MEMORANDUM REPORT NO. 155
3RD EDITION

AN AQUATIC PLANT MANAGEMENT PLAN FOR LITTLE MUSKEGO LAKE

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Special Acknowledgment is due to Zofia Noe, Specialist, for her contribution to the preparation of this report.

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INTRODUCTION 1

Credit: SEWRPC Staff

1.1 PURPOSE OF PLAN

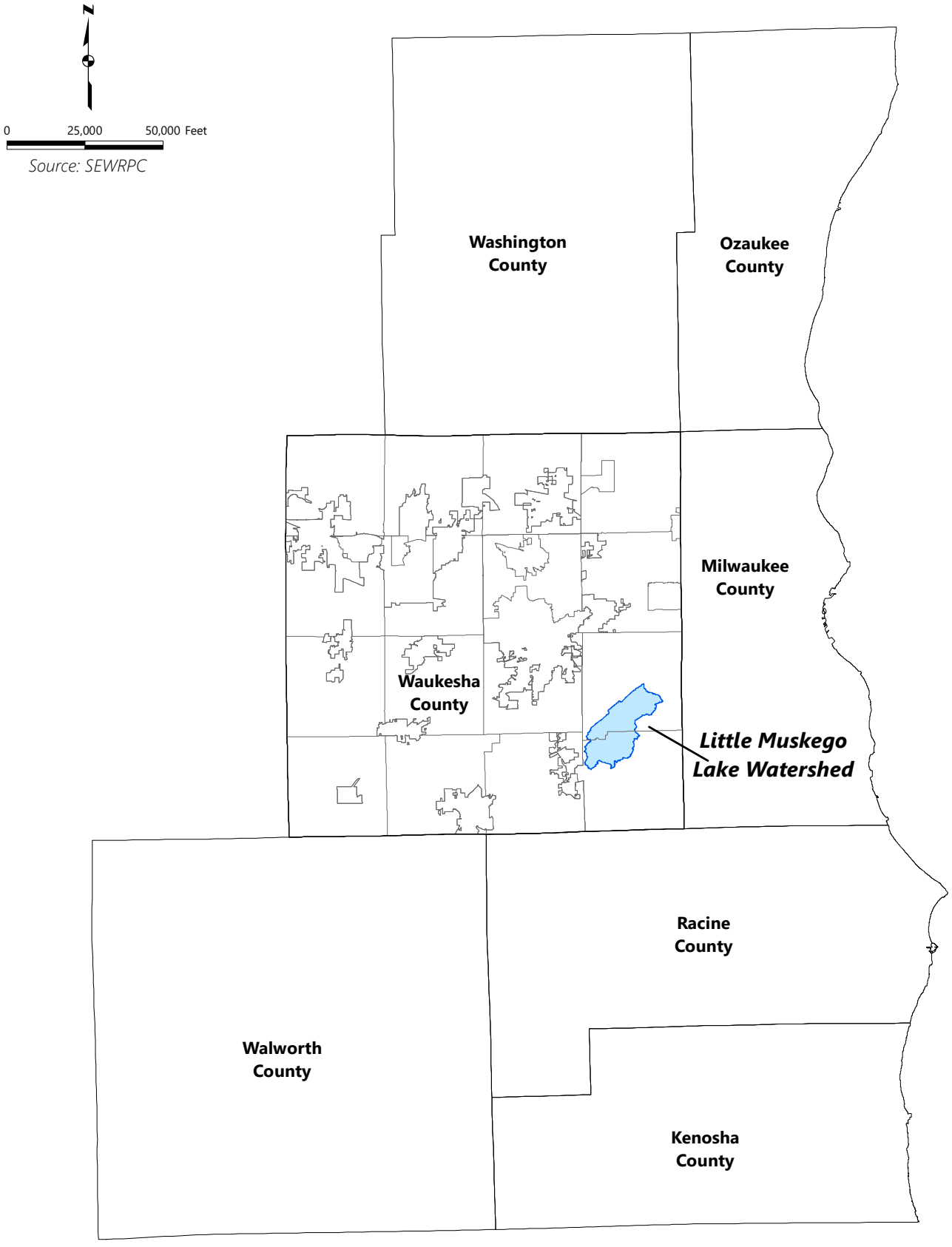
Located within U.S. Public Land Survey Sections 4, 5, 8, and 9, Township 5 North, Range 20 East, in the City of Muskego, Waukesha County (see Map 1.1), Little Muskego Lake, together with its watershed and associated wetlands, is a valuable recreational resource (see "Little Muskego Lake Characteristics and Assets" section below). However, the recreational and aesthetic values of Little Muskego Lake have been perceived to be adversely affected by excessive aquatic plant growth within portions of the Lake. The purpose of this plan is to refine the existing aquatic plant management plan for the Lake.[1] The scope of this report is limited to a consideration of the aquatic plant communities present within the Lake, documentation of historical changes in the plant communities based upon existing data and information, and refinement of those management measures that can be effective in the control of aquatic plant growth. The recommendations provided in this report are appropriate and feasible aquatic plant management measures for enhancing and preserving the native plant community and water quality of Little Muskego Lake, while still providing the public with opportunities for safe and enjoyable recreation within the Lake's watershed.

It is important to note that this plan complements other existing plans,[2] programs, and ongoing management actions in the Little Muskego Lake watershed and represents the continuing commitments of government agencies, municipalities, and citizens to diligent lake planning and natural resource protection. Additionally, it was designed to assist State agencies, local units of government, nongovernmental organizations, businesses, and citizens in developing strategies that will benefit the natural assets of Little Muskego Lake. By using the strategies outlined in this plan, results will be achieved that enrich and preserve the natural environment.

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

[2] *Wisconsin Department of Natural Resources Publication No. PUBL-WR-375-94,* A Nonpoint Source Control Plan for the Muskego-Wind Lakes Priority Watershed Project, *October 1993; SEWRPC Community Assistance Planning Report No. 222,* A Lake Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *June 1996.*

Map 1.1
Location of the Little Muskego Lake Watershed



This planning program was funded, in part, by the Little Muskego Lake Protection and Rehabilitation District (LMLPRD) and, in part, through a Chapter NR 190 Lake Management Planning Grant awarded to the LMLPRD and administered by the Wisconsin Department of Natural Resources (WDNR). The inventory and aquatic plant management plan elements presented in this report conform to the requirements and standards set forth in the relevant *Wisconsin Administrative Codes*.[3]

1.2 LITTLE MUSKEGO LAKE CHARACTERISTICS AND ASSETS

Little Muskego Lake is the second in a chain of lakes that receives water principally from Jewel Creek, which passes through Linnie Lac prior to entering Little Muskego Lake from the north. Little Muskego Lake is a 481-acre lake with a volume of 7,170 acre-feet, a maximum water depth of 65 feet, and a mean depth of 14 feet (see Map 1.2 for the Lake's bathymetry). The Lake's levels are maintained by a fixed height dam, which discharges into Muskego Creek, and then into Big Muskego Lake, Wind Lake, and, ultimately, the Fox River, about 10 miles downstream of the Little Muskego Lake outlet. The WDNR has classified the Lake as a drainage lake meaning that the Lake has both an inlet and outlet where the main water source is stream drainage. The general orientation of Little Muskego Lake is north-south. The most steeply sloped portions of the lakebed are located at the southern end of the Lake adjacent to the deep hole. Extensive shallow water areas are located around the periphery of the Lake, principally along the northern, southwestern, and eastern shorelines.

The Lake is 7.1 miles long, with a shoreline development factor of 2.3, indicating that, due to its natural irregularities, the shoreline is a little over two times longer than a perfectly circular lake of the same area. Shoreline development factor is important because it is often related to the amount of littoral zone (the shallower, nearshore area of a lake usually rich in plant and animal life) in a lake. The greater a lake's shoreline development factor, the more irregular its shoreline and, therefore, the greater the likelihood of the lake providing more littoral zone area with habitat suitable for plant and animal life. For purposes of comparison, the shoreline development factor of 2.3 can be compared to that of Silver Lake in Waukesha County, which has a shoreline development factor of 1.3 indicating a nearly circular shape, and that of Center Lake, in Kenosha County, which has a shoreline development factor of 4.1 reflecting that waterbody's highly irregular shape. Table 1.1 summarizes the hydrologic and morphologic characteristics of the Lake.

In addition to the shape of the lake basin, other factors, such as bottom sediment composition and basin contours, impact the amount of biological activity in a lake. Lake bottom sediment types in the nearshore areas of Little Muskego Lake consist of soft sediments along about 70 percent of the shoreline, mainly along the western and northern shorelines; gravel and rubble along about 25 percent of the shoreline, mostly along the southeastern shoreline and around the small island on the eastern side of the Lake; and, sand along about 5 percent of the shoreline. Additionally, the Lake bottom has fairly extensive areas of shallow water along the less steeply sloped portions of the Lake, primarily along the northern, southwestern, and eastern sides of the Lake. A preponderance of soft bottom sediments and the relatively flat lake bottom contours in the shallower areas of the Lake are conditions often associated with lakes of higher aquatic plant productivity.

Little Muskego Lake and its watershed have a wide range of assets. For example, Little Muskego Lake is able to support a variety of recreational opportunities as is evidenced by the recreational survey completed by Southeastern Wisconsin Regional Planning Commission (SEWRPC) staff in the summer of 2013 (see Chapter 2 for more details), which shows that Lake users engage in full-body contact uses (such as swimming from the beach) as well as high-speed boating and fishing activities. The Lake is also able to support a wide variety of fish including largemouth bass, panfish, northern pike, and walleye. Additionally, the Lake's watershed contains a variety of wetlands, uplands, and woodlands. It is also expected that the Lake and its watershed support several species of reptiles and amphibians that live in and around the Lake, as well as a number of both resident and migrant bird species that inhabit the area.[4]

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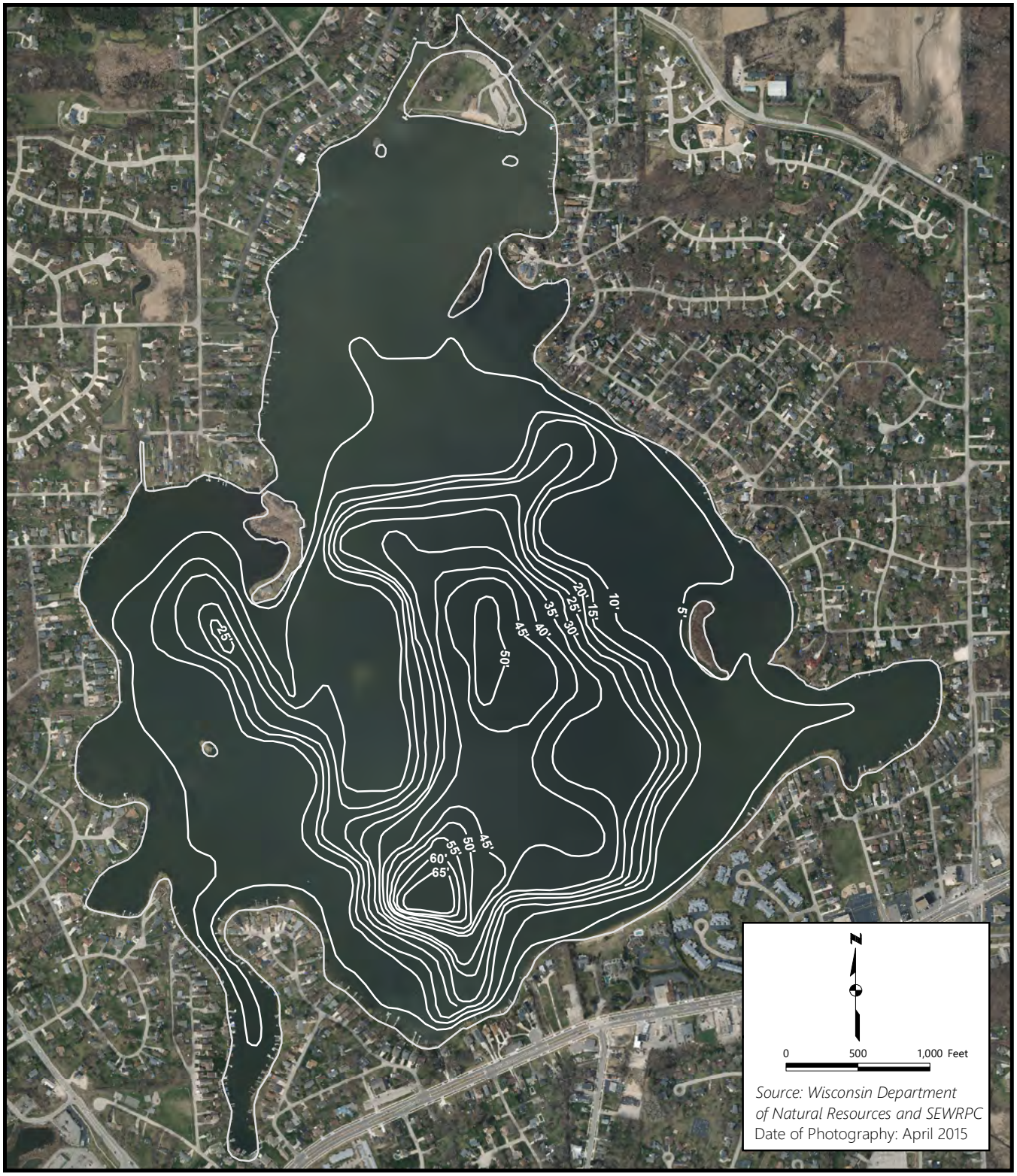
[3] *This plan has been prepared pursuant to the standards and requirements set forth in the following chapters of the* Wisconsin Administrative Code*: Chapter NR 1, "Public Access Policy for Waterways;" Chapter NR 40, "Invasive Species Identification, Classification and Control;" Chapter NR 103, "Water Quality Standards for Wetlands;" Chapter NR 107, "Aquatic Plant Management;" and Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations*."

[4] *These estimates are based on bird, amphibian, and reptile databases for the Region.*

Map 1.2
Little Muskego Lake's Bathymetry



—20'— WATER DEPTH CONTOUR IN FEET

1.3 AQUATIC PLANT MANAGEMENT PROGRAM GOALS AND OBJECTIVES

The overall goal of this effort was to produce an aquatic plant management plan update for Little Muskego Lake. General goals and objectives were developed in consultation with the LMLPRD and the City of Muskego, as well as in consultation with the public. These goals and objectives also directly address goals established in the Waukesha County land and water resource management plan[5] and include:

- Describing existing and historical conditions in the Little Muskego Lake watershed including potential point and nonpoint pollutant sources, nutrient and contaminant inputs, and nutrient and contaminant balances. This report identifies pollution sources, and provides nutrient load estimates, which can inform pollution control management efforts;

- Documenting the aquatic plant community and fishery of Little Muskego Lake, with emphasis on the occurrence and distribution of non-native species. This report details the findings of the 2013 and 2015 SEWRPC aquatic plant surveys, and the 2014 WDNR aquatic plant survey to help quantify the status of the aquatic plant community, and summarizes fish surveys completed by WDNR staff;

- Identifying the extent of existing and potential future water quality problems likely to be experienced in the Lake. This effort includes examining the Lake water quality using monitoring data collected as part of ongoing programs along with estimating the magnitude of potential future changes. This report includes an inventory of available water quality data for Little Muskego Lake; and

- Formulating appropriate Lake management recommendations, including public information and education strategies and other actions necessary to address the identified problems and issues of concern.

Table 1.1
Hydrology and Morphometry of Little Muskego Lake

Parameter	Measurement
Size	
Surface Area of Lake	481 acres
Direct Tributary Area[a]	1,425 acres
Total Tributary Area[a]	6,736 acres
Lake Volume	7,170 acre-feet
Residence Time[b]	0.9 year
Shape	
Length of Lake	1.3 miles
Width of Lake	1.0 mile
Length of Shoreline	7.1 miles
Shoreline Development Factor[c]	2.3
General Lake Orientation	North-South
Depth	
Maximum Depth	65 feet
Mean Depth	14 feet
Depth Area Less Than Three Feet	27 percent
Depth Area Three to 20 Feet	47 percent
Depth Area More Than 20 feet	26 percent

[a] *Current measurements regarding tributary size may differ slightly from earlier reports; current measurements are based on elevation refinements and more precise determinations of internally drained areas made possible through Commission digital terrain modeling analysis. In addition, the surface area of Little Muskego Lake is excluded from the tributary areas.*

[b] *Residence time is the number of years required for natural water sources under typical weather conditions to fill the lake one time. Natural water sources include runoff from the surrounding areas, precipitation falling directly upon a lake, water entering from tributary streams, and water contributed to a lake by groundwater.*

[c] *Shoreline development factor is the ratio of the shoreline length to the circumference of a circular lake of the same area. It can be used as an indicator of biological activity (i.e., the higher the value, the more likely the lake will be to have a productive biological community) and the length of shoreline per acre of open water.*

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, and SEWRPC

This report uses the information described above to develop a comprehensive set of specific recommendations to protect and enhance Little Muskego Lake, related to the issues and concerns of Little Muskego Lake residents, including an aquatic plant management plan. Implementing the recommended actions should be an important step in achieving long-term, sustainable Lake use and protection objectives.

[5] *Waukesha County,* Waukesha County Land and Water Resource Management Plan: 2012 Update.

INVENTORY FINDINGS 2

Credit: Flickr User Donal Rask

2.1 INTRODUCTION

Despite being a valuable resource, as described in Chapter 1, Little Muskego Lake requires aquatic plant management. To meet this end and to provide for the continued recreational use of the Lake, the Little Muskego Lake Protection and Rehabilitation District (LMLPRD) executed an agreement with the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to investigate the characteristics of Little Muskego Lake and its watershed and to develop an aquatic plant management update.

As a part of this planning process, a number of watershed and lake inventories were conducted, including:

- A survey of the aquatic plant community and comparison to results of previous aquatic plant surveys
- Analysis of available water quality data
- Characterization of watershed, land use, and shoreline conditions and potential sources of pollution, nutrients, and contaminants
- A summary of fish and wildlife data
- A survey of recreational uses on Little Muskego Lake

This chapter presents the results of each of these inventories.

2.2 AQUATIC PLANT MANAGEMENT

Aquatic plant management is the initial and primary purpose of this planning effort. Consequently, this section first discusses the general need for aquatic plant management by evaluating the current state of aquatic plants in Little Muskego Lake as compared to historical plant conditions and effectiveness of past plant management efforts. This data was then used to consider potential future aquatic plant management alternatives.

All lakes have plants. In fact, in nutrient-rich lakes such as Little Muskego Lake,[6] it is normal to have abundant aquatic plant growth in shallow areas. Additionally, it is important to note that **native aquatic plants are an integral part of lake ecosystems.** Aquatic plants serve a number of valuable functions including: improving water quality by using excess nutrients; providing habitat for invertebrates and fish; stabilizing lake bottom sediments; and supplying food and oxygen to the lake through photosynthesis. Given the importance of native aquatic plants to overall Lake health, it is desirable to periodically re-examine the abundance, distribution, and diversity of aquatic plants. Such data are then contrasted to historical conditions in the Lake itself and other similar lakes. Both comparisons help quantify the overall health of the aquatic plant community. A judgement can subsequently be made regarding the need for aquatic plant management and the locations and methods that provide the most overall apparent benefit to the Lake's health and user needs. Data and interpretations related to Little Muskego Lake are presented below.

Aquatic Plants in Little Muskego Lake

SEWRPC 2013 Aquatic Plant Survey

SEWRPC staff completed an aquatic plant survey for Little Muskego Lake during August and September 2013, using the point-intercept methodology.[7] Of the 503 sites shallow enough (15 feet or less) to be sampled in Little Muskego Lake, 485 had vegetation. This survey revealed that there were eighteen *native* submergent aquatic plant species found in Little Muskego Lake. The five most dominant native species were (in descending order of abundance): coontail *(Ceratophyllum demersum)*, eel-grass/wild celery (*Vallisneria americana)*, southern Naiad (*Najas guadalupensis*), waterweed/elodea (*Elodea canadensis*), and sago pondweed (*Stuckenia pectinata)*. In addition, the survey found the presence of two *invasive* aquatic plant species: Eurasian water milfoil *(Myriophyllum spicatum)* and curly-leaf pondweed *(Potamogeton crispus)*. Table 2.1 lists all aquatic plant species detected by SEWRPC during 2013 as well as each plant's abundance and dominance. Appendix A includes distribution maps for each aquatic plant species along with a brief description of the ecological significance of each plant and identification tips.

With a total of nineteen different native submerged and floating species of aquatic plants identified in 2013, it can be concluded that Little Muskego Lake contains a **very good diversity of aquatic species** (see Figure 2.1), especially for a lake of its size. Many lakes in the Region have communities of a dozen or more submergent aquatic plant species. It should be noted that muskgrass (eighth dominant species) is a macrophytic algal species, which is largely responsible for marl formation. Marl formation reduces lake water phosphorus concentrations through sequestration, which helps improve water quality, demonstrating the valuable ecological service muskgrass provides in Little Muskego Lake. Therefore, native plants, such as muskgrass, should be protected to the greatest extent practical.

The 2013 study conducted on Little Muskego Lake indicates that the sparsest plant growth is in the shallow northern portion of the Lake. This is potentially a result of high boat traffic coming in and out of the boat access located at Idle Isle Park. Furthermore, in the 2013 survey, of the 503 sites sampled that contained vegetation, 334 locations had wild celery and 344 sites had coontail (see Appendix A). While coontail occurred at more sites, its overall growth was less dense than that of wild celery, and it was located predominantly in the deeper portions of the Lake. Wild celery was quite dense throughout the Lake and was often found in shallower portions of the Lake. Wild celery has grown to a "nuisance" level in Little Muskego Lake, which is a concern to Lake residents and Lake users when it comes to proper management of this species. It is important, however, to note that even though a plant grows to a nuisance level and impedes access to a lake, it should not necessarily be *eliminated* or even significantly reduced, because it may serve other beneficial functions. For example, southern naiad, muskgrass, and elodea play a major role in providing shade, habitat, and food for fish and other important aquatic organisms. These plant species also play a significant role in reducing shoreline erosion since they can dampen waves that could otherwise damage shorelines. Additionally, the shade that these plants provide helps reduce growth of undesirable plants such as Eurasian water milfoil

[6] *Nutrient-rich lakes are very common in the Southeastern Wisconsin Region due to nutrient-rich soils. Southeastern Wisconsin soils are rich in phosphorus, a key and oftentimes growth-limiting plant nutrient.*

[7] *The point-intercept method uses predetermined sampling locations arranged in a grid pattern across the entire lake surface as fixed sampling sites. Each site is located using global positioning system (GPS) technology and a single rake haul is taken at each site. A quantitative assessment of the rake fullness (on a scale of zero to three) is then made for each species identified. Further details on the methodology can be found in Wisconsin Department of Natural Resources Publication No. PUB-SS-1068 2010.*

Table 2.1
Abundance Data for Aquatic Plant Species Sampled in Little Muskego Lake: August 2013

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a]	Frequency of Occurrence Within Vegetated Areas[b]	Average Rake Fullness[c]	Relative Frequency of Occurrence[d] (percent)	Visual Sightings[e]
Floating Plants						
Nymphaea odorata (white water lily)	Native	3	0.6	0.2	3.00	0
Submerged Plants						
Ceratophyllum demersum (coontail)	Native	344	70.9	1.7	18.85	0
Vallisneria americana (eel-grass/wild celery)[f]	Native	334	68.9	1.9	18.30	0
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	201	41.4	1.3	11.01	0
Najas guadalupensis (southern Naiad)	Native	193	39.8	1.4	10.58	0
Elodea canadensis (waterweed/elodea)	Native	150	30.9	1.2	8.22	0
Stuckenia pectinata (sago pondweed)[f]	Native	148	30.5	1.4	8.11	0
Potamogeton illinoensis (Illinois pondweed)[f]	Native	117	24.1	1.5	6.41	0
Chara spp. (muskgrass)	Native	98	20.2	1.5	5.37	0
Potamogeton richardsonii (clasping-leaf pondweed)[f]	Native	92	19.0	1.4	5.04	0
Heteranthera dubia (water stargrass)	Native	49	10.1	1.2	2.68	0
Potamogeton gramineus (variable pondweed)	Native	41	8.5	1.1	2.25	0
Potamogeton zosteriformis (flat-stem pondweed)	Native	19	3.9	1.1	1.04	0
Potamogeton crispus (curly-leaf pondweed)	Invasive	15	3.1	1.6	0.82	0
Utricularia spp. (bladderwort)	Native	8	1.6	1.4	0.44	0
Potamogeton foliosus (leafy pondweed)	Native	4	0.8	1.0	0.22	0
Potamogeton nodosus (long-leaf pondweed)	Native	3	0.6	1.0	0.16	0
Potamogeton pusillus (small pondweed)	Native	2	0.4	1.0	0.11	0
Potamogeton strictifolius (stiff pondweed)	Native	2	0.4	1.0	0.11	0
Polygonum amphibium (water smartweed)	Native	1	0.2	2.0	0.05	0
Potamogeton amplifolius (large-leaf pondweed)[f]	Native	1	0.2	1.0	0.05	0

Note: Sampling occurred at 503 sampling sites in August 2013. 485 of these sites had vegetation. Red text indicates non-native and/or invasive species. See Appendix A for distribution maps and identifying features.

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

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

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

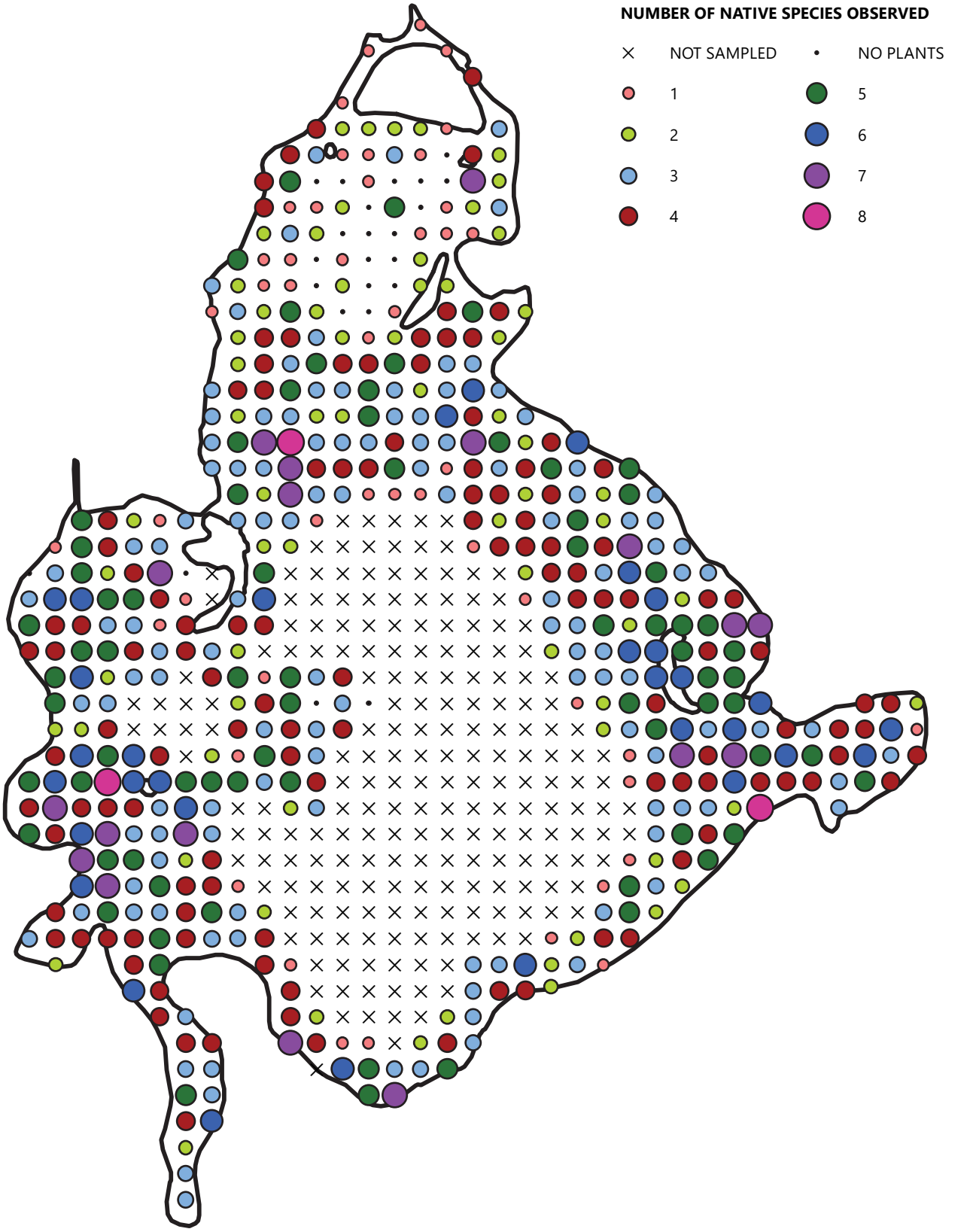
[d] *Relative Frequency of Occurrence, expressed as a percent, is the frequency of that particular species compared to the frequencies of all species present.*

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

[f] *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 2.1
Little Muskego Lake Aquatic Plant Survey Sites and Species Richness: August 2013



Note: The above diagram presents the data for number of species observed in Little Muskego Lake at each sampling site during the August 2013 aquatic plant survey. Sampling occurred at 503 sampling sites; 485 had vegetation. Samples were collected between August 26 and September 4, 2013.

Source: Wisconsin Department of Natural Resources and SEWRPC

and curly-leaf pondweed. Given these benefits, removal of native plants, even if they may be perceived as a nuisance, should be avoided when developing plans for aquatic plant management.

In addition to the native plants, the 2013 survey revealed that **the *invasive* species Eurasian water milfoil (*Myriophyllum spicatum*) was, overall, the third most dominant aquatic plant species**, and was distributed throughout the Lake (see Figure 2.2). Eurasian water milfoil has been known to cause severe recreational use problems in lakes in the Southeastern Wisconsin Region, because it can grow to the water surface and can displace native plant species. These results indicate that the Lake has abundant levels of plants that can deter recreational use, thereby warranting aquatic plant management.

Also identified was the *invasive* aquatic plant **curly-leaf pondweed (*Potamogeton crispus*)**. However, the distribution and density of curly-leaf pondweed was sparse in Little Muskego Lake (see Figure 2.3). In the spring, curly-leaf pondweed can interfere with recreational use of a lake by forming dense mats at the water's surface, and it can displace native aquatic plants. By mid-summer, curly-leaf pondweed starts to die off causing plant fragments to accumulate on shorelines.[8] The mid-summer die off is reflected in the sparse distribution found during late-summer surveys. As a result, there is likely a need to actively control its population.

The terms "non-native" and "invasive" are often confused and incorrectly assumed to be synonymous. Non-native is an overarching term describing living organisms introduced to new areas beyond their native range with intentional or unintentional human help. Non-native species may not necessarily harm ecological function or human use values in their new environments. Invasive species are the subset of non-native species that cause damaging impacts on the ecological health of their new environments and/or are considered a nuisance to human use values. In summary, **invasive species are non-native but not all non-native species are invasive**.

Invasive species, either plants or animals, can severely disrupt both terrestrial and aquatic natural systems**. Invasive species reproduce prolifically and often have no natural predators to control their growth, factors that allow them to outcompete native species for space and other necessary resources. This can devastate native species populations that have well developed co-dependencies with native plants and animals.**

WDNR 2014 Aquatic Plant Survey

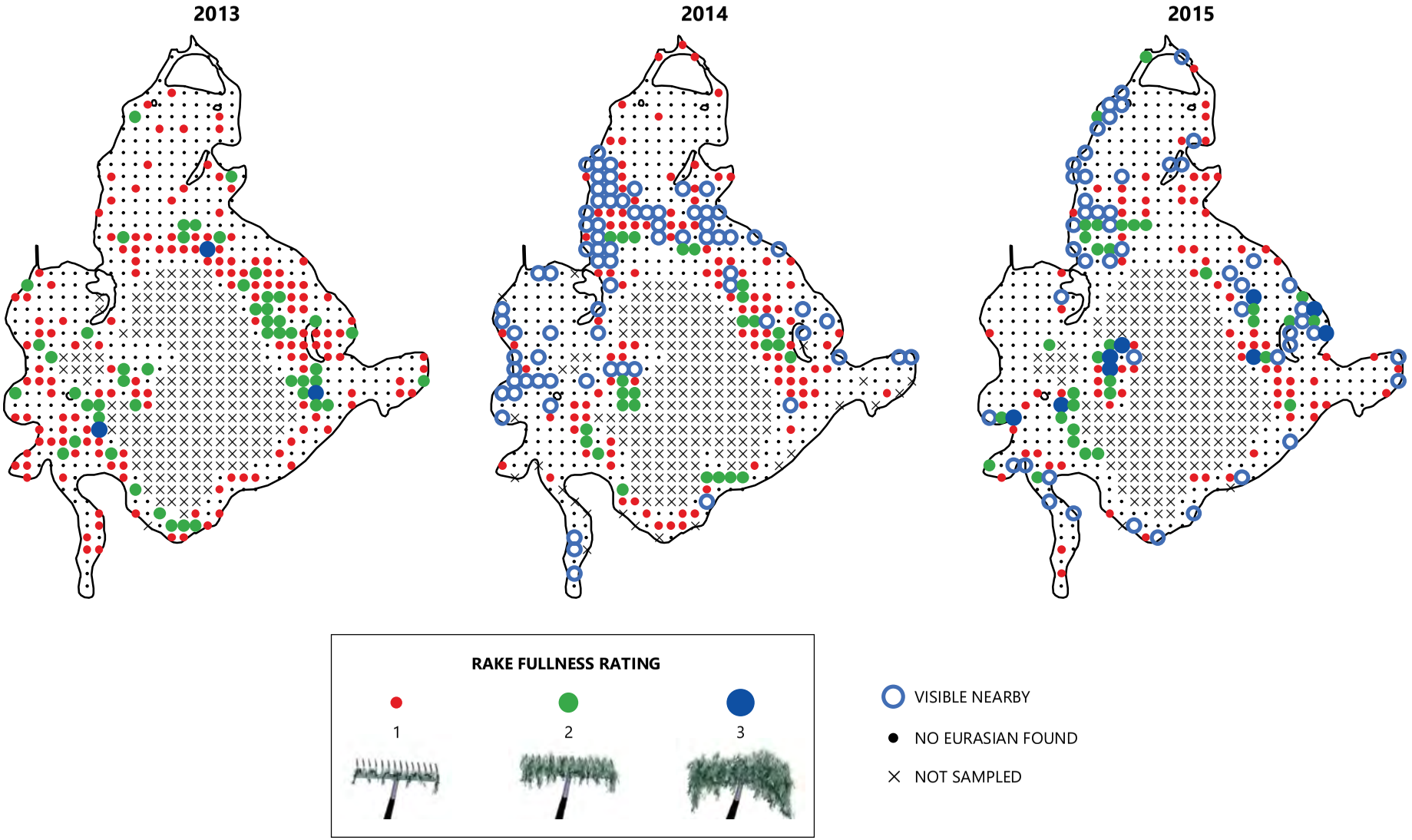
WDNR staff completed an aquatic plant survey of Little Muskego Lake during September 2014 using the point-intercept method. This survey was conducted as a routine sampling of lakes throughout the Region. Of the 564 sites sampled in Little Muskego Lake in 2014, 442 had vegetation (see Figure 2.4). Table 2.2 lists all aquatic plant detected by WDNR during 2014 as well as each plant's relative abundance and dominance. Both the 2013 and 2014 surveys were conducted using the point-intercept method, allowing for a comparison of species relative frequency. According to the data, the relative frequency of coontail, and Eurasian water milfoil decreased. Conversely, wild celery and muskgrasses relative frequencies increased. Furthermore, six additional species were identified in 2014, although all were present in very small amounts: northern water milfoil (*Myriophyllum sibiricum*), slender Naiad (*Najas flexilis*), spiny Naiad (*Najas marina*), Fries' pondweed (*Potamogeton friesii*), white-stem pondweed (*Potamogeton praelongus*), and white water crowfoot (*Ranunculus aquatilis*).

There was a 20 percent decrease in Eurasian water milfoil's dominance value between 2013 and 2014 (see Table 2.2 and Figure 2.2). Many of the native plants also experienced reductions in growth between the 2013 and 2014 growing seasons. This is most likely due to the extremely cold winter of 2013 to 2014. Little Muskego Lake and other lakes within the region reported ice cover between 30 to 38 inches.[9] Thick ice cover and snow reduced light penetration to aquatic plants. Eurasian water milfoil growing in areas equal to or shallower than ice thickness was largely frozen out. See Appendix A for comparisons of species distribution.

[8] *Curly-leaf pondweed has a shortened growing season. It usually starts growing in early spring and starts to die back by mid-summer. Therefore, the populations of curly-leaf in the 2014 WDNR and the 2013 and 2015 SEWRPC field surveys most likely do not represent the actual population in the Lake.*

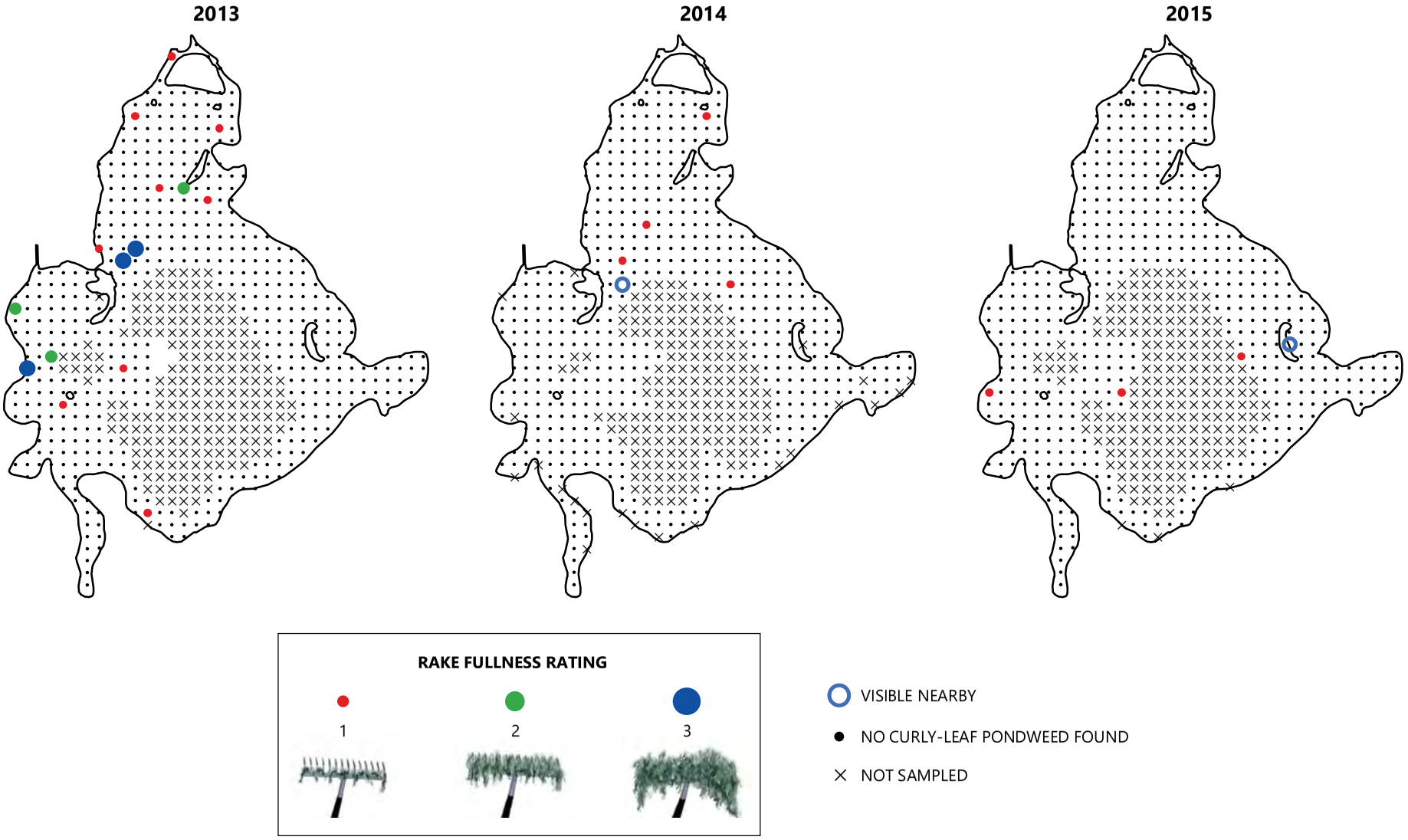
[9] *Personal communication with WDNR Water Resources Management Specialist.*

Figure 2.2
Eurasian Water Milfoil Occurrence in Little Muskego Lake: August 2013, September 2014, and September 2015



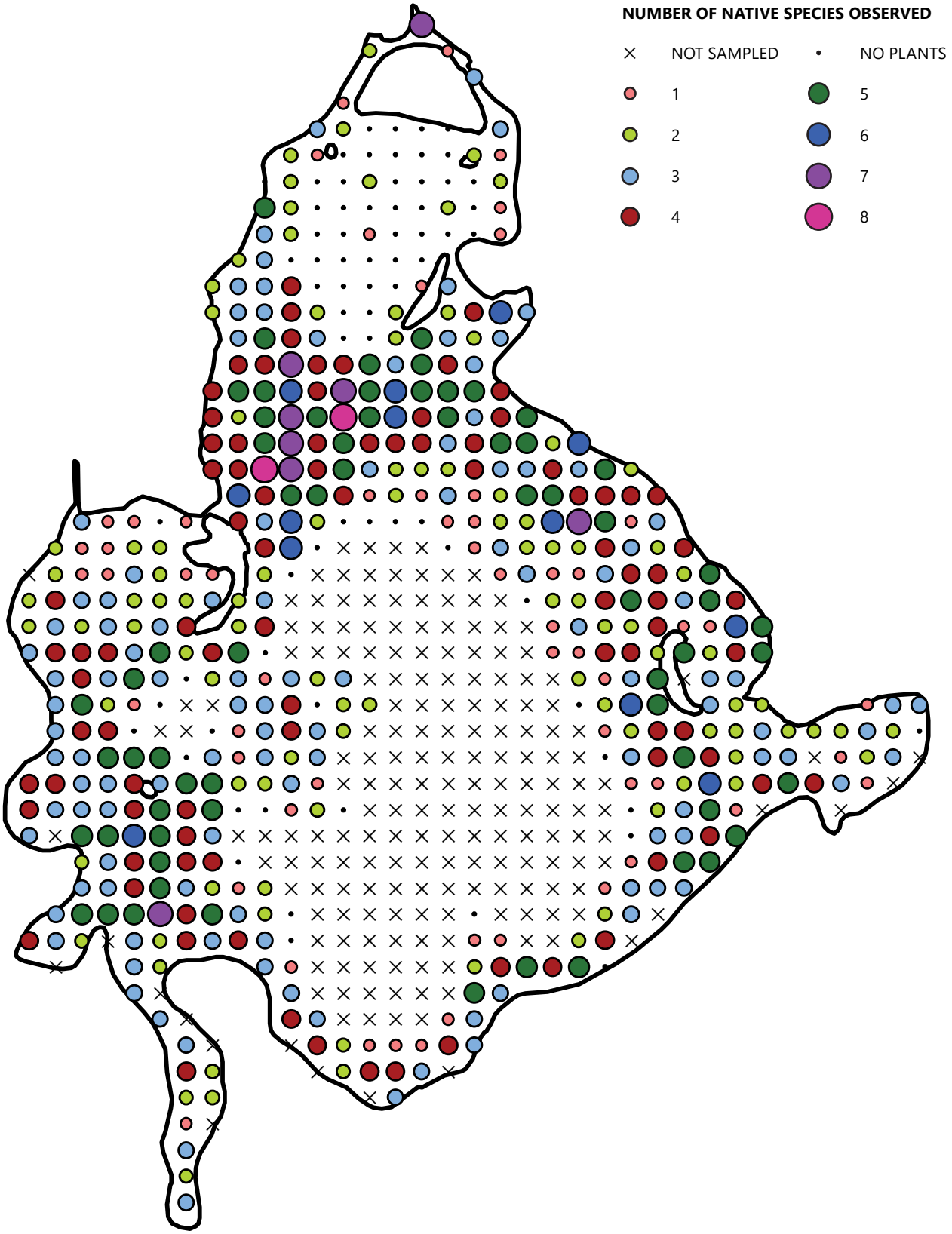
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.3
Curly-leaf Pondweed Occurrence in Little Muskego Lake: August 2013, September 2014, and September 2015



Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.4
Little Muskego Lake Aquatic Plant Survey Sites and Species Richness: September 2014



Note: The above diagram presents the data for number of species observed in Little Muskego Lake at each sampling site during the September 2014 aquatic plant survey; sampling occurred at 564 sampling sites, 442 had vegetation. Samples were collected between September 9 and 18, 2014.

Source: Wisconsin Department of Natural Resources and SEWRPC

Table 2.2
Abundance Data for Aquatic Plant Species Sampled in Little Muskego Lake: September 2014

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a]	Frequency of Occurrence Within Vegetated Areas[b]	Average Rake Fullness[c]	Relative Frequency of Occurrence[d] (percent)	Visual Sightings[e]
Floating Plants						
Nymphaea odorata (white water lily)	Native	1	0.2	2.0	0.07	3
Submerged Plants						
Vallisneria americana (eel-grass/wild celery)[g]	Native	309	69.9	1.4	20.57	3
Ceratophyllum demersum (coontail)	Native	260	58.8	1.4	17.31	4
Najas guadalupensis (southern naiad)	Native	207	46.8	1.0	13.78	1
Chara spp. (muskgrass)	Native	162	36.7	1.3	10.79	0
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	135	30.5	1.2	8.99	76
Potamogeton illinoensis (Illinois pondweed)[g]	Native	106	24.0	1.2	7.06	16
Elodea canadensis (waterweed/elodea)	Native	90	20.4	1.0	5.99	0
Potamogeton richardsonii (clasping-leaf pondweed)[g]	Native	74	16.7	1.1	4.93	14
Heteranthera dubia (water stargrass)	Native	53	12.0	1.0	3.53	6
Stuckenia pectinata (sago pondweed)[g]	Native	47	10.6	1.0	3.13	10
Potamogeton zosteriformis (flat-stem pondweed)	Native	19	4.3	1.0	1.26	5
Potamogeton friesii (Fries' pondweed)	Native	10	2.3	1.0	0.67	0
Najas flexilis (slender naiad)	Native	6	1.4	1.0	0.40	1
Potamogeton foliosus (leafy pondweed)	Native	6	1.4	1.0	0.40	1
Nitellopsis obtusa (starry stonewort)	Invasive	5	1.1	1.0	0.33	0
Potamogeton crispus (curly-leaf pondweed)	Invasive	4	0.9	1.0	0.27	1
Myriophyllum sibiricum (northern water milfoil)	Native	3	0.7	1.0	0.20	0
Potamogeton gramineus (variable pondweed)	Native	2	0.5	1.0	0.13	0
Najas marina (spiny naiad)[f]	Non-native	1	0.2	1.0	0.07	0
Potamogeton praelongus (white-stem pondweed)[g]	Native	1	0.2	1.0	0.07	0
Ranunculus aquatilis (white water crowfoot)	Native	1	0.2	1.0	0.07	0

Note: Sampling occurred at 564 sampling sites in September 2014. 442 of these sites had vegetation. Red text indicates non-native and/or invasive species. See Appendix A for distribution maps and identifying features.

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

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

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

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

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

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

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

Source: Wisconsin Department of Natural Resources and SEWRPC

Finally, a new potentially invasive macrophytic algal species, starry stonewort (*Nitellopsis obtusa*), was identified during the 2014 survey conducted by WDNR (see Table 2.2 and Figure 2.5). The species was only found in low densities at five sampling sites in Hillview Bay located in the northwest corner of the Lake. However, this was a concern because starry stonewort can form extremely dense mats, which may affect the species richness of the aquatic plant community and can cause recreational use impediments. The overgrowth of starry stonewort can also reduce the movement of fish and other animals and reduce fish spawning.[10] Starry stonewort is indigenous to Eurasia and first appeared in the United States in 1978 along the St. Lawrence River. At the writing of this report, starry stonewort has been found in Indiana, Michigan, Minnesota, New York, Pennsylvania, Vermont, and Wisconsin.[11] The finding of this new species in Little Muskego Lake in 2014 was the first in Wisconsin and led to randomized sampling of lakes in the Region, conducted by WDNR staff, to search for and identify starry stonewort. After its discovery in Little Muskego Lake, starry stonewort also was found in Big Muskego Lake and Bass Bay Lake in Waukesha County, Pike Lake and Silver Lake in Washington County, and Long Lake and Wind Lake in Racine County.

SEWRPC and WDNR 2015 Starry Stonewort Surveys

SEWRPC staff collaborated with WDNR staff in April 2015 to conduct a more concentrated point-intercept survey of Hillview Bay to assess the presence and extent of starry stonewort. A total of 305 points were sampled within the bay for presence of both fragments of the macroalgae and the distinct bulbils it produces (See Appendix A). Starry stonewort fragments and/or bulbils were found at 47 sampling points (see Figure 2.6). At that time, rake fullness, a measure of species abundance, was not rated because it was too early in the growing season. In addition to the point-intercept survey, a meander survey was conducted around the entire Lake, targeting areas such as boat landings, inlets, and shorelines downwind of boat landings.[12] During the April meander survey, no other populations of starry stonewort were found.

The concentrated survey was conducted again by WDNR staff in July and September 2015. Since these studies were conducted during the growing season, there was sufficient algal material to assess density at each point where starry stonewort was found. Other aquatic plant species present were documented as well. Starry stonewort was identified and collected at 168 of the 305 sampling points in July and 170 points in September (see Table 2.3). Although, the number of sites at which starry stonewort was found increased, the relative frequency of the species decreased slightly, because of a density decrease at most sites. Some of this may be attributed to management efforts already underway that are discussed later in this report. In addition to starry stonewort, the two most frequently found species in Hillview Bay were muskgrasses (*Chara spp*.) and wild celery (*Vallisneria americana*).

SEWRPC 2015 Aquatic Plant Survey

In September 2015, SEWRPC staff conducted an additional aquatic plant survey of the entire Lake using the point-intercept method. This survey was conducted as a reassessment of the aquatic plant community and of the presence and extent of starry stonewort populations, if any, throughout the Lake. Of the 500 sites sampled in Little Muskego Lake in 2015, 462 had vegetation (see Figure 2.7). Table 2.4 lists all aquatic plant species detected by SEWRPC during 2015 as well as each plant's relative abundance and dominance. The 2015 survey was conducted with the same method as the surveys in 2013 and 2014 allowing for a comparison of

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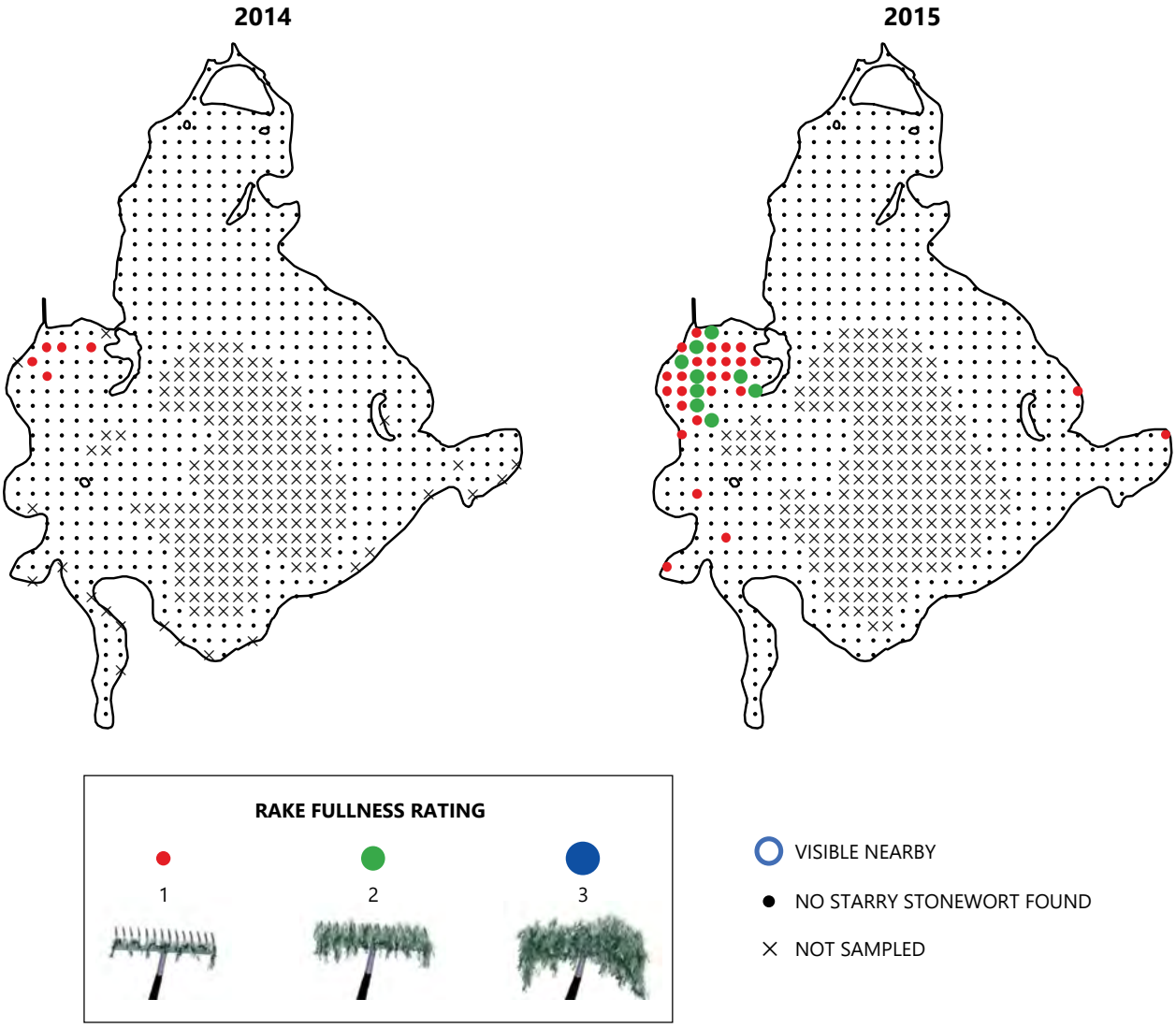
[10] "Aquatic Invasive Species Quick Guide: Starry Stonewort (*Nitellopsis obtusa L.*)". *Golden Sands Resource Conservation and Development Council, Inc. This Quick Guide is part of a series on aquatic invasive species, and may be reproduced for educational purposes. Visit uwsp.edu/cnr/uwexlakes/clmn or goldensandsrcd.org/our-work/water to download this series of handouts. Developed by Golden Sands Resource Conservation & Development Council, Inc. as part of an aquatic invasive species education program, supported by a grant from the Wisconsin Department of Natural Resources. Maintained and updated by the Wisconsin Citizen Lake Monitoring Network.*

[11] USGS Nonindigenous Aquatic Species Database, Gainesville, FL, and NOAA Great Lakes Aquatic Nonindigenous Species Information System, Ann Arbor, MI. nas.er.usgs.gov/queries/GreatLakes/FactSheet.aspx?NoCache=10%2F12%2F2010+4%3A29%3A34+AM&SpeciesID=1688&State=&HUCNumb.

[12] *The meander survey is conducted by choosing target areas such as inlets, plant filled bays, rocky bars/points, developed shorelines, shorelines downwind of boat landings, and backyard boat access points and then driving a boat slowly between targets sites and between shallow water and maximum rooting depth, performing about 10 rake throws between target sites for a total of 50 meander survey sites. More information can be found in: Wisconsin Department of Natural Resources*, Aquatic Invasive Species Early Detection Monitoring: Standard Operating Procedures, *Draft June 7, 2013*.

Figure 2.5
Starry Stonewort Occurrence in Little Muskego Lake: September 2014 and September 2015



Note: Starry stonewort was not found in Little Muskego Lake in 2013.

Source: Wisconsin Department of Natural Resources and SEWRPC

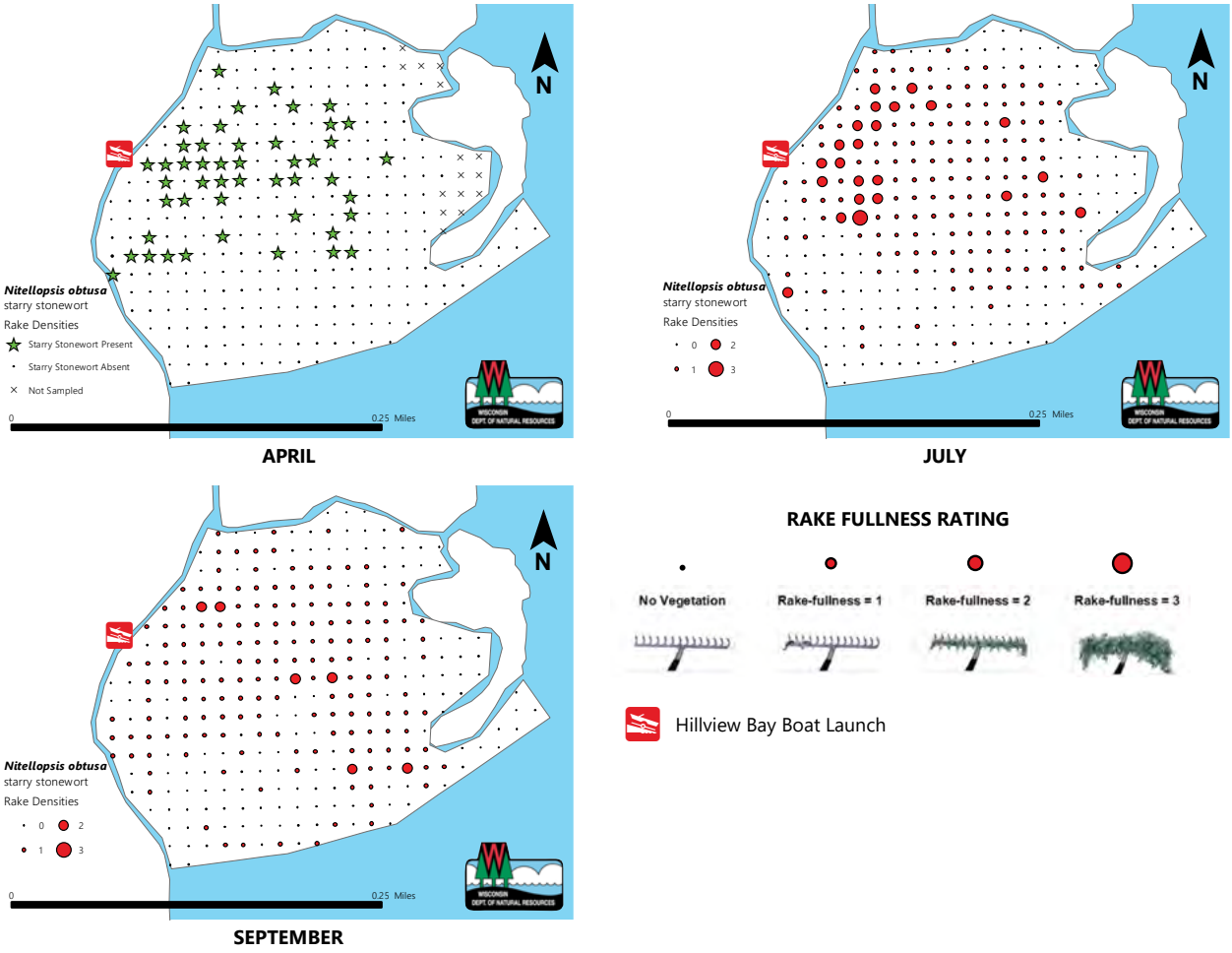
species relative frequency. According to the 2015 data in Table 2.4, wild celery, elodea, and Sago pondweed rebounded from their decreases in 2014 while coontail did not. Conversely, muskgrasses increased even further in dominance from 2014. The presence of southern Naiad decreased greatly from 2014 to 2015. Eurasian water milfoil's relative frequency did not change between 2014 and 2015.

Starry stonewort's relative frequency increased slightly from 2014 to 2015. In addition to increased densities and range of the population within Hillview Bay, satellite populations of starry stonewort were found in five locations around Little Muskego Lake. Three of these populations were found in the western portion of the Lake, close to the original colony, while two other populations were found on the eastern shore of the Lake. Volunteer divers also located five populations outside of Hillview Bay during the summer of 2015, but all were located in the western portion of the Lake.

Historical Aquatic Plant Comparison

Little Muskego Lake's aquatic plant community was surveyed by WDNR staff in August 1967, July 1992, and September 2014 and by SEWRPC staff in July 1994, August 2002, October 2007, August 2013, and September

Figure 2.6
Starry Stonewort Occurrence in Hillview Bay, Little Muskego Lake: April,[a] July,[b] and September[b] 2015



Note: Starry stonewort was not found in Little Muskego Lake in 2013.

[a] *The survey completed in April looked for presence of algal fragments and bulbils. It was too early in the growing season for significant algal growth so rake density, a measure of the abundance of starry stonewort at a sampling point, was not rated.*

[b] *The surveys conducted in July and September were late enough in the growing season to rate rake density, a measure of the abundance of starry stonewort at a sampling point.*

Source: Wisconsin Department of Natural Resources and SEWRPC

2015. The aquatic plant surveys conducted in the Lake prior to 2013 used line-transect methodology,[13] while the 2013, 2014, and 2015 field surveys used the point-intercept method. As a result of the use of two different methodologies, a direct comparison of the historical aquatic plant data to the most recent aquatic plant data was not developed. Nevertheless, earlier data do allow comparison of the presence and abundance of particular aquatic plants species observed over time within the Lake (see Table 2.5). Little Muskego Lake exhibits an overall increase in species diversity since aquatic plant surveys began. In particular, most of the additional species reported since 2007 have been comprised of various pondweeds, a group of aquatic plants beneficial to lake ecosystems (see Appendix A). The differences between these surveys may reflect: 1) differing sampling techniques, 2) the results of aquatic plant management practices, 3) differences in sampling dates during the growing season, or 4) the natural periodicity of different species. Surveys

[13] *The line-transect survey was developed from the grid sampling method of Jesson and Lound (1964). Twenty-five transects approximately 1,000 feet apart were established on a Lake map. Each transect (or line) extended from the shoreline to the maximum rooting depth within the Lake. Four sampling points were established on each transect line at 1.5 feet, 5.0 feet, 9.0 feet, and 11.0 feet. Each sampling point was a six-foot diameter circle. Each circle was divided into four quadrants and sampled with a garden rake.*

Table 2.3
Aquatic Plant Abundance Data for Hillview Bay in Little Muskego Lake: July and September 2015

Aquatic Plant Species	Native or Invasive	July[a]		September[b]	
		Number of Sites Found	Relative Frequency[c] (percent)	Number of Sites Found	Relative Frequency[c] (percent)
Floating Plants					
Nymphaea odorata (white water lily)	Native	--	--	3	0.3
Submerged Plants					
Vallisneria americana (eel-grass/wild celery)	Native	235	32.5	238	27.0
Chara spp. (muskgrass)	Native	231	32.0	280	23.6
Nitellopsis obtusa (starry stonewort)	Invasive	168	23.3	170	19.3
Elodea canadensis (waterweed/elodea)	Native	37	5.1	60	6.8
Ceratophyllum demersum (coontail)	Native	32	4.4	37	4.2
Najas guadalupensis (southern naiad)	Native	--	--	11	1.3
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	--	--	9	1.0
Potamogeton illinoensis (Illinois pondweed)	Native	14	1.9	54	6.1
Elodea nuttallii (slender waterweed)	Native	5	0.7	--	--
Stuckenia pectinata (sago pondweed)	Native	--	--	86	9.8
Heteranthera dubia (water stargrass)	Native	--	--	4	0.5

Note: In April 2015, sampling occurred at 290 sites. The survey focused on presence and extent of starry stonewort and did not document other species or record rakefull values. Therefore, data were not included in this table for comparison. Red text indicates non-native and/or invasive species, see Appendix A for more details.

[a] *Sampling occurred at 282 sites; 274 sites had vegetation.*

[b] *Sampling ocured at 290 sites; 286 sites had vegetation.*

[c] *The relative frequency is an individual plant's frequency of occurrence divided by the sum of the frequency of occurrence of all plants.*

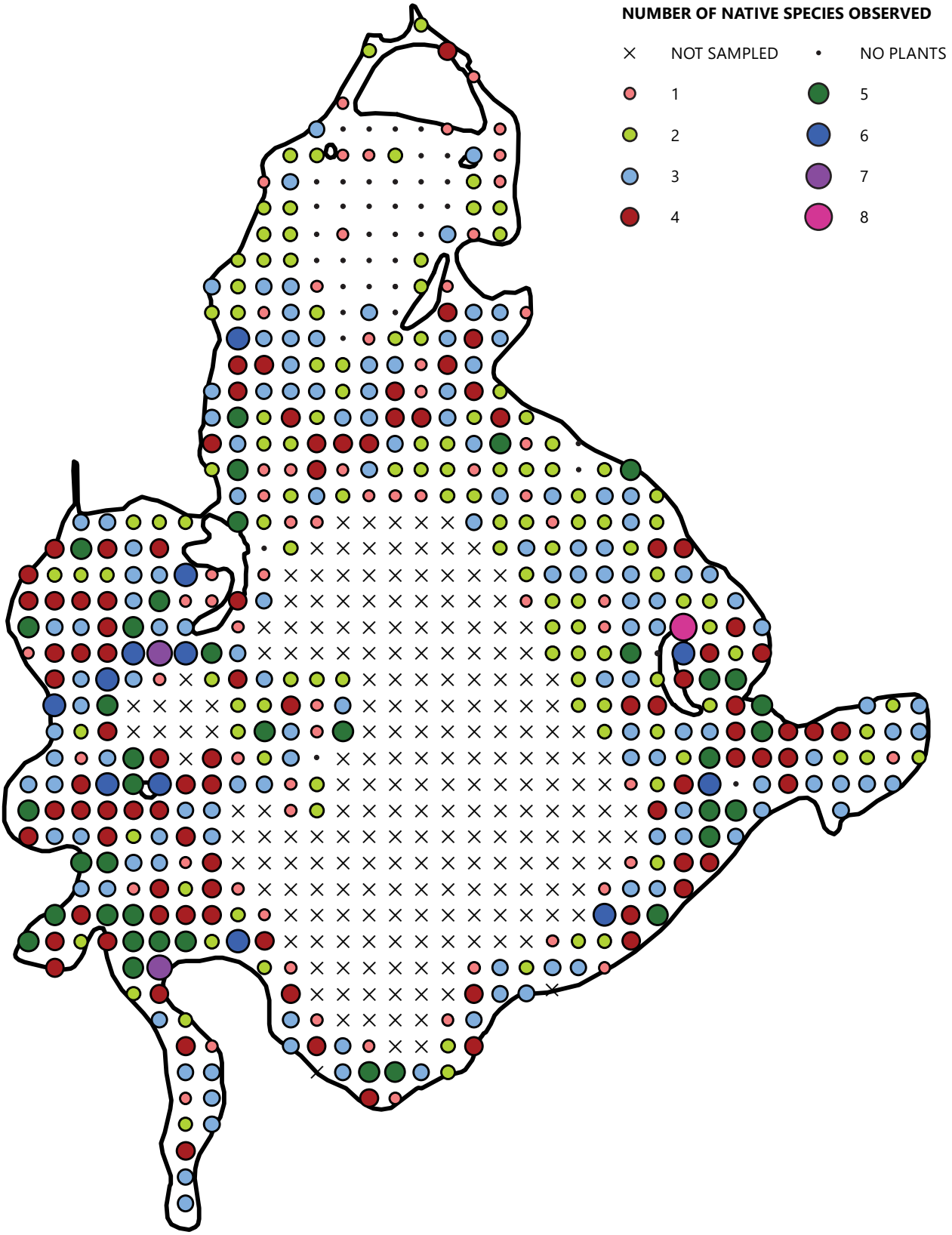
Source: Wisconsin Department of Natural Resources and SEWRPC

completed before 2007 were primarily completed in July and August, while more recent surveys have been completed in September. Differences also may reflect more aggressive aquatic plant management techniques in the past.

Comingled Stands of Invasive and Native Species

Curly-leaf pondweed, Eurasian water milfoil, and starry stonewort often form mixed stands with native plants. In recent surveys, curly-leaf pondweed has been found to coexist with up to eight native species, including muskgrasses, elodea, clasping-leaf pondweed, Sago pondweed, flat-stem pondweed, and water stargrass. However, curly-leaf pondweed tends to die out by early to mid-summer, so its coexistence with other species is limited (see Figure 2.8). Eurasian water milfoil, on the other hand, is well established throughout Little Muskego Lake and can often be mixed into stands with as many as eight native species (see Figure 2.9). Starry stonewort also coexists with several other native aquatic plant species (see Figure 2.10). In 2014, starry stonewort distribution was sparse and was only found with a few native aquatic plants, including wild celery, clasping-leaf pondweed, and southern naiad. In 2015, starry stonewort was found mixed with as many as six native species: wild celery, Sago pondweed, elodea, white water lilies, muskgrasses, and coontail. Comingling of invasive species with native aquatic plants is important to consider when determining aquatic plant management techniques. Eurasian water milfoil management, for example, could be eradicated with heavy chemical treatment. However, since Eurasian water milfoil often forms mixed stands with native plants, including a very similar looking native milfoil plant (see Appendix A), this technique would fail to preserve native plant populations. Heavy chemical treatment of areas containing starry stonewort could reduce native species populations and create more space for starry stonewort to establish, because there are no known approved herbicide chemicals that can destroy starry stonewort bulbils (reproductive structures). Therefore, all aquatic plant management alternatives described in this section balance three oftentimes conflicting goals: maintaining human access to open waters, controlling the extent and spread of Eurasian water milfoil and other non-native species, and protecting native aquatic plants.

Figure 2.7
Little Muskego Lake Aquatic Plant Survey Sites and Species Richness: September 2015



Note: The above diagram presents the data for number of species observed in Little Muskego Lake at each sampling site during the September 2015 aquatic plant survey; sampling occurred at 500 sampling sites, 462 had vegetation. Samples were collected between September 9 and 21, 2015.

Source: Wisconsin Department of Natural Resources and SEWRPC

Table 2.4
Abundance Data for Aquatic Plant Species Sampled in Little Muskego Lake: September 2015

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a]	Frequency of Occurrence Within Vegetated Areas[b]	Average Rake Fullness[c]	Relative Frequency of Occurrence[d] (percent)	Visual Sightings[e]
Floating Plants						
Nymphaea odorata (white water lily)	Native	3	0.6	2.7	0.21	5
Submerged Plants						
Vallisneria americana (eel-grass/wild celery)[f]	Native	339	69.2	1.8	23.79	12
Ceratophyllum demersum (coontail)	Native	247	50.4	1.5	17.33	4
Chara spp. (muskgrass)	Native	186	38.0	1.9	13.05	4
Elodea canadensis (waterweed/elodea)	Native	161	32.9	1.3	11.30	2
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	128	26.1	1.4	8.98	55
Stuckenia pectinata (sago pondweed)[f]	Native	116	23.7	1.4	8.14	15
Heteranthera dubia (water stargrass)	Native	64	13.1	1.4	4.49	18
Nitellopsis obtusa (starry stonewort)	Invasive	35	7.1	1.3	2.46	0
Najas guadalupensis (southern naiad)	Native	33	6.7	1.1	2.32	2
Potamogeton praelongus (white-stem pondweed)[f]	Native	32	6.5	1.3	2.25	11
Najas flexilis (slender naiad)	Native	30	6.1	1.1	2.11	0
Potamogeton illinoensis (Illinois pondweed)[f]	Native	19	3.9	1.5	1.33	8
Potamogeton gramineus (variable pondweed)	Native	18	3.7	1.2	1.26	9
Potamogeton richardsonii (clasping-leaf pondweed)[f]	Native	7	1.4	1.0	0.49	13
Potamogeton crispus (curly-leaf pondweed)	Invasive	3	0.6	1.0	0.21	1
Potamogeton friesii (Fries' pondweed)	Native	3	0.6	1.0	0.21	2
Potamogeton foliosus (leafy pondweed)	Native	1	0.2	1.0	0.07	1

Note: Sampling occurred at 500 sampling sites in September 2015. 490 of these sites had vegetation. Red text indicates non-native and/or invasive species. See Appendix A for distribution maps and identifying features.

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

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

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

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

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

[f] *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.

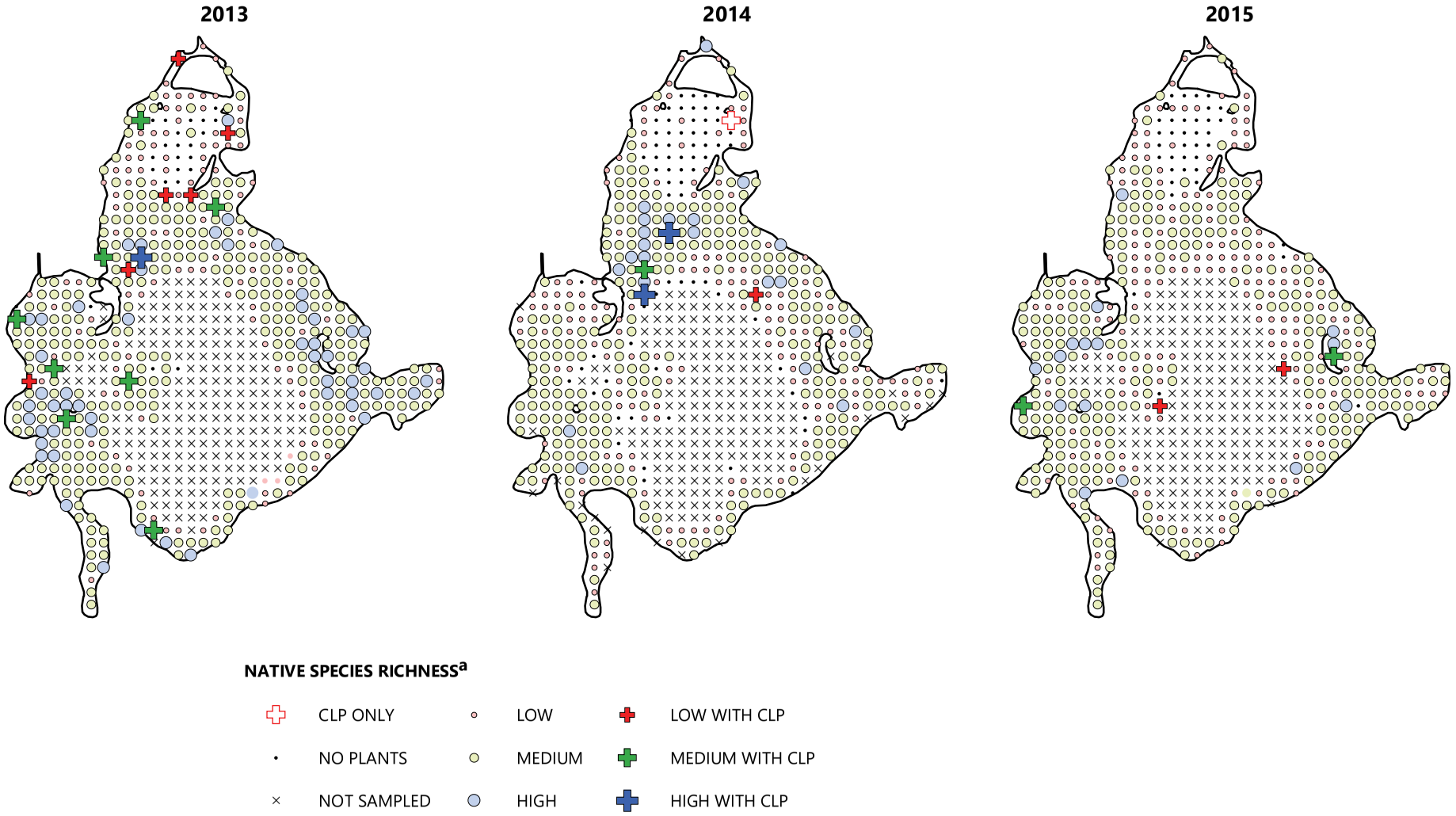
Source: Wisconsin Department of Natural Resources and SEWRPC

Table 2.5
Aquatic Plant Species Observed in Little Muskego Lake: 1967, 1992, 1994, 2002, 2007, 2013, 2014, and 2015

Aquatic Plant Species	August 1967	July 1992	June 1994	August 2002	September 2007	August 2013	September 2014	September 2015
Invasive Aquatic Plants								
Myriophyllum spicatum (Eurasian water milfoil)	--	X	X	X	X	X	X	X
Nitellopsis obtusa (starry stonewort)	--	--	--	--	--	--	X	X
Potamogeton crispus (curly-leaf pondweed)	X	X	X	X	X	X	X	X
Non-native Aquatic Plants								
Najas marina (Spiny naiad)	--	--	--	--	--	--	X	--
Native Aquatic Plants								
Ceratophyllum demersum (coontail)	X	X	X	X	X	X	X	X
Chara spp. (muskgrass)	X	X	X	X	X	X	X	X
Elodea canadensis (waterweed/elodea)	X	--	--	X	X	X	X	X
Heteranthera dubia (water stargrass)	--	--	--	X	X	X	X	X
Myriophyllum sibiricum (northern water milfoil)	X	--	--	--	X	--	X	--
Najas flexilis (slender naiad)	--	X	X	X	X	--	X	X
Najas guadalupensis (southern naiad)	--	--	--	--	--	X	X	X
Nitella spp. (nitella)	--	X	--	--	--	--	--	--
Nymphaea odorata (white water lily)	X	X	X	X	--	X	X	X
Polygonum amphibiam (water smartweed)	--	--	--	--	--	X	--	--
Potamogeton amplifolius (large-leaf pondweed)	--	--	--	--	--	X	--	--
Potamogeton foliosis (leafy pondweed)	--	--	--	--	X	X	X	X
Potamogeton friesii (Fries' pondweed)	--	--	--	--	--	--	X	X
Potamogeton gramineus (variable pondweed)	--	--	--	X	X	X	X	X
Potamogeton illinoensis (Illinois pondweed)	--	--	--	X	X	X	X	X
Potamogeton nodosus (long-leaf pondweed)	--	--	--	--	--	X	--	--
Potamogeton praelongus (whitestem pondweed)	X	--	--	--	--	--	X	X
Potamogeton pusillus (small pondweed)	--	--	--	X	X	X	--	--
Potamogeton richardsonii (clasping-leaf pondweed)	--	X	X	X	X	X	X	X
Potamogeton spp. (narrow leaf pondweed)	X	--	--	--	--	--	--	--
Potamogeton strictifolius (stiff pondweed)	--	--	--	--	--	X	--	--
Potamogeton zosteriformis (flat-stem pondweed)	X	X	X	X	X	X	X	--
Ranunculus aquatilis (white water crowfoot)	--	--	--	X	X	--	X	--
Ranunculus sp. (water crowfoot)	X	--	--	--	--	--	--	--
Stuckenia pectinata (sago pondweed)	X	--	--	X	X	X	X	X
Utricularia spp. (bladderwort)	--	--	--	--	X	X	--	--
Vallisneria americana (eel-grass/wild celery)	X	X	X	X	X	X	X	X
Total Native Species	11	8	7	14	16	19	18	15

Source: Wisconsin Department of Natural Resources and SEWRPC

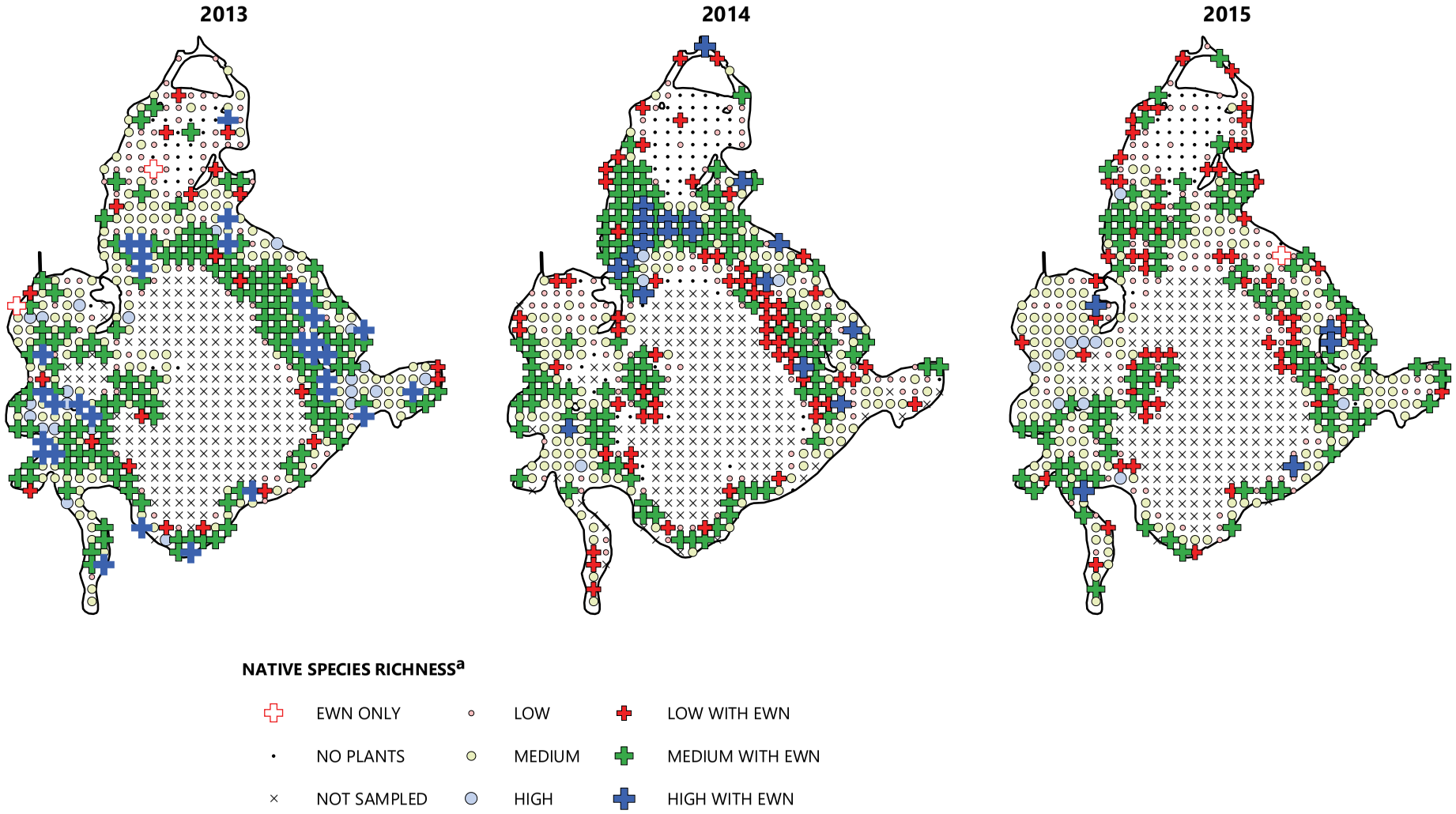
Figure 2.8
Comingled Stands of Curly-leaf Pondweed and Native Aquatic Plants in Little Muskego Lake: August 2013, September 2014, and September 2015



[a] *Native species richness refers to the number of native plants present at sampling site: Low=1 or 2; Medium=3, 4, or 5; and High=6, 7, or 8.*

Source: Wisconsin Department of Natural Resources and SEWRPC

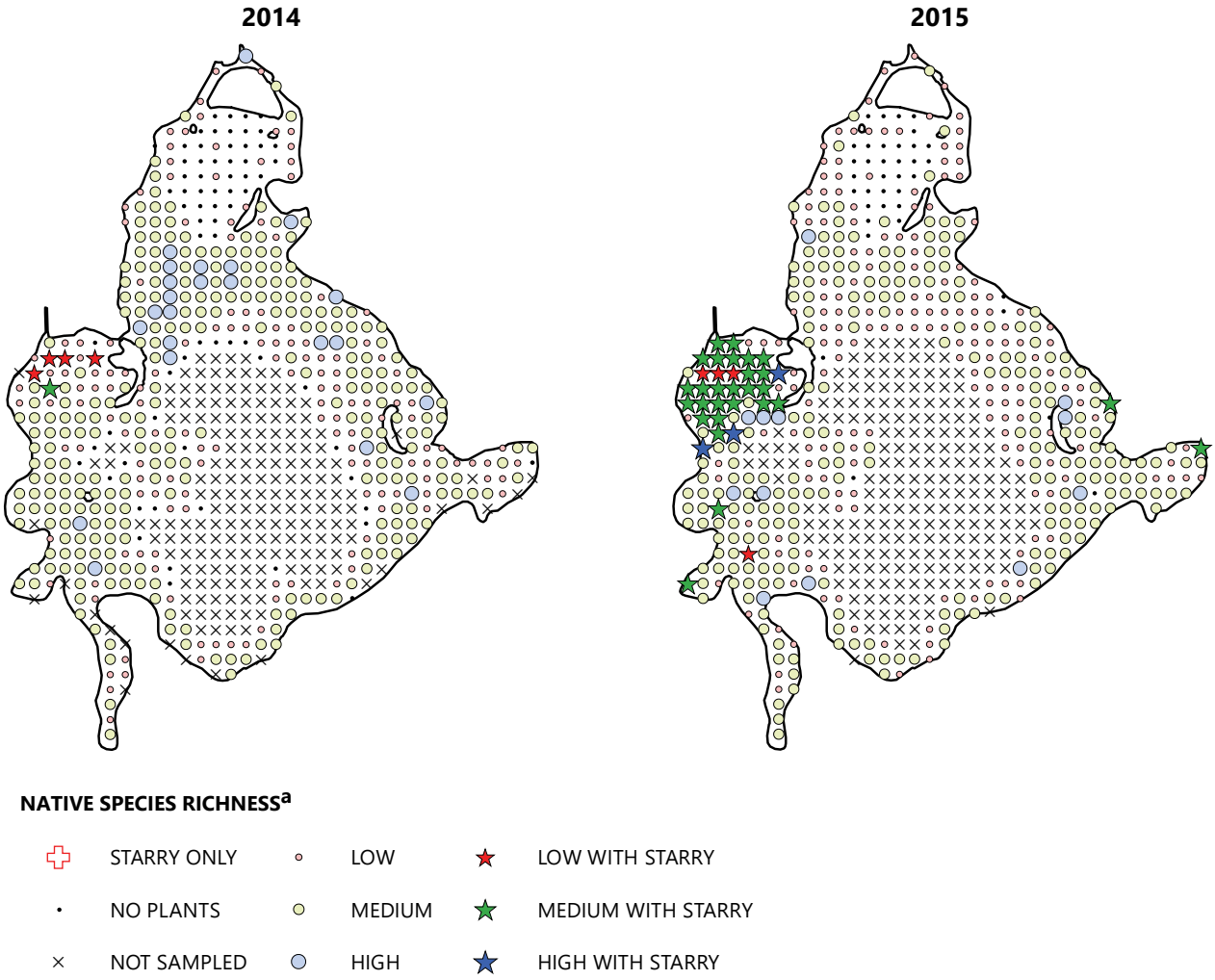
Figure 2.9
Comingled Stands of Eurasian Water Milfoil and Native Aquatic Plants in Little Muskego Lake: August 2013, September 2014, and September 2015



[a] *Native species richness refers to the number of native plants present at sampling site: Low=1 or 2; Medium=3, 4, or 5; and High=6, 7, or 8.*

Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.10
Comingled Stands of Starry Stonewort and Native Aquatic Plants in Little Muskego Lake: September 2014 and September 2015



Note: Starry stonewort was not found in Little Muskego Lake in 2013.

[a] *Native species richness refers to the number of native plants present at sampling site: Low=1 or 2; Medium=3, 4, or 5; and High=6, 7, or 8.*

Source: Wisconsin Department of Natural Resources and SEWRPC

Past and Present Aquatic Plant Management Practices

Aquatic plants have occurred within Little Muskego Lake in such abundance that they have frequently been perceived as a problem, interfering with recreational uses and aesthetic enjoyment of the Lake. The aquatic plant surveys conducted on Little Muskego Lake within the last 10 years indicate a relatively stable aquatic plant community. Few changes are apparent during this period, despite an extensive aquatic plant management program. The Lake generally supports a healthy and diverse aquatic macrophyte community, although stands of Eurasian water milfoil occur throughout the waterbody.

As set forth in the adopted lake management plan, a documented aquatic plant management program has been carried out on Little Muskego Lake since 1950, when records of aquatic plant management efforts were first maintained by the WDNR. Prior to 1950, aquatic plant management interventions are likely to have occurred, but were not recorded. The early aquatic plant control program conducted on Little Muskego Lake can be categorized as a chemical control program designed to minimize nuisance growths of aquatic macrophytes and algae (see Table 2.6). Between 1950 and 1969, copper sulfate and sodium arsenite were the primary chemicals used to control perceived nuisance growths of algae and aquatic plants. Additionally, Endothall and 2,4-D, along with a host of other chemicals have been applied to Little Muskego

Table 2.6
Chemical Herbicides Applied to Aquatic Plants in Little Muskego Lake: 1950-2015

	Algae Control		Macrophyte Control					
Year	Cutrine Plus (gallons)	Copper Sulfate (pounds)	Sodium Arsenite (pounds)	2,4-D (pounds)	Hydrothol (gallons)	Diquat (gallons)	Glyphosate (gallons)	Endothall/Aquathol (gallons)
1950-1969	--	200	47,096	20.0	--	--	--	4.96 lbs.
1970-1989	861.5	190	--	87.0 + 868.5 (gallons)	--	68.5	--	510.9 + 40.0 lbs.
1990	68.0	--	--	--	--	6.0	--	25.0
1991	--	--	--	--	--	--	--	18.0 lbs.
1992	35.0	--	--	--	--	35.0	--	36.25
1993	52.5	--	--	--	--	29.0	--	27.0
1994	13.5	--	--	--	--	19.0	--	21.5
1995	18.5	--	--	--	--	18.5	--	18.5
1997	--	--	--	--	--	27.5	--	27.5
1998	2.5	--	--	--	--	--	--	--
1999	2.5	2.5 gallons	--	3,530	--	--	--	--
2000	--	--	--	1,600	--	--	--	--
2001	--	--	--	3,600	--	--	--	--
2002	--	--	--	6,225	--	1.5	--	--
2003	--	12.5 gallons	--	5,750	--	--	--	--
2004	--	--	--	2,100	--	--	--	--
2005	--	--	--	7,600	--	--	--	--
2006	--	--	--	5,150	--	--	--	--
2007	--	--	--	2,300	--	--	--	--
2008	--	--	--	5,000	--	--	--	--
2009	--	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--	--
2011	--	--	--	221.5 (gallons)	--	--	--	--
2012	--	--	--	462.0 (gallons)	--	--	--	--
2013	--	--	--	537.0 (gallons)	--	--	--	--
2014	--	--	--	1,138.8	--	--	--	--
2015	--	--	--	702.2	--	--	--	188.8
Total	1,054.0	390.0 + 15.0 gallons	47,096	44,803 + 2,089.0 gallons	--	205.0	--	666.65 + 62.96 pounds.

Note: Gallons represent liquid forms of chemical; pounds represent granular forms. Additionally, in 1960, 0.5 pounds of silvex were applied; and in 1980, 8.5 gallons of Hydrothol were applied.

Source: Wisconsin Department of Natural Resources and SEWRPC

Lake since 1968 to help control the non-native aquatic plant species Eurasian water milfoil and curly-leaf pondweed. In the early 2000s, the plant control program shifted toward aquatic plant harvesting as a major element of the aquatic plant management strategy within the Lake. In 2007, over 10,000 tons of harvested aquatic plant biomass were removed from the Lake. Chemical treatment is still used *in combination* with harvesting, especially along developed shorelines.

Chemical applications for Little Muskego Lake consist of chemical shoreline treatment of various extents along the developed shorelines within the Lake as shown in Figure 2.11. Management records have shown that chemical treatment, along with mechanical harvesting, has helped to reduce the non-native aquatic plant species populations. In addition, shoreline treatments have allowed for better access and navigation throughout the Lake.

Finally, as stated previously, starry stonewort is becoming a concern due to its potential to severely disrupt the natural ecology of the Lake and create recreational disturbance, based on the pattern of growth among other lakes in the United States. In 2016 and 2017, several options were tested on Little Muskego Lake and were guided by the WDNR to determine the best control solutions for starry stonewort. The results of these experimental treatment methods, once evaluated, will guide future management efforts of starry stonewort.

WDNR Designated Sensitive Areas

Sensitive Areas are identified by the WDNR as sites that have special importance biologically, historically, geologically, ecologically, or even archaeologically.[14] Sensitive Areas of aquatic vegetation are identified by the WDNR as offering critical or unique fish and wildlife habitat, including seasonal or life stage requirements, or offering water quality or erosion control benefits to the body of water. Currently, the WDNR designates four Sensitive Areas within Little Muskego Lake (see Map 2.1). **It is important that WDNR-designated Sensitive Areas are accurately identified and properly managed (WDNR permits required) to preserve their ecological value and the overall health of the Little Muskego Lake aquatic ecosystem.**

2.3 WATER QUALITY

As part of the discussion regarding aquatic plant management within Little Muskego Lake, it is important to evaluate the water quality within the Lake. The most commonly used metrics for assessing water quality include: water clarity, water temperature, and the concentrations of chloride, phosphorus, chlorophyll-*a*, and dissolved oxygen (see Table 2.7 for further information regarding these parameters). These parameters can influence aquatic plant growth in a variety of ways. For example, nutrient pollution from certain fertilizers can cause a lake's phosphorus concentrations to increase, spurring aquatic plant and algal growth.

It is important to establish and benchmark current water quality conditions. To do this, concentrations of the aforementioned parameters (phosphorus, water clarity, chlorophyll-*a*, dissolved oxygen), and potentially other substances, are measured and compared to past levels to determine if water quality has been changing over time. Values that suggest progressively worsening conditions can help reveal which pollutants should be targeted for reduction strategies. This information should be reviewed within the context of general lake characteristics to help determine the extent of water quality concerns and the methods suitable for effectively dealing with these problems. Although development of a water quality maintenance and improvement program is outside the scope of this plan, key water-quality indices are quantified in this section.

Temperature, Oxygen, and Stratification

Stratification refers to a condition when the temperature difference (and associated density difference) between a lake's surface (the *epilimnion*) and the deep waters (the *hypolimnion*) is great enough to form thermal layers that can impede mixing of gases and pollutants between the two layers (see Figure 2.12). If a lake stratifies, oxygen-rich surface water in contact with the atmosphere does not freely mix with water in deeper portions of the lake. Therefore, the deeper hypolimnetic water cannot exchange gases with the atmosphere. Metabolic processes continue to consume oxygen in the hypolimnion. If oxygen demands are

[14] *Areas are identified as Sensitive Areas pursuant to Chapter NR 107 of the Wisconsin Administrative Code after a comprehensive examination and study is completed by WDNR staff.*

Figure 2.11
Chemical Application Along Developed Shoreline of Little Muskego Lake: 2014 and 2015

Note: Polygons denote areas that underwent aquatic plant herbicide application in Spring 2014 and 2015. Letter-number codes are assigned by Clean Lakes Midwest, Incorporated for the purpose of identifying areas to be treated. Letters are assigned counter-clockwise in alphabetical order. The number denotes the year of treatment. In 2014 (left,) blue polygons denote areas treated in June 2014 and the yellow polygon denotes an area treated in July 2014. In 2015 (right), yellow polygons indicate areas treated with a combination of liquid endothall and liquid 2,4-D, while green polygons indicate areas treated with only liquid 2,4-D.

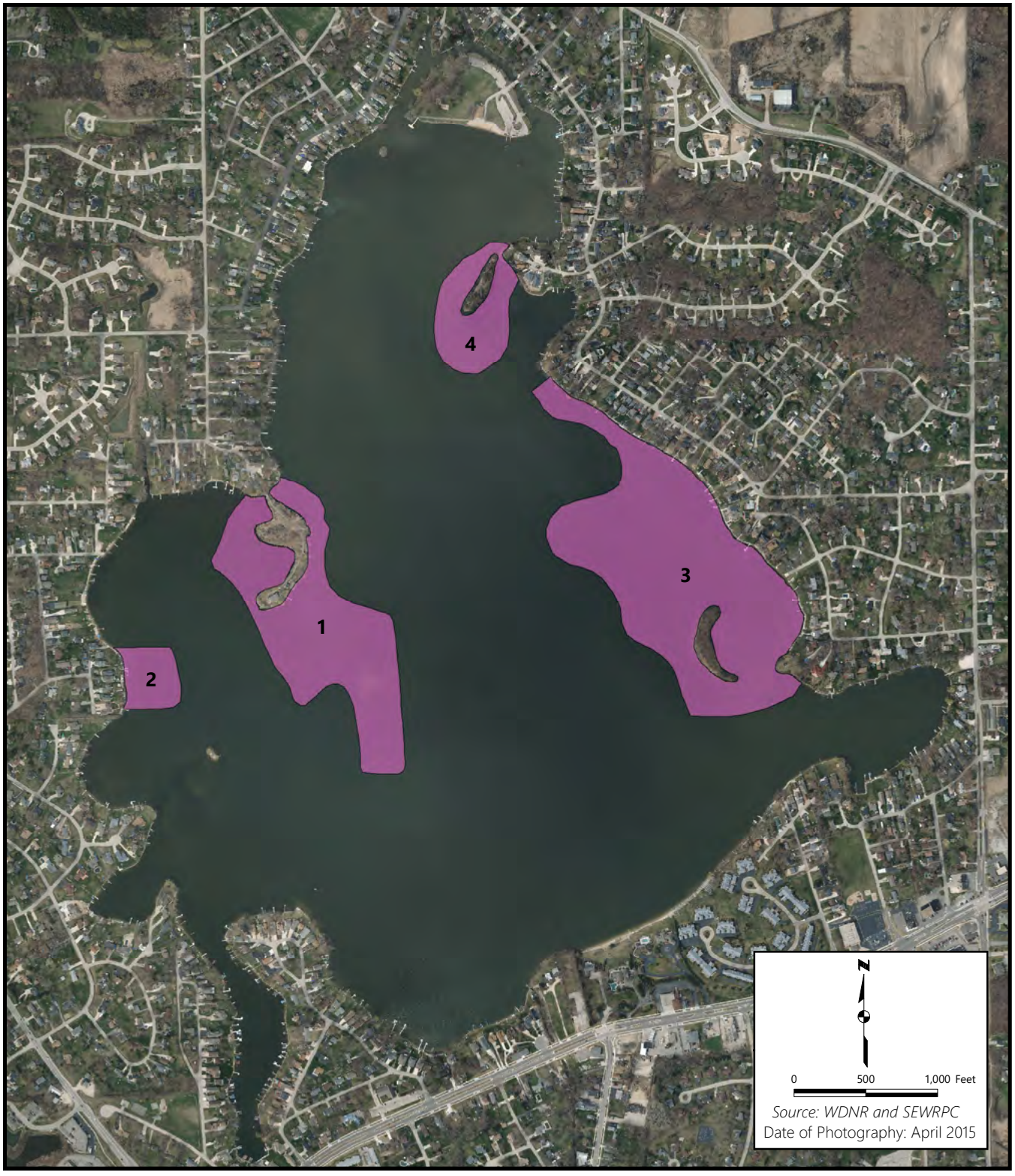
Source: Clean Lakes Midwest, Incorporated and SEWRPC

high (such as in an enriched lake), or if the volume of deep isolated hypolimnetic water is small (limiting oxygen storage potential), deep portions of a lake can become extremely low or even completely devoid of oxygen (*anoxic*) for a period of time. While some lakes remain permanently stratified, stratification in most Wisconsin lakes breaks down at least twice per year (once in spring and once in fall) in response to changing seasons and ambient weather conditions.

A lake must be relatively deep to stratify. In general, lakes in Southeastern Wisconsin less than 15 feet deep are unlikely to stratify, whereas lakes with depths greater than 20 feet are likely to stratify. A lake's propensity to stratify is heavily influenced by the lake's shape, size, orientation, landscape position, surrounding vegetation, through flow, water sources, and a host of other factors. Depth to the *thermocline* (the transition layer between the epilimnion and hypolimnion, sometimes also called the *metalimnion*) can range from less than 10 feet to well over 20 feet in typical Southeastern Wisconsin lakes.

Most stratifying lakes in the Region become stratified sometime during mid- to late-spring, with a short (usually less than a week) period of whole-lake water circulation and mixing (turnover) that takes place once during spring and once again in the fall (see Figure 2.12). At turnover, the lake's temperature is uniform from the surface to the bottom. Lakes that stratify and turn over in the spring and fall are termed "dimictic." Mixing can also occur in response to windy conditions in some lakes. Lakes can also stratify in winter when warmer, denser water is found in the deeper portions of the lake. It is important to determine if stratification and turnovers occur because nutrients, low-oxygen water, and in some cases pollutants and sediment that have accumulated in the isolated bottom waters can suddenly mix into the entire water column during the turnover period, causing water quality and plant management problems. For example, abundant nutrients from deep portions of a lake can mix into near-surface water, which in turn can fuel nuisance-level algae and plant growth.

Map 2.1
Sensitive Areas Within Little Muskego Lake



3 SENSITIVE AREA AND ID

Table 2.7
Water Quality Parameter Descriptions, Typical Values, and Regulatory Limits/Guidelines

Parameter	Description	Southeastern Wisconsin Values[a]		Regulatory Limit or Guideline	Little Muskego Lake Values	
		Median	Range		Median	Range
Chloride (mg/L)	Low concentrations (e.g., < 5 mg/L) naturally occur in lakes due to natural weathering of bedrock and soils. Human activities increase concentrations (e.g., road salts, wastewater, water softener regeneration) and can effect certain plants and animals. Chloride remains in solution once in the environment and **can serve as an excellent indicator of other pollutants**.	41	18-126	Acute toxicity[b, c] (757) Chronic toxicity[b, d] (395)	53[d]	33-223[d]
Chlorophyll-*a* (µg/L)	The major photosynthetic "green" pigment in algae. The amount of chlorophyll-*a* present in the water is an indicator of the biomass, or amount of algae, in the water. **Chlorophyll-*a* levels above 10 µg/L generally result in a green-colored water** that may be severe enough to impair recreational activities such as swimming or waterskiing and are commonly associated with eutrophic lake conditions.	9.9	1.8-706.1	2.6[e]	12.0[f]	0.3-81.0[f]
Dissolved Oxygen (mg/L)	Dissolved oxygen levels are one of the most critical factors affecting the living organisms of a lake ecosystem. Generally, dissolved oxygen levels are higher at the surface of a lake, where there is an interchange between the water and atmosphere, stirring by wind action, and production of oxygen by plant photosynthesis. Dissolved oxygen levels are usually lowest near the bottom of a lake where decomposer organisms and chemical oxidation processes deplete oxygen during the decay process. **A concentration of 5.0 mg/L is considered the minimum level below which many oxygen-consuming organisms, such as fish, become stressed**. Many species of fish are unlikely to survive when dissolved oxygen concentrations drop below 2.0 mg/L.	--	--	≥5.0[f]	--[g]	0.0-17.2[h]
Growing Season Epilimnetic Total Phosphorus (mg/L)	Phosphorus enters a lake from natural and human-derived sources and is a fundamental building block for plant growth. Excessive phosphorus can lead to nuisance levels of plant growth, unsightly algal blooms, decreased water clarity, and oxygen depletion, all of which can stress or kill fish and other aquatic life**. A concentration of less than 0.030 mg/L is the concentration considered necessary in a stratified drainage lake such as Little Muskego Lake** to limit algal and aquatic plant growth to levels consistent with recreational water use objectives. Phosphorus concentration exceeding 0.030 mg/L are considered to be indicative of eutrophic lake conditions.	0.030	0.080-0.720	0.030[f]	0.020	0.010-0.061
Water Clarity (feet)	Measured with a Secchi disk (a ballasted black-and-white, eight-inch-diameter plate) which is lowered into the water until a depth is reached at which the disk is no longer visible. It can be affected by physical factors, such as suspended particles or water color, and by various biologic factors, including seasonal variations in planktonic algal populations living in a lake. **Measurements less than 5 feet are considered indicative of poor water clarity and eutrophic lake conditions**.	4.6	3.0-12.0	10.9[e]	7.0	2.3-18.0
Water Temperature (°F)	Temperature increases above seasonal ranges are dangerous to fish and other aquatic life. Higher temperatures depress dissolved oxygen concentrations and often correlate with increases in other pollutants.	--	--	Ambient[f] (35-77) Sub-Lethal[f] (49-80) Acute[f] (77-87)	--[g]	33-85

[a] *Wisconsin Department of Natural Resources Technical Bulletin No. 138,* Limnological Characteristics of Wisconsin Lakes, *Richard A. Lillie and John W. Mason, 1983.*

[b] *Wisconsin Administration Code Chapter NR 105, Surface Water Quality Criteria and Secondary Values for Toxic Substances. July, 2010.*

[c] *The acute toxicity criterion is the maximum daily concentration of a substance which, if not exceeded more than once every three years, ensures adequate protection of sensitive species of aquatic life and maintains surface water use.*

[d] *The median chloride concentration likely does not reflect current conditions in the Lake because chloride concentrations have consistently increased over time. The uppermost range likely better represents current Lake concentrations.*

[e] *U.S. Environmental Protection Agency, Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria: Lakes and Reservoirs in Nutrient Ecoregion VII, EPA 822-B-00-009, December 2000.*

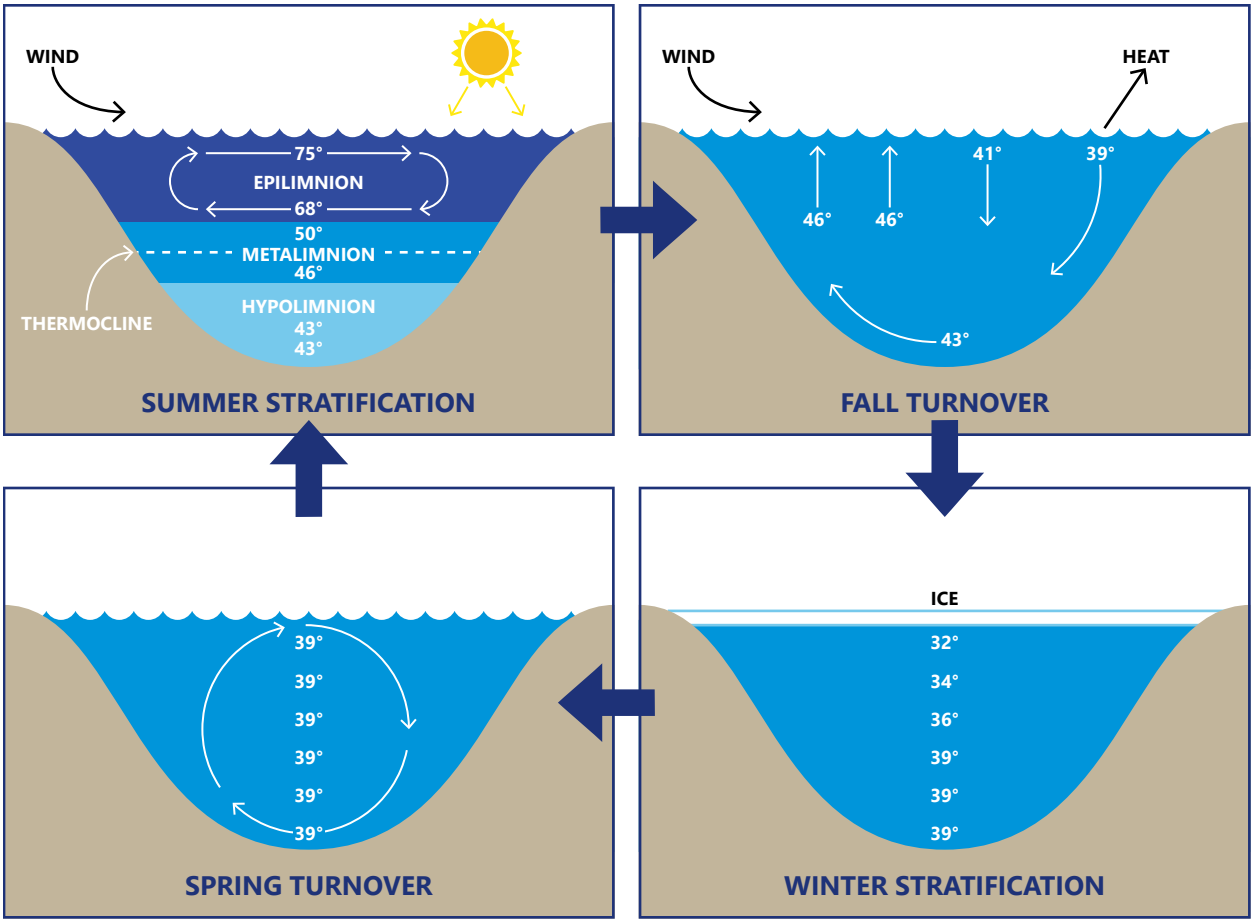
[f] *Wisconsin Administrative Code Chapter NR 102, Water Quality Standards for Wisconsin Surface Waters, November 2010.*

[g] *Oxygen concentrations and temperatures vary with depth and season. Median values provide little insight to understand lake conditions.*

[h] *Concentration above the upper saturation limit of oxygen in water. Supersaturation is also injurious to fish and other aquatic life.*

Source: Wisconsin Department of Natural Resources, Wisconsin State Legislature, U.S. Environmental Protection Agency, and SEWRPC

Figure 2.12
Typical Seasonal Thermal Stratification Within Deeper Lakes



Source: University of Wisconsin-Extension and SEWRPC

When a lake is stratified, near-surface water is considerably warmer, supports abundant algae, and contains abundant oxygen. The thermocline is generally found somewhere between 10 and 20 feet below the surface, with the depth varying lake-to-lake, month-to-month, and year-to year. Water within the thermocline rapidly cools with depth and contains less oxygen than the epilimnion. Below the thermocline, water in the hypolimnion is much colder than water at the lake's surface and may not mix with the epilimnion until fall. Little sunlight penetrates past the thermocline; therefore, the deeper portions of the lake do not host significant photosynthetic activity and hence do not receive oxygen from plants. However, oxygen continues to be consumed by decomposition and other processes in the deeper portions of the lake. As a result, oxygen concentrations in the hypolimnion decline after the lake stratifies and cannot be replenished until the lake fully mixes during its fall turnover.

Little Muskego Lake temperature and dissolved oxygen profiles were fully described from 1987 through 1993 in a previous report.[15] In addition, an aeration project was implemented in open-water, aimed at reducing stratification and improving conditions within the Lake between spring 1987 and fall 1991. Temperature and oxygen profiles from this period reflect the lack of stratification caused by aeration as intended. Profiles after this time period (i.e., beginning in 1992) show stratification in the Lake after the aeration project ceased operation.

[15] *SEWRPC Community Assistance Planning Report No. 222,* op cit.

Temperature and dissolved oxygen concentration profiles in this report were assembled from all available data spanning the past 15 years as shown in Figures 2.13 and 2.14, respectively.[16] The data suggest that **Little Muskego Lake continues to stratify every year and remains stratified throughout the summer.** The depth to the thermocline varies month-to-month and year-by-year, however, in recent years it has formed between 15 and 25 feet below the Lake's surface. **Little Muskego Lake does not appear to exhibit significant stratification under winter ice**. Water achieves its maximum density in its liquid form at approximately four degrees Celsius. Denser, warmer water occasionally accumulates in the deepest areas of the Lake.

Based upon the profile data, **Little Muskego Lake is usually fully mixed in April, with oxygen concentrations capable of supporting aquatic life present at essentially all depths**. **During summer, water in Little Muskego Lake's hypolimnion contains little to no oxygen**. By mid-May, just as the Lake stratifies, portions of the Lake below 20 feet (i.e., the lower limit of the epilimnion) contain less than 5 mg/L during most years.[17] Recent profile data indicate that, during summer, stratification occurs down to an approximate depth of 25 feet (i.e., upper limit of the hypolimnion) and water depths below this are usually devoid of any oxygen until mixing occurs again in the fall. That depth corresponds to approximately 100 acres of the Lake bottom area (see Figure 2.15) which is equivalent to 1,450 acre-feet of Lake volume (see Figures 2.16 and 2.17). During some summers, notably 2013, waters below depths as shallow as 15 feet were thermally stratified by July and devoid of oxygen into September. That is equivalent to approximately 150 acres of Lake bottom and 2,100 acre-feet of Lake volume.

Oxygen saturation relates the concentration of oxygen actually measured in water to a concentration in equilibrium with the atmosphere at a given temperature. Values between 90 and 110 percent saturation are generally considered desirable for aquatic life. Summer oxygen saturation profiles (see Figure 2.18), particularly in August 2013, reveal that the near-surface waters of Little Muskego Lake have been supersaturated with oxygen during portions of the day,[18] a result of abundant photosynthetic activity, a factor likely related to human-induced nutrient enrichment. Although no information is available for nighttime conditions, many water bodies exhibiting oxygen supersaturation during the day experience low oxygen saturation levels at night, a condition related to respiration and decomposition continuing to occur while photosynthesis is lacking. Such conditions are stressful to aquatic organisms and can lead to fish kills in summer, but fish kills have not been observed recently in this Lake. Oxygen saturation commonly peaks near the thermocline, a condition suggestive of nutrient enrichment sourced in the hypolimnion. The available data is rather limited, and more profiles will need to be measured to determine if this phenomenon is common in the Lake.

Phosphorus

Aquatic plants and algae require nutrients such as phosphorus for growth. However, excessive phosphorus can lead to nuisance levels of plant growth, unsightly algal blooms, decreased water clarity, and oxygen depletion, all of which can stress or kill fish and other aquatic life.

When Little Muskego Lake is fully mixed in the spring, phosphorus concentrations are similar throughout the various depths of the Lake and average 0.029 mg/L over the period of record. Although the most recent spring concentration was slightly higher than in previous years, the overall data set shows a trend of decreasing spring phosphorus concentrations since 1974 (see Figure 2.19).

As previously described, an aeration project was implemented to reduce stratification and improve conditions within Little Muskego Lake between spring 1987 and fall 1991.[19] This project caused summer phosphorus concentrations to be slightly more uniform within the Lake as shown in Figure 2.20. When

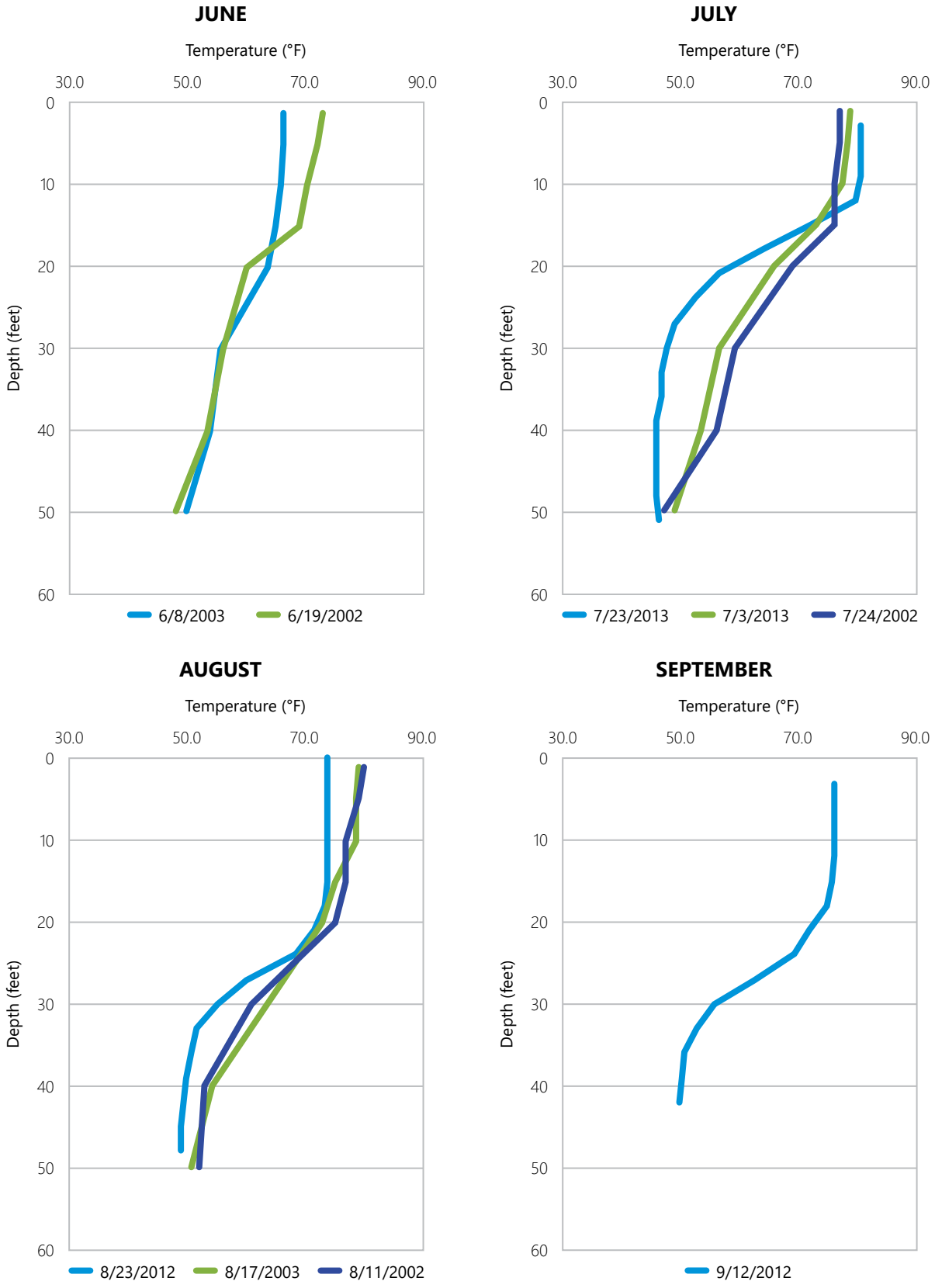
[16] *Water quality data for Little Muskego Lake is available at the following website: dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=762700.*

[17] Ibid. *and SEWRPC Memorandum Report No. 155 (2nd Edition),* op cit.

[18] *Supersaturation refers to a condition when the amount of dissolved substance exceeds the substance's maximum solubility in the solvent under normal circumstances. Such conditions are typically unstable. Dissolved gas comes out of water as bubbles. Fish exposed to oxygen saturations greater than 115 percent can develop bubbles in their tissues (a condition similar to "the bends" experienced by deepwater divers).*

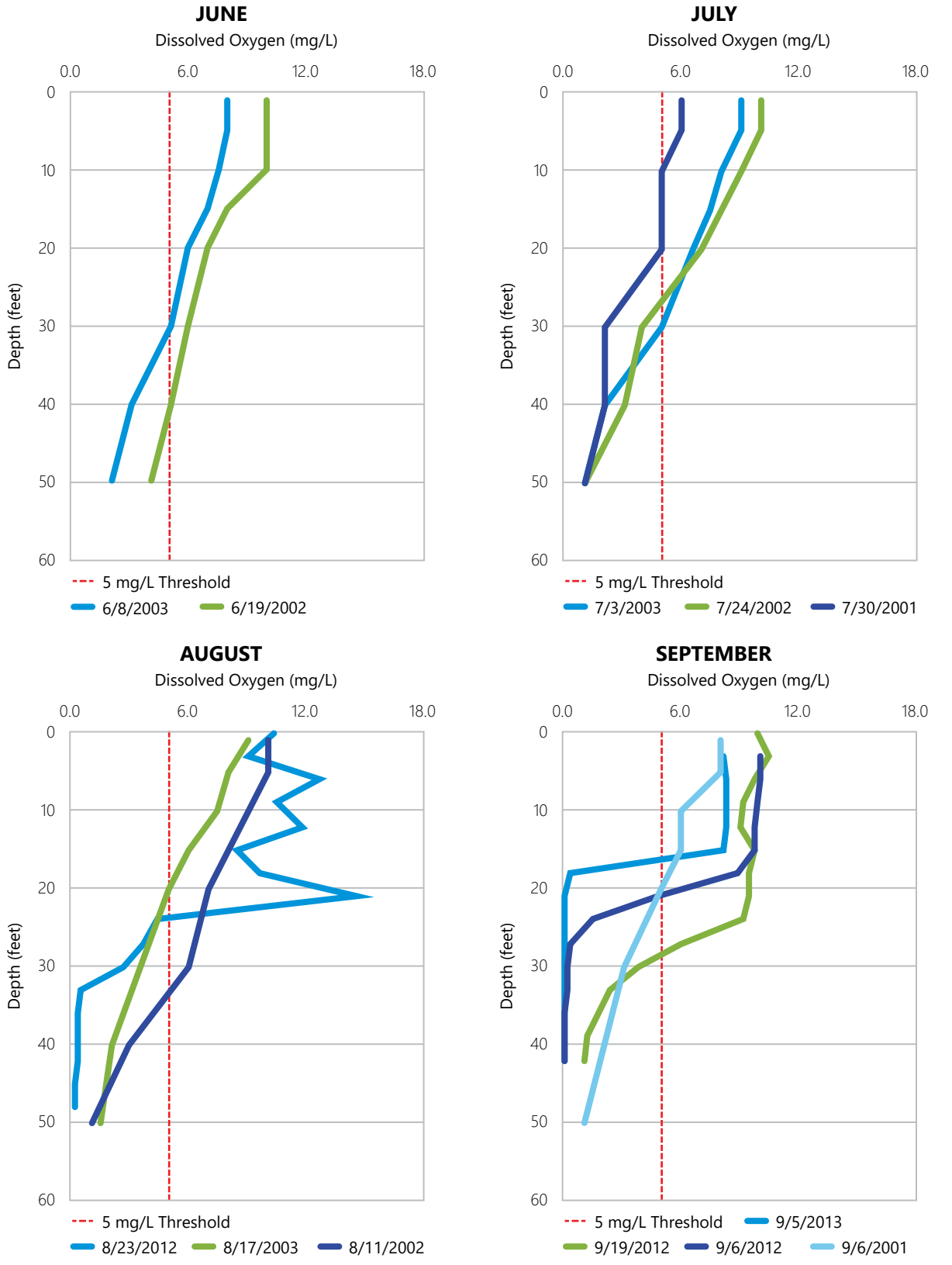
[19] *SEWRPC Community Assistance Planning Report No. 222,* op cit.

Figure 2.13
Little Muskego Lake Summer Temperature Profiles



Source: Wisconsin Department of Natural Resources and SEWRPC

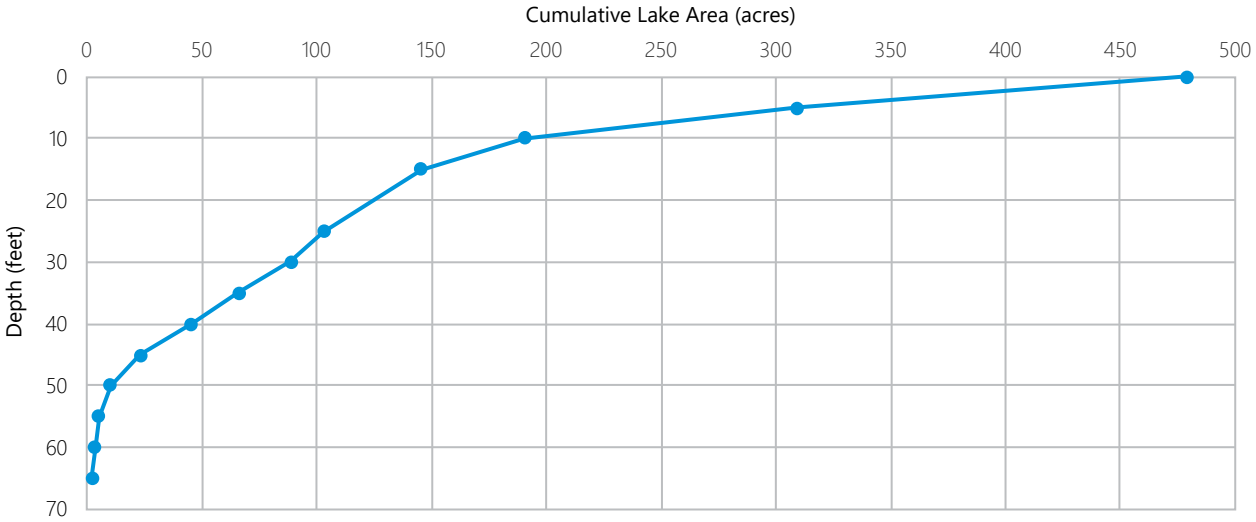
Figure 2.14
Little Muskego Lake Summer Dissolved Oxygen Profiles



Note: A minimum dissolved oxygen concentration of 5 mg/L is the regulatory standard necessary for sustaining aquatic life water use objectives. As dissolved oxygen levels drop below 5 mg/L, aquatic life is put under stress.

Source: Wisconsin Department of Natural Resources and SEWRPC

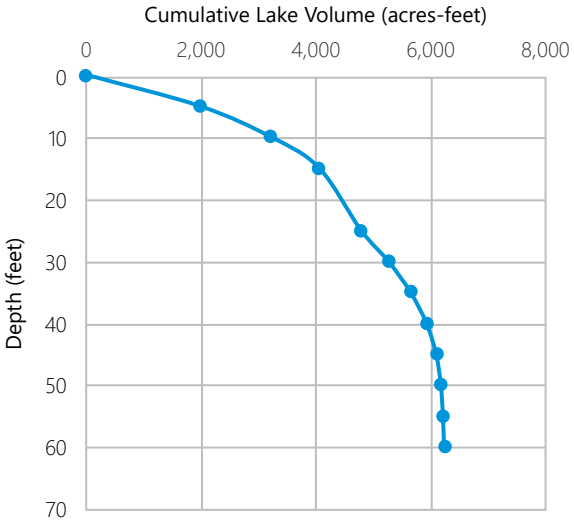
Figure 2.15
Little Muskego Lake Depth Versus Surface Area



Note: This is a cumulative plot of the total surface area of the Lake with depths greater than or equal to depicted values. For example, roughly 180 acres of the Lake has water depths greater than 10 feet.

Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.16
Little Muskego Lake Depth Versus Volume



Note: This is a cumulative plot of the total volume of the Lake contained in depths less than or equal to the depicted values. For example, roughly 3,100 acre-feet of the Lake's total volume is contained in the upper 10 feet of the Lake's water column.

Source: Wisconsin Department of Natural Resources and SEWRPC

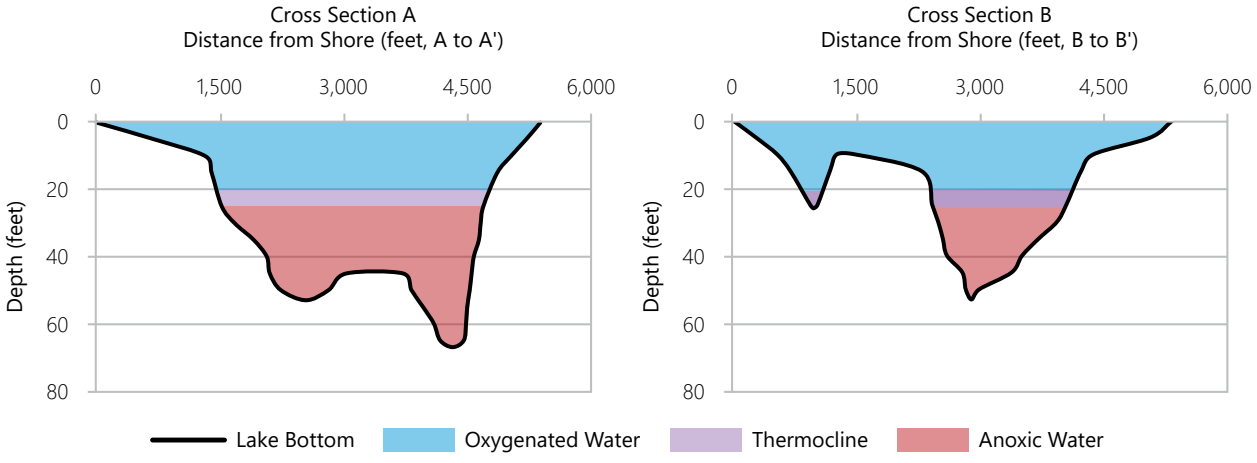
the Lake is stratified, summer (June through August) phosphorus concentrations vary widely. Samples collected near the surface commonly have the lowest phosphorus concentrations—averaging 0.026 mg/L, a value well below the aquatic life impairment threshold of 0.060 mg/L for deep lowland drainage lakes (see Figure 2.20).[20] This value is also below the substantially lower recreational impairment threshold of 0.030 mg/L for such lakes established under the *Wisconsin Administrative Code*.[21] Furthermore, summer surface total phosphorus concentrations have been decreasing significantly since the termination of the aeration project conducted between 1987 and 1991. During the aeration period, surface total phosphorus concentrations averaged 0.037 mg/L and ranged between 0.012 mg/L and 0.061 mg/L. The most recent surface total phosphorus concentrations (2010-2015) averaged 0.016 mg/L and ranged between 0.010 mg/L and 0.020 mg/L.

Phosphorus concentrations reach their highest values in the deeper waters of Little Muskego Lake during warm season stratification (see Figure 2.20). Samples drawn from the Lake's hypolimnion during the summer months can contain phosphorus concentrations almost ten times higher than near-surface lake water, with values averaging 0.158 mg/L, and ranging from 0.040 mg/L to 0.277 mg/L over the period of available record, not including years when stratification was modified

[20] *Wisconsin Department of Natural Resources,* Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting.

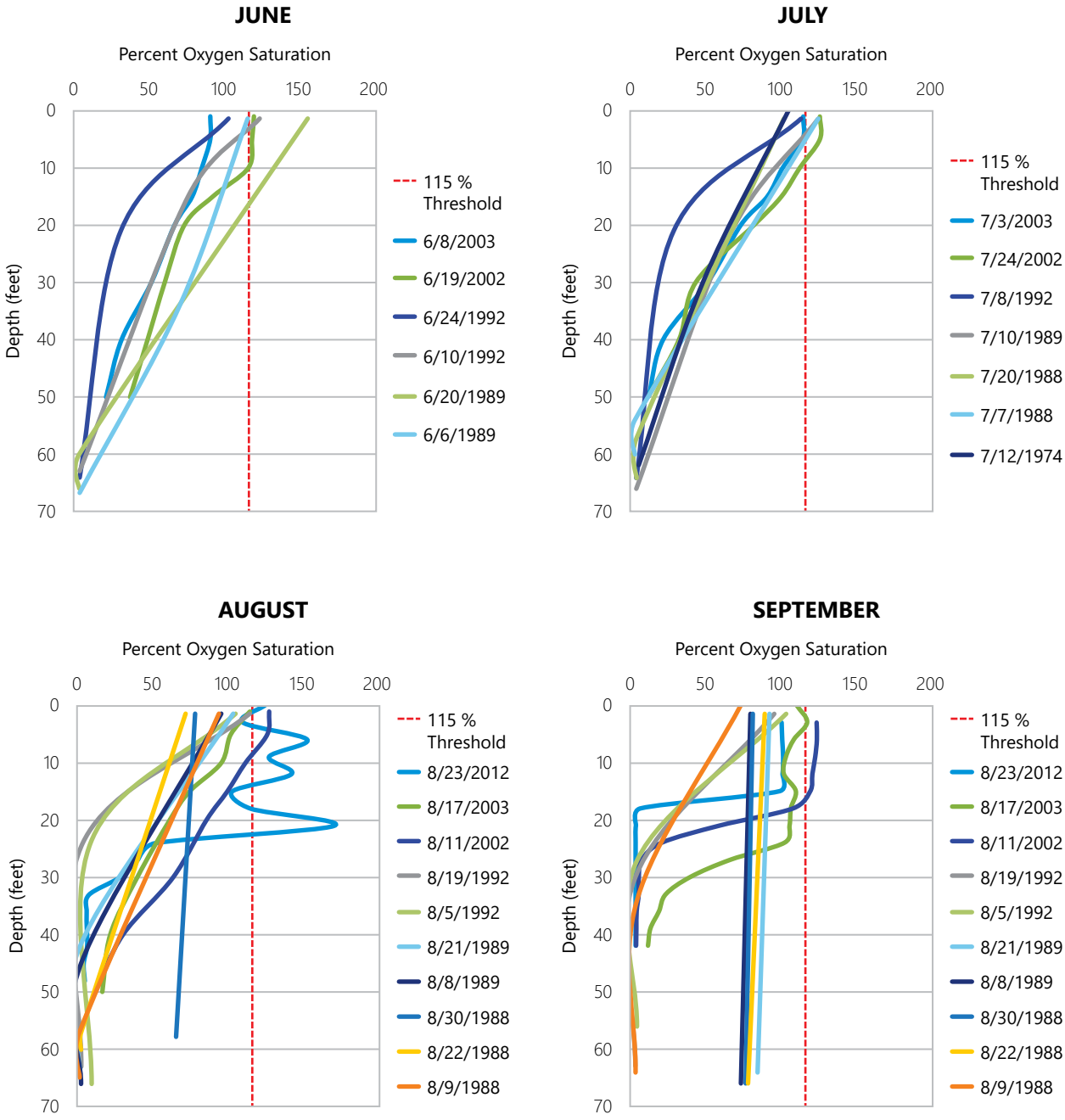
[21] *Wisconsin Administrative Code Chapter NR 102,* op. cit.

Figure 2.17
Typical Midsummer Extent of Anoxic Water in Little Muskego Lake



Source: Wisconsin Department of Natural Resources and SEWRPC

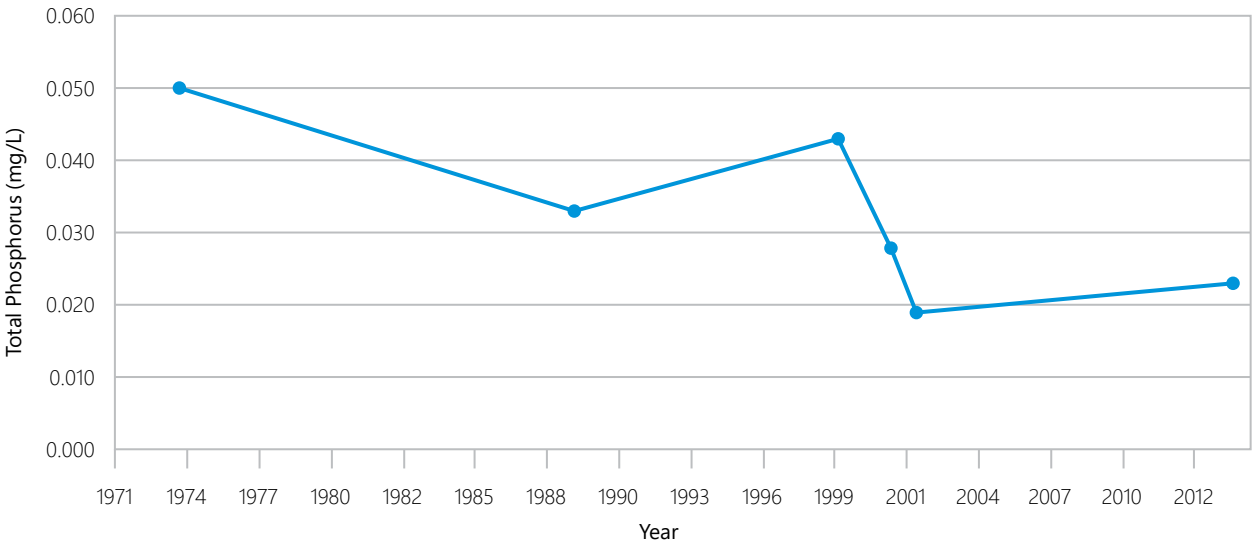
Figure 2.18
Little Muskego Lake Summer Oxygen Saturation Profiles



Note: Exposure of fish to oxygen saturations greater than 115 percent can cause fish kills, due to the formation of bubbles in their tissues (a condition similar to "the bends" experienced by deepwater divers).

Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.19
Spring (Fully Mixed) Phosphorus Trend in Little Muskego Lake: 1974-2015



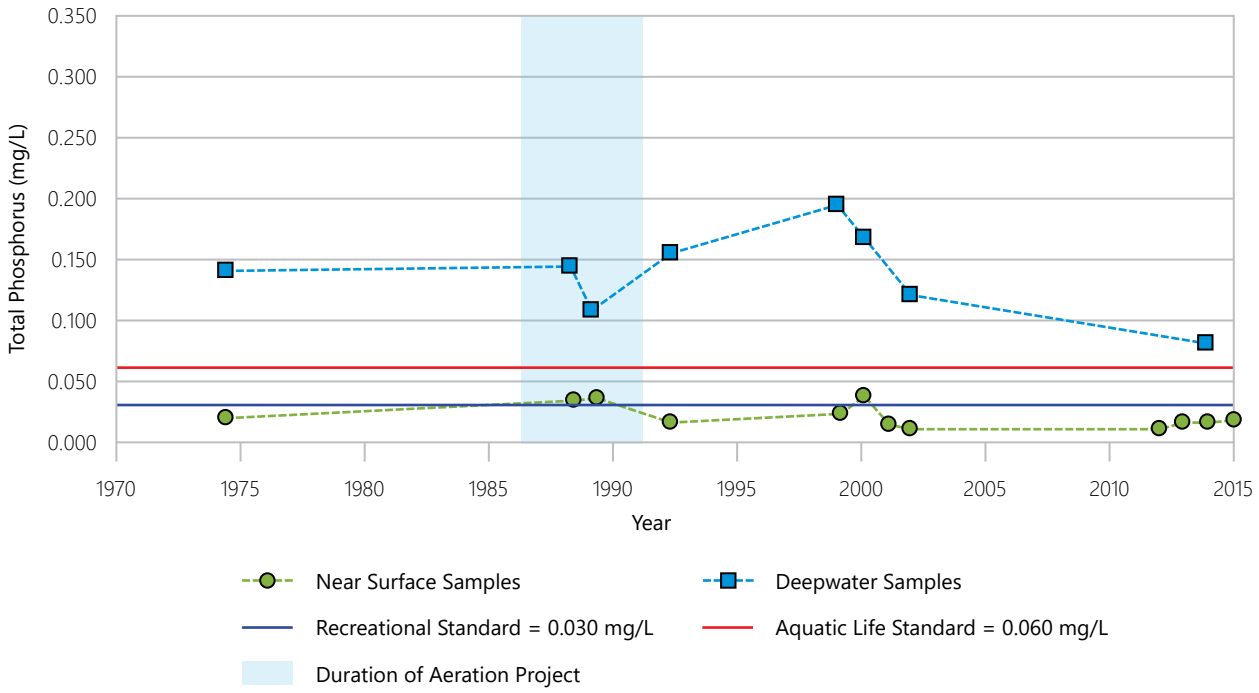
Source: Wisconsin Department of Natural Resources and SEWRPC

by the aeration project. Phosphorus concentrations rapidly increase immediately after the Lake stratifies, commonly reaching their maximum values during August. This is a common occurrence on many lakes since biological productivity and attendant organic loading to deep portions of lakes declines after peaking in late spring. It is not possible to determine if deep water total phosphorus concentrations have decreased in the same way as surface phosphorus concentrations, because little deep water data is available. The most recent deep water concentration of 0.082 mg/L was collected in June 2014 (see Figure 2.20). This value is substantially lower than the overall average discussed above, but is not representative of the entire summer.

Internal loading refers to release of phosphorus stored in a lake's bottom sediment under certain water quality conditions associated with stratification. Phosphorus is typically not particularly soluble and often adheres to particles that settle to the lake bottom. When organic detritus and sediment settle to the lake bottom, decomposer bacteria break down the organic substances, a process that consumes oxygen. If lake-bottom waters become devoid of oxygen, the activity of certain decomposer bacteria, together with certain geochemical reactions that occur only in the absence of oxygen, can allow phosphorus from plant remains and lake-bottom sediment to dissolve into the water column. This allows phosphorus that is otherwise trapped in deep lake-bottom sediment to be released into lake water. This liberated phosphorus can mix into the water column during the next turnover period, fueling plant and algae growth. In most lakes, phosphorus is the nutrient controlling overall plant and algal growth, so additional phosphorus loading can lead to increased plant and algal growth.

Internal phosphorus mass loading attributable to dissolution from seasonally anoxic bottom sediment can be estimated using whole lake total phosphorus water concentrations determined during the fully mixed conditions occurring at or shortly after spring turnover (see Figure 2.19) and from lake water samples collected from the hypolimnion during the stratified conditions occurring in summer (see Figure 2.20), and assuming that little mixing between the epilimnion and hypolimnion occurs after the Lake stratifies. As discussed previously, the median mid-summer phosphorus concentration in the hypolimnion of Little Muskego Lake is 0.154 mg/L, varying from 0.040 mg/L to 0.277 mg/L. Little Muskego Lake's hypolimnion typically occupies approximately 1,450 acre feet of the Lake's total water volume. Although values vary significantly between years, internal loading likely contributes on average about 490 pounds of phosphorus to the water column between late spring and midsummer during most years. Internal loading appears to contribute approximately 980 pounds of phosphorus during extreme years. Since anoxic water covers about 100 acres of the Lake bottom during an average year, each acre of lake-bottom exposed to anoxic water contributes approximately 4.9 pounds of phosphorus to the water column during a typical summer, and 9.8 pounds per acre during years of high loading.

Figure 2.20
Summer (Fully Stratified) Phosphorus Concentrations in Little Muskego Lake: 1974-2015



Source: Wisconsin Department of Natural Resources and SEWRPC

Assuming that most phosphorus is contributed to the water column between May 1 and August 31, a unit area phosphorus flux rate from anoxic bottom sediment can be computed.[22] Little Muskego Lake's computed unit area phosphorus flux rate is 4.6 milligrams per square meter per day (roughly five one hundredths of a pound per acre per day) during typical years, and 9.1 milligrams per square meter per day during years of high internal loading. The values during typical years and extreme years are on the lower end of the range of values determined as part of a State of Michigan lake sediment column study. The Michigan study reports unit-area phosphorus flux rates ranging from 1.6 to 29.5 milligrams per square meter per day.[23] The Little Muskego Lake values are also low when compared with studies completed in Minnesota. Minnesota lakes that were eventually treated to reduce internal phosphorus loading exhibited unit area phosphorus flux rates ranging from 9.3 to 14.1 milligrams per square meter per day.[24] These comparisons add creditability to the phosphorus flux rates calculated for Little Muskego Lake and point to limited contributions from internal loading in the overall nutrient balance of the Lake during most years.

Chlorophyll-*a*

Chlorophyll-*a* (µg/L) is the major photosynthetic ("green") pigment in algae. The amount of chlorophyll-*a* present in water is an indication of the biomass, or amount, of algae in the water. The median chlorophyll-*a* concentration for lakes in Southeastern Wisconsin is approximately 9.9 µg/L, but can range from 1.8 to 706.1 µg/L.[25] Summer chlorophyll-*a* concentrations have been measured in Little Muskego Lake since the late 1980s and indicate that high chlorophyll-*a* levels found during the aeration project appear to have subsided (see Figure 2.21). Concentrations as high as 81 µg/L occurred during the summer months between 1987 and 1991. Since then, summer chlorophyll-*a* averages 7.3 µg/L, comparable to the regional median, indicating that algal blooms have become less dense. Values rarely rise above 10 µg/L, a concentration

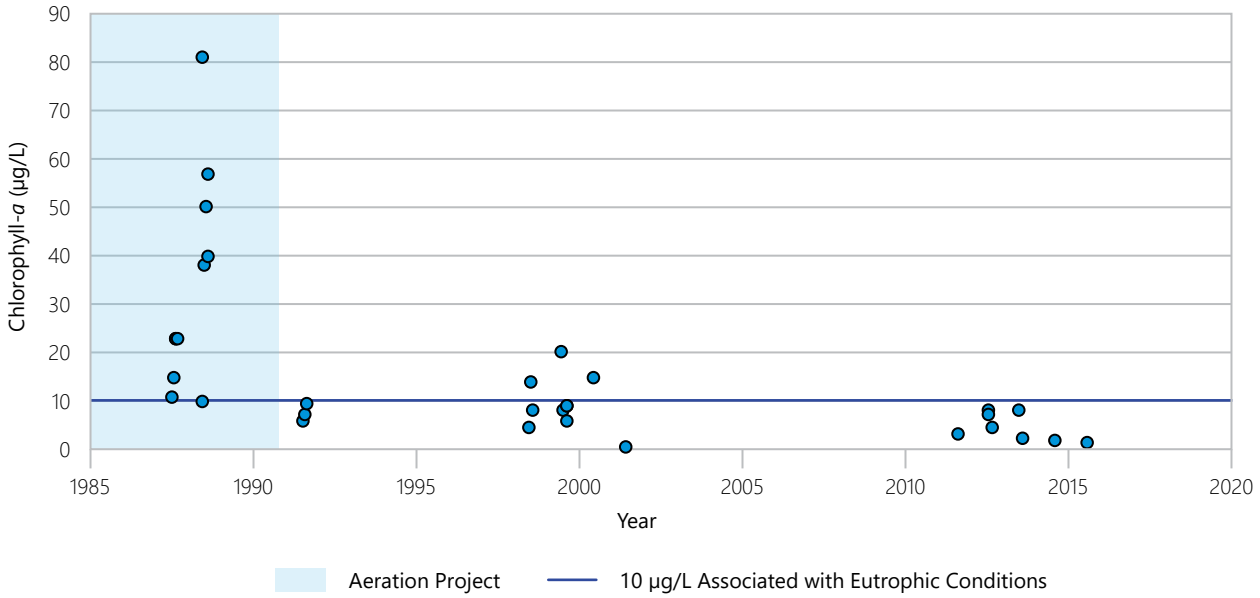
[22] *Unit area flux rate refers to the mass of a substance moving past a threshold over a set area during a unit of time.*

[23] *Steinman, Alan, Rick Rediske and K. Ramesh Reddy,* "The Reduction of Internal Phosphorus Loading Using Alum in Spring Lake, Michigan," *Journal of Environmental Quality, Volume 33, pp. 2040-2048, 2004.*

[24] *Bassett Creek Watershed Management Commission,* "Twin Lake Phosphorus Internal Loading Investigation," *March 2011.*

[25] *Wisconsin Department of Natural Resources Technical Bulletin No. 138,* op. cit.

Figure 2.21
Little Muskego Lake Summer Chlorophyll-*a* Measurements: 1987-2016



Note: Summer (June, July, and August) chlorophyll-*a* measurements were not taken prior to 1985.

Source: Wisconsin Department of Natural Resources and SEWRPC

associated with eutrophic conditions (e.g., green colored water and more prevalent algae blooms). This coincides with decreasing phosphorus concentrations in Little Muskego Lake.

Chloride

Under natural conditions, surface water in Southeastern Wisconsin contains very low concentrations of chloride. Studies completed in Waukesha County lakes during the early 1900s report 3 to 4 mg/L of chloride. Most Wisconsin lakes saw little increase in chloride concentrations until the 1960s, but a rapid increase thereafter.[26] Chloride concentrations in Little Muskego Lake were first recorded from September 1973 to February 1975, at which time concentrations averaged 51 mg/L. Chloride concentrations were again recorded in April 1989 and were reported to be approximately 72 mg/L. During the period between April 1999 and April 2002, chloride concentrations averaged 121 mg/L. The most recent concentration, reported in April 2014, was 223 mg/L (see Figure 2.22). This value exceeds regional lake averages, but is below regulatory limits set forth in Chapter NR 105, "Surface Water Quality Criteria and Secondary Values for Toxic Substances," of the *Wisconsin Administrative Code* (see Table 2.7).

Chloride is considered a conservative pollutant, meaning that natural processes other than evaporation typically do *not* detain or remove it from water. Humans use chloride bearing materials for a multitude of purposes (e.g., road salt for anti-icing and deicing, water softening, industrial processes). Therefore, chloride concentrations are normally positively correlated with human-derived pollutant concentrations. Chloride is indicative of a suite of human-sourced and human enriched chemicals. These chemicals include agricultural nutrients and pesticides, pharmaceuticals, petroleum products, and a host of other substances in common use by modern society. For this reason, chloride concentrations are a good indicator of the overall level of human activity, potential impact, and possibly the overall health of a water body. Rapidly increasing chloride concentrations attest to the fact that **Little Muskego Lake is subject to a great deal of cultural pressure and the Lake has a propensity to accumulate human-introduced substances,** a condition that could reduce water quality and overall ecosystem function over time.

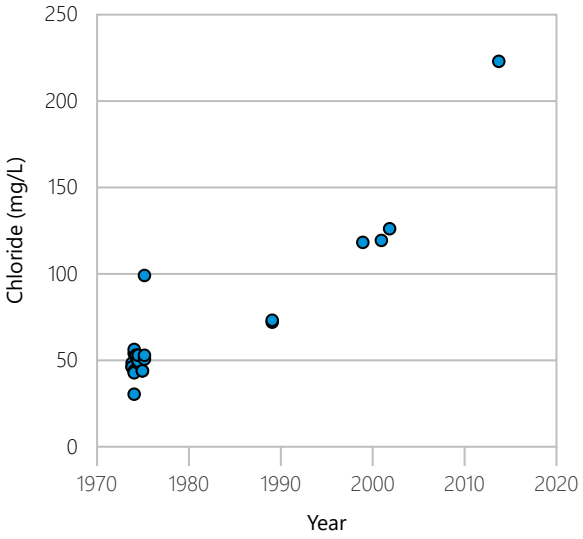
[26] Ibid.

Water Clarity

Secchi depth, a measure of water transparency, is often used as an easy to measure and understand water quality indicator. Water transparency can be affected by physical factors, such as water color and suspended particles, and by various biological factors, including seasonal variations in planktonic algal populations living in the lake. Secchi depth is often highest during winter months, indicating high water clarity, and lowest during summer months, when biological activity is highest and water clarity is lowest. Secchi depths have been collected at the "deep hole," or the deepest area of Little Muskego Lake, since 1973 (see Figure 2.23).

Prior to 2001, average summer water clarity was predominantly poor to fair, averaging approximately five feet. Since then, average summer water clarity has more than doubled and ranges between eight and 16 feet. The increased water clarity can be attributed to the presence of an established population of zebra mussels, which was officially confirmed by WDNR in 1999. Secchi depth measurements were also taken between July and September in the North Bay in 2012 and 2013 and averaged approximately five feet both years.

Figure 2.22
Little Muskego Lake Chloride Concentrations: 1973-2014



Source: Wisconsin Department of Natural Resources and SEWRPC

The WDNR has recently begun publishing satellite-based water clarity information, a surrogate for Secchi depth measurements. The most recent satellite-based water clarity information now available is from 2015. Figure 2.24 shows this information as presented on the WDNR website for Little Muskego Lake. Secchi depth measurements contrast water clarity at a single location in the Lake whereas satellite-derived maps provide clarity information throughout the Lake, allowing differences in water clarity to be studied. The August 2015 satellite image shows that the clearest water was found in the deeper portion of the Lake while the North Bay exhibited extremely low water clarity of two feet or less. This is most likely due to the presence of suspended sediments stirred up by high boat traffic leaving and entering the Idle Isle Park boat launch. Overall, the satellite-based data correlates with Secchi depth measurements collected in recent years. However, Secchi depth readings generally appear to be recorded in the portion of the Lake with the highest water clarity. Therefore, nearshore water clarity may be much lower than the values recorded at the "deep hole" site.

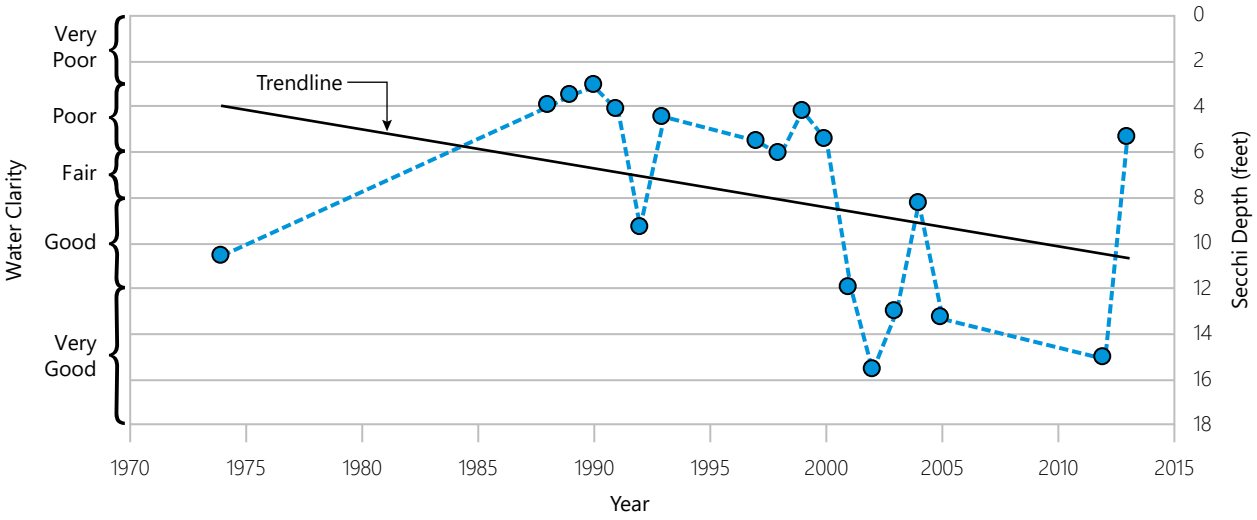
Trophic Status

Lakes are commonly classified according to their degree of nutrient enrichment, or trophic status. The ability of lakes to support a variety of recreational activities and healthy fish and other aquatic life communities is often correlated with the lake's degree of nutrient enrichment. Three terms are generally used to describe the trophic status of a lake: oligotrophic (nutrient poor), mesotrophic (moderately fertile), and eutrophic (nutrient rich) (see Figure 2.25). Each of these states can happen naturally. Lakes tend to naturally shift to a more nutrient-rich state, a progression sometimes referred to as "aging" (see Figure 2.26). However, if a lake rapidly shifts to a more eutrophic state, human-induced pollution may be responsible for this change. An indicator of severe human pollution is when a lake displays "hyper-eutrophic" nutrient levels, a condition indicating highly enriched water (see Figure 2.27). Hyper-eutrophic conditions do not commonly occur under natural conditions, and are nearly always related to human pollutant sources.

Based on water chemistry data collected in the past five years, **Little Muskego Lake appears to be a mesotrophic lake** with Wisconsin Trophic State Indices (WTSI) ranging from the mid-thirties to low-fifties and an overall average WTSI of 43 (see Figure 2.28). For a deep lowland drainage lake, that average is considered to represent **a "good" lake condition.**[27] Historically, WTSI values were sometimes as high as 68, which is considered eutrophic and a poor lake condition. Overall, total phosphorus, chlorophyll-*a*, and Secchi

[27] *Wisconsin Department of Natural Resources,* Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting, *September 2013*.

Figure 2.23
Little Muskego Lake Average Annual Summer Secchi-Disk Measurements: 1974-2013



Note: Secchi depth in 2013 is represented by only one summer measurement made on July 23. Additional depths collected in September 2013 were 10.8 and 13.8 feet, and reflected depths more consistent with means from previous years.

Source: Wisconsin Department of Natural Resources and SEWRPC

depth WTSI have been decreasing since the 1990s, indicating that water quality within Little Muskego Lake has been improving since the termination of the aeration project conducted between 1987 and 1991. As more phosphorus is removed through macrophyte harvesting and phosphorus inputs are reduced through watershed best management practices, conditions could further improve within Little Muskego Lake.

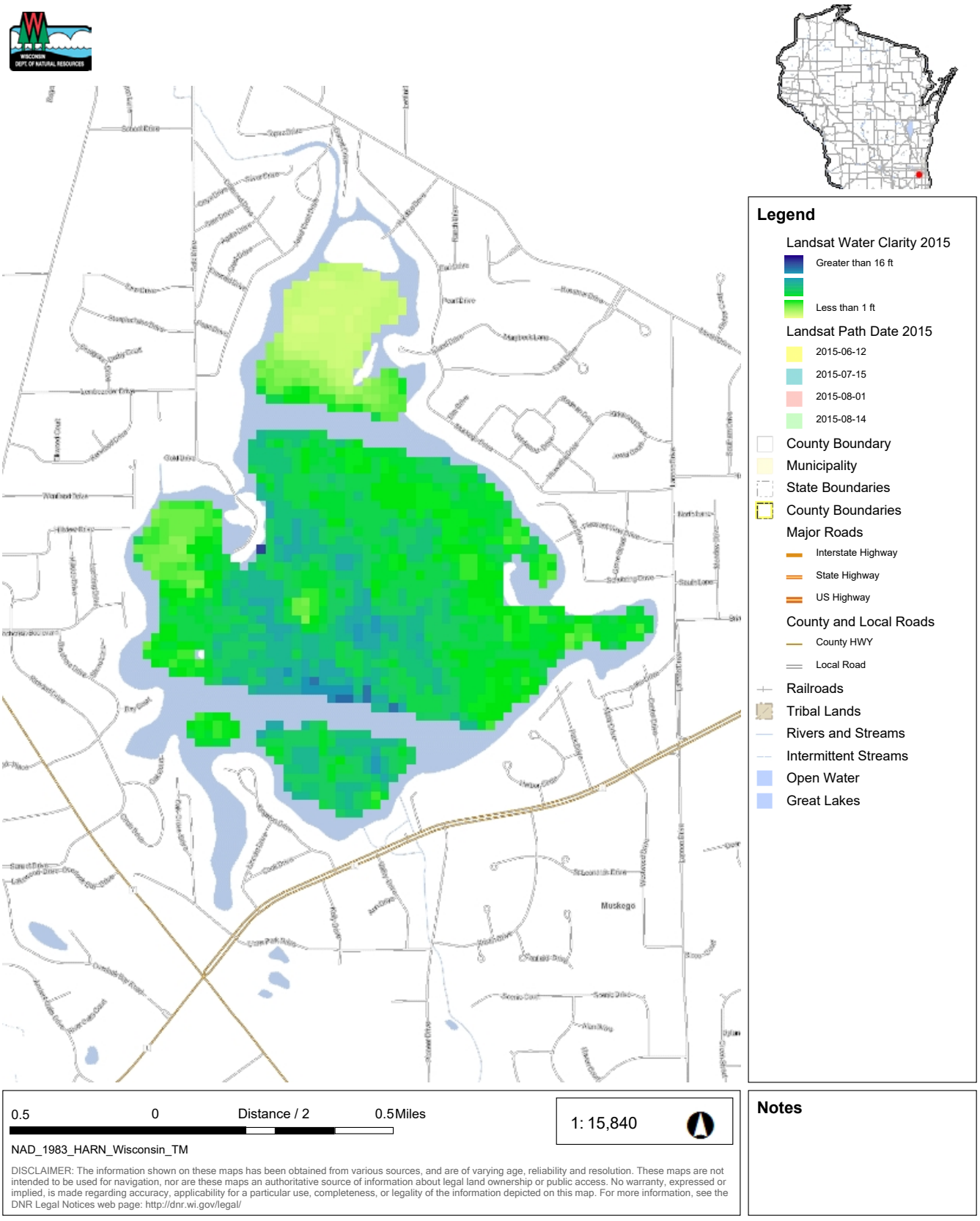
2.4 WATERSHED AND SHORELINE CHARACTERISTICS AND POLLUTANT LOADINGS

The types and amounts of pollutants that enter a lake are highly dependent on the ways surrounding land (i.e., lake watershed) is used. Different land uses produce different pollutants (see Figure 2.29). For example, agricultural land can be a significant contributor of sediment (from soil eroded from cultivated areas and subsequently delivered to lakes by streams) and nutrients (from fertilizers and topsoil washed off fields). The types of agricultural practices employed influence the amount and timing of erosion and sediment and nutrients delivered to a lake. For example, tillage can promote erosion by loosening soils while tiles and ditches may hasten runoff and reduce the ability of sediment and nutrients to be captured before they enter waterways. Conversely, conservation tillage, cover crops, and pastured lands can reduce erosion and nutrient delivery. Urban land uses (e.g., residential, industrial, commercial development) can contribute significant amounts of heavy metals, petroleum products, toxic organic compounds, nutrients, and other substances. For example, oil leaked onto pavement, aromatic compounds in paving materials and sealers, and fertilizers applied to lawns may be transported to a lake by stormwater runoff. The potential for runoff and pollutant transport is influenced by the permeability, degree of cover, and slope of soils. The amount of pollutant actually reaching water bodies may be higher if slopes are steep and ground is bare, paved, or relatively impermeable. Given this connection, it is important to understand past, present and planned future land use within the watershed. Based on these land use conditions, models can estimate the amount of pollution likely entering a lake. This can help identify portions of the watershed that are more likely contributing to water quality deterioration and can help focus pollution reduction strategies and efforts.

Location and Extent of the Little Muskego Lake Watershed

Before a watershed can be characterized, the boundaries of the watershed must be carefully identified and located. Watershed delineation involves analyzing land surface elevations surrounding a lake to identify areas where runoff drains toward the lake. This analysis determines whether identified potential pollution sources have a route to enter the lake. For example, if a nonpoint pollution source is near a lake but outside of the watershed, surface runoff from that source would not reach the lake. Therefore, this pollution source would not be a direct threat to the lake's water quality.

Figure 2.24
Little Muskego Lake Satellite-Derived Water Clarity: August 1, 2015

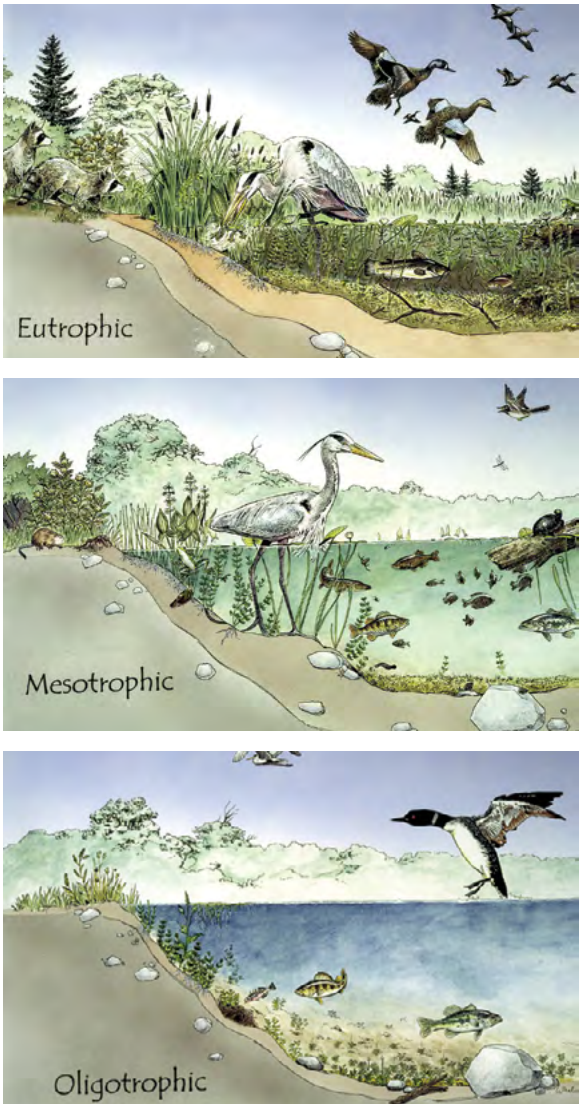


Source: Wisconsin Department of Natural Resources

To characterize the watershed and get an inventory of the information described above, SEWRPC staff used two-foot elevation contour interval maps to delineate Little Muskego Lake's watershed. The SEWRPC existing (year 2010) land use inventory and planned land uses based on the City of Muskego and City of New Belin comprehensive plans were used to quantify the areal extents of various land use categories under existing and planned conditions within the watershed.[28] This exercise, in combination with the use of two models that calculate pollutant loadings,[29] resulted in an inventory of Little Muskego Lake's watershed characteristics. These characteristics are discussed below.

Little Muskego Lake's direct tributary area, which drains directly to the Lake without passing through any upstream waterbody, is shown on Map 2.2. That area is located almost entirely within the City of Muskego, with only a small portion being in the City of New Berlin. **This area, which drains directly to Little Muskego Lake without passing through any upstream waterbody, is approximately 1,425 acres,** or about 2.2 square miles, in areal extent. **The total area tributary to Little Muskego Lake is approximately 6,736 acres**, or about 10.5 square miles, in areal extent. As shown on Map 2.3, the Lake watershed includes portions of the City of New Berlin, as well as the City of Muskego, both in Waukesha County, and includes lands tributary to Linnie Lac, located upstream of the Lake. **There are three internally drained areas in the western portion of the watershed. These areas, totaling 1,709 acres, or 2.7 square miles, contain depressional areas that would retain rainfall runoff during normal precipitation events.**

Figure 2.25
Illustration of Trophic States



Source: DH Environmental Consulting, 1995

Type and Location of Past Land Use Changes Within the Little Muskego Lake Watershed

Historical urban development within the Little Muskego Lake watershed is shown on Map 2.4. Changes in population and households over time are shown in Table 2.8. These changes can also be seen through comparison of aerial photographs representing conditions in 1941 and 2015, the most recent date for which regionwide digital orthophotography is available, as shown on Map 2.5. The population and the number of housing units within the Little Muskego Lake watershed have generally exhibited steady growth since 1960, as shown in Table 2.8. The greatest increase in population occurred between 1960 and 1970 when the number of people increased from 6,365 persons to 8,569 persons, an increase of 35 percent. The number of housing units also increased during this period, increasing from 1,617 units to 2,065 units, an increase of 28 percent. The population and housing units increased at a slower rate during the following decades. Between 2000 and 2010 the population decreased by 3 percent and the number of households only increased by 5 percent, indicating a decrease in the number of people living in each home.

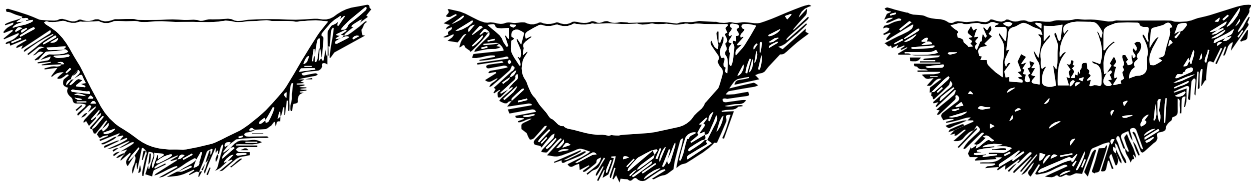
Type and Location of Existing and Planned Land Use Within the Little Muskego Lake Watershed

The extent and location of current land use within the delineated watershed can help determine the potential causes of pollution to the Lake. Current land use can be used to estimate total pollution loads that could

[28] *Geographical Information Systems (GIS) were used to complete these analyses.*

[29] *Wisconsin Lake Model Spreadsheet (WiLMS version 3.0) and the unit area load-based (UAL) models.*

Figure 2.26
The Effect of Aging on Lake Trophic Status



OLIGOTROPHIC

- Clear water, low productivity
- Very desirable fishery of large game fish

MESOTROPHIC

- Increased production
- Accumulated organic matter
- Occasional algal bloom
- Good fishery

EUTROPHIC

- Very productive
- May experience oxygen depletion
- Rough fish common

Source: Wisconsin Department of Natural Resources

potentially be entering the Lake. That information can be used to determine where to focus management efforts (e.g., if agriculture is the primary source of phosphorus, this may be an efficient place to begin pollution reduction efforts).

In addition to current land use in the watershed, it is also possible to determine the planned land use changes that are expected to occur in the future. Knowing this information is important, as it helps determine the areas that may need to be targeted for management efforts in the future, as well as the potential extent of future pollution issues.

The land uses within the subwatershed of Little Muskego Lake are primarily urban, with low- to medium-density residential uses being the dominant forms of urban land use. The shoreline of the Lake is almost entirely developed for residential uses. Existing land uses in the direct tributary area, as of 2010, are shown on Map 2.6 and are summarized in Table 2.9. Future changes are expected to include further limited urban development, infilling of already platted lots, and the possible redevelopment of existing properties at urban densities. Under planned conditions, as summarized in Table 2.9 and shown on Map 2.7, urban land uses in the direct tributary area of Little Muskego Lake are expected to increase from about 76 percent of the watershed area to about 89 percent. Rural uses are anticipated to decline from about 24 percent of the watershed area to about 11 percent under planned conditions. In particular, agricultural land would be expected to be significantly reduced from 152 acres to 10 acres to accommodate new urban growth and the creation of new recreational areas. As shown on Map 2.7, these changes are predicted to occur mostly in the northeastern portion of the direct tributary area. These land use changes have the potential to modify the nature and delivery of nonpoint source contaminants to the Lake, with concomitant impacts on the aquatic plant communities within the waterbody.

In the larger Little Muskego Lake watershed, as summarized in Table 2.10 and shown on Map 2.6, existing 2010 land uses were about evenly divided, with agricultural land uses being the dominant form of rural land and low density residential being the dominant urban use. Future changes in land use within the total watershed to Little Muskego Lake are expected to be similar in nature to those anticipated within the subwatershed, albeit not as pronounced. Rural land uses are anticipated to diminish from 49 percent of the existing land coverage to about 38 percent of the planned land use coverage, while urban land uses are expected to increase from about 51 percent of the land cover to approximately 62 percent.

Land uses within the three internally drained areas, under both year 2010 and planned land use conditions, are summarized in Table 2.11. Water retained in these internally drained features would be slowly released through the groundwater system into surface water features, such as streams and wetlands, or lost to the atmosphere through evaporation, although during extreme precipitation events, some of these areas could overflow to the Lake. Under typical conditions, these areas would not contribute pollutant loads to the Lake, and these lands have been excluded from the nonpoint source pollution loading estimates discussed in the following text.

Pollution Loadings and Sources

Land use data was used within a unit area load-based (UAL) model to estimate pollutant loadings (sediment, phosphorus, copper, and zinc) that could potentially be entering the Lake,[30] as summarized in Table 2.12. These calculations indicate that urban land use is the only significant source of heavy metals. Heavy metal monitoring has not occurred within the Lake. However, control of runoff from urban areas should be targeted if heavy metals become an issue within the Lake in the future. The planned conversion of agricultural land to urban use may increase copper and zinc runoff load to Little Muskego Lake by about 16 and 22 percent, respectively. The UAL model also suggests that, under year 2010 land use conditions, agricultural land uses contribute about 53 percent of the sediment and about 50 percent of the phosphorus reaching Little Muskego Lake in surface water runoff. Under planned conditions, agricultural lands will be converted to urban land use, and the overall mass of sediment and phosphorus from agricultural land that is delivered to Little Muskego Lake will decrease by about 20 percent each.

Figure 2.27
Photograph of a Hyper-Eutrophic Lake

Source: University of Minnesota, College of Natural Resources, 2003

The Wisconsin Lake Model Suite (WiLMS) can also be used to estimate phosphorus loading to lakes. Similar to the approach employed by the UAL model, land use, hydrologic, and watershed area information are used to estimate the total flux of phosphorus to a lake during a typical year.[31] The WiLMS model produces a range of probable phosphorus load values (low, most likely, and high). Load estimates are then used to predict water quality in the receiving lakes using several regression equations. The regression equations have been designed to fit a variety of lake types. For example, some are designed for reservoirs, some for deep lakes, while others are general lake models.

Given 2010 land use estimates (not including the internally drained areas in the watershed), the WiLMS model predicts between 1,690 and 5,016 pounds of phosphorus could be delivered to Little Muskego Lake per year. The low-range values predicted by the WiLMS model essentially match those estimated by the UAL model, suggesting that the lower range loading values may better portray conditions in the watershed. Therefore, the lower range values were also used to predict present and future (i.e., using planned land use) water quality of Little Muskego Lake.

Using the low-range loading estimates for the reason discussed above, one regression-based model (the Reckhow Natural Lake Model) best fit observed conditions in Little Muskego Lake.[32] The Reckhow Natural Lake Model estimated growing season mean phosphorus values of 0.025 mg/L, a value within six percent of the average observed value of 0.0235 mg/L (see Figure 2.19). However, it is still a slight overestimate of current phosphorus concentrations in the Lake. Considering decreasing total phosphorus concentrations and WTSI values within the Lake, comparison of measured conditions to model results suggests significant removal or flushing of excess phosphorus from Little Muskego Lake and/or potential use of best management practices within the watershed to reduce phosphorus inputs.

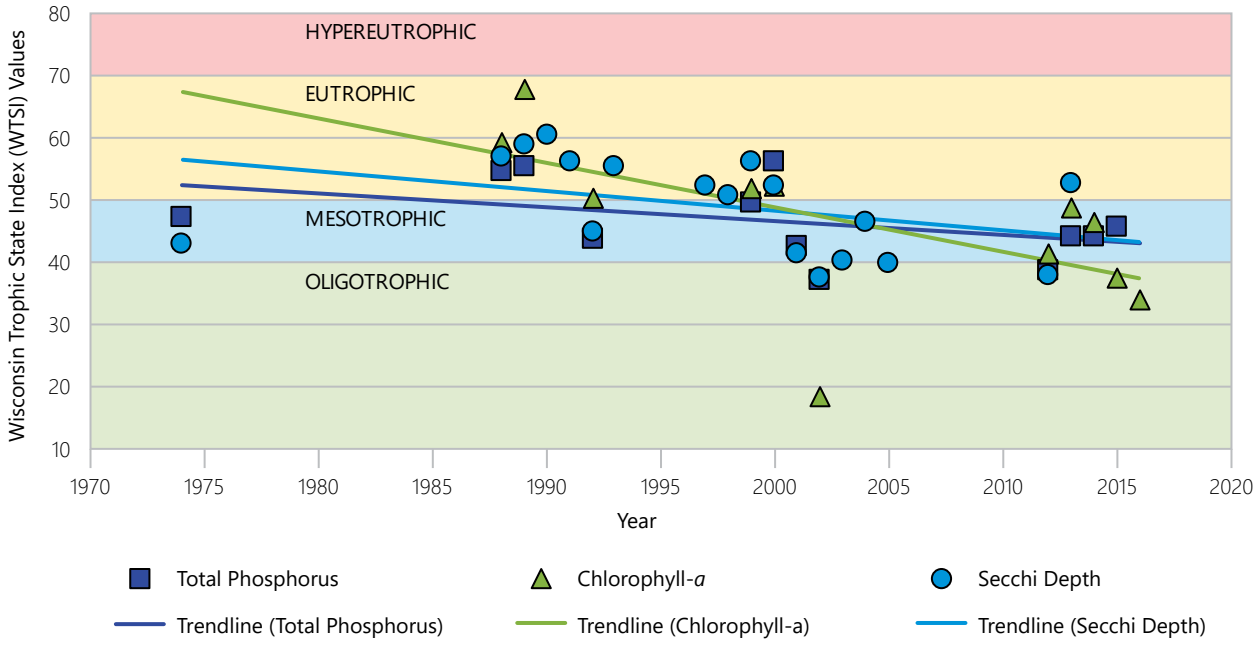
Little Muskego Lake's growing season mean phosphorus concentrations under planned land use conditions (using the Reckhow Natural Lake Model) are actually predicted to increase slightly (0.002 mg/L). These estimates suggest that planned land use conditions will not significantly change summer phosphorus

[30] Ibid.

[31] *These models do not account for groundwater influx and exit from the Lake. Models can be manipulated to include this variable, if sufficient interest is expressed by lake users and managers as part of a future study. Including groundwater in future models may not necessarily improve the accuracy of the models, but will account for and potentially eliminate a currently untested variable from the simulation process.*

[32] *Reckhow, K.H., "Uncertainty applied to Vollenweider's phosphorus criterion", J. Water. Poll. Cont. Fed., Volume 51(8), pages 2123-2128, 1979.*

Figure 2.28
Little Muskego Lake Average Summer Trophic State Indices: 1974-2016



Source: Wisconsin Department of Natural Resources and SEWRPC

concentrations in the Lake on their own. It must be noted that these predictions are based solely on watershed conditions, and do not include factors, such as internal loading, which could increase or decrease phosphorus concentrations, or long-term changes in land management, lake management, and stormwater management, which normally would reduce phosphorus concentrations. Hence, if development is required to follow a stringent set of stormwater water quality practices, there is a real chance to decrease phosphorus loading to the Lake even with additional development. This can be further reinforced through widespread use of residential, agricultural, and open land best management practices.

Finally, Private Onsite Wastewater Treatment Systems (POWTS) or septic systems can be a significant source of phosphorus pollution when not properly maintained. Most of the urban development in the total watershed area is served by sanitary sewers, but some areas of existing urban development in both the area directly tributary to the Lake and the larger watershed are served by POWTS.

Pollution Mitigation Abilities

Many infrastructure and land management features can filter or remove polluted stormwater before it enters a lake system. Identifying the type and location of such features can help determine if pollution sources potentially enter a lake directly (without any treatment) or pass through treatment features. Treatment features are as follows:

1. **Stormwater detention or retention basins:** Stormwater management basins, when properly maintained, can detain water during and after rainfall events, slowing the flow of the water, and allowing many pollutants (e.g., sediments, nutrients, heavy metals) to settle out before reaching downstream water bodies. Since particulate phosphorus is tightly bound to sediment, trapping sediment reduces phosphorus loads passed downstream. These basins need to be periodically dredged and may require other maintenance to ensure they function properly. **Stormwater detention or retention basins in a lake's watershed are a useful means of protecting or improving lake water quality by significantly reducing sediment and nutrient loads to the lake**. Stormwater basins are normally designed to decrease peak flows by storing water during the heaviest runoff period and releasing stored water at a controlled rate over an extended period of time. Some basins are designed to infiltrate a portion of the stormwater, recharging groundwater supplies. Stormwater management basins may extend the period when intermittent streams actively flow and contribute to the value

of riparian and instream habitat. However, they may also warm water, can sometimes attract nuisance species, and can be barriers to aquatic organism migration.

2. **Wetlands:** Wetlands, which are generally identifiable by saturated soils and **water-loving plants, are beneficial to the health of a lake, particularly when located at or along the lake's shoreline, within the floodplain, and along the shores of tributary streams**. Wetlands slow runoff moving toward the lake, which causes reduced flood peaks and allows sediment and affiliated pollutants to settle in a similar fashion to stormwater management basins. Additionally, **the plant life located in wetlands is able to assimilate and process pollutants such as phosphorus and incorporate them into biomass**, thereby preventing the pollutant from entering a lake. These natural features are well known as "nature's pollution filtration system" and are key to the life histories of a large number of fish, amphibians, birds, and other animals. Without wetlands, familiar species such as northern pike may not be able to naturally reproduce. Knowing where wetlands are located can help determine if a pollution source is a high risk to downstream waters, since wetlands can detain or retain certain pollutants.

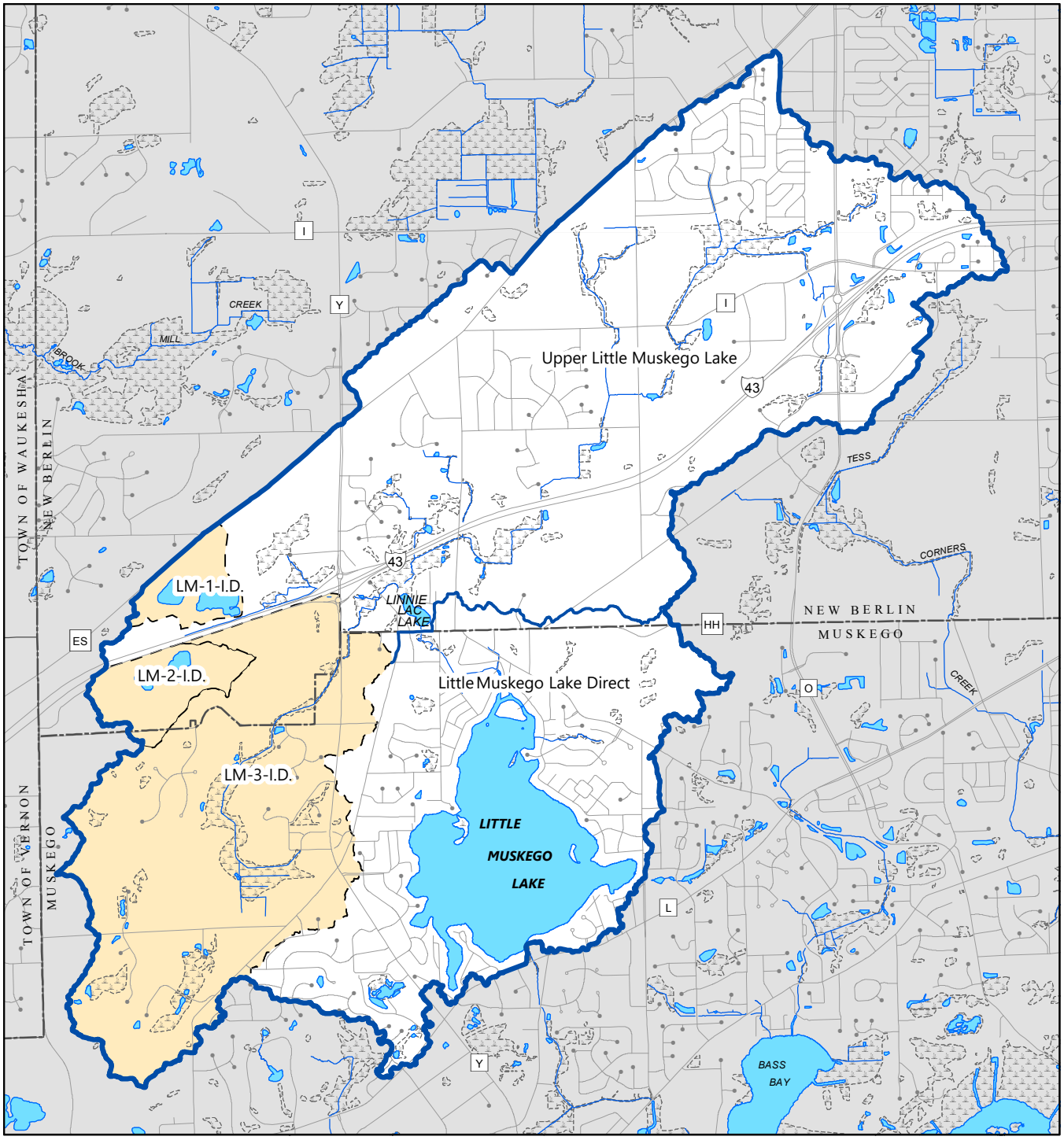
3. **Natural terrestrial buffers:** Natural buffers primarily refer to vegetative features such as woodlands or prairies. When these areas, like wetlands, are densely vegetated, they can slow the flow of water and incorporate pollutants into biomass. Consequently, **these areas, located in an area that intercepts water flowing toward the Lake, can help lower pollution risks to the Lake**. Moreover, enhancing these features, particularly in areas adjacent to a waterbody, can decrease the amount of pollution entering that waterbody. Like wetlands, such areas are critical to the life cycle of many herptiles (amphibians and reptiles) and birds.

4. **Floodplains:** Floodplains are areas inundated during periods of heavy runoff. The portions of floodplains that convey floodwater are referred to as floodways. Flood fringe areas, which are located adjacent to, and beyond, the floodway on either side of a stream, are lower velocity, shallower depth areas where the energy of the flowing water is spread out over a broader area and floodwaters are temporarily stored. Flood fringe lands help

Figure 2.29
Illustrations of Land Use Affecting Waterbodies

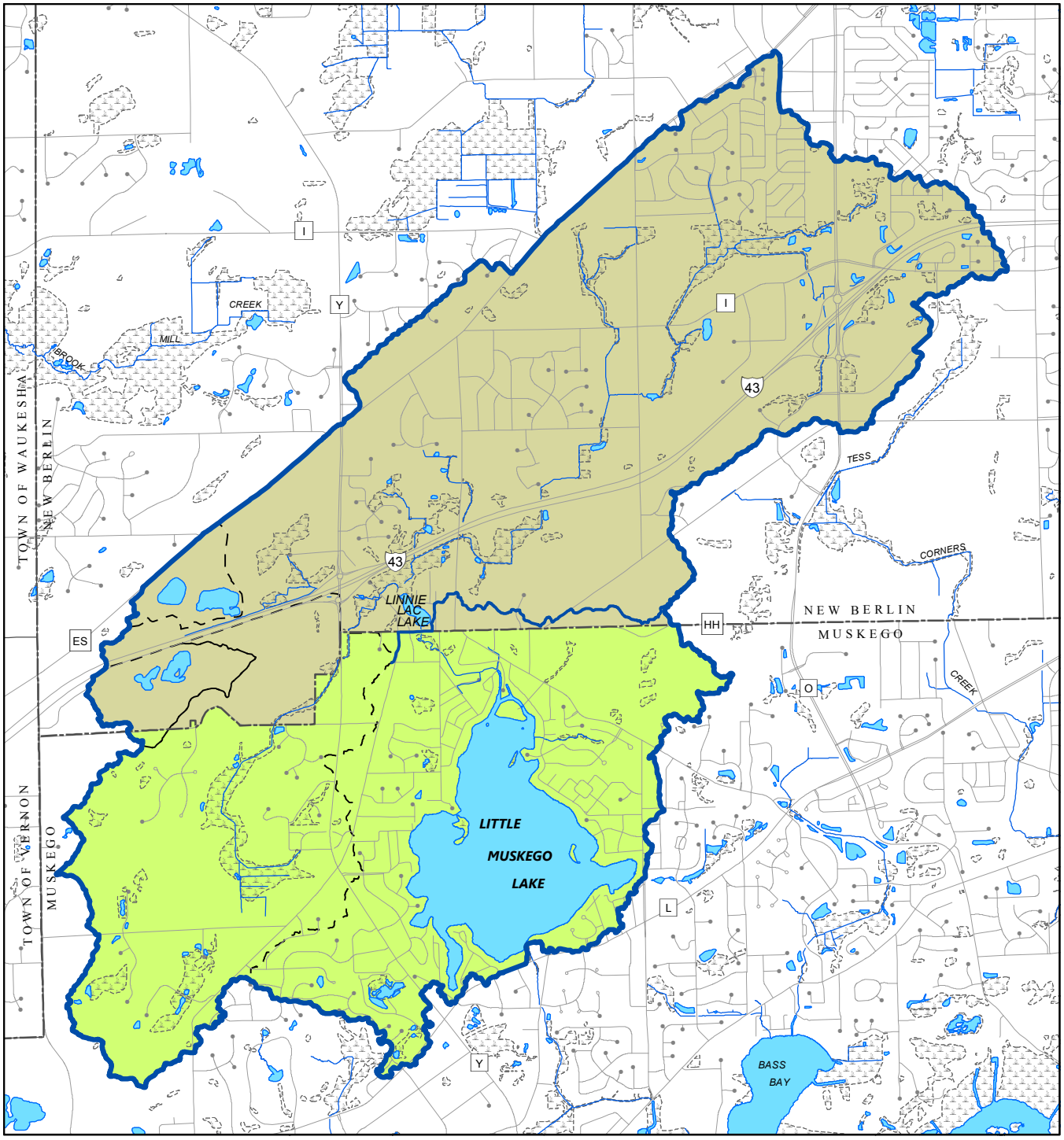
Source: Illustration by Frank Ippolito, www.productionpost.com. Modified from D.M. Carlisle and others. The quality of our Nation's waters—Ecological health in the Nation's streams, 1993-2005: U.S. Geological Survey Circular 1391, 120 p., pubs.usgs.gov/circ/1391/, 2013, and SEWRPC

Map 2.2
Little Muskego Lake Watershed and Direct Tributary Area



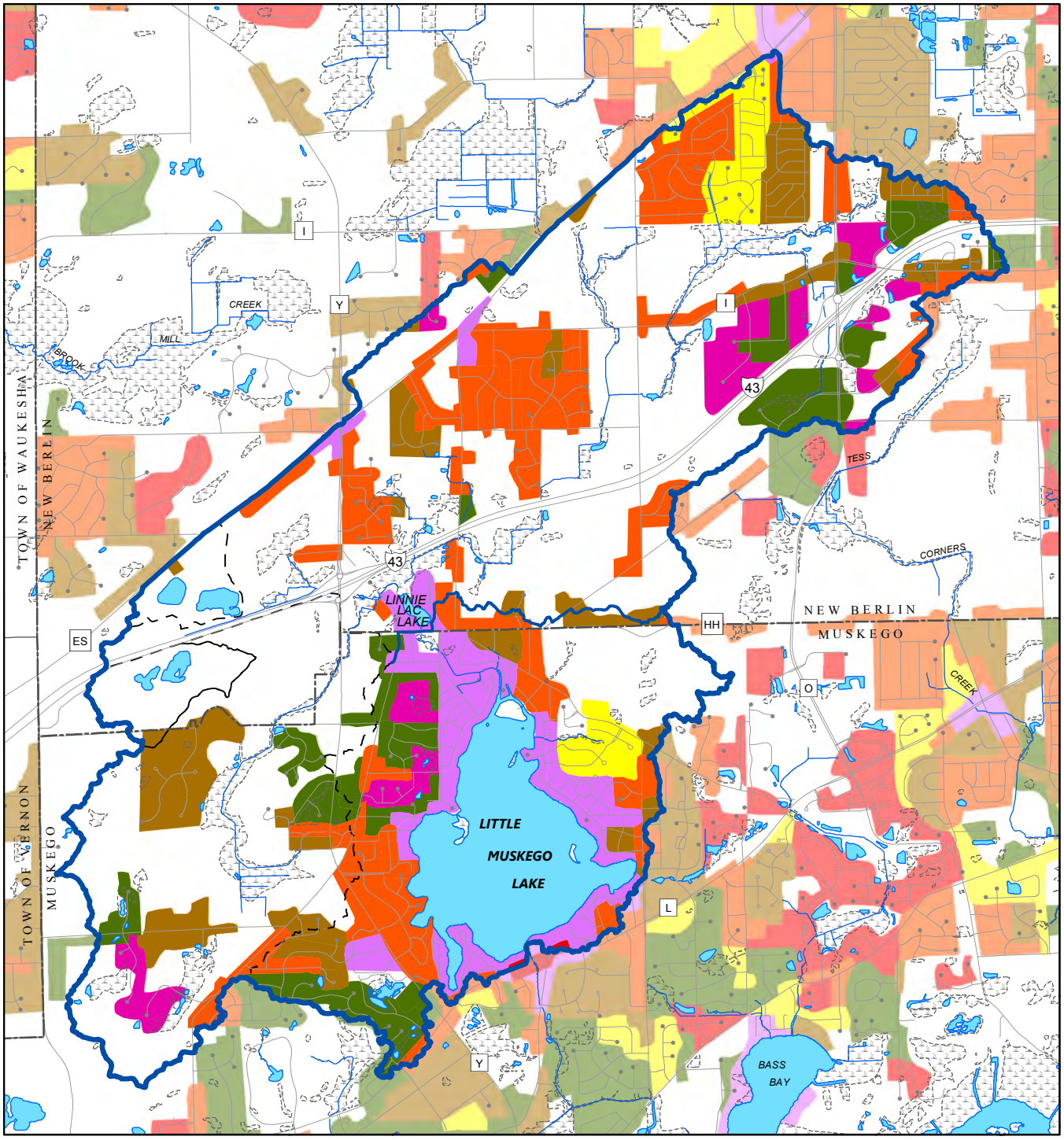
Source: SEWRPC

Map 2.3
Civil Divisions Within the Little Muskego Lake Watershed: 2015



Source: SEWRPC

Map 2.4
Historical Urban Growth Within and Near the Little Muskego Lake Watershed: 1860-2010



1850 - 1939
1940 - 1950
1951 - 1970
1971 - 1980
1981 - 1990
1991 - 2000
2001 - 2010

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

WETLAND
SURFACE WATER
STREAM
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
INTERNALLY DRAINED AREAS

N

0 2,000 4,000 Feet

Source: SEWRPC

Table 2.8
Population and Households in the Little Muskego Lake Tributary Area: 1960-2035

Year	Population	Change from Previous Decade		Households	Change from Previous Decade	
		Number	Percent		Number	Percent
1960	6,365	--	--	1,617	--	--
1970	8,569	2,204	35	2,065	448	28
1980	9,037	468	5	2,633	568	28
1990	9,985	948	10	3,231	598	23
2000	11,152	1,167	12	4,000	769	24
2010	10,862	-290	-3	4,195	195	5
Planned 2035	12,574	1,712	16	4,716	521	12

Note: Planned 2035 data based on 2000 census data and do not reflect changes that may have occurred between 2000 and 2010. These data differ slightly from those reported in the 2004 and 2009 SEWRPC studies on Little Muskego due to refinements of the Little Muskego Lake tributary area boundary made possible through Commission digital terrain modeling analysis.

Source: U.S. Bureau of Census and SEWRPC

reduce downstream flood elevations through storing floodwaters and can reduce stream power, thereby reducing erosion and pollutant mobilization/transport. Additionally, flood fringe areas can act as sediment, nutrient, and pollutant traps, and provide refuge to aquatic life, affording similar ecological services as wetland habitat. Floodplains provide the broadest value in their natural state, but can still provide valuable service when developed in compatible open space uses. Floodplains can be restored along manipulated drainage ways as part of projects that help stabilize eroding beds and banks.

5. **Artificial terrestrial buffers (e.g., grassed waterways, vegetative strips):** Artificial buffers take a number of forms. A few examples include grassed waterways, vegetative strips, and gardens located along shorelines. Such buffers are generally constructed to intercept runoff shortly before it enters a river or lake. They function in a similar way to natural buffers (i.e., slowing runoff); however, they need to be carefully designed and should use native plants to ensure that they function well in the longer term. **Artificial buffers can enhance lake water quality without significant adverse effects to residential and agricultural land uses**. Further details regarding artificial buffers and their efficacy are included in Appendix B.

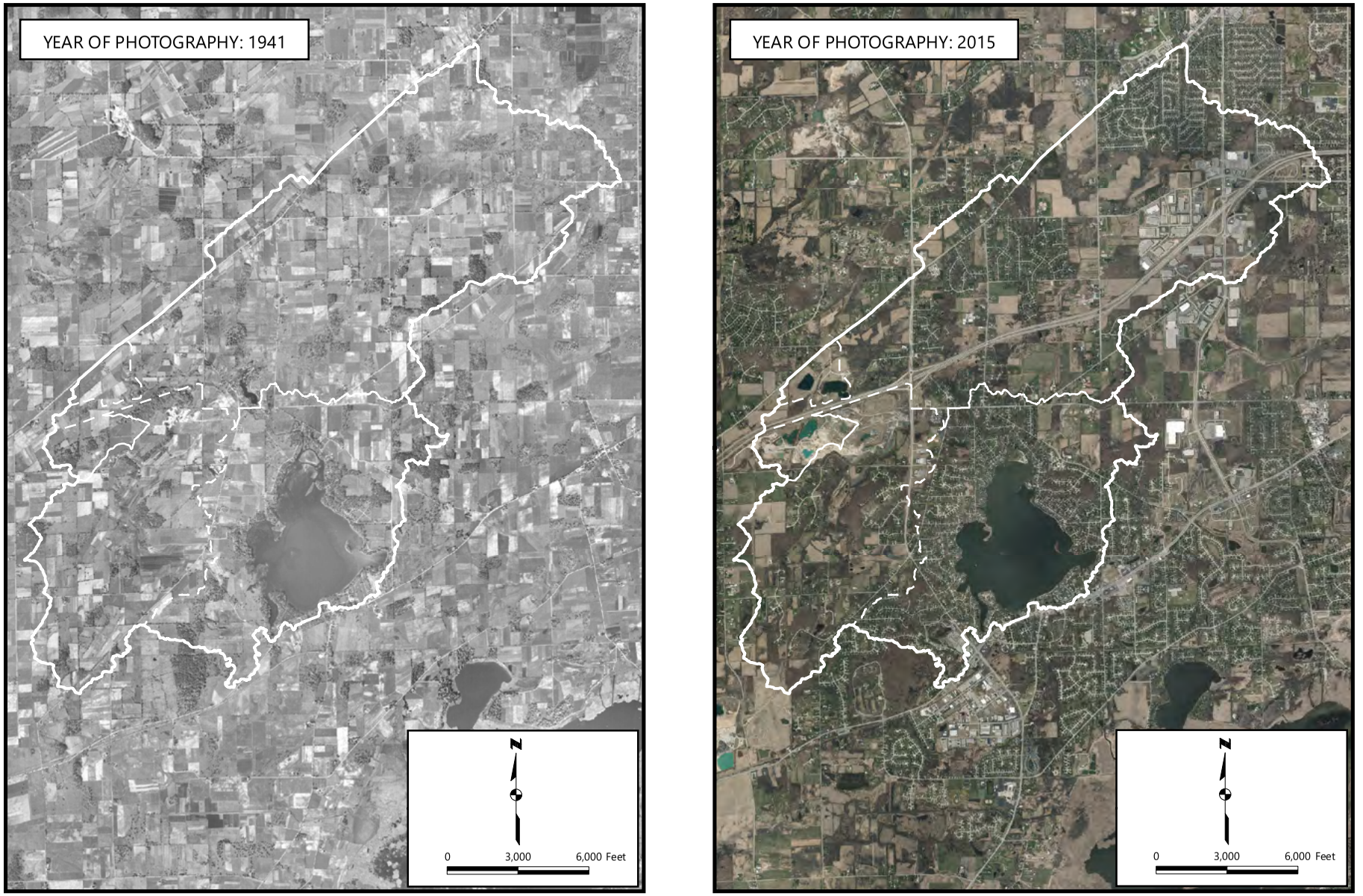
6. **Nearshore Aquatic Vegetative Buffers:** In-lake vegetation (e.g., bulrush and cattails) in shallow nearshore areas can filter and assimilate nutrients and sediments to some degree before runoff reaches the main body of a lake. Such areas also help protect shorelines from erosion and provide valuable aquatic habitat to a wide range of animals. Consequently, encouraging survival and enhancement of nearshore vegetation can help improve lake water quality.

It should be noted that these features can overlap and may provide multiple benefits. To locate each of the features described above, SEWRPC staff completed an inventory of the detention basins, wetlands, and natural features such as woodlands within the watershed, using existing databases, mapping software, and aerial imagery. Additionally, to identify the extent of shoreline buffers, SEWRPC staff completed a field assessment of the Little Muskego Lake shoreline during summer of 2014. These inventories are described below.

Many small stormwater basins are located throughout the Little Muskego Lake watershed. If stormwater basins are created in the contributing watershed area in the future, they will need to be properly maintained, and will help limit or reduce the amount of urban nonpoint source pollution entering the Lake from the land areas draining to these basins. Where feasible, constructing such basins to collect runoff from areas of existing development would decrease pollutant loads.

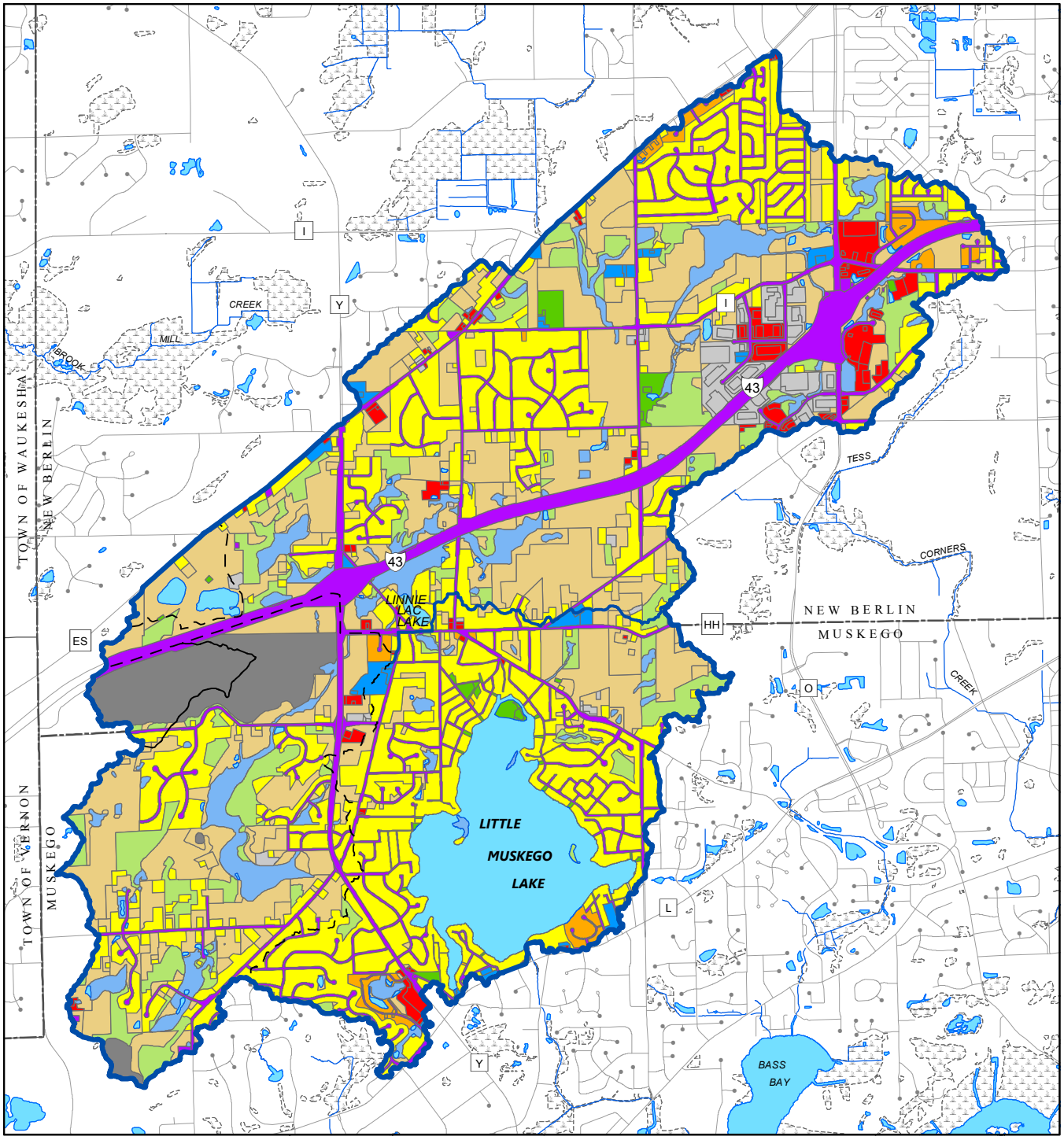
Approximately six percent of the Little Muskego Lake watershed is comprised of wetlands. These wetlands are scattered along the tributaries that drain into Linnie Lac and then Little Muskego Lake (see Map 2.8). These wetlands provide the Lake with a degree of pollution and sediment reduction from surface water runoff entering the Lake through Jewel Creek. The potential to naturally remove pollutants, in combination with the many other benefits provided by wetlands, illustrates how crucial protecting these wetlands is for Little Muskego Lake.

Map 2.5
Historical Aerial Photographs of the Little Muskego Lake Watershed: 1941 and 2015



Source: SEWRPC

Map 2.6
2010 Land Use Within the Little Muskego Lake Watershed



Source: SEWRPC

Table 2.9
Existing and Planned Land Use Within the Area Directly Tributary to Little Muskego Lake

Land Use Categories[a]	Existing[b]		Planned[c]	
	Acres	Percent of Total	Acres	Percent of Total
Urban				
Residential				
Single-Family, Suburban-Density	--	--	--	--
Single-Family, Low-Density	253	17.7	341	23.9
Single-Family, Medium-Density	531	37.3	540	37.9
Single-Family, High-Density	--	--	--	--
Multifamily	36	2.5	36	2.5
Commercial	19	1.3	37	2.6
Industrial	4	0.3	1	<0.1
Governmental and Institutional	25	1.8	23	1.8
Transportation, Communication, and Utilities	196	13.8	218	15.3
Recreational	22	1.5	75	5.3
Urban Subtotal	1,086	76.2	1,273	89.3
Rural				
Agricultural	152	10.7	10	0.7
Other Open Lands	67	4.7	22	1.6
Wetlands	38	2.7	38	2.7
Woodlands	77	5.4	77	5.4
Water[d]	5	0.3	5	0.3
Extractive	--	--	--	--
Landfill	--	--	--	--
Rural Subtotal	339	23.8	152	10.7
Total	1,425	100.0	1,425	100.0

[a] *Parking included in associated use.*

[b] *Based on SEWRPC year 2010 existing land use inventory*

[c] *Based on comprehensive plans adopted by the Cities of Muskego and New Berlin.*

[d] *Five acres of open water exist within the upland area directly tributary to Little Muskego Lake. Little Muskego Lake occupies an additional 481 acres.*

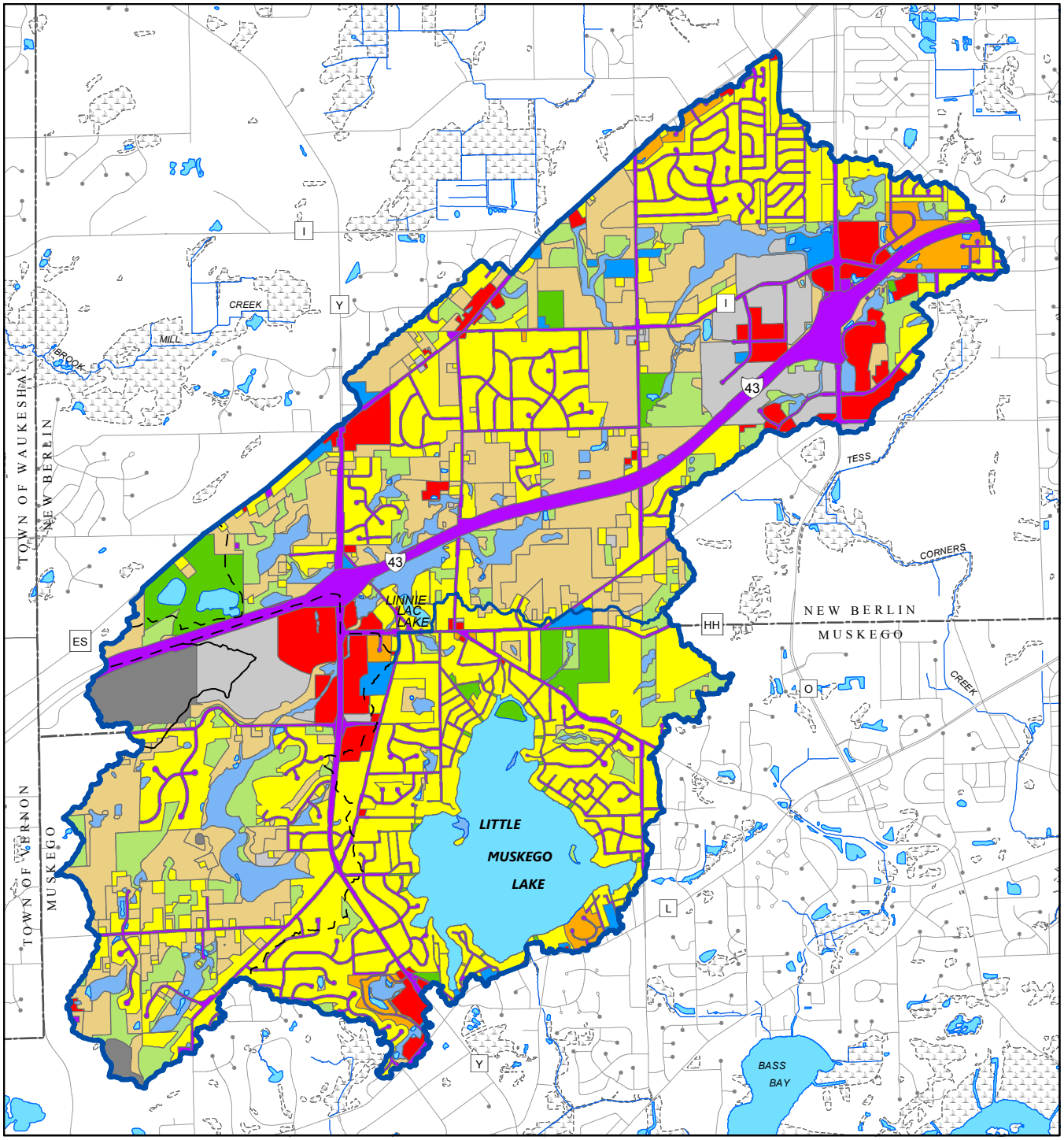
Source: City of Muskego, City of New Berlin, and SEWRPC

Woodlands, uplands, and other "natural areas," as mentioned above, act as buffers to waterbodies. About 8 percent of the Little Muskego Lake watershed is composed of woodlands. Woodlands and other "natural areas" are particularly valuable when located in areas adjacent to the Lake or its tributaries (see Map 2.8).

Mapped floodplains comprise 4.5 percent of the Little Muskego Lake watershed. These areas are located along the tributaries to Linnie Lac and Little Muskego Lake and overlap with many of the wetlands and woodlands present within the watershed (see Map 2.9).

Artificial terrestrial buffers and other shoreline protection measures (e.g., riprap) along the shorelines of Little Muskego Lake are shown on Map 2.10. Figure 2.30 illustrates common shoreline protection techniques. A majority of the Little Muskego Lake shoreline is composed of hard structures such as riprap or bulkheads. However, "soft" shoreline protection, referred to as "vegetative shore protection" (see Figures 2.31 and 2.32) is increasingly popular with riparian owners. This shoreline protection not only protects the shoreline from erosive forces, but also improves the viewshed and provides natural habitat for wildlife. These and other vegetative buffers also provide the Lake with some protection from the pollution that could otherwise enter the Lake (e.g., lawn clippings, fertilizers, oils from cars). Very little of the Lake shoreline was composed of vegetation at the time of the survey and several areas of erosion were identified.

Map 2.7
Planned Land Use Within the Little Muskego Lake Watershed



Source: City of Muskego, City of New Berlin, and SEWRPC

Table 2.10
Existing and Planned Land Use Within the Little Muskego Lake Watershed

Land Use Categories[a]	Existing[b]		Planned[c]	
	Acres	Percent of Total	Acres	Percent of Total
Urban				
Residential				
Single-Family, Suburban-Density	174	2.6	179	2.7
Single-Family, Low-Density	1,190	17.7	1,338	19.8
Single-Family, Medium-Density	652	9.7	679	10.1
Single-Family, High-Density	--	--	--	--
Multifamily	95	1.4	118	1.8
Commercial	163	2.4	341	5.0
Industrial	155	2.3	322	4.8
Governmental and Institutional	68	1.0	83	1.2
Transportation, Communication, and Utilities	857	12.7	929	13.8
Recreational	53	0.8	188	2.8
Urban Subtotal	3,407	50.6	4,177	62.0
Rural				
Agricultural	1,456	21.6	1,207	17.9
Other Open Lands	584	8.7	219	3.2
Wetlands	413	6.1	413	6.1
Woodlands	546	8.1	546	8.1
Water[d]	54	0.8	54	0.8
Extractive	260	3.9	104	1.6
Landfill	16	0.2	16	0.2
Rural Subtotal	3,329	49.4	2,559	38.0
Total	6,736	100.0	6,736	100.0

[a] *Parking included in associated use.*

[b] *Based on SEWRPC year 2010 existing land use inventory*

[c] *Based on comprehensive plans adopted by the Cities of Muskego and New Berlin.*

[d] *54 acres of open water exist within the total upland area draining to Little Muskego Lake. Little Muskego Lake occupies an additional 481 acres.*

Source: City of Muskego, City of New Berlin, and SEWRPC

2.5 FISHERIES AND WILDLIFE

Fish Management

Little Muskego Lake is managed for bluegill, largemouth bass, northern pike, and walleye. The WDNR reports that the fish population in Little Muskego Lake is comprised of numerous fish species, with panfish and largemouth bass being common and walleye and northern pike being present.[33] The large size and high number of panfish suggests habitat degradation in Little Muskego Lake.[34] Common carp also are present in moderate numbers although very few young carp were observed during a 2012 survey.[35] The populations of various gamefishes have been maintained through WDNR stocking programs. As summarized in Table 2.13, stocking of walleye, largemouth bass, and northern pike into Little Muskego Lake has occurred periodically since 1973.

Birds and Other Wildlife

Given the land uses present around the shorelands of the Lake, generally only smaller animals and waterfowl can be expected to inhabit the lakeshore. Muskrats, beaver, grey and fox squirrels, and cottontail rabbits are probably the most abundant and widely distributed fur-bearing mammals in the immediate riparian areas.

[33] *Wisconsin Department of Natural Resources Publication No. PUBL-FM-800-2005,* Wisconsin Lakes, *2005.*

[34] *Personal communication with WDNR Fisheries Biologist.*

[35] *Wisconsin Department of Natural Resources Correspondence/Memorandum,* Comprehensive Survey Report of Little Muskego Lake – Waukesha County (WBIC 775900), *August 2, 2016.*

Table 2.11
Existing and Planned Land Use Within the Internally Drained Areas Tributary to Little Muskego Lake

Land Use Categories[a]	Existing[b]		Planned[c]	
	Acres	Percent of Total	Acres	Percent of Total
Urban				
Residential				
Single-Family, Suburban-Density	174	10.2	179	10.5
Single-Family, Low-Density	132	7.7	183	10.7
Single-Family, Medium-Density	7	0.4	7	0.4
Single-Family, High-Density	0	0.0	0	0.0
Multifamily	8	0.5	8	0.5
Commercial	9	0.5	89	5.2
Industrial	8	0.5	120	7.0
Governmental and Institutional	8	0.5	7	0.4
Transportation, Communication, and Utilities	124	7.3	169	9.9
Recreational	1	0.1	67	3.9
Urban Subtotal	471	27.6	829	48.5
Rural				
Agricultural	357	20.9	324	19.0
Other Open Lands	267	15.6	98	5.7
Wetlands	129	7.6	129	7.6
Woodlands	181	10.6	181	10.6
Water[d]	28	1.6	28	1.6
Extractive	260	15.2	104	6.1
Landfill	16	0.9	16	0.9
Rural Subtotal	1,238	72.4	880	51.5
Total	1,709	100.0	1,709	100.0

[a] *Parking included in associated use.*

[b] *Based on SEWRPC year 2010 existing land use inventory*

[c] *Based on comprehensive plans adopted by the Cities of Muskego and New Berlin.*

[d] *28 acres of open water exist within the upland internally drained areas that do not drain to Little Muskego Lake. No part of Little Muskego Lake is located in these areas.*

Source: City of Muskego, City of New Berlin, and SEWRPC

Larger mammals, such as the whitetail deer, would generally be expected to be confined to the larger wooded areas and the open meadows found in the park and open space lands within the tributary areas of the Lake.

The Little Muskego Lake tributary areas support a significant population of waterfowl including mallards, wood duck, and blue-winged teal. During the migration seasons a greater variety of waterfowl may be present and in greater numbers.[36]

Amphibians and reptiles are vital components of the Little Muskego Lake ecosystem, and include frogs, toads, and salamanders, and turtles and snakes, respectively. About 15 species of amphibians and 15 species of reptiles would normally be expected to be present in the Little Muskego Lake area.[37]

2.6 RECREATIONAL USES AND FACILITIES

Little Muskego Lake is a multi-purpose waterbody serving a variety of recreational and other uses. Active recreation includes boating, waterskiing, tubing, swimming, and fishing during the summer months, and cross-country skiing, snowmobiling, and ice fishing during the winter. Public access to Little Muskego Lake is provided by four boat launches and 14 public access carry in-sites around the Lake (see Map 2.11) and is

[36] *Wisconsin Breeding Bird Atlas II, Wisconsin Society of Ornithology, http://wsobirds.org/atlas.*

[37] *Wisconsin Herpetological Atlas Project, University of Wisconsin-Milwaukee Field Station, http://www4.uwm.edu/fieldstation/herpetology/atlas.html.*

Table 2.12
Unit Area Load Model Estimated Annual Pollutant Loading: Little Muskego Lake

Land Use Category	Pollutant Loads: Existing			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	53.0	459.7	23.3	171.4
Commercial	60.4	184.8	33.9	229.5
Industrial	55.3	172.0	32.3	219.0
Governmental	15.3	81.0	4.2	48.0
Transportation	40.3	80.6	175.9	630.4
Recreational	0.6	14.0	0.0	0.0
Subtotal	224.9	992.2	269.7	1,298.8
Rural				
Agricultural	247.3	945.1	0.0	0.0
Other Open Lands	1.5	34.9	0.0	0.0
Wetlands	0.5	11.4	0.0	0.0
Woodlands	0.7	14.6	0.0	0.0
Water	2.4	3.3	0.0	0.0
Subtotal	252.3	1,009.2	0.0	0.0
Total	477.2	2,001.4	269.7	1,298.8

Land Use Category	Pollutant Loads: Existing			
	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
Urban				
Residential[a]	58.1	505.9	26.6	194.7
Commercial	98.8	302.4	55.4	375.5
Industrial	76.0	236.3	44.4	301.0
Governmental	19.4	102.6	5.3	60.8
Transportation	41.8	83.6	182.4	653.6
Recreational	1.5	32.7	0.0	0.0
Subtotal	295.5	1,263.6	314.2	1,585.6
Rural				
Agricultural	198.7	759.4	0.0	0.0
Other Open Lands	0.6	13.3	0.0	0.0
Wetlands	0.5	11.4	0.0	0.0
Woodlands	0.7	14.6	0.0	0.0
Water	2.4	3.3	0.0	0.0
Subtotal	202.8	801.9	0.0	0.0
Total	498.3	2,065.5	314.2	1,585.6

[a] *Includes suburban-density, low-density, medium-density, high-density, and multifamily residential land use.*

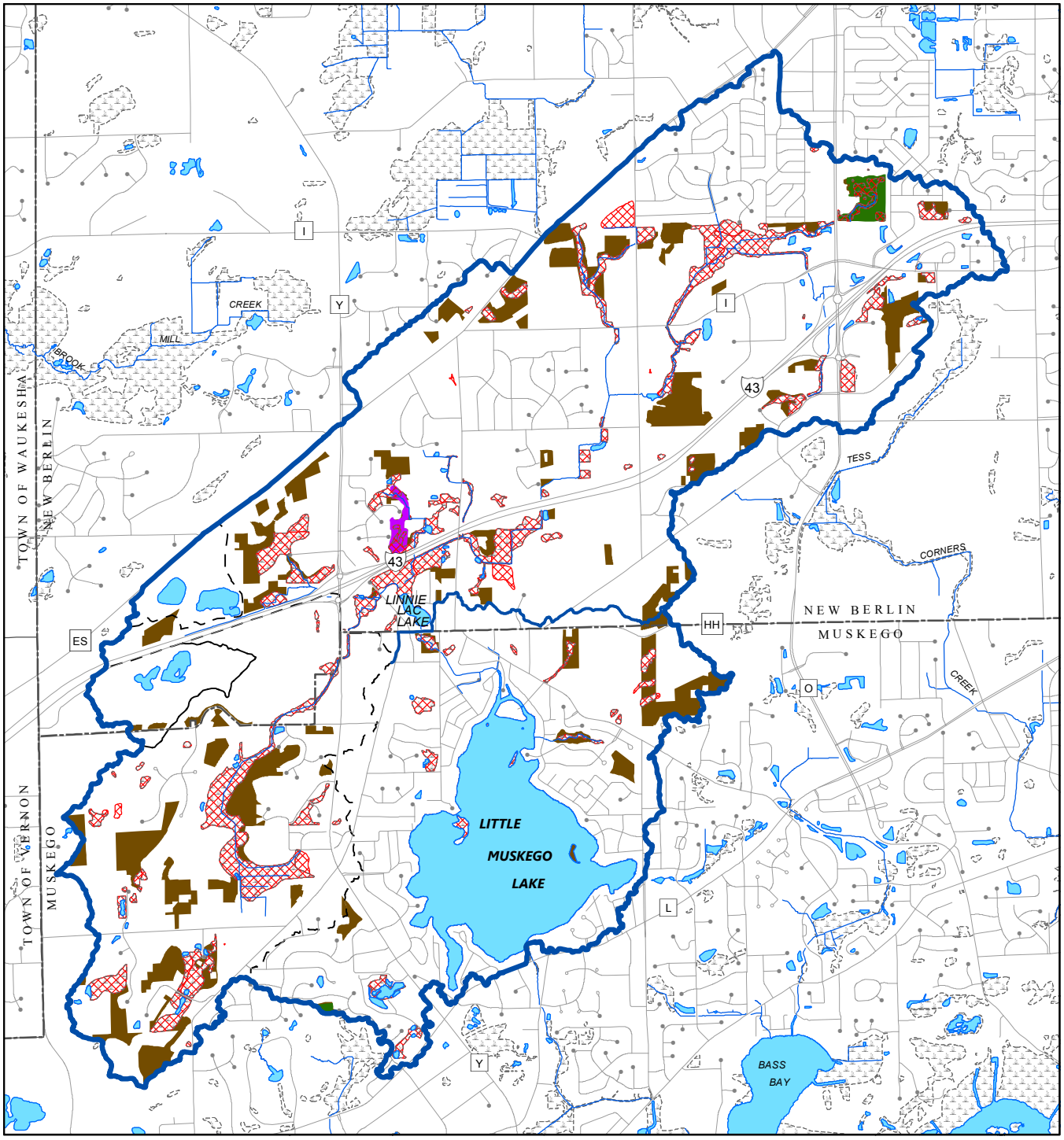
Source: City of Muskego, City of New Berlin, and SEWRPC

considered by the WDNR to have adequate public recreational boating access, as defined in Chapter NR 1 of the *Wisconsin Administrative Code*. A fee of $7.00 per day is charged. Annual passes are offered for a fee of $42.00 for City of Muskego residents and $63.00 for non-residents. It appears that the launch fees could be increased by at least $1.00.[38] Launch fees can influence the intensity of use of the launch facility, and can be considered as part of a program to help avoid excess boat densities on the Lake.

The types of watercraft docked or moored on a lake, as well as the relative proportion of nonmotorized to motorized watercraft, reflect the attitudes of the primary users of the lake, the riparian residents. To help characterize the recreational use of Little Muskego Lake, a watercraft census (i.e., a boat count along the

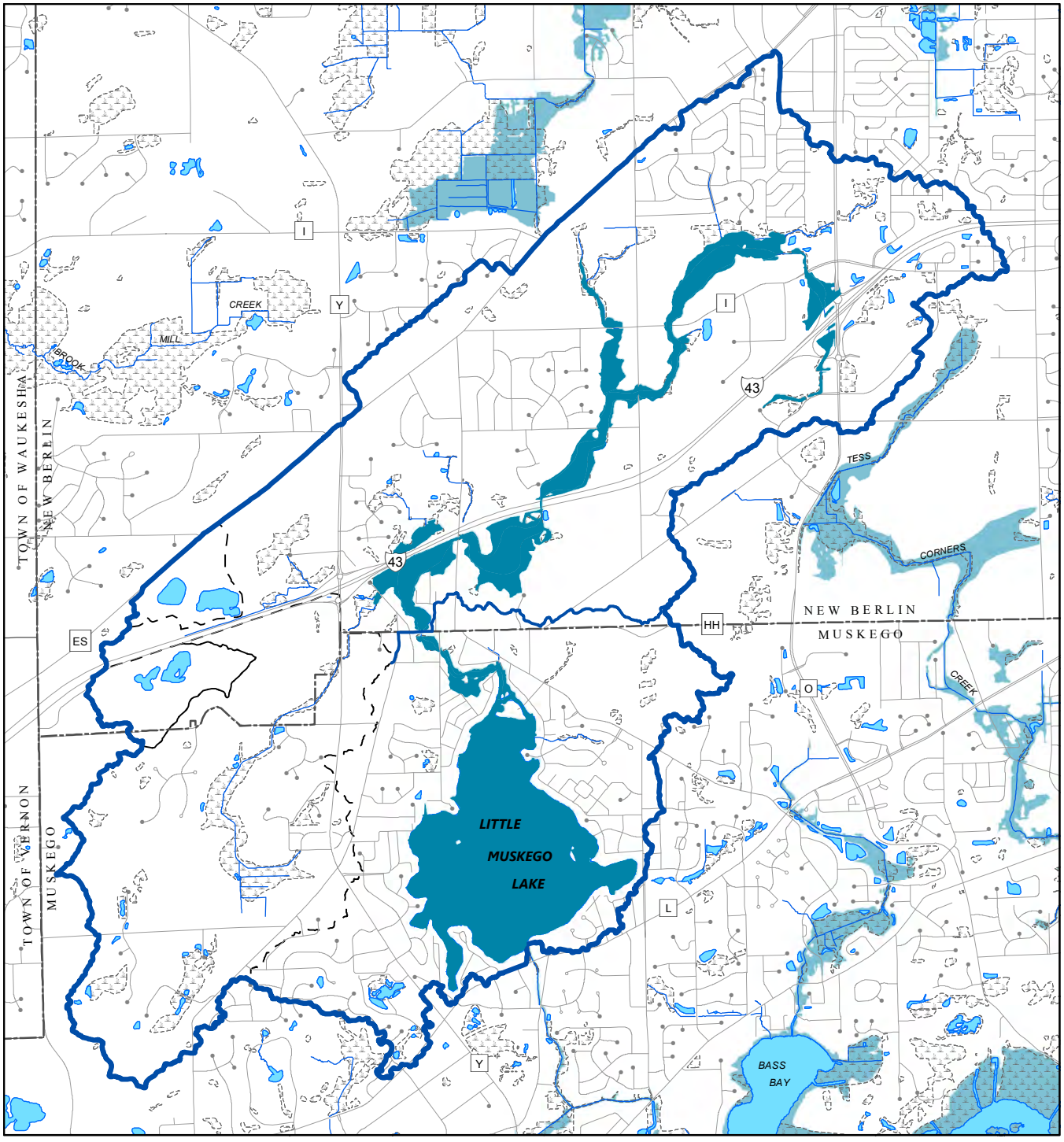
[38] *NR 1.91(11)a encourages free boat launching but allows a maximum one-day base fee equivalent to the one-day fee for residents to enter state parks ($8.00 at the time of this report). NR1.91(11)b allows additional surcharges based upon the presence of an attendant (20% base fee surcharge), the size of boats served (30% base fee surcharge for boats between 20 and 26 feet in length and 60% base fee surcharge for boats greater than 26 feet in length), and the presence of on-site toilet facilities (20% base fee surcharge).*

Map 2.8
Natural Areas, Critical Species Habitat, Wetlands, and Woodlands in the Little Muskego Lake Watershed



Source: SEWRPC

Map 2.9
Floodplains Within and Near the Little Muskego Lake Watershed



1-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Colors outside the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

WETLAND
STREAM
WATERSHED BOUNDARY
SUBWATERSHED BOUNDARY
INTERNALLY DRAINED AREAS

N

0 2,000 4,000 Feet

Source: SEWRPC

Map 2.10
Shoreline Assessment of Little Muskego Lake: 2014

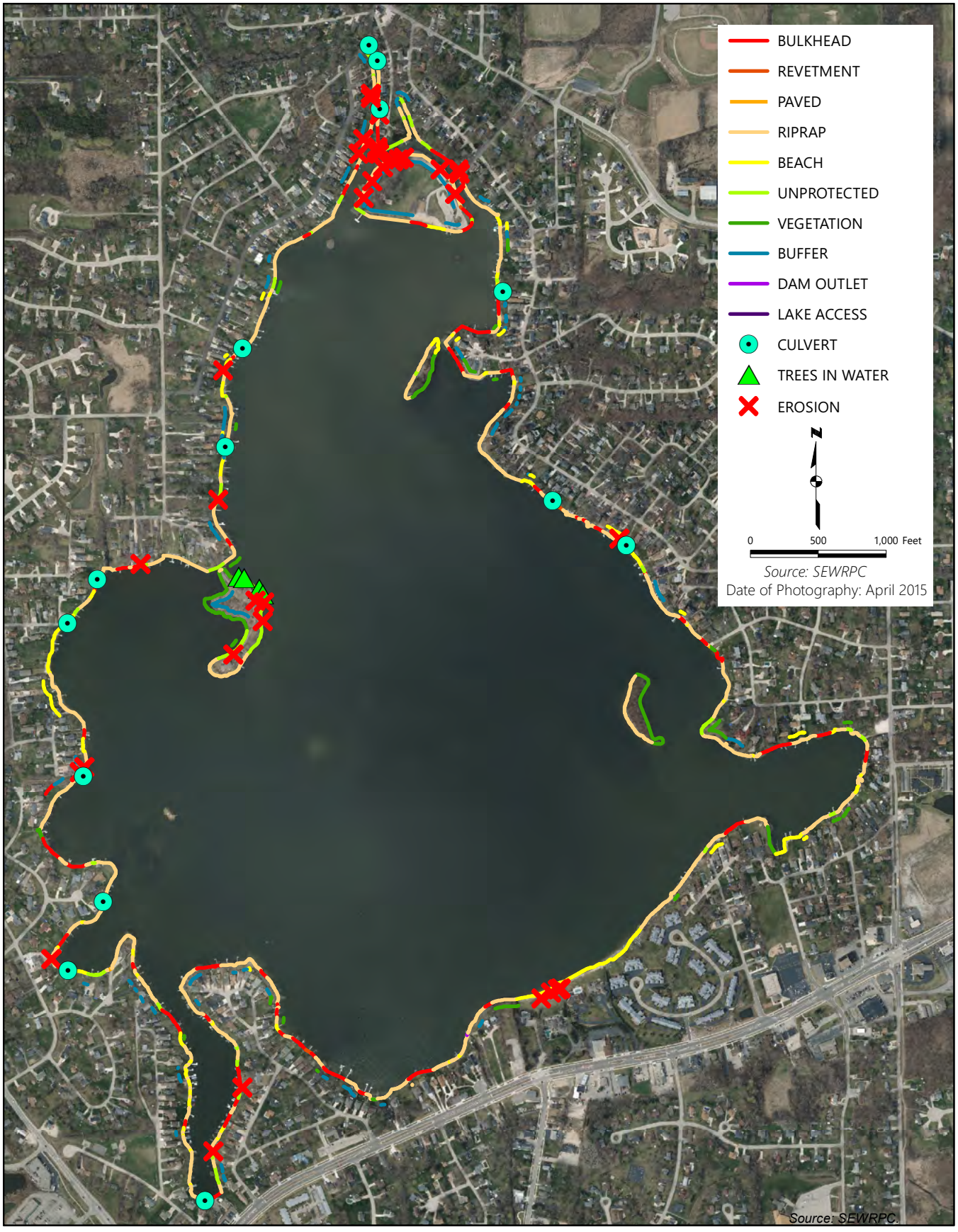


Figure 2.30
Typical Shoreline Protection Techniques

RIP RAP

NATURAL VEGETATION

BULKHEAD

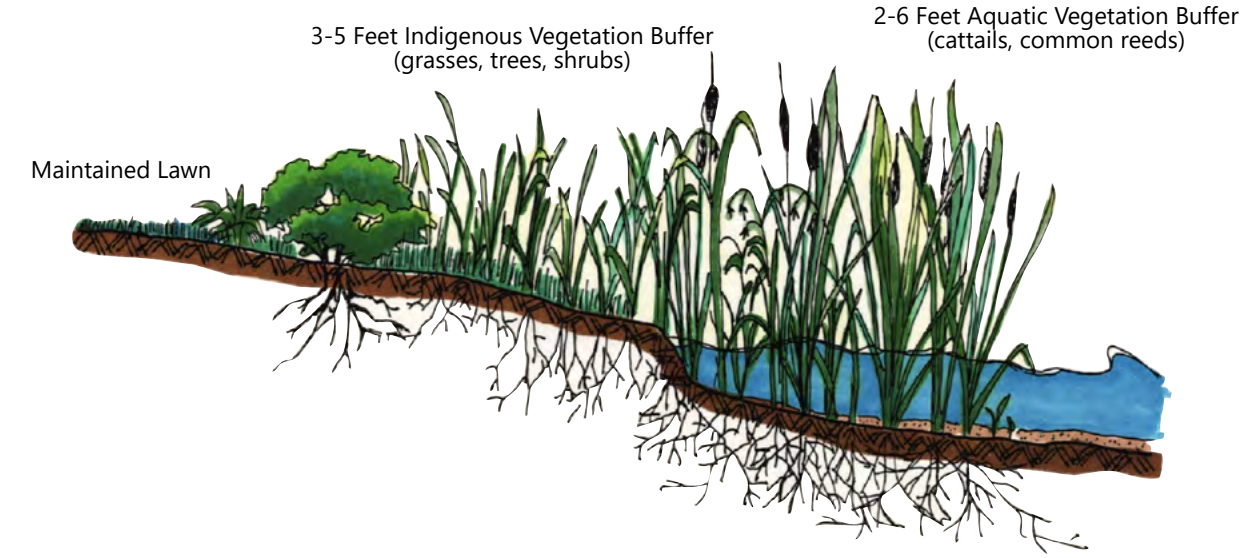
REVETMENT

Source: SEWRPC

shoreline) was completed by SEWRPC staff in the summer of 2013. At the time of the survey, 980 boats and personal watercrafts were observed either moored in the water or stored on land in the shoreland areas around Little Muskego Lake as shown in Table 2.14. Approximately 62 percent of all docked or moored boats were motorized, with power boats, pontoon boats, and personal watercraft comprising the most common types. Of the nonmotorized watercraft observed, kayaks and paddleboats were the most common. To assess the degree of recreational boating use of a lake, it has been estimated that, in Southeastern Wisconsin, the number of watercraft operating at any given time is 2 to 5 percent of the total number of watercraft docked and moored. On Little Muskego Lake, this would amount to about 20 to 50 boats.

Another way to assess the degree of recreational boat use on a lake is through direct counts of boats actually in use on a lake at a given time. Surveys to assess the types of watercraft in use on a typical summer weekday and a typical summer weekend day on Little Muskego Lake were conducted by SEWRPC staff in the summer of 2013. The results of weekday surveys are shown in Tables 2.15 and 2.16, while weekend observations are presented in Tables 2.17 and 2.18. Little Muskego Lake experiences heavy use by recreational boaters during open water periods, especially on weekends. As shown in these tables, power boats and fishing boats were the most popular types of watercraft in use on the Lake during weekdays and weekends. Kayaks and canoes were also popular watercraft throughout various parts of the day. Tables 2.16 and 2.18 show how people were using Little Muskego Lake on a typical summer week day and a typical summer weekend in 2013. The most popular weekday and weekend recreational activities were park going and swimming, most often at Idle Isle Park. On weekends, fishing from shore was also a very popular activity.

Figure 2.31
Natural Shoreline Buffer Schematic and Example



Source: Washington County Planning and Parks Department and SEWRPC

Figure 2.32
Example of "Soft" Shoreline Structures

NATURAL SHORELINE

BIO-LOGS

BUFFERS (VEGETATIVE STRIPS)

CATTAILS

Source: SEWRPC

The type of boating taking place varies by the day of the week, time of day, and prevailing weather conditions. According to a Statewide survey that subdivided results by region,[39] boaters in Southeastern Wisconsin took to the water in the greatest numbers during July, with slightly lower numbers of boaters found on the water during June and August (see Table 2.19). These months account for approximately two-thirds of the total number of boater-days logged in the Region for the entire year. About three to four times as many boaters use their boats on weekends than weekdays (see Table 2.20). The weekday/weekend statistics compare favorably with SEWRPC Little Muskego Lake boat counts, however, weekend use can be high.

Fishing was by far the most popular activity in Southeastern Wisconsin in both spring and fall, and remains a leading reason for boat use throughout the summer (see Table 2.19). Again, the data produced by the Commission's boat count on Little Muskego Lake corresponds quite well with regional averages, suggesting that Little Muskego Lake boating activity is in line with those averages. The typical boat used on inland lakes in Southeastern Wisconsin is an open hulled vessel measuring approximately 18 feet long, powered by a motor producing approximately 90 horsepower (see Tables 2.21 and 2.22). Sailboats comprise approximately 24 percent of boat traffic (15 percent non-powered and 9 percent powered), while other nonpowered boats comprise only two percent of boats found on waterbodies in the Region.

[39] *Wisconsin Department of Natural Resources Technical Bulletin 174,* Boating Pressure on Wisconsin's Lakes and Rivers, Results of the 1989-1990 Wisconsin Recreational Boating Study, Phase 1, *1991.*

Table 2.13
Fish Stocked into Little Muskego Lake: 1973-2015

Year	Species Stocked	Number Stocked	Average Length (inches)
1973	Walleye	30,125	4.00
	Largemouth Bass	345,500	1.00
	Northern Pike	1,154,500	Fry
	Walleye	2,500,000	Fry
1974	Largemouth Bass	19,500	3.00
	Walleye	46,875	3.00
	Northern Pike	500,000	Fry
1975	Walleye	22,500	4.00
	Northern Pike	640,000	Fry
	Walleye	1,000,000	Fry
1976	Walleye	50,000	3.00
	Northern Pike	495,000	Fry
1977	Walleye	15,275	5.00
1984	Walleye	460,000	1.00
1986	Northern Pike	2,000	9.00
1991	Northern Pike	2,000	8.00
	Walleye	12,330	4.00
1992	Northern Pike	2,000	8.00
	Walleye	24,000	2.00
1993	Northern Pike	2,300	8.00
1994	Northern Pike	1,559	4.80
1995	Northern Pike	2,242	6.20
	Walleye	25,300	2.10
1997	Walleye	25,300	1.50
1998	Northern Pike	2,450	Small Fingerling
1999	Northern Pike	2,722	2.40
	Walleye	49,564	2.70
2000	Northern Pike	2,500	3.70
2001	Northern Pike	3,795	3.60
	Walleye	50,150	2.45
2002	Northern Pike	1,250	3.10
2003	Walleye	51,250	2.10
2005	Walleye	25,371	1.50
2006	Northern Pike	2,530	2.50
2008	Northern Pike	2,000	7.30
2009	Walleye	17,710	1.30
	Northern Pike	619	7.50
2011	Walleye	17,710	1.39
2012	Northern Pike	940	7.90
2013	Walleye	17,710	Small Fingerling
2014	Northern Pike	1,011	Large Fingerling
2015	Northern Pike	841	Large Fingerling

Source: Wisconsin Department of Natural Resources and SEWRPC

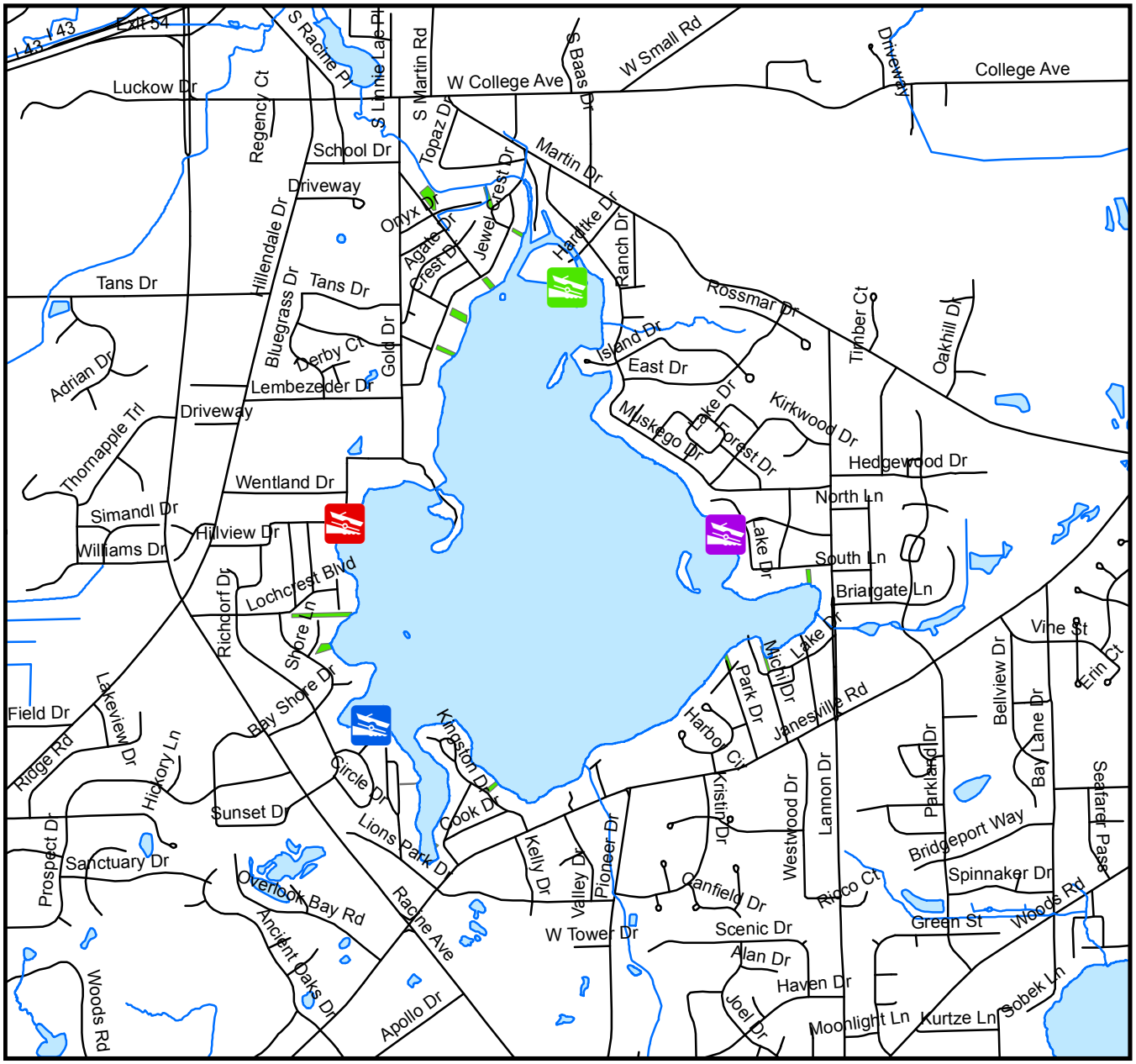
Only a few respondents to the WDNR boating survey felt that excessive boat traffic was present on Southeastern Wisconsin lakes.[40] A study completed in Michigan attempted to quantify desirable levels of boat traffic on an array of lakes used for a variety of purposes. That study concluded that **10 to 15 acres of *useable lake area*[41] per boat provides a reasonable and conservative average maximum desirable boating density**, and covers a wide variety of boat types, recreational uses, and lake characteristics.[42] **Use**

[40] Ibid.

[41] *Useable lake area as defined under that study is the size of the open water area that is at least 100 feet from the shoreline.*

[42] *Progressive AE,* Four Township Recreational Carrying Capacity Study, Pine Lake, Upper Crooked Lake, Gull Lake, Sherman Lake, *Study prepared for Four Township Water Resources Council, Inc. and the Townships of Prairieville, Barry, Richland, and Ross, May 2001.*

Map 2.11
Lake Access Sites Around Little Muskego Lake



Map ID	Description	Facilities									
		Boat Ramp	Mooring Slips	Fee	Car-Trailer Parking	Car Parking	Pier	Swim Beach	Picnic Area	Shelter	Playground
	Idle Isle Park	Paved	None	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Hillview Drive	Paved	None	Yes	No	No	No	No	No	No	No
	Oak Court	Paved	None	Yes	No	No	No	No	No	No	No
	Pleasant View Drive	Paved	None	Yes	No	No	No	No	No	No	No

Carry-in Only Public Access Sites

N

0 1,000 2,000 Feet

Source: City of Muskego Planning Department, Wisconsin Department of Natural Resources, and SEWRPC

rates above this threshold are considered to negatively influence public safety, environmental conditions, and the ability of a lake to host a variety of recreational pursuits. High-speed watercraft require more space, necessitating boat densities less than the low end of the range. The suggested density for a particular lake is:

Minimum desirable acreage per boat =
10 acres + (5 acres x (high-speed boat count/total boat count))

The SEWRPC watercraft survey demonstrates that highest boat use occurs during weekends. Very often, all boats in use during peak periods were capable of high-speed operation. Given this fact, the formula presented above suggests that 15 acres of useable open water should be available per boat on each lake. Given that roughly 350 useable acres (defined in this report as the area that excludes the slow-no-wake zone within 150 feet of shore) are available for boating in Little Muskego Lake, no more than 22 to 23 boats should be present on the Lake at any one time to avoid use problems. The density of boats, particularly those capable of high speed use, actually observed on Little Muskego Lake is usually less than the maximum optimal density. However, on weekends, the number of boats observed on the Lake can be more than double the recommended density. This situation can result in use conflicts, safety concerns, and environmental degradation. If densities continue to be high in the future, boating ordinances and regulations should be reviewed and, if necessary, modified.

Table 2.14
Watercraft Docked or Moored on Little Muskego Lake: 2013[a]

Type of Watercraft	Watercrafts Observed
Powerboat	174
Fishing Boat	37
Pontoon Boat	260
Personal Watercraft	144
Canoe	52
Sailboat	23
Kayak	138
Paddle Boat	83
Row Boat	49
Paddleboard	20
Total	980

[a] *Includes trailered watercraft and watercraft on land observable during survey.*

Source: SEWRPC

2.7 ORDINANCES

Zoning ordinances dictate where development can take place, the types of development allowed, and the terms that need to be met for development to be permitted. Shoreland zoning, stormwater management, and construction erosion control ordinances help minimize water pollution, flooding, and other negative impacts of development on water resources.

Local Ordinances

The Cities of Muskego and New Berlin have adopted their own general zoning, floodplain zoning, shoreland-wetland zoning, subdivision control, construction site erosion control, and stormwater management control ordinances in both communities, as summarized in Table 2.23.

Boating and In-Lake Ordinances

Boating and in-lake ordinances regulate the use of the Lakes in general, and, when implemented properly, **can help prevent inadvertent damage to the Lakes such as excessive noise and wildlife disturbance, severe shoreline erosion from excessive wave action reaching the shoreline, and agitation of sediment and aquatic vegetation in shallow areas**. Recreational boating activities on Little Muskego Lake are subject to State of Wisconsin boating and water safety laws as set forth in Chapter 30, *Wisconsin Statutes*. Additionally, the Lake is subject to boating ordinances promulgated by the City of Muskego (Appendix C). These ordinances are generally enforced by a warden or by the local law enforcement agency.

Table 2.15
Active Recreational Watercraft and Related Activities on Little Muskego Lake – Weekdays: Summer 2013

		Time and Date									
		6:00 a.m. to 8:00 a.m.[a]		8:00 a.m. to 10:00 a.m.		10:00 a.m. to Noon		Noon to 2:00 p.m.		2:00 p.m. to 4:00 p.m.	
Category	**Observation**	August 6	August 27	July 25	August 23	August 20	August 29	July 16	August 27	August 13	August 29
Observation	Air Temperature (°F)	67	77	63	73	85	84	93	91	71	87
	Sky Conditions	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	Clear
Type of Watercraft (number in use)	Power/ski boat	0	0	2	6	4	7	6	8	1	7
	Pontoon boat	0	0	0	1	4	0	7	4	1	2
	Fishing boat	2	2	4	4	3	2	4	1	0	3
	Personal watercraft	0	0	0	0	2	1	8	1	2	2
	Kayak/canoe	0	0	0	0	2	0	0	1	2	2
	Rowboat	0	0	0	0	0	0	0	0	0	0
	Sailboat	0	0	0	0	0	0	0	0	0	0
	Wind board/paddle board	0	0	0	0	2	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure										
	Low speed	0	0	0	1	2	0	6	0	3	0
	High speed	0	0	0	2	3	1	5	2	1	1
	Fishing	2	2	4	5	3	2	8	1	0	3
	Skiing/tubing	0	0	2	2	1	1	6	2	0	3
	Sailing/windsurfing	0	0	0	0	0	0	0	0	0	0
	Rowing/paddling/pedaling	0	0	0	0	4	0	0	1	2	2
	At anchor[b]	0	0	0	1	4	6	0	9	0	7
Total	On water	2	2	6	11	17	10	25	15	6	16
	Capable of high speed use	2	2	6	11	13	10	25	14	4	14
	In high-speed use at same time	0	0	2	4	4	2	11	4	1	4

[a] *Local ordinance prohibits boat speed in excess of slow no-wake between the hours of 8:30 p.m. and 8:00 a.m.*

[b] *There is a shallow sandbar located in the southwestern area of the Lake's main basin that is a favorite gathering place for boaters to anchor and swim and socialize.*

Source: SEWRPC

Table 2.16
Recreational Activities Observed on Little Muskego Lake – Weekdays: Summer 2013

	Time and Date									
	6:00 a.m. to 8:00 a.m.[a]		8:00 a.m. to 10:00 a.m.		10:00 a.m. to Noon		Noon to 2:00 p.m.		2:00 p.m. to 4:00 p.m.	
Category	August 6	August 27	July 25	August 23	August 20	August 29	July 16	August 27	August 13	August 29
Observation										
Air Temperature (°F)	67	77	63	73	85	84	93	91	71	87
Sky Conditions	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	Clear
Activity (average number of people)										
Park Goer	3	0	6	10	40	23	77	113	27	--[b]
Beach Swimming	0	0	0	0	17	17	64	56	2	--[b]
Boat/Raft Swimming	0	0	0	0	12	0	17	22	0	--[b]
Canoeing/Kayaking	0	0	0	0	0	0	0	0	2	--[b]
Sailboating	0	0	0	0	0	0	0	0	0	--[b]
Wind Surfing/Paddle Boarding	0	0	0	0	2	0	0	0	0	--[b]
Rowing	0	0	0	0	0	0	0	0	0	--[b]
Paddleboating	0	0	0	0	0	0	0	0	0	--[b]
Fishing from Boats	2	0	5	12	7	4	9	3	0	--[b]
Fishing from Shore	1	0	3	6	9	5	3	2	5	--[b]
Low-Speed Cruising	0	0	0	3	5	0	6	0	6	--[b]
High-Speed Cruising	0	0	0	6	3	4	6	9	3	--[b]
Skiing/Tubing	0	0	5	10	6	4	11	6	0	--[b]
Personal Watercraft Operation	0	0	0	0	3	1	14	1	2	--[b]
Other	0	0	0	0	0	0	0	0	0	--[b]

[a] *Local ordinance prohibits boat speed in excess of slow no-wake between the hours of 8:30 p.m. and 8:00 a.m.*

[b] *Due to time constraints activities were not observed.*

Source: SEWRPC

Table 2.17
Active Recreational Watercraft and Related Activities on Little Muskego Lake – Weekends: Summer 2013

		Time and Date				
		8:00 a.m. to 10:00 a.m.	10:00 a.m. to Noon	Noon to 2:00 p.m.		2:00 p.m. to 4:00 p.m.
Category	**Observation**	August 10	August 18	July 27	August 18	August 24
Observation	Air Temperature (°F)	67	77	58	81	83
	Sky Conditions	Overcast	Clear	Cloudy	Clear	Clear
Type of Watercraft (number in use)	Power/ski boat	2	10	2	14	26
	Pontoon boat	1	5	2	10	15
	Fishing boat	7	2	6	2	4
	Personal watercraft	2	3	0	6	7
	Kayak/canoe	3	0	0	5	3
	Rowboat	0	0	0	0	0
	Sailboat	0	0	0	1	0
	Wind board/paddle board	0	0	0	0	0
	Paddleboat (pedalboat)	0	0	0	1	0
	Other	0	0	0	0	0
Activity of Watercraft (number engaged)	Motorized cruise/pleasure					
	Low speed	3	6	2	3	7
	High speed	0	4	0	7	7
	Fishing	8	0	6	2	4
	Skiing/tubing	1	6	2	7	4
	Sailing/windsurfing	0	0	0	1	0
	Rowing/paddling/pedaling	3	0	0	5	3
	At anchor[a]	0	4	0	14	30
Total	On water	15	20	10	39	55
	Capable of high speed use	12	20	10	32	52
	In high-speed use at same time	1	10	2	14	7

Note: Local ordinance prohibits boat speed in excess of slow no-wake between the hours of 8:30 p.m. and 8:00 a.m.

[a] *There is a shallow sandbar located in the southwestern area of the Lake's main basin that is a favorite gathering place for boaters to anchor and swim and socialize.*

Source: SEWRPC

Table 2.18
Recreational Activities Observed on Little Muskego Lake – Weekends: Summer 2013

	Time and Date				
	8:00 a.m. to 10:00 a.m.	10:00 a.m. to Noon	Noon to 2:00 p.m.		2:00 p.m. to 4:00 p.m.
Category	August 10	August 18	July 27	August 18	August 24
Observation					
Air Temperature (°F)	67	77	58	81	83
Sky Conditions	Overcast	Clear	Cloudy	Clear	Clear
Activity (average number of people)					
Park Goer	15	33	63	83	76
Beach Swimming	9	4	0	14	37
Boat/Raft Swimming	0	12	0	35	0
Canoeing/Kayaking	3	0	0	5	0
Sailboating	0	0	0	2	0
Wind Surfing/Paddle Boarding	0	0	0	0	0
Rowing	0	0	0	0	0
Paddleboating	0	0	0	1	0
Fishing from Boats	14	5	14	5	8
Fishing from Shore	9	9	21	20	15
Low-Speed Cruising	6	16	5	15	0
High-Speed Cruising	0	11	3	12	0
Skiing/Tubing	3	11	0	18	0
Personal Watercraft Operation	0	4	0	8	0

Note: Local ordinance prohibits boat speed in excess of slow no-wake between the hours of 8:30 p.m. and 8:00 a.m.

Source: SEWRPC

Table 2.19
Boating Activity in the Region by Month: 1989-1990

Activity	Percent Respondents Participating[a]						
	April	May	June	July	August	September	October
Fishing	68	57	49	41	44	42	49
Cruising	29	39	42	46	46	47	43
Water Skiing	3	9	20	27	19	16	8
Swimming	2	4	18	31	25	19	5
Average boating party size: 3.4 people							

[a] *Respondents may have participated in more than one activity.*

Source: Wisconsin Department of Natural Resources

State Regulations

The State Legislature required the WDNR to develop performance standards for controlling nonpoint source pollution from agricultural and nonagricultural land and from transportation facilities.[43] The performance standards, which are set forth in Chapter NR 151, "Runoff Management," of the *Wisconsin Administrative Code,* indicate requirements for best management practices. There are also regulations with respect to construction sites, wetland protective areas, and buffer standards.

Water quality objectives are presented in Chapter NR 102, "Water Quality Standards for Wisconsin Surface Waters," of the *Wisconsin Administrative Code*. These rules set water quality standards that promote healthy aquatic ecosystems and public enjoyment of the water body. Some of the standards set in this rule applicable to Little Muskego Lake include the following:

1. Dissolved oxygen greater than or equal to 5.0 mg/L

2. pH between 6.0 and 9.0 SU

3. Fecal coliform geometric mean less than or equal to 200 colonies per 100 milliliters, single sample maximum less than or equal to 400 colonies per 100 milliliters

4. Total phosphorus (summer epilimnion) 30 µg/L (or 0.030 mg/L)

5. Chloride acute toxicity 757 mg/L, chronic toxicity 395 mg/L

Chapter NR 102 further stipulates maximum water temperatures for each month, with the highest standards applying to July and August when the following maxima apply: ambient water temperature of less than or equal to 77°F, sublethal water temperature of less than or equal to 80°F for one week or less, and acute water temperature of less than or equal to 87°F for one day or less.

The regulations described above play a crucial part in maintaining the health of Little Muskego Lake and of all the resources within its watershed.

[43] *The State performance standards are set forth in the Chapter NR 151, "Runoff Management," of the* Wisconsin Administrative Code. *Additional code chapters that are related to the State nonpoint source pollution control program include: Chapter NR 152, "Model Ordinances for Construction Site Erosion Control and Storm Water Management" (This Chapter will be revised in response to the 2013 Wisconsin Act 20 as noted in WDNR Guidance #3800-2014-3, "Implementation of 2013 Wisconsin Act 20 for Construction Site Erosion Control and Stormwater Management," October 2014.); Chapter NR 153, "Runoff Management Grant Program;" Chapter NR 154, "Best Management Practices, Technical Standards and Cost-Share Conditions;" Chapter NR 155, "Urban Nonpoint Source Water Pollution Abatement and Storm Water Management Grant Program;" and Chapter ATCP 50, "Soil and Water Resource Management." Those chapters of the* Wisconsin Administrative Code *became effective in October 2002. Chapter NR 120, "Priority Watershed and Priority Lake Program," and Chapter NR 243, "Animal Feeding Operations," were repealed and recreated in October 2002.*

Table 2.20
Daily Distribution of Boating in the Region: 1989-1990

Day of the Week	Percent Respondents Participating[a]
Sunday	46
Monday	16
Tuesday	14
Wednesday	16
Thursday	13
Friday	17
Saturday	46

[a] *Respondents may have participated in more than one day.*

Source: Wisconsin Department of Natural Resources

Table 2.21
Propulsion Types in the Region: 1989-1990

Propulsion Type	Percent Respondents Participating[a]
Outboard	53
Inboard/Outboard	14
Inboard	6
Other (powered)	1
Sail	15
Sail with Power	9
Other (nonpowered)	2
Average horse power: 86.5	

[a] *Respondents may have participated in more than one day.*

Source: Wisconsin Department of Natural Resources

Table 2.22
Hull Types in the Region: 1989-1990

Hull Type	Percent Respondents Participating[a]
Open	68
Cabin	17
Pontoon	9
Other	6
Average length: 18.4 feet Average beam width: 6.4 feet	

[a] *Respondents may have participated in more than one day.*

Source: Wisconsin Department of Natural Resources

Table 2.23
Land Use Regulations Within the Area Tributary to Little Muskego Lake in Waukesha County by Civil Division

	Type of Ordinance				
Community	General Zoning	Floodplain Zoning	Shoreland or Shoreland-Wetland Zoning	Subdivision Control	Erosion and Sedimentation Control and Stormwater Management
City of Muskego	Adopted	Adopted	Adopted	Adopted	Adopted
City of New Berlin	Adopted	Adopted	Adopted	Adopted	Adopted

Source: SEWRPC

ALTERNATIVE AND RECOMMENDED AQUATIC PLANT MANAGEMENT PRACTICES 3

Credit: SEWRPC Staff

3.1 INTRODUCTION

Little Muskego Lake generally contains a robust and fairly diverse aquatic plant community capable of supporting a warmwater fishery, although some areas of the Lake suffer impairment of recreational boating opportunities and other lake-oriented activities, due to an abundance of macrophytes such as coontail and Eurasian water milfoil. For example, in those areas of the Lake where Eurasian water milfoil is abundant, certain recreational uses are limited, the aesthetic quality of the Lake is impaired, and in-Lake habitat is degraded. The plant primarily interferes with recreational boating activities by clogging propellers and cooling water intakes, snagging paddles, and slowing sailboats by wrapping around keels and control surfaces. The plant also causes concern among swimmers who can become entangled within the plant stalks. Thus, without control measures, these areas can become problematic for boat navigation, fishing, and swimming. In contrast, native aquatic plants, generally found at slightly deeper depths, pose fewer potential problems for navigation, swimming, and fisheries, and many native aquatic plants provide good fish habitat, sustaining food resources, and offer shelter for juvenile and young-of-the-year fishes. Consequently, aquatic plant management continues to be an important issue of concern to this lake-oriented community and its visitors.

Alternatives and recommended refinements to the existing aquatic plant management plan are presented in this chapter.[44] These measures are focused on those actions that are applicable to the Little Muskego Lake Protection and Rehabilitation District (LMLPRD) and the City of Muskego, with lesser emphasis given to those measures that are applicable to other agencies with jurisdiction within the area tributary to the Lake. Recommended management measures are summarized in Table 3.1.

3.2 AQUATIC PLANT MANAGEMENT MEASURES

Aquatic plant management measures can be classified into five groups: 1) ***physical measures***, which include lake bottom coverings; 2) ***biological measures***, which use living organisms, including herbivorous insects; 3) ***manual measures***, which involve manual plant removal by people using hand-held rakes or by hand; 4) ***mechanical measures***, which include harvesting and removing aquatic plants with a machine

[44] *SEWRPC Memorandum Report No. 155, 2nd Edition,* An Aquatic Plant Management Plan for Little Muskego Lake, Waukesha County, Wisconsin, *February 2009*.

Table 3.1
Summary of Recommendations

Recommendation	Suggested Priority Level
AQUATIC PLANT MANAGEMENT RECOMMENDATIONS	
1. Hand-pull and/or rake nuisance plant growth in near-shore areas	MEDIUM
2. Isolate Hillview Bay area with buoys	HIGH
3. Conduct aquatic plant harvesting to create navigation and access lanes in Little Muskego Lake	HIGH
a. Leave at least one foot of plant material at Lake bottom while harvesting	HIGH
b. Employ "top-cut" harvesting to encourage native plant growth	HIGH
c. Inspect all cut plants for live animals	MEDIUM
d. Do not harvest in early spring and in Sensitive Areas to avoid disturbing fish spawning	HIGH
e. All harvester operators must successfully complete WDNR training to assure adherence to harvesting permit specifications and limitations	HIGH
f. Include comprehensive plant pickup program	HIGH
g. Plant debris is collected and disposed of at designated disposal sites	HIGH
4. Limit navigational shoreline chemical treatment for Eurasian and hybrid water milfoil and curly-leaf pondweed to early spring and conduct chemical residue monitoring when chemical treatment occurs	HIGH
5. Whole-lake chemical treatment of Little Muskego Lake to control Eurasian water milfoil and curly-leaf pondweed if permit application is completed by the LMLPRD and approved by the WDNR	MEDIUM
6. Extended lake drawdown of Little Muskego Lake to control starry stonewort if method is found to be effective and permit application is completed by the LMLPRD and approved by the WDNR	MEDIUM
7. Prevent introduction of new invasive species	HIGH
a. Educate residents how they can help prevent invasive species from entering their lake	HIGH
b. Continue enrollment in Clean Boats Clean Waters program	HIGH
c. Target boat launch sites for aquatic plant control	HIGH
d. Participate in citizen monitoring for new invasive species through Wisconsin Citizen Lake Monitoring Network	HIGH
Reevaluate aquatic plant management plan every five years	HIGH
ANCILLARY PLAN RECOMMENDATIONS	
Water Quality Management	
1. Continue comprehensive water quality monitoring program covering Little Muskego Lake	HIGH
2. Encourage pollution reduction efforts along the shorelines (best management practices)	MEDIUM
3. Protect and enhance buffers, wetlands, and floodplains	HIGH
a. Provide information to riparian owners that describe the benefits of buffers	HIGH
b. Establish a shoreline best management practice and shoreline buffer enhancement program	HIGH
Recreational Use Management	
1. Maintain and enhance boating through improving access by implementing harvesting recommendations in "Aquatic Plant Management Recommendations"	HIGH
2. Maintain and enhance swimming through engaging in "swimmer-conscious" aquatic plant management effort by adopting recommendations in "Aquatic Plant Management Recommendations"	HIGH
3. Maintain and enhance fishing activities by protecting and improving aquatic habitat and ensuring the fish community remains viable	HIGH
a. Continue current fish stocking practices	MEDIUM
b. Improve aquatic habitat in the Lake by allowing or installing woody debris and/or vegetative buffers along the Lake's edge	HIGH
c. Mitigate water quality stress on aquatic life and maximize habitable areas	HIGH
4. Pursue an increase in boat launch fees, parking restrictions, or boat limits on Little Muskego Lake to increase recreational safety	HIGH
Plan Implementation	
1. Apply for grants when available	HIGH
2. Encourage Lake users and residents to actively participate in future management efforts	MEDIUM
3. Encourage key players to attend meetings, conferences, and/or training programs to build their lake management knowledge	MEDIUM
4. Continue to reinforce stakeholder inclusivity and transparency with respect to all Lake management activities	HIGH
5. Foster and monitor efforts to communicate concerns, goals, actions, and achievements to future Lake managers	HIGH
Create an action plan which highlights action items, timelines, goals, and responsible parties	HIGH
Educate Lake residents, users, and governing bodies on the content of this plan	HIGH
Pursue a comprehensive lake and watershed management plan in order to incorporate recent developments and activities.	MEDIUM

Source: SEWRPC

known as a harvester or by suction harvesting; and 5) ***chemical measures***, which include using aquatic herbicides to kill nuisance and non-native aquatic plants. More information regarding these alternatives is provided below. All of these control measures are stringently regulated and most require a State of Wisconsin permit. Chemical controls, for example, require a permit and are regulated under Chapter NR 107, "Aquatic Plant Management," of the *Wisconsin Administrative Code*, while placing bottom covers (a physical measure) requires a WDNR permit under Chapter 30 of the *Wisconsin Statutes*. All other aquatic plant management practices are regulated under Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations" of the *Wisconsin Administrative Code*.

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

Physical Measures

Lake-bottom covers and light screens control rooted plants by creating a physical barrier that reduces or eliminates plant-available sunlight. They are often used to create swimming beaches on muddy shores, to improve the appearance of lakefront property, and to open channels for motorboats. Various materials can be used with varied levels of success. For example, pea gravel, which is usually widely available and relatively inexpensive, is often used as a bottom cover material despite the fact that plants readily recolonize pea gravel deposited upon lake bottoms. Other options include synthetic materials (e.g., polyethylene, polypropylene, fiberglass, and nylon) known as bottom screens or barriers that can provide relief from rooted plants for several years. Synthetic bottom screens are susceptible to disturbance by watercraft propellers and to gas build-up from decaying plant biomass trapped under the barrier and therefore may have to be placed and removed each year. In the case of Little Muskego Lake, the need to encourage native aquatic plant growth while simultaneously controlling the growth of invasive species, often in the same location, suggests that placing lake bottom covers as a method to control aquatic plant growth does not appear to be warranted. Furthermore, the WDNR typically does not permit lake bottom covers and no physical measure is known to effectively control starry stonewort. Therefore, physical measures are not considered viable for Little Muskego Lake and are not recommended under this plan.

Biological Measures

Biological controls offer an alternative approach to controlling nuisance or exotic plants. Biological control techniques commonly employ herbivorous insects that feed upon nuisance plants. Such approaches have been shown to be successful in some Southeastern Wisconsin lakes.[45] For instance, a study completed on Whitewater Lake from 1996 until 1997 suggested that the milfoil weevil (*Eurhychiopsis lecontei)* appeared to reduce the abundance of Eurasian water milfoil.[46] According to the study, Eurasian water milfoil declined substantially as the weevil population increased in the study plot areas. However, given that Little Muskego Lake has high boat activity, a developed shoreline, which limits the existence of leaf-litter habitat preferred by the weevil, and that this technique is no longer commercially available, the use of *Eurhychiopsis lecontei* is not considered viable on Little Muskego Lake and is not recommended. No biological control measures are presently known to combat starry stonewort.

Manual Measures

Manually removing specific types of aquatic vegetation is a highly selective means of controlling nuisance aquatic plant growth, including starry stonewort, Eurasian water milfoil, and curly-leaf pondweed. There are two common manual removal methods: raking and hand-pulling. Each method is described in the following paragraphs.

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

[46] *Wisconsin Cooperative Fishery Research Unit,* Wisconsin Milfoil Weevil Project, *1999.*

Raking is conducted in nearshore areas with specially designed hand tools. This method removes non-native plants in shallow nearshore areas and also provides a **safe and convenient method to control aquatic plants in deeper nearshore waters around piers and docks**. The advantages of raking are that 1) the tools are relatively inexpensive (costing between $100 and $150 each), 2) they are easy to use, 3) they generate immediate results, and 4) they immediately remove plant material from a lake (including seeds and plant fragments) thereby reducing nutrient release and sedimentation from decomposing plant material and reducing the reproductive potential of target plants. Should Lake residents decide to implement this method of control, an interested party could acquire a number of these specially designed rakes for use by the riparian owners on a trial basis. Therefore, raking is considered a viable option to manage overly abundant and undesirable plant growth in areas where other management efforts are not feasible. However, raking may be an ill-advised method for starry stonewort control as it may not fully remove the main reproductive structures, or bulbils (see Appendix A) found under the sediment or near the bottom of the algae.

The second manual control, hand-pulling of stems where they occur in isolated stands, provides an alternative means of controlling plants such as Eurasian water milfoil and starry stonewort. **This method is particularly helpful when attempting to target non-native plants in the high growth season, when native and non-native species often coexist**. This method is more selective than rakes, mechanical removal, and chemical treatments, and, if carefully applied, is less damaging to native plants. Additionally, physically removing plant material prevents sedimentation and nutrient release from targeted plants, which incrementally helps maintain water depth and better water quality. Physical removal also reduces the amount of target plant seeds and plant fragments, which helps reduce the reproductive ability of target plants. Given these advantages, manual removal of Eurasian water milfoil, curly-leaf pondweed, and starry stonewort through hand-pulling is considered a viable option in Little Muskego Lake and recommended where practical. It could be employed by volunteers or homeowners, as long as they are trained to properly identify Eurasian water milfoil, curly-leaf pondweed, and starry stonewort. In the case of starry stonewort, the removal of bulbils from sediments should be emphasized to ensure successful control. WDNR provides a wealth of guidance materials, including an instructional video describing manual plant removal. These guidance materials will be valuable to the residents of the Lake, if this management alternative is implemented.

Pursuant to Chapter NR 109 of the *Wisconsin Administrative Code*, **both raking and hand-pulling of aquatic plants are allowed without a permit** under the following conditions:

- Eurasian water milfoil, curly-leaf pondweed, starry stonewort, and purple loosestrife may be removed if the native plant community is not harmed in the process.
- Thirty feet or less of shoreline may be cleared, however, this total must include docks, piers, boatlifts, rafts, and areas undergoing other plant control treatment. Vegetation may generally be removed up to 100 feet out from the shoreline.
- Plant materials that drift onto the shoreline may be removed.
- The shoreline is not a designated sensitive area.
- All raked and hand-pulled plant material is removed from the lake.

Any other **manual removal requires a State permit, unless employed in the control of designated non-native/invasive species**, such as Eurasian water milfoil. In general, State permitting requirements for manual aquatic plant removal call for all raked or hand-pulled material to be removed from the lake. **Note: no mechanical equipment may be legally used without a WDNR-issued permit (i.e., dragging equipment such as a rake behind a motorized boat).**

Mechanical Measures

Two mechanical harvesting methods are currently permitted and employed in Wisconsin. These methods include aquatic plant harvesters (mechanical harvesting) and suction harvesting. More details about each are presented in the following paragraphs.

Plant Harvesting

Aquatic plants can be mechanically gathered using specialized equipment known as harvesters. This equipment consists of an adjustable cutting apparatus that cuts plants at selected depths from the surface to up to about five feet below the water surface and a collection system (e.g., a conveyor and a basket) that gathers most cut plant material. Mechanical harvesting can be a practical and efficient means of controlling sedimentation and plant growth, because it removes plant biomass that would otherwise decompose and release nutrients and sediment into a lake. Mechanical harvesting is particularly effective for large-scale projects.

An advantage of mechanical harvesting is that the harvester, when properly operated, "mows" the tops of aquatic plants. Therefore, this method typically **leaves enough living plant material in a lake to provide shelter for aquatic wildlife and to stabilize lake-bottom sediments.** Aquatic plant harvesting also has been shown to facilitate growth of native aquatic plants by allowing light to penetrate to the lakebed. This is particularly effective when controlling invasive plant species that commonly grow very early in the season when native plants have not yet emerged or appreciably grown. Finally, harvesting does not kill native plants in the way that other control methods do. Instead, this method simply cuts them back.

A disadvantage of mechanical harvesting is that **the harvesting process may fragment plants and, therefore, unintentionally facilitate spread of Eurasian water milfoil and starry stonewort**, both of which utilize fragmentation as a means of propagation, particularly in areas where plant roots have been removed. This further emphasizes the need to prevent harvesting that removes the roots of native plants. Harvesting may also agitate bottom sediments in shallow areas, thereby increasing turbidity and resulting in deleterious effects such as smothering of fish breeding habitat and nesting sites. Agitating bottom sediments also increases the risk of non-native species recolonization, as invasive species tend to thrive on disrupted lake-bottom sediment. To this end, **WDNR-issued permits do not allow harvesting with larger harvesting equipment in areas having a water depth of less than three feet. Smaller harvesters with shallow drafts are now available commercially to harvest in water that is approximately two feet deep.** If employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can ultimately reduce regrowth of nuisance plants while maintaining native plant communities.

It should again be noted that some **cut plant fragments can escape the harvester's collection system**. This negative side effect is fairly common. To compensate for this, most harvesting programs include a plant pickup program. The program often uses harvesters to collect large accumulations of floating plant debris, and often includes regular pickup from lakefront property owners who actively rake plant debris onto their docks. 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 accumulation on the lake shore.

Given that mechanical harvesting has been in operation on Little Muskego Lake for approximately 20 years and that the LMLPRD has invested in its own harvesting equipment during that time, and since the LMLPRD's mechanical harvesting has demonstrated the ability to provide navigation lanes, control nuisance and exotic species, and prevent sedimentation with minimal damage to the Lake ecosystem, harvesting is considered viable and recommended for Little Muskego Lake (see "Aquatic Plant Management Recommendations" for more detail). However, if this program is to be employed, plant collection programs to prevent nuisance amounts of aquatic plant fragment accumulation (i.e., elodea fragments) and a training program for all operators should be continued.[47] It is important to note that normal boating activity on Little Muskego Lake (particularly during weekends) creates far more plant fragments than are generated from the harvesting operations. Therefore, this plant pickup program is essential for the protection of this Lake, even in areas where harvesting has not recently occurred. In addition, the delineated Sensitive Areas in Little Muskego Lake need to be identified and verified by the harvesting operator to ensure proper precautions are observed. Furthermore, it is important that the LMLPRD continue to maintain expense records of previous and potential costs for Lake management, such as harvesting and harvesting equipment, which includes: labor, fuel, permits, grading, outside services, supplies, future equipment, and repairs (see Tables 3.2 and 3.3). Expense records allow the District to budget resources for future management efforts.

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[47] *WDNR staff have offered to host this training session to ensure that all harvester operators are aware of the terms of the harvesting permit.*

Suction Harvesting

An alternative aquatic plant harvesting method has emerged – Diver Assisted Suction Harvesting (DASH). First permitted in 2014, DASH (also known as suction harvesting) is a mechanical process where divers identify and pull select aquatic plants by their roots from the lake bed and then insert the entire plant into a suction hose that transports the plant to the lake surface for collection and disposal. The process is essentially a more efficient and wide-ranging method for hand-pulling aquatic plants. Such labor-intensive work by skilled professional divers is, at present, a costly undertaking and long-term evaluations will need to determine the efficacy of the technique. Nevertheless, many apparent advantages are associated with this method, including: 1) **lower potential to fragment plants** when compared to traditional harvesting and hand-pulling, thereby reducing spread and regrowth of invasive plants like starry stonewort and Eurasian water milfoil; 2) **increased selectivity of plant removal** when compared to traditional harvesting, thereby reducing the loss of native plants, and 3) **lower frequency of fish habitat disturbances**. The cost of using suction harvesting as a means of management is variable and depends on the range and acreage of the project areas as well as other factors. Additionally, plant density, shoreline access, disposal issues and selectivity by WDNR are all considerations that need to be evaluated to ensure that the potential use of DASH is a feasible management alternative for Little Muskego Lake. DASH was first utilized in Hillview Bay in fall of 2015, because the method allowed for the removal of stonewort biomass and bulbils. Efforts were concentrated around the Hillview Bay boat landing. Future aquatic plant surveys will monitor the effectiveness of the DASH technique and inform future management decisions for starry stonewort control in Little Muskego Lake.

Table 3.2
Summary of Little Muskego Lake Annual Mechanical Harvesting Costs Within the Last Five Years

Year	Costs ($)
2012	182,664
2013	174,105
2014	173,218
2015	172,000
2016	161,500

Source: LMLPRD and SEWRPC

Table 3.3
Summary of Little Muskego Lake Projected Mechanical Harvesting Costs

Year	Costs ($)
2017	170,000
2018	170,000
2019	170,000

Source: LMLPRD and SEWRPC

Both mechanical harvesting and suction harvesting are regulated by WDNR and require a permit. Non-compliance with permit requirements is legally enforceable and may lead to fines and/or complete permit revocation. The information and recommendations provided in this report will help frame permit requirements. Permits can be granted to cover up to a five-year period.[48] At the end of that period, a new plant management plan will need to be developed that assesses the success of completed management techniques and efforts. The updated plan should be based on a new aquatic plant survey and should evaluate the plant management activities that occurred in the Lake since the previous plan was completed.[49] These plans and plan execution are overseen by the WDNR aquatic invasive species coordinator for the region.[50]

Chemical Measures

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

1. **Unknown and/or conflicting evidence about long-term effects of chemicals on fish, fish food sources, and humans:** Chemicals approved by the U.S. Environmental Protection Agency to treat

[48] *Five-year permits are granted so that a consistent aquatic plant management plan can be implemented over that time. This process allows the aquatic plant management measures that are undertaken to be evaluated at the end of the permit cycle.*

[49] *Aquatic plant harvesters must submit reports documenting harvesting activities as an integral part of the permit requirements.*

[50] *Information on the current aquatic invasive species coordinator can be found on the WDNR website.*

aquatic plants have been studied to rule out short-term (acute) effects on human and wildlife health. Some studies also examine long-term (chronic) effects of the chemical on animals (e.g., the effects of being exposed to these herbicides for many years). However, it is often impossible to conclusively state that *no* long-term effects exist due to animal testing protocol, time constraints, and other issues. Additionally, long-term studies have not addressed 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] Appendix D contains additional facts on the herbicide 2,4-D. Some lake property owners judge the risk of using chemicals as being too great, despite legality of use. Consequently, the concerns of lakefront owners should be taken into consideration whenever chemicals are used. Additionally, if chemicals are used, they should be used as early in the season as practical and possible. This helps ensure that applied chemicals decompose before swimmers and other lake users begin to actively use the lake.[53]

2. **A risk of increased algal blooms due to suppressed macrophyte competition:** Water borne nutrients promote aquatic plant and algae growth. If rooted aquatic plants are not the primary users of water-borne nutrients, algae tend to be more abundant. Action must be taken to avoid excessive chemical use and loss of native plants, particularly if healthy fish populations are to be maintained since fish require aquatic plants for food, shelter, and oxygen.

3. **A potential increase in dissolved plant nutrients and organic sediments, and associated anoxic conditions, which can stress aquatic life, cause algal blooms, and promote fish kills:** When chemicals are used to control large mats of aquatic plants, the dead plant material generally settles to the bottom of a lake and subsequently decomposes. This process leads to an accumulation of organic-rich sediment and can deplete oxygen from the water column as bacteria decompose plant remains. Stratified lakes, such as Little Muskego Lake, are particularly vulnerable to oxygen depletion in deep areas. Excessive oxygen loss can inhibit a lake's ability to support fish and can trigger processes that release phosphorus from bottom sediment, further increasing lake nutrient levels. Although anoxia-related fish kills have not been observed on Little Muskego Lake, these concerns emphasize the need to limit chemical control to early spring, when Eurasian water milfoil has not yet formed dense mats.

4. **Adverse effects on desirable aquatic organisms due to loss of native species:** Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. If native plants are unintentionally lost due to chemical application, fish and wildlife populations often suffer. Consequently, if chemicals are applied, the only chemicals used should be those that preferentially target Eurasian water milfoil and curly-leaf pondweed. Such chemicals should be applied in early spring when native plants have not yet emerged.

5. **A need for repeated treatments due to existing seed banks and/or plant fragments:** As mentioned previously, chemical treatment is not a one-time solution. The fact that the plants are not actively removed from the lake increases the possibility for seeds/fragments to remain in the lake after treatment, thereby allowing for a resurgence of the species the next year. Additionally, leaving large areas void of plants (both native and invasive) creates a disturbed area (i.e., an area without any established plant community). Eurasian water milfoil and starry stonewort tend to thrive in such areas. In summary, applying chemical herbicides to large areas can provide opportunities for nuisance plant reinfestation, which in turn necessitates repeated herbicide applications.

6. **Hybrid water milfoil's resistance to chemical treatments:** Hybrid water milfoil complicates management since research suggests that certain strains may have higher tolerance to commonly

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

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

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

utilized aquatic herbicides such as 2,4-D and Endothall.[54] Consequently, further research on the efficacy and impacts of herbicides on hybrid water milfoil is needed to better understand appropriate dosing rates. Hybrid water milfoil has not been confirmed in Little Muskego Lake, but could impact treatment regimens if found in the future.

7. **Unknown efficacy for control of starry stonewort:** Chemical treatment of starry stonewort appears to have mixed results in other states and does not currently appear to be an effective method for controlling this new species. Further research will need to be conducted to find an effective means of reducing and controlling starry stonewort populations.

According to management records, chemical applications, along with mechanical harvesting, have helped reduce non-native aquatic plant species populations and promote better access and navigation throughout Little Muskego Lake. Therefore, continued use of treatments that help reduce and control non-native aquatic plant species, especially in shoreline areas where mechanical harvesting would not be deemed feasible, is considered a viable option for Little Muskego Lake.

3.3 AQUATIC PLANT MANAGEMENT RECOMMENDATIONS

The individual recommendations presented below, and which collectively constitute the recommended aquatic plant management plan, balance three major goals. These goals include 1) improving navigational access within the Lake; 2) protecting the native aquatic plant community; and 3) controlling curly-leaf pondweed, Eurasian water milfoil, and starry stonewort populations. Plan provisions also ensure that current recreational use of the Lake (e.g., swimming, boating, and fishing) is maintained to the greatest extent practical.

The most effective plans for managing nuisance and invasive aquatic plant growth rely on a *combination* of methods and techniques. A "silver bullet" single-element strategy rarely produces the most efficient, most reliable, or best overall result. Therefore, to enhance access, navigation, and the health of Little Muskego Lake, the following aquatic plant management techniques are recommended as part of this plan, as described below:

1. **Manual removal of starry stonewort, Eurasian water milfoil, and nuisance plant growth in near-shore areas** should be considered in areas too shallow, inaccessible, or otherwise unsuitable for other plant control methods. "Manual removal" is defined as control of aquatic plants by hand or using hand-held non-powered tools. Given what is known of plant distribution, this option is given a medium priority. 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 the recreational use area such as a pier) that does not extend more than 100 feet into the Lake, provided that all the resulting plant materials are removed from the Lake.[55] A permit *is* required if the LMLPRD or other group actively engages in such work or if the work is done in or adjacent to a WDNR-designated Sensitive Area.[56] Prior to the "hand-pulling" season, an educational campaign should be actively promoted to help assure that shoreline residents appreciate the value of native plants, understand the relationship between algae and plants (i.e., more algae will grow if fewer plants remain), know the basics of plant identification, and the specifics about the actions they are allowed to legally take to "clean up" their shorelines.[57]

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[54] *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 Triclopyr," Journal of Aquatic Plant Management*, Volume 48, pp. 12-14, January 2010; 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, *Volume 6, Issue 3, pp. 411-567, April 2013*.

[55] *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 invasive plants.*

[56] *If a lake district or other group wants to complete a project to remove invasive species along the shoreline or if that removal would occur in a WDNR-designated Sensitive Area, a permit is necessary under Chapter NR 109, "Aquatic Plants: Introduction, Manual Removal And Mechanical Control Regulations," of the* Wisconsin Administrative Code, *as the removal of aquatic plants is not being completed by an individual property owner along his or her property or is in a protected area.*

[57] *SEWRPC and WDNR staff could help with this educational program.*

2. **Continued isolation of the Hillview Bay area**, as shown on Figure 3.1, due to the presence of the densest population of starry stonewort.[58] This option should be given high priority to reduce the spread of starry stonewort throughout the Lake. This can be achieved by placement of signage and buoys and by thorough cleaning and inspection of the harvester utilized in this area before it leaves Hillview Bay. That harvester should solely offload at the offloading site located within the Bay, as indicated on Figure 3.1. These procedures should be followed for any harvester that enters the area. These procedures should continue until a metric for starry stonewort population density and abundance is developed and met that would indicate that isolation is no longer necessary or effective. This metric will be established by the WDNR and will be directed by the monitoring of starry stonewort populations within Little Muskego Lake and other affected lakes in Wisconsin.

3. **Aquatic plant harvesting to create access and navigation lanes** should be considered a high priority. As can be seen on Figure 3.1, harvesting to create *access and navigation lanes* is recommended in areas of the Lake that have dense aquatic plant growth that impedes boat access to the main body of the Lake. It is important to note that the entire area may not require intensive plant management.

    a. Access lanes between piers in the littoral zone are recommended to be cut 30 feet wide and no more than three to four feet deep.

    b. It is recommended that aquatic plants within marked 150-foot-wide navigational lanes through Sensitive Areas 1 and 3 be cut to a depth of no more than three feet below the water's surface. **To preserve spawning ground for fish, these navigation lanes should not be harvested until June 30th.**

    c. A 100-foot wide swath of Sensitive Area should be left unharvested between the shoreline and the navigation lane in Sensitive Area 1 to maintain healthy fish habitat.

    d. A 30-foot-wide navigation lane along piers, parallel to shore, is recommended within Sensitive Area 3.

    e. **30-foot wide access channels perpendicular to shore should be harvested for every two piers in the 100-foot swath between the 150-foot-wide navigation lane and the 30-foot-wide access lane in Sensitive Area 3**. These lanes will allow Lake residents boating access into and out of the deeper waters of Little Muskego Lake while preserving fish habitat. A harvesting figure for Little Muskego Lake is located in Appendix E.

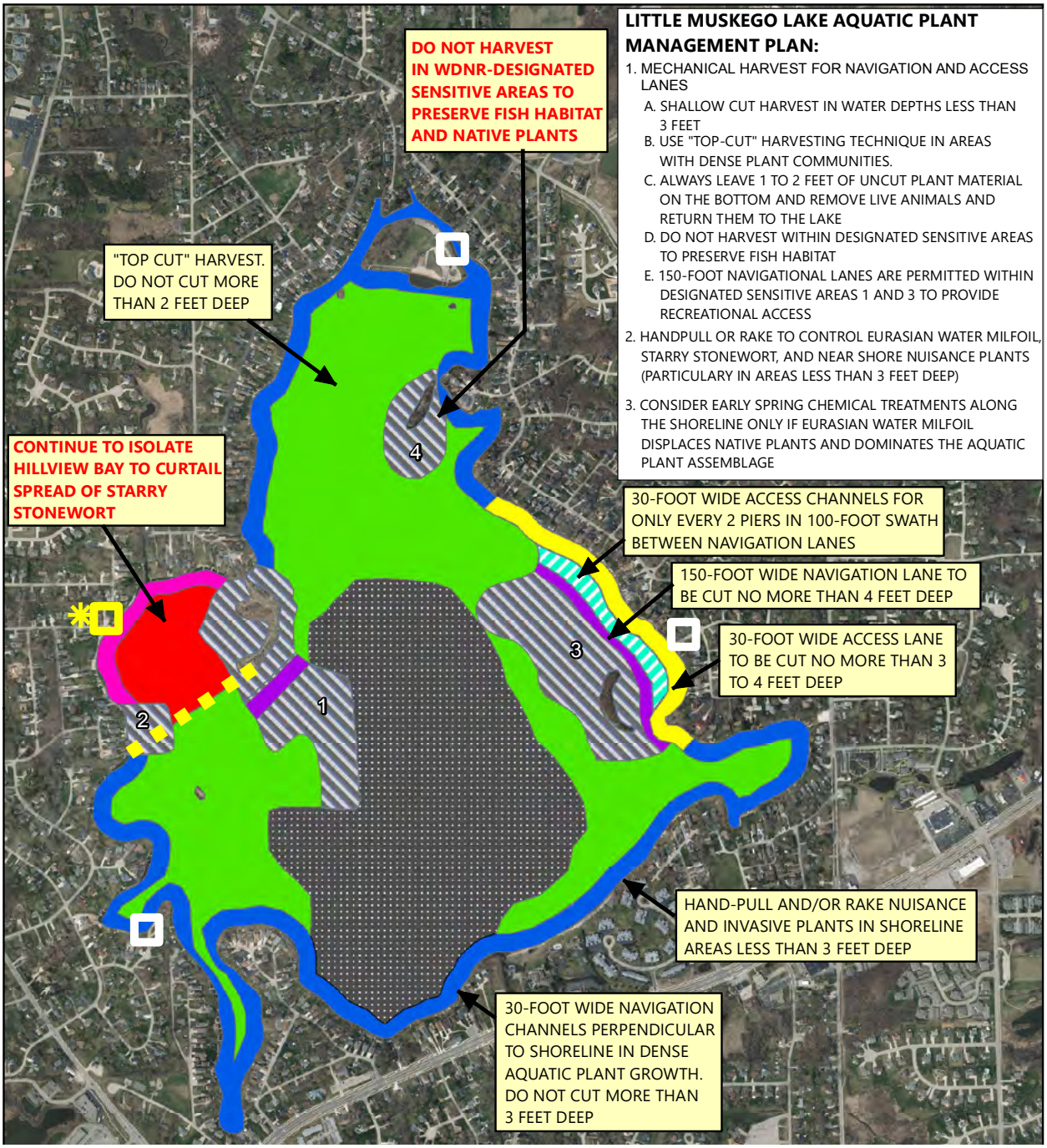
    The following specifications should be added to current practices to help assure continued recreational use of the Lake and the health of the native plant community and fisheries.

    a. **Leave at least one foot of plant material at the Lake bottom while harvesting** to help lessen bottom-sediment disturbance and maintain native plants communities. This should be considered a high priority. Disturbing lake bottom sediment can uproot native plants and can promote colonization of new areas by Eurasian water milfoil and starry stonewort. Leaving one to two feet of uncut plant material will likely not present an implementation problem in the areas with water depths greater than three feet. Harvesting should normally not be employed in portions of the Lake less than three feet deep or where the harvester cannot leave one foot of uncut plants. In such shallow areas, raking, hand-pulling, or shallow cut harvesting should be substituted. Although harvesting may be conducted in portions of the Lake between three and seven feet deep, it should be restricted to shallow top cutting to provide navigational lanes around the Lake.

    b. Applying the concepts described in the previous paragraph, areas with healthy native plant communities coexisting with Eurasian water milfoil should **use the "top-cut" harvesting technique by cutting no more than three to four feet below the water's surface and leaving two feet of plant material on the bottom** (see Figure 3.1 and 3.2). This should be considered a high priority. Top cutting (or canopy cutting) plants, such as Eurasian water milfoil, has been

[58] *Starry stonewort is an invasive algal species which the LMLPRD is currently seeking to contain.*

Figure 3.1
Aquatic Plant Management Recommendations for Little Muskego Lake



HARVESTING ZONES

- NAVIGATION LANE (30 FOOT WIDTH)
- ACCESS CHANNELS
- NAVIGATION CHANNELS
- NAVIGATION LANES (150 FOOT WIDTH)
- TOP-CUT (0-2 FEET DEEP)
- RESTRICTED NAVIGATION CHANNELS (30 FOOT WIDTH)*
- RESTRICTED TOP-CUT (0-2 FEET DEEP)*
- GREATER THAN 15 FEET - NO CUTTING REQUIRED
- WDNR-DESIGNATED SENSITIVE AREAS - NO CUTTING

RESTICTED OFF-LOADING SITE

ISOLATION LINE

UNRESTRICTED OFF-LOADING SITE

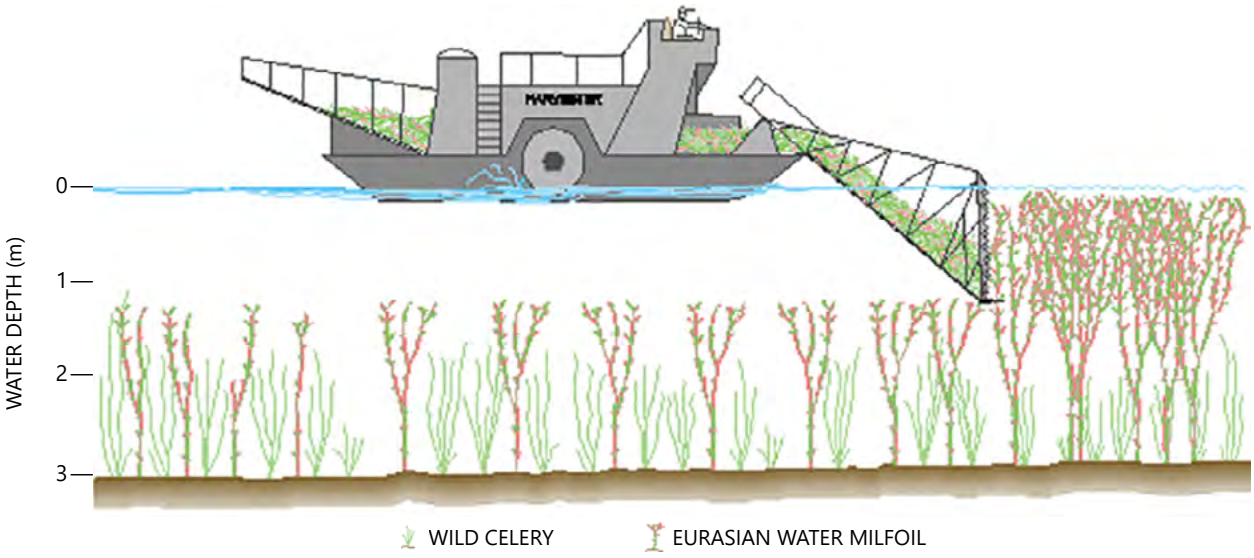
* Harvester must unload and be cleaned before leaving restricted area (Hillview Bay).

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

Date of Photography: April 2015

Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 3.2
Plant Canopy Removal or "Top Cutting" with an Aquatic Plant Harvester



Note: Selective cutting or seasonal harvesting to a depth of no more than 3 to 4 feet can be done by aquatic plant harvesters. Removing the canopy of Eurasian water milfoil may allow native species to reemerge.

Source: Wisconsin Department of Natural Resources and SEWRPC

shown to reduce the competitive advantage of Eurasian water milfoil and encourage native plant growth. Harvesting should not occur where the harvester is unable to leave one foot of plant material; raking and hand-pulling should be used instead of harvesting in these areas. The Lake District has the option to purchase a skimmer or "floater" FB-120 harvester, which allows for mechanical harvesting in shallow water or areas near the shore and around piers—often a limiting factor with large harvesters (see Appendix F for more details on the FB-120 harvester).

c. **Inspect all cut plants for live animals. Live animals should be immediately returned to the water**. This should be considered a medium priority. A second staff person equipped with a net is recommended to accompany and assist the harvester operator. Animals can get caught in the harvester and harvested plants, particularly when cutting larger plant mats. Consequently, cut materials must be carefully examined to avoid inadvertent harvest of fish, crustaceans, amphibians, turtles, and other animals.

d. **Harvesting should not occur in the early spring or in Sensitive Areas** (high priority) to avoid disturbing spawning fish. Many fish species spawn in early spring. Studies suggest that spawning can be significantly disturbed by harvesting activities. Thus, avoiding harvesting during this time can benefit the Lake's fishery. Harvesting operations elsewhere in the Lake should begin in mid- to late-May of each year to minimize any impact on the fish spawning season and should not take place in shallow waters, generally three feet or less in depth, to avoid disturbance to fish habitat and beds of native aquatic plants. However, special care should be taken to avoid disturbing bass spawning areas in Little Muskego Lake between May 1 and June 30 of each year. For example, **if significant captures of fishes, eggs, fry, or fingerlings, are observed while harvesting, harvesting should be immediately curtailed so as to minimize potential impacts on the lake fishery**.

e. **All harvester operators must successfully complete WDNR training to help assure adherence to harvesting permit specifications and limitations** (high priority). Training should be provided by the regional WDNR aquatic invasive species coordinator and/or taught by the Lake District foreman and should cover, at a minimum 1) "deep-cut," "shallow-cut," and "top-cut" techniques and when to employ each in accordance with this plan; 2) review of the aquatic plant management plan and associated permits with special emphasis focused on the need to restrict cutting in

shallow areas; 3) identification of and regulations pertaining to WDNR-designated Sensitive Areas; 4) plant identification to encourage preservation of native plant communities; and 5) emphasis on thorough cleaning and inspection of harvesters before leaving Hillview Bay to curtail spread of starry stonewort. Additionally, this training course should reaffirm that all harvester operators are obligated to record their work for inclusion in annual harvesting permit-required reports.

f. Harvesting and boating activity can fragment plants. Plant fragments may float in the Lake, accumulate on shorelines, and help spread undesirable plants. The harvesting program should **continue to include a comprehensive plant pickup program** that all residents can use (high priority). This plant pickup program is given a high priority rating, because this management activity will help lower the probability of spreading the invasive species—particularly starry stonewort—to other areas of the Lake and/or reduce the probability of spreading these fragments to other lakes. This helps assure 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 practical, and harvester operators should consider focusing pickup efforts in the eastern shoreline areas after weekends, because plant fragments tend to accumulate in these areas due to normal prevailing wind patterns.

g. **All plant debris collected from harvesting activities should be collected and disposed of at the designated disposal sites**, as shown in Appendix G. Special care should be taken to assure that plant debris is not disposed in wetland locations or within a floodplain (high priority). **Disposing any aquatic plant material within identified floodplain and wetland areas is prohibited.**

4. ***Early spring*** **navigational shoreline chemical treatment of Little Muskego Lake for control of Eurasian water milfoil and curly-leaf pondweed in areas where these plants begin displacing the native community.** Chemical treatment, along with mechanical harvesting, have been the primary methods of aquatic plant management employed in 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 occur in the *early spring* when 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 water milfoil and its hybrid, and curly-leaf pondweed (e.g., 2,4-D and Endothall) should be used.[59] A WDNR permit and WDNR 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. If chemical treatment does occur, **chemical residue monitoring in the Lake** is also recommended (low priority).

5. ***Whole-lake chemical treatment*** **of Little Muskego Lake to help control curly-leaf pondweed and Eurasian water milfoil, to reduce frequency of chemical applications, and to allow native aquatic plant populations to grow.** A chemical whole-lake approach has been suggested for managing Eurasian water milfoil and curly-leaf pondweed in Little Muskego Lake (medium priority). The WDNR considers such treatments on a lake-by-lake basis. The Lake District needs to assemble a comprehensive set of information for WDNR to consider whole-lake treatment. The Lake District, or commonly the applicator, must assemble information on all of the following as part of the permit application process:

   a. A list of proposed treatment chemicals and/or mixtures

   b. Proposed target concentrations, timing, and application methods

   c. Probable cost and schedule

   d. The anticipated longevity of the treatment

[59] *Wisconsin Department of Natural Resources PUBL-WR-236 90,* Chemical Fact Sheet: 2,4-D, *May 1990; Wisconsin Department of Natural Resources PUBL-WR-237 90,* Chemical Fact Sheet: Endothall*, May 1990.*

The WDNR will consider the following during review of the whole-lake permit application:

a. **Lake volume**. The entire Little Muskego Lake volume needs to be accurately estimated. The volume of the epilimnion layer needs to be segregated because the amount of chemical applied depends upon the volume of water in the epilimnion layer.[60]

b. **Water temperature profile**. Whole-lake treatments are most effective and typically required to be implemented in spring as soon as possible after the Lake stratifies. Little Muskego Lake temperature profiles should be monitored from ice off until the end of May to ensure the whole Lake is fully stratified. The temperature of the epilimnion needs to be monitored to ensure that the minimum temperature requirements on the chosen chemical's label are met.[61]

c. **Target plant density**. The relative abundance of undesirable plants should be measured in Little Muskego Lake. Depending on the lake, average Eurasian water milfoil rake fullness rating of between two and three at a minimum of 35 percent of vegetated sampling sites are required, based on a recent comprehensive point-intercept survey. Other factors such as water depths and history of plant abundance may also need to be taken into account.

d. **Native plants**. The type and abundance of native plant populations and their sensitivity to chemical treatment must be considered.

e. **Aquatic plant distribution**. This evaluation helps determine if plants in Little Muskego Lake are found in more monotypic beds or intermixed with Eurasian water milfoil, starry stonewort, and natives.

Care must be exercised to carefully select herbicides that selectively control Eurasian water milfoil and curly-leaf pondweed to prevent excessive loss of native aquatic species. **A WDNR permit and WDNR staff supervision are required to implement this alternative.** Additionally, lakeshore property owners need to be informed of the chemical treatment and permit conditions before chemicals are applied. **Residual chemical concentrations should be monitored after application is complete**. Generally chemical residue monitoring is undertaken as a standard component of whole-lake treatments to determine if applied chemicals are well dispersed throughout the Lake. Chemical monitoring should be given a high priority whenever a whole-lake treatment is completed.

6. ***Extended lake drawdown*** **of Little Muskego Lake to help control starry stonewort and to allow native aquatic plant populations to grow.**[62] A lake drawdown approach has been suggested for managing starry stonewort in Hillview Bay of Little Muskego Lake pending the results of a study to determine the effects of desiccation and freezing on starry stonewort bulbils (medium priority). **The WDNR will require and consider the following during review of the drawdown permit application:**

   a. **Bottom contours**.[63] Lake bottom contours need to be determined and mapped with a GPS in order to develop a new bathymetric map.

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

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[60] *When completely stratified, the epilimnion layer is the top layer of the lake that is warmer and less dense.*

[61] *WDNR has volunteers measure the temperature profile of the lake before it becomes stratified up until the point the lake is completely stratified. This is to ensure that the lake can be chemically treated with the proper dosage of chemical herbicides.*

[62] *At the publication of this report, a drawdown had been completed on Little Muskego Lake between September 5 and October 12, 2017. The drawdown reached a total of 74 inches. Lake refill started after ice out in April 2018. The results of the drawdown are pending review by the WDNR. Initial surveys have been completed but have not yet been evaluated.*

[63] *Upon review of the drawdown the bathymetric contours of Little Muskego Lake should be reevaluated with the assistance of a small-scale WDNR Surface Water Grant.*

c. **Lake acreage**. Lake bottom acreage exposed during various intervals of the drawdown (12 inches, 24 inches, 36 inches, 42 inches, and 84 inches if pumping occurs) must be determined.

d. **Drawdown and refill times for the Lake**. This knowledge will guide proper timing of drawdown to maximize effectiveness and minimize impacts to Lake users.

e. **Drawdown discharge rate**. A safe discharge rate will need to be calculated to prevent downstream flooding and erosion.

A WDNR permit and WDNR staff supervision are required to implement this alternative. Additionally, lakeshore property owners need to be informed of the drawdown and permit conditions before the technique is implemented. **Starry stonewort populations should be monitored after refill is complete** to assess efficacy and guide future management. Aquatic plant monitoring should be given a high priority.

7. The introduction of new invasive species is a constant threat. **Preventing introduction of new invasive species** is crucial to maintaining a healthy lake. To help decrease the chance of this occurring, 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 (Appendix H) and invasive species identification (Appendix I).

   b. The LMLPRD should continue **enrollment in the Clean Boats Clean Waters program** (a State program targeting invasive species prevention) to proactively encourage Lake users to clean boats and equipment before and after launching and using them in Little Muskego Lake.[64] This will help lower the probability of new invasive species entering the Lake and will reduce the probability of spreading starry stonewort to other lakes;

   c. Since boat launches are likely entry points for invasive species, **boat launch sites should be targeted for focused aquatic plant control**; and

   d. If a new invasive species is found in the Lake, efforts to eradicate the new species should immediately be evaluated and, if possible, be employed to help prevent establishment. The WDNR has funding that can aid in early eradication efforts, particularly as it pertains to aquatic plants (Table 3.4). Therefore, **citizen monitoring for new invasive species is recommended**. The Wisconsin Citizen Lake Monitoring Network (CLMN) provides training to help local citizens participate in these efforts.

Figure 3.1 is provided to help lake managers implement aquatic plant management plan recommendations. However, aquatic plant management must react to what is actually occurring at the time of treatment. Consequently, this aquatic plant management plan must be reevaluated in three to five years (near the end of the five-year permitting cycle). Such reevaluation is assigned a high priority. This effort should include a comprehensive point-intercept aquatic plant survey and a summary of aquatic plant management activities actually completed during the current permit period. This analysis will help Lake managers quantify and judge the effectiveness of the aquatic plant management plan described in this report and will allow appropriate adjustments to be made.

3.4 ANCILLARY PLAN RECOMMENDATIONS

Water Quality Management

Water quality is one of the key parameters used to determine the overall health of a waterbody and helps guide management efforts for a lake and its watershed. To this end, the following strategies are recommended:

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

Table 3.4
Example WDNR Grant Programs Supporting Lake Management Activities

Category	Program	Grant Program	Maximum Grant Award	Minimum Financial Match	Application Due Date
Water	Surface Water Grants	Aquatic Invasive Species (AIS) Prevention and Control	Education, Prevention, and Planning Projects: $150,000 Established Population Control Projects: $200,000 Early Detection and Response Projects: $20,000 Research and Development: annual funding limit of $500,000 Maintenance and Containment: permit fee reimbursement	25 percent 25 percent 25 percent 25 percent 25 percent	December 10 February 1 Year-Round Year-Round Year-Round
		Lake Classification and Ordinance Development	$50,000	25 percent	December 10
		Lake Protection	$200,000	25 percent	February 1
		Lake Management Planning: Large and Small Scale	Small Scale: $3,000 Large Scale: $25,000	33 percent 33 percent	December 10 December 10
	Citizen-Based Monitoring Partnership Program		$4,999		Spring
	Targeted Runoff Management		Small Scale: $150,000 Large Scale: $1,000,000	30 percent 30 percent	April 15 April 15
	Urban Nonpoint Source and Stormwater Management		Design/Construction: $150,000 Property Acquisition: $50,000	50 percent 50 percent	April 15 April 15
Conservation and Wildlife	Knowles-Nelson Stewardship Program	Acquisition of Development Rights			May 1
		Natural Areas			February 1, August 1
		Sport Fish Restoration		50 percent	February 1
		Streambank Protection			February 1, August 1
Boating	Boat Enforcement Patrol		Up to 75 percent reimbursement	None	Various
	Recreational Boating Facilities		Up to 50 percent of total eligible cost		
Recreation	Knowles-Nelson Stewardship Program	Acquisition and Development of Local Parks			May 1
		Habitat Area			February 1, August 1
		Urban Green Space			May 1

Note: More information regarding these example grant programs may be found online at the following address: dnr.wi.gov/aid/grants.html. Additional Federal, state, and local grant opportunities are available.

Source: Wisconsin Department of Natural Resources and SEWRPC

1. **Continuing to participate in the University of Wisconsin-Extension Citizen Lake Monitoring Network (CLMN)**. This should be considered a high priority. Water quality monitoring is the barometer allowing a lake's current condition and longer term changes to be understood, and is a key road map to maintaining and improving lake health. Therefore, regularly recurring water quality monitoring should be a high priority. To allow comparison with previously collected data and, thereby, allow trends to be identified, samples should continue to be collected at the site identified as the "deep hole" site (i.e., the point above the deepest part of the Lake, see Map 1.2). At a minimum, water quality samples should be collected and submitted to a laboratory in early spring shortly after ice out (e.g., early April) and at least once during mid-summer (e.g., late July). Field measurements (e.g., water clarity, temperature, and dissolved oxygen) should be collected much more frequently. At a minimum, water quality samples should be analyzed for the following parameters:

    a. Field measurements

        » Water clarity (i.e., Secchi depth)

        » Temperature (profiled over the entire water depth range at the deepest portion of the Lake with more frequent readings near the thermocline)

        » Dissolved oxygen (profiled over the entire water depth range at the deepest portion of the Lake with more frequent readings near the thermocline)

        » Specific conductance (near-surface sample, profiles with depth if equipment is available)

    b. Laboratory samples

        » Total phosphorus (near-surface sample with supplemental samples collected near the deepest portions of the Lake)

        » Total nitrogen (near-surface sample)

        » Chlorophyll-*a* (near-surface sample)

        » Chloride (near-surface sample)

    Laboratory tests quantify the amount of a substance within a sample under a specific condition at a particular moment in time, and are particularly valuable benchmark values. Field measurements can often serve as reasonable surrogates for common laboratory tests. For example, water clarity decreases when total suspended solids and/or chlorophyll-*a* concentrations are high, samples with high concentrations of total suspended solids commonly contain more phosphorus, and water with higher specific conductance commonly contains more salt and, therefore, more chloride. Periodically sampling water and concurrently running a targeted array of laboratory and field tests not only provides data for individual points in time, but can also allow laboratory results to be correlated with field test results. Once a relationship is established between laboratory and field values, this relationship can be used as an inexpensive means to estimate the concentrations of key water quality indicators normally quantified using laboratory data.

    The Clean Lakes Monitoring Network (CLMN) provides training and guidance regarding monitoring lake health.[65] Volunteers commonly monitor water clarity, temperature, and dissolved oxygen throughout the open water season (preferably every 10 to 14 days) and basic water chemistry (i.e., phosphorus and chlorophyll-*a* concentrations) four times per year (two weeks after ice off and during the last two weeks of June, July, and August).

[65] *More information regarding the CLMN may be found at the following website: uwsp.edu/cnr-ap/UWEXLakes/Pages/programs/clmn/default.aspx*

Supplemental temperature/oxygen profiles collected at other times of the year (e.g., other summer dates, nighttime in summer, fall, winter) can be helpful. For example, oxygen profiles collected during midsummer nights, just before sunrise, help evaluate diurnal oxygen saturation swings. In addition, chloride should also be monitored once per year when the Lake is fully mixed. Monitoring chloride concentrations allows the rate of concentration increase over time to be quantified. This will help discern the overall impact of cultural influence on the Lake and to evaluate if chloride concentrations are approaching levels that could foster negative changes in the Lake's ecosystem.

Regular water quality monitoring helps Lake managers promptly identify variations in the Lake's water quality and improves the ability to understand problems and propose solutions. Hence, continuation of water quality monitoring efforts will be important in assessing success and determining the direction of future management efforts.

2. **Encouraging pollution reduction efforts along the shorelines (best management practices)** also is currently recommended as a water quality management technique and is considered a medium priority. Pollution reduction measures include eliminating use of fertilizer where practical, ensuring cars are not leaking fluids on driveways, maintaining rain gardens (Figure 3.3) to mitigate impermeable surface runoff volume and quality, preventing soil erosion, properly disposing of leaf litter and grass clippings, and properly storing salts and other chemicals, so they do not drain to the Lake. Reducing winter salt application where feasible should also be considered. Communicating these best management practices, and engaging in a campaign to encourage their use (e.g., offering to pick up grass clipping or leaves) will incrementally reduce their contribution to water quality problems.

Figure 3.3
Example of a Rain Garden

Note: Further details are provided from the Natural Resource Conservation Service and Wisconsin Department of Natural Resources websites at: nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/ndpmctn7278.pdf; and dnr.wi.gov/topic/Stormwater/raingarden/.

Source: U.S. Department of Agriculture, Natural Resource Conservation Service and Wisconsin Department of Natural Resources

3. **Protecting and enhancing shorelines, buffers, wetlands, and floodplains** helps safeguard areas that already benefit the Lake and require little to no additional inputs of money and labor. **Enhancing these features is often a cost-effective way of increasing the level of lake protection** and should be considered a high priority. The use of buffers and wetlands along the shoreline helps filter out nutrients, protect the Lake from future phosphorus loading issues, and provide food, shelter, and habitat for fish and wildlife. The implementation of this recommendation could involve:

    a. **Providing information to riparian property owners that describes the benefits of nearshore and terrestrial buffers** to the Lake. Encourage landowners to protect buffers where they remain and to enhance, restore, or create buffers in favorable areas where they are highly degraded or absent (high priority). These materials could include instructions on installation, typical costs, and potentially a list of suppliers of services or supplies. Such programs would be most productive if accompanied by an incentive program that helps share the cost of installation or provides tax incentives.

    The U.S. Department of Agriculture Farm Service Agency has programs for buffer enhancement in agricultural areas. These two programs are the Conservation Reserve Program (CRP) and affiliated Conservation Reserve Enhancement Program (CREP). Both of these initiatives use vegetation to slow and filter stormwater runoff. If thoughtfully designed and located, groundwater recharge may also be enhanced. Grants may also be available for novel initiatives such as cropped buffers, where farmers receive a compensatory payment for growing crops that help filter runoff.

b. **Establishment of a shoreline best management practice and shoreline buffer enhancement program** is recommended and is considered a high priority. This program could encourage the development of rain gardens, buffers (e.g., native plantings and native aquatic plantings), and fish habitat (e.g., coarse woody structure and "fish sticks") along the shoreline.[66] WDNR recently introduced a "Healthy Lakes" grant program that could help fund some of these efforts (see Appendix J for more information).

Implementation of these recommendations will significantly contribute to tracking and improving the water quality within Little Muskego Lake.

Recreational Use Management

As is discussed in Chapter 2, the primary uses for Little Muskego Lake (in no particular order) are boating, swimming, and fishing. Since recreation is a priority under this plan, it is necessary to emphasize the recommendations that help maintain or encourage these recreational uses. Consequently, the following recommendations are made:

1. **Maintaining and enhancing boating through improving access** (high priority). This can be achieved through implementing the harvesting recommendations included in this chapter (see "Aquatic Plant Management Recommendations" section).

2. **Maintaining and enhancing swimming through engaging in "swimmer-conscious" aquatic plant management efforts** (high priority). This can be achieved by adopting the aquatic plant management recommendations made earlier in this chapter (see "Aquatic Plant Management Recommendations" section), including 1) continuing the plant pickup program, 2) ensuring that any future chemical treatments occur *only in the early spring* (to prevent human contact), 3) implementing hand-pulling and raking in the nearshore areas (to facilitate nearshore swimming), and 4) implementing hand-pulling and harvesting recommendations aimed at controlling Eurasian water milfoil (as this species often deters swimming).

3. **Maintaining and enhancing fishing activities by protecting and improving aquatic habitat and ensuring the fish community remains viable** (high priority). This recommendation can be achieved by implementing the following aquatic wildlife recommendations:

   a. **Continuing current fish stocking practices**. This should be considered a medium priority and will help assure that the fishery is maintained while efforts to increase natural spawning and juvenile recruitment are improved;

   b. **Improving aquatic habitat in the Lake by allowing or installing coarse woody structure and/or vegetative buffers along the Lake edge**. Implementation of this should be considered a high priority. Elements could include educational or incentive-based programs to encourage riparian landowners to install "fish sticks" (see Figure 3.4), leave fallen trees in the water, and develop buffer systems along the shoreline. Grant funding is available through the "Healthy Lakes" program on a competitive basis for the implementation of "fish sticks" projects (Appendix J). Installing buffers will also have the added benefit of deterring geese populations from congregating on shoreline properties. Finally, guidelines in the "Aquatic Plant Management Recommendations" section of this report should be implemented to improve the aquatic plant community, thus improving aquatic habitat.

   c. **Mitigating water quality stress on aquatic life and maximizing areas habitable to desirable fish**. The primary issue in this category is presently a decrease in native plant communities that provide essential food, habitat, spawning area, and shelter. The aquatic plant management recommendations discussed earlier in this chapter incorporate this element and should be considered a high priority. Other stressors may develop in the future (e.g., new invasive species and other water quality concerns) and conditions should be carefully monitored for their impact on aquatic life.

[66] *Natural shorelines generally have hundreds of fallen trees per mile along the shoreline. "Fish sticks" is a term coined for engineered installation of coarse woody structure (logs) along lake shorelines to mimic these natural conditions. Generally these projects involve anchoring logs into the shore so that the log is oriented perpendicular to the shoreline.*

4. **Pursuing an increase in boat launch fees, parking restrictions, and limiting the number of boats that can utilize the Lake at any one time to reduce unsafe boating activity**, particularly on weekends when the number of boats on the Lake can reach very dense levels (see "Recreational Uses and Facilities" section in Chapter 2). This should be considered a high priority. Curtailing boat traffic would also reduce risks of spreading starry stonewort to other lakes and introducing additional non-native species into Little Muskego Lake. The City of Muskego would ultimately be responsible for implementing any of these management tactics, while Muskego Police would provide enforcement.

In general, **management efforts should be employed to enhance the health and, in turn, the recreational use of the Lake** (high priority). This should be a general principal guiding all future management, including the efforts that are undertaken consistent with the recommendations of this plan.

Plan Implementation

A number of factors commonly inhibit local citizens and management groups from effectively executing lake management projects. Consequently, the following suggestions are offered to enhance project execution:

Figure 3.4
Examples of Completed "Fish Sticks" Projects

Note: Further details are provided from the Wisconsin Department of Natural Resources at: dnr.wi.gov/topic/fishing/documents/outreach/FishSticksBestPractices.pdf.

Source: Wisconsin Department of Natural Resources

1. **Apply for grants, when available**, to support implementation of programs recommended under this plan (Appendix K). This should be considered a high priority. This process requires coordination, creativity, and investment of stakeholder time to be effective. Table 3.4 provides a list of grant opportunities that can potentially be used to implement plan recommendations.

2. **Encourage Lake users and residents to actively participate in future management efforts**. Not only does this effort help assure community support, but also supplements the donor and volunteer pool working toward improving the Lake. This should be considered a medium priority. This should include cooperation with volunteer groups (e.g., Scout troops, NGOs, church groups). Not only will their engagement in future efforts benefit the Lake, it will also benefit the economic value of their properties.

3. **Encourage key players to attend meetings, conferences, and/or training programs to build their lake management knowledge** and to enhance institutional knowledge and capacity. In recognition of limits on financial resources and time available for such activities, this element is assigned a medium priority. Some examples of capacity-building events are the Wisconsin Lakes Partnership Convention (which targets local lake managers) and the "Lake Leaders" training program (which teaches the basics of lake management and provides ongoing resources to lake managers). Both of these are hosted by the University of Wisconsin-Extension. Additionally, in-person and on-line courses, workshops, training, regional summits, and general meetings can also be of value. Attendance at these events should include follow-up documents/meetings, so that the lessons learned can be communicated to the larger Lake group.

4. **Continue to reinforce stakeholder inclusivity and transparency with respect to all Lake management activities**. If stakeholders do not fully understand the aims and goals of a project, or if they do not trust the process, excess energy can be devoted to conflict, a result that benefits no one. For this reason, this element is assigned high priority. These efforts should be implemented through public meetings, social media, newsletters, emails, and any other mechanism that helps gather a full suite of information and build consensus. In this way, all data and viewpoints can be identified and considered, and conflicts can be discussed, addressed, and mitigated prior to finalizing plans and implementing projects.

5. **Foster and monitor efforts to communicate concerns, goals, actions, and achievements to future Lake managers**. Institutional knowledge is a powerful tool that should be preserved whenever possible. Actions associated with this are sometimes embedded in organization bylaws (e.g., minutes), and are therefore assigned high priority. Open communication helps further increase the capacity of Lake management entities. This may take the form of annual meetings, websites, social media, newsletters, emails, reports and any number of other means that help compile and report actions, plans, successes, and lessons learned. These records should be kept for future generations.

Additionally, a major recommendation that should be considered a high priority is the **creation of an action plan that highlights action items, timelines, goals, and responsible parties**. This document will help ensure that the plan recommendations are implemented in a timely, comprehensive, transparent, and effective manner. Additionally, an action plan can help ensure that all responsible parties are held accountable for their portions of the plan's implementation.

A major recommendation to promote implementation of this plan is the **education of the Lake residents, users, and governing bodies** on the content of this plan. A campaign to communicate the relevant information in the plan should therefore be given a high priority.

Finally, it is recommended that the Lake District pursue a comprehensive lake and watershed management plan in order to incorporate recent developments and activities. This plan would be an update to SEWRPC Community Assistance Planning Report No. 222, *A Lake Management Plan for Little Muskego Lake, Waukesha County, Wisconsin*, June 1996. This should be given medium priority.

3.5 SUMMARY

This report, which documents the findings and recommendations of a study, and the resultant plan, requested by the LMLPRD, examines existing and anticipated conditions, potential aquatic plant management problems, and recreational use problems on Little Muskego Lake. The plan includes recommended actions and management measures for the resolution of those problems.

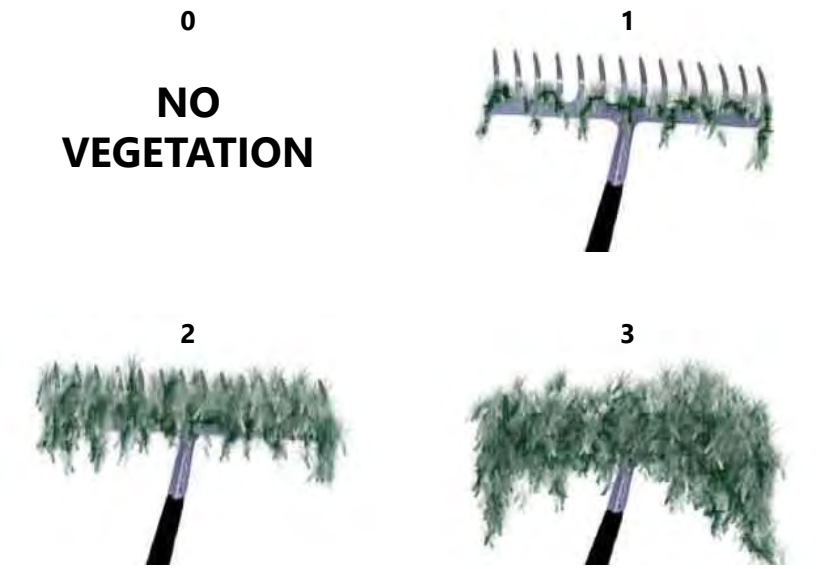
To help implement plan recommendations, Table 3.1 summarizes all recommendations and their priority level. Additionally, Figure 3.1 indicates where the aquatic plant management recommendations should be implemented. This figure will provide current and future Little Muskego Lake managers with a visual representation of where to target management efforts.

This chapter is intended to guide ideas and actions. The recommendations should, therefore, provide a starting point for addressing the issues that have been identified in Little Muskego Lake and its watershed. Successful implementation of the plan will require vigilance, cooperation, and enthusiasm, not only from local management groups, but also from State and regional agencies, Waukesha County, municipalities, and Lake residents. The recommended measures will provide the water quality and habitat protection necessary to maintain and establish conditions that are suitable for the maintenance and improvement of the natural beauty and ambience of Little Muskego Lake and its ecosystem, and the enjoyment of its human population today and in the future.

APPENDICES

APPENDIX A
LITTLE MUSKEGO LAKE AQUATIC PLANT SPECIES DETAILS[67]

Figure A.1
Rake Fullness Ratings



Source: Wisconsin Department of Natural Resources and SEWRPC

SOURCES OF INFORMATION:

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

Robert W. Freckman Herbarium: wisplants.uwsp.edu

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

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

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

[67] *Maps of species distribution are only shown for years in which a particular species was found during a point-intercept survey.*

Ceratophyllum demersum — Coontail

Native

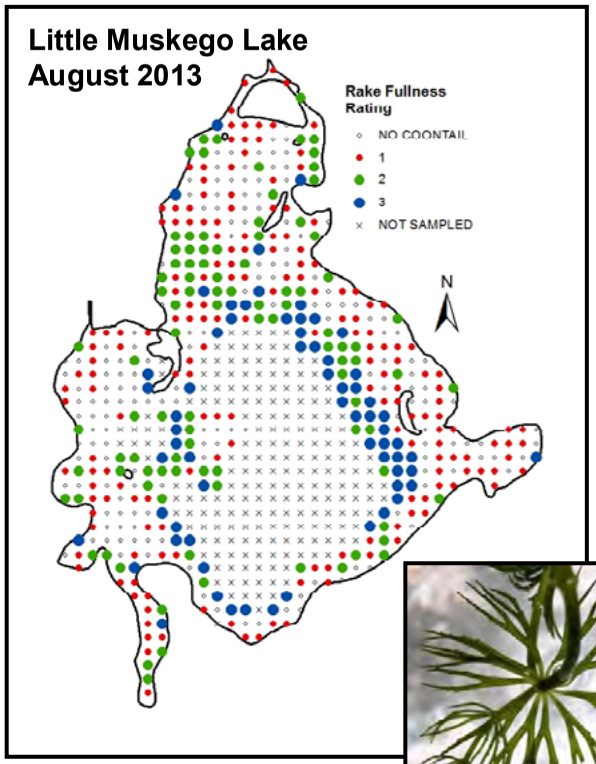
Identifying Features

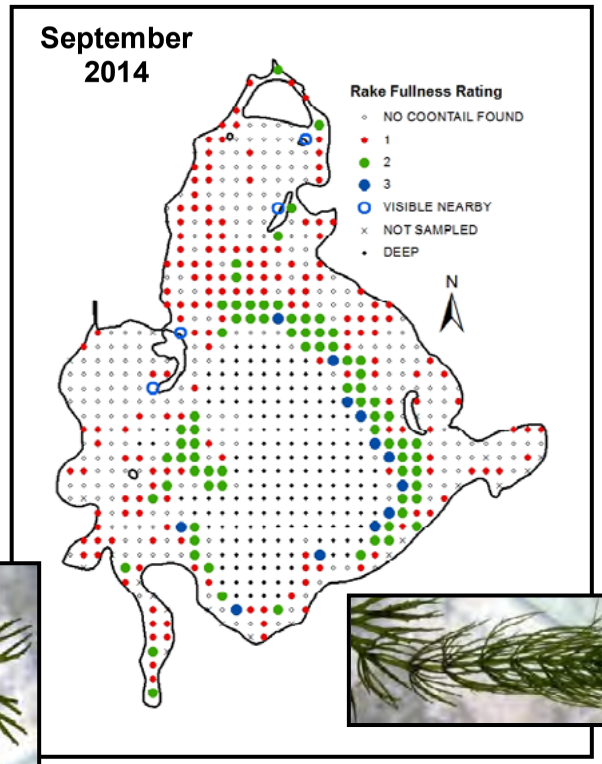
- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

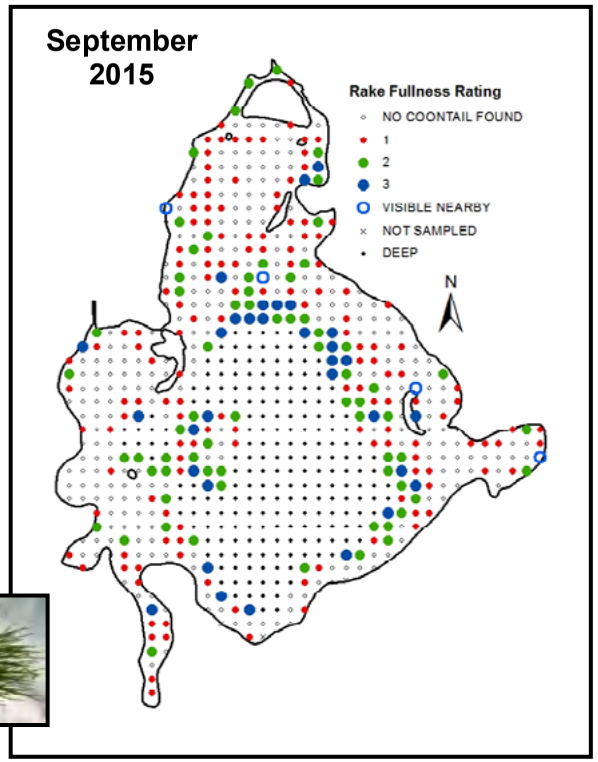
Coontail is similar to spiny hornwort (*C. echinatum*) and muskgrass (*Chara* spp.), but spiny hornwort has some leaves with three to four orders of branching, and coontail does not produce the distinct garlic-like odor of muskgrass when crushed

Ecology

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







Chara spp.

Native

Muskgrasses

Algae (not vascular plants)

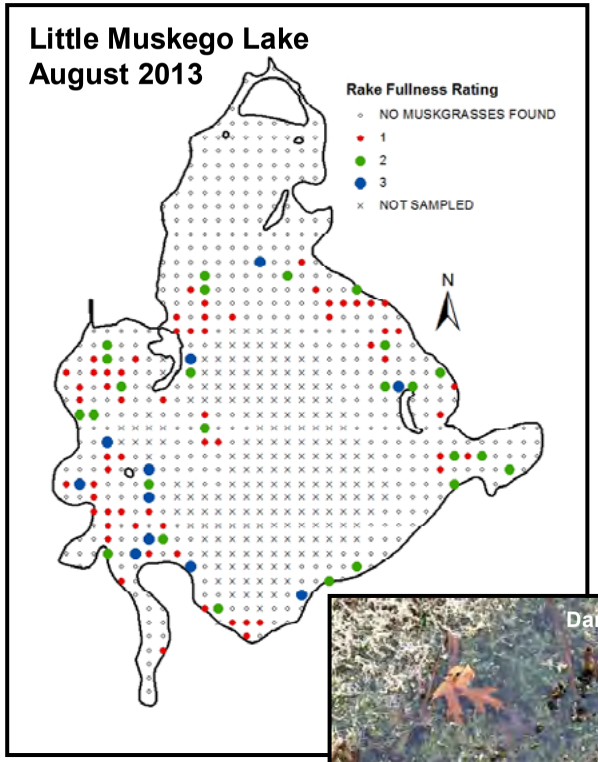
Identifying Features

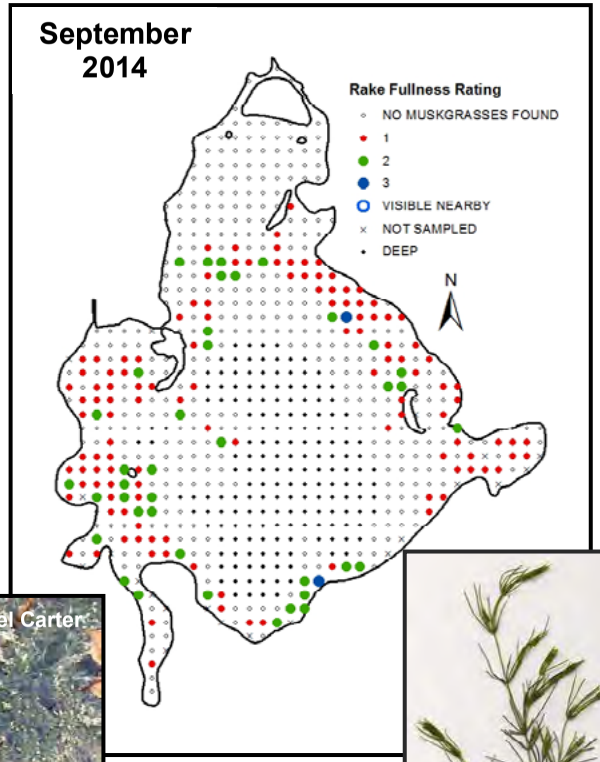
- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo on left, below)
- Yellow reproductive structures develop along the whorled branches in summer
- Emits a garlic-like odor when crushed

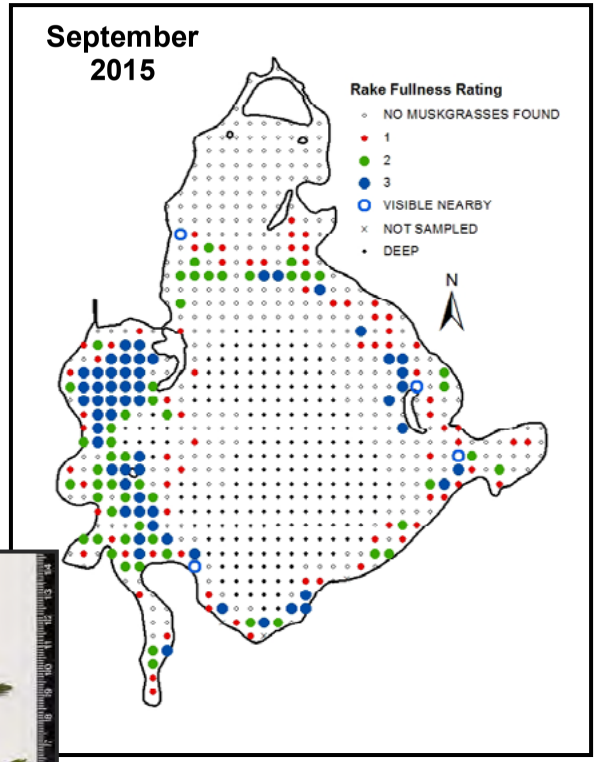
Stoneworts (*Nitella* spp.) are similar large algae, but their branches are smooth rather than ridged and more delicate

Ecology

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







Elodea canadensis — Common Waterweed

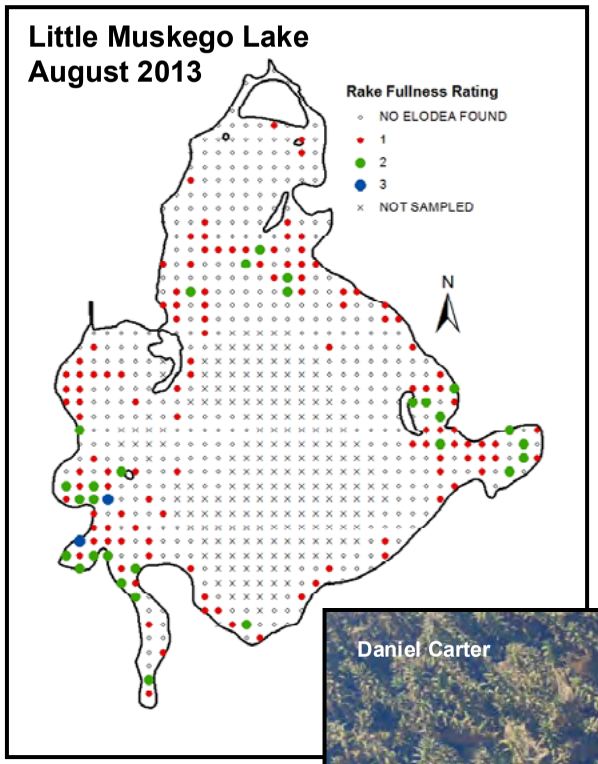
Native

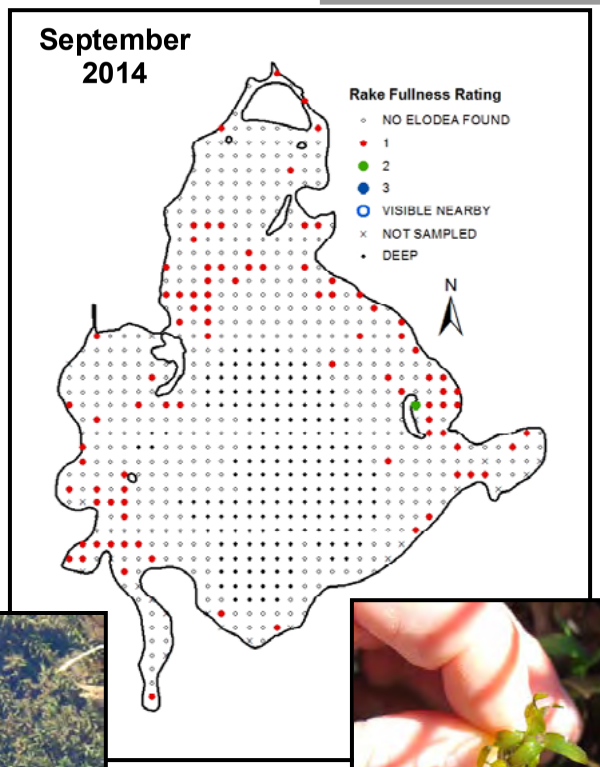
Identifying Features

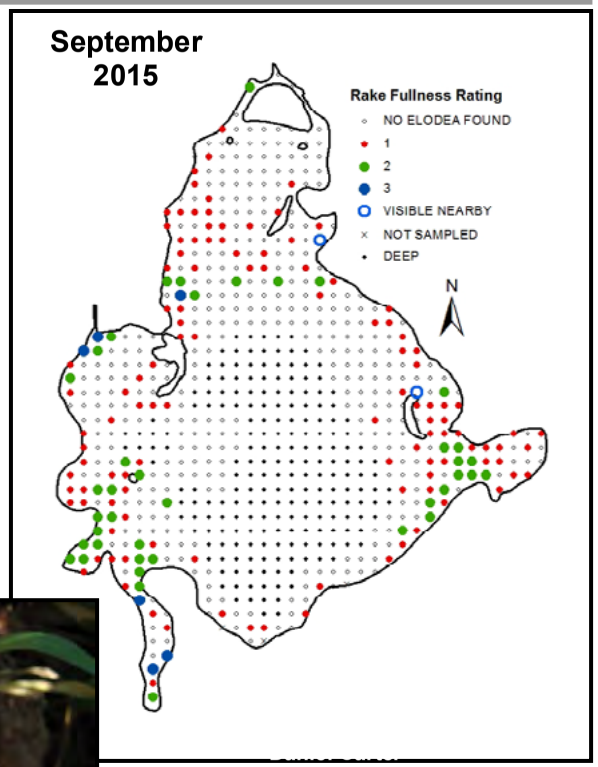
- Slender stems, occasionally rooting
- Leaves lance-shaped, in whorls of three (rarely two or four), 6.0 to 17 mm long and averaging 2.0 mm wide
- When present, tiny male and female flowers on separate plants (females more common), raised to the surface on thread-like stalks

Ecology

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







Heteranthera dubia — Water Stargrass

Native

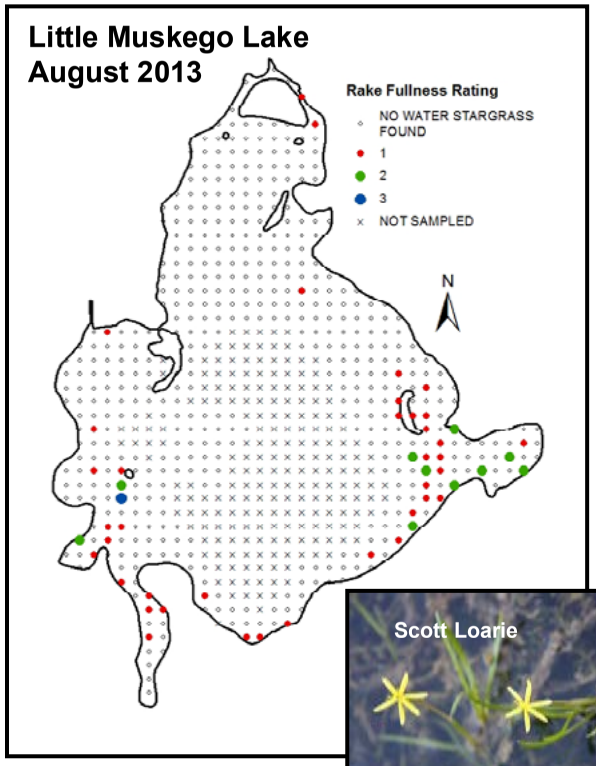
Identifying Features

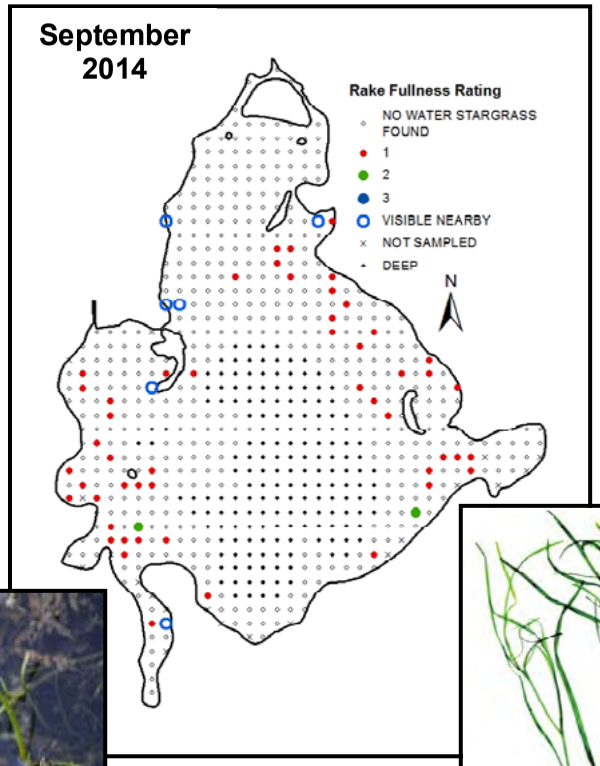
- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

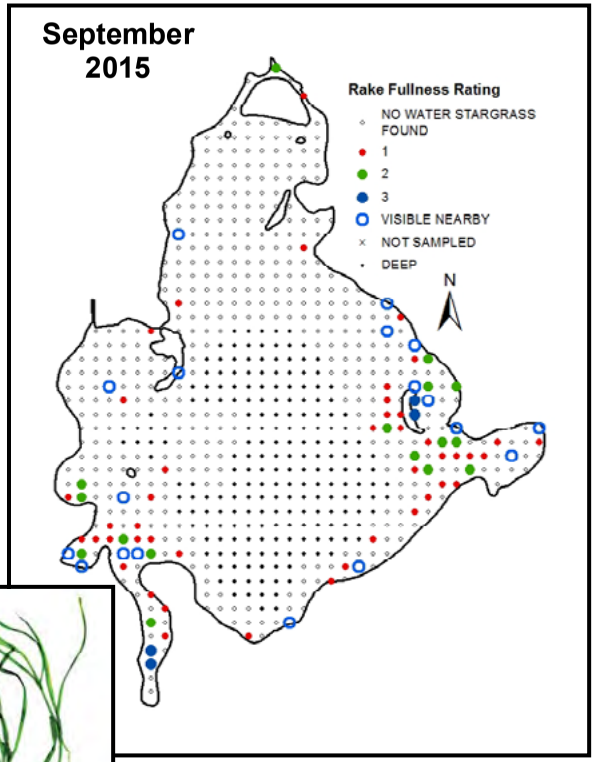
  Yellow stargrass may be confused with pondweeds that have narrow leaves, but it is easily distinguished by its lack of a prominent midvein and, when present, yellow blossoms

Ecology

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







Myriophyllum sibiricum — Northern Water Milfoil

Native

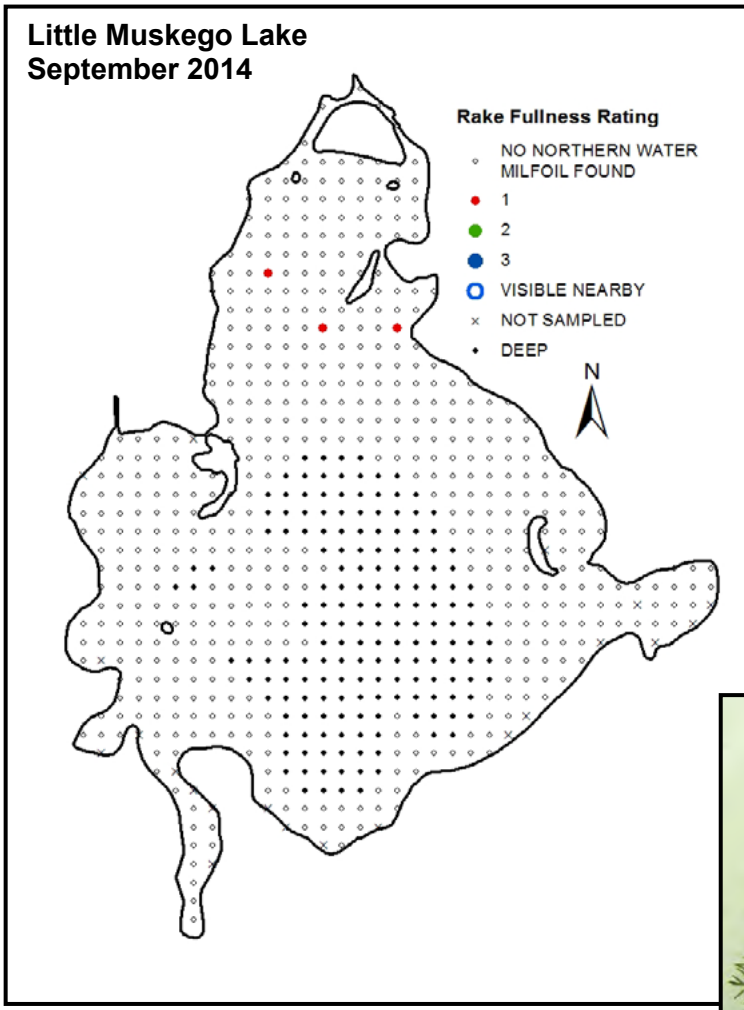
Identifying Features

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

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

Ecology

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



Myriophyllum spicatum — Eurasian Water Milfoil

Nonnative/Exotic

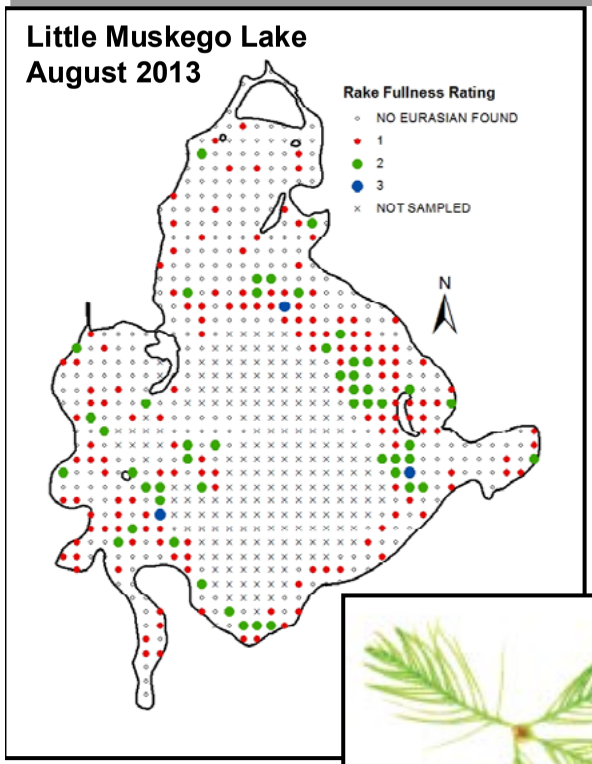
Identifying Features

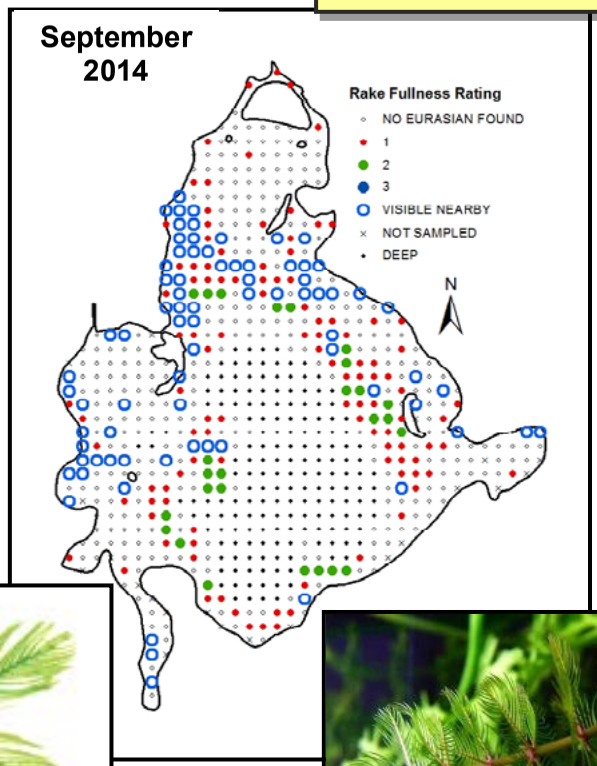
- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

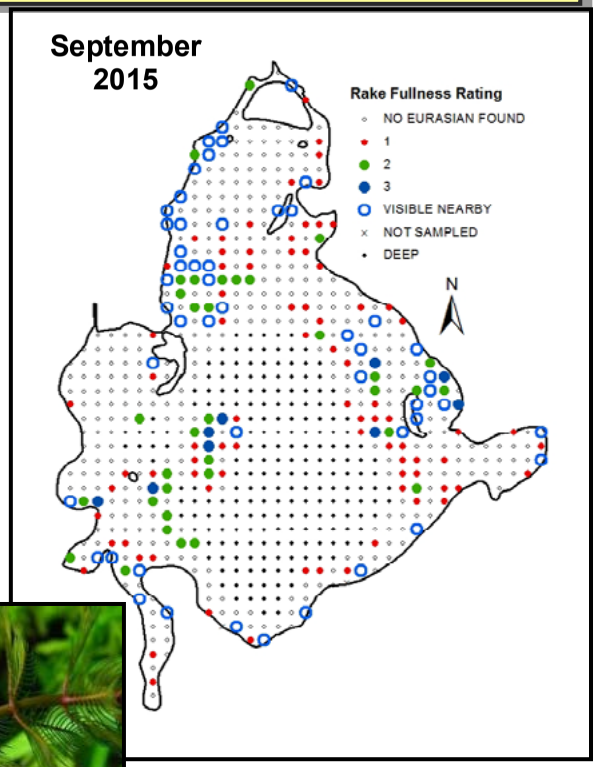
Eurasian water milfoil is similar to northern water milfoil (*M. sibiricum*). However, northern water milfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

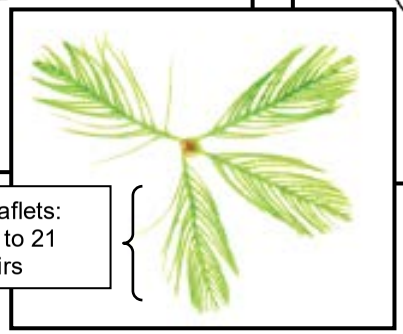
Ecology

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









Najas flexilis (**Bushy Pondweed or Slender Naiad**) and *Najas guadalupensis* **(Southern Naiad)**[2]

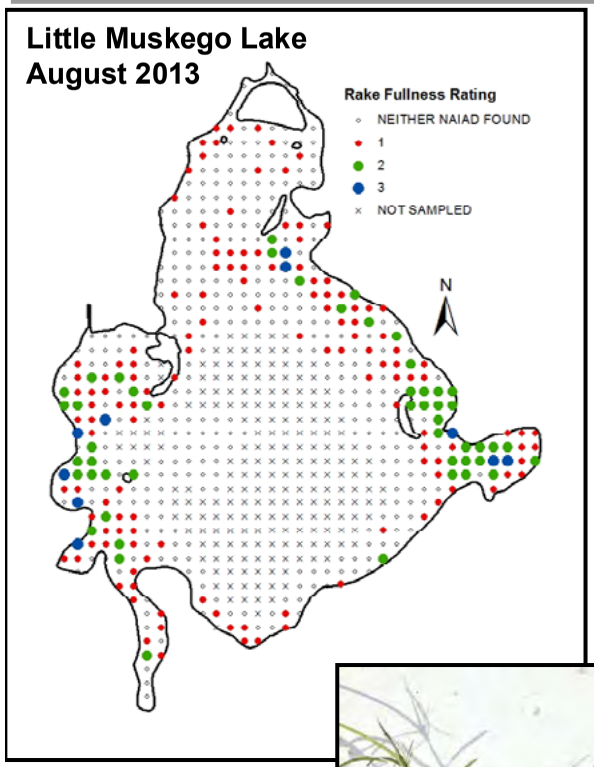
Native

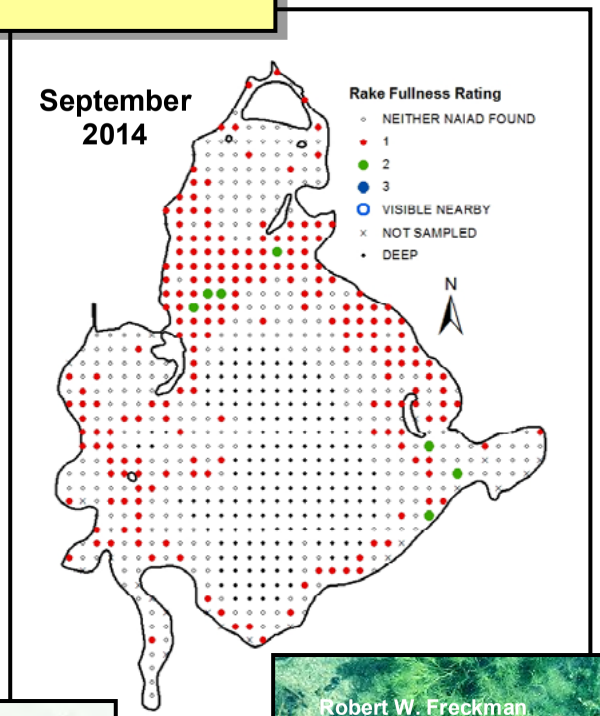
Identifying Features

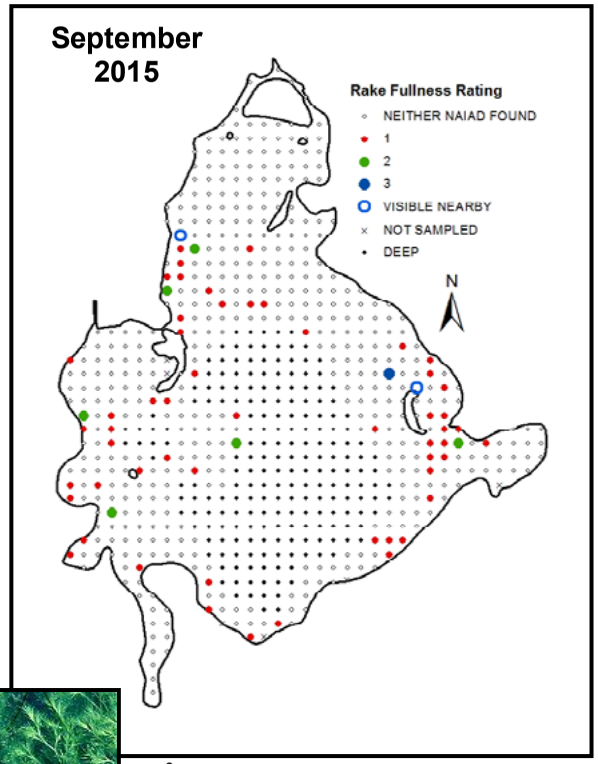
- *Najas flexilis* - Leaves narrow (0.4 to 1.0 mm) and pointed with broader bases where they attach to the stem and finely serrated margins; variable size and spacing of leaves, as well as compactness of plant, depending on growing conditions.
- *Najas guadalupensis* - Leaves 0.2 to 2.0 mm wide and blunt with slight shoulder bases where they attach to the stem and finely serrated margins; Leaves opposite and may appear loosely whorled.

Ecology

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







Leaves narrow with serrated edges

[2]*Najas flexilis and Najas guadalupensis were grouped together in distribution maps because the species can be difficult to distinguish. A majority of the plants were identified as Najas guadalupensis.*

Najas marina — Spiny Naiad

Nonnative/Exotic

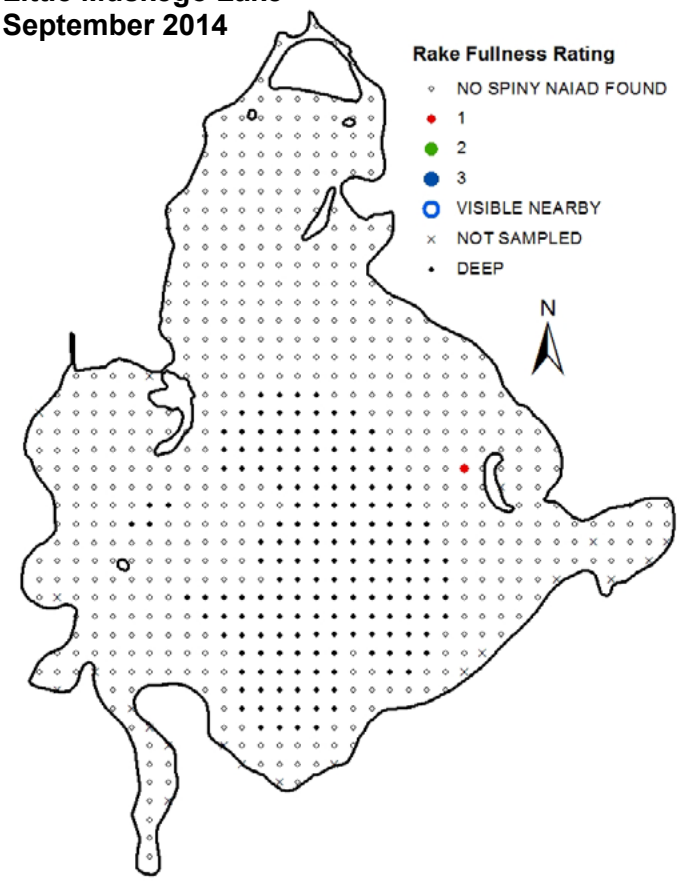
Identifying Features

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

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

Ecology

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

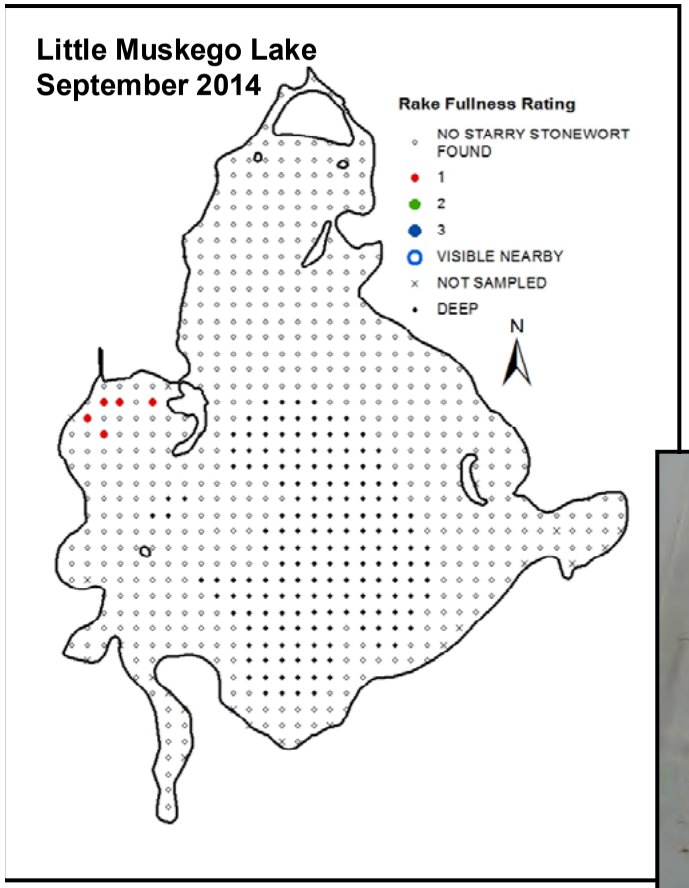


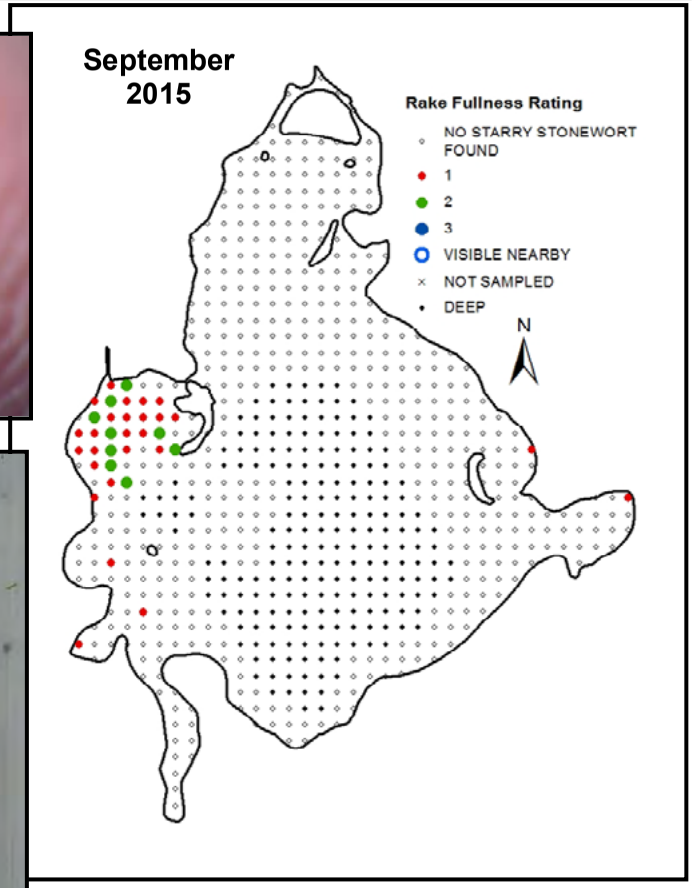
Nitellopsis obtusa
Non-native/Exotic

Starry Stonewort
Algae (not vascular plants)

Identifying Features
- Stems and leaf-like side branches delicate and smooth, side branches arranged in whorls or 4-6 branchlets
- More robust than other members of family
- Distinctive star-shaped bulbils

Ecology
- Alkaline lakes
- Typically annual, but can act like perennial during mild winters
- Occurs as separate male and female plants – currently, only male exists in U.S.
- Can form dense mats and grow over two meters tall





Nymphaea odorata — White Water Lily

Native

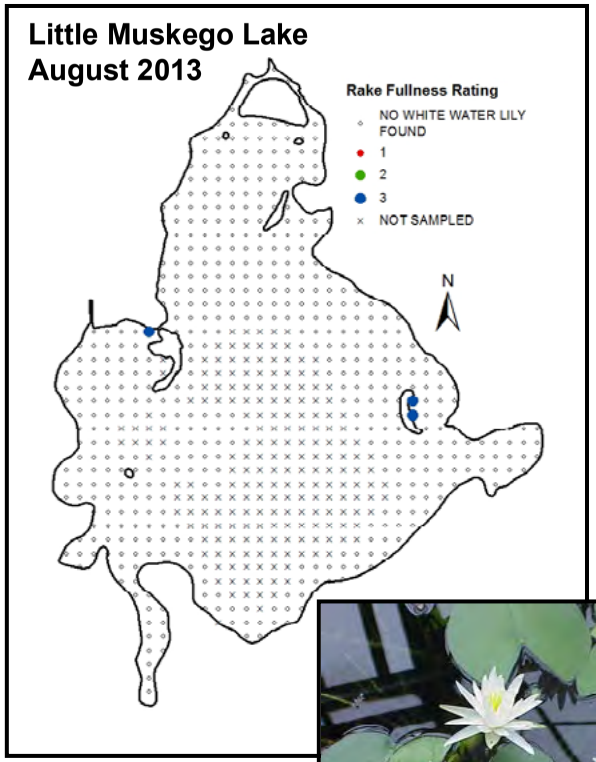
Identifying Features

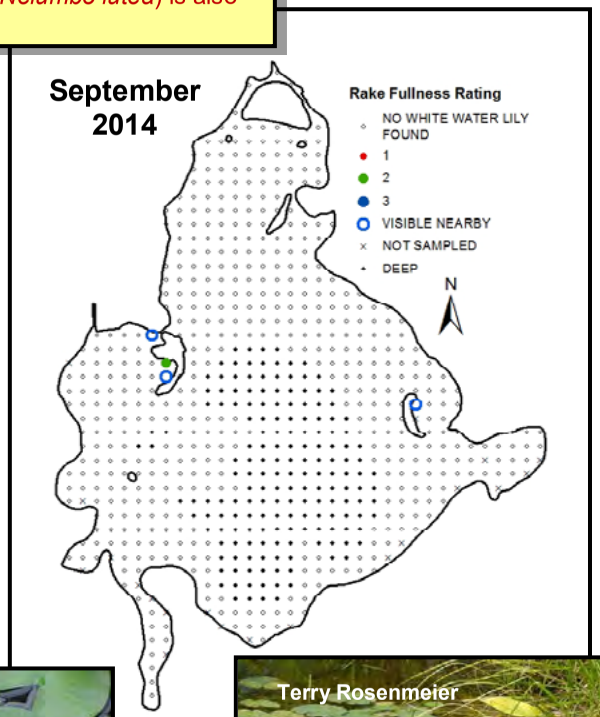
- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

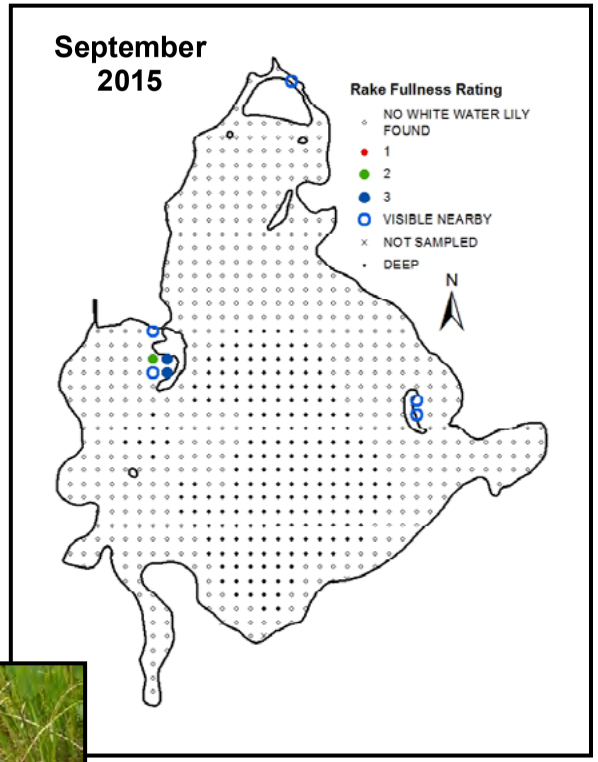
Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are *unnotched*

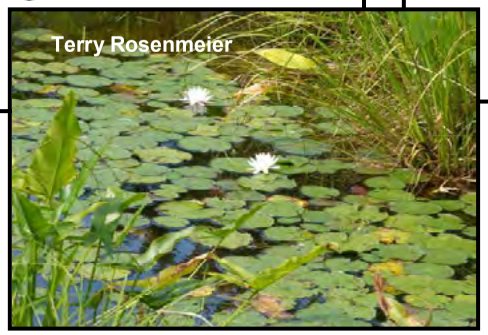
Ecology

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









Polygonum amphibium (Persicaria amphibia) — Water Smartweed

Native

Identifying Features

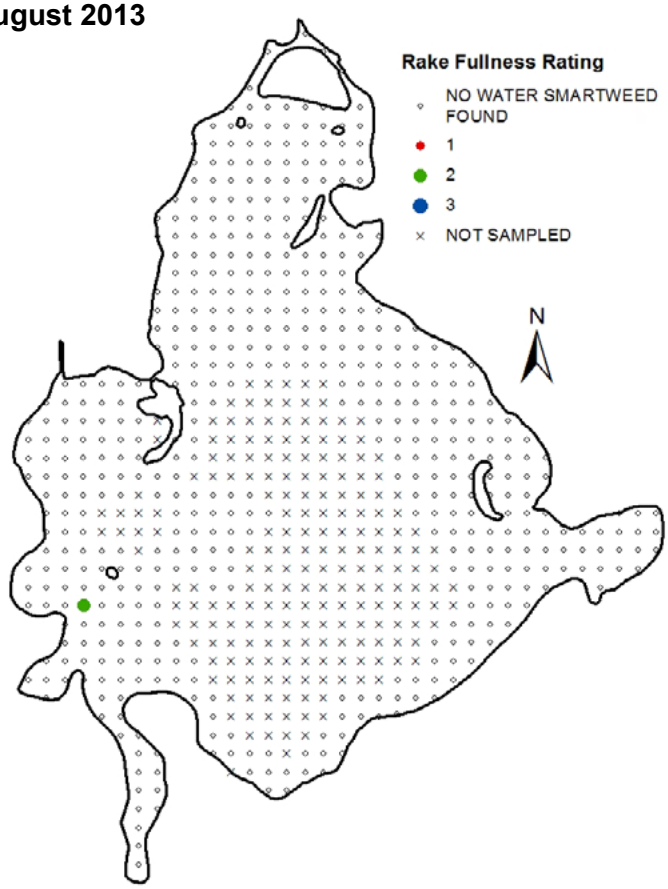
- Occurs in both floating and upright, land adapted forms
- Floating leaves smooth, elliptical, and with a rounded tip and emergent leaves hairy with pointed tips
- Swollen leaf nodes along stems
- Pink, cylindrical clusters of small flowers

The floating forms of water smartweed could be mistaken for pondweeds (*Potamogeton spp.*) but water smartweed can be easily distinguished by its lack of submersed leaves and its swollen leaf nodes.

Ecology

- Very widespread and common in areas with saturated soils and in shallows of backwaters, ponds, and lakes
- Reproduces by seed and overwinters via perennial rhizomes
- Seeds consumed by waterfowl and *particularly important for migratory waterfowl*
- Provides habitat for fish and aquatic invertebrates

Little Muskego Lake
August 2013



Potamogeton amplifolious — Large-Leaf Pondweed

Native

Identifying Features

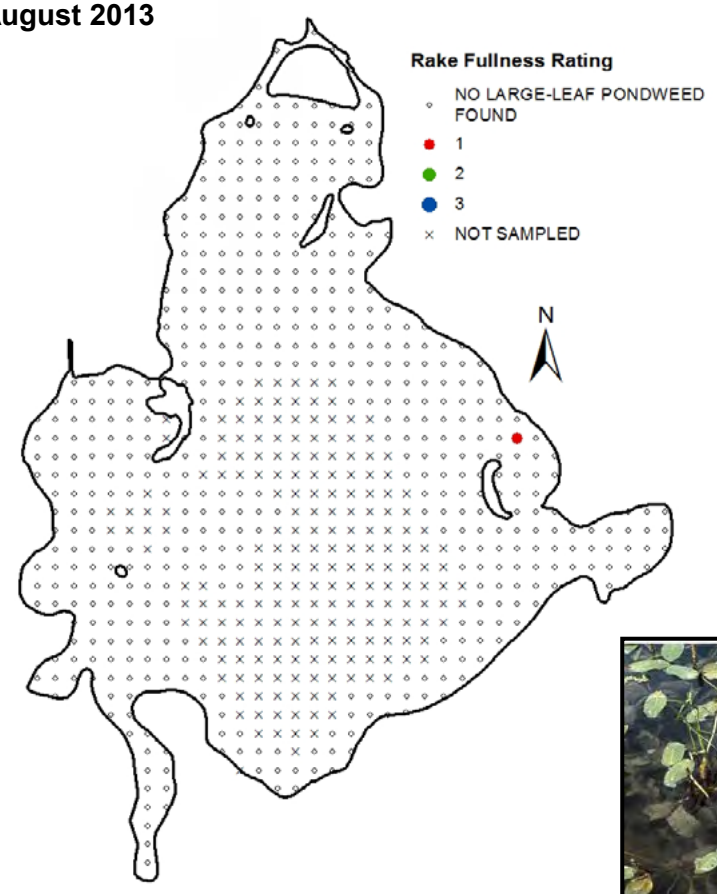
- When produced, floating leaves 2-23 cm long *with 27-49 veins* and petiole longer than leaf blade
- Submersed leaves large and sickle-shaped, 4-7 cm wide, 8-20 cm long, *with more than 19 veins*, and folded upwards along the sides
- White stipules up to 12 cm long

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

Ecology

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

Little Muskego Lake
August 2013




USDA Plants Database

Potamogeton crispus — Curly-Leaf Pondweed[3]

Non-native/Exotic

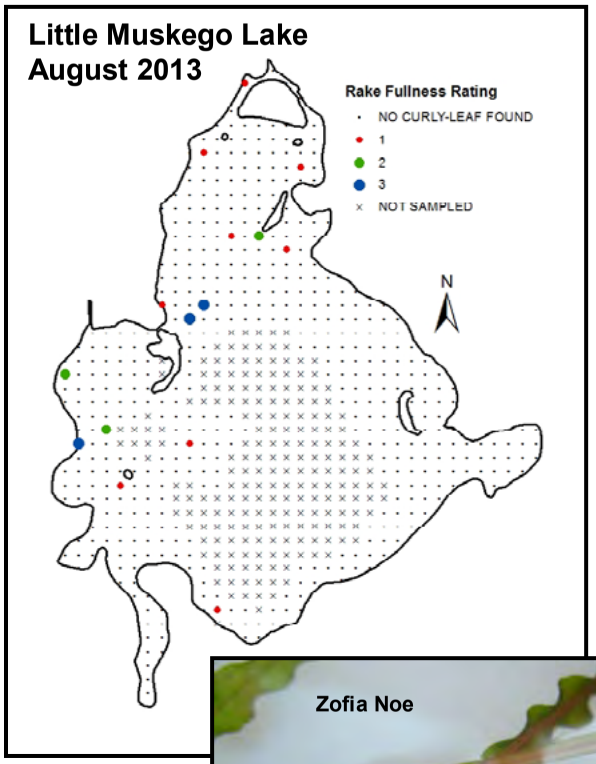
Identifying Features

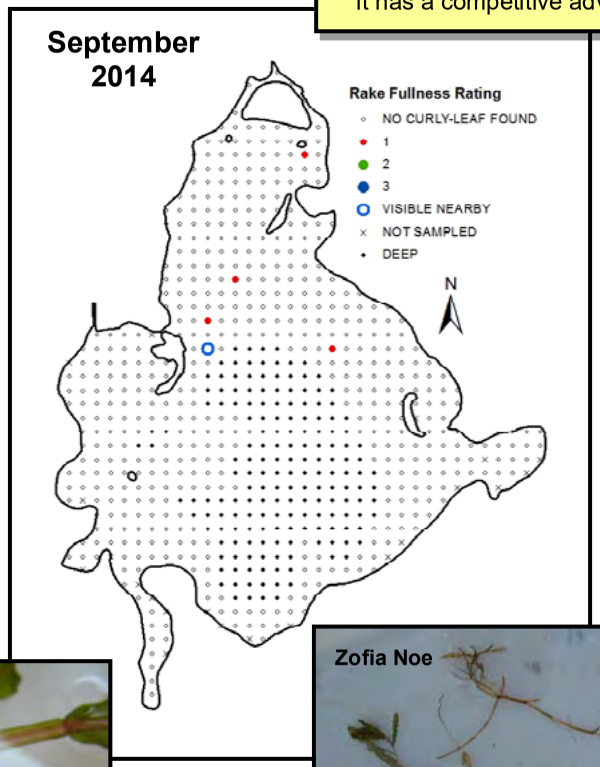
- Stems slightly flattened and both stem and leaf veins often somewhat pink
- Leaf margins very wavy and finely serrated
- Stipules (3.0 to 8.0 mm long) partially attached to leaf bases, disintegrating early in the season
- Produces pine cone-like overwintering buds (turions)

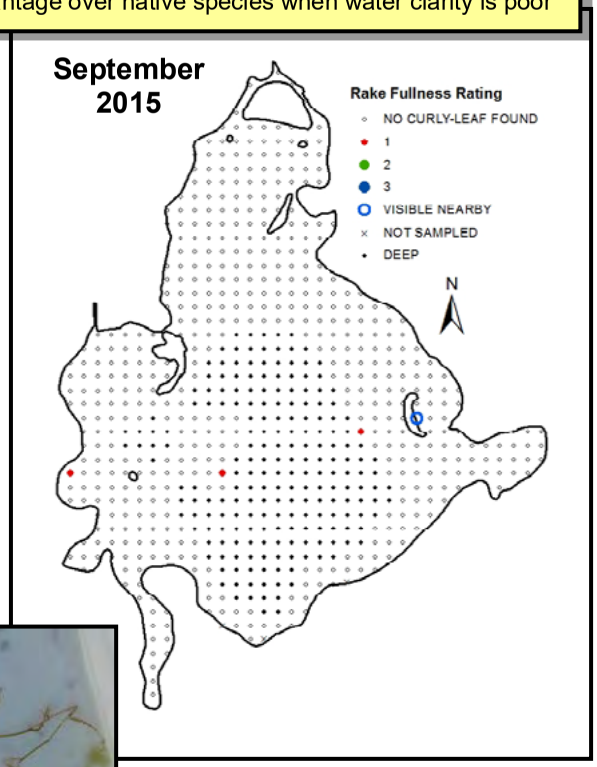
  Curly-leaf pondweed may resemble clasping-leaf pondweed (*P. richardsonii*), but the leaf margins of the latter are not serrated

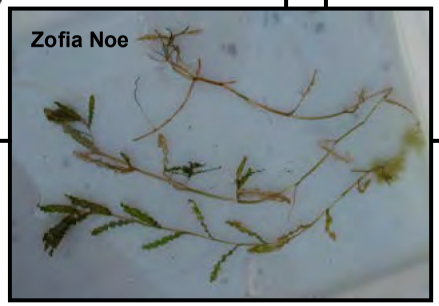
Ecology

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









[3]*Distribution maps of curly-leaf pondweed do not reflect spring distrubtion because surveys were performed in late summer.*

Potamogeton foliosus — Leafy Pondweed

Native

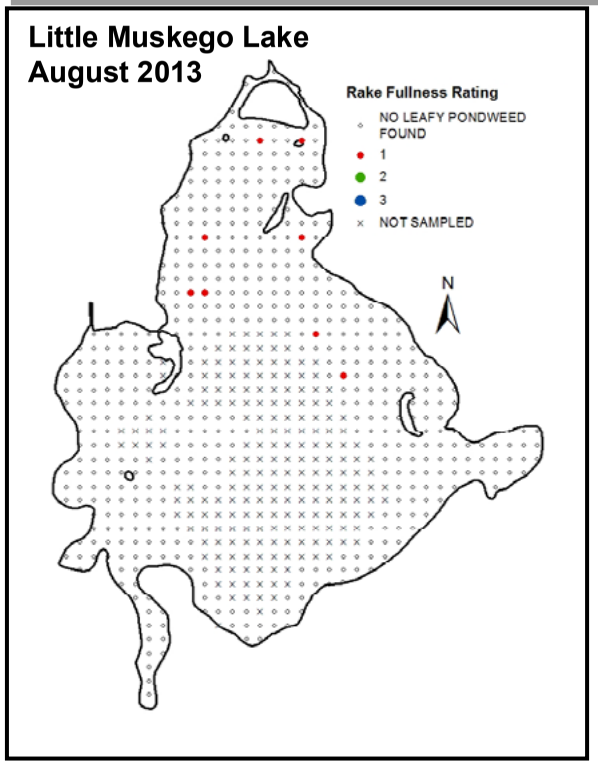
Identifying Features

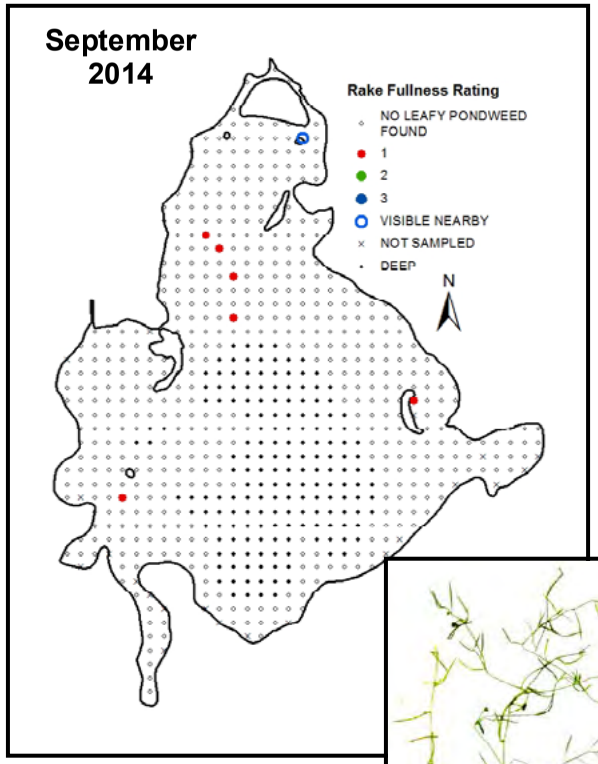
- Narrow, submersed leaves (one-half to three inches long and one-half to two mm wide), narrowing slightly near the stem, with 3-5 veins, and the leaf tip usually tapering to a point
- No floating leaves
- Flowers and fruit on short stalks in the axils of the upper leaves

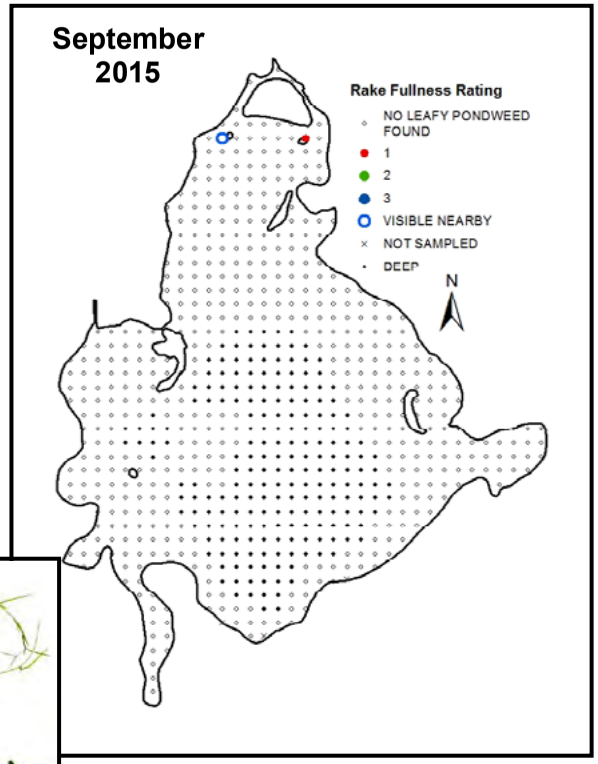
Leafy pondweed is similar to small pondweed (*P. pusillus*), when not in flower and fruit. However, unlike small pondweed, it lacks glands where the leaves meet the stem. The flowers and fruits of small pondweed are borne on longer, more slender stalks and in whorls that are spaced apart.

Ecology

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







Potamogeton friesii — Fries' Pondweed

Native

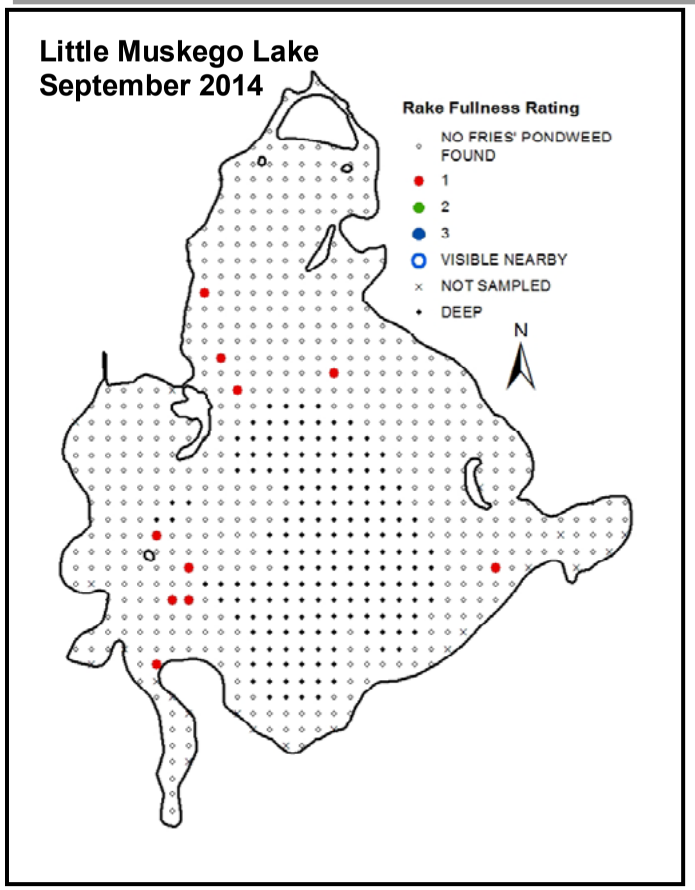
Identifying Features

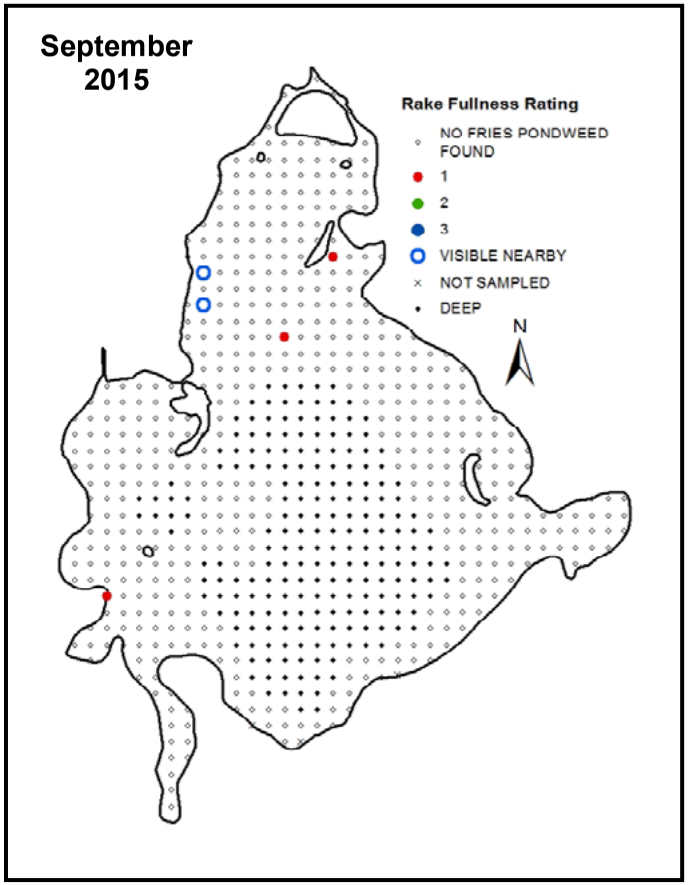
- Slender stems slightly compressed
- Submerged leaves linear with no petiole, one row of lacunar cells on each side of midvein, and 5-7 veins
- Tip of leaf rounded with short bristle
- Winter bud fan shaped and in two planes, with inner leaves at 90 degrees from outer leaves

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

Ecology

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





Potamogeton gramineus — Variable Pondweed

Native

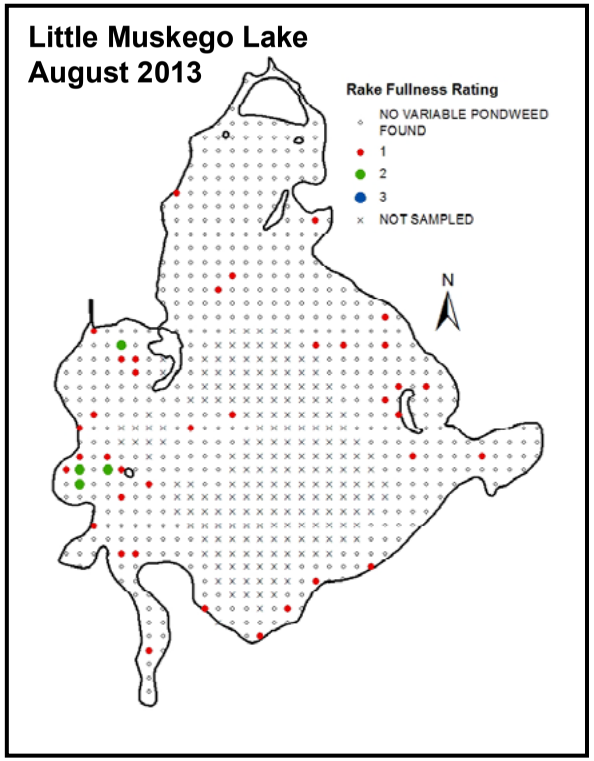
Identifying Features

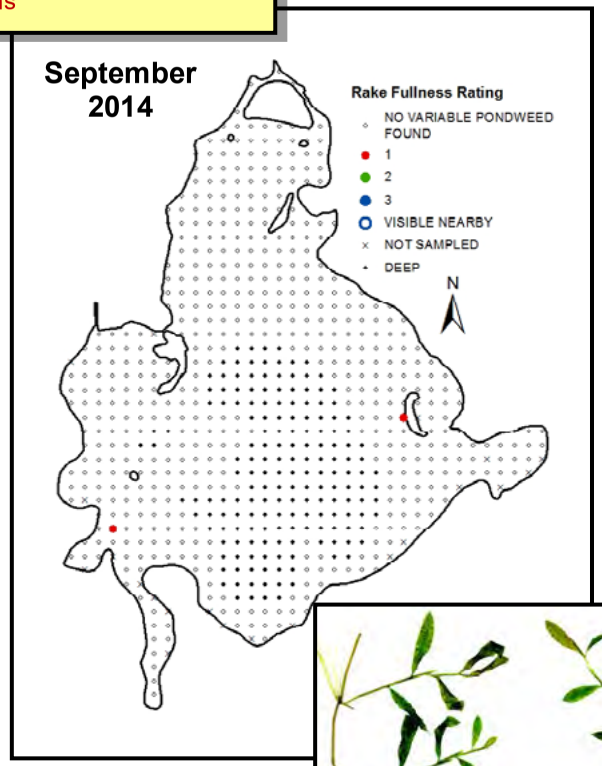
- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- Floating leaves with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard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

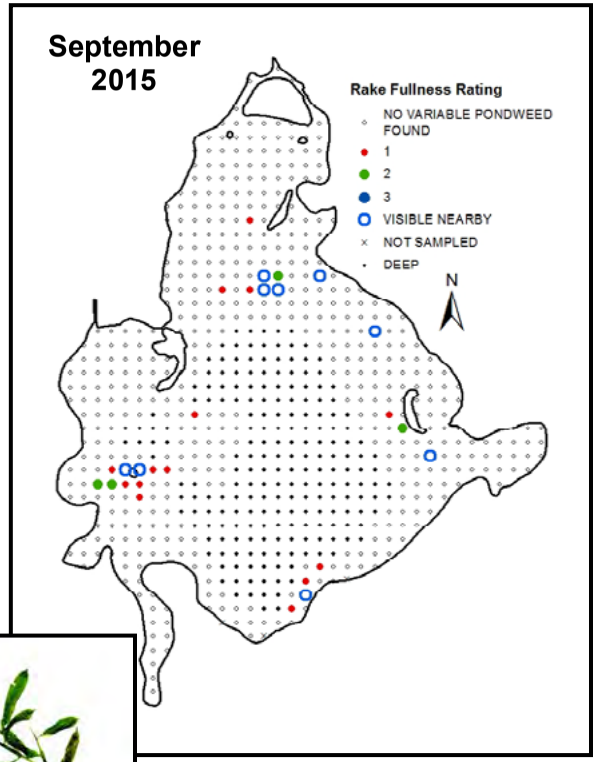
Variable pondweed is similar to Illinois pondweed (*P. illinoensis*), but Illinois pondweed has submerged leaves with nine to 19 veins

Ecology

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







Potamogeton illinoensis — Illinois Pondweed

Native

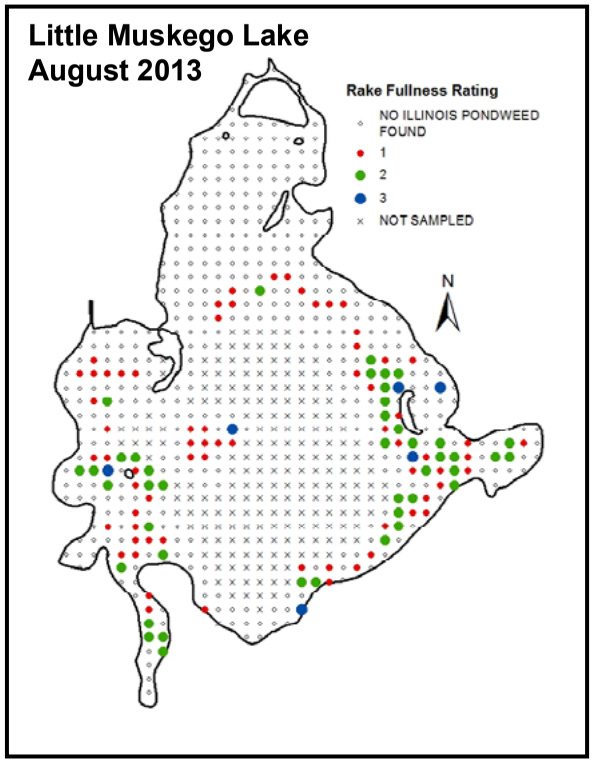
Identifying Features

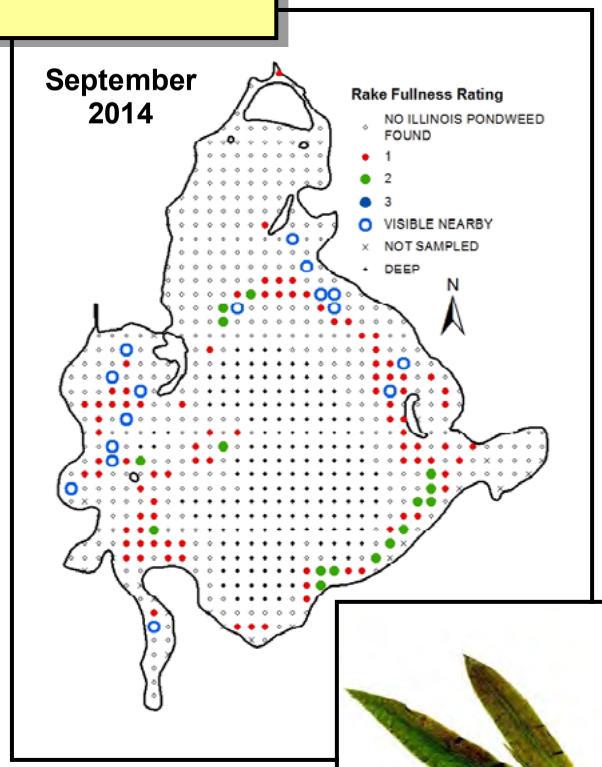
- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

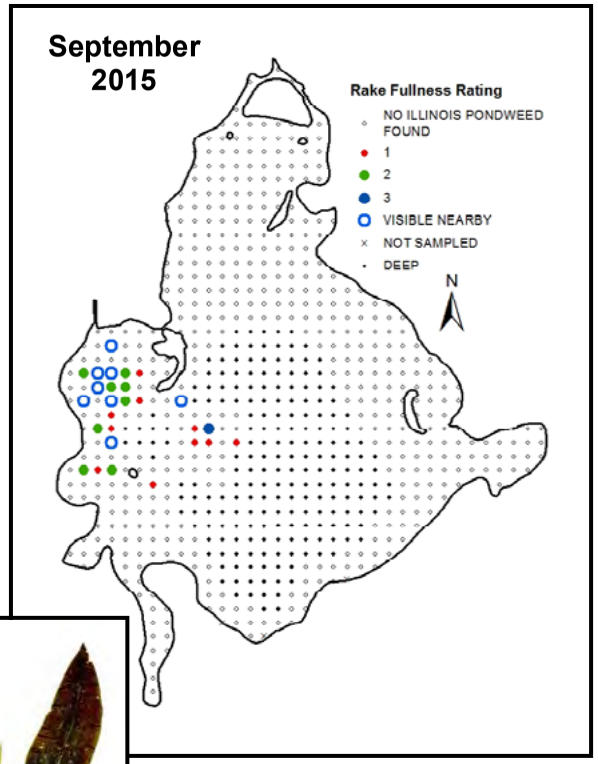
Variable pondweed (*P. gramineus*) is similar to Illinois pondweed, but differs in having three to seven veins on submerged leaves

Ecology

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







Potamogeton nodosus — Long-Leaf Pondweed

Native

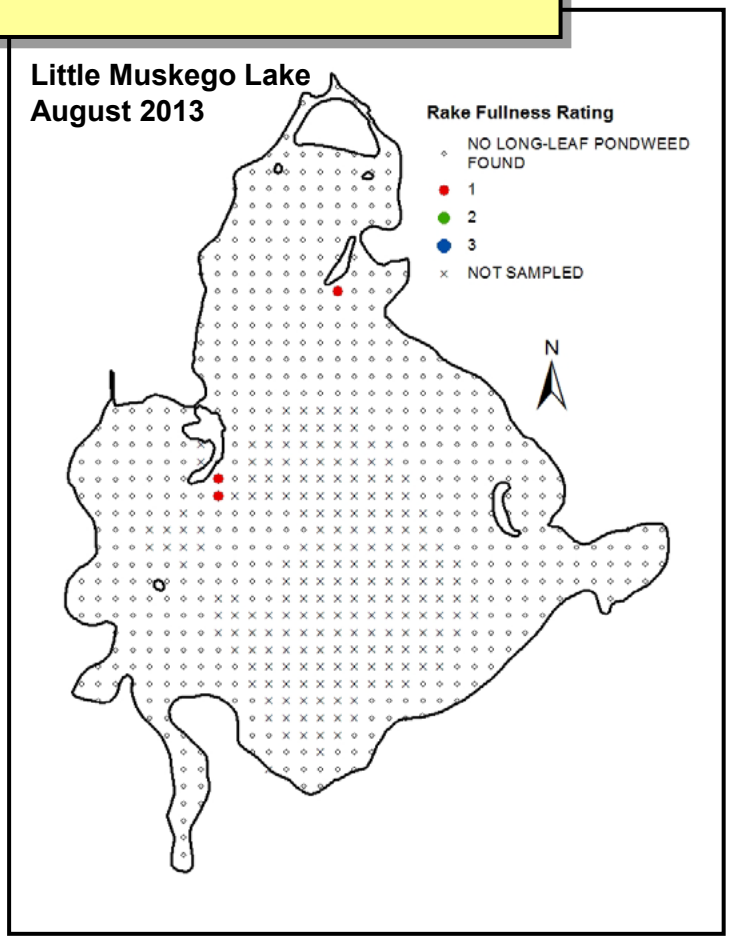
Identifying Features

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

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

Ecology

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



Potamogeton praelongus — White-Stem Pondweed

Native

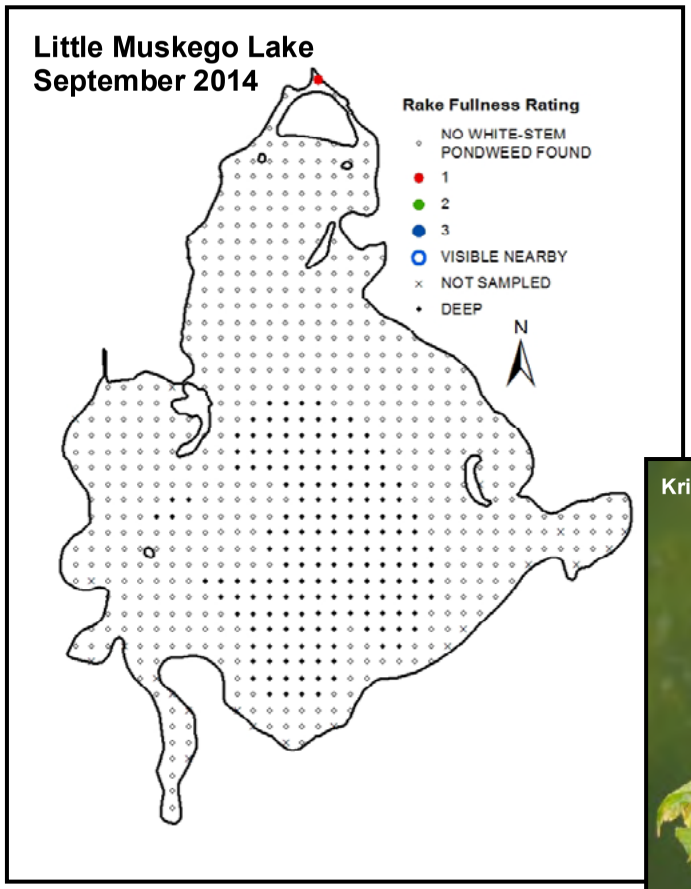
Identifying Features

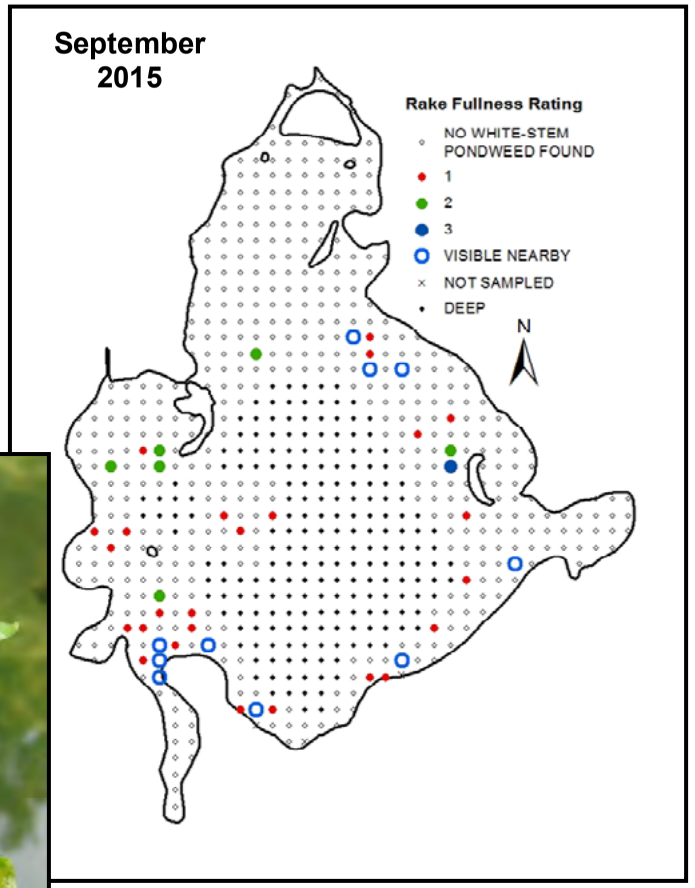
- Stems usually pale and zig-zagging
- Leaves clasping, alternate, with three to five prominent veins and 11 to 35 smaller ones, with boat-shaped tips that often split when pressed between fingers

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

Ecology

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





Potamogeton richardsonii — Clasping-Leaf Pondweed

Native

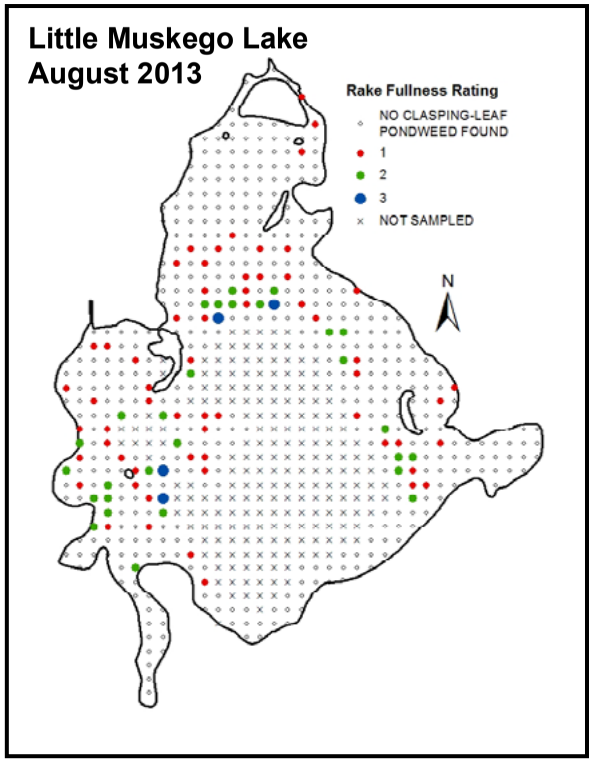
Identifying Features

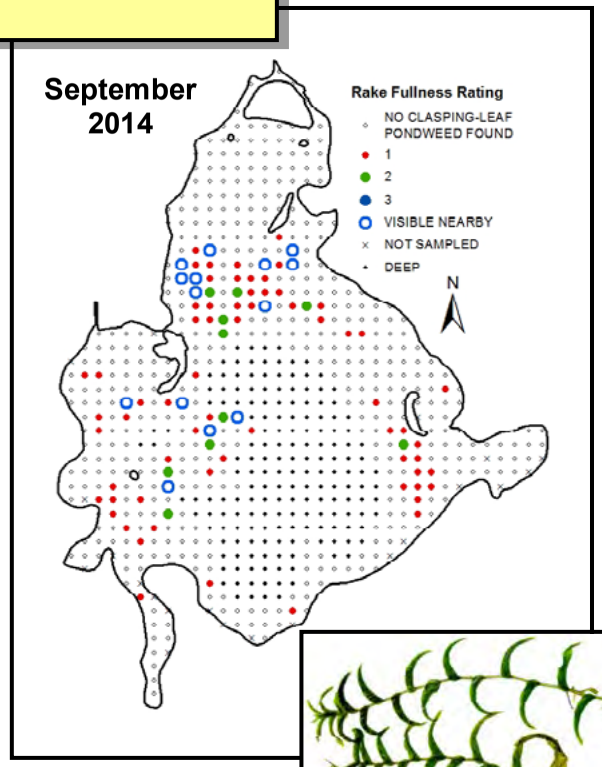
- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

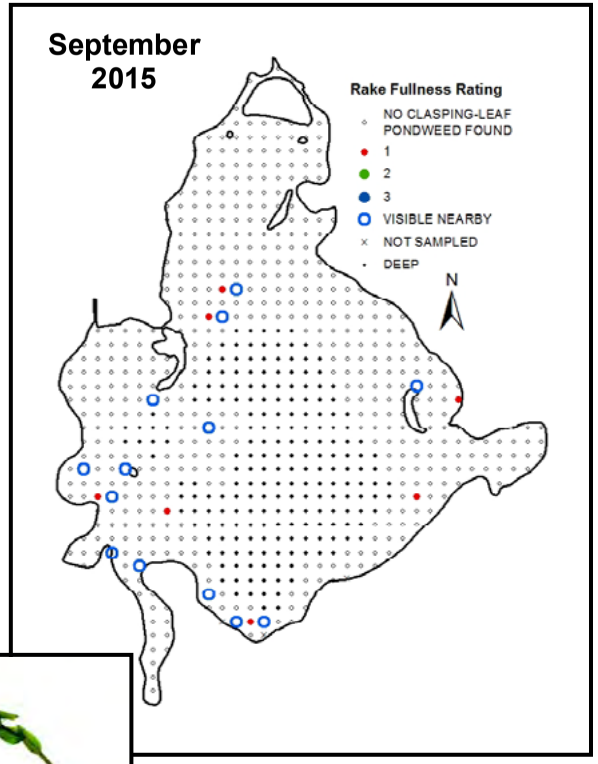
Clasping pondweed is similar to white-stem pondweed (*P. praelongus*), but the latter has boat-shaped leaf tips that split when pressed between one's fingers. The exotic curly-leaf pondweed (*P. crispus*) may appear similar, but differs by having serrated leaf margins

Ecology

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







Potamogeton zosteriformis — Flat-Stem Pondweed

Native

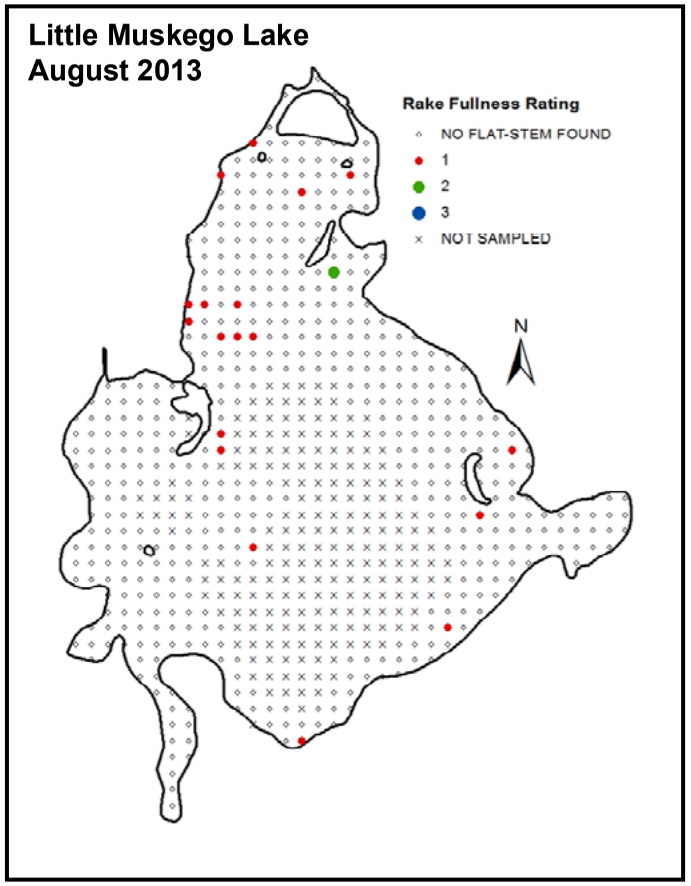
Identifying Features

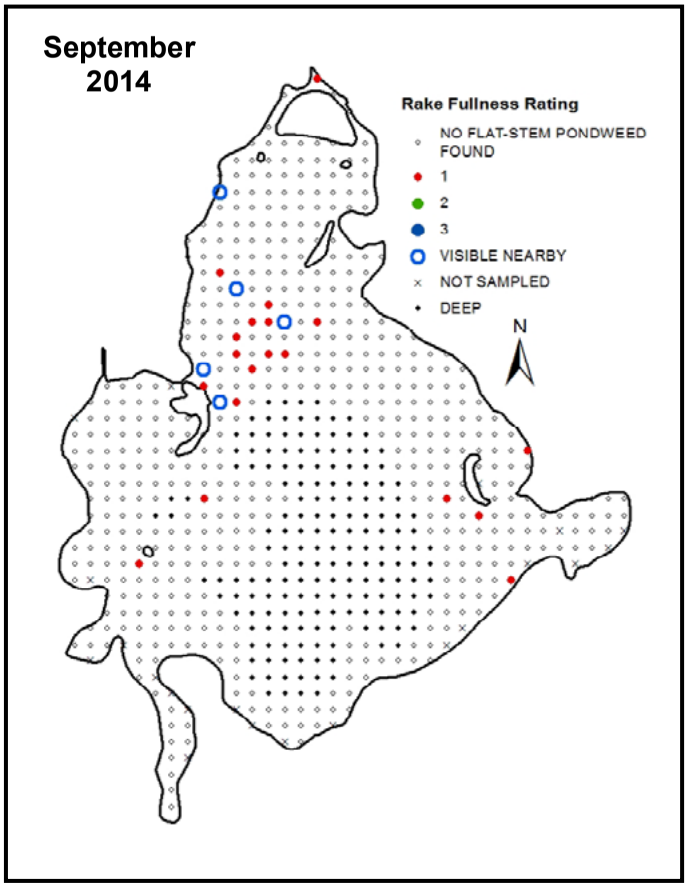
- Stems strongly flattened
- Leaves up to four to eight inches long, pointed, with a prominent midvein and many finer, parallel veins
- Stiff winter buds consisting of tightly packed ascending leaves

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

Ecology

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





Ranunculus aquatilis — White Water Crowfoot[4]

Native

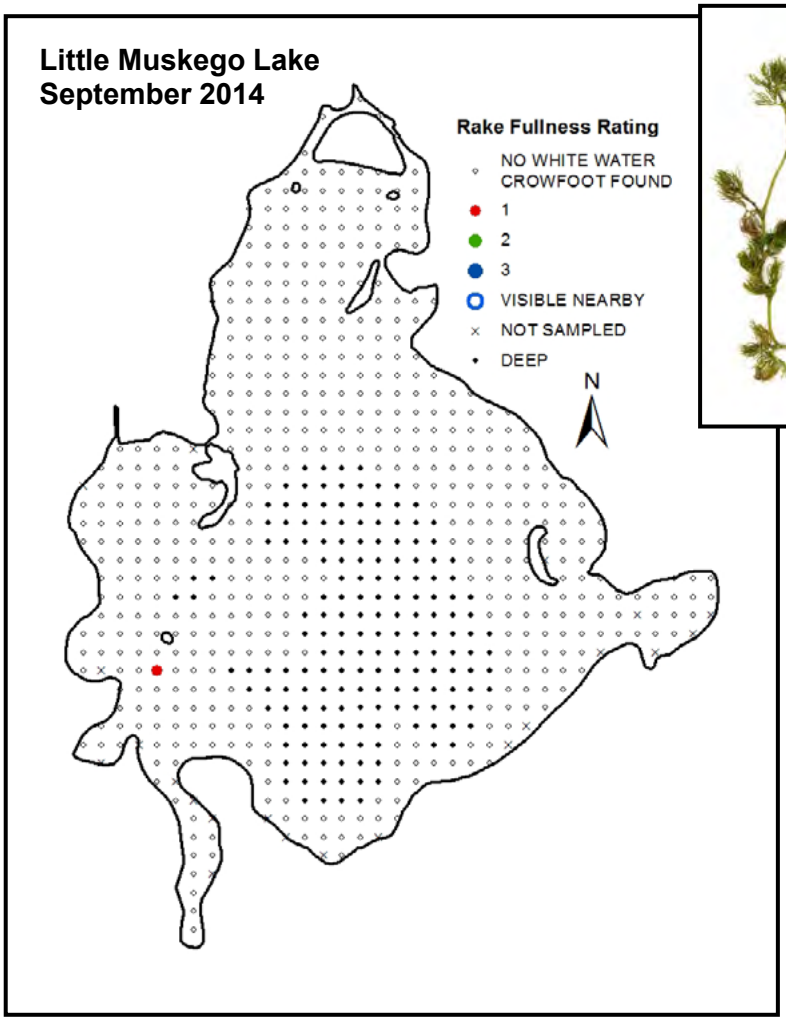
Identifying Features

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

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

Ecology

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



[4]Distribution map of white water crowfoot does not reflect spring distribution because the survey was performed in late summer.

Stuckenia pectinata — Sago Pondweed

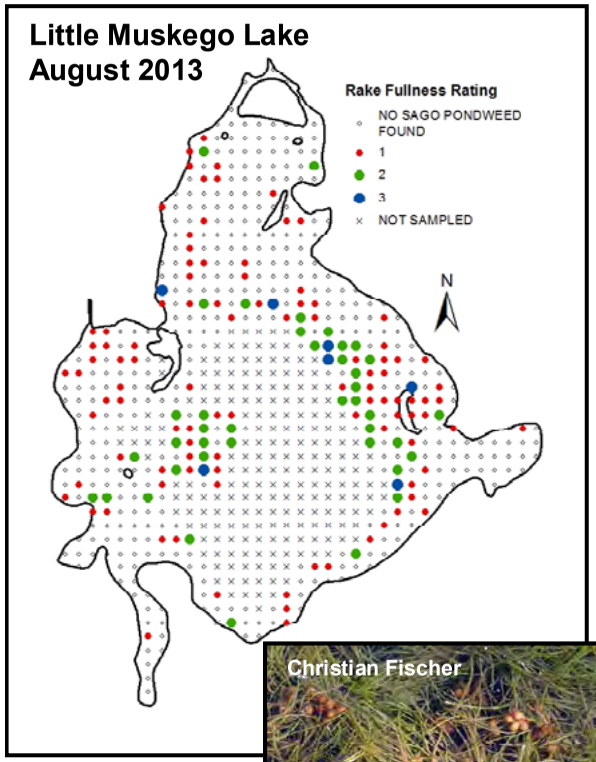
Native

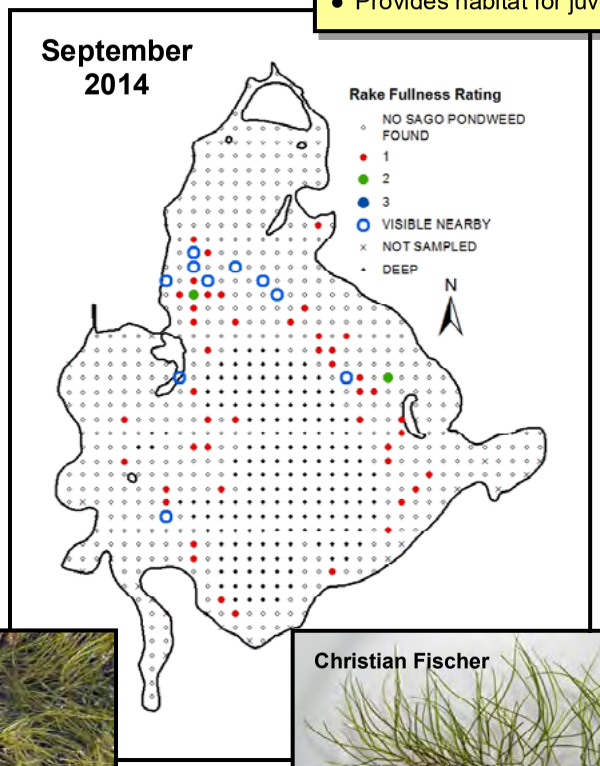
Identifying Features

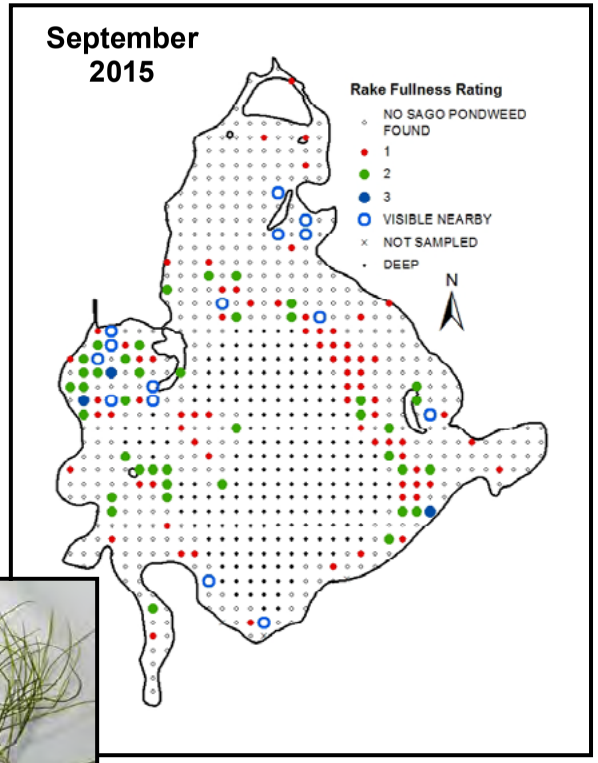
- Stems often *slightly zig-zagged* and forked multiple times, yielding a fan-like form
- Leaves one to four inches long, very thin, and ending in a sharp point
- Whorls of fruits spaced along the stem may appear as beads on a string

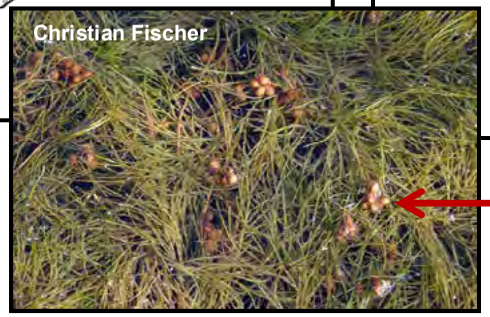
Ecology

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









SEWRPC RIPARIAN BUFFER GUIDE NO. 1 "MANAGING THE WATER'S EDGE"

APPENDIX B

Managing the Water's Edge

Making Natural Connections

Problem Statement:

Despite significant research related to buffers, there remains no consensus as to what constitutes optimal riparian buffer design or proper buffer width for effective pollutant removal, water quality protection, prevention of channel erosion, provision of fish and wildlife habitat, enhancement of environmental corridors, augmentation of stream baseflow, and water temperature moderation.

Southeastern Wisconsin Regional Planning Commission

Our purpose in this document is to help protect and restore water quality, wildlife, recreational opportunities, and scenic beauty.

This material was prepared in part with funding from the U.S. Environmental Protection Agency Great Lakes National Program Office provided through CMAP, the Chicago Metropolitan Agency for Planning.

Managing the Water's Edge

Introduction

Perhaps no part of the landscape offers more variety and valuable functions than the natural areas bordering our streams and other waters.

These unique "riparian corridor" lands help filter pollutants from runoff, lessen downstream flooding, and maintain stream baseflows, among other benefits. Their rich ecological diversity also provides a variety of recreational opportunities and habitat for fish and wildlife. Regardless of how small a stream, lake, or wetland may be, adjacent corridor lands are important to those water features and to the environment.

Along many of our waters, the riparian corridors no longer fulfill their potential due to the encroachment of agriculture and urban development. This publication describes common problems encountered along streamside and other riparian corridors, and the many benefits realized when these areas are protected or improved. It also explains what landowners, local governments, and other decision-makers can do to capitalize on waterfront opportunities, and identifies some of the resources available for further information. While much of the research examined here focuses on stream corridors, the ideas presented also apply to areas bordering lakes, ponds, and wetlands throughout the southern Lake Michigan area and beyond. This document was developed as a means to facilitate and communicate important and up-to-date general concepts related to riparian buffer technologies.

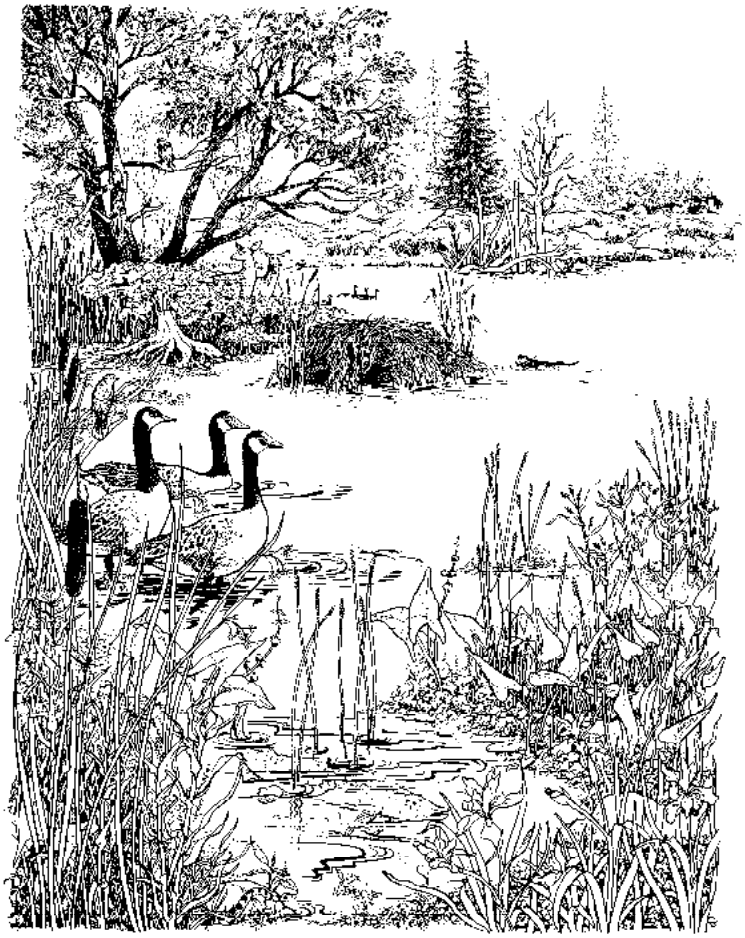
Riparian corridors are unique ecosystems that are exceptionally rich in biodiversity

Contents

University of Wisconsin—Extension

What Are Riparian Corridors? Riparian Buffer Zones?

The word riparian comes from the Latin word *ripa*, which means bank. However, in this document we use riparian in a much broader sense and refer to land adjoining any water body including ponds, lakes, streams, and wetlands. This term has two additional distinct meanings that refer to 1) the "natural or relatively undisturbed" corridor lands adjacent to a water body inclusive of both wetland and upland flora and fauna and 2) a buffer zone or corridor lands in need of protection to "buffer" the effects of human impacts such as agriculture and residential development.



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The word buffer literally means something that cushions against the shock of something else (noun), or to lessen or cushion that shock (verb). Other useful definitions reveal that a buffer can be something that serves to separate features, or that is capable of neutralizing something, like filtering pollutants from stormwater runoff. Essentially, buffers and buffering help protect against adverse effects.

Riparian buffer zones function as core habitat as well as travel corridors for many wildlife species.

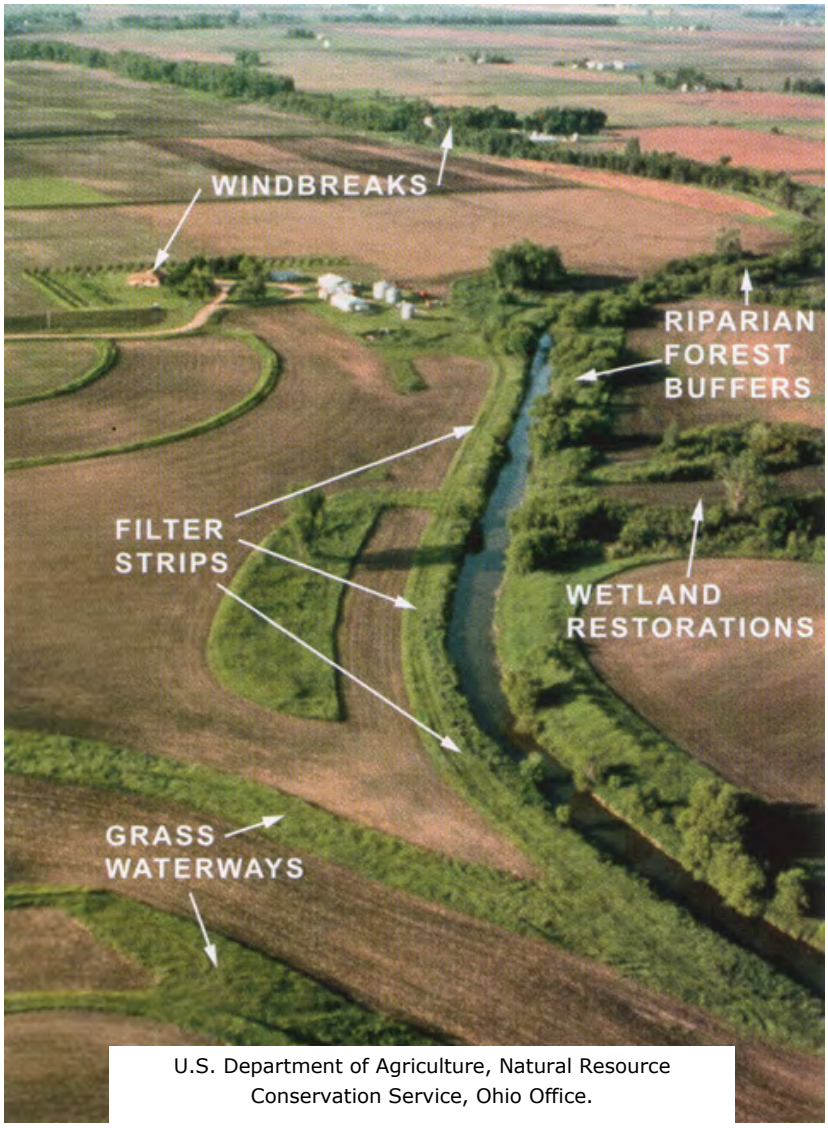
Riparian buffers are zones adjacent to waterbodies such as lakes, rivers, and wetlands that simultaneously protect water quality and wildlife, including both aquatic and terrestrial habitat. These zones minimize the impacts of human activities on the landscape and contribute to recreation, aesthetics, and quality of life. **This document summarizes how to maximize both water quality protection and conservation of aquatic and terrestrial wildlife populations using buffers.**

What Are Riparian Corridors? Riparian Buffer Zones?

Buffers **can** include a range of complex vegetation structure, soils, food sources, cover, and water features that offer a variety of habitats contributing to diversity and abundance of wildlife such as mammals, frogs, amphibians, insects, and birds. Buffers can consist of a variety of canopy layers and cover types including ephemeral (temporary-wet for only part of year) wetlands/seasonal ponds/spring pools, shallow marshes, deep marshes, wetland meadows, wetland mixed forests, grasslands, shrubs, forests, and/or prairies. Riparian zones are areas of transition between aquatic and terrestrial ecosystems, and they can potentially offer numerous benefits to wildlife and people such as pollution reduction and recreation.

In the water resources literature, riparian buffers are referred to in a number of different ways. Depending on the focus and the intended function of a buffer, or a buffer-related feature, buffers may be referred to as stream corridors, critical transition zones, riparian management areas, riparian management zones, floodplains, or green infrastructure.

It is important to note that within an agricultural context, the term buffer is used more generally to describe filtering best management practices most often at the water's edge. Other practices which can be interrelated may also sometimes be called buffers. These include grassed waterways, contour buffer strips, wind breaks, field border, shelterbelts, windbreaks, living snow fence, or filter strips. These practices may or may not be adjacent to a waterway as illustrated in the photo to the right. For example, a grassed waterway is designed to filter sediment and reduce erosion and may connect to a riparian buffer. These more limited-purpose practices may link to multipurpose buffers, but by themselves, they are not adequate to provide the multiple functions of a riparian buffer as defined here.



U.S. Department of Agriculture, Natural Resource Conservation Service, Ohio Office.

Beyond the Environmental Corridor Concept

The term "environmental corridors" (also known as "green infrastructure") refers to an interconnected green space network of natural areas and features, public lands, and other open spaces that provide natural resource value. Environmental corridor planning is a process that promotes a systematic and strategic approach to land conservation and encourages land use planning and practices that are good for both nature and people. It provides a framework to guide future growth, land development, and land conservation decisions in appropriate areas to protect both community and natural resource assets.

Environmental corridors are an essential planning tool for protecting the most important remaining natural resource features in Southeastern Wisconsin and elsewhere. Since development of the environmental corridor concept, there have been significant advancements in landscape ecology that have furthered understanding of the spatial and habitat needs of multiple groups of organisms. In addition, advancements in pollutant removal practices, stormwater control, and agriculture have increased our understanding of the effectiveness and limitations of environmental corridors. In protecting water quality and providing aquatic and terrestrial habitat, there is a need to better integrate new technologies through their application within riparian buffers.

SEWRPC has embraced and applied the environmental corridor concept developed by Philip Lewis (Professor Emeritus of Landscape Architecture at the University of Wisconsin-Madison) since 1966 with the publication of its first regional land use plan. Since then, SEWRPC has refined and detailed the mapping of environmental corridors, enabling the corridors to be incorporated directly into regional, county, and community plans and to be reflected in regulatory measures. The preservation of environmental corridors remains one of the most important recommendations of the regional plan. Corridor preservation has now been embraced by numerous county and local units of government as well as by State and Federal agencies. The environmental corridor concept conceived by Lewis has become an important part of the planning and development culture in Southeastern Wisconsin.

Beyond the Environmental Corridor Concept

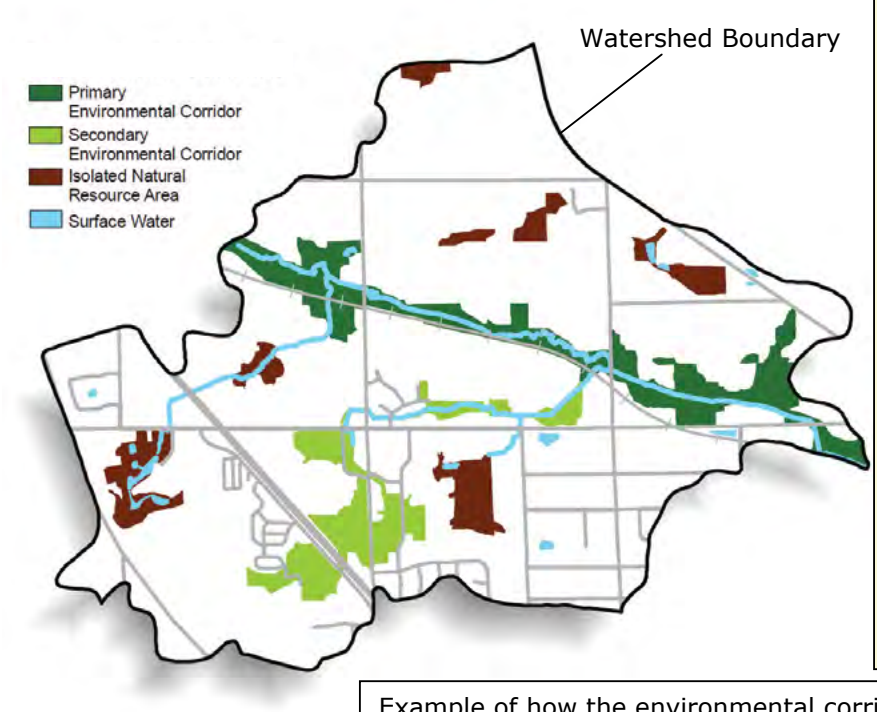
Environmental corridors are divided into the following three categories.

- **Primary environmental corridors** contain concentrations of our most significant natural resources. They are at least 400 acres in size, at least two miles long, and at least 200 feet wide.
- **Secondary environmental corridors** contain significant but smaller concentrations of natural resources. They are at least 100 acres in size and at least one mile long, unless serving to link primary corridors.
- **Isolated natural resource areas** contain significant remaining resources that are not connected to environmental corridors. They are at least five acres in size and at least 200 feet wide.

Key Features of Environmental Corridors

- Lakes, rivers, and streams
- Undeveloped shorelands and floodlands
- Wetlands
- Woodlands
- Prairie remnants
- Wildlife habitat
- Rugged terrain and steep slopes
- Unique landforms or geological formations
- Unfarmed poorly drained and organic soils
- Existing outdoor recreation sites
- Potential outdoor recreation sites
- Significant open spaces
- Historical sites and structures
- Outstanding scenic areas and vistas

Beyond the Environmental Corridor Concept

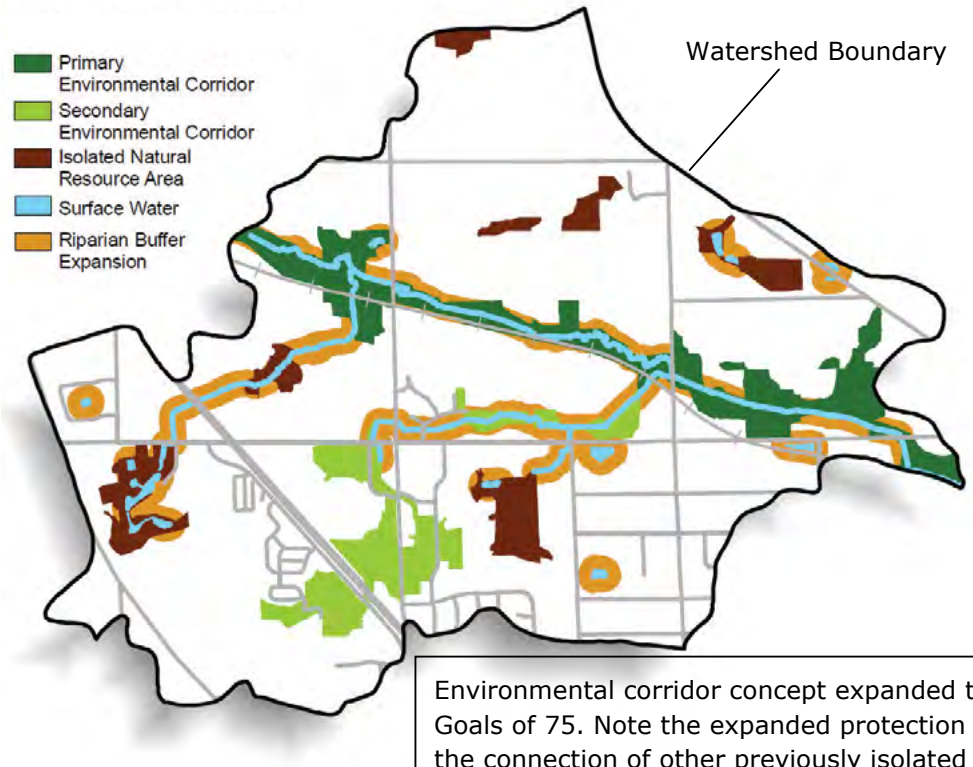


The Minimum Goals of **75** within a Watershed

75% minimum of total stream length should be naturally vegetated to protect the functional integrity of the water resources. (Environment Canada, How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great lakes Areas of Concern, Second Edition, 2004)

75 foot wide minimum riparian buffers from the top edge of each stream bank should be naturally vegetated to protect water quality and wildlife. (SEWRPC Planning Report No 50, A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, December 2007)

Example of how the environmental corridor concept is applied on the landscape. For more information see "Plan on It!" series **Environmental Corridors: Lifelines of the Natural Resource Base** at http://www.sewrpc.org/SEWRPC/LandUse/EnvironmentalCorridors.htm



Environmental corridor concept expanded to achieve the Goals of 75. Note the expanded protection in addition to the connection of other previously isolated areas.

Habitat Fragmentation—The Need for Corridors

Southeastern Wisconsin is a complex mosaic of agricultural and urban development. Agricultural lands originally dominated the landscape and remain a major land use. However, such lands continue to be converted to urban uses. Both of these dominant land uses fragment the landscape by creating islands or isolated pockets of wetland, woodland, and other natural lands available for wildlife preservation and recreation. By recognizing this fragmentation of the landscape, we can begin to mitigate these impacts.

New developments should incorporate water quality and wildlife enhancement or improvement objectives as design criteria by looking at the potential for creating linkages with adjoining lands and water features.

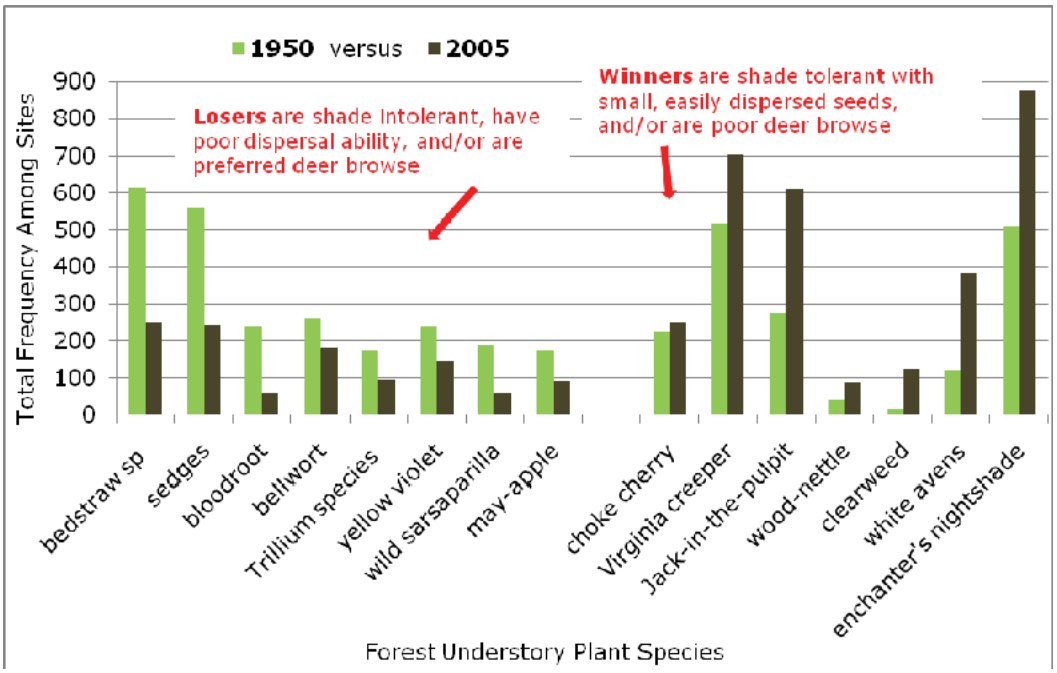
At the time of conversion of agricultural lands to urban uses, there are opportunities to re-create and expand riparian buffers and environmental corridors reconnecting uplands and waterways and restoring ecological integrity and scenic beauty locally and regionally. For example, placement of roads and other infrastructure across stream systems could be limited so as to maximize continuity of the riparian buffers. This can translate into significant cost savings in terms of reduced road maintenance, reduced salt application, and limited bridge or culvert maintenance and replacements. This simple practice not only saves the community significant amounts of money, but also improves and protects quality of life. Where necessary road crossings do occur, they can be designed to provide for safe fish and wildlife passage.

Overland travel routes for wildlife are often unavailable, discontinuous, or life endangering within the highly fragmented landscapes of Southeastern Wisconsin and elsewhere.

State Threatened Species: Blanding's turtle

Habitat Fragmentation—The Need for Corridors

Forest understory plant species abundance among stands throughout Southern Wisconsin



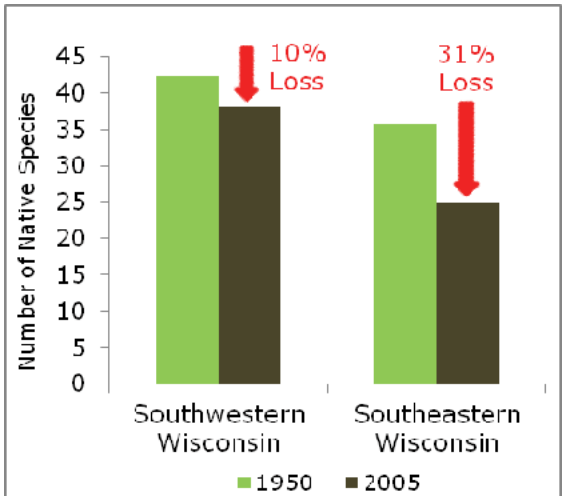
Forest fragmentation has led to significant plant species loss within Southern Wisconsin

(Adapted from David Rogers and others, 2008, Shifts in Southern Wisconsin Forest Canopy and Understory Richness, Composition, and Heterogeneity, Ecology, 89 (9): 2482-2492)

"...these results confirm the idea that large intact habitat patches and landscapes better sustain native species diversity. It also shows that people are a really important part of the system and their actions play an increasingly important role in shaping patterns of native species diversity and community composition. Put together, it is clear that one of the best and most cost effective actions we can take toward safeguarding native diversity of all types is to protect, enhance and create corridors that link patches of natural habitat."
Dr. David Rogers, Professor of Biology at the University of Wisconsin-Parkside

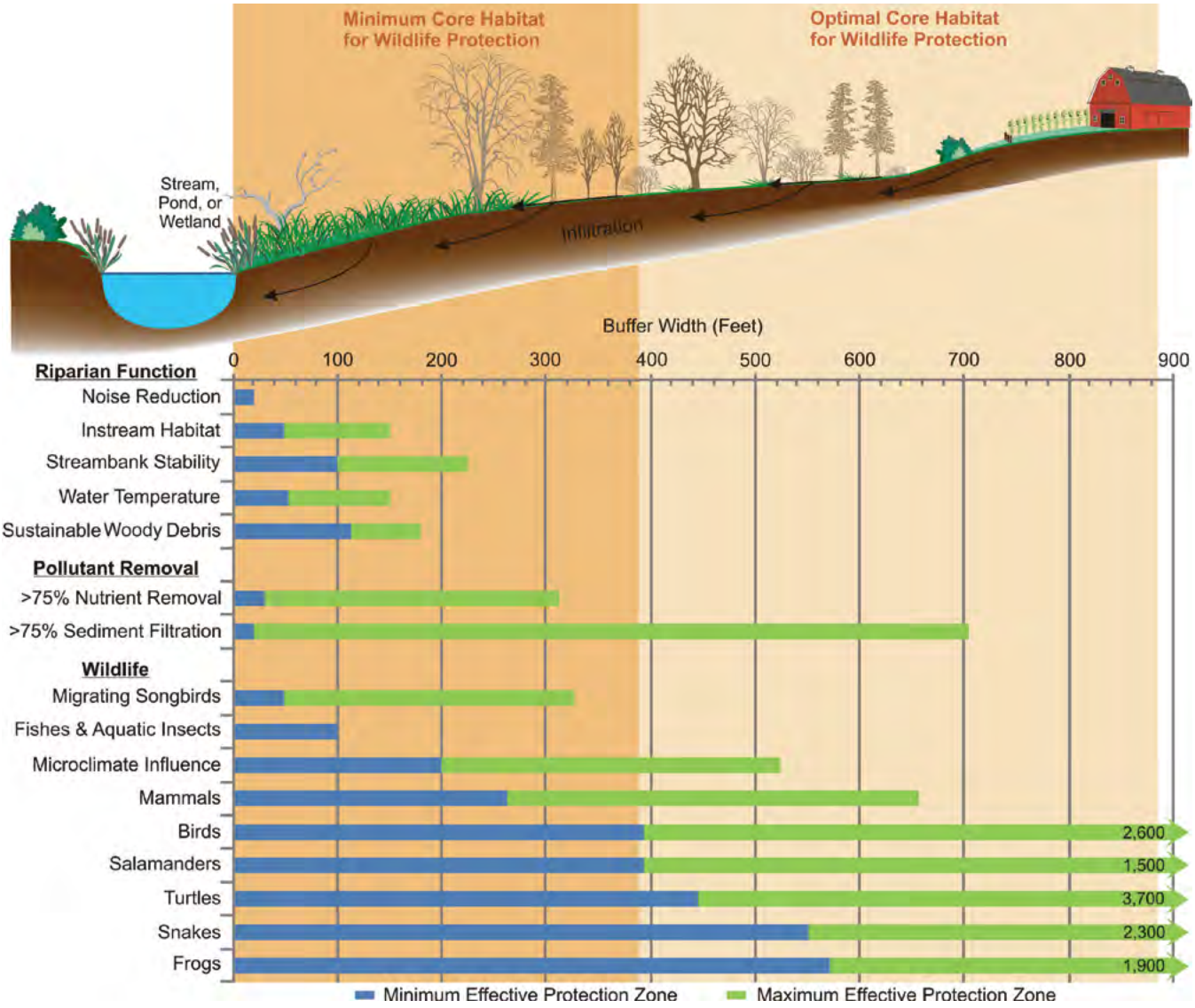
Since the 1950s, forests have increasingly become more fragmented by land development, both agricultural and urban, and associated roads and infrastructure, which have caused these forests to become isolated "islands of green" on the landscape. In particular, there has been significant loss of forest understory plant species over time (shrubs, grasses, and herbs covering the forest floor.) It is important to note that **these forests lost species diversity even when they were protected as parks or natural areas**.

One major factor responsible for this decline in forest plant diversity is that routes for native plants to re-colonize isolated forest islands are largely cut-off within fragmented landscapes. For example, the less fragmented landscapes in Southwestern Wisconsin lost fewer species than the more fragmented stands in Southeastern Wisconsin. In addition, the larger-sized forests and forests with greater connections to surrounding forest lands lost fewer species than smaller forests in fragmented landscapes.



Wider is Better for Wildlife

Why? Because buffer size is the engine that drives important natural functions like food availability and quality, access to water, habitat variety, protection from predators, reproductive or resting areas, corridors to safely move when necessary, and help in maintaining the health of species' gene pools to prevent isolation and perhaps extinction.



One riparian buffer size does not fit all conditions or needs. There are many riparian buffer functions and the ability to effectively fulfill those functions is largely dependent on width. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, as shown above, water temperature protection generally does not require as wide a buffer as provision of habitat for wildlife. Based on the needs of wildlife species found in Wisconsin, the minimum core habitat buffer width is about 400 feet and the optimal width for sustaining the majority of wildlife species is about 900 feet. Hence, the value of large undisturbed parcels along waterways which are part of, and linked to, an environmental corridor system. The minimum effective buffer width distances are based on data reported in the scientific literature and the quality of available habitats within the context of those studies.

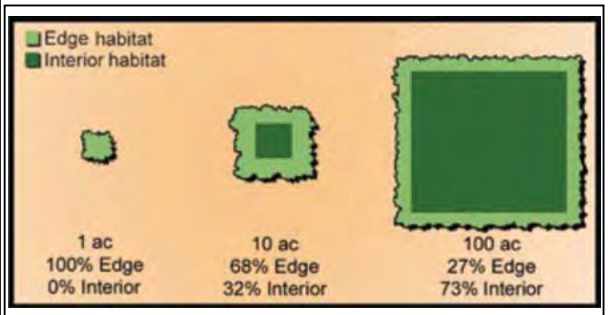
Wider is Better for Wildlife

Wildlife habitat needs change within and among species. **Minimum Core Habitat and Optimum Core Habitat distances were developed from numerous studies to help provide guidance for biologically meaningful buffers to conserve wildlife biodiversity.** These studies documented distances needed for a variety of biological (life history) needs to sustain healthy populations such as breeding, nesting, rearing young, foraging/feeding, perching (for birds), basking (for turtles), and overwintering/dormancy/hibernating. These life history needs require different types of habitat and distances from water, for example, one study found that Blanding's turtles needed approximately 60-foot-wide buffers for basking, 375 feet for overwintering, and up to 1,200 feet for nesting to bury their clutches of eggs. Some species of birds like the Blacked-capped chickadee or white breasted nuthatch only need about 50 feet of buffer, while others like the wood duck or great blue heron require 700-800 feet for nesting. Therefore, **understanding habitat needs for wildlife species is an important consideration in designing riparian buffers.**

Although *Ambystoma* salamanders require standing water for egg laying and juvenile development, most other times of the year they can be found more than 400 feet from water foraging for food.

Wisconsin Species	Mimimum Core Habitat (feet)	Optimum Core Habitat (feet)	Number of Studies
Frogs	571	1,043	9
Salamanders	394	705	14
Snakes	551	997	5
Turtles	446	889	27
Birds	394	787	45
Mammals	263	No data	11
Fishes and Aquatic Insects	100	No data	11
Mean	388	885	

This approach was adapted from *R.D. Semlitsch and J.R. Bodie, 2003, Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibian and Reptiles, Conservation Biology, 17(5):1219-1228*. These values are based upon studies examining species found in Wisconsin and represent mean linear distances extending outward from the edge of an aquatic habitat. The Minimum Core Habitat and Optimum Core Habitat reported values are based upon the mean minimum and mean maximum distances recorded, respectively. Due to a low number of studies for snake species, the recommended distances for snakes are based upon values reported by *Semlitsch and Bodie.*



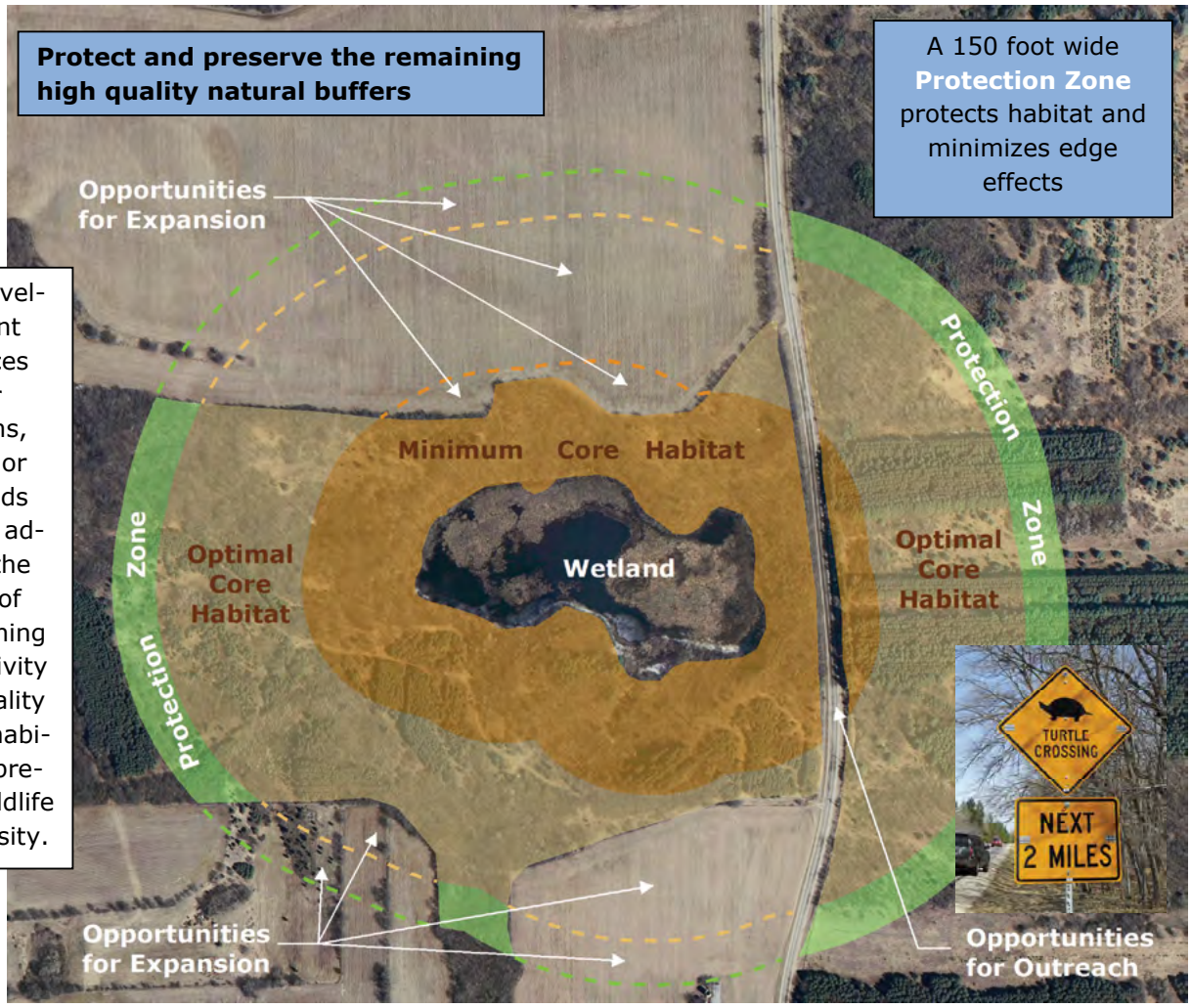
"***Large patches typically conserve a greater variety and quality of habitats, resulting in higher species diversity and abundance.***" *Larger patches contain greater amounts of interior habitat and less edge effects, which benefits interior species, by providing safety from parasitism, disease, and invasive species.*

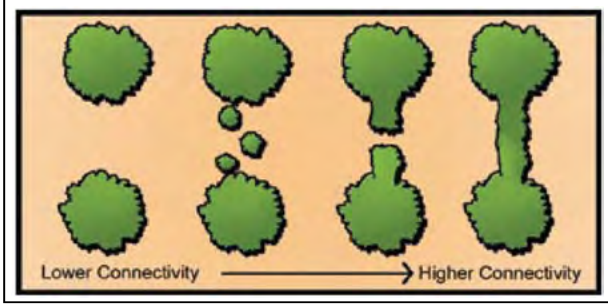
(Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station)

Maintaining Connections is Key

Like humans, all forms of wildlife require access to clean water. Emerging research has increasingly shown that, in addition to water, more and more species such as amphibians and reptiles cannot persist without landscape connectivity between quality wetland and upland habitats. Good connectivity to upland terrestrial habitats is essential for the persistence of healthy sustainable populations, because these areas provide vital feeding, overwintering, and nesting habitats found nowhere else. Therefore, both aquatic and terrestrial habitats are essential for the preservation of biodiversity and they should ideally be managed together as a unit.

Land development practices near streams, lakes, or wetlands need to address the issue of maintaining connectivity with quality upland habitats to preserve wildlife biodiversity.

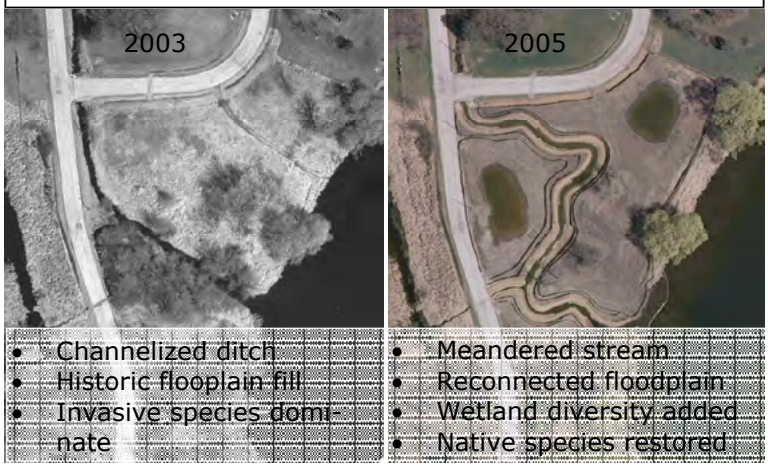




Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup 2008).

Basic Rules to Better Buffers

There are opportunities to improve buffer functions to improve water quality and wildlife habitat, even in urban situations



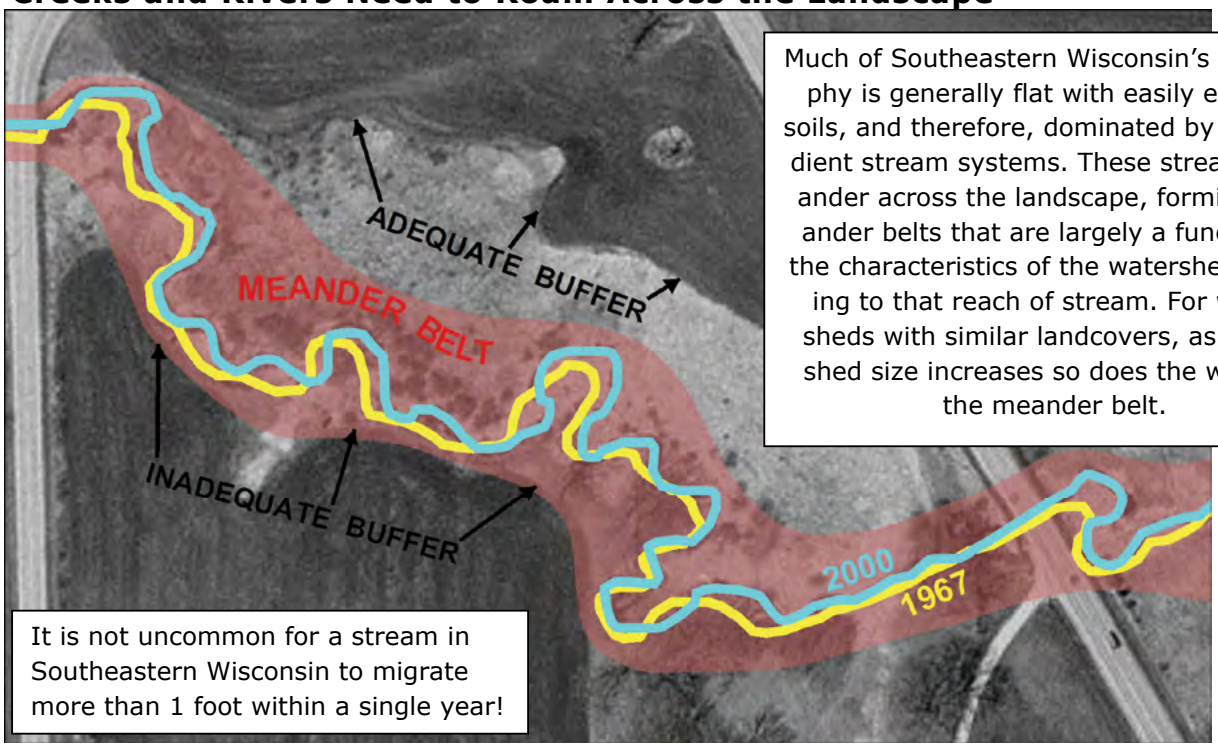
Protecting the integrity of native species in the region is an objective shared by many communities. The natural environment is an essential component of our existence and contributes to defining our communities and neighborhoods. Conservation design and open space development patterns in urbanizing areas and farm conservation programs in rural areas have begun to address the importance of maintaining and restoring riparian buffers and connectivity among corridors.

How wide should the buffer be? Unfortunately, there is no one-size-fits all buffer width adequate to protect water quality, wildlife habitat, and human needs. Therefore, the answer to this question depends upon the predetermined needs of the landowner and community objectives or goals.
As riparian corridors become very wide, their pollutant removal (buffering) effectiveness may reach a point of diminishing returns compared to the investment involved. However, the prospects for species diversity in the corridor keep increasing with buffer width. For a number of reasons, 400- to 800-foot-wide buffers are not practical along all lakes, streams, and wetlands within Southeastern Wisconsin. Therefore, communities should develop guidelines that remain flexible to site-specific needs to achieve the most benefits for water resources and wildlife as is practical.

Key considerations to better buffers/corridors:

- Wider buffers are better than narrow buffers for water quality and wildlife functions
- Continuous corridors are better than fragmented corridors for wildlife
- Natural linkages should be maintained or restored
- Linkages should not stop at political boundaries
- Two or more corridor linkages are better than one
- Structurally diverse corridors (e.g., diverse plant structure or community types, upland and wetland complexes, soil types, topography, and surficial geology) are better than corridors with simple structures
- Both local and regional spatial and temporal scales should be considered in establishing buffers
- Corridors should be located along dispersal and migration routes
- Corridors should be located and expanded around rare, threatened, or endangered species
- Quality habitat should be provided in a buffer whenever possible
- Disturbance (e.g. excavation or clear cutting vegetation) of corridors should be minimized during adjacent land use development
- Native species diversity should be promoted through plantings and active management
- Non-native species invasions should be actively managed by applying practices to preserve native species
- Fragmentation of corridors should be reduced by limiting the number of crossings of a creek or river where appropriate
- Restoration or rehabilitation of hydrological function, streambank stability, instream habitat, and/or floodplain connectivity should be considered within corridors.
- Restoration or retrofitting of road and railway crossings promotes passage of aquatic organisms

Creeks and Rivers Need to Roam Across the Landscape



Much of Southeastern Wisconsin's topography is generally flat with easily erodible soils, and therefore, dominated by low gradient stream systems. These streams meander across the landscape, forming meander belts that are largely a function of the characteristics of the watershed draining to that reach of stream. For watersheds with similar landcovers, as watershed size increases so does the width of the meander belt.

It is not uncommon for a stream in Southeastern Wisconsin to migrate more than 1 foot within a single year!

Healthy streams naturally meander or migrate across a landscape over time. Streams are transport systems for water and sediment and are continually eroding and depositing sediments, which causes the stream to migrate. When the amount of sediment load coming into a stream is equal to what is being transported downstream—and stream widths, depths, and length remain consistent over time—it is common to refer to that stream as being in a state of **"dynamic equilibrium."** In other words the stream retains its physical dimensions (equilibrium), but those physical features are shifted, or migrate, over time (dynamic).

Room to Roam

Riparian buffer widths should take into account the amount of area that a stream needs to be able to self-adjust and maintain itself in a state of dynamic equilibrium. … These are generally greater than any minimum width needed to protect for pollutant removal alone.

Streams are highly sensitive, and they respond to changes in the amounts of water and sediment draining to them, which are affected by changing land use conditions. For example, streams can respond to increased discharges of water by increased scour (erosion) of bed and banks that leads to an increase in stream width and depth—or "degradation." Conversely, streams can respond to increased sedimentation (deposition) that leads to a decrease in channel width and depth—or "aggradation."

Why Should You Care About Buffers?

Economic Benefits:

- Increased value of riparian property
- Reduced lawn mowing time and expense
- Increased shade to reduce building cooling costs
- Natural flood mitigation protection for structures or crops
- Pollution mitigation (reduced nutrient and contaminant loading)
- Increased infiltration and groundwater recharge
- Prevented loss of property (land or structures) through erosion
- Greater human and ecological health through biodiversity

Recreational Benefits:

- Increased quality of the canoeing/kayaking experience
- Improved fishing and hunting quality by improving habitat
- Improved bird watching/wildlife viewing quality and opportunities
- Increased potential for expansion of trails for hiking and bicycling
- Opportunities made available for youth and others to locally reconnect with nature

Riparian buffers make sense and are profitable monetarily, recreationally, and aesthetically!

Social Benefits:

- Increased privacy
- Educational opportunities for outdoor awareness
- Improved quality of life at home and work
- Preserved open space/balanced character of a community
- Focal point for community pride and group activities
- Visual diversity
- Noise reduction

A Matter of Balance

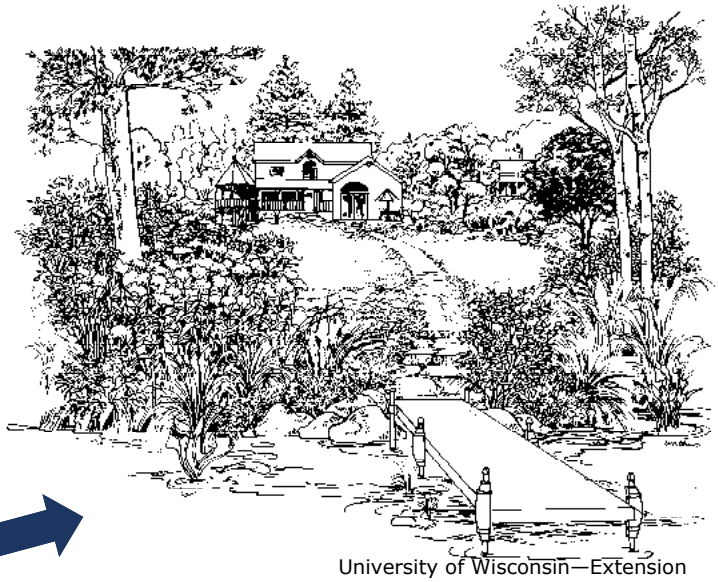
University of Wisconsin—Extension

Although neatly trimmed grass lawns are popular, these offer limited benefits for water quality or wildlife habitat. A single house near a waterbody may not seem like a "big deal," but the cumulative effects of many houses can negatively impact streams, lakes, and wetlands.

All the lands within Southeastern Wisconsin ultimately flow into either the Mississippi River or the Great Lakes systems. The cumulative effects of agriculture and urban development in the absence of mitigative measures, ultimately affects water quality in those systems. Much of this development causes increases in water runoff from the land into wetlands, ponds, and streams. This runoff transports water, sediments, nutrients, and other pollutants into our waterways that can lead to a number of problems, including flooding that can cause crop loss or building damage; unsightly and/or toxic algae blooms; increased turbidity; damage to aquatic organisms from reduced dissolved oxygen, lethal temperatures, and/or concentrations of pollutants; and loss of habitat.

Riparian buffers are one of the most effective tools available for defending our waterways. Riparian buffers can be best thought of as forming a living, self-sustainable protective shield. This shield protects investments in the land and all things on it as well as our quality of life locally, regionally, and, ultimately, nationally. Combined with stormwater management, environmentally friendly yard care, effective wastewater treatment, conservation farming methods, and appropriate use of fertilizers and other agrichemicals, **riparian buffers complete the set of actions that we can take to minimize impacts to our shared water resources.**

Lakeshore buffers can take many forms, which require a balancing act between lake viewing, access, and scenic beauty. Lakeshore buffers can be integrated into a landscaping design that complements both the structural development and a lakeside lifestyle. Judicious placement of access ways and shoreline protection structures, and preservation or reestablishment of native vegetation, can enhance and sustain our use of the environment.



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Case Study—Agricultural Buffers

Agricultural nonpoint source pollution runoff continues to pose a threat to water quality and aquatic ecosystems within Wisconsin and elsewhere. In an effort to address this problem, the Wisconsin Buffer Initiative was formed with the goal of designing a buffer implementation program to achieve science-based, cost-effective, water quality improvements (report available online at http://www.soils.wisc.edu/extension/nonpoint/wbi.php).

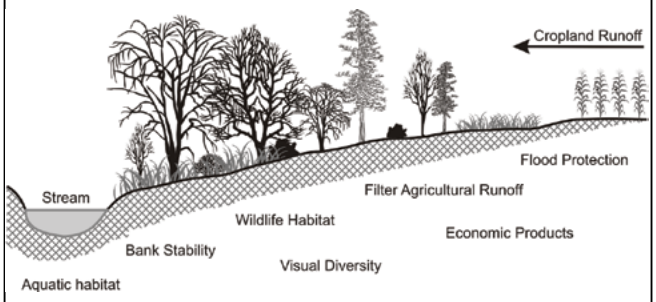
Challenge:
Buffers may take land out of cultivated crop production and require additional cost to install and maintain. Cost sharing, paid easements, and purchase of easements or development rights may sometimes be available to offset costs.

Benefits:
Buffers may offset costs by producing perennial crops such as hay, lumber, fiber, nuts, fruits, and berries. In addition, they provide visual diversity on the landscape, help maintain long-term crop productivity, and help support healthier fish populations for local enjoyment.

While it is true that riparian buffers alone may not always be able to reduce nutrient and sediment loading from agricultural lands, WBI researchers found that "…***riparian buffers are capable of reducing large percentages of the phosphorus and sediment that are currently being carried by Wisconsin streams. Even in watersheds with extremely high loads (top 10%), an average of about 70% of the sediment and phosphorus can be reduced through buffer implementation***." (*Diebel, M.J. and others, 2009, Landscape planning for agricultural nonpoint source pollution reduction III: Assessing Phosphorus and sediment reduction potential, Environmental Management, 43:69-83.*).

Federal and state natural resource agencies have long recognized the need to apply a wide range of Best Management Practices on agricultural lands to improve stream water quality. Although there are many tools available in the toolbox to reduce pollutant runoff from agricultural lands, such as crop rotations, nutrient and manure management, conservation tillage, and contour plowing, riparian buffers are one of the most effective tools to accomplish this task. Their multiple benefits and inter-connectedness from upstream to downstream make riparian buffers a choice with watershed-wide benefits.

Determine what benefits are needed.



The USDA in *Agroforestry Notes* (AF Note-4, January 1997) outlines a four step process for designing riparian buffers for Agricultural lands:

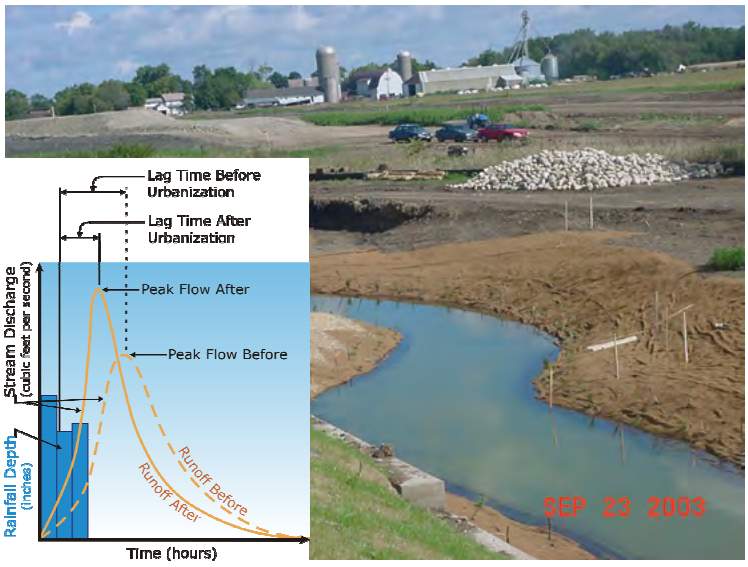
1-Determine what buffers functions are needed
2-Identify the best types of vegetation to provide the needed benefits
3-Determine the minimum acceptable buffer width to achieve desired benefits
4-Develop an installation and maintenance plan

Drain tiles can bypass infiltration and filtration of pollutants by providing a direct pathway to the water and "around" a buffer. This is important to consider in design of a buffer system which integrates with other agricultural practices.

Case Study—Urbanizing Area Buffers

When development occurs near a waterbody, the area in driveways, rooftops, sidewalks, and lawns increases, while native plants and undisturbed soils decrease. As a result, the ability of the shoreland area to perform its natural functions (flood control, pollutant removal, wildlife habitat, and aesthetic beauty) is decreased. In the absence of mitigating measures, one the consequences of urban development is an increase in the amount of stormwater, which runs off the land instead of infiltrating into the ground. Therefore, **urbanization impacts the watershed, not only by reducing groundwater recharge, but also by changing stream hydrology** through increased stormwater runoff volumes and peak flows. This means less water is available to sustain the baseflow regime. The urban environment also contains increased numbers of pollutants and generates greater pollutant concentrations and loads than any other land use. This reflects the higher density of the human population and associated activities, which demand measures to protect the urban water system.

Mitigation of urban impacts may be as simple as not mowing along a stream corridor or changing land management and yard care practices, or as complex as changing zoning ordinances or widening riparian corridors through buyouts.

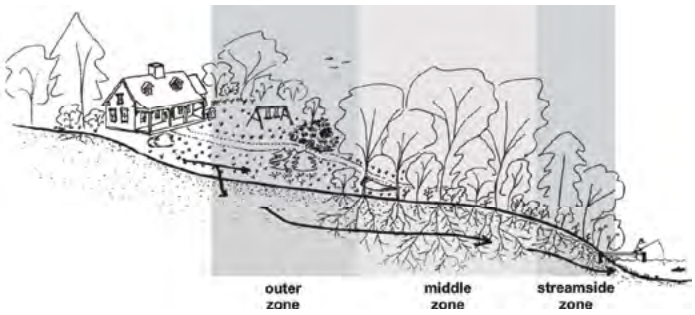


Comparison of hydrographs before and after urbanization. Note the rapid runoff and greater peak streamflow tied to watershed development. (Adapted from Federal Interagency Stream Restoration Working Group (FISRWG), Stream Corridor Restoration: Principles, Processes, and Practices, October 1998)

Challenge:
Urban development requires balancing flood protection, water quality protection, and the economic viability of the development.

Opportunities:
Buffers may offset costs by providing adequate space for providing long-term water quantity and water quality protection. In addition, they provide visual diversity on the landscape, wildlife habitat and connectedness, and help maintain property values.

Anatomy of an urban riparian buffer



The most effective urban buffers have three zones:

Outer Zone-Transition area between the intact buffer and nearest permanent structure to capture sediment and absorb runoff.

Middle Zone-Area from top of bank to edge of lawn that is composed of natural vegetation that provides wildlife habitat as well as improved filtration and infiltration of pollutants.

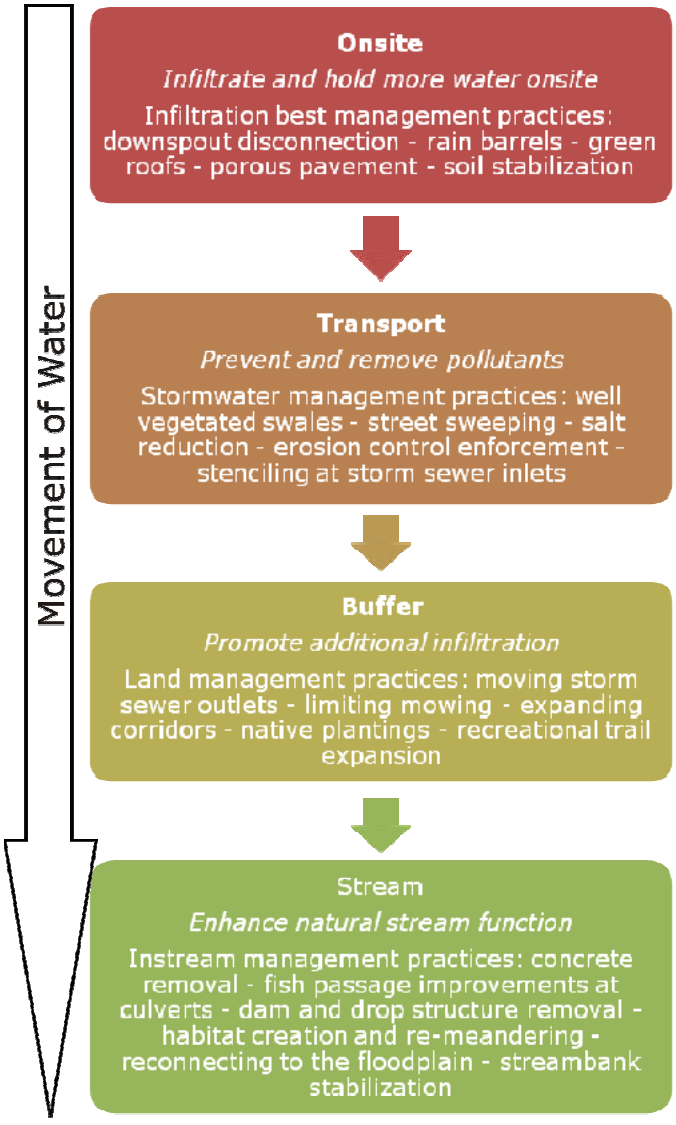
Streamside Zone-Area from the water's edge to the top of the bank or uplands that provides critical connection between water, wetland, and upland habitats for wildlife as well as protect streams from bank erosion

(Fact sheet No. 6 Urban Buffer in the series Riparian Buffers for Northern New Jersey)

Case Study—Urban Buffers

Placement of riparian buffers in established urban areas is a challenge that requires new and innovative approaches. In these areas, historical development along water courses limits options and requires balancing flood management protection versus water quality and environmental protection needs. Consequently, some municipalities have begun to recognize the connections between these objectives and are introducing programs to remove flood-prone structures and culverts from the stream corridors and allow recreation of the stream, restoring floodplains, and improving both the quality of life and the environment.

In urban settings it may be necessary to limit pollution and water runoff before it reaches the buffer.



Challenge:
There are many potential constraints to establishing, expanding, and/or managing riparian buffers within an urban landscape. Two major constraints to establishment of urban buffers include:

1) **Limited or confined space to establish buffers** due to encroachment by structures such as buildings, roadways, and/or sewer infrastructure;
2) **Fragmentation of the landscape** by road and railway crossings of creeks and rivers that disrupt the linear connectedness of buffers, limiting their ability to provide quality wildlife habitat.

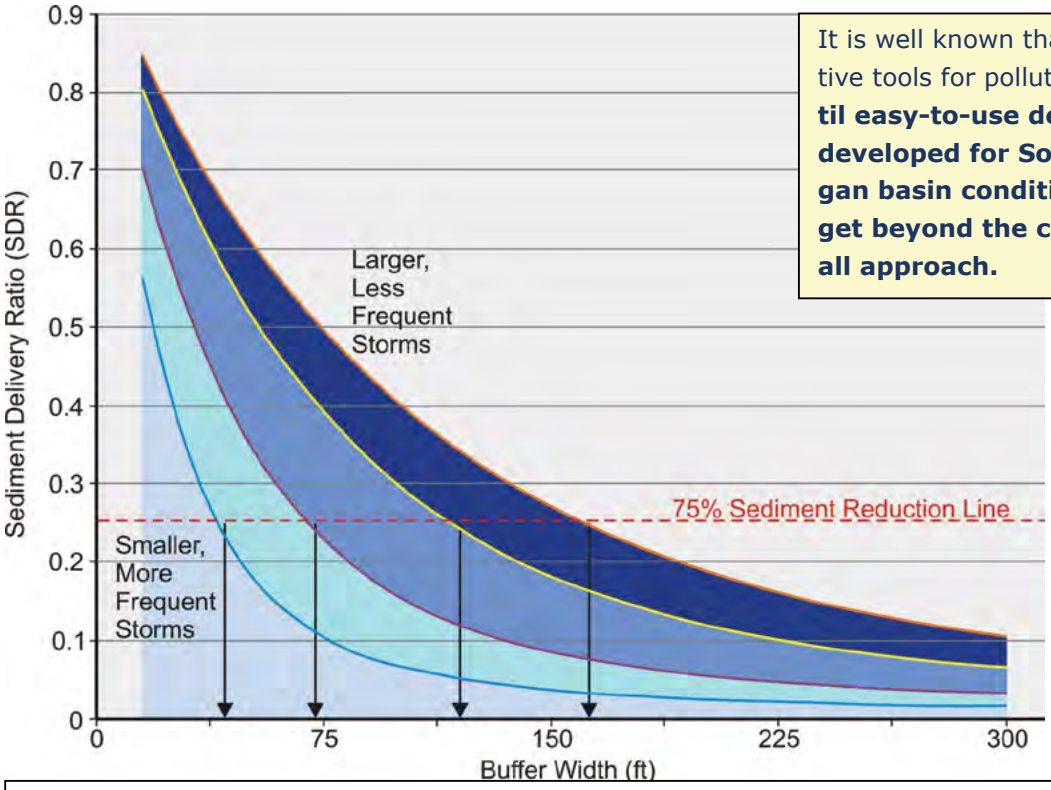
Much traditional stormwater infrastructure intercepts runoff and diverts it directly into creeks and rivers, bypassing any benefits of buffers to infiltrate or filter pollutants. This is important to consider in design of a buffer system for urban waterways, which begin in yards, curbsides, and construction sites, that are figuratively as close to streams as the nearest storm sewer inlet.

A Buffer Design Tool

Design aids are needed to help municipalities, property owners, and others take the "guesswork" out of determining adequate buffer widths for the purpose of water resource quality protection. While there are various complex mathematical models that can be used to estimate sediment and nutrient removal efficiencies, they are not easily applied by the people who need them including homeowners, farmers, businesses and developers.

To fill this gap, design aid tools are being developed using factors such as slope, soils, field length, incoming pollutant concentrations, and vegetation to allow the user to identify and test realistic buffer widths with respect to the desired percent pollutant load reduction and storm characteristics. By developing a set of relationships among factors that determine buffer effectiveness, the width of buffer needed to meet specific goals can be identified.

In the example below, 50-foot-wide buffers are necessary to achieve 75 % sediment removal during small, low intensity storms, while buffers more than 150 feet wide are necessary to achieve the same sediment reduction during more severe storms. Based on this information, decision-makers have the option of fitting a desired level of sediment removal into the context of their specific conditions. Under most conditions, a 75-foot width will provide a minimum level of protection for a variety of needs (SEWRPC PR No. 50, Appendix O.)



It is well known that buffers are effective tools for pollutant removal, but **until easy-to-use design aid tools are developed for Southern Lake Michigan basin conditions, we can never get beyond the current one size fits all approach.**

This generalized graph depicts an example of model output for an optimal buffer width to achieve a 75% sediment reduction for a range of soil and slope, vegetation, and storm conditions characteristic of North Carolina. *(Adapted from Muñoz-Carpena R., Parsons J.E.. 2005. VFSMOD-W: Vegetative Filter Strips Hydrology and Sediment Transport Modeling System v.2.x. Homestead, FL: University of Florida. http://carpena.ifas.ufl.edu/vfsmod/citations.shtml)*

Buffers Are A Good Defense

Today's natural resources are under threat. These threats are immediate as in the case of chemical accidents or manure spills, and chronic as in the case of stormwater pollution carrying everything from eroded soil, to fertilizer nutrients, to millions of drips from automobiles and other sources across the landscape. Non-native species have invaded, and continue to invade, key ecosystems and have caused the loss of native species and degradation of their habitats to the detriment of our use of important resources.

> ***"Riparian ecosystems are naturally resilient,*** *provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change."*
>
> *(N. E. Seavy and others, Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research, 2009, Ecological Restoration 27(3):330-338)*

A more subtle, but growing, concern is the case of stresses on the environment resulting from climate change. Buffers present an opportunity for natural systems to adapt to such changes by providing the space to implement protective measures while also serving human needs. **Because riparian buffers maintain an important part of the landscape in a natural condition, they offer opportunities for communities to adjust to our changing world.**

Well-managed riparian buffers are a good defense against these threats. In combination with environmental corridors, buffers maintain a sustainable reserve and diversity of habitats, plant and animal populations, and genetic diversity of organisms, all of which contribute to the long-term preservation of the landscape. Where they are of sufficient size and connectivity, riparian buffers act as reservoirs of resources that resist the changes that could lead to loss of species.

Refuge or protection from increased water temperatures as provided by natural buffers is important for the preservation of native cold-water, cool-water, and warm-water fishes and their associated communities.

Buffers Provide Opportunities

River, lake, and wetland systems and their associated riparian lands form an important element of the natural resource base, create opportunities for recreation, and contribute to attractive and well-balanced communities. These resources can provide an essential avenue for relief of stress among the population and improve quality of life in both urban and rural areas. Such uses also sustain industries associated with outfitting and supporting recreational and other uses of the natural environment, providing economic opportunities. Increasing access and assuring safe use of these areas enhances public awareness and commitment to natural resources. Research has shown that property values are higher adjoining riparian corridors, and that such natural features are among the most appreciated and well-supported parts of the landscape for protection.

We demand a lot from our riparian buffers!

Sustaining this range of uses requires our commitment to protect and maintain them.

Summary

The following guidance suggestions highlight key points to improve riparian corridor management and create a more sustainable environment.

Riparian corridors or buffers along our waters may contain varied features, but all are best preserved or designed to perform multiple important functions.

Care about buffers because of their many benefits. Riparian buffers make sense and are profitable monetarily, recreationally, aesthetically, as well as environmentally.

Enhance the environmental corridor concept. Environmental corridors are special resources which deserve protection. They serve many key riparian corridor functions, but in some cases, could also benefit from additional buffering.

Avoid habitat fragmentation of riparian corridors. It is important to preserve and link key resource areas, making natural connections and avoiding habitat gaps.

Employ the adage "wider is better" for buffer protection. While relatively narrow riparian buffers may be effective as filters for certain pollutants, that water quality function along with infiltration of precipitation and runoff and the provision of habitat for a host of species will be improved by expanding buffer width where feasible.

Allow creeks and rivers room to roam across the landscape. Streams are dynamic and should be buffered adequately to allow for natural movement over time while avoiding problems associated with such movement.

Consider and evaluate buffers as a matter of balance. Riparian buffers are a living, self-sustainable shield that can help balance active use of water and adjoining resources with environmental protection.

Agricultural buffers can provide many benefits. Riparian buffers in agricultural settings generally work well, are cost-effective, and can provide multiple benefits, including possibly serving as areas to raise certain crops.

Urban buffers should be preserved and properly managed. Though often space-constrained and fragmented, urban buffers are important remnants of the natural system. Opportunities to establish or expand buffers should be considered, where feasible, complemented by good stormwater management, landscaping, and local ordinances, including erosion controls.

A buffer design tool is needed and should be developed. Southeastern Wisconsin and the Southern Lake Michigan Basin would benefit from development of a specific design tool to address the water quality function of buffers. Such a tool would improve on the currently available general guidance on dimensions and species composition.

Buffers are a good defense. Combined with environmental corridors, riparian buffers offer a good line of defense against changes which can negatively impact natural resources and the landscape.

Managing the Water's Edge

MORE TO COME

Future editions in a riparian buffer planning series are being explored with the intent of focusing on key elements of this critical land and water interface. Topics may include:

- Information sharing and development of ordinances to integrate riparian buffers into existing land management plans and programs
- Integration of stormwater management practices and riparian buffer best management practices
- Application of buffers within highly constrained urban corridors with and without brownfield development
- Installation of buffers within rural or agricultural lands being converted to urban uses
- Utilization of buffers in agricultural areas and associated drainage systems
- Integration of riparian buffers into environmental corridors to support resources preservation, recreation and aesthetic uses
- Preservation of stream courses and drainageways to minimize maintenance and promote protection of infrastructure
- Guidance for retrofitting, replacement, or removal of infrastructure such as dams and road crossings, to balance transportation, recreation, aesthetic, property value, and environmental considerations.
- Protection of groundwater recharge and discharge areas
- Protection of high quality, sensitive coastal areas, including preservation of recreational potential

MORE INFORMATION

This booklet can be found at http://www.sewrpc.org/RBMG-no1 . Please visit the website for more information, periodic updates, and a list of complementary publications.

* * *

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May 7, 2010

APPENDIX C

BOATING ORDINANCE FOR THE CITY OF MUSKEGO

CITY OF MUSKEGO

CHAPTER 20 - PUBLIC WATERS AND BEACHES

20.01 STATE STATUTES ADOPTED
The statutory provisions describing and defining regulations with respect to boats and boating, and particularly Section 30.50 to 30.71, Wisconsin Statutes and any amendments thereto, exclusive of any provisions therein relating to the penalties to be imposed or the punishment for violation thereof, are hereby adopted. Any act required to be performed or prohibited by any such statute, which are incorporated herein by reference is required or prohibited by this section. (Ord. #725 - 5-12-92)

20.02 ADDITIONAL REGULATIONS - Motorboats. (Ord. #462 - 9-13-83)
(1) (2) and (4) are deleted. (Ord. #462 - 9-13-83)
(3) No person may operate a motorboat within 150 feet of any dock, pier, or buoyed restricted area at a speed in excess of slow-no-wake. (Ord. #983 - 04-13-99)
(5) Excessive Motor Noise. Motorboats shall not be continuously operated without the motor cover firmly secured.
(6) Mufflers. The engine of every motorboat propelled by an internal combustion engine shall be equipped with a muffler which is so constructed and kept in constant operation that it prevents excessive or unusual noise at all times while the engine is in operation. (Ord. #443 - 11-23-82)

20.025 LITTLE MUSKEGO LAKE - SPEED RESTRICTIONS. (Ord. #502 - 10-9-84)
No one shall operate a motorboat upon Little Muskego Lake between the hours of 8:30 P.M. and 8:00 A.M. at a speed in excess of slow-no-wake.

20.03 ADDITIONAL REGULATIONS - WATER SKIING (CR. #167)
(1) Whenever a boat is used for towing purposes, for water sports or otherwise, there shall be no less than 2 persons in the towing boat, one to operate the boat and one to be in charge of the tow line.
(2) When pulling a skier or another boat the tow rope shall not exceed 75 feet in length.
(3) Any person operating a boat or watercraft on Lake Denoon or Big Muskego Lake’s Bass Bay which is towing a person or persons engaged in water skiing, aqua planing, or similar sport or activity must operate in a counterclockwise direction on the lake. A counterclockwise direction is determined by viewing the direction of travel of the boat or watercraft as viewed from a bird's-eye view of the entire lake. (Ord. #953 - 02/19/98)

20.04 EMERGENCY ASSISTANCE (Cr. #167)
When the operator of a boat observes the display on a boat or by a person with an orange flag approximately 18 by 30 inches, he shall render to the boat or person displaying the flag, such assistance as may be necessary to save the boat or persons, or to minimize the damages to them, in so far as is possible to do so without serious danger to his own boat or the persons on board. No person shall display such a flag unless he is in need of assistance to prevent bodily injury or destruction of property.

20.05 WATER SKI JUMPS (Ord. #413 - 06-09-81)
(1) Permit Required. No person shall place or maintain or permit to be placed or maintained any so called "water ski jump" on any lake in the City without a permit from the Council. Such permit shall be for a period of not more than 6 months and shall state the limitations of use.
(2) Application. An application for a permit hereunder shall set forth the following:
(a) Name and address of the owner of the structure.
(b) A scale map of the location of the structure, drawn to a scale of not less than one inch to 200 feet.
(c) Proposed method of securing the structure.
(d) A description of the life and warning devices to be used which shall conform to the rules of the Wisconsin Department of Natural Resources and the U.S. Coast Guard.
(e) Length of time for which the permit is requested.

(f) A copy of a policy of public liability insurance applicable to the structure and its use in an amount of not less than $100,000.00.
(g) A proposed plan for safeguarding the area during jumps from 150 feet before the take off to 100 feet after the landing.
(h) The daylight hours during which the jump will be used.
(3) No person shall tow another person on water skis for the purpose of using a water ski jump which is in violation of this section.
(4) In granting such a license, the City expressly reserves the right to revoke any such license for any reason if it is felt by the City that said license is no longer in the best interest of the public.
(5) A permit fee of $10.00 shall be paid at the time of application. (Ord. #599 03-17-88)

20.06 RACES ON ICE
(1) License Required. No person shall sponsor, promote, participate or engage in any automobile or motorcycle race or other contest on the ice of any lake or other public waters located in the City of Muskego, unless said race or contest has first been specially licensed by the Council and the permit fee therefore as hereinafter provided, has been paid to the City of Muskego.
(2) Application. Application for such a license shall be made to the Council at least 20 days prior to the date on which said race or other contest is to be held. The application for such license shall state:
(a) The name of the person or organization promoting said race or contest;
(b) The type of race or contest and the number of vehicles to be involved;
(c) The names and addresses of the persons who will participate therein;
(d) The time and place of said race or contest;
(e) The number of persons who it is anticipated will attend said race of contest;
(f) The time at which said race or contest will conclude.
(3) License Fee. Each application for such permit shall be accompanied by cash or a certified check in the amount of $200.00, and if a license is granted, the minimum sum of $25 shall be retained as and for the license fee and such an additional sums shall be retained as is necessary for the purposes stated in (4). (Ord. #523 - 04-09-85)
(4) Purposes of Section. The purpose of this section is to promote and protect the safety, health and welfare of the citizens of the City and persons attending such contest, and amount of license fee theretofore, provided is to be a reasonable sum for making an investigation as to the circumstances of the application to provide for necessary additional police protection and to clean up the area after the event. (Ord. #523 - 04-09-85)

20.07 OPERATION OF MOTOR VEHICLES ON ICE
(1) Operation prohibited on Bass Bay. No person shall use or operate any automobile or other motor driven vehicle in excess of 750 pounds gross vehicle weight upon the ice surface of that part of Big Muskego Lake known as Bass Bay, which is the Bay located at the Northwest end of said Big Muskego Lake.
(2) Operations Regulated. No person shall use or operate any automobile or other motor driven vehicle upon the ice surface of any lake or part thereof located in the City:
(a) In any manner so as to endanger persons engaged in skating or in any other winter sport or recreational activity being engaged in upon the ice.
(b) At a speed in excess of 10 miles per hour
(c) When more than 4 persons occupy said vehicle.
(d) To tow, pull or push any person or persons on sleds, skis, skates, toboggan or device or thing of any kind.
(e) Between the hours of 9:30 p.m. and 5:30 a.m. (Am #94)
(f) Unless the operator of the motor vehicle has a valid operator's license, if the motor vehicle is an automobile, truck, motorcycle or moped. (Ord. #597 - 03-03-88)
(3) Propeller driven vehicles prohibited. No person shall operate any propeller driven vehicle, device or thing, whether or not designed for the transporting of a person or persons upon the ice surface of any lake or part thereof located in the City.
(4) Definitions:
(a) The "automobile" as used in this section shall mean all motor vehicles of the type and kind

permitted to be operated on the highways in the State of Wisconsin.
(b) "Motor Driven Vehicle", as used in this section, shall mean any kind of device or thing designed or utilized for propulsion or movement upon the ice using a motor, whether of internal combustion design or not.
(5) No City liability. All traffic on the ice-bound waters lying within the City shall be at the risk of the traveler as set forth in sec. 30.81(3), Wis. Stats., and nothing in this section shall be construed as rendering the enacting authority liable for any accident to those engaged in permitted traffic while this Code is in effect.
(6) Exceptions. Use of snowmobiles and all-terrain vehicles as defined by statutes of the State of Wisconsin, shall not be governed by this section. (Ord. #638 - 04-06-89)

20.08 SKIN DIVING (Ord. #417 - 01-26-82)
(1) No person may engage in underwater diving or swimming with the use of swimming fins or skin diving in waters other than marked swimming areas or within 150 feet of shoreline, and no person may engage in underwater diving or swimming with the use of self-contained underwater breathing apparatus in waters other than marked swimming areas, unless the location of such diving or swimming is distinctly marked by driver's flag, not less than 12 inches high and 15 inches long, displaying one diagonal white stripe 3 inches wide on a red background, and of height above the water so as to be clearly apparent at a distance of 100 yards under normal conditions, and so designed and displayed as to be visible from any point on the horizon. Except in case of emergency, anyone engaging in such diving or swimming shall not rise to the surface outside of a radius of 50 feet from such flag. No person engaged in such diving or swimming in established traffic lanes; nor shall any such person alone or with another, intentionally or unintentionally, block or obstruct any boat in any manner from proceeding to its destination where a reasonable alternative is unavailable. A reasonable alternative route is available when the otherwise unobstructed boat can proceed to its destination without reducing its lawful speed, by passing to
the right or to the left of a marked diving operation.
(2) Swimming. When swimming without the use of self-contained underwater breathing apparatus, a suitable boat (motor or otherwise) shall accompany any person or persons swimming more than 150 feet from the shoreline or 75 feet from any anchored swimming raft on any waters within the City of Muskego, and upon adoption of an identical ordinance by the Town of Norway.

20.09 PERMITS REQUIRED FOR SWIMMING BEACHES.
(1) No person shall maintain a swimming beach which is open to the public upon payment of an entrance fee in the City without having first obtained a permit in writing therefore from the Council. Such permit, if issued, shall be for a period of not to exceed one year, and shall not be transferable or assignable.
(2) Before a permit will be issued, an application in writing must be filed with the City Clerk. Such application shall set forth in detail:
(a) The name and address of the owner of the property on which the commercial beach is to be operated.
(b) Length of time for which the permit is requested.
(c) The proposed plan for safeguarding the area during the hours of operation.
(d) The hours during which the commercial venture will be operated.
(3) No person shall operate a commercial beach unless the swimming area is distinctly and clearly marked off by buoys, and it is further required that during the hours that the beach is used by swimmers there shall be a lifeguard on duty who shall possess a Red Cross Life Saving Certificate or its equivalent and who shall be capable of rendering immediate assistance to persons in distress in the water. (Am. #167)

20.10 UNIFORM AIDS TO NAVIGATION: WATERWAY MARKERS. (Cr. #111)
(1) Definitions. A waterway marker is any device designed to be placed in, on or near any navigable water within the City, to convey an official message to a boat operator on matters which may affect health, safety or well-being. Aids to navigation refer to buoys, beacons and other fixed objects in the water which are used to mark obstructions to navigation or to direct navigation through safe channels.
(2) Waterway Markers Used On Waters Within The City. No waterway markers shall be placed in, on or near any navigable waters within the City, except such buoys or other markers as have

been established by the Department of Natural Resources and the United States Coast Guard as uniform navigational aids. The rules and regulations of the Department of Natural Resources and the United States Coast Guard with respect to specifications, color schemes, lettering and marking requirements of waterway markers and aids to navigation shall be kept on file in the Office of the City Clerk. (Reference Wisconsin Administrative Code, Chapter WCD5, Boat Regulations and Registration)
(3) Display of Waterway Markers. No waterway marker shall be displayed, except in conformity with the requirements of the Department of Natural Resources. (Reference Wisconsin Administrative Code as per Section 2). The areas in Big Muskego Lake, Bass Bay, Little Muskego Lake, and Lake Denoon to be marked with regulatory markers requiring slow, no-wake speed shall be as from time to time established by Resolution of the Common Council. (Ord. #929 - 07-03-97)
(4) Authority To Place Markers: Permit Required.
(a) No person shall place any waterway marker or aid to navigation in any navigable waters within the City without a permit to do so issued by the Common Council. Application for a permit shall be made in duplicate on forms provided by the City and filed with the City Clerk. The application shall be set forth in detail:
1. The name and address of applicant.
2. Description of real estate of owner or occupant.
3. Type of marker requested.
4. A sketch showing proposed location of the markers.
(b) The application shall be accompanied by a permit fee as determined from time to time by the Common Council. The permit when authorized shall be issued by the City Clerk, and it shall not be transferable or assignable. The permit shall remain in effect unless surrendered by the applicant, or canceled or revoked by the Common Council for one year.
(5) Maintenance of Waterway Markers. Waterway markers shall be maintained in proper condition or be replaced or removed.
(6) Exemptions. The temporary placement of mooring buoys, race course markers and water ski course markers for special events may be reviewed and authorized by the Finance Committee on an annual basis. (Ord. #1067 - 05-03-2001)

20.11 ADDITIONAL REGULATIONS
The Common Council may from time to time adopt local regulations not contrary to or inconsistent with state statute relative to the equipment, use, or operation of boats, pursuant to Section 30.77(3) and (4) Statutes. Any regulations so adopted shall be promptly posted at all public access points within the jurisdiction of the City of Muskego and a copy thereof shall also be filed with the Department of Natural Resources. (Ord. #313; 6-8-76.)

20.12 NAMING OF PUBLIC WATERS (Ord, #979 - 02/18/99)
Note: Proposed names for public waters require approval of the Wisconsin Geographic Names Council in order to be recognized on maps outside the City.
(1) Requests to name or rename a creek, stream, river or lake shall be made in writing and brought before the Committee of the Whole for recommendation to the Common Council. The person(s) who submitted the request shall provide background information into the rationale behind the request, including biographical information if to be named after a person. Any letters from appropriate organizations and individuals which provide evidence of substantial local support for the proposal shall be submitted at that time. If the creek, stream, river or lake is included in a Lake Protection and Rehabilitation District, approval from the district must be obtained prior to the submittal of the request to the City. Upon approval of the Common Council, the proposed name change shall be submitted to the Wisconsin Geographic Names Council for approval. The Council meets every February to act on all requests.
(2) Once a public body of water is named after a person, the name of the public body of water cannot be changed for a period of one hundred years.
(3) All costs associated with the naming, including the cost of any recording necessary and the cost of signage shall be paid by the person(s) submitting the request. This cost may be waived by the Common Council.

20.13 PENALTIES (Ord. #979 - 02/18/99)
Wisconsin State boating penalties as found in Section 30.80 Wisconsin Statutes and deposits as established in the Uniform Deposit and Bail Schedule established by the Wisconsin Judicial Conference, are hereby adopted by reference with all references to fines amended to forfeitures and all references to imprisonment deleted. The penalty for violation of local regulations not contrary to or inconsistent with State Statute shall be as provided in Chapter 25 of the Municipal Code, unless a specific penalty for a specific ordinance or regulation contained in Chapter 20 or adopted pursuant thereto is adopted. (Ord. #942 - 08-21-97)

COMMON COUNCIL - CITY OF MUSKEGO
ORDINANCE #891

AN ORDINANCE TO AMEND CHAPTER 20, SECTION 20.10 (3)
OF THE MUNICIPAL CODE OF THE CITY OF MUSKEGO

(Display of Waterway Markers)

THE COMMON COUNCIL OF THE CITY OF MUSKEGO, WAUKESHA COUNTY, WISCONSIN, DO ORDAIN AS FOLLOWS:

SECTION 1: Chapter 20, Section 20.10 (3) of the Municipal Code of the City of Muskego, Wisconsin, is hereby amended to read as follows:

Display of Waterway Markers. No waterway marker shall be displayed, except in conformity with the requirements of the Department of Natural Resources. (Reference Wisconsin Administrative Code as per Section 2). The areas in Little Muskego Lake to be marked with regulatory markers requiring slow, no-wake speed shall be as from time to time established by Resolution of the Common Council.

SECTION 2: The several sections of this ordinance are declared to be severable. If any section or portion thereof shall be declared by a decision of a court of competent jurisdiction to be invalid, unlawful, or unenforceable, such decision shall apply only to the specific section or portion thereof directly specified in the decision, and not affect the validity of all other provisions, sections, or portion thereof of the ordinance which shall remain in full force and effect. Any other ordinance whose terms are in conflict with the provisions of this ordinance are hereby repealed as to those terms that conflict.

SECTION 3: This ordinance shall be in full force and effect from and after its passage and publication.

PASSED AND APPROVED THIS 23RD DAY OF APRIL, 1996.

CITY OF MUSKEGO

David D. De Angelis, Mayor

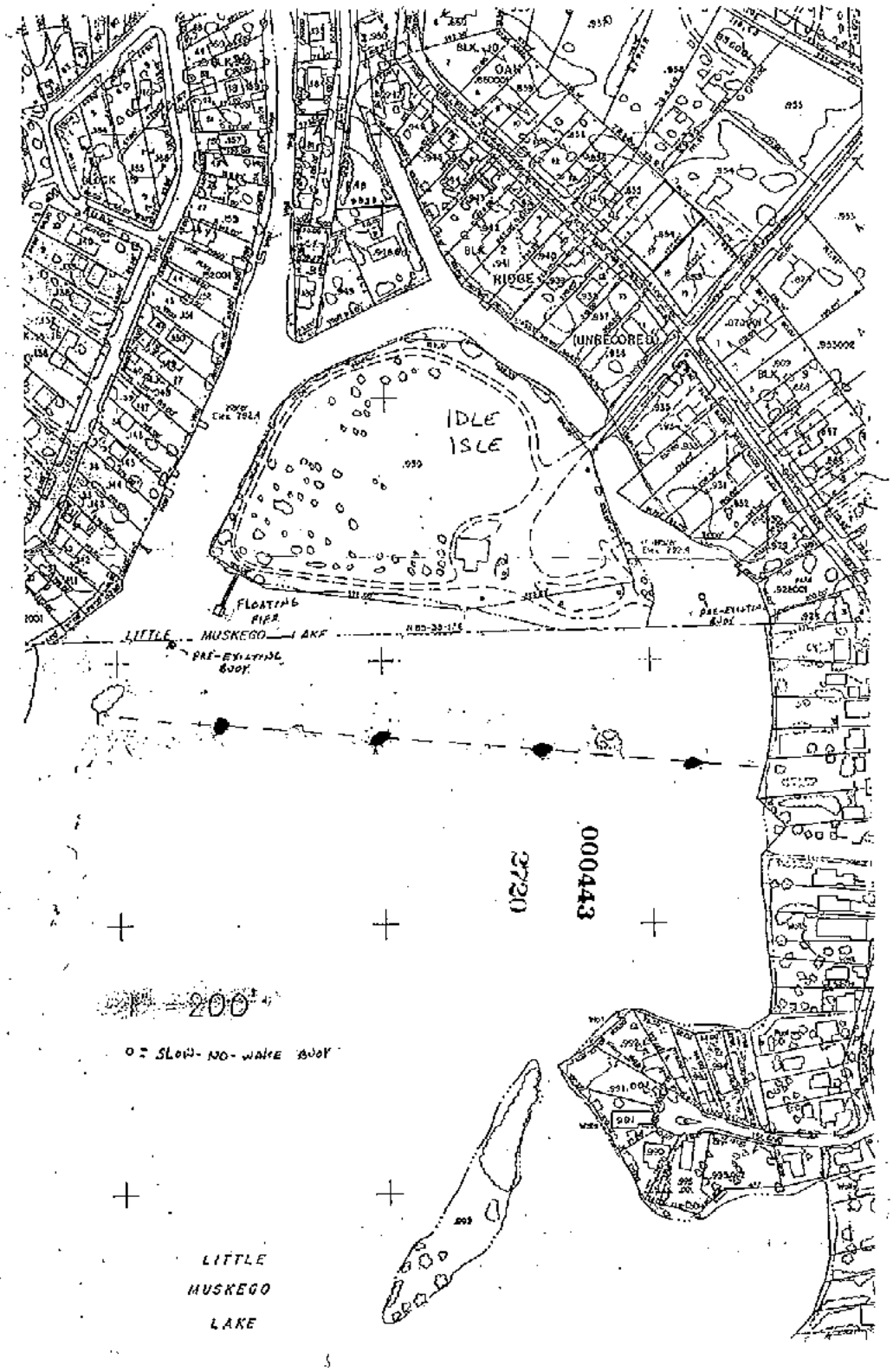
ATTEST:

Jean K. Maenda
City Clerk

4/96jmb

First Reading 4/9/96

Published on the 2nd day of May, 1996.


IDLE
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LITTLE MUSKEGO LAKE
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BUOY
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200'±
SLOW-NO-WAKE BUOY
LITTLE
MUSKEGO
LAKE

APPENDIX D

2,4-D CHEMICAL FACT SHEET

2,4-D Chemical Fact Sheet

Formulations

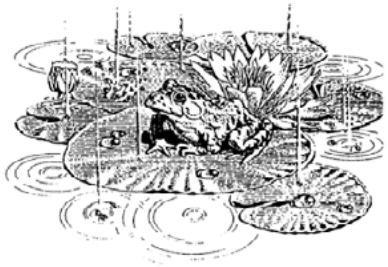
2,4-D is an herbicide that is widely used as a household weed-killer, agricultural herbicide, and aquatic herbicide. It has been in use since 1946, and was registered with the EPA in 1986 and re-reviewed in 2005. The active ingredient is 2,4-dichloro-phenoxyacetic acid. There are two types of 2,4-D used as aquatic herbicides: dimethyl amine salt and butoxyethyl ester. Both liquid and slow-release granular formulations are available. 2,4-D is sold under the trade names Aqua-Kleen, Weedar 64 and Navigate (product names are provided solely for your reference and should not be considered endorsements nor exhaustive).

Aquatic Use and Considerations

2,4-D is a widely-used herbicide that affects plant cell growth and division. It affects primarily broad-leaf plants. When the treatment occurs, the 2,4-D is absorbed into the plant and moved to the roots, stems, and leaves. Plants begin to die in a few days to a week following treatment, but can take several weeks to decompose. Treatments should be made when plants are growing.

For many years, 2,4-D has been used primarily in small-scale spot treatments. Recently, some studies have found that 2,4-D moves quickly through the water and mixes throughout the waterbody, regardless of where it is applied. Accordingly, 2,4-D has been used in Wisconsin experimentally for whole-lake treatments.

2,4-D is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). Desirable native species that may be affected include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.



Post-Treatment Water Use Restrictions

There are no restrictions on eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Following the last registration review in 2005, the ester products require a 24-hour waiting period for swimming. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of 2,4-D (the time it takes for half of the active ingredient to degrade) ranges from 12.9 to 40 days depending on water conditions. In anaerobic lab conditions, the half-life has been measured up to 333 days. After treatment, the 2,4-D concentration in the water is reduced primarily through microbial activity, off-site movement by water, or adsorption to small particles in silty water. It is slower to degrade in cold or acidic water, and appears to be slower to degrade in lakes that have not been treated with 2,4-D previously.

There are several degradation products from 2,4-D: 1,2,4-benzenetriol, 2,4-dichlorophenol, 2,4-dichloroanisole, chlorohydroquinone (CHQ), 4-chlorophenol and volatile organics.

Impacts on Fish and Other Aquatic Organisms

Toxicity of aquatic 2,4-D products vary depending on whether the formulation is an amine or an ester 2,4-D. The ester formulations are toxic to fish and some important invertebrates such as water fleas (*Daphnia*) and midges at application rates; the amine formulations are not toxic to fish or invertebrates at application rates. Loss of habitat following treatment may cause reductions in populations of invertebrates with either formulation, as with any herbicide treatment. These organisms only recolonize the treated areas as vegetation becomes re-established.

Available data indicate 2,4-D does not accumulate at significant levels in the bodies of fish that have been tested. Although fish that are exposed to 2,4-D will take up some of the chemical, the small amounts that accumulate are eliminated after exposure to 2,4-D ceases.

On an acute basis, 2,4-D is considered moderately to practically nontoxic to birds. 2,4-D is not toxic to amphibians at application rates; effects on reptiles are unknown. Studies have shown some endocrine disruption in amphibians at rates used in lake applications, and DNR is currently funding a study to investigate endocrine disruption in fish at application rates.

As with all chemical herbicide applications it is very important to read and follow all label instructions to prevent adverse environmental impacts.

Human Health

Adverse health effects can be produced by acute and chronic exposure to 2,4-D. Those who mix or apply 2,4-D need to protect their skin and eyes from contact with 2,4-D products to minimize irritation, and avoid inhaling the spray. In its consideration of exposure risks, the EPA believes no significant risks will occur to recreational users of water treated with 2,4-D.

Concerns have been raised about exposure to 2,4-D and elevated cancer risk. Some (but not all) epidemiological studies have found 2,4-D associated with a slight increase in risk of non-Hodgkin's lymphoma in high exposure populations (farmers and herbicide applicators). The studies show only a possible association that may be caused by other factors, and do not show that 2,4-D causes cancer. The EPA determined in 2005 that there is not sufficient evidence to classify 2,4-D as a human carcinogen.

The other chronic health concern with 2,4-D is the potential for endocrine disruption. There is some evidence that 2,4-D may have estrogenic activities, and that two of the break-down products of 2,4-D (4-chlorophenol and 2,4-dichloroanisole) may affect male reproductive development. The extent and implications of this are not clear and it is an area of ongoing research.

For Additional Information

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

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

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

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

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

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

DNR PUB-WT-964 2012

MECHANICAL HARVESTING OPERATIONS WITHIN LITTLE MUSKEGO LAKE

APPENDIX E

Figure E.1
Harvesting Sequence for Little Muskego Lake[a, b, c]

1. HARVEST CHANNELS 30 FEET IN WIDTH PARALLEL TO THE SHORELINE AND 30-FOOT-WIDE SHARED-ACCESS LANES PERPENDICULAR TO THE SHORELINE EXTENDING TOWARDS THE CENTER OF THE LAKE, AS SHOWN IN **ZONE A** AND **ZONE B** ON MAP. THIS ENTIRE AREA MAY NOT REQUIRE INTENSIVE MANAGEMENT.

2. MAINTAIN NAVIGATIONAL CHANNELS AND CONTROL STATE-DESIGNATED NON-NATIVE INVASIVE SPECIES AS REQUIRED THROUGHOUT THE LAKE BASIN THROUGH PERFORMING TOP CUTS (0-2 FEET DEEP) IN **ZONE C**. THESE HARVESTERS SHOULD NOT ENTER ZONE G.

3. HARVEST 150-FOOT-WIDE NAVIGATION LANES NO MORE THAN 3-4 FEET DEEP THROUGH SENSITIVE AREAS 1 AND 3 IN **ZONE D**. TO PRESERVE SPAWNING GROUND FOR FISH, ZONE D SHOULD NOT BE HARVESTED UNTIL JUNE 30TH.

4. HARVEST ACCESS CHANNELS 30 FEET IN WIDTH PERPENDICULAR TO SHORE EVERY 2 PIERS IN **ZONE E**.

5. CONTROL STATE-DESIGNATED NON-NATIVE INVASIVE SPECIES AS REQUIRED IN THE RESTRICTED AREA BY USING TOP CUTS (0-3 FEET DEEP) IN **ZONE F** AND **ZONE G**, AS SHOWN ON MAP USING A HARVESTER RESTRICTED TO THIS AREA ONLY. USE THE RESTRICTED OFFLOADING SITE LOCATED IN THIS LOCATION ONLY.

6. DEEP CUT OPEN WATER AREA (**ZONE H**) IF NAVIGATION IS IMPEDED BY NUISANCE PLANT GROWTH.

7. INSPECT ALL CUT MATERIAL FOR FISH AND ANIMALS. ANY ORGANISMS FOUND SHOULD IMMEDIATELY BE RETURNED TO THE LAKE. ADDITIONALLY, THE MATERIALS SHOULD BE INSPECTED FOR STARRY STONEWORT AS AN EARLY DETECTION METHOD.

8. ALL CUT MATERIALS SHOULD BE DEPOSITED ON DESIGNATED DISPOSAL SITES. PRECAUTION SHOULD BE TAKEN TO ENSURE MATERIAL IS NOT PLACED IN WETLAND AREAS.

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

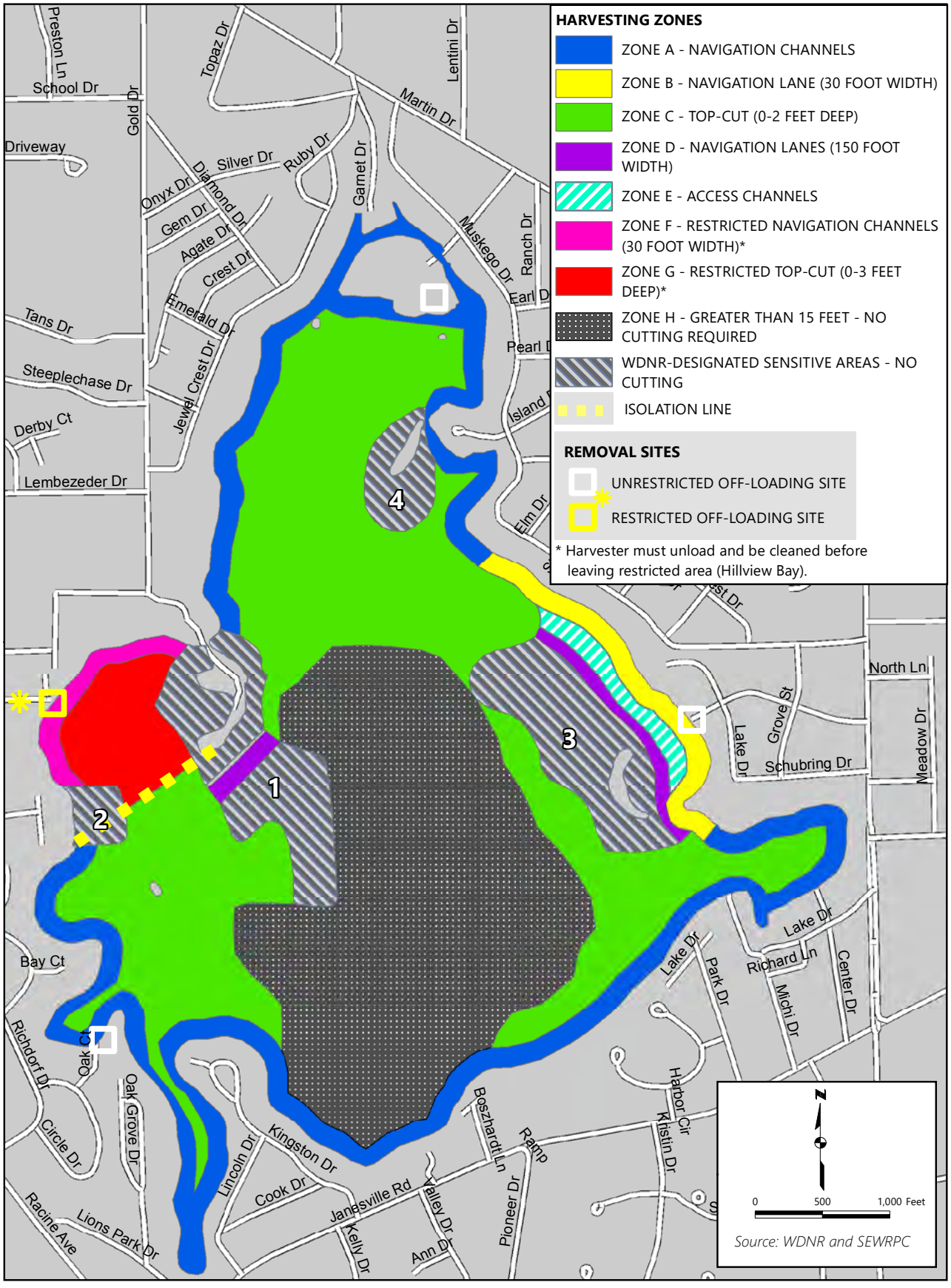
[a] *NO HARVESTING SHOULD BE CONDUCTED IN WDNR SENSITIVE AREA ZONES, within 100 feet of the island areas, except as required for control of State-designated non-native invasive species.*

[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

Map E.1
Harvesting Map for Little Muskego Lake



FB-120 SERIES SKIMMERS/HARVESTERS INFORMATIONAL BROCHURE

APPENDIX F

FB-120 series skimmers / harvesters

The FB-120 Series Skimmer / Harvester is a shallow draft machine designed to pick up floating aquatic plants and debris along shorelines. Stern mounted paddle wheels give this machine a narrow profile and precision steering in confined areas.

The standard FB-120 features a 4' 0" (1,24 meters) wide horizontal swath, *(cutter bars not shown on the unit above)*, and can store 130 cubic feet (3,68 cubic meters) of collected vegetation on board. Perforated sheet material under the pick up conveyor flat wire belting allows for more efficient collection of smaller debris and aquatics such as duckweed *(lemna minor)* and algae.

AQUARIUS SYSTEMS
A Division of D&D Products Inc

PO Box 215 | 200 N Harrison Street | North Prairie | Wisconsin | 53153 USA
| P 262-392-2162 | T 800-328-6555 | F 262-392-2984
info@aquarius-systems.com | www.aquarius-systems.com

fb-120 skimmers / harvesters

AQUARIUS SYSTEMS
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info@aquarius-systems.com | www.aquarius-systems.com

FB-120 Series - Skimmer Harvester

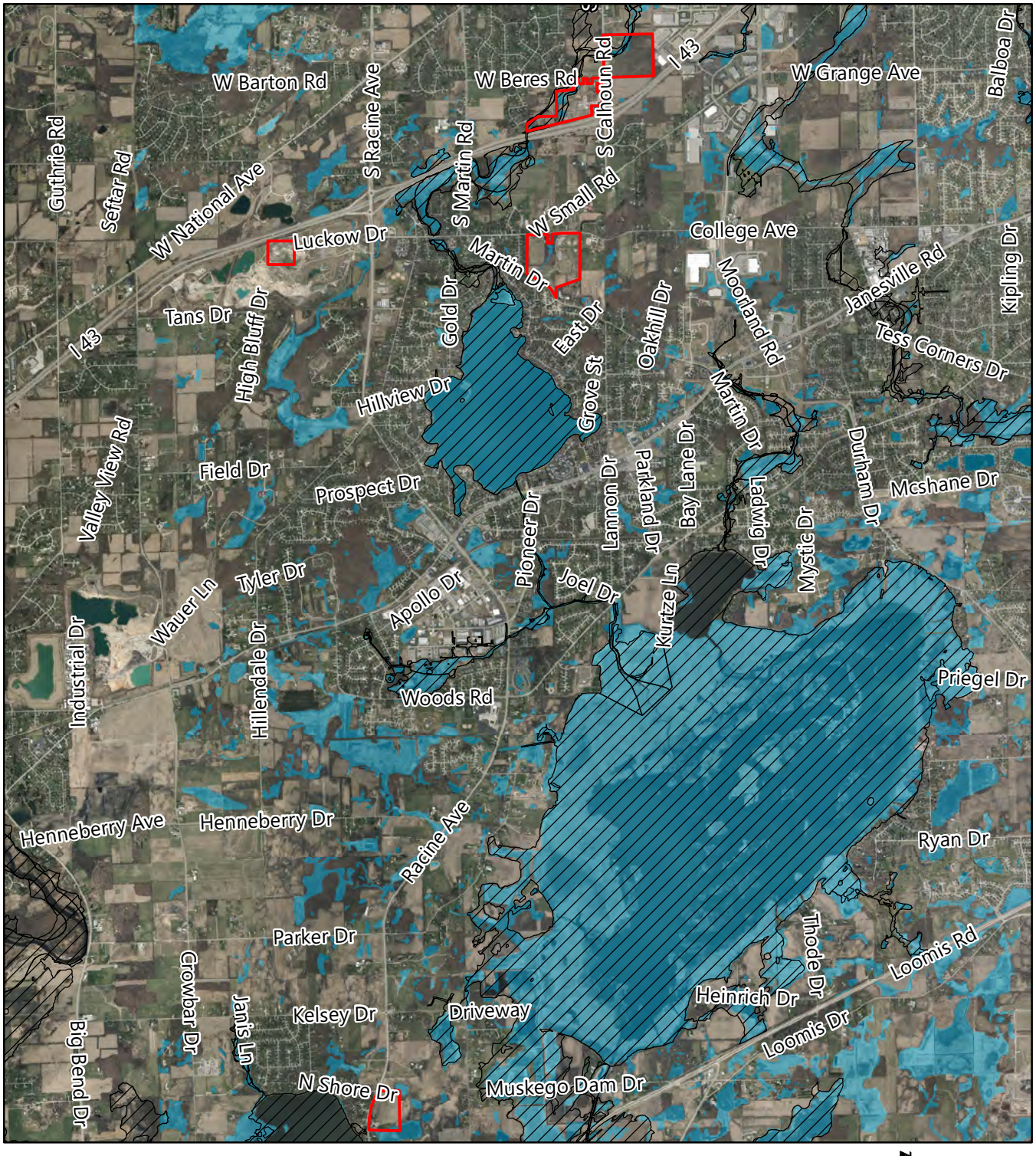
Specifications		Imperial	Metric
Dimensions	Operating Length	32' 7"	9,93 meters
	Operating Width	10' 10"	3,30 meters
	Operating Height	4' 6"	1,37 meters
	Shipping Length	32' 7"	9,93 meters
	Shipping Width	8' 6"	2,59 meters
	Shipping Height	5' 7"	1,70 meters
	Overall Weight	5,500 lb	2,495 kgs.
Flotation	Pontoon Length, each	22' 9"	6,93 meters
	Pontoon Width, each	25"	63 cm
	Pontoon Height, each	26"	66 cm
	Draft, Empty	13"	33 cm
	Draft, Fully Loaded	17"	43 cm
Power Source	Standard Engine	Gasoline	Gasoline
	Engine Rating	Minimum 24 HP	Minimum 17,9 kW
	Engine Protection	Low oil & high temp shutdown	Low oil & high temp shutdown
	Fuel Tanks, Quantity / Description	2 portable tanks, 6 gallons each	2 portable tanks, 22 liters each
Hydraulics	Hydraulic System	Gear pump	Gear pump
	Hydraulic Oil	Clarion 46 - environmentally safe, marine grade	Clarion 46 - environmentally safe, marine grade
	Hydraulic Reservoir Capacity	18 gallons w/ temp & level gauge	68 liters w/ temp & level gauge
	Hydraulic System Protection	Relief valves, low oil & clogged filter sensors	Relief valves, low oil & clogged filter sensors
Control Bridge	Location	Starboard side next to storage hold container	Starboard side next to storage hold container
	Instrumentation & Controls	Levers, gauges, warning lights & alarms	Levers, gauges, warning lights & alarms
	Operator Amenities	Padded vinyl lean-to seat, sun/rain canopy	Padded vinyl lean-to seat, sun/rain canopy
	Operator Protection	All hydraulic lines/valves enclosed & shielded	All hydraulic lines/valves enclosed & shielded
Harvesting Head	Harvesting Width	4'	1,22 meters
	Harvesting Depth	0 to 4' deep	0 to 1,22 meters deep
	Cutter Knives	Reciprocating 3" stroke, chrome plated	Reciprocating 76 mm stroke, chrome plated
	Conveyor Belting	1" x 1" standard duty galvanized mesh	25 mm x 25 mm standard duty galvanized mesh
Storage Container	Length x Width	20' 4" x 4' 7"	6,20 meters x 1,40 meters
	Capacity, Volume / Weight	130 cubic feet / 1800 lb	3,68 cubic meters / 816 kgs.
	Conveyor Belting	1" x 1" standard duty galvanized mesh	25 mm x 25 mm standard duty galvanized mesh
	Discharge Height, from water surface	4' 2"	1,27 meters
Propulsion	Propulsion System & Location	Twin paddle wheels, side mounted	Twin paddle wheels, side mounted
	Operation & RPM Speed	Independent, forward & reverse, 0 to 50 RPM	Independent, forward & reverse, 0 to 50 RPM
Fabrication	Hull Material	Carbon steel	Carbon steel
	Frame Material	Carbon steel	Carbon steel
	Fasteners	Stainless steel 18/8 throughout	Stainless steel 18/8 throughout
Finish	Preparation	Abrasive sandblast, epoxy primer	Abrasive sandblast, epoxy primer
	Paint Type, above the waterline	High quality polyurethane	High quality polyurethane
	Paint Type, below the waterline	High quality marine epoxy	High quality marine epoxy
	Color, Manufacturer's Standard	Light blue	Light blue

General Arrangement Drawing # 2411

DISPOSAL SITES FOR HARVESTING OPERATIONS ON LITTLE MUSKEGO LAKE

APPENDIX G

Map G.1
All Mechanical Harvesting Disposal Site Locations for Little Muskego Lake: 2016



DISPOSAL LOCATION

IDENTIFIED WETLANDS

1-PERCENT-ANNUAL-PROBABILITY
(100-YEAR RECURRANCE) FLOODPLAIN

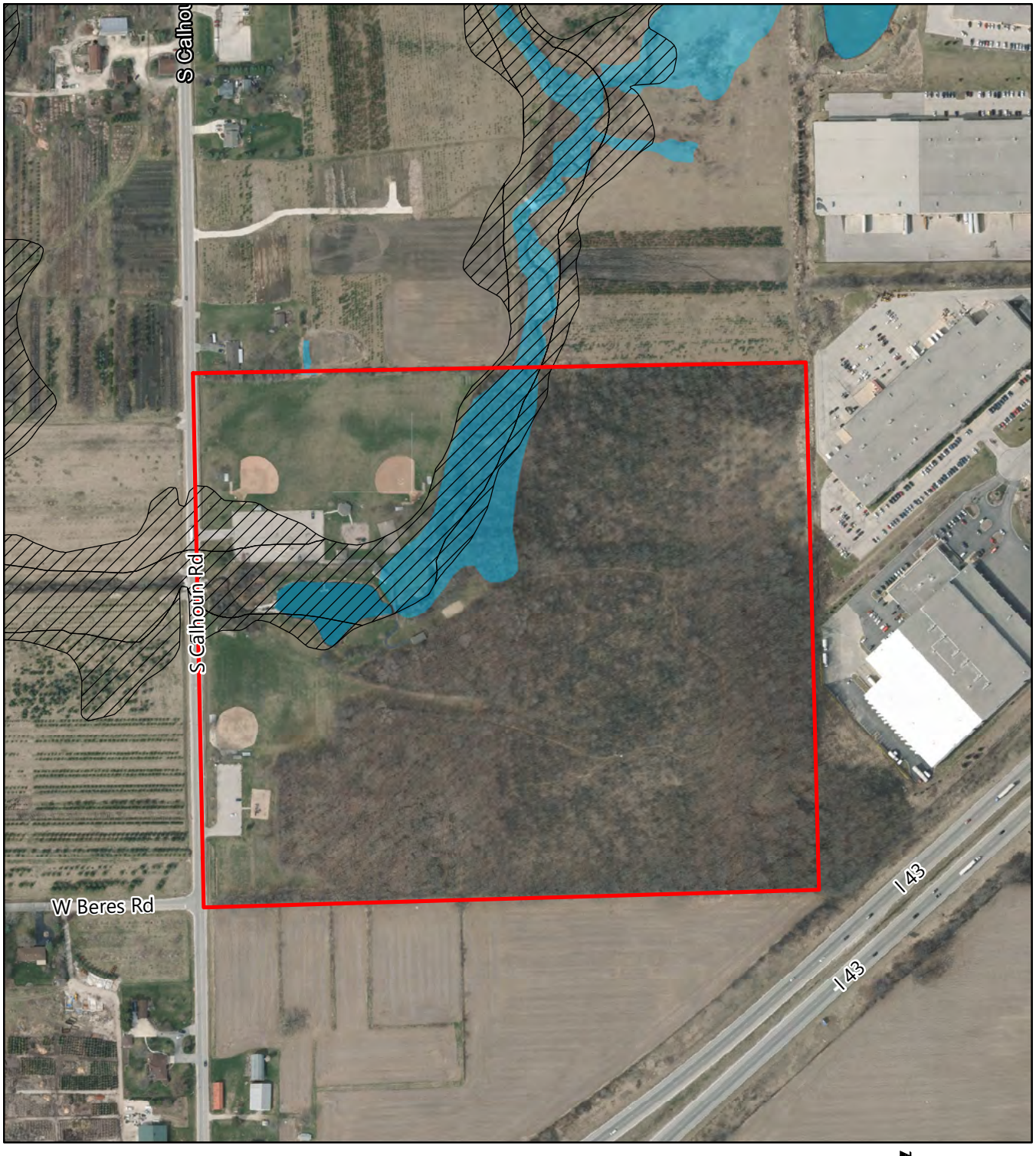
N

0 2,500 5,000 Feet

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

Map G.2
Mechanical Harvesting Disposal Site Location for Little Muskego Lake: Calhoun Park



DISPOSAL LOCATION

IDENTIFIED WETLANDS

1-PERCENT-ANNUAL-PROBABILITY
(100-YEAR RECURRANCE) FLOODPLAIN

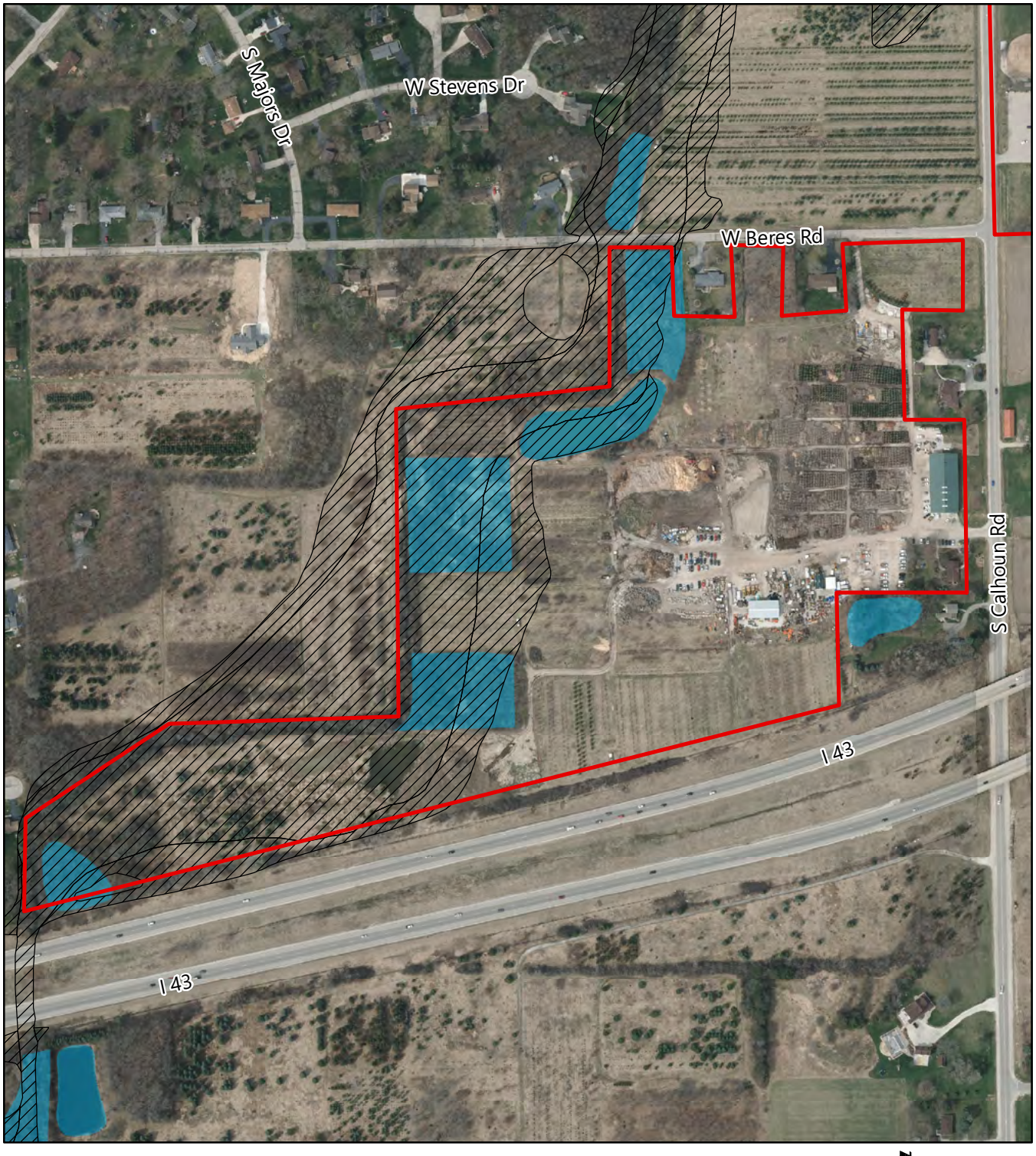
N

0 200 400 Feet

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

Map G.3
Mechanical Harvesting Disposal Site Location for Little Muskego Lake: Trees on the Move



DISPOSAL LOCATION

IDENTIFIED WETLANDS

1-PERCENT-ANNUAL-PROBABILITY
(100-YEAR RECURRANCE) FLOODPLAIN

N

0 200 400 Feet

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

Map G.4
Mechanical Harvesting Disposal Site Location for Little Muskego Lake: New Valley Sand and Gravel

DISPOSAL LOCATION

IDENTIFIED WETLANDS

1-PERCENT-ANNUAL-PROBABILITY
(100-YEAR RECURRANCE) FLOODPLAIN

N

0 200 400 Feet

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

Map G.5
Mechanical Harvesting Disposal Site Location for Little Muskego Lake: Park Arthur

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

Map G.6
Mechanical Harvesting Disposal Site Location for Little Muskego Lake: Denoon

DISPOSAL LOCATION

IDENTIFIED WETLANDS

1-PERCENT-ANNUAL-PROBABILITY
(100-YEAR RECURRANCE) FLOODPLAIN

N

0 200 400 Feet

Date of Photography: April 2015

Source: Little Muskego Lake Protection and Rehabilitation District and SEWRPC

APPENDIX H

WATERCRAFT INSPECTION

FOR MORE INFORMATION

If you would like more information about aquatic invasive species, the problems they cause, regulations to prevent their spread, or methods and permits for their control, contact one of the following offices:

Wisconsin Department Of Natural Resources
888-WDNRINFO
DNR.WI.GOV search "Aquatic Invasives"

University of Wisconsin- Extension
(715) 346-2116
WWW.UWSP.EDU/CNR/UWEXLAKES

Wisconsin Sea Grant
(608) 262-0905
WWW.SEAGRANT.WISC.EDU
WWW.PROTECTYOURWATERS.NET

Thanks to the following for supporting educational efforts on aquatic invasive species:

- *U.S. Fish and Wildlife Service*
- *Great Lakes Indian Fish and Wildlife Commission*
- *National Park Service*

PUB WT-801 2011

Graphic Design by Amy Torrey,
Environmental Resources Center, UW-Extension

Photo Credits:
Sea Grant, UW-Extension, DNR

STOP Aquatic HITCHHIKERS

ENJOYING THE GREAT OUTDOORS

Enjoying the great outdoors is important to many of us. Boating, fishing, hunting, and wildlife watching are traditions that we want to preserve for our children and their children. Today, these traditions are at risk. Aquatic invaders such as zebra mussels, purple loosestrife, Eurasian water-milfoil, bighead and silver carp, threaten our valuable waters and recreation. These and other non-native, or exotic, plants and animals do not naturally occur in our waters and are called invasive species because they cause ecological or economic harm.

These invasive species can get into lakes, rivers, and wetlands by "hitching" rides with anglers, boaters, and other outdoor recreationists, who transport them from one waterbody to another.

Once established, these "aquatic hitchhikers," can harm native fisheries, degrade water quality, disrupt food webs and reduce the quality of our recreational experiences.

The good news is that the majority of waters are not yet infested with invasive species and by taking the necessary steps you can help protect our valuable waters.

If you think you have found an INVASIVE SPECIES:

REPORT NEW SIGHTINGS

If you suspect a new infestation of an invasive plant or animal, save a specimen and report it to a local Department of Natural Resources or Sea Grant office. Wisconsin has "ID" cards, websites, and volunteer monitoring networks to help you identify and report invasive species.

CONSULT YOUR NATURAL RESOURCE AGENCY

Do-it-yourself control treatments may be illegal and can make matters worse by harming native fish, wildlife, and plants. Before attempting to control an invasive species or add new plants along your shoreline, contact your local Department of Natural Resources office. DNR staff can provide recommendations and notify you what permits are required.

DNR.WI.GOV search "Aquatic Invasives"

STOP AQUATIC HITCHHIKERS

IS A NATIONAL CAMPAIGN THAT HELPS RECREATIONAL USERS TO BECOME PART OF THE SOLUTION TO STOP THE TRANSPORT AND SPREAD OF AQUATIC INVASIVE SPECIES.

IN WISCONSIN IT IS THE LAW...

Aquatic hitchhikers can spread in many ways such as on recreational equipment, and in water. Fortunately, there are a few simple actions you can take to prevent them from spreading.

INSPECT boats, trailers, and equipment

REMOVE all attached aquatic plants, animals, and mud before launching and before leaving the water access.

Many invasive species spread by attaching themselves to boats, trailers, and equipment and "hitching a ride" to another waterbody. Therefore, Wisconsin law requires that you remove these aquatic hitchhikers before you launch your boat or leave the access area.

DRAIN all water from your boat, motor, bilge, live wells, bait containers and all equipment before leaving the water access.

Many types of invasive species are very small and easily overlooked. In fact, some aquatic hitchhikers, like zebra mussel larvae, are invisible to the naked eye. To prevent the transport of these aquatic hitchhikers drain water from all equipment before you leave the access area.

For more information visit:
DNR.WI.GOV and search "bait laws"

Draining ballast water and lake or river water can prevent the spread of aquatic invasive species and fish diseases, like VHS.

NEVER MOVE plants or live fish away from a waterbody.

In Wisconsin, it is illegal to transport any aquatic plants, mud, live fish or live fish eggs away from any state waterbody. This includes live gamefish and roughfish, like gizzard shad. There are exceptions for minnows obtained from a Wisconsin licensed bait dealer or registered fish farm, which may be transported away live and used again:

- ***On the same waterbody, or***
- ***On any other waterbody if no lake or river water, or other fish were added to their container***

BUY minnows from a Wisconsin licensed bait dealer.

For more information on collecting your own minnows visit:
DNR.WI.GOV and search "VHS Prevention"

DISPOSE of unwanted bait and other animals or aquatic plants in the trash.

When possible, dispose of unwanted bait in the trash at access points. Never release them into the environment.

If possible, dispose of ALL unwanted bait (including earthworms) in a trash can at the boat landing or access point. Otherwise, take them home and dispose of them by placing them in the trash, composting them, or using them in a garden as fertilizer. Likewise, other aquatic plants or animals that you collect, or buy in a pet store, should NEVER be released into the wild.

WISCONSIN REGULATION

Wisconsin has several laws to prevent the spread of aquatic invasive species and the fish disease Viral Hemorrhagic Septicemia (VHS). Failure to follow Wisconsin law can result in fines up to or exceeding **$2000**. Don't be caught unaware!

ADDITIONAL STEPS:

Although not required by WI law, additional steps are highly recommended, particularly if you are transporting a boat and/or equipment from one waterbody to another. Additional steps include:

SPRAY, RINSE, or DRY boats and recreational equipment to remove or kill species that were not visible when leaving a waterbody. Before transporting to another water: ***Spray/rinse with high pressure, and/or hot tap water (above 104° F or 40° C), especially if moored for more than a day. OR Dry for at least five days.***

DISINFECT boats and recreational equipment to kill species and fish diseases that were not visible when leaving a waterbody. Many aquatic hitchhikers can survive out of water for some period of time. ***To prevent their spread, you can sanitize your boat, trailer or equipment by washing it with a mixture of 2 Tbs of household bleach per 1 gallon of water.***

OTHER WATER USES:

Don't get caught spreading aquatic invasive plants or animals! Wisconsin laws, as highlighted above, can apply to many types of water activities, not just boating and fishing. Although these activities might not seem dangerous, they CAN establish and spread invasive species. It is important you follow the steps above for all water activities in order to prevent the spread of aquatic invasive species. These activities include:

- ***Using personal watercraft***
- ***Shore and fly-fishing***
- ***Sailing***
- ***Scuba Diving***
- ***Waterfowl hunting***

FAILURE TO FOLLOW WISCONSIN LAWS CAN LEAD TO FINES.

For additional information contact your local DNR staff or visit:
DNR.WI.GOV

Protect Your Boat

Zebra mussels attach to a variety of materials, including fiberglass, aluminum, wood, and steel and may damage a boat's finish. Veligers are extremely small and can be drawn into engine passages. Once they settle out in the engine cooling system, they can grow into adults and may block intake screens, internal passages, hoses, seacocks, and strainers. The best ways for boat owners to avoid these types of damage are:

- **Use a boatlift** to completely remove the watercraft from the water when not in use.
- **Run your boat regularly** if it is moored in zebra mussel infested waters. Run the engine at least twice a week at slow speeds (about 4-½ mph) for 10 to 15 minutes. Monitor engine temperatures – if you notice an increase, it may mean that zebra mussels are clogging your cooling system. Immediately inspect the system and remove any zebra mussels. The end of boating season is also a good time to inspect and clean the cooling system.

- **Lift the motor out of the water between uses if mooring.** Fully discharge any water that may still remain in the lower portion of the cooling system.
- **Tip down the motor and discharge the water when leaving a waterbody** to reduce the likelihood of transporting veligers (in water) to another waterbody.
- **Clean your boat and equipment.** Physically remove (scrape) adult mussels from your boat, trailer, and equipment by hand. Young zebra mussels and veligers may be too small to see. Wash your boat with high-pressure hot water (use water >104˚F if possible). Use high-pressure cold water if hot water is not available. *(Avoid pressure washing classic wooden boats or others not made of metal.)*
- **Apply anti-fouling paints or coatings to the hull and the engine's cooling system** to prevent zebra mussel attachment. It is best to purchase these from an area boat dealer or your local marina. Anti-fouling paints that are copper based can be used in Wisconsin, and typically need to be reapplied every one to two years. In-line strainers can also be installed in the engine's cooling system.
- **Use motor "muffs", also known as motor flushers, to remove zebra mussels and other materials from your boat engine or personal watercraft.** Clamp the motor flusher onto the lower unit over the cooling inlets on either side of the motor, and screw the nozzle of your garden hose into it. Run the boat engine for approximately 10 minutes or as suggested by the manufacturer.

Amy Bellows, WI DNR

Special note of caution for anglers

Dispose of unwanted bait in the trash - do not transfer bait or water from one waterbody to another. Larval zebra mussels or other invasive species could be present in the water with the bait.

Help prevent aquatic hitchhikers from catching a ride on your boat or equipment:

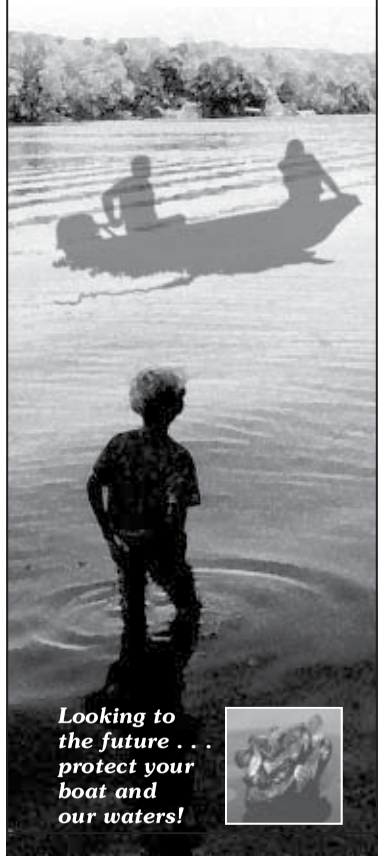
- ✓ **Inspect** and **remove** aquatic plants and animals,
- ✓ **Drain** water,
- ✓ **Dispose** of unwanted bait in the trash,
- ✓ **Rinse** with hot and/or high-pressure water, OR
- ✓ **Dry** for 5 days.

Clean Boats . . . Clean Waters

For a list of known zebra mussel infested waters, visit:
www.dnr.wi.gov/org/water/wm/GLWSP/exotics/zebra.html

Cover photo: L. Pohlod. Inset: Great Lakes Sea Grant Network
Designed by L. Pohlod, Blue Sky Design, LLC *PUB-WT-383 2004*

Zebra Mussel Boater's Guide

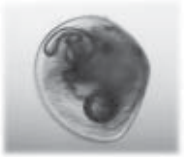


Zebra mussel identification and life cycle

Ohio Sea Grant

Mature zebra mussels look like small D-shaped clams. Their yellowish-brown shells have alternating light and dark stripes. Zebra mussels can reach a maximum of 2 inches in length, though most are smaller than an inch. They are typically found attached to solid objects, often growing in large clusters.

Ontario Ministry of Natural Resources



Amy Bellows, WI DNR

Zebra mussels begin as eggs, then develop into free-swimming larvae (called **veligers**), which are microscopic. The veliger photos shown above were taken with the aid of a microscope. Veligers are spread by currents; after about three weeks, they settle out and firmly attach themselves to hard surfaces, where they grow into adults. Their lifespan is typically three to five years. They begin to reproduce after a year or two - females can release up to one million eggs per year!

James Lubner, University of Wisconsin Sea Grant

What do zebra mussels do?

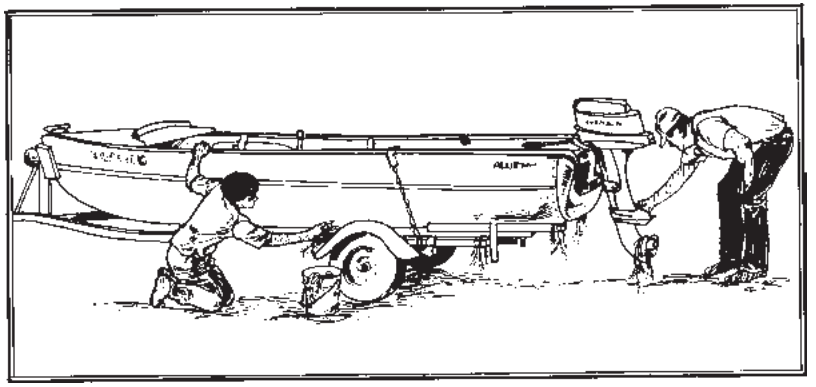
Zebra mussels are **filter feeders** that can filter large volumes of water (up to 1 Liter/day). In some cases they can filter the whole volume of a lake in a few months. They remove plankton – tiny plants and animals – from the water. What they eat (and what they don't eat) ultimately ends up on the lake or river bottom. Plankton is an important food source for young fish, native mussels, and other aquatic organisms. Zebra mussels may concentrate this food at the bottom, leaving open water species with **less to eat**!

Because they are so good at filtering, zebra mussels often **make water clearer**. This may force **light-sensitive fish**, like salmon and walleye, into deeper water to seek shelter from the sun. Increased light penetration allows aquatic plants to grow in deeper water and spread to a larger area. This may help smaller fish to survive by giving them places to hide, but makes it harder for large, predatory fish to find food. **Thicker plant growth** may also cause problems for boaters and anglers.

Don Schloesser, Great Lakes Science Center, National Biological Services

Zebra mussels cause people additional problems. They **clog water intakes and pipes** – large water users on the Great Lakes spent $120 million from 1989 to 1994 to combat zebra mussels. They also **attach to piers, boatlifts, boats, and motors,** which can cause damage requiring costly repair and maintenance. Even when they die, their **sharp shells** wash up on beaches, creating foul odors and cutting the feet of swimmers.

How can I help prevent the spread of zebra mussels?



Microscopic veligers may be carried in livewells, bait buckets, bilge water – any water that's transported to another waterbody. They can also travel in currents to downstream waters. Adults can attach to boats or boating equipment that are moored in the water. They frequently attach to aquatic plants, which themselves may hitch a ride on boats and equipment. For these reasons, it is important to take the following steps to prevent the spread of zebra mussels and other aquatic invasive species while boating:

Before moving your boat from one water body to another:

- ✓ **Inspect** and **remove** aquatic plants, animals, and mud from your boat, trailer, and equipment,
- ✓ **Drain** all water from your equipment (boat, motor, bilges, transom wells, live wells, etc.),
- ✓ **Dispose** of unwanted bait in the trash, not in the water,
- ✓ **Rinse** your boat and equipment with hot (> 104˚F) and/or high pressure water, particularly if moored for more than one day, OR
- ✓ **Dry** your boat and equipment thoroughly (in the sun) for five days.

Pressure washing note:

Avoid pressure washing classic and wooden boats, along with canoes and kayaks that are not made of metal. These types of boats should be drained, cleared of all plant and animal materials, and left in the sun to dry completely.

Effective May 2002, Section 30.715, WI Act 16 prohibits launching a boat or placing a boat or trailer in navigable waters if it has aquatic plants or zebra mussels attached.

Watercraft Inspector Handbook

2014 Edition

Wisconsin Lakes Partnership

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Acknowledgments:

The *Watercraft Inspector Handbook* is a guide for people who are passionate about "their" lake and who have a vision for future generations. The "Clean Boats, Clean Waters" program is sponsored and promoted by the Wisconsin Department of Natural Resources, UW-Extension, and Wisconsin Lakes.

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Welcome to the Clean Boats, Clean Waters Watercraft Inspection Program!

Aquatic invasive species have long been recognized as a serious threat to the United States. According to Cornell University, in 1999, introduced species of animals, plants, and microbes cost the U.S. economy at least $138 billion a year. In 2001, Wisconsin spent over $600,000 on aquatic and terrestrial plants and exotic birds, thousands more for sea lamprey control and hundreds of thousands for control of zebra mussels. These facts make folks a little nervous about the future of Wisconsin inland water bodies.

Wisconsin's 15,081 lakes are fortunate to have volunteers who monitor water clarity, water chemistry, aquatic plants, and invasive plants. Since 1986, these folks have functioned as the "eyes" of aquatic biologists. With the arrival of aquatic invasive species, now more than ever citizens are needed to help preserve and protect Wisconsin's water bodies. The "Clean Boats, Clean Waters" program is an opportunity for citizens to help stop the spread of invasive species across the state.

Through "Clean Boats, Clean Waters," inspectors are trained to organize and conduct a watercraft inspection and education program in their community. This program originated in northern Wisconsin as a middle school project. The "Milfoil Masters" program alerted adults and youth that citizen volunteers can make a difference in helping prevent the spread of invasive species.

To continue statewide volunteer efforts, the **"Clean Boats, Clean Waters" Watercraft Inspection Program** was created in the fall of 2003. The mission of this program is to promote water resource stewardship by actively involving individuals in preventing the spread of harmful aquatic invasive species. To accomplish this goal, the program sponsors statewide training workshops and has developed resource handbooks, tool kits, and educational information; a statewide coordinator now supports inspection efforts.

Wisconsin realizes that passionate citizens are the keys to reaching hundreds of recreationalists visiting the state. Inspectors who instruct boaters on how to perform watercraft inspections are helping to prevent new invasions and are helping to maintain Wisconsin's valuable water resource.

Thank you for taking the time to learn, act, and protect Wisconsin's waters from invasive species! The rewards of these efforts will be appreciated by many generations to come.

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Section 2: What do watercraft inspections involve?

Section 3: How do inspectors share their inspection data?

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Section 1:
What is the program all about?

Wisconsin's Comprehensive Management Plan

To Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species, created in 2003

Aquatic invasive species (AIS) have long been recognized as a serious problem in Wisconsin. The Department of Natural Resources, in cooperation with the University of Wisconsin Sea Grant and the Great Lakes Indian Fish and Wildlife Commission, has prepared a plan to coordinate responses to the problems associated with AIS. This plan is one component of a comprehensive state effort to control invasive species that involves all affected state agencies and tribal governments working together to prevent the further introductions of invasive species (both aquatic and terrestrial) into Wisconsin's ecosystems. This plan focuses on prevention as the key strategy for limiting the impacts of aquatic invasive species by controlling the initial introduction and subsequent transfer from one water body to another. Prevention strategies rely heavily on information, education, and communication. Therefore, this plan includes the full range of those activities in order to implement an effective prevention program.

However, prevention techniques alone are inadequate for limiting the negative impacts caused by aquatic invasive species. This plan also suggests that control, mitigation, or elimination strategies must be considered. It incorporates information and education/ outreach activities, watercraft inspection efforts, and policy, and legislative initiatives as key components of the overall program.

The goals of Wisconsin's comprehensive management plan are designed to address different stages of the AIS invasion:

1. The initial introductions of AIS into Wisconsin waters from other parts of the continent or world;
2. The spread of AIS populations to previously unaffected state waters; and
3. The colonization of self-sustaining AIS populations within water bodies, including the harmful impacts resulting from such colonization.

Goal 1:

Implement procedures and practices to prevent new introductions of AIS into Lakes Michigan and Superior, Wisconsin's boundary waters (the Mississippi and St. Croix Rivers), and the inland waters of the state.

Because of the limited experience with most AIS, the long-term consequences of their impacts are not yet known. With a more robust global economy, it is anticipated that without a new prevention program, new introductions are highly likely. For that reason, prevention actions at the national and regional level, as well as at the individual jurisdictional level, are critical. The highest prevention priority is the control of ballast water discharges.

Several other potential transport mechanisms could result in releases of AIS into the Great Lakes and inland state waters. Some of these vectors are: the transportation and rearing systems related to the aquaculture industry, commercial barge traffic, and recreational boating; inter-Great Lake boating associated with research or

management activities; scuba diving; the sale and distribution of fishing bait; the transfer and disposal of nonindigenous pets; plant nurseries; fish stocking activities and individual releases by anglers.

Three of the potential AIS transport mechanisms have been selected for specific actions: the sale and distribution of bait, aquaculture and aquarium industries, and ballast water discharges.

Specific actions related to this goal are: work with the bait industry, agriculture, and aquarium industries and transoceanic shipping to collect information about vectors and AIS transport mechanisms in general, and evaluate new technologies or management practices for effective control of AIS.

Goal 2:

Establish management strategies to limit the spread of established populations of AIS into inland waters of the state.

The introduction of AIS into the Great Lakes has resulted in the spread of AIS to inland waters. The spread of established populations of AIS is primarily caused by human activities such as transfer of boats, bait handling, and water transport. Water resource user groups are frequently not aware of which waters are infested with AIS, the problems associated with AIS and the precautions they should take to limit the spread of AIS.

Specific actions related to this goal are: determine which species pose the greatest problems; determine the level of monitoring needed to document AIS distribution; assess the sampling and monitoring programs for priority invasive species; implement education and outreach programs to increase public awareness and improve coordination efforts on AIS by encouraging cooperation with partner organizations, agencies, and volunteers.

Goal 3:

Abate harmful ecological, economic, social, and public health impacts resulting from infestation of AIS and, where possible, eliminate those impacts.

Appropriate strategies to control AIS and abate their impacts may not be technically, economically, or environmentally feasible. Control strategies must always be designed so as not to cause significant environmental impacts.

Specific actions related to this goal are: assess the public health, social, economic, and ecological impacts of AIS to Wisconsin waters; determine control actions that are appropriate to limit impacts, that are cost-effective approaches, and that provide long-term solutions; evaluate the effectiveness of the control strategies after they have been implemented.

This plan provides the generalized approaches that must be followed to protect indigenous species and the socioeconomic benefits that are threatened by aquatic invasive species. It is likely that management plans for individual species, such as zebra mussels and Eurasian water-milfoil, will be developed as a result of this plan.

For detailed information about this plan, visit: http://dnr.wi.gov/topic/Invasives/documents/compstateansplanfinal0903.pdf.

Wisconsin's comprehensive state management plan was approved by the National Aquatic Nuisance Species Task Force at their November 2003 meeting. Their approval qualifies the state for federal funding to implement the specific actions as detailed in the plan.

The Aquatic Invasive Species Volunteer Program Vision

The Aquatic Invasive Species Volunteer Program promotes water resource stewardship by actively involving individuals in preventing the spread of aquatic invasive species that can harm Wisconsin's ecosystems, economy, and recreational opportunities.

Citizen involvement in watercraft inspections and monitoring for invasives increases public awareness about the potential impacts of aquatic invasive species. Volunteers serve to inform and educate the public about how people can help prevent the spread of invasives by inspecting their watercraft and removing aquatic plants and animals from their boats and equipment before leaving an access site.

To accomplish these objectives, the volunteer program supports:

- Watercraft inspections for aquatic invasive species.
- Communication with the public about the laws and issues surrounding the existence, spread, and effects of invasives to Wisconsin's waters.
- Distribution of educational resources and publications.
- Collection of data to evaluate the potential spread of invasive species, public awareness of invasive species issues, and the effectiveness of the invasive species program.
- Response to technical inquiries from the public concerning invasive species.

"If there is magic on this planet, it is contained in water."

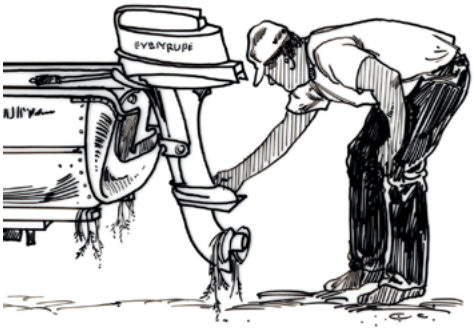
- Loren Eiseley

The Immense Journey, 1957

Section 2:

What do watercraft inspections involve?

Getting Started



Recreational boating is a significant corridor for the spread of invasive species between water bodies in Wisconsin. This pathway is a concern because of the more than 610,000 registered boaters moving around Wisconsin's 15,081 lakes. Inspecting watercraft for invasive species offers a frontline defense at the lake landing to prevent further destruction of lake ecosystems. Watercraft inspections are designed to increase public awareness about invasive species and to assist boaters in taking preventive steps to avoid further spreading of critters.

Attending a "Clean Boats, Clean Waters" training workshop provides you with all the tools you need to start a watercraft inspection program in your community. Developing an effective program requires patience, time, and an eye for organizing a working schedule. A group that consists of a inspection cooordinator and a committee of several people is the best way to distribute the tasks equally and prevent volunteer burnout. When planning a watercraft program, consider the five Ws: Whom, What, When, Where, and Why.

WHOM will you recruit for the watercraft inspection team?

Volunteers, both adults and youth, can be recruited through your lake association newsletter, local schools, 4-H, or Boy and Girl Scout groups. Many service organizations are looking for community involvement opportunities. We recommend at least two people at the landing. Ideally, an adult should work with a youth volunteer. Boaters are very cooperative when a young person is giving the message: "Clean Boats, Clean Waters, please."

WHAT are the duties of a watercraft inspector?

Before you build a watercraft inspection team, decide what skills and tasks volunteers need for an effective interaction with the public at the boat landings. Generally, inspectors perform three duties: verbally share educational materials and information about aquatic invasive species and how they're spread, visually check boats and recreational equipment for any hitchhiking plants or animals, and demonstrate how to clean recreational equipment and what prevention steps boaters need to take every time they leave the water.

Additional duties, such as recording data on the Watercraft Inspection Report Form (see Section 3), assist us in collecting information about the recreational use of the lake, traveling patterns of boaters, and whether the boaters are performing the prevention steps. Inspectors should also be ready to collect, accurately label, and store any suspect plant or animal that is attached to any recreational equipment.

Here are some specific skills to consider:

- **Congenial**: able to meet new people courteously at the landings.
- **Communicative**: effectively educate the public on invasive species.
- **Flexible**: be willing to work weekends and holiday hours.
- **Informed**: understand the harmful impacts of aquatic invasive species.
- **Physically able**: able to inspect watercraft and trailers for invasive species.

- **Accurate**: document verbal surveys, record, and submit any suspect invasive species specimens to local/regional DNR service station.
- **Computer knowledgeable**: able to submit watercraft inspection data to DNR Web site at http://dnr.wi.gov/lakes/cbcw-data.

To identify the watercraft inspection team at the boat landing, all volunteers should have their own royal blue "Clean Boats, Clean Waters" T-shirt. Inspectors need to wear this T-shirt to signify that they are working for a specific program, "Clean Boats, Clean Waters," and not harassing boaters at the landings. Two T-shirts are included in each of the resource kits and more may be purchased by calling UW Extension-Lakes at 715-346-2116. As an added bonus, 'Clean Boats, Clean Waters' logo stickers are included in the resource kit to use when the weather is inclement and short-sleeve T-shirts just won't work. Just peel off the protective backing on the logo, and place the sticker on your sweatshirt or coat. No matter what the weather, boaters will be able to identify the watercraft inspection team at a glance.

WHEN is the best time to inspect at the boat landing?

When recruiting volunteers, be specific about the amount of time you want them to work. For example, a volunteer is more likely to agree to a three-hour shift once or twice a month rather than an open invitation to volunteer all summer on the weekends and holidays. Volunteers will more readily step up if they know the expectations and how much time is realistically needed.

To get the most "bang for your buck," become acquainted with the activity on your lake and when the lake is the busiest. Are the weekends a flurry of activity from Friday night at 4 p.m. until 8 p.m. Sunday? Or is Saturday morning from 6 a.m. until 10 a.m. the active time at the landings? Usually, holiday weekends during the summer are the busiest times at the landings. Anglers are usually up and on the lake by dawn and always out on opening day of fishing season. Recreational boaters usually use the lake in the afternoon, and sunny, warm days draw lots of people to the lake! Do not forget about fishing tournaments and special lake events that draw many boats at the landings. Remember, the boat landing is the first place an aquatic invasive species takes hold.

WHERE will the watercraft inspection process take place?

It is a good idea to find out who owns the boat landing before you begin to schedule work shifts for your inspectors. The landing may be owned and maintained by one of several entities: the federal government, state, township, lake association, or a private individual. To check ownership, you might need to contact several organizations, such as the Wisconsin Department of Natural Resources, county zoning offices, town halls, or local businesses. Knowing ownership will be helpful if you are thinking about installing signage, waste disposal containers, or boat washing facilities (see Section 4).

If you have limited inspection resources and many public and private landings, determine which landings receive the most boat traffic. Think about which landing is most likely to be the first place a hitchhiking invasive will appear.

WHY is this inspection program necessary?

Be prepared to answer this question. Often lake owners are frustrated with the public trust doctrine that mandates public use of all waters in Wisconsin. Lake owners feel it is unfair that they bare the brunt of the cost of managing an aquatic invasive species. The Wisconsin Department of Natural Resources is allocating some money toward the management of invasive species, but not nearly enough for 15, 081 lakes. Therefore, any proactive steps in preventing the

introduction and spread of invasive species are more cost-effective than waiting for them to arrive.

Preventing aquatic invasive species is a better management option than the expensive alternative. For example, treating Eurasian water-milfoil infestations with chemicals on average costs around $300 to $500 per acre. Eurasian water-milfoil can grow two inches per day and can fragment into hundreds of new plants within hours, so it would not take long for Eurasian water-milfoil to cover hundreds of acres. If this fact does not impress you, contact members of a lake organization struggling with an invasive species. They would be happy to discuss the tremendous impact that one invasive species caused in their community. Remember, prevention is worth a pound of cure.

Online Resources

There are tons of useful online resources available to aid you in your aquatic invasive species (AIS) outreach efforts! Many of these resources are available on either the UW-Extension Lakes website or the WI Department of Natural Resources (DNR) website.

UW-Extension Lakes: http://www.uwsp.edu/uwexlakes

DNR Invasive Species: http://dnr.wi.gov/topic/invasives

AIS Publications

Many AIS-specific resource materials (such as brochures, stickers, etc.) are available to assist you in your outreach efforts. A list of the publications currently available can be found at http://dnr.wi.gov/lakes/invasives/AISPubList.pdf.

These free publications can be ordered by e-mailing DNRAISinfo@wisconsin.gov or calling 608-267-9868.

AIS Contacts

We have numerous AIS staff available to assist you – with general questions, trainings, grant applications, and more! You can search our online database of AIS contacts by their location in the state or by their role/specialty.

AIS Contact List: http://dnr.wi.gov/lakes/invasives/topics.aspx

AIS Distribution Information

Find out what lakes and rivers have AIS in your area! You can view lists of AIS waters by county, region, or Great Lakes basin, or see a statewide list.

View Distribution Info by Waterbody: http://dnr.wi.gov/lakes/invasives/AISByWaterbody.aspx

You can also search by species, selecting a specific aquatic invasive and viewing all of the waterbodies in which it is present.

View Distribution Info by Species: http://dnr.wi.gov/lakes/invasives/BySpecies.aspx

AIS Control Grants

Grant funding is available for AIS projects conducted on any waters of the state. They can be used for education, prevention, planning, early detection, rapid response, and established invasives control projects. Check out the DNR's AIS Grants webpage for more information and details on eligibility, the application process, and more.

AIS Grants: http://dnr.wi.gov/Aid/AIS.html

CBCW Supplies & More!

For all things CBCW, visit the UWEX-Lakes CBCW website. You can check out the CBCW supplies and ordering info, view the current workshop schedule, download the CBCW Handbook, and more.

CBCW Watercraft Inspection: http://www.uwsp.edu/uwexlakes/cbcw

Liability

Watercraft inspections are Wisconsin's main aquatic invasive species containment and prevention tool! More and more lake communities are organizing watercraft inspection teams for youth and adults interested in preventing the spread of aquatic invasive species. Inspection teams that perform watercraft inspections at boat landings can often find themselves in the midst of heavy boat launching activity.

So, can there be liability risks associated with sponsoring a volunteer watercraft inspections program?

The answer is yes. The purpose of this information is to summarize some of the basic issues that lake associations, lake districts, and individuals should keep in mind when deciding to sponsor a watercraft inspection program. This information addresses the issues associated with accident liability. *The following is not meant to be a substitute for legal advice; organizations should seek assistance from an attorney for answers to specific questions.*

Liability Risks for Organization and Individuals

A number of parties may be held responsible for an accident occurring on the boat landing. The **individual** who may be most directly connected to the incident may be held responsible as well as the **lake association**, **lake district,** and **any other entity** that may be hosting the event.

Liability Risks of Organizations:

- **Nonprofit corporations organized under chapter 181** may be held liable if an accident occurs. However, incorporation insulates the individual members' assets from liability in the event of a lawsuit. Only the assets of the corporation, not those of individual members, will become available to satisfy a court judgment.

- **Nonprofit associations not organized under chapter 181** may also take advantage of a law passed in 1997 that insulates the assets of individual members from being used to satisfy a judgment against the association (Chapter 184, Wis. Stats.). According to the law, a nonprofit association is an entity with three or more members that mutually agree to pursue a nonprofit purpose. A "member" under the law is an individual who may take part in the selection of persons to manage the operation of the association. According to state law, in the case of an unincorporated association with three or more "members," only the assets of the association will be used to satisfy a judgment.

- **Public inland lake and rehabilitation districts** organized under chapter 33 of the state statutes may also be subject to a lawsuit. A judgment against a lake district cannot exceed $50,000 (§ 893.80 Wis. Stats.), but any judgment against a lake district must be added to the next tax levy.

- **Workers' compensation** laws come into play when an employee of a lake association or a lake district commissioner is injured while performing the duties of his or her position. If a lake association has three or more paid employees and pays in any one-calendar quarter compensation in excess of $500.00, the association or

employer may be required to pay the medical bills incurred for an injury that occurred while the person was on the job (Chapter 102, Wis. Stats.). If the association relies on volunteers, these laws may be avoided. A lake management district may be held responsible for a job-related injury of an elected commissioner regardless of whether or not compensation is received.

Liability Risks for Individuals:

- **If lake district officers, board members,** or **employees** are held personally responsible for an injury while acting within the scope of their duties as officers, board members, and employees, the lake district must pay the cost of any judgment rendered against them (§§ 895.46 Wis. Stats).- Incorporated lake associations must indemnify directors or officers in most cases (§181.0872 Wis. Stats.)

- **Individuals who provide services** to nonprofit corporations organized under chapter 181 for free, in other words volunteers, cannot be sued in most cases. However, volunteers who operate a motor vehicle or other vehicle that requires a license or operator's permit may be held personally liable should an accident occur (§181.0670 Wis. Stats.)

- **Federal law also protects volunteers of nonprofit corporations, associations, and governmental entities from liability** provided no compensation, aside from reimbursement for expenses, is received.–This law, however, does not protect individuals who are operating a motorized vehicle or vessel that requires an operator's license or permit (42 U.S.C. § 14501, Volunteers Protection Act of 1997).

Insurance

All insurance policies are different. The following points are intended to cover the most basic issues:

- Lake districts and incorporated and unincorporated associations can purchase insurance to protect against the risk of personal injury.

- Homeowner and automobile policies typically protect the owner of the policy against accidents that occur when the individual is acting as a volunteer. Coverage, however, is often not provided when the individual is an employee or employer or when an admission or rental fee is charged. Any volunteer who is operating a boat should be required to have homeowner's, automobile, or boat insurance. The policy should be checked to make sure volunteer work is covered.

Prepared by Tamara A. Dudiak, University of Wisconsin Extension-Lakes

For additional discussion on liability issues for lake organizations, see T. Mentkowski, 1999, *Liability Risks and Protections for Wisconsin Lake Organizations.*

Materials to Have When Working at a Boat Landing

Not all your materials need to be taken to the boat landings. It's better to sort through the materials and decide what educational information is best suited for your area. The "Clean Boats, Clean Waters" program provides a tote bag in which to store all the educational materials in the resource kit. We recommend at least one resource kit for every landing you are monitoring. By using multiple resource kits, each inspection team can have all the materials they need at hand.

A key brochure to distribute to all boaters is "Help Stop Aquatic Hitchhikers" (WT-801). This brochure not only has pictures of the different aquatic invasive species, but also describes the prevention steps that boaters need to take every time they leave the water. In addition, the brochure describes Wisconsin's illegal-to-launch law and the penalties that can occur if an invasive species is not removed before the boat is launched. This brochure is a good reminder to all boaters, whether or not they have talked with a watercraft inspector.

When talking with anglers or when questions regarding Wisconsin's live bait laws come up, the "Fishing with Bait" brochure and "Wisconsin anglers remember" sticker are excellent to have on hand. These two publications clearly outline Wisconsin's rules on the use of live bait and are excellent resources to share with folks who are confused by the detailed regulations.

Select other materials to take to the boat launch based on which aquatic invasive is most threatening in your area. Perhaps Eurasian water-milfoil is really a pressing issue for your lake; then it makes sense to give boaters an EWM/NWM identification card in addition to the "Help Stop Aquatic Hitchhikers" brochure. Resist the temptation to give the boater one of every card in the resource kit because boaters will often discard them. It's best to start by handing out a little bit of information and have additional brochures available if the boaters want to learn more about a particular invasive species.

Boat landings can be very busy during the summer, and you may need more materials before the end of boating season. It's easy to order more of these free publications! The Aquatic Invasive Species Publication List and instructions on how to order more materials are available online. Refer to your "AIS Online Resources" handout or visit: http://dnr.wi.gov/lakes/invasives/AISPubList.pdf

Additional boat launch items to consider:

- Clipboard and pencil.
- Copy of the boat landing script (see Section 2).
- Watercraft Inspection Report Form and Watercraft Inspection Prompts Handout (see Section 3).
- Listing of lakes with AIS presence in your area.
- Wisconsin map.
- "Stop Aquatic Hitchhikers" stickers.
- "WI Anglers: Minnow Use Reminder" stickers.
- "Fishing with Bait" brochures.
- Other selected (free!)AIS publications.
- Cell phone and local contact phone numbers for emergencies.
- Digital camera.
- Plastic bags, permanent marker, and cooler to collect and store any suspect specimens.

Watercraft Inspection Tips

Use the following DO and DON'T lists to prepare your boat landing message.

The DO List

- ✓ Wear the "Clean Boats, Clean Waters" T-shirt to promote the message. This message gives credibility to the program and to the efforts that inspectors are making across the state.
- ✓ Always introduce yourself and mention the organization you are working for and why you are at the landing.
- ✓ Try to approach boat owners before they are on the ramp.
- ✓ Always ask if the boater would mind answering a few questions.
- ✓ Be polite and courteous to all boaters you encounter.
- ✓ Listen to a boater's concerns. Remember that you are encouraging boaters to take an interest in invasive species.
- ✓ Make sure boaters know that they can make a difference!

The DON'T List

- ✗ Don't begin asking questions immediately upon approaching boaters, because as they might be confused about who you are and why they should give you their time.
- ✗ Avoid delaying boaters too much or causing a backup.
- ✗ Never preach to a boater; your mission is to educate, not alienate.
- ✗ Do not emphasize the idea that fines are involved, because this approach can make people hostile or defensive.
- ✗ If the boater is reluctant to cooperate, hand out educational material and record whatever information you can.

An effective watercraft inspection team is prepared to raise boater awareness and to encourage and demonstrate the necessary steps to avoid spreading invasive species. On very rare occasions, you may be uncomfortable about a situation or person. Always back away from a potentially dangerous or violent situation. Never encourage confrontation, no matter how strongly you might feel about the subject. **Remember, you are not enforcers of rules and should never jeopardize your own safety**. If you are suspicious of someone (for example, a loiterer or someone who is not intending to go boating), do not hesitate to leave the launch site. You are better to be safe than sorry. If you feel that a boat launch site is unsafe in any way, please notify the organization you are working for.

Boat Landing Message

Getting out and speaking to the public can be intimidating. New inspectors can feel a little anxious and nervous. This prepared script will help inspectors practice and role-play before their first boater shows up at the landing. Practicing with other folks will give them the confidence it takes to greet a boater. If new inspectors really want to watch a "pro," they just need to ask a few kids to get involved. Are kids intimidated? No way!

This prepared script is only one example of the many methods of addressing boaters at the landings and performing watercraft inspections. Each inspector should develop his or her own style and learn how to adapt in a variety of boat landing experiences. Try to approach boaters before they are on the ramp, and use the Watercraft Inspection Report form to record the information about the boater (see Section 3). At times you may have only 30 seconds to talk to the boater; other times, long lines at the landings may provide you with lots of time to talk. Remember, if the boater is not interested, just hand out educational material and record whatever information you can.

No matter what style you use to approach boaters, any watercraft inspection process should include these points:

1. Tell them who you are, whom you represent, and why you are there.
2. Ask if they have a short time to answer some questions.
3. Use the Watercraft Inspection Report form to assist you in your conversation and record boater responses.
4. Ask if they are familiar with the AIS prevention steps that are required by law, such as draining all water from boats, livewells, and equipment before leaving the landing. Briefly explain why these steps are important, using the Prompts to assist you. Be sure to share your local concerns and highlight what species are found in (or nearby) your area.
5. Ask if they will join you in an inspection of their boat and equipment.
6. Talk while inspecting, and point out watercraft checkpoints. If they do not want to assist you in the inspection, continue to talk about invasive species as you inspect.
7. Give your final message, the prevention steps:
   - Inspect your boat, trailer and equipment and
   - Remove any attached aquatic plants, animals, and mud.
   - Drain all water from boats, vehicles, and equipment (including live wells and containers holding your catch).
   - Never move live fish away from a waterbody.
8. Offer them the "Stop Aquatic Hitchhikers" brochure and sticker, along with any other educational materials pertinent to their questions or your lake.
9. Thank them for their time and cooperation!

Sample Script

As the boat approaches, write down the time of the boat inspection and if the boat is entering or leaving the water.

Introduce yourself:

Good Morning / Afternoon. I am from _____. We are working with state agencies and local groups to talk with boaters about invasive species and help them check their boats for Eurasian water-milfoil (EWM) and zebra mussels (ZM). We are trying to keep EWM/ZM and other harmful invasives from spreading from lake to lake. I have a few quick questions I would like to ask you, and then I would like to walk around your watercraft with you and point out a few places where these species can attach to boats and trailers.

Ask the questions and record on the Watercraft Inspection Report Form:

1. Have you been contacted by a watercraft inspector this season?
2. Are you willing to answer a few questions?
3. Was boat used during the past 5 days on a different waterbody?

   (If the answer is yes) Where?

Use conversational approach to discuss the AIS prevention steps listed on the form with the boater, asking the follow-up questions to engage the boater. Use the educational prompts on the "Prompts" handout as needed to explain the importance of each step and discuss local AIS concerns.

Wisconsin law requires boaters to take the following steps when leaving a boat landing:

Steps 1 & 2: **Inspect** boat, trailers, and equipment and **remove** any attached plants/animals.

Have you heard of this before? (see prompt)

Step 3: **Drain** all water from **boats**, vehicles, and equipment.

Do you have any questions? (see prompt)

If angler, state the following steps:

Step 4: **Drain** water from **livewells** and containers holding your catch.

This is a relatively new law. Were you aware that this is required? (see prompt)

Do you use live bait? (If YES, share message below.)

Bait Message: If live bait comes in contact with lake/river water, it can only be used on that same waterbody or discarded in trash. (bait=minnows/leeches/worms)

Do you have any questions on this law as it can be a little confusing? (If yes, see prompt and offer bait sticker/brochure.)

Perform a watercraft check:

If you would walk around your boat with me, I can show you some areas to look for invasive hitchhikers.

Make sure you talk aloud as you inspect; it helps reinforce the "Clean, Boats, Clean Waters" behavior. Talk to boaters about inspecting and cleaning their watercraft and about draining the water from their boat—such as the bilge, bait buckets and live wells—before they leave the access.

Vegetation can be found on motor boats, the motor/prop, anchors, bunks, rollers, the trailer axle, lights/wiring; for jet skis, it can be found in the intake grate and propeller; and for sailboats, it can be found in the centerboards. Check your anchor and anchor line to see if any plants are clinging to it. Since water is another way invasives are spread, livewells, motors, and equipment need to be drained.

Some aquatic invasives, such as zebra mussels, are also found on the motor/prop, on the sides and bottom of boat below the waterline, on the anchor, and clinging to vegetation. Always inspect the hull and sides of your boat for aquatic invasives; if it feels gritty or sandy, it may be that new zebra mussels are attached. An extra precaution that you can take to eliminate other aquatic invasives is to wash your boat with warm tap water or take your boat through a car wash or dry your boat and equipment in the sun for five days before entering another lake.

Leave boaters with a final message:
"Clean Boats = Clean Waters"

Please make it a habit to:

- **Inspect** your boat, trailer and equipment and
- **Remove** any attached aquatic plants, animals, and mud.
- **Drain** all water from boats, vehicles, and equipment (including live wells and containers holding your catch).
- Never move live fish away from a waterbody.

Offer boaters the "Stop Aquatic Hitchhikers" brochure and sticker, which can be placed on the side of the trailer winch post or hitch. Tell them that this sticker can serve as a reminder of the AIS prevention steps. Offer anglers the "Wisconsin Anglers: Minnow Use Reminder" sticker and "Fishing with Bait" brochure. Tell them that those two items describe Wisconsin's bait laws clearly, in case they have any questions.

Thank the boaters for their time and cooperation!

After you've contact the boater, record the number of people who heard your prevention message and indicate how confident you feel about the boater's understanding of the AIS prevention steps. This completes the Watercraft Inspection Report Form!

Potential Scenarios/Questions from Boaters

"Why are you out here wasting resources when the plant is going to come anyway?"

Even the most educated will ask this question. Just be prepared mentally for such viewpoints and think about why you are out here and what you will say in reply. Expect the unexpected. Here are some suggested responses:

Even if we cannot keep the plants out completely, we can prevent a lot of widespread damage. Prevention also gives us time to adopt new control methods as they are developed in the future. The longer we keep invasives out of a lake, the longer we put off the enormous costs of management and property devaluation.

"Aren't all plants bad anyway?"

It is important to clear up this misconception! This is what you can say:

Native plants are essential lifelines for an aquatic ecosystem, providing the basis for all life within. The problem lies with non-native, invasive plants that have no natural inhibitors and, therefore, outcompete native plants, lowering the water body's aquatic diversity.

"I don't have time for this... I know all about it already!"

This remark is fairly common. If the boaters do not wish to help you with the survey, you must respect their rights and let them be. In such a situation, the suggested action would be to offer them a brochure and wish them a nice day.

"Why did it take Wisconsin so long to do something, when milfoil has been a national problem for over a decade?"

There is no good answer to this question because it's a very good point. Here is how you can respond:

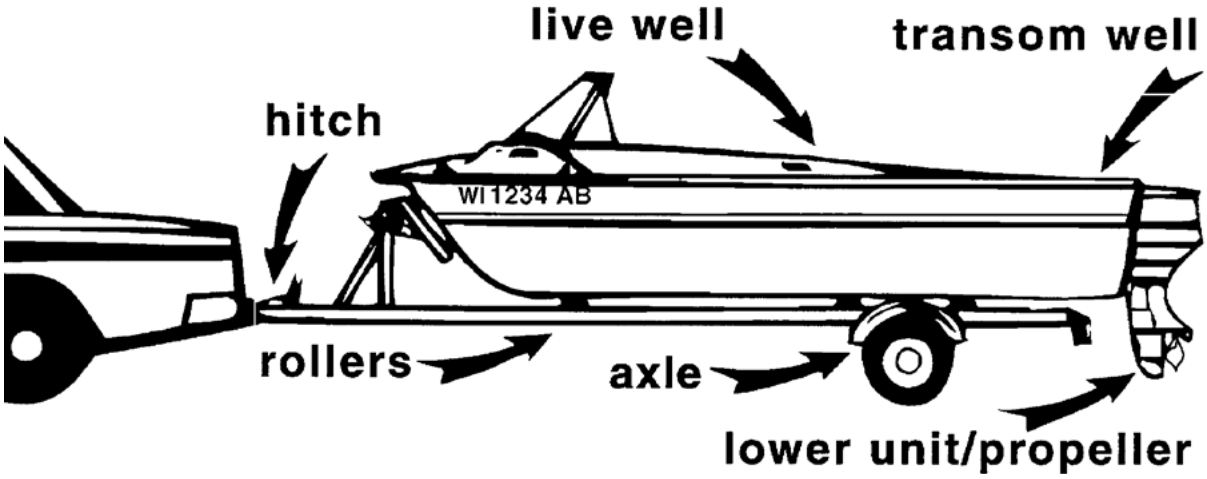
Traditionally, environmental problems become established before we do anything about them. In this case, we have learned from other states, and are trying to take action well before these plants spread to many of our sensitive environments. Instead of focusing on what could have been done, we should focus energies on the present and future.

"Why do I have to take these prevention steps when I only use my boat in one lake?"

This question gives you the opportunity to talk about the value of changing our behaviors and why it is important.

That's a great question! Although you always visit the same lake, it is still useful for you to take these prevention steps every time you boat. Repeating these steps helps the actions become a regular part of your boating behavior, so that if you do ever decide to take your boat to another lake, you will remember to take the prevention steps. Prevention is the key to stopping the spread of aquatic invasive species.

Watercraft Check Points



Trailer:

- ❑ Axle
- ❑ Bunks
- ❑ Frame
- ❑ License Plate
- ❑ Lights/wiring
- ❑ Rollers
- ❑ Spare Tire
- ❑ Wheels
- ❑ Winch Rope

Boat:

- ❑ Floor
- ❑ Hull
- ❑ Livewell
- ❑ Transom Well

Motor:

- ❑ Intake Pipe
- ❑ Prop
- ❑ Lower Unit

Boat Accessories:

- ❑ Anchor
- ❑ Bow Line
- ❑ Ladder
- ❑ Tow Rope
- ❑ Transducer

Other Accessories:

- ❑ Bait Bucket
- ❑ Fishing Line
- ❑ Landing Net
- ❑ Tackle

How to Handle Violations

With thousands of boaters traveling throughout the state and with many of those boaters jumping from lake to lake within one day, it is very realistic to expect someone to try to launch a weed-filled trailer at your landing. Since 2001, it has been illegal to launch a boat or trailer with aquatic plants or zebra mussels attached, and in 2009 it became illegal to transport aquatic vegetation or water from one place to another, in addition to other AIS laws (see Section 3 for more details). Not all folks know about Wisconsin's AIS laws. Even after a number of publications, news articles, and television programs concerning invasive species, not all boaters realize the importance of their action or lack of action in preventing the spread. Keep in mind that you should first try to educate the public.

If you choose to report launching violations, make sure you have done your homework. Contact your local DNR Conservation Warden and local law enforcement to let them know that you'll be doing inspections. Ask if they are willing to provide you with support in the case of a violation, what information is necessary for enforcement, and more importantly, ask whether the enforcement officer will be willing be act on a violation if he or she has not witnessed the event. Knowing these answers before the event will certainly predict a better outcome.

So what happens when a boater violates an AIS law? Several options can occur, from the least offensive reaction to the strongest objections to remove and comply with the law.

The soft touch: Boaters who are unaware of the AIS laws will probably put the boat in the water and think nothing about it. Unfortunately, this has been the practice for many years, which is one reason Wisconsin is struggling to control the spread of aquatic invasive species. However, you have an opportunity to educate that boater about the dangers of invasive plants and the prevention steps that boaters need to take each time they leave a body of water. With luck, boaters will listen to your message and remove aquatic plants and drain all water without any assistance.

An assertive approach: So what do you do if a boater doesn't get the point? Offer to assist the boater in checking and removing any aquatic plants. Always ask permission first before you touch any boat, trailer, or personal equipment. If the boater gives you permission, go ahead and help remove the plants and ask if you can keep a sample, especially if you suspect an invasive species. Let the boater know that you're just trying to prevent them from receiving a citation from any law enforcement or wardens that stop by, because the wardens are stepping up the number of citations they're issuing for AIS violations.

The strongest approach: And what if the boater refuses to remove the aquatic plants or drain water from their boat and equipment? At this time, you really stress the fact that it is illegal to not comply with the prevention steps that you're recommending, and you use the Violation Report form to record the basic information that a law enforcement officer requires in order to pursue the complaint. If you take a picture, it should include the boat registration number and attached plants. Usually, by this last step, the boater complies, the plants come off the boat, and the lake remains safe from another invasive arrival.

If the boater chooses to launch after all your efforts, then you can report the facts to a law enforcement officer. The definition of "law enforcement officer" for purposes of section 30.715 (4), Wisconsin Statutes, is noted at section 30.50 (4s), Wisconsin Statutes, which reads:

30.50 (4s) "Law enforcement officer" has the meaning specified under s. 165.85 (2) (c) and includes a person appointed as a conservation warden by the department under s. 23.10 (1).

Section 165.85 (2) (c), Wisconsin Statutes, in turn defines "law enforcement officer" as any person employed by the state or any political subdivision of the state, for the purpose of detecting and preventing crime and enforcing laws or ordinances and who is authorized to make arrests for violations of the laws or ordinances that the person is employed to enforce.

The definition of "law enforcement officer" is obviously very broad and would clearly allow law enforcement officers of counties and municipalities throughout the state to enforce the AIS regulations and laws. Your best resource is your regional DNR Water Guard or local DNR Conservation Warden. Before you pursue any enforcement action, make contact with your local warden to know what information the warden expects from you. The warden will decide how to process the violation.

We are excited to now have DNR Conservation Wardens devoted primarily to providing education and enforcement on the AIS laws and regulations. Each DNR region in Wisconsin has at least one Water Guard; in some cases, more than one.

Photo provided by WDNR

AIS Violation Report Form

BoatLanding/Location:_____

Date:_____ Time:_____ AM or PM

County:_____ Town/Village/City:_____

Vehicle License Number:_____ State Registered:_____

Boat Registration:_____ State Registered:_____

Car/Boat/Personal Watercraft Information -

Year:_____ Make:_____ Model:_____ Color:_____

Violator Information: Male or Female

Name of Boat Operator:_____

Hair:_____ Eyes:_____ Approx. Height/Weight:_____

Other Description (clothing, etc.):_____

Photo Taken of Violation: Yes or No

Description of Violation/Comments:_____

_____

_____

_____

CBCW Inspector's Contact Information -

Name:_____ Phone Number:_____

Address:_____

❒ Please check box if law enforcement may contact you for more information about the violation. You will remain confidential in this case.

❒ Please check box if you do not want law enforcement to contact you for more information about the violation.

Regional Water Guard Contact Info:	**To report the violation, contact your area Water Guard or DNR Warden OR call 1-800-TIP-WDNR**	Local DNR Warden Contact Info:
_____		_____
_____		_____

Section 3:

How do inspectors share their inspection data?

Collecting & Reporting Inspection Data

As a part of conducting watercraft inspections, data is collected by volunteer and paid Clean Boats, Clean Waters inspectors at boat landings and recorded on the Watercraft Inspection Report form. This form contains questions that help citizens and the state better understand boaters' knowledge and behaviors regarding aquatic invasive species. The data gathered at the boat landings is then entered into a large online database, called the Surface Water Integrated Monitoring System or SWIMS, by watercraft inspectors.

Data collected at boat landings provides citizens and the state with valuable information.

Photo by Robert Korth

There are **many advantages** to keeping records for the watercraft inspection program:

- With limited state resources, it makes sense for each inspection team to track their own data.
- Collecting data helps the inspection team discover traveling patterns of boaters who visit their lake.
- The data may be useful information if the local lake association or lake district applies for a DNR Lake Planning and Management Grant or an Aquatic Invasive Species Prevention and Control Grant.
- The data could also be useful for local ordinance reviews that pertain to the boat landing or waterbody use.
- **Most importantly**, by recording and sharing information on SWIMS online database, inspection teams will assist lake managers with invasive species prevention and control and will quantify the impacts that both paid and volunteer inspectors are having on invasive species. **Having this information helps justify the continued need to support the invasive species programs.**

How to Use the Watercraft Inspection Report Form

Each day that you conduct watercraft inspections, you will be collecting data about boater behaviors and awareness on the Watercraft Inspection Report form. The forms are designed to be used at one boat landing for one day. Each day you inspect boats, you will use a new report form, and you may use multiple report forms if you visit more than one boat landing in a day. If you run out of room on the report form during your time at the landing that day, it's no problem - just start a new form and staple it to the other forms that you complete at that boat landing for that date. Below are a few guidelines to assist you in effectively collecting and recording the correct information on your form.

Preparing the Form for Inspections

To get your inspection form ready to enter data, fill in the top section with the who, what, when, and where information. This information can be typed into the form and printed out ahead of time or written on the form by hand.

- Inspector Name(s): Enter your name here. You may include the names of any other inspectors who are working with you at the boat landing on that day.
- Date: Enter the date you are conducting inspections. Remember, data forms can only be used for one day on one waterbody at one boat landing. If you go to another boat landing the same day, start using a new form.
- Start Time & End Time: Enter what time you are starting inspections and what time you will wrap-up inspections for the day.
- Total Hours Spent: Indicate whether you are volunteering your time or being paid to do inspections by entering the total number of hours you spend at the boat landings on either the "Volunteer" or "Paid" lines.
- Waterbody Name: Enter the name of the lake where you are conducting inspections.
- County: Enter the name of the county in which you are conducting inspections. Since many lakes have similar names, this helps us know the exact location.
- Landing Location Description: Enter the name of the boat landing where you are inspecting. If the landing has no name, describe your location on the lake as thoroughly as possible. Later when you're ready to enter your data into the online database, we can make sure the correct landing names are available for your waterbody.

Collecting Data During Inspections

Now you're ready to begin inspections. When you encounter a boater, you will introduce yourself and begin your conversation with them about AIS. The questions to ask them are outlined on the form as follows, and you will record their responses, in most cases by marking the appropriate boxes on the data form.

- In the "Boat Was…" section, note if the boat or trailer was entering the water or leaving the water. On waters that have aquatic invasive species already present, inspections should take place as boaters and anglers are leaving the landing. Sharing information with them as they leave the water helps ensure the AIS are being contained in that waterbody and not being spread elsewhere. On waters free of AIS, inspectors have a choice of educating boaters when they're entering or leaving the water. Either time offers a good opportunity to share information.

- The "Questions to Ask Boater" section includes three questions that you should talk about with the boater.

  - **Have you been contacted by an inspector this season?** Answers to this question help prevent you from sharing the same AIS prevention message with the same boaters over and over. We don't want to over-saturate the same boaters with the same message - this could frustrate them. This question also helps us to learn more about how many boaters and anglers we are reaching with inspections. It also tells you about the boater's potential awareness of AIS and boat inspections. Boaters who have never talked to an inspector before will often need more information than someone who has been inspected previously.
  - **Are you willing to answer a few questions?** If the answer is yes, continue on to the next question. If the answer is no, thank the boater for their time and tell them to have a nice day. Your conversation with them is complete.
  - **Was the boat used during the past five days on a different waterbody?** If the answer if yes, record the name (and county and state, if possible) of the last waterbody. This allows state and local groups to compile information on boater traveling patterns. If the answer is no or I don't know, please indicate that my marking the corresponding box.

- You're now ready to engage the boater in an educational conversation, using the questions and prompts listed under the "Discuss Following Prevention Steps with Boater" section.

  - Following the steps listed on the form, share the prevention message step by step and ask the follow-up questions listed after each step with the boater. Use the prompts provided on the "AIS Prevention Steps Prompts" handout to assist you with localizing your message and answering any questions you receive.

- For all anglers, share the additional step and follow-up question regarding draining livewells. If the angler uses live bait, please share the bait message and follow-up question included on the form. This information can also be shared with boaters who have questions about bait laws.

- The last two questions on the form are observations and opinions to be recorded by the inspector. These are not questions that should be asked of the boater.

  - The "Number of People Contacted" question refers to the number of people who heard your message. This can include any children who were listening while their parents prepared to launch their boats or individuals who were simply visiting the landing.

  - The "I feel confident that boater understands the steps necessary to prevent the spread of AIS" question asks for your **opinion**. After talking with the boater about the prevention steps, indicate your level of confidence that the boater **understands** the prevention steps. This is not the same as whether of not you feel the boater will take the steps - just how confident you are that they received the AIS message.

Wrapping Up After Inspections

Once you've completed your inspections at that boat landing for the day, you may have one form or many forms full of the data that you've collected. Before you put the forms aside to enter later, be sure to do just a few quick things to make sure your data form is complete.

- Fill in any additional thoughts or comments you'd like to record in the "Comments" section at the bottom of the form, such as the weather conditions, if there were any unusual occurrences that day, or anything else you'd like to share.

- Data is collected and entered for each landing each day. If you have multiple data sheets, use the "Sheet__of__" spot to indicate how many total sheets you have for that day and number each sheet accordingly.

- Lastly, total each column on the datasheet and enter the total number in the last row titled **"Totals"**. To do this, count the number of checks or marks you have made in each column and record that number in the "Totals" row (the exception being the waterbody and county/ state names as they cannot be totaled). Don't forget, data is collected and entered for each landing each day. So, if you have multiple datasheets, you'll count the column marks on all of the datasheets and have a grand total for each column that includes the data from all sheets.

Now you're ready to enter your data into the online database known as SWIMS (Surface Water Integrated Monitoring System). More information and instructions on how to enter data can be found in the following pages. **Best of luck in your watercraft inspection program, and remember to let boaters know that they're making a difference by following the prevention steps!**

State of Wisconsin
Department of Natural Resources
Wisconsin Lakes Partnership

Watercraft Inspection Report

Form 3200-120 (R 4/14)

Notice: Information is collected under s. 33.02, Wis. Stats. Personally identifiable information, including names of volunteers, will be broadly distributed in conjunction with lakes data.

Inspector Name(s)	Date	Start Time ◯am ◯pm	End Time ◯am ◯pm	Total Hours Spent: Paid: ______ Volunteer: ______
Waterbody Name	County	Landing Location		

Boat Was... Entering	Boat Was... Leaving	Questions to Ask Boater: Have you been contacted by a watercraft inspector this season? Y	N	Are you willing to answer a few questions? Y	N	Was boat used during the past 5 days on a different waterbody? Y	N	If YES, where? Waterbody Name / County / State	Don't know	Number of People Contacted	I feel confident that boater understands the steps necessary to prevent the spread of AIS. (Check one) Strongly Agree	Agree	Disagree	Strongly Disagree
TOTALS														

Discuss Following Prevention Steps with Boater

WI Law requires boaters to take the following steps when leaving a boat landing:

Steps 1 & 2: **Inspect** boat, trailers and equipment and **remove** any attached plants/animals.

» Have you heard of this before? (see prompt)

Step 3: **Drain** all water from **boats**, vehicles and equipment.

» Do you have any questions? (see prompt)

If angler, state following steps:

Step 4: **Drain** water from **livewells** and containers holding your catch.

» This is a relatively new law. Were you aware that this is required? (see prompt)

Do you use live bait? (If YES, share message below.)

Bait Message: If live bait comes in contact with lake/river water, it can only be used on that same waterbody or discarded in trash. (bait=minnows/leeches/worms)

» Do you have any questions on this law as it can be a little confusing? (If yes, see Prompt and offer bait sticker/brochure)

TOTALS: Enter the totals & waterbody information into SWIMS at **http://dnr.wi.gov/lakes/cbcw-data**

Comments:

Sheet ____ of ____

Sharing Information

Everyone who attends a "Clean Boats, Clean Waters" training workshop is entered into the watercraft inspector database. Each participant's name, address, and contact information is collected during the workshop and reported in the inspector database. This helps us keep track of the inspection efforts that are going on around the state.

Obtain a SWIMS User ID & Password

Ready to enter your inspection data? Watercraft inspectors must obtain a user ID and password before they can enter any information into the SWIMS online database. Here's how:

1. Go to: **https://on.wisconsin.gov**.
2. Click on the link labeled **"Self-Registration"**.
3. Scroll all the way down to the bottom of the page and click **"Accept"**.
4. Fill in your name and e-mail address. (Note: Only fields with a red asterik* next to them need to be filled out. Leave the postal address field blank. Addresses for inspectors are kept in a separate database.)
5. Choose a User ID, password, and a secret question (used in case you forget your account information.)
6. Click **"Submit"**. Now check your e-mail account. You should have an e-mail from "wisconsin.gov". Open the e-mail and **click on the link in the e-mail**. Log in with your new User ID and password.
7. You're almost done! **The final step is to e-mail your User ID to: jennifer.filbert@wisconsin.gov.** In the e-mail, **state that you are a part of Clean Boats, Clean Waters and say where you are going to be inspecting** (i.e. Big Lake in Shawano County). Also, **mention if your inspection efforts are part of a DNR lake or AIS grant**. Within a couple of business days, your User ID will be entered into the SWIMS database, and you will be sent an e-mail letting you know that you're all set up to enter data.

Common Questions/Issues & Tips:

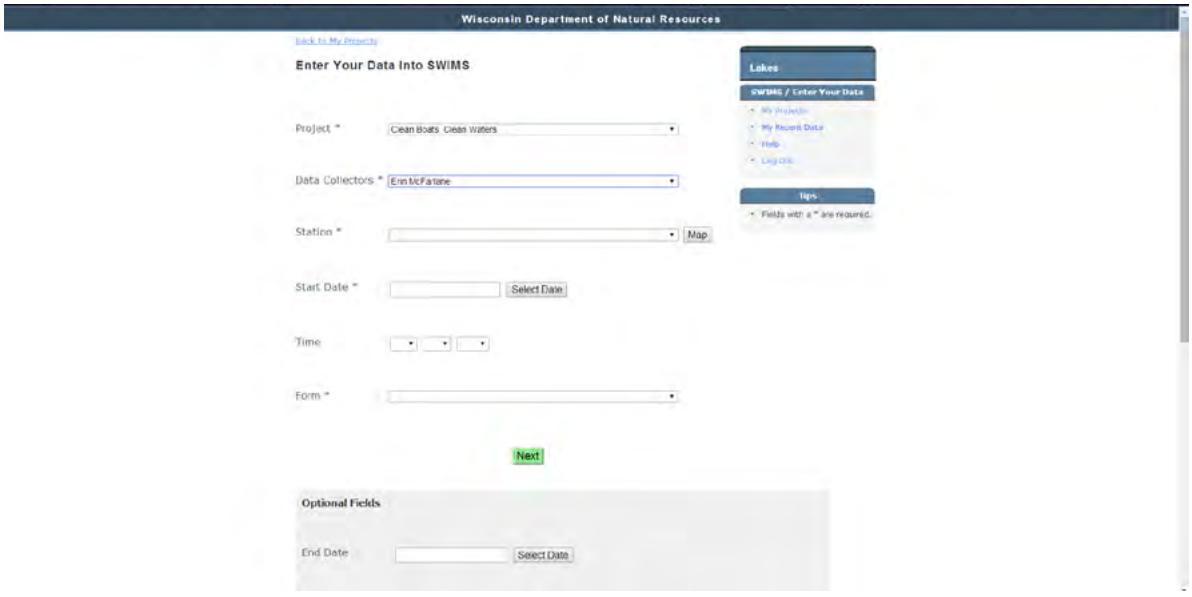
- ⇨ ***When I open the e-mail to click the link, the link doesn't work.*** If the link in the e-mail wraps to the second line and if you click and don't get a log in page, try copying and pasting the part that wrapped around onto the end of the URL.
- ⇨ ***I don't know what to put for the Secret Question.*** The secret question should be something you can easily remember that doesn't change. You want to pick something where there aren't too many ways to type the answer. For example, name of first pet, color of first car you owned. The secret question has nothing to do with your password, but if you forget your password, it's a way for the computer to tell that it's really you.
- ⇨ ***I don't have an e-mail address.*** If you don't have an email address, there are many places on the Web where you can get a free email account from Google, Hotmail (MSN), Yahoo!, etc.

- ***When I try to fill in my information (name, address, etc.), it doesn't accept it.*** There is a bug with entering postal addresses, so leave the address blank. Also note: even if you don't fill in the address, addresses for inspectors are kept in a separate database system, so we will still have your address if you have already given it to us.
- ***I got a user id and password, but when I try to log into SWIMS, but it won't recognize me.*** Be sure to e-mail your user ID to Jennifer (see step 8).

Entering Your Data Into SWIMS

After you receive your user ID and password, you will be able to enter the information you have collected during the watercraft inspections. Online data entry involves entering the numbers in the"Totals" row located at the bottom of your report form. Here are step-by-step instructions on how to enter your inspection data into SWIMS:

1. Go to: **http://dnr.wi.gov/lakes/cbcw-data** (this web address is also listed on the Watercraft Inspection Report form).
2. **Log in with your user ID and password.** If you forget your password, just click on "Forgot Your Password?"
3. Your "My Projects" page will list your active CBCW projects. Projects are often specific to the lake being inspected (example: Clean Boats, Clean Waters - Long Lake). If you are inspecting many waterbodies in a county, your project may be broken down by county and year (example: Clean Boats, Clean Waters - Oneida County). Click **"Enter Data"**.
4. Ensure the correct project is listed by using the dropdown menu. Then, **select the data collectors and station (boat landing)**. If there are additional data collectors that you'd like to add but they're not listed in the dropdown menu, send jennifer.filbert@wisconsin.gov a list of names, and she will add them to you dropdown box. Alternatively, inspector names can be listed in the "Comments" field.



5. **Select the Start date and time** (when you started working at the landing that day). End date and time are optional.
6. Under Form, ensure the **Watercraft Inspection Report (Revised 3/2014)** is selected.
7. Down below, you have the option of entering the End Date and Time, as well as your written observations in the **comments** box (i.e. weather, wildlife).
8. **Click "Next" to begin filling in your totals**. The data you enter will be in the "Totals" row found at the bottom of your report form.
9. When you've filled in the totals, **click "Next" and you can enter any waterbody names that boaters reportedly visited during the past five days**.
10. Then, **click "Next Date" to continue entering data for another day, or click "Next Station" to enter data collected at another boat landing. If you're finished with data entry, click "Done"**. When you click "Done", you will see the data you recently entered.

Editing Existing Data

You can edit data you've entered during the current inspection season. Here's how:

1. Log into SWIMS at: http://dnr.wi.gov/lakes/cbcw-data.
2. Click **"Edit Data"** listed under your CBCW project. Click the **pencil icon** for the date you want to edit.
3. You can edit comments, etc. on the first page if necessary, and then click **"Next"**. You can now edit your results. If you hit **"Save and Return to List"**, your changes will save, and you'll return to the list of data entries.

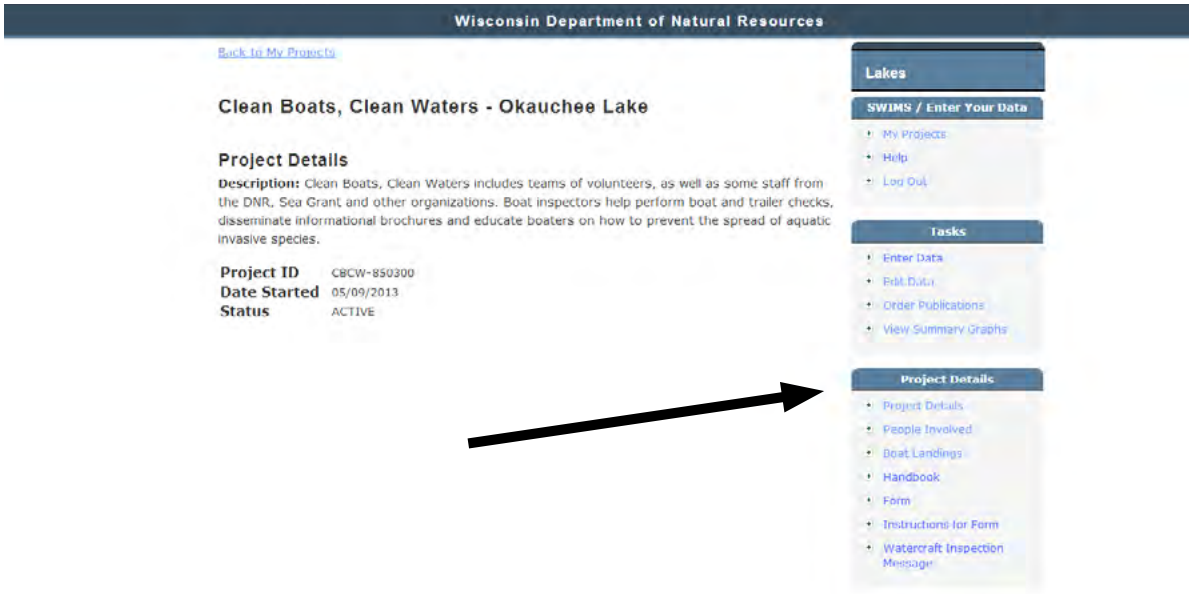
Common Question:

- ***What if the landing I need isn't listed? What if I'm not sure?*** You can select a landing and click "Show Map" to see where it is located. Otherwise, contact Jennifer at jennifer.filbert@wisconsin.gov to have a landing added or to suggest a better description for the landing.

If you need assistance with anything related to reporting your data, feel free to contact Jennifer at jennifer.filbert@wisconsin.gov.

Project Details

After logging into SWIMS, you will see your "My Projects" page that lists all of the projects you are associated with. By clicking "More" under a specific project, you can view the details of that project. You can also access a variety of project details and resources located in the tool bar on the right-hand side of the page. This includes information like: a list of the landings associated with the project, a list of inspectors involved in the project, data download and summary graphs of the project data, and links to the CBCW manual, Watercraft Inspection Report form, and more.



"Anything else you're interested in is not going to happen if you can't breathe the air and drink the water. Don't sit this one out. Do something. You are by accident of fate alive at an absolutely critical moment in the history of our planet."

- Carl Sagan

Section 4:

How can inspectors take care of their boat landings?

Boat Landing Inventory

The "Clean Boats, Clean Waters" program offers an excellent opportunity for inspectors to inventory the boat landings on their lake. Oftentimes the signage is old or damaged and needs to be replaced. Boat ramps and piers may need servicing or trash buckets may be missing. If the landing has a message board or kiosk, inspectors can post informational brochures about invasive species and contact numbers if a questionable plant or animal is found. Remember, the boat landing is the first opportunity for inspectors to educate boaters. The watercraft inspection team cannot be there for every boater, so inspectors must be prepared to offer education and information at any time.

It is important to know who owns the landing and who to contact when maintenance needs to be done. Inspectors should always seek permission prior to making any changes at the landing site.

If the landing is in need of signage, inspectors can contact their local DNR service center for the appropriate sign (see the following pages for the sign posting information and an image of the AIS landing sign). To assist inspectors in developing an educational message, the "Clean Boats, Clean Waters" resource kit and the "Clean Boats, Clean Waters" Web site: http://www.uwsp.edu/cnr/uwexlakes/cbcw contain examples of brochures and flyers that can be customized for each community.

Photo by UW-Extension Lakes

Instructions for AIS Sign Installation

Thank you for posting Wisconsin's new AIS signs! AIS signs are an effective tool for reminding and educating boaters about AIS prevention steps and Wisconsin's AIS Law. It is our goal to place AIS signs at all public boat landings in the state.

Before Installation…

Required:

Contact Diggers Hotline before you install any post at a boat landing. Although new posts may not be required, it is helpful to contact Diggers Hotline to avoid surprises in the field. The request to Diggers Hotline can be submitted electronically. For more information, visit: http://www.diggershotline.com and click on "Ready to file? Click here!". Always call before you dig or put a post in the ground!
Diggers Hotline - Wisconsin's One-Call Center: **CALL 811 or (800) 242-8511 | (877) 500-9592 (emergency only)**

Recommended steps:

Taking the time to put together a map, obtain permission, and plan a route saves time and miles in the field. Plan ahead and follow these recommended steps:

1. Delineate township lines on map copied from Wisconsin Gazetteer and County plat books.
2. Identify lake and river landings on maps.
3. Obtain permission from landing owners by contacting Federal agencies, DNR (Forestry/ Fisheries) department, county (Land and Water Conservation, Forestry or Parks), cities, towns, villages, and private owners. Boat landing operators and managers can also be searched online within the "more information" section at: http://dnr.wi.gov/topic/lands/boataccess. County clerks offices also frequently have this information available. Please see attached sample permission letter and form for details.
4. Gather additional needed materials, such as printing off boat landing survey forms for each boat landing that will receive a new sign (see page 8-10 for survey form). This may also be a good opportunity to replenish publications at kiosks. To place AIS publication orders, please email orders to DNRAISinfo@wisconsin.gov.
5. Contact local officials for directions to landings and for locations of commonly used private landings not on the map. They often can provide names or phone numbers of private landing owners and other helpful information.

Current signs at boat landings:

There are three AIS signs that the DNR has provided in the past and you will likely encounter at boat landings. The intent of the new sign is to replace these old signs. Therefore, we recommend you take down these signs during your visit and return them to your local DNR office. These signs will be recycled for the new signs, which will greatly reduce our costs. These signs are:

1. "Exotic Species Advisory"

2. "HELP Prevent the Spread of Aquatic Exotic Plants and Animals"

3. "Please Stop and Remove All Aquatic Plants and Animals and Drain Water from Boat and Trailer"

Sign Installation

Equipment you will need:

- ✓ 7-8 foot metal U-posts (U channel posts).
- ✓ Post pounder/sledge hammer
- ✓ Step Stool
- ✓ Hammer
- ✓ Cordless drill and drill bits
- ✓ 5/16" socket and wrench
- ✓ 5/16" x 2 ½" Hex bolts for securing yellow signs to post.
- ✓ 5/16" x 2 ½" Carriage bolts for securing metal signs (no washer needed).
- ✓ 5/16" Lock nuts (with plastic threads so no lock washer needed)
- ✓ 5/16" Tufnut (anti-theft) security nuts, bolts, and washers for posting areas where signs tend to disappear.
- ✓ Maps:
  - Wisconsin Gazetteer
  - Lake Maps
  - Plat Books
- ✓ Other:
  - Boat landing survey form (1 form/sign), see attached
  - Permission slips, see attached
  - Directions to landings
  - Boat Landing Inventory Form (water resistant paper suggested)
  - Ear plugs/muffs
  - Gloves
  - Hard Hat
  - Cell Phone
  - Digital Camera
  - Regional DNR Telephone Directory
  - Warden Contact Numbers
  - Sun block
  - Sunglasses
  - Pencils
  - Permanent marker
  - Clip Board
  - Watercraft Inspection Report (to record any watercraft inspection efforts)
  - Brochures, Wild Cards to distribute to the public at the landings

How to install a sign:

1. Contact Diggers Hotline before you install and request permission to install a new sign.
2. Find ideal sign location facing water, that is easily visible to boat landing users.
3. Make sure sign is out of way of vehicle traffic. In order to maintain public safety, NO signs should ever be installed on traffic regulatory sign posts. If there are any questions about appropriate sign location at public access sites, please consult the property manager.
4. Use post pounder or sledge hammer and secure U-post 2-3 feet in ground making sure the open end of "U" faces the water.
5. Align top of sign with top of U-post and insert bolts from front of sign through predrilled hole in the top and bottom of the sign and post. (Make sure both holes line up with holes in post before securing with nut or tufnut).
6. Use socket and/or wrench to secure nut or tufnut to bolt.
7. Make sure sign is secure.
8. Place red "this waterbody is known to contain…" sticker, if applicable. Check online at http://dnr.wi.gov/lakes/invasives/AISByWaterbody.aspx for a list of waterbodies known to contain AIS.
9. FILL OUT boat landing survey form and upload information into SWIMS or return by mail.
10. Repeat at next landing.

What to do after new signs have been installed:

1. Recycle metal and plastic signs, posts, and hardware to a local recycling facility. You may also keep them if you think you may be able to use them in the future.
2. Remember to enter your boat landing survey form into SWIMS or to mail it back to:

AIS Education Specialist
Wisconsin DNR- WT/4
101 S. Webster St.
Madison, WI 53703

If you have additional questions/comments please contact Bob Wakeman at robert.wakeman@wisconsin.gov. Thank you again for your efforts in protecting Wisconsin's waters!

The new AIS boat landing sign is 18" wide by 24" high and is made from reflective metal.

Sample Permission Letter

State of Wisconsin / DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
William H. Smith, Regional Director

Northern Region Headquarters
107 Sutliff Ave.
Rhinelander, Wisconsin 54501-3349
TELEPHONE 715-365-8900
FAX 715-365-8932
TTY 715-365-8957

Date:

Subject: Permission to post signs at boat landings

Dear Town Board of Supervisors,

One of the ways the Wisconsin Department of Natural Resources (WDNR) is addressing the challenge of combating invasive species in Wisconsin's waters is by posting signs at boat landings. These signs alert boaters to invasive species present in the waterbody and provide tips to prevent their spread to other lakes and streams. Other strategies to combat this problem include monitoring lakes for invasive species, training volunteers to monitor their own boat landings through the Clean Boats/ Clean Waters workshops, watercraft inspection efforts by agency staff and dissemination of education/outreach materials.

Your assistance is requested to help us post the signs. *Please forward to us a list of boat landings under your ownership.* We will then inform you which lakes contain invasive species and thus should be posted with the warning signs. *Your written permission granting authority to the WDNR to place signs at your boat landings is also necessary before sign placement can occur.*

Enclosed are copies of three metal signs. The plastic "yellow exotics advisory" sign is placed at boat landings on infested waters and the "Help Prevent…" sign is placed on uninfested waters. Both these signs are placed near the launch site. The "Stop" sign is posted as they leave the launch site as a reminder to boaters to clean their boats and equipment.

Feel free to contact me with any questions or concerns. **Please return the authorization form and the list of landings to me at the address above.**

Thank you for your interest and cooperation.

Sincerely,

Contact information

Sample Permission Form

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin / DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
William H. Smith, Regional Director

Northern Region Headquarters
107 Sutliff Ave.
Rhinelander, Wisconsin 54501-3349
TELEPHONE 715-365-8900
FAX 715-365-8932
TTY 715-365-8957

Authorization to Post Signs at Boat Landings

The County Board of _____ hereby grants permission to the Wisconsin Department of Natural Resources to place signs at boat landings under our ownership and/or control. The signs are to alert and educate boaters to the problem of invasive species in our waters.

Granted this day of _____

_____ Signature

Authorized Representative

BOAT LANDINGS UNDER OUR OWNERSHIP

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Boat Landing Sign Survey

Our goal is to have new aquatic invasive species (AIS) signs on every public boat landing in the state of Wisconsin. In order to meet this goal, we need to determine which boat landings have received the new AIS signs and which boat landings we still need to visit. **Please fill out a separate survey for each Wisconsin DNR AIS sign that you install at an access point. This survey information can be uploaded to SWIMs or mail to:**

AIS Education Specialist
Wisconsin DNR- WT/4
101 S. Webster St.
Madison, WI 53703

The information you provide will help us greatly. Thanks for all of your hard work to protect Wisconsin's waters!

Name_____**Date of Installation** _____

Location of Access Point

Please fill out all known information.

County:_____

Municipality Name: _____

Waterbody Type:

- ❒ Lake
- ❒ River
- ❒ Wetland with navigable waterway
- ❒ Other _____

Waterbody Name: _____

Boat Landing Name: _____

Address/Closest Named Road:

_____

_____

_____

Follow-up Questions
Please fill in all known information.

Question 1: What type of access point was this?

- ❒ Ramp
- ❒ Carry-in
- ❒ Other

If Other, please explain:_____

Question 2: Before you installed the new AIS sign, 'Prevent the Spread…', were there other AIS signs at the access point?

Circle one: Yes / No

If Yes, check all that apply:

- ❒ Yellow 'Exotic Species Advisory' sign
- ❒ Green and white 'Help…. Prevent the Spread…' sign
- ❒ Green, white and red stop sign 'Please Stop and…'
- ❒ County ordinance sign
- ❒ Lake Association sign
- ❒ Other: _____

NOTE: Once new AIS signs are installed, we ask that you please remove all other DNR AIS signs. This includes the yellow 'Exotic Species Advisory' sign, the green and white 'Help Prevent the Spread…' sign, and the green, white and red stop sign.

Question 3: Did you remove any of these signs during your visit, or do you have plans to in the near future?

Circle one: Yes / No

If Yes, check all that apply:

- ❒ Yellow 'Exotic Species Advisory' sign
- ❒ Green and white 'Help…. Prevent the Spread' sign
- ❒ Green, white and red stop sign 'Please Stop and…'
- ❒ County ordinance sign
- ❒ Lake Association sign
- ❒ Other: _____

Question 4: When installing the sign, were you able to reuse the post from previous DNR signs?

Circle one: Yes / No

Question 5: Was this waterbody known to contain invasive species? (List of waters known to contain AIS at http://dnr.wi.gov/lakes/invasives/AISByWaterbody.aspx)

Circle one: Yes / No / Unsure

If Yes, was the red sticker "This Waterbody Is Known to Contain Invasive Species" applied to the bottom of the sign? Circle one: Yes / No

Question 6: Was the sign installed facing the water so people leaving the water could read it or facing the launching area so people launching could read it?

Circle one: Water / Land

Question 7: The ideal location for an AIS sign is at the access point, facing the water. However, we recognize this is not always possible. Please indicate the location that best represents where this sign is currently located (Check one):

- ❒ Next to the access point, facing water
- ❒ Next to access point, facing launch area
- ❒ On a pier or dock
- ❒ Next to or on a shelter or kiosk
- ❒ Next to the parking lot entrance or exit
- ❒ Other: _____

Question 8: Does the access point appear to be in proper working order? Yes / No

If No, please explain: _____
_____

Question 9: How many people installed the sign?

Circle one: 1 / 2 / 3 / Other:_____

Question 10: How would you describe yourself? (Check one that best applies.)

- ❒ DNR employee
- ❒ County employee
- ❒ Municipal employee
- ❒ Boat landing owner/operator
- ❒ Lake Association Member
- ❒ CBCW Volunteer
- ❒ Other: _____

Again, thank you for your efforts to protect Wisconsin Waters! **Please contact Christal Campbell with any questions: 608-266-0061 / christal.campbell@wisconsin.gov.**

Boat Landing Questions

Invasive species are posing an increasing threat to the quality of water experiences in Wisconsin. Communities are looking at developing a campaign to educate boaters at the landings on the possibilities and consequences of moving aquatic invasives. Other communities are developing plans to look at their water resources and prevent or slow the spread of aquatic invasives. The following is a list of questions that we have been hearing from communities as they consider various prevention plans.

Landing Ownership and Maintenance

How can I find out who owns the boat landing?

Ownership of boat landings can be determined through a variety of methods. Plat maps are one useful source, as are searches at the register of deeds office for the county in which the landing is located. Department of Natural Resources (DNR)–owned and leased boat landings are identified on the DNR Web site under the "State Parks and Forests" Web pages. The DNR Web site also provides a page that contains links to the Web sites of county-owned parks.

Do state-owned parks operate under different rules than county, village, or city parks?

State-owned parks with boat landings are regulated under ch. 26, Wis. Stats. and ch. NR 45, Wis. Adm. Code. County, village, and cities that own parks with boat landings usually operate such parks and boat landings under local ordinances.

Who is responsible for maintaining the boat landings?

Whoever owns or operates a boat landing is responsible for its maintenance.

Can boat landings be closed or have special launch hours?

State-operated boat landings are required to operate under the same hours as the state parks. Most Wisconsin state parks, recreation areas, trails, and forest campgrounds are open from 6 a.m. to 11 p.m. Occasionally, DNR sites have different hours as required under conditional use permits. Boat landings that have been funded by the DNR and that are operated under lease from the DNR must maintain the same hours. Other locally owned sites are subject to hours established by the local unit of government. The state does not regulate launch hours unless the hours create a significant impediment to public use of the site. Once a boat has been launched, it must be allowed to exit from the lake, even if after the prescribed launching hours.

What signage and items (composting bins, garbage cans) are acceptable and legal at landings?

Informational signs at DNR public access sites can be installed and should be located in compliance with shoreland zoning and other local regulations whenever practicable. Boat landings that are the responsibility of other governmental entities or private individuals or businesses are not exempt from the requirements of local zoning ordinances, and responsible parties will need to apply for any permits that may be required under applicable zoning ordinances. Signs may be required to be set back 75 feet from the ordinary high-water mark of navigable waters (although the DNR is likely to propose some changes to ch. NR 115, Wis. Adm. Code, that would exempt from county shoreland setback requirements certain regulatory and informational signs that meet specified standards). Composting

bins and garbage containers that are large and relatively immobile will need to be set back at least 75 feet from the ordinary high-water mark of navigable waters. However, the DNR's shoreland zoning program has taken the position for some time that small items that are easily moved by hand (such as movable garbage cans and picnic tables) are not subject to shoreland setback requirements in county shoreland zoning ordinances, even though the definition of "structure" found in dictionaries, ch. NR 116, Wis. Adm. Code (floodplain zoning ordinance rules), and in many local zoning ordinances is broad enough to theoretically include such items. Small structures that are easily moved by hand are likely to be specifically exempted from shoreland setback requirements when ch. NR 115, Wis. Adm. Code, is revised.

Launching fees

Are there state guidelines for communities that are considering boat launching fees?

The DNR encourages free boat launching. However, under s. NR 1.91(11), Wis. Adm. Code, a reasonable launch fee may be charged under authority of s. 30.77, Stats., for the purpose of operating and maintaining a boat access site owned or operated by municipalities, lake management districts, and other access providers. Excessive, unjustified, or unreasonable boat launching fees restrict or prohibit public boating access and use of navigable waters in the state. A reasonable launch fee for the purposes of s. 30.77, Stats., is one that does not exceed the maximum allowable amount under criteria identified in s. NR 1.91(11), Wis. Adm. Code. The base fee that can be charged for a state resident is that fee that is charged a state resident vehicle for entrance to the state parks.

Under s. NR 1.91(11), Wis. Adm. Code, public boating access surcharges may be added to a base fee for specific services identified in that code section. However, prior approval by the DNR is required when a public boating access provider proposes to charge a fee in excess of the resident state park daily entry fee. In addition, no more than the base fee may be charged for nonmotorized or nontrailered boats. Surcharge fees may be charged for vehicles with trailers at boat landings in the following circumstances: when an attendant is on duty, for on-site toilet facilities, at Great Lakes sites, for boats that are at least 20 feet in length but less than 26 feet in length, and for boats that are greater than 26 feet in length.

Do the fees have to be used for a particular item?

Boat launch fees are to be used for operation and maintenance of a boat launch site. Boat launch fees cannot exceed amounts established in s. NR 1.91, Wis. Adm. Code. The DNR's jurisdiction or authority is limited to whether the fee amounts comply with the s. NR 1.91, Wis. Adm. Code requirements.

Can the fees include the costs of operating a boat wash facility?

Boat launch fees may only be used for the operation and maintenance of a boat launch site, which could include a boat wash facility. However, as noted above, additional fees cannot be charged for a boat wash facility.

Can a special nonresident or out-of-state resident fee be charged?

Under s. NR 1.91(11)(g), Wis. Adm. Code, local units of government, including lake management districts that maintain and operate public boating access sites, may charge differential fees on the basis of residency within the unit of government maintaining or operating the access. If a fee is charged, the fees for a nonresident may not exceed 150% of the fee charged a resident and may not exceed the maximum allowable amounts except when surcharges for boats longer than 20 feet are in place.

Can a special fee be charged by someone who is not a riparian owner?

As noted above, differential fees can only be charged on the basis of residency within the unit of government maintaining or operating an access site. A special fee based only on riparian ownership or lack thereof would not be appropriate.

Can the launch fee be increased over time to assist in lake management costs, for example, controlling invasive species?

Boat launch fees can not exceed the maximum allowable amount established under s. NR 1.91 (11), Wis. Adm. Code.

Can the launch fee include nonmotorized equipment such as canoes, scuba equipment, or kayaks?

Under s. 30.50(2), Stats., a boat means "every description of watercraft used or capable of being used as a means of transportation on water, except a seaplane on the water and a fishing raft." This definition means that canoes and kayaks could be required to pay a launch fee, but a fee could not be charged for scuba equipment. However, no more than the base fee may be charged for a canoe or kayak because they are nonmotorized or nontrailered boats. A nonmotorized boat is a boat that is not a motorboat but that is designed and constructed to be used as a boat for transportation of a person or persons on water. The term includes, but is not limited to, any canoe, sailboat, inflatable boat or similar device, rowboat, raft, and dinghy that is not a motorboat.

If a fee is charged, how can it be collected?

Normally, launch fees are collected through the use of launch attendants who are on duty during the day or through the use of an honor system, in which the user voluntarily pays for launching when no attendant is on duty.

Do funds need to be reported?

Launch fees are the responsibility of the municipality that is operating the launch site. Any questions or concerns concerning the reporting of launch fees should be directed to the municipality that maintains the launch site. The DNR's jurisdiction or authority is limited to whether the fee amounts comply with s. NR 1.91, Wis. Adm. Code.

What is the public trust doctrine?

The Wisconsin Constitution establishes a state-administered public trust for navigable waters of the state. Under the public trust doctrine, the state holds the beds of navigable bodies of water in trust for all its citizens and has an obligation to protect public rights in navigable waters.

What is the relationship of the public trust doctrine to local regulations?

The public trust doctrine plays a substantial role in any decision relating to the public's access to and use of public waterways. The doctrine provides that the government holds all navigable waters in trust for the benefit of, and unrestricted use by, the public as a whole. This doctrine essentially creates a property right for the public as a whole in the waterways within a state. Access and use of waters may be restricted only under the police powers of the state for the protection and conservation of the public health, safety, and welfare, including environmental conservation and recreational purposes. Any regulation of the use of waterways must be reasonable in respect to the public interest being protected.

Under s. 30.77, Stats., no municipality, public inland lake protection and rehabilitation district, or town sanitary district may enact any ordinance or local regulation that requires local numbering, registration, or licensing of boats or any ordinance or local regulation that charges fees for inspection.

In addition, these entities may not, except as provided in subs. 30.77 (2) and (3), Stats., enact any ordinance or local regulation that in any manner excludes any boat from the free use of the waters of this state or that pertains to the use, operation, or equipment of boats or that governs any activity regulated by ss. 30.50 to 30.71, Stats.

Under s. 30.77(2), Stats., any municipality may enact ordinances that are in strict conformity with ss. 30.50 to 30.71, Stats., or rules of the DNR promulgated under those sections. Under s. 30.77(3), Stats., any town, village, or city may, in the interest of public health, safety, or welfare, including the public's interest in preserving the state's natural resources, enact ordinances applicable on any waters of this state within its jurisdiction if the ordinances are not contrary to or inconsistent with that chapter and if the ordinances relate to the equipment, use, or operation of boats or to any activity regulated by ss. 30.60 to 30.71. These ordinances are subject to advisory review by the DNR (s. 30.77(3)(d), Stats.).

Boat Wash Facilities

Are there state guidelines for construction, placement, and use of a permanent boat wash station at a landing?

There are no existing state guidelines for the construction, placement, and use of permanent boat wash stations.

Are there state guidelines for portable washing stations?

There are no state guidelines for portable washing stations.

Can a lake association, district, or municipality require boat washing as a condition of access to public waters?

Washing as a condition of access may be required only if a boat wash facility is readily available for public use, if no fee is required for the use of the boat wash facility, and if the requirement does not unreasonably exclude any boat from access to public waters.

Could a lake association or district place a boat wash facility on an access area owned by the state?

A lake association or district would need the permission of the DNR to place a boat wash facility on an access area owned by the state. In such circumstances the lake association or district would need to enter into a land use agreement (lease) with the DNR. Such agreements would include an assumption of all risk by the operator and an insurance requirement.

Could lake association or district volunteers manage a boat wash facility on a state-owned access area? What conditions (such as liability waivers) would need to exist?

Yes, a volunteer-run boat wash facility on a state-owned access area could be accomplished through an operational lease that included indemnification clauses.

Is there any permissible basis for closing a public launch site?

The closing of a public launch site by a county or town would be viewed as an abandonment of a public access, which would require DNR approval. The DNR may grant an abandonment only if the access site or part thereof proposed to be abandoned or discontinued is replaced prior to granting the petition, or if the access proposed to be abandoned does not contribute to the quality or quantity of public access on the body of water. In addition, an access site may be abandoned if environmental degradation is occurring at the site as a result of existing use and if abandonment of the access will reduce or eliminate the degradation without reducing public interests in access to that body of water.

The DNR's authority does not apply to cities and villages, but court approval may still be

required if the access site is part of a platted subdivision or if the site is considered part of a highway and objections from adjoining landowners are received.

Could a local ordinance place conditions on the use of a launch site and limit access if boats are not washed?

A local ordinance may place conditions on the use of a launch site and limit access if boats are not washed only if a boat wash facility is readily available for public use, if no fee is required for the use of the boat wash facility and if the requirement does not unreasonably exclude any boat from access to public waters.

Boat Washing Facilities

A number of inquiries have been received by DNR and UW-Extension staff on the feasibility of installing boat washing stations at water access sites. The stations could be used as a tool by lake communities to reduce the risk of transport of aquatic nuisance species by recreational boaters. Wisconsin has not conducted any studies to determine the feasibility of using a boat wash facility. However, other states and provinces (Minnesota and Ontario) have tested various applications of boat washing stations, both permanent and portable, under mandatory and volunteer situations. Here is what was learned:

Boat washing facilities are not considered a substitute for the steps that the aquatic invasive species program asks boaters to take when leaving the launch site. The cornerstone of Wisconsin's "Clean Boats, Clean Waters" program is a consistent list of precaution steps that are emphasized in all public education brochures, pamphlets, watch cards, public service announcements, and signage. Those steps are:

1. INSPECT your boat, trailer and equipment
2. REMOVE any attached aquatic plants or animals (before launching, after loading and before transporting on a public highway).
3. DRAIN all water from boats, motors and all equipment.
4. NEVER MOVE live fish away from a waterbody.

Boat washing is just one of the prevention steps, and installation of a wash station should accompany other education efforts that focus on all the steps listed here.

Boat washing stations are a costly alternative to an effective watercraft inspection program and a well-planned education campaign. Several issues need to be considered before the installation of washing stations:

1. costs for construction and maintenance of these facilities;
2. physical constraints for installation of the stations;
3. that washing cannot be made mandatory for all boaters;
4. safety of the facility and liability;
5. practical concerns about how best to capture and treat the wastewater;
6. boater acceptance of delays due to washing; and
7. unsolved legal questions related to whether fees could be charged for cleaning boats as a condition of launching.

There are circumstances and situations under which it may be advisable to install a boat wash facility:

1. if prevention and containment is a serious issue or a condition of a permit, or

2. if the venue is one in which heavy use is occurring as a result of a specific activity (boating and fishing tournaments or sailing regattas) or heavy boating periods (July 4th and Labor Day).

   In these situations a portable washing unit could work well as an educational and awareness tool to show boaters how to properly clean their boats.

If lake associations are going to install and operate a boat wash station, here are some guidelines that they should follow:

- Make sure that the boat washing station is part of an overall watercraft inspection and education program; not use it as a substitute for the other prevention steps boaters are asked to take.
- Do not require washing as a condition of launching; rather, treat boat washing as a voluntary option so boaters can feel assured that they are doing everything possible to protect the resource.
- Use common sense in designing the facility—do not drain the water back to the lake, and compost all waste or put it in the trash.
- Give some serious thought as to whether the facility should be manned or unmanned, portable or permanent.
- Make sure that a reliable construction firm is in charge of the design, construction, and maintenance of the facility.
- Be aware of the safety and liability issues of a wash station and follow all OSHA regulations.
- Seek feedback on boater acceptance of the facility, if possible. Such information adds to the DNR's understanding and research of boat landing facilities.
- Consider installing a boat washing facility for boaters leaving an infested water body to prevent the spread of invasive aquatic species.
- Place any wash station at least 75 feet back from the lake to avoid conflicts with shoreland zoning regulations.
- Use the lake water as a source for the washing facility if possible.
- Restrict the use of detergents, algaecides, or disinfecting agents that could harm the lake or nearby residents.
- Provide clear instructions on how to use the boat washing facility properly and safely and include an educational message as to why it's important.
- Use high-pressure hot water for the wash facility if possible (it is most effective).
- Charge only a reasonable fee for cleaning a boat before launching (such a fee would be based on the resident state park daily entrance fee).

Please note that specifications on the types of boat washing facilities that are most effective are not readily available and are likely to vary based on specific needs. Therefore, they were not included in the guidelines. Lake associations can contact their local DNR staff to obtain information on vendors in their area who could help the community decide what type of washer would be most effective for their particular use.

Lake organizations, watershed associations, or other local units of government that may be interested in installing a boat washing facility need to understand the following message: wash stations are a poor substitute for an effective education and watercraft inspection program that emphasizes inspection and removal, *but* washing stations can be one component of an overall prevention and control strategy.

APPENDIX I

AQUATIC AND WETLAND INVASIVE PLANTS IN WISCONSIN

Regulated Aquatic Invasive Plants in WI

Please report any **prohibited** species (as indicated by the red frame box) to the WDNR.
Report by email to: Invasive.Species@wi.gov or **by phone at: (608) 266-6437**
OR to find out more information, for information on reporting restricted species and whom to contact go to:
http://dnr.wi.gov/invasives/aquatic/whattodo/

Flowering rush
(Butomus umbellatus)

Purple loosestrife
(Lythrum salicaria)

Curly-leaf pondweed
(Potamogeton crispus)

Eurasian water milfoil
(Myriophyllum spicatum)

Australian swamp stonecrop *(Crassula helmsii)*

Brazilian waterweed
(Egeria densa)

Hydrilla
(Hydrilla verticillata)

European frog-bit
(Hydrocharis morsus-ranae)

African elodea
(Lagarosiphon major)

Parrot feather
(Myriophyllum aquaticum)

Brittle waternymph
(Najas minor)

Yellow floating heart
(Nymphoides peltata)

Water chestnut
(Trapa natans)

Fanwort
(Cabomba caroliniana)

Didymo or rock snot (alga)
(Didymosphenia geminata)

Starry stonewort (alga)
(Nitellopsis obtusa)

Restricted Species Prohibited Species

For more information about NR 40 (WI's Invasive Species Rule), Restricted, or Prohibited species please visit: www.dnr.wi.gov/invasives/classification

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

DNR PUB-WT-960-2011

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WISCONSIN DEPT. OF NATURAL RESOURCES

Design and Layout by Bonnie Reichert

CHAPTER NR 40:
INVASIVE SPECIES IDENTIFICATION CLASSIFICATION AND CONTROL
AQUATIC INVASIVE PLANTS SUMMARY

The Invasive Species Rule (Chapter NR 40) went into effect on September 1, 2009. The rule establishes a comprehensive, science-based way to classify and regulate invasive species in Wisconsin. The rule divides species into 2 categories, "Prohibited" and "Restricted," with different regulations and control requirements. The rule also establishes "Preventative Measures" to show what actions we can take to slow the spread of invasive species. Chapter NR 40 covers over 128 species, including plants, animals, and microorganisms.

WI Statute 23.22 defines **Invasive Species** as "nonindigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Not all nonnative plants are harmful, so NR 40 helps us determine which ones are invasive.

Prohibited Invasive Plants *

- These species are not yet in the state or only in a few places
- These species are likely to cause environmental and/or economic harm
- It is still possible to eradicate these species and prevent their spread statewide

Regulations: **Cannot transport, possess, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is required. DNR may order or conduct a control effort

Restricted Invasive Plants *

- These species are already widely established in the state
- High environmental and/or economic impacts are evident with these species
- Complete eradication of these species is unlikely

Regulations: **Cannot transport, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is encouraged but not required
*All viable part of the species (including seeds) are covered by these regulations.

What This Means for You

The primary goal of NR 40 is to slow the spread of invasive species in Wisconsin. The Department is using a "stepped enforcement" protocol, which emphasizes education and voluntary compliance. However, citations may be issued for aquatic invasive species violations. Remember:

- **It is illegal to buy, sell, give away, or barter any species listed under Chapter NR 40.**
- **Please become familiar with the listed plants and their regulated status for your county.**
- **You are responsible to comply with all elements of Chapter NR 40.**

Regulations differ slightly for certain species. Please go to the WDNR website to see listed exemptions for NR40, as well as the rule's implications for aquatic invertebrates, fish, and terrestrial species:

www.dnr.wi.gov/invasives/classification

For more information contact the WDNR
Invasive Species Project Coordinator at:
Email: Invasive.Species@wi.gov
Phone: (608) 266-6437

CS.v.8/30/11

Common Wetland Invasive Plants in WI

Please report **prohibited** species (as indicated by red on the maps) and all other species marked with an asterisk(*) when found in or near wetlands or shores. Provide the following data: exact location, land ownership (if known), population size, a photo or voucher specimen, and your contact information.

To report a sighting: send an email to: Invasive.Species@wi.gov or CALL 608-267-5066

Common buckthorn
(Rhamnus cathartica)

Glossy buckthorn
(Frangula alnus = Rhamnus frangula)

Non-native bush honeysuckles
(Lonicera spp.)

Canada thistle
(Cirsium arvense)

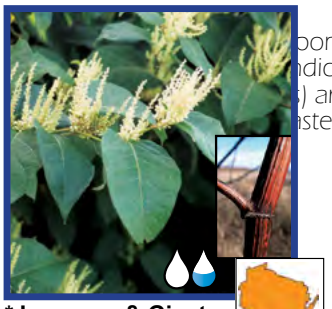
Common forget-me-not
(Myosotis scorpioides)

Dame's rocket
(Hesperis matronalis)

***Flowering rush**
(Butomus umbellatus)

***Garden valerian or heliotrope** *(Valeriana officinalis)*

Garlic mustard
(Alliaria petiolata)

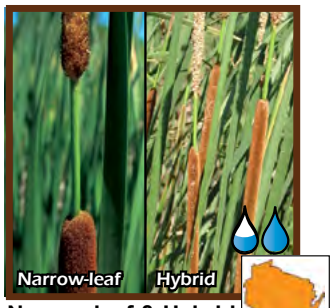


***Japanese & Giant knotweed** *(Polygonum cuspidatum & P. sachalinense)*

Moneywort
(Lysimachia nummularia)

***Purple loosestrife**
(Lythrum salicaria)

Watercress
(Nasturtium officinale)



Narrow-leaf & Hybrid cattail *(Typha angustifolia & T. x glauca)*

***Phragmites**
(Phragmites australis)

Reed canary grass
(Phalaris arundinacea)

Restricted Species | Prohibited/Restricted Species | Prohibited Species

Species without a map are not regulated by NR 40 (WI's Invasive Species Rule)

Tree | Vine | Grass | Shrub | Forb

SOMEWHAT WET (Floodplain forests, Seasonally flooded basins)

WET (Wet meadows, Shrub swamps, Wooded swamps)

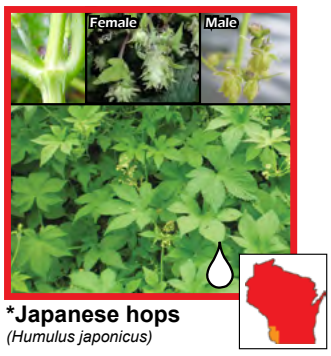
VERY WET (Deep marsh, Shallow marsh)

Early Detection Wetland Invasive Plants in WI

Early detection plants are either not yet present in WI or not widespread but have the potential to become widespread.

European high-bush cranberry *(Viburnum opulus* L. *subsp. opulus)*

***Chinese yam** *(Dioscorea oppositifolia)*



***Japanese hops** *(Humulus japonicus)*

Annual salt marsh aster *(Symphyotrichum subulatum)*

Cut-leaved teasel *(Dipsacus laciniatus)*

***European marsh thistle** *(Cirsium palustre)*

False spirea *(Sorbaria sorbifolia)*

***Giant hogweed** *(Heracleum mantegazzianum)*

***Hairy willow herb** *(Epilobium hirsutum)*

***Poison hemlock** *(Conium maculatum)*

Queen-of-the-meadow *(Filipendula ulmaria)*

Seaside goldenrod *(Solidago sempervirens)*

Yellow garden loosestrife *(Lysimachia vulgaris)*

***Yellow iris** *(Iris pseudacorus)*

***Japanese stilt grass** *(Microstegium vimineum)*

***Tall or Reed manna grass** *(Glyceria maxima)*

For more information about NR 40 (WI's Invasive Species Rule), Restricted, or Prohibited species please visit: www.dnr.wi.gov/invasives/classification

For more information about the plant species please visit: http://dnr.wi.gov/wetlands/invasive.html

Bureau of Endangered Resources
and Division of Forestry
Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

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Design and Layout by Bonnie Reichert

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

APPENDIX J

Green Lake, Green Lake County - Lisa Reas

WISCONSIN'S HEALTHY LAKES IMPLEMENTATION PLAN

2014-2017

WISCONSIN
DEPT. OF NATURAL RESOURCES

Wisconsin
Lakes
Partnership

TABLE OF CONTENTS

Team Members:
Dave Ferris, Burnett County Land and Water Conservation Department
Pat Goggin, Lake Specialist, UW-Extension Lakes
Jane Malischke, Wisconsin DNR Environmental Grants Specialist
Tom Onofrey, Marquette County Zoning Department
Carroll Schaal, Wisconsin DNR Lakes and Rivers Section Chief
Pamela Toshner, Wisconsin DNR Lake Biologist

The statewide Healthy Lakes initiative is a true, collaborative team effort. The Healthy Lakes Implementation Plan describes relatively simple and inexpensive best practices that lakeshore property owners can implement. The Plan also includes funding/accountability, promotion, and evaluation information so we can grow and adapt the Plan and our statewide strategy to implement it into the future. Working together, we can make Healthy Lakes for current and future generations.

Design and layout by Amy Kowalski, UWEX Lakes

INTRODUCTION

Wisconsin's lakes define our state, local communities, and our own identities. Fond memories of splashing in the water, seeing moonlight reflect off the lake, and catching a lunker last a lifetime. With over 15,000 lakes dotting the landscape, it's no surprise that fishing alone generates a $2.3 billion economic impact each year , and the majority of property tax base rests along shorelines in some of our counties. Unfortunately, we've learned through science that our love for lakes causes management challenges, including declines in habitat and water quality. In fact, the loss of lakeshore habitat was the number one stressor of lake health at a national scale. Lakes with poor lakeshore habitat tend to have poor water quality. Working together to implement *Wisconsin's Healthy Lakes Implementation Plan* (Plan), we can improve and protect our lakes for future generations to enjoy, as well.

This Plan identifies relatively simple habitat and water quality best practices that may be implemented on the most typical lakeshore properties in Wisconsin. We encourage do-it-yourselfers to use these practices but have also created a Wisconsin Department of Natural Resources (DNR) Lake Classification and Protection Grant *Healthy Lakes* sub-category for funding assistance. Furthermore, local partners like lake groups and counties may choose to integrate the Plan into their lake management, comprehensive planning, and shoreland zoning ordinance efforts.

It's important to consider this plan in the context of the lake and local community's management complexity. The best practices' effectiveness will increase cumulatively with additional property owner participation and depend on the nature and location of the lake. For example, if every property owner implemented appropriate Healthy Lakes best practices on a small seepage lake, also known as a pothole or kettle lake, within a forested watershed, the impact would be greater than on a large impoundment in an agricultural region of Wisconsin. Nevertheless, all lakes will benefit from these best practices, and even with limited impact, they are a piece of the overall lake management puzzle that lakeshore property owners can directly control. More lakeshore property owners choosing to implement Healthy Lakes best practices through time means positive incremental change and eventually success at improving and protecting our lakes for everyone.

GOALS AND OBJECTIVES

Wisconsin's Healthy Lakes Implementation Plan goal is to protect and improve the health of our lakes by increasing lakeshore property owner participation in habitat restoration and runoff and erosion control projects.

- Statewide objective: single-parcel participation in Healthy Lakes will increase 100% in 3 years (i.e. 2015 to 2017).
- Individual lake objective: lake groups or other partners may identify their own habitat, water quality, and/or participation goal(s) through a local planning and public participation process.
  - Partners may adopt this Plan, as is by resolution, or integrate the Plan into a complimentary planning process such as lake management or comprehensive planning.

Wisconsin's Healthy Lakes Implementation Plan, and the diversion and rock infiltration practices in particular, are not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design. Technical assistance and funding are still available for these sites; contact your county land and water conservation department or local DNR lakes biologist for more information.

The target audience for this Plan and implementation of the associated practices is lakeshore property owners, including: permanent and seasonal homeowners, municipalities, and businesses.

It will be necessary to do additional planning work to implement Wisconsin's Healthy Lakes Plan and, again, the level of effort will depend on the complexity of the lake and its local community. Planning could be as simple as site-specific property visits and development of design plans, to integrating the Plan into a broader and more comprehensive effort. Your lake group, county land and water conservation department, non-profit conservation association, UW-extension lakes specialist or local educator, and/or DNR lake biologist can provide planning guidance or contacts.

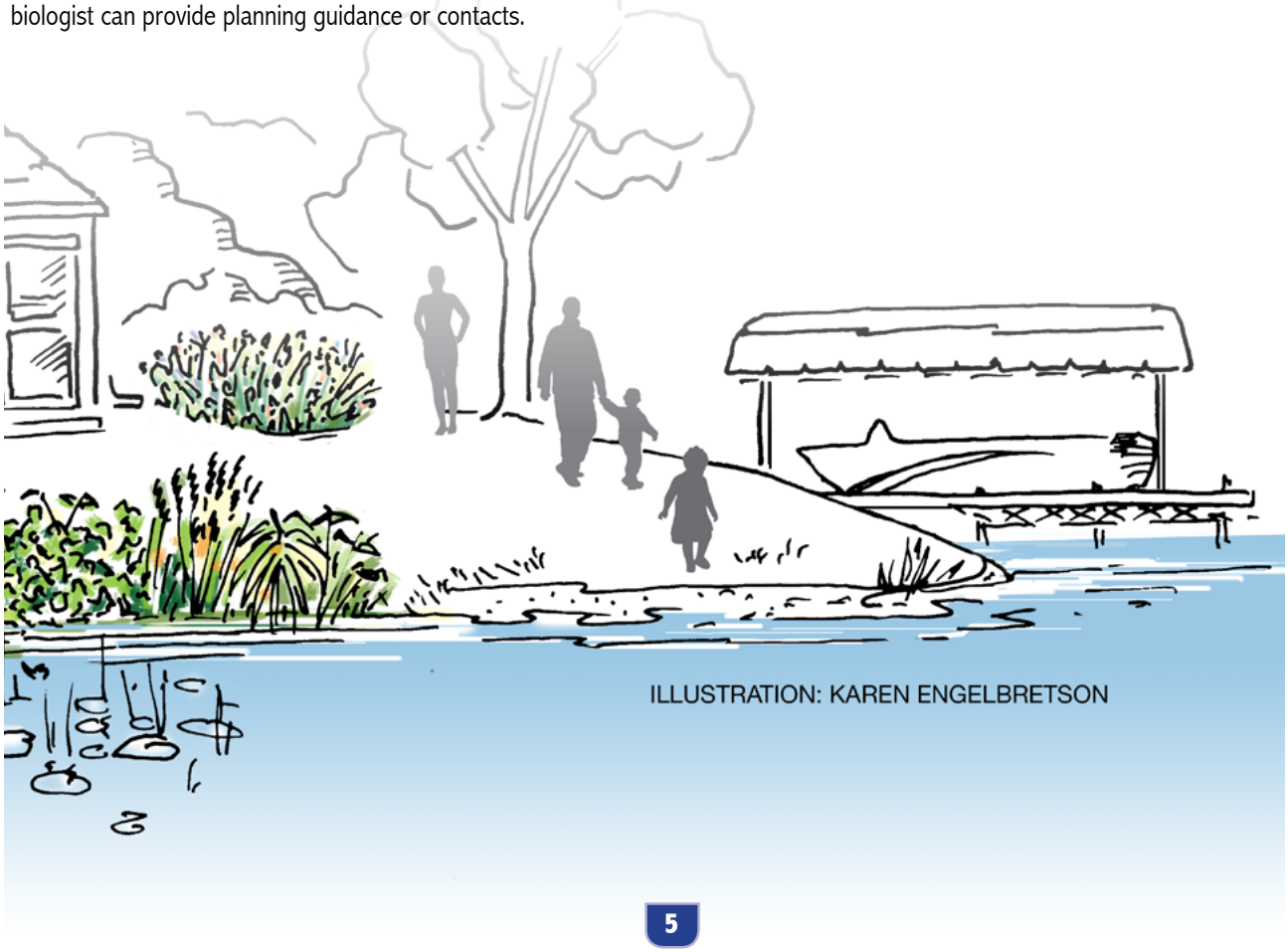


ILLUSTRATION: KAREN ENGELBRETSON

DEFINITIONS

Best practice: a working method, described in detail, which has consistently shown results.

Divert: redirect runoff water.

Habitat: where a plant or animal lives.

Infiltrate: soak into the ground.

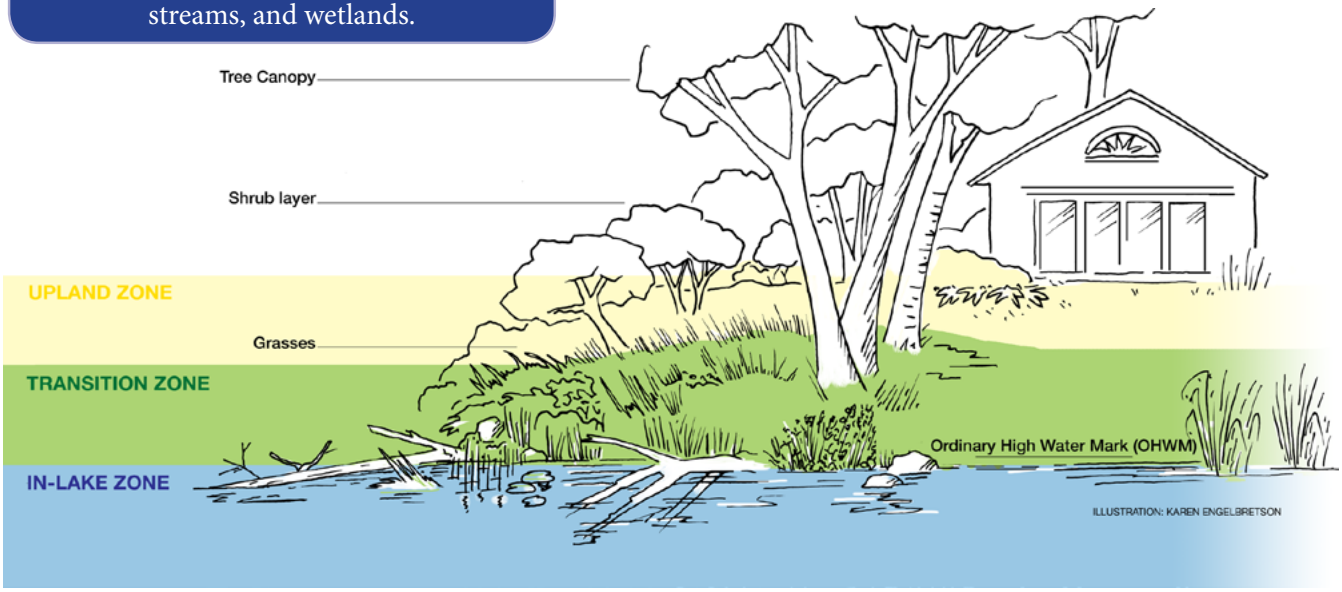
Installed: project cost that includes all materials, labor, and transportation.

Runoff: rain and snowmelt that doesn't soak into the ground and instead moves downhill across land and eventually into lakes, streams, and wetlands.

Wisconsin's Healthy Lakes Implementation Plan divides a typical lakeshore parcel into the following 3 management zones: 1) in-lake, 2) transition, and 3) upland (see illustration below). Best practices are identified for each zone. A team selected these practices based on customer feedback. These practices are:

- relatively simple and inexpensive to implement,
- appropriate for typical lakeshore properties, and
- beneficial to lake habitat and/or water quality.

The Plan also provides cost ranges and averages and technical, regulatory, and funding information for each practice. Fact sheets for each best practice support the Plan and provide more technical detail, and additional guidance is referenced if it currently exists. There is also a funding and administration FAQ fact sheet for those considering pursuing Healthy Lakes grants.



HEALTHY LAKES PLAN

BEST PRACTICES

Best practice descriptions follow. Each description defines the practice, identifies lake health benefits, provides cost ranges and averages based on recent projects, and identifies additional technical and regulatory information. The costs provided are installed costs, which include all materials, labor, and transportation but do not include technical assistance, including design and project management/administration work. Cost ranges are a result of geographic location, property conditions like soils and slopes, and contractor supply and proximity to the project site.

PRACTICE 1 | FISH STICKS

...large woody habitat structures that utilize whole trees grouped together resulting in the placement of more than one tree per 50 feet of shoreline. Fish Sticks structures are anchored to the shore and are partially or fully submerged.

LAKE HEALTH BENEFITS	Improve fish and wildlife habitat Prevent shoreline erosion
COSTS	Range - $100-$1000 per cluster (3-5 trees), installed Average - Cost per unit (3-5 trees) averages $500, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Fish Sticks* http://tinyurl.com/healthylakes DNR Fish Sticks Best Practices Manual http://dnr.wi.gov (search for *Fish Sticks best practices*)
REGULATORY INFORMATION	DNR: **Habitat Structure - Fish Sticks General Permit** ($303 fee unless DNR grant-funded) Fish Sticks must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/cluster of 3-5 trees Fish Sticks may be a stand-alone grant activity only if the vegetation protection area (i.e. buffer) complies with local shoreland zoning. If not, the property owner must commit to leaving a 350 ft^2 area un-mowed at the base of the cluster(s) or implement native plantings (Practice 2).

PRACTICE 2 | 350 FT² NATIVE PLANTINGS

...template planting plans with corresponding lists of native plants suited to the given function of the plan. The 350 ft² area should be planted adjacent to the lake and include a contiguous area, rather than be planted in patches. Functions are based on the goals for the site. For example, one property owner may want to increase bird and butterfly habitat while another would like to fix an area with bare soil. Native planting functions include the following: lakeshore, bird/butterfly habitat, woodland, low-growing, deer resistant, and bare soil area plantings.

LAKE HEALTH BENEFITS	Improve wildlife habitat Slow water runoff Promote natural beauty
COSTS	**Range** - $480-$2400 for 350 ft² area, installed **Average** - $1000 per 350 ft², installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *350 ft² Native Plantings* http://tinyurl.com/healthylakes 350 ft² Native Plantings Best Practices Manual
REGULATORY INFORMATION	DNR: an aquatic plant chemical control permit may be necessary if using herbicides in or adjacent to the lakeshore. Native plantings must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/350 ft² native plantings installed and implemented according to the technical requirements. Only one 350 ft² native planting per property per year is eligible for funding. The native plantings dimension must be 350 ft² of contiguous area at least 10 feet wide and installed along the lakeshore. Final shape and orientation to the shore are flexible.

ZONE 2: TRANSITION

PRACTICE 3 | DIVERSION PRACTICE

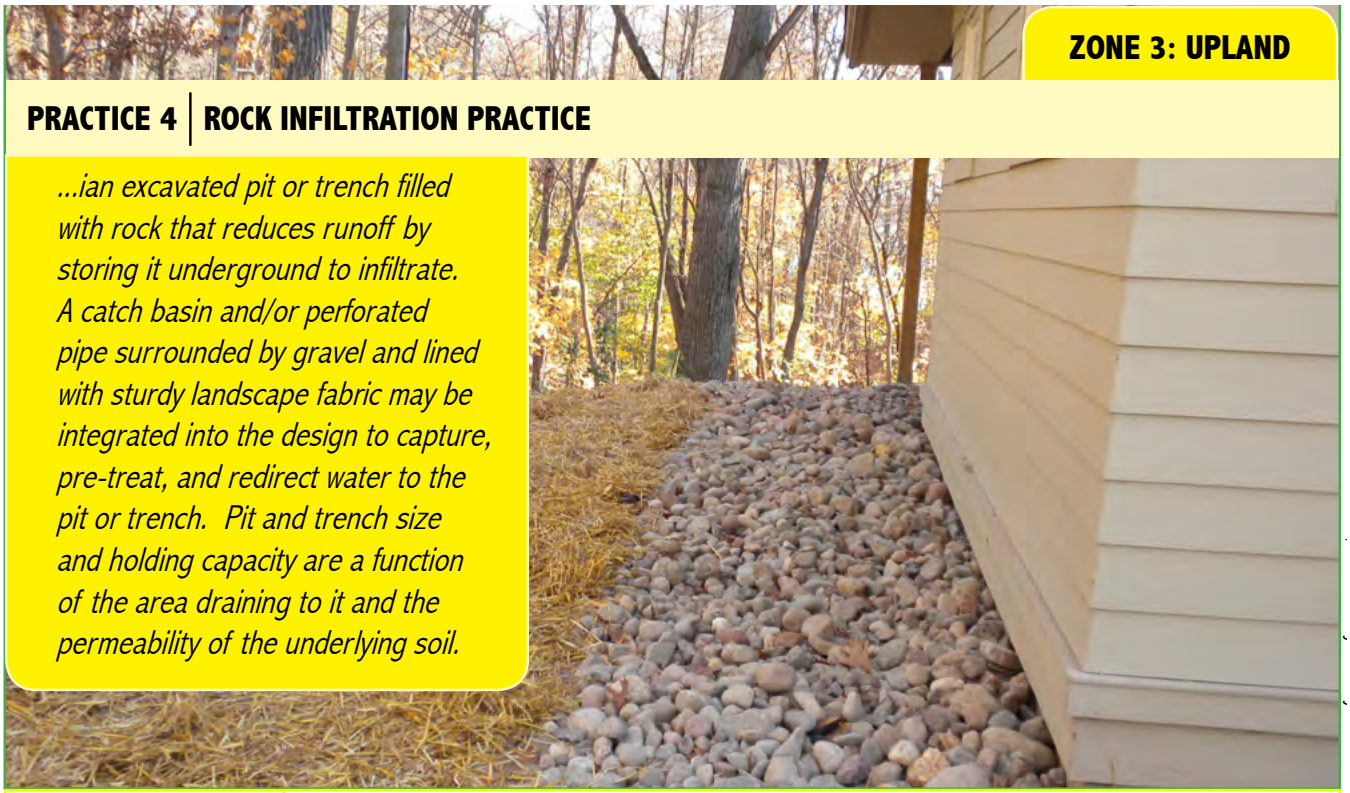
...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	**Range** - $25-$3750, installed **Average** - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

PRACTICE 3 | DIVERSION PRACTICE

...includes a water bar, diverter, and broad-based dip. These practices use a berm or shallow trench to intercept runoff from a path or road and divert it into a dispersion area. Depending on the site, multiple diversion practices may be necessary.

LAKE HEALTH BENEFITS	Divert runoff water.
COSTS	Range - $25-$3750, installed Average - $200, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Diversion Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Diversion practices must comply with the local shoreland and floodplain zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/diversion practice installed and implemented according to the technical requirements. Healthy Lakes diversion practice grant funding is not intended for large, heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.



ZONE 3: UPLAND

PRACTICE 4 | ROCK INFILTRATION PRACTICE

...ian excavated pit or trench filled with rock that reduces runoff by storing it underground to infiltrate. A catch basin and/or perforated pipe surrounded by gravel and lined with sturdy landscape fabric may be integrated into the design to capture, pre-treat, and redirect water to the pit or trench. Pit and trench size and holding capacity are a function of the area draining to it and the permeability of the underlying soil.

LAKE HEALTH BENEFITS	Divert runoff water. Clean runoff water. Infiltrate runoff water.
COSTS	Range - $510-$9688 per rock infiltration practice, installed Average - $3800 per rock infiltration practice, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rock Infiltration Practice* http://tinyurl.com/healthylakes
REGULATORY INFORMATION	DNR: none. Rock infiltration practices must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rock infiltration practice installed and implemented according to the technical requirements. Healthy Lakes rock infiltration practice grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

ZONE 3: UPLAND

PRACTICE 5 | RAIN GARDEN

...a landscaped shallow depression with loose soil designed to collect roof and driveway runoff.

LAKE HEALTH BENEFITS	Improve wildlife habitat. Divert runoff water. Clean runoff water. Infiltrate runoff water. Promote natural beauty.
COSTS	Range - $500-$9000 per rain garden, installed Average - $2500 per rain garden, installed
TECHNICAL REQUIREMENTS	Healthy Lakes Fact Sheet Series: *Rain Garden* http://tinyurl.com/healthylakes *Rain Gardens: A How-to Manual for Homeowners* http://dnr.wi.gov/topic/Stormwater/documents/RgManual.pdf
REGULATORY INFORMATION	DNR: none. Rain gardens must comply with the local shoreland zoning ordinance. Consult with your county or municipal zoning staff.
HEALTHY LAKES GRANT FUNDING	Maximum of $1000/rain garden installed and implemented according to the technical requirements. Healthy Lakes rain garden grant funding is not intended for heavily developed parcels, sites with large volumes of runoff, or sites with complex problems that may require engineering design.

FUNDING AND ACCOUNTABILITY

Administrative details and the application process are described in detail in the DNR's Water Grant Application and Guidelines (http://dnr.wi.gov/ search for surface water grants) and the Healthy Lakes website (http://tinyurl/healthylakes) and *Administration and Funding FAQ* fact sheet.

Healthy Lakes grant funding highlights:

- 75% state share grant with a maximum award of $25,000, including up to 10% of the state share available for technical assistance and project management. Technical assistance and project management do not include labor and are based on the entire state share of the grant, not the best practice caps.
- 25% match from sponsors, participating property owners or other partners. The grant sponsor may determine individual property owner cost share rates, provided the state's share of the practice caps ($1000) and total grant award (75%) are not exceeded. The grant sponsor's match may include technical assistance and project management costs beyond the state's 10% share.
- Sponsor may apply on behalf of multiple property owners, and the property owners do not have to be on the same lake.
- Standard 2-year grant timeline to encourage shovel-ready projects.
- Landowners may sign a participation pledge to document strong interest in following through with the project.
- Standard deliverables, including a signed Conservation Commitment with operation and maintenance information and 10-year requirement to leave projects in place. Also:
  - Native plantings must remain in place according to local zoning specs if within the vegetation protection area (i.e. buffer).
  - Fish Sticks projects require a 350 ft^2 native planting at shoreline base or commitment not to mow, if the property does not comply with the shoreland vegetation protection area (i.e. buffer) specifications described in the local shoreland zoning ordinance.
- Standardized application and reporting forms and process.
- 10% of projects randomly chosen each year for self-reporting and/or professional site visits.

PROMOTION

Wisconsin's Healthy Lakes Implementation Plan will be supported and promoted as a statewide program. Lake groups, counties, towns, villages, cities, and other partners may choose to adopt and implement the Plan as is or to integrate into their own planning processes. Statewide promotion, shared and supported by all partners, includes the following:

- A Healthy Lakes logo/brand.
- A website with plan, practice, and funding detail to be housed on the Wisconsin Department of Natural Resources' and University of Wisconsin-Extension Lakes' websites. It may also include the following:
  - Link to science and supporting plans.
  - Shoreline restoration video.
  - How-to YouTube clips.
  - Tips on how to communicate and market healthy lakeshores.
  - Maps with project locations without personally identifiable information.

EVALUATION OF RESULTS

Wisconsin's Healthy Lakes Implementation Plan and results will be evaluated annually and updated in 2017, if warranted. Best practices may be modified, removed, or added depending on the results evaluation.

The following information will be collected to support an objective evaluation:

- County and lake geographic distribution and participation in Healthy Lakes projects.
- Lakeshore property owner participation in Healthy Lakes projects, including numbers and locations of best practices implemented.
- Standardized Healthy Lakes grant project deliverable report including:
  - Numbers of Fish Sticks trees and clusters.
  - Dimensional areas restored.
  - Structure/floral diversity (i.e. species richness).
  - Impervious surface area and estimated water volumes captured for infiltration.

The results may be used to model nutrient loading reductions at parcel, lake, and broader scales and to customize future self-reporting options, like plant mortality and fish and wildlife observations, for lakeshore property owners.

ACKNOWLEDGEMENTS

L to R: Patrick Goggin, Jane Malischke, Pamela Toshner, Carroll Schaal, Tom Onofrey, Dave Ferris

Wisconsin's Healthy Lakes Implementation Plan and corresponding technical information and grant funding are the results of a collaborative and participatory team effort. We would like to thank the staff, agency, business, and citizen partners, including *Advanced Lake Leaders*, who provided feedback for our team, including the many partners who completed a customer survey and provided valuable comments during the public review of proposed DNR guidance. We would like to express our gratitude to the following contributors and information sources, respectively: Cheryl Clemens, John Haack, Dave Kafura, Amy Kowalski, Jesha LaMarche, Flory Olson, Tim Parks, Bret Shaw, Shelly Thomsen, Scott Toshner, Bone Lake Management District, Maine Lake Smart Program, and Vermont Lake Wise Program.

We appreciate your continued feedback as our Healthy Lakes initiative evolves into the future. Please contact DNR Lake Biologist Pamela Toshner (715) 635-4073 or pamela.toshner@wisconsin.gov if you have comments or questions.

APPENDIX K

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANTS

Lake Classification and Local Ordinance Development Grants
NR 191.30, Wis. Admin. Code

Overview:
Lake Classification projects will be conducted by counties to study the characteristics of lakes and assign them into different management classifications for the purpose of implementing lakes-based protection activities. Protection activities may be regulatory (such as improved Shoreland), land or lake use ordinances, or other best management practices or protection activities for protecting and improving water quality or aquatic habitats. Lake classification projects can be used to implement the prescribed management activities.

Development of local regulations or ordinance projects will be conducted by any unit of local government to protect or improve a lake's water quality or its natural ecosystem. Lake Classification and Local Ordinance Development projects can be funded separately or jointly. Because of their similar nature, these two grant project types are combined into one grant subprogram. Although technically "management" grants by statute, the activities associated with each are fundamentally planning and, therefore, the DNR has grouped them in with other planning grants with application deadline of Dec. 10 each year.

Lake Classification

Purpose:
Lake Classification grants provide financial opportunities for Wisconsin counties to assist in lake protection efforts. Using existing and collected lake data, county lakes with similarities can be grouped to assist in the administration of shoreland zoning or land and water conservation programs.

Eligible Projects

Classification:

- Data collection, analysis using GIS, and mapping to place waters in classes. Types of data may include lake size, depth, shape, and water quality, watershed size, potential nonpoint pollution sources, land uses and development patterns, recreational uses, fish and wildlife habitat, etc.
- Objective setting for the classification system.
- Investigation and selection of appropriate classification criteria.
- Investigation and assignment of appropriate protection and management tools. All projects must propose lake protection activities for each classification.
- Assist the DNR in setting lake water quality standards.

Note: Projects may not result in lowering existing state minimum standards designed to protect lakes.

Protection and Implementation:

- Development of educational materials and training programs to improve the understanding and compliance with the lake classification.
- Compliance monitoring and enforcement.
- Technical assistance to landowners to comply and implement protection activities.
- Developing or improving administrative procedures and processes.
- Ordinance development: zoning, watercraft regulation, construction site erosion control, public water access, piers and moorings, etc.
- Adoption of policies which encourage management of waters based on the specific needs of each waterbody.
- Implementation of alternative management tools: purchase of land or development rights, conservation easements, development of individual lake and watershed plans, etc.

NOTE: A county must have adopted a lake classification system prior to the date of application to be eligible for an implementation grant.

Ineligible Projects:
Projects not eligible for funding under this subchapter include water safety patrols.

Note: Lake Classification projects may be conducted to assist the department in setting lake water quality standards. However, any proposal for the classification of lakes to be used in setting lake water quality standards or for enacting requirements for the implementation of water quality standards based on new or existing classifications only become effective when adopted by the department as rules under s. 281.15, Wis. Stats.

Local Ordinance Development

Purpose:
Lake Ordinance development grants are intended for local governments and lake districts to create or improve regulations that will protect or improve a lake's water quality or its natural ecosystem.

Eligible Projects:
To be eligible for funding consideration, all projects must include the development of an ordinance to be presented for adoption by the local governing board with an assessment of the administration and enforcement capacity and cost to implement the ordinance. Land use planning alone is not an eligible activity.

Types of ordinances may include: boating or lake use, conservancy, wetland, shoreland, floodplain, construction erosion control, stormwater control or other ordinances with water quality or lake protection benefit. Boating ordinances that assist in managing the recreational use of surface waters should be focused on addressing the environmental impacts of lake use rather than just safety concerns.

Typical activities and eligible project costs include:

- Review and evaluation of an existing regulation or ordinance effectiveness, including necessary surveys.
- Mapping of environmental features, land use planning, and related activities as needed limited to what is necessary to the development of the proposed regulation. These activities should not be the main focus of the projects.
- Legal fees to develop regulation or ordinance language.
- Public meetings and materials, printing, postage, surveys, mailing, and similar costs related to community education on the need for and implementation of an ordinance or regulation.
- Training of officials and citizens for compliance and enforcement of an existing or new regulation or ordinance.
- Labor costs required to carry out activities identified in the grant agreement provided they require additional staff or increased hours of existing staff. Costs of additional staff positions or increased staff hours shall be based on management unit rates for the position including salary, fringe benefits and other items determined to be appropriate by the DNR.
- Other costs determined by the DNR to be necessary to carry out the development of a regulation or ordinance.

Legal fees incurred in appealing DNR decisions are not reimbursable costs. Lake associations and nonprofit conservation organizations do not have regulatory authority and therefore are not eligible for ordinance development projects unless there are clear commitments from the regulatory authority to the project. The management unit that is adopting the ordinance should be the sponsor.

If the project is an ordinance update or upgrade project specific to s. NR 115 Wisconsin's Shoreland Protection Program, s. NR 117 Wisconsin's City and Village Shoreland-Wetland Protection Program or s. NR 118 Standards for Lower St. Croix Scenic Waterway, it will need to be reviewed and certified by DNR staff. You can search the DNR staff directory under contacts on the DNR home page using "Shoreland Zoning" in the subject box to find the appropriate person to conduct the review and certification. It's recommended that you make this contact before you begin your application. Appropriate DNR staff should be advised of the process from the start of any shoreland ordinance project. For all other ordinance development projects local adoption or DNR approval is not required. However, the proposed regulation must be presented to the county or town board for adoption.

Routine ordinance enforcement is not an eligible cost for any grant in this subsection. However, site inspections and enforcement can be eligible for local ordinance development projects or lake classification if it is proposed as developing or enhancing the enforcement process. The project might create and test new forms or procedures such as compliance audits, automated record keeping or explore new information management technologies. A report on the "findings" of this element is a deliverable.

Funding Possibilities:
Maximum amount of grant is 75% of the total project costs, not to exceed $50,000.

Lake Management Planning Grants
Section 281.68, Wis. Stats., NR 190, Wis. Admin. Code

Overview:
Lake management planning grants are intended to provide financial assistance to eligible applicants for the collection, analysis, and communication of information needed to conduct studies and develop management plans to protect and restore lakes and their watersheds. Projects funded under this subprogram often become the basis for implementation projects funded with Lake Protection grants. There are two categories of lake management planning grants: small-scale and large-scale.

Small Scale Lake Planning
NR 190, Wis. Admin. Code

Purpose:
Small-scale projects are intended to address the planning needs of lakes where education, enhancing lake organizational capacity, and obtaining information on specific lake conditions are the primary project objectives. These grants are well suited for beginning the planning process, conducting minor plan updates, or developing plans and specification for implementing a management recommendation.

Eligible Projects:
- Specific monitoring and assessment projects. Collect and report chemical, biological, and physical data about lake ecosystems for a Tier I assessments, Tier II diagnostic or Tier III project evaluation.
    - Tier I if initial basic monitoring is needed to assess the general condition or health of the lake.
    - Tier II if an assessment has been conducted and more detailed data collection is needed to diagnose suspected problems and identify management options.
    - Tier III if the monitoring and assessment will be used to evaluate the effectiveness of a recently implemented project or lake management strategy.
- Collecting and disseminating existing information about lakes for the purpose of broadening the understanding of lake use, Lake Ecosystem conditions and lake management techniques.
- Conducting workshops or trainings needed to support planning or project implementation.
- Projects that will assist management units as defined in s. NR191.03 (4) & s. NR 190.003 (4) the formation of goals and objectives for the management of a lake or lakes.

Ineligible Projects:
Projects not specifically mentioned above.

Funding Possibilities:
Maximum amount of grant funding is 67% of the total project costs, not to exceed $3,000.

(see next page for Large Scale Projects)

Large Scale Projects
NR 190, Wis. Admin. Code

Purpose:
Large-scale projects are intended to address the needs of larger lakes and lakes with complex and technical planning challenges. The result will be a lake management plan; more than one grant may be needed to complete the plan.

Eligible Projects:
- Collection of new or updated, physical, chemical and biological information about lakes or lake ecosystems.
- Definition and mapping of Lake Watershed boundaries, sub-boundaries and drainage system components.
- Descriptions and mapping of existing and potential land conditions, activities and uses within lake watersheds that may affect the water quality of a lake or its ecosystem.
- Assessments of water quality and of fish, aquatic life, and their habitat.
- Institutional assessment of lake protection regulations - review, evaluation or development of ordinances and other local regulations related to the control of pollution sources, recreational use or other human activities that may impact water quality, fish and wildlife habitat, natural beauty or other components of the lake ecosystem.
- Collection of sociological information through surveys or questionnaires to assess attitudes and needs and identify problems necessary to the development of a long-term lake management plan.
- Analysis, evaluation, reporting and dissemination of information obtained as part of the planning project and the development of management plans.
- Development of alternative management strategies, plans and specific project designs, engineering or construction plans and specifications necessary to identify and implement an appropriate lake protection or improvement project.

Ineligible Projects:
Any project not specified above.

Funding Possibilities:
Maximum amount of grant funding is 67% of the total project costs, not to exceed $25,000. Multiple grants in sequence may be used to complete a planning project, not to exceed $100,000 for each lake. The maximum grant award in any one year is $50,000 for each lake. If phasing is necessary, all phases should be fully identified and a timeline identified in the initial application.

Lake Protection Grant Program
Sections 281.69 and 281.71, Wis. Stats., NR 191, Wis. Admin. Code

Overview:
Lake protection and classification grants assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems. There are four basic Lake Protection subprograms:

a) Fee simple or Easement Land Acquisition
b) Wetland and Shoreline Habitat Restoration
c) Lake Classification and Local Ordinance Development
d) Lake Plan implementation

Land/Easement Acquisition
NR 191.10, Wis. Admin. Code

Purpose:
Grants under this subprogram are intended for the acquisition of property or property rights (also called easements) to protect lakes and their ecosystems. Land acquisition projects are reviewed and processed by DNR environmental grant specialists. All other types of surface water protection grant projects are reviewed by DNR Lake and River Grant Coordinators. A list of environmental grant specialists appears in the front of this guide.

Eligible Costs:

- The fair market value of the property as determined by DNR-approved appraisals
- Cost of appraisal(s)
- and survey fees
- Relocation payments
- Land stabilization
- Title insurance and gap insurance
- Recording fees
- Historical and cultural assessments (if required by the DNR)
- Baseline documentation for natural resources (required for conservation easements)
- Environmental inspections and audits
- Attorney fees not to exceed $2,000
- Closing costs
- Building demolition may be an eligible cost based on the degree to which the demolition contributes to lake protection or restoration.

Ineligible Costs:

- Acquisition of any property that is subject to a reversionary right or has restrictions or covenants which would prevent the property from being managed for purposes consistent with this grant program
- Land acquired through eminent domain or condemnation; projects where landowners were not treated fairly and negotiations were not conducted on a willing buyer-willing seller basis
- Acquisition of land on which a dam is located
- Environmental clean-up costs
- Brokerage fees paid by the buyer
- Real estate transfer taxes
- Any other cost not identified as eligible above

Funding Possibilities:
Maximum amount of grant funding is 75% of total costs, not to exceed $200,000.

Wetland and Shoreline Habitat Restoration
NR 191.20, Wis. Admin. Code

Purpose:
Wetland and shoreland habitat restoration grants are intended to provide financial assistance to protect or improve the water quality or natural ecosystem of a lake by restoring adjacent degraded wetlands or tributary to lakes. Shoreline habitat restoration grants are intended to provide financial assistance, including incentive payments, to owners of developed lake front lots to re-establish riparian habitat.

Eligible Projects:

- Development of plans, specifications and environmental assessment, including pre- and post-engineering and design costs.
- Construction, earth moving, or structure removal costs.
- Native plant stock or seeds for re-establishing vegetation.
- Incentive payments per landowner not to exceed $250.
- Public meetings and education and promotional materials, mailing and similar costs related to the distribution of information about restoration.
- Necessary monitoring in order to measure success in achieving the ecologic function of restoration activities.
- Purchase of fee simple or easement land acquisition on which wetland restoration activities will take place. The cost of preparing and filing deed restrictions on the property where restoration will take place.
- Labor costs required to carry out activities identified in the grant agreement including technical assistance.
- Other costs determined by the DNR as necessary to carry out a successful wetland or shoreline habitat restoration.
- Water regulatory permits required for the project. Reasonable planning, engineering and design costs necessary to complete the permit application incurred within 12 months prior to the application deadline become eligible for reimbursement for projects awarded a grant.
- Technical assistance provided to individuals seeking building permits if the intent is to improve the site's habitat conditions or comply with mitigation conditions.

Ineligible Projects:

- Environmental cleanup,
- Stairs
- Walkways
- Piers
- Costs of actual restoration that is intended to comply with a regulatory action, including wetland or shoreland mitigation projects.

Funding Possibilities:
Maximum amount of grant funding is 75% of the total project costs, not to exceed $100,000

Lake Management Plan Implementation
NR 191.40, Wis. Admin. Code

Purpose:
Lake management plan implementation grant provides financial assistance to eligible applicants that have completed a lake management plan to implement the plan's DNR-approved recommendations.

Eligible Projects:
Typical projects will include watershed or shoreland best management practices (BMPs) for nonpoint source pollution control or in-lake restoration actions like an alum treatment. s. NR 154, Wis. Admin.

Code, Best Management Practices (BMP) and Cost Share Conditions, provide DNR grant policy on the implementation of 42 nonpoint source pollution control practices. These have been established in partnership with other state and federal agencies and approved by the US Environmental Protection Agency as part of the State's Nonpoint Source Program Management Plan. Adherence to these BMPs assures eligibility for federal cost-share funds and the ability to use state-funded projects as match Clean Water Act Section 319 funds received by the DNR.

Providing grant funding for lake restoration activities that improve the recreational or environmental values of a lake are defined as natural resource enhancement services under s. NR 1.91, Wis. Admin. Code. Grant funding for these services can only be provided for lake and river projects where the public has been afforded a minimum level of public boating access as defined in s. NR 1.91(4) d. Typical projects funded by surface water grants that fall into this category are "in-water" activities such as aeration, aquatic plant management, alum treatments, bio-manipulation, drawdown, fish stocking and fishery rehabilitation, habitat restoration, and hypolimnetic withdrawal. An additional eligibility requirement for funding these activities is that the sources or causative factors of the problems to be remediated should have been or very likely will be controlled prior to implementation.

Habitat improvement or protection activities or any other type of project that will work toward protecting or improving lakes and lake ecosystems may be eligible as long as the recommendation presented in the lake management plan has been officially approved by the DNR. An application for all necessary permits must be filed with the DNR by the date on which a grant application is submitted.

Eligible Costs:

- Construction, labor, materials, supplies, laboratory costs related to eligible activities.
- Planning and engineering, landscape or construction design plans and specifications that is necessary to determine appropriate options and recommendations for lake protection improvement.
- Other costs as approved by the DNR and necessary for implementing a recommendation in an approved lake management plan.

Ineligible Project Costs:
Any project not specified above.

Funding Possibilities:
Grants are based on 75% of the total eligible project costs not to exceed the maximum grant amount of $200,000.

Healthy Lakes Projects
NR 190, Wis. Admin. Code

Purpose:
The Healthy Lakes grants are a sub-set of Plan Implementation Grants intended as a way to fund increased installation of select best management practices (BMPs) on waterfront properties without the burden of developing a complex lake management plan. Details on the select best practices can be found in the Wisconsin Healthy Lakes Implementation Plan and best practice fact sheets.

Eligible Projects:
Eligible best practices with pre-set funding limits are defined in the Wisconsin Healthy Lakes Implementation Plan, which local sponsors can adopt by resolution and/or integrate into their own local planning efforts. By adopting the Wisconsin Healthy Lakes Implementation Plan, your lake organization is immediately eligible to implement the specified best practices. Additional technical information for each of the eligible practices is described in associated factsheets.

The intent of the Healthy Lakes grants is to fund shovel-ready projects that are relatively inexpensive and straight-forward. The Healthy Lakes grant category is not intended for large, complex projects, particularly those that may require engineering design. All Healthy Lake grants have a standard 2-year timeline.

Ineligible Projects:
Any project not specified in the Wisconsin Healthy Lakes Implementation Plan.

Eligible Costs:
Best practices in the Wisconsin Healthy Lakes Implementation Plan are defined for each of 3 zones on a typical developed lake shore residential lot identified.

- Zone 1 (shallow near shore water) includes fish sticks, a practice that places trees in the water to improve fish and aquatic life habitat and protect shorelines;
- Zone 2 (transition) includes various 350 square foot native planting plots and diversion practices to improve habitat and slow runoff;
- Zone 3 (upland) includes rain gardens, diversion practices and rock infiltration practices as eligible best practices to manage runoff from structures and other impervious surfaces.

Technical assistance costs may be reimbursed not to exceed 10% of the state share of project costs.

Funding Possibilities:
Maximum amount of grant funding is 75% of the total project cost, not to exceed $25,000. Grants run for a 2-year time period. Maximum costs per practice are also identified in the Wisconsin Healthy Lakes Implementation Plan.

2018 UPDATE FOR HARVESTING PERMIT APPLICATION

APPENDIX L

Table L.1
Abundance Data for Aquatic Plant Species Sampled in Little Muskego Lake: September 2018

Aquatic Plant Species	Native or Invasive	Number of Sites Found[a]	Frequency of Occurrence Within Vegetated Areas[b]	Average Rake Fullness[c]	Relative Frequency of Occurrence[d]	Visual Sightings[e]
Floating Plants						
Nymphaea odorata (white water lily)	Native	1	0.3	2.0	0.14	1
Submerged Plants						
Vallisneria americana (eel-grass/wild celery)[f]	Native	195	60.4	1.4	27.27	5
Nitellopsis obtusa (starry stonewort)	Invasive	122	37.8	1.4	17.06	2
Chara contraria (common stonewort)	Native	82	25.4	1.2	11.47	1
Ceratophyllum demersum (coontail)	Native	68	21.1	1.2	9.51	2
Stuckenia pectinata (sago pondweed)[f]	Native	52	16.1	1.4	7.27	1
Chara globularis (globular stonewort)	Native	52	16.1	1.2	7.27	0
Najas flexilis (slender naiad)	Native	34	10.5	1.2	4.76	0
Potamogeton friesii (Fries' pondweed)	Native	24	7.4	1.0	3.36	0
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	18	5.6	1.1	2.52	2
Potamogeton illinoensis (Illinois pondweed)[f]	Native	12	3.7	1.4	1.68	16
Heteranthera dubia (water stargrass)	Native	11	3.4	1.5	1.54	3
Elodea canadensis (waterweed/elodea)	Native	10	3.1	1.3	1.40	0
Nitella flexilis (slender stonewort)	Native	10	3.1	1.1	1.40	0
Potamogeton richardsonii (clasping-leaf pondweed)[f]	Native	8	2.5	1.4	1.12	0
Chara braunii (Braun's stonewort)	Native	7	2.2	1.0	0.98	0
Potamogeton zosteriformis (flat-stem pondweed)	Native	6	1.9	1.2	0.84	0
Potamogeton foliosus (leafy pondweed)	Native	2	0.6	1.0	0.28	0
Potamogeton crispus (curly-leaf pondweed)	Invasive	1	0.3	1.0	0.14	0

Note: Sampling occurred at 493 sampling sites in September 2018. 323 of these sites had vegetation. Red text indicates non-native and/or invasive species.

[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

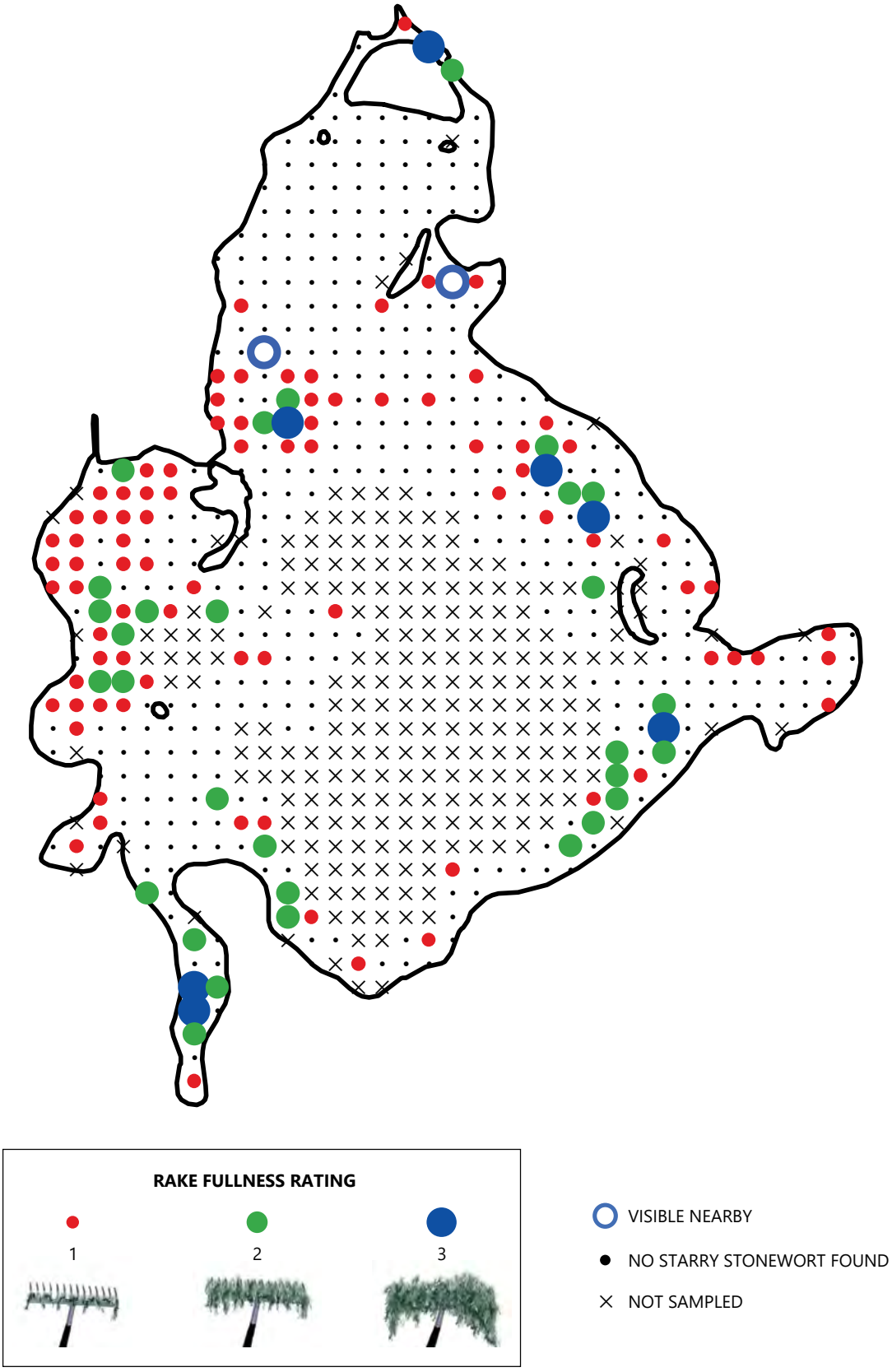
Table L.2
Aquatic Plant Species Observed in Little Muskego Lake: 2013, 2014, 2015, and 2018

Aquatic Plant Species	August 2013	September 2014	September 2015	September 2018
Invasive Aquatic Plants				
Myriophyllum spicatum (Eurasian water milfoil)	X	X	X	X
Nitellopsis obtusa (starry stonewort)	--	X	X	X
Potamogeton crispus (curly-leaf pondweed)	X	X	X	X
Non-native Aquatic Plants				
Najas marina (Spiny naiad)	--	X	--	--
Native Aquatic Plants				
Ceratophyllum demersum (coontail)	X	X	X	X
Chara spp. (muskgrass)[a]	X	X	X	X
Elodea canadensis (waterweed/elodea)	X	X	X	X
Heteranthera dubia (water stargrass)	X	X	X	X
Myriophyllum sibiricum (northern water milfoil)	--	X	--	--
Najas flexilis (slender naiad)	--	X	X	X
Najas guadalupensis (southern naiad)	X	X	X	--
Nitella spp. (nitella)	--	--	--	X
Nymphaea odorata (white water lily)	X	X	X	X
Polygonum amphibiam (water smartweed)	X	--	--	--
Potamogeton amplifolius (large-leaf pondweed)	X	--	--	--
Potamogeton foliosis (leafy pondweed)	X	X	X	X
Potamogeton friesii (Fries' pondweed)	--	X	X	X
Potamogeton gramineus (variable pondweed)	X	X	X	--
Potamogeton illinoensis (Illinois pondweed)	X	X	X	X
Potamogeton nodosus (long-leaf pondweed)	X	--	--	--
Potamogeton praelongus (whitestem pondweed)	--	X	X	--
Potamogeton pusillus (small pondweed)	X	--	--	--
Potamogeton richardsonii (clasping-leaf pondweed)	X	X	X	X
Potamogeton spp. (narrow leaf pondweed)	--	--	--	--
Potamogeton strictifolius (stiff pondweed)	X	--	--	--
Potamogeton zosteriformis (flat-stem pondweed)	X	X	--	X
Ranunculus aquatilis (white water crowfoot)	--	X	--	--
Ranunculus sp. (water crowfoot)	--	--	--	--
Stuckenia pectinata (sago pondweed)	X	X	X	X
Utricularia spp. (bladderwort)	X	--	--	--
Vallisneria americana (eel-grass/wild celery)	X	X	X	X
Total Native Species	19	18	15	13

[a] *Chara species were not differentiated in aquatic plant surveys before 2018, hence Chara contraria, Chara globularis, and Chara braunii (see Table L.1) were combined in this table for comparison as to not inflate the number of different native species found. It is highly likely that these different species existed within Little Muskego Lake before 2018, but were not differentiated because of the lack of identification resources and knowledge.*

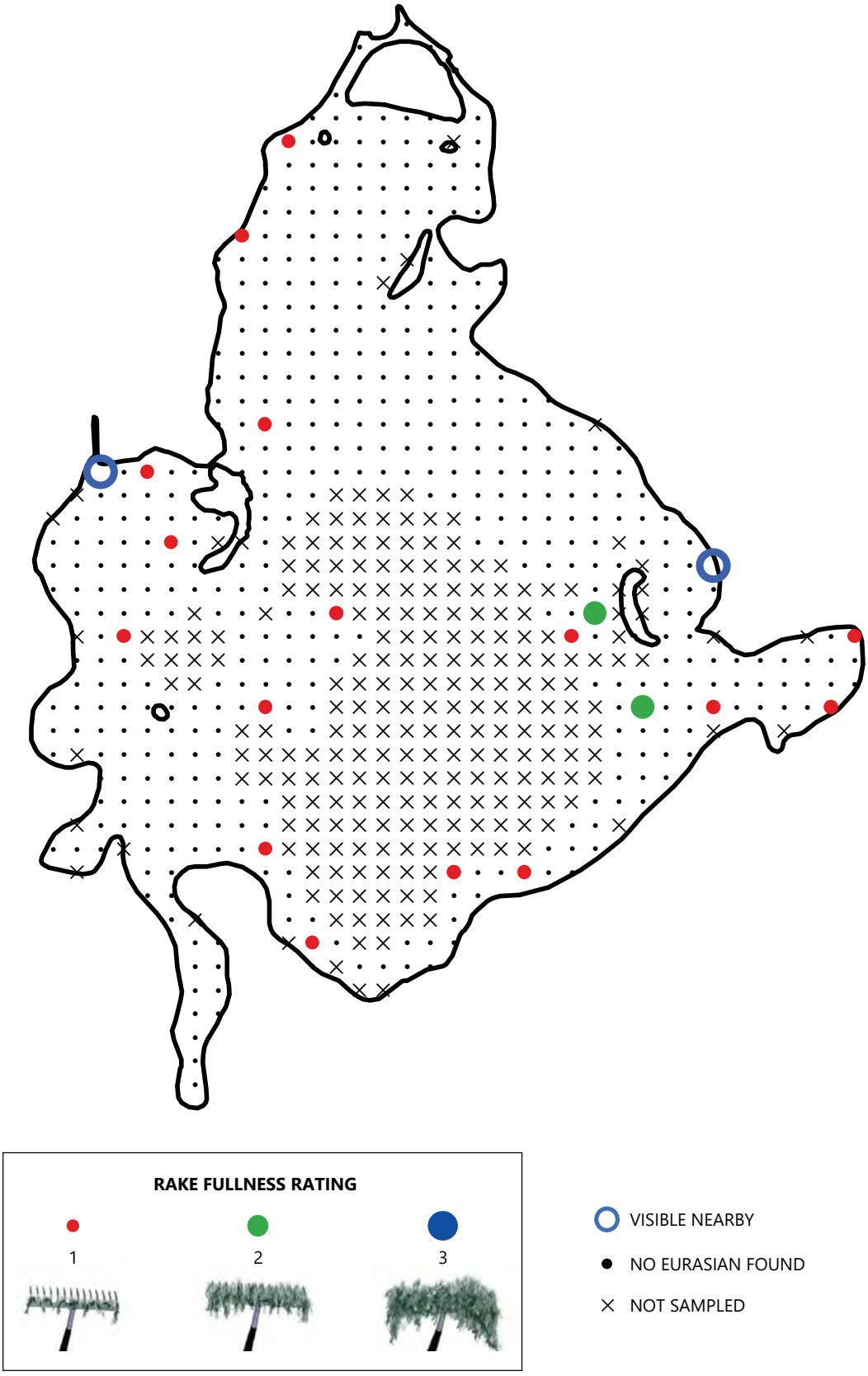
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure L.1
Starry Stonewort Occurrence in Little Muskego Lake: September 2018



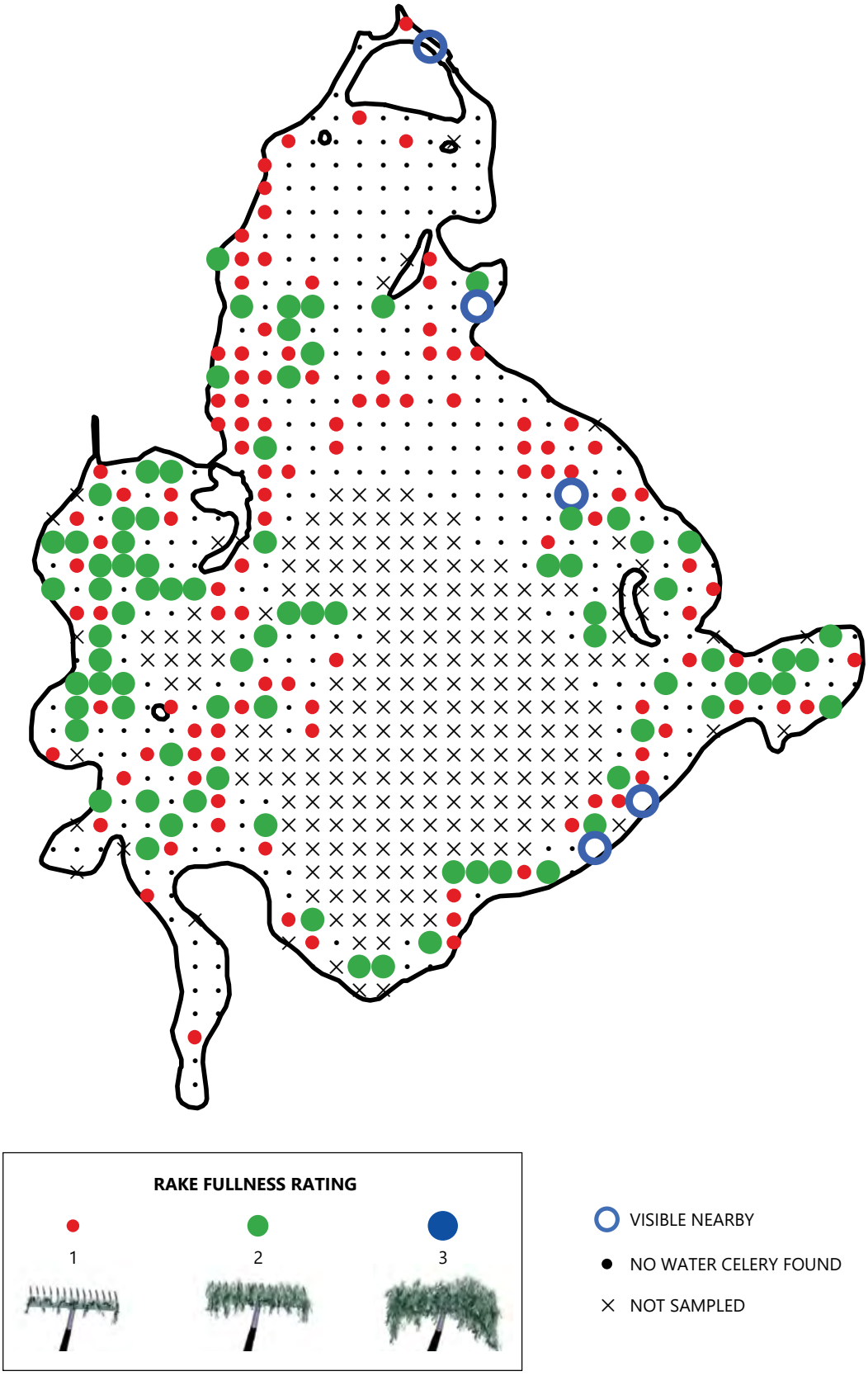
Source: Wisconsin Department of Natural Resources

Figure L.2
Eurasian Water Milfoil Occurrence in Little Muskego Lake: September 2018



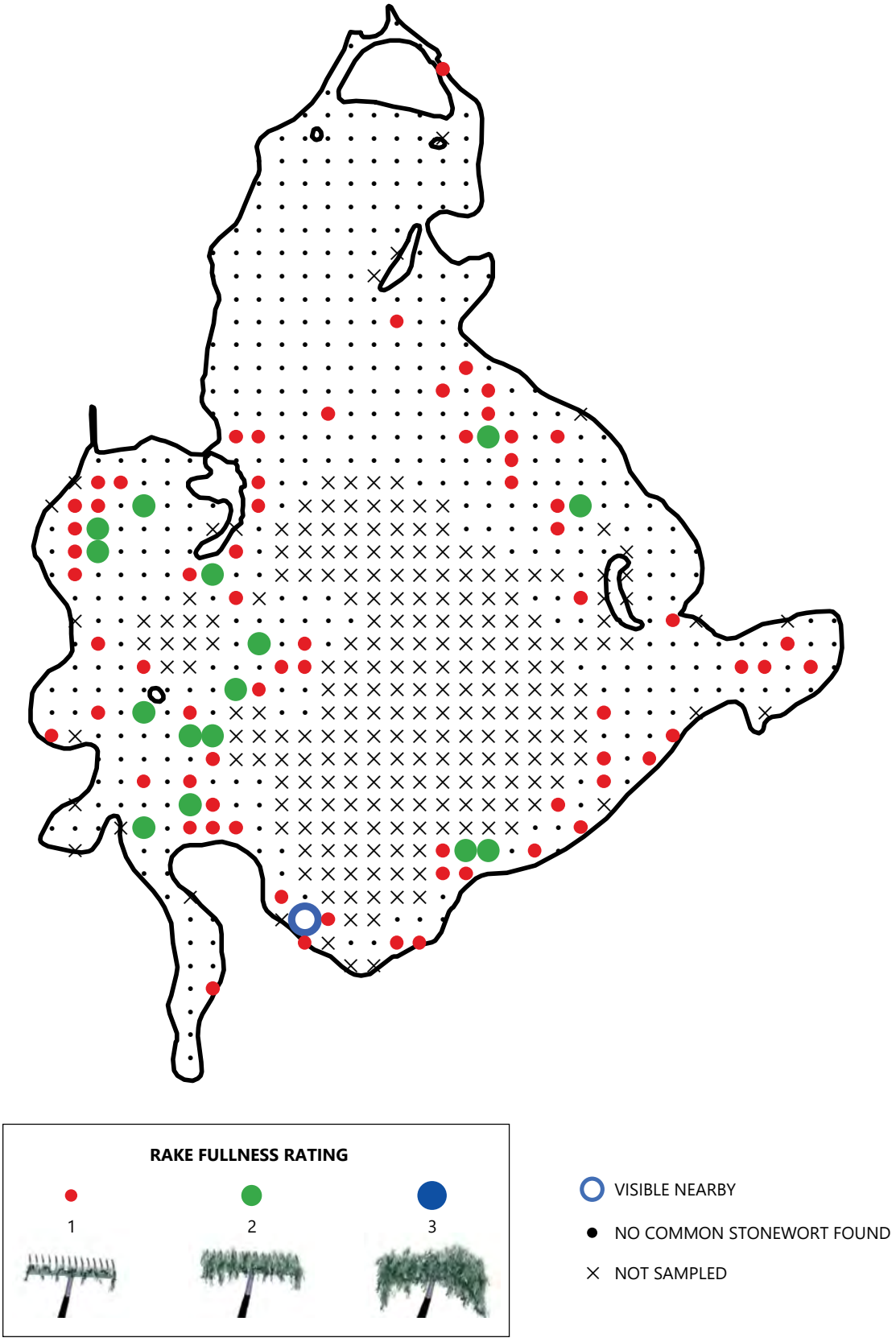
Source: Wisconsin Department of Natural Resources

Figure L.3
Water Celery Occurrence in Little Muskego Lake: September 2018



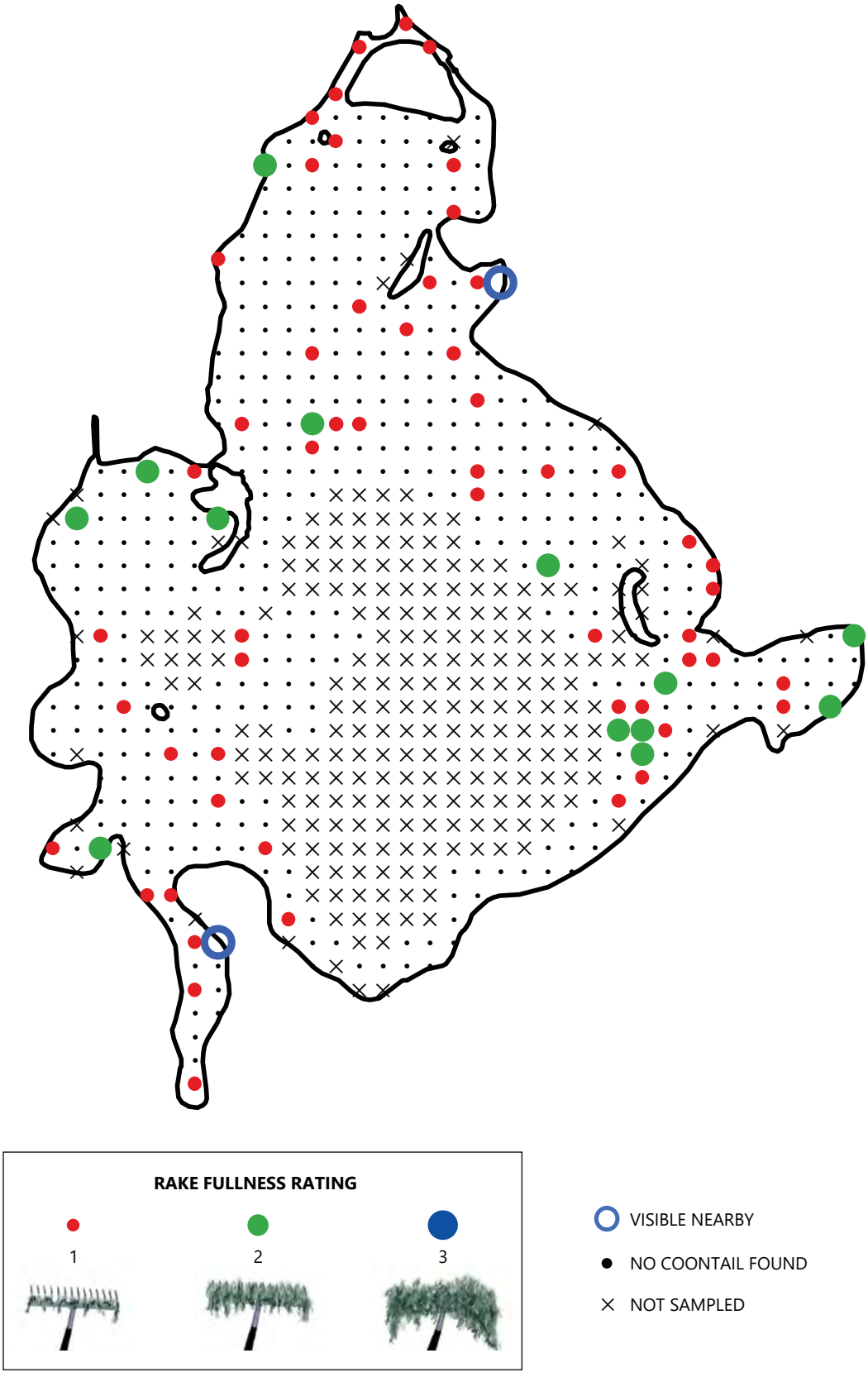
Source: Wisconsin Department of Natural Resources

Figure L.4
Common Stonewort Occurrence in Little Muskego Lake: September 2018



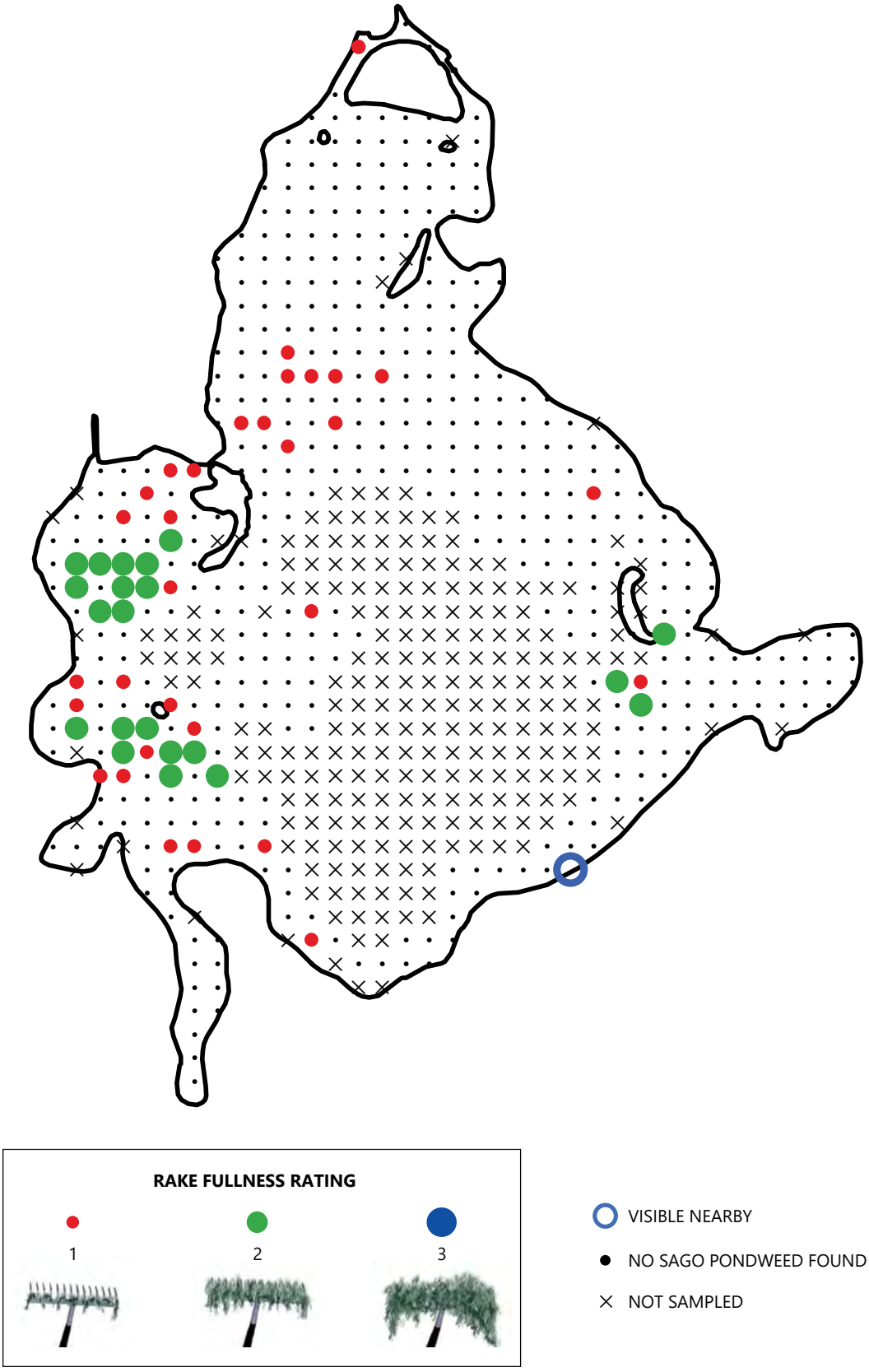
Source: Wisconsin Department of Natural Resources

Figure L.5
Coontail Occurrence in Little Muskego Lake: September 2018



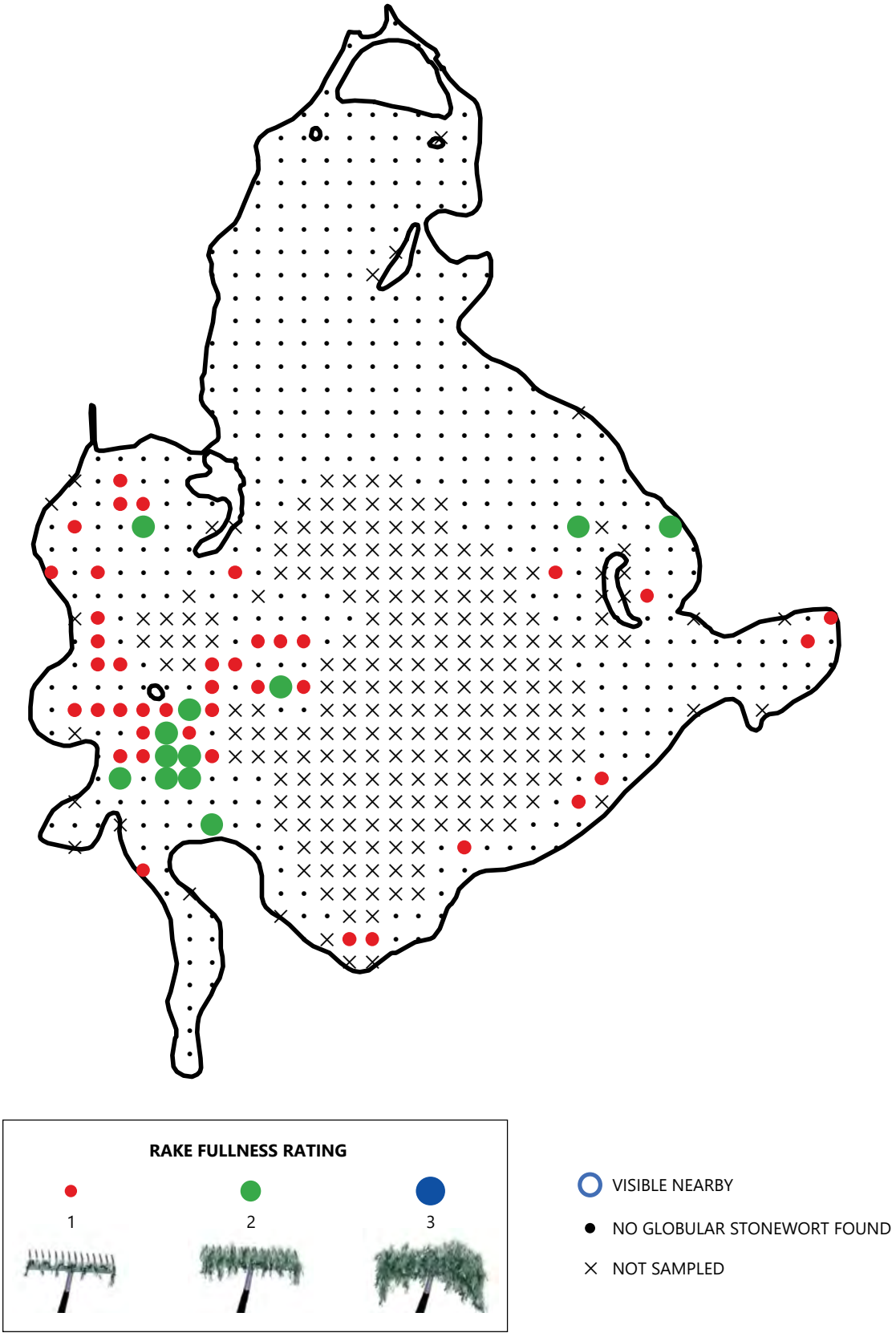
Source: Wisconsin Department of Natural Resources

Figure L.6
Sago Pondweed Occurrence in Little Muskego Lake: September 2018



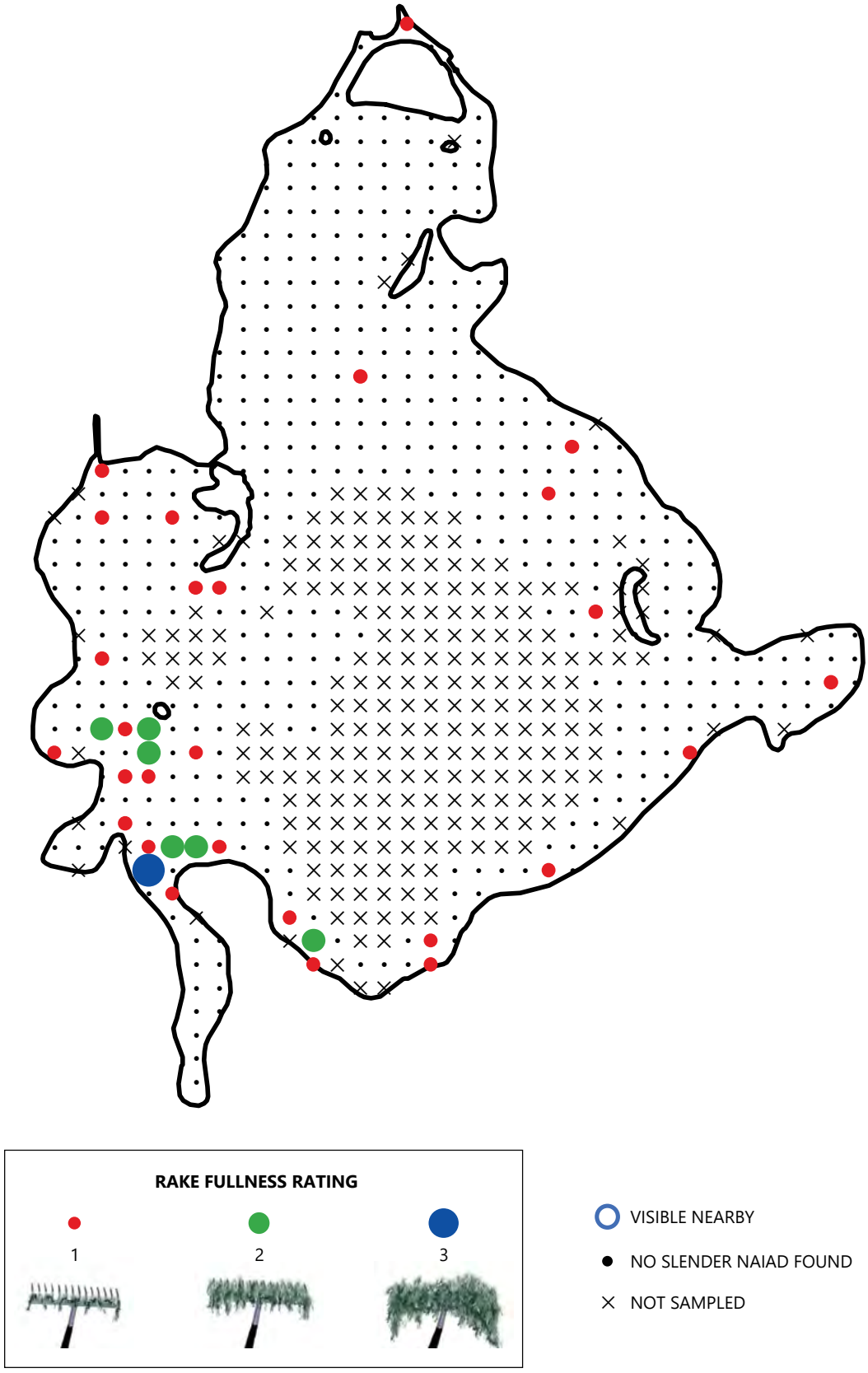
Source: Wisconsin Department of Natural Resources

Figure L.7
Globular Stonewort Occurrence in Little Muskego Lake: September 2018



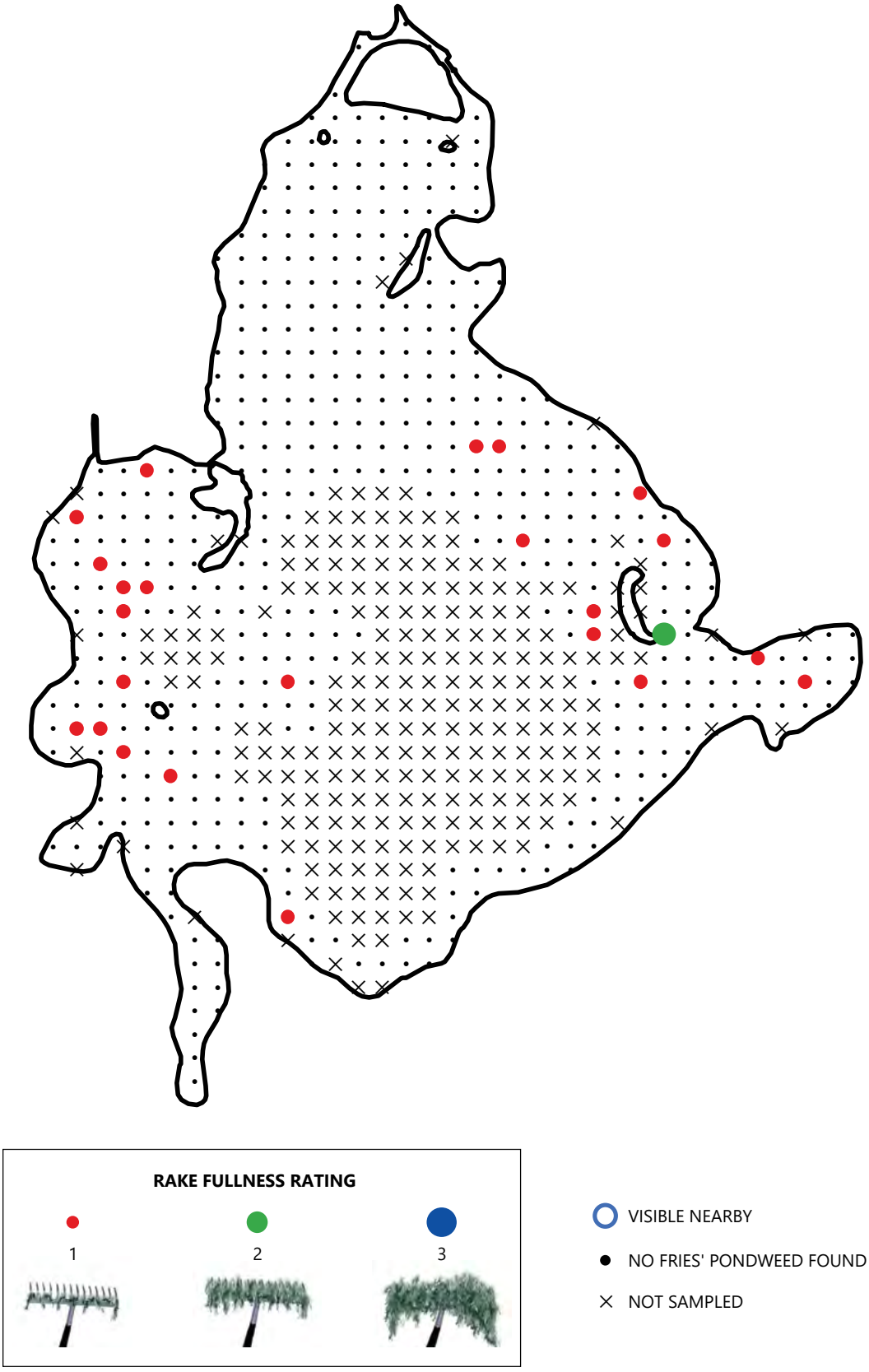
Source: Wisconsin Department of Natural Resources

Figure L.8
Slender Naiad Occurrence in Little Muskego Lake: September 2018



Source: Wisconsin Department of Natural Resources

Figure L.9
Fries' Pondweed Occurrence in Little Muskego Lake: September 2018



Source: Wisconsin Department of Natural Resources