Lake Education and Planning Services, LLC
PO Box 26
Cameron, Wisconsin 54822

UPPER TURTLE LAKE, BARRON COUNTY

2023-2027 Aquatic Plant Management Plan
WDNR WBIC: 2079800

Prepared by: Dave Blumer, Lake Educator
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Upper Turtle Lake District
Turtle Lake, WI 54829

Distribution List

No. of Copies	Sent to
1	John Vono Upper Turtle Lake District Vonoj02@outlook.com 651-472-3560
1	Alex Smith Wisconsin Department of Natural Resources Alex.smith@wisconsin.gov 715-416-0249
1	Austin Dehn Wisconsin Department of Natural Resources Austin.dehn@wisconsin.gov 715-919-8059

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PREPARED FOR THE UPPER TURTLE LAKE DISTRICT

1.0 Introduction

Upper Turtle Lake (UTL) is a hard water drainage lake located in west-central Barron County, Wisconsin. The health and quality of the native plant community is above average, with a floristic quality that ranks in the upper quartile on a statewide and regional basis. Curly-leaf pondweed (CLP), an aquatic invasive species (AIS), was documented for the first time in 2010, but had likely been in the lake much longer than that. Up to and through the early years past 2010, CLP seldom occurred as monotypic beds and appeared to enhance early season habitat in the lake by providing fish forage and cover areas. In 2017, the CLP population exploded to more than 130 acres, significantly larger and more monotypic, then anything that had been documented before.

The first Aquatic Plant Management (APM) Plan for UTL was completed in 2010. The goal for CLP was to simply monitor its spread in the lake. With the increase in CLP levels in 2017, the Upper Turtle Lake District (UTLD) recognized the need for a coordinated strategy to actively manage CLP and other aquatic invasive species, and to prevent the introduction of new invasive species. The original APM Plan was updated in 2017 to guide a more aggressive CLP management plan between 2018 and 2022. From 2018 to 2021, the UTLD implemented a large-scale, chemical treatment program to bring CLP back to or below levels documented in 2010.

This document is an update of the 2018-22 APM Plan. The new APM Plan covers management recommendations from 2023 to 2027. It includes a review of the management activities completed from 2018 to 2022 and the impact they had on CLP, native aquatic plants, water quality, and other aspects of lake health. It also includes aquatic plant management goals, objectives, and actions for the next five years (2023-27).

1.1 Upper Turtle Lake District

In 2017, the Upper Turtle Lake Association began the steps necessary to become a Lake Management District. A Lake District is a specialized unit of government designed to manage the lake. A Lake District has the ability to tax property within the district. A lake district is a governmental body with statutory responsibilities to the resource, local citizens, and taxpayers. Like all government entities, the powers and operations of a lake district are set by law with legal responsibilities and consequences designed to ensure that the rights and interests of the public are protected. Lake Districts have a unique blend of powers and governance provisions tailored to fit the needs of local lake communities. A Lake District's day-to-day operations are carried out by a board of commissioners composed of elected volunteers and local officials. The financial direction of the Lake District is determined by Lake District residents and property owners at an annual meeting.

After multiple public meetings and discussions, the Upper Turtle Lake Association became the Upper Turtle Lake District and since 2018 has been the main management organization for UTL. The purpose of the UTLD is to preserve, protect, and enhance Upper Turtle Lake and its surroundings for today and future generations. The UTLD has a webpage at https://www.upperturtlelake.com and a Facebook page at https://www.facebook.com/UpperTurtleLakeDistrict. The UTLD holds its annual meeting in August each year. UTLD Commissioner Meetings are held approximately every two months and are open to the public.

1.2 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.

1.3 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 1). 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.

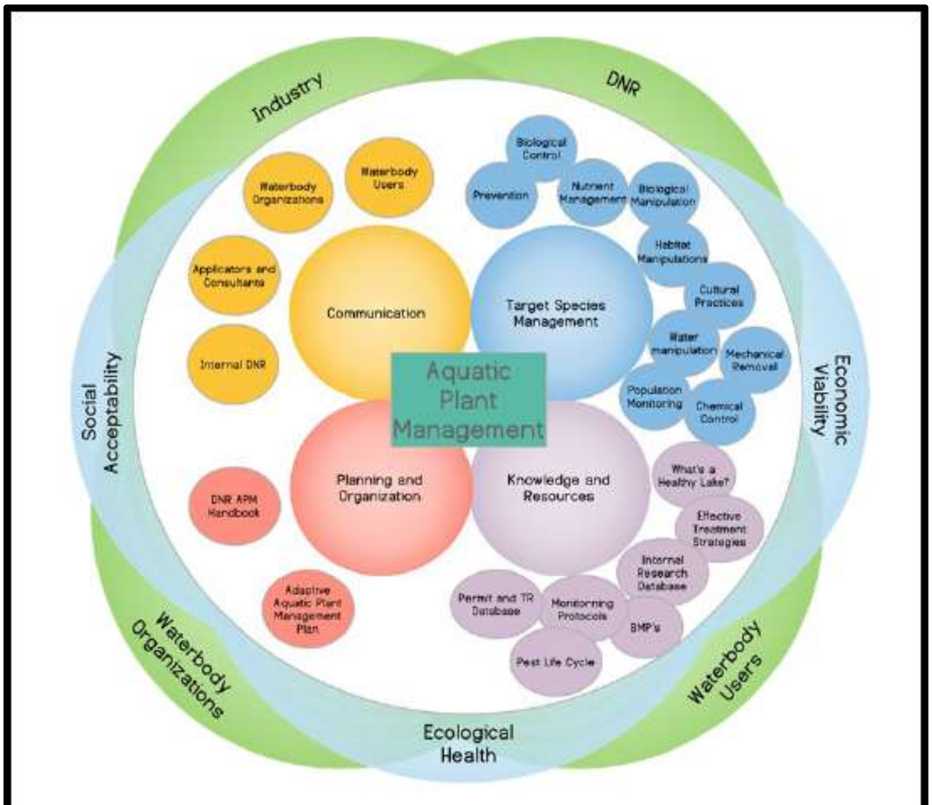


Figure 1: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

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.

2.0 Public Participation and Stakeholder Input

3.0 Overall Management Goal

The overall management goal for UTL between 2023 and 2027 is slightly different than the overall management goal between 2018 and 2022. From 2018 to 2022 the main goal was to bring the amount of CLP in UTL back to levels that were documented in 2010 – from 130 plus acres in 2017 back to around 10 acres documented in 2010. By doing so, it was expected that the overall health and usability of UTL would be enhanced or improved. From 2023 to 2027, the goal is similar in that the overall health and usability of the lake is more important than ever, however, the goal is no longer to reduce the amount of CLP in the lake, but rather to maintain it at the lower levels reached after four years of intensive management; and at the same time, focus on enhancing or improving the native aquatic plant community and water quality which will lead to the lake's better health and usability. More discussion about this overall goal is included in Section 10.0 and in Appendix A.

The following is a list of the individual goals for this new APM Plan. More information about these goals can be found in Section 11.0 and in Appendix B.

Goal 1: <u>CLP Management.</u> Maintain CLP at or below 2022 (and 2010) levels through environmentally responsible management methods that will minimize negative impacts to the native plant community.

Goal 2: <u>AIS Education and Awareness.</u> Continue to educate property owners and lake users on aquatic invasive species through public outreach and education programs to help contain existing AIS in and around the lake and new AIS that could get introduced to the lake.

Goal 3: <u>Research and Monitoring.</u> Develop a better understanding of the lake and the factors affecting lake water quality through continued and expanded monitoring efforts.

Goal 4: <u>Adaptive Management.</u> Follow an adaptive management approach that measures and analyzes the effectiveness of control activities and modifies the management plan as necessary to meet goals and objectives.

This five-year plan is intended to be a living document which can be modified from time to time to ensure goals are being met. Minor changes and adaptations are expected and may be made annually, but any major change in activities or management philosophy will be presented to the UTLD and the WDNR for approval.

4.0 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.

4.1 Watershed

A watershed is an area of land from which water drains to a common surface water feature, such as a stream, lake, or wetland. The UTL watershed covers 2,117 acres which includes the 427 acre lake area (Figure 2).

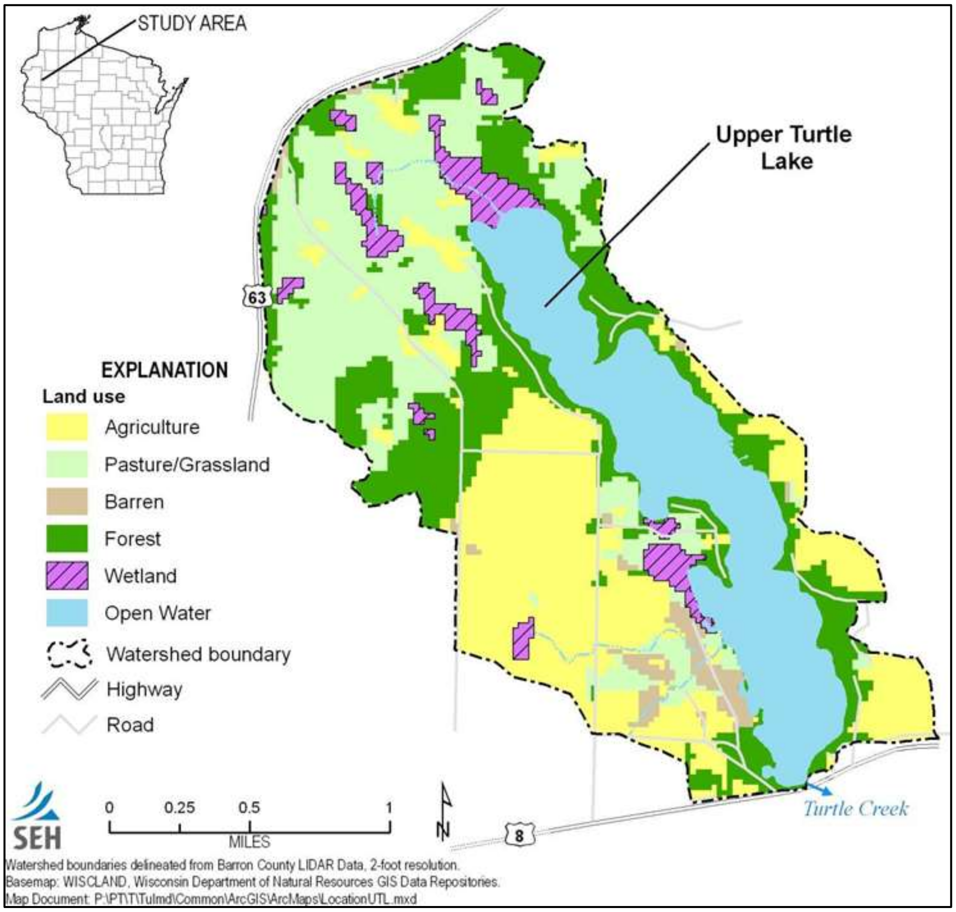


Figure 2: Upper Turtle Lake watershed - location and land use

The UTL watershed is part of the Hay River (HUC 0705000706) watershed which is a part of the even larger Red Cedar River watershed (HUC 07050007) (Figure 3). UTL is the headwaters of Turtle Creek which exits from the south end of the lake, flows through Lower Turtle Lake, and eventually ends up in the Hay River well south.

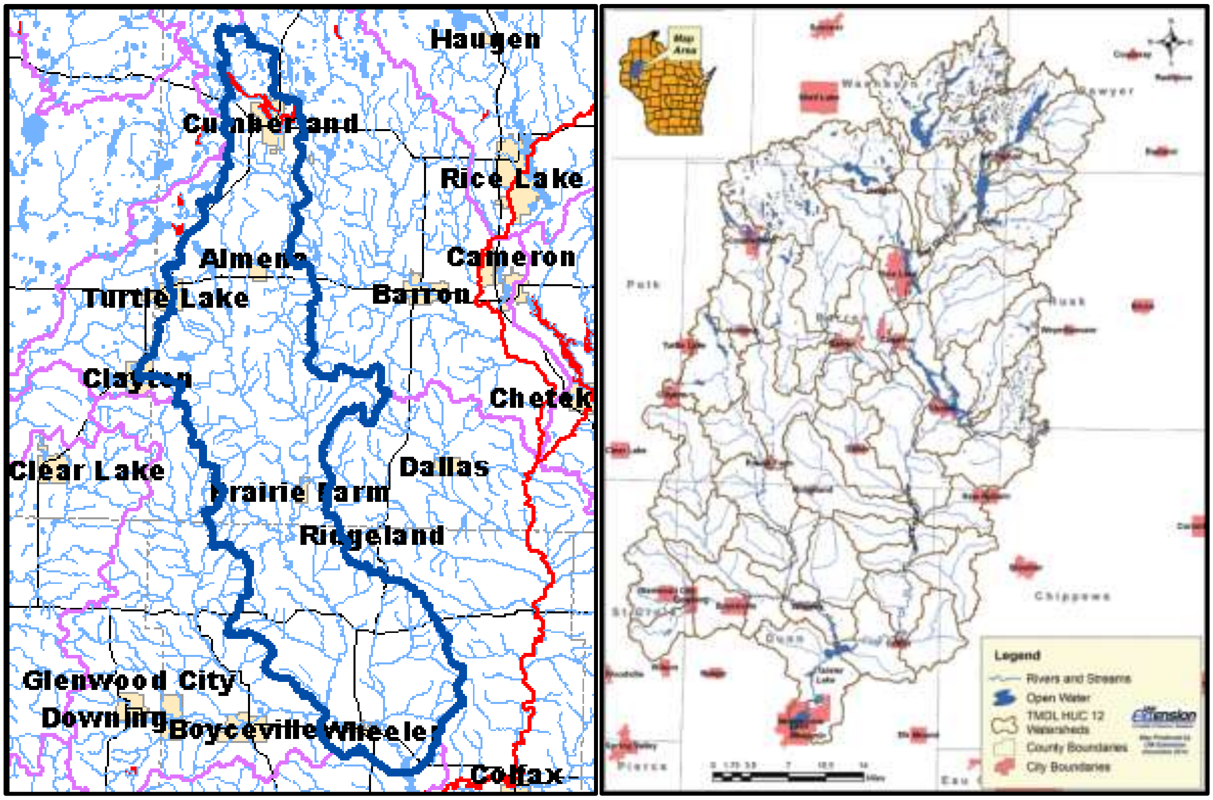


Figure 3: Left- Red Cedar River Watershed *(Red Cedar River Water Quality Partnership, 2015)* **Right- Hay River Sub-watershed** *(WDNR, 1996)*

Land use in the UTL watershed is primarily classified as agricultural (row crops, pasture, etc.) and a mix of forests, wetlands, and barrens (Figure 2). Agricultural land use covers nearly 50% of the watershed and consists primarily of large-scale row cropping. Residential areas make up a relatively small portion of the land use; however, the majority of residential areas are concentrated around the lakes in the watershed leading to more immediate and likely greater impacts to water quality than areas located further away from the lakes.

Land cover and land use management practices within a watershed 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 UTL and its tributary streams.

4.2 Physical Characteristics

Upper Turtle Lake is a drainage lake in west-central Barron County, Wisconsin about 2.5 miles east of the Village of Turtle Lake. The lake covers 427 acres, has a maximum depth of 26 feet and an average depth of 14-ft, and 7.37 miles of shoreline. The north basin is relatively shallow while the south and central basins are a fair bit deeper. Because of this, most of the north basin is part of the littoral zone (area of a lake that supports aquatic plant growth). More of the littoral zone exists in a narrow band around the rest of the lake (Figure 4).

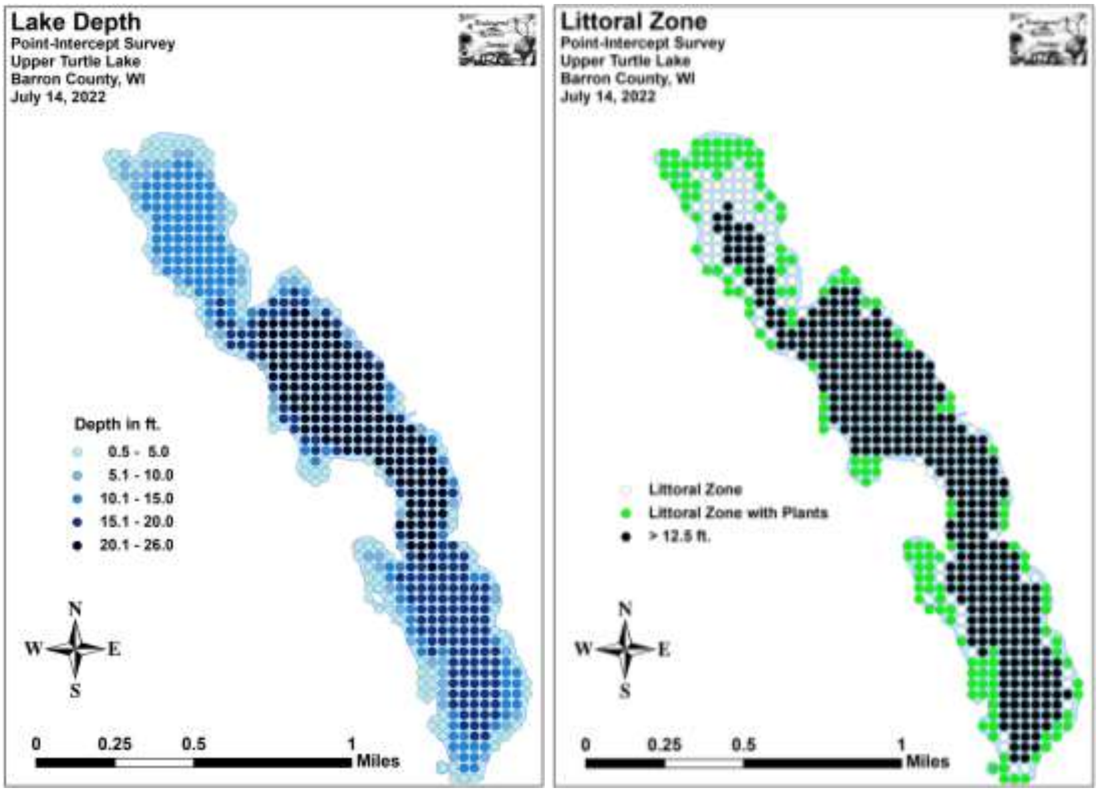


Figure 4: 2022 Depth and Littoral Zone of Upper Turtle Lake

The majority of the lake bottom consists of muck with some rock and sand interspersed throughout (Figure 5).

Figure 5: Lake Substrate in 2022

4.3 Water Quality

4.3.1 Impaired Waters Listing

Every two years, Sections 303(d) and 305(b) of the Federal Clean Water Act (CWA) require states to publish a list of all waters not meeting water quality standards. Assessing surface water quality throughout the state is the responsibility of the Wisconsin Department of Natural Resources (WDNR) through the Wisconsin's Consolidated Assessment and Listing Methodology (WisCALM). WisCALM uses available data to determine impairments based on two categories: natural (fish and aquatic life, FAL) and recreational (human/full body emersion activities, REC). A lake can exceed state standards in either or both of these categories and designations are generally based on the concentration of total phosphorus (TP), the nutrient that supports aquatic life; and the concentration of chlorophyll-a (Chla), a measurement used to determine the biomass of algae in the water. Both are measured in micrograms per liter (µg/L). WisCALM provides guidance on the assessment of water quality data against surface water quality standards set for the state (WI-DNR, 2021).

The Wisconsin acceptable standard for summer TP in the REC category for natural inland lakes like UTL is a mean concentration ≤30 µg/L (Figure 6). The WisCALM assessment protocol for Chla is based on the number of days in a sampling season (July 15-September 15) that have moderate algal levels based on Chla concentrations that exceeds 20µg/L. Once that level has been exceeded, the amount of algae in the surface water it represents discourages people from swimming (Figure 7). If the concentration of Chla exceeds 20µg/L for more than 5% of the expected lake use days, then the water is considered impaired.

Since 1999, TP has been sampled 77 times from April to October. Almost 78% (60/77) of those samples have results >30µg/L. The average TP concentration was 42.7µg/L ranging from as low as 14.0µg/L (June 2002) to as high as 119µg/L (August 2017). Since 1999, Chla has been sampled 37 times between July 15 and September 15. Just over 59% (22/37) of those samples have had results >20µg/L, clearly exceeding the 5% of lake use days trigger for an impaired water. The average Chla concentration over that time was 29µg/L ranging from as low as 1.4µg/L (July 2002) to as high as 75.7µg/L (August 2022).

Figure 6: Wisconsin numeric water quality standards for phosphorus *(WDNR, 2018)*

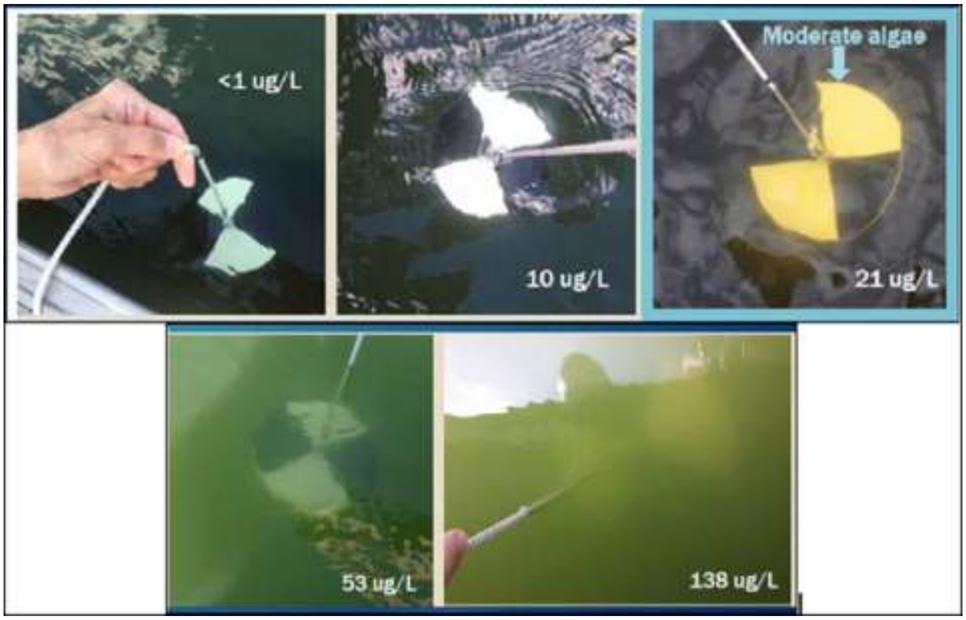


Figure 7: Chl-a concentrations and the corresponding water clarity as measured by a Secchi disk *(WDNR, 2018)*

UTL was first placed on the Impaired Waters List for "excess algae growth" in 2014. It remains on the 303d list as the last WisCALM assessment in 2022 found that TP and Chla sample data exceeded WisCALM listing thresholds for both REC and FAL. Likely sources for phosphorus in the lake are shoreland and watershed runoff, internal loading from the sediments, and CLP die off and senescence mid-summer.

4.3.2 Red Cedar River Watershed (Tainter and Menomin Lakes) TMDL

The Red Cedar River Watershed currently has an approved TMDL and Management Plan to reduce phosphorus loading to make water quality improvements in Tainter and Menomin Lakes. A TMDL is a plan for restoring impaired waters that identifies the maximum amount of a pollutant, in this case phosphorus, which a body of water can receive while still meeting water quality standards. Within that management plan, it states that "Some lake management techniques have the potential to decrease the amount of available phosphorus in Tainter and Menomin Lakes. These include not only local practices designed specifically to benefit these two lakes but also those benefiting upstream lakes in the watershed if those practices result in reduction of phosphorus leaving the lake and entering the watershed" (Red Cedar River Water Quality Partnership, 2015). Upper Turtle Lake, Turtle Creek, Lower Turtle Lake, and the Hay River are included in the Management Plan for Tainter and Menomin Lakes, as such there may be resources available through it to help with management actions in UTL.

4.4 Water Quality Data

The Citizen Lake Monitoring Network[1] (CLMN) is a water quality monitoring partnership between the WDNR, 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 (TP and Chla); collect temperature and dissolved oxygen

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

data; and monitor for the first appearance of aquatic invasive species near boat landings, other access points, or along the shoreline. Volunteers on UTL have been collecting CLMN water quality data since 1994. From 1994-1998 only water clarity data was collected using the Secchi disk. In 1999, volunteers started collecting water quality chemistry including TP and Chla. There are a few gaps in data between 1994 and 2022, but for the most part monitoring has been fairly consistent.

4.4.1 Secchi Readings of Water Clarity

Since 1994, there has been a consistent, but not alarming trend in water clarity from average annual readings close to 7-ft in the 1990's and early 2000's to closer to 6-ft in the late 2010's early 2020's (Figure 8). The Secchi average over that time was 6.70ft. Approximately 35% of all Secchi readings of water clarity collected by volunteers were better than the average annual reading. Water clarity during the open water season follows a common pattern. April water clarity may be somewhat reduced by ice out and turnover and runoff into the lake during snowmelt. May and June present the best water clarity. Water clarity begins to worsen in July, with August and September being the worst. By October, water clarity begins to improve again (Figure 9).

This pattern is primarily driven by water temperature – with cooler water unable to support abundant algae and aquatic plant growth (except for CLP) through June. Also through June, dense or abundant CLP (Figure 10) growth can interfere with the growth of native aquatic plants. In July, two things happen – the water continues to warm, and CLP dies and senesces releasing phosphorus into the water. The warmer water and increase in phosphorus leads to the rapid growth of algae in August and September reducing aquatic vegetation to floating leaf plants - like lily pads (Figure 11). Plants like coontail, duckweed, and watermeal (Figure 11) that are not rooted to the bottom of the lake and can pull their needed nutrients from the lake water also do well.

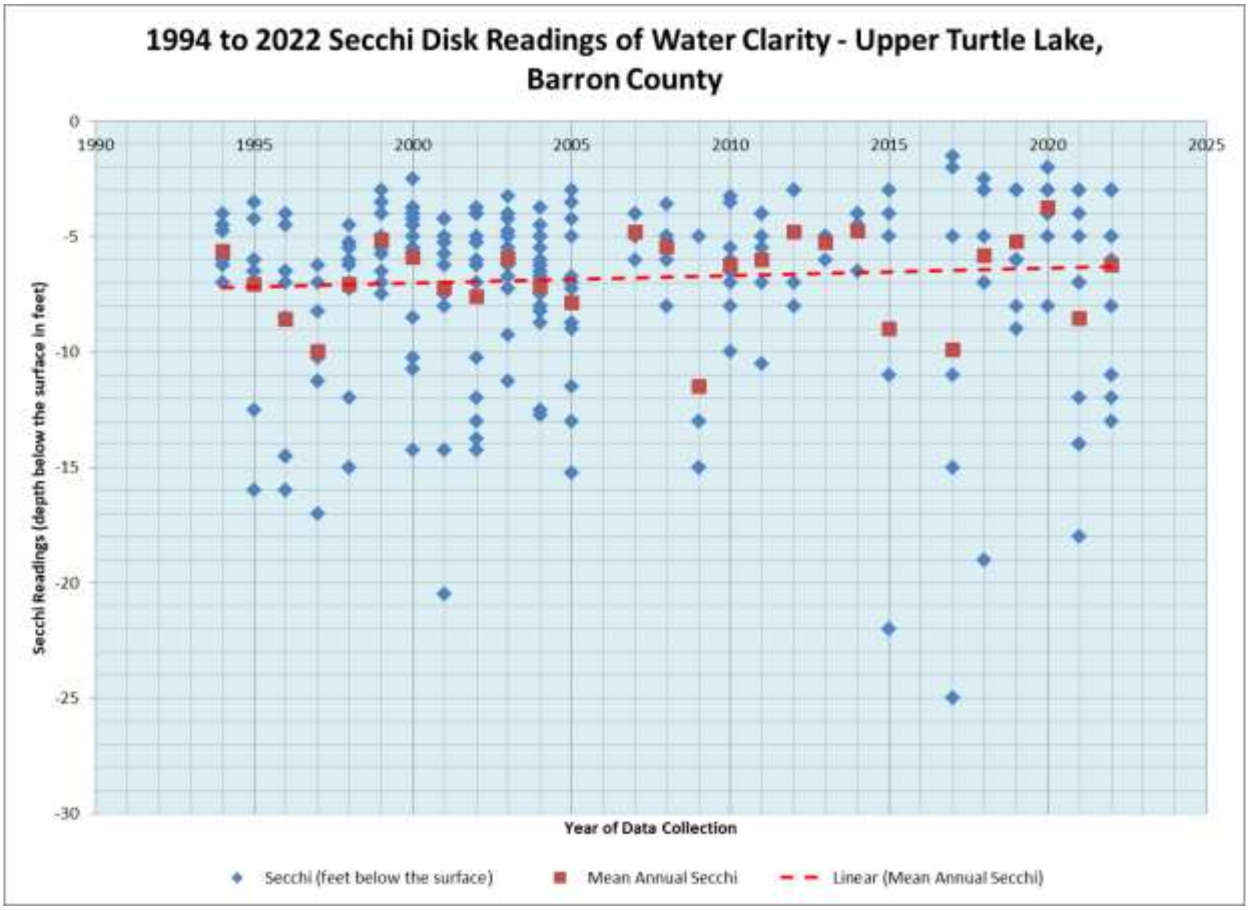


Figure 8: 1994 – 2022 Secchi depth readings, average annual readings, and trend line

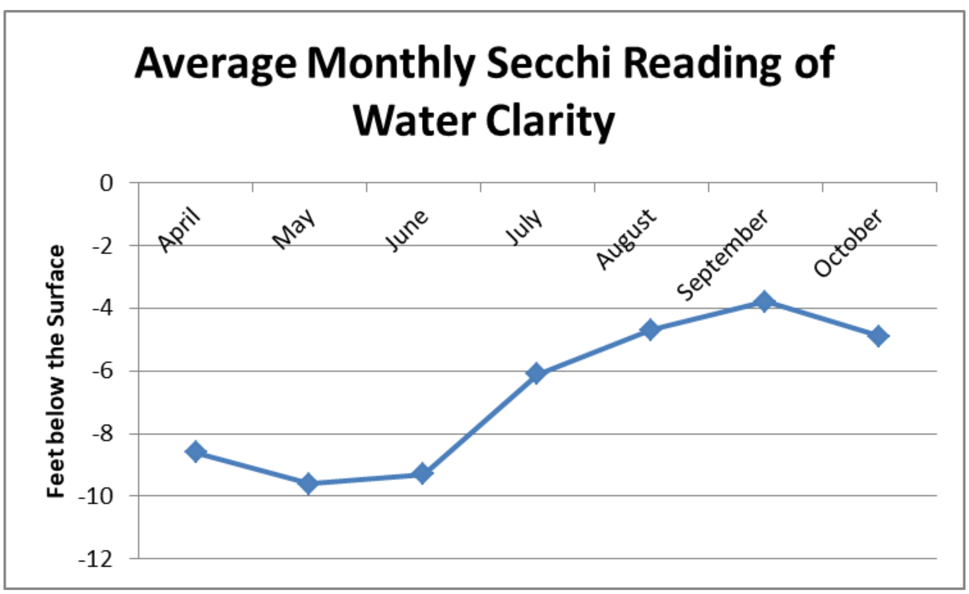


Figure 9: Average monthly Secchi depth readings of water clarity (based on all 1994-2022 CLMN data)

Curly-leaf pondweed (USGS 2017)

Figure 10: Curly-leaf Pondweed (CLP)

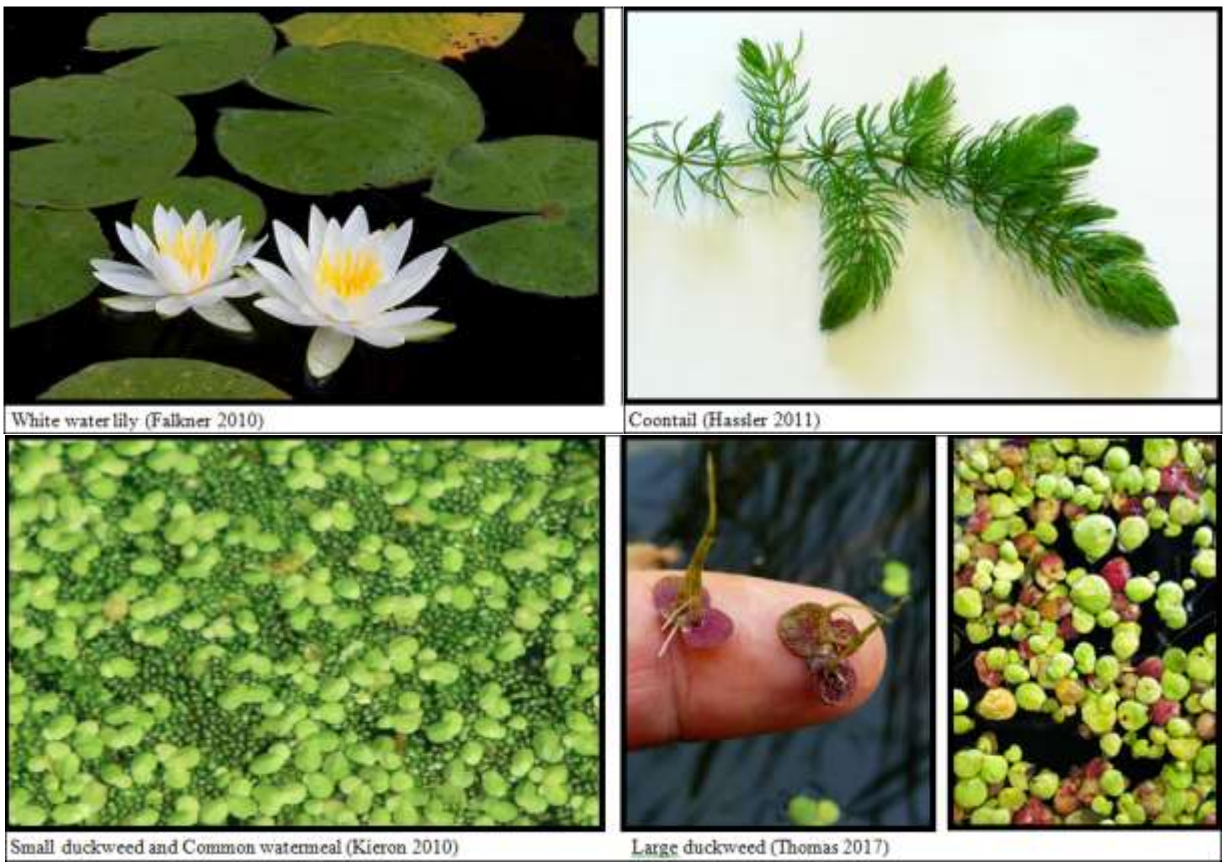


Figure 11: Aquatic plants that do well in lakes with low water clarity (Berg, 2017)

4.4.2 Water Chemistry – TP and Chla

The water chemistry data shows the most noticeable decline in water quality. Since 1999, there has been a steady increase in both TP and Chla concentration in the lake. There are blocks of data from 2000 to 2005, from 2010 to 2015, and from 2017-2022 (Figure 12). There is a definite increase from the early 2000's to the early 2010's, and another definite increase from the early 2010's to the late 2010's and early 2020's. 2017 was the worst year on record for water quality with large spikes in both TP and Chla. 2017 was also the year when 130+ acres of CLP were mapped in the lake and no management was completed.

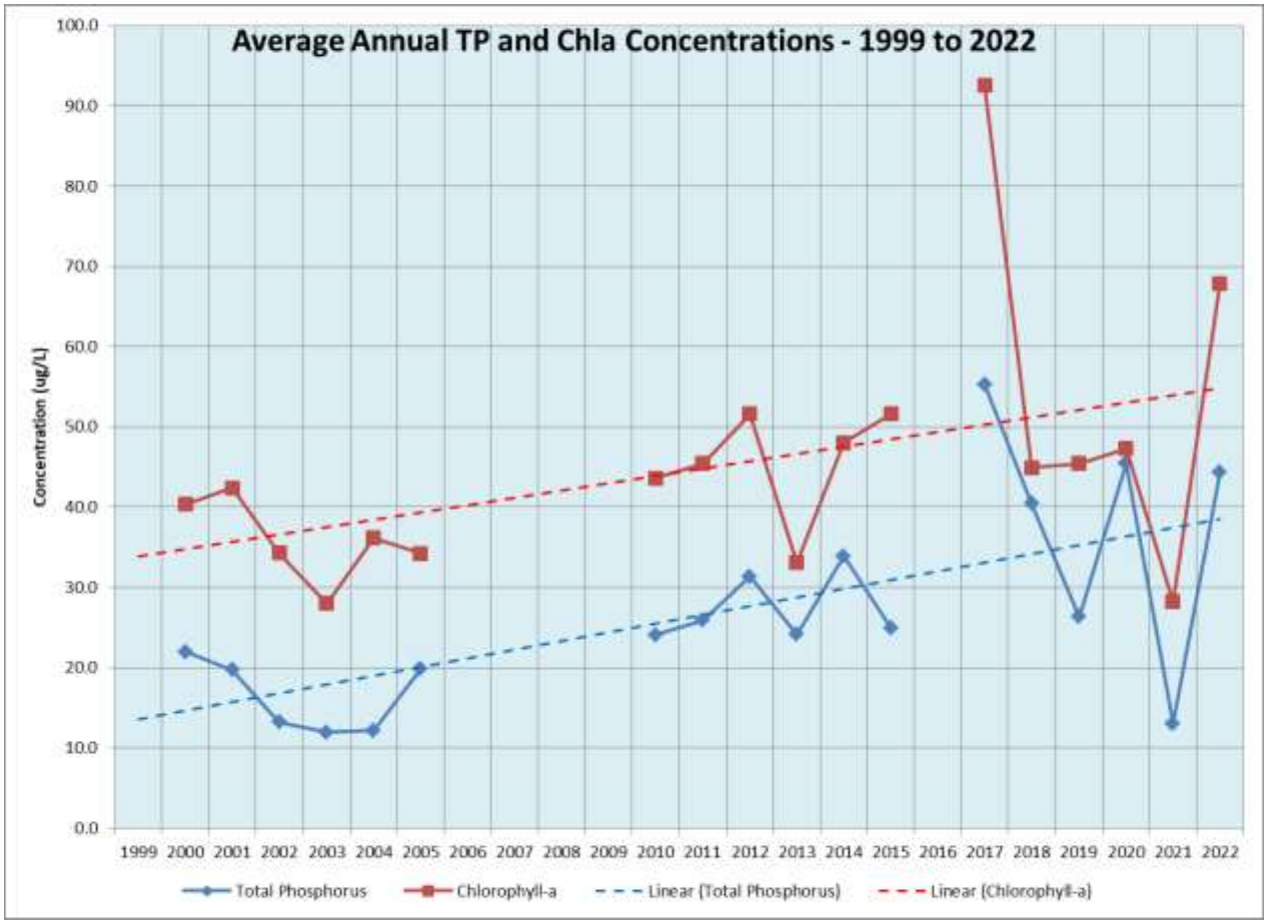


Figure 12: Average annual TP and Chla concentrations plus trend lines

Monthly concentrations of TP and Chla follow a similar pattern to that if the Secchi disk readings of water clarity. Concentrations start off low in the spring and early summer, and then increase sharply in July, reaching their peak in September. As the water cools down in October the concentrations go down again (Figure 13).

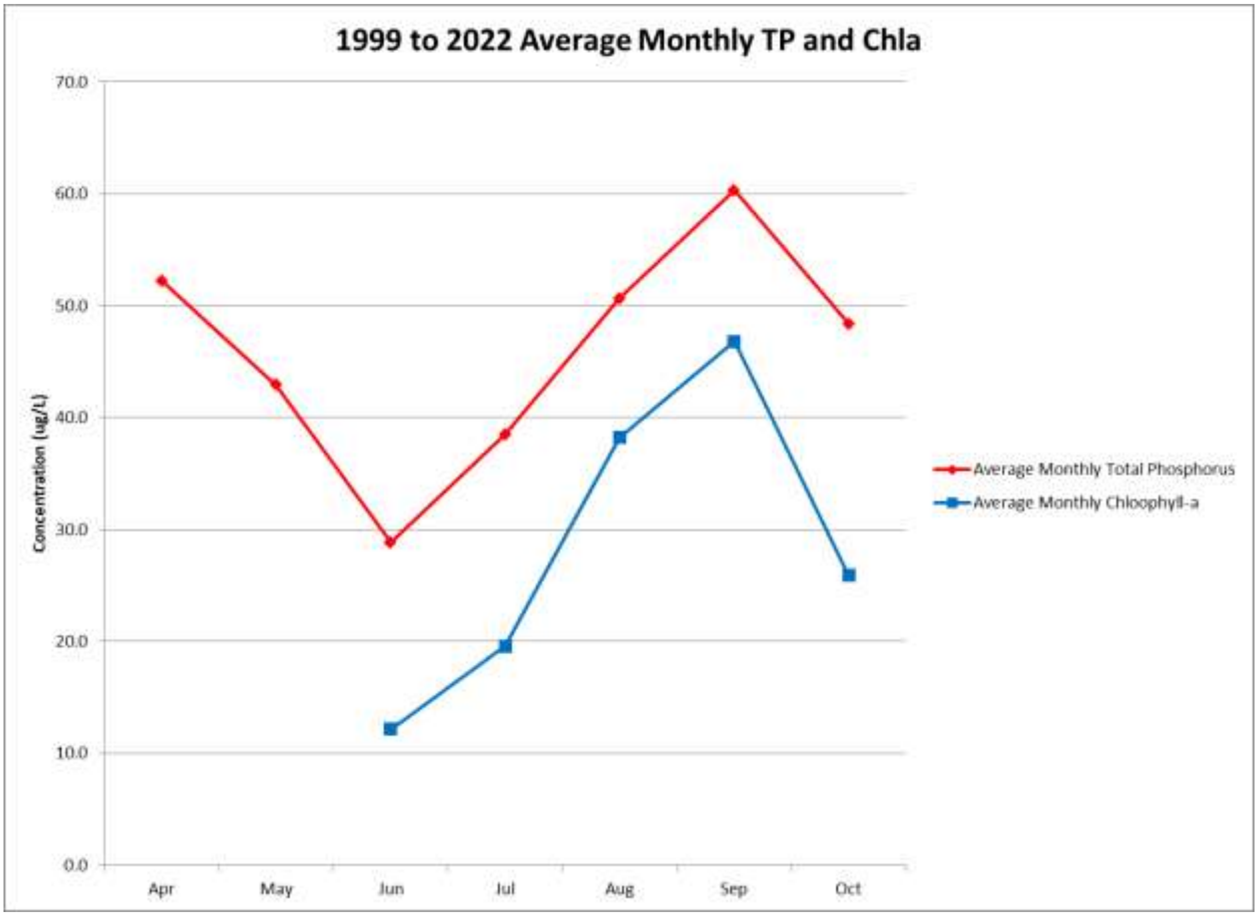


Figure 13: Average monthly TP and Chla concentrations (based on all 1999-2022 CLMN data)

4.4.3 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.

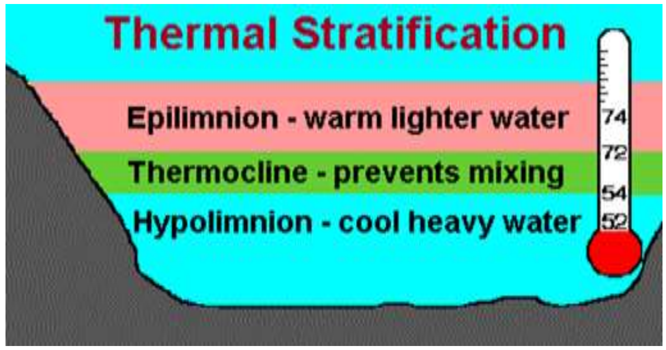


Figure 14: Summer thermal stratification

UTL appears not to stratify for more than just a few days at a time, which means the lake remains fairly mixed through a good portion of the season. When it does stratify, oxygen 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.

4.4.1 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 15). Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth (Figure 15). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 15).

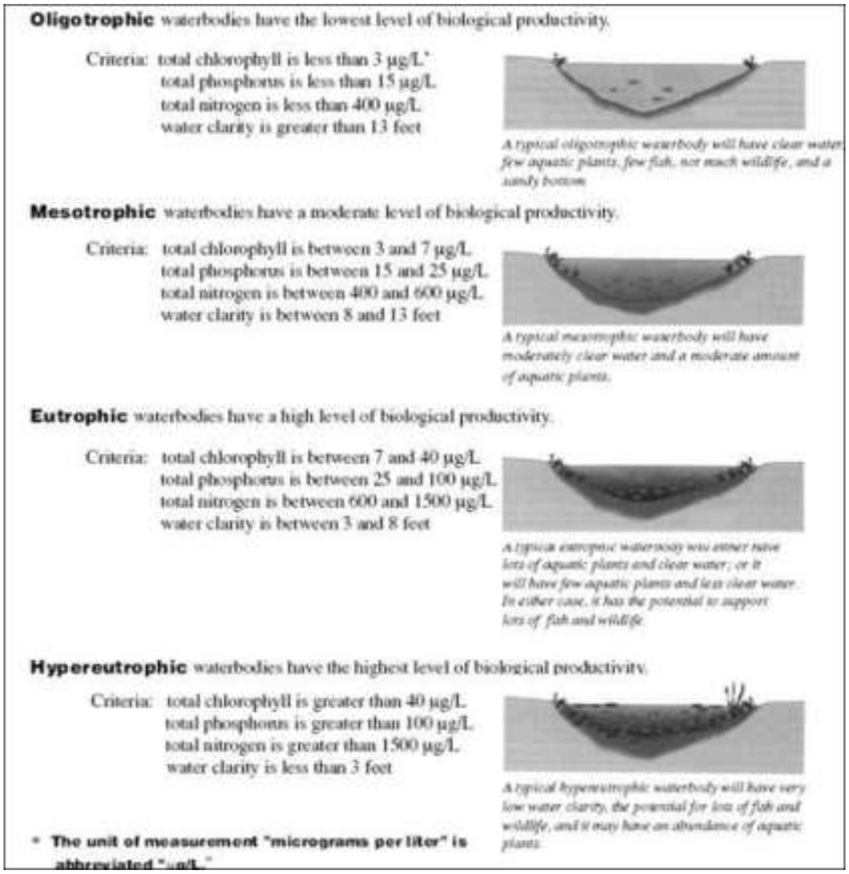


Figure 15: Trophic States in Lakes

Generally, TSI values from 0-40 are considered oligotrophic, 40-50 are mesotrophic, 50-70 are eutrophic, and anything above 70 is considered hypereutrophic.

The measurements of all three parameters (Secchi - feet, TP & Chla - µg/L) can be converted to values that fit in the TSI range of 0 to 100. By doing so, all three can be compared together to establish trends (Figure 16). In UTL, the average Secchi TSI value for all readings is 52, the average total phosphorus TSI is 57, and the average chlorophyll-*a* TSI is 57. These values mean that Upper Turtle Lake is a eutrophic lake with a high level of biological productivity.

Like the actual values recorded during sampling, TSI values can be used to create figures that show increasing or decreasing values. In Figure 17, the average annual Secchi TSI value for each year of data has been posted. The declining Secchi disk reading and where it fits in the 0-100 scale (oligotrophic, mesotrophic, or eutrophic) is easy to see.

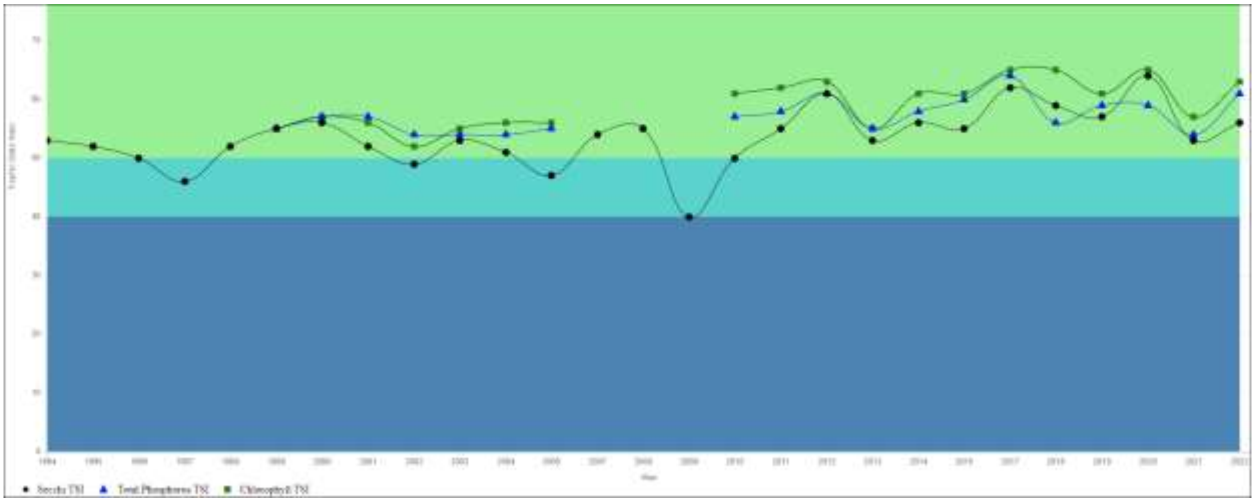


Figure 16: Yearly TSI Values for Chla, Secchi (water clarity), and TP (CLMN)

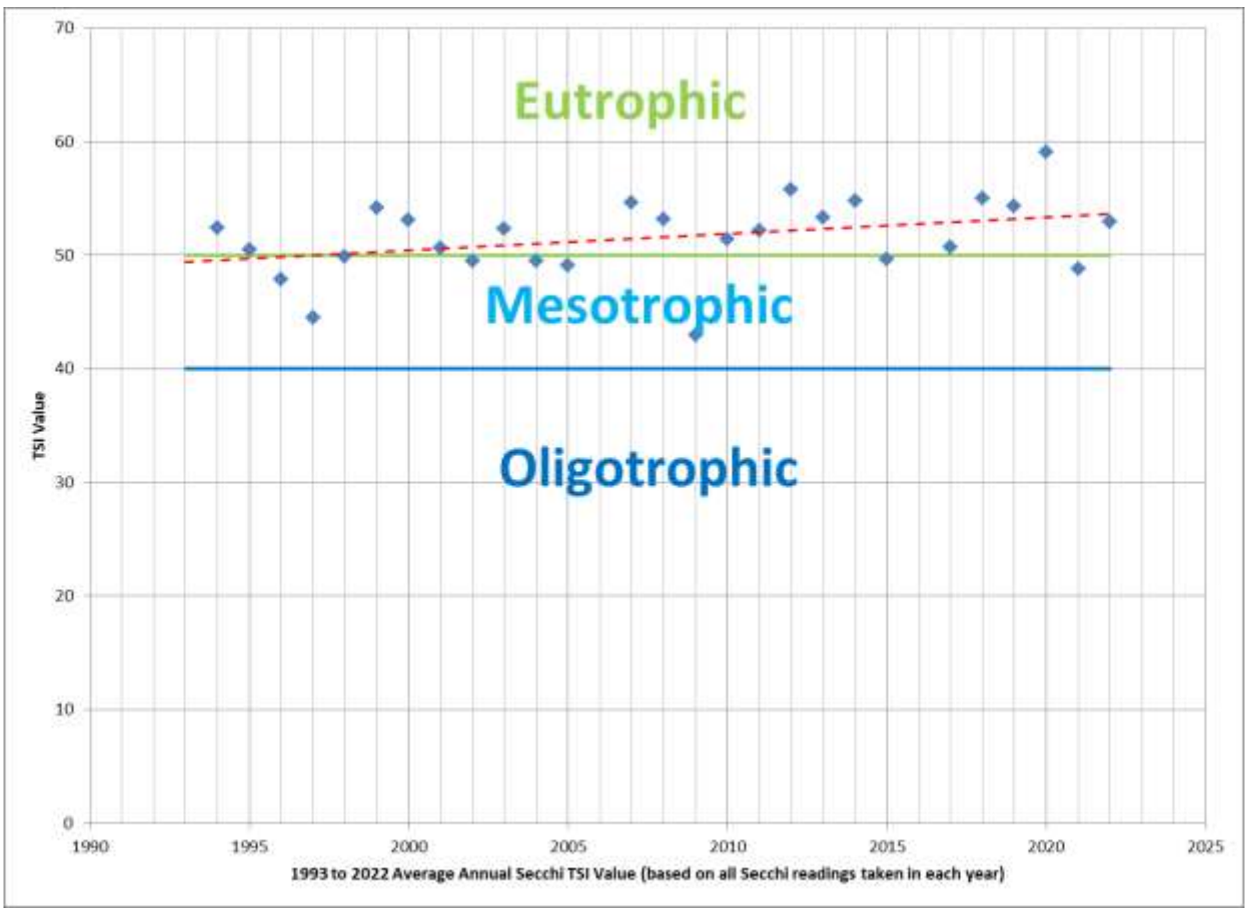


Figure 17: Average Annual Secchi TSI value

4.5 Fisheries and Wildlife

UTL is a warm water fishery with abundant panfish (bluegills, crappies, and sunfish), large and smallmouth bass, northern pike, and walleye (Table 1). The largest fisheries within UTL are the panfish, but there was also a good amount of bass, walleye, and other predatory fish.

Table 1: Summary of 2011 Spring Fisheries Assessment

2011 Spring Fisheries Assessment				
Species	Relative Abundance (catch per mile)	Minimum Length (Inches)	Maximum Length (Inches)	Average Length (Inches)
Walleye	14.58	7.5	25	19.13
Black Crappie	6	7.5	10	9.25
Bluegill	187	2.5	8.5	5.1
Largemouth Bass	39.79	6	17.5	12.45
Northern Pike	0.42	19.5	24	22
Pumpkinseed	7	3	7	5.32
Rock Bass	7	5	8.5	7.61
Smallmouth Bass	0.42	12.5	13	13
Yellow Perch	34	2.5	10	5.53

UTL is currently involved in a WDNR study with the goal of stabilizing walleye populations that have seen significant decreases in the past 20 years. One of the possible causes for the decrease in walleye numbers is thought to be the increase in bass populations which can reduce walleye populations through direct predation. As a part of this study, yearly surveys are conducted to assess the bass, northern, and walleye populations. The ultimate goal of this study is to find management mechanisms which allow walleye populations to remain at steady numbers through natural reproduction.

UTL is considered to be a treatment lake for this study which means that large walleye fingerlings are stocked when the young of the year survey results show less than 10 catch per effort (CPE). This is why walleye stocking was resumed in UTL in 2014. Before this, small walleye fingerling were stocked pretty regularly from 1975-2004 (Table 2). This study will be continuing through 2024, so the final results have not yet been tallied, but initial results show no significant changes in bass populations with increases in the walleye populations which was caused by the stocking efforts of 2014 and 2016 (Figure 18).

Table 2: Historic walleye stocking in Upper Turtle Lake

Stocking Year	Age Class	# of Fish Stocked	Avg Fish Length(IN)
2020	LARGE FINGERLING	4268	7.18
2018	LARGE FINGERLING	4268	6.3
2016	LARGE FINGERLING	4270	7.2
2014	LARGE FINGERLING	4260	6.15
2004	SMALL FINGERLING	32912	1.2
2002	SMALL FINGERLING	41892	1.45
2000	SMALL FINGERLING	21000	1.5
1992	FINGERLING	20979	2
1990	FINGERLING	21090	3
1988	FINGERLING	21106	3
1986	FINGERLING	23000	3
1984	FINGERLING	21120	3
1982	FINGERLING	21840	3
1980	FINGERLING	10400	3
1978	FINGERLING	21942	3
1976	FINGERLING	21965	3
1975	FINGERLING	20020	3

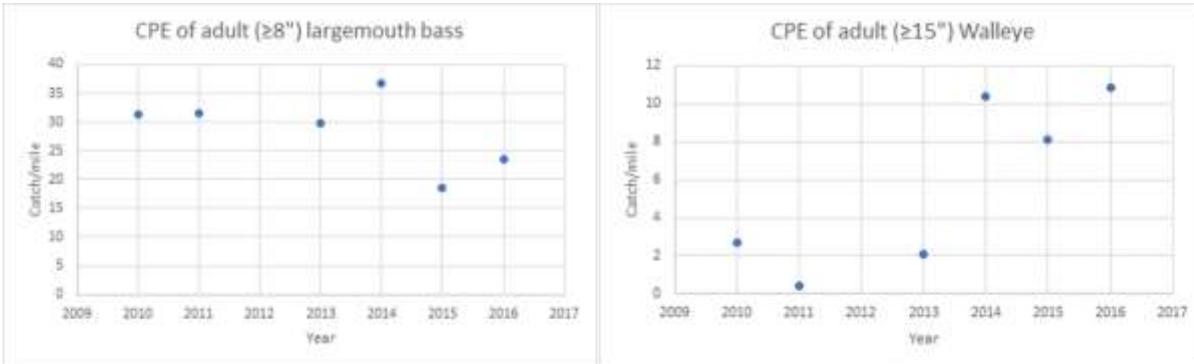


Figure 18: Yearly Catch per Effort of Largemouth Bass and Walleye

The Natural Heritage Inventory (NHI) database contains recent and historic observations of rare species and plant communities. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). There are seven plant species found within the same township and range (T34N, R14W) as UTL (Table 3). None of these species were found in UTL during the 2021 whole-lake, summer, point-intercept survey.

Table 3: NHI results for the Town of Almena, Barron County (T34N, R14W)

Lake–Shallow, Soft, Seepage	NA	Community~
Long-beaked Bald-rush	THR	Plant~
Longstem Water-wort	SC	Plant~
Mink Frog	SC/H	Frog~
Northern Dry-mesic Forest	NA	Community
Robbins' Spike-rush	SC	Plant~
Snail-seed Pondweed	SC	Plant~
Torrey's Bulrush	SC	Plant~
Vasey's Pondweed	SC	Plant~
Water-thread Pondweed	SC	Plant~
Bald Eagle		Bird~

The only invasive animal species that has been verified within UTL is the Chinese mystery snail. There is not a lot known about the direct impacts that these snails have on the natural systems they invade, but there is some evidence that they cause some decline in native snail populations. Chinese mystery snails also occasionally experience mass die off which result in aesthetic issues with large amounts washing up on shore and subsequently decomposing along the shoreline.

4.5.1 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. Figure 19 shows the sensitive areas identified by the WDNR (2001) in UTL. 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. Further details for each sensitive area can be found in the Upper Turtle Lake Sensitive Area Designation (WDNR, 2001).

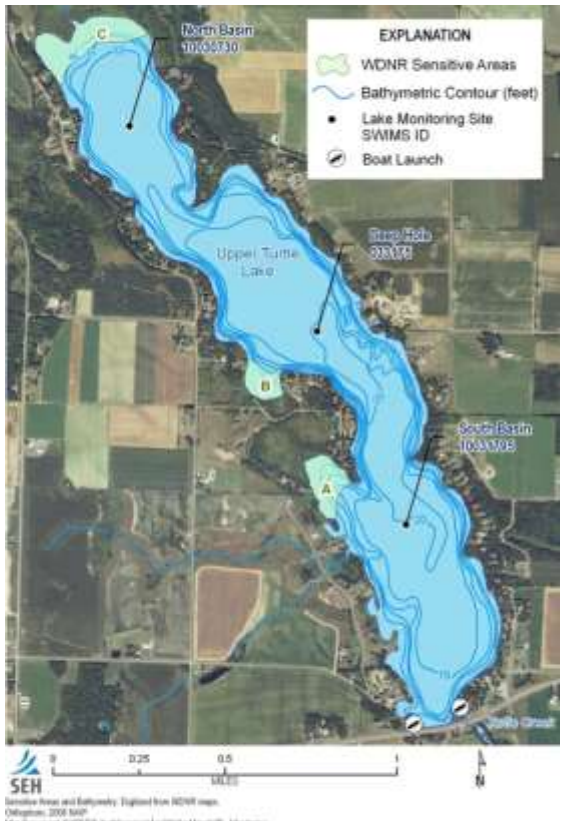


Figure 19: Sensitive Areas and Water Quality Sampling Sites in Upper Turtle Lake (SEH, 2011)

5.0 Attributes to Help Maintain a Healthy Lake and Watershed

The health of a lake is reflective of what goes on around it. Several things have a direct impact on water quality, the health of the lake ecosystem (plants, fish, and wildlife), and the value of the property around it.

5.1 Wetlands

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

Due to the dense vegetation within and location within the landscape, wetlands within the watershed of a lake are important for retaining stormwater from rain and melting snow moving towards surface waters. Once runoff reaches a wetland, the wetland plants and soils have the capacity to store and filter pollutants from that runoff. Wetlands also provide groundwater recharge and discharge by allowing the surface water to move into and out of the groundwater system. The filtering capacity of wetland plants and substrates help protect groundwater quality.

Wetlands along the shore of a lake act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents and by anchoring sediments. This shoreline protection is important in waterbodies like UTL where boat traffic, water current, and wave action can cause substantial damage to the shore.

There are not a lot of wetlands in the UTL watershed (Figure 20). There appears to be a good sized wetland along the southwest shore however, this area has been heavily developed into residential areas which are no longer capable of acting as natural wetlands. Along the northern shore there is a large wetland complex, which has been left natural. This area is bordered by two farm fields, so it is likely acting as a buffer between the fields and the lake helping absorb many of the excess nutrients that would otherwise run from the fields into UTL.

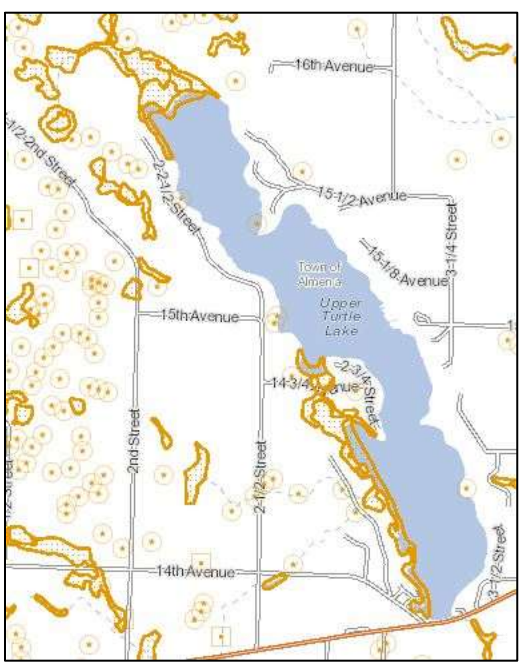


Figure 20: Upper Turtle Lake Wetlands (Wisc. Wetlands Inventory August 23, 2017)

5.2 Coarse Woody Habitat

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. It provides erosion control along the shore and can reduce sediment suspension in the lake improving water clarity. It provides a surface for algal growth which is an important food base for aquatic macro invertebrates. It serves as important refuge, foraging, and spawning habitat for fish, aquatic invertebrates, turtles, birds, and other animals (Wolter, 2012). 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).

CWH is often removed by shoreline residents to improve aesthetics or enhance recreational opportunities like 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 amount of CWH within UTL has not been quantified.

5.3 Shorelands

How the shoreline of a lake is managed can have big impacts on the water quality and health of that lake. Activities such replacing natural vegetation with lawns, clearing brush and trees, importing sand to make artificial beaches, and installing structures such as piers, can cause water quality decline and change what species can survive in the lake. 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.

5.3.1 Threats to Shorelands

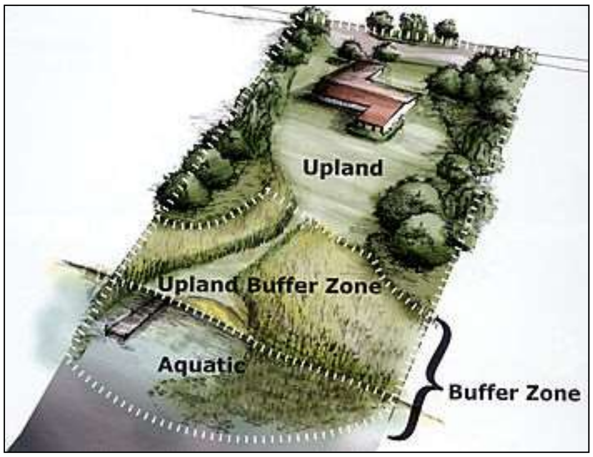
When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, houses, decks, garages, sheds, piers, rafts and other structures, wells, septic systems, lawns, sandy beaches and more. Many of these changes result in the compaction of soil and the removal of 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.

5.3.2 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 21 shows the difference between a natural and unnatural shoreline adjacent to a lake home.



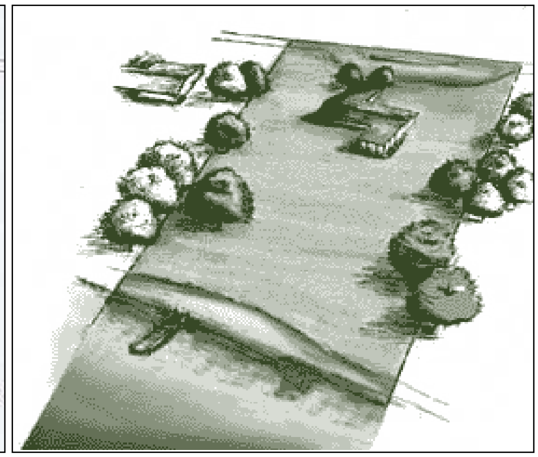


Figure 21: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

Residential development encompasses most of the shoreland surrounding UTL. Turf grass, mowed lawns to the edge of the lake, exposed earth, and rip rap increase the amount of runoff from roof tops, driveways, lawns and pathways to the lake. The WDNR encourages the installation of relatively simple best management practices including rain gardens, native plantings, and runoff diversion projects through its Healthy Lakes Initiative[2]. Several property owners around UTL installed best management practices as a part of a 2010-2016 lake protection project. The UTLD should sponsor more of these projects for individual property owners who are interested in improving their shorelines.

5.4 Culverts in the Watershed

Under rural roads throughout the watershed, gullies, streams, and waterways are routed through plastic, steel, or concrete structures often significantly narrower than the width of the streams at normal flow. Undersized, collapsed, or poorly designed road crossings fragment natural stream pattern and ecosystems, contribute to erosion, and exacerbate flooding. They block native fish and other aquatic organisms from moving upstream to the cooler waters and habitat they need to survive and reproduce. High flows forced through undersized culvert pipes or bridges increase water velocities, eroding the bed and banks at their outlets, and in some cases, creating large drop-offs to the streams below.

Debris builds up quickly at the upstream ends of undersized culvert pipes, backing up natural flows, flooding roads, and requiring ongoing maintenance by local road crews. Undersized bridges may allow the passage of most debris, but still back up flows, impounding water upstream, eroding banks and widening the channel. Streambanks at either end of undersized road crossings are often eroded. When stripped of plants and the

[2] For more information about projects to improve habitat and reduce runoff go to: https://healthylakeswi.com/

root systems that stabilize them, the streambanks collapse adding more sediment and other pollutants that can compromise fish and wildlife habitat and/or be carried to downstream waters.[3]

Even if a waterway is considered intermittent – only flows during spring snowmelt or during large rain events – the sediment and other pollutants carried down them to the lake can cause problems. A culvert survey can be done within a small watershed like the one that surrounds UTL to identify those culverts that are not functioning properly. Additional survey work can be done to evaluate the waterway to determine if they can be improved in some way. A preliminary map has already been created that shows the location of the culverts closest to the lake (Figure 22). To complete the inventory, each culvert needs to be evaluated on various parameters as mentioned in several monitoring guidelines. In addition, some level of watershed monitoring could be completed to estimate nutrient and sediment load to the lake and how certain BMPs could reduce that load.

Figure 22: Location of culverts under roads around Upper Turtle Lake (map provided by UTLD Volunteers from the fall of 2022)

[3] https://www.ausableriver.org/threats/undersized-culverts

6.0 2018-2021 Curly-leaf Pondweed Management

When the initial aquatic plant management plan for Upper Turtle Lake was written in 2010, CLP was not a significant issue within the lake. While present, the beds were limited in size, interspersed with native species, and they helped provide early season habitat for fish and other aquatic animals. A bed mapping survey completed in late May 2010 yielded a total of 7.83 acres of CLP spread throughout the lake in 33 different beds with a mean bed size of 0.24 acres (Figure 23). This was not the case in 2017.

In June 2017, another survey was completed to see how the plant population within Upper Turtle Lake had changed. The 2017 survey showed that the CLP population had exploded to cover 132.35 acres of Upper Turtle Lake with 81.25 acres of that considered to be a severe impairment to navigation lanes. The 33 beds from the 2010 survey appeared to have consolidated and expanded down to 11 beds with a mean bed size of 12.03 acres (Figure 23). The large increase in CLP documented in 2017 likely caused negative impacts to the native aquatic plant community, water quality, and lake use and navigation. At the time it was unknown if the incredibly large CLP beds were the new norm in the lake, but anecdotal evidence (comments from property owners) suggests the CLP population had been expanding for several years.

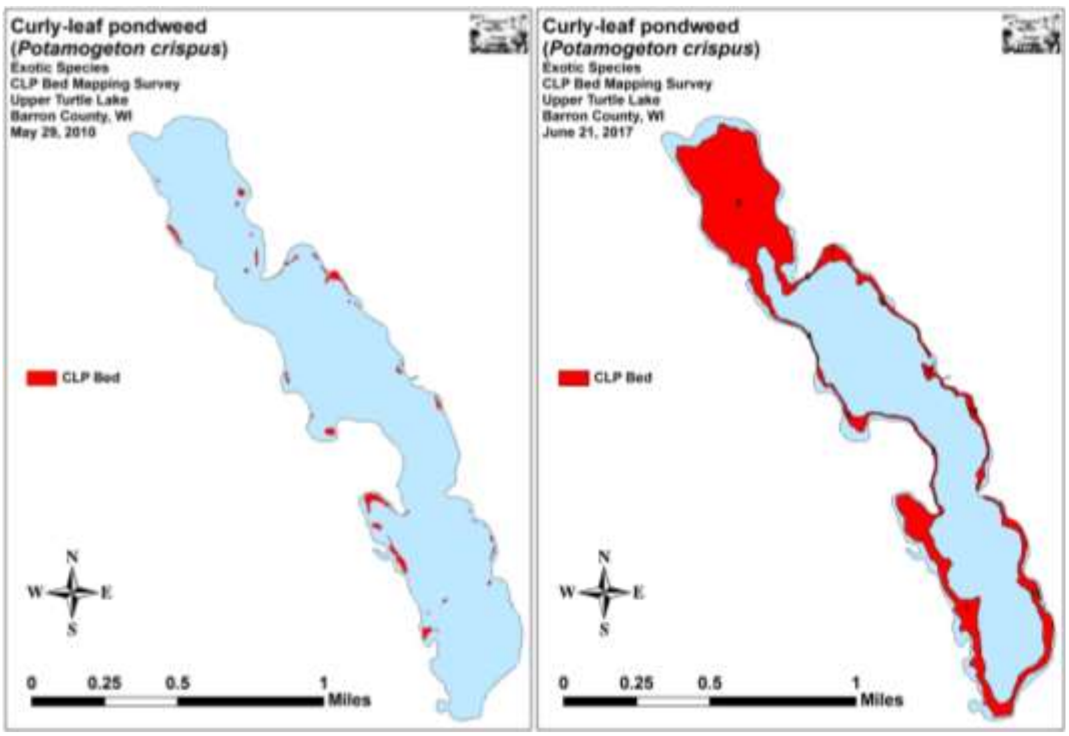


Figure 23: CLP Bed Maps 2010 (left) and 2017(right)

After multiple discussions with the UTLD, WDNR, and the consultant retained by the UTLD, it was decided to implement a 3-5 year CLP management plan focused on the large-scale use of aquatic herbicides to reduce CLP density and distribution. Management actions were included in the last APM Plan (2018-22), with implementation beginning in 2018. Once started, it was expected that CLP management using herbicides would continue for at least three or four years.

6.1 2018

The largest area of CLP in 2017 was on the north end of the lake where almost 80 acres of dense growth CLP was mapped (Figure 23). Surface water enters UTL on the north end and moves through the lake north to south to the outlet on the furthest point south on the lake adjacent to the public boat landing. The outlet is the start of Turtle Creek which flows into Lower Turtle Lake about a mile downstream. One of the first questions that needed answering was what would happen to the herbicide once applied to the lake. Would it stay in place, or would water movement carry it away from the treated areas? If water movement carried it away, how fast would that happen? Would the herbicide have time to leave the lake and move on down to Lower Turtle Lake? To answer these questions, before jumping into a large-scale, basically whole-lake, herbicide application, a Rhodamine Dye study, to simulate a large-scale herbicide application was setup and implemented in 2018.

6.1.1 2018 Rhodamine Dye Study

On May 22, 2018 nearly 100-lbs of liquid Rhodamine dye was applied by Northern Aquatic Services (Figure 24) to 72 acres of water in the north basin of UTL. The concentration of the dye, once spread through the entire north basin, was expected to be 10 ppb. The conditions the dye was applied under were perfect with water temperature at about 60°F, air temperature at about 73°F and no wind. Weather conditions remained "perfect" for several days after the application.

Figure 24: Dale Dressel with Northern Aquatic Services applying Rhodamine dye to Upper Turtle Lake on May 22, 2018

A monitoring plan was prepared that included 24 sampling sites: 7 within the proposed treatment area; 14 outside the treatment area but still in Upper Turtle Lake; and 3 in Lower Turtle Lake. Dye concentration readings were taken at 8 time intervals (1,3,5,8,24,48,72 & 96 hours after treatment) with a fluorimeter borrowed from the WDNR.

Data collection started one hour after the application of Rhodamine dye was completed and continued to the last sampling period at 96 hours. After the 96 hour sampling run when it appeared the dye was not moving through the lake very rapidly and had not reached the outlet at the south end of the lake, sampling sites scheduled on Lower Turtle Lake were cancelled, and another run at 144 hours was added.

The dye applied to the water acted like it was expected to except that it took a lot longer than anticipated for it to leave the north basin and begin spreading throughout the lake. When the dye was finally picked up outside of the north basin at 24 hours after treatment, it was in relatively low concentrations. The highest concentrations reached within the treated area were between five and eight hours after treatment, with a few of these exceeding what would have been 10 ppb (Figure 25). It took until 48 hours after treatment for the dye to leave the north basin where it was applied. When it did leave, the concentration was not very high with the exception of a couple locations in the center of the middle bay (Figure 25). At no time during the 96 hour sampling plan did the dye reach the outlet of the lake.

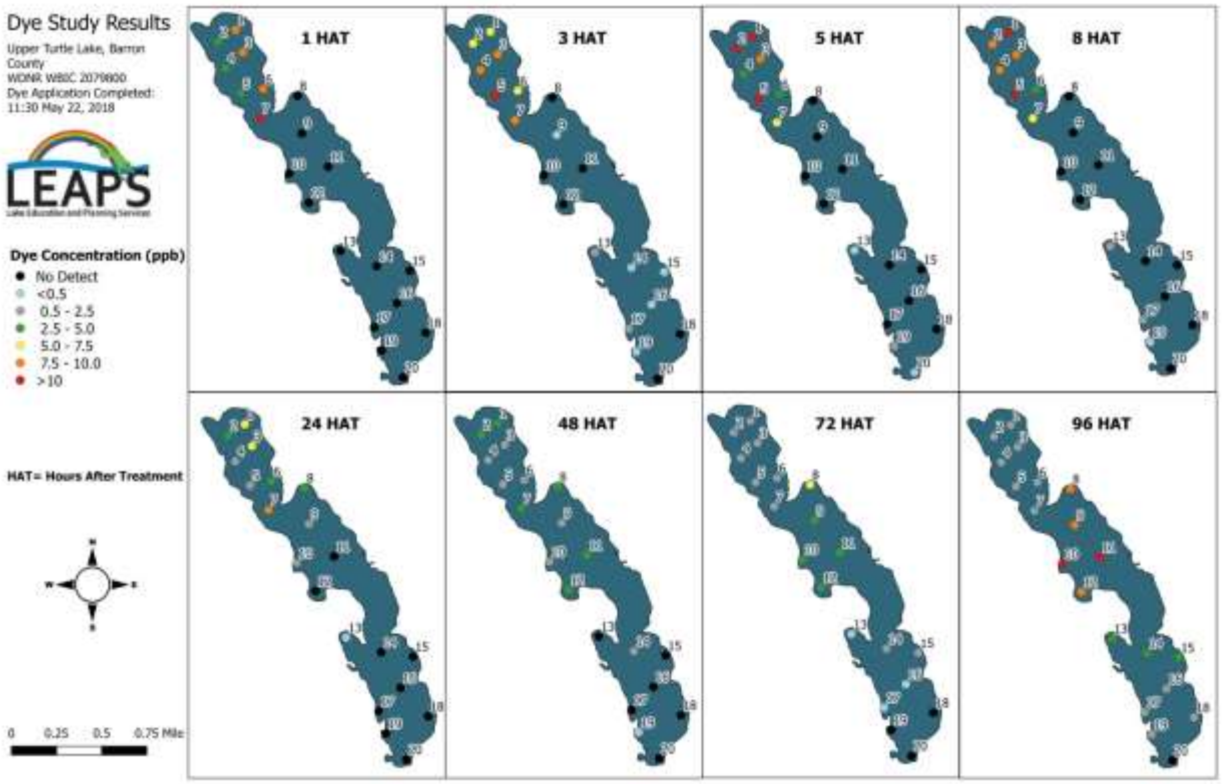


Figure 25: Rhodamine dye movement in Upper Turtle Lake (LEAPS, 2018)

At 144 hours after treatment, six days after treatment, another dye sampling run was completed. As it turned out the sixth day after dye application fell on the Monday of Memorial Day weekend in 2018. Sampling shows some very interesting results (Figure 26). On the day of sampling – Memorial Day – the person collecting the data commented on how difficult it was to get the samples due to the heavy amount of boat traffic on the lake. Heavy boat traffic not only made sampling difficult, it likely altered the results. In the north basin where the Rhodamine dye had dissipated to very low readings after 72 hours, the readings were suddenly back up to where they were at five and eight hours after treatment. Dye concentrations were also up in the rest of the lake including dye being found for the first time at the outlet, albeit at very low concentrations. The only explanation for this is the dye was stirred up by all the boat traffic, perhaps supporting the idea that chemically treating a body of water just before a holiday is not a good idea.

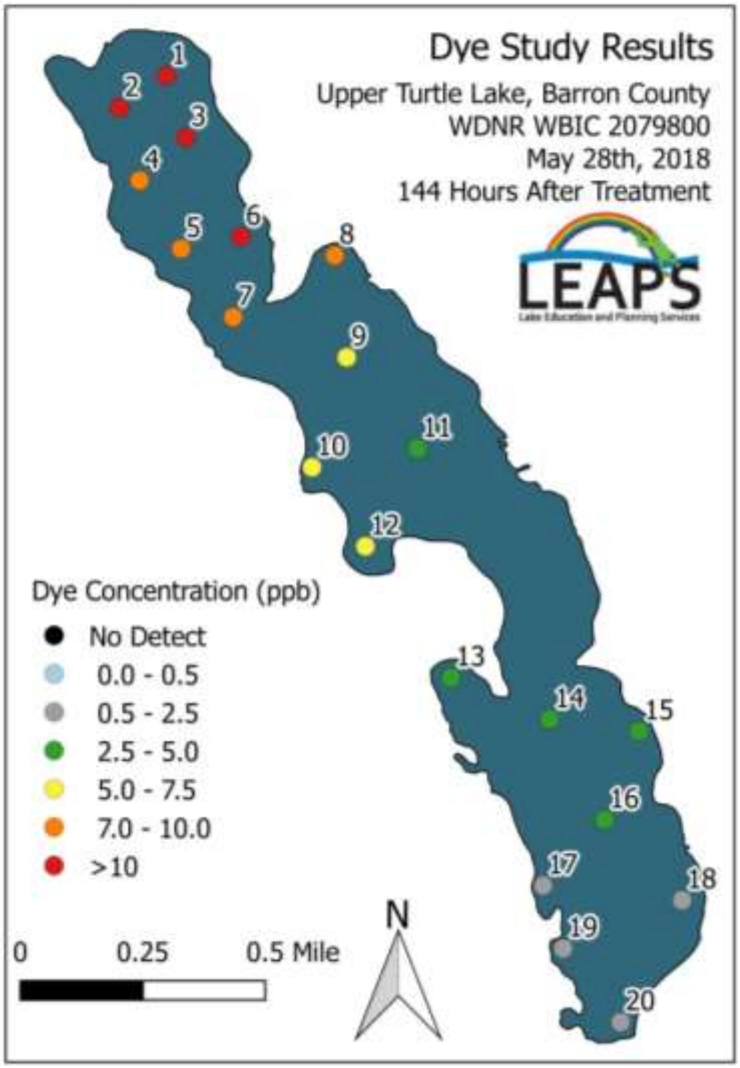


Figure 26: Rhodamine Dye study sampling results at 144 hours (six days) after treatment. In this case, the sixth day after treatment fell on Memorial Monday (LEAPS, 2018)

6.1.2 2018 Small-scale Liquid Endothall Application for CLP Control

At the same time the dye study was going on, a small-scale chemical treatment on a single bed of CLP totaling 9.88 acres in size was completed in a protected bay on the west side of the lake (Figure 27). Liquid endothall (Aquathol K®) was used at a 1.5ppm application rate per acre-foot of water treated. Endothall applications typically require 18-24 hours of contact time with the target plant species to effectively kill it. While it was expected that liquid endothall would be effective in controlling CLP, more information was desired before jumping into a whole-lake, large-chemical treatment. The dye study results supported the ascertain that the liquid endothall would work given that it took nearly 48 hours for the dye to leave the north basin in any appreciable amount. In addition to the dye study, a pre and post-chemical treatment plant survey study was also completed.

6.1.2.1 Pre/Post-treatment Aquatic Plant Survey

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2018a). Within the ≈10 acre chemical treatment area, a 66 point pre and post-treatment survey grid was created (Figure 27). Points were sampled prior to the application of endothall and several weeks after the application to determine changes in CLP and native aquatic plants. During the pre-treatment survey CLP was found at 55 of 66 sites (Figure 28). During the post-treatment survey, CLP was found at only 11 points (Figure 28). Each of these detections was a plant that was only a couple of inches tall making it likely they it sprouted after the chemical treatment. These results demonstrated a highly significant decline in total CLP as well as rake fullness 2; and a moderately significant decline in rake fullness 3 (Figure 29).

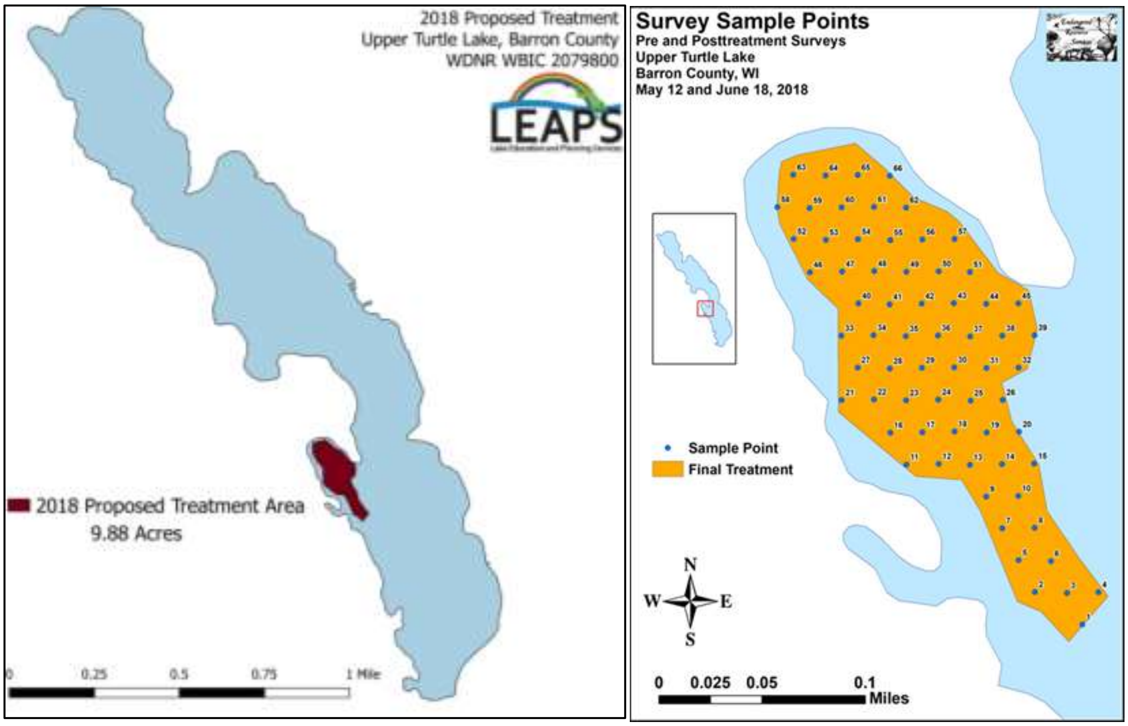


Figure 27: 2018 Herbicide application plan – treatment area (left); pre and post-treatment survey points (right)

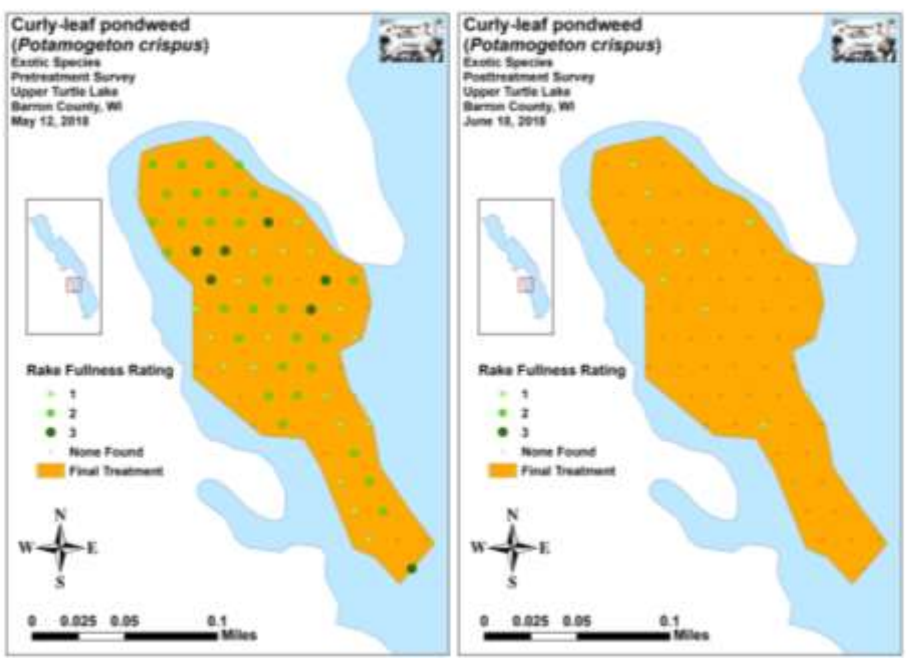


Figure 28: 2018 Pre and post-treatment point-intercept plant survey results

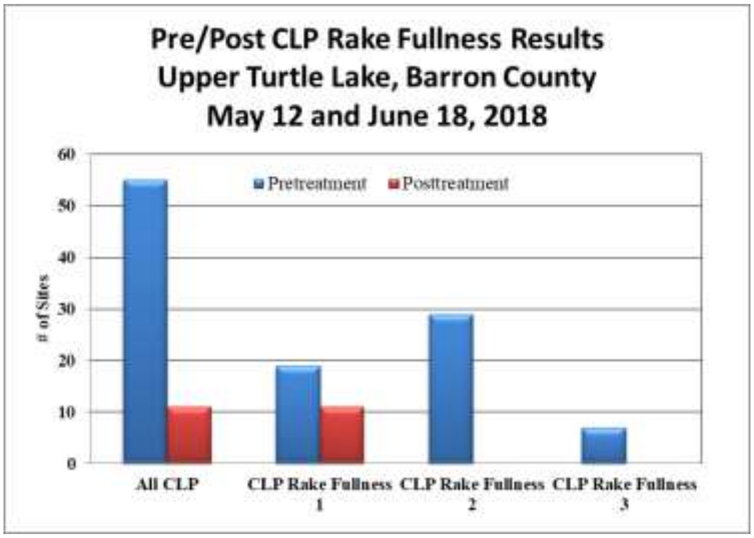


Figure 29: Changes in CLP Rake Fullness

As for the presence of native aquatic plants, the littoral zone was essentially unchanged however, the frequency of occurrence at any point for any plant species dropped sharply from 92.4% pretreatment to 48.4% posttreatment. Total plant richness was unchanged with seven species found during each survey, so the elimination of CLP was often the elimination of the only plant that had been present pre-treatment. The Simpson's Diversity Index increased from a moderate pre-treatment value of 0.59 to a moderately high post-treatment value of 0.76. The Floristic Quality Index (another measure of native plant community health) fell slightly from 15.5 pretreatment to 13.9 posttreatment (Table 4).

Two species experienced significant declines from pre to post-treatment – CLP and Small Pondweed (*Potamogeton pusillus*) (Figure 30). Mean native species richness at points with native vegetation was almost unchanged from 1.27species/point pre-treatment to 1.29species/point post-treatment. Total mean rake fullness experienced a highly significant decline from a low/moderate 1.79 pre-treatment to a very low 1.23 post-treatment.

Table 4: Pre/Posttreatment Surveys Summary Statistics Upper Turtle Lake, Barron County May 12 and June 18, 2018

Summary Statistics:	Pre	Post
Total number of points sampled	66	66
Total number of sites with vegetation	61	31
Total number of sites shallower than the maximum depth of plants	66	64
Freq. of occur. at sites shallower than max. depth of plants (in percent)	92.4	48.4
Simpson Diversity Index	0.59	0.76
Mean Coefficient of Conservatism	6.3	5.7
Floristic Quality Index	15.5	13.9
Maximum depth of plants (ft)	14.0	13.5
Mean depth of plants (ft)	7.1	5.5
Median depth of plants (ft)	7.0	5.0
Average number of all species per site (shallower than max depth)	1.41	0.59
Average number of all species per site (veg. sites only)	1.52	1.23
Average number of native species per site (shallower than max depth)	0.58	0.42
Average number of native species per site (sites with native veg. only)	1.27	1.29
Species Richness	7	7
Mean Rake Fullness (veg. sites only)	1.79	1.23

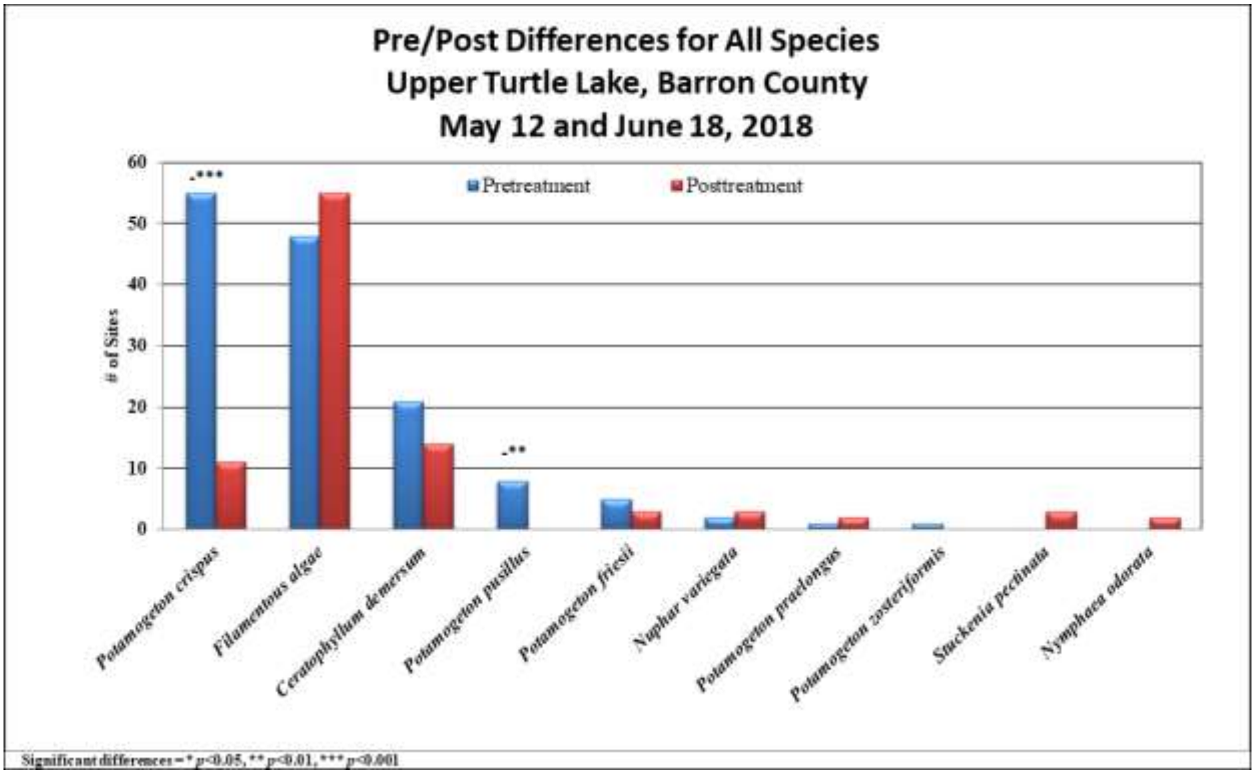


Figure 30: Pre/post-treatment aquatic plant changes

These results suggested that the application of herbicide would be effective at controlling CLP, but some losses in at least one other aquatic plant species, small pondweed, could be expected, as could a decline in native plant density and abundance.

6.1.3 2018 CLP Turion Survey

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2018b). The amount of CLP that grows in a lake in any given year can be influenced by many factors including early or late ice, deep or little snow cover, and both air and water temperature (Valley & Heiskary, 2012). If the conditions are right, CLP may dominate the littoral area of a lake in one year, and be almost non-existent a year later. As such, bed mapping may not always be the best indicator of how much CLP is in a lake.

CLP occasionally reproduces by seed, but the vast majority of plants resprout from stiff overwintering buds called turions that are normally produced in number by the plants prior to their late June/early July senescence (Figure 31). After the pinecone-like turions germinate in late fall or early winter, plants continue to grow slowly under the ice. Following ice out, growth accelerates, and plants rapidly canopy allowing them a competitive advantage over slower growing native species (Figure 31)[4].

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[4] https://files.dnr.state.mn.us/natural_resources/invasives/aquaticplants/curlyleafpondweed/curlyleaf_factsheet.pdf

Figure 31: CLP sprouting from a previous year's turion (Berg, 2018); CLP life cycle (Johnson, 2006)

Research suggests approximately 50% of turions germinate in a growing season while the rest remain dormant until the following growing season when another 50% will germinate (Johnson, 2012). Depending on the level of turions at a given location and knowing that latent turions may be able to survive for over 5 years in the sediment, it may take several years of control to notice a reduction in the number of turions in the sediment.

Following the 2018 summer growing season on October 28, a fall turion survey of 80 points spread throughout the 2017 bed mapping areas, was conducted by an aquatic plant specialist (Figure 32). The main goal of the survey was to determine the level of CLP turions within UTL's historic high density CLP areas to serve as a baseline for future turion surveys following multiple years of management.

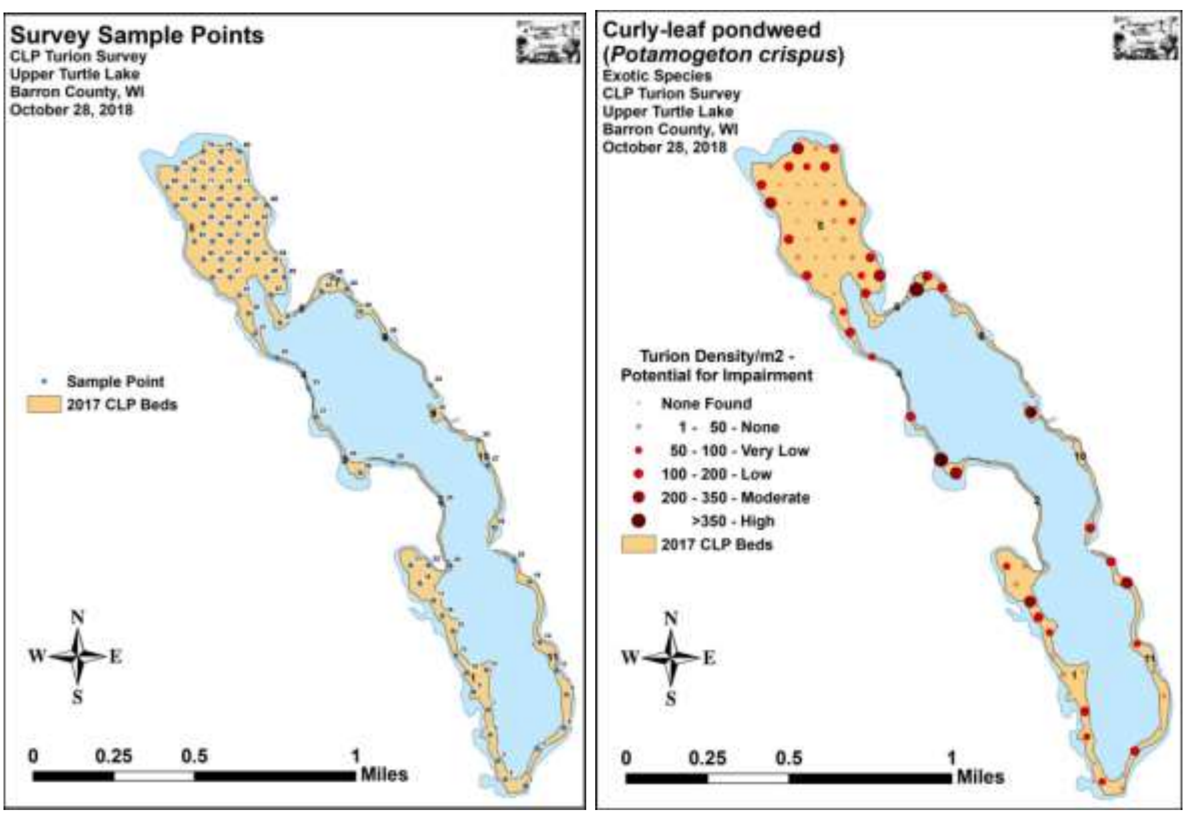

Figure 32: 2018 CLP turion sampling points (left), and results (right) *(Berg M. , 2018b)*

During the survey, a total of 296 CLP turions were counted at 53 of the 80 survey points (66.3% coverage) (Table 5). Of these, nine points (11.3% coverage/17.0% of points with turions) exceeded the expected "nuisance level" of 200/m2 (Johnson, 2012), and 37 points (46.3% coverage/69.8% of points with turions) topped 50 turions/m 2 meaning it is likely there would be at least some potential for navigation impairment (Figure 32).

Table 5: 2018 CLP turion survey statistics and Potential for Impairment Chart *(Berg M. , 2018b)*

Summary Statistics:	
Total number of points sampled	80
Total live turions	296
Total # of points with live turions	53
Frequency of occurrence (in percent)	66.3
Number of points at or above nuisance level (+200/m^2)	9
% nuisance level	11.3
Maximum turions/m^2	689
Mean turions/m^2	79.65
Standard deviation/m^2	112.95

Turion Density/m2 - Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High

The 2018 CLP turion survey was redone in the fall of 2021. Comparison of the two reports will be made later in this document.

6.2 2019

Based on the newly approved APM Plan and results from preparatory data collection in 2018, a CLP management proposal was developed for UTL in 2019. Before the dye study and turion data was collected in 2018, the generally accepted management plan was to concentrate on the north basin of the lake where over 70 acres of moderate to dense growth CLP was mapped in 2017. This level of CLP did not materialize in 2018, and the turion data showed that the CLP in the north basin and in the rest of the lake was concentrated around the edges of the lake in water that averaged about 6.5 feet in depth. The water movement study completed in 2018 showed that at least in the north basin, that any herbicide placed there would likely stay for a prolonged period of time before dissipating out to the rest of the lake.

By incorporating this data into 2019 management planning, the areas with CLP to be chemically treated were expanded beyond the north basin without increasing the expected total area, simply because it was felt that chemically treating the edges of the lake without purposely targeting the center of the north basin would be sufficient for control. What could have been a 70 plus acre treatment in the north basin alone became a 38 acre treatment in the north basin, with another 36 acres included from other parts of the lake where moderate to dense CLP was identified and confirmed by turion data. The water movement data from the dye study also showed that a lower concentration of herbicide could be used as it was expected that it would not dissipate as quickly as first believed.

A final CLP chemical management proposal included seven areas of CLP that totaled 74.09 acres throughout the lake (Figure 33). Unfortunately, a grant application submitted by the UTLD was not awarded, so only pre and post-treatment point-intercept survey work was completed. Concentration testing throughout the lake and into Lower Turtle Lake was included in the grant application, but was not completed when the grant was not awarded. Despite a lack of grant funding, the 74+ acre CLP treatment was completed and paid for in full by the UTLD. Approximately 417 gallons of Aquathol K, liquid herbicide with the active ingredient endothall was applied on May 15, 2019 at 1.25 ppm in larger areas, and 1.50 ppm in smaller areas (Figure 33).

2019 Upper Turtle Lake Proposed Large-Scale CLP Chemical Treament (01-23-2019)					
Treatment Characteristics				Curly-leaf Pondweed Control Treatment application	
Treatment Site	Acreage	Mean Depth (feet)	Volume (acre-feet)	Treatment a.i. ppm	gallons[†]
1	38.35	6.50	249.28	1.25	199.4
2	6.60	6.50	42.90	1.50	42.9
3	3.50	6.50	22.75	1.50	22.8
4	11.56	6.50	75.14	1.25	60.1
5	3.32	6.50	21.58	1.50	21.6
6	6.03	6.50	39.20	1.50	39.2
7	4.73	6.50	30.75	1.50	30.7
Whole Lake	74.09		481.59		416.70
* Aquathol K® liquid aquatic herbicide (a.i. endothall)					

Whole Lake Volume = 6213.15 acre-feet
Whole Lake Volume = 7,663,796,262 liters
Whole Lake Volume = 2,024,560,287 gallons

Expected Whole-lake Concentration 0.0002058010

Figure 33: 2019 CLP chemical management proposal for Upper Turtle Lake

6.2.1 2019 Pre and Post-treatment Aquatic Plant Survey

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2019). A 387 point sampling grid created by the aquatic plant surveyor at 28m resolution approximated to just over 5 pts/acre – just over the minimum of 4 pts/acre required by WDNR protocol for pre/post treatment surveys. All survey points occurred in areas between 2.5ft and 18.0ft of water.

CLP was found at 249 of 387 sites during the pre-treatment survey (64.3% coverage) (Figure 34) with almost 35% of the proposed treatment areas having a significant infestation. During the post-treatment survey, CLP was only found at two points. These results demonstrated a highly significant decline in total CLP as well as rake fullness 3, 2, and 1 (Figure 35).

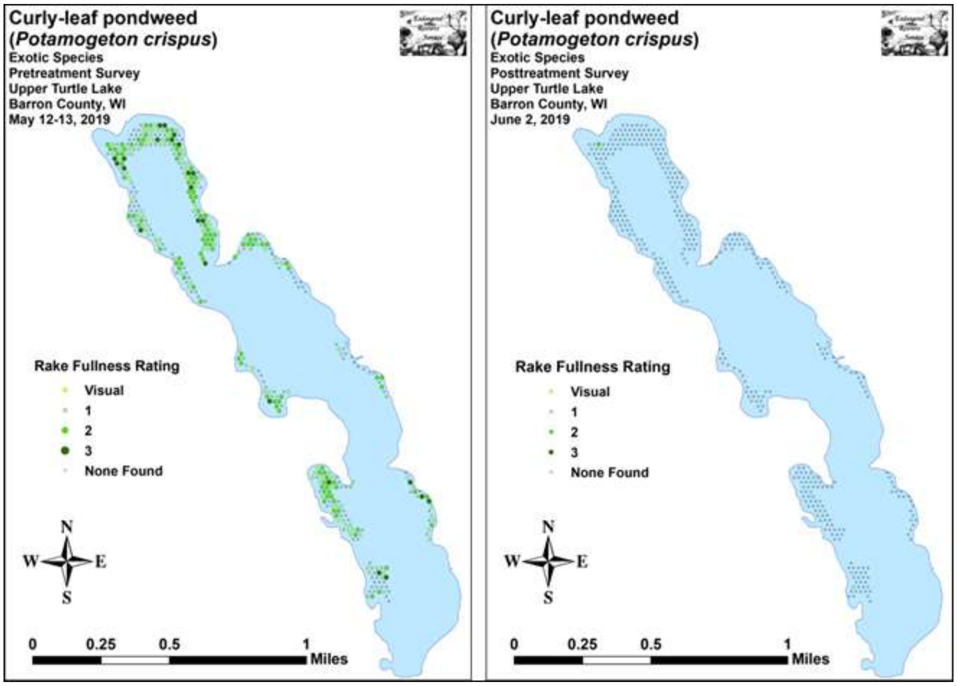

Figure 34: Pre/post-treatment CLP density and distribution

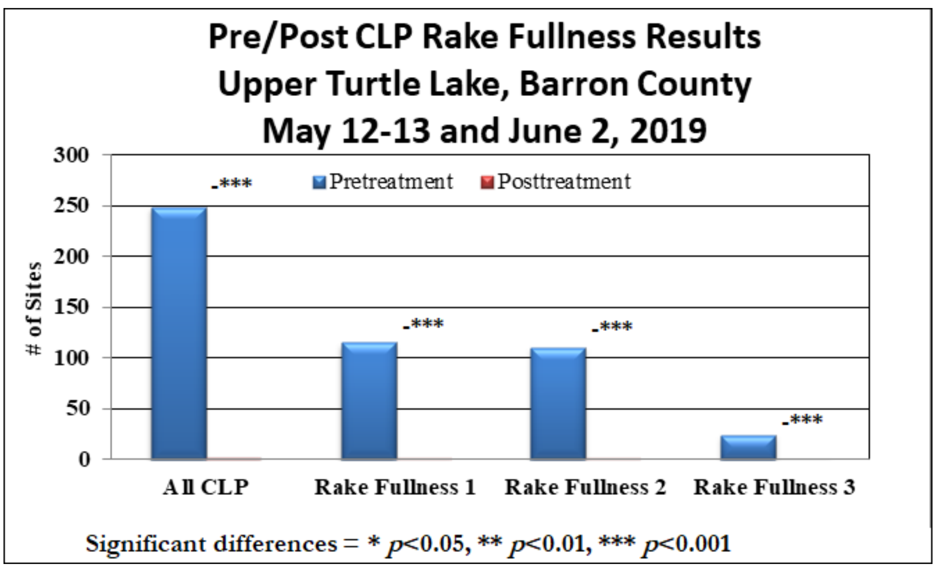

Figure 35: Changes in CLP rake fullness

Within the bed, plants grew at a mean and median depth of 7.5ft and 7.0ft respectively during the pre-treatment survey. This fell sharply to a mean of 5.9ft and a median of 5.5ft during the post-treatment survey – presumably due to the elimination of CLP which dominated the majority of deep water points. The littoral zone declined slightly from 14.0ft pre-treatment to 13.0ft post-treatment; however, the frequency of plant occurrence dropped sharply from 80.5% pre-treatment to 39.2% post-treatment. Total richness increased from seven species pre-treatment to eight species post-treatment, while the Simpson's Diversity Index (SDI) fell sharply from a moderate pre-treatment value of 0.52 to a very low post-treatment value of 0.22. The Floristic Quality Index (FQI) (another measure of native plant community health) increased slightly from 13.5 pretreatment to 14.0 posttreatment (Table 6).

Mean native species richness at points with native vegetation was almost unchanged from 1.13species/point pre-treatment to 1.08species/point post-treatment. Total mean rake fullness experienced a highly significant decline from a low/moderate 1.74 pre-treatment to a low 1.46 post-treatment.

Table 6: Pre/post-treatment surveys summary statistics Upper Turtle Lake, Barron County May 12-13 and June 2, 2019

Summary Statistics:	Pre	Post
Total number of points sampled	387	387
Total number of sites with vegetation	306	142
Total number of sites shallower than the maximum depth of plants	380	362
Freq. of occur. at sites shallower than max. depth of plants (in percent)	80.53	39.23
Simpson Diversity Index	0.52	0.22
Mean Coefficient of Conservatism	5.5	5.3
Floristic Quality Index	13.5	14.0
Maximum depth of plants (ft)	14.0	13.0
Mean depth of plants (ft)	7.5	5.9
Median depth of plants (ft)	7.0	5.5
Average number of all species per site (shallower than max depth)	1.06	0.42
Average number of all species per site (veg. sites only)	1.32	1.08
Average number of native species per site (shallower than max depth)	0.41	0.42
Average number of native species per site (sites with native veg. only)	1.13	1.08
Species Richness	7	8
Mean Rake Fullness (veg. sites only)	1.74	1.46

Several native aquatic plant species also suffered a significant decline. Coontail (*Ceratophyllum demersum*) was the most widely distributed native species in both the pre-treatment and post-treatment surveys. Fries' pondweed (*Potamogeton friesii*), the second most widely distributed species in the pre-treatment survey and a species known to be highly sensitive to endothall, appeared to have been eliminated from the treatment areas as none was found in the rake or seen inter-point anywhere post-treatment. Small pondweed, another species sensitive to endothall, also experienced a moderately significant decline in distribution. White water lily (*Nymphaea odorata*), a late-growing species, was the only plant that showed a moderately significant increase in distribution post-treatment (Figure 36).

Three other species (Common waterweed, Water stargrass, and Flat-stem pondweed) disappeared between the pre and post-treatment but were only present at one point each. Four other new species were identified in the post-treatment survey (Slender naiad, Northern watermilfoil, Sago pondweed, and yellow water lily (Spatterdock). However the changes in these species from pre to post were not statistically significant.

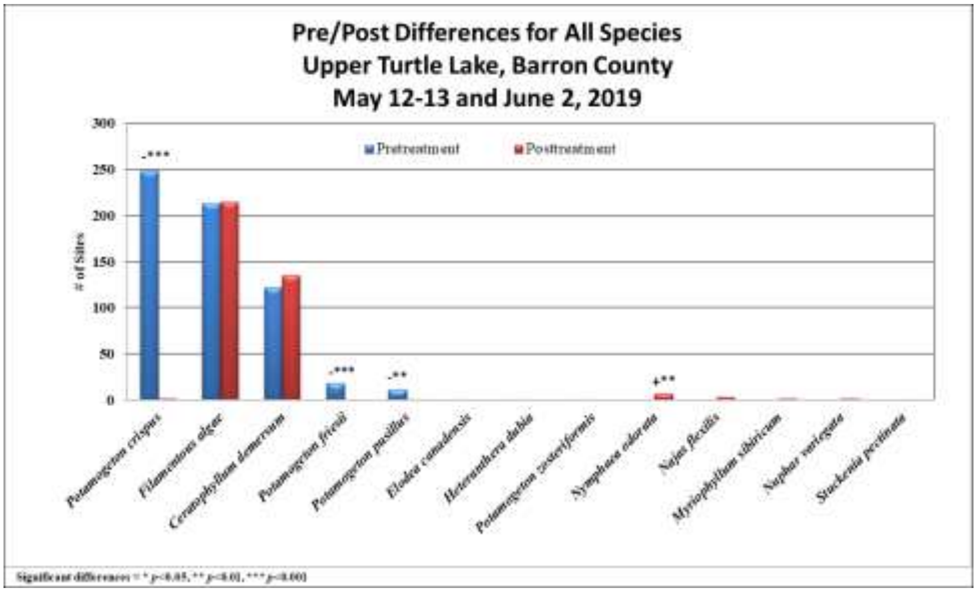

Figure 36: 2019 Pre/post-treatment changes in aquatic plants

6.3 2020

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2020). The 2019 treatment produced a highly significant reduction in CLP throughout the lake. Knowing it takes several years to exhaust the CLP turion bank, at least three years of CLP management using aquatic herbicides was planned. The year 2020 was the second year of large-scale CLP management. On May 3rd, a pre-treatment survey was conducted within the proposed treatment beds to document spring CLP densities and to finalize treatment plans.

The original CLP treatment plan for 2020 was the same as what was treated in 2019. The seven proposed treatment areas covered 74.07 acres or approximately 17.35% of the lake's 427 total acres. The May 3rd pretreatment survey found CLP at 105 of 387 sites during the pretreatment survey (27.1% coverage) (Figure 37). Of these, none had a rake fullness rating of 3, 21 rated a 2, and the remaining 84 were a 1. This produced a mean rake fullness of 1.20 and suggested that 5.4% of the treatment area had a significant infestation, way down from 2019. CLP plants were largely absent from Bed 3, so it was eliminated from the original treatment plan. Elsewhere, patchy CLP resulted in the initial treatment polygons being modified. This produced a decline of 8.77 acres (-11.84%) from initial expectations. On bed was split into two smaller beds making 8 beds totaling 65.3 acres.

Treatment occurred on May 15th, 2020 with Northern Aquatic Services applying Aquathol K (endothall) at a rate of 1.25-1.5ppm (377.7 total gallons). The reported water temperature at the time of treatment was 60°F, while the air temp was 68°F. Wind speeds were clocked at 4-7mph out of the west.

Following the herbicide application on May 15th, a post-treatment survey was completed on June 11th to evaluate the effectiveness of this control effort. During the post-treatment survey, CLP was found at ten points (2.6% coverage) all of which were represented by a single plant that was either severely chemically burned or only a few inches big suggesting it had sprouted from a latent turion after the treatment (Figure 37). These results demonstrated a highly significant decline in total CLP density and distribution as well as rake fullness 2 and 1 (Figure 38).

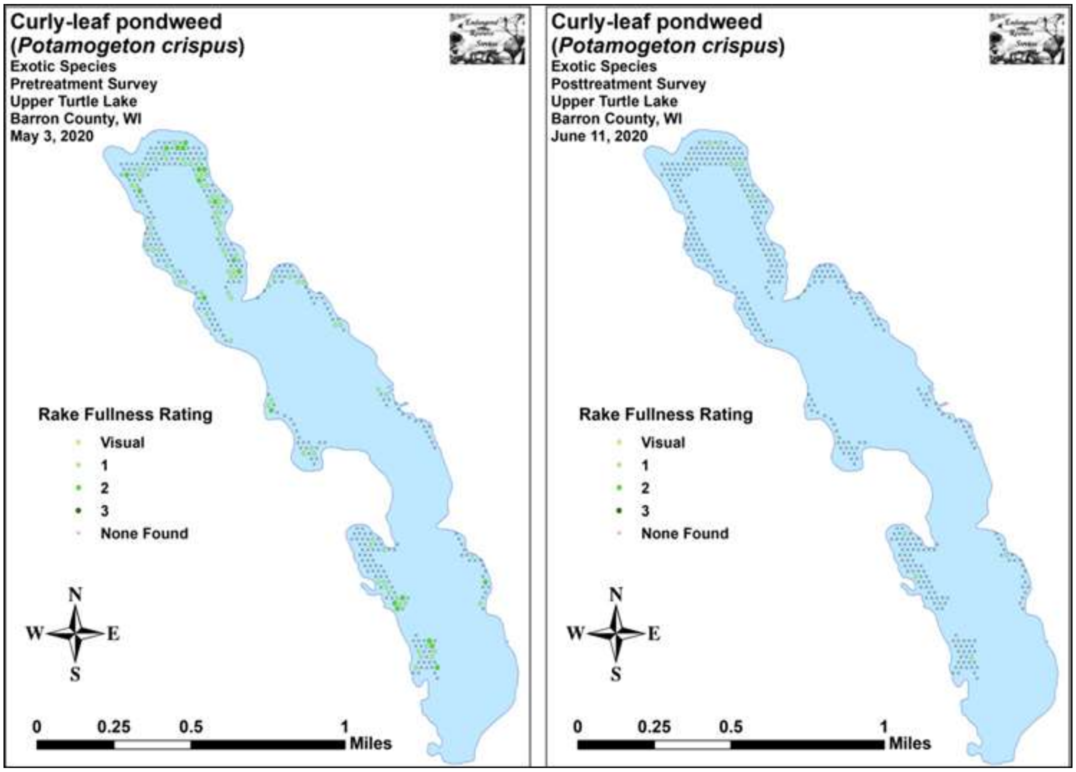

Figure 37: 2020 Pre/post-treatment CLP density and distribution

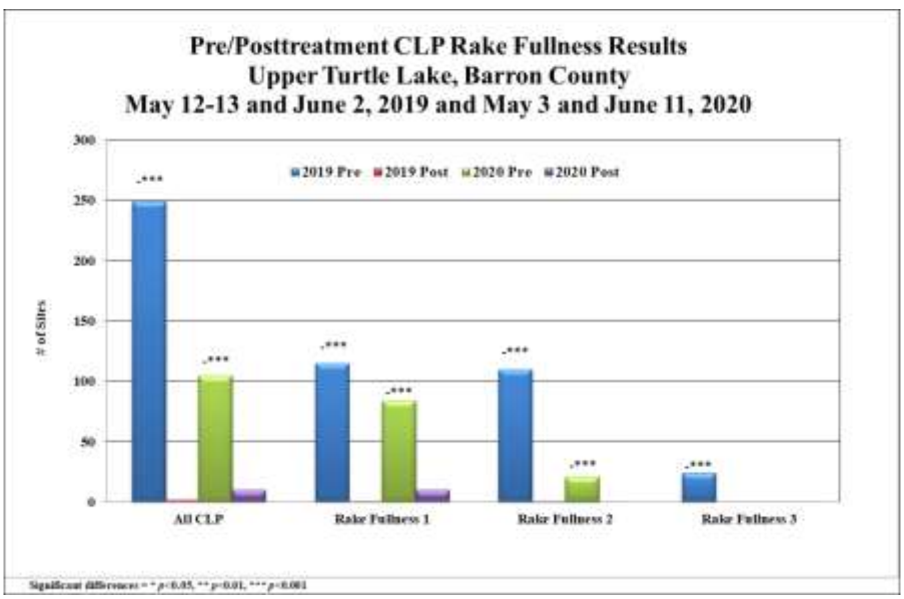

Figure 38: 2019-2020 Changes in CLP rake fullness

The littoral zone declined slightly from 14.0ft pre-treatment to 13.0ft post-treatment; however, the frequency of plant occurrence dropped sharply from 54.2% pre-treatment to 37.3% post-treatment. This was a further decline from 2019 when plant frequency was 80.5% pre-treatment and 39.2% post-treatment. Total richness increased from five species pre-treatment (down from seven species in 2019) to 12 species post-treatment (up from eight species in 2019). However, the SDI fell from a moderate pre-treatment value of 0.52 to a low 0.37

post-treatment (generally similar to 0.52 pre/0.22 post in 2019). The FQI increased slightly from 11.0 pre-treatment to 17.2 post-treatment (down from 13.5 pre/up from 14.0 post in 2019) (Table 7).

Mean native species richness at points with native vegetation experienced a moderately significant increase from a very low 1.01 species/point pre-treatment to a low 1.18/point post-treatment (in 2019 there were 1.13 species/point pretreatment and 1.08 species/point posttreatment. Total mean rake fullness saw a highly significant increase from a low 1.55 pretreatment to a low/moderate 1.79 posttreatment (in 2019 mean rake fullness was 1.74 pre/1.46 post) (Table 7).

Table 7: 2020 Pre and post-treatment, point-intercept survey results

Summary Statistics:	Pre 2020	Post 2020
Total number of points sampled	387	387
Total number of sites with vegetation	207	140
Total # of sites shallower than the maximum depth of plants	382	375
Freq. of occur. at sites shallower than max. depth of plants (in %)	54.2	37.3
Simpson Diversity Index	0.52	0.43
Mean Coefficient of Conservatism	5.5	5.2
Floristic Quality Index	11.0	17.2
Maximum depth of plants (ft)	14.0	13.0
Mean depth of plants (ft)	7.4	6.3
Median depth of plants (ft)	7.0	5.5
Average # of all species per site (shallower than max depth)	0.61	0.45
Average # of all species per site (veg. sites only)	1.12	1.20
Average # of native species per site (shallower than max depth)	0.33	0.42
Average # of native species per site (sites with native veg. only)	1.01	1.18
Species Richness	5	12
Mean Rake Fullness (veg. sites only)	1.55	1.79

Coontail was the most widely distributed native species in the pre-treatment and post-treatment surveys in both 2019 and 2020. Its 2020 distribution was almost unchanged (122 sites pre/126 post), and its increase in density from a mean rake fullness of 1.75 pre-treatment to 1.84 post-treatment was not significant. These values were generally similar to 2019 data when Coontail experienced a non-significant increase in distribution from 122 sites pretreatment to 135 sites posttreatment, but suffered a significant decline in density from a mean rake fullness of 1.60 pretreatment to 1.46 posttreatment.

Fries' pondweed was the second most common species in the 2019 pre-treatment survey, but appeared to have been eliminated from the treatment areas post-treatment. It was also not seen in 2020.

Small pondweed was seen at two points with a mean rake of 1.50 during the 2020 pre-treatment survey and at none post-treatment.

In 2019, White water lily, a late-growing species, was the only plant that showed a moderately significant increase in distribution post-treatment. The 2020 survey found filamentous algae experienced a highly significant increase in distribution and Small duckweed (*Lemna minor*), Large duckweed (*Spirodela polyrhiza*), and Common watermeal (*Wolffia columbiana*) all had significant increases in distribution. Filamentous algae, the two duckweeds, and common watermeal are all species that generally do well in degraded water quality conditions and when other, larger, rooted plants disappear from the littoral zone. In addition to the three species just mentioned, Muskgrass (*Chara sp.)* also showed up for the first time, pot-treatment. Water stargrass, Sago pondweed, Northern watermilfoil and Slender naiad were also present post-treatment in 2020 as they were in 2019 (Figure 39).

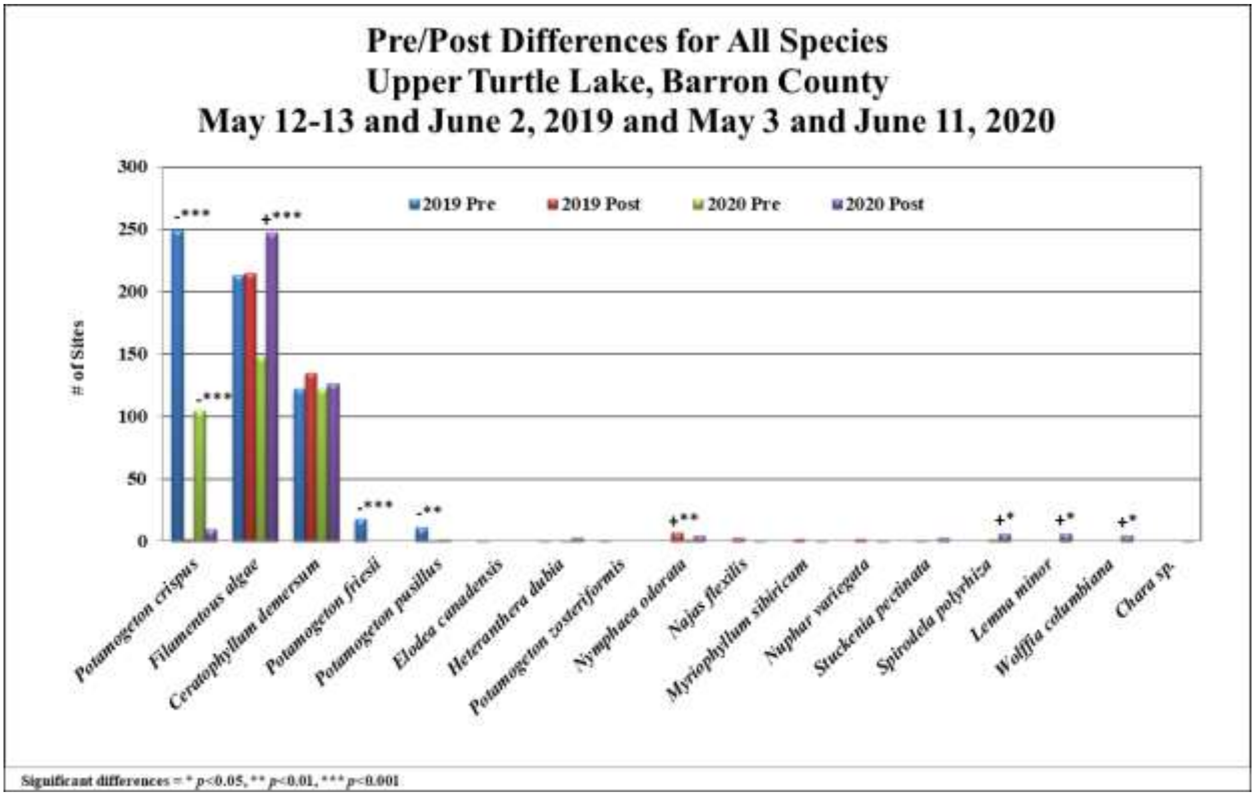

Figure 39: 2019-2020 Pre/post-treatment changes in aquatic plants

6.4 2021

Both the 2019 and 2020 treatments produced a highly significant reduction in CLP throughout the lake. Knowing it takes several years to exhaust the CLP turion bank, at least three years of CLP management using aquatic herbicides was planned. The year 2021 was the third year of large-scale CLP management. The 2021 CLP treatment plan included ten areas totaling 57.1 acres. Several of the smaller beds were combined making seven total areas. On May 1st, a pre-treatment survey was conducted within the proposed treatment beds to document spring CLP densities and to finalize treatment plans.

6.4.1 2021 Pre/Post-Treatment Plant Survey

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2021). CLP was found in the rake at 134 of 292 sites during the pre-treatment survey (45.9% coverage) with 24 additional visual sightings (Figure 40). Of these, three had a rake fullness rating of 3, 44 rated a 2, and the remaining 87 were a 1. This produced a mean rake fullness of 1.37 and suggested that 16.1% of the treatment area had a significant infestation (rake fullness 2 and 3). Because the May 1st pre-treatment survey found CLP plants were present throughout the proposed treatment areas, it was decided to continue with treatment as originally planned.

Treatment occurred on May 11th, 2021, with Northern Aquatic Services applying Aquathol K (endothall) at a rate of 1.25-1.5ppm (356.1 total gallons). The reported water temperature at the time of treatment was 57°F, while the air temp was 54°F. Wind speeds were clocked at 3-6mph out of the northwest.

During the post-treatment survey, CLP was found at 12 points (4.1% coverage) of which none rated a 3, two rated a 2, and the remaining ten were a 1 for a mean rake fullness of 1.17 (Figure 40). All of the CLP plants seen post-treatment were either chemically burned making their ability to survive or set turions questionable, or they were represented by a single plant that was only a few inches tall suggesting it had sprouted from a latent turion after the treatment. These results demonstrated a highly significant decline in total CLP distribution, rake fullness 2 and 1, and visual sightings; and a nearly significant decline in mean density (Figure 41).

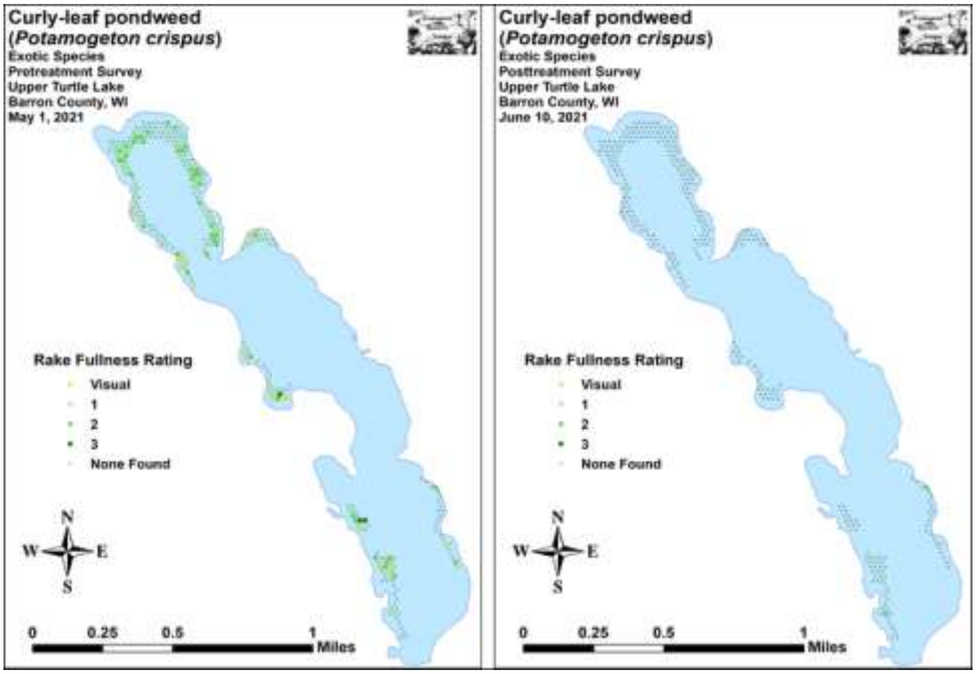

Figure 40: 2021 Pre/post-treatment CLP density and distribution

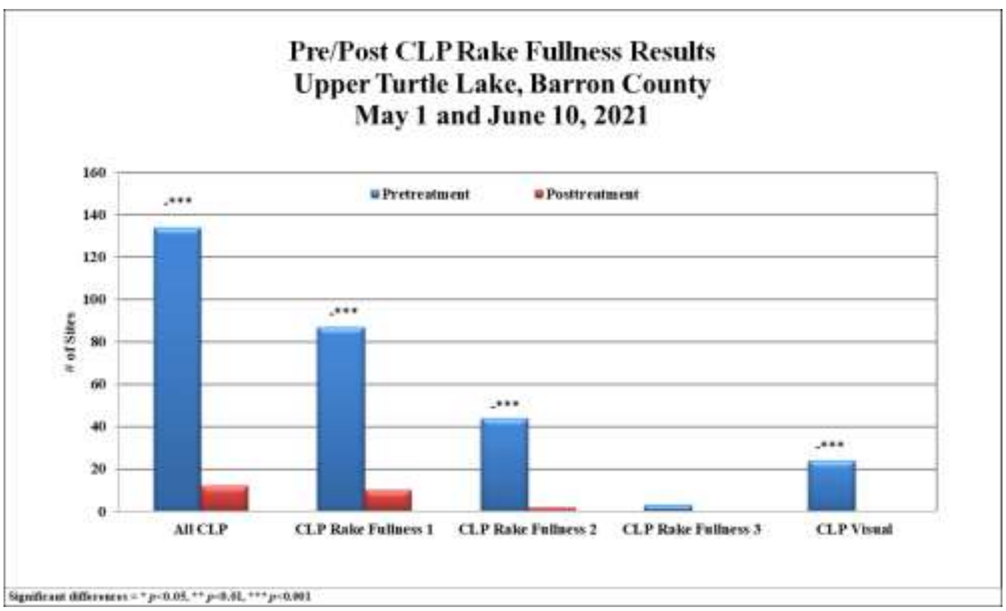

Figure 41: 2021 Pre/post-treatment changes in CLP rake fullness

The littoral zone declined sharply from 13.0ft pre-treatment to 10.5ft post-treatment. This was accompanied by a highly significant decline in the frequency of plant occurrence from 204 points (72.1% pre-treatment littoral coverage) to 103 points (41.7% post-treatment littoral coverage).

Total richness increased from four species pre-treatment to six species posttreatment. However, the SDI fell from a moderate pre-treatment value of 0.51 to a low 0.31 post-treatment. The FQI increased slightly from a very low 5.2 pre-treatment to a low 12.5 post-treatment.

Mean native species richness at points with native vegetation experienced a non-significant increase from a very low 1.02 species/point pretreatment to 1.04/point posttreatment. Total mean rake fullness saw a highly significant increase from a low 1.58 pre-treatment to a moderate 1.91 post-treatment.

Coontail was the most widely-distributed native species in the pre and post-treatment surveys. It underwent a non-significant decline in coverage from 102 sites pre-treatment to 89 sites post-treatment. However, its increase in density from a mean rake fullness of 1.72 pre-treatment to 2.02 post-treatment was moderately significant.

In the absence of rooted plants to absorb nutrients, filamentous and floating algae proliferated in the lake. Present at 158 points with a mean rake fullness of 1.40 during the pre-treatment survey, filamentous algae underwent a highly significant post-treatment increase in both density and distribution to 214 sites with a mean rake of 1.73. The algae not only covered many parts of the bottom, but also tended to create mats at the surface.

No other species showed significant changes in distribution from pre to post in 2021 (Figure 42). Similarly, no native species were common enough to do individual statistical density analysis on. Northern watermilfoil, white water lily, muskgrass, and water stargrass were still present in the post-treatment survey, however, common waterweed and sago pondweed were not.

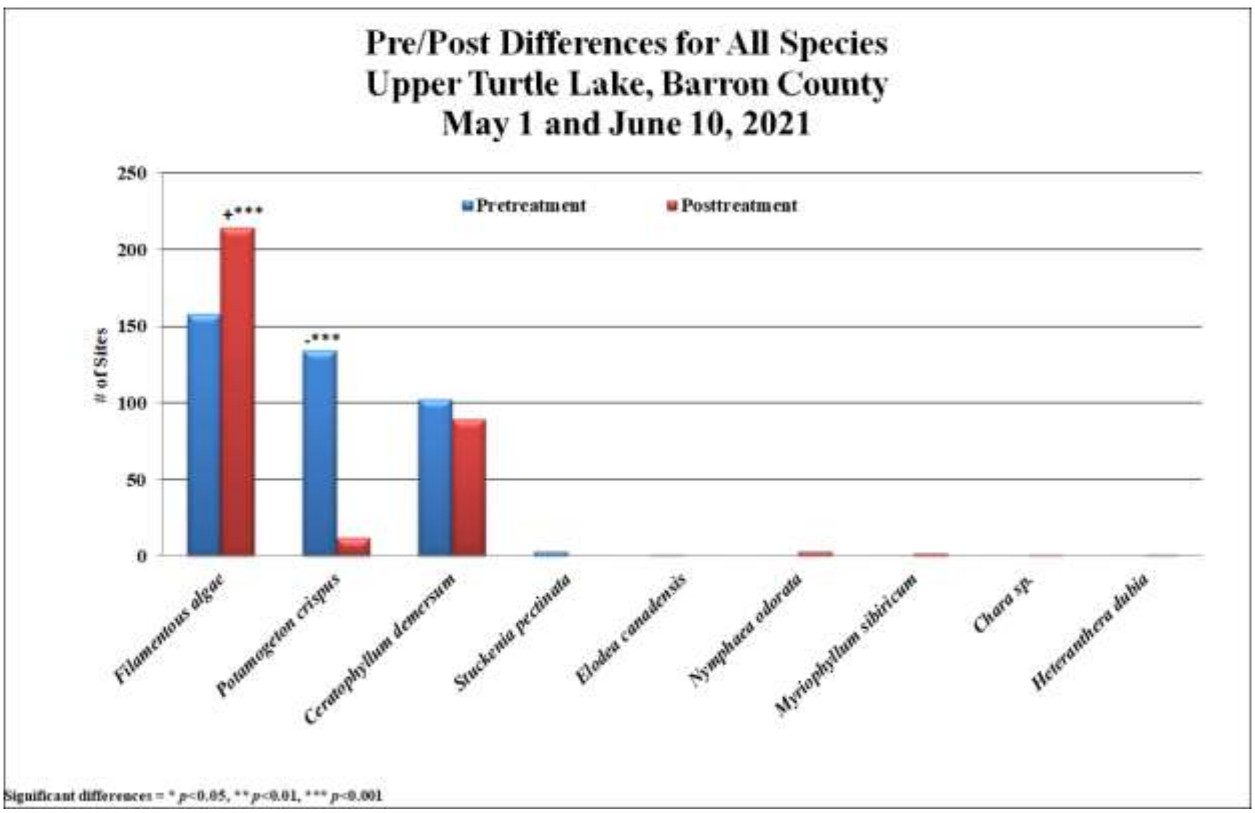

Figure 42: 2021 Pre/post-treatment changes in aquatic plants

6.4.2 2021 CLP Turion Survey

Information in this section is taken from a report prepared by Endangered Resource Services (Berg M. , 2021a). Following the 2021 summer growing season, a repeat of the 2018 fall turion survey was conducted. The goals of the survey were to determine the remaining level of CLP turions within the lake's historic high density CLP areas; compare these levels to the original turion survey data from 2018; and predict whether the levels of remaining turions suggested there would likely be navigation issues in 2022.

The 2021 survey showed a dramatic and highly significant reduction of CLP turions in the lake following three years of large-scale active management. Collectively, a total of just 68 turions – a 77.0% reduction compared to the 2018 survey – were counted. Turions were present at 33 of 80 points (41.3% coverage) – a 37.7% reduction in total coverage. Of these, none exceeded the expected "nuisance level" of 200/m2, and only nine points (11.3% coverage/27.3% of points with turions) topped 50 turions/m2 suggesting they would have any potential for navigation impairment (Table 8). Visual analysis of the map found no areas are likely to have widespread impairment with the possible exception of the northern half of Bed 1 on the southwest shoreline (Figure 43). Despite this area, the lake-wide reduction in the mean turion density compared to 2018 was highly significant.

Three years of large-scale chemical treatment of CLP was able to reduce the amount of CLP that should be present in the lake. Ultimately, the level of CLP growth the UTLD and its constituency is comfortable with will determine how much, if any, of the lake is actively managed for CLP in the coming years. In addition to this, negative impacts on water quality and the native aquatic plant community, and how both can recover, must be considered.

Table 8: CLP Turion Survey - Summary Statistics Upper Turtle Lake, Barron County October 28, 2018 and October 17, 2021

Summary Statistics:	2018	2021
Total number of points sampled	80	80
Total # of points with live turions	53	33
Frequency of occurrence (in percent)	66.3	41.3
Total live turions	296	68
Number of points at or above potential impairment (+50/m^2)	37	9
% potential impairment	46.3	11.3
Number of points at or above predicted nuisance level (+200/m^2)	9	0
% nuisance level	11.3	0.0
Maximum turions/m^2	689	194
Mean turions/m^2	79.65	18.30
Standard deviation/m^2	112.95	31.60
Standard error of the paired difference		0.57
Degrees of freedom		79
t-statistic		-5.02
p - value		**$<$0.001**

Significant differences = * $p<0.05$, ** $p<0.01$, *** $p<0.001$

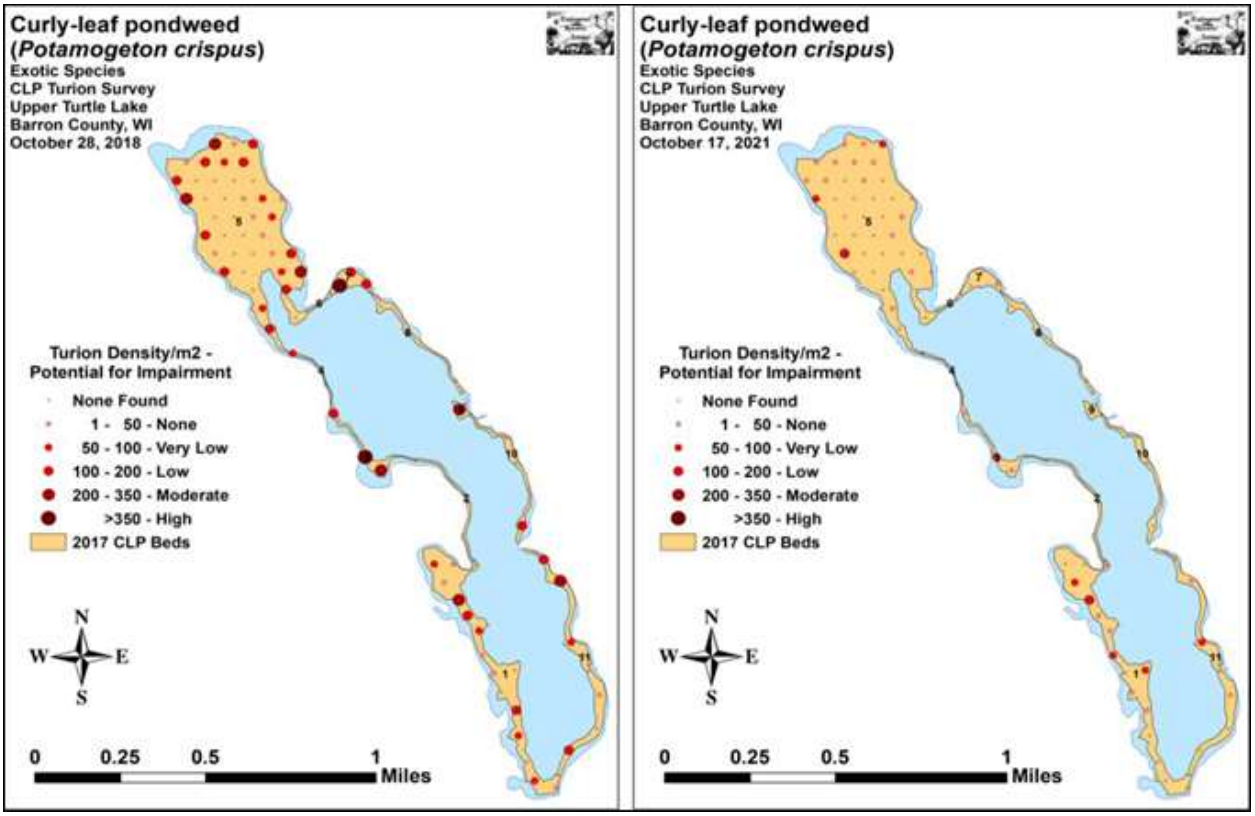

Figure 43: 2018 and 2021 Fall CLP Turion Survey Density and Distribution

6.5 2018-2021 Pre/Post Summary

From 2018 to 2021 between 9 and 75 acres of CLP was chemically managed each year (Table 9). Through pre and post-treatment, point-intercept aquatic plant survey work completed in each year of management, it is clear that the use of liquid endothall effectively controlled CLP, even succeeding in bringing down the level of turions in the sediment beneath the treated areas. Unfortunately, pre and post-treatment survey work also showed that several native species were significantly and negatively impacted by the use of endothall. Fries pondweed and Flat-stem pondweed disappeared from the treatment areas after the 2019 treatment. Small pondweed disappeared after the 2021 treatment. Several other species may have been negatively impacted including Illinois pondweed, Clasping-leaf pondweed, and Blunt-leaf pondweed, however these impacts were not significant. Several species increased significantly in density and distribution including Small and large duckweed and Watermeal. Several other species including White waterlily, Water stargrass, and Northern watermilfoil also increased in density and distribution, but were not significant. Filamentous algae in the treated areas showed a hugely significant increase in density and distribution. Filamentous algae, along with the duckweeds, common watermeal and white water lily are all native plant species that do well under degraded water quality conditions and would be expected to flourish in the absence of other native aquatic plants and abundant nutrients.

Table 9: 2018 to 2021 CLP chemical management summary

CLP Management - Upper Turtle Lake Aquathol K (liquid endothal)			
Year	**Beds**	**Acres**	**Conc (ppm)**
2018	1	9.88	1.5
2019	7	74.09	1.25
2020	8	65.3	1.25
2021	7	57.1	1.25

6.6 Water Quality and Aquatic Plant Management

From previous sections of this Plan, it is clear that water quality is declining in UTL, but how does water clarity, phosphorus, and chlorophyll-a during the last four years chemical management of CLP compare to previous blocks of time when CLP management was not taking place. Figure 44 reflects the mean average Secchi reading of water clarity over 5-yr blocks of time working back from 2022. It is clear that from 2018 to 2022 when CLP was actively managed during four of the five years, water clarity is worse.

Figure 45 reflects TP and Chla values over three blocks of consistent water sampling. Like water clarity, it appears that the last years when CLP management has taken place has increased the amount of algae in the lake as indicated by elevated TP and Chla concentrations. Of note however, is that the worst year for TP was in 2017 when 130 plus acres of CLP was mapped and no management was completed. The second worst year was 2022 when no CLP management was completed and the amount of CLP was significantly reduced.

It can be reasoned that in 2017 no management of 132 acres of CLP increased the amount of available phosphorus in the water, likely when the CLP senesced and released its phosphorus into the water column. However, the same reasoning does not apply in 2022 when no management was completed and there was only a limited amount of CLP present. The difference in 2022 would be the decline in native aquatic plant diversity and density that occurred as a result of 4 years of intensive CLP management. Fewer large plants use up less of the available phosphorus, so more is available to grow algae.

Also of note is the fact that the data shows that TP and Chla concentrations were already higher from 2010 to 2015 than they were from 2000-2005. This suggests that other factors are also influencing water quality.

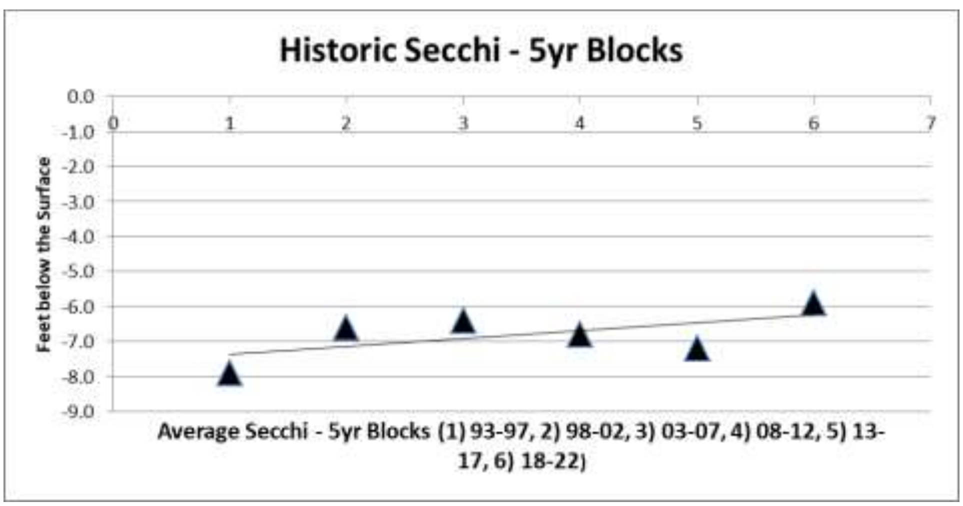

Figure 44: Historic water clarity (based on Secchi readings from 5-yr blocks of time from 1993 to 2022

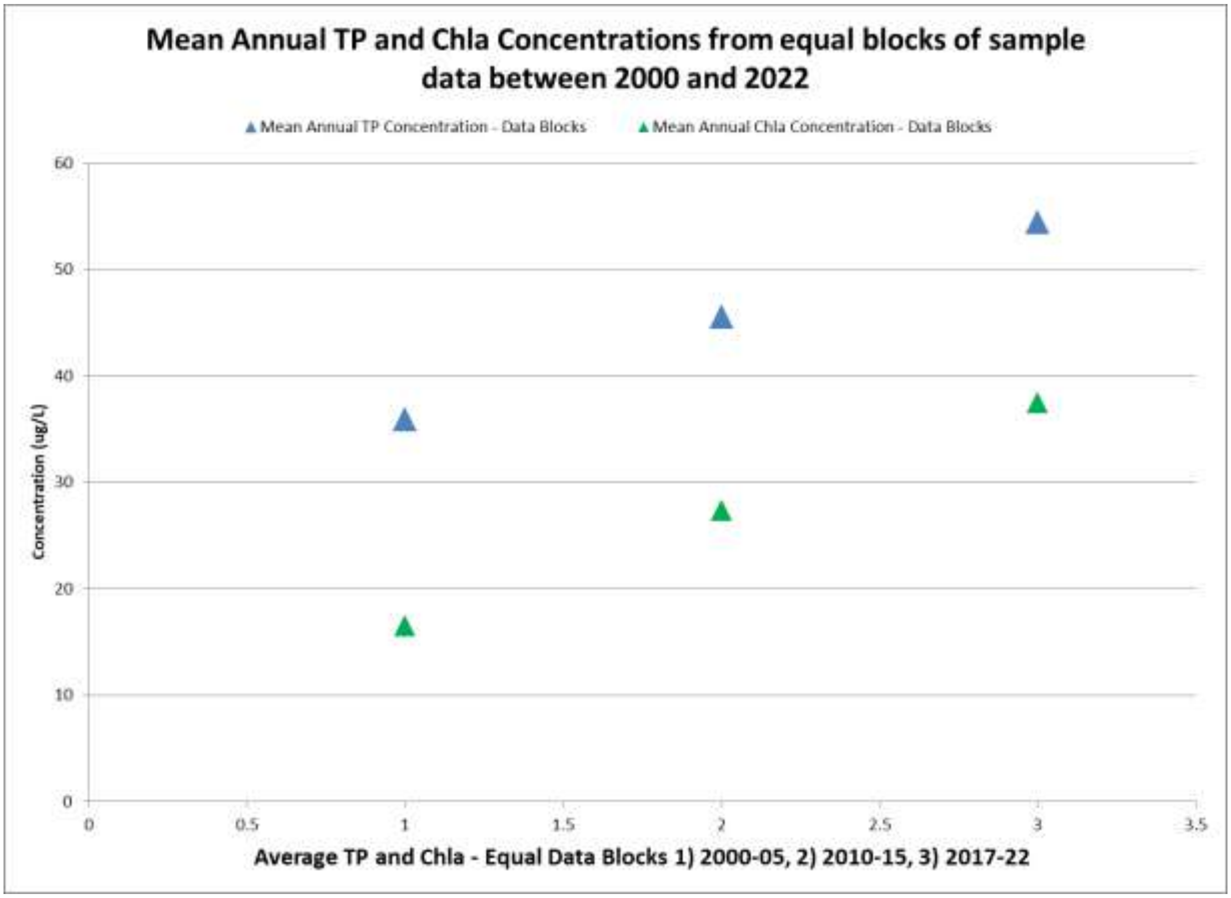

Figure 45: Changes in TP and Chla concentrations over time based on equal blocks of data collected 2000-05, 2010-15, and 2017-22

7.0 2010, 2017, and 2022 Aquatic Plant Surveys

While there is always some natural variation from year to year in the makeup of the aquatic plant community in a lake, human changes to a lake, including intensive management of an invasive species like CLP, may have a more obvious impact to aquatic plants. Under active management, it is recommended by the WDNR that whole-lake, point-intercept, aquatic plant surveys be completed at least every five years. There have been three such surveys completed in UTL. An initial APM Plan was developed in 2011 using data from the first whole lake point-intercept survey completed in 2010. As a precursor to updating the 2011 plan in 2018, another point-intercept survey using the same points and procedure from the 2010 survey was completed in 2017. Results from the 2017 survey were compared to the 2010 survey to determine how the lake's vegetation may have changed. This survey was again completed in 2022 as a precursor to updating the 2018 plan. The 2022 survey included an early-season point-intercept survey, CLP bed mapping, and a full point-intercept survey for all aquatic plants on in mid-summer.

7.1 2010, 2017, and 2022 Early Season, Whole-lake, CLP Point-intercept Surveys

Information in the next several sections related to plant survey work completed in the lake, is taken in part from reports written by ERS (Berg M. S., 2023).

Using a 595 point sampling grid established for UTL in 2010, a whole-lake, point-intercept survey was completed in the spring of each year during the height of CLP growth. Each survey point was located using a handheld mapping GPS unit and a rake used to sample an approximately 2.5ft section of the bottom. When found, CLP was assigned a rake fullness value of 1-3 as an estimation of abundance. Visual sightings of CLP within six feet of the sample point were also documented. In 2010, 256 points were sampled during the early season PI. In 2017, 290 points were sampled; and in 2022, 224 points were sampled. Data from the 2010, 2017, and 2022 CLP point-intercept surveys were compared to see if there were any significant changes in the lake's vegetation. For individual plant species as well as count data, Chi-square analysis was used on the WDNR Pre/Post survey worksheet. For comparing averages (mean species/point and mean rake fullness/point), t-tests were used. Differences were considered significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$ (UWEX 2010).

The 2010 early season PI survey found CLP at 52 of 256 sites which approximated to 8.7% of the entire lake and 20.3% of the then 13.0ft spring littoral zone. A rake fullness value of 3 was recorded at ten points, a 2 at 25 points, and a value of 1 at 17 points for mean rake fullness of 1.87. CLP was also recorded as a visual at six points. The combined 35 points with rake fullness of 2 or 3 extrapolated to 5.9% of the entire lake and 13.7% of the littoral zone having a significant infestation (Figure 46).

Because CLP was found growing to 15.0ft in 2017 (up from 13.0ft in 2010), every point in the lake <17ft. was rake sampled during the early-season point-intercept survey. CLP was found at 216 of 290 points which approximated to 36.3% of the entire lake and 74.5% of the spring littoral zone. A rake fullness value of 3 was recorded at 69 points, a 2 at 71 points, and a 1 at 76 points for combined mean rake fullness of 1.97. CLP was noted as a visual at an additional eight points (Figure 46). The combined 140 points with rake fullness of a 2 or a 3 extrapolated to 23.5% of the entire lake and 48.3% of the spring littoral zone having a significant infestation.

The changes from 2010 to 2017 suggested a highly significant increase in total CLP as well as rake fullness 3, 2, and 1; however, the increase in combined mean rake fullness was not significant ($p=0.19$). Collectively, from 2010-2017, there was a 315% increase in total CLP coverage as well as an even 300% increase in areas where the infestation was significant enough to likely be considered a nuisance.

The 2022 early season PI survey found CLP at 57 of 224 points which approximately to 9.6% of the entire lake and 25.4% of the spring littoral zone. A rake fullness value of 3 was recorded at 26 points, a 2 at 9 points, and a 1 at 22 points for combined mean rake fullness of 2.07. CLP was noted as a visual at an additional 11 points (Figure 47).

Following four years of active management, 2022 results documented a complete reversal as highly significant declines in total CLP as well as rake fullness 3, 2, and 1 were found (Figure 48). Collectively, from 2017-2022, there was a -73.6% decline in total CLP coverage as well as an even -75% decline in areas where the infestation was significant enough to likely be considered a nuisance.

To better understand the changes since the original 2010 survey, that data was compared with the 2022 survey (brackets in Figure 48). These results showed non-significant increases in total, total distribution, rake fullness 1, and visual sightings; a moderately significant increase in rake fullness 3; and a significant decline in rake fullness 2. Total coverage from 2010-2022 increased by 9.6%; however, nuisance coverage was unchanged. Taken in this context, the UTLMD's management from 2018-2021 has essentially returned CLP to 2010 levels, which was the stated goal for management in the 2018-22 APM Plan.

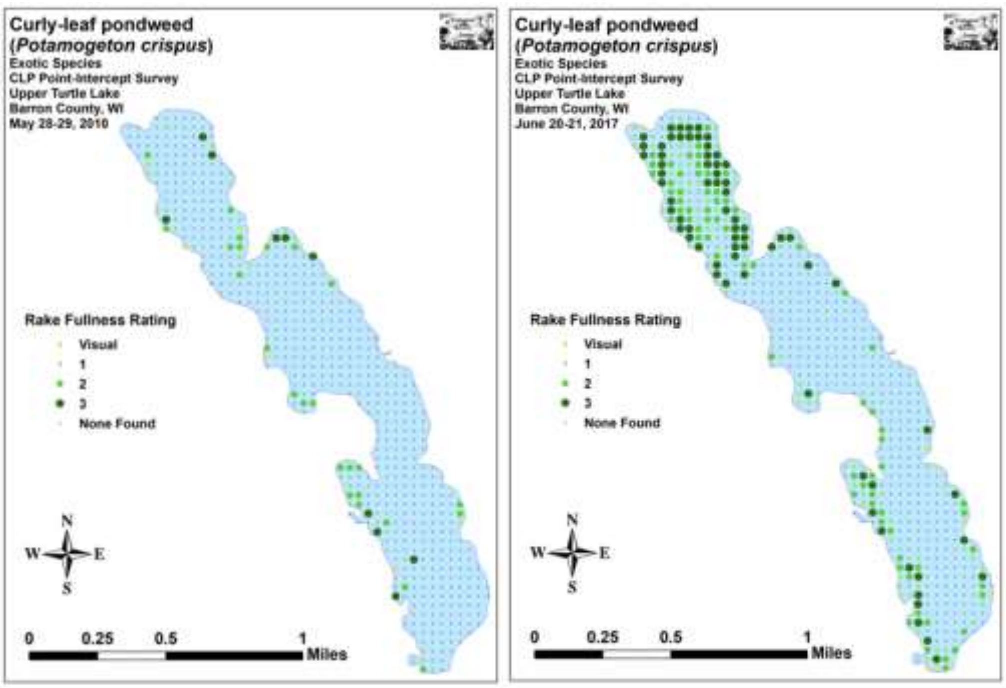

Figure 46: 2010 and 2017 early season CLP point-intercept survey results

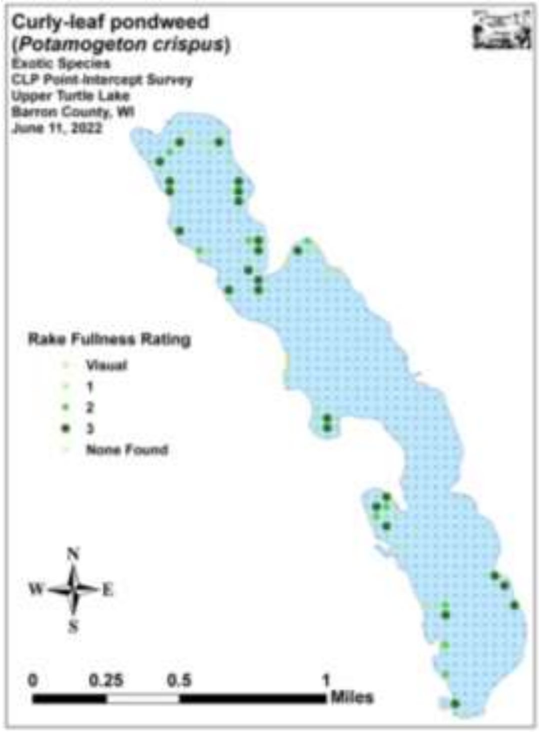

Figure 47: 2022 Early season CLP point-intercept survey results

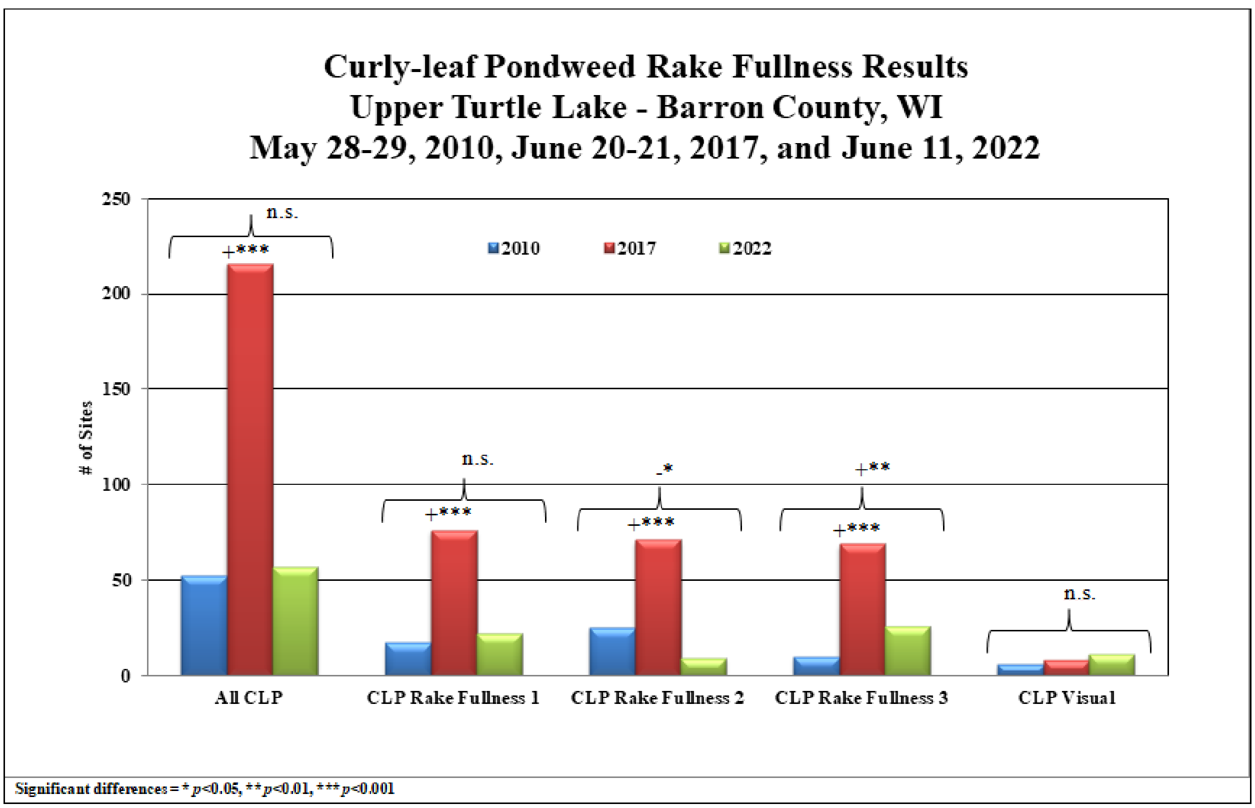

Figure 48: 2010, 2017, and 2022 Changes in Early-season CLP Rake Fullness (ERS)

7.2 2010, 2017, and 2022 CLP Bed Mapping

During a bed mapping survey, the lake's entire visible littoral zone is searched. By definition, a "bed" is determined to be any area where CLP was visually estimated to make up >50% of the area's plants, is generally continuous with clearly defined borders, and is canopied, or close enough to being canopied that it would likely interfere with boat traffic. After a bed is located, GPS coordinates are taken at regular intervals while motoring around the perimeter of the area. The GPS points are used to create maps with the acreage of each area. The rake density range and mean rake fullness of each area or bed mapped is also estimated. The maximum depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (none – easily avoidable with a natural channel around or narrow enough to motor through/minor – one prop clear to get through or access open water/moderate – several prop clears needed to navigate through/severe – multiple prop clears and difficult to impossible to row through) is also recorded.

In 2010, 33 CLP beds scattered throughout the lake's littoral zone were mapped (Figure 49). Only four were greater than 0.5 acre, and, collectively, they covered 7.83 acres (1.83% of the lake's 427 acres). The 2017 survey showed a dramatic increase in coverage as CLP dominated the entire littoral zone with the exception of sandy and rocky areas next to the immediate shoreline and areas that were dominated by lily pads. Although the lake essentially contained one continuous bed, it was divided into 11 separate areas based on density and potential navigation impairment. In total, canopied CLP covered 132.40 acres (31.0% of the lake's surface area). This represented a 124.57 acre increase (+1,590%) over the 2010 bed mapping survey (Figure 49).

In 2022, 16 beds scattered throughout the lakes littoral zone were mapped totaling 16.64 acres (3.9% of the lake's 427 acres) (Figure 50). Of these, 7 were greater than an acre in size (one-4 acres+, two-2 acres+, four-1 acre+). The rake fullness value or density rating for 10 of the 16 beds was considered a 2 or 3 indicating approximately 3.0% of the entire lake surface with a moderate to severe infestation of CLP, down 918% from the 2017 totals.

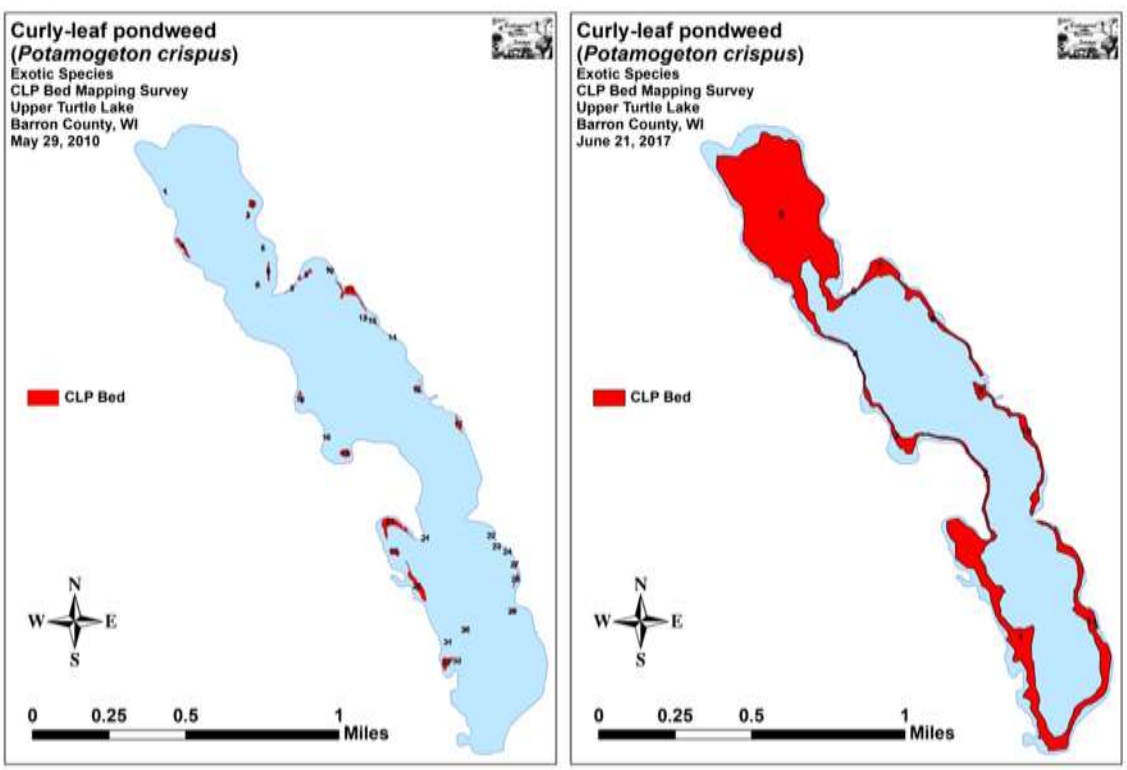

Figure 49: 2010 and 2017 CLP bed mapping results

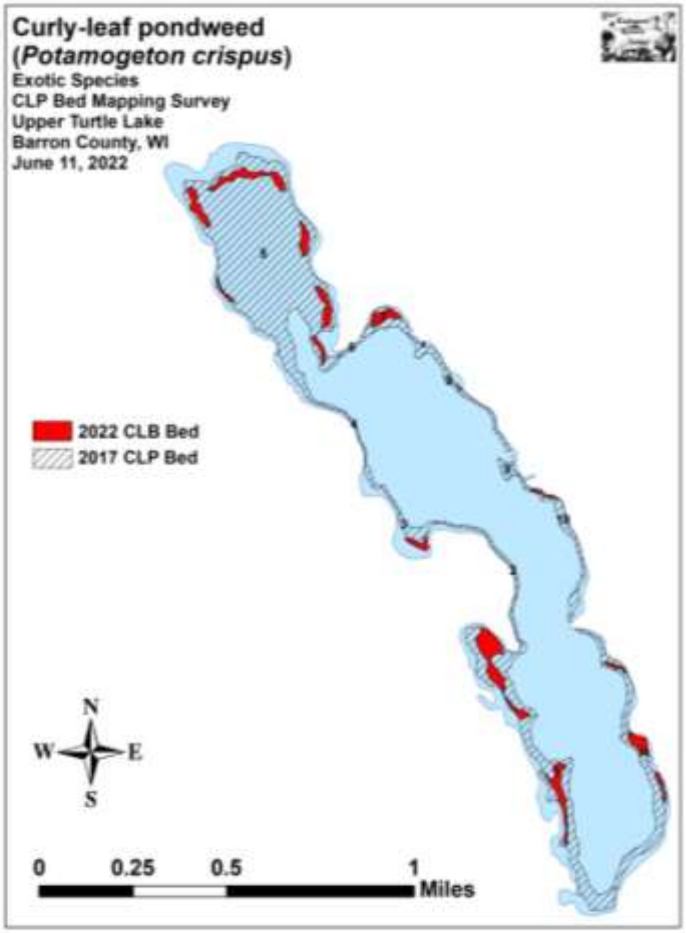

Figure 50: 2022 CLP bed mapping results

7.3 2010, 2017, and 2022 Warm-water Whole-lake, Point-intercept Aquatic Plant Survey

In July 2022 plants were found growing to 12.5ft (down from 14.0ft in 2017 and 13.5ft in 2010). The 155 points in 2022 with vegetation (approximately 26.1% of the entire lake bottom and 66.8% of the littoral zone) were a non-significant decline from 2017 when plants were found at 163 sites (27.4% of the entire lake bottom/59.7% of the littoral zone). This decline was also non-significant when compared to the 166 points with vegetation found during the 2010 survey (27.9% total coverage/62.6% littoral coverage) (Figure 51).

Growth in 2022 was slightly skewed to deep water as the mean plant depth of 4.9ft was more than the median depth of 4.0ft. Each of these values were lower than in 2017 when deep water plants were more common (mean of 5.5ft/median of 4.5ft), but they are nearly identical to 2010 when a mean of 5.2ft and an identical median of 4.0ft was calculated.

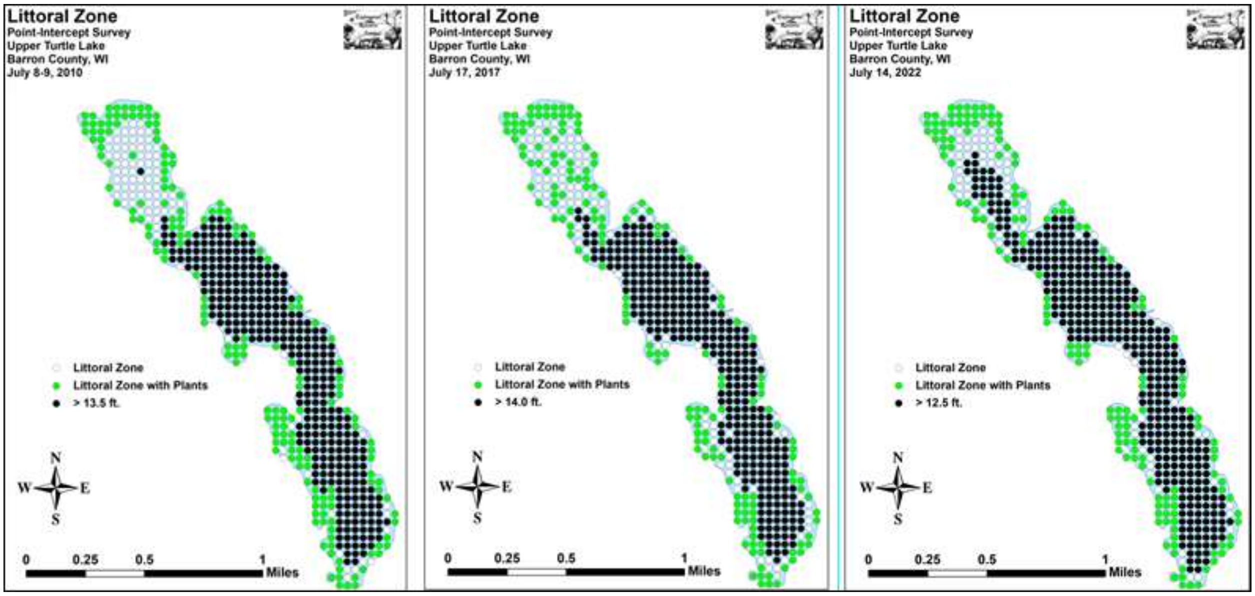

Figure 51: 2010, 2017, and 2022 Littoral Zone

Plant diversity was moderately high in 2022 with a Simpson Index value of 0.83; however this was down sharply from 0.88 in 2017 and 0.89 in 2010. Species richness was low/moderate with 27 species found in the rake (down from 28 in 2017 and 31 in 2010); however, this total increased to 35 species when including visuals and plants seen during the boat survey. This number was also down slightly from the 38 total species found in 2017 and 40 total species found in 2010.

From 2010 to 2017, a non-significant decline in mean native species richness at sites with native vegetation was documented - from 3.01 species/site to 2.97 species/site. Visual analysis of the maps suggested the north bay experienced a widespread increase in localized richness, while the southern 1/3rd of the lake showed an almost equal decline (Figure 52).

In 2022, a further and highly significant decline in mean native species richness was documented – down to 2.17 species/site. Although these losses in localized richness appeared to be a lakewide event, they were especially pronounced in the north bay (Figure 53).

Total rake fullness experienced a highly significant decline from a high/moderate 2.33 in 2010 to a low/moderate 1.79 in 2017. It was noted by the surveyor, that this decline was a lakewide event, and, with few exceptions, the only sizable remaining high density beds occurred near the creek inlet and in shallow water near shore in the most nutrient-rich bays (Figure 54).

In 2022, the lake's biomass underwent a highly significant rebound to a high/moderate 2.32 – nearly identical to 2010 levels. Analysis of the maps showed localized rake density from the 2010 and 2022 surveys were almost identical in all parts of the lake (Figure 54).

A comparison of all statistical values from the 2010, 2017, and 2022 summer, whole-lake, point-intercept aquatic plant surveys is given in Table 10.

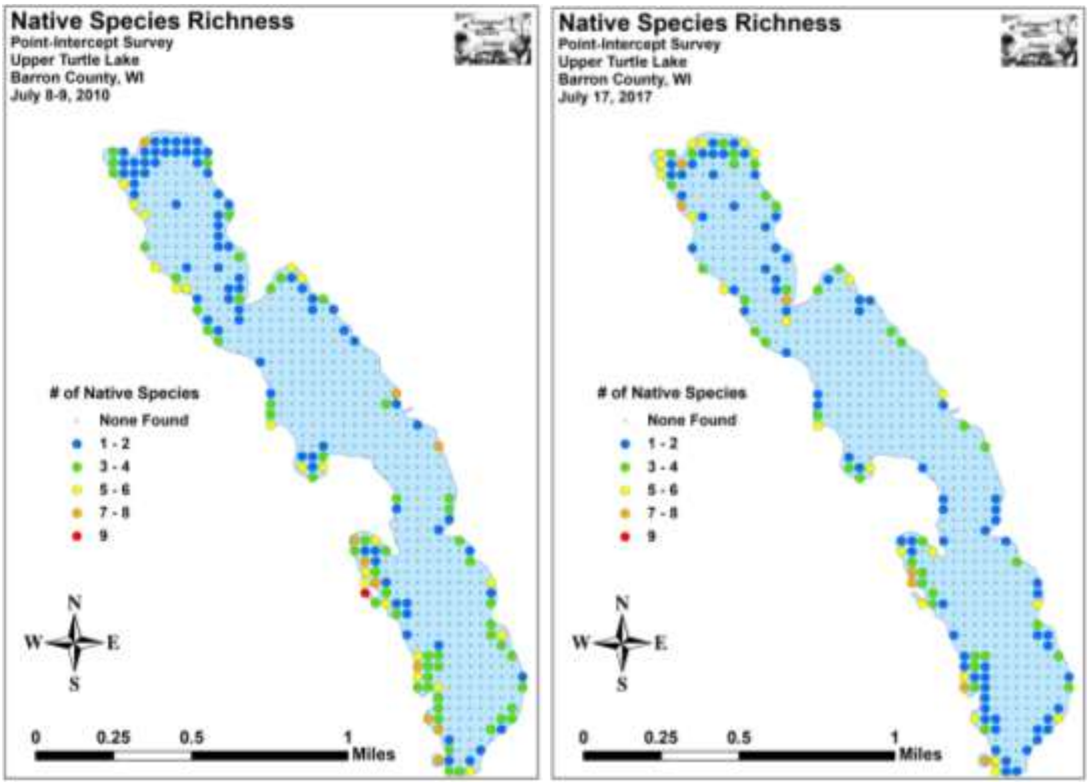

Figure 52: 2010 and 2017 Native Species Richness

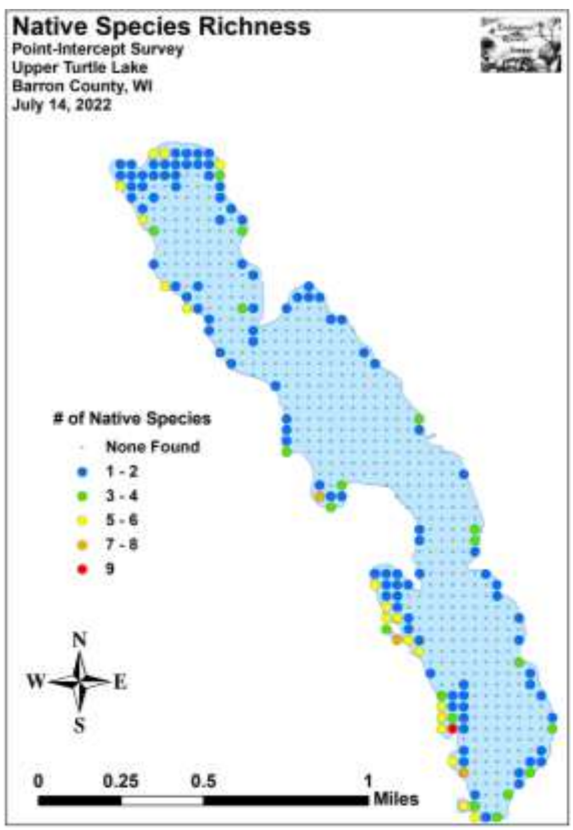

Figure 53: 2022 Native Species Richness

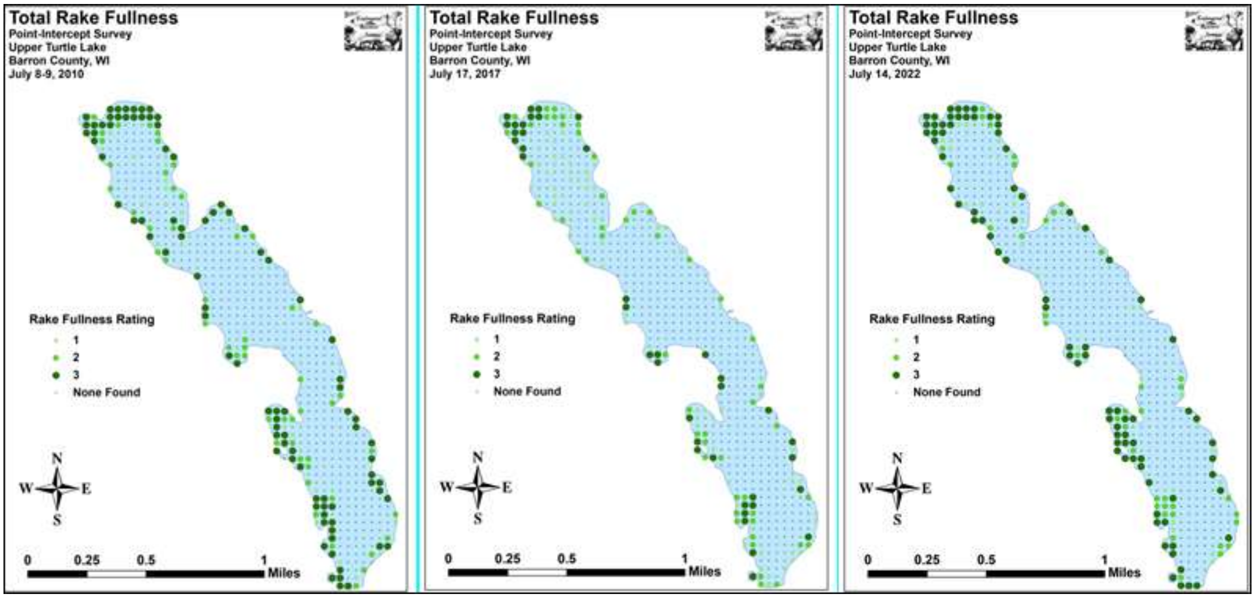

Figure 54: 2010, 2017, and 2022 Total Rake Fullness

Table 10: Aquatic Macrophyte P/I Survey Summary Statistics 2010, 2017, and 2022

Summary Statistics: Upper Turtle Lake	2010	2017	2022
Total number of points sampled	595	595	595
Total number of sites with vegetation	166	163	155
Total number of sites shallower than the maximum depth of plants	265	273	232
Frequency of occurrence at sites shallower than maximum depth of plants	62.6	59.7	66.8
Simpson Diversity Index	0.89	0.88	0.83
Maximum depth of plants (ft)	13.5	14.0	12.5
Mean depth of plants (ft)	5.2	5.5	4.9
Median depth of plants (ft)	4.0	4.5	4.0
Number of sites sampled using a rake on a rope	0	15	0
Number of sites sampled using a rake on a pole	297	374	280
Average number of all species per site (shallower than max depth)	1.92	1.70	1.51
Average number of all species per site (veg. sites only)	3.07	2.84	2.26
Average number of native species per site (shallower than max depth)	1.87	1.59	1.37
Average number of native species per site (sites with native veg. only)	3.01	2.97	2.17
Species richness	31	28	27
Species richness (including visuals)	35	29	30
Species richness (including visuals and boat survey)	40	38	35
Mean rake fullness (veg. sites only)	2.33	1.79	2.32

7.3.1 Changes in Native Aquatic Plant Species

From 2010 to 2017, when no aquatic plant management had taken place, ten native aquatic plant species showed significant changes lakewide. Fries' pondweed, Northern water-milfoil, and Muskgrass suffered highly significant declines; Illinois pondweed and Wild celery underwent moderately significant declines; and Slender naiad saw a significant decline. Conversely, filamentous algae demonstrated a highly significant increase; White water lily had a moderately significant increase; and CLP and Forked duckweed experienced significant increases. Taken as a whole, these results suggested the lake had undergone a habitat shift away from rooted species that need at least fair water clarity toward species that can tolerate poor clarity (White water lily), favor high suspended nutrient levels (duckweeds and filamentous algae), and exploit disturbance (CLP).

From 2017 to 2022, after 4-yrs of active CLP management using herbicide, nine species saw significant changes in distribution. Flat-stem pondweed, Fries' pondweed, and Small pondweed suffered highly significant declines; and filamentous algae, Small duckweed, and Forked duckweed saw significant declines. Conversely, Coontail underwent a moderately significant increase; and Slender naiad and Muskgrass each experienced significant increases. Flat-stem, Fries', and Small pondweeds (Figure 55) were all previously dominant plants in Upper Turtle Lake. Their decline is not entirely surprising given that each is sensitive to the same chemical (endothall) used to control CLP, so it is likely that their decline is tied to the management program. Several other species may have been negatively impacted including Illinois pondweed, Clasping-leaf pondweed, and Blunt-leaf pondweed, however these impacts were not significant. The increase in Coontail may be in response to its ability to rapidly exploit open habitat (Figure 56).

Perhaps no species benefitted more from the changes on the lake than White water lily (Figure 56). Present in the rake at six points with a mean density of 1.50, it was just the seventeenth-ranked species during the original 2010 survey. By 2017, it had undergone a moderately significant increase in distribution (18 points) and a significant increase in density (mean rake fullness of 2.06) as it rose to the eight-ranked species in the community. In 2022, it jumped to the sixth-ranked species as it continued to expand – primarily along the western shoreline of the lake. Although neither the increase in distribution (22 sites) nor the increase in biomass (mean rake of 2.18) were significant compared to 2017 (p=0.40/p=0.30), each of these values represented highly significant increases compared to the original 2010 survey. Water stargrass (Figure 56) is another species that increased from 2017 to 2022. Filamentous algae showed a significant increase in density and distribution (Figure 57). Filamentous algae, coontail, white water lily, and water stargrass are all native plant species that do well under degraded water quality conditions and would be expected to flourish in the absence of other native aquatic plants and abundant nutrients.

Figure 55: Fries pondweed, Flat-stem pondweed, and Small pondweed

Figure 56: Coontail, Water stargrass, White water lily


Figure 57: Floating mats of filamentous algae at the edge of lily pads – 6/10/21

7.4 Wild Rice

Wild rice is an aquatic grass which grows in shallow water in lakes and slow flowing streams. This grass produces a seed which is a nutritious source of food for wildlife and people. The seed matures in August and September with the ripe seed dropping into the sediment, unless harvested by wildlife or people. It is a highly protected and valued natural resource in Wisconsin. Only Wisconsin residents may harvest wild rice in the state. According to the WDNR Surface Water Data Viewer, Upper Turtle Lake is not wild rice water.

8.0 Non-native, Aquatic Invasive Plant and Animal Species

CLP is the most problematic non-native, AIS in the lake. Purple loosestrife and reed canary grass are invasive wetland plants that are found within the wetlands around Upper Turtle Lake. There are also several non-native invasive species that are not currently found within or around the lake, but could be introduced if preventative measures are not taken. Chinese Mystery Snails are abundant in UTL and common carp are present, but no other animal species is present. Zebra mussels likely pose the greatest threat to UTL as there are several lakes in NW Wisconsin that could act as a source lake for transient boaters using UTL. More information is given for each non-native species in the following sections.

8.1 Curly-leaf Pondweed

Curly-leaf Pondweed is found throughout the entire littoral zone of Upper Turtle Lake, and it has become one of the most prevalent AIS found throughout Wisconsin. There are over 15 lakes within Barron County that have CLP present including Lower Vermillion, Poskin Lake, and Beaver Dam Lake.

Curly-leaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 58). It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all of Lower 48 States and most of Canada.

CLP spreads through burr-like winter buds (turions) (Figure 58), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring. It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. CLP forms surface mats that interfere with aquatic recreation.

Figure 58: CLP Plants and Turions

8.2 Eurasian Watermilfoil (EWM)

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 59). 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 59: EWM

EWM is not currently found on UTL, but it can be found nearby in Echo, Beaver Dam and Lower Vermillion Lakes less than ten miles from UTL. Because there is a large population of Northern watermilfoil, there is the potential for EWM and NWM to hybridize if EWM were to be introduced to UTL. This hybrid milfoil is believed to be less sensitive to chemical management than the parental strands which make management much more difficult (LaRue, Zuelling, & Thum, 2012). This hybrid milfoil can be found in nearby Horseshoe Lake. Because there are several established populations of EWM and its hybridized counterpart so close to UTL, prevention and monitoring for this AIS should be a large part of future management.

8.3 Purple Loosestrife

Purple loosestrife (Figure 60) 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.

Purple loosestrife has been identified in the wetlands surrounding UTL, but it has not developed into the monotypic beds that can damage wetlands. While this should be monitored for any change, active management of purple loosestrife is not required.


Figure 60: Purple Loosestrife

8.4 Japanese Knotweed

Knotweeds are robust, bamboo-like perennials introduced from Asia that are spreading throughout the Great Lakes states. The main species is Japanese Knotweed. Knotweed grows in dense stands 6-12-ft tall (Figure 61). Its stems are hollow, green to reddish in color and bamboo-like. Its leaves are bright green, broad, egg or heart shaped, with a pointed tip. Small white flowers in branched spray appear July through August. Dormant in winter, the dead reddish brown stems often remain standing. It emerges from root crowns in April and reaches full height in June. The heaviest concentrations of knotweed are usually along rivers and roads, but are also found in parks, backyards, along lake shore, in forests and on farms. Japanese knotweed reproduces occasionally by seed, but spreads primarily by extensive networks of underground rhizomes, which can reach 6 feet deep, 60 feet long, and become strong enough to damage pavement and penetrate building foundations. There is evidence which suggests that this plant has allelopathic properties which means it is able to excrete chemicals that inhibit the growth of some surrounding plants (Parepa, Schaffner, & Bossdorf, 2012). This helps the plant spread very quickly once established. Controlling Japanese knotweed is difficult and requires persistence and diligence. It can be dug, cut, covered, chemically sprayed, or have herbicide injected into individual stems. Japanese knotweed has been found near UTL, but not on its shores. There is a bed of Japanese knotweed at the intersection of Hwy 8 and 2-3/4 St. just to the west of the boat landing, but again it is not on the shores of UTL.

Figure 61: Japanese Knotweed

8.5 Yellow Flag Iris

Yellow flag iris (Figure 62) 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 62: Yellow Flag Iris (not from Upper Turtle Lake)

Yellow flag iris has been seen along the shores of UTL, and while it may only be a plant or two right now, it is possible that the population will expand.

8.6 Chinese Mystery Snails

Chinese mystery snails have been identified within UTL. The population in UTL has been verified by the WDNR, but the actual extent is somewhat unknown.

The Chinese mystery snails and the banded mystery snails (Figure 63) 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 lake residents 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 63: Chinese Mystery Snails (not from Upper Turtle Lake)

8.7 Zebra Mussels

Zebra mussels (Figure 64) 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.

Figure 64: Zebra Mussels

In the fall of 2016, zebra mussels were found in a northwest Wisconsin lake for the first time. Zebra mussels are now in at least three northwestern Wisconsin lakes including Big and Middle McKenzie Lakes in Burnett County and Deer Lake along State Hwy 8 in Polk County. These more local infestations increase the likelihood that zebra mussels will spread faster throughout northwest Wisconsin. A study was completed a couple of years back that identified characteristics within lakes that would best support a new infestation of zebra mussels. The result of that study was an on-line application referred to as the AIS Smart Prevention database which ranks lakes in WI as suitable, borderline suitable, or not suitable habitat for zebra mussel survival. UTL is listed as suitable, so it is possible that a population could become established if they were ever introduced to the lake (Center for Limnology, 2016).

8.8 Rusty Crayfish

Rusty crayfish were observed within UTL in 2009, but this was not verified by the WDNR, so the extent of this population is unknown.

Rusty crayfish (Figure 65) live in lakes, ponds and streams, preferring areas with rocks, logs and other debris in water bodies with clay, silt, sand or rocky bottoms. They typically inhabit permanent pools and fast moving streams of fresh, nutrient-rich water. Adults reach a maximum length of 4 inches. Males are larger than females upon maturity and both sexes have larger, heartier, claws than most native crayfish. Dark "rusty" spots are usually apparent on either side of the carapace, but are not always present in all populations. Claws are generally smooth, with grayish-green to reddish-brown coloration. Adults are opportunistic feeders, feeding upon aquatic plants, benthic invertebrates, detritus, juvenile fish and fish eggs.

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

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

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

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

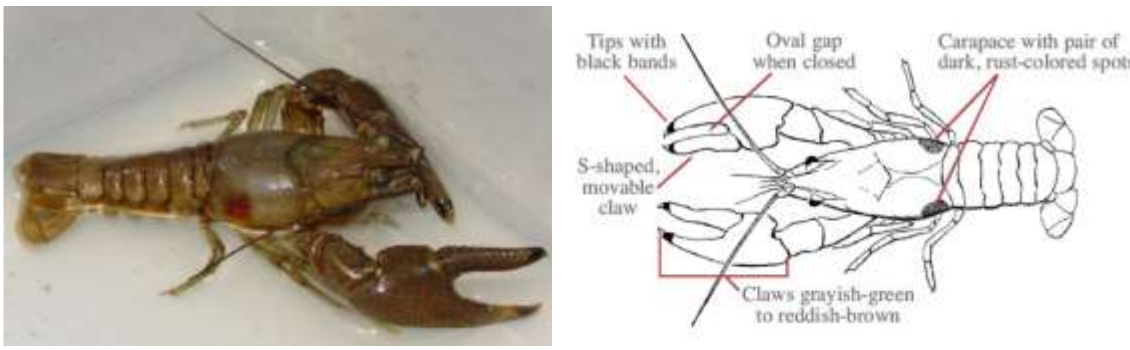

Figure 65: Rusty Crayfish and identifying characteristics

8.9 AIS Prevention Strategy

UTL already has several established AIS. However there are many more that could be introduced to the lake. The UTLD supports annual watercraft inspection and an AIS Signage program at the public access. Information is 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 continues to be implemented. Both of these programs follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network AIS Monitoring program.

The UTLD also works on educating its constituency. They sponsor lake community events including AIS identification and management workshops; and distribute education and information materials to lake property owners and lake users through the newsletter, webpage, and general mailings.

9.0 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 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, and 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.

9.1 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, 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 CLP in UTL is not a recommended option. To keep CLP from causing greater harm, active management strategies will need to continue to be implemented.

9.2 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 66). 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.

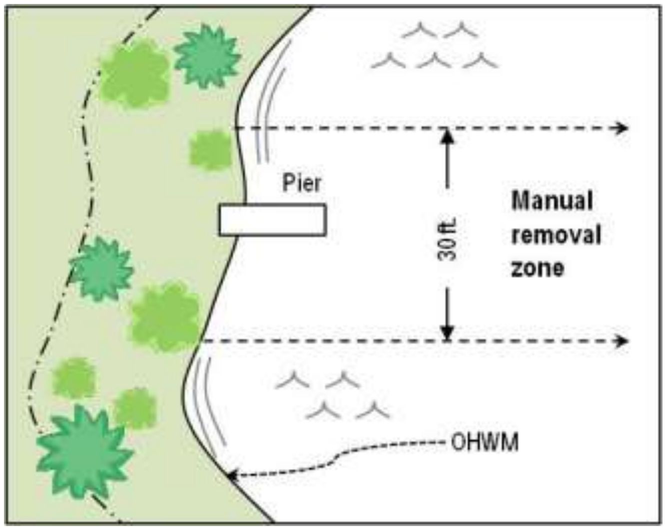

Figure 66: Aquatic vegetation manual removal zone

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. Such locations do exist on UTL (Figure 19), although they are mostly in areas that undeveloped. 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 UTL, CLP growing in some areas of the lake may be best managed by hand-pulling/manual removal. However it is not suitable to manage all of the CLP in the lake this way. A renewed effort to continue to teach property owners to identify, and then physically remove CLP growing in the lake near their property is included as an activity in this plan. If EWM is found in the lake, physical removal will likely be the first and fastest control response.

9.3 Diver Removal

Pulling CLP and/or EWM while snorkeling or scuba diving in deeper water is also allowable without a permit and can be effective at slowing the spread of a new aquatic invasive species infestation within a waterbody when done properly. Diver removal would most likely be used once the over-whelming amount of CLP has been reduced to such a point where diver removal can be effective. Efforts would be focused on removing small areas in between years when chemical treatments are used, or to remove areas missed or too small to be managed using herbicides.

9.4 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 67). 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 67). 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.

Like diver removal, DASH would be focused on removing small areas of CLP and EWM (if ever discovered in the lake) in between years when herbicides are used.

Figure 67: DASH – Feeding EWM into the underwater Suction Hose (Marinette Co.); and a sample DASH Pontoon Boat (Beaver Dam Lake Management District)

9.5 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 Application is required annually. The application is reviewed by the WDNR and other entities and a permit awarded if required criteria are met. Using repeated mechanical disturbance such as bottom rollers or sweepers can be effective at control in small areas, but in Wisconsin these devices are illegal and generally not permitted.

9.5.1 Large-scale Mechanical Harvesting

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 68). 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.

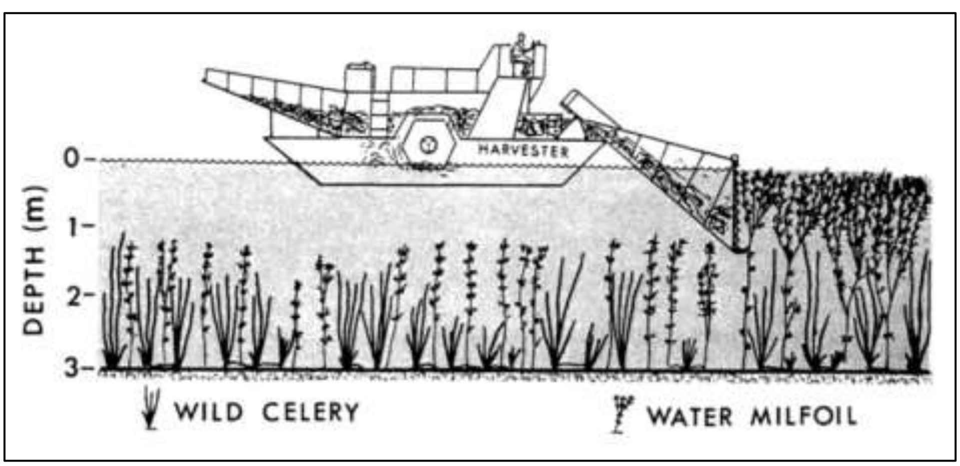

Figure 68: How a mechanical harvester works *(Engle, 1987)*

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 increase the amount of EWM in a lake by creating more fragments that can go on to establish new sites elsewhere. 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, however, of aquatic plant harvesting 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. Also, once a permit for mechanical harvesting has been approved, harvesting can occur in the approved areas as often as necessary to manage the vegetation.

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Harvesters can remove thousands of pounds of vegetation in a relatively short time period. Its results - open water and accessible boat lanes - are immediate, and can be enjoyed without the restrictions on lake use which follow 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.

9.5.1.1 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 $60,000 to $250,000. 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, Diver Aided Suction Harvest (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 presented by contracting is that the timing of the harvesting is entirely dependent upon the contractor's schedule which can result in the vegetation being harvested after the optimal time. However 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, and there are reduced costs or no costs to the UTLD if less or no harvesting is completed in any given year.

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 as well. 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.

Mechanical harvesting is a recommended management option for the CLP present on UTL.

9.5.2 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 69) 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 69: WaterBug remote-controlled aquatic plant harvester (https://lakeweedharvester.com/waterbug/)

The WaterGator (Figure 70) 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 11 compares the two different machines.

Figure 70: WaterGator remote-controlled aquatic plant harvester (https://lakeweedharvester.com/watergator/)

Table 11: 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 watershield seems to pile up in front of the take-up belt so at times I stop and tilt the belt up in order to get the watershield to load onto it and consequently get dumped into the storage bunk/belt. So it's not everything I hoped for but a definite step in the right direction."

Joel Meyer, Kirby Lake Management District.

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

9.6 Habitat Alteration

9.6.1.1 Bottom Barriers and Shading

Physical barriers, fabric or other, placed on the bottom of the lake to reduce CLP growth would eliminate all plants, inhibit fish spawning, affect benthic invertebrates, and could cause anaerobic conditions which may release excess nutrients from the sediment. Gas build-up beneath these barriers can cause them to dislodge from the bottom and sediment can build up on them allowing CLP 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 turns limits the depth at which plants can grow. Typically dyes have been added to a small water body to darken the water. Bottom barriers and attempts to further reduce light penetration in UTL are not recommended.

9.6.1.2 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. In Collins Lake, New York the biomass of curly-leaf pondweed remained significantly lower than pre-dredging levels 10-yrs after dredging (Tobiessen, Swart, & Benjamin, 1992). Dredging is very expensive, requires disposal of sediments, and has major environmental impacts. It is not a selective procedure so it can't be used to target any one particular species with great success except under extenuating circumstances. Dredging at any level must be permitted by the WDNR. It should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen J. , 2000). Dredging is not a recommended management action for UTL.

9.6.1.3 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.

Control of aquatic plants in these cases can last a number of years. The low lake levels may negatively affect native plants, provides an opportunity for adventitious species such as annuals, often reduces the recreational value of a waterbody, and can impact the fishery if spawning areas are affected. The cost of a drawdown is dependent on the outlet of the lake; if no control structure is present, pumping of the lake can be cost prohibitive whereas costs can be minimal if the lake can be lowered by opening a gate.

A drawdown is not recommended for aquatic plant control on UTL. The lack of an outlet structure and the presence of a diverse aquatic plant community make water level manipulation impractical.

9.7 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. There are no biological controls available for the management of CLP.

9.7.1 Galerucella Beetles

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 71). 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 71: 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 established. Beetles can be obtained from many of the public wetlands around Wisconsin. Because rearing these beetles requires the cultivation of a restricted species, a permit is necessary. Beetle rearing and release is not a recommended management actions to control purple loosestrife around UTL, however, if there are volunteers willing to set up a beetle rearing station, there are many places within just a few miles of the lake where the beetles would be a welcomed management action.

9.7.2 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 (Gettsinger, Turner, Madson, & Netherland, 1997). This certainly should be the case in UTL, where certain native aquatic plant species have taken a hit with the 3-4 years of intensive CLP management between 2018 and 2021. Historically, native plants in UTL have been fairly diverse and abundant. The goal of this plan is to restore, enhance, and protect native plant populations while preventing CLP from ever expanding to the levels it reached in 2017.

9.8 Chemical Control

Aquatic herbicides are granular or liquid chemicals specifically formulated for use in water to kill plants or cease 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 means that, in most cases, the herbicide will be degraded 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, the 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).

From 2018 to 2021, the main goal of aquatic plant management in UTL was to reduce the distribution and density of CLP from its high in 2017 of 130+ acres of dense growth to levels where CLP has less negative impact on the lake and other aquatic vegetation last seen in 2010. This goal was reached, but as mentioned, certain native aquatic plants were also reduced or potentially eliminated from the system altogether. In the next five years, the goal is to keep CLP levels low with a combination of management actions, while at the same time hoping that the native aquatic plant community will recover to what it was before CLP took over.

9.8.1 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.

9.8.2 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 of the herbicide applied. As such, chemically treating areas less than 5.0 acres in size is generally not recommended.

9.8.1 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 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.

9.8.2 Herbicides Used in Upper Turtle Lake

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants or are applied to the water in either a liquid or granular form. Herbicides affect plants through either systemic or direct contact action. Systemic herbicides are capable of killing the entire plant. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and able to re-grow.

Herbicides can be classified as broad-spectrum (kill or injure a wide variety of plant species) or selective (effective on only certain species). Non-selective, broad spectrum herbicides will generally affect all plants that they come in contact with. Selective herbicides will affect only some plants. Often dicots, like Eurasian water milfoil, will be affected by selective herbicides whereas monocots, such as curly-leaf pondweed will not be affected. The selectivity of a particular herbicide can be influenced by the method, timing, formulation, and concentration used.

The only herbicide used to date in UTL for control of CLP is endothall. Endothall is a contact herbicide (i.e., it affects plant cells on contact and does not move throughout the plant tissue) that inhibits respiration, prevents the production of proteins and lipids, and disrupts the cellular membrane in plants. Factors such as density and size of the plants present, water movement, and water temperature determine how quickly endothall works. For effective control, endothall is applied when plants are actively growing. Under favorable conditions, plants begin to decompose within a few days after application. Uptake of endothall is increased at higher water temperatures and higher light levels.

Endothall products vary somewhat in the target species they control, so it is important to always check the product label for the list of affected species. Endothall products are labeled to control CLP and EWM. Native species that are labeled as susceptible to endothall include coontail, naiads, milfoils, other pondweeds, sago pondweed, water stargrass, and horned pondweed.[5]

Aquathol K® is the trade name of the endothall-based herbicide applied to control CLP in UTL. Application rates were either 1.25 or 1.50 ppm based on the size of the treatment area and an expected herbicide/plant contact time of 18-32 hours. From 2018 to 2021, chemical treatment took place during the middle of May when it was established that CLP was actively growing and many native aquatic plants were not.

9.8.2.1 Small-scale Use of Aquathol K to Control CLP

Concern on the part of the WDNR regarding the use of small-scale Aquathol K applications to control CLP was expressed during the most recent Aquatic Plant Management Industry Meeting held January 31, 2023. There is some concern that the product(s) may be being used in a manner that may be limiting efficacy, specifically, the use of Aquathol K (liquid endothall) and Aquathol Super K (granular endothall) at lower rates for spot treatments due to rapid dissipation of the product(s). This is especially true when the effects of dilution are great enough to affect contact times. There are concerns that when CLP distribution is sporadic throughout a lake, treatment sizes are so 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

[5] Endothall Fact Sheet_FINAL (1).pdf

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

9.8.2.2 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.

While this study only included lakes that were chemically treating to control EWM, it does reveal an important management tradeoff and encourages careful consideration of how the real and perceived impacts of invasive species and the methods used for their control are balanced, likely even for CLP.

9.8.2.3 Pre and Post Treatment Aquatic Plant Surveying

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 an APM Plan for the lake and approved by the UTLD and the WDNR has identified specific goals for non-native invasive species and native plants species. Such goals 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.

10.0 Management Discussion

During the 2010 early-season CLP surveys, CLP was present throughout the lake, but it was not acting overly invasive and appeared to be "just another plant species" in the lake's macrophyte community. In the summer survey from 2010, it was also noted that native species had recolonized most of the areas CLP occupied earlier in the growing season. In 2017, following the explosion in CLP density and distribution, this was no longer the case as water clarity was so poor that there was almost no regrowth on the outer edge of the littoral zone following CLP's late June senescence. This poor water clarity appeared to be creating a negative feedback loop as most plants in water >6ft deep were dying and turning black. Ultimately, as they rotted, these dying macrophytes were contributing more nutrients to the water column and thus producing even more algae leading to even poorer clarity.

One of the goals of the last APM Plan was to improve water quality, or at least prevent further negative changes that had presented themselves from 2010 to 2017. Water quality (water clarity, phosphorus level, and chlorophyll (algae) was at its worst in 2017 possibly due in part to the amount of CLP in the system at the time.

In a 2012 investigative report from the Minnesota Pollution Control Agency and MN-DNR, the authors found that results from literature and 11 sentinel lakes where curly-leaf pondweed is present and monitored suggest the relationships between curly-leaf senescence and water quality vary substantially among lakes. The post-senescence decreases in water clarity are most pronounced in shallow lakes with minimal native vegetation. In these lakes, abundant growth of curly-leaf is followed by severe algal blooms. However, in shallow lakes with abundant native vegetation, the post-senescence decreases in water clarity are muted (Heiskary & Valley, 2012). This latter statement describes what was seen by the Aquatic Plant Surveyor during the 2010 survey work. Then in 2017, the first statement about severe algae blooms following abundant growth CLP was true. The Aquatic Plant Surveyor stated that in 2017, a shift in the aquatic plant community was evident from rooted species that need at least fair water clarity toward species that can tolerate poor clarity, favor high suspended nutrient levels, and exploit disturbance.

CLP management that began in 2018 had the goal of not only reducing observable early season CLP growth but also the number of turions in the sediment that leads to increased CLP abundance. This in turn was expected to help restore native aquatic plants later in the season and lead to better water quality. Instead, it appears to have continued the trend toward poorer water quality, and reduced the native aquatic plant community even further. Following four years of aggressive active management that chemically treated more than 50 acres annually, CLP levels in the lake were sharply reduced, back to levels that were recorded in 2010. This part of the plan was successful. Turion density in the sediment was also significantly reduced. Unfortunately, the native aquatic plant community has not rebounded – at least not yet. White water lily, coontail, and duckweeds have increased, but several other, formerly common, native pondweed species – Flat-stem, Fries', and Small, all species susceptible to the same herbicide used to kill CLP have all but disappeared from the lake.

Because of this, it is recommended that the UTLD adopt management goals in the next five years that focus on small-scale control in the worst areas of the lake to relieve significant navigation impairment rather than a large-scale blanket treatment. No longer is it necessary to complete three or more successive years of large-scale management with the goal of restoring a more desirable balance of CLP and native aquatic vegetation. By taking a measured approach, collateral damage to beneficial aquatic plant species and the important habitat and water quality benefits they provide may be minimized. Even CLP, when kept at a minimum, provides value to a lake because it grows through the winter and spring when other plants are absent, supporting a source of food and habitat for fish and other aquatic creatures during these times

The ultimate goal of this plan is to maintain the usability of the lake and to improve habitat and water quality through limited aquatic plant management.

10.1 CLP 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 again having a negative impact on the lake. To do this, a combination of manual/physical removal, mechanical harvesting (including DASH), and chemical control methods are recommended for UTL. 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 (≈ 5 feet) around docks and along shorelines.
    a. Can be completed at any time during the CLP growing season
    b. 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. Would likely be contracted by the UTLD
    b. Can be completed at any time during the CLP growing season
    c. 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 where practical and if resources are available. DASH may allow larger areas of CLP to be managed without the use of herbicides.
    a. Would likely be contracted by the UTLD
    b. Can be completed at any time prior to when turions are set
    c. DASH requires a WDNR Mechanical Harvesting permit.
5) Mechanical harvesting (small or large-scale) can be used when there is too much CLP to manage effectively with DASH, there is not enough CLP to warrant the use of herbicides, and/or individual areas recommended for CLP management do not reach the required 5 acres.
    a. Would likely be contracted by the UTLD
        i. Unless the UTLD were to purchase their own small or large-scale harvester
    b. Should be completed when CLP has reached or is near peak growth, but prior to when turions are set
    c. Requires a WDNR Mechanical Harvesting permit
6) Application of aquatic herbicides can be used in any area under the following guidelines
    a. Requires a WDNR Chemical Application permit
    b. Herbicides must be applied by a licensed Applicator
    c. 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 contracted diver, DASH, or mechanical harvesting services
        v. Limited financial resources
        vi. Less than a majority constituent support for a proposed management action.
    d. 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 >9 acres (5% of the littoral zone) will be considered large-scale
        1. Whole-lake herbicide concentration should be calculated based on the proposed application rate.
        2. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys should be considered.
        3. Herbicide concentration testing should be considered

e. ***Split (back to back) herbicide application
    i. Proposed chemical treatment areas are between 3.0 and 5.0 acres in size
    ii. May also be applicable when treatment areas >5.0 acres are long and narrow
    iii. Liquid endothall (Aquathol K) is used at 3 ppm
        1. Half (1.5ppm) is applied during the first treatment
        2. The remaining half (1.5ppm) is applied between 8-24 hours later
    iv. Treatments >9 acres (5% of the littoral zone) will be considered large-scale
        1. Whole-lake herbicide concentration should be calculated based on the proposed application rate.
        2. Pre (prior year) and post (year of and/or year after) treatment aquatic plant surveys should be considered.
        3. Herbicide concentration testing should be considered.

***Split applications are subject to annual WDNR approval regardless of inclusion in an approved APM Plan.**

Many of the management actions outlined for CLP would also be effective for the management of Eurasian watermilfoil should it be found in UTL over the next five years. A different herbicide would be used; likely ProcellaCOR or a liquid 2,4D based herbicide. Annual management decisions for CLP (or 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.

11.0 Aquatic Plant Management Goals

This Aquatic Plant Management Plan establishes the following goals for aquatic plant management in Upper Turtle Lake:

1. **CLP Management.** Maintain CLP at or below 2022 (and 2010) levels through environmentally responsible management methods that will minimize negative impacts to the native plant community.

2. **AIS Education and Awareness.** Continue to educate property owners and lake users on aquatic invasive species through public outreach and education programs to help contain existing AIS in and around the lake and new AIS that could get introduced to the lake.

3. **Research and Monitoring.** Develop a better understanding of the lake and the factors affecting lake water quality through continued and expanded monitoring efforts.

4. **Adaptive Management.** Follow an adaptive management approach that measures and analyzes the effectiveness of control activities and modifies the management plan as necessary to meet goals and objectives.

11.1 Goal 1. CLP Management

In the first APM Plan for UTL completed in 2010 the only goal for CLP was to make property owners and lake users aware of its presence and to monitor it for expansion. Unfortunately, this goal did not reach the level of importance necessary to really be effective and as a result, CLP expanded to a level considered to be very detrimental to the lake by 2017.

The second APM Plan for UTL focused on returning CLP to a level where it had little negative impact on the lake (like in 2010). The main goal of management was to reduce both the visible mats of CLP that dominated more than 25% of the total surface area of the lake and the turion density in the sediment that supported this level of visible growth to what they were back in 2010. Four years of large-scale, application of aquatic herbicides did just that, but also negatively impacted several native aquatic plant species and may have exacerbated poor water quality. A lake needs aquatic vegetation and minimizing repeated losses of any native species is vital to its health.

The main goal of this third installment of the APM Plan for UTL is to keep CLP at levels where its negative impact to the lake is minimized without causing undue harm to the native aquatic plant community. With no management, CLP will likely reclaim much of the dominance it showed in 2017. Some level of CLP management is needed if only to reduce nuisance conditions that interfere with early season navigation and summer native plant growth. Repeated large-scale herbicide application in the same areas multiple years in succession is likely no longer necessary. Instead, CLP management actions will be scenario-based and include small-scale physical removal, diver removal, DASH, mechanical harvesting, and the targeted use of aquatic herbicides.

11.1.1 CLP Survey Work

Management of CLP will be updated regularly based on pre-management surveys and annual bed mapping surveys completed by either trained UTLD volunteers or resource professionals retained by the UTLD. Pre-management surveys should be completed as soon after ice out as possible to begin getting a perspective on how the given growing season will impact the amount of CLP in the lake. WDNR permitting either needs to wait to be completed until some perspective is gained from these surveys, or have the possibility of managing more CLP then expected built into it. This is easy with a mechanical harvesting permit, more difficult with a chemical application permit. Once pre-management surveys are completed management plans should be reviewed and modified if necessary. Annual CLP bed mapping surveys, completed at the height of CLP growth, will be used to quantify the extent of CLP in the lake in any given year. Generally speaking, greater amounts of CLP during a bed mapping survey will lead to more extensive management plans the following year.

Once these surveys are completed discussion pertaining to next season management will begin. Should it be determined that large-scale application of aquatic herbicides will come into play in the following year, additional pre-treatment surveys of aquatic plants may be completed to document the present of native plants. Post-treatment surveys may be included in the year of treatment and/or in the year after treatment. Pre and post treatment surveys are not required by the WDNR unless the chemically treated area covers more than 10% of the littoral zone (18 acres in UTL). However, completing these tasks is highly recommended in any treatment program as they provide a means to measure success.

11.1.2 Herbicide Concentration Testing

Herbicide concentration testing was last completed in UTL in 2018 to determine how long the herbicide placed in the lake to control CLP would remain and how far it would travel outside of the area it was placed. The approach taken to determine the answers to these questions was a rhodamine dye study, where red dye is put in the water at a concentration similar to what would be applied if it were the herbicide. Since 2018, no herbicide concentration testing has been completed primarily because it was not required by the WDNR given that the UTLD was covering 100% of management costs themselves.

At least in the first year covered in this APM Plan where aquatic herbicides are used, it is highly recommended that herbicide concentration testing be done in real time. Herbicide concentration testing helps determine if the amount of herbicide applied reached the expected concentrations, how fast it dissipates, and if it is transported to other parts of the lake that were not intended for treatment. If a chemical treatment is not very effective, concentration testing can help determine why.

11.2 Goal 2. AIS Education and Awareness

Aquatic invasive species can be transported via a number of vectors, but most invasions are associated with human activity. Maintaining signs and continuing watercraft inspection at the public boat landing should be done to educate lake users about what they can do to prevent the spread of AIS.

Early detection and rapid response efforts increase the likelihood that a new aquatic invasive species will be addressed successfully while the population is still localized and levels are not beyond that which can be contained and eradicated. Once an aquatic invasive species becomes widely established in a lake, complete eradication becomes extremely difficult, so attempting to partially mitigate negative impacts becomes the goal. The costs of early detection and rapid response efforts are typically far less than those of long-term invasive species management programs needed when an AIS becomes established.

It is recommended that the UTLD continue to implement a proactive and consistent AIS monitoring program. At least three times during the open water season, trained volunteers should patrol the shoreline and littoral zone looking for EWM and other species like purple loosestrife, Japanese knotweed, giant reed grass, and zebra mussels. Free support for this kind of monitoring program is provided as part of the UW-Extension Lakes/WDNR CLMN AIS Monitoring Program. Any monitoring data collected should be recorded annually and submitted to the WDNR SWIMS database.

Providing education, outreach opportunities, and materials to the lake community will improve general knowledge and likely increase participation in lake protection and restoration activities. It is further recommended that the UTLD continue to cultivate an awareness of the problems associated with AIS and enough community knowledge about certain species to aid in detection, planning, and implementation of management alternatives within their lake community. It is also recommended that the UTLD continue to strive to foster greater understanding and appreciation of the entire aquatic ecosystem including the important role plants, animals, and people play in that system.

Understanding how their activities impact the aquatic plants and water quality of the lakes is crucial in fostering a responsible community of lakeshore property owners. To accomplish this, the UTLD should distribute, or redistribute informational materials and provide educational opportunities on aquatic invasive species and other factors that affect the lakes. At least one annual activity (picnic at the lake, public workshop, guest speakers, etc.) should be sponsored and promoted by the UTLD that is focused on AIS. Results of water quality monitoring should be shared with the lake community at the annual meeting, or another event, to promote a greater understanding of the lake ecosystem and potentially increase participation in planning and management.

11.3 Goal 3. Research and Monitoring

Long-term data can be used to identify the factors leading to changes in water quality. Such factors include aquatic plant management activities, changes in the watershed land use, and the response of the lakes to environmental changes. The CLMN Water Quality Monitoring Program supports volunteer water quality monitors across the state following a clearly defined schedule. UTL has been a part of this program for many years and should continue its involvement.

The intensity/success of water quality monitoring efforts should be evaluated at least every three years. The background information and trends provided by these data are invaluable for current and future lake and aquatic plant management planning.

To monitor any changes in the plant community, it is recommended that whole-lake point intercept aquatic plant surveys be completed at three to five-year intervals. This will allow managers to adjust the APM Plan as needed in response to how the plant community changes as a result of management and natural factors. The next whole-lake point-intercept survey should be planned for 2026 with an update of this plan completed in 2027.

Since at least 2010, the UTLD has supported efforts to improve/restore native shoreland around the lake that lead to healthier habitat and less polluted runoff from properties immediately adjacent to the lake. These efforts should continue and can be supported by the Wisconsin Healthy Lakes and Rivers Initiative. In addition, the UTLD should continue to work with the Barron County Soil and Water Conservation Department to address runoff concerns in the greater watershed. Fortunately for the UTLD, many of the agricultural producers in the watershed already support best management practices that keep valuable soil on the land – not allowing it to get to the lake. Partnerships between these farmers, the UTLD, and Barron County should continue to be fostered and maintained.

11.4 Goal 4. Adaptive Management

This APM Plan is a working document guiding management actions on Upper Turtle Lake for the next five years. This plan will follow a scenario-based, adaptive management approach by adjusting actions as the results of management and data obtained deem fit following IPM strategy. This plan is therefore a living document, progressively evolving and improving to meet environmental, social, and economic goals, to increase scientific knowledge, and to foster good relations among stakeholders. Annual and end of project assessment reports are necessary to monitor progress and justify changes to the management strategy, with or without state grant funding. Project reporting will meet the requirements of all stakeholders, gain proper approval, allow for timely reimbursement of expenses, and provide the appropriate data for continued management success. Success will be measured by the efficiency and ease in which these actions are completed.

12.0 Implementation and Evaluation

This plan is intended to be a tool for use by the UTLD to move forward with aquatic plant management actions that will maintain the health and diversity of Upper Turtle 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 UTLD funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix C.

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

13.0 Wisconsin Department of Natural Resources Grant Programs

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

The cost of the last EWM management actions completed in 2023 will have to be covered by the UTLD. Future management actions could be supported by WDNR Surface Water grant funding should the UTLD 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

14.0 Outside Resources to Help with Future Management Planning

Many of the actions recommended in this plan cannot be completed solely by the UTLD. 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 UTLD could partner with to implement the actions in this plan.

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Appendix A

WDNR Upper Turtle Sensitive Areas Report

Appendix B

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Appendix C

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Appendix D

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Appendix E

WDNR Lake Shoreland and Shallows Habitat Monitoring Field Protocol

Appendix F

Upper Turtle Lake Aquatic Plant Management Goals, Objectives, and Actions

Appendix G

Upper Turtle Lake APMP Implementation Matrix

Appendix H

Annual Calendar of Actions to be Implemented

Appendix I

WDNR Healthy Lakes Initiative

Appendix J

Upper Turtle Lake AIS Rapid Response Plan

Appendix K
Aquathol K Product Label