and overall value of some physical measures is questionable. The WDNR does not permit these kinds of controls. Consequently, lake-bottom covers are not a viable aquatic plant control strategy for the Lake.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance or exotic plants. Biological control techniques traditionally use herbivorous insects that feed upon nuisance plants. This approach has been effective in some southeastern Wisconsin lakes.[10] Milfoil weevils do best in waterbodies with balanced panfish populations,[11] and under conditions that include dense Eurasian water milfoil beds where the plants reach the surface and are close to shore, natural shoreline areas where leaf litter provides habitat for over-wintering, and little boat traffic. This technique is not presently commercially available making the use of

[10] *B. Moorman,* A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control*, Lake Line, Vol. 17, No. 3, pp. 20-21, 34-37, September 1997; see also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy,* Insect Influences in the Regulation of Plant Population and Communities*, pp. 659-696, 1984; and C.B. Huffacker and R.L. Rabb, editors, Ecological Entomology, John Wiley, New York, New York, USA.*

[11] *Panfish such as bluegill and pumpkinseed are predators of herbivorous insects. High populations of panfish lead to excess predation of Milfoil weevils.*

milfoil weevils (*Eurhychiopsis lecontei)* a non-viable option. Additionally, since the Lake only has highly developed shore areas, high boat activity, and an abundance of panfish, milfoil weevils are not likely well suited for application at Fowler Lake.

Manual Measures

Manual removal of specific types of vegetation provides a highly selective means of controlling nuisance aquatic plant growth, including invasive species such as Eurasian water milfoil.

Two common manual removal methods are used: raking and hand-pulling. Each rely on physically removing target plants from the Lake. Removing plant material from the Lake reduces nutrient loads to the lake and the volume of plant materials that would normally have contributed to the accumulation of lake-bottom sediment. Hence, both of these conditions help to incrementally maintain water depths and improve water quality. Furthermore, removing target plants reduces their reproductive potential. Raking and hand pulling are described in more detail in the following paragraphs.

Raking with specially designed hand tools is particularly useful in shallow nearshore areas. This method allows nonnative plants to be removed and also provides a **safe and convenient aquatic plant control method in deeper nearshore waters around piers and docks**. Advantages of this method include:

- Tools are relatively inexpensive ($100 to $150 each)
- The method is easy to learn and use
- Results are immediately apparent
- Plant material is immediately removed from a lake (including seeds and plant fragments)

Should Fowler Lake residents decide to implement this method of control, an interested party could acquire a number of these specially designed rakes for riparian owners to use on a trial basis. If those rakes satisfy users' needs and objectives, additional property owners could be encouraged to purchase rakes. In areas where other management efforts are not feasible, raking is a viable option to manage overly abundant or undesirable plant growth.

The second manual control method—**hand-pulling** whole plants (stems, roots, leaves, and seeds) where they occur in isolated stands—provides an alternative means of controlling plants such as Eurasian water milfoil and curly-leaf pondweed. **This method is particularly helpful when attempting to target nonnative plants in the high growth season, when native and nonnative species often coexist and intermix**. Since the City of Oconomowoc already conducts plant pick-up services, homeowners would not have to haul these manually pulled plants away (see section below). This method is more highly selective than rakes, mechanical removal, and chemical treatments, and if carefully applied, is less damaging to native plant communities. Given these advantages, hand-pulling Eurasian water milfoil and curly-leaf pondweed is considered a viable option in Fowler Lake, where practical. Volunteers or homeowners could employ this method, as long as they are properly trained to identify Eurasian water milfoil, curly-leaf pondweed, or any other invasive plant species of interest. WDNR provides a wealth of guidance materials, including an instructional video describing manual plant removal, to help educate volunteers and homeowners.

Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, **aquatic plants may be raked or hand pulled without a WDNR permit** under the following conditions:

- Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife may be removed if the native plant community is not harmed in the process
- No more than 30 lineal feet of shoreline may be cleared, however, this total must include shoreline lengths occupied by docks, piers, boatlifts, rafts, and areas undergoing other plant control treatment. In general, regulators allow vegetation to be removed up to 100 feet out from the shoreline
- Plant material that drifts onto the shoreline must be removed

- The shoreline is not a designated sensitive area
- Raked, hand-cut, and hand-pulled plant material must be removed from the lake

Any other **manual removal program requires a State permit, unless specifically used to control designated nonnative invasive species** such as Eurasian water milfoil. In general, State manual aquatic plant removal permits call for all hand-pulled material to be removed from the lake. **Mechanical equipment (e.g., dragging equipment such as a rake behind a motorized boat or the use of weed rollers) is not authorized for use in Wisconsin at this time. Recommendations regarding hand-pulling, hand-cutting, and raking are discussed later in this document.**

Mechanical Measures

Two methods of mechanical harvesting are currently permitted and employed in Wisconsin. These methods include use of an aquatic plant harvester (mechanical harvesting) and suction harvesting. More details about each are presented below.

Mechanical Harvesting

Aquatic plants can be mechanically gathered using specialized equipment known as harvesters. Harvesters consist of an adjustable depth cutting apparatus that can remove plants from the surface to up to about five feet below the water surface. The cut plants are then gathered with a collection system (e.g., a conveyor and a basket) that picks up most cut plant material. Mechanical harvesting can be a practical and efficient means of controlling nuisance plant growth as well as reducing in-lake nutrient recycling, sedimentation, and target plant reproductive potential. In other words, harvesting removes plant biomass, which would otherwise decompose and release nutrients, sediment, and seeds or other reproductive structures (e.g., turions, bulbils, plant fragments) into a lake. Mechanical harvesting is particularly effective for large-scale projects.

An advantage of mechanical harvesting is that the harvester, when properly operated, "mows" aquatic plants and, therefore, typically **leaves enough living plant material in the lake to provide shelter for aquatic wildlife and to stabilize lake-bottom sediment. None of the other aquatic plant management methods leave living plant material in place after treatment**. Aquatic plant harvesting also has been shown to facilitate growth of native aquatic plants by allowing light to penetrate to the lakebed and stimulate growth of suppressed native plants. This is particularly effective when controlling invasive plant species that commonly grow very early in the season when native plants have not yet emerged or appreciably grown. Finally, harvesting does not kill native plants in the way that other control methods do. Instead, this method simply trims them back.

A disadvantage of mechanical harvesting is that the harvesting process may **fragment plants and thereby unintentionally facilitate the spread of Eurasian water milfoil**, which utilizes fragmentation as a means of propagation. Milfoil fragments are particularly successful in establishing themselves in areas where plant roots have been removed. This further emphasizes the need to prevent harvesting that removes native plant roots. Harvesting may also agitate bottom sediments in shallow areas, thereby increasing turbidity and resulting in deleterious effects such as smothering of fish breeding habitat and nesting sites. Agitating bottom sediment also increases the risk of nonnative species recolonization, as invasive species tend to thrive on disrupted and/or bare lake bottom. To this end, **most WDNR-issued permits do not allow deep-cut harvesting in water less than three feet deep**,[12] which limits the utility of this alternative in many littoral areas. Nevertheless, if employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can ultimately reduce regrowth of nuisance plants while maintaining, or even enhancing, native plant communities.

Some cut **plant fragments can escape the harvester's collection system**. This negative side effect is fairly common. To compensate for this, most harvesting programs include a plant pickup program(the City of Oconomowoc has a collection system). The plant pickup program uses the harvester to gather and collect significant accumulations of floating plant debris and regularly picks up from the docks of lakefront

[12] *Deep-cut harvesting is harvesting to a distance of only one foot from the lake bottom. This is not allowed in shallow areas, because it is challenging to properly ensure that the harvester does not hit the lake bottom in these areas.*

property owners who actively rake plant debris into piles on their docks and shorelines.[13] This kind of program, when applied systematically, can reduce plant propagation from plant fragments and can help alleviate the negative aesthetic consequences of plant debris accumulating on shorelines. However, it is important to note that normal boating activity on Fowler Lake (particularly during weekends) creates far more plant fragments than generated from the harvesting operations. Therefore, this plant pickup program is essential for the protection of the Lake, even in areas where harvesting has not recently occurred.

Suction Harvesting (DASH)

An alternative aquatic plant harvesting method has emerged called Diver Assisted Suction Harvesting (DASH). First permitted in 2014, DASH (also known as suction harvesting) is a mechanical process where divers identify and pull select aquatic plants by their roots from the lakebed and then insert the entire plant into a suction hose that transports the plant to the lake surface for collection and disposal. The process is essentially a more efficient and wide-ranging method for hand-pulling aquatic plants. Such labor-intensive work by skilled professional divers is, at present, a costly undertaking and long-term monitoring will need to evaluate the efficacy of the technique. Nevertheless, many apparent advantages are associated with this method, including: 1) **lower potential to release plant fragments** when compared to mechanical harvesting, raking, and hand-pulling, thereby reducing spread and regrowth of invasive plants like Eurasian water milfoil; 2) **increased selectivity in terms of plant removal** when compared to mechanical and hand harvesting, thereby reducing the loss of native plants; and 3) **lower potential for disturbing fish habitat**. However, given how costly DASH can be and how widespread the Eurasian water milfoil is across the Lake, DASH is not considered a viable control option for managing Eurasian water milfoil throughout Fowler Lake. However, DASH can provide relief of nuisance native and non-native plants around piers. If individual property owners chose to employ DASH, a NR 109 permit is required.

Both mechanical harvesting and suction harvesting are regulated by WDNR and require a permit.[14] Non-compliance with permit requirements is an enforceable violation of Wisconsin law and may lead to fines and/or complete permit revocation. The information and recommendations provided in this memorandum will help frame permit requirements. Permits can cover up to a five-year period.[15] At the end of that period, it would be necessary to develop a new plant management plan. The updated plan must consider the results of a new aquatic plant survey and should evaluate the success, failure, and effects of earlier plant management activities that occurred in the lake.[16] These plans and plan execution are overseen by the WDNR aquatic invasive species coordinator for the region.[17] Recommendations are discussed later in this document.

Chemical Measures

Use of chemical herbicides in aquatic environments is **stringently regulated and requires a WDNR permit and WDNR staff oversight during application**. Chemical herbicide treatment is a short-term method to control heavy growths of nuisance aquatic plants. Chemicals are applied to growing plants in either liquid or granular form. The advantages of using chemical herbicides to control aquatic plant growth include relatively low cost as well as the ease, speed, and convenience of application. Disadvantages associated with chemical control include:

- **Unknown and/or conflicting evidence about long-term effects of chemicals on fish, fish food sources, and humans**—The U.S. Environmental Protection Agency, which approves chemicals for aquatic plant treatment, studies aquatic plant herbicides to rule out short-term (acute) effects on humans and wildlife. Additionally, some studies also examine long-term (chronic) effects of the chemical on animals (e.g., the effects of being exposed to these herbicides for many years). However, it is often impossible to conclusively state that no long-term effects exist due to the

[13] *The plant pick-up program by the City of Oconomowoc collects plant material generated by landowner raking and/or hand pulling along their own shoreline once per week on Friday during the cutting season.*

[14] *Permits for mechanical harvesting can be dependent on the type of harvesters utilized. The City of Oconomowoc uses an Aquamarine Model HM-420 harvester.*

[15] *Five-year permits allow a consistent aquatic plant management plan to be implemented over a significant length of time. This process allows the selected aquatic plant management measures to be evaluated at the end of the permit cycle.*

[16] *Aquatic plant harvesters must report harvesting activities as one of the permit requirements.*

[17] *Information on the current aquatic invasive species coordinator is found on the WDNR website.*

animal testing protocol, time constraints, and other issues. Additionally, long-term studies have not addressed all potentially affected species.18 For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.[19] Some lake property owners judge the risk of using chemicals as being too great, despite legality of use. Consequently, the concerns of lakefront owners should be considered whenever chemical treatments are proposed. Additionally, if chemicals are used, they should be applied as early in the season as practical and possible. This helps assure that the applied chemical decomposes before swimmers and other lake users begin to actively use the lake.[20]

- **An increased risk of algal blooms**—Water borne nutrients promote growth of aquatic plants and algae. If rooted aquatic plants are not the primary user of water-borne nutrients, algae tends to be more abundant. Action should be taken to avoid both loss of native plants and excessive chemical use, which can compromise the health of a lake's native plant community and reduce the ability of rooted aquatic plants to compete with algae for limiting nutrients. **Balance must be maintained between rooted aquatic plants and algae - when the population of one declines, the other may increase in abundance to nuisance levels.** In addition to decreasing competition for water-borne nutrients, the death and decomposition of aquatic plants can increase nutrient levels in lake water. Higher nutrient concentrations fuel aquatic plant and algal growth.

- **A potential increase in organic sediments, and associated anoxic conditions, can stress aquatic life and cause fish kills**—When chemicals are used to control large mats of aquatic plants, the dead plant material generally settles to the bottom of a lake and subsequently decomposes. This process leads to an accumulation of organic-rich sediment and can deplete oxygen from the water column as bacteria decompose plant remains. Stratified lakes, such as Fowler Lake, are particularly vulnerable to oxygen depletion, especially in summer in deeper areas of the Lake. Excessive oxygen loss can inhibit a lake's ability to support certain fish and can trigger processes that release phosphorus from bottom sediment, further increasing lake nutrient levels. These concerns emphasize the need to limit chemical control to early spring, when Eurasian water milfoil has not yet formed dense mats.

- **Adverse effects on desirable aquatic organisms due to loss of native species**—Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. A robust and diverse native plant community is a foundational element to the overall conditions a lake needs to provide and host desirable gamefish populations since fish, and the organisms fish eat, require aquatic plants for food, shelter, and oxygen. If native plants are unintentionally lost due to insensitive herbicide application, fish and wildlife populations often suffer. Consequently, if chemical herbicides are applied to the Lake, these chemicals must preferentially target Eurasian water milfoil or curly-leaf pondweed. Such chemicals should be applied in early spring when native plants have not yet emerged.

- **A need for repeated treatments due to re-emergence of target plants from existing seed banks and/or plant fragments**—As mentioned previously, chemical treatment is not a one-time solution. The fact that the treated plants are not actively removed from the Lake increases the potential for viable seeds/fragments to remain after treatment, thereby allowing for resurgence of the target species the next year. Additionally, leaving large areas void of plants (both native and invasive) creates a disturbed area without an established plant community. Eurasian water milfoil thrives in disturbed areas. In summary, applying chemical herbicides to large areas can provide opportunities for reinfestation, which in turn necessitates repeated herbicide applications.

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[18] *U.S. Environmental Protection Agency, EPA-738-F-05-002, 2,4-D RED Facts, June 2005.*

[19] *M.A. Ibrahim, et al.,* Weight of the Evidence on the Human Carcinogenicity of 2,4-D, *Environmental Health Perspectives, Vol. 96, December 1991, p. 213-222.*

[20] *Though the manufacturers indicate that swimming in 2,4-D-treated lakes is allowable after 24 hours, it is possible that some swimmers may want more of a wait time to ensure that they receive less exposure to the chemical. Consequently, allowing for extra time is recommended, so that residents and lake users can feel comfortable that they are not being unduly exposed.*

- **Hybrid water milfoil's resistance to chemical treatments**—Hybrid water milfoil complicates management, since research suggests that certain strains may have higher tolerance to commonly utilized aquatic herbicides such as 2,4-D and Endothall.[21,22] Consequently, further research on the efficacy and impacts of herbicides on hybrid water milfoil needs to be conducted to better understand the appropriate dosing applied within lakes, which will require increased time and cost.

- **Effectiveness of small-scale chemical treatments**—Small-scale treatments of 2,4-D on Eurasian water milfoil have been proven to have highly variable results. A study completed in 2015 concluded that less than 50 percent of the 98 treatment areas were effective, or had more than a 50 percent reduction in Eurasian water milfoil.[23] For a treatment to be effective it must meet a certain exposure time while maintaining a target concentration; however, due to the dissipation of chemicals (e.g., wind and wave action) target concentrations are often not met. Therefore, when deciding to implement small-scale chemical treatments the variability in results with the cost of treatment should be examined.

As discussed earlier, other factors complicate chemical herbicide application in lakes, namely coincident growth of Eurasian water milfoil and native species, the physical similarities between native water milfoil and Eurasian water milfoil, and the presence of hybrid Eurasian water milfoil. Hybrid water milfoil has not been verified to exist in Fowler Lake, but is likely to occur. **Since Eurasian water milfoil tends to grow early in the season, *early spring* chemical application is an effective way to target the Eurasian water milfoil while minimizing impact to desirable native plants**. Early spring application has the advantage of being more effective due to the colder water temperatures, a condition enhancing herbicidal effects and reducing the dosing needed for effective treatment. Early spring treatment also reduces human exposure (swimming is not particularly popular in very early spring) and limits the potential for unintentional damage to native species.

Considering the expanse of Eurasian water milfoil in the eastern basin of Fowler Lake and the cost of chemical treatment, a whole Lake treatment, or large spot treatment in that basin, is not recommended.[24] This is also supported by the efficiency and effectiveness of the harvesting operations, along with their added benefit to the ecology and water quality of Fowler Lake compared to chemical application. However, small spot treatments enclosed with a barrier (e.g., turbidity barrier) could be a viable alternative for treating shoreline areas and navigation lanes if determined feasible by the District. Whatever the case, monitoring should continue to ensure that Eurasian water milfoil populations do not become more problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The most effective plans to manage nuisance and invasive aquatic plant growth rely on a *combination* of methods and techniques. A "silver bullet" single-minded strategy rarely produces the most efficient, most reliable, or best overall result. Therefore, to enhance access to, and the health of, Fowler Lake, this plan recommends five aquatic plant management techniques as described below. The recommended aquatic plant management plan for Fowler Lake is set forth in Figure 4.

1. **Mechanical harvesting of invasive and nuisance aquatic plants** should continue to be considered a high priority. As indicated, it is proposed that aquatic plant management activities be restricted in certain ecologically valuable areas of the Lake. Aquatic plant management operations will be concentrated in the main basin of the Lake and near the boating access ramp as well as in the

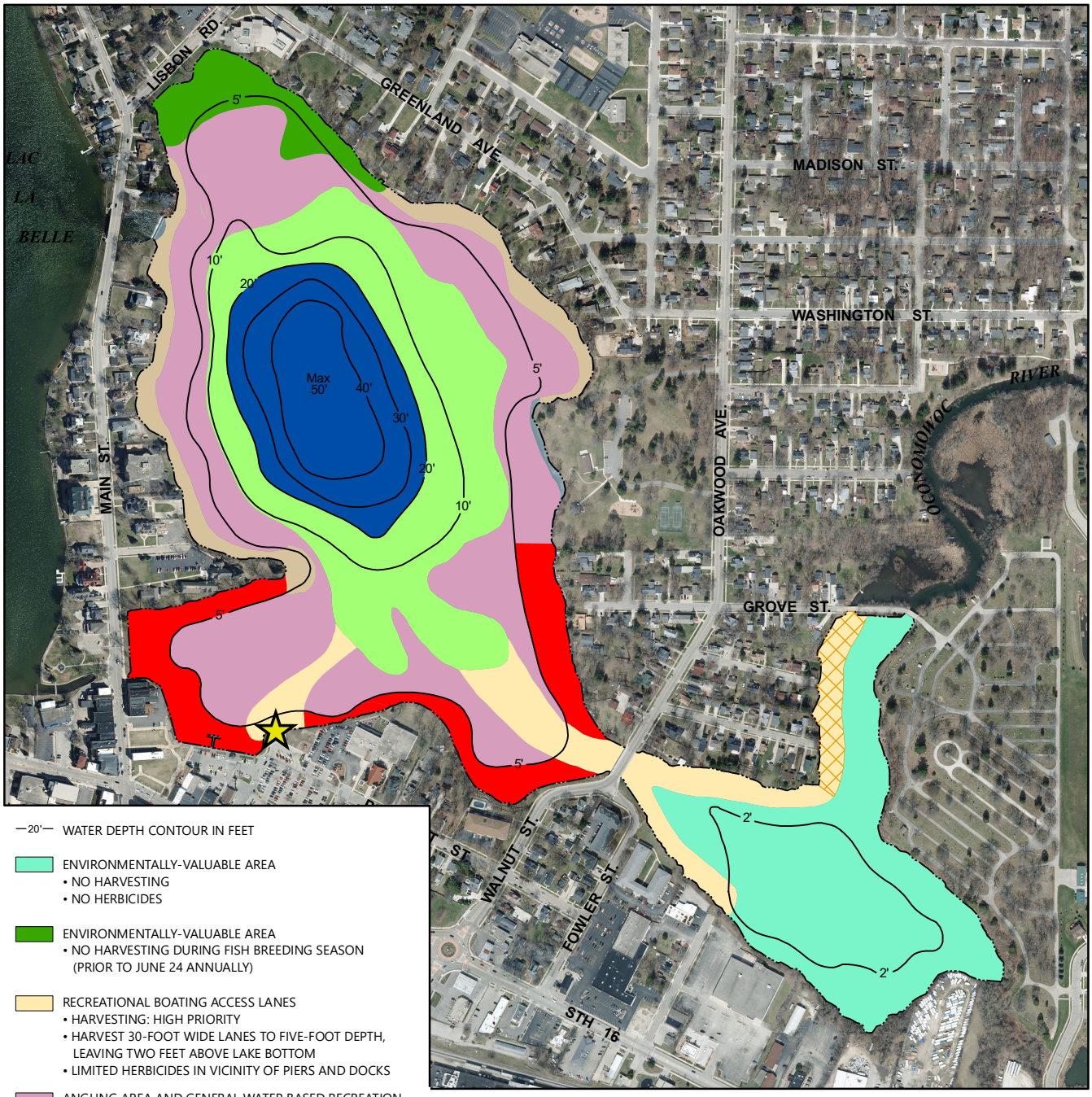
[21] *L.M. Glomski, M.D. Netherland, "Response of Eurasian and Hybrid Watermilfoil to Low Use Rates and Extended Exposures of 2,4-D and Triclpyr",* Journal of Aquatic Plant Management, *Vol. 48, 2010, p. 12-14.*

[22] *E.A. LaRue, et al., 'Hybrid Watermilfoil Lineages are More Invasive and Less Sensitive to a Commonly Used Herbicide than Their Exotic Parent (Eurasian Watermilfoil)",* Evolutionary Applications, *Vol. 6, 2013, p. 462-471*

[23] *M. Nault, et al.,*"Control of Invasive Aquatic Plants on a Small Scale," *Lakeline, Spring 2015, p. 35-39*

[24] *WDNR has been studying the efficacy of spot treatments versus whole lake treatments for the control of Eurasian water milfoil and it has been found that spot treatments are not an effective measure for reducing Eurasian water milfoil populations, while whole lake treatments have proven effective depending on conditions.*

Figure 4
Recommended Aquatic Plant Management Plan Elements for Fowler Lake: 2018



—20'— WATER DEPTH CONTOUR IN FEET

ENVIRONMENTALLY-VALUABLE AREA
- NO HARVESTING
- NO HERBICIDES

ENVIRONMENTALLY-VALUABLE AREA
- NO HARVESTING DURING FISH BREEDING SEASON (PRIOR TO JUNE 24 ANNUALLY)

RECREATIONAL BOATING ACCESS LANES
- HARVESTING: HIGH PRIORITY
- HARVEST 30-FOOT WIDE LANES TO FIVE-FOOT DEPTH, LEAVING TWO FEET ABOVE LAKE BOTTOM
- LIMITED HERBICIDES IN VICINITY OF PIERS AND DOCKS

ANGLING AREA AND GENERAL WATER BASED RECREATION
- HARVESTING: MODERATE PRIORITY; HARVEST TO THREE-FOOT DEPTH LEAVING TWO FEET ABOVE LAKE BOTTOM

RECREATIONAL BOATING AREA
- HARVESTING: LOW PRIORITY
- MAINTAIN RECREATIONAL WATER SKI AREA AT ABOUT 10-FOOT CONTOUR; HARVEST TO SIX-FOOT DEPTH LEAVING ONE FOOT ABOVE LAKE BOTTOM

SHORELINE ZONE: WATER DEPTH LESS THAN THREE FEET
- MANUAL HAVESTING OF 30 FOOT SHORELINE CORRIDOR
- PIERHEAD COLLECTION OF FRAGMENTS AND MANUALLY HARVESTED PLANTS
- LIMITED HERBICIDES IN VICINITY OF PIERS AND DOCKS

OPEN WATER AREA
- NO AQUATIC PLANT CONTROLS RECOMMENDED

RECREATIONAL BOATING ACCESS LANES
- HARVESTING LIMITED BY WATER DEPTH: LOW PRIORITY
- HARVEST PERIODICALLY AS WATER DEPTHS ALLOWS
- LIMITED HERBICIDES IN VICINITY OF PIERS AND DOCKS

EURASIAN WATER MILFOIL CONTROL AREA
- HARVESTING RECOMMENDED: HIGH PRIORITY
- MANUAL HARVESTING OF 30 FEET OF SHORELINE CORRIDOR
- LIMITED HERBICIDE APPLICATION TO BE CONSIDERED FOR EURASIAN WATER MILFOIL CONTROL
- PIERHEAD COLLECTION OF FRAGMENTS AND MANUALLY HARVESTED PLANTS

ACCESS LOCATION

N

Date of Photography: April 2015
Source: WDNR and SEWRPC

Note: The extent of implementation among these areas will depend on available staff, time, budget, and plant growth characteristics within a given season. Management area size and locations are not scaled and only illustrate overall concept. See "Aquatic Plant Management Recommendations."

principal boating and fishing areas. There are no identified environmentally sensitive areas in those portions of the Lake.

In contrast, the upper reaches of the impoundment above the N. Oakwood Avenue Bridge have more of a wetland character and will be excluded from aquatic plant management operations, except for provision of an access channel along the northern and southern shores and for operations associated with the eradication of purple loosestrife in this area. In addition, harvesting will not take place in waters less than three feet deep to avoid the disturbance of fish spawning and nursery areas and beds of native aquatic plants. Special efforts will be made to avoid disturbing major spawning and habitat areas of sport fish in Fowler Lake during the spring spawning season, May 1 to June 24th.

As noted above, the goal of the management program is to accommodate recreational uses of the impoundment as much as possible and to enhance the public perception of the impoundment as the "centerpiece" of the City of Oconomowoc, without inflicting irreparable damage on the ecosystem of the Lake, its structure and function. To accomplish this goal, specific control measures will be applied in the various Lake zones identified in Figure 4:

a. **Inspect all cut plants for live animals. Live animals should be immediately returned to the water**. This should be considered a medium priority. The WDNR recommends that a second staff person equipped with a net accompany and assist the harvester operator. Animals can get caught in the harvester and harvested plants, particularly when cutting larger plant mats. However, if a second staff person is not feasible, the harvester operator should stop the harvester to remove caught animals such as turtles, gamefish, and amphibians.

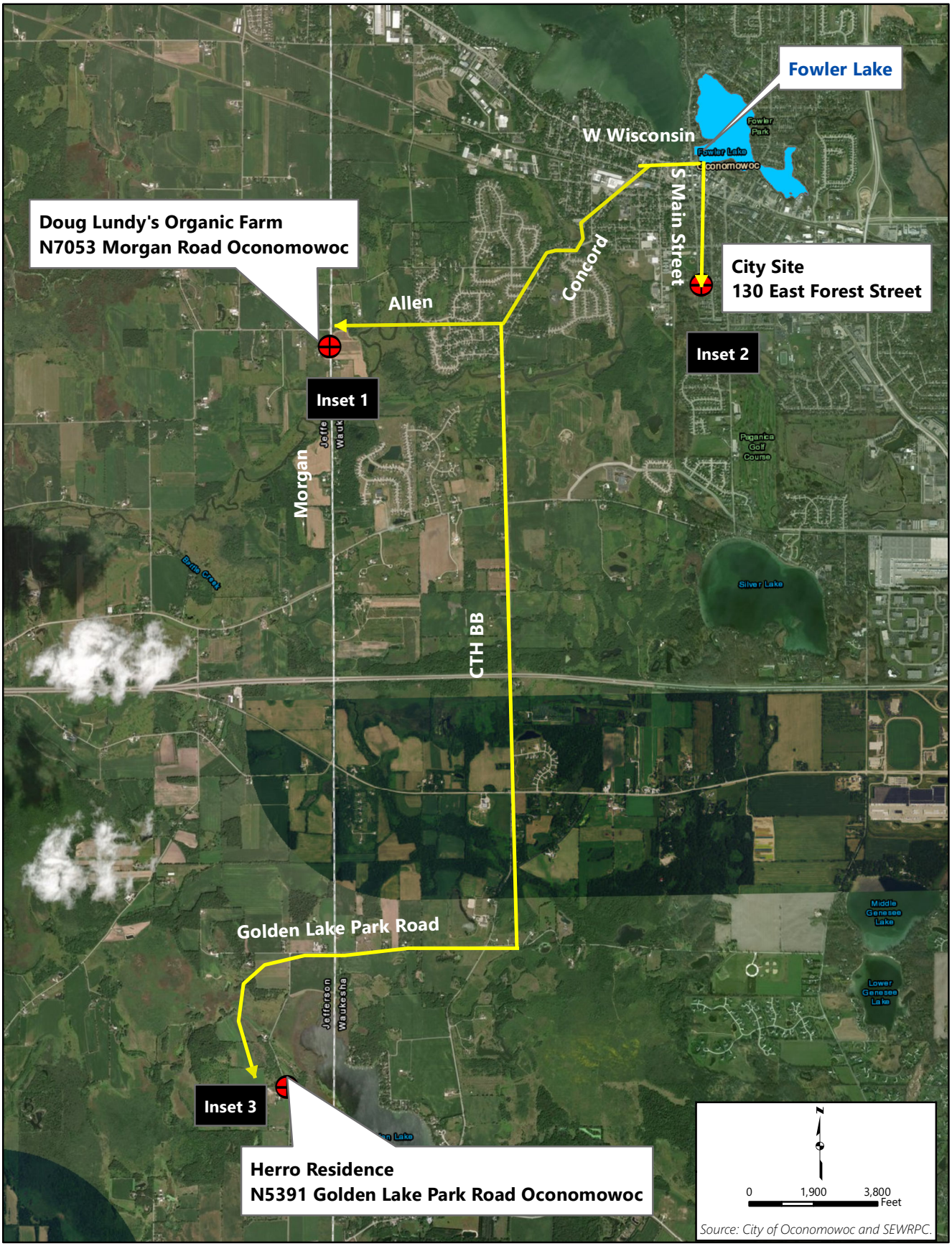
b. **All harvester operators must successfully complete governmental training to help assure adherence to harvesting permit specifications and limitations** (high priority). The regional WDNR aquatic invasive species coordinator and/or the City of Oconomowoc's Public Works Department should continue to provide training to all summer harvester operators. At a minimum, training should cover 1) "deep-cut" versus "shallow-cut" techniques and when to employ each in accordance with this plan, 2) review of the aquatic plant management plan and associated permits with special emphasis focused on the need to restrict cutting in shallow areas, 3) identification of, and regulations pertaining to, WDNR-designated Sensitive Areas, and 4) plant identification to encourage preservation of native plant communities. Additionally, this training course should reaffirm that all harvester operators are legally obligated to record their work for inclusion in annual reports that are required under harvesting permits.

c. Harvesting and boating activity can fragment plants. Plant fragments may float in the Lake, accumulate on shorelines (particularly within the eastern basin of the Lake), and help spread undesirable plants. The harvesting program should continue to include **a comprehensive plant pickup program** that all residents can use (high priority). This helps assure that harvesting does not create a nuisance for Lake residents. The program includes residents raking plants, placing them in a pile in a convenient location accessible to the harvester (e.g., the end of a pier) for regularly scheduled pickup of cut plants by the City of Oconomowoc harvester operators. This effort should be as collaborative as practical and harvester operators should consider focusing pickup efforts in the eastern basin after weekends, because plant fragments tend to accumulate throughout this area due to normal prevailing wind patterns.

d. **All plant debris collected from harvesting activities should be collected and disposed of at the designated disposal sites**, as shown in Map 1. **Disposing of any aquatic plant material within identified floodplain and wetland areas is prohibited**, and special care should be taken to assure that plant debris is not disposed of in such areas (high priority).

2. **Manual removal of nuisance plant growth and invasive plants in near-shore areas** should be considered a priority for landowners. "Manual removal" is defined as control of aquatic plants by hand or using hand-held non-powered tools. Given what is known of plant distribution, this option is given a high priority. Pursuant to Chapter NR 109 of the Wisconsin Administrative Code, riparian property owners do not need to obtain a permit to hand-rake and/or hand-pull aquatic if they meet the following criteria:

Map 1
Harvesting Disposal Sites and Truck Route



Map 1, Inset 1
Fowler Lake Harvesting Disposal Site: Doug Lundy's Organic Farm

Map 1, Inset 2
Fowler Lake Harvesting Disposal Site: City Site

Map 1, Inset 3
Fowler Lake Harvesting Disposal Site: Herro Residence

- Nonnative plants such as Eurasian water milfoil, curly-leaf pondweed, and purple loosestrife may be removed if the native plant community is not harmed in the process,

- Native plants may be removed from one area measuring 30 feet or less in width along the lake's shoreline may be cleared. This area must include the riparian land owner's docks, piers, boatlifts, rafts, and areas undergoing other plant control treatment,

- Aquatic vegetation may generally be removed up to 100 feet out from the shoreline only within the 30-foot wide zone, however, the actual distance vegetation control may extend into a lake depends upon site conditions,

- Plant material that drifts onto the shoreline must be removed,

- The shoreline in question is not a designated sensitive area, and/or

- Raked and hand-pulled plant material is removed from the lake.25

  A permit *is* required if the property owner lives adjacent to a sensitive area or if another group actively engages in such work.[26] In addition, no mechanical equipment (e.g., towing equipment such as a rake behind a motorized boat or using weed rollers) may be legally used without a WDNR-issued permit. Prior to the "hand-pulling" season, an educational campaign should be actively promoted to help assure that shoreline residents appreciate the value of native plants, understand the relationship between algae and plants (i.e., more algae will grow if fewer plants remain), know the basics of plant identification, and the specifics about the actions they are allowed to legally take to "clean up" their shorelines.[27]

3. **DASH could be employed by individuals to provide relief on nuisance native and nonnative plants around piers** (low priority). If an individual landowner chooses to implement DASH, the activity is typically confined to the same width of 30 feet of shoreline and cannot extend more than 100 feet into the Lake as described above in regarding manual harvest. Any use of DASH requires a Chapter NR 109 permit.

4. **Chemical treatment could be employed by individuals to provide relief from nonnative plants around piers** (low priority). Currently, the City of Oconomowoc will not be sponsoring a chemical treatment program for access/navigation lanes. However, property owners may pursue a Chapter NR 107 permit to treat shoreline areas. When employed, a physical barrier (e.g., turbidity barrier) should be used to reduce chemical dispersal. The City of Oconomowoc and/or the Fowler Lake Management District may consider a rapid response chemical treatment for a Chapter NR 40 prohibited species (not restricted species, see Appendix A), where appropriate, if such a species (e.g., hydrilla, *Hydrilla verticillata*) were to appear in Fowler Lake in the future.

Harvesting Plan

Depth of Harvesting and Treatment of Fragments

The Aquamarine HM-420 Aquatic Plant Harvester has a maximum cutting depth of five to seven feet. While this exceeds the actual water depth of fully one-third of the impoundment, it is not the intention of the City of Oconomowoc to denude the impoundment of aquatic plants given the heavy angling use of the water body, its morphology, which is not conducive to extensive motorized boat traffic, and the program goals. All plant cuttings and fragments will be collected by the harvester on the site. Those fragments accumulating

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[25] *The manual removal area limitation for nearshore aquatic plants applies to shorelines where native plants are present. The removal area limitation does not apply to areas populated solely with nonnative and invasive plants.*

[26] *If a lake district or other group wants to remove invasive species along the shoreline, a permit is necessary under Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations," of the* Wisconsin Administrative Code*, as the removal of aquatic plants is not being completed by an individual property owner along his or her property.*

[27] *SEWRPC and WDNR staff could help review documents developed for this purpose.*

along the shore will be collected by the City or the riparian homeowners. Fragments can be used by the homeowners as garden mulch.

Harvested Plant Material Transfer Site(s)

Off-loading of harvested plant material will take place at the boating access site at St. Paul Street, as shown on Figure 4. Plant material will be removed from the harvester on a transporter and conveyed to the off-loading area, where it will be transferred to a dump truck using a conveyor and transported to disposal sites identified by the City of Oconomowoc. Plant material will be collected and disposed of daily to avoid leaching of nutrients back into the impoundment and to minimize the visual degradation of the environment near the boat launching site. The operators will stringently police the off-loading site to ensure minimal disruption of boating and of the activities of people using the riparian areas of the Lake.

Disposal of Harvested Plant Material

Harvested plant material will be combined with the City's grass clippings and land-spread at the dedicated sites shown on Map 1, Insets 1-3.

Precautions to Protect Wildlife, Fisheries, and Ecologically Valuable Areas

Operators will be provided with a laminated copy of the approved harvesting plan map as set forth in Figure 4, showing the limits of harvesting operations. A copy of this map will be kept on the harvester at all times. No harvesting will be conducted in the upper reaches of the Lake (except for the navigation channel described above) to prevent disturbance of the wetland areas, and also in those areas of three feet or less in depth to protect sport fish habitat and spawning areas. Harvesting operations in the areas identified as suitable for sport fish spawning will be restricted until June 24th to permit undisturbed spawning.

Public Information

It is the policy of the City of Oconomowoc to maintain an active dialogue with the community. This dialogue is carried out through the public press and through various City Committees, public meetings, and other scheduled hearings. In addition, the Fowler Lake Management District holds regular public meetings. Where necessary, personal contacts should be made with homeowners.

Harvesting Schedule

The harvesting season will begin no earlier than May 15 and will end no later than September 15 of each year. Harvesting will average 30 to 35 hours per week over a five-day week, depending on weather conditions and plant growth, to minimize recreational conflicts. In addition, harvesting will be confined to daylight hours to minimize public disturbances resulting from harvester and plant removal operations. As described above, harvesting operations will also be modified to protect fish spawning areas and other ecologically valuable areas of the Lake as set forth in Figure 4.

EQUIPMENT NEEDS AND OPERATION

Equipment Needs and Total Costs

The City currently owns and operates an Aquamarine model HM-420S harvester,[28] MSC-23 Pier Conveyor, and T-12 Transport Barge. This equipment was purchased in 2004 and the City is looking to replace it in 2019, if grant funding is available. The specifications for this harvesting operation equipment and cost estimates for replacement are included in Appendix B.[29]

Maintenance Schedule, Storage, and Related Costs

Routine maintenance will be performed by the City of Oconomowoc in accordance with the manufacturer's recommended maintenance schedule. Maintenance costs will be borne by the City of Oconomowoc.

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[28] *The "S" denotes the modifications made by Aquarius Systems Inc., North Prairie, Wisconsin, to the aquatic plant harvester in 2007 to permit the machine to pass underneath the N. Oakwood Avenue bridge; the superstructure of the harvester is able to be folded down to reduce the height of the machine. Personal Communication, Mark Frye, Director of Public Works, City of Oconomowoc.*

[29] *Note that the pricing listed for this equipment in Appendix B was valid through March 31, 2017.*

Winter storage of the harvesting equipment will be the responsibility of the City of Oconomowoc. The harvester will be stored at the municipal garage.

Insurance Coverage

Insurance coverage on the harvester will be incorporated into the policy held by the City of Oconomowoc on all capital equipment. Liability insurance for the operation of the harvester will also be borne by the City. The relevant certificates of insurance will be held by the City of Oconomowoc.

Operators, Training and Supervision

The harvester will be owned and operated by the City of Oconomowoc, which will be responsible for day-to-day operation of the equipment. The City will provide operator training as required. The City staff has extensive experience in the operation of this type of machinery. Initial training would be provided by Aquamarine on delivery of the machinery.

Day-to-day supervision will be by the City staff, with oversight by the Director of Public Works.

EVALUATION AND MONITORING

Daily Record-Keeping Relating to the Harvesting Operation

Daily harvesting activities will be recorded by the operator in a harvester operations log. An annual summary of the harvesting program will be submitted to the City of Oconomowoc Common Council, or a designated Committee thereof, and made available to the public at that time. The summary will also be published at the annual meeting of the Fowler Lake Management District.

It is the intention of the City of Oconomowoc to undertake a periodic, formal review of the harvesting program as set forth in the Management Plan for Fowler Lake, a copy of which has been provided to the Wisconsin Department of Natural Resources Southeast District Office.

Daily Record-Keeping Relating to the Harvester

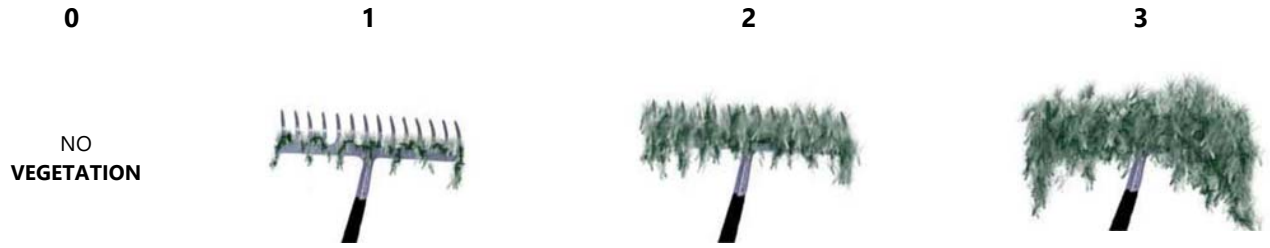
Daily maintenance and service records showing engine hours, fuel consumed and oil used, will be recorded in the harvester operations log.

The amount of plant material harvested yearly is set forth in Table 4.

FOWLER LAKE AQUATIC PLANT SPECIES DETAILS

APPENDIX A

Figure A.1
Rake Fullness Ratings



Source: Wisconsin Department of Natural Resources and SEWRPC

SOURCES OF INFORMATION:

Borman, S., Korth, R., & Temte, J. (2014). *Through the Looking Glass: A Field Guide to Aquatic Plants, Second Edition*. Stevens Point, WI, USA: Wisconsin Lakes Partnership.

Robert W. Freckman Herbarium: *wisplants.uwsp.edu*

Skawinski, P. M. (2014). *Aquatic Plants of the Upper Midwest: A Photographic Field Guide to Our Underwater Forests, Second Edition*. Wausau, Wisconsin, USA: Self-Published.

University of Michigan Herbarium: *www.michiganflora.net/home.aspx*

UW-System WisFlora 2016: *wisflora.herbarium.wisc.edu/index.php*

Ceratophyllum demersum — Coontail

Native

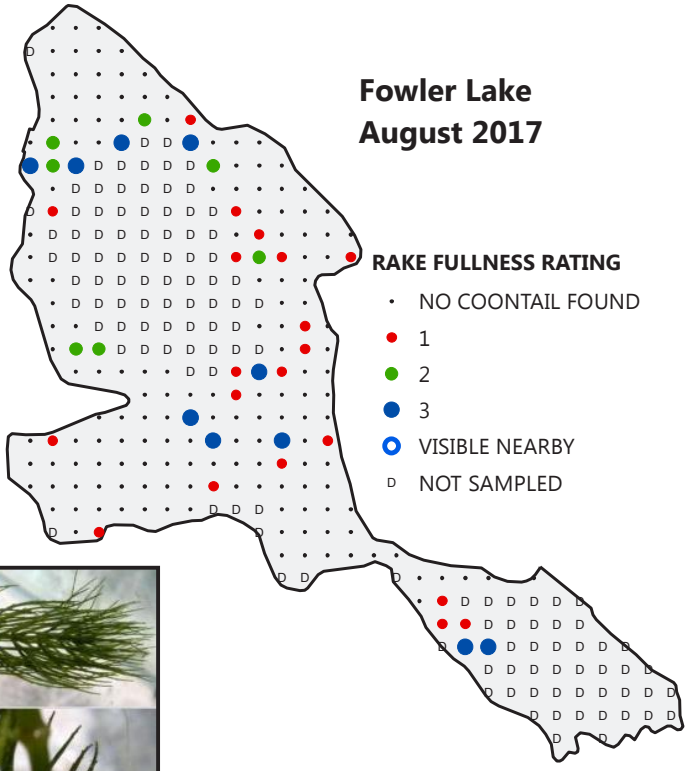
Identifying Features

- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

Coontail is similar to spiny hornwort (*C. echinatum*) and muskgrass (*Chara* spp.), but spiny hornwort has some leaves with three to four orders of branching, and coontail does not produce the distinct garlic-like odor of muskgrass when crushed

Ecology

- Common in lakes and streams, both shallow and deep
- Tolerates poor water quality (high nutrients, chemical pollutants) and disturbed conditions
- Stores energy as oils, which can produce slicks on the water surface when plants decay
- Anchors to the substrate with pale, modified leaves rather than roots
- Eaten by waterfowl, turtles, carp, and muskrat

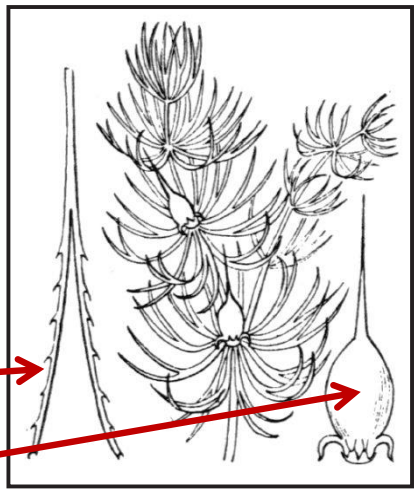


Second-Order Leaf Branching

First-Order Leaf Branching

Toothed Leaf Margins

Fruit (rare)



Chara spp.

Native

Muskgrasses

Algae (not vascular plants)

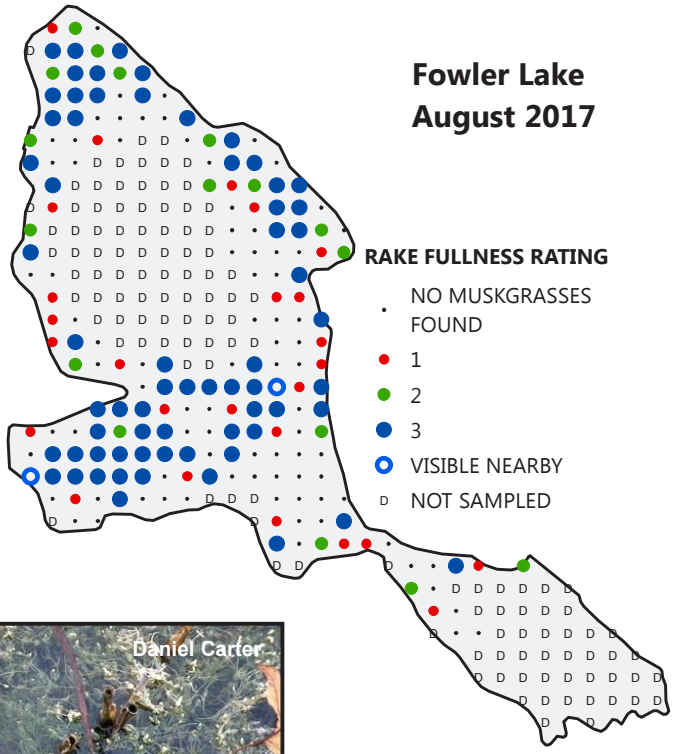
Identifying Features

- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo on left, below)
- Yellow reproductive structures develop along the whorled branches in summer
- Emits a garlic-like odor when crushed

Stoneworts (*Nitella* spp.) are similar large algae, but their branches are smooth rather than ridged and more delicate

Ecology

- Found in shallow or deep water over marl or silt, often growing in large colonies in hard water
- Overwinters as rhizoids (cells modified to act as roots) or fragments
- Stabilizes bottom sediments, often among the first species to colonize open areas
- Food for waterfowl and excellent habitat for small fish



Elodea canadensis — Common Waterweed

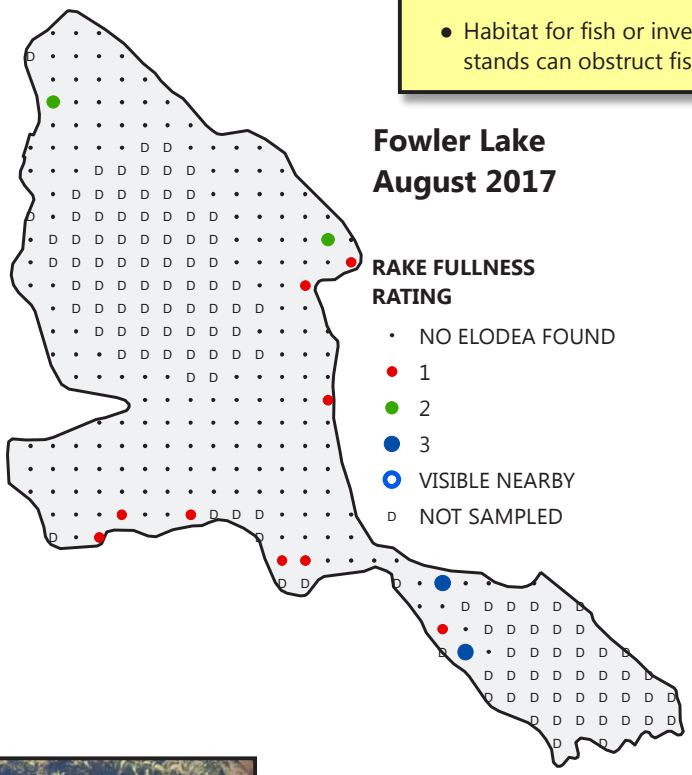
Native

Identifying Features

- Slender stems, occasionally rooting
- Leaves lance-shaped, in whorls of three (rarely two or four), 6.0 to 17 mm long and averaging 2.0 mm wide
- When present, tiny male and female flowers on separate plants (females more common), raised to the surface on thread-like stalks

Ecology

- Found in lakes and streams over soft substrates tolerating pollution, eutrophication and disturbed conditions
- Often overwinters under the ice
- Produces seeds only rarely, spreading primarily via stem fragments
- Provides food for muskrat and waterfowl
- Habitat for fish or invertebrates, although dense stands can obstruct fish movement



Heteranthera dubia — Water Stargrass

Native

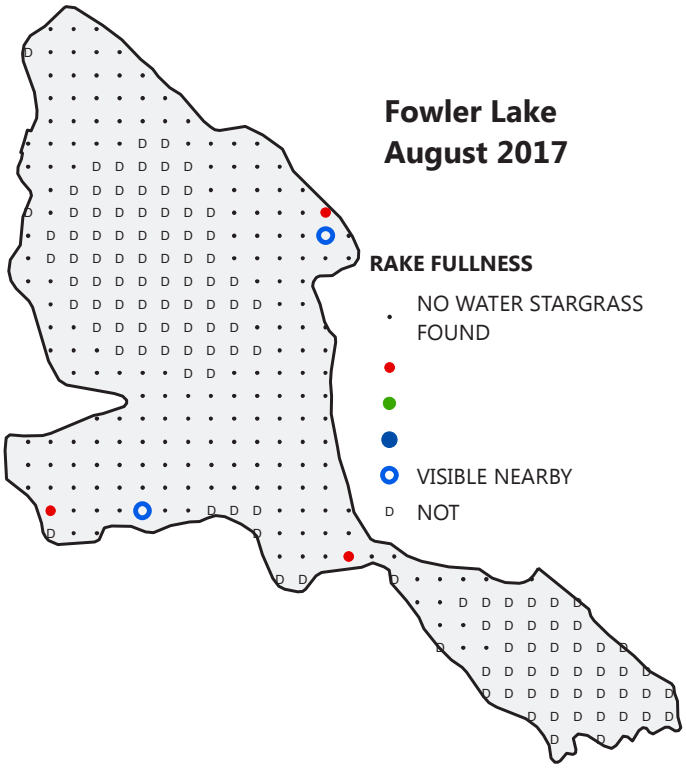
Identifying Features

- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

Yellow stargrass may be confused with pondweeds that have narrow leaves, but it is easily distinguished by its lack of a prominent midvein and, when present, yellow blossoms

Ecology

- Found in lakes and streams, shallow and deep
- Tolerates somewhat turbid waters
- Overwinters as perennial rhizomes
- Limited reproduction by seed
- Provides food for waterfowl and habitat for fish



Lythrum salicaria — Purple Loosestrife

Nonnative/Exotic

Identifying Features

- Terrestrial or semi-aquatic, emergent forb
- Stems often angled with four, five, or more sides, and growing one to two m tall
- Flowers deep pink or purple, six-parted, 12 to 25 mm wide, and in groups
- Leaves lance-like, four to 11 cm long and either opposite or in whorls of three

Purple loosestrife, if small, is similar to winged loosestrife (*Lythrum alatum*), but winged loosestrife differs in having leaves generally smaller (<5.0 cm long), leaves mostly alternate (only lower leaves opposite), and flowers mostly held singly in the leaf axils rather than in pairs or groups

Ecology/Control

- Found in shallows, along shores, and in wet to moist meadows and prairies
- Invasive and continues to escape from ornamental plantings
- Galerucella beetles have been successfully used to control purple loosestrife. Plants may also be dug or pulled when small, but they subsequently should be placed in a landfill or burned. Several herbicides are effective, but application near water may require permits and aquatic-use formulas

Myriophyllum sibiricum — Northern Water Milfoil

Native

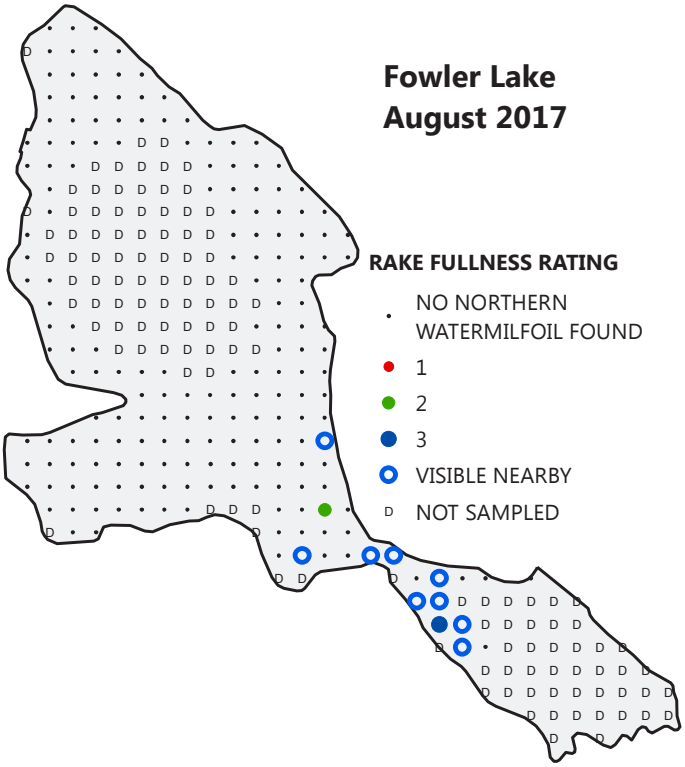
Identifying Features

- Light-colored, stout stems
- Leaves in whorls of four to five, divided into four to 12 pairs of leaflets, lower leaflets longer than the upper ones
- Forms winter buds (turions) in autumn

Northern water milfoil is similar to other water milfoils. Eurasian water milfoil (*M. spicatum*) tends to produce more leaflets per leaf and have more delicate, pinkish stems

Ecology

- Found in lakes and streams, shallow and deep
- Overwinters as winter buds and/or hardy rootstalks
- Consumed by waterfowl
- Habitat for fish and aquatic invertebrates
- Hybridizes with Eurasian water milfoil, resulting in plants with intermediate characteristics



Myriophyllum spicatum — Eurasian Water Milfoil

Nonnative/Exotic

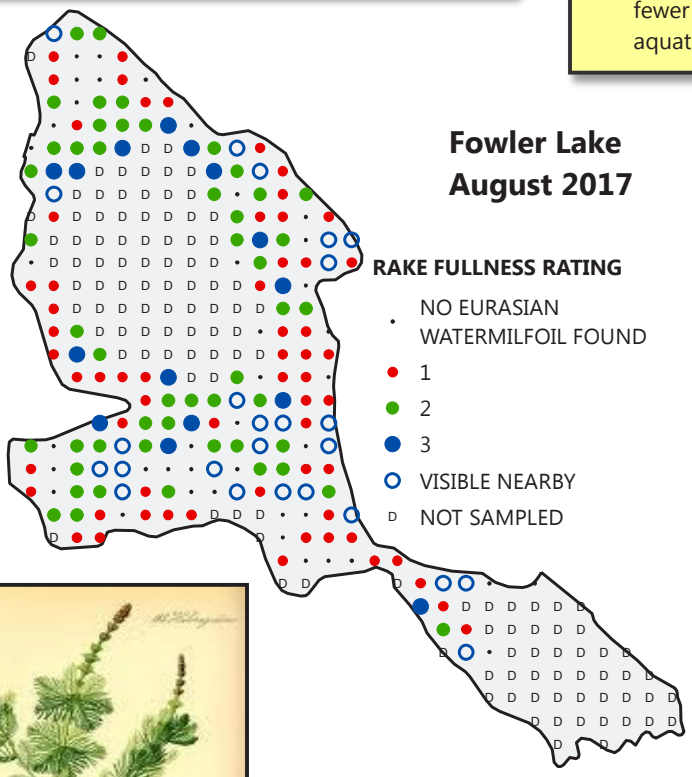
Identifying Features

- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

Eurasian water milfoil is similar to northern water milfoil (*M. sibiricum*). However, northern water milfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

Ecology

- Hybridizes with northern (native) water milfoil, resulting in plants with intermediate characteristics
- Invasive, growing quickly, forming canopies, and getting a head-start in spring due to an ability to grow in cool water
- Grows from root stalks and stem fragments in both lakes and streams, shallow and deep; tolerates disturbed conditions
- Provides some forage to waterfowl, but supports fewer aquatic invertebrates than mixed stands of aquatic vegetation



Najas flexilis — Bushy Pondweed or Slender Naiad

Native

Identifying Features

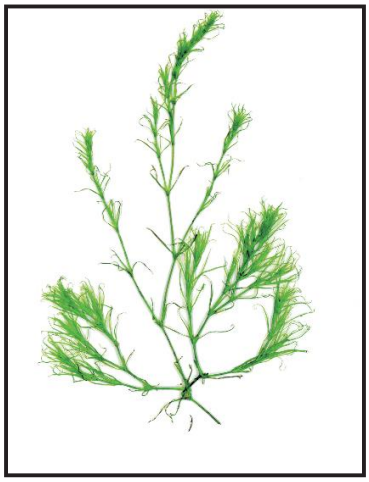
- Leaves narrow (0.4 to 1.0 mm) and pointed with broader bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Variable size and spacing of leaves, as well as compactness of plant, depending on growing conditions

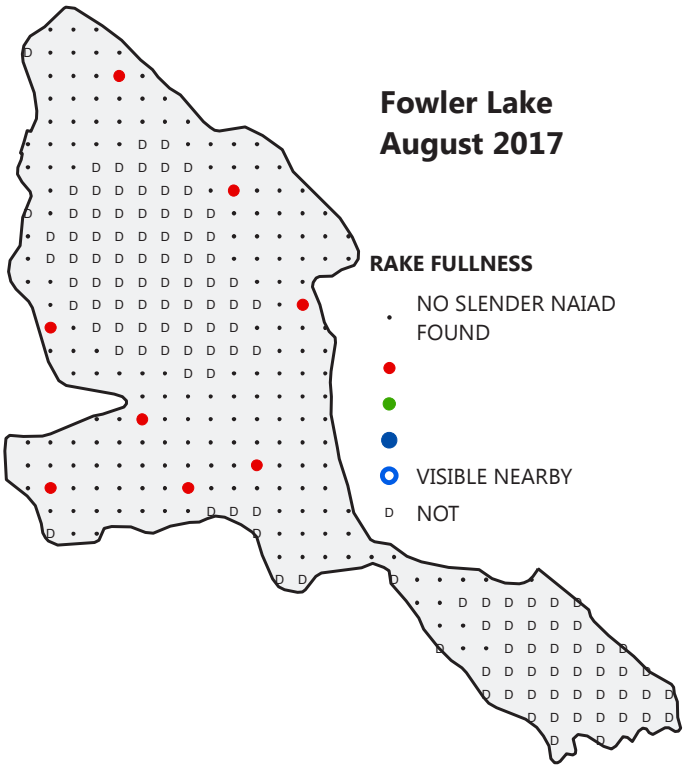
Two other *Najas* occur in southeastern Wisconsin. Southern naiad (*N. guadalupensis*) has wider leaves (to 2.0 mm). Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

Ecology

- In lakes and streams, shallow and deep, often in association with wild celery
- *One of the most important forages of waterfowl*
- An annual plant that completely dies back in fall and regenerates from seeds each spring; also spreading by stem fragments during the growing season

Leaves narrow with serrated edges





Najas guadalupensis — Southern Naiad

Native

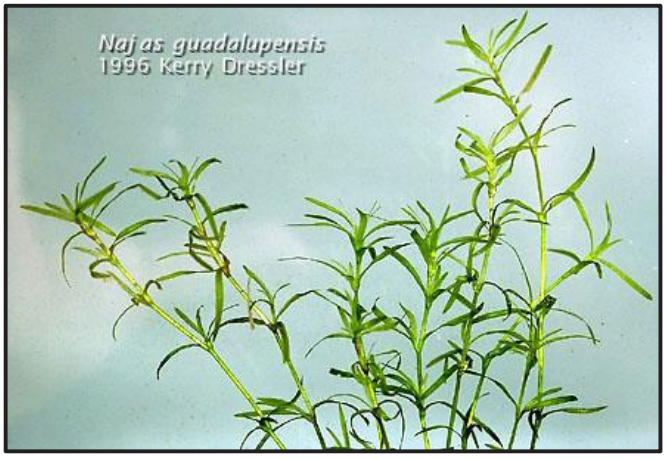
Identifying Features

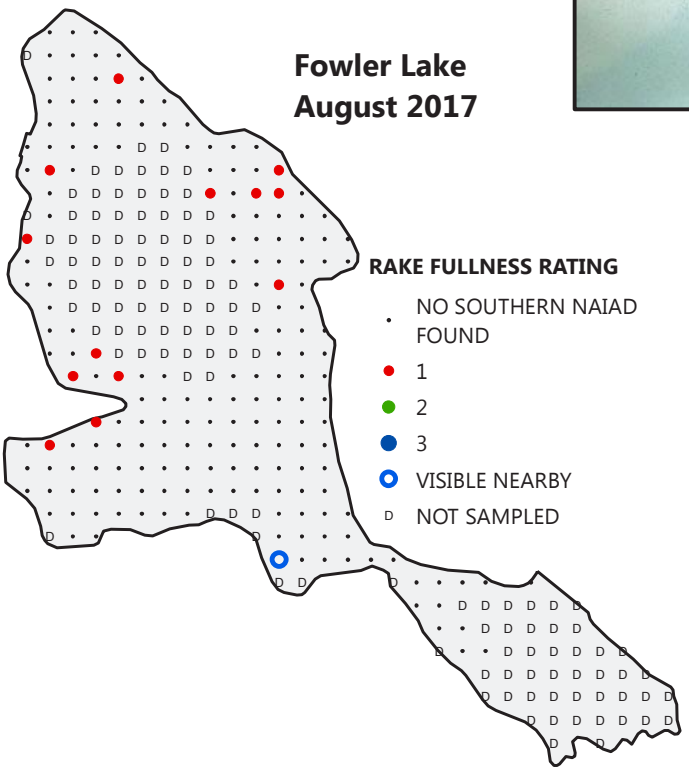
- Leaves 0.2 to 2.0 mm wide and blunt with slight shoulder bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Leaves opposite and may appear loosely whorled

Two other *Najas* occur in southeastern Wisconsin. Slender naiad (*N. flexilis*) has narrower leaves (to 0.6 mm) with a pointed tip. Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

Ecology

- In shallow to deep lakes and sandy, gravelly soil
- An annual plant that completely dies back in fall and regenerates from seeds each spring; also spreading by stem fragments during the growing season





Najas marina — Spiny Naiad

Nonnative/Exotic

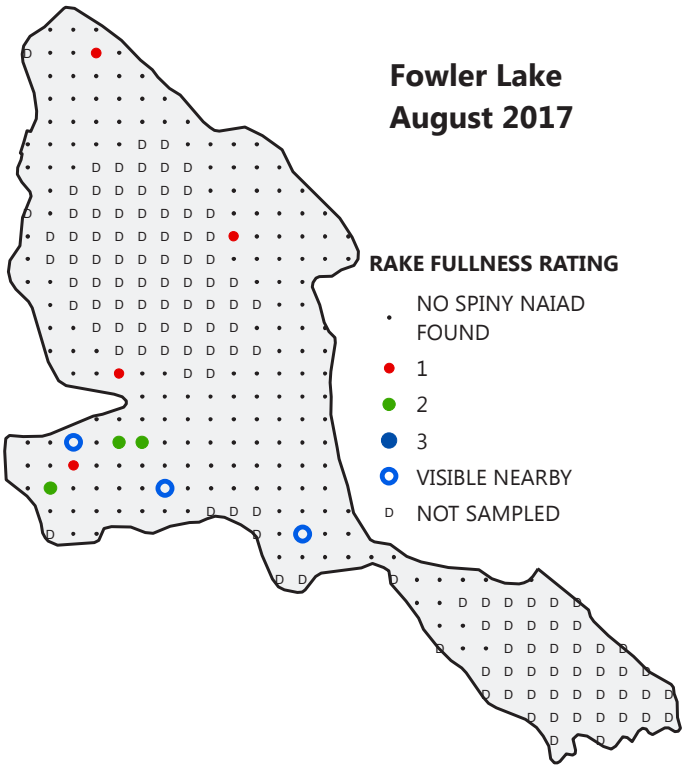
Identifying Features

- Stems stiff and spiny, often branching many times
- Leaves stiff, 1.0 to 4.0 mm thick, with coarse teeth along the margins and midvein on the underside

Spiny naiad is quite distinct from other naiads due to its larger, coarsely toothed leaves and the irregularly pitted surface of its fruits. Spiny naiad is presumably introduced in Wisconsin, but it is considered native in other states, including Minnesota

Ecology

- Alkaline lakes, water quality ranging from good to poor
- An annual, regenerating from seed each year
- Occurs as separate male and female plants
- Capable of growing aggressively



Nuphar variegata — Spatterdock

Native

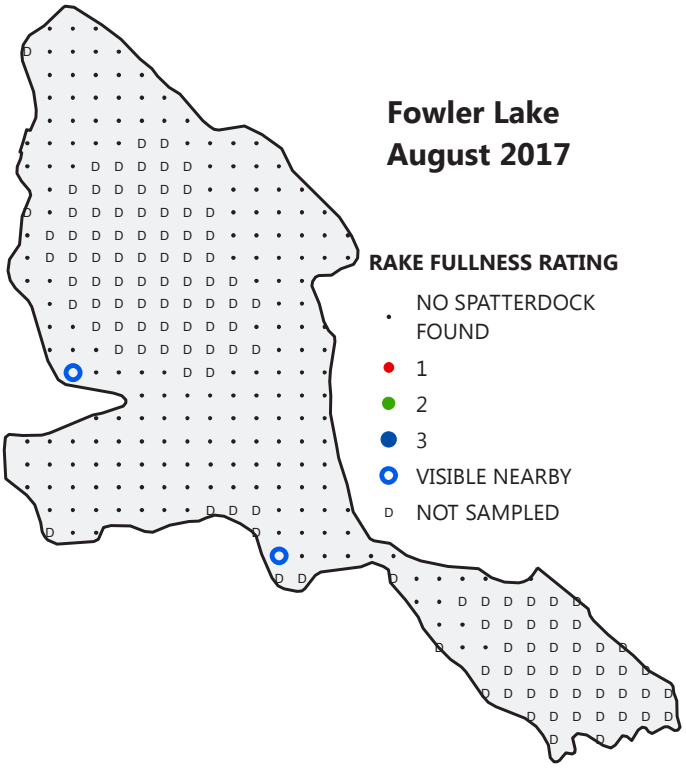
Identifying Features

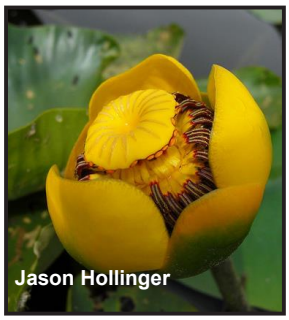
- Leaf stalks winged in cross-section
- Most leaves floating on the water surface, heart-shaped, and notched, with rounded lobes at the base
- Yellow flowers, 2.5 to 5.0 cm wide, often with maroon patches at the bases of the sepals (petal-like structures) when viewed from above

Unlike spatterdock, the similar yellow pond lily (*Nuphar advena*) has leaf stalks that are not winged in cross-section, leaves that more often emerge above the water surface, and leaf lobes that are more pointed. Spatterdock is superficially similar to water lilies (*Nymphea* spp.), but it has yellow versus white flowers and leaves somewhat heart-shaped versus round. American lotus (*Nelumbo lutea*) is also similar, but its leaves are round and un-notched, and its flowers are much larger

Ecology

- In sun or shade and mucky sediments in shallows and along the margins of ponds, lakes, and slow-moving streams
- Overwinters as a perennial rhizome
- Flowers opening during the day, closing at night, and with the odor of fermented fruit
- Buffers shorelines
- Provides food for waterfowl (seeds), deer (leaves and flowers), and muskrat, beaver, and porcupine (rhizomes)
- Habitat for fish and aquatic invertebrates





Nymphaea odorata — White Water Lily

Native

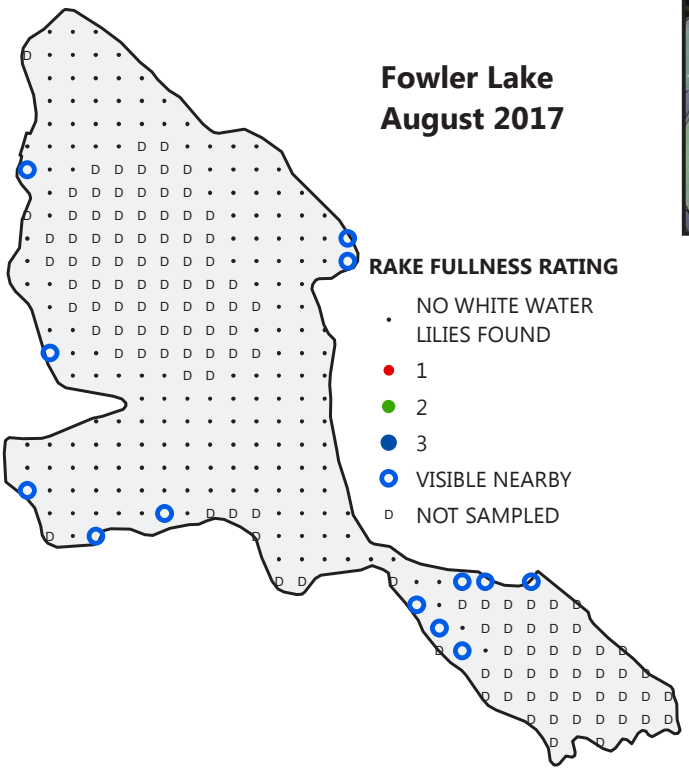
Identifying Features

- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are *unnotched*

Ecology

- Found in shallow waters over soft sediments
- Leaves and flowers emerge from rhizomes
- Flowers opening during the day, closing at night
- Seeds consumed by waterfowl, rhizomes consumed by mammals



Potamogeton amplifolious — Large-Leaf Pondweed

Native

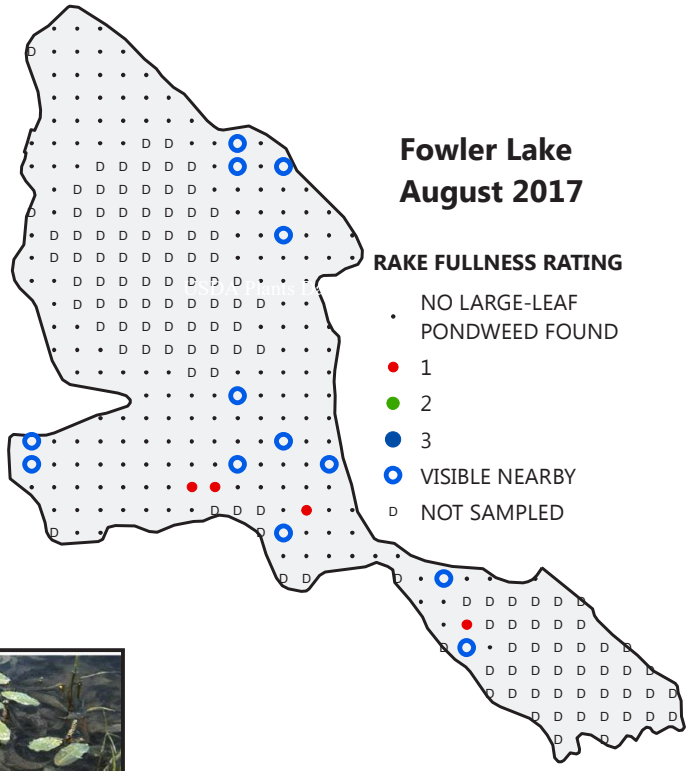
Identifying Features

- When produced, floating leaves 2-23 cm long *with 27-49 veins* and petiole longer than leaf blade
- Submersed leaves large and sickle-shaped, 4-7 cm wide, 8-20 cm long, *with more than 19 veins*, and folded upwards along the sides
- White stipules up to 12 cm long

Large-leaf pondweed may be distinguished from Illinois pondweed (*P. illinoensis*) by the greater number of veins on submersed and floating leaves.

Ecology

- Soft substrate, shallow and deep lakes
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Provides habitat and/or food for fish, muskrat, waterfowl, and insects



Potamogeton crispus — Curly-Leaf Pondweed

Nonnative/Exotic

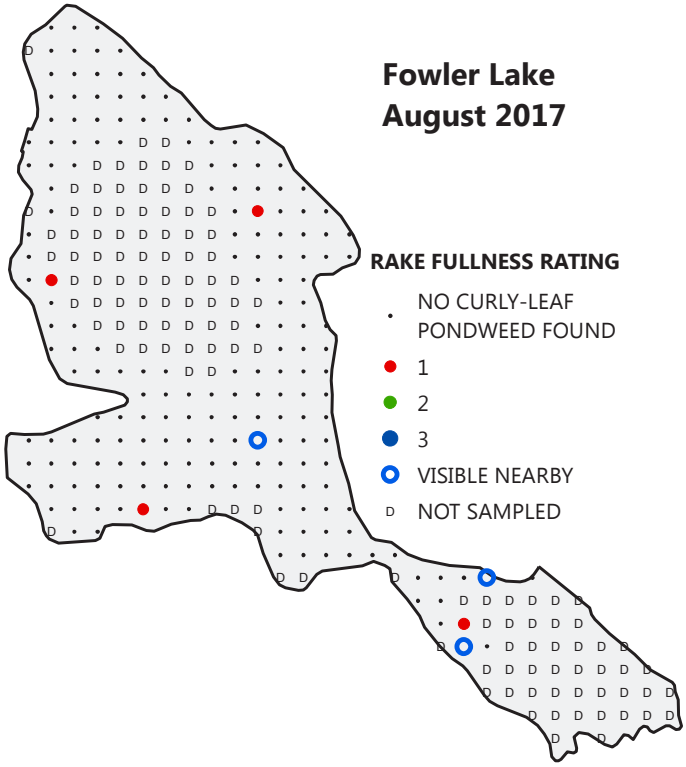
Identifying Features

- Stems slightly flattened and both stem and leaf veins often somewhat pink
- Leaf margins very wavy and finely serrated
- Stipules (3.0 to 8.0 mm long) partially attached to leaf bases, disintegrating early in the season
- Produces pine cone-like overwintering buds (turions)

Curly-leaf pondweed may resemble clasping-leaf pondweed (*P. richardsonii*), but the leaf margins of the latter are not serrated

Ecology

- Found in lakes and streams, both shallow and deep
- Tolerant of low light and turbidity
- Disperses mainly by turions
- Adapted to cold water, growing under the ice while other plants are dormant, but dying back during mid-summer in warm waters
- Produces winter habitat, but mid-summer die-offs can degrade water quality and cause algal blooms
- Maintaining or improving water quality can help control this species, because it has a competitive advantage over native species when water clarity is poor



Potamogeton gramineus — Variable Pondweed

Native

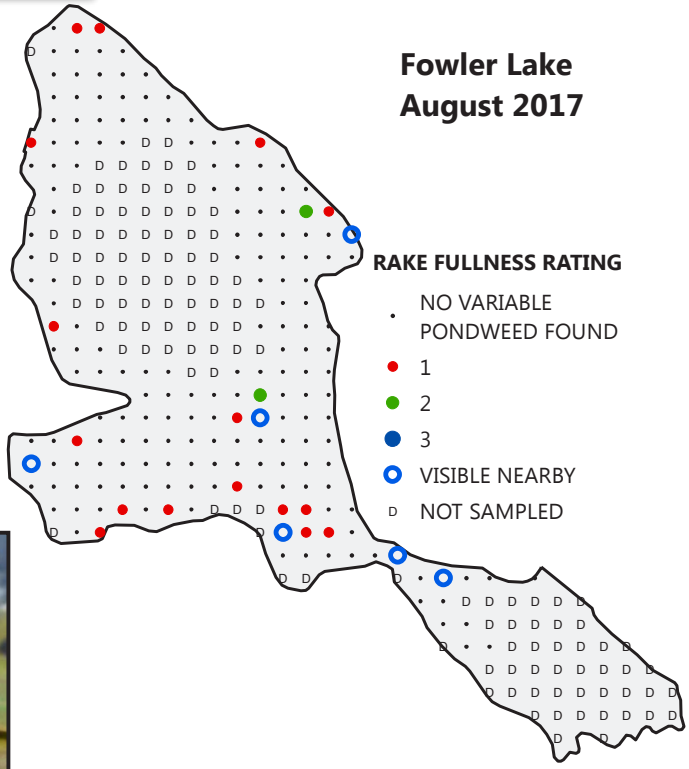
Identifying Features

- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- Floating leaves with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard water

Variable pondweed is similar to Illinois pondweed (*P. illinoensis*), but Illinois pondweed has submerged leaves with nine to 19 veins

Ecology

- Shallow to deep water, often with muskgrass, wild celery, and/or slender naiad; requires more natural areas that receive little disturbance
- Overwinters as rhizomes or winter buds (turions)
- Provides food for waterfowl, muskrat, deer, and beaver
- Provides habitat for fish and aquatic invertebrates



Potamogeton illinoensis — Illinois Pondweed

Native

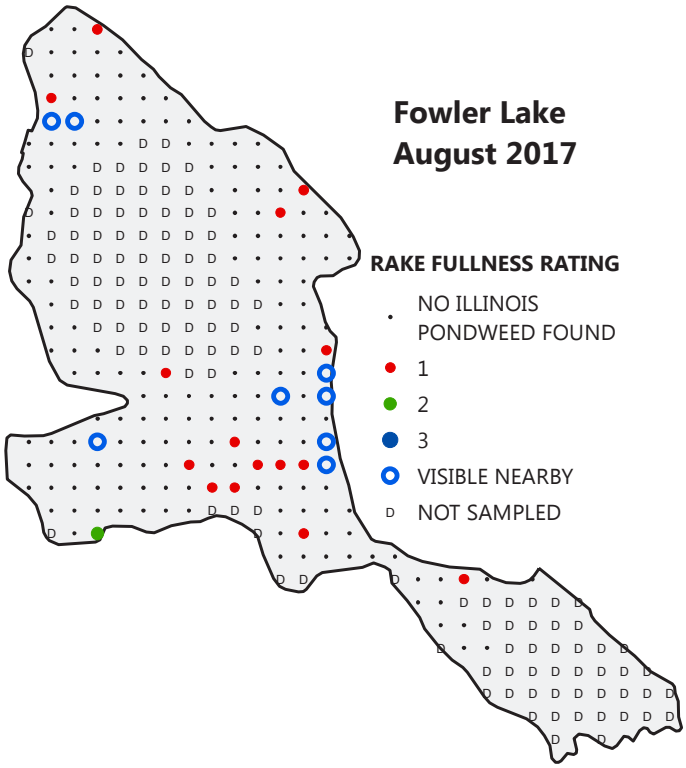
Identifying Features

- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

Variable pondweed (*P. gramineus*) is similar to Illinois pondweed, but differs in having three to seven veins on submerged leaves

Ecology

- Lakes with clear water, shallow or deep, neutral or hard, over soft sediments
- Overwinters as rhizomes or remains green under the ice
- Provides food for waterfowl, muskrat, deer, and beaver
- Provides excellent habitat for fish and aquatic invertebrates



Potamogeton natans — Floating-Leaf Pondweed

Native

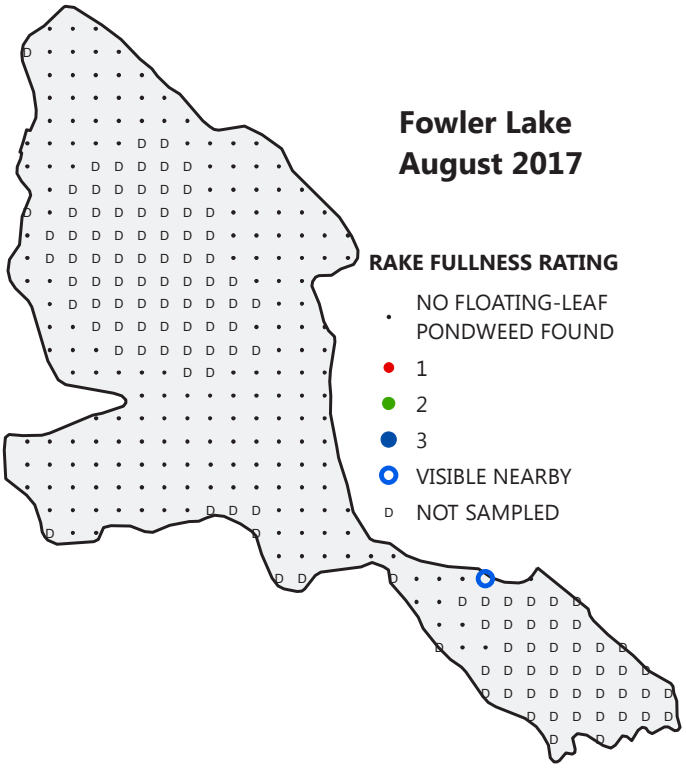
Identifying Features

- Floating leaves (5.0 to 10 cm long) with heart-shaped bases and 17 to 37 veins
- Floating leaf stalks bent where they meet the leaf, causing the leaf to be held at roughly a 90-degree angle to the stalk
- Submersed leaves (1.0 to 2.0 mm wide) linear and stalk-like, with three to five veins

Floating-leaf pondweed is similar to Oakes' pondweed (*P. oakesianus*) and spotted pondweed (*P. pulcher*). Oake's pondweed is smaller, with floating leaves 2.5 to 6.0 cm long and submersed leaves 0.25 to 1.0 mm wide. Spotted pondweed differs in having small black spots on its stems and leaf stalks and lance-shaped submersed leaves with wavy margins

Ecology

- Usually in shallow waters (<2.5 m) over soft sediment
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Holds fruit on stalks until late in the growing season, which provides valuable feeding opportunities for waterfowl
- Provides good fish habitat



Potamogeton richardsonii — Clasping-Leaf Pondweed

Native

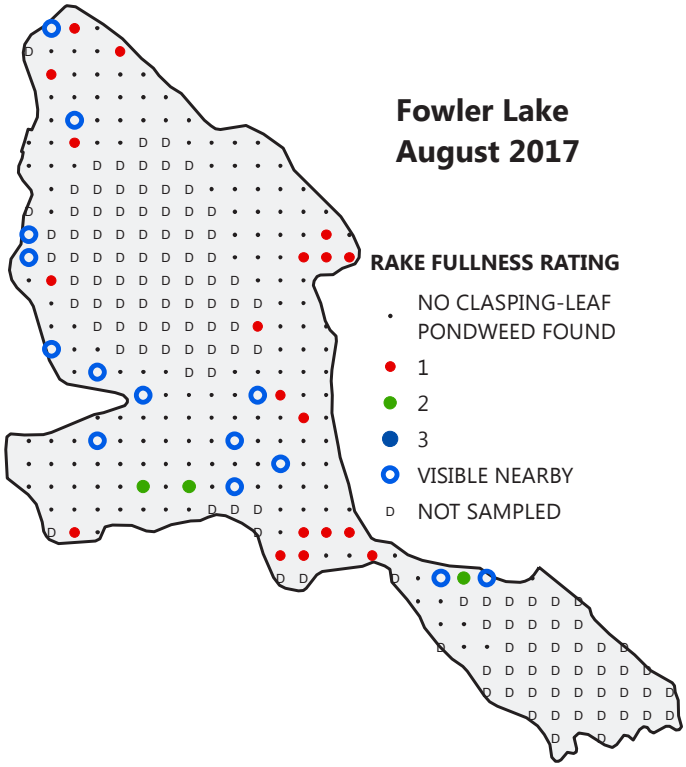
Identifying Features

- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

Clasping pondweed is similar to white-stem pondweed (*P. praelongus*), but the latter has boat-shaped leaf tips that split when pressed between one's fingers. The exotic curly-leaf pondweed (*P. crispus*) may appear similar, but differs by having serrated leaf margins

Ecology

- In lakes and streams, shallow and deep, often in association with coontail
- Tolerant of disturbance
- Fruits a food source for waterfowl and plants browsed by muskrat, beaver, and deer
- Stems emerging from perennial rhizomes



Potamogeton zosteriformis — Flat-Stem Pondweed

Native

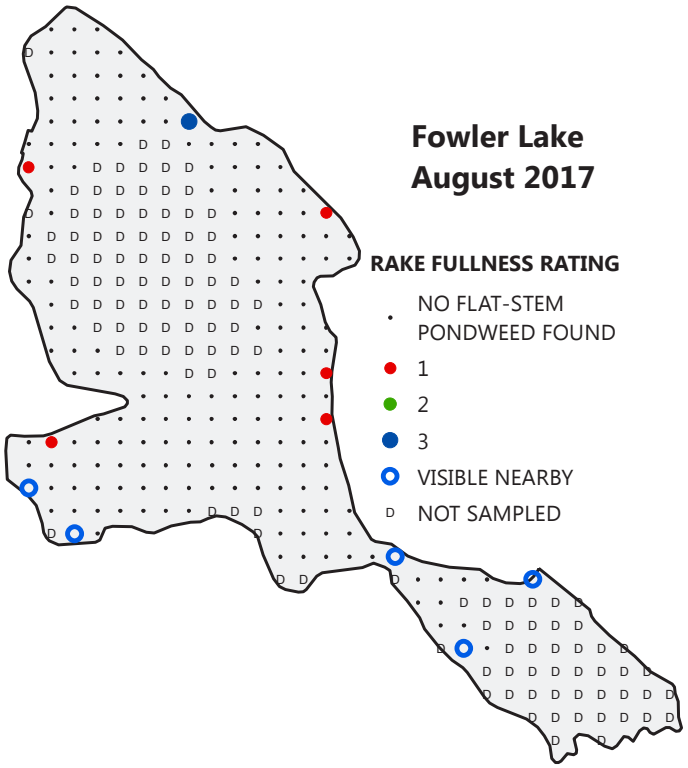
Identifying Features

- Stems strongly flattened
- Leaves up to four to eight inches long, pointed, with a prominent midvein and many finer, parallel veins
- Stiff winter buds consisting of tightly packed ascending leaves

Flat-stem pondweed may be confused with yellow stargrass (*Zosterella dubia*), but the leaves of yellow stargrass lack a prominent midvein.

Ecology

- Found at a variety of depths over soft sediment in lakes and streams
- Overwinters as rhizomes and winter buds
- Has antimicrobial properties
- Provides food for waterfowl, muskrat, beaver, and deer
- Provides cover for fish and aquatic invertebrates



Stuckenia pectinata — Sago Pondweed

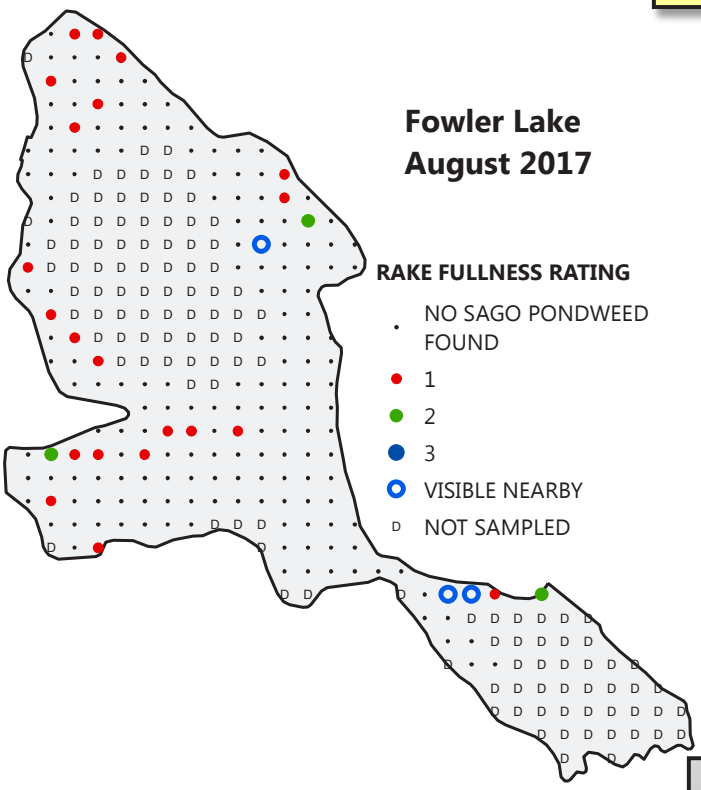
Native

Identifying Features

- Stems often *slightly zig-zagged* and forked multiple times, yielding a fan-like form
- Leaves one to four inches long, very thin, and ending in a sharp point
- Whorls of fruits spaced along the stem may appear as beads on a string

Ecology

- Lakes and streams
- Overwinters as rhizomes and starchy tubers
- Tolerates murky water and disturbed conditions
- Provides abundant fruits and tubers, which are an *important food for waterfowl*
- Provides habitat for juvenile fish



Utricularia vulgaris — Common Bladderwort

Native

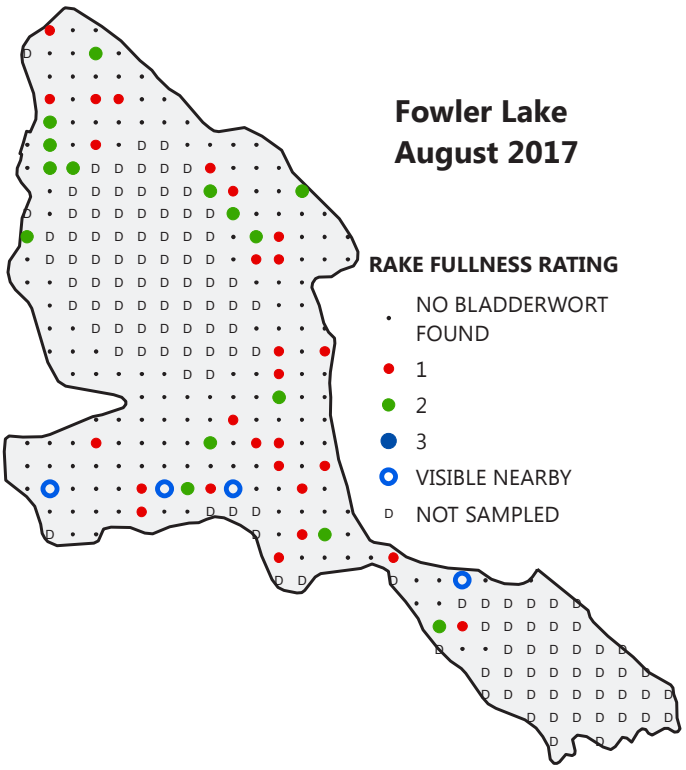
Identifying Features

- Flowers snapdragon-like, yellow, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems either floating (due to air bladders) or anchored in the substrate; branches finely divided, if floating

Several similar bladderworts occur in southeastern Wisconsin

Ecology

- Most species found in quiet shallows and along shores, but common bladderwort (*Utricularia vulgaris*) sometimes occurring in water several feet deep
- Provides forage and cover for a wide range of aquatic organisms
- Bladders capture and digest prey, including small invertebrates and protozoans



Vallisneria americana — Water Celery/Eelgrass

Native

Identifying Features

- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

The foliage of water celery could be confused with the submersed leaves of bur-reeds (*Sparganium* spp.) or arrowheads (*Sagittaria* spp.), but the leaves of water celery are distinguished by their prominent middle stripe. The leaves of ribbon-leaf pondweed (*Potamogeton epihydrus*) are also similar to those of eelgrass, but the leaves of the former are alternately arranged along a stem rather than arising from the plant base

Ecology

- Firm substrates, shallow or deep, in lakes and streams
- Spreads by seed, by creeping rhizomes, and by offsets that break off and float to new locations in the fall
- All portions of the plant consumed by waterfowl; an especially important food source for Canvasback ducks
- Provides habitat for invertebrates and fish

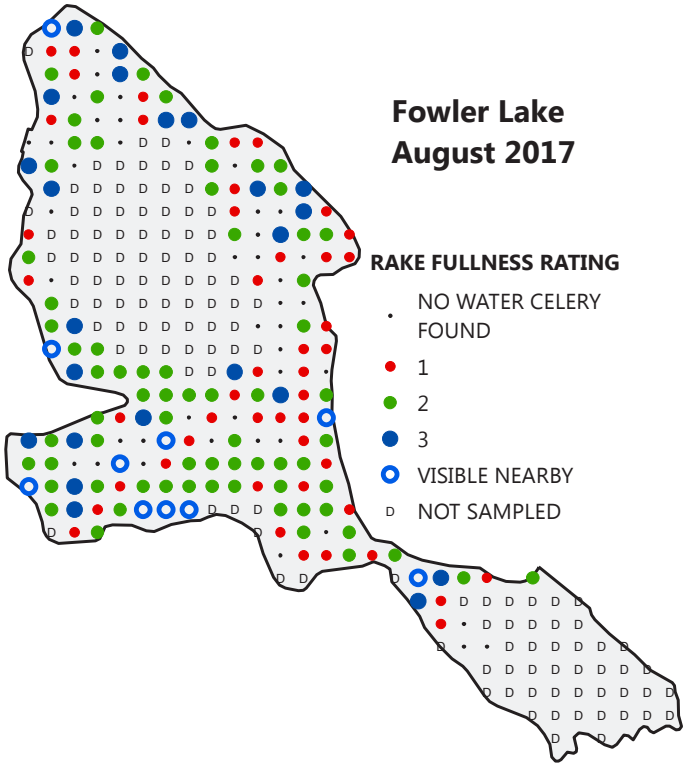


Table A.1
Fowler Lake Point Intercept Aquatic Plant Survey Data: August 22-24, 2017

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* ,Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum*, Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
2	1	43.108895	-88.489222				White Water Lilies and Spadderdock																									
3	2	43.108884	-88.488362				White Water Lilies and Spadderdock																									
4	3	43.109216	-88.489644				Point on Land																									
5	4	43.109210	-88.489214				White Water Lilies and Spadderdock																									
6	5	43.109205	-88.488784				White Water Lilies and Spadderdock																									
7	6	43.109199	-88.488354				White Water Lilies and Spadderdock																									
8	7	43.109193	-88.487924				Point on Land																									
9	8	43.109188	-88.487494				Point on Land																									
10	9	43.109182	-88.487064				Point on Land																									
11	10	43.109542	-88.490496				Point on Land																									
12	11	43.109537	-88.490066				White Water Lilies and Spadderdock																									
13	12	43.109531	-88.489636				White Water Lilies and Spadderdock																									
14	13	43.109525	-88.489206				White Water Lilies and Spadderdock																									
15	14	43.109520	-88.488776				White Water Lilies and Spadderdock																									
16	15	43.109514	-88.488346				White Water Lilies and Spadderdock																									
17	16	43.109508	-88.487916				White Water Lilies and Spadderdock																									
18	17	43.109503	-88.487486				White Water Lilies and Spadderdock																									
19	18	43.109497	-88.487056				White Water Lilies and Spadderdock																									
20	19	43.109857	-88.490488				White Water Lilies and Spadderdock																									
21	20	43.109852	-88.490058				White Water Lilies and Spadderdock																									
22	21	43.109846	-88.489628				White Water Lilies and Spadderdock																									
23	22	43.109840	-88.489198				White Water Lilies and Spadderdock																									
24	23	43.109835	-88.488768				White Water Lilies and Spadderdock																									
25	24	43.109829	-88.488338				White Water Lilies and Spadderdock																									
26	25	43.109823	-88.487908				White Water Lilies and Spadderdock																									
27	26	43.109818	-88.487478				White Water Lilies and Spadderdock																									
28	27	43.110184	-88.491341				Point on Land																									
29	28	43.110178	-88.490911	3	M			3	v	V	3		3		v					v	v					v						
30	29	43.110172	-88.490481	5	M			3			3																					
31	30	43.110167	-88.490051				White Water Lilies and Spadderdock																									
32	31	43.110161	-88.489621				White Water Lilies and Spadderdock																									
33	32	43.110155	-88.489191				White Water Lilies and Spadderdock																									
34	33	43.110150	-88.488761				White Water Lilies and Spadderdock																									
35	34	43.110144	-88.488331				White Water Lilies and Spadderdock																									
36	35	43.110138	-88.487901				White Water Lilies and Spadderdock																									
37	36	43.110499	-88.491333	3	M			3	2		1	1	1		3					v								2	1			
38	37	43.110493	-88.490903	5	M			1	1	1	1				v						1							1				
39	38	43.110488	-88.490473				White Water Lilies and Spadderdock																									
40	39	43.110482	-88.490043				White Water Lilies and Spadderdock																									
41	40	43.110476	-88.489613				White Water Lilies and Spadderdock																									
42	41	43.110470	-88.489183				White Water Lilies and Spadderdock																									
43	42	43.110465	-88.488753				White Water Lilies and Spadderdock																									
44	43	43.110820	-88.491755	5	R			3	3			2			v					v									3			
45	44	43.110814	-88.491325	5	M			1	1		1				v														1			
46	45	43.110808	-88.490895				White Water Lilies and Spadderdock																									
47	46	43.110803	-88.490465				White Water Lilies and Spadderdock																									
48	47	43.110797	-88.490035				White Water Lilies and Spadderdock																									

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
49	48	43.110791	-88.489605				White Water Lilies and Spadderdock																									
50	49	43.110786	-88.489175				White Water Lilies and Spadderdock																									
51	50	43.110780	-88.488745				White Water Lilies and Spadderdock																									
52	51	43.111169	-88.494328				Point on Land																									
53	52	43.111163	-88.493898				Point on Land																									
54	53	43.111140	-88.492178				Point on Land																									
55	54	43.111135	-88.491748	5	M			1	1																				V			
56	55	43.111129	-88.491317	3	M			3	v				3		v						v	v			v		v		3			
57	56	43.111123	-88.490887	3	M			3	v			3								v			1		2		v	v	2			
58	57	43.111118	-88.490457	3	M			1		v		1								v				v	V		1		1			
59	58	43.111106	-88.489597	3	M			2				2								V						v	2		2			
60	59	43.111484	-88.494320	4	M			3	1			3	1				v		v						1			1				
61	60	43.111478	-88.493890	5	M			1					1		v										1				1			
62	61	43.111472	-88.493460	5	M			2				2																	1			
63	62	43.111467	-88.493030	4	M			2				1		1															2			
64	63	43.111461	-88.492600	4	R			1	1			1			v										1				1			
65	64	43.111455	-88.492170	5	M			2	1						v							v				v		1	2			
66	65	43.111855	-88.498613				Point on Land																									
67	66	43.111850	-88.498183	4	R			1	1																1	v			1			
68	67	43.111844	-88.497753	3	R			2	1		1		1							V		1	2				1		2			
69	68	43.111804	-88.494742				Point on Land																									
70	69	43.111799	-88.494312	5	M			1				1									v	v							1			
71	70	43.111793	-88.493882	6	M			3	1									v				1	1		1			1	2			
72	71	43.111787	-88.493452	5	M			3	1													1			1			2				
73	72	43.111782	-88.493022	6	M			3	1			3													1				2			
74	73	43.112170	-88.498605	6	M			2	2					1															2			
75	74	43.112165	-88.498175	6	M			3	2			1																	3			
76	75	43.112159	-88.497745	4	M			1	1																				1			
77	76	43.112153	-88.497315	4	S			3				3	1									1							2			
78	77	43.112148	-88.496885	3	M			1	1	1				v														1	v			
79	78	43.112142	-88.496455	4	S			1	1											v		1							v			
80	79	43.112136	-88.496025	3	S			1	1				1																V			
81	80	43.112131	-88.495595				Point on Land																									
82	81	43.112125	-88.495165				Point on Land																									
83	82	43.112119	-88.494735				Dock																									
84	83	43.112114	-88.494305	6	M			2														1							2			
85	84	43.112108	-88.493874	6	M			2													1	1							2			
86	85	43.112103	-88.493444	6	M			2	1						2														2			
87	86	43.112097	-88.493014	6	M			1	v																				1			
88	87	43.112491	-88.499027	2	R			1	1			V								v						v			v			
89	88	43.112485	-88.498597	6	M			3				3				1		2									1	v	2			
90	89	43.112480	-88.498167	6	M			3	2			3																	3			
91	90	43.112474	-88.497737	5	M			3	2			3																	2			
92	91	43.112468	-88.497307	5	M			3	V			3																	1			
93	92	43.112463	-88.496877	5	M			3	1			3													2			1	2			
94	93	43.112457	-88.496447	5	M			2	2									v										v	2			
95	94	43.112452	-88.496017	5	M			2				1				1					1				2			2	2			

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil		*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
96	95	43.112446	-88.495587	5	M			3			1	3									1		1					1	2			
97	96	43.112440	-88.495157	6	M			2	V													1	1		v			v	2			
98	97	43.112435	-88.494727	6	M			1	1																				1			
99	98	43.112429	-88.494297	6	M			2	v																				2			
100	99	43.112423	-88.493867	6	M			1	v																			1	1			
101	100	43.112418	-88.493437	6	M			2	2																				2			
102	101	43.112806	-88.499020	6	M			2	1												v	v							2			
103	102	43.112800	-88.498589	6	M			3				3																	2			
104	103	43.112795	-88.498159	7	M			3	2			3						1														
105	104	43.112789	-88.497729	6	M			3	v			3																				
106	105	43.112784	-88.497299	5	M			3	v			3																	v			
107	106	43.112778	-88.496869	5	M			3				3																				
108	107	43.112772	-88.496439	6	M			3				3																	1			
109	108	43.112767	-88.496009	6	M			3				3											1						2			
110	109	43.112761	-88.495579	7	M			2	v																				2			
111	110	43.112755	-88.495149	7	M			3				3									v								2			
112	111	43.112750	-88.494719	6	M			2	2							1							1						2			
113	112	43.112744	-88.494289	6	M			2	2		1												1		v			1	2			
114	113	43.112738	-88.493859	6	M			2	1														1						2			
115	114	43.112733	-88.493429	6	M			1	1												v		v					1	1			
116	115	43.113121	-88.499012	6	M			3	2			1									v								3			
117	116	43.113116	-88.498582	6	M			2			1						1									1	2		2			
118	117	43.113110	-88.498152	7	M			3	2									v				1					1		3			
119	118	43.113104	-88.497722	6	M			3	2			3											v		v		1	1	2			
120	119	43.113099	-88.497292	6	M			2	v			2						2														
121	120	43.113093	-88.496862	6	M			3	2			3						2									1					
122	121	43.113087	-88.496432	6	M			3	3			3																	v			
123	122	43.113082	-88.496002	7	M			1																					1			
124	123	43.113076	-88.495571	9	M			3	2		3																	2				
125	124	43.113070	-88.495141	7	M			3	2			3											1		v				2			
126	125	43.113065	-88.494711	7	M			3	v	v		3																1				
127	126	43.113059	-88.494281	8	M			3	2		3	1									v							1				
128	127	43.113053	-88.493851	6	M			1																					1			
129	128	43.113048	-88.493421	5	M			2	v		1	2			v								v						2			
130	129	43.113419	-88.497714	5	M			3	3			3					1												2			
131	130	43.113414	-88.497284	6	M			3	1			3																	1			
132	131	43.113408	-88.496854	6	M			3	2			3				1													3			
133	132	43.113402	-88.496424	6	M			2	2			1															1		2			
134	133	43.113397	-88.495994	9	M			3	3		3																1					
135	134	43.113391	-88.495564	8	M			1	1																				1			
136	135	43.113385	-88.495134	7	M			1				1										1					1	1				
137	136	43.113380	-88.494704	7	M			3	v			3										v							1			
138	137	43.113374	-88.494274	7	M			3	V			3																	1			
139	138	43.113368	-88.493844	8	M			1	1																1				1			
140	139	43.113363	-88.493414	5	M			3	v			3														1			V			
141	140	43.113723	-88.496846	6	M			2	1																v				2			
142	141	43.113717	-88.496416	8	M			3	2			3																	2			

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil		*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
143	142	43.113712	-88.495986	7	M			3	2			3																	2			
144	143	43.113706	-88.495556	8	M			3	2			3																	2			
145	144	43.113700	-88.495126	7	M			3	v		1	3									v								1			
146	145	43.113695	-88.494696	7	M			3	2			3										2			v				2			
147	146	43.113689	-88.494266	7	M			3	3			v											v		1			2	3			
148	147	43.113683	-88.493836	7	M			1	1			1																	1			
149	148	43.113678	-88.493406	4	S			3	1			3	1										v						2			
150	149	43.114055	-88.498129	5	M			3	1			2					1		V										3			
151	150	43.114049	-88.497699	6	M			2	1																v				2			
152	151	43.114044	-88.497269	7	M			2	1			1					1	1											2			
153	152	43.114038	-88.496838	8	M			2	1																				2			
154	153	43.114033	-88.496408	9	M			3	3			3											1						2			
155	154	43.114027	-88.495978				DEEP																									
156	155	43.114021	-88.495548				DEEP																									
157	156	43.114016	-88.495118	10	M			3	2		1																		3			
158	157	43.114010	-88.494688	9	M			3			3	3																	1			
159	158	43.114004	-88.494258	9	M			1	1		1																	1				
160	159	43.113999	-88.493828	8	M			1	1																				1			
161	160	43.113993	-88.493398	3	R			1				1											v			1						
162	161	43.114376	-88.498551	3	S			1	1			1								v					v				v			
163	162	43.114370	-88.498121	7	M			3	3		2	3																	2			
164	163	43.114365	-88.497691	8	M			2	2		2						1										1		2			
165	164	43.114359	-88.497261				DEEP																									
166	165	43.114353	-88.496831				DEEP																									
167	166	43.114348	-88.496401				DEEP																									
168	167	43.114342	-88.495971				DEEP																									
169	168	43.114336	-88.495541				DEEP																									
170	169	43.114331	-88.495111				DEEP																									
171	170	43.114325	-88.494681				DEEP																									
172	171	43.114319	-88.494250	10	M			1	1																			1				
173	172	43.114314	-88.493820	9	M			1	1		1																		1			
174	173	43.114308	-88.493390	5	R			1	1			1											1					1	1			
175	174	43.114691	-88.498543	6	M			2	1			1				1						1							2			
176	175	43.114685	-88.498113	8	M			3	2																		1		3			
177	176	43.114680	-88.497683				DEEP																									
178	177	43.114674	-88.497253				DEEP																									
179	178	43.114668	-88.496823				DEEP																									
180	179	43.114663	-88.496393				DEEP																									
181	180	43.114657	-88.495963				DEEP																									
182	181	43.114651	-88.495533				DEEP																									
183	182	43.114646	-88.495103				DEEP																									
184	183	43.114640	-88.494673	15	M			1																	1							
185	184	43.114634	-88.494243	10	M			1	1																							
186	185	43.114629	-88.493813	9	M			3	1		1																		2			
187	186	43.114623	-88.493383	6	M			3				3																	1			
188	187	43.115006	-88.498536	7	M			2	1			1															1		2			
189	188	43.115000	-88.498106				DEEP																									

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
190	189	43.114995	-88.497675				DEEP																									
191	190	43.114989	-88.497245				DEEP																									
192	191	43.114983	-88.496815				DEEP																									
193	192	43.114978	-88.496385				DEEP																									
194	193	43.114972	-88.495955				DEEP																									
195	194	43.114966	-88.495525				DEEP																									
196	195	43.114961	-88.495095				DEEP																									
197	196	43.114955	-88.494665				DEEP																									
198	197	43.114949	-88.494235	10	M			2	2			1																				
199	198	43.114944	-88.493805	9	M			2	2			1				1																
200	199	43.115327	-88.498958	7	M			1	1																				1			
201	200	43.115321	-88.498528	10	M			1	1	1															1							
202	201	43.115315	-88.498098				DEEP																									
203	202	43.115310	-88.497668				DEEP																									
204	203	43.115304	-88.497238				DEEP																									
205	204	43.115298	-88.496808				DEEP																									
206	205	43.115293	-88.496378				DEEP																									
207	206	43.115287	-88.495948				DEEP																									
208	207	43.115281	-88.495517				DEEP																									
209	208	43.115276	-88.495087				DEEP																									
210	209	43.115270	-88.494657	10	M			1	1																				1			
211	210	43.115264	-88.494227	9	M			3	3								1															
212	211	43.115259	-88.493797	7	M			3				3	1																2			
213	212	43.115642	-88.498950	6	M			3				3													v		1		2			
214	213	43.115636	-88.498520				DEEP																									
215	214	43.115630	-88.498090				DEEP																									
216	215	43.115625	-88.497660				DEEP																									
217	216	43.115619	-88.497230				DEEP																									
218	217	43.115613	-88.496800				DEEP																									
219	218	43.115608	-88.496370				DEEP																									
220	219	43.115602	-88.495940				DEEP																									
221	220	43.115597	-88.495510				DEEP																									
222	221	43.115591	-88.495080	12	M			1			1																					
223	222	43.115585	-88.494650	10	M			2	2		2																	1				
224	223	43.115580	-88.494220	9	M			1	1		1																	1	1			
225	224	43.115574	-88.493789	6	S			1	1																1							
226	225	43.115568	-88.493359	4	M			1	v			1													1				1			
227	226	43.115563	-88.492929	2	S			2	1		1	2	1							v					1				1			
228	227	43.115957	-88.498943	6	R			2	2			2					1								v			2	1			
229	228	43.115951	-88.498512				DEEP																									
230	229	43.115945	-88.498082				DEEP																									
231	230	43.115940	-88.497652				DEEP																									
232	231	43.115934	-88.497222				DEEP																									
233	232	43.115929	-88.496792				DEEP																									
234	233	43.115923	-88.496362				DEEP																									
235	234	43.115917	-88.495932				DEEP																									
236	235	43.115912	-88.495502				DEEP																									

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil		*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
237	236	43.115906	-88.495072	9	M			2	2									1											2			
238	237	43.115900	-88.494642	9	M			3	3		1																v	2				
239	238	43.115895	-88.494212	8	M			3	2			3									v							1	3			
240	239	43.115889	-88.493782	5	M			3				3																	2			
241	240	43.115883	-88.493352	5	M			3	v			2	2	v											1				2			
242	241	43.115878	-88.492922	3	M			1	v											v		v							1			
243	242	43.116272	-88.498935				Point on Land																									
244	243	43.116266	-88.498505	15	M			1	1		1	1																		1		
245	244	43.116261	-88.498075				DEEP																									
246	245	43.116255	-88.497645				DEEP																									
247	246	43.116249	-88.497215				DEEP																									
248	247	43.116244	-88.496784				DEEP																									
249	248	43.116238	-88.496354				DEEP																									
250	249	43.116232	-88.495924				DEEP																									
251	250	43.116227	-88.495494				DEEP																									
252	251	43.116221	-88.495064	9	M			2	2		1																	2	1			
253	252	43.116215	-88.494634	9	M			1	1	1		1																				
254	253	43.116210	-88.494204	7	M			3	1			3											1									
255	254	43.116204	-88.493774	4	M			3				3										2					2		3			
256	255	43.116198	-88.493344	4	M			1	1					1								1				1			1			
257	256	43.116581	-88.498497	8	M			3	V			3																	3			
258	257	43.116576	-88.498067				DEEP																									
259	258	43.116570	-88.497637				DEEP																									
260	259	43.116564	-88.497207				DEEP																									
261	260	43.116559	-88.496777				DEEP																									
262	261	43.116553	-88.496347				DEEP																									
263	262	43.116547	-88.495917				DEEP																									
264	263	43.116542	-88.495487	10	M			2	2			2					1											2	2			
265	264	43.116536	-88.495057	9	M			1				1				1												1	1			
266	265	43.116530	-88.494626	8	M			3	2			2					1												3			
267	266	43.116525	-88.494196	5	M			3	1			3					1										1		2			
268	267	43.116519	-88.493766	5	M			3	2			3											1					2	3			
269	268	43.116902	-88.498919	6	R			3	2		3	3								V						1			3			
270	269	43.116896	-88.498489	9	M			3	3		2						1											2	2			
271	270	43.116891	-88.498059	10	M			3	3		3																	2				
272	271	43.116885	-88.497629				DEEP																									
273	272	43.116879	-88.497199				DEEP																									
274	273	43.116874	-88.496769				DEEP																									
275	274	43.116868	-88.496339				DEEP																									
276	275	43.116862	-88.495909				DEEP																									
277	276	43.116857	-88.495479	9	M			3	3		2																	1	2			
278	277	43.116851	-88.495049	8	M			3	2			3									v											
279	278	43.116845	-88.494619	7	M			3	v			3																	2			
280	279	43.116840	-88.494189	6	M			2	1								1				v						1		2			
281	280	43.117217	-88.498912	2	M			2				2										1										
282	281	43.117211	-88.498482	11	M			2	2		2																	2				
283	282	43.117206	-88.498052	10	M			2	2																1				2			

Table A1 (continued)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil		*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas guadalupensis*, Southern naiad	*Najas marina* , Spiny naiad	*Nuphar variegata* , Spatterdock	*Nymphaea odorata* , White water lily	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton natans* , Floating-leaf pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	sp1 Possibly different cha	sp2	sp3
284	283	43.117200	-88.497621	9	M			2	2			1																1	2			
285	284	43.117194	-88.497191	10	M			3	3		3																					
286	285	43.117189	-88.496761				DEEP																									
287	286	43.117183	-88.496331				DEEP																									
288	287	43.117177	-88.495901	12	M			3	3		3																					
289	288	43.117172	-88.495471	8	M			3	2			2																	2			
290	289	43.117166	-88.495041	5	M			3	V			3									v								1			
291	290	43.117160	-88.494611	5	M			1	1													1							1			
292	291	43.117526	-88.498474	7	M			3				3											v					2	1			
293	292	43.117521	-88.498044	6	M			3	1			3											V		V		1		2			
294	293	43.117515	-88.497614	9	M			2	2																							
295	294	43.117509	-88.497184	9	M			2	2																							
296	295	43.117504	-88.496754	11	M			2	2		2																		1			
297	296	43.117498	-88.496324	8	M			3	3																				3			
298	297	43.117493	-88.495893	8	M			3			1	3														3			3			
299	298	43.117841	-88.498466	6	M			3	2			3	2										1					1	3			
300	299	43.117836	-88.498036	6	M			3				3																				
301	300	43.117830	-88.497606	8	M			3	2			3															1	1	2			
302	301	43.117825	-88.497176	9	M			2	2																			1				
303	302	43.117819	-88.496746	9	M			3	1			3																	1			
304	303	43.117813	-88.496316	8	M			2	1																				2			
305	304	43.118157	-88.498459	6	M			3	1			2													1		1		2			
306	305	43.118151	-88.498028	7	M			3				3																	1			
307	306	43.118145	-88.497598	6	M			3				3																				
308	307	43.118140	-88.497168	7	M			3	1			2				1	1												3			
309	308	43.118134	-88.496738	8	M			3				3																	2			
310	309	43.118477	-88.498881				Point on Land																									
311	310	43.118472	-88.498451	6	M			3	1			3																	1			
312	311	43.118466	-88.498021	7	M			3				3																	1			
313	312	43.118460	-88.497591	7	M			2				2						1										2				
314	313	43.118455	-88.497161	6	M			3	1			3													1		1		3			
315	314	43.118787	-88.498443	4	S			1	v			1													v			1	v			
316	315	43.118781	-88.498013	6	M			3	2			2										1			1		1		3			
317	316	43.118775	-88.497583	6	M			2	2													1	1				1		2			

Table A.2
Summary Statistics for the Fowler Lake Point-Intercept Aquatic Plant Survey: August 22-24, 2017

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	**STATS**	Total vegetation	*Myriophyllum spicatum*, Eurasian water milfoil	*Potamogeton crispus*, Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas guadalupensis, Southern naiad	Najas marina, Spiny naiad	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Stuckenia pectinata, Sago pondweed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	sp1 Possibly different chara	sp2	sp3
2	Fowler Lake																									
3	Waukesha County																									
4	WBIC 849400																									
5	Survey Dates: 8/22, 23, 24/2017																									
6	**INDIVIDUAL SPECIES STATS:**																									
7	**Frequency of occurrence within vegetated areas (%)**		65.80	2.07	19.17	55.96	6.74	1.55	1.04	4.15	6.74	3.63			2.07	9.33	8.29		11.40	3.11	12.44	21.76	72.54	0.52		
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		65.80	2.07	19.17	55.96	6.74	1.55	1.04	4.15	6.74	3.63			2.07	9.33	8.29		11.40	3.11	12.44	21.76	72.54	0.52		
9	**Relative Frequency (%)**		21.3	0.7	6.2	18.2	2.2	0.5	0.3	1.3	2.2	1.2			0.7	3.0	2.7		3.7	1.0	4.0	7.1	23.5	0.2		
10	Relative Frequency (squared)	0.15	0.05	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.06	0.00		
11	**Number of sites where species found**		127	4	37	108	13	3	2	8	13	7			4	18	16		22	6	24	42	140	1		
12	**Average Rake Fullness**	2.26	1.63	1.00	1.73	2.36	1.46	1.00	2.50	1.00	1.00	1.43			1.00	1.11	1.06		1.14	1.33	1.13	1.36	1.83	1.00		
13	**#visual sightings**		25	3		2		2	9		1	3	2	13	13	6	8	1	14	5	3	4	10			
14	**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present		
15																										
16	**SUMMARY STATS:**																									
17	**Total number of sites visited**	**193**																								
18	**Total number of sites with vegetation**	**193**																								
19	**Total number of sites shallower than maximum depth of plants**	**193**																								
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**100.00**																								
21	**Simpson Diversity Index**	**0.85**																								
22	**Maximum depth of plants (ft)****	**15.00**																								
23	**Number of sites sampled using rake on Rope (R)**	**0**																								
24	**Number of sites sampled using rake on Pole (P)**	**0**																								
25	**Average number of all species per site (shallower than max depth)**	**3.08**																								
26	**Average number of all species per site (veg. sites only)**	**3.08**																								
27	**Average number of native species per site (shallower than max depth)**	**2.37**																								
28	**Average number of native species per site (veg. sites only)**	**2.43**																								
29	**Species Richness**	**19**																								
30	**Species Richness (including visuals)**	**22**																								

SPECIFICATIONS FOR HARVESTING OPERATION EQUIPMENT AND COST ESTIMATES FOR REPLACEMENT

APPENDIX B

PO Box 215
200 North Harrison Street
North Prairie, Wisconsin 53153 U.S.A.
Phone: 262-392-2162
Toll Free: 800-328-6555
Fax: 262-392-2984
Email: info@aquarius-systems.com
Web Site: www.aquarius-systems.com

CITY OF OCONOMOWOC - FOWLER LAKE
OCONOMOWOC, WISCONSIN
BUDGETARY PROPOSAL

Contract Number 102516.01

QUANTITY	DESCRIPTION	PRICE EACH*
1	**HM-420 Harvester**	**$130,450.00**
	Hatz Silent Pack Air-Cooled Diesel Engine	*Standard*
	Optional: 304L Stainless Steel Hull	$9,000.00
	Optional: Modifications to achieve lower height for bridge clearance	$7,500.00
	Optional: Standard Duty Stainless Belting, ALL Conveyors	$6,190.00
	Optional: UHMW Wear Strips on #1 Conveyor Frame	$1,860.00
	Bimini sun/rain canopy	*Included*
	Environmental marine safe hydraulic oil & grease	*Included*
	Permanent 18 gallon fuel tank	*Included*
	Aquarius blue color scheme	*Standard*
	Alternate Color Scheme; please state at time of order _____	*No Charge*
	Basic spare parts & tool kits	*Included*
1	**TR-23 Trailer**	**$16,500.00**
~	**Onsite Training as needed up to 16 hours**	***Included***
~	**Freight Charges**	***No Charge***
~	**TOTAL**	**$171,500.00**

* *Exclusive of all options unless otherwise noted*
NOTE: Budgetary pricing valid through March 31, 2017. Pricing to be updated closer to time of order*

Contract Number	*102516.01*
Company's Initials	*taw*
Page Number	*1 of 1*

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CITY OF OCONOMOWOC - FOWLER LAKE
OCONOMOWOC, WISCONSIN
BUDGETARY PROPOSAL

Contract Number 102516.01

QUANTITY	DESCRIPTION	PRICE EACH*
1	**MSC-23 Pier Conveyor**	**$51,100.00**
	Power Pack Engine	*Included*
	2" Pintle Ring Hitch	*Standard*
	Environmental marine safe hydraulic oil & grease	*Included*
	Aquarius blue color scheme	*Standard*
	Alternate Color Scheme; please state at time of order _____	*No Charge*
	Basic spare parts & tool kits	*Included*
~	**Onsite Training as needed up to 16 hours**	***Included***
~	**Freight Charges**	***No Charge***
~	**TOTAL**	**$51,100.00**

* *Exclusive of all options unless otherwise noted*
NOTE: Budgetary pricing valid through March 31, 2017. Pricing to be updated closer to time of order*

Contract Number	*102516.01*
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Page Number	*1 of 1*

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CITY OF OCONOMOWOC - FOWLER LAKE
OCONOMOWOC, WISCONSIN
BUDGETARY PROPOSAL

Contract Number 102516.01

QUANTITY	DESCRIPTION	PRICE EACH*
1	**T-12 Transport Barge – LOW PROFILE**	**$128,650.00**
	Hatz Silent Pack Air-Cooled Diesel Engine	*Standard*
	Optional: 304L Stainless Steel Hull	$9,000.00
	Optional: Standard Duty Stainless Belting, ALL Conveyors	$3,990.00
	Bimini sun/rain canopy	*Included*
	Environmental marine safe hydraulic oil & grease	*Included*
	Permanent 18 gallon fuel tank	*Included*
	Aquarius blue color scheme	*Standard*
	Alternate Color Scheme; please state at time of order _____	*No Charge*
	Basic spare parts & tool kits	*Included*
1	**TR-23 Trailer**	**$16,500.00**
~	**Onsite Training as needed up to 16 hours**	***Included***
~	**Freight Charges**	***No Charge***
~	**TOTAL**	**$158,140.00**

* *Exclusive of all options unless otherwise noted*
NOTE: Budgetary pricing valid through March 31, 2017. Pricing to be updated closer to time of order*

Contract Number	*102516.01*
Company's Initials	*taw*
Page Number	*1 of 1*

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