Aquatic Plant Management & Invasive Species Prevention Plan

for

Matthews Lake
Washburn County, Wisconsin

2022-2026

Plan approved August 29, 2022

Prepared for the Matthews Lake Association
Funded in part by WDNR Aquatic Invasive Species Grant AEPP59820

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Photos from Cover Page: 1) Decontamination station at the Matthews Lake boat landing. 2) Garden Weasel tool in use in Matthews Lake collecting Chinese mystery snails. 3) Chinese mystery snails collected from Matthews Lake using the Garden Weasel tool. 4) I-LIDS camera at the Matthews Lake boat lading provide reminders for boaters to inspect and decontaminate their watercraft. 5) Point-intercept map of Matthews Lake with artistic effect. 6) Large-leaf pondweed was the second-most commonly occurring species in Matthews Lake in 2020. Photo credit Matthew Berg.

This plan was approved by the Wisconsin Department of Natural Resources on August 29th, 2022. See page 26 for more information on the approval process.

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Executive Summary

Matthews Lake is located 7 miles southwest of Minong in Washburn County, Wisconsin. Matthews Lake is 267 acres in surface area with clear water, a maximum depth of 32 feet, a healthy native aquatic plant community, and abundant vegetation (but not causing impairment) in much of the lake. There is one public access at the northwest shore along County Highway F. Residents use the lake for fishing, recreational boating, swimming, kayaking, viewing nature, quiet reflection, and paddle boarding. These are just some recreational activities observed or discussed during the 2020 survey and meetings in 2020-21.

Prompted by concerns about phosphorus levels and nearby AIS infestations, the Matthews Lake Association (MLA) partnered with Aquatic Plant & Habitat Services LLC to apply for an Aquatic Invasive Species Education & Prevention Grant through the Wisconsin Department of Natural Resources (WDNR). The grant provided funding assistance for an aquatic plant survey in 2020, a public planning meeting in August 2021, and development of this management plan, which is the first aquatic plant management plan/AIS prevention plan for Matthews Lake. There were no aquatic invasive plant species found during the 2020 aquatic plant survey.

This management plan provides background information about Matthews Lake, reviews ongoing AIS prevention activities, and presents management options. All these components contributed to a strategy that includes the goals listed below and in Section 5.0. The WDNR provides guidance and regulations for managing aquatic ecosystems. This management plan adheres to WDNR guidance (specifically Chapters NR107, NR109, NR40 and Chapter 30/31) and proposed actions will be implemented in compliance with state laws and regulations.

Goal 1 – Prevent the introduction of aquatic invasive species.
Goal 2 – Actively monitor Matthews Lake for early detection of AIS.
Goal 3 – Provide educational opportunities pertaining to aquatic plants and AIS.
Goal 4 – Protect native aquatic plants, organisms, and associated native mammal and fish populations.
Goal 5 – Maintain desirable trophic states (high water quality).

1.0 Matthews Lake Background Information

1.1 Study Site

Matthews Lake (WBIC 2710800) is located in Washburn County, Wisconsin with a surface area of 267 acres and maximum depth of 32 feet[1]. Matthews Lake is situated approximately 7 miles southwest of Minong, Wisconsin. The lake is considered mesotrophic from a nutrient standpoint. More on this is described in Section 1.5.

The lake is classified by the WDNR as a seepage lake, meaning there is no inlet our outlet and the primary source of water is precipitation and runoff with some groundwater flowing into the lake. It is worth noting, however, that a surface water outlet exists along the southern shore (Figure 1). A Washburn County Geographic Information Web server map suggests that this surface water outlet flows from Matthews Lake and southward to join Stuntz Brook.

Figure 1 – Matthews Lake Maps & Photo of Outlet

Above: Map of Matthews Lake illustrating locations of public boat landing, water quality monitoring site, and surface water outlet.

Top Right: Map of Matthews Lake from Washburn County Geographic Information Web Server illustrating location of surface water outlet connecting with Stuntz Brook.

Right: Photo of unnamed surface water outlet along the southern shore of Matthews Lake. Photo courtesy of Richard Howard

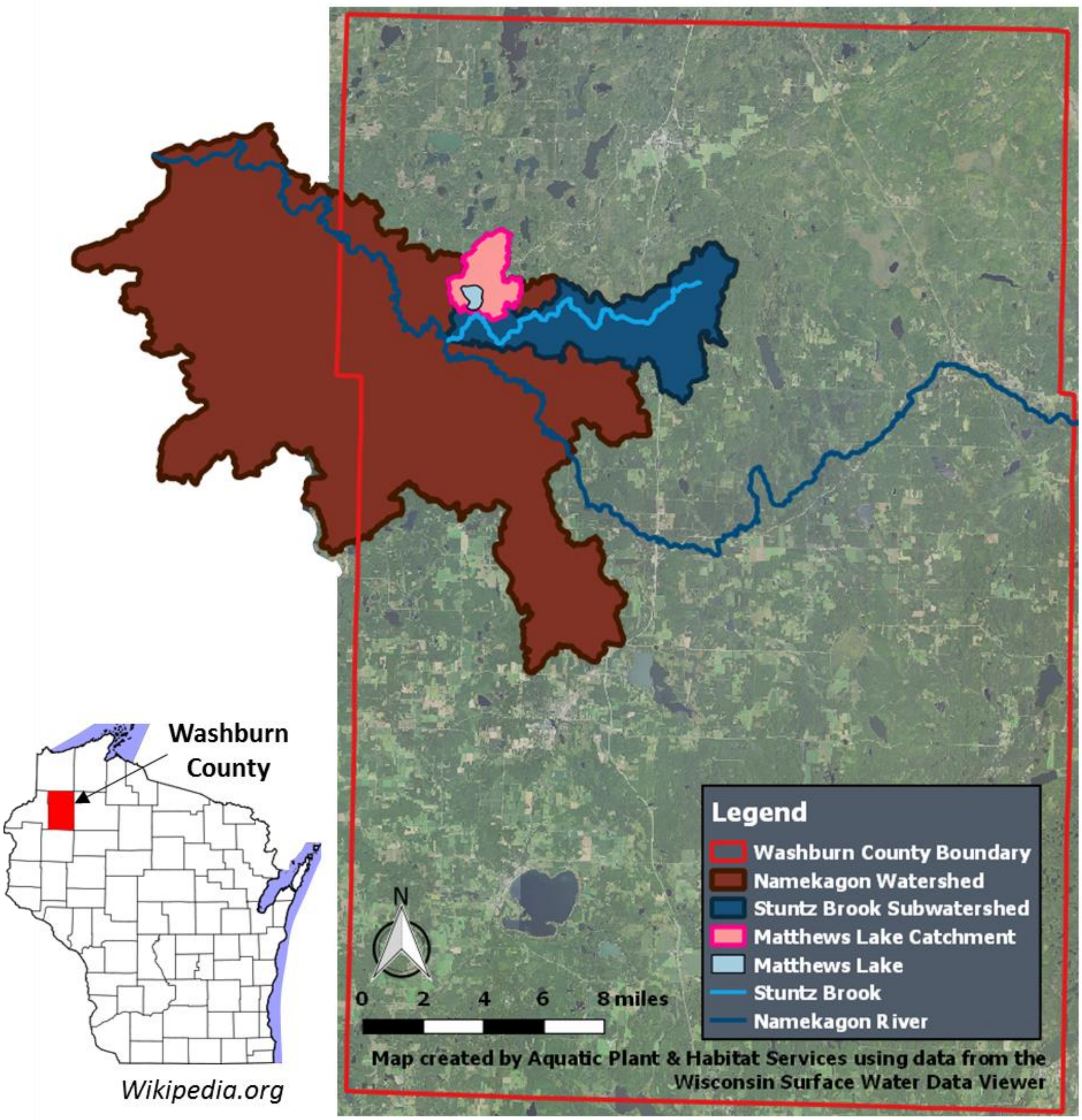
[1] Maximum depth recorded during 2020 aquatic plant survey. WDNR webpage for Matthews Lake suggests the maximum depth is 26 ft. https://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2710800&page=facts

1.2 Watershed, Shore Lands, and Water Quality Implications

1.2.1 Watershed

Matthews Lake lies within the Namekagon Watershed, which includes the brown, blue, and pink areas in Figure 2. Within the Namekagon Watershed is the Stuntz Brook Sub-watershed, which is includes the blue and pink area illustrated in Figure 2. The direct catchment of Matthews Lake includes only the pink area in Figure 2.

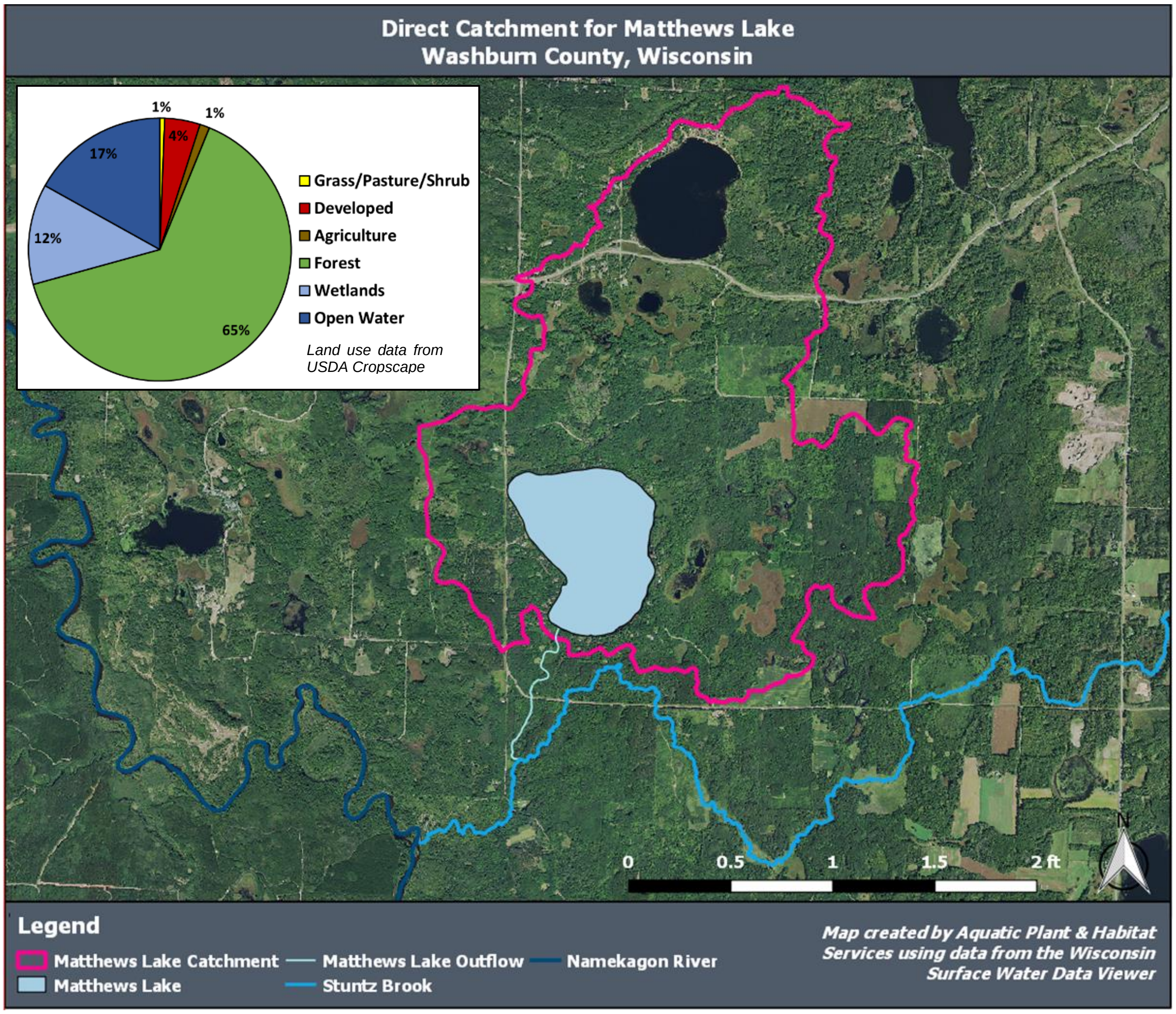
Figure 2 – Map of Matthews Lake Catchment, Sub-watershed, & Watershed



1.2.2 Direct Catchment

The direct catchment, or watershed, for Matthews Lake is illustrated in the pink shaded area of Figure 2 and a close-up of the area is outlined in pink in Figure 3. The area is is 2,766 acres (4.32 square miles). According to data from the USDA Cropscape, the catchment is 65% forested, 17% open water, and 12% wetlands. The remaining 6% is developed, agricultural, or gras/pasture/shrub (Figure 3).

Figure 3 – Map of Matthews Lake Catchment & Land Use Chart



1.3 Watershed Model by Washburn County

As part of the grant project in creating this management plan, Washburn County staff provided watershed nutrient loading data to help determine whether there were concerns related to pollution, especially phosphorus (P). Using the Model My Watershed (modelmywatershed.org) web application, source loading estimates were calculated. The P load estimate was128 lbs/year. This is within the range of source loading in the Wisconsin Lake Mondel Suite (WiLMS), which modeled a low P load estimate of 111lbs/year, most likely estimate of 154 lbs/year, and high estimate of 313 lbs/year.

Sources	Sediment (lbs)	Nitrogen (lbs)	Phosphorus (lbs)
Hay/Pasture	1,776.40	10.4	0.8
Wooded Areas	2,466.00	18.1	1.2
Wetlands	117.8	53.3	2.8
Low-Density Mixed	19.7	0.4	0
Medium-Density Mixed	15.3	0.3	0
Low-Density Open Space	946.2	20	2.2
Farm Animals	0	226	51.9
Stream Bank Erosion	61.7	0	0
Subsurface Flow	0	1,868.70	48.9
Septic Systems	0	36.3	19.3
Totals	5403.1	2233.5	127.7

See **Appendix C** for more information on septic system effluent

1.4 Water Quality Implications

The water quality of a lake, stream, or river is directly impacted by its watershed, which includes land that is directly adjacent to a lake. When waterfront land changes from forest-covered to a house, driveway, deck, garage, septic systems, lawns and sandy beaches, the water quality will be directly affected. It is the cumulative land cover change of many waterfront properties that leads to a decline in water quality.

Lake property owners are the last line of defense in protecting water quality from the impacts of human development.

For example, the amount of P entering a lake increases as land use changes from forested to residential (Panuska & Lillie 1995, Jeffrey 1985). A developed site with a lawn will allow more runoff volume carrying P and nitrogen than a forested site (Graczyk et al 2003). P is generally the key nutrient that leads to algae and nuisance aquatic plant growth. P sources include human waste (failing septic systems), animal waste (farm runoff), soil erosion, detergents, and lawn fertilizers (Shaw et al. 2004). Detergents and lawn fertilizer are presumed less of an issue with recent laws. Developed sites have more impervious surface that does not allow precipitation to infiltrate into the soils. This precipitation becomes surface water runoff at warmer temp. than at non-developed sites (Galli 1988). The warmer water that flows into the lake can lead to increased lake water temp., and as water temps. increase the amount of dissolved oxygen it can “hold” decreases.

The combined impacts of increased water temperatures, lower dissolved oxygen, and higher phosphorus can all result from shoreland development.

1.5 Trophic State & Water Quality

Trophic state and water quality are often used interchangeably and while the two are related, they are not the same. Trophic state describes the biological condition of a lake using a scale that is based on measurable and objective criteria. Water quality is an objective descriptor of a lake's condition based on the observer's use of the lake. For example, clear-water lakes are often described as having "good" or "excellent" water quality, which may be true for swimmers or SCUBA divers. The same ultra-clear system may have low productivity and thus a limited fishery leading to an "average" water quality classification by an angler. This section describes the trophic state of Matthews Lake using Carlson's Trophic State Index (1996).

Water clarity, total phosphorus, and chlorophyll-*a* are variables used to determine the productivity or trophic state of a lake. Each variable can be used independently to gain insight on the approximate trophic state. However, combining data for clarity, phosphorus, and chlorophyll-*a* yields a more accurate lake classification. The Carlson Trophic State Index (TSI) is frequently used to determine biomass in aquatic systems. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms. Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Red ovals in Figure 4 represent Matthews Lake's ranges).

Figure 4 – Trophic State Gradient adapted from Simpson & Carlson (1996)

TSI	Chlorophyll-a (ug/L)	Secchi Depth (ft)	Total Phosphorus (ug/L)	Attributes	Fisheries & Recreation
<30	<0.95	>26	<6	Oligotrophic: Clear water, oxygen throughout the year in the hypolimnion	Salmonid fisheries dominate
30-40	0.95 - 2.6	13 - 26	6 - 12	Oligotrophic: Hypolimnia of shallower lakes may become anoxic	Salmonid fisheries in deep lakes only
40-50	2.6 - 7.3	6.5 - 13	12 - 24	Mesotrophic: Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60	7.3 - 20	3 – 6.5	24 - 48	Eutrophic: Anoxic hypolimnia, macrophyte problems possible	Warm-water fisheries only. Bass may dominate.
60-70	20 - 56	1.5 - 3	48 - 96	Eutrophic: Blue-green algae dominate, algal scums and macrophyte problems	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating.
70-80	56 - 155	0.75 – 1.5	96 - 192	Hypereutrophic: (light limited productivity). Dense algae and macrophytes	Rough fish dominate; summer fish kills possible
>80	>155	<0.75	192 - 384	Algal scums, few macrophytes	

1.5.1 Water Clarity

Figure 5 – Secchi Disk

The depth to which light can penetrate, or water clarity, is a factor that limits aquatic plant growth. Water clarity is measured by lowering a black and white Secchi disk (8 inches diameter) in the water and recording the depth of disappearance. The disk is then lowered further and slowly raised until it reappears. The Secchi depth is the mid-point between the depth of disappearance and the depth of reappearance. Because light penetration is usually associated with nutrient levels and algae growth, a lake is considered eutrophic when Secchi depths are less than 6.5 feet. Secchi depths vary throughout the year, with shallower readings in summer when algae concentrations increase, thus limiting light penetration. Conversely, deeper readings occur in spring and late fall when algae growth is lower. Although the Secchi disk is a useful, inexpensive, and widely used way to assess water clarity, it has limitations in lakes with tannin-stained water because the water color will affect the Secchi disk reading.

Volunteers on Matthews Lake have monitored Secchi depth since 2000 at the deepest area of the lake illustrated in Figure 1. The average summer (July & August) Secchi depth since 2000 is 12.5 feet, therefore classifying Matthews Lake as a **MESOTROPHIC** system from a water clarity standpoint but very near oligotrophic classification (Figure 4).

1.5.2 Phosphorus

Phosphorus is an important nutrient for plant growth and is commonly the limiting nutrient for plant production in Wisconsin lakes. As a limiting factor, adding small quantities of phosphorus to a lake can lead to dramatic increases in plant and algae growth and should therefore be the focus of management efforts to protect or improve water quality. Phosphorus can be monitored at various depths because when a lake is thermally stratified in summer (warm water at surface, cooler water at bottom), higher levels of phosphorus are found in deeper waters. This is due to decomposition and sinking of dead zooplankton and algae, thereby causing a “build-up” of nutrients in deeper waters that do not readily mix during thermal stratification. Also due to the lack of mixing in summer, the oxygen levels in deeper waters fall. When dissolved oxygen is absent at the sediment-water interface, chemical changes allow phosphorus that was trapped in the sediment to be re-suspended into the water column thereby causing internal phosphorus loading.

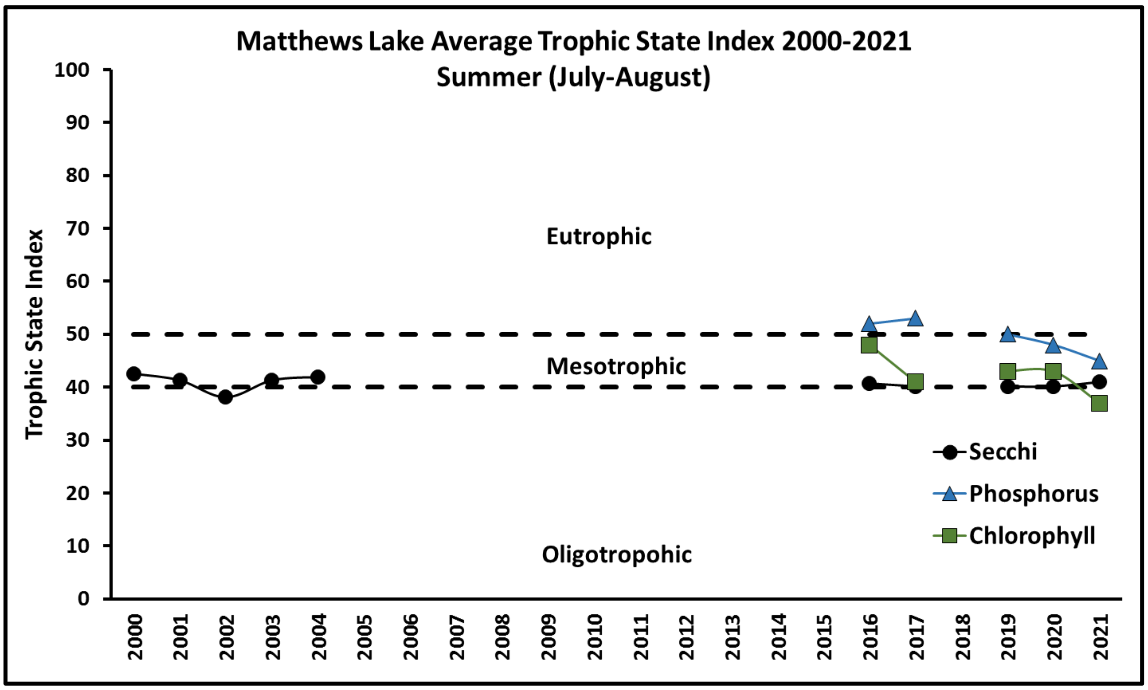
Total phosphorus was monitored in Matthews Lake since 2016 using water samples from the surface (0-6 feet) at the citizen lake monitoring site illustrated in Figure 1. The average summer (July & August) total phosphorus TSI since 2016 is 50, therefore classifying Matthews Lake as a **MESOTROPHIC** system from a nutrient standpoint (Figure 6).

1.5.3 Chlorophyll-a

Chlorophyll-*a* is the green pigment found in plants and algae. The concentration of chlorophyll-*a* is used as a measure of the algal population in a lake. For trophic state classification, preference is given to the chlorophyll-*a* trophic state index (TSI_{CHL}) because it is the most accurate at predicting algal biomass. The equations for calculating TSI are based on Carlson & Simpson (1996).

Chlorophyll-*a* has been monitored in Matthews Lake since 2016 using water samples from the surface (0-6 feet) at the citizen lake monitoring site illustrated in Figure 1. The average summer (July & August) TSI_{CHL} since 2016 is 42, therefore classifying Matthews Lake as a **MESOTROPHIC** system from a algal biomass standpoint (Figure 4).

Figure 6 – Matthews Lake Trophic State Index Chart

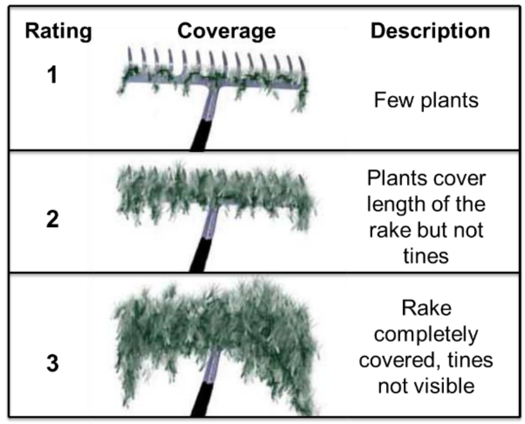


1.6 Aquatic Plants

1.6.1 2020 Survey Methods

An aquatic plant survey of Matthews Lake was completed by Aquatic Plant and Habitat Services LLC July 27-28th, 2020. Survey assistance was provided by AEM Consulting LLC and Washburn County AIS Coordinator. The plant survey followed a statewide standard protocol developed by Hauxwell et al. (2010) with predetermined survey points. In Matthews Lake, the survey points were spaced 53 meters (~174 ft.) apart and there were 381 points total. The plants were surveyed from a boat using a double-sided rake head on a telescopic pole or rope, depending on site depth. Rake fullness was determined using guidelines in Figure 7. A map of the survey grid can be found in Appendix A.

Figure 7 – Total Rake Fullness Illustration



1.6.2 2020 Survey Results

There were a possible 381 survey points in Matthews Lake based on the point-intercept survey grid (Appendix A). The maximum rooting depth of plants was 25 feet and there were 300 sample points shallower than the maximum rooting depth. Nearly three-quarters of those sites (218 or 73%) had vegetation present (Table 1, Figure 8). Diversity was high with a species richness of 30 species found on the rake (not including filamentous algae or aquatic moss), another 1 species within 6ft of survey points but not on the rake (considered "visual"), and another 1 species found greater than 6ft from survey points. The Simpson Diversity Index was high with a value of 0.93 out of a maximum possible value of 1.00. The Floristic Quality Index was 34.4, which is higher than the average value of 24.3 for other lakes in the same ecoregion. Overall, the aquatic plant community of Matthews Lake is diverse, heterogeneous, and indicative of low human disturbance.

Table 1 – Aquatic Plant Survey Results for Matthews Lake 2020

Summary Statistic			2020
1	Total # of sites visited		380
2	Total # of sites with vegetation		218
3	Max. depth of plants (feet)		25 ft
4	Total # of sites shallower than max. depth of plants		301
5	Frequency of occurrence at sites shallower than max. depth of plants (Littoral FOO)		72%
6	Average # of species per site	a) Shallower than max. depth	2.40
		b) Vegetated sites only	3.31
		c) Native shallower than max. depth	2.40
		d) Native species at vegetated sites only	3.31
7	Species Richness	a) Total # species on rake at all sites	30
		b) Including visuals	31
8	Simpson's Diversity Index		0.93
9	Mean Coefficient of Conservatism		6.6
10	Floristic Quality Index		34.4

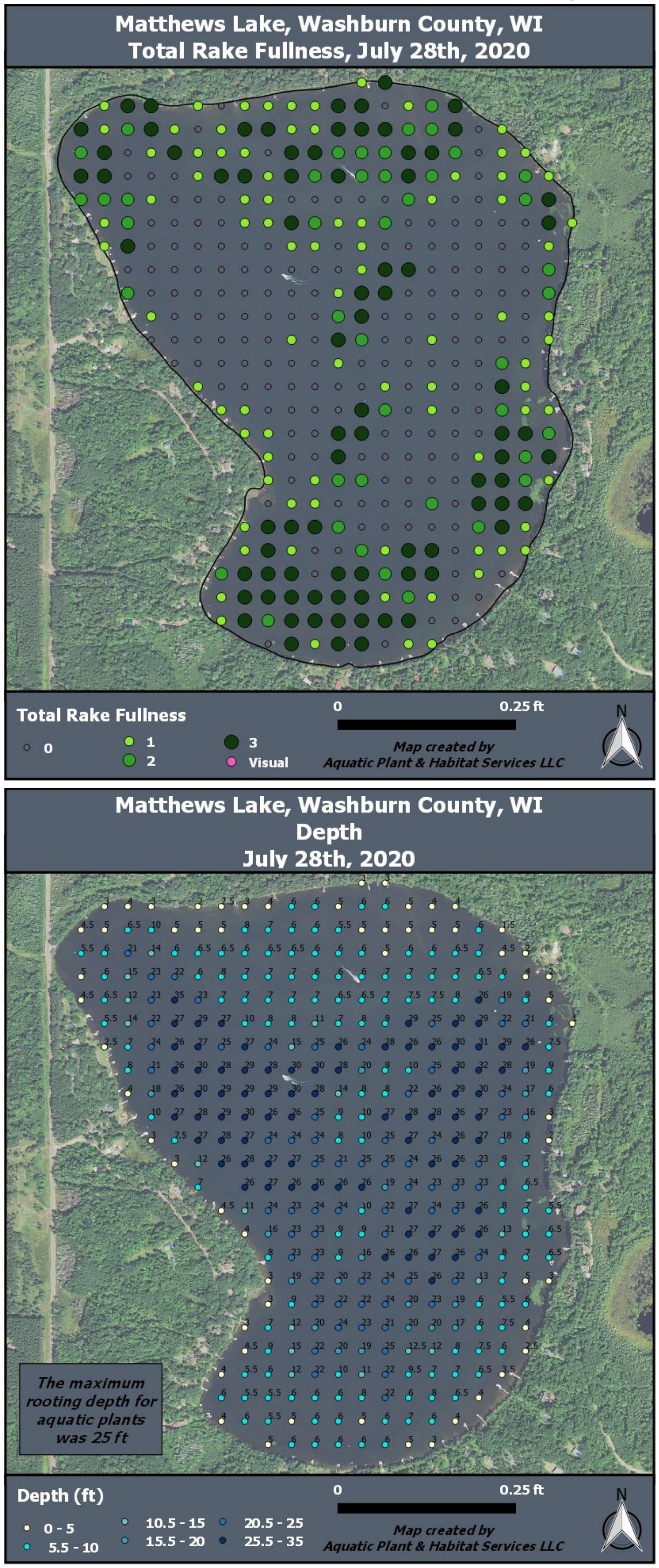
Fern pondweed, large-leaf pondweed, and variable pondweed were the three most common species found in 2020 with littoral frequencies of 32%, 24%, and 21%, respectively (Table 2). Together, they accounted for 32% of the total relative frequency, which further supports the concept that Matthews Lake has a highly heterogeneous plant community. Maps of individual species are in Appendix B.

There were two species found in 2020 with a high conservatism(C) value of 9 or 10 including dwarf watermilfoil and creeping spearwort (Table 2, Appendix B). The C value estimates the likelihood of that plant species occurring in an environment that is relatively unaltered from pre-settlement conditions. As human disturbance occurs, species with a low C value are more likely to dominate a lake.

Table 2 - Matthews Lake Individual Species Statistics, 2020

Common Name	Scientific Name	FOO in Veg. Areas	Littoral Frequency (%)	Relative Frequency (%)	# Sites	Avg. Rake Fullness	# Visual
Fern pondweed	*Potamogeton robbinsii*	44.29	32.33	13.43	97	1.87	1
Large-leaf pondweed	*Potamogeton amplifolius*	32.42	23.67	9.83	71	1.27	0
Variable pondweed	*Potamogeton gramineus*	29.22	21.33	8.86	64	1.05	0
Slender naiad	*Najas flexilis*	25.57	18.67	7.76	56	1.13	0
Wild celery	*Vallisneria americana*	25.11	18.33	7.62	55	1.07	0
Southern naiad	*Najas guadalupensis*	23.29	17.00	7.06	51	1.51	0
Common waterweed	*Elodea canadensis*	20.55	15.00	6.23	45	1.31	0
Flat-stem pondweed	*Potamogeton zosteriformis*	20.09	14.67	6.09	44	1.18	0
Small pondweed	*Potamogeton pusillus*	19.18	14.00	5.82	42	1.48	0
Slender nitella	*Nitella flexilis*	14.16	10.33	4.29	31	1.32	0
Common stonewort	*Chara contraria*	13.70	10.00	4.16	30	1.03	0
Water marigold	*Bidens beckii*	7.31	5.33	2.22	16	1.00	0
Illinois pondweed	*Potamogeton illinoensis*	7.31	5.33	2.22	16	1.06	1
Needle spikerush	*Eleocharis acicularis*	5.94	4.33	1.80	13	1.15	0
Brown-fruited rush	*Juncus pelocarpus*	5.48	4.00	1.66	12	1.00	0
Coontail	*Ceratophyllum demersum*	5.02	3.67	1.52	11	1.09	0
Dwarf watermilfoil	*Myriophyllum tenellum*	5.02	3.67	1.52	11	1.00	0
White-stem pondweed	*Potamogeton praelongus*	4.11	3.00	1.25	9	1.22	0
Braun's stonewort	*Chara braunii*	4.11	3.00	1.25	9	1.11	0
Crested arrowhead	*Sagittaria cristata*	3.65	2.67	1.11	8	1.13	0
Water star-grass	*Heteranthera dubia*	2.28	1.67	0.69	5	1.00	0
Clasping-leaf pondweed	*Potamogeton richardsonii*	2.28	1.67	0.69	5	1.00	0
Arrowhead	*Sagittaria sp.*	2.28	1.67	0.69	5	1.00	0
Northern water-milfoil	*Myriophyllum sibiricum*	1.83	1.33	0.55	4	1.00	1
Stiff pondweed	*Potamogeton strictifolius*	1.83	1.33	0.55	4	1.00	0
Spatterdock	*Nuphar variegata*	0.91	0.67	0.28	2	1.50	3
Softstem bulrush	*Schoenoplectus tabernaemontani*	0.91	0.67	0.28	2	1.00	1
Common bladderwort	*Utricularia vulgaris*	0.91	0.67	0.28	2	1.00	0
Lake quillwort	*Isoetes lacustris*	0.46	0.33	0.14	1	1.00	0
Creeping spearwort	*Ranunculus flammula*	0.46	0.33	0.14	1	1.00	0
Aquatic moss		0.46	0.33	-	1	2.00	0
Creeping spikerush	*Eleocharis palustris*	0.00	0.00	0.00	0	0.00	1
species with high coefficient of conservatism (9 or 10)							
**Found during the "boat survey" (not at survey points & greater than 6 ft from any survey point)							

Figure 8 – Matthews Lake Total Rake Fullness & Depth Maps, 2020

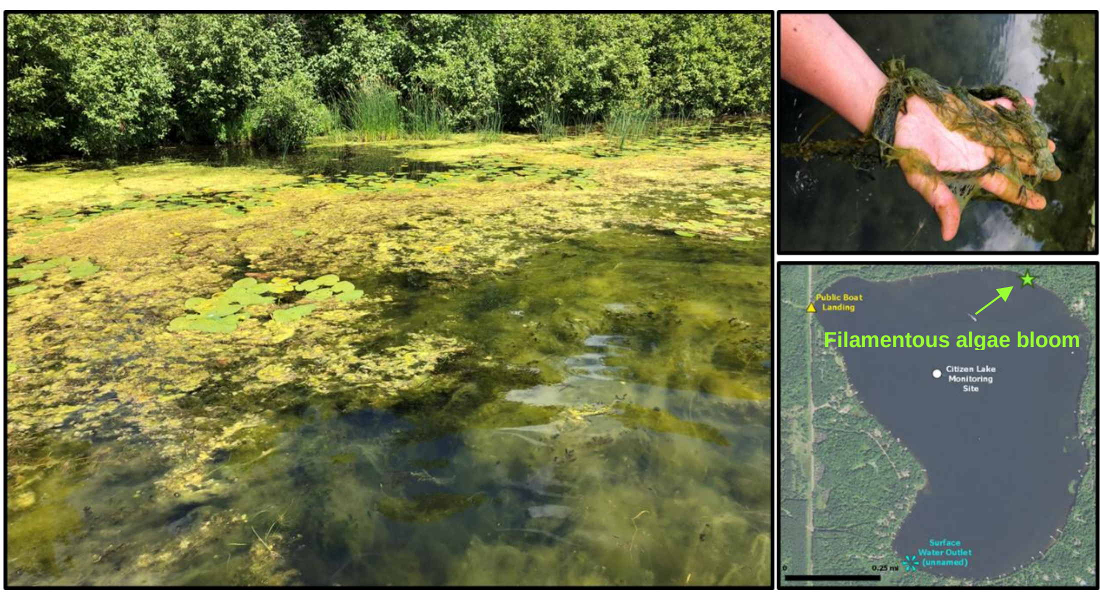


1.6.3 Filamentous Algae

Filamentous algae are single algal cells that are microscopic as individuals but they form long filaments of cells that become visible to the naked eye. The filaments entwine to form a mat that resembles wet wool or cotton and remain submerged until enough air is trapped among the filaments to cause a floating mat. Filamentous algae are found in backwaters and near shore areas where nutrients (especially phosphorus) are readily available. At non-nuisance levels, the algae can provide cover for small aquatic organisms that serve as food for fish. However, floating mats of algae are not aesthetically pleasing and they interfere with recreation such as swimming and fishing.

No filamentous algae was found at sampling points during the aquatic plant survey in July 2020. However, upon request from the MLA an area along the northeast shore was documented as a location where filamentous algae reportedly blooms each summer. In 2020 the area was approximately 30 ft X 50 ft of vegetation (mainly coontail, common waterweed, spadderdock, and softstem bulrush) with abundant submersed and floating filamentous algae. The area has a natural shoreline (100 ft to the west and 400 ft to the east) with no obvious source of phosphorus or other nutrients. This could be an area where groundwater flows into Matthews Lake and if so, perhaps the groundwater has high nutrient content. Further investigation of the overall groundwater flow patterns or even groundwater collection in this area may provide additional information.

Figure 9 – Filamentous Algae Bloom in Matthews Lake, July 2020



1.7 Fishery

The most recent electrofishing survey of Matthews Lake occurred in Spring 2010 and was conducted by the WDNR. The purpose of the survey was to characterize fish species composition, relative abundance, and size structure. A total of 351 fish were collected during the 2010 survey. There were 5 species present, of which the most common species were largemouth bass (180) and bluegill (159) (Table 3). Low abundance species included pumpkinseed, black crappie, and hybrid sunfish. Not found during the survey but confirmed present in Matthews Lake are walleye, northern pike, muskellunge, smallmouth bass, and yellow perch.

Table 3 – 2010 Spring Electrofishing Results

Common Name	Number	Min Length (in)	Max Length (in)	Average Length (in)
Largemouth Bass	180	5.5	13.5	11.0
Bluegill	159	1.9	9.1	3.9
Pumpkinseed	9	2.7	7.9	6.5
Black Crappie	2	8.7	9.1	-
Hybrid Sunfish	1	7.4	7.4	-

A creel survey was conducted by the WDNR from May-October 2014 and December-March 2015 in order to estimate overall fishing pressure, gauge fishing effort directed at each species, and record catch and harvest information. The survey found largemouth bass and bluegill were the two species of greatest directed effort. The species of greatest total harvest were bluegill, black crappie, and largemouth bass, respectively (Table 4).

Table 4 – Matthews Lake Creel Survey Synopsis 2014-2015

SPECIES	DIRECTED EFFORT (Hours)	PERCENT OF TOTAL	TOTAL CATCH	SPECIFIC CATCH RATE (Hrs/Fish)	TOTAL HARVEST	SPECIFIC HARVEST RATE (Hrs/Fish)	MEAN LENGTH OF HARVESTED FISH
Walleye	255	3.3%	18	100.0	0	NA	NA
Northern Pike	1293	16.8%	2175	1.1	48	50.0	20.0
Muskellunge	496	6.4%	13	100.0	0	NA	NA
Smallmouth Bass	10	0.1%	0	NA	0	NA	NA
Largemouth Bass	2001	25.9%	3911	0.7	587	4.2	11.9
Bluegill	2173	28.2%	11673	0.2	4633	0.5	7.5
Pumpkinseed	24	0.3%	99	2.0	63	2.0	7.1
Black Crappie	1348	17.5%	2697	0.5	1232	1.1	9.5
Yellow Perch	117	1.5%	127	2.5	80	2.9	9.6

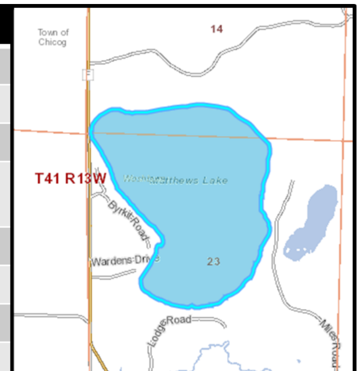
Table copied from Matthews Lake Creel Survey Report 2014-2015.
Specific catch rate is the # of hours it took to catch the species of fish. Information is only from anglers specifically targeting that species.
Specific harvest rate is the # of hours it took to harvest the species of fish (the fish caught was of desired and legal length). Information is only from anglers specifically targeting that species.

1.8 Wildlife

The Wisconsin Natural Heritage Inventory (NHI) lists species and natural communities that are known or suspected to be rare in Wisconsin. The species are legally designated as endangered or threatened or they may be listed in an advisory capacity of special concern. The NHI lists species according to township and range, which includes T41 R13W for Matthews Lake. There are 13 NHI species in Matthews Lake area (T41 R13W, Table 5).

Table 5 – Rare Plant & Animal Species in the Area

Common Name	Scientific Name
Lake Sturgeon	Acipenser fulvescens
Elktoe (mussel)	Alasmidonta marginata
Dwarf Milkweed	Asclepias ovalifolia
Northern Barrens Tiger Beetle	Cicindela patruela patruela
Purple Wartyback	Cyclonaias tuberculata
Emydoidea blandingii	Blanding's Turtle
Etheostoma microperca	Least Darter
Glyptemys insculpta	Wood Turtle
Lithobates septentrionalis	Mink Frog
Percina evides	Gilt Darter
Plestiodon septentrionalis	Prairie Skink
Potamogeton oakesianus	Oakes' Pondweed
Utricularia resupinata	Northern Bladderwort



There are many ways that lakeshore residents can improve wildlife habitat. First is to recognize that the zone within 100 feet of the lakeshore and into the shallows of the lake is a critical area for mammals, birds, reptiles, amphibians, and fish. Leaving trees, shrubs, and vegetation is one way to protect existing habitat. If a lakeshore has already been cleared and developed then residents can restore habitat by selecting areas that will not be mowed and/or planting native plants and landscaping in a way that is aesthetically pleasing to residents and supplies habitat for wildlife.

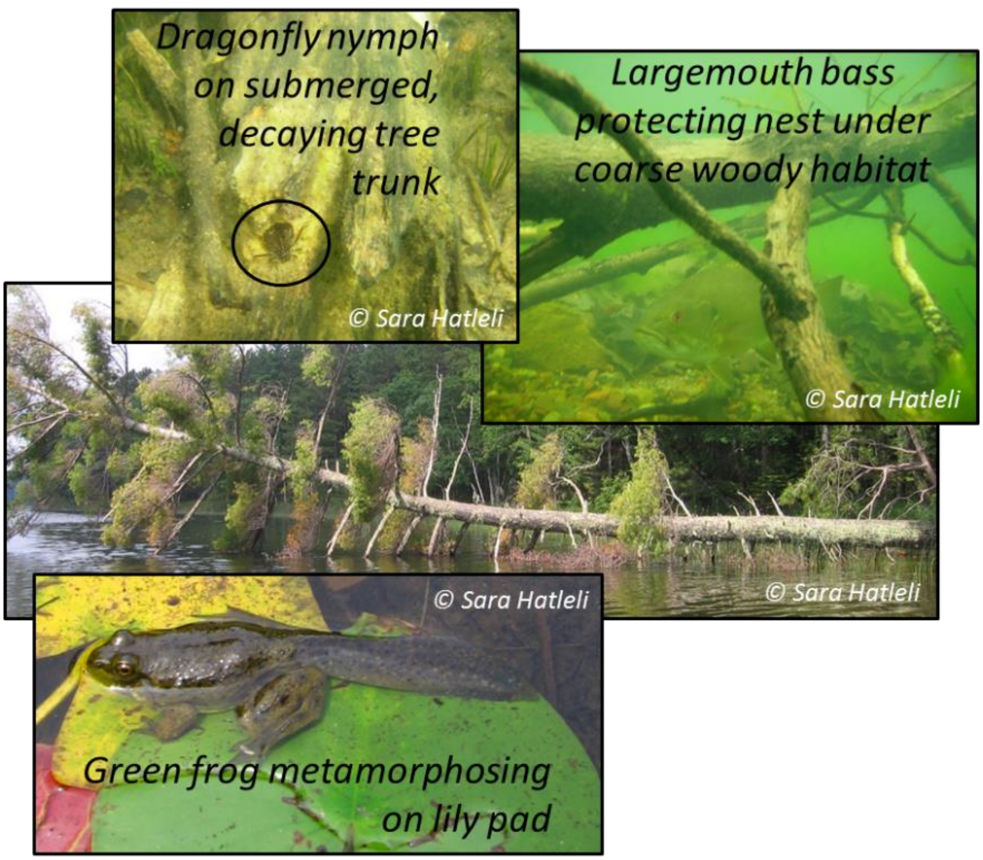
Protecting and restoring lakeshore buffers and natural shoreline also prevents issues with Canada geese that show preference for manicured lawns. Geese are attracted to a mowed lawns because of the visibility it affords. Geese avoid areas with taller plants in an effort to elude predators. The addition of taller native plantings along the lakeshore can help deter geese.

Figure 10 – Photo of Mowed Lawn and Multiple Geese

Near shore vegetation in the lake creates habitat for frogs, turtles, furbearers, and waterfowl. Minimal clearing in this area will maintain critical habitat for these animals and important areas for fish spawning and development. Fallen trees along the lakeshore also provide structural habitat for wildlife and fish. Examples include turtles basking on these fallen trees and wood ducks and mallards loafing on them as well. Anglers often target fallen trees in lakes because they serve as structure for fish (Figure 11). There are grant programs that promote placement of trees back in the water, but it is much easier to leave trees where they fall naturally whenever possible.

Moving away from the lakeshore and further upland, we know that land use impacts water quality and thus impacts which species of animals can thrive in and around the lake. And although this is important, the more critical concept is for lakeshore residents to be conscious of their practices near the lake.

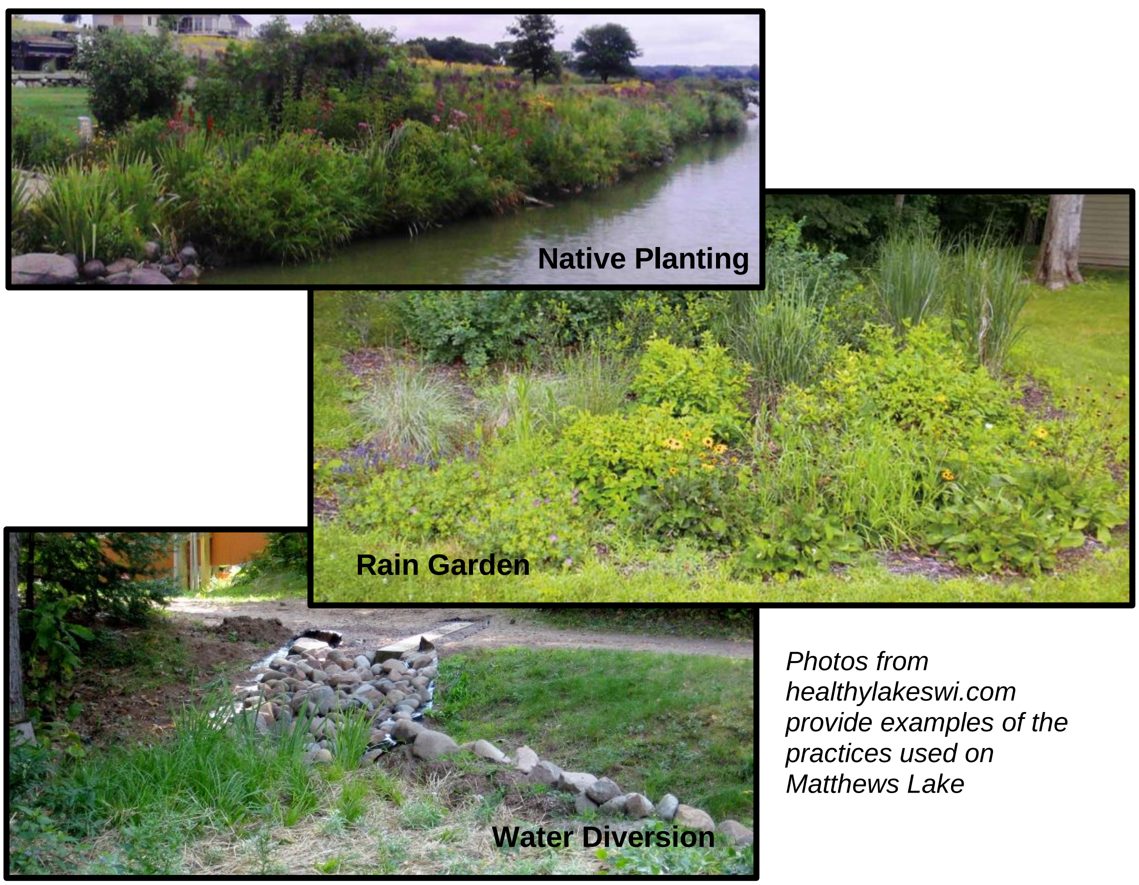
Figure 11 – Near Shore Habitat Photos



1.9 Healthy Lakes Practices on Matthews Lake

In summer 2020 the Matthews Lake Association (MLA) partnered with Washburn County Lakes and Rivers Association (WCLRA) and Washburn County to perform site visits at eight privately-owned parcels on Matthews Lake. The site visits allowed for planning to install vegetated buffer plantings to decrease surface water runoff into Matthews Lake. In fall 2020 the sites were prepared to make them shovel-ready for native plantings through the WDNR Healthy Lakes grant program. In 2021, MLA had 8 committed landowners with 12 practices to be installed on their properties including native plantings to protect the lake from surface water runoff and nutrient loading while providing habitat for native wildlife. Also included was a water diversion installed to direct runoff to a spot where it can better soak into the soil and rock infiltration practice where surface water runoff can be captured and also soak into the soil. Lastly, there were three rain gardens that will help surface water infiltrate into the soil rather than contribute to runoff. MLA secured $9870 in grant funding to provide cost share for these practices.

Figure 12 – Healthy Lakes Practices



Photos from healthylakeswi.com provide examples of the practices used on Matthews Lake

2.0 Aquatic Invasive Species

2.1 Aquatic Invasive Species in Matthews Lake

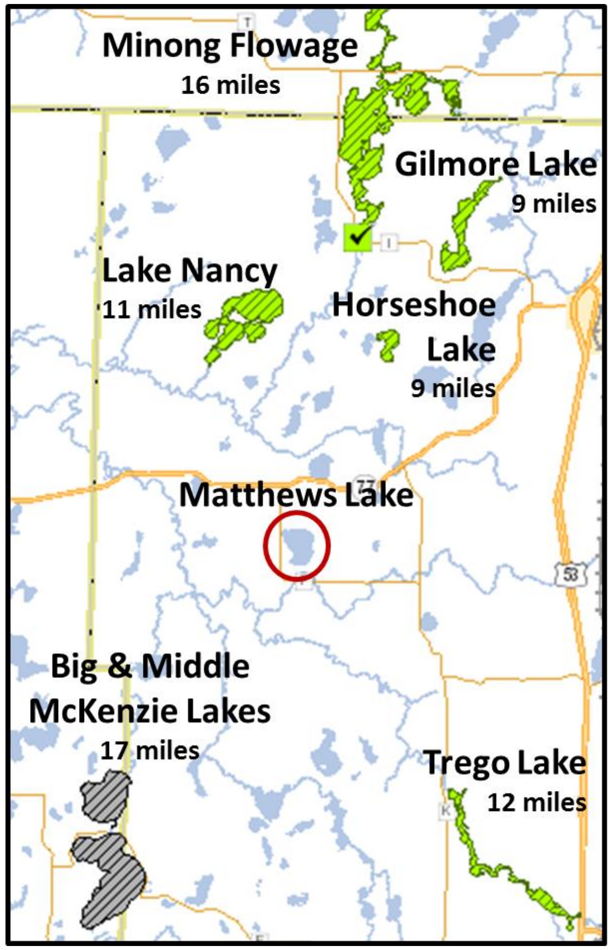
Aquatic invasive species (AIS) are defined by their tendency to out-compete native species thereby threatening the diversity and balance of plants and animals that are native to a particular system. The only invasive species documented in Matthews Lake is the Chinese mystery snail (*Cipangopaludina chinensis*). The snails feed on organic and inorganic bottom material mostly by scraping and diatoms are probably the most nutritious food it ingests (Jokinen 1982). This produces young by means of eggs which are hatched within the body of the parent. Females live up to 5 years, while males live up 3-4 years. Female fertility is very high, with brood pouches containing over 100 embryos at once. Young are born from June through October in eastern North America in shallow water, then females begin migrating to deeper water for the winter in the fall (Jokinen 1982). Chinese mystery snails can be impactful when they die off in large number and foul beaches and shore land areas. Some lake residents on Matthews Lake manually remove Chinese mystery snails from shallow lake areas adjacent to their property using the medium Garden Weasel Nut Gatherer (Figure 13). This creative method of manual removal may have been conjured by Matthews Lake residents! Chinese mystery snails are not reported to be a serious threat to the Matthews Lake ecosystem or recreation at this time.

Figure 13 – Chinese Mystery Snail Removal

2.2 Aquatic Invasive Species NEAR Matthews Lake

The invasive species of great concern for introduction into Matthews Lake are Eurasian watermilfoil (*Myriophyllum spicatum,* EWM) and zebra mussels (ZM) (*Dreissena polymorpha*). These are not the only nearby invasive species. However, steps taken to prevent the introduction of EWM and ZM will help prevent the introduction of other invasive plants and animals.

Figure 14 – EWM & ZM Lakes Nearby



EWM is found in five nearby lakes including Lake Nancy, Horseshoe Lake, Trego Lake, Minong Flowage, and Gilmore Lake. Zebra mussels are found in Big & Middle McKenzie Lakes (**Error! Reference source not found.**, distance represents driving mileage). The proximity of these lakes with invasive species is relevant because boats leaving a lake with AIS can introduce the plants or animals into other lakes if proper prevention steps are not taken (see section 3.0 on AIS prevention).

Eurasian Watermilfoil

Zebra Mussels

EWM is a non-native, invasive aquatic plant that can outcompete native species, grows well in disturbed areas, and can grow to form dense mats of vegetation at the lake surface thereby impairing navigation and recreation. EWM is largely spread when fragments of the plant are transported from one body of water to another on boat trailers. The fragments can sprout adventitious roots and become established in lake.

Zebra mussels are non-native, invasive aquatic invertebrates that filter feed on beneficial algae, which is a critical component of a lake ecosystem's food web. They do not filter feed on the harmful bluegreen algae, however. Decrease in algae can lead to increased water clarity and greater maximum rooting depth of aquatic plants. Zebra mussels attach to hard surfaces, including native clams.

Once introduced, there are very few options and often no feasible options for control.

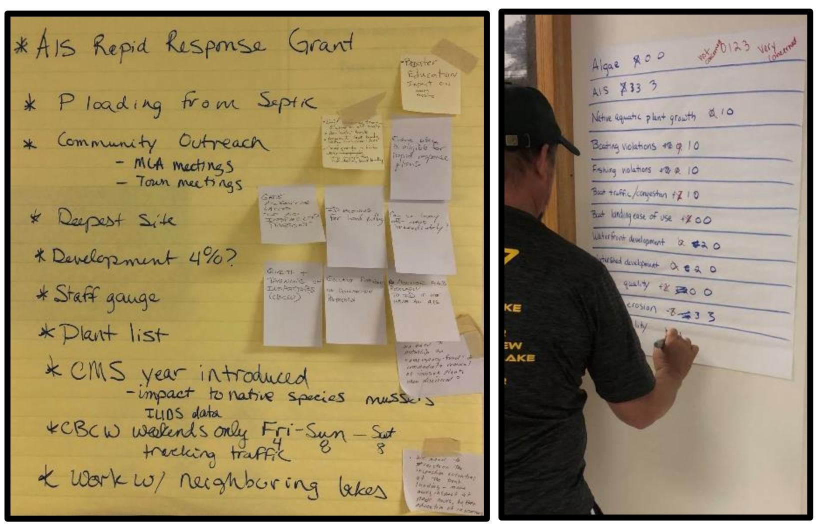
2.3 Public Input & Planning

2.3.1 Public Meeting

A public meeting was held August 14th, 2021 at the Chicog Town Hall, Trego, WI to gather public input regarding aquatic plant management and aquatic invasive species (AIS) prevention in Matthews Lake. A notice of the meeting was published in the Spooner Advocate on August 5th and 12th. The input was used in developing goals for this management plan. There were 10 people in attendance including the facilitator (Sara Hatleli, Aquatic Plant & Habitat Services LLC). During the meeting information was shared on the 2020 aquatic plant survey results, AIS found in and near Matthews Lake, and ways to prevent the introduction of AIS, especially Eurasian watermilfoil and zebra mussels, into Matthews Lake. Participants provided written comments on their recreational use of the lake and their concerns about the lake. Verbal input was also recorded during the meeting through notes kept by the facilitator on a large poster. Once written public input was gathered, a timeline of next steps were presented.

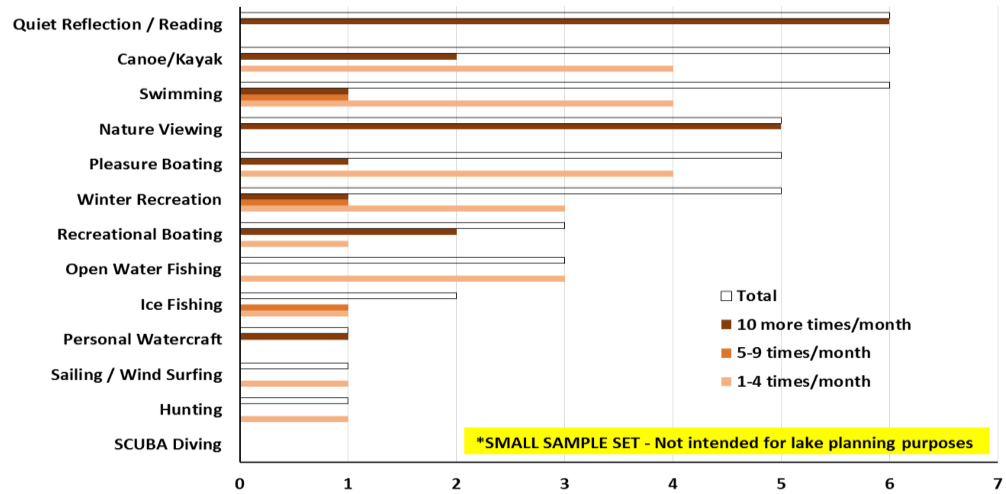
There were three opportunities for participants to provide written input. 1) Recreational use of Matthews Lake, 2) Concerns about Matthews Lake, 3) General written comments were collected on post-it notes.

Figure 15 – Written & Verbal Input from Participants



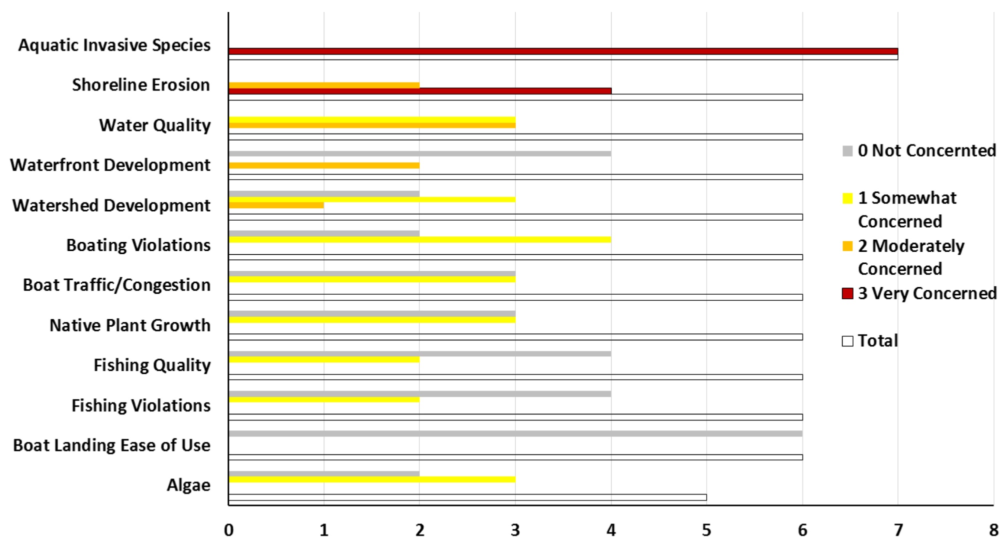
Recreational Use

Participants were invited to answer the following question and provide one answer per property: “How often do you or your family/friends participate in these activities on Matthews Lake?” Due to the very small sample size of participants, the results are not intended to guide lake management. However, this provides an example of social survey data that could be collected by the Matthews Lake Association to guide future management & projects,



Concerns about Matthews Lake

Participants were invited to share their level of concern about various lake-related issues.



General Written Comments

1. Boater education of wave impacts to shoreline
2. Limit distance from shore on all boats
3. Ban “wake” boats
4. Prosecute fast boats with “wake free times”
5. Create grants which provide enough for monitoring boat landing
6. Ensure plan is eligible for rapid response plans
7. Gate McKenzie Lakes if no inspector present
8. ID resources for hand pulling
9. Can we buoy off areas immediately?
10. Quality & training of inspectors (CBCW)
11. Educate residents on disinfection protocols
12. Monitor plants regularly to ID if we have AIS
13. We need to establish an emergency fund for immediate removal of AIS when discovered
14. We need to strengthen the inspection activities at the boat landing, more hours, peak hours, better education of inspectors

2.3.2 APMP Review and Comment

A draft of this management plan was available to the Matthews Lake Association on from March 10 through April 14th, 2022. During this review period, MLA made the following recommendations:

- Include Sections 7 and 8 in order to be better prepared if EWM were found in Matthews Lake.
- The following was added under Objective 2b: Hire a consultant annually as funds are available to perform a meander survey of the boat landing area looking for aquatic invasive plants, particularly EWM.

A second draft of the plan was sent to the WDNR and Washburn County for another round of review on April 19th, 2022. Minor changes to the content were suggested but no major changes to the plan occurred.

The third draft was made available to the general public for review and comment from May 19 through June 9, 2022. A public notice was placed in the local Spooner Advocate and on the MLA website on May 19. There were no comments received during the public comment period.

Adoption by the Matthews Lake Association
The Matthews Lake Board of Directors voted unanimously on July 6th, 2022 to approve the plan.

Approval by the WDNR
The APMP was provided to the WDNR on July 11th with the request for official approval. The plan was officially approved by the WDNR on August 29th, 2022 (approval letter in Appendix 10.4).

3.0 Ongoing AIS Prevention & Monitoring

3.1 Clean Boats Clean Waters

Watercraft inspection through the Clean Boats Clean Waters Program has been underway at the Matthews Lake boat landing since 2010. During watercraft inspections, boaters are encouraged to:

- **Inspect** boat, trailer and equipment
- **Remove** all attached plants or animals
- **Drain** all water from boats, motors, livewells and other equipment
- **Never** move live fish away from a waterbody
- **Dispose** of unwanted bait in the trash
- **Buy** minnows from a Wisconsin bait dealer, and use leftover minnows only if using them on that same waterbody.

Every year, the Clean Boats Clean Waters Program promotes the **Drain Campaign**, which occurs around Memorial Day weekend. Watercraft inspectors share the message with anglers to drain livewells and ice their catch, which helps prevent the spread of invasive species. Transporting water away from a lake or stream can contribute to the spread of invasive species because some disease, animals and plants can get caught in motors, livewells and buckets. To help anglers, the WDNR offers free ice packs during the campaign weekend at select boat landings.

The **Landing Blitz** is a statewide effort every fourth-of-July weekend to remind boaters to stop the spread of aquatic invasive species. Fourth-of-July is Wisconsin's busiest boating holiday.

3.2 Internet Landing Installed Device Sensor (I-LIDS)

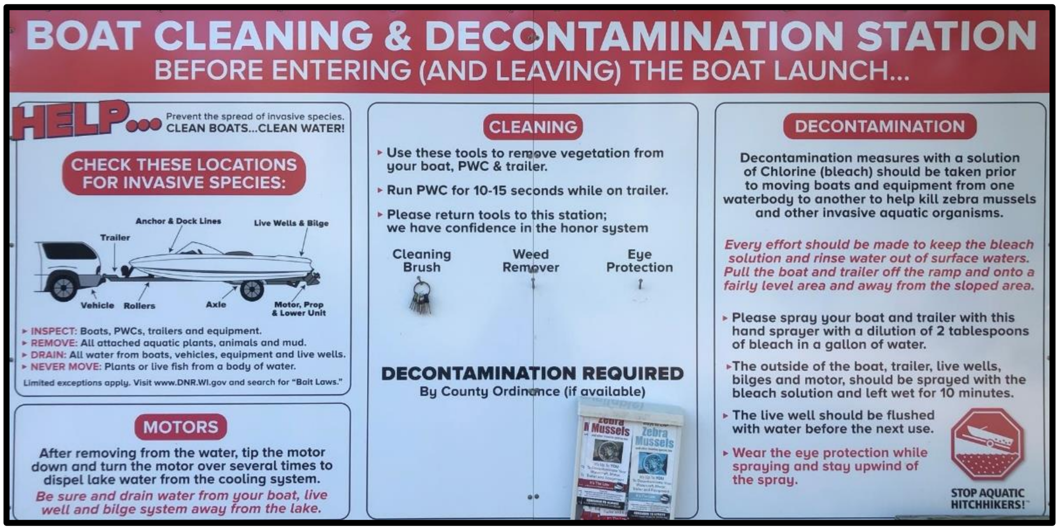
Even when a watercraft inspector is not present, boat launching activities are recorded by a motion-activated camera and reviewed by paid interns, volunteers, or other workers in order to detect whether a boat was launched with aquatic plants attached to a trailer, which is illegal in Wisconsin. Boaters are more likely to comply with watercraft inspection requirements when the I-LIDS system is in place. The system continues to play a role in AIS prevention for Matthews Lake (Figure 16).

Figure 16 – I-LIDS at Matthews Lake Boat Landing

3.3 Decontamination Station

A decontamination station is also present at the Matthews Lake boat landing. The sign includes instructions for watercraft inspection and using a mild bleach and water solution to spray on the boat, trailer, and equipment (Figure 17).

Figure 17 – Matthews Lake Decontamination Station



3.4 Boater's Advisory Signage

Since the confirmed presence of zebra mussels in 2016 in Big McKenzie Lake and 2017 in Middle McKenzie Lake (17 mile drive from Matthews Lake) there have been heightened efforts to prevent zebra mussels from spreading to other lakes in the area. Figure 18 is a photo of a sign at the Matthews Lake boat landing intended to provide information to boaters to help prevent the spread of zebra mussels into the lake.

Figure 18 – Matthews Lake Advisory Sign

3.5 Know Your Guests & Disinfection Protocols

Lake property owners who invite guest watercraft to Matthews Lake are advised to inquire where and when the guest watercraft was last launched. This information will allow the property owner and guest to determine the best steps for disinfection before the guest watercraft is launched. For example, if a boat is coming from a waterbody that has confirmed zebra mussel presence, it is recommended that the boat not be used in Matthews Lake. If both parties decide to use the boat in Matthews Lake, the guest watercraft should be disinfected using bleach in accordance with the literature review by Bates et al.[2] The literature is helpful in understanding how to properly disinfect watercraft based on scientific studies. Table 6 copied from the literature review document provides an example of how different methods of disinfection are effective on certain invertebrates but not on others.

Table 6 – Efficacy of Disinfection for Invertebrates

AIS	Steam Cleaning (212°F)	Hot Water (140°F)	Drying (5 days)	Chlorine (500 ppm, 10 min)	Virkon (2:100 solution, 20 min)	Freezing (26°F†)
Faucet Snail	☑ 18*	☑ 18*	⊗ 35	⊗ 18	®	®
New Zealand mud snail	☑ 4, 65*	☑ 4, 65*	☑ 6*, 66*	⊗ 76*	☑ 9, 10*, 74, 76, 83	☑ 4, 6*
Quagga Mussel (Adults)	☑ 7*,16*	☑ 7*,16*	☑ 14*	®	☑ 9	®
Quagga Mussel (Veligers)	☑ 4, 17, 80*	☑ 4, 17	☑ 69*	®	☑ 9	®
Zebra Mussel (Adult)	☑ 7*, 8*, 25	☑ 7*, 8*, 25	☑ 14*, 25*, 27	☑ 22*	®	☑ 25, 27
Zebra Mussel (Veligers)	☑ 4, 80*	☑ 4	®	☑ 22*, 25	®	®
Asian Clam	☑ 4, 37, 78	☑ 4, 37	⊗ 4	⊗ 37*, 38*	®	®
Spiny Water Flea (Adult)	☑ 7*, 47*, 80*	☑ 7*, 47*	®	☑ 76, 83	☑ 76, 83	☑ 76, 83
Spiny Water Flea (Resting Eggs)	☑ 2*, 80*	☑ 2*	☑ 2*, 4	⊗ 2	®	⊗ 2*
Bloody Red Shrimp	®	☑ 83*	☑ 83*	☑ 83*	☑ 83*	®
Rusty Crayfish	☑ †	☑ †	®	®	®	®

Key:
☑= Effective- Eliminates spp when applied at rates outlined in the manual code.
⊗=Not Effective- Requiring higher rates and/or longer time periods than outlined in code to eliminate spp.
®= Research Needed- No/insufficient sources or references found.

[2] Literature Review on Efficacy of Disinfection Methods by Species https://dnr.wisconsin.gov/topic/Invasives/disinfection.html, click on the link for "disinfection methods for species present."

3.6 Zebra Mussel Prevention Monitoring

Volunteers and Washburn County AIS Specialist have been monitoring for zebra mussel presence in Matthews Lake in recent years. Volunteers use plate samplers to detect the presence of zebra mussels. The Washburn County AIS specialist has also performed plankton net tows to detect the presence of zebra mussel veligers (microscopic, free-swimming larval stage). To date, no zebra mussels have been detected and prevention monitoring is planned for continuation.

Figure 19 – Zebra Mussel Monitoring Gear

Sample plate WITHOUT zebra mussels **Sample plate WITH zebra mussels** **Plankton tow net for veligers**

4.0 Plant Management Options

The best way to manage aquatic plants will be different for each lake and depends on the plant community, the species that require control, whether AIS are present, the level of human use of the system, and various other background information previously presented in this management plan. Aquatic plant management rules can be found in Wisconsin Administrative Codes, Chapters NR107 (chemical), NR109 (manual/mechanical), NR40 (invasive species) and Chapter 30/31 (waterways). NR107 and NR109 are undergoing rule revision at the time of writing this management plan, with expected revisions to be completed in 2023. Many management activities require a permit.

There are five broad categories for aquatic plant management:

- **No active management,** which means nothing is done to control plant growth, but a strong monitoring and education component may be included.
- **Manual & mechanical removal of plants**, which includes hand pulling, raking, using plant harvesters, and diver assisted suction harvest.
- **Chemical treatment**, which is the use of herbicide to kill aquatic plants.
- **Physical habitat alteration,** which means plants are reduced by altering variables that affect growth such as sediment, light availability, or depth.
- **Biological control**, which includes the use of living organisms, such as insects, to control plant growth.

The benefits and limitations of each of these broad groups is described below. All actions are accompanied by risks and potential impact to non-target aspects of a lake, but the benefits must outweigh those risks and potential detriments. A table of management options was created by the WDNR in 2008 and is also a valuable resource and can be found at the UW-Extension Lakes webpage at *https://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-E.pdf*.

4.1 Feasibility Factors

In order for a control method to be appropriate, it must be feasible from a biological, social, and financial perspective. ***Biological feasibility*** infers the control action will not cause significant harm to other aspects of lake ecology. ***Socially feasible*** actions are those that have support from project partners and in this case include the MLA, WDNR, and Washburn County. Social feasibility also infers that control actions meet regulatory requirements and will be formally permitted by regulatory agencies. ***Financial feasibility*** simply implies that any control action is affordable for the MLA and partners providing cost share.

4.2 No Active Management

Sometimes the best course of management is to take no immediate action. There are many benefits including the lack of disturbance to desirable native species and the lake system, there is no financial cost (aside from possibly survey costs), there are no unintended consequences of chemical treatment, and no permit is required. Disadvantages to this approach include the potential for AIS infestations to grow. This approach often includes a strong monitoring and educational component. A "***No Active Management" approach is feasible for Matthews Lake at this time.***

Manual & Mechanical Control

Manual and mechanical control includes pulling plants by hand or by using harvesting machines or devices. Permits are required for some activities and there are a variety of options under this type of control. Mechanical control is regulated under Chapter NR 109[3].

4.2.1 Manual Plant Removal

Figure 20 – Manual Removal Photo

Shore land property owners are allowed to manually remove a 30-foot wide section of native aquatic plants parallel to their shoreline without a permit. This can only occur in a single area and there must be piers, boatlifts, swim rafts, or other recreational or other water use devices within that 30-foot zone. This method can only be employed where other plant control methods are not being used and cannot be used in designated sensitive areas. At the time of writing this management plan, there are no designated sensitive areas on Matthews Lake. Property owners considering this method for recreational purposes are encouraged to contact their local WDNR Water Resources Management Specialist[4] if they have any questions or need clarification on native plant removal at their particular site. Additionally, there are no limits on raking loose plant material that accumulates along the shoreline. AIS can be selectively removed by manual means anywhere along shore or in open water area without a permit. Regulations require that the native plant community is not harmed during manual removal of AIS. Benefits of these techniques include little damage to the lake and plant community, the removal can be highly selective, and can be very effective in a small bed of AIS. On the other hand, this method can be very labor intensive. ***Manual removal in Matthews Lake is feasible for small-scale control if invasive species are detected. If EWM is found, fragments of the plant can root and grow elsewhere, so all of the plant must be removed.***

4.2.2 Diver Assisted Suction Harvest (DASH)

Figure 21 – DASH Photo

This form of mechanical removal involves the use of suction tubes connected to pumps mounted on a barge or pontoon. The suction tubes reach to the bottom of the lake and SCUBA divers manually uproot plants (often EWM) to be sucked through the tubes, up to the barge, and strained. EWM fragments from harvesting can grow new plants in the lake so it is important for DASH workers to minimize fragmentation and remove plant fragments. DASH is also selective toward EWM so it can help in protecting

[3] Chapter NR 109 *https://docs.legis.wisconsin.gov/code/admin_code/nr/100/109.pdf*.

[4] At the time of writing, the appropriate contact is Tyler Mesalk at 715-635-4227, tyler.mesalk@wisconsin.gov.

native and low frequency species and can be highly effective. DASH is labor intensive and costly at $2,500-$3,000 per day and removal rate depends on the density of EWM on-site, the height of EWM, and the number of different locations that need to be targeted for removal. ***Using DASH to control EWM or CLP if either are found is a feasible control method depending on the size of the plant bed(s). This method would work well in small infestation sites.***

4.2.3 Mechanical Harvest

This method includes "mowing" of aquatic plants down to depths of 5 feet and then collecting the plants and removing them from the lake. This technique is most appropriate for lake systems with large-scale or whole-lake aquatic plant issues. Mechanical harvesters provide immediate results and usually cause minimal impact to lake ecology while removing some, albeit likely minimal, nutrients from the lake via plant biomass reduction. Harvesting lanes in dense plants beds can improve growth and survival of some fish species. Also, if harvesting is done early enough in the season, impacts to native plants should be minimal (Barton et. al. 2013). However, care should be taken when harvesting early in the season to minimize impacts to spawning fish. A disposal site for harvested plants is a necessary part of a harvesting plan. The cost of hiring a mechanical harvester o visit the lake costs approximately $2,200 per day. The purchase of a brand new harvester is highly variable and depends on the type of harvester purchased. Cutting harvesters begin at $100,000. A harvester that can skim and pull the plants is $76,000. With a cutting harvester, a shore conveyor (starting at $35,000) is needed to offload the plants into a truck or dumpster for transport to a disposal site. A Recreational Boating Facilities Grant may help pay for up to 50% of eligible costs associated with purchasing harvesting equipment. Annual costs include paying an operator, storage of the harvester, insurance, and maintenance. As an example, Blake Lake's (Polk County) 2018 harvesting budget was $27,700[5].

Using a small mechanical harvester is NOT a feasible management option for Matthews Lake because there are no large-scale aquatic plant issues caused by native or invasive species.

Figure 22 – Mechanical Harvester Photos

[5] 2018 Annual Harvesting Budget Blake Lake: $2,500 APM Coordinator, $1,500 Lakes Convention, $475 Dues, $8,500 Harvester Labor & Expenses, $4,500 Insurance, $4,525 Administration, $5,700 Lake Management Plan.

4.3 Chemical Control

Figure 23 – Chemical Treatment Photo

The amount of time required to control plants using herbicides depends upon the specific product, formulation (granular or liquid), and concentration used. Herbicides must be applied in accordance with label guidelines and restrictions. For EWM control, an herbicide generally known as 2,4-D is often used because it is supposed to be selective to broadleaf plants such as EWM. Impacts to native aquatic plants are an important factor when deciding whether to use chemical control. If the native plants are reduced by repeated chemical control, there is more area for invasive species to grow. Also, if the duration of EWM control only lasts for one or two growing seasons, one should weigh the financial costs combined with impacts to native plants versus the relatively short-lived control. ***Chemical control is NOT a feasible option for aquatic plant control in Matthews Lake at this time. Native plant species are not causing recreational use impairment. There are no invasive plant species documented.***

4.4 Physical Habitat Alteration

Various physical habitat alterations exist and most are not appropriate for consideration in Matthews Lake. Many of these alterations require a Chapter 30 permit.

4.4.1 Bottom Barriers

Bottom barriers prevent light from reaching aquatic plants, but kill all plants, and some allow for gas accumulation under the barrier and subsequent dislodging, they can impact fish spawning and food sources, and an anaerobic environment below the barrier could cause nutrient release from the sediment. Bottom barriers are appropriate for public swimming areas near beaches, but not recommended in front of private properties in Matthews Lake.

4.4.2 Drawdown

This control technique involves the lowering of water levels and exposing sediments to freezing and drying, which results in plant death. A water level control device, such as a dam, is required for this method. This technique is not appropriate for plant management in Matthews Lake because there is no water control structure that would allow enough water drawdown to be effective.

4.4.3 Dredging

Dredging includes the removal of plants along with sediment and is most appropriate for systems that are extremely impacted with sediment deposition and nuisance plant growth. Matthews Lake does not meet these criteria and therefore dredging is not recommended as a plant control method.

4.4.4 Dyes

The use of dyes is for reducing water clarity thereby reducing light availability to aquatic plants. This is only appropriate for very small water bodies with no outflow and is therefore not recommended for Matthews Lake.

4.4.5 Non-point Source Nutrient Control

No permit is required for this type of nutrient management, which reduces the runoff of nutrients from the watershed. As a result, fewer nutrients enter the lake and are therefore not available for plant growth. This approach is beneficial because it attempts to correct the source of a nutrient problem and not just treat the symptoms. Controlling non-point source pollution is always a good idea, even though water chemistry and clarity data suggest Matthews Lake is not currently facing nutrient input issues.

4.5 Biological Control

4.5.1 Insects

A native insect commonly known as the milfoil weevil (*Euhrychiopsis lecontei*) is a biological control agent for EWM. The native weevils lay eggs in the tips of milfoil plants. When the larvae hatch, they feed on the tips of the stem and burrow into the stem. Furthermore, adult weevils feed on leaves of milfoil plants. The weevils are native to Wisconsin and normally feed on northern water-milfoil (*Myriophyllum sibiricum*) but have demonstrated preference for EWM, even when native milfoil species are present (Solarz & Newman, 2001). It is not known whether native populations of weevils already exist in Matthews Lake. Stocking weevils has been done on other lakes, but whether they effectively control EWM depends on the ability for the weevil to survive in the introduced lake. They require natural shorelines for overwintering and seem to survive best in shallow milfoil beds (Jester, 1999). Furthermore, predation can be a major limiting factor in weevil survival, especially when high populations of sunfish (*Lepomis sp.,* including bluegill) are present (Ward & Newman, 2006). ***If EWM were to be found in Matthews Lake and this option is pursued in the future, the first step would be to determine whether the native weevils are already naturally present.***

4.5.2 Native Plantings

Another form of biological control is to introduce a diverse native plant community that will compete with EWM. Native plants provide valuable food and habitat for fish and wildlife and a diverse community is more repellant to invasive species. ***Fortunately, Matthews Lake has a healthy and diverse aquatic plant community. Protection of native plants is a large component of controlling EWM and CLP in lakes.***

5.0 Management Strategy 2022-2026[6]

5.1 Goal 1 – Prevent the introduction of aquatic invasive species

Objective 1a. Continue watercraft inspections.

- Continue to seek grant funds annually to hire watercraft inspectors.
- Participate in the Drain Campaign in early summer each year (Section 3.1).
- Participate in the Landing Blitz on the weekend(s) nearest Independence Day each year (Section 3.1).

Objective 1b: Maintain decontamination station to support the Washburn County Decontamination Ordinance.

On February 23rd, 2018 the Washburn County Board of Supervisors passed ordinance (Chapter 46, Article 4, Section 46-48) that states "if a decontamination station is present at a boat landing, the boater is required to use it, going in and out of a waterbody."

- MLA will maintain the decontamination station with the appropriate gear and bleach solution.

Objective 1c: Continue I-LIDS monitoring at the boat landing.

- MLA will continue to coordinate volunteers, paid interns, or other personnel to monitor boat launching and watch for plants attached to trailers that are launched in the lake.
- MLA will continue to maintain I-LIDS because the presence of a video monitoring system alone increases compliance with steps that help prevent introduction of AIS.

Goals, Objectives, and Action Items		Entities Involved	2022	2023	2024	2025	2026	Surface Water Grant Eligible
1. Prevent the introduction of aquatic invasive species								
1a	**Continue watercraft inspections**							
	Seek grant funds annually to hire watercraft inspectors	MLA	X	X	X	X	X	
	Participate in the Drain Campaign in early summer	MLA	X	X	X	X	X	X
	Participate in the Landing Blitz, Independence Day weekend	MLA	X	X	X	X	X	
1b	**Maintain decontamination station to support the Washburn County Decontamination Ordinance.**							X
	Maintain decontamination station	MLA	X	X	X	X	X	
1c	**Continue I-LIDS monitoring at the boat landing.**							
	Coordinate volunteers, paid interns, etc to watch recorded video	MLA	X	X	X	X	X	X
	Maintain I-LIDS hardware and software	MLA	X	X	X	X	X	

[6] The goals are numbered for reference but the numbering is not meant to infer priority.

5.2 Goal 2 – Actively monitor Matthews Lake for early detection of AIS.

Objective 2a: Conduct volunteer aquatic invasive species monitoring.
Most volunteers conduct monitoring a few times per year at high-risk sites in the lake (e.g., boat landings, between shore and 15 ft deep, etc.) for early detection.

- MLA recruit/retain volunteers to monitor for AIS, particularly zebra mussels and EWM. Other species of concern include curly-leaf pondweed, rusty crayfish, waterfleas, New Zealand mudsnail, and starry stonewort.
- Volunteers attend an AIS identification training offered by the WDNR or Washburn County. AIS identification is also mentioned in Objective 3a.
- If an AIS is found, follow the procedure in Section 6.0. Washburn County AIS Coordinator may also be contacted for reporting and verification.

Objective 2b: Use formal AIS and aquatic plant surveys when possible.

- Work with the Washburn County AIS Coordinator to determine availability for formal AIS surveys. Surveys may be possible every few years.
- Hire a consultant as funds are available to complete a whole-lake point-intercept and AIS surveys at least every five years (next survey due in 2025).
- Hire a consultant annually as funds are available to perform a meander survey of the boat landing area looking for aquatic invasive plants, particularly EWM.

Objective 2c: If a new AIS is verified, apply for Early Detection & Response Grant from the WDNR.

- If a new AIS is verified, apply for a grant to partially cover expenses related to survey and control measures as appropriate. See Section 7.

	Goals, Objectives, and Action Items	Entities Involved	2022	2023	2024	2025	2026	Surface Water Grant Eligible
2. Actively monitor Matthews Lake for early detection of AIS.								
2a	**Conduct volunteer aquatic invasive species monitoring.**							Volunteer time is eligible for match in many grants.
	Recruit/retain volunteers to monitor for zebra mussels and Eurasian watermilfoil especially.	MLA	X	X	X	X	X	
	Volunteers participate in training for AIS identification.	MLA	X	X	X	X	X	
	If AIS found, follow procedure in Section 6.0.	MLA	X	X	X	X	X	
2b	**Use formal AIS and aquatic plant surveys when possible.**							CO time eligible for match in many grants.
	Request survey assistance from Washburn Co. when they are available.	MLA, CO	X	X	X	X	X	
	Hire a consultant to conduct formal point-intercept and AIS surveys at least every five years. Contact consultant in 2024 to plan for survey in 2025.	MLA, RP			X	X		Apply for grant in 2024 to complete survey in 2025.
	Hire a consultant to conduct a meandering survey around the boat landing looking for invasive plants, particularly EWM.	MLA, RP	X	X	X	X	X	
1c	**If a new AIS is verified, apply for Early Detection & Response Grant.**							
	Apply for a grant to partially cover expenses as appropriate for the AIS found.	MLA	X	X	X	X	X	Grant application work not grant eligible

MLA = Matthews Lake Association. CO = Washburn County. WDNR = Wisconsin Department of Natural Resources. RP = Hired Resource Professional

5.3 Goal 3 – Provide educational opportunities pertaining to aquatic plants and aquatic invasive species.

Objective 3a: Organize two educational events that focus on AIS identification and prevention.

In 2023 and 2025, ideally in early summer, an educational event will be organized by the MLA that specifically focuses on identification of AIS and prevention techniques. This event could occur in conjunction with other scheduled social events or meetings sponsored by the MLA.

- Include funding for educational events as needed if any grant applications are submitted in 2022 or 2024 (essentially the year before the educational event).
- Work with Washburn County AIS Coordinator, WDNR, Washburn County Lakes and Rivers Association and/or private consultant to provide instruction on AIS identification and steps to prevent the spread of AIS into the lake.

Objective 3b: Continue to use the Matthews Lake website and social media for education.

Information pertaining to invasive species, social events, and other topics are available at matthewslakeassociationblogspot.com. Additional educational links would complement these existing links.

- Include a post for this APMP once it is adopted by the MLA and approved by the WDNR.
- Post information on the MLA Facebook page to keep the public informed on current activities related to aquatic plants, AIS, how to prevent the spread of AIS, educational events, etc.

Goals, Objectives, and Action Items		Entities Involved	2022	2023	2024	2025	2026	Surface Water Grant Eligible
3. Provide educational opportunities pertaining to aquatic plants and aquatic invasive species.								
3a	**Organize two educational events that focus on AIS identification and prevention.**							Grant application work not grant eligible.
	Include funding for educational events if any grant applications are submitted in 2022 or 2024 (essentially the year before the educational event).	MLA	X		X			
	Work with CO, WDNR, WCLRA and/or private consultant to provide instruction on AIS identification and steps to prevent the spread of AIS into the lake.	MLA		X		X	X	Planning, Education Grants
3b	**Continue to use the Matthews Lake website and social media for education.**							
	Post this APMP on MLA website.	MLA	X					
	Post current activities related to aquatic plants, AIS, how to prevent the spread of AIS, educational events, etc.	MLA			X	X		Volunteer time is eligible for match in many grants.

5.4 Goal 4 – Protect native aquatic plants, organisms, and associated native mammal and fish populations.

Objective 4a: Minimize the manual removal of native plants for navigation and recreation.

In some instances, native aquatic plants can hinder recreational activities along shore. Property owners can remove some native plants but there are restrictions under Wisconsin Administrative Code, Chapter NR109 and more detail on this code is described in Section 4.2.1 of this plan.

- If property owners remove the plants manually (not mechanically or chemically), this should only be done at a minimal level to meet the goal of protecting native plant species.

Objective 4b: Inform Matthews Lake residents of the important role aquatic plants play in lake ecosystems.

- Include the benefits of aquatic plants in educational event activities listed in Obj. 3a.
- Post a "plant of the month" on the MLA Facebook page and/or website.

Goals, Objectives, and Action Items		Entities Involved	2022	2023	2024	2025	2026	Surface Water Grant Eligible
4. Protect native aquatic plants, organisms, and associated native mammal and fish populations.								
4a	**Minimize the manual removal of native plants for navigation and recreation.**							Not grant eligible unless removing AIS.
	Property owners may remove native plants manually at a minimal level.	MLA	X	X	X	X	X	
	Work with CO, WDNR, WCLRA and/or private consultant to provide instruction on AIS identification and steps to prevent the spread of AIS into the lake.	MLA		X		X	X	Planning, Education Grants
4b	**Inform Matthews Lake residents of the important role aquatic plants play in lake ecosystems.**							Planning, Education Grants
	Include the benefits of aquatic plants in educational event listed in Obj. 3a.	MLA		X		X		
	Post a "plant of the month" on the MLA Facebook page and/or website.	MLA	X	X	X	X	X	Volunteer time eligible for match.

5.5 Goal 5 – Maintain desirable trophic states (high water quality).

Trophic state and water quality are used interchangeably and while the two are related, they are not the same. Trophic state describes the biological condition of a lake using a scale that is based on measurable criteria. Water quality is a more subjective descriptor of a lake's condition based on the observer's use of the lake (see Section 1.5 for more detail). The clear water is a result of low-to-moderate nutrient levels in the lake and maintaining this level is important.

Objective 5a: Continue Citizen-based Monitoring.

Volunteers have monitored water clarity, total phosphorus, and/or chlorophyll in Matthews Lake since 2000. Matthews Lake is mesotrophic (moderate nutrients). Continued monitoring is essential to track these important indicators of water quality.

- The MLA will communicate with the volunteer that is conducting monitoring and sampling each year to help ensure the volunteer is available to complete monitoring and sampling. The volunteer will enter data into SWIMS database.

Objective 5b: Promote riparian practices that protect high water clarity.

Lake water quality/clarity can be linked to property values. Water clarity is directly impacted by surface water runoff of lakeshore properties (see Section 1.3 for more information). A Healthy Lakes Grant in 2021 was secured to improve shoreland practices at 7 properties on the lake.

- Continue to educate lakeshore residents about shoreland practices that protect the lake and about Healthy Lakes grant opportunities to help fund these projects. This can be done in connection with educations activities listed in Obj. 3a.

Goals, Objectives, and Action Items		Entities Involved	2022	2023	2024	2025	2026	Surface Water Grant Eligible
5. Maintain desirable trophic states (high water quality)..								
5a	**Continue Citizen-based Monitoring.**							Volunteer time may be eligible for match depending on the grant type.
	Communicate with the volunteer that is conducting monitoring and sampling each year.	MLA	X	X	X	X	X	
5b	**Promote riparian practices that protect high water clarity.**							Planning, Education Grants
	Educate lakeshore residents about shoreland practices and Healthy Lakes grant opportunities (include Obj. 3a.)	MLA		X		X		

6.0 Verification Steps for Detection of New AIS

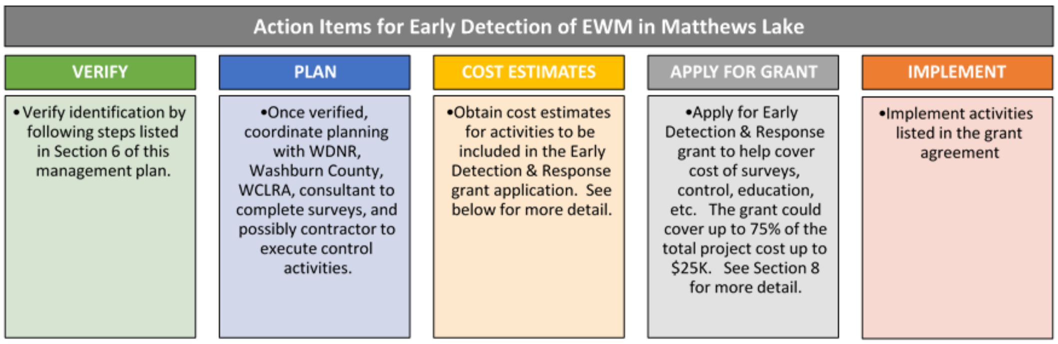
The following is copied from the WDNR webpage
https://dnr.wisconsin.gov/topic/Invasives/report.html

- **Photograph** Take a digital photo(s) of the species in the setting where it was found and include a common object in the photo for size reference.
  - For plants include flowers, leaves, stem arrangement, and fruits.
  - For animals include shells, top and bottom and any identifying characteristics.
- **Collect** up to 5 intact specimens to aid identification.
  - For plants, try to get the root system, stems, leaves, flowers, and seeds. Place plants in a Ziplock bag with a damp paper towel.
  - For animals, try to get the entire animal if possible. Place animals in a jar with water or ethanol. Place on ice and store in a refrigerator as soon as possible.
- **Record** details using:
  - Your planned project data in the Surface Water Integrated Monitoring Systems (SWIMS); OR
  - Aquatic Invasive Species Incident Report [PDF] ; OR
  - Just take notes.

Submit the photos, specimen and form/notes to the DNR Aquatic Invasive Species Regional Coordinator/Point of Contact and SWIMS. At the time of writing this AIS Prevention plan, the point of contact is Alexander Selle (Alexander.Selle@wisconsin.gov)
.

7.0 Action Items if EWM is Detected

At the time of writing, the AIS with actionable control measures and the most likely to be introduced into Matthews Lake, if any, is Eurasian watermilfoil. If detected early when EWM is at low occurrence and low density, the cost of control measures will be minimal. However, a strong surveying and monitoring component is required to ensure the EWM population stays small and/or eradicated once control measures begin. For these reasons, EWM was the focus species in developing this section. If a different aquatic invasive plant is discovered, many of these action items would still apply.



Graphic developed by Aquatic Plant & Habitat Services LLC

7.1 More on Cost Estimates

Eligible expenses for an Early Detection & Response Grant include education, population monitoring, early planning steps, control actions that are appropriate when they are likely to result in population removal or limitation of a population to a small size (See Section 8). Control actions must be developed in coordination with the WDNR. Flat rates for grant eligible costs are listed in Table 7 as a guideline. For example, an aquatic plant survey of Matthews Lake would be $1,753 base + $5.73 per littoral point * 381 littoral points = $3,940. A bed mapping survey cost would depend on whether pre/post sample points are surveyed. DASH cost is approximately $2,600 per day and is most appropriate for dense beds of EWM whereas manual removal by snorkelers is more ideal for EWM that is scattered, with a cost of approximately $2,000 per day.

Table 7 – DNR Flat Rates Copied from Grant Guidance

Practice	Activity	Average cost
AIS early detection	Early detection survey	$72 per km of shoreline
Shoreland assessment	Shoreland Habitat Assessment	$345 base + $146 per km of shoreline
Aquatic plant monitoring	Point-intercept or pre/post survey	$1,753 base + $5.73 per littoral* point
APM monitoring	Aquatic Herbicide Concentration Monitoring (Lab work & analysis)	$2,487/project
APM monitoring	Early-season or Late-season AIS Survey (recon and mapping)	$1,153 base + $0.89 per km of shoreline
AIS control	2,4-D Application	$3,866 base + $131 per treated acre
AIS control	Purple Loosestrife	$500/year
Planning	Social Survey	$585/survey effort

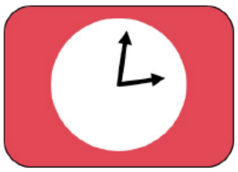
Flat rates for field surveys include costs related to fieldwork, but not analysis and reporting (e.g. setup, travel, proportional equipment costs, sample collection, time.)

8.0 Early Detection & Response Grant Guidance

The following is copied from page 22 of the DNR Surface Water Grant Program Applicant Guide and Program Guidance

SURFACE WATER GRANT PROGRAM APPLICANT GUIDE AND PROGRAM GUIDANCE

Aquatic Invasive Species Control Grants – Early Detection & Response



When invasive species are newly introduced, it's a good idea to learn more about the population and start planning; some applicants may not want to wait for the next annual grant cycle to secure funding. Early detection and response grants can give eligible applicants a jump-start into planning and management. Because projects occur without the guidance of a management plan, projects must be conducted in coordination with the department.

Prerequisites

Eligible organization. Individual land holders may apply for grants for prohibited species.
Populations of restricted species must be *pioneering* populations

Funding

Grants may cover up to 75% of total project costs.
Up to $25,000 is available per project.

Reimbursements

One grant advance is available for up to 25% of the total grant award.
One partial payment is available per year.
10% of the grant award is retained until approval of deliverables and reimbursement documentation.

Eligible projects

Early Detection & Response projects should focus on education, population monitoring and early planning steps for any population of ch. NR40 classified prohibited species, or pioneering populations of ch. NR40 restricted species. Control actions may be appropriate when they are likely to result in population removal or limitation of a population to small size. Control actions must be developed in coordination with the department and are subject to department approval.

Conditions

One grant is available for *pioneering* populations of restricted invasive species. Multiple grants sought in succession are available for prohibited species.

Pioneering populations are in the early stages of colonization. The department may use best professional judgement, considering the population extent, abundance, and spatial distribution to determine whether the population may be qualified as a pioneer population.

For rooted aquatic plant species, a pioneering population covers a small area, is typically sparse, and will have been verified during the preceding 5 years. A pioneering population will cover an area that is less than 3 acres in size or has colonized less than 3% of the habitable area of the lake, stream reach, or wetland, whichever is greater.

The department may specify control measures and require monitoring and reporting activities for projects funded in part with early detection and response dollars.

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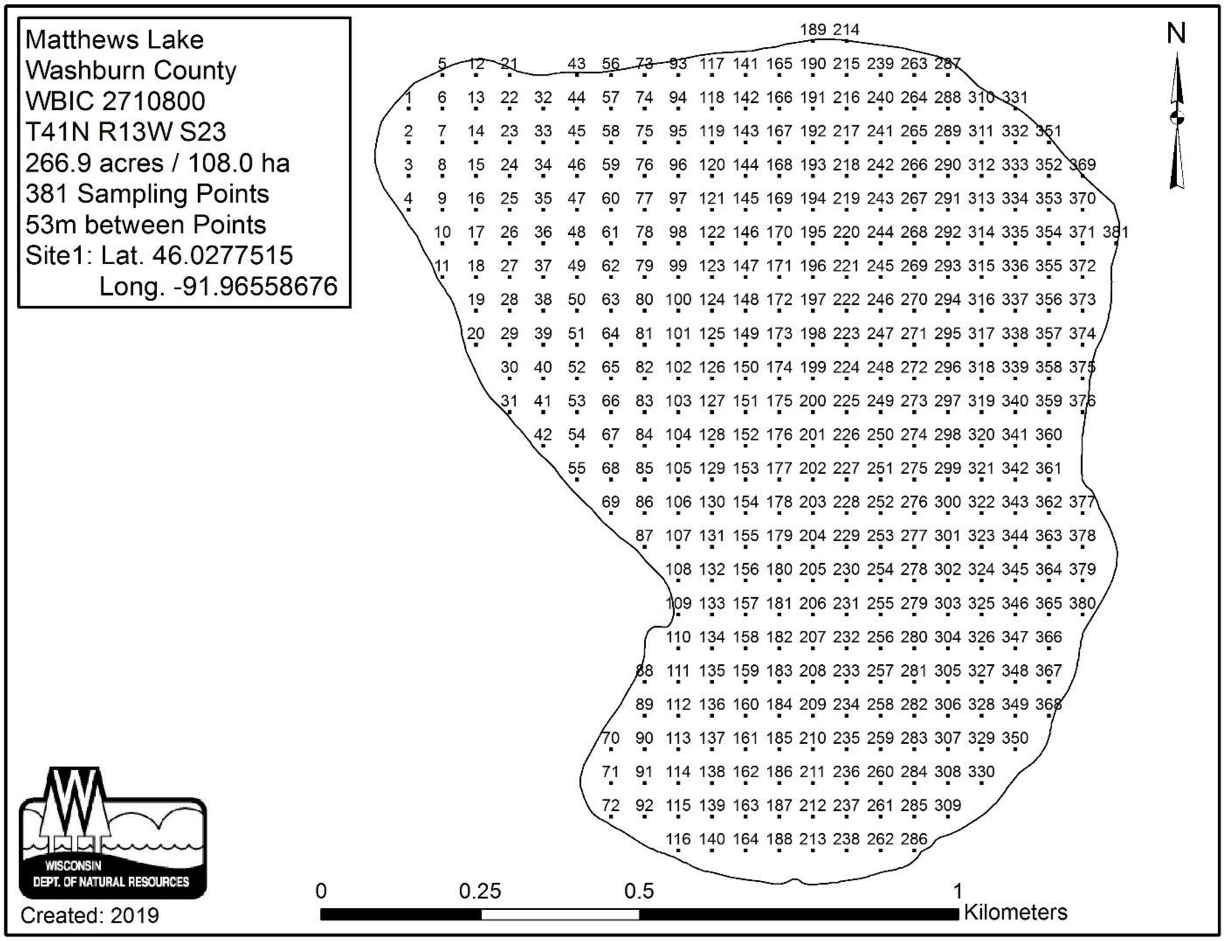
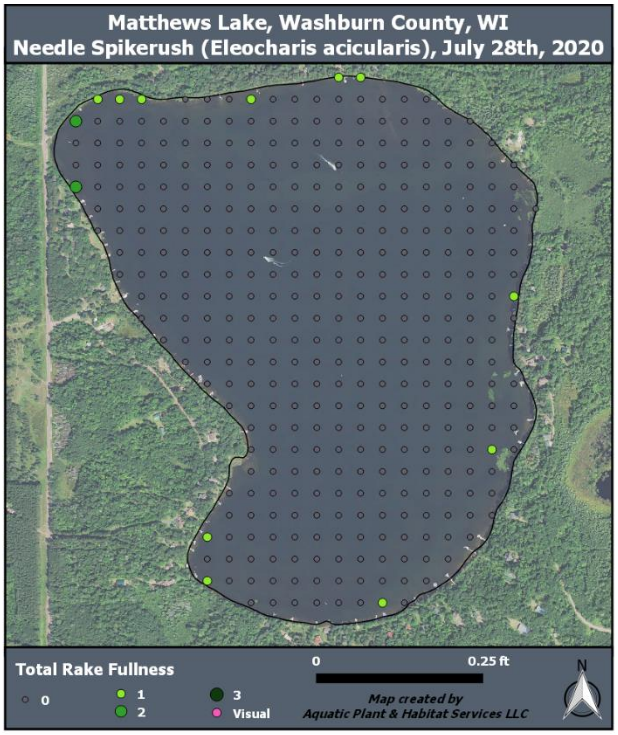
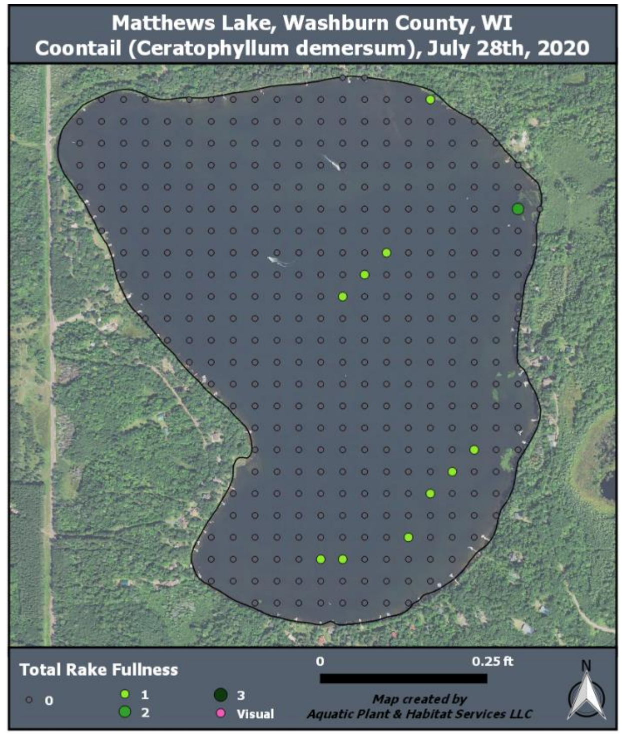
10.0 **Appendix**

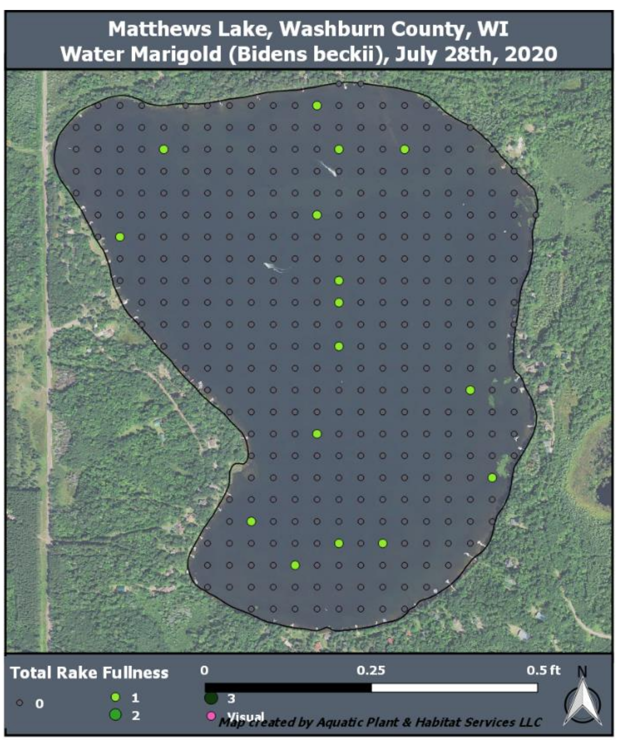
10.1 Appendix A – Matthews Lake Aquatic Plant Survey Grid

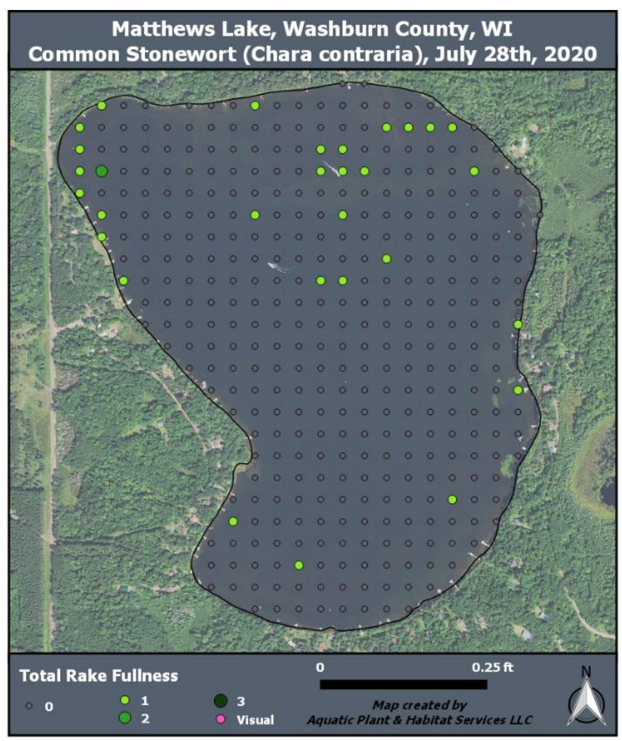


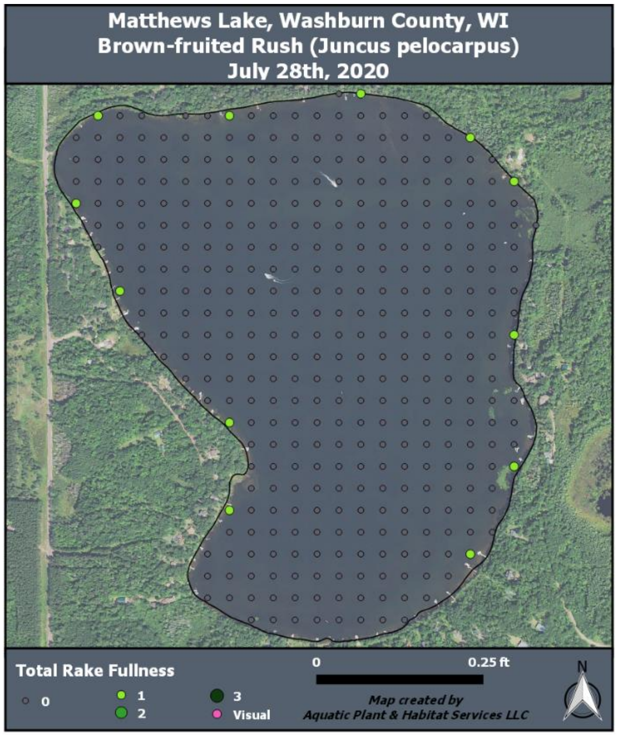
10.2 Appendix B – Matthews Lake Aquatic Plant Species Maps










Matthews Lake, Washburn County, WI
Brown-fruited Rush (Juncus pelocarpus)
July 28th, 2020
Total Rake Fullness
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Visual
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0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
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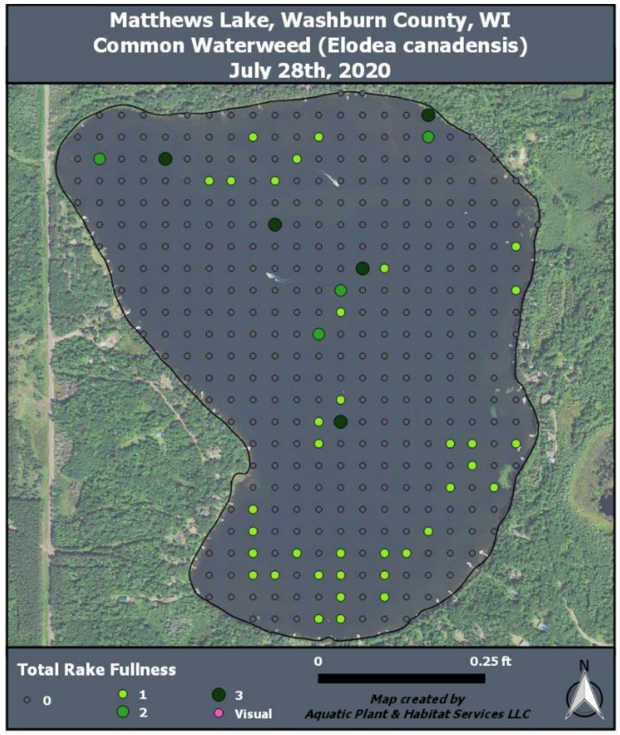
Matthews Lake, Washburn County, WI
Common Waterweed (Elodea canadensis)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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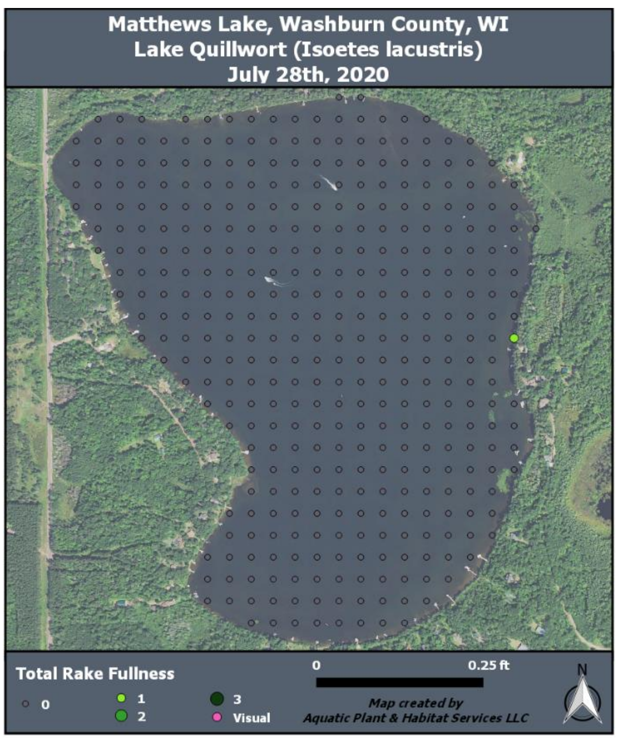
Matthews Lake, Washburn County, WI
Lake Quillwort (Isoetes lacustris)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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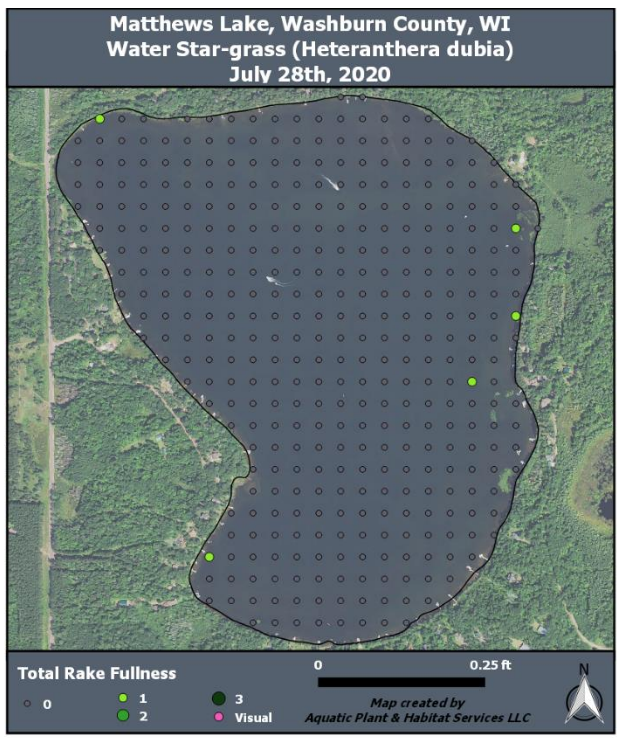
Matthews Lake, Washburn County, WI
Water Star-grass (Heteranthera dubia)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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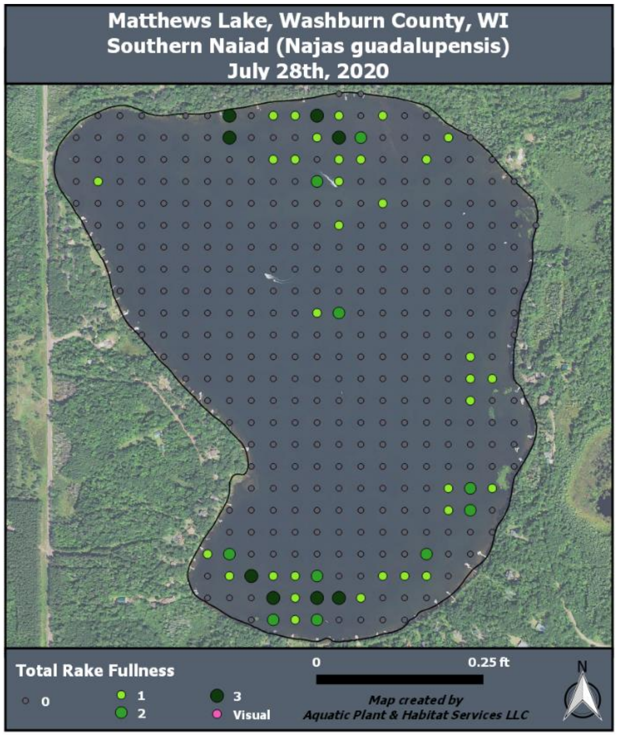
Matthews Lake, Washburn County, WI
Southern Naiad (Najas guadalupensis)
July 28th, 2020
Total Rake Fullness
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Visual
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Map created by
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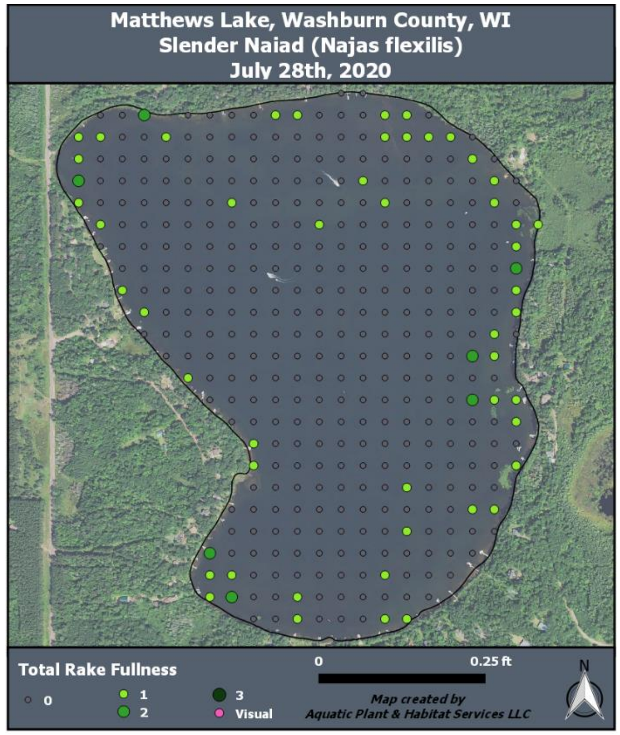
Matthews Lake, Washburn County, WI
Slender Naiad (Najas flexilis)
July 28th, 2020
Total Rake Fullness
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Map created by
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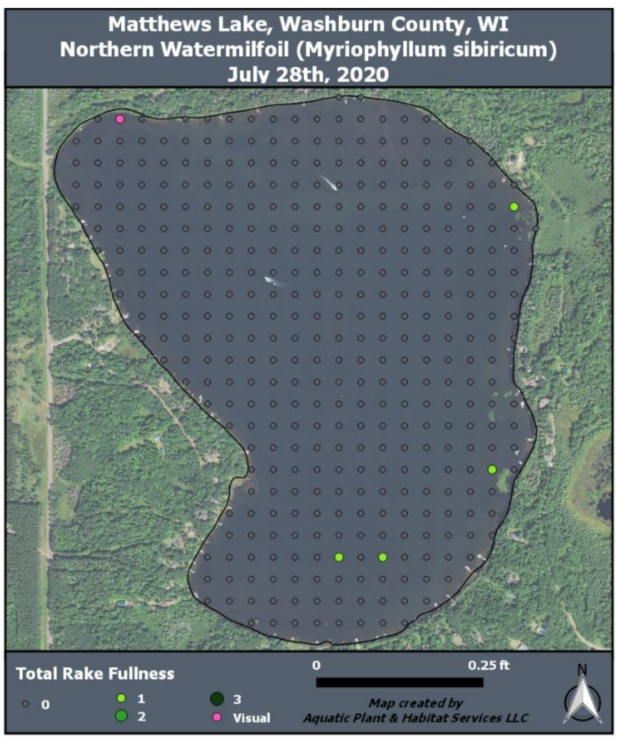
Matthews Lake, Washburn County, WI
Northern Watermilfoil (Myriophyllum sibiricum)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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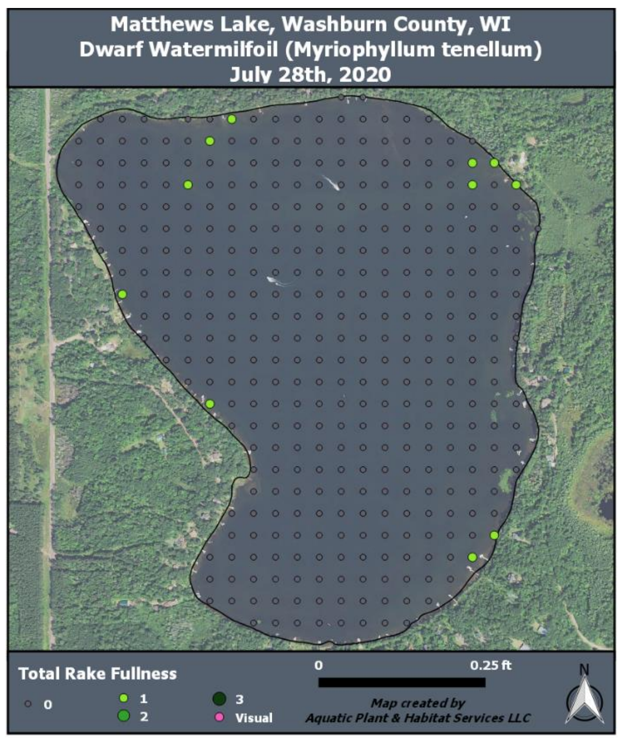
Matthews Lake, Washburn County, WI
Dwarf Watermilfoil (Myriophyllum tenellum)
July 28th, 2020
Total Rake Fullness
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Map created by
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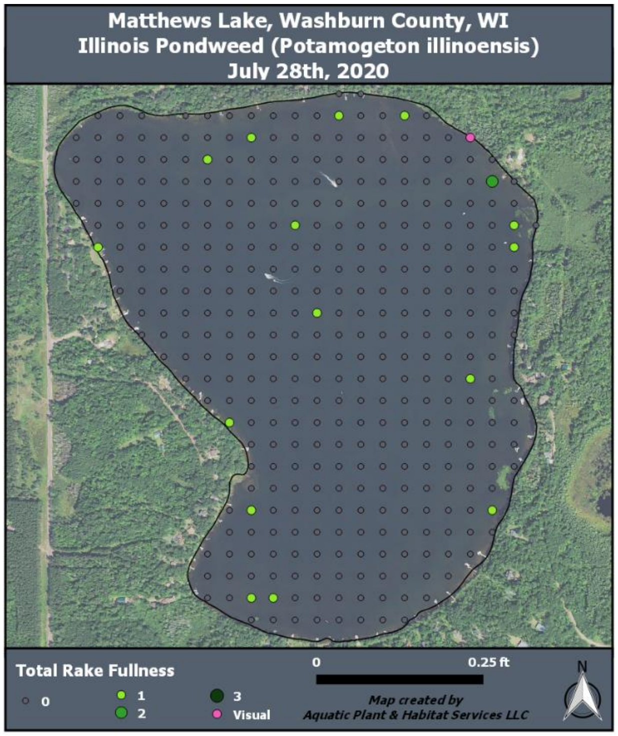
Matthews Lake, Washburn County, WI
Illinois Pondweed (Potamogeton illinoensis)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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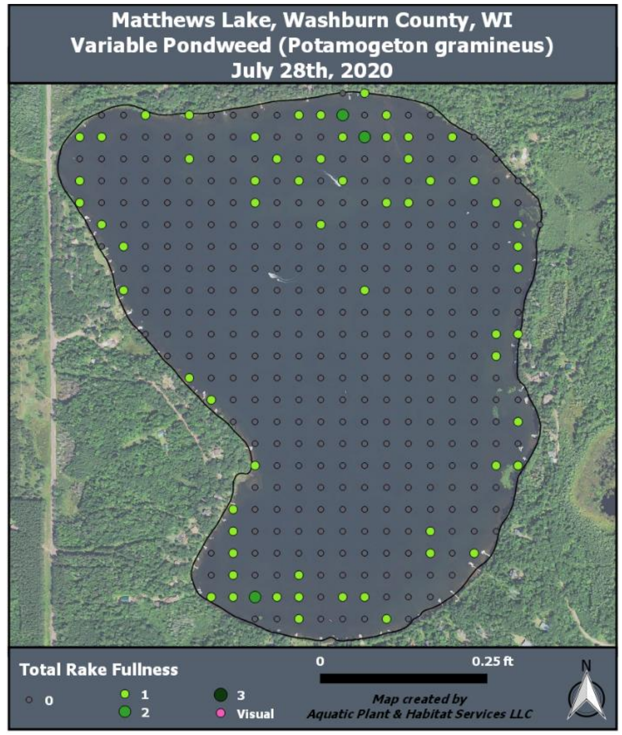
Matthews Lake, Washburn County, WI
Variable Pondweed (Potamogeton gramineus)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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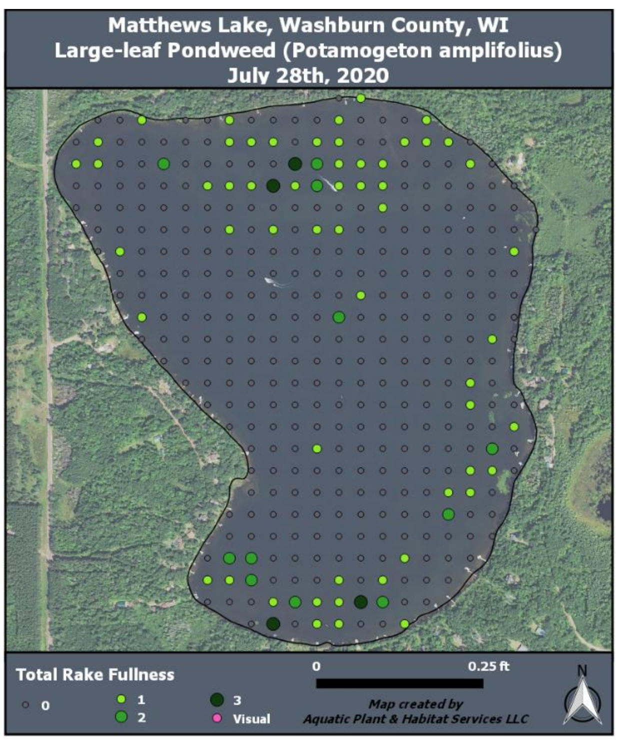
Matthews Lake, Washburn County, WI
Large-leaf Pondweed (Potamogeton amplifolius)
July 28th, 2020
Total Rake Fullness
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Map created by
Aquatic Plant & Habitat Services LLC
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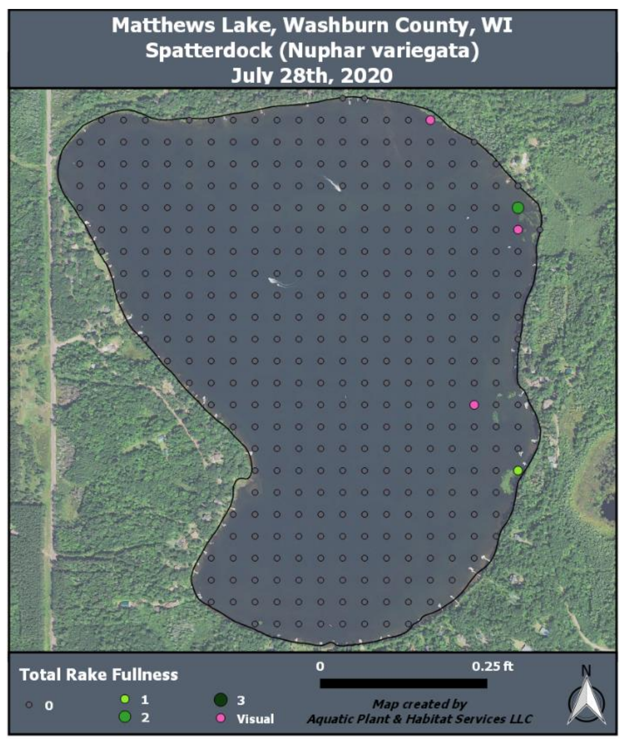
Matthews Lake, Washburn County, WI
Spatterdock (Nuphar variegata)
July 28th, 2020
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Map created by
Aquatic Plant & Habitat Services LLC
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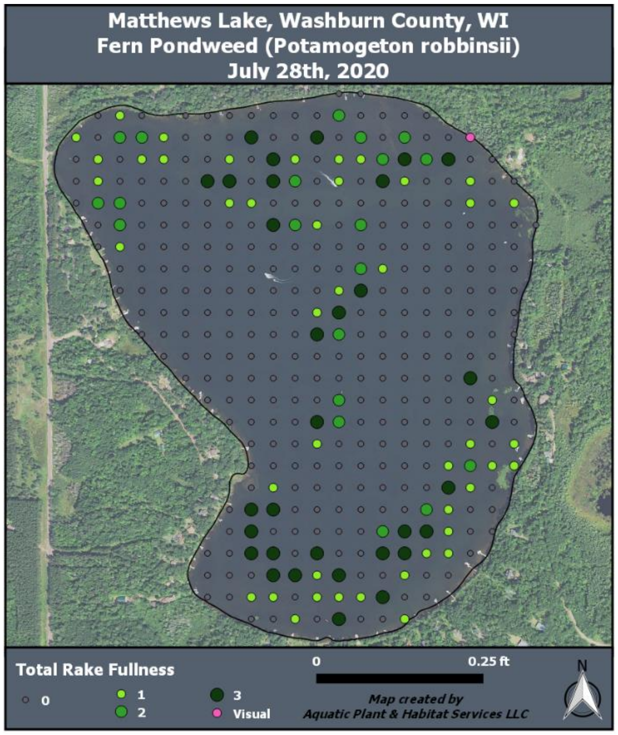
Matthews Lake, Washburn County, WI
Fern Pondweed (Potamogeton robbinsii)
July 28th, 2020
Total Rake Fullness
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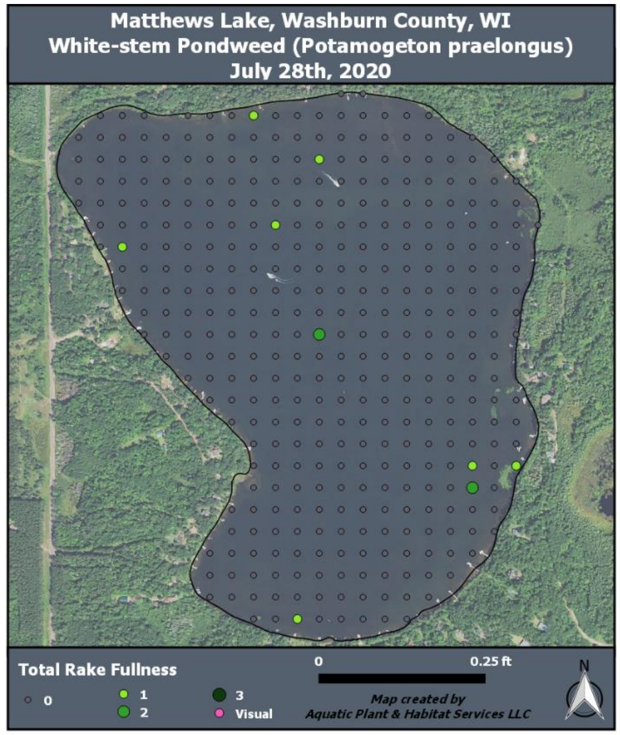
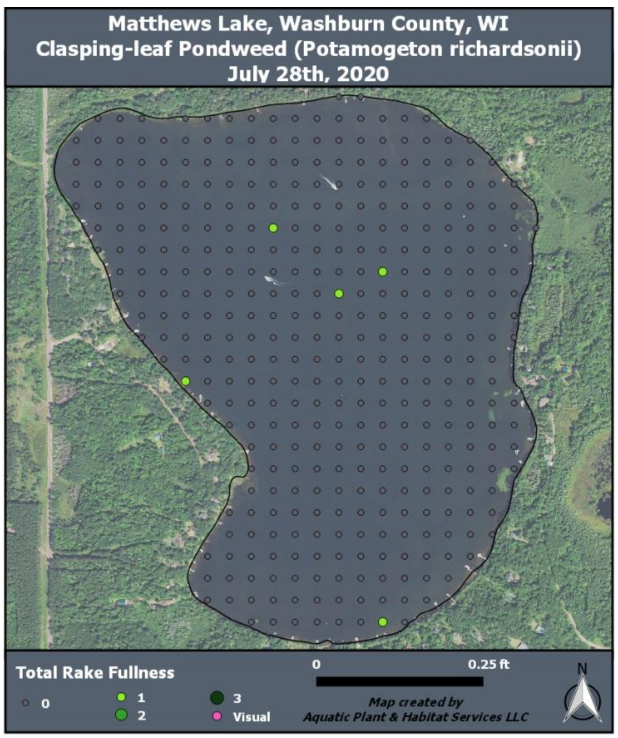
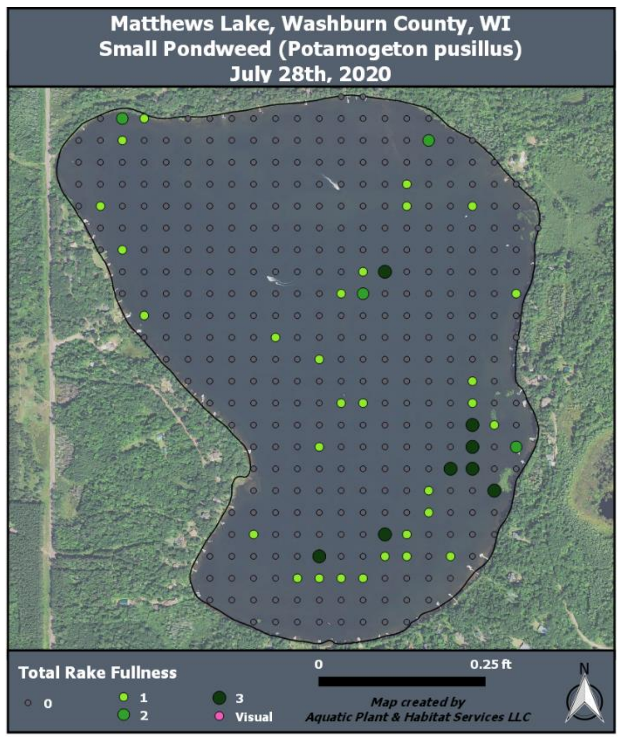
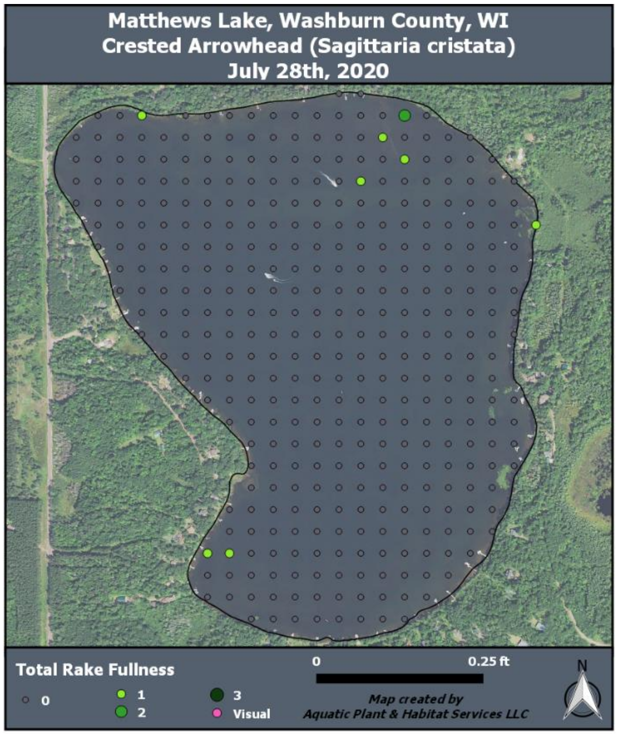
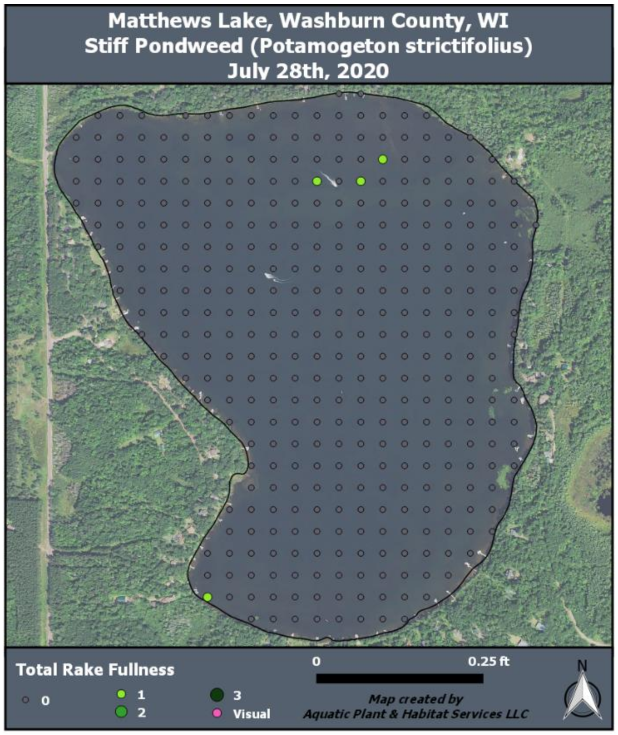
0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

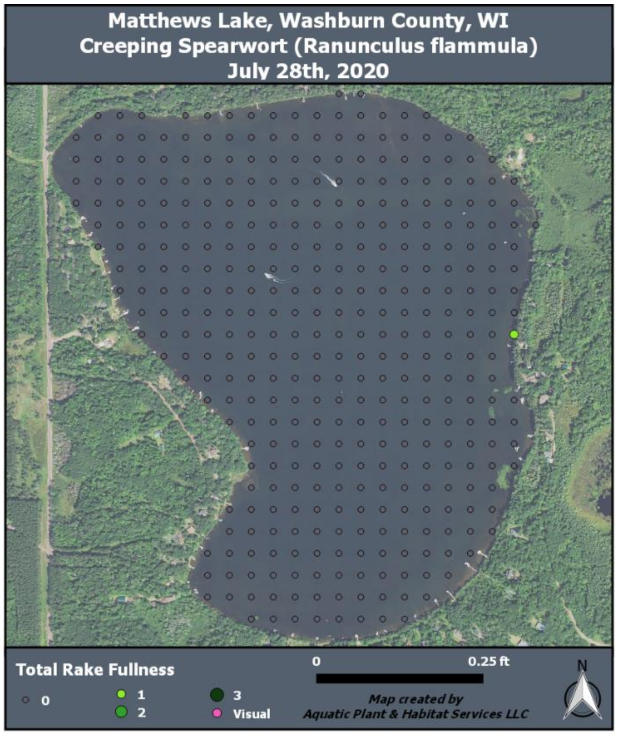

Matthews Lake, Washburn County, WI
White-stem Pondweed (Potamogeton praelongus)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

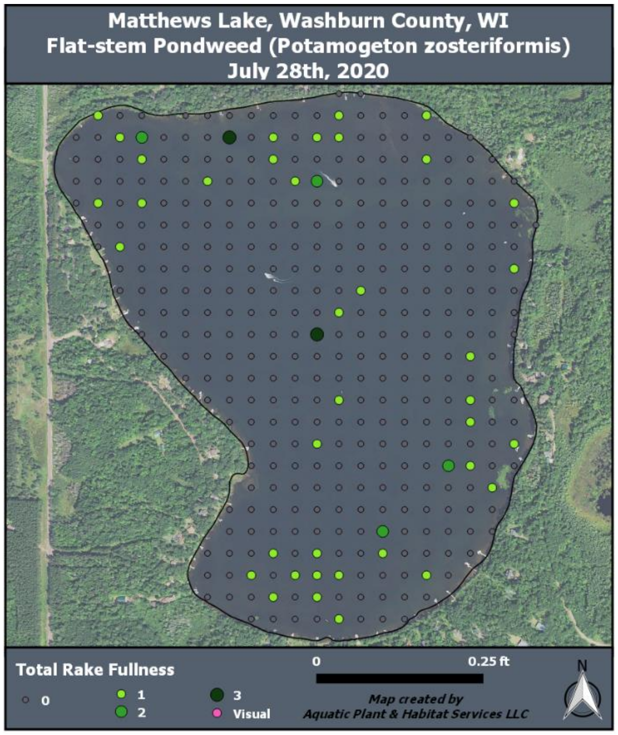

Matthews Lake, Washburn County, WI
Clasping-leaf Pondweed (Potamogeton richardsonii)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

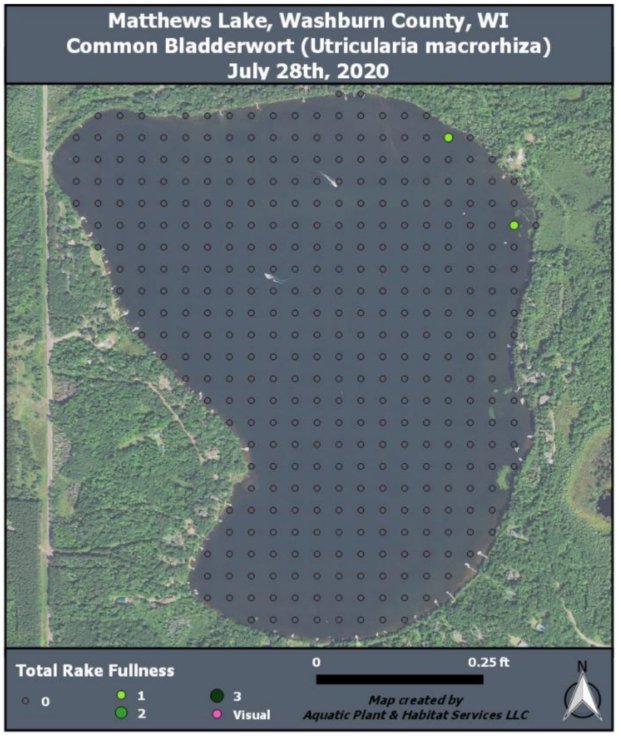

Matthews Lake, Washburn County, WI
Small Pondweed (Potamogeton pusillus)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

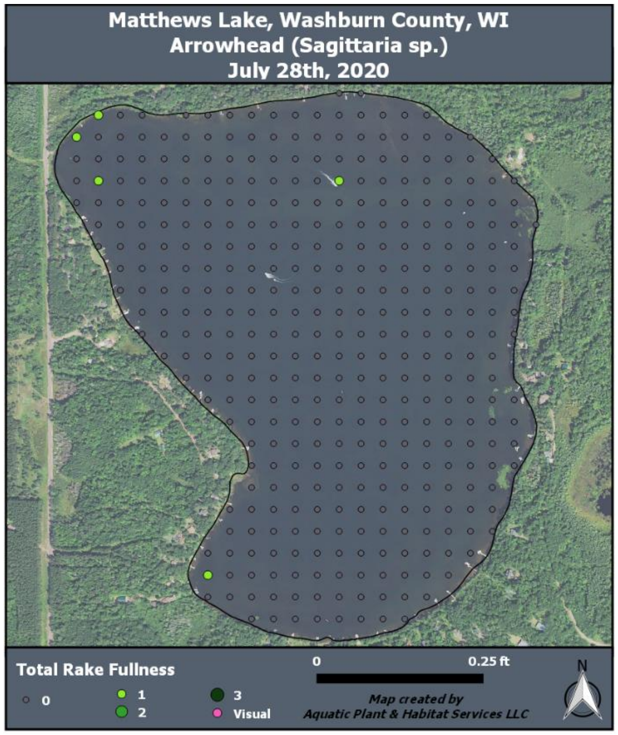

Matthews Lake, Washburn County, WI
Crested Arrowhead (Sagittaria cristata)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0 0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

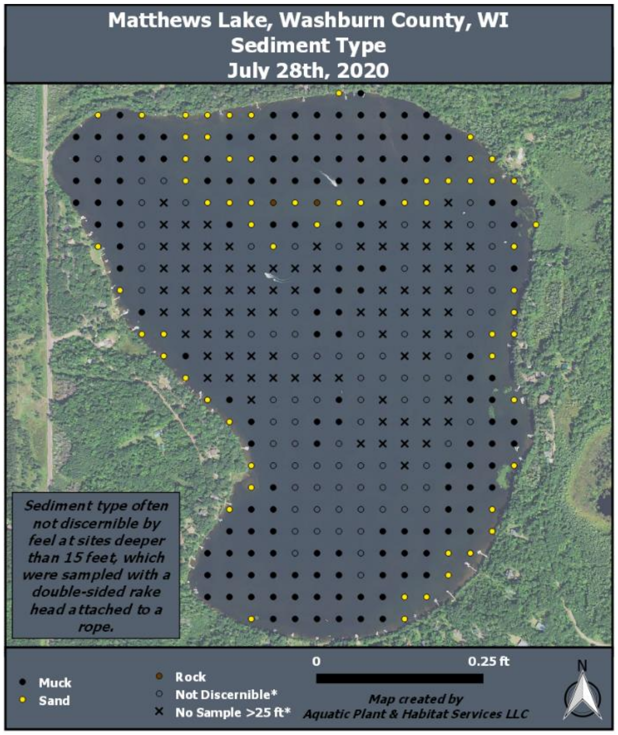

Matthews Lake, Washburn County, WI
Stiff Pondweed (Potamogeton strictifolius)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0 0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N

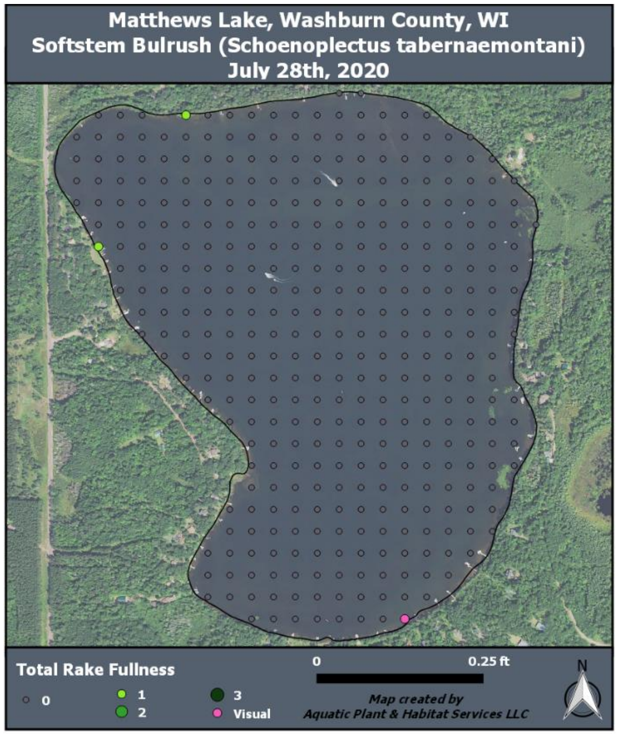

Matthews Lake, Washburn County, WI
Creeping Spearwort (Ranunculus flammula)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0 0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N


Matthews Lake, Washburn County, WI
Flat-stem Pondweed (Potamogeton zosteriformis)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0 0.25 ft
Map created by
Aquatic Plant & Habitat Services LLC
N


Matthews Lake, Washburn County, WI
Common Bladderwort (Utricularia macrorhiza)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
N
Map created by
Aquatic Plant & Habitat Services LLC


Matthews Lake, Washburn County, WI
Arrowhead (Sagittaria sp.)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
N
Map created by
Aquatic Plant & Habitat Services LLC


Matthews Lake, Washburn County, WI
Sediment Type
July 28th, 2020
Sediment type often not discernible by feel at sites deeper than 15 feet, which were sampled with a double-sided rake head attached to a rope.
Muck
Sand
Rock
Not Discernible*
No Sample >25 ft*
0
0.25 ft
N
Map created by
Aquatic Plant & Habitat Services LLC


Matthews Lake, Washburn County, WI
Softstem Bulrush (Schoenoplectus tabernaemontani)
July 28th, 2020
Total Rake Fullness
0
1
2
3
Visual
0
0.25 ft
N
Map created by
Aquatic Plant & Habitat Services LLC

10.3 Appendix C – Discussion on Septic Effluent in Lakes

Review of Methods for Detecting Septic Effluent in Lakes

-For consideration by the Matthews Lake Association-

In partial fulfillment of Aquatic Invasive Species Grant #AEPP59820

10.3.1 Background & Summary

An Aquatic Invasive Species Education, Planning, & Prevention grant was awarded to the Matthews Lake Association (MLA) in February 2020 with activities to be completed by December 2022. MLA members have expressed concern about septic system effluent containing phosphorus (P) leaching into the soils and possibly into Matthews Lake. As part of the grant application process in late 2019, methods to test this in Matthews Lake were researched & intended to be part of the grant application, but the methods for testing P contributions from septic systems were found to be highly complex and needed further exploration. After reevaluation, the MLA requested funding for Aquatic Plant & Habitat Services LLC (APHS) to compile a summary of methods for measuring P loading from septic systems & costs of each.

Within the resources allocated for this effort, APHS concluded there is no widely accepted method for testing P contributions to lakes from septic system effluent. There are, however, ways to test for septic system tracers such as pharmaceuticals and personal care products. Some ongoing research on methods to measure P loading in lakes from septic effluent is also summarized.

Although P loading in lakes from septic effluent is a reasonable concern with increased development, it is important to note that the majority of P loading in lakes is from lakeshore development and changing land use. The last line of defense for runoff nutrient input into lakes are the lakeshore properties. The MLA is taking steps to engage lake residents in best management practices to slow runoff and capture phosphorus before it enters the lake. In 2020-21, there were 8 property owners that agreed to incorporate Healthy Lakes practices on their properties.

10.3.2 Measuring Phosphorus from Septic Systems is Complex

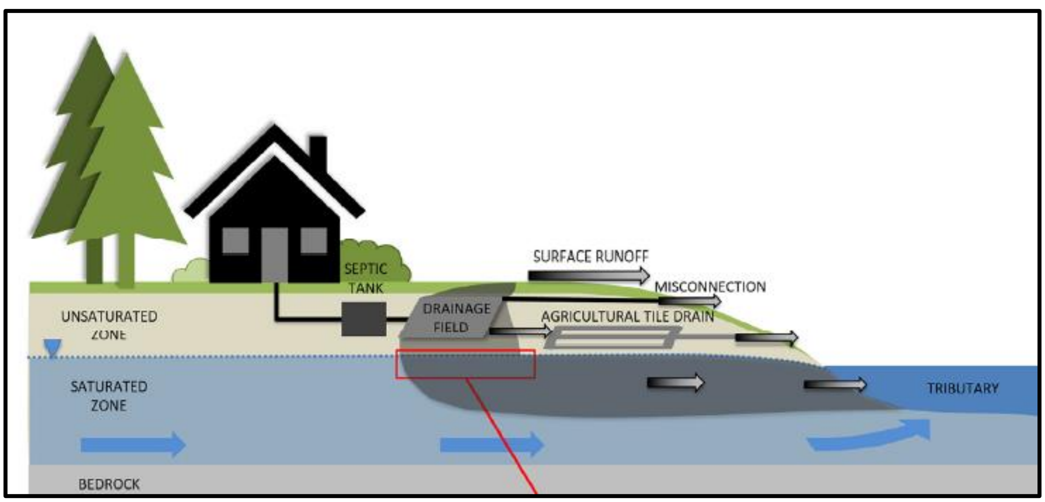
Phosphorus Mobility in the Soil and Environmental Factors

Phosphorus mobility in the soil is complex and depends on several environmental factors including redox conditions, soils, adsorption, and sewage loading rate. Redox is a process in which one substance or molecule is reduced and another oxidized. Reduction and oxidation (redox) are considered together as complimentary processes. Septic systems installed in calcareous soils (containing calcium carbonate) result in an average of 66% of P in septic effluent being retained in and below the drain field. Septic systems installed in non-calcareous sediment result in an average of 90% of P in septic effluent being retained in and below the drain field (Robertson et al. 2019). Adsorption is the process by which a solid holds molecules of a gas or liquid or solute as a thin film. Phosphorus migration can be slowed when the P molecules bind to particles. It is thought that as septic systems age, drainfield soils become saturated with P molecules therefore allowing greater P migration through the soil to unintended locations. However, Robertson et. al (2019) found a lack of correlation between septic system age and P retention in drainfields at 24 sites studied over a 30-year period. This suggests sorption is not the dominant process causing P removal (at least not at the sites studied), but this supposition does not appear widely accepted and suggests further research is needed. Higher sewage load to a system decreases hydraulic retention time in the drainfield sediment and potentially decreases P retention in the drainfield (Robertson et. al. 2019 & Greary and Lucas, 2019).

Isolating Phosphorus From Septic Effluent is Complex

Phosphorus in groundwater may be from various sources including overlying soils, dissolution of minerals that contain phosphate, agricultural fertilizer, animal waste, septic systems, and infiltration of wastewater (Fuhrer et. al. 1999). Groundwater discharges directly to lakes (Figure 1) and Matthews is classified as a seepage lake, the principle source of water is precipitation or runoff supplemented by groundwater. Therefore, it is reasonable to expect that when a lake is downgradient, hydrologically speaking, from a septic system, traces of effluent from that septic system may enter the lake via groundwater flow. Groundwater flow paths converge and therefore dilute any septic effluent that may be present, which complicates the ability to measure phosphorus sources from septic effluent. Linking groundwater phosphorus directly to effluent from a septic system is challenging.

Figure 24 – Septic System & Groundwater Flow. Copied from Oldfield et.al. 2020



10.3.3 Testing for Septic Effluent Tracers

"Using Acesulfame to Determine Septic System Impact to Wisconsin Lakes"

Hannah Lukasik, Amy Nitka, and Paul McGinley

Acesulfame (ACE) is an artificial sweetener. Artificial sweeteners are resistant to decay and specific to human wastewater. Therefore, their presence in groundwater and surface water can be linked to human wastewater with high confidence. This study was conducted by undergraduate Hannah Lukasik at UW-

Stevens Point with results presented in poster format in April, 2021. Lukasik collected surface water samples from seven lakes in Portage and Waupaca Counties and analyzed them for ACE. ACE was found at each of the seven lakes and was weakly correlated with the number of parcels when adjusted for total groundwater inflow into the lake.
Although this study demonstrates ACE presence in the lakes from septic effluent, it does not address phosphorus loading from septic effluent. However, ACE and other artificial sweeteners can be used as a "signature" for septic effluent, thereby providing a way for researchers to detect phosphorus and nitrate loading in surface waters from septic systems.

Water and Environmental Analysis Lab, UW-Stevens Point

The Water and Environmental Analysis Lab (WEAL) can screen surface water samples for the presence of human waste by testing for 13 compounds including artificial sweeteners, antibiotics, and other personal care products. The cost for one sample is $200. Timing and location of sample collection in Matthews Lake should be taken into close consideration. If only one sample is collected, it should occur during spring or fall turnover when the lake is mixed. Knowing the areas in the lake of groundwater discharge and areas where lake water recharges back into groundwater would also be important if samples near lakeshore development (with septic systems) is pursued. At this time, groundwater discharge and recharge locations of Matthews Lake are not known. Project development around this topic would require conversations with the Center for Watershed Science and Education at UWSP and possibly with DNR and County natural resource professionals.

10.3.4 Ongoing Work to Measure Phosphorus Loading in Lakes from Septic Effluent

"Fate of Groundwater Phosphorus from Septic Systems Near Lakes"

Dr. Paul McGinley, UW-Stevens Point
Although there is no widely accepted method for measuring P loading in lakes from septic effluent, there is ongoing research on the topic. Dr. McGinley's project began in 2021 in three lakes in central Wisconsin. Researchers are identifying near-shore locations of groundwater inflow using temperature profile monitoring. Groundwater samples from these areas will be analyzed for chloride, nitrate, pH level, phosphorus and artificial sweeteners. Similar to Lukasik's project (above), the presence of artificial sweeteners would "provide an unambiguous tracer of septic system impact and eliminate contradictory signals from organic matter mineralization." Soils collected near the lakeshore will also be collected to explore the ability of soil to retain phosphorus, which would ultimately impact how much phosphorus is "free" to flow into the lake.

<u>Contacts made while investigating this topic</u>
Pamela Toshner, WDNR. Dr. Paul McGinley, UWSP. Hannah Lukasik, UWSP. Bill Devita, WEAL UWSP. Lisa Burns, Washburn Co. Brent Edlin, Washburn Co.

10.4 Appendix D – WDNR Letter of Approval of Plan

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
810 W. Maple Street
Spooner WI 54801

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

WISCONSIN DEPT. OF NATURAL RESOURCES

March 3, 2022

Letter sent from WDNR on August 29th, 2022

Mr. John Nickleby and Ed Wink
Via Email

Subject: Aquatic Plant Management & Invasive Species Prevention Plan for Matthews Lake

Dear Mr. Nickleby and Mr. Wink:

Thank you for your efforts to understand and manage Matthews Lake, Washburn County. This letter is to notify you that the DNR approves the Matthews Lake 2022-2026 Aquatic Plant Management & Invasive Species Prevention Plan (Plan). Management recommendations described in the Plan are eligible for funding under NR193 Surface Water Grants, subject to the application requirements of the program.

Please note the following contacts for future management purposes:

- Aquatic Invasive Species early detection and response: Alex Selle, alexander.selle@wisconsin.gov and (715) 413-2376.
- Surface water grants: Kris Larsen, kris.larsen@wisconsin.gov and (715) 635-4072.

Thanks to you and the lake community for your continued efforts to manage Matthews Lake.

Sincerely yours,

Pamela Toshner

Pamela Toshner
Lake & Watershed Protection Specialist

CC: Sara Hatleli, Aquatic Plant and Habitat Services, LLC
Kris Larsen, Alex Selle, and Jill Sunderland, WDNR

dnr.wi.gov
wisconsin.gov

Naturally WISCONSIN