

AQUATIC PLANT MANAGEMENT PLAN FOR LITTLE MUSKEGO LAKE

WAUKESHA COUNTY, WISCONSIN



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MUSKEGO
LAKE

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NUMBER 155 (4TH EDITION)

**AQUATIC PLANT MANAGEMENT PLAN FOR
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN**

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Credit: Commission Staff

The Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) completed this aquatic plant inventory and management study of Little Muskego Lake (Lake) on behalf of the Little Muskego Lake District (District). This memorandum report is the Commission's fifth report focusing on Little Muskego Lake, and the fourth aquatic plant management plan.^{1,2,3,4} The Wisconsin Department of Natural Resources (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

Little Muskego Lake is a 481-acre drainage lake located entirely within the City of Muskego in Waukesha County (see Map 1.1). The Lake's surrounding tributary area is 6,736 acres (approximately 10.5 square miles) and is located within both the City of Muskego and the City of New Berlin (see Map 1.1). The Lake is fed by Jewel Creek and drained by Muskego Creek. There are 19 access points to the Lake, which include two channel access points through Jewel Creek into the Lake (see Map 1.2). Attaining a maximum depth of 65 feet, the deepest portions of the Lake are not capable of supporting an aquatic plant community, although previous surveys have indicated that the shallow nearshore areas support abundant growth of rooted aquatic plants (see Map 1.3).

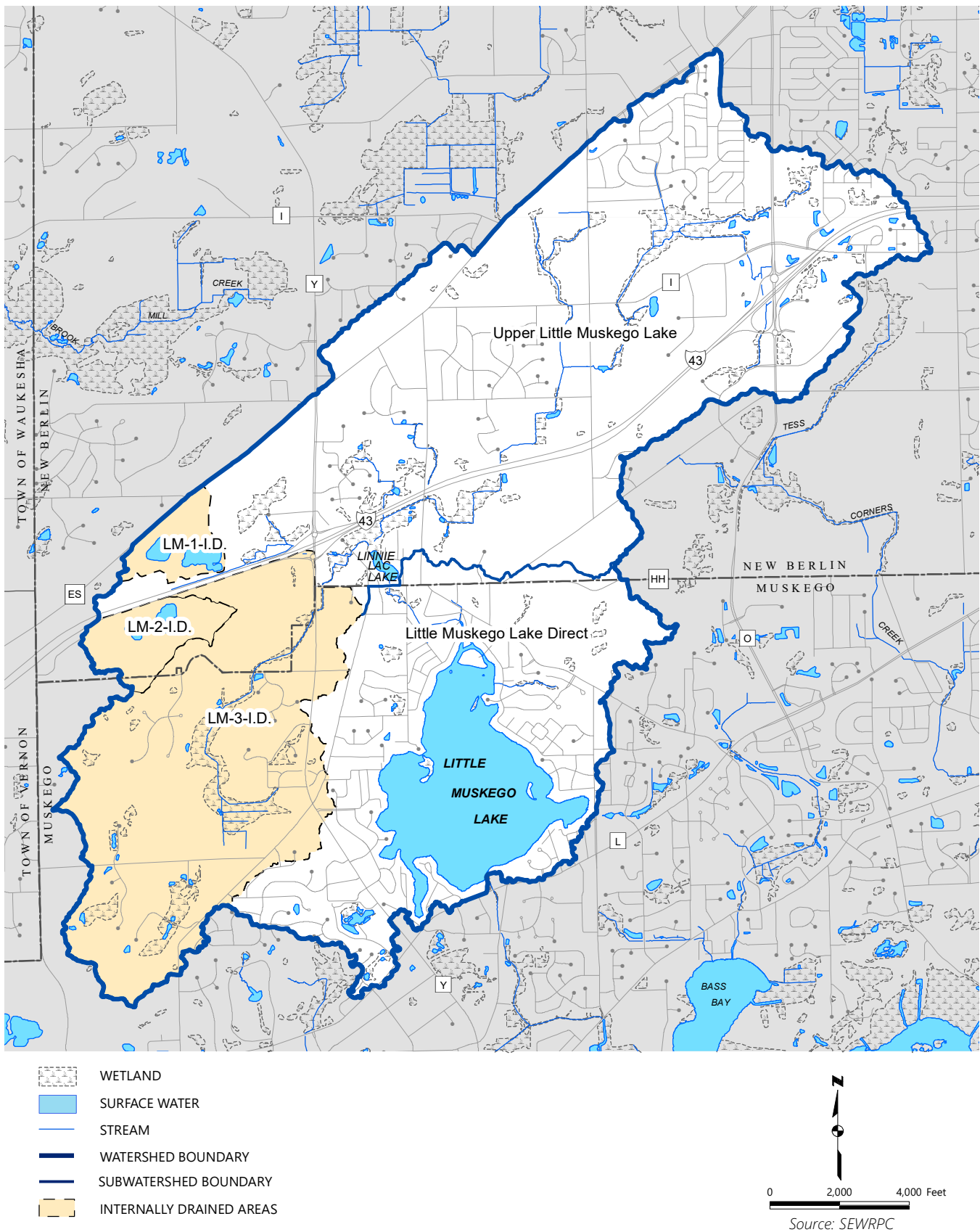
¹ SEWRPC *Community Assistance Planning Report No. 222, A Lake Management Plan for Little Muskego Lake*, Waukesha County, Wisconsin, 1996.

² SEWRPC *Memorandum Report No. 155 (1st Edition), An Aquatic Plant Management Plan for Little Muskego Lake*, Waukesha County, Wisconsin, 2004.

³ SEWRPC *Memorandum Report No. 155 (2nd Edition), An Aquatic Plant Management Plan for Little Muskego Lake*, Waukesha County, Wisconsin, 2009.

⁴ SEWRPC *Memorandum Report No. 155 (3rd Edition), An Aquatic Plant Management Plan for Little Muskego Lake*, Waukesha County, Wisconsin, 2019.

Map 1.1 Little Muskego Lake Watershed and Direct Tributary Area



Map 1.2
Public Access and Local Names on Little Muskego Lake



Note: Date of Photograph 2024



Public Boat Launch



Dam



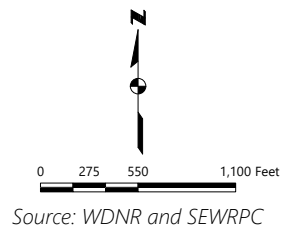
0 310 620 1,240 Feet

Source: LMLD and SEWRPC

Map 1.3
Bathymetry of Little Muskego Lake



—20'— Water Depth Contour in Feet



The Lake has had nine aquatic plant surveys completed since 2013 with the most recent survey in 2023 and the most recent aquatic plant management plan completed in 2019 by the Commission.⁵ Previous aquatic plant surveys have observed several beneficial native species including several species of muskgrass (*Chara* spp.), naiads (*Najas* spp.), and pondweeds (*Potamogeton* spp.). Several non-native aquatic plant species have also been identified in previous surveys: curly-leaf pondweed (CLP) (*Potamogeton crispus*), Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*), starry stonewort (SSW) (*Nitellopsis obtusa*), spiny naiad (*Najas marina*), and hybrid watermilfoil (*Myriophyllum spicatum x sibiricum*). Curly-leaf pondweed was first verified on the Lake in 1967.⁶ Eurasian watermilfoil was verified on the Lake in 1993.⁷ In 2014, starry stonewort was vouchered and verified, along with spiny naiad and an EWM population that had hybridized with the native species of milfoil (northern watermilfoil, *Myriophyllum sibiricum*).⁸ This starry stonewort observation was the first for an inland lake in Wisconsin.

There are four WDNR-designated sensitive areas on the Lake; these areas are particularly important for sustaining elements of the lake's ecology, such as providing fish spawning and rearing habitat, and consequently intensive management is limited in these areas. These areas are described in greater detail in Section 2.4, "WDNR-Designated Sensitive Areas."

The District manages aquatic plant growth on Little Muskego Lake to enhance navigation and recreational opportunities, primarily through mechanical harvesting and chemical treatments for invasive species control. The boundary of the Little Muskego Lake District contains both riparian and non-riparian properties that contribute to the management of the harvesting program amongst other District initiatives (see Map 1.4). In order to renew their aquatic plant management permit, every five years the District is required to reevaluate the aquatic plant community and update the aquatic plant management plan. To renew its permits to conduct this management, the District retained the Commission to 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 for 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 the proposed continuation of aquatic plant management in the Lake.

This updated aquatic plant management (APM) plan summarizes information and recommendations needed to manage nuisance plants (including SSW and EWM). 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 data and suggestions can be valuable resources when developing requisite APM permit applications and implementing future aquatic plant management efforts.

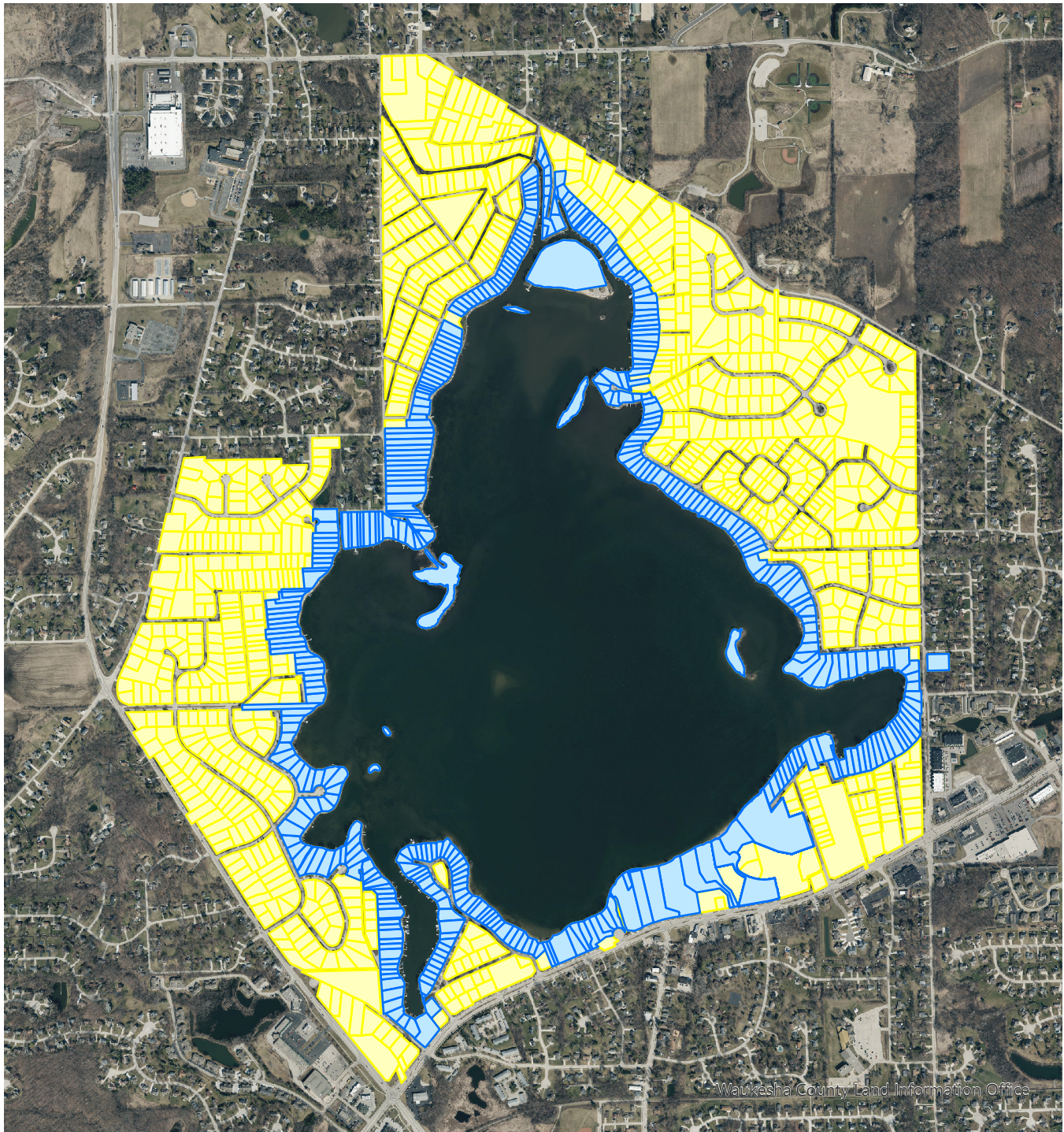
⁵ Ibid.

⁶ See apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=762700&page=invasive.

⁷ Ibid.

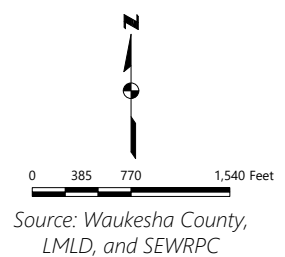
⁸ Ibid.

Map 1.4 Little Muskego Lake District Parcels



Note: Single tax parcels can have multiple locations. Therefore, if one location has riparian access all associated properties were labeled as such. For the most up-to-date parcel status visit the County's and/or the District's GIS website.

- Non-Riparian District Parcels
- Riparian Parcels



Credit: Commission 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 Little Muskego Lake APM plan considered input from the Little Muskego Lake District (District), Wisconsin Department of Natural Resources (WDNR), and the public. Objectives of the Little Muskego Lake APM program include the following.

- Effectively control the quantity and density of nuisance aquatic plant growth in well-targeted portions of Little Muskego 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 lakes 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 lakes' 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 lakes' ecological health through environmentally sound management of vegetation, wildlife, fish, and other aquatic/semi-aquatic organisms in and around the lakes.

- Promote a high-quality water-based experience for residents and visitors to the lakes consistent with the policies and practices of the WDNR, as described in the regional water quality management plan, as amended.⁹

To meet these objectives, the District executed an agreement with the Southeastern Wisconsin Regional Planning Commission (Commission or SEWRPC) to examine the Lake's aquatic plant community and to develop an aquatic plant management plan. This chapter presents the results of previous and current aquatic plant surveys and management efforts on the Lake.

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 support many other beneficial functions (see Table 2.1). For example, water lilies play a significant role in providing shade, habitat, and food for fish and other important aquatic organisms. They also help prevent damage to the lakeshore by dampening the power of waves that could otherwise erode the shoreline. Additionally, the shade that these plants provide helps reduce the growth of undesirable plants because it limits the amount of sunlight reaching the lake bottom. Given these benefits, large-scale removal of native plants that may be perceived as a nuisance should be avoided when developing plans for aquatic plant management.

Aquatic Plant Surveys

Little Muskego Lake's aquatic plant community has been evaluated nine times since 2013 with the most recent survey in 2023 (see Table 2.2). Commission staff surveyed the Lake's aquatic plants in 2013 and 2015.¹⁰ Few lakes across southeastern Wisconsin have as many aquatic plant surveys as Little Muskego Lake, especially by WDNR staff. These surveys have been conducted in support of ongoing WDNR research on the biology and management of starry stonewort (*Nitellopsis obtusa*). Little Muskego Lake was the first reported lake in Wisconsin to have starry stonewort, discovered by WDNR staff in 2014, and is one of several lakes across the state that were designated as long-term trends lakes to monitor starry stonewort (SSW) populations and what ecological and recreational impacts these populations have on Wisconsin lakes. Every

⁹ 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.

¹⁰ All other aquatic plant surveys were performed by the WDNR and Waukesha County.

Table 2.1
Ecological Qualities Associated with Aquatic Plant Species in Little Muskego Lake

Aquatic Plant Species Present	Ecological Significance
<i>Ceratophyllum demersum</i> (coontail)	Provides good shelter for young fish; supports insects valuable as food for fish and ducklings
<i>Chara</i> spp. (muskgrasses)	A favorite waterfowl food and fish habitat, especially for young fish
<i>Elodea canadensis</i> (common waterweed)	Provides shelter and support for insects which are valuable as fish food
<i>Heteranthera dubia</i> (water stargrass)	Locally important food source for waterfowl and forage for fish; native
<i>Myriophyllum sibiricum</i> (northern watermilfoil)	Leaves and fruit provide food for waterfowl and shelter and foraging for fish
<i>Najas flexilis</i> (slender naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
<i>Najas guadalupensis</i> (southern naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
<i>Nymphaea odorata</i> (white water lily)	Seeds consumed by waterfowl while rhizoids consumed by mammals
<i>Potamogeton friesii</i> (Fries' pondweed)	Seeds provide food for waterfowl and habitat for fish and aquatic invertebrates
<i>Potamogeton gramineus</i> (variable pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by waterfowl
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Provides some food for ducks; native
<i>Ranunculus aquatilis</i> (white water crowfoot)	Provides habitat for fish and macroinvertebrates
<i>Stuckenia pectinata</i> (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish; native
<i>Utricularia</i> spp. (bladderworts)	Stems provide food and cover for fish; native
<i>Vallisneria americana</i> (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

Table 2.2
Little Muskego Lake Aquatic Plant Survey Summaries: 2013-2023

Survey Date(s)	Species Richness	Maximum Depth of Colonization (feet)	Littoral Zone Frequency of Occurrence (%)	Average Number of Native Species Per Site	Floristic Quality Index	Mean Coefficient of Conservatism
9/14/2023	18	24.0	87.08	2.07	22.72	5.87
8/17/2022 – 8/18/2022	18	12.0	94.65	2.08	18.33	4.73
8/23/2021 – 8/25/2021	16	17.0	93.81	2.13	17.90	5.17
9/15/2020	18	15.0	93.06	2.03	21.38	5.71
8/26/2019	25	12.0	89.71	2.68	24.98	5.89
9/7/2018	22	12.0	70.68	1.52	18.48	5.33
9/9/2015 – 9/21/2015	18	15.5	98.00	2.58	22.72	5.87
9/9/2014 -9/18/2014	22	22.0	88.00	2.71	25.46	6.00
8/26/2013 – 9/4/2013	21	15.0	96.00	3.19	25.92	5.95

Note: Species richness includes visual sightings.

Source: WDNR and SEWRPC

survey conducted from 2013 to 2023 has used the same point-intercept grid and methodology.^{11,12,13} 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 Little Muskego Lake consists of 710 sampling points spaced at 52 meters (170.6 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.

Aquatic Plant Survey Metrics

Each aquatic plant species has preferred habitat conditions in which that species thrives as well as conditions that limit or completely inhibit its growth. For example, water conditions (e.g., depth, clarity, source, alkalinity, and nutrient concentrations), substrate composition, the presence or absence of water movement, and pressure from herbivory and/or competition all can influence the type of aquatic plants found in a water body. All other factors being equal, water bodies with a diverse array of habitat variables are more likely to host a diverse aquatic plant community. Human management can also affect the biological diversity (biodiversity) of waterbodies. Thoughtful aquatic plant management can help maintain, or even enhance, aquatic plant biodiversity.

Several metrics are useful to describe aquatic plant community condition and design management strategies. These metrics include total rake fullness, maximum depth of colonization, species richness, biodiversity, evaluation of sensitive species, and relative species abundance. Metrics derived from the 2018 and 2023 point-intercept surveys are described below.

Total Rake Fullness

The Little Muskego Lake plant surveyors qualitatively rated the plant abundance at each survey point by how much of the sampling rake was covered by all aquatic plant species.¹⁴ This rating, called total rake fullness, can be a useful metric evaluating general abundance of aquatic plants as part of the point-intercept survey. As shown in Figure 2.2 and Table 2.3, total rake fullness across all surveyed points in Little Muskego Lake averaged 1.79 in 2023, an increase from the 2018 average rake fullness of 1.55. In 2023, total rake fullness was highest in the northeast portion of the Lake. Across the range of surveys since 2013, total rake fullness is generally greatest in the northeast and southwest portions of the Lake that are generally shallower which allows denser plant growth. The deeper areas, particularly in the center of the Lake are not conducive to extensive aquatic plant growth, as the depths are light-limiting for aquatic plants at the current water clarity levels.

Maximum Depth of Colonization

Maximum depth of colonization (MDC) can be a useful indicator of water quality, as turbid and/or eutrophic (nutrient-rich) lakes generally have shallower MDC than lakes with clear water.¹⁵ It is important to note that for surveys using the point-intercept protocol, the protocol allows sampling to be discontinued at depths greater than the maximum depth of colonization for vascular plants. However, aquatic moss and macroalgae, such as muskgrass (*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. In 2023 the MDC of Little Muskego Lake was 24 feet, double the MDC of the 2018 survey, suggesting greater water clarity within the time period (Table 2.2). The majority of plant observations deeper than 20 feet in these surveys were of coontail (*Ceratophyllum demersum*).

¹¹ Sampling methodology changed from transect-based methods in the 2002 and 2007 surveys to a point-intercept method beginning with the 2013 survey.

¹² 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. Leverage, S. Borman, S. Engel, and D. Helsel, 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.

¹³ 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.

¹⁴ This method follows the standard WDNR protocol.

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

Figure 2.1
Aquatic Plant Point Intercept Grid for Little Muskego Lake

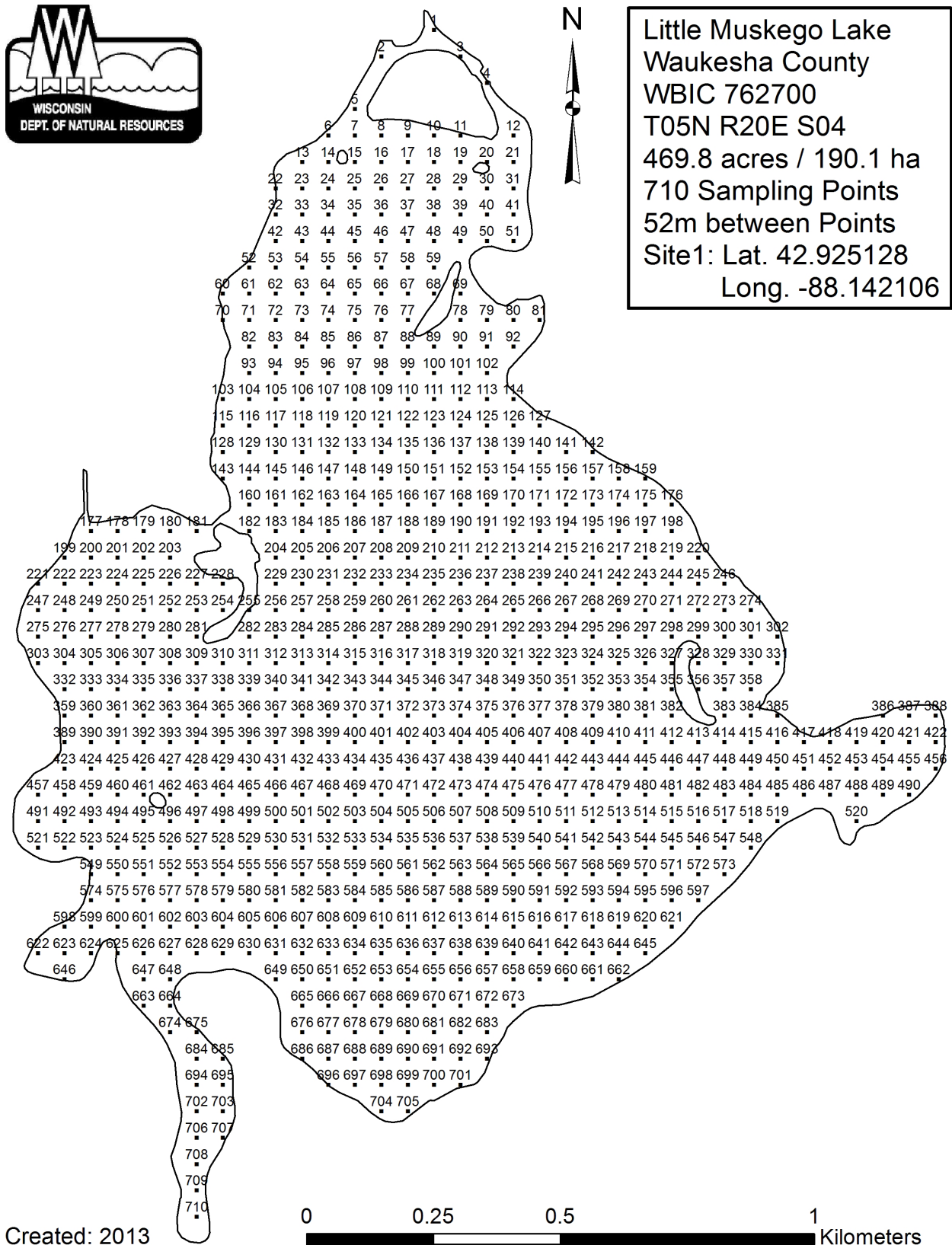
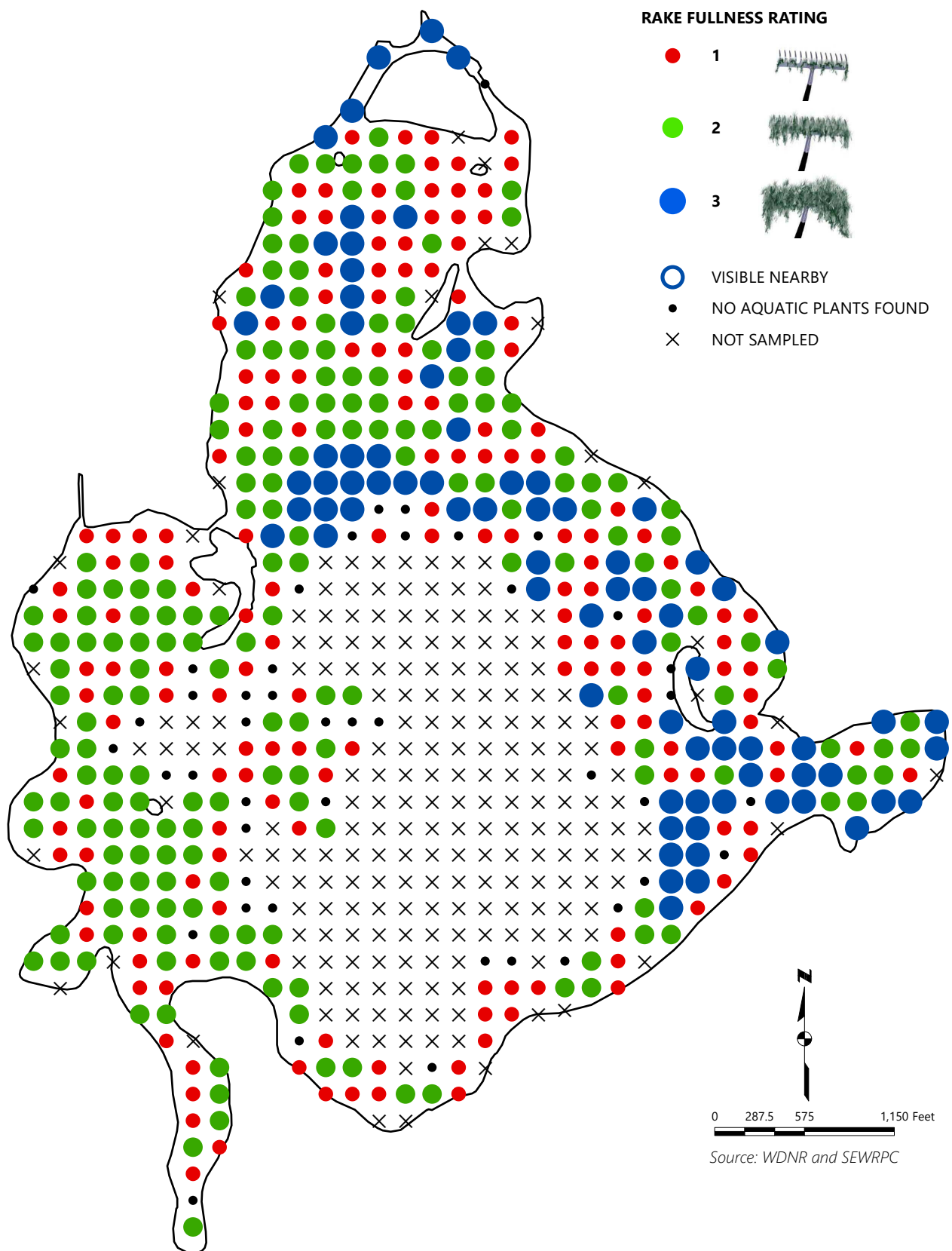


Figure 2.2
Total Rake Fullness on Little Muskego Lake: September 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

When viewing both the MDC over the time period of 2013-2023 and historic Secchi depth measurements (shown in Figures 2.3 and 2.4), long-term water quality trends suggest increasing water clarity.

Species Richness

The number of distinct types of aquatic plants present in a lake is referred to as the *species richness* of the lake. Larger lakes with diverse lake basin morphology, less human disturbance, and/or healthier, more resilient lake ecosystems have greater species richness. Aquatic plants provide a wide variety of benefits to lakes, examples of which are briefly described in Table 2.1. The 2023 species richness was 18, an apparent decrease from the 22 species observed during the 2018 survey.¹⁶ The total number of species observed at each sampling point in 2023 is shown in Figure 2.5. Between one and six aquatic plant species were found at any single sampling point throughout the Lake in 2023, with the highest richness at the points on the shoreline and in the northern portion of the Lake where water depths are shallower to allow more light penetration.

The observed species richness of Little Muskego Lake has varied throughout the plant surveys between 2013 and 2023, which may reflect cyclical changes in the aquatic plant population as well as differences between individual surveyors. Some species observed in earlier surveys were not observed during the 2023 survey (see Table 2.4). Additionally, there were plants identified to the genus level in some surveys that were identified to the species level in other surveys, e.g., the identification of muskgrass species in 2018, 2019, and 2021. 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. Despite fluctuations, muskgrass, a type of macroalgae, has continuously been amongst the most observed species in the Lake. This is a critical group of species to protect, as muskgrass 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.¹⁷ 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.

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). The SDI expresses values on a zero to one scale where 0 equates to no diversity and 1 equates to infinite diversity. Using this measure, a community dominated by one or two species would be considered less diverse than one in which several different species have similar abundance. In general, more diverse biological communities are better able to maintain ecological integrity (ecosystem structure, function, and composition) in response to environmental stresses such as changes in temperature, water quality, or other disturbances. Promoting biodiversity not

Table 2.3
Little Muskego Aquatic Plants
Summary Statistics: PI Survey: 2023

Statistic	Value
Total number of sites visited	681
Total number of sites with vegetation	445
Total number of sites shallower than maximum depth of plants	511
Frequency of occurrence at sites shallower than maximum depth of plants	87.08
Simpson Diversity Index	0.86
Maximum depth of plants (feet)	24.0
Number of sites sampled using rake on Rope (R)	20
Number of sites sampled using rake on Pole (P)	476
Average number of all species per site (shallower than max depth)	2.55
Average number of all species per site (vegetation sites only)	2.92
Average number of native species per site (shallower than max depth)	1.71
Average number of native species per site (vegetation sites only)	2.50
Species Richness	17
Species Richness (including visuals)	18

Source: WDNR and SEWRPC

¹⁶ The 2018 survey identified the genus *Chara* to the species level, whereas the 2023 survey only identified *Chara* as the genus. The difference in identification may not reflect the true differences in species richness.

¹⁷ 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

Trends in Mean C, FQI Scores, Species Richness, and MDC Within Little Muskego Lake: 2013-2023

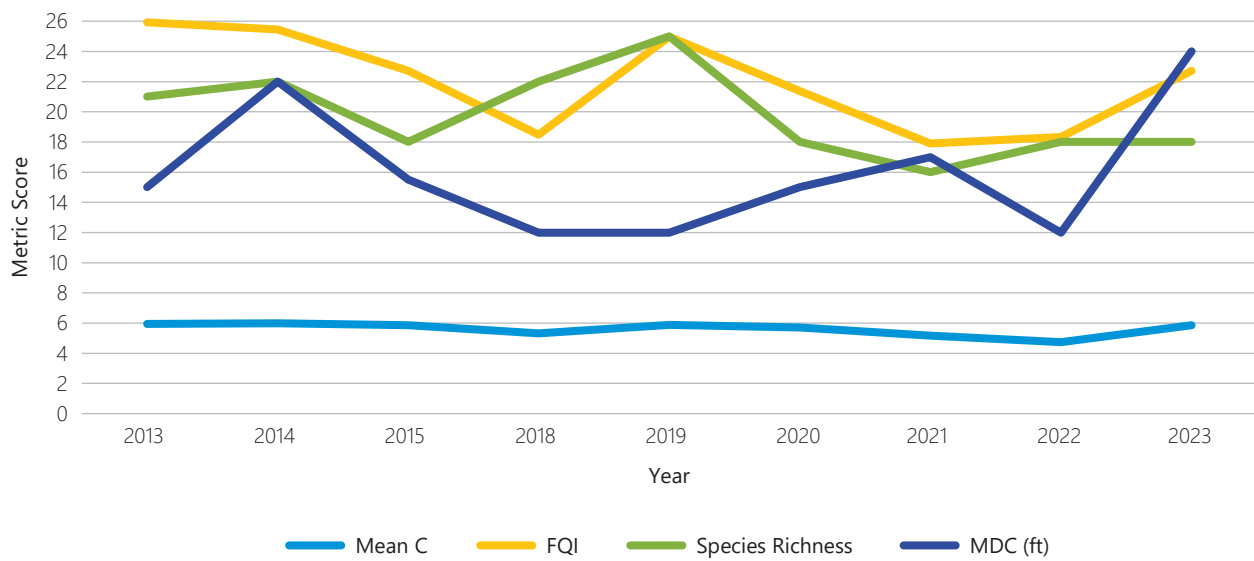
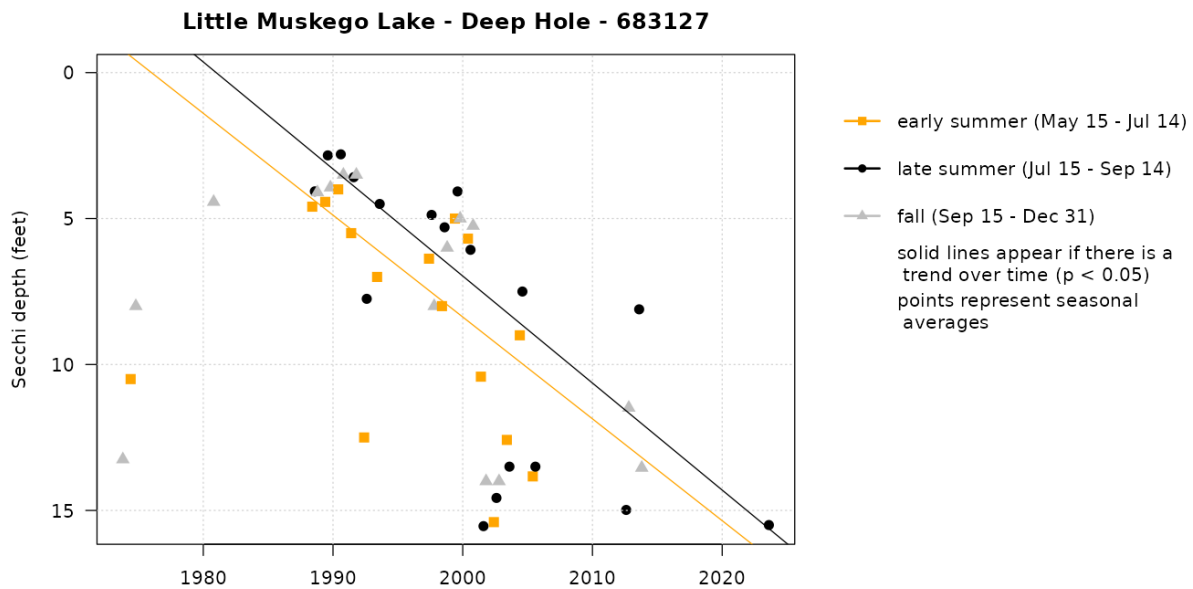


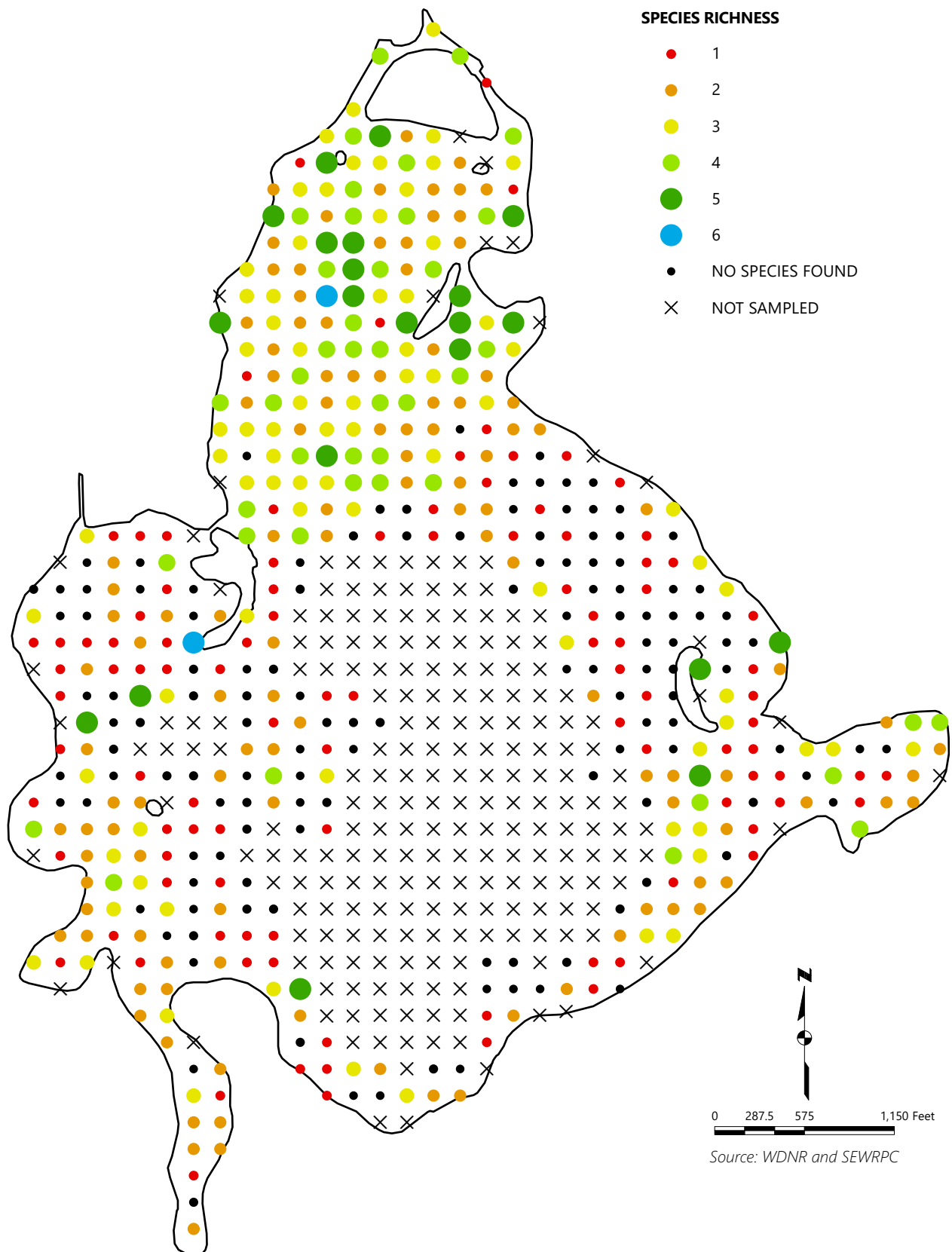
Figure 2.4

Secchi Depth Trends at the Deep Hole in Little Muskego Lake: 1973-2023



Source: WDNR

Figure 2.5
Species Richness in Little Muskego Lake: September 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Table 2.4
Submerged Aquatic Plant Species Observed in Little Muskego Lake: 1967-2023

Aquatic Plant Species	Native or Invasive	1967	1992	1994	2002	2007	2013	2014	2015	2018	2019	2020	2021	2022	2023
<i>Ceratophyllum demersum</i> (coontail)	Native	X	X	X	X	X	X	X	X	X	X	X	X	--	X
<i>Chara braunii</i> , (Braun's stonewort)	Native	--	--	--	--	--	--	--	--	X	X	--	X	--	--
<i>Chara contraria</i> , (common stonewort)	Native	--	--	--	--	--	--	--	--	X	X	X	--	--	--
<i>Chara globularis</i> , (globular stonewort)	Native	--	--	--	--	--	--	--	--	X	X	X	--	--	--
<i>Chara</i> spp. (muskgrass)	Native	X	X	X	X	X	X	X	X	--	--	X	X	X	X
<i>Elodea canadensis</i> (common waterweed)	Native	X	--	--	X	X	X	X	X	X	X	X	X	X	X
<i>Heteranthera dubia</i> (water stargrass)	Native	--	--	--	X	X	X	X	X	X	X	X	X	X	X
<i>Myriophyllum sibiricum</i> (northern water milfoil)	Native	X	--	--	X	X	--	X	--	--	--	--	--	--	X
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	--	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Najas flexilis</i> (slender naiad)	Native	--	X	X	X	X	--	X	X	X	X	X	X	X	X
<i>Najas guadalupensis</i> (southern naiad)	Native	--	--	--	--	X	X	X	X	--	X	X	X	X	X
<i>Najas marina</i> (spiny naiad)	Naturalized	--	--	--	--	--	--	X	--	--	--	--	--	X	--
<i>Nitella</i> spp. (stonewort)	Native	--	X	--	--	--	--	--	--	--	--	--	--	--	--
<i>Nitellopsis obtusa</i> (starry stonewort)	Invasive	--	--	--	--	--	--	X	X	X	X	X	X	X	X
<i>Nymphaea odorata</i> (white-water lily)	Native	X	X	X	X	--	X	X	X	X	X	--	X	--	X
<i>Persicaria amphibia</i> (water smartweed)	Native	--	--	--	--	--	X	--	--	--	--	--	--	--	--
<i>Potamogeton amplifolius</i> (large-leaf pondweed)	Native	--	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Potamogeton crispus</i> (curly-leaf pondweed)	Invasive	X	X	X	X	X	X	X	X	X	--	--	--	X	--
<i>Potamogeton foliosus</i> (leafy pondweed)	Native	--	--	--	--	X	X	X	X	X	X	X	--	--	X
<i>Potamogeton friesii</i> (Fries' pondweed)	Native	--	--	--	--	--	--	X	X	X	X	X	--	X	--
<i>Potamogeton gramineus</i> (variable pondweed)	Native	--	--	--	X	X	X	X	X	--	X	X	--	--	X
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	--	--	--	X	X	X	X	X	X	X	X	X	X	X
<i>Potamogeton nodosus</i> (long-leaf pondweed)	Native	--	--	--	--	--	X	--	--	--	--	--	--	--	--
<i>Potamogeton praelongus</i> (white-stem pondweed)	Native	X	--	--	--	--	--	X	X	--	--	--	X	X	X
<i>Potamogeton pusillus</i> (small pondweed)	Native	--	--	--	X	X	X	--	--	--	X	--	X	--	X
<i>Potamogeton richardsonii</i> (clasping-leaf pondweed)	Native	--	X	X	X	X	X	X	X	X	X	X	--	X	--
<i>Potamogeton</i> spp. (pondweed)	Native	X	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Potamogeton strictifolius</i> (stiff pondweed)	Native	--	--	--	--	--	--	--	--	--	X	--	--	--	--
<i>Potamogeton zosteriformis</i> (flat-stem pondweed)	Native	X	X	X	X	X	X	X	--	X	X	X	--	--	--
<i>Ranunculus aquatilis</i> (white water crowfoot)	Native	--	--	--	X	X	X	X	--	--	--	--	--	--	--
<i>Ranunculus</i> spp. (water crowfoot)	Native	X	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Stuckenia pectinata</i> (sago pondweed)	Native	X	--	--	X	X	X	X	X	X	--	X	X	X	X
<i>Utricularia gibba</i> (creeping bladderwort)	Native	--	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Utricularia</i> spp. (bladderwort)	Native	--	--	--	--	X	X	--	--	--	--	--	--	--	--
<i>Vallisneria spiralis</i> (eelgrass/water celery)	Native	X	X	--	X	X	X	X	X	X	X	X	--	X	X
<i>Zannichellia palustris</i> , (horned pondweed)	Native	--	--	--	--	--	--	--	--	--	X	--	--	--	--
Total Species		12	10	8	17	19	20	22	18	18	21	18	13	16	17

Source: WDNR and SEWRPC

only helps sustain an ecosystem but preserves the spectrum of options useful for future management decisions.

The Lake has good biodiversity with an SDI of 0.86 in 2023, the same as the 2018 survey. Actions that conserve and promote aquatic plant biodiversity in the Lake are critical to its long-term health, as they not only help sustain and increase the robustness and resilience of the existing ecosystem, but also promote efficient and effective future aquatic plant management.

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.¹⁸ The FQI is an assessment metric used to evaluate how closely a lake's aquatic plant community matches that of undisturbed, pre-settlement conditions.¹⁹ 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 FQI of Little Muskego Lake in 2023 was 22.72, an increase from 18.48 in 2018 (Figure 2.3). This increase may in part be attributed to the long-term drawdown in the winter of 2018 that aimed to decrease invasive species populations and promote native aquatic plant species growth. For reference, the average FQI value for the Southeastern Wisconsin Till Plains ecoregion is 20.0, indicating that the Lake supports species that are sensitive to ecological disturbance similarly to other lakes in the Region.

The WDNR currently uses an aquatic plant bioassessment method published by Mikulyuk et al., 2017 to assess whether lakes should be listed on the 303(d) impaired waters list. This method identifies species that are tolerant, moderately tolerant, and sensitive to human disturbance. Four sensitive species, as identified in this methodology, were identified during the 2023 survey: slender naiad (*Najas flexilis*), southern naiad (*Najas guadalupensis*), small pondweed (*Potamogeton pusillus*), and variable pondweed (*Potamogeton gramineus*).²⁰ Of these species, small pondweed was the most observed in the 2023 survey and was typically found in the southwestern portion of the Lake. The number of sensitive species identified at each survey points are shown in Figure 2.6.

Relative Species Abundance

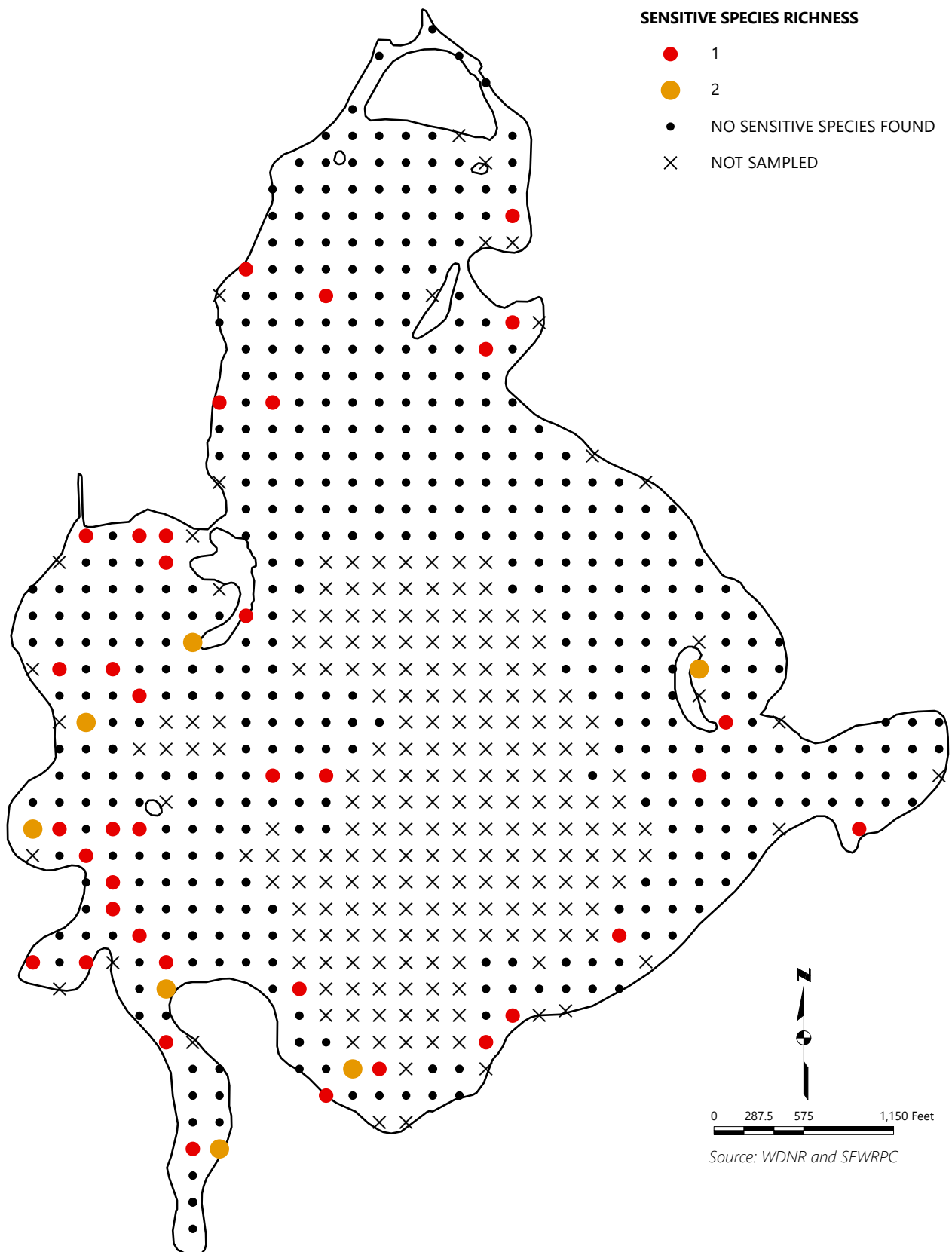
Based on the 2023 point-intercept survey, the five most abundant submerged aquatic plant species in the Lake were, in decreasing order of abundance: 1) eelgrass (*Vallisneria americana*) at 313 points, 2) muskgrasses (*Chara sp.*) at 220 points, 3) waterweed (*Elodea canadensis*) at 209 points, 4) Eurasian watermilfoil (*Myriophyllum spicatum*) at 144 points, and 5) coontail (*Ceratophyllum demersum*) at 115 points. The distribution of the most common non-invasive aquatic plant species identified as part of the 2023 survey are mapped in Appendix A. The shallow, nearshore areas around much of the Lake are characterized by a mixture of muskgrass, waterweed, and eelgrass. As stated above, coontail was the most common species observed in deeper vegetated areas of the Lake and is particularly abundant along the northern deep edge. The most common invasive plants were starry stonewort and Eurasian watermilfoil which were typically found in the northern bay of the Lake. Only three points showed any plant growth greater than 11 feet of depth, with species found including coontail and EWM.

¹⁸ Vestergaard, O. and Sand-Jensen, K., Alkalinity and Trophic State Regulate Aquatic Plant Distribution in Danish Lakes, *Aquatic Botany* 67, 2000.

¹⁹ S. Nichols, Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications, *Lake and Reservoir Management* 15(2), 1999.

²⁰ Mikulyuk, A.M., et al., A Macrophyte Bioassessment Approach Linking Taxon-Specific Tolerance and Abundance in North Temperate Lakes, *Journal of Environmental Management* 199: 172-180, 2017.

Figure 2.6
Sensitive Species Richness in Little Muskego Lake: 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Invasive Species

This subsection will discuss invasive species observations in Little Muskego Lake, as these are often the focus of aquatic plant management efforts.

Eurasian Watermilfoil (EWM)

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.^{21,22} 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.²³ For reasons such as these, EWM can grow to dominate an aquatic plant community in as little as two years.^{24,25} 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.²⁶

Human produced EWM fragments (e.g., created by boating through EWM), as well as fragments generated from natural processes (e.g., wind-induced turbulence, animal feeding/disturbance) readily colonize 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.²⁷ The fragments can also cling to boats, trailers, motors, and/or bait buckets where they can remain alive for weeks contributing to transfer of milfoil to other lakes. For these reasons, it is especially important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

In the 2023 survey, EWM was found at 32.36 percent of vegetated points, an increase from 5.57 percent in the 2018 survey (see Figure 2.7). In the 2023 survey, the largest EWM populations were in the north of the Lake along with moderate populations occurring at the points nearest to the shoreline around the Lake (see Figure 2.8).

When reviewing historic population patterns, EWM was observed at 41.44 percent of vegetated points in Little Muskego Lake in 2013, 5.57 percent in 2018, and 32.36 percent in 2023. The EWM population decreased every year from 2013 to 2018, then began to climb in population that reached a maximum of 41.98 percent of vegetated points in the 2021 survey. The population hit a low of occurrence at 0.45 percent of vegetated points in the 2022 survey before increasing again to 32.36 percent in the most recent 2023 survey. The stark population changes seem to be the opposite of the observed starry stonewort population changes during the time period, suggesting that the two invasives may compete for habitat and oscillate in dominance (see Figure 2.9).

Curly-Leaf Pondweed

Curly-leaf pondweed (CLP) has maintained a low abundance within Little Muskego Lake since 2013 and has never exceeded four percent of vegetated points within any aquatic plant survey. This plant, like EWM, is identified in Chapter NR 109 of the *Wisconsin Administrative Code* as a nonnative invasive aquatic plant. Although survey data suggests that it is presently a minor species in terms of dominance, and, as such, is less likely to interfere with recreational boating activities, the plant can grow dense stands that exclude other

²¹ U. S. Forest Service, Pacific Islands Ecosystems at Risk (PIER), 2019.: hear.org/pier/species/myriophyllum_spicatum.htm

²² 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.

²³ Ibid.

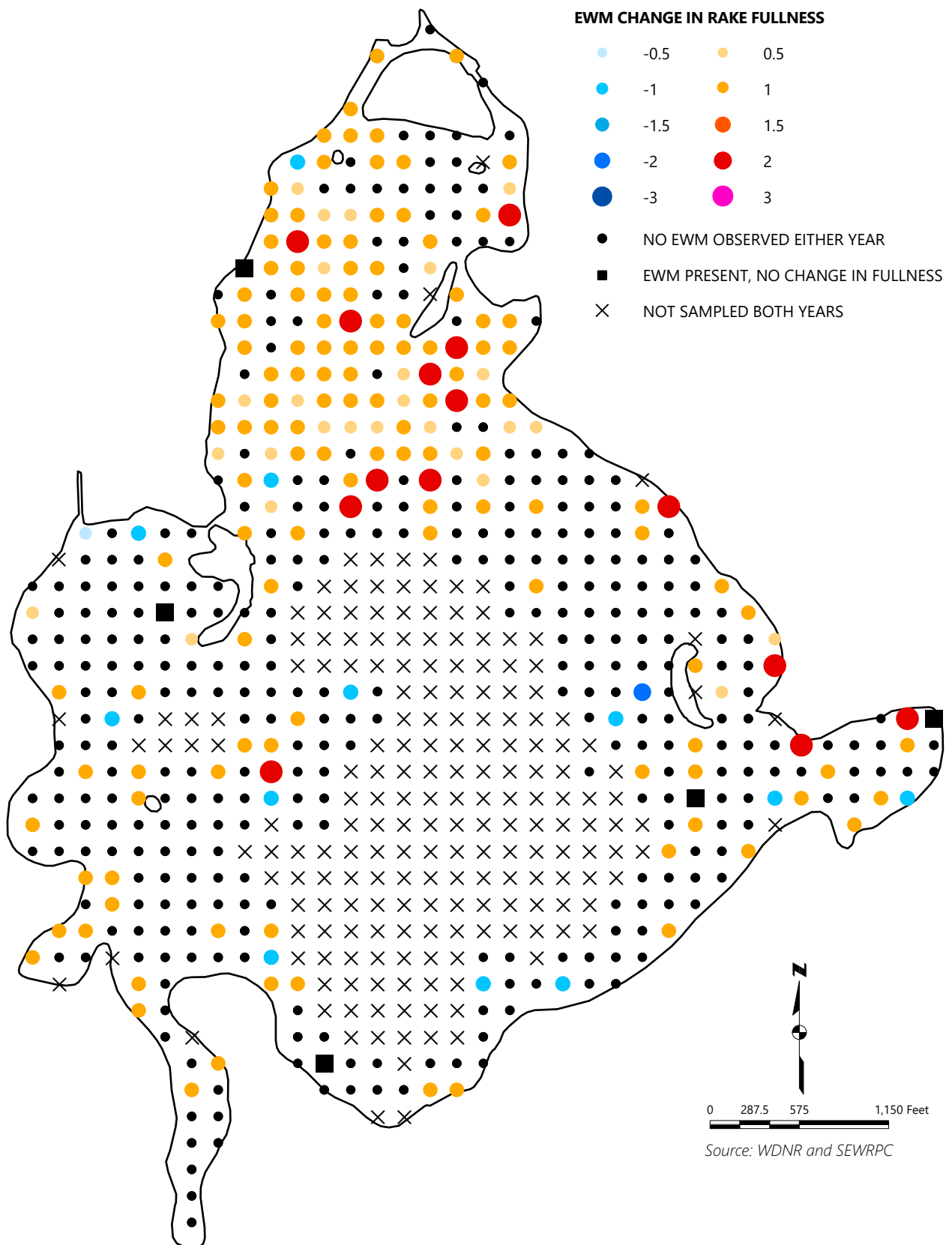
²⁴ S.R. Carpenter, The Decline of *Myriophyllum spicatum* in a Eutrophic Wisconsin (USA) Lake, *Canadian Journal of Botany* 58(5), 1980.

²⁵ 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.

²⁶ S.R. Carpenter, 1980, *op. cit.*

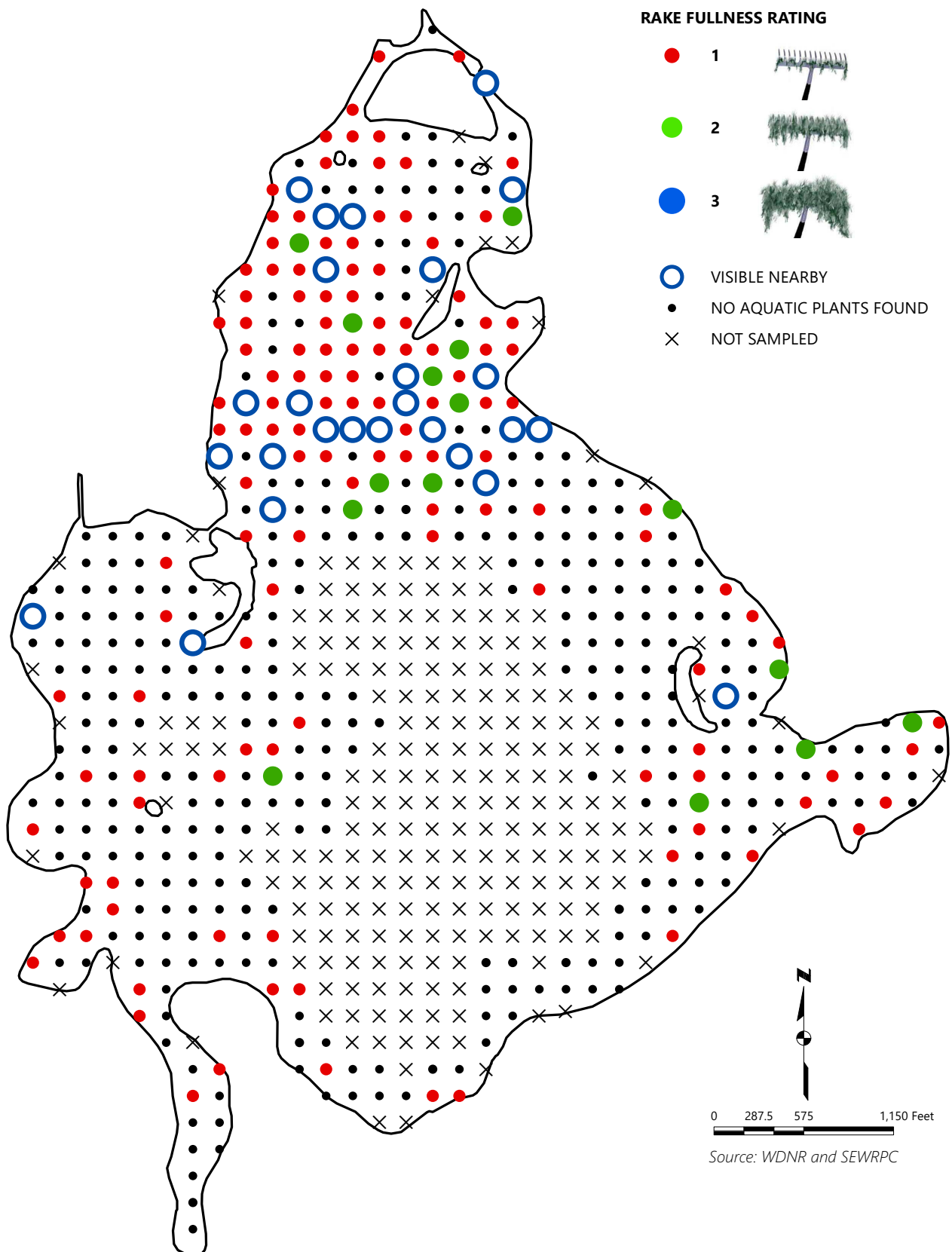
²⁷ J.D. Wood and M. D. Netherland, How Long Do Shoot Fragments of Hydrilla (*Hydrilla verticillata*) and Eurasian Watermilfoil (*Myriophyllum spicatum*) Remain Buoyant?, *Journal of Aquatic Plant Management* 55: 76-82, 2017.

Figure 2.7
Change in Eurasian Watermilfoil Rake Fullness in Little Muskego Lake: 2018-2023



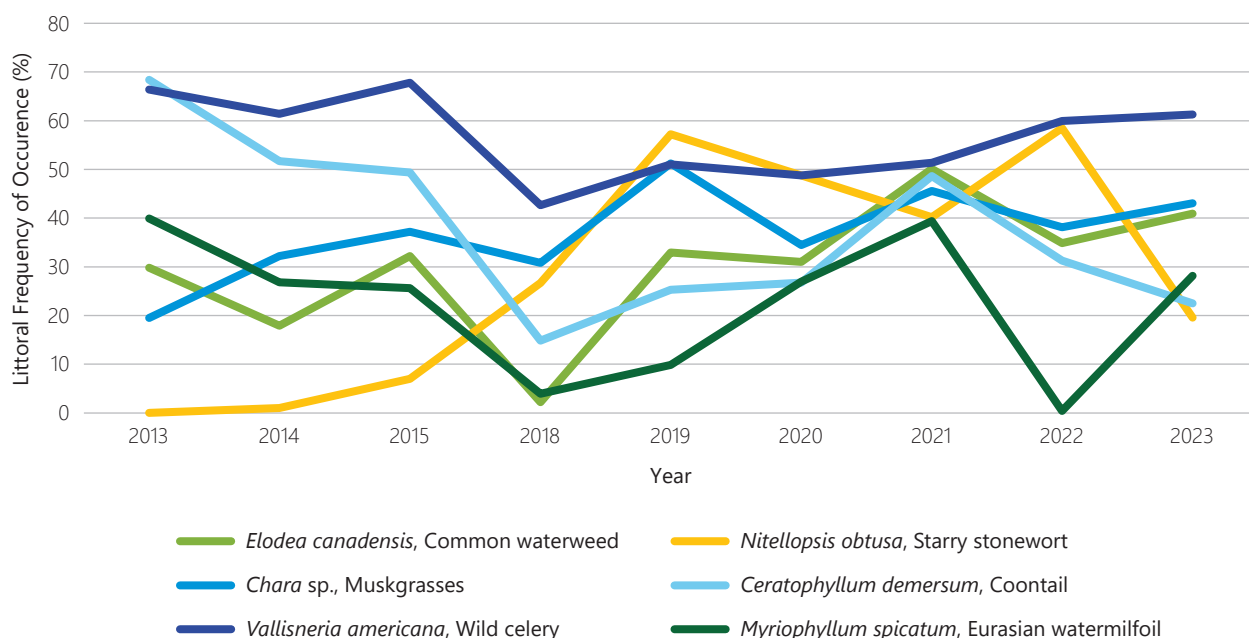
Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure 2.8
Eurasian Watermilfoil Total Rake Fullness in Little Muskego Lake: September 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure 2.9
Trends in Common Aquatic Plants Within Little Muskego Lake



Note: For years 2018, 2019, and 2021, the littoral frequency occurrence percentage of *Chara* sp. was the summation of *Chara contraria*, *Chara globularis*, and *Chara braunii*. This summation provided consistency with how *Chara* sp. was observed in other surveys.

Source: WDNR and SEWRPC

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, as the surveys conducted on Little Muskego Lake have historically been conducted in late August to early September.

CLP was not found in the 2023 survey and was only found at one point in 2018 (see Figure 2.10). The 2013 survey has had the highest percentage of CLP in the data set, occurring at 15 sites. From 2014-2019, CLP was reported at sites or as visuals less than five times in a given survey. This species was only observed as a visual in the 2020 survey and was not observed in the 2021 survey. The 2022 survey reported a 2.71 percentage of occurrence in vegetated areas, and was then absent in the 2023 survey.

Spiny Naiad

Spiny naiad is native to North America but was introduced to, and has become naturalized in, Wisconsin. 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.²⁸ However, spiny naiad is reported to be used as a food source for waterfowl, marsh birds, muskrat, and shelter/forage area for fish. Like CLP, spiny naiad is not common within Little Muskego Lake and was not found in the 2023 nor the 2018 surveys. It has been documented twice, found at one point in the 2014 and 2022 surveys, respectively.

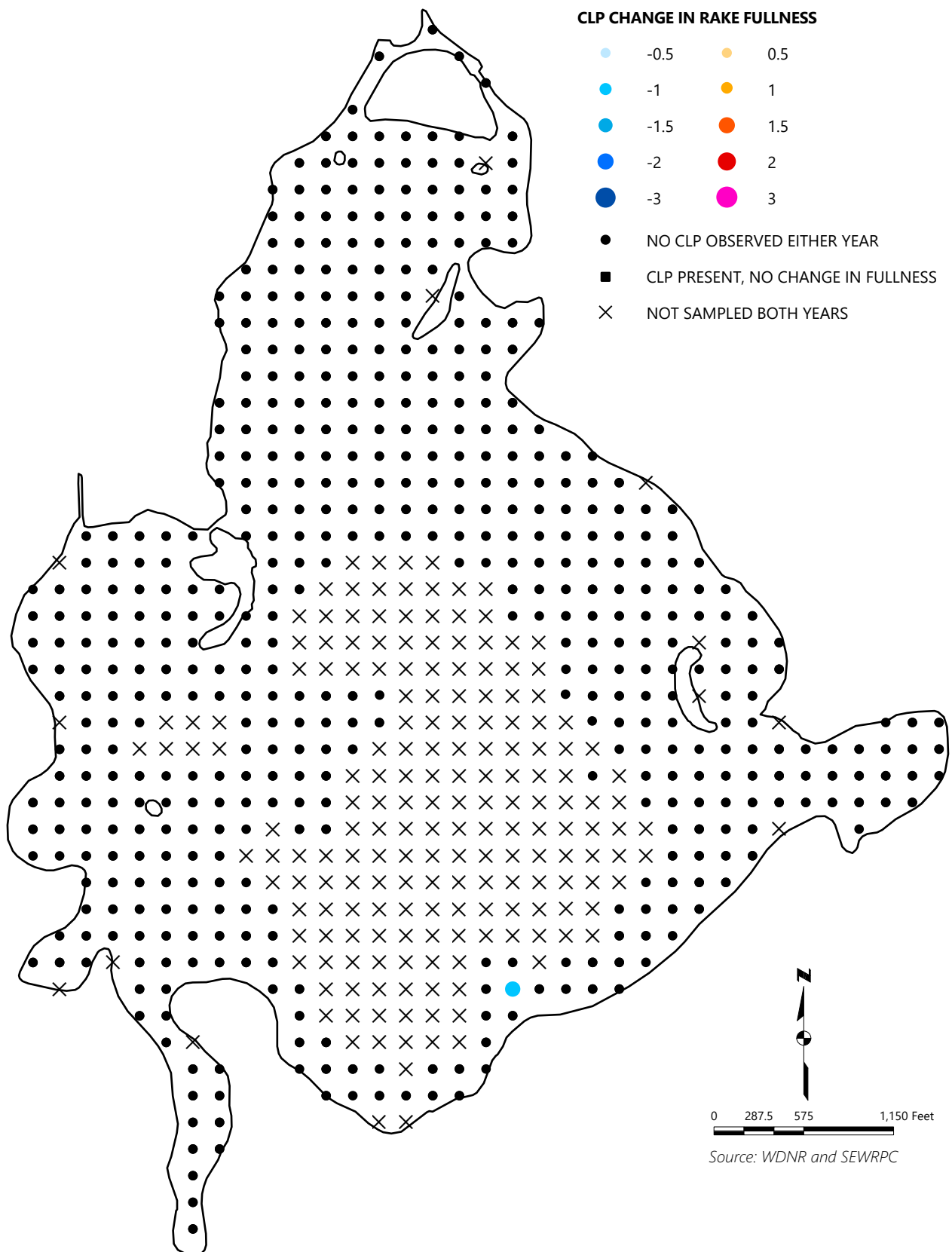
Starry Stonewort

Starry stonewort (*Nitellopsis obtusa*) is a relatively new aquatic invasive macroalga species in Wisconsin. As a member of the Characeae, starry stonewort is related to native *Chara*, *Lychnothamnus*, *Nitella*, and *Tolypella* species, which have roughly similar characteristics and are found in many hardwater lakes across Wisconsin. Native to Eurasia, the first discovery of the species in North America was in the St. Lawrence Seaway in 1978; it has since spread to several northeastern and midwestern US states as well as southern Ontario.²⁹

²⁸ Wisconsin Department of Natural Resources, Chapter NR 40, Invasive Species Identification, Classification and Control, April 2017.

²⁹ starrystonewort.org/maps.

Figure 2.10
Change in Curly Leaf Pondweed Rake Fullness in Little Muskego Lake: 2018-2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

As previously stated in this report, starry stonewort was first reported in Wisconsin in Little Muskego Lake during the September 2014 survey. In the 2014 survey, SSW was found in low densities at five sampling sites in Hillview Bay located in the northwest corner of the Lake.³⁰ Starry stonewort has since spread to several lakes throughout Southeastern Wisconsin, including Geneva Lake in Walworth County.³¹

In its native range, SSW has been shown to provide food and habitat for aquatic organisms as well as enhance lake water quality by reducing sediment suspension and acting as a phosphorus sink.³² In invaded lakes, SSW can form dense beds, with reported maximum heights of 4 to 7 feet, outcompete both native and other invasive plant species, and cover fish spawning areas.^{33,34,35} This species is capable of both sexual and asexual reproduction, which can occur through plant fragments as well as the star-shaped bulbils for which the species is named.³⁶ Only male species have been observed in North America thus far, indicating that all spread has been through asexual reproduction. Bulbils may stay viable in lake sediment for several years, making it extremely difficult to eradicate SSW from a waterbody.

SSW was observed at 22.47 percent of vegetated points in 2023, a decrease from 37.77 percent of vegetated points seen in 2018 (see Figure 2.11). The 2023 survey found the highest populations in the northwestern bays as well as the northern portions of the Lake, although scattered populations were still seen throughout (see Figure 2.12). SSW was first observed at 1.0 percent of vegetated points in Little Muskego Lake in 2014, rising in occurrence in each survey until reaching 57.20 percent of vegetated points in 2019. Populations have since fluctuated in each survey.

Apparent Changes in Observed Aquatic Plant Communities: 2018 Versus 2023

The 2023 aquatic plant survey identified a total of 18 different plant species including visuals, similar to the 22 species found in the 2018 aquatic plant survey. Thus, it is evident that Little Muskego Lake has a highly diverse aquatic plant community. Overall, the plant species found in the Lake remain largely the same.

In addition to the number of different aquatic plant species detected in the Lake, several other comparisons can be drawn between the 2018 and 2023 aquatic plant survey results, as summarized below:

- The total littoral vegetated frequency of occurrence increased by 3.8 from 2018 to 2023. It was 87.08 in 2023 compared to 70.68 in 2018 (see Table 2.2).
- The MDC in Little Muskego Lake during the 2023 survey was 24 feet, double the MDC of 12 feet in the 2018 survey (see Table 2.2).
- The composition and order of the five most common species changed from 2018 to 2023. Three of the five topmost common species remained the same but the other two most common species changed. In 2023 the five were 1) eelgrass, 2) muskgrass (*Chara* spp.), 3) waterweed, 4) Eurasian watermilfoil, and 5) coontail. In 2018 the five most common species were 1) eelgrass, 2) starry stonewort, 3) common stonewort (*Chara contraria*), 4) coontail, and 5) sago pondweed. Table 2.5 illustrates changes in littoral frequency of occurrence for common species.

³⁰ For more information regarding the earlier SSW surveys, see SEWRPC Memorandum Report No. 155 (3rd Edition) An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, June 2019.

³¹ apps.dnr.wi.gov/lakes/invasives/AISLists.aspx?species=STARRY_STONEW.

³² For a more complete review of SSW ecology in its native and invasive range, see D.J. Larkin, A.K. Monfils, A. Boissezon, R.S. Sleith, P.M. Skawinski, C.H. Welling, B.C. Cahill, and K.G. Karol, Biology, Ecology, and Management of Starry Stonewort (*Nitellopsis obtusa*; Characeae): A Red-listed Eurasian Green Alga Invasive in North America, *Aquatic Botany* 148: 15-24, 2018 as well as State of Michigan, Status and Strategy for Starry Stonewort (*Nitellopsis obtusa* (Desv. In Loisel.) J. Groves) Management, last updated December 2017 (www.michigan.gov/documents/invasives/egle-ais-nitellopsis-obtusa-strategy_708937_7.pdf).

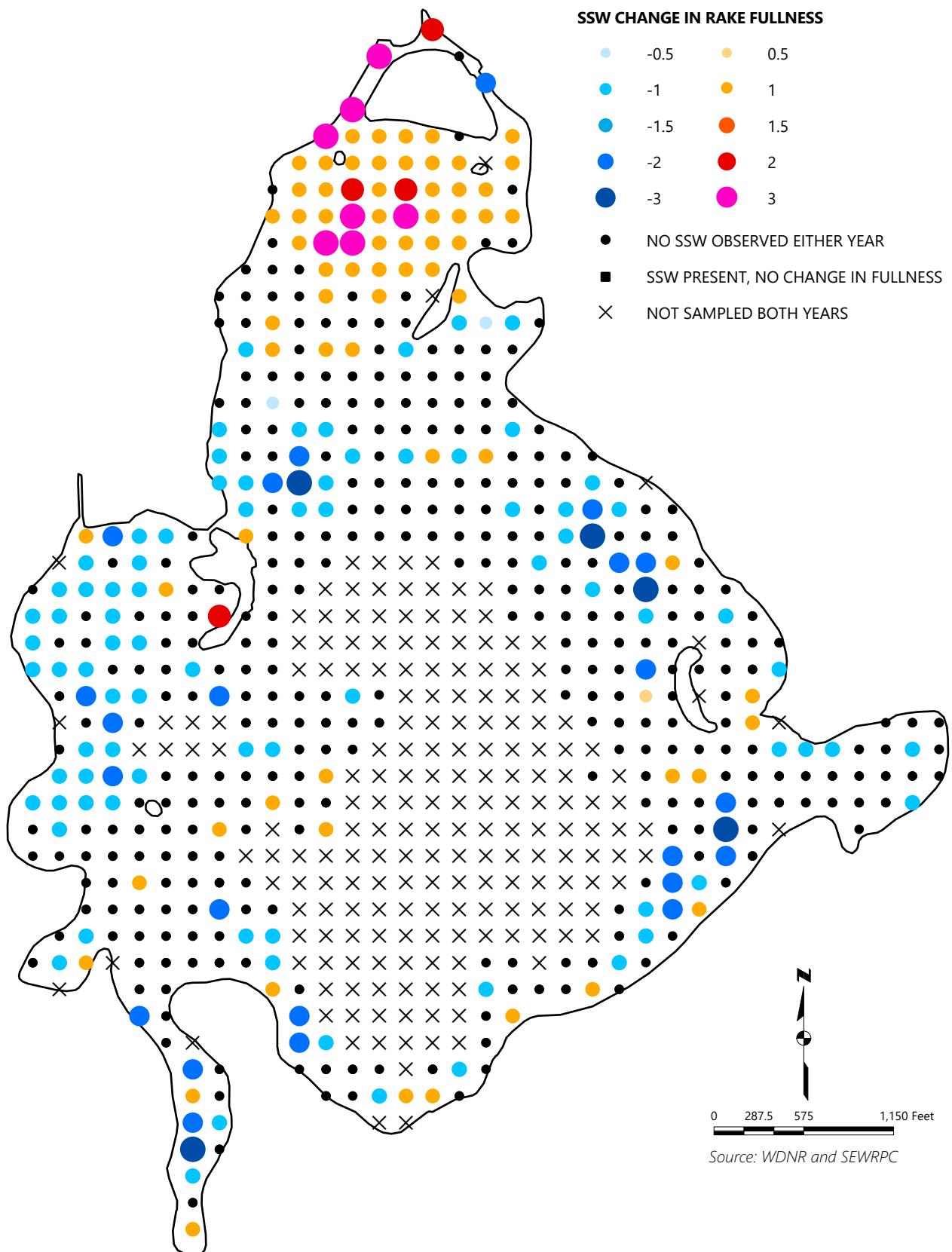
³³ Ibid.

³⁴ dnr.wisconsin.gov/sites/default/files/topic/Invasives/Nitellopsis%20obtusa.pdf.

³⁵ G.D. Pullman and G. Crawford, A Decade of Starry Stonewort in Michigan, *Lakeline* 36-42, 2010.

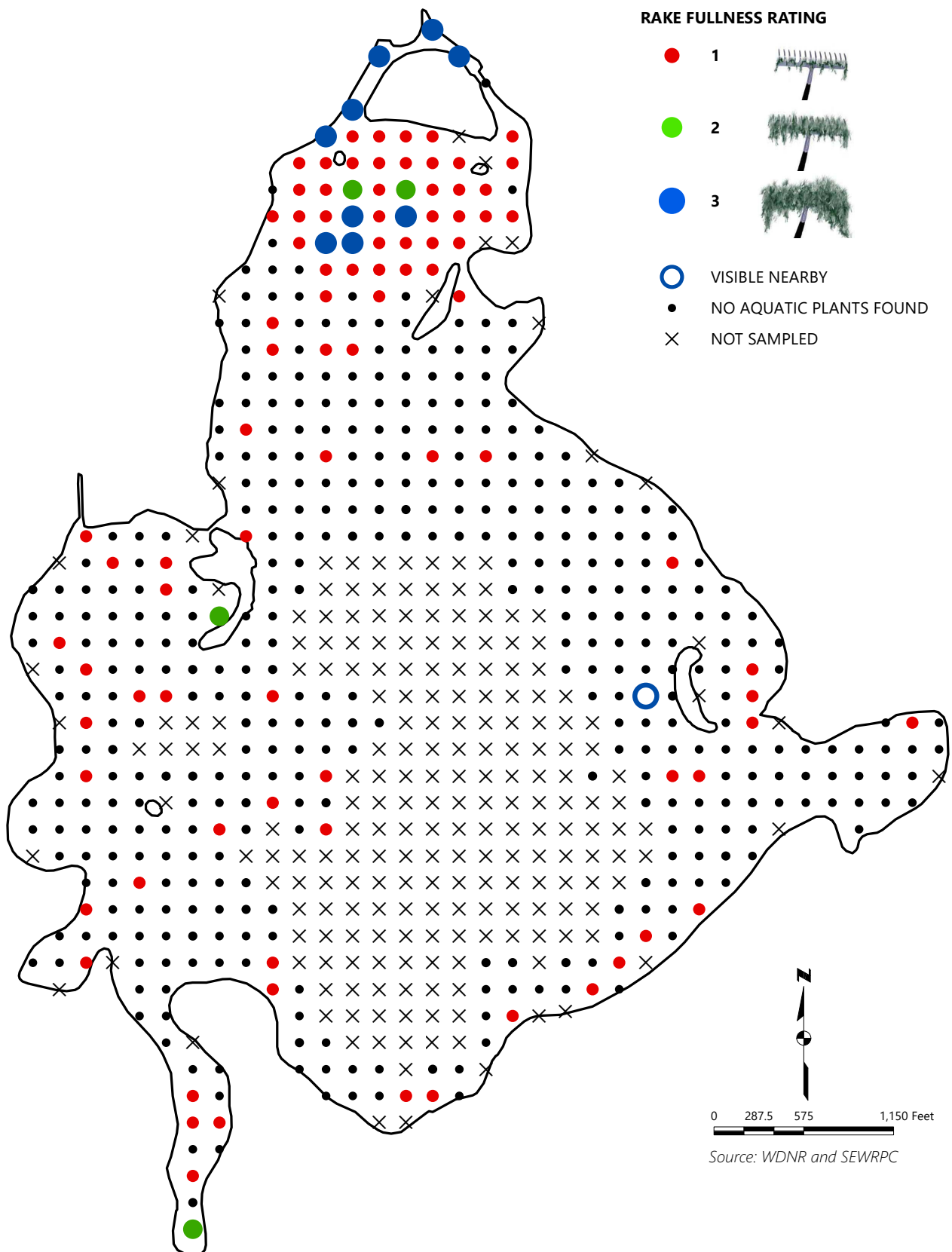
³⁶ dnr.wisconsin.gov/topic/Invasives/fact/StarryStonewort.

Figure 2.11
Change in Starry Stonewort Rake Fullness in Little Muskego Lake: 2018-2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure 2.12
Starry Stonewort Total Rake Fullness in Little Muskego Lake: September 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Table 2.5
Little Muskego Lake Aquatic Plant Littoral Frequency of Occurrence: 2013-2023

Aquatic Plant Species	2013	2014	2015	2018	2019	2020	2021	2022	2023	Avg.	Min.	Max.
Aquatic moss	--	--	--	--	0.21	--	--	--	--	0.21	0.21	0.21
<i>Ceratophyllum demersum</i> , Coontail	68.39	51.69	49.40	14.88	25.31	26.73	48.66	31.26	22.50	37.65	14.88	68.39
<i>Chara contraria</i> , Common stonewort	--	--	--	17.94	36.63	29.48	--	--	--	28.02	17.94	36.63
<i>Chara globularis</i> , Globular stonewort	--	--	--	11.38	7.41	15.88	--	--	--	11.56	7.41	15.88
<i>Chara braunii</i> , Braun's stonewort	--	--	--	1.53	7.20	--	0.21	--	--	2.98	0.21	7.20
<i>Chara</i> sp., Muskgrasses	19.48	32.21	37.20	--	--	34.49	--	38.12	43.05	34.09	19.48	43.05
<i>Elodea canadensis</i> , Common waterweed	29.82	17.89	32.20	2.19	32.92	31.02	50.10	34.90	40.90	30.21	2.19	50.1
Filamentous algae	--	2.78	--	8.10	9.67	15.71	4.33	10.28	9.20	8.58	2.78	15.71
Freshwater sponge	--	0.20	--	--	--	--	--	0.64	0.98	0.61	0.20	0.98
<i>Heteranthera dubia</i> , Water star-grass	9.74	10.54	12.80	2.41	2.06	2.65	8.45	1.93	14.09	7.19	1.93	14.09
<i>Myriophyllum sibiricum</i> , Northern watermilfoil	--	0.60	--	--	--	--	--	--	1.57	1.09	0.60	1.57
<i>Myriophyllum spicatum</i> , Eurasian watermilfoil	39.96	26.84	25.60	3.94	9.88	26.94	39.38	0.43	28.18	22.35	0.43	39.96
<i>Najas flexilis</i> , Slender naiad	--	1.19	6.00	9.63	12.35	1.84	0.82	6.21	2.94	5.12	0.82	12.35
<i>Najas guadalupensis</i> , Southern naiad	38.37	41.15	6.60	--	1.03	0.41	0.62	0.64	0.98	11.26	0.41	41.15
<i>Najas marina</i> , Spiny naiad	--	0.20	--	--	--	--	--	0.21	--	0.21	0.20	0.21
<i>Nitellopsis obtusa</i> , Starry stonewort	--	0.99	7.00	26.70	57.20	48.78	40.21	58.46	19.57	32.36	0.99	58.46
<i>Nymphaea odorata</i> , White water lily	0.60	0.20	0.60	0.22	0.41	--	0.21	--	0.39	0.38	0.20	0.60
<i>Persicaria amphibia</i> , Water smartweed	0.20	--	--	--	--	--	--	--	--	0.2	0.20	0.20
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	0.20	--	--	--	--	--	--	--	--	0.2	0.20	0.20
<i>Potamogeton crispus</i> , Curly-leaf pondweed	2.98	0.80	0.60	0.22	--	--	--	2.57	--	1.26	0.22	2.98
<i>Potamogeton foliosus</i> , Leafy pondweed	0.80	1.19	0.20	0.44	2.67	0.41	--	--	0.20	0.84	0.2	2.67
<i>Potamogeton friesii</i> , Fries' pondweed	--	0.40	0.60	5.25	3.09	0.61	--	11.13	--	3.51	0.4	11.13
<i>Potamogeton gramineus</i> , Variable pondweed	8.15	0.40	3.60	--	0.41	0.82	--	--	0.20	2.26	0.2	8.15
<i>Potamogeton illinoensis</i> , Illinois pondweed	23.26	21.07	3.80	2.63	4.32	2.86	2.06	7.07	3.13	7.8	2.06	23.26
<i>Potamogeton nodosus</i> , Long-leaf pondweed	0.60	--	--	--	--	--	--	--	--	0.6	0.60	0.60
<i>Potamogeton praelongus</i> , White-stem pondweed	--	--	6.40	--	--	--	0.41	0.86	4.11	2.95	0.41	6.40
<i>Potamogeton pusillus</i> , Small pondweed	0.40	--	--	--	1.85	--	0.41	--	6.07	2.18	0.40	6.07
<i>Potamogeton richardsonii</i> , Clasp-leaf Pondweed	18.29	14.71	1.40	1.75	3.91	0.20	--	0.21	--	5.78	0.20	18.29
<i>Potamogeton strictifolius</i> , Stiff pondweed	0.40	--	--	--	0.41	--	--	--	--	0.41	0.40	0.41
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	3.78	3.78	--	1.31	0.62	2.04	--	--	--	2.31	0.62	3.78
<i>Ranunculus aquatilis</i> , White water crowfoot	--	0.20	--	--	--	--	--	--	--	0.20	0.20	0.20
<i>Spirodela polyrrhiza</i> , Large duckweed	--	--	--	--	0.21	--	--	--	--	0.21	0.21	0.21
<i>Stuckenia pectinata</i> , Sago pondweed	29.42	9.34	23.20	11.38	15.84	1.84	4.33	14.99	5.48	12.87	5.48	29.48
<i>Utricularia gibba</i> , Creeping bladderwort	--	--	--	--	--	--	--	0.43	--	0.43	0.43	0.43
<i>Utricularia vulgaris</i> , Common bladderwort	1.59	--	--	--	--	--	--	--	--	1.59	1.59	1.59
<i>Vallisneria spiralis</i> , Wild celery	66.4	61.43	67.80	42.67	51.03	48.78	51.34	59.96	61.25	55.53	42.67	67.8
<i>Zannichellia palustris</i> , Horned pondweed	--	--	--	--	1.23	--	--	--	--	1.23	1.23	1.23

Note: This table presents the frequency of occurrence within areas of the Lake that were shallow enough to support aquatic plant growth. *Potamogeton natans* has only ever been observed as a visual observation and thus does not have a calculated frequency of occurrence. The Avg., Min., and Max. columns present the average, minimum, and littoral frequency of occurrence across the year range for each species.

Source: WDNR and SEWRPC

- EWM occurrence increased slightly between 2018 and 2023. EWM was found at 32.36 percent of vegetated points, an increase from 5.57 percent in the 2018 survey (see Figure 2.7 and Table 2.6).
- CLP occurrence decreased between 2018 and 2023. CLP was observed at one point in the 2018 survey and not found in the 2023 survey (see Figure 2.10).
- Spiny naiad was not observed in the 2018 or 2023 surveys.
- SSW occurrence decreased between 2018 and 2023. SSW was observed at 22.47 percent of vegetated points in 2023, a decrease from 37.77 percent of vegetated points seen in 2018 (see Figure 2.11 and Table 2.6).
- Several native aquatic plant species were found to have small populations within Little Muskego Lake in the 2023 survey, including white water lily (*Nymphaea odorata*), leafy pondweed (*Potamogeton foliosus*), and variable pondweed (*Potamogeton gramineus*). All of which were found at less than five points across the Lake.

As was described earlier, sensitive aquatic plant species are the most vulnerable to human disturbance. Therefore, changes in sensitive species abundance can indicate the general magnitude of human disturbance derived stress on a waterbody's ecosystem. The number of sensitive species at each sample point during 2018 and 2023 were contrasted (see Figure 2.13). Overall, the sensitive species richness decreased between 2018 and 2023. A few significant observations were noted:

- Four sensitive species were observed in the 2023 survey: slender naiad (*Najas flexilis*), southern naiad (*Najas guadalupensis*), small pondweed (*Potamogeton pusillus*), and variable pondweed (*Potamogeton gramineus*). Of these species, small pondweed was the most observed in the 2023 survey and was typically found in the southwestern portion of the Lake.
- The number of sensitive species increased from two species in 2016 (small nitella (*Nitella flexilis*) and slender naiad (*Najas flexilis*)) to four species in 2023.
- The only common sensitive species in the Lake in both the 2018 and 2023 surveys was slender naiad. The least-found sensitive species was variable pondweed (*Potamogeton gramineus*) which was found at only a single site in 2023.
- Sensitive species were distributed throughout the Lake; however, they were only found at 43 of the 445 surveyed points (9.7 percent) (see Figure 2.6).
- Gains and losses in the number of sensitive species at each survey point were distributed throughout the Lake, with more points gaining sensitive species numbers than losing them (see Figure 2.13).

2.3 PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic plants have been managed in some form on Little Muskego Lake since the late 1950s when sodium arsenite was used to control aquatic plants (see Table 2.7). This, alongside copper sulfate for algal control, was used up until the late 1960s. Additionally, Endothall and 2,4-D have been applied to the Lake to help control non-native invasive aquatic plant species. In the early 2000s, aquatic plant harvesting became a major element of the aquatic plant management strategy of the Lake, though harvesting had been in use for several years prior. The most current aquatic plant management strategy uses harvesting in combination with chemical treatments, particularly along developed shorelines during the summer. In the winter, the Lake performs annual drawdowns. Little Muskego Lake has utilized other aquatic plant management techniques for the treatment of starry stonewort, such as DASH harvesting in 2015 and a six-foot drawdown in 2017; both are detailed later in this chapter.

Table 2.6

Aquatic Plant Abundance in Little Muskego Lake: 2018 Versus 2023

Aquatic Plant Species	Native or Invasive	Number of Sites Found ^a (2018/2023)	Frequency of Occurrence Within Vegetated Areas ^b (2018/2023)	Average Rake Fullness ^c (2018/2023)	Relative Frequency of Occurrence ^d (2018/2023)	Visual Sightings ^e (2018/2023)
<i>Ceratophyllum demersum</i> (Coontail)	Native	68/115	21.05/25.84	1.19/1.37	9.5/8.8	2/0
<i>Chara braunii</i> , (Braun's stonewort)	Native	7/0	2.17/0	1.00/0	1.0/0	0/0
<i>Chara contraria</i> (Common stonewort)	Native	82/0	25.39/0	1.18/0	11.5/0	1/0
<i>Chara globularis</i> (Globular stonewort)	Native	52/0	16.10/0	1.23/0	7.3/0	0/0
<i>Chara</i> sp. (Muskgrasses) ^f	Native	0/220	0/49.44	0/1.36	0/16.9	0/3
<i>Elodea canadensis</i> (Common waterweed)	Native	10/209	3.10/46.97	1.30/1.23	1.4/16.1	0/0
<i>Heteranthera dubia</i> (Water stargrass)	Native	11/72	3.41/16.18	1.45/1.31	1.5/5.5	3/9
<i>Myriophyllum sibiricum</i> (Northern watermilfoil)	Native	0/8	0/1.80	0/1.00	0/0.6	0/0
<i>Myriophyllum spicatum</i> (Eurasian water milfoil)	Invasive	18/144	5.57/32.36	1.11/1.10	2.5/11.1	2/26
<i>Najas flexilis</i> (Slender naiad)	Native	34/15	10.53/3.37	1.24/1.00	4.8/1.2	0/0
<i>Najas guadalupensis</i> (Southern naiad)	Native	0/5	0/1.12	0/1.00	0/0.4	0/0
<i>Nitellopsis obtusa</i> (Starry stonewort)	Invasive	122/100	37.77/22.47	1.36/1.22	17.1/7.7	2/1
<i>Nymphaea odorata</i> (White water lily)	Native	1/2	0.31/0.45	2.00/1.00	0.1/0.2	1/1
<i>Potamogeton crispus</i> (Curly-leaf pondweed)	Invasive	1/0	0.31/0	1.00/0	0.1/0	0/0
<i>Potamogeton foliosus</i> (Leafy pondweed)	Native	2/1	0.62/0.22	1.00/1.00	0.3/0.1	0/0
<i>Potamogeton friesii</i> (Fries' pondweed) ^f	Native	24/0	7.43/0	1.04/0	3.4/0	0/0
<i>Potamogeton gramineus</i> (Variable pondweed)*	Native	0/1	0/0.22	0/1.00	0/0.1	0/0
<i>Potamogeton illinoensis</i> (Illinois pondweed)	Native	12/16	3.72/3.60	1.42/1.19	1.7/1.2	0/0
<i>Potamogeton praelongus</i> (White-stem pondweed) ^f	Native	0/21	0/4.72	0/1.48	0/1.6	0/1
<i>Potamogeton pusillus</i> (Small pondweed)	Native	0/31	0/6.97	0/1.13	0/2.4	0/0
<i>Potamogeton richardsonii</i> , (Clasping-leaf pondweed)	Native	8/0	2.48/0	1.38/0	1.1/0	0/0
<i>Potamogeton zosteriformis</i> (Flat-stem pondweed)	Native	6/0	1.86/0	1.17/0	0.8/0	0/0
<i>Schoenoplectus acutus</i> (Hardstem bulrush)	Native	0/0	0/0	0/0	0/0	1/1
<i>Stuckenia pectinata</i> (Sago pondweed) ^g	Native	52/28	16.10/6.29	1.40/1.32	7.3/2.2	1/4
<i>Wolffia borealis</i> (Northern watermeal)	Native	0/0	0/0	0/0	0/0	2/0
<i>Wolffia columbiana</i> (Common watermeal)	Native	0/0	0/0	0/0	0/0	2/0
<i>Vallisneria spiralis</i> (Wild celery) ^f	Native	195/313	60.37/70.34	1.42/1.44	27.3/24.1	5/2

Table continued on next page.

Table 2.6 (Continued)

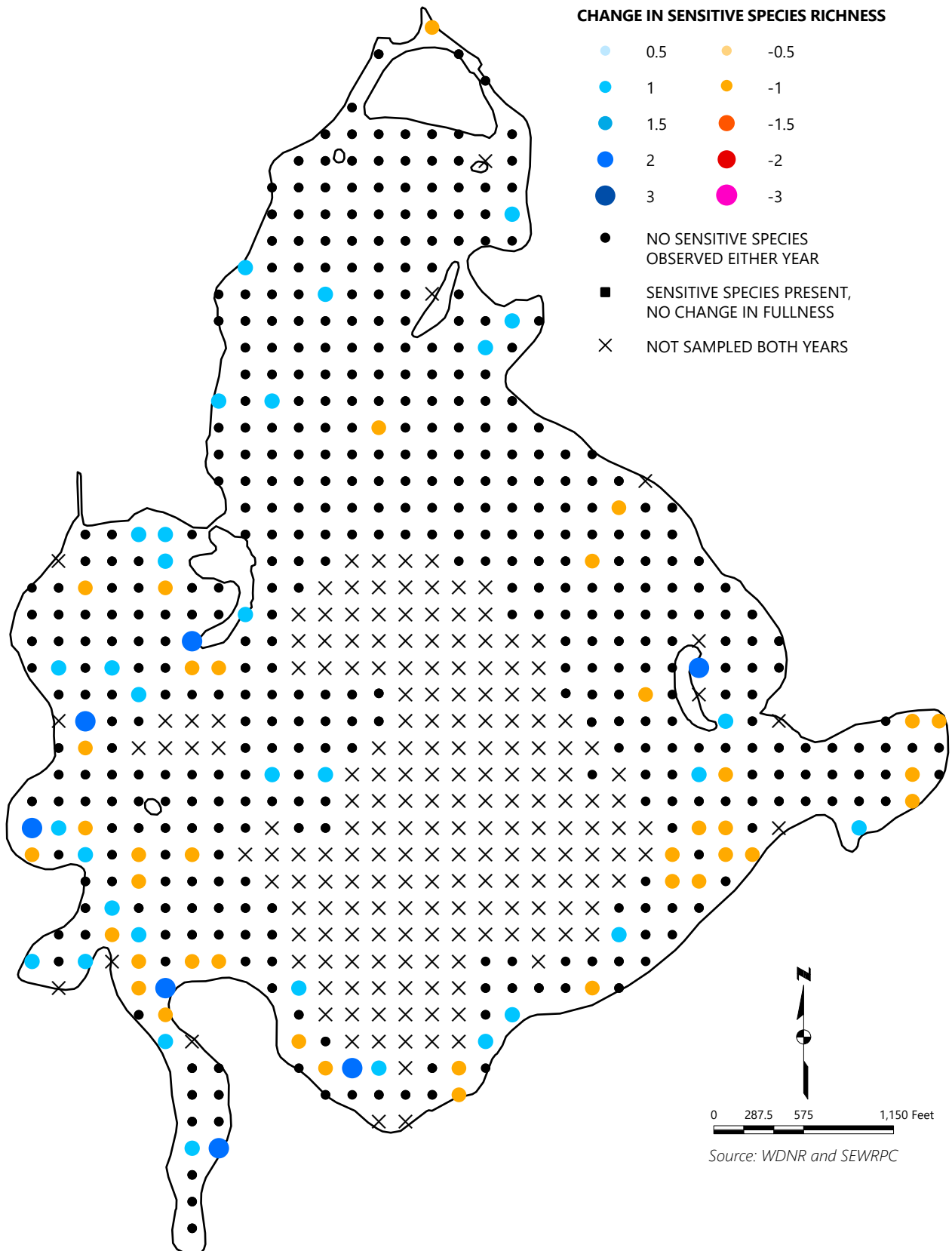
Note: Red text indicates non-native and/or invasive species. See Appendix A for distribution maps of common species. In 2018, muskgrass (*Chara* spp.) species were individually identified but in 2023 these species were only identified to genus.

- ^a *Number of Sites* refers to the number of sites at which the species was retrieved and identified on the rake during sampling.
- ^b *Frequency of Occurrence*, expressed as a percent, is the percentage of times a particular species occurred when there was aquatic vegetation present at the sampling site.
- ^c *Average rake fullness* is the average amount, on a scale of 0 to 3, of a particular species at each site where that species was retrieved by the rake.
- ^d *Relative Frequency of Occurrence*, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.
- ^e *Visual sightings* is the number of sites where that particular species was visually observed within six feet of the actual rake haul location but was not actually retrieved on the rake and was not, therefore, assigned a rake fullness measurement for that site. At sites where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake.

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

Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.13
Change in Sensitive Species Richness in Little Muskego Lake: 2018-2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Table 2.7
Chemical Controls on Little Muskego Lake: 1950-2025^a

Year ^b	Cutrine Plus (gallons)	Copper Sulfate		2,4-D		Endothal/Aquathol		Weedar 64 (gallons)	Diquat (gallons)	ProcellaCOR (gallons)
		Pounds	Gallons	Pounds	Gallons	Pounds	Gallons			
1950-1969	--	200	--	20.0	--	4.96	--	--	--	--
1970-1989	861.5	190	--	87.0	868.5	40.0	510.9	--	68.5	--
1990	68.0	--	--	--	--	--	25.0	--	6.0	--
1991	--	--	--	--	--	18.0	--	--	--	--
1992	35.0	--	--	--	--	--	36.25	--	35.0	--
1993	52.5	--	--	--	--	--	27.0	--	29.0	--
1994	13.5	--	--	--	--	--	21.5	--	19.0	--
1995	18.5	--	--	--	--	--	18.5	--	18.5	--
1997	--	--	--	--	--	--	27.5	--	27.5	--
1998	2.5	--	--	--	--	--	--	--	--	--
1999	2.5	--	2.5	3,530.0	--	--	--	--	--	--
2000	--	--	--	1,600.0	--	--	--	--	--	--
2001	--	--	--	3,600.0	--	--	--	--	--	--
2002	--	--	--	6,225.0	--	--	--	--	1.5	--
2003	--	--	12.5	5,750.0	--	--	--	--	--	--
2004	--	--	--	2,100.0	--	--	--	--	--	--
2005	--	--	--	7,600.0	--	--	--	--	--	--
2006	--	--	--	5,150.0	--	--	--	--	--	--
2007	--	--	--	2,300.0	--	--	--	--	--	--
2008	--	--	--	5,000.0	--	--	--	--	--	--
2009	--	--	--	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--	--	--	--
2011	--	--	--	--	221.5	--	--	--	--	--
2012	--	--	--	--	462.0	--	--	--	--	--
2013	--	--	--	--	537.0	--	--	--	--	--
2014	--	--	--	1,138.8	--	--	--	--	--	--
2015	--	--	--	702.2	--	--	188.8	--	--	--
2019	--	--	--	--	--	--	111.3	--	--	--
2020	--	--	--	--	--	--	372.6	--	--	414
2021	--	--	--	--	--	--	372.6	--	--	414.1
2022	--	--	--	--	--	--	--	--	--	53.9 ^c
2024	--	--	--	--	--	--	--	459	--	115.25
2025	--	--	--	--	--	--	108.5	256.75	--	--
Total	1,054.0	390	15.0	44,803.0	2,089.0	62.96	666.65	715.75	205.0	997.25

^a One time use applications were not included in the table for interpretability. The single-use treatments are as follows: In 1960, 0.5 pounds of silvex were applied; between 1950 and 1969, 49,096 pounds of Sodium Arsenite were applied; in 1980, 8.5 gallons of Hydrothol were applied; and in 2019, 488.1 gallons of DFMA 4 IVM were applied.

^b Chemical data was not available for years 2016, 2017, 2018, and 2023, and were thus not included in the table.

^c Measurement was converted from PDU to gallons through the conversion listed on the ProcellaCOR label, (Number of acres X average depth (feet) X PDU X 3.17) / 128 = gallons

Source: WDNR and SEWRPC

A benefit of harvesting versus chemical treatment is that harvesting physically removes plant mass and the nutrients contained therein. These nutrients, such as phosphorus, can contribute to Lake eutrophication; their removal can therefore decrease the amount of nutrient loading contributed yearly by surface runoff and tributary streams. The amount of harvested material from Little Muskego Lake is shown in Table 2.8. As of 2025, the District operates four large-scale harvesters, a barge for transporting raked plants from private piers and public beaches, and four conveyors for offloading harvested plants. Additionally, a truck is leased by the District during the harvesting season and is used for the transportation of plants to disposal sites. The amount of phosphorus removed via harvesting was unable to be confidently estimated by available records, though trends in Secchi depth readings taken at the Lake's deep hold site showed trends of increasing water clarity and this was consistent with an increase in the maximum depth of colonization of aquatic plants (see Table 2.2 and Figure 2.4). As eutrophic, nutrient-rich, water systems have poor water clarity, the increasing water clarity in Little Muskego Lake may be partially attributed to sustained harvesting efforts and removal of such nutrients.

2.4 WDNR-DESIGNATED SENSITIVE AREAS

Within or immediately adjacent to bodies of water, the WDNR, pursuant to authority granted under Chapter 30 of the *Wisconsin State Statutes* and Chapter NR 170 of the *Wisconsin Administrative Code*, can designate environmentally sensitive areas on lakes that have special biological, geological, ecological, or archaeological significance, "offering critical or unique fish and wildlife habitat, including seasonal or life-stage requirements, or offering water quality or erosion control benefits of the body of water". Wisconsin law mandates special protections for these "Areas of Special Natural Resource Interest" (ASNRI). These include "Sensitive Areas," or "Critical Habitat Designation" areas which are home to approximately eighty percent of the plants and animals on the state's endangered and threatened species list. A significant part of the critical habitat designation lies in the fact that it assists waterfront owners by identifying these areas so that they can design their waterfront projects to protect habitat and ensure the long-term health of the lake where they live. If a project is proposed in a designated Sensitive Area, the permit process allows WDNR to ensure that proposed projects will not harm these sensitive resources.

The WDNR has identified four Sensitive Areas in Little Muskego Lake (see Map 2.1).³⁷ The following provides a summary of the Sensitive Area descriptions and their ecological values from the 1992 WDNR Little Muskego Sensitive Area designation report (see Appendix B). Though these areas may shift in community composition, these designated Sensitive Areas provide unique and essential ecosystem services within Little Muskego Lake. A brief overview of these Areas and their benefits on the Lake is summarized below:

- Sensitive Area (SA) 1 surrounds the western peninsula with coverage of approximately 2,500 feet of shoreline that extends out to 10 feet of depth. This area consists of rock and muck substrate. The vegetation, both emergent (cattail and bulrushes) and submergent (flatstem pondweed and muskgrass) provide habitat for multiple species of waterfowl, songbirds, and amphibians. The area provides excellent fish spawning, habitat, and cover.
- Sensitive Area 2 is located on the western shore of the Lake, extending from the shoreline out to around 10 feet of water. The area was noted to have beneficial species of pondweed and muskgrass that provide food sources for waterfowl and cover for fish.
- Sensitive Area 3 is located along the eastern shore of the Lake, encompassing around 3,000 feet of shoreline and Holz Island, extending out to 10 feet of depth. The substrate is a mix of gravel, sand, and muck, which provides an excellent variety of habitat for both fish and plants. Native emergent, submergent, and floating aquatic plant species were dominant. Fisheries biologists noted the area was suitable for fish spawning, nursery, and feeding, as well as providing habitat and food sources for wildlife.

³⁷ The WDNR is granted authority to define sensitive areas under Section NR 107.05(3)(i) of the Wisconsin Administrative Code.

Table 2.8
Estimated Aquatic Plants Harvested in Little Muskego Lake: 2015-2025

Year	Estimated Cutter Loads	Estimated Truck Loads	Estimated Plant Material Removed (cubic yards)
2015	901	515	5,150
2016	973	556	5,560
2017	846	483	4,830
2018 ^a	266	149	1,490
2019	577	329	3,290
2020	959	548	5,480
2021	1,461	730	7,300
2022	1,076	604	6,040
2023	1,010	567	5,670
2024	1,000	562	5,620
2025	800	455	4,550
Total	9,869	5,498	54,980
Mean Per Year	897	500	4,998

Note: The Little Muskego Lake harvesting team recorded harvested plant material by 'cutter loads'. A single 'truck load' was estimated by the LMLD to transport 1.7 'cutter loads'. A single 'truck load' was estimated to equal 10 cubic yards of plant material.

^a The decrease in plant material removed in the 2018 harvesting season was due to the 6' extended lake drawdown that occurred the previous winter as a response to decrease starry stonewort populations.

Source: Little Muskego Lake District and SEWRPC

- Sensitive Area 4 is located on the eastern shoreline and includes a 1.24-acre island. The area's plant diversity was noted to provide valuable pondweed species (flatstem pondweed), as well as nursery and feeding areas for gamefish. The Area is one of the critical habitat areas in the Lake for wildlife, as the shoreline resources were utilized by kingfishers, tree swallows, mallards, and great blue herons.

Due to their Sensitive Area designation, aquatic plant management is restricted except under specified conditions. These conditions are further outlined in Appendix B.

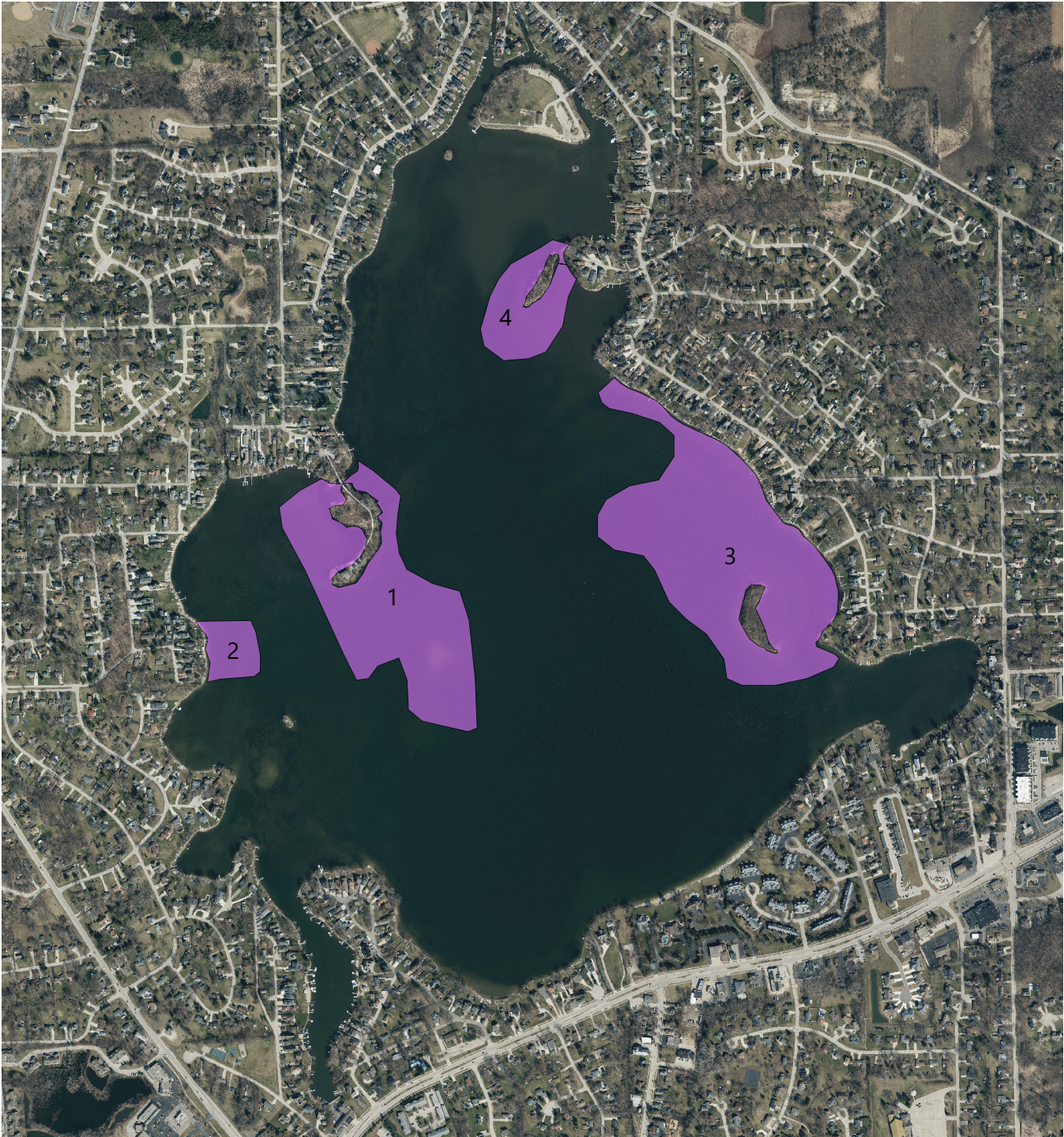
2.5 POTENTIAL AQUATIC PLANT CONTROL METHODOLOGIES

Aquatic plant management techniques can be classified into six categories.

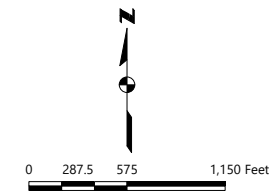
- *Physical measures* include lake bottom coverings.
- *Biological measures* include the use of organisms such as herbivorous insects.
- *Manual measures* involve physically removing plants by hand or using hand-held tools such as rakes.
- *Mechanical measures* rely on artificial power sources and can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

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

Map 2.1
Sensitive Areas Within Little Muskego Lake



 Sensitive Area and ID



Source: WDNR and SEWRPC

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.^{38,39} More details about each aquatic plant management category 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.⁴⁰ 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.⁴¹ These plans and plan execution are reviewed and overseen by the WDNR regional lakes and aquatic invasive species coordinators.⁴²

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 generally 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.⁴³ For example, milfoil weevils (*Eurhychiopsis lecontei*) have been used to control EWM. Milfoil weevils do best in waterbodies with balanced panfish populations,⁴⁴ where dense EWM beds reach the surface close to shore, where natural shoreline areas include leaf litter that provides habitat for over-wintering weevils, and where there is comparatively little boat traffic. This technique is not presently commercially available, making the use of milfoil weevils non-viable.

Manual Measures

Manually removing specific types of vegetation is a highly selective means of controlling nuisance aquatic plant growth, including invasive species such as EWM. Two commonly employed methods include hand raking and hand pulling. Both physically remove target plants from a lake. Since the vast majority of 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 incrementally maintain water depth, improves water quality, and can help decrease the spread of nuisance/exotic plants. Hand raking and hand pulling are readily allowed by WDNR and are practical methods to control riparian landowner scale problems.

³⁸ docs.legis.wisconsin.gov/statutes/statutes/30/ii/18.

³⁹ docs.legis.wisconsin.gov/statutes/statutes/31/02.

⁴⁰ 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.

⁴¹ Aquatic plant harvesters must report harvesting activities as one of the permit requirements.

⁴² Information on the current aquatic invasive species coordinator is found on the WDNR website.

⁴³ 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.

⁴⁴ Panfish such as bluegill and pumpkinseed are predators of herbivorous insects. High populations of panfish lead to excess predation of milfoil weevils.

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

- Tools are inexpensive (\$100 to \$150 each)
- The method is easy to learn and use
- It may be employed by riparian landowners without a permit if certain conditions are met
- Results are immediately apparent
- Plant material is immediately removed from a lake (including seeds)⁴⁵

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 mix. 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 mechanical harvesting methods are currently employed in Wisconsin: mechanical harvesting and suction harvesting. Both are regulated by WDNR and require a permit.⁴⁶ Sediment removal through dredging methods is only permitted for control of invasive species.

Mechanical Harvesting

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

In addition to controlling plant growth, gathering and removing plant material from a lake reduces in-lake nutrient recycling, sedimentation, and targets plant reproductive potential. In other words, harvesting removes plant biomass, which would otherwise decompose and release nutrients, sediment, and seeds or other reproductive structures (e.g., turions, bulbils, plant fragments) into a lake. Mechanical harvesting is particularly effective and popular for large-scale open-water projects. However, small harvesters are also produced that are particularly suited to working around obstacles such as piers and docks in shallow nearshore areas.

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

⁴⁵ Most of the material is removed during raking, however fragmentation/local spread from raking can occur in addition to fragmentation/local spread from wave action/other mechanical disruption.

⁴⁶ 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,⁴⁷ which limits the utility of this alternative in many littoral and shoal areas. Nevertheless, if employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can reduce regrowth of nuisance plants while maintaining, or even enhancing, native plant communities.

Cut plant fragments commonly escape the harvester's collection system and form mats or accumulate on shorelines. In addition, boating activity can fragment aquatic plants and also contribute to accumulations of cut plant fragments in the lake or along the shoreline. 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.

Dredging

Dredging encompasses a wide variety of methods that remove sediment from the lake bottom. These methods can include mechanical dredging, where sediment is excavated from the lake bottom; hydraulic dredging, which removes sediment via suction; and jetting devices that use pressurized water to dislodge sediment. All forms of dredging require a WDNR Waterways permit and dredging intended to remove aquatic plants also requires an aquatic plant management permit.⁴⁸

For aquatic plant management, dredging may be utilized to target invasive species populations and is generally not permitted for control of native plants.⁴⁹ Dredging removes the invasive plants, roots, and associated sediment that may contain reproductive fragments. However, dredging is not frequently used for aquatic plant management in southeastern Wisconsin due to its high costs, challenges in testing and disposing of dredged material, impacts to water quality (i.e., increased turbidity during operations) and lake biota, and that it leaves exposed sediment that can be readily colonized by invasive species. More common uses and benefits of dredging in lakes are enhancing navigation by increasing water depth and making long-term water quality improvements by removing nutrient-rich sediment from the lake.

Previous aquatic plant management plans for Little Muskego Lake have identified potential dredging areas in the Lake to increase boating and riparian access as well as potentially reduce nutrient release from sediments.⁵⁰ If homeowners want to improve navigation to their docks due to shallow sediment, they can apply for a dredging permit separately from the aquatic plant management permit. However, due to the high cost and potential for disturbance to the dredged area, dredging for aquatic plant management is not often advised as more targeted methods for invasive removal such as DASH have become popularized.

⁴⁷ 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.

⁴⁸ dnr.wisconsin.gov/topic/Waterways/dredging.

⁴⁹ See the WDNR Dredging – Invasive/Non-Native Plant Species Management General Permit Application Checklist at the following link: dnr.wisconsin.gov/sites/default/files/topic/Waterways/checklist/GP/GP-DredgingInvasiveSpeciesManagement.pdf.

⁵⁰ SEWRPC Community Assistance Planning Report No. 222, A Lake Management Plan for Little Muskego Lake, June 1996.

Suction Harvesting, DASH, and Diver-Assisted Hand Pulling

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

First permitted in 2014, DASH is a mechanical process where divers identify and pull select aquatic plants and roots from the lakebed and then insert the entire plant into a suction hose that transports the plant to the surface for collection and disposal. The process is a mechanically assisted method for hand-pulling aquatic plants. DASH was utilized on the Lake in Hillview Bay in 2015 as a management method for the removal of starry stonewort biomass and bulbils. Two DASH treatments were performed in the Hillview Bay area as a part of a “Rapid Response” Aquatic Invasive Species Grant received by the District that year. Due to the low effectiveness of the DASH treatment on the starry stonewort populations, the District has not performed DASH since.

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. If the District or individual property owners choose to employ DASH, a NR 109 permit is required. 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 harvesting which in turn reduces native plant loss; and 3) lower potential for disturbing fish habitat.

Chemical Measures

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

- **Unknown and/or conflicting evidence about the effects of long-term chemical exposure on fish, fish food sources, and humans.** The U.S. Environmental Protection Agency, the agency responsible for approving aquatic plant treatment chemicals, studies aquatic plant herbicides to evaluate short-term exposure (acute) effects on human and wildlife health. Some studies also examine long-term (chronic) effects of chemical exposure on animals (e.g., the effects of being exposed to these herbicides for many years). However, it is often impossible to conclusively state that no long-term effects exist due to the animal testing protocol, time constraints, and other factors. Furthermore, long-term studies cannot address all potentially affected species.⁵¹ For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.⁵² Some lake property owners judge the risk of using chemicals as being excessive despite legality of use. Consequently, the concerns of lakefront owners should be considered whenever chemical treatments are proposed. Moreover, if chemicals are used, they should be applied as early in the season as practical. This helps assure that the applied chemical decomposes before swimming, water skiing, and other active body-contact lake uses begin.⁵³ Early season application also is generally the best time to treat EWM and curly-leaf pondweed for a variety of technical reasons explained in more detail as part of the “loss of native aquatic plants and related reduction or loss of desirable aquatic organisms” bullet below.

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

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

⁵³ *Though the manufacturers indicate that swimming in 2,4-D-treated lakes is allowable after 24 hours, it is possible that some swimmers may want more of a wait time to lessen chemical exposure. Consequently, allowing extra wait time is recommended to help lake residents and users can feel comfortable that they are not being unduly exposed to aquatic plant control chemicals.*

- **Reduced water clarity and increased risk of algal blooms.** Water-borne nutrients promote growth of both aquatic plants and algae. If rooted aquatic plant populations are depressed, demand for dissolved nutrients will be lessened. In such cases, algae tend to become more abundant, a situation reducing water clarity. For this reason, lake managers must avoid needlessly eradicating native plants and excessive chemical use. Lake managers must strive to maintain balance between rooted aquatic plants and algae - when the population of one declines, the other may increase in abundance to nuisance levels. In addition to upsetting the nutrient balance between rooted aquatic plants and algae, dead chemically treated aquatic plants decompose and contribute nutrients to lake water, a condition that may exacerbate water clarity concerns and algal blooms.
- **Reduced dissolved oxygen/oxygen depletion.** When chemicals are used to control large mats of aquatic plants, the dead plant material settles to the bottom of a lake and decomposes. Plant decomposition uses oxygen dissolved in lake water, the same oxygen that supports fish and many other vital beneficial lake functions. In severe cases, decomposition processes can deplete oxygen concentrations to a point where desirable biological conditions are no longer supported.⁵⁴ Ice covered lakes, and the deep portions of stratified lakes, are particularly vulnerable to oxygen depletion. Excessive oxygen loss can inhibit a lake's ability to support certain fish and can trigger processes that release phosphorus from bottom sediment, further enriching lake nutrient levels. These concerns emphasize the need to limit chemical control and apply chemicals in *early* spring, when EWM and curly-leaf pondweed have not yet formed dense mats.
- **Increased organic sediment deposition.** Dead aquatic plants settle to a lake's bottom, and, because of limited oxygen and/or rapid accumulation, may not fully decompose. Accumulation of this material can create flocculent organic-rich sediment and ultimately reduce water depth. Care should be taken to avoid creating conditions leading to rapid thick accumulations of dead aquatic plants to promote more complete decomposition of dead plant material.
- **Loss of native aquatic plants and related reduction or loss of desirable aquatic organisms.** EWM and other invasive plants often grow in complexly intermingled beds. Additionally, EWM is physically similar to, and hybridizes with, native milfoil species. Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. A robust and diverse native plant community forms the foundation of a healthy lake, and the conditions needed to provide and host desirable gamefish. Fish, and the organisms fish eat, require aquatic plants for food, shelter, and oxygen. If native plants are lost due to insensitive herbicide application, fish and wildlife populations often suffer. For this reason, if chemical herbicides are applied to the Lake, these chemicals must target EWM or curly-leaf pondweed and therefore should be applied in early spring when native plants have not yet emerged. Early spring application has the additional advantage of being more effective due to colder water temperatures, a condition enhancing herbicidal effects and reducing the dosing needed for effective treatment. Early spring treatment also reduces human exposure concerns (e.g., swimming is not particularly popular in early spring).
- **Need for repeated treatments.** Chemical herbicides are not a one-time silver-bullet solution—instead, treatments need to be regularly repeated to maintain effectiveness. Treated plants are not actively removed from the Lake, a situation increasing the potential for viable seeds/fragments to remain after treatment, allowing target species resurgence in subsequent years. Additionally, leaving large expanses of lakebed devoid of plants (both native and invasive) creates a disturbed area without an established plant community. EWM thrives in disturbed areas. In summary, applying chemical herbicides to large areas can provide opportunities for exotic species reinfestation and new colonization which in turn necessitates repeated and potentially expanded herbicide applications.

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

- **Hybrid watermilfoil's resistance to chemical treatment.** The presence of hybrid watermilfoil complicates chemical treatment programs. Research suggests that certain hybrid strains may be more tolerant to commonly utilized aquatic herbicides such as 2,4-D and Endothall.^{55,56} Consequently, further research regarding hybrid watermilfoil treatment efficacy is required to apply appropriate herbicide doses. This increases the time needed to acquire permits and increases application program costs.
- **Effectiveness of small-scale chemical treatments.** Small-scale EWM treatments using 2,4-D have yielded highly variable results. A study completed in 2015 concluded that less than half of 98 treatment areas were effective or had more than a 50 percent EWM reduction.⁵⁷ For a treatment to be effective, a target herbicide concentration must be maintained for a prescribed exposure time. However, wind, wave, and other mixing actions can dissipate herbicide doses, which decrease their effectiveness in the target area and negatively impact non-target areas and species. Therefore, when deciding to implement small-scale chemical treatments, the variability in results and treatment cost of treatment should be examined and contrasted.

The District presently uses selective herbicide treatments for control of nonnative invasive plant populations, such as EWM, as a part of their aquatic plant management program. In compliance with WDNR permit requirements, the District must submit a map of the proposed treatment locations, treatment dimensions, and riparian landowners as a part of their permit application. Examples of past maps submitted for Little Muskego Lake are shown in Appendix C. The application amounts and chemical types may change throughout time based on biotic responses to treatment. It is recommended that the type of herbicide used is rotated year to year to prevent the development of resistance by EWM. Monitoring should continue to ensure that invasive populations do not become problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

Water Level Manipulation Measures

Manipulating water levels can also be an effective method for controlling aquatic plant growth and restoring native aquatic plant species, particularly emergent species such as bulrush and wild rice.⁵⁸ In Wisconsin, water level manipulation is considered to be most effective by using winter lake drawdowns, which expose lake sediment to freezing temperatures while avoiding conflict with summer recreational uses. One to two months of lake sediment exposure can damage or kill aquatic plant roots, seeds, and turions through freezing and/or desiccation. As large areas of lake sediment need to remain exposed for extended periods, water level manipulation is most cost effective in lakes with operable dam gates that can provide fine levels of control of water elevations within the lake. In lakes without dams, high capacity water pumping can be used to reduce lake levels at much greater cost.

While water level manipulation affects all aquatic plants within the drawdown zone, not all plants are equally susceptible to drawdown effects. Abundance of water lilies and milfoils (*Myriophyllum* spp.) can be greatly reduced by winter drawdowns while other species, such as duckweeds, may increase in abundance.⁵⁹ 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.^{60,61} Thus, drawdowns can be

⁵⁵ L.M. Glomski and M.D. Netherland, Response of Eurasian and Hybrid Watermilfoil to Low Use Rates and Extended Exposures of 2,4-D and Triclpyr, *Journal of Aquatic Plant Management* 48: 12-14, 2010.

⁵⁶ E.A. LaRue et al., Hybrid Watermilfoil Lineages are More Invasive and Less Sensitive to a Commonly Used Herbicide than Their Exotic Parent (Eurasian Watermilfoil), *Evolutionary Applications* 6: 462-471, 2013.

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

⁵⁸ 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.

⁵⁹ G.D. Cooke, Lake Level Drawdown as a Macrophyte Control Technique, *Water Resources Bulletin* 16(2): 317-322, 1980

⁶⁰ Onterra, LLC, Lac Sault Dore, Price County, Wisconsin: Comprehensive Management Plan, 2013.

⁶¹ Onterra, LLC, Musser Lake Drawdown Monitoring Report, Price County, Wisconsin, 2016.

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, bur-reeds, 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.⁶²

Little Muskego Lake has performed a yearly drawdown of approximately 20 inches since the early 2000s to prevent shoreline erosion caused by the contraction and expansion of ice near the shoreline.⁶³ In 2017, an experimental extended drawdown of approximately six feet was performed as an aquatic plant management method to freeze out starry stonewort bulbils as well as decrease other invasive populations like EWM. The extended drawdown resulted in decreased EWM and coontail populations (decreases from 31.2 percent to 5.4 percent and 36.6 percent to 15.4 percent, respectively) and revived native aquatic plant species, though it was determined to be ineffective at controlling starry stonewort populations, which increased approximately 50 percent the following year.⁶⁴ This drawdown may have been complicated by a series of significant rainfall events that kept the sediment moist and counteracted the intended desiccating effects of the drawdown on the SSW population. Extensive supervision and problem solving was needed by the City of Muskego Public Works to implement and maintain the drawdown. Multiple pumps were needed to help facilitate the drawdown of the Lake to the full 74 inches. In the winter, the Lake drawdown was generally maintained to 50 inches instead of 74 inches due to rain and groundwater discharge.

Water level manipulation can have the aforementioned unintended impacts and can also influence the water chemistry and lake fauna.^{65,66} Decreased water clarity and dissolved oxygen concentrations as well as increased nutrient concentrations and algal abundance have all been reported following lake drawdowns. Rapid drawdowns can leave lake macroinvertebrates and mussels stranded in exposed lake sediment, increasing their mortality, and subsequently reducing prey availability for fish and waterfowl. Similarly, drawdowns can disrupt the habitat and food sources of mammals, birds, and herptiles, particularly when nests are flooded as water levels are raised in the spring. Therefore, thoughtful consideration of drawdown timing, rates, and elevation, as well as the life history of aquatic plants and fauna within the lake is highly recommended. Mimicking the natural water level regime of the lake as closely as possible may be the best approach to achieve the desired drawdown effects and minimize unintended and detrimental consequences.

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

- Existing lake bottom contours should be reevaluated (see Map 1.3) with any changes mapped to develop updated bathymetric information.
- Lake volume needs to be accurately determined for each foot of depth contour.
- Lake bottom acreage exposed during various intervals of the drawdown must be determined.
- Knowledge of the drawdown and refill times for the Lake would guide proper timing of drawdown to maximize effectiveness and minimize impacts to Lake users.
- A safe drawdown discharge rate would need to be calculated to prevent downstream flooding and erosion.

⁶² *Blanke et al., 2019, op. cit.*

⁶³ legis.wisconsin.gov/eupdates/sen28/Little_Muskego_Lake.pdf.

⁶⁴ *Ibid.*

⁶⁵ *Blanke et al., 2019, op. cit.*

⁶⁶ *Cooke, op. cit.*

- Considering that it was not possible to maintain a 74 inch water level draw down in the winter of 2017, future draw downs should figure out effectiveness of 50 inch versus 74 inch difference in sediment exposure goals and effectiveness and costs for any future draw downs.
- 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.

MANAGEMENT RECOMMENDATIONS AND PLAN IMPLEMENTATION

3



Credit: Commission Staff

This Chapter summarizes the information and recommendations needed to manage aquatic plants in Little Muskego Lake, particularly the nonnative species of Eurasian watermilfoil (EWM), curly-leaf pondweed (CLP), and starry stonewort (SSW). Accordingly, it presents a range of alternatives that could potentially be used, and provides specific recommendations related to each alternative. The measures discussed focus on those that can be implemented by the Little Muskego Lake District (District) and the City of Muskego in collaboration with the Wisconsin Department of Natural Resources (WDNR) and Lake residents. The aquatic plant management recommendations contained in this chapter are limited to approaches that monitor and control nuisance level aquatic plant growth in the Lake after growth has already occurred.

The individual recommendations presented below, and which collectively constitute the recommended aquatic plant management plan, balance three major goals:

- Improving navigational access within the Lake
- Protecting the native aquatic plant community
- Controlling EWM, CLP, and SSW populations

Plan provisions also ensure that current recreational uses of the Lake (e.g., swimming, boating, fishing) are maintained or promoted. The plan recommendations described below consider common, State-approved, aquatic plant management alternatives including manual, biological, physical, chemical, and mechanical measures.

3.1 RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The most effective plans to manage nuisance and invasive aquatic plant growth rely on a combination of methods and techniques as well as consideration of when and where these techniques should be applied. The recommended aquatic plant management plan is presented in Figure 3.1⁶⁷ and briefly summarized in the following paragraphs.

1. **Aquatic plant harvesting for navigation and access lanes** should be considered a high priority in areas of the Lake that have dense aquatic plant growth that impedes boat access to the main body of the Lake. Access lanes between piers in the littoral zone are recommended to be cut 30 feet wide and no more than four feet deep. "Top-cut"/shallow harvesting should be used in water depths less than three feet and/or areas with dense aquatic plant growth. At least 12 inches of uncut plant material should remain on the Lake bottom while harvesting to help lessen bottom-sediment disturbance and maintain native plant communities.

150-foot navigational lanes are permitted within WDNR-designated sensitive areas 1 and 3 to provide recreational access. These navigational lanes should be cut to a depth of no more than three feet below the water's surface and not be harvested until June 30th in order to preserve spawning ground for fish. In sensitive area 1, a 100-foot swath between the shoreline and the navigation lane shall remain unharvested to maintain healthy habitat for fish. In sensitive area 3, a 30-foot wide navigation lane along piers, parallel to shore, is recommended. Between the 30-foot-wide access lane and the 150-foot-wide navigation lane within sensitive area 3, 30-foot-wide access channels should be harvested for every two piers to extend through the 100-foot swath between access and navigation lanes. These lanes will allow Lake residences boating access into and out of deeper waters of Little Muskego while preserving fish habitat. Current harvesting lanes and dimensions can be viewed in Figure 3.2 and Table 3.1.

2. **Manual removal of starry stonewort, Eurasian watermilfoil, and nuisance plant growth in nearshore areas.** In nearshore areas less than three feet deep where other management efforts are not feasible, manual removal (i.e., hand-pulling and/or raking) may be a viable and practical method to manage nuisance and invasive plants. Riparian landowners need not obtain a permit for manually removing aquatic plants if this activity is confined to a 30-foot width of shoreline (including recreational use areas such as piers) that does not extend more than 100 feet into the Lake, provided that all the resulting plant material is removed from the Lake.⁶⁸ A permit is required if the LMLD or other group engages with the work or if the work is done in or adjacent to a WDNR-designated sensitive area.⁶⁹ Prior to the manual removal season, educational campaigns should be promoted to better educate landowners about the benefits of aquatic plants in the Lake, the manual removal of aquatic plants, plant identification, proper disposal of plant material and the specifics about the actions they are allowed to legally take to "clean up" their shorelines.⁷⁰
3. **Early spring navigational shoreline chemical treatment for control of Eurasian watermilfoil and curly-leaf pondweed in areas where these plants begin displacing the native plant community.** Chemical treatments in conjunction with mechanical harvesting have been the primary methods of aquatic plant management employed by the Lake and have been an effective short-term management technique for navigation and access. If chemical treatments continue to be applied along developed shoreline and critical boating areas that cannot be mechanically harvested, treatment should only

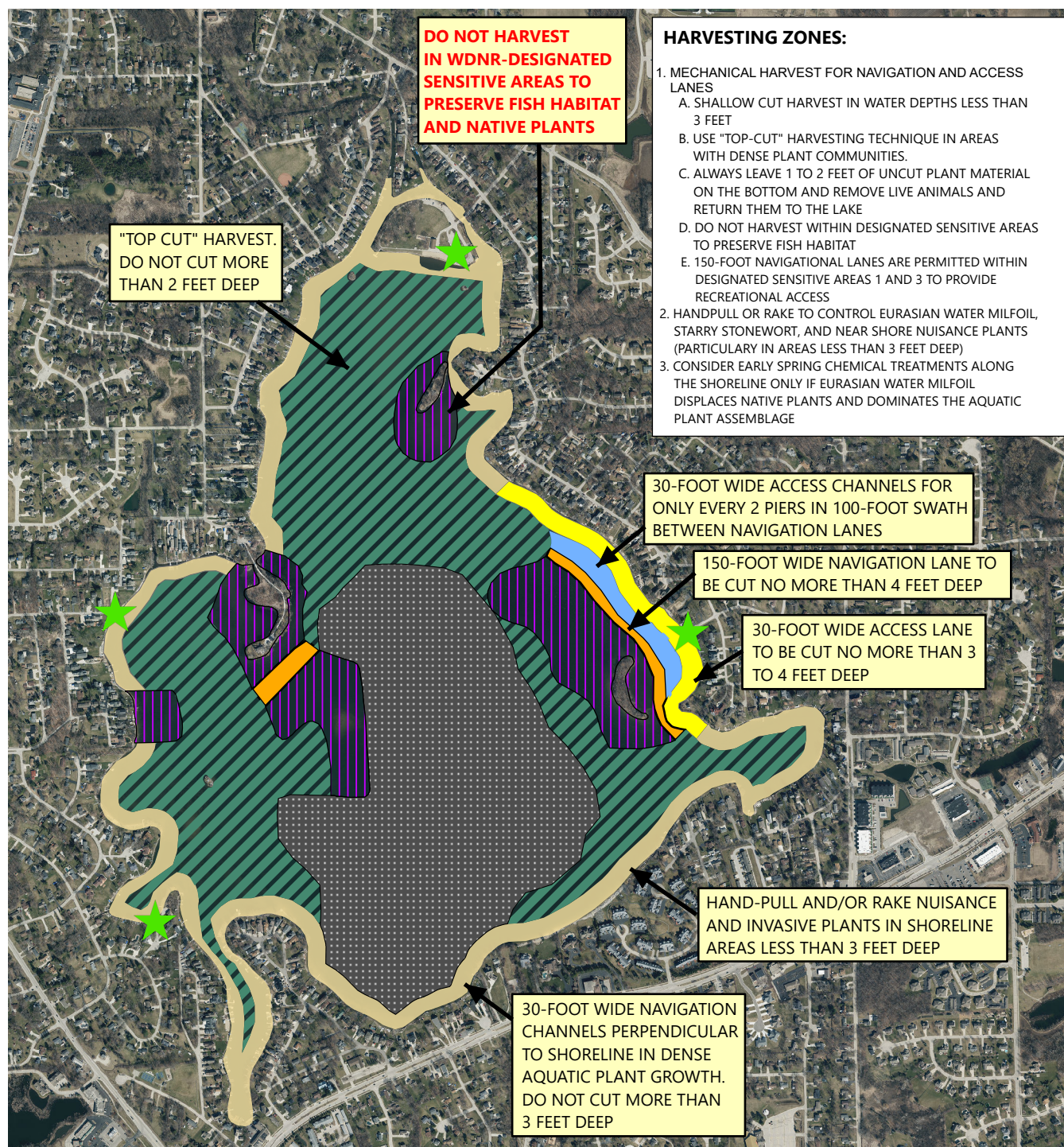
⁶⁷ Line width and locations are not scaled and only illustrate overall concept. The actual size, orientation, and depth of plant management activities depend upon sensitive area restrictions and permit conditions and site-specific factors. Site-specific factors include, but are not limited to, the composition of the plant community, water depth, shoreline configuration and obstacles.

⁶⁸ The manual removal area limitation for nearshore aquatic plants applies to shorelines where native plants are present. The removal area limitation does not apply to areas populated solely with non-native and/or invasive plants.

⁶⁹ Permits for this removal are necessary under Chapter NR 109, Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations of the Wisconsin Administrative Code, as the removal of aquatic plants is not being completed by an individual property owner along his or her property.

⁷⁰ Commission and WDNR staff could help review such documents developed for this purpose.

Figure 3.1
Aquatic Plant Management Plan for Little Muskego Lake: 2026-2030



Note: Line width and shaded area size and locations are not scaled and only illustrate overall concept.

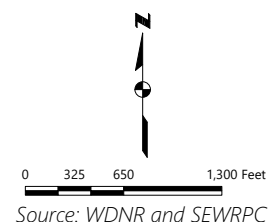
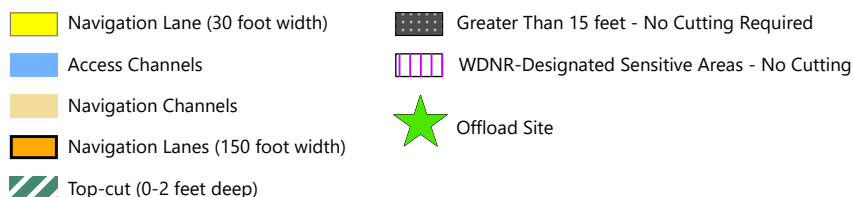
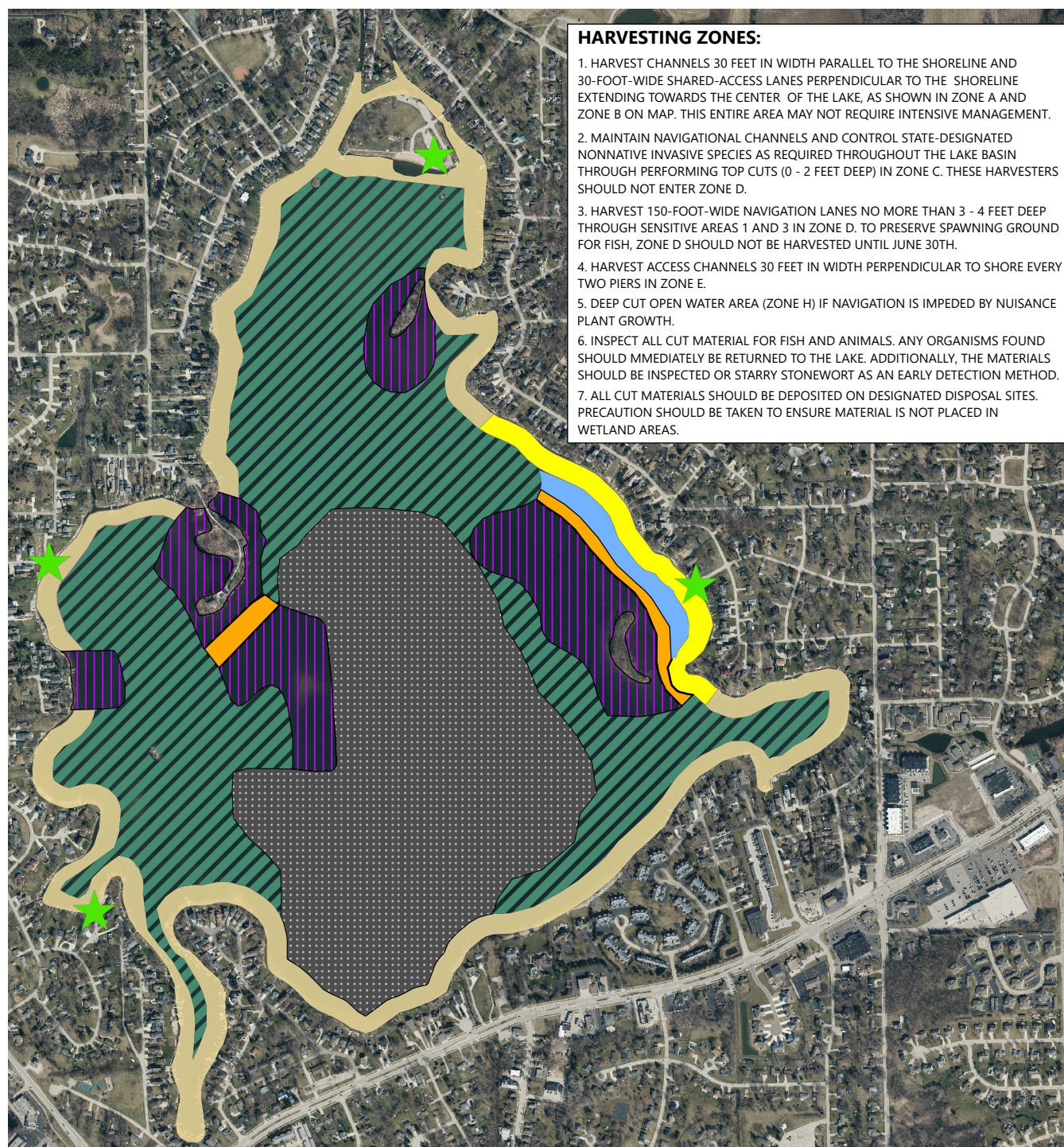


Figure 3.2
Recommended Harvesting Lanes for Little Muskego Lake: 2026-2030



Harvesting Zones

- | | |
|--|--|
| Zone A - Navigation Channels | WDNR-Designated Sensitive Areas - No Cutting |
| Zone B - Navigation Lane (30 foot width) | Offload Site |
| Zone C - Top-cut (0-2 feet deep) | |
| Zone D - Navigation Lanes (150 foot width) | |
| Zone E - Access Channels | |
| Zone F - No Cutting Required | |

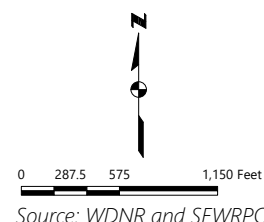


Table 3.1
Aquatic Plant Harvesting Lane Dimensions for Little Muskego Lake

Area	Acres	Length (feet)	Width (feet)	Average Depth of Cut (feet)
A	25.48	37,000	30	3
B	3.27	4,752	30	4
C	223.60	15,837	615	2
D	1.94	260	325	2
E	0.74	340	95	2

Source: LMLD and SEWRPC

occur in the early spring when the water temperatures range between 50 – 60 degrees Fahrenheit and human contact and risks to native plants are most limited. Additionally, to prevent the loss of native aquatic species, only herbicides that selectively control Eurasian watermilfoil, hybrid watermilfoil, and curly-leaf pondweed (e.g., 2,4-D and Endothall) should be used. A WDNR permit and staff supervision are required to implement this alternative. Lakeshore property owners need to be informed of the chemical treatment and permit conditions before chemicals are applied. Additionally, chemical applications should be timed and placed to minimize impact to fish spawning. If chemical treatment does occur, chemical residue monitoring in the Lake is also recommended.⁷¹

4. **Whole-lake chemical treatment of the Lake to help control curly-leaf pondweed and Eurasian watermilfoil, to reduce the frequency of chemical applications, and to allow native aquatic plant populations to grow.** A whole-lake chemical approach has been suggested for managing Eurasian watermilfoil and curly-leaf pondweed in Little Muskego Lake. The WDNR considers such treatments on a lake-by-lake basis. The District needs to assemble a comprehensive set of information for WDNR to consider whole-lake treatment, as this method of aquatic plant control has a number of drawbacks (e.g., water quality, comparatively nonselective, chemical side effects, and more) and is considered under special circumstances.
5. **Continue monitoring for invasive species populations.** The Lake should be monitored regularly for known invasive species and decrease the chances of the introduction of new invasive species. The following recommendations are given a high priority.
 - a. Educate residents how they can help prevent invasive species from entering the Lake by distributing education handouts about topics such as watercraft inspection and invasive species identification.
 - b. Targeted focused aquatic plant control at boat launch sites, as boat launches are likely entry points for invasive species.
 - c. Citizen monitoring for new invasive species through programs such as The Wisconsin Citizen Lake Monitoring Network (CLMN).⁷² Frequent, quick searches (e.g., meander surveys) near access points can help detect a novel invasive species population and enable control actions before it can spread across the waterbody.
6. **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 Little Muskego Lake.⁷³ The City of Muskego has both installed a permanent wash station at the Idle Isle launch and sponsors CBCW AIS education and boat education programs that provide CBCW services.⁷⁴ These and other measures will help lower the probability of invasive species entering and leaving the Lake.

⁷¹ Wisconsin Department of Natural Resources PUBL-WR-237 90, Chemical Fact Sheet: Endothall, May 1990.

⁷² For more information on monitoring invasive species through the CLMN program, see the following webpage: www3.uwsp.edu/cnr-ap/UWEXLakes/Pages/programs/clmn/AIS.aspx.

⁷³ Further information about Clean Boats Clean Waters can be found on the WDNR website at: dnr.wi.gov/lakes/cbcw.

⁷⁴ Information obtained from email correspondence between Commission staff and Fay Amerson on May 22, 2025.

7. **Ensure accessible, accurate record-keeping of District activities through training, utilizing existing informational resources, and centralizing information.** Maintaining accessible report records within the District allows direct and standardized comparison of operations (i.e., harvesting, chemical treatments, and other lake management efforts) across time and may be used in guiding future management decisions. It is important that these records are housed somewhere accessible to future board members(e.g., a shared cloud storage system), as board turnover can cause loss of information if kept by individuals only. Information can be shared at the District’s annual meeting, hosted on the District website, or entered into the ePermitting System through the WDNR.⁷⁵
8. **Stay abreast of best management practices to address invasive species.** The District should continue to regularly communicate with the Waukesha County AIS Coordinator and WDNR staff about the most effective treatment options for EWM and SSW as novel techniques and/or chemical products that may more effectively target these species become available.
9. **Consider establishing slow-no-wake areas within one or more of the sensitive areas** to help protect and preserve the aquatic plant communities and associated fisheries and wildlife habitat within them for the long-term protection of Little Muskego Lake.

Management Methods

The following subsection provides recommendations on which aquatic plant management methods are currently suitable for Little Muskego Lake.

Harvesting Conditions

Figure 3.1 illustrates the overall aquatic plant recommendations for Little Muskego Lake. Harvesting routes are further outlined in Figure 3.2, shown in Table 3.1. To assure sustainable recreational use and the long-term health of the Lake, the following conditions must be added to all aquatic plant harvesting practices.

1. **Maintain and operate harvesting equipment in conformance with manufacturer’s recommendations.** For example, never operate the harvester in water shallower than the maximum draft range of the harvester (e.g., 20 inches for the ILH7-450 Aquatic Weed Harvester) and never operate with the cutter head or paddle wheels at or near the lake bottom.
2. **Inspect all cut plants for live animals. Immediately return live animals to the water.** Animals such as fish, turtles, and amphibians commonly become entangled with harvested plant matter, particularly when cutting large plant mats. When feasible, a second staff person equipped with a net could accompany and assist the harvester operator remove and return animals incidentally caught during harvesting.
3. **Harvesting should not occur in the early spring to avoid disturbing fish spawning.** Studies suggest that harvesting activities can significantly disturb the many fish species that spawn in early spring. Thus, avoiding harvesting during this time can benefit the Lake’s fishery.
4. **All harvester operators should adhere to the harvesting specifications and practices as described in the harvesting permit.** Harvester operators should review the aquatic plant management plan and associated permits, with special emphasis focused on the need to restrict cutting in shallow areas, possess plant identification skills to encourage preservation of native plant communities, and knowledge of the proposed cutting area acreage and actual volume harvested as required. Ensuring all employees are knowledgeable and consistent in efforts ensures long-term program success.
5. **Management, record keeping, monitoring, and evaluation.** District staff manage harvesting operations and are responsible for the overall plan execution and logistics. All daily harvesting activities will be documented in writing by the harvester operator in a permanent harvesting operations log. Harvesting patterns, harvested plant volumes, weed pickup, plant types, harvesting location, and other information will be recorded.⁷⁶ Daily maintenance and service logs recording engine hours, fuel consumed, lubricants added, oil used, and general comments will be recorded. Furthermore, this

⁷⁵ dnr.wisconsin.gov/permits/water.

⁷⁶ Volume is most often reported in cubic yards of harvested material.

log should include a section to note equipment performance problems, malfunctions, or anticipated service. All data will streamline functionality in harvesting operations. Monitoring information will be summarized in an annual summary report prepared by the District, submitted to WDNR, and available to the public.

6. **Standardization of harvesting operations.** When defining the amount of harvested plant material from the Lake, estimations are typically made regarding the mass of plants harvested. As previously mentioned, accurate record keeping is essential for organization, but standardization of these estimations allows for continued accuracy. Standardization methods should define:
 - *What is a “load” of plants?* These loads can vary based on if the load is for a harvester or a truck.
 - *How are partial loads accounted for?* Partial loads can be rounded to the nearest quarter or half.
 - *What is the volume capacity of your equipment?* Knowing the capacity can help with estimations of harvested aquatic plant material carried.
 - *How is the weight of aquatic plants accounted for?* Different aquatic plant communities can have differing weights at the same volume due to their intrinsic density, or how tightly packed together they are when harvested. Periodically weighing a sample of harvested plants to ensure accuracy may be useful when making estimations.
7. **Implement plant pickup program.** Harvesting as well as recreational boating can fragment plants, especially on the weekends. Plant fragments may float in the Lake, accumulate on shorelines, and help spread undesirable plants. The harvesting program should include a comprehensive plant pickup program that all residents can use. This helps ensure that harvesting does not create a nuisance for Lake residents. The program typically includes residents raking plants, placing them in a convenient location accessible to the harvester (e.g., the end of a pier), and regularly scheduled pickup of cut plants by the harvester operators. This effort should be as collaborative as is practical.
8. **Properly dispose of plant debris.** All plant debris collected from harvesting activities must be collected and disposed of at designated disposal sites. Current harvesting offload sites are shown in Appendix D. Maintaining long-term disposal sites is crucial for aquatic plant harvesting operations. A contracted disposal site as well as potential disposal sites are additionally shown in Appendix D. Previous disposal site contracts that have been terminated may need to be re-negotiated with property owners. No aquatic plant material may be deposited within identified floodplain and wetland areas.

Future Funding

Current efforts pursued by the District have been effective at maintaining a healthy and diverse aquatic plant community while suppressing aquatic invasive species populations. The District should continue to utilize WDNR Surface Water Grants to further their efforts in monitoring the Lake, inspecting watercraft at boat launches, and targeting areas for management. Key grant programs to fund these efforts are as follows:

- **Clean Boats, Clean Waters** – this grant program covers up to 75 percent of up to \$24,000 to conduct watercraft inspections, collect data, educate boaters about invasive species, and reporting invasive species to the WDNR.
- **Aquatic Invasive Species Prevention** – this grant program covers up to 75 percent of either \$4,000 or \$24,000 for projects that help prevent the spread of AIS species. Eligible costs include the acquisition of decontamination equipment at public boat launches as well as targeted management at boat launches or other access points. All lakes are eligible for at least \$4,000 in funding but lakes that are designated as high priorities for AIS spread statewide, due to large amounts of boat traffic and/or the presence of particular invasive species, are eligible for \$24,000. Due to the presence of the invasive starry stonewort (*Nitellopsis obtusa*) in the lake, Little Muskego Lake is eligible for up to \$24,000 via this grant program. The District must continue to participate in the Clean Boats, Clean Waters program to maintain eligibility for this grant program.

- **Aquatic Invasive Species Control** – this grant program covers up to 75 percent of up to \$50,000 for small-scale projects and \$150,000 for large-scale projects that suppress or reduce an AIS population within a lake. Given the current limited spread of EWM and CLP within the lakes, the small-scale project is more appropriate at this time. The large-scale projects should be considered if the populations of these species increase or a novel invasive species, such as starry stonewort, is observed within the lake. Aquatic Invasive Species Control grants fund projects that utilize integrated pest management and are designed to cause multi-season suppression of the target species. An approved aquatic plant management plan is a requirement to participate in this program and only approved recommendations from the plan are eligible projects for funding through this program.
- **Recreational Boating Facilities Grant Program**⁷⁷ – this grant program covers up to 50 percent of \$250,00 for a recreational boating facility project. These projects can include aquatic plant harvesting equipment, rehabilitation of facilities, trash skimming equipment, improvement or repair of locks, construction projects such as ramps or dredging for safe water depths. The City has received grants from this program in the past to assist with the funding of projects.

The District should consider applying for these grant programs whenever feasible to support the monitoring, communication, watercraft inspection, and targeted management recommended in this aquatic plant management plan.

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 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 as well as options for future funding. Figure 3.1 summarizes and indicates where aquatic plant management recommendations should be implemented.

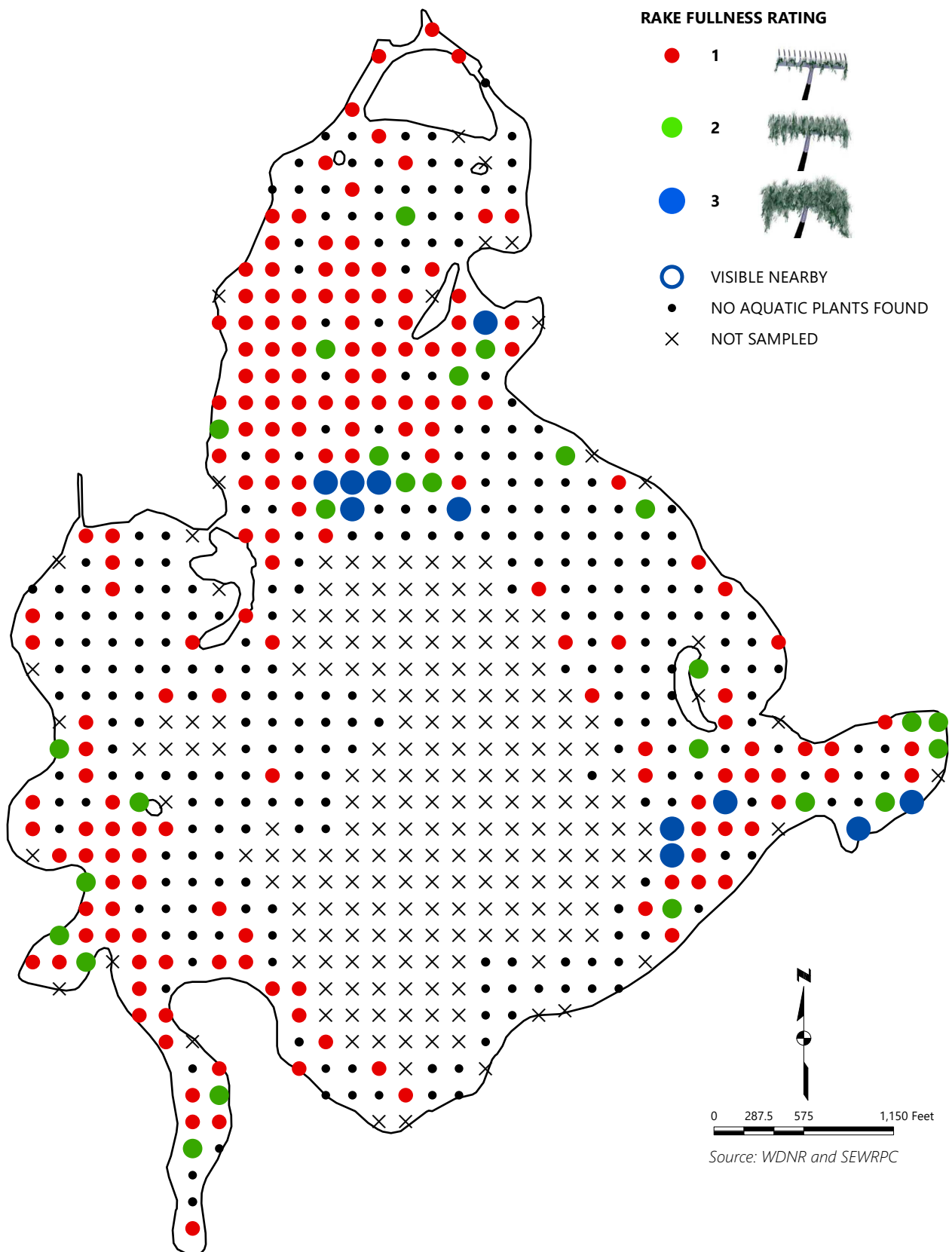
Successfully implementing this plan will require cooperative engagement from the District, State and regional agencies, Waukesha County, municipalities, and residents/users of the Lake. The recommended measures help foster conditions that sustain and enhance the natural beauty and ambience of Little Muskego Lake while promoting a wide array of water-based recreational activities suitable for the Lake's intrinsic characteristics.

⁷⁷ dnr.wisconsin.gov/aid/RBF.html.

APPENDICES

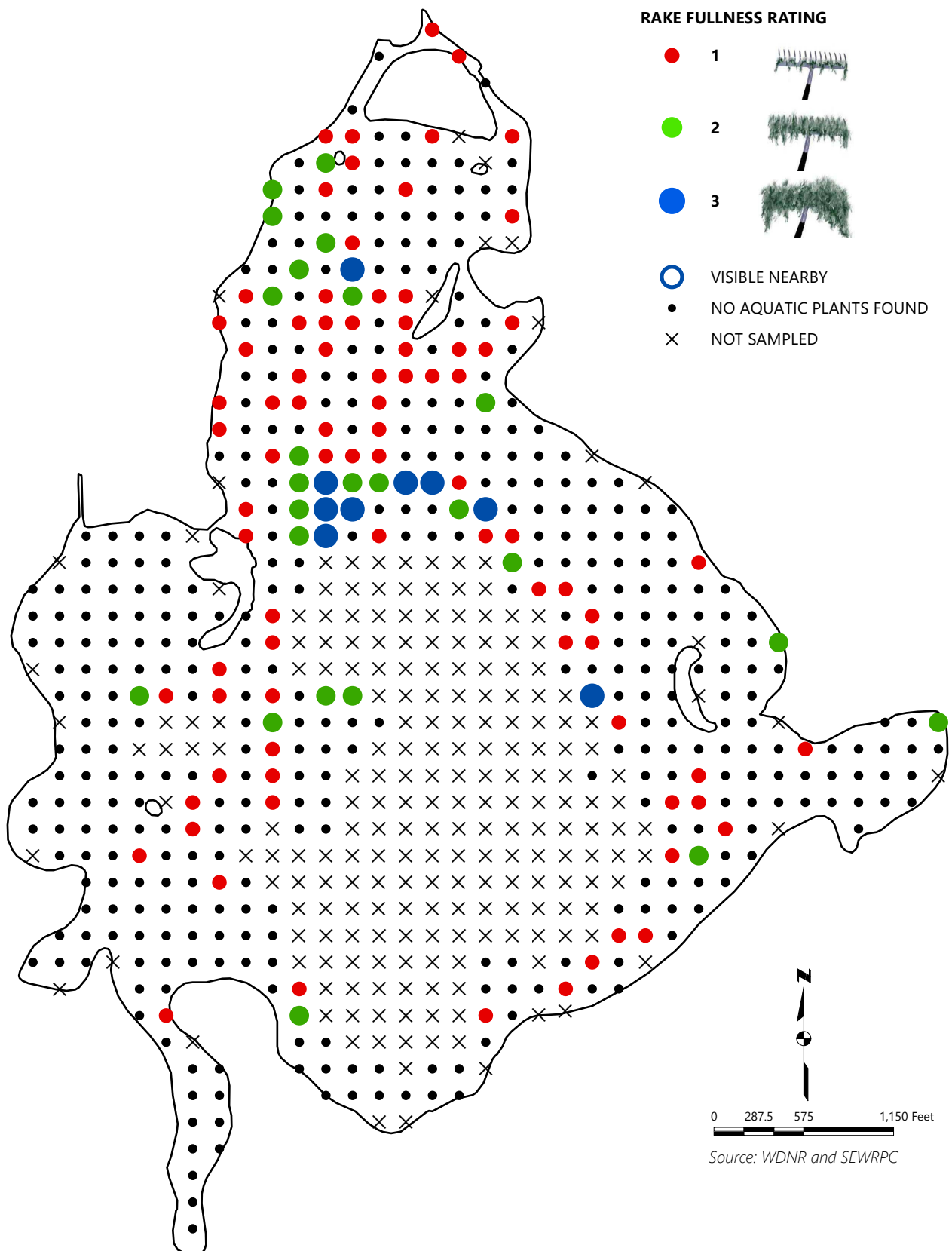
AQUATIC PLANT SPECIES DISTRIBUTION MAPS APPENDIX A

Figure A.1
Common Waterweed Total Rake Fullness in Little Muskego Lake: September 2023



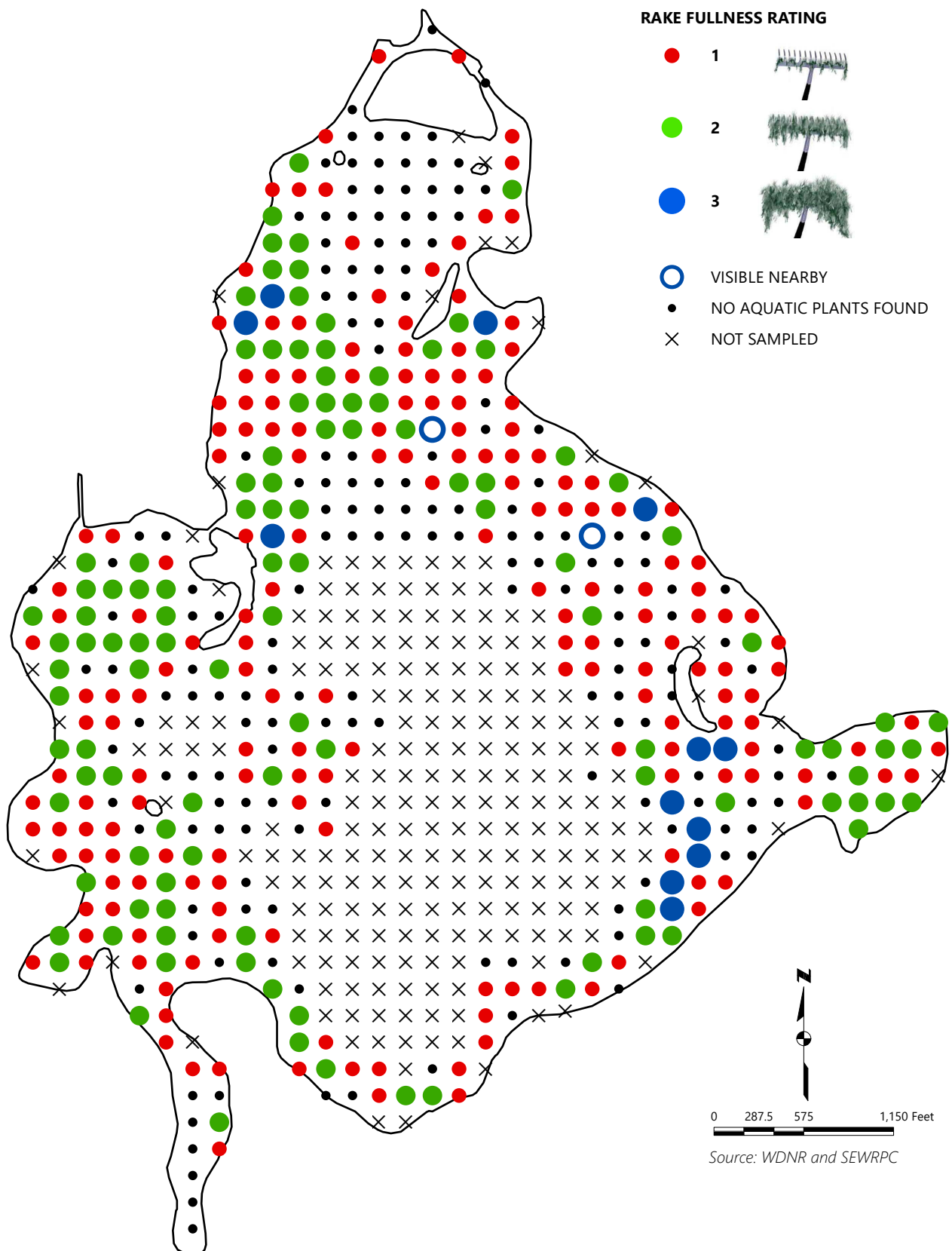
Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure A.2
Coontail Total Rake Fullness in Little Muskego Lake: September 2023



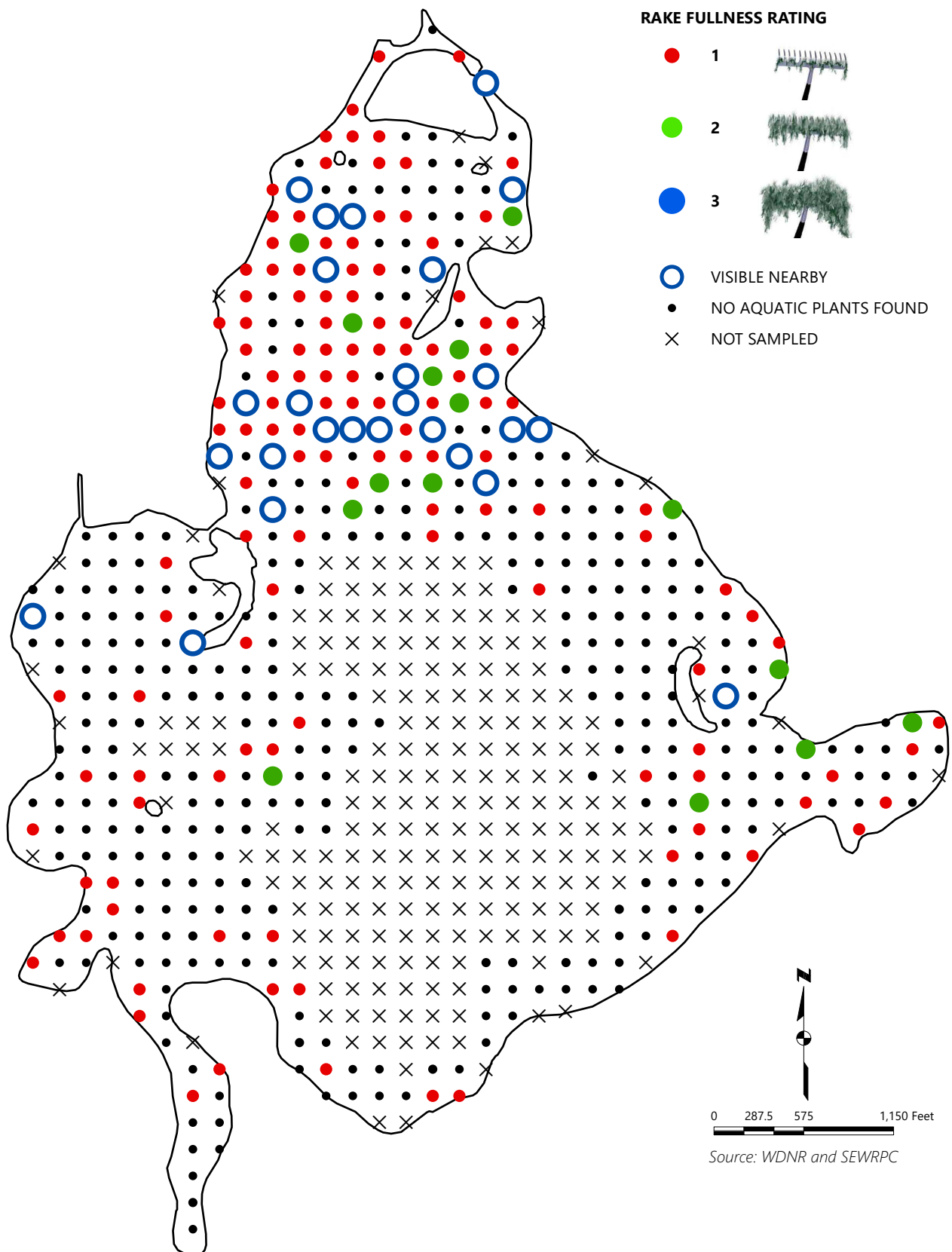
Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure A.3
Eelgrass Total Rake Fullness in Little Muskego Lake: September 2023



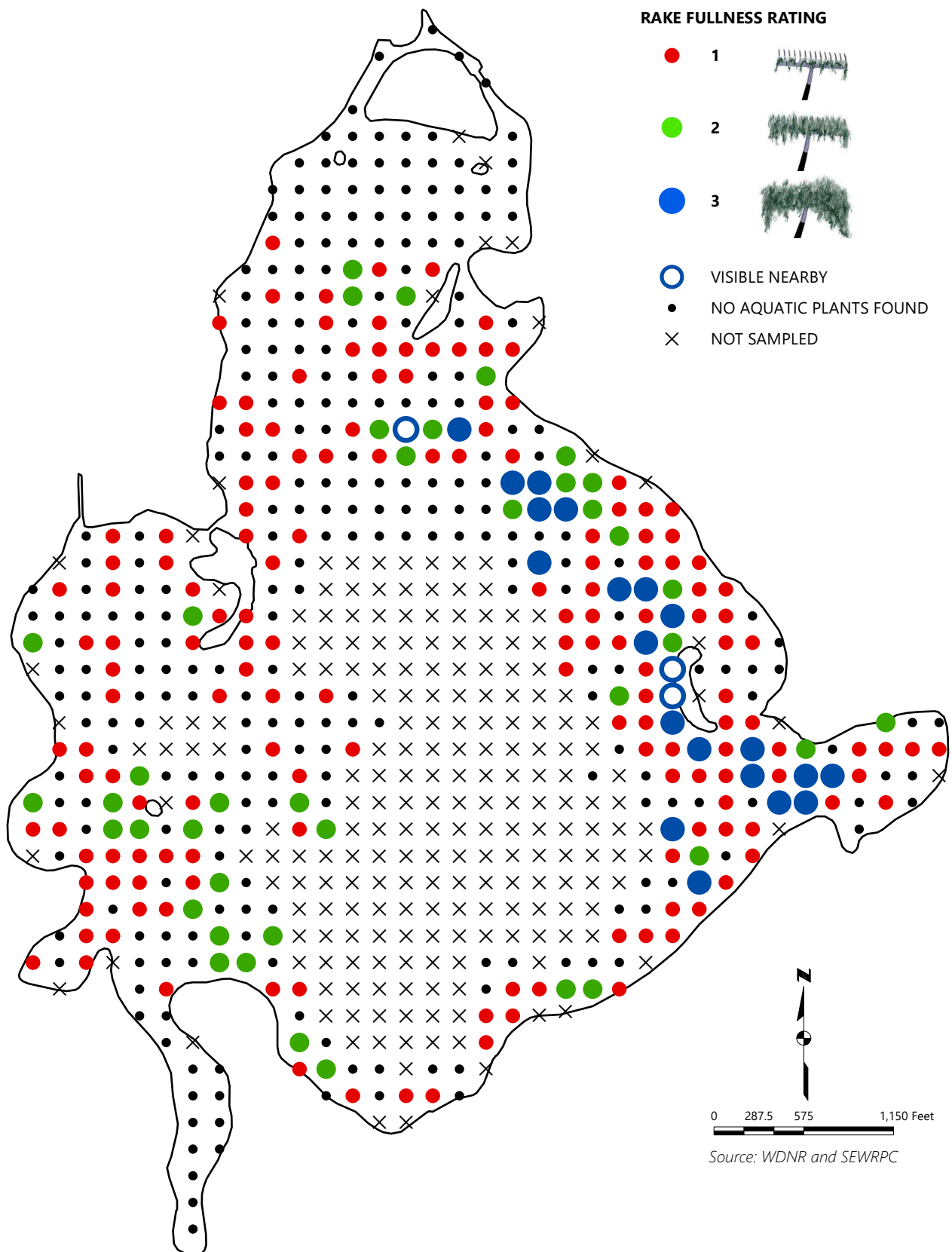
Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure A.4
Eurasian Watermilfoil Total Rake Fullness in Little Muskego Lake: September 2023



Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

Figure A.5
Muskgrass Total Rake Fullness in Little Muskego Lake: September 2023

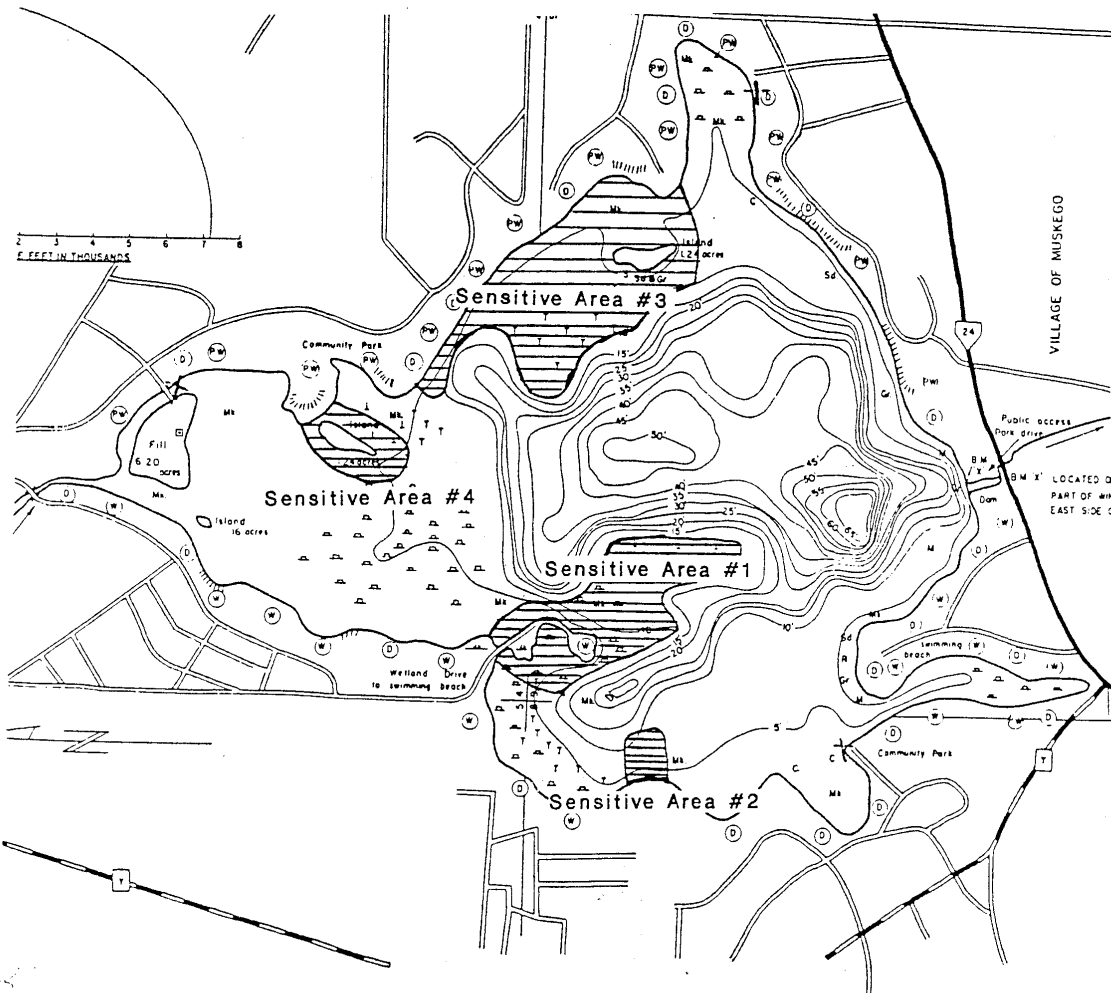


Note: Survey was conducted on Little Muskego Lake on September 14th, 2023.

1992 SENSITIVE AREA DESIGNATION REPORT APPENDIX B

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
CHAPTER NR 107 SENSITIVE AREA DELINEATIONS
APPLICABLE TO LITTLE MUSKEGO LAKE

Little Muskego Lake Sensitive Areas





Carroll D. Besadny
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Southeast District

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**AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR AREA 1
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN**

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 1 surrounds the entire peninsula on the western shore and has approximately 2500 feet of shoreline. It includes the shallow sand bar and extends lakeward to include all the lake within the 10 foot contour depth (see map). Substrate in area one is composed of rock and gravel (60%) and muck (40%).

A variety of plant species were identified within this sensitive area. The area currently supports narrow leaf pondweeds, chara, white water lily, cattails, and bulrush. Table 1 lists the aquatic plants found in sensitive area 1 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as an E2H wetland. This type of wetland is Emergent/Wet Meadow, Narrow-leaved persistent, Standing water, Palustrine. This wetland is regulated by the US Army Corps of Engineers and the City of Muskego.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel believes this area experiences greater water quality and clarity as a result of the aquatic vegetation. He also recognized the species richness and diversity of the area and considered these plants an excellent source for increasing their distribution. They are also a very good buffer against invasion by non-native species.

Department Fishery Biologist Randy Schumacher states this area "offered an outstanding diversity of all forms of habitat whether it be structure of vegetation, depth, substrate from rock and gravel to soft substrate." He adds, "it certainly is one of the most valuable areas on the lake for preservation of overall fish habitat and quality." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

The aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The proximity of the adjacent wetland, quality of the aquatic vegetation, and value these plants provide warrants protection of the area. Little Muskego

The following riparian activities will be restricted as follows:

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

Boardwalks are not allowed.

The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members:

Mark Anderson, Wildlife Manager - (414)594-2135
Randy Schumacher, Fish Manager - (414)594-2135
Liesa Nesta, Water Regulation and Zoning - (414)263-8678
Dan Helsel, Water Resources Manager - (414)263-8714
Greg Borzick, Water Resources Specialist - (414)263-8586

Table 1. Aquatic Plants Found in Sensitive Area 1.

Submergent Plants

Flatstem Pondweed <u>Potamogeton zosteriformis</u>	Extremely valuable, provides cover for fish and supports insects for fish food, excellent food source for waterfowl, stabilizes bottom sediment, characteristic of good water quality
<u>Chara</u> (Macroscopic Algae)	Supports insects for fish food, stabilizes bottom sediments, protects against invasion by exotics, usually low growing
Eurasian Water Milfoil (<u>Myriophyllum spicatum</u>)	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments

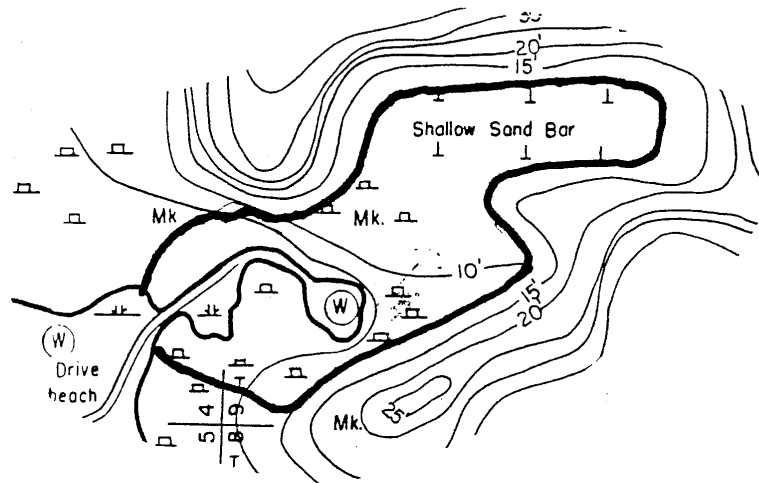
Floating Plants

White Water Lily <u>Nymphaea</u>	Provides shade and cover for panfish, largemouth bass, and northern pike, good food source for waterfowl, aesthetically pleasing
-------------------------------------	--

Emergent/Wetland Plants

Cattails <u>Typha</u>	Provide cover for fish and spawning areas for northern pike, good food source for waterfowl and muskrat, stabilizes shoreline and protects against erosion
Bulrush <u>Scirpus</u>	

Little Muskego Lake Sensitive Area #1



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating

- White waterlilies (30%)
- Flatstem pondweed (15%)
- Chara (macro-algae) (20%)
- Eurasian watermilfoil (30%)

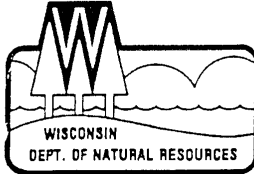
Emergent (Shoreline)

- Cattails (50%)
- Bullrush (50%)

Valuable population of native species which provide an excellent source for increasing their distribution

Fish Spawning, Nursery and Feeding - critical mix of emergent/submergent aquatic plants. May be key area for maintaining healthy fish populations for entire lake especially northern pike

Wildlife - Unique area for waterfowl, heron, songbirds. Predominantly used as feeding and shelter area for waterfowl and shorebirds.



Carroll D. Besadny
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AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR AREA 2
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 2 is located on the western shore and has approximately 350 feet of shoreline. It extends perpendicular from the shore to approximately 10 feet of water (see map).

A healthy population of plants was identified within this sensitive area. The area currently supports narrow leaf pondweeds, large leaf pondweeds, and chara. Table 1 lists the aquatic plants found in sensitive area 2 and identifies the benefits each provides.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel witnessed increased water clarity in this area he believes is a result of the aquatic vegetation. Dan also noted the native species act as an very good buffer against invasion by non-native species. This area also harbors Richardson pondweed, a beneficial native aquatic plant and the only occurrence identified in Little Muskego Lake.

Department Fishery Biologist Randy Schumacher identified this area as outstanding habitat for a variety of fish. The area is very diverse and contains valuable spawning, nursery, and feeding areas. He states the area "has excellent structure for gamefish." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

This aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The unique presence of Richardson Pondweed and the valuable qualities of the aquatic vegetation warrant protection of this area. Little Muskego Lake will benefit as a result of this sensitive area designation and subsequent aquatic plant protection.

How will the lake benefit from this area?

This sensitive area supports the only occurrence of Richardson pondweed in Little Muskego Lake. Richardson pondweed is a beneficial large leaf pondweed that is uncommon in southeastern Wisconsin. The area also supports a healthy

The following riparian activities will be restricted as follows:

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

Boardwalks are not allowed.

The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members listed below:

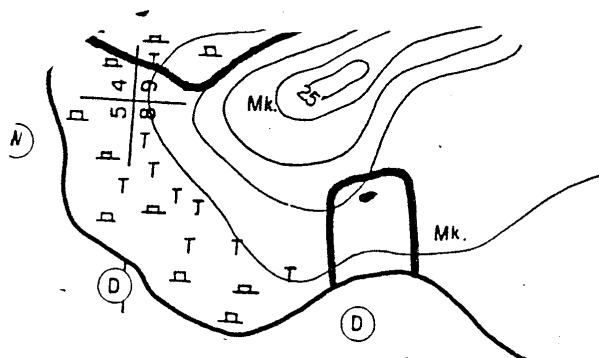
Identification Team

Mark Anderson, Wildlife Manager - (414)594-2135
Randy Schumacher, Fish Manager - (414)594-2135
Liesa Nesta, Water Regulation and Zoning - (414)263-8678
Dan Helsel, Water Resources Manager - (414)263-8714
Greg Borzick, Water Resources Specialist - (414)263-8586

Table 1. Aquatic Plants Found in Sensitive Area 2.

Richardson Pondweed <u>Potamogeton richardsonii</u>	Uncommon and extremely valuable, provides cover for panfish, largemouth bass, and northern pike, supports insects for fish food, excellent food source for waterfowl, stabilizes bottom sediment
<u>Chara</u> (Macroscopic Algae)	Supports insects for fish food, stabilizes bottom sediments, protects against invasion by exotics, usually low growing
Eurasian Water Milfoil <u>Myriophyllum spicatum</u>	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments

Little Muskego Lake Sensitive Area #2



Critical and/or Unique Habitat:

Aquatic Plant Species

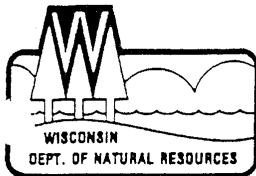
Submerged/Floating

- Flatstem pondweed (15%)
- Richards pondweed (15%)
- Chara (macro-algae) (55%)
- Eurasian watermilfoil (15%)

Only occurrence of Richards pondweed observed within the entire lake. Healthy population of Chara contributing to the low occurrence of Eurasian watermilfoil.

Fish Spawning, Nursery and Feeding - Low abundance of native submergent aquatic plants supplies critical habitat for spawning and nursery habitat for bass and panfish.

Wildlife - Pondweed provides a valuable food resource for waterfowl. Area observed to be used by tree swallows, cedar waxwings and woodducks.



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AQUATIC PLANT MANAGEMENT
SENSITIVE AREA DESIGNATION FOR AREA 3
LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 3 is located along the eastern shoreline and contains approximately 3000 feet of mainland shoreline. It begins at a point on the shore southeast of Holz island, extends around the 1.24 acre island, and continues north, following the 10 foot depth contour line to a point south of the community park (see map). Substrate is composed of gravel, sand, and muck.

A variety of plant species were identified within this sensitive area. The area currently supports narrow leaf pondweeds, chara, white lily pads, sedges, cattails, and bulrush. Table 1 lists the aquatic plants found in sensitive area 3 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as a wetland. This wetland is regulated by the US Army Corps of Engineers and the WDNR.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel suggests this area experiences greater water quality and clarity as a result of the aquatic vegetation. He recognized the species richness and diversity of the area and considered these plants an excellent source for increasing their distribution. He also noted they are an excellent buffer against invasion by non-native species.

Department Fishery Biologist Randy Schumacher notes this area "probably offers the best overall 'mix' of habitats for all important fish" He also noted that there was "plenty of feeding and living habitat. Loss of (aquatic vegetation) quality would significantly benefit carp and could lead to lakewide poor water quality." Randy's final comment was, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

This aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

Management Restrictions

The following **in-lake activities** will be restricted as follows:

Aquatic plant screens are allowed along developed shorelines only.
Reviewed on a case by case basis. WDNR permit required.

Piers and boardwalks allowed along developed shorelines only.
Compliance with local pier ordinances and WDNR limits required.

Pea gravel and sand blankets allowed along developed shorelines only. Reviewed on a case by case basis. WDNR permit required.

Mechanical plant harvesting is not recommended.

Chemical control limited to the exotic species Eurasian Water Milfoil (*Myriophyllum spicatum*) and Curly-Leaf Pondweed (*Potamogeton crispus*) along developed shorelines only.

Dredging is not allowed.

Filling is not allowed.

The following **riparian activities** will be restricted as follows:

Boardwalks are allowed on island for educational purposes.

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members listed below:

Identification Team

Mark Anderson, Wildlife Manager - (414)594-2135
Randy Schumacher, Fish Manager - (414)594-2135
Liesa Nesta, Water Regulation and Zoning - (414)263-8678
Dan Helsel, Water Resources Manager - (414)263-8714
Greg Borzick, Water Resources Specialist - (414)263-8586

Little Muskego Lake Sensitive Area #3



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating

- White waterlilies (20%)
- Flatstem pondweed (25%)
- Chara (macro-algae) (25%)
- Naiads (10%)
- Eel grass (10%)
- Eurasian watermilfoil (10%)

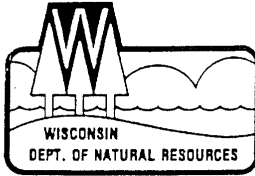
Emergent (Shoreline)

- Bullrush (25%)
- Cattail (25%)

Native aquatic plant species are dominant throughout area # 3 providing an excellent source for increasing their distribution in the lake. Water clarity was very good (greater than 6 feet).

Fish Spawning, Nursery and Feeding - The native aquatic plants and good water clarity of this area provides excellent feeding and shelter habitat for all species of fish. Loss of native vegetation/water clarity could detrimentally contributed to increased carp habitat.

Wildlife - Native pondweeds and waterlilies provide unique habitat and valuable food resources for waterfowl, herons and a variety of songbirds. Island is important to both aquatic and terrestrial furbearers.



Carroll D. Besadny
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Southeast District
Post Office Box 12436
2300 N. Martin Luther King Jr. Drive
Milwaukee, Wisconsin 53212
TELEPHONE: 414-263-8500
TELEFAX #: 414-263-8434

AQUATIC PLANT MANAGEMENT SENSITIVE AREA DESIGNATION FOR AREA 4 LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN

Date of Designation: July 15, 1992

Sensitive Area Site Description

Sensitive area 4 is located along the eastern shoreline and contains approximately 350 feet of mainland shoreline. It begins on the south side of the peninsula near the community park, extends around the 1.24 acre island, and continues north at a distance 300 feet from shore. The sensitive area ends at the tip of the peninsula (see map). The maximum water depth in sensitive area 4 is five feet, the average depth is three feet. The substrate is approximately 50% muck, 30% silt, 15% gravel, and 5% sand.

This area supports a three species of pondweeds. Table 1 lists the aquatic plants found in sensitive area 4 and identifies the benefits each provides.

A portion of the shoreline adjacent to the sensitive area has been mapped and classified as a wetland. This wetland is regulated by the US Army Corps of Engineers and the WDNR.

Why is this area a sensitive area?

Following an inspection of Little Muskego Lake, Department of Natural Resources personnel concluded this area was particularly valuable to the water quality and biological integrity of the lake. Each biologist considered the qualities of this area unique and valuable for the following reasons:

Water Resource Manager Dan Helsel believes this area has excellent location for native plant recolonization if left undisturbed. As seen in other areas of Little Muskego Lake, native plants would increase water quality and clarity and help maintain species diversity.

Department Fishery Biologist Randy Schumacher states this area, "offers adult habitat because it is relatively undisturbed (with the) trees and weed beds close to the island." Randy adds, "There is no doubt in my mind we have picked out the areas on the lake that need to be preserved in something close their present state for maintenance and long-term water quality."

The aquatic plants in this sensitive area supply valuable wildlife habitat for waterfowl, songbirds, and furbearers. Wildlife Biologist Mark Anderson states he observed a "diverse supply of wildlife habitat." He adds "the littoral (shallow) areas ... offer feeding areas both on the vegetation and the invertebrates by waterfowl and feeding on the emerging insects by the song birds present."

The proximity of the adjacent wetland, quality of the aquatic vegetation, and value these plants provide warrants protection of the area. Little Muskego Lake will benefit as a result of this sensitive area designation and subsequent aquatic plant protection.

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Pea gravel and sand blankets allowed along developed shorelines only. Reviewed on a case by case basis. WDNR permit required.

Mechanical plant harvesting is not recommended outside 50 feet from the shoreline.

Chemical control limited to the exotic species Eurasian Water Milfoil (Myriophyllum spicatum) and Curly-Leaf Pondweed (Potamogeton crispus) along developed shorelines only.

Dredging is not allowed.

Filling is not allowed.

The following riparian activities will be restricted as follows:

Boardwalks are allowed on island for educational purposes.

Wetland alterations are not allowed. Wetlands are protected under shoreland wetland ordinances.

The protection of Little Muskego Lake will require cooperation and understanding by everyone that uses the lake. Positive actions today will help protect the lake for future generations. If you have any questions regarding the identification of Little Muskego Lake as a sensitive area or the management implications, please feel free to contact any one of the identification team members listed below:

Identification Team

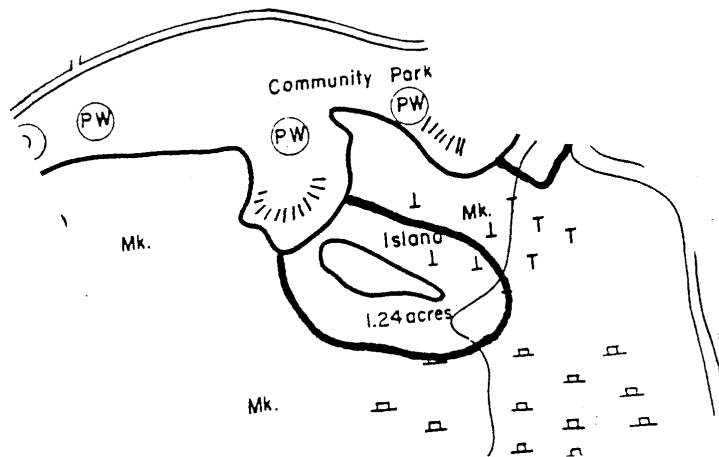
Mark Anderson, Wildlife Manager - (414)594-2135
Randy Schumacher, Fish Manager - (414)594-2135
Liesa Nesta, Water Regulation and Zoning - (414)263-8678
Dan Helsel, Water Resources Manager - (414)263-8714
Greg Borzick, Water Resources Specialist - (414)263-8586

Table 1. Aquatic Plants Found in Sensitive Area 4.

Submergent Plants

Flatstem Pondweed <u>Potamogeton zosteriformis</u>	Very valuable, provides cover for bluegill and largemouth bass, supports insects for fish food, provides food source for waterfowl, stabilizes bottom sediment
Coontail <u>Ceratophyllum demersum</u>	Very valuable, provides cover for young bluegill and largemouth bass, northern pike, and walleye, supports insects for fish food, provides food source for waterfowl
Eurasian Water Milfoil <u>Myriophyllum spicatum</u>	Exotic species, limited value, waterfowl occasionally eat its seeds, stabilizes bottom sediments

Little Muskego Lake Sensitive Area #4



Critical and/or Unique Habitat:

Aquatic Plant Species

Submerged/Floating

- Coontail (25%)
- Flatstem pondweed (50%)
- Eurasian watermilfoil (25%)

Establishment of a healthy bed of aquatic plants in this location of the lake will help trap sediments entering the lake from the inlet (erosion control). Recolonization by native species should be promoted within this area.

Fish Spawning, Nursery and Feeding - The area provides some spawning habitat for northern and bass species. Predominantly this area provides a nursery and feeding habitat for all gamefish.

Wildlife - One of the critical habitat areas in the northern portion of the lake for wildlife. A number of species were observed to be utilizing the shoreline resource of this area including three kingfishers, tree swallows, mallards, and four great blue herons.

PAST CHEMICAL TREATMENT APPLICATIONS

APPENDIX C

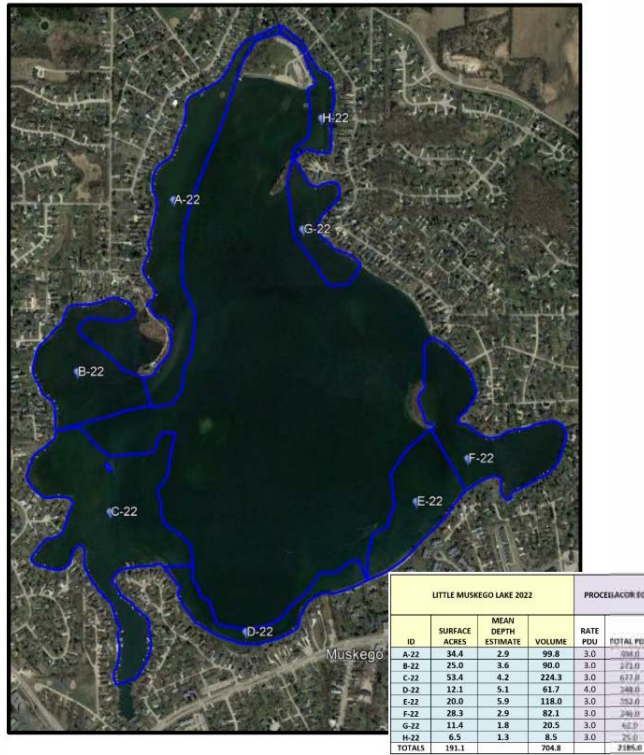
LITTLE MUSKEGO LAKE AIS CONTROL PROJECT-FINAL 2020 TREATMENT AREAS
LITTLE MUSKEGO LAKE MANAGEMENT DISTRICT
WAUKESHA COUNTY, WISCONSIN



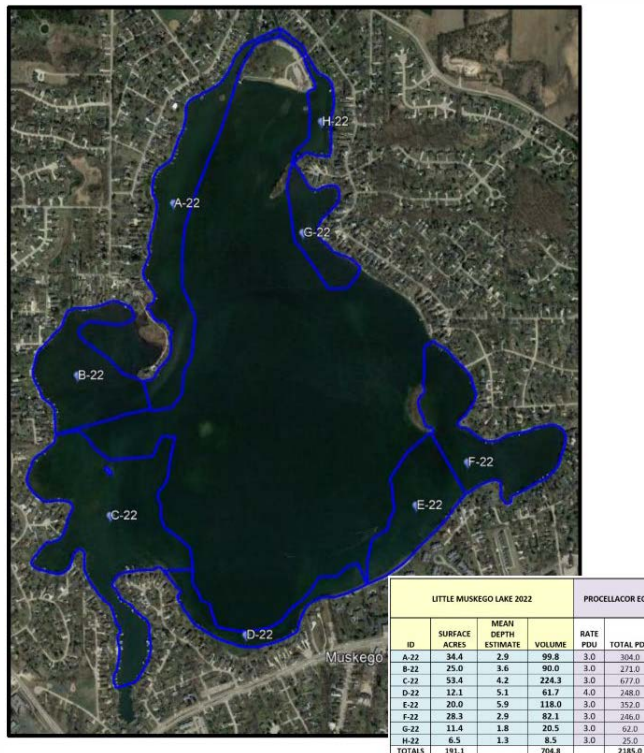
LITTLE MUSKEGO LAKE 2020 FINAL TREATMENT SITE & HERBICIDE RATE DATA

2020 Little Muskego Lake Treatment Site & Herbicide Rate Data				Aquathol K (liquid endosulf)			ProcellaCOR (liquid fluroxypyrifen-benzyl)		
ID	Acreage	Mean Depth Estimate	Volume	Rate PPM	Gallons Per Acre	Total Gallons	Rate PDU	PDU Per Acre	Total PDU
A-20	12.6	2.50	32	1.50	2.25	28.8	1.0	2.5	32.0
B-20	5.0	3.40	17	1.50	3.06	15.3	1.0	3.4	17.0
C-20	5.0	3.40	17	1.50	3.06	15.3	1.0	3.4	17.0
D-20	28.0	3.40	95	1.50	3.06	85.7	1.0	3.4	95.0
E-20	23.2	4.00	93	1.50	3.6	83.5	1.0	4.0	93.0
F-20	13.0	4.50	59	1.50	4.05	52.7	1.0	4.5	59.0
G-20	7.5	3.50	26	1.50	3.15	23.6	1.0	3.5	26.0
H-20	16.0	3.50	56	1.50	3.15	50.4	1.0	3.5	56.0
I-20	5.5	3.50	19	1.50	3.15	17.3	1.0	3.5	19.0
Totals	116.0					372.6			414.0

**LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN
2022 FINAL MAP + STRATEGY**



**LITTLE MUSKEGO LAKE, WAUKESHA COUNTY, WISCONSIN
2022 FINAL MAP + STRATEGY**

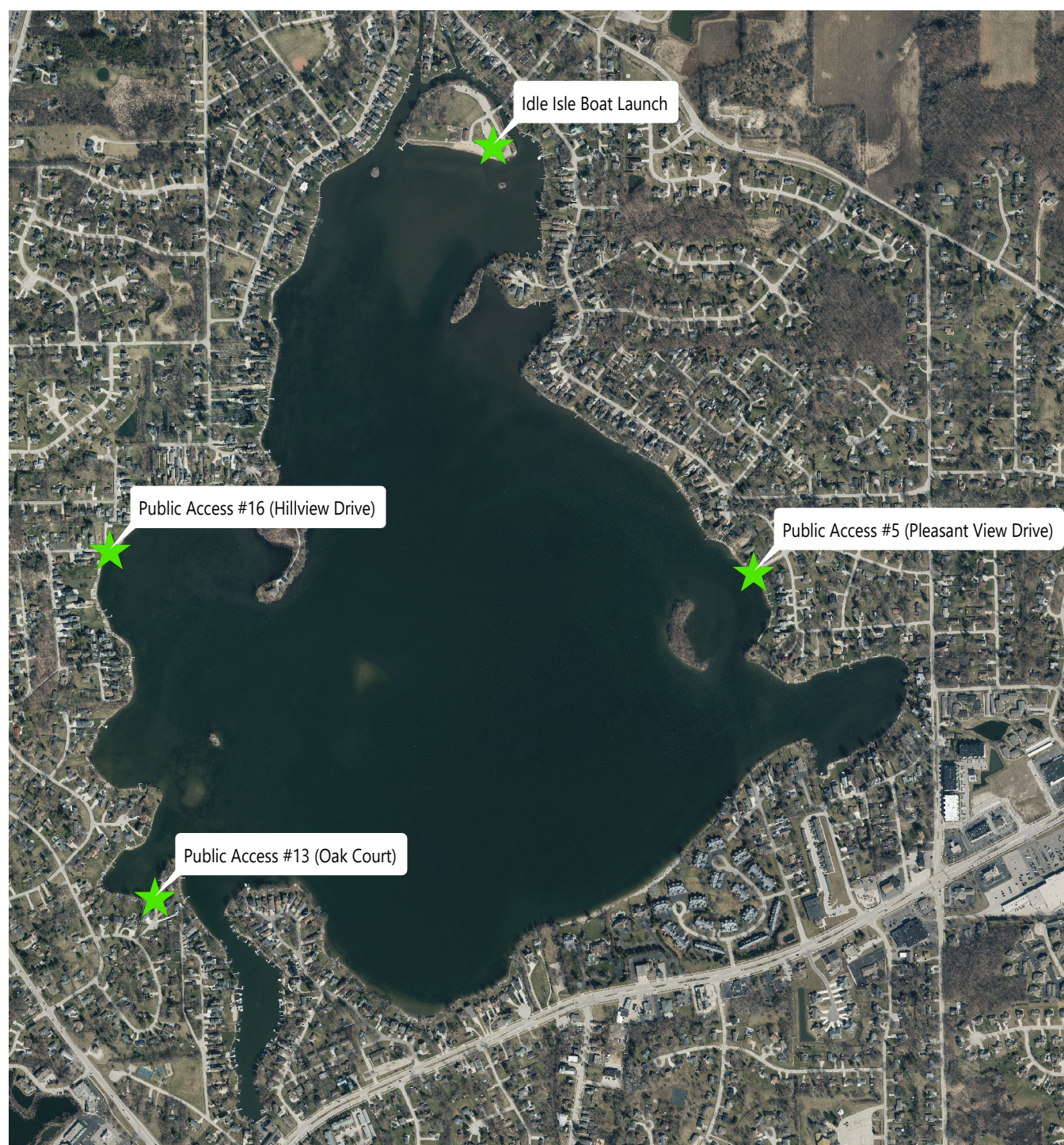


Source: WDNR

HARVESTING OPERATIONS

APPENDIX D

Figure D.1
Aquatic Plant Harvesting Offload Sites in Little Muskego Lake



★ Aquatic Plant Harvesting
Offload Site

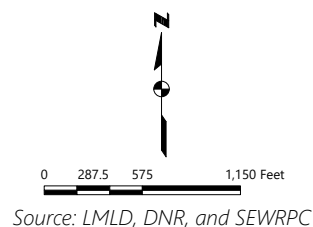
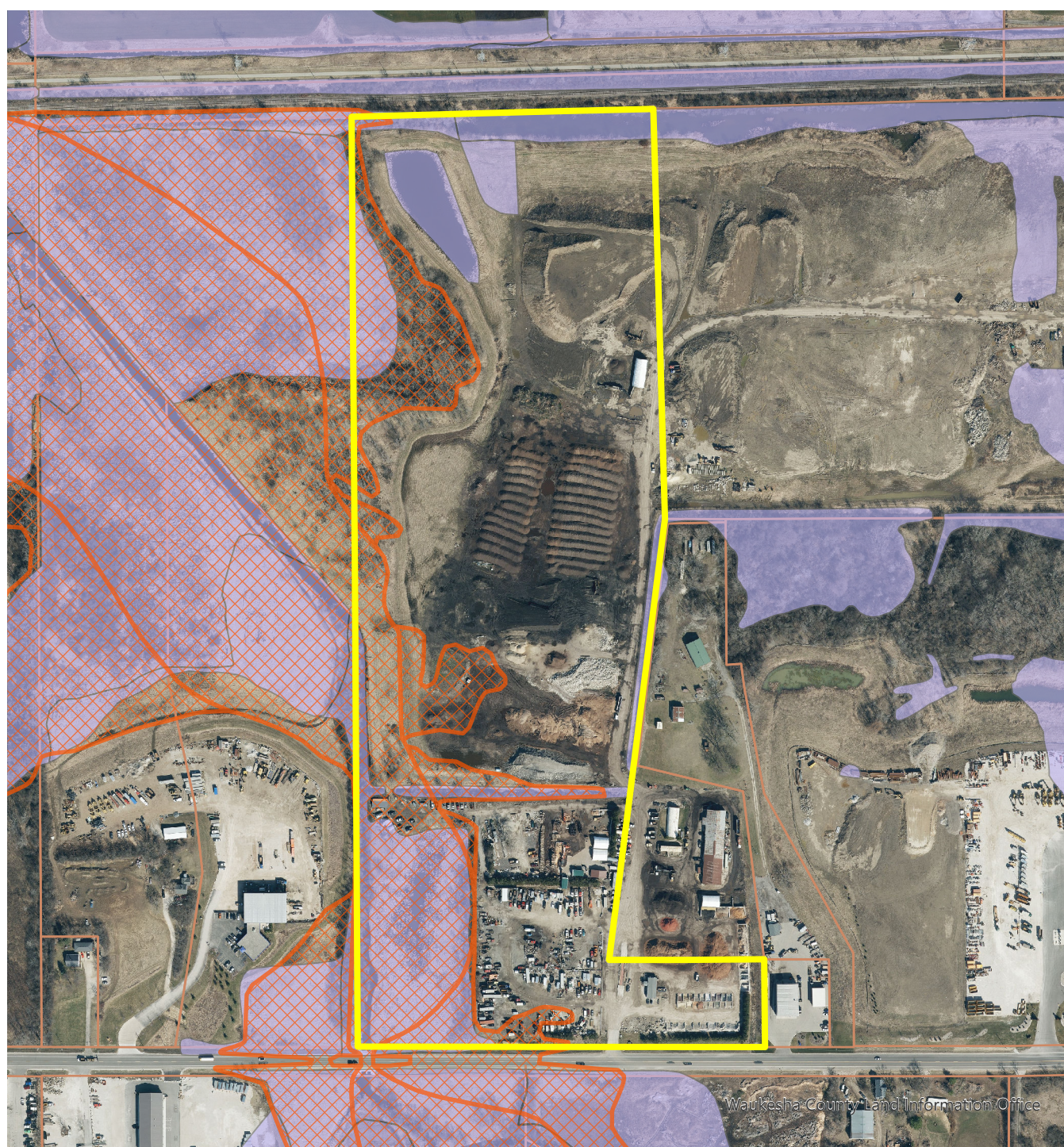


Figure D.2
Certified Products/Workman Meadows Harvesting Disposal Site



- Wetlands
- Harvesting Disposal Site
- FEMA-Designated AE Flood Zone

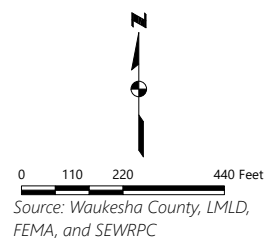
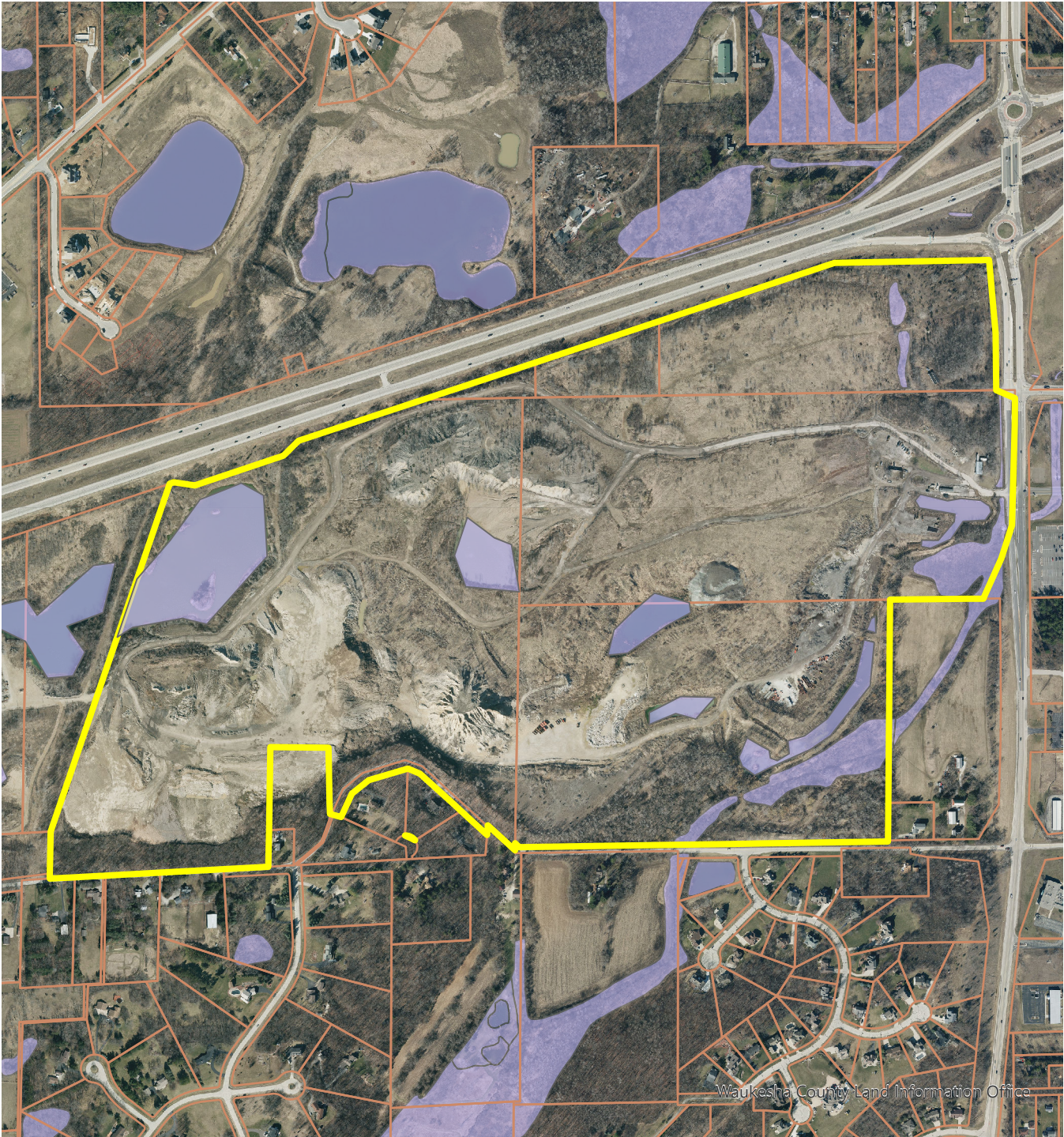


Figure D.3
Potential Harvesting Disposal Site on Racine Ave: Valley Sand and Gravel



Note: No floodplains were identified in the parcel.

-  Potential Harvesting Disposal Sites
-  Wetlands

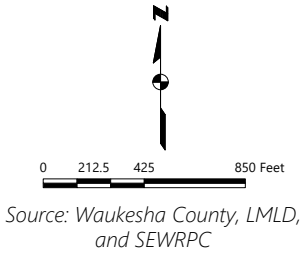
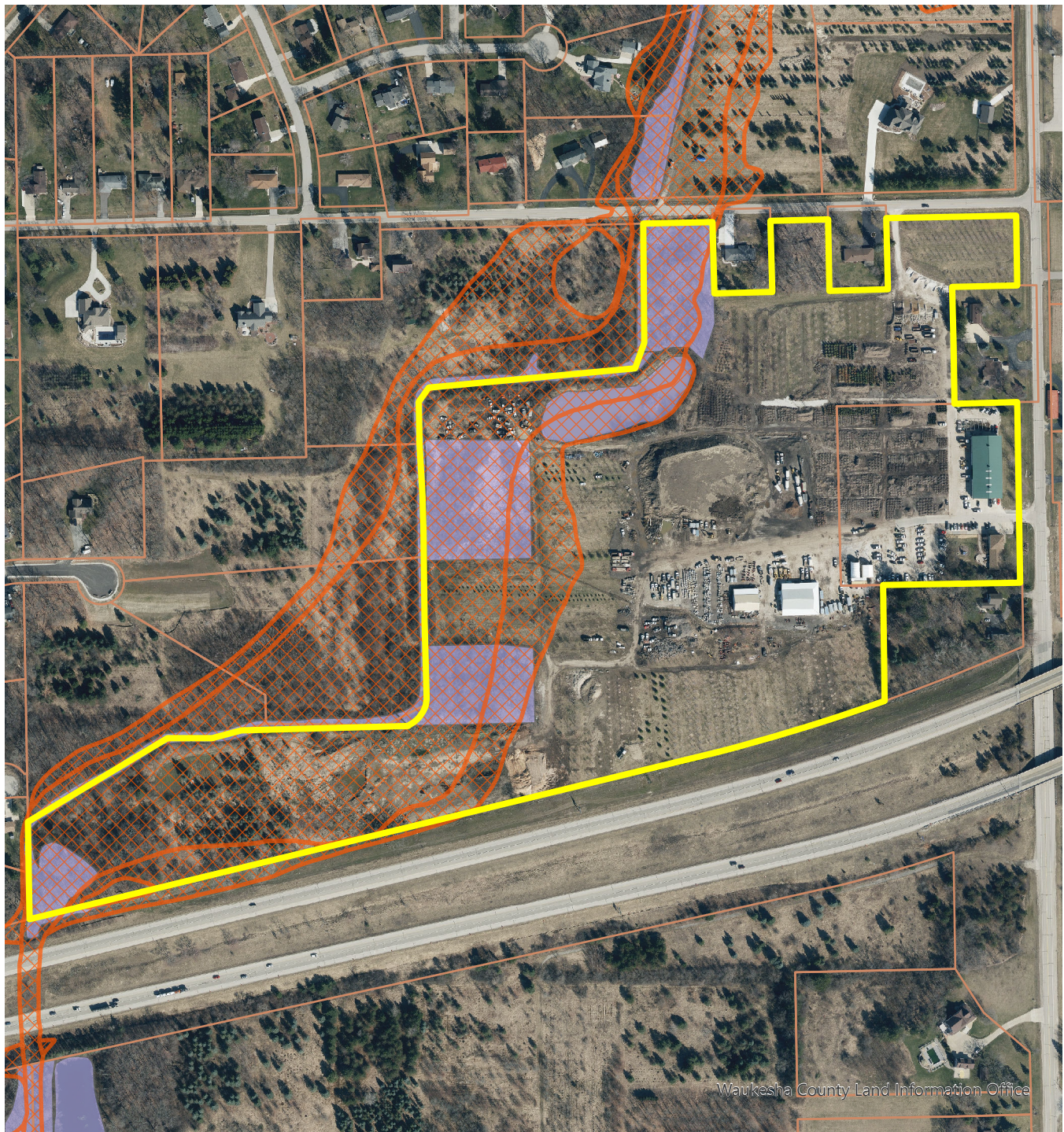
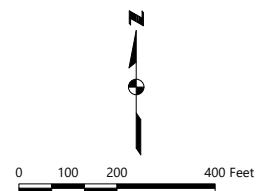


Figure D.4
Potential Harvesting Disposal Site on Calhoun Rd: Trees-on-the-Move

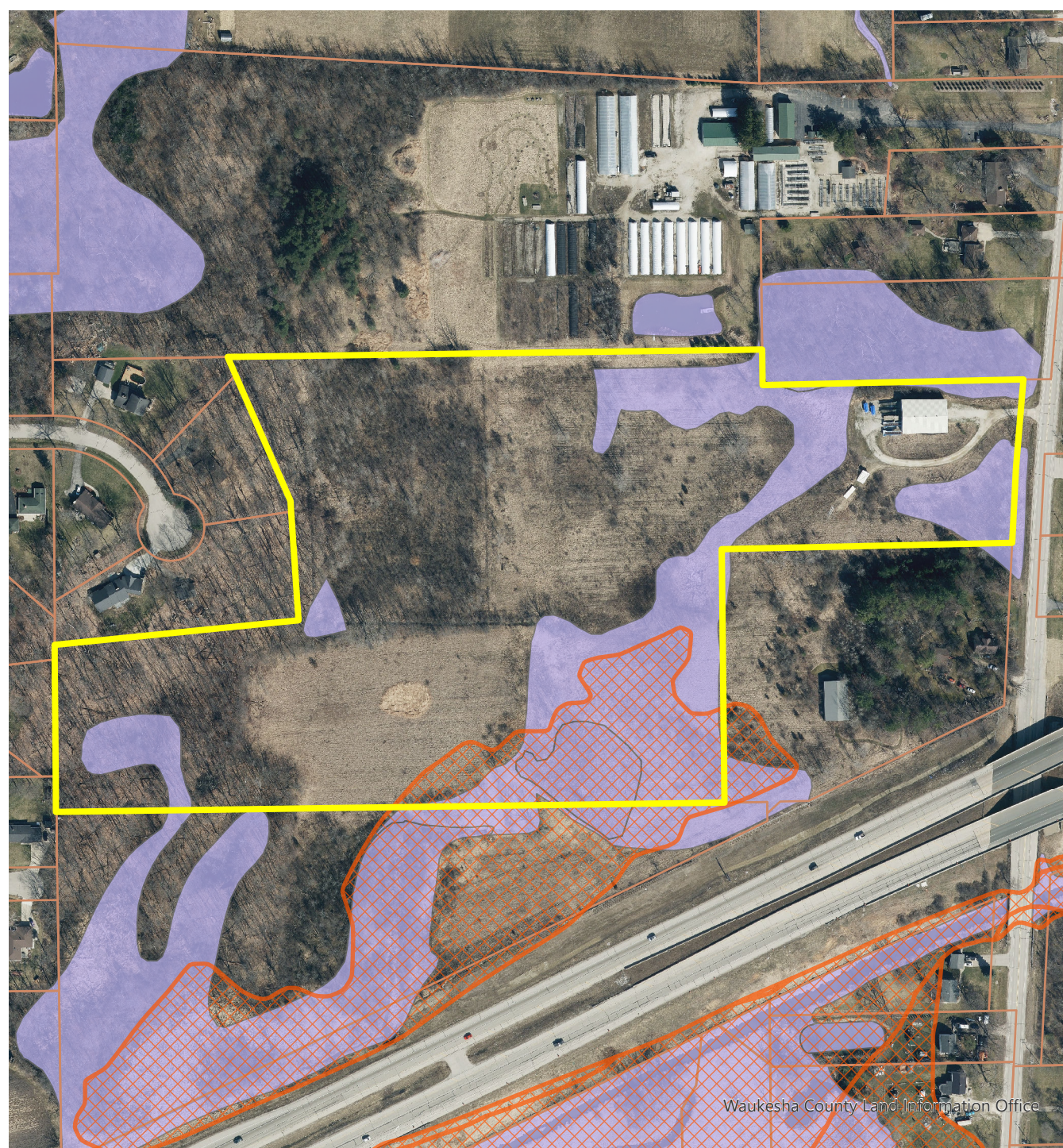


- Potential Harvesting Disposal Sites
- Wetlands
- FEMA-Designated AE Flood Zone

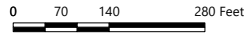


Source: Waukesha County, LMLD,
 FEMA and SEWRPC

Figure D.5
Potential Harvesting Disposal Site: Martin Road



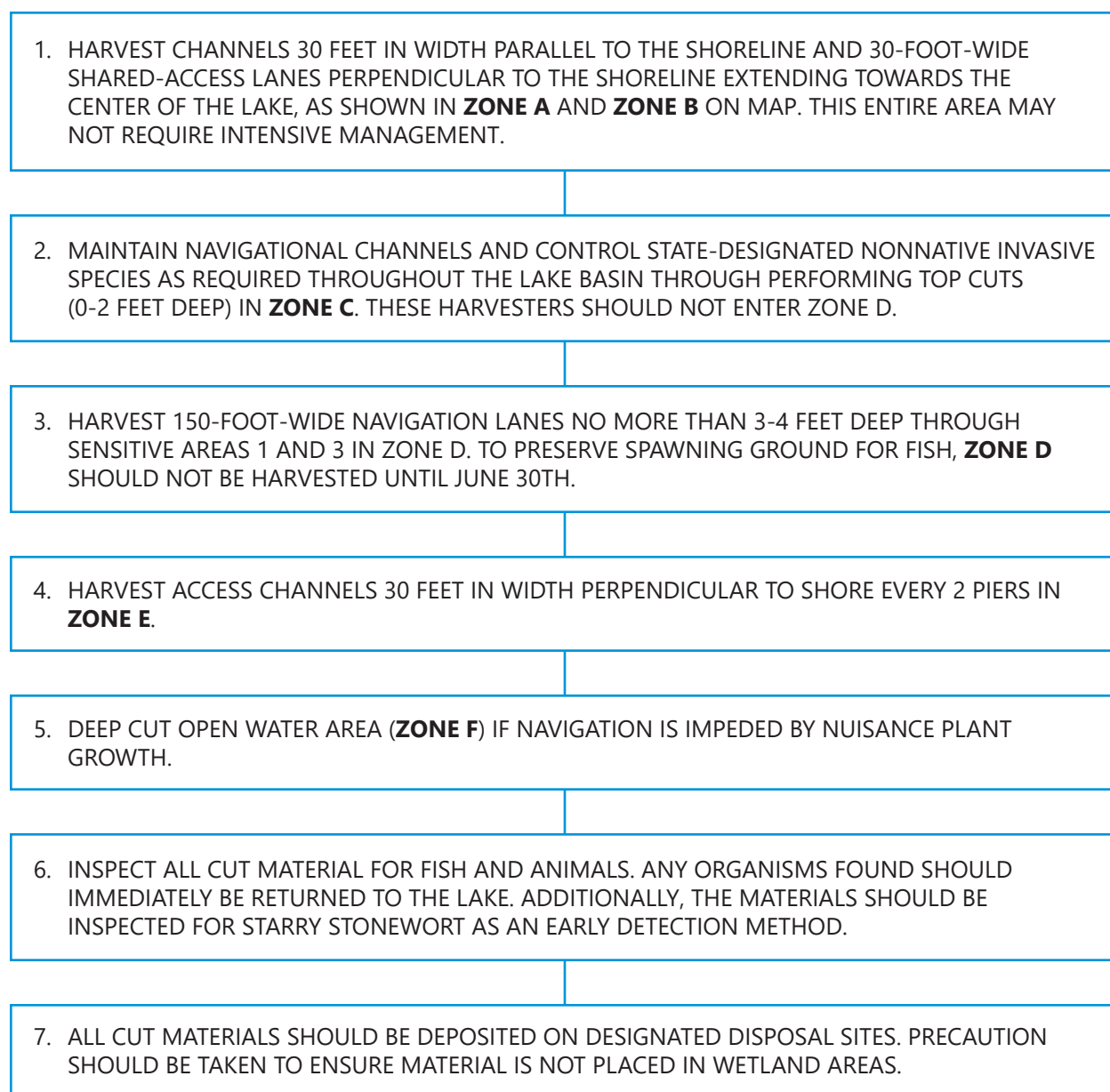
- Potential Harvesting Disposal Sites
- Wetlands
- FEMA-Designated AE Flood Zone



 Source: Waukesha County, LMLD, FEMA, and SEWRPC

HARVESTING OPERATIONS GUIDANCE

APPENDIX E

Figure E.1
Harvesting Sequence for Little Muskego Lake: 2026-2030^{a,b,c}



Note: Sequence 1 and 2 could be done concurrently in one area of the Lake as a time-saving measure.

^a No harvesting should be conducted within WDNR-designated Sensitive Areas or within 100 feet of the island areas, except as required for control of State-designated nonnative invasive species.

^b One foot of plant material should always be left on the lake bottom to ensure lake bottom stabilization and maintenance of fish habitat.

^c No harvesting should occur in areas less than 3 feet deep.

Source: Wisconsin Department of Natural Resources and SEWRPC

