Aquatic Plant Management Plan
Deer Lake
Polk County, Wisconsin

Draft
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Photo by Tom McBride

Sponsored By
Deer Lake Improvement Association

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Funded By
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Executive Summary

This Aquatic Plant Management Plan for Deer Lake presents a strategy for managing aquatic plants by protecting native plant populations, managing curly leaf pondweed, and preventing establishment of invasive species through the year 2027. The plan also covers a response to zebra mussels, an aquatic invader found in the lake in late 2016 that has expanded considerably. The plan includes data about the plant community, watershed, and water quality of the lake. It also reviews a history of aquatic plant management on Deer Lake.

An aquatic plant point intercept survey was completed most recently for Deer Lake in 2022. Aquatic plant surveys were also completed in 2003, 2006, 2010, and 2016. The aquatic plant surveys found that Deer Lake has a healthy, abundant, and diverse aquatic plant community. Native aquatic plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of non-native invasive plants – all critical functions for the lake.

The Deer Lake Aquatic Plant Management Plan will help the Deer Lake Improvement Association carry out activities to meet plan aquatic plant management goals. These goals were established in the 2006 Deer Lake Aquatic Plant Management Plan and reviewed for the 2012, 2017, and 2023 plans.

Plan Goals

1) Protect and restore healthy native aquatic plant communities.
2) Prevent the introduction of aquatic invasive species.
3) Respond rapidly and aggressively to any newly introduced aquatic invasive species.
4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.
5) Educate and engage the public regarding lake stewardship.

Introduction

The Aquatic Plant Management Plan for Deer Lake is sponsored by the Deer Lake Improvement Association (DLIA). The plan is an update of a plan approved by the Wisconsin Department of Natural Resources (DNR) in October 2017. The plan update was funded by Wisconsin DNR Aquatic Invasive Species grants and the DLIA.

Two local organizations are involved in management of Deer Lake: the Deer Lake Improvement Association which addresses immediate in-lake water quality issues, aquatic invasive species prevention, and aquatic plant management, and the Deer Lake Conservancy which addresses long-range water quality issues through watershed management. Because both immediate and long term management affect aquatic plants in the lake, activities of both organizations are reported in this management plan.

This aquatic plant management plan presents a strategy for managing aquatic plants by protecting native plant populations, managing curly leaf pondweed, and preventing the establishment of additional invasive species. The plan also covers a response to zebra mussels, an aquatic invader found in the lake in late 2016. The plan includes data about the plant community, watershed, and water quality of the lake. Based on this data and public input, goals and strategies for the sound management of aquatic plants in the lake are presented. This plan will guide the DLIA and the DNR in aquatic plant management for Deer Lake over the next five years (from 2024 through 2028).

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

The DLIA Aquatic Plant Management (APM) Advisory Committee provided input for the development of this plan. The APM Advisory Committee met on February 22, 2023 when they reviewed aquatic plant management planning requirements, aquatic plant management goals, and aquatic plant management efforts to date. At meetings on March 22, April 5, and April 18 the committee made recommendations for ongoing management strategies.

The DLIA board announced the availability of the draft Aquatic Plant Management Plan for review with a public notice in the Inter-County Leader. Copies of the plan were made available to the public on the DLIA web site: deerlakewi.com. Comments will be accepted through June 19, 2023.

Property Owner Survey

The Deer Lake Conservancy conducted an on-line survey of lake residents in 2020 in preparation for the development of the Deer Lake Management Plan. There were 309 survey notices mailed, and 157 completed the entire survey – a return rate of 51%. Selected results of the on-line survey are discussed below, and full results are found as an appendix to the 2020 Deer Lake Management Plan. While the survey was not prepared to guide the aquatic plant management plan, the results provide some helpful information.

Popular lake activities, rated in the list below by degree of enjoyment (adding results of "Quite a bit" and "A Great Deal"), demonstrate potential conflicts for aquatic plant management. (Other available responses were "Not at All" and "Some.") Enjoying the view, appreciating peace and tranquility, and observing wildlife were the most enjoyed activities. These activities are supported by aquatic plants in the lake. However, motor boating and swimming - which may be limited by aquatic plant growth – closely followed as the top activities enjoyed on the lake.

<u>Recreational Activities where "Quite a Bit" + "A Great Deal" = 50% or more:</u>

- Enjoying the view 98%
- Peace & tranquility 90%
- Observing wildlife 80%
- Entertaining & gatherings...80%
- Motor boating..77%
- Swimming...66%

Additional survey results indicated a range of concerns of lake residents. Respondents reported that invasive plant growth was near the top of their concerns in 2020.

<u>Issues where "Quite a Bit" + "A Great Deal" = 50% or more:</u>

- Protecting the lake environment 87%
- Maintaining investment value 77%
- Invasive aquatic plants 69%
- Erosion & runoff across property 66%
- Shoreline erosion 64%
- Cost of property taxes 62%
- Boat wakes 58%
- Nuisance algae blooms 55%

Lake Information

The Lake

Deer Lake is an 812-acre lake located in Polk County, Wisconsin in the Towns of St. Croix Falls (S25, T34N, R18W) and Balsam Lake (S29 and S30, T34N, R17W). The maximum depth of the lake is 46 feet, and the mean depth is 26 feet. Its subwatersheds are primarily on the north side of the lake. The area of these watersheds that drain directly to the lake totals almost 5,071 acres.[2] The lake is fed by intermittent streams entering mostly on the north side of the lake. There is a single outlet in the southeast corner.

Deer Lake is mesotrophic with July and August secchi depths averaging 15 feet in the East Deep Hole in the past five years (2018-2022). The Deer Lake littoral zone (the depth to which plants grow) reached to 21 feet in 2022. This littoral zone depth is much higher than surrounding lakes in the region because water clarity is high and light penetrates more deeply. Past littoral zone depths were 26 feet in 2016, 28 feet in 2010, 27 feet in 2007, and 24 feet in 2003. The bottom substrate is muck or sand as shown in Figures 1 and 2 below.

Table 1. Deer Lake Information

Size (acres)	812
Mean depth (feet)	26
Maximum depth (feet)	46
Littoral zone depth (feet)	21
July/August secchi depth (2018 – 2022)(feet)	15

[2] Subwatershed area from Colton Sorenson, Polk County Land and Water Resources Department, November 8, 2022.

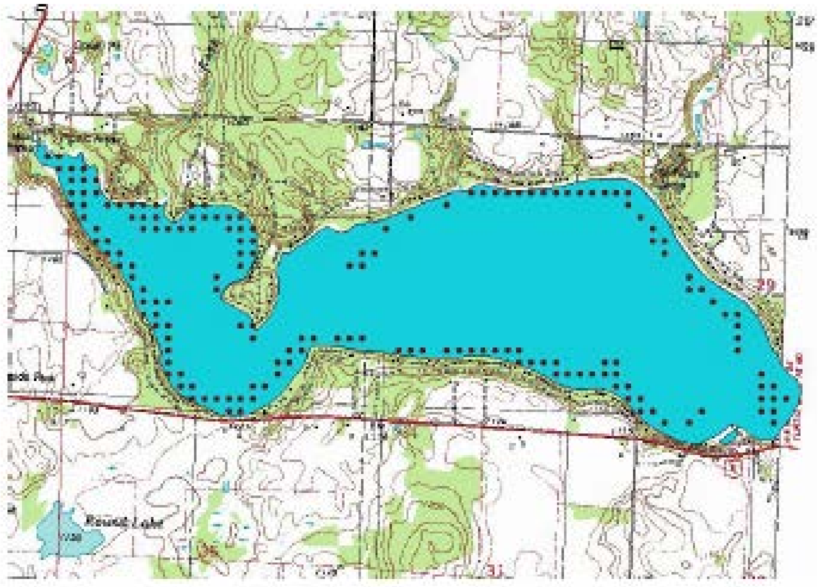

Figure 1. Dominant Sediment Muck

Figure 2. Dominant Sediment Sand

A lake map which illustrates public and private access points is found as Figure 3. Areas shaded in light green indicate properties owned by the Deer Lake Conservancy. The access on the south side of the lake along US Highway 8 is the private, Lagoon access.

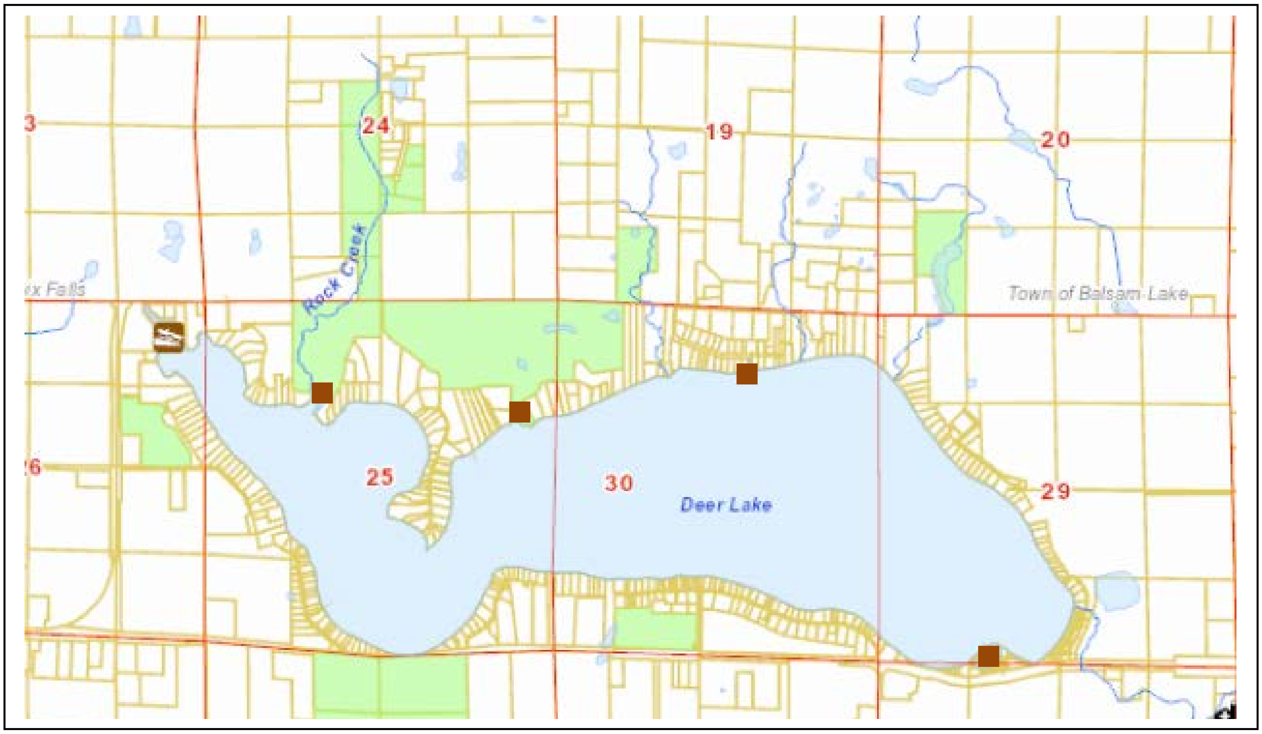

Figure 3. Deer Lake Map with Access Points

Water Quality

Water quality is frequently reported by the trophic state or nutrient level of the lake. Nutrient-rich lakes are classified as eutrophic. These lakes tend to have abundant aquatic plant growth and low water clarity due to algae blooms. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms. Oligotrophic lakes are nutrient-poor with little growth of plants and algae.

Secchi depth readings are one way to assess the trophic state of a lake. The secchi depth is the depth at which the black and white secchi disk is no longer visible when it is lowered into the water. Greater secchi depths occur with greater water clarity. Secchi depth readings, phosphorus concentrations, and chlorophyll measurements can each be used to calculate a Trophic State Index (TSI) for lakes. TSI values range from 0 – 110 with higher numbers representing more nutrient-rich lakes. Lakes with TSI values greater than 50 are considered eutrophic. Those with values in the 40 to 50 range are mesotrophic. Lakes with TSI values below 40 are considered oligotrophic. Monitoring results place Deer Lake in the mesotrophic to oligotrophic TSI range.

Citizen lake monitoring volunteers collected water samples and data from the lake almost every year since 1987. Results are available from the DNR website. In 2022, the data is supplemented by an ongoing (2022-2024) water quality study. Results reported here are from the East Deep Hole. For better comparison between lakes, only July and August results are summarized and reported in the table and figures that follow. The average 2022 summer Chlorophyll-a was 6 µg/l compared to a Northwest Georegion summer average of 15.9 µg/l. Over the past five years (2018-2022), secchi depths averaged 15 feet in the East Deep Hole.

Table 2. Citizen Lake Monitoring Results July and August 2022[2]

	East Deep Hole
Secchi Depth (ft)	15
Total Phosphorus (µg/l)	18.3
Chlorophyll (µg/l)	6
Trophic State Index (TSI based on secchi)	38
TSI (based on Chla)	48
TSI (based on TP)	50

[2] *Reports and Data: Polk County*. DNR website. November 2022. https://dnr.wi.gov/lakes/waterquality/Station.aspx?id=493063

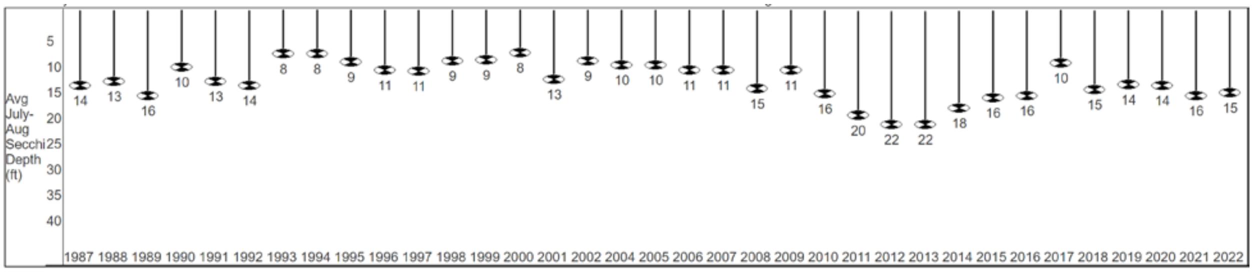

Figure 4. Deer Lake East Deep Hole July and August Average Secchi Depths

Figure 4 illustrates the secchi depth July and August averages for the East Deep Hole. Figure 5 graphs the Trophic State Index (TSI) for the same location, based upon secchi depth, chlorophyll a, dissolved oxygen, and total phosphorus results. Lower than expected algae growth (chlorophyll a) and related increased water clarity may be influenced by grazing of algae by zooplankton or some factor in addition to phosphorus levels.

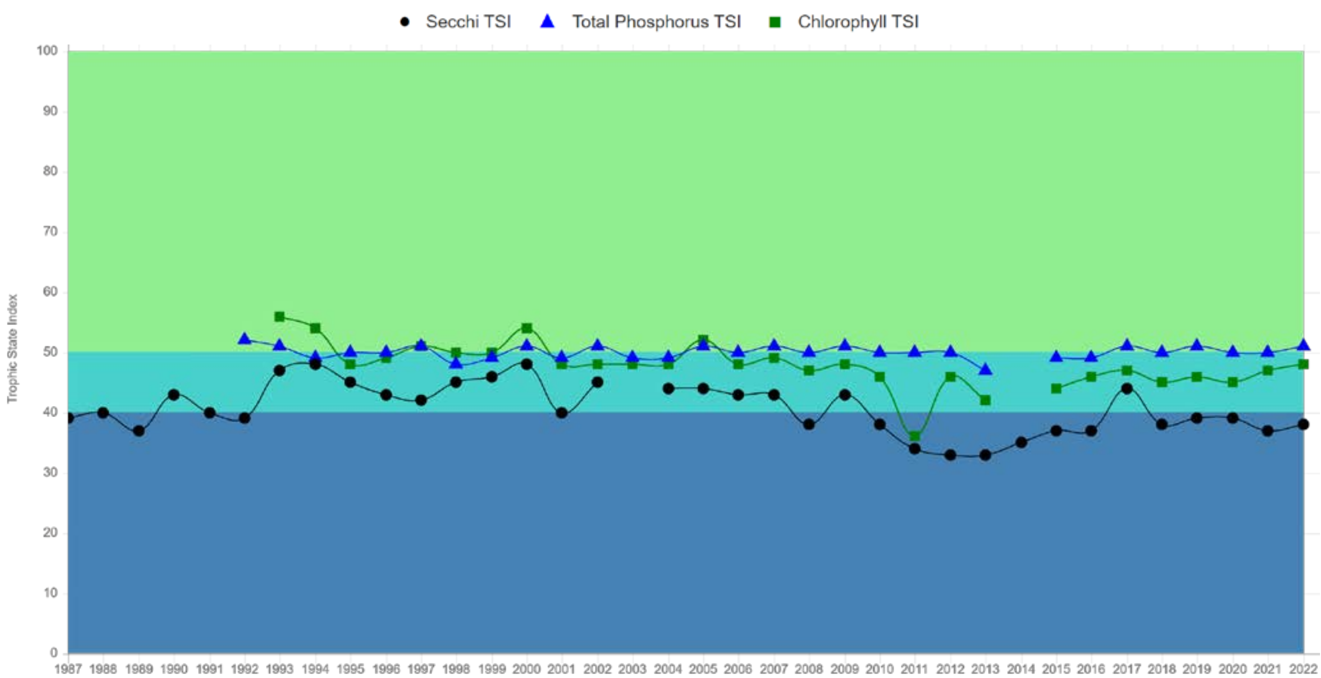

Figure 5. Deer Lake East Deep Hole July and August Average Trophic State

Water Quality Studies

The Deer Lake Conservancy and Deer Lake Improvement Association together sponsored a comprehensive in-lake study in 2003 with assistance from Department of Natural Resources planning grant funds. A major initiative of the Conservancy has been to implement the recommendations of two water quality studies commissioned by the Deer Lake Improvement Association in the early nineties (Barr Engineering 1993 and 1995). The studies sought to identify causes and solutions for the perceived decline in Deer Lake water quality in preceding decades. The studies concluded the following:

> *Based on the runoff water quality data, water quality of Deer Lake's tributary streams could be considered poor. The potential increase in nutrient loading from agricultural watersheds into Deer Lake is the single biggest threat to the long-term health of Deer Lake. Specifically, Deer Lake should focus its attention on the following issues related to the agricultural watersheds.*
>
> 1. *Promote the retention/detention of stormwater runoff within Deer Lake's watershed. This activity includes protection of any existing depressions and wetlands. Additionally, creation of new detention areas, especially within the direct watershed and watersheds 2 and 3 should be encouraged.*
> 2. *Promote the stabilization and restoration of stream beds within Deer Lake's watershed.*

Watersheds

In the early 1990's, the Polk County Land Conservation Department and the Department of Natural Resources gathered information for the development of the Balsam Branch Priority Watershed Plan. The plan established an in-lake water quality goal of 19 µg/l summer phosphorus concentration. According to lake models, achieving this goal required a total phosphorus loading reduction of 36% (equivalent to 65% reduction of watershed loading) from levels in the early 1990s. The Conservancy adopted these goals and has emphasized watershed practices to achieve them. Current (2022) summer total phosphorus concentration achieves the in-lake phosphorus goal with July and August levels averaging 18.3 µg/L in the east basin.

Conservancy efforts have largely focused on reducing phosphorus carried in runoff from Deer Lake watersheds. These watersheds are illustrated in Figure 6. Watershed boundaries were recently updated with better topographic data based on LIDAR data and more accurate culvert locations. A timeline of project installation is included on page 17.

A 2003 study estimated then current watershed phosphorus loading, phosphorus loading reductions from installation of conservation practices since 1996, and remaining loading from the direct drainage area (JEO 2003). From 1996 to 2000, the estimated annual watershed phosphorus loading to Deer Lake decreased by 51%. Installed practices in the 2000s track a total phosphorus loading reduction from 1996 levels of 61%. However, this tracking does not account for new construction and changes in rainfall patterns which are bringing more frequent, high-intensity storms and more resulting runoff.

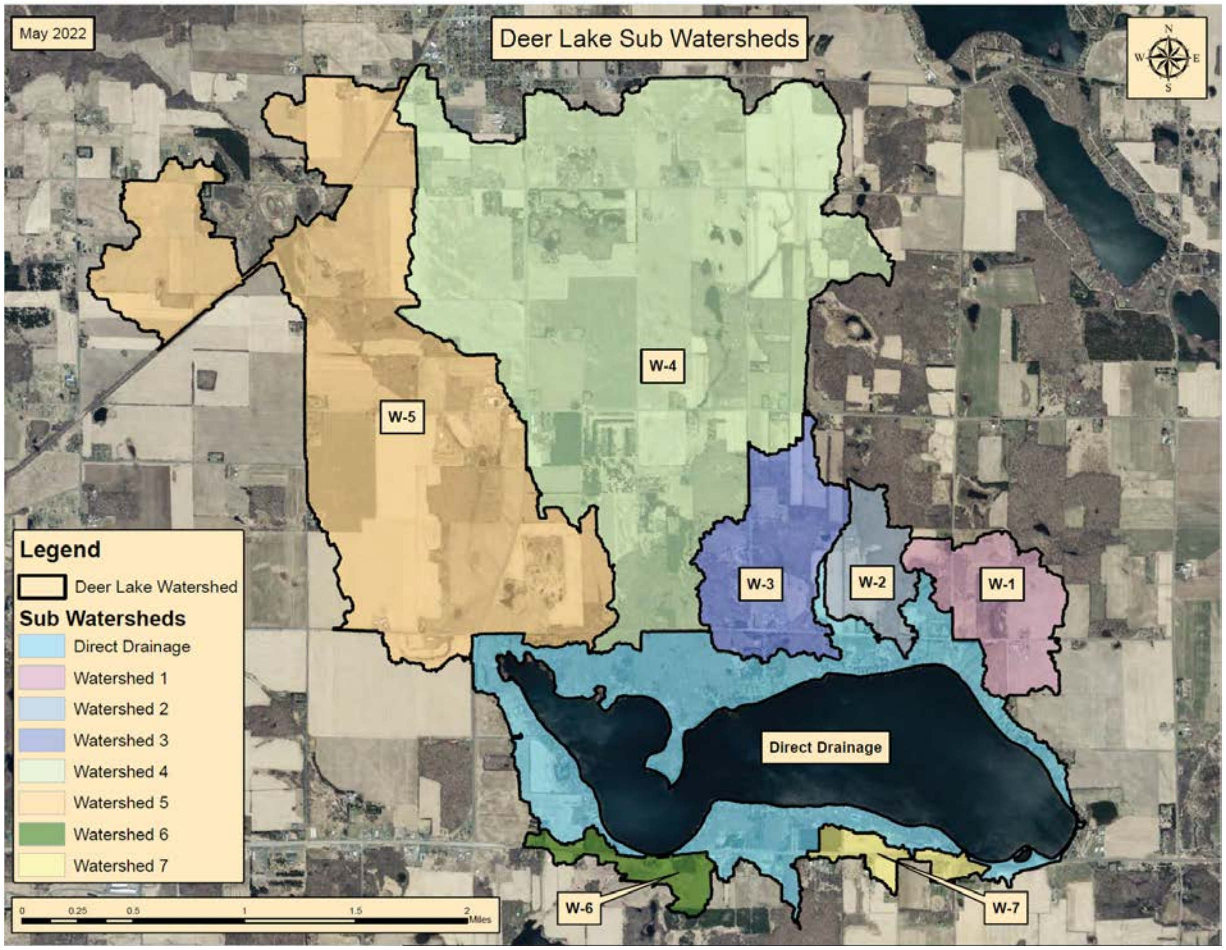

Figure 6. Deer Lake Watersheds

The Deer Lake Conservancy initiated a watershed and water quality study in 2022 to re-examine loading of phosphorus in runoff from Deer Lake watersheds and resulting impacts on lake water quality. Flow and water quality parameters on Deer Lake intermittent tributaries will be monitored from 2022 through 2024. In lake water quality data is also being collected. Results will be used to examine watershed reduction goals and priorities.

Deer Lake Conservancy Project Timeline

Organization is Incorporated	1995
W2 Basin Construction	1997
W2 Prairie Planting	1998
Dry Creek (W3) Property Acquired	1998
W3 Sediment Basins	1998
W3 Tire Removal	1998
W3 Wetland Restorations	1998
Rock Creek (W4) Prairie Acquired	1998
W4 Gravel Pit Restoration	1998
W3 Prairie Planting	1999
Rock Creek (W4) Woodland Acquired	1999
W4 Prairie Planting	1999
Blakeman Hill (W1) Easements	1999
W1 Wetland Restoration	1999
Trail System Developed (W3 and W4)	2000
Flagstad Farm Acquired	2002
Flagstad Farm Prairie	
Flagstad Farm Well Closure	
Flagstad Farm Prairie Maintenance (NRCS)	
Flagstad Farm Gravel Pits Restored	
Maple Cove Prairie Donated	2003
Foussard Kane Forest Donated	2006
Direct Drainage Project Begins	2006
WDOT Releases Highway 8 EIS	2007
Prokop Stormwater Ponds and Easement	2008
McKenzie Forest Acquired	2009 and 2011
Schletty Stormwater Ponds and Rock Waterway	2009
St. Croix River Association Stewardship Award	2011
Direct Drainage Projects Installed	2008 to 2022
W1 Pond Updated (outlet and ditch checks)	2015
NALMS Lake Management Success Award	2015
Lower Rock Creek Acquisition and Trails	2016
Sedimentation Basin Installed	2017
Johnson Preserve Acquisition and Trails	2017
W1 North Pond Acquisition	2020
Northeast Pond Preserve (W1) Basin Construction	2022

Aquatic Habitats

Primary Human Use Areas

A public boat landing owned by the Town of St. Croix Falls is located at the northwest corner of the lake. The boat landing includes space for parking 25 vehicles and trailers. Many anglers travel from the Twin Cities, Minnesota metropolitan area, and access the lake at this boat landing. It is also a popular local destination. According to Heath Benike, former DNR fisheries biologist, "Deer Lake is one of the most important and popular musky fisheries in the state of Wisconsin. Many resident as well as non-resident anglers use Deer Lake, and this is the only public landing on the lake." The Town of St. Croix Falls boat landing on Deer Lake is used extensively throughout the year. While there are only 25 parking spots on the lake, a busy weekend brings an estimated use by over 200 vehicles. Daily weekday use is about 15 – 25 vehicles.

A private boat launch is located at the southeast corner of the lake near the outlet. This area is referred to as the Lagoon. The Town of Balsam Lake owns a walk-in access on Dry Creek Road.

The shoreline of Deer Lake is largely developed for residential use with about 330 residences. Many are large homes constructed for year-round use. Lake residents use focuses around their docks placed in the relatively shallow, littoral zone of the lake.

Deer Lake Fishery[3]

Deer Lake has a diverse fish community that is comprised of muskellunge, northern pike, largemouth bass, bluegill, black crappie, yellow perch, green sunfish, rock bass, white sucker, bullhead species, as well as various minnow species. Deer Lake is not managed for or stocked with walleye, and walleye occasionally present in DNR fisheries surveys are from unknown sources. There is no known natural reproduction of walleye in Deer Lake.

Deer Lake has an exceptional muskellunge fishery, with moderate abundance and size structure. It is managed as an A2 muskellunge lake and is stocked every other year at a rate of 1.5 fingerlings per acre. The muskellunge fishery is dependent upon stocking, as no natural reproduction is known to occur. Muskellunge are not native to Deer Lake (DNR, 2018).

[3] Fisheries information provided by Aaron Cole, DNR Fish Biologist. Email communication June 11, 2020.

Table 3. Deer Lake Fish Stocking Summary 1973– 2018

Wisconsin Department of Natural Resources
Fish Stocking Summary
DNR Hatcheries, Ponds, and Coop Ponds

Please Note: The stocking records for the current stocking year will be posted annually after verification by our fisheries biologists. Please contact your local fisheries biologist if you have questions about our current stocking practices.

County Name: POLK | Waterbody Name: DEER LAKE | Local Waterbody Name | Location (TRS)

Year	Stocked Waterbody Name	Local Waterbody Name	Location	Species	Strain (Stock)	Age Class	Number Fish Stocked	Avg Fish Length (IN)
2018	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	1,328	12.15
2016	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	725	11.80
2014	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	1,211	11.25
2012	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	1,211	12.80
2010	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	532	12.30
2008	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	596	10.85
2006	DEER LAKE		34N-17W-29	MUSKELLUNGE	UPPER CHIPPEWA RIVER	LARGE FINGERLING	444	12.40
2004	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	LARGE FINGERLING	807	11.00
2002	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	LARGE FINGERLING	1,614	10.40
2000	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	LARGE FINGERLING	1,200	11.10
1997	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	LARGE FINGERLING	800	11.95
1996	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,600	11.30
1993	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,614	12.00
1992	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,600	11.00
1991	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,600	12.00
1990	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	800	11.00
1989	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	800	11.00
1988	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,600	9.00
1987	DEER LAKE		34N-17W-29	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,400	11.00
1985	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,500	9.00
1984	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,150	10.50
1982	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	950	9.00
1981	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	715	10.00
1980	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,600	10.00
1979	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,100	12.00
1978	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,000	11.00
1978	DEER LAKE		34N-17W-29	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,650	9.00
1977	DEER LAKE		34N-17W-29	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,000	11.00
1977	DEER LAKE		34N-17W-29	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,000	10.33
1976	DEER LAKE		34N-17W-29	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,200	10.00
1975	DEER LAKE		34N-17W-29	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,600	11.00
1974	DEER LAKE		34N-17W-29	LARGEMOUTH BASS	UNSPECIFIED	FINGERLING	200	15.00
1974	DEER LAKE		36N-15W-23	NORTHERN PIKE X MUSKELLUNGE	UNSPECIFIED	FINGERLING	349	11.00
1973	DEER LAKE		36N-15W-23	MUSKELLUNGE	UNSPECIFIED	FINGERLING	1,500	11.00

Deer Lake also supports quality populations of bluegill, black crappie, and yellow perch. Most pan fish populations have moderate to high abundance and size structure and receive considerable angling effort. The largemouth bass population has been considered abundant with low size structure during recent fisheries surveys.

Overall, Deer Lake has desirable fish populations for most of the species present and is popular among anglers. Besides musky, all other fish species present in Deer Lake have naturally-reproducing populations and do not require supplemental stocking.

Fishery Recommendations
Maintaining natural shorelines, fish spawning habitats, areas with aquatic vegetation, and good water quality are critical for the future of the primary sport fish populations and the overall health of Deer Lake.

Table 4. Fish Spawning Times and Considerations

Fish Species	**Spawning Temp. (Degrees F)**	**Spawning Substrate / Location**	**Comments**
Northern Pike	Upper 30s – mid 40s (right after ice-out)	Emergent and submergent vegetation in 0.5-3 feet of water	Eggs are broadcasted and adhere to vegetation
Yellow Perch	Mid 40s – low 50s	Submergent vegetation or large woody debris	Broadcast spawn Eggs resemble a helical strand that drapes over vegetation or woody debris
Black Crappie	Upper 50s – low 60s	Nests are built in 1-6 feet of water.	Nest builders
Largemouth Bass Bluegills	Mid 60s – low 70s	Nests are built in 1-6 feet of water.	Nest builders

Functions and Values of Native Aquatic Plants

Naturally occurring native plants are extremely beneficial to the lake. They provide a diversity of habitats, help maintain water quality, sustain fish populations, and support common lakeshore wildlife such as loons and frogs.

Water Quality

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algal growth. Some plants can even filter and break down pollutants. Plant roots and underground stems help to prevent re-suspension of sediments from the lake bottom. Stands of emergent plants (whose stems protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline. There are very few stands of emergent plants around Deer Lake, making protection of these areas particularly important.

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 many species of fish. Other fish, such as bluegills, graze directly on the plants themselves. Plant beds in shallow water provide important spawning habitat for many fish species.

Waterfowl

Plants offer food, shelter, and nesting material for waterfowl. Birds eat both the invertebrates that live on plants and the plants themselves.[4]

Protection against Invasive Species

Non-native invasive aquatic species threaten native plants in Northern Wisconsin. The most common are Eurasian water milfoil (EWM) and curly leaf pondweed (CLP). These species are described as opportunistic invaders. This means that they take over openings in the lake bottom where native plants have been removed. Without competition from other plants, these invasive species may successfully become established and spread in the lake. This concept of opportunistic invasion can also be observed on land, in areas where bare soil is quickly taken over by weeds.

Removal of native vegetation not only diminishes the natural qualities of a lake, but it increases the risk of non-native species invasion and establishment. The presence of invasive species can change many of the natural features of a lake and often leads to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native plants may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.[5]

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[4] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.

[5] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.

Habitat Areas

The littoral, or plant supporting, zone of the lake provides critical habitat for fish, waterfowl, and other wildlife. It is found in a narrow band around Deer Lake at depths up to 21 feet. This depth extends horizontally from the shore to approximately 115 to 1700 feet into the lake.

Sensitive Area Study

The DNR sensitive area study (1992) identified three areas that merit special protection of aquatic habitat. These areas are shown in Figure 7. In the same report, they describe all of Deer Lake as unique. “Areas of aquatic vegetation provide the necessary seasonal or life stage requirements of the associated fisheries, and the aquatic vegetation offers water quality or erosion control benefits to the body of water.” In the designated sensitive areas, aquatic vegetation removal is limited to navigational channels no greater than 25 feet wide. Chemical treatments are discouraged and if navigational channels must be cleared, pulling by hand is preferable.

Resource Value of Area A

Sensitive Area A is located at the northwestern end of Deer Lake and includes the public boat launch. This area encompasses approximately 2,500 feet of shoreline. The area provides important habitat for centrarchid (bass and panfish) and esocid (northern pike and muskellunge) spawning and nursery areas. This area also provides important habitat for forage species. Wildlife are also reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians benefit from this valuable habitat.

Resource Value of Area B

Sensitive Area B is located adjacent to Area A, extending along the western shoreline of Deer Lake. This area encompasses approximately 1,200 feet of shoreline. *The habitat values of Site B mirror those described for Area A above.*

Resource Value of Area C

Sensitive Area C encompasses a small bay at the northwestern corner of Deer Lake. This bay comprises the entrance of Rock Creek. Approximately 600 feet of shoreline are located in this sensitive area. *The habitat values of Site C mirror those described for Area A above.* The Deer Lake Conservancy purchased a large portion of the shoreline of this sensitive area in October 2016.

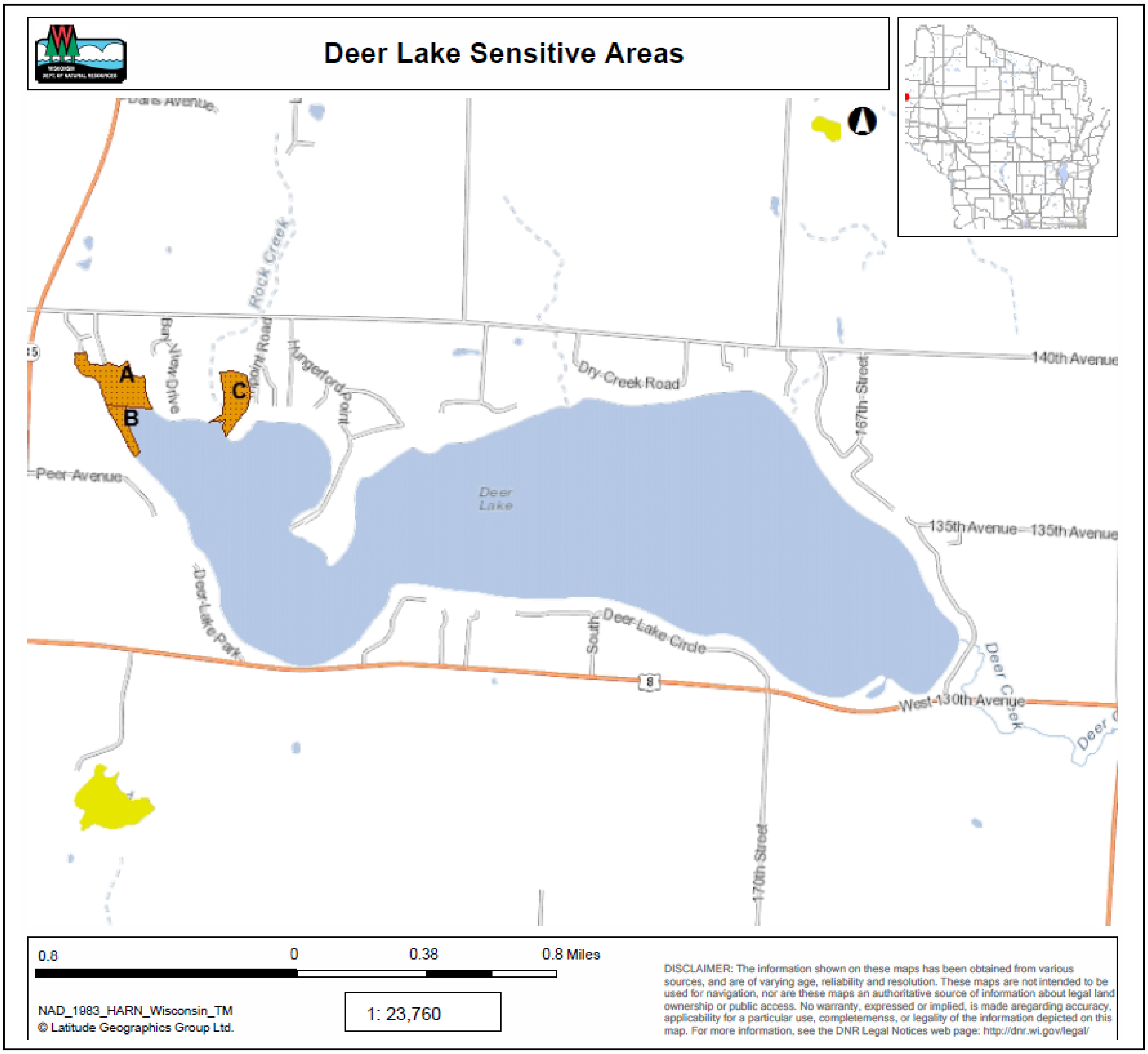

Figure 7. Deer Lake Sensitive Areas (Critical Habitat Areas)

Significant Habitat Areas

Plant surveyor, Steve Schiffer, also identified and described four significant plant habitats based on the location and coverage of plant species. These regions are labeled A-D in Figure 8. Regions A and B overlap with DNR-designated Sensitive Areas.

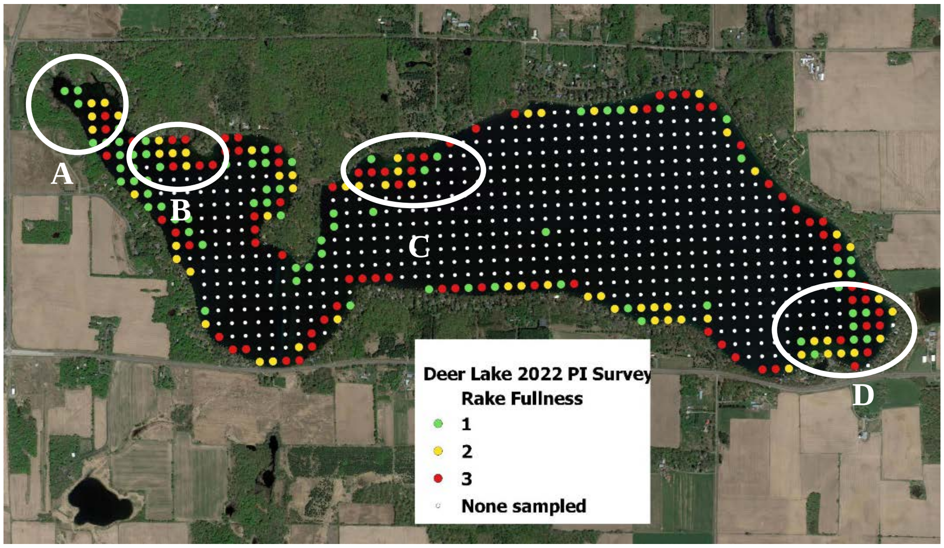

Figure 8. Significant Plant Habitats and Rake Fullness

<u>Area A</u>

Area A near the landing contains high nutrient muck sediment. This is the only area that has consistent floating plant coverage. It also has the most extensive coverage of emergent plants. Floating and emergent plants provide habitat for various organisms ranging from small invertebrates to small mammals that other plants do not provide. In addition, the boat traffic in this area is extensive, and these plants help stabilize the sediment and protect the shoreline. Plants in this region include white water lily (floating plant), soft-stem bulrush (emergent), cattails (emergent), common bur-reed (emergent), large duckweed (floating), and numerous submergent plants such as clasping pondweed, stiff-water crowfoot, coontail, common waterweed, and white-stem pondweed. Area A also has the highest species richness (variety of species) on the lake.

Due to the proximity to the boat launch and the presence of high-nutrient sediment, Area A is a high concern for invasive plant species introduction. In fact, the non-native aquatic forget me not and narrow-leaved cattail are already present.

Figure 9. Plants present in Area A (left to right): Broad-leaved Cattail, Common Bur-reed, Soft-stem Bullrush, and White Water Lily

Area B

Area B has a small area of emergent vegetation near shore and is contained in a wetland that is part of the lake bed. This area has a shallow, low-nutrient substrate with sensitive plants present, including waterwort and quillwort. It also has extensive coverage of the submerged plant northern watermilfoil.

Figure 10. Plant present in Area B: Spiny-spored Quillwort

Emergent plants include cattails, soft-stem bulrush, and common bur-reed. This is one of only two areas of the lake with the floating leaf plant, white water lily. Area B had several points with high species richness in the 2022 aquatic plant survey. One sample point had nine different species on one rake sample. The area is also a likely location for invasive species infestation.

Area C

Area C has a range of sediment types from muck to sand and gravel and resulting range of habitats. Chara sp. is common in this area, thriving in a sand substrate. This bay and surrounding area is one of only a few areas that have widespread plant coverage, largely due to shallow water. Common plants include Chara sp., coontail, flat-stem pondweed, northern watermilfoil, and sago pondweed.

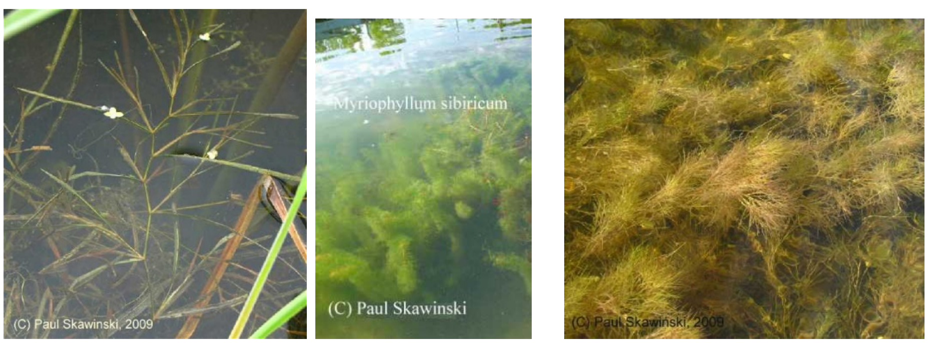

Figure 11. Plants present in Area C (left to right): Flat-stem Pondweed, Northern Watermilfoil, and Sago Pondweed

Area D

Area D is another bay with widespread aquatic plant coverage. The southern portion of this area includes a rocky and sandy substrate, which limits the species of plants present. These are often more sensitive plants. The species richness of the sample points was moderate to high.

Common plants in Area D include clasping pondweed, coontail, flat-stem pondweed, northern watermilfoil, and wild celery. Area D has the most coverage of variable pondweed, which can thrive in sandy/rocky substrates. Variable pondweed is also quite sensitive to disturbance.

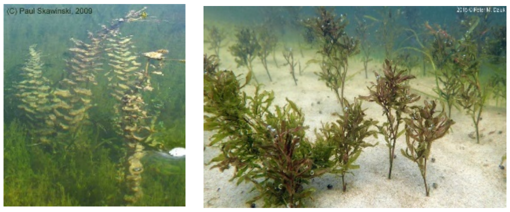

Figure 12. Plants present in Area D (left to right): Clasping Pondweed and Variable Pondweed Photo use permission from Paul Skawinski

Aquatic Plant Survey Results

Ecological Integrity Service completed a Deer Lake aquatic plant inventory in June and August 2022, according to the DNR-specified point intercept method. This survey was a follow-up to surveys completed in 2010 and 2016.

The results discussed below are summarized or taken directly from the aquatic plant survey. The survey and data analysis methods for the aquatic macrophyte survey are found in the following report: *Aquatic Macrophyte Survey: Point Intercept Method Deer Lake (WBIC: 2619400), Polk County Wisconsin June/August 2022*, by Steve Schieffer, Ecological Integrity Services, Inc. (Schieffer, 2022).

Using a standard formula based on a lake's shoreline shape and length, islands, water clarity, depth, and size, the Wisconsin Department of Natural Resources (DNR) generated the sampling point grid of 752 points. Figure 13 below shows the distribution of these sampling points. Once the depth at which plants grow is determined, points deeper are not sampled.

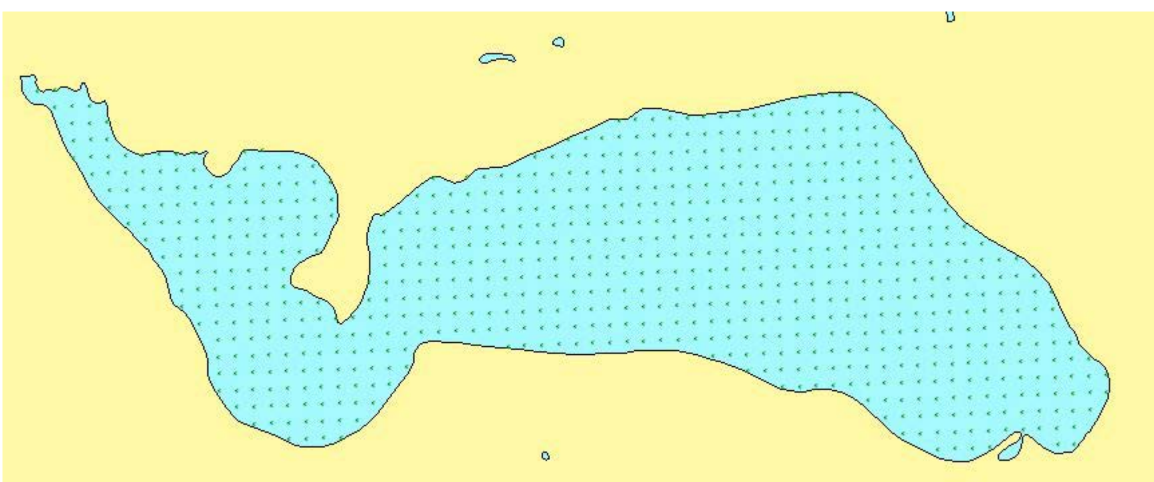

Figure 13. Sampling Point Grid

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 illustrated in Table 5 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

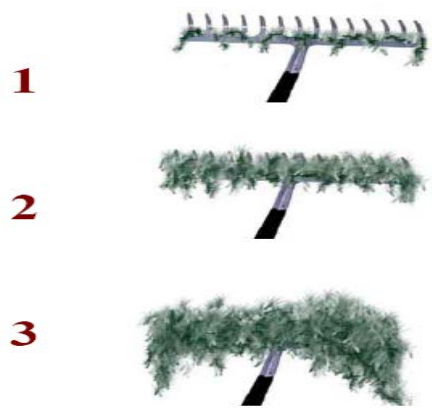

Figure 14. Plant Rake Fullness

Deer Lake point intercept aquatic macrophyte survey results show a diverse, healthy plant community. About 90% of the littoral zone (defined by the maximum depth of plants) had aquatic plant growth. Since the littoral zone in Deer Lake is quite narrow around most of the shoreline, the overall coverage of plants in the lake is quite low at 29% of all sample points. Where plants are growing, growth is quite dense, with high rake fullness as illustrated in Figure 15. Many areas had a heavy growth of *Chara sp*. or coontail (*Ceratophyllum demersum*).

The Simpson’s Diversity Index was 0.9, indicating most samples resulted in different species on successive rake samples. There were 32 species of macrophytes sampled; 31 were native species, and one was a non-native species. The mean number of species sampled at each sample site with plants was 2.7 species. Deer Lake has high water clarity, and this is supported by plants sampled at a maximum water depth of nearly 21 feet.

Table 6. Deer Lake Plant Survey Summary (2022)

Survey Parameter	
Total number of sites in the sample grid	752
Total number of sites with vegetation	220
Total number of sites shallower than the maximum depth of plants	243
Frequency of occurrence at sites shallower than the maximum depth of plants	90.53
Mean rake fullness (where plants present)	2.04
Simpson Diversity Index	0.90
Maximum depth of plants (ft)	20.7
Mean depth of plants (ft)	8.7
The average number of all species per site (shallower than max depth)	2.42
The average number of all species per site (veg. sites only)	2.69
The average number of native species per site (shallower than max depth)	2.42
The average number of native species per site (veg. sites only)	2.69
Species Richness	32
Species Richness (including visuals)	32

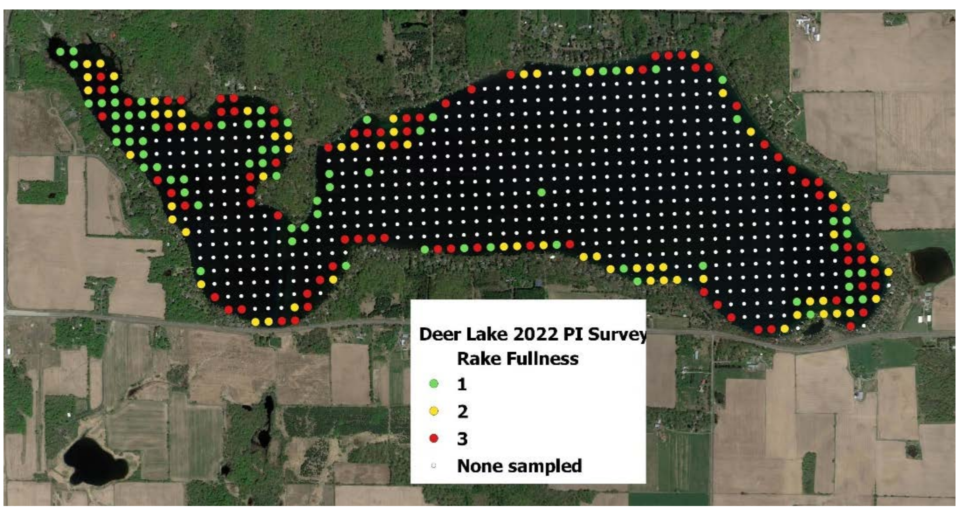

Figure 15. Deer Lake Point Intercept Survey Rake Fullness (2022)

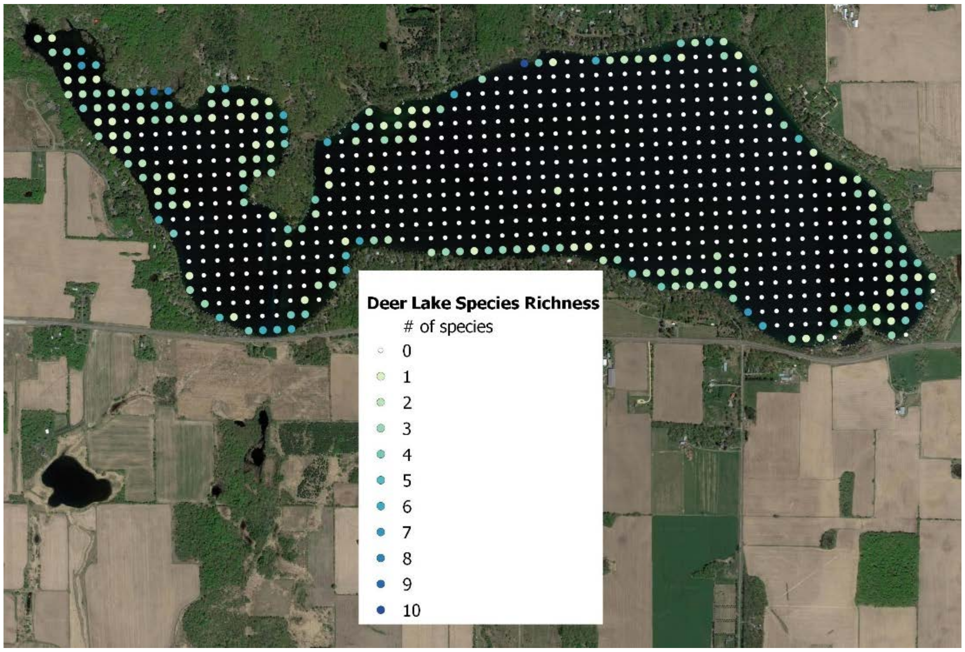

Figure 16. Deer Lake Point Intercept Survey Species Richness (2022)

The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community response to development and human influence on the lake. It takes into account the species of aquatic plants present and their tolerance for changing water quality and habitat characteristics. A plant's tolerance is expressed as a coefficient of conservatism (C). Native plants in Wisconsin are assigned a conservatism value between 0 and 10. A plant with a high conservatism value has more specialized habitat requirements and is less tolerant of disturbance and/or water quality changes. Those with lower values are more able to adapt to disturbance or changing conditions, and can therefore be found in a wider range of habitats.

The FQI is calculated using the number of species present and these plants' species conservatism values. A higher FQI generally indicates a healthier aquatic plant community.

Table 7. Floristic Quality Index

FQI Parameter	Deer Lake 2016	Deer Lake 2022	Ecoregion median
Number of species in FQI	30	31	14
Mean conservatism	6.17	6.26	5.6
FQI	33.8	33.84	20.9

As Table 7 shows, the FQI is much higher than the ecoregion median from Dr. Stanley Nichol's database (Nichols, 1999). Also, the mean conservatism increased slightly from 2016 to 2022, showing that human activity does not appear to affect the Deer Lake aquatic plant community.

Sensitive Species

One species sampled in 2022 is listed as a species of special concern in Wisconsin. *Stuckenia filiformis* (fine-leaved pondweed) is a special concern species classified as S2 because it is "imperiled in Wisconsin due to a restricted range, few populations or occurrences, or steep declines." In addition, *Elatine minima* (waterwort) has a conservatism value of "9".

Table 8. Deer Lake Sensitive Aquatic Plant Species 2022

Species	Designation
Stuckenia filiformis-fine-leaved pondweed[6]	Wisconsin species of special concern
Elatine minima-waterwort	Conservatism value of 9 (10 is the highest)

Figure 17. (left to right) Fine-leaved Pondweed (Stuckenia filiformis) and Waterwort (Elantine minima)

Northern Wild Rice

Wild rice is an aquatic plant with special significance to Native American Tribes. It was not found in Deer Lake in any of the aquatic plant surveys (2003, 2006, 2010, 2016, or 2022).

[6] This plant has not been sampled in Deer Lake before. A voucher specimen was sent to the Freckmann Herbarium at UW-Stevens Point and was verified as *Stuckenia filiformis*.

Comparison of Plant Surveys

Comparing periodic aquatic macrophyte surveys helps to identify any changes in the plant community. Ecological Integrity Service conducted Deer Lake aquatic macrophyte surveys with consistent methods in 2010, 2016, and 2022.[8]

Table 9. Comparison of Deer Lake Plant Surveys 2010, 2016, and 2022

Parameter	**2010**	**2016**	**2022**
% of points with plants	29.9	29.6	29.2
Species richness	28	32	32
Dominant species	Forked duckweed (*Lemna trisulca)*	Coontail *Ceratophyllum demersum*	Coontail *Ceratophyllum demersum*
% of littoral with plants	88.2	87.8	90.5
Simpson's Diversity Index	0.89	0.91	0.9
Floristic Quality Index (FQI)	33.4	33.8	34.8
Maximum depth of plants (feet)	28.0	26.2	20.7

As Table 9 portrays, the plant community has changed little over the years based on the parameters evaluated. The species richness, diversity index, coverage of plants, and FQI have remained consistent. The biggest difference is the maximum depth of plants with lower maximum depth in the 2022 survey. Changes in maximum plant depth could result from decreasing water clarity, but this is not the case for Deer Lake. Declines in species that grow in deeper water could also lead to a decline in maximum depth. As a result, this data was reviewed in detail, and specific concerns were not identified.

In 2010, *Nitella sp*. (stonewort) was sampled at 28 feet, a relative outlier. The next deepest point with plant growth was 22.6 feet, which is closer to the 20.7 depth where plants grew in 2022. In 2016, the deepest with plant growth was 26.2 feet, which had forked duckweed. There were also plants sampled in 2016 at 23.2, 22.7, and 22.3 feet. The most common plants growing more than 21 feet in 2010 and 2016 were coontail, forked duckweed, and elodea. In many of the same sample sites greater than 20 feet, no plants were sampled in 2022. These same plants were sampled in depths just below 20 feet in 2022.

For a more in-depth change analysis, the frequency of occurrence of individual species was analyzed using a chi-square analysis. If the frequency change is statistically significant, the p-value derived from the chi-square will be less than 0.05. The lower the p-value, the more statistically significant the difference.

There was a statistically significant increase in two species from 2016 to 2022 and in five species from 2010 to 2022 (Table 10).

[8] A macrophyte survey was also conducted in 2006, but that was the very beginning of using point intercept methods and the protocol has changed. For a more valid comparison, the 2010 survey data is the earliest data that is used.

Table 10. Significant Aquatic Plant Increases (2010 – 2022)

Species with Significant Increases	Significant 2010-2022 (p-value)	Significant 2016-2022 (p-value)
Chara sp. (muskgrass)	Yes (6.6×10^{-11})	Yes (0.00004)
Potamogeton gramineus (variable pondweed)	Yes (7.5×10^{-8})	
Stuckenia pectinate (sago pondweed)	Yes (0.00001)	
Potamogeton richardsonii (clasping pondweed)	Yes (0.001)	
Potamogeton zosteriformis (flat-stem pondweed)	Yes (0.013)	Yes (0.00006)

The chi-square analysis shows a statistically significant decrease in three species from 2016 to 2022 and in five native species from 2010 to 2022 (Table 11). Curly-leaf pondweed (invasive) had a statistically significant reduction from 2010 to 2022 (early season point intercept survey), which is desirable.

Table 11. Significant Aquatic Plant Decreases (2010 – 2022)

Species with Significant Decreases	Significant 2010-2022 (p-value)	Significant 2016-2022 (p-value)
Lemna trisulca (forked duckweed)	Yes (1.5×10^{-15})	Yes (8.9×10^{-9})
Potamogeton praelongus (white-stem pondweed)	Yes (0.00002)	
Potamogeton robbinsii (fern pondweed)	Yes (0.0002)	Yes (0.02)
Elodea canadensis (common waterweed)	Yes (0.004)	Yes (0.03)
Vallisneria americana (wild celery)	Yes (0.006)	
Potamogeton crispus (curly-leaf pondweed) (invasive)	Yes (0.015)	

Potential concerns are raised with significant decreases in native plant species. The causes of the decreases are unknown, but reduction due to herbicide used in curly leaf pondweed management is of potential concern. Since the herbicide used is broad spectrum, all plants growing at the time of treatment may be susceptible to the herbicide. Because there were five species with significant increases, the potential for herbicide as the cause of the decrease is low. Also, most native plants in Deer Lake did not appear to form widespread beds, but rather small clumps of different species. A minor fluctuation in sampling location can change the possibility of sampling or not sampling a plant, leading to frequency changes in the data.

Aquatic Invasive Species

Five non-native, invasive plant species were found on Deer Lake in 2022.

- Yellow Iris (*Iris psuedacorus*)
- Aquatic forget me not (*Myosotis scorpioides*)
- Reed canary grass (*Phalaris arundincea*)
- Narrow-leaved cattail (*Typha angustifolia*)
- Curly-leaf pondweed (*Potamogeton crispus*)

All species listed above (except curly-leaf pondweed) were identified during a boat meander survey to identify potential invasive species. They have all been observed on the lake in the past.

Yellow Iris
Yellow iris (*Iris psuedacorus*) is an ornamental plant used in flower gardens. It can become dense and dominate wetland areas. Deer Lake yellow iris sites are small clumps or individual plants, with no dense beds forming. The number of locations has increased somewhat since 2016 (Figure 18).

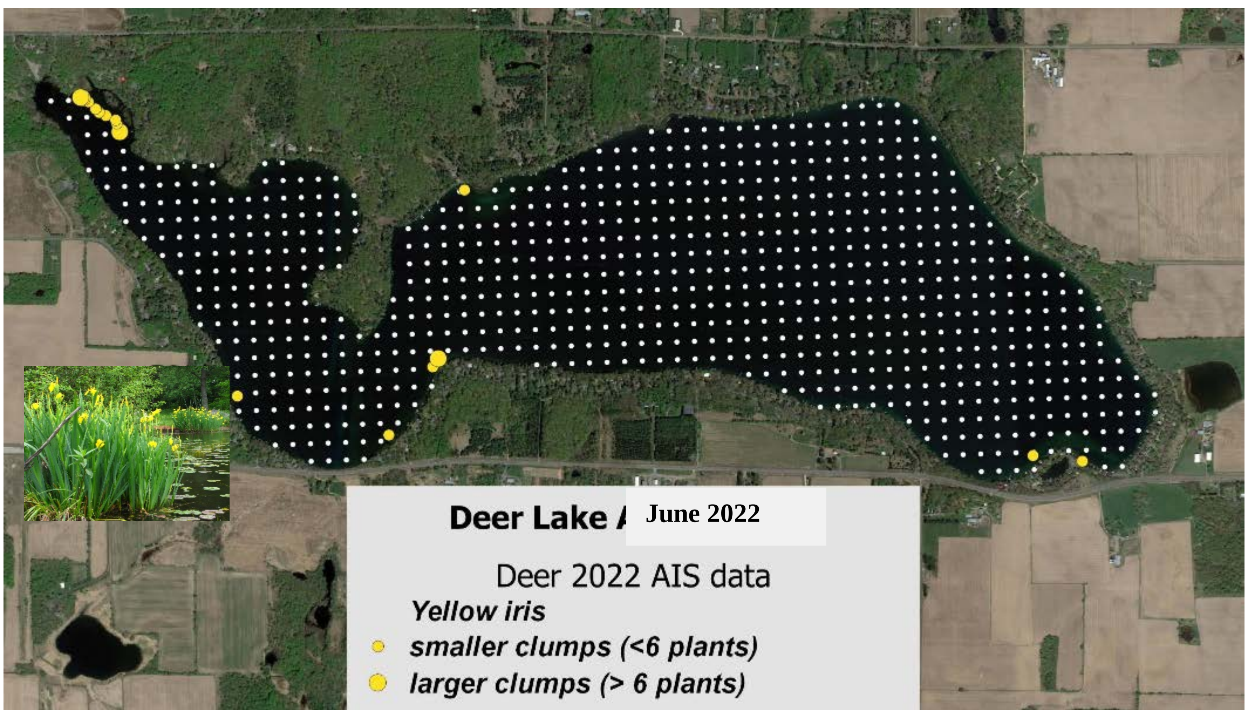

Figure 18. Observed Yellow Iris, June 2022

Aquatic Forget Me Not

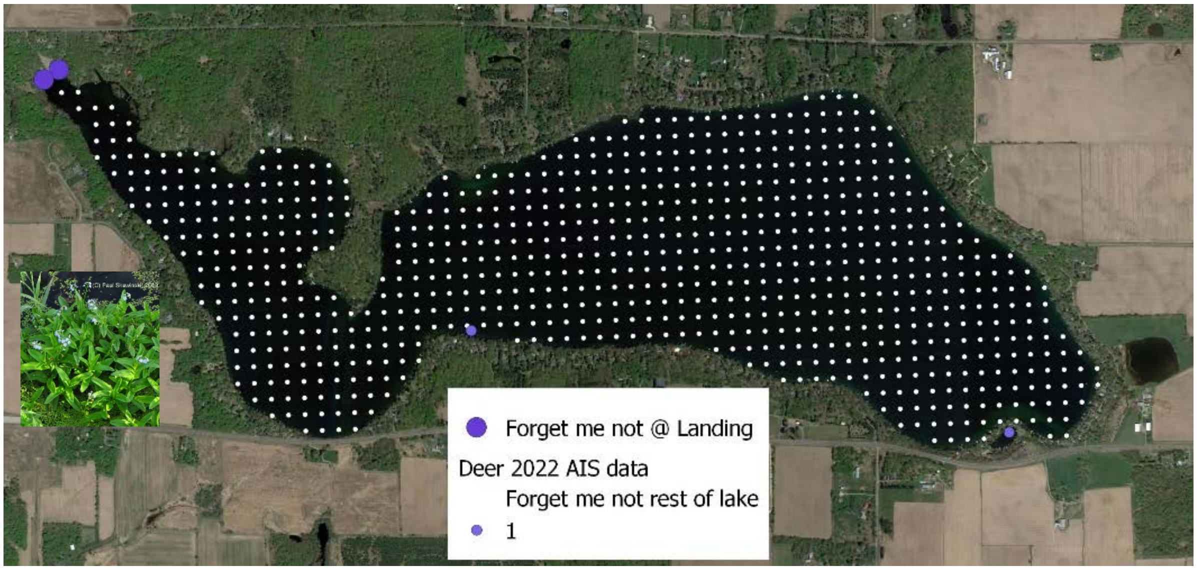

Figure 19. Observed Aquatic Forget Me Not, August 2022

Forget me not (*Myosotis scorpioides)* is also planted in flower gardens. An aquatic version can grow on the water surface, forming a mat of stems and roots. This has occurred near the boat landing. Mitigation of the forget-me-not is recommended. Figure 19 shows the locations of forget me not.

Narrow-leaved Cattail

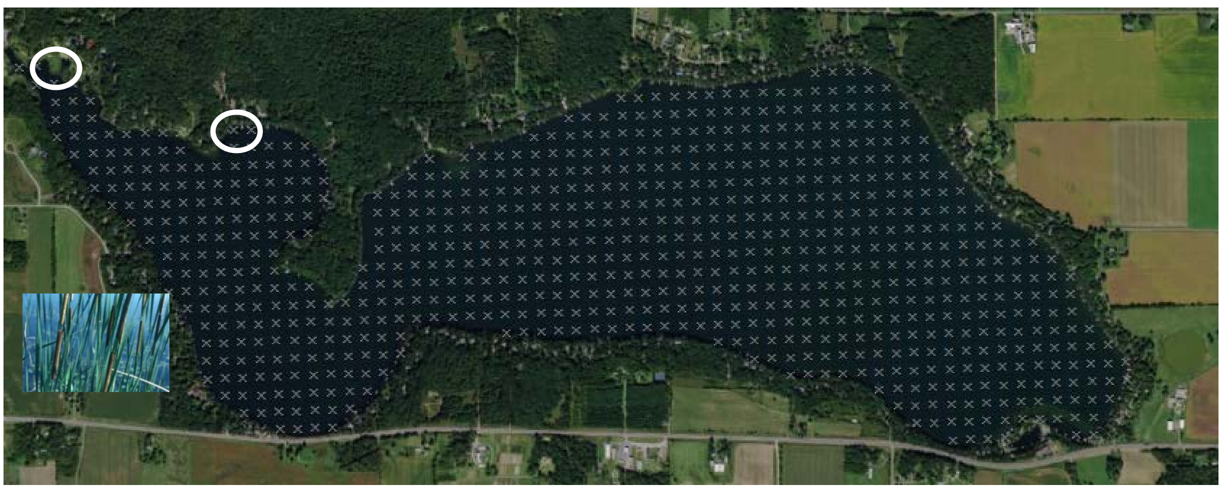

Figure 20. Observed Narrow-leaved Cattail, August 2022

Narrow-leaved cattail *(Typha angustifolia)* is a common invasive plant around Wisconsin wetlands. It can form dense stands. It serves a similar role as the native broad-leaved cattail, but tends to thrive better than the native in deeper water. This plant commonly hybridizes with the native form. Narrow-leaved cattail was observed in two locations in Deer Lake (Figure 20). Mitigation of this plant is uncommon.

Reed Canary Grass

Reed canary grass (*Phalaria arundincea)* is widespread throughout Wisconsin readily establishing in disturbed areas around lakes and wetlands. Mitigation is not common unless a native plant restoration project is planned. A large bed of reed canary grass was found in the lake bed near the boat landing, and this plant is present in numerous locations along the Deer Lake shoreline.

More information about several aquatic invasive species is included in the APM Companion Document.

All of the above species are restricted species in Wisconsin. According to NR 40, restricted invasive species are already established in the state and cause or have the potential to cause significant environmental or economic harm or harm to human health. Restricted species are subject to a ban on transport, transfer and introduction, but possession is allowed with the exception of fish and crayfish.

Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Polygonum sachalinense*) are a concern for riparian areas of Deer Lake. The Polk County Land and Water Resources Department located several riparian locations throughout Polk County including where giant knotweed was found intentionally planted on private property along Deer Lake Park Road in 2017 (now 186th Street) during an invasive species survey.

There is a high risk that Eurasian water milfoil (EWM) and other aquatic invasive species may become established in Deer Lake. The lake is a popular lake for musky fishing and tournament fishing. Many fishermen travel from the Twin Cities, Minnesota area, and access the lake at the boat landing. With Eurasian water milfoil present in many urban Twin Cities lakes, there is a threat of transporting plant fragments and other AIS on boats and motors. Suitable habitat for northern water milfoil, which is spread throughout Deer Lake, is another factor that increases susceptibility to invasion by Eurasian water milfoil.

In Polk County, EWM is found in Cedar Lake, Half Moon Lake, Horseshoe Lake, Indianhead Flowage, North Twin Lake, South Twin Lake, Pike Lake, Long Trade (8 lakes), and the St. Croix River. Department of Natural Resource scientists have also found Eurasian water milfoil in many lakes in nearby Wisconsin counties of Burnett (6 lakes), Barron (9 lakes), and St. Croix (8 lakes).[9]

[9] https://dnr.wi.gov/lakes/invasives/AISLists.aspx?species=EWM&location=ANY

Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c)."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[10]

Curly leaf pondweed beds were first mapped and inventoried in detail on Deer Lake in mid-June 2005. These beds had coverage of at least 50% CLP, and growth had topped out at the surface. The resulting map is included as Figure 21. Additional CLP beds were subsequently located near the Lagoon in the southeast portion of the lake. Aside from the northern shore on the east part of the lake, these beds have been the focus of CLP treatment efforts since that time.

[10] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species.* Prepared by Wisconsin DNR. September 2003.

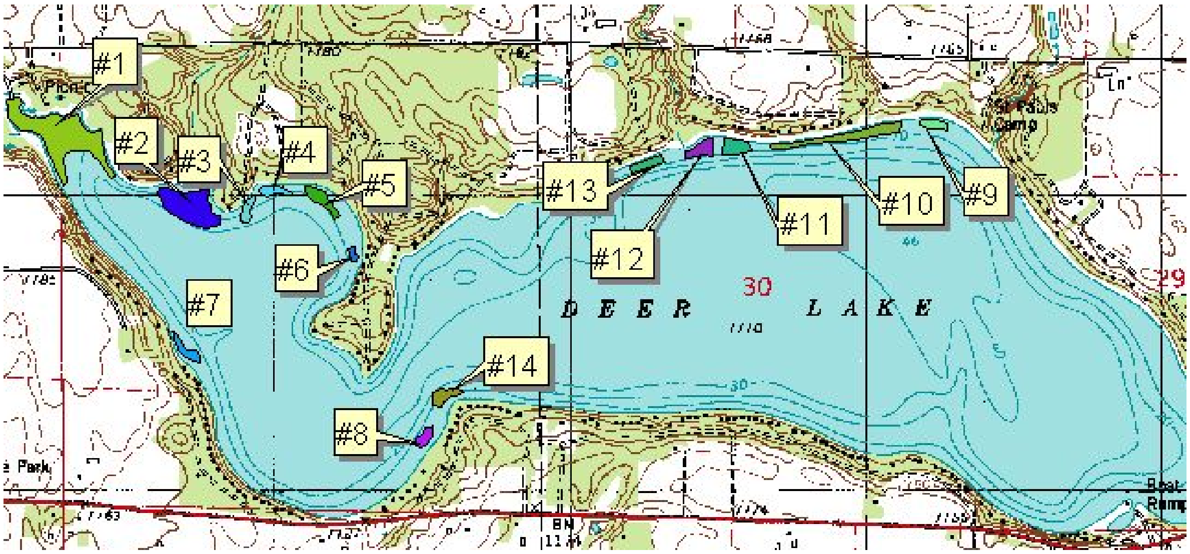

Figure 21. Curly Leaf Pondweed Beds on Deer Lake 2005

Curly leaf pondweed (CLP) has been mapped and monitored annually since 2005. In addition, the DLIA conducted early season herbicide treatments of CLP from 2006-2022. In May 2022, curly leaf pondweed beds totaling 7.6 acres were identified and treated with herbicide. These beds had CLP topped out at the surface, but had lower CLP frequency than in past years (35% overall compared with >50% in past years). This represents less than 3% of the littoral area. More information about DLIA curly leaf pondweed management efforts and results are in a following section of this plan.

Figure 22. Curly Leaf Pondweed Treatment Areas 2022

Zebra Mussels *(Dreissena polymorpha)*
While zebra mussels are invertebrates rather than plants, they are an invasive species of concern covered in this aquatic plant management plan. A single adult zebra mussel was found near the northeast shore of Deer Lake on September 2, 2016. The substrate was rocky. Zebra mussels tend to attach to hard surfaces like piers, docks, boats, and rocks. The DLIA informed dock service providers and residents and requested that they check and report any docks or equipment pulled out of Deer Lake. No additional evidence of zebra mussel adults or larvae was found in 2016 or 2017 following repeated searches and resident notification (Harmony Environmental, 2017). The US Fish and Wildlife Service found no adult zebra mussels on a plate sampler at the landing in 2017 or 2018.[11]

Zebra mussels have expanded significantly in Deer Lake since 2016. The DLIA sponsored monitoring efforts using plate samplers and concrete blocks and initially recorded results. By the date of a September 2019 mailing to lake residents, a total of only 4 adult zebra mussels had been found.[12] In October of 2020, an article in the DLIA newsletter Deer Tales described zebra mussel distribution as "numerous with a diffuse distribution." By spring of 2022, zebra mussels had been found all around Deer Lake. The DLIA no longer tracks resident zebra mussel monitoring results.

During the summer 2022 aquatic plant survey, numerous plant samples had extensive zebra mussels attached. The most common plant species with zebra mussels was *Chara sp*. Some coontail samples and northern watermilfoil samples also had zebra mussels attached. The frequency of sampling plants with zebra mussels was not recorded, but it was estimated that of the 220 sites with plants, at least 33% of them had zebra mussels. There were also some shallow areas of the lake with dense zebra mussel coverage on the lake bottom (Schieffer, 2022).

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Figure 23. Deer Lake Aquatic Plant Sample with Zebra Mussels Attached

[11] Dave Wedan, email communication, October 11, 2018.
[12] DLIA resident mailing September 3, 2019.


Figure 24. Deer Lake Substrate with Zebra Mussels near the Outlet

The Wild Rivers Conservancy and the National Park Service monitor zebra mussel veligers (larval form) in Deer Lake and other area lakes. Veliger monitoring results coincided with adults observed with few detected through 2019 then increasing from 2020 to 2022 when the zebra mussel population began to spread throughout the lake.

Table 12. Deer Lake Veliger Tow Results

2016	Not detected
2017	Not detected
2018	Not detected
2019	.003/L
2020	.040/L
2021	1.97/L
2022	14.2/L

Deer Lake is one of only three locations where zebra mussels are confirmed in Polk County. The others are Balsam Lake (verified in 2022) and the Indianhead Flowage on the St. Croix River (verified in 2021).[13] Zebra mussels were found in Lake Wapogasset in the summer of 2022, but not enough specimens were found to confirm this discovery as of February 2023. Zebra mussels are still relatively rare across northwestern Wisconsin.

Control

The Deer Lake Improvement Association investigated control measures available and the likely results for the 2017 aquatic plant management plan. It was expected that control efforts might be reasonable if zebra mussels were identified within a discreet area following extensive monitoring

[13] https://dnr.wi.gov/lakes/invasives/AISLists.aspx?species=ZM&location=49

efforts. A containment curtain can be used to separate the treatment area from the rest of the lake to be able to maintain concentration of chemical for the desired exposure time. However, by the time zebra mussel locations were known in Deer Lake, they had spread throughout the lake. Widespread distribution makes control measures difficult.

Control options listed in Table 13 have been tried in Minnesota with some success.[14] However, the Wisconsin DNR has not permitted zebra mussel control and is not currently investigating options to do so.[15] In Christmas Lake, treatment with various control measures was found to be effective within a treatment area, only to have zebra mussels discovered outside of the area multiple times. Because of cost and effects on non-target organisms, whole lake treatment is not likely a viable option for Deer Lake.

In Lake Minnewashta in Carver County, Minnesota a zebra mussel rapid response project and report provides important control information.[16] *Zebra mussels were first discovered in Minnewashta by the MCWD's early detection monitoring program on August 18, 2016. Through further surveys, the population appeared to be localized to the public access area and a rapid response was initiated. Partners in the response included MCWD, Carver County and the Lake Minnewashta Preservation Association. A 29 acre bay was cordoned off with barriers, and treated with EarthTec QZ for 10 days at a target copper concentration of 0.3 to 0.5 ppm. An additional 0.61 acre area, within the 29 acre area and surrounding the boat launch where the infestation occurred, was also cordoned off with barriers and treated with EarthTec QZ. Bump treatments were necessary to maintain target concentration, and occurred on days 1, 3, 6 & 8.100% mortality of zebra mussels was observed by day 10. Other parameters monitored included dissolved oxygen, pH, conductivity, water temperature and observations on non-target impacts. A survey of docks and lifts taken out of the water by residents was also conducted on October 28, 2016 with no zebra mussels found.*

EarthTec QZ was chosen as the product of choice due to costs; the cost of Potash was quoted as 3 times as expensive. Timeliness was also a consideration. Potash would have required an amended or new emergency authorization from the US EPA, whereas EarthTec QZ already had an EPA approved label for zebra mussels. A lower Copper concentration range of 0.3 to 0.5 ppm was proposed for the EarthTec QZ treatment based previous data from the manufacturer and previous lab trials by MCWD that showed 100% mortality of zebra mussels with EarthTec QZ at 0.5 and 1.0 ppm at 8 days exposure.

Zebra mussel sampling and copper monitoring methods are included in the report. Dissolved oxygen levels were very low during the treatment period but increased after the containment curtain was removed. A minor fish kill occurred in the area during the treatment with species detailed in the report. Native mussels that were installed in cages for monitoring purposes were

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[14] McComas, Steve. *Zebra Mussel Early Detection, Rapid Response, and Control Plan for Forest Lake, Washington Co, Minnesota.* April 2015.
Kylie Cattoor, Minnesota DNR, Presentation Joint Minnesota Wisconsin Zebra Mussel Workshop. St. Croix Falls, WI. April 24, 2017.
http://www.minnehahacreek.org/project/lake-minnewashta-zebra-mussel-treatment

[15] Tyler Mesalk, Wisconsin DNR, Polk County Zebra Mussel Forum presentation, February 2, 2023.

[16] Rapid Response to Zebra Mussel Infestation Lake Minnewashta Carver County, MN.
Eric Fieldseth and Jill Sweet, Minnehaha Creek Watershed District, December 30, 2016

likely killed by the treatment. Native plants were damaged within the treatment area. Not including staff time for monitoring and supervising the treatment, the project cost including containment curtain and 29 acres of treatment totaled $31,936.

Table 13. Zebra Mussel Control Options

Method	Action	Permit	Comments
Potash (potassium chloride)	Molluscicide	EPA permit required (may take 2-3 months)	Target concentration 100 ppm potassium. Christmas Lake (10/14, 12/14, 6/15, 7/15). Application did not work well under ice.[12]
Copper compounds (Cu^{2+}) (e.g. Earth TechQZ)	Molluscicide	WNDR permit	Multiple applications may be necessary to maintain 0.3 - 0.5 ppm copper concentration for 8-14 days. Lake Minnewashta 29-acre bay (9/16) – target concentration 0.3 – 0.5 ppm for 10 days. Also used in Christmas Lake (10/14, 12/14). Lower dose applications to control veligers are under investigation.
Zequanox	Biocide (dead bacterial cells)	DNR permit	Settles to the bottom, impacts to native mussels, DO drop. Used in Christmas Lake 9/14. Leave barrier in place maximum of 24 hours because of nontarget impacts.[17] Likely highest cost of chemical treatments.
Tarps and benthic barriers	Smothers everything, destroys habitat	DNR permit	Lake Tahoe (from Cattoor presentation). Leave in place 3 weeks to 1 1/2 years.
Drawdown, dewatering	Long exposure time required	DNR permit	Not be practical for Deer Lake.
Predation	Fish eat ZM: sunfish, common carp, sheepshead		Little research, no strong success indicated.

Table 14. Lake Minnewashta Zebra Mussel Treatment Costs (29-acre bay)

Item	Cost
Enclosure Curtain	$9,000
EarthTecQz	$17,861
Applicator	$5,075
Total Cost	**$31,936.00**

[17] https://www.maisrc.umn.edu/news/lessons-learned-xmas

In 2019, Minnesota Aquatic Invasive Species Research Center (MAISRC) and United States Geological Survey (USGS) researchers conducted an experimental application of low-dose copper in Lake Minnetonka. The concentration was substantially lower than previously used for adult zebra mussels in Minnesota lakes—60 parts per billion (ppb) vs. one part per million (ppm) of free copper. This 'suppression strategy' has shown promise in early-stage trials. The objectives of the study were to determine the effectiveness of low-dose copper for reducing zebra mussel recruitment and to monitor the response of native biota.

Potential treatment-related impacts to native species varied. Zooplankton mean density declined after exposure in the treated bay compared to an increase in the control bay. Similar trends were observed in abundance and family richness of benthic invertebrates that were collected. Chlorophyll A concentration increased about three-fold immediately after treatment, but returned to baseline levels two weeks post-treatment. No treatment-related adverse impacts were observed to the native mussels 24 hours after exposure. Survival of caged native fish within the treated and control bays was similar except for fathead minnows. Mean fathead minnow survival was 84 and 38% in the control and treated bays, respectively. Of interest, the mean tissue copper residue in fathead minnows was higher than other fish species in the treated bay. Mean copper tissue residue was highest in zebra mussels, followed by native mussels (MAISRC, 2021).

The goal of the MAISRC project described above is to develop lake-specific, low-dose copper treatments for zebra mussel suppression that minimizes impacts to native biota and maximizes ecosystem benefits. Researchers completed two years of post-treatment monitoring of the 2019 low dose copper treatment in St. Alban's bay, Lake Minnetonka. The results showed that the treatment effectively reduced the population for at least one year after treatment; mussels reestablished in the treated bay in 2021. One year after treatment, native biotic community composition was similar to pretreatment levels; analysis of the 2021 data on native communities in in progress.[18]

Due to the lack of documented long-term control efficacy, as well as the potential risk to non-target species, the Wisconsin Department of Natural Resources (DNR) does not currently support the use of pesticides to control zebra mussels in lakes or rivers. Any product which claims to kill, control, repel, mitigate, or prevent zebra mussels would be considered a pesticide and must be registered with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP). In addition, the proposed use of any pesticidal product in a Wisconsin waterbody would also require an approved Chapter NR 107 permit for the control of aquatic organisms (WDNR, 2023).

[18] https://maisrc.umn.edu/copper-control

Aquatic Plant Management

This section reports recent management activities on the lake. Available management methods are included in the APM Companion Document.

Aquatic Plant Management Permits

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107 – Aquatic Plant Management. A permit is required for any aquatic chemical application in Wisconsin. Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) due, in the case of Deer Lake, to the designation of sensitive areas.

The requirements for manual and mechanical plant removal are described in *NR 109 – Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, (with the exception of wild rice) from his/her shoreline up to a 30-foot corridor. A riparian landowner may also manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[19]

The DNR withdrew proposed revisions to the administrative rules that regulate aquatic plant management in Wisconsin from the August 2022 Natural Resources Board meeting due to concerns expressed by some stakeholders leading up to the meeting. According to the DNR website, the proposed rule was intended to create a more effective, transparent management program for the control of aquatic invasive species and problematic aquatic plants. The proposed rule was consistent with the EPA (Environmental Protection Agency) and APM (aquatic plant management) industry best management practices and included a fee increase that would have been used to improve customer service and support the program.[20]

[19] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR web site: www.dnr.state.wi.us.

[20] https://dnr.wisconsin.gov/topic/lakes/plants/rules

Preventing Invasive Species

Methods the DLIA and others can consider to prevent invasive species (AIS) introduction and establishment include: education to lake users, Clean Boats Clean Waters program, landing surveillance cameras, decontamination, lake monitoring, and a rapid response strategy for any new invasive species discovered. Costs, advantages, disadvantages and additional information about AIS prevention options are presented in Table 15.

Education to Lake Users

Education efforts focus on identification and prevention of new invasive species. Activities might include aquatic invasive species (AIS) information presented at annual meetings and workshops, signage at the public landings, lake maps and brochures with AIS messages, and web site and newsletter information.

The DLIA currently distributes information through their website: deerlakewi.com. However, aside from promoting the Clean Boats, Clean Waters Program, no information regarding AIS prevention was found on the website. Past copies of the DLIA newsletter Deer Tales which is mailed to lake owners, are posted on the website.

Clean Boats Clean Waters (CBCW) Program

Clean Boats Clean Waters educators provide boaters with information on the threat posed by 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 AIS prevention measures.

A Clean Boats, Clean Waters program began at the Town of St. Croix Falls boat landing on Deer Lake in 2006 with more comprehensive staffing from 2009-2022.[21] The boat landing is generally staffed on weekends from Memorial Day through late August or early September. The hours the landing was staffed each year are included in Figure 25, and the number of boats inspected is shown in Figure 26. The Town of St. Croix Falls provides payroll services for the program. A DNR Clean Boats, Clean Waters grant can currently provide 75% funding up to $4,000 as long as a minimum of 200 hours are covered at a landing or pair of landings.

[21] https://dnr.wi.gov/lakes/invasives/WatercraftSummary.aspx?landing=493221

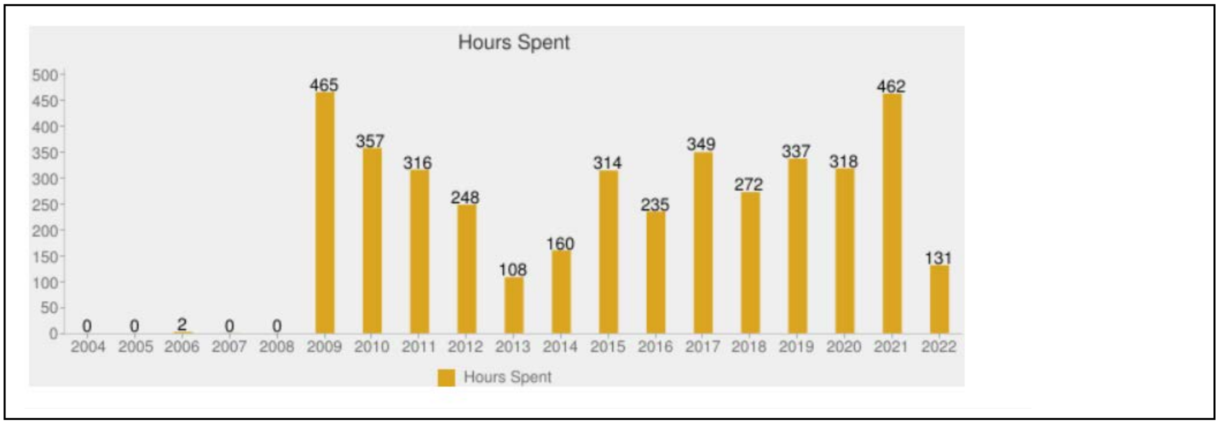

Figure 25. Clean Boats, Clean Waters Hours 2006-2022

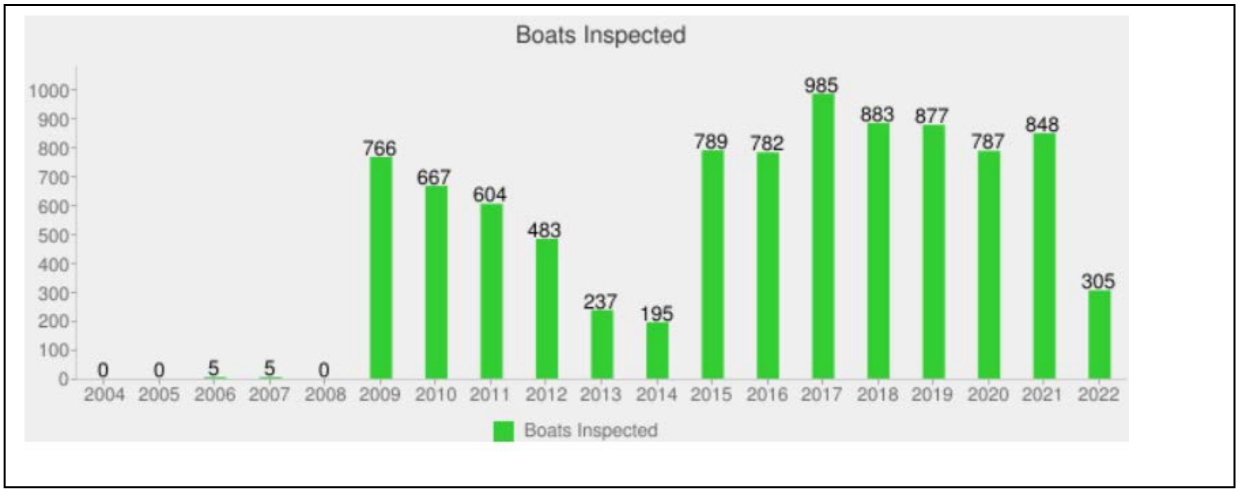

Figure 26. Clean Boats, Clean Waters Boats Inspected 2006-2022

Landing Surveillance Cameras

Some lake organizations use video cameras at public landings to record landing activity. Videos can be 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 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 to 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.

Lake Monitoring

The objective of lake monitoring is to look for new invasive species. Monitoring for invasive species is generally focused around boat landings and other areas of high public use. Trained volunteers or consultants may complete the monitoring. Divers may be used. It is critical to complete aquatic invasive species visual surveys when algae growth is low and visibility is good.

The APM Monitor, Steve Schieffer conducts AIS meandering survey of the littoral zone in June, July, and August. The entire littoral zone is surveyed with special attention near boats, in high traffic areas, near landings, and in high nutrient bays/points.

Rapid Response for New Invasive Species

The activity is intended to control any new invasive species that are found in the lake. Rapid response protocols include the following:

- monitoring for invasive species
- education of lake residents and visitors
- contacts to confirm invasive species identification
- procedures for notification
- plans for removal and control
- funding contingencies and grants.

A Rapid Response protocol is included as Appendix A.

The DLIA approved a rapid response policy at a board meeting June 12, 2010. It authorizes the DLIA Environment Committee Chair to spend up to $15,000 for rapid response for Eurasian water milfoil. Further spending can be authorized with approval of two DLIA officers.

Polk County Land and Water Resources Department (LWRD)
The DLIA can obtain assistance with training, AIS identification and educational activities from the Polk County Land and Water Resources Department.

Table 15. Aquatic Invasive Species Prevention Options (2022 costs)

Method	**Installation Cost**	**Lifetime**	**Annual Cost**	**Labor**	**Advantages**	**Disadvantages**	**DNR Grants**
Clean Boats, Clean Waters	$0	NA	$200 (t-shirts, hats, data sheets)	$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	No tracking of use or audio or video reminders	Grant 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 (zoning regulations, road setbacks, physical installation, aesthetics, utilities, logistics)	75% funding available

Method	Installation Cost	Lifetime	Annual Cost	Labor	Advantages	Disadvantages	DNR Grants
Decontamination Station: Hot water, high pressure wash*	$15,000 - $20,000	10 years	$500 (fuel, maintenance, winter storage)	$ 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 REEQUIREMENTS 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 yrs 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.

Past Aquatic Plant Management

As reported in the 2006 aquatic plant management plan, the Deer Lake Improvement Association contracted with an herbicide applicator to conduct inspections for the presence of Eurasian water milfoil near the boat landing and for filamentous algae along the littoral zone from 2000-2005.

Filamentous Algae Treatment

The Deer Lake Improvement Association has used copper sulfate compounds to alleviate nuisances caused by filamentous algae for many years on Deer Lake. Algae treatments were managed by the Deer Lake Improvement Association Environmental Committee Chair. Up to 15 acres of treatment area were allowed at any one time. From 1993 – 2000 up to five acres were treated for filamentous algae control at a time. In recent years, treatment frequency has decreased drastically. Reductions in treatment are a result of both different treatment standards and reductions in filamentous algae growth. The conditions of the 2006 aquatic plant management plan required that filamentous algae must be matted at the surface rather than attached to plants near bottom sediments before treatment is authorized. In 2008 there were seven occasions when copper sulfate was used to treat filamentous algae. In 2009 0.45 acres were treated.

The 2010 aquatic plant management plan included the following nuisance conditions to authorize the control of filamentous algae:

Identifying nuisance growth of filamentous algae:
100% of rake samples have filamentous algae present
Floating mats exceed 1,000 square feet in aerial coverage
Algaecide treatment will occur only when total mats identified exceed 1 acre

Filamentous algae treatment according to DNR treatment records was as follows: 2010: 2.78 acres, 2011: 1.7 acres, and 2012 – 5 acres. Copper sulfate treatments were at a rate of 10 pounds per acre. Chelated forms of copper sulfate such as Cutrine Plus may be advantageous because they tend to stay in solution longer than copper sulfate.[22] A Cutrine Plus application rate of 0.6 ppm copper is recommended for a medium density filamentous algae growth. The maximum application rate is 1 ppm copper.[23]

Copper in Deer Lake Sediments

A study completed by MacDonald et al. (2000) developed consensus based numerical sediment quality guidelines for metals in freshwater ecosystems. This study provides guidelines for metals in freshwater ecosystems that reflect threshold effect concentrations (TECs, below which harmful effects are unlikely to be observed) and probable effect concentrations (PECs, above which harmful effects are likely to be observed). **The consensus based TEC for copper is 31.6 mg/kg and the consensus based PEC for copper is 149 mg/kg.** (from the Long Lake Management Plan 2013)

<u>Deer Lake sediment copper levels:</u>

Deer Lake - West	120	MG/KG	5/23/2000
Deer Lake – East	94	MG/KG	5/23/2000

[22] J. Aquat. Plant Manage. 34:39-40. 1996.
[23] Cutrine Plus Specimen Label.

Boat Landing

In 2003 the boat landing area was treated with herbicides with the express purpose of preventing the introduction of Eurasian water milfoil in this area. More recent analysis has shown this practice unacceptable for invasive species prevention. Instead, education and monitoring efforts are stressed. The Department of Natural Resources permits were issued for the purpose of allowing boats to pass each other and navigate from the boat landing.

Individual Access Corridors

Individual access corridors (limited to a 25-foot width) were treated with herbicide only at a landowner's request and expense. Many years ago, the treatments were allowed for the entire riparian frontage. In 2007, 49 owners received permits for 25-foot wide herbicide treatments. From the early 1980's through 2006, there were 40 to 69 owners who received permits.

The DNR Northern Region released an Aquatic Plant Management Strategy in the summer of 2007 to protect the important functions of aquatic plants in lakes. As part of this strategy, the DNR prohibited management of native aquatic plants in front of individual lake properties after 2008 unless management was designated in an approved aquatic plant management plan.[24] Because of the importance of the native plant population for habitat, protection against erosion, and as a guard against invasive species infestation, plant removal with herbicides as an option for individual property corridors must be carefully reviewed before permits are issued. The DNR did not allow removal after January 1, 2009 unless the "impairment of navigation" and/or "nuisance" conditions were clearly documented.

Herbicide treatments for navigation in the lagoon area (southeast corner of the lake) were permitted in 2008 through 2012. These treatments extended 30 feet beyond the docks. Herbicides used include Cutrine (copper sulfate), Aquathal K (liquid endothall), and Reward. These treatments were privately managed by the Lagoon Association.

Individual Access Corridor Management

Discussion

Aquatic plants sometimes create nuisances for residents attempting to swim and boat from the shoreline. However, it is important that residents are aware of the risks of clearing of access corridors. Native aquatic plants provide critical habitat for fish and other aquatic creatures. Corridors cleared of native plants may provide sites for colonization by invasive, non-native species.

Herbicide treatment of individual access corridors has been allowed in only a few cases on Deer Lake since the DNR Northern Region office changed its native plant management policy in 2007. Hand pulling/raking is allowed in an area up to 25 feet wide on Deer Lake. (This is 30 feet wide on most lakes, but on Deer Lake the entire lake fringe is considered a sensitive area.) Because native plants prevent the establishment of Eurasian water milfoil and provide important

[24] Aquatic Plant Management Strategy. DNR Northern Region. Summer 2007.

water quality and habitat benefits, there is no plan to open up herbicide treatment for individual corridors around Deer Lake. A channel out from the public boat landing is generally navigable as a result of boat traffic.

Herbicide treatments for navigation in the Lagoon area (southeast corner of the lake) were permitted in 2008 through 2012. The DLIA Environment Committee Chair was asked to evaluate plant growth the first year of treatment to see if the DLIA had any objections to the use of herbicide there. Since then, the DNR has allowed herbicide treatment with no DLIA overview. The threshold to allow treatment according to DNR policy is “severe navigation impairment.” Navigation is deemed impaired when it is not possible to navigate through an area with a motor boat.

The only time a permit is not required to control aquatic plants is when a waterfront property owner manually removes (i.e., hand-pulls or hand rakes), or gives permission to someone to manually remove, plants (except wild rice) from his/her shoreline in an area that is 25 feet or less in width along the shore. The non-native invasive plants (Eurasian water milfoil, curly leaf pondweed, and purple loosestrife) may be manually removed beyond 25 feet without a permit, as long as native plants are not harmed. Wild rice removal always requires a permit.

> Individual Access Corridors are the openings from a waterfront property owner’s shoreline out into the lake. These corridors may be a maximum of twenty-five feet wide and must remain in the same location from year to year.

Guidance for Deer Lake Property Owners

1. Herbicide control of nuisance aquatic plants for boat access and swimming is discouraged because of potential damage to this critical habitat zone. It is illegal for homeowners to apply herbicides without a license and a DNR permit.
2. The DNR currently restricts any native plant removal in the littoral zone (area where plants grow) adjacent to private residences to a width of no more than 25 feet.
3. Residents wishing to control curly leaf pondweed with hand pulling may do so throughout their shoreline area, but must be confident of plant identification and remove all plant fragments.
4. If nuisance aquatic plant growth is controlled in late summer, manual means such as plant rakes must be used. Plant fragments should be removed from the lake and placed on an upland area such as a garden or compost pile.
5. The DNR will provide inspection and direction for any native plant management.

Deer Lake Curly Leaf Pondweed Management

The Deer Lake Aquatic Plant Management Plan (2017) recommended an early season endothall treatment for curly leaf pondweed nuisance areas.

Curly Leaf Pondweed Goals and Objectives (2017 APM Plan)

Goal. Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

Objectives

- Success will be attained when treatment measures significantly reduce CLP bed acreage and rake density with minimal damage to native plants.
- Facilitate the growth of native species.

Defining curly leaf pondweed beds

- May/June mean coverage = 30% or higher (2010 APM plan standard for a bed was 50% or higher)
- May/June curly leaf pondweed stem growth reaches surface and is thick enough to impede navigation (stem height > 1 meter)

The endothall treatments were planned to occur when water temperatures ranged from 55 - 60 degrees Fahrenheit to target this invasive species before significant native plant growth had occurred and to be above the temperatures when yellow perch are nesting. To limit impacts on black crappie that nest in shallow waters, spraying occurred only at depths greater than 1 meter. Treatment locations were located using GPS equipment, and herbicide application amounts and concentrations were recorded in permit records.

CLP Treatment Results

Deer Lake CLP treatments and general results are summarized in Table 16. The Deer Lake Improvement Association received a permit to treat up to 10 acres of curly leaf pondweed beds from 2006 to 2009 with 7 to 10 acres treated during this time period. Additional nuisance beds were added in 2010 to total 32.5 acres. Pre- and post-treatment monitoring was conducted each year according to standard DNR methods once available in 2007.

The target concentration of the herbicide endothall was originally 2.6 gallons per acre or about 0.75 ppm. Beginning in 2010, the target endothall concentration was increased to 1.5 ppm, then to 2.0 ppm in 2017. There was also more emphasis on treating only under calm wind conditions, and the size of some beds was also expanded up to 20 feet beyond the extent of CLP growth. With these measures, treatment efficacy increased, and control of CLP was more effective.

Table 16. Deer Lake Curly Leaf Pondweed Treatment[25]

	Acres Treated (ID'd)	Date of Treatment	Target Concen-tration of Endothall[26]	Water Temperature	Wind Speed	Significant decrease in CLP/Effective Control	Significant decrease in natives from previous year
2006	7.35	May 30	0.75 ppm	60 F	5-10 mph	**No**	None detected
2007	9.99	May 22	0.75 ppm	58 F[27]	10-15 mph	**No**	None detected
2008	9.95	May 20	0.75 ppm	52 F (49?)		**Maybe** – lower densities, Bed 2 decreased in area by 25%	None detected
2009	7	May 21	0.75 ppm	?	18 mph, gusts to 28	**No**	None detected
2010	32.5	May 18	1.25 ppm	56 F	5 mph	**Yes**	Yes
2011	24.61	May 29	<1 ppm	56 F	0 to 5 mph	**No**	Uncertain
2012	23.4	May 9	1.5 ppm	58 F	4 mph	**Yes**	None detected
2013	21	May 28	1.5 ppm	57 F	5-6 mph	**Yes**	Yes, 4 species decreased
2014	23	May 29	1.5 ppm	?	?	**Yes**	No
2015	23	May 8	1.5 ppm	56 F	4-7 mph	**Yes**	Yes, Coontail
2016	23	April 29	1.5 ppm	49 F	0-3 mph	**Yes**	Increase (2) Decrease (2)
2017	23	May 5	2.0 ppm	51 F	calm	**Yes**	Increase (1) Decrease (3)
2018	18.8	May 21	2.0 ppm	58 F	0-4 mph	**Yes**	Decrease (3)
2019	12.5	May 28	2.0 ppm	54 F	3-6 mph	**Yes**	None detected
2020	12.5 (7.7)	May 14	2.0 ppm	52 F	0-2 mph	**Yes**	No decrease
2021	6.45	May 17	2.0 ppm	58 F	0-2 mph	**Yes**	Decrease (1)
2022	7.6	May 23	2.0 - 3.0 ppm	56	3-4 mph	**Yes**	Decrease (1)

25 Information Aquatic Plant Management Herbicide Treatment Records submitted by the applicator to DNR.
26 Treatment concentrations have been adjusted from gal/acre to ppm for comparison.
27 Not recorded on permit report. Information from applicator.

Long term effectiveness of CLP control measures would be demonstrated with declines in the number of acres treated and reductions in the frequency of CLP measured at identified sample points prior to herbicide treatment. Deer Lake herbicide treatments resulted in statistically significant reductions in the frequency of occurrence before and after treatments each year from 2012 – 2022. However, after an initial reduction from 32 acres in 2011 to 25 acres in 2010, CLP growth (acres) in beds remained nearly constant through 2017.

In 2017 the targeted endothall concentration was increased from 1.5 ppm to 2.0 ppm. Beginning in 2018, there were further declines in the area of CLP identified for treatment (Table 16 and Figure 29). By 2022, 7.6 acres of CLP in beds were identified for herbicide treatment. The 2022 *Herbicide Treatment Analysis* is included as Appendix B. More detailed results and pre- and post-monitoring methods are described in that report (Ecological Integrity Service, 2022).

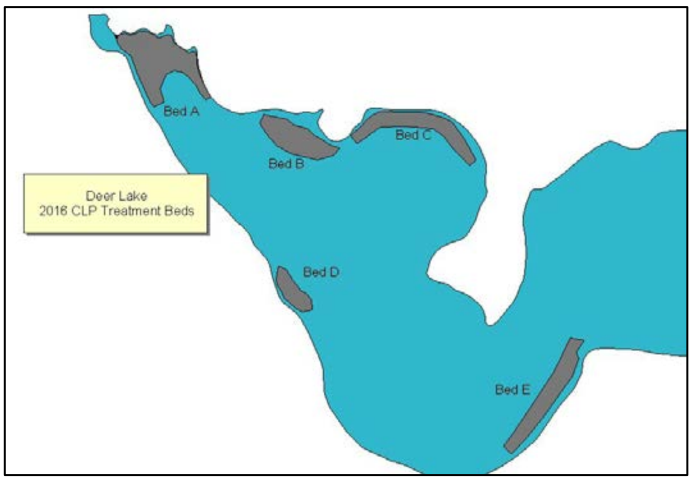

Figure 27. Curly Leaf Pondweed Treatment Areas 2016 (23 acres)

Figure 28. Curly Leaf Pondweed Treatment Areas 2022 (7.6 acres)

Figure 29 illustrates acres of CLP treated each year from 2012 – 2017 and the CLP frequency of occurrence in beds before and after treatment each year. There was a reduction in CLP bed acres treated since 2017.

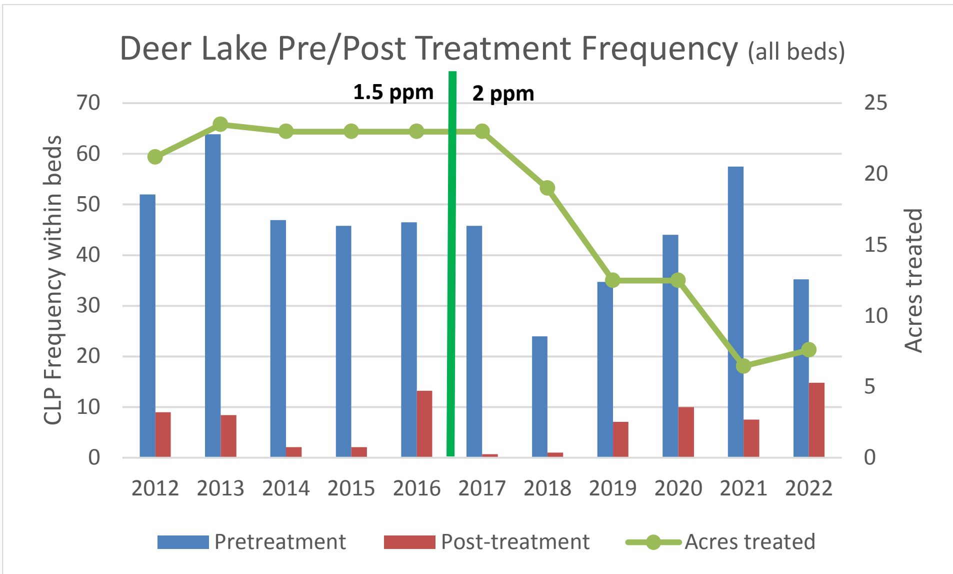

Figure 29. CLP Pre- and Post-Treatment Frequency of Occurrence (2012-2022)

However, from 2018 to 2022, there is no evidence of statistically significant reduction of overall CLP growth (pre-treatment frequency of occurrence) in Deer Lake (Figure 30). The pretreatment values are different from CLP pretreatment frequency in beds displayed in Figure 29 because here the 2018 sample points are used through 2022 for an overall measure of change.

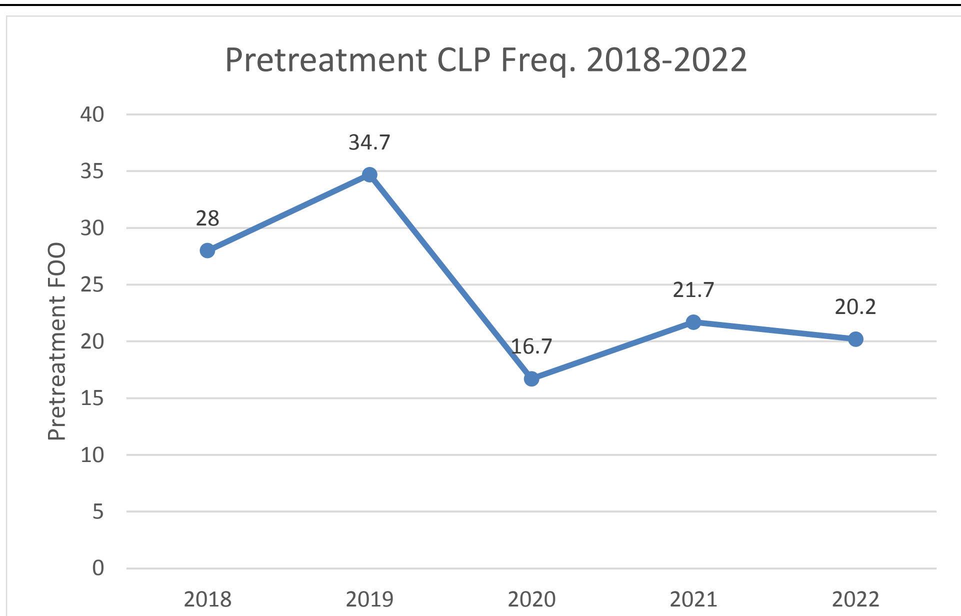

Figure 30. Deer Lake CLP Pretreatment Frequency 2018-2022

Turion Monitoring

Turions are the reproductive structures from which new CLP plants will germinate in fall and early spring. CLP turions can live in lake sediments for many years. A primary objective of the CLP herbicide treatment program is to kill CLP plants before they can form turions, thereby depleting the turion bank in the sediments and preventing future CLP growth.

Turion monitoring measures the density of turions in the sediment. Turion sediment monitoring is conducted in the fall after CLP plants die back. A sediment sampler is used to collect bottom sediment at several randomly selected sample points within the treatment beds. The sample is then filtered with a filter bucket, and the turions are counted. Because the sample collection area is known, the number of turions per square meter of lake bed can be estimated.

Repeated years of turion density measurements provide a means to predict the following year's CLP growth and to evaluate the long-term effectiveness of the herbicide treatment program. Long-term turion density changes are shown in Figure 31. The turion density decreased consistently since 2019. In 2021 and 2022, the mean turion density was the lowest since 2013.

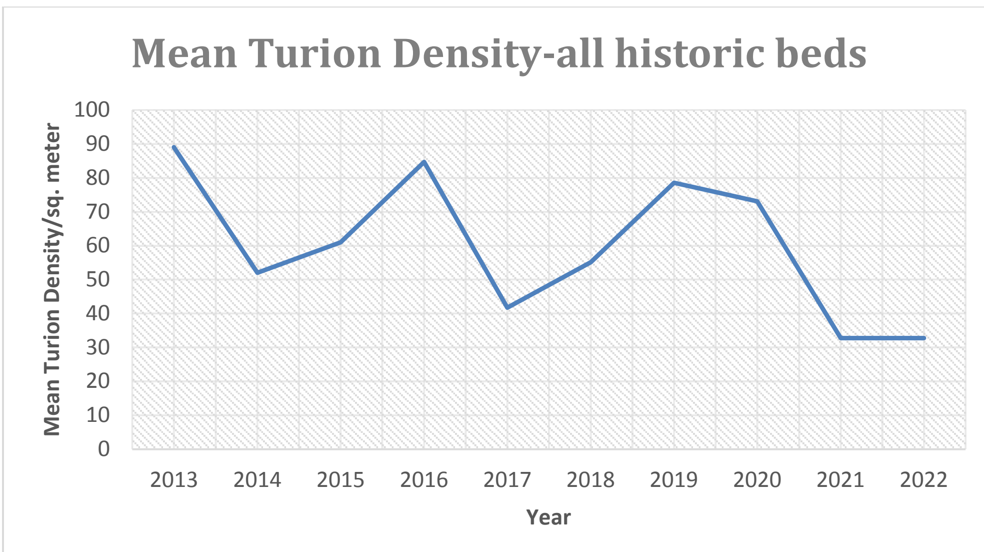

Figure 31. Turion Density Change (All CLP beds) from 2013 to 2021

CLP Herbicide Treatment Effectiveness

There is evidence of declining effectiveness of treatment along with declining acres of CLP treated in Deer Lake. This is likely due, at least in part, to the smaller identified individual treatment beds. It may also be influenced by the overall acreage treated in the lake. Herbicide dissipates quickly from small treatment areas which can render treatment ineffective with resulting diminishing returns.

Figure 32 graphs the correlation between size of the CLP bed treated and treatment effectiveness based on CLP frequency of occurrence following treatment. Treatment years from 2017 – 2022 are graphed because target herbicide concentrations were increased to 2 ppm in 2017 and remained at that level or higher through 2022. The graph trendline shows declining effectiveness with smaller treatment beds. The p-value of this trendline is 0.02, which indicates the relationship between the area of bed and post-FOO is statistically significant within 95% confidence. Stated simply, when larger beds are treated, treatment effectiveness is greater.

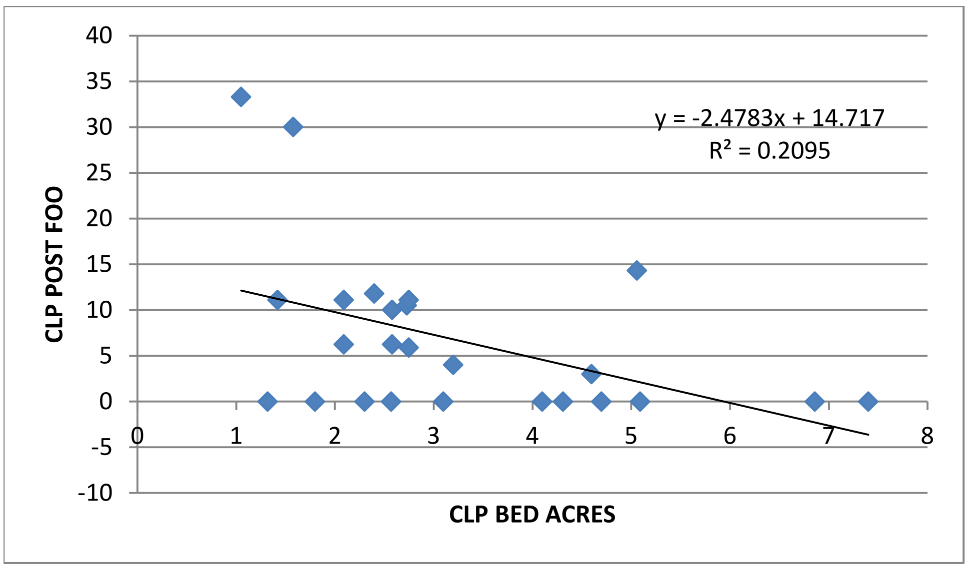

Figure 32. Deer Lake CLP Post Treatment Frequency of Occurrence by Size of Bed Treated (2017 – 2022)

Figure 33 examines effectiveness of treatment related to total acres of CLP treated by examining the percent reduction achieved[28] compared with total acres treated. There is evidence of declining effectiveness as total treatment area decreases on Deer Lake.

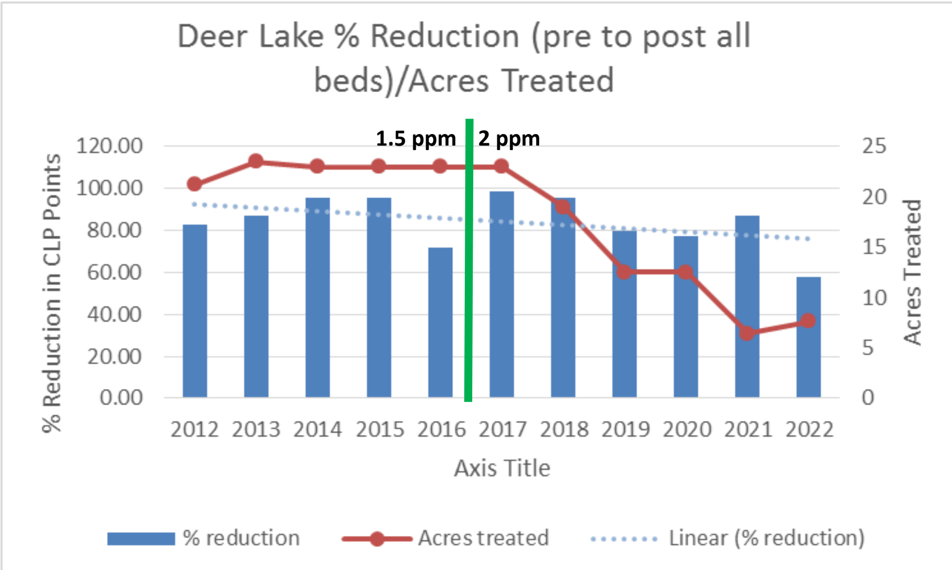

Figure 33. Deer Lake CLP Percent Reduction by Total Acres Treated

[28] Percent reduction = the number of points with CLP at pretreatment minus the number of points with CLP at post treatment, and then calculates the % of the pretreatment CLP pts.
*For example: assume 20 pts with CLP before treatment and 2 pts with CLP after treatment = decrease of 18 CLP points. 18/20*100% = 90% Reduction in CLP points.*

Future CLP Management

The plan update provides an opportunity to reflect on the objective for controlling CLP. Because of declining herbicide effectiveness with smaller treatment areas, is not possible or reasonable to eliminate CLP from Deer Lake.

There are important questions to answer to establish future direction for CLP management on Deer Lake. The 2017 plan objective identified **success as "attained when treatment measures significantly reduce CLP bed acreage and rake density with minimal damage to native plants."**

<u>Questions to consider</u>

- *Do current levels of CLP growth still cause the nuisance conditions created by CLP that spurred a control program?*
- *What amount of CLP (frequency and acreage) is considered "significantly reduced"?*
- *How much CLP growth is acceptable in Deer Lake?*
- *What harm is CLP causing (or would cause if not mitigated)?*
- *Where are the thresholds for effective herbicide treatment?*

With answers to these questions, we can work to establish standards to keep CLP growth at an acceptable low level.

CLP program standards can address diminishing returns by potential establishing:

- CLP bed minimum frequency of occurrence (what makes CLP growth a treatable bed?)
- Minimum bed size for treatment
- Minimum total treatment area

Also consider:

- Herbicide concentration
- Wind velocity/direction

The DNR rejected consideration of a proposed permit application to control CLP on Deer Lake in February 2023. An email from DNR staff explained "This year the WDNR is phasing out permits for endothall at treatment sites of less than 5 acres. If an applicant has an active APM plan from the last five years that calls for endothall treatments, they could receive a permit for 2023. The APM plan I have on file for Deer Lake is from 2017, unfortunately putting it outside that 5-year window. **In 2024 no lake, approved plan or not, will be approved for less than 5-acre endothall treatments**."[29] As shown in Figure 32, few CLP beds have reached the 5-acre threshold since 2017. Only Bed A near the boat landing has reached this threshold. Bed A was not treated in 2021 or 2022 and not proposed for treatment in 2023 because of low CLP growth.

[29] Austin Dehn, DNR Aquatic Plant Management Specialist. Email communication February 6, 2023.

DNR Grant Support
DNR grants have supported CLP control efforts since 2007 paying 50% of the cost of treatment and monitoring. The DLIA covered 100% of the cost in 2015, then again received grants covering 50% of the cost of the program through the end of 2023.

Table 17. Deer Lake DNR AIS Control Grants

Grant Number	Dates Covered	Grant Amount	% State Grant
ACEI-024-07	4/1/07 – 12/31/09	$16,612.50	50
ACEI-105-12	10/01/11-12/31/14	$39,875.00	50
ACEI-18116	4/15/16 – 6/30/19	$22,025.00	50
ACEI-20118	4/15/2018 -12/31/2023*	$39,630.00	50

*Extensions were granted because of savings from smaller than expected treatment areas.

Implementation

Plan Timeframe

This plan covers a five year time frame: from 2024 to 2028. As new knowledge is acquired and events unfold, actions will be updated as appropriate.

Action Plan and Updates

An aquatic plant management action plan, included as Appendix C, outlines how each action will be accomplished listing a timeline, resources needed, and responsible parties. The action plan chart will be updated annually in June (or more frequently) to keep actions and budgets current. Actions may be modified as new information becomes available. The Environmental Committee Chair will facilitate this effort in cooperation with Deer Lake Improvement Association Board.

Aquatic Invasive Species Grants

Department of Natural Resources Surface Water Grants are available to assist in funding some of the action items as indicated in the action plan. Grants provide up to 75% funding. Applications are accepted each year with a final digital deadline of November 15. Draft applications are due September 15. Current Deer Lake Improvement Association grants are shown in Table 18 below.

Table 18. Current DLIA Grants

Grant Number	Dates Covered	Amount	% State Grant
CBCW-2023	2/15/23 – 12/31/23	$4,000	75
ACEI-20118	4/15/2018 -12/31/2023	$39,630.00	50

Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for Deer Lake. It also presents strategies of actions that will be used to reach aquatic plant management plan goals.

Goals are broad statements of desired results.

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.

The **Action Plan** outlines a timeline, resources needed, partners, and funding sources for each action item.

The **Educational Strategy** in Goal 5 prioritizes desired behaviors, lists messages, and provides a range of methods to reach lake residents and visitors.

Plan Goals

1) Protect and restore healthy native aquatic plant communities.
2) Prevent the introduction of aquatic invasive species.
3) Respond rapidly and aggressively to any newly introduced invasive, non-native aquatic plant and/or animal species.
4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.
5) Educate and engage the public regarding lake stewardship.

Responsible Parties for Aquatic Plant Management (APM) Implementation and Monitoring

Deer Lake Improvement Association Board (DLIA) – elected representatives responsible for oversight of the lake association. Some actions may require a vote of the board.
Environment Committee Chair – makes day-to-day APM decisions and directs contractors in herbicide treatments and aquatic plant monitoring. The chair will have volunteers and consultants to assist in these activities. The DLIA Environment Committee Chair is currently Kate Wright.
CBCW Lead – leads and coordinates volunteer AIS education activities including Clean Boats, Clean Waters monitoring and education at the boat landings. The CBCW Lead is currently Kate Wright.
Herbicide Contractor – the herbicide applicator hired by the DLIA Board to complete herbicide treatment as permitted by the Wisconsin Department of Natural Resources. The most recent Herbicide Contractor is Northern Aquatic Services.
APM Monitor– a consultant hired to complete monitoring under the direction of the Environment Committee Chair and the DLIA Board. The current APM Monitor is Steve Schieffer with Ecological Integrity Service.
Plan Consultant – facilitates public involvement and writes the APM plan. The plan consultant also assists the Environment Committee Chair in managing plan actions as needed. The current plan consultant is Cheryl Clemens with Harmony Environmental.
DNR – APM staff will review aquatic plant management permit applications and enforce permit conditions.
Polk County LWRD – Staff from the Polk County Land and Water Resources Department will help with education, plant identification, and decontamination establishment.

Goal 1) Protect and restore healthy native aquatic plant communities.

Discussion

Deer Lake supports a healthy and diverse native plant community that is well-above average when compared to other lakes within the North Central Hardwoods Ecoregion of Wisconsin. The littoral zone, which contains all of the aquatic vegetation, occurs in a relatively narrow band around the lake margins. If waterfront property owners remove plants from even narrow corridors in front of their properties, the result would be significant negative effects on healthy, desirable native stands of plants. Native aquatic plants are responsible for the lake's excellent fisheries, and they help to sustain high water quality. Removing extensive areas of native plants would remove the benefits they provide and potentially hasten the spread of undesirable non-native plants such as curly leaf pondweed or even Eurasian watermilfoil (if introduced). Public information and education will remain important for successful native aquatic plant protection.

Aquatic plant habitat and ecosystem values

The management challenge for Deer Lake is to control aquatic plant nuisances without unduly damaging native plants and their benefits in the lake. For this to occur, residents must understand the values of aquatic plants in Deer Lake. An important educational message will be communicating the distinction between "good plants" and "bad plants." Most plants are good: in fact, a diverse native plant community is essential for a healthy lake ecosystem. Others are bad: invasive species may displace native aquatic plants and their benefits.

Waterfront activities

Another important message will be to discourage boating disturbance within 200 feet of the shoreline (500 feet for wake boats). Although this area is a no-wake zone according to state regulation for jet skis (it is 100 feet for other watercraft), many boaters still travel above no-wake speed close to the shoreline. This activity is strongly discouraged for the following reasons:

- Boats may uproot native plants and break aquatic plants into fragments
- Bare substrate is more likely to be colonized by non-native species
- Plant fragments contribute phosphorus to the water as they decay
- High wakes cause shoreline erosion. Shoreline erosion deposits sediment in the lake which can result in suitable conditions for invasive plant growth.

Waterfront residences can also negatively affect native plant communities by causing disturbance of existing plant beds and altering sediment characteristics. Regular waterfront use like boating, swimming, and clearing can remove native aquatic plants. Erosion and runoff from waterfront property may bring nutrients and sediment to the lake, alter sediment characteristics, and encourage the spread of invasive plants.

Large-scale management of curly leaf pondweed
Continued early season herbicide treatment of curly leaf pondweed is recommended as long as treatment success is demonstrated. Treatment success is measured by the reduction in curly leaf pondweed without statistically significant damage to native plant populations. Curly leaf pondweed treatment results and impact to native plants will be measured through standard DNR pre and post monitoring methods.

Curly leaf pondweed awareness
Resident understanding of the distinction between curly leaf pondweed and native aquatic plants is critical. With a better understanding of curly leaf pondweed's growth characteristics and negative impacts to the lake, residents may be encouraged to change their purpose from removing all aquatic plants to a desire to control the invasive curly leaf pondweed. Poorly informed lake residents may chose wholesale control of "weeds" if unable to distinguish between aquatic plant nuisances of invasive plants from the relative values of native aquatic plants. Better understanding and promotion of reasons for controlling curly leaf pondweed may reduce the desire for complete plant removal.

Objectives

A. Lake residents understand the benefits of native aquatic plants and the means to protect them.

B. Lake residents can distinguish between native plants and invasive species such as curly leaf pondweed and Eurasian water milfoil.

C. Restore the lake's ecosystem by promoting the replacement of curly leaf pondweed with native aquatic plants (detailed control actions under Goal 4).

Evaluation Action

1. Conduct whole lake aquatic plant surveys every three to five years to track plant species composition and distribution. These surveys are conducted using standardized DNR methods and assigned GPS points. These surveys also serve as evaluation actions for Goal 2.

Actions

2. Follow the Educational Strategy in Goal 5 to provide residents with information regarding aquatic plant values and methods to limit impacts to them.

3. Conduct an early season, low dose endothall treatment to reduce curly leaf pondweed growth (methods covered under Goal 4).

4. Follow the Educational Strategy in Goal 5 to clearly communicate the curly leaf pondweed strategy to lake residents. The DLIA will provide residents with the information needed to accurately identify curly leaf pondweed. Residents will be encouraged to hand-pull small stands in the lake in front of their property. The importance of positive identification will be emphasized.

Goal 2) Prevent the introduction of aquatic invasive species.

Discussion

With many nearby and Twin Cities lakes infested with Eurasian water milfoil, the threat of introduction to Deer Lake is high. Many other invasive species also pose a threat to Deer Lake.

A Clean Boats Clean Waters (CBCW) Program has been present at the Deer Lake public landing since 2006. Program activities include inspecting watercraft and educating residents and visitors regarding identification, threats, and control of aquatic invasive species.

Objectives

A. No new aquatic invasive species are introduced into Deer Lake.

B. Lake residents and visiting anglers take measures to prevent AIS introduction.

C. Lake users decontaminate boats when entering and leaving Deer Lake.

Actions

1. Continue the Clean Boats Clean Waters Program at the Town of St. Croix Falls public boat landing to educate boaters entering and leaving Deer Lake and encourage voluntary inspection and compliance. Continue the successful partnership with the Town of St. Croix Falls for payroll services.

2. Update and maintain invasive species prevention signs at the boat landings.

3. Request that fishing tournament sponsors provide boat and trailer inspections and decontamination using accepted invasive species prevention techniques. Emphasize decontamination needed because of zebra mussel presence in Deer Lake.

4. Work with the Town of St. Croix Falls to pursue installation of a decontamination station using a mild bleach solution. Consider the addition of security cameras to encourage station use.

5. Work with the Polk County Sheriff's Department to encourage enforcement of the Do Not Transport and AIS Decontamination Ordinance.

Goal 3) Respond rapidly and aggressively to any newly introduced invasive, non-native aquatic plant and/or animal species.

Discussion

Monitoring for the presence of Eurasian water milfoil and other aquatic invasive species is critical for a successful rapid response program. The public boat landing at the northwest corner of the lake and the private landing on the southeastern shore will be the focal points for monitoring. Invasive species introduction is most likely here in these high use locations. Deer Lake inflows are not connected to other lake systems, so these areas will not be targeted. Lake residents will be encouraged to learn to identify Eurasian water milfoil and purple loosestrife, and a contact for positive identification of potential specimens will be made available.

Objectives

A. The DLIA is ready to respond to invasive threats which are discovered.

B. Newly introduced invasive species are detected early.

C. Appropriate control measures are identified and implemented.

Actions

Follow the Rapid Response Plan in Appendix A.

1. Train and support lake resident volunteers to identify Eurasian water milfoil and other invasive plants and aquatic animals.
   a. Seek full time lake residents (minimum of five).
   b. Provide pictures and supplemental information to all Deer Lake individuals.

2. Continue professional monitoring for invasive species at the public boat landing, the Lagoon private landing, along the littoral zone in June and August (also ***Evaluation Action*** for Goal 2).

3. Designate responsibilities for the Rapid Response Plan annually.

4. Maintain a non-lapsing contingency fund of at least $15,000 for removal of invasive species.

Zebra Mussel Response

Evaluation Actions

1. Use standard WDNR plate sampler method to assess zebra mussel populations.

2. Encourage and support Polk County/Wild Rivers Conservancy zebra mussel veliger monitoring.

Actions

3. Follow and support adult and juvenile zebra mussel control research efforts such as those at the MN Aquatic Invasive Research Center and/or the WI DNR.

4. Work with and encourage WI DNR to allow investigation and use of low-impact methods to alleviate the impacts of zebra mussels in Deer Lake.

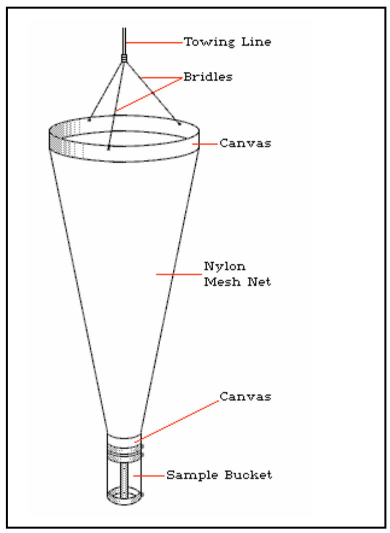

Figure 34. Monitoring Equipment: Sampling Plates and Nets for Veliger Tows

Goal 4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

Objectives

A. Dense curly leaf pondweed (CLP) growth in each bed is limited to 5 acres or less.
B. Damage to native aquatic plant species is minimized.
C. The growth of native species is facilitated with CLP removal.

Defining curly leaf pondweed beds

- May/June mean coverage = 25 % or higher
- May/June curly leaf pondweed stem growth reaches surface and is thick enough to impede navigation (stem height > 1 meter)

Evaluation Actions

1. Map CLP beds each year at peak growth (June). This mapping may identify CLP beds for treatment in following year(s). If a bed reaches 4 acres, continue with step 3 in the following year anticipating potential bed expansion.[30] Seek DNR grant funding for anticipated control efforts.

2. Conduct annual monitoring of sediment CLP turions in years when aquatic plant point intercept survey is conducted.

Actions

3. Complete early season curly leaf pondweed treatment using a low-dose (currently 2.0 – 3.0 ppm) endothall treatment.
    - Apply for APM permit (February).
    - Solicit bids for herbicide treatment (February).
    - Verify CLP bed boundaries with pre-monitoring in April or May.
    - If beds reach 5-acre minimum threshold, proceed with treatment. If they do not, notify contractor and DNR that herbicide treatment will not occur.
    - Complete early season herbicide treatment when water temperatures are between 50º and 60º F and wind is calm.
    - Complete post-treatment monitoring.

The endothall treatment will occur when water temperatures are between approximately 50º and 60º Fahrenheit to target this invasive species before significant native plant growth has occurred. Treatment locations will be located using GPS equipment, and herbicide application amounts and concentrations will be recorded. Pre and post monitoring will be completed according to standardized DNR methods. Monitoring results and research results from other projects will guide potential additional treatments of nuisance curly leaf pondweed areas.

[30] Deer Lake early season CLP treatment results have been effective with minimum beds size of 3 acres with 19 total acres treated. These standards would be recommended if allowed. However, DNR currently requires a minimum bed size of 5 acres.

Goal 5. Educate and engage the public regarding lake stewardship.

<u>High Priority Targeted Behaviors</u>

1. Individuals of Deer Lake understand and support aquatic plant management efforts.

<u>Messages:</u>

- *Explain the aquatic plant management plan and its recommendations.*
- *Learn how to identify common aquatic invasive species including curly leaf pondweed (provide photos and ID information).*
- *Zebra mussels are not a lost cause. Our effective management of curly leaf pondweed shows we can produce results.*
  - *Updates of zebra mussel research and reports of results.*
  - *Deer Lake can be a test lake with WI DNR and academics.*
  - *How to live with zebra mussels: footwear, wetsuits, gloves, and medical response if cut.*
- *Additional AIS threaten Deer Lake. Protection / prevention and decontamination efforts are still needed.*
- *It is important to continue our success managing curly leaf pondweed*
  - *Provide updates of the curly leaf pondweed control program.*
  - *Let residents know it is ok to remove CLP along the entire shoreline.*
  - *Chemical treatment does not work where there is a drop off and is not used with very scattered plants.*

<u>Methods (specific to this behavior, additional methods listed later):</u>

1. Plan summary (4-page)

2. Everyone inspects boats, trailers, and equipment; removes vegetation; and drains ballast tanks, motors, and live wells upon entering and when leaving the lake.

<u>Messages:</u>

- *Decontaminate when entering and leaving the lake.*
- *We can still prevent AIS such as Eurasian water milfoil.*
- *Provide frequently asked questions and answers and strong CBCW staff training.*
- *Use arrows and STOP on pavement to direct traffic to decontamination station.*
- *Have multiple sprayers at the station to be able to catch boats entering and leaving the lake.*
- *Share AIS prevention messages with your family and friends: inspect, remove, drain, dry*

<u>Methods (specific to this behavior, additional methods listed later):</u>

Signs: Decontamination is required.

Use simple messages, eliminate redundancy, include only the most important information

3. Individuals of Deer Lake take action to mitigate runoff and erosion that carries nutrients and sediment from their property to the lake.

Messages:

- *Erosion and runoff from waterfront property may alter sediment characteristics and encourage the spread of invasive plants.*
- *Controlling phosphorus prevents severe algae blooms, including surface mats of filamentous algae.*
- *Deer Lake Conservancy (partner) efforts have removed an estimated amount of over 3,200 pounds of phosphorus that formerly flowed to the lake each year. Each pound of phosphorus can lead to 500 pounds of algae growth in the lake. That represents 800 tons of algae! Your efforts can help to keep additional phosphorus out of the lake and prevent excessive algae growth into the future.*
- *Cut branches not trees.*
- *Don't mow grass all the way to the lake. A buffer of dense, natural growth slows and absorbs runoff.*
- *Install construction site erosion control practices when soil is disturbed.*
- *Sediment from building and road construction sites flows to water resources causing environmental damage.*
- *Where to buy erosion control supplies, seeds, etc.*
- *Use best management practices to reduce erosion from construction sites and limit ongoing erosion and runoff from shoreline property.*
- *Minimize impermeable surfaces to reduce runoff and pollution from property.*

Additional Targeted Behaviors

4. Boaters practice no-wake boating within 200 feet of the shoreline (500 feet for wake boats).

Messages: *Traveling above no-wake speed within 200 feet (500 feet for wake boats) of the shoreline is strongly discouraged for the following reasons:*

- *Boats may uproot native plants and break aquatic plants into fragments.*
- *Plant fragments contribute phosphorus to the water as they decay.*
- *High wakes cause shoreline erosion depositing sediment next to the shoreline and creating suitable conditions for invasive species.*
- *WI no-wake rules = 100 feet from shoreline for boats, 200 feet from shoreline for jet skis.*
- *Wake boats should stay in the middle, deeper areas of the lake to prevent sediment disturbance and shoreline erosion.*
- *How far is 200/500 feet? (Give examples around the lake.)*

5. Individuals of Deer Lake can distinguish between invasive and native plants. They allow native aquatic plants next to the shoreline to grow.

Messages:

- *Native aquatic plants are important to the lake. They help to keep the water clear; provide food for fish, waterfowl, and other animals; keep lake bottom sediments in place; and prevent establishment of invasive species.*
- *Communicate the distinction between "good native plants" and "bad non-native invasive plants." Most plants are good: in fact, a diverse native plant community is essential for a healthy lake ecosystem. Others are bad: invasive species may displace native aquatic plants and their benefits.*
- *If you must remove plants to navigate, use hand removal methods such as raking.*

6. Individuals of Deer Lake understand the importance of and maintain natural shorelines.

Messages:

- *Define and describe natural shorelines.*
- *Natural shorelines can enhance views to and from the water and allow recreational activities.*
- *Native aquatic and shoreline plant communities provide fish and wildlife habitat, minimize erosion, protect water quality, are adapted to local conditions, shield against invasion of non-native species, and provide natural shoreline beauty.*
- *Don't alter vegetation right after you purchase a lake property.*
- *Shoreline development impacts are cumulative.*
- *Pesticide and fertilizer use should be minimized in the shoreland zone (within 1000 feet of the lake).*

7. Individuals of Deer Lake quarantine equipment such as docks and lifts for at least one month prior to moving them from one lake or river to another.

Message:

- *Keep docks and equipment out of the water at least one month before transporting between lakes*

8. Individuals of Deer Lake contribute financially to support DLIA invasive species and other management efforts.

Messages:

- *Describe programs with more specific language – not just "water quality." List costs and need for each program.*

- *Reasons to support DLIA efforts.*

Outreach and Education Methods *(used to support multiple targeted behaviors, need to use multiple methods and repeated messages)*

<u>Deer Lake Residents</u>
Annual meeting presentations
Handouts used at annual meeting
Deer Tales newsletter
DLIA website (make it mobile-friendly)
Deer Lake Facebook account
DLIA email list
Deer Lake directory
New homeowner packet
Brochures
Landowner guide
Neighborhood groups/gatherings (consider multi-issue, immediate issues might be most successful)
Young-adult led activities
Deer Lake Conservancy Report
Deer Lake Conservancy website
Homeowner technical assistance for controlling waterfront runoff

<u>Deer Lake Visitors</u>
Clean Boats, Clean Waters (and handouts distributed)
Landing Camera
Signs

<u>Fishing Tournament Participants</u>
Coordination with tournament organizers

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Appendix A. Rapid Response Strategy for Aquatic Invasive Species

Definition: Aquatic Invasive Species (AIS) are non-native plant and animal species that can out-compete and overtake native species damaging native lake habitat and sometimes creating nuisance conditions. AIS currently in Deer Lake include curly leaf pondweed (CLP), zebra mussels, and Chinese mystery snail. Riparian species (along the shoreline) include narrow-leaf cattail, aquatic forget-me-not, and yellow iris. Additional AIS threaten the lake and will be monitored throughout the lake by volunteers and consultants.

1. Maintain a contingency fund for rapid response for rapid response to aquatic invasive species (DLIA Board).

2. Conduct volunteer and professional monitoring (Herbicide Contractor and/or APM Monitor) at the public landing, the private landing at the Lagoon, and other likely areas of AIS introduction. If a suspected AIS is found, contact the Polk County LWRD AIS Coordinator or Environment Committee Chair.

3. Direct lake residents and visitors to contact the Polk County LWRD AIS Coordinator or Environment Committee Chair if they see a plant or animal in the lake they suspect might be an AIS. Signs at the public boat landings, web pages, handouts at annual meeting, and newsletter articles will provide photos and descriptions of AIS that have a high likelihood of threatening Deer Lake, contact information, and instructions.

4. Potential AIS identification will be confirmed with the Polk County LWRD (or professional with knowledge) or the Wisconsin DNR.

   Document the sample with a digital photo if possible.
   Record GPS location coordinates of collection location if possible. Alternatives are marking with a float and/or on a map.

   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 (if available). 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, or DLIA Environment Committee Chair, who will then inform Polk County LWRD and lake management consultant.

    b. Post a notice at the public landing (DNR has these signs available) and include a notice in the next newsletter. Notices will inform residents and visitors of the approximate location of AIS and provide appropriate means to avoid its spread (DLIA Board).

7. Determine the extent of the AIS introduction (DLIA in cooperation with Polk County LWRD and WDNR). Divers may be used. If small amounts of AIS are found during this assessment, divers may be directed to identify locations with GPS points and hand pull plants/remove animals found. All plant fragments will be removed from the lake when hand pulling.

8. Select a control plan in cooperation with the WDNR (DLIA Board). 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. DLIA 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 DLIA 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 DLIA 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, WNDR and/or other agency representatives).

13. Review the procedures and responsibilities of this rapid response plan on an annual basis. Changes may be made with approval of the DLIA Board.

EXHIBIT A[31]

DEER LAKE IMPROVEMENT ASSOCIATION

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APM MONITOR

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HERBICIDE CONTRACTOR

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Lake Restoration	763-428-1543

DIVERS

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

[31] This list will be reviewed and updated each year.

ADDITIONAL REFERENCES

WDNR websites on AIS
http://dnr.wi.gov/lakes/invasives/GoalsNew.aspx?show=emerging
http://dnr.wi.gov/lakes/invasives/AISDiscoveryCommunicationProtocol.pdf

Appendix B. Herbicide Analysis for Treatment of *Potamogeton crispus* (curly-leaf pondweed). June, October-2022.

Herbicide Analysis for Treatment of *Potamogeton crispus* (curly-leaf pondweed)

June, October-2022

Deer Lake, Polk County Wisconsin

WBIC: 2619400

Data collection and Analysis by: Ecological Integrity Service, LLC
Amery, Wisconsin

Analysis summary

On May 23, 2022 (water temperature 56 ^{o}F), the herbicide endothall was applied in four beds targeting *Potamogeton crispus*, curly-leaf pondweed (CLP) in Deer Lake, Polk County, Wisconsin. The beds totaled 7.6 acres. The comparison of the 2022 pretreatment to the 2022 post-treatment frequency using chi-square analysis showed a statistically significant reduction in the CLP; however, the post-treatment survey resulted in a CLP frequency of 14.8%. The pretreatment survey comparison of 2021 to 2022 (not including a newly added bed) also showed a reduction in CLP frequency but was not statistically significant. A chi-square analysis comparing the pretreatment frequency in 2014 to the pretreatment frequency in 2022 showed a statistically significant reduction. A chi-square analysis of native species revealed a statistically significant reduction in one native plant species, *Myriophyllum sibiricum (northern watermilfoil)*. Several native species had frequency increases. A bed mapping survey resulted in no beds of CLP growth, with only a few locations of single plants or small clumps observed. A turion analysis in October showed that the overall mean density of turions was stable at 32.8 turions/m^2 in 2021 and 2022 (not including the new bed in 2022).

Introduction

On May 23, 2022, an herbicide treatment targeting curly-leaf pondweed (*Potamogeton crispus*) was conducted using endothall in Deer Lake, Polk County, WI. This analysis will outline the areas treated, describe the treatment protocol, and analyze the effectiveness of the treatment.

The treatment areas for Deer Lake were made up of four beds labeled B, C, E, and G (totaling 7.6 acres). Historically, there have been five beds treated, A-E, but due to lack of CLP growth, D was not treated in 2020, 2021, or 2022. Bed A had limited growth in 2021 and 2022, so it was not treated in 2021 or 2022.

The herbicide endothall was used in the treatment of the CLP. The water temperature was 56 degrees F, and winds were reported as 3-4 mph from the southwest direction at the time of application.

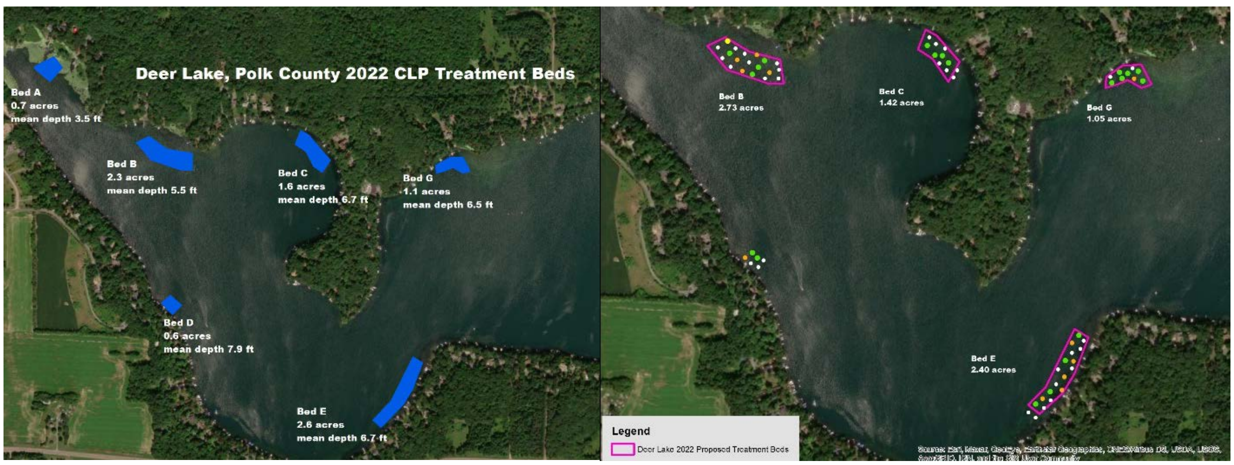

Figure 1: Map of adjusted beds from 2022, with the proposed on the left and the final beds based upon the pretreatment survey results on the right.

Deer Lake-2022	Area (acres)	Mean Depth (ft)	Acre-feet	Target concentration	Water Temp (^{o}F)	Wind (speed/direction)
Bed B	2.73	5.5	15.02	2.0 ppm	56	3-4/SW
Bed C	1.42	6.7	9.51	3.0 ppm	56	3-4/SW
Bed E	2.4	6.7	16.08	2.0 ppm	56	3-4/SW
Bed G	1.05	6.2	6.51	3.0 ppm	56	3-4/SW

Table 1: Treatment bed information, including area, depth, and treatment conditions. This data was provided by the herbicide applicator on the herbicide treatment record (HTR).

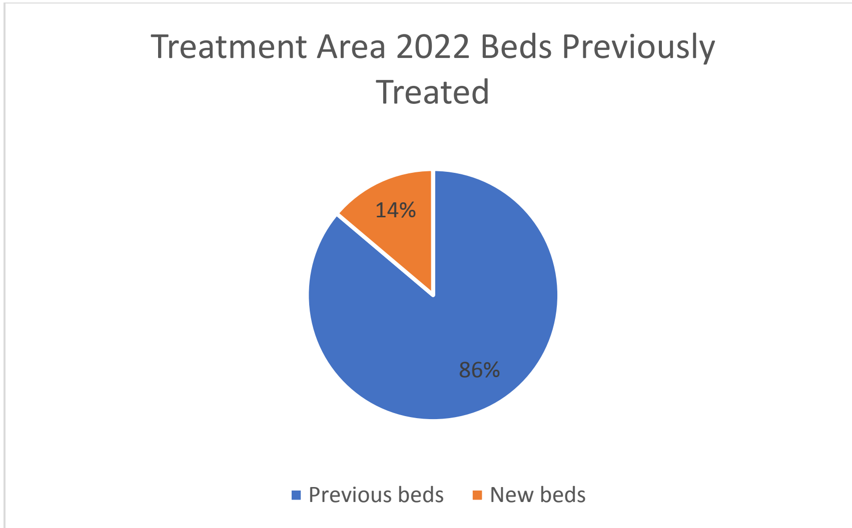

Figure 2: Treatment area treated in the previous year and new areas by percent. Note that 86% of the treated area in 2022 was treated in 2021. 14% was new (Bed G).

Methods

To conduct and analyze the treatment, two surveys were conducted following the treatment protocol outlined in 2009 by the Wisconsin DNR. The first survey is referred to as a pretreatment survey. This involves going to predetermined GPS coordinates within the proposed treatment area. A high-definition underwater camera, as well as a rake, is used to determine the presence of CLP at that sample point. Density is not measured as the plants are typically very small, and density is subjective but is rated low/high density based upon the relative number of CLP plants. The presence of CLP is determined. There are many points checked outside of the bed delineation to ensure the boundary is correct. The pretreatment survey was conducted on May 4, 2022.

The second survey is known as the post-treatment survey. This survey involves going to the same GPS coordinates as the pre-treatment survey and doing a rake sample at the point. If any CLP is on the rake, the density of the CLP is recorded (see Figure 2 for reference). All other species are also recorded from the rake sample to verify no damage to the native plants. The post-treatment survey was conducted on June 16, 2022.

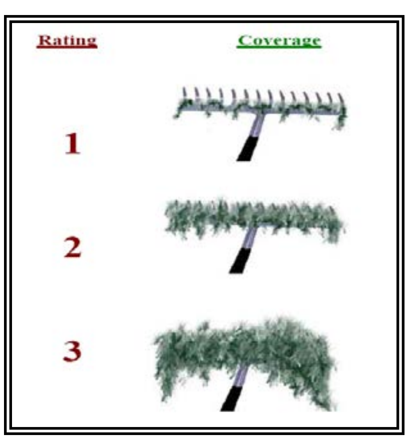

Figure 2: Density rating system and example CLP rake sample.

When the surveys are complete, the frequency of occurrence is determined as well as the mean density for each bed as well as all beds combined. The frequency of occurrence for each native plant species sampled is also calculated. The chi-square analysis is then used to determine if the change in frequency is statistically significant ($p<0.05$). The goal is to find the chi-square analysis to show that the frequency of CLP is significantly reduced and the native plants are not significantly reduced.

The comparison for reduction can involve three evaluations. First, the result from the previous year's post-treatment survey is compared to the present year's post-treatment survey. This reflects long-term effectiveness. As more treatments are done in annual succession, these frequency values can become very similar since the CLP growth is significantly reduced. This can make it appear that the treatment is not progressing successfully since the frequency appears not to be reduced. Each year, new turions can germinate in the fall/winter and create new growth. The result from turion germination is a low frequency in the post-treatment survey, but in the next spring, the CLP has grown immensely and will result in a high frequency.

To reflect that new growth and the effect of the treatment, a second comparison is made. This compares the frequency of CLP in the spring pre-treatment survey to the post-treatment results in that same year. This shows what the CLP growth was just before treatment and the result after treatment.

The third method is to evaluate the pretreatment survey frequency from year to year. Since the pretreatment survey frequency reflects new growth from turion germination, a reduction from year to year can show a long-term reduction since it reflects the new CLP growth resulting from turions. If the CLP frequency goes down each year, there must be fewer turions germinating each year.

Use of sample points from year to year:

If long-term evaluation of pretreatment frequency is conducted, it is important to use the original sample points from previous years. As treatment beds are made smaller due to less CLP growth, the number of sample points that are contained within the smaller bed gets smaller. However, if the CLP is reduced long-term and the CLP does not return to the sample points now outside of the treatment bed, it will be reflected in a smaller frequency of occurrence using all original sample points. This allows for valid comparison. In comparing surveys, the sample points being used in the compared surveys will be explained.

In the end, a statistically significant reduction when comparing the pre-treatment frequency to the post-treatment frequency is desired. We would also like a consistent frequency reduction from year to year, depending on how low it is, in the pretreatment and post-treatment surveys in successive years. If the frequency in any post-treatment survey is very low (less than 10% as an example), lowering this frequency even more may not be realistic, but it is desired. Comparing the pretreatment surveys from year to year can show the progress being made as it reflects growth after turion germination, thus reflecting potential overall reduction. Turions can remain viable for several years, affecting the reduction amounts achieved.

A turion analysis is conducted to reflect further potential future growth and the cumulative success of treatments. This analysis involves going to sample points near the middle of the CLP bed (assuming this will reflect the highest density). At each sample point, a sediment sampler is lowered to the lake sediment, and a sediment sample is obtained. Two samples are obtained from each side of the boat at each location. The samples are then separated with a screened bucket to isolate the turions. The turions are then counted, and the density of turions is calculated in turions/square meter. Consistently successful treatments should show a trend of reduced turion density each year. This way, it is known that the treatments are killing plants before turion production, resulting in an overall reduction in CLP in those beds.

a. **b.** **c.**

Figure 3: a shows sediment sample; b shows separation; c shows separated turions.

Results

The frequency of occurrence (FOO) for the pretreatment and post-treatment surveys from 2022 is outlined in Table 2. It shows that the pretreatment frequency of CLP in Beds B and E was quite low. However, CLP was observed between sample points, so herbicide application proceeded (and the pretreatment survey frequency threshold outlined in the Deer Lake Aquatic Plant Management Plan was referenced by the AIS leaders). The frequency for all beds combined was separated into “including Bed G” and “not including Bed G” for easier comparison of the previous year’s surveys.

The herbicide treatment successfully reduced the CLP frequency from before treatment to after treatment. Within all treatment beds, the FOO decreased from 35.2% to 14.8%, a significant reduction based on a chi-square analysis (Table 3). Figures 5 and 6 are maps showing the CLP growth before and after treatment, and Figure 7 graphically shows the frequency from the pretreatment and post-treatment surveys. Figure 8 shows that the post-treatment mean density within Beds B, C and E increased from 0.1 in 2021 to 0.11 in 2022 (not statistically significant).

Bed	2022 Pre FOO	2022 Post FOO	2022 Mean density (post)
B	26.3%	10.5%	0.1
C	44.4%	11.1%	0.11
E	23.5%	11.8%	0.12
G	66.7%	33.3%	0.33
All treated beds except G	28.9%	11.1%	0.11
All treated beds	35.2%	14.8%	0.15

Table 2: Frequency and density stats from pre and post-treatment surveys, 2022.

A good method to evaluate the long-term reduction in overall CLP growth from herbicide treatment is to compare the pretreatment frequencies from previous years and do a chi-square analysis. In comparing 2022 to the 2021[1] pretreatment frequency, there was a decrease in frequency which was statistically significant. Comparing the pretreatment survey of 2014 to 2022 (using original sample points), there has been a statistically significant reduction; thus, CLP growth has decreased over those seven years. Figure 9 graphically shows the changes in pretreatment frequency.

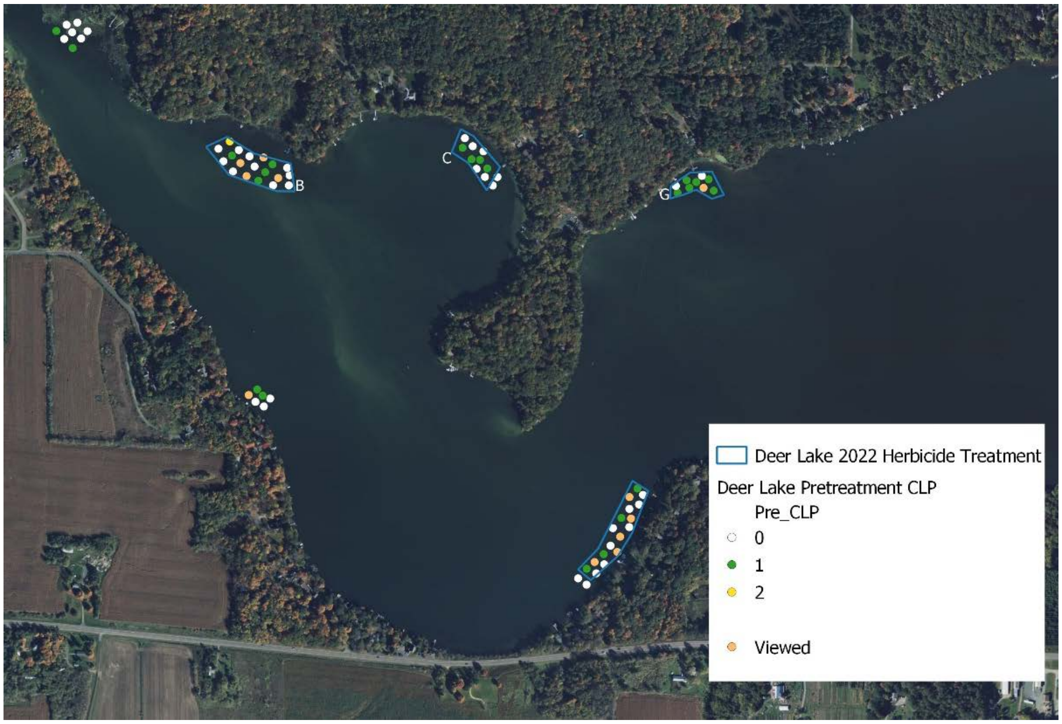

Figure 5: Map of pretreatment CLP presence/absence within each bed, 2022.

[1] When comparing previous year's surveys, the sample points for the earlier survey were used to determine the frequency of both surveys compared. This allows for the frequency data to indicate valid change in CLP.

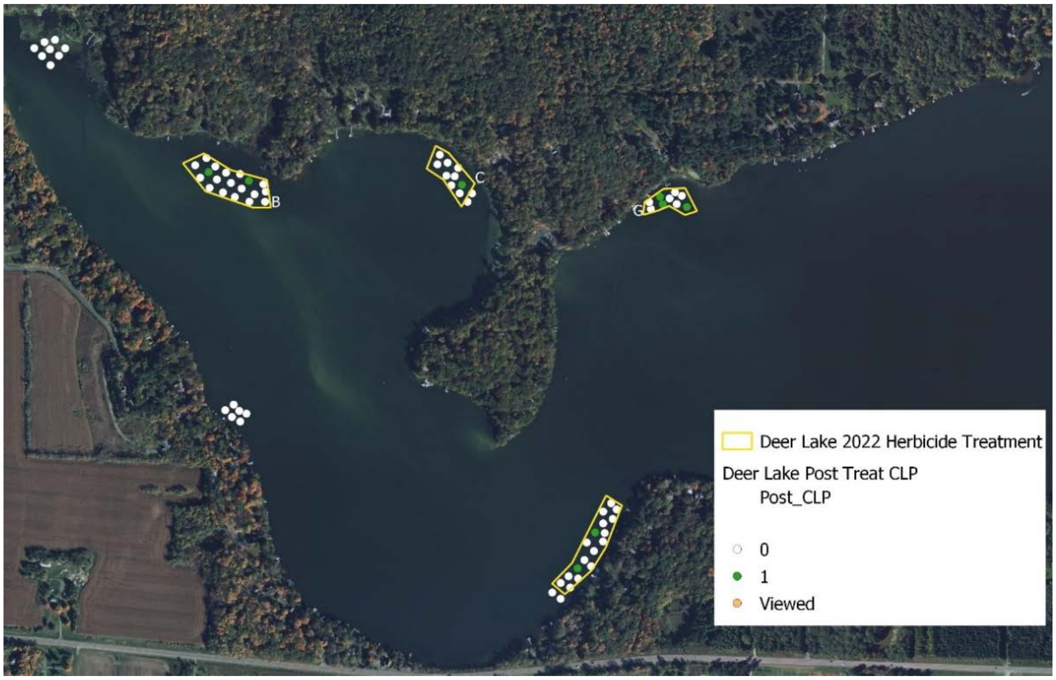

Figure 6: Map of post-treatment CLP density within each bed, 2022.

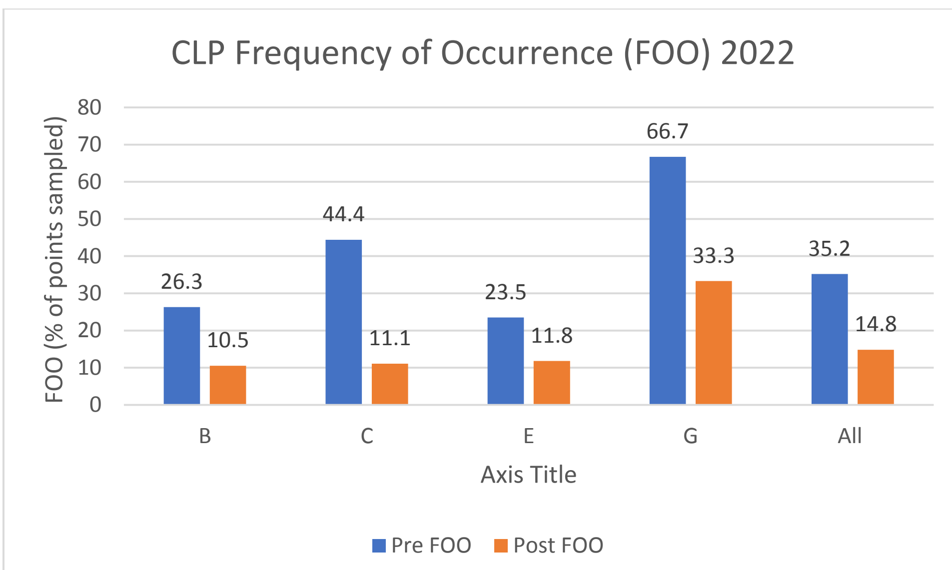

Figure 7: Graph showing the pretreatment and post-treatment frequency of occurrence (FOO) for each CLP treatment bed.

Survey comparison	Change in CLP Frequency	Chi-square P value	Significant reduction?
2022 Pre to 2022 Post (2021 points)	35.2% to 14.8% (decrease)	0.01	Yes
2021 Pre to 2022 Pre	57.5% to 28.9%	0.006	Yes

(2021 sample points)	(decrease)		
2018 Pre to 2022 Pre (historical points from 2018)	28% to 20.2% (decrease)	0.2	No
2014 Pre to 2022 Pre (from points used in 2014 survey)	46.9% to 11.7% (decrease)	**6.08×10^{-13}**	Yes

Table 3: Chi-square analysis comparing the frequency of various surveys and the significance of any change. Note the highly significant reduction since 2014 in the CLP pretreatment frequency.

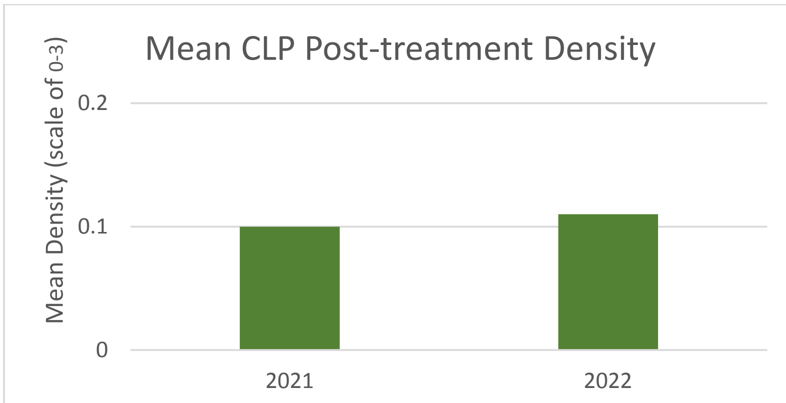

Figure 8: Graph comparing the mean CLP density of 2021 and 2022.

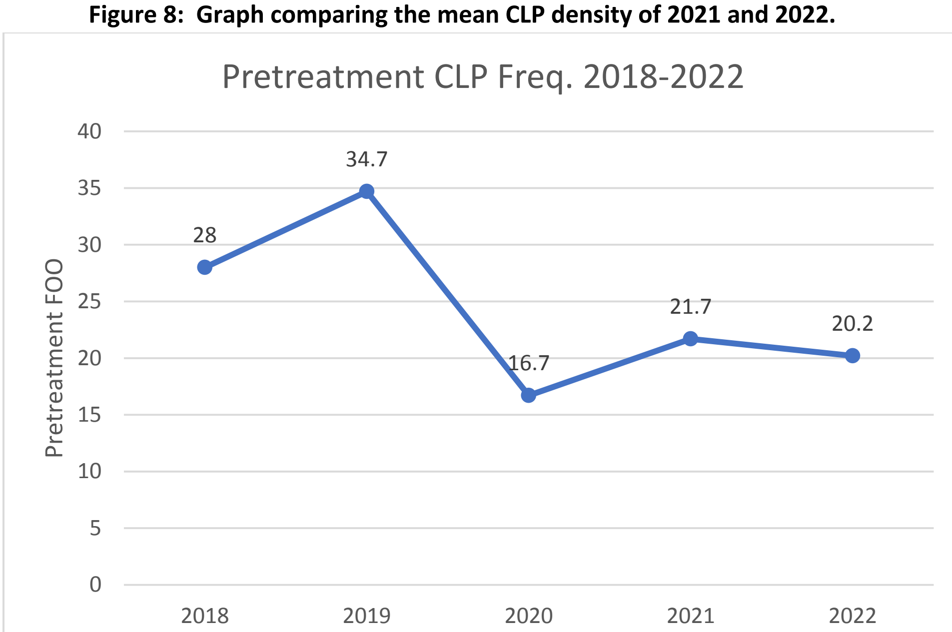

Figure 9: Graph showing overall pretreatment FOO using all sample points from 2018 for valid comparison.

The area of CLP treatments (determined largely based on pretreatment frequencies) has decreased over the years. This supports the reduction in CLP likely from repeated successful herbicide treatments. Table 4 shows CLP historical treatment areas (Bed G not included) from 2010 to 2022. A slight increase in the area treated occurred from 2021 to 2022, but the area has consistently decreased overall.

Year	Acres treated on Deer Lake
2010	23.6
2019	12.45
2020	7.1
2021	6.45
2022	6.55 (past beds)/7.60 (added new bed)

Table 4: Summary of acres treated in various years to reflect the change in CLP bed coverage.

Native species analysis

A successful herbicide treatment not only results in the reduction of targeted species but also has no impact on the reduction of native plant species. Table 5 summarizes the results of the chi-square analysis showing the p-value and the significance of any reduction.

Native species	Frequency 2021	Frequency 2022	Is reduction significant?	P-value
Lemna trisulca, forked duckweed	0.05	0.09	Increase	n/a
Potamogeton praelongus, White-stem pondweed	0.12	0.04	No	0.2
Ceratophyllum demersum, Coontail	0.18	0.28	Increase	n/a
Myriophyllum sibiricum, Northern milfoil	0.25	0.09	Yes	**0.04**
Potamogeton richardsonii, Clasping pondweed	0.15	0.22	Increase	n/a
Heteranthera dubia, water stargrass	0.08	0.18	Increase	n/a
Ranunculus aquatilis, stiff water crowfoot	0.22	0.24	Increase	n/a
Chara sp., muskgrasses	0.58	0.63	Increase	n/a
Stuckenia pectinatum, sago pondweed	0.02	0.06	Increase	n/a
Bidens beckii, water marigold	0.05	0.02	No	0.4
Vallisneria americana, wild celery	0.02	0.00	No	0.24
Potamogeton zosteriformis, Flat-stem	0.00	0.06	Increase	n/a

pondweed				
Potamogeton friesii, Fries' pondweed	0.01	0.02	Increase	n/a

Table 5: Chi-square analysis results of native species to determine the reduction in native species frequency from 2020 to 2021.

The chi-square analysis for native species shows one statistically significant reduction in a native species. That species is *Myriophyllum sibiricum* (northern watermilfoil). The cause of this reduction is not known. The p-value is just below the 0.05 threshold, so the significance is not strong. This could be from the herbicide but is unlikely as most other species increased in frequency. Sampling location variation could cause this, especially since the northern milfoil occurs in clusters. It could also be seasonal variation. Plants can vary in terms of when they come out of dormancy in the spring, thus causing variation in frequency in any given year. This reduction should be recognized and should be monitored in future years. A most recent full-lake point intercept survey should be evaluated to determine if this is a trend.

Turion analysis

In October, a turion density survey is completed annually to determine the mean bed density of the reproductive structure. If treatment is successful, the CLP plants cannot mature enough to produce turions. This will reduce the turions released into the sediment, leading to fewer CLP plants germinating in the fall. This should result in less CLP growth observed in the spring pre-treatment survey. Over time, consistent turion density decreases can indicate long-term CLP reduction. Table 6 shows the turion density results from 2022.

Bed (Historical and not treated in 2022)	**2022 Mean Turions/sq. meter**
(A)	23.45
B	25.80
C	53.75
(D)	43.00
E	12.29
G (new)	21.5
Mean for historical beds	**32.82**
Mean including Bed G	31.88

Table 6: Mean turion density (turions/square meter) from data collected Oct 2022.

Figure 10 is a map showing the turion density by sample location, and Figure 11 shows the density within each bed over several years. There were turions sampled in only 23.7% of the sample points. The turion samples ranged from a low of 0.0 turions/m^2 to a high of 516 turions/m^2. The standard deviation of the turion density in all samples was 91, indicating the data ranges a great deal. By the bed, the mean turion density ranged from 0 (Bed C) to 79.9 (Bed E).

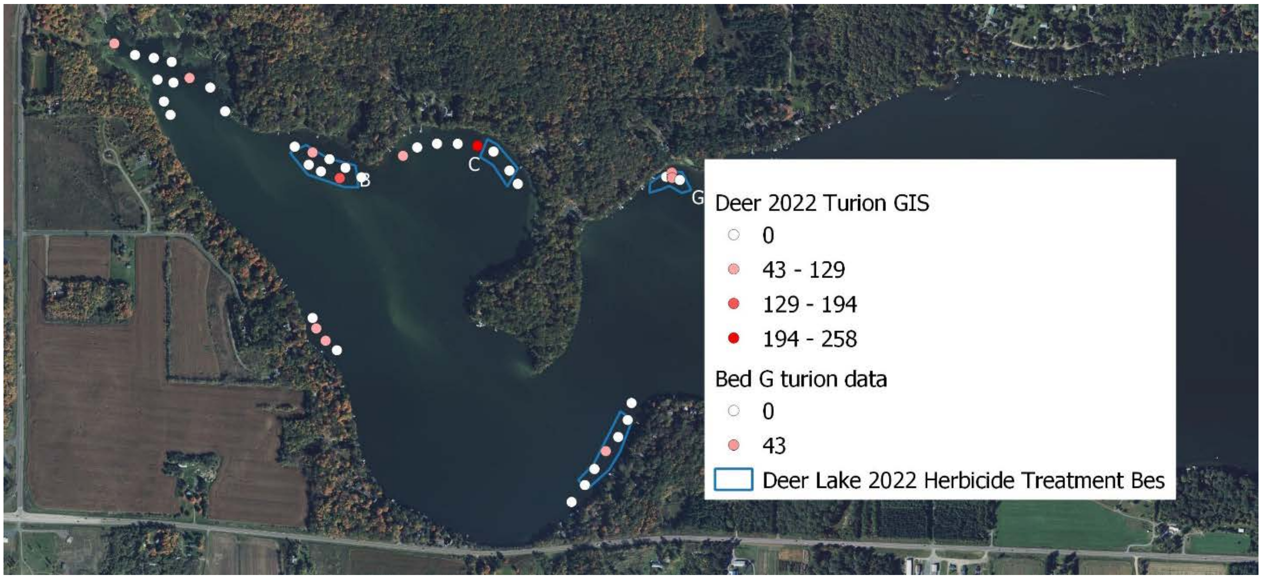

Figure 10: Map showing turion density within each bed treated in 2022 or historically treated. The values are in turions/square meter.

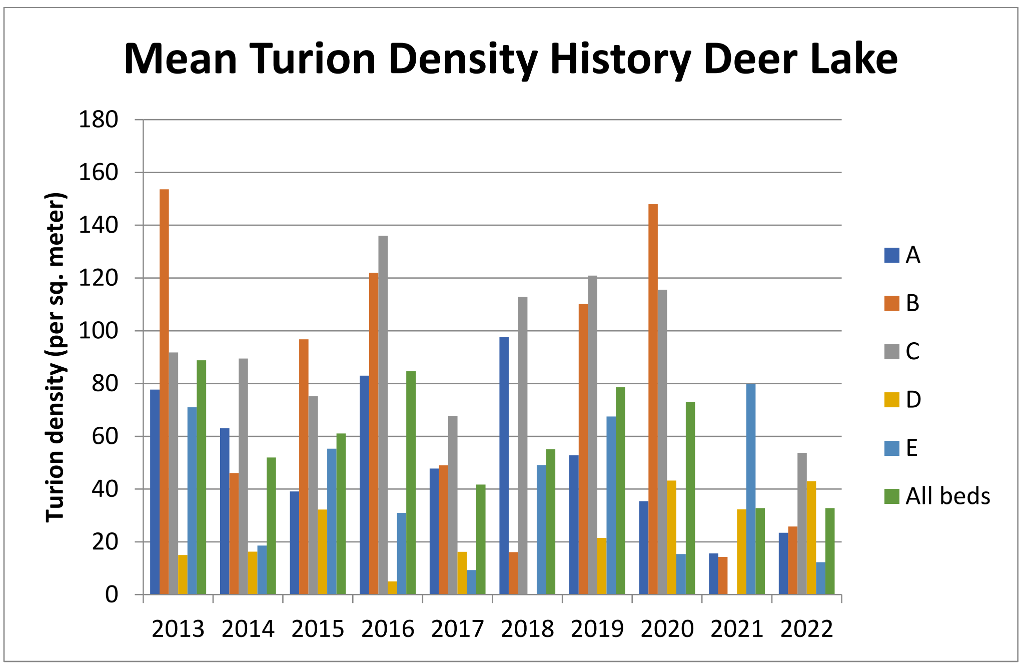

Figure 11: Mean turion density in historically treated beds from 2013 to 2022.

The long-term turion density changes are shown in Figure 12. As this graph shows, the turion density has decreased consistently since 2019. In 2021 and 2022, the mean turion density was the lowest since 2013.

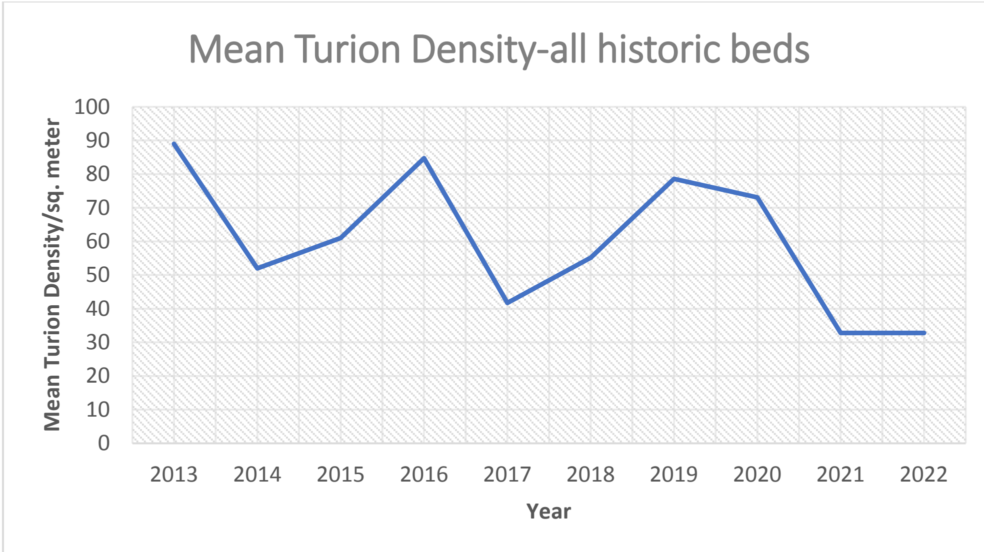

Figure 12: Graph showing turion density change (all beds) from 2013 to 2021.

Bed Mapping

Each year during peak growth, the entire littoral zone is meander surveyed for any CLP outside the treatment areas. In addition, the littoral zone full-lake point intercept survey points were surveyed. Since CLP tends to be highly variable, the location, size, and density of CLP beds can change annually. Figure 13 shows the CLP mapped in June 2022 following May 23, 2022, herbicide treatment (combined meander survey and point intercept results). The green dots are single or a few plants; the yellow is small clumps of CLP. A bed is defined by having CLP at or near the surface, at least 50% coverage within the defined border, and a border that can be followed in a boat. No beds of CLP could be delineated due to a lack of CLP coverage and density. By comparison, 1.4 acres of CLP beds were delineated following the herbicide treatment in 2021.

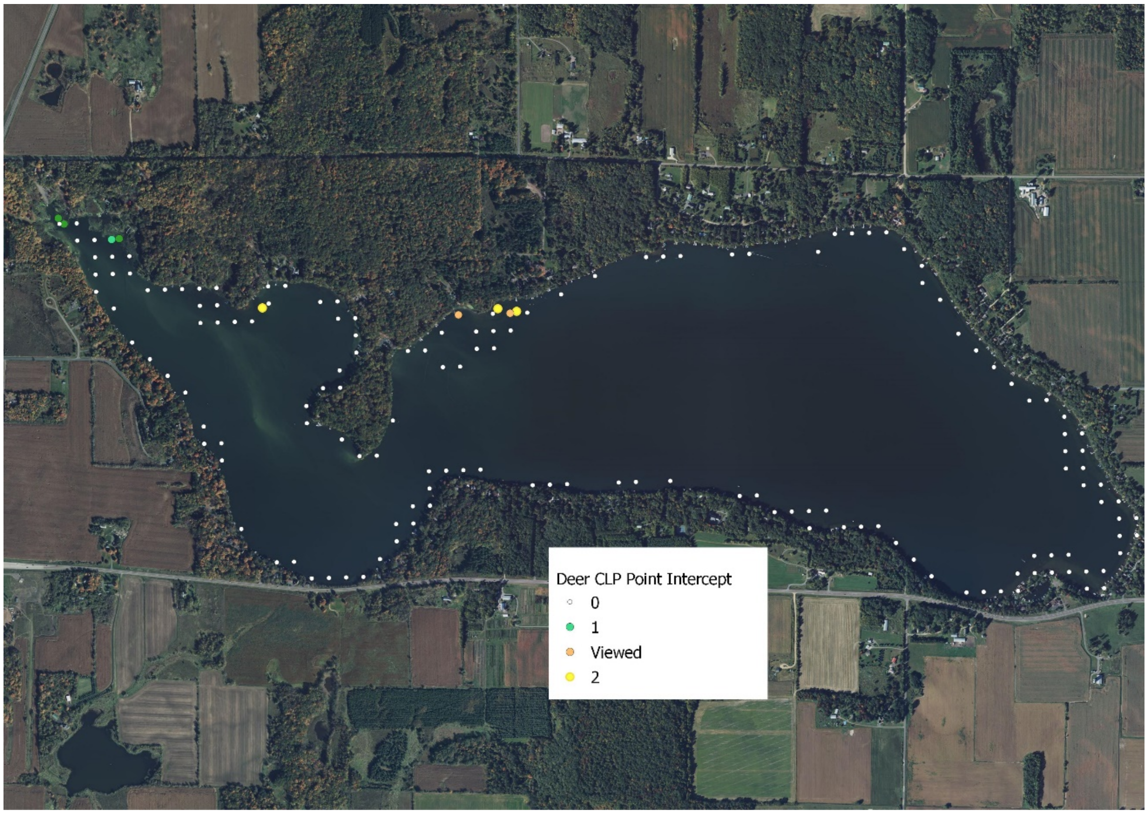

Figure 13: CLP mapped in June 2022. No CLP was growing densely enough to delineate beds. Only a few small clumps or individual plants were observed, with no beds delineated.

Discussion

The 2022 CLP herbicide application resulted in a statistically significant reduction in CLP frequency from before treatment to after treatment. The frequency decreased from 35.2% to 14.8%. Although the treatment appears to have reduced the growth of CLP, the frequency of 14.8% after treatment within the beds is somewhat high. Evaluation of pretreatment survey frequency can indicate long-term reduction. The pretreatment frequency in 2022 showed a statistically significant reduction from 2021 to 2022, 2018 to 2022, and 2014 to 2022. The reduction from 2014 to 2022 had an extremely low p-value, demonstrating that the reduction is very significant. With a post-treatment frequency of 14.8% in 2022, the pretreatment frequency in 2023 (if herbicide treatment occurs) may increase somewhat.

The turion analysis supports successful treatment and long-term CLP reduction. The turion density remained identical from 2021 to 2022. This may be due to some CLP growth after treatment in 2021. However, in 2021 and 2022, the turion density was the lowest since evaluating turion density beginning in 2013. This trend is a desirable result since the next year's CLP growth is from germinating turions. If the turion density is lower, the growth of CLP in the following spring should be lower. With this in mind, the 2022 turion survey shows that CLP will return in spring 2023 but shouldn't be very dense. Also, Beds A and D (not treated in 2021 or 2022) turion density indicate the CLP should be checked in those beds in spring 2023.

The 2022 bed mapping survey showed CLP growth was reduced compared to 2021 in areas outside the treatment beds and most previous years. CLP growth can vary immensely from year to year, so continued monitoring should continue to occur to determine if any of the beds return in future years and potentially become an issue. The CLP growth in other area lakes had lower intensity than in previous years.

References

Borman, Susan, Robert Korth, and Jo Tempte. *Through the Looking Glass.* The University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

Crow, Garrett E., and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

Ecological Integrity Service. Herbicide Analysis for Treatment of *Potamogeton crispus* (curly-leaf pondweed) 2021 Deer Lake, Polk County Wisconsin

The University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft. 46 p.

UW-Extension. Aquatic Plant Management website. http://www4.uwsp.edu/cnr/uwexlakes/ecology/apmguide.asp appendix d.

Appendix-2022 Data

Sample pt	Latitude	Longitude	y_proj	x_proj	Pre_CLP	Post_CLP	C. demersum	H. dubia	P. richardsonii	P. zosteriformis	L. trisulca	P. freisii	R. aquatilis	Chara sp.	B. beckii	M. sibiricum	S. pectinata	P. praelongus
Bed G																		
W1	45.40573	-92.5315	5028130	536665.7	1	0	0	0	0	0	0	0	1	3	0	0	0	0
W2	45.40551	-92.5313	5028106	536676.5	1	1	0	0	0	0	0	0	0	3	0	0	0	0
W3	45.40557	-92.5316	5028112	536654.9	v	0	1	0	1	1	0	0	0	1	0	0	0	0
W4	45.40579	-92.5317	5028137	536651.3	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W5	45.40568	-92.5318	5028124	536639.4	1	0	0	0	0	0	0	0	1	2	0	0	0	0
W6	45.40557	-92.532	5028112	536625	1	1	0	0	1	1	1	0	0	1	0	0	0	0
W7	45.40571	-92.5321	5028128	536619	1	1	0	1	0	0	1	0	1	0	1	0	0	0
W8	45.40547	-92.5323	5028101	536599.8	1	0	1	1	1	1	1	0	0	0	0	0	0	0
W9	45.4056	-92.5324	5028116	536596.2	0	0	1	0	0	0	0	1	1	0	0	0	0	0
Bed E																		
W10	45.39973	-92.5333	5027463	536530.3	0	0	0	0	0	0	0	0	0	1	0	0	0	0
W11	45.39985	-92.5334	5027476	536518.4	1	0	0	0	0	0	0	0	0	1	0	0	0	0
W12	45.39969	-92.5336	5027458	536501.6	v	0	0	0	0	0	0	0	0	3	0	0	0	0
W13	45.39955	-92.5334	5027442	536522	0	0	0	0	0	0	0	0	0	0	0	0	0	1
W14	45.39928	-92.5336	5027412	536505.2	v	0	0	0	0	0	0	0	1	1	0	0	0	0
W15	45.39946	-92.5336	5027433	536501.6	0	0	0	0	0	0	0	0	0	2	0	0	0	0
W16	45.39929	-92.5338	5027414	536484.8	1	1	0	1	0	0	0	0	0	0	0	0	0	0
W17	45.3991	-92.5341	5027392	536466.8	0	0	0	0	0	0	0	0	0	1	0	0	0	0
W18	45.39912	-92.5336	5027394	536501.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W19	45.39893	-92.5339	5027374	536482.4	v	0	0	0	1	0	0	0	0	0	0	0	0	0
W20	45.39876	-92.5341	5027355	536462.1	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W21	45.39864	-92.5339	5027342	536476.4	v	0	0	0	0	0	0	0	0	1	0	0	0	0
W22	45.39841	-92.5343	5027315	536448.9	0	0	0	0	1	0	0	0	0	2	0	0	0	0
W23	45.3986	-92.5343	5027337	536447.7	1	1	0	1	0	0	0	0	0	0	0	0	0	0
W24	45.39845	-92.5346	5027320	536428.5	v	0	0	0	0	0	0	0	0	3	0	0	0	1
W25	45.39832	-92.5348	5027306	536411.7	1	0	0	0	1	0	0	0	0	1	0	0	0	0
W26	45.39824	-92.5345	5027296	536432.1	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W27	45.39802	-92.5348	5027272	536411.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W28	45.39814	-92.535	5027285	536393.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bed D (not treated)																		
W29	45.40156	-92.5434	5027662	535738.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W30	45.40141	-92.5435	5027645	535725.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W31	45.40162	-92.5436	5027668	535722.8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
W32	45.4015	-92.5438	5027654	535707.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W33	45.40173	-92.5437	5027681	535710.8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
W34	45.40163	-92.5439	5027669	535692.9	v	0	0	0	0	0	0	0	0	0	0	0	0	0
Bed C																		
W35	45.40626	-92.5376	5028186	536187.7	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W36	45.40593	-92.5378	5028149	536173.3	0	0	2	0	0	0	0	0	0	0	0	1	0	0
W37	45.40578	-92.5375	5028133	536191.3	0	0	2	0	0	0	0	0	1	1	0	0	0	0
W38	45.40561	-92.5373	5028115	536208.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W39	45.40577	-92.5372	5028133	536217.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W40	45.40594	-92.5375	5028150	536196.1	1	1	0	1	0	0	0	0	1	0	0	1	0	0
W41	45.4061	-92.5377	5028168	536180.5	1	0	1	0	0	0	0	0	1	3	0	0	0	0
W42	45.40611	-92.5379	5028170	536162.5	1	0	0	0	0	0	0	0	1	3	0	0	0	0
W43	45.40636	-92.5379	5028197	536164.9	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W44	45.40633	-92.5381	5028194	536143.4	1	0	0	0	0	0	0	0	2	1	0	0	0	0
W45	45.40651	-92.5381	5028214	536148.2	0	0	0	0	0	0	1	0	1	1	0	0	0	0
Bed B																		
W46	45.40581	-92.5428	5028134	535776.7	0	0	0	0	1	0	0	0	0	3	0	0	0	0
W47	45.40561	-92.5428	5028112	535775.5	0	0	2	0	0	0	0	0	0	0	0	0	0	0
W48	45.40562	-92.5433	5028112	535742	0	0	3	0	0	0	0	0	0	0	0	0	0	0
W49	45.40575	-92.5431	5028128	535752.8	v	0	2	0	0	0	0	0	0	0	0	0	0	0
W50	45.40595	-92.5429	5028149	535772	0	0	0	0	2	0	0	0	0	3	0	0	0	0
W51	45.40601	-92.5433	5028156	535740.8	1	1	1	0	1	0	0	0	0	2	0	0	1	0
W52	45.40586	-92.5435	5028140	535725.2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
W53	45.4057	-92.5437	5028122	535710.8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
W54	45.40614	-92.5435	5028171	535721.6	v	0	0	1	0	0	2	0	0	0	0	1	1	0
W55	45.40597	-92.5438	5028152	535702.5	0	0	1	0	0	0	0	0	0	3	0	0	0	0
W56	45.40579	-92.544	5028131	535685.7	v	0	3	0	0	0	0	0	0	0	0	0	0	0
W57	45.40617	-92.5439	5028173	535691.7	0	0	0	0	0	0	0	0	0	3	0	0	0	0
W58	45.40604	-92.5442	5028159	535672.5	v	0	1	1	0	0	0	0	0	1	0	1	0	0
W59	45.40588	-92.5444	5028141	535656.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W60	45.40629	-92.5442	5028186	535668.9	0	0	0	1	0	0	0	0	1	2	0	0	1	0
W61	45.40618	-92.5444	5028174	535654.5	1	1	2	0	1	0	0	0	0	0	0	0	0	0
W62	45.40607	-92.5446	5028162	535636.6	0	0	3	0	0	0	0	0	0	0	0	0	0	0
W63	45.40631	-92.5448	5028189	535625.8	0	0	0	0	0	0	0	0	2	2	0	1	0	0
W64	45.40645	-92.5444	5028204	535649.7	2	0	0	0	0	0	0	0	0	3	0	0	0	0
Bed A (not treated)																		
W65	45.40855	-92.5483	5028436	535346.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W66	45.40841	-92.5485	5028420	535333.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W67	45.40822	-92.5487	5028400	535315.5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
W68	45.40871	-92.5486	5028454	535325.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W69	45.40853	-92.5487	5028433	535314.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W70	45.4084	-92.5489	5028419	535297.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W71	45.40867	-92.5489	5028449	535302.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W72	45.40855	-92.5491	5028436	535280.7	1	0	0	0	0	0	0	0	0	0	0	0	0	0
				count	23	8	15	8	10	3	5	1	13	34	1	5	3	2

Turion survey data

ident	y_proj	x_proj	Ts/sq m
1	5027516	536538.3	0
2	5027469	536528	0
3	5027423	536502.2	0
4	5027384	536468.7	86
5	5027335	536437.8	0
6	5027291	536412	0
7	5027245	536375.9	0
8	5028111	536223.7	0
9	5028147	536200.5	43
10	5028199	536156.7	43
11	5028214	536112.9	258
12	5028220	536058.7	0
13	5028220	536002	0
14	5028209	535947.8	0
15	5028186	535909.1	86
16	5028160	535651.3	0
17	5028142	535684.8	0
18	5028124	535736.4	172
19	5028127	535795.7	0
20	5028153	535751.8	43
21	5028176	535708	0
22	5028194	535661.6	86
23	5028209	535612.6	0
24	5027655	535731.2	0
25	5027681	535700.2	86
26	5027714	535674.5	86
27	5027743	535664.1	0
28	5028305	535421.7	0
29	5028369	535380.5	43
30	5028294	535272.2	0
31	5028330	535254.1	0
32	5028395	535323.7	86
33	5028382	535279.9	0
34	5028390	535236.1	0
35	5028439	535274.8	0
36	5028449	535225.8	0
37	5028457	535174.2	0
38	5028488	535117.4	129
39	5028133	536629.5	43
40	5028144	536644.9	43
41	5028130	536645.7	0
42	5028125	536666.9	0

Appendix C. Aquatic Plant Management Action Plan