MEMORANDUM REPORT NO. 81
2ND EDITION

AQUATIC PLANT MANAGEMENT PLAN UPDATE FOR THE PHANTOM LAKES

WAUKESHA COUNTY, WISCONSIN: 2019

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INTRODUCTION 1

Credit: Phantom Lakes Management District

The Southeastern Wisconsin Regional Planning Commission (the Commission) completed this aquatic plant inventory and management study on behalf of the Phantom Lakes Management District (District). The Wisconsin Department of Natural Resources (WDNR) financed much of the project cost through a Wisconsin Administrative code NR 190 *Lake Management Planning Grants* award (project ID LPL164817). This memorandum is the Commission's fourth study focusing on Waukesha County's Phantom Lakes.[1]

The WDNR used data and conclusions generated as part of the Commission's study to help evaluate the Lakes' aquatic plant community and draft the 2019 – 2023 Aquatic Plant Control permit (see Appendix A). While drafting the aquatic plant management permit, the WDNR made suggestions to help clarify information presented in the Commission's report. These suggestions were subsequently incorporated into the Commission's final published plan.

1.1 PROJECT SETTING, BACKGROUND, SCOPE, AND INTENT

The Phantom Lakes (the Lakes) are a pair of water bodies located in extreme south-central Waukesha County. The smaller southern lake is named Phantom Lake or occasionally Upper Phantom Lake (we chose to use Upper Phantom Lake in this report for clarity). Upper Phantom Lake is a 110-acre, 29-foot deep natural lake with no significant tributaries. A narrow channel connects Upper Phantom Lake to Lower Phantom Lake. Lower Phantom Lake is a shallow reservoir created by damming the Mukwonago River. Lower Phantom Lake covers 373 acres and has a maximum depth of 12 feet. The Lakes share a common water level. The water levels of both lakes are controlled by the dam which is located at the extreme eastern end of Lower Phantom Lake.

The Lakes are intensively used for a diverse array of water-based recreation. As is typical for many if not most Southeastern Wisconsin lakes, the Lakes are nutrient rich—fueling luxuriant aquatic vegetation. The shallow

[1] *The three earlier Commission reports include: SEWRPC Memorandum Report No. 81,* An Aquatic Plant Management Plan for the Phantoms Lakes, Waukesha County, Wisconsin, *July 1993; SEWRPC Community Assistance Report No. 230,* A Lake Management Plan for the Phantom Lakes, Waukesha County, Wisconsin (Volume 1 Inventory Findings, Volume Two: Alternatives and Recommended Plan*), January 2006; SEWRPC Staff Memorandum*, An Aquatic Plant Management Plan Update for Upper and Lower Phantom Lakes, Waukesha County Wisconsin: 2011*, May 4, 2012*.

nature of much of Lower Phantom Lake and some portions of Upper Phantom Lake fosters abundant plant growth, a condition sometimes leading to lake-use problems. To help support a wide variety of recreational uses, the District manages aquatic plant populations under a permit issued by the WDNR. The ongoing management program relies primarily upon mechanical aquatic plant harvesting. According to available feedback and data, the aquatic plant community is responding well to current management practices, and lake recreational use has not been unduly restricted in most areas. Nevertheless, some shoreline residents and lake users believe aquatic plant management could be improved. Therefore, some aspects of aquatic plant management remain an issue of concern and controversy.

The District's aquatic plant management (APM) permit was granted for a five-year period beginning in 2012. Permit extensions were granted to allow aquatic plant harvesting to continue, including permission to continue aquatic plant management under the conditions of the 2012 permit through June 2019.[2] A new permit is needed, a situation requiring a comprehensive on-the-water aquatic plant inventory. To support this endeavor, the Commission completed an aquatic plant inventory during 2017. The resultant data were used to evaluate the Lakes' plant community conditions and apparent reaction to recent management practices. This information was then used to update the 2012 APM plan. The draft plan update was scrutinized throughout much of 2018 and early 2019 by the District, Lake residents and users, and regulators. The resultant APM plan considers input and suggestions from a wide cross section of individuals and organizations interested in the Lakes.

This updated APM plan summarizes information and recommendations needed to manage nuisance plants (including Eurasian water milfoil and curly-leaf pondweed). Additionally, though not directly needed for APM permit process, this plan briefly examines recent water quality and quantity information.[3] The plan covers five main topics:

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

The aquatic plant management component of this memorandum focuses upon approaches to monitor and control actively growing nuisance populations of aquatic plants. The plan presents a range of alternatives that could potentially be used to achieve desired APM goals and provides specific recommendations related to each alternative. These measures focus on those that the District can implement and collaborate on with Lake residents/users and the WDNR.

The current study is not meant to update the comprehensive lake management plan and therefore does not address watershed issues, land use, in-depth water quality/quantity interpretations, history, recreational use, fish/wildlife, and other such topics typical of comprehensive lake plans. Earlier comprehensive lake management reports address other management strategies that can help prevent degradation of the Lakes' water quality and aquatic plant community.[4] Examples of such management actions include strategies to reduce phosphorus loads to the Lake and measures to prevent accidental introduction of new invasive plants and animals.

In summary, this document helps interested parties understand the particular plant management measures to be used in and around the Lakes and provides a quick review of basic water quality/quantity trends. These data and suggestions can be valuable resources when developing requisite APM permit applications and implementing future aquatic plant management efforts.

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[2] *Email, Heidi Bunk (WDNR) to Bob Schmidt (District), Phantom Extension to June 30th, May 17, 2019.*

[3] *The District specifically requested that this element be included with the Commission's scope of work to help identify water quality change or the potential for change. Water quality changes can influence aquatic plant growth.*

[4] *SEWRPC Community Assistance Planning Report No. 230, op. cit.*

INVENTORY FINDINGS AND RELEVANCE TO RESOURCE MANAGEMENT 2

Credit: Phantom Lakes Management District

Natural resource planning relies upon data to quantify conditions, identify management challenges and limitations, and predict the influence of potential courses of action. These factors are collectively considered to evaluate and recommend practices that promote sustainable use, help safeguard human and environmental health, balance diverse lake user interests, address sometimes disparate lake user desires, and comply with regulatory objectives and requirements. The study discussed in this plan included on-the-water data collection, gathering and studying supplemental water quality and hydrology information, and attending several District meetings. The following sections briefly describe data collection efforts, summarize and highlight resultant data, interpret data trends and relationships, and make useful conclusions to guide resource planning.

2.1 AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

Aquatic plant management (APM) programs are designed to further a variety of lake user and riparian land owner goals and desires. For example, most APM programs aim to improve lake navigability. However, APM programs must also be sensitive to other lake uses and must maintain or enhance a lake's ecological integrity. Consequently, APM program objectives are commonly developed in close consultation with many interested parties. The Phantom Lakes APM plan considered input from many entities and individuals including the Phantom Lakes Management District (the District), lake users, riparian landowners, and the WDNR. Objectives of the Phantom Lakes APM program include the following.

- Effectively control the quantity and density of nuisance aquatic plant growth in well-targeted portions of the Phantom Lakes (the Lakes). This objective helps:
    - Enhance water-based recreational opportunities
    - Improve community-perceived aesthetic values
    - Maintain or enhance the Lakes' natural resource value

- Manage the Lakes in an environmentally sensitive manner in conformance with *Wisconsin Administrative Code* standards and requirements under Chapters NR 103 *Water Quality Standards for Wetlands*, NR 107 *Aquatic Plant Management*, and NR 109 *Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. Following these rules helps the District preserve and enhance the Lakes' water quality, their biotic communities, their habitat value, and their essential structure and relative function in relation to adjacent areas. These principles were examined at length in the 2006 comprehensive lake plan,[5] as amended.

- Protect and maintain public health and promote public comfort, convenience, and welfare while safeguarding the Lakes' ecological health through environmentally sound management of vegetation, wildlife, and fish and other aquatic/semi-aquatic organisms in and around the Lakes.

- Promote a high-quality water-based experience for residents and visitors to the Lakes consistent with the policies and practices of the WDNR, as described in the regional water quality management plan, as amended.[6]

To meet these objectives, the District executed an agreement with the Commission to investigate the characteristics of the Phantom Lakes and their watersheds and to develop an aquatic plant management plan update. As part of this planning process, a number of watershed and lake inventories were conducted, including:

- Surveys of the aquatic plant community and comparison to results of previous surveys

- Hydrology and water quantity

- Analysis of the available water quality data

This chapter presents the results of each of these inventories.

2.2 AQUATIC PLANT COMMUNITY COMPOSITION, CHANGE, AND QUALITY

The Lakes' aquatic plant communities were evaluated several times since the 1960s. WDNR staff surveyed the aquatic plant community during 1967 and 1980.[7,8,9] Commission staff surveyed the Lakes' aquatic plants in 1993,[10] 2002,[11] 2011,[12] and 2017. Species lists and abundance data derived from the 2011 and 2017 surveys for each lake are compared in Tables 2.1 and 2.2. The 2011 and 2017 surveys both used the same

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[5] *Ibid*.

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

[7] *Belonger, Brian J.,* Aquatic Plant Survey of Major Lakes in the Fox River (Illinois) Watershed*, WDNR Research Report Number 39, 1969*.

[8] *SEWRPC and Wisconsin Department of Natural Resources Lake Use Report No. FX-14,* Lower Phantom Lake, Waukesha County, Wisconsin*, 1969; SEWRPC and Wisconsin Department of Natural Resources Lake Use Report No. FX-33,* Upper Phantom Lake, Waukesha County, Wisconsin*, 1969*.

[9] *Wisconsin Department of Natural Resources,* Phantom Lakes, Waukesha County: Feasibility Study Results, Management Alternatives*, October 1982*.

[10] *SEWRPC Memorandum Report No. 81, op. cit.*

[11] *SEWRPC Community Assistance Planning Report No. 230, op. cit.*

[12] *SEWRPC Staff Memorandum, 2012, op. cit.*

Table 2.1
Aquatic Plant Abundance, Upper Phantom Lake: July 19, 2011, Versus August 8 and 9, 2017

Aquatic Plant Species	Native or Invasive	Number of Points Found[a] (2011/2017)	Frequency of Occurrence Within Vegetated Areas[b] (2011/2017)	Average Rake Fullness[c] (2011/2017)	Relative Frequency of Occurrence[d] (2011/2017)	Visual Sightings[e] (2011/2017)
Ceratophyllum demersum (coontail)	Native	0/1	0/0.9	0/1.0	0/0.4	0/0
Chara spp. (muskgrasses)*	Native	113/57	66.5/50.9	2.2/1.5	24.1/24.6	0/4
Elodea canadensis (waterweed)	Native	1/4	0.6/3.6	1.0/1.3	0.2/1.7	0/0
Heteranthera dubia (water stargrass)	Native	0/2	0/1.8	0/1.5	0/0.9	0/0
Myriophyllum heterophyllum (various-leaved water milfoil)*	Native	0/11	0.0/9.8	0.0/1.6	0.0/4.7	0/8
Myriophyllum sibiricum (northern water milfoil)	Native	41/0	23.8/0.0	1.4/0.0	8.7/0.0	0/0
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	23/16	13.5/14.3	2.0/1.6	4.9/6.9	0/4
Najas flexilis (bushy, or slender, pondweed)	Native	6/1	3.5/0.9	1.3/1.0	1.3/0.4	0/0
Najas marina (spiny, or brittle, naiad)[f]	Naturalized	84/52	49.4/46.4	1.5/1.1	17.9/22.4	0/1
Nitella spp. (Nitella)*	Native	16/0	9.4/0	1.5/0	3.4/0	0/0
Nuphar variegata (spatterdock)	Native	3/0	1.8/0	2.0/0	0.6/0	0/0
Nymphaea odorata (white water lily)	Native	4/0	2.4/0	1.3/0	0.9/0	0/0
Potamogeton amplifolius (large-leaf pondweed)*[g]	Native	0/0	0/0	0/0	0/0	0/1
Potamogeton foliosus (leafy pondweed)	Native	1/0	0.6/0	1.0/0	0.2/0	0/0
Potamogeton gramineus (variable pondweed)*[g]	Native	19/14	11.2/12.5	1.4/1.1	4.1/6.0	0/7
Potamogeton illinoensis (Illinois pondweed)[g]	Native	15/1	8.8/0.9	1.3/2.0	3.2/0.4	0/0
Potamogeton pusillus (small pondweed)*	Native	1/0	0.6/0	1.0/0	0.2/0	0/0
Potamogeton richardsonii (clasping-leaf pondweed)[g]	Native	8/4	4.7/3.6	1.3/1.0	1.7/1.7	0/1
Potamogeton zosteriformis (flat-stem pondweed)	Native	3/2	1.8/1.8	1.0/1.5	0.6/0.9	0/0
*Sagittaria (*arrowhead)	Native	2/0	1.2/0	2.0/0	0.4/0	0/0
Stuckenia pectinata (Sago pondweed)[g]	Native	41/44	24.1/39.3	1.2/1.1	8.7/19.0	0/1
Utricularia vulgaris (common bladderwort)*	Native	45/3	26.5/2.7	1.1/1.3	9.6/1.3	0/1
Vallisneria americana (eel-grass/wild celery)	Native	43/20	25.3/17.9	1.3/1.1	9.2/8.6	0/3

Notes:

- During the 2011 survey, sampling occurred at 170 sampling points on July 19th, 2011. Of the 172 sampling points that were shallower than the maximum depth of known aquatic plant growth, 170 were vegetated. During the 2017 survey, sampling occurred at 159 sampling points on August 8th and 9th, 2017. Of the 159 sampling points that were shallower than the maximum depth of known aquatic plant growth, 112 had vegetation.
- Red text indicates non-native and/or invasive species.
- An asterisk (*) next to a species name indicates that the species is considered "sensitive," with a coefficient of conservatism (C) value of seven or greater.
- See Appendix C for distribution maps and identifying features.
- Cattails were observed and noted during the aquatic plant survey, but were not sampled. Both native and invasive Typha species are likely present.

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

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

Table continued on next page.

Table 2.1 (Continued)

[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 points 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 points where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake. (It is likely that visual sightings were not taken in 2011).*

[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

Table 2.2
Aquatic Plant Abundance, Lower Phantom Lake: July 21, 2011, Versus July 31 and August 1, 2, and 7, 2017

Aquatic Plant Species	Native or Invasive	Number of Points Found[a] (2011/2017)	Frequency of Occurrence Within Vegetated Areas[b] (2011/2017)	Average Rake Fullness[c] (2011/2017)	Relative Frequency of Occurrence[d] (2011/2017)	Visual Sightings[e] (2011/2017)
Ceratophyllum demersum (coontail)	Native	39/54	14.7/21.3	1.5/1.8	3.9/6.1	0/8
Chara spp. (muskgrasses)*	Native	94/131	35.5/51.6	2.6/2.6	9.4/14.8	0/4
Elodea canadensis (waterweed)	Native	58/57	21.9/22.4	1.8/1.4	5.8/6.5	0/1
Heteranthera dubia (water stargrass)	Native	3/1	1.1/0.4	1.0/2.0	0.3/0.1	0/0
Lemna trisulca (forked duckweed)	Native	0/1	0/0.4	0/1.0	0/0.1	0/0
Myriophyllum heterophyllum (various-leaved milfoil)*	Native	0/96	0/37.80	0/1.9	0/10.9	0/21
Myriophyllum sibiricum (northern milfoil)	Native	142/0	53.6/0.0	2.2/0.0	14.2/0.0	0/0
Myriophyllum spicatum (Eurasian water milfoil)	Invasive	115/77	43.4/30.3	2.1/1.6	11.5/8.7	0/9
Najas flexilis (bushy, or slender, pondweed)	Native	16/20	6.0/7.9	1.2/1.3	1.6/2.3	0/2
Najas marina (spiny, or brittle, naiad)[f]	Naturalized	16/7	6.0/2.8	1.6/1.6	1.6/0.8	0/3
Nitella spp. (Nitella)*	Native	2/5	0.8/2.0	1.0/1.0	0.2/0.6	0/0
Nuphar variegata (spatterdock)	Native	33/16	12.5/6.3	2.5/1.6	3.3/1.8	0/22
Nymphaea odorata (white water lily)	Native	31/3	11.7/1.2	2.3/1.0	3.1/0.3	0/13
Potamogeton amplifolius (large-leaf pondweed)*[,g]	Native	0/4	0/1.6	0/1.5	0/0.5	0/3
Potamogeton crispus (curly-leaf pondweed)	Invasive	1/4	0.4/1.6	1.0/1.0	0.1/0.5	0/1
Potamogeton foliosus (leafy pondweed)	Native	0/3	0/1.2	0/1.3	0/0.3	0/1
Potamogeton friesii (Fries' pondweed)*	Native	0/2	0/0.8	0/1.0	0/0.2	0/1
Potamogeton gramineus (variable pondweed)*[,g]	Native	8/16	3.0/6.3	1.3/1.3	0.8/1.8	0/1
Potamogeton illinoensis (Illinois pondweed)[g]	Native	22/24	8.3/9.5	1.4/1.3	2.2/2.7	0/8
Potamogeton natans (floating-leaf pondweed)	Native	8/5	3.0/2.0	1.3/1.4	0.8/0.6	0/6
Potamogeton nodosus (long-leaf pondweed)*	Native	3/0	1.1/0	1.0/0	0.3/0	0/0
Potamogeton praelongus (white-stem pondweed)*[,g]	Native	15/1	5.7/0.4	1.3/1.0	1.5/0.1	0/0
Potamogeton richardsonii (clasping-leaf pondweed)[g]	Native	100/92	37.7/36.2	1.5/1.4	10.0/10.4	0/25
Potamogeton zosteriformis (flat-stem pondweed)	Native	47/16	17.7/6.3	1.5/1.4	4.7/1.8	0/5
*Sagittaria cuneata (*arum-leaved arrowhead)*	Native	0/46	0/18.1	0/2.0	0/5.2	0/6
Stuckenia pectinata (Sago pondweed)[g]	Native	78/31	29.4/12.2	1.5/1.2	7.8/3.5	0/11
Utricularia vulgaris (common bladderwort)*	Native	74/70	27.9/27.6	1.3/1.9	7.4/7.9	0/18
Vallisneria americana (eel-grass/wild celery)	Native	98/101	37.0/39.8	2.2/1.9	9.8/11.4	0/5

Notes:

- During the 2011 survey, sampling occurred at 170 sampling points on July 19th, 2011. Of the 172 sampling points that were shallower than the maximum depth of known aquatic plant growth, 170 were vegetated. During the 2017 survey, sampling occurred at 159 sampling points on August 8th and 9th, 2017. Of the 159 sampling points that were shallower than the maximum depth of known aquatic plant growth, 112 had vegetation.
- Red text indicates non-native and/or invasive species.
- An asterisk (*) next to a species name indicates that the species is considered "sensitive," with a coefficient of conservatism (C) value of seven or greater.
- See Appendix C for distribution maps and identifying features.
- Cattails were observed and noted during the aquatic plant survey, but were not sampled. Both native and invasive Typha species are likely present.

Table continued on next page.

Table 2.2 (Continued)

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

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

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

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

[e] Visual Sightings *is the number of points 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 points where this occurred, the species was simply marked as "present" at that site. Recording the number of visual sightings helps give a better picture of species distribution throughout the lake. (It is likely that visual sightings were not taken in 2011).*

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[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

point-intercept grid and methodology.[13,14,15] Therefore, the same points were sampled using the same techniques on roughly the same date approximately six years apart. Such consistency enables more detailed evaluation of aquatic plant abundance and distribution change than has been possible in the past. The raw data generated during the 2017 aquatic plant survey is included in Appendix B.

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

Several metrics are useful to describe aquatic plant community condition and design management strategies. These metrics include maximum depth of colonization, species richness, biodiversity, evaluation of sensitive species, and relative species abundance. Metrics derived from the 2011 and 2017 point-intercept surveys are described below.

Maximum Depth of Colonization

Significant plant growth was found in Upper Phantom Lake as deep as 15 feet below the water surface during 2011 and 2017 while a few plants were growing in water as deep as 16 feet during 2011. In Lower Phantom Lake, plant growth has been observed throughout all depths of the lake, as the maximum depth of the lake is only 12 feet. Maximum depth of colonization (MDC) is a useful indicator of water quality, as turbid and/or eutrophic (nutrient-rich) lakes generally have shallower MDC than lakes with clear water.[16] It is important to note that for surveys using the point-intercept protocol, the protocol allows sampling to be discontinued at depths greater than the maximum depth of colonization for vascular plants. However, aquatic moss and macroalgae, such as *Chara* spp. and *Nitella* spp., frequently colonize deeper than vascular plants and thus may be under-sampled in some lakes. For example, *Chara globularis* and *Nitella flexilis* have been found growing as deep as 37 feet and 35 feet, respectively, in Silver Lake, Washington County.

Species Richness

The number of different types of aquatic plants present in a lake is referred to as the *species richness* of the lake. Larger lakes with diverse lake basin morphology, less human disturbance, and/or healthier, more resilient lake ecosystems generally have greater species richness. Aquatic plants provide a wide variety of benefits to lakes, examples of which are briefly described in Table 2.3. Upper Phantom Lake typically hosts fewer aquatic plant species when compared to Lower Phantom Lake and therefore has less species richness than Lower Phantom Lake.

Upper Phantom Lake exhibited higher species richness when compared to Lower Phantom Lake only during the initial plant inventory completed during 1967 (see Tables 2.4 and 2.5). Upper Phantom Lake's species richness declined considerably by the time of the next plant inventory (1980), and continued to decline

[13] *It is noteworthy that sampling methodology changed from transect-based methods in the earlier surveys (1967 through 2002) to a point-intercept method beginning in 2011.*

[14] *Jesson, R. and R. Lound, Minnesota Department of Conservation Game Investigational Report No. 6,* An Evaluation of a Survey Technique for Submerged Aquatic Plants*, 1962; as refined in the memo from Stan Nichols to J. Bode, J. Leverence, S. Borman, S. Engel, and D. Helsel, entitled "Analysis of Macrophyte Data for Ambient Lakes-Dutch Hollow and Redstone Lakes Example," Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension, February 4, 1994.*

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

[16] *Canfield Jr, D.E., Langeland, L., and Haller, W.T. "Relations between water transparency and maximum depth of macrophyte colonization in lakes."* Journal of Aquatic Plant Management*, 23, 1985.*

Table 2.3
Examples of Positive Ecological Qualities Associated with Aquatic Plant Species Present in the Phantom Lakes

Aquatic Plant Species Present	Ecological Significance
Ceratophyllum demersum (coontail)	Provides good shelter for young fish; supports insects valuable as food for fish and ducklings; native
Chara spp. (muskgrass)	A favorite waterfowl food and fish habitat, especially for young fish; native
Elodea canadensis (waterweed)	Provides shelter and support for insects which are valuable as fish food; native
Heteranthera dubia (water stargrass)	Locally important food source for waterfowl and forage for fish; native
Myriophyllum heterophyllum (various-leaved milfoil)	Waterfowl utilize fruit and foliage as food source; foliage provides invertebrate habitat, as well as shade, shelter, and foraging for fish; native
Myriophyllum sibiricum (northern water milfoil)	Leaves and fruit provide food for waterfowl and shelter and foraging for fish; native
Myriophyllum spicatum (Eurasian water milfoil)	None known. Invasive nonnative. Hinders navigation, outcompetes desirable aquatic plants, reduces water circulation, depresses oxygen levels, and reduces fish/invertebrate populations
Najas flexilis (bushy pondweed)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas guadalupensis (southern naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Najas marina (spiny naiad)	Important food source for waterfowl, marsh birds, and muskrats; provides food and shelter for fish; native
Nitella spp. (stonewort)	Sometimes grazed by waterfowl; forage for fish; native
Potamogeton amplifolius (large-leaf pondweed)	Also known as bass-weed or musky-weed, this plant is highly prized by fishermen as prime fish habitat; provides excellent shelter for small fish and foraging opportunities for predator fish; valuable waterfowl food; native
Potamogeton crispus (curly-leaf pondweed)	Adapted to cold water; mid-summer die-off can impair water quality; invasive nonnative
Potamogeton foliosus (leafy pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
Potamogeton gramineus (variable pondweed)	The fruit is an important food source for many waterfowl; also provides food for muskrat, deer, and beaver; native
Potamogeton illinoensis (Illinois pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton natans (floating-leaf pondweed)	The late-forming fruit provides important food source for ducks; provides good fish habitat due to its shade and foraging opportunities; native
Potamogeton nodosus (long-leaf pondweed)	Fruit grazed by waterfowl; provides food for muskrat, beaver, and deer; habitat for invertebrates and forage opportunities for fish; native
Potamogeton oakesianus (Oakes pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton praelongus (white-stem pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; the presence of white-stem pondweed in a lake is usually an indicator of good water quality due to this plant's intolerance of polluted conditions; native
Potamogeton pusillus (small pondweed)	Provides shade and shelter for fish; harbor for insects; seeds are eaten by wildfowl; native
Potamogeton richardsonii (clasping-leaf pondweed)	The fruit is an important food source for waterfowl; the stem and leaves supply food for muskrat, beaver, deer, and moose and provide forage and cover for fish; native
Stuckenia pectinata (Sago pondweed)	This plant is the most important pondweed for ducks, in addition to providing food and shelter for young fish; native
Potamogeton zosteriformis (flat-stem pondweed)	Provides some food for ducks; native
Utricularia vulgaris (bladderwort)	Stems provide food and cover for fish; native
Vallisneria americana (eel-grass/wild celery)	Provides good shade and shelter, supports insects, and is valuable fish food; native

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

Source: SEWRPC

Table 2.4
Submerged Aquatic Plant Species Observed in Upper Phantom Lake: 1967-2017

Submerged Aquatic Plant Species	1967	1980	1993	2002	2011	2017
Ceratophyllum demersum (coontail)	Present	Present	--	Present	--	Present
Chara spp. (muskgrass)	Present	Present	Present	Present	Present	Present
Elodea canadensis (waterweed)	Present	Present	--	Present	Present	Present
Heteranthera dubia (water stargrass)[a]	--	--	--	Present	--	Present
Myriophyllum heterophyllum (various-leaved milfoil)	--	--	Present	--	--	Present
Myriophyllum sibiricum[b] (northern water milfoil)	Present	Present	--	Present	Present	--
Myriophyllum spicatum (Eurasian water milfoil)	--	--	Present	Present	Present	Present
Najas flexilis (bushy pondweed)	Present	Present	Present	Present	Present	Present
Najas marina (spiny naiad)	--	--	--	Present	Present	Present
Nitella spp. (stonewort)	Present	--	--	Present	Present	--
Potamogeton amplifolius (large-leaf pondweed)	Present	Present	--	--	--	--
Potamogeton crispus (curly-leaf pondweed)	Present	Present	--	Present	--	--
Potamogeton foliosus (leafy pondweed)	--	--	--	Present	Present	--
Potamogeton gramineus (variable pondweed)	--	--	--	Present	Present	Present
Potamogeton illinoensis (Illinois pondweed)	--	--	--	--	Present	Present
Potamogeton natans (floating-leaf pondweed)	Present	--	--	--	--	--
Potamogeton oakesianus (Oakes pondweed)	Present	--	--	--	--	--
Potamogeton praelongus (white-stem pondweed)	--	--	Present	Present	--	--
Potamogeton pusillus (small pondweed)	--	--	--	Present	Present	--
Potamogeton richardsonii (clasping-leaf pondweed)	Present	--	--	Present	Present	Present
Potamogeton zosteriformis (flat-stem pondweed)	Present	--	Present	Present	Present	Present
Stuckenia pectinata (Sago pondweed)[c]	Present	Present	--	Present	Present	Present
Utricularia vulgaris (bladderwort)	Present	--	Present	Present	Present	Present
Vallisneria americana (eel-grass/wild celery)	Present	Present	Present	Present	Present	Present
Total Observed	15	9	8	19	16	15

Note: Surveys completed between 1967 and 2002 followed transect-based methodology; surveys conducted in 2011 and 2017 utilized point-intercept methodology.

[a] *Formerly known as Zosterella dubia.*

[b] *Formerly known as Myriophyllum exalbescens.*

[c] *Formerly known as Potamogeton pectinatus.*

Source: SEWRPC

until at least 1993. Species richness doubled in Upper Phantom Lake between 1993 and 2002. Since 2002, Upper Phantom Lake's species richness has remained substantially higher than the 1980-1993 time period. However, Upper Phantom Lake's species richness has slightly declined since 2002. The 2017 aquatic plant survey of Upper Phantom Lake identified 16 species.

Lower Phantom Lake's aquatic plant species richness during the earliest survey (1967) was the lowest ever recorded. Species richness remained relatively stable between 1967 and 1993, and did not decline as it did in Upper Phantom Lake during the same time period. Like Upper Phantom Lake, Lower Phantom Lake's species richness increased between 1993 and 2002. Unlike Upper Phantom Lake, Lower Phantom Lake's species richness continues to increase. The 2017 aquatic plant survey of Lower Phantom Lake identified 23 species.

Since the dramatic increase in species richness in both Lakes was first noted using transect-based methodologies, it is unlikely that the large change in species richness is an artifact of the switch to point-intercept sampling. Moreover, the dominant aquatic plant species and their relative distribution noted using transect-based sampling methodologies seem to agree well with information gathered using point-intercept sampling methodologies.[17] The increase in reported aquatic plant species numbers in both Lakes since 1993 may be a function of more rigorous sampling rather than a reflection of any significant changes in the communities themselves. Nevertheless, it is not uncommon for aquatic plant community diversity to fluctuate in response to a variety of drivers such as weather/climate, predation, and lake-external stimuli

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

Table 2.5
Submerged Aquatic Plant Species Observed in Lower Phantom Lake: 1967-2017

Submerged Aquatic Plant Species	1967	1980	1992	1993	2002	2011	2017
Ceratophyllum demersum (coontail)	Present	Present	Present	Present	Present	Present	Present
Chara spp. (muskgrass)	Present	Present	Present	Present	Present	Present	Present
Elodea canadensis (waterweed)	Present	Present	Present	Present	Present	Present	Present
Heteranthera dubia (water stargrass)[a]	--	--	--	--	Present	Present	Present
Myriophyllum heterophyllum (various-leaved milfoil)	--	--	--	Present	--	--	Present
Myriophyllum sibiricum[b] (northern water milfoil)	Present	Present	--	--	Present	Present	--
Myriophyllum spicatum (Eurasian water milfoil)	--	--	Present	Present	Present	Present	Present
Najas flexilis (bushy pondweed)	Present	Present	--	--	Present	Present	Present
Najas guadalupensis (southern pondweed)	--	--	Present	Present	--	--	--
Najas marina (spiny naiad)	--	--	--	--	Present	Present	Present
Nitella spp. (stonewort)	--	--	--	--	Present	Present	Present
Potamogeton amplifolius (large-leaf pondweed)	Present	Present	Present	Present	Present	--	Present
Potamogeton crispus (curly-leaf pondweed)	Present	Present	Present	Present	Present	Present	Present
Potamogeton filiformis (narrow-leaf pondweed)	--	--	Present	--	--	--	--
Potamogeton foliosus (leafy pondweed)	--	--	--	--	--	--	Present
Potamogeton friessii (Fries' pondweed)	--	--	--	--	--	--	Present
Potamogeton gramineus (variable pondweed)	--	--	--	--	Present	Present	Present
Potamogeton illinoensis (Illinois pondweed)	--	--	Present	--	Present	Present	Present
Potamogeton natans (floating-leaf pondweed)	Present	Present	Present	Present	Present	Present	Present
Potamogeton nodosus (long-leaf pondweed)	--	--	--	--	--	Present	--
Potamogeton praelongus (white-stem pondweed)	Present	--	Present	Present	Present	Present	Present
Potamogeton richardsonii (clasping-leaf pondweed)	--	Present	Present	--	Present	Present	Present
Potamogeton zosteriformis (flat-stem pondweed)	Present	Present	Present	Present	Present	Present	Present
Stuckenia pectinata (Sago pondweed)[c]	Present	Present	Present	Present	Present	Present	Present
Utricularia vulgaris (bladderwort)	Present	Present	Present	Present	Present	Present	Present
Vallisneria americana (eel-grass/wild celery)	Present	Present	Present	Present	Present	Present	Present
Total Observed	13	13	16	14	20	20	22

Note: Surveys completed between 1967 and 2002 followed transect-based methodology; surveys conducted in 2011 and 2017 utilized point-intercept methodology.

[a] *Formerly known as Zosterella dubia.*

[b] *Formerly known as Myriophyllum exalbescens.*

[c] *Formerly known as Potamogeton pectinatus.*

Source: SEWRPC

such as nutrient supply. This is especially true in the case of a lake's individual pondweed species, which tend to vary in abundance throughout the growing season in response to temperature, insolation, and other ecological factors.

Biodiversity and Species Distribution

Species richness is often incorrectly used as a synonym for biodiversity. The difference in meaning between these terms is both subtle and significant. Biodiversity is based on the number of species present in a habitat along with the abundance of each species. For the purposes of this study, abundance was determined as the percent of observations of each species compared to the total number of observations made. Aquatic plant biodiversity can be measured with the Simpson Diversity Index (SDI).[18] Using this measure, a community dominated by one or two species would be considered less diverse than one in which several different species have similar abundance. In general, more diverse biological communities are better able to maintain ecological integrity. Promoting biodiversity not only helps sustain an ecosystem, but preserves the spectrum of options useful for future management decisions.

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

Data collected during 2017 reveal that Upper Phantom Lake's SDI was 0.83, a slight decrease from the 0.87 measured during 2011. This decline was due to a small decrease in richness and relative abundance, particularly of common bladderwort (*Utricularia vulgaris*) and eelgrass (*Vallisneria americana*). Lower Phantom Lake's SDI was found to be 0.92 in both 2017 and 2011. All SDI values reveal considerable biodiversity in the Lakes. As mentioned above, the 2017 aquatic plant survey identified 16 different aquatic plant species in Upper Phantom Lake and 23 species in Lower Phantom Lake. Actions that conserve and promote aquatic plant biodiversity are critical to the long term health of the Lakes. Such actions not only help sustain and increase the robustness and resilience of the existing ecosystem, but also promote efficient and effective future aquatic plant management.

Even though both the Lakes exhibit good species richness and biodiversity, no one location in either lake contains all identified aquatic plant species. During 2017, between one and six aquatic plant species were found at any one sampling point in Upper Phantom Lake (Map 2.1), and one to nine species were found at any single sampling point in Lower Phantom Lake. Upper Phantom Lake's greatest species richness occurs in the nearshore areas of the southeastern bay and the northern end of the Lake. Lower Phantom Lake's greatest species richness is found in its southeastern and southern bays, as well as along the northeast shore.

Sensitive Species

Aquatic plant metrics, such as species richness and the floristic quality index (FQI), can be useful for evaluating lake health. In hard water lakes, such as those common in Southeastern Wisconsin, species richness generally increases with water clarity and decreases with nutrient enrichment.[19] The FQI is an assessment metric used to evaluate how closely a lake's aquatic plant community matches that of undisturbed, pre-settlement conditions.[20] To formulate this metric, Wisconsin aquatic plant species were assigned conservatism (C) values on a scale from zero to ten that reflect the likelihood that each species occurs in undisturbed habitat. These values were assigned based on the species substrate preference, tolerance of water turbidity, water drawdown tolerance, rooting strength, and primary reproductive means. Native "sensitive" species that are intolerant of ecological disturbance receive high C values, while natives that are disturbance tolerant receive low C values. Invasive species are assigned a C value of 0. A lake's FQI is calculated as the average C value of species identified in the lake, divided by the square root of species richness. Lower Phantom had higher FQI than Upper Phantom in both the 2011 and 2017 aquatic plant surveys. Additionally, Lower Phantom Lake exhibited increased FQI from 2011 to 2017, indicating a healthier aquatic ecosystem, while Upper Phantom Lake's FQI slightly declined. All four surveys had FQI values that are higher than average for the Southeastern Wisconsin Till Plains ecoregion of 20.0, indicating that these lakes have healthy aquatic plant communities. The 2017 Lower Phantom FQI of 28.8 is indicative of the high number of ecologically sensitive species present in this Lake.

Relative Species Abundance

Over the past 50 years, muskgrass (*Chara* spp.), a type of macroalgae, has consistently been either the most or one of the most abundant aquatic plants in both lakes. This is a critical species to protect, as muskgrass has several unique environmental preferences as well as beneficial functions in lakes. Muskgrass is nearly always associated with hard water lakes, particularly those with significant groundwater seepage and springs. This species has been found to promote marl formation and induce dissolved phosphorus to be precipitated to the lake bottom, reducing phosphorus concentrations in the water column and thus improving water clarity.[21] Additionally, muskgrass is a favorite waterfowl food and helps stabilize lake-bottom sediment, as it has been observed to grow deeper than most vascular plants. Its prevalence in a lake's aquatic plant community may tangibly contribute to lake water quality, promoting the growth of other desirable native plant species.

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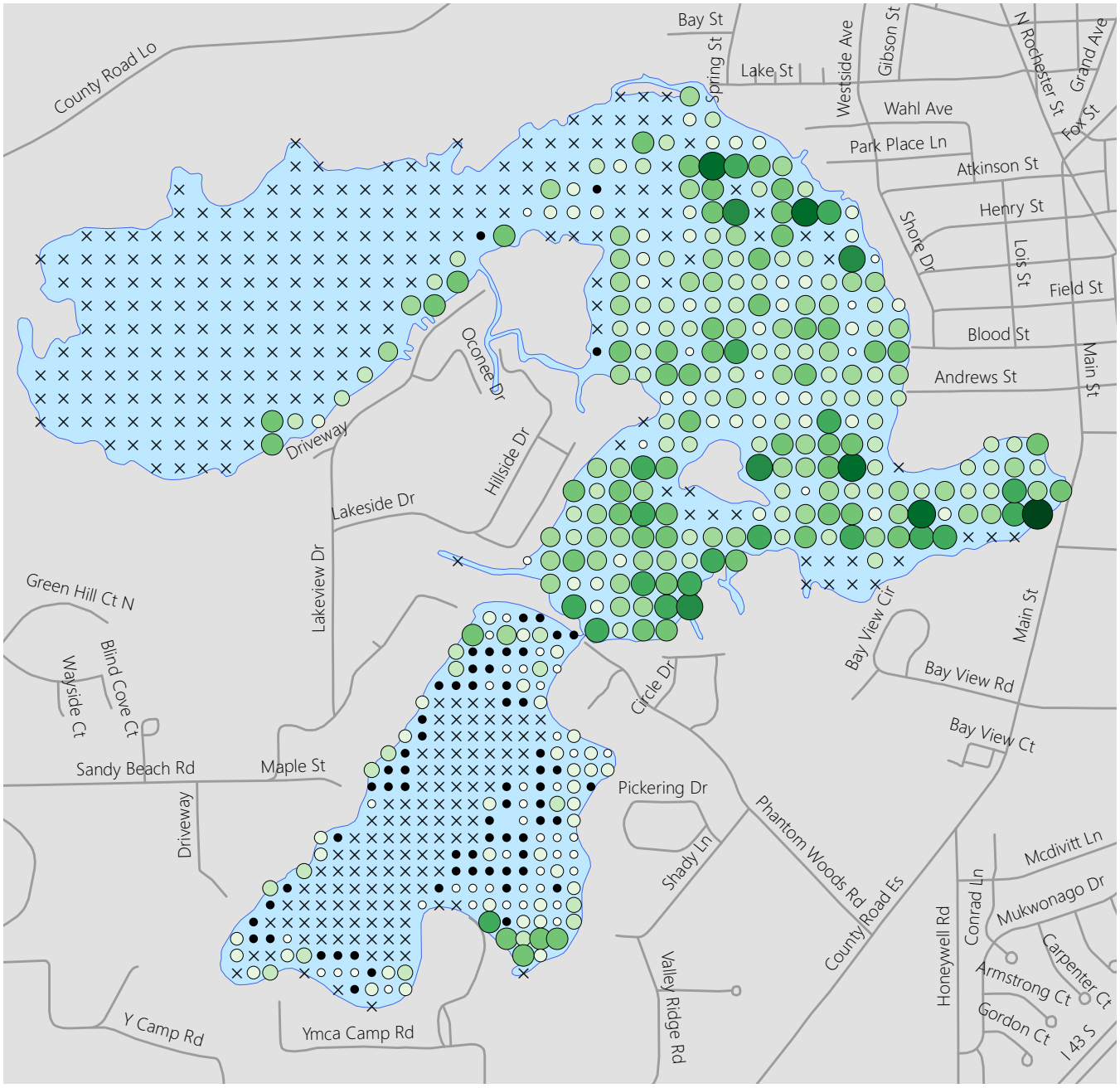
[19] *Vestergaard, O. and Sand-Jensen, K. "Alkalinity and trophic state regulate aquatic plant distribution in Danish lakes."* Aquatic Botany *67, 2000.*

[20] *Nichols, S. "Floristic quality assessment of Wisconsin lake plant communities with example applications."* Lake and Reservoir Management *15 (2), 1999.*

[21] *Scheffer, M., and van Ness, E.H. "Shallow lakes theory revisited: various alternative regimes driven by climate, nutrient, depth, and lake size."* Hydrobiologia *584, 2007.*

Map 2.1
Aquatic Plant Species Richness, Phantom Lakes: August 2017



NUMBER OF NATIVE SPECIES OBSERVED

1 2 3 4 5 6 7 8 9

NO PLANTS FOUND

NOT SAMPLED

ROADS

N

0 500 1,000 2,000 Feet

Note: Samples were collected in Upper Phantom Lake between August 7 and August 8, 2017 and on Lower Phantom Lake between July 31 and August 7, 2017.

Source: WDNR and SEWRPC

A wide variety of high value and oftentimes sensitive pondweed species (*Potamogeton*, spp.) are also found in the Lakes. Lower Phantom Lake is particularly rich in pondweed species. Other native aquatic plants that have been found over the years in varying abundance include native milfoils (e.g., *Myriophyllum heterophyllum* and *M. sibiricum*), eelgrass (*Vallisneria americana*), common bladderwort (*Utricularia vulgaris*), and waterweed (*Elodea canadensis*). Exotic Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*) became more abundant in the Lakes between 1993 and 2002. Increased abundance of EWM seems to correspond with decreased abundance of native milfoil species and increased abundance of several native species (e.g., eel-grass, muskgrass, and waterweed). Overall EWM abundance appears to decreasing. Exotic spiny naiad (*Najas marina*) has also become abundant in Upper Phantom Lake during the past 10 to 20 years.

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

Based on the 2017 point-intercept survey, the four most abundant submerged aquatic plant species in Upper Phantom Lake are, in decreasing order of abundance: 1) Muskgrass, 2) spiny naiad (an invasive), 3) sago pondweed, and 4) eelgrass. As of 2017, these four species represented about 75 percent of the aquatic plants found in Upper Phantom Lake.

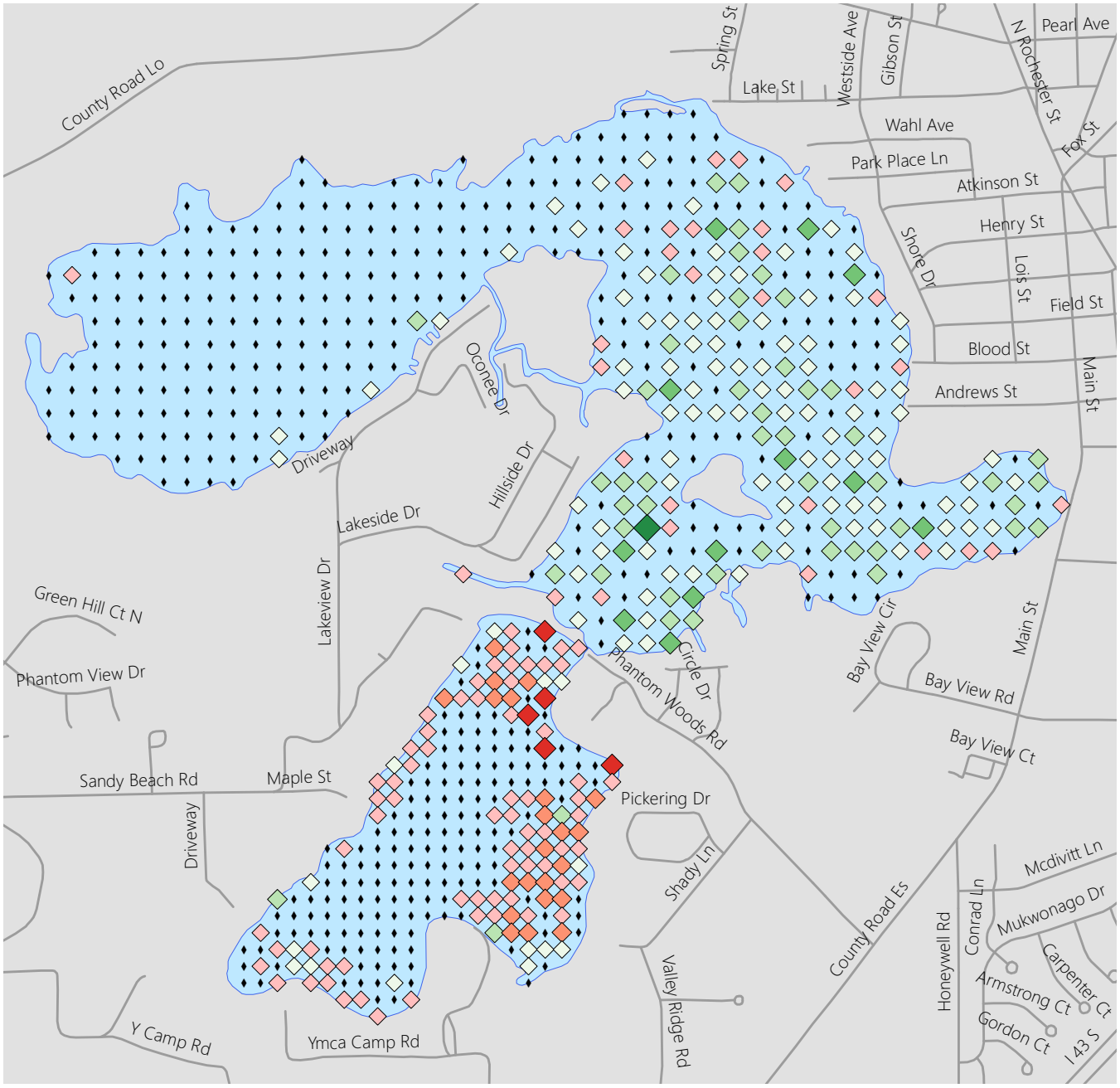
Based upon the 2017 point-intercept survey, the four most abundant aquatic plants in Lower Phantom Lake are, in decreasing order of abundance: 1) muskgrass, 2) eelgrass, 3) clasping-leaf pondweed, and 4) bladderwort. These four species represented about 45 percent of the plants in Lower Phantom Lake as of 2017.

Apparent Changes in Observed Aquatic Plant Communities: 2011 Versus 2017

The distribution of each aquatic plant species identified as part of the 2017 survey is mapped in Appendix C. The 2017 aquatic plant inventory identified 15 species of submerged aquatic plants (16 counting emergent plants and visuals) in Upper Phantom Lake and 23 species (29 counting emergent plant species and visuals) in Lower Phantom Lake. In contrast, the 2011 aquatic plant inventory identified 16 submerged aquatic plant species (19 total) in Upper Phantom and 20 submerged species (22 total) in Lower Phantom. Despite a small decrease in the number of submerged species in Upper Phantom Lake and a small increase in the number of species in Lower Phantom Lake, the number of submerged plant species in the two lakes has been relatively stable since 2002 (Tables 2.4 and 2.5).

As was described earlier, sensitive aquatic plant species are likely the most vulnerable to human disturbance. Therefore, changes in sensitive species abundance can indicate the general magnitude of human disturbance derived stress on a waterbody's ecosystem. The number of sensitive species (i. e., species with C value of seven or greater) at each sample point during 2011 and 2017 were contrasted (Map 2.2). Sensitive species richness increased at most points on Lower Phantom between 2011 and 2017 but decreased on Upper Phantom Lake over the same time period. One sensitive species, muskgrass (*Chara* spp., C value of 7), was identified at fewer points in Upper Phantom in 2017 than in 2011. Additionally, stonewort (*Nitella* spp., C value of 7) was not identified whatsoever in Upper Phantom Lake during 2017 after being identified at nearly 10 percent of shallow points in the 2011 survey. Both *Chara* and *Nitella* are in the same macroalgae family (*Characeae*) so changes in lake ecology, such as increasing phosphorus concentrations, may similarly decrease the competitiveness of both genera. On Lower Phantom Lake, Eurasian watermilfoil (*Myriophyllum spicatum*) abundance decreased across the waterbody while muskgrass abundance increased from 2011 to 2017. Additionally, new sensitive species were observed during 2017, including widespread observation of arum-leaved arrowhead (*Sagittaria cuneata*) as well as limited observances of several *Potamogeton* species. The decrease in Eurasian water-milfoil and new establishment of these sensitive species are positive indicators for Lower Phantom Lake's overall health.

Map 2.2
Change in Sensitive Species Richness, Phantom Lakes: 2011 Versus 2017



CHANGE IN RICHNESS OF SENSITIVE SPECIES

-3 -2 -1 0 1 2 3 4

ROADS

N

0 500 1,000 2,000 Feet

Note: Samples were collected in Upper Phantom Lake between August 7 and August 8, 2017 and on Lower Phantom Lake between July 31 and August 7, 2017.

Source: WDNR and SEWRPC

In addition to the number of different aquatic plant species detected in each Lake, several other comparisons can be drawn between the 2011 and 2017 aquatic plant survey results, as examined below.

General Trends – Upper Phantom Lake

- Most aquatic plants grew at fewer points in 2017 as compared to 2011. Of the 13 species of submerged aquatic plants sampled in both 2011 and 2017, 11 were found to be growing at fewer points. Only two plants were found at more points during 2017. These data suggest that, on a lake-wide basis, the overall area where plants grew in Upper Phantom Lake was less extensive in 2017 than 2011.

- Based on average rake fullness, plant density was relatively unchanged. About half the plants exhibited slightly higher rake fullness averages, and about half exhibited slightly lower average rake fullness averages.

- Several plants were found at one-half or fewer the number points in 2017 as compared to 2011 (i.e., various-leafed water milfoil, bushy pondweed, Illinois pondweed, clasping-leaf pondweed, common bladderwort). Common bladderwort exhibited the greatest decline in abundance, from being identified at 26 percent of littoral points in 2011 to two percent of littoral points in 2017.

- The two exotic species (EWM and spiny naiad) were also found at substantially fewer points in 2017 than 2011.

- Spiny naiad was much more widespread than EWM.

- Muskgrass remains the most widespread plant in the Lake, despite being found at about half the number of sampling points in 2017 compared to 2011. Its frequency of occurrence relative to all other species in the Lake was essentially the same in both surveys.

- In general terms, the overall composition of the aquatic plant community seems to have been relatively stable between 2011 and 2017.

- Little difference was noted in the relative frequencies of many of the plant species between 2011 and 2017. Additionally, the relative frequency of occurrence hierarchy did not substantially change.

- Invasive EWM was present but not particularly abundant in either 2011 or 2017. EWM was the 7th most widespread plant in 2011 and 5th most widespread plant in 2017. Nevertheless, the lake use, habitat value threats, and attendant management challenges posed by EWM are serious. EWM must continue to be monitored and managed vigilantly and aggressively.

- Several submerged aquatic plant species have been found at only a few sampling points. Coontail (*Ceratophylum demersum*) and water stargrass (*Heteranthera dubia*) were not noted in the 2011 survey but were collected as part of the 2017 sampling event, while stonewort (*Nitella* spp.), leafy pondweed (*Potamogeton foliosus*), and small pondweed (*Potamogeton pusillus*) were collected as part of the 2011 sampling event but were not noted during 2017. The absence of these species, particularly the high C value species like stonewort, leafy pondweed, and small pondweed, can substantially impact the Lake's FQI. Additionally, large-leaf pondweed (*Potamogeton amplifolius*) was not sampled in either 2011 or 2017, but was visually sighted in 2017.

General Trends – Lower Phantom Lake

- In general terms, the overall composition and frequency hierarchy of the aquatic plant community shifted towards more desirable native plants between 2011 and 2017.

- Based on average rake fullness, aquatic plant growth density was similar between 2011 and 2017.

- Of the 18 aquatic plant species of identified in both 2011 and 2017, nine were found to be growing at fewer points, eight were found at more points, and one was found at the same number of points.

- Four submerged native plant species observed in 2017 (various-leaved milfoil (*Myriophyllum heterophyllum*), large-leaf pondweed (*Potamogeton amplifolius*), leafy pondweed (*Potamogeton foliosus*), and Fries' pondweed (*Potamogeton friesii*)) were not observed in 2011. One submerged species observed in 2011 (long-leaf pondweed (*Potamogeton nodosus*)) was not observed in 2017. It is unclear whether these species have recently established in Lower Phantom or were simply not observed in the 2011 survey due to their relative scarcity in this lake.

- Several plants were found at half or fewer points in 2017 as compared to 2011 (i.e., water stargrass, spiny naiad, white-stem pondweed, flat-stem pondweed, sago pondweed).

- Water stargrass, stonewort, floating-leaf pondweed (*Potamogeton natans*), and white-stem pondweed were not widespread in either 2011 or 2017.

- Two of the three exotic species (EWM and spiny naiad) were also found at substantially fewer points in 2017 as compared to 2011.

- Curly-leaf pondweed, a relatively uncommon invasive plant in Lower Phantom Lake, was found at several more points in 2017. Since curly-leaf pondweed senesces early in the season, the mid- to late-summer sampling timeframe may not accurately represent this plant's true abundance in the Lake.

- EWM remains the most widespread submerged exotic plant in the Lake in 2017, but it is no longer the most widespread aquatic plant in the Lake, as it was in 2011. Four native aquatic plants (muskgrass, various-leafed milfoil, clasping-leaf pondweed, and eel-grass) were more widespread in the 2017 survey than EWM. Nevertheless, EWM remains the 5th most abundant submerged aquatic plant in the Lake—the lake use and habitat value threats and attendant management challenges posed by EWM are serious. For this reason, EWM must continue to be monitored and vigilantly managed.

- Muskgrass abundance increased between 2011, when it was the 5th most widespread species, and 2017, when it was the most widespread species. The spread of muskgrass is desirable from lake water quality and habitat value perspectives.

Relative Abundance of Milfoil Species

Three milfoil species have been reported in the Phantom Lakes during the past 50 years. These include native or northern water milfoil (*Myriophyllum sibiricum*, formerly known as *Myriophyllum exalbescens*), native various leaved milfoil (*Myriophyllum heterophyllum*), and exotic EWM (*Myriophyllum spicatum*). The native milfoil species can appear similar to EWM and can hybridize with EWM, conditions confounding identification.

The relative abundance of each milfoil species has fluctuated considerably over the years. For example, various-leaved milfoil was fairly abundant during 1993 and 2017 but absent the remaining years. Similarly, northern milfoil was absent during 1993 and 2017 but present all remaining years. This dichotomy suggests the variation in native *Myriophyllum* species abundance may be related to identification procedures rather than actual fluctuation in native milfoil species abundance. Given the ability of EWM to hybridize with at least northern milfoil, it is also possible that the relative abundance of EWM and native water milfoil may be somewhat blurred, especially the historical surveys. Therefore, dramatic year-to-year variation in *Myriophyllum* species abundance should be viewed with some skepticism.

Eurasian Watermilfoil (EWM)

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

EWM is one of eight milfoil species found in Wisconsin and is the only exotic or nonnative milfoil species. EWM favors mesotrophic to moderately eutrophic waters, fine organic-rich lake-bottom sediment, warmer water

with moderate clarity and high alkalinity, and tolerates a wide range of pH and salinity.[22,23] In Southeastern Wisconsin, EWM can grow rapidly and has few natural enemies to inhibit its growth. Furthermore, it can grow explosively following major environmental disruptions, as small fragments of EWM can grow into entirely new plants.[24] For reasons such as these, EWM can grow to dominate an aquatic plant community in as little as two years.[25, 26] In such cases, EWM can displace native plant species and interfere with the aesthetic and recreational use of waterbodies. However, established populations may rapidly decline after approximately ten to 15 years.[27]

EWM is a significant recreational use problem in Southeastern Wisconsin lakes. For example, boating through dense EWM beds can be difficult and unpleasant. Because EWM can reproduce from stem fragments, recreational use conflicts can help spread EWM. Human produced EWM fragments (e.g., fragments created by power boating through EWM), as well as fragments generated from natural processes (e.g., wind-induced turbulence, animal feeding/disturbance) readily colonize new sites, especially disturbed sites, contributing to EWM spread. EWM fragments can remain buoyant for two to three days in summer and two to six days in fall, with larger fragments remaining buoyant longer than smaller ones.[28] The fragments can also cling to boats, trailers, motors, and/or bait buckets where they can remain alive for weeks contributing to transfer of milfoil to other lakes. For these reasons, it is very important to remove all vegetation from boats, trailers, and other equipment after removing them from the water and prior to launching in other waterbodies.

EWM is not particularly widespread in Upper Phantom Lake, occurring chiefly in nearshore and other shallow areas where water is less than 10 feet deep. EWM was observed at 23 points of 172 points shallower than the maximum depth of colonization (MDC) (i.e., about 13.4 percent of visited points), in Upper Phantom Lake during 2011 and 16 points of the 159 points visited (i.e., about 10.1 percent of points shallower than the MDC) during 2017 (see Table 2.1). Therefore, the area occupied by EWM relative to other plants declined by two percent between 2011 and 2017. Similar to other aquatic plants in Upper Phantom Lake, EWM average rake fullness decreased between 2011 and 2017 at most sampling points (Map 2.3). However, EWM appears to have colonized additional areas, especially a short distance to the east of the Lake's center where water is about ten feet deep.

EWM is more widespread in Lower Phantom Lake than Upper Phantom Lake. EWM growth is most dense in the northwestern portion of Lower Phantom Lake's open water area adjacent to expansive wetlands which dominate the western half of the Lake. While EWM is scattered throughout the Lake, the number of sampling points where EWM was found decreased from 43 percent in 2011 to 30 percent in 2017 (Table 2.2). Not only was EWM less widespread in 2017, it grew at reduced density, with average rake fullness declining from 2.1 in 2011 to 1.6 in 2017. As can be seen in Map 2.3, EWM rake fullness declined throughout the central portion of the Lake's eastern basin.

A word of caution: EWM has proven itself to be an aggressive and highly successful species that can overrun desirable aquatic plant communities. While the changes reflected by the results of the 2017 surveys of the Phantom Lakes are certainly encouraging, this plant is fully capable of staging a complete reversal of this apparent downward population trend. Therefore, EWM must continue to be actively monitored and vigilantly managed.

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[22] *U.S. Forest Service, Pacific Islands Ecosystems at Risk (PIER), 2019. May be downloaded at the following website: www.hear.org/pier/species/myriophyllum_spicatum.htm.*

[23] *Nichols, S. A. and B. H. Shaw, "Ecological life histories of the three aquatic nuisance plants Myriophyllum spicatum, Potamogeton crispus, and Elodea Canadensis,"* Hydrobiologia*, 131 (1), 1986.*

[24] *Ibid.*

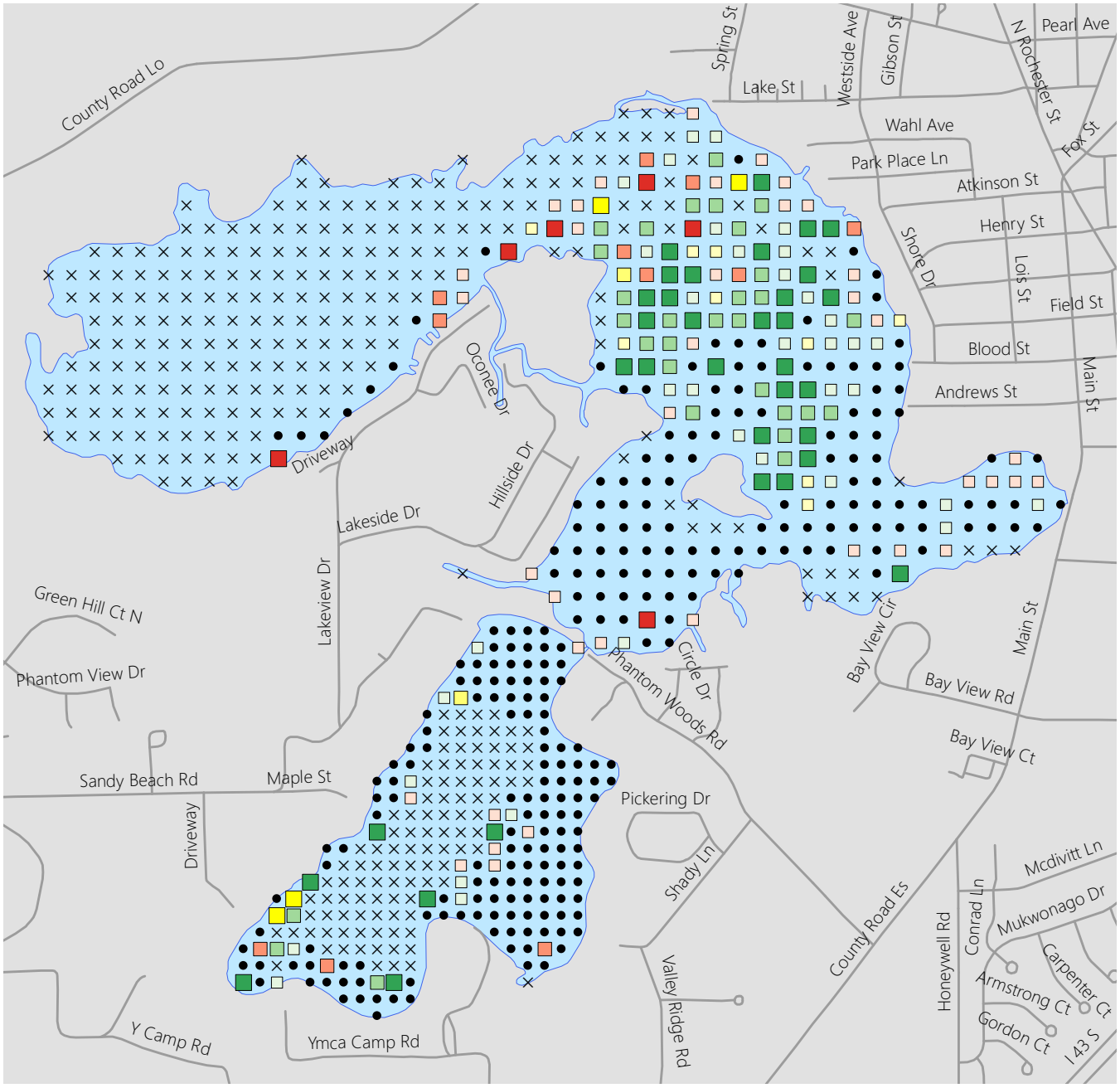
[25] *Carpenter, S. R., "The Decline of Myriophyllum spicatum in a eutrophic Wisconsin (USA) lake,"* Canadian Journal of Botany*, 58 (5), 1980.*

[26] *Les, D. H., and L. J. Mehrhoff, "Introduction of nonindigenous vascular plants in southern New England: a historical perspective,"* Biological Invasions*, 1:284-300, 1999.*

[27] *Carpenter, S. R. op. cit.*

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

Map 2.3
Eurasian Watermilfoil Rake Fullness, Phantom Lakes: 2011 Versus 2017



CHANGE IN RAKE FULLNESS OF EURASIAN WATERMILFOIL

- × NOT SAMPLED
- ● NO EURASIAN WATERMILFOIL
- DECREASE OF 1
- DECREASE OF 2
- DECREASE OF 3
- NO CHANGE, RAKE FULLNESS OF 1
- NO CHANGE, RAKE FULLNESS OF 2
- NO CHANGE, RAKE FULLNESS OF 3
- INCREASE OF 1
- INCREASE OF 2
- INCREASE OF 3
- ROADS

N

0 500 1,000 2,000 Feet

Source: WDNR and SEWRPC

Table 2.6
Phantom Lakes Aquatic Plant Chemical Control History

	Algae Control		Macrophyte Control			
Year	Cutrine-Plus (gallons)	Copper Sulphate (pounds)	Sodium Arsenite (pounds)	2,4-D (pounds)	Diquat (gallons)	Endothall/ Aquathol (gallons)
1950-1959	--	--	1,080	--	--	--
1960-1969[a]	--	245.0	2,796	2,280[b]	128.0 lbs.	30.0 lbs.
1970	8.0	103.5	--	--	31.5	24.0 + 1,117.0 lbs.
1971	--	115.0	--	--	20.0	98.0
1972	--	350.0	--	--	15.0	115.0
1973	--	450.0	--	--	--	160.0
1974	--	285.0	--	--	--	--
1975	--	150.0	--	--	--	90.0
1976-2018[a]	--	--	--	--	--	--
Total	8.0	1,698.5	3,876	2,280	66.5 + 128.0 lbs.	Endothall 114.0 + 30.0 lbs. Aquathol 373.0 + 1,117 lbs.

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

[b] *Also, 40 pounds of 2,4,5-T in 1969.*

Source: Wisconsin Department of Natural Resources and SEWRPC

Other Exotic Submergent Aquatic Plants

Curly-leaf pondweed continues to be present in Lower Phantom Lake. This plant, like EWM, is identified in Chapter NR 109 of the *Wisconsin Administrative Code* as a nonnative invasive aquatic plant. Although survey data suggests it presently is only a relatively minor species in terms of dominance, and, as such, is less likely to interfere with recreational boating activities, the plant can grow dense stands that exclude other high value aquatic plants. For this reason, curly-leaf pondweed must continue to be monitored and managed as an invasive member of the aquatic community. Lastly, it must be remembered that curly-leaf pondweed senesces by midsummer, and therefore may be underrepresented in the inventory data presented in this report.

Spiny naiad is native to North America but was introduced to, and has become naturalized in, Wisconsin. Spiny naiad is present in both Lakes, but is only abundant in Upper Phantom Lake. Spiny naiad was found at substantially more points in Upper Phantom Lakes during 2017 as compared to 2011. Spiny naiad is a restricted species in Wisconsin, and is therefore identified as an established invasive species that has the potential to cause significant environmental or economic harm.[29] Spiny naiad is reported to be used as a food source for waterfowl, marsh birds, muskrat, and shelter/forage area for fish.

2.3 PAST AND PRESENT AQUATIC PLANT MANAGEMENT PRACTICES

Aquatic plants have been controlled on the Phantom Lakes since at least the 1950s – the earliest date that control program records were kept by State agencies. However, aquatic plant control on the Phantom Lakes probably predates the 1950s by several decades. Early aquatic plant control relied on chemical treatment with sodium arsenite. Sodium arsenite applications were discontinued in 1969 and were supplanted by organic-based herbicides. To control floating algae, copper sulfate and Cutrine-Plus were applied to the Lakes. No aquatic herbicides are known to have been applied to the Phantom Lakes since 1975 (Table 2.6).

Since the mid-1980s, mechanical aquatic macrophyte harvesting has been the primary aquatic plant control method used on the Lakes. The volume of aquatic plants harvested each year varies substantially (Table 2.7). A benefit of harvesting versus chemical treatment is that plant mass, and the nutrients contained therein, are physically removed from the Lakes by harvesting. This action also removes phosphorus from the Lakes. The

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

total phosphorus removed from the Lakes by harvesting was calculated for this study, with the following notes and assumptions:

- Although plants were harvested during 2014, the volume of plant material removed during 2014 was not available at the time of printing. The average annual phosphorus removal rate over the period (2,294 pounds) was substituted into our estimates.

- The density of the wet harvested plants was assumed to be 900 pounds per cubic yard.

- The amount of phosphorus contained by aquatic plants varies by species, lake, and time. The phosphorus content of harvested plants used estimates from the Wisconsin Lutheran College (WLC) on Pewaukee Lake, the U.S. Geological Survey on Whitewater and Rice lakes (Whitewater-Rice), and a study conducted on a eutrophic lake in Minnesota (Minnesota). The WLC study assumed that plant wet weight is 6.7 percent of dry weight and that total phosphorus constitutes 0.2 percent of the total dry weight of the plant. The Whitewater-Rice and Minnesota studies assumed that dry weight is 15 and 7 percent of the wet weight, respectively, and phosphorus constituted 0.31 and 0.30 percent of the dry plant weight, respectively. Assumed values for the percent of dry weight to wet weight and the total phosphorus concentrations are similar to those found other studies.[30, 31]

Table 2.7
Volume of Aquatic Plants Harvested from the Phantom Lakes: 2005-2018

Year	Plant Material Removed (cubic yards)
2005	1,362
2006	4,572
2007	6,730
2008	7,260
2009	10,764
2010	9,481
2011	10,296
2012	10,111
2013	9,259
2014	N/A
2015	6,820
2016	19,655
2017	16,387
2018	16,629

Note: Information for 2014 was not available.

Source: Wisconsin Department of Natural Resources and SEWRPC

Using this methods, the Commission estimates that aquatic plant harvesting has removed over 15 tons of phosphorus from the Lakes during the 13 years for which plant harvest records are available (Figure 2.1). During the past three years, about two tons of phosphorus are removed from the Lakes each year. The WDNR's Presto-Lite tool estimates that the average total annual phosphorus load to the Lakes is 3,319 pounds. Therefore, aquatic plant harvesting may remove as much phosphorus from the Lakes as is contributed annually by runoff and tributary streams.

The public reportedly views the ongoing aquatic plant management program favorably, although some interest in expanding and/or intensified harvesting has been expressed. For example, some riparian landowners would like access lanes expanded or extended. Also, some homeowners are frustrated by the amount of cut or otherwise loose aquatic plants accumulating along their shorelines. Lastly, some interest has been expressed in spot treating critical areas with aquatic herbicides.

2.4 IDENTIFIED SENSITIVE AREAS

The WDNR has identified four sensitive areas in the Phantom Lakes (Map 2.4).[32] One sensitive area occupies a relatively small area in the southeast corner of Upper Phantom Lake. In contrast, essentially all of Lower Phantom Lake is identified as sensitive area. The only portion of Lower Phantom Lake not identified as sensitive area is a 150-foot wide strip paralleling the northeast shoreline of the Lake extending northwest from the public boat launch to roughly Lake Street. The WDNR recently extended this strip a short distance to the west where shoreline use is similar. This extension allows landowners and the District more aquatic plant management options and thereby fosters riparian landowner access opportunities similar to those along most of the northeastern shoreline.

[30] *Carvalho, KM, Martin, DF., "Removal of Aqueous Selenium by Four Aquatic Plants,"* Journal of Aquatic Plant Management, *39:33-36, 2001.*

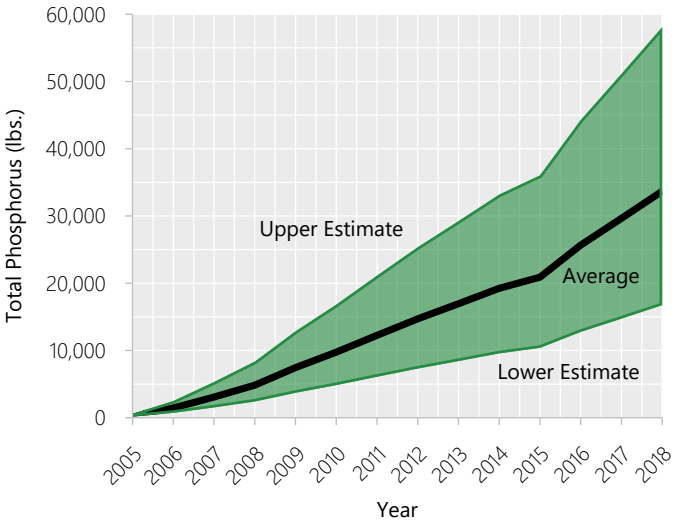
[31] *Thiébaut G. Phosphorus and Aquatic Plants. In: White PJ, Hammond JP (eds) "The Ecophysiology of Plant-Phosphorus Interactions,"* Plant Ecophysiology, *7, 2008.*

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

WDNR sensitive area reports include management recommendations and other information that both benefit and constrain aquatic plant management and riparian land owners. A copy of the sensitive area report for the Phantom Lakes is included in Appendix D. In general, the WDNR's management recommendations are designed to help maintain the valuable functions sensitive areas provide lakes. All sensitive areas trap sediment and nutrients and thereby help protect the Phantom Lakes' water quality. They also provide spawning, nursery and foraging opportunities to native fish and are excellent habitat for waterfowl, furbearers, and herptiles. However, protecting these areas requires limitations and restrictions be placed upon aquatic plant management. A few examples of these limitations and restrictions include the following:

- In Upper Phantom Lake's Sensitive Area One, mechanical harvesting is prohibited
- In Lower Phantom Lake, mechanical harvesting is limited to navigation lanes, no generalized open lake harvesting is allowed

Figure 2.1
Approximate Mass of Phosphorus Removed from the Phantom Lakes by Aquatic Plant Harvesting: 2005-2018



Note: Average annual phosphorus removal (2294 lbs/year) used for missing data in 2014.

Source: PLPRD and SEWRPC

- In Lower Phantom Lake Sensitive Area Two, only one harvesting channel is allowed to provide lake access to the condominium development pier near Bay View Circle
- In Lower Phantom Lake Sensitive Area Three, mechanical harvesting is limited to one navigational channel along the developed shoreline and extending to the main lake
- In all sensitive area aquatic plant harvesting lanes, effort should be made to minimize vegetation removal and focus removal work on non-native species

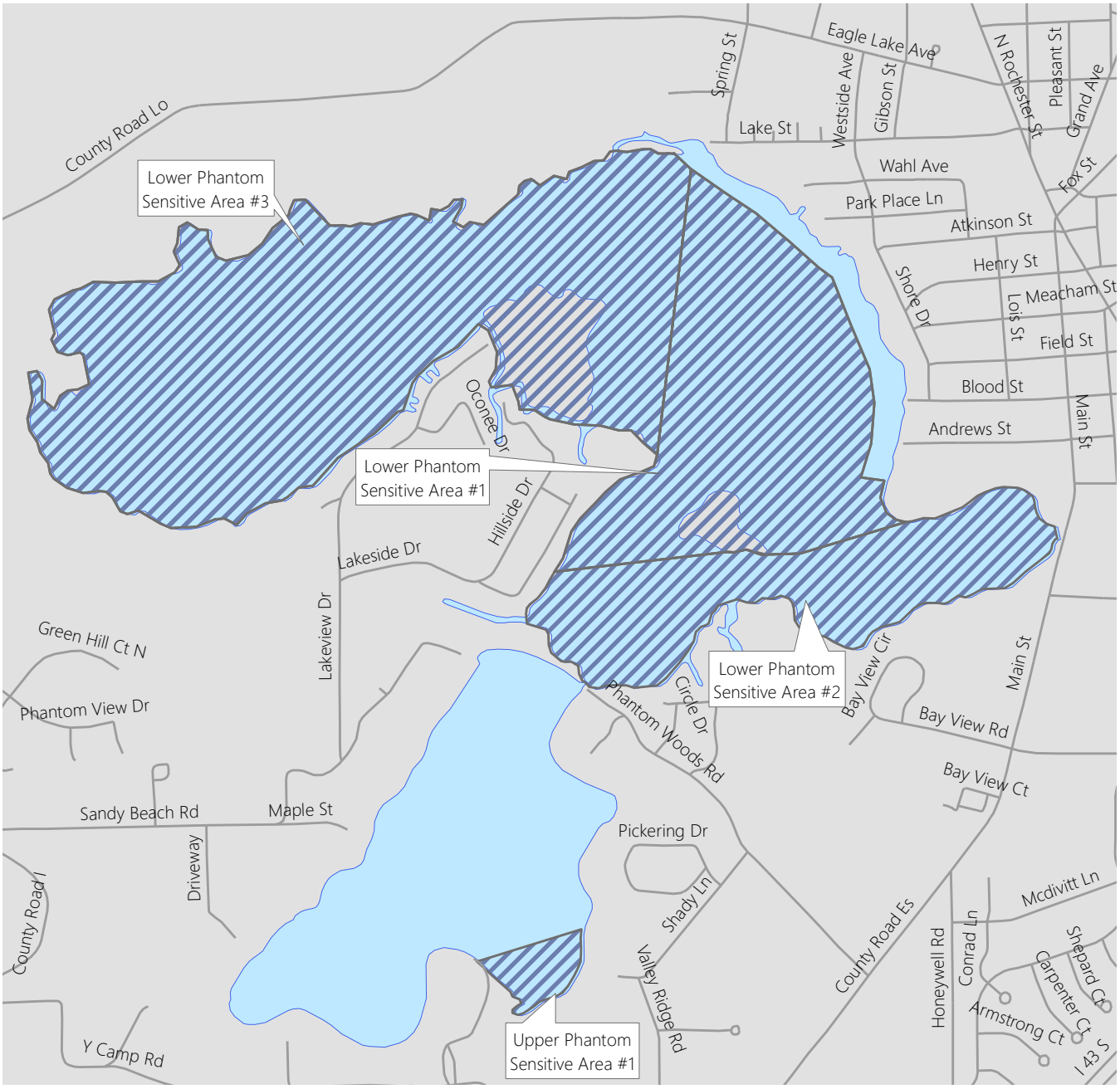
2.5 POTENTIAL AQUATIC PLANT CONTROL METHODOLOGIES

Aquatic plant management techniques can be classified into five categories.

1. *Physical measures* include lake bottom coverings
2. *Biological measures* include the use of organisms, including herbivorous insects
3. *Manual measures* involve physically removing plants by hand or using hand-held tools such as rakes
4. *Mechanical measures* rely on artificial power sources and remove aquatic plants with a machine known as a harvester or by suction harvesting
5. *Chemical measures* use aquatic herbicides to kill nuisance and nonnative plants *in-situ*

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

Map 2.4
WDNR-Designated Phantom Lakes Sensitive Areas: 2019



SENSITIVE AREAS

LAKES

ROADS

N

0 500 1,000 2,000 Feet

Source: WDNR and SEWRPC

Removal and Mechanical Control Regulations." Furthermore, the aquatic plant management measures described in this plan are consistent with the requirements of Chapter NR 7, "Recreational Boating Facilities Program," and with the public recreational boating access requirements relating to eligibility under the State cost-share grant programs set forth in *Wisconsin Administrative Code* Chapter NR 1, "Natural Resources Board Policies." More details about each aquatic plant management type of methodology are discussed in the following sections while recommendations are provided later in this document.

Non-compliance with aquatic plant management permit requirements is an enforceable violation of Wisconsin law and may lead to fines and/or complete permit revocation. The information and recommendations provided in this memorandum help frame permit requirements. Permits can cover up to a five-year period.[33] At the end of that period, the aquatic plant management plan must be updated. The updated plan must consider the results of a new aquatic plant survey and should evaluate the success, failure, and effects of earlier plant management activities that have occurred on the lake.[34] These plans and plan execution are reviewed and overseen by the WDNR regional lakes and aquatic invasive species coordinators.[35]

Physical Measures

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

Biological Measures

Biological control offers an alternative to direct human intervention to manage nuisance or exotic plants. Biological control techniques traditionally use herbivorous insects that feed upon nuisance plants. This approach has been effective in some southeastern Wisconsin lakes.[36] For example, milfoil weevils (*Eurhychiopsis lecontei)* have been used to control EWM. Milfoil weevils do best in waterbodies with balanced panfish populations,[37] where dense Eurasian water milfoil beds reach the surface close to shore, where natural shoreline areas include leaf litter that provides habitat for over-wintering weevils, and where there is comparatively little boat traffic. This technique is not presently commercially available making the use of milfoil weevils non-viable.

Manual Measures

Manually removing specific types of vegetation is a highly selective means of controlling nuisance aquatic plant growth, including invasive species such as EWM. Two commonly employed methods include hand raking and hand pulling. Both physically remove target plants from a lake. Since plant stems, leaves, roots and seeds are actively removed from the lake, the reproductive potential and nutrients contained by pulled/raked plants material is also removed. These plants, seeds, and nutrients would otherwise re-enter the lake's water column or be deposited on the lake bottom. Hence, this aquatic plant management technique helps incrementally maintain water depth, improves water quality, and can help decrease the spread of nuisance/exotic plants. Since hand raking and hand pulling are readily allowed by WDNR, and since both are practical methods to control riparian landowner scale problems, these methods are described in more detail in the following paragraphs.

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

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

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

[36] *B. Moorman, "A Battle with Purple Loosestrife: A Beginner's Experience with Biological Control,"* Lake Line*, 17 (3):20-21, 34-37, September 1997; see also, C.B. Huffacker, D.L. Dahlsen, D.H. Janzen, and G.G. Kennedy, "Insect Influences in the Regulation of Plant Population and Communities," 659-696, 1984; and C.B. Huffacker and R.L. Rabb, editors,* Ecological Entomology*, John Wiley, New York, New York, USA.*

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

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

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

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

Mechanical Measures

Two methods of mechanical harvesting are currently employed in Wisconsin—mechanical harvesting and suction harvesting. Both are regulated by WDNR and require a permit.[38]

Mechanical Harvesting

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

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

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

A disadvantage of mechanical harvesting is that the harvesting process may fragment plants and thereby unintentionally propagate EWM and curly-leaf pondweed. EWM fragments are particularly successful in establishing themselves in areas where plant roots have been removed. This underscores the need to avoid harvesting or otherwise disrupting native plant roots. Harvesting may also agitate bottom sediments in

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

shallow areas, thereby increasing turbidity and resulting in deleterious effects such as smothering fish breeding habitat and nesting sites. To this end, most WDNR-issued permits do not allow deep-cut harvesting in water less than three feet deep,[39] which limits the utility of this alternative in many littoral and shoal areas. Nevertheless, if employed correctly and carefully under suitable conditions, harvesting can benefit navigation lane maintenance and can ultimately reduce regrowth of nuisance plants while maintaining, or even enhancing, native plant communities.

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

Suction Harvesting and DASH

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

An alternative aquatic plant suction harvesting method has emerged called Diver Assisted Suction Harvesting (DASH). First permitted in 2014, DASH is a mechanical process where divers identify and pull select aquatic plants and roots from the lakebed and then insert the entire plant into a suction hose that transports the plant to the surface for collection and disposal. The process is essentially a mechanically assisted method for hand-pulling aquatic plants. Such labor-intensive work by skilled professional divers is, at present, a costly undertaking and long-term monitoring will need to evaluate the efficacy of the technique. Nevertheless, many apparent advantages are associated with this method including: 1) lower potential to release plant fragments when compared to mechanical harvesting, raking, and hand-pulling, thereby reducing spread and growth of invasive plants like EWM; 2) increased selectivity of plant removal when compared to mechanical techniques and hand raking which in turn reduces native plants loss; and 3) lower potential for disturbing fish habitat.

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

Chemical Measures

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

- **Unknown and/or conflicting evidence about the effects of long-term chemical exposure on fish, fish food sources, and humans.** The U.S. Environmental Protection Agency, the agency responsible for approving aquatic plant treatment chemicals, studies aquatic plant herbicides to evaluate short-term exposure (acute) effects on human and wildlife health. Some studies also

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

examine long-term (chronic) effects of chemical exposure on animals (e.g., the effects of being exposed to these herbicides for many years). However, it is often impossible to conclusively state that no long-term effects exist due to the animal testing protocol, time constraints, and other factors. Furthermore, long-term studies cannot address all potentially affected species.[40] For example, conflicting studies/opinions exist regarding the role of the chemical 2,4-D as a human carcinogen.[41] Some lake property owners judge the risk of using chemicals as being excessive despite legality of use. Consequently, the concerns of lakefront owners should be considered whenever chemical treatments are proposed. Moreover, if chemicals are used, they should be applied as early in the season as practical. This helps assure that the applied chemical decomposes before swimming, water skiing, and other active body-contact lake uses begin.[42] Early season application also is generally the best time to treat EWM and curly-leaf pondweed for a variety of technical reasons explained in more detail as part of the "loss of native aquatic plants and related reduction or loss of desirable aquatic organisms" bullet below.

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

- **Reduced dissolved oxygen/oxygen depletion.** When chemicals are used to control large mats of aquatic plants, the dead plant material generally settles to the bottom of a lake and decomposes. Plant decomposition uses oxygen dissolved in lake water, the same oxygen that supports fish and many other vital beneficial lake functions. In severe cases, decomposition processes can deplete oxygen concentrations to a point where desirable biological conditions are no longer supported.[43] Ice covered lakes and the deep portions of stratified lakes are particularly vulnerable to oxygen depletion. Excessive oxygen loss can inhibit a lake's ability to support certain fish and can trigger processes that release phosphorus from bottom sediment, further enriching lake nutrient levels. These concerns emphasize the need to limit chemical control and apply chemicals in *early* spring, when EWM and curly-leaf pondweed have not yet formed dense mats.

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

- **Loss of native aquatic plants and related reduction or loss of desirable aquatic organisms.** EWM and other invasive plants often grow in complexly intermingled beds. Additionally, EWM is physically similar to, and hybridizes with, native milfoil species. Native plants, such as pondweeds, provide food and spawning habitat for fish and other wildlife. A robust and diverse native plant community forms the foundation of a healthy lake and the conditions needed to provide and host desirable gamefish. Fish, and the organisms fish eat, require aquatic plants for food, shelter,

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

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

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

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

and oxygen. If native plants are lost due to insensitive herbicide application, fish and wildlife populations often suffer. For this reason, if chemical herbicides are applied to the Lakes, these chemicals must target EWM or curly-leaf pondweed and therefore should be applied in early spring when native plants have not yet emerged. Early spring application has the additional advantage of being more effective due to colder water temperatures, a condition enhancing herbicidal effects and reducing the dosing needed for effective treatment. Early spring treatment also reduces human exposure concerns (e.g., swimming is not particularly popular in very early spring).

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

- **Hybrid water milfoil's resistance to chemical treatment**. The presence of hybrid water milfoil complicates chemical treatment programs. Research suggests that certain hybrid strains maybe more tolerant to commonly utilized aquatic herbicides such as 2,4-D and Endothall.[44,45] Consequently, further research regarding hybrid water milfoil treatment efficacy is required to apply appropriate herbicide doses. This increases the time needed to acquire permits and increases application program costs. Hybrid water milfoil has not been verified to exist in the Phantom Lakes, but is likely present.

- **Effectiveness of small-scale chemical treatments**. Small-scale EWM treatments using 2,4-D have yielded highly variable results. A study completed in 2015 concluded that less than half of 98 treatment areas were effective, or had more than a 50 percent EWM reduction.[46] For a treatment to be effective, a target herbicide concentration must be maintained for a prescribed exposure time. However, wind, wave and other oftentimes difficult to predict mixing actions often dissipate herbicide doses. Therefore, when deciding to implement small-scale chemical treatments, the variability in results and treatment cost of treatment should be examined and contrasted.

Considering the large expanse of EWM in the eastern basin of Lower Phantom Lake and the cost of chemical treatment, a whole-lake treatment, or large spot treatment in that basin, is not recommended.[47] This is also supported by the efficiency and effectiveness of the ongoing harvesting operation, along with this approach's added benefit to the ecology and water quality of the Lakes compared to chemical application. However, small spot treatments enclosed with a barrier (e.g., turbidity barrier) could be a viable alternative for treating shoreline areas and navigation lanes if determined feasible by the District. Whatever the case, monitoring should continue to ensure that EWM does not become more problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

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

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

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

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

2.6 HYDROLOGY

All water now present in the Region's lakes originally fell as precipitation somewhere in the lake's surface-watershed or groundwatershed.[48] Lakes in Southeastern Wisconsin depend on one or more of the following sources of water: precipitation falling directly upon the lake's open water surface, runoff resulting from precipitation in the lake's surface-watershed, or precipitation/runoff that percolated into the ground and entered the lake through springs and seeps.

Water Sources

Upper Phantom Lake was artificially deepened and enlarged by damming the Mukwonago River, an action that also flooded former marshlands in turn creating Lower Phantom Lake. The two lakes now share the same water elevation and are joined by a navigable channel. During extremely dry weather, water surface elevation in the Lakes can fall far enough to expose bottom materials in the channel connecting the Lakes, allowing Upper Phantom Lake to occasionally maintain a slightly higher water elevation than Lower Phantom Lake.[49]

Although the Phantom Lakes are located entirely within the Town and Village of Mukwonago in Waukesha County, the area contributing runoff to the Lakes extends into the Towns of Eagle, East Troy, Genesee, LaGrange, Ottawa, Palmyra, and Troy, and the Villages of Eagle, East Troy, and North Prairie. Recent refinements in topographic mapping allows the watershed contributing runoff to the Lakes to be delineated more accurately. The refined surface-watershed is contrasted to the surface-watershed presented in earlier Commission reports in Map 2.5. The Phantom Lakes' total surface-watershed covers 46,275 acres, or about 72 square miles. Of this total, 7,087 acres are internally drained (Map 2.6).[50] Based upon these maps, surface-water runoff from 39,188 acres (approximately 61 square miles) ultimately feeds the Phantom Lakes.

Based upon groundwater elevation contours, precipitation falling or accumulating within a 60,595 acre area feeds the Mukwonago River's water table flow system upstream of the Phantom Lakes. Groundwater is most visible when it emerges from the ground as springs and seeps. Known spring locations and groundwater elevation contours confirm that the Mukwonago River is a very important groundwater discharge area, especially upstream of the Phantom Lakes (Map 2.7). Large expanses of land area, many of which are underlain by conditions highly conducive to infiltration, act as groundwater recharge areas for the seeps and springs feeding the River (Map 2.8).

Even though the Mukwonago River receives large volumes of groundwater from an extensive land area, groundwater elevation contours suggest that relatively small areas recharge groundwater directly feeding the Lakes (see Maps 2.7 and 2.8). Groundwater elevation contours suggest that percolating water from 834 acres feeds the springs and seeps discharging directly to Upper Phantom Lake. Similarly, groundwater elevation contours suggest that water infiltrating from 4,105 acres feeds springs and seeps discharging directly to Lower Phantom Lake. Given these data, seeps and springs probably discharge limited volumes of water directly to the Lakes. Groundwater contours, topography, and soil conditions also suggest that the most favorable areas for seeps and springs discharging directly to the Lakes include the southern shoreline of Upper Phantom Lake and the marshy shorelines along the western end of Lower Phantom Lake.

Upper Phantom Lake is a natural lake with an open-water surface area of 107 acres. The Lake has a very small watershed for its size – only about 848 acres of upland drain directly to Upper Phantom Lake. Upper Phantom Lake has a watershed to lake area ratio of roughly 7.9:1. Lakes with watershed to lake area ratios

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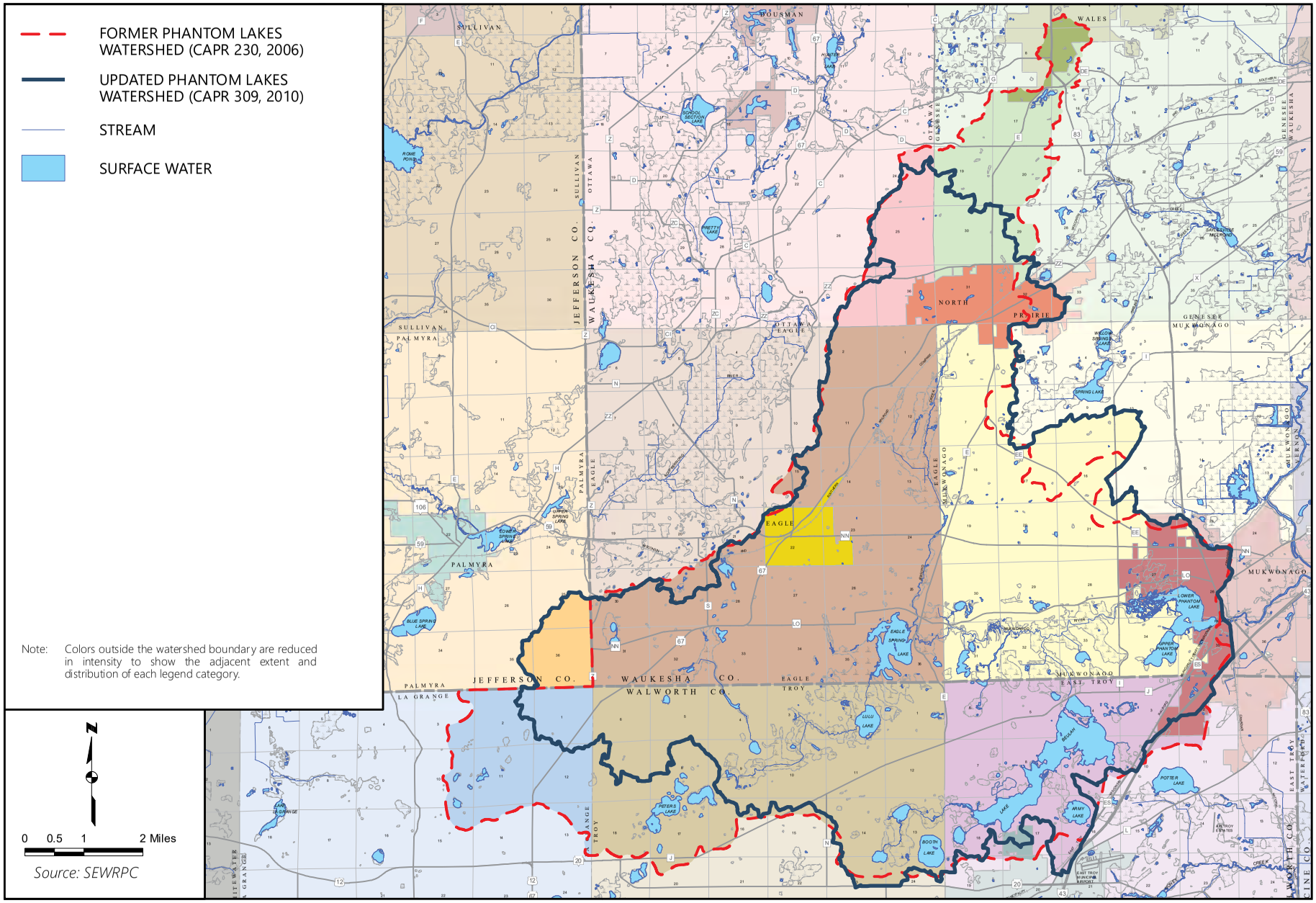
[48] *A watershed is the area contributing water to a specific water body. A surface-watershed (commonly abbreviated to "watershed") is the area of land where precipitation leaving the landscape as runoff eventually reaches the water body in question. A groundwatershed is the land area where water percolating into the soil will reach saturated conditions and move laterally to a discharge point that feeds the waterbody in question. Surface-watersheds and ground-watersheds commonly do not exactly overlap.*

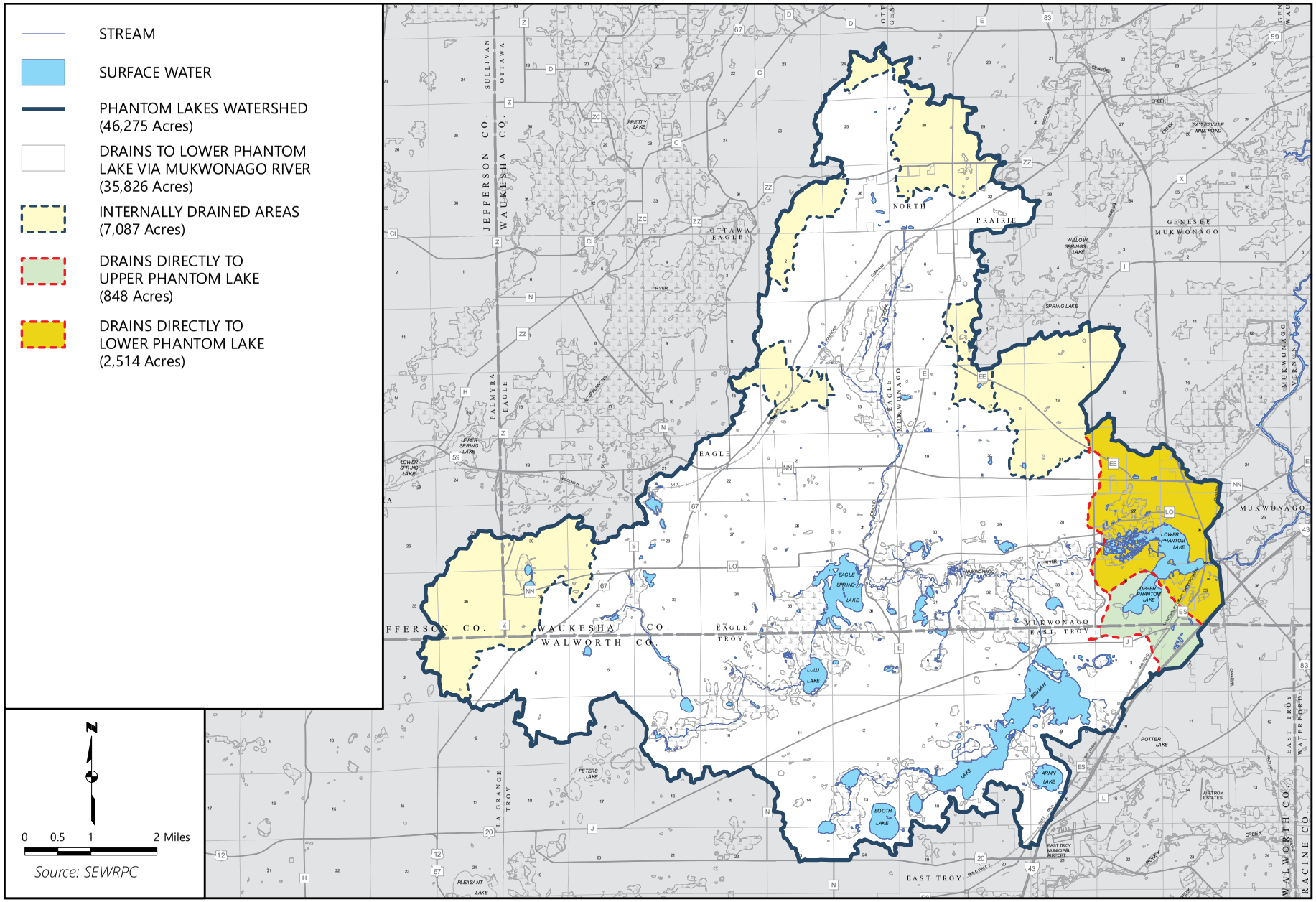
[49] *SEWRPC Community Assistance Planning Report No. 230,* A Lake Management Plan for the Phantom Lakes*, 2006.*

[50] *Internally drained areas were defined as closed depressions at least 20 feet deep. They may take the form of depressions in upland areas segregated from the remainder of the watershed by prominent ridges. Internally drained areas do not contribute to surface water runoff. Instead, water in internally drained areas either evaporates or percolates into the soil contributing to groundwater recharge.*

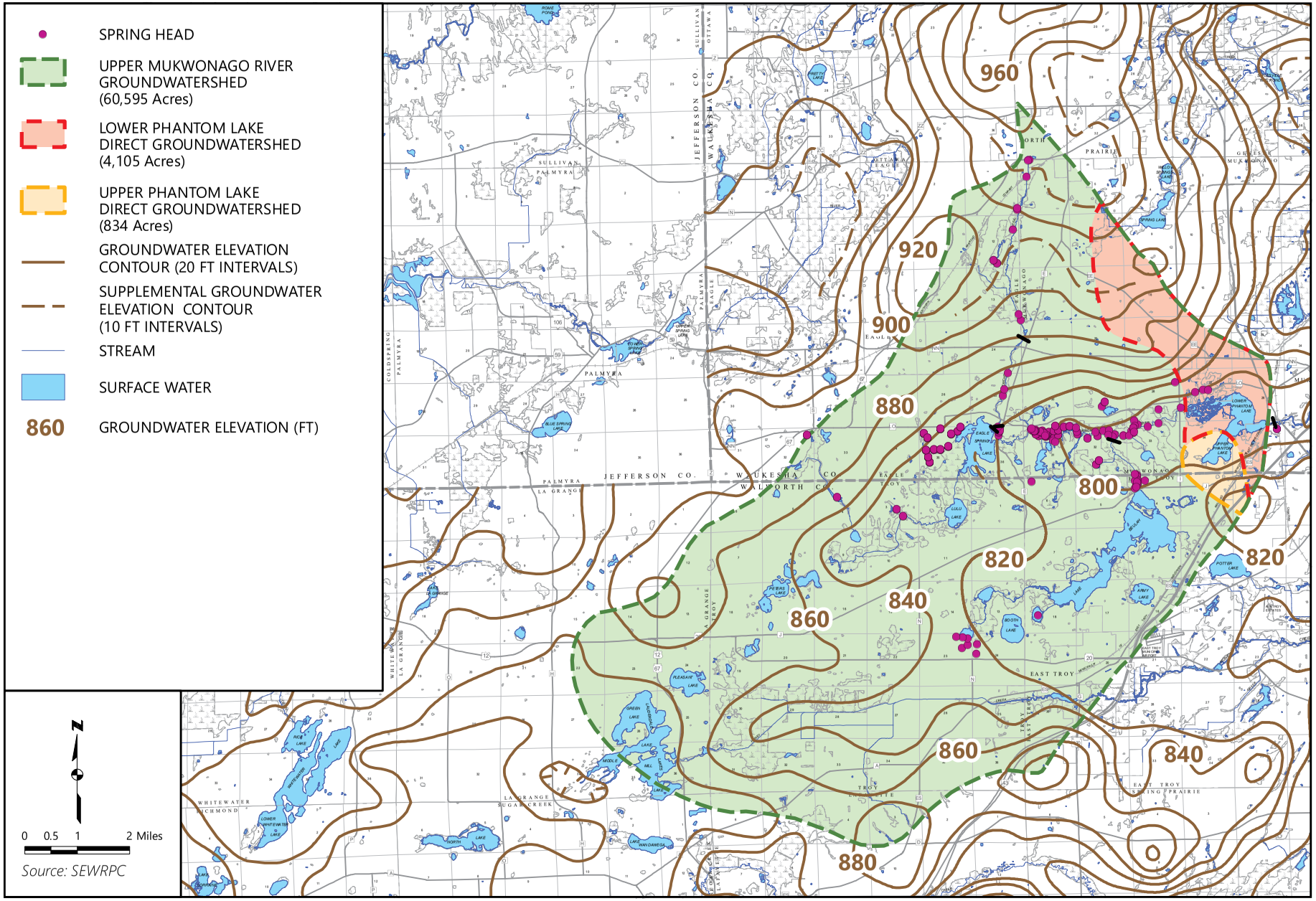
Map 2.5
Upper Mukwonago River/Phantom Lakes Watershed



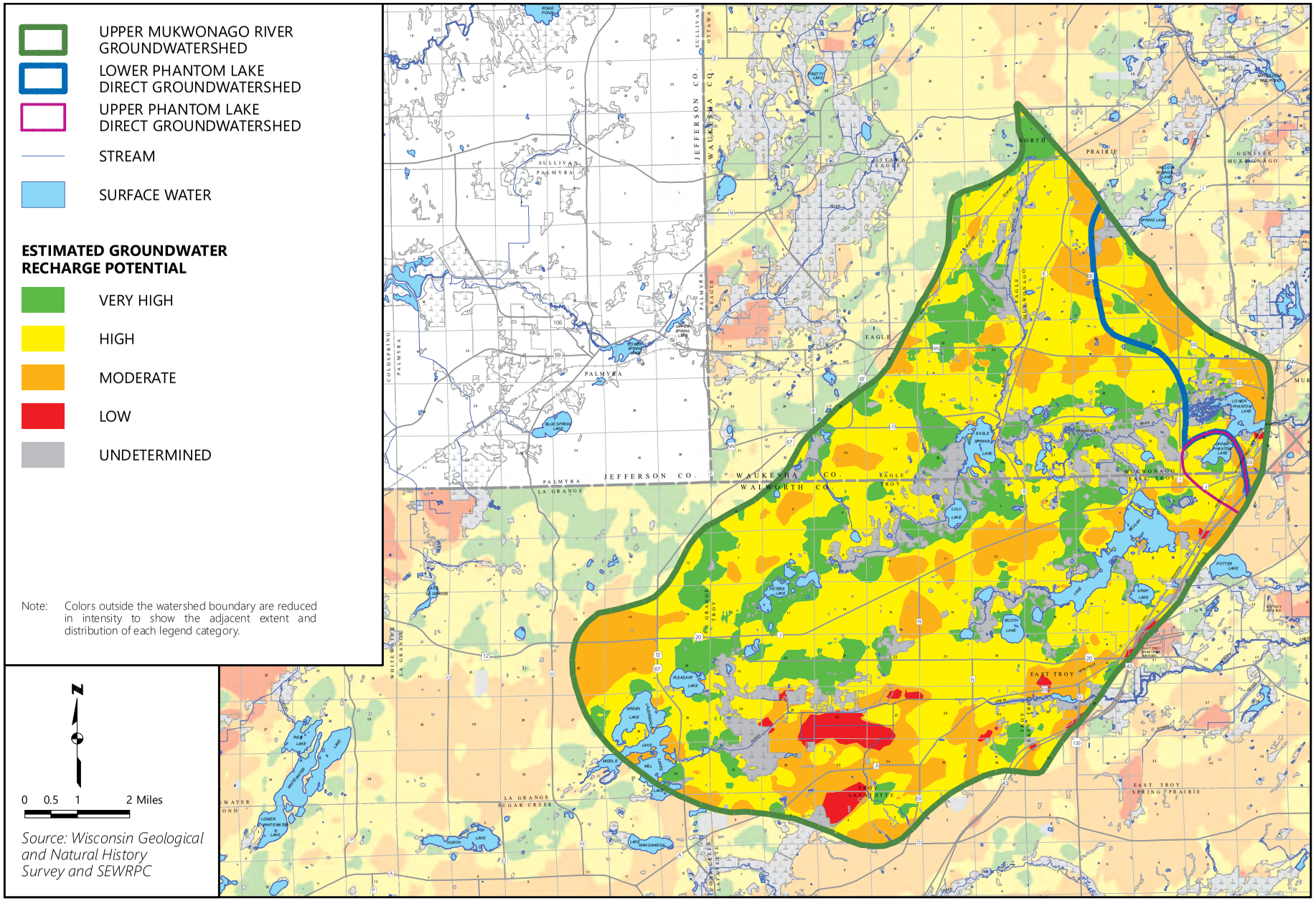
Map 2.6
Upper Mukwonago River/Phantom Lakes Watershed – Drainage Areas



Map 2.7
Upper Mukwonago River/Phantom Lakes Groundwatershed



Map 2.8
Estimated Groundwater Recharge Potential Within the Upper Mukwonago River/Phantom Lakes Groundwatershed



above 10:1 tend to have a higher potential to develop water quality problems.[51] Relatedly, lakes with large watersheds are comparatively more vulnerable to human disturbance.

Upper Phantom Lake has no mapped tributaries but does have a defined perennial outlet. Upper Phantom Lake's outlet is visible on historical maps drawn before the lake outlet dam was constructed,[52] and therefore could be labelled a spring or drained lake.[53] About a third of the Lake's water supply has been estimated to be contributed by groundwater, slightly less than half by surface-water runoff, and the balance through precipitation directly upon the Lake's open water surface.[54] Since two-thirds of the Lake's water budget is believed to be related to precipitation, Upper Phantom Lake is best described as a drained lake.

Lower Phantom Lake is the third lake in a chain of three lakes located along the mainstem of the Mukwonago River – Lulu and Eagle Spring Lakes both lie upstream. Lower Phantom Lake is larger but much shallower than Upper Phantom Lake. Lower Phantom Lake was created by human activity. A dam at the extreme eastern end of the Lake impounds water over a former wetland area. Extensive marshlands still occupy the western end of the Lake. Lower Phantom Lake's surface area is usually considered to be 433 acres. Approximately 2,514 acres of upland drain directly to Lower Phantom Lake. However, the Mukwonago River and Upper Phantom Lake are also both tributary to Lower Phantom Lake. Surface water runoff and direct precipitation from 39,295 acres drains to Lower Phantom yielding a watershed to lake area ratio of about 91:1. Therefore, Lower Phantom Lake is much more prone to water quality problems and human disturbance than Upper Phantom Lake. Since the Lake has perennial tributaries and a perennial outlet, Lower Phantom Lake is classified as a drainage lake.

Influence on Lake Conditions

Even though the Lakes are contiguous and share a common water elevation, the sources of water to each lake are very different. Since Upper Phantom Lake has no mapped tributary streams, this lake's water supply depends primarily upon springs, seeps, precipitation falling upon the Lake's surface, and diffuse runoff from its rather small watershed. None of these water sources is particularly large given the rather limited areal extent of land contributing surface-water and groundwater to the Lake. The Lake's limited water supply and greater depth create a situation where water remains in the Lake for considerable lengths of time. Water residence time in Upper Phantom Lake has been estimated to be 361 days.[55,56] Such conditions reduce the chance for heavy pollutant loads to be delivered to the Lake, but also reduce the Lake's pollutant flushing potential.

Lower Phantom Lake's direct watershed is also relatively small. This means that, like Upper Phantom Lake, Lower Phantom Lake has only limited amounts of surface-water and groundwater contributed by the lake-direct watershed. However, both the Mukwonago River and Upper Phantom Lake discharge to Lower Phantom Lake. Water contributed by the Mukwonago River completely dominates Lower Phantom Lake's water supply budget, a situation making lake-direct discharge springs and seeps, precipitation, and direct runoff relatively inconsequential. Because Lower Phantom Lake is shallow and has a large tributary, water is quickly flushed from the Lake. Water residence time in Lower Phantom Lake has been estimated to be 13 days.[57] Lakes with large tributaries are more likely to experience significant pollutant loads but are more capable of quickly flushing pollutants downstream.

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[51] *Uttormark, Paul D. and Mark L. Hutchins,* Input Output Models as a Decision Criteria for Lake Restoration*, University of Wisconsin-Madison, Wisconsin Water Center Technical Report No. 78.04, 1978.*

[52] *Board of Commissioners of Public Lands, Plat Map Township 5 North, Range 18 East, 1837. Available online at: www.digicoll.library.wisc.edu/SurveyNotes/Search.html.*

[53] *Spring lakes derive much of their water from groundwater. The major source of water to drained lakes is runoff from the the lakes' watershed.*

[54] *SEWRPC Community Assistance Planning Report No. 230,* A Lake Management Plan for the Phantom Lakes, Waukesha County, Wisconsin*, 2006.*

[55] *Residence time is the estimated time required for a water volume equivalent to a lake's entire volume to enter a lake during periods of normal precipitation.*

[56] *SEWRPC CAPR No. 230, op. cit.*

[57] *SEWRPC CAPR No. 230, op. cit.*

Watershed Yield

Since 1973, the United Stated Geological Survey has measured the Mukwonago River's flow and occasionally other parameters just downstream of Lower Phantom Lake. A graph summarizing the River's average daily flow at this stream gaging station is included as Figure 2.2, with monthly boxplots (explanation of boxplots symbols presented in Figure 2.3) of average daily flow presented in Figure 2.4. The volume of water discharged during a given year can be divided by the watershed area to express the equivalent depth of water flowing from the watershed to the gaging station during a set period of time. The average annual watershed yield for the Mukwonago River watershed for 44 years is presented in Figure 2.5. During this period of time, the River's watershed yielded between 5.6 to 17.0 inches per year, averaging 10.5 inches. A prolonged period of consistently lower watershed yield is evident between 1994 and 2006. During this period of time, watershed yield remained at or below long-term average watershed yield, a situation undoubtedly influencing the hydrology and potentially limnology and biology of waterbodies in the watershed. Even with this low-flow period, overall watershed yield is trending slightly upward over the period of available record. This means that slightly more surface water and likely groundwater has been discharged to the Lakes on average over time. Nevertheless, it must be remembered that many years are wetter or drier than average, a situation yielding comparatively few recent years with watershed yield mirroring long-term averages.

The Role of Groundwater in Water Budgets

Since significant amounts of groundwater discharge to the Mukwonago River upstream of Lower Phantom Lake, much of the total annual flow of the River is groundwater sourced. Characteristics of the Mukwonago River's flow downstream of Lower Phantom Lake between 1973 and 2019 suggest that during typical years, roughly 3.7 to 9.2 inches of water percolate into the Lake's groundwatershed each year and ultimately discharge to the Mukwonago River.[58] Similarly, these data suggest that groundwater supplies as much as two-thirds of the River's annual flow during dry years and about half the River's overall flow during wet years. Clearly, groundwater is a significant contributor to the Mukwonago River's water budget.

The amount of water flowing out of Lower Phantom Lake varies significantly day to day, season to season, and year to year (see Figures 2.2, 2.4 and 2.5). Several year long periods have experienced higher than average or lower than average flow. Casual examination suggests these extremes are related to periods of extended and/or extreme wet weather and drought. Nevertheless, over the 46 years of available record, average Mukwonago River flow volumes appear to be trending upward. This suggests that the water residence time in Lower Phantom Lake, and possibly Upper Phantom Lake, are decreasing over time.

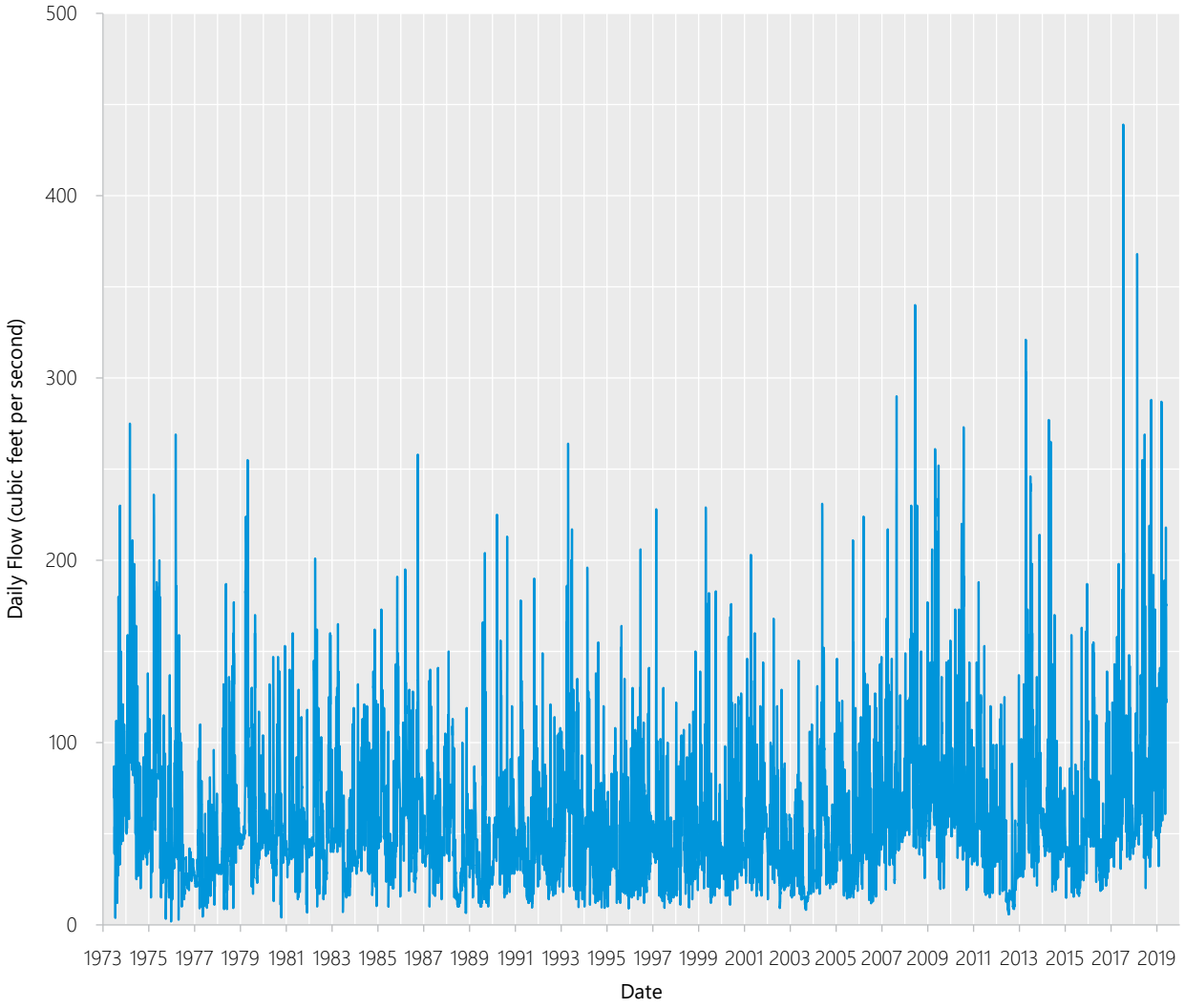
Watershed yield, watershed area, hydrograph characteristics, precipitation data, and evaporation estimates can be used to provide a rough estimate of the relative volume of water contributed by groundwater to area waterbodies. Unlike the Mukwonago River, groundwater is not the dominant overall water supply to the Lakes. Groundwater is Upper Phantom Lake's dominant source or water only during extremely dry weather. While groundwater remains an important water source during average weather, it is a minor source during wet weather. On account of Lower Phantom Lake receiving large surface-water inflows from the Upper Mukwonago River and Phantom Lake, direct groundwater discharge is a minor component of Lower Phantom Lake's water budget. With this information in mind, changes in groundwater discharge volumes are unlikely to significantly affect water quality in Lower Phantom Lake at any time. Groundwater discharge volumes are also unlikely to significantly affect Upper Phantom Lake's water quality with the possible exception of long stretches of extremely dry weather.

2.7 SUPPLEMENTAL LAKE BATHYMETRY

Water depth information is collected during the Commission's aquatic plant inventory process. Although this water depth information is not collected to produce highly accurate bathymetric maps, it can be used to produce water depth contours in shallow portions of water bodies. Water depth information is commonly very old or completely lacking in many area lakes. Water depth contours were mapped by merging the 2017 shallow depth water depth measurements (i.e., water depths less than or equal to 12 feet) with pre-existing bathymetric maps. Copies of these updated maps are presented as Maps 2.9 and 2.10 of this plan.

[58] *During extreme drought, groundwater flow to the River may be lower than this range, but contribute a higher proportion of the River's overall flow. Similarly, during extended periods of heavy precipitation, groundwater flow to the River may increase, but contribute a comparatively smaller proportion of the River's overall flow.*

Figure 2.2
Daily Flow of the Mukwonago River Downstream of Lower Phantom Lake: 1973-2019



Source: USGS and SEWRPC

2.8 WATER QUALITY UPDATE

As part of the 2006 Lake Plan, the Commission drew several conclusions from water quality data available at that time. These conclusions included the following points:

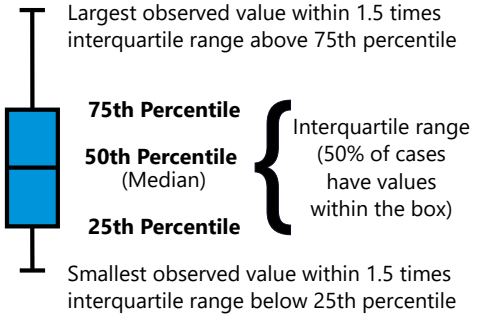
- The Lakes were typical Southeastern Wisconsin hard-water lakes with relatively good water quality.
- Upper Phantom Lake stratified during winter and summer and mixed in fall and spring. Lower Phantom Lake was not known to stratify for significant lengths of time.
- Winter kill was not an issue in either lake.
- Water clarity in Upper Phantom Lake ranged from about five to 14 feet, with an average Secchi depth of about ten feet in spring, nine feet in summer, and eight feet in fall. Lower Phantom Lake's water clarity was similar to Upper Phantom Lake, with Secchi depth measurements ranging from six feet to 12 feet Secchi depth, averaging about ten feet in spring, nine feet in summer, and eight feet in fall.

- Chlorophyll-*a* concentrations in Upper Phantom Lake ranged from 3.0 to 14.5 micrograms per liter (µg/l). In Lower Phantom Lake, chlorophyll-*a* concentrations ranged from 2.0 to 7.0 µg/l. Concentrations above 10.0 µg/l generally yield a visible green water color.

- Spring turnover water samples contained 12.0 µg/l phosphorus in Upper Phantom Lake and 9.0 µg/l in Lower Phantom Lake.[59]

- The Commission classified both lakes as moderately fertile having the potential to support abundant aquatic plant growth and productive fisheries.

Figure 2.3
Explanation of Symbols Used in Box-Plot Graphs



Source: SEWRPC

Temperature

Seasonal air temperature fluctuation and varying amounts of sunshine influence lake temperatures, causing waters to mix and stratify seasonally. In spring and fall, most lakes are well mixed and therefore are the same temperature from the water surface to the lake bottom. In summer, surface water warms and becomes more buoyant than underlying cooler water. In deeper lakes (e.g., 20 feet or deeper) a distinct warm upper layer (referred to as the lake's "epilimnion") and a separate colder deep layer ("hypolimnion") form, a condition which causes the lake to be considered "stratified". The temperature change between the epilimnion and hypolimnion is generally abrupt, occurring in a relatively narrow depth band referred to as the "thermocline." Lakes can also weakly stratify in winter since water is most dense at 39 degrees Fahrenheit. Since water freezes at 32 degrees Fahrenheit, the warmest water in lakes during midwinter (aside from areas influenced by groundwater seepage, springs, and surface-water inputs) can often be found near the lake bottom in the deepest portions of the lake.

Water temperature profiles have been collected at the Lakes for the past 20 years. Upper Phantom Lake's temperature profiles clearly reveal that the Lake stratifies during summer (Figure 2.6). In general, stratification begins to develop during May and breaks down sometime in September. Early in the season, the thermocline is found at a shallow depth (e.g., confined to a band somewhere between 10 and 20 feet below the water surface). By late summer, the top of the thermocline is found approximately 20 feet below the water surface, often extending to the lake bottom, a situation where very little of the Lake's volume is contained by the hypolimnion. Lower Phantom Lake's temperature profiles reveal that the Lake never stratifies (Figure 2.7).

Oxygen

A reliable oxygen supply is vital to desirable aquatic organisms and the overall lake health. In general, oxygen concentrations should remain above 5.0 mg/l to support a healthy fishery in most of the Region's inland lakes.[60,61]

Based upon data collected in both Lakes and no reports of winter fish kills, Upper Phantom Lake's oxygen concentrations are generally sufficient to support desirable aquatic life throughout the year (Figure 2.8). When the Lake stratifies, water in the deepest portion of the Lake is unable to obtain oxygen from the atmosphere or from most of the Lake's aquatic plants. Organic matter from the biologically active epilimnion continues to settle into the hypolimnion where it decomposes, a process that consumes oxygen. For this reason, oxygen concentrations decline in Upper Phantom Lake's deep areas after the Lake stratifies during

[59] *SEWRPC CAPR No. 230 contained a typographical error. Phosphorus was incorrectly labelled as expressed in milligrams per liter (mg/l). The phosphorus values presented in the plan should have been labelled as micrograms per liter (µg/l).*

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

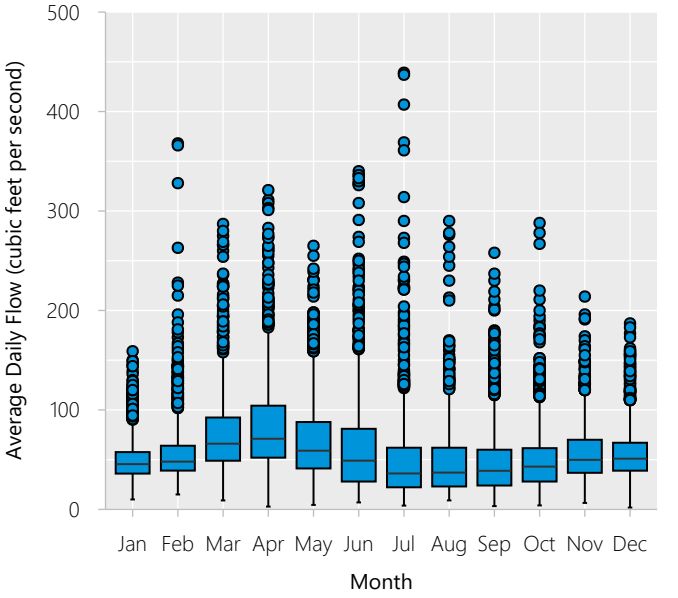
[61] *Oxygen dissolves into water. Cooler water is capable of holding more oxygen than warm water. Oxygen saturation is calculated by comparing the oxygen concentration at a particular temperature to the theoretical oxygen saturation value for that temperature. Generally, oxygen saturation values should remain between 90 and 110 percent best support healthy fisheries.*

the summer. The Lake's deepest areas may become hypoxic (low oxygen) or anoxic (no oxygen), and are therefore not habitable to fish during much of summer.

Lakes with high fertility are most prone to have hypoxic or anoxic hypolimnia. Relatedly, lakes with anoxic hypolimnia are most prone to supporting geochemical reactions that release phosphorus from lake-bottom sediments, the nutrient that limits lake plant and algal growth in most of the Region's lakes. Therefore, a self-reinforcing feedback loop can develop where fertile lakes are made even more fertile through lake-bottom phosphorus release ("internal loading"). Similarly, reducing external nutrient loads can reduce lake fertility which in turn can decrease the temporal and spatial extent of anoxia and thereby reduce internal loading. The depth where hypoxic water is found during mid- to late-summer in Upper Phantom Lake has gradually decreased over the monitoring period (Figure 2.9) suggesting reduced overall Lake fertility. Given that the Lake is excessively fertile (see phosphorus section later in this chapter for more detail), this suggests improving conditions in Upper Phantom Lake.

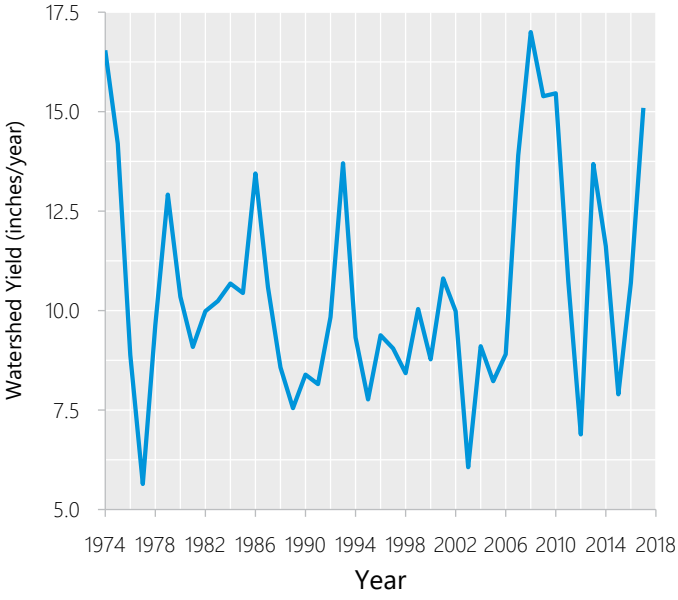
Lower Phantom Lake does not stratify, therefore, oxygen concentrations do not significantly vary with depth (Figure 2.10). Based upon available data and no known winter fish kills, the Lake generally contains sufficient oxygen to support healthy fisheries. During summer, oxygen concentrations have occasionally been less than the minimum required to support a healthy fishery, with the greatest prevalence of such conditions occurring during late summer. Low oxygen conditions do not appear to be related to high water temperatures. Instead, low oxygen concentrations may be related to high in-Lake oxygen demand, a condition often related to large volumes of decomposing organic material. Possible sources of decomposing plant material include senescing aquatic plants, masses of aquatic plant remains, or organic rich debris transported to the Lake by the Mukwonago River.

Figure 2.4
Mukwonago River Monthly Average Flow Downstream of Lower Phantom Lake: 1973-2019



Source: USGS and SEWRPC

Figure 2.5
Average Annual Watershed Yield of the Mukwonago River Upstream of the Village of Mukwonago: 1974-2017

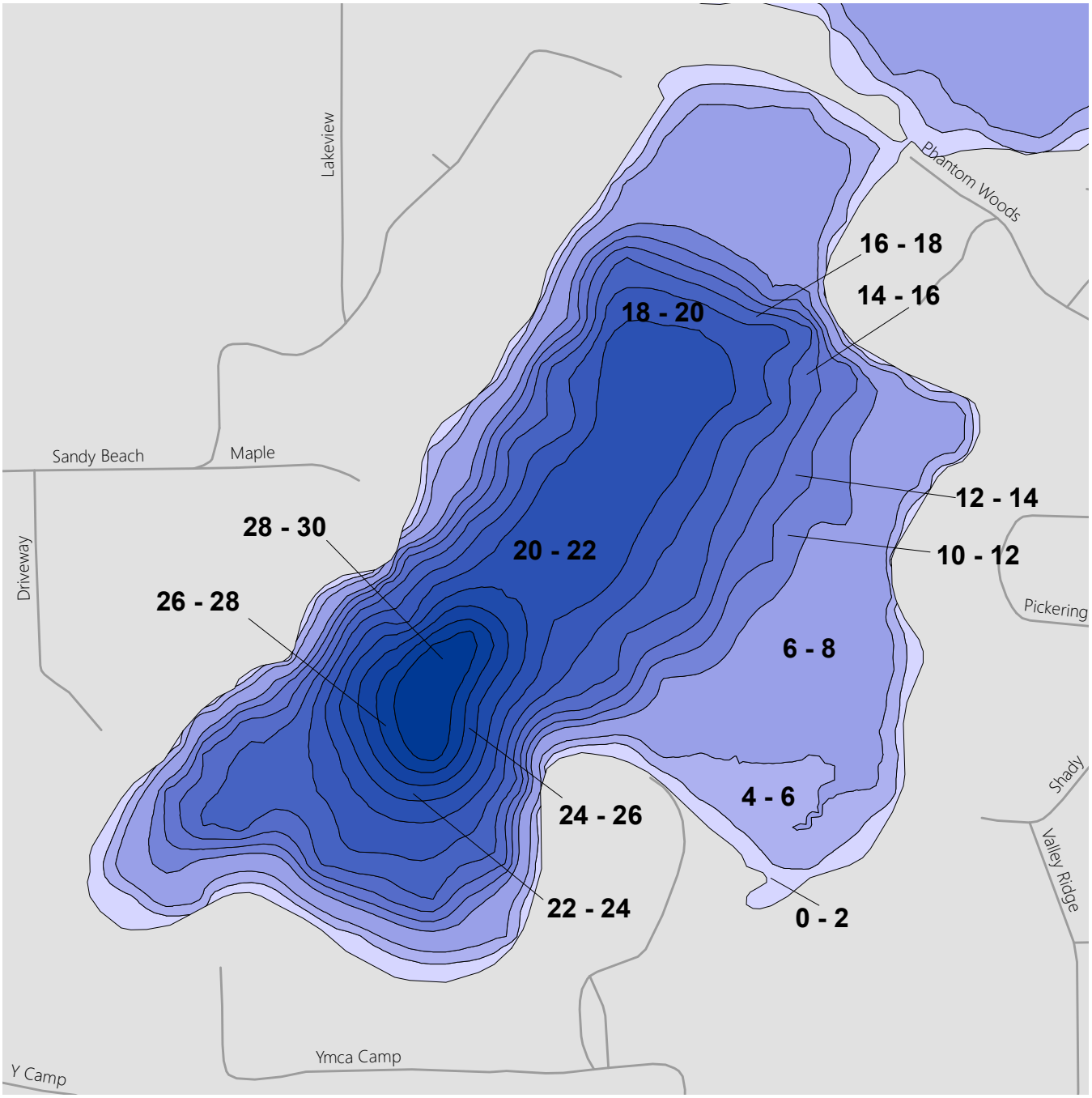


Source: USGS and SEWRPC

Trophic State Index

Lake trophic state index (TSI) is calculated using physical, biological, and chemical indicators of lake nutrient enrichment. Lakes with low numeric scores (i.e., less than 40) generally have clear water of excellent quality and are termed oligotrophic. Lakes with TSI values between 50 and 60 are termed eutrophic and have limited water clarity, fewer algal species, overly-abundant aquatic plant growth, and deep areas that are commonly devoid of oxygen during summer. Mesotrophic lakes (TSI values between 40 and 50) have TSI values intermediate between oligotrophic and eutrophic lakes and are common in Southeastern

Map 2.9
Upper Phantom Lake Updated Water Depth Contours



WATER DEPTH CONTOURS (FEET)

0 - 2	8 - 10	16 - 18	24 - 26
2 - 4	10 - 12	18 - 20	26 - 28
4 - 6	12 - 14	20 - 22	28 - 30
6 - 8	14 - 16	22 - 24	

ROADS

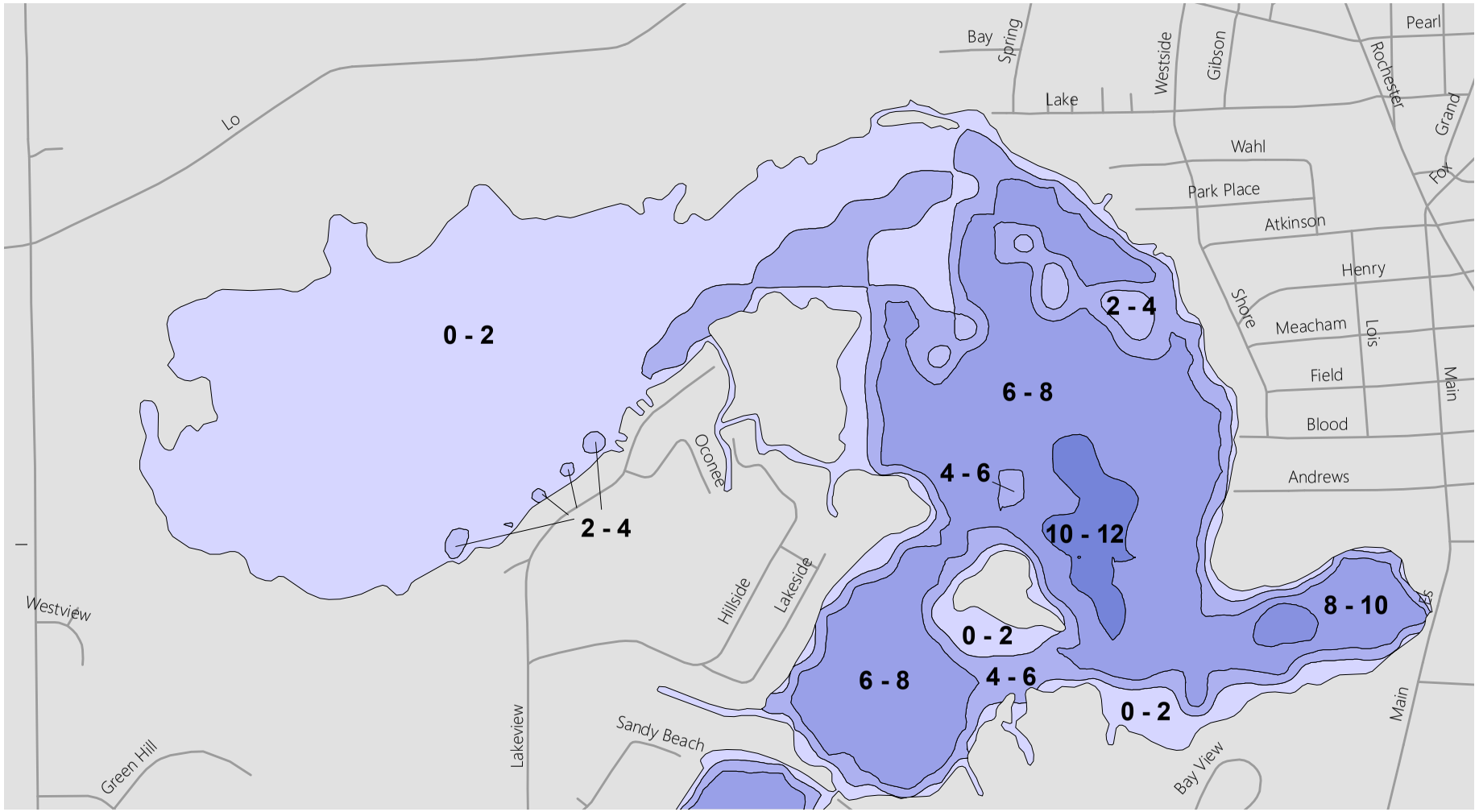
N

Not to Scale

Source: WDNR and SEWRPC

NOTE: Water depths portrayed in this map are based upon sonar mapping from 1955 and 1967 as well as manual depth soundings in shallow water collected as part of the 2017 aquatic plant survey. In general, water depth contours greater than 15 feet rely solely on historical sonar mapping while shallow water depth contours rely primary on 2017 depth sounding.

Map 2.10
Lower Phantom Lake Updated Water Depth Contours



WATER DEPTH CONTOURS (FEET)

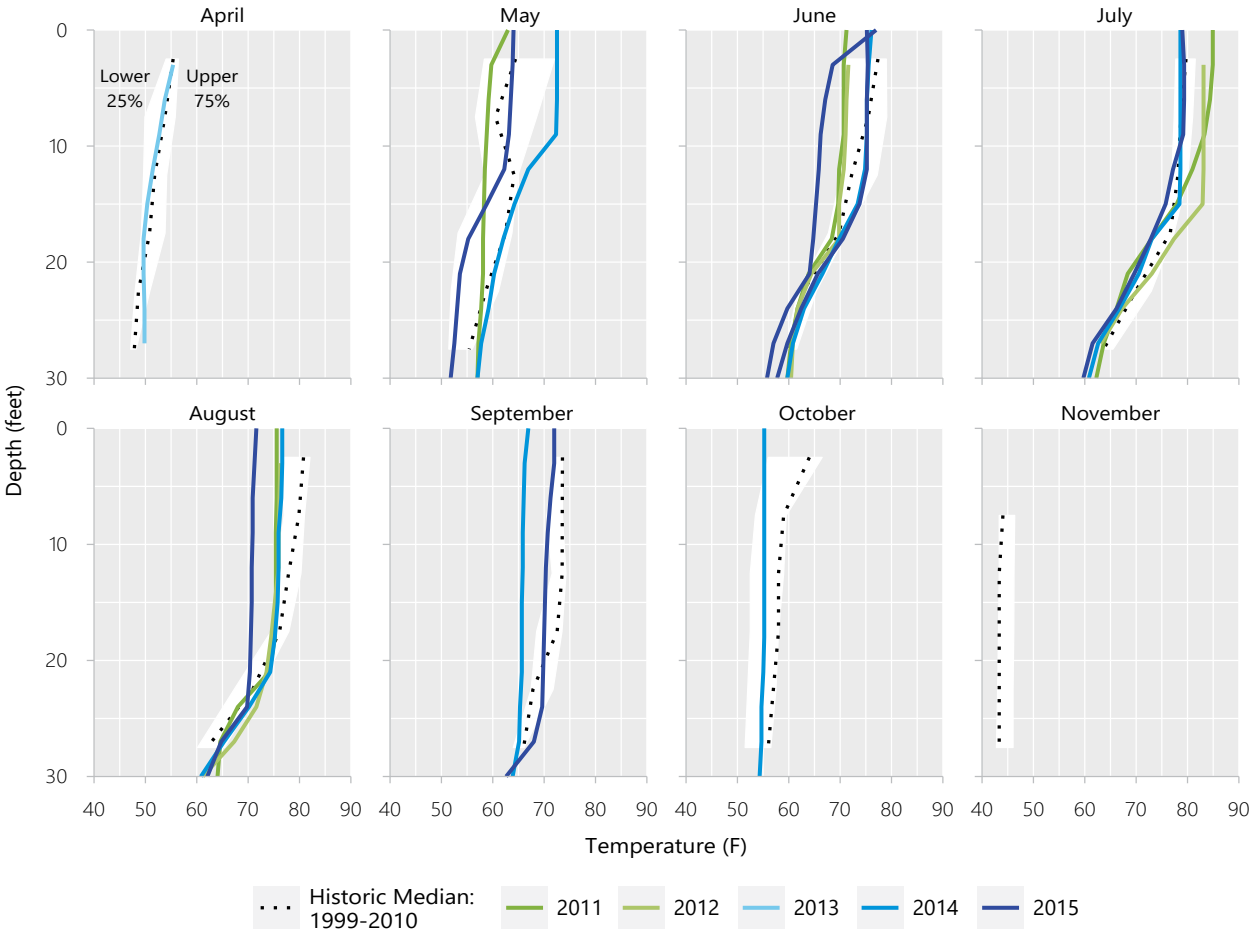
- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 10
- 10 - 12
- ROADS

Not to Scale

Source: WDNR and SEWRPC

NOTE: Water depths protrayed in this map are based upon manual depth soundings collected as part of the 2017 aquatic plant survey.

Figure 2.6
Upper Phantom Lake Water Temperature Profiles: 1999-2015



Source: Wisconsin Department of Natural Resources and SEWRPC

Wisconsin. Hypereutrophic lakes (TSI values above 70) rarely occur naturally and are normally associated with human influence. Hypereutrophic lakes commonly experience algal blooms, poor water clarity, and, in extreme cases, summer fish kills.

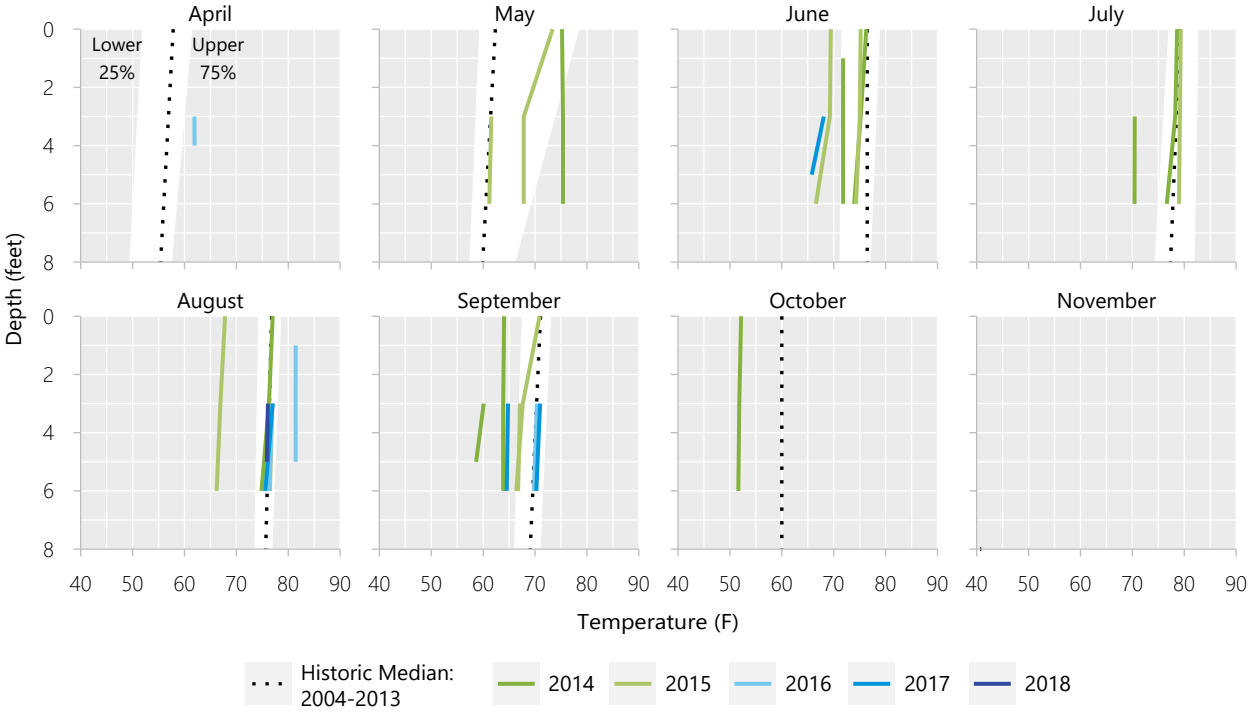
Using the Wisconsin trophic state index (WTSI) formula,[62] the Commission calculated a series of historical WTSI values for both lakes using chlorophyll-*a* (an indicator of the amount of algae suspended in the water), secchi depth (a measure of overall water clarity), and total phosphorus (the nutrient limiting plant growth in most lakes) data and plotted changes over time, particularly from the early 1990s to present (Figures 2.11 and 2.12). As can be seen from these plots, the WTSI values vary over time but have followed identifiable trends, as examined below.

Upper Phantom Lake

Upper Phantom Lake's chlorophyll-*a* and secchi depth WTSI values have both trended lower, demonstrating progressively less floating algae and clearer water over time. At the same time, total phosphorus concentrations/WTSI values have trended higher, a situation that normally *increases* algal abundance and *decreases* water clarity. This apparent dichotomy may be attributable to changes in the Lake's biology. For example, summer chlorophyll-a concentrations often decrease in lakes recently colonized by zebra mussels (*Dreissena polymorpha*) because these animal feed by filtering algae from the water column, an

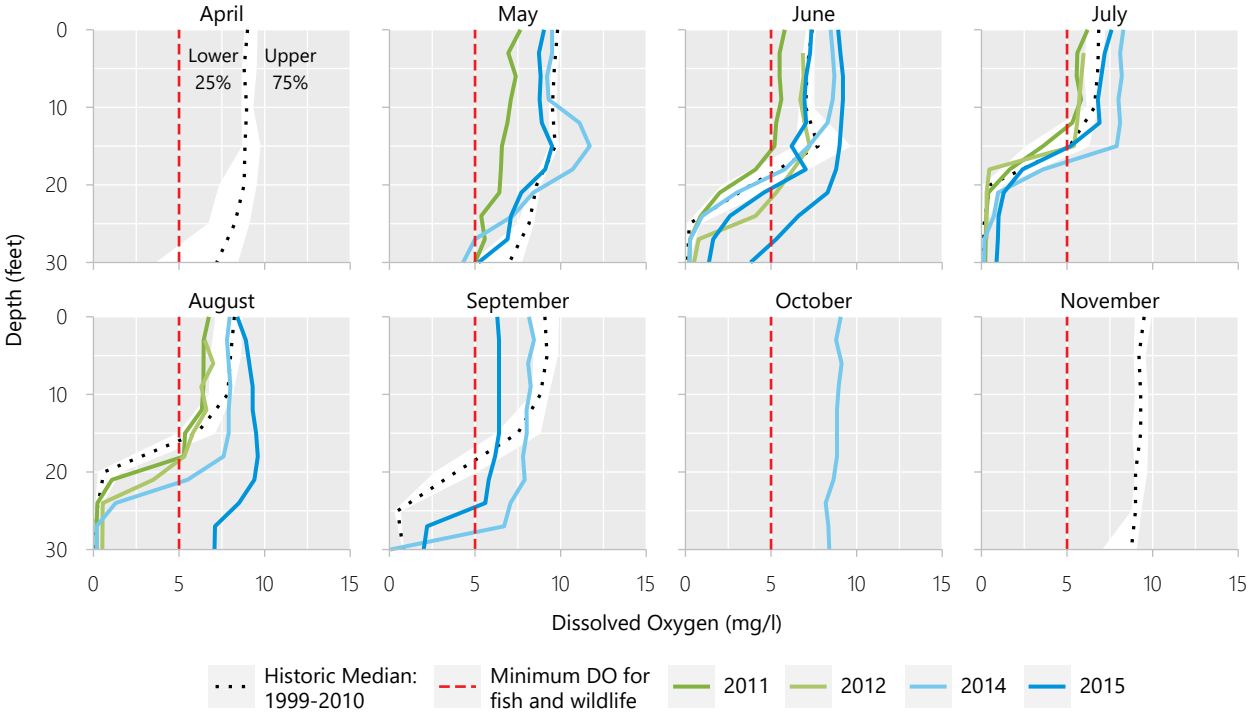
[62] *Lillie, R. A, S. Graham, and P. Rasmussen,* Trophic State Index Equations and Regional Predictive Equations for Wisconsin Lakes*, Research Management Findings Number 35, Wisconsin Department of Natural Resources, Bureau of Research, May 1993.*

Figure 2.7
Lower Phantom Lake Water Temperature Profiles: 2004-2018



Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.8
Upper Phantom Lake Water Dissolved Oxygen Profiles: 1999-2015



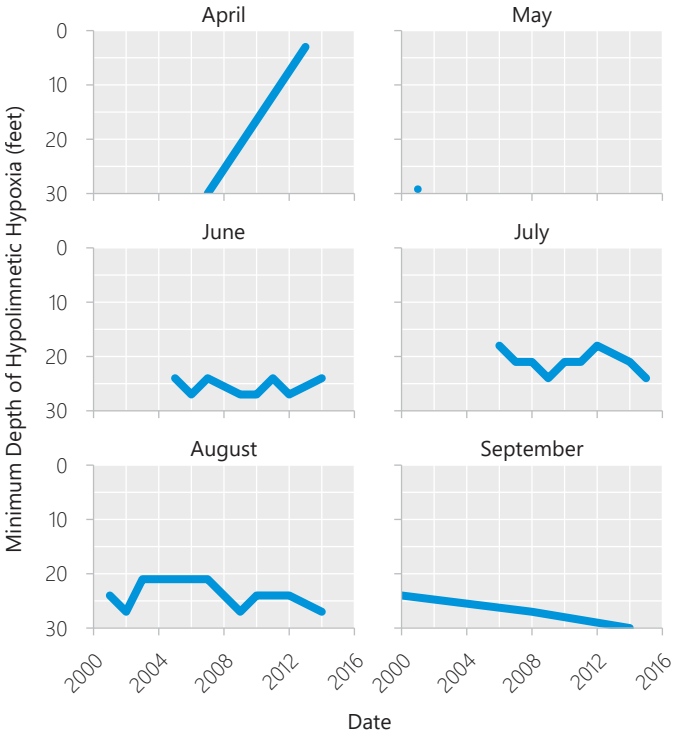
Source: Wisconsin Department of Natural Resources and SEWRPC

action increasing water clarity. Zebra mussels were confirmed to be present in both Upper and Lower Phantom Lakes in 2001. Changes in zooplankton abundance related to fishery changes can also influence algal abundance. Both these conditions may result in total phosphorus WTSI values greater than either chlorophyll-*a* or Secchi depth WTSI values - the situation existing in Upper Phantom Lake.

Lower Phantom Lake

Lower Phantom Lake's chlorophyll-*a* and total phosphorus WTSI values have remained essentially static for the past 40 years. However, secchi depth WTSI has increased over time, seemingly indicating that water clarity is decreasing with no corresponding change in total phosphorus or chlorophyll-*a*. Before assuming this is a vital trend, it must be remembered that Lower Phantom Lake is generally very shallow (mean depth of 4 feet), the maximum reported secchi depths are nearly the same as the Lake's total depth, and the deep hole location where sampling takes place is very limited in areal extent. These factors could easily create a situation where slight changes to sampling location or water depth could profoundly affect secchi depth results – the secchi disk may be visible while lying on the Lake bottom. The secchi disk was indeed reported to have hit the Lake's bottom on the majority of measurements between 2004 and 2018, generally an indication of good water quality. Therefore, many of these secchi depths appear to be more closely related to the Lake's limited water depth where measurements were made rather than changes in actual water clarity.

Figure 2.9
Depth to Hypoxia Upper Phantom Lake: 2000-2015



Note: Hypoxia is defined as a dissolved oxygen concentration of 1.0 mg/l or lower.

Source: Wisconsin Department of Natural Resources and SEWRPC

Phosphorus

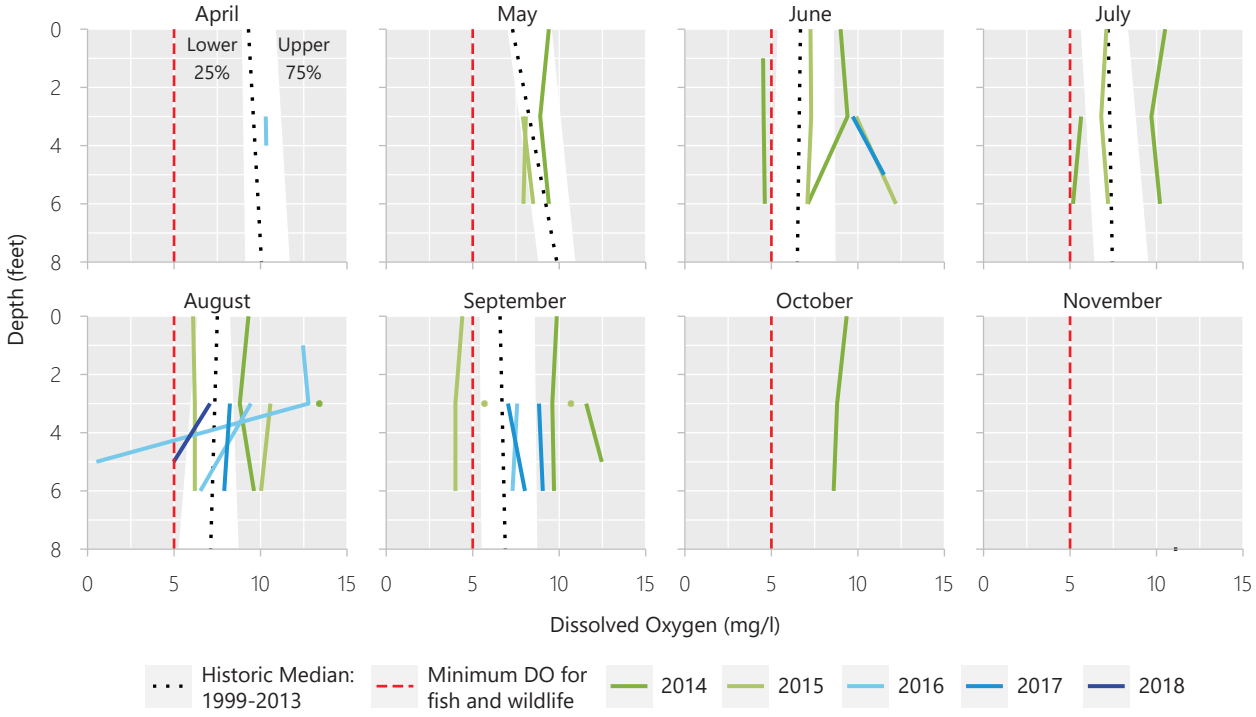
Upper Phantom Lake was added to Wisconsin's impaired waters list during 2016 on account of excessive total phosphorus. For the purpose of phosphorus regulatory goals, Upper Phantom Lake is classified as a seepage lake, which is appropriate given its water sources. Water in such lakes should contain no more than 20 µg/l total phosphorus.[63] As can be seen from Figure 2.13, Upper Phantom Lake's water commonly contains phosphorus concentrations meeting or exceeding this value. Total phosphorus concentrations have declined during the past few years. Casual analysis suggests that the highest total phosphorus values seem to potentially correlate with periods of lower effective precipitation. Water retention time increases during drier periods, a condition that reduces the Lake's ability to dilute and flush nutrients downstream.

Lower Phantom Lake is a non-stratified drainage lake, which is appropriate given its shallow depth and that the Mukwonago River flows through the Lake (entire water volume is replaced about every 13 days). Water in non-stratified drainage lakes should have no more than 40 µg/l total phosphorus.[64] Total phosphorus concentrations have averaged less than half the standard while maximum total phosphorus concentrations in the Lake remain well below the standard (Figure 2.14).

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

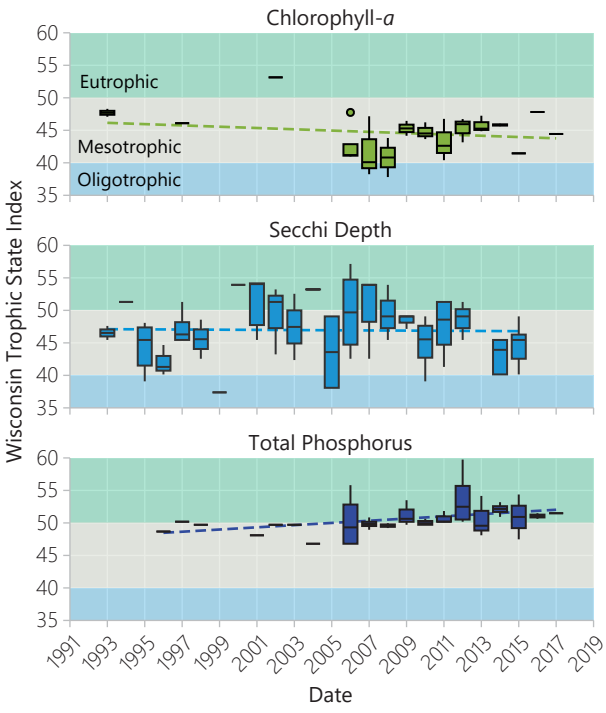
[64] *Ibid.*

Figure 2.10
Lower Phantom Lake Dissolved Oxygen Profiles: 1999-2018



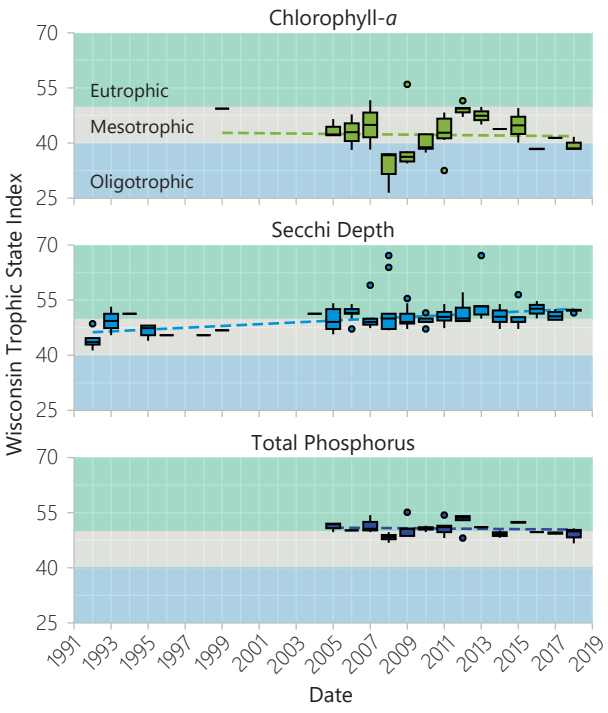
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.11
Upper Phantom Lake Summer (June 1st to September 15th) Trophic State Index Trends: 1992-2018



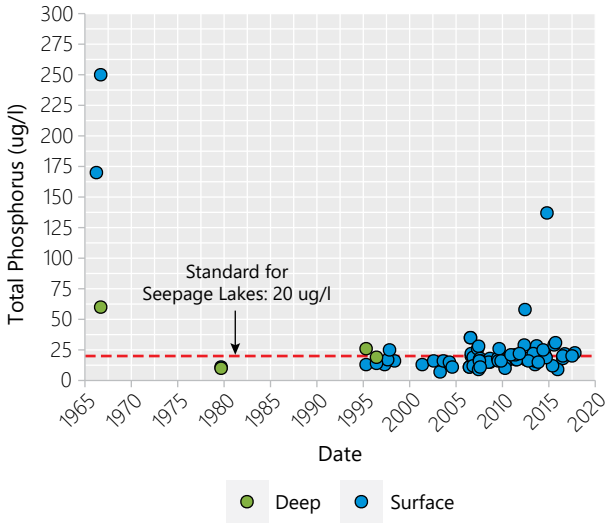
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.12
Lower Phantom Lake Summer (June to September) Trophic State Index Trends: 1992-2018



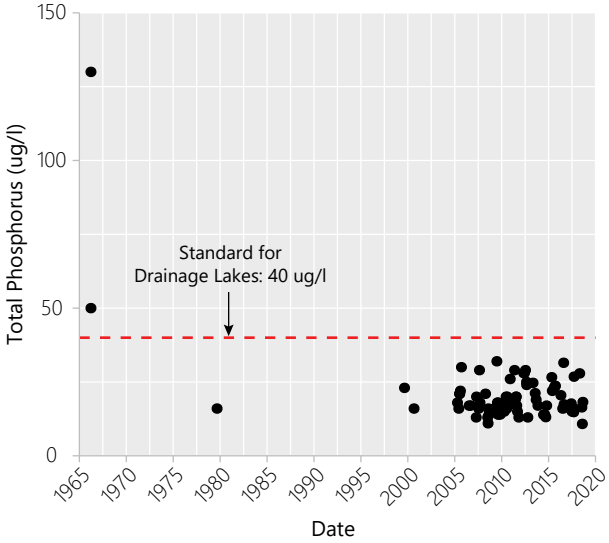
Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.13
Upper Phantom Lake Phosphorus Concentrations: 1966-2017



Source: Wisconsin Department of Natural Resources and SEWRPC

Figure 2.14
Lower Phantom Lake Phosphorus Concentrations: 1966-2018

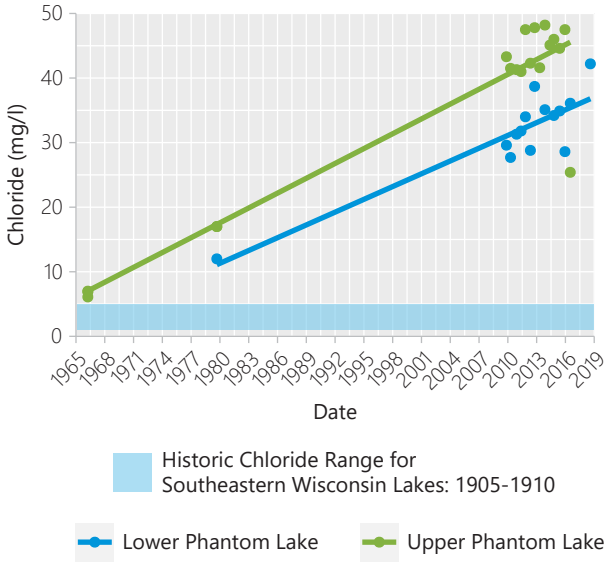


Source: Wisconsin Department of Natural Resources and SEWRPC

Chloride

Natural chloride concentrations in the Region's waterbodies were typically very low prior to European settlement (e.g., less than 5 mg/l). Modern human influence has dramatically increased waterbody chloride concentrations, a trend that has been particularly evident during the past 50 years. As is typical for Southeastern Wisconsin lakes, the concentrations of chloride more than doubled over the past 40 years (Figure 2.15). Although the concentrations now found in the Lakes are substantially below regulatory thresholds, chloride concentrations have consistently increased, a situation that can make aquatic habitats incrementally more inhospitable to desirable native aquatic plants and animals. Conversely, many undesirable exotic invasive plants and animals are well adapted to high-salt environments and may be increasingly favored by increasing chloride concentrations.

Figure 2.15
Chloride Concentration Trends in the Phantom Lakes: 1966-2018



Source: Wisconsin Department of Natural Resources and SEWRPC

MANAGEMENT RECOMMENDATIONS AND PLAN IMPLEMENTATION 3

Credit: SEWRPC Staff

The Phantom Lakes are exceedingly different ecosystems. This situation warrants substantial differences in the aquatic plant management plans employed within each lake. While both lakes are eutrophic to mesotrophic with hard water, they greatly differ in their hydrology, stratification patterns, and aquatic plant communities. Lower Phantom Lake is shallow with abundant aquatic vegetation, with a particularly rich array of sensitive native species. On account of this and other factors, much of Lower Phantom Lake has been designated as Sensitive Area by the WDNR to protect the many sensitive and rare aquatic plants and animals in this ecosystem and the excellent natural resource services the Lake provides. Upper Phantom Lake, as a deeper lake with more open water, has a healthy aquatic plant community, but lacks several of the sensitive species found in Lower Phantom. Invasive aquatic plants, particularly Eurasian watermilfoil (EWM), are present but declining in both lakes. Aquatic plant management continues to be an important issue of concern to the communities and visitors of both lakes.

Holistic management alternatives and recommended refinements to the existing aquatic plant management plan are presented in this chapter. These measures focus upon in-lake actions (e.g., active aquatic plant management, stakeholder education, riparian outreach), activities that are primarily (and oftentimes solely) District responsibilities. Given the scope of this study, little emphasis is given to measures whose scope and location are more suitably taken up by other governmental agencies. For example, agencies with jurisdiction over areas tributary to the Lakes (e.g., town or county government) may be better suited to address measures to reduce nutrient inputs to the Lakes. Reduced nutrient input can passively reduce aquatic plant abundance and thereby tangibly influence aquatic plant management. Nevertheless, to most effectively manage aquatic plants, the District should actively seek out and collaborate with such agencies.

3.1 RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

The most effective plans to manage nuisance and invasive aquatic plant growth generally rely on a *combination* of methods and techniques. A single-minded "silver bullet" strategy rarely produces the most efficient, most reliable, or best overall result. Therefore, to enhance lake access, recreational use, and lake health, this plan recommends a combination of five aquatic plant management techniques. For the reader's convenience, the various elements of the recommended aquatic plant management plan are identified

and schematically presented (Maps 3.1 and 3.2)[65] and are briefly summarized in the following paragraphs. Additional details useful to implement the plant management plan follow this summary.

1. **Mechanically harvest invasive and nuisance aquatic plants.** Mechanical harvesting should remain the primary means to manage invasive and nuisance aquatic plants on both Upper and Lower Phantom Lake. Harvesting must avoid, or must be substantially restricted, in certain areas of both lakes. This includes areas of particular ecological value, areas that provide unique habitat, areas that are difficult to harvest due to lake morphology (e.g., excessively shallow water depth), and where boat access is not desired or necessary (e.g., marshland areas). Lower Phantom Lake is essentially entirely sensitive area, a situation restricting mechanical harvesting to discrete lanes. Limiting harvesting to lanes is a lake management compromise that protects sensitive areas yet allows riparian residents and boat launch users to access and navigate the Lakes, engage in a variety of water-related recreational pursuits, and access open water areas. In all cases on both Lakes, care should be taken to avoid harvesting native aquatic plants – harvesting should focus on areas of profuse invasive plant growth. It should be noted that the District is considering acquiring specialized small-size harvesting equipment that may be able to harvest some shallow nearshore areas that have been difficult or impossible to service with traditional full-size harvesting equipment. If such equipment is procured, mechanical harvesting may be expanded to additional areas.

2. **Dredge limited nearshore areas in designated mechanical harvest lanes.** Riparian landowners have commented on loss of water depth and increased nuisance aquatic plant growth, both of which impede lake access. This concern was especially underscored along the northeast shoreline of Lower Phantom Lake (e.g., in the general area near the termini of Lake Street, Wahl Avenue, and Atkinson Street) during recent public meetings. Additionally, the access channels that penetrate densely vegetated riparian areas on the peninsula near the center of the Lake and along the south shoreline near the channel to Upper Phantom Lake are particularly shallow and difficult to harvest. Dredging may benefit navigation in these areas. While the primary purpose of dredging is increased water depth, dredging also removes aquatic plants and allows better future access to mechanical harvesting equipment. Post-dredging disrupted lake bed is very prone to colonization by invasive plants, therefore, to discourage spread of invasive plants, the extent of dredging should be limited to the minimum practical area.

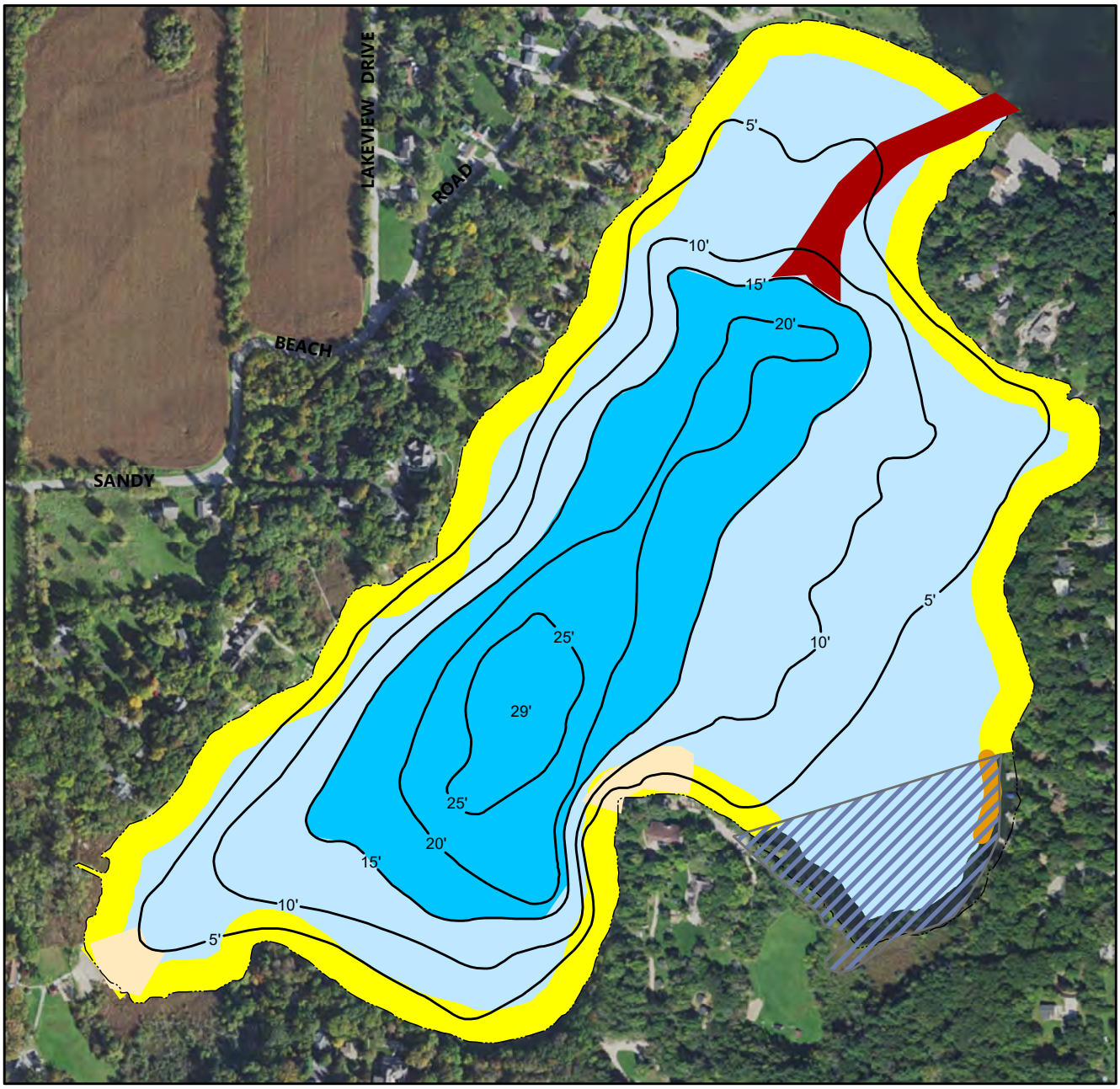
3. **Manually remove nearshore invasive and nuisance plant growth.** Manual removal involves controlling aquatic plants by hand or using hand-held non-powered tools. Riparian landowners should consider manual removal of undesirable plants an integral and vital part of the Lakes' overall plant management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

4. **Use diver assisted suction harvesting (DASH) in high-use, congested, nearshore areas.** Riparian landowners could supplement or supplant manual harvesting by using DASH. If an individual landowner chooses to implement DASH, the activity is typically confined to the same area undergoing manual aquatic plant control – it is not a method to increase the amount of lakefront undergoing active management. DASH requires a Chapter NR 109 permit.

5. **Chemically treat nonnative plants around private piers.** Large-scale chemical treatment is not part of the District's aquatic plant management plan for a variety of reasons, and is unlikely to be incorporated into District's general aquatic plant management anytime soon. Nevertheless, the District may want to consider a rapid response chemical treatment for Chapter NR 40 prohibited species (e.g., hydrilla, *Hydrilla verticillata)*, where appropriate, if such a species were to appear in the Lakes in the future. Individual property owners with frontage not abutting designated sensitive areas

[65] *The maps in this chapter are the same maps referred to in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit for the Phantom Lakes (SE-2019-68-5219M). However, the map title numbers have been changed from the map titles used in the permit. Each map in this chapter contains a footnote indicating the number by which it was referred to in the permit.*

Map 3.1
Recommended Aquatic Plant Management Plan for Upper Phantom Lake: 2019



—20'— WATER DEPTH CONTOUR IN FEET

30-FOOT TRANSIT LANE IN SENSITIVE AREA

SHORELAND AREAS
- DO NOT DISTURB NATIVE AQUATIC PLANTS AND RIPARIAN VEGETATION
- CONTROL INVASIVE SPECIES AS NECESSARY

HABITAT AND MIXED USE AREA
- MONITOR NONNATIVE SPECIES
- HARVEST EURASIAN WATERMILFOIL AND CURLY LEAF PONDWEED DOMINATED AREAS
- AVOID HARVESTING NATIVE AQUATIC PLANTS

SENSITIVE AREA
- NO CONTROL

BEACH USE
- MANUAL HARVEST NEAR SHORE
- MECHANICAL HARVEST OFF SHORE
- LIMITED HERBICIDE USE TO CONTROL NONNATIVE SPECIES AND ALGAE

OPEN WATER
- NO CONTROL

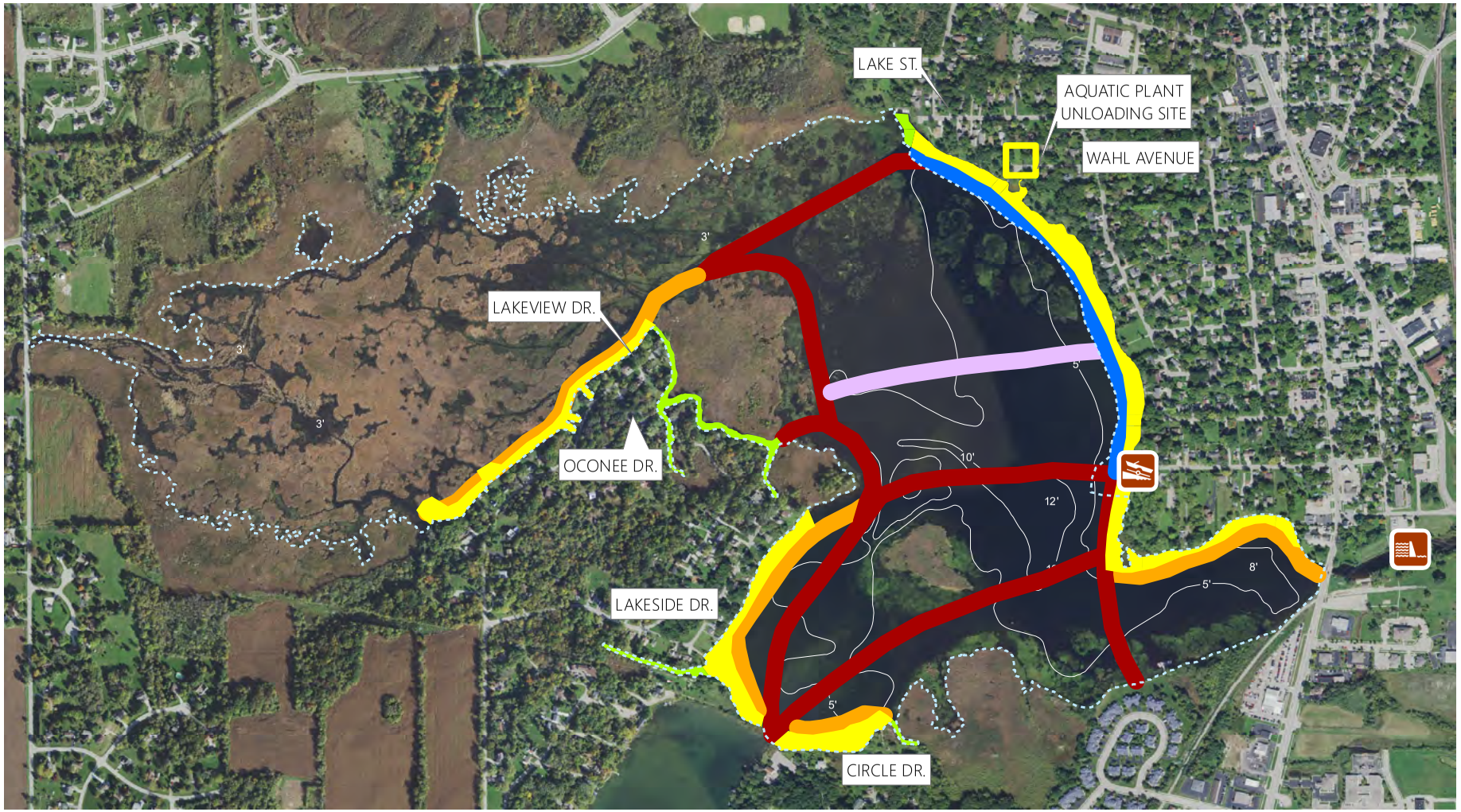
50-FOOT TRANSIT LANE

N

Not to Scale
Source: SEWRPC
Date of Photography: April 2015

Note: This is referred to as Map 11 in the 2019 – 2023 Mechnical / Manual Aquatic Plant Control permit. The extent of implementation among these areas will depend on available staff, time, budget, and plant growth characteristics within a given season. Management area size and locations are not scaled and only illustrate overall concept. See "Aquatic Plant Management Recommendations." Bathymetry contours sourced from WDNR historical lake map created in 1967. These are not for navigation.

Map 3.2
Recommended Aquatic Plant Management Plan for Lower Phantom Lake: 2019



SENSITIVE AREA NAVIGATION EXCEPTIONS:
- 30-FOOT TRANSIT LANES
- 50-FOOT TRANSIT LANES
- 50-FOOT TRANSIT LANES AFTER JUNE 15TH
- 75 FOOT TRANSIT LANES
- SHORELAND AREA
- SMALL HARVESTER ONLY

– 20' – WATER DEPTH CONTOUR IN FEET

BOAT LAUNCH

DAM

AQUATIC PLANT UNLOAD SITE

SENSITIVE AREA DELINEATION

Note: This map is referred to as Map 12 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit. The extent of implementation among these areas will depend on available staff, time, budget, and plant growth characteristics within a given season.Management area size and locations are not scaled and only illustrate overall concept. See "Aquatic Plant Management Recommendations." Bathymetry contours sourced from WDNR historical lake map created in 1964. These are not for navigation.

N

Not to Scale

Source: WDNR and SEWRPC.

DATE OF PHOTOGRAPHY: APRIL 2015

Table 3.1
Phantom Lakes Mechanical Harvester Specifications

Specification	Aquarius Model Number		
	HM-420	HM-820	FB-120
Estimated Draft - Empty	11″ – 12″	11 – 12″	12″ – 13″
Estimated Draft – Fully Loaded	19″ – 20″	19″ – 20″	17″ – 18″
Harvested Plant Storage Capacity	460 cubic feet 10,500 pounds	1050 cubic feet 16,800 pounds	130 cubic feet 1800 pounds
Cutting Depth Range	0″ – 66″	0″ – 66″	0″ – 48″
Effective Cutting Width	84″	120″	48″
Overall Operating Width	14′-6″	17′-3″	10′-10″
Overall Operating Length	40′-6″	45′-6″	32′-7″
Estimated Production	0.425 acres/hour	0.610 acres/hour	n/a

Source: SEWRPC

may pursue a Chapter NR 107 permit to treat their shorelines. This method of aquatic plant control has a number of drawbacks (e.g., water quality, comparatively nonselective, chemical side effects, and more) and should only be considered under special circumstances. When employed, a physical barrier (e.g., turbidity barrier) should be used to reduce chemical dispersal.

Mechanical Harvesting

The District operates two Aquarius Systems brand harvesters on the Lakes: one Model HM-420 and one Model HM-820. These full-size harvesters are well suited to open water areas where water is generally greater than 36-inches deep. Additionally, the District is considering acquiring a mini harvester such as an Aquarius Systems Model FB-120 to allow it to efficiently harvest plants in shallow and/or congested nearshore areas. The Model FB-120 can be operated in as little as 18 inches of water and, due to its smaller size, is very maneuverable. In shallow waters, slow speed operation and extreme diligence must be taken to avoid contacting the lake bottom with the cutter head. Table 3.1 lists these vessels' draft, effective cutting width, and cutting depth capability as specified by Aquarius Systems.[66] In all areas, at least one foot of living plant material must remain attached to the lake bottom after cutting.

Since the two lakes have very different morphometry, some of the tactics to implement aquatic plant harvesting on each lake are quite different. Unique tactics for each lake are described in more detail below.

- Upper Phantom Lake. The proposed mechanical harvesting tactics are very similar to those incorporated into the previous plan. The only substantive changes is conformance with the mechanical harvesting ban in most of the sensitive area in the southeast corner of the Lake (see Map 3.1).

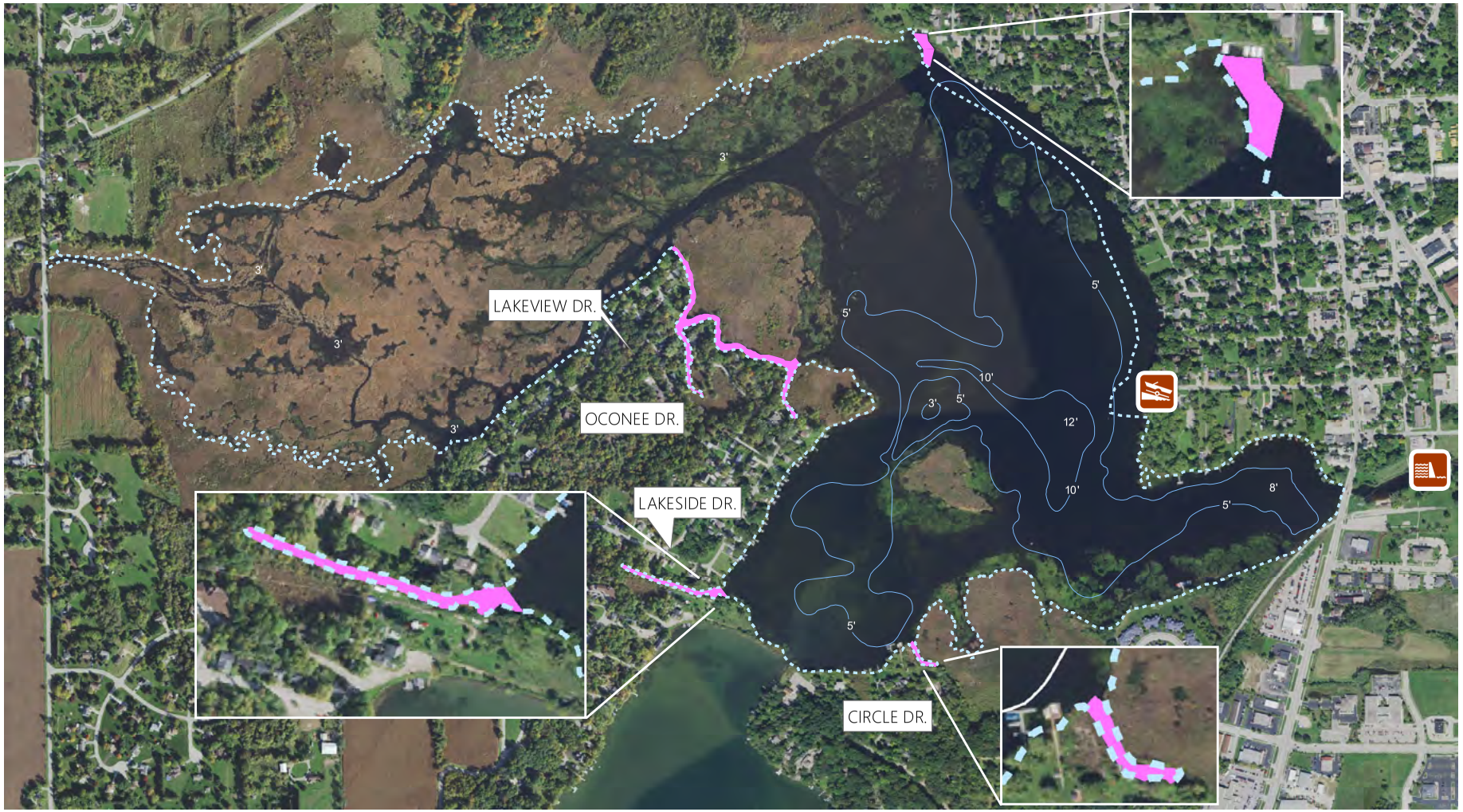
- Lower Phantom Lake. The approximate orientation and extent of proposed harvesting lanes in the main body of Lower Phantom Lake are similar those published in the 2012 aquatic plant management plan.[67] The general locations of harvesting lanes are schematically illustrated on Map 3.2. The precise locations of the harvest lanes must be chosen carefully and must be maintained in a fixed position throughout the year to avoid unintentional disturbance to adjacent sensitive areas. Lane position should consider water depth, plant species present, lane use, and boating habits/practices on the Lakes. For example, whenever possible, lanes should favor deeper water areas, should support the Lake's recreational uses, and should attempt to focus plant harvest on invasive species.

  Navigation channels extend varying distances from the main body of the Lake into heavily vegetated riparian areas (see Map 3.3). These areas include the peninsula in the west-central portion of the Lake near Lakeview and Oconee Streets, near the Lakeside and Circle Drives close to the channel connecting Upper and Lower Phantom Lake, and in the northeast corner of the Lake near the west end of Lake Street. The District's existing harvesting equipment is too large to be suitable in these channels, but a small-scale mechanical harvester may be used provided water depths are sufficient.

[66] *Email from Travis Webb (Aquarius Systems) to Dale Buser (SEWRPC), Harvester Info – Aquarius, May 14, 2019.*

[67] *SEWRPC CAPR 230, op. cit.*

Map 3.3
Small Harvester Only Lanes on Lower Phantom Lake: 2019



SENSITIVE AREA NAVIGATION EXCEPTIONS:
SMALL HARVESTER ONLY

– 20' – WATER DEPTH CONTOUR IN FEET
BOAT LAUNCH
DAM
AQUATIC PLANT UNLOAD SITE
SENSITIVE AREA DELINEATION

Note: This map is referred to as Map 17 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit. The extent of implementation among these areas will depend on available staff, time, budget, and plant growth characteristics within a given season. Management area size and locations are not scaled and only illustrate overall concept. See "Aquatic Plant Management Recommendations." Bathymetry contours sourced from WDNR historical lake map created in 1964. These are not for navigation.

Not to Scale
Source: WDNR and SEWRPC.
DATE OF PHOTOGRAPHY: APRIL 2015

Landowners may also choose to employ DASH or nearshore dredging in these areas. Water depth increases related to dredging may allow additional channel areas to be mechanically harvested.

According to information shared at public meetings, the extent of the environmentally sensitive area in the northeast corner of Lower Phantom Lake will be slightly reduced allowing more active management along a small stretch of additional shoreline. Additionally, generalized aquatic plant harvesting for EWM control in the central portion of Lower Phantom Lake is no longer recommended.

Full-size harvesters must not be operated nearshore in water less than 36 inches feet deep. Mechanical harvesting may possibly be expanded in shallow, obstacle-prone nearshore areas throughout the Lakes if a small-scale harvester is available. Even though the District's harvesters may be able to navigate in waters in as shallow as 12 inches when empty, at least 12 inches of plant growth should remain standing after harvesting. Therefore, aside from regulatory restrictions, mechanically harvesting aquatic plants in extremely shallow water (e.g., areas with less than 18 inches of water depth) is not practical. Additional information regarding cutting patterns and depth is provided in the following paragraphs.

a. **Harvesting may begin as early as May 15th and may extend as late as October 15th.** Harvesting may occur in most areas throughout the season, however the northern-most 50-foot wide lane crossing Lower Phantom Lake may not be harvested until after June 15th of each year. To avoid recreational lake-use conflict and promote safety, active harvesting work should occur only during daylight hours and should attempt to avoid high lake-use days and hours. For example, active harvesting should attempt to avoid weekends, holidays, and late afternoons when lake use is often greatest in the Region. Harvesting is anticipated to occur up to five days per week and up to eight hours per day. Harvesting schedules, cutting patterns, and overall intensity will need to be modified to protect spawning fish, selectively target invasive and nuisance plant growth, and promote/protect native plant growth. Finally, to reduce in-lake sedimentation, harvest heavily in September.

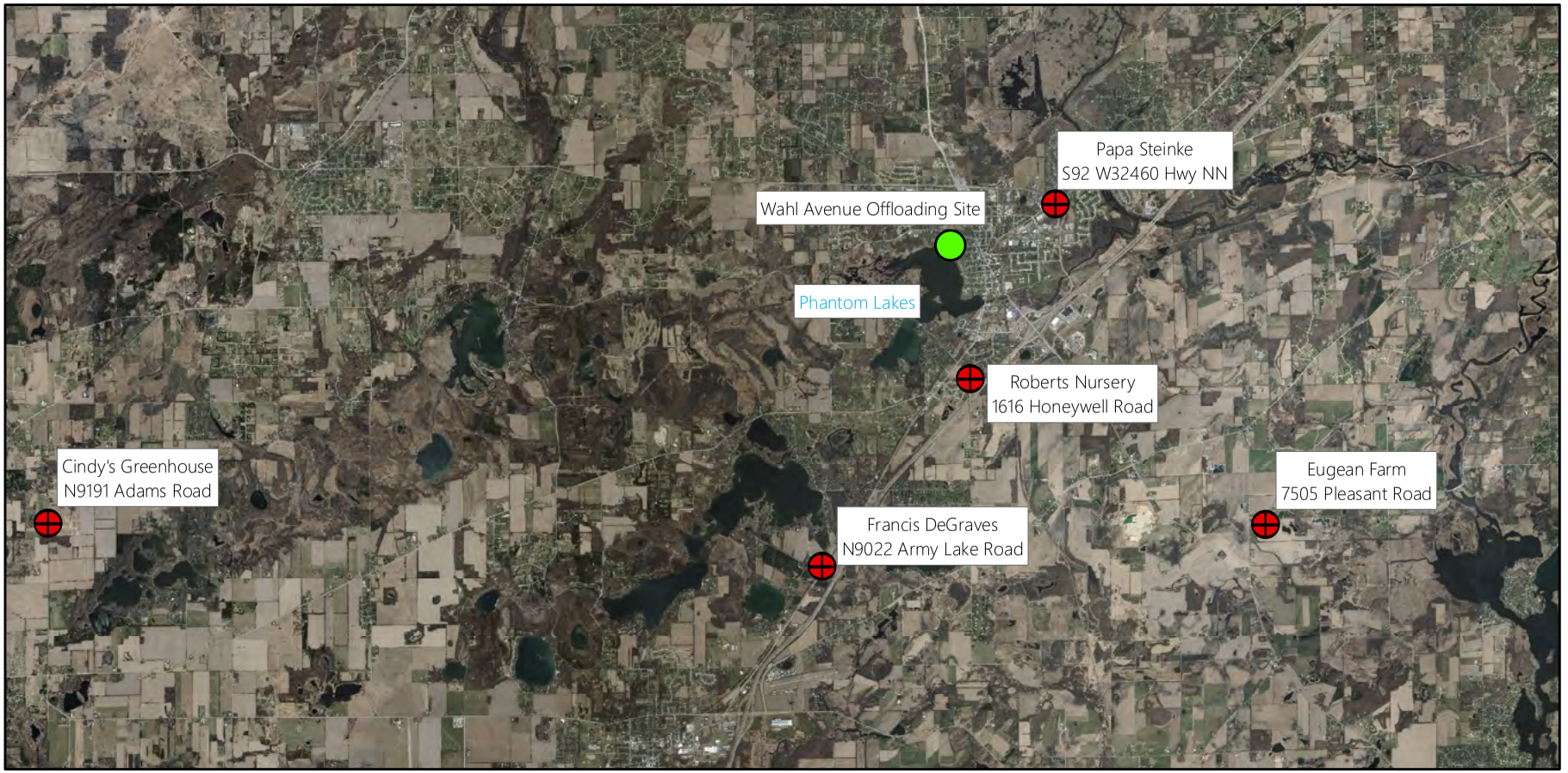
b. **Maintain at least 12 inches of living plant material after harvesting.** The District's current aquatic plant harvesters can cut aquatic plants up to 66 inches below the water surface. Harvesting equipment operators must not intentionally denude the lakebed. Instead, the goal of harvesting is to maintain and promote healthy native aquatic plant growth. Harvesting invasive aquatic plants can promote native plant regrowth since many invasive aquatic plants grow very early in the season depriving later emerging native plants of light and growing room.

   Maintaining aquatic plant beds in the Lakes, especially those dominated by native aquatic plants, is warranted and consistent with overall program goals given the importance of angling, high wildlife value, and the Lake's morphology causing portions of the Lakes to not be conducive to extensive motorized boat traffic. At least one foot of living plant material must be retained after harvesting to reduce resuspension of lake-bottom sediments and to maintain desirable plant communities, such as those dominated by the low-growing *Chara* spp. When water depths are shallow (e.g., less than four or five feet deep), slow speed and extreme care must be employed while harvesting aquatic plants to avoid contacting the harvester's cutter head with the lake bottom.

c. **Collect and properly dispose harvested plants and collected plant fragments.** Plant cuttings and fragments must be immediately collected upon cutting to the extent practicable. Plant fragments accumulating along shorelines should be collected by riparian landowners. Fragments collected by the landowners can be used as garden mulch or compost or may be picked up by harvester operators (see point d).

   All plant debris collected from harvesting and riparian landowner plant pickup must be properly disposed. Harvested/collected plant material will be offloaded at Wahl Avenue (Map 3.4). Plant material will be removed from the harvester, deposited on a transporter, and conveyed to the off-loading area. A conveyor will transfer plant material to a dump truck that will in turn transport harvested plants to a disposal site. The locations of the currently approved disposal sites are shown in

Map 3.4
Phantom Lakes Harvested Plant Offloading and Disposal Sites



Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: This map is referred to as Map 13 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

Map 3.4. Detailed maps of each disposal site are found in Maps 3.5, 3.6, 3.7, 3.8, and 3.9.[68] Disposing any aquatic plant material within identified floodplain and wetland areas is prohibited.

Plant material will be collected and disposed daily to reduce undesirable odors and pests, to avoid leaching nutrients back into waterbodies, and to minimize visual impairment of lakeshore areas. Operators will stringently police the off-loading to assure efficient, neat operation.

d. **Implement a regularly scheduled aquatic plant pickup program.** Aquatic plant harvesting and powerboating are prime examples of human activities that fragment plants. Plant fragments generated by harvesting, boating, severe weather, and other factors may float in the Lake, may accumulate along shorelines, and may encourage spread of undesirable plants. For these reasons, the harvesting program should integrate a comprehensive plant pickup program for all riparian property owners that in turn helps assure that harvesting does not create a nuisance for Lake residents. The program includes riparian property owners gathering plant fragments along their shorelines, placing gathered plants in a pile in a convenient location accessible to the harvester (e.g., the end of a pier), and the harvester operators adhering to a regular pickup schedule. This effort should be as collaborative as practical and harvester operators should consider focusing pickup efforts after weekends, holidays, and other periods of high boat traffic or intense harvesting activity. Additionally, the eastern shorelines of lakes are often most prone to accumulate plant fragments due to prevailing wind patterns.

e. **Establish Supplemental Plant Material Transfer Site(s).** District staff should investigate the potential for establishing a supplemental harvester off-loading site on the southern sides of the Lakes to reduce equipment transit times to offload areas. Supplemental offloading sites can boost harvesting efficiency, reduce lake traffic and affiliated lake use conflicts, and can lower equipment operating costs through reduced fuel and maintenance demands. Should suitable off-loading site(s) be identified, active use of new site(s) is incorporated into this plan.

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

- Transit Lanes: Channels about 30- to 75-feet wide, or approximately three to ten full-size harvester widths wide, are intended to provide travel thoroughfares for recreational watercraft. These channels generally parallel the shoreline or cross a lake. Plant cutting depths vary from 18 to 66 inches, as water depth allows. At least one foot of plant material must remain on the Lake bottoms to minimize resuspension of lake-bottom sediment and maintain desirable plant communities.

- Habitat Areas: Areas of the Lakes that are either very shallow and/or that have a predominantly marsh-like character. In Lower Phantom Lake, this includes the entire Lake aside from a 150-foot wide strip between the public boat launch and approximately the westerly terminus of Lake Street. Habitat areas help protect the Lakes' water quality and sustain important biological functions. They should be protected from human aquatic plant intervention except where necessary to provide targeted navigational access (e.g., allow lake access to riparian property owners, transit lanes to allow boaters access to portions of the Lakes more suitable to general navigation). Habitat areas should be monitored for the presence of invasive plants. Purple loosestrife infestations should be actively controlled, invasive plant populations should be monitored, and action may be needed to combat newly established types of invasive aquatic plants. Additional litter collection efforts will probably be required in these areas to maintain their aesthetic appeal.

[68] *The aquatic plant disposal sites at Cindy's Greenhouse (Map 3.8) and Eugean Farms (Map 3.9) were disclosed during the development of the mechanical harvesting permit and were not included in previous drafts of this report.*

Map 3.5
Papa Steinke Aquatic Plant Disposal Site

WETLANDS

PROPERTY BOUNDARY

N

0 200 400 Feet

Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: This map is referred to as Map 14 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

There are no one-percent-annual-probability (100-year recurrence interval) floodplains within the mapped area.

Map 3.6
Roberts Nursery Aquatic Plant Disposal Site

WETLANDS

PROPERTY BOUNDARY

N

0 200 400 Feet

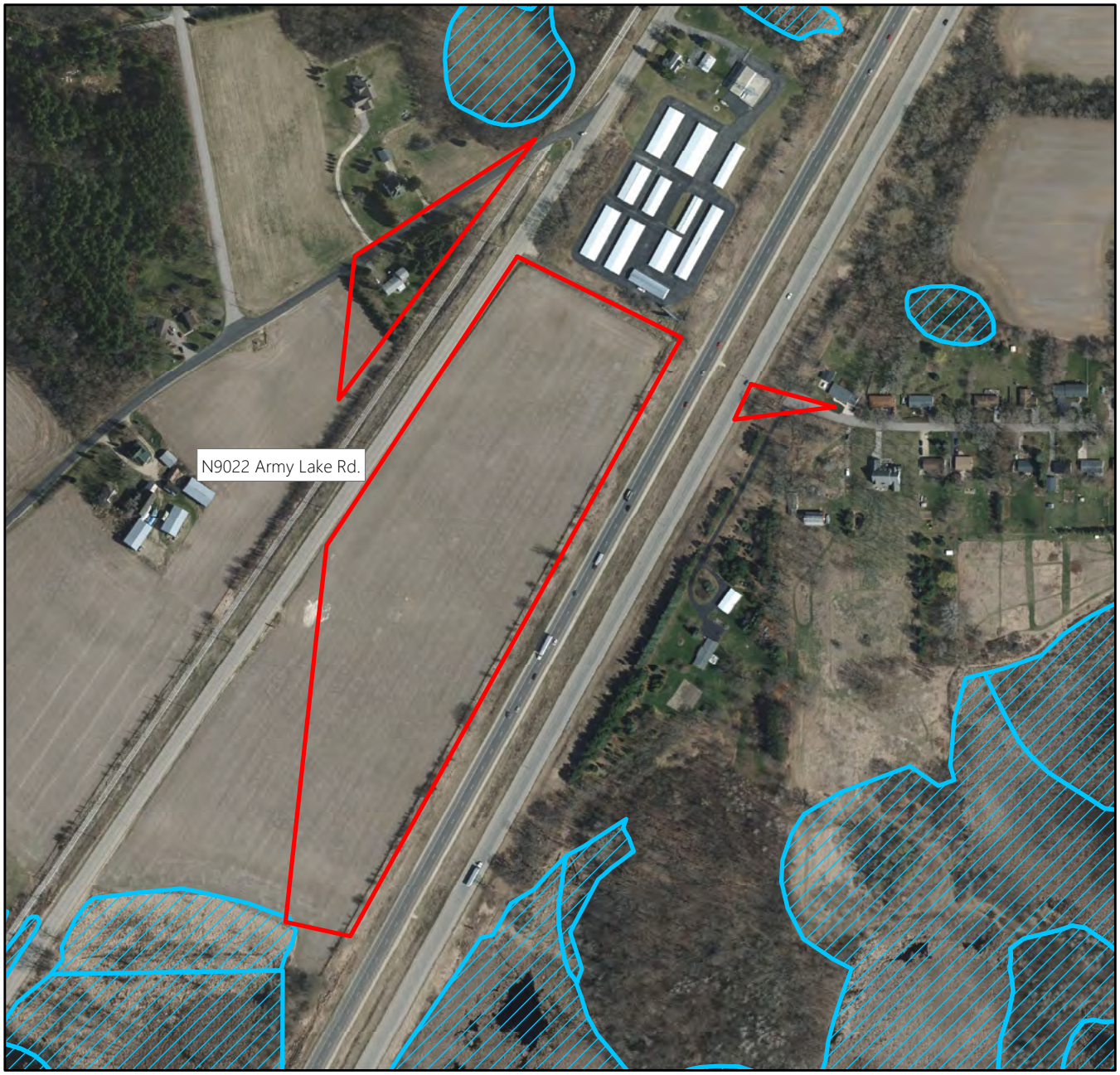
Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: This map is referred to as Map 15 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

There are no one-percent-annual-probability (100-year recurrence interval) floodplains within the mapped area.

Map 3.7
Francis DeGraves Aquatic Plant Disposal Site



Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: This map is referred to as Map 16 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

There are no one-percent-annual-probability (100-year recurrence interval) floodplains within the mapped area.

Map 3.8
Cindy's Greenhouse Aquatic Plant Disposal Site

WETLANDS

PROPERTY BOUNDARY

N

0 270 540 Feet

Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: Note: This map is referred to as Map 18 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

There are no one-percent-annual-probability (100-year recurrence interval) floodplains within the mapped area.

Map 3.9
Eugean Farms Aquatic Plant Disposal Site

WETLANDS

PROPERTY BOUNDARY

N

0 190 380 Feet

Date of Photography: April 2015

Source: Phantom Lakes Management District, Wisconsin Department of Natural Resources, and SEWRPC

Note: Note: This map is referred to as Map 19 in the 2019 – 2023 Mechanical / Manual Aquatic Plant Control permit.

There are no one-percent-annual-probability (100-year recurrence interval) floodplains within the mapped area.

- Mixed-Use Areas: These areas are found only in open water portions of Upper Phantom Lake outside of sensitive areas where water depth is anticipated to support rooted aquatic plant growth. Aquatic plants should be monitored for the presence of invasive species, and mechanical harvesting work should focus on areas dominated by invasive species or needed to promote reasonable recreational use of the Lake. Areas dominated by native aquatic plants and not required for reasonable Lake access and use should be left unaltered.

- Open Water Areas: Deep-water areas of Upper Phantom Lake where water depth precludes growth of vascular rooted aquatic plants. No control should be necessary in these areas. These areas are prime locations for high-speed boating, and are intended to be linked to boating transit and access channels.

- Shoreland Areas: Areas immediately adjacent to piers and docks along developed shorelines. To the extent practical, aquatic and riparian vegetation should be maintained. Plant management within shoreland is recommended to be left to the riparian landowners - exemptions allow some landowners to manage plants along their own shorelines. Since shoreland areas are generally densely populated, it is time consuming, difficult, and costly for mechanical harvesters to maneuver between piers and boats, a situation that may also generate liability for damage to boats and piers. If a small-scale harvester is acquired, it may be used in shoreland areas provided that water depths are greater than 18 inches and that at least 12 inches of living plant material is maintained on the lake bottom after cutting.

- Beach Use Areas: Similar to shoreland areas, except that most aquatic and riparian vegetation is removed.

g. **Avoid harvesting muskgrass and other high-value aquatic plants and focus harvesting efforts on invasive aquatic plant growth.** To reduce the risk for water quality degradation, special effort should be taken to avoid cutting muskgrass wherever and whenever possible. Conversely, harvesting intensity should be increased during times of the year (i.e., spring and early summer) when invasive aquatic plant growth predominates and within areas where invasive species are most abundant. For example, curly leaf pondweed may be particularly abundant early in the cutting season but is largely absent by midsummer, a growth cycle that may require changes to harvesting routes and schedules over the season.

h. **Limit aquatic plant management and human disturbance in designated sensitive areas.** With the exception of the nearshore areas of Lower Phantom Lake near the Village of Mukwonago, the majority of Lower Phantom Lake is WDNR-designated sensitive area. The shallow southeastern bay of Upper Phantom Lake is also a WDNR-designated sensitive area. Delineation/management reports for these environmentally sensitive areas are included in Appendix D. Management approaches within these areas are summarized below.

    - Within Upper Phantom Lake Sensitive Area Number One, the WDNR will consider, on a case-by-case basis, use of aquatic herbicides to control pioneer stands of nonnative plants, prohibits mechanical harvesting and physical aquatic plant control measures such as placement of aquatic plant screens and dredging, and restricts placement of piers and other shoreline work.

    - Within Lower Phantom Lake Sensitive Area Number One, which encompasses much of the main basin of Lower Phantom Lake but excludes portions of the eastern shoreline, the WDNR will consider, on a case-by-case basis, use of aquatic herbicides to control pioneer stands of nonnative plants, limits mechanical harvesting to navigational channels which may be harvested only after fish spawning is complete, prohibits aquatic plant screens, and restricts shoreline work.

    - Within Lower Phantom Lake Sensitive Area Number Two, which comprises the southernmost portion of the main basin of Lower Phantom Lake, use of aquatic herbicides is not generally recommended. Furthermore, the WDNR limits mechanical harvesting to navigational channels after fish spawning is complete, prohibits aquatic plant screens, prohibits rip rap on undeveloped shoreline or wetland filling, and restricts many forms of shoreline work.

- Within Lower Phantom Lake Sensitive Area Number Three, which is located on the west end of the Lake near the mouth of the Mukwonago River, the WDNR prohibits herbicide treatments, limits aquatic plant harvesting to one navigational lane along developed shoreline to the main lake, allows dredging to maintain this navigational channel, and limits shoreline work.

As noted in other portions of this plan, applying aquatic plant management measures in each of these areas is subject to State of Wisconsin permitting requirement pursuant to Chapters NR 107 and NR 109 of the *Wisconsin Administrative Code*, and the specific recommendations described in this SEWRPC memorandum report.

i. **Adapt harvesting patterns and schedules to ambient conditions.** Operators shall be provided with a laminated copy of the approved harvesting plan. A copy of the plan shall be kept on board the harvester at all times. Harvester operators must fully understand that aquatic plant management maps are schematic in nature and care must be taken to choose harvester routes that best accomplish overall plan objectives (e.g., favor deeper water areas). In any case, mechanical harvesters will not be operated in the marshy western reaches of Lower Phantom Lake (except for maintaining the defined access channels and boating transit areas described above) to prevent disturbing wetland and excessively shallow areas and to protect fish and wildlife habitat and sediment/nutrient traps. Harvesting should not commence in areas identified as suitable for sport fish spawning until June 15th or when fish spawning activity is no longer noted.[69] This harvest prohibition is extended to June 15th during all years in the lane crossing the northern portion of Lower Phantom Lake.

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

k. **Using marker buoys and landmarks.** Temporary marker buoys may benefit harvesting operations by denoting areas to be cut. However, the modest size of the Lakes and the presence of numerous shoreline landmarks generally reduces the need for marker buoys except as may be required to alert and control recreational boat traffic. Harvester operators must be familiar with the intent and execution logistics related to harvesting. Familiarity with local landmarks to the degree necessary to carry out the plan and/or use of marker buoys is component to this endeavor.

l. **Active outreach.** District staff will endeavor to maintain active dialogue with riparian landowners, the lake user community, regulators, and other interested partied. This dialogue may be promoted through public meetings, newsletters, newspaper articles, public notices, and on-line resources such as the District's webpage. In addition, the District holds regular public meetings which are appropriately noticed. Where necessary, personal contact to select parties may be warranted.

m. **Insurance, maintenance, repair, and storage.** Appropriate insurance covering the harvester and ancillary equipment will be incorporated into the District's policy. The District will provide liability insurance for harvester operators and other staff. Insurance certificates will be procured and held by the District. Routine day-to-day equipment maintenance will be performed by the harvester operator or other individuals identified by the District in accordance with the manufacturer's recommendations and suggestions. To this end, harvester operators shall be familiar with equipment manuals and appropriate maintenance/manufacturer contacts. Operators will immediately notify District staff of any equipment malfunctions, operating characteristics, or sounds suggesting malfunction and/or

[69] *Considering the timing of aquatic plant harvesting and the fish community of the Phantom Lakes, bass and panfish would be the most likely fish spawning in the areas subject to aquatic plant harvesting. These fish spawn in well-defined circular sandy or gravelly nests ("redds") which are typically visible from the water surface. Adult fish fan and guard these nests, actions that can make them readily visible. Harvester operators should actively scan the lake bottom for the presence of active redds and avoid harvesting areas where redds are present until spawning is completed, eggs hatch, and adults disperse.*

the need for repair. Equipment repair beyond routine maintenance will be arranged by the District. Maintenance and repair costs will be borne by the District. The District will be responsible for properly transporting and storing harvesting equipment during the off season.

n. **Management, record keeping, monitoring, and evaluation.** District staff manage harvesting operations, and, although they may delegate tasks, are ultimately responsible for overall plan execution and logistics. Nevertheless, daily harvesting activities will be documented in writing by the harvester operator in a permanent harvester operations log. Harvesting patterns, harvested plant volumes, weed pickup, plant types, and other information will be recorded. Daily maintenance and service logs recording engine hours, fuel consumed, lubricants added, oil used, and general comments will be recorded. Furthermore, this log should include a section to note equipment performance problems, malfunctions, or anticipated service. Monitoring information will be summarized in an annual summary report prepared by the District, submitted to the WDNR, and available to the general public. The report will also present information regarding harvesting operation and maintenance, equipment acquisitions and/or needs, expenditures, and budgets.

o. **Logistics, supervision, and training.** Harvesting equipment is owned and operated by the District. District staff or designated board members are responsible for overall harvesting program oversight and supervision. Although District staff are ultimately responsible for equipment operation, they may delegate tasks to competent individuals when technically and logistically feasible. The District must assure such individuals are appropriately trained to successfully and efficiently carry out their respective job functions. For example, District members/staff likely have extensive experience operating and maintaining harvesting equipment and have detailed knowledge of lake morphology, plant growth, and overall lake biology. These individuals should actively share this knowledge through an on-the-job training initiative. The equipment manufacturer may also be able to provide advice, assistance, and insight regarding equipment operation and maintenance.[70] Boating safety courses are available through many media and are integral to individuals involved with on-the-water work.

   All harvester operators must successfully complete appropriate training, must be thoroughly familiar with equipment function, must be able to rapidly respond to equipment malfunction, must be familiar with the Lake's morphology and biology, and must recognize landmarks to help assure adherence to harvesting permit specifications and limitations. Additionally, harvester operators must be able to recognize the various native and invasive aquatic plants present in the Lakes. Such training may be provided through printed and on-line study aids, plant identification keys, and the regional WDNR aquatic species coordinator as well as the Washington/Waukesha County aquatic invasive species coordinator.[71]. At a minimum, training should:

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

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

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

   - Help operators identify WDNR-designated sensitive areas and be well-versed regarding the aquatic plant management restrictions therein

[70] *The DISTRICT's equipment as of May 2019 was manufactured by Aquarius Systems, A Division of D&D Products, Post Office Box 215, 200 North Harrison Street, North Prairie, Wisconsin 53153, telephone (262) 392-2162, www.aquarius-systems.com.*

[71] *Washington and Waukesha Counties jointly sponsor a unique program that employs individuals to help control aquatic invasive species in the Counties' waterbodies. More information about this program may be found at either the Washington or Waukesha County website. Waukesha County's information can be viewed at: www.waukeshacounty.gov/AIS/?utm_source=Aquatic+Invasive+Species+Update&utm_campaign=AIS+December+2018+Update&utm_medium=email.*

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

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

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

Riparian Nearshore Navigational Dredging

The Lakes' nearshore waters are very shallow in many well developed areas, a situation impeding navigation, hindering lake access, and deterring nuisance aquatic plant harvesting in some highly used areas. If water depths were slightly deeper in portions of these critical areas, navigation, riparian lake access, and nuisance aquatic plant management could be significantly enhanced to better meet the stated needs of lake users, particularly riparian landowners. This situation is particularly pronounced in Lower Phantom Lake.

Historically, dredging is typically a complicated and expensive process. Wisconsin recently simplified the process that allows owners of shoreland property to increase water depth in contiguous waterbodies for navigational or recreational purposes. Several general permits are available to allow riparian landowners to remove sediment from lake and stream beds. These general permits include the following:

- General permit for small scale dredging of lakes and streams, permit number GP17-2017-WI (WDNR-GP17-2017), issued June 30, 2017, expiring June 30, 2022

- General permit to remove accumulated plant and animal nuisance deposits from the beds of navigable waters, permit number GP5-2018-WI (WDNR-GP5-2018), issued September 18, 2018, expiring September 18, 2023

- General permit for riparian navigational dredging of man-made impoundments, WDNR-GP20-2018, issued September 27, 2018, expiring September 23, 2023

All general permits are subject to many eligibility requirements. Several of these eligibility requirements are similar between all three general permits. Examples of some of the common eligibility requirement themes are listed below.

- The applicant must be the riparian landowner or someone given permission by the riparian landowner

- Action must be taken to protect fish

- Action must be taken to prevent releasing sediment to waterbodies

- Dredge spoils must not be disposed in floodplains and wetlands

Given the limited water depth along portions of the lakeshore (particularly in Lower Phantom Lake) and the Lake's characteristics, the general permit which may be of most interest to the District is general permit WDNR-GP20-2018, *General permit for riparian navigational dredging of man-made impoundments*, a copy of which is included in Appendix E. The WDNR identifies both Lower and Upper Phantom Lake as eligible for this general permit. This general permit allows a riparian property owner to remove up to 50 cubic yards of bed material per year for the purpose of allowing shoreland property owners to navigate from their

shoreline to the "line of navigation".[72] Over two dozen standards must be met for a project to be eligible for the general permit, including the following highlights.

- While up to 50 cubic yards may be removed per year, no more than 250 cubic yards may be removed over multiple years.

- Dredging must be confined to the property owner's riparian zone within a 30 foot wide channel and must not extend farther into the lake than the line of navigation.

- Dredging is completed to maintain or improve navigation and only removes "unconsolidated bed" material such as clay, silt, sand, and muck. Unconsolidated sediment, for the purpose of this permit, does not include gravel, rock, cobbles, or bedrock.

- The permit applicant must have permission of the riparian landowner and, if applicable, the owner of the flowage bed, to remove bed material.

- Dredging associated with mining projects, sale or lease of dredged material, or which proposes in-water disposal of dredge spoil are ineligible.

- Aquatic plants may be removed incidental to dredging without an additional aquatic plant permit as required under *Wisconsin Administrative Code* Chapter NR 109 "Aquatic Plants: Introduction, Manual Removal and Mechanical Control Regulations" provided that aquatic plants are removed solely within a single area no more than 30 feet wide. Piers, boatlifts, and any other navigational aids must be located within this 30 foot wide zone.

- Dredge spoil may not be temporarily or permanently placed in wetlands, floodplains, or below the ordinary high water mark of a waterbody.

- Dredging work must prevent dispersal of sediment beyond the dredging project area.

- Dredging shall not remove fallen trees, woody debris, or WDNR-approved fish habitat structures.

- Projects that involve removal of contaminated or potentially contaminated sediment or sediment, or caps, barriers, or other engineered controls related to remediation of contamination, may be ineligible for this permit or may require submittal of additional information. It should be noted that shooting range projectile fallout areas are included in the contaminated definition and are ineligible for the general permit.

To defray the oftentimes great expense and technical challenges of dredging, riparian landowners in other lakes have worked collectively. For example, riparian property owners along a stretch of shoreline may each contribute to a project that provides each property a common navigable channel leading to the lake.

Riparian landowners have another option to remove small volumes of material from lakebeds. As stated in *Wisconsin Administrative Code* Chapter 345 "Dredging in Navigable Waterways," riparian landowners are exempt from permitting for small scale projects that rely solely on hand-held devices and that do not employ the aid of external or auxiliary power. Each riparian landowner may remove up to one foot in depth of bed material from up to 100 square feet of bed each year. Dredge material may not contain hazardous substances and may not be temporarily or permanently stored in wetlands, floodplains, or below the ordinary high water mark of navigable waterways. Erosion must be controlled as part of the project. This exemption does not apply in areas of special natural resource interest, within a public rights feature, or in perennial trout streams.

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[72] *The line of navigation is defined as the water depth contour where water is three feet deep or the depth required to operate a boat demonstrated to need more than three feet of water. Water depths are based upon normal summer low water levels or, when a water level order has been established, the low water level. Alternately, when a municipality has adopted a pierhead line under Chapter 30, "Navigable Waters, Harbors and Navigation," of the* Wisconsin Statutes *the line of navigation is the municipal pierhead line.*

Dredging profoundly disturbs lake-bottom sediment and removes most, if not all, ambient plant material. The bare bottom sediment will eventually be recolonized by plants. Unfortunately, invasive plants such as EWM and curly-leaf pondweed aggressively colonize disturbed areas. Disturbance from dredging may cause invasive and nuisance plants to spread to new areas and grow more prolifically, particularly if dredging is repeated frequently. Thus, dredging should be infrequent and confined to the smallest areas needed to enhance or maintain navigation.

Nearshore Manual Aquatic Plant Removal

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

Hand-pulling EWM and curly-leaf pondweed is considered a viable option in the Phantom Lakes and should be employed wherever practical. Volunteers or homeowners could employ this method, as long as they are properly trained to identify EWM, curly-leaf pondweed, or any other invasive plant species of interest. WDNR provides a wealth of guidance materials (including an instructional video describing manual plant removal) to help educate volunteers and homeowners.

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

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

Any other manual removal technique requires a State permit, unless specifically used to control designated nonnative invasive species such as Eurasian water milfoil. Mechanical equipment (e.g., dragging equipment such as a rake behind a motorized boat or the use of weed rollers) is not authorized for use in Wisconsin at this time. Nevertheless, riparian landowners may use mechanical devices to cut or mow exposed lakebed. Furthermore, purple loosestrife may also be removed with mechanical devices if native plants are not harmed and if the control process does not encourage spread or regrowth of purple loosestrife or other nonnative vegetation.

Permits are also required if shoreland property owners abut a sensitive area or if another group actively engages in such work.[73] Most of Lower Phantom Lake's shoreline and the southeastern bay in Upper Phantom Lake are designated sensitive areas, and a permit is therefore required to manually remove aquatic plants in many shoreline areas around the Lakes.

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

Prior to the hand-pulling season, shoreline residents should be reminded of the utility of manual aquatic plant control through an educational campaign. This campaign should also foster shoreline resident awareness of native plant values and benefits, promote understanding of the interrelationship between aquatic plants and algae (i.e., if aquatic plants are removed, more algae may grow), assist landowners in identifying the types of aquatic plants along their shorelines, and familiarize riparian landowners with the specific tactics they may legally employ to "tidy up" their shorelines.[74]

Suction Harvesting and DASH

Suction harvesting may be a practical method to control aquatic plants if dredging is warranted, but it is not likely to be a cost-effective, environmentally friendly, or practical method to manage aquatic plants alone. For this reason, suction harvesting is not practical for widespread application at the Lakes. However, it may provide a practical alternative in excessively shallow nearshore areas where increased water depth could meaningfully improve navigability (e.g., narrow access channels connecting lots without open-water frontage to Lower Phantom Lake).

Given how time consuming and costly DASH can be to employ, and given the prevalence of invasive and nuisance plant growth across the Lakes, DASH will never likely be a primary component of the District's general nuisance and invasive plant management strategy. Nevertheless, some lake districts have employed DASH to aggressively combat small-scale pioneer infestations of invasive species. The District may wish to consider using DASH should such a situation arise in the future. Furthermore, DASH may also be considered as a temporary solution to remove nuisance plants in nearshore areas until a mini-harvester is acquired. Therefore, using DASH in specialized spot applications is component to this plan.

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

Chemical Treatment

Considering the large expanse of EWM in the eastern basin of Lower Phantom Lake and the cost of chemical treatment, a whole-lake treatment, or large spot treatment in that basin, is not recommended.[75] This is also supported by the efficiency and effectiveness of the ongoing harvesting operation, along with this approach's added benefit to the ecology and water quality of the Lakes compared to chemical application. However, small spot treatments enclosed with a barrier (e.g., turbidity barrier) could be a viable alternative for treating shoreline areas and navigation lanes if determined feasible by the District. Whatever the case, monitoring should continue to ensure that EWM does not become more problematic. If further monitoring suggests a dramatic change in these invasive species populations, management recommendations should be reviewed.

3.2 SUMMARY AND CONCLUSIONS

As requested by the District, The Commission worked with the District to develop a scope of work and secure funding to provide information useful to short- and long-term lake management. While the primary motivation for this effort was to gather information needed to renew the District's aquatic plant management permit, the District also requested that the Commission update water quality and quantity information. This report, which documents the findings and recommendations of the study, examines existing and anticipated conditions, potential aquatic plant management problems, and lake-use. Conformant with the study's intent, the plan includes recommended actions and management measures for the resolution of those problems. Maps 3.1 and 3.2 summarize and generally locate where aquatic plant management recommendations should be implemented.

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

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

This document is intended to inspire and guide ideas and actions. The recommendations should, therefore, be considered a starting point for addressing issues identified in the Phantom Lakes and their watersheds. Successfully implementing this plan will require vigilance, cooperation, and enthusiasm, not only from local management groups, but also from State and regional agencies, Waukesha and Walworth Counties, municipalities, and residents/users of the Lakes. The recommended measures help foster conditions sustaining and enhancing the natural beauty and ambience of the Phantom Lakes ecosystems while promoting a wide array of water-based recreational activities suitable for the Lakes' intrinsic characteristics.

APPENDICES

MECHANICAL/MANUAL AQUATIC PLANT CONTROL PERMIT FOR PHANTOM LAKES

APPENDIX A

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
Waukesha Service Center
141 NW Barstow Street Room 180
Waukesha WI 53188

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

July 10th, 2019

Phantom Lakes Management District
P.O. Box 391
Mukwonago, WI 53149

Subject: 2019-2023 Harvesting Permit
SE-2019-68-5219M

Dear Phantom Lakes Management District,

The Department has received your application for your Mechanical / Manual Aquatic Plant Control permit to mechanically harvest aquatic plants in a maximum of 87 acres in Upper and Lower Phantom Lakes, Waukesha County. We have found your application to be complete and you are being issued a 5 year permit with conditions that expire December 31st, 2023. It is recommended that a new plant survey be completed during the summer of 2023 in preparation for a new multiple permit application in 2024.

Attached is a copy of your permit with the conditions that must be followed. In addition, I have included a copy of our findings of fact and conclusions of law and your right to appeal our action. A copy of the permit must be kept on the harvester at all times during operation. Please read your permit conditions carefully so that you are fully aware of what is expected of you.

Your next step will be to notify me by email (Heidi.Bunk@Wisconsin.gov) when you plan to begin harvesting. If you have questions or concerns, I can be reached by email or at 262-574-2130.

Sincerely,

Heidi Bunk

Heidi Bunk
DNR Lakes Biologist

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

Permit for Mechanical Harvesting of Aquatic Plants

The Phantom Lakes Management District is hereby granted under Section 23.24, Wisconsin Statutes and Administrative Code NR 109, a permit to conduct mechanical harvesting of aquatic plants in 87 acres of Upper and Lower Phantom Lakes, located in Sections 26, 27, 34 and 35, Township 5 North, Range 18 East, Village of Mukwonago and Town of Mukwonago, Waukesha County. This permit is issued for a **five-year term** and will expire on December 31st, 2023. This permit is subject to the conditions below.

PERMIT CONDITIONS

1. You **must notify** Lakes Biologist Heidi Bunk (Heidi.Bunk@Wisconsin.gov) one working day prior to the anticipated starting date of the harvesting operation, and provide a harvesting schedule upon request. Department staff may schedule and conduct an onsite supervision of harvesting. This notification is required on an annual basis.

2. The quantity and species of plants to be mechanically harvested must be in accordance with the permit application.

3. The District will harvest up to 87 acres with the Town of Mukwonago and Village of Mukwonago. Specific location of channels should follow Maps 11, 12, and 17.

4. A copy of the permit and maps shall be maintained on board the harvester(s) at all times while harvesting operations are being conducted.

5. Harvesting operators shall be trained in the basic identification of aquatic plants.

6. Mechanical harvesting in Lower Phantom Lake will consist of 3 different channel widths. Map 12 denotes 30 foot transit lanes, 50 foot transit lanes, and a 75 foot transit lane. There is one additional 50 foot transit lane that may be cut after June 15th. A minimum of 12 inches of aquatic plant growth must remain at the bottom of the lake.

7. Harvesting in the areas indicated in Map 17 must be cut by a smaller harvester approved by the Department. A minimum of 12 inches of aquatic plant growth must remain at the bottom of the lake.

8. Harvesting in Lower Phantom Lake may not be conducted outside the designated channels denoted on Map 12.

9. Harvesting transit lines, as indicated on Map 12, may not take place in less than three feet of water in any area of Lower Phantom Lake. A minimum of 12 inches of aquatic plant growth must remain at the bottom of the lake.

10. Harvesting transit lines, as indicated on Map 11, may not take place in less than three feet of water in any area of Upper Phantom Lake. A minimum of 12 inches of aquatic plant growth must remain at the bottom of the lake.

11. Monotypic stands of Eurasian water milfoil and curly leaf pondweed may be cut in Upper Phantom Lake as described on Map 11 (Habitat and Mixed Use Area). Stands of native aquatic plants may not be cut. A minimum of 12 inches of aquatic plant growth must remain at the bottom of the lake.

12. Mechanical harvesting must follow the "top-cut" method to target the non-native aquatic plant growth present near the surface, while allowing for native aquatic plant communities to remain for habitat and sediment stabilization purposes.

13. The cutting bar and paddle wheels on the harvester shall not be set to disturb the bottom sediment in the lake. At no time shall harvesting remove all plant material down to the sediments.

14. All aquatic plants cut must be removed immediately from the water. Disposal of the harvested aquatic plants must be located in the areas specified in the harvesting permit application and must be in accordance with any applicable county and local regulations. Plants cannot be disposed of in a wetland or floodplain. The disposal sites are marked in Maps 13, 14, 15, 16, 18 and 19. The five approved sites for aquatic plant disposal include:

    Papa Steinke, S92 W32460 Hwy NN, Mukwonago, WI 53149
    Roberts Nursery, 1616 Honeywell Road, Mukwonago, WI 53149
    Francis DeGraves, N9022 Army Lake Road, East Troy, WI, 53120
    Cindy's Greenhouse, N9161 Adams Road, East Troy, WI 53120
    Eugean Farms, 7505 Pleasant Road, Waterford, WI, 53185

15. All mechanical harvesting records must be maintained and made available to the Department upon request. Annual reports summarizing harvesting activities shall be given to the Department **by November 1**. The annual report shall include information such as a map showing the areas harvested, the total acres harvested and the total amount of plant material removed from the body of water.

FINDINGS OF FACT

1. The Phantom Lakes Management District has filed an application for a permit to conduct a mechanical harvesting operation on Upper and Lower Phantom Lakes in Sections 26, 27, 34 and 35 of Township 5 North, Range 18 East, Village of Mukwonago and Town of Mukwonago in Waukesha County. The specific areas to be harvested are shown in the map(s) included as a formal a part of the permit.

2. The Department has determined the proposed mechanical harvesting will provide aquatic plant nuisance relief in the designated areas. The mechanical harvesting will allow for increased navigation and recreational opportunities.

3. The Department has determined that there will be no significant adverse impacts resulting from the mechanical harvesting of Upper and Lower Phantom Lakes if harvesting takes place in accordance with permit conditions.

4. The total harvesting area is up to 87 acres in the areas shown on the maps and referenced in the Aquatic Plan Management Plan as approved in the conditions above.

5. The Department has determined that a portion of the permitted harvesting area is in a Department designated Sensitive Area.

CONCLUSIONS OF LAW

The Department has authority under the above indicated Statutes and Administrative Codes, to issue a permit for mechanical harvesting of aquatic plants.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin Statutes and Wisconsin Administrative Code establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to Ss. 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed or otherwise served by the Department, to serve a petition within the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to Section 227.42, Wisconsin Statutes, you have 30 days after the decision is mailed or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review. This notice is provided pursuant to Section 227.48(2), Wisconsin Statutes.

Dated at Waukesha, WI July 10th, 2019

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES
For the Secretary

By Heidi Bunk
Heidi Bunk
DNR Lake Biologist

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Aquatic Plant Control Mechanical / Manual Permit Application

Form 3200-113 (R 10/16)

Notice: Pursuant to s. 23.24, Wis. Stats., the information requested on this form is required by the Department of Natural Resources (DNR) to permit aquatic plant control mechanical and/or manual application. Failure to complete and submit this form will result in no permit being issued. Personally identifiable information collected will be used for program administration and may be made available to requesters to the extent required under Wisconsin's Open Records law [ss. 19.31 - 19.39, Wis. Stats.].

For DNR Use Only	
Date Received 7/2/2019	ID Number SE-2019-68-5219M
Fee Received $300	County Code 68
Exp. Date 12/31/2023	WBIC 765800, 766000

Section I: Applicant Data

Permit Applicant Name	Applicant is:
Phantom Lakes Management District	☐ Private Individual ☐ Contractor
Applicant Mailing Address: PO Box 391	☑ Lake Organization (Specify) Phantom Lakes Management Di...

City	State	Zip	Lake Property Address (if different)	City	State	Zip
Mukwonago	WI	53149				

Phone Number xxx- xxx-xxxx	Email Address	Phone Number xxx- xxx-xxxx	Email Address
262-378-1267 x	gonefishing@phantomlakes.us	x	

Individuals and organizations (e.g. Lake District, Lake Association, Property Owners Association, County Department of Recreation), sponsoring removal.

Name	Address	Phone	Email Address
Phantom Lakes Management District	PO Box 391	262-378-1267	gonefishing@phantomlakes.u

Has a Lake Management plan been provided to the DNR?	If Yes, date approved of most current copy	Location of Applicant file copy
○ Yes ○ No ◉ Don't Know		

Does the proposed plant removal agree with the approved plan? ◉ Yes ○ No
If NO, explain, Attach additional sheets if necessary.

Is this area within or adjacent to a Sensitive Area designated by the Wisconsin Department of Natural Resources?
◉ Yes ○ No ○ Don't Know If yes, list sites:
attached

Waterbody of proposed plant removal	Lake Surface Area (acres):	County	Section	Township	Range
Upper & Lower Phantom Lakes	540	Waukesha	26	05 N	18 ◉ E ○ W

Name of Firm (if sub-contracted)	Phone Number xxx-xxx-xxxx	Extension:
NA	000-000-0000	

Street Address	City	State	Zip
NA	NA	WI	00000

Name of 1st Plant Disposal Site (if applicable)	1/4 1/4	1/4	Section	Township	Range	County
Cindy's Greenhouse N9161 Adams Road East Troy WI 53120	NE	SE		N	◉ E ○ W	Walworth
Name of 2nd Plant Disposal Site (if applicable)	1/4 1/4	1/4	Section	Township	Range	County
Four other sites: Papa Steinke Nursery, Robert's Nursery, Francis De Graves, Eugean Farms	...	...		N	○ E ○ W	

Length of project area 0 ft. x Shoreline or area width 0 ft. /43,560= 0.000 Estimated Acreage Avg. Depth 0 ft.

Offshore Control Site Length 0 ft. x Shoreline or area width 0 ft. /43,560= 0.000 Estimated Acreage Avg. Depth 0 ft.

TOTAL ESTIMATED ACREAGE 0.00 87

Section II: Location of Aquatic Plant Removal (cont.)

What type of aquatic plants below the Ordinary High Water Mark are proposed to be removed? (check all that apply)

☑ Emergent (above water level) ☑ Submergent (below water level) ☑ Floating Leaf (at the surface i.e. lily pads)

Section III: Map & Property Ownership

In the attachment section, attach a copy of a lake map that includes the property(s) to be harvested. On the map identify the following required information.

- Area and dimensions of each proposed plant removal area.
- Location of all riparian neighbors (property owners riparian to and adjacent to the proposed removal area) including project participants and non participants. Consecutively number ea riparian neighbor (both project participants and non-participants). In the space below:
- Name all riparian owners, including project participants & non-participants. The number should correspond with the numbered properties on the map. Attach additional sheets if neces
- Check Yes box to indicate project participants and No box for non-participants.

Name of Riparian Neighbor	Project Participant	Control Dimensions (calculated acreage)
see attached llist	○ Yes ◉ No	0.00

Section IV: Methods

What mechanical or manual methods to remove plants are proposed? (check all that apply)

☑ Mechanical harvesting ☐ Raking ☐ Other (specify)

☐ Hand Pulling ☐ Cutting ☐ Alum

If alum is proposed, has a plan been developed? ○ Yes ○ No If yes, please include the plan with this application.

Please explain why you selected the proposed cutting method(s).

Section VI: Reasons for Aquatic Plant Removal

Purpose of Aquatic Plant Removal:

☑ Maintain navigational channel for common use

☑ Maintain private boat access

☑ Maintain private access for fishing

☑ Improve Swimming

☑ Other Facilitate growth of native plants

Nuisance Caused By:

☑ Emergent water plants

☑ Submergent water plants

☑ Floating water plants

☐ Other

Name of plants, if known

Section VII: Integrated Pest Management (Alternatives Considered)

	A. Previously Done?	B. Presently Proposed?
1. Chemical	◉ Yes ○ No	○ Yes ◉ No
2. Dredging	○ Yes ◉ No	○ Yes ◉ No
3. Drawdown	○ Yes ◉ No	○ Yes ◉ No
4. Nutrient controls in watershed	○ Yes ◉ No	○ Yes ◉ No
5. Nutrient controls on property	○ Yes ◉ No	○ Yes ◉ No
6. Other	○ Yes ◉ No	○ Yes ◉ No

Note: Consider feasibility of alternatives for each control site. this information not only helps the department make a decision on this applicatio but also helps you evaluate your investment in aquatic plant management.

Describe the level of success for alternative methods previously used:

1. Chemical	No information on success available, last chemical treatment prior to 1980s.
2. Dredging	
3. Drawdown	
4. Nutrient controls in watershed	
5. Nutrient controls on property	
6. Other	

Section VIII: Applicants Responsibilities

1. The applicant has prepared a detailed map, which shows the length, width and average depth of each area proposed for the control of rooted vegetation.

2. The applicant understands that the Department of Natural Resources may require supervision of any aquatic plant management project involving removal. Supervision may include inspection of the proposed treatment area and/or equipment, before, during, or after removal. The applicant is required to notify the regional office 4 working days in advance of each anticipated date of plant removal with the date, time, location and size of plant removal unless the Department waives this requirement. The advance notification may be specified in your permit.

3. The applicant agrees to inform all operators of harvesting equipment of the conditions and terms of this permit and to insure that all operators understand and abide by those terms and conditions.

4. The applicant agrees to comply with all terms and conditions of this permit, if used, as well as applicable Wisconsin Administrative Rules. The required fee is attached.

5. Conditions related to invasive species movement. The applicant and operator agree to the following methods required under s. NR 109.05(2), Wis. Adm. Code for controlling, transporting and disposing of aquatic plants and animals, and moving water:
   - Aquatic plants and animals shall be removed and water drained from all equipment as required by s. 30.07, Wis. Stats., and ss. NR 19.055 and 40.07, Wis. Adm. Code.
   - Operator shall comply with the most recent Department-approved 'Boat, Gear, and Equipment Decontamination and Disinfection Protocol' Manual Code # 9183.1, available at http://dnr.wi.gov/topic/invasives/disinfection.html

I hereby certify that the above information is true and correct and that copies of the application have been provided to the appropriate parties name in Section II and that the conditions of the permit will be adhered to. All portions of this permit, map and accompanying cover letter must be in possession of the applicant or their agent at time of plant removal. During plant removal activities, all provisions of applicable Wisconsin Administrative Rules must be complied with, as well as the specific conditions contained in the permit cover letter.

Electronically Signed

Applicant's Signature

DNR Use Only

Review Notes:

☐ National Heritage Inventory Review

Section IX: Permit to Carry Out Mechanical or Manual Removal of Aquatic Plants

The foregoing application is approved. Permission is hereby granted to the applicant to mechanically or manually remove aquatic plants described in the application during the season. The approval of an aquatic plant management permit may not represent an endorsement of the permitted activity, but represents that the applicant has complied with Wisconsin Administrative Rules.

Season Year(s): 2019-2023

Application fee if received? ☒ Yes ○ No

State of Wisconsin
Department of Natural Resources For the Secretary

By Adeidre Burns

Regional Director or Designee

7/10/19 (Date Signed)

7/10/19 (Date Mailed)

If you believe that you have a right to challenge this decision, you should know that Wisconsin statutes and administrative rule establish time periods within which requests to review Department decisions must be filed.

For Judicial review of a decision pursuant to ss. 227.52 and 227.53, Wis. Stats., you have 30 days after the decision is mailed or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for review shall name the Department of Natural Resources as the respondent.

To request a contested case hearing pursuant to s. 227.42, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. The filing of a request for a contested case hearing is not a prerequisite for judicial review and does not extend the 30-day period for filing a petition for judicial review.

This notice is provided pursuant to s. 227.48(2), Wis. Stats.

Attachments and Checklists

Main Permit Application

Mechanical - Manual Plant Control Application (3200-113) :

Completion Status: Complete

Upload Required Attachments (15 MB per file limit) - Help reduce file size and trouble shoot file uploads

* indicates completion of this item is required

Note: To add additional attachments using the down arrow icon. To replace an existing file, use the 'Click here to attach file ' link. To remove additional items, select the item and press CNTRL Delete.

Riparian Owners	File Attachment	PLMD-riparian-2019list.xlsx
Site Map	File Attachment	map2.pdf
Site Map	File Attachment	map2.pdf
Site Map	File Attachment	map3.pdf
Site Map	File Attachment	map4.pdf
Site Map	File Attachment	map5.pdf
Site Map	File Attachment	map6.pdf
Site Map	File Attachment	proposed2018harvestingmap.jpg

Errors:

Online Payment

Wisconsin Department of Natural Resources Invoice Number: WP-00019193

Total Due: $300.00

Payment Confirmation # WS2WT3003625734

STEP 1:

Payment is Complete

Confirmation Number: WS2WT3003625734

STEP 2 :

Please note that payment is considered successful when your financial institution renders payment for this transaction. Failure of US Bank to collect and transfer funds from the permit applicant to the DNR, does not release the applicant of financial responsibility and the DNR reserves the right to collect unpaid fees.

All payments are collected by US Bank which is an external website contracted by the Wisconsin Department of Natural Resources for the sole purpose of collecting payments over the web.

Sign and Submit Permit

Applicant Responsibilities and Certification

1. The applicant has prepared a detailed map which shows the length, width and average depth of each area proposed for the control of rooted vegetation and the surface area in acres or square feet for each proposed algae treatment.
2. The applicant understands that the Department of Natural Resources may require supervision of any aquatic plant management project involving chemicals. Under s. NR 107.07, Wis. Adm. Code, supervision may include inspection of the proposed treatment area, chemicals and application equipment before, during or after treatment. The applicant is required to notify the regional office 4 working days in advance of each anticipated treatment with the date, time, location and size of treatment unless the Department waives this requirement. The advance notification may be specified in your permit.
3. The applicant agrees to comply with all terms or conditions of this permit, if issued, as well as all provisions of Chapter NR 107, Wis. Adm. Code. The required application fee is attached.
4. The applicant has provided a copy of the current application to any affected property owners' association, inland lake district and, in the case of chemical applications for rooted aquatic plants, to all owners of property riparian or adjacent to the treatment area. The applicant has also provided a copy of the current chemical fact

sheet for the chemicals proposed for use to any affected property owner's association or inland lake district.

5. Conditions related to invasive species movement. The applicant and operator agree to the following methods required under s. NR 109.05(2), Wis. Adm. Code for controlling, transporting and disposing of aquatic plants and animals, and moving water:
    - Aquatic plants and animals shall be removed and water drained from all equipment as required by s. 30.07, Wis. Stats., and ss. NR 19.055 and 40.07, Wis. Adm. Code.
    - Operator shall comply with the most recent Department-approved 'Boat, Gear, and Equipment Decontamination and Disinfection Protocol', Manual Code # 9183.1, available at http://dnr.wi.gov/topic/invasives/disinfection.html

I hereby certify that the above information is true and correct and that copies of the application have been provided to the appropriate parties name in Section II and that the conditions of the permit will be adhered to. All portions of this permit, map and accompanying cover letter must be in possession of the applicant or their agent at time of plant removal. During plant removal activities, all provisions of applicable Wisconsin Administrative Rules must be complied with, as well as the specific conditions contained in the permit cover letter.

☑ Check if you are signing as Agent for Applicant.	i:0#.f|wamsmembership|mkwinter signed on 2019-06-28...
☑ I hereby certify that the above information is true and correct and that copies of this application have been provided to the appropriate parties named in Section II and that the conditions of the permit and pesticide use will be adhered to.	

APPENDIX B

PHANTOM LAKES 2017 POINT-INTERCEPT SURVEY DATA

Table B.1
Lower Phantom Lake Point-Intercept Aquatic Plant Survey Data: July 31 – August 7, 2017

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybrid water-milfoil	Potamogeton crispus ,Curly-leaf pondweed	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Lemna minor, Small duckweed	Lemna trisulca, Forked duckweed	Myriophyllum heterophyllum, Various-leaved water-milfoil	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas marina, Spiny naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton foliosus, Leafy pondweed	Potamogeton friesii, Fries' pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton nodosus, Long-leaf pondweed	Potamogeton praelongus, White-stem pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Sagittaria cuneata, Arum-leaved arrowhead	Spirodela polyrhiza, Large duckweed	Stuckenia pectinata, Sago pondweed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	Aquatic moss	Freshwater sponge	Filamentous algae	Ricciа fluitans	Ricci
2	1	42.853157	-88.346154	3	M			3	1				3	2				2	1													1					2						
3	2	42.853147	-88.345482	4.5	M			3	v									3						v													2						
4	3	42.853137	-88.344809	5	M			3	v			3						2										1			V						3						
5	4	42.853128	-88.344136	2.5	M			3				3						2									1	1			v												
6	5	42.853662	-88.346814	3.5	M			3										3	2								2					1				1	2						
7	6	42.853652	-88.346141	4.5	M			3										3																			2						
8	7	42.853642	-88.345468	5	M			3				3						1									1									1						
9	8	42.853632	-88.344795	5	M			3	3			3																			v				1	1					
10	9	42.853623	-88.344122	6	M			3				3						2										2			1				1	3						
11	10	42.853613	-88.34345	3	M			3	1			2	2					2	1			V													1	2						
12	11	42.854166	-88.347474	3	M			3	1		v	3										v														2						
13	12	42.854157	-88.346801	5.5	M			3				3								1													1									
14	13	42.854147	-88.346128	3.5	M			3				3																v														
15	14	42.854137	-88.345455	5	M			3										3															1		1	2						
16	15	42.854128	-88.344782	5	M			3				3						2											1				1		1	2						
17	16	42.854118	-88.344109	5	M			3					1					3						1					1						1							
18	17	42.854108	-88.343436	3.5	M			3				V						3									1	1				1					1					
19	18	42.854059	-88.340072				WATER LILIES																																			
20	19	42.85405	-88.339399				WATER LILIES																																				
21	20	42.85404	-88.338726				WATER LILIES																																				
22	21	42.85403	-88.338053				WATER LILIES																																				
23	22	42.8547	-88.350152				MISSED																																				
24	23	42.854671	-88.348134	3.5	M	P		3	2																												3					
25	24	42.854662	-88.347461	5	M	P		3				3	1					2						2																		
26	25	42.854652	-88.346788	6	M	P		3				3						3															1			1	2						
27	26	42.854642	-88.346115	5.5	M	P		3				3						1	1																		3						
28	27	42.854632	-88.345442	4	M	P		3				3								2							1															
29	28	42.854623	-88.344769	5	M	P		2										2	1																	2	2					
30	29	42.854613	-88.344096	5.5	M	P		2										2										2					v				2					
31	30	42.854603	-88.343423	4.5	M	P		3				3															1										1					
32	31	42.854593	-88.34275	3	M	P		3				3						2					1									v	2				1					
33	32	42.854584	-88.342077	3	M	P		3				3										v			v							2				1					
34	33	42.854554	-88.340059				WATER LILIES																																				
35	34	42.854545	-88.339386				WATER LILIES																																				
36	35	42.854535	-88.338713				WATER LILIES																																				
37	36	42.854525	-88.33804	5.5	M	P		3				3												1													1					
38	37	42.854515	-88.337367				WATER LILIES																																				
39	38	42.855157	-88.347447	4	R	P		3			1		1					3																		v						
40	39	42.855147	-88.346774	5	M	P		3				3																					1				1					
41	40	42.855137	-88.346102	6	M	P		3			1							3													v					2						
42	41	42.855127	-88.345429	5.5	M	P		3				3						1									2										1					
43	42	42.855118	-88.344756	4.5	M	P		3				V						3											1			v					2					
44	43	42.855108	-88.344083	5.5	M	P		3		v		V						3																		v	v	3					
45	44	42.855098	-88.34341	3.5	M	P		2				2															1					2										
46	45	42.855088	-88.342737	4	M	P		2				2						2									2										1					
47	46	42.855079	-88.342064	4.5	M	P		2										1	1													1				2						
48	47	42.855069	-88.341391	3	M	P		3				3					1						V						v			2					2					
49	48	42.855059	-88.340718	3.5	M	P		3				3																							v		2					
50	49	42.855049	-88.340045	5	M	P		2									1						2									1				2	2					
51	50	42.85504	-88.339372	6.5	M	P		3				3																				v				2					
52	51	42.85503	-88.338699	4.5	M	P		2	1			1	1				2															1	1				2					
53	52	42.85502	-88.338027	3.5	M	P		2				2					2						V														1					
54	53	42.85501	-88.337354	3.5	M	P		3	1								3														v	v			v	1					
55	54	42.855001	-88.336681	4.5	M	P		3				3	1				v						V										1			1					
56	55	42.854991	-88.336008	5	M	P		3	1			3	1				2						1	V					2												
57	56	42.854981	-88.335335				WATER LILIES																																				
58	57	42.854971	-88.334662				WATER LILIES																																				
59	58	42.854962	-88.333989				WATER LILIES																																				
60	59	42.855642	-88.346761	4.5	M	P		3										3											1								3					
61	60	42.855632	-88.346088	5.5	M	P		3				3						3											1				1									
62	61	42.855623	-88.345415	5.5	M	P		3				3						1											2				v				3					
63	62	42.855613	-88.344742	5.5	M	P		3				3						2									1		3								1	2					
64	63	42.855603	-88.34407	4.5	M	P		3				3											V					v		v						v						
65	64	42.855593	-88.343397				WATER LILIES AND BULRUSHES																																				
66	65	42.855584	-88.342724				WATER LILIES AND BULRUSHES																																				
67	66	42.855574	-88.342051				WATER LILIES AND BULRUSHES																																				
68	67	42.855564	-88.341378	3.5	M	P		3				3																				1									
69	68	42.855554	-88.340705	4.5	M	P		2				2						v																			2					

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
70	69	42.855545	-88.340032	7.5	M	P		3			3	2																					2					2					
71	70	42.855535	-88.339359	5.5	M	P		3				2						v														1					1	2					
72	71	42.855525	-88.338686	5	M	P		2										2									v					1			1		2					
73	72	42.855515	-88.338013	4	M	P		3				3																			v											
74	73	42.855506	-88.33734	5	M	P		2										2	1								1										2					
75	74	42.855496	-88.336667	6.5	M	P		3			1	1						2	1												2				v	2	3					
76	75	42.855486	-88.335995	6	M	P		3				3						1																								
77	76	42.855476	-88.335322	5.5	M	P		2										2									1					1			2						
78	77	42.855466	-88.334649	5	M	P		3				2						3														1	1								
79	78	42.855457	-88.333976	5	M	P		3				1	1					3	1																1	1					
80	79	42.855447	-88.333303	4.5	M	P		3	v			3	1				v	2														2	1		v		1	2				
81	80	42.856137	-88.346748	4.5	M	P		3				3	1					2														1						2				
82	81	42.856127	-88.346075	5	M	P		3				3						v																		2					
83	82	42.856118	-88.345402	5.5	M	P		3				3						v									2					1					1				
84	83	42.856108	-88.344729	5.5	M	P		3										3															v				1	2				
85	84	42.856098	-88.344056				WATER LILIES AND BULRUSHES																																					
86	85	42.856088	-88.343383				WATER LILIES AND BULRUSHES																																					
87	86	42.856049	-88.340692	5	M	P		3				3																				2					2					
88	87	42.85604	-88.340019	10.5	M	P		2	1			2																														
89	88	42.85603	-88.339346	5.5	M	P		3				3																				2				1	3					
90	89	42.85602	-88.338673	5	M	P		1				1						1																				1				
91	90	42.85601	-88.338	4	M	P		1			1							1																				1				
92	91	42.856001	-88.337327	4	M	P		1									1										v					V					1				
93	92	42.855991	-88.336654	5	M	P		3				2					2																				2				
94	93	42.855981	-88.335981	9	M	P		2			2	1					1																				2				
95	94	42.855971	-88.335308	6	M	P		2									2															1			v						
96	95	42.855961	-88.334635	5	M	P		2									2											1										2				
97	96	42.855952	-88.333962	5.5	S	P		2					1				1										1					1				1		2				
98	97	42.855942	-88.33329	6	S	P		1																				1				1					1	1				
99	98	42.855932	-88.332617	6	M	P		2					2				v															v	v					1				
100	99	42.856806	-88.358848				WETLAND																																			
101	100	42.856797	-88.358175				WETLAND																																			
102	101	42.856787	-88.357502				WETLAND																																			
103	102	42.856777	-88.356829				WETLAND																																			
104	103	42.856622	-88.346062	4.5	M	P		3				3	2					1										1														
105	104	42.856613	-88.345389	5	M	P		3				3						2										2											3				
106	105	42.856603	-88.344716	5	M	P		3				3						2										1				2				1		3				
107	106	42.856593	-88.344043	4	M	P		3				3						1				V							1		1										
108	107	42.856554	-88.341351	5.5	M	P		3			2	3						3				V	v														3	2				
109	108	42.856544	-88.340678	9	M	P		3			3	3																			v						2				
110	109	42.856535	-88.340006	8	M	P		3	1			2							2												1		1								
111	110	42.856525	-88.339333	7	M	P		3				3						1													1					3	2				
112	111	42.856515	-88.33866	5	M	P		3				1						2	1					v				1			2					3	3				
113	112	42.856505	-88.337987	5	M	P		2				1						2																			2				
114	113	42.856496	-88.337314				ON LAND																																			
115	114	42.856466	-88.335295	4.5	M	P		2	1				2				1																					2				
116	115	42.856457	-88.334622	7	M	P		3	1			3					1																			2				
117	116	42.856447	-88.333949	6.5	M	P		3	1			3																			1				1	1					
118	117	42.856437	-88.333276	5.5	M	P		3	1			3					1																				3				
119	118	42.857321	-88.36018				WETLAND																																			
120	119	42.857311	-88.359508				WETLAND																																			
121	120	42.857302	-88.358835				WETLAND																																			
122	121	42.857292	-88.358162				WETLAND																																			
123	122	42.857282	-88.357489				WETLAND																																			
124	123	42.857273	-88.356816				WETLAND																																			
125	124	42.857263	-88.356143				WETLAND																																			
126	125	42.857253	-88.35547	3	M	P		3	3		2							1				V	v		2																
127	126	42.857108	-88.345376				MISSED																																			
128	127	42.857098	-88.344703	5.5	M	P		3				3									1																				
129	128	42.857088	-88.34403	4.5	M	P		3				3																				2					2				
130	129	42.857079	-88.343357	4	M	P		3				3											V									2									
131	130	42.857049	-88.341338	7	M	P		3				3																				v					3				
132	131	42.85704	-88.340665	8	M	P		3	1			3						v														1		1			1				
133	132	42.85703	-88.339992	8.5	M	P		3			1	3																				v					1				
134	133	42.85702	-88.339319	8.5	M	P		3				3						v	v													v					2				
135	134	42.85701	-88.338646	5	M	P		3				3						V															1				v	v				
136	135	42.857001	-88.337973	5	M	P		2											1													v						2				
137	136	42.856952	-88.334609	3.5	S	P		1					1				1																					1				
138	137	42.856942	-88.333936	4.5	M	P		2	1				1				1																					2				
139	138	42.856932	-88.333263	3.5	M	P		1				1	1				1					v																1				
140	139	42.857845	-88.362186				WETLAND																																			
141	140	42.857835	-88.361513				WETLAND																																			
142	141	42.857826	-88.36084				WETLAND																																			
143	142	42.857816	-88.360167				WETLAND																																			
144	143	42.857806	-88.359494				WETLAND																																			
145	144	42.857797	-88.358821				WETLAND																																			
146	145	42.857787	-88.358149				WETLAND																																			
147	146	42.857777	-88.357476				WETLAND																																			
148	147	42.857768	-88.356803				WETLAND																																			
149	148	42.857758	-88.35613				WETLAND																																			
150	149	42.857748	-88.355457	2.5	M	P		2			1		2								1				1										2					
151	150	42.857739	-88.354784	2.5	M	P		1			1		1										1																	
152	151	42.857729	-88.354111	3	M	P		3		1	2		3																											

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
153	152	42.857593	-88.34469				OVERGROWN																																				
154	153	42.857583	-88.344017	4.5	M	P		3										3	1																			3				
155	154	42.857574	-88.343344	4	M	P		3										3	1									1				1						3				
156	155	42.857564	-88.342671	3.5	M	P		3				3																					3									
157	156	42.857554	-88.341998	6	M	P		3				3																									3				
158	157	42.857544	-88.341325	10	M	P		3				3																									3				
159	158	42.857535	-88.340652	8	M	P		2																									2		1	2						
160	159	42.857525	-88.339979	9.5	M	P		3				3																									2				
161	160	42.857515	-88.339306	6.5	M	P		3				3						V				v										1				v	v				
162	161	42.857505	-88.338633	5	M	P		3				3						2																							
163	162	42.857496	-88.33796	5	M	P		1					v					1																				1			
164	163	42.85834	-88.362173				WETLAND																																			
165	164	42.85833	-88.3615				WETLAND																																			
166	165	42.858321	-88.360827				WETLAND																																			
167	166	42.858311	-88.360154				WETLAND																																			
168	167	42.858301	-88.359481				WETLAND																																			
169	168	42.858292	-88.358808				WETLAND																																			
170	169	42.858282	-88.358135				WETLAND																																			
171	170	42.858272	-88.357462				WETLAND																																			
172	171	42.858263	-88.356789				WETLAND																																			
173	172	42.858253	-88.356117				WETLAND																																			
174	173	42.858243	-88.355444				WETLAND																																			
175	174	42.858234	-88.354771				WETLAND																																			
176	175	42.858224	-88.354098				WETLAND																																			
177	176	42.858214	-88.353425	3.5	M	P		3			2		3																								v				
178	177	42.858078	-88.344003	4	M	P		3	1			1								3													2							
179	178	42.858069	-88.34333	6.5	M	P		3	1			2																				2								
180	179	42.858059	-88.342658	3.5	M	P		3				3						V																				V			
181	180	42.858049	-88.341985	4	M	P		2										2				v										1		2						
182	181	42.85804	-88.341312	6.5	M	P		2										2																2						
183	182	42.85803	-88.340639	8.5	M	P		3	1			3																									3			
184	183	42.85802	-88.339966	11.5	M	P		3			3	3																												
185	184	42.85801	-88.339293	8	M	P		2			v	2																v												
186	185	42.858	-88.33862	5	M	P		3										3														v						3		
187	186	42.857991	-88.337947	5.5	M	P		3										2														2						3		
188	187	42.857981	-88.337274	2.5	R	P		1					1					1																				1		
189	188	42.858835	-88.36216				WETLAND																																			
190	189	42.858825	-88.361487				WETLAND																																			
191	190	42.858816	-88.360814				WETLAND																																			
192	191	42.858806	-88.360141				WETLAND																																			
193	192	42.858796	-88.359468				WETLAND																																			
194	193	42.858787	-88.358795				WETLAND																																			
195	194	42.858777	-88.358122				WETLAND																																			
196	195	42.858767	-88.357449				WETLAND																																			
197	196	42.858758	-88.356776				WETLAND																																			
198	197	42.858748	-88.356103				WETLAND																																			
199	198	42.858739	-88.35543				WETLAND																																			
200	199	42.858729	-88.354757				WETLAND																																			
201	200	42.858719	-88.354085				WETLAND																																			
202	201	42.858709	-88.353412				WETLAND																																			
203	202	42.8587	-88.352739	3	M	P		1	v		1		1													1														
204	203	42.858593	-88.345336	4	M	P		3				3																				v			v		1			
205	204	42.858583	-88.344663	4	M	P		2			2	1																									2			
206	205	42.858574	-88.34399	6.5	M	P		3	1		2															1					1		3			1			
207	206	42.858564	-88.343317	8	M	P		3	2		3											v											1			2	1		
208	207	42.858554	-88.342644	4.5	M	P		3			v	3							v																	v			
209	208	42.858544	-88.341971	3.5	M	P		3				3						2																v						
210	209	42.858535	-88.341298	8.5	M	P		1	1			1																												
211	210	42.858525	-88.340625	9.5	M	P		2			2	1	2																			1								
212	211	42.858515	-88.339952	7	M	P		3										2	3															3			2	1		
213	212	42.858505	-88.33928	6.5	M	P		3				3						3														2								
214	213	42.858496	-88.338607	5.5	M	P		3										3						v								v						3		
215	214	42.858486	-88.337934	5	M	P		2										2														v						2		
216	215	42.858476	-88.337261	3.5	M	P		3										3														1				2	3			
217	216	42.85932	-88.361474				WETLAND																																			
218	217	42.859311	-88.360801				WETLAND																																			
219	218	42.859301	-88.360128				WETLAND																																			
220	219	42.859292	-88.359455				WETLAND																																			
221	220	42.859282	-88.358782				WETLAND																																			
222	221	42.859272	-88.358109				WETLAND																																			
223	222	42.859263	-88.357436				WETLAND																																			
224	223	42.859253	-88.356763				WETLAND																																			
225	224	42.859243	-88.35609				WETLAND																																			
226	225	42.859234	-88.355417				WETLAND																																			
227	226	42.859224	-88.354744				WETLAND																																			
228	227	42.859214	-88.354071				WETLAND																																			
229	228	42.859205	-88.353398				WETLAND																																			
230	229	42.859195	-88.352725				WETLAND																																			
231	230	42.859185	-88.352052	3.5	M	P	no plants				v												V	v												v				
232	231	42.859098	-88.345996																																					
233	232	42.859088	-88.345323	4	M	P		3			1												V									3		1			2		
234	233	42.859078	-88.34465	6	M	P		1																								1	1	1						
235	234	42.859069	-88.343977	5.5	M	P		2				1	1																			2	1	2						

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
236	235	42.859059	-88.343304	6.5	S	P	NO PLANTS					V																																
237	236	42.859049	-88.342631	6	M	P		3				3																				V				v	v	3					
238	237	42.859039	-88.341958	5.5	M	P		3				3						v						1								1				V	1					
239	238	42.85903	-88.341285	8.5	M	P		3			2	3																								2					
240	239	42.85902	-88.340612	9	M	P		3			3	3																								2					
241	240	42.85901	-88.339939	6.5	M	P		3	v			3						v																		V					
242	241	42.859	-88.339266	6	M	P		3	v			3						v														1					2				
243	242	42.858991	-88.338593	7	M	P		1				1								1																						
244	243	42.858981	-88.33792	4.5	M	P		3			v	3						v														v				v					
245	244	42.858971	-88.337247	4	M	P		1			1		1					1														1						1				
246	245	42.859806	-88.360788				WETLAND																																			
247	246	42.859796	-88.360115				WETLAND																																			
248	247	42.859787	-88.359442				WETLAND																																			
249	248	42.859777	-88.358769				WETLAND																																			
250	249	42.859767	-88.358096				WETLAND																																			
251	250	42.859758	-88.357423				WETLAND																																			
252	251	42.859748	-88.35675				WETLAND																																			
253	252	42.859738	-88.356077				WETLAND																																			
254	253	42.859729	-88.355404				WETLAND																																			
255	254	42.859719	-88.354731				WETLAND																																			
256	255	42.859709	-88.354058				WETLAND																																			
257	256	42.8597	-88.353385				WETLAND																																			
258	257	42.85969	-88.352712				WETLAND																																			
259	258	42.85968	-88.352039				WETLAND																																			
260	259	42.859593	-88.345983				WATER LILIES																																			
261	260	42.859583	-88.34531	4	M	P		3	1		1																							3		1				
262	261	42.859573	-88.344637	5	M	P		1	1																							1		1						
263	262	42.859564	-88.343964	6	M	P		3	1			1																				3		3						
264	263	42.859554	-88.343291	6	M	P		3	2											1														3			2			
265	264	42.859544	-88.342618	6	M	P		3			2	3	1					v																2						
266	265	42.859535	-88.341945	6	M	P		2				2							v													2					2			
267	266	42.859525	-88.341272	6.5	M	P		3				3																									v			
268	267	42.859515	-88.340599	6.5	M	P		3				3	1																					2			1			
269	268	42.859505	-88.339926	6.5	M	P		3	1			2											1								1		3			3			
270	269	42.859495	-88.339253	6.5	M	P		3				2								1											2					3	2		
271	270	42.859486	-88.33858	5	M	P		3				3																								v			
272	271	42.859476	-88.337907	4.5	M	P		3				3						v		v											v								
273	272	42.859466	-88.337234	4	M	P		2					1					1													1						2		
274	273	42.860301	-88.360775				WETLAND																																			
275	274	42.860291	-88.360102				WETLAND																																			
276	275	42.860282	-88.359429				WETLAND																																			
277	276	42.860272	-88.358756				WETLAND																																			
278	277	42.860262	-88.358083				WETLAND																																			
279	278	42.860253	-88.35741				WETLAND																																			
280	279	42.860243	-88.356737				WETLAND																																			
281	280	42.860233	-88.356064				WETLAND																																			
282	281	42.860224	-88.355391				WETLAND																																			
283	282	42.860214	-88.354718				WETLAND																																			
284	283	42.860204	-88.354045				WETLAND																																			
285	284	42.860195	-88.353372				WETLAND																																			
286	285	42.860185	-88.352699				WETLAND																																			
287	286	42.860175	-88.352026				WETLAND																																			
288	287	42.860166	-88.351353	2.5	M	P		3					3						2			1														2					
289	288	42.860156	-88.35068	2	M	P		2	2	1	1		2										v	v													1			
290	289	42.860088	-88.345969				WETLAND																																			
291	290	42.860078	-88.345296	5	M	P		3	1									v										v			2		3						
292	291	42.860069	-88.344623	5.5	M	P		3																				v			2		3						
293	292	42.860059	-88.34395	4.5	M	P		3	1			3								2												1	3						
294	293	42.860049	-88.343277	8	M	P		2			2							1																					
295	294	42.860039	-88.342605	6.5	M	P		2	1		2																				1		1						
296	295	42.86003	-88.341932	7	M	P		3			v	3																								3			
297	296	42.86002	-88.341259	7	M	P		3			2	1								2											1						1		
298	297	42.86001	-88.340586	7	M	P		3				3																								v			
299	298	42.86	-88.339913	6	M	P		3			v	3						V		v																v			
300	299	42.859991	-88.33924	5.5	M	P		2										2													1		1			v			
301	300	42.859981	-88.338567	4.5	M	P		3				3																											
302	301	42.859971	-88.337894	4	M	P		3	1			3																				1						1		
303	302	42.859961	-88.337221	2.5	M	P		1	1									1																			1		
304	303	42.860806	-88.361435				WETLAND																																			
305	304	42.860796	-88.360762				WETLAND																																			
306	305	42.860786	-88.360089				WETLAND																																			
307	306	42.860777	-88.359416				WETLAND																																			
308	307	42.860767	-88.358743				WETLAND																																			
309	308	42.860757	-88.35807				WETLAND																																			
310	309	42.860748	-88.357397				WETLAND																																			
311	310	42.860738	-88.356724				WETLAND																																			
312	311	42.860729	-88.356051				WETLAND																																			
313	312	42.860719	-88.355378				WETLAND																																			
314	313	42.860709	-88.354705				WETLAND																																			
315	314	42.8607	-88.354032				WETLAND																																			
316	315	42.86069	-88.353359				WETLAND																																			
317	316	42.86068	-88.352686				WETLAND																																			
318	317	42.86067	-88.352013				WETLAND																																			

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
319	318	42.860661	-88.35134				WETLAND																																				
320	319	42.860651	-88.350667	3	M	P		2	2		1		1									V																				
321	320	42.860641	-88.349994	3	M	P		1	1				1			1						V	V		v								v								
322	321	42.860583	-88.345956				WETLAND																																				
323	322	42.860573	-88.345283	4.5	M	P		2	1		2																				1	1		2								
324	323	42.860564	-88.34461	4.5	M	P		3					1																			3											
325	324	42.860554	-88.343937				GRASSES																																				
326	325	42.860544	-88.343264	5	M	P		2	1																						1	V		2		1						
327	326	42.860534	-88.342591	6	M	P		3	1		2																				3			3			2					
328	327	42.860525	-88.341918	6	M	P		3				3																										2	1				
329	328	42.860515	-88.341245	7	M	P		3			v	3																										v					
330	329	42.860505	-88.340572	6	M	P		3				3																										3					
331	330	42.860495	-88.339899	5	M	P		3				3																										v					
332	331	42.860486	-88.339226	4.5	M	P		3				3						v																				v					
333	332	42.860476	-88.338553	4.5	M	P		3	1			3							2												1								1				
334	333	42.860466	-88.33788	4.5	M	P		3	v				1					v		1																		3					
335	334	42.86131	-88.362095				WETLAND																																				
336	335	42.861301	-88.361422				WETLAND																																				
337	336	42.861291	-88.360749				WETLAND																																				
338	337	42.861282	-88.360076				WETLAND																																				
339	338	42.861272	-88.359403				WETLAND																																				
340	339	42.861262	-88.35873				WETLAND																																				
341	340	42.861253	-88.358057				WETLAND																																				
342	341	42.861243	-88.357384				WETLAND																																				
343	342	42.861233	-88.356711				WETLAND																																				
344	343	42.861224	-88.356038				WETLAND																																				
345	344	42.861214	-88.355365				WETLAND																																				
346	345	42.861204	-88.354692				WETLAND																																				
347	346	42.861195	-88.354019				WETLAND																																				
348	347	42.861185	-88.353346				WETLAND																																				
349	348	42.861175	-88.352673				WETLAND																																				
350	349	42.861166	-88.352				WETLAND																																				
351	350	42.861156	-88.351327				WETLAND																																				
352	351	42.861146	-88.350654				WETLAND																																				
353	352	42.861136	-88.349981	3.5	M	P		1	1														V	V												1					
354	353	42.861068	-88.34527	4	M	P		2	2	1	1		1										1											v								
355	354	42.861059	-88.344597	4.5	M	P		2	2																											2	1				
356	355	42.861049	-88.343924	5	M	P		3																							2		3			2					
357	356	42.861039	-88.343251				CHARA AND GRASSES																																				
358	357	42.86103	-88.342578	5	M	P		3	2		1																				2		3		1						
359	358	42.86102	-88.341905	6.5	M	P		2	2																						1		2			V					
360	359	42.86101	-88.341232	5	M	P		3				3																1			1	v				2					
361	360	42.861	-88.340559	5.5	M	P		3										3													1		1								
362	361	42.860991	-88.339886	4.5	M	P		3				3																			v					2					
363	362	42.860981	-88.339213				WATER LILIES																																				
364	363	42.860971	-88.33854	4	M	P		2	1		1										1		2		1					1				1				1	1			
365	364	42.860961	-88.337867	4	M	P		2	v																														2				
366	365	42.861786	-88.360736				WETLAND																																				
367	366	42.861777	-88.360063				WETLAND																																				
368	367	42.861767	-88.35939				WETLAND																																				
369	368	42.861757	-88.358717				WETLAND																																				
370	369	42.861748	-88.358044				WETLAND																																				
371	370	42.861738	-88.357371				WETLAND																																				
372	371	42.861728	-88.356698				WETLAND																																				
373	372	42.861719	-88.356025				WETLAND																																				
374	373	42.861709	-88.355352				WETLAND																																				
375	374	42.861699	-88.354679				WETLAND																																				
376	375	42.86169	-88.354006				WETLAND																																				
377	376	42.86168	-88.353333				WETLAND																																				
378	377	42.86167	-88.35266				WETLAND																																				
379	378	42.861661	-88.351987				WETLAND																																				
380	379	42.861651	-88.351314				WETLAND																																				
381	380	42.861641	-88.350641				WETLAND																																				
382	381	42.861632	-88.349968				WETLAND																																				
383	382	42.861622	-88.349295	4	M	P	no plants cut channel																																				
384	383	42.861612	-88.348622	4	M	P		3	3		2		3								1	1	V																				
385	384	42.861593	-88.347276				WETLAND																																				
386	385	42.861583	-88.346603				WETLAND																																				
387	386	42.861573	-88.34593				WETLAND																																				
388	387	42.861564	-88.345257	4	M	P		3	3		2		1										v															1				
389	388	42.861554	-88.344584	4.5	M	P		1			1																									1					
390	389	42.861544	-88.343911				WATER LILIES																																				
391	390	42.861534	-88.343238	4.5	M	P		2	1														2										2								
392	391	42.861525	-88.342565	5.5	M	P		2	1																						2		2			2					
393	392	42.861515	-88.341892	5	M	P		3				3																				2	1			3					
394	393	42.861505	-88.341219				WATER LILIES																																				
395	394	42.861495	-88.340546	4.5	M	P		2															2						1				1				2				
396	395	42.861486	-88.339873				WATER LILIES																																				
397	396	42.861476	-88.3392				WATER LILIES																																				
398	397	42.861466	-88.338527	4.5	M	P		3											3																				2				
399	398	42.862243	-88.35803				WETLAND																																				
400	399	42.862233	-88.357357				WETLAND																																				
401	400	42.862223	-88.356684				WETLAND																																				

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
402	401	42.862214	-88.356011				WETLAND																																				
403	402	42.862204	-88.355338				WETLAND																																						
404	403	42.862194	-88.354665				WETLAND																																						
405	404	42.862185	-88.353992				WETLAND																																						
406	405	42.862175	-88.353319				WETLAND																																						
407	406	42.862165	-88.352646				WETLAND																																						
408	407	42.862156	-88.351973				WETLAND																																						
409	408	42.862146	-88.3513				WETLAND																																						
410	409	42.862136	-88.350627				WETLAND																																						
411	410	42.862127	-88.349954				WETLAND																																						
412	411	42.862117	-88.349281				WETLAND																																						
413	412	42.862107	-88.348608				WETLAND																																						
414	413	42.862098	-88.347935	4	M	P		1	1	1			1																																
415	414	42.862088	-88.347262	4	M	P		3	3		1		2																																
416	415	42.862078	-88.346589	3.5	M	P		2	2				2								1																								
417	416	42.862068	-88.345917	4	M	P		1	1		1		1																																
418	417	42.862059	-88.345244				WATER LILIES																																						
419	418	42.862049	-88.344571				WATER LILIES																																						
420	419	42.862039	-88.343898				WATER LILIES																																						
421	420	42.862029	-88.343225	6	M	P		3	3		2																																	
422	421	42.86202	-88.342552	4.5	M	P		3	2			2										1												2	3			3						
423	422	42.86201	-88.341879	6	M	P		3				1						1				V											2		2		1	3						
424	423	42.862	-88.341206				WATER LILIES																																					
425	424	42.86199	-88.340533	5	M	P		3			3											2					1		v				1										
426	425	42.861981	-88.33986	6	M	P		3				2										1		2				1					1	1			3	1					
427	426	42.861971	-88.339187	5.5	M	P		3			1		1																2				2	1				1					
428	427	42.861961	-88.338514	3	M	P		2	2																		1											1					
429	428	42.862738	-88.358017				WETLAND																																					
430	429	42.862699	-88.355325				WETLAND																																					
431	430	42.86269	-88.354652				WETLAND																																					
432	431	42.86268	-88.353979				WETLAND																																					
433	432	42.86267	-88.353306				WETLAND																																					
434	433	42.86266	-88.352633				WETLAND																																					
435	434	42.862651	-88.35196				WETLAND																																					
436	435	42.862641	-88.351287				WETLAND																																					
437	436	42.862631	-88.350614				WETLAND																																					
438	437	42.862622	-88.349941				WETLAND																																					
439	438	42.862612	-88.349268				WETLAND																																					
440	439	42.862602	-88.348595				WETLAND																																					
441	440	42.862593	-88.347922				WETLAND																																					
442	441	42.862583	-88.347249	4	M	P		3	3		2		2					1																									
443	442	42.862573	-88.346576	4	M	P		3	3		2		1																														
444	443	42.862563	-88.345903	4	M	P		3	3																																		
445	444	42.862554	-88.34523				WATER LILIES																																					
446	445	42.862544	-88.344557				WATER LILIES																																					
447	446	42.862534	-88.343884				WATER LILIES																																					
448	447	42.862525	-88.343211	5	M	P		2	1		2																		1								1	1					
449	448	42.862515	-88.342538	4.5	M	P		2			1		1										2									2					1					
450	449	42.862505	-88.341865				WATER LILIES																																					
451	450	42.862495	-88.341192	5.5	M	P		3					2							2															3								
452	451	42.862486	-88.340519	5	M	P		2	1														2					1	v					1			1					
453	452	42.862476	-88.339846	5	M	P		3	2																							1		1				2				
454	453	42.863185	-88.354639				WETLAND																																					
455	454	42.863175	-88.353966				WETLAND																																					
456	455	42.863146	-88.351947				WETLAND																																					
457	456	42.863136	-88.351274				WETLAND																																					
458	457	42.863127	-88.350601				WETLAND																																					
459	458	42.863097	-88.348582				WETLAND																																					
460	459	42.863088	-88.347909				WETLAND																																					
461	460	42.863078	-88.347236				WETLAND																																					
462	461	42.863068	-88.346563				WETLAND																																					
463	462	42.863059	-88.34589	4	M	P		3	3		3		2								1																						
464	463	42.863049	-88.345217	3.5	M	P		2	2		2		1																														
465	464	42.863039	-88.344544	3.5	M	P		3	3		2		1									V																				
466	465	42.863029	-88.343871				WATER LILIES																																					
467	466	42.86302	-88.343198	3.5	M	P		3	2		3		1										2							v			1									
468	467	42.86301	-88.342525	4	M	P		3	1		3		2										2										1	1	1		1	1					
469	468	42.863	-88.341852	5.5	M	P		3	3														V										3		3		1	3	3				
470	469	42.86299	-88.341179	4.5	M	P		2				1																					2		v		1		2				
471	470	42.862981	-88.340506	3.5	M	P		2	1				1							1													1						2				
472	471	42.86368	-88.354626				WETLAND																																					
473	472	42.863612	-88.349915				WETLAND																																					
474	473	42.863583	-88.347896				WATER LILIES																																					
475	474	42.863573	-88.347223				WATER LILIES																																					
476	475	42.863563	-88.34655				WATER LILIES																																					
477	476	42.863554	-88.345877				WATER LILIES																																					
478	477	42.863544	-88.345204				WATER LILIES																																					
479	478	42.863534	-88.344531	4	M	P		2	2		1		1											1						v							1					
480	479	42.863524	-88.343858	4	M	P		2	2				1											v				v														
481	480	42.863515	-88.343185				WATER LILIES																																					
482	481	42.863505	-88.342512	4.5	M	P		1	1																							1					v					
483	482	42.863495	-88.341839	5	M	P		2	V																							1						2				
484	483	42.863485	-88.341166	4	M	P		3	3																							1						3				

Table continued on next page.

Table B.1 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BE	BG	BN	BO	BR	BU	BW	CA	CB	CI	CN	CO	CP	CR	CS	CT	CW	CZ	DE	DL	ED	EF	ER	ES	EZ	FA	FB	FC	FD
485	484	42.864058	-88.346537				WATER LILIES																																				
486	485	42.864049	-88.345864				WATER LILIES																																						
487	486	42.864039	-88.345191				WATER LILIES																																						
488	487	42.864029	-88.344518				WATER LILIES																																						
489	488	42.864019	-88.343845				WATER LILIES																																						
490	489	42.86401	-88.343172	4.5	M	P		2	2				1															1															
491	490	42.864	-88.342499	3.5	M	P		2	2																			v				1						v				
492	491	42.864534	-88.345177				WATER LILIES																																					
493	492	42.864524	-88.344504				WATER LILIES																																					
494	493	42.864515	-88.343831				WATER LILIES																																					
495	494	42.864505	-88.343158	2	M	P		1	1						v								V									1		v	v	1							

Table B.2
Summary Statistics for the Lower Phantom Lake Point-Intercept Aquatic Plant Survey: July 31 – August 7, 2017

	B	C	D	E	Q	S	AC	AI	AQ	AS	AZ	BA	BD	BG	BI	BM	BN	BU	BZ	CA	CB	CD	CE	CI	CL	CQ	CX	DP	DR	ED	EE	EL	EM
1	**STATS**	Total vegetation	*Myriophyllum spicatum*, Eurasian water milfoil	*Potamogeton crispus*, Curly-leaf pondweed	*Ceratophyllum demersum*, Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis*, Common waterweed	*Heteranthera dubia*, Water star-grass	*Lemna minor*, Small duckweed	*Lemna trisulca*, Forked duckweed	*Myriophyllum heterophyllum*, Various-leaved water-milfoil	*Myriophyllum sibiricum*, Northern water-milfoil	*Najas flexilis*, Slender naiad	*Najas marina*, Spiny naiad	*Nitella* sp., Nitella	*Nuphar variegata*, Spatterdock	*Nymphaea odorata*, White water lily	*Potamogeton amplifolius*, Large-leaf pondweed	*Potamogeton foliosus*, Leafy pondweed	*Potamogeton friesii*, Fries' pondweed	*Potamogeton gramineus*, Variable pondweed	*Potamogeton illinoensis*, Illinois pondweed	*Potamogeton natans*, Floating-leaf pondweed	*Potamogeton praelongus*, White-stem pondweed	*Potamogeton richardsonii*, Clasping-leaf pondweed	*Potamogeton zosteriformis*, Flat-stem pondweed	*Sagittaria cuneata*, Arum-leaved arrowhead	*Spirodela polyrhiza*, Large duckweed	*Stuckenia pectinata*, Sago pondweed	*Utricularia vulgaris*, Common bladderwort	*Vallisneria americana*, Wild celery	Aquatic moss	Freshw
2	Lower Phantom																																
3	Waukesha																																
4	765800																																
5	7/31, 8/1, 8/2, 8/7/17																																
6	**INDIVIDUAL SPECIES STATS:**																																
7	**Frequency of occurrence within vegetated areas (%)**		30.31	1.57	21.26	51.57	22.44	0.39		0.39	7.09	30.71	7.87	2.76	1.97	6.30	1.18	1.57	1.18	0.79	6.30	9.45	1.97	0.39	36.22	6.30	18.11		12.20	27.56	39.76		
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		29.96	1.56	21.01	50.97	22.18	0.39		0.39	7.00	30.35	7.78	2.72	1.95	6.23	1.17	1.56	1.17	0.78	6.23	9.34	1.95	0.39	35.80	6.23	17.90		12.06	27.24	39.30		
9	**Relative Frequency (%)**		8.7	0.5	6.1	14.8	6.5	0.1		0.1	2.0	8.8	2.3	0.8	0.6	1.8	0.3	0.5	0.3	0.2	1.8	2.7	0.6	0.1	10.4	1.8	5.2		3.5	7.9	11.4		
10	Relative Frequency (squared)	0.08	0.01	0.00	0.00	0.02	0.00	0.00		0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00		0.00	0.01	0.01		
11	**Number of sites where species**		77	4	54	131	57	1		1	18	78	20	7	5	16	3	4	3	2	16	24	5	1	92	16	46		31	70	101		
12	**Average Rake Fullness**	2.58	1.58	1.00	1.76	2.59	1.40	2.00		1.00	1.44	2.05	1.30	1.57	1.00	1.56	1.00	1.50	1.33	1.00	1.25	1.25	1.40	1.00	1.37	1.38	1.98		1.19	1.89	1.88		
13	**#visual sightings**		9	1	8	4	1		1		3	19	2	3		22	13	3	1	1	1	8	6		25	5	6	1	11	18	5		
14	**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present		
15																																	
16	**SUMMARY STATS:**																																
17	**Total number of sites visited**	**257**																															
18	**Total number of sites with**	**254**																															
19	**Total number of sites shallower than maximum depth of plants**	**257**																															
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**98.83**																															
21	**Simpson Diversity Index**	**0.92**																															
22	**Maximum depth of plants (ft)****	**11.50**																															
23	**Number of sites sampled using rake on Rope (R)**	**0**																															
24	**Number of sites sampled using rake on Pole (P)**	**240**																															
25	**Average number of all species per site (shallower than max depth)**	**3.44**																															
26	**Average number of all species per site (veg. sites only)**	**3.48**																															
27	**Average number of native species per site (shallower than max depth)**	**3.09**																															
28	**Average number of native species per site (veg. sites only)**	**3.14**																															
29	**Species Richness**	**27**																															
30	**Species Richness (including visuals)**	**29**																															

Table B.3
Upper Phantom Lake Point-Intercept Aquatic Plant Survey Data: August 7 – 8, 2017

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BO	BR	BU	BW	CI	CP	CR	CZ	DE	EF	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
1	sampling point	Latitude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Myriophyllum spicatum* , Eurasian water-milfoil or Hybrid water-milfoil	*Potamogeton crispus* , Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Chara* sp., Muskgrasses	*Elodea canadensis* , Common waterweed	*Heteranthera dubia* , Water star-grass	*Myriophyllum sibiricum* , Northern water-milfoil	*Najas flexilis* , Slender naiad	*Najas marina* , Spiny naiad	*Nitella* sp., Nitella	*Potamogeton amplifolius* , Large-leaf pondweed	*Potamogeton gramineus* , Variable pondweed	*Potamogeton illinoensis* , Illinois pondweed	*Potamogeton richardsonii* , Clasping-leaf pondweed	*Potamogeton zosteriformis* , Flat-stem pondweed	*Stuckenia pectinata* , Sago pondweed	*Utricularia vulgaris* , Common bladderwort	*Vallisneria americana* , Wild celery	*Wolffia borealis*, Northern watermeal	*Wolffia columbiana*, Common watermeal	*Zannichellia palustris* , Horned pondweed	*Zizania aquatica* , Southern wild rice	*Zizania palustris* , Northern wild rice	*Zizania* sp., Wild rice	Aquatic moss	Freshwater sponge	Filamentous algae	*Riccia fluitans*	*Ricc*
2	1	42.8467229	-88.35678228	4	M			3				3												1													
3	2	42.8463628	-88.35679182	6	M			2	V			2					1							1													
4	3	42.8460028	-88.35680137				SWIM AREA																														
5	4	42.8470759	-88.3562834	10	M			1									1																				
6	5	42.8467159	-88.35629295	10	M			2	2																												
7	6	42.8463558	-88.3563025				SWIM AREA																														
8	7	42.8459957	-88.35631205	5	S		NO PLANTS								v					v																
9	8	42.847789	-88.35577496	5	S			1				1					1			1				1													
10	9	42.847429	-88.35578451	12	M			3	3																												
11	10	42.8470689	-88.35579407				DEEP																														
12	11	42.8467088	-88.35580362	14	M		NO PLANTS																														
13	12	42.8463488	-88.35581317				DEEP																														
14	13	42.8459887	-88.35582272	3.5	M			3				3												1		V											
15	14	42.847782	-88.35528562	11	M			3	3																												
16	15	42.8474219	-88.35529518				DEEP																														
17	16	42.8470619	-88.35530473				DEEP																														
18	17	42.8467018	-88.35531429	15	M			1				1					1																				
19	18	42.8463417	-88.35532384	5	M			1				1					1			1																	
20	19	42.848135	-88.35478673	8.5	M			1				1					1			1							1									
21	20	42.847775	-88.35479628				DEEP																														
22	21	42.8474149	-88.35480584				DEEP																														
23	22	42.8470548	-88.3548154				DEEP																														
24	23	42.8466948	-88.35482496				DEEP																														
25	24	42.8463347	-88.35483452	6.5	M			1				1					1							1			1									
26	25	42.8459746	-88.35484407				DEEP																														
27	26	42.8488481	-88.35427826	2.5	R			1							1		1							1													
28	27	42.8484881	-88.35428782	7	M			1				1												1													
29	28	42.848128	-88.35429739				DEEP																														
30	29	42.8477679	-88.35430695				DEEP																														
31	30	42.8474079	-88.35431651				DEEP																														
32	31	42.8470478	-88.35432607				DEEP																														
33	32	42.8466877	-88.35433563				DEEP																														
34	33	42.8463277	-88.35434519	13.5	M			2	2																												
35	34	42.8459676	-88.35435475	5	M			1				1					1																				
36	35	42.8488411	-88.35378892	11	M		NO PLANTS																														
37	36	42.848481	-88.35379848				DEEP																														
38	37	42.848121	-88.35380804				DEEP																														
39	38	42.8477609	-88.35381761				DEEP																														
40	39	42.8474008	-88.35382717				DEEP																														
41	40	42.8470408	-88.35383674				DEEP																														
42	41	42.8466807	-88.3538463				DEEP																														
43	42	42.8463206	-88.35385586	15	M		NO PLANTS		v																												
44	43	42.8459606	-88.35386542	9	M			1				1					1																				
45	44	42.8456005	-88.35387499				DEEP																														
46	45	42.8488341	-88.35329957				DEEP																														
47	46	42.848474	-88.35330914				DEEP																														
48	47	42.8481139	-88.3533187				DEEP																														
49	48	42.8477539	-88.35332827				DEEP																														
50	49	42.8473938	-88.35333784				DEEP																														
51	50	42.8470337	-88.3533474				DEEP																														
52	51	42.8466737	-88.35335697				DEEP																														
53	52	42.8463136	-88.35336654	15	M			1									1																				
54	53	42.8459535	-88.3533761	12	M			1				1																									
55	54	42.8455935	-88.35338567	4.5	S		NO PLANTS																														
56	55	42.8502673	-88.35277194	3	S		NO PLANTS					v			v					v																	
57	56	42.8499072	-88.35278151	4	S		NO PLANTS																														

Table continued on next page.

Table B.3 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BO	BR	BU	BW	CI	CP	CR	CZ	DE	EF	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
58	57	42.8495471	-88.35279108	6	R		NO PLANTS		v											v																	
59	58	42.8491871	-88.35280065				DEEP																															
60	59	42.848827	-88.35281022				DEEP																															
61	60	42.8484669	-88.35281979				DEEP																															
62	61	42.8481069	-88.35282936				DEEP																															
63	62	42.8477468	-88.35283893				DEEP																															
64	63	42.8473868	-88.3528485				DEEP																															
65	64	42.8470267	-88.35285807				DEEP																															
66	65	42.8466666	-88.35286764				DEEP																															
67	66	42.8463066	-88.35287721				DEEP																															
68	67	42.8459465	-88.35288678	14	M			1	1																													
69	68	42.8455864	-88.35289635	6.5	S			1				1													1													
70	69	42.8452264	-88.35290591				ON LAND																															
71	70	42.8506203	-88.35227301	3	S			1				1			1		1			1																		
72	71	42.8502602	-88.35228258	5.5	M		NO PLANTS																															
73	72	42.8499002	-88.35229216	8	M		NO PLANTS																															
74	73	42.8495401	-88.35230173				DEEP																															
75	74	42.84918	-88.3523113				DEEP																															
76	75	42.84882	-88.35232088				DEEP																															
77	76	42.8484599	-88.35233045				DEEP																															
78	77	42.8480998	-88.35234002				DEEP																															
79	78	42.8477398	-88.35234959				DEEP																															
80	79	42.8473797	-88.35235917				DEEP																															
81	80	42.8470196	-88.35236874				DEEP																															
82	81	42.8466596	-88.35237831				DEEP																															
83	82	42.8462995	-88.35238788				DEEP																															
84	83	42.8459395	-88.35239745	9	M			2				1					1									1												
85	84	42.8455794	-88.35240703	5	M			1									1			1																	
86	85	42.8509733	-88.35177407	3.3	M			1				1	1				1																				
87	86	42.8506132	-88.35178365	9	M		NO PLANTS																															
88	87	42.8502532	-88.35179323	13.5	M		NO PLANTS																															
89	88	42.8498931	-88.3518028	14	M			1	1																													
90	89	42.8495331	-88.35181238				DEEP																															
91	90	42.849173	-88.35182196				DEEP																															
92	91	42.8488129	-88.35183153				DEEP																															
93	92	42.8484529	-88.35184111				DEEP																															
94	93	42.8480928	-88.35185068				DEEP																															
95	94	42.8477327	-88.35186026				DEEP																															
96	95	42.8473727	-88.35186983				DEEP																															
97	96	42.8470126	-88.35187941				DEEP																															
98	97	42.8466525	-88.35188898				DEEP																															
99	98	42.8462925	-88.35189856				DEEP																															
100	99	42.8459324	-88.35190813	5	M			1									1			1		1		1													
101	100	42.8455723	-88.3519177	3.5	S		NO PLANTS								V		V			v																	
102	101	42.8516864	-88.35126555	3	S			1				1								v																	
103	102	42.8513263	-88.35127513	7	M		NO PLANTS																															
104	103	42.8509663	-88.35128471	14	M		NO PLANTS																															
105	104	42.8506062	-88.35129429				DEEP																															
106	105	42.8502461	-88.35130387				DEEP																															
107	106	42.8498861	-88.35131345				DEEP																															
108	107	42.849526	-88.35132303				DEEP																															
109	108	42.8491659	-88.35133261				DEEP																															
110	109	42.8488059	-88.35134219				DEEP																															
111	110	42.8484458	-88.35135176				DEEP																															
112	111	42.8480857	-88.35136134				DEEP																															
113	112	42.8477257	-88.35137092				DEEP																															
114	113	42.8473656	-88.3513805	3.5	S			1				1																										
115	114	42.8520394	-88.3507666	8	M			1									1																				
116	115	42.8516793	-88.35077618				DEEP																															
117	116	42.8513193	-88.35078577				DEEP																															
118	117	42.8509592	-88.35079535				DEEP																															
119	118	42.8505991	-88.35080493				DEEP																															
120	119	42.8502391	-88.35081451				DEEP																															
121	120	42.849879	-88.3508241				DEEP																															
122	121	42.849519	-88.35083368				DEEP																															
123	122	42.8491589	-88.35084326				DEEP																															
124	123	42.8487988	-88.35085284				DEEP																															
125	124	42.8484388	-88.35086242				DEEP																															
126	125	42.8480787	-88.350872				DEEP																															
127	126	42.8477186	-88.35088158	12	S		NO PLANTS																															

Table continued on next page.

Table B.3 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BO	BR	BU	BW	CI	CP	CR	CZ	DE	EF	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
128	127	42.8473586	-88.35089116				ON LAND																														
129	128	42.8527525	-88.35025806	4	M			1				V					1							1		v											
130	129	42.8523924	-88.35026764	6.5	M			1								1	1			1						1											
131	130	42.8520323	-88.35027723	14	M			2	2																												
132	131	42.8516723	-88.35028682				DEEP																														
133	132	42.8513122	-88.3502964				DEEP																														
134	133	42.8509522	-88.35030599				DEEP																														
135	134	42.8505921	-88.35031557				DEEP																														
136	135	42.850232	-88.35032516				DEEP																														
137	136	42.849872	-88.35033474				DEEP																														
138	137	42.8495119	-88.35034433				DEEP																														
139	138	42.8491518	-88.35035391				DEEP																														
140	139	42.8487918	-88.3503635				DEEP																														
141	140	42.8484317	-88.35037308	14.5	M			1	1																												
142	141	42.8480716	-88.35038266	13.5	S			1	1								1																				
143	142	42.8477116	-88.35039225	9	M			2	2															2													
144	143	42.8473515	-88.35040183				ON LAND																														
145	144	42.8531055	-88.34975909	4.5	M			1				1								1				1	1	1											
146	145	42.8527454	-88.34976868	6	M		NO PLANTS																														
147	146	42.8523854	-88.34977827	7	M		NO PLANTS																														
148	147	42.8520253	-88.34978786	12.5	M		NO PLANTS																														
149	148	42.8516652	-88.34979745				DEEP																														
150	149	42.8513052	-88.34980704				DEEP																														
151	150	42.8509451	-88.34981662				DEEP																														
152	151	42.850585	-88.34982621				DEEP																														
153	152	42.850225	-88.3498358				DEEP																														
154	153	42.8498649	-88.34984539				DEEP																														
155	154	42.8495049	-88.34985498				DEEP																														
156	155	42.8491448	-88.34986456				DEEP																														
157	156	42.8487847	-88.34987415				DEEP																														
158	157	42.8484247	-88.34988374	13	M			1									1																				
159	158	42.8480646	-88.34989332	8.5	S		NO PLANTS																														
160	159	42.8477045	-88.34990291	7	M			1									1							1													
161	160	42.8473445	-88.3499125	5	M			1				1					1																				
162	161	42.8534585	-88.34926012	4	M			2				1					1			1																	
163	162	42.8530984	-88.34926971	5.5	M			1																		1											
164	163	42.8527384	-88.34927931	6	M		NO PLANTS																														
165	164	42.8523783	-88.3492889	7	M		NO PLANTS																														
166	165	42.8520182	-88.34929849	9.5	M			1																1													
167	166	42.8516582	-88.34930808				DEEP																														
168	167	42.8512981	-88.34931767				DEEP																														
169	168	42.850938	-88.34932726				DEEP																														
170	169	42.850578	-88.34933685				DEEP																														
171	170	42.8502179	-88.34934644				DEEP																														
172	171	42.8498579	-88.34935603				DEEP																														
173	172	42.8494978	-88.34936562	15	M		different chara?	1	1		1	1																									
174	173	42.8491377	-88.34937522	15	M		NO PLANTS																														
175	174	42.8487777	-88.3493848	13.5	M			1	1																												
176	175	42.8484176	-88.34939439	11	M			1	1															1			1										
177	176	42.8480575	-88.34940398	8	M		NO PLANTS																														
178	177	42.8476975	-88.34941357	6.5	M			1																1													
179	178	42.8473374	-88.34942316	4.5	M			1				1					1							1													
180	179	42.8469774	-88.34943275	3	M			3				3		2	3						1	2	1													
181	180	42.8534514	-88.34877074	4	M			2				2					1																			
182	181	42.8530914	-88.34878034	5	M			2				2					1						1	1		1										
183	182	42.8527313	-88.34878993	6	M		NO PLANTS																														
184	183	42.8523712	-88.34879952	6.5	M			1									1							1													
185	184	42.8520112	-88.34880912	8	M		NO PLANTS																														
186	185	42.8516511	-88.34881871	13	M			1									1																				
187	186	42.8512911	-88.34882831				DEEP																														
188	187	42.850931	-88.3488379				DEEP																														
189	188	42.8505709	-88.34884749				DEEP																														
190	189	42.8502109	-88.34885709				DEEP																														
191	190	42.8498508	-88.34886668	14	M		NO PLANTS																														
192	191	42.8494907	-88.34887627	13	M			1									1																				
193	192	42.8491307	-88.34888587	11	R		NO PLANTS																														
194	193	42.8487706	-88.34889546	9	M			1									1																				
195	194	42.8484105	-88.34890505	8	M			1																1													
196	195	42.8480505	-88.34891465	7	M		NO PLANTS																														
197	196	42.8476904	-88.34892424	5.5	M		NO PLANTS																														

Table continued on next page.

Table B.3 (Continued)

	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BO	BR	BU	BW	CI	CP	CR	CZ	DE	EF	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
198	197	42.8473304	-88.34893383	4	M			1									1							1													
199	198	42.8469703	-88.34894342	4.5	M			1									1																				
200	199	42.8466102	-88.34895301	2	M			2					1	1	2							v	1														
201	200	42.8534444	-88.34828136	4	S			1									1																				
202	201	42.8530843	-88.34829096	5	M			2				2					2							1													
203	202	42.8527242	-88.34830055	6	M		NO PLANTS																														
204	203	42.8523642	-88.34831015	6.5	M			1									1									1											
205	204	42.8520041	-88.34831975	7	M			2				1					2									1											
206	205	42.8516441	-88.34832935	8.5	M		NO PLANTS																														
207	206	42.851284	-88.34833894				DEEP																														
208	207	42.8509239	-88.34834854				DEEP																														
209	208	42.8505639	-88.34835814				DEEP																														
210	209	42.8502038	-88.34836773				DEEP																														
211	210	42.8498437	-88.34837733	12	M			1																1													
212	211	42.8494837	-88.34838692	10	M			1																1													
213	212	42.8491236	-88.34839652	9.5	M			1	1															1													
214	213	42.8487636	-88.34840612	8	M		NO PLANTS																														
215	214	42.8484035	-88.34841571	7	M		NO PLANTS																														
216	215	42.8480434	-88.34842531	7	M		NO PLANTS																														
217	216	42.8476834	-88.3484349	6	M			1													1																
218	217	42.8473233	-88.3484445	5	M			2				2																									
219	218	42.8469632	-88.34845409	2.5	M			1				v												1													
220	219	42.8466032	-88.34846369	4	M			3							3									1		1											
221	220	42.8462431	-88.34847328	2.5	M			3				3	2		v								2		v												
222	221	42.845883	-88.34848287				ON LAND																														
223	222	42.8534373	-88.34779198	3.5	S		NO PLANTS																														
224	223	42.8530772	-88.34780158	5	M			2				1					1				1				2												
225	224	42.8527172	-88.34781118	5.5	M			2									2							1													
226	225	42.8523571	-88.34782078	6	M			1				1			1		1							1													
227	226	42.8519971	-88.34783038	5.5	M		NO PLANTS													v																	
228	227	42.851637	-88.34783998	7.5	M			1							1											1											
229	228	42.8512769	-88.34784958				DEEP																														
230	229	42.8509169	-88.34785918				DEEP																														
231	230	42.8505568	-88.34786878	12	M		NO PLANTS																														
232	231	42.8501967	-88.34787838	10.5	M			1									1																				
233	232	42.8498367	-88.34788798	10	M		NO PLANTS																														
234	233	42.8494766	-88.34789757	8	M		NO PLANTS																														
235	234	42.8491166	-88.34790717	7	M		NO PLANTS																														
236	235	42.8487565	-88.34791677	6.5	M			1																1													
237	236	42.8483964	-88.34792637	6.5	M			1				1												1													
238	237	42.8480364	-88.34793597	6	M			1																1													
239	238	42.8476763	-88.34794557	5	M			1																1													
240	239	42.8473162	-88.34795516	4.5	M			1				1												1													
241	240	42.8469562	-88.34796476	4	M			1				V					1							1													
242	241	42.8465961	-88.34797436	3.5	M			3	2			2	1		3								1	1													
243	242	42.846236	-88.34798396	3	M			3	v			3			v																						
244	243	42.8530702	-88.3473122	4	M		NO PLANTS																														
245	244	42.8527101	-88.3473218	4	M			3				3												1													
246	245	42.8523501	-88.34733141	2.5	R		NO PLANTS								V																						
247	246	42.8509098	-88.34736982	11.5	M			1				1																									
248	247	42.8505497	-88.34737942	9	M			1				1					1							1													
249	248	42.8501897	-88.34738902	8	M		NO PLANTS																														
250	249	42.8498296	-88.34739862	8.5	M			1				1																									
251	250	42.8494696	-88.34740822	7.5	M			1				1			1											1											
252	251	42.8491095	-88.34741783	7	M		NO PLANTS																														
253	252	42.8487494	-88.34742743	6.5	M			1				1																									
254	253	42.8483894	-88.34743703	6	M			1									1							1													
255	254	42.8480293	-88.34744663	5.5	M			1				1												1													
256	255	42.8476692	-88.34745623	5.5	M			1									1																				
257	256	42.8473092	-88.34746583	4.5	M			1				1																									
258	257	42.8469491	-88.34747543	4.5	M			1									1									1											
259	258	42.846589	-88.34748503	3	M			2				2			1				v	2						2											
260	259	42.8530631	-88.34682282	2.5	S			1	1																												
261	260	42.8509027	-88.34688046	6.5	M			2				2																									
262	261	42.8505427	-88.34689006	7	M			1				1																									
263	262	42.8501826	-88.34689967	7	M			1				1												1													
264	263	42.8498225	-88.34690927	6.5	M			1				1												1													
265	264	42.8494625	-88.34691887	6	M			1									1							1		1											
266	265	42.8491024	-88.34692848	6.5	M			1												v						1											
267	266	42.8487424	-88.34693808	5.5	M			2				1					2																				

Table continued on next page.

Table B.3 (Continued)

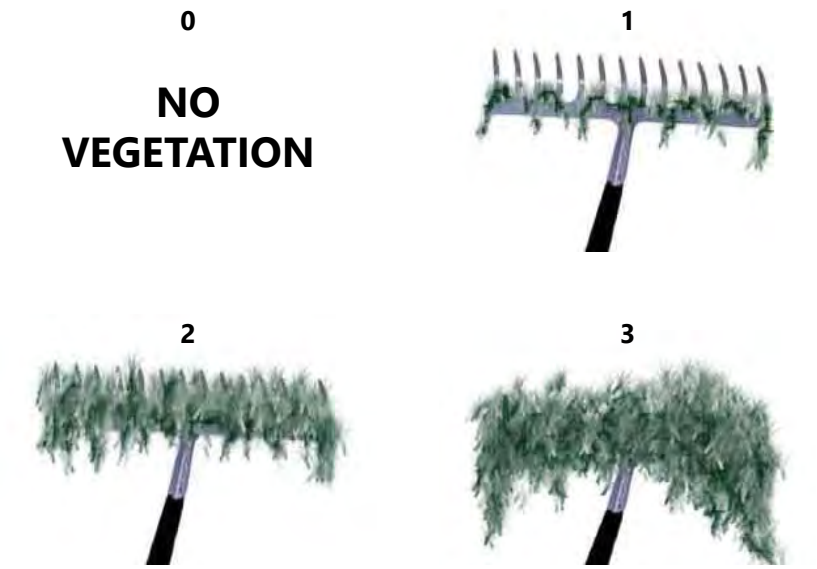
	J	K	L	M	N	O	P	Q	R	S	AE	AG	AQ	AW	BO	BR	BU	BW	CI	CP	CR	CZ	DE	EF	ER	ES	ET	EU	EV	EW	EX	EY	EZ	FA	FB	FC	FD
268	267	42.8483823	-88.34694769	5	M			1				1					1																				
269	268	42.8480222	-88.34695729	5	M			2				2					2																				
270	269	42.8476622	-88.34696689	4.5	M			3				3					3							v												
271	270	42.8473021	-88.3469765	4	M			2												1				2		2										
272	271	42.846942	-88.3469861	3.5	M			3				3			V											1										
273	272	42.8505356	-88.3464007	6.5	M			2				2													1											
274	273	42.8501755	-88.34641031	6	M			1				1			1																					
275	274	42.8498155	-88.34641992	4.5	R		NO PLANTS																													
276	275	42.8505285	-88.34591134	5	M		NO PLANTS								v																					
277	276	42.8501685	-88.34592095	5	M			1				1					1									v										

Table B.4
Summary Statistics for the Upper Phantom Lake Point-Intercept Aquatic Plant Survey: August 7 – 8, 2017

	B	C	D	Q	S	AC	AI	BA	BD	BG	BU	CB	CD	CL	CQ	DR	ED	EE	EL	EM	EN
1	**STATS**	Total vegetation	*Myriophyllum spicatum*, Eurasian water milfoil	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Elodea canadensis, Common waterweed	Heteranthera dubia, Water star-grass	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Najas marina, Spiny naiad	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton richardsonii, Clasping-leaf pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Stuckenia pectinata, Sago pondweed	Utricularia vulgaris, Common bladderwort	Vallisneria americana, Wild celery	Aquatic moss	Freshwater sponge	Filamen
2	Upper Phantom																				
3	Waukesha																				
4	766000																				
5	8/7 to 8/8/2017																				
6	**INDIVIDUAL SPECIES STATS:**																				
7	**Frequency of occurrence within vegetated areas (%)**		14.29	0.89	50.89	3.57	1.79	9.82	0.89	46.43		12.50	0.89	3.57	1.79	39.29	2.68	17.86			
8	**Frequency of occurrence at sites shallower than maximum depth of plants**		10.06	0.63	35.85	2.52	1.26	6.92	0.63	32.70		8.81	0.63	2.52	1.26	27.67	1.89	12.58			
9	**Relative Frequency (%)**		6.9	0.4	24.6	1.7	0.9	4.7	0.4	22.4		6.0	0.4	1.7	0.9	19.0	1.3	8.6			
10	Relative Frequency (squared)	0.17	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.05		0.00	0.00	0.00	0.00	0.04	0.00	0.01			
11	**Number of sites where species found**		16	1	57	4	2	11	1	52		14	1	4	2	44	3	20			
12	**Average Rake Fullness**	1.40	1.56	1.00	1.46	1.25	1.50	1.64	1.00	1.13		1.07	2.00	1.00	1.50	1.05	1.33	1.10			
13	**#visual sightings**		4		4			8		1	1	7		1		1	1	3			
14	**present (visual or collected)**		present	present	present	present	present	present	present	present	present	present	present	present	present	present	present	present			
15																					
16	**SUMMARY STATS:**																				
17	**Total number of sites visited**	**159**																			
18	**Total number of sites with vegetation**	**112**																			
19	**Total number of sites shallower than maximum depth of plants**	**159**																			
20	**Frequency of occurrence at sites shallower than maximum depth of plants**	**70.44**																			
21	**Simpson Diversity Index**	**0.83**																			
22	**Maximum depth of plants (ft)****	**15.00**																			
23	**Number of sites sampled using rake on Rope (R)**	**0**																			
24	**Number of sites sampled using rake on Pole (P)**	**0**																			
25	**Average number of all species per site (shallower than max depth)**	**1.46**																			
26	**Average number of all species per site (veg. sites only)**	**2.07**																			
27	**Average number of native species per site (shallower than max depth)**	**1.03**																			
28	**Average number of native species per site (veg. sites only)**	**1.82**																			
29	**Species Richness**	**15**																			
30	**Species Richness (including visuals)**	**16**																			

APPENDIX C
UPPER AND LOWER PHANTOM LAKES AQUATIC PLANT SPECIES DETAILS

Figure C.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

Ceratophyllum demersum — Coontail

Native

Identifying Features

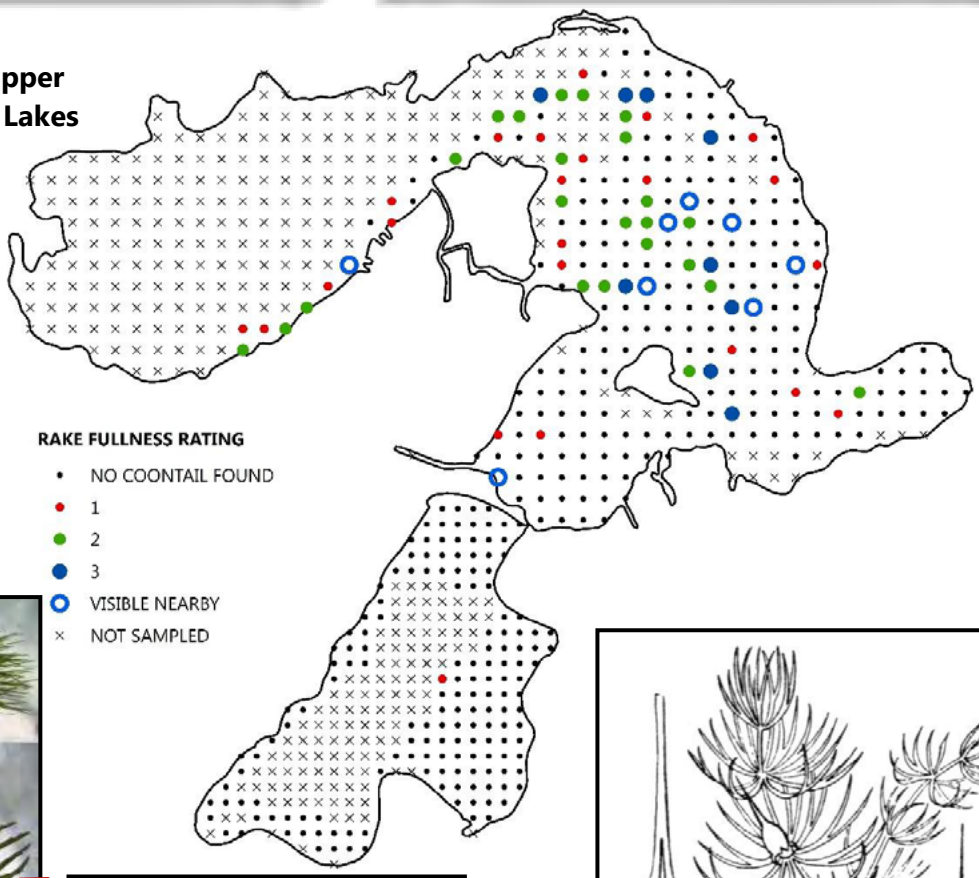
- Often bushy near tips of branches, giving the raccoon tail-like appearance ("coontail")
- Whorled leaves with one to two orders of branching and small teeth on their margins
- Flowers (rare) small and produced in leaf axils

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017

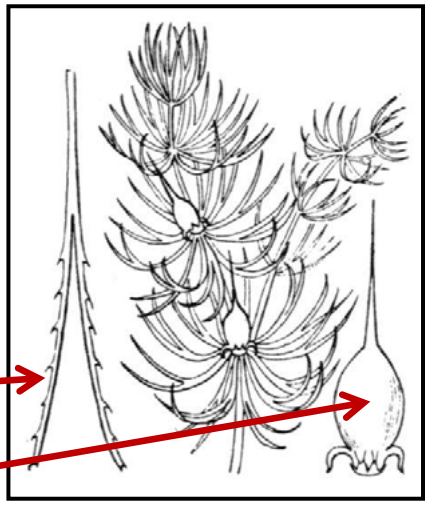


Second-Order Leaf Branching

First-Order Leaf Branching

Toothed Leaf Margins

Fruit (rare)



Chara spp.

Native

Muskgrasses

Algae (not vascular plants)

Identifying Features

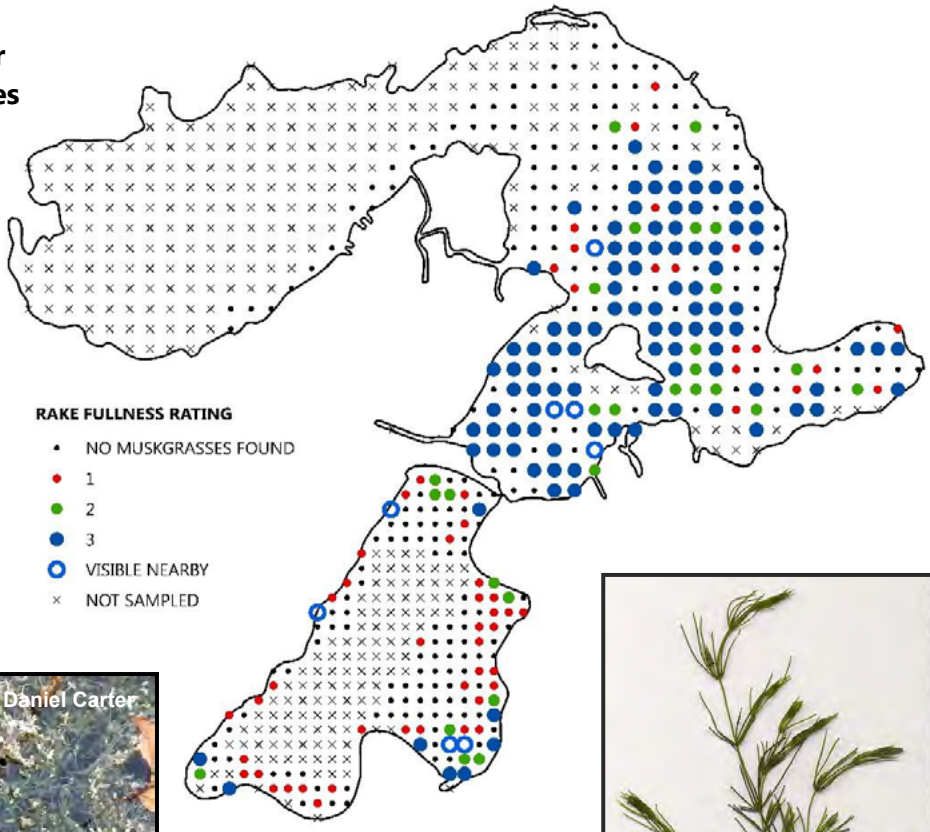
- Leaf-like, ridged side branches develop in whorls of six or more
- Often encrusted with calcium carbonate, which appears white upon drying (see photo on left, below)
- Yellow reproductive structures develop along the whorled branches in summer
- Emits a garlic-like odor when crushed

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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Elodea canadensis — Common Waterweed or Elodea

Native

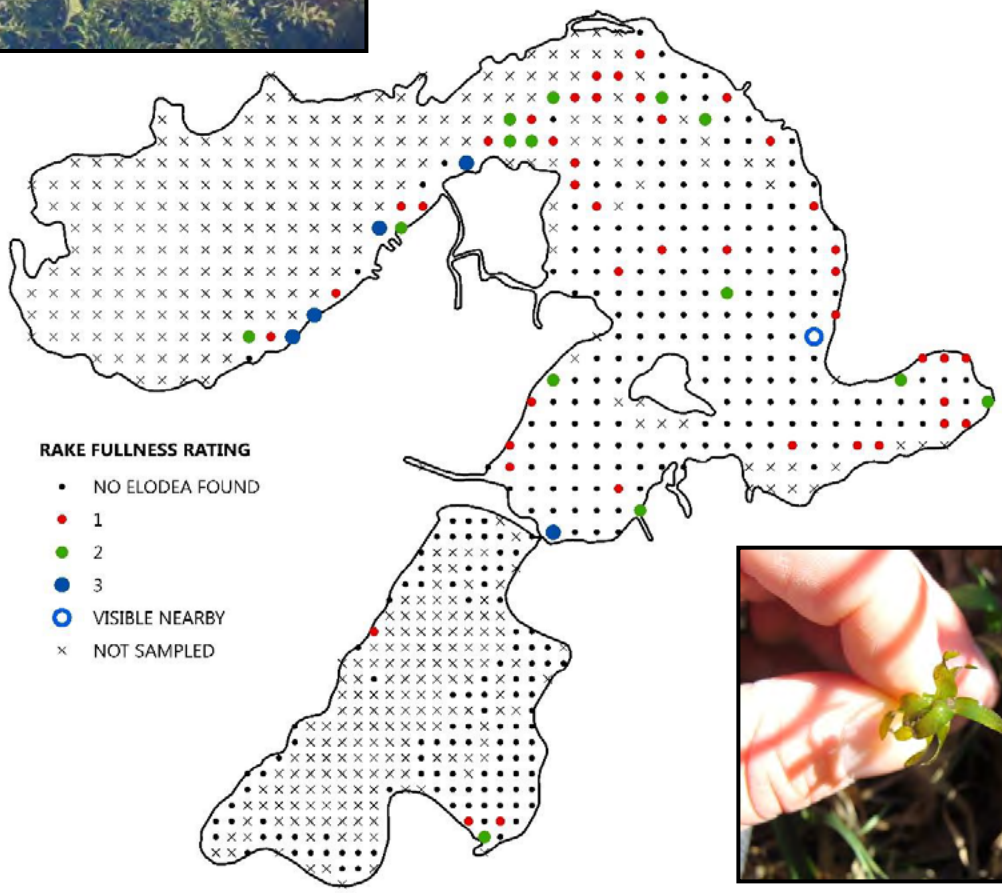
Identifying Features

- 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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Heteranthera dubia — Water Stargrass

Native

Identifying Features

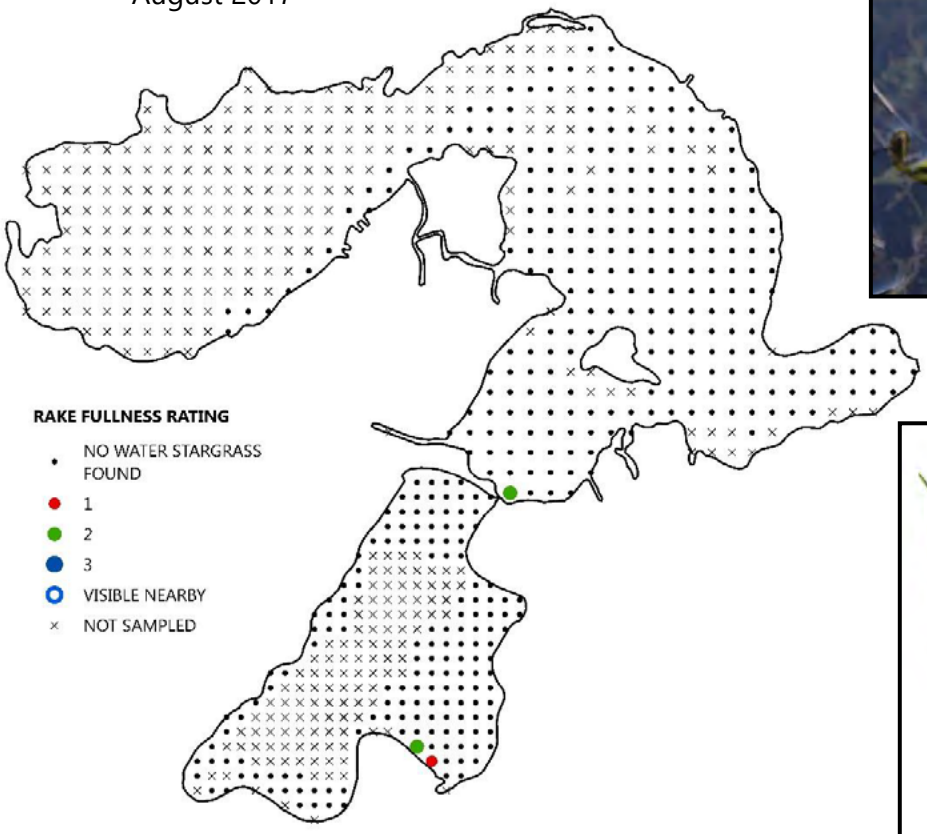
- Stems slender, slightly flattened, and branching
- Leaves narrow, alternate, with no stalk, and lacking a prominent midvein
- When produced, flowers conspicuous, yellow, and star-shaped (usually in shallow water) or inconspicuous and hidden in the bases of submersed leaves (in deeper water)

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Lythrum salicaria — Purple Loosestrife

Nonnative/Exotic

Identifying Features

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

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

Ecology/Control

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

Myriophyllum sibiricum — Northern Watermilfoil

Native

Identifying Features

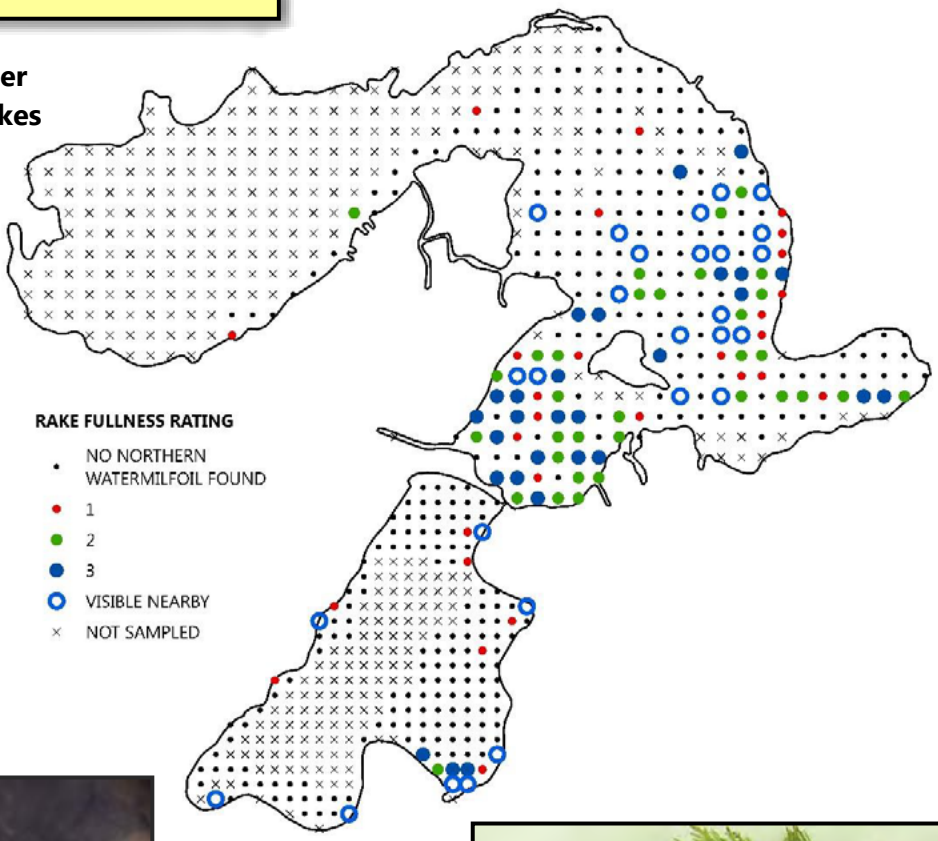
- Light-colored, stout stems
- Leaves in whorls of four to five, divided into four to 12 pairs of leaflets, lower leaflets longer than the upper ones
- Forms winter buds (turions) in autumn

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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Myriophyllum heterophyllum — Various-leaved Watermilfoil

Native

Identifying Features

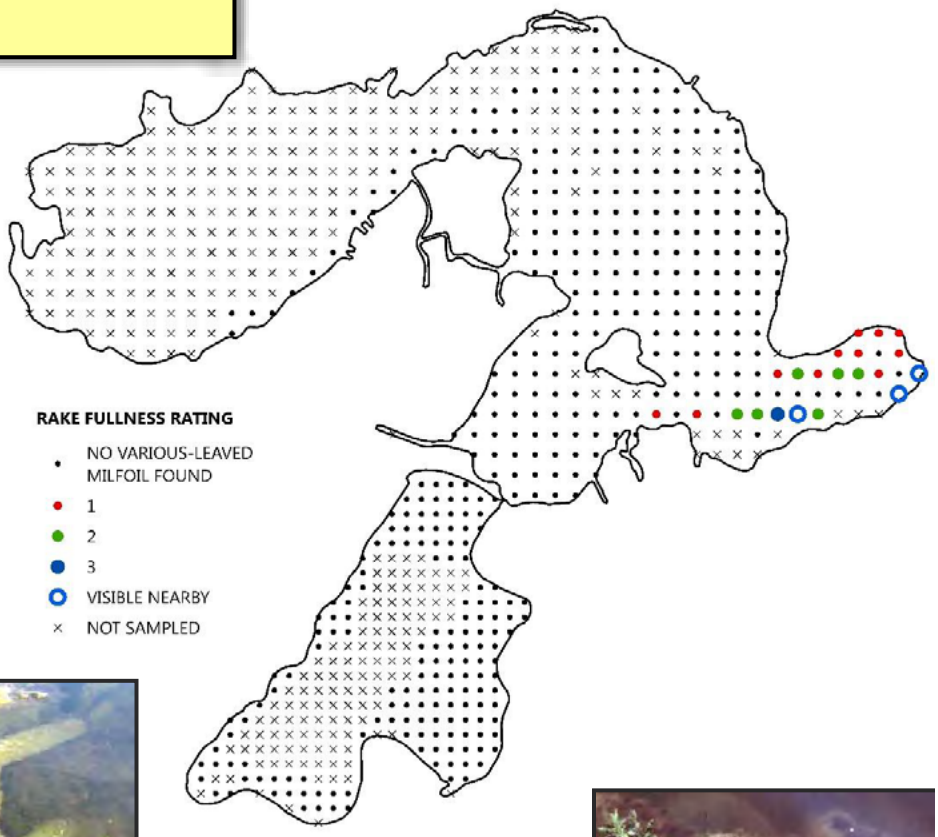
- Very short internodes lead to very bushy appearance
- Leaves in whorls of four to six, with some scattered on stem, divided into seven to 14 pairs of leaflets
- No winter buds are formed
- Flower bracts are larger than flowers and have smooth or slightly serrated edges

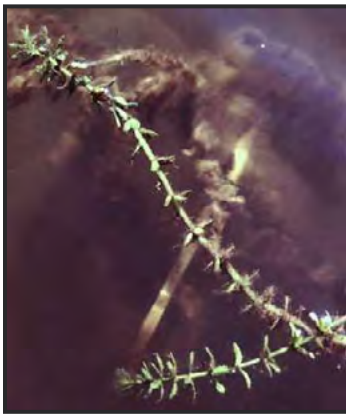
Various-leaved watermilfoil is similar to other water milfoils. Eurasian watermilfoil (*M. spicatum*) tends to be less bushy, limp out of water, and produce more leaflets per leaf

Ecology

- Found in lakes and streams, up to 15 feet but mostly shallower
- Plants on wet shorelines may produce deeply serrate "terrestrial" leave or bracts
- Consumed by waterfowl
- Provides habitat for aquatic invertebrates and shade, shelter, and foraging for fish

Lower (top) and Upper (bottom) Phantom Lakes
August 2017





Myriophyllum spicatum — Eurasian Watermilfoil

Nonnative/Exotic

Identifying Features

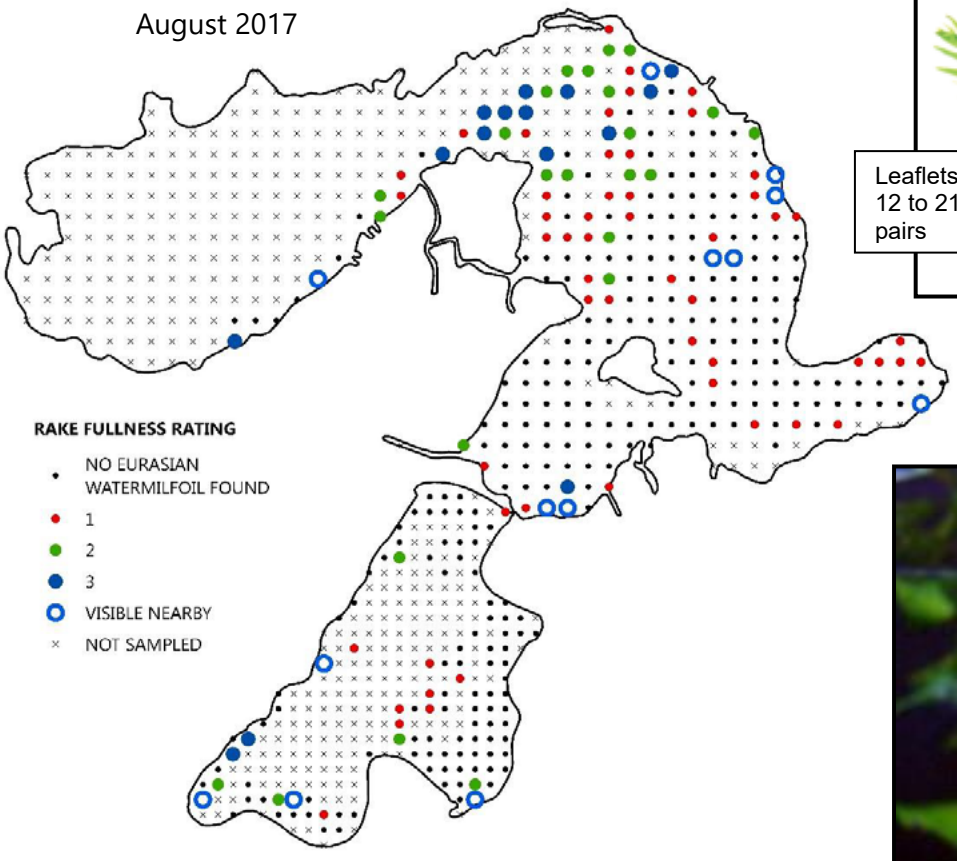
- Stems spaghetti-like, often pinkish, growing long with many branches near the water surface
- Leaves with 12 to 21 pairs of leaflets
- Produces no winter buds (turions)

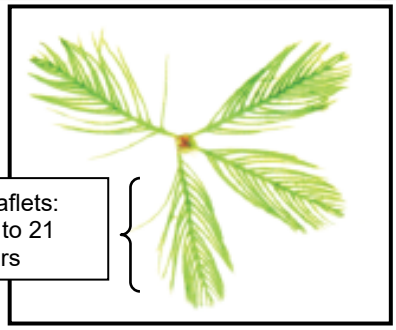
Eurasian watermilfoil is similar to northern watermilfoil (*M. sibiricum*). However, northern watermilfoil has five to 12 pairs of leaflets per leaf and stouter white or pale brown stems

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017





Najas flexilis — Bushy Pondweed or Slender Naiad

Native

Identifying Features

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

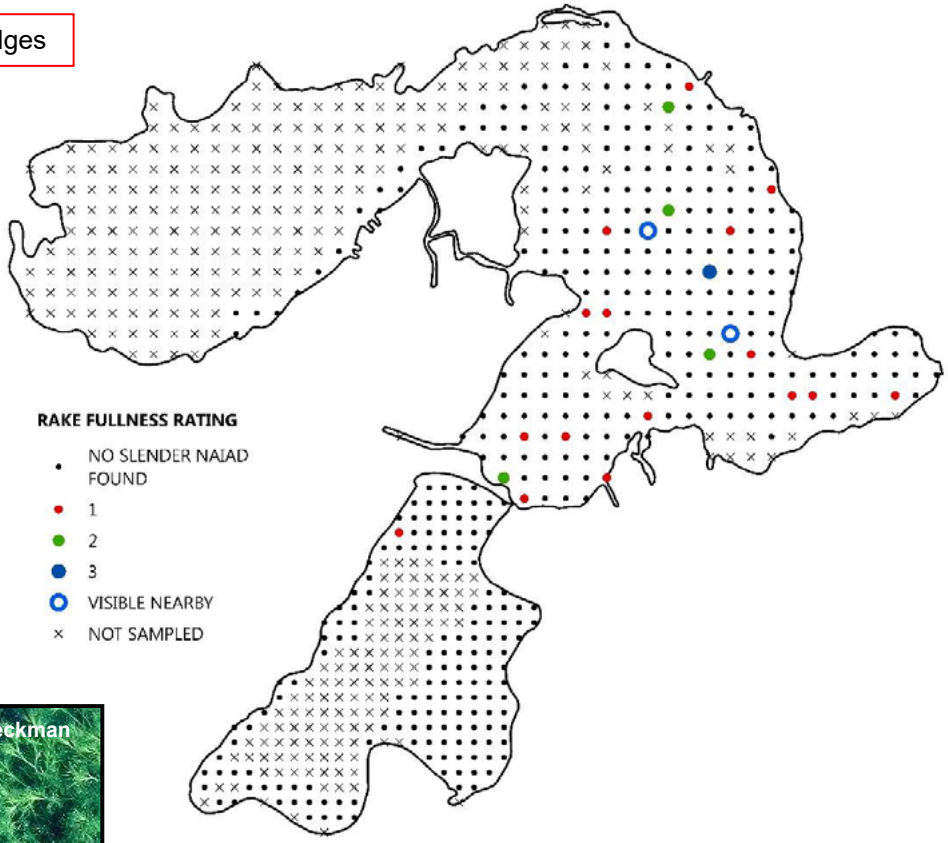
Two other *Najas* occur in southeastern Wisconsin. Southern naiad (*N. guadalupensis*) has wider leaves (to 2.0 mm). Spiny naiad (*N. marina*) has coarsely toothed leaves with spines along the midvein below

Ecology

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

Leaves narrow with serrated edges

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Najas marina — Spiny Naiad

Nonnative/Exotic

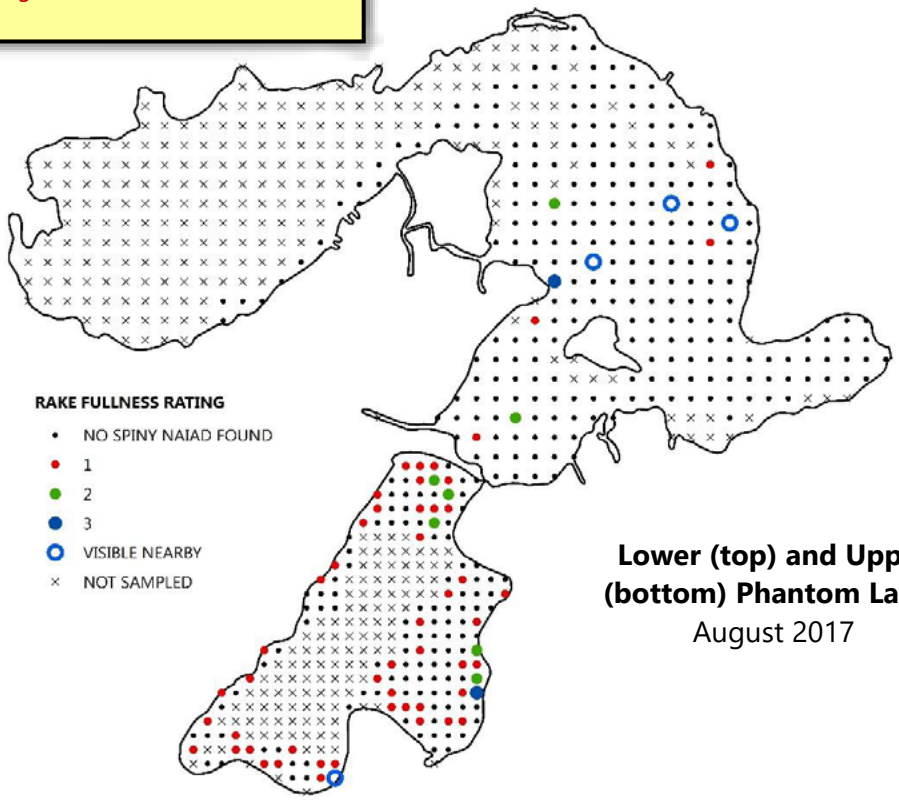
Identifying Features

- 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



Lower (top) and Upper (bottom) Phantom Lakes
August 2017


Kristian Peters

Nitella spp.

Native

Nitellas (Stoneworts)

Algae (not vascular plants)

Identifying Features

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

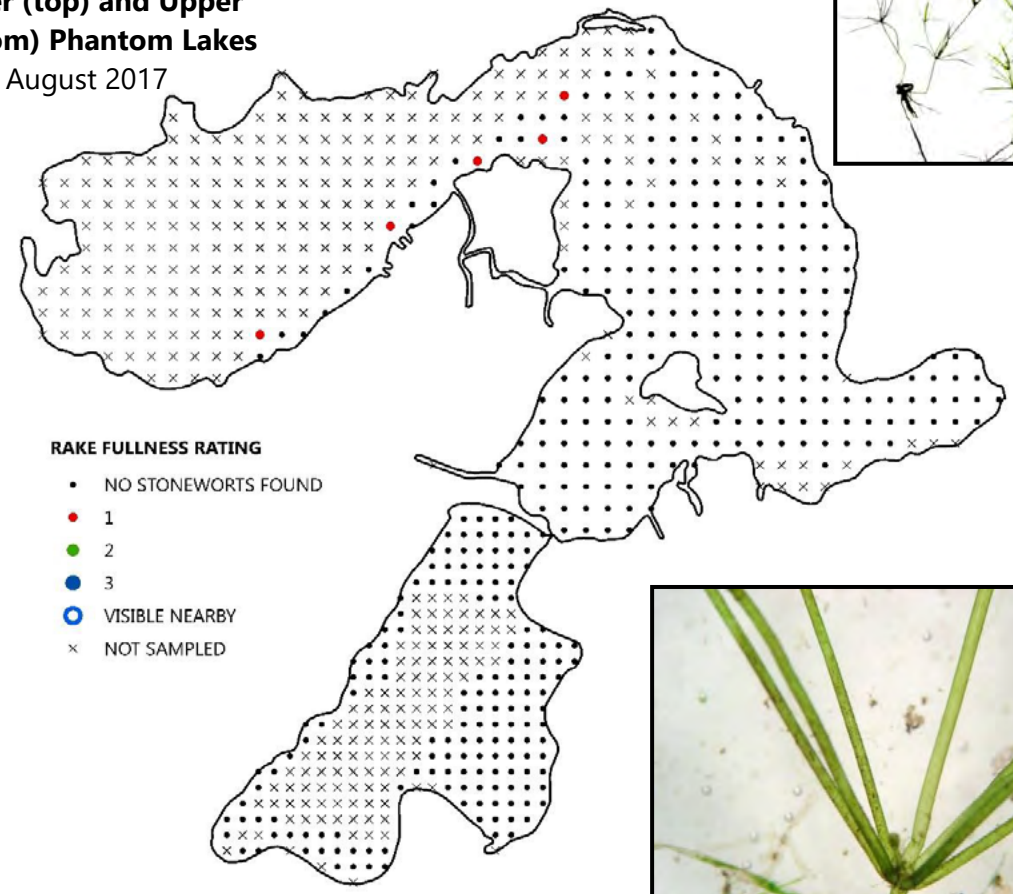
Muskgrasses (*Chara* spp.) are large algae similar to stoneworts (*Nitella* spp.), but their branches are ridged and more robust than those of stoneworts. Another similar group of algae, *Nitellopsis* spp., differ from stoneworts by having whorls of side branches that are at more acute angles to the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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes

August 2017



Nuphar variegata — Spatterdock

Native

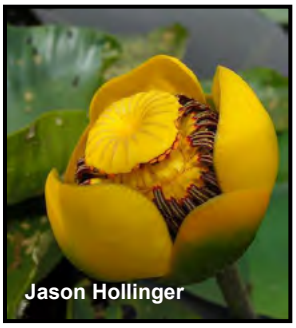
Identifying Features

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

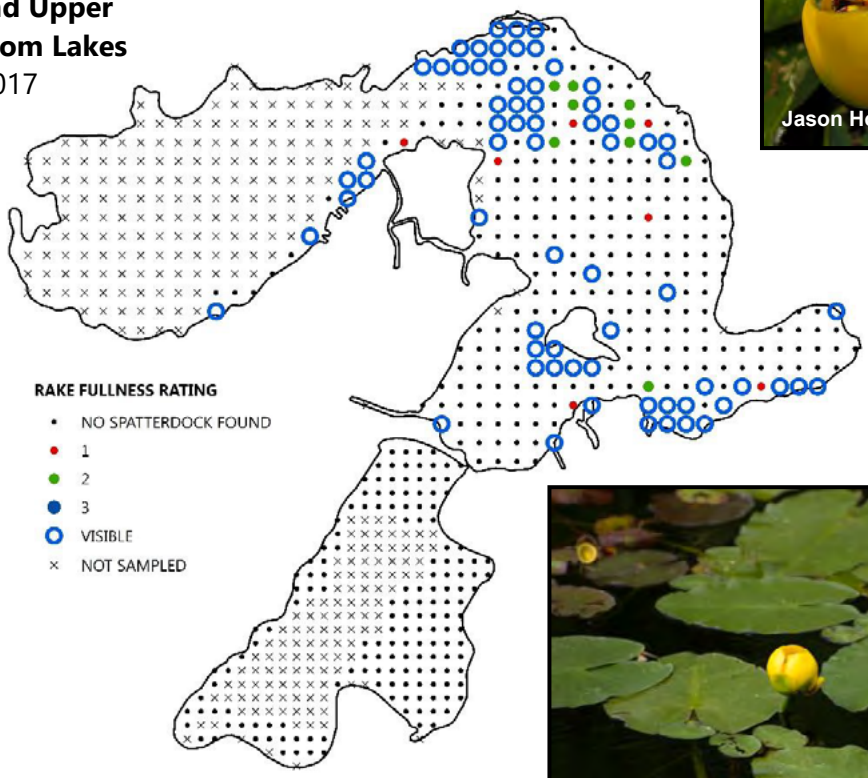
Unlike spatterdock, the similar yellow pond lily (*Nuphar advena*) has leaf stalks that are not winged in cross-section, leaves that more often emerge above the water surface, and leaf lobes that are more pointed. Spatterdock is superficially similar to water lilies (*Nymphea* spp.), but it has yellow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

Ecology

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


Jason Hollinger

Lower (top) and Upper (bottom) Phantom Lakes
August 2017




Ron Edwards

Nymphaea odorata — White Water Lily

Native

Identifying Features

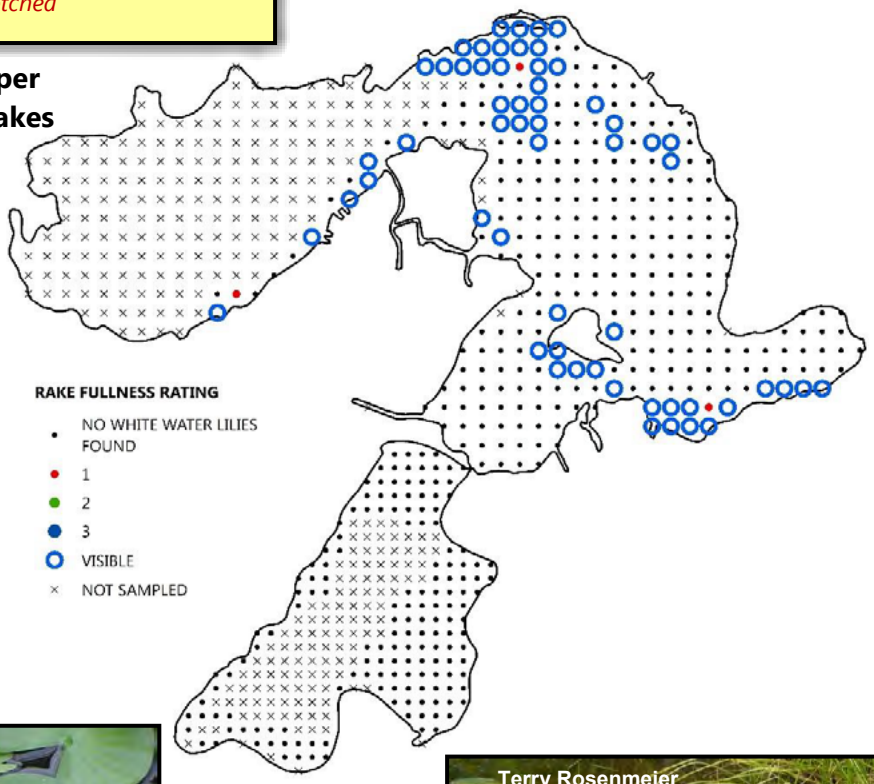
- Leaf stalks round in cross-section with four large air passages
- Floating leaves round (four to 12 inches wide under favorable conditions), *with a notch* from the outside to the center, and reddish-purple underneath
- Flowers white with a yellow center, three to nine inches wide

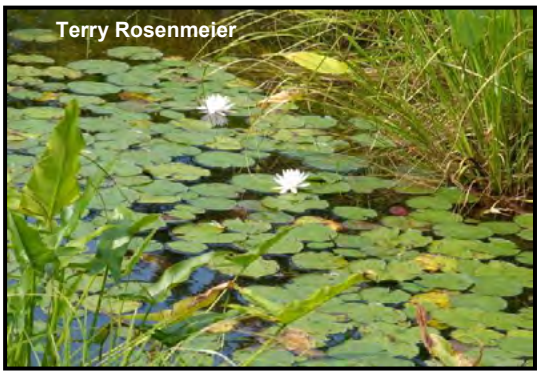
Pond lilies (*Nuphar* spp.) are superficially similar, but have yellow flowers and leaves somewhat heart-shaped. American lotus (*Nelumbo lutea*) is also similar, but its leaves are *unnotched*

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017





Potamogeton amplifolious — Large-Leaf Pondweed

Native

Identifying Features

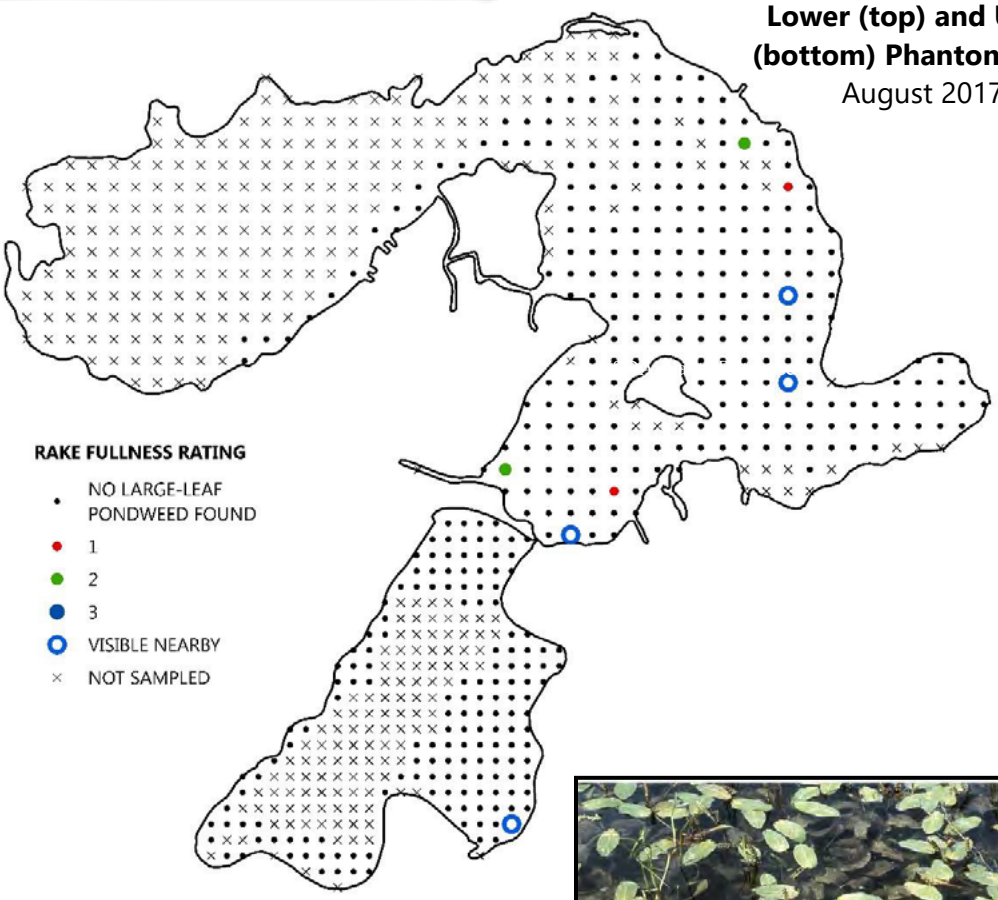
- When produced, floating leaves 2-23 cm long *with 27-49 veins* and petiole longer than leaf blade
- Submersed leaves large and sickle-shaped, 4-7 cm wide, 8-20 cm long, *with more than 19 veins*, and folded upwards along the sides
- White stipules up to 12 cm long

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton crispus — Curly-Leaf Pondweed

Nonnative/Exotic

Identifying Features

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

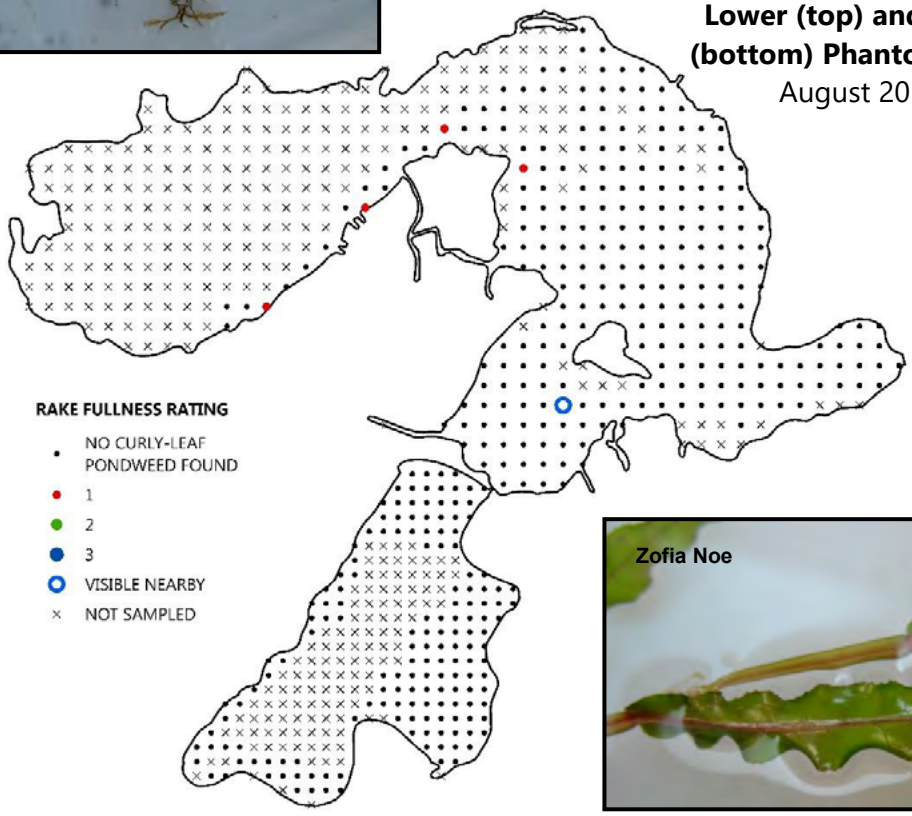
Curly-leaf pondweed may resemble clasping-leaf pondweed (*P. richardsonii*), but the leaf margins of the latter are not serrated

Ecology

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

Zofia Noe

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Zofia Noe

Potamogeton foliosus — Leafy Pondweed

Native

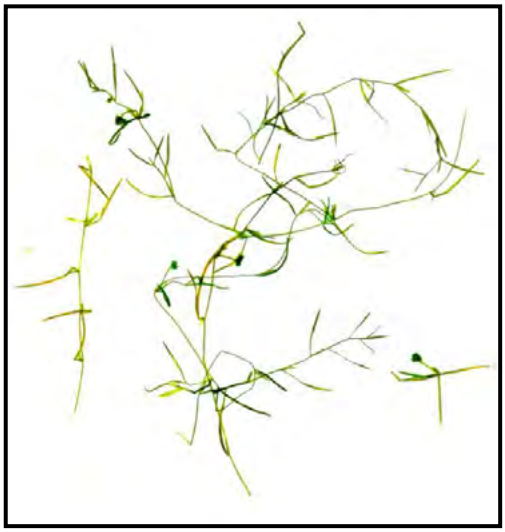
Identifying Features

- 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

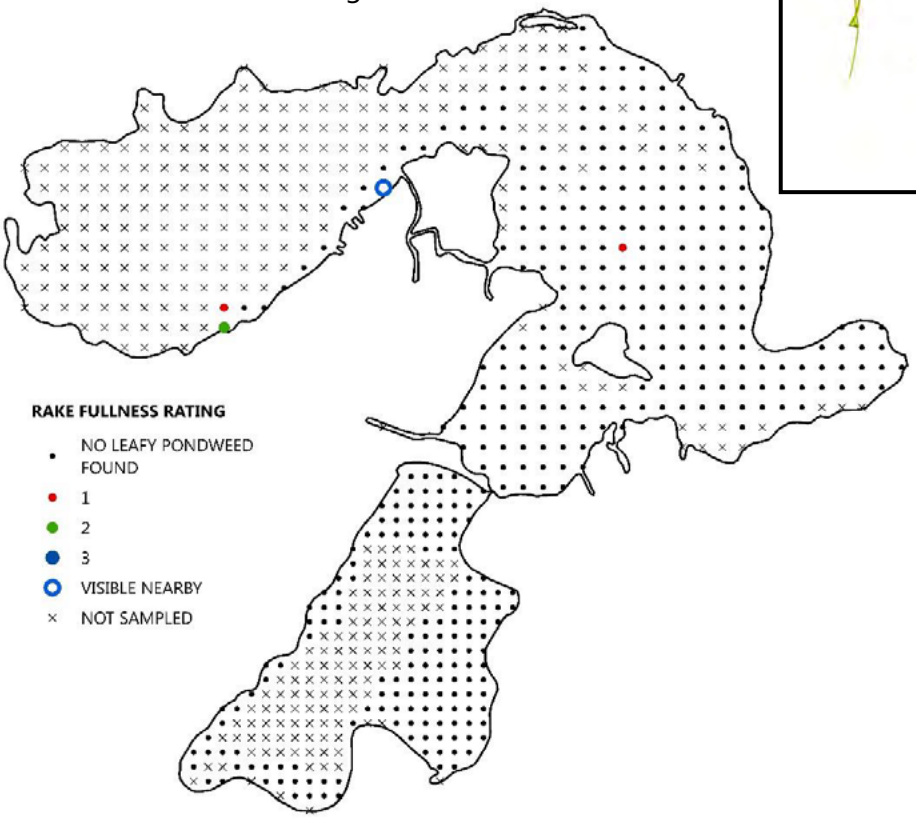
Leafy pondweed is similar to small pondweed (*P. pusillus*), when not in flower and fruit. However, unlike small pondweed, it lacks glands where the leaves meet the stem. The flowers and fruits of small pondweed are borne on longer, more slender stalks and in whorls that are spaced apart.

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



Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton friesii — Fries' Pondweed

Native

Identifying Features

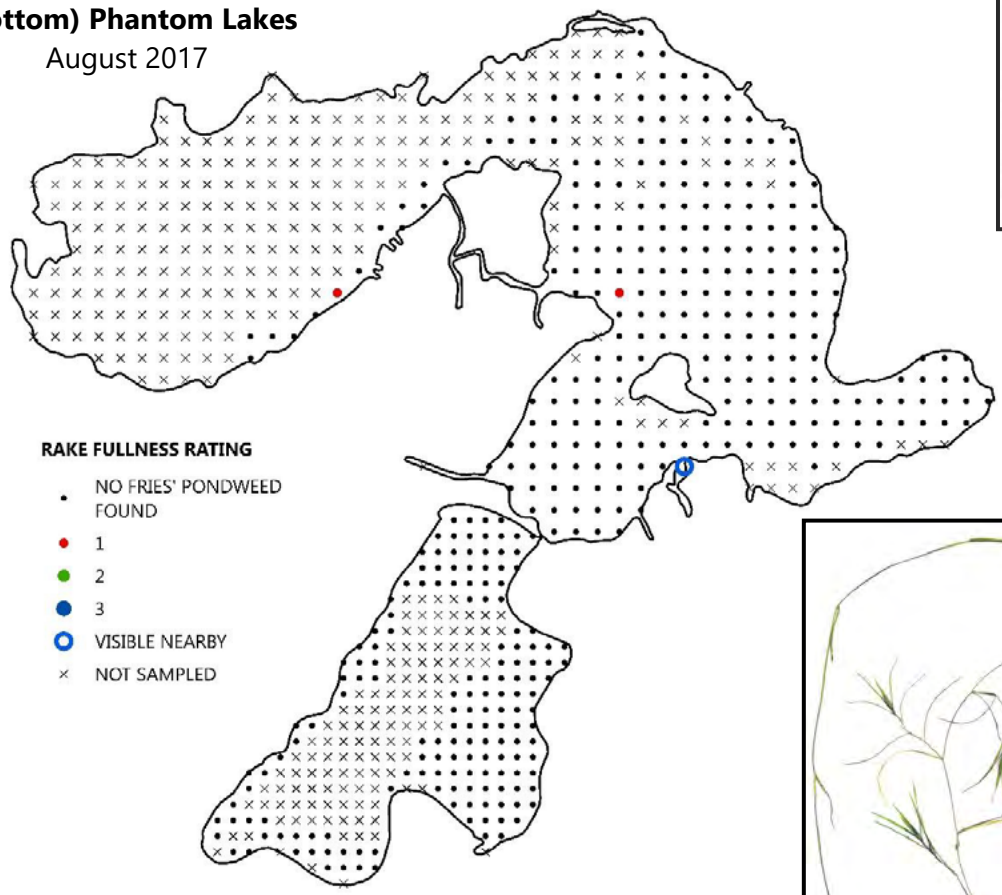
- Slender stems slightly compressed
- Submerged leaves linear with no petiole, one row of lacunar cells on each side of midvein, and 5-7 veins
- Tip of leaf rounded with short bristle
- Winter bud fan shaped and in two planes, with inner leaves at 90 degrees from outer leaves

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton gramineus — Variable Pondweed

Native

Identifying Features

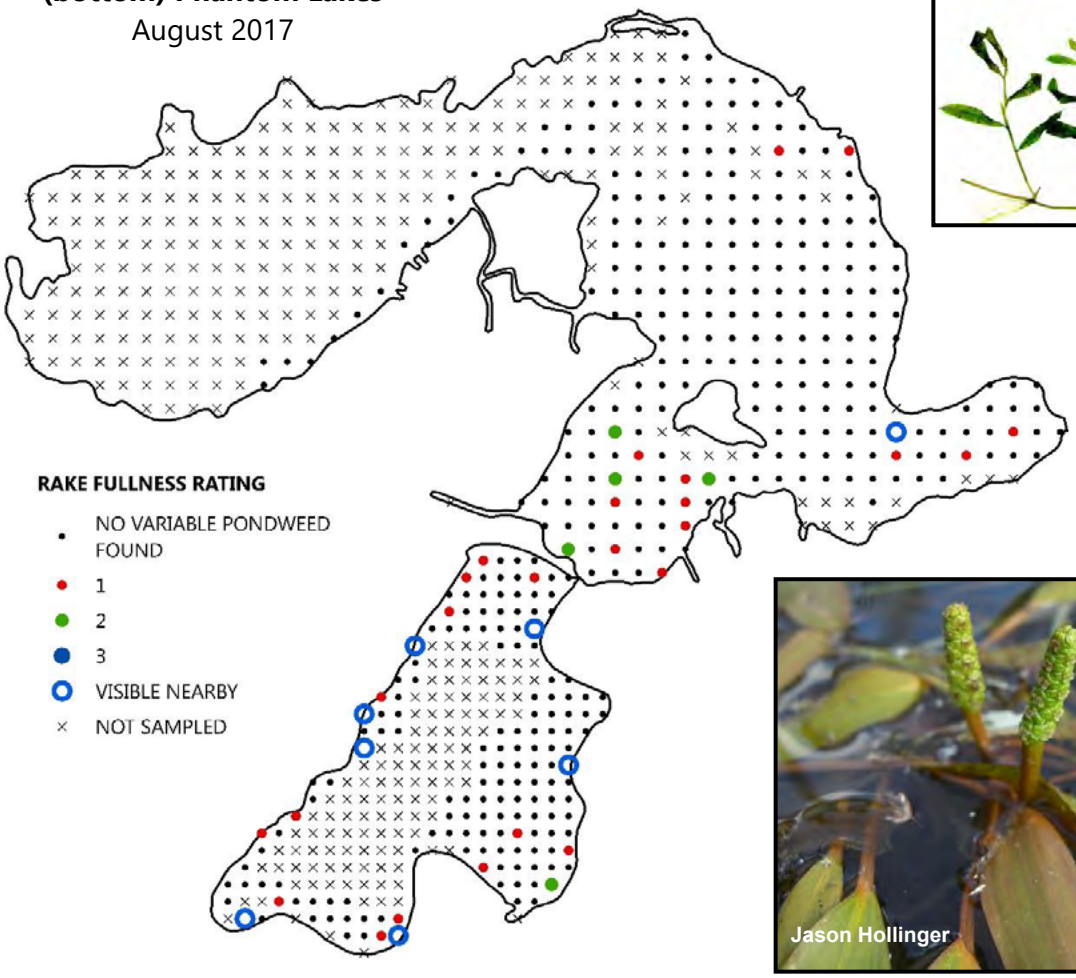
- Often heavily branched
- Submerged leaves narrow to lance-shaped, with three to seven veins, smooth margins, without stalks, but the blade tapering to the stem
- Floating leaves with 11 to 19 veins and a slender stalk that is usually longer than the blade
- Often covered with calcium carbonate in hard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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton illinoensis — Illinois Pondweed

Native

Identifying Features

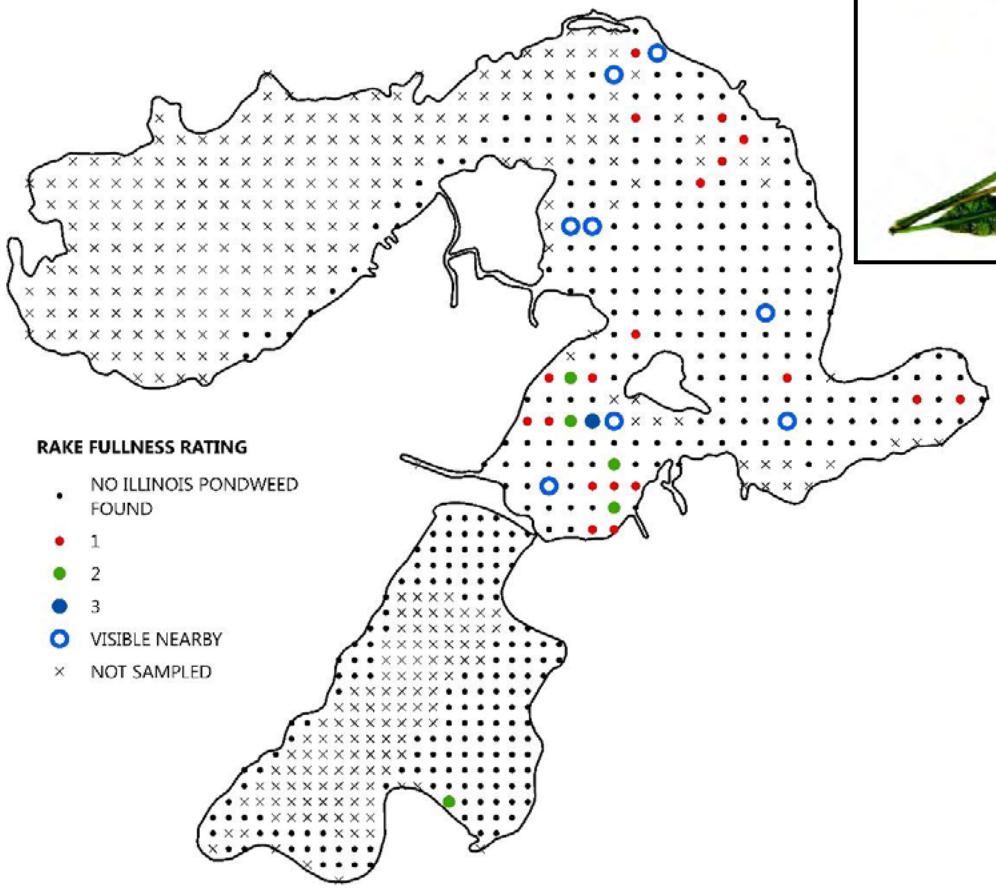
- Stout stems up to 2.0 m long, often branched
- Submerged leaves with nine to 19 veins (midvein prominent) on short stalks (up to 4.0 cm) or attached directly to the stem
- Floating leaves, if produced, elliptical, with 13 to 29 veins
- Often covered with calcium carbonate in hard water

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton natans — Floating-Leaf Pondweed

Native

Identifying Features

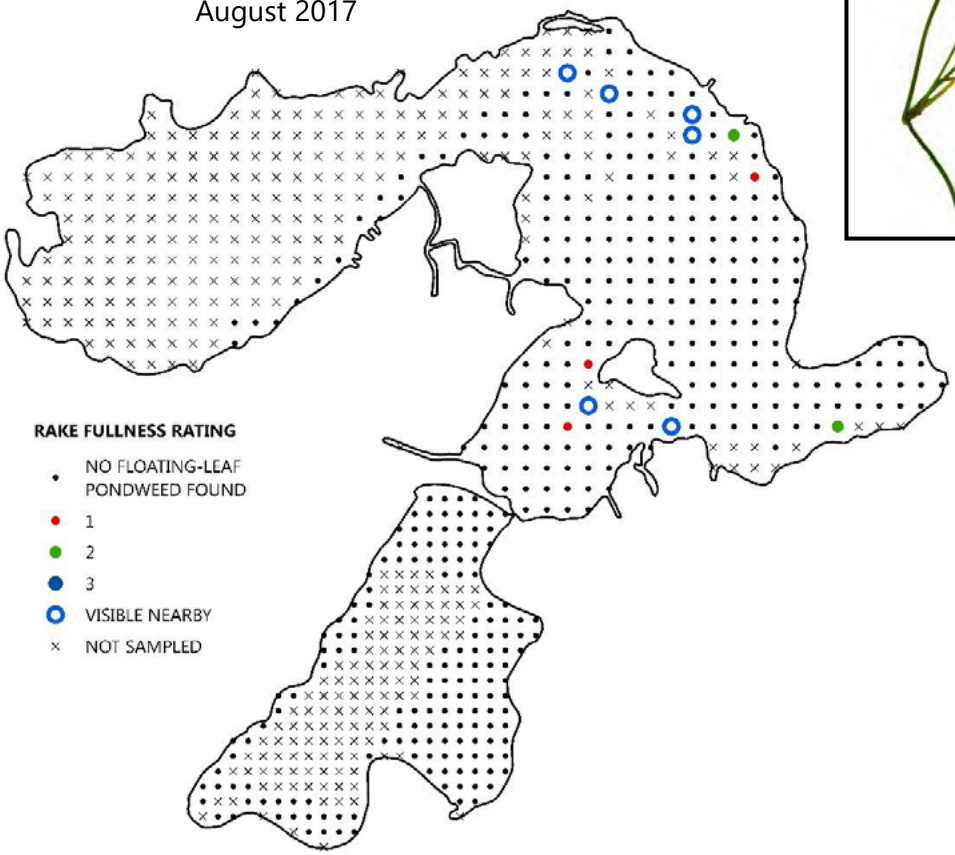
- Floating leaves (5.0 to 10 cm long) with heart-shaped bases and 17 to 37 veins
- Floating leaf stalks bent where they meet the leaf, causing the leaf to be held at roughly a 90-degree angle to the stalk
- Submersed leaves (1.0 to 2.0 mm wide) linear and stalk-like, with three to five veins

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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton praelongus — White-Stem Pondweed

Native

Identifying Features

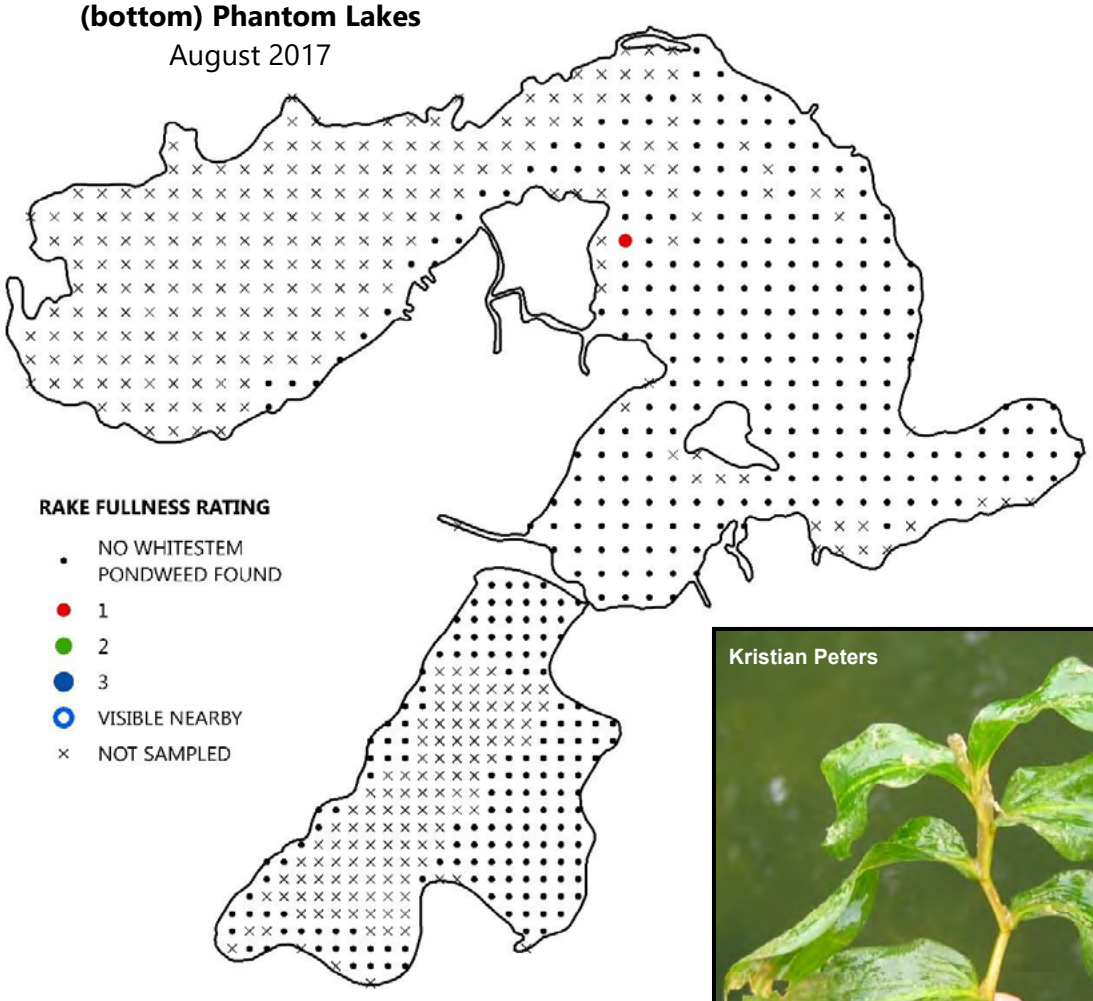
- Stems usually pale and zig-zagging
- Leaves clasping, alternate, with three to five prominent veins and 11 to 35 smaller ones, with boat-shaped tips that often split when pressed between fingers

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton richardsonii — Clasping-Leaf Pondweed

Native

Identifying Features

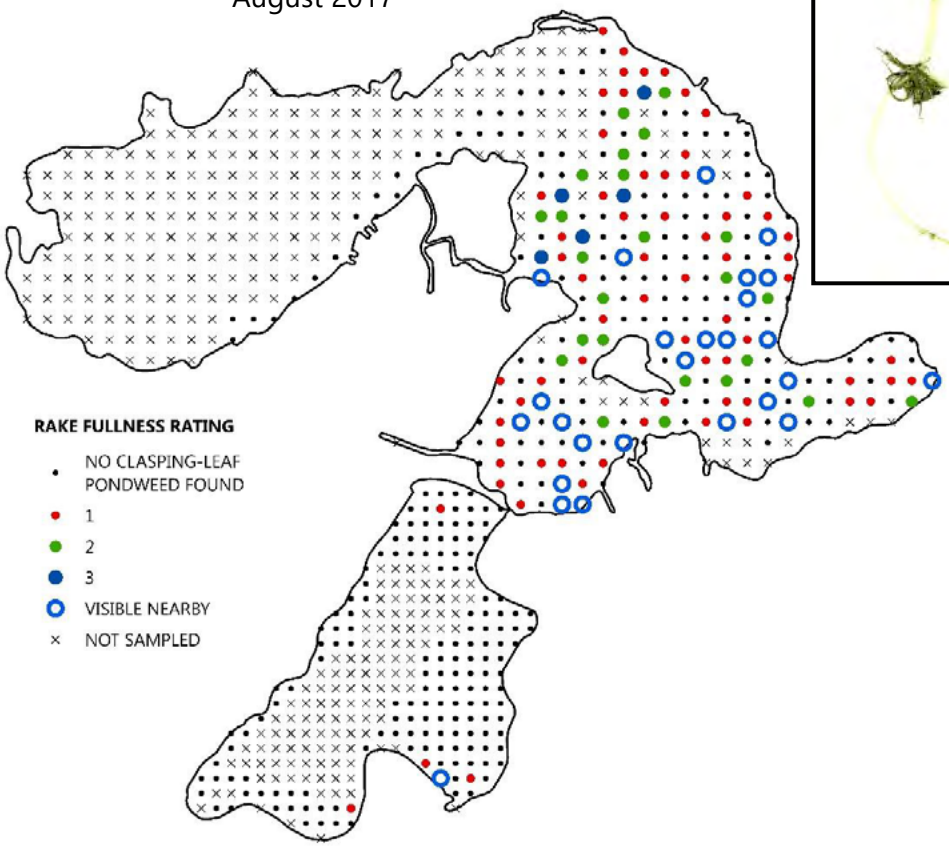
- Leaves alternating along and clasping the stem, with wavy edges, coming to a point at the tip, and often with three to five veins prominent among many more that are faintly visible
- Produces no floating leaves

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Potamogeton zosteriformis — Flat-Stem Pondweed

Native

Identifying Features

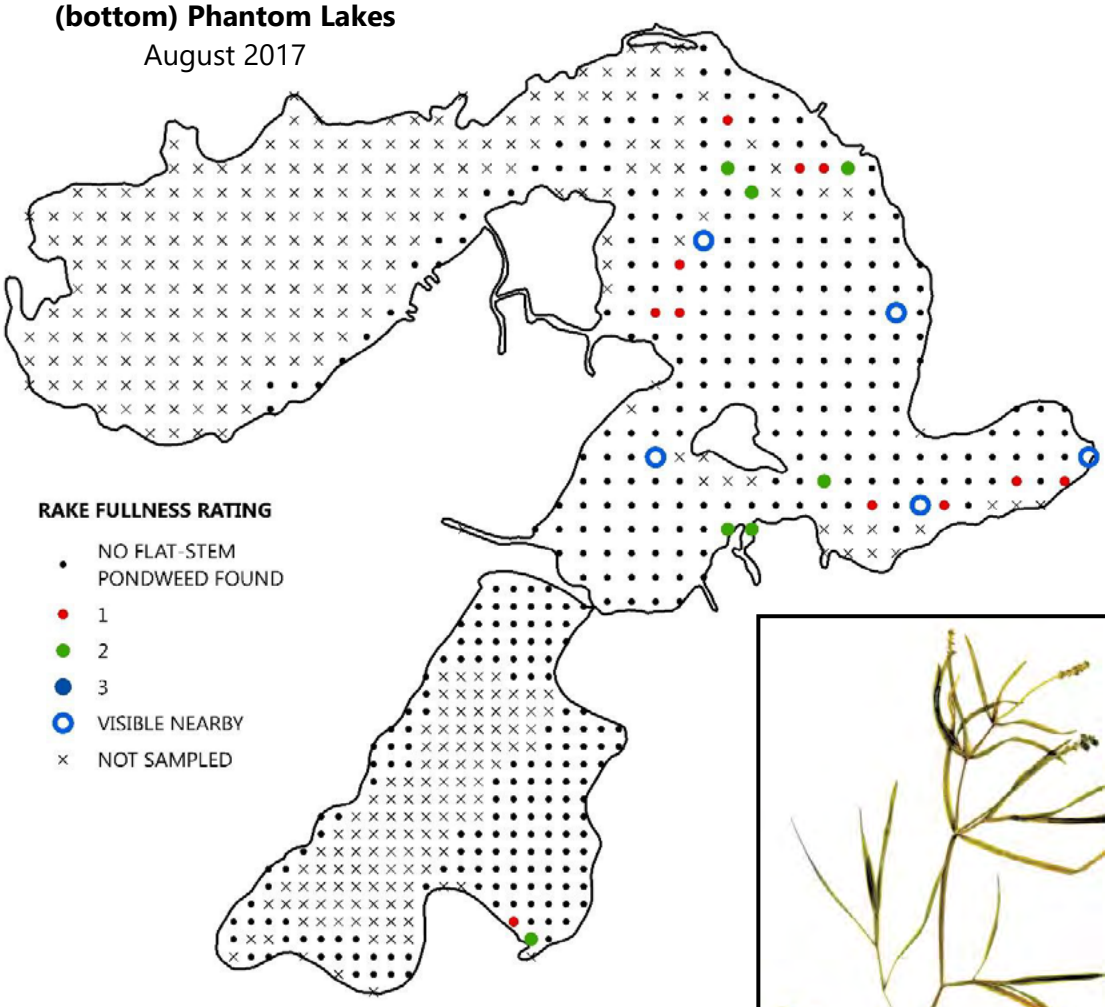
- Stems strongly flattened
- Leaves up to four to eight inches long, pointed, with a prominent midvein and many finer, parallel veins
- Stiff winter buds consisting of tightly packed ascending leaves

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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Sagittaria cuneata — Arum-Leaved Arrowhead

Native

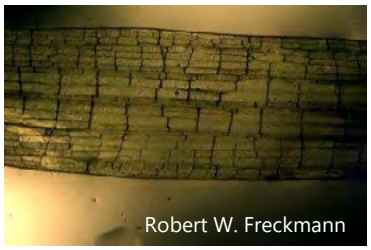
Identifying Features

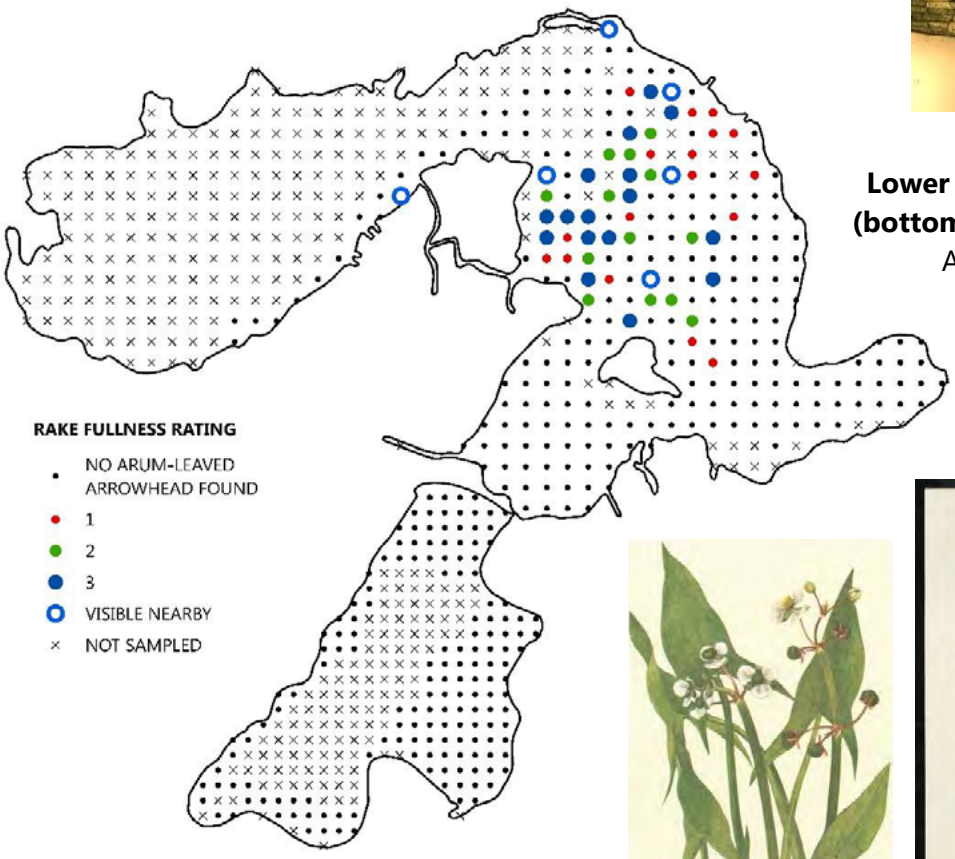
- When not submersed, produces arrow-shaped leaves on recurved (bent backward) petioles
- When submersed, produces long ribbon-like leaves that resemble the leaves of *Vallisneria americana*
- Produces arrow-shaped or elliptic floating leaves on surface of water
- Flowers with three rounded, white petals

Other arrowhead species (*S. latifolia* and *S. brevirostra*) do not produce floating leaves. *Vallisneria americana* has similar ribbon-like leaves but they are flat, not spongy at the base, and have easily visible trasversal veins (short veins perpendicular to the long viens) from bottom to tip of the leaf

Ecology

- Streams, rivers, ditches, lakes, and streams; usually in shallow water or on wet shores
- Emerges in spring from perennial rhizomes and tubers and reproduces by seed under favorable conditions
- *Among the highest value aquatic plants for wildlife, with high-energy tubers providing important food for mammals and migratory waterfowl (another common name is "duck potato") and leaf canopies providing shade and shelter for small fish*





Lower (top) and Upper (bottom) Phantom Lakes
August 2017

Stuckenia pectinata — Sago Pondweed

Native

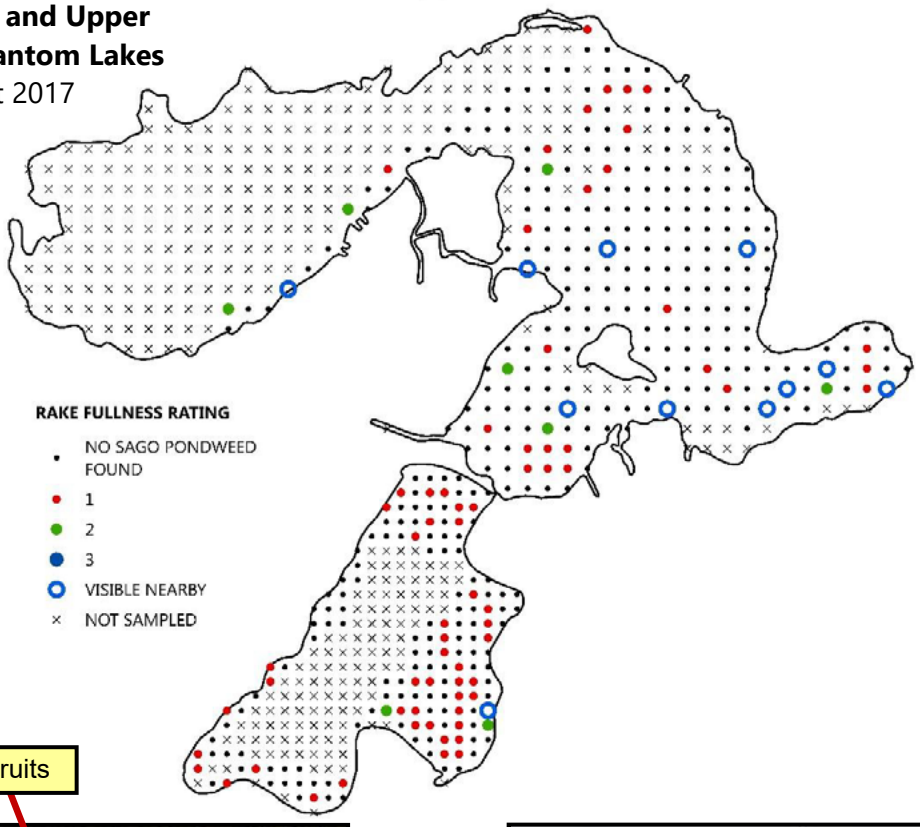
Identifying Features

- 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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Utricularia vulgaris — Common Bladderwort

Native

Identifying Features

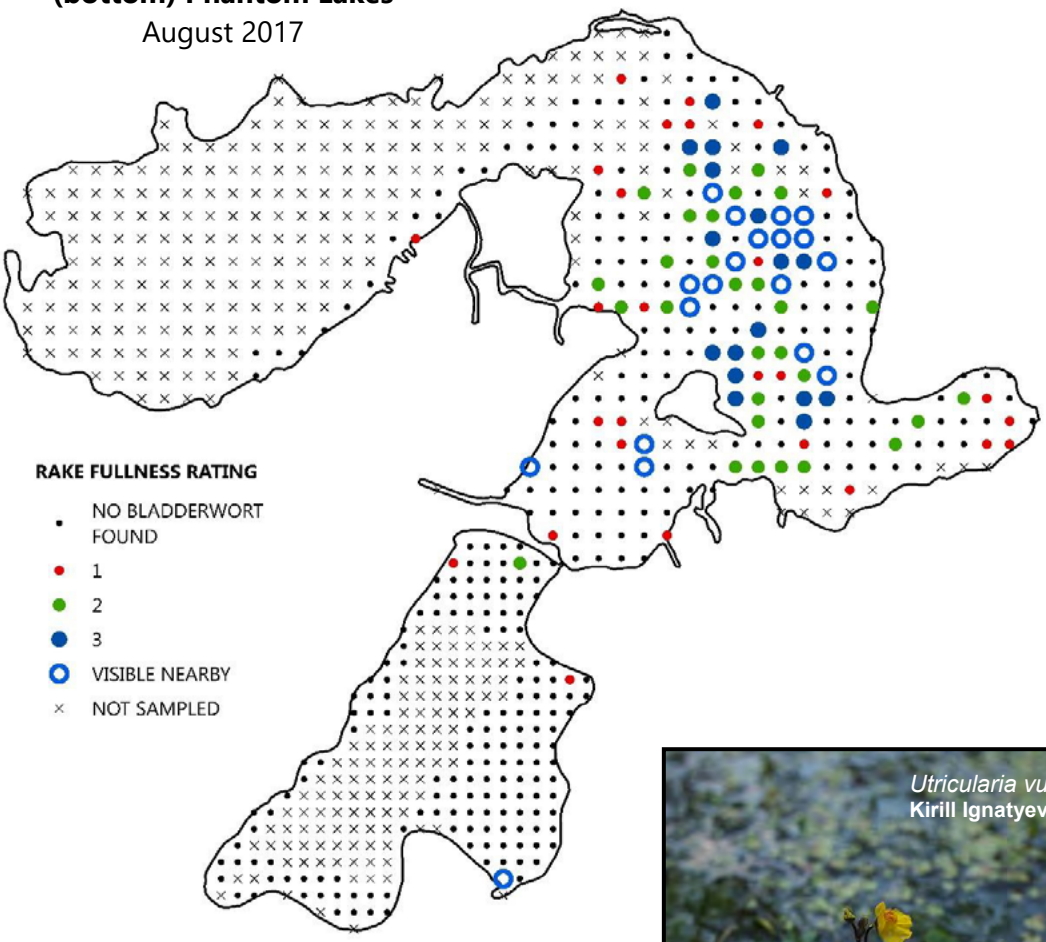
- Flowers snapdragon-like, yellow, held on stalks above the water surface
- *Producing bladders* (small air chambers on the stem) that capture prey and give buoyancy to the stem
- Stems floating (due to air bladders; branches finely divided

Several similar bladderworts occur in southeastern Wisconsin

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



Vallisneria americana — Wild Celery or Eelgrass

Native

Identifying Features

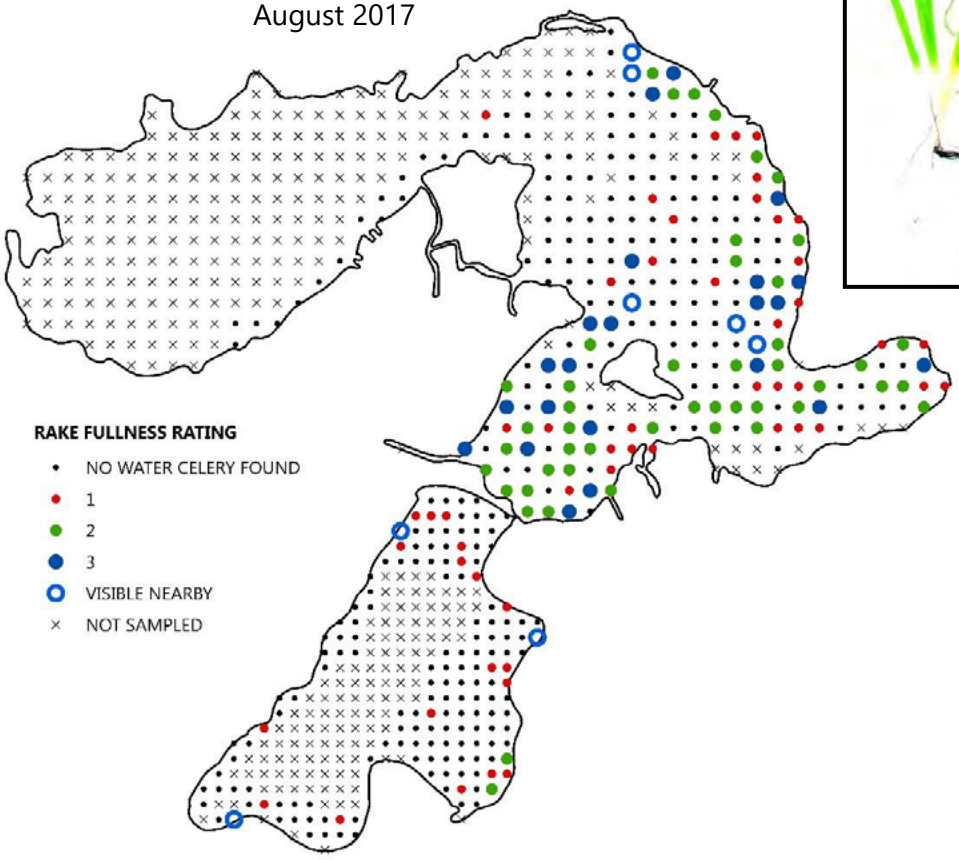
- Leaves ribbon-like, up to two meters long, with a prominent stripe down the middle, and emerging in clusters along creeping rhizomes
- Male and female flowers on separate plants, female flowers raised to the surface on spiral-coiled stalks

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

Ecology

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

Lower (top) and Upper (bottom) Phantom Lakes
August 2017



APPENDIX D

PHANTOM LAKES SENSITIVE AREA REPORT

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Gloria L. McCutcheon, Regional Director

Waukesha Service Center
141 Barstow Street, Room 180
Waukesha, Wisconsin 53188
Telephone 262-574-2100
FAX 262-574-2117

December 28th, 2006

Completed Sensitive Area Designation for Upper and Lower Phantom Lakes

Dear Upper and Lower Phantom Lake Community Members,

The Department of Natural Resources (Department) recently completed the report regarding sensitive areas on Lower and Upper Phantom Lakes. The Department notified residents (via a direct mailing) of the proposed sensitive areas in November 2005. Public presentations on the proposed sensitive areas occurred on two separate occasions: November 22nd, 2005 and August 24th, 2006. The comment period extended to January 17th, 2006. This letter serves to notify you that the process of designating sensitive areas on Lower and Upper Phantom Lakes has been completed.

A number of written and verbal comments were provided to the Department by landowners. Department staff conducted several follow up field visits in the summer of 2006 to address comments provided by landowners. Maps of the finalized sensitive area locations are enclosed, as well as a copy of the final report.

Sensitive areas are defined in Natural Resource Code NR 107.05 (3)(i)(1) as "areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to body of water."

The Department appreciates the time that many of you took to submit your comments regarding the sensitive areas on Upper and Lower Phantom Lakes. If you have any additional questions, please contact me at 262.574.2130.

Sincerely,

Heidi J. Bunk
DNR Lakes Biologist

Cc: Phantom Lakes Management District
Town of Mukwonago
Village of Mukwonago
Waukesha County
Maureen McBroom, Water Management Specialist
Warden Doug Zeihen
Dr. Jeff Thornton, SEWRPC

DRAFT

Phantom Lakes (Waukesha County, Wisconsin)
Integrated Sensitive Area Report

Assessment Dates:	July 30, 2001 July 26, August 23rd, September 1st, 2005
Number of Sensitive Areas Surveyed:	4
Site Evaluators:	Pam Schense, Water Management Specialist Sue Beyler, Fisheries Biologist Heidi Bunk, Lakes Biologist Jim Jackley, Wildlife Biologist Mike Hemmingsen, Water Resources Specialist
Authors:	Pat Campfield, Water Resources Specialist Heidi Bunk, DNR Lakes Biologist Mike Hemmingsen, Water Resources Specialist

General Lake Information

The Phantom Lakes consist of two lakes – Upper Phantom and Lower Phantom Lakes - located in south-central Waukesha County (Township 5 North, Range 18 East, Section 34 and Township 5 North, Range 18 East, Sections 26, 27, and 35). The surface area of Upper Phantom Lake is 118 acres, its maximum depth is 29 feet, and the average depth is 10 feet. Lower Phantom Lake has a surface area of 433 acres, a maximum depth of 12 feet, and an average depth of 4 feet. Upper Phantom is a drainage lake, fed primarily by precipitation, runoff, and groundwater. It has no major surface inlets. Lower Phantom is an impoundment located on the Mukwonago River, with depths of <5 feet in 80% of the lake. Lake level is controlled by a dam to the west of Highway 83 on the Mukwonago River, the single surface-water outlet from the Lakes (WDNR 1982).

The Phantom Lakes serve as "all sports" lakes. The main access site on Andrews Street meets the requirement of "adequate public access" defined by NR 1.91(11), Wis. Adm. Code.

The Phantom Lakes have multiple recreational uses. These include fishing, water skiing, swimming, canoeing, kayaking, pontoon boat site seeing and small craft sailing in summer months and ice fishing, cross-country skiing, ice-skating, and hunting during winter. Throughout the year, the lakes provide natural scenic beauty and opportunities for walking, jogging, bird watching, and picnicking.

Overall, the Phantom Lakes have a diverse fish population, including multiple forage, non-game and game species. 22 fish species were observed during fish surveys

conducted in 1994 and 1996. These include northern pike, grass pickerel, largemouth bass, yellow perch, warmouth, white crappie, rock bass, bluegill, pumpkinseed, green sunfish, sunfish hybrids, Johnny darter, blackchin shiner, blacknose shiner, bluntnose minnow, mudminnow, banded killifish, yellow bullhead, common carp, brook silverside, lake chubsucker, and starhead topminnow (Ehrlinger 1994; Nesta *et al.* 1996). The fish community is extremely diverse in the Mukwonago River downstream of the dam, consisting of 41 species. The Mukwonago River is one of the most pristine waterways in Wisconsin, requiring special attention and protection from development and habitat degradation.

The starhead topminnow (*Fundulus dispar*) is listed as an **endangered species** by the State of Wisconsin. Endangered species listing applies to any species whose continued existence as a viable component of the ecosystem is determined by the DNR to be in jeopardy on the basis of scientific evidence. *F. dispar* prefers quiet, shallow water with abundant aquatic vegetation. It has been found in clear to slightly turbid water (Becker 1983). This habitat type occurs throughout the Phantom Lakes and its preservation is highly recommended. Starhead topminnows spawn in late spring to early summer. Common food items include terrestrial and aquatic insects, crustaceans, mollusks, and delicate aquatic vegetation.

The lake chubsucker (*Erimyzon sucetta*) is listed as a State **species of special concern** (Lyons et al. 2000). The abundance or distribution of special concern species is likely reduced; however the designation has not been proven scientifically. The purpose of this category is to focus attention on certain species before they become threatened or endangered. The lake chubsucker relies on dense vegetation for cover throughout its life cycle. Low growing beds of aquatic plants (such as slender naiad) and filamentous algae are preferred for spawning between late March and early July. Young lake chubsuckers feed on copepods, cladocerans (e.g., *Daphnia*), and midge larvae. Adults prey upon these same items, as well as algae, molluscs, and both larval and adult insects. It is a valuable forage fish and fry are a preferred food of largemouth bass (Becker 1983). Preservation is highly recommended in areas where lake chubsucker habitat exists.

Fish habitat in the Phantom Lakes consists mostly of aquatic vegetation. Minimal woody debris, overhanging vegetation, and fallen trees exist along the developed shoreline. The remaining undeveloped shoreline provides critical habitat for fish, reptiles, amphibians, waterfowl, and both small and large mammals.

Prime wildlife habitat exists on the Phantom Lakes where shoreline and waterfront areas remain natural or in areas where waterfront owners kept “natural corridors” in place. During urbanization of the lakes, most developed properties retained some large trees, conserving the canopy. However, these owners also eliminated the sub-canopy and associated shrubbery. The sub-canopy provides important nesting, feeding, and cover habitat for multiple species. Consequently, most wildlife remaining in and around the Phantom Lakes consists of urban-tolerant species. Resident mammal populations include white-tailed deer, muskrats, cottontail rabbits, and some squirrels. Songbirds, wood ducks, mallards, and Canada geese are representative avian (bird)

species. The remaining undeveloped areas associated with the Lakes provide the only balanced cover for a number of wildlife species.

The Phantom Lakes Lake Management District is the primary sponsor for aquatic plant management goals/plans on the lakes, currently controlling nuisance plants by harvesting. In past aquatic plant studies of the Phantom Lakes (1967 and 1980), approximately 27 plant species were observed (WDNR 1982). In 1967, 25 native species occurred. Eighteen native species were observed in a 1980 survey. In both surveys, two exotic species were noted, Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*).

In the 2001 sensitive area survey, Department staff observed 14 native aquatic plant species in sensitive area 1 of Upper Phantom Lake. In Lower Phantom Lake, 17 native plant species occurred in sensitive area 1 and 20 native species were observed in sensitive area 2. 17 aquatic plant species were observed in sensitive area 3. Two exotic species were observed. Eurasian watermilfoil (*Myriophyllum spicatum*) occurred in each area. Curly-leaf pondweed (*Potamogeton crispus*) was observed in Lower Phantom Lake in sensitive area 2.

Exotic Species

Southeastern Wisconsin lakes have been invaded by aquatic exotic species, most notably zebra mussels, Eurasian watermilfoil, and purple loosestrife. Most exotic species are introduced to a waterbody by transient boaters. The disturbance of lake substrate from human activity (boating, plant harvesting, chemical treatments, etc.) plays a significant role in the colonization and/or expansion of exotic species, particularly exotic plants.

Eurasian watermilfoil has established itself as one of the most common and abundant plants in the Phantom Lakes. It occurred in all of the sensitive areas, although at different densities. Eurasian watermilfoil is one of eight milfoil species currently found in Wisconsin. It is often misidentified as one of its seven native cousins, and vice versa. In many areas within the Lakes, this non-native milfoil has established large monocultures and outcompeted many native plants. These very dense beds of milfoil not only impede the growth of native plant species but also inhibit fish movement and create navigational problems for boaters.

The regenerative ability of Eurasian milfoil is another obstacle when attempting to control this species. Fragments of Eurasian watermilfoil detached by harvesting, boating, and other recreational activities can float to non-colonized areas of a lake or downstream to additional lakes in the drainage system and create new colonies. Chemical treatment is often used when an isolated stand of Eurasian watermilfoil is identified. A few lakes have successfully used the milfoil weevil to suppress milfoil populations. However, the most effective 'treatment' of exotic milfoil is <u>prevention</u> through public education.

Curly-leaf pondweed is another submerged, exotic species found in the Phantom Lakes. Like Eurasian watermilfoil, curly-leaf grows into large, homogenous stands. It also crowds out native vegetation, creates navigational problems, and limits fish movement. A unique characteristic of curly-leaf pondweed is that the plant dies off by the end of June each year, increasing nutrient availability in the water column. This often contributes to summer algal blooms and decreased water quality.

The unusual life cycle of curly-leaf pondweed makes management difficult. The plant germinates as temperatures decrease in the fall. Curly-leaf is highly tolerant of cold temperatures and reduced sunlight, continuing to grow under lake ice and snow cover. With ice-off and increasing water temperatures in the spring, the plant produces fruit, flowers, and buds (turions). Turions are the main reproductive mechanism of curly-leaf. To control the species in lakes, the plant must be combated before turions become viable. The majority of plant harvesters have not started cutting when curly-leaf is most susceptible and a small window of opportunity exists for chemical treatment.

Purple loosestrife, a hardy perennial native to Europe, was desirable primarily as an ornamental plant but also marketed for bee keeping. It was transported in soil used as ballast during shipping. Since its introduction to North America in the early 1800s, purple loosestrife has become common in gardens and wetlands, as well as around lakes, rivers, and roadways. The species is highly invasive and thrives in disturbed areas. Monotypic (dense) stands of purple loosestrife outcompete native plants, resulting in the destruction of food, cover, and nesting sites for wildlife and fish. Occasional small stands of purple loosestrife were noted throughout the Phantom Lakes.

Purple loosestrife most often spreads when seeds adhere to animals. Humans should be aware of picking up seeds on clothing and equipment when in the vicinity of the plant. Loosestrife can be controlled manually, biologically, or with a broad-leaf herbicide. Young plants can be pulled but adult plants have large root structures and must be excavated with a garden fork. Biological control is most effective on large stands of purple loosestrife. Five different insects are known to feed on this plant. Four of those have been used as control agents in the United States. Of the five species, *Galerucella pusilla* and *G. calmariensis* are leaf-eating beetles; *Nanophyes brevis* and *N. marmoratus* are flower-eating beetles; and *Hylobius trasversovittatus* is a root-boring weevil. Only *N. brevis* has not been released in the United States (WDNR 2003).

Shoreland Management

Wisconsin's Shoreland Management Program, a partnership between state and local governments, works to protect clean water, habitat for fish and wildlife, and natural scenic beauty. The program establishes minimum standards for lot sizes, structural setbacks, shoreland buffers, vegetation removal, and other activities within the shoreland zone. The shoreland zone includes land within 1000 feet of lakes, 300 feet of rivers, and floodplains. Current research shows that present standards are probably inadequate for the protection of water resources (Woodford and Meyer 2003, Garn 2002). Therefore, many communities have chosen to go beyond minimum standards to ensure protection of

our natural resources. This report provides management guidelines for activities within the lake and in the immediate shoreland areas. Before any recommendations in this report are completed, please check with the Department of Natural Resources and local units of government for required approvals.

A vital step in protecting our water resources is to maintain effective vegetative buffers. A shoreland buffer should extend from the water onto the land at least 35 to 50 feet. Studies have shown that buffers less than 35 feet are not very effective in reducing water pollution. Wider buffers of 50 feet or more can help provide important wildlife habitat for songbirds, turtles, frogs, and other animals, as well as filter pollutants from runoff. In general, no mowing should occur in the buffer area, except perhaps in a viewing access corridor. The plant composition of a buffer should match the flora found in natural Wisconsin lakeshores. A buffer should include three layers - herbaceous, shrub, and tree.

In addition, the reader also should investigate other innovative ways to reduce the impacts of runoff flowing into the lake while improving critical shoreline habitat (see Greene 2003). This may include the use of phosphorus-free fertilizers, installing rain gardens, setting the lawnmower at a higher mower height, decreasing the area of impervious surfaces, or restoring aquatic plant communities.

Introduction

Wisconsin Department of Natural Resources personnel conducted sensitive area designation surveys on the Phantom Lakes following the Department's sensitive area survey protocol. The main survey occurred on July 30, 2001. Follow up surveys were conducted on July 26th, 2005 and August 23, 2005. This study utilized an integrated team of DNR resource managers with input from multiple disciplines: water regulation, water chemistry, fisheries, lake biology, and wildlife.

Sensitive areas are defined in Wisconsin Administrative Code NR 107.05 (3)(i)(1) as *areas of aquatic vegetation identified by the department 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*. Department resource managers determined that four areas met this definition. Their recommendations on the future management of these areas are included below.

Overview of Sensitive Area Designations

Sensitive areas often have aquatic or wetland vegetation, terrestrial (land) vegetation, gravel or rubble lake substrate, or areas that contain large woody cover (fallen trees or logs). These areas may provide water quality benefits to the lake, reduce shoreline erosion, and provide habitat necessary for seasonal and/or life stage requirements of fish, invertebrates, and wildlife. A designated sensitive area alerts interested parties (i.e., DNR personnel, county zoning personnel, lake associations, etc.) that the area contains critical habitat vital to sustaining a healthy lake ecosystem and/or

may feature an endangered plant or animal. Information presented in a sensitive area report may discourage certain permits from being approved within these sites.

Whole Lake Recommendations:

Several recommendations from Department staff pertain to the Phantom Lakes chain as a whole rather than to individual sensitive areas:

1. Native aquatic plant beds should be protected and maintained.
2. Prevent the spread of exotic species through sign postings, education, etc. and control exotic species where established.
3. Comply with State and Local Shoreland Zoning standards by maintaining no-cut buffers and setbacks, removing non-conforming structures, and limiting impervious surfaces.
4. Create shoreland buffers and maintain existing buffers.
5. Monitor water quality for early detection of changes and possible degradation.

Resource Value of Sensitive Area Site 1 – Upper Phantom Lake

Sensitive area 1 is located within a bay in the southeast portion of Upper Phantom Lake. Eurasian watermilfoil is less dense here than in other areas of Upper Phantom Lake and it is adjacent to a high quality wetland. Substrates in the bay include sand, clay, muck, and detritus. This area is not harvested. The average water depth in this bay is 4 to 6 feet. The shoreline is 90% wetland, 5 % wooded and 5 % developed. This is the only area of Upper Phantom Lake that is not heavily developed.

The bay acts as a sediment and nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 1) helps control shoreline erosion. It also provides walleye, northern pike, largemouth bass, bluegill, yellow perch, and forage fish (suckers and minnows) with spawning, nursery, and foraging habitats (Table 2).

The majority of the shoreline along Upper Phantom Lake does not provide much wildlife habitat. However, this sensitive area provides excellent habitat for ducks, geese, songbirds, muskrat, mink, reptiles, and amphibians, unique to Upper Phantom Lake. The combination of submersed aquatic plants and wetland edge plants provide cover, nesting and feeding areas for wildlife. Scattered woody material houses insect larvae that are in turn consumed by fish and wildlife.

Table 1. Plants observed in sensitive area 1 of Upper Phantom Lake.

	Emergent	Submergent	Free-floating	Exotic
PRESENT (0-25% Cover)		*Elodea* (waterweed) *P. illinoiensis* (Illinois pondweed)	*Nymphaea odorata* (white water lily) *Nuphar advena* (yellow water lily) *P. natans* (floating-leaf pondweed)	
COMMON (26-50% Cover)		*Utricularia* (bladderwort) *P. pectinata* (sago pondweed) *P. robbinsii* (fern) *P. ampliforius* (large-leaf pondweed)		*Myriophyllum spicatum* (Eurasian watermilfoil)
ABUNDANT (51-75% Cover)		*Chara* (muskgrass) *Vallisneria* (wild celery) *Myriophyllum* (native milfoil) *Najas* (bushy naiad) *P. richardsonii* (clasping-leaf pondweed)		
DOMINANT (76-100% Cover)				

Table 2. Sensitive area 1 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye		water lily, milfoil, sago	milfoil, sago	milfoil, sago
Northern Pike		water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds
Largemouth Bass	sand, milfoil	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds	water lily, milfoil, sago, pondweeds
Bluegill and Pumpkinseed	sand	water lily, milfoil, sago, clasping leaf, pondweeds	water lily, milfoil, sago, clasping leaf, pondweeds	water lily, milfoil, sago, clasping leaf, pondweeds
Yellow Perch	milfoil, sago	water lily, milfoil, sago	sago, milfoil	sago, milfoil
Suckers		water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf
Minnows		water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf	water lily, milfoil, sago, clasping leaf

Management Recommendations for Upper Phantom Lake Sensitive Area #1

1. Selective chemical treatment on a case-by-case basis for pioneer stands of non-native species.
   A. Post "Exotics Alert" sign(s) at boat landings.
   B. Protect native plant species.
   C. Seasonally protect fish spawning habitat.

2. No mechanical harvesting.

3. No filling of wetlands.

4. New piers are allowed to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law.

5. None of the following in-lake activities will be allowed:
   Dredging
   Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks
   Pea gravel/sand blankets
   Rip rap

6. The following in-lake activities are allowed with conditions:
   A. No alteration of the littoral zone except to improve fish habitat.
   B. No disturbance of shoreline unless actively eroding.

7. Strictly enforce shoreland and wetland ordinances.
   A. Use bioengineering for any necessary shoreland stabilization.
   B. Increase shrub/herbaceous cover.
   C. Expand width of existing wildlife corridor.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

Resource Value of Sensitive Area Site 1 – Lower Phantom Lake

Sensitive area 1 is the middle portion of Lower Phantom Lake. Substrates in this portion of the lake include gravel, sand, clay, and detritus. This area is heavily harvested. The shoreline is 85% developed and 15 % wetland.

The entire lake (Lower Phantom) is sensitive with the exception of the developed shoreline running from the public boat launch on Andrews Street, north along the shoreline up to Lake Street. This portion of the developed shoreline is <u>not sensitive</u> from the water's edge out 150 feet from shore.

This littoral (shallow) area acts as a nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 3) helps control shoreline erosion and is highly diverse, with several native pondweed species. Forage fish and the endangered starhead topminnow utilize the area for spawning, nursery, and foraging habitats (Table 4).

This area of the lake provides spawning, nursery, feeding and protective cover habitat for largemouth bass, panfish, perch and minnows. Northern pike and walleye fry utilize the area for nursery and feeding (Table 4). This area of Lower Phantom Lake is not critical to wildlife. The extensive residential development of the adjacent shoreline in this portion of Lower Phantom Lake has reduced available wildlife habitat.

Table 3. Plants observed in sensitive area 1 of Lower Phantom Lake.

	Emergent	**Submergent**	**Free-floating**	**Algae**
PRESENT (0-25% Cover)	*Sparganium* (bur-reed)	*Elodea* (waterweed) *P. amplifolius* (large-leaf pondweed)	*Nymphaea odorata* (white water lily) *Lemna* (duckweed) *Spirodela* (large duckweed) *P. natans* (floating-leaf pondweed)	filamentous algae
COMMON (26-50% Cover)		*Ceratophyllum* (coontail) *Utricularia* (bladderwort) *P. nodosus* (long-leaf pondweed) *P. robbinsii* (fern) *P. richardsonii* (clasping-leaf pondweed)		
ABUNDANT (51-75% Cover)		*Myriophyllum* (native watermilfoil) *Najas* (bushy pondweed) *P. pectinatus* (sago pondweed)	**Exotic** *Myriophyllum spicatum* (Eurasian watermilfoil)	
DOMINANT (76-100% Cover)		*Vallisneria* (wild celery)		

Table 4. Sensitive area 1 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye		water lily, milfoil, sago	sago, milfoil	sago, milfoil
Northern Pike		water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Largemouth Bass	sand, milfoil	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds
Bluegill and Pumpkinseed	sand	water lily, wild celery, milfoil	water lily, wild celery, milfoil	water lily, wild celery, milfoil
Yellow Perch	milfoil, pondweeds	water lily, wild celery, milfoil, pondweeds	milfoil, pondweeds	milfoil, pondweeds
Suckers		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago
Minnows		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago
Starhead Topminnow		water lily, milfoil, sago	water lily, milfoil, sago	water lily, milfoil, sago

Management Recommendations for Lower Phantom Lake Sensitive Area # 1

1. Selective chemical treatment on a case-by-case basis for pioneer stands of non-native species.
   A. Post "Exotics Alert" sign(s) at boat landings.
   B. Protect native plant species.

2. Mechanical harvesting must follow the plan approved by the DNR. Harvesting is restricted to navigational channels after fish spawning activities have finished.
   A. Minimize native aquatic plant removal, managing selectively for non-native species and protecting pondweeds and emergent vegetation. Harvesting efforts should be concentrated on monotypic (dense) stands of Eurasian watermilfoil.
   B. No alteration of littoral zone except to improve fish habitat.
   C. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

3. New piers are allowed to provide riparians with access, but the number of slips allowed will be equal to "reasonable use" as defined by state law.

4. Dredging, pea gravel, and rip rap will be permitted on a case-by-case basis.

5. None of the following in-lake activities allowed:
   Wetland Filling
   Aquatic plant screens
   Wetland alterations
   Boardwalks

6. Strictly enforce shoreland and wetland ordinances.
   A. Use bioengineering for any necessary shoreland stabilization.
   B. Create shoreline/bank vegetative buffers.
   C. Use non-chemical lawn care.

7. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

Resource Value of Sensitive Area Site 2 – Lower Phantom Lake

This area is located near the outlet of the Lake where the Mukwonago River continues flowing eastward. The area consists of two bays, one located in the southeastern portion of Lower Phantom Lake and one located in the southwestern portion of Lower Phantom Lake. This area is developed along approximately 50% of the shoreline. 40 % of the frontage is wetland and 10% of the frontage is wooded. This area contains a high quality wetland complex. This area contains the greatest diversity of emergent, submergent, and floating plants within the Phantom Lakes, including wild rice.

Substrates in the bay are variable and include sand, gravel, clay, and muck. Navigation lanes are harvested in this area.

The area acts as a sediment and nutrient trap for the lake, helping to protect water quality. Aquatic vegetation (Table 5) helps control shoreline erosion and is highly diverse, with several native pondweed species. It also provides walleye, northern pike, largemouth bass, bluegill, yellow perch, and the endangered starhead topminnow with spawning, nursery, and foraging habitats (Table 6).

This area is a very valuable fish nursery and contains good habitat for amphibians and reptiles. The residential portion of this sensitive area provides little habitat for wildlife, but does contain an abundant and diverse collection of native pondweed species. This area is a very valuable fish nursery and contains good habitat for amphibians and reptiles.

The wetland portion of this sensitive area provides shelter, nesting and feeding areas for ducks, geese, herons, rails, bittern, songbirds, upland wildlife, muskrat, mink, reptiles, and amphibians. The abundance and diversity of native pondweed species provide essential cover for a variety of fish species. This area of the lake provides excellent spawning and nursery habitat for walleye as well.

Table 5. Plants observed in sensitive area 2 of Lower Phantom Lake.

	Emergents	**Submergents**	**Free-floating**	**Exotics**
PRESENT (0-25% Cover)	*Scirpus* (bulrush) *Sagittaria* (arrowhead)	*Utricularia* (bladderwort)	*Lemna* (duckweed) *P. natans* (floating-leaf pondweed)	*P. crispus* (curly-leaf pondweed)
COMMON (26-50% Cover)	***Zizania* (wild rice)**	*Elodea* (waterweed) *P. pectinatus* (sago pondweed) *P.illinoensis* (Illinois pondweed) *P. amplifolius* (large-leaf pondweed) *P. foliosus* (leafy pondweed)		*Myriophyllum spicatum* (Eurasian watermilfoil)
ABUNDANT (51-75% Cover)	*Decodon* (water-willow)	*Chara* (muskgrass) *Vallisneria* (wild celery) *Najas* (bushy naiad) *P. robinsii* (fern) *P. richarsonii* (clasping-leaf pondweed)	*Nuphar advena* (yellow water lily) *Nymphaea* (white water lily)	
DOMINANT (76-100% Cover)	*Typha* (cattail)			

Table 6. Sensitive area 2 habitat utilized by resident fish species of the Phantom Lakes.

Fish Species	Spawning	Nursery	Feeding	Protective Cover
Walleye	gravel	water lily, sago	sago	sago
Northern Pike	*Chara*	*Chara*, water lily, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Largemouth Bass		water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Bluegill and Pumpkinseed		water lily, *Chara*, wild celery, pondweeds	water lily, wild celery, pondweeds	water lily, wild celery, pondweeds
Yellow Perch	pondweeds	water lily, *Chara*, wild celery, pondweeds	pondweeds	pondweeds
Starhead Topminnow		water lily, sago	water lily, sago	water lily, sago

Management Recommendations for Lower Phantom Lake Sensitive Area # 2

1. Chemical treatment is not recommended due to close proximities to Mukwonago River and swimming area.
   A. Post "Exotics Alert" sign(s) at boat landings.

2. Limited mechanical harvesting following management plan. Harvesting is restricted to a navigational channel along the developed shoreline but only after spawning activities have finished. One harvesting channel is allowed to provide ingress and egress to the condo pier off of Bay View Circle.
   A. Minimize aquatic plant removal, managing selectively for non-native species and protecting pondweeds, emergent vegetation, water celery, and aquatic wetland fringe area. Harvesting efforts should be concentrated on monotypic (dense) stands of Eurasian watermilfoil.
   B. No alteration of littoral zone except to improve fish habitat.
   C. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

3. New piers are allowed to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law.

4. None of the following in-lake activities are recommended:
   Pea Gravel
   Rip Rap

5. None of the following in-lake activities are allowed:
   Filling of wetland
   Aquatic plant screens
   Cutting large expanses of wetland vegetation
   Rip rap on the undeveloped shoreline

6. The following in-lake activities allowed with conditions:
   Dredging only for navigational access, on a case-by-case basis
   Boardwalks on a case by case basis to provide open water access only for a riparian landowner

7. Strictly enforce shoreland and wetland ordinances.
   A. Use soft bioengineering for any necessary shoreland stabilization.
   B. Create shoreline/bank vegetative buffers.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.
   A. Minimize swimming/wading area.
   B. Implement a "No-Wake Zone" along the undeveloped shoreline.

Resource Value of Sensitive Area Site 3 – Lower Phantom Lake

This sensitive area provides a buffer for runoff entering the lake. It traps sediment and nutrients, helping to protect water quality. Aquatic vegetation helps control shoreline erosion. This is a relatively shallow (≤ 5 feet) area that consists of the western half of Lower Phantom Lake extending from the inlet of the Mukwonago River. A navigational channel is harvested along the developed shoreline.

This sensitive area is very large and has been divided into five subsections A, B, C, D, and F so a more accurate plant survey could be conducted. See Appendix 1 for location of subsections. The majority of the shoreline is undeveloped.

Subsection A contains thirteen aquatic plant species. The water depth is approximately 3 feet near the water lilly bed. Songbirds and shorebirds were both observed and heard among the water willow beds. The dominate substrate is silt.

Subsection B contains eleven aquatic plant species and the water depth is approximately 1-3 feet deep. A harvested path through section B along the houses contains few plants. The wetland side of the path is dominated by cattails.

Subsection C is a large wetland complex containing five aquatic plant species. White water lilies and water willows dominate. Water depth in the harvested channel is approximately 3.5 to 4 feet deep. The dominate substrate is silt.

Subsection D borders a developed shoreline with a water depth of approximately 4 to 5 feet. A channel has been harvested. The channel area is dominated by Eurasian water milfoil. Outside the channel, water willow dominates in most places while cattails dominate in some. A total of thirteen aquatic plant species were observed in subsection D.

Subsection E contains seven aquatic plant species and is generally dominated by cattails. Water willows were the dominate plant in a few patches, interspersed with the cattails. The harvested channel is generally less than five feet deep.

This area of Lower Phantom lake provides high quality nesting, feeding and cover habitat for ducks, geese, herons, swans, bittern, a variety of songbirds, upland wildlife, muskrat, mink, reptiles, and amphibians. This area also provides high quality fish nursery and fish feed habitat.

Plant Species in Sensitive Area 3 (further divided into 5 sub-areas)					
Species	A	B	C	D	E
Decodon (water-willow)	Dominant	Present / Common	Dominant	Dominant	Dominant
Scirpus (bulrush)	Common				
Nymphaea odorata (white water lily)	Dominant	Common	Dominant	Common	Dominant
Utricularia (bladderwort)	Abundant				
Ceratophyllum (coontail)	Common				
P. zosteriformis (flat-stemmed pondweed)	Present			Present	
P. richardsonii (clasping-leaf pondweed)	Abundant				
Myriophyllum spicatum (Eurasian watermilfoil)	Abundant			Dominant in Channel	Abundant
Myriophyllum (native watermilfoil)	Common				
P. pectinatus (sago pondweed)	Abundant				Present
Nuphar advena (yellow water lily)	Common	Common		Common	Present
Lemna (duckweed)	Present				
Vallisneria (wild celery)	Yes				
Typha (cattail)		Dominant	Present	Dominant	Dominant
Carex stricta (Hummock Sedge)		Present		Common	
Eupatorium (joe pye weed)		Present		Common	
Lythrum (purple loosestrife)		Present	Present	Present	
Sagittaria (arrowhead)		Common		Common	
Cornus racemosa (Grey Dogwood)		Common			
Cornus sericea (Red Osier Dogwood)		Common			
V. vulpina ssp. Riparia (River Bank Grape)		Common / Abundant			
Eastwoodia elegans (Yellow aster)			Present	Present	
Solidago (Goldenrod)				Present	
Verbena hastata (Blue Vervain)				Present	
P. natans (floating-leaf pondweed)					Present

Management Recommendations for Lower Phantom Lake Sensitive Area # 3

1. No chemical treatment allowed.

2. Mechanical harvesting is limited to one navigational channel along the developed shoreline out towards the main lake.

3. None of the following in-lake activities are allowed:
   Filling of wetland
   Aquatic plant screens
   Cutting large expanses of wetland vegetation
   Rip rap on the undeveloped shoreline
   Pea gravel/sand blankets

4. The following in-lake activities allowed with conditions:
   Dredging only for navigational access, on a case-by-case basis along the developed shoreline (adjacent to Lakeview Drive)
   Boardwalks on a case by case basis to provide open water access only for a riparian landowner
   Rip rap on a case by case basis on the developed shoreline along Lakeview Drive

5. Dredging is allowed to maintain the existing navigational channel along Lakeview Drive out to the main lake.

6. New piers are allowed along the developed shoreline (along Lakeview Drive) to provide riparians with access, but the number of slips allowed will likely be less than "reasonable use" as defined by state law. New piers along the undeveloped shoreline will not be permitted.

7. Strictly enforce shoreland and wetland ordinances.

8. Efforts should be undertaken to create and enforce ordinances, and educate developers on preventing erosion.

9. A "no-wake" zone should be created.

10. Do not remove fallen trees along shoreline, except where navigation is impaired. If navigation is impaired by a fallen tree, cut into smaller pieces and place outside of boating lanes.

Conclusion

Four sensitive areas have been identified at this time. The Phantom Lakes system is very sensitive to further development and loss of remaining habitat. This sensitive area report identifies the characteristics and management recommendations for each of these areas. In Wisconsin, lakes attract many users and water quality in these lakes affects many more. The Phantom Lakes attract a diversity of user groups, inevitably creating conflict. An integrated approach that includes the public and all of the Lakes' governing units is essential. The objective is to create and maintain a balance between recreational use and preservation of habitat, which is essential to the Lakes' health. Improving or at least maintaining water quality on Wisconsin lakes is critical. By protecting and restoring habitat these resources will continue to provide ecosystem functions and responsible recreational opportunities for years to come.

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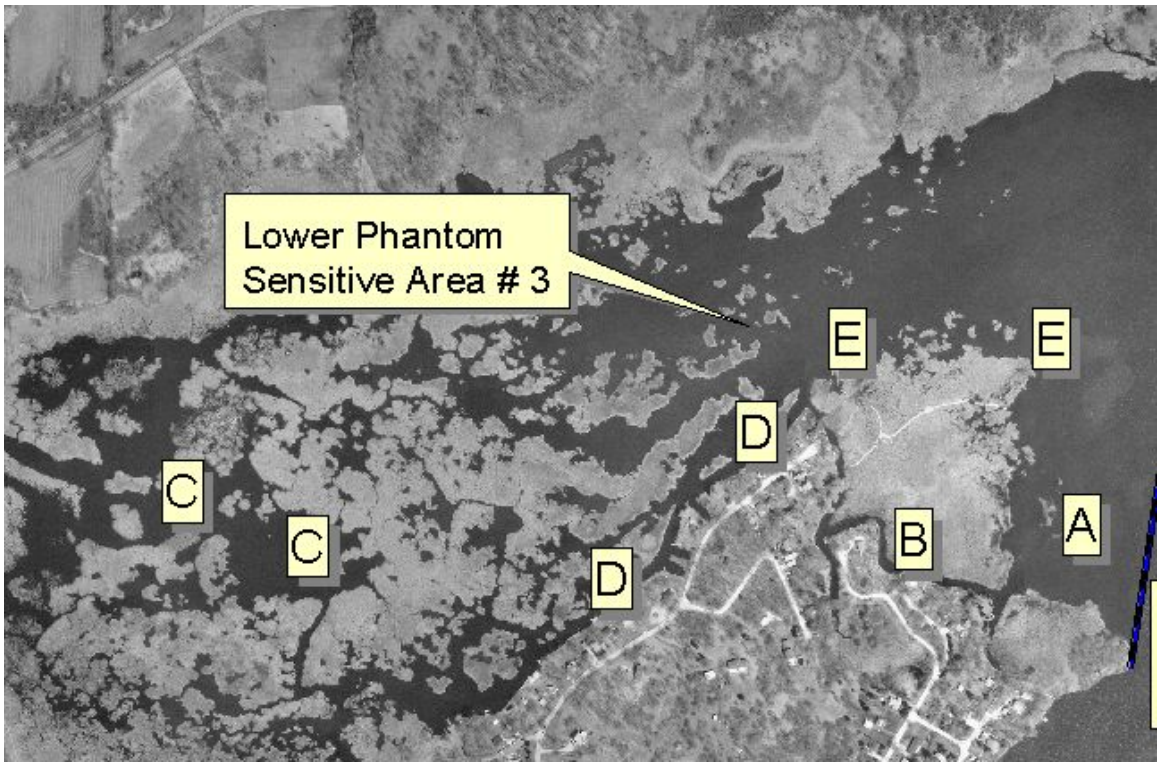
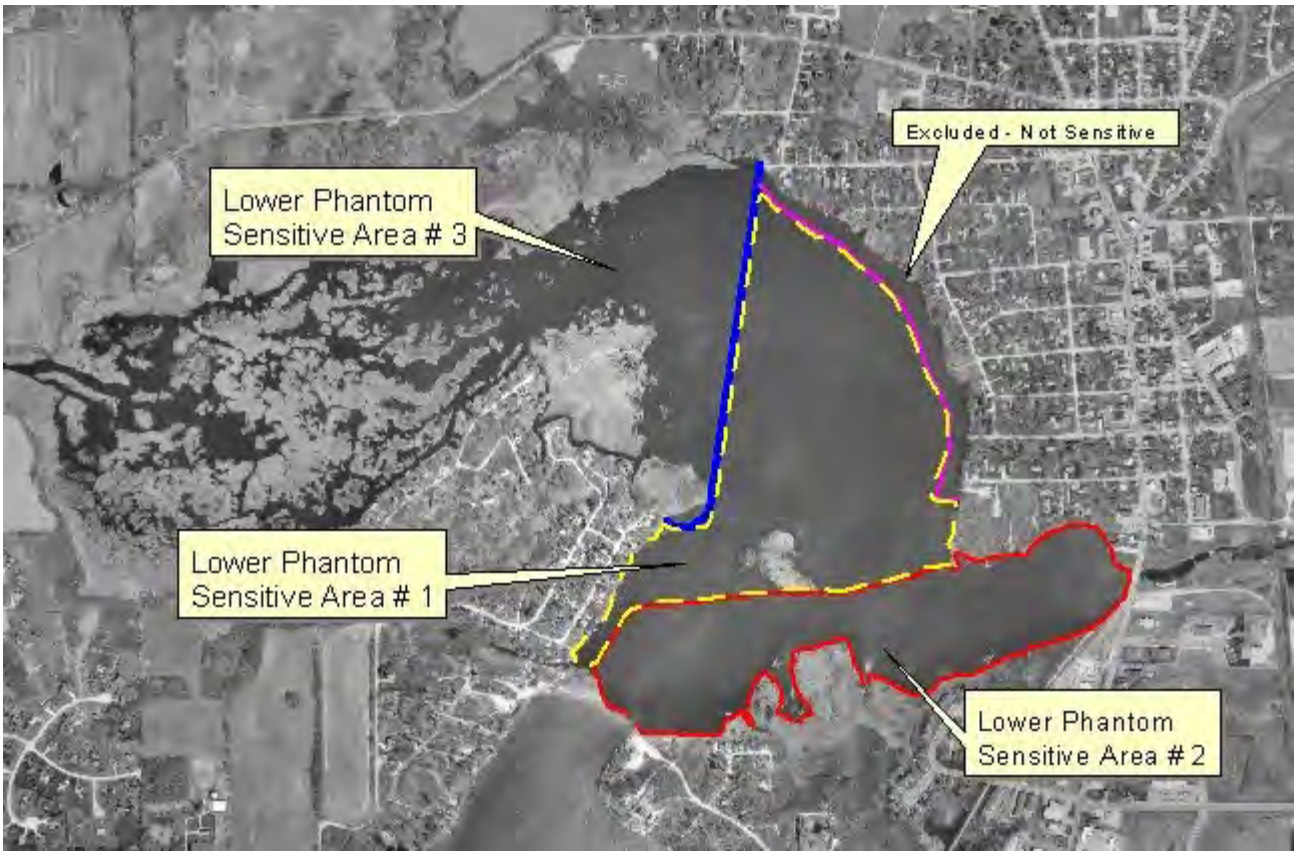
Appendix 1
Subsections of Sensitive Area # 3

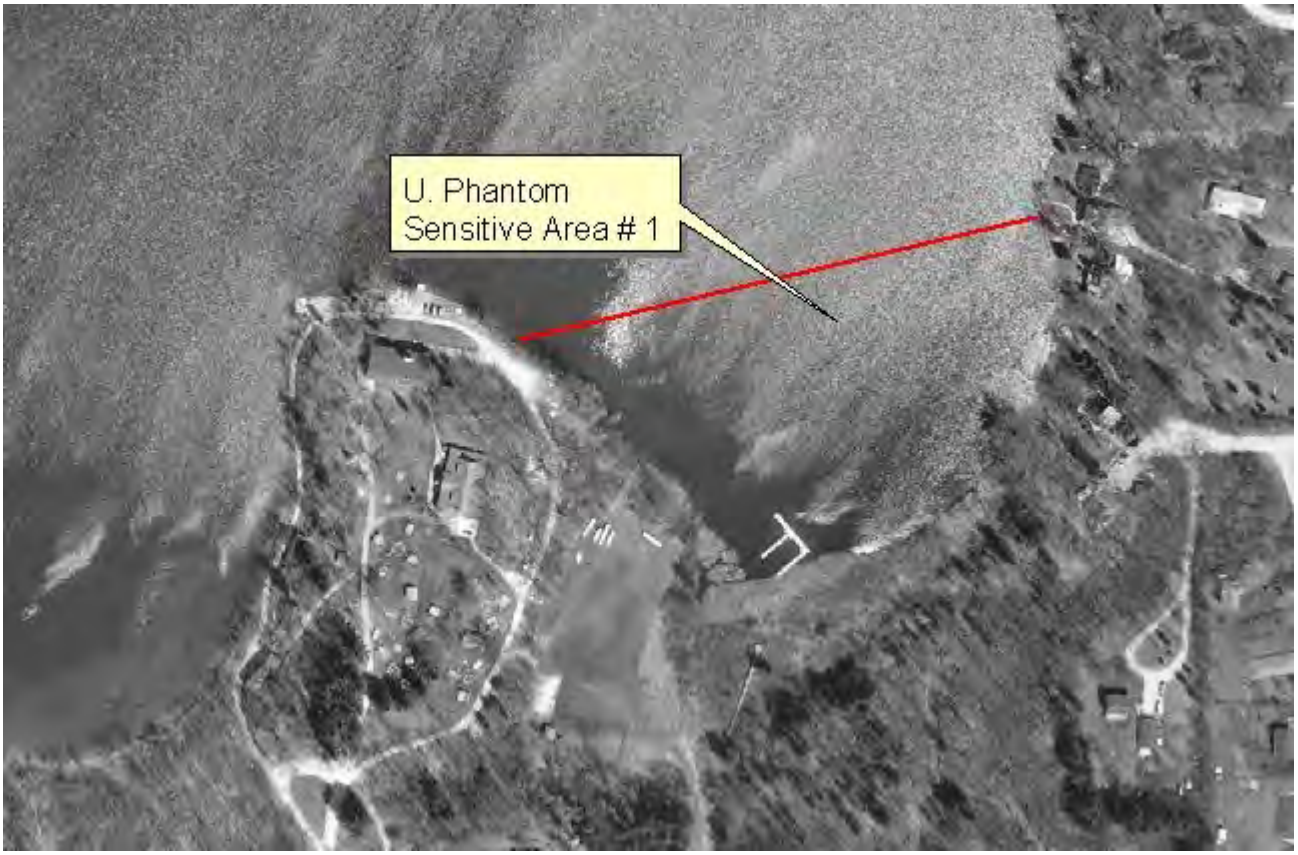


APPENDIX 2 - Aquatic plants within sensitive areas of the Phantom Lakes

	Upper Phantom	Lower Phantom		
	Area 1	Area 1	Area 2	Area 3
Emergent				
Zizania (wild rice)			X	
Typha (cattail)			X	X
Scirpus (bulrush)			X	X
Decodon (water-willow)			X	X
Sagittaria (arrowhead)			X	X
Sparganium (bur-reed)		X		
Cornus racemosa (Grey Dogwood)				X
Cornus sericea (Red Osier Dogwood)				X
V. vulpina ssp. Riparia (River Bank Grape)				X
Eastwoodia elegans (Yellow aster)				X
Solidago (Golden rod)				X
Eupatorium (joe pye weed)				X
Carex stricta (Hummock Sedge)				X
Verbena hastata (Blue Vervain)				X
Submergent				
Myriophyllum (native watermilfoil)	X	X		X
Chara (muskgrass)	X		X	
P. amplifolius (large-leaf pondweed)	X	X	X	
Elodea (waterweed)	X	X	X	
Utricularia (bladderwort)	X	X	X	X
Ceratophyllum (coontail)		X		X
P. pectinatus (sago pondweed)	X	X	X	X
Vallisneria (wild celery)	X	X	X	X
P. illinoensis (Illinois pondweed)	X		X	
Najas (bushy naiad)	X	X	X	

P. richardsonii (clasping-leaf pondweed)	X	X	X	X
P. robinsii (fern)	X	X	X	
P. nodosus (long-leaf pondweed)		X		
P. foliosus (leafy pondweed)			X	
P. zosteriformis (flat-stemmed pondweed)				X
Free-floating				
Nuphar advena (yellow water lily)	X		X	X
Nymphaea odorata (white water lily)	X	X	X	X
P. natans (floating-leaf pondweed)	X	X	X	X
Lemna (duckweed)		X	X	X
Spirodela (large duckweed)		X		
Exotic				
Myriophyllum spicatum (Eurasian watermilfoil)	X	X	X	X
P. crispus (curly-leaf pondweed)			X	
Lythrum (purple loosestrife)				X
Algae				
filamentous		X		


Excluded - Not Sensitive
Lower Phantom
Sensitive Area # 3
Lower Phantom
Sensitive Area # 1
Lower Phantom
Sensitive Area # 2


U. Phantom
Sensitive Area # 1

GENERAL PERMIT FOR RIPARIAN NAVIGATIONAL DREDGING OF MAN-MADE IMPOUNDMENTS

APPENDIX E

STATE OF WISCONSIN DEPARTMENT OF NATURAL RESOURCES

GENERAL PERMIT FOR RIPARIAN NAVIGATIONAL DREDGING OF MAN-MADE IMPOUNDMENTS

PERMITTEE:	The General Public in Wisconsin
PERMIT NO.:	WDNR-GP20-2018
ISSUING OFFICE:	Waterways & Wetland Protection Section, Bureau of Watershed Management, External Services Division, Wisconsin Department of Natural Resources (department)
ISSUANCE DATE:	September 27, 2018
EXPIRATION DATE:	September 27, 2023

GENERAL PERMIT INFORMATION: This general permit (WDNR-GP20-2018) authorizes a riparian property owner to "dredge" up to 50 cubic yards per year to maintain a boating navigation channel, from the shoreline to the line of navigation (typically 3 feet of water). This general permit is only valid on "man-made impoundments" and is valid for 5 years.

GENERAL PERMIT AUTHORIZATIONS: In compliance with the provision(s) of Wis. Stats. 30.20(1)(b), no person may remove any material from the bed of any lake or navigable stream unless an individual or a general permit has been issued under s. 30.20, Wis. Stats. or authorization has been granted by the legislature.

Wis. Stats. s. 30.206(1)(a) and s. 30.20(3) require and authorize the "department" to issue general permits that authorize any person in the State of Wisconsin to perform work in accordance with the terms and conditions of the general permit specified below after satisfying all applicable permit terms and conditions. Please refer to the following sections of this permit for the specific eligibility standards, application requirements, certification requirements and responsibilities, conditions, findings of fact, conclusions of law, and definitions required by WDNR-GP20-2018.

OTHER AUTHORIZATIONS NECESSARY: WDNR-GP20-2018 authorizations are subject to all applicable terms and conditions specified in this permit. However, WDNR-GP20-2018 authorizations are provisional and require that project proponents obtain other required local, state or federal permits before any work may proceed. The U.S. Army Corps of Engineers may require permits for dredging projects that affect Section 10 Navigable Waters under the Rivers and Harbor Act of 1899 or projects that will result in a discharge under the Clean Water Act.

PROJECT DESCRIPTION AND LOCATION: The removal of material from the beds of navigable waters is regulated under Wis. Stats. subs. 30.20 (1), (1g), (1m), (1t), (2) and (3) and any person that intends to remove material from the bed of a navigable lake or stream must obtain a permit from the department. Under Wis. Stats. 30.20 (3)(b), the department is directed to issue a state-wide general permit for riparian navigational dredging up to 50 cubic yards per year from "inland", man-made impoundments and "associated features."

GENERAL PERMIT COVERAGE: Unless notified by the department to the contrary, the effective date of coverage under this general permit is 30 calendar days after a complete application package has been received by the designated department office. Application information can be found on the department's webpage by search "waterway permits."

WDNR-GP20-2018 permit coverage is valid for a period of 5 years from the date the department determines the activity is authorized by this general permit or until the authorized activity has been completed, whichever occurs first. Thereafter, permit coverage terminates unless another complete notification package is submitted and approved by the department to retain coverage under this permit or a reissued version of this permit.

State of Wisconsin Department of Natural Resources
for the Secretary

Mike Thompson
Watershed Bureau Director
Division of External Services

27SEP18
Date Signed

GENERAL PERMIT FOR RIPARIAN NAVIGATIONAL

DREDGING OF MAN-MADE IMPOUNDMENTS WDNR-GP20-2018

Table of Contents

WDNR-GP20-2018 TERMS AND CONDITIONS

The following sections describe the general permit authorization procedures implemented by the department in WDNR-GP20-2018. Projects must meet all the terms and conditions of this permit to be eligible for coverage under WDNR-GP20-2018.

NOTE: The term "you" and its derivatives, as used in this general permit, means the person who submitted and signed the complete notification package for coverage under the General Permit or the person who removes material from the bed of a man-made impoundment under coverage of this General Permit. The term the "department" or "this office" refers to the appropriate Wisconsin Department of Natural Resources regional service center or central office headquarters having jurisdiction over the authorized activity or the appropriate official of that office acting under the authority of the Secretary of the department.

SECTION 1 – ELIGIBLITY STANDARDS AUTHORIZATION

To be eligible for coverage and authorization under this general permit to dredge up to 50 cubic yards per year from an inland man-made impoundment, any person is required to obtain a permit under Wis. Stats. s. 30.20(3)(b) and must meet all the following eligibility standards and permit conditions.

Projects that do not meet all the standards are not eligible for this general permit and are therefore excluded from coverage under WDNR-GP20-2018. For projects that do not qualify for WDNR-GP20-2018, you may apply for an Individual Permit as outlined in Wis. Stats. s. 30.208(2). Further, s. 30.206(3r), Wis. Stats. allows the department to require an individual permit in lieu of a general permit if the department determines that the proposed activity is not authorized under WDNR-GP20-2018 or conducts an investigation and visits the site and determines that conditions specific to the site require restrictions on the activity in order to prevent significant adverse impacts to the public rights and interest, environmental pollution, as defined in Wis. Stats. s. 299.01(4), or material injury to the riparian rights of any riparian owner.

A. ELIGIBLITY STANDARDS APPLICABLE TO ALL PROJECTS

Project Design Standards

1. The "dredging" purpose is to allow the "riparian" owner to navigate from the shoreline of his or her riparian property to the "line of navigation."
2. The dredging is located exclusively within the "riparian zone" of the property owner.
3. For each riparian property, the area of dredging must be limited to a navigation channel not exceeding 30 feet wide and not exceeding the "line of navigation" as measured during summertime low water levels.
4. For each riparian property, the amount of "dredged material" may not exceed 50 cubic yards annually and may not exceed 250 cubic yards during the 5-year approval of this general permit.
5. The dredging is for the removal of "unconsolidated sediment" comprised of clay, silt, sand or muck and shall be to improve or maintain navigation.
6. The applicant is the riparian owner or has the permission of the riparian owner to dredge the bottom material.
7. If applicable, the applicant has permission from the flowage bed owner to dredge the bottom material.
8. The dredging may not be associated with any metallic or nonmetallic mining project.
9. Projects that propose in-water disposal of dredged materials are ineligible for this general permit.
10. Native aquatic vegetation may be removed incidental to the dredging event for the purpose of improving navigation only under this general permit without needing an additional aquatic plant management permit as required by Wis. Adm. Code NR 109 provided that:
    a. Removal of native aquatic vegetation is limited to a single area with a maximum width of 30 feet measured along the shoreline.
    b. Any aids to navigation (e.g., piers, boatlifts) are located within that 30-foot wide zone or immediately adjacent to the zone.
11. Projects involving the lease or sale of any dredged material are not eligible for this general permit. The lease or sale of dredged material from a navigable lake requires a dredging contract from the department under Wis. Stats. s. 30.20(2)(a).
12. Proposed dredging cannot conflict with any department approved lake management plan. See http://dnr.wi.gov/lakes/grants/. Go to the Lake Protection and Classification Grants awarded link and select the Lake Management Plan in the activity section.
13. Dredged material may not be temporarily or permanently placed within a wetland, floodway identified in a local floodplain zoning ordinance, or re-deposited below the "ordinary high water mark" of a navigable waterway.
14. The project shall be conducted in a manner that prevents the dispersal of sediment away from the project site. Temporary control measures such as turbidity barriers or silt curtains shall be used and shall be installed prior to

dredging and removed from the waterbody when water on both sides of the curtain are visually equal. Any temporary control measures shall follow all state lighting requirements and may not obstruct navigation. You may need a waterway marker permit or aids to navigation if dredging in a navigation channel or routinely used water route under Wis. Adm. Code NR 5.09.

15. Erosion control measures must meet or exceed the technical standards for erosion control approved by the department under Wis. Adm. Code subch. V of Ch. NR 151. Any area where topsoil is exposed during construction must be immediately seeded and mulched to stabilize disturbed areas and prevent soils from being eroded and washed into the waterway. Note: These standards can be found at the following website: http://dnr.wi.gov/topic/stormwater/standards/

16. Dredging, including dewatering activities, shall be conducted to minimize objectionable deposits, as described in NR 102.04(1)(a) and (c), Wis. Adm. Code, of sediment to the maximum extent practicable.

Location and Timing Standards

17. The project is located on an inland, "man-made impoundment" or an "associated feature."

18. Dredging may only remove unconsolidated sediments defined as primarily clays, silt, muck, and sand. Dredging may not occur in an area of primarily bedrock, cobble, rock and gravel.

19. The project is located in a man-made impoundment with a watershed comprised of more than 30% combined agricultural and urban land use development based upon the department's most recent WiscLand dataset.

20. Removal of coarse woody debris, trees, and other fish and wildlife habitat structures authorized by the department is prohibited.

21. The dredging may not be located in a man-made impoundment that is identified as any of the following:

    a. an outstanding or exceptional resource water under Wis. Stats. s. 281.15,

    b. an "area of special natural resource" interest as defined in Wis. Stat. s. 30.01(1am), or

    c. a "public rights feature" as defined in Wis. Adm. Code NR 1.06(5).These waterways can be found on the SWDV at https://dnrmaps.wi.gov/H5/?Viewer=SWDV&view=designated.

22. The dredging may not be located in man-made impoundment having self-sustaining populations of walleye located in the ceded territory of the state where resource allocation rights are shared by sovereign tribes as defined in Wis. Adm. Code NR 1.07(4)(d). These waterways can be found on the SWDV at http://dnr.wi.gov/topic/surfacewater/swdv/ and turn on the layer called "Walleye Waters" which is under the "Fisheries Management" layer.

23. Projects that involve the removal of material from waters that were ammunition fall areas for gun ranges or projects that involve the removal of "hazardous waste" are ineligible for this general permit.

24. Projects involving the removal of material where a sediment cap, cover, installed barrier or where other engineering controls have been installed as part of a federal or state environmental remediation to manage contaminated sediment are ineligible for this general permit. Examples of environmental remediation

programs are the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), the Resource Conservation and Recovery Act (RCRA), Great Lakes Legacy Act, and a Spill Response under Wis. Stats. Ch. 292 or Wis. Adm. Code Ch. NR 700 or both. For sediment cap or cover information see SWIMS database at http://dnr.wi.gov/topic/surfacewater/swims/

25. Fish Spawning. To minimize adverse impacts on fish movement, fish spawning, and egg incubation periods, the removal of material may not occur from March 1 through June 15.

    NOTE: The regional department Fisheries Biologist may waive or modify these timing restrictions in writing. To request in writing a waiver or modification of fish spawning timing restrictions for your project please use the checklist listed as Appendix 1 and the department website at: http://dnr.wi.gov/topic/Waterways/contacts.html to find the county contact for your project to send the requested information.

Contaminated and Hazardous Sediment Eligibility Standards

26. The applicant shall provide information about the potential for the proposed dredged material to contain "contaminated sediments" or "hazardous substances" if:

    a) The proposed dredging site is listed or immediately adjacent to a site on the Bureau for Remediation and Redevelopment Tracking System (BRRTS) website or other county, state, or federal web-based data system that tracks the presence of a contaminated properties. BRRTS database information can be found at http://dnr.wi.gov/topic/Brownfields/clean.html, or

    b) The department advises the applicant that it has specific information that indicates the potential that "contaminated sediments" or "hazardous substances" may be present in proposed area to be dredged and there is a need to verify if contamination is present and at what concentrations.

    Note: There may be cases where the department already has specific information about the presence of contaminated sediments or hazardous substances in a waterbody and may not require additional sampling. Specific information required by the department could include but is not limited to:

    1. The collection and laboratory analysis of the dredged material in compliance with Ch. NR 347, Wis. Adm. Code; or
    2. The review of historical dredge material information from the vicinity of the proposed project that was collected and analyzed in accordance with Ch. NR 347, Wis. Adm. Code; or
    3. Assessment of the potential for contaminated sediments or hazardous substances to be present based upon the characteristic of the watershed, industrial and municipal discharges to the waterbody and dredge material data from similar waterways.

27. Projects, where contaminated sediments or hazardous substances are detected, must include best management practices to mitigate the potential for surface and groundwater contamination. The best management practices must be included in the project design plans and approved the by the department.

Note: Dredging projects must also obtain approval and/or administrative exemption, and put in place practices to comply with, the Wisconsin Pollutant Discharge Elimination System (WPDES) and Waste Material Management programs. For projects where contaminated sediments or hazardous substances are found, the department may require an individual permit application under Wis. Stats. s. 30.206(3r).

SECTION 2 – APPLICATION REQUIREMENTS FOR COVERAGE

You are required to comply with the following application requirements:

1. To comply with the requirements in NR 347.05, Wis. Adm. Code and prior to submission of an application, applicants shall provide the department with preliminary dredging project information including:
   a) Name of waterbody and location of project;
   b) Volume of material to be dredged;
   c) Brief description of dredging method and equipment, including any containment best management practices to be used;
   d) Brief description of how the dewatering discharge from the dredged material will be managed;
   e) Brief description of the proposed dredged material disposal method and location, including a Waste Material Management Self-Certification Exemption for Dredge Material Flowchart form.
   f) Any previous sediment sampling (including field observations) and analysis data from the area to be dredged or from the proposed disposal site;
   g) Copy of a map showing the area to be dredged, the depth of cut, the specific location of the proposed sediment sampling sites and the bathymetry of the area to be dredged; and
   h) Anticipated starting and completion dates of the proposed project.

   NOTE: The department will review your preliminary dredging project information and contact you about any required sediment sampling or general permit eligibility questions.

   Considering the preliminary information provided by the applicant and the factors described in #25, the department shall then make a determination within 30 business days if there is reason to believe that the material proposed to be dredged is contaminated. This initial evaluation by the department may be used in specifying sediment sampling and analysis required under s. NR 347.06, Wis. Adm. Code.

2. After the department has contacted you in response to the your submitted preliminary dredging project information and you have carefully confirmed that your project meets the purpose and all the terms and conditions of this general permit, submit a *complete application package* outlined below, to the department. The complete application package should be received a minimum of 30 calendar days before the desired project start date. To apply for a permit, visit department's e-permitting system at: https://dnr.wi.gov/Permits/Water/

3. To gain coverage under this general permit, submit a complete application package. A complete application package must include all information required by the general permit checklist:

   a) A Complete Application form certifying that the project meets the terms and conditions of WDNR-GP20-2018. This form can be found at http://dnr.wi.gov/Permits/Water/ .

   b) The appropriate application fee.

   c) A copy of the deed or similar proof of ownership of the site where the activity will occur. If you do not own the site, also include proof of any notice(s) and permission(s) required by Section IA, Standards #6 or #7 of this general permit.

   d) A project diagram that shows all of the following:

      i. Project location relative to the ordinary high water mark (OHWM).

      ii. A plan view to scale showing the area of proposed removal.

      iii. The location of turbidity and erosion control measures to be utilized during the dredging operation and disposal of the material.

   e) A copy of the results from any sediment sampling, required under NR 347, Wis. Adm. Code (if applicable).

   f) Maps of the project site that show and identify the location of all the following:

      i. Shoreline property boundaries for all applicant and including adjacent properties

      ii. In water riparian properties boundaries to the line of navigation.

      iii. The proposed disposal location.

   g) Photographs that represent existing project site conditions at the disposal site and the site where the dredging will take place.

   h) Documentation showing Endangered Resources (ER) under s. 29.604 Wis. Stats. will not be impacted. Options include:

      i. An ER Preliminary Assessment from the NHI Public Portal. The NHI Public Portal is located here: http://dnr.wi.gov/topic/ERReview/PublicPortal.html. If the ER Preliminary Assessment from the NHI Public Portal shows that "Further actions are required" then submit one of the following:

         1. A department ER Review letter. The request form for an ER Review letter is located here: http://dnr.wi.gov/files/PDF/forms/1700/1700-047fillable.pdf

         2. A Certified ER Review letter. The list of Certified Reviewers is available here: http://dnr.wi.gov/topic/ERReview/Documents/CertifiedReviewers.pdf

      Note: Documents associated with Endangered Resources are valid one year from the date they are prepared.

4. The department may request that you provide additional information necessary to verify compliance with the terms and conditions of this permit. The department may make a request for additional information one time during the 30-day period.

If the department makes a request for additional information, the 30-day period is paused on the date the person applying for authorization receives the request for additional information. The clock remains paused until the date on which the department receives the information, at which point the clock resumes from the point it was initially stopped.

5. Under Wis. Stats. s. 30.206(3r), the department may determine the project is not eligible for this general permit and require that the project be reviewed through the individual permit process outlined in Wis. Stats Ch. 30.

SECTION 3 – CERTIFICATION AND RESPONSIBILITIES

The applicant certifies and agrees to the following:

1. You agree to be the responsible party that supervises and oversees all aspects of the project to ensure compliance with the terms and conditions of WDNR-GP20-2018.
2. Upon submittal of a complete application package to the department, you have certified that the project will be conducted in compliance with all the terms and conditions of WDNR-GP20-2018.

SECTION 4 – GENERAL PERMIT CONDITIONS

The applicant agrees to comply with the following conditions:

1. **Application**. You must submit a complete application package to the department as outlined in Section 2 of this general permit. If requested, you must furnish to the department within a reasonable timeframe any information the department needs to verify compliance with the terms and conditions of this permit.
2. **Certification**. Acceptance of general permit WDNR-GP20-2018 and efforts to begin work on the activities authorized by this general permit signifies that you have certified the project meets all eligibility standards outlined in Section 1 of this permit and that you have read, understood and agreed to follow all terms and conditions of this general permit.
3. **Project Plans**. This permit does not authorize any work other than the work that is specifically described in the notification package and plans submitted to the department and that you certified is in compliance with the terms and conditions of WDNR-GP20-2018.
4. **Erosion Control**. You must use proper methods for the excavation, loading, hauling, dewatering and disposal of all materials. Sealed trucks must be used to eliminate any spillage onto public roadways. If any spillage does occur it must be cleaned up immediately.
5. **Expiration**. Unless notified by the department to the contrary, the effective date of coverage under this permit is 30 calendar days after the designated department office receives a complete application package.

   This WDNR-GP20-2018 is valid for a period of 5 years from the date of issuance. Any activity that the department determines is authorized by WDNR-GP20-2018 remains authorized under WDNR-GP20-2018 for a period of 5 years from the date of the department's determination or until the activity is completed, whichever occurs first, regardless of whether WDNR-GP20-2018 expired before the activity is completed.

   There is no limit to the number of times dredging can occur over the course of

this general permit if the sum of each event during a calendar year does not exceed 50 cubic yards per year and does not exceed 250 cubic yards during the 5 year authorization. Each dredging event must adhere to the terms and conditions, including the eligibility standards, of this general permit.

6. **Other Permit Requirements**. You are responsible for obtaining any other state permits for the dewatering or disposal of the dredged material and any other permits or approvals that may be required for your project by local zoning ordinances and the U.S. Army Corps of Engineers (USACE) before starting your project. To locate the USACE staff responsible for review projects in Wisconsin please visit http://www.mvp.usace.army.mil/Missions/Regulatory.aspx.

   Note: The department will forward a copy of your application package to the U.S. Army Corps of Engineers for their review and determination regarding federal permit requirements and coverage.

7. **Project Start**. You must notify the department using the information provided on the confirmation of coverage letter you receive before starting any activity and again not more than 5 days after the activity is completed. Before each dredging event the general permit holder shall notify the department at least 5 business days prior to the work with the following information:

   a) Existing General Permit Docket or Identification number verifying existing coverage

   b) Location of dredging

   c) Proposed volume amount

   d) Proposed dimensional dredging area

   e) Dredged material disposal location

8. **Permit Posting**. You must post a copy of this permit at a conspicuous location on the project site for at least 5 days prior to the project starting, and the copy must remain posted on the project site at least five days after the project is complete. You must also have a copy of the permit and approved plan available at the project site at all times until the project is complete.

9. **Permit Compliance**. The department may revoke coverage of this permit if dredging is not carried out in compliance with the terms and conditions of this permit. Any act of noncompliance with this permit constitutes a permit violation and is grounds for enforcement action. Additionally, if any conditions of this permit are found to be invalid or unenforceable, authorization for all activities to which that condition applies is denied.

10. **Project Completion**. ***Within one week*** of project completion you must submit to the department a statement certifying that the project is in compliance with all the terms and conditions of this permit and photographs of the work authorized by this permit.

11. **Site Access**. Upon reasonable notice, you must allow access to the site to any department employee who is investigating the project's construction, operation, maintenance or compliance with the terms and conditions of WDNR-GP20-2018 and applicable laws.

12. **Invasive Species**. To stop the spread of invasive species and viruses from one navigable waterway to another navigable waterway, all equipment or portions of equipment used for constructing, operating, or maintaining the project, including tracked vehicles, barges, boats, silt or turbidity curtains, hoses, sheet piles, and

pumps, must be decontaminated for invasive species and viruses before and after use or prior to use within another navigable waterway. Follow the most recent department approved washing and disinfection protocols and department approved best management practices to avoid the spread of invasive species as outlined in Wis. Adm. Code Ch. NR 40. These protocols and practices can be found on the department website at http://dnr.wi.gov/topic/Invasives/bmp.html Keyword: "equipment operator" or "invasive bmp" and at http://dnr.wi.gov/topic/Invasives/documents/EquipOper.pdf

13. **Federal and State Threatened and Endangered Species.** WDNR-GP20-2018 does not affect the department's responsibility to ensure that all authorizations comply with Wisconsin's Endangered Species Law (s. 29.604 Wis. Stats.) and Section 7 of the Federal Endangered Species Act. No department authorization under this permit will be granted for projects found not to comply with these laws/Acts. In order to be in compliance, documentation is required showing Endangered Resources (ER) concerns have been addressed. Please note: documents associated with Endangered Resources are valid one year from the date they are prepared. Documentation options include:

    a. An ER Review Verification Form showing that the project is covered by the Broad Incidental Take Permit for no/low impact activities and therefore does not require a review.

    b. An ER Preliminary Assessment from the NHI Public Portal stating the no further actions are necessary or further actions are recommended. The NHI Public Portal is located here: http://dnr.wi.gov/topic/ERReview/PublicPortal.html.

    c. If the ER Preliminary Assessment from the NHI Public Portal shows that "Further actions are required" then submit one of the following:

        i. A department ER Review letter. The request form for an ER Review letter is located here: http://dnr.wi.gov/files/PDF/forms/1700/1700-047fillable.pdf.

        ii. A Certified ER Review letter. The list of Certified Reviewers is available here: http://dnr.wi.gov/topic/ERReview/Documents/CertifiedReview ers.pdf.

14. **Historic Properties and Cultural Resources.** WDNR-GP20-2018 does not affect the department's responsibility to ensure that all authorizations comply with Section 106 of the National Historic Preservation Act and Wis. Stats. s. 44.40. No department authorization under this permit will be granted for projects found not to comply with these laws. The project must avoid impacts to archaeological sites or historic structures and is subject to department and Wisconsin Historical Society review and approval before authorization under this general permit is valid. Information on the location and existence of historic resources can be obtained from the State Historic Preservation Office and the National Register of Historic Places. If cultural, archaeological, or historical resources are unearthed during activities authorized under this permit, work must be stopped immediately, and the State Historic Preservation Officer must be contacted for further instruction.

15. **Preventive Measures.** Measures must be adopted to prevent potential pollutants from entering a wetland or water body. Construction materials and debris, including fuels, oil, and other liquid substances, may not be stored in the construction work area in a manner that would allow them to enter a wetland or water body as a result of spillage, natural runoff, or flooding. In addition, biodegradable hydraulic fluid should be used in equipment that is operated below

the ordinary high water mark. If a spill of any potential pollutant should occur, it is the responsibility of the permittee to remove such material, minimize any contamination resulting from this spill, and immediately notify the State Duty Officer at **1-800-943-0003**.

16. **Property Rights**. This permit does not convey any property rights or interests of any sort or any exclusive privilege. The permit does not authorize any injury or damage to private property, any invasion of personal rights, or any infringement of federal, state or local laws or regulations.
17. **Limits of State Liability**. In authorizing work, the State Government does not assume any liability, including for any of the following:
    a) Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.
    b) Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the State in the public interest.
    c) Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.
    d) Design or construction deficiencies associated with the permitted work.
    e) Damage claims associated with any future modification, suspension, or revocation of this WDNR-GP20-2018.
18. **Enforcement.** The department may enforce violations of the terms and conditions of WDNR-GP20-2018 under the provisions of ss. 30.292 and 30.298, Wis. Stats.
19. **Rescission.** The department has the ability to rescind coverage under this general permit if information provided by the applicant in support of the permit application proves to have been false, incomplete, or inaccurate.

SECTION 5 – FINDINGS OF FACT

1. The department has determined that the project site and project plans meet the standards in WDNR-GP20-2018 to qualify for this General Permit.
2. The dredging will not materially interfere with navigation, cause environmental pollution as defined in Wis. Stats. s. 299.01(4), or result in significant cumulative adverse environmental impacts, injury or significant adverse impacts to the public rights and interests in the waterway, material injury to the rights or riparian rights of any riparian owner, or adverse impacts to the riparian property rights of adjacent riparian owners, pursuant to Wis. Stats. s. 30.206(1)(ag) and (3r)(a)2.
3. The department and the applicant have completed all procedural requirements, and the project as permitted will comply with all applicable requirements of WDNR-GP20-2018 and Wis. Adm. Code Chapters NR 102, 103, 150, 299, and 310.

SECTION 6 – CONCLUSIONS OF LAW

1. The department has authority under Wis. Stats. Ch. 30 to issue a permit for the completion of this project.
2. The department has complied with Wis. Stats. s. 1.11.

SECTION 7 – DEFINITION OF TERMS

You accept the following definitions for use with this general permit:

1. "Area of special natural resource interest" has the meaning in Wis. Stats. s. 30.01 (1am).
2. "Associated feature" of an impoundment means connected surface water to the impoundment that is affected by the artificially raised water level such as individual lake basins, back bays and channels.
3. "Contaminated sediments" has the meaning specified in the Wisconsin Pollutant Discharge Elimination System general permit to discharge carriage and/or interstitial water from dredging operations. (WPDES Permit No. WI-0046558-06-0).
4. "Department" means the Department of Natural Resources.
5. "De minimus" has the meaning in Wis. Adm. Code 345.03(2) and means the dredging of less than 2 cubic yards in a calendar year from a specific waterbody or disturbance of bottom material during the manual removal of aquatic plants that meet the requirements of Wis. Adm. Code s. NR 109.06 (2).
6. "Dredged material" means any material removed below the ordinary high water mark (OHWM) or from the bed of a navigable waterway by dredging. The bed of a navigable waterway extends landward to the OHWM.
7. "Dredging" means any part of the process of the removal or disturbance of material from below the OHWM or from the bed of a navigable waterway, transport of the material to a disposal, re-handling or treatment facility; treatment of the material; discharge of carriage or interstitial water; and disposal of the material. For the purpose of Ch. 30, Wis. Stats., dredging does not include "de minimus" activities.
8. "Hazardous substance" has the meaning specified in s. 292.01 (5), Wis. Stats.
9. "Hazardous waste" has the meaning specified in s. 661.03, Wis. Adm. Code.
10. "Man-made impoundment" for the purpose of WDNR-GP20-2018, has the meaning of a lake with artificially raised water levels created by a man-made dam or structure on a stream or river. Lake includes lakes, reservoirs, flowages or millponds listed in the most current version of the Wisconsin Lakes, Publ-FH-800.
11. "Inland waters" has the meaning given in s. 29.001(45), Wis. Stats.
12. "Line of navigation" means the depth contour where the water is 3 feet deep or the depth required to operate a boat demonstrated to need greater than 3 feet of water (see Wis. Stats. s. 30.01(3c)). Water depths are based on the normal summertime low levels on the waterway or summer minimum levels where established by department order.

    Note: Where a municipality has adopted an ordinance establishing a municipal pierhead line authorized under Wis. Stats. s. 30.13, the line of navigation is the municipal pierhead line.

13. "Navigable waterway" means any body of water with a defined bed and banks that is navigable under Wisconsin law. In Wisconsin, a body of water is navigable if it is capable of floating on a regularly recurring basis the lightest boat or skiff used for recreation or any other purpose. This incorporates the definition at Wis. Stats. s.30.01(4m), and current case law, which requires a watercourse to have a bed and banks, *Hoyt v. City of Hudson*, 27 Wis. 656 (1871), and requires a navigable waterway to float on a regularly recurring basis the lightest boat or skiff,

DeGayner & Co., Inc. v. DNR, 70 Wis. 2d 936 (1975); Village of Menomonee Falls v. DNR, 140 Wis. 2d 579 (Ct. App. 1987).

14. "Ordinary high water mark" (OHWM) has the meaning specified in s. NR 345.03(10), Wis. Adm. Code
15. "Outlying Waters" has the meaning given in s. 29.001(63), Wis. Stat., and means Lake Superior, Lake Michigan, Green Bay, Sturgeon Bay, Sawyer's Harbor and the Fox River from its mouth up to the dam at De Pere.
16. "Public Rights Feature has the meaning given in s. NR 1.06(5), Wis. Adm. Code.
17. "Riparian" means an owner of land adjacent to a navigable waterway.
18. "Riparian zone" has the meaning specified in s. 30.01(5r), Wis. Stats.
19. "Stabilize" means the process of making a site steadfast or firm, minimizing soil movement by the use of practices such as mulching and seeding, sodding, landscaping, paving, graveling or other appropriate measures. See Wisconsin Construction Site Technical Standards at http://dnr.wi.gov/topic/stormwater/standards/const_standards.html
20. "Unconsolidated sediment" is defined as loose materials ranging in size from clay and silt to sand and muck. Unconsolidated sediment does not include bedrock, cobble, rock or gravel