MEMORANDUM REPORT NO. 260

AQUATIC PLANT MANAGEMENT PLAN FOR EAGLE SPRING LAKE

WAUKESHA COUNTY, WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

Special acknowledgement is due to Zofia Noe, Senior Specialist – Biologist; Dr. Thomas Slawski, Chief Biologist; Dale J. Buser, PE. PH Principal Senior Specialist; Megan Deau, Senior Graphic Designer, and Alexa Carzoli, Administrative Assistant for their contributions to the conduct of this study and the preparation of this report

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Prepared by the
Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

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INTRODUCTION 1

Credit: SEWRPC Staff

The Southeastern Wisconsin Regional Planning Commission (Commission) completed this aquatic plant inventory and management study on behalf of the Eagle Spring Lake Management District (the District). The Wisconsin Department of Natural Resources (WDNR) financed much of the project cost through an Aquatic Invasives Education grant award (project AEPP63521). This memorandum report is the Commission's third study focusing on Eagle Spring Lake.[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

Eagle Spring Lake is an impounded 279-acre through-flow, or drainage, lake, located on the Mukwonago River within U.S. Public Land Survey Sections 25, 26, 35 and 36, Township 5 North, Range 17 East, in the Town of Eagle, Waukesha County. The Lake is fed and drained by the Mukwonago River, which forms an important tributary stream to the Fox (Illinois) River, joining the Fox River in the Village of Mukwonago, also in Waukesha County. The Lake is a moderately nutrient-rich (mesotrophic), alkaline, hardwater lake with a bottom composed of 50 percent muck, 25 percent sand, and 25 percent gravel.[2,3] The WDNR has identified the Lake in their draft list of state high-quality waters.[4] Lulu Lake, approximately a half-mile upstream of the Lake, is an Outstanding Resource Water while the reach of the Mukwonago River draining the Lake is an Exceptional Resource Water.

[1] *The two earlier Commission reports are Community Assistance Planning Report CAPR No. 226,* A Lake Management Plan for Eagle Spring Lake, Waukesha County, Wisconsin*, 1997 and CAPR No. 226, 2nd Edition*, A Lake Management Plan for Eagle Spring Lake, Waukesha County, Wisconsin*, 2011.*

[2] *dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=768600&page=facts*

[3] *CAPR No. 226, 2nd Edition, 2011,* op. cit.

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

Attaining only a maximum depth of eight feet, all of Eagle Spring Lake can support abundant growth of rooted aquatic plants and emergent vegetation (see Map 1.1).[5] Previous aquatic plant surveys have observed several beneficial native species, including muskgrass (*Chara* spp.) and sensitive pondweeds (*Potamogeton* spp.).[6,7,8] Invasive aquatic plant species, including Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*), hybrid watermilfoil (*Myriophyllum sibiricum X M. spicatum*), spiny naiad (*Najas marina*), and curly-leaf pondweed (*Potamogeton crispus*), have also been observed in the Lake.

The District manages aquatic plant growth on the Lake to enhance navigation and recreational opportunities, primarily through mechanical harvesting although chemical treatments have been used for invasive species control. Aquatic plant management is regulated by the WDNR and requires a permit. The District is 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 July 2016 and the last aquatic plant management plan update was completed in 2017, both by Lakeland Biologists.[9] To renew their permit, the 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 EWM 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 District 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.

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[5] *CAPR No. 226, 2nd Edition, 2011,* op. cit.

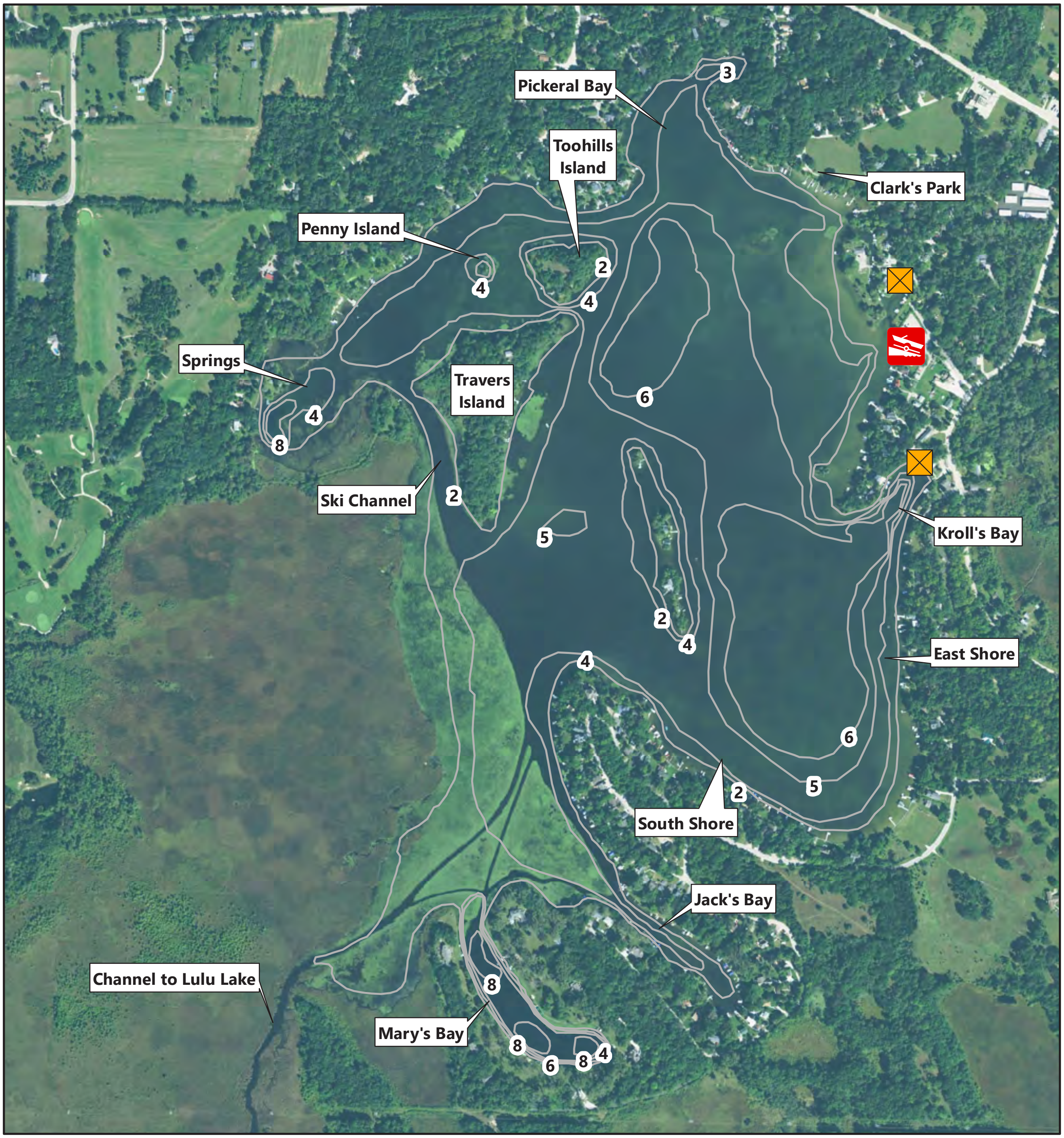
[6] *CAPR No. 226, 1997,* op. cit.

[7] *CAPR No. 226, 2nd Edition, 2011,* op. cit.

[8] *Lakeland Biologists, 2017,* op. cit.

[9] *Lakeland Biologists,* An Aquatic Plant Management Update for Eagle Spring Lake in Waukesha County, Wisconsin*, 2017.*

Map 1.1
Eagle Spring Lake Bathymetry and Local Placenames



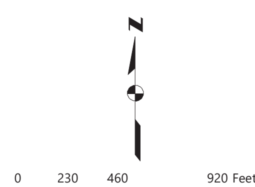
BATHYMETRIC LINE

8 WATER DEPTH (FEET)

BOATLAUNCH

DAM

Note: The bathymetric contours presented in this map utilize the 1967 bathymetric contours as drawn by the Wisconsin Department of Natural Resources as well as contours drawn following a 2006 survey by The Nature Conservancy and the Eagle Spring Lake Management Association.



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 Eagle Spring Lake APM plan considered input from many entities including the Eagle Spring Lake Management District (the District) and the Wisconsin Department of Natural Resources (WDNR). Objectives of the Eagle Spring Lake APM program include the following.

- Effectively control the quantity and density of nuisance aquatic plant growth in well-targeted portions of Eagle Spring 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 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.[10]

To meet these objectives, the District 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 major 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 1990s. Commission staff surveyed the Lake's aquatic plants in 1994,[11] 2008,[12] and 2021. Lakeland Biologists also conducted a survey in 2016.[13] Species abundance data derived from the 2016 and 2021 surveys for the Lake are compared in

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[10] *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*.

[11] *Community Assistance Planning Report CAPR No. 226,* A Lake Management Plan for Eagle Spring Lake, Waukesha County, Wisconsin*, 1997*.

[12] *CAPR No. 226, 2nd Editon,* A Lake Management Plan for Eagle Spring Lake, Waukesha County, Wisconsin*, 2011.*

[13] *Lakeland Biologists,* An Aquatic Plant Management Update for Eagle Spring Lake in Waukesha County, Wisconsin*, 2017*.

Table 2.1. The 2016 and 2021 surveys both used the same point-intercept grid and methodology.[14,15,16] In this method, 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 Eagle Spring Lake consists of 452 sampling points spaced at 50 meters (164 feet) apart (see 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 2016 and 2021. This consistency enables more detailed evaluation of aquatic plant abundance and distribution change than has been possible in the past.

Each aquatic plant species has preferred habitat conditions in which that species generally 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 very 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 maximum depth of colonization, species richness, biodiversity, evaluation of sensitive species, and relative species abundance. Metrics derived from the 2016 and 2021 point-intercept surveys are described below.

Maximum Depth of Colonization

Aquatic plants were observed at all Lake depths throughout Eagle Spring Lake during 2016 and 2021. 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.[17] As Eagle Spring Lake has aquatic plants growing in its deepest portions, water clarity does not appear to be a factor limiting plant growth in any areas of the Lake. 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 (*Chara* spp.) 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.

Species Richness

The number of different 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 generally have greater species richness. Aquatic plants provide a wide variety of benefits to lakes, examples of which are briefly described in Table 2.2.

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[14] *Sampling methodology changed from transect-based methods in the earlier surveys (1994 and 2008) to a point-intercept method beginning with the 2016 survey.*

[15] *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.*

[16] *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.*

[17] *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.*

Table 2.1
Aquatic Plant Abundance – Eagle Spring Lake: July 2016 Versus August 2021

Aquatic Plant Species	Native or Invasive	Number of Points Found[a] (2016/2021)	Frequency of Occurrence Within Vegetated Areas[b] (2016/2021)	Average Rake Fullness[c] (2016/2021)	Relative Frequency of Occurrence[d] (2016/2021)	Visual Sightings[e] (2016/2021)
Myriophyllum spicatum (eurasian water milfoil)	Invasive	28/134	8.46/39.88	1.18/1.24	2.8/11.8	8/5
Najas marina (spiny naiad)	Invasive	70/42	21.15/12.50	1.19/1.31	7.1/3.7	2/0
Potamogeton crispus (curly-leaf pondweed)	Invasive	0/0	0/0	0/0	0/0	1/0
Ceratophyllum demersum (coontail)	Native	5/5	1.51/1.49	1.40/1.29	0.5/0.4	0/0
Chara spp. (muskgrasses)*	Native	226/140	68.28/41.67	1.36/1.29	22.9/12.3	0/0
Elodea canadensis (common waterweed)	Native	12/8	3.63/2.38	1.17/1.13	1.2/0.7	1/1
Heteranthera dubia (water stargrass)	Native	0/2	0/0.60	0/1.50	0/0.2	0/0
Myriophyllum verticillatum (whorled water milfoil)*	Native	56/50	16.92/14.88	1.13/1.18	5.7/4.4	46/4
Najas flexilis (slender naiad)	Native	164/185	49.55/55.06	1.09/1.07	16.6/16.2	3/1
Najas guadalupensis (southern naiad)*	Native	0/3	0/0.89	0/1	0/0.3	0/0
Nitella furcata (forked nitella)*	Native	0/5	0/1.49	0/1	0/0.4	0/0
Nitella spp. (stonewort)*	Native	1/0	0.30/0	1/0	0.1/0	0/0
Nuphar advena (yellow pond lily)*	Native	9/0	2.72/0	1/0	0.9/0	73/0
Nuphar variegata (spatterdock)	Native	0/14	0/4.17	0/1.07	0/1.2	0/31
Nymphaea odorata (white water lily)	Native	10/6	3.02/1.79	1/1.33	1/0.5	76/39
Potamogeton foliosus (leafy pondweed)	Native	2/2	0.60/0.60	2/1	0.2/0.2	1/0
Potamogeton gramineus (variable pondweed)*,[f]	Native	0/152	0/45.24	0/1.05	0/13.3	0/1
Potamogeton illinoensis (Illinois pondweed)[g]	Native	2/56	0.60/16.67	1/1.05	0.2/4.9	1/1
Potamogeton natans (floating-leaf pondweed)	Native	2/2	0.60/0.60	2/1.05	0.2/0.2	4/1
Potamogeton nodosus (long-leaf pondweed)*	Native	0/1	0/0.3	0/1	0/0.1	0/0
Potamogeton richardsonii (clasping-leaf pondweed)[f,g]	Native	107/3	32.33/0.89	1.01/1	10.8/0.3	11/0
Potamogeton zosteriformis (flat-stem pondweed)	Native	3/6	0.91/1.79	3/1	0.3/0.3	0/0
Schoenoplectus subterminalis (water bulrush)*	Native	8/0	2.42/0	1/0	0.8/0	3/0
Schoenoplectus tabernaemontani (softstem bulrush)	Native	0/0	0/0	0/0	0/0	1/1
Sparganium natans (small bur-reed)*	Native	13/17	3.93/5.06	1/1.24	1.3/1.5	3/1
Stuckenia pectinata (sago pondweed)[g]	Native	41/63	12.39/18.75	1.05/1.03	4.1/5.5	28/2
Typha spp. (cattail)	Native	0/0	0/0	0/0	0/0	6/1
Utricularia minor (small bladderwort)*	Native	0/3	0/0.89	0/1	0/0.3	0/0
Utricularia vulgaris (common bladderwort)*	Native	26/13	7.85/3.87	1/1.08	2.6/1.1	0/2
Vallisneria americana (eelgrass/water celery)[g]	Native	204/228	61.63/67.86	1.04/1.15	20.6/20.0	37/1

Table continued on next page.

Table 2.1 (Continued)

Note:

- During the 2016 survey, sampling occurred at 358 sampling points on July 26 and 28, 2016. Of the sampling points visited, 331 were vegetated. During the 2021 survey, sampling occurred at 374 sampling points on August 2 and 3, 2021. Of the sampling points visited, 336 had vegetation.
- Red text indicates non-native and/or invasive species.
- An asterisk (*) next to a species name indicates that the species is considered "sensitive," with a coefficient of conservatism C value of seven or greater.
- See Appendix A for distribution maps and identifying features.

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

[b] Frequency of Occurrence Within Vegetated Areas, *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 species compared to the frequencies of all species present.*

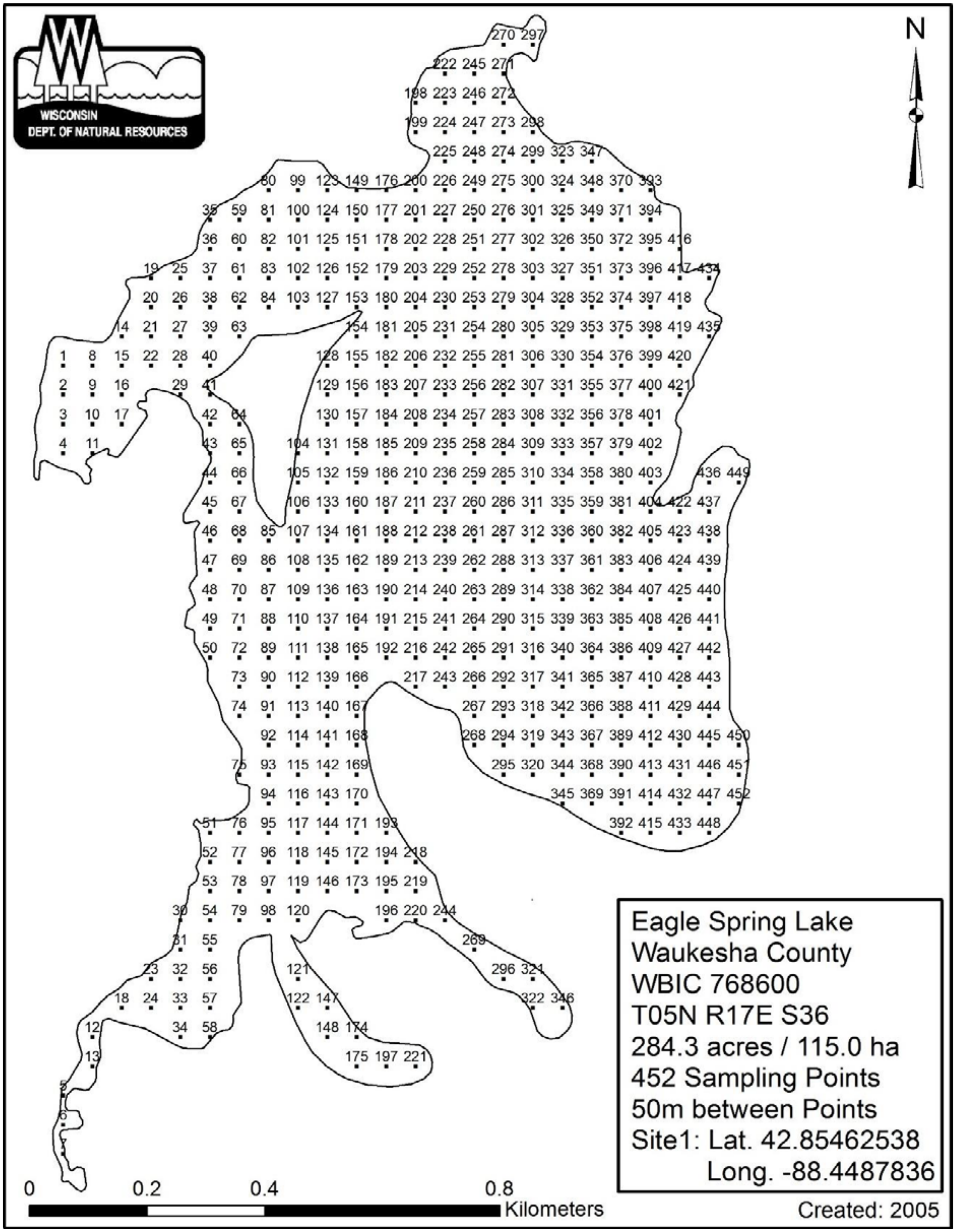
[e] Visual Sightings *is the number of points where that species was visually observed within six feet of the actual rake haul location but was not actually retrieved on the rake and was not, therefore assigned a rake fullness measurement for that site. At points where this occurred, the species was 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] *It is possible that* P. gramineus *was mis-identified as* P. richardsonii *in the 2016 aquatic plant survey.*

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

Source: Lakeland Biologists, Wisconsin Department of Natural Resources and SEWRPC

Figure 2.1
Aquatic Plant Sampling Map for Eagle Spring Lake



Source: WDNR and SEWRPC

Table 2.2
Examples of Positive Ecological Qualities Associated with Aquatic Plant Species Present in Eagle Spring 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
Myriophyllum verticillatum (whorled water milfoil)	Waterfowl utilize fruit and foliage as food source; foliage provides invertebrate habitat, as well as shade, shelter, and foraging for fish; native
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; 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

Eagle Spring Lake exhibited high species richness overall during the initial plant inventory completed in 1994 (see 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 2021 aquatic plant survey identified 24 native species in the Lake. This species richness is higher than average for similarly sized lakes within Southeastern Wisconsin. The total number of species observed at each sampling point is shown in Figure 2.2.

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).[18] Using this measure, a community dominated by one or two species would be considered less diverse than one in which several different

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

Table 2.3
Aquatic Plant Abundance – Eagle Spring Lake: July 2016 Versus August 2021

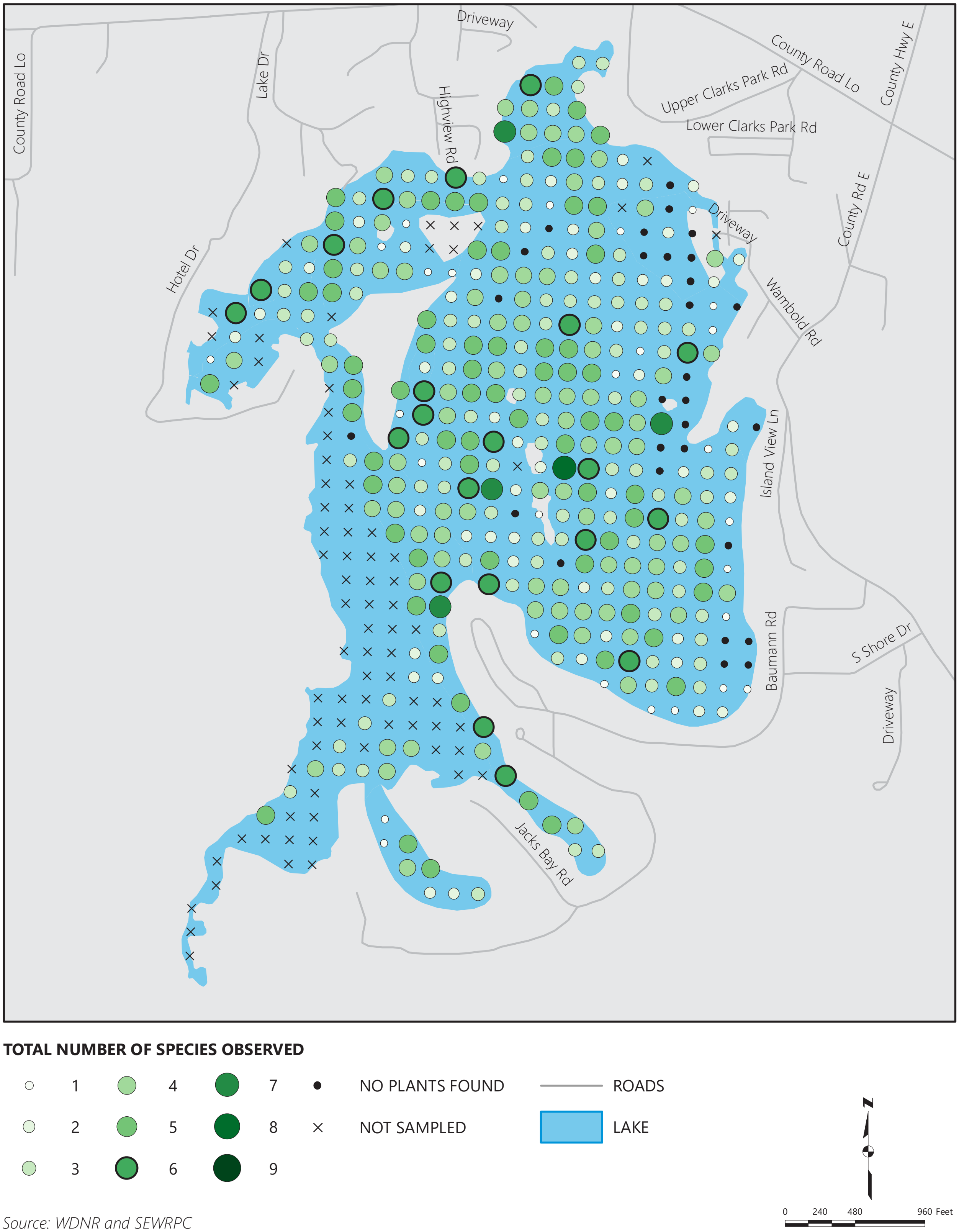
Aquatic Plant Species	1994	2008	2016	2021
Ceratophyllum demersum (coontail)	X	X	X	X
Chara spp. (muskgrasses)*	X	X	X	X
Elodea canadensis (common waterweed)	X	X	X	X
Eleocharis acicularis (needle spikerush)	--	X	--	--
Heteranthera dubia (water stargrass)	--	X	--	X
Myriophyllum spicatum (eurasian water milfoil)	X	X	X	X
Myriophyllum spp. (watermilfoils)	X	X	X	--
Myriophyllum verticillatum (whorled water milfoil)	--	--	--	X
Najas flexilis (slender naiad)	X	X	X	X
Najas guadalupensis (southern naiad)	--	--	--	X
Najas marina (spiny naiad)	X	X	X	X
Nitella furcata (forked nitella)	--	--	--	X
Nitella spp. (stoneworts)	--	--	X	--
Nuphar advena (yellow pond lily)	--	--	X	--
Nuphar variegata (spatterdock)	--	--	--	X
Nymphaea odorata (white water lily)	--	--	X	X
Potamogeton crispus (curly-leaf pondweed)	X	X	X	--
Potamogeton foliosus (leafy pondweed)	--	X	X	X
Potamogeton gramineus (variable pondweed)	X	X	--	X
Potamogeton illinoensis (illinois pondweed)	X	X	X	X
Potamogeton natans (floating-leaf pondweed)	X	X	X	X
Potamogeton nodosus (long-leaf pondweed)	--	--	--	X
Potamogeton pusillus (small pondweed)	--	X	--	--
Potamogeton richardsonii (clasping-leaf pondweed)	--	X	X	X
Potamogeton zosteriformis (flat-stem pondweed)	X	X	X	X
Ranunculus longirostris (longbeak buttercup)	X	X	--	--
Schoenoplectus subterminalis (water bulrush)	--	--	X	--
Schoenoplectus tabernaemontani (softstem bulrush)	--	--	X	X
Sparganium natans (small bur-reed)	--	--	X	X
Stuckenia pectinata (sago pondweed)	X	X	X	X
Typha spp. (cattail)	--	--	X	X
Utricularia minor (small bladderwort)	--	--	--	X
Utricularia vulgaris (common bladderwort)	X	X	X	X
Vallisneria americana (eelgrass/water celery)	X	X	X	X
Native Species Richness	13	18	20	24
Total Species Richness	16	21	23	26

Source: Lakeland Biologist, ESLMD, Wisconsin Department of Natural Resources, and SEWRPC

species have similar abundance. In general, more diverse biological communities are better able to maintain ecological integrity. Promoting biodiversity not only helps sustain an ecosystem but preserves the spectrum of options useful for future management decisions.

Data collected during 2021 reveal that the Lake's SDI was 0.88, an increase from 0.85 measured during 2016. The 2021 SDI value reveal considerable biodiversity in the Lake. Even though the Lake exhibits good species richness and biodiversity, no one location in the Lake contained all identified aquatic plant species. During 2021, between one and eight aquatic plant species were found at any single sampling point throughout the Lake (Figure 2.2). 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.

Figure 2.2
Aquatic Plant Species Richness – Eagle Spring Lake: 2021



Source: WDNR and 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 2016 was 25.9 while the 2021 FQI was 28.4. 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.

Eight sensitive species, as defined by the Commission as a species with a C value of seven or more, were identified during the 2021 survey: muskgrass, whorled watermilfoil (*Myriophyllum verticillatum*), southern naiad (*Najas guadalupensis*), forked nitella (*Nitella furcata*), variable-leaved pondweed (*Potamogeton gramineus*), long-leaf pondweed (*Potamogeton nodosus*), small bur-reed (*Sparganium natans*), small bladderwort (*Utricularia minor*), and common bladderwort (*Utricularia vulgaris*).

Relative Species Abundance

Based on the 2021 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) slender naiad (*Najas flexilis*), 3) variable-leaved pondweed, 4) muskgrass, and 5) Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*). A community of intermixed eelgrass, slender naiad, muskgrass, and variable-leaved pondweed interspersed by EWM or whorled milfoil comprised much of the Lake's central area. Many of the more rarely observed species in the Lake were found along the Lake's northwestern and western edges, either intermixed with the commonly observed species or in dense, monocultural stands (e.g., meadow of small bur-reed in northwestern arm of the Lake). Photographs of the Lake's aquatic plant community are presented in Figure 2.3.

Over the past 30 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.[21] 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.

A variety of high value and oftentimes sensitive pondweed species are found in the Lake. Other native aquatic plants that have been found over the years in varying abundance include eelgrass, slender naiad, and Sago pondweed (*Stuckenia pectinata*). Exotic Eurasian watermilfoil was observed in the 1994 survey and each survey since. Overall EWM abundance has substantially increased since the 2016 survey.

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[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] *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.*

Figure 2.3
Aquatic Plant Community of Eagle Spring Lake

Eelgrass (*Vallisneria americana*) and whorled milfoil (*Myriophyllum verticillatum*)

Eurasian watermilfoil (*Myriophyllum spicatum*)

Naiads (*Najas* spp.) and whorled milfoil

Eelgrass, naiads, and variable-leaved pondweed (*Potamogeton gramineus)*

Source: SEWRPC

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 predation cycles related to the relative abundance of milfoil weevils (*Eurhychiopsis lecontei*).

Apparent Changes in Observed Aquatic Plant Communities: 2016 versus 2021

The distribution of each aquatic plant species identified as part of the 2021 survey is mapped in Appendix A. The 2021 aquatic plant inventory identified 24 species of aquatic plants (26 including visual-only observations) in the Lake. In contrast, the 2016 aquatic plant inventory identified 20 species (23 including visual-only observations). Overall, the number of aquatic plant species in the Lake has increased since the 1994 survey (16 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.

General Trends

In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2016 and 2021 aquatic plant survey results, as examined below.

- The total vegetated frequency of occurrence remained high (greater than 90 percent) and stable between 2016 and 2021, indicating that most of the Lake bottom continues to be covered by aquatic vegetation.

- The MDC remained stable at 10 feet between 2016 and 2021, 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 2016 and 2021. Muskgrass moved from the most observed species in 2016 to the fourth-most observed in 2021. Eelgrass, the second most observed species in 2016, was the most observed species in 2021. Variable-leaved pondweed and EWM were new additions to the five most observed species in 2021, replacing spiny naiad and clasping-leaf pondweed.

- EWM was found at substantially more points in 2021 than in 2016 while spiny naiad, another invasive species, was found at slightly fewer points in 2021 than 2016. Curly-leaf pondweed, which was observed at only one point in 2016, was not observed during the 2021 survey.

- Several native submerged aquatic plant species appear to have small populations within the Lake. Coontail (*Ceratophyllum demersum*), water stargrass (*Heteranthera dubia*), southern naiad, several pondweed species (leafy, floating, and long-leaf pondweeds), and small bladderwort were only observed at a few points in the 2016 and 2021 surveys.

- Variable-leaved pondweed, which was observed scarcely in 1994 and 2008 and not observed at all in 2016, was the third most observed species in the 2021 survey. In contrast, clasping-leaf pondweed was observed at substantially fewer points in 2021 than in 2016. These are both sensitive species with similar growth habitats.

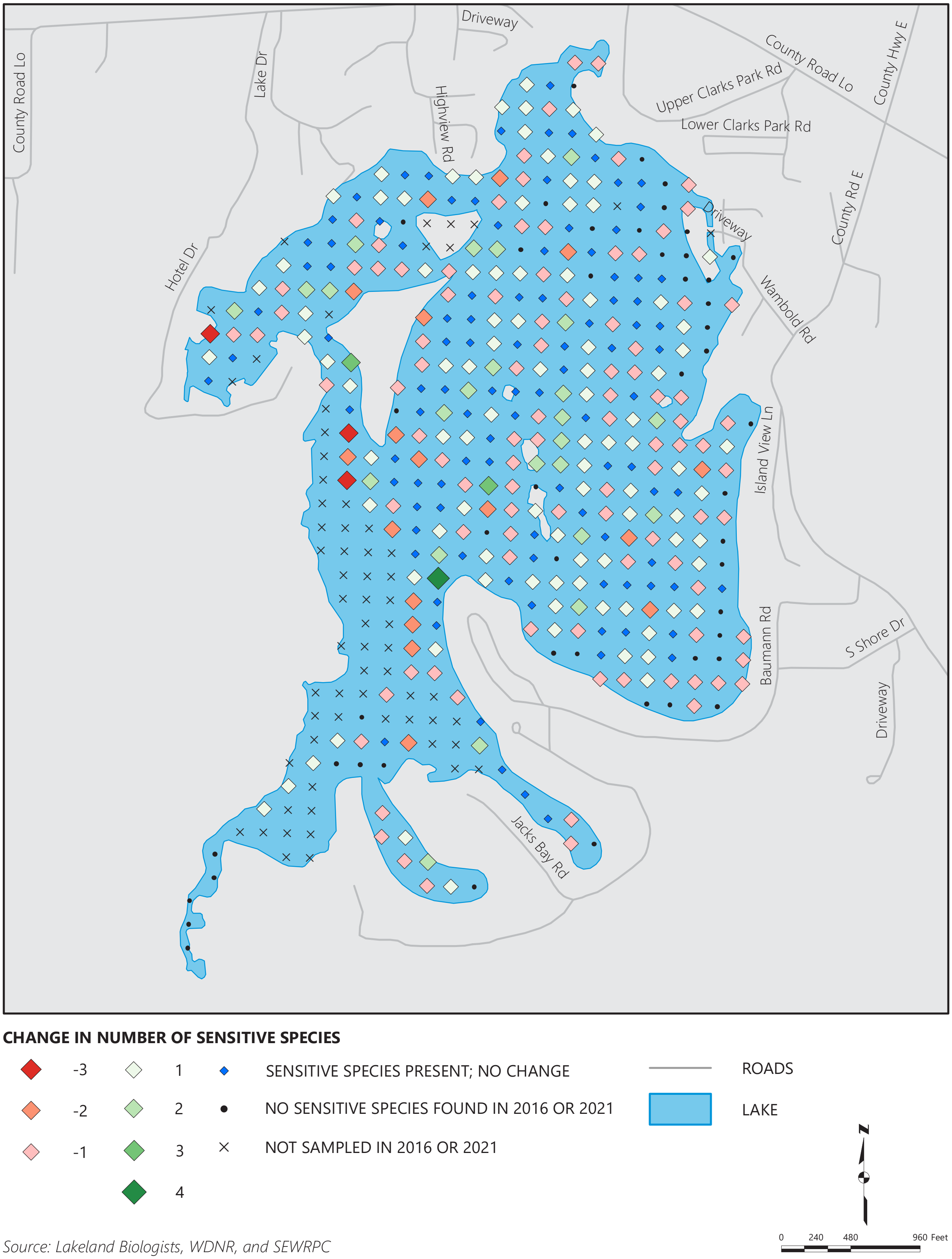
- While much of the Lake had a similar aquatic plant community composition, there were distinct communities in other portions of the Lake. The northern shoreline had dense beds of spiny naiad that were not observed in other areas. Dense muskgrass beds were observed along the northwestern shoreline and along the western shoreline of the South Shore Drive peninsula. Areas west of Travers Island had extensive beds of small bur-reed growing mixed with other sensitive native species. The finger bay locally known as Mary's Bay has the largest abundance of coontail in the Lake.

- While Commission staff did not survey much of the heavily vegetated western edge of the Lake, this area was thoroughly covered by white water lily and spatterdock with occasional stands of softstem bulrush (*Schoenoplectus tabernaemontani)*. There is also a sizable stand of softstem bulrush in the northeastern section of the Lake near Clark's Park that Commission staff were unable to survey due to the shallow water in this area.

As was described earlier, sensitive aquatic plant species are likely 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 2016 and 2021 were contrasted (Figure 2.4). Overall, the sensitive species richness increased between 2016 and 2021, reflecting a stable and healthy plant community. A few significant observations were noted:

- The 2021 survey identified variable-leaved pondweed at 152 sampling points within the Lake while the 2016 survey did not identify this species at any point. Similarly, the 2016 survey identified 81 sampling points with yellow pond lily (*Nuphar advena*) while the 2021 survey did not identify any points with this species. While changes could be due to sizable shifts in the aquatic plant community, it seems more likely that these changes are due to differences in species identification between the surveys. Consequently, 2016 observations of yellow pond lily were not considered when creating Figure 2.4.

Figure 2.4
Change in Sensitive Species Richness – Eagle Spring Lake: 2016 Versus 2021



Source: Lakeland Biologists, WDNR, and SEWRPC

- The most common sensitive "species" in the Lake in the 2016 survey was muskgrass while variable-leaved pondweed was the most common sensitive species in 2021.[22] While muskgrass was the second most common sensitive species in 2021, its vegetated frequency of occurrence declined by approximately 27 percent from the 2016 survey.

- While sensitive species were distributed throughout much of the Lake, the western edge of the Lake between Penny Island and the northern end of Mary's Bay had the most observations of sensitive species. Several sensitive species, including forked Nitella, small bladderwort, and small bur-reed, were only found in this portion of the Lake. The only sizable areas without sensitive species observations were the southeastern corner of the Lake and an area just west of the public boat launch which had little aquatic plant growth of any kind (see Figure 2.5).

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 District's primary targets for control through its ongoing aquatic plant management program, particularly as hybrid milfoil has been observed in the Lake. 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.[23,24] 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.[25] For reasons such as these, EWM can grow to dominate an aquatic plant community in as little as two years.[26,27] 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.[28]

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.[29] 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 very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

Hybrid milfoil, a cross between native northern milfoil (*M. sibiricum*) and invasive EWM (*M. spicatum*) is a particular concern for the District. These hybrid milfoils have been shown to have increased tolerance

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[22] *Commission staff did not identify muskgrass to species in the field, so all references to muskgrass are to the genus (*Chara *spp.). All species of* Chara *are currently identified as sensitive species.*

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

[24] *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.*

[25] Ibid.

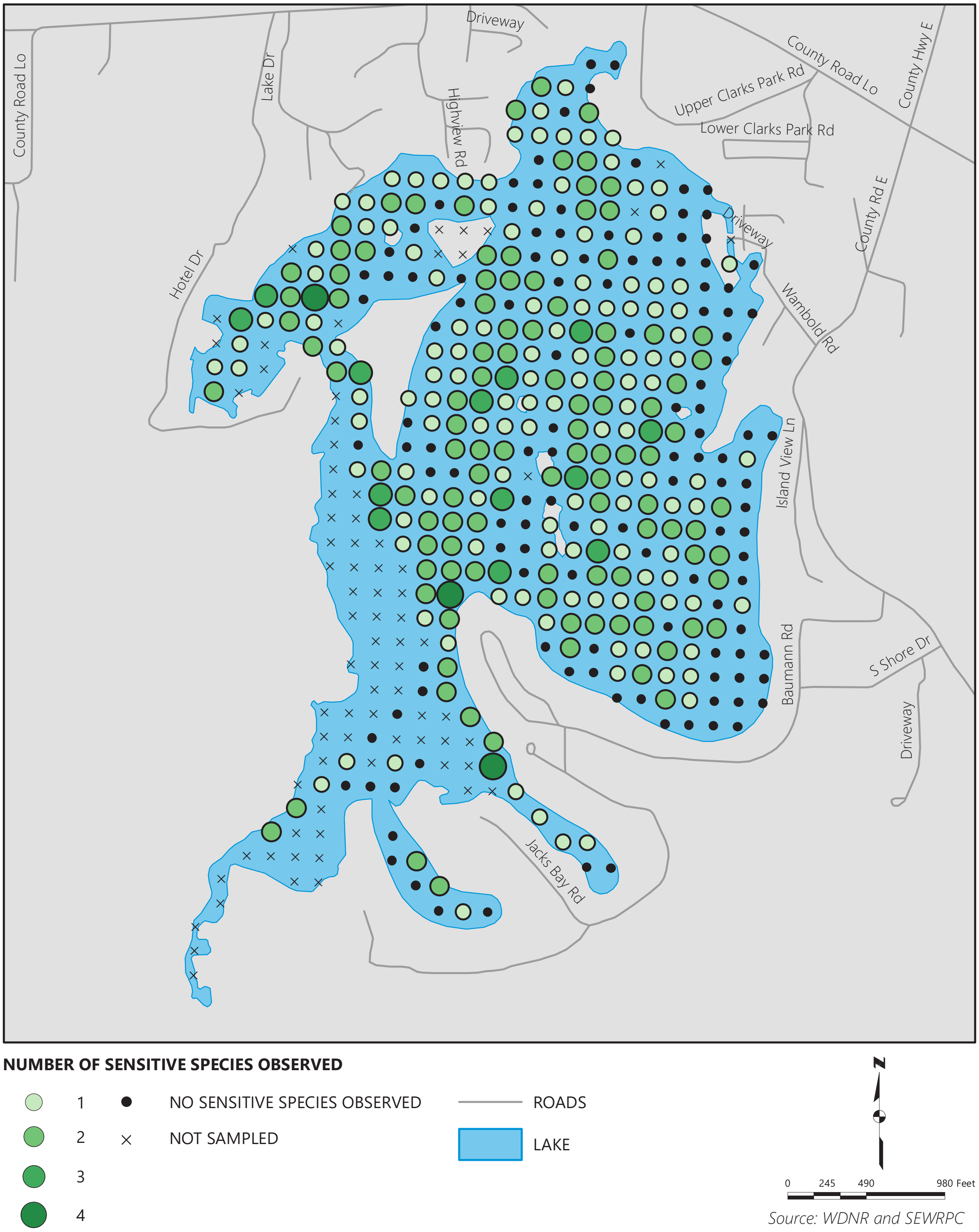
[26] *S.R. Carpenter, "The Decline of* Myriophyllum spicatum *in a Eutrophic Wisconsin (USA) Lake,"* Canadian Journal of Botany *58(5), 1980.*

[27] *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.*

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

[29] *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 2.5
Aquatic Plant Sensitive Species Richness – Eagle Spring Lake: 2021



Source: WDNR and SEWRPC

of commonly used aquatic plant herbicides, such as 2,4-D.[30,31,32] Identifying a milfoil as a hybrid requires genetic analysis, as there are no distinguishing anatomical characteristics to differentiate hybrid milfoil from EWM. Hybrid milfoil was first verified in Eagle Spring Lake in 2019 through a District-commissioned study where 20 samples of milfoil were collected for genetic analyses.[33] Of these 20 samples, 12 were pure EWM and 8 were hybrid milfoil (see Map 2.1). Due to their admixture in the Lake and the inability to differentiate the strains visually, Commission staff did not attempt to identify pure EWM vs. hybrid milfoil during their 2021 survey and instead just identified any milfoils with characteristics like EWM as EWM.

EWM is chiefly occurs in the eastern portion of the Lake where there is reduced presence of other aquatic plant species. EWM was observed at 7.8 percent of surveyed points (28 of 358 points) in the Lake during 2016 and 35.6 percent of surveyed points (134 of 374 points) in 2021. Therefore, the area occupied by EWM relative to other plants substantially expanded between 2016 and 2021 (see Figure 2.6). Average rake fullness of EWM remained relatively low in both surveys (1.18 in 2016 and 1.24 in 2021), indicating that EWM is not growing abundantly in all observed areas. However, there are some areas with abundant EWM growth, particularly near Kroll's Bay, Jack's Bay, Pickeral Bay, and along the south shore. District staff have noted that EWM grows most abundantly and recovers more quickly following treatment in areas with organic lake sediment compared to areas with sandy or gravelly sediment.[34]

Other Exotic Submergent Aquatic Plants

Curly-leaf pondweed was not observed during the 2021 survey and was only observed at one point along the northeastern Lake shoreline in 2016. 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 relatively 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 relatively common in Eagle Spring Lake, with observations at 19.6 percent of surveyed points in 2016 and 11.2 percent of surveyed points in 2021. 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.[35] However, spiny naiad is reported to be used as a food source for waterfowl, marsh birds, muskrat, and shelter/forage area for fish. As stated in the "General Trends" subsection, dense spiny naiad beds were present near of Penny Island, particularly on the northern Lake shoreline north of the Island. In other areas of the Lake, spiny naiad was only found at low abundance and largely intermixed with other species.

Water Lilies

The District has expressed concern that the extent of native water lilies (*Nymphaea odorata* and *Nuphar variegata*) along the western edge of the Lake had been receding in recent years. Commission staff mapped the extent of water lilies present in 2018 National Agricultural Imagery Program (NAIP) imagery, which was chosen as this imagery is taken during the growing season (see Figure 2.7). The water lily extent in the 2018 NAIP was then compared to the extent visible in 2005, 2010, and 2015 NAIP imagery. It does not appear that there has been significant recession of native water lilies along the western edge of the Lake based on this analysis.

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[30] *M. Nault et al., "Herbicide Treatments in Wisconsin Lakes,"* LakeLine*, 2012.*

[31] *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.*

[32] *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.*

[33] *Personal communication between Michelle Nault, WDNR, and Commission staff via email, June 2020.*

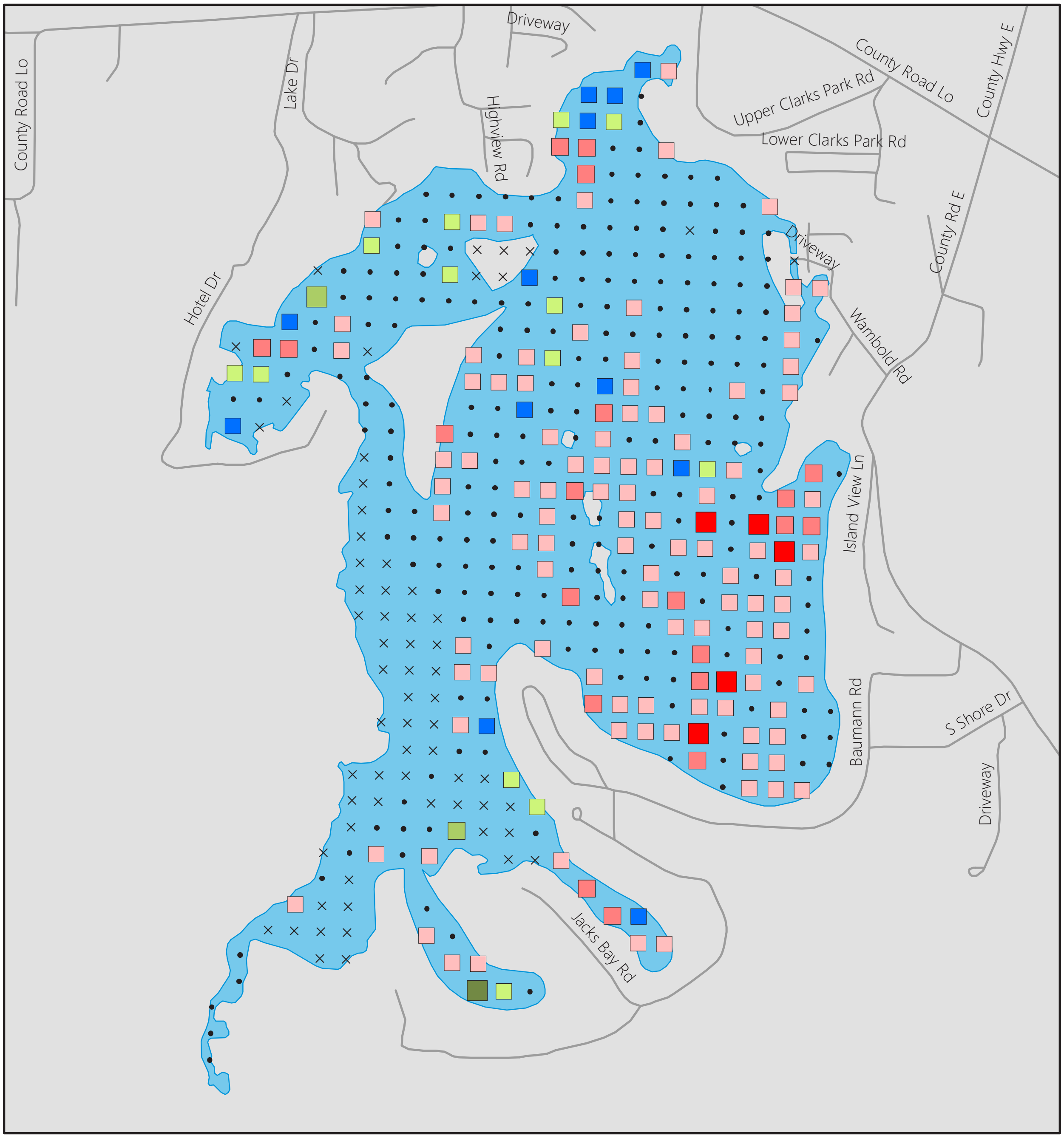
[34] *Personal communication between District staff and Commission staff during the January 28, 2022 meeting.*

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

Map 2.1
Eagle Spring Lake Hybrid and Eurasian Watermilfoil

Source: ESLMD and SEWRPC

Figure 2.6
Change in Eurasian Watermilfoil Rake Fullness – Eagle Spring Lake: 2016 Versus 2021



CHANGE IN EWM RAKE FULLNESS

-3	1	NOT EWM FOUND IN 2016 OR 2021	ROADS
-2	2	NOT SAMPLED IN 2016 OR 2021	LAKE
-1	3	EWM PRESENT; NO CHANGE IN FULLNESS	

Source: Lakeland Biologists, WDNR, and SEWRPC

Figure 2.7
Eagle Spring Lake Water Lily Extent: 2005-2018

Source: USDA AND SEWRPC

2.3 PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic plants have been controlled on Eagle Spring 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. Early aquatic plant control relied on chemical treatment with sodium arsenite, which was sprayed onto the Lake's surface within 200 feet of shoreline.[36] Approximately 4,360 pounds of sodium arsenite were applied to the Lake between 1950 and 1969, when its application was discontinued by the State due to the potential health hazards it posed to aquatic life and human health.[37] 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 1970s.

Since 1969, the aquatic herbicides Aquathol® 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 Eagle Spring Lake was discontinued after 1978. 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 generally used to control EWM. However, it can also kill beneficial species, such as water lilies (*Nymphaea* spp. and *Nuphar* spp.). Between 1999 and 2018, the District applied both granular and liquid forms of 2,4-D herbicide to the Lake in spots treatments for EWM (see Appendix B).[38] The District has not applied 2,4-D to the Lake since 2019. After experimenting with chemical delivery forms and timing, the District has noted that chemical applications may not be as effective in the northwestern arm of the Lake due to the presence of groundwater springs that dilute the chemical concentrations.[39,40]

On May 18th 2020, four prescription dose units (equivalent to 12.8 fluid ounces) of the novel herbicide ProcellaCOR™ was applied in Pickeral Bay to control its EWM and hybrid milfoil population (see Appendix B).[41] EWM was observed at eight of the fourteen survey points within Pickeral Bay in 2021. ProcellaCOR™ was first registered by the Environmental Protection Agency in for aquatic use in 2017 and by the WDNR in 2018 (see Appendix C). According to the WDNR chemical fact sheet, ProcellaCOR™ mimics plant growth hormones to kill plants through excessive cell elongation but has a different binding affinity than similar registered products, such as 2,4-D. Toxicity tests conducted using model species suggest that ProcellaCOR™ poses no risk concerns for non-target wildlife, nor does it pose a risk to human health with acute or chronic exposure. However, effects of ProcellaCOR™ on lake ecology is still an area of active research due to its novel use in aquatic plant management.

Diver Assisted Suction Harvesting (DASH) was utilized on an experimental basis in one location along the northwestern shoreline of the Lake in 2015 with the goal of removing EWM.[42] This method can more selectively target aquatic plant species but is generally more expensive and labor intensive than harvesting or chemical treatment. The treatment resulted in loss of several non-EWM species, disturbed the sediment, and the area treated with DASH in 2015 was reported to have EWM regrowth of moderate density the following year.[43] Consequently, the 2017 APM plan only recommended DASH for individual riparian owners wishing to remove aquatic plants near their piers.[44]

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[36] *CAPR 226, 2nd Edition, 2011,* op. cit.

[37] Ibid.

[38] *Lakeland Biologists, 2017,* op. cit.

[39] *Personal communication between District staff and Commission staff during the January 28, 2022 meeting.*

[40] *The WDNR has researched the efficacy of 2,4-D applications in several lakes. Information regarding this research can be found on the following webpage: dnr.wi.gov/lakes/plants/research/Project.aspx?project=111623272.*

[41] *The ProcellaCOR™ active ingredients, directions for use, and dose amounts can be found on the following webpage: www.sepro.com/Documents/ProcellaCOR_EC--Label.pdf.*

[42] Ibid.

[43] *Personal communication between District staff and Commission staff during the January 28, 2022 meeting.*

[44] Ibid.

Mechanical aquatic macrophyte harvesting has been used in conjunction with chemical treatments to control aquatic plant growth in the Lake. The harvesting has been largely limited to lanes along the northern, southeastern, and southern shorelines, but surface cutting has been permitted in the Lake's main body in areas where EWM is dominant (exceeds 50 percent cover).[45] Harvesting records from 2021 indicate that the most frequently harvested areas targeting EWM removal are in Pickeral Bay, Jack's Bay, the Lake's southern shoreline, and the eastern shoreline of North and South islands.[46] The volume of aquatic plants harvested each year varies substantially (Table 2.4).

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 percent of dry weight and that total phosphorus constitutes 0.2 percent of the total dry weight of the plant. The Whitewater-Rice and Minnesota studies assumed that dry weight is 15 and 7 percent of the wet weight, respectively, and phosphorus constituted 0.31 and 0.30 percent 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 other studies.[47,48]

Using these methods, the Commission estimates that aquatic plant harvesting has removed approximately 750 pounds of phosphorus from the Lake during the nine years for which plant harvest records are available (see Figure 2.8). The District's harvesting removes an average of 83 pounds of phosphorus from the Lake each year. The WDNR's Presto-Lite tool estimates that the average total annual phosphorus load to the Lake is 917 pounds, with an 80 percent confidence interval of 438 to 1,922 pounds.[49] Therefore, aquatic plant harvesting removes up to 19 percent of the total phosphorus contributed annually by surface runoff and tributary streams.

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

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[45] Ibid.

[46] *Letter from Thomas Day, Eagle Spring Lake Management District Harvesting Manager, to Heidi Bunk, WDNR Lakes Biologist, on October 20, 2021.*

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

[48] *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.*

[49] *For more information on the WDNR PRESTO-Lite tool, see the following webpage: dnr.wisconsin.gov/topic/SurfaceWater/PRESTO.html.*

- *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

Table 2.4
Volume of Aquatic Plants Harvested from Eagle Spring Lake

Year	Plant Material Removed (cubic yards)
2013	916.7
2014	313.0
2015	156.5
2016	389.8
2017	213.4
2018	325.6
2019	326.9
2020	182.1
2021	264.4

Source: Eagle Spring Lake Management District

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.[50,51] 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 a five-year period.[52] 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.[53] These plans and plan execution are reviewed and overseen by the WDNR regional lakes and aquatic invasive species coordinators.[54]

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.[55] For example, milfoil weevils

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

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

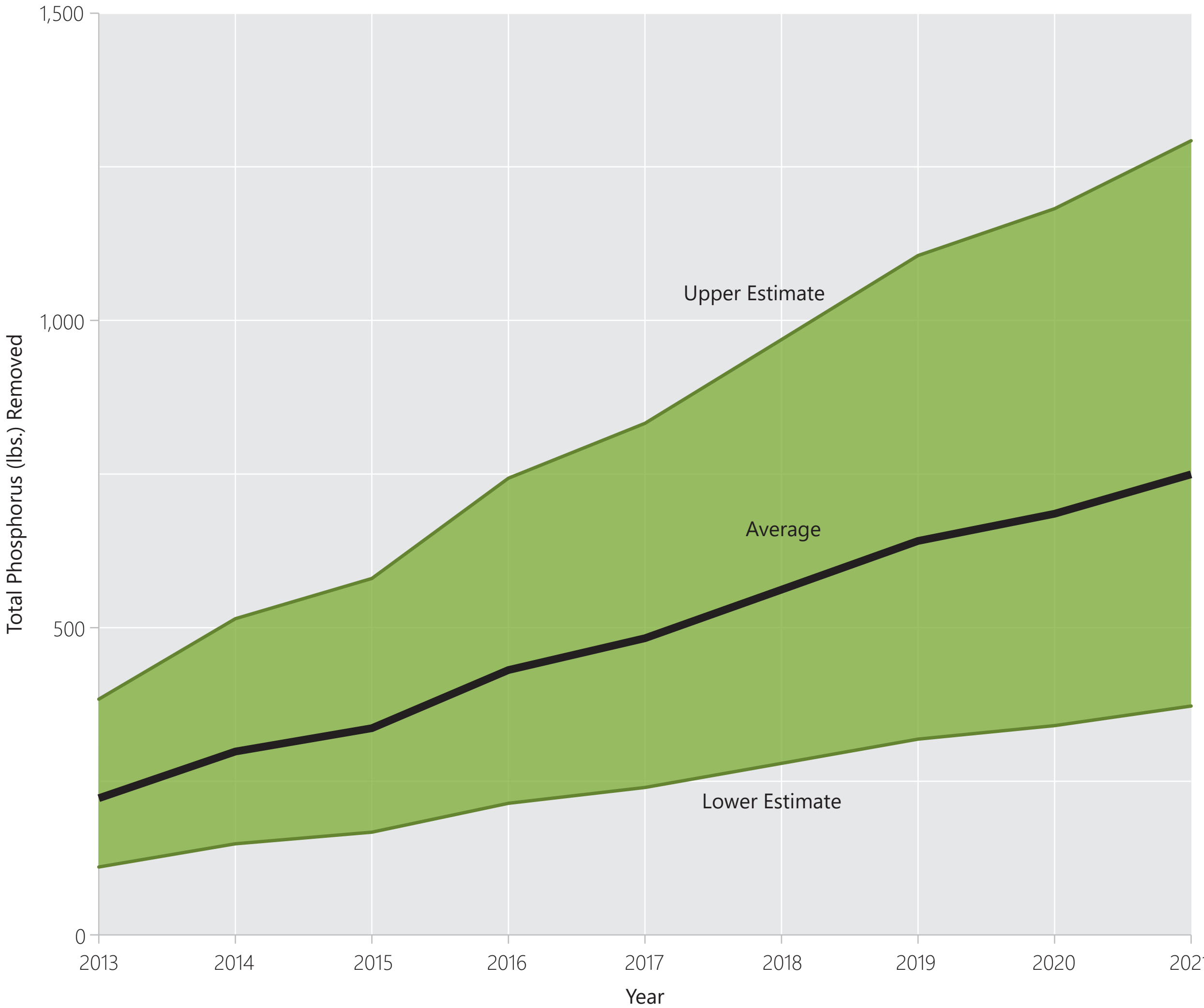
[52] *Five-year permits allow a consistent aquatic plant management plan to be implemented over a significant length of time. This process allows the selected aquatic plant management measures to be evaluated at the end of the permit cycle.*

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

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

[55] *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.*

Figure 2.8
Eagle Spring Lake Phosphorus Removal by Harvesting: 2013 - 2021



Source: Eagle Spring Lake Management District and SEWRPC

(*Eurhychiopsis lecontei)* have been used to control EWM. Milfoil weevils do best in waterbodies with balanced panfish populations,[56] 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. The District committed to an approximately $10,000 milfoil weevil project in 1997 to reduce growth of EWM, but it was not deemed to be effective.[57]

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 technique helps

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

[57] *Personal communication between District staff and Commission staff during the January 28, 2022 meeting.*

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 relatively 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.[58]

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 very early in the season (e.g., EWM, curly-leaf pondweed) when native plants have not yet emerged or appreciably grown.

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

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,[59] 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 ultimately 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.

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 essentially 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 relatively 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.

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[59] *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.*

- **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.[60] For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.[61] 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.[62] 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.

- **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 generally 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.[63] 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.

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

[61] *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.*

[62] *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.*

[63] *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.*

- **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 very early spring).

- **Need for repeated treatments.** Chemical herbicides are not a one-time silver-bullet solution, instead, treatments generally 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.

- **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.[64,65] 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.[66] 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 eastern portion of the Lake, a large spot treatment in that basin may be utilized.[67] 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 District. 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.

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[64] *Glomski and Nederland, 2010,* op. cit.

[65] *LaRue et al., 2013,* op. cit.

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

[67] *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.*

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.[68] In Wisconsin, water level manipulation is generally 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 long 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 generally 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.[69] 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.[70,71] Thus, drawdowns can be used to dramatically alter the composition of a 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.[72]

Water level manipulation can also have unintended impacts on water chemistry and lake fauna.[73,74] 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 major effects on lake ecology. Consequently, detailed information on the Lake's hydrology, including groundwater, should be compiled before undertaking such an operation.[75] The WDNR would likely require and consider the following during review of the drawdown permit application:

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

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[68] *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.*

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

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

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

[72] *Blanke et al.,* op. cit.

[73] Ibid.

[74] *Cooke,* op. cit.

[75] *Summaries of the hydrologic and groundwater conditions in and around Eagle Spring Lake with references to other studies were provided in CAPR 226, 2nd Edition, 2011,* op. cit.

- 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.

3 MANAGEMENT RECOMMENDATIONS AND PLAN IMPLEMENTATION

Credit: SEWRPC Staff

Eagle Spring Lake (the Lake) supports a robust and diverse aquatic plant community. The Lake contains several sensitive and rare native aquatic plant species, and it directly connects with upstream Lulu Lake, a lake designated by the Wisconsin Department of Natural Resources (WDNR) as an Outstanding Resource Water. However, invasive species such as Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) and spiny naiad (*Najas marina*) are widespread 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, to most effectively manage aquatic plants, the Eagle Spring Lake Management District (the District) should actively seek out and collaborate with such agencies.

3.1 RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The most effective plans to manage nuisance and invasive aquatic plant growth generally 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.

1. **Mechanically harvest invasive and nuisance aquatic plants.** Mechanical harvesting should remain the primary means to manage invasive and nuisance aquatic plants on Eagle Spring Lake. Harvesting must avoid, or must be substantially restricted, in certain areas of the Lake.[76] 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 western edge of Eagle Spring Lake is composed of floating-leaf and emergent vegetation, a situation restricting mechanical harvesting to lanes that protect sensitive areas yet allows riparian residents and boat launch users to navigate between the Lake and Lulu Lake, 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 District's aquatic plant management plan and chemical treatments have previously been limited treat nonnative plants in specific areas of the Lake. Nevertheless, the District 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 in the littoral zone of the Lake was nearly 40 percent in 2021 (Table 2.1) the District may choose to pursue a large-scale chemical treatments to reduce the EWM population in the eastern and 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 special 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 Eagle Spring Lake.[77] This will help lower the probability of invasive species entering the Lake.

Mechanical Harvesting

The District currently operates one Aquarius Systems brand harvester on the Lake: model HM-420. This mid-size harvester has the capacity to cut up to 5.5 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.

The approximate orientation and extent of proposed harvesting areas within the Lake are similar those published in the 2017 aquatic plant management plan and were developed with consideration of sensitive and invasive species presence as well as the Lake's water-skiing patterns. The general locations of harvesting areas are schematically illustrated in Figure 3.1. 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.

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[76] *Lakeland Biologists,* An Aquatic Plant Management Plan Update for Eagle Spring Lake in Waukesha County, Wisconsin*, March 2017.*

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

1. **Except for navigational access lanes, harvesters must not be operated nearshore in water less than 36 inches feet deep.** Mechanical harvesting may possibly be expanded in shallow, obstacle-prone nearshore areas throughout the Lake if a small-scale harvester is available. Even though the District'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 District'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 very 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.

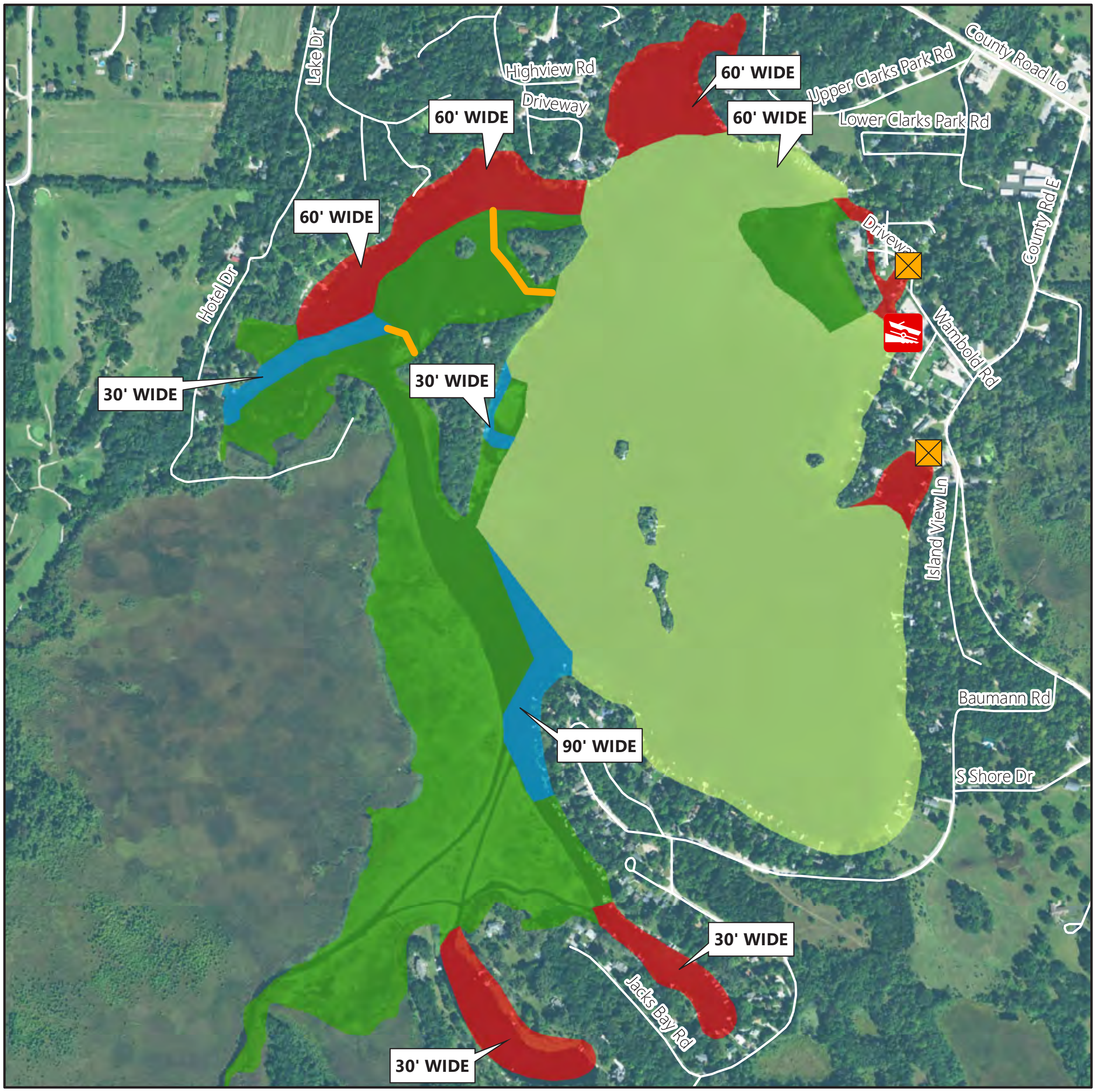
4. **Adapt harvester cutting patterns and depths to support lake use and promote ecological health.** Aquatic plant harvesting techniques should vary in accordance with the type and intensity of human recreational use, lake characteristics, the distribution and composition of aquatic plants, and other biological considerations. For example, in sensitive areas, relatively wide transit lanes connect boat launches, highly populated shorelines, and open-water areas. Narrower access lanes connect less trafficked areas and sparsely populated shorelines to open-water areas and transit lanes. The approaches to employ in differing management areas are illustrated in Figure 3.1 and described below.

   a. Harvesting is limited in certain areas of the Lake: Harvesting is not recommended in areas denoted as "Habitat" on Figure 3.1, aside from navigation and access lanes as described below. These areas have sensitive aquatic plant species and support important habitat for birds, herptiles, and aquatic organisms.[78] This recommendation should be reconsidered if invasives species become dominant in these areas.

   b. Navigation lanes are given high priority: Channels providing travel thoroughfares for watercraft should be prioritized. These channels are generally parallel to the shoreline, except for access channels through "Habitat" areas. Navigation lanes in the Lake's northwestern springs area are limited to a 30 foot width while navigation lanes in bays and along the Lake's northern shoreline are limited to a 60 foot width (see Figure 3.1). Lanes along the Lake's main body are limited to a 90 foot width, aside from a lane outside of Clark's Park at 60 foot width. Access lanes in "Habitat" areas are limited to a 15 foot width.

[78] *Lakeland Biologists, 2017,* op. cit.

Figure 3.1
Recommended Eagle Spring Lake Aquatic Plant Management Plan: 2022



HABITAT: ECOLOGICALLY VALUABLE AREAS; NO AQUATIC PLANT MANAGEMENT

HARVEST ONLY: HARVEST LANES TO PROVIDE BOATING ACCESS; CHEMICAL USE NOT RECOMMENDED

HARVEST AND CHEMICAL: HARVEST LANES TO PROVIDE BOATING ACCESS; LIMITED CHEMICAL USE TO CONTROL ALGAE AND PLANTS

MAIN LAKE: HARVEST LANES UP TO 90' TO PROVIDE BOATING ACCESS; LIMITED CHEMICAL USE TO CONTROL ALGAE AND PLANTS; CUT 3' FROM SURFACE WHERE EURASIAN WATERMILFOIL DOMINANT (>50% COVERAGE)

BOAT LAUNCH

DAM

N

LANES IN HABITAT

15' ACCESS LANES

Source: Eagle Lake Management District and SEWRPC

Harvesting should only occur when EWM cover exceeds 50 percent. The maximum cut depth along the northwestern shoreline from Penny Island to the springs is limited to two feet from the surface (see Figure 3.1). 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.

c. <u>EWM management areas are given medium priority</u>: Areas in the Lake's main body where EWM has greater than 50 percent of the aquatic coverage should be top cut to a maximum depth of three feet 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. <u>Recreation areas are given low priority</u>: These areas are for alleviating nuisance, surface-matting growth for riparian owners. Surface cutting should be employed and restricted from pier heads to open water for riparian access. The Lake bottom from pier heads to shore will not be mechanically harvested; only manual methods will be used. Avoid harvesting eelgrass (*Vallisneria americana*) except in areas that reach "nuisance" conditions – when eelgrass is closer than two feet from the water's surface. To reduce the risk for water quality degradation, special effort should be taken to avoid cutting eelgrass wherever and whenever possible. Conversely, harvesting intensity should be increased during times of the year (i.e., spring and early summer) when invasive aquatic plant growth predominates and within areas where invasive species are most abundant.

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 District's policy. The District will provide liability insurance for harvester operators and other staff. Insurance certificates will be procured and held by the District. Routine day-to-day equipment maintenance will be performed by the harvester operator or other individuals identified by the District 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 District 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 District. Maintenance and repair costs will be borne by the District. The District will be responsible for properly transporting and storing harvesting equipment during the off season.

8. **Management, record keeping, monitoring, and evaluation.** District staff manage harvesting operations, and, although they may delegate tasks, are ultimately 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 District, submitted to the WDNR, and available to the general 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 District. District staff or delegated board members are responsible for overall harvesting program oversight and supervision. Although District staff are ultimately responsible for equipment operation, they may delegate tasks to competent individuals when technically and logistically feasible. The District must assure such individuals are appropriately trained to successfully and efficiently carry out their respective job functions. For example, District members/staff likely 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.

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 District 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.[79]

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

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.[80]

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. Previous attempts at utilizing Diver Assisted Suction Harvesting (DASH) in the Lake were not deemed successful at reducing or removing EWM populations in the following year after application.[81]

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 District's general nuisance and invasive plant management strategy. Nevertheless, some lake districts have employed DASH to aggressively combat small-scale pioneer infestations of invasive species. The District 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 generally 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*.

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

[81] *Lakeland Biologists, 2017,* op. cit.

Chemical Treatment

Chemical treatment is not recommended in the areas of the Lake denoted as "Habitat" or "Harvest Only" on Figure 3.1. These areas contain and/or are adjacent to sensitive aquatic plant species as well as important habitat for birds, herptiles, and aquatic organisms.

Considering the increased expanse of EWM in the eastern half of the Lake, a large-scale treatment in this area may be beneficial.[82] 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 District. 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 Wambold dam and the Kroll outlet control water levels in the Lake. Both dams utilize stops boards while the Wambold dam also has a hand-operated mechanical gate.[83] Since both structures are operable, a winter drawdown could be used to control invasive species. Since the EWM in the Lake predominantly grows at deeper depths than many of the native and sensitive species, a larger drawdown would be required to affect the EWM population that would expose many of these 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 District 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.

3.2 SUMMARY AND CONCLUSIONS

As requested by the District, The Commission worked with the District 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 District'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. Figures 3.1 summarize and generally locate 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 Eagle Spring Lake's ecosystem while promoting a wide array of water-based recreational activities suitable for the Lake's intrinsic characteristics.

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

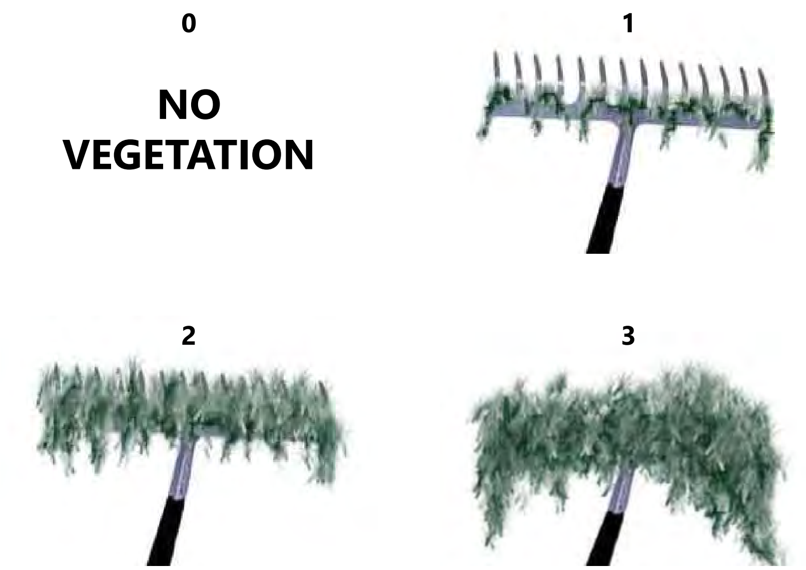
[83] *See Eagle Spring Lake Management District,* Dam & Related Operations Guide, *August 2021 for more information. The 2010 operating order issued by the WDNR sets the Lake levels between a minimum of 820.52 feet and a maximum of 820.82 feet Mean Sea Level. A WDNR permit would be required to manipulate the water levels on the Lake.*

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

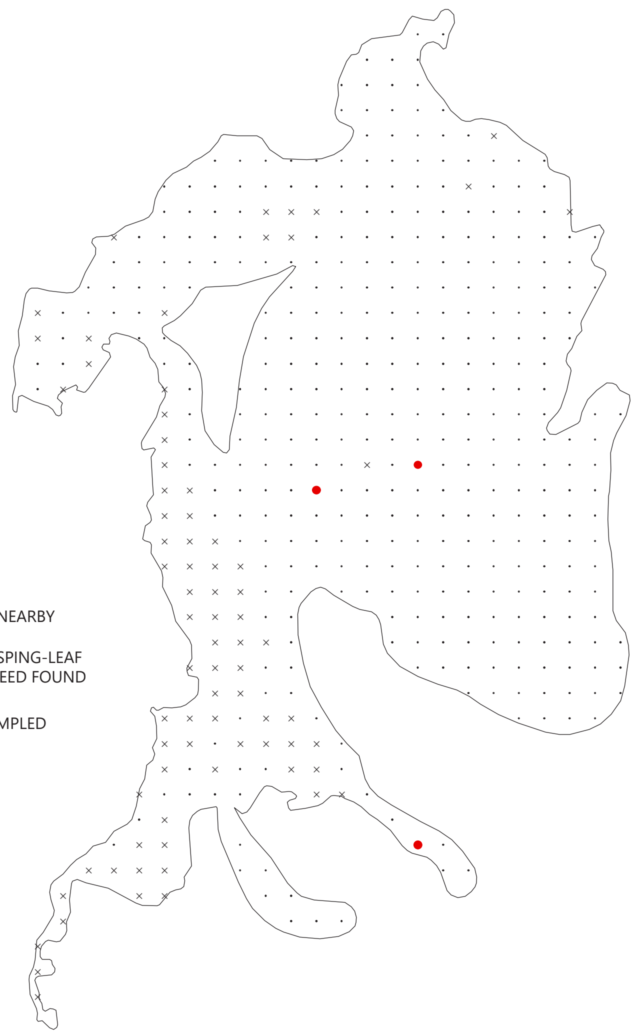
- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

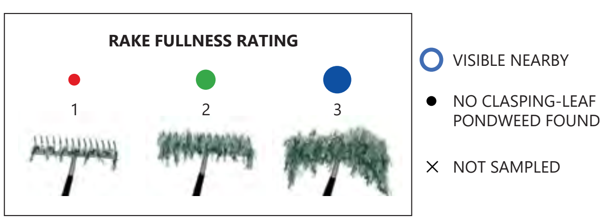
Clasping pondweed is similar to white-stem pondweed (*P. praelongus*), but the latter has boat-shaped leaf tips that split when pressed between one's fingers. The exotic curly-leaf pondweed (*P. crispus*) may appear similar, but differs by having serrated leaf margins

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 BLADDERWORT

Utricularia vulgaris

Credit: Wikimedia Commons User Leonhard Lenz

Identifying Features

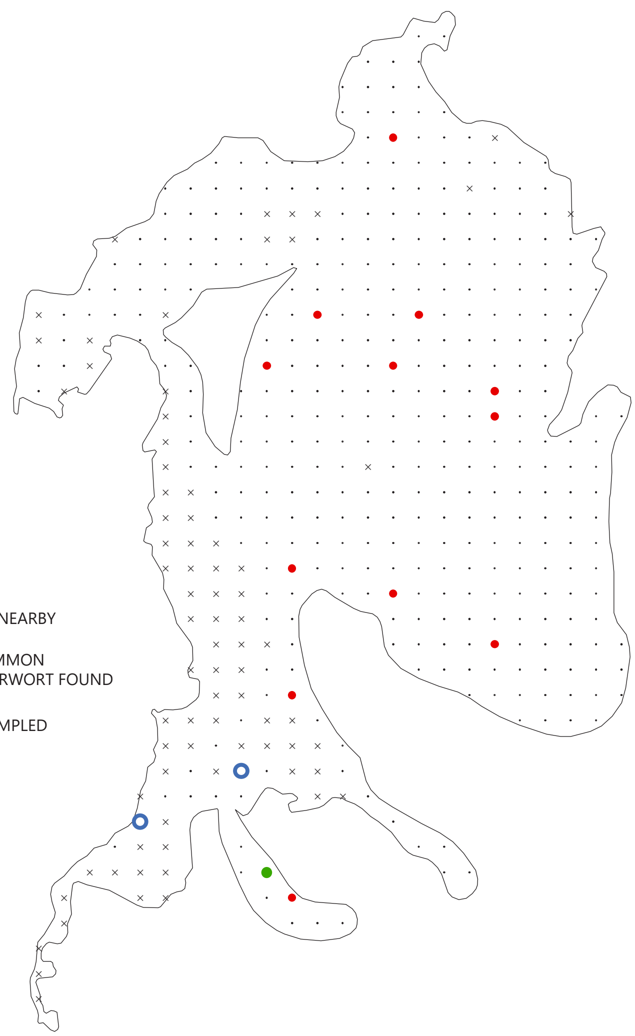
- Flowers snapdragon-like, yellow, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems floating (due to air bladders; branches finely divided

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: Flickr User Joshua Mayer



Native

COMMON WATERWEED

Elodea canadensis

Credit: Flickr User Corey Raimond

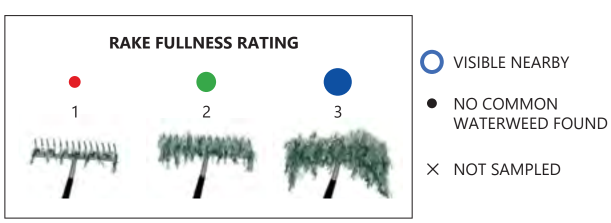
Identifying Features

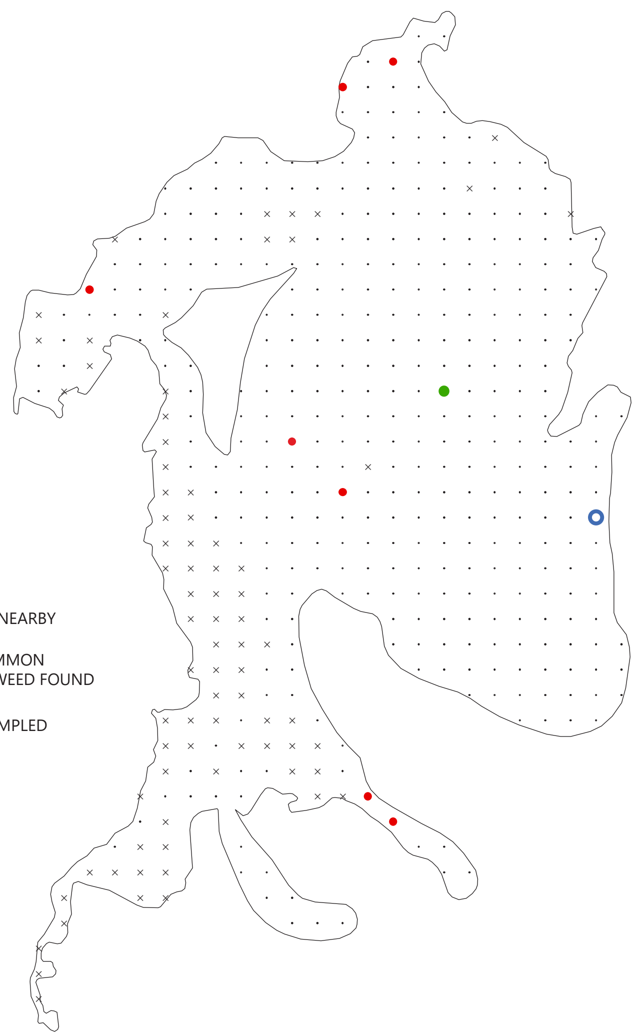
- Slender stems, occasionally rooting
- Leaves lance-shaped, in whorls of three (rarely two or four), 6.0 to 17 mm long and averaging 2.0 mm wide
- When present, tiny male and female flowers on separate plants (females more common), raised to the surface on thread-like stalks

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

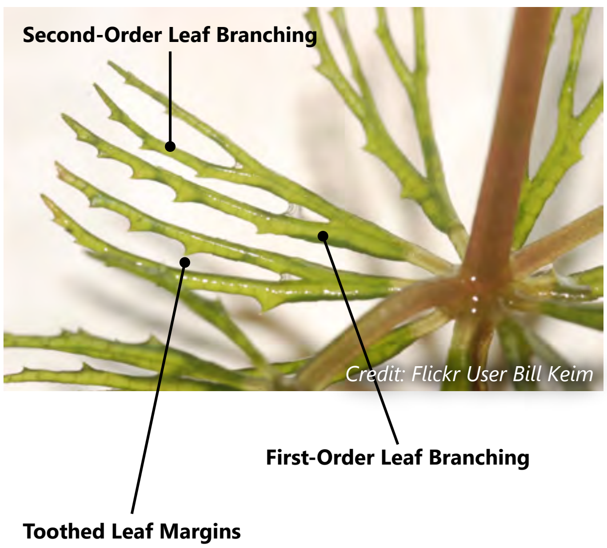
Identifying Features

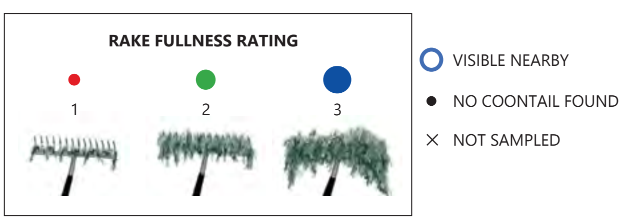
- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of
- branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

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





Nonnative/ Exotic

EURASIAN WATERMILFOIL

Myriophyllum spicatum

Credit: Paul Skawinski

Identifying Features

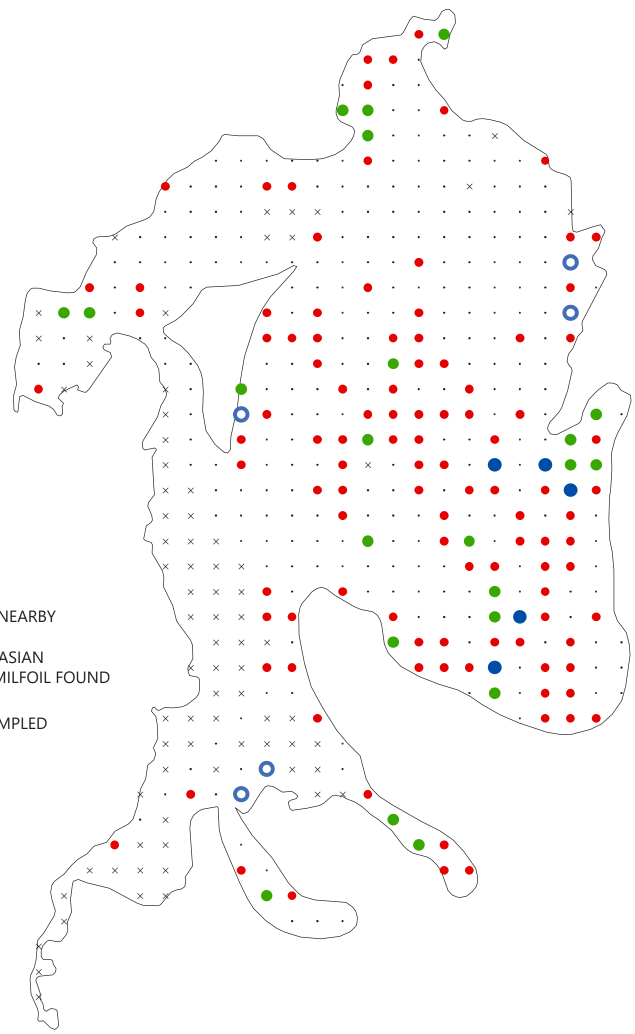
- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

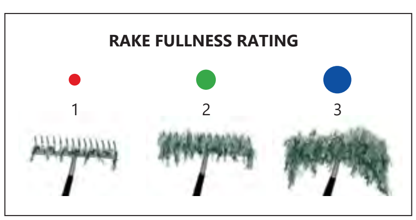
Eurasian watermilfoil is similar to northern watermilfoil (*M. sibiricum*). However, northern watermilfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

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

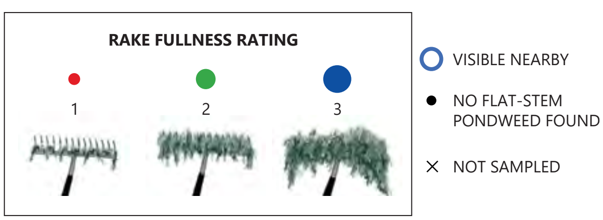
- Stems strongly flattened
- Leaves up to four to eight inches long, pointed, with a prominent midvein and many finer, parallel veins
- Stiff winter buds consisting of tightly packed ascending leaves

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

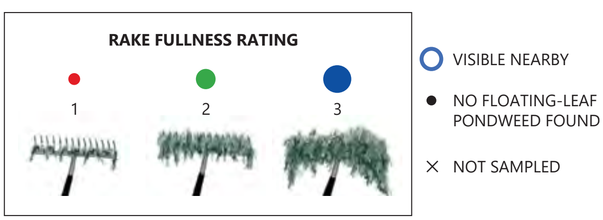
- Floating leaves (5.0 to 10 cm long) with heart-shaped bases and 17 to 37 veins
- Floating leaf stalks bent where they meet the leaf, causing the leaf to be held at roughly a 90-degree angle to the stalk
- Submersed leaves (1.0 to 2.0 mm wide) linear and stalk-like, with three to five veins

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



Native

FORKED NITELLA

Nitella furcata

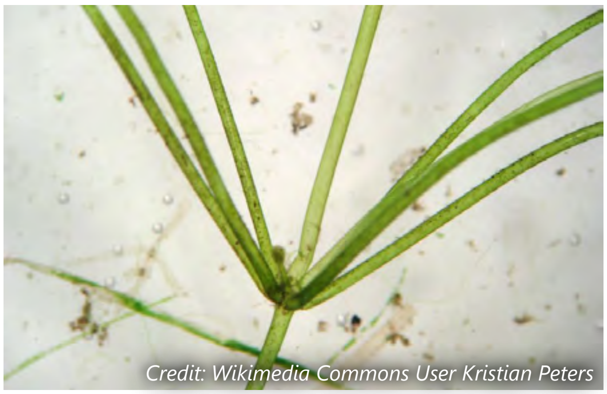
Credit: Wikimedia Commons User Show_ryu

Identifying Features

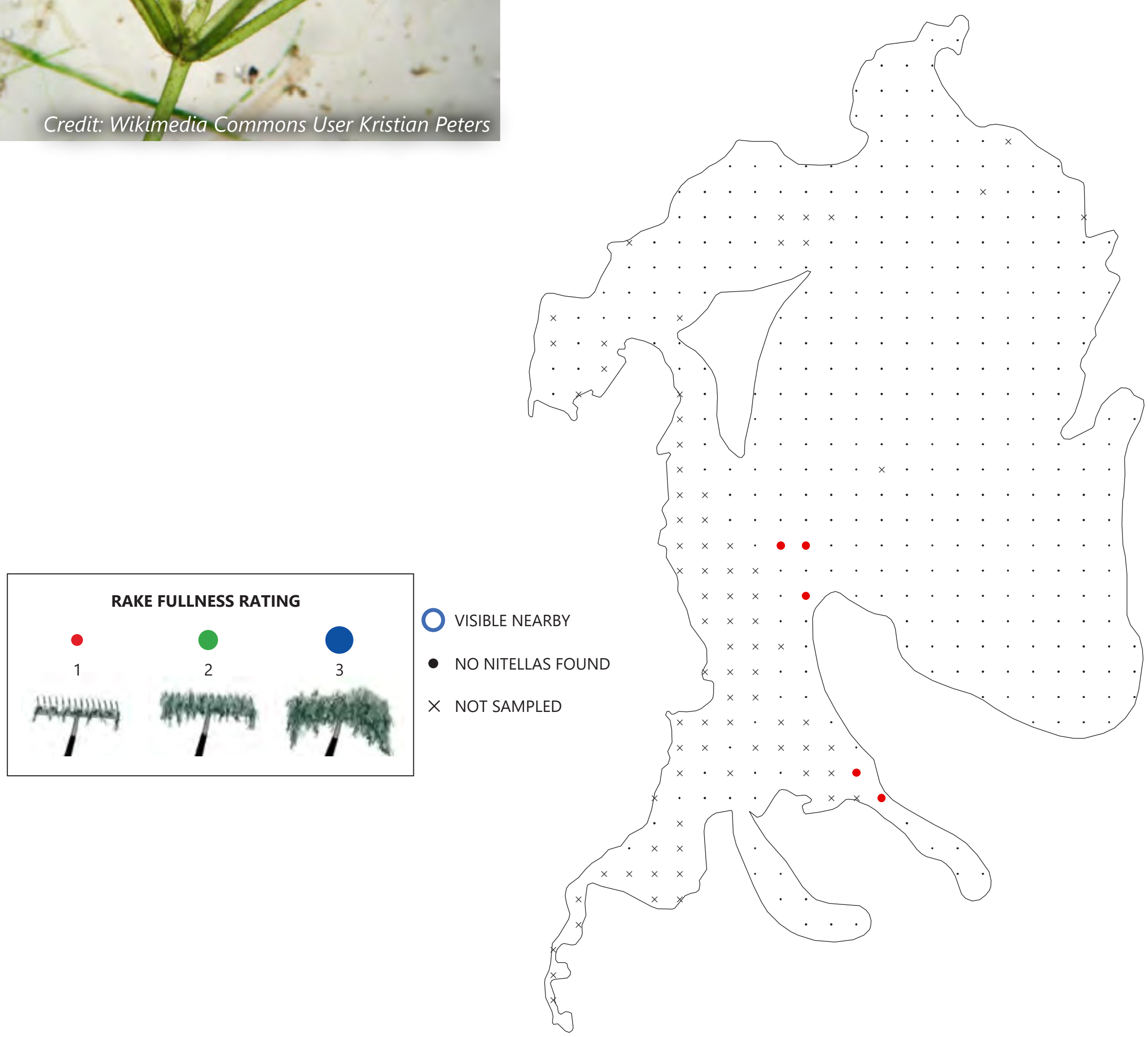
- 1-4 inches tall
- Consists of main stem and many tufts or balls of “leaves”
- May be green or encrusted with gray minerals

Ecology

- Occurs in quiet, shallow waters
- Usually not seen until late summer-fall



Credit: Wikimedia Commons User Kristian Peters



Native

ILLINOIS PONDWEED

Potamogeton illinoensis

Credit: Flickr User Dick Culbert

Identifying Features

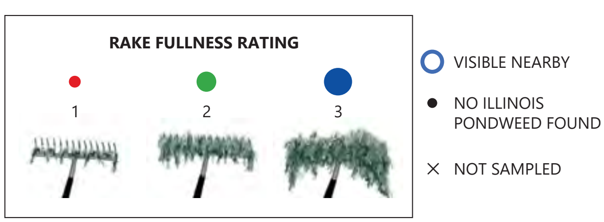
- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

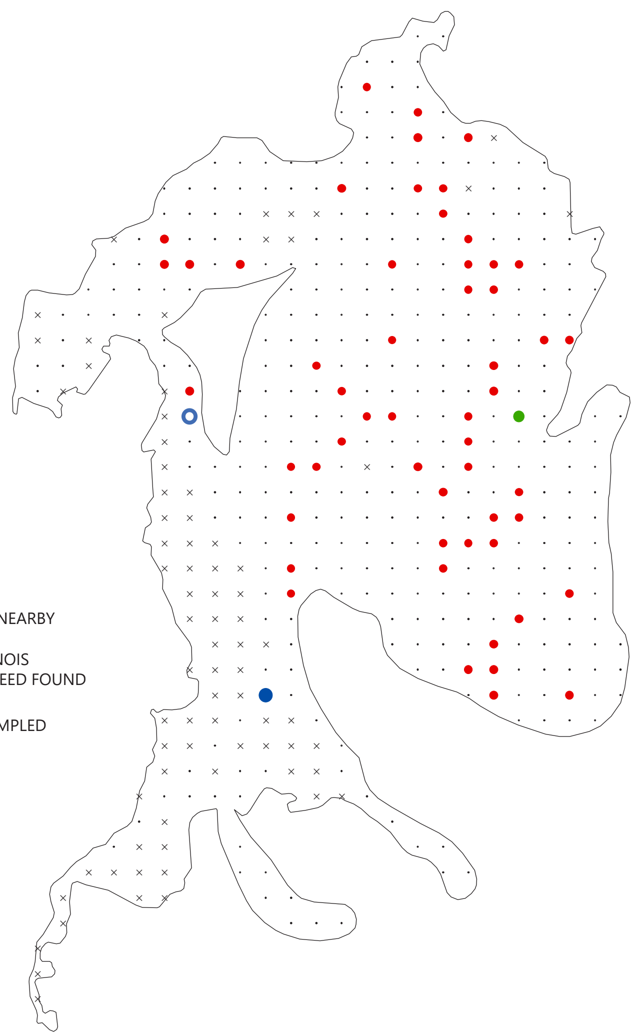
Variable pondweed (*P. gramineus*) is similar to Illinois pondweed, but differs in having three to seven veins on submerged leaves

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

LEAFY PONDWEED

Potamogeton foliosus

Credit: Flickr User Jim Stasz

Identifying Features

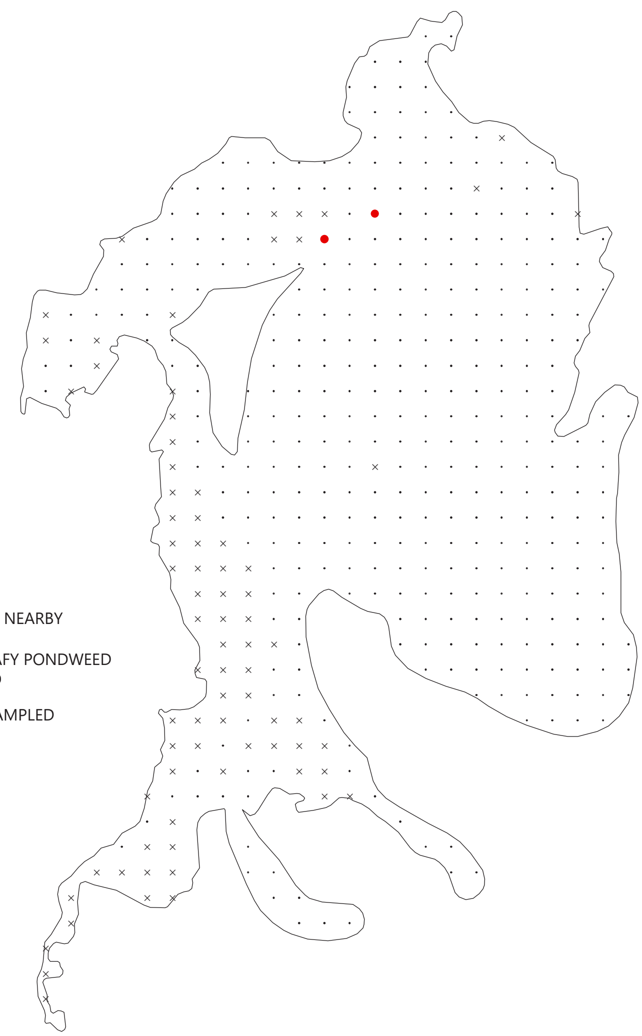
- Narrow, submersed leaves (one-half to three inches long and one-half to two mm wide), narrowing slightly near the stem, with 3-5 veins, and the leaf tip usually tapering to a point
- No floating leaves
- Flowers and fruit on short stalks in the axils of the upper leaves

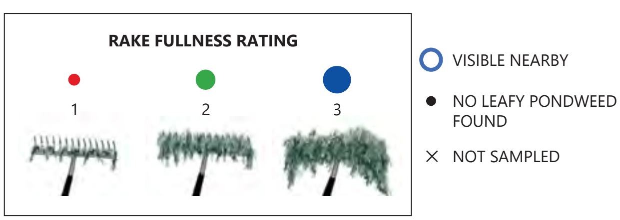
Leafy pondweed is similar to small pondweed (*P. pusillus*), when not in flower and fruit. However, unlike small pondweed, it lacks glands where the leaves meet the stem. The flowers and fruits of small pondweed are borne on longer, more slender stalks and in whorls that are spaced apart.

Ecology

- Prefers shallow waters over soft sediments in lakes and streams
- Overwinters as rhizomes or winter buds (turions)
- Tolerates eutrophic waters and can improve water quality in such environments
- Fruits fed upon by waterfowl and available earlier in the year than most other aquatic fruits
- Cover for invertebrates and juvenile fish

Credit: Flickr User Brenton Butterfield





Native

LONG-LEAF PONDWEED

Potamogeton nodosus

Credit: Wikimedia Commons User Stefan.lefnaer

Identifying Features

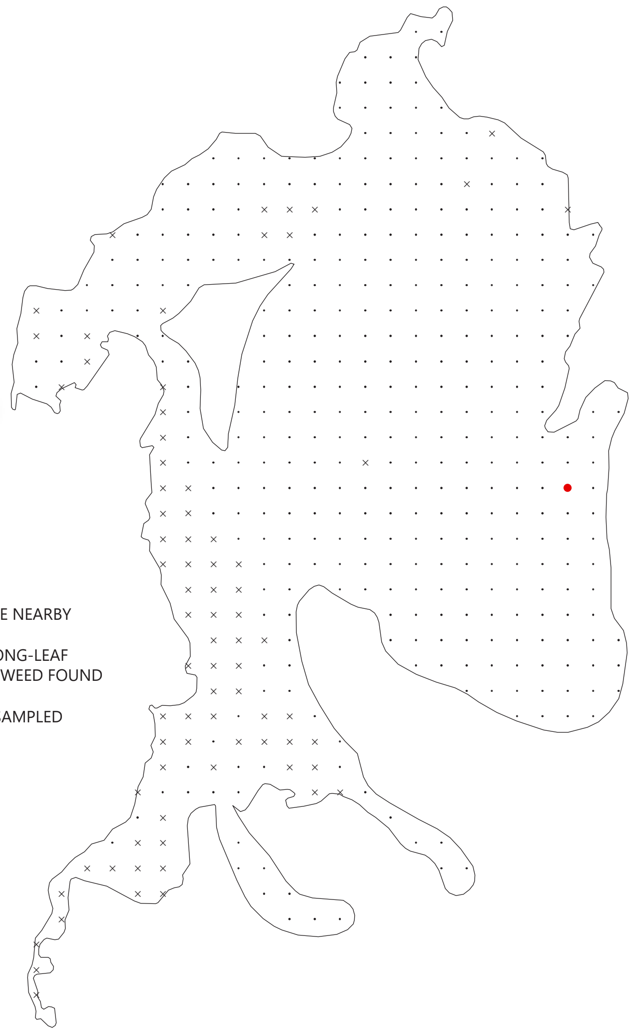
- Floating leaves 5.0 to 13 cm long, tapering to leaf stalks that are longer than the attached leaf blades
- Submersed leaves up to 30 cm long and 1.0 to 2.5 mm wide, with seven to 15 veins, and long leaf stalks
- Stipules 4.0 to 10 cm long, free from the leaves, disintegrating by mid-summer

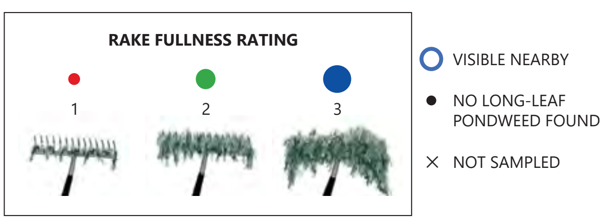
Long-leaf pondweed may be distinguished from other pondweeds that have similar floating leaves (e.g., *P. illinoensis* and *P. natans*) by the long leaf stalks of its submersed leaves. The floating leaves of *P. natans* also differ by having a heart-shaped base and by being held to the leaf stalks at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





Native

MUSKGRASSES

Chara spp.

Credit: Flickr User Jeremy Halls

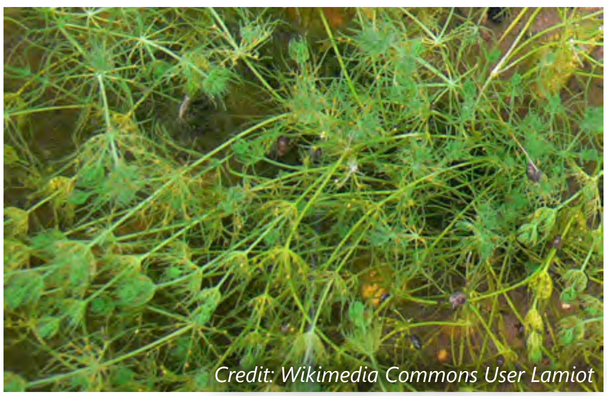
Identifying Features

- 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

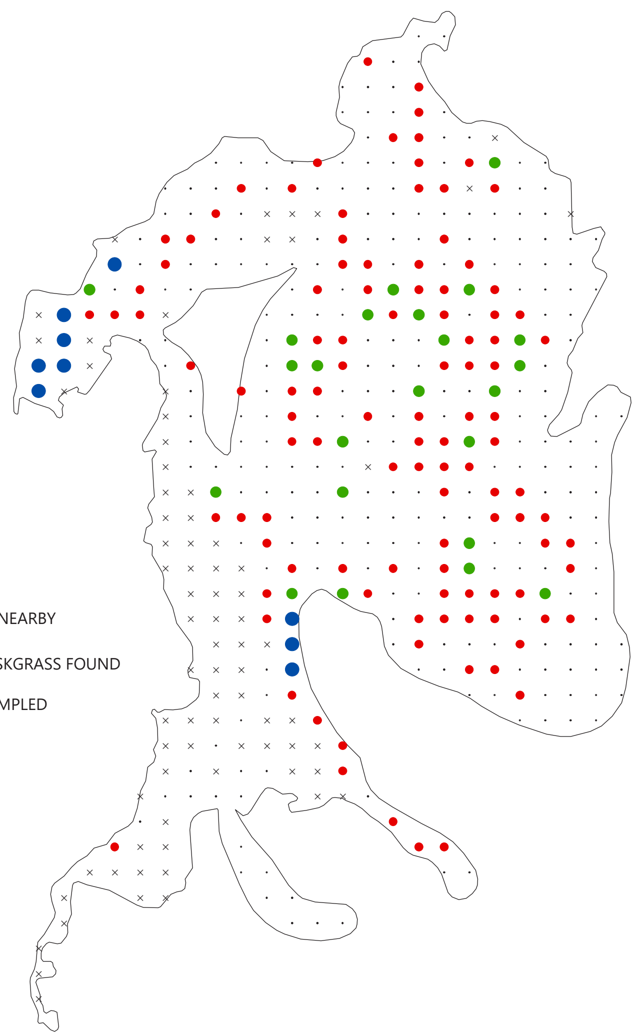
Stoneworts (*Nitella* spp.) are similar large algae, but their branches are smooth rather than ridged and more delicate

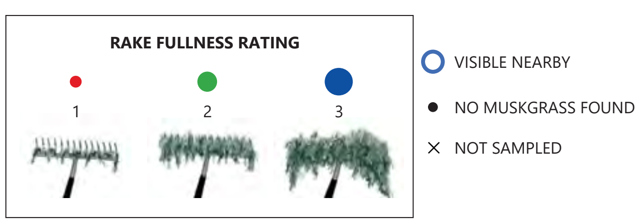
Ecology

- 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





Native

SAGO PONDWEED

Stuckenia pectinata

Credit: Flickr User Christian Fischer

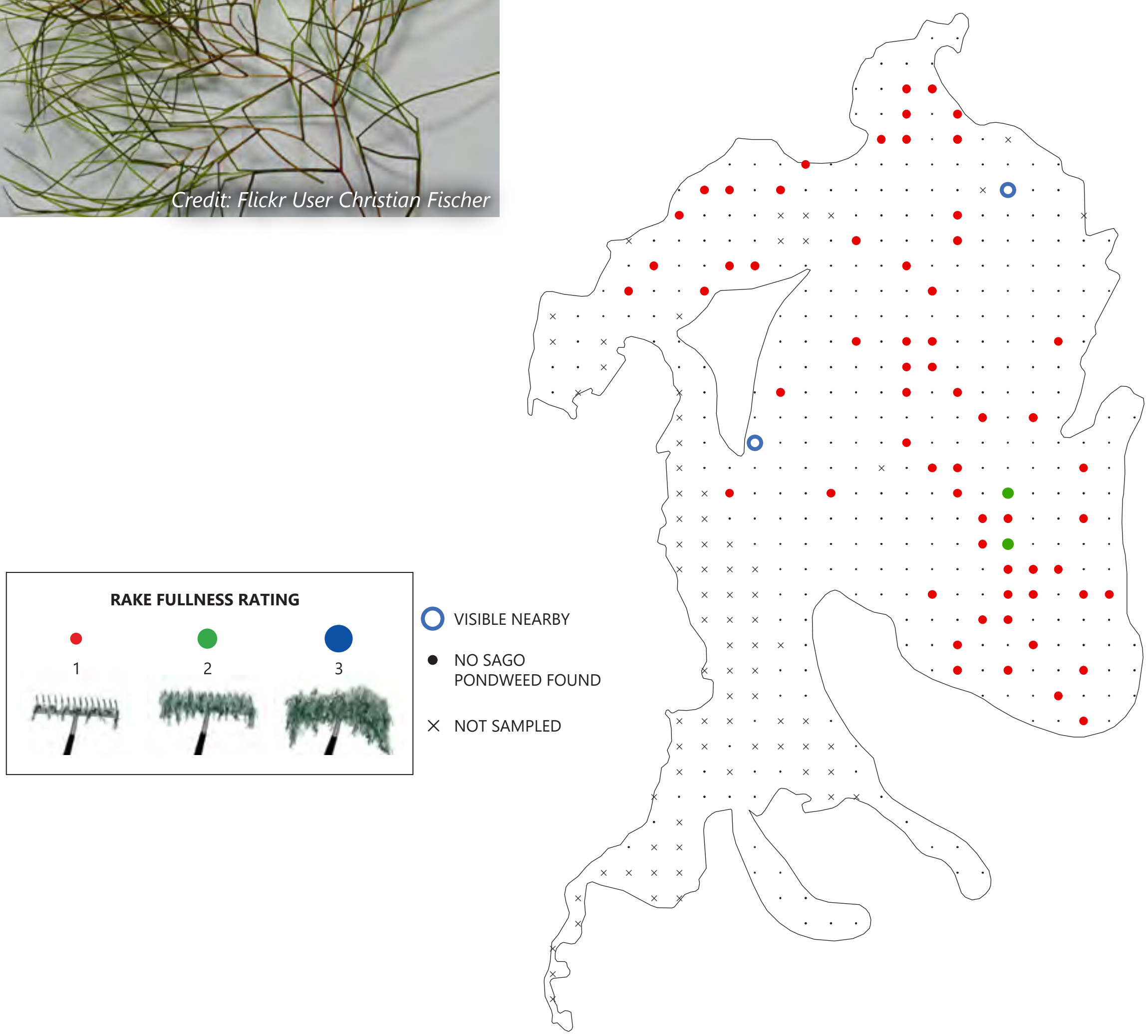
Identifying Features

- 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

SLENDER NAIAD

Najas flexilis

Credit: Wikimedia Commons User Robert H. Mohlenbrock

Identifying Features

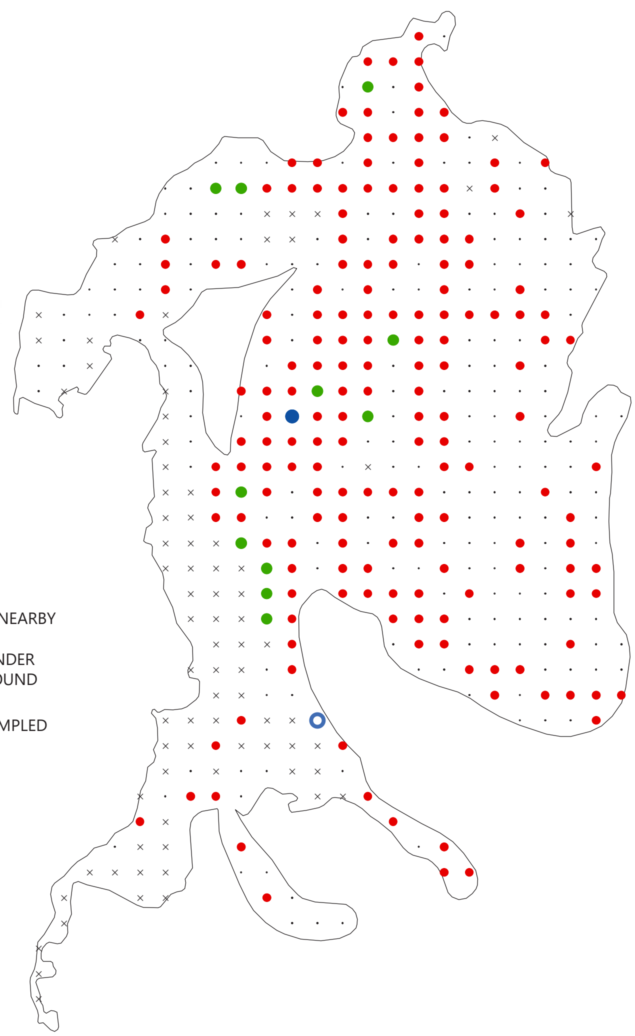
- Leaves 0.2 to 2.0 mm wide and blunt with slight shoulder bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Leaves opposite and may appear loosely whorled

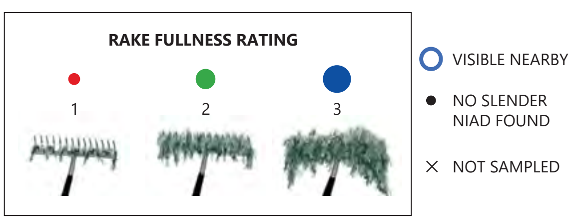
Two other Najas occur in southeastern Wisconsin. Slender naiad (*N. flexilis*) has narrower leaves (to 0.6 mm) with a pointed tip. Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

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





Native

SMALL BLADDERWORT

Utricularia minor

Credit: Wikimedia Commons User Andrea Moro

Identifying Features

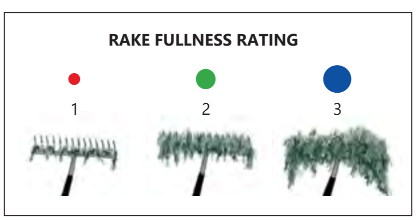
- Flowers snapdragon-like, yellow, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems floating (due to air bladders; branches finely divided
- Generally smaller and less branched than common bladderwort,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

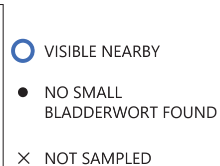
Several similar bladderworts occur in southeastern Wisconsin

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 BUR-REED

Sparganium natans

Credit: Flickr User Andrey Zharkikh

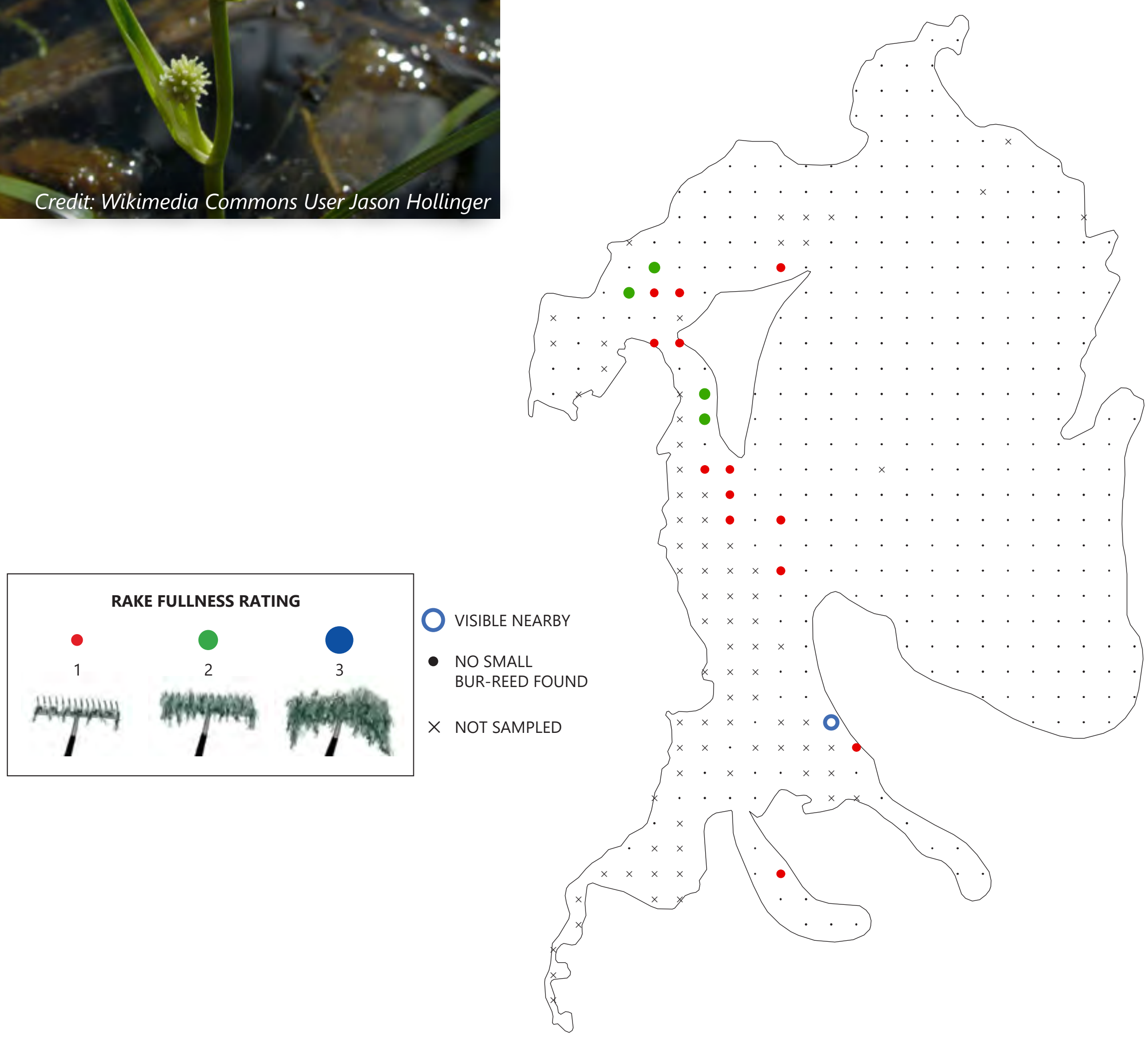
Identifying Features

- Produces linear leaves less than 0.5” wide that are flat on both sides
- Leaves either float on the water’s surface or stand erect above it
- Flowers as a spike with green to white petals
- Forms a bur-like head of beaked nutlets

Ecology

- Found growing in shallow water of lakes, ponds, streams, and rivers
- Prefers full sun with sandy or muddy soils
- Important food source for waterfowl, wetland birds, muskrats, and some insect species

Credit: Wikimedia Commons User Jason Hollinger



Credit: Wikimedia Commons User Robert H. Mohlenbrock

Native

SOUTHERN NAIAD

Najas guadalupensis

Identifying Features

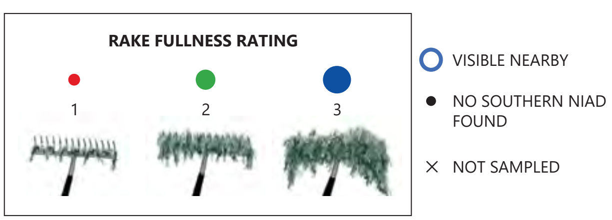
- Leaves 0.2 to 2.0 mm wide and blunt with slight shoulder bases where they attach to the stem and finely serrated margins
- Flowers, when present, tiny and located in leaf axils
- Leaves opposite and may appear loosely whorled

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



Native

SPATTERDOCK

Nuphar variegata

Credit: Wikimedia Commons User Cephas

Identifying Features

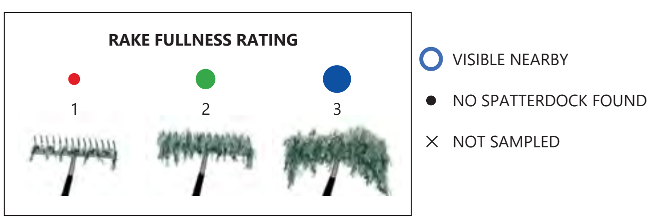
- Leaf stalks winged in cross-section
- Most leaves floating on the water surface, heart-shaped, and notched, with rounded lobes at the base
- Yellow flowers, 2.5 to 5.0 cm wide, often with maroon patches at the bases of the sepals (petal-like structures) when viewed from above

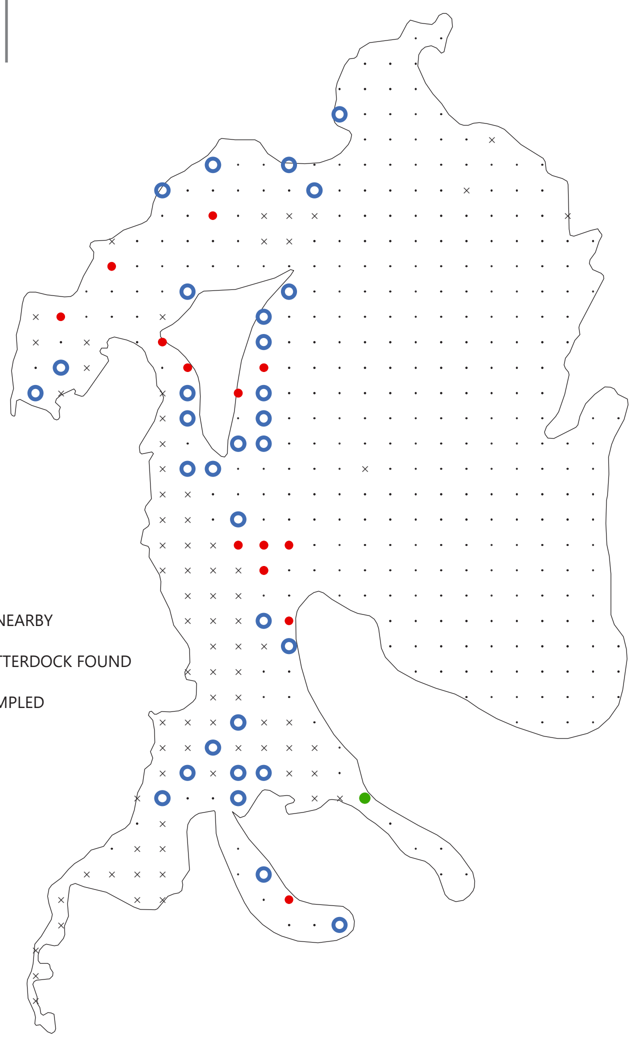
Unlike spatterdock, the similar yellow pond lily (Nuphar advena) has leaf stalks that are not winged in cross-section, leaves that more often emerge above the water surface, and leaf lobes that are more pointed. Spatterdock is superficially similar to water lilies (Nymphea spp.), but it has yellow versus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

Ecology

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

Credit: Flickr User Jason Hollinger





Nonnative/ Exotic

SPINY NAIAD

Najas marina

Credit: Wikimedia Commons User Pascale Guinchard

Identifying Features

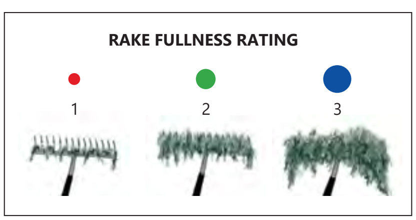
- Stems stiff and spiny, often branching many times
- Leaves stiff, 1.0 to 4.0 mm thick, with coarse teeth along the margins and midvein on the underside

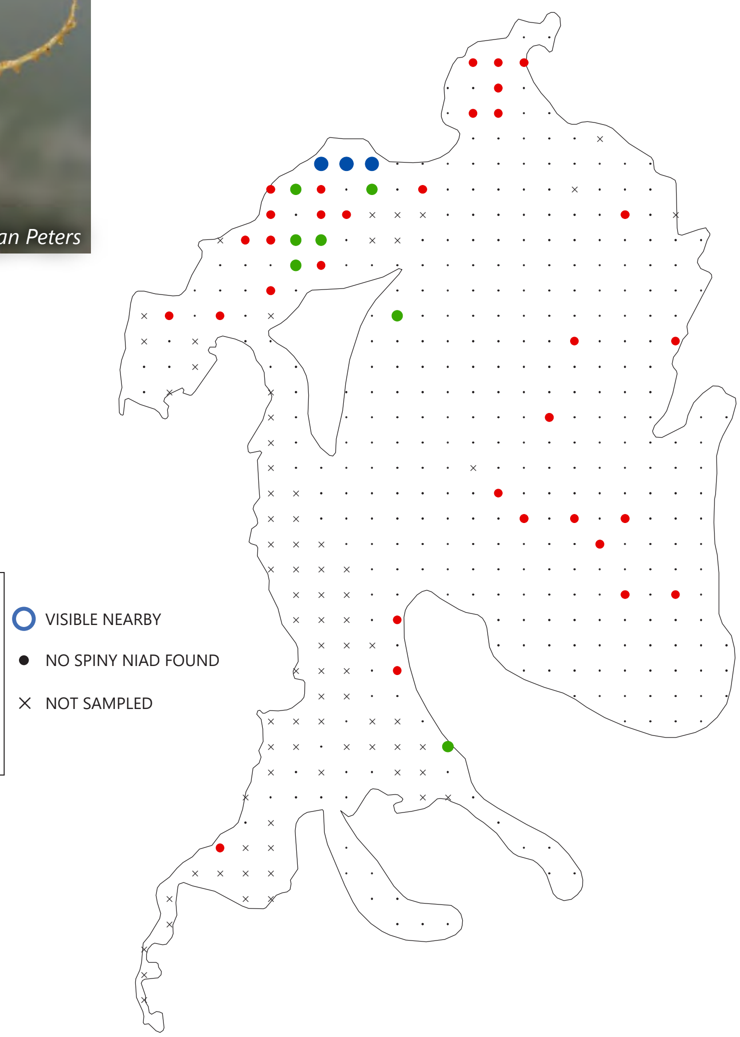
Spiny naiad is quite distinct from other naiads due to its larger, coarsely toothed leaves and the irregularly pitted surface of its fruits. Spiny naiad is presumably introduced in Wisconsin, but it is considered native in other states, including Minnesota

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





Native

VARIABLE PONDWEED

Potamogeton gramineus

Credit: Wikimedia Commons User Tristan He

Identifying Features

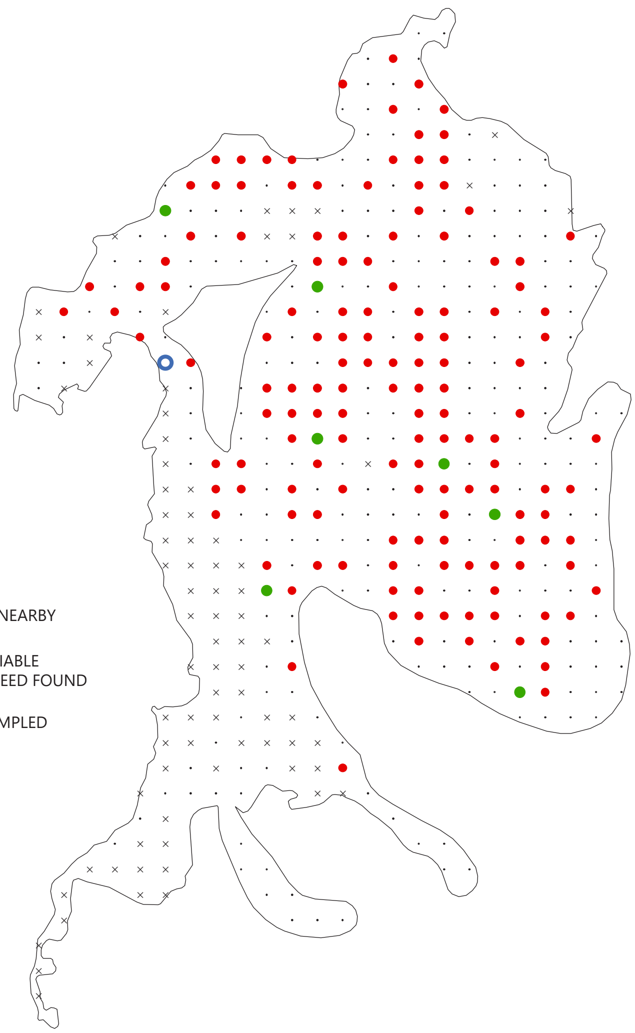
- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- Floating leaves with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard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

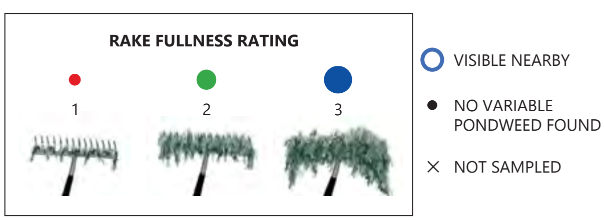
Variable pondweed is similar to Illinois pondweed (*P. illinoensis*), but Illinois pondweed has submerged leaves with nine to 19 veins

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

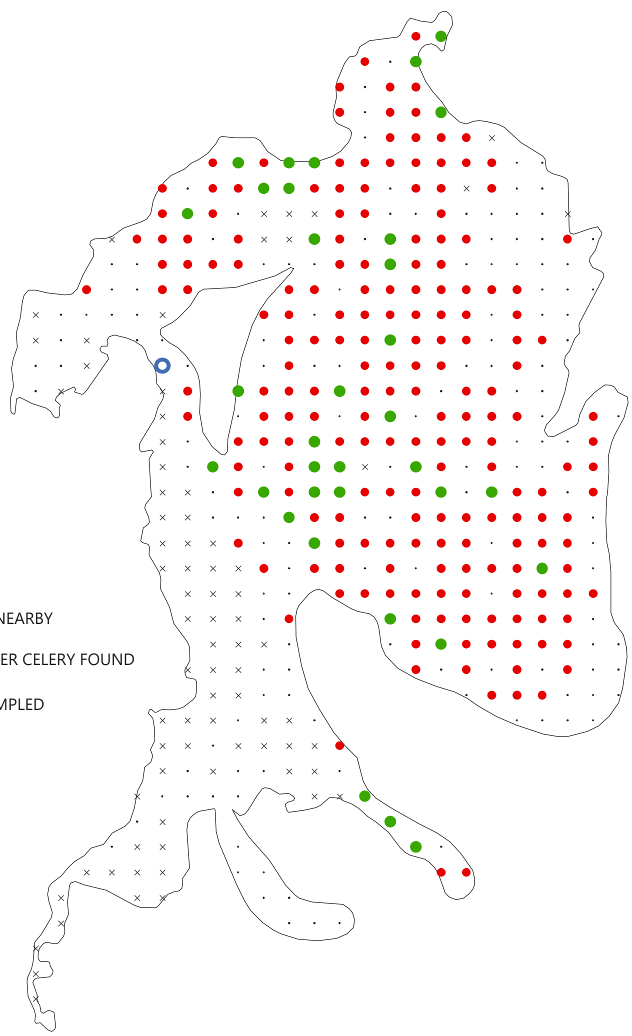
- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

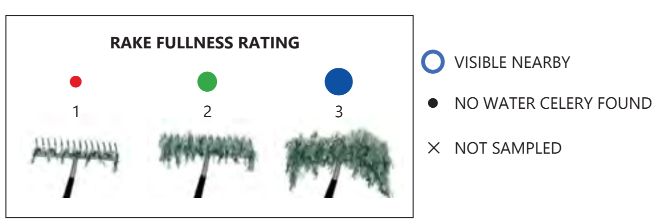
The foliage of eelgrass could be confused with the submersed leaves of bur-reeds (*Sparganium* spp.) or arrowheads (*Sagittaria* spp.), but the leaves of eelgrass are distinguished by their prominent middle stripe. The leaves of ribbon-leaf pondweed (*Potamogeton epihydrus*) are also similar to those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

WHITE WATER LILY

Nymphaea odorata

Credit: Flickr User Ryan Hodnett

Identifying Features

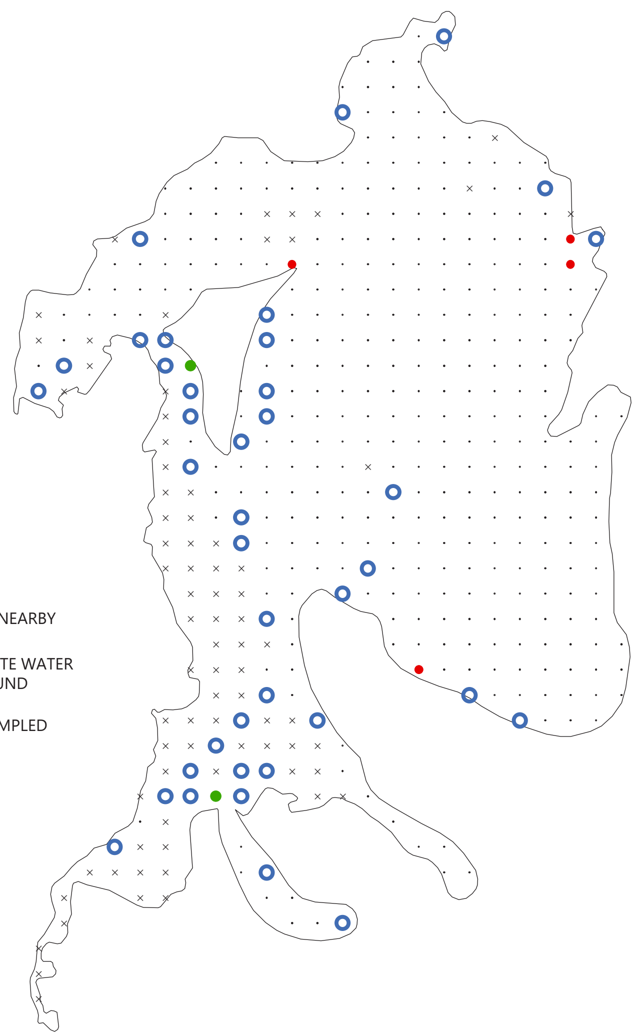
- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

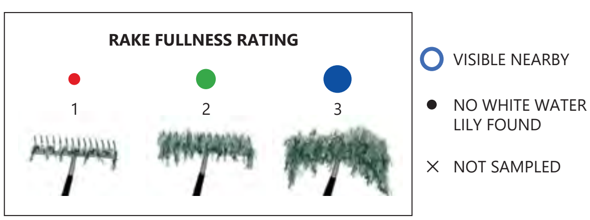
Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are unnotched

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





Native

WHORLED WATERMILFOIL

Myriophyllum vericillatum

Credit: Wikimedia Commons User Panek

Identifying Features

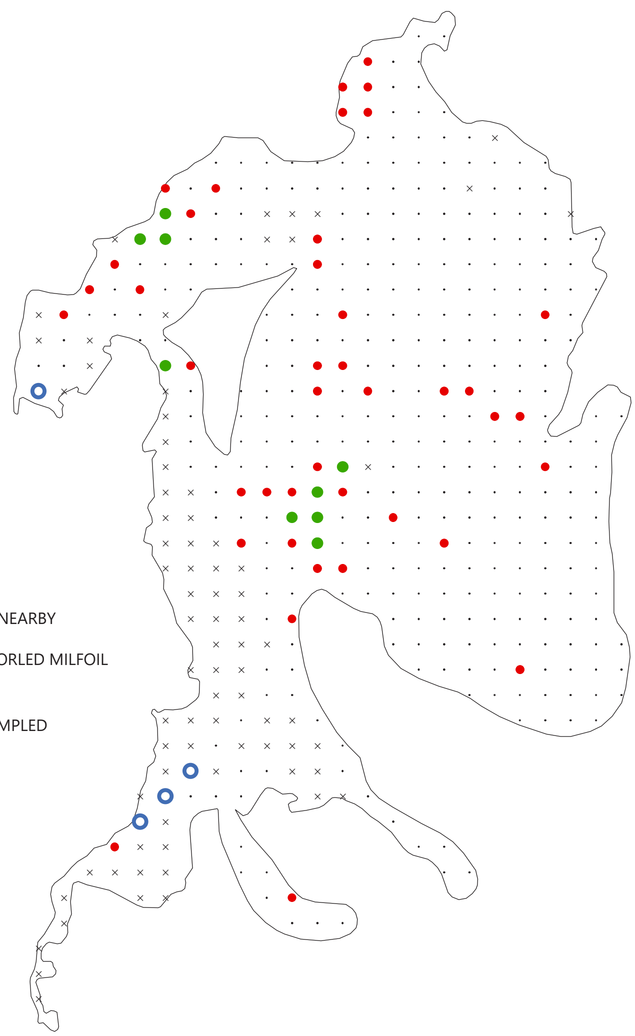
- Very short internodes lead to very bushy appearance
- Leaves in whorls of four to six, most leaves with no leaf stalk, divided into eight to 17 pairs of leaflets
- Small, club-shaped winter buds formed adjacent to stem in autumn
- Flower bracts are deeply lobed

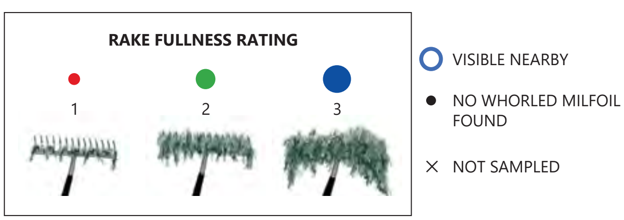
Whorled watermilfoil is similar to other water milfoils. Various-leaved watermilfoil (*M. heterophyllum*) has similarly large leaf bracts that have smooth or slightly serrated edges. Eurasian watermilfoil (*M. spicatum*) tends to be less bushy, limp out of water, and produce more leaflets per leaf.

Ecology

- Found in shallow to deep lakes and streams
- Consumed by waterfowl
- Provides habitat for aquatic invertebrates and shade, shelter, and foraging for fish spawn

Credit: Wikimedia Commons User Panek





EAGLE SPRING LAKE CHEMICAL TREATMENTS

APPENDIX B

Table B.1
Eagle Spring Lake Chemical Treatments: 1999 – 2021

Treatment Dates	Jack's Bay	Mary's Bay	South Shore	East Shore	Clarks Park	Pickeral Bay	Burke	Bolan	Toohills Island	3 Island	Travers Island
06/09/1999	100/A	--	--	--	--	--	--	--	--	--	--
07/11/2000	--	--	101.5/A	--	--	--	--	--	--	--	--
05/15/2001	99.8/A	--	--	99.8/A	99.8/A	99.8/A	99.8/A	99.8/A	99.8/A	99.8/A	99.8/A
05/15/2002	147-197/A	--	--	147-197/A	--	--	147-197/A	147-197/A	--	--	--
05/12/2003	--	--		--	101.1/A	101.1/A	--	--	101.1/A	--	101.1/A
05/17/2004	100/A	--	100/A	100/A	100/A	100/A	100/A	100/A	--	--	--
09/14/2004	--	100/a	--	--	--	--	--	--	--	--	--
05/09/2005	--	--	--	--	----	--	--	--	--	--	--
09/19/2005	150/A	--	--	--		--	--	--	--	--	--
09/12/2006	--	--	100/A	100/A	100/A	100/A	112/A	100/A	100/A	100/A	100/A
09/10/2007	125/A	100/A	--	--	--	--	--	--	--	--	--
09/08/2008	--	--	--	100/A	100/A	100/A	--	--	--	--	--
09/14/2009	100/A	--	--	--	--	--	--	--	--	--	--
2010						No treatments					
09/062011	100/A	--	--	100/A	100/A	100/A	--	--	--	--	--
05/15/2012	100/A	--	--	--	--	--	--	150/A	--	--	--
06/17/2013	2ppm	--	--	--	100/A	100/A	--	--	--	--	--
09/09/2013	--	--	2ppm	--	--	--	--	--	--	2ppm	--
09/24/2013	--	2ppm	--	--	--	--	2ppm	2ppm	--	--	--
05/28/2014	--	--	--	--	2ppm	2ppm	--	--	--	--	--
05/18/2015	2ppm	--	--	--	--	2ppm	--	--	--	--	--
2016						No treatments					
05/15/2017	--	--	--	2ppm	3ppm	3ppm	--	--	--	--	--
05/14/2018	2ppm	--	--	--	3ppm	3ppm	--	--	--	--	--
2019						No treatments					
05/18/2020	--	--	--	--	--	ProcellaCor 4PDU	--	--	--	--	--
2021						No treatments					
Total Treatments	12	3	4	7	11	13	6	7	3	3	3

Note: 1999 – 2014 treatments were done with 2, 4-D (per Acre is granular and ppm is liquid)

Source: Eagle Lake Management District

FLORPYRAUXIFEN-BENZYL CHEMICAL FACT SHEET

APPENDIX C

July 2018
EGAD #: 3200-2018-83

Florpyrauxifen-benzyl Chemical Fact Sheet

Formulations

Florpyrauxifen-benzyl was registered with the EPA for aquatic use in 2017. The active ingredient is 2-pyridinecarboxylic acid, 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoro-, phenyl methyl ester. The current Wisconsin-registered formulation is a liquid (ProcellaCOR™ EC) solely manufactured by SePRO Corporation.

Aquatic Use and Considerations

Florpyrauxifen-benzyl is a systemic herbicide that is taken up by aquatic plants. The herbicide is a member of a new class of synthetic auxins, the arylpicolinates, that differ in binding affinity compared to other currently registered synthetic auxins. The herbicide mimics the plant growth hormone auxin that causes excessive elongation of plant cells that ultimately kills the plant. Susceptible plants will show a mixture of atypical growth (larger, twisted leaves, stem elongation) and fragility of leaf and shoot tissue. Initial symptoms will be displayed within hours to a few days after treatment with plant death and decomposition occurring over 2 – 3 weeks. Florpyrauxifen-benzyl should be applied to plants that are actively growing; mature plants may require a higher concentration of herbicide and a longer contact time compared to smaller, less established plants.

Florpyrauxifen-benzyl has relatively short contact exposure time (CET) requirements (12 – 24 hours typically). The short required CET may be advantageous for localized treatments of submersed aquatic plants, however, the target species efficacy compared to the size of the treatment area is not yet known.

In Wisconsin, florpyrauxifen-benzyl may be used to treat the invasive Eurasian watermilfoil (*Myriophyllum spicatum*) and hybrid Eurasian watermilfoil (*M. spicatum* X *M. sibiricum*). Other invasive species such as floating hearts (*Nymphoides* spp.) are also susceptible. In other parts of the country, it is used as a selective, systemic mode of action for spot and partial treatment of the invasive plant hydrilla (*Hydrilla verticillata*). Desirable native species that may also be negatively affected include waterlily species (*Nymphaea* spp. and *Nuphar* spp.), pickerelweed (*Pontederia cordata*), and arrowhead (*Sagittaria* spp.).

It is important to note that repeated use of herbicides with the same mode of action can lead to herbicide-resistant plants, even in aquatic plants. Certain hybrid Eurasian watermilfoil genotypes have been documented to have reduced sensitivity to aquatic herbicides. In order to reduce the risk of developing resistant genotypes, avoid using the same type of herbicides year after year, and utilize effective, integrated pest management strategies as part of any long-term control program.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated waterbodies, or using water for drinking water. There is no restriction on irrigation of turf. Before treated water can be used for non-agricultural irrigation besides turf (such as shoreline property use including irrigation of residential landscape plants and homeowner gardens, golf course irrigation, and non-residential property irrigation around business or industrial properties), follow precautionary waiting periods based on rate and scale of application, or monitor herbicide concentrations until below 2 ppb. For agricultural crop irrigation, use analytical monitoring to confirm dissipation before irrigating. The latest approved herbicide product label should be referenced relative to irrigation requirements.

Herbicide Degradation, Persistence and Trace Contaminants

Florpyrauxifen-benzyl is broken down quickly in the water by light (i.e., photolysis) and is also subject to microbial breakdown and hydrolysis. It has a half-life (the time it takes for half of the active ingredient to degrade) ranging from 1 – 6 days. Shallow clear-water lakes will lead to faster degradation than turbid, shaded, or deep lakes.

Florpyrauxifen-benzyl breaks down into five major degradation products. These materials are generally more persistent in water than the active herbicide (up to 3 week half-lives) but four of these are minor metabolites detected at less than 5% of applied active ingredient. EPA concluded no hazard concern for metabolites and/or degradates of florpyrauxifen-benzyl that may be found in drinking water, plants, and livestock.

Florpyrauxifen-benzyl binds tightly with surface sediments, so leaching into groundwater is unlikely. Degradation products are more mobile, but aquatic field dissipation studies showed minimal detection of these products in surface sediments.

Impacts on Fish and Other Aquatic Organisms

Toxicity tests conducted with rainbow trout, fathead minnow, water fleas (*Daphnia* sp.), amphipods (*Gammarus* sp.), and snails (*Lymnaea* sp.) indicate that florpyrauxifen-benzyl is not toxic for these species. EPA concluded florpyrauxifen-benzyl has no risk concerns for non-target wildlife and is considered "practically non-toxic" to bees, birds, reptiles, amphibians, and mammals.

Florpyrauxifen-benzyl does not bioaccumulate in fish or freshwater clams due to rapid metabolism and chemical depuration.

Human Health

EPA has identified no risks of concern to human health since no adverse acute or chronic effects, including a lack of carcinogenicity or mutagenicity, were observed in the submitted toxicological studies for florpyrauxifen-benzyl regardless of the route of exposure. EPA concluded with reasonable certainty that drinking water exposures to florpyrauxifen-benzyl do not pose a significant human health risk.

For Additional Information

Environmental Protection Agency Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Washington State Department of Ecology. 2017.
https://fortress.wa.gov/ecy/publications/documents/1710020.pdf

Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

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