MEMORANDUM REPORT
NO. 134 (3RD EDITION)

AQUATIC PLANT MANAGEMENT PLAN FOR FOWLER LAKE

WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

INTRODUCTION 1

Credit: SEWRPC Staff

The Southeastern Wisconsin Planning Commission (Commission) completed this aquatic plant inventory and management study on behalf of the City of Oconomowoc (City) and the Fowler Lake Management District (District). The Wisconsin Department of Natural Resources (WDNR) financed much of the project cost through an Aquatic Invasives Species grant award (project AEPP64922). This memorandum report is the Commission's sixth study focusing on Fowler Lake; the most recent study was SEWRPC Staff Memorandum, *An Aquatic Plant Management Update for Fowler Lake, Waukesha County, Wisconsin*, completed in 2018.[1] The WDNR will use data and conclusions generated as part of the Commission's study to help evaluate the Lake's aquatic plant community and draft an updated Aquatic Plant Control permit.

1.1 PROJECT SETTING, BACKGROUND, SCOPE, AND INTENT

Fowler Lake is an impounded 99-acre two-story lake, located on the Oconomowoc River within U.S. Public Land Survey Section 33, Township 8 North, Range 17 East, in the City of Oconomowoc, Waukesha County. The Lake is fed and drained by the Oconomowoc River, which forms an important tributary stream to the Rock River, joining the Rock River in the Town of Ixonia in Jefferson County. The Lake is a nutrient-limited (oligotrophic), alkaline, hardwater lake with a bottom composed of 70 percent muck, 15 percent gravel, 10 percent rock, and 5 percent sand.[2] The WDNR has identified the Lake in their published list of state high-quality waters.[3] The nearest upstream lake on the Oconomowoc River is Oconomowoc, which was also recognized one the state's high-quality waters list, while Lac La Belle, which is on the 303(d) impaired waters list, is just downstream of Fowler Lake.

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[1] *The five earlier Commission reports are as follows: 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; SEWRPC Memorandum Report No. 134 (2nd Edition),* An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin*, July 2012; and SEWRPC Staff Memorandum,* An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin*, May 2018.*

[2] *dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=849400&page=facts.*

[3] *For more information on the WDNR's Healthy Watersheds, High-Quality Waters initiative, see the following: dnr.wisconsin.gov/topic/SurfaceWater/HQW.html.*

Attaining a maximum depth of 50 feet, the deepest portions of Fowler Lake are not capable of supporting an aquatic plant community but shallow nearshore areas do support abundant growth of rooted aquatic plants (Map 1.1).[4] The previous aquatic plant survey conducted by the Commission in 2017 observed 19 species, including several beneficial native species like muskgrass (*Chara* spp.), Sago pondweed (*Stuckenia pectinata*), eelgrass (*Vallisneria americana*), large-leaf pondweed (*Potamogeton amplifolius*), and Illinois pondweed (*Potamogeton illinoensis*).[5] Invasive aquatic plant species, including Eurasian watermilfoil (*Myriophyllum spicatum*), spiny naiad (*Najas marina*), and curly-leaf pondweed (*Potamogeton crispus*), were also observed in the Lake at this time.

The City manages aquatic plant growth on the Lake to enhance navigation and recreational opportunities, primarily through mechanical harvesting as use of chemical treatments was discontinued in the 1990s.[6] Aquatic plant management is regulated by the WDNR and requires a permit. The City and District are required to reevaluate the aquatic plant community, update the aquatic plant management plan, and renew the aquatic plant management permit every five years. Aquatic plant inventories and management plans have been completed at the Lake several times in the past to support aquatic plant management permit applications. The last aquatic plant inventory was completed in August 2017 and the last aquatic plant management plan update was completed in 2018, both by the Commission.[7] To renew their permit, the City and District must reevaluate the Lake's aquatic plant community and update the aquatic plant management plan. This updated plan needs to consider the present status of the aquatic plant community, must identify plant community changes that may have occurred, must examine the potential success or lack of success of the current aquatic plant management strategies, must consider current trends and issues that pertain to aquatic plant management issues and techniques, and must describe the methods and procedures associated with proposed continuation of aquatic plant management in the Lake.

This updated APM plan summarizes information and recommendations needed to manage nuisance plants (including Eurasian watermilfoil and curly-leaf pondweed). The plan covers four main topics:

- APM Goals and Objectives
- Aquatic Plant Community Changes and Quality
- Aquatic Plant Control Alternatives
- Recommended Aquatic Plant Management Plan

This memorandum focuses upon approaches to monitor and control actively growing nuisance populations of aquatic plants and presents a range of alternatives that could potentially be used to achieve desired APM goals and provides specific recommendations related to each alternative. These measures focus on those that the City can implement and collaborate with Lake residents/users and the WDNR. The current study is not intended to be a comprehensive evaluation of the myriad factors influencing the Lake's overall health and recreational use potential and therefore does not address watershed issues, land use, in-depth water quality or quantity interpretations, history, recreational use, fish and wildlife, and other such topics typical of comprehensive lake plans.

In summary, this document helps interested parties understand the plant management measures to be used in and around the Lake. These data and suggestions can be valuable resources when developing requisite APM permit applications and implementing future aquatic plant management efforts.

[4] *SEWRPC Staff Memorandum, 2018,* op. cit.

[5] Ibid.

[6] Ibid.

[7] Ibid.

Map 1.1
Fowler Lake Bathymetry

BOAT LAUNCH

20 WATER DEPTH CONTOUR IN FEET

DAM

0 155 310 620 Feet

Note: The bathymetric contours presented in this map utilize the 1955 bathymetric contours as drawn by the Wisconsin Department of Natural Resources.

Source: ESLMD, WDNR, and SEWRPC

INVENTORY FINDINGS AND RELEVANCE TO RESOURCE MANAGEMENT 2

Credit: SEWRPC Staff

2.1 AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

Aquatic plant management (APM) programs are designed to further a variety of lake user and riparian landowner goals and desires. For example, most APM programs aim to improve lake navigability. However, APM programs must also be sensitive to other lake uses and must maintain or enhance a lake's ecological integrity. Consequently, APM program objectives are commonly developed in close consultation with many interested parties. The Fowler Lake APM plan considered input from many entities including the City of Oconomowoc (City) and the Wisconsin Department of Natural Resources (WDNR). Objectives of the Fowler APM program include the following.

- Effectively control the quantity and density of nuisance aquatic plant growth in well-targeted portions of Fowler Lake (the Lake). This objective helps:
    - Enhance water-based recreational opportunities,
    - Improve community-perceived aesthetic values, and
    - Maintain or enhance the Lake's natural resource value.
- Manage the Lake in an environmentally sensitive manner in conformance with *Wisconsin Administrative Code* standards and requirements under Chapters NR 103 *Water Quality Standards for Wetlands*, NR 107 *Aquatic Plant Management*, and NR 109 *Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. Following these rules helps the City and District preserve and enhance the Lake's water quality, biotic communities, habitat value, and essential structure and relative function in relation to adjacent areas.
- Protect and maintain public health and promote public comfort, convenience, and welfare while safeguarding the Lake's ecological health through environmentally sound management of vegetation, wildlife, fish, and other aquatic/semi-aquatic organisms in and around the Lake.

- Promote a high-quality water-based experience for residents and visitors to the Lake consistent with the policies and practices of the WDNR, as described in the regional water quality management plan, as amended.[8]

To meet these objectives, the City executed an agreement with the Southeastern Wisconsin Regional Planning Commission (Commission) to investigate the characteristics of the Lake and to develop an aquatic plant management update. As part of this planning process, surveys of the aquatic plant community and comparison to results of previous surveys were conducted. This chapter presents the results of each of these inventories.

2.2 AQUATIC PLANT COMMUNITY COMPOSITION, CHANGE, AND QUALITY

All healthy lakes have plants and native aquatic plants form a foundational part of a lake ecosystem. Aquatic plants form an integral part of the aquatic food web, converting sediments and inorganic nutrients present in the water into organic compounds that are directly available as food to other aquatic organisms. Through photosynthesis, plants utilize energy from sunlight and release the oxygen required by many other aquatic life forms into the water. Aquatic plants also serve several other valuable functions in a lake ecosystem, including:

- Improving water quality by filtering excess nutrients from the water
- Providing habitat for invertebrates and fish
- Stabilizing lake bottom substrates
- Supplying food for waterfowl and various lake-dwelling animals

Even though aquatic plants may hinder human use and/or access to a lake, aquatic plants should not necessarily be eliminated or even significantly reduced in abundance because they often support many other beneficial functions. For example, water lilies play a significant role in providing shade, habitat, and food for fish and other important aquatic organisms. They also help prevent damage to the lakeshore by dampening the power of waves that could otherwise erode the shoreline. Additionally, the shade that these plants provide helps reduce the growth of undesirable plants because it limits the amount of sunlight reaching the lake bottom. Given these benefits, large-scale removal of native plants that may be perceived as a nuisance should be avoided when developing plans for aquatic plant management.

Aquatic Plant Surveys

The Lake's aquatic plant community has been evaluated several times since the first survey by Sorge and Lowry in 1984.[9] Commission staff surveyed the Lake's aquatic plants in 1997, 2007, 2011, 2017, and 2022. Species abundance data derived from the 2017 and 2022 surveys for the Lake are compared in Table 2.1. The 2017 and 2022 surveys both used the same point-intercept grid and methodology.[10,11,12] In this method,

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[8] *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*.

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

[10] *Sampling methodology changed from transect-based methods in the earlier surveys (1984, 1997, and 2007) to a point-intercept method beginning with the 2011 survey. See SEWRPC Staff Memorandum,* An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin, *May 2018 for more information on the 2017 survey.*

[11] *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 S. 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.*

[12] *J. Hauxwell, S. Knight, K. Wagner, A. Mikulyuk, M. Nault, M. Porzky, and S. Chase,* Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications, *Wisconsin Department of Natural Resources, Bureau of Science Services, Publication No. PUB-SS-1068 201, March 2010.*

Table 2.1
Fowler Lake Aquatic Plant Survey Summary: August 2017 versus July 2022

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a] (2017/2022)	Frequency of Occurrence Within Vegetated Areas[b] (2017/2022)	Average Rake Fullness[c] (2017/2022)	Relative Frequency of Occurrence[d] (2017/2022)	Visual Sightings[e] (2017/2022)
Ceratophyllum demersum (coontail)	Native	37/52	19.2/24.8	1.73/1.21	6.22/5.6	0/0
Chara spp. (muskgrass)	Native	108/144	56.0/68.57	2.36/1.72	18.2/15.6	2/1
Elodea canadensis (waterweed)	Native	13/25	6.7/11.9	1.46/1.20	2.18/2.7	0/1
Heteranthera dubia (water stargrass)	Native	3/15	1.55/7.14	1.00/1.00	0.50/1.6	2/1
Lemna spp. (duckweeds)	Native	0/3	--/1.43	--/1.00	--/0.3	0/4
Lemna trisulca (forked duckweed)	Native	--/1	--/0.48	--/1.00	--/0.1	0/0
Myriophyllum sibiricum (northern watermilfoil)	Native	2/35	1.04/16.67	2.50/1.03	0.34/3.8	9/0
Myriophyllum spicatum (eurasian watermilfoil)	Invasive	127/101	65.8/48.1	1.63/1.29	21.34/10.9	25/8
Najas flexilis (slender naiad)	Native	8/65	4.15/31.0	1.00/1.05	1.34/7.0	0/1
Najas guadalupensis (southern naiad)	Native	13/17	6.74/8.10	1.00/1.00	2.18/1.8	1/0
Najas marina (spiny naiad)[f]	Naturalized	7/7	3.63/3.33	1.43/1.14	1.18/1.8	3/0
Nitella spp. (stonewort)	Native	--/22	--/10.5	--/1.09	--/2.4	0/0
Nuphar variegata (spatterdock)[g]	Native	0/0	--/--	--/--	--/--	2/0
Nymphaea odorata (white water lily)	Native	0/0	--/--	--/--	--/--	13/6
Potamogeton amplifolius (large-leaf pondweed)[h]	Native	4/11	2.07/7.62	1.00/1.06	0.67/1.7	13/16
Potamogeton crispus (curly-leaf pondweed)	Invasive	4/19	2.07/9.05	1.00/1.00	0.67/2.1	3/0
Potamogeton friesii (fries' pondweed)	Native	0/19	--/9.05	--/1.00	--/2.1	0/0
Potamogeton gramineus (variable pondweed)	Native	18/12	9.33/5.71	1.11/1.08	3.03/1.3	6/2
Potamogeton illinoensis (illinois pondweed)[h]	Native	16/11	8.29/5.24	1.06/1.00	2.69/1.2	8/0
Potamogeton natans (floating-leaf pondweed)	Native	0/2	--/0.95	--/1.00	--/0.2	1/0
Potamogeton nodosus (long-leaf pondweed)	Native	0/1	--/0.48	--/1.00	--/0.1	0/0
Potamogeton praelongus (white-stem pondweed)[h]	Native	0/3	--/1.43	--/1.00	--/0.3	0/0
Potamogeton pusillus (small pondweed)	Native	0/3	--/1.43	--/1.00	--/0.3	0/0
Potamogeton richardsonii (clasping-leaf pondweed)[h]	Native	22/27	11.4/12.9	1.14/1.04	3.70/2.9	14/3
Potamogeton zosteriformis (flat-stem pondweed)	Native	6/37	3.11/17.62	1.33/1.08	1.01/4.0	5/1
Ranunculus aquatilis (white water crowfoot)	Native	0/3	--/1.43	--/1.00	--/0.3	0/0
Spirodela polyrhiza (large duckweed)	Native	0/5	--/2.38	--/1.00	--/0.5	0/1
Stuckenia pectinata (sago pondweed)[h]	Native	24/52	12.4/25.8	1.13/1.02	4.03/5.6	3/1
Utricularia minor (small bladderwort)	Native	0/3	--/1.43	--/1.00	--/0.3	0/0
Utricularia vulgaris (bladderwort)	Native	42/64	21.8/30.5	1.36/1.09	7.06/6.9	4/1
Vallisneria americana (eel-grass/wild celery)[h]	Native	140/158	72.5/75.2	1.83/1.65	23.53/17.1	10/6
Wolffia spp. (watermeal)	Native	0/1	--/0.48	--/1.00	--/0.1	0/0

Note: Sampling occurred at 213 sampling sites on July 11th and 12th, 2022. 210 of these 213 sites had vegetation. Red text indicates non-native and/or invasive species. See Appendix A for distribution maps and identifying features.

Table 2.1 (Continued)

[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] *Although* Nuphar variegata *was not observed at a survey point in 2022, this species was recorded as a boat survey species near point 58 in the southeastern portion of the Lake.*

[h] *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

sampling sites are based on predetermined global positioning system (GPS) location points that are arranged in a grid pattern across the entire surface of a lake. The grid pattern for Fowler Lake consists of 316 sampling points spaced at 35 meters (115 feet) apart (Figure 2.1). At each grid point sampling site, a single rake haul is taken and a qualitative assessment of the rake fullness, on a scale of zero to three, is made for each species identified. The same points were sampled using the same techniques on roughly the same date in 2017 and 2022. This consistency enables more detailed evaluation of aquatic plant abundance and distribution change than has been possible in the past.

Commission staff conducted the 2022 survey on July 11th and 12th with the assistance of the City's Department of Public Works aquatic plant harvesting crew. Conditions on both days of the survey were excellent, with sunny to partly sunny skies, low wind speeds, and little to no other boat traffic. The Lake's water clarity was superb, which enhanced visual observations of aquatic plant species within six feet of the sampling location. In general, the aquatic plant specimens were mature and several species were in flower (e.g., white water lily (*Nymphaea odorata*)). In addition to the aquatic plants, Commission staff observed waterfowl, fish, great blue herons, muskrats, an otter, and a freshwater sponge during the survey.

While Commission staff strived to survey as much of the Lake as feasible, certain areas of the Lake were not surveyed in 2022. These areas included the central portion of the main Lake body, which was determined to be too deep for vascular aquatic plants to grow, as well as the southeast portion of the Lake, where shallow water and abundant floating-vegetation limited the ability to drive the survey boat without severely disrupting the aquatic habitat.[13] Other points that were not surveyed were either due to the proximity of the Lake's outlet dam, temporary obstacles, and points that were deemed to be on shore.

Aquatic Plant Survey Metrics

Each aquatic plant species has preferred habitat conditions in which that species thrives as well as conditions that limit or completely inhibit its growth. For example, water conditions (e.g., depth, clarity, source, alkalinity, and nutrient concentrations), substrate composition, the presence or absence of water movement, and pressure from herbivory and/or competition all can influence the type of aquatic plants found in a water body. All other factors being equal, water bodies with a diverse array of habitat variables are more likely to host a diverse aquatic plant community. For similar reasons, some areas of a particular lake may contain plant communities with little diversity, while other areas of the same lake may exhibit good diversity. Historically, human manipulation has often favored certain plants and reduced biological diversity (biodiversity). Thoughtful aquatic plant management can help maintain or even enhance aquatic plant biodiversity.

Several metrics are useful to describe aquatic plant community condition and design management strategies. These metrics include total rake fullness, maximum depth of colonization, species richness, biodiversity, evaluation of sensitive species, and relative species abundance. Metrics derived from the 2017 and 2022 point-intercept surveys are described below.

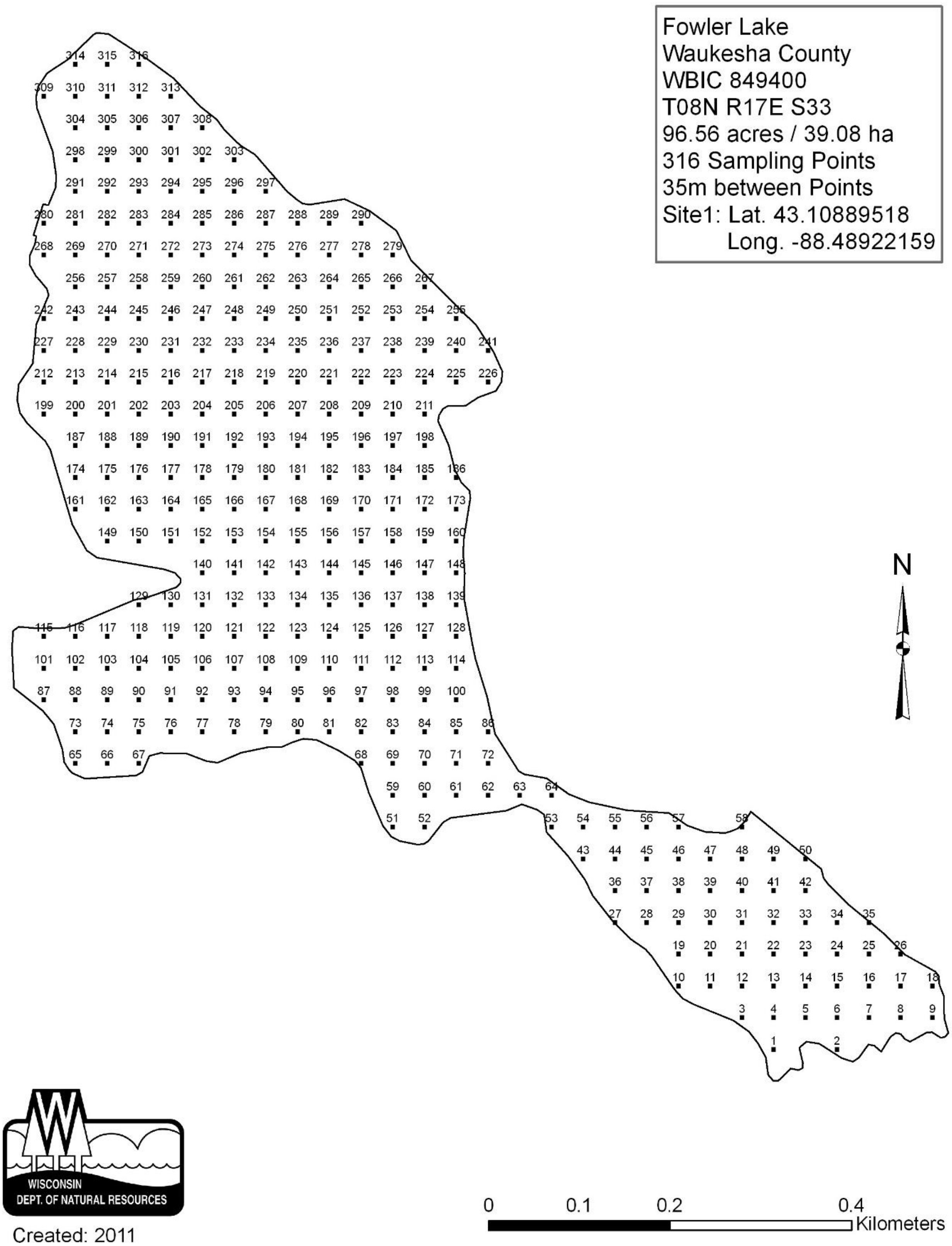
Total Rake Fullness

As described earlier in this section, Commission staff qualitatively rated the plant abundance at each survey point by how much of the sampling rake was covered by all aquatic plant species.[14] This rating, called total rake fullness, can be a useful metric evaluating general abundance of aquatic plants as part of the point-intercept survey. As shown in Figure 2.2, total rake fullness across all surveyed points averaged 2.04, with the southern portion of main Lake having the highest total rake fullness. Total rake fullness was particularly high in the bay south of Veterans Memorial Park and in an area northwest of North Oakwood Avenue. Deeper areas generally had lower total rake fullness, likely due to light availability limiting the growth of most plant species.

[13] *The southeast portion of the Lake is not an area with active aquatic plant management, as indicated by the 2018 aquatic plant management plan.*

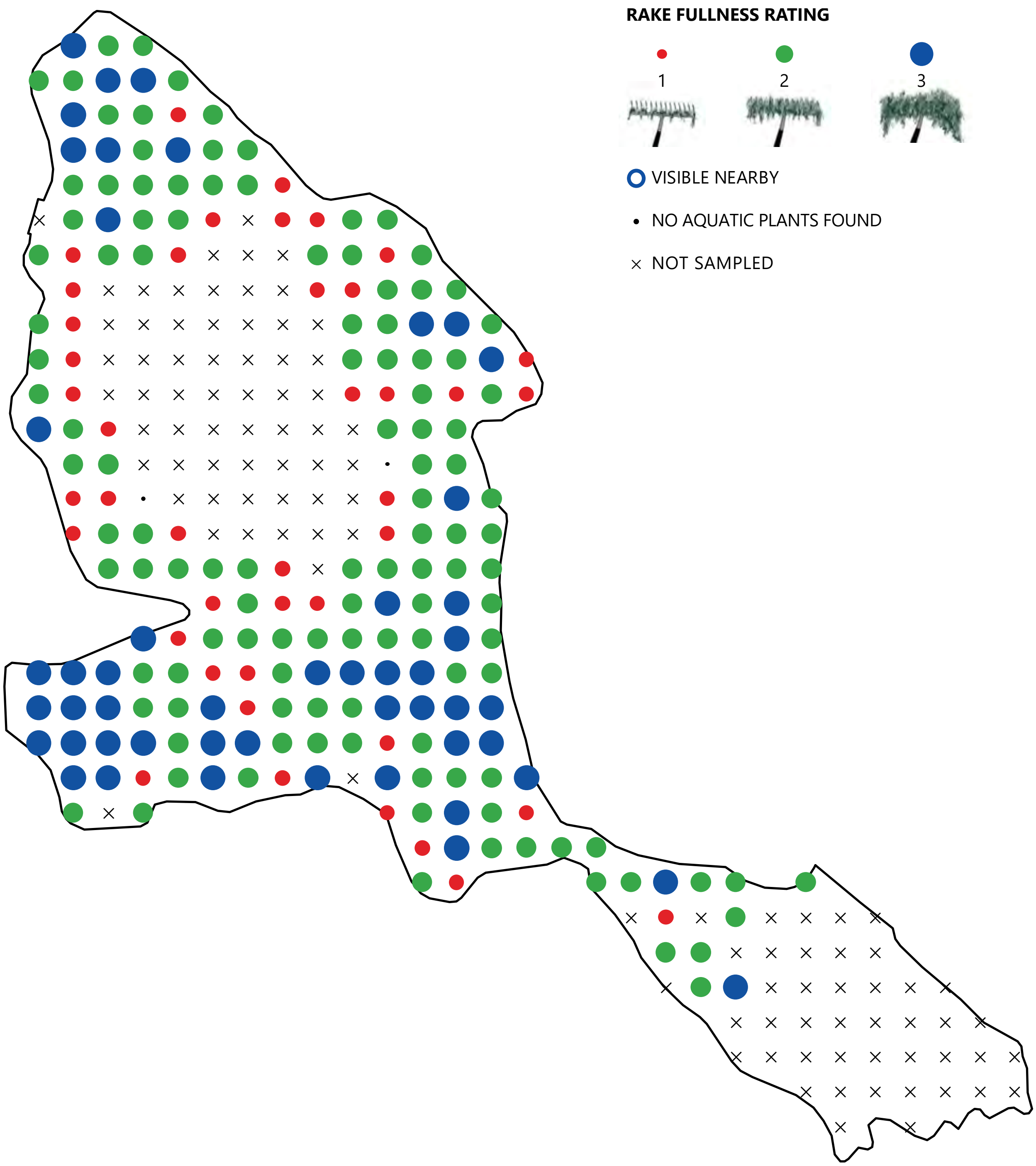
[14] *This method follows the standard WDNR protocol.*

Figure 2.1
Aquatic Plant Sampling Map for Fowler Lake



Source: WDNR and SEWRPC

Figure 2.2
Total Aquatic Plant Rake Fullness in Fowler Lake: July 2022



Note: Samples were collected in Fowler Lake between July 11 and 12, 2022.

Source: Wisconsin Department of Natural Resources and SEWRPC

Maximum Depth of Colonization

Maximum depth of colonization (MDC) can be a useful indicator of water quality, as turbid and/or eutrophic (nutrient-rich) lakes generally have shallower MDC than lakes with clear water.[15] It is important to note that for surveys using the point-intercept protocol, the protocol allows sampling to be discontinued at depths greater than the maximum depth of colonization for vascular plants. However, aquatic moss and macroalgae, such as muskgrass and nitella (*Nitella* spp.), frequently colonize deeper than vascular plants and thus may be under-sampled in some lakes. For example, *Chara globularis* and *Nitella flexilis* have been found growing as deep as 37 feet and 35 feet, respectively, in Silver Lake, Washington County.

In Fowler Lake, aquatic plants were observed to a maximum depth of 15 feet in 2017 and to a maximum depth of 25 feet in 2022, although many of the plant observations deeper than 16 feet were of *Nitella*.[16] Thus, vascular plants are generally light-limited deeper than 16 feet indicating that water clarity appears to have improved or at least been consistent from 2017 to 2022. While the Commission did not thoroughly survey depths greater than 20 feet, a rake toss at 30-foot depth did not return any *Nitella*, suggesting that even this plant may be light limited beyond this depth.

Species Richness

The number of distinct types of aquatic plants present in a lake is referred to as the species richness of the lake. Larger lakes with diverse lake basin morphology, less human disturbance, and/or healthier, more resilient lake ecosystems have greater species richness. Aquatic plants provide a wide variety of benefits to lakes, examples of which are briefly described in Table 2.2.

Fowler Lake exhibited high species richness overall during the initial plant inventory completed in 1994 (Table 2.3). The Lake has maintained high species richness throughout the surveys that followed with only slight increases or decreases from year to year. It is not uncommon for aquatic plant community diversity to fluctuate in response to a variety of drivers such as weather/climate, predation, and lake-external stimuli such as nutrient supply. This is especially true in the case of a lake's individual pondweed species, which tend to vary in abundance throughout the growing season in response to temperature, insolation, and other ecological factors. The 2022 aquatic plant survey identified 28 native species in the Lake. This species richness is much higher than average for similarly sized lakes within Southeastern Wisconsin. The total number of species observed at each sampling point is shown in Figure 2.3.

Biodiversity and Species Distribution

Species richness is often incorrectly used as a synonym for biodiversity. The difference in meaning between these terms is both subtle and significant. Biodiversity is based on the number of species present in a habitat along with the abundance of each species. For the purposes of this study, abundance was determined as the percent of observations of each species compared to the total number of observations made. Aquatic plant biodiversity can be measured with the Simpson Diversity Index (SDI).[17] Using this measure, a community dominated by one or two species would be considered less diverse than one in which several different species have similar abundance. In general, more diverse biological communities are better able to maintain ecological integrity in response to environmental stresses. Promoting biodiversity not only helps sustain an ecosystem but preserves the spectrum of options useful for future management decisions.

The Lake has excellent biodiversity, as indicated by an SDI of 0.91 in 2022, which was an increase from an SDI of 0.88 measured in 2017.[18] The 2022 SDI value reveals considerable biodiversity in the Lake. Between one and eleven aquatic plant species were found at any single sampling point throughout the Lake, with generally higher diversity in shallow areas than deeper areas (Figure 2.3). These results demonstrate that current aquatic plant management activities are working well. Actions that conserve and promote aquatic plant biodiversity are critical to the long term health of the Lake. Such actions not only help sustain and increase the robustness and resilience of the existing ecosystem, but also promote efficient and effective future aquatic plant management.

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[15] *D.E. Canfield Jr, L. Langeland, and W.T. Haller, "Relations Between Water Transparency and Maximum Depth of Macrophyte Colonization in Lakes,"* Journal of Aquatic Plant Management *23, 1985.*

[16] *SEWRPC Staff Memorandum, 2018,* op. cit.

[17] *The SDI expresses values on a zero to one scale where 0 equates to no diversity and 1 equates to infinite diversity.*

[18] *SEWRPC Staff Memorandum, 2018,* op. cit.

Table 2.2
Examples of Positive Ecological Qualities Associated with a Subset of the Aquatic Plant Species Present in Fowler Lake

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish; supports insects valuable as food for fish and ducklings; native
Chara spp. (muskgrasses)	A favorite waterfowl food and fish habitat, especially for young fish; native
Elodea canadensis (common waterweed)	Provides shelter and support for insects which are valuable as fish food; native
Heteranthera dubia (water stargrass)	Locally important food source for waterfowl and forage for fish; native
Myriophyllum spicatum (Eurasian watermilfoil)	None known. Invasive nonnative. Hinders navigation, outcompetes desirable aquatic plants, reduces water circulation, depresses oxygen levels, and reduces fish/invertebrate populations
Najas flexilis (slender naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas guadalupensis (southern naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas marina (spiny naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; naturalized non-native
Nitella spp. (stoneworts)	Sometimes grazed by waterfowl; forage for fish; native
Potamogeton crispus (curly-leaf pondweed)	Adapted to cold water; mid-summer die-off can impair water quality; invasive nonnative
Potamogeton gramineus (variable pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
Potamogeton natans (floating-leaf pondweed)	The late-forming fruit provides important food source for ducks; provides good fish habitat due to its shade and foraging opportunities; native
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks; native
Stuckenia pectinata (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish; native
Utricularia spp. (bladderworts)	Stems provide food and cover for fish; native
Vallisneria americana (eelgrass/water celery)	Provides good shade and shelter, supports insects, and is valuable fish food; native

Note: Information obtained from A Manual of Aquatic Plants by Norman C. Fassett, University of Wisconsin Press; Guide to Wisconsin Aquatic Plants, Wisconsin Department of Natural Resources; and, Through the Looking Glass: A Field Guide to Aquatic Plants, Wisconsin Lakes Partnership, University of Wisconsin-Extension.

Source: SEWRPC

Sensitive Species

Aquatic plant metrics, such as species richness and the floristic quality index (FQI), can be useful for evaluating lake health. In hard water lakes, such as those common in Southeastern Wisconsin, species richness generally increases with water clarity and decreases with nutrient enrichment.[19] The FQI is an assessment metric used to evaluate how closely a lake's aquatic plant community matches that of undisturbed, pre-settlement conditions.[20] To formulate this metric, Wisconsin aquatic plant species were assigned conservatism (C) values on a scale from zero to ten that reflect the likelihood that each species occurs in undisturbed habitat. These values were assigned based on the species substrate preference, tolerance of water turbidity, water drawdown tolerance, rooting strength, and primary reproductive means. Native "sensitive" species that are intolerant of ecological disturbance receive high C values, while natives that are disturbance tolerant receive low C values. Invasive species are assigned a C value of 0. A lake's FQI is calculated as the average C value of species identified in the lake, divided by the square root of species richness. The Lake's FQI in 2017 was 22.2 while the 2022 FQI was 31.4.[21] Both surveys had higher FQI values than the 20.0 average FQI for the Southeastern Wisconsin Till Plains ecoregion, indicating that the Lake supports species that are more sensitive to ecological disturbance than the average lake in the Region.

[19] *Vestergaard, O. and Sand-Jensen, K. "Alkalinity and Trophic State Regulate Aquatic Plant Distribution in Danish Lakes,"* Aquatic Botany *67, 2000.*

[20] *S. Nichols, "Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications,"* Lake and Reservoir Management *15(2), 1999.*

[21] *SEWRPC Staff Memorandum, 2018,* op. cit.

Table 2.3
Fowler Lake Submerged Aquatic Plant Species Relative Frequency: 1984 – 2022

	Transect Survey[a,b]			Point-Intercept Survey[b]		
Aquatic Plant Species	1984	1997	2007[c]	2011	2017	2022
Ceratophyllum demersum (coontail)	14.6	9.4	19.6	10.0	6.2	5.6
Chara spp. (muskgrass)	27.0	16.1	6.0	15.6	18.2	15.6
Elodea canadensis (waterweed)	--	4.8	0.9	1.6	2.2	2.7
Heteranthera dubia (water stargrass)	--	--	2.6	0.7	0.5	1.6
Myriophyllum sibiricum (northern watermilfoil)	--	--	18.8	2.3	0.3	3.8
Myriophyllum spicatum (eurasian watermilfoil)	21.3	14.2	4.3	18.2	21.3	10.9
Najas flexilis (slender naiad)	--	8.5	6.0	5.6	1.3	7.0
Najas guadalupensis (southern naiad)	--	--	--	--	2.2	1.8
Najas marina (spiny naiad)	0.8	1.2	--	1.6	1.2	0.8
Nitella spp. (stonewort)	2.7	--	--	--	--	2.4
Potamogeton amplifolius (large-leaf pondweed)	--	0.6	1.7	--	0.7	1.7
Potamogeton crispus (curly-leaf pondweed)	2.2	3.6	3.4	0.4	0.7	2.1
Potamogeton foliosus (leafy pondweed)	--	--	1.8	0.9	--	--
Potamogeton friesii (fries' pondweed)	--	--	--	--	--	2.1
Potamogeton gramineus (variable pondweed)	--	--	3.4	4.3	3.0	1.3
Potamogeton illinoensis (illinois pondweed)	6.2	--	8.5	1.3	2.7	1.2
Potamogeton natans (floating-leaf pondweed)	--	--	--	--	Present[d]	0.2
Potamogeton nodosus (long-leaf pondweed)	--	--	--	--	--	0.1
Potamogeton praelongus (white-stem pondweed)	--	8.2	--	--	--	0.3
Potamogeton pusillus (small pondweed)	--	--	--	1.4	--	0.3
Potamogeton richardsonii (clasping-leaf pondweed)	1.8	0.6	5.1	2.6	3.7	2.9
Potamogeton zosteriformis (flat-stem pondweed)	--	7.0	0.9	0.3	1.0	4.0
Ranunculus aquatilis (white water crowfoot)	--	--	--	--	--	0.3
Stuckenia pectinata (sago pondweed)	8.4	7.0	8.5	6.7	4.0	5.6
Utricularia minor (small bladderwort)	--	--	--	--	--	0.3
Utricularia vulgaris (bladderwort)	4.8	6.4	4.3	4.9	7.1	6.9
Vallisneria americana (eelgrass/wild celery)	10.2	12.4	18.8	20.3	23.5	17.1
Total Number of Submerged Species	11	14	17	18	19	26

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 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.*

[c] *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.*

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

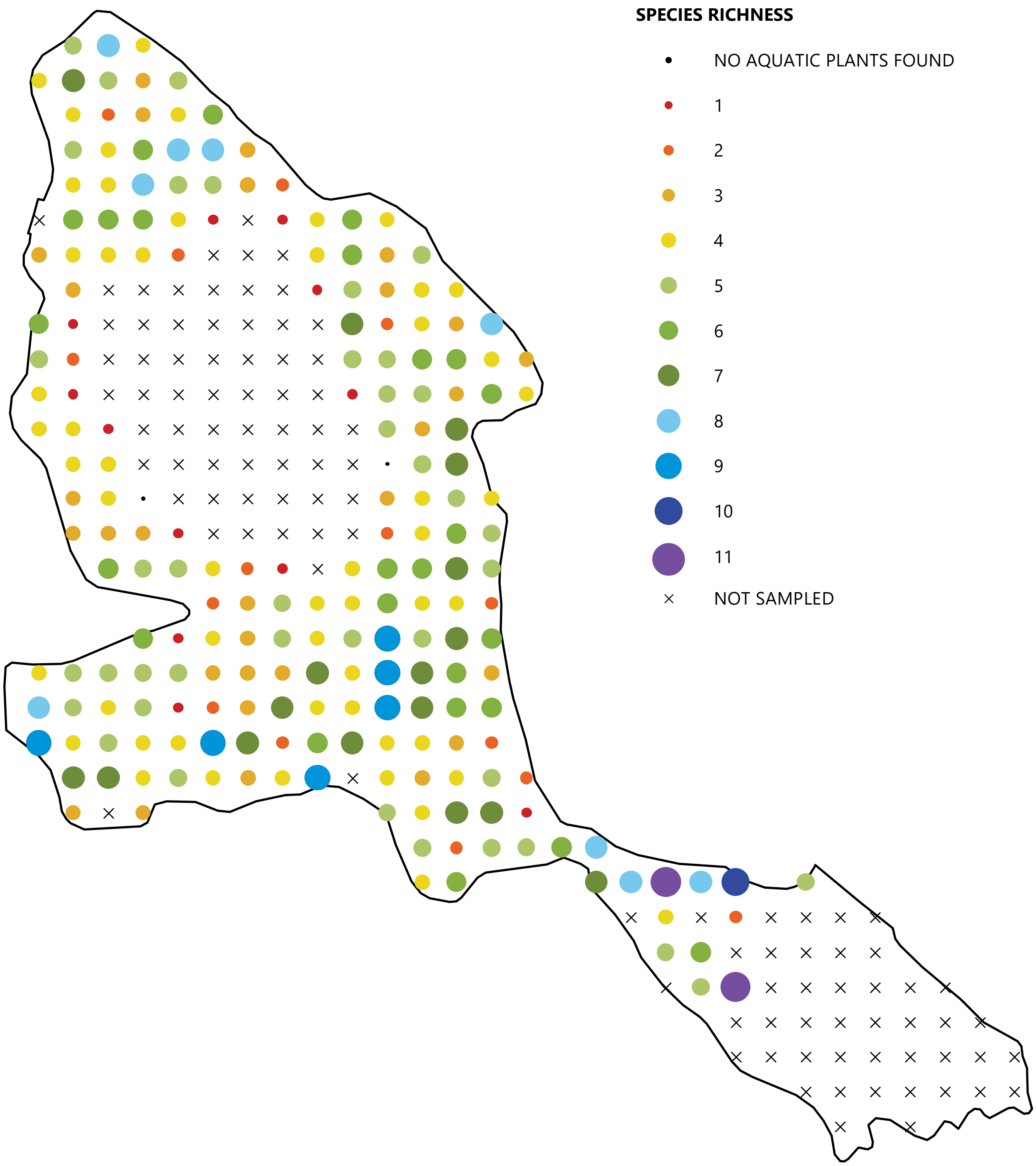
Source: SEWRPC

Twelve sensitive species, as defined by the Commission as a species with a C value of seven or more, were identified during the 2022 survey: muskgrass (*Chara* spp.), southern naiad (*Najas guadalupensis*), nitella (*Nitella* spp.), large-leaf pondweed (*Potamogeton amplifolius*), Fries' pondweed (*Potamogeton friesii*), variable-leaved pondweed (*Potamogeton gramineus*), long-leaf pondweed (*Potamogeton nodosus*), white-stem pondweed (*Potamogeton praelongus*), small pondweed (*Potamogeton pusillus*), white water crowfoot (*Ranunculus aquatilis*), small bladderwort (*Utricularia minor*), and common bladderwort (*Utricularia vulgaris*). The number of sensitive species identified at each survey points are shown in Figure 2.4.

Relative Species Abundance

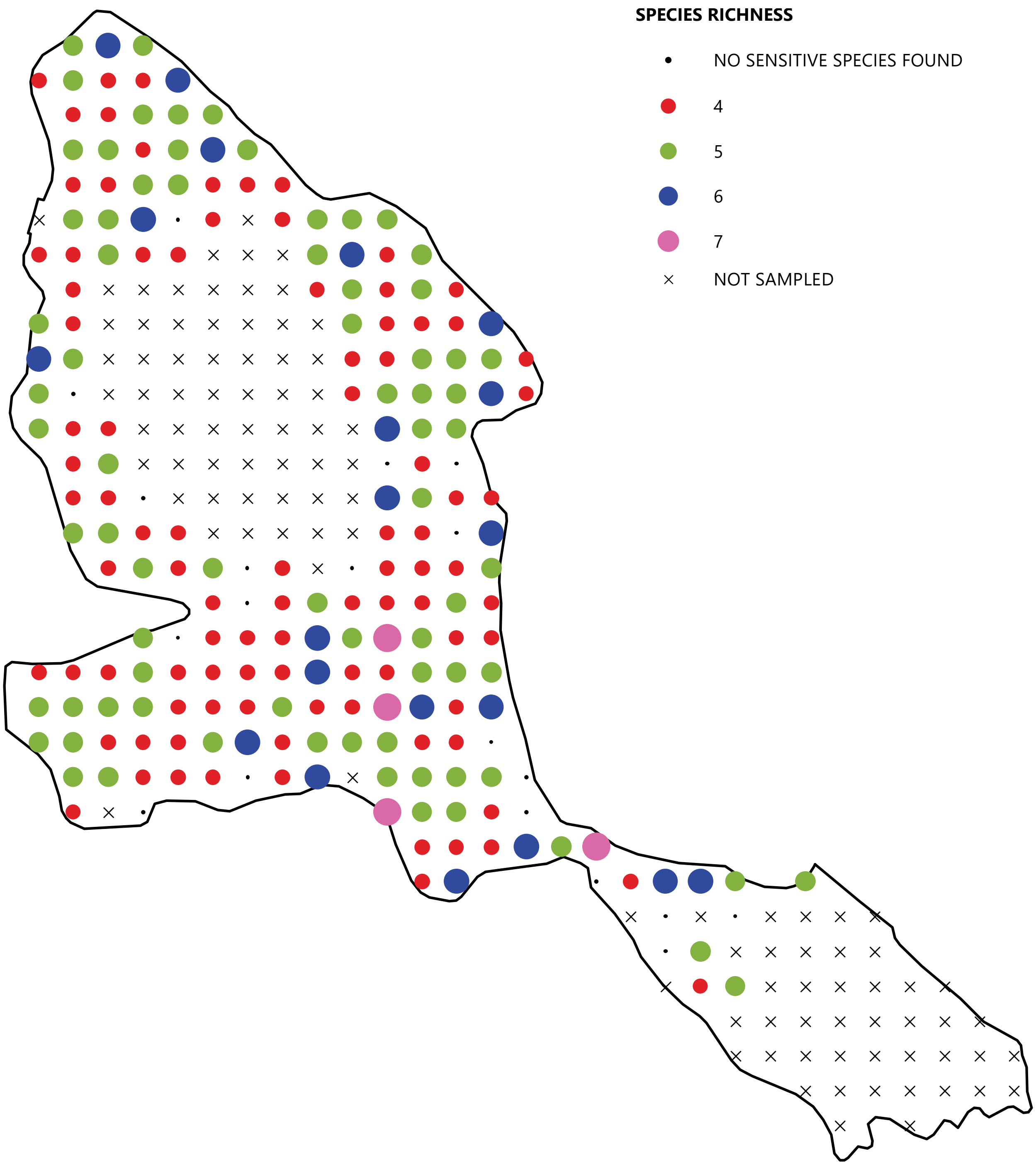
Based on the 2022 point-intercept survey, the five most abundant submerged aquatic plant species in the Lake were, in decreasing order of abundance: 1) eelgrass (*Vallisneria americana*), 2) muskgrass, 3) Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*), 4) slender naiad (*Najas flexilis*), and 5) common bladderwort. Eelgrass and muskgrass were found throughout most of the main body of the Lake with scattered slender

Figure 2.3
Species Richness in Fowler Lake: July 2022



Note: Samples were collected in Fowler Lake between July 11 and 12, 2022.
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.4
Sensitive Species Richness in Fowler Lake: July 2022



Note: Samples were collected in Fowler Lake between July 11 and 12, 2022.

Source: Wisconsin Department of Natural Resources and SEWRPC

naiad, common bladderwort, sago pondweed (*Stuckenia pectinata*), and native pondweeds (*Potamogeton* spp.). While found throughout the Lake, EWM was more common in the southern part of the main Lake. The central portion of the Lake was largely too deep to support aquatic plant growth, except for *Nitella* growing in the 16 to 25 foot range. The portion of the Lake southeast of North Oakwood Avenue had a distinctly different community than the rest of the Lake, with dense growth of water lilies (*Nymphaea odorata*) and spatterdock (*Nuphar variegata*) as well as occurrence of species not commonly observed in the rest of the Lake, such as white water crowfoot, duckweeds (*Lemna* spp. and *Spirodela polyrhiza*), and coontail (*Ceratophyllum demersum*). Photographs of the Lake's aquatic plant community are presented in Figure 2.5.

Over the past 35 years, muskgrass, a type of macroalgae, has consistently been either the most or one of the most abundant aquatic plants in the Lake. This is a critical group of species to protect, as muskgrass has several unique environmental preferences as well as beneficial functions in lakes. Muskgrass is nearly always associated with hard water lakes, particularly those with significant groundwater seepage and springs. This species has been found to promote marl formation and induce dissolved phosphorus to be precipitated to the lake bottom, reducing phosphorus concentrations in the water column and thus improving water clarity.[22] Additionally, muskgrass is a favorite waterfowl food and helps stabilize lake-bottom sediment, as it has been observed to grow deeper than most vascular plants. Its prevalence in a lake's aquatic plant community may tangibly contribute to lake water quality, promoting the growth of other desirable native plant species.

As mentioned in the "Sensitive Species" subsection above, a variety of high value and oftentimes sensitive pondweed species are found in the Lake. The number and relative abundance of these native pondweed species have increased over the years, from a combined relative frequency of occurrence of 8 percent in 1984 to a combined relative frequency of occurrence of 14 percent in 2022. Other native aquatic plants not previously described that have been found over the years in varying abundance include northern watermilfoil (*Myriophyllum sibiricum*), water stargrass (*Heteranthera dubia*), and elodea (*Elodea canadensis*). The native forked duckweed (*Lemna trisulca*) and white water crowfoot were observed for the first time in Fowler Lake in 2022 while several other species that have only been observed in one previous survey, namely white-stem pondweed, small pondweed, and slender nitella, were also observed in this survey.

Exotic Eurasian watermilfoil, curly-leaf pondweed (*Potamogeton crispus*) (CLP), and spiny naiad (*Najas marina*) were observed in the 1984 survey and each survey since. The relative species abundance of EWM and spiny naiad in this survey of 10.9 percent and 0.8 percent, respectively, were lower than in most previous surveys of the Lake while the relative species abundance of CLP was like previous surveys. However, many observations of CLP in this survey were of the turion rather than a growing plant, so the CLP abundance may have been higher earlier in the summer when CLP is typically at its peak.

Changing aquatic plant communities are often the result of change in and around the lake. Causes of change include aquatic plant management practices, land use (which in turn commonly affects nutrient and water supply and availability), lake use, climate, and natural biological processes such as natural population cycles of specific plants. Regarding plant-specific population cycles, it is not uncommon for various pondweed species to succeed each other during the growing season, with some species being more prevalent in cooler water, while others are more prevalent in warmer water. In contrast to such seasonal succession, aquatic plants such as EWM are known to have year-to-year abundance and relative scarcity cycles, possibly due to climatic factors and/or herbivory cycles related to the relative abundance of milfoil weevils (*Eurhychiopsis lecontei*).

Apparent Changes in Observed Aquatic Plant Communities: 2017 versus 2022

The distribution of each aquatic plant species identified as part of the 2022 survey is mapped in Appendix A. The 2022 aquatic plant inventory identified 30 species of aquatic plants (31 including visual-only observations) in the Lake. In contrast, the 2017 aquatic plant inventory identified 19 species (22 including visual-only observations).[23] Overall, the number of aquatic plant species in the Lake has substantially increased since the 1984 survey (11 species identified), but this may be due in part to the difference in methodology and better aquatic plant identification over the course of these surveys.

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[22] *M. Scheffer and E.H. van Ness, "Shallow Lakes Theory Revisited: Various Alternative Regimes Driven by Climate, Nutrient, Depth, and Lake Size,"* Hydrobiologia *584, 2007.*

[23] *SEWRPC Staff Memorandum, 2018,* op. cit.

General Trends

In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2017 and 2022 aquatic plant survey results, as examined below.

- The total littoral vegetated frequency of occurrence remained extremely high (greater than 95 percent) and stable between 2017 and 2022, indicating that almost all the shallow Lake bottom continues to be covered by aquatic vegetation.

- The MDC may have slightly increased from 15 to 16 feet between 2017 and 2022, indicating that water clarity continues to support aquatic plant growth at all depths in the Lake.

- The composition and order of the five most common species shifted between 2017 and 2022. Eelgrass was the most observed species in 2017 and 2022. EWM, the second-most observed species in 2017, became the third-most observed species in 2022 as muskgrass moved from third into second. Common bladderwort moved from the fourth- to the fifth-most observed species between 2017 and 2022 as slender naiad was the fourth-most observed species in 2022.

- EWM was found at substantially fewer points in 2022 than in 2017 while CLP was found at more points in 2022 than 2017 and spiny naiad was observed at seven points in both surveys.

- Several native submerged aquatic plant species have small populations within the Lake. White water crowfoot, water stargrass, southern naiad, several pondweed species (floating, long-leaf, small, and white-stem pondweeds), and small bladderwort were only observed at a few points in 2022 survey.

- While Commission staff did not survey much of the heavily vegetated southeastern edge of the Lake, this area was thoroughly covered by white water lily and spatterdock. Only the outer edges of this area are harvested, and this area does not appear to be disrupted by boat traffic.

As was described earlier, sensitive aquatic plant species are the most vulnerable to human disturbance. Therefore, changes in sensitive species abundance can indicate the general magnitude of human disturbance derived stress on a waterbody's ecosystem. The number of sensitive species (i. e., species with C value of seven or greater) at each sample point during 2017 and 2022

Figure 2.5
Aquatic Plant Community of Fowler Lake

The main body of the Lake hosts an intermixed community of muskgrass (*Chara* spp.), eelgrass (*Vallisneria americana*), pondweeds (*Potamogeton* spp.), Eurasian watermilfoil (*Myriophyllum spicatum*), and other species.

Dense muskgrass bed in the foreground with white water lily (Nymphaea odorata) at the top of the photo.

A harvested lane to facilitate boating access between the northern shoreline and the dense lily growth in the southeastern portion of the Lake.

Source: SEWRPC

were contrasted (Figure 2.6). Overall, the sensitive species richness increased between 2017 and 2022, reflecting a stable and healthy plant community. A few significant observations were noted:

- The most common sensitive "species" in the Lake in both the 2017 and 2022 survey was muskgrass.[24] While Commission staff did not identify muskgrass to species at each survey point, specimens of *Chara contraria* and *Chara globularis* were observed during the survey.

- Sensitive species were distributed throughout almost the entire Lake; only 17 of the 213 surveyed points (eight percent) did not have a sensitive species present (Figure 2.4).

- Gains and losses in the number of sensitive species at each survey point were distributed throughout the Lake, with more points gaining sensitive species numbers than losing them (Figure 2.6).

Eurasian Watermilfoil (EWM)

EWM is an ongoing and serious concern in many Wisconsin lakes, especially nutrient-rich lakes such as those common in Southeastern Wisconsin. EWM has been one of the City's primary targets for control through its ongoing aquatic plant management program. Additionally, riparian landowners also direct substantial effort to EWM control.

EWM is one of eight milfoil species found in Wisconsin and is the only exotic or nonnative milfoil species. EWM favors mesotrophic to moderately eutrophic waters, fine organic-rich lake-bottom sediment, warmer water with moderate clarity and high alkalinity, and tolerates a wide range of pH and salinity.[25,26] In Southeastern Wisconsin, EWM can grow rapidly and has few natural enemies to inhibit its growth. Furthermore, it can grow explosively following major environmental disruptions, as small fragments of EWM can grow into entirely new plants.[27] For reasons such as these, EWM can grow to dominate an aquatic plant community in as little as two years.[28,29] In such cases, EWM can displace native plant species and interfere with the aesthetic and recreational use of waterbodies. However, established populations may rapidly decline after approximately ten to 15 years.[30]

EWM is a significant recreational use problem in Southeastern Wisconsin lakes. For example, boating through dense EWM beds can be difficult and unpleasant. Because EWM can reproduce from stem fragments, recreational use conflicts can help spread EWM. Human produced EWM fragments (e.g., fragments created by power boating through EWM), as well as fragments generated from natural processes (e.g., wind-induced turbulence, animal feeding/disturbance) readily colonize new sites, especially disturbed sites, contributing to EWM spread. EWM fragments can remain buoyant for two to three days in summer and two to six days in fall, with larger fragments remaining buoyant longer than smaller ones.[31] The fragments can also cling to boats, trailers, motors, and/or bait buckets where they can remain alive for weeks contributing to transfer of milfoil to other lakes. For these reasons, it is especially important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

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[24] *Commission staff did not identify muskgrass to species at each point in the plant survey, so all references to muskgrass are to the genus (*Chara *spp.). All species of* Chara *are currently identified as sensitive species.*

[25] *U. S. Forest Service,* Pacific Islands Ecosystems at Risk (PIER)*, 2019.: hear.org/pier/species/myriophyllum_spicatum.htm.*

[26] *S.A. Nichols and B. H. Shaw, "Ecological Life Histories of the Three Aquatic Nuisance Plants:* Myriophyllum spicatum*,* Potamogeton crispus*, and* Elodea canadensis*,"* Hydrobiologia *131(1), 1986.*

[27] Ibid.

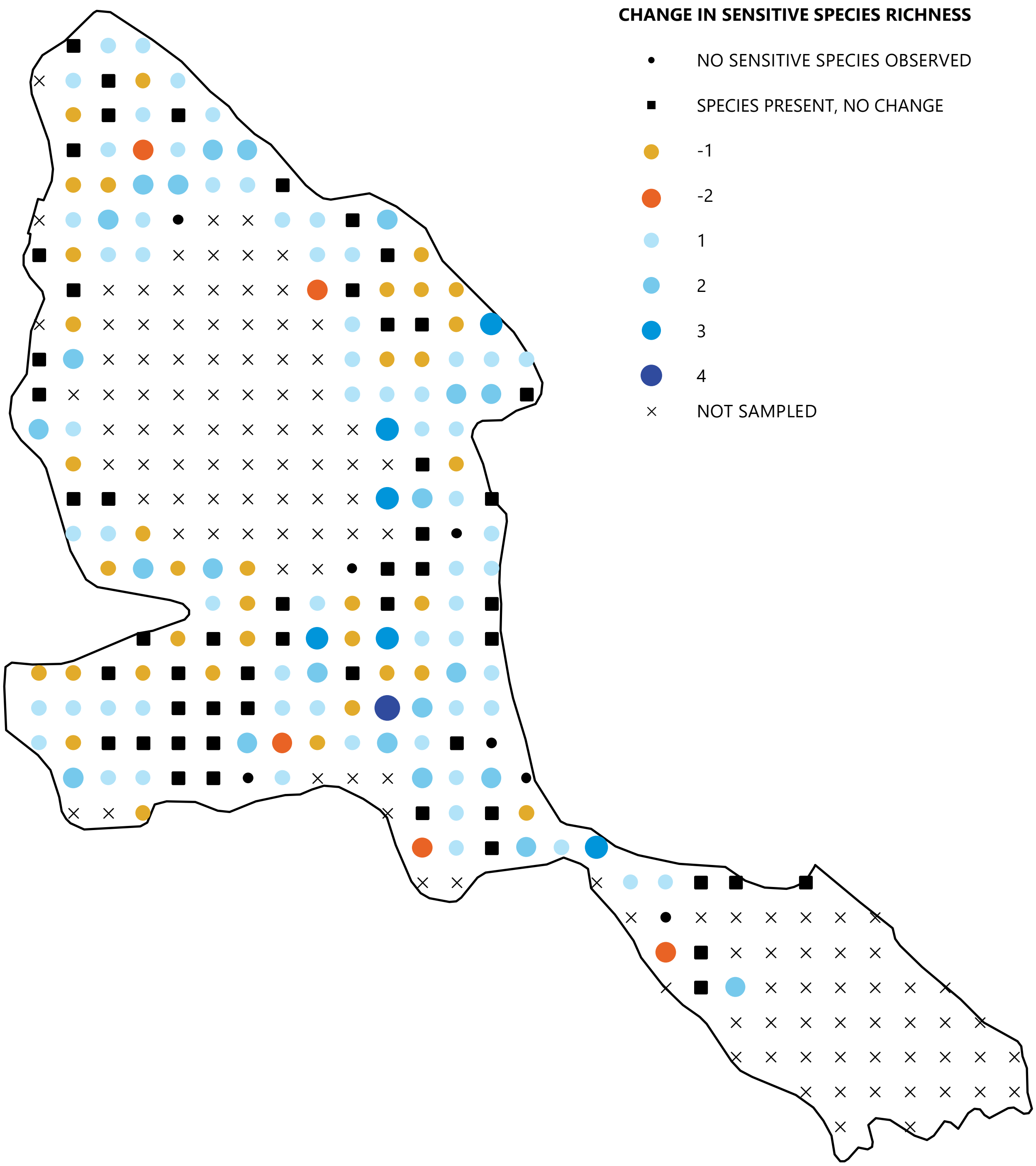
[28] *S.R. Carpenter, "The Decline of Myriophyllum spicatum in a Eutrophic Wisconsin (USA) Lake,"* Canadian Journal of Botany *58(5), 1980.*

[29] *Les, D. H., and L. J. Mehrhoff, "Introduction of Nonindigenous Vascular Plants in Southern New England: a Historical Perspective,"* Biological Invasions *1: 284-300, 1999.*

[30] *S.R. Carpenter, 1980,* op. cit.

[31] *J.D. Wood and M. D. Netherland, "How Long Do Shoot Fragments of Hydrilla (*Hydrilla verticillata*) and Eurasian Watermilfoil (*Myriophyllum spicatum*) Remain Buoyant?",* Journal of Aquatic Plant Management *55: 76-82, 2017.*

Figure 2.6
Change in Sensitive Species Richness in Fowler Lake: August 2017 versus July 2022



Source: Wisconsin Department of Natural Resources and SEWRPC

EWM was observed at 65.8 percent of surveyed points (127 out of 193 points) in the Lake during 2017 and 48.1 percent of surveyed points (101 of 213 points) in 2022.[32] Therefore, the area occupied by EWM relative to other plants slightly decreased between 2017 and 2022. Average rake fullness of EWM was moderate in 2017 and decreased slightly in 2022 (1.63 in 2017 and 1.29 in 2022), with substantial declines in EWM rake fullness in deeper areas of the main body of the Lake (Figure 2.7). However, there are some areas with abundant EWM growth, particularly areas south of East Grove Street in the main body of the Lake. This area has also experienced an increase in EWM rake fullness since the 2017 survey and thus should be considered a focus area for EWM management.

Other Exotic Submergent Aquatic Plants

Curly-leaf pondweed was observed at 19 points in the 2022 survey and at four points in the 2017 survey.[33] This plant, like EWM, is identified in Chapter NR 109 of the *Wisconsin Administrative Code* as a nonnative invasive aquatic plant. Although survey data suggests that it is presently a minor species in terms of dominance, and, as such, is less likely to interfere with recreational boating activities, the plant can grow dense stands that exclude other high value aquatic plants. For this reason, curly-leaf pondweed must continue to be monitored and managed as an invasive member of the aquatic community. As curly-leaf pondweed senesces by midsummer, it may be underrepresented in the inventory data presented in this report.

Spiny naiad is native to North America but was introduced to, and has become naturalized in, Wisconsin. This species is not common within Fowler Lake, with observations at 3.6 percent of surveyed points in 2017 and 3.3 percent of surveyed points in 2022. The WDNR has labeled spiny naiad as a restricted species in Wisconsin, identifying it as an established invasive species that has the potential to cause significant environmental or economic harm.[34] However, spiny naiad is reported to be used as a food source for waterfowl, marsh birds, muskrat, and shelter/forage area for fish. Within the Lake, spiny naiad was observed at only seven survey points located in the northern and western parts of the main Lake body. At these points, spiny naiad did not constitute a large portion of the plant abundance, with a rake fullness of one at six of the survey points and a fullness of two at the remaining point.

2.3 PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic plants have been controlled on Fowler Lake since at least the 1950s – the earliest date that control program records were kept by State agencies. However, aquatic plant control on the Lake probably predates the 1950s 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 by the State due to the potential health hazards it posed to aquatic life and human health.[35] Copper sulfate and Cutrine-Plus were also applied to control floating algae abundance, although this practice has been discontinued in the Lake since the late 1980s.

From 1969 to the mid-1990s, the aquatic herbicides Aquathol, Hydrothol, diquat, and 2,4-D have been used to control aquatic plant growth. Aquathol is a contact herbicide that primarily kills pondweeds, but does not control other potentially nuisance species, such as EWM. Its usage on Fowler Lake was discontinued in the 1980s. The herbicide 2,4-D is a systemic herbicide that is absorbed by the leaves and translocated to other parts of the plant; it is more selective than the other herbicides listed above and is used to control EWM. However, it can also kill beneficial species, such as water lilies (*Nymphaea* sp. and *Nuphar* sp.). The City has not applied 2,4-D to the Lake since 1995 and has no plans to utilize 2,4-D or other chemical treatments in the near future.[36]

[32] *SEWRPC Staff Memorandum, 2018,* op. cit.

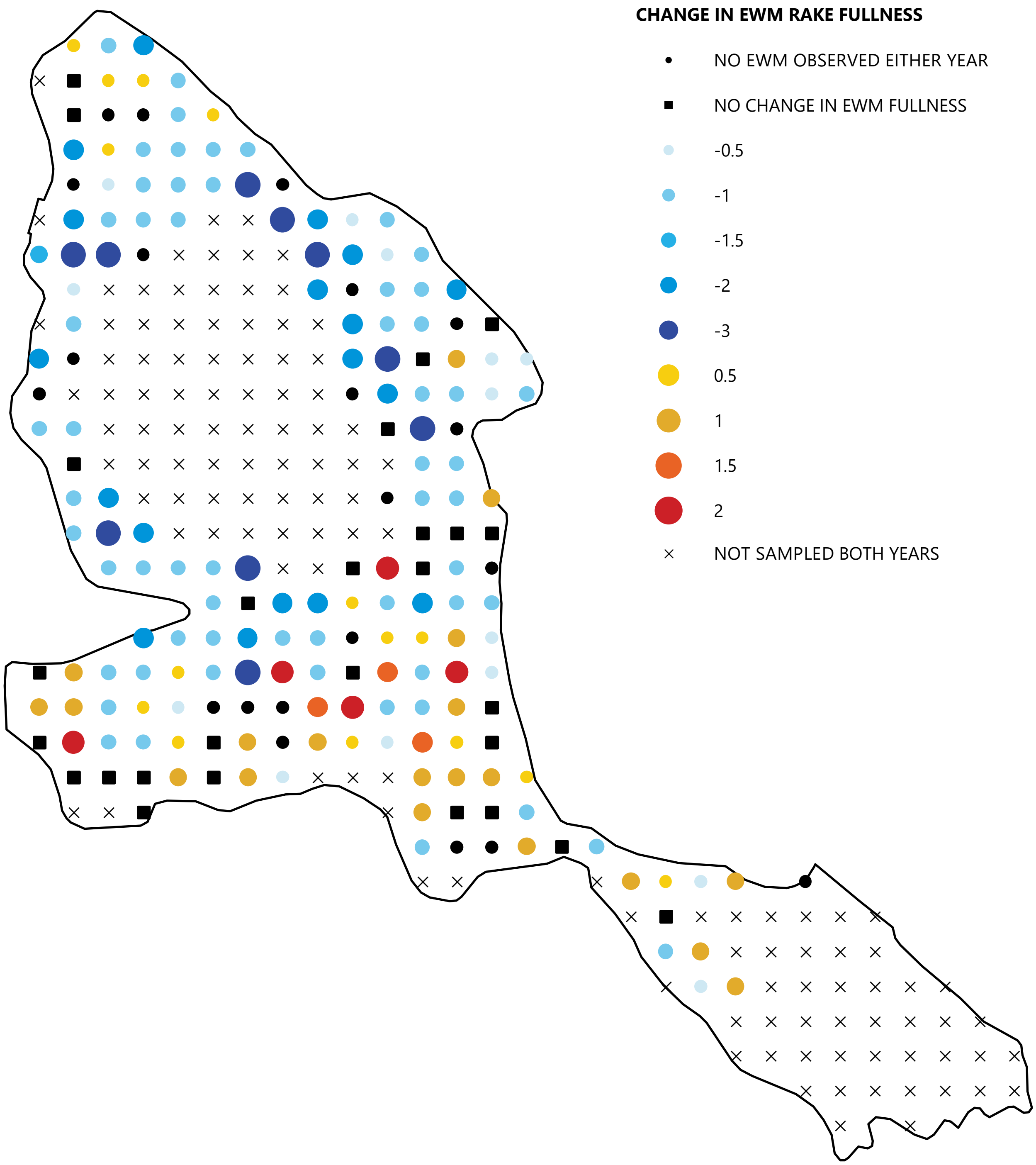
[33] Ibid.

[34] *Wisconsin Department of Natural Resources, Chapter NR 40,* Invasive Species Identification, Classification and Control*, April 2017.*

[35] Ibid.

[36] *Personal communication between Mark Frye, City of Oconomowoc City Administrator, with Commission staff on March 21, 2022.*

Figure 2.7
Change in Eurasian Watermilfoil Rake Fullness in Fowler Lake: August 2017 versus July 2022



Source: Wisconsin Department of Natural Resources and SEWRPC

Since the mid-1990s, mechanical aquatic macrophyte harvesting has been the predominant method used to control aquatic plant growth on the Lake with a primary focus on facilitating recreational boating access and to a lesser extent angling and other forms of recreation. The City is currently permitted to harvest 43 acres, which are delineated into eight harvesting areas across the Lake, and the City operates a shore pick-up program as well.[37] Generally, harvesting operations begin during the first week of June and end by September 15th, although the City staff still operate some shore pick-up a few days after the 15th during some years. Harvesting occurs on Monday through Friday during this period, with shore pick-up commonly conducted on Friday as well. Interruptions to the harvesting program are most frequently due to weather (e.g., thunderstorms, high winds, excessive heat), but mechanical problems and crew shortages also caused interruptions in service.

Harvesting records from 2018 to 2022 indicate that EWM constitutes most of the harvested plants but eelgrass, pondweeds, muskgrass, coontail, and common bladderwort are harvested as well. Observations of CLP in the harvested plants drop off by late June to early July in time with this species' senescence during the warmer summer months. The total volume of aquatic plants harvested each year varies substantially, but harvested volumes are generally lower than they were from 2006 to 2012 (Table 2.4). The City maintains records on the volumes of plants harvested from separate areas of the Lake, which are identified by the City as "Sections" (Figure 2.8).[38] In 2020 and 2021, the highest volumes of harvested plants were generally from Sections 2, 7, and 8 while Sections 1, 5, and 6 contributed moderate amounts and Section 3, 4, and the shore pickup program contributed the lowest volumes. Section 2, which covers the southeastern portion of the main Lake, contributed the highest volume and was visited the most times by the aquatic plant harvester. Section 8, which covers the portion of the Lake southeast of North Oakwood Avenue, was visited the fewest times of any Section but still contributed the second-highest total volumes.

A benefit of harvesting versus chemical treatment is that harvesting physically removes plant mass and the nutrients contained therein. The Commission calculated the pounds of total phosphorus removed through harvesting in the Lake by multiplying the annual mass of aquatic plants removed by the phosphorus concentration of those aquatic plants, with the following notes and assumptions:

- The density of the wet harvested plants was assumed to be approximately 300 pounds per cubic yard.

- The amount of phosphorus contained by aquatic plants varies by species, lake, and time. The phosphorus content of harvested plants used estimates from the Wisconsin Lutheran College (WLC) on Pewaukee Lake, the U.S. Geological Survey on Whitewater and Rice lakes (Whitewater-Rice), and a study conducted on a eutrophic lake in Minnesota (Minnesota). The WLC study assumed that plant wet weight is 6.7% of dry weight and that total phosphorus constitutes 0.2% of the total dry weight of the plant. The Whitewater-Rice and Minnesota studies assumed that dry weight is 15 and 7% of the wet weight, respectively, and phosphorus constituted 0.31 and 0.30% of the dry plant weight, respectively. Assumed values for the percent of dry weight to wet weight and the total phosphorus concentrations are similar to those found in other studies.[39,40]

[37] *Letter from Mark Frye, City of Oconomowoc Director of Public Works, to Heidi Bunk, WDNR Lakes Biologist, on October 7, 2022.*

[38] *A map with the Section delineations was included in a letter from Mark Frye, City of Oconomowoc Director of Public Works, to Heidi Bunk, WDNR Lakes Biologist, on October 4, 2021.*

[39] *K.M. Carvalho and D.F. Martin, "Removal of Aqueous Selenium by Four Aquatic Plants," Journal of Aquatic Plant Management 39: 33-36, 2001.*

[40] *G. Thiébaut "Phosphorus and Aquatic Plants. In: P.J. White and J.P. Hammond (eds) The Ecophysiology of Plant-Phosphorus Interactions,"* Plant Ecophysiology *7, 2008.*

Using these methods, the Commission estimates that aquatic plant harvesting has removed approximately 2,471 pounds of phosphorus from the Lake during the six years for which plant harvest records are available (Figure 2.9). The City's harvesting removes an average of 554 pounds of phosphorus from the Lake each year. A 1984 Commission study estimated that the average total annual phosphorus load to the Lake was 2,630 pounds.[41] Therefore, aquatic plant harvesting may remove up to 21 percent of the total phosphorus contributed annually by surface runoff and tributary streams.

Table 2.4
Aquatic Plants Harvested in Fowler Lake: 2006 – 2022

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
2018	28,023
2019	45,047
2020	43,475
2021	64,951
2022	54,486
Mean Per Year	61,602

Source: City of Oconomowoc

2.4 POTENTIAL AQUATIC PLANT CONTROL METHODOLOGIES

Aquatic plant management techniques can be classified into six categories.

- *Physical measures* include lake bottom coverings
- *Biological measures* include the use of organisms such as herbivorous insects
- *Manual measures* involve physically removing plants by hand or using hand-held tools such as rakes
- *Mechanical measures* rely on artificial power sources and remove aquatic plants with a machine known as a harvester or by suction harvesting
- *Chemical measures* use aquatic herbicides to kill nuisance and nonnative plants *in-situ*
- *Water level manipulation measures* utilize fluctuations in water levels to reduce aquatic plant abundance and promote growth of specific native species

All aquatic plant control measures are stringently regulated and most require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under *Wisconsin Administrative Code* Chapter NR 107, "Aquatic Plant Management" 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 *Wisconsin Administrative Code* Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations." Furthermore, the aquatic plant management measures described in this plan 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 *Wisconsin Administrative Code* Chapter NR 1, "Natural Resources Board Policies." Water level manipulations require a permit and are regulated under *Wisconsin Statutes* 30.18 and 31.02.[42,43] More details about aquatic plant management each are discussed in the following sections while recommendations are provided later in this document.

Non-compliance with aquatic plant management 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 help frame permit requirements. Permits can cover up to

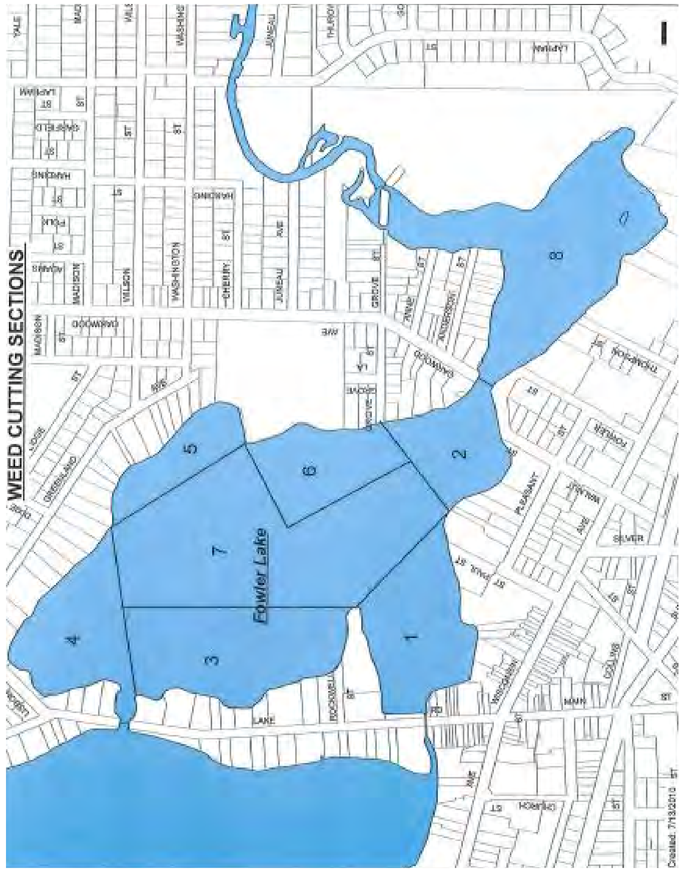
[41] *SEWRPC Community Assistance Planning Report No. 187*, A Management Plan for Fowler Lake, Waukesha County, Wisconsin, *March 1996*.

[42] *docs.legis.wisconsin.gov/statutes/statutes/30/ii/18*.

[43] *docs.legis.wisconsin.gov/statutes/statutes/31/02*.

a five-year period.[44] At the end of that period, the aquatic plant management plan must be updated. 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 have occurred on the lake.[45] These plans and plan execution are reviewed and overseen by the WDNR regional lakes and aquatic invasive species coordinators.[46]

Figure 2.8
Aquatic Plant Harvesting Map for Fowler Lake



Source: City of Oconomowoc and SEWRPC

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 control offers an alternative to direct human intervention to manage 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.[47] For example, milfoil weevils (*Eurhychiopsis lecontei)* have been used to control EWM. Milfoil weevils do best in waterbodies with balanced panfish populations,[48] where dense EWM beds reach the surface close to shore, where natural shoreline areas include leaf litter that provides habitat for over-wintering weevils, and where there is comparatively little boat traffic. This technique is not presently commercially available making the use of milfoil weevils non-viable.

Manual Measures

Manually removing specific types of vegetation is a highly selective means of controlling nuisance aquatic plant growth, including invasive species such as EWM. Two commonly employed methods include hand raking and hand pulling. Both physically remove target plants from a lake. Since plant stems, leaves, roots, and seeds are actively removed from the lake, the reproductive potential and nutrients contained by pulled/raked plants material is also removed. These plants, seeds, and nutrients would otherwise re-enter the lake's water column or be deposited on the lake bottom. Hence, this aquatic plant management

[44] *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.*

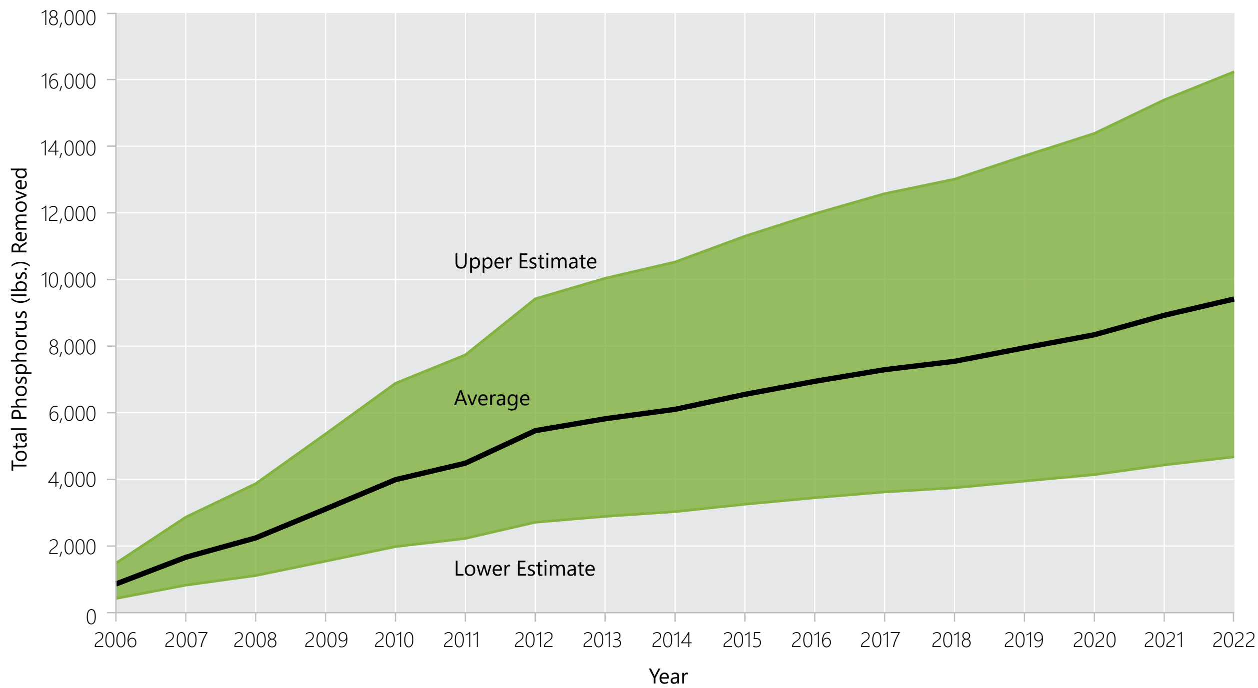
[45] *Aquatic plant harvesters must report harvesting activities as one of the permit requirements.*

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

[47] *B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control,"* LakeLine *17(3): 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.*

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

Figure 2.9
Fowler Lake Phosphorus Removal by Harvesting: 2006 - 2022



Source: City of Oconomowoc and SEWRPC

technique helps incrementally maintain water depth, improves water quality, and can help decrease the spread of nuisance/exotic plants. Since hand raking and hand pulling are readily allowed by WDNR, and since both are practical methods to control riparian landowner scale problems, these methods 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 provides a safe and convenient aquatic plant control method in deeper nearshore waters around piers and docks. Advantages of this method include:

- Tools are inexpensive ($100 to $150 each),
- The method is easy to learn and use,
- It may be employed by riparian landowners without a permit if certain conditions are met,
- Results are immediately apparent, and,
- Plant material is immediately removed from a lake (including seeds)

The second manual control method, hand-pulling whole plants (stems, roots, leaves, seeds) where they occur in isolated stands, is a simple means to control nuisance and invasive plants in shallow nearshore areas that may not support large-scale initiatives. This method is particularly helpful when attempting to target nonnative plants (e.g., EWM, curly-leaf pondweed) during the high growth season when native and nonnative species often comingle. Hand pulling is more selective than raking, mechanical removal, and chemical treatments, and, if carefully applied, is less damaging to native plant communities. Recommendations regarding hand-pulling, hand-cutting, and raking are discussed later in this document.

Mechanical Measures

Two methods of mechanical harvesting are currently employed in Wisconsin - mechanical harvesting and suction harvesting. Both are regulated by WDNR and require a permit.[49]

Mechanical Harvesting

Aquatic plants can be mechanically gathered using specialized equipment commonly referred to as harvesters. Harvesters use an adjustable depth cutting apparatus that can cut and remove plants from the water surface to up to about five feet below the water surface. The harvester gathers cut plants with a conveyor, basket, or other device. Mechanical harvesting is often a very practical and efficient means to control nuisance plant growth and is widely employed in Southeastern Wisconsin.

In addition to controlling plant growth, gathering and removing plant material from a lake reduces in-lake nutrient recycling, sedimentation, and targets 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 and popular for large-scale open-water projects. However, small harvesters are also produced that are particularly suited to working around obstacles such as piers and docks in shallow nearshore areas.

An advantage of mechanical harvesting is that the harvester, when properly operated, “mows” aquatic plants and, therefore, typically leaves enough living plant material in place to provide shelter for aquatic wildlife and stabilize lake-bottom sediment. Harvesting, when done properly, does not kill aquatic plants, it simply trims plants back. Aside from residual plant mass remaining because of imperfect treatment strategy execution, none of the other aquatic plant management methods purposely leave living plant material in place after treatment. Aquatic plant harvesting has been shown to allow light to penetrate to the lakebed and stimulate regrowth of suppressed native plants. This is particularly effective when controlling invasive plant species that commonly grow quickly early in the season (e.g., EWM, curly-leaf pondweed) when native plants have not yet emerged or appreciably grown.

A disadvantage of mechanical harvesting is that the harvesting process may fragment plants and thereby unintentionally propagate EWM and curly-leaf pondweed. EWM fragments are particularly successful in establishing themselves in areas where plant roots have been removed. This underscores the need to avoid harvesting or otherwise disrupting native plant roots. Harvesting may also agitate bottom sediments in shallow areas, thereby increasing turbidity and resulting in deleterious effects such as smothering fish breeding habitat and nesting sites. To this end, most WDNR-issued permits do not allow deep-cut harvesting in water less than three feet deep,[50] which limits the utility of this alternative in many littoral and shoal areas. Nevertheless, if employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can reduce regrowth of nuisance plants while maintaining, or even enhancing, native plant communities.

Cut plant fragments commonly escape the harvester’s collection system and form mats or accumulate on shorelines. To compensate for this, most harvesting programs include a plant pickup program. Some plant pickup programs use a harvester to gather and collect significant accumulations of floating plant debris as well as sponsor regularly scheduled aquatic plant pick up from lakefront property owner docks. Property owners are encouraged to actively rake plant debris along their shorelines and place these piles on their docks for collection. 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. Nevertheless, it is important to remember that normal boating activity (particularly during summer weekends) often creates far more plant fragments than generated from mechanical harvesting. Therefore, a plant pickup program is often essential to protect a lake’s health and aesthetics, even in areas where harvesting has not recently occurred.

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[49] *Mechanical control permit conditions depend upon harvesting equipment type and specific equipment specifications.*

[50] *Deep-cut harvesting is harvesting to within one foot of the lake bottom. This is not allowed in shallow water because it is challenging to ensure that the harvester avoids lake-bottom contact in such areas.*

Suction Harvesting and DASH

Another mechanical plant harvesting method uses suction to remove aquatic plants from a lake. Suction harvesting removes sediment, aquatic plants, plant roots, and anything else from the lake bottom and disposes this material outside the lake. Since bottom material is removed from the lake, this technique also requires a dredging permit in addition to the aquatic plant management permit.

First permitted in 2014, DASH is a mechanical process where divers identify and pull select aquatic plants and roots from the lakebed and then insert the entire plant into a suction hose that transports the plant to the surface for collection and disposal. The process is a mechanically assisted 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 growth of invasive plants like EWM; 2) increased selectivity of plant removal when compared to mechanical techniques and hand raking which in turn reduces native plant loss; and 3) lower potential for disturbing fish habitat.

Given how costly DASH can be and how widespread EWM is found in some portions of the Lake, DASH is not considered a viable control option for managing EWM throughout the Lake. Nevertheless, DASH can provide focused relief of nuisance native and non-native plants around piers and other critical areas. If individual property owners chose to employ DASH, a NR 109 permit is required.

Chemical Measures

Aquatic chemical herbicide use is stringently regulated. A WDNR permit and direct WDNR staff oversight is required during application. Chemical herbicide treatment is used for short time periods to temporarily control excessive nuisance aquatic plant growth. Chemicals are applied to growing plants in either liquid or granular form. Advantages of chemical herbicides aquatic plant growth control include low cost as well as the ease, speed, and convenience of application. However, many drawbacks are also associated with chemical herbicide aquatic plant control including the following examples.

- **Unknown and/or conflicting evidence about the effects of long-term chemical exposure on fish, fish food sources, and humans.** The U.S. Environmental Protection Agency, the agency responsible for approving aquatic plant treatment chemicals, studies aquatic plant herbicides to evaluate short-term exposure (acute) effects on human and wildlife health. Some studies also examine long-term (chronic) effects of chemical exposure 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 animal testing protocol, time constraints, and other factors. Furthermore, long-term studies cannot address all potentially affected species.[51] For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.[52] Some lake property owners judge the risk of using chemicals as being excessive despite legality of use. Consequently, the concerns of lakefront owners should be considered whenever chemical treatments are proposed. Moreover, if chemicals are used, they should be applied as early in the season as practical. This helps assure that the applied chemical decomposes before swimming, water skiing, and other active body-contact lake uses begin.[53] Early season application also is generally the best time to treat EWM and curly-leaf pondweed for a variety of technical reasons explained in more detail as part of the "loss of native aquatic plants and related reduction or loss of desirable aquatic organisms" bullet below.

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

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

[53] *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 lessen chemical exposure. Consequently, allowing extra wait time is recommended to help lake residents and l users can feel comfortable that they are not being unduly exposed to aquatic plant control chemicals.*

- **Reduced water clarity and increased risk of algal blooms.** Water-borne nutrients promote growth of both aquatic plants and algae. If rooted aquatic plant populations are depressed, demand for dissolved nutrients will be lessened. In such cases, algae tend to become more abundant, a situation reducing water clarity. For this reason, lake managers must avoid needlessly eradicating native plants and excessive chemical use. Lake managers must strive to maintain balance between rooted aquatic plants and algae - when the population of one declines, the other may increase in abundance to nuisance levels. In addition to upsetting the nutrient balance between rooted aquatic plants and algae, dead chemically treated aquatic plants decompose and contribute nutrients to lake water, a condition that may exacerbate water clarity concerns and algal blooms.

- **Reduced dissolved oxygen/oxygen depletion.** When chemicals are used to control large mats of aquatic plants, the dead plant material settles to the bottom of a lake and decomposes. Plant decomposition uses oxygen dissolved in lake water, the same oxygen that supports fish and many other vital beneficial lake functions. In severe cases, decomposition processes can deplete oxygen concentrations to a point where desirable biological conditions are no longer supported.[54] Ice covered lakes and the deep portions of stratified lakes are particularly vulnerable to oxygen depletion. Excessive oxygen loss can inhibit a lake's ability to support certain fish and can trigger processes that release phosphorus from bottom sediment, further enriching lake nutrient levels. These concerns emphasize the need to limit chemical control and apply chemicals in *early* spring, when EWM and curly-leaf pondweed have not yet formed dense mats.

- **Increased organic sediment deposition.** Dead aquatic plants settle to a lake's bottom, and, because of limited oxygen and/or rapid accumulation, may not fully decompose. Flocculent organic rich sediment often results, reducing water depth. Care should be taken to avoid creating conditions leading to rapid thick accumulations of dead aquatic plants to promote more complete decomposition of dead plant material.

- **Loss of native aquatic plants and related reduction or loss of desirable aquatic organisms.** EWM and other invasive plants often grow in complexly intermingled beds. Additionally, EWM is physically similar to, and hybridizes with, native milfoil species. Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. A robust and diverse native plant community forms the foundation of a healthy lake and the conditions needed to provide and host desirable gamefish. Fish, and the organisms fish eat, require aquatic plants for food, shelter, and oxygen. If native plants are lost due to insensitive herbicide application, fish and wildlife populations often suffer. For this reason, if chemical herbicides are applied to the Lake, these chemicals must target EWM or curly-leaf pondweed and therefore should be applied in early spring when native plants have not yet emerged. Early spring application has the additional advantage of being more effective due to colder water temperatures, a condition enhancing herbicidal effects and reducing the dosing needed for effective treatment. Early spring treatment also reduces human exposure concerns (e.g., swimming is not particularly popular in early spring).

- **Need for repeated treatments.** Chemical herbicides are not a one-time silver-bullet solution – instead, treatments need to be regularly repeated to maintain effectiveness. Treated plants are not actively removed from the Lake, a situation increasing the potential for viable seeds/fragments to remain after treatment, allowing target species resurgence in subsequent years. Additionally, leaving large expanses of lakebed devoid of plants (both native and invasive) creates a disturbed area without an established plant community. EWM thrives in disturbed areas. In summary, applying chemical herbicides to large areas can provide opportunities for exotic species reinfestation and new colonization which in turn necessitates repeated and potentially expanded herbicide applications.

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[54] *The WDNR's water quality standard to support healthy fish communities is 5 mg/L for warmwater fish communities and 7 mg/L for coldwater fish communities.*

- **Hybrid watermilfoil's resistance to chemical treatment**. The presence of hybrid watermilfoil complicates chemical treatment programs. Research suggests that certain hybrid strains may be more tolerant to commonly utilized aquatic herbicides such as 2,4-D and Endothall.[55,56] Consequently, further research regarding hybrid watermilfoil treatment efficacy is required to apply appropriate herbicide doses. This increases the time needed to acquire permits and increases application program costs.

- **Effectiveness of small-scale chemical treatments**. Small-scale EWM treatments using 2,4-D have yielded highly variable results. A study completed in 2015 concluded that less than half of 98 treatment areas were effective or had more than a 50 percent EWM reduction.[57] For a treatment to be effective, a target herbicide concentration must be maintained for a prescribed exposure time. However, wind, wave and other oftentimes difficult to predict mixing actions often dissipate herbicide doses. Therefore, when deciding to implement small-scale chemical treatments, the variability in results and treatment cost of treatment should be examined and contrasted.

Considering the expanse of EWM in the southeastern portion of the main Lake, a large spot treatment in that area may be utilized.[58] In addition, 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 City. Whatever the case, monitoring should continue to ensure that EWM does not become more problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

Water Level Manipulation Measures

Manipulating water levels can also be an effective method for controlling aquatic plant growth and restoring native aquatic plant species, particularly emergent species such as bulrush and wild rice.[59] In Wisconsin, water level manipulation is considered to be most effective by using winter lake drawdowns, which expose lake sediment to freezing temperatures while avoiding conflict with summer recreational uses. One to two months of lake sediment exposure can damage or kill aquatic plant roots, seeds, and turions through freezing and/or desiccation. As large areas of lake sediment need to remain exposed for extended periods, water level manipulation is most cost effective in lakes with operable dam gates that can provide fine levels of control of water elevations within the lake. In lakes without dams, high capacity water pumping can be used to reduce lake levels at much greater cost.

While water level manipulation affects all aquatic plants within the drawdown zone, not all plants are equally susceptible to drawdown effects. Abundance of water lilies (*Nymphaea* spp. and *Nuphar* spp.) and milfoils (*Myriophyllum* spp.) can be greatly reduced by winter drawdowns while other species, such as duckweeds (*Lemna* spp.), may increase in abundance.[60] Two studies from Price County, Wisconsin show reduced abundance of invasive EWM and curly-leaf pondweed and increased abundance of native plant species following winter drawdowns.[61,62] Thus, drawdowns can be used to dramatically alter the composition of a

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[55] *L.M. Glomski and 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 *48: 12-14, 2010.*

[56] *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 *6: 462-471, 2013.*

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

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

[59] *For detailed literature reviews on water level manipulation as an aquatic plant control measure, see C. Blanke, A. Mikulyuk, M. Nault, et al.,* Strategic Analysis of Aquatic Plant Management in Wisconsin*, Wisconsin Department of Natural Resources, pp. 167-171, 2019 as well as J.R. Carmignani and A.H. Roy, "Ecological Impacts of Winter Water Level Drawdowns on Lake Littoral Zones: A Review,"* Aquatic Sciences *79: 803-824, 2017.*

[60] *G.D. Cooke, "Lake Level Drawdown as a Macrophyte Control Technique,"* Water Resources Bulletin *16(2): 317-322, 1980*

[61] *Onterra, LLC,* Lac Sault Dore, Price County, Wisconsin: Comprehensive Management Plan*, 2013.*

[62] *Onterra, LLC,* Musser Lake Drawdown Monitoring Report*, Price County, Wisconsin, 2016.*

lake's aquatic plant community. Many emergent species rely upon the natural fluctuations of water levels within a lake. Conducting summer and early fall drawdowns have effectively been used to stimulate the growth of desired emergent vegetation species, such as bulrush, burreeds, and wild rice, in the exposed lake sediments, which subsequently provide food and habitat for fish and wildlife. However, undesired emergent species, such as invasive cattails and phragmites, can also colonize exposed sediment, so measures should be taken to curtail their growth during a drawdown.[63]

Water level manipulation can also have unintended impacts on water chemistry and lake fauna.[64,65] Decreased water clarity and dissolved oxygen concentrations as well as increased nutrient concentrations and algal abundance have all been reported following lake drawdowns. Rapid drawdowns can leave lake macroinvertebrates and mussels stranded in exposed lake sediment, increasing their mortality, and subsequently reducing prey availability for fish and waterfowl. Similarly, drawdowns can disrupt the habitat and food sources of mammals, birds, and herptiles, particularly when nests are flooded as water levels are raised in the spring. Therefore, thoughtful consideration of drawdown timing, rates, and elevation as well as the life history of aquatic plants and fauna within the lake is highly recommended. Mimicking the natural water level regime of the lake as closely as possible may be the best approach to achieve the desired drawdown effects and minimize unintended and detrimental consequences.

As discussed above, water level manipulation is a large-scale, permitted operation that can have major effects on lake ecology. Consequently, detailed information on the Lake's hydrology, including groundwater, should be compiled before undertaking such an operation. The WDNR would likely require and consider the following during review of the drawdown permit application:

- Existing lake bottom contours should be reevaluated (Map 1.1) with any changes mapped to develop updated bathymetric information.

- Lake volume needs to be accurately determined for each foot of depth contour.

- Lake bottom acreage exposed during various intervals of the drawdown must be determined.

- Knowledge of the drawdown and refill times for the Lake would guide proper timing of drawdown to maximize effectiveness and minimize impacts to Lake users.

- A safe drawdown discharge rate would need to be calculated to prevent downstream flooding and erosion.

- Effects on the lake drawdown to the structural integrity of outlet dams should be examined.

- A WDNR permit and WDNR staff supervision are required to draw down a lake. Additionally, lakeshore property owners need to be informed of the drawdown and permit conditions before the technique is implemented. Targeted invasive species populations should be monitored before and after refill is complete to assess efficacy and guide future management.

[63] *Blanke et al., 2019,* op. cit.

[64] Ibid.

[65] *Cooke,* op. cit.

MANAGEMENT RECOMMENDATIONS AND PLAN IMPLEMENTATION 3

Credit: SEWRPC Staff

Fowler Lake (the Lake) supports a robust and diverse aquatic plant community. The Wisconsin Department of Natural Resources (WDNR) has identified the Lake in their published list of state high-quality waters.[66] However, the invasive Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) is widespread in the southern portion of the Lake and may negatively affect the growth of native species as well as recreational use of the Lake. On account of these and other factors, aquatic plant management continues to be an important approach to maintaining the excellent natural resource service the Lake provides.

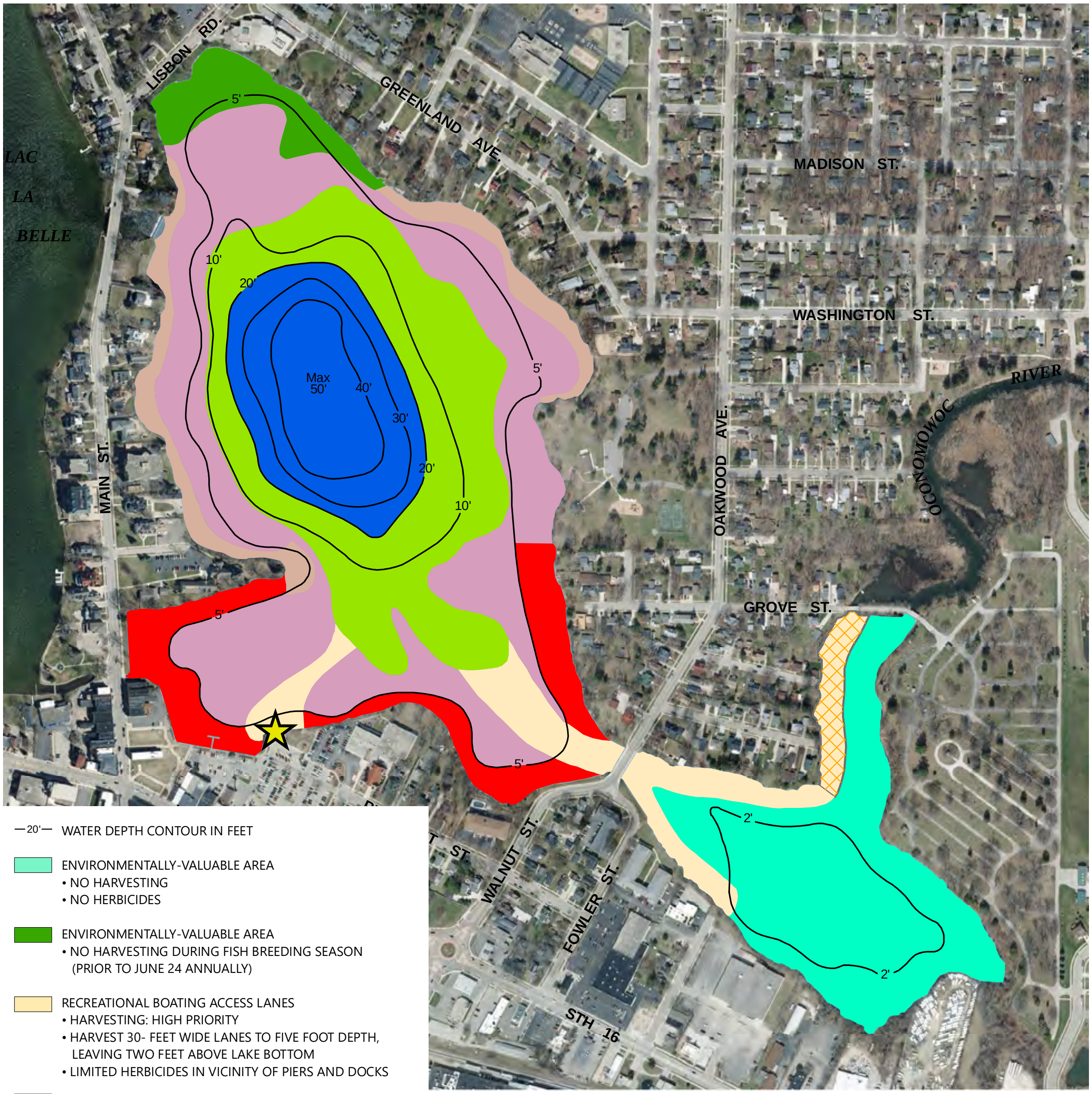
Holistic management alternatives and recommended refinements to the existing aquatic plant management plan are presented in this chapter. Given the scope of this study, little emphasis is given to measures whose scope and location are more suitably taken up by other governmental agencies. For example, agencies with jurisdiction over areas tributary to the Lake (e.g., Town or County government) may be better suited to address measures to reduce nutrient inputs to the Lake. Reduced nutrient input can passively reduce aquatic plant abundance and thereby tangibly influence aquatic plant management. Nevertheless, the City of Oconomowoc (City) and the Fowler Lake Management District (District) should actively seek out and collaborate with such agencies to manage aquatic plants most effectively.

3.1 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 single-minded "silver bullet" strategy rarely produces the most efficient, most reliable, or best overall result. Therefore, to enhance lake access, recreational use, and lake health, this plan recommends a combination of several aquatic plant management techniques. For the reader's convenience, the various elements of the recommended aquatic plant management plan are schematically presented (Figure 3.1) and are briefly summarized in the following paragraphs. Additional details useful to implement the plant management plan follow this summary.

[66] *For more information on the WDNR's Healthy Watersheds, High-Quality Waters initiative, see the following: dnr.wisconsin.gov/topic/SurfaceWater/HQW.html.*

Figure 3.1
Recommended Aquatic Plant Management Plan Elements for Fowler Lake: 2022



—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- FEET 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 withing a given season. Management area size and locations are not scaled and only illustrate overall concept. See "Aquatic Plant Management Recommendations."

1. **Mechanically harvest invasive and nuisance aquatic plants.** Mechanical harvesting should remain the primary means to manage invasive and nuisance aquatic plants on Fowler Lake. Harvesting must avoid, or must be substantially restricted, in certain areas of the Lake.[67] This includes areas of greater ecological value, areas that provide unique habitat, areas that are difficult to harvest due to lake morphology (e.g., excessively shallow water depth), and where boat access is not desired or necessary (e.g., marshland areas). Much of the southeastern portion of Fowler Lake is composed of floating-leaf vegetation, a situation restricting mechanical harvesting to lanes that protect sensitive plants yet allows riparian residents and boat launch users to navigate between the Lake and the upstream Oconomowoc River, engage in a variety of water-related recreational pursuits, and access open water areas. Care should be taken to avoid harvesting native aquatic plants – harvesting should focus on areas of profuse invasive plant growth.

2. **Manually remove nearshore invasive and nuisance plant growth.** Manual removal involves controlling aquatic plants by hand or using hand-held non-powered tools. Riparian landowners should consider manual removal of undesirable plants an integral and vital part of the Lake's overall plant management plan. Manual removal is often the plan element that yields the transitional interface between landowner uses, desires, and concerns, and public management of the overall waterbody. Manual removal does not require a permit if riparian landowners remove only invasive plants without injuring native plants or remove nuisance native aquatic plants along 30 or less feet of shoreline (inclusive of dock, pier, and other lake access areas) and generally not more than 100 feet into the lake.

3. **Chemically treat nonnative plants around private piers**. Large-scale chemical treatment is not part of the City's aquatic plant management plan. Nevertheless, the City may want to consider a rapid response chemical treatment for Chapter NR 40 prohibited species (e.g., hydrilla, *Hydrilla verticillata)*, where appropriate, if such a species were to appear in the Lake in the future. In addition, because EWM frequency of occurrence in the surveyed littoral zone of the Lake was 48.1 percent in 2022 (Table 2.1), the City may choose to pursue a large-scale chemical treatments to reduce the EWM population in the southern portions of the Lake. This method of aquatic plant control has several drawbacks (e.g., water quality, comparatively nonselective, chemical side effects, and more) and should only be considered under exceptional circumstances.

4. **Continue participation in the Clean Boats Clean Waters program** to proactively encourage Lake users to clean boats and equipment before launching and using them in Fowler Lake.[68] This will help lower the probability of novel invasive species entering the Lake.

Mechanical Harvesting

The City currently operates one Aquarius Systems brand harvester on the Lake: HM-420s.[69] This mid-size harvester has the capacity to cut up to 5.2 feet deep using a 7 foot wide cutter bar. This depth is suitable for harvesting in most of the Lake. In shallow waters, slow speed operation and extreme diligence must be taken to avoid contacting the lake bottom with the cutter head. In all areas, at least one foot of living plant material must remain attached to the lake bottom after cutting. This harvester is supported by an MSC-23 Pier Conveyor and T-12 Transport Barge that are used to transport cut plants to a dump truck on shore for off-site disposal.

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[67] *SEWRPC Staff Memorandum,* An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin*: 2018, 2018.*

[68] *Further information about Clean Boats Clean Waters can be found on the WDNR website at: dnr.wi.gov/lakes/cbcw/.*

[69] *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 can be folded down to reduce the height of the machine. Personal Communication, Mark Frye, Director of Public Works, City of Oconomowoc.*

The approximate orientation and extent of proposed harvesting areas within the Lake were maintained as published in the 2018 aquatic plant management plan due to the robust and improving aquatic plant community observed during the 2022 survey.[70] The general locations of harvesting areas are schematically illustrated in Figure 3.1. The recreational boating access lanes and EWM control areas identified as high priorities for harvesting in the plan are already focus areas for the City and return high volumes of harvested plants (Sections 2 and 8 in Figure 2.8). The northern environmentally-valuable area and the shoreline zones, which have low priority for harvesting, roughly cover Sections 3, 4, and 5; these Sections have low volumes of harvested plants and have experienced a decline in EWM rake fullness since the 2017 survey (Figure 2.7). The precise locations of the harvest areas must be chosen carefully and must be maintained in a fixed position throughout the year to avoid unintentional disturbance to adjacent sensitive areas. Harvesting lane position should consider water depth, plant species present, lane use, and boating habits/practices on the Lake. For example, whenever possible, lanes should favor deeper water areas, should support the Lake's recreational uses, and should attempt to focus plant harvest on invasive species. Additional information regarding cutting patterns and depth is provided below.

1. **Except for navigational access lanes, harvesters must not be operated nearshore in water less than 36 inches feet deep**. Mechanical harvesting may be expanded in shallow, obstacle-prone nearshore areas throughout the Lake if a small-scale harvester is available. Even though the City's harvester may be able to navigate in waters in as shallow as 12 inches when empty, at least 12 inches of plant growth should remain standing after harvesting. Therefore, aside from regulatory restrictions, mechanically harvesting aquatic plants in extremely shallow water (e.g., areas with less than 18 inches of water depth) is not practical.

2. **Maintain at least 12 inches of living plant material after harvesting**. The City's current aquatic plant harvester can cut aquatic plants up to 65 inches below the water surface. Harvesting equipment operators must not intentionally denude the lakebed. Instead, the goal of harvesting is to maintain and promote healthy native aquatic plant growth. Harvesting invasive aquatic plants can promote native plant regrowth since many invasive aquatic plants grow early in the season depriving later emerging native plants of light and growing room.

3. **Collect and properly dispose harvested plants and collected plant fragments**. Outside of mapped areas, the harvester may surface skim free-floating vegetation that has been previously cut or uprooted, but not collected, to a depth of one foot. Use of the cutter head is not permitted for this action. In addition, plant cuttings and fragments must be immediately collected upon cutting to the extent practicable. Plant fragments accumulating along shorelines should be collected by riparian landowners. Fragments collected by the landowners can be used as garden mulch or compost.

   All harvested and collected plant material is deposited at individual sites within the Township that are not located in a floodplain or wetland. Disposing any aquatic plant material within identified floodplain and wetland areas is prohibited. Plant material will be collected and disposed daily to reduce undesirable odors and pests, to avoid leaching nutrients back into waterbodies, and to minimize visual impairment of lakeshore areas. Operators will stringently police the off-loading to assure efficient, neat operation.

4. **Adapt harvester cutting patterns and depths to support lake use and promote ecological health**. Aquatic plant harvesting techniques should vary in accordance with the type and intensity of human recreational use, lake characteristics, the distribution and composition of aquatic plants, and other biological considerations. The approaches to employ in differing management areas are illustrated in Figure 3.1 and described below.

[70] *SEWRPC Staff Memorandum,* An Aquatic Plant Management Plan for Fowler Lake, Waukesha County, Wisconsin*, May 2018.*

a. Harvesting is limited in certain areas of the Lake: Harvesting is not recommended in areas denoted as "environmentally-valuable" in Figure 3.1. Similarly, harvesting is not recommended in the shoreline zones along the western and eastern shores of the main body of the Lake. As noted earlier in this Section, these areas have low and declining EWM abundance (Figure 2.7). Raking and other manual aquatic plant removal methods should be utilized in these areas.

b. Recreational boating access lanes are given high priority: Channels providing travel thoroughfares for watercraft, such as between the boat launch and the main Lake as well as under North Oakwood Avenue, should be continue to be prioritized (Figure 3.1). Harvesting in these areas should strive to leave at least two-feet of vegetation above the Lake bottom to promote fish habitat. The only exception is the access lane along the western Lake shoreline south of the Grove Street bridge, which should be considered low priority as harvesting can be limited by water depth.

c. EWM control areas are given high priority: These nearshore areas in the main Lake should be harvested to control surface matting of EWM growth and promote native species growth. Again, at least one foot of plant material must remain on the Lake bottom to minimize resuspension of lake-bottom sediment and maintain desirable plant communities.

d. Angling and general recreation areas are given moderate priority: These areas, which generally include five- to ten-foot depths in the main Lake body, should be harvested to three-foot depth and leave at least two feet of aquatic vegetation along the Lake bottom to promote fish habitat.

e. Recreational boating areas are given low priority: These areas, which generally include seven- to twenty-foot depths in the main Lake body, should be harvested to six-foot depth and leave at least one foot of vegetation along the Lake bottom. This management will promote recreational boating and water ski use while also leaving vegetation for aquatic organism habitat.

5. **Harvesting native pondweeds (*Potamogeton* spp.) and muskgrasses (*Chara* spp.) is prohibited**. These plants provide habitat for young fish, reptiles, and insects in the Lake.

6. **Immediately return incidentally captured living animals to the water**. As harvested plants are brought on board the harvester, plant material must be actively examined for live animals. Animals such as turtles, fish, and amphibians commonly become entangled within harvested plants, particularly when cutting large plant mats. A second deckhand equipped with a net should accompany and help the harvester operator rescue animals incidentally collected during aquatic plant harvesting. If a second deckhand is not available, the harvester operator shall halt harvesting and remove animals incidentally collected during plant harvesting. Such stop-and-start work can dramatically decrease harvesting efficiency. Therefore, the WDNR recommends two staff be present on operating harvesters.

7. **Insurance, maintenance, repair, and storage**. Appropriate insurance covering the harvester and ancillary equipment will be incorporated into the City's policy. The City will provide liability insurance for harvester operators and other staff. Insurance certificates will be procured and held by the City. Routine day-to-day equipment maintenance will be performed by the harvester operator or other individuals identified by the City in accordance with the manufacturer's recommendations and suggestions. To this end, harvester operators shall be familiar with equipment manuals and appropriate maintenance/manufacturer contacts. Operators will immediately notify City staff of any equipment malfunctions, operating characteristics, or sounds suggesting malfunction and/or the need for repair. Equipment repair beyond routine maintenance will be arranged by the City. Maintenance and repair costs will be borne by the City. The City will be responsible for properly transporting and storing harvesting equipment during the off season.

8. **Management, record keeping, monitoring, and evaluation**. City staff manage harvesting operations, and, although they may delegate tasks, are responsible for overall plan execution and logistics. Nevertheless, daily harvesting activities will be documented in writing by the harvester

operator in a permanent harvester operations log. Harvesting patterns, harvested plant volumes, weed pickup, plant types, and other information will be recorded. Daily maintenance and service logs recording engine hours, fuel consumed, lubricants added, oil used, and general comments will be recorded. Furthermore, this log should include a section to note equipment performance problems, malfunctions, or anticipated service. Monitoring information will be summarized in an annual summary report prepared by the City, submitted to the WDNR, and available to the public. The report will also present information regarding harvesting operation and maintenance, equipment acquisitions and/or needs, expenditures, and budgets.

9. **Logistics, supervision, and training**. Harvesting equipment is owned and operated by the City Department of Public Works. City staff are responsible for overall harvesting program oversight and supervision. Although City staff are responsible for equipment operation, they may delegate tasks to competent individuals when technically and logistically feasible. The City must assure such individuals are appropriately trained to successfully and efficiently carry out their respective job functions. For example, City staff have extensive experience operating and maintaining harvesting equipment and have detailed knowledge of lake morphology, plant growth, and overall lake biology. These individuals should actively share this knowledge through an on-the-job training initiative. The equipment manufacturer may also be able to provide advice, assistance, and insight regarding equipment operation. Boating safety courses are available through many media and are integral to individuals involved with on-the-water work.

   All harvester operators must successfully complete appropriate training, must be thoroughly familiar with equipment function, must be able to rapidly respond to equipment malfunction, must be familiar with the Lake's morphology and biology, and must recognize landmarks to help assure adherence to harvesting permit specifications and limitations. Additionally, harvester operators must be able to recognize the various native and invasive aquatic plants present in the Lake. Such training may be provided through printed and on-line study aids, plant identification keys, and the regional WDNR aquatic species coordinator. At a minimum, training should:

   - Explain "deep-cut" versus "shallow-cut" techniques and when to employ each in accordance with this plan

   - Discuss equipment function, capabilities, limitations, hazards, general maintenance, and the similarities and differences between the various pieces of equipment they may be expected to operate

   - Review the aquatic plant management plan and associated permits with special emphasis focused on the need to restrict cutting in shallow and nearshore areas

   - Assure operators can confidentially identify aquatic plants and understand the positive values such plants provide to the Lake's ecosystem which in turn encourages preservation of native plant communities

   - Reaffirm that all harvester operators are legally obligated to accurately track and record their work to include in permit-requisite annual reports

   The training program must integrate other general and job-specific items such as boating navigational conventions, safety, courtesy and etiquette, and State and local boating regulations. Other topics that should be covered include first aid training, safety training, and other elements that help promote safe, reliable service.

10. **Dispose of debris and collected plant material from harvesting activities at the designated disposal sites**. The disposal sites currently used by the City of Oconomowoc's harvesting program are illustrated on Map 3.1.[71] Disposing of any aquatic plant material within identified floodplain and wetland areas is prohibited and special care should be taken to ensure that plant debris is not disposed of in such areas. This recommendation should be considered a high priority.

Nearshore Manual Aquatic Plant Removal

In nearshore areas where other management efforts are not feasible, raking may be a viable and practical method to manage overly abundant and/or undesirable plant growth. Should Lake residents decide to utilize raking to manually remove aquatic plants, the City or other interested party could acquire several specially designed rakes for riparian owners to use on a trial basis and/or rent or loan. If those rakes satisfy users' needs and objectives, additional property owners would be encouraged to purchase their own rakes.

Hand-pulling EWM is considered a viable option in the Lake and should be employed wherever practical. Volunteers or homeowners could employ this method, if they are properly trained to identify EWM, 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.[72]

Pursuant to Chapter NR 109 *Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations* of the *Wisconsin Administrative Code*, riparian landowners may rake or hand pull aquatic plants without a WDNR permit under the following conditions:

- EWM, curly-leaf pondweed, and purple loosestrife may be removed by hand if the native plant community is not harmed in the process.
- Raked, hand-cut, and hand-pulled plant material must be removed from the lake.
- 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.

Any other manual removal technique requires a State permit, unless specifically used to control designated nonnative invasive species such as EWM. 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. Nevertheless, riparian landowners may use mechanical devices to cut or mow exposed lakebed. Furthermore, purple loosestrife may also be removed with mechanical devices if native plants are not harmed and if the control process does not encourage spread or regrowth of purple loosestrife or other nonnative vegetation.

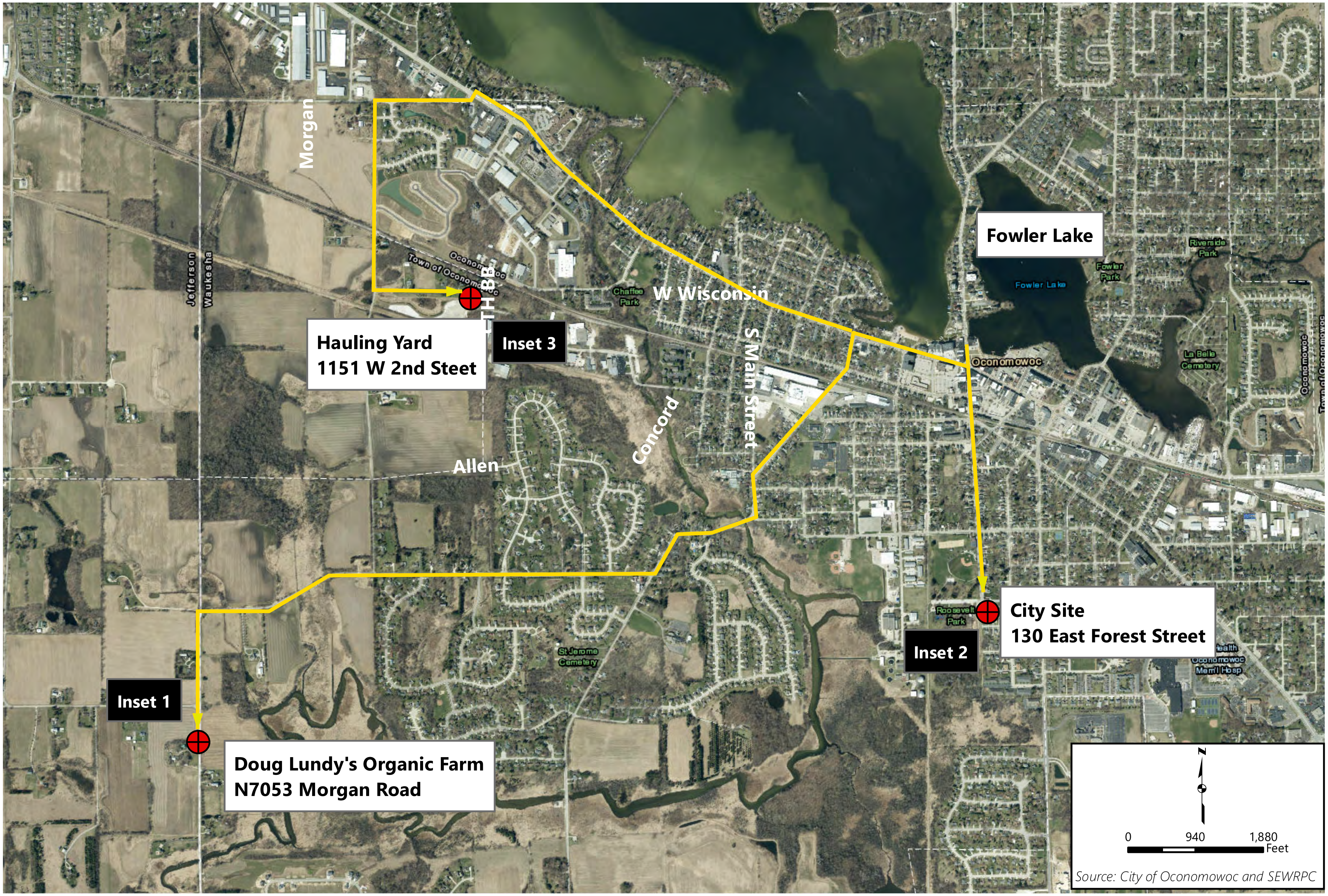
Prior to the hand-pulling season, shoreline residents should be reminded of the utility of manual aquatic plant control through an educational campaign. This campaign should also foster shoreline resident awareness of native plant values and benefits, promote understanding of the interrelationship between aquatic plants and algae (i.e., if aquatic plants are removed, more algae may grow), assist landowners identify the types of aquatic plants along their shorelines, and familiarize riparian landowners with the specific tactics they may legally employ to "tidy up" their shorelines.[73]

[71] *Aerial imagery of each disposal site are presented in Map 3.1: Insets 1 through 3.*

[72] *Visit dnr.wi.gov/lakes/plants for more information on identification and control of invasive aquatic plants.*

[73] *Commission and WDNR staff could help review documents developed for this purpose.*

Map 3.1
Fowler Lake Harvesting Disposal Sites and Route



Source: City of Oconomowoc and SEWRPC

Map 3.1 (Inset 1)
Fowler Lake Harvesting Disposal Site: Doug Lundy's Organic Farm

DISPOSAL SITE

Note: There are no mapped floodplains or wetlands within this site.

N

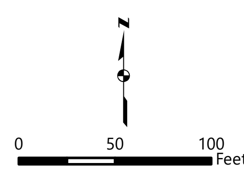
0 50 100 Feet

Source: City of Oconomowoc and SEWRPC

Map 3.1 (Inset 2)
Fowler Lake Harvesting Disposal Site: City Site

DISPOSAL SITE

Note: There are no mapped floodplains or wetlands within this site.



Source: City of Oconomowoc and SEWRPC

Map 3.1 (Inset 3)
Fowler Lake Harvesting Disposal Site: Hauling Yard

Note: There are no mapped floodplains or wetlands within this site.

Source: City of Oconomowoc and SEWRPC

Suction Harvesting and DASH

Suction harvesting may be a practical method to control aquatic plants, but it is not likely to be a cost-effective, environmentally friendly, or practical method to manage aquatic plants alone. For this reason, suction harvesting is not practical for widespread application at the Lake.

Given how time consuming and costly DASH can be to employ and given the limited presence of invasive and nuisance plant growth across the Lake, DASH will never likely be a primary component part of the City's general nuisance and invasive plant management strategy. Nevertheless, some lake organizations have employed DASH to aggressively combat small-scale pioneer infestations of invasive species. The City may wish to consider using DASH should such a situation arise in the future.

DASH may be of interest to private parties in specific situations. For example, DASH could be employed by individuals to control nuisance native and nonnative plants around piers and other congested areas. If an individual landowner or groups of landowners choose to utilize DASH, the activity is typically confined to the same area as riparian landowner manual aquatic plant manual control (30 feet of shoreline per property extending no more than 100 feet in areas including piers and other navigation aids). DASH requires a permit under *Wisconsin Administrative Code Chapter* NR 109 *Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations*.

Chemical Treatment

Large-scale chemical treatment is not recommended in Fowler Lake due to the low relative abundance of invasive species and the high diversity and abundance of sensitive species distributed throughout much of the Lake; these sensitive species may be negatively affected by such a treatment. 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 City. Whatever the case, monitoring should continue to ensure that EWM does not become more problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

Water Level Manipulation

The Peacock dam (also known as the Fowler Lake dam) controls water levels in the Lake. As the EWM is largely located to just the southern portion of the main Lake, a Lake-wide drawdown would not effectively target this area and would expose many of sensitive species to desiccation. Consequently, a winter drawdown is not recommended at this time, but the option should be considered if an invasive species population becomes much more widespread. If the City wishes to utilize drawdowns as a lake management tool, a hydrologic study of the Lake should first be conducted to better inform how the Lake would respond to drawdown scenarios. The Lake was drawn down two feet from September to October 2022 to facilitate dam repairs and information gathered for and from this drawdown may be useful for planning a drawdown for aquatic plant management.[74]

3.2 SUMMARY AND CONCLUSIONS

As requested by the City, the Commission worked with the City to develop a scope of work and secure funding to provide information useful to short- and long-term lake management. The primary motivation for this effort was to gather information needed to renew the City's aquatic plant management permit. This report, which documents the findings and recommendations of the study, examines existing and anticipated conditions, potential aquatic plant management problems, and lake-use. Conformant with the study's intent, the plan includes recommended actions and management measures. Figure 3.1 summarizes and locates where aquatic plant management recommendations should be implemented.

Successfully implementing this plan will require vigilance, cooperation, and enthusiasm, not only from local management groups, but also from State and regional agencies, Waukesha County, municipalities, and residents/users of the Lake. The recommended measures help foster conditions sustaining and enhancing the natural beauty and ambience of Fowler Lake's ecosystem while promoting a wide array of water-based recreational activities suitable for the Lake's intrinsic characteristics.

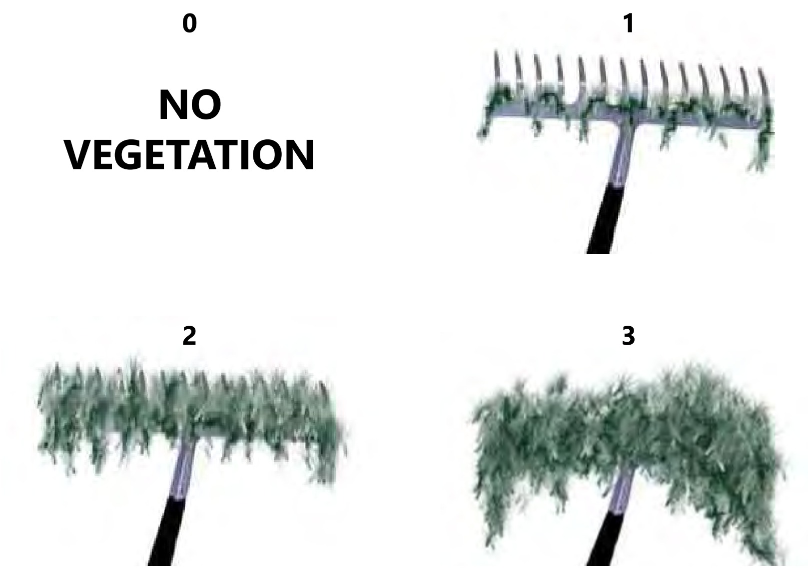
[74] *www.oconomowoc-wi.gov/CivicAlerts.aspx?AID=1380.*

APPENDICES

APPENDIX A

LAKE AQUATIC PLANT SPECIES DETAILS

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: michiganflora.net/home.aspx

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

Native

CLASPING-LEAF PONDWEED

Potamogeton richardsonii

Credit: Flickr User Bas Kers

Identifying Features

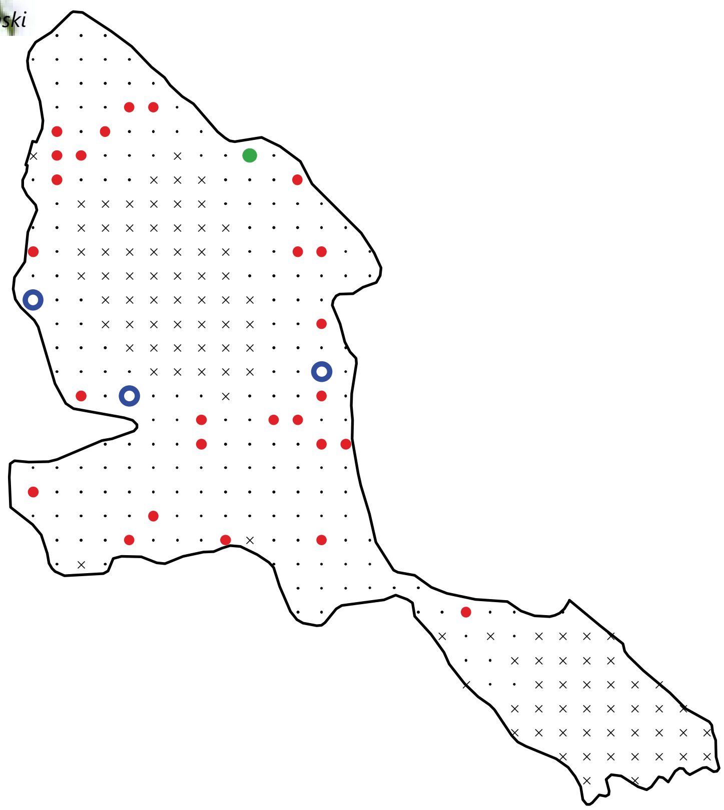
- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

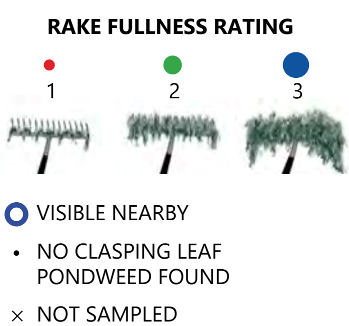
Clasping pondweed is similar to white-stem pondweed (*P. praelongus*), but the latter has boat-shaped leaf tips that split when pressed between one's fingers. The exotic curly-leaf pondweed (*P. crispus*) may appear similar, but differs by having serrated leaf margins

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

Credit: Paul Skawinski





Native

COMMON WATERWEED

Elodea canadensis

Credit: Flickr User Corey Raimond

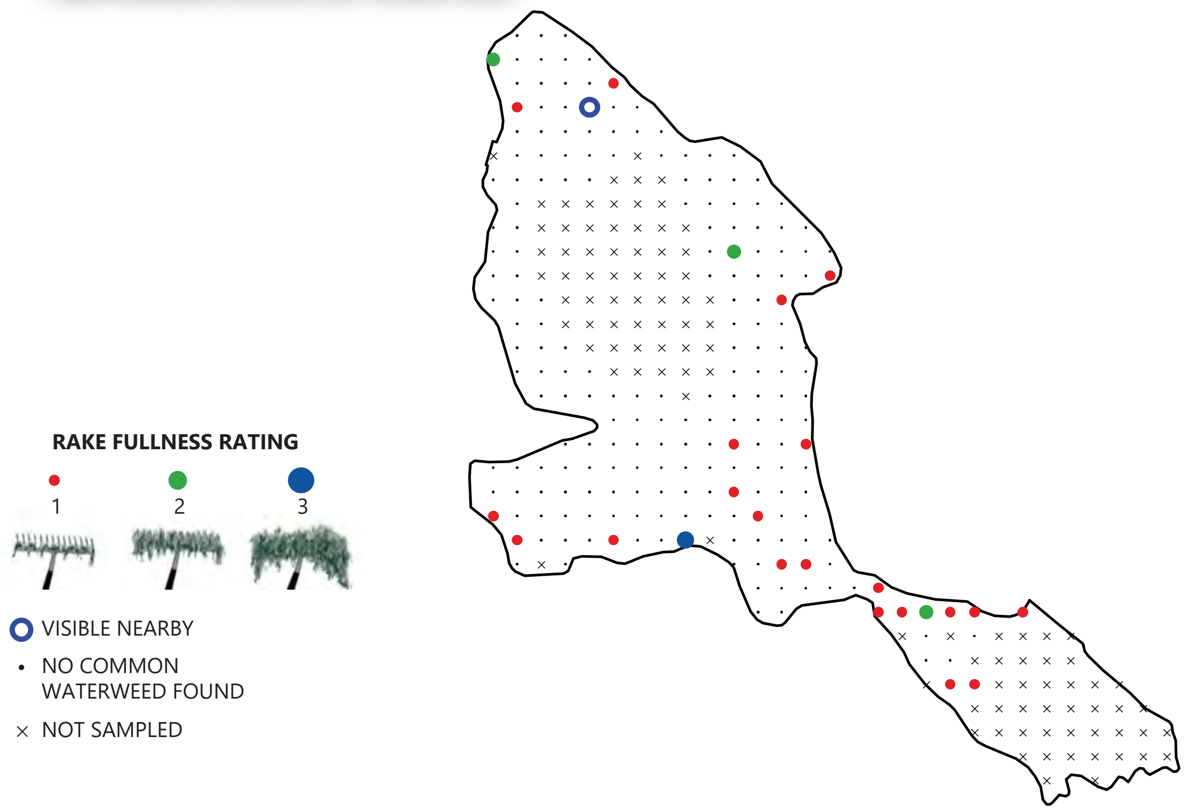
Identifying Features

- 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

Credit: Wikimedia Commons User Christian Fischer



Native

COONTAIL

Ceratophyllum demersum

Credit: Flickr User Bill Keim

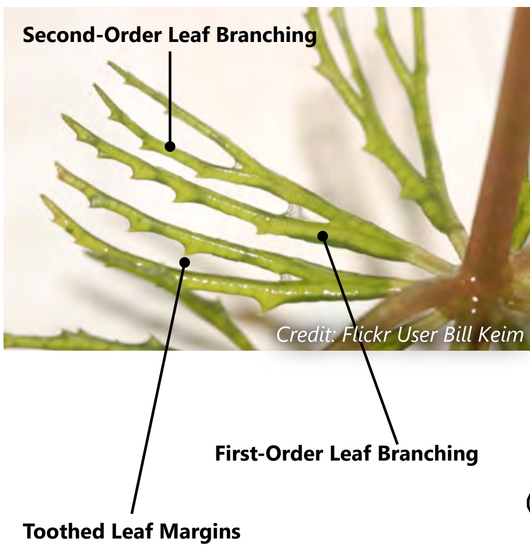
Identifying Features

- 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

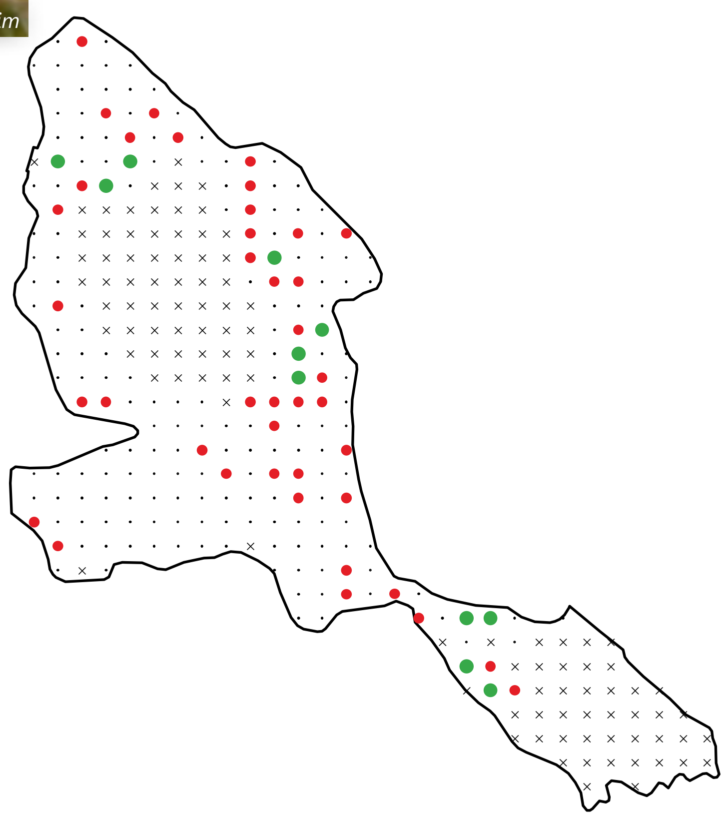
Coontail is similar to spiny hornwort (C. echinatum) and muskgrass (Chara spp.), but spiny hornwort has some leaves with three to four orders of branching, and coontail does not produce the distinct garlic-like odor of muskgrass when crushed

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



Credit: Flickr User Bill Keim



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

• NO COONTAIL FOUND

× NOT SAMPLED

Nonnative/ Exotic

CURLY-LEAF PONDWEED

Potamogeton crispus

Credit: Paul Skawinski

Identifying Features

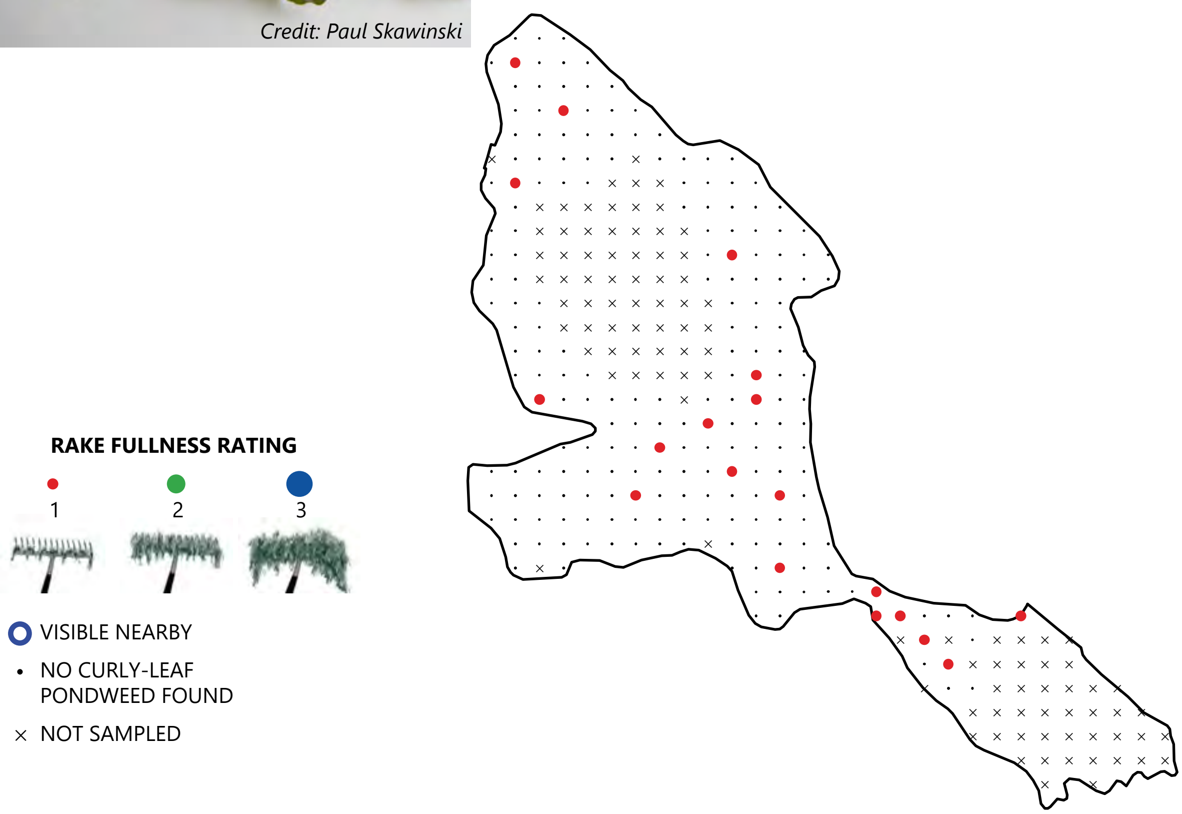
- Stems slightly flattened and both stem and leaf veins often somewhat pink
- Leaf margins very wavy and finely serrated
- Stipules (3.0 to 8.0 mm long) partially attached to leaf bases, disintegrating early in the season
- Produces pine cone-like overwintering buds (turions)

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

Credit: Paul Skawinski



Native

SMALL, FORKED, AND PERENNIAL DUCKWEED

Lemna spp.

Credit: Wikimedia Commons User Mokkie

Identifying Features

- Free-floating, green, round fronds
- May have several fronds in a cluster, but each frond has only one root
- Small Duckweed (*L. minor*) is smooth and flat on the top
- Forked Duckweed (*L. trisulca*) has pointed fronds, giving it an "oar and rowboat" appearance
- Perennial Duckweed (*L. turionifera*) has a row of small bumps down the middle

Ecology

- Free-floating duckweed is not dependent on depth, sediment type, or water clarity
- Associated with eutrophic waters

L. minor

Credit: Flickr User Andreas Rockstein

L. trisulca

Credit: Wikimedia Commons User Petr Filippov

L. turionifera

Credit: Wikimedia Commons User Stefan.lefnaer

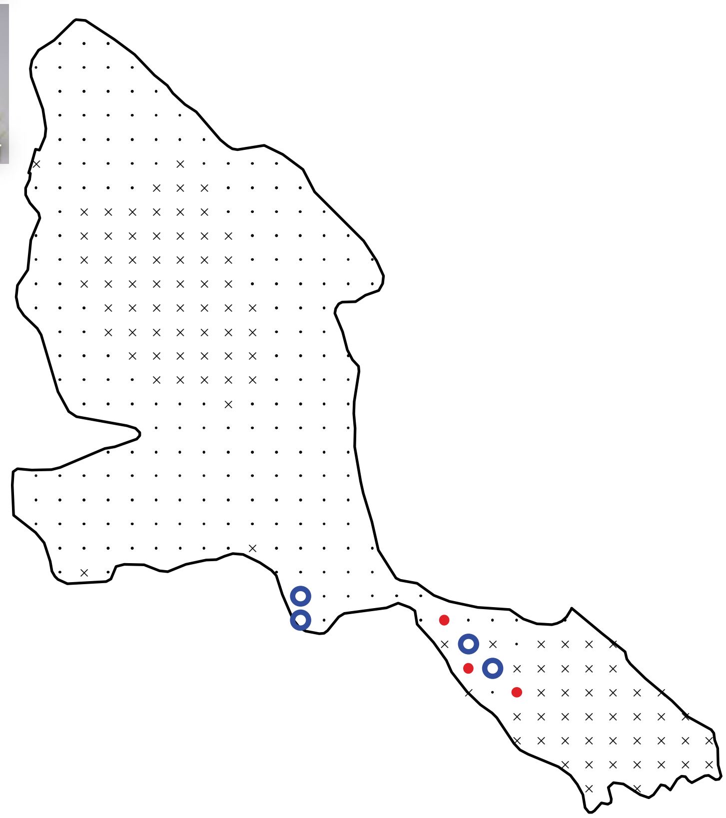
RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

NO DUCKWEED FOUND

NOT SAMPLED



Nonnative/ Exotic

EURASIAN WATERMILFOIL

Myriophyllum spicatum

Credit: Paul Skawinski

Identifying Features

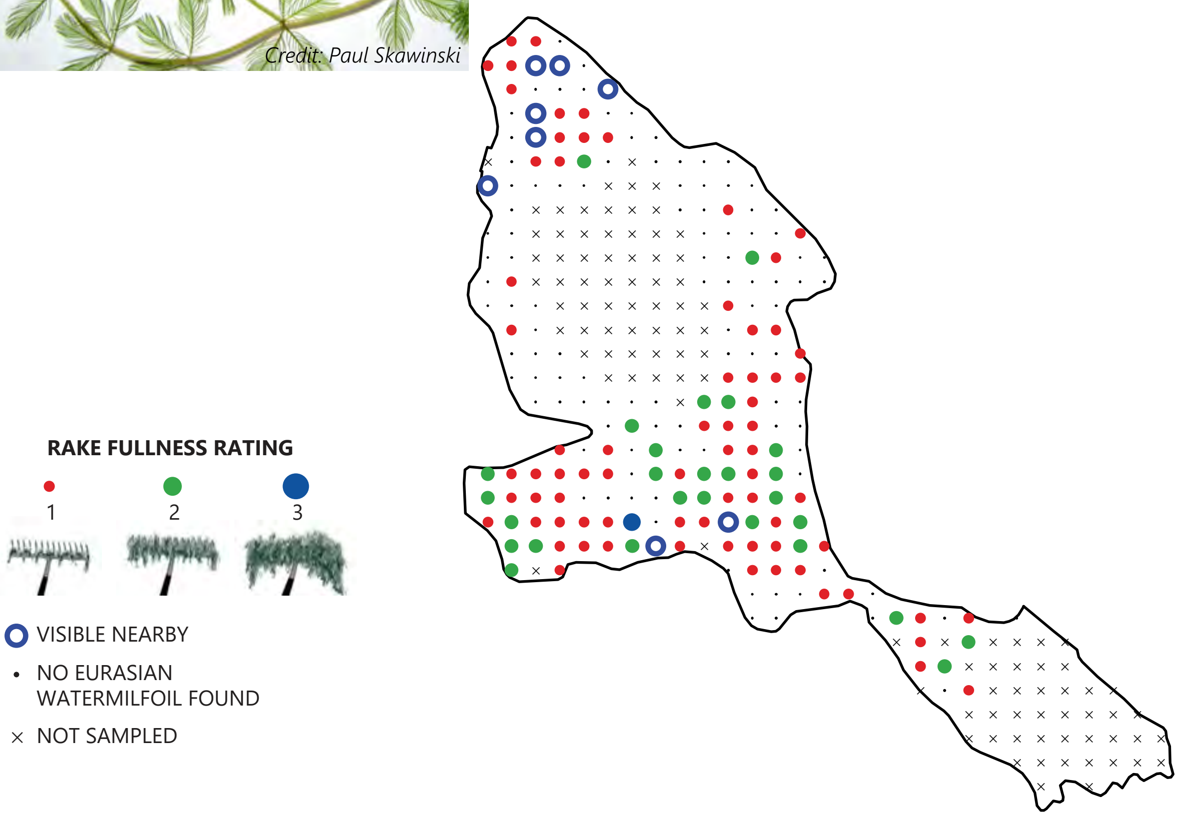
- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

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

Ecology

- Hybridizes with northern (native) watermilfoil, 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

Credit: Paul Skawinski



Native

FLAT-STEM PONDWEED

Potamogeton zosteriformis

Credit: Donald Cameron

Identifying Features

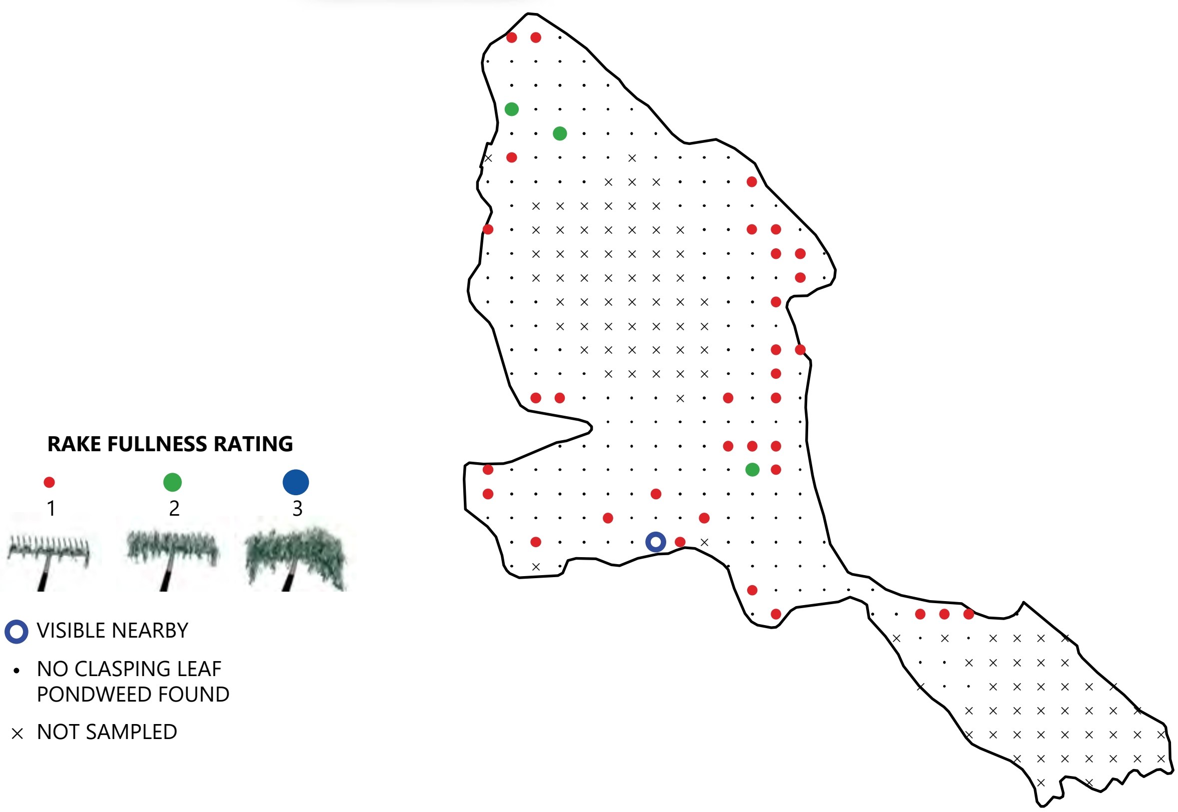
- Stems strongly flattened
- Leaves up to four to eight inches long, pointed, with a prominent midvein and many finer, parallel veins
- Stiff winter buds consisting of tightly packed ascending leaves

Flat-stem pondweed may be confused with yellow stargrass (*Heteranthera 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

Credit: Donald Cameron



Native

FLOATING-LEAF PONDWEED

Potamogeton natans

Credit: Wikimedia Commons User Stefan.lefnaer

Identifying Features

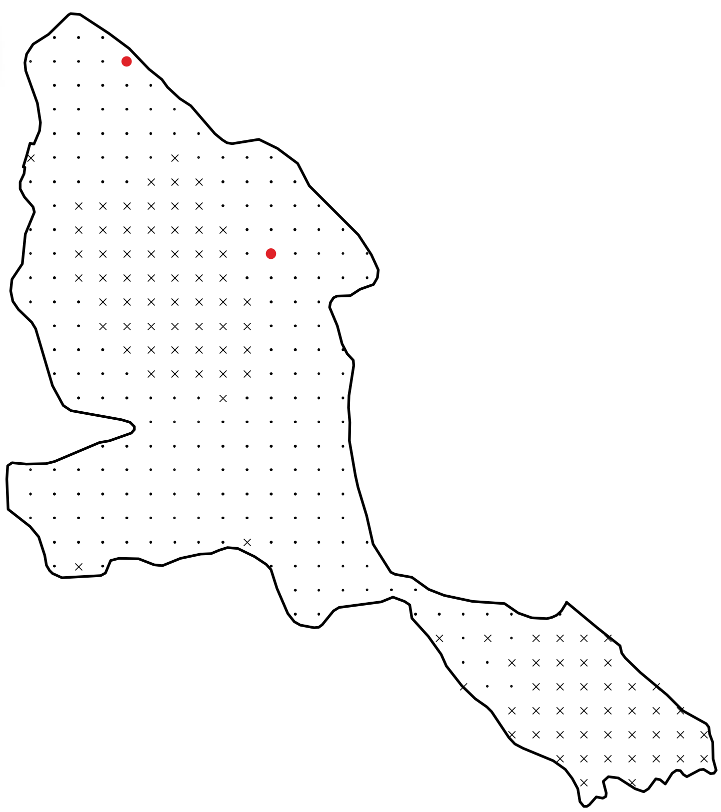
- Floating leaves (5.0 to 10 cm long) with heart-shaped bases and 17 to 37 veins
- Floating leaf stalks bent where they meet the leaf, causing the leaf to be held at roughly a 90-degree angle to the stalk
- Submersed leaves (1.0 to 2.0 mm wide) linear and stalk-like, with three to five veins

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

Credit: Wikimedia Commons User Stefan. lefnaer



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

NO FLOATING LEAF PONDWEED FOUND

NOT SAMPLED

Native

FRIES' PONDWEED

Potamogeton friesii

Credit: Flickr User Lliam Rooney

Identifying Features

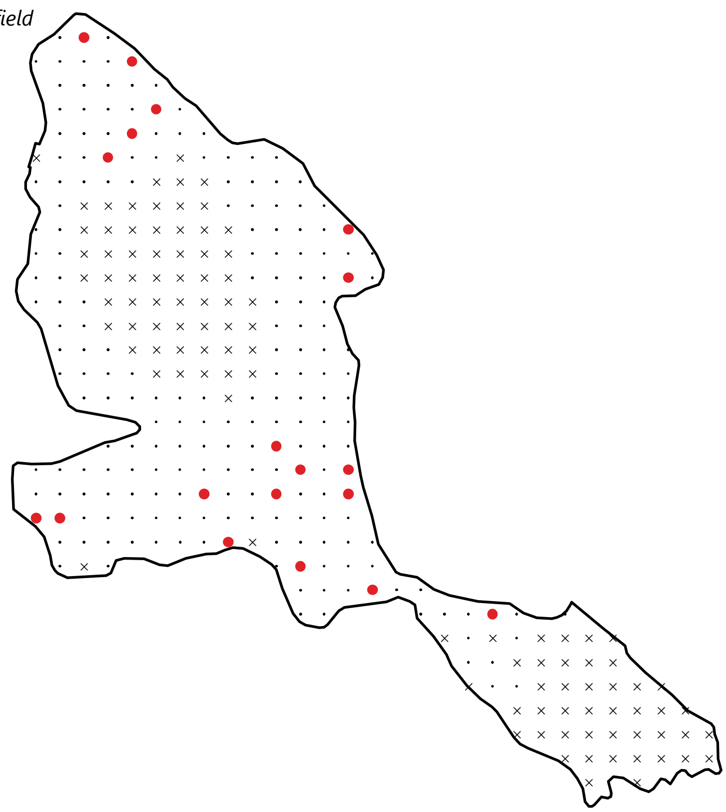
- Slender stems slightly compressed
- Submerged leaves linear with no petiole, one row of lacunar cells on each side of midvein, and 5-7 veins
- Tip of leaf rounded with short bristle
- Winter bud fan shaped and in two planes, with inner leaves at 90 degrees from outer leaves

Fries' pondweed is similar to other narrow-leaved pondweeds such as small pondweed (*P. pusillis*) and stiff pondweed (*P. strictifolius*) but other narrow pondweeds do not create a fan shaped winter bud

Ecology

- Common in calcareous lakes and slow-moving streams
- Overwinters largely as winter buds (turions)
- Provides food for waterfowl,
- Provides habitat for fish and aquatic invertebrates

Credit: Flickr User Brenton Butterfield



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

• NO FRIES' PONDWEED FOUND

× NOT SAMPLED

Native

ILLINOIS PONDWEED

Potamogeton illinoensis

Credit: Flickr User Dick Culbert

Identifying Features

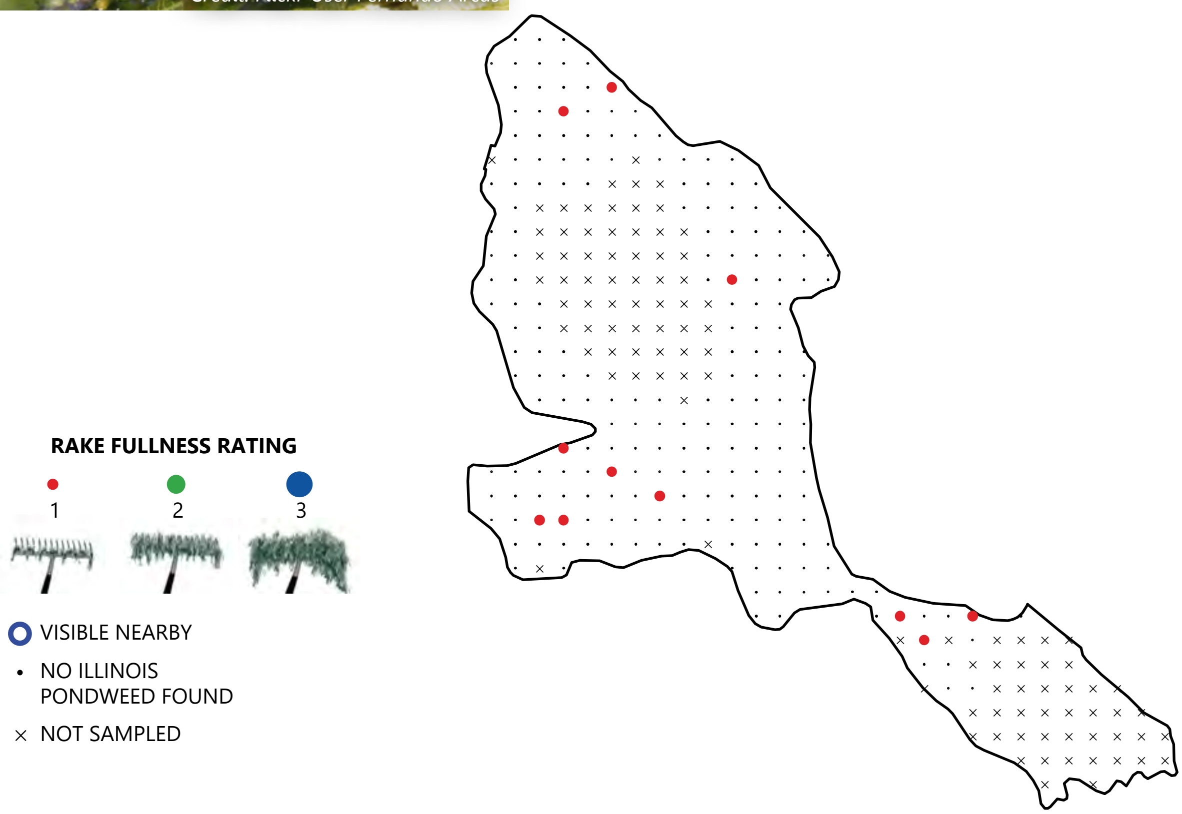
- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

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

Credit: Flickr User Fernando Arcas



Native

LARGE DUCKWEED
Spirodela polyrrhiza

Credit: Flickr User gailhampshire

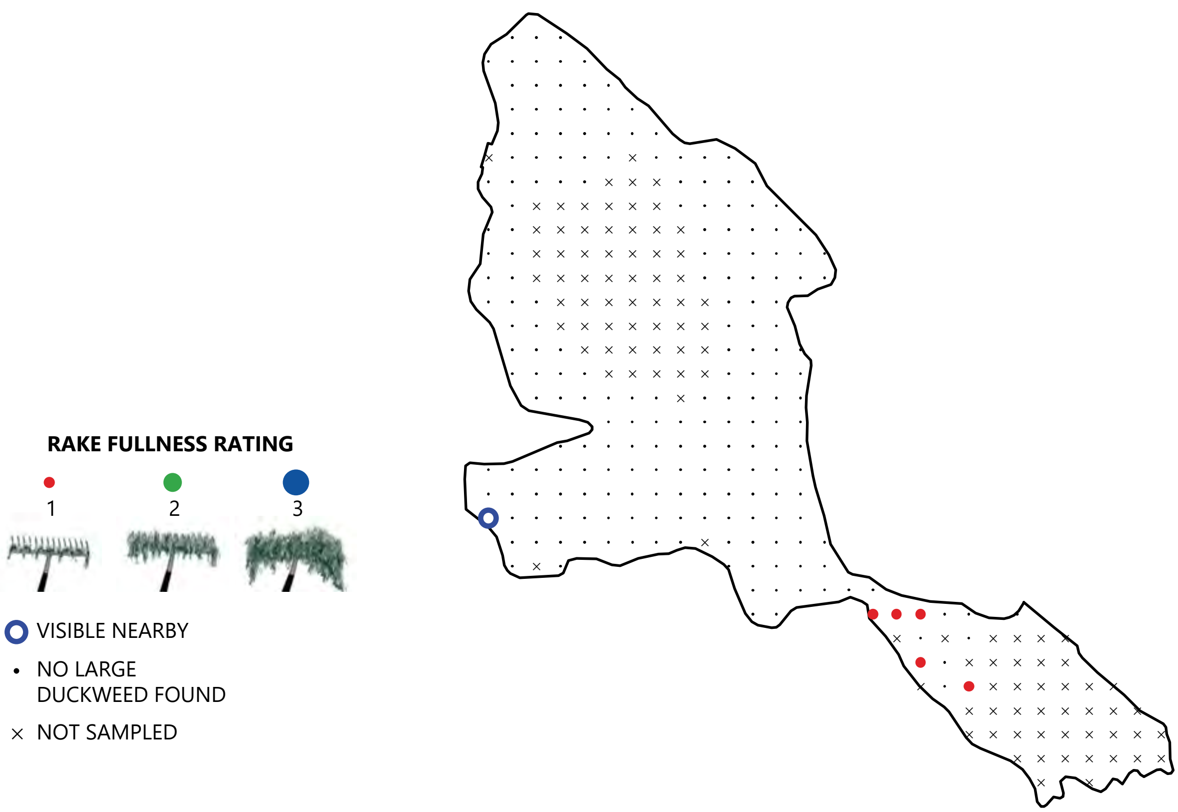
Identifying Features

- Free-floating, nearly cicular fronds with 5 – 15 veins
- Often has several fronds in a cluster, with multiple roots
- Typically green above and a reddish-purple beneath

Ecology

- Found throughout Wisconsin
- Often found with duckweed species
- Not dependent on depth, sediment type, or water clarity
- Requires adequate nutrients in the water to sustain growth

Credit: Wikimedia Commons User Stefan.lefnaer



Native

LARGE-LEAF PONDWEED

Potamogeton amplifolious

Credit: Wikimedia Commons User Edward G. Voss

Identifying Features

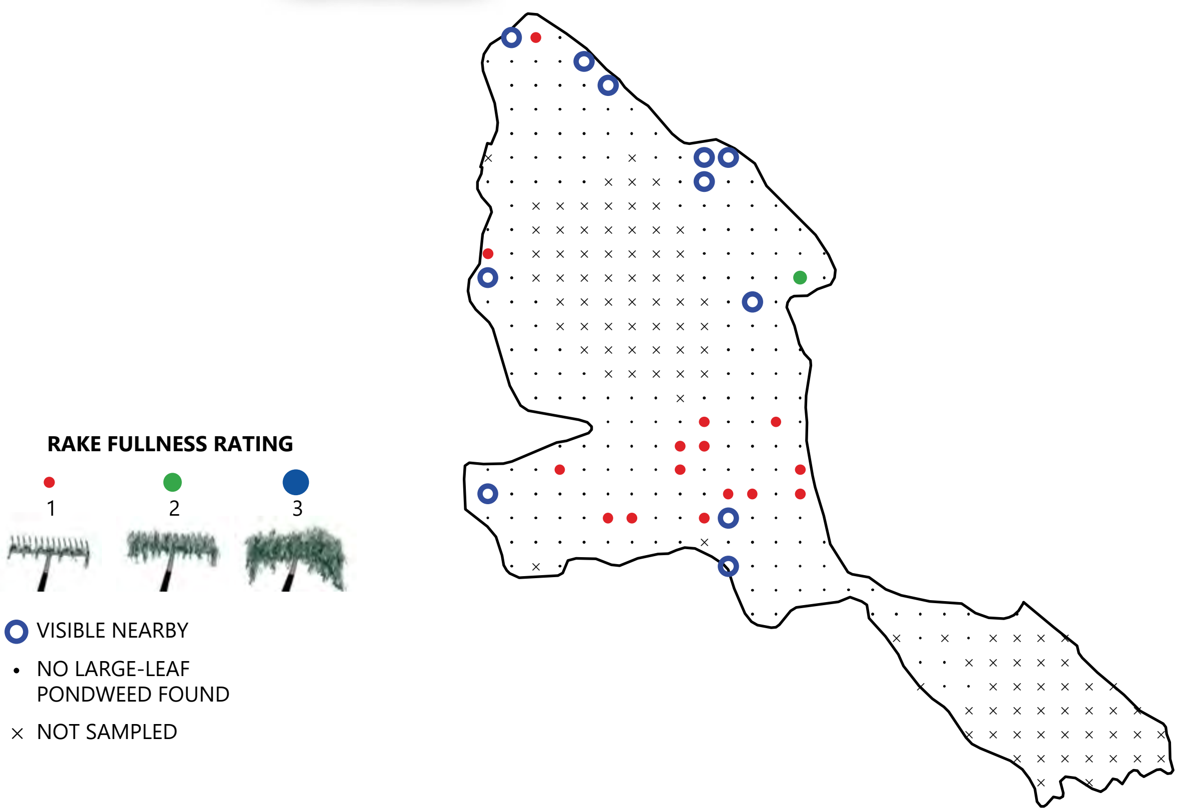
- When produced, floating leaves 2-23 cm long *with 27-49 veins* and petiole longer than leaf blade
- Submersed leaves large and sickle-shaped, 4-7 cm wide, 8-20 cm long, *with more than 19 veins*, and folded upwards along the sides
- White stipules up to 12 cm long

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

Credit: Paul Skawinski



Native

LONG-LEAF PONDWEED

Potamogeton nodosus

Credit: Wikimedia Commons User Stefan.lefnaer

Identifying Features

- Floating leaves 5.0 to 13 cm long, tapering to leaf stalks that are longer than the attached leaf blades
- Submersed leaves up to 30 cm long and 1.0 to 2.5 mm wide, with seven to 15 veins, and long leaf stalks
- Stipules 4.0 to 10 cm long, free from the leaves, disintegrating by mid-summer

Long-leaf pondweed may be distinguished from other pondweeds that have similar floating leaves (e.g., *P. illinoensis* and *P. natans*) by the long leaf stalks of its submersed leaves. The floating leaves of *P. natans* also differ by having a heart-shaped base and by being held to the leaf stalks at roughly 90-degree angles. In *P. illinoensis* the stalks of floating leaves, if produced, are shorter than the leaf blades

Ecology

- Streams and lakes, shallow and deep, but more often in flowing water
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Harbors large numbers of aquatic invertebrates, which provide food for fish

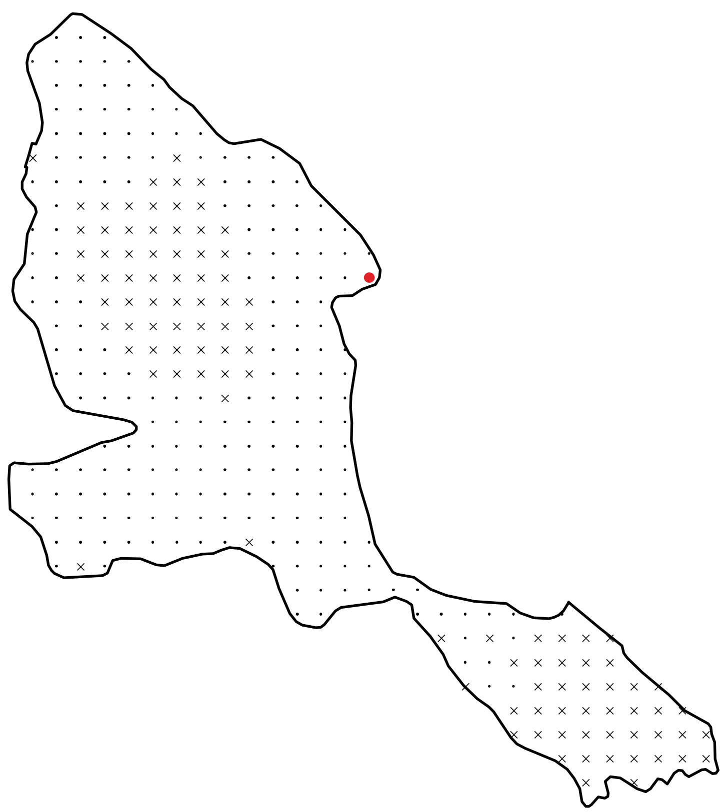
Credit: Wikimedia Commons User Stefan.lefnaer

RAKE FULLNESS RATING

VISIBLE NEARBY

NO LARGE-LEAF PONDWEED FOUND

NOT SAMPLED



Native

MUSKGRASSES

Chara spp.

Credit: Flickr User Jeremy Halls

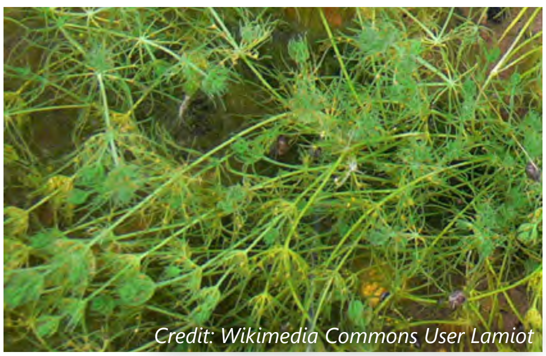
Identifying Features

- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo 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



Credit: Wikimedia Commons User Lamiot

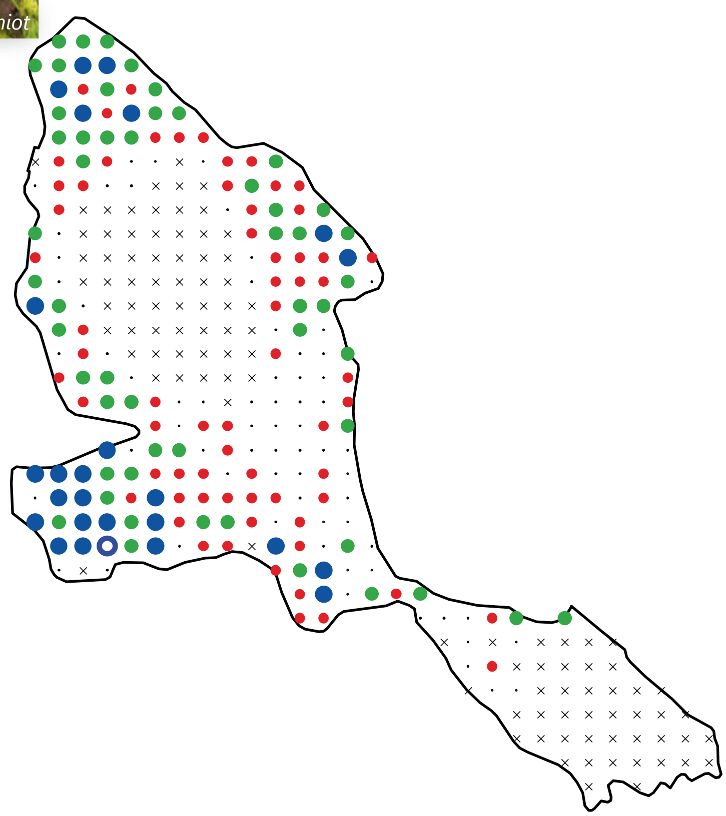
RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

NO MUSKGRASS FOUND

NOT SAMPLED



Native

NITELLA OR STONEWORTS

Nitella spp.

Credit: Wikimedia Commons User Show_ryu

Identifying Features

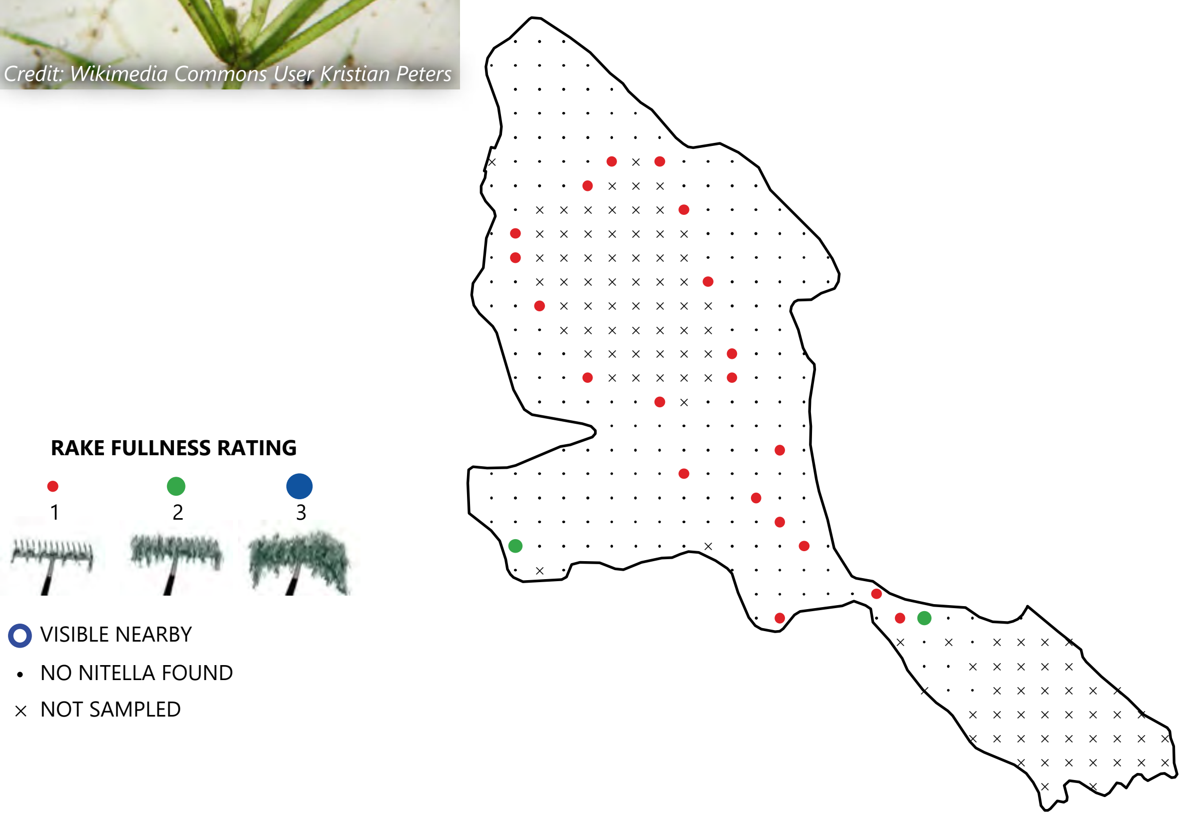
- Stems and leaf-like side branches delicate and smooth, side branches arranged in whorls
- Bright green
- Reproductive structures developing along the whorled branches

Muskgrasses (*Chara* spp.) are large algae similar to stoneworts (*Nitella* spp.), but their branches are ridged and more robust than those of stoneworts. Another similar group of algae, *Nitellopsis* spp., differ from stoneworts by having whorls of side branches that are at more acute angles to the main stem and star-shaped, pale bulbils that, when present, are near where side branches meet the main stem

Ecology

- Often found in deep lake waters over soft sediments
- Overwinters as rhizoids (cells modified to act as roots) or fragments
- Habitat for invertebrates, creating foraging opportunities for fish
- Sometimes browsed upon by waterfowl

Credit: Wikimedia Commons User Kristian Peters



Native

NORTHERN WATERMILFOIL

Myriophyllum sibiricum

Credit: Flickr User Corey Raimond

Identifying Features

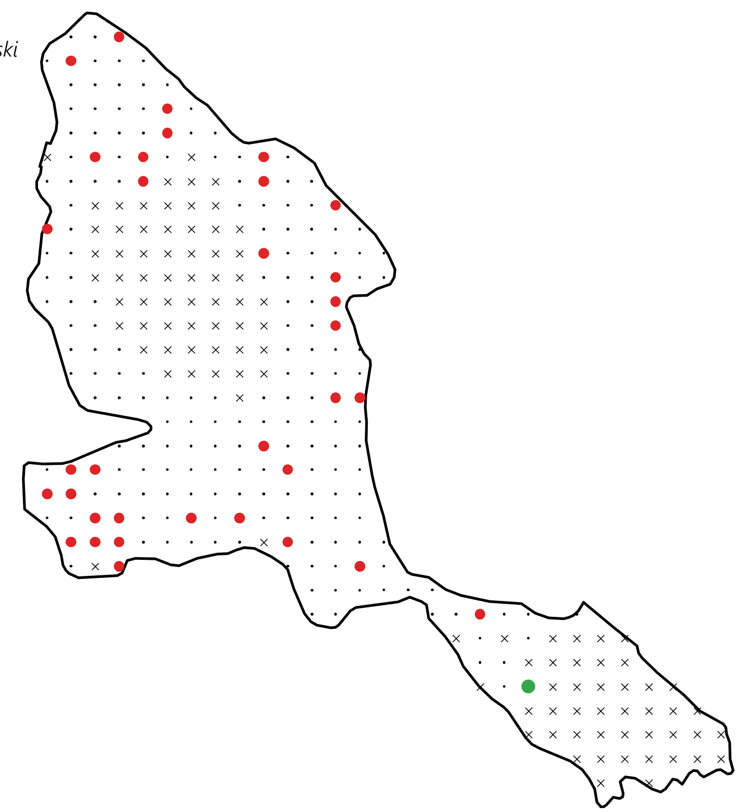
- Light-colored, stout stems
- Leaves in whorls of four to five, divided into four to 12 pairs of leaflets, lower leaflets longer than the upper ones
- Forms winter buds (turions) in autumn

Northern watermilfoil is similar to other water milfoils. Eurasian watermilfoil (*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 watermilfoil, resulting in plants with intermediate characteristics

Credit: Paul Skawinski



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

NO NORTHERN MILFOIL FOUND

NOT SAMPLED

Native

SAGO PONDWEED

Stuckenia pectinata

Credit: Flickr User Christian Fischer

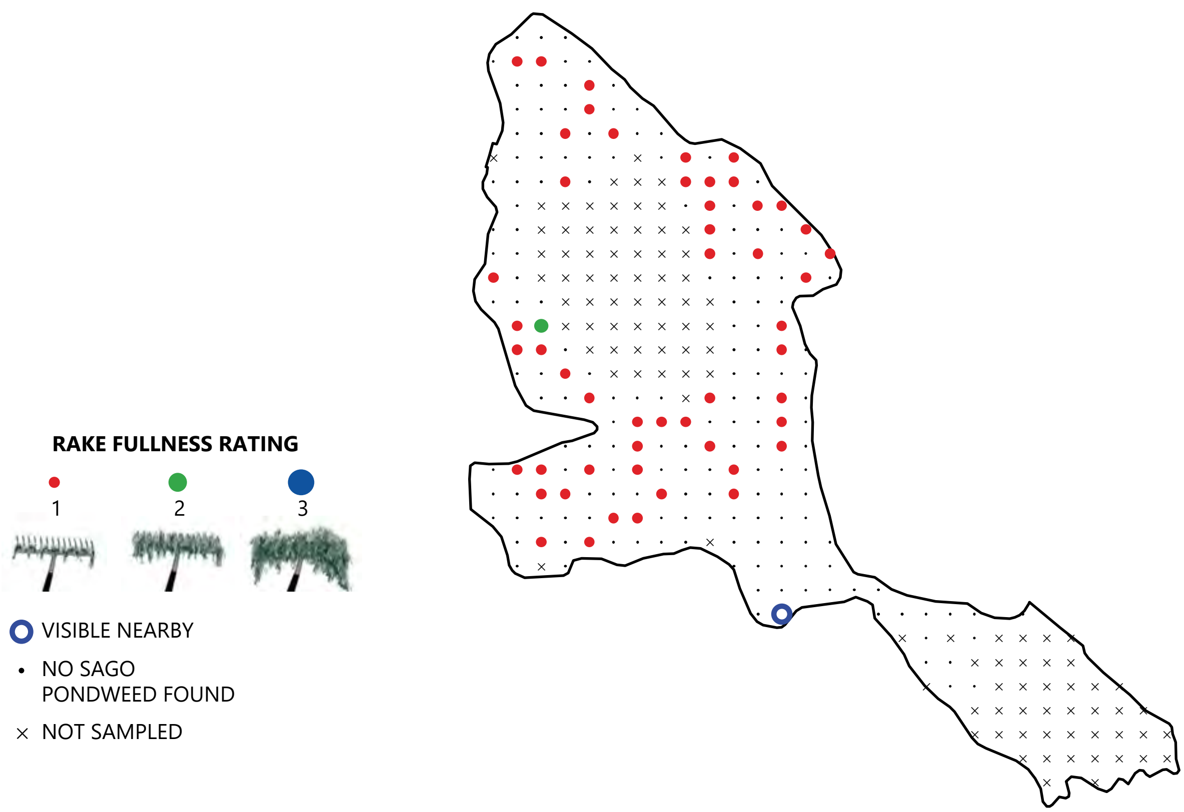
Identifying Features

- 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

Credit: Flickr User Christian Fischer



Native

SMALL BLADDERWORT

Utricularia minor

Credit: Wikimedia Commons User Andrea Moro

Identifying Features

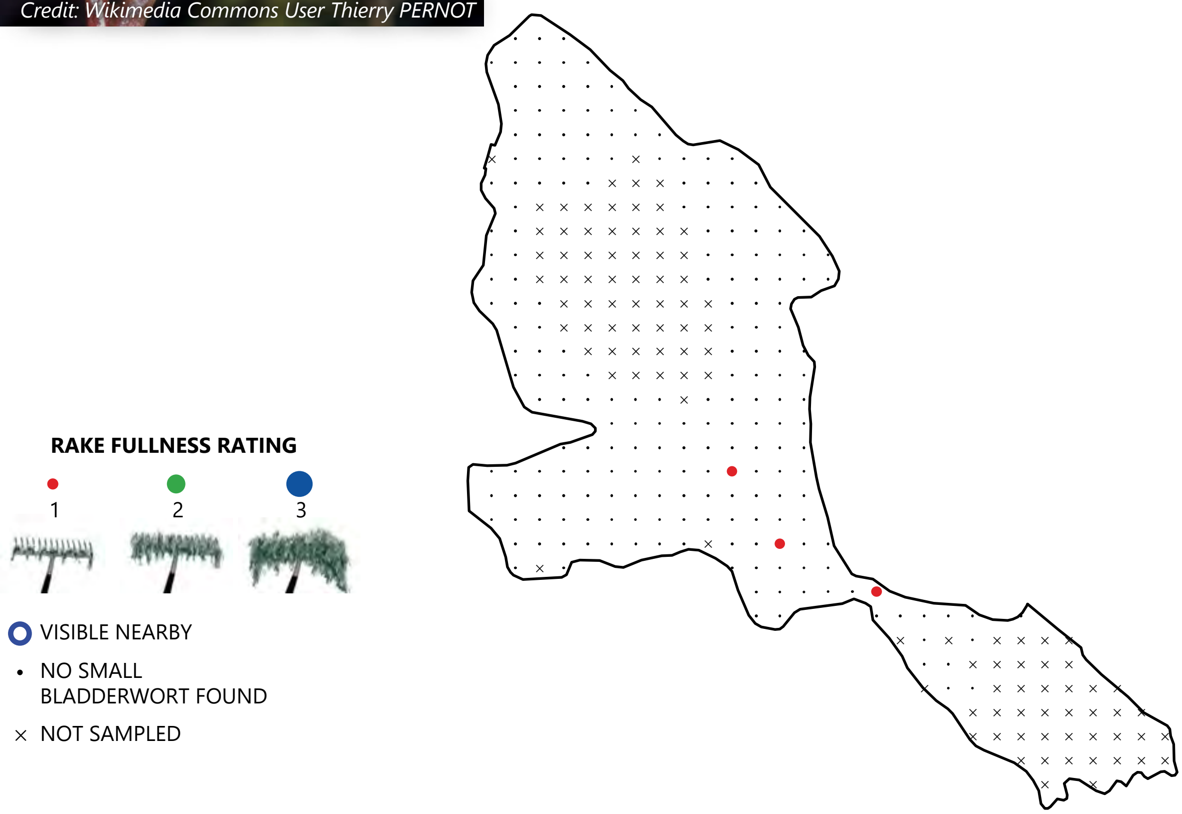
- Flowers snapdragon-like, yellow, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems floating (due to air bladders; branches finely divided
- Generally smaller and less branched than common bladderwort, growing between 2 and 6 inches.

Several similar bladderworts occur in southeastern Wisconsin

Ecology

- Most often found in quiet shallows and along shores, but common bladderwort sometimes occurs 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

Credit: Wikimedia Commons User Thierry PERNOT



Native

SMALL PONDWEED

Potamogeton pusillus

Credit: Wikimedia Commons User Christian Fischer

Identifying Features

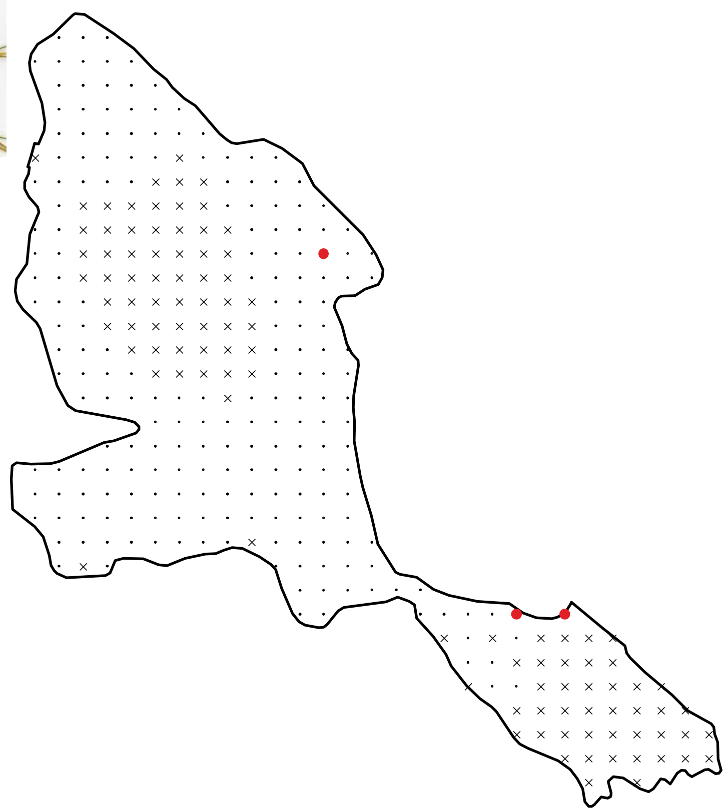
- Narrow, submersed leaves (1-7 cm long and 0.2-2.5 mm wide), attaching directly to the stem, with 3 veins, leaf tips blunt or pointed, and often with raised glands where the leaf attaches to the stem
- Produces no floating leaves
- Numerous winter buds (turions) produced with rolled, inner leaves resembling cigars
- Flowers and fruits produced in whorls spaced along slender stalk

Small pondweed is similar to leafy pondweed (*P. foliosus*), when not in flower and fruit. However, unlike leafy pondweed, it often has raised glands where the leaves meet the stem. The flowers and fruits of small pondweed are also borne on longer, more slender stalks and in whorls that are spaced apart.

Ecology

- Streams and lakes, shallow and deep, but more often in flowing water
- Emerges in spring from buds formed along rhizomes
- Provides food for waterfowl, muskrat, beaver, and deer
- Harbors large numbers of aquatic invertebrates, which provide food for fish

Credit: Wikimedia Commons User Christian Fischer



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

• NO SMALL PONDWEED FOUND

× NOT SAMPLED

Native

SOUTHERN NAIAD

Najas guadalupensis

Credit: Wikimedia Commons User Robert H. Mohlenbrock

Identifying Features

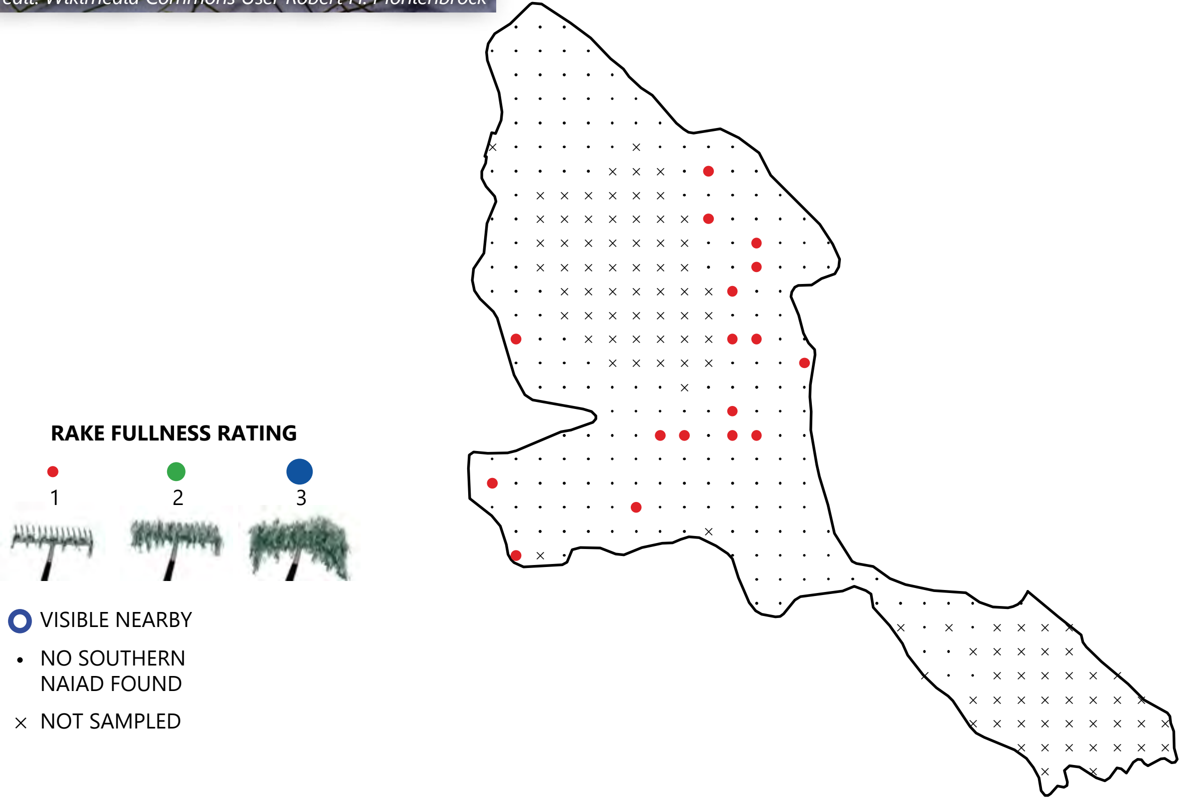
- Leaves 0.2 to 2.0 mm wide and blunt with slight shoulder bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Leaves opposite and may appear loosely whorled

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

Credit: Wikimedia Commons User Robert H. Mohlenbrock



Nonnative/ Exotic

SPINY NAIAD
Najas marina

Credit: Wikimedia Commons User Pascale Guinchard

Identifying Features

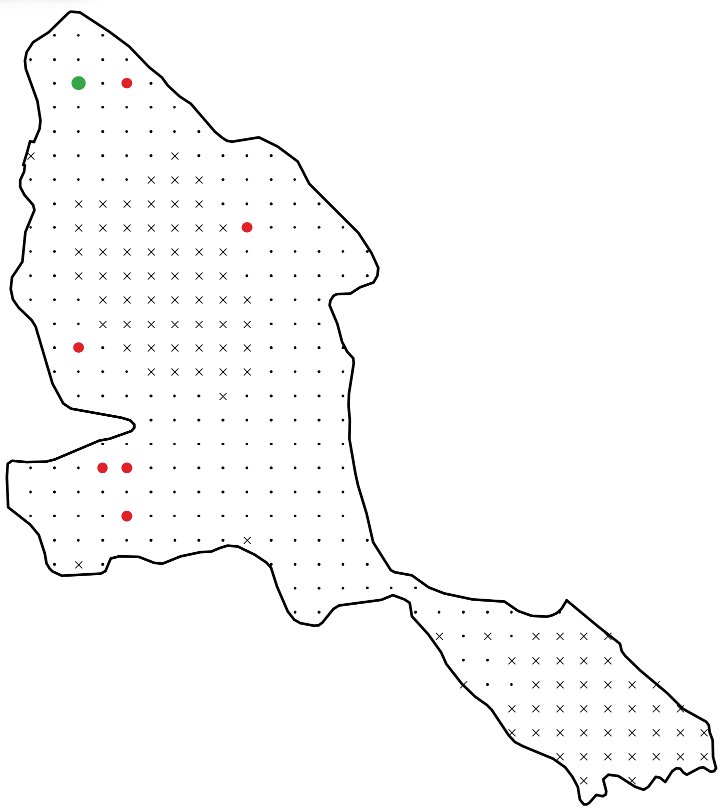
- Stems stiff and spiny, often branching many times
- Leaves stiff, 1.0 to 4.0 mm thick, with coarse teeth along the margins and midvein on the underside

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

Credit: Wikimedia Commons User Kristian Peters



RAKE FULLNESS RATING

VISIBLE NEARBY

NO SPINY NAIAD FOUND

NOT SAMPLED

Native

VARIABLE PONDWEED

Potamogeton gramineus

Credit: Wikimedia Commons User Tristan He

Identifying Features

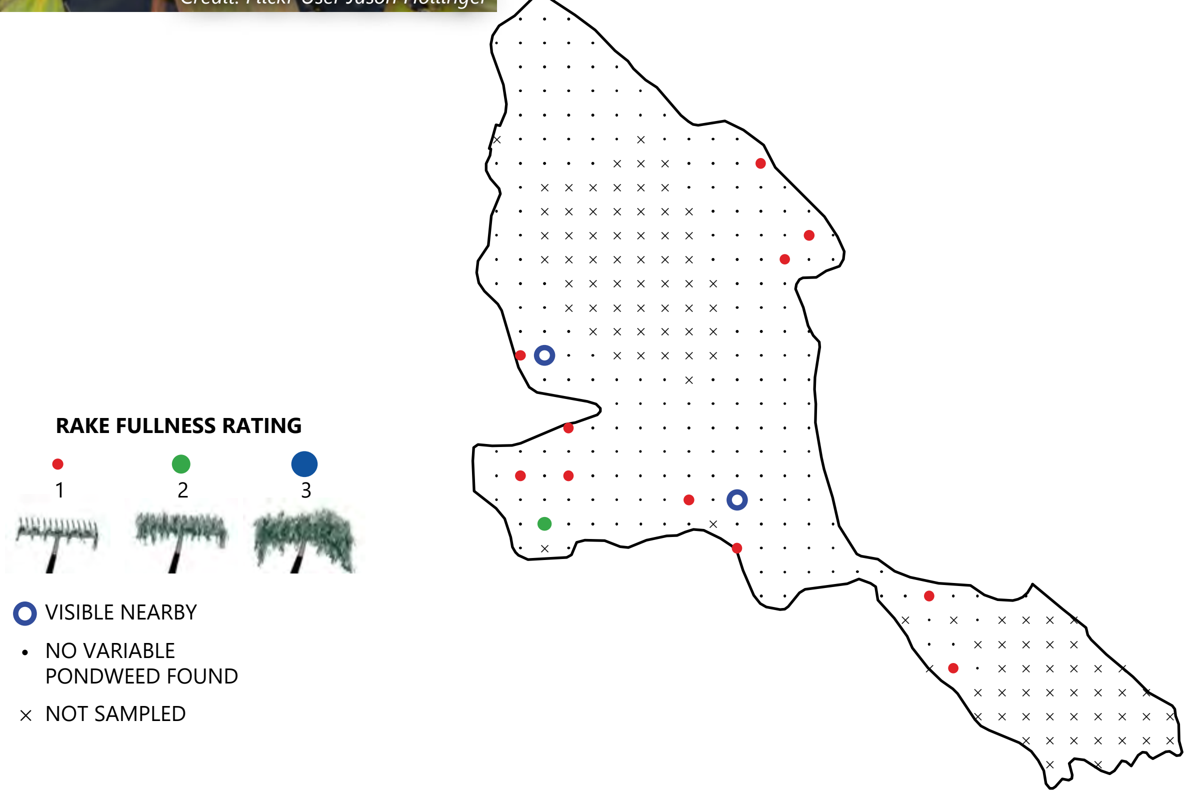
- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- Floating leaves with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard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

Credit: Flickr User Jason Hollinger



Native

WATER CELERY OR EELGRASS

Vallisneria americana

Credit: Wikimedia Commons User Fredlyfish4

Identifying Features

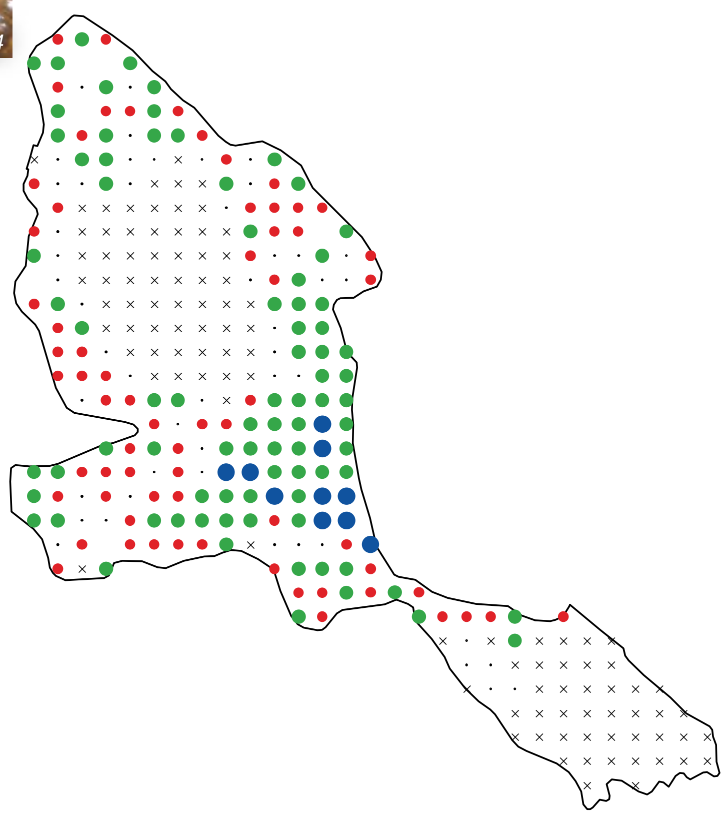
- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

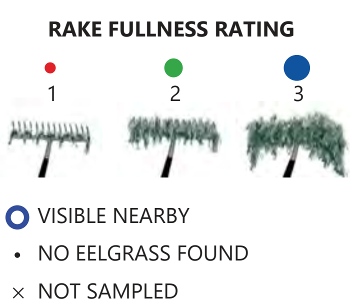
The foliage of eelgrass could be confused with the submersed leaves of bur-reeds (*Sparganium* spp.) or arrowheads (*Sagittaria* spp.), but the leaves of eelgrass are distinguished by their prominent middle stripe. The leaves of ribbon-leaf pondweed (*Potamogeton epihydrus*) are also similar to those 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

Credit: Wikimedia Commons User Fredlyfish4





Native

WATER STARGRASS

Heteranthera dubia

Credit: Wikimedia Commons User Fritzflohrreynolds

Identifying Features

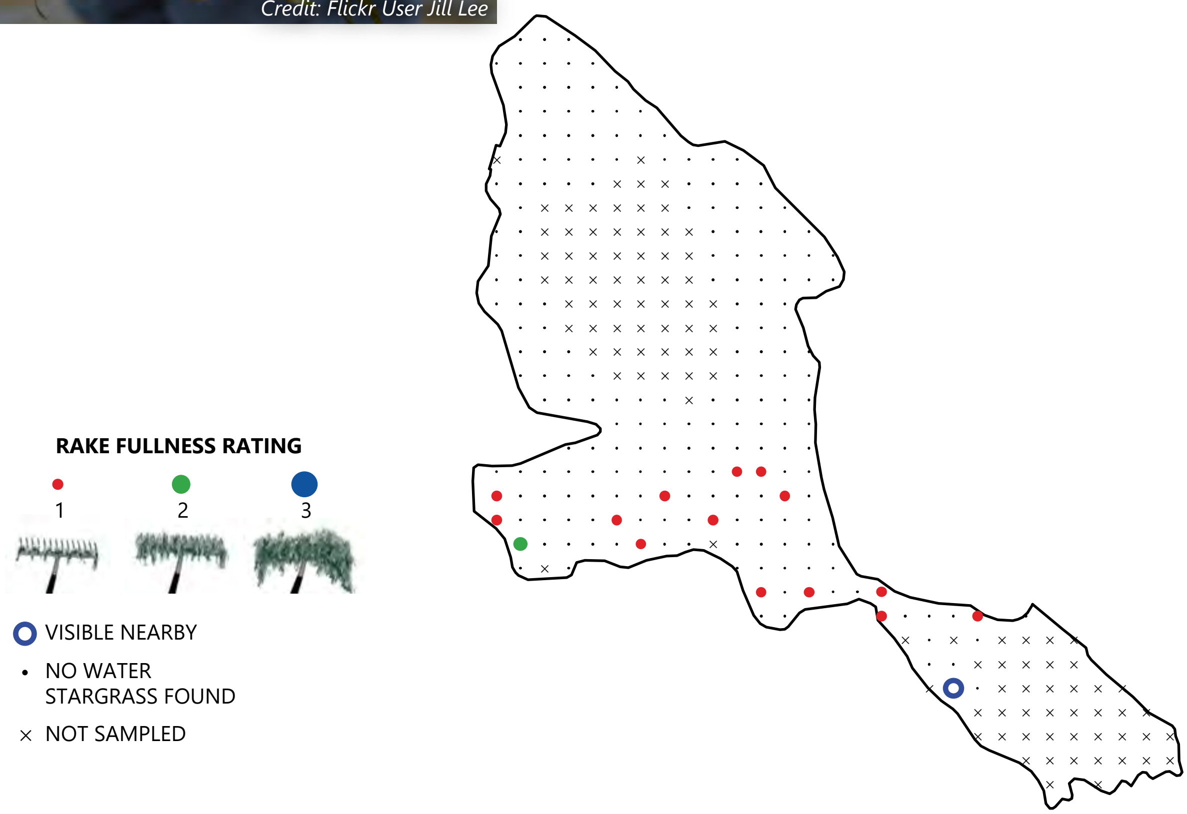
- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

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

Credit: Flickr User Jill Lee



Native

COMMON, NORTHERN, AND BRAZILIAN WATERMEAL
Wolffia spp.


Credit: Wikimedia Commons User Stefan.lefnaer

Identifying Features

- Free-floating, green plant without roots, stems, or leaves, spherical or oblong
- Individual plants hardly larger than a pinhead
- Common Watermeal (*W. columbiana*) pale green, asymmetrical globes
- Northern Watermeal (*W. borealis*) flattened, ellipsoid, and dotted, with a pointed apex
- Brazilian Watermeal (*W. brasiliensis*) dotted, ellipsoid, with a rounded apex

Ecology

- Found throughout Wisconsin, except northern lakes and forest ecoregion
- Often found with duckweed species
- Not dependent on depth, sediment type, or water clarity
- Requires adequate nutrients in the water to sustain growth


W. columbiana
Credit: Wikimedia Commons User Stefan.lefnaer


W. borealis
Credit: Flickr User Andrey Zharkikh


W. brasiliensis
Credit: Flickr User Jim Stasz

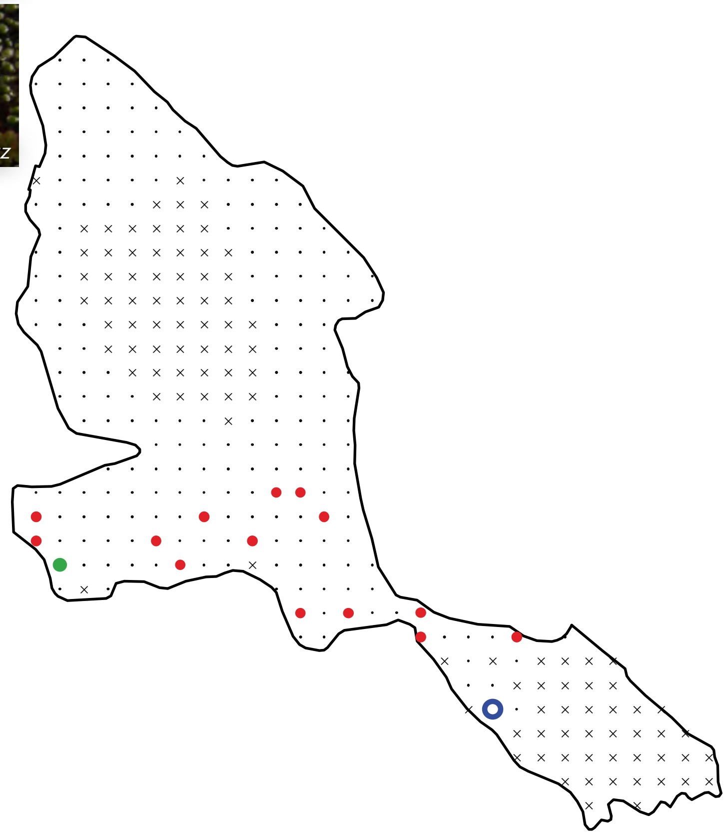
RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

NO WATER STARGRASS FOUND

NOT SAMPLED



Native

WHITE-STEM PONDWEED

Potamogeton praelongus

Credit: Flickr User Bas Kers

Identifying Features

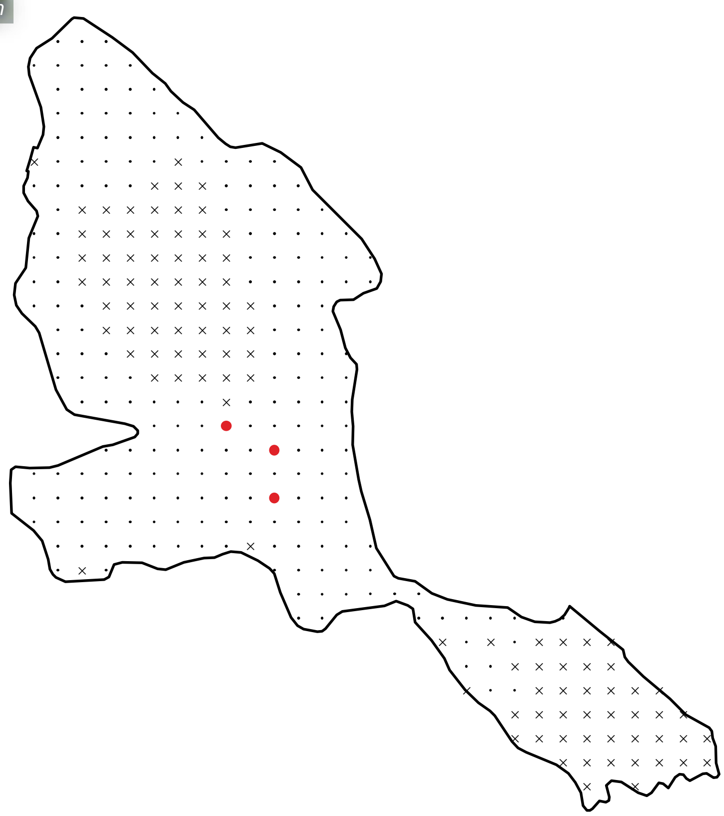
- Stems usually pale and zig-zagging
- Leaves clasping, alternate, with three to five prominent veins and 11 to 35 smaller ones, with boat-shaped tips that often split when pressed between fingers

White-stem pondweed is similar to clasping pondweed (*P. richardsonii*), but the leaves of clasping pondweed do not have boat-shaped tips that split when pressed

Ecology

- Found in clear lakes in water three to 12 feet deep over soft sediments
- "Indicator species" due to its sensitivity to water quality changes; its disappearance indicating degradation; requires more natural areas that receive little disturbance
- Sometimes remains evergreen beneath the ice
- Provides food for waterfowl, muskrat, beaver, and deer
- Provides habitat for trout and muskellunge

Credit: Flickr User fabelfroh



RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

• NO WHITE-STEM PONDWEED FOUND

× NOT SAMPLED

WHITE WATER CROWFOOT

Ranunculus aquatilis

Credit: Wikimedia Commons User Hans Hillewaert

Native

Identifying Features

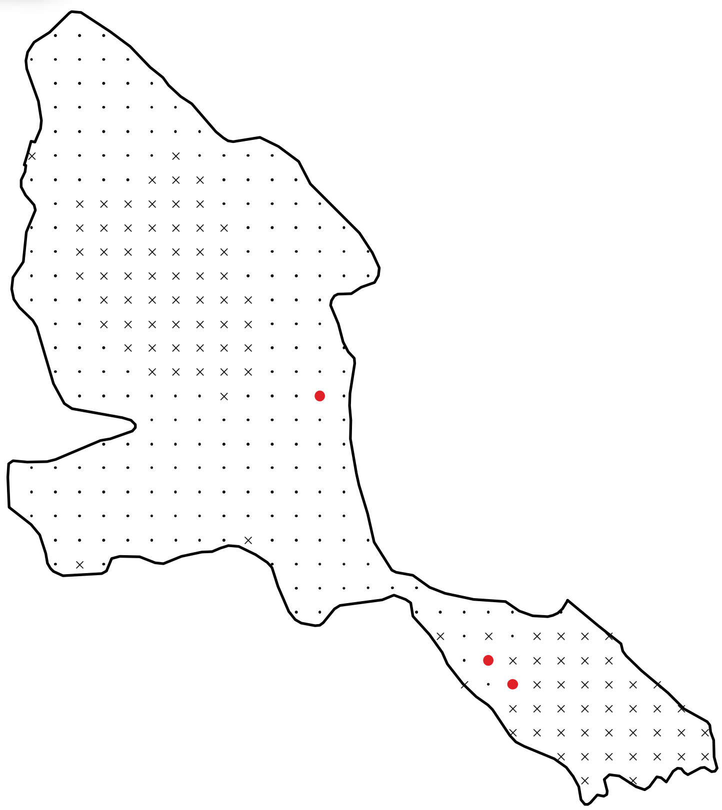
- Submersed leaves finely divided into thread-like sections, and arranged alternately along the stem
- Flowers white, with five petals
- May or may not produce floating leaves

White water crowfoot is similar to other aquatic *Ranunculus* spp. However, the latter have yellow flowers and leaf divisions that are flat, rather than thread-like.

Ecology

- Shallow water in lakes or streams, often with high alkalinity
- Often forms dense patches near springs or sand bars
- Emerges from rhizomes in the spring
- Fruit and foliage consumed by waterfowl and upland birds alike
- Habitat for invertebrates that are food for fish like trout

Credit: Wikimedia Commons User Chmee2



RAKE FULLNESS RATING

VISIBLE NEARBY

• NO WHITE WATER CROWFOOT FOUND

× NOT SAMPLED

Native

WHITE WATER LILY
Nymphaea odorata

Credit: Flickr User Ryan Hodnett

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

Credit: Wikimedia Commons User Kurt Stüber

RAKE FULLNESS RATING

1 2 3

VISIBLE NEARBY

• NO WHITE WATER LILY FOUND

× NOT SAMPLED