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LONG TRADE LAKE, POLK COUNTY

2024-2028 APMP
WDNR WBIC: 2640500

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AQUATIC PLANT MANAGEMENT PLAN-LONG TRADE LAKE

PREPARED FOR THE LONG TRADE LAKE ASSOCIATION

INTRODUCTION

Long Trade Lake is a 151 acre lake in Watertown Township in Polk County. Long Trade Lake is located in the Trade River watershed (Figure 1). The Trade River Watershed is approximately 124,754 acres in size and contains 167 miles of streams and rivers, 2,902 acres of lakes and 21,757 acres of wetlands. The watershed is dominated by forest (46%), grassland (19%) and wetlands (17%), and is ranked medium for nonpoint source issues affecting streams.

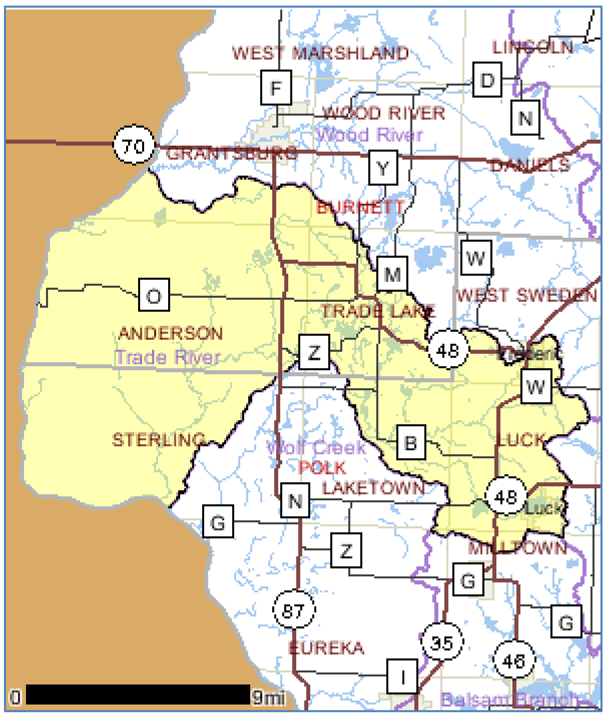


Figure 1 – Trade River Watershed (SC10)

Within the watershed, the Trade River begins in Polk County near Luck, WI, flows north in Burnett County and loops back to the south into the northwest of Polk County and then discharges into the St. Croix River (Figure 2). The Trade River flows through a chain of four lakes: Long Trade (Polk County), Round, Little Trade, and Big Trade (Burnett County). Long Trade Lake is the first lake in a chain that the Trade River flows through on its way to the St. Croix River.

For many years, these four lakes have been united under a common lake association for many years. In 2022, the property owners on Long Trade Lake left the Round-Trade Lakes Improvement Association (RTLIA) and formed their own lake association, the Long Trade Lake Association (LTLA). The LTLA has been designated a "qualified lake association" by the WDNR so is eligible to apply for and receive WDNR Surface Water Grants.

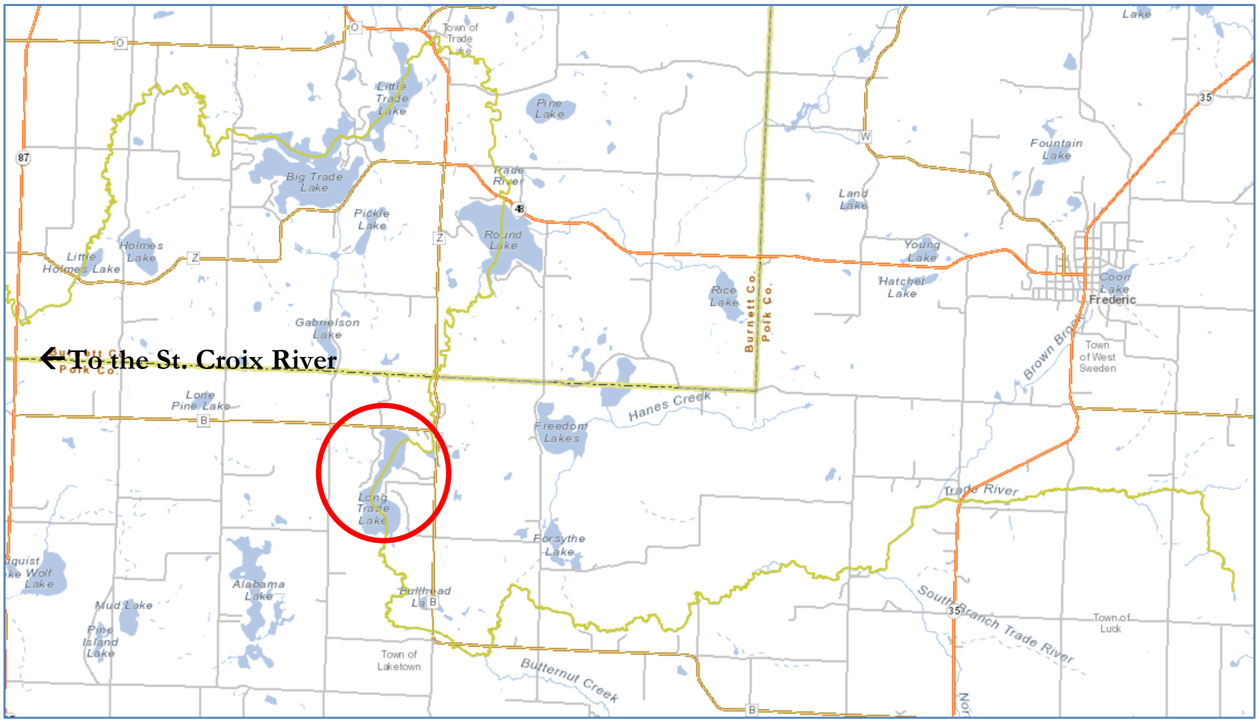


Figure 2 – Trade River Map – Long Trade Lake (circled in red)

Long Trade Lake is considered a "Reservoir" under the state's Natural Community Determinations. As such it is not considered a natural lake, but rather an impoundment created by an 11-ft dam on the Trade River. Still, Long Trade Lake is a shallow lake generally remaining mixed throughout the summer season. Stated lake uses for Long Trade Lake are fishing and swimming. These uses are not being met, and the lake was added to the Wisconsin Impaired Waters list in 2012 for Total Phosphorus, Excess Algal Growth, and Eutrophication. Long Trade Lake was evaluated for phosphorus and algae every two years between 2014 and 2022. Phosphorus levels were found to be too high, which was reflected in algal blooms. This lake is covered by a restoration plan: Implementation Plan for the Lake St. Croix Nutrient Total Maximum Daily Load (expires 2025). During the 2022 evaluation, both total phosphorus and chlorophyll sample data exceeded 2022 WisCALM listing thresholds for the Recreation use and Fish and Aquatic Life use[1].

All four of the lakes along the Trade River have exhibited signs of excess fertility for decades. The Polk County Land and Water Resources Department completed a project in 2019 that resulted in a Lake Management Plan (LMP) for Long Trade Lake covering the years 2019-2024. The Vision or overall statement for Long Trade Lake from the LMP is for the constituency and supporting stakeholders to take "a proactive approach to ensure a quiet lake with a diversity of habitats that support fishing, wildlife, recreation, and quality of life." To do this, five goals were developed.

- Goal 1. Improve water quality to reduce nuisance algae blooms
- Goal 2. Protect, maintain, and enhance fish and wildlife habitat while enhancing the natural scenic beauty of Long Trade Lake
- Goal 3. Provide information and education with the intent of changing stakeholder behaviors to protect Long Trade Lake
- Goal 4. Sustain the implementation of the plan by evaluating the progress of lake management efforts

[1] https://dnr.wi.gov/water/impairedDetail.aspx?key=16678

- Goal 5. Implement the goals of the Long Trade Lake Aquatic Plant Management Plan

At the time the LMP was published, aquatic plant management on Long Trade Lake was being guided by an Aquatic Plant Management (APM) Plan completed in 2018. This document is an update of the 2018-2022 APM Plan.

PREVIOUS AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

Eurasian watermilfoil (EWM) was identified in Long Trade Lake in 1995. Curly-leaf pondweed (CLP), another aquatic invasive species (AIS) has been in the lake for a longer period of time. Management of these two species, while at the same time, trying to protect and increase the number of native aquatic plant species in the lake, has been and will continue to be the focus of aquatic plant management in Long Trade Lake. The 2018-2022 APM Plan had the following goals.

- **Goal 1** – Promote and support aquatic plant management strategies that will control the spread of aquatic invasive species without negatively impacting native vegetation in Long Trade Lake.
- **Goal 2** – Reduce the threats that existing AIS will leave the lake; that new aquatic invasive species will be introduced into the lake; and that new AIS introduced to the lake will go undetected in the lake.
- **Goal 3** – Promote and support nearshore and riparian best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Long Trade Lake.
- **Goal 4 –** Develop a Comprehensive Lake Management Plan for Long Trade Lake.
- **Goal 5** – Complete appropriate and on-going tracking, monitoring, and management strategy modification to allow for thorough evaluation of management actions, and determinations that those management actions are on target, on track, on schedule, on budget, and within expected parameters.
- **Goal 6** – Encourage and engage lake residents and visitors to be active lake stewards.
- **Goal 7** – Implement the Long Trade Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.

Under Goal 1, were three main objectives: keep the level of EWM to below 2.0 acres or 4% of the littoral zone (50 acres); reduce the total acreage of CLP by 25-50%; and increase the number of native aquatic plant species in the lake. Under the implementation of the 2018-22 APM Plan, the first two objectives were met. According to the report completed by Endangered Resource Services (ERS), the results from the 2022 EWM survey work represented a combined 93.8% decline in early season EWM coverage as well as the total elimination (-100%) of areas where the infestation would likely have been considered a nuisance. Mid-summer and fall EWM bed mapping in Long Trade Lake basically showed no change in EWM coverage, which was very low to begin with. The report further declared that lakewide, from 2016-2022; there was a decline of 61.5% in total CLP coverage as well as a decline of 68.1% in likely nuisance areas caused by CLP.

The diversity of native aquatic plants pretty much stayed the same from 2016 to 2022 with 31 species identified in the lake when including those plants considered visuals, identified during a boat survey, and on the rake during actual sampling. Twice during this time frame, attempts were made to introduce and establish Northern watermilfoil in the lake. Volunteers, in cooperation with both LEAPS and ERS planted dozens of Northern watermilfoil turions in two different places in the lake. After the first year, several Northern watermilfoil plants did take root, but they were quickly snuffed out by poor water clarity. More information will be provided about the aquatic plant community in a later section of this document.

Under Goal 2 the objectives included implementing a watercraft inspection program, upkeep of AIS signage at the public access, and AIS monitoring. All three of these things were done.

Under Goal 3, projects to improve shoreland habitat around the lake and to reduce runoff into the lake were to be implemented. From 2018 to 2022, many were.

Goal 4 was completed in cooperation with the Polk County Land and Water Conservation Department with a LMP published in late 2019.

The objectives under Goals 5-7 were to establish a well-educated, well-versed, and concerned and aware constituency. The objectives were met as the property owners around the lake, now brought together by their own Lake Association continue to be involved and aware of the health of the lake and how the implementation or no implementation of management actions impact it.

LONG TRADE LAKE ASSOCIATION

As previously mentioned, in 2022 the property owners on Long Trade Lake formed their own qualified lake association and pulled out of the Round Trade Lakes Improvement Association. Implementation of this plan will be the first activities completed by the new Long Trade Lake Association.

The concerned citizens on Long Trade Lake have been involved in many lake related activities for many years and plan to continue in the future. These activities are conducted to protect the lake from contamination by pollutants, monitoring the condition of the water to detect unfavorable tendencies and limit the damage caused by aquatic invasive species. They include the following:

- Completion of five Healthy Lakes Grant projects
- Water quality monitoring through participation in the Citizen Lake Monitoring Network
- Watercraft inspection through the Clean Boats Clean Waters initiative
- Monitoring the location of the EWM in the lake
- Physical removal of EWM along the lakeshore when possible, and assisting in the chemical treatments.
-

There are approximately 73 property owners on Long Trade Lake, and as of 6/5/2023 there are 42 paid members of the new Lake Association. Time is spent communicating with and educating the property owners on Long Trade Lake about aquatic invasive species, water quality, algae and what contributes to it. The LTLA publishes newsletters, sponsors face-to-face gatherings, meetings and a summer picnic. The LTLA is a 501C-3 non-profit Wisconsin Corporation that receives $40 in annual dues from each of its members, is grant eligible, and that holds a Class “B” raffle license.

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

During the process of developing this APM Plan, the consultant met in person with the LTLA at least two times. Email and phone exchanges were more numerous. On June 11, 2023 the consultant submitted a final draft of the APM Plan to the Board of the LTLA. They in turn, forwarded it to approximately 70 property owners on the lake on June 26, 2023. Neither the LTLA Board nor the LTLA Constituency passed any comments or questions on to the consultant during a review period that lasted much longer than 21 days. On August 7, 2023, the LTLA Board unanimously approved the APM Plan and recommended it be sent to the WDNR with a request for review and approval. This request was made around August 20, 2023.

CHANGES IN CURLY-LEAF PONDWEED (CLP) (BERG M. , 2022)

During the initial 2012 survey completed by ERS, the spring littoral zone extended to 9.0ft, and CLP and EWM were the deepest growing plants. CLP was present in the rake at 93 locations with 11 additional visual sightings. This approximated to 24.7% total coverage and 54.1% of the littoral zone having at least some CLP present. Of these, 46 had a rake fullness rating of 3, 16 rated a 2, and 31 rated a 1 (mean rake fullness of 2.16). This suggested 16.5% of the lake and 36.0% of the littoral zone had a significant infestation (rake fullness 2 or 3).

In May 2016, CLP was present in the rake at 65 points (17.3% of the entire lake/54.6% of the 6.5ft spring littoral zone) with 11 additional visual sightings (Figure 3). Of these, 17 rated a rake fullness of 3, 30 were a 2 (12.5% of the lake/39.5% of the littoral zone with a significant infestation), and the remaining 18 were a 1 for a mean rake fullness of 1.98.

In 2022, CLP was present in the rake at 25 sample points with 12 additional visual sightings (Figure 3). This extrapolated to 6.6% of the entire lake and 25.5% of the spring littoral zone having at least some CLP present. Of these, three rated a rake fullness value of 3, 12 were a 2, and the remaining ten were a 1 for a combined mean rake fullness of 1.72. The 15 points with a rake fullness of a 2 or a 3 suggested 4.0% of the entire lake and 15.3% of the spring littoral zone had a significant infestation.

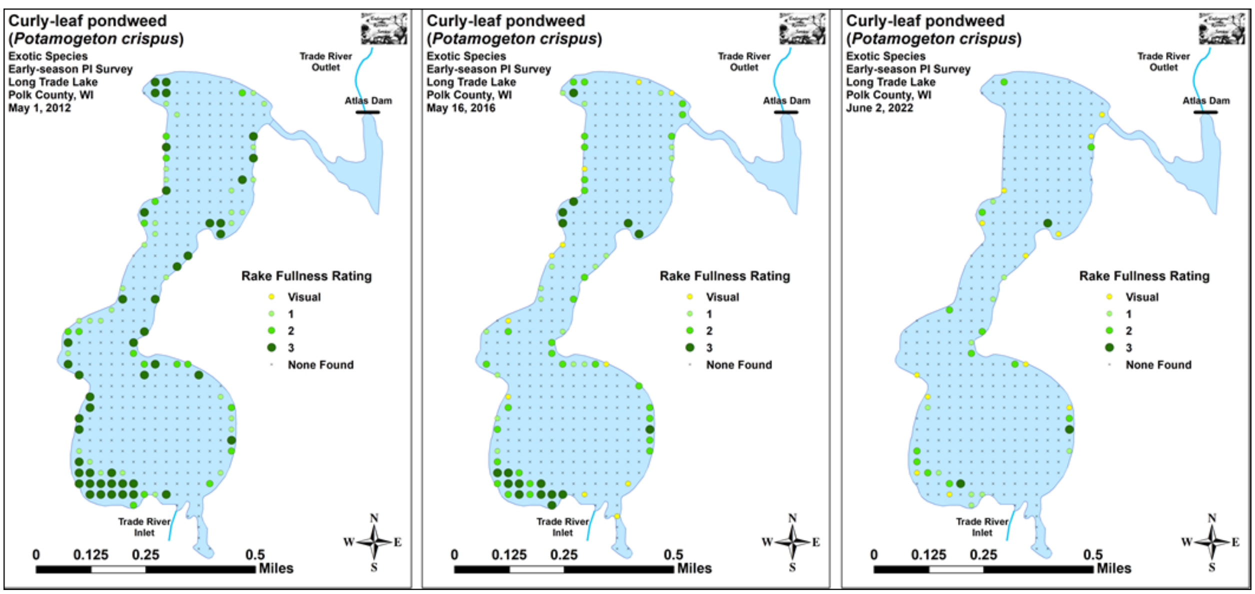


Figure 3: 2012, 2016, and 2022 spring/early summer CLP

In addition to point-intercept survey data, early summer CLP bed mapping was completed several times since 2012. In May 2012, it was found that most of the lake's littoral zone was dominated by canopied beds of CLP with scattered patches of EWM mixed in. Native plants were comparatively rare with the exception of Coontail (*Ceratophyllum demersum*) and White water lily (*Nymphaea odorata*) both of which were largely restricted to water less than 3ft deep. This distribution of CLP was divided into 10 separate beds by ERS. Collectively, the 10 CLP beds in 2012 covered 33.09 acres or 22.1% of the lake's 150 total acres (Figure 4). Two additional beds in the lake outlet channel and "pond" behind the dam brought the total to 38.60 acres.

The 2016 survey found CLP again dominated the spring littoral zone. ERS mapped 11 beds that covered 28.42 surface acres (18.9% of the lake) with an additional bed in the outlet bringing the total to 30.21 acres (figure 4). This was a reduction of 8.39 acres (-21.7%) compared to the 2012 survey with much of the loss occurring near the river inlet, in the outlet channel, and in the "mill pond". There was also some pull-back from deeper water with the shrinking of the spring 2016 littoral zone.

In 2022, the late 2022 ice-off followed by a rapid warm up did not appear to favor CLP growth. Regardless, 17 beds of CLP were delineated, all but one was less than an acre, and most seemed unlikely to cause more than minor navigation impairment (Figure 4). Collectively, these 17 beds totaled 5.29 acres (3.5% coverage) – a decline of 23.13 acres (-81.4%) compared to 2016. It was noted during the 2022 survey that the pullback in CLP area was lakewide, but it was especially complete in the outlet channel and mill pond where a single additional bed in the immediate lake outlet covered just 0.14 acre. This brought the total CLP acreage to 5.43 acres – 24.78 acres less than the combined total in 2016 (-82.0%), and 33.17 acres less than in 2012 (-85.9%) (Table 1).

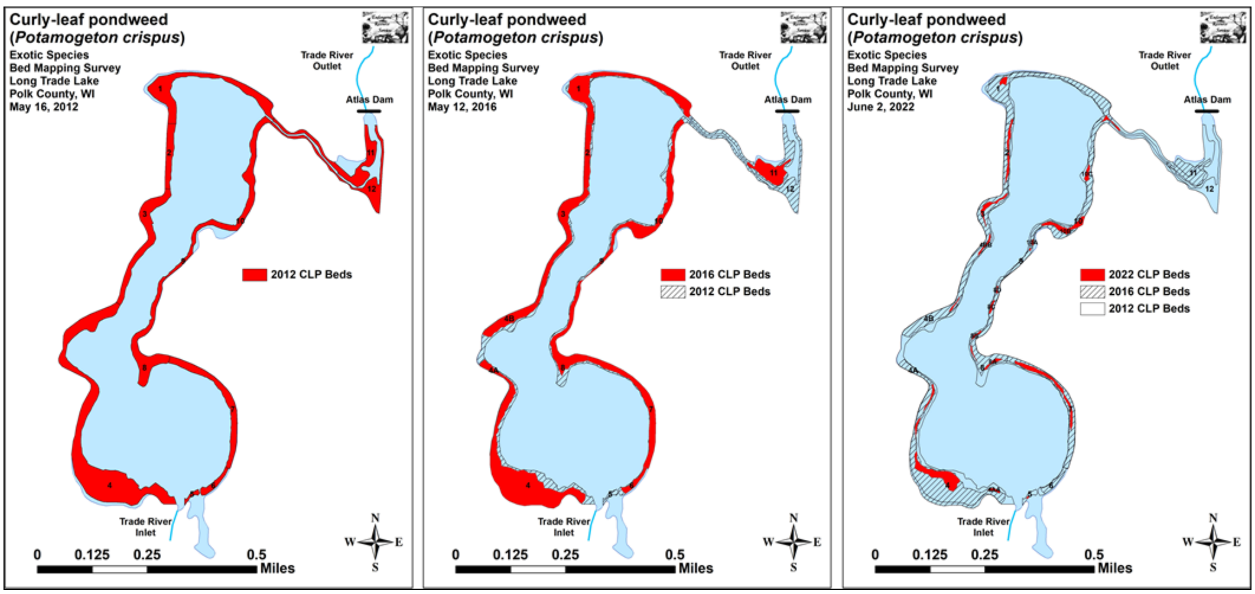


Figure 4 – 2012, 2016, and 2022 CLP bed-mapping

Table 1 – Curly-leaf Pondweed Bed Summary Long Trade Lake - Polk County, Wisconsin May 16, 2012, May 12, 2016, and June 2, 2022

Bed Number	2022 Acreage	2016 Acreage	2012 Acreage	2016-2022 Change in Acreage	Rake Range/ Mean Rake Fullness	Depth Range/Mean Depth	Canopied	Potential Navigation Impairment	2022 Field Notes
1	0.15	4.29	4.58	-4.14	<<1-2; 1	2-4; 2	Yes	Moderate	Bed in uninhabited bay.
2	0.43	1.22	1.43	-0.79	<<<1-2; <1	2-5; 3	Yes	None	Narrow ribbon.
3	0.36	2.82	3.26	-2.46	<<<1-3; 2	2-5; 3	Yes	Minor	Highly variable.
4 (A and B)	2.08	10.64	13.06	-8.56	<<<1-3; 1	2-6; 4	Yes	Minor	Fragmented former bed.
5	0.02	0	0.20	0.02	1-2; 1	2-4; 3	Yes	Minor	Microbed by river inlet.
6	0	0.50	0.62	-0.50	<<<1	2-5; 3	Yes	None	A few scattered plants.
7	0.93	2.84	2.93	-1.91	<<<1-3; 2	2-5; 3	Yes	Minor	Ribbon along shoreline.
8 (A-D)	0.41	2.44	3.28	-2.03	<<1-3; 2	2-5; 4	Yes	Minor	Too narrow to be mod.
9	0.02	0.36	0.40	-0.34	<<1-2; 2	2-5; 4	Yes	None	Microbed.
10 (A-C)	0.89	3.32	3.33	-2.43	<<1-3; 1	2-6; 4	Yes	Minor	Patchy scattered beds.
11	0	1.79	2.99	-1.79	<<<1	2-6; 3	Yes	None	A few scattered plants.
12	0.14	0	2.52	0.14	1-3; 2	1-4; 2	Yes	Moderate	Bed in outlet channel.
Total Acres	**5.43**	**30.21**	**38.60**	**-24.78**					

CHANGES IN EURASIAN WATERMILFOIL (EWM) (BERG M. , 2022)

In 2012, EWM was present in the rake at 27 points (7.2% total coverage/15.7% littoral coverage) with four additional visual sightings (Figure 5). Of these, six rated a rake fullness of 3, ten were a 2, and 11 were a 1 (mean rake fullness of 1.81). This suggested 4.3% of the entire lake and 9.3% of the spring littoral zone had a significant amount of EWM.

The 2016 survey found EWM at 32 points (8.5% total coverage/26.9% littoral coverage) with eight additional visual sightings (Figure 5). Six of these rated a 3, 15 were a 2 (5.6% of the lake/17.6% of the spring littoral zone had a significant infestation), and 11 were a 1 for a mean rake fullness of 1.84. None of these values were significantly different from the 2012 survey.

In 2022, EWM was found at just two points (0.5% total coverage/2.0% littoral coverage) and both had a rake fullness of 1 (Figure 5).

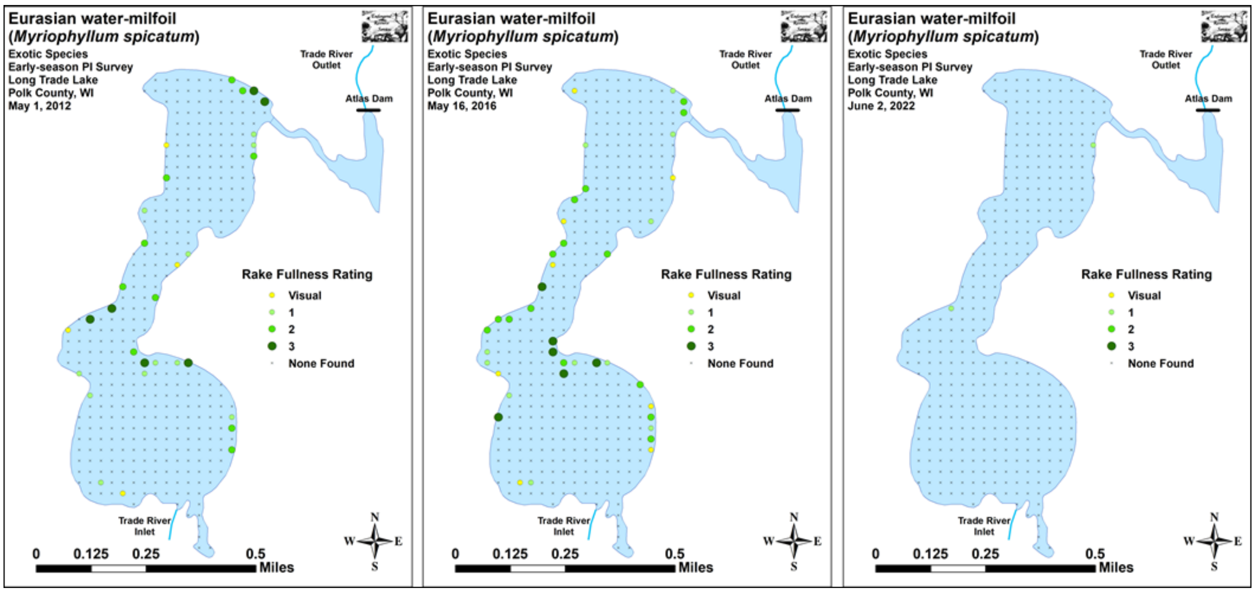


Figure 5 – 2012, 2016, and 2022 early season EWM

LAKE INVENTORY

In order to make recommendations for aquatic plant and lake management, basic information about the water body of concern is necessary. A basic understanding of physical characteristics including size and depth, critical habitat, water quality, water level, fisheries and wildlife, wetlands and soils is needed to make appropriate recommendations for improvement.

PHYSICAL CHARACTERISTICS

Long Trade Lake (WBIC 2640500) is a drainage reservoir in northwestern Polk County, about ten miles southeast of Grantsburg, Wisconsin. Long Trade Lake is the first in a series of four lakes that are connected by the Trade River. The water level is controlled by an 11 foot dam owned by Polk County at the Trade River outlet. According to the WDNR, Long Trade Lake is 153 acres with a maximum depth of 13-ft. Physical characteristics of the watershed, derived from GIS and other sources, are provided in Figure 6 and Table 2.

The area of land that drains to a lake is called a watershed. Land use in the Long Trade Lake watershed was delineated using WISLAND 2 satellite derived data and aerial photos from 2014 for use in the 2019-2024 LMP developed by Polk County (Polk County, 2019). The most common land use in the Long Trade Lake watershed is forest (44%), followed by grassland (24%), wetland (15%), agriculture (11%), developed (3%), and open water (3%). Developed areas are fairly sparce around Long Trade Lake, but much of the land around the lake as well as along the shores of Trade River which flows directly into Long Trade Lake is used for agriculture. While this is not the sole source of nutrients entering Long Trade Lake, these areas likely have a significant impact on the water quality of the lake.

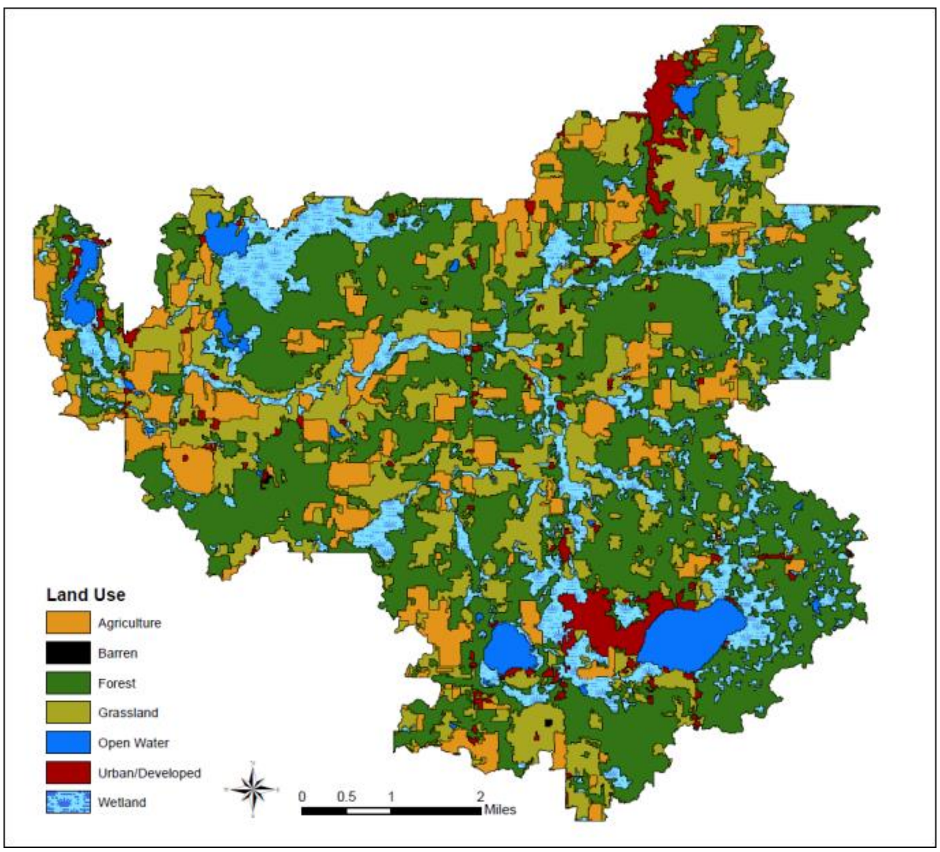


Figure 6: Watershed Land Use for Long Trade Lake, Polk County (Polk County, 2019)

Table 2: Watershed Characteristics of Long Trade Lake, Polk County

Land Use	Acres	Acres (%)
Forest	12,846	44%
Grassland	6,891	24%
Wetland	4,241	15%
Agriculture	3,361	11%
Developed	969	3%
Open Water	913	3%
Barren	7	0%
Total	**29,228**	**100%**

Land cover and land use management practices have a strong influence on water quality. Increases in impervious surfaces, such as roads, rooftops and compacted soils, associated with residential and agricultural land uses can reduce or prevent the infiltration of runoff. This can lead to an increase in the amount of rainfall runoff that flows directly into Long Trade Lake and its tributary streams. The removal of riparian, i.e., near shore, vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to the lake during rain events.

WATER QUALITY

WATER CLARITY

The Citizen Lake Monitoring Network[2] (CLMN) is a water quality monitoring partnership between the WDNR, the Wisconsin Lakes Partnership, and over a 1,000 citizen volunteers statewide. The goals of the CLMN are to collect high quality data, to educate and empower volunteers, and to share this data and knowledge. Volunteers measure water clarity using the Secchi disk, as an indicator of water quality (based on clarity). They also comment on other parameters including lake level, water color, murkiness, and how they perceive the lake on any given monitoring date using a 1 to 5 scale with 1 being "great, fantastic" and 5 being "really bad". Volunteers may also collect chemistry data; collect temperature and dissolved oxygen data; and monitor for the first appearance of aquatic invasive species near boat landings, other access points, or along the shoreline. Volunteers on Long Trade Lake have been collecting CLMN water quality data off and on since the CLMN program started in 1986.

Figure 7 reflects all of the years between 1986 and 2022 with at least one Secchi disk reading. From 1986 to 2022 the average annual Secchi disk reading of water clarity is 2.94ft (green line). There are several gaps in data, specifically between 2010 and 2015, but otherwise, there appears to be a slight trend (blue line) of improving water clarity with wide variance between the deepest and the shallowest readings.

[2] For more information about the CLMN go to: https://dnr.wisconsin.gov/topic/lakes/clmn

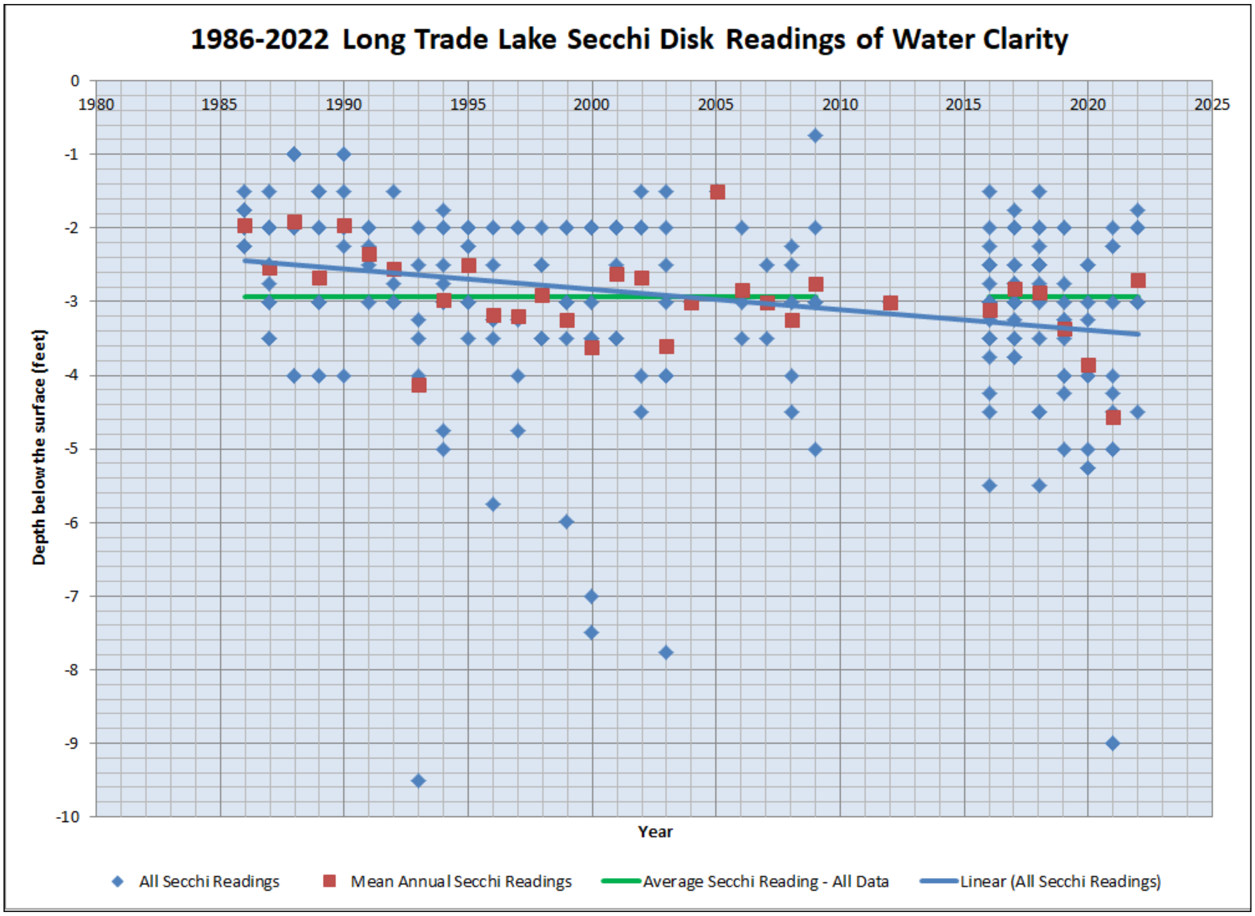


Figure 7: All CLMN water clarity data and annual means

Water clarity during the open water season in Long Trade Lake follows a common pattern. April water clarity may be somewhat reduced by ice out and turnover and runoff into the lake during snowmelt. This is followed by what is usually the best water clarity in May and early June when the water is still too cold to support the growth of algae. Water clarity begins to worsen in June and July, with August and early September being the worst due to warmer water and abundant phosphorus supporting the growth of algae. By October, water clarity begins to improve again as the water cools down again and algae die and sink to the bottom of the lake (Figure 8).

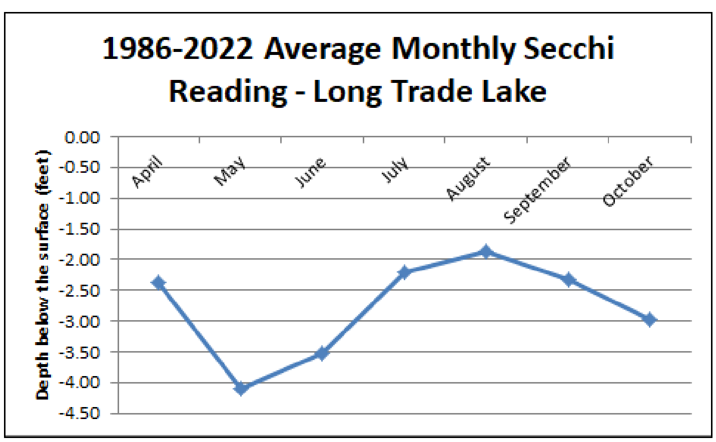


Figure 8: Average monthly Secchi disk readings of water clarity (all CLMN data)

WATER CHEMISTRY – TP AND CHLA

The "expanded" water quality monitoring level of the CLMN includes volunteers collecting Total Phosphorus (TP) and Chlorophyll-a (ChlA) data along with Secchi disk readings of water clarity. Since 2005, volunteers on Long Trade Lake have been collecting TP and ChlA data with a few gaps through the CLMN water quality monitoring program.

CLMN protocol for TP monitoring involves collecting water samples four times during the open water season to determine the amount of phosphorus in the water. Phosphorus is the main nutrient needed for both aquatic plant and algae growth in a lake. Figure 9 reflects the annual average of TP in Long Trade Lake over time. There is a good block of consistent data from 2005 to 2009, and then again from 2016 to 2020. It appears that there is an improving trend in the concentration of TP.

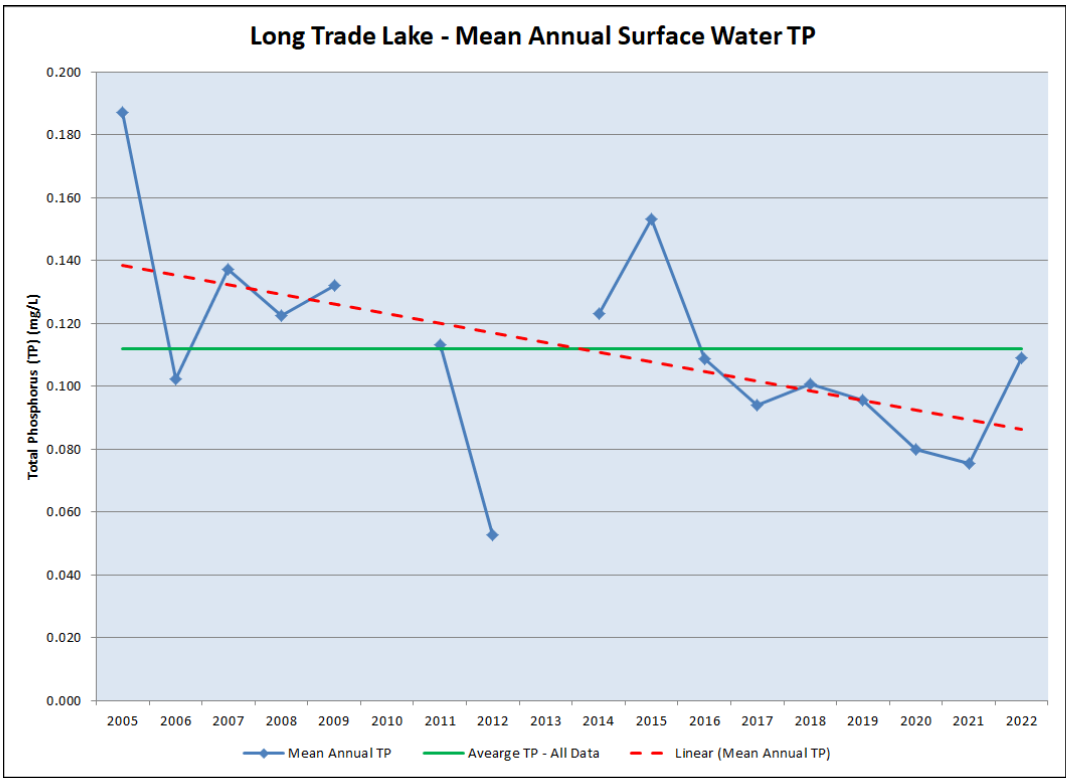


Figure 9: Average annual TP concentrations

Chlorophyll-a monitoring involves collecting water samples three times during the open water season. ChlA is the pigment that makes all plants green. In a lake, ChlA is used as a measurement of the amount of algae that is in the water. ChlA data has been collected on Long Trade Lake since 2005 with a few gaps. All CLMN ChlA data was included in this analysis ChlA data shows a trend of lessening amounts of algae in the lake water, particularly in the last 7 years or so (Figure 10). This trend holds up well with the trend of slightly better water clarity and the lesser amount of TP in the water during the same time frame. The amount of algae in the water is one of the main things that impacts water clarity. The more algae that there is, the greener the water gets, and the less deep the Secchi reading is. The amount of algae in the water is often the result of how much phosphorus is available.

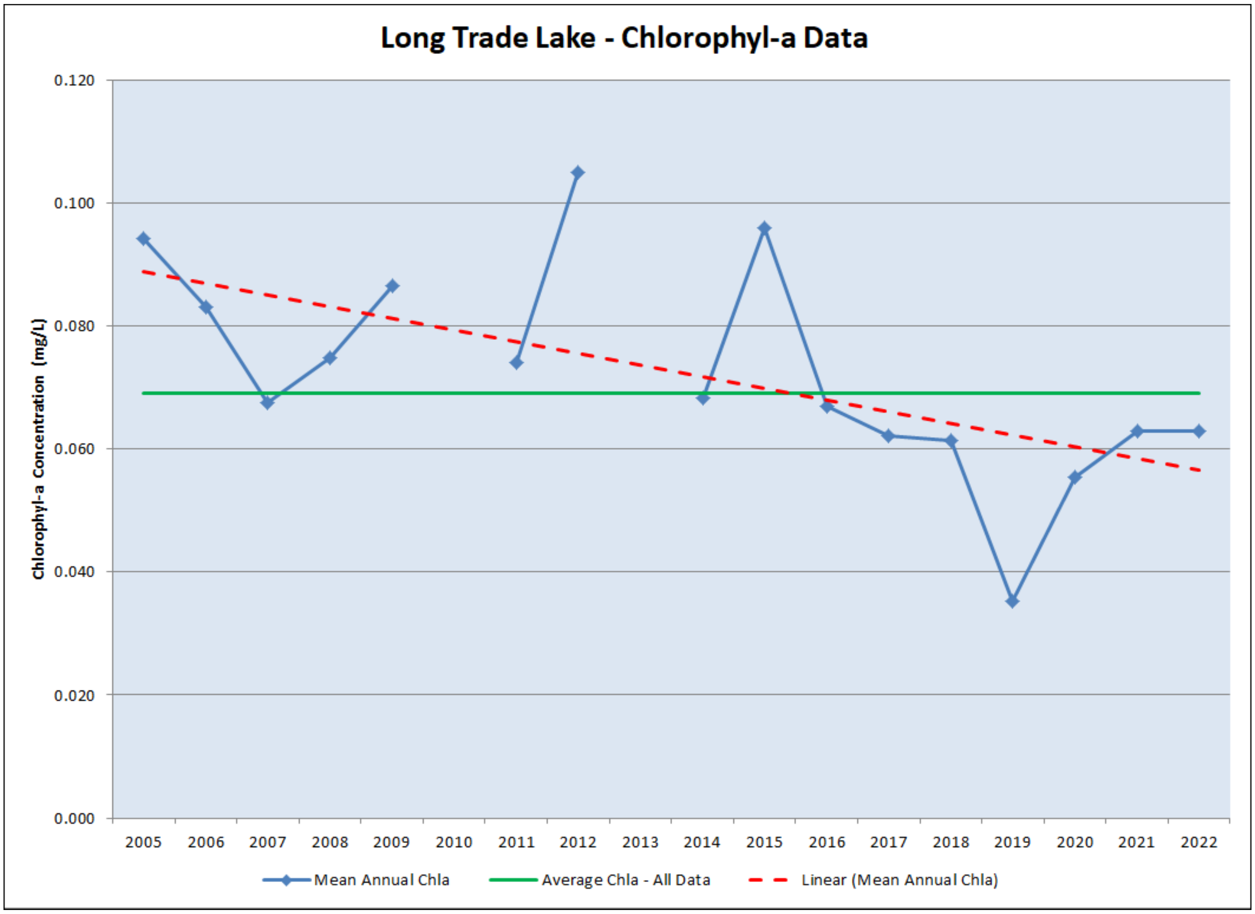


Figure 10: Average annual Chla concentrations plus trend line

TROPHIC STATE INDEX – LAKE PRODUCTIVITY

Water clarity (based on Secchi disk readings), total phosphorus, and chlorophyll-a are parameters that can be used to determine the productivity or trophic status of a lake. The Carlson trophic state index (TSI) is a frequently used biomass-related index. The trophic state of a lake is defined as the total weight of living biological material (or biomass) in a lake at a specific location and time. Eutrophication is the movement of a lake's trophic state in the direction of more plant biomass. Eutrophic lakes tend to have abundant aquatic plant growth, high nutrient concentrations, and low water clarity due to algae blooms (Figure 11). Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth (Figure 11). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 11).

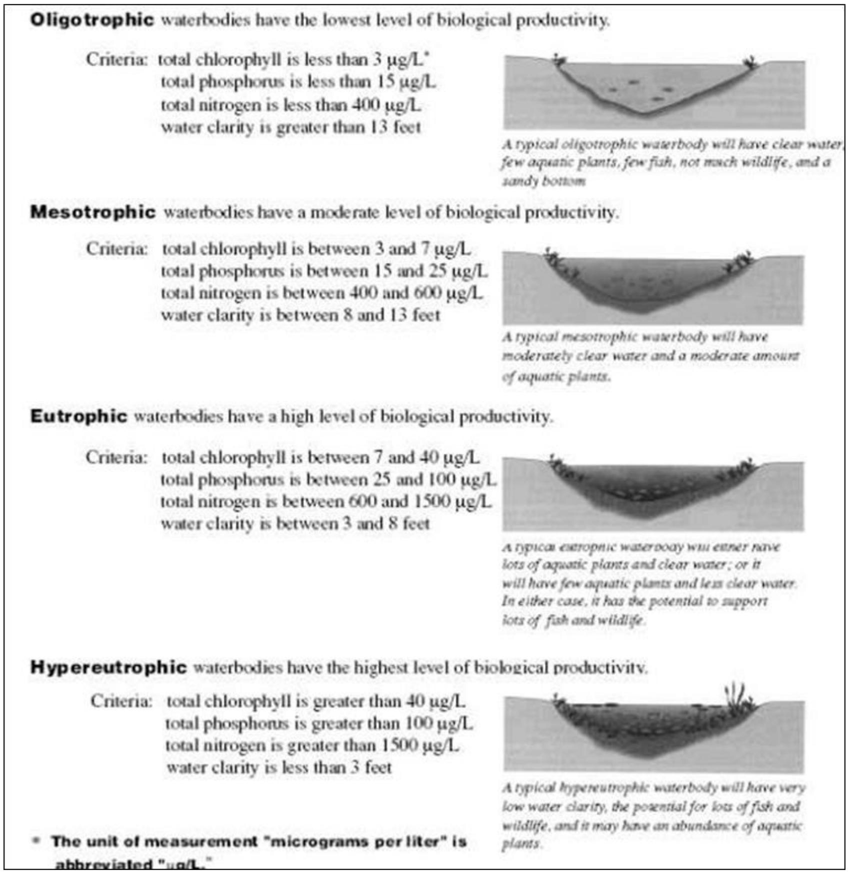


Figure 11: Trophic states in lakes

The TSI scale runs from "0" to "100". Generally, TSI values from 0-40 are considered oligotrophic, 40-50 are mesotrophic, 50-70 are eutrophic, and anything above 70 is considered hypereutrophic (Table 3).

Table 3: TSI Scale (Cedar Corporation, 2006)

Table 3-4: Trophic State Index (TSI)		
TSI Value	**Water Quality Attributes**	**Fisheries, Recreation or Example Lakes**
<30	**Oligotrophic:** Clear water, oxygen through the year in the hypolimnion. Water supply may be suitable unfiltered.	Salmonid fisheries dominate.
30-40	Hypolimnia of shallower lakes may become anoxic during the summer.	Salmonid fisheries in deep lakes only. Example: Lake Superior (WDNR)
40-50	**Mesotrophic:** Water moderately clear but increasing probability of anoxia in hypolimnion during summer. Possible iron, manganese, taste and odor problems may worsen in water supply. Water turbidity requires filtration.	Walleye may predominate and hypolimnetic anoxia results in loss of salimonoids.
50-60	**Eutrophic:** Lower boundary of classic eutrophy. Decreased transparency, anoxic hypolimnion during the summer, macrophyte problems evident, warm water fisheries dominant.	Bass may dominate.
60-70	Dominance of blue-green algae, algal scums probable, extensive macrophyte problems. Possible episodes of severe taste and odor from water supply. Anoxic hypolimnion, water-water fisheries.	Nuisance macrophytes, algal scums and low transparency may discourage swimming and boating.
70-80	**Hypereutrophic:** Light limited productivity, dense algal blooms and macrophyte beds.	Lake Menomin & Tainter Lake, Dunn County, WI (WDNR).
>80	Algal scums, few macrophytes, summer fishery kills.	Dominant rough fish.

The measurements of all three parameters (Secchi - feet, TP & Chla - µg/L) can be converted to values that fit in the TSI range of 0 to 100. By doing so, all three can be compared together to establish trends (Figure 12). The dark blue area of Figure 12 is considered oligotrophic; the light blue mesotrophic; and the green eutrophic. The annual average summer Secchi disk readings (black dots) all fall in the eutrophic area. Chla values (green squares) and TP values also all fall in the eutrophic area.

TSI data can be used for more than just visualizing trends. Over time, several familiar patterns emerge from the data. Carlson and Havens (2005) discussed the patterns that frequently emerge when looking at long-term trend data and TSI values. Since 2005, TSI values for Secchi, TP, and ChlA are relatively close to one another (Figure 12). This pattern suggests that algae blooms are dependent on the amount of phosphorus available, and by reducing the available phosphorus, the amount of algae, or at least the time and severity of algae blooms in the lake, may also be reduced (Carlson & Havens, 2005).

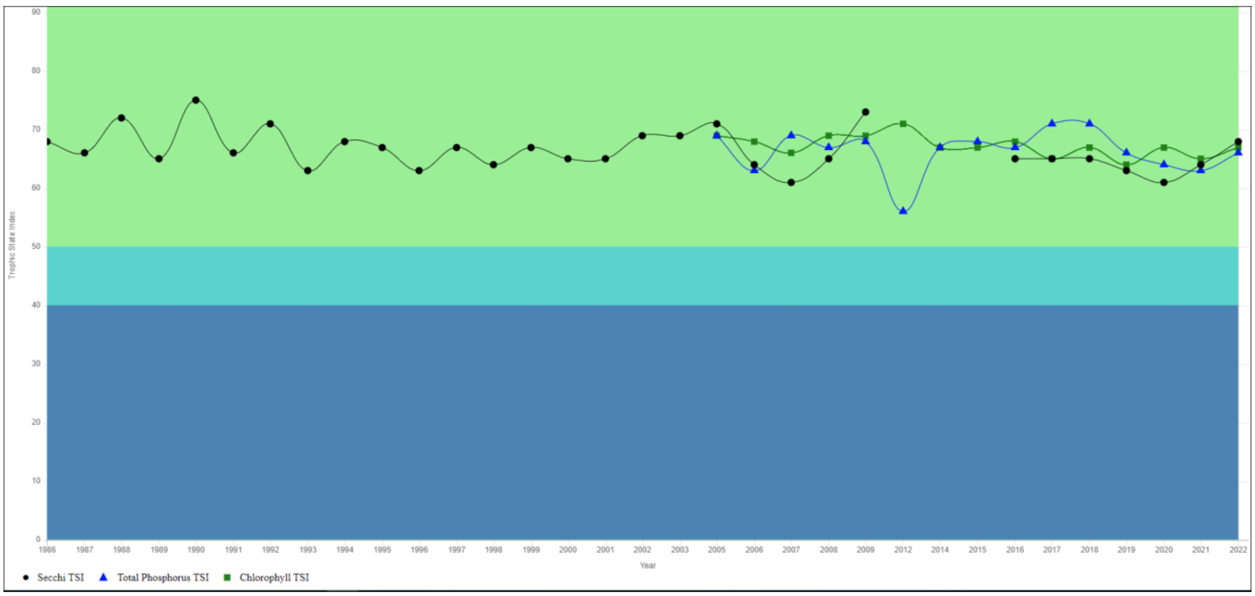


Figure 12: Yearly TSI values for Chla, Secchi (water clarity), and TP (CLMN)

TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen are important factors that influence aquatic organisms and nutrient availability in lakes. As temperature increases during the summer in deeper lakes, the colder water sinks to the bottom and the lake develops three distinct layers as shown in Figure 13. This process, called stratification, prevents mixing between the layers due to density differences which limits the transport of nutrients and dissolved oxygen between the upper and lower layers. In most lakes in Wisconsin that undergo stratification, the whole lake mixes in the spring and fall when the water temperature is between 53 and 66°F, a process called overturn. Overturn begins when the surface water temperatures become colder and therefore denser causing that water to sink or fall through the water column. Below about 39°F, water becomes less dense and begins to rise through the water column. Water at the freezing point is the least dense which is why ice floats and warmer water is near the bottom (called inverse stratification) throughout the winter.

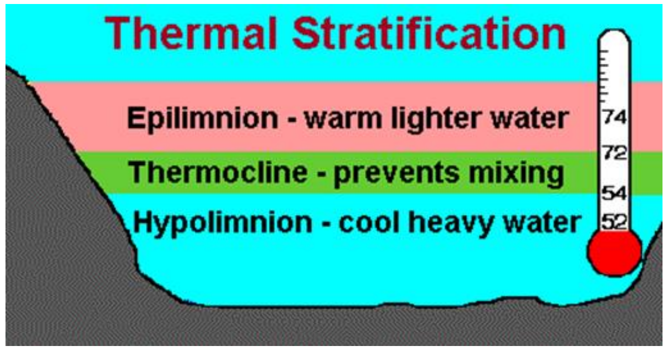


Figure 13: Summer thermal stratification

When a lake stratifies, dissolved oxygen (DO) levels in the bottom or hypolimnion portion of the lake may drop dramatically or disappear altogether. When this happens, nutrients normally trapped in the sediment can be released back into the water increasing the phosphorus available to grow more algae, degrading water quality further.

Long Trade Lake does not stratify. Temperature and DO monitoring in the entire water column of Long Trade Lake has been a part of the data that is collected annually. The tables in Figure 14, taken from the last full season of temperature and DO monitoring (2022), show that the lake does not stratify but rather stays mixed with both temperature and DO levels remaining fairly constant regardless of the month.

05/15/2022		
Depth FEET	Temp. DEGREES F	D.O. MG/L
0	67.3	7.81
3	66.7	7.79
6	66	7.65
9	63	6.42
12	57.6	2.61

06/20/2022		
Depth FEET	Temp. DEGREES F	D.O. MG/L
0	75	9.69
3	74.8	9.71
6	74.4	9.51
9	70	3.54
12	63	.28

07/25/2022		
Depth FEET	Temp. DEGREES F	D.O. MG/L
0	76.7	8.77
3	76	7.26
6	76	6.92
9	75.7	5.24
12	68.9	.28

08/28/2022		
Depth FEET	Temp. DEGREES F	D.O. MG/L
0	72.4	7.53
3	72.3	7.51
6	72.2	7.37
9	71.4	4.98
12	70	3.01

Figure 14: Temperature and DO profiles in Round Lake (2020 CLMN data)

FISHERIES AND WILDLIFE

Panfish, largemouth bass, and northern pike are all listed as common species in Long Trade Lake, while walleye are thought to be present. Carp are also found in Long Trade Lake, but the population is small enough that it does not seem to be causing problems within the lake (WDNRc, 1992). There is no fish stocking data from the WDNR suggesting that fish stocking has not occurred in the lake since 1972. The most recent WDNR fish surveys were conducted in 2003 and 2008. The 2003 survey was aimed at establishing a baseline while the 2008 survey was a late spring survey meant to assess bass and pan fish populations. Table 4 summarizes these surveys.

Table 4: WDNR Fisheries Data

2003 Baseline Survey				
Species	Relative Abundance (Catch per Mile)	Minimum Length (inches)	Maximum Length (inches)	Average Length (inches)
Black crappie	4	4.5	6.5	6
Bluegill	322	3	8.5	6.18
Largemouth Bass	35.67	7.5	18.5	13.61
Northern Pike	4	19	24.5	21.42
Pumpkinseed	3	5	6.5	6.08
Yellow Perch	12	6	9.5	8.42

2008 Late Spring Bass/ Panfish Assesment				
Species	Relative Abundance (Catch per Mile)	Minimum Length (inches)	Maximum Length (inches)	Average Length (inches)
Black Crappie	26	7	10	8.1
Bluegill	334	3	8.5	6.15
Largemouth Bass	40	6.5	19	12.47
Pumpkinseed	18	5	7	6.58
Yellow Perch	2	8	9	8.75

Both surveys show a large population of bluegills within Long Trade Lake as well as a healthy population of largemouth bass. There were noticeably more black crappies and pumpkinseeds found during the 2008 survey, but this is likely due to the timing of the survey more than any sort of drastic change in those populations. This is also the likely cause for the difference in yellow perch and northern pike that were found.

While the lake does not suffer greatly from winter fishkills due to oxygen depletion under the ice, it does suffer from spring fishkills caused by the fish virus “columnaris”. In nature, delays in spring fish spawning caused by changes in normal spring weather patterns can weaken fish enough to make them susceptible to the virus, which always present in the water. Columnaris outbreaks may also occur in lakes and streams during oxygen deprivation times such as droughts and high temperatures of the summer months. However, if the fish are healthy it’s not a problem. In August 2017 there was a large die-off of 4-6” crappies blamed on the virus (Personal Communication Aaron Cole, WDNR). Summer columnaris outbreaks are not common on this lake, but warm temperatures and possible oxygen deprivation likely triggered the outbreak. This outbreak, coupled with suffering water quality in the lake at the same time, made for extremely undesirable conditions on Long Trade Lake in August.

No non-native animal species have been observed in Long Trade Lake. There are currently two species, Chinese mystery snails and rusty crayfish, have been observed in the Trade River, but they are not yet found in Long Trade Lake. Little is known about Chinese mystery snails though they seem to cause negative impacts on the native snail populations. Rusty crayfish are substantially more aggressive than their native counterparts, and reproduce rapidly which is why they can be incredibly harmful to plant populations and fisheries in the lakes they inhabit.

The Natural Heritage Inventory (NHI) database contains recent and historic observations of rare species and plant communities. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). There is one plant (Brittle Prickly-pear [THR]) and one reptile species (Blanding’s turtle [SC]) that are found within the same township and range as Long Trade Lake (T36N, R18W).

CRITICAL HABITAT

Every body of water has areas of aquatic vegetation that offers critical or unique fish and wildlife habitat. Such areas can be identified by the WDNR and recognized as Sensitive Areas per Ch. NR 107. The WDNR has not identified sensitive areas on Long Trade Lake, but this does not mean they do not exist. There are areas of the lake that should be left in an undisturbed state to provide aquatic habitat and ecosystem services necessary for a healthy lake. Aquatic habitat areas provide the basic needs (e.g. habitat, food, nesting areas) for waterfowl, fish, and wildlife. Disturbance to these areas during mechanical harvesting should be avoided or minimized and chemical treatment is generally not allowed. Areas of rock and cobble substrate with little or no fine sediment are considered high quality walleye spawning habitat. No dredging, structures, or deposits should occur in these sensitive areas.

COARSE WOODY HABITAT (WOLTER, 2012)

Coarse woody habitat (CWH) in lakes is classified as trees, limbs, branches, roots, and wood fragments at least 4 inches in diameter that enter a lake by natural (beaver activity, toppling from ice, wind, or wave scouring) or human means (logging, intentional habitat improvement, flooding following dam construction). CWH in the littoral or near-shore zone serves many functions within a lake ecosystem including erosion control, as a carbon source, and as a surface for algal growth which is an important food base for aquatic macro invertebrates. Presence of CWH has also been shown to prevent suspension of sediments, thereby improving water clarity. CWH serves as important refuge, foraging, and spawning habitat for fish, aquatic invertebrates, turtles, birds, and other animals. The amount of littoral CWH occurring naturally in lakes is related to characteristics of riparian forests and likelihood of toppling. However, humans have also had a large impact on amounts of littoral CWH present in lakes through time. During the 1800's the amount of CWH in northern lakes was increased beyond natural levels as a result of logging practices. But time changes in the logging industry and forest composition along with increasing shoreline development have led to reductions in CWH present in many northern Wisconsin lakes.

CWH is often removed by shoreline residents to improve aesthetics or select recreational opportunities (swimming and boating). Jennings et al. (2003) found a negative relationship between lakeshore development and the amount of CWH in northern Wisconsin lakes. Similarly, (Christensen, Hewig, Schindler, & and Carpenter, 1996) found a negative correlation between density of cabins and CWH present in Wisconsin and Michigan lakes. While it is difficult to make precise determinations of natural densities of CWH in lakes it is believed that the value is likely on the scale of hundreds of logs per mile. The positive impact of CWH on fish communities have been well documented by researchers, making the loss of these habitats a critical concern. One study determined that black crappie selected nesting sites that were usually associated with woody debris, silty substrate, warmer water, and protected from wind and waves (Pope & Willis, 1997).

Fortunately, remediation of this habitat type is attainable on many waterbodies, particularly where private landowners and lake associations are willing to partner with county, state, and federal agencies. Large-scale CWH projects are currently being conducted by lake associations and local governments with assistance from the WDNR where hundreds of whole trees are added to the near-shore areas of lakes. For more information on this process visit: http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html (last accessed on 12-29-2016).

Small-scale CWH projects, more commonly referred to as "fishsticks," can also be done by individual property owners, and are eligible for grant assistance through the WNDR Healthy Lakes program. This program is intended to help individual property owners make a positive impact on their lake's ecosystem through small-scale projects such as fishsticks (Figure 15).

Figure 15: Coarse woody habitat-Fishsticks projects

As a part of the multi-year project to develop a Lake Management Plan for Long Trade Lake, Polk County completed a both a coarse woody habitat survey and a shoreland inventory in 2017. During the coarse woody habitat survey, project participants identified 38 locations along the shoreline of Long Trade Lake where trees or other coarse woody structures were present (about ten trees per mile of shoreline) (Figure 16). Given that in the few years since the 2017 survey, several severe storms blew across the area where Long Trade Lake is located, reassessing the amount of coarse woody habitat would be a beneficial activity and help the LTLA make decisions about adding fishsticks.

Figure 16: 2017 coarse woody habitat locations in Long Trade Lake

SHORELANDS

How the shoreline of a lake is managed can have big impacts on the water quality and health of that lake. Natural shorelines prevent polluted runoff from entering lakes, help control flooding and erosion, provide fish and wildlife habitat, may make it harder for AIS to establish themselves, muffle noise from watercraft, and preserve privacy and natural scenic beauty. Many of the values lake front property owners appreciate and enjoy about their properties - natural scenic beauty, tranquility, privacy, relaxation - are enhanced and preserved with good shoreland management. And healthy lakes with good water quality translate into healthy lake front property values.

Shorelands may look peaceful, but they are actually the hotbed of activity on a lake. 90% of all living things found in lakes - from fish, to frogs, turtles, insects, birds, and other wildlife - are found along the shallow margins and shores. Many species rely on shorelands for all or part of their life cycles as a source for food, a place to sleep, cover from predators, and to raise their young. Shorelands and shallows are the spawning grounds for fish, nesting sites for birds, and where turtles lay their eggs. There can be as much as 500% more species diversity at the water's edge compared to adjoining uplands.

Lakes are buffered by shorelands that extend into and away from the lake. These shoreland buffers include shallow waters with submerged plants (like coontail and native pondweeds), the water's edge where fallen trees and emergent plants like rushes might be found, and upward onto the land where different layers of plants (low ground cover, shrubs, trees) may lead to the lake. A lake's littoral zone is a term used to describe the shallow water area where aquatic plants can grow because sunlight can penetrate to the lake bottom. Shallow lakes might be composed entirely of a littoral zone. In deeper lakes, plants are limited where they can grow by how deeply light can penetrate the water.

Shorelands are critical to a lake's health. Activities such replacing natural vegetation with lawns, clearing brush and trees, importing sand to make artificial beaches, and installing structures such as piers, can cause water quality decline and change what species can survive in the lake. In addition to being potentially damaging, some of these undertakings require permits and approval. Most changes to lakebed exposed by fluctuating water levels (removal of sediments, additions of beach sand, etc.), often require permits and approval. The only exceptions to this are manual removal of a 30 foot corridor of native plants or the removal of non-native invasive plants. These regulations have been put in place to encourage property owners to responsibly manage their shorelands to improve and maintain the quality of the lake as a whole.

Protecting Water Quality

Shoreland buffers slow down rain and snow melt (runoff). Runoff can add nutrients, sediments, and other pollutants into lakes, causing water quality declines. Slowing down runoff will help water soak (infiltrate) into the ground. Water that soaks into the ground is less likely to damage lake quality and recharges groundwater that supplies water to many of Wisconsin's lakes. Slowing down runoff water also reduces flooding, and stabilizes stream flows and lake levels.

Shoreland wetlands act like natural sponges trapping nutrients where nutrient-rich wetland sediments and soils support insects, frogs, and other small animals eaten by fish and wildlife.

Shoreland forests act as filters, retainers, and suppliers of nutrients and organic material to lakes. The tree canopy, young trees, shrubs, and forest understory all intercept precipitation, slowing runoff, and contributing to water infiltration by keeping the soil's organic surface layer well-aerated and moist. Forests also slow down water flowing overland, often capturing its sediment load before it can enter a lake or stream. In watersheds with a significant proportion of forest cover, the erosive force of spring snow melts is reduced as snow in forests melts later than snow on open land, and melt water flowing into streams is more evenly distributed. Shoreland trees grow, mature, and eventually fall into lakes where they protect shorelines from erosion, and are an important source of nutrients, minerals and wildlife habitat.

Natural Shorelands Role in Preventing AIS

In addition to removing essential habitat for fish and wildlife, clearing native plants from shorelines and shallow waters can open up opportunities for invasive species to take over. Like tilling a home garden to prepare it for seeding, clearing shoreland plants exposes bare earth and removes the existing competition (the cleared shoreland plants) from the area. Nature fills a vacuum. While the same native shoreland plants may recover and reclaim their old space, many invasive species possess "weedy" traits that enable them to quickly take advantage of new territory and out-compete natives.

The act of weeding creates continual disturbance, which in turn benefits plants that behave like weeds. The modern day practice of mowing lawns is an example of keeping an ecosystem in a constant state of disturbance to the benefit of invasive species like turf grass, dandelions, and clover, all native to Europe. Keeping shoreline intact is a good way to minimize disturbance and minimize opportunities for invasive species to gain a foothold.

Threats to Shorelands

When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, houses, decks, garages, sheds, piers, rafts and other structures, wells, septic systems, lawns, sandy beaches and more. Many of these changes result in the compaction of soil and the removal of trees and native plants, as well as the addition of impervious (hard) surfaces, all of which alter the path that precipitation takes to the water.

Building too close to the water, removing shoreland plants, and covering too much of a lake shore lot with hard surfaces (such as roofs and driveways) can harm important habitat for fish and wildlife, send more nutrient and sediment runoff into the lake, and cause water quality decline.

Changing one waterfront lot in this fashion may not result in a measurable change in the quality of the lake or stream. But cumulative effects when several or many lots are developed in a similar way can be enormous. A lake's response to stress depends on what condition the system is in to begin with, but bit by bit, the cumulative effects of tens of thousands of waterfront property owners "cleaning up" their shorelines, are destroying the shorelands that protect their lakes. Increasing shoreline development and development throughout the lake's watershed can have undesired cumulative effects.

Shoreland Preservation and Restoration

If a native buffer of shoreland plants exists on a given property, it can be preserved and care taken to minimize impacts when future lake property projects are contemplated. If a shoreline has been altered, it can be restored. Shoreline restoration involves recreating buffer zones of natural plants and trees. Not only do quality wild shorelines create higher property values, but they bring many other values too. Some of these are aesthetic in nature, while others are essential to a healthy ecosystem. Healthy shorelines mean healthy fish populations, varied plant life, and the existence of the insects, invertebrates and amphibians which feed fish, birds and other creatures. Figure 17 shows the difference between a natural and unnatural shoreline adjacent to a lake home. More information about healthy shorelines can be found at the following website: http://wisconsinlakes.org/index.php/shorelands-a-shallows (last accessed 12-29-2016).

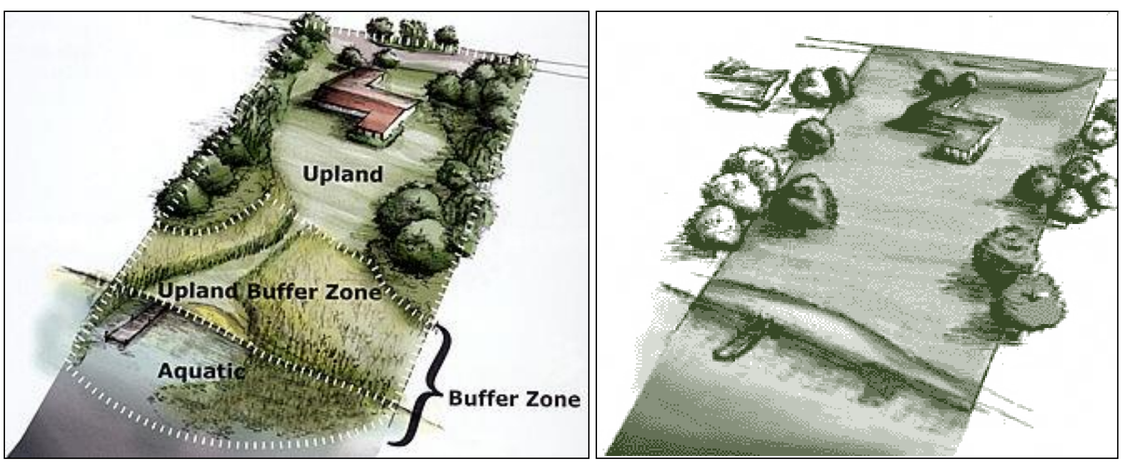


Figure 17: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

As a part of the multi-year project to develop a Lake Management Plan for Long Trade Lake, Polk County completed a shoreland inventory in 2017. During that survey, it was determined that the shoreline of the lake is primarily undisturbed (68%) as compared to disturbed (32%). Within the disturbed area though, most of the shoreland ground cover was mowed grass (Figure 18).

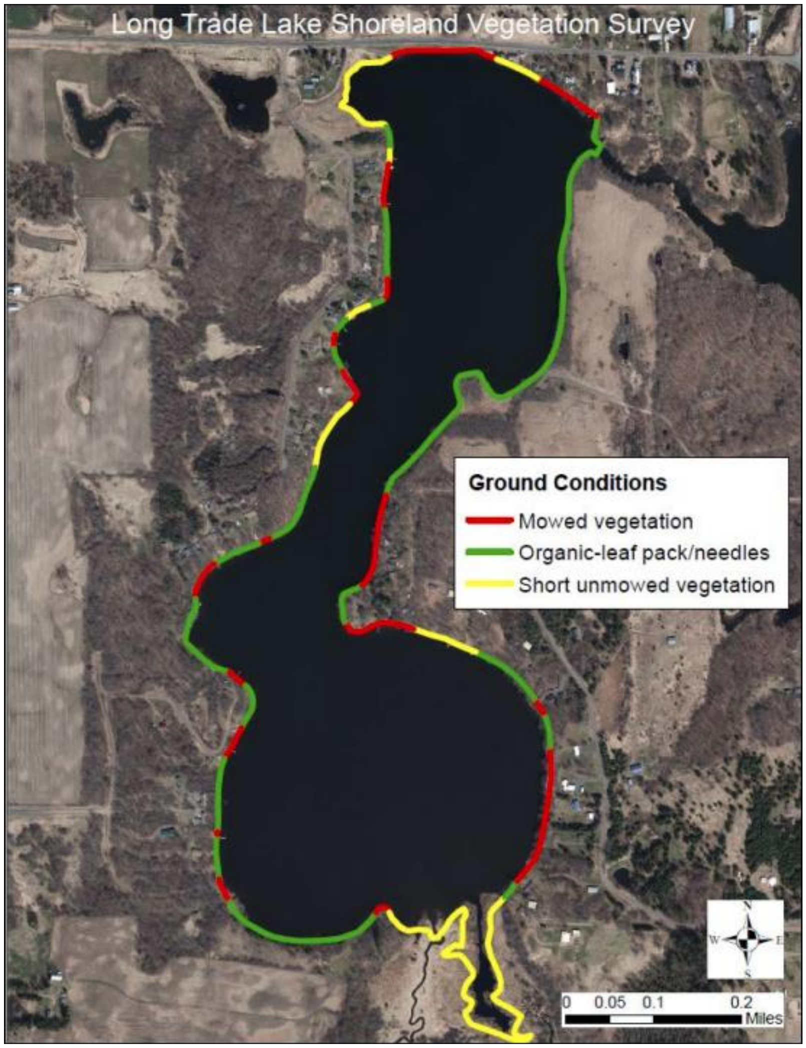


Figure 18: Ground cover around Long Trade Lake (Polk Co, 2019)

ATTRIBUTES TO HELP MAINTAIN A HEALTHY LAKE AND WATERSHED

Natural areas such as forests and wetlands allow for more infiltration of precipitation when compared with conventional tilled row cropped fields and developed residential sites containing lawns, rooftops, sidewalks, and driveways. This occurs because dense vegetation lessens the impact of raindrops on the soil surface, thereby reducing erosion and allowing for greater infiltration of water. Additionally, wetlands provide extensive benefits through their ability to filter nutrients and allow sediments to settle out before reaching lakes and rivers. In the Long Trade Lake watershed 44% of the land use is forest and 15% is wetland (Polk County, 2019).

WETLANDS

A wetland is an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions. Wetlands have many functions which benefit the ecosystem surrounding Long Trade Lake. Wetlands with a higher floral diversity of native species support a greater variety of native plants and are more likely to support regionally scarce plants and plant communities. Wetlands provide fish and wildlife habitat for feeding, breeding, resting, nesting, escape cover, travel corridors, spawning grounds for fish, and nurseries for mammals and waterfowl.

Wetlands also provide flood protection within the landscape. Due to the dense vegetation and location within the landscape, wetlands are important for retaining stormwater from rain and melting snow moving towards surface waters and retaining floodwater from rising streams. This flood protection minimizes impacts to downstream areas. Wetlands provide water quality protection because wetland plants and soils have the capacity to store and filter pollutants ranging from pesticides to animal wastes.

Wetlands also provide shoreline protection to Long Trade Lake because shoreline wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. This shoreline protection is important in waterways where boat traffic, water current, and wave action cause substantial damage to the shore. Wetlands also provide groundwater recharge and discharge by allowing the surface water to move into and out of the groundwater system. The filtering capacity of wetland plants and substrates help protect groundwater quality. Wetlands can also stabilize and maintain stream flows, especially during dry months. Aesthetics, recreation, education and science are also all services wetlands provide. Wetlands contain a unique combination of terrestrial and aquatic life and physical and chemical processes.

Figure 19 shows the location of the wetlands in the greater Long Trade Lake watershed.

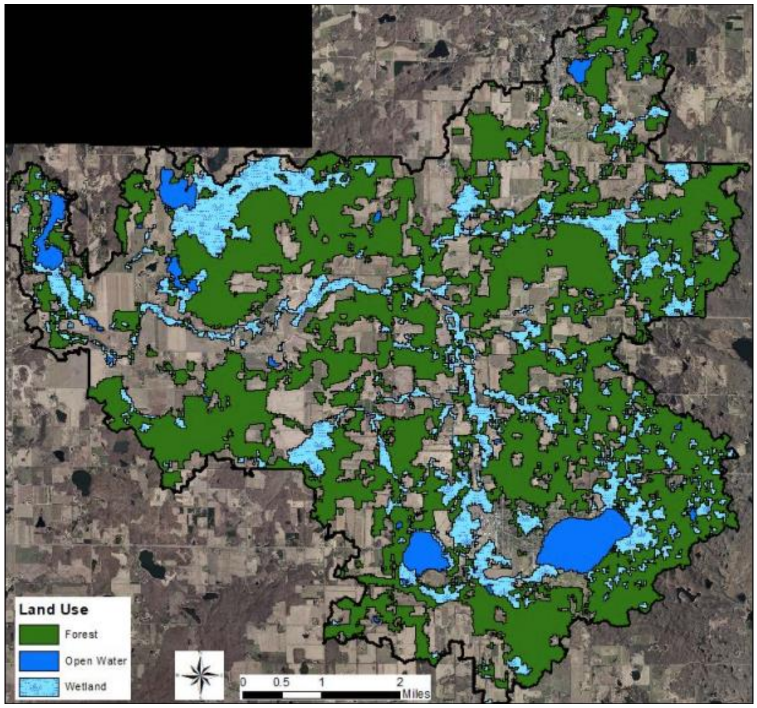


Figure 19: Long Trade Lake forests, wetlands, and open water (Polk County, 2019)

SOILS

Soils are classified into hydrologic soil groups to indicate their potential for producing runoff. Group A soils have a high infiltration rate which makes the potential amount of runoff very low. These soils are, generally very sandy and allow water to pass through unimpeded. Conversely, group D soils have a very low infiltration rate making their runoff potential fairly high. Group D soils are generally very dense with high amounts of organic material. This causes water to move slowly through group D soils often resulting in standing water on flat surfaces and flowing water over sloped surfaces. Most of the soils within the Long Trade Lake watershed fall into groups C and C/D (NRCSa, 2016) (Figure 20). These soils are very good for agriculture, but they also have a fairly high runoff potential. If managed appropriately, the runoff can be minimized in these areas.

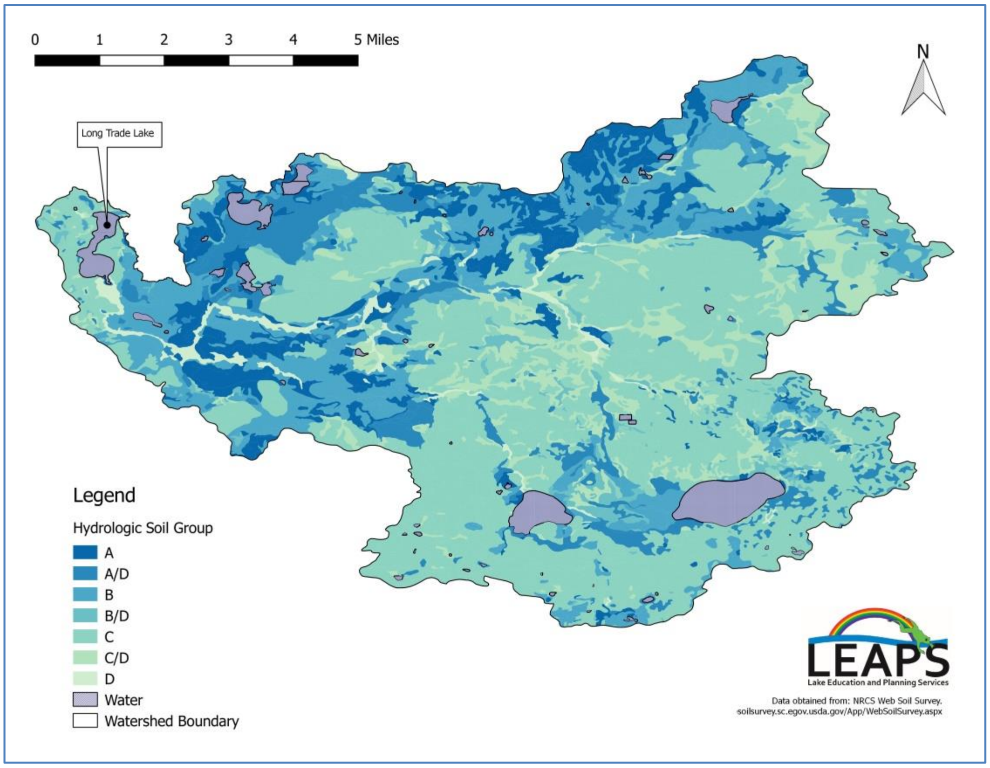


Figure 20: Hydrologic Soil Group Classification in the Long Trade Lake Watershed

2006, 2016, AND 2022 WHOLE LAKE POINT INTERCEPT AQUATIC PLANT SURVEYS

One of the most important parts of updating an existing APM Plan for a lake is comparing the aquatic plant community from before the plan is implemented to the aquatic plant community after the plan has been implemented. The first whole-lake, point-intercept (PI) survey was completed by Polk County in 2006. Endangered Resource Services completed the 2016 whole-lake, PI survey, and completed the most recent survey in 2022. The following sections assess how the aquatic plant community changed from 2006 to 2016 to 2022.

WARM-WATER FULL POINT-INTERCEPT AQUATIC PLANT SURVEY

In anticipation of updating their plan in 2023, the RTLIA, under the direction of Lake Education and Planning Services, LLC, (LEAPS) authorized three lakewide surveys in 2022. On June 2nd, an early-season CLP PI and bed mapping surveys were conducted. These were followed by a warm-water PI survey of all macrophytes on July 23rd. The surveys' objectives were to document the current levels of CLP and EWM, and to determine if any new exotic plants had invaded the lake. It is also to compare data from the 2006, 2016, and 2022 whole lake PI surveys to identify any significant changes in the lake's vegetation over this time. The data presented in the following sections are taken from the 2022 Final Aquatic Plant Survey Report completed by ERS (Berg M. , 2022).

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth and total acreage, Jennifer Hauxwell (WDNR) generated the original 376-point sampling grid that has been used for each survey since 2006. Each survey point in the grid is located using a handheld mapping GPS unit (Garmin 76CSx). At the point, a rake is used to sample an approximate 2.5ft section of the bottom. Plants that are found on the rake are assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 21). All visual sightings of aquatic plants within six feet of a sample point are also noted.

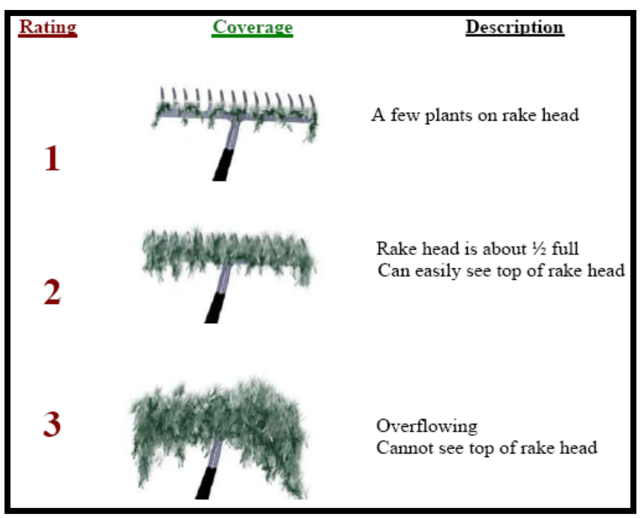
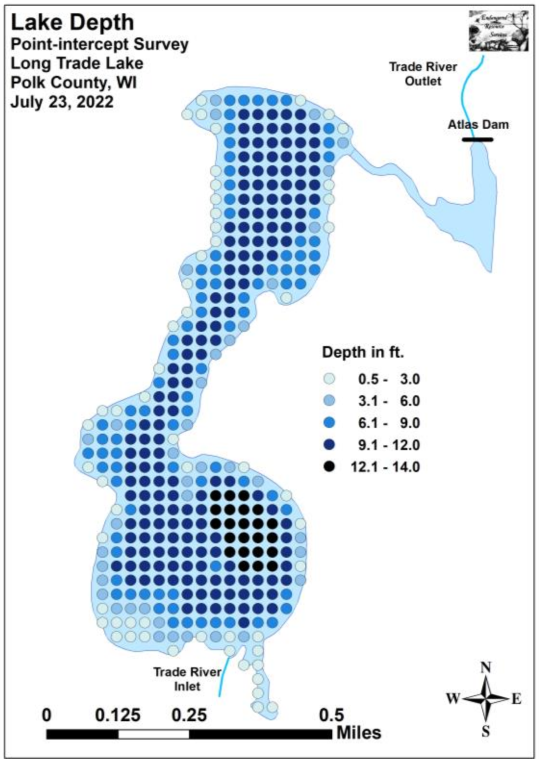


Figure 21: Rake fullness ratings (UWEX, 2010)

Depth readings taken at Long Trade Lake's 376 survey points revealed the lake's southern basin at the river inlet was an uneven bowl with a shallow bay on the southeast end that gradually dropped off into a 12ft+ flat on the northeast end. Other notable features in the southern third of the lake included a small rock hump that topped out at 8ft almost directly in the center of the basin, a rock bar that project directly south of the north-central point, and a relatively shallow 9ft bay in the northwest corner. The central third of the lake was a narrow steep-sided 10ft trench running southwest to northeast. In the lake's northern third, shallow bays that bottomed out in 7ft of water were found northwest of the central "neck", at the east side public boat landing, and in the northwest corner of the lake. In the riverine outlet channel, water depths never topped 3ft although areas in the "pond" behind the dam were over 10ft (Figure 22).

The lake's bottom substrate was categorized as 81.1% organic and sandy muck (305 points), 15.4% pure sand (58 points), and 3.5% rock (13 points). Most sandy and rocky areas occurred immediately along the shoreline, on exposed points, on the bar and sunken island in the south basin, and at the river inlet. These areas quickly transitioned to nutrient-poor sandy and organic muck at most depths over 4ft (Figure 22).



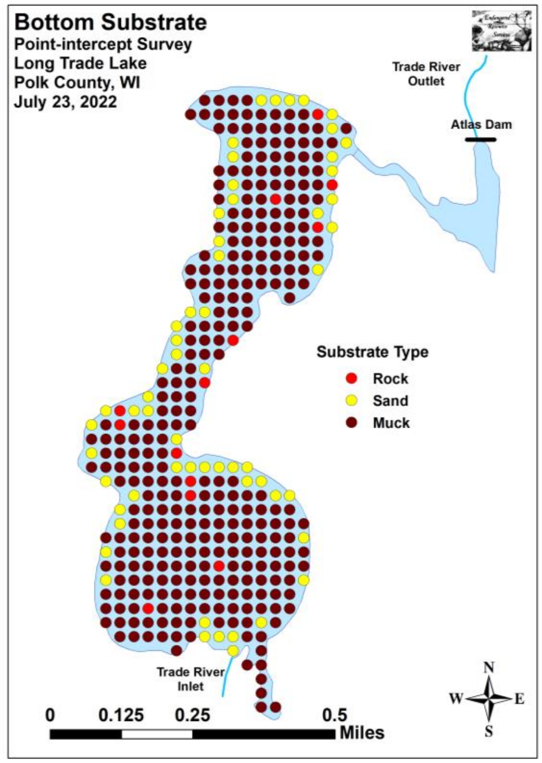


Figure 22: 2022 lake depth and bottom substrate

During the July 2022 survey, plants were found growing in up to 7.0ft (identical to 2016, but down from 7.5ft in 2006) (Table 5). Of the 376 points, 82 points had vegetation (approximately 21.8% of the entire lake bottom and 71.3% of the littoral zone). This was only slightly higher than results from 2016 (78 points, 20.7%), and much higher than the 58 points (58.6%) with vegetation in the 2006 survey. Although this suggests a sharp increase in coverage, comparing these percentages is somewhat problematic as many areas with dense vegetation near the river inlet were not surveyed in 2006 (Figure 23).

Table 5 – PI Survey Summary Statistics Long Trade Lake, Polk County 2006, 2016, and 2022

Summary Statistics:	2006	2016	2022
Total number of points sampled	130	376	376
Total number of sites with vegetation	58	78	82
Total number of sites shallower than the maximum depth of plants	99	113	115
Frequency of occurrence at sites shallower than maximum depth of plants	58.6	69.0	71.3
Simpson Diversity Index	0.85	0.87	0.84
Maximum depth of plants (ft)	7.5	7.0	7.0
Mean depth of plants (ft)	3.1	3.0	3.2
Median depth of plants (ft)	3.0	3.0	3.0
Number of sites sampled using a rake on a rope	0	0	0
Number of sites sampled using a rake on a pole	130	376	376
Average number of all species per site (shallower than max depth)	1.89	2.46	2.60
Average number of all species per site (veg. sites only)	3.22	3.56	3.65
Average number of native species per site (shallower than max depth)	1.63	2.38	2.56
Average number of native species per site (sites with native veg. only)	3.10	3.59	3.63
Species richness	11	24	21
Species richness (including visuals)	13	26	25
Species richness (including visuals and boat survey)	15	31	31
Mean rake fullness (veg. sites only)	Est. 1.80	2.29	2.50

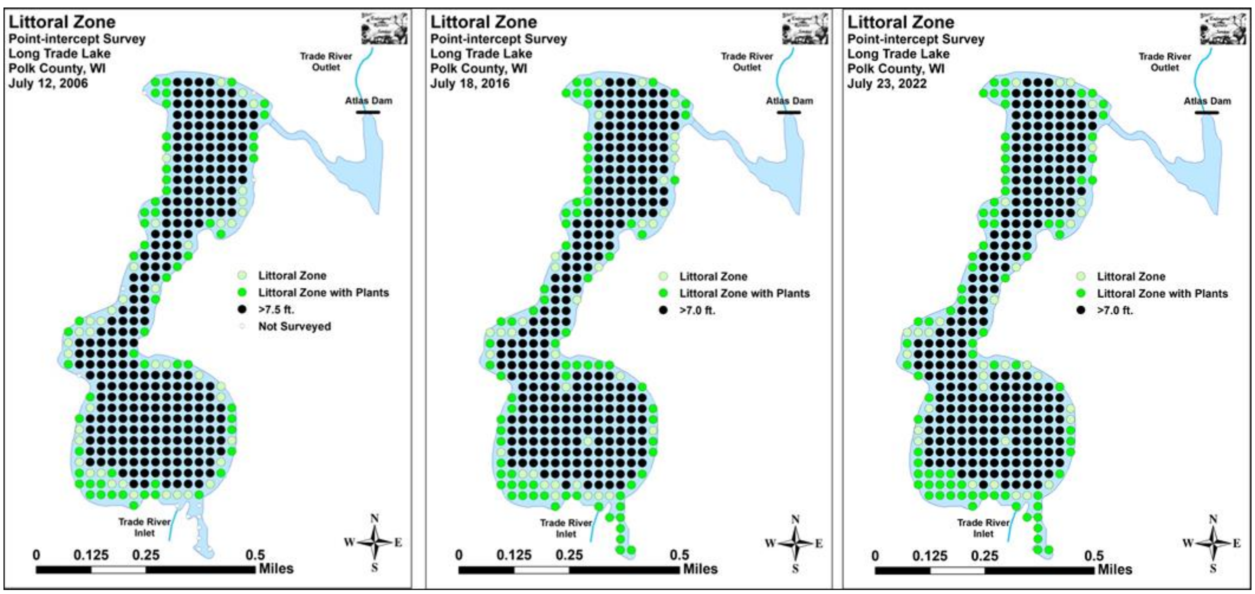


Figure 23: 2006, 2016, and 2022 littoral zone (ERS)

From 2006 to 2016, a nearly significant increase in mean native species at sites with native vegetation from 3.10/site to 3.59/site was documented. Visual analysis of the maps showed most localized increases occurred in the southwest bay and the river inlet (Figure 24). In 2022, a further non-significant increase to 3.63 native species/site with native vegetation was documented. Comparing the maps from the most recent surveys found few differences.

Total rake fullness experienced a highly significant increase from a low/moderate 1.80 in 2006 to a high/moderate 2.29 in 2016. This increase was especially evident in the southwest and northwest bays. Similar to localized richness, at least some of this increase was likely due to the 2016 survey accessing points with dense plant growth in the river inlet/southeast slough areas that the previous WDNR surveyors excluded (Figure 25). The 2022 survey again documented an increase in mean density to a high mean rake fullness of 2.50. Although this was only nearly significant, analysis of the maps suggested these increases were widespread.

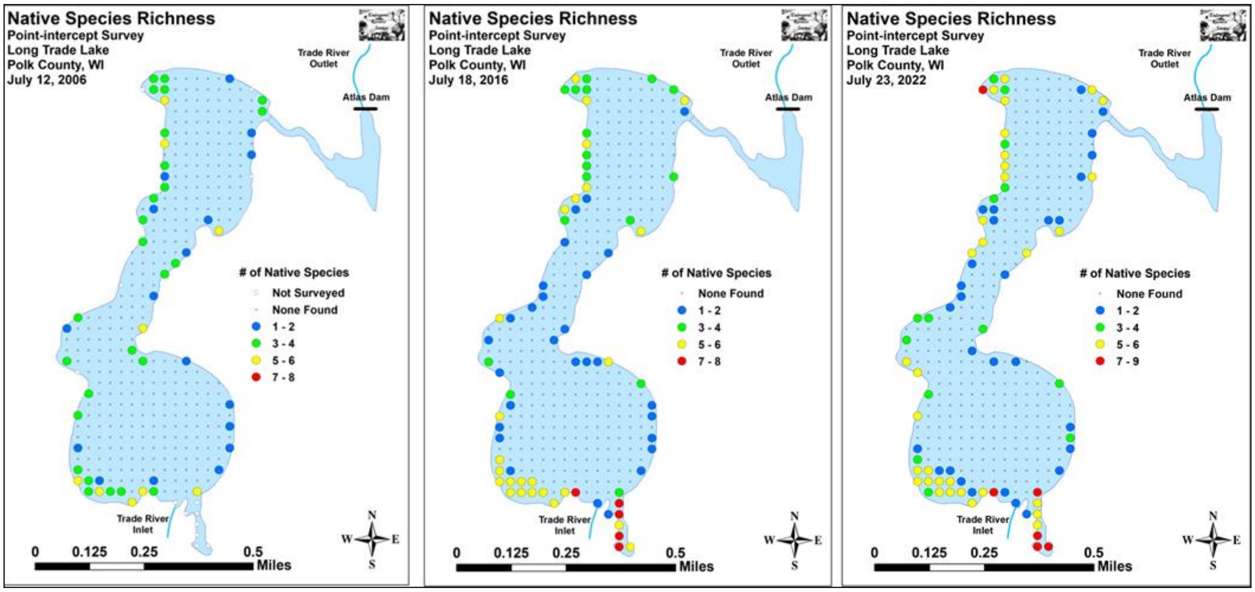


Figure 24: 2006, 2016, and 2022 native species richness

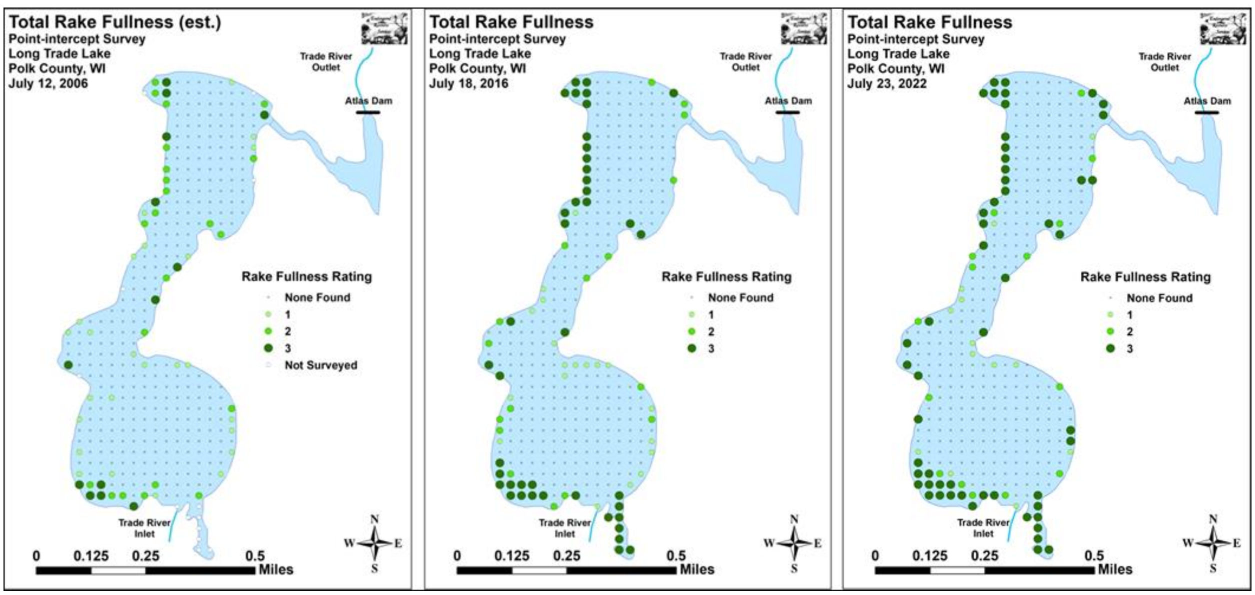


Figure 25: 2006, 2016, and 2022 total rake fullness

CHANGES IN THE AQUATIC PLANT COMMUNITY

Long Trade Lake has a very limited native plant community that is dominated by lower conservatism value species which can tolerate the lake's poor to very poor water clarity. Although low in numbers and richness, these plants are supremely important to the lake as they are the basis of the aquatic ecosystem. They capture the sun's energy and turn it into usable food, "clean" the water of excess nutrients, and provide habitat for other organisms like aquatic invertebrates and the lake's fish populations. Because of this, preserving them is critical to maintaining the lake's overall health. Changes in the aquatic plant community that is as limited as the one in Long Trade Lake, even small ones, can have large impacts on the health of the lake and its ecosystem. Figure 26 reflects the changes for all aquatic plant species since 2006.

The plant survey results from 2006, 2016, and 2022 corroborate the above statement with coontail, white waterlily, watermeal, small duckweed, and large duckweed consistently being the most abundant native plant species. All five are frequently found in lakes that suffer from a lack of water clarity that reduces sunlight penetration into deeper water. Of the five species, only white waterlily is actually rooted to the bottom of the lake. The rest are free floating in the water column and at the surface of the lake. White waterlily pulls all of its needed energy from the sun from leaves floating on the surface. While 31 different aquatic plant species were identified in the lake in both the 2016 and 2022 surveys, a majority of them are very limited in their distribution and abundance, and of course rooted to the bottom. Most are submerged plants with most of their leafy material below the surface of the lake where poor water clarity cause more negative impacts.

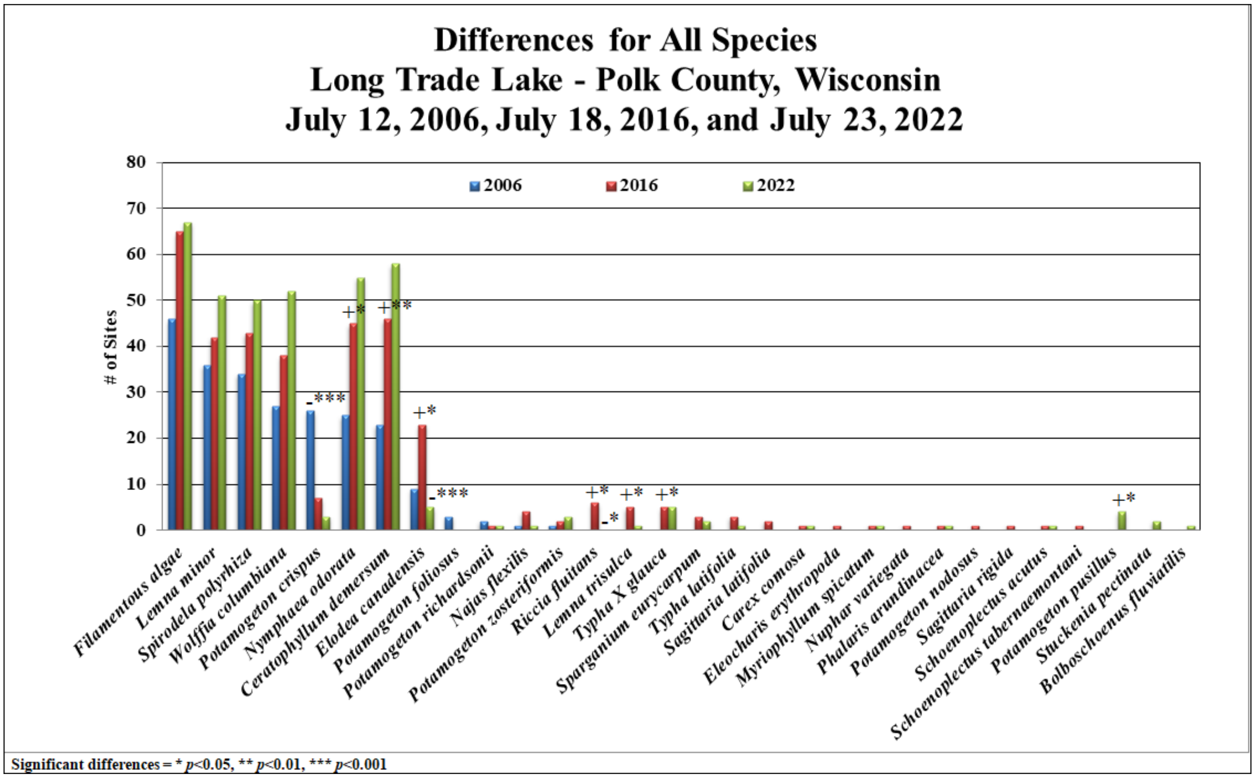


Figure 26 – Changes in aquatic plant species identified during the 2006, 2016, and 2022 Point-Intercept Aquatic Plant Surveys

Three measurements of the health of the aquatic plant community outside of these survey statistics are the Simpson's Diversity Index (SDI), Floristic Quality Index (FQI), and Coefficient of Conservatism.

SIMPSON'S DIVERSITY INDEX

A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's Diversity Index, the index value represents the probability that two individual plants (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be more resistant to invasion by exotic species.

The SDI in 2006 was 0.85. In 2016 the value was just slightly higher at 0.87. In 2022, the value dropped to 0.84.

FLORISTIC QUALITY INDEX (FQI)

This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake. Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Long Trade Lake is in the North Central Hardwood Forests Ecoregion.

In 2006, a total of 10 native index species were identified in the rake during the point-intercept survey. They produced a mean C of 4.9 and a FQI of 15.5. These values are both well below the average values for the North Central Hardwood Forests. In 2016, a total of 22 native index plants were identified on the rake during the point-intercept survey. They produced a mean C of 4.9 and a FQI of 23.0. In 2022, both values were lower than in previous surveys with only 19 species on the rake, a mean C of 4.6, and a FQI of 19.6. Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Long Trade Lake below average for this part of the state. The FQI was just slightly below the median FQI of 20.9 for the North Central Hardwood Forests (Nichols, 1999).

WILD RICE

According to the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), Long Trade, Round, Little Trade and Big Trade lakes are not wild rice waters. Additionally, wild rice was not found during the aquatic plant surveys of the lakes or during the Sensitive Areas survey.

AQUATIC INVASIVE SPECIES (AIS)

In addition to CLP and EWM, two other exotic species growing in and around Long Trade Lake were found: Reed canary grass and Hybrid cattail. Despite only being in the rake at one point and recorded as a visual at two others, Reed canary grass was often a dominant plant just beyond the lakeshore. A ubiquitous plant in the state, there's likely little that can be done about it.

Native to southern but not northern Wisconsin, Narrow-leaved cattail and its hybrids with Broad-leaved cattail are becoming increasingly common in northern Wisconsin where they also tend to be invasive. A large nearly monotypic stand of Hybrid cattails was found surrounding the river inlet with a few smaller patches scattered elsewhere along the shoreline. Broad-leaved cattails were also present near the river inlet, but most of them were growing on the periphery of the Hybrid cattails. In the northwest bay, Broad-leaved cattail was still the dominant species.

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

Eurasian watermilfoil (EWM) and curly-leaf pondweed (CLP) are the most problematic invasive species found in Long Trade Lake. In addition purple loosestrife and reed canary grass have been identified along the shores of Long Trade Lake. Purple loosestrife and reed canary grass are shoreland or wetland plants not generally problematic within the lake, but can be very problematic on the shores and in the wetlands adjacent to the lake. More information is given for each non-native species in the following sections.

EWM

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 27). It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, EWM is difficult to distinguish from Northern water milfoil. EWM has 9-21 pairs of leaflets per leaf, while Northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

EWM grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, and bait buckets; and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms in infested lakes.

Figure 27: EWM

In some lakes, EWM has hybridized with the native northern milfoil. This hybrid milfoil is believed to be less sensitive to chemical management than the parental strands which make management much more difficult (LaRue, Zuelling, & Thum, 2012). The milfoil present in Long Trade Lake is not believed to be a hybrid strand, but regular EWM is present and causing issues within Long Trade Lake.

CURLY-LEAF PONDWEED

Curly-leaf pondweed (CLP) has been found in a large portion of the littoral zone around Long Trade Lake. CLP is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 28). It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported, at various extents, in all of the continental United States.

CLP spreads through burr-like winter buds (turions) (Figure 18), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring. It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches and shorelines.

Figure 28: CLP Plants and Turions

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 29) is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers that vary from purple to magenta possess 5-6 petals aggregated into numerous long spikes, and bloom from August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, more than 20 states, including Wisconsin have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways.

Figure 29: Purple Loosestrife

YELLOW FLAG IRIS

Yellow flag iris (Figure 30) is a showy perennial plant that can grow in a range of conditions from drier upland sites, to wetlands, to floating aquatic mats. A native plant of Eurasia, it can be an invasive garden escapee in Wisconsin's natural environments. Yellow flag iris can produce many seeds that can float from the parent plant, or plants can spread vegetatively via rhizome fragments. Once established it forms dense clumps or floating mats that can alter wildlife habitat and species diversity. All parts of this plant are poisonous, which results in lowered wildlife food sources in areas where it dominates. This species has the ability to escape water gardens and ponds and grow in undisturbed and natural environments. It can grow in wetlands, forests, bogs, swamps, marshes, lakes, streams and ponds. Dense areas of this plant may alter hydrology by trapping sediment and/or blocking flow.

Yellow iris has broad, sword-shaped leaves that grow upright, tall and stiff. They are green with a slight blue-grey tint and are very difficult to distinguish from other ornamental or native iris species. Flowers are produced on a stem that can grow 3-4 feet tall among leaves that are usually as tall or taller.

The flowers are showy and variable in color from almost white to a vibrant dark yellow. Flowers are between 3-4 inches wide and bloom from April to June. Three upright petals are less showy than the larger three downward pointing sepals, which may have brown to purple colored streaks.

Seeds are produced in fruits that are 6-angled capsules, 2-4 inches long. Each fruit may have over 100 seeds that start pale before turning dark brown. Each seed has a hard outer casing with a small air space underneath, which allows the seeds to float.

The roots are thick, fleshy pink-colored rhizomes spread extensively in good conditions, forming thick mats that can float on the surface of the water.

When not flowering, yellow flag iris could be easily confused with the native blue flag iris as well as other ornamental irises that are not invasive. Blue flag iris is usually smaller and does not tend to form as dense clumps or floating mats. When not flowering or showing fruiting bodies, yellow flag iris may be confused with other wetland plants such as cattails or sweet flag species. Small populations may be successfully removed using physical methods. Care should be taken if hand-pulling plants as some people show skin sensitivity to plant sap and tissues. All parts of the plant should be dug out – particularly rhizomes and disposed of in a landfill or by burning. Cutting the seed heads may help decrease the plant spreading.

Aquatic formulas of herbicides may be used to control yellow flag iris, however, permits may be needed. Foliar spray, cut stem/leaf application and hand swiping of herbicide have all shown effectiveness.

Figure 30: Yellow flag iris

NARROW-LEAF CATTAIL, REED CANARY GRASS, GIANT REED GRASS, AND JAPANESE KNOTWEED

Narrow-leaf Cattail (Figure 31)

Narrow-leaf cattails have leaves that are erect, linear, and flat. The leaf blades are 0.15-0.5" wide, and up to three feet long. About 15 leaves emerge per shoot that are dark green in color and rounded on the back of the blade. The top of the leaf sheath has thin, ear-shaped lobes at the junction with the blade that usually disintegrates in the summer. Numerous tiny flowers are densely packed into a cylindrical spike at end of the stem that is divided into the upper section of yellow, male flowers and the lower brown, sausage-shaped section of female flowers. The gap between male and female sections is about 0.5-4" in narrow-leaved cattail. They flower in late spring. These plants also reproduce vegetatively by means of starchy underground rhizomes that form large colonies.

Reed Canary Grass (Figure 31)

Reed canary grass is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades. Blades are flat and have a rough texture on both surfaces. Single flowers occur in dense clusters from May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

Reed canary grass can grow on dry soils in upland habitats and in the partial shade of oak woodlands, but does best on fertile, moist organic soils in full sun. This species can invade most types of wetlands, including marshes, wet prairies, sedge meadows, fens, stream banks, and seasonally wet areas; it also grows in disturbed areas such as bergs and spoil piles.

Common Reed Grass (Figure 31)

Often just called phragmites, common reed grass is a perennial wetland grass that grows three to 20 feet tall with dull, very slightly ridged, stiff and hollow stems. It creates dense clones where canes remain visible in winter. Leaf sheaths tightly clasp the stem, are difficult to remove, and stay on throughout the winter. Its flowers are bushy, light brown to purple plumes that are composed of spikelets that bloom July-September. The plumes are 7.5-15 inches long and resemble feather dusters. It roots are stout, oval rhizomes that can reach up to six feet deep into the ground and 10 feet horizontally.

Japanese Knotweed (Figure 31)

Japanese knotweed is an herbaceous perennial that forms large colonies of erect, arching stems (resembling bamboo). Stems are round, smooth and hollow with reddish-brown blotches. Plants reach up to 10' and the dead stalks remain standing through the winter. New infestations of Japanese knotweed often occur when soil contaminated with rhizomes is transported or when rhizomes are washed downstream during flooding. It poses a significant threat to riparian areas where it prevents streamside tree regeneration and increases soil erosion. Root fragments as small as a couple of inches can resprout, producing new infestations. The plant can disrupt nutrient cycling in forested riparian areas, and contain allelopathic compounds (chemicals toxic to surrounding vegetation).

Figure 31: Narrow-leaf cattail (upper left), Reed canary grass (upper right), Phragmites (lower left), and Japanese knotweed (lower right)

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Several non-vegetative, aquatic, invasive species are very likely to be present within Long Trade Lake. The two species that are believed to be present within Long Trade Lake are Chinese mystery snails and rusty crayfish. It is important for property owners to be able to identify these species if they are encountered in Long Trade Lake; there are also several other species that property owners should be familiar with that are not currently present within Long Trade Lake, but could easily become established.

CHINESE MYSTERY SNAILS

Chinese mystery snails have been identified near the Atlas dam within Long Trade Lake. While this is a single observation, there is a possibility for these snails to easily spread with the help of the river itself or an unwary person.

The Chinese mystery snails (Figure 32) are non-native snails that have been found in a number of Wisconsin lakes. There is not a lot yet known about these species, however, it appears that they have a negative effect on native snail populations. The mystery snail's large size and hard operculum (a trap door cover which protects the soft flesh inside), and their thick hard shell make them less edible by predators.

The female mystery snail gives birth to live crawling young. This may be an important factor in their spread as it only takes one impregnated snail to start a new population. Mystery snails thrive in silt and mud areas although they can be found in lesser numbers in areas with sand or rock substrates. They are found in lakes, ponds, irrigation ditches, and slower portions of streams and rivers. They are tolerant of pollution and often thrive in stagnant water areas. Mystery snails can be found in water depths of 0.5 to 5 meters (1.5 to 15 feet). They tend to reach their maximum population densities around 1-2 meters (3-6 feet) of water depth. Mystery snails do not eat plants. Instead, they feed on detritus and in lesser amounts on algae and phytoplankton. Thus removal of plants along the shoreline area will not reduce the abundance of mystery snails.

Lakes with high densities of mystery snails often see large die-offs of the snails. These die-offs are related to the lake's warming coupled with low oxygen (related to algal blooms). Mystery snails cannot tolerate low oxygen levels. High temperatures by themselves seem insufficient to kill the snails as the snails could move into deeper water.

Many people are worried about mystery snails being carriers of the swimmer's itch parasite. In theory they are potential carriers, however, because they are an introduced species and did not evolve as part of the lake ecosystem, they are less likely to harbor the swimmer's itch parasites.

Figure 32: Chinese Mystery Snails

RUSTY CRAYFISH

Rusty crayfish have been identified along the lengths of the Trade River which makes it very likely that they are present within Long Trade Lake, but their presence in Long Trade Lake has not been verified.

Rusty crayfish (Figure 33) live in lakes, ponds and streams, preferring areas with rocks, logs and other debris in water bodies with clay, silt, sand or rocky bottoms. They typically inhabit permanent pools and fast moving streams of fresh, nutrient-rich water. Adults reach a maximum length of 4 inches. Males are larger than females upon maturity and both sexes have larger, heartier, claws than most native crayfish. Dark "rusty" spots are usually apparent on either side of the carapace, but are not always present in all populations. Claws are generally smooth, with grayish-green to reddish-brown coloration. Adults are opportunistic feeders, feeding upon aquatic plants, benthic invertebrates, detritus, juvenile fish and fish eggs.

The native range of the rusty crayfish includes Ohio, Tennessee, Kentucky, Indiana, Illinois and the entire Ohio River basin. However, this species may now be found in Michigan, Massachusetts, Missouri, Iowa, Minnesota, New York, New Jersey, Pennsylvania, Wisconsin, New Mexico and the entire New England state area (except Rhode Island). The Rusty crayfish has been a reported invader since at least the 1930's. Its further spread is of great concern since the prior areas of invasion have led to severe impacts on native flora and fauna. It is thought to have spread by means of released game fish bait and/or from aquarium release. Rusty crayfish are also raised for commercial and biological harvest.

Rusty crayfish reduce the amount and types of aquatic plants, invertebrate populations, and some fish populations--especially bluegill, smallmouth and largemouth bass, lake trout and walleye. They deprive native fish of their prey and cover and out-compete native crayfish. Rusty crayfish will also attack the feet of swimmers. On the positive side, rusty crayfish can be a food source for larger game fish and are commercially harvested for human consumption.

Rusty crayfish may be controlled by restoring predators like bass and sunfish populations. Preventing further introduction is important and may be accomplished by educating anglers, trappers, bait dealers and science teachers of their hazards. Use of chemical pesticides is an option, but does not target this species and will kill other aquatic organisms.

It is illegal to possess both live crayfish and angling equipment simultaneously on any inland Wisconsin water (except the Mississippi River). It is also illegal to release crayfish into a water of the state without a permit.

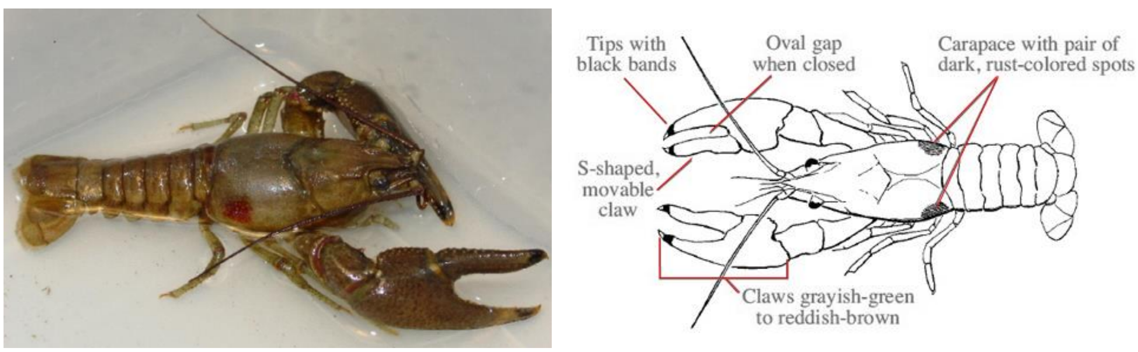


Figure 33: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels (Figure 34) are an invasive species that have inhabited Wisconsin waters and are displacing native species, disrupting ecosystems, and affecting citizens' livelihoods and quality of life. They hamper boating, swimming, fishing, hunting, hiking, and other recreation, and take an economic toll on commercial, agricultural, forestry, and aquacultural resources. The zebra mussel is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them since that time. They were most likely brought to North America as larvae in ballast water of ships that traveled from fresh-water Eurasian ports to the Great Lakes. Zebra mussels look like small clams with a yellowish or brownish D-shaped shell, usually with alternating dark- and light-colored stripes. They can be up to two inches long, but most are under an inch. Zebra mussels usually grow in clusters containing numerous individuals.

Zebra mussels feed by drawing water into their bodies and filtering out most of the suspended microscopic plants, animals and debris for food. This process can lead to increased water clarity and a depleted food supply for other aquatic organisms, including fish. The higher light penetration fosters growth of rooted aquatic plants which, although creating more habitat for small fish, may inhibit the larger, predatory fish from finding their food. This thicker plant growth can also interfere with boaters, anglers and swimmers. Zebra mussel infestations may also promote the growth of blue-green algae, since they avoid consuming this type of algae but not others.

Once zebra mussels are established in a water body, very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Some of the preventative and physical control measures include physical removal, industrial vacuums, and back flushing.

Chemical applications include solutions of chlorine, bromine, potassium permanganate and even oxygen deprivation. An ozonation process is under investigation (patented by Bollyky Associates Inc.) which involves the pumping of high concentrations of dissolved ozone into the intake of raw water pipes. This method only works in controlling veligers, and supposedly has little negative impacts on the ecosystem. Further research on effective industrial control measures that minimize negative impacts on ecosystem health is needed.

In 2009, a study was conducted on Wisconsin waters to determine their suitability for zebra mussel invasion. This study used several different variables and ran statistical models to determine if lakes were suitable, borderline suitable, or not suitable. Long Trade Lake did not have enough data for this study to make conclusions about the suitability, but Round Lake, downstream of Long Trade Lake was determined to be borderline suitable while most other lakes in the region were deemed suitable. There are also two other lakes on the Trade River (Big Trade Lake and an unnamed lake further downstream) that are considered to be suitable. Taking this into consideration, it is fairly likely that Long Trade Lake is borderline suitable or suitable.

In the fall of 2016, one of the lakes deemed suitable by the 2009 study was found to have zebra mussels. Big McKenzie Lake in Burnett County was the first lake in Northwestern Wisconsin to have a documented zebra mussel infestation. In addition to Big McKenzie Lake, Middle McKenzie Lake in Burnett County, Deer Lake, Lake Wapogasset, and Balsam Lake in Polk County, and Bass Lake in St. Croix County also have documented infestations.

Figure 34: Zebra Mussels

AIS PREVENTION STRATEGY

Long Trade Lake already has several established AIS. However there are many more that could be introduced to the lake. Property owners on Long Trade Lake, now members of the new LTLA, have and will continue to implement a watercraft inspection and AIS Signage program at the public access point on the lake. Information will be shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program will be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network AIS Monitoring program.

Additionally, having an educated and informed lake resident population is the best way to keep non-native AIS at bay in Long Trade Lake. To foster this, the LTLA will host and/or sponsor lake community events including AIS identification and management workshops; distribute education and information materials to lake property owners and lake users through the newsletter, webpage, and general mailings.

WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY

There are many techniques for managing aquatic plants in Wisconsin. Often management may mean protecting desirable aquatic plants by selectively hand pulling the undesirable ones. Sometimes more intensive management may be needed such as using harvesting equipment, herbicides, or biological control agents. Because aquatic plants are recognized as a natural resource to be protected, managed, and used wisely, the development of long-term, integrated aquatic plant management strategies to identify important plant communities and manage nuisance aquatic plants in lakes, ponds or rivers is often required by the State of Wisconsin.

The Public Trust Doctrine is the driving force behind all management, plant or other, in Wisconsin lakes. Protecting and maintaining Wisconsin's lakes for all of Wisconsin's people are at the top of the list in determining what is done and where. Two other factors that reflect Wisconsin's changing attitude toward aquatic plants. One is a growing realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem; and the other is the concern over the spread of AIS.

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is an ecosystem-based management strategy that focuses on long-term prevention and/or control of a species of concern. Adapted for aquatic plant management, IPM considers all the available control practices such as: prevention, biological control, biomanipulation, nutrient management, habitat manipulation, substantial modification of cultural practices, pesticide application, water level manipulation, mechanical removal and population monitoring (Figure 35). In addition to monitoring and considering information about the target species' life cycle and environmental factors, groups can decide whether the species' impacts can be tolerated or whether those impacts warrant control. Then, an IPM-based plan informed by current, comprehensive information on pest life cycles and the interactions among pests and the environment can be formed. If control is needed, data collected on the species and the waterbody will help groups select the most effective management methods and the best time to use them.

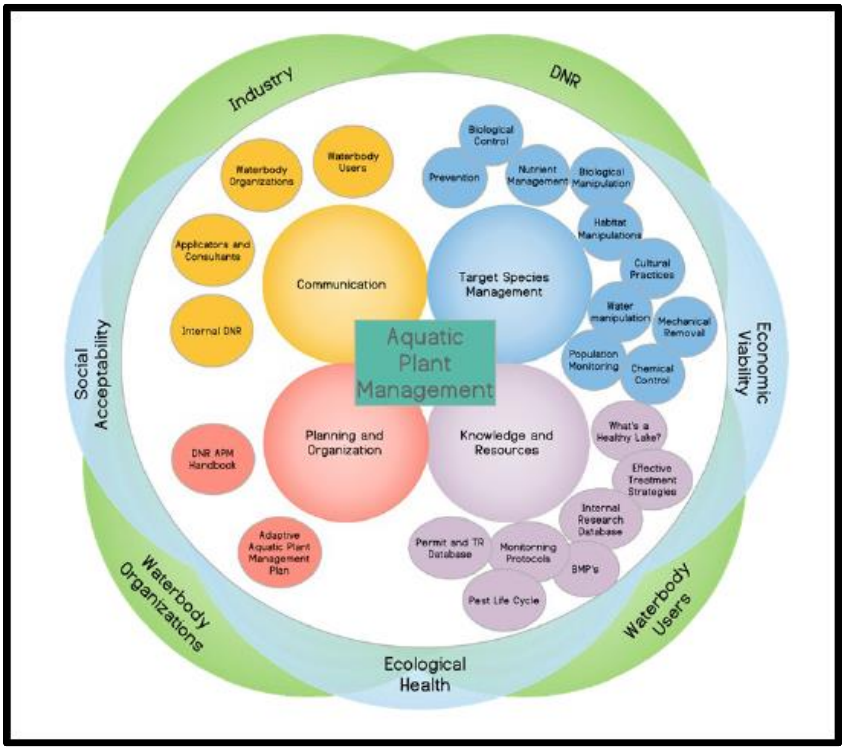


Figure 35: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

The most effective, long-term approach to managing a species of concern is to use a combination of methods. Approaches for managing pests are often grouped in the following categories:

- **Assessment** – is the use of learning tools and protocols to determine a waterbodies' biological, chemical, physical and social properties and potential impacts. Examples include: point-intercept (PI) surveys, water chemistry tests and boater usage surveys. This is the most important management strategy on every single waterbody.
- **Biological Control** – is the use of natural predators, parasites, pathogens and competitors to control target species and their impacts. An example would be beetles for purple loosestrife control.
- **Cultural controls** – are practices that reduce target species establishment, reproduction, dispersal, and survival. For example, a Clean Boats, Clean Waters program at boat launches can reduce the likelihood of the spread of species of concern.
- **Mechanical and physical controls** – can kill a target species directly, block them out, or make the environment unsuitable for it. Mechanical harvesting, hand pulling, and diver assisted suction harvesting are all examples.
- **Chemical control** – is the use of pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Groups should use the most selective pesticide that will do the job and be the safest for other organisms and for air, soil, and water quality.

IPM is a process that combines informed methods and practices to provide long-term, economic pest control. A quality IPM program should adapt when new information pertaining to the target species is provided or monitoring shows changes in control effectiveness, habitat composition and/or water quality. While each situation is different, eight major components should be established in an IPM program:

1. Identify and understand the species of concern
2. Prevent the spread and introduction of the species of concern
3. Continually monitor and assess the species' impacts on the waterbody
4. Prevent species of concern impacts
5. Set guidelines for when management action is needed
6. Use a combination of biological, cultural, physical/mechanical and chemical management tools
7. Assess the effects of target species' management
8. Change the management strategy when the outcomes of a control strategy create long-term impacts that outweigh the value of target species control.

MANAGEMENT ALTERNATIVES

Nuisance aquatic plants can be managed a variety of ways in Wisconsin. The best management strategy will be different for each lake and depends on which nuisance species needs to be controlled, how widespread the problem is, and the other plants and wildlife in the lake. In many cases, an integrated pest management (IPM) approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species such as EWM or CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. It is important to remember however, that regardless of the plant species targeted for control, sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to a lake ecosystem and should not be done unless it can be shown they will be beneficial and occur with minimal negative ecological impacts.

Management alternatives for nuisance aquatic plants can be grouped into four broad categories:

- Manual and mechanical removal
- Chemical application
- Biological control
- Physical habitat alteration.

Manual and mechanical removal methods include pulling, cutting, raking, harvesting, suction harvesting, and other means of removing the physical plant from the water and in some cases requires a WDNR permit. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant and always requires a WDNR permit. Biological control methods include organisms that use the plant for a food source or parasitic organisms that use the plant as a host, killing or weakening it. Biological control may also include the use of species that compete successfully with the nuisance species for available resources. This activity may require a WDNR permit. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. These activities may require permits under the WDNR waterways and wetlands program. It may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Informed decision-making on aquatic plant management implementation requires an understanding of plant management alternatives and how appropriate and acceptable each alternative is for a given lake. The following sections list scientifically recognized and approved alternatives for controlling aquatic vegetation.

NO MANAGEMENT

When evaluating the various management techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with nonnative species, the environmental consequences of doing nothing may be high, possibly even higher than any of the effects of management techniques. Unmanaged, these species can have severe negative effects on water quality, native plant distribution, abundance and diversity, and the abundance and diversity of aquatic insects and fish (Madsen, 1997). Nonindigenous aquatic plants are the problem, and the management techniques are the collective solution. Nonnative plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "biomagnify" in lakes, rivers, and wetlands (Madsen, 2000).

Foregoing any management of EWM or CLP in Long Trade Lake is not a recommended option. To keep these plants from causing greater harm, management will continue to be implemented.

HAND-PULLING/MANUAL REMOVAL

Manual or physical removal of aquatic plants by means of a hand-held rake or cutting implement; or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit per NR 109.06. As a general rule though, these activities can only occur in a zone that is no more than 30-ft wide and adjacent to a pier or lake use area (Figure 36). There is no limit as to how far out into the lake the 30-ft zone can extend, however clearing large swaths of aquatic plants not only disrupts lake habits, it also creates open areas for non-native species to establish.

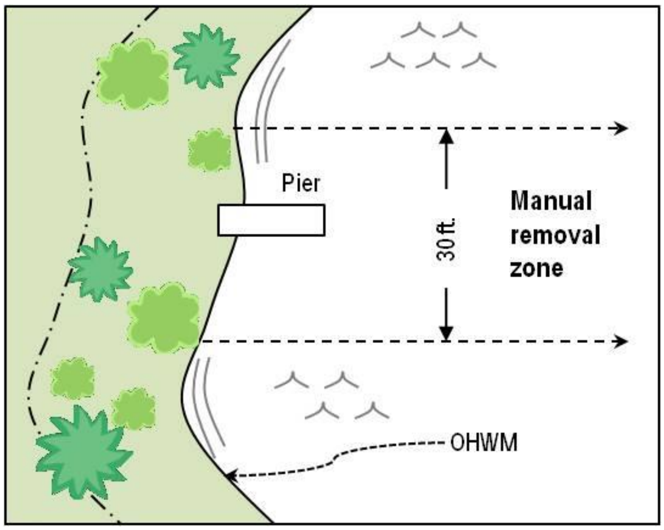


Figure 36: Aquatic vegetation manual removal zone

Physical removal of aquatic plants does require a permit if the removal area is located in a "sensitive" or critical habitat area previously designated by the WDNR. Manual or physical removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this is the best form of control. If water clarity in a body of water is such that aquatic plants can be seen in deeper water, pulling AIS while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2) and can be effective at slowing the spread of a new AIS infestation within a lake when done properly.

In some areas of Long Trade Lake, EWM and CLP may be best managed by hand-pulling/manual removal. However it is not suitable to manage all of the AIS in the lake this way. Efforts should continue to teach property owners to identify, and then physically remove EWM and CLP growing in the lake near their property. The LTLA should regularly provide education and training for residents on the lake to teach them how to identify nonnative invasive species and how to properly remove them from around their docks, in their swimming areas, and along their shores.

DIVER ASSISTED SUCTION HARVESTING

Diver Assisted Suction Harvesting (DASH) is a hand removal method that requires a diver to handfeed the offending vegetation into an underwater suction tube once removed from the lake bottom. DASH is considered mechanical harvesting as it requires the assistance of a mechanical system to implement (Figure 37). DASH increases the ability of a diver to remove the offending vegetation from a larger area, faster, but also requires a Mechanical Harvesting permit from the WDNR. The cost to implement DASH is also more expensive than employing a diver alone. A DASH boat consists of a pontoon boat equipped with the necessary water pump, catch basin, suction hose, and other apparatus (Figure 36). Estimates to build a custom DASH boat, range from $15,000.00 to $20,000.00. Contracted DASH services usually run in the $2,000.00 to $3,000.00 per day range.

Figure 37: DASH – Feeding EWM into the underwater Suction Hose (Marinette Co.); and a sample DASH Pontoon Boat (Beaver Dam Lake Management District)

Provided the conditions are conducive to DASH, this could be an effective management strategy for some areas of either EWM or CLP on Long Trade Lake. It should be noted that while this could work, the low water clarity could have a large impact on the effectiveness of DASH removal within Long Trade Lake. Furthermore, the cost would likely be prohibitive, particularly with physical removal by property owners proven to be an effective supportive management method.

MECHANICAL REMOVAL

Mechanical management involves the use of devices not solely powered by human means to aid removal. This includes gas and electric motors, ATV's, boats, tractors, etc. Using these instruments to pull, cut, grind, or rotovate aquatic plants is illegal in Wisconsin without a permit. Diver Aided Suction Harvest (DASH) is considered mechanical removal. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control permit is required annually, although the WDNR is now offering multi-year harvesting permits in some instances. The permit application is reviewed by the WDNR and other entities and awarded if required criteria are met. Once an annual permit for mechanical harvesting has been approved, harvesting can occur in the approved areas as often as necessary to manage the vegetation.

Using repeated small-scale mechanical disturbance such as bottom rollers or sweepers can be effective at control in small areas, but in Wisconsin these devices are not wholly supported by the WDNR, may be illegal, and are generally not permitted.

LARGE-SCALE MECHANICAL HARVESTING

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 38). The size and harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and depending on the machine, up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight). An average harvester can cut between 2 and 8 acres of aquatic vegetation per day. The average lifetime of a mechanical harvester is 10 years.

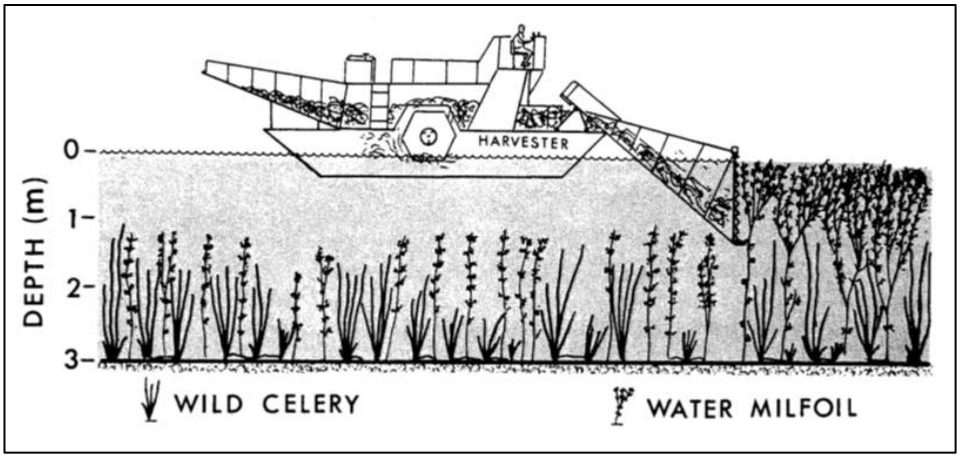


Figure 38: How a mechanical harvester works (Engle, 1987)

Harvesters can remove thousands of pounds of vegetation in a relatively short time period. They are not, however, species specific. Everything in the path of the harvester will be removed, including the target species, other plants, macro-invertebrates, semi-aquatic vertebrates, forage fishes, young-of-the-year fishes, and even adult game fish found in the littoral zone (Booms, 1999). Plants are cut at a designated depth, but the root of the plants is often not disturbed. Cut plants will usually grow back after time, and re-cutting several times a season is often required to provide adequate annual control (Madsen J. , 2000).

Harvesting activities in shallow water can re-suspend bottom sediments into the water column releasing nutrients and other accumulated compounds (Madsen J. , 2000). Even the best aquatic plant harvesters leave some cutting debris in the water to wash up on the shore or create loose mats of floating vegetation on the surface of the lake. This “missed” cut vegetation can potentially spread offending vegetation as it floats around the lake and establishes in new sites. Floating mats of “missed” cut vegetation can pile up on shorelines creating another level of nuisance that property owners may have to deal with.

A major benefit of aquatic plant harvesting however, is the removal of large amounts of plant biomass from a water body. This large-scale removal can help reduce organic material build up in the bottom of the lake over time and even help to improve water clarity and reduce phosphorus loading.

The results of mechanical harvesting - open water and accessible boat lanes - are immediate, and can be enjoyed without the restrictions on lake use which follow some herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic plants. The nutrients stored in the plants are also removed from the lake, and the build-up of organic material that normally occurs as a result of the decaying of this plant matter is reduced. Additionally, repeated harvesting may result in thinner, more scattered growth.

Disposal sites are a key component when considering the mechanical harvesting of aquatic plants. The sites must be on shore and upland to make sure the plants and their reproductive structures don’t make their way back into the lake or to other lakes. The number of available disposal sites and their distance from the targeted harvesting areas will determine the efficiency of the operation, in terms of time and cost.

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For CLP, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments or other plant parts with them, and facilitate the spread of aquatic invasive species from one body of water to another.

Large-scale mechanical harvesting is commonly used for control of CLP, and in the absence of other management alternatives, or conditions that prevent the use of other management alternatives, can also be an effective way to reduce EWM biomass in a water body.

Harvesting Totals and Estimated Costs (Owning versus Contracting Services)

Costs per acre vary with numbers of acres harvested, accessibility of disposal sites to the harvested areas, density and species of the harvested plants, and whether a private contractor or public entity does the work. Costs as low as $250 per acre have been reported. Private contractors generally charge $500 to $800 per acre or $2000 to $3000 per day. The purchase price of new harvesters ranges from $75,000 to $300,000. There are several harvester manufacturers in the United States (including at least two in Wisconsin) and some lake groups may choose to operate and purchase their own machinery rather than contracting for these services.

In the last several years, more companies have started offering contracted mechanical harvesting, DASH, and physical removal services. Several companies are located in the northern half of Wisconsin including TSB Lakefront Restoration and Diving (New Auburn, WI) and Aquatic Plant Management (Minocqua, WI). Several other companies exist in southeastern WI, the Twin Cities area, and even in northern Illinois. Most of the services they offer run about $2,500-$3,500.00 per day.

There are benefits and drawbacks for both contracted harvesting and purchasing a harvester outright. With contracted harvesting, the cost per acre can vary depending on vegetation density, distance between the area being harvesting and the off-loading site, and the distance to the designated disposal site. Another issue is timing. When contracted harvesting takes place, is likely going to be dependent on the availability of the contractor, not necessarily on when the best time to complete harvesting is. Contracted harvesting removes the necessity for a large outlay of funds for purchasing a harvester, requires no maintenance and storage costs, and no insurance costs. Furthermore, there are reduced costs or no costs if, in any given year, there is less or no harvesting needed.

Purchasing is the more expensive option due to not only the initial cost of purchase, but also insurance, storage, maintenance, and an operator's salary (unless volunteer operated). However, there are many benefits to purchasing. Purchasing a harvester eliminates the potential for new AIS to be introduced to the lake from the harvester, the cost per acre tends to go down the longer a harvester is operational, and these costs will not increase dramatically if the amount of vegetation being harvested increases. This also allows harvesting to be done during the best times as well as providing a way to maintain navigation channels throughout the summer. The biggest drawbacks to purchasing a harvester are the increased up-front cost and the annual costs associated with maintaining the harvester. Even during years with less harvesting, the maintenance, storage, and other miscellaneous costs will remain around the same as those costs would be during years that require large amounts of harvesting.

SMALL-SCALE MECHANICAL HARVESTING

There are a wide range of small-scale mechanical harvesting techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with all mechanical harvesting, removing the cut plants is required. Equipment costs range in price from around $200 for rakes to around $3000 for electric, boat mounted cutters. Using a weed rake or cutter that is run by human power is allowed without a permit, but the use of any device that includes a motor, gas or electric, would require a permit. Dragging a bed spring or bar behind a boat, tractor or any other motorized vehicle to remove vegetation is also illegal without a permit. Although not truly considered mechanical management, incidental plant disruption by normal boat traffic is a legal method of management. Active use of an area is often one of the best ways for riparian owners to gain navigation relief near their docks. Most aquatic plants won't grow well in an area actively used for boating and swimming. It should be noted that purposefully navigating a boat to clear large areas is not only potentially illegal it can also re-suspend sediments, encourage AIS growth, and cause ecological disruptions.

A more recent option for small-scale mechanical harvesting of aquatic plants is using a "mini" harvester that is remote-controlled. Weeders Digest currently offers two versions of a remote controlled mini mechanical harvester, the WaterBug and the WaterGator.

The WaterBug (Figure 39) is 5.4' wide by 11' 9" long but weighs only 370 lbs. and boasts a storage bunk capacity of 600 lbs. This makes it easy for one person to use as it fits on a compact trailer that can be pulled behind a 4-wheeler or garden tractor. It floats in as little as 4" of water and can cut and skim 34" wide, is adjustable to 15-16" water depth by remote control (can be set manually to a depth of 24"), and features long-lasting batteries that can operate 5 hours on a single charge.

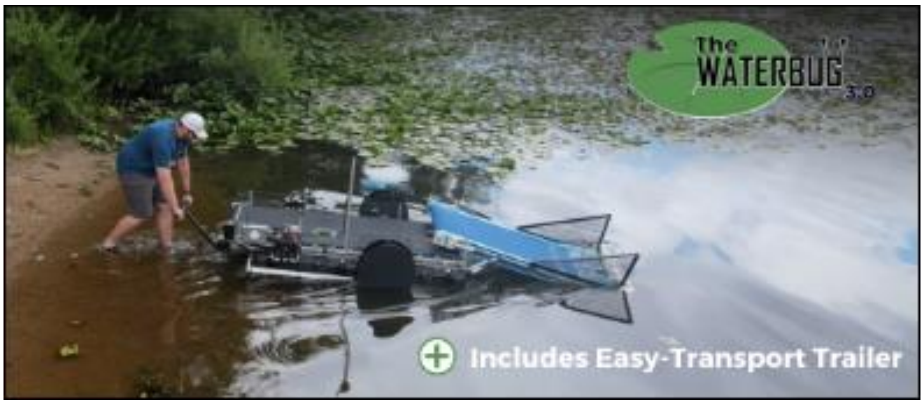


Figure 39: WaterBug remote-controlled aquatic plant harvester (https://lakeweedharvester.com/waterbug/)

The WaterGator (Figure 40) features the same technology as the WaterBug including a harvesting camera that shows the operator what the WaterGator sees on the remote viewing screen. The WaterGator cuts, skims, and collects aquatic vegetation. It is easy for any user to operate, and it is extremely versatile, with a cutting range reaching 3-1/2 feet deep, and a generous cutting and skimming width of 42 inches. It has a storage bunk capacity of 1,200 lbs. double that of the WaterBug. The WaterGator is battery powered, and provides the operator with 8-plus hours of run time on a single charge. The WaterGator is designed for larger ponds, lake shores, channels, and other medium size bodies of water.

The cost of a WaterBug is estimated at around $17,000.00. The cost of a WaterGator is about double that at $35,000.00. Table 6 compares the two different machines.

Figure 40: WaterGator remote-controlled aquatic plant harvester (https://lakeweedharvester.com/watergator/)

Table 6: Specifications – WaterBug vs WaterGator (https://weedersdigest.com/watergator-remote-controlled-aquatic-harvester/)

SPECS/FEATURES	WaterBug	WaterGator
CUTTING DEPTH	Down to 30"	Down to 36"
SICKLE CUTTING WIDTH	34.5"	42"
BUNK CAPACITY	600 lbs.	1,200 lbs.
OVERALL LENGTH	11'9"	12' 8"
OVERALL WIDTH	5'4"	6' 5"
MACHINE WEIGHT	375 lbs	650 lbs.
DRAFT	4"	4"
AUTO-LEVELLING	No	Yes
PADDLE WHEELS	2	4
CONSTRUCTION	marine grade aluminum and stainless-steel	marine grade aluminum and stainless-steel
SINGLE CHARGE RUN TIME	4-6 hrs.	8 hrs.
BATTERY CHARGE TIME	5 hrs.	8 hrs.
CHARGER TYPE	15 amps	25 amp
BATTERY	Lead Acid	Lead Acid
REMOTE w/VIEWING CAMERA	Yes	Yes
REMOTE RANGE	1,000'	1,000'

One Lake District in Barron County, WI purchased a WaterGator in 2022 to help them implement an aquatic plant harvesting program focused on providing navigation and access lanes through dense growth watershield and other native vegetation. Prior to the purchase of a WaterGator, this group used a pontoon-mounted, cutting bar to cut vegetation, and then used rakes to collect the cut material. After a full season of use, the main operator had this to say about the WaterGator.

"The harvester worked well, given how its' made but it could easily use some improvements. The paddle wheels seem undersized in that they don't seem to really bite the water as efficiently as they might so it takes too long to get from one location on the lake to

another and it flounders around when there's a breeze. But maybe a better operator could help. One time I took the pontoon boat and pushed the harvester across the lake and I've rigged a harness for towing. I'd like to see us putting on an operator's platform. With the glare from the sky, it's hard to see where to cut, with the view through the TV camera in many instances. And I have to wonder if the relatively smooth belt is as efficient as a different type might be. No problem picking up lilies but watershield seems to pile up in front of the take-up belt so at times I stop and tilt the belt up in order to get the watershield to load onto it and consequently get dumped into the storage bunk/belt. So it's not everything I hoped for but a definite step in the right direction."

Joel Meyer, Kirby Lake Management District

The company that builds and markets both the WaterBug and WaterGator is located in the Twin Cities area of MN. They promote the two mini harvesters as able to "cut, skim, and collect" aquatic vegetation. If permitted by the WDNR, either machine could provide some level of nuisance relief for CLP, removal of surface mats of filamentous algae, and aesthetic improvements of a shoreline.

HABITAT ALTERATION

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce invasive plant growth would eliminate all plants, inhibit fish spawning, affect benthic invertebrates, and could cause anaerobic conditions which may release excess nutrients from the sediment. Gas build-up beneath these barriers can cause them to dislodge from the bottom and sediment can build up on them allowing EWM to re-establish. Bottom barriers are typically used for very small areas and provide only limited relief.

Creating conditions in a lake that may serve to shade out AIS growth has also been tried with mixed success. The general intention is to reduce light penetration in the water which in turns limits the depth at which plants can grow. Typically dyes have been added to a small water body to darken the water. Bottom barriers and attempts to further reduce light penetration in Long Trade Lake are not recommended.

DREDGING

Dredging is the removal of bottom sediment from a lake. Its success is based on altering the target plant's environment. It is not usually performed solely for aquatic plant management but rather to restore lakes that have been filled in with sediment, have excess nutrients, inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson, 1982). In shallow lakes with excess plant growth, dredging can make areas of the lake too deep for plant growth. It can also remove significant plant root structures, seeds/turions, rhizomes, tubers, etc. Dredging is not a recommended management action for Long Trade Lake.

DRAWDOWN

Long Trade Lake is the only one of the four lakes in the Trade River system that is impacted by a dam. As such, a thorough evaluation of using a drawdown to control AIS in the lake was completed (SEH Inc, 2012). While it is possible to do a drawdown of the lake, blockage in the stream/channel between the main lake and the millpond immediately above the dam limits how far down the water can be taken down to about 3.5 feet. In order to be effective, the water level would need to be drawn down at least 5-ft. Furthermore, in a vote taken in 2012 after the results of the drawdown evaluation were reported, the Long Trade Lake constituency decided not to pursue a drawdown as a management action.

BIOLOGICAL CONTROL

Biological control involves using one plant, animal, or pathogen as a means to control a target species in the same environment. The goal of biological control is to weaken, reduce the spread, or eliminate the unwanted population so that native or more desirable populations can make a comeback. Care must be taken however, to insure that the control species does not become as big a problem as the one that is being controlled. A special permit is required in Wisconsin before any biological control measure can be introduced into a new area.

EWM WEEVILS

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. *Euhrychiopsis lecontei* is an aquatic weevil native to Wisconsin that feeds on aquatic milfoils (Figure 41). Their host plant is typically northern watermilfoil; however they seem to prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian water milfoil is found. They often produce several generations in a given year and over winter in undisturbed shorelines around the lake. All aspects of the weevil's life cycle can affect the plant. Adults feed on the plant and lay their eggs. The eggs hatch and the larva feed on the plant. As the larva mature they eventually burrow into the stem of the plant. When they emerge as adults later, the hole left in the stem reduces buoyancy often causing the stem to collapse. The resulting interruption in the flow of carbohydrates to the root crowns reduces the plant's ability to store carbohydrates for over wintering reducing the health and vigor Newman et al. (1996).

Figure 41: EWM Weevil (https://klsa.wordpress.com/published-material/milfoil-weevil-guide/)

The weevil is not a silver bullet. They do not work in all situations. The extent to which weevils exist naturally in a lake, adequate shore land over wintering habitat, the population of bluegills and sunfish in a system, and water quality characteristics are all factors that have been shown to affect the success rate of the weevil. A weevil survey was completed on Long Trade Lake in 1996. This survey determined that while weevils are present in Long Trade Lake, there is not a sufficient number to effectively control EWM. The use of weevils is not recommended in this management plan, particularly since the process necessary to do so has changed significantly in the last few years. There is no longer a company that "raises" weevils for EWM control. Weevils can still be raised by volunteers in cooperation with an overseeing entity, but requires that all EWM used in the rearing process be secured from the host lake, and only weevils reared on host lake EWM can be released into the host lake. Further monitoring and possible weevil rearing is not recommended for Long Trade Lake.

GALERUCELLA BEETLES

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 42). The entire lifecycle of Galerucella beetles is dependent on purple loosestrife. In the spring, adults emerge from the leaf litter below old loosestrife plants. The adults then begin to feed on the plant for several days until they begin to reproduce. Females lay their eggs on loosestrife leaves and stems. When the larvae emerge from these eggs they begin feeding on the leaves and developing shoots. When water levels are high these larvae will burrow into the loosestrife stems to pupate into adult beetles. These new adults emerge and begin feeding on the loosestrife again (Sebolt, 1998). Galerucella beetles do not forage on any plants other than purple loosestrife. Because of this the populations, once established, are self-regulating. When the purple loosestrife population drops off, the beetle population also declines. When the loosestrife returns, the beetle numbers will usually increase.

Figure 42: Galerucella beetle

These beetles will not eradicate purple loosestrife entirely. This is true of almost all forms of biological control. Galerucella beetles will help regulate loosestrife which will allow native plants to also become re-established. Raising Galerucella beetles does not require a lot skill or materials. Materials consist of 3-5 gallon pails, a kids wading pool, fine mesh nets, and a net supporting structure. The cooperator must also have access to purple loosestrife plants and a source of "starter beetles". Because rearing these beetles requires the cultivation of a restricted species, a permit is necessary. Purple loosestrife rootstock and starter beetles can be obtained from the WDNR, private vendors, or many of the public wetlands around Wisconsin. Volunteers on Long Trade Lake and the other lakes in the system have already reared and released beetles for control of purple loosestrife in wetlands and along lake and river shoreline in the area. If there is an interest, this activity could continue.

NATIVE PLANT RESTORATION

A healthy population of native plants might slow invasion or reinvasion of non-native aquatic plants. It should be the goal of every management plan to protect existing native plants and restore native plants after the invasive species has been controlled. In many cases, a propagule bank probably exists that will help restore native plant communities after the invasive species is controlled (Getsinger et al (1997).

CHEMICAL CONTROL

Aquatic herbicides are granular or liquid chemicals specifically formulated for use in water to kill plants or retard plant growth. Herbicides approved for aquatic use by the U.S. Environmental Protection Agency (EPA) are considered compatible with the aquatic environment when used according to label directions.

The WDNR evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The Department frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also mean that, in most cases, the herbicide will be degraded and gone by the time peak recreation on the water starts.

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application, relatively low cost, and the ability to somewhat selectively control particular plant types with certain herbicides. Disadvantages of using chemical herbicides include possible toxicity to aquatic animals or humans, oxygen depletion after plants die and decompose which can cause fishkills, a risk of increased algal blooms as nutrients are released into the water by the decaying plants, adverse effects on desirable aquatic plants, loss of fish habitat and food sources, water use restrictions, and a need to repeat treatments due to existing seed/turion banks and plant fragments. Chemical herbicide use can also create conditions favorable for non-native AIS to outcompete native plants (for example, areas of stressed native plants or devoid of plants).

EFFICACY OF AQUATIC HERBICIDES

The efficacy of aquatic herbicides is dependent on both application concentration and exposure time, and these factors are influenced by two separate but interconnected processes - dissipation and degradation. Dissipation is the physical movement of the active herbicide within the water column both vertically and horizontally. Dissipation rates are affected by wind, water flow, treated area relative to untreated area, and water depths. Degradation is the physical breakdown of the herbicide into inert components. Depending on the herbicide utilized, degradation occurs over time either through microbial or photolytic (chemical reactions caused by sunlight exposure) processes.

SMALL-SCALE HERBICIDE APPLICATION

Small-scale herbicide application involves treating areas less than 10 acres in size. Small-scale chemical application is usually completed in the early season (April through May). Research related to small-scale herbicide application generally shows that these types of treatment are less effective than larger scale treatments due to rapid dilution and dispersion (dissipation) of the herbicide applied. As such, chemically treating areas less than 5.0 acres in size is generally not recommended.

Small-scale Use of Herbicides to Control AIS

Concern on the part of the WDNR regarding the use of small-scale herbicide applications to control CLP or EWM has been expressed for several years. As an example, during the most recent Wisconsin Aquatic Plant Management Industry Meeting held January 31, 2023 concerns were expressed specifically to the use of Aquathol K (liquid endothall) and Aquathol Super K (granular endothall) to control CLP. The concerns were, that when CLP distribution is sporadic throughout a lake and treatment areas are small, that the efficacy of Aquathol K and Aquathol Super K may be compromised due to rapid dilution.

Back in 2013, United Phosphorus, Inc. (UPI), the makers of Aquathol K and Super K, met with the WDNR to discuss some basic strategies for the use of these products in Wisconsin Lakes (Meganck, Skogerboe, & Adrian, 2013). UPI suggested using a minimum threshold of five acres for Aquathol K and Aquathol Super K when controlling CLP when employed in managing it on a whole lake basis. Several key points were agreed upon based on recent research involving the application of Aquathol products for CLP spot treatments where herbicide concentrations were monitored over time:

1) Identifying the spatial distribution of CLP is important to proper whole-lake management scenarios. The success of a CLP management project can hinge on whether treatments are applied in the appropriate areas. Therefore, accurate and up-to-date information is needed to assure that product selection and dosage is appropriate.

2) Split applications may be needed on spot treatments rather than one application to assure product has sufficient contact time. Ex: A smaller 3 acre shoreline treatment, apply 1.5ppm in first part of treatment, and 1.5ppm in second part of treatment, either hours later or following day depending on risk of dissipation.

3) When applying herbicide on spot treatments, treatment size must be sufficient to counter dilution effects. Spot treatments may need to be expanded to minimum 5 acre treatment polygons when target species are sporadically located. Spot treatments that are greater than five percent of the total lake area, whole-lake herbicide concentrations should be calculated.

4) When the goal is a whole-lake treatment, application of product should not be applied at a rate higher than the suggested rate of control for non-target species, if they are present. Application rates can be applied at higher rates over weed beds, if natives are not present.

5) Aquathol Super K will not hold the herbicide in the area longer, and is not more effective than Aquathol K. Dissipation of both products is similar in the lake environment.

Similar views have been expressed about the use of 2,4D or triclopyr based aquatic herbicides for control of EWM. Small-scale applications tend to dissipate rapidly minimizing effective results. Granular herbicides do not provide any greater contact time than liquid herbicides. Large-scale herbicide applications with an expected long target species contact time should require a lower application rate. Like endothall and CLP, areas to be treated with 2,4D or triclopyr should be at least 5 acres in size. Smaller treatment areas are likely to be less effective, and possibly denied by the WDNR when considering chemical permit applications and/or requests for grant funding. For both endothall and 2,4D-based aquatic herbicides, the desired target species contact time is between 18 and 36 hours, with the greater contact times more desirable.

ProcellaCOR, used more and more for the control of EWM, requires a much lower target species/herbicide contact time – down to only 2-4 hours. Even so, treatment areas of at least an acre are recommended by the WDNR.

Installation of a Limno-Barrier or Curtain

Small-scale herbicide applications can be made more effective by installing a limno-barrier or curtain around a treatment area to help hold the applied herbicide in place, for a longer period of time. By doing so, the herbicide/target species contact time is increased. The curtain is generally a continuous sheet of plastic that extends from the surface to the bottom of the lake (Figure 43). The surface edge of the curtain is generally supported by floatation devices. The bottom of the curtain is held in place by some form of weighting. The curtain or barrier, sometimes thousands of feet of it, is installed around the proposed treatment area with the purpose of holding the herbicide in place longer by preventing dilution and drift away from the treated area (Figure 44).

Figure 43: Limno-curtain material on a roll before installation (photo from Marinette Co. LWCD)

Figure 44: Limno-curtain installed on Thunder Lake (photo from Marinette Co. LWCD)

In the Thunder Lake, Marinette County limno-curtain trial completed in 2020, a curtain was installed around two small areas (0.9 and 2.9 acres) of dense growth EWM prior to chemical treatment. Liquid 2,4-D was applied at 4.0ppm inside the barrier. The barriers stayed in place until 48 hours after treatment. Herbicide concentration testing was completed within the treated areas to determine how long the herbicide stayed in place and at what concentration. Figure 45 reflects what happened to the herbicide that was applied. Herbicide concentrations stayed relatively high for a longer period of time (48 hrs). Once the curtain was removed, the herbicide dissipated rapidly.

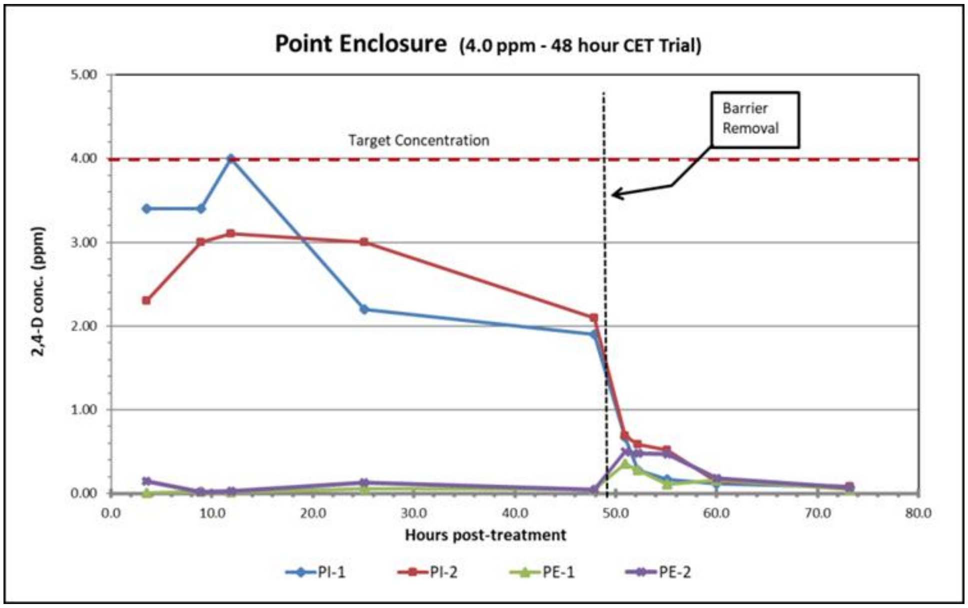


Figure 45: Herbicide concentration results from 2020 Thunder Lake limno-curtain trial (Marinette Co LWCD)

LARGE-SCALE HERBICIDE APPLICATION

Large-scale herbicide application involves treating areas more than 10 acres in size. Like small-scale applications, this is usually completed in the early-season (April through May) for control of non-native invasive species like CLP or EWM while minimizing impacts on native species. It is generally accepted that with large-scale applications the likelihood of the herbicide staying in contact with the target plant for a longer time is greater. If the volume of water treated is more than 10% of the volume of the lake, or the treatment area is ≥160 acres, or 50% of the lakes littoral zone, effects can be expected at a whole-lake scale. Large-scale herbicide application can be extended in some lakes to include whole bay or even whole lake treatments. The size of the treatment area, the more contained the treatment area, and the depth of the water in the treatment area, are factors that impact how whole bay or whole lake treatments are implemented.

COMMON AQUATIC HERBICIDES

ProcellaCOR® is a relatively new systemic, selective herbicide that can be used to target EWM with limited impact to most native species. It is fast acting, making it an effective control measure on smaller beds that may be too large for DASH, especially ones in high boat traffic areas and/or deeper water. Applications rates are measured in ounces, not gallons as is common with almost all other liquid herbicides. And while it is more expensive to use than 2,4-D equivalents, it has been shown to provide two or more years of control without re-application.

Sonar® whose active ingredient is fluridone, is a broad spectrum herbicide that interferes with the necessary processes in a plant that create the chlorophyll needed to turn sunlight into plant food through a process called photo-synthesis. Sonar is generally applied during a whole-lake application and is expected to be in the lake at very low concentrations for weeks or months once applied.

2,4-D and triclopyr are active ingredients in several selective herbicides including 2,4-D Amine 4®, Navigate®, DMA 4®, Renovate®, and Renovate Max G®. These herbicides stimulate plant cell growth causing them to rupture, but primarily in narrow-leaf plants like milfoil. These herbicides are considered selective as they have little to no effect on broad-leaf plants like pondweeds in treated areas. ProcellaCOR, fluridone, 2,4-D, and triclopyr are all considered systemic. When applied to the treatment area, plants in the treatment area draw the herbicide in through the leaves, stems, and roots killing all of the plant, not just the part that comes in contact with the herbicide.

Aquathol® whose active ingredient is endothall and Reward® whose active ingredient is diquat are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. Neither of these is considered selective and has the potential to kill all of the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like CLP begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide like Aquathol, as few other plants would be impacted. Using these products later in the season, will kill all vegetation in contact with the herbicide and can provide substantial nuisance relief from a variety of aquatic plants. Endothall based herbicides are the most commonly used herbicides for CLP control, but diquat can be used under the appropriate circumstances.

It is possible to apply more than one herbicide at a time when trying to establish control of unwanted aquatic vegetation. An example would be controlling EWM and CLP at the same time with an early season application, and controlling aquatic plants and algae at the same time during a mid-season nuisance relief application. Applying systemic and contact herbicides together has a synergistic effect leading to increased selectivity and control. Single applications of the two could result in reduced environmental loading of herbicides and monetary savings via a reduction in the overall amount of herbicide used and of the manpower and number of application periods required to complete the treatment.

Pre and Post Treatment Aquatic Plant Surveying

When introducing new chemical treatments to lakes where the treatment size is greater than ten acres or greater than 10% of the lake littoral area and more than 150-ft from shore, the WDNR may require pre and post chemical application aquatic plant surveying. Results from pre and post treatment surveying are used to improve consistency in analysis and reporting, and in making the next season's management recommendations.

The number of pre and post treatment sampling points required is based on the size of the treatment area. Ten to twenty acres generally requires at least 100 sample points. Thirty to forty acres requires at least 120 to 160 sampling points. Areas larger than 40 acres may require as many as 200 to 400 sampling points. Regardless of the number of points, each designated point is sampled by rake recording depth, substrate type, and the identity and density of each plant pulled out, native or invasive.

In the year prior to an actual treatment, the area to be treated must have a mid-season/summer/warm water point intercept survey completed that identifies the target plant and other plant species that are present. A pre-treatment aquatic plant survey is done in the year the herbicide is to be applied, prior to application to confirm the presence and level of growth of the target species. A post-treatment survey is done in the same year as the chemical treatment was completed or in the year after a chemical treatment was completed, sometimes both. A post-treatment survey should be scheduled when native plants are well established, generally mid-July through mid-August. For the post-treatment survey, the same points sampled in the pre-treatment survey will again be sampled. For whole-lake scale treatments, a full lake-wide PI survey should be conducted.

Continued implementation of pre and post-chemical treatment aquatic plant surveying is an important tool in determining the impacts of management actions on both the target and non-target species. It is equally important that APM Plans for a given lake identify specific goals for non-native invasive species and native plants species. Such goals for AIS could include reducing coverage by a certain percent, reducing treatments to below large-scale application designations, and/or reducing density from one level to a lower level. A native plant goal might be to see no significant negative change in native plant diversity, distribution, or density. Results from pre and post treatment surveying are used to improve consistency in analysis and reporting, and in making the next season's management recommendations.

Chemical Concentration Testing

Chemical concentration testing is often done in conjunction with treatment to track the fate of the chemical herbicide used. Concentration testing can help to determine if target concentrations are met, to see if the chemical moved outside its expected zone, and to determine if the chemical breaks down in the system as expected. Monitoring sites are located both within and outside of the treatment area, particularly in areas that may be sensitive to the herbicide used, where chemical drift may have adverse impacts, where movement of water or some other characteristic may impact the effect of the chemical, and where there may be impacts to drinking and irrigation water. Water samples are collected prior to treatment and for a period of hours, days, weeks, or even months following chemical application.

OVERUSE OF AQUATIC HERBICIDES

Concerns exist when herbicide treatments using the same herbicide are done over multiple and subsequent years. Target plant species may build up a tolerance to a given herbicide making it less effective, susceptible plant species may be damaged and/or disappear from the lake (ex. water lilies), concerns over fish and other wildlife might occur, and concern over recreational use in chemically treated water may be voiced. By using several different aquatic herbicides interspersed with physical or mechanical removal efforts between treatments, many of these concerns are minimized.

ProcellaCOR is classified as an auxin herbicide (WSSA Group 4; HRAC Group O), similar to other systemic herbicides including 2,4D and triclopyr. Weed populations may develop biotypes that are resistant to different herbicides with the same mode of action. If herbicides with the same mode of action are used repeatedly, resistant biotypes may eventually dominate the weed population and may not be controlled by these products. To delay development of herbicide resistance, the following practices are recommended:

- Alternate use of products containing ProcellaCOR EC with other products with different mechanisms of action.
- ProcellaCOR EC can be tank mixed or used sequentially with other approved products to broaden the spectrum of weed control, provide multiple modes of action and control weeds that ProcellaCOR EC does not control.
- Herbicides should be used based on an IPM program.
- Monitor treated areas and control escaped weeds.

CONCERNS RELATED TO WHOLE-LAKE/LARGE-SCALE CHEMICAL TREATMENTS

In 2020, the WDNR published a paper (Mikulyuk, et al., 2020) comparing the ecological effects of the invasive aquatic plant EWM with the effects of lake-wide herbicide treatments used for EWM control using aquatic plant data collected from 173 lakes in Wisconsin, USA. First, a pre–post analysis of aquatic plant communities found significant declines in native plant species in response to lake-wide herbicide treatment. Second, multi-level modeling using a large data set revealed a negative association between lake-wide herbicide treatments and native aquatic plants, but no significant negative effect of invasive EWM alone. Taken together, their results indicate that lake-wide herbicide treatments aimed at controlling EWM had larger effects on native aquatic plants than they did on the species targeted for control - EWM.

This study reveals an important management tradeoff and encourages careful consideration of how the real and perceived impacts of invasive species like EWM in a lake and the methods used for their control are balanced.

EWM was first identified in Long Trade Lake in 1995. Management efforts between 1995 and 2013 were limited with biological control (weevils), drawdown, and limited chemical application considered, but not implemented. Lake monitoring through CLMN volunteers has been fairly consistent since 1986, but active management didn't begin until 2007 when the Polk County Land and Water Resources Department (LWRD) conducted a whole-lake point-intercept survey on Long Trade Lake in an effort to establish baseline data on the plant community of the lake. In 2011, Polk County Land and Conservation Department completed the first Aquatic Plant Management Plan for the Trade Lakes system which was focused primarily on management of EWM. In 2012, RTLIA contracted Short Elliot Hendrickson, Inc. (SEH) and Endangered Resources Services, LLC. (ERS) to develop a CLP management plan as an addition to the existing APM Plan.

With the completion of the first APM plan, property owners on Long Trade Lake, now LTLA volunteers, began doing yearly EWM physical removal beginning in 2012. In an effort to reduce the amount of CLP in the lake, early spring chemical treatments were done annually through 2021. EWM was chemically treated less often between 2013 and 2017, and only twice (2018 & 2020) since the completion of the 2018-2022 APM Plan that was prepared by LEAPS. LgT volunteers completed physical removal of EWM in every year under the 2013-17 and 2018-22 APM Plan (Table 7).

Table 7: AIS Management on Long Trade Lake, 2013-2023

AIS Management on Long Trade Lake, 2013-2023											
Task	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
APM Plan					X						in process
AIS Control Grant				X	X	X	X	X	X		
Spring EWM Treatment (acres)	5.63			11.46	2.56	6.8		2.39			
Fall EWM Bed Mapping	X	X	X	X	P	X	X	X	X	x	P
EWM Physical Removal	X	X	X	X	X	X	X	X	X	X	X
Spring CLP Treatment (acres)	9.31	4.89	3.78	11.46	2.16	6.5	3.61	6.25	7.67		
CLP Bed Mapping	X	X	X	X		X	X	X	X	X	P
Pre/post-treatment Plant Survey	X	X	X	X		X	X	X			
Whole-lake PI Survey				X						X	
X= Completed, P=Proposed											

Two different herbicides have been used in Long Trade Lake. Aquathol K with the active ingredient endothall was used for CLP management; and several brand names (DMA 4, Shredder Amine 4, and 2,4D Amine 4) of liquid herbicides with the active ingredient 2,4D were used with mostly positive, but occasional limited success. For example, the 2019 chemical treatment of CLP was not successful as there was more CLP after treatment than there was before treatment. The likely explanation for this is treating too early and/or an ideal growing season (cool and moist) for an extended period after the chemical treatment was completed (Table 8).

Based on late summer or fall EWM bed mapping surveys, for the most part EWM only expanded in a year when a EWM chemical treatment was not completed in the spring of that year. From Table 9, EWM increased from no measureable beds in 2013 to 0.22 acres in 2014; from 0.22 acres to 11.33 acres in 2015; from .02 acres to 0.97 acres in 2019; from 0.2 acres to 0.84 in 2021; and from 0.84 acres to 2.24 acres in 2022.

Table 8: 2013-2022 CLP and EWM herbicide treatment details and results

Year	# of Beds	Total Area Treated (acres)	Range of Bed Size	Herbicide	Concentration	Results- AIS	Results- Native Plants
2013	16 -CLP 9 - EWM	9.31	0.12-1.4	Aquathol K DMA-4	2.0 ppm 3.0 ppm	CLP- Significant decrease EWM- No change	5 species showed significant increases.
2014	5 - CLP	4.25	0.52-1.07	Aquathol K	2.0 ppm	CLP- Significant decrease	White water lily- Significant increase. Common waterweed- Significant decrease. All other plants- No change
2015	9 - CLP	3.78	0.21-1.0	Aquathol super K	2.0 ppm	CLP- Significant decrease EWM- No change	No significant changes
2016	8 - EWM 6 - CLP	12.86	0.29-4.58	Aquathol K DMA-4	2.0 ppm 3.0 ppm	Significant decrease in both CLP and EWM	No significant changes
2017	3 - EWM 2-CLP	2.56	0.40-1.25	Aquathol K, DMA-4	2.0 ppm 3.0 ppm	Data incomplete	Data incomplete
2018	5-CLP 5 - EWM	CLP 6.8 EWM 6.8	0.95-1.97	Aquathol K Shredder	2.0 ppm 3.0 ppm	Significant decrease in both	One native species showed significant decrease (small
2019	5 - CLP	3.61	0.38-1.3	Aquathol K	2.0 ppm	CLP- Significant increase, EWM up	No significant changes
2020	9 - CLP 2 - EWM	CLP 6.25 EWM 2.39	1.18-3.01	Aquathol K Shredder	2.0 ppm 3.0 ppm	Significant decreases in both	No significant changes
2021	2 - CLP	7.67	1.79 - 5.88	Aquathol K	1.75-2.0 ppm	Significant decrease in CLP, significant increase in EWM	No significant changes
2022	no treatment	0	0	NA	NA	NA	NA

Table 9: Historical Late-summer/Fall Eurasian Water-milfoil Bed Mapping Summary Long Trade Lake, Polk County 2011-2022

Bed Number	2022 Area in Acres	2021 Area in Acres	2020 Area in Acres	2019 Area in Acres	2018 Area in Acres	2017 Area in Acres	2016 Area in Acres	2015 Area in Acres	2014 Area in Acres	2013 Area in Acres	2012 Area in Acres	2011 Area in Acres
1	0	0	0	0	0	0.02	0	0.36	0	0	0.45	0.70
2 and 2A	0	0	0	0	0	0.05	0	0.54	0	0	0	1.89
3, 3A, and 3B	0.49	0.03	0.11	0.04	0	0.26	0	2.24	0	0	0.02	2.69
4	0	0	0	0	0	0	0	0	0	0	0	0.13
4B	0	0	0	0.02	0	0.01	0	0.12	0	0	0.03	0
5	0	0	0	0	0	0	0	0	0	0	0	0.51
6	0	0	0	0	0	0.23	0	1.52	0	0	0.13	1.23
6B	0	0.37	0.09	0.44	0.02	0.29	0	2.18	0.22	0	0.76	0
Mill Pond	0	0	0	0	0	0	0	0	0	0	0	0
7	0.63	0.03	0	0.16	0	0	0	0.73	0	0	0.21	1.03
8	0	0	0	0	0	0	0	0.01	0	0	0	0.11
9	0	0	0	0	0	0.01	0	0	0	0	0	0.16
10	0	0	0	0	0	0.02	0	0	0	0	0	0.29
11	1.12	0	0	0	0	<0.01	0	0.48	0	0	0	0.88
12 and 12A	0	0.40	0	0.31	0	0.09	0	3.05	0	0	0	3.35
13	0	0	0	0	0	0.02	0	0.09	0	0	0	0
Total Acres	**2.24**	**0.84**	**0.20**	**0.97**	**0.02**	**1.00**	**0.00**	**11.33**	**0.22**	**0.00**	**1.60**	**12.97**

CLP

Small-scale treatments on Long Trade Lake since 2013 have been fairly effective at reducing CLP populations in the areas that have been treated. These yearly treatments have made a noticeable impact on the distribution and density of CLP within Long Trade Lake (Figure 47). While small-scale treatments should not be the only management action for CLP on Long Trade Lake, they should continue to be a part to an integrated plant management strategy.

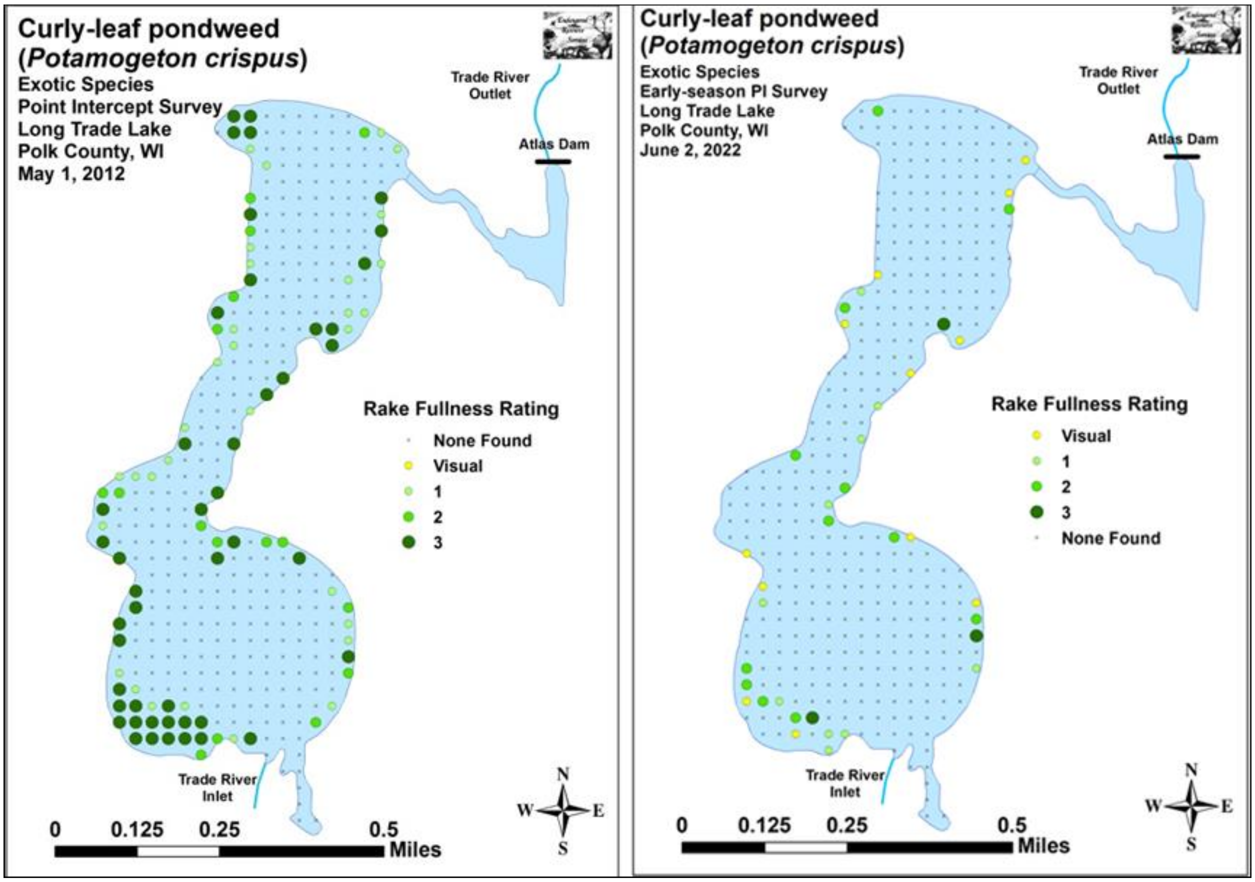
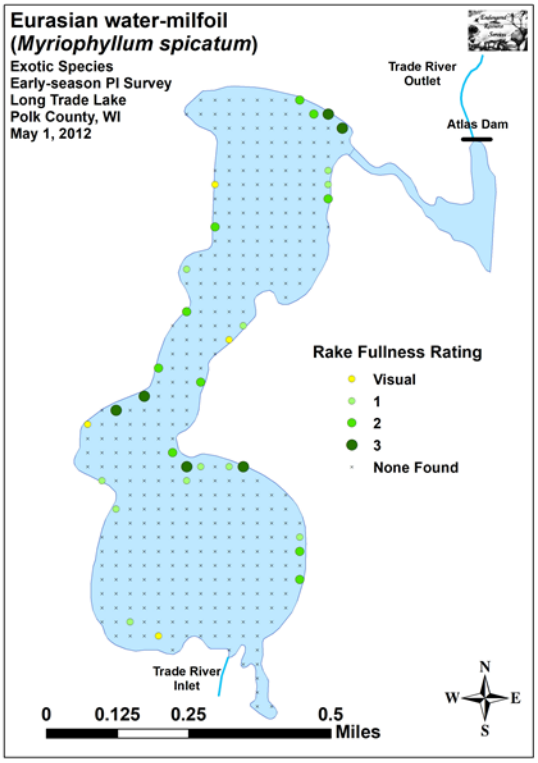


Figure 46: Early season CLP PI survey results from 2012 (left) and 2022 (right)

EWM

EWM treatments in Long Trade Lake since 2013 have also been effective. The amount of EWM in the system has remained low, with herbicide applications only occurring in five of the 10 years between 2013 and 2022. However, there is some evidence that in years where no herbicide was applied to control EWM, the amount of EWM increased in the lake (Table 9), suggesting that positive results were not as long-term as would be liked. Future applications of herbicide will probably use ProcellaCOR instead of 2,4D-based herbicides to see if longer term results can be maintained. Ideally, EWM treatments will only need to happen every 2-3 years on Long Trade Lake.



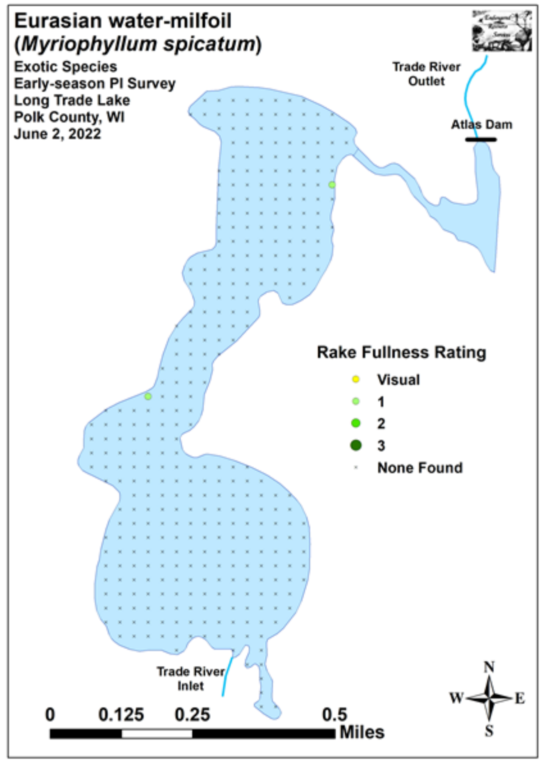


Figure 47: Early season EWM PI survey results from 2012 (left) and 2022 (right)

MANAGEMENT DISCUSSION

EWM

The littoral (plant growing) zone of Long Trade Lake in 2016 was approximately 125 acres (82% of the total surface area). From 2018 to 2022, the years covered under the last APM Plan, EWM in Long Trade Lake, as identified by bed-mapping surveys each year has fluctuated between 0.02 (2018) and 2.24 (2022) acres (Table 9). In the last APM Plan, a goal was set to keep the total amount of EWM in the main body of the lake at or below 2.0 acres in any given year. That was a reasonable goal for the 2018-22 APM Plan and is a reasonable goal to keep in the 2024-28 APM Plan. To do this, a scenario-based approach to EWM management will be implemented.

EWM - SCENARIO BASED MANAGEMENT

In a scenario-based approach to EWM management, there is no set minimum or maximum amount of EWM that is "OK" in the lake, or a "trigger" for management. Any amount of EWM at any time can be managed in the lake, albeit using different management alternatives. When to use what management alternative is the basis of a scenario-based approach to control EWM while at the same time, minimizing issues that might be caused to native aquatic vegetation, either by greater amounts of EWM or from the management used to control EWM.

A combination of manual/physical removal and chemical control methods are recommended for Long Trade Lake. Some level of EWM management, even if it is just monitoring with rake removal, should be completed every year. By doing so, it is expected that the hit or strain on available resources (financial and human) will be minimal. Volunteer burnout occurs when those volunteers see their efforts are not having a positive impact or are way too little too late to have a positive impact.

Mechanical harvesting (except for DASH), artificially enhanced biological control (for EWM), habitat manipulation, and zero management are not recommended at this time.

Given the main goal of the LTLA and the Long Trade Lake Constituency is to control EWM in a sound, ecological manner, the following monitoring and control activities have been outlined:

1) EWM will be monitored by volunteers throughout the growing season.
2) Fall bedmapping will be completed annually by a Resource Professional or trained LTLA volunteers.
3) Areas of EWM with sparse, isolated plants will be hand pulled or raked by volunteers in shallow water (≈ 3 feet) around docks and along shorelines.
    a. These actions can be completed at any time during the open-water season and do not require a WDNR permit.
4) Snorkel, rake, and/or scuba diver removal will take place in areas with isolated plants, small clumps, or small beds of plants where practical and if resources are available.
    a. These actions would likely be contracted by the lake organization (but could be done by LTLA volunteers), can be completed at any time during the open-water season, and do not require a WDNR permit.
5) Diver-assisted Suction Harvest or DASH can be used in place of or in combination with snorkel, rake, and/or scuba diver removal where practical and if resources are available.
    a. These services would likely be contracted by the lake organization, can be completed at any time during the open-water season, but do require a WDNR Mechanical Harvesting permit.
    b. DASH may allow larger areas of EWM to be managed without the use of herbicides.
6) Aquatic herbicides can be used in any area if its application can be justified under the following guidelines

a. Conditions exist that are likely to make other management alternatives less effective
    i. Bed size and density of EWM in the area
    ii. Location of the area in relation to lake access and usability
    iii. Water depth and clarity
    iv. Limited or unavailable access to contracted diver or DASH services
    v. Limited financial resources
    vi. Less than a majority constituent support for a proposed management action.
b. Areas that are <5.0 acres should be treated with ProcellaCOR
    i. Application rates will be limited to 5pdus/acft or less, unless discussion with the Company dealing ProcellaCOR, the Consultant/lake organization, the WDNR, and the Applicator recommend and agree on higher rates.
c. Areas ≥5.0 acres may be treated with ProcellaCOR, 2,4D-based herbicides, or 2,4D/triclopyr blends, depending on available resources.
    i. Suggested application rates for ProcellaCOR would be 3-4pdus/acft.
    ii. Suggested application rates for 2,4D or triclopyr-based herbicides would be 4ppm/acft.
    iii. Treatments >5 acres (10% of the littoral zone) using any herbicide may have a lakewide impact so the following monitoring is suggested.
        1. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys.
        2. Herbicide concentration monitoring.
d. The same area will not be chemically treated two years in a row with the same herbicide or any herbicide with the same mode of action – in this case classified as a Group 4 herbicide (ProcellaCOR, 2,4D, and triclopyr).

CLP

CLP is well established in Long Trade Lake covering as much as 34 acres or more than 27% of the littoral zone. In 2016, CLP covered only 26 acres suggesting management from 2013-2016 did succeed in reducing the amount of CLP. In 2022, bed mapping of CLP showed only 5.43 acres. In the past, the majority of CLP growth in the lake was considered moderate to dense in nature interfering with native aquatic plant growth in the spring, causing navigation and nuisance conditions in parts of the lake in the late spring and early summer, and then contributing to nutrient loading and organic material build up in the sediment mid-summer. Maintaining the amount of moderate to dense growth CLP in the lake at levels similar to 2022 would lessen the undesirable impacts of the plant in the lake. To do this, a scenario-based approach to EWM management will be implemented.

CLP – SCENARIO BASED MANAGEMENT

In a Technical Review of the literature available discussing CLP, two WDNR researchers identified the following potential lake impacts as it relates to CLP (Mikulyuk & Nault, 2009).

1) **Economic Impact** - Monotypic stands of P. crispus can be quite a nuisance, presenting significant navigational difficulties to recreational users. P. crispus can also stimulate algal blooms which can decrease the aesthetic value of a waterbody. These factors have a significant impact on the recreational and real estate value of a waterbody, and may also have an impact on the tourism industry. Impacts are greatest in the species' introduced range, where it is considered a noxious weed.
2) **Social Impact** - P. crispus can be a substantial nuisance to recreational users by impeding navigation and tangling fishing line. This species can also reduce swimming access and stimulate unsightly, possibly toxic algal blooms. Its environmental effects can decrease the aesthetic value of a waterbody as well as affect property values and tourism.

3) **Impact on Crops and Other Plants** - Given this species' tendency to grow in monocultures with high productivity, it has been reported to cause decreases in biodiversity by outcompeting native plants. However, it should be noted that the impact of this species on the native plant community is disputed, with some authors concluding that the fact that the plant acts like a winter annual removes it from negatively impacting native species. In its native range it can be productive, but is not generally reported as a nuisance.
4) **Impact on Habitat** - Massive stands of P. crispus substantially alter a waterbody's internal loading, and can also reduce the fetch of a lake, sometimes inducing stratification in normally unstratified systems. In a comparative study that evaluated four related macrophyte species, P. crispus produced the highest shoot growth rate and biomass. It can grow in dense monotypic stands and affect habitat structure, which may have impacts on commercially and recreationally sought after fish species. P. crispus has been reported to decrease the amount of light reaching the sediment surface. However, the plant may have positive effects in extremely degraded systems. One study reports that planting of P. crispus in enclosures improved water transparency, decreased electric conductivity, increased pH, and was shown to have an inhibitory effect on green algae.
5) **Impact on Biodiversity** - Several sources report that P. crispus has a negative effect on macrophyte biodiversity and often outcompetes native plants.

A scenario-based approach to CLP management is recommended over the next five years. A scenario-based approach means that any amount of CLP may be managed in the lake; however, the management actions implemented will be dictated by the conditions that exist in the lake at any given time. Not all CLP needs to be removed from the lake, but efforts should be made to keep it from gaining more purchase in the lake. To do this, a combination of manual/physical removal, DASH, and chemical control methods are recommended for Long Trade Lake. As such, the following monitoring and control activities have been outlined:

1) CLP will be monitored by volunteers and resource professionals every year.
    a. Pre-management surveys will be completed annually as soon as CLP begins to make an appearance in an effort to judge the severity of seasonal growth.
    b. Early summer CLP bedmapping will be completed annually in early to mid-June in an effort to track its expansion or decline.
2) Areas of CLP with sparse, isolated plants can and should be hand-pulled or raked by LTLA volunteers in shallow water (≈ 3 feet) around docks and along shorelines.
    a. These services can be completed at any time during the CLP growing season, and do not require a WDNR permit.
3) Snorkel, rake, and/or scuba diver removal of CLP can and should take place in areas with isolated plants, small clumps, or small beds of plants where practical and if resources are available.
    a. These services would likely be contracted by the LTLA (but could be completed by LTLA volunteers), can be completed at any time during the open-water season, and do not require a WDNR permit.
4) Diver-assisted Suction Harvest or DASH can be used in place of or in combination with snorkel, rake, and/or scuba diver removal of CLP allowing larger areas of CLP to be managed without the use of herbicides.
    a. These services would likely be contracted by the LTLA, can be completed at any time during the open-water season, but do require a WDNR Mechanical Harvesting permit.
5) Application of aquatic herbicides can be used in any area under the following guidelines
    a. Conditions exist that are likely to make other management alternatives less effective
        i. Bed size and density of CLP in the area
        ii. Location of the area in relation to lake access and usability
        iii. Bottom substrate, water depth, and/or clarity are prohibitive
        iv. Limited or unavailable access to diver, or DASH services

v. Limited financial resources
vi. Less than a majority constituent support for a proposed management action.

b. One-time herbicide application
    i. Proposed chemical treatment areas are at least 5.0 acres in size.
    ii. Liquid endothall (Aquathol K) is used at 1-3 ppm
    iii. Chemical treatments will be considered large-scale
        1. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys should be considered.
        2. Herbicide concentration testing should be considered
    iv. Requires a WDNR Chemical Application permit
    v. Herbicides must be applied by a licensed Applicator

Annual management decisions for CLP and EWM will always be based on the level of infestation, current understanding of management alternatives, resources available, what is acceptable to the constituency, and what the WDNR will approve.

OTHER AIS MONITORING AND MANAGEMENT

LTLA volunteers will continue to monitor the shoreline for purple loosestrife, removing what is found if possible. The LTLA may be involved in rearing beetles for biological control of purple loosestrife however where those beetles are released each year will be determined by the location and most dense areas of purple loosestrife.

No formally recognized management of reed canary grass or Chinese mystery snails is expected, although shoreland improvement projects completed during the time span of this plan might impact the level of reed canary grass along the shore.

LTLA volunteers will participate in the CLMN AIS Monitoring Program annually looking for zebra mussels, rusty crayfish, hydrilla, and other AIS not already in the lake.

COARSE WOODY HABITAT

Coarse woody habitat was assessed in 2016 and could be reassessed during the implementation of this 5-year plan. If there is a need, willing property owners sought for the installation of one or more Healthy Lake Fishsticks projects.

SHORELAND IMPROVEMENT

Nutrient and sediment loading to the lake is a concern and have led to Long Trade Lake being placed on the EPA/State of Wisconsin Impaired Waters list. Multiple shoreland improvement projects have already been implemented around Long Trade Lake, continuing to support these projects around the lake an in its watershed will benefit the lake. Information on small-scale, grant eligible projects for interested property owners can be found at https://healthylakeswi.com/.

WATER QUALITY

Implementation of projects associated with the 2019-2024 Lake Management Plan, Healthy Lakes projects, and aquatic plant management are all expected to have a positive impact on water quality in the lake. LTLA volunteers should continue to monitor water quality in Long Trade Lake through the CLMN Expanded Water Quality Testing Program, future grants, and in cooperation with Polk County activities.

2024-2028 AQUATIC PLANT MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

The following Goals, Objectives, and Actions are similar to the ones presented in the 2018-22 APM Plan. Based on the information shared in this document the following aquatic plant management goals, objectives, and actions are recommended. The Goals, Objectives, and Actions are also available in Appendix A.

Goal 1 – Promote and support aquatic plant management strategies that will control the spread of aquatic invasive species without negatively impacting native vegetation in Long Trade Lake.

1) Objective 1 – Keep level of EWM to below 2.0 acres as indicated by annual late summer EWM bed mapping within the littoral zone
   a) Action – Implement a scenario-based, integrated pest management approach to EWM control.
2) Objective 2 – Keep the level of CLP between 5 and 10 acres as indicated by early summer CLP bed mapping within the littoral zone.
      i) Action – Implement a scenario-based, integrated pest management approach to CLP control.
3) Objective 3 – Monitor for and manage other AIS
   a) Action – Participate in the CLMN AIS Monitoring Program
   b) Action – Consider rearing Galerucella beetles for purple loosestrife control

Goal 2 – Reduce the threats that existing AIS will leave the lake; that new aquatic invasive species will be introduced into the lake; and that new AIS introduced to the lake will go undetected in the lake.

1) Objective 1 – Clean Boats, Clean Waters
   a) Action – Complete up to 200 hours of watercraft inspection time annually with grant funding
   b) Action – Maintain and/or improve AIS signage at landing
2) Objective 2 – AIS Monitoring
   a) Action – Participate in CLMN AIS monitoring
3) Objective 3 – AIS Education
   a) Action – Distribute AIS education and identification materials
   b) Action – Plan and implement AIS identification and physical removal workshops

Goal 3 – Promote and support nearshore and riparian best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Long Trade Lake.

1) Objective 1 – Implement State of Wisconsin Healthy Lakes Initiative
   a) Action - Promote and implement up to five Healthy Lakes projects
   b) Action – Apply for Healthy Lake grant funding to support projects that improve shoreland habitat and reduce runoff into the lake

Goal 4 – Implement management actions that are included in the 2019-24 Lake Management Plan for Long Trade Lake

1) Objective 1 – Identify, support, and/or implement management actions to reduce watershed loading of nutrients and sediment.
   a) Action – Work with the Polk County Land and Water Conservation Department and/or other consultants to plan, implement, and evaluate management actions.

Goal 5 – Complete appropriate and on-going tracking, monitoring, and management strategy modification to allow for thorough evaluation of management actions, and determinations that those management actions are on target, on track, on schedule, on budget, and within expected parameters.

1) Objective 1 – Continue water quality testing for Secchi, temperature, dissolved oxygen, total phosphorus, and chlorophyll a at the Deep Hole in Long Trade Lake
    a) Action – Continue involvement in the Citizen Lake Monitoring Network (CLMN)
2) Objective 2 – Add a CLMN monitoring site in the millpond
    a) Action- Contact WDNR to establish millpond monitoring site
3) Objective 3 – Complete Annual Project Activity and Assessment Reports
    a) Action – The LTLA and their Consultant will prepare end-of-year reports summarizes the management actions taken and how they impacted the lake.
    b) Action – Review end of year summary reports with the LTLA and WDNR to determine following year management actions.

Goal 6 – Encourage and engage lake residents and visitors to be active lake stewards.

1) Objective 1 – Promulgate behavior change in residents in the following areas: AIS, shoreland development, aquatic vegetation, and responsibility for the lake.
    a) Action – Encourage lake residents to understand AIS concerns, learn to identify AIS, watch for and identify AIS in the lake, and report what they find and/or remove it
    b) Action – Encourage boaters to implement appropriate AIS prevention strategies on their watercraft; observe no-wake rules for boats and PWC close to shore and to each other; and be considerate of others on the lake
    c) Action – Encourage lake residents to let vegetation in the water grow and to plant native plants along their shore
    d) Action – Encourage lake residents to care for their lake, not just their lawn
        i) Provide education materials, welcome packets, newsletters, information/education displays, Facebook, webpage, meetings and other resources to increase the level of public awareness on the lake

Goal 7 – Implement the 2024-28 Long Trade Lake Aquatic Plant Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.

1) Objective 1 - Build and support partnerships.
    a) Action – Work with WDNR, Polk County, Town of Laketown, local businesses, contractors, and other resources to support management actions
2) Objective 2 – Keep lake residents informed about plan activities
    a) Action – Complete newsletters, hold public meetings, and distribute educational and informational materials to the LTLA constituency.
3) Objective 3 - Select cost effective implementation actions
    a) Action – Work within the budget constraints to establish the best management actions to implement annually
    b) Action – Apply for State of Wisconsin grant funding to support education, planning, and management implementation

IMPLEMENTATION AND EVALUATION

This plan is intended to be a tool for use by the LTLA to move forward with aquatic plant management actions that will maintain the health and diversity of Long Trade Lake and its aquatic plant community. This plan is not intended to be a static document, but rather a living document that will be evaluated on an annual basis and updated as necessary to ensure goals and community expectations are being met. This plan is also not intended to be put up on a shelf and ignored. Implementation of the actions in this plan through funding obtained from the WDNR and/or LTLA funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix B.

Since many actions occur annually, a calendar of actions to be implemented was created in Appendix C.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

There are several WDNR grant programs that may be able to assist the LTLA in implementing its new APM Plan. AIS grants are specific to actions that involve education, prevention, planning, and in some cases, implementation of AIS management actions. Lake Management Planning grants can be used to support a broad range of management planning and education actions. Lake Protection grants can be used to help implement approved management actions that would help to improve water quality.

The cost of the last EWM management actions completed in 2023 will have to be covered by the LTLA. Future management actions could be supported by WDNR Surface Water grant funding should the LTLA wish to apply for it. Grant funding is not a guarantee, but will not be awarded if it is not applied for. More information about WDNR grant programs can be found at: https://dnr.wisconsin.gov/aid/SurfaceWater.html

OUTSIDE RESOURCES TO HELP WITH FUTURE MANAGEMENT PLANNING

Many of the actions recommended in this plan cannot be completed solely by the LTLA. They will continue to need the help of an outside consultant or other outside resource. Multiple outside resources and expertise exist to help guide implementation. Appendix D lists several outside resources that the LTLA could partner with to implement the actions in this plan.

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Appendix A – Goals, Objectives, and Actions

Appendix B – Funding and Implementation Matrix

Appendix C – Calendar of Actions

Appendix D – WDNR Dredging Exemptions Checklist