

Amery Lakes Aquatic Plant Management Plan

Pike, North Twin, and South Twin Lakes

Polk County, Wisconsin

DRAFT PLAN

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Sponsored By

Amery Lakes Protection and Rehabilitation District

Prepared By

Harmony Environmental

Ecological Integrity Services

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Committee Members

Jon Bergquist, Pike Lake Resident

Debbie Christopherson, Amery Lakes Protection and Rehabilitation District Board

Jason Whitley, North Twin Lake Resident

Tom Hartman, Amery Lakes Protection and Rehabilitation District Board

Mike Manor, City of Amery, Amery Lakes Protection and Rehabilitation District Board

Sara Schanon Jensen, North Twin Lake Resident

Advisors

Steve Schieffer, Amery Lakes Protection and Rehabilitation District Board and Ecological Integrity Service

Tyler Mesalk, Wisconsin Department of Natural Resources

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Introduction

This aquatic plant management plan for the Amery Lakes of Pike, North Twin, and South Twin in Polk County, Wisconsin presents a strategy for managing aquatic plants by protecting native plant populations, alleviating nuisance conditions, and preventing establishment and spread of invasive species. The plan includes data about the plant community, watershed, and water quality of Amery Lakes. Based on this data and public input, goals and strategies for the sound management of aquatic plants are presented. This plan will guide the Amery Lakes Protection and Rehabilitation District (Amery Lakes District) and the Wisconsin Department of Natural Resources (WDNR) in aquatic plant management for Amery Lakes over the next five years (from 2023 through 2027).

Amery Lakes Aquatic Plant Management Goals

Goal I. Prevent the introduction of aquatic invasive species.

Goal II. Control the spread of aquatic invasive species.

Goal III. Preserve the diverse native plant community.

Goal IV. Protect Amery lakes through education and involvement of lake residents and visitors.

This aquatic plant management plan is guided by public input, scientific data, and requirements from the Wisconsin Department of Natural Resources (WDNR). The plan is required by WDNR regulations for certain aquatic plant management activities and to obtain grants that fund aquatic invasive species management. The WDNR's aquatic plant management planning guidelines and Northern Region Aquatic Plant Management Strategy framed the development of the plan. WDNR sampling protocol and plant survey methods were also utilized in plan development.

More information about managing aquatic plants in Wisconsin is available from <http://dnr.wi.gov/lakes/plants/> and in an *Aquatic Plant Management Companion Document* (Clemens, 2022).

Public Input for Plan Development

Three advisory committee meetings were held to guide the development of the Amery Lakes Aquatic Plant Management (APM) Plan. The group met to learn about APM planning requirements, the condition of the Amery lakes and watershed, aquatic plant management to date, and management options available. The APM Committee expressed a variety of concerns that are reflected in the goals and objectives for aquatic plant management in this plan. The committee also guided implementation strategies in the plan.

Following advisory committee input, the draft plan update was made available to lake residents and other interested parties. Residents were made aware of the availability of the draft with a notice published in the Amery Free Press. The plan was available for review between March 27 and April 24, 2023 on the City of Amery web site (amerywisconsin.org).

Lake Information

Amery Lakes are located in Polk County, Wisconsin in the city of Amery and the town of Lincoln. Information about the lakes is reported in Table 1 below. A map of the lakes with public boat landings indicated is included as Figure 1.

Table 1. Amery Lakes Information (Wisconsin Department of Natural Resources, 2022)

Lake	Type	Lake Acres	Watershed Acres	Watershed/ Lake Ratio	Max Depth	Mean Depth
Pike (WBIC 2624000)	Seepage	148	399	2.7	33 feet	14 feet
North Twin (WBIC 2623900)	Drainage	129	178	1.4	27 feet	11 feet
South Twin (WBIC 2623800)	Drainage	72	124	1.7	9 feet	5 feet

Water Quality

The 2014 Amery Lakes Aquatic Plant Management Plan provided an overview of lake water quality, the watershed, previous lake studies, and the Amery Clean Lakes project. The Amery Clean Lakes project included stormwater planning, an ordinance update, and installation of the Flagpole Park stormwater wetland and several homeowner demonstration projects.

Trophic State

Trophic state describes the productivity of a lake. The least productive or nutrient-rich lakes are oligotrophic lakes. The most productive lakes are referred to as eutrophic. Those in the middle are called mesotrophic. More productive lakes have more nutrients available for algae and aquatic plant growth. If a watershed with little runoff and phosphorus sources surrounds a lake, the water will tend to have low phosphorus levels. This will result in limited plant and algae growth, causing it to be classified as an oligotrophic lake. Amery Lakes are classified as mesotrophic lakes. The lakes have low watershed to lake area ratios which range from 1.4 to 2.7. Typically, water quality decreases with an increasing ratio of watershed area to lake area.

The Amery Lakes District began collection of water quality samples and measuring secchi depth through a licensed laboratory in 2022. Results are presented in Table 2. Chlorophyll results put Pike Lake in oligotrophic range and North and South Twin in mesotrophic range for samples collected in 2022. Lake water quality data was previously collected and analyzed by the Amery High School Freshwater Ecology class.

Table 2. Amery Lakes Water Quality Monitoring Results 2022²

	June	Aug	Sept	Average
Pike Lake				
Chl-a (µg/L)	2.2	2.7	3.7	2.7
TP (µg/L)	28	ND	28	<28
SRP (µg/L)	ND	2	ND	
North Twin Lake				
Chl-a (µg/L)	2.8	2.4	5.4	3.5
TP (µg/L)	ND	ND	13	<13
SRP (µg/L)	ND	ND	3	
South Twin Lake				
Chl-a (µg/L)	4.1	1.1	5.2	3.5
TP (µg/L)	30	ND	24	<27
SRP (µg/L)	ND	ND	3	<3

ND – NOT DETECTED

Table 3. Secchi Depth Monitoring Results

	May	June	July	Aug	Sept	Average
Pike Lake (in feet)	21	17	15	12	9	14.8
North Twin (in feet)	17	14	14	11.5	12	13.7

² LOD for SRP was 2 ppb, for TP 6 ppb. LOQ for SRP was 6 ppb, for TP 18 ppb. Testing completed at Water and Environmental Analysis Lab, University of Wisconsin-Stevens Point.

Limit of Detection (LOD): The concentration at which you detect your compound of interest but the concentration of your compound is too low to really distinguish from other compounds (background noise). **Limit of Quantification (LOQ):** The concentration at which you are confident enough to accurately quantify the concentration of your compound of interest. <https://mytapscore.com/blogs/tips-for-taps/how-low-can-you-go-lab-detection-limits-explained>

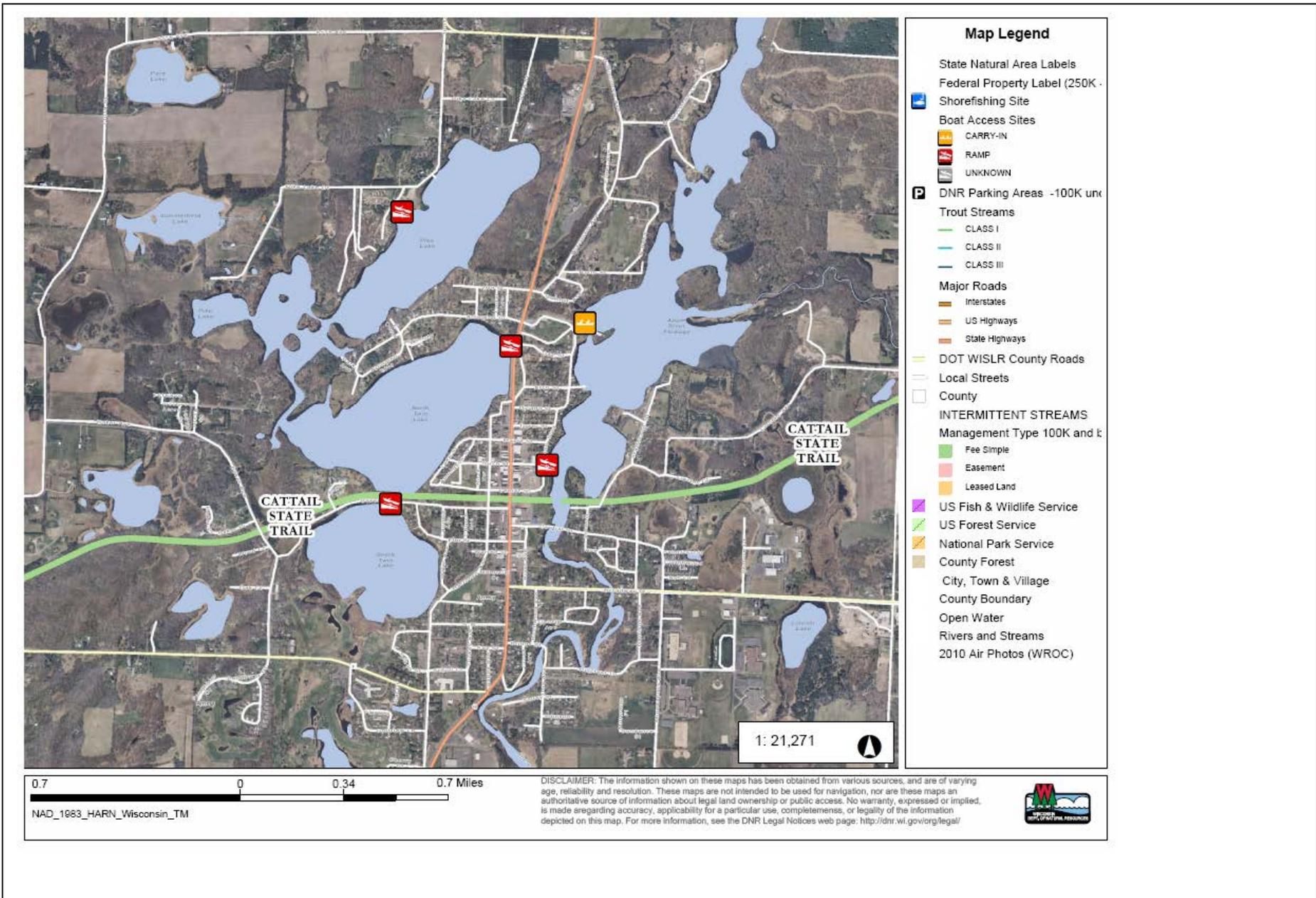
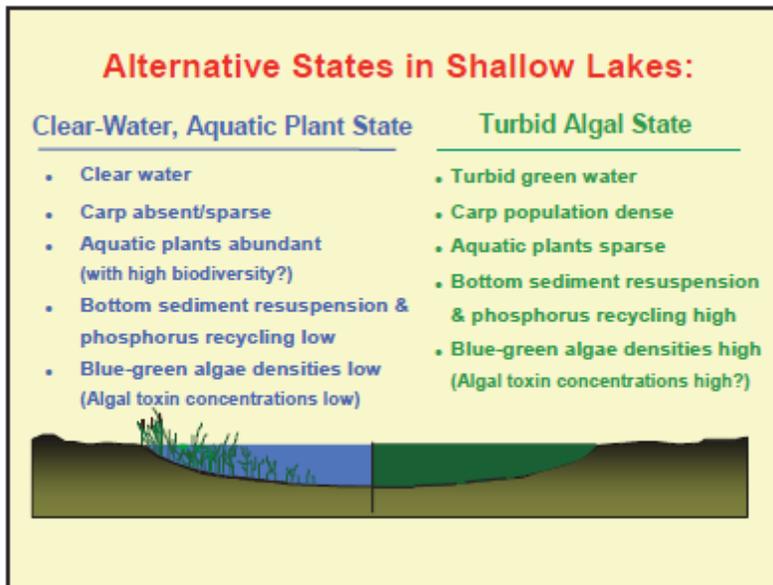


Figure 1. Map of Amery Lakes (from WDNR WebView)

Water Quality in Shallow Lakes

It is important to note that aquatic plants play a critical role in maintaining water quality in the Amery Lakes – especially in South Twin, because it is very shallow. If aquatic plants are not present in shallow lakes, nutrient-rich sediments can be re-suspended, and water clarity would be expected to decrease dramatically. The figure below illustrates that for shallow-water lakes, an aquatic plant dominated system is highly preferable to a lake without aquatic plants. In fact, restoration efforts for shallow lakes frequently focus on re-establishing aquatic plants in order to improve water clarity.



From Lake Wingra presentation adopted from Sheffer 1990

Figure 2. Alternative States in Shallow Lakes

Aquatic Habitats

Shoreline Inventory

In 2008 and 2009, the Amery High School Freshwater Ecology class completed a shoreline inventory as part of a Wisconsin Lakes Protection Grant project (Amery High School, 2009). This shoreline inventory recorded if shorelines were developed or natural. In addition, the riparian zone (ordinary high water mark to 35 feet) was evaluated for type (natural, hard or impervious, lawn, etc.). Finally, there were critical habitat areas delineated on all the lakes. The results are reported in the 2014 Amery Lakes Aquatic Plant Management Plan and included in Appendix A.

Residential development of shorelines tends to decrease aquatic plants and habitat in the lake (Radomski, 2001). With more development, aquatic vegetation tends to be removed either intentionally or through increased boat traffic. The preservation of undeveloped areas can protect aquatic habitat. Installation of coarse woody debris (habitat) or “fish sticks” improves habitat by establishing structure for fish and invertebrates (Bozek, 2001). In areas where “fish sticks” are installed, decreased boating disturbance will likely result and aquatic plants can thrive.

Functions and Values of Native Aquatic Plants

Naturally occurring native plants provide a diversity of habitat, help maintain water quality, sustain the fishing quality for which the Amery Lakes are known, and support common lakeshore wildlife from loons to frogs.

Water Quality

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algae growth. Some plants can even filter and break down pollutants. Plant roots and underground stems help to prevent resuspension of sediments from the lake bottom. Stands of emergent plants (with stems that protrude above the water surface) and floating plants help to blunt wave action and prevent erosion at the shoreline.

Fishing

Habitat created by aquatic plants provides food and shelter for both young and adult fish. Invertebrates living on or beneath plants are a primary food source for fish. Other fish such as bluegills graze directly on the plants themselves. Plant beds provide important spawning habitat for many fish species. Northern pike eggs adhere to vegetation.

Waterfowl

Plants offer food, shelter, and nesting material. Birds eat both the invertebrates that live on plants and the plants themselves.³ Emergent plants are especially important.

Protection against Invasive Species

Non-native invasive species threaten native plants in Northern Wisconsin. The most common, Eurasian water milfoil (EWM) and curly leaf pondweed (CLP), are present in Amery Lakes. These species are described as opportunistic invaders. This means that these “invaders” benefit where an opening occurs from removal of plants. Without competition from other plants, invasive species may successfully become established in a lake. Removal of native vegetation not only diminishes the natural qualities of a lake, it may increase the risk that an invasive species can successfully invade onto the site where native plants have been removed. This concept is easily observed on land where bare soil is quickly taken over by weeds that establish themselves as new occupants of the site. While not providing a guarantee against invasive plants, protecting and allowing the native plants to remain may reduce the success of an invasive species becoming established in a lake. Invasive species can change many of the natural features of a lake and often lead to expensive annual control plans. Native vegetation may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.⁴

³ Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.

⁴ Taken from *Aquatic Plant Management Strategy*. DNR Northern Region. Summer 2007.

Fish Community

The Amery Lakes District developed a Fisheries Management Plan for Pike Lake, North Twin Lake, and South Twin Lake to guide the Amery Lakes District's actions in assisting the Wisconsin Department of Natural Resources in managing the lakes (Amery Lakes P&R District, 2011). Fisheries information is from this management plan with updates from Kyle Broadway, WDNR Fisheries Biologist.⁵

Fish Species

According to Kyle Broadway, WDNR Fisheries Biologist, the fish community in North Twin, South Twin, and Pike Lakes largely consists of a bass, panfish, northern pike, and a stocked walleye fishery. The species present in these lakes include: bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), walleye (*Sander vitreus*), bullhead species (*Ameiurus spp.*), white sucker (*Catostomus commersonii*), and several minnow species.

Low-density (compared to similar complex-warm-clear Wisconsin Lakes) bluegill and largemouth bass populations with good size structures are present in each lake with pumpkinseed sunfish also contributing to the panfish population.

Largemouth bass and northern pike have excellent reproduction in all three lakes. However, natural walleye production is limited in the lakes, and a regular stocking program is necessary to sustain an adult walleye fishery.

Fish Stocking

The WDNR and Amery Lakes District stocked walleye fingerling beginning in 1997. Table 4 summarizes the stocking efforts. Large fingerlings were stocked because of poor survival rates for small fingerlings. WDNR recommended stocking large fingerlings at a rate of 10 per acre. WDNR stocking ended in 2013. Since 2008, WDNR allowed the Amery Lakes District to stock large fingerlings at a rate of up to 30 per acre. Amery Lakes District walleye stocking continued through 2022.

South Twin Lake was restocked with fish after a partial winter kill in 2001-2002 (Heath Benike, WDNR, 2008). Oxygen levels in South Twin Lake were also reported to be low (1 mg/L) in February 2014. This occurred while the South Twin aerator was running, but the inlet culvert from North Twin Lake was not running due to low water.⁶

Fishing Activity

North Twin and Pike Lakes are both favorite family fishing lakes, especially during the summer months. South Twin is not fished as heavily but also offers excellent fishing. Ice fishing is also a popular activity on the lakes. Anglers are targeting pan fish, walleyes, northern pike and largemouth bass. It is common to see twenty to twenty-five ice fishing houses on North Twin Lake in January and February and a lesser number on Pike Lake. As in the summer months, ice fishing pressure on South Twin Lake is not as high.

⁵ Broadway, Kyle, WDNR Fisheries Biologist. Email communication, December 6, 2022. Information from 2018 WDNR fishery survey data.

⁶ Schieffer, Steve. Email communication, February 24, 2014.

Amery Lakes District Fisheries Management

According to the 2011 Fisheries Management Plan, the Amery Lakes District will manage fisheries with the following activities:

- Encourage maintenance and installation of woody habitat to improve fish habitat and shoreline restoration to improve riparian habitat.
- Consider supporting restocking in South Twin if a fish kill occurs, but do not support aeration of the lake.
- Continue stocking large walleye fingerlings at a rate of 30 per acre and encourage WDNR to do the same (2011 plan recommendation).⁷ The Amery Lakes District currently follows WDNR-recommended stocking rate of 10 per acre.
- Manage all three lakes for quality pan fish populations.
- Encourage catch and keep to manage the numbers of largemouth bass and northern pike in at least North Twin and Pike Lakes.
- Continue efforts to maintain or improve the water quality of the lakes.
- Continue an aggressive position of invasive species prevention and management.

⁷ According to Kyle Broadway, WDNR Fisheries Biologist. Survival rates of large fingerling walleye to age 1 are highest at a stock rate of 10 fish/acre compared to both higher and lower stocking rates.

Table 4. Walleye Stocking in Amery Lakes

Year	Source	Age Class	Numbers Stocked - Pike	Numbers Stocked – North Twin
1997	WDNR	Large Fingerlings	3,975	3,400
1999	WDNR	Small Fingerlings	3,975	3,375
2001	WDNR	Small Fingerlings	3,975	3,375
2002	Lake District	Large Fingerlings	1,500	1500
2003	WDNR	Small Fingerlings	3,975	3,375
2004	Lake District	Large Fingerlings	1,500	1,500
2005	WDNR	Small Fingerlings	7,042	7,042
2006	Lake District	Large Fingerlings	1,500	1,500
2008	Lake District	Large Fingerlings	1,700	1,500
2009	WDNR	Small Fingerlings	5,723	4,960
2009	Lake District	Large Fingerlings	2,100	2,100
2010	Lake District	Large Fingerlings	2,500	2,500
2011-2017	Lake District	Large Fingerlings	3,000	3,000
2013	WDNR	Large Fingerlings	2,385	2,025
2018	Lake District	Large Fingerlings	2,000	2,000
2020	Lake District	Large Fingerlings	1,600	1,400
2022	Lake District	Large Fingerlings	1,600	1,400

Aquatic Plant Community

Steve Schieffer completed pro-bono aquatic plant point intercept surveys for project lakes according to standard WDNR protocol. Summarized results follow. Plant survey methods are found in the Aquatic Plant Management companion document which is incorporated by reference (Clemens, 2022).

A rake is used to collect plant samples at each sample point that occurs at depths where plants are likely to grow. Rake fullness is recorded for each species (as described in Table 5 and illustrated in Figure 3 below) at every sample point. Rake fullness and presence/absence at each sample point are used to generate survey results.

Table 5. Aquatic Plant Survey Rake Fullness Ratings

Rake Fullness Rating	Criteria for Rake Fullness Rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

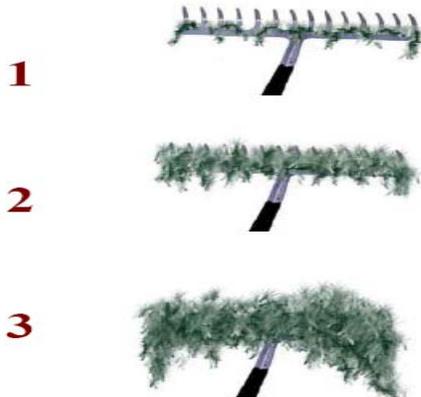


Figure 3. Plant Rake Fullness

Pike Lake Aquatic Plant Survey Summary (2021)

Pike Lake has widespread aquatic plant coverage at moderate to high density in the littoral zone (the depths at which plants grow in the lake). The littoral zone in the main lake basin is limited because the depth drops off quickly going out from shore. The diversity of the plant community is exceptional, with a species richness of 48 and a very high Simpson’s diversity index of 0.95.⁸ The excellent water clarity in Pike Lake is reflected in the 24.7-foot maximum depth of plants sampled (Schieffer, 2022).

Table 6. Pike Lake 2021 Point Intercept Survey Summary Statistics

Total number of sites visited	396
Total number of sites with vegetation	263
Total number of sites shallower than maximum depth of plants	309
Frequency of occurrence at sites shallower than maximum depth of plants	85.11
Simpson Diversity Index	0.95
Maximum depth of plants	24.70 ft.
Mean depth of plants	4.84 ft.
Average number of all species per site (shallower than maximum depth)	2.92
Average number of all species per site (vegetated sites only)	3.43
Average number of native species per site (shallower than maximum depth)	2.89
Average number of native species per site (vegetated sites only)	3.40
Species richness	48
Species richness (including visuals)	50

⁸ Simpson’s diversity index which ranges from 0 to 1 is a measure of the diversity of the plant community. The greater the index value, the more diverse and healthy the plant community. In theory, the value is the chance that two species sampled are different. An index of “1” indicates that the two will always be different (diverse) and a “0” indicates that the species will never be different (only one found).

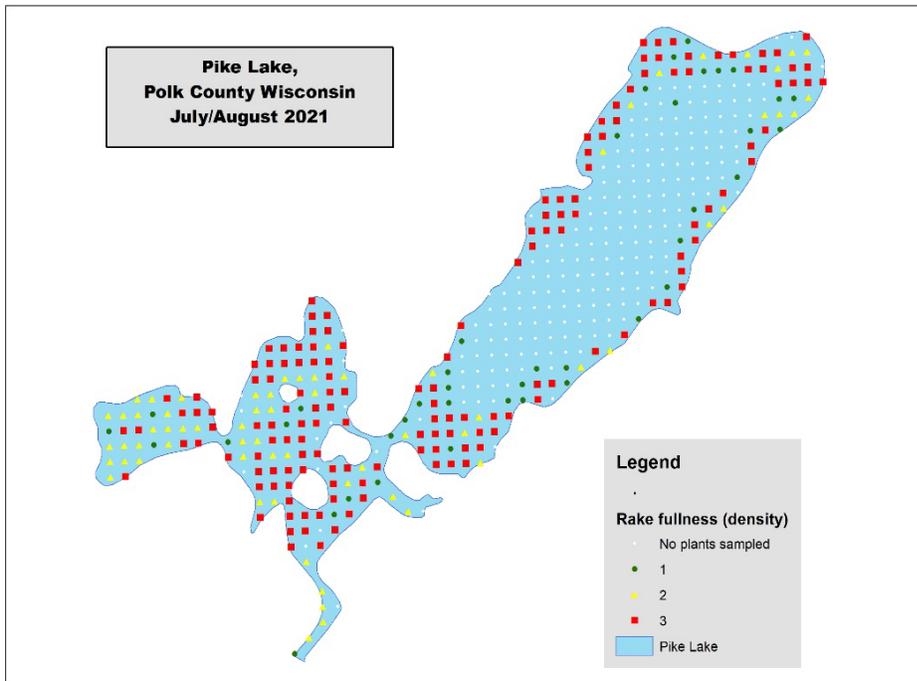


Figure 4. Pike Lake Rake Fullness (2021)

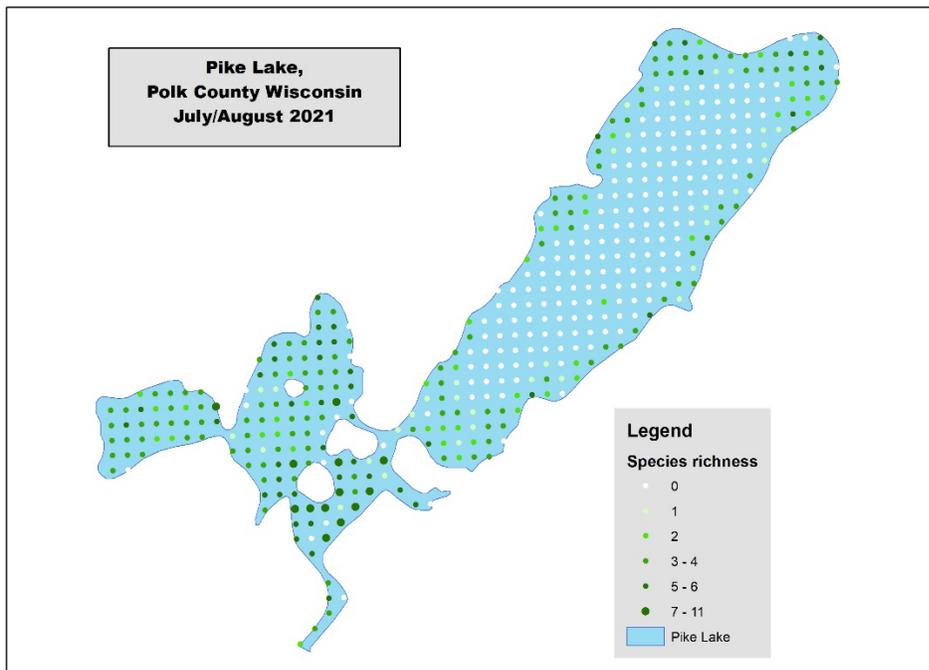


Figure 5. Pike Lake Species Richness (2021)

The southwestern portion of Pike Lake, commonly referred to as the “Bass Hole,” has widespread coverage of dense plant growth. It is also the region where most of the plant diversity and species richness occurs. The plants in this area provide an exceptional aquatic plant community for Pike Lake, with excellent habitat for fish, birds, reptiles, amphibians, and mammals. Protection of the aquatic plant community of this area is paramount to maintain habitat diversity.

The most common plant in Pike Lake was spatterdock, a floating leaf plant. The relative frequency of spatterdock was 10%, which indicates that this plant did not dominate the plant community (it was only sampled 1 in every 10 plants).

The other most common plants were white water lily (also a floating leaf plant) and fern pondweed. Both are common plants in Wisconsin lakes that provide excellent habitat for invertebrates. Spatterdock and white-water lily provide important habitat for fish and amphibians.

Table 7. Pike Lake Species List (2021)

Species *Frequency of Occurrence	FOO* Vegetated	FOO* Littoral Depth	Relative Freq.	Number Sampled	Mean Rake Fullness	Number Viewed
<i>Nuphar variegata</i> , Spatterdock	34.60	29.45	10.08	91	1.01	11
<i>Nymphaea odorata</i> , White water lily	28.14	23.95	8.19	74	1.05	9
<i>Potamogeton robbinsii</i> , Fern pondweed	26.24	22.33	7.64	69	1.57	
<i>Potamogeton natans</i> , Floating-leaf pondweed	25.48	21.68	7.42	67	1.04	4
<i>Chara sp.</i> , Muskgrasses	24.71	21.04	7.20	65	2.28	4
<i>Ceratophyllum demersum</i> , Coontail	22.05	18.77	6.42	58	1.22	1
<i>Utricularia purpurea</i> , Large purple bladderwort	21.29	18.12	6.20	56	1.46	1
<i>Myriophyllum sibiricum</i> , Northern water milfoil	17.49	14.89	5.09	46	1.09	8
<i>Brasenia schreberi</i> , Watershield	15.21	12.94	4.43	40	1.03	2
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	15.21	12.94	4.43	40	1.55	
<i>Schoenoplectus subterminalis</i> , Water bulrush	11.79	10.03	3.40	31	1.00	4
<i>Potamogeton richardsonii</i> , Claspingleaf pondweed	11.41	9.71	3.32	30	1.07	3
<i>Stuckenia pectinata</i> , Sago pondweed	10.65	9.06	3.10	28	1.04	3
<i>Potamogeton illinoensis</i> , Illinois pondweed	10.27	8.74	2.99	27	1.04	4
<i>Vallisneria americana</i> , Wild celery	8.75	7.44	2.55	23	1.13	1
<i>Myriophyllum verticillatum</i> , Whorled water milfoil	4.18	3.56	1.22	11	1.00	
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	4.18	3.56	1.22	11	1.00	2
<i>Sparganium angustifolium</i> , Narrow-leaved bur-reed	4.18	3.56	1.22	11	1.00	
<i>Utricularia intermedia</i> , Flat-leaf bladderwort	4.18	3.56	1.22	11	1.00	1
<i>Elodea canadensis</i> , Common waterweed	3.42	2.91	1.00	9	1.00	
<i>Heteranthera dubia</i> , Water star-grass	3.42	2.91	1.00	9	1.11	
<i>Myriophyllum spicatum</i> , Eurasian water milfoil	3.04	2.59	0.89	8	1.13	2
<i>Pontederia cordata</i> , Pickerelweed	3.04	2.59	0.89	8	1.25	1

Species *Frequency of Occurrence	FOO* Vegetated	FOO* Littoral Depth	Relative Freq.	Number Sampled	Mean Rake Fullness	Number Viewed
<i>Potamogeton gramineus</i> , Variable pondweed	3.04	2.59	0.89	8	1.00	2
<i>Utricularia vulgaris</i> , Common bladderwort	3.04	2.59	0.89	8	1.00	
<i>Eleocharis robbinsii</i> , Robbins' spikerush	2.66	2.27	0.78	7	1.14	3
<i>Lemna trisulca</i> , Forked duckweed	2.66	2.27	0.78	7	1.00	
<i>Sparganium eurycarpum</i> , Common bur-reed	2.66	2.27	0.78	7	1.29	
<i>Nitella</i> sp., Nitella	2.28	1.94	0.66	6	1.00	
<i>Zizania palustris</i> , Wild rice	2.28	1.94	0.66	6	1.00	3
<i>Najas flexilis</i> , Slender naiad	1.90	1.62	0.55	5	1.00	
<i>Potamogeton praelongus</i> , White-stem pondweed	1.90	1.62	0.55	5	1.00	
<i>Utricularia gibba</i> , Creeping bladderwort	1.52	1.29	0.44	4	1.00	
<i>Potamogeton friesii</i> , Fries' pondweed	1.14	0.97	0.33	3	1.00	
<i>Potamogeton pusillus</i> , Small pondweed	1.14	0.97	0.33	3	1.00	
<i>Sagittaria rigida</i> , Sessile-fruited arrowhead	1.14	0.97	0.33	3	1.00	1
<i>Lemna minor</i> , Small duckweed	0.76	0.65	0.22	2	1.00	
<i>Ranunculus aquatilis</i> , White water crowfoot	0.76	0.65	0.22	2	1.00	
<i>Sagittaria graminea</i> , Grass-leaved arrowhead	0.76	0.65	0.22	2	1.00	1
<i>Carex comosa</i> , Bottle brush sedge	0.38	0.32	0.11	1	1.00	
<i>Dulichium arundinaceum</i> , Three-way sedge	0.38	0.32	0.11	1	1.00	
<i>Eleocharis erythropoda</i> , Bald spikerush	0.38	0.32	0.11	1	2.00	
<i>Potamogeton epihydrus</i> , Ribbon-leaf pondweed	0.38	0.32	0.11	1	1.00	
<i>Schoenoplectus acutus</i> , Hardstem bulrush	0.38	0.32	0.11	1	1.00	
<i>Spirodela polyrhiza</i> , Large duckweed	0.38	0.32	0.11	1	1.00	
<i>Typha angustifolia</i> , Narrow-leaved cattail	0.38	0.32	0.11	1	2.00	2
<i>Utricularia minor</i> , Small bladderwort	0.38	0.32	0.11	1	1.00	
<i>Carex lacustris</i> (lake sedge)	0.38	0.32	0.11	1	1.00	
Aquatic moss	0.76	0.65		2	1.00	
Filamentous algae	3.80	3.24		10	1.00	
<i>Comarum palustre</i> , Marsh cinquefoil						1
<i>Schoenoplectus tabernaemontani</i> , Softstem bulrush						1

Sensitive Plants and Floristic Quality Index

There were no endangered or threatened species sampled in Pike Lake. Robbin’s spikerush (*Eleocharis robbinsii*), a species of special concern, was sampled in both 2021 and 2012. In 2021 it was sampled at seven sample points, all in the southwestern portion of the lake.

There were eight sensitive plants species with high conservatism values sampled in the 2021 Pike Lake point intercept survey (Table 8).

Table 8. Sensitive Species Sampled in the 2021 Pike Lake Point Intercept Survey

Sensitive Species Sampled	Number Sampled	Conservatism Value
<i>Utricularia minor</i> , small bladderwort	1	10
<i>Sagittaria graminea</i> , grass-leaved arrowhead	2	9
<i>Schoenoplectus subterminalis</i> , water bulrush	31	9
<i>Dulichium arundinaceum</i> , three-way sedge	1	9
<i>Sparganium angustifolium</i> , narrow-leaved bur-reed	11	9
<i>Utricularia gibba</i> , creeping bladderwort	4	9
<i>Utricularia intermedia</i> , flat-leaf bladderwort	11	9
<i>Utricularia purpurea</i> , large purple bladderwort	56	9

The high floristic quality index (FQI) value shows the tremendous ecological health of the Pike Lake plant community.⁹ The number of species, mean conservatism value, and FQI are all substantially higher than the eco-region median FQI where Pike Lake is located.

Table 9. Pike Lake Floristic Quality Index (2021) and Eco-Region Comparison

Parameter	Pike Lake	Eco-region
	2021	Median
Number of Species (used in FQI)	45	14
Mean Conservatism	6.6	5.6
FQI	44.0	20.9

⁹ The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A higher conservatism value indicates that a plant is intolerant to disturbance, while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes largely due to human influence (Nichols, 1999). The FQI is calculated using the number of species and the average conservatism value of all species used in the index.

Invasive Species

There were three non-native, invasive species sampled in 2021 in Pike Lake: Eurasian water milfoil (EWM) (*Myriophyllum spicatum*), curly-leaf pondweed (CLP) (*Potamogeton crispus*), and narrow-leaved cattail (*Typha angustifolia*).

Comparison between 2013 and 2021 Plant Surveys

Limited conclusions can be drawn by comparing the 2013 and 2021 Pike Lake aquatic plant surveys because more points were sampled in 2021. These additional points were in the southwestern portion of the lake locally referred to as the “Bass Hole.” The area was not sampled in 2013 because of low water that resulted in limited navigability by motor boat. Increased diversity reflected by increased species richness, Simpson’s diversity index, and FQI was likely due to the additional points sampled in the Bass Hole in 2021.

There were nine species with a statistically significant increase in frequency from 2013 to 2021. Most of these species are most common in the area where the increased sampling occurred. However, increases in Illinois pondweed and Sago pondweed occurred mainly outside of this area. There was a significant increase in the invasive species EWM (from 0 locations in 2013 to 8 in 2021). This is not desirable, but the frequency of this plant was still low in 2021. EWM growth is evaluated annually on Pike Lake.

Table 10. Pike Lake Plant Survey Results Comparison (2013 and 2021)

Parameter	2013	2021
Number of points with plants sampled*	207	263
% of the defined littoral zone with plants sampled*	97.2	85.1
Maximum depth with plants sampled	20.2	24.7
Species richness	45	48
Simpson’s diversity index	0.94	0.95
FQI	42.4	44.0

**The “Bass Hole” area of Pike Lake was not sampled in 2013 because of low water. The area was sampled in 2021.

Table 11. Pike Lake Species with Statistically Significant Frequency Increases (2013 to 2021)

Species with Statistically Significant Increase	P value	Significance
<i>Nuphar variegata</i> , Spatterdock	0.0002	***
<i>Potamogeton robbinsii</i> , Fern pondweed	0.03	*
<i>Utricularia purpurea</i> , Large purple bladderwort	4.9X10 ⁻⁹	***
<i>Brasenia schreberi</i> , Watershield	0.001	**
<i>Schoenoplectus subterminalis</i> , Water bulrush	5.4X10 ⁻⁵	***
<i>Stuckenia pectinata</i> , Sago pondweed	0.02	*
<i>Potamogeton illinoensis</i> , Illinois pondweed	0.009	**
<i>Myriophyllum verticillatum</i> , Whorled water milfoil	0.03	*
<i>Utricularia intermedia</i> , Flat-leaf bladderwort	0.03	*
<i>Myriophyllum spicatum</i> , Eurasian water milfoil (EWM)	0.01	*

Statistically significant decreases occurred in seven native species in Pike Lake between 2013 and 2021. The cause of these decreases is not known. In the case of wild rice, decreased growth may be due to higher water levels. Wild rice in Pike Lake tends to grow best during low water conditions. In 2013, the lake levels were low and had been low for a few years, resulting in extensive wild rice growth. In 2021, the water levels were about average, but this followed several years of high-water levels, which likely resulted in less rice growth.

Table 12. Pike Lake Species with Statistically Significant Frequency Decreases (2013 to 2021)

Species with Statistically Significant Decrease	P value	Significance
<i>Chara sp.</i> , Muskgrasses	0.03	*
<i>Ceratophyllum demersum</i> , Coontail	0.003	**
<i>Myriophyllum sibiricum</i> , Northern water milfoil	7.3X10 ⁻⁵	***
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	0.007	**
<i>Utricularia vulgaris</i> , Common bladderwort	2.3X10 ⁻¹²	***
<i>Lemna trisulca</i> , Forked duckweed	0.007	**
<i>Zizania palustris</i> , Wild rice	0.0005	***

Declines in northern water milfoil are a potential concern. Herbicide control of EWM occurred twice between 2013 and 2021, and northern water milfoil would be susceptible to the herbicides used. However, northern water milfoil growth can vary from year to year, so the decline could also possibly be natural variation.

North Twin Aquatic Plant Survey Summary (2019)

North Twin Lake has a diverse aquatic plant community with extensive coverage of plants throughout the lake. Nearly 98% of the littoral zone (defined by depth where plants grow) had plants growing. The species richness was 36 species, with the Simpson’s diversity index fairly high. The maximum depth of plants reflects good water clarity with plants sampled as deep as 17.7 feet (Schieffer, 2020).

Table 13. North Twin Lake 2019 Point Intercept Survey Summary Statistics

Summary Statistics	
Total number of sites shallower than maximum depth of plants	307
Total number of sites with vegetation	300
Frequency of occurrence at sites shallower than maximum depth of plants	97.72%
Simpson Diversity Index	0.89
Maximum depth of plants	17.70 ft.
Mean depth of plants	7.73 ft.
Average number of all species per site (shallower than maximum depth)	3.07
Average number of all species per site (vegetated sites only)	3.17
Average number of native species per site (shallower than maximum depth)	3.06
Average number of native species per site (vegetated sites only)	3.15
Species richness	36
Species richness (including visuals)	38

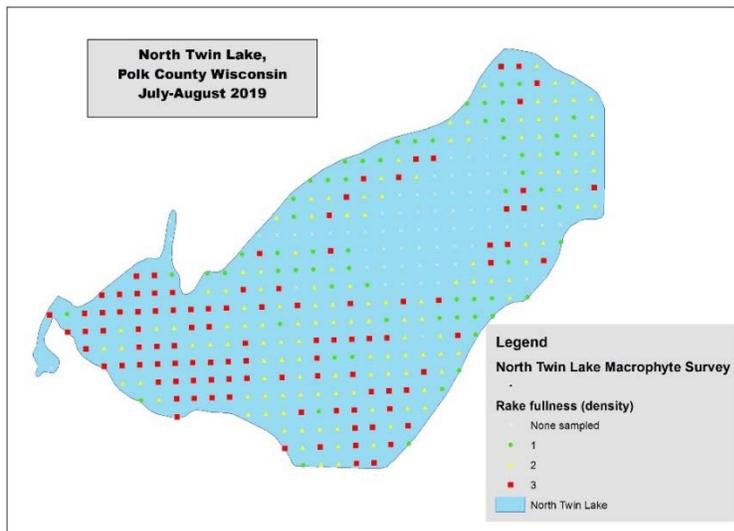


Figure 6. North Twin Rake Fullness (2019)

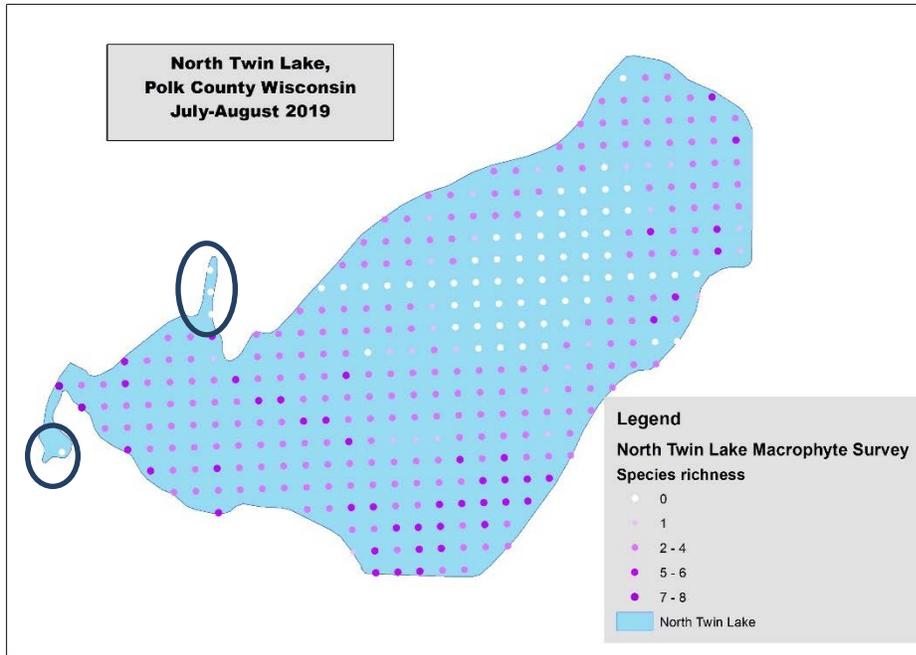


Figure 7. North Twin Lake Species Richness (2019)

The locations with the highest number of species per point occurred in the southern bay and the west bay near the narrows coming in from Pike Lake. The circled areas in Figure 7 were not navigable (and therefore, not sampled) but did have extensive plant growth.

Table 14. North Twin Lake Species List (2019)

Species	FOO* Vegetated	FOO* Littoral	Relative Freq.	Number Sampled	Mean Rake Fullness	Number Viewed
* Frequency of Occurrence						
<i>Potamogeton robbinsii</i> , Fern pondweed	59.33	57.98	18.74	178	1.67	1
<i>Ceratophyllum demersum</i> , Coontail	55.00	53.75	17.37	165	1.27	
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	44.67	43.65	14.11	134	1.10	
<i>Myriophyllum sibiricum</i> , Northern water milfoil	38.00	37.13	12.00	114	1.07	6
<i>Elodea canadensis</i> , Common waterweed	27.33	26.71	8.63	82	1.02	
<i>Potamogeton praelongus</i> , White-stem pondweed	16.67	16.29	5.26	50	1.16	4
<i>Potamogeton richardsonii</i> , Claspingleaf pondweed	14.00	13.68	4.42	42	1.02	4
<i>Vallisneria americana</i> , Wild celery	9.00	8.79	2.84	27	1.00	
<i>Potamogeton pusillus</i> , Small pondweed	8.33	8.14	2.63	25	1.16	
<i>Bidens beckii</i> , Water marigold	7.33	7.17	2.32	22	1.00	1
<i>Chara sp.</i> , Muskgrasses	5.67	5.54	1.79	17	1.41	
<i>Potamogeton natans</i> , Floating-leaf pondweed	5.00	4.89	1.58	15	1.00	1
<i>Nymphaea odorata</i> , White water lily	4.00	3.91	1.26	12	1.00	3
<i>Brasenia schreberi</i> , Watershield	3.67	3.58	1.16	11	1.18	2
<i>Nuphar variegata</i> , Spatterdock	2.33	2.28	0.74	7	1.00	2
<i>Potamogeton strictifolius</i> , Stiff pondweed	2.00	1.95	0.63	6	1.00	1
<i>Najas flexilis</i> , Slender naiad	1.67	1.63	0.53	5	1.00	1
<i>Ranunculus aquatilis</i> , White water crowfoot	1.67	1.63	0.53	5	1.00	1
<i>Myriophyllum spicatum</i> , Eurasian water milfoil	1.33	1.30	0.42	4	1.00	
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	1.00	0.98	0.32	3	1.00	4
<i>Potamogeton gramineus</i> , Variable pondweed	1.00	0.98	0.32	3	1.00	1
<i>Sagittaria cristata</i> , Crested arrowhead	1.00	0.98	0.32	3	1.00	
<i>Elodea nuttallii</i> , Slender waterweed	0.67	0.65	0.21	2	1.00	
<i>Heteranthera dubia</i> , Water star-grass	0.67	0.65	0.21	2	1.00	2
<i>Myriophyllum alterniflorum</i> , Alternate-flowered water milfoil	0.67	0.65	0.21	2	1.00	
<i>Pontederia cordata</i> , Pickerelweed	0.67	0.65	0.21	2	1.00	2
<i>Potamogeton foliosus</i> , Leafy pondweed	0.67	0.65	0.21	2	1.00	1
<i>Stuckenia pectinata</i> , Sago pondweed	0.67	0.65	0.21	2	1.00	
<i>Isoetes echinospora</i> , Spiny spored-quillwort	0.33	0.33	0.11	1	1.00	
<i>Lemna trisulca</i> , Forked duckweed	0.33	0.33	0.11	1	1.00	
<i>Nitella sp.</i> , Nitella	0.33	0.33	0.11	1	1.00	
<i>Potamogeton friesii</i> , Fries' pondweed	0.33	0.33	0.11	1	1.00	
<i>Sparganium natans</i> , Small bur-reed	0.33	0.33	0.11	1	1.00	
<i>Typha angustifolia</i> , Narrow-leaved cattail	0.33	0.33	0.11	1	1.00	
<i>Utricularia purpurea</i> , Large purple bladderwort	0.33	0.33	0.11	1	1.00	1
<i>Utricularia vulgaris</i> , Common bladderwort	0.33	0.33	0.11	1	1.00	
<i>Sparganium eurycarpum</i> , Common bur-reed	viewed	only				1
<i>Typha latifolia</i> , Broad-leaf cattail	viewed	only				1

The most common species in North Twin Lake was fern pondweed (*Potamogeton robbinsii*) with a relative frequency of 18.7%. This relative frequency indicates that no one plant dominated the plant community as less than 1 in 5 plants sampled was the dominant species. Fern pondweed has a mean conservatism value of 8, which indicates the plant is quite sensitive. Having the most dominant plant with a conservatism value this high indicates the plant community is healthy. Fern pondweed was followed by coontail (*Ceratophyllum demersum*) and flat-stem pondweed (*Potamogeton zosteriformis*) as the second and third most common species.

Sensitive Plants and Floristic Quality Index

No endangered, threatened, or species of special concern were sampled or viewed. There were three species sampled that are considered sensitive, with high conservatism values.

Table 15. Sensitive Species Sampled in the 2019 North Twin Lake Point Intercept Survey

Sensitive Species	Number Sampled	Conservatism Value
<i>Myriophyllum alterniflorum</i> , alternate flowered milfoil	2	10
<i>Sparganium natans</i> , small bur-reed	1	9
<i>Utricularia purpurea</i> , large purple bladderwort	1	9

Table 16. North Twin Lake Floristic Quality Index (2019) and Eco-Region Comparison

Parameter	North Twin Lake 2019	Eco-region Median
Number of species (used in FQI)	34	14
Mean Conservatism	6.5	5.6
FQI	37.9	20.9

Invasive Species

There were two non-native, invasive species sampled in North Twin Lake in 2019: Eurasian water milfoil (*Myriophyllum spicatum*) and narrow-leaved cattail (*Typha angustifolia*). Curly leaf pondweed was not found in the 2019 aquatic plant survey, but it is not expected to be found in July and August when the survey was conducted.

Comparison to 2012 Survey

An aquatic macrophyte survey was also conducted on North Twin Lake in 2012. Small changes occurred in the plant community over seven years. First, there were 21 fewer sample points with plants present in 2019 compared to 2012. This decrease is not likely due to the 2019 herbicide application because no reduction in native plants was observed within the treated areas between the surveys conducted before

and after the herbicide treatment. The maximum depth of plants changed little, with a decrease of 0.8 feet from 2012 to 2019.

Table 17. North Twin Lake Plant Survey Comparison (2012 and 2019)

Parameter	2012	2019
Number of points with plants sampled	321	300
% of the defined littoral zone with plants	97.5	97.7
Maximum depth plants sampled	18.5	17.7
Species richness	29	36
Simpson’s diversity index	0.87	0.89
FQI	31.9	37.9

There was greater aquatic plant diversity in 2019 with seven more species sampled, and the Simpson’s diversity index was slightly higher. The FQI also was higher in 2019. Since 2019 was the only year plant management occurred in North Twin Lake, the negative changes were likely due to natural or sample variation. The positive changes indicate the plant community was healthy and not degrading.

Each plant species sampled in 2012 and 2019 was compared by using a chi-square analysis to determine if changes (increases or decreases) were statistically significant. There was a statistically significant increase in six native species and one invasive species (EWM) from 2012 (not present) to 2019. EWM was first identified in North Twin Lake in 2018.

Table 18. North Twin Lake Species with Statistically Significant Increases (2012 to 2019)

Species with Statistically Significant Increase	P value	Significance
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	0.01	**
<i>Potamogeton pusillus</i> , Small pondweed	0.01	**
<i>Bidens beckii</i> , Water marigold	0.0002	***
<i>Chara sp.</i> , Muskgrasses	0.01	*
<i>Potamogeton natans</i> , Floating-leaf pondweed	0.02	*
<i>Potamogeton strictifolius</i> , Stiff pondweed	0.01	*
<i>Myriophyllum spicatum</i> , Eurasian water milfoil	0.04	*

The more * indicates a greater significance in the change.

There was a statistically significant decrease in three native species and one non-native, invasive species. The most significant native decrease was in coontail, which has a high frequency in North Twin Lake. This may be due to natural declines or sample variation. The invasive species *Potamogeton crispus* (curly-leaf pondweed or CLP) was not sampled in 2019 in North Twin Lake likely because of survey timing. The plant survey occurred in July and August when CLP has likely died back. CLP has been present in North Twin Lake for many years, but it has not reached nuisance levels that warrant mitigation.

Table 19. North Twin Lake Species with Statistically Significant Decreases (2012 to 2019)

Species with Statistically Significant Decrease	P value	Significance
<i>Ceratophyllum demersum</i> , Coontail	0.001	**
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	0.04	*
<i>Lemna trisulca</i> , Forked duckweed	0.04	*
<i>Potamogeton crispus</i> , Curly-leaf pondweed (CLP)	0.002	**

The more * indicates a greater significance in the change.

South Twin Lake Aquatic Plant Survey Summary (June 2019)

The South Twin Lake point intercept plant survey was conducted June 25 and 26, 2019. Results indicated a moderately diverse plant community with species richness of 27 and a Simpson’s diversity index of 0.86. The plant coverage was extensive. Nearly 100% of the sample points had plants present. The density of plants was also high. Most of the sample points had a rake fullness of 2 or 3 (Schieffer, 2020).

Table 20. South Twin Lake 2019 Point Intercept Survey Summary Statistics

Total number of sites with vegetation	195
Total number of sites is shallower than maximum depth of plants	194
Frequency of occurrence at sites shallower than maximum depth of plants	99.48
Simpson Diversity Index	0.86
Maximum depth of plants	14.0 ft.
Mean depth of plants	6.2 ft.
Average number of all species per site (shallower than max depth)	3.41
Average number of all species per site (veg. sites only)	3.43
Average number of native species per site (shallower than max depth)	3.38
Average number of native species per site (veg. sites only)	3.43
Species Richness	27

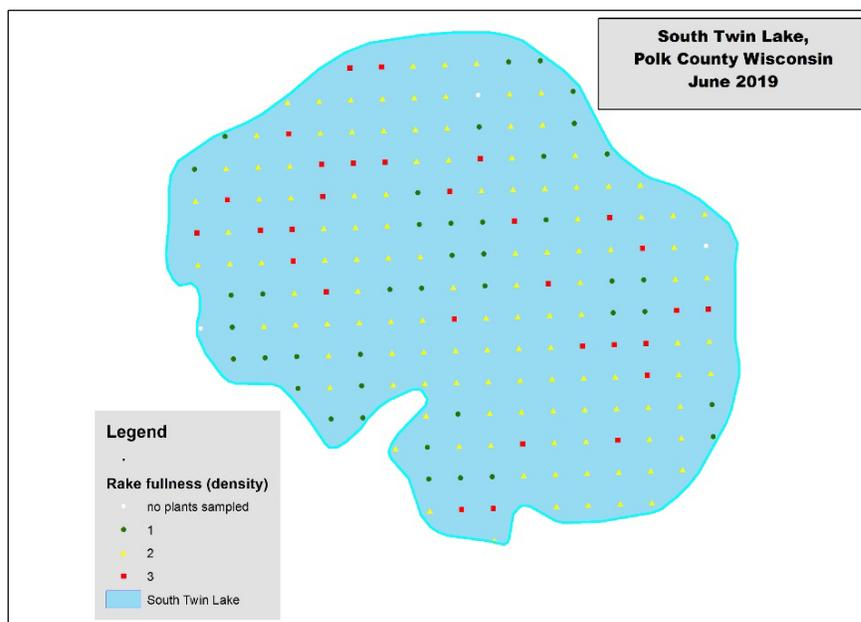


Figure 8. South Twin Lake Rake Fullness (2019)

Table 21. South Twin Lake Species List (2019)

Species	FOO* Veg	FOO* Littoral	Relative Freq.	# Sampled	Rake Fullness	# Viewed
<i>Potamogeton robbinsii</i> , Fern pondweed	83.9	83.5	24.5	162	1.26	1
<i>Elodea canadensis</i> , Common waterweed	76.2	75.8	22.2	147	1.06	
<i>Ceratophyllum demersum</i> , Coontail	48.2	47.9	14.0	93	1.26	
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	24.4	24.2	7.1	47	1.00	4
<i>Potamogeton illinoensis</i> , Illinois pondweed	21.8	21.6	6.3	42	1.00	8
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	14.5	14.4	4.2	28	1.00	
<i>Lemna trisulca</i> , Forked duckweed	11.9	11.9	3.5	23	1.00	
<i>Myriophyllum sibiricum</i> , Northern water milfoil	11.4	11.3	3.3	22	1.00	3
<i>Heteranthera dubia</i> , Water star-grass	7.3	7.2	2.1	14	1.00	
<i>Nuphar variegata</i> , Spatterdock	4.7	4.6	1.4	9	1.11	7
<i>Potamogeton gramineus</i> , Variable pondweed	4.7	4.6	1.4	9	1.00	2
<i>Potamogeton richardsonii</i> , Clasp-leaf pondweed	4.7	4.6	1.4	9	1.00	
<i>Brasenia schreberi</i> , Watershield	3.6	3.6	1.1	7	1.00	6
<i>Nymphaea odorata</i> , White water lily	3.1	3.1	0.9	6	1.00	10
<i>Potamogeton crispus</i> , Curly-leaf pondweed	3.1	3.1	0.9	6	1.00	
<i>Potamogeton pusillus</i> , Small pondweed	3.1	3.1	0.9	6	1.00	
<i>Bidens beckii</i> , Water marigold	2.6	2.6	0.8	5	1.00	
<i>Potamogeton praelongus</i> , White-stem pondweed	2.6	2.6	0.8	5	1.20	
<i>Chara sp.</i> , Muskgrasses	2.1	2.1	0.6	4	1.00	
<i>Potamogeton natans</i> , Floating-leaf pondweed	2.1	2.1	0.6	4	1.00	7
<i>Sagittaria sp.</i> , Arrowhead rosette	2.1	2.1	0.6	4	1.00	1
<i>Ranunculus aquatilis</i> , White water crowfoot	1.6	1.5	0.5	3	1.00	1
<i>Najas flexilis</i> , Slender naiad	1.0	1.0	0.3	2	1.00	
<i>Nitella sp.</i> , Nitella	1.0	1.0	0.3	2	1.00	
<i>Pontederia cordata</i> , Pickerelweed	0.5	0.5	0.2	1	1.00	2
<i>Utricularia resupinata</i> , Small purple bladderwort	0.5	0.5	0.2	1	1.00	
<i>Vallisneria americana</i> , Wild celery	0.5	0.5	0.2	1	1.00	
Aquatic moss	1.6	1.5		3	1.00	
Filamentous algae	1.6	1.5		3	1.00	
<i>Utricularia vulgaris</i> , common bladderwort	viewed	only				1

Aquatic plant growth is widespread in South Twin Lake with no particular regions of the lake that had more plant coverage or more diversity. The most common plant sampled in South Twin Lake was fern pondweed, with a relative frequency of 24.5. This demonstrates that fern pondweed dominated the lake: 1 in 4 plants sampled was fern pondweed. This desirable plant has a high conservatism value of 8, which indicates a healthy plant community.

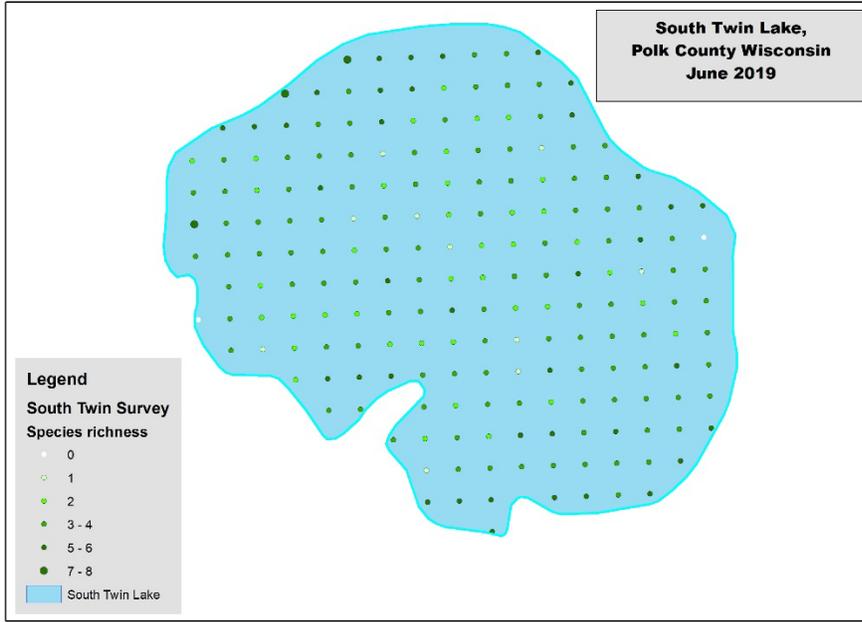


Figure 9. South Twin Lake Species Richness (2019)

Sensitive Species and Floristic Quality Index

No endangered or threatened plant species were sampled or viewed in South Twin Lake, but one species was of particular concern. That species was small purple bladderwort (*Utricularia resupinate*). This species has a conservatism value of 9 and was the only plant sampled with a high conservatism value of 9 or 10.

Table 22. South Twin Lake Floristic Quality Index and Eco-region Comparison (2019)

Parameter	South Twin Lake 2019	Eco-region Median
Number of species (used in FQI)	25	14
Mean Conservatism	6.4	5.6
FQI	32.0	20.9

Invasive Species

Curly-leaf pondweed (*Potamogeton crispus*) was the only invasive plant sampled in South Twin Lake. Eurasian water milfoil (EWM)(*Myriophyllum spicatum*) was observed in an AIS meander survey in 2019, but was not sampled on the rake or viewed within six feet of the sample point in the 2019 point intercept survey.

Comparison to 2006 survey

The Polk County Land and Water Resources Department conducted a point intercept survey of aquatic plants on South Twin Lake in July and August 2006 (Williamson, 2006). Numerous changes were evident when comparing the 2006 and 2019 survey results. However, the grid of sampling points provided in 2006 differed from the sample grid in 2019. Sample grids, which are provided by WDNR, are generally the same between sample periods. The difference in the number of points (242 vs. 195) could contribute to the differences in survey results.

Table 23. South Twin Lake Plant Survey Comparison (2006 and 2019)

Survey Parameter	2006	2019
Number of points with plants sampled	233	193
% of the defined littoral zone with plants sampled	96.3	99.5
Maximum depth with plants sampled	11.4	14.0
Species richness	36	27
Simpson’s diversity index	0.92	0.86
FQI	36.9	32.0

The plant diversity was the most significant change, with the species richness decreasing by nine species and the Simpson’s diversity index falling by a substantial value. The plant diversity declines contributed to the FQI decrease.

There was a statistically significant increase in the frequency of two plant species. One increase was in the invasive species curly-leaf pondweed (CLP). This increase is likely due to the timing of the two surveys. The 2006 survey occurred in late July and early August when CLP was dormant. The survey in 2019 occurred in late June, when CLP was still present.

Table 24. South Twin Lake Species with Statistically Significant Increases (2006 to 2019)

Species with Statistically Significant Increase	P-value	Significance
<i>Potamogeton richardsonii</i> , Clasp-leaf pondweed	0.004	**
<i>Potamogeton crispus</i> , Curly-leaf pondweed	0.007	**

Table 25. South Twin Lake Species with Statistically Significant Decreases (2006 to 2019)

Species with Statistically Significant Decrease	P-value	Significance
<i>Ceratophyllum demersum</i> , Coontail	1.2X10 ⁻¹³	***
<i>Potamogeton amplifolius</i> , Large-leaf pondweed	0.03	*
<i>Potamogeton zosteriformis</i> , Flat-stem pondweed	1.8X10 ⁻¹²	***
<i>Lemna trisulca</i> , Forked duckweed	0.04	*
<i>Myriophyllum sibiricum</i> , Northern water milfoil	5.0X10 ⁻¹⁰	***
<i>Heteranthera dubia</i> , Water star-grass	0.03	*
<i>Potamogeton pusillus</i> , Small pondweed	7.1X10 ⁻⁷	***
<i>Potamogeton praelongus</i> , White-stem pondweed	0.03	*
<i>Ranunculus aquatilis</i> , White water crowfoot	0.01	*
<i>Vallisneria americana</i> , Wild celery	4.4X10 ⁻¹⁰	***
<i>Potamogeton foliosus</i> , leafy pondweed	0.0003	***

There was a significant decrease in 11 species. This would be concerning. However, no management practices were conducted on South Twin Lake since 2006. Human activity around the lake has also changed very little. Furthermore, the survey in 2006 occurred in late July/early August, and in 2019 it was in late June. There was a late ice-out date in 2019, so it is possible several plants were behind in growth, lowering the probability they would get sampled. Lastly, the 2019 survey had significantly fewer sample points than in 2006. This was adjusted in the chi-square analysis, which would potentially account for those differences, but additional sample points could still contribute to reflecting significant changes.

Aquatic Invasive Species

Aquatic Invasive Species (AIS) are aquatic nonindigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.¹⁰ Invasive species, identified in project lakes either through aquatic plant survey, aquatic invasive species meander surveys, or observations by qualified scientists, are summarized in the table below. Only Eurasian water milfoil (EWM) and curly leaf pondweed (CLP) are submergent aquatic plants which grow submerged in the water. Narrow-leaved cattail and purple loosestrife are emergent plants that grow along shorelines and in wetlands. More information about invasive species is found in the APM Companion Document and on the DNR website.¹¹

Table 26. Amery Lakes Invasive Species

	Pike Lake	North Twin Lake	South Twin Lake
Eurasian Water Milfoil	☑	☑	☑
Curly Leaf Pondweed	☑	☑	☑
Narrow-leaved Cattail	☑	☑	
Purple Loosestrife		☑	☑

Yellow iris was identified in a wetland along South Twin Lake and removed around 2018. No current locations of yellow iris plants are known on Amery lakes.

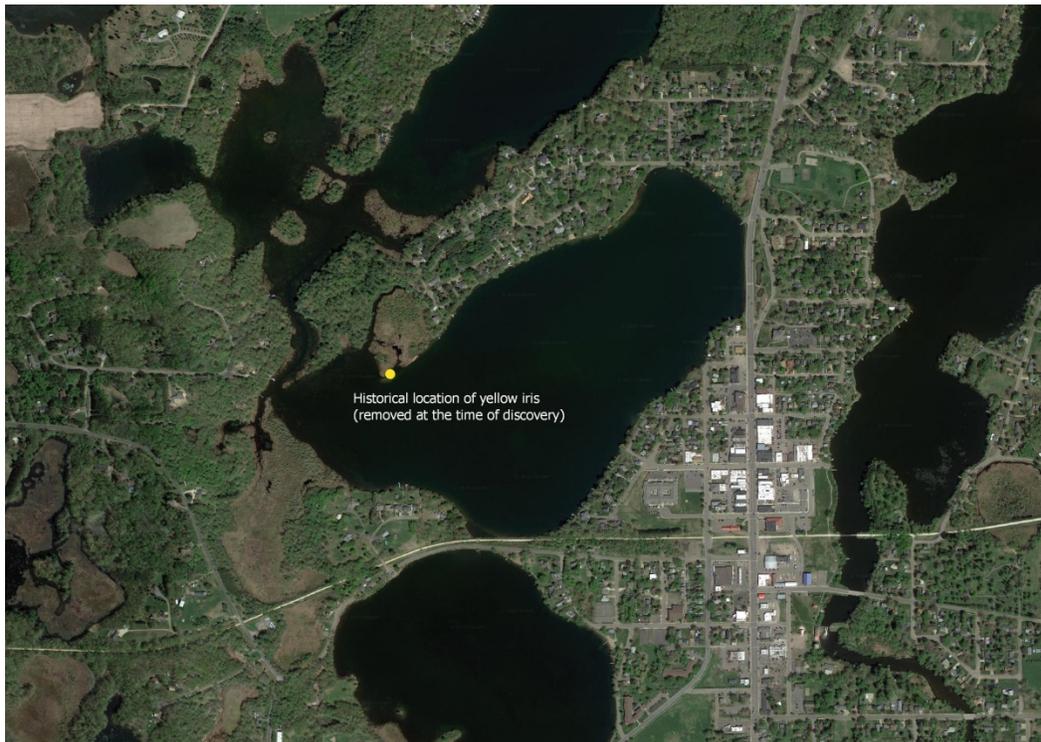


Figure 10. Former South Twin Lake Yellow Iris Location

¹⁰ Wisconsin Statute Section 23.22 (1) (c)

¹¹ <https://dnr.wisconsin.gov/topic/Invasives>

Purple Loosestrife

Purple loosestrife was observed on North Twin Lake in the 2012 survey as shown in Figure 11. At that time, a few plants were seen growing along the bog area along the western shore. These plants were removed. A similar number of purple loosestrife plants were found in this same area around 2004 and were removed.¹² Purple loosestrife has also been observed on South Twin Lake. Purple loosestrife can spread rapidly, and therefore should be monitored carefully in this important bog habitat.

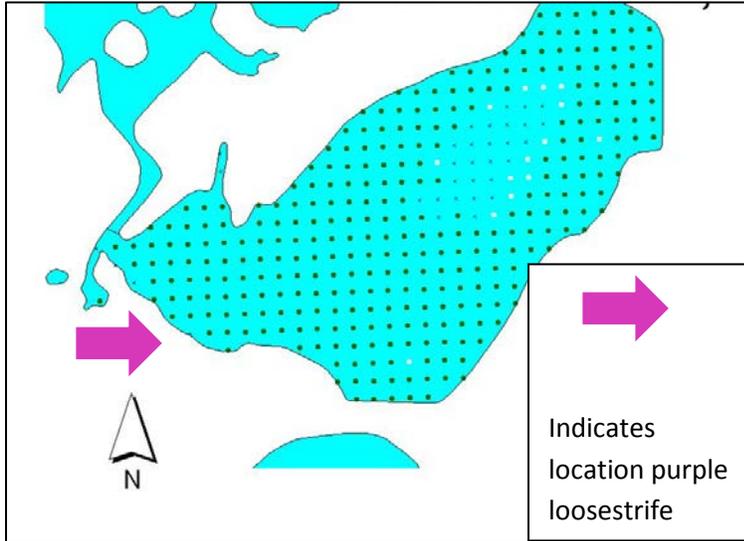


Figure 11. North Twin Lake Purple Loosestrife Observed

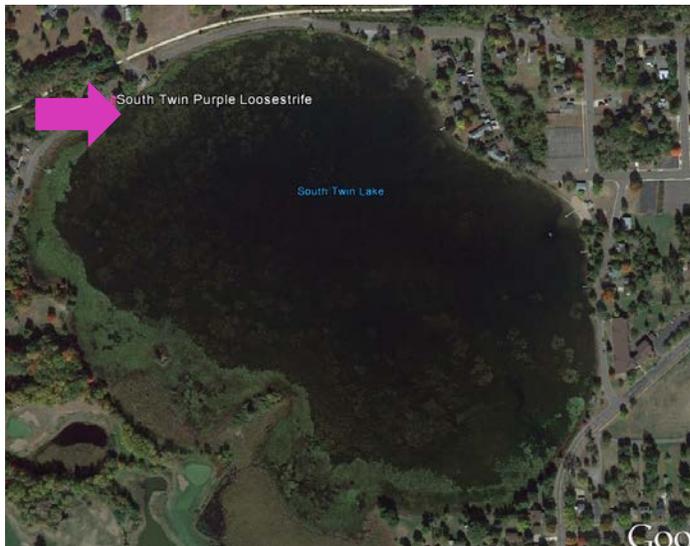


Figure 12. South Twin Lake Purple Loosestrife Observed

¹² Personal communication. Steve Schieffer, February 2014.

Narrow-leaved Cattail

Narrow-leaved cattail is an introduced species and according to the Wisconsin DNR, is potentially invasive.¹³ Some literature suggests that narrow-leaved cattail does not act invasively when competing with broad leaf cattail. It can tend to be more common than broad-leaf cattail because narrow-leaved cattail is tolerant of deeper water. One study suggests that in more shallow water, which broad-leaf cattail prefers, the narrow-leaf cattail remained the same or declined slightly.¹⁴ Narrow-leaved cattail can also hybridize with broad leaf cattail, and this hybrid tends to spread more quickly than narrow-leaved cattail.

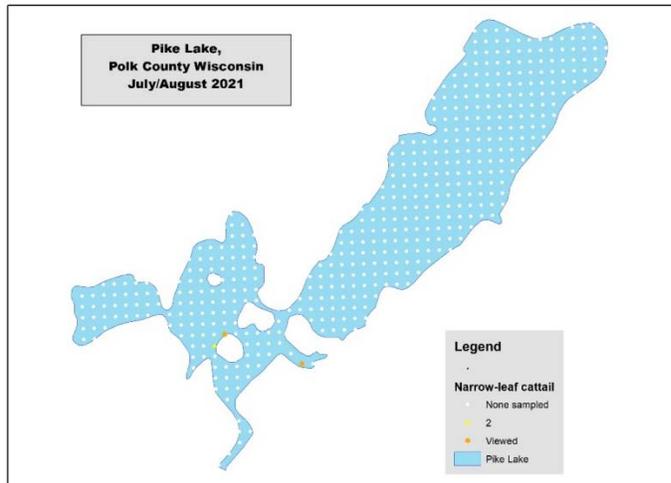


Figure 13. Pike Lake Narrow-leaved Cattail (2021)

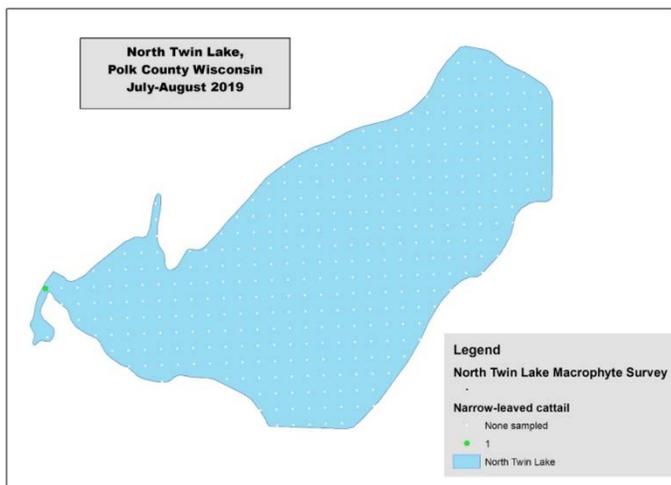


Figure 14. North Twin Lake Narrow-leaved Cattail (2019)

¹³ Dr. Susan Knight, Wisconsin DNR personal communication.

¹⁴ James B. Gracea, Robert G. Wetzelb. *Long-term Dynamics of Typha Populations. Aquatic Botany*, Volume 61, Issue 2, 1 June 1998, Pages 137–146.

Curly Leaf Pondweed

Curly leaf pondweed (CLP) has not grown to nuisance levels in project lakes. In Pike Lake, it tends to grow in clumps rather than in large, dense beds. Curly leaf pondweed was sampled in Pike Lake in both the June 2012 and June 2021 point intercept surveys. Most was found on the northeast end of the lake (Ecological Integrity Service and Harmony Environmental, 2014) (Schieffer, Amery Lakes Aquatic Plant Survey Results, 2021).

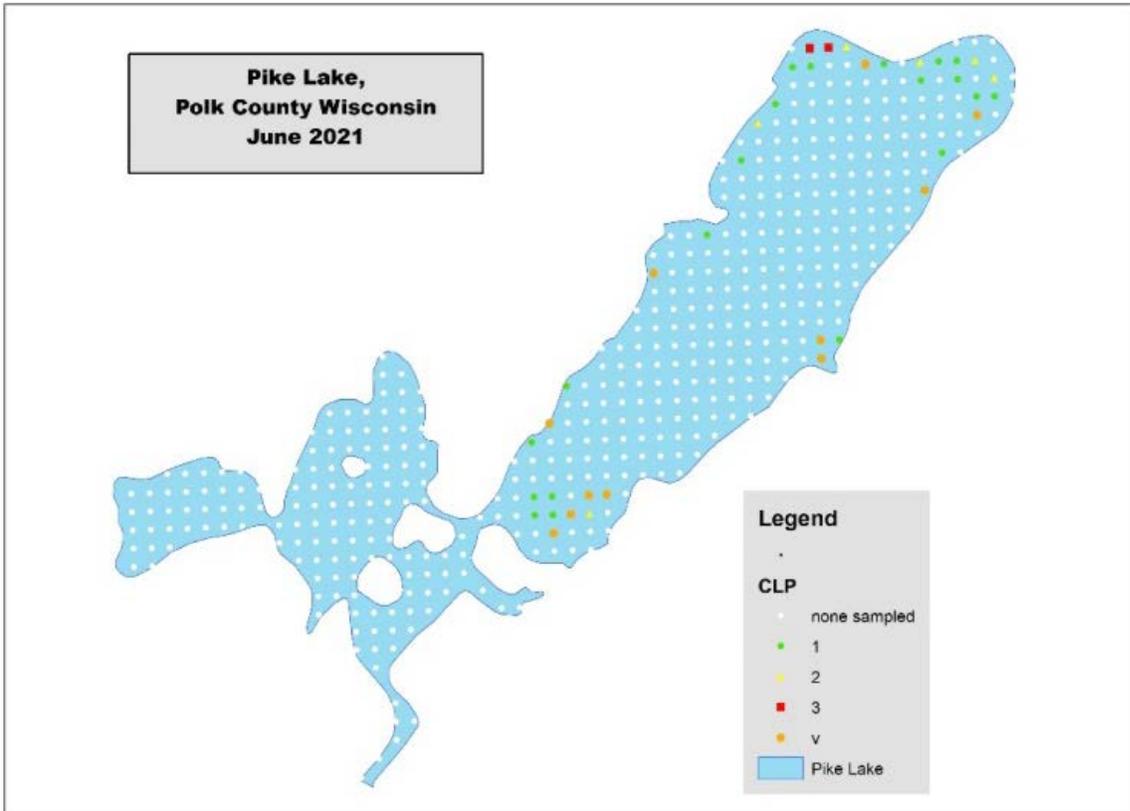


Figure 15. Pike Lake CLP Rake Fullness (2021)

CLP was sampled in 12 locations in North Twin Lake in June 2012. At that time there were small CLP beds in the northeast and southeast bays. CLP was also present in the west basin near the narrows where CLP growth was scattered with a wide range of density (Ecological Integrity Service and Harmony Environmental, 2014). Curly leaf pondweed was not found in the 2019 aquatic plant survey, but it is not expected in July and August when the survey was conducted. Curly-leaf pondweed was sampled on South Twin Lake in June 2019.

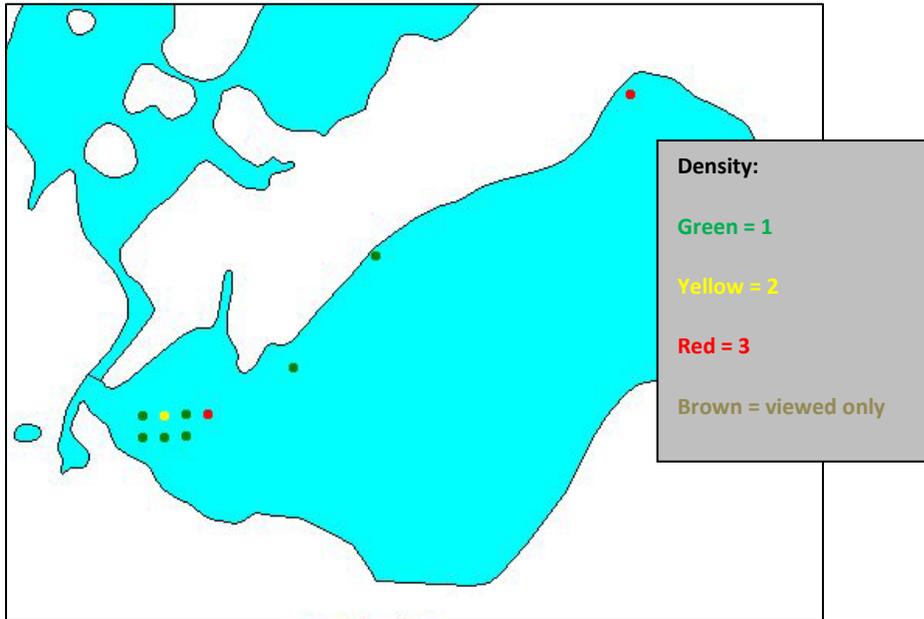


Figure 16. North Twin Lake Curly Leaf Pondweed Distribution (June 2012)

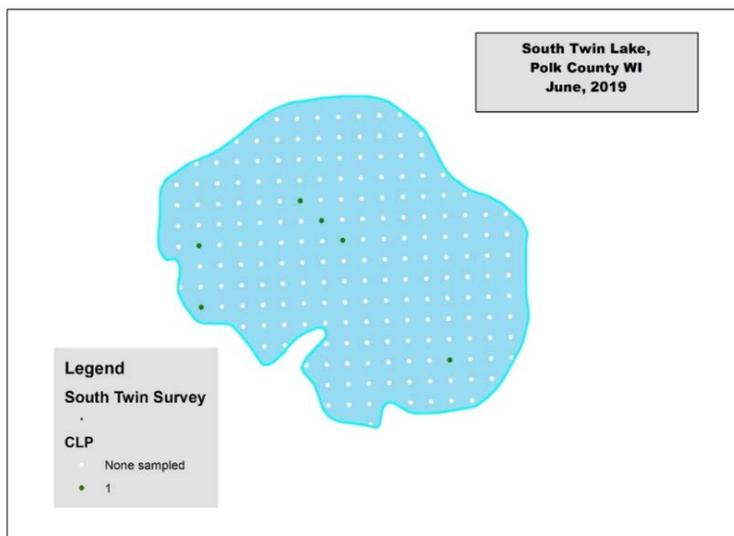


Figure 17. South Twin Lake CLP Distribution (June 2019)

Eurasian Water Milfoil

Eurasian water milfoil (EWM - *Myriophyllum spicatum*) was discovered in Pike Lake in 2010. The Amery Lakes District has managed EWM growth using herbicide, hand-pulling, and DASH (Diver Assisted Suction Harvesting) since that time. EWM is now present in all three Amery Lakes.

EWM was first discovered in North Twin Lake 2018. EWM growth expanded since that time, and herbicide treatments occurred in 2019 and 2022.

Eurasian water milfoil (EWM) was observed in South Twin Lake in a 2019 AIS meander survey, but was not sampled on the rake or viewed within six feet of any sample points in the 2019 point intercept survey. Growth has expanded, and a 5.84 acre bed was identified in 2022 for potential treatment in 2023.

Amery Lakes District Aquatic Plant Management

This section reviews Amery Lakes District aquatic plant management activities. Potential management methods are included in a reference companion document to this plan.

Eurasian Water Milfoil Management

Pike Lake

Eurasian water milfoil control efforts began the year it was first found in Pike Lake in 2010. This pioneer stand was located along the northwest shore, east of the boat landing. The stand was delineated and treated with the herbicide 2,4-D in 2010. The herbicide treatment was successful with a 100% frequency prior to treatment and a 5% frequency following treatment.

When EWM was found near the original treatment area and along the northwest shoreline during subsequent monitoring in 2010-2013, it was hand-pulled by divers. Figure 18 shows the locations of EWM during the point intercept survey of 2012 and the original 2010 treatment area.

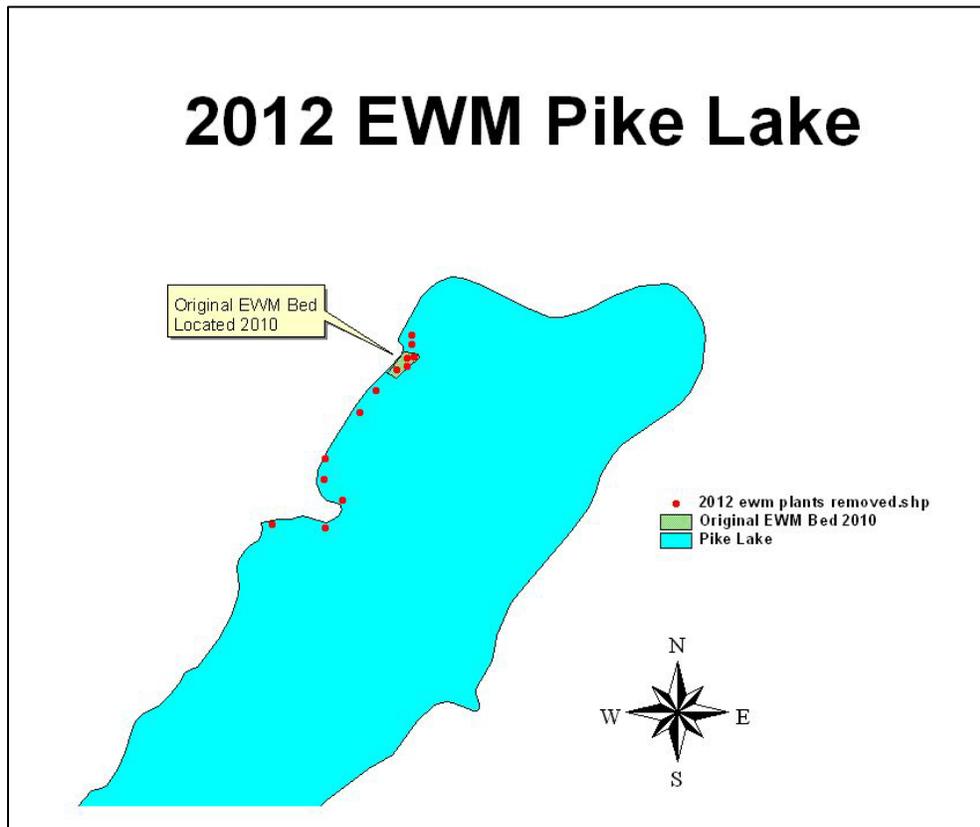


Figure 18. Pike Lake Eurasian Water Milfoil Distribution (2012)



Figure 19. Scuba Diving to Monitor for Eurasian Water Milfoil

EWM control efforts are summarized in Table 27. EWM became dense enough to warrant herbicide treatment again in Pike Lake 2013. Figure 20 shows the areas delineated and treated. In 2013 the pretreatment frequency of EWM in treatment beds was 84%. Following treatment, the EWM frequency was 8%. Subsequent 2,4-D herbicide treatments of less than one acre each year occurred on Pike Lake in 2015 and 2016 with good short-term results. A trial of Diver Assisted Suction Harvesting (DASH) in 2017 and 2018 resulted in reduced density of EWM, but it did not reduce the presence of the plant.

The herbicide ProcellaCOR (Florpyrauxifen-benzyl) was used to treat a total of 0.65 acres of EWM in three beds on Pike Lake in 2020. Reductions in EWM were measured in biovolume (ft³) rather than frequency of occurrence for this treatment. Statistically significant reductions were noted in all beds, and the two very small beds decreased from a total of 8494 ft³ to 0 ft³ EWM following treatment.

On June 15, 2022, the herbicide ProcellaCOR was again used to mitigate growth of 3.08 acres of EWM in three beds in Pike Lake. Detailed treatment results are included in Appendix B (Schieffer, 2022). The frequency of the EWM went from 90% to 0%, and there were no new beds and only a few individual plants observed in September 2022 on Pike Lake.

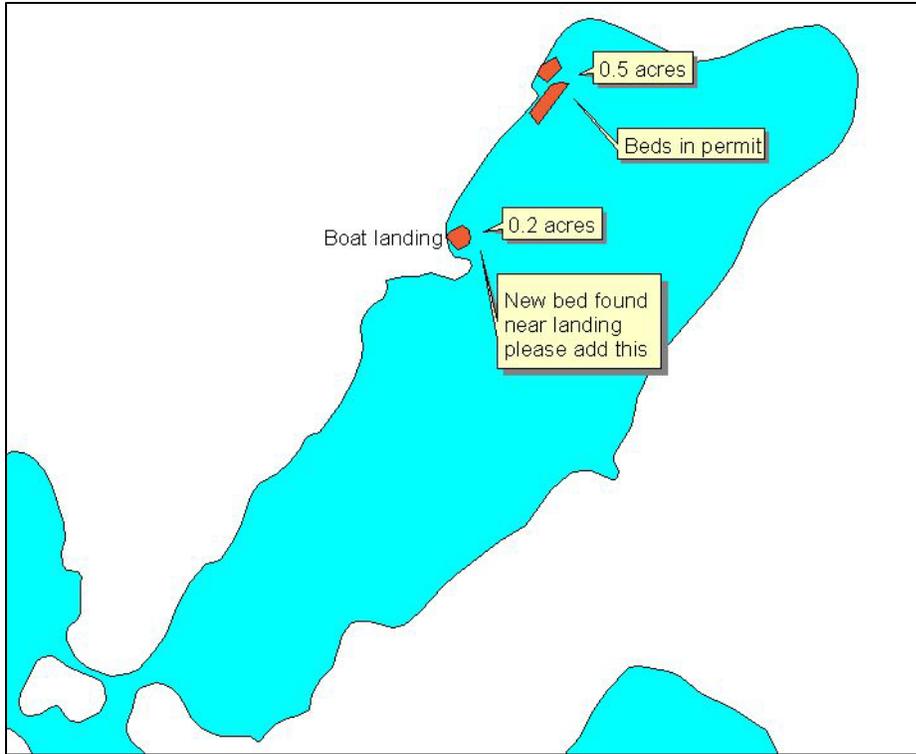


Figure 20. Pike Lake Eurasian Water Milfoil Treatment Beds (2013)

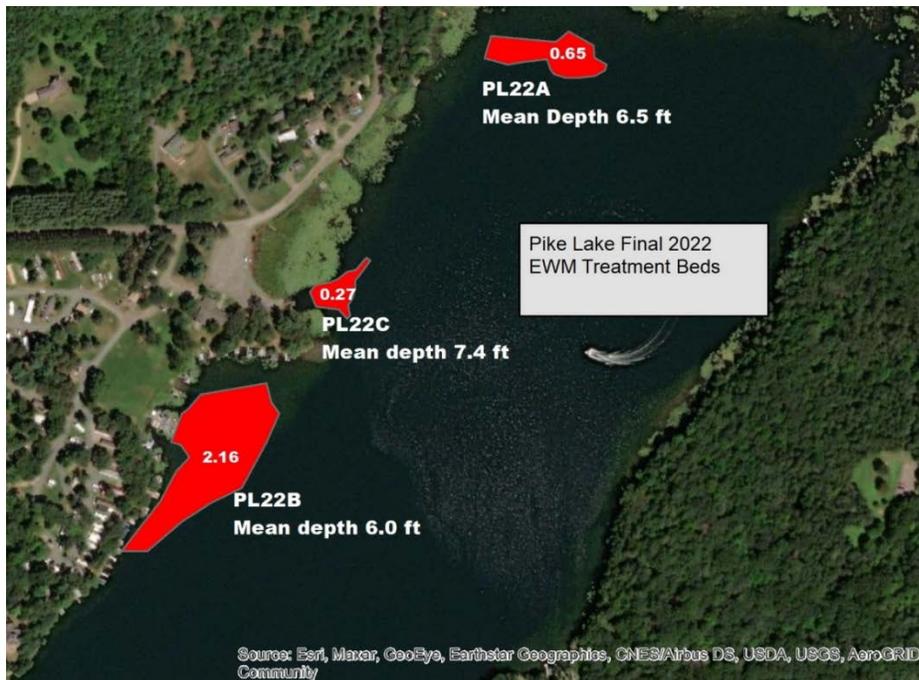


Figure 21. Pike Lake Eurasian Water Milfoil Treatment Beds (2022)

North Twin Lake

Eurasian water milfoil was discovered in North Twin Lake in 2018 and treated with herbicide in June 2019. The herbicide ProcellaCOR (Florpyrauxifen-benzyl) targeted one EWM bed totaling 0.56 acres (shown in red in Figure 21). The frequency of occurrence of EWM in the bed prior to treatment was 100%, and it was 0% after treatment. There was no significant reduction in native species following herbicide treatment. A meander and point intercept survey of the entire lake (in August 2019 following the herbicide treatment) found individual plants or very small clumps of EWM in six locations, all in fairly close proximity to the treatment bed (Schieffer, 2019).



Figure 22. North Twin Lake EWM June 2019 Treatment Bed and August 2019 Locations

On June 15, 2022, the herbicide ProcellaCOR was applied to five beds of Eurasian watermilfoil (EWM) totaling 3.26 acres on North Twin Lake. Detailed treatment results are included in Appendix C (Schieffer, 2022). The herbicide treatment resulted in no EWM sampled within the treatment beds in August 2022. There were no statistically significant reductions in native plants between August 2021 and August 2022 following the June 2022 herbicide treatment.

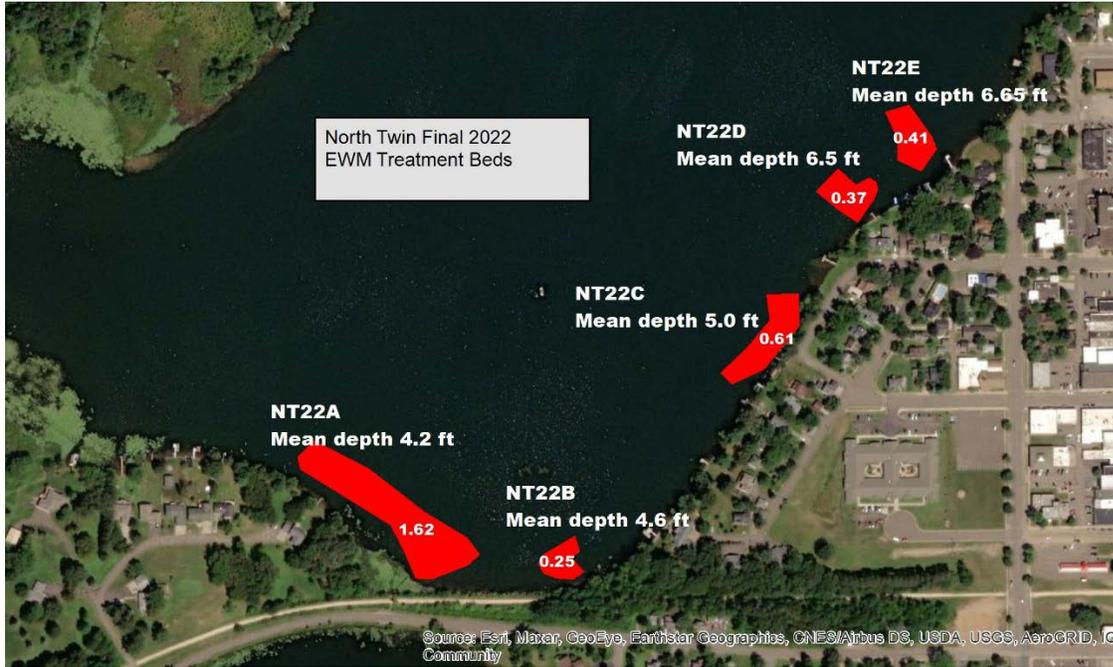


Figure 23. North Twin EWM Treatment Beds (2022)

There were no beds of EWM remaining in September 2022 on North Twin Lake. Therefore, there should be no need for herbicide treatment in 2023. Monitoring will continue as there were a few single plants viewed in new areas of the lake. These could expand into beds in the future (Schieffer, 2022).

South Twin Lake

When the lake was surveyed for EWM on September 2, 2022, there were 5.84 acres of EWM found growing in a concentrated bed (Figure 24). Some points within the bed were not sampled to avoid EWM disturbance and spread. The identified bed would allow for good coverage should herbicide be used to mitigate the EWM. If herbicide is applied, the map will be updated before herbicide application. Some EWM clumps/individual plants observed outside the delineated bed would not warrant herbicide application because of low density EWM growth (Schieffer, 2022).



Figure 24. South Twin Lake EWM Survey (2022)

Table 27. Amery Lakes EWM Control Efforts

	2010	2011 - 2012	2013	2015	2016	2017	2018	2019	2020	2022
Pike Lake	0.23 acres 2,4-D ID	HP	0.7 acres 2,4-D	0.44 acres 2,4-D	0.15 acres 2,4-D	DASH 0.25 acres	DASH 0.15 acres		0.5 acres Procella-COR	3.08 acres Procella-COR
North Twin Lake							ID	0.56 acres Procella-COR		3.26 acres Procella-COR
South Twin Lake								ID		5.84 acre bed delineated

*Control efforts highlighted in bold had measured statistically significant reductions

ID: First confirmed EWM identification in the lake

HP: Hand-pull

AIS Rapid Response Grants

The Amery Lakes District received Wisconsin DNR Aquatic Invasive Species Rapid Response Grants for Pike Lake in 2011 (AIRR09111) and for North Twin Lake in 2020 (AIRR25120). The \$10,500 grant for North Twin Lake ended 12/31/2022.

Lake Monitoring

The objective of lake monitoring is to look for new invasive species, track the spread of Eurasian water milfoil and curly leaf pondweed, and perform lake chemistry and secchi disk measurements.

Pike and North Twin Lakes were surveyed for Eurasian water milfoil each year since 2010. South Twin was checked less frequently until it was found there in 2019. The Lakes District reinstated formal water quality monitoring in 2022.

Rapid Response for New Aquatic Invasive Species

The activity is intended to control any new invasive species that are found in the lake. The rapid response protocol is found in Appendix D.

Preventing Aquatic Invasive Species

Aquatic Invasive Species Education

Amery Lakes Aquatic Invasive Species (AIS) resident education occurs primarily through the Lakes District annual printed newsletter and the Clean Boats Clean Waters Program.

Clean Boats Clean Waters Program

Clean Boats Clean Waters (CBCW) educators provide boaters with information on the threat posed by Eurasian water milfoil and other invasive species. They offer tips on how to keep boats, trailers and equipment free of aquatic hitchhikers. They also collect information on boater behavior, concerns, and knowledge of existing local and state laws related to anti-AIS measures.

CBCW staffing is provided on the North Twin Lake Landing. In 2022, the landing was staffed for 200 hours reaching 438 boaters. The Amery Lakes District received a WDNR grant to support the CBCW Program in 2014, 2015, 2017, and 2019 to 2022. The Lakes District manages hiring and payroll.

Landing Surveillance Cameras

Some lake organizations use video cameras at public landings to record landing activity. Videos are reviewed, and if watercraft are launched with vegetation attached, enforcement action may be initiated. Violations of the ordinance and state rule which prohibits transporting and launching boats and trailers with vegetation attached can be enforced by local law enforcement officers. The camera also serves as a reminder for boaters to check their equipment. Specialized AIS surveillance cameras are in place at Bone Lake and Church Pine Lake in Polk County. Other landings are using less expensive security cameras which provide a video feed and recording. These are in place on Cedar Lake and Town of Garfield landings in Polk County. DNR grants can be used to support camera and sign installation. Maintenance and video/photo review are not grant-eligible expenses.

Decontamination Stations

Boat washing stations use hot water and/or high pressure to remove potential aquatic invasive species from boats, trailers, and equipment. The hot water kills the AIS, and the high pressure removes them. At 140°F, a hot water rinse for 10 seconds in each spot will kill all adult mussels and most other AIS. At 120°F, a contact time of two minutes is needed to destroy zebra mussels (MNDNR 2017). Use of boat washing stations is voluntary in Wisconsin unless there are local ordinances to require decontamination. Polk County recently passed an ordinance which requires decontamination if offered at a public or private water access.

Several lake organizations in Burnett and Washburn County, Wisconsin have installed decontamination stations which use a mild bleach solution to decontaminate boats. The solution of 2.5 tablespoons of household bleach/gallon of water is sprayed on boats and trailers. A contact time of ten minutes is required when using this solution. The bleach solution must be replaced regularly – daily replacement is preferred. Signage is installed to provide instructions for and to encourage use (NW WI ZM Team 2018). Tools for plant and debris removal generally accompany signs.

Self-service commercial systems for boat decontamination are also available. CD3 systems include a large sign board structure, vacuum, blower, and hand tools. CD3 Systems are equipped with technology that logs tool use and provides automatic reports and maintenance alerts. These systems are installed at Bone Lake and Half Moon Lake in Polk County.

Table 28. Aquatic Invasive Species Prevention Options (2022 costs)

Method	Installation Cost	Lifetime	Annual Cost	Labor	Advantages	Disadvantages	WDNR Grants
Clean Boats, Clean Waters	\$0	NA	\$200 (t-shirts, hats, data sheets) + labor	\$10 - \$17/hour	Person-to person education	Difficult to find staff Payroll management required (cost and responsible party) Insurance needed (liability, workers comp.) May need 2 staff with students	Funding available up to \$4,000/landing 75% funding 200-hour minimum
ILIDS Camera*	\$11,000	6 years	\$2,500 (not grant eligible)	Volunteers to view video (optional)	Doesn't require staff Audio and video reminders Threat of enforcement Provide visit counts	Moderate/high cost	Funding available up to \$24,000 (depreciated), 75% funding
Security Camera	\$2,000				Low cost May be installed for other purposes	Security Camera	Funding eligibility uncertain
Decontamination Station: Sign, mild bleach sprayer and tools	\$200 - \$500	NA	\$50	Volunteer or staff to change bleach solution)	Low cost Doesn't require staff – although effectiveness would likely increase with staffing	Need 10 minute contact time May not be used Need to change bleach solution every day or so Siting station may be complicated	75% funding available

Method	Installation Cost	Lifetime	Annual Cost	Labor	Advantages	Disadvantages	WDNR Grants
Decontamination Station: Hot water, high pressure wash*	\$15,000 - \$20,000	10 years	\$500 (fuel, maintenance, winter storage) + labor	\$ varies	10 second hot water, 2 minute warm water contact kills ZM	High cost Difficult to find staff Training and procedures require oversight Need to drain away from lake or contain water	Funding available up to \$24,000 (depreciated), 75% funding
Decontamination Station: CD3 system* (signs, hand tools, blower, vacuum)	\$25,000 - \$30,000	8 years	\$1,200 - \$1,500 (not grant eligible)	\$0	Doesn't require staff	High cost May not dry enough to remove zebra mussels	Funding available up to \$24,000 (depreciated), 75% funding

*DEPRECIATION REQUIREMENTS APPLY - While there is no longer a \$4k limit for ILIDS, all equipment that has a useful life of greater than one year and cost of \$5,000 or more per unit must be depreciated and prorated for the duration of the grant period (up to 4 years for prevention grants).

Example: Grantee builds a decontamination unit for AIS prevention at a cost of \$8,800. The life of the decontamination unit is 10 years.

Therefore, the amount that can be claimed each year in reimbursement requests for the decontamination unit is \$880 (\$8,800 divided by 10 years = \$880 each year). If the life of the grant is 3 years, under this scenario, the grantee would be eligible to claim a total of \$2,640 (\$880/year x 3 years = \$2,640) towards the purchase of the decontamination unit. Depreciation applies in the following cases:

- If the grantee receives a donated piece of equipment that has a value of \$5,000 or more.
- If one unit of equipment is purchased at a cost of \$5,000 or more.
- If the total cost of components of a customized piece of equipment is \$5,000 or more.

Historical Aquatic Plant Management Activities

Historical Amery Lakes District Aquatic Plant Management included harvesting and chemical control of aquatic plants from 1982 to 2001. The City of Amery applied copper sulfate and controlled plants with herbicide at the city beach on South Twin Lake in the 1980s. The city also treated North Twin Lake and South Twin Lake for algae in the 1970s and 1980s. Private riparian owners contracted with commercial applicators to apply herbicides for aquatic plant control in some locations from the mid-1980s through 2007. More detail on these activities is provided in the 2014 Amery Lakes Aquatic Plant Management Plan.

Plan Goals, Objectives, and Strategies

Plan goals, objectives, and strategies or actions are detailed below. The implementation plan or action plan details how action steps will be carried out over the next two year period. This action plan will be updated annually in June.

Goals are broad statements of desired results. Goals are listed in order of priority established by the advisory committee.

Objectives are the measurable accomplishments toward achieving a goal. Methods to evaluate progress toward plan objectives are listed below the objectives and are included in the implementation plan as “Evaluation Actions.”

Actions are the steps taken to accomplish objectives and ultimately goals.

GOALS

Goal I. Prevent the introduction of aquatic invasive species.

Goal II. Control the spread of aquatic invasive species.

Goal III. Preserve the diverse native plant community.

Goal IV. Protect Amery lakes through education and involvement of lake residents and visitors.

GOAL I. Prevent the introduction and spread of aquatic invasive plant species.

Definition: Aquatic Invasive Species (AIS) are aquatic nonindigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.¹⁵ AIS currently in Amery Lakes include Eurasian water milfoil (all lakes), curly leaf pondweed (CLP - all lakes), purple loosestrife (PL - North and South Twin). Yellow iris was found in North Twin Lake in the past and removed. Additional AIS threaten Amery lakes.

Objectives

- A. Lake residents and visitors follow AIS prevention steps.
- B. No new AIS are established in Amery lakes.
- C. New AIS introductions are discovered early.

NOTE: Current monitoring strategy relies heavily on donated professional services and student/class support.

¹⁵ Wisconsin Statute Section 23.22 (1) (c)

EVALUATION ACTIONS

Establish and follow protocols for regular AIS monitoring of Amery Lakes. (OBJ B and C)

Involve professionals, students, and citizen volunteers in AIS monitoring.

Table 29. Amery Lakes AIS Monitoring Matrix

	Professional Surveys¹⁶	Student Survey¹⁷	Volunteer AIS¹⁸
AIS including Eurasian Water Milfoil and Purple Loosestrife All Lakes	Annually in August. Meander Survey: monitor entire littoral zone by cruising in a boat. Map any beds/plants delineated in GIS.		Potential for Purple Loosestrife survey
EWM Pre and Post Treatment	August (year prior to, year of, and 3 years after treatment). Point Intercept Survey: in identified treatment beds according to DNR protocol.		
Curly Leaf Pondweed Pike Lake and North Twin	Bed mapping and pre and post treatment surveys only if treatment thresholds identified in student surveys.	Annually in late May. Complete point intercept survey in known CLP areas. Meander survey in remaining areas. Add to CLP point intercept monitoring areas if identified.	
Yellow Iris All Lakes	Monitor riparian zones in all lakes in early June AIS survey (only if not present in late-May student survey)	Monitor riparian zones in all lakes in late May	Potential for Yellow Iris survey
Full Lake Survey	Point Intercept Survey completed in preparation for management plan update. Every 5-7 years.		
Zebra Mussel Monitoring	Run calcium and hardness samples for each lake to assess zebra mussel suitability.		Bricks, cement blocks, and/or plate samplers

¹⁶ Professional surveys are currently provided pro bono by Steve Schieffer, a consultant and Amery Lakes District board member.

¹⁷ Student surveys will be provided by students in Amery High School Freshwater Ecology led by Ryan Humpal, teacher.

¹⁸ If volunteers complete surveys, training will be provided by the Lakes District.

AIS PREVENTION ACTIONS

1. Continue the Clean Boats, Clean Waters Program at the North Twin Lake boat landing. Consider moving CBCW to the Shoreview Landing once a camera is installed at the North Twin Lake landing. (OBJ A AND B)
2. Install a camera and signage at the North Twin Lake boat landing. (OBJ A AND B)

Goal II. Control the spread of aquatic invasive species.

Objectives

- A. Limit dense EWM coverage and prevent its spread.
- B. Minimize negative impacts to recreation.
- C. Minimize negative impacts to native plants and ecosystems.

EVALUATION ACTION. Conduct summer monitoring using standard protocols annually. Map individual EWM plants, clumps of EWM, and dense beds of EWM growth. A clump or bed of EWM has a clear outline where EWM is visible. A dense bed of EWM has a EWM frequency of occurrence of at least 50% with a mean rake density of 1.5.

EWM CONTROL ACTION

1. Control EWM using treatment standards for lake area tolerance level to limit impacts throughout Amery Lakes. Low-tolerance and high tolerance areas are established based on likelihood of spread (lower tolerance with more likelihood) and predicted impacts to native plant populations (herbicide use avoided in important habitat areas). EWM tolerance areas are mapped in Figure 25.

Low-tolerance areas

- Low-tolerance areas include boat landings, the narrows between Pike Lake and North Twin Lake, and culvert inflows and outflows.
- Remove scattered and clumps of EWM growth using hand-removal or DASH as needed.
- Minimum herbicide treatment area and bed size = 4,000 ft².

Mid-tolerance areas

- Minimum treatment total area per lake = 3 acres
- Minimum individual bed size of dense EWM growth = 4,000 ft²

High-tolerance areas: South Twin and Bass Hole

- Minimum treatment total area per lake = 5 acres
- Minimum individual bed size of dense EWM growth = 1 acre

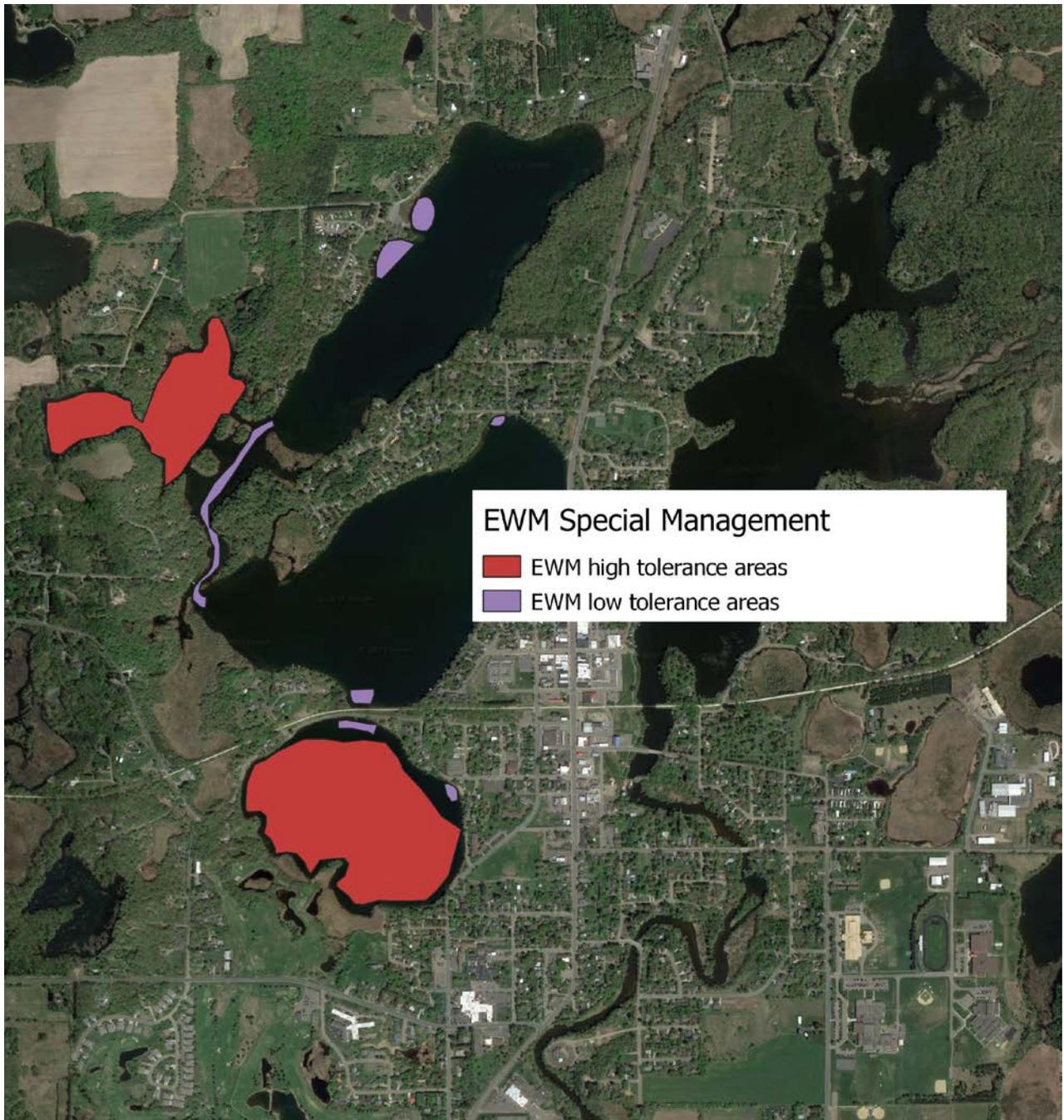


Figure 25. Low-tolerance and High-tolerance Eurasian Water Milfoil Areas

EWM Herbicide Treatment Procedures

- 1) Identify dense EWM beds with mean rake density of 1.5 and 50% FOO of EWM or higher that are at least 4,000 ft². Small beds in close proximity may be combined into one bed to provide better treatment results.
- 2) Identify areas for treatment based on standards for low, medium, and high-tolerance to EWM growth.
- 3) Apply for APM permits in May based on monitoring from the previous year and adjusted as needed from the spring pretreatment survey.
- 4) Treat beds using ProcellaCOR at accepted dosage levels. Treatment times and water temperatures are targeted to limit damage to native aquatic plants.
 - Herbicide must be applied when conditions are calm *as authorized by Amery Lakes District*. The maximum wind speed at time of application will be <10 mph as measured on-site. The forecast wind speed (including gusts) for the 24 hours following application will not be greater than 15 mph.
 - Consider other herbicides as they become available.
 - Application will use procedures and timing to limit impacts to native plant populations. However, some native plants may experience declines.
- 5) Complete pre (year prior to treatment) and post monitoring (year of treatment and three years following treatment) using standardized WDNR protocols.

Objective D. Purple loosestrife and yellow iris are minimized around Amery lakes.

EVALUATION ACTION. Conduct annual mapping of purple loosestrife and yellow iris.

Action C1. Remove purple loosestrife and yellow iris in the season they are discovered by hand or with chemical applications.

- Encourage property owners to remove these aquatic invasive species on their own (and dispose of them properly).
- DNR permits are required for herbicide use on and near the water and will be obtained prior to their use.
- Lake district volunteers may remove these AIS with permission of property owners using hand removal methods.
- Contractors may be hired to remove AIS with permission of property owners using herbicides.
- Biocontrol may be used to control PL for large areas of growth, especially if areas are difficult to access.

Objective E. Curly leaf pondweed (CLP) does not impair navigation on Pike Lake or North Twin Lake.

EVALUATION ACTION. Monitor CLP using May point intercept survey in areas previously known to have CLP present. New monitoring zones may be identified and added.

Action C1. Early season CLP herbicide control will be used only if the following conditions exist for at least 3 consecutive years.

- Minimum total CLP growth in beds/treatment area per lake = 10 acres
- Minimum bed size = 5 acres
- A low-dose, early season Endothall treatment will be used according to accepted procedures as outlined below or updated with new information.

CLP Herbicide Treatment Procedures

1) Standards for when CLP treatment may be warranted:

- identified as a severe spring navigation impairment or undergoing rapid expansion
- CLP growth on an individual lake maintains 10 acres for at least 3 years
- May/June curly leaf pondweed stem growth is at or near (within 1 foot of) the surface and is thick enough to impede navigation
- bed has a frequency of occurrence of at least 50%
- density rating averages >2 (on a 0-3 scale)
- treatment success is likely (not near substantial drop-off (greater than 10 feet mean depth change), wide rather than narrow band, etc.)

2) Apply for APM permits for CLP early season Endothall treatment for spring navigation channels and/or CLP beds in February based on monitoring from the previous year.

3) Conduct treatment according to permit conditions.

4) Pre and post monitoring procedures to be completed by a professional volunteer or consultant hired by the District Board and supervised by the AMERY LAKES DISTRICT according to standard DNR methods.

6) Adapt treatment methods according to best available information.

- Use application rates of liquid Endothall of 1.5 to 2.0 ppm for beds and 2 ppm for navigation channels.
- Treatment will occur when water temperatures are between 45 and 60 degrees F. No treatment will occur once temperatures exceed 60 degrees F.
- Herbicide must be applied when conditions are calm *as authorized by Amery Lakes District*. The maximum wind speed at time of application will be <10 mph as measured on-site. The forecast wind speed (including gusts) for the 24 hours following application will not be greater than 15 mph.



Figure 26. Previously Known Curly Leaf Pondweed Areas

Table 30. CLP Monitoring Procedures (North Twin and Pike Lakes)

Description	Who Completes	Timing
<p>CLP Point Intercept Survey at designated sample points within known CLP regions in the lakes. Record presence/absence and rake density.</p>	<p>Amery High School Freshwater Ecology Class</p>	<p>Late May</p>
<p>CLP Meander Survey recording CLP plants and beds away from known CLP regions. If a new CLP bed reaches 5 acres, and is present for at least 3 years, add to the student CLP point intercept survey.</p>	<p>Amery High School Freshwater Ecology Class</p>	<p>Late May</p>
<p>CLP Bed Delineation and Pre and Post Treatment Survey if acreage thresholds are reached with beds meeting the following criteria: FOO within CLP bed > than 50% and mean rake density is ≥ 2 with growth at or near the surface in at least 3 consecutive years.</p>	<p>Professional</p>	<p>Late May and Mid-June</p>

Objective F. The Amery Lakes District is prepared to rapidly respond to new AIS introduction.

ACTION. Follow procedures described in Amery Lakes AIS Rapid Response Protocol (Appendix D).

- Complete regular monitoring
- Notify appropriate individuals if AIS are discovered
- Develop control measures and apply for necessary permits
- Fund necessary control measures including seeking grant funding
- Review and update the AIS Rapid Response Protocol annually.

GOAL III. Preserve the diverse native plant community.

Objective A. The functions and values of diverse native plants are acknowledged when considering any aquatic plant management activity.

EVALUATION ACTION

Complete aquatic plant point intercept survey for each lake every 5 – 7 years.

PROGRAM GUIDANCE

1. Use AIS control measures that limit impacts to native plants.
2. Limit herbicide treatments for AIS where recreational impacts or ecological harm are not identified.
3. Follow criteria for EWM tolerance levels.

Objective B. Restore developed shorelines to native habitats.

Action B1. Provide technical and financial assistance to encourage lakeshore owners to restore native plants along the lake shoreline.

Goal IV. Protect Amery lakes through education and involvement of lake residents and visitors.

OBJECTIVES/DESIRED BEHAVIORS

- A. Lake users practice good lake stewardship including observing no wake rules.
- B. AIS prevention best practices are followed.
- C. Native plant removal is avoided.
- D. Owners restore shorelines to natural vegetation and reduce runoff from their properties.

EDUCATION MANAGEMENT STRATEGIES/ACTIONS

Audiences¹⁹

Lake owners (OWN)

Valhalla Campground residents

Lake visitors (VISIT)

Fishing tournament participants

General public (GEN)

Amery residents and surrounding area

Students in schools

¹⁹ Suggested audiences are listed for each message.

Messages: Aquatic Invasive Species Prevention

- How to prevent transport of aquatic invasive species (AIS) – Inspect, Remove, Drain, and Dry. (ALL – EMPHASIZE VISIT)
- Zebra mussel threats: nearby lakes with zebra mussels, how they are transmitted, photos of zebra mussel infestations, impacts; potential fines for not following ordinance. Zebra mussel larvae/veligers are invisible to the naked eye. (ALL – EMPHASIZE VISIT)
- Identify common aquatic invasive species with photographs and descriptions. (ALL)

Messages: Aquatic Invasive Species Control

- Aquatic invasive species (AIS) like curly leaf pondweed can be pulled by hand along the entire length of the shoreline. Be sure you know how to identify AIS before pulling, and dispose of the plants properly. (OWN)
- Aquatic plants removed by hand make great compost and mulch for gardens. (OWN)

Messages: Native Plant Protection

- Native aquatic plants provide the base for fish and wildlife habitat and keep invasive plants at bay. They also keep water clean by stabilizing sediments and taking up nutrients. Native aquatic plants are not weeds. (ALL)
- Describe the difference between native and invasive aquatic plants – why are they good/bad, impacts to water quality. (ALL)
- Only hand removal of aquatic plants is legal without a permit in Wisconsin. Removal of aquatic plants by hand methods (such as raking) must be limited to an area no more than thirty feet wide on each waterfront parcel. (OWN)
- Any removal of native plants by mechanical (harvesting) or chemical (herbicide) methods requires a permit. (OWN)
- Describe best practices for shorelines. Shoreline vegetation/buffers can prevent sediment runoff thereby preventing undesirable aquatic plant growth. Impacts of rip rap. (OWN)
- Observe no wake rules to protect native plants and shorelines. (ALL)

Messages: Overall Lake Stewardship

- Celebrate Amery Lakes, which are very high value lakes with excellent water quality and aquatic plant diversity. Highlight successes. (ALL)
- Objectives/impacts of past water quality projects. (ALL)
- Understanding lake ecosystems: what makes a lake healthy? (ALL)
- The aquatic plant management plan guides Amery Lakes District plant management efforts. Provide description of activities planned and completed. (OWN)
- Practice good lawn care: keep grass clippings, fertilizer (especially those with phosphorus), herbicides and pesticides out of the lakes. (OWN)
- Ice anglers should pick up their litter and refrain from burning on the ice. (VISIT)
- Avoid littering when visiting Amery lakes. (VISIT)

Selected Methods

1. Clean Boats, Clean Waters outreach at the landings
2. Maintain/update boat landing signs
3. Amery Lakes District newsletter
4. Creative/active outreach at community events (Fall Festival, Music on the River, Love your Library, etc.)
5. Quarterly reports to the Amery City Council
6. Update Lakes District web page on the City of Amery website
7. Articles/Know your Lakes Column in the Amery Free Press
8. Lake stewardship info added to boater education classes

Organize and support an Amery Lakes Education Committee to carry out selected methods.

Additional Methods to Consider

- Lakes District email list to contact interested people
- Community education classes
- Educational materials for elementary school
- Library displays, information distribution, and presentations
- Radio programs
- Local cable TV programs
- Outreach at fishing tournaments
- A countywide lakes fair held in North Park

Appendix A. Amery Lakes Shoreline Inventory

In 2008 and 2009, the Amery High School Freshwater Ecology class completed a shoreline inventory as part of a Wisconsin Lakes Protection Grant project (Amery High School, 2009). This shoreline inventory recorded if shorelines were developed or natural. In addition, the riparian zone (ordinary high water mark to 35 feet) was evaluated for type (natural, hard or impervious, lawn, etc.). Finally, there were critical habitat areas delineated on all the lakes. The results are reported in the 2014 Amery Lakes Aquatic Plant Management Plan and included in Appendix A.

Table 31. Shoreline Development on Amery Lakes

Lake	Natural	Lawn	Rip rap	Hard surface	Structure	Sand	Sea wall
Pike	74.5%	4.0%	3.5%	0.3%	0.2%	0.0%	0.0%
North Twin	34.7%	25.1%	34.3%	0.8%	0.3%	0.4%	2.1%
South Twin	38.6%	10.8%	9.5%	0.2%	0.0%	1.2%	0.0%

Table 32. Amery Lakes Riparian Zone Composition

Lake Riparian	Natural (wetland)	Lawn	Road/hard surface	Sand	Structure
North Twin	37.0% (25.1%)	48.6%	13.8%	0.5%	0.14%
Pike Lake	89.4% (7.1%)	9.1%	1.4%	0.0%	0.05%
South Twin	41.4% (26.1%)	34.9%	20.8%	2.8%	0.07

As Table 32 shows, Pike Lake had extensive natural riparian vegetation, with nearly 90% of the riparian zone (from the water to 35 feet inland) natural. This was mostly due to the large amount of undeveloped shoreline in the backwaters of the lake and to undeveloped York Park, which makes up about 25% of the main lake shoreline.

Both North and South Twin had extensive lawn and hard surface in the riparian zones surrounding the lakes. These areas can contribute extensively to high nutrient loads from runoff.

Critical Habitat

The map below shows the areas that were considered critical habitat areas for Pike Lake, North Twin Lake, and South Twin Lake. The areas were selected because they provide benefits for fish, birds, mammals, and/or protect water quality, and/or are critical to the lake ecosystem health. These areas have not been formally adopted by the Department of Natural Resources.



Figure 27. Proposed Critical Habitat Areas A-F



Figure 28. Proposed Critical Habitat Area G



Figure 29. Proposed Critical Habitat Area H

Table 33. Summary of Proposed Critical Habitat Areas

Critical Habitat Area	Location and Description
A	Area A is a backwater of Pike Lake (known as “Bass Hole”). Area has large amount of floating vegetation and near shore shrub cover. Submergent vegetation is very diverse providing valuable cover and many fine leaved species important for plankton. Steep bank on south shore could be erosion concern so maintaining shrub and tree cover important. Large amount of large woody debris in the littoral zone. Large numbers of waterfowl, birds, and mammals such as beaver and muskrat use this area.
B	Area B is on north and east shore of Pike Lake backwater area. Many floating and emergent plants in this area. Floating bog on east shore. Many birds use this area including an extensive area for water fowl breeding and rearing.
C and D	Area C is on east side of channel between Pike Lake and North Twin Lake. This area has extensive growth of northern wild rice and a species of concern, <i>Eleocharis robbinsii</i> (Robbin’s spikerush). There are also large amounts of floating and emergent vegetation. This area is used extensively by birds, waterfowl, and mammals. Loons have used this area for nesting in past years. Numerous species of amphibians and reptiles can be observed here too.
E	Area E is located at the west shore of North Twin Lake. Much of this area is part of a large floating, acidic bog. This bog includes tamarack, orchids, and cape sundew. The littoral zone includes floating vegetation that provides important cover.
F	Area F is a large tract of natural vegetation/undisturbed riparian zone which is limited on North Twin Lake. The plant species include large amounts of emergent vegetation with many birds using this area for habitat. There is a gravel bar near the east end of this area that could provide spawning habitat for walleye (if any natural reproduction is occurring).
G	Area G is basically all the area of York Park on Pike Lake. This is a large portion of the lake shore on Pike Lake that is not developed. There are important sand areas for panfish spawning and rearing (with nearby plant beds for cover). The eastern most portion of this area is a speculated water recharge area for Pike Lake. Numerous floating and emergent plants are contained here as well.
H	Area H is the only natural/undeveloped portion of South Twin Lake. This area has a large amount of floating and emergent vegetation. The riparian zone is very thick with a shrub and grass cover and functions as an important buffer to the golf course which abuts the lake.

Critical Habitat Areas

The Department of Natural Resources *critical habitat areas* include both *sensitive areas* and *public rights features*. *Sensitive areas* offer critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offer water quality or erosion control benefits to the area (Administrative code

107.05(3)(1)(1)). Wisconsin Department of Natural Resources is given the authority for the identification and protection of sensitive areas of the lake in this code. *Public rights features* are areas that fulfill the right of the public for navigation, quality and quantity of water, fishing, swimming, or natural scenic beauty. Protecting these *critical habitat areas* requires the protection of shoreline and in-lake habitat. A *critical habitat area* designation would provide a framework for management decisions that impact the ecosystem of the lake.

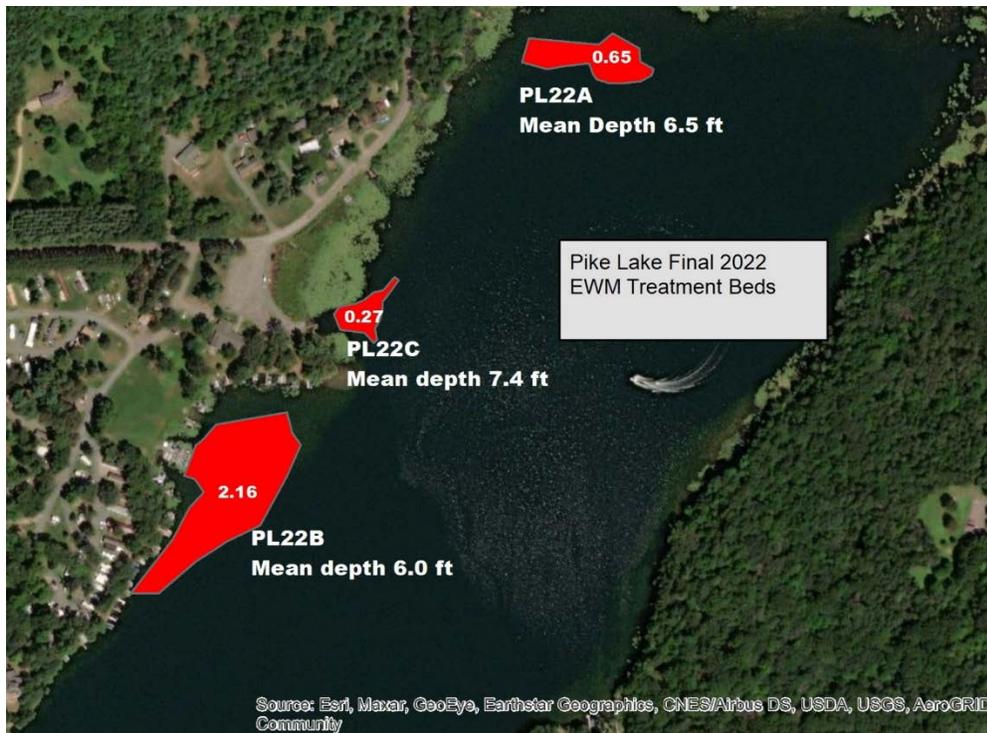
Appendix B. Pike Lake, Polk County, Wisconsin EWM Herbicide Treatment Evaluation (WBIC: 2624000)

Introduction/treatment sites

On June 15, 2022, the herbicide ProcellaCOR has applied to three beds of Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*) for mitigation of the EWM. The total area treated was 3.08 acres. The table below summarizes the treatment bed characteristics and treatment conditions. The beds were delineated in August 2021 and adjusted based on the early June 2022 growth of the EWM.

Bed	Area (acres)	Mean Depth (feet)	Acre-feet	Water Temp	Wind	ProcellaCOR Dose
PL22A	0.65	6.5	4.23	72	0-3/NW	5 pdu/acre-foot
PL22B	2.16	6.0	12.96	72	0-3/NW	4 pdu/acre-foot
PL22C	0.29	7.4	2.00	72	0-3/NW	5 pdu/acre foot

The map below shows the locations and sizes of the various treatment beds.



To evaluate the success of the treatment, a pretreatment survey for the EWM was conducted in August 2021. A post-treatment survey was conducted in late August 2022 using the same sample points within the treatment beds. A chi-square analysis of the plant frequency was used to determine if a reduction (or increase) is statistically significant. A p-value < 0.05 is considered significant, and the lower the p-value, the more significant the change was in the frequency.

Results

The table below shows the pretreatment and post-treatment frequency of EWM. The significance of the change in each bed and all beds combined is listed, along with the p-value. As this data shows, each bed had a significant reduction in EWM frequency, with an overall p-value of 2.4×10^{-12} for all beds combined.

Bed	Pretreatment frequency	Post-treatment frequency	Change/significant?	P-value (from chi-square)
PL22A	90.0%	0%	Decrease/yes	5.0×10^{-5}
PL22B	85.7%	0%	Decrease/yes	6.1×10^{-7}
PL22C	100.0%	0%	Decrease/yes	5.3×10^{-4}
All beds combined	90.0%	0%	Decrease/yes	2.4×10^{-12}

The following maps show the rake fullness of EWM within each treatment bed. The first map is before treatment (August 2021), and the second is after treatment (August 2022).



Summary

The June 2022 treatment using ProcellaCOR on three beds of EWM in Pike Lake reduced the targeted EWM. The frequency of the EWM went from 90% to 0%.

There were no beds of EWM remaining in September 2022 on Pike Lake. Therefore, there should be no need for herbicide treatment in 2023. Monitoring will continue as there were a few single plants viewed in new areas of the lake. These could expand into beds in the future.

The pretreatment native plant frequency data was unavailable, so native plant changes were not evaluated in this treatment.

Appendix C. North Twin Lake, Polk County, Wisconsin EWM Herbicide Treatment Evaluation (WBIC: 2623900)²⁰

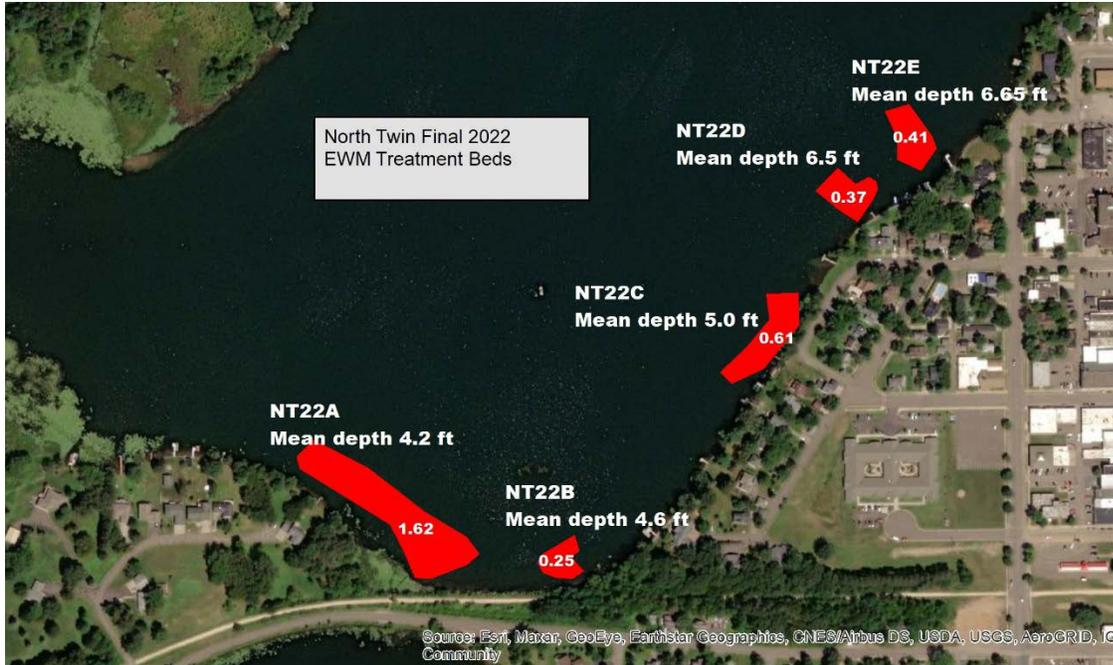
Introduction/treatment sites

On June 15, 2022, the herbicide ProcellaCOR was applied to five beds of Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*) for mitigation of the EWM. The total area treated was 3.26 acres. The table below summarizes the treatment bed characteristics and treatment conditions. The beds were delineated in August 2021 and adjusted based on the early June 2022 growth of the EWM.

North Twin Lake EWM 2022						
Bed	Area	Mean Depth (feet)	Acre-foot	Water temp. (°F)	Wind velocity/direction	Concentration of herbicide applied
NT22A	1.62	4.2	6.80	72	2-6/NW	4 pdu/acre-foot
NT22B	0.25	4.6	1.15	72	2-6/NW	5 pdu/acre-foot
NT22C	0.61	5	3.05	72	2-6/NW	5 pdu/acre-foot
NT22D	0.37	6.5	2.41	72	2-6/NW	5 pdu/acre-foot
NT22E	0.41	6.65	2.73	72	2-6/NW	5 pdu/acre-foot
Total	3.26		16.14			

The map on the following page shows the locations and sizes of the various treatment beds.

²⁰ Steve, Schieffer. 2022.



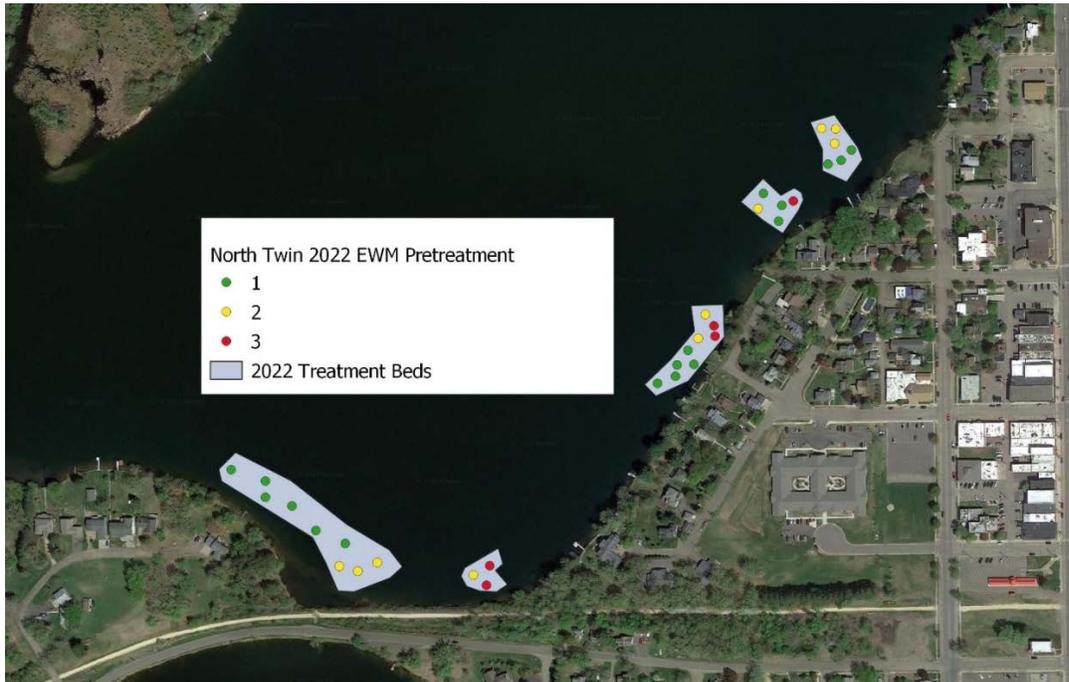
To evaluate the success of the treatment, a pretreatment survey for the EWM and native plants was conducted in August 2021. A post-treatment survey was conducted in late August 2022 using the same sample points within the treatment beds. A chi-square analysis of the plant frequency was used to determine if a reduction (or increase) is statistically significant. A p-value < 0.05 is considered significant, and the lower the p-value, the more significant the change was in the frequency.

Results

The table below shows the pretreatment and post-treatment frequency of EWM. The significance of the change in each bed and all beds combined is listed, along with the p-value. As this data shows, each bed had a significant reduction in EWM frequency, with a p-value of 1.2×10^{-15} for all beds combined.

Bed	Pretreatment frequency	Post-treatment frequency	Change/significant?	P-value (from chi-square)
NT22A	100%	0%	Decrease/yes	2.0×10^{-5}
NT22B	100%	0%	Decrease/yes	0.014 (small sample)
NT22C	100%	0%	Decrease/yes	2.0×10^{-5}
NT22D	100%	0%	Decrease/yes	0.002
NT22E	100%	0%	Decrease/yes	0.0005
All beds	100%	0%	Decrease/yes	1.2×10^{-15}

The following maps show the rake fullness of EWM within each treatment bed. The first map is before treatment (August 2021), and the second is after treatment (August 2022).



A successful herbicide treatment not only reduces the frequency and density of the target species (EWM), but will have little to no effect on the native plant species. The table below summarizes the native plants sampled in the pretreatment and post-treatment surveys, along with the chi-square analysis results.

Native species	Number Sampled August 2021	Number Sampled August 2022	Change	P value	Significant?
<i>Potamogeton richardsonii</i> -clasping pondweed	15	16	+	0.80	No
<i>Potamogeton robbinsii</i> -fern pondweed	15	14	-	0.80	No
<i>Vallisneria americana</i> -wild celery	13	15	+	0.61	No
<i>Potamogeton amplifolius</i> -large-leaf pondweed	4	3	-	0.69	No
<i>Elodea canadensis</i> -common waterweed	4	3	-	0.69	No
<i>Najas flexilis</i> -slender naiad	1	1	n/c	1.00	No
<i>Potamogeton zosteriformis</i> -flat-stem pondweed	1	1	n/c	1.00	No
<i>Potamogeton pusillus</i> -small pondweed	3	1	-	0.30	No
<i>Stuckenia pectinate</i> -sago pondweed	2	2	n/c	1.00	No
<i>Potamogeton praelongus</i> -whitestem pondweed	6	5	-	0.74	No
<i>Myriophyllum sibiricum</i> -northern watermilfoil	5	1	-	0.09	No
<i>Potamogeton gramineus</i> -variable pondweed	0	1	+	0.31	No

The native plant chi-square shows no statistically significant reductions in native plant species. Northern watermilfoil was close but the p-value is just above the 0.05 threshold. Northern watermilfoil would be susceptible to the herbicide applied. These results are desired as the EWM reduced, and there were no negative effects on the native plants.

Summary

The June 2022 treatment using ProcellaCOR on five beds of EWM in North Twin Lake reduced the targeted EWM. The frequency of the EWM went from 100% to 0%. In addition, there was no significant reduction in native plants.

There were no beds of EWM remaining in September 2022 on North Twin Lake. Therefore, there should be no need for herbicide treatment in 2023. Monitoring will continue as there were a few single plants viewed in new areas of the lake. These could expand into beds in the future.

Appendix D. Rapid Response for Early Detection of Aquatic Invasive Species

Definition: Aquatic Invasive Species (AIS) are non-native species that can out-compete and overtake native plant species damaging native lake habitat and sometimes creating nuisance conditions. AIS currently in Amery Lakes include Eurasian water milfoil (EWM – all lakes), curly leaf pondweed (CLP - all lakes), purple loosestrife (PL - North and South Twin). Additional AIS threaten Amery Lakes and will be monitored by professional monitors or volunteers.

1. Develop and maintain a contingency fund of \$3,000 for rapid response to Aquatic Invasive Species discovery in Amery Lakes (Amery Lakes District Board).
2. Conduct monthly volunteer and professional monitoring according to the Amery Lakes AIS Monitoring Matrix (Table 28). If a suspected AIS is found, contact the Polk County LWRD AIS Coordinator or volunteer AIS Coordinator.
3. Direct lake residents and visitors to contact the Polk County LWRD AIS Coordinator or volunteer AIS Coordinator if they find a suspected AIS. Signs at the public boat landings, web pages, handouts at annual meeting, and newsletter articles will provide plant photos and descriptions, contact information, and instructions.
4. Potential AIS identification will be confirmed with the Polk County LWRD (or professional with knowledge) or the Wisconsin DNR.
 - a. Document the sample with a digital photo if possible.
 - b. Record GPS location coordinates of collection location if possible. Alternatives are marking with a float and/or on a map.
 - c. Fill out an AIS Incident Report from the Wisconsin DNR. This form can be found at: <https://dnr.wisconsin.gov/topic/Invasives/report.html>. Contact Wisconsin DNR and deliver plant samples to Polk County LWRD or Wisconsin DNR, 810 West Maple St., Spooner, WI 54801.
 - If the sample is a plant, collect 3-5 intact specimens and attempt to keep all parts of the plant present (roots, leaves, fruits, and flowers if present). Place in plastic, sealed bag(s) and refrigerate or put on ice.
 - If the sample is an animal, collect up to five specimens. Place in a jar with water, put on ice and transport to refrigerator. Transfer specimen to a jar filled with rubbing alcohol (except for Jellyfish – leave in water).
5. Mark the location of suspected AIS (Polk County LWRD AIS Coordinator or volunteer AIS Coordinator). Use GPS points (in decimal degrees), if available, or mark the location with a small float.

6. If identification is positive:
 - a. Inform the person who reported the AIS and the board, Polk County LWRD AIS Coordinator, or volunteer AIS Coordinator, who will then inform Polk County LWRD and lake management consultant.
 - b. Post a notice at the public landing (WDNR has these signs available) and include a notice in the next newsletter. Notices will inform residents and visitors of the approximate location of the AIS and provide appropriate means to avoid its spread (Board).
7. Use volunteer professional assistance, or hire a consultant to determine the extent of the AIS introduction (Board). A diver may be used. If small amounts of AIS are found during this assessment, the consultant will be directed to identify locations with GPS points and hand pull plants found. Whole plants will be pulled and efforts made to reduce plant fragmentation. All plant fragments will be removed from the lake when hand pulling.
8. Select a control plan in cooperation with the WDNR (Board) and consultant. The goal of the rapid response control plan will be eradication of the AIS. Control methods may include hand pulling, use of divers to manually or mechanically remove the AIS from the lake bottom, application of herbicides, and/or other effective and approved control methods.
9. Implement the selected control plan including applying for the necessary permits. Regardless of the control plan selected, it will be implemented by persons who are qualified and experienced in the technique(s) selected.
10. Amery Lakes District funds may be used to pay for any reasonable expense incurred during the implementation of the selected control plan, and implementation will not be delayed by waiting for WDNR to approve or fund a grant application.
11. The Board will work with the WDNR to confirm a start date for an Early Detection and Rapid Response AIS Control Grant as soon as possible. Thereafter, the Board shall formally apply for the grant.
12. Frequently inspect the area of the AIS to determine the effectiveness of the treatment and whether additional treatment is necessary (APM Monitor, Consultant).
13. Review the procedures and responsibilities of this rapid response plan in each even year. Changes may be made with approval of the Board.

EXHIBIT A²¹

AMERY LAKES PROTECTION AND REHABILITATION DISTRICT

Board Chair and Steve Schieffer: 715-554-1168
Volunteer AIS Coordinator ecointegservice@gmail.com

POLK COUNTY LAND AND WATER RESOURCES DEPARTMENT

AIS Coordinator (Katelin Anderson) katelin.anderson@polkcountywi.gov
715.485.8637
Water Quality Specialist (Colton Sorensen) colton.sorensen@polkcountywi.gov
715-485-8639

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Permits (Austin Dehn) austin.dehn@wisconsin.gov

Grants and Lakes Coordinator (Tyler Mesalk) tyler.mesalk@wisconsin.gov
(715) 635-4227

APM MONITOR

Ecological Integrity Services Steve Schieffer: 715-554-1168
ecointegservice@gmail.com

HERBICIDE CONTRACTOR

Lake Restoration 763-428-1543
Northern Aquatic Services (Dale Dressel) ddressel@centurytel.net
715-755-3507

DIVERS

Ecological Integrity Services Steve Schieffer: 715-554-1168
ecointegservice@gmail.com
Jeremy Williamson

²¹ This list will be reviewed and updated each year.

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