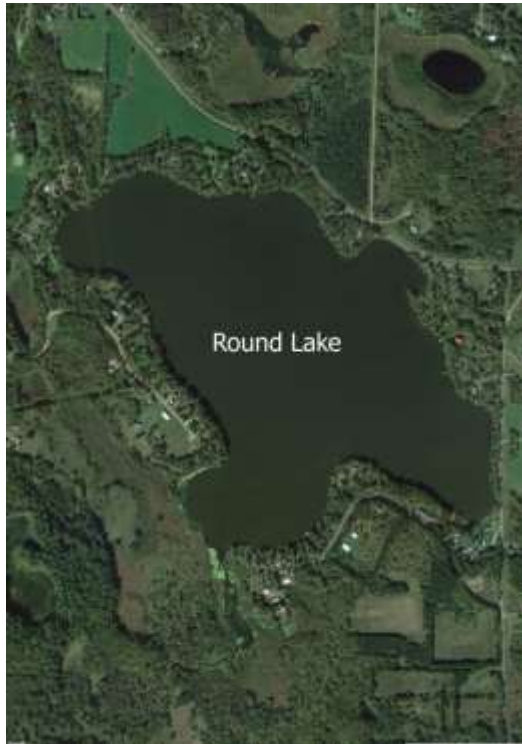


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ROUND TRADE LAKE, BURNETT COUNTY

2024-2028 APMP
WDNR WBIC: 2640100

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June 2023



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AQUATIC PLANT MANAGEMENT PLAN-ROUND LAKE

PREPARED FOR THE ROUND-TRADE LAKE IMPROVEMENT
ASSOCIATION/ROUND LAKE MANAGEMENT DISTRICT

INTRODUCTION

Round Lake is a 208 acre lake in Trade Lake Township in Burnett County. Round 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%), with the rest being agriculture, and is ranked medium for nonpoint source issues affecting streams.

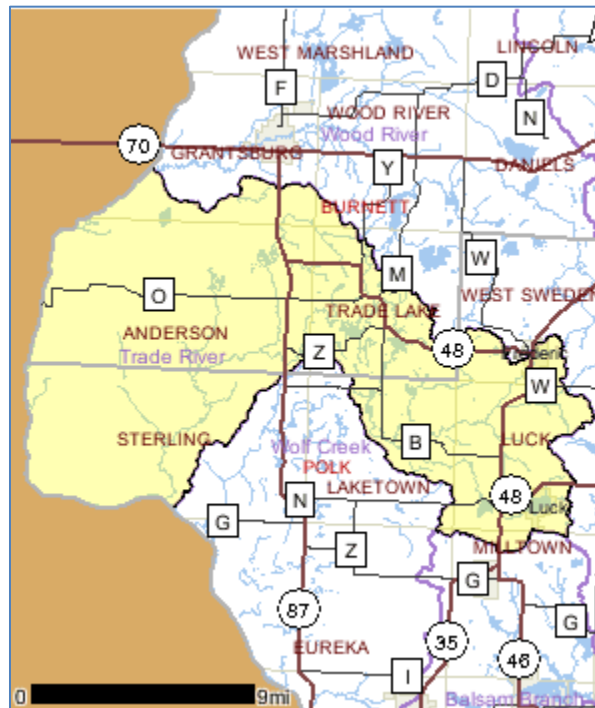


Figure 1 – Trade River Watershed (SC10)

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). Round Lake is the second lake in a chain that the Trade River flows through on its way to the St. Croix River.

Long Trade Lake has its own lake association. Round Lake is currently part of the Round Trade Lakes Improvement Association (RTLIA), but has recently completed the necessary steps to become a Lake District. Little Trade and Big Trade lakes are the last two lakes in the chain and are also part of the RTLIA.



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

Round Lake is considered a “Deep Lowland” lake under the state's Natural Community Determinations. Deep lowland lakes are generally deep enough to stratify during the summer season, have water draining from them, and may have water entering them from upstream. Stated lake uses for Round 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. Round Lake was first listed as an impaired water in 1998 for mercury build up in fish tissue caught in the lake. 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 use¹.

All four of the lakes along the Trade River have exhibited signs of excess fertility for decades. The signs of eutrophication are evident on these waters but a water quality focused management plan has only been developed for Long Trade Lake (Polk Co., 2019) definitive nutrient and hydraulic budget has not been documented. A feasibility study to evaluate the hydraulic and nutrient loading as well as in-lake monitoring to determine recycling and profile characteristics remains a high priority for Round Lake.

PREVIOUS AQUATIC PLANT MANAGEMENT GOALS AND OBJECTIVES

Eurasian watermilfoil (EWM) was identified in Round Lake in 2003. Curly-leaf pondweed (CLP), another aquatic invasive species (AIS) was officially recognized in 2008, but has likely been in the lake much longer than that. 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 Round Lake. The 2018-2022 APM Plan had the following goals.

¹ <https://dnr.wi.gov/water/impairedDetail.aspx?key=16678>

- **Goal 1** – Promote and support aquatic plant management strategies that will control the spread of aquatic invasive species without negatively impacting native vegetation in Round 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 Round Lake.
- **Goal 4** – 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 5** – Encourage and engage lake residents and visitors to be active lake stewards.
- **Goal 6** – Implement the Round Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.

Under Goal 1, there were two main objectives: keep the level of EWM to below 2.75 acres; and to minimize negative impacts caused by dense growth CLP. Under the implementation of the 2018-22 APM Plan, the first objectives was not met, the second was. According to the report completed by Endangered Resource Services (ERS), when compared to 2016, the 2022 early season survey work suggested EWM had undergone significant increases in mean density, total distribution, and rake fullness 3. These results represented a combined 166.7% increase in EWM coverage as well as a 350% increase in areas where the infestation would likely be considered a nuisance (Berg 2022).

When comparing 2016 to 2022 CLP survey results, declines in both total distribution and density were found, but neither was significant. Lakewide, from 2016-2022, there was a decline (-28.6%) in total CLP coverage as well as a decline (-33.3%) in likely nuisance areas.

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, no projects to improve shoreland habitat around the lake and to reduce runoff into the lake were completed, so this goal needs to be revisited in the new APM Plan.

The objectives under Goals 4-6 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 being brought together by their own Lake District continue to be involved and aware of the health of the lake and how the implementation or no implementation of management actions impact it.

ROUND-TRADE LAKE IMPROVEMENT ASSOCIATION

The Round Trade Lake Improvement Association is a non-profit, state incorporated, association currently comprised of Round Lake, Big Trade Lake, and Little Trade Lake. Long Trade Lake (Polk Co) and Spirit Lake (Burnett Co) were once a part of the RTLIA but no longer. The RTLIA was originally incorporated March 26, 1974, by residents of Round and Trade Lakes with its official offices located in the Township of Trade Lake.

Membership in the RTLIA requires payment of dues in the sum of \$30.00 annually. Completed membership forms and investment can be given to any of the officers, board members, lake chairman, or it can be mailed. A current listing of all the officers, board members, and chairman is available by visiting the RTLIA web site at www.tradelakeassoc.org. Minutes from meetings, additional information about the RTLIA, and many other resources are available on the webpage. The RTLIA is also on Facebook. Some current and future goals for the RTLIA include but are not limited to the following:

- Complete water quality studies of the lakes in the Trade River system
- Develop long-term strategies to maintain and improve the water quality of the lakes in the Trade River system
- Control or reduce the spread of exotic plant species in the lakes and on the surrounding lakeshores.
- Increase active membership in the Lake Improvement Association.

ROUND LAKE MANAGEMENT DISTRICT

In early 2022, the property owners on Long Trade Lake pulled out of the RTLIA and formed their own Lake Association. In late 2022, the property owners on Round Lake began the process of forming their own lake district. A Lake District is an official government entity with the power to tax its constituents in order to raise money to implement management actions that maintain or improve the lake. This process was nearly complete at the time this APM Plan was completed, so it is expected that going into 2024, the Round Lake Management District will be the governing body for Round Lake. Lake Districts are automatically eligible to apply for and receive WDNR Surface Water grants.

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

OVERALL MANAGEMENT GOAL

The overall management goal for Round Lake continues to be maintaining EWM at low levels that do not interfere with lake use. For the purposes of this management plan, that level is less than 2.7 acres for EWM as identified annually during a late summer point-intercept aquatic plant survey. Management actions including physical removal and limited use of aquatic herbicides will continue when criteria to do so is met. In addition, DASH and/or limited mechanical harvesting may be incorporated. A secondary goal is to keep the amount of CLP in the lake at low levels that will help promote early season growth of native aquatic plants. Related to native aquatic plants, the goal is to maintain or increase the number of species, distribution, and density of native aquatic plants and to see an increase in those measurements used to determine the health and stability of the community: Simpson Diversity Index, Floristic Quality Index, and Mean Coefficient of Conservatism over the next five years.

Almost all aquatic plant survey data that is referenced in this document is from the 2022 final report prepared by Endangered Resource Services (ERS) (Berg, 2022).

CHANGES IN CURLY-LEAF PONDWEED (BERG, 2022)

During the initial 2012 survey completed by ERS, the spring littoral zone reached 10.0ft, and CLP and EWM were the deepest growing plants. CLP was present in the rake at 9 locations with 2 additional visual sightings. This approximated to 0.9% total coverage and 4.2% of the littoral zone having at least some CLP present. Of these, none had a rake fullness rating of 3, four rated a 2, and five were a 1 (mean rake fullness of 1.44). This suggested 0.4% of the lake and 1.9% of the littoral zone had a significant infestation (rake fullness 2 or 3) (Figure 3).

In June 2016, CLP was present in the rake at 21 points (2.1% of the entire lake/15.6% of the then 5.0ft spring littoral zone) with 12 additional visual sightings (Figure 3). None of these rated a rake fullness of 3, six were a 2 (0.6% of the lake/4.4% of the littoral zone with a significant infestation), and the remaining 15 were a 1 for a mean rake fullness of 1.29.

In 2022, CLP was present in the rake at 15 sample points with 2 additional visual sightings (Figure 3). This extrapolated to 1.5% of the entire lake and 7.8% of the spring littoral zone having at least some CLP present. Of these, none rated a rake fullness value of 3, four were a 2, and the remaining 11 were a 1 for a combined mean rake fullness of 1.27. The four points with a rake fullness of a 2 or a 3 suggested 0.4% of the entire lake and 2.1% of the spring littoral zone had a significant infestation.

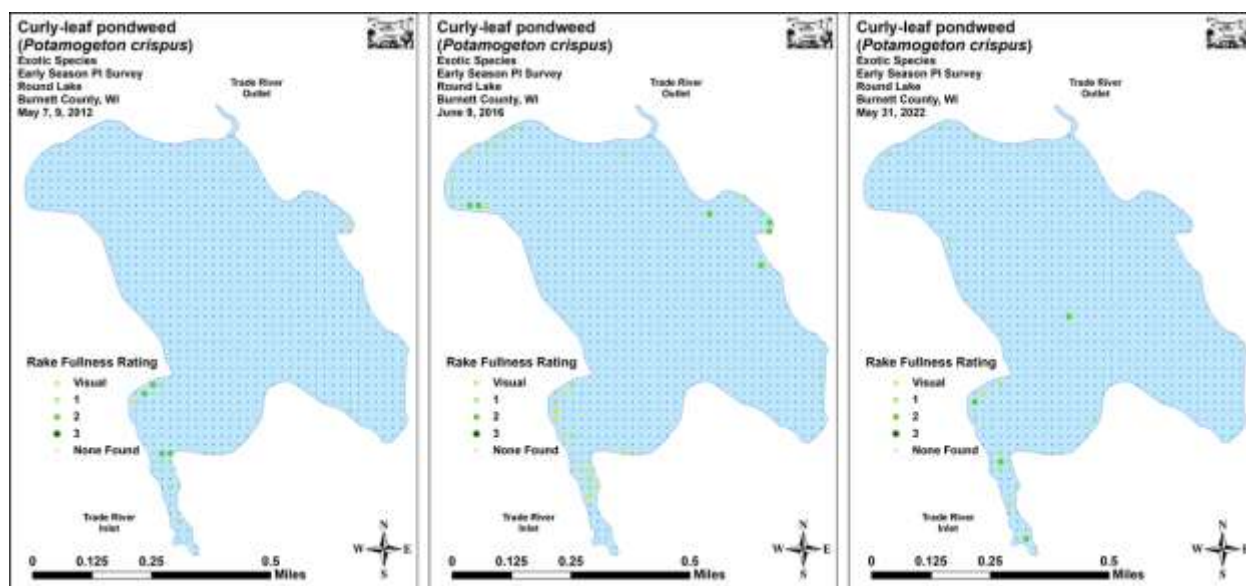


Figure 3: 2012, 2016, and 2022 early-season CLP density and distribution

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 much of the lake's littoral zone was dominated by beds of EWM with scattered patches of CLP mixed in. Ultimately, three areas with significant CLP that covered 4.80 acres or 2.3% of the lake's 208 total acres were mapped (Table 1) (Figure 4). Fortunately, most CLP occurred in the river inlet, and those beds that were adjacent to residences were relatively narrow. Although an inconvenience, most property owners likely would have required no more than a single prop clear to access open water.

The 2016 survey found CLP was more widespread but covered a smaller overall area as several of the beds mapped in 2012 had fragmented. In total, eight beds totaling 1.22 surface acres (0.6% of the lake) (Table 1) were delineated. This was a reduction of 3.58 acres (-74.6%) compared to the 2012 survey with much of the loss occurring near the river inlet and in the northwest bay (Figure 4).

The late 2022 ice-off followed by a rapid warm up did not appear to favor Curly-leaf pondweed growth. However, eight beds were again mapped. All were less than 1-acre, and none seemed likely to cause more than minor navigation impairment (Figure 4). Collectively, they totaled just 0.44 acre (0.2% coverage) – a decline of 0.78 acre (-63.9%) compared to 2016, and 4.36 acres less than in 2012 (-90.8%) (Table 1).

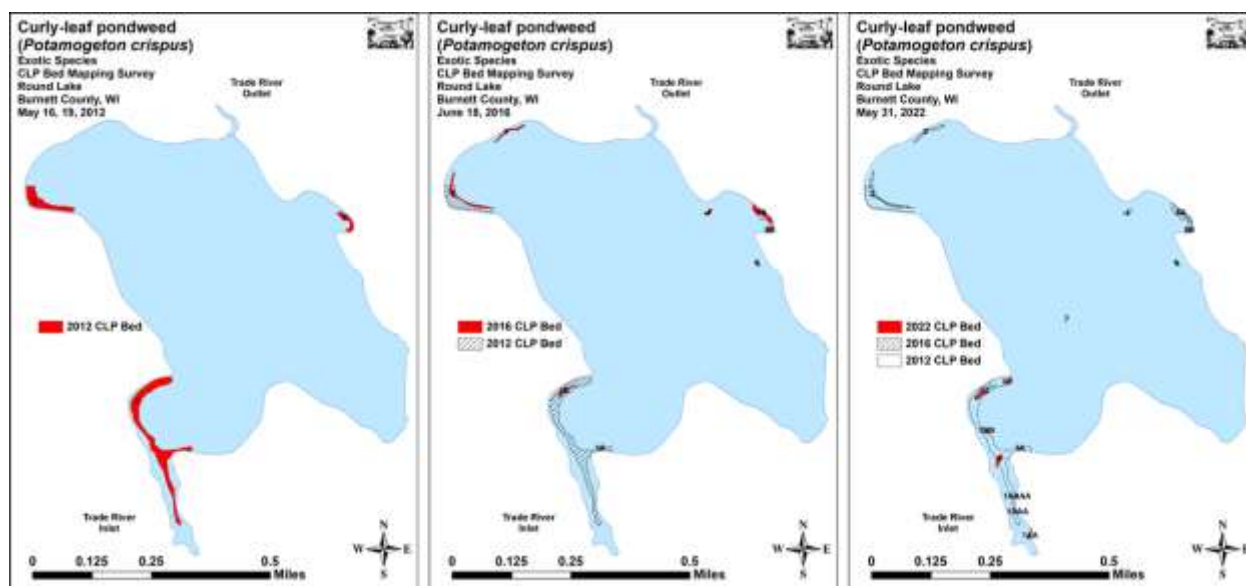


Figure 4: 2012, 2016, and 2022 early-season CLP beds

Table 1: Curly-leaf Pondweed Bed Summary Round Lake - Burnett County, Wisconsin
May 16 and 19, 2012, June 18, 2016, and May 31, 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 (A-AAAA)	0.23	0.02	3.31	0.21	<1-2; 2	1-4; 2	Yes	None	In river channel/inlet.
1B/1BB/1C	0.21	0.14	-	0.07	<1-2; 2	2-5; 4	Yes	Minor	Too narrow to be mod.
2	0	0.42	1.15	-0.42	<<<1	2-5; 4	Yes	None	A few scattered plants.
3	0	0.19	0	-0.19	<<<1	2-5; 4	Yes	None	A few scattered plants.
4	0	0.08	0	-0.08	<<<1	2-5; 4	Yes	None	A few scattered plants.
5 (A and B)	0	0.33	0.34	-0.33	<<<1	2-5; 4	Yes	None	A few scattered plants.
6	0	0.04	0	-0.04	<<<1	2-5; 4	Yes	None	A few scattered plants.
7	<0.01	0	0	<0.01	<1-2; 2	5-6; 5	Yes	Minor	Microbed on rock island.
Total Acres	0.44	1.22	4.80	-0.78					

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

During the initial 2012 spring survey, EWM was much more common than CLP. EWM was present in the rake at 45 points (4.5% total coverage/21.2% littoral coverage) with five additional visual sightings (Figure 5). Of these, 11 rated a rake fullness of 3, 13 were a 2, and 21 were a 1 (mean rake fullness of 1.78). This suggested 2.4% of the entire lake and 11.3% of the spring littoral zone had a significant amount of EWM.

The 2016 survey found EWM at 6 points (0.6% total coverage/4.4% littoral coverage) with 4 additional visual sightings. None of these had a rake fullness rating of 3, two were a 2 (0.2% of the lake/1.5% of the spring littoral zone had a significant infestation), and four were a 1 for a mean rake fullness of 1.33 (Figure 5).

In 2022, EWM was found at 16 points (1.6% total coverage/8.3% littoral coverage) with 5 visual sightings (Figure 5). Six points had a rake fullness of 3, three were a 2 (0.9% of the lake/4.7% of the spring littoral zone had a significant infestation), and the remaining seven were a 1 for a mean rake fullness of 1.94.

When comparing the original 2012 survey with the 2022 survey, long term reductions in EWM were found. Specifically, it was noted there was a highly significant decline in total EWM distribution; and moderately significant declines in rake fullness 2 and rake fullness 1. Taken as a whole, both total coverage (-64.4%) and nuisance coverage (-62.5%) dropped sharply.

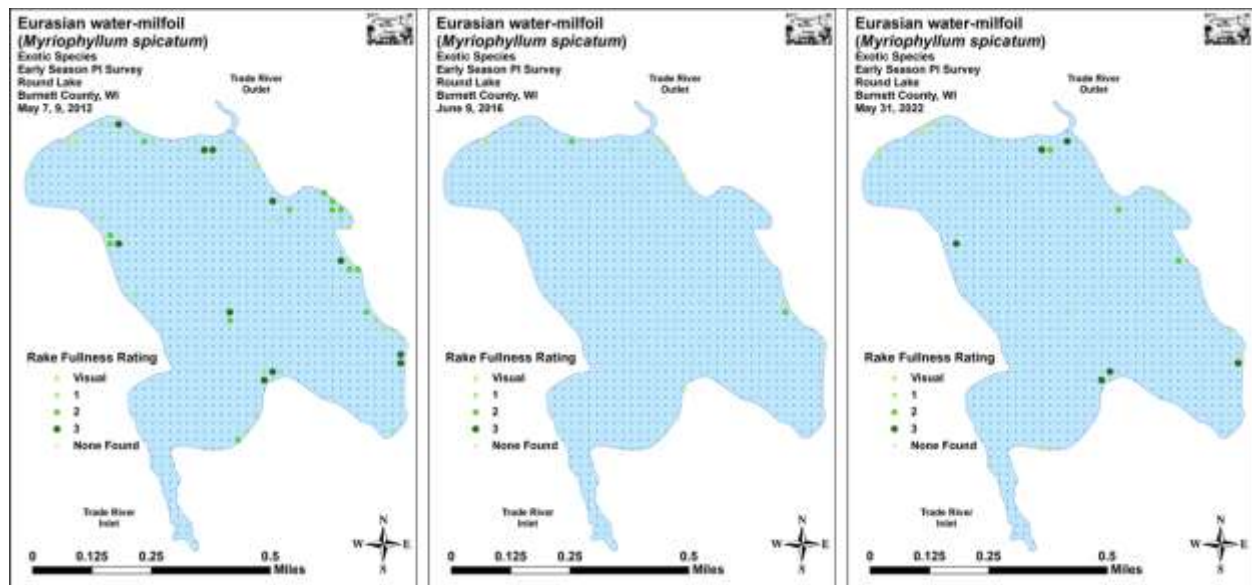


Figure 5: Early season 2010, 2016, and 2022 EWM density and distribution

Summer EWM levels on Round Lake appear largely tied to the level of late-spring management and/or annual changes in water clarity. In 2010, WDNR surveyors found EWM at 13 points (1.3% coverage/4.1% of surveyed littoral points). This suggested 0.1% of the entire lake and 0.3% of the surveyed littoral points had a significant amount of EWM (Figure 6). The 2016 survey found EWM at 21 points (2.1% total coverage/11.7% littoral coverage) with 16 additional sightings (Figure 6).

Compared to 2010, the July 2016 results suggested there had been a non-significant increase ($p=0.28$) in total distribution, and a significant increase in density. None of the individual rake ratings showed significant change, but visual sightings underwent a highly significant increase (Figure 6). Collectively, there was a 61.5% increase in EWM coverage as well as a 600% increase in areas where the infestation was significant enough to likely be considered a nuisance.

The July 2022 survey found EWM at 18 points (1.8% total coverage/8.7% littoral coverage) with seven visual sightings (Figure 6). When compared to 2016, the 2022 findings suggested EWM had undergone a non-significant increase in mean density and a non-significant decline in total distribution. Similarly, none of the changes in rake ratings were significant, but the number of visual sightings showed a significant decline (Figure 6). These results represented an overall decrease (-14.3%) in EWM coverage, but a 42.9% increase in areas where the infestation would likely be considered a nuisance.

Comparing the original 2010 survey with the 2022 survey found no significant changes in EWM distribution or any of the rake fullness ratings; however, mean density underwent a moderately significant increase. Taken as a whole, total coverage increased 38.5%, while nuisance coverage jumped 900%.

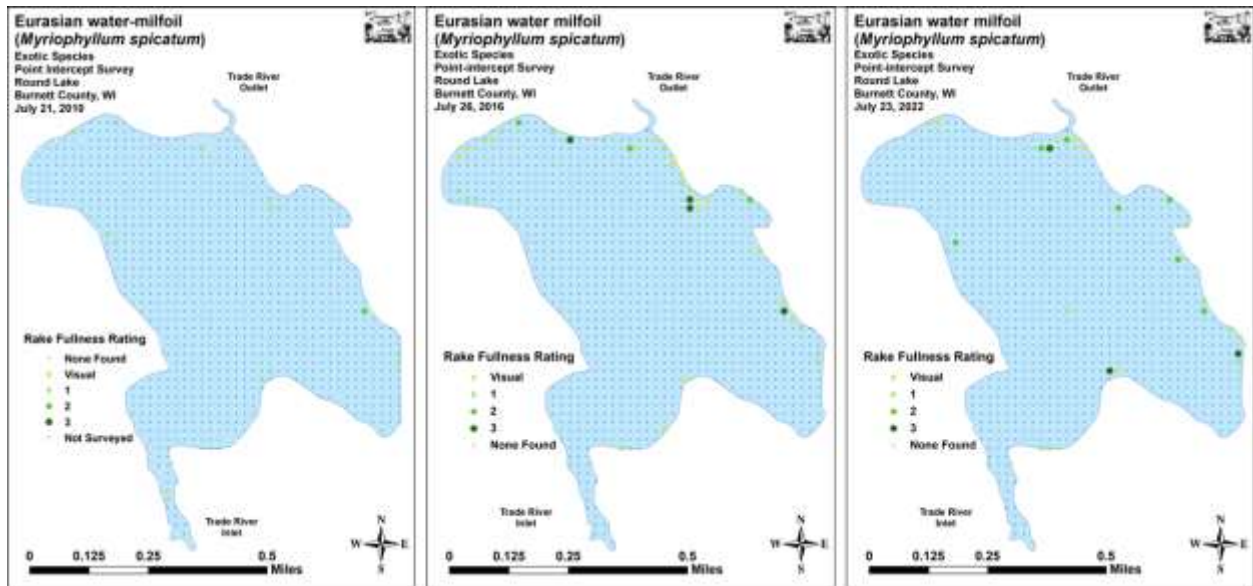


Figure 6: Summer 2010, 2016, and 2022 EWM density and distribution

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

Round Lake (WBIC 2640100) is a hard water drainage lake located in south central Burnett County. It is the second in a chain of four lakes along the Trade River. According to the Wisconsin Department of Natural Resources (WDNR), Round Lake has a surface area of 208 acres and a maximum depth of 27 feet.

The primary land use in the Round Lake watershed is forest land which occupies about 42% of the 35,595 acre watershed with agricultural uses (i.e. row crops, pasture, etc.) at around 38%. Development accounts for about 8% of the land cover with the heaviest development (land that is covered by greater than 50% impervious surfaces) contributing less than 1%. Of this developed area, very little is found around Round Lake. Wetlands and undeveloped grasslands account for just under 9% of the land use in the Round Lake watershed while open water covers the remaining 3% (Figure 7, Table 2).

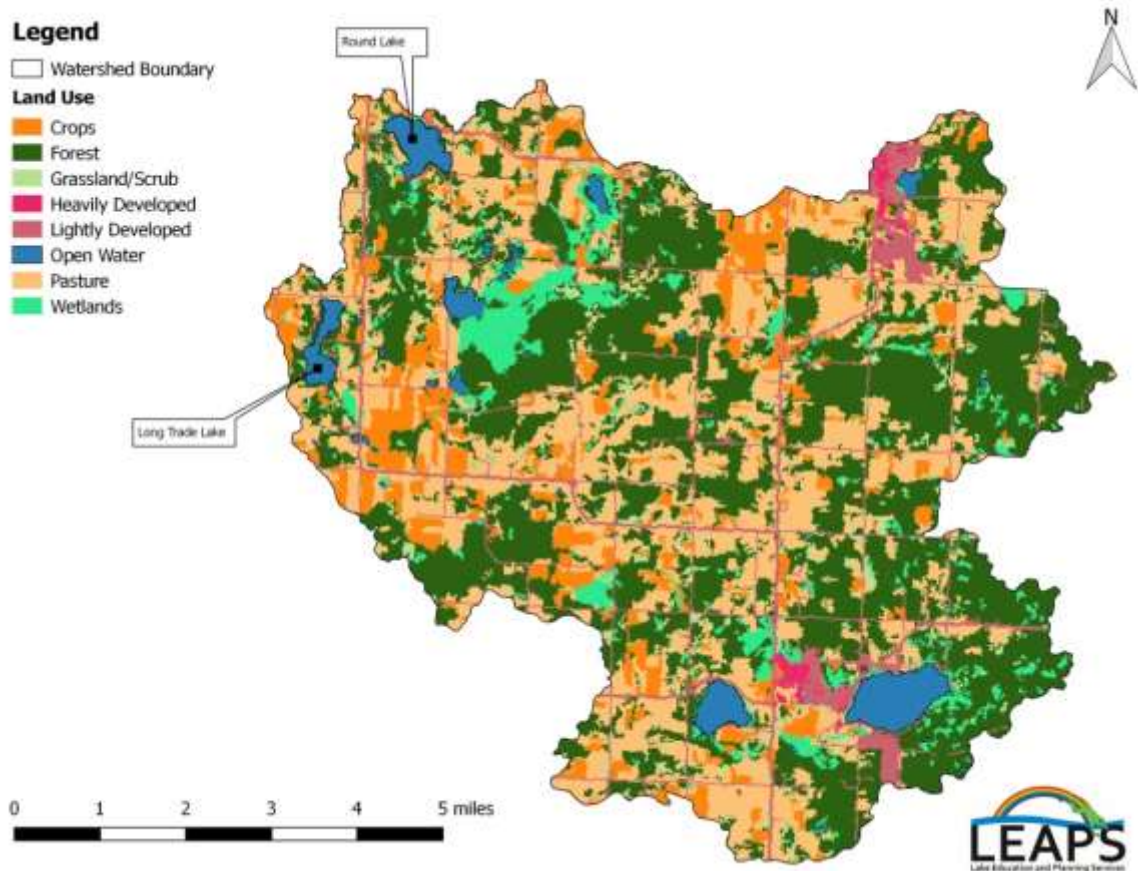


Figure 7 - Watershed Land Use for Round Lake, Burnett County (LEAPS, 2016)

Table 2 - Physical Characteristics of Round Lake in Burnett County

Lake Characteristics		Watershed Land Use	
Lake Area (acres)	207.3	Open Water	1,230.70
Watershed Area (acres)	35,596.60	Forest	15,074.90
Maximum Depth (feet)	27	Agriculture (Crops and Pasture)	13,574.80
Mean Depth (feet)	15	Grassland/ Scrub	994.7
Miles of Shoreline	5	Heavily Developed	207
Lake Type	Drainage	Lightly Developed	2,467.40
		Wetlands	2,045.10
		Total	35,596.60

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 Round Lake as well as into the Trade River. 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.

Round Lake has one active resort on the lake.

WATER QUALITY

WATER CLARITY

The Citizen Lake Monitoring Network² (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 Round Lake have been collecting CLMN water quality data off and on since the CLMN program started in 1986.

From 1986 to 2022 the average annual Secchi disk reading of water clarity is 4.34ft. Figure 8 reflects all of the years with two or more Secchi disk readings. There is a large gap in Secchi disk readings between 1994 and 2000, but otherwise, there appears to be a slight trend 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>

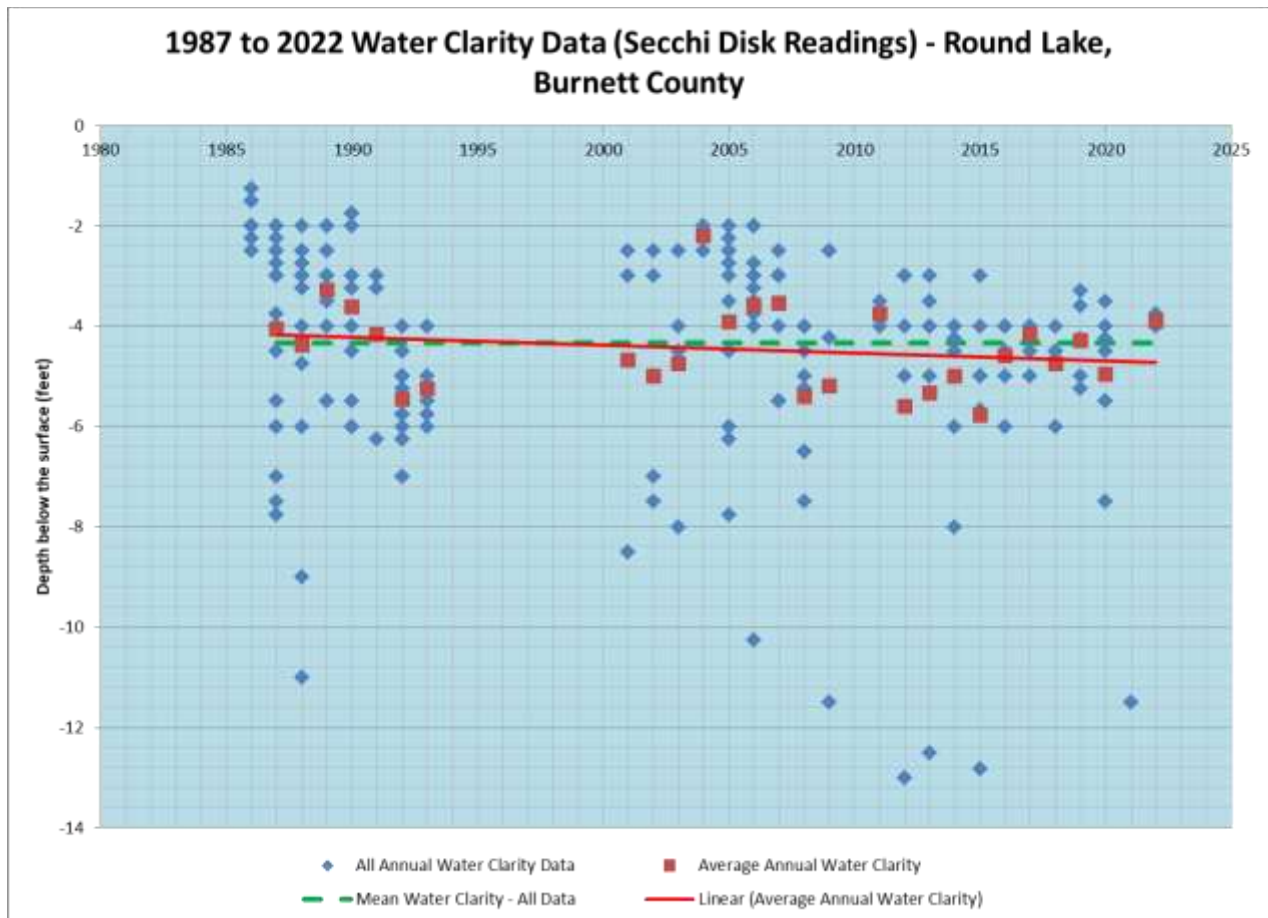


Figure 8: All CLMN water clarity data and annual means

Water clarity during the open water season in Round Lake follows a common pattern. In many lakes across the state, including Round Lake, 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 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 9).

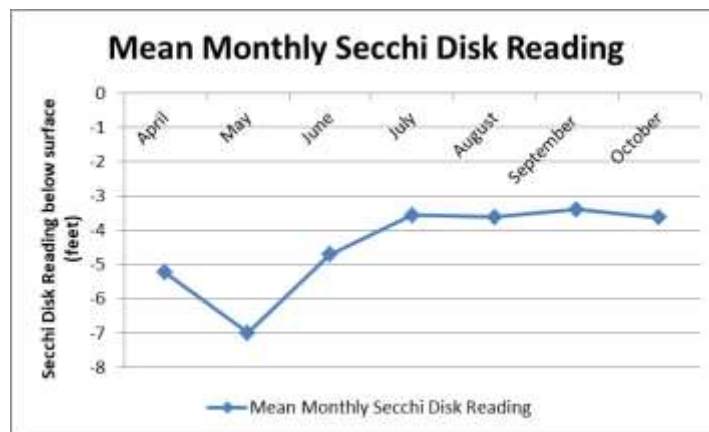


Figure 9: Average monthly Secchi disk readings of water clarity (all CLMN data)

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, RTLIA volunteers 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 10 reflects the annual average of TP in Round 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 in the early 2000’s TP levels were generally higher than they were during the late 2000-teens.

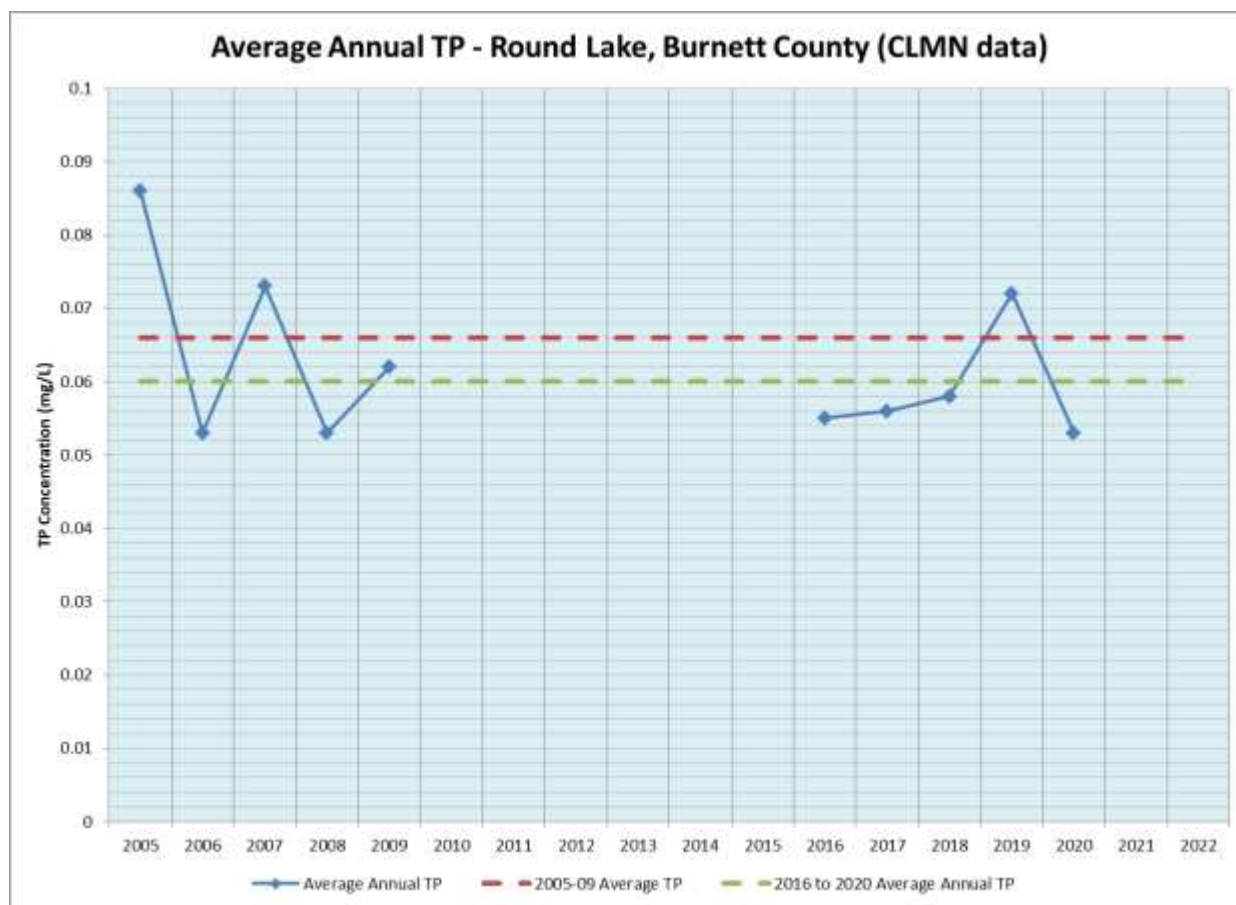


Figure 10: Average annual TP concentrations

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 Round Lake since 2005 with a few gaps. All CLMN ChlA data was included in this analysis except for annual means when there was only one water sample collected. Those years were removed. ChlA data shows a trend of lessening amounts of algae in the lake water, particularly in the last 10 years or so (Figure 11). This trend holds up well with the trend of slightly greater water clarity in the late 20teens and early 2020’s 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.

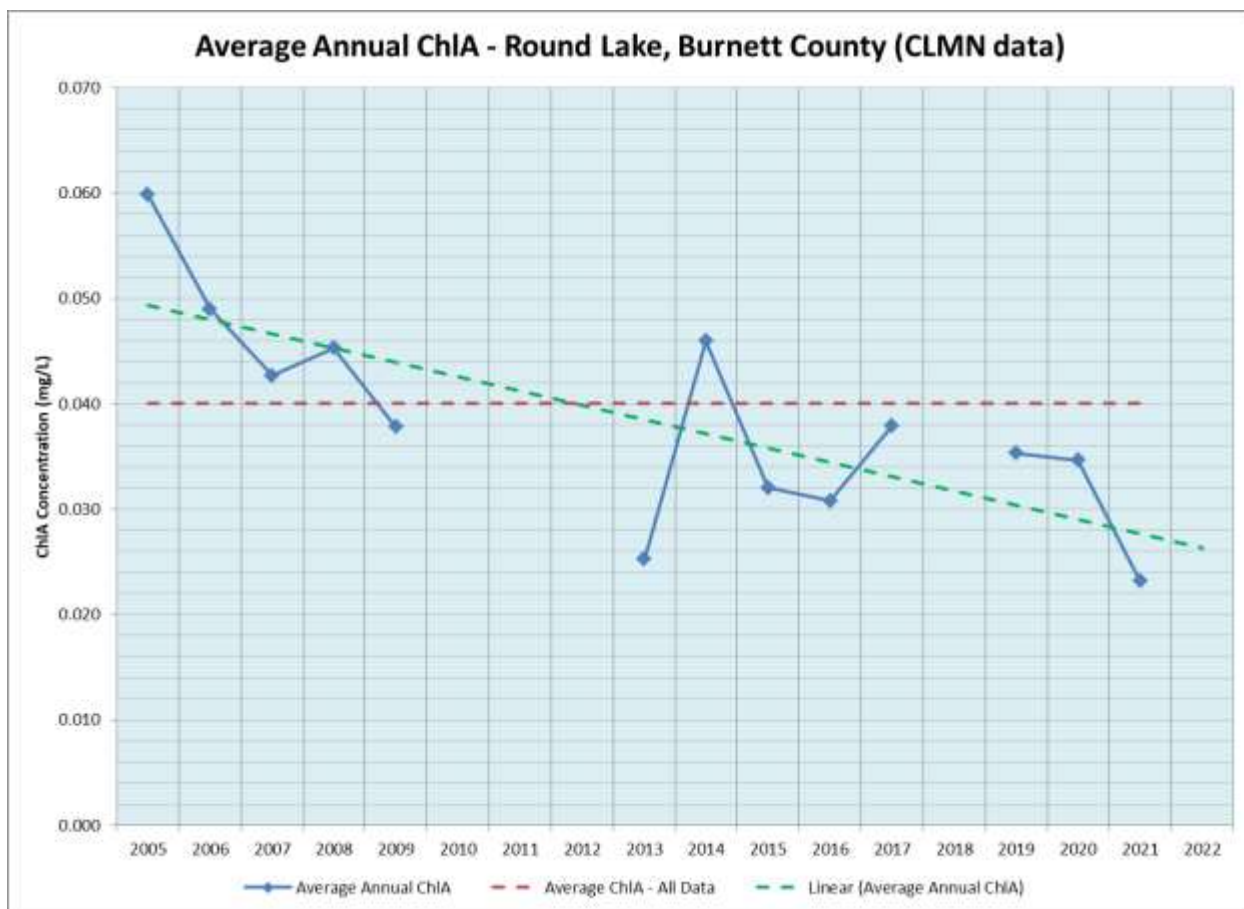


Figure 11: Average annual Chla concentrations plus trend line

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 12). Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth (Figure 12). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 12).

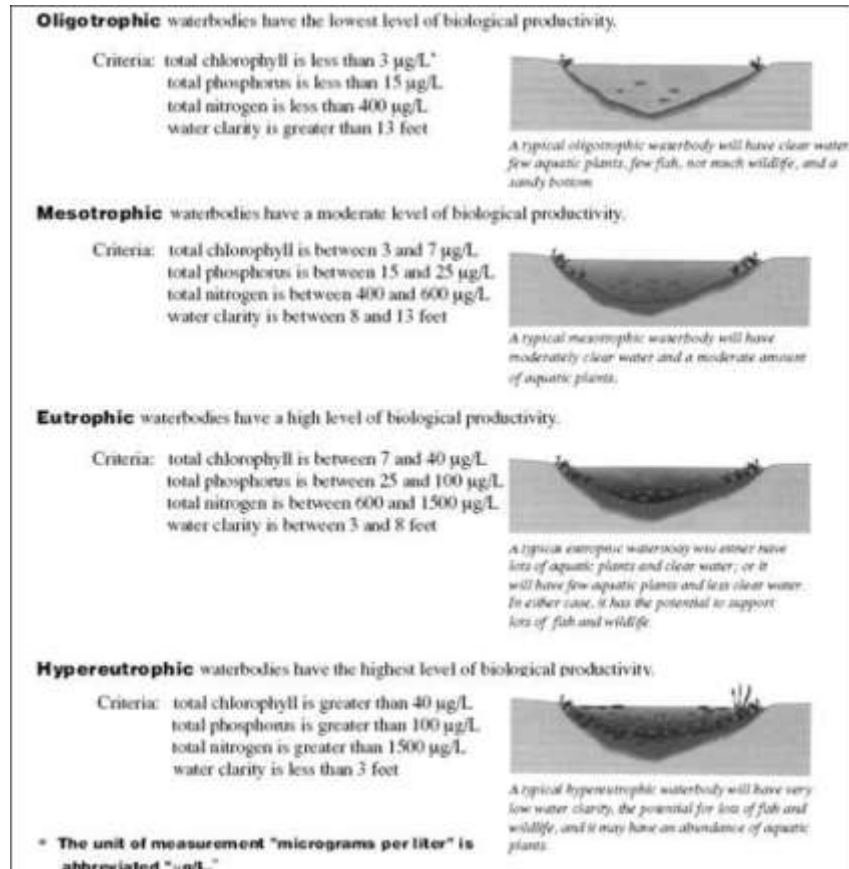


Figure 12: Trophic states in lakes

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 salmonoids.
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 Menominee & 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 - $\mu\text{g/L}$) 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 13). The dark blue area of Figure 13 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 13). 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).

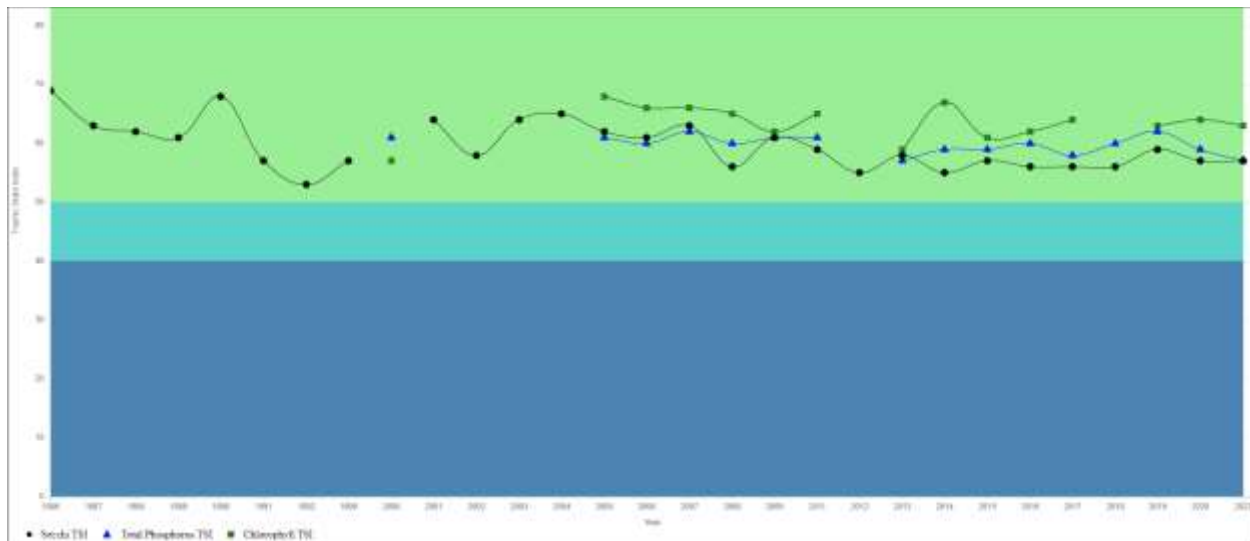


Figure 13: Yearly TSI values for Chla, Secchi (water clarity), and TP (CLMN)

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 14. 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.

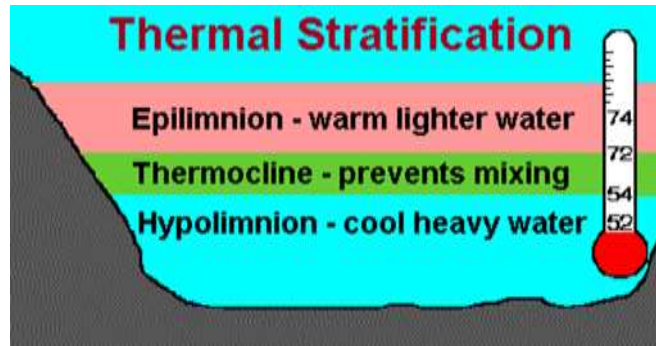


Figure 14: Summer thermal stratification

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.

At around 26ft, Round Lake is stratified through most of the open water season. Temperature and DO monitoring in the entire water column of Round Lake has been a part of the data that is collected annually. The tables in Figure 15, taken from the last full season of temperature and DO monitoring (2020), show that the lake does stratify at around 9-12ft leading to anaerobic water (water with no DO) below that depth into the month of September. This lack of DO in the hypolimnion likely leads to phosphorus being released from the bottom of the lake during most of the summer months. Figure 16 shows a more complete season's worth of monitoring in 2007. Turnover in the spring and again in the fall are clearly visible – with water temperature and DO nearly the same from surface to bottom in April and late October.

06/29/2020			07/29/2020			08/27/2020		
Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L
0	77.7	10.92	0	83.9	14.41	0	77.3	8.73
3	77.2	10.04	3	81.9	15.68	3	77.2	8.64
6	75.7	10.19	6	79.2	14.24	6	76.8	8.5
9	72.9	7.8	9	76.4	4.43	9	74.7	3.01
12	70.9	5.9	12	73.9	.28	12	70.7	.14
15	63.1	.2	15	69.7	.19	15	66.6	.16
18	56.6	.19	18	64.2	.16	18	62.1	.15
21	54.9	.21	21	59.9	.15	21	59.2	.16
24	54	.23	24	57.3	.15	24	57.5	.16
25.4	55.2	.23	26	55.5	.12	26	55.5	.17

09/27/2020			10/29/2020		
Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L
0	64	10.7	0	40.5	12.68
1	63.9	10.82	1	40.5	12.42
2	63.8	10.82	2	40.5	12.3
3	63.6	10.54	3	40.5	12.13
4	61.7	7.93	5	40.5	12.08
5	61.2	4.4	6	40.5	12.04
6	60.9	1.55	7	40.5	11.28
7	60.1	.74			

Figure 15: Temperature and DO profiles in Round Lake (2020 CLMN data)

04/15/2007			06/30/2007			07/15/2007		
Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L
0	47		0	76.2	11.84	0	75.8	11.08
3	44	12	3	75.5	11.21	3	75.6	11
6	41.5		6	74.7	8.45	6	75.3	10.8
9	41.1	12	9	74.2	7.01	9	74.1	9.08
12	41	12	12	72.1	.13	12	73.2	5.06
15	40.8	12	15	68.8	.03	15	72.7	2.19
18	40.7	12	18	64.8	.06	18	71.1	.14
21	40.4		21	62.1	.08	21	65.3	.12
24	40.4		24	60.8	.11	24	65.7	.12

08/25/2007			10/07/2007			10/27/2007		
Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L	Depth FEET	Temp. DEGREES F	D.O. MG/L
0	71.8	11.95	0	65.5	11.42	0	51.4	9.84
3	71.7	11.88	3	65.3	11.27	3	51.4	9.82
6	71.6	11.77	6	64.9	10.74	6	51.5	9.78
9	71.3	10.66	9	63.9	5.57	9	51.6	9.77
12	69.5	.68	12	61.8	7.29	12	51.6	9.71
15	69.2	.09	15	61.5	6.44	15	51.6	9.69
18	68.8	.1	18	61.5	5.36	18	51.6	9.66
21	68	.12	21	61.6	4.68	21	51.6	9.31
24	65.5	.12	24	62.2	2.41	24	51.6	8.99

Figure 16: Temperature and DO profiles in Round Lake (2007 CLMN data)

FISHERIES AND WILDLIFE

Until recent years, Round Lake had been stocked fairly regularly with walleye since 1973. The most recent stocking consisted of 7,493 walleye fingerlings (4-6 inch) in 2011. Aside from walleye, panfish, largemouth bass, and northern pike are common while smallmouth bass are present.

According to the Natural Heritage Inventory (NHI), there are two protected species within the same township as Round Lake. The brittle prickly-pear is a terrestrial plant that is found in dry sandy areas. While this threatened plant is not found in close proximity to Round Lake, it should be considered for any projects that concern the Round Lake watershed. The second protected species found near Round Lake is Blanding's turtle which is not listed as threatened or endangered, but is considered a species of special concern, and is listed as a protected wild animal under NR10.02. It is fairly likely that Blanding's turtles are present within and around Round Lake. Minimizing impact to these turtles should be considered when planning management.

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 identified as Sensitive Areas per Ch. NR 107. Although Round Lake has not been surveyed by the WDNR for sensitive areas, 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 et al. (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 WDNR 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 17).



Figure 17 - Coarse woody habitat-Fishsticks projects

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 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 as 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 18 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 12-27-2016).

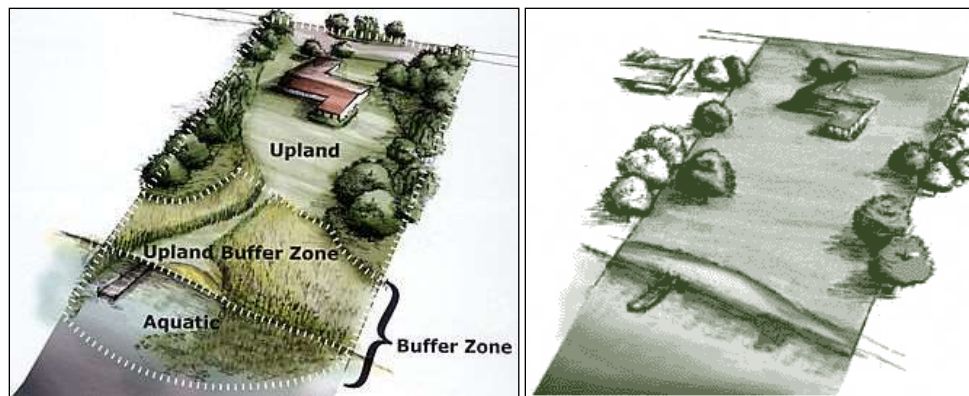


Figure 18 - Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

Some of the property surrounding Round Lake has been left natural. However, there are some areas that have been heavily developed. In these areas, the natural shoreland buffer has been disturbed which contributes negatively to lake health by preventing rainwater and snowmelt from being filtered by the native vegetation before entering the lake. Improvements to the shoreline in these areas can help lessen human impact on the lake, and many of these projects are fairly easy to do.

2010, 2016, AND 2022 WHOLE LAKE POINT INTERCEPT AQUATIC PLANT SURVEYS

A prerequisite to updating the APMP for Round Lake was to compare how the lake's vegetation had changed since the last point intercept survey. In 2010, a warm-water, whole-lake, point-intercept survey of aquatic plants was completed by the Polk County Land and Water Conservation Department. This survey was repeated in 2016 by ERS, and again 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 May 31st, early-season CLP point-intercept and bed mapping surveys were conducted. These were followed by a warm-water point-intercept 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 2010, 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, 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 1,000-point sampling grid that has been used for each survey since the WDNR's first survey following the discovery of EWM. 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 19). All visual sightings of aquatic plants within six feet of a sample point are also noted.

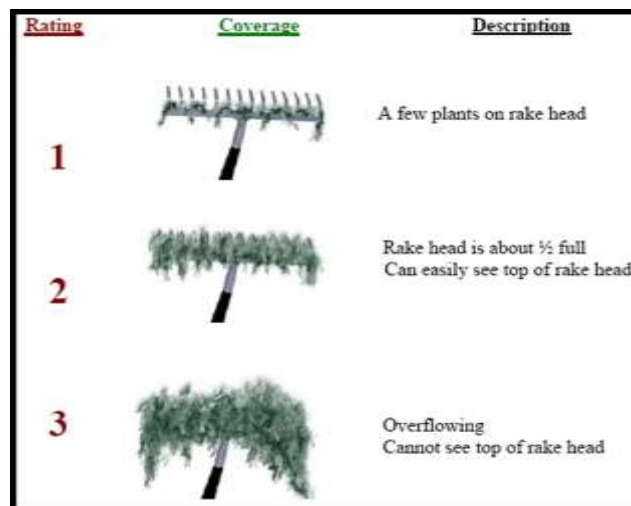


Figure 19: Rake fullness ratings (UWEX, 2010)

Depth readings taken at Round Lake's 1,000 survey points revealed the lake's northwest, northeast, and southwest bays all sloped gradually away from shore into 10ft+ while the west-central shoreline dropped off more sharply into a 15-20ft flat. Along the eastern shoreline, this drop-off into the 20ft+ flat was even more pronounced. Mid-lake, several small bars and humps interrupted the lake's otherwise fairly uniform topography (Figure 20).

The lake's bottom substrate was categorized as 43.4% pure sand (125 points), 30.9% organic and sandy muck (89 points), and 25.7% rock (74 points). Most sandy and rocky areas occurred immediately along the shoreline, on exposed points, and on the mid-lake bars and sunken islands. The only areas with muck occurred in and near the river inlet and scattered around the northwest and northeast bays (Figure 20).

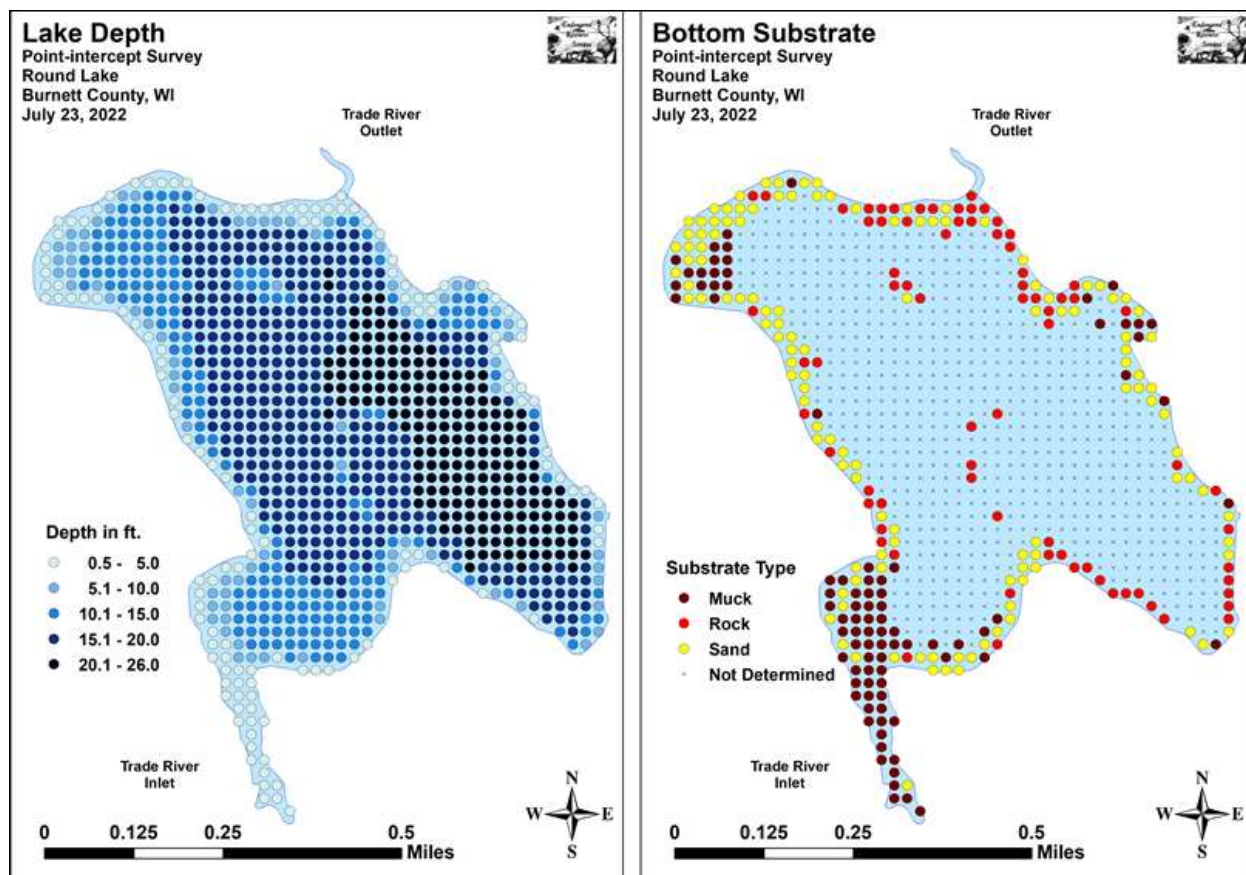


Figure 20: Lake depth and bottom substrate

During the July 2022 survey, plants were found growing in up to 9.5ft (up from 8.5ft to 2016, but down from 15.5ft in 2010) (Table 4). The 138 points with vegetation (approximately 13.8% of the entire lake bottom and 67.0% of the littoral zone) were a non-significant increase from 2016 when plants were found at 127 sites (12.7% of the entire lake bottom/70.9% of the littoral zone). The 2022 total was also higher than the 2010 survey when surveyors found plants growing at 112 points (35.2% of the littoral zone). 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 2010 (Figure 21).

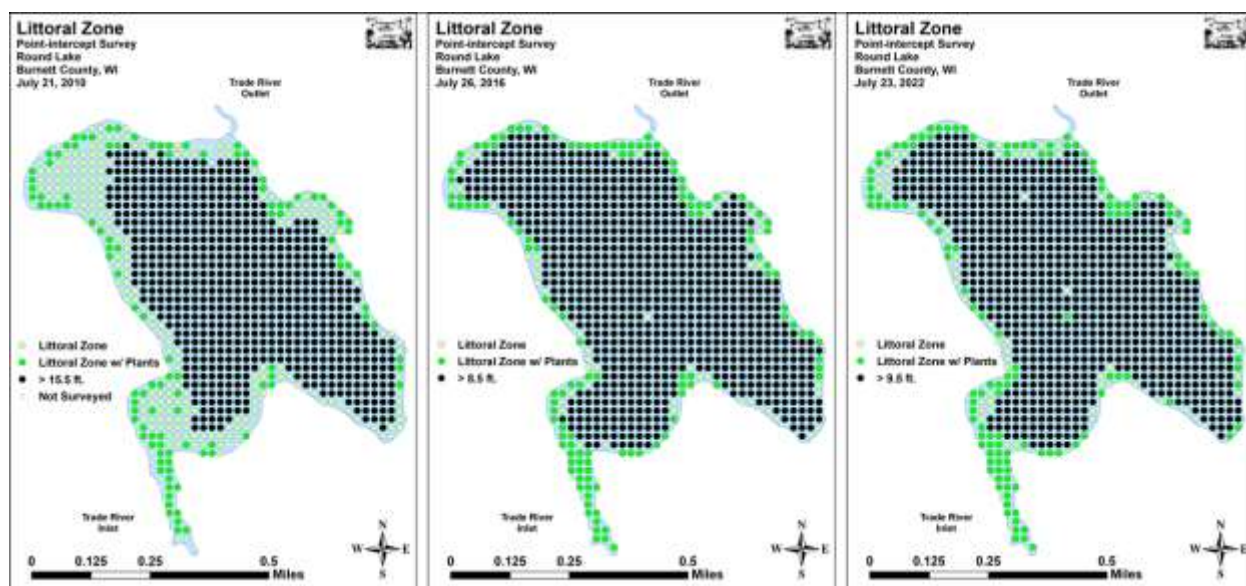


Figure 21: 2010, 2016, and 2022 littoral zone

Table 4 – 2010, 2016, and 2022 point-intercept aquatic plant survey statistics

Summary Statistics:	2010	2016	2022
Total number of points sampled	333	1,000	1,000
Total number of sites with vegetation	112	127	138
Total number of sites shallower than the maximum depth of plants	318	179	206
Frequency of occurrence at sites shallower than maximum depth of plants	35.2	70.9	67.0
Simpson Diversity Index	0.87	0.91	0.89
Maximum depth of plants (ft)	15.5	8.5	9.5
Mean depth of plants (ft)	5.5	2.8	3.0
Median depth of plants (ft)	4.0	2.0	2.0
Number of sites sampled using a rake on a rope	8	0	0
Number of sites sampled using a rake on a pole	326	288	284
Average number of all species per site (shallower than max depth)	0.78	2.08	1.87
Average number of all species per site (veg. sites only)	2.22	2.94	2.79
Average number of native species per site (shallower than max depth)	0.74	1.88	1.73
Average number of native species per site (sites with native veg. only)	2.17	2.74	2.60
Species richness	19	26	25
Species richness (including visuals)	22	28	36
Species richness (including visuals and boat survey)	27	39	41
Mean rake fullness (veg. sites only)	1.49	2.02	2.12

From 2010 to 2016, a moderately significant increase in mean native species at sites with native vegetation from 2.17/site to 2.74/site was documented. Visual analysis of the maps showed most localized increases occurred in the southwest and northwest bays (Figure 22). In 2022, a non-significant decline to a mean of 2.60 native species per site with native vegetation was recorded. Comparing the maps from the most recent surveys found most losses occurred in the northwest bay, but these were partially offset by a general increase in localized richness in and near the river inlet.

Total rake fullness experienced a highly significant increase from a low/moderate 1.49 in 2010 to a moderate 2.02 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 accessing points with dense plant growth in the river inlet that the previous surveyors excluded (Figure 23). The 2022 survey again documented an increase to a mean rake fullness of 2.12. Although this was only nearly significant, analysis of the maps suggested these increases were widespread.

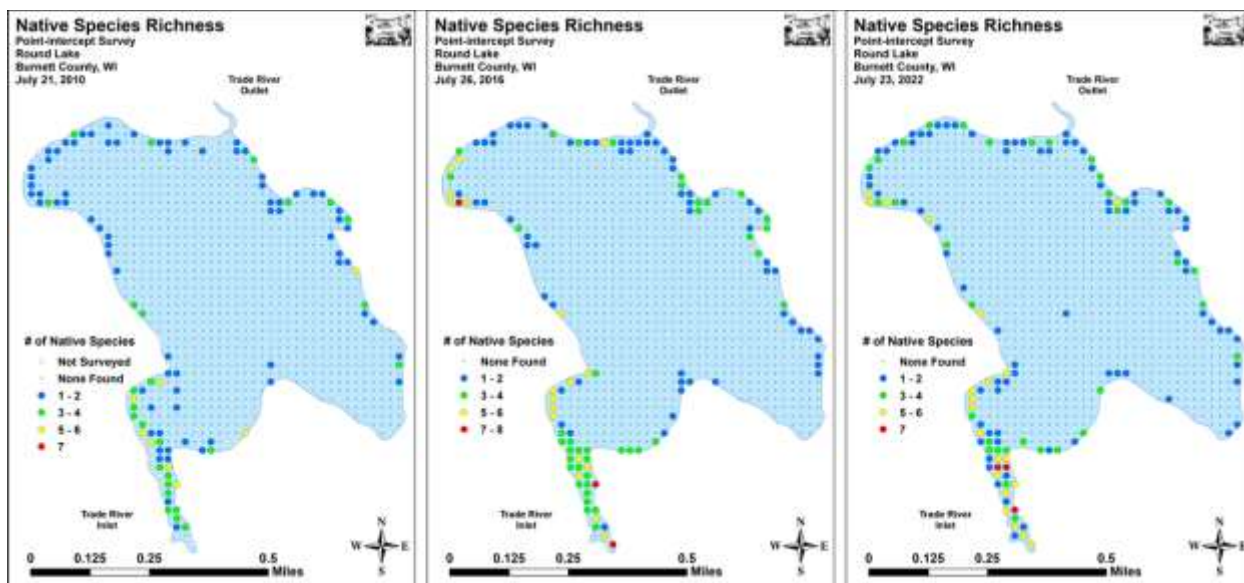


Figure 22: 2010, 2016, and 2022 native species richness

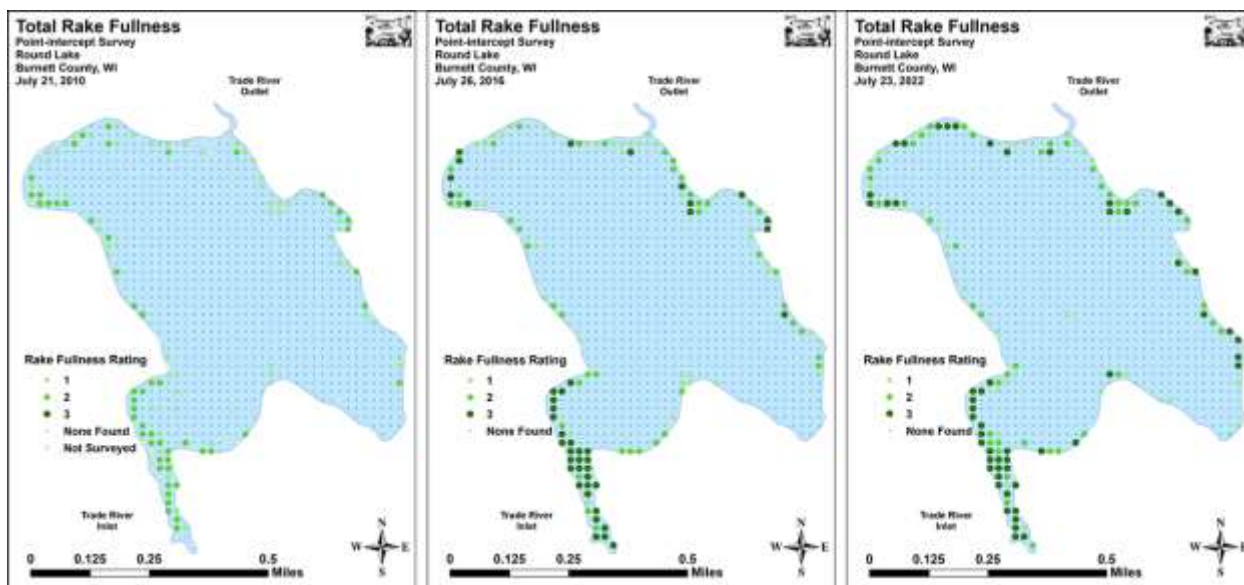


Figure 23: 2010, 2016, and 2022 total rake fullness

CHANGES IN THE AQUATIC PLANT COMMUNITY

Round Lake continues to have a somewhat limited native plant community that is dominated by lower conservatism value species which can tolerate the lake's poor water clarity. Although generally few in number, 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.

The plant survey results from 2010, 2016, and 2022 corroborate the above statement with coontail, white waterlily, common waterweed, duckweeds, and watermeal consistently being the most abundant native plant species. All are frequently found in lakes that suffer from a lack of water clarity that reduces sunlight penetration into deeper water. The good news is that the number of different species in the lake is increasing. From 2010 to 2016 the number of species identified on the rake, as a visual, or during a boat survey of the lake increased from 27 to 39 species. Some of this is likely because of different surveyors, but from 2016 to 2022 under the same surveyor, the number of species identified again went up from 39 to 41 (Table 4). Figure 24 reflects all the changes in aquatic plant species across the three surveys.

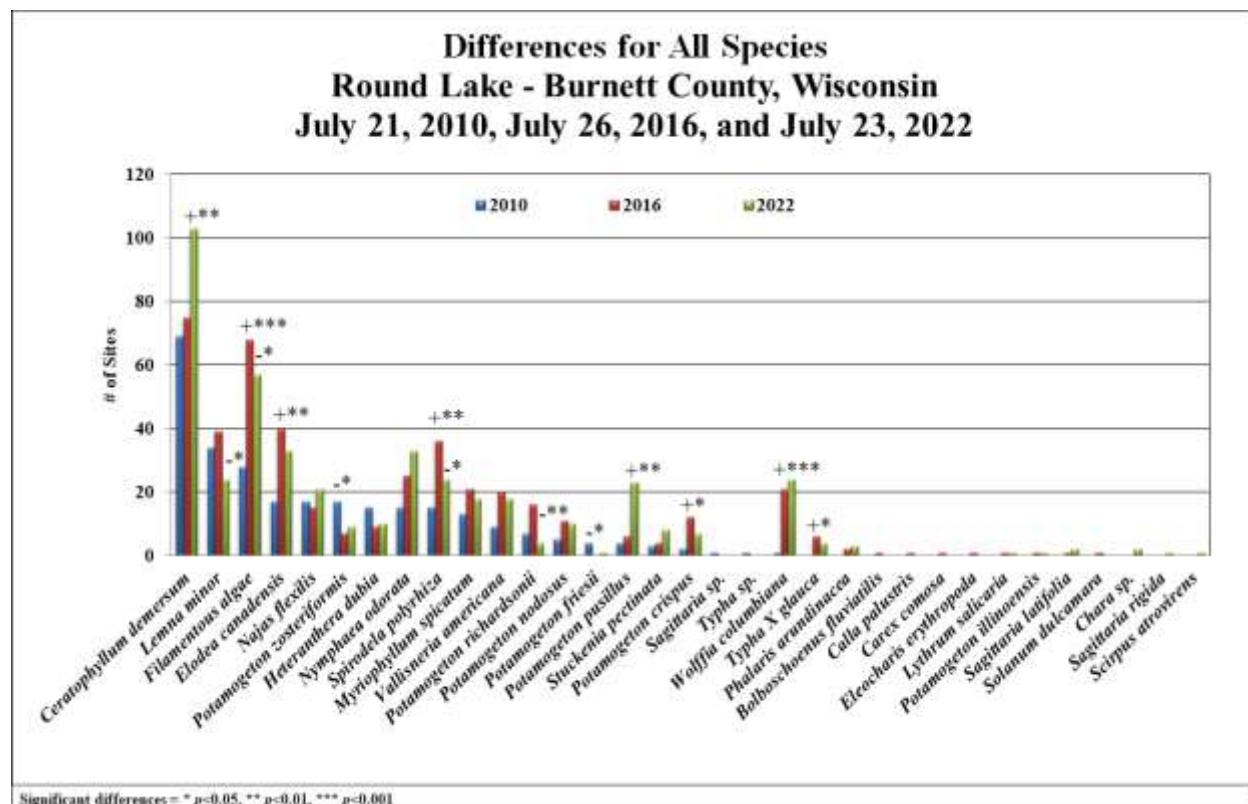


Figure 24 – Changes in aquatic plant species identified during the 2010, 2016, and 2022 PI aquatic plant surveys

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 2010 was 0.87. In 2016 the value increased to 0.91. In 2022 it declined slightly to 0.89 (Table 4).

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. Round Lake is in the North Central Hardwood Forests Ecoregion.

In 2010, 16 native index species were identified in the lake during the point-intercept survey. They produced a mean C of 5.1 and a FQI of 20.3. In 2016, 21 native index plants were identified in the lake during the point-intercept survey. They produced a mean C of 5.0 and a FQI of 22.9. In 2022, 20 native index plants were identified in the lake during the point-intercept survey. They produced a mean C of 5.3 and a FQI of 23.5, the highest values of all three surveys. Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Round Lake below average for this part of the state. The FQI was just slightly above the median FQI of 20.9 for the North Central Hardwood Forests (Nichols, 1999).

From 2016 to 2022, only five species saw significant changes in distribution. Claspingleaf pondweed underwent a moderately significant decline. Small duckweed and Large duckweed saw significant declines. Coontail and Small pondweed underwent moderately significant increases. Fries pondweed was again found on the rake, and Flat-stem pondweed, Sago pondweed, and water stargrass were found at more points than they had been in 2016, when there was some concern that chemical treatments using a contact herbicide might have harmed these species, possibly making it hard for them to recover.

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, six other exotic species were found growing in and around Round Lake: Yellow iris, Purple loosestrife, Common forget-me-not, Reed canary grass, Bittersweet nightshade, and Hybrid cattail. Yellow iris was first documented in the lake in 2016, and, despite continued attempts at removal, a well-established super cluster along with smaller nearby satellite clusters continue to grow in the northeast bay (Figure 25).

Most Purple loosestrife found was scattered around the river inlet; however, a few individual plants were also found in the northwest bay (Figure 25). Most of the plants were growing as individual stems or small isolated clusters, but, unlike in 2016, several areas in the inlet appeared to be merging into beds.

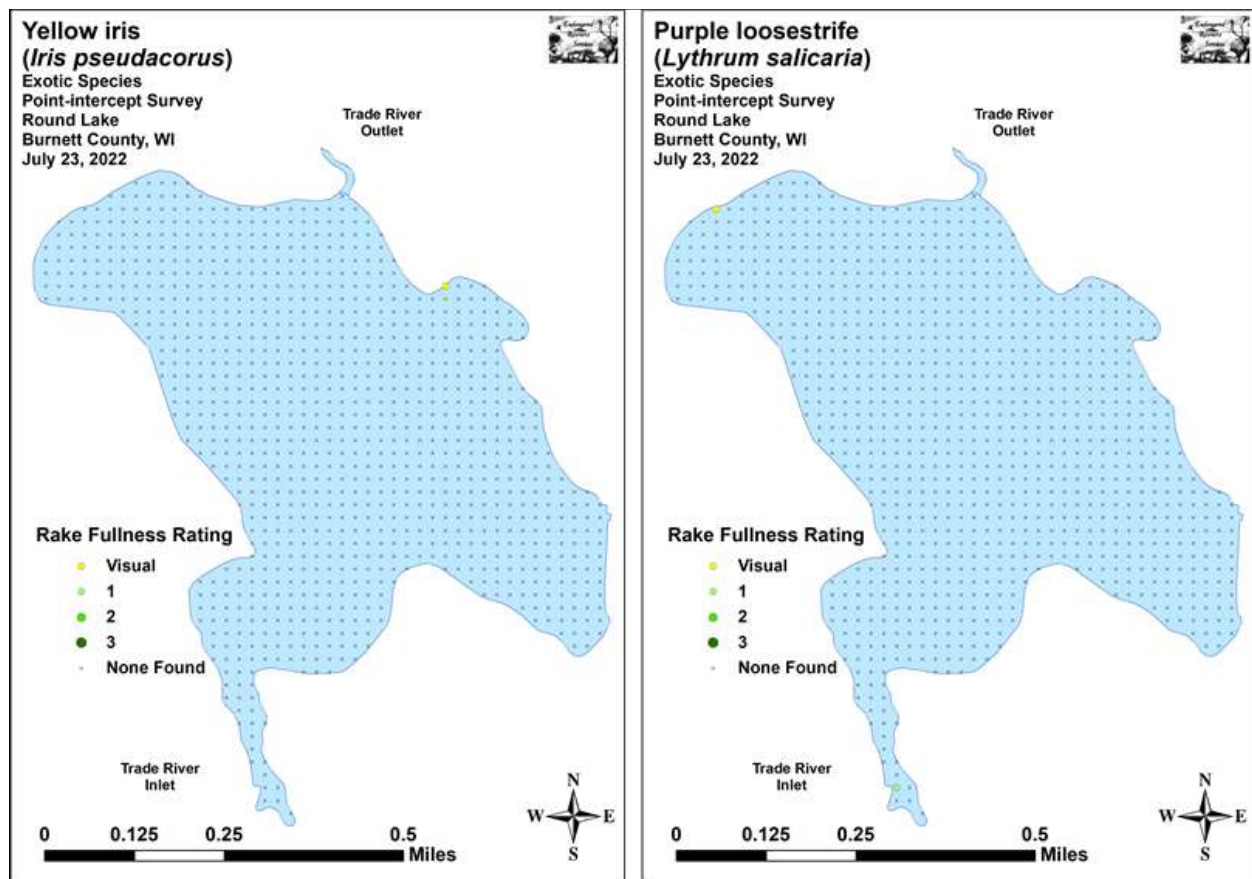


Figure 25: 2022 Yellow iris and Purple loosestrife distribution and density

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

EWM is the most problematic non-native, aquatic invasive species in the lake. It is a submerged vegetation species (rooted to the bottom of the lake and growing under the surface of the water) that has the potential to outcompete more desirable native aquatic plants. CLP is another submerged aquatic invasive species that is problematic in some lakes, but maintains enough of a presence in Round Lake to warrant watching it and implementing management if it reaches criteria set. Purple loosestrife, yellow flag iris, 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 26). 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 26: EWM complete root and stem and floating fragment with adventitious roots

CLP

Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. 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. By early July, the plant completes its life cycle, dies, and drops to the lake bottom (Figure 27). 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.

CLP spreads through burr-like winter buds (turions), which are moved among waterways (Figure 27). 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 27: CLP plants and turions

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 28) 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 28: Purple loosestrife

YELLOW FLAG IRIS

Yellow flag iris (Figure 29) 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 (*Iris versicolor*) 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 (*Typha* spp.) or sweet flag (*Acorus* spp.) 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 29: Yellow flag iris

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

Narrow-leaf Cattail (Figure 30)

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 30)

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 berms and spoil piles.

Common Reed Grass (Figure 30)

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. Its roots are stout, oval rhizomes that can reach up to six feet deep into the ground and 10 feet horizontally.

Japanese Knotweed (Figure 30)

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 30: 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 animal species could be introduced to the lakes, but have not been identified at the present time. It is important for lake property owners and users to be knowledgeable of these species in order to identify them if and when they show up.

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 and the banded mystery snails (Figure 31) 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 31: 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 Round Lake, but their presence has not been verified.

Rusty crayfish (Figure 32) 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.

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.

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.

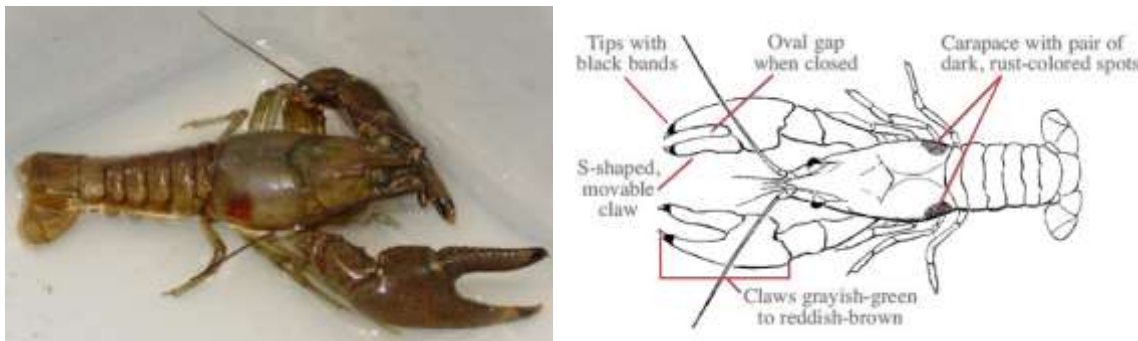


Figure 32: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels (Figure 33) 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. In this study, Round 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.

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 33: Zebra Mussels

AIS PREVENTION STRATEGY

Round Lake already has several established AIS. However there are many more that could be introduced to the lake. The RTLIA has 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 educated and informed lake residents is the best way to keep non-native AIS at bay in Round Lake. To foster this, the RTLIA and/or the new Round Lake Management District should 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 34). 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.

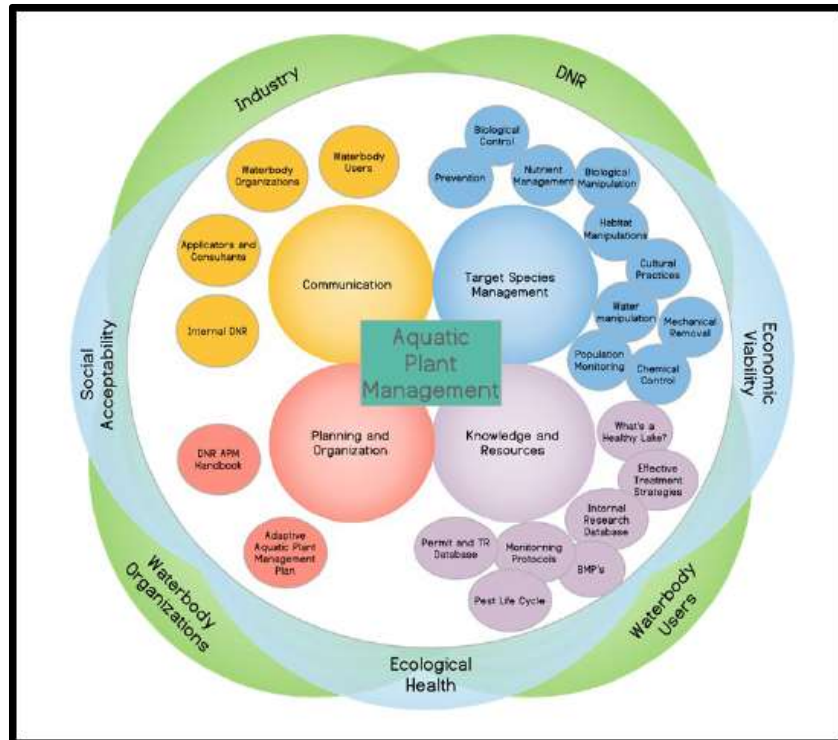


Figure 34: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

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 CLP and EWM 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. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant. It is illegal to put any chemical into waters of Wisconsin without a chemical application permit from the WDNR. Some forms of physical removal, specifically suction harvest and mechanical harvesting also require 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 WDNR permits. They may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Informed decision-making related to 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 like CLP and EWM, 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 J. , 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 J. , 2000).

Foregoing any management of EWM or CLP in Round 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 35). 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.

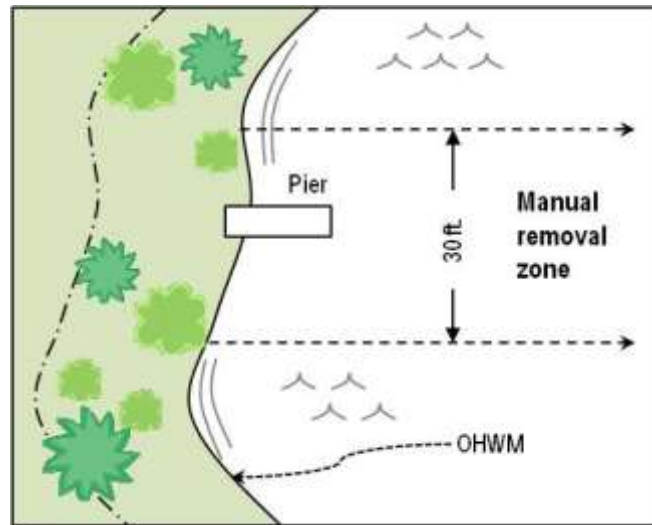


Figure 35: Aquatic vegetation manual removal zone

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 Round 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 RTLIA/RLMD 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 HARVEST

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 36). 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 36: 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 Round Lake.

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 37). 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.

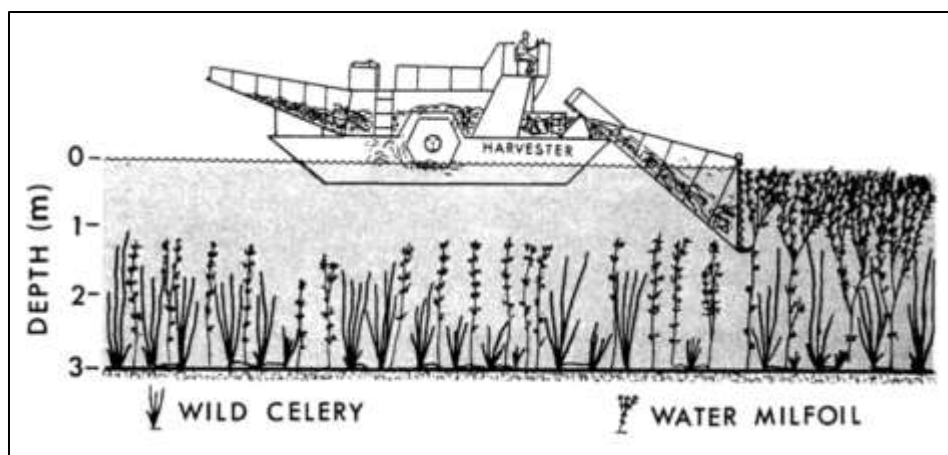


Figure 37: How a mechanical harvester works (Engle, 1987)

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 shoreline 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. There are many benefits to contracted harvesting, the biggest one being the reduced costs associated with contracting. There is no large outlay of funds for purchasing a harvester, no maintenance and storage costs, no insurance costs, and there are reduced costs or no costs if, in any given year, there is less or no harvesting completed.

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. Commercial rakes and cutters range in prices from \$200 for rakes to around \$3000 for electric cutters with a wide range of sizes and capacities. 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 38) 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 38: WaterBug remote-controlled aquatic plant harvester
(<https://lakeweederharvester.com/waterbug/>)

The WaterGator (Figure 39) 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 5 compares the two different machines.



Figure 39: WaterGator remote-controlled aquatic plant harvester
(<https://lakeweederharvester.com/watergator/>)

Table 5: 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, in their case, 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 watershed 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 watershed 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 the growth of AIS would likely 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 AIS to re-establish. Bottom barriers are typically used for very small areas and provide only limited relief. Currently the WDNR does not permit this type of control.

Creating conditions in a lake that may serve to shade out plant growth has also been tried with mixed success. The general intention is to reduce light penetration in the water which in turn 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 Round 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 Round Lake.

DRAWDOWN

Dropping the lake level to allow for the desiccation, aeration, and freezing of lake sediments has been shown to be an effective aquatic plant management technique. Repeated drawdowns lasting 4 to 6 months that include a freezing period are the most effective. Drawdowns are not an option for Round Lake as it does not have a controllable outlet.

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.

GALERUCELLA BEETLES

Two species of *Galerucella* beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 40). 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 40: 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 Round 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.

EWM WEEVILS

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. *Eubrychiopsis 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. 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.

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, treatment 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 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 Aquathol K and Aquathol Super K 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 projects 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 Application

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, longer. 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 42). 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 43).



Figure 42: Limno-curtain material on a roll before installation (photo from Marinette Co. LWCD)



Figure 43: 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 44 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.

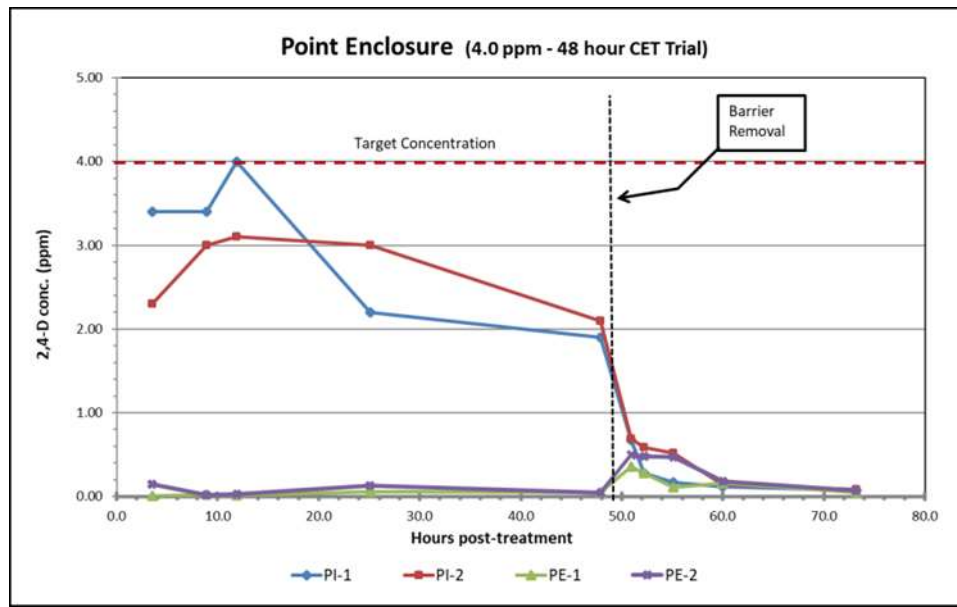


Figure 44: Herbicide concentration results from 2020 Thunder Lake limno-curtain trial (Marinette Co LWCD)

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 also very 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. In addition, 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 monocots 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 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 in the same field, 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 did the target of 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.

Management in Round Lake has been focused on a well-established population of EWM. EWM was first found in Round Lake in 2003, and was left essentially unmanaged until the initial APM Plan was written in 2011. By this time, EWM had pretty much gained a foothold in most of the littoral zone within Round Lake (Figure 45).



Figure 45: 2011 and 2012 fall EWM bed mapping

The 2011 APM Plan made it possible to start managing EWM in 2012. Since that time, EWM has been chemically treated annually except for 2019 and 2022. After the 2018 chemical treatment, EWM was almost non-existent in the lake that fall, for this reason, no chemical treatment of EWM was planned in 2019 (Table 6). CLP was chemically treated for the first time in 2019 (Table 6). Table 7 provides more detail about what was treated and how. It also briefly describes the result of each year's treatment on the target species and native aquatic vegetation.

Table 6 - Management on Round Lake, 2011-2023

AIS Management on Round Lake, 2011-2023													
Task	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
APM Plan	X						X						X
AIS Control Grant		X	X	X	X	X	X	X	X				
AIS Planning Grant												X	X
AIS Rapid Response Grant													
Spring EWM Treatment (acres)		5.96	15.74	5.68	4.08	4.13	4.84	8.86	0	9.7	4.41	0	9.11
Fall EWM Bed Mapping	X	X	X	X	X	X	X	X	X	X	X		P
EWM Physical Removal		X	X	X	X	X	X	X	X	X	X	X	X
CLP Bed Mapping		X				X					X	X	
Spring CLP Treatment (acres)	NA	NA	NA	NA	NA	NA	NA	0	3	0	0	0	0
Pre-treatment Plant Survey		X	X	X	X			X	X	X	X		
Post Treatment Plant Survey		X	X	X	X			X	X	X	X		
Whole-lake PI Survey		X				X						x	

X= Completed, P=Proposed

Table 7 – Herbicide treatments on Round Lake from 2012-2023

Year	# of Beds	Total Area Treated (acres)	Range of Bed Size	Herbicide	Concentration	Results- AIS	Results- Native Plants
2012	7	5.96	0.24-1.55	Granular 2,4-D	0.92 acres @ 4.0 ppm 5.04 acres @ 3.0ppm	EWM- Significant decrease	Coontail, Wild celery, Water star-grass, and Sago pondweed- Significant increases. All others- No changes.
2013	21	15.74	0.11-2.13	Liquid 2,4-D	15.74 acres @ 3.0ppm	EWM- Significant decrease	Common waterweed, Wild celery, White water lily, and Water star-grass- Significant increases. All others- No changes
2014	5	5.68	0.24-1.79	Liquid 2,4-D Granular 2,4- D	5.44 acres @ 3.0 ppm 0.24 acres @ 4.0 ppm	EWM- less than ideal due to high water	Wild celery, White water lily, Slender naiad- Significant increases, All other- No changes
2015	8	4.08	0.11-1.48	Liquid 2,4-D Granular 2,4- D	3.03 acres @ 3.5 ppm 1.05 acres @ 3.5-4.0 ppm	EWM- Significant decrease	Common waterweed, Claspingleaf pondweed, and wild celery- Significant increases, All other- No changes
2016	4	4.16	0.15-2.9	Diquat	2 gal/acre*ft	No decrease in EWM	Significant decrease in CLP
2017	4	4.84	0.8-1.59	Liquid 2,4-D	1.39 acres @ 3.5ppm 3.45 acres @ 4.0ppm	EWM significant decrease	No pre/post treatment survey completed
2018	4	8.86	1.03-3.27	Liquid 2,4-D	4.0ppm	EWM significant decrease	No significant decreases, 6 species increase
2019	0	0	NA	NA	NA	EWM significant	
	CLP 4	3	0.25-1.47	liquid endothal	2.0ppm	Decrease in CLP	No significant decreases, 5 species increase
2020	6	9.7	1.23-2.12	Liquid 2,4-D	3.5ppm	EWM significant decrease	No significant decreases, 8 species increase
2021	4	4.41	0.87-1.45	Liquid 2,4-D (limnocortain)	4.0ppm	EWM significant decrease	No significant decreases, 8 species increase
2022	0	0	NA	NA	NA	EWM significant increase (PI Survey)	No pre/post treatment survey completed
2023	6	9.11	1.01-2.26	Liquid 2,4-D (3beds) ProceliaCOR (1bed)	8.01 acres @ 4ppm 1.01 acres @ 5pduis (P-COR)	pending	No pre/post treatment survey completed

Fall EWM bed mapping was completed in every year between 2011 and 2021. It was skipped in 2022; however a summer point-intercept survey was completed. EWM bed mapping is planned for 2023, but has not been completed yet. Table 8 reflects the results of bed mapping. It is clear, that herbicides with the active ingredient 2,4-D work to reduce the acreage of EWM in the lake on a seasonal basis, but have not demonstrated longer than seasonal results except after the 2018 chemical treatment where almost no EWM was found in the fall of 2018 except in the outlet area of the lake. This led to no chemical management of EWM in 2019.

Table 8: Fall EWM bed mapping on Round Lake from 2011 to 2021

Bed Number	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
Merged 1-6	3.03	2.06	3.68	1.93	1.24	5.66	2.16	-	-	-	-
1 and 1A/AA	0	0	0.10	0	0.17	Merged	0	0	0	0.52	1.91
2	0.68	0.04	0.06	0	0.14	Merged	0	0.16	0.10	0.47	0.74
3 and 3A/AA	1.51	1.67	2.66	1.82	0.59	Merged	1.55	1.81	1.00	2.58	3.57
4	0.08	0.13	0.19	Merg. w/3	Merg. w/3	Merged	Merg. w/3	Merg. w/3	0.11	0.68	0.63
5	0.46	0.12	0.26	0.02	0.06	Merged	0.49	0.26	0	0.46	1.21
6	0.30	0.10	0.41	0.09	0.28	Merged	0.11	0.06	0	0.43	0.61
7 and 7A	0.58	0.46	<0.01	0	0.28	0.78	0.65	0.05	0	0.80	1.73
8	0.37	0.16	0.71	0.25	0.52	0.57	0.43	0.23	0	0.19	0.55
9	0.15	0	0.02	0	0.06	0	0	0	0	0.20	0.26
10	0.07	0	0.08	0	0	0	0	0	0	0.06	0.11
11	0	0	0	0	0	0	0	0	0	0.06	0.11
12	0	0	0	0	0	0	0	0	0	0	0.13
13	0.56	0.06	0.05	0	0.25	0.08	0.28	0	0	0.44	1.04
14 and 14A/AA	0	0.17	0.02	0	0.39	0.19	0.06	0.07	0	0.39	0.92
15A	0.03	0.01	0	0	0	0.01	0.04	0	0	0	0
15	0.04	0	0	0	0	0	0	0	0	0.12	0.27
16	0	0	0	0	0	0	0	0	0	0.09	0.26
17	0	0	0	0	0	0	0	0.10	0	0.15	0.46
18	0	0	0	0	0	0	0	0	0	0	0.13
19A/AA/AAA	0.47	0.04	0.04	<0.01	0.03	0.27	0.03	0.46	0.19	1.15	2.27
20	0	0	0	0	0	0	0	0	0.01	0.05	0.10
Total Acres	5.31	2.95	4.60	2.18	2.76	7.57	3.65	3.20	1.41	8.84	17.01

2021 LIMNO-CURTAIN INSTALLATION

The outlet area of the lake is a difficult place to use aquatic herbicides. Water flow out of the lake is substantial in this area making maintaining an appropriate target species/applied herbicide contact time difficult to maintain. In 2021, a limno-curtain was installed on either side of the outlet and extended out into the lake past the proposed treatment areas (Figure 46 & 47) in an attempt to slow down the movement of water through the treated areas and out of the lake. Both herbicide concentration testing and pre and post treatment aquatic plant surveys were completed along the north shore of Round Lake within the two treated areas adjacent to the outlet.

PRE AND POST-TREATMENT AQUATIC PLANT SURVEY

From these beds, Lake Education and Planning Services (LEAPS) generated 20 survey points within the proposed treatment area around the outlet that would reflect the plant community before and after chemical treatment with liquid 2,4-D (Figure 46). Each survey point was located in the field using a handheld mapping GPS unit (Garmin 76CSx), and a rake was used to sample an approximately 2.5ft section of the bottom. All 20 sites had vegetation in both the pre and post survey. After the treatment, the mean coefficient of conservatism and the Floristic Quality Index (measures of native plant community health) rose. The average number of species, the average number of native species, and the overall species richness rose in the post treatment survey as well. These results indicate that the plant community changed and improved after the treatment.

EWM was present at 16 of 20 sites during the pretreatment survey (80%) coverage with 2 additional visual sightings. This produced a mean rake fullness rating of 2.2 and suggested that 70% of the treatment area had a significant EWM infestation. During the posttreatment survey, EWM was present at 3 sites (15% coverage) with an average rake fullness of 1.7. These results demonstrate a significant decline in rake fullness and distribution in EWM.

HERBICIDE CONCENTRATION TESTING

Herbicide concentration testing was performed to determine the effectiveness of using the limno-curtain barriers at increasing herbicide contact time. Volunteers collected samples west of the outlet, east of the outlet, and downstream approximately 475 feet at the Highway 48 road crossing (Figure 46). Samples were collected at 1, 4, 8, 16, 24, and 36 hour intervals at the three sites for a total of 18 samples (Table 2). The Wisconsin State Lab of Hygiene processed the samples.

To severely damage EWM enough to provide control, concentrations of 2,4-D need to be between 2-4 ppm (parts per million). The herbicide was applied at a rate of 4ppm, and within 1 hour was 15% of its original concentration at the sampling sites west and east of the outlet (Figure 48). This indicates that the herbicide was being taken up by plants and simultaneously being washed down stream as shown by a 0.94ppm reading at the outlet downstream of the application site. These results indicate that after 1 hour, the concentration of 2,4-D was no longer at an effective concentration at the sampling sites. However, the long term exposure of lower concentrations over the course of at least the 36 hour concentration sampling period was effective in controlling EWM. This is evidenced by the fact that a month later, EWM was significantly reduced in the treatment area.

Without comparing these data to previous studies at the site using limno-curtain barriers, it is not possible to discern whether the barriers effectively increased the herbicide contact time. Thus, further studies at this location using limno-curtains to assess their effectiveness at increasing herbicide contact time are recommended.

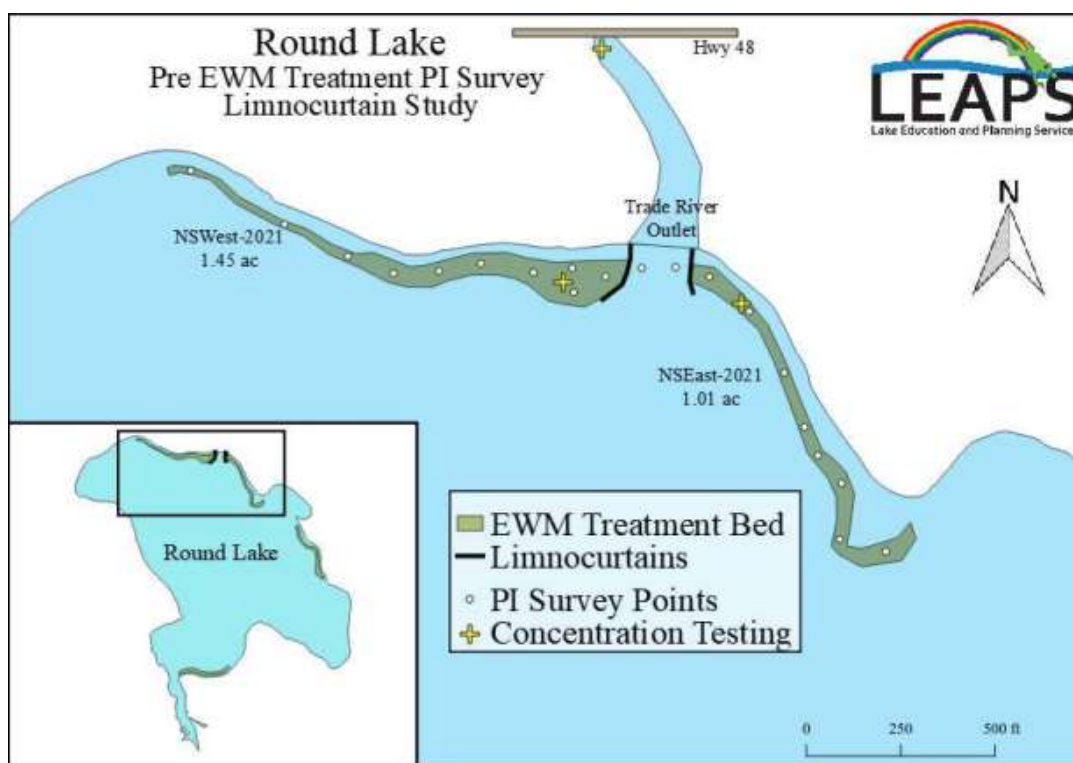


Figure 46: 2021 installation of a limno-curtain



Figure 47: Volunteers installing the 2021 limno-curtain at the out of Round Lake

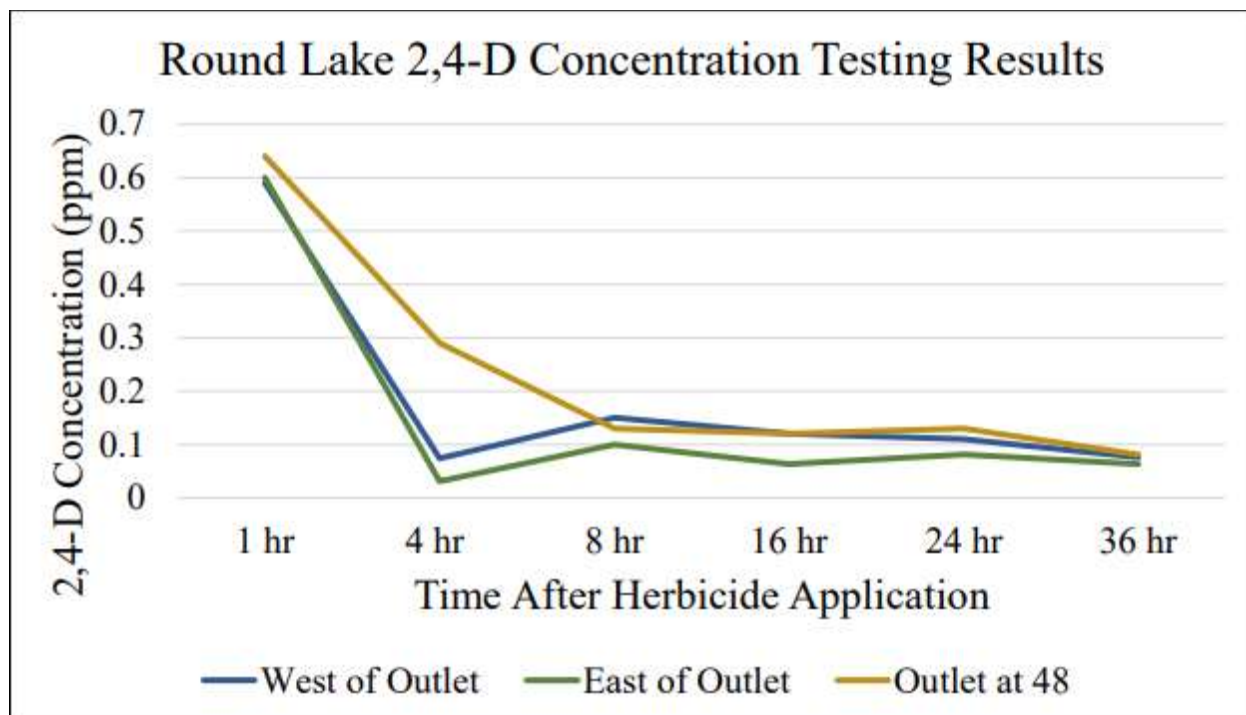


Figure 48: 2021 Round Lake 2,4-D concentration testing results

MANAGEMENT DISCUSSION

EWM

The littoral (plant growing) zone of Round Lake in 2016 was approximately 40 acres, approximately 20% of the total surface area (208 acres). In 2022 the littoral zone was approximately the same. Since 2012, the first year of chemical treatment of EWM on the lake, the amount of EWM in Round Lake as identified by fall bed-mapping surveys has average about 3.97 acres. Under the first APM Plan (2012-2016) the average amount of EWM in the fall was 4.92 acres. Under the recently expired APM Plan (2017-2022) the average amount of EWM was 3.56 acres. These values represent a little more than 10% of the littoral zone.

The frequency of occurrence of EWM in the littoral zone of the lake was 4.09% in 2010, 11.73% in 2016, and 8.74% in 2022. While the 2022 value is better than the 2016 value, it is still more than twice as high as what the frequency of occurrence in 2010 was. The goal for EWM in this new APM Plan is to bring the frequency of occurrence back down to 2010 values or lower. A frequency of occurrence of 4.09% equates to about 13 points or 2.7 acres with EWM. The goal in the last APM Plan was to keep the level of EWM in Round Lake as identified in a fall bed mapping survey, below 2.75 acres of the littoral zone (6.9%) in any given year. Although this goal was met in only one year since 2017, it is still reasonable when incorporating a scenario-based management approach.

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 Sand 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 goal of the RTLIA and the Round 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 RdL volunteers.
- 3) Areas of EWM with sparse, isolated plants will be hand pulled or raked by volunteers in shallow water (\approx 3 feet) around docks and along shorelines.
 - a. These services 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 of EWM will 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 lake organization, 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 of EWM 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, and 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 <5.00 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 3-5pdus/acft.
 - ii. Suggested application rates for 2,4D or triclopyr-based herbicides would be 4ppm/acft depending on size (larger treatment areas could be managed with <4ppm/acft.
 - iii. Treatments >5 acres using ProcellaCOR 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.
 - iv. Treatments >9 acres using any aquatic herbicide may have a lakewide impact so the following monitoring is required.
 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) (see next Section).

Installation of a Limno-curtain

The installation of a limno-curtain would likely improve the results of EWM management, particularly when using liquid 2,4D products. However, the curtain should be installed all the way around or nearly all the way around any treatment areas adjacent to the outlet of the lake. Moreover, the curtain should be constructed in such a way that there are fewer gaps between the posts that keep the curtain in place during and after the treatment. An example of material that could be used is shown in Figure 49.



Figure 49: Limno-curtain material

CLP

In a Technical Review of the literature available discussing CLP (*Potamogeton crispus*/*P. crispus*), 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.

CLP – SCENARIO BASED MANAGEMENT

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 Round 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 volunteers in shallow water (≈ 3 feet) around docks and along shorelines.
 - a. These actions 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 actions would likely be contracted by the lake organization (but could be done by RdL 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 lake organization, can be completed at any time during the open-water season, and require a WDNR Mechanical Harvesting permit.
 - b. Can be completed at any time prior to when turions are set
 - c. DASH requires 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. Single or combined area treatments >10.0 acres 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

Round Lake volunteers will continue to monitor the shoreline for purple loosestrife, removing what is found if possible. Round Lake volunteers will 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.

Round Lake 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 has never been quantified in Round Lake. At some point during the implementation of this 5-year plan, the amount of CWH will be quantified and willing property owners sought for the installation of one or more CWH/Fishsticks projects. Increasing the level of CWH in the lake would likely improve the overall fishery in the lake.

SHORELAND IMPROVEMENT

As increasing nutrients and sediment to the lake is a concern and has led to Round Lake being placed on the EPA/State of Wisconsin Impaired Waters list. Making improvements to the nearshore area around the lake and upstream of the lake in the Trade River could benefit the lake. Information on small-scale, grant eligible projects for interested property owners can be found at <https://healthylakeswi.com/>

WATER QUALITY

It is recommended that Round Lake volunteers to collect basic water quality data through the Citizen Lake Monitoring Network (CLMN) expanded water quality monitoring program. This program begins with the collection of water clarity data, but can be expanded to include temperature and oxygen profiling, and collection of water samples to be analyzed for total phosphorus and chlorophyll a. It would also be beneficial to determine water and nutrient budgets for the lake.

A water budget is an accounting of all the water that flows into and out of a project area. This area can be a wetland, a lake, or any other point of interest. Development can alter the natural supply of water and severely impact an area, especially if there are nearby ponds or wetlands. A water budget is needed to determine the magnitude of these impacts and to evaluate possible mitigation actions. Components of a water budget include: precipitation, evaporation, evapotranspiration, surface runoff, and groundwater flow. The first three terms of the water budget equation, precipitation, evaporation, and evapotranspiration, are natural processes that are largely unaffected by development. However, changes in land use can significantly affect surface runoff and groundwater flow. For example, commercial development may intercept surface runoff that ran into a wetland and redirect it to a stormwater control basin. This stormwater basin may hold the water until it evaporates or release it to an outlet stream. In either case, the wetland is deprived of the surface runoff that was available before the development. Similarly, water supply wells can permanently lower groundwater levels and change flow directions.

The calculation of a nutrient budget is an essential step in the evaluation of a lake's trophic status. A nutrient budget provides a means to evaluate and rank nutrient sources that may contribute to algal problems. It is most important to determine the quantity of nutrients (especially phosphorus) entering the lake, as well as the

ultimate fate of those nutrients. Components of a nutrient budget include: tributary loading and discharge; atmospheric loading; direct surface runoff; septic leachate and groundwater loading; groundwater phosphorus, and internal release of phosphorus from the sediment of the lake.

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 Round Lake.

- 1) Objective 1 – Keep level of EWM to below 2.75 acres as indicated by annual summer littoral point-intercept surveys of aquatic vegetation
 - a) Action – Implement a scenario-based, integrated pest management approach to EWM control.
- 2) Objective 2 – Minimize negative impacts caused by dense growth CLP
 - a) 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 - 200 hours annually with grant funding
 - b) Action - Volunteer hours only without grant funding
- 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 Round Lake.

- 1) Objective 1 – Implement State of Wisconsin Healthy Lakes Initiative
 - a) Action – Complete a Shoreland Habitat Assessment on Round Lake
 - b) Action - Promote Healthy Lakes projects based on the results of the Shoreland Habitat Assessment
 - c) Action – Apply for Healthy Lake grant funding to support projects that improve shoreland habitat and reduce runoff into the lake

Goal 4 – 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 Round Lake
 - a) Action – Continue involvement in the Citizen Lake Monitoring Network (CLMN)

- b) Action – Purchase a Temp/DO meter to support water quality testing on Round Lake
- 2) Objective 2 – Complete Annual Project Activity and Assessment Reports
 - a) Action – The RTLIA 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 RTLIA and WDNR to determine following year management actions.

Goal 5 – 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 6 – Implement the 2024-28 Round 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, Burnett County, Town of Trade Lake, local businesses, contractors, and other resources to support management actions
- 2) Objective 2 – Keep lake residents are informed about plan activities
 - a) Action – Continue supporting Round Lake involvement in the RTLIA
 - b) Action – Continue reaching out to the lake constituency to inform and seek input for management actions
- 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 RLMD to move forward with aquatic plant management actions that will maintain the health and diversity of Round 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 RTLIA/RLMD 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 RLMD 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 action completed in 2023 was covered by the RTLIA. Future management actions could be supported by WDNR Surface Water grant funding should the RLMD 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 RLMD. 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 E lists several outside resources that the RLMD could partner with to implement the actions in this plan.

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Appendix A- Round Lake Goals, Objectives, and Actions

Appendix B- Funding and Implementation Matrix

Appendix C- Calendar of Actions

Appendix D- WDNR Dredging Exemption Checklist