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UPPER TURTLE LAKE, BARRON COUNTY

2018-2022 APMP
WDNR WBIC: 2079800

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Upper Turtle Lake Association
Turtle Lake, WI 54829

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PREPARED FOR THE UPPER TURTLE LAKE ASSOCIATION

INTRODUCTION

Upper Turtle Lake 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, is known to be in the lake and reed canary grass and purple loosestrife, both established exotic species, are also present around the lake. Until recently, 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 was significantly larger than the fairly benign population that was seen in 2010. While it is possible that CLP has been spreading at a fast but steady pace since the most recent plant survey, in 2010, the ideal winter and spring conditions in 2017 likely exacerbated the issue and potentially caused a massive population increase.

In 2010, UTLA partnered with the Lower Turtle Lake Management District to fund management planning efforts resulting in the first Aquatic Plant Management plan being presented to the UTLA in 2011. There has not been any form of active management on Upper Turtle Lake, but UTLA volunteers have been collecting water clarity data through Citizen Lake Monitoring Network (CLMN) since 1994. In 1999, the UTLA added water chemistry data to measure total phosphorus and chlorophyll-A concentrations. Since 2003, the CLMN water chemistry data has shown a slight increase in total phosphorus concentrations.

With the increase in CLP levels, the Upper Turtle Lake Association has recognized the need for a coordinated strategy to begin actively managing CLP and other aquatic invasive species and to prevent the introduction of new invasive species. This Aquatic Plant Management Plan was developed to fulfill that need by setting forth goals and aquatic plant management activities for the next five year. An outline of the aquatic plant management goals, objectives, and activities can be found in Appendix F. A priority and funding implementation matrix is included in Appendix G, and a five-year timeline for completion of the activities is included in Appendix H. 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 UTLA and the WDNR for approval.

2011 MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

The following is a review of the management goals, objectives and actions from the 2011 management plan on Upper Turtle Lake:

1. Protect and enhance the native species community
2. Monitor and control the aquatic invasive species in Upper Turtle Lake
3. Prevent the introduction of new aquatic invasive species and prevent the spread of invasive species from Upper Turtle Lake to other lakes.
4. Reduce nutrient and pollutant loading to the lake and monitor water quality.
5. Evaluate aquatic plant management on an annual basis and revise the APM Plan as necessary.

The objectives and actions that were found in the 2011 APM Plan were focused on education, monitoring, and prevention. After this original plan was written and approved in 2011, very few of these goals were met.

Water quality monitoring was conducted by volunteers through the Citizen Lake Monitoring Network, and no new AIS have been found in Upper Turtle Lake. However, the curly-leaf pondweed (CLP) population has expanded greatly and there has been no data collected regarding this expansion since the original plant survey work done in 2010. Because of this, there is a need to collect more data to determine the appropriate scale and method of CLP management. Additionally, there have been minimal education or prevention efforts through Clean Boats Clean Waters or other Lake Association sponsored events.

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

The concern over expanding CLP in Upper Turtle Lake began in early 2017, when dense growth CLP in the lake seemed to be covering nearly all of the shallow water areas. The UTLA became concerned and contracted with an aquatic plant surveyor to map the extent of CLP in the lake. Survey work confirmed more than 130 acres of mostly dense growth CLP in the 427 acre lake. An Aquatic Plant Management (APM) Plan had been completed in 2011 the put CLP on a watch list, as at that time it was only present in about 10 acres of the lake. Once the extent of CLP in 2017 was known, it became clear to the UTLA that their existing APM Plan needed to be updated.

In early July 2017, a cabin owner on Upper Turtle Lake, contact LEAPS requesting a discussion related to management of CLP in the lake. Prior to an during this time, three property owners on the lake began contacting lake residents to solicit support for CLP mapping and management in 2017 and beyond, and to gage interest in the formation of a Lake District to help maintain Upper Turtle Lake. A meeting was scheduled with the UTLA and LEAPS to discuss management planning and the update of the 2011 APM Plan. Prior to the meeting, LEAPS contacted the WDNR Regional Lakes Coordinator and asked what would be expected in an update of the existing APM Plan. The items presented by the WDNR were discussed during the meeting on July 21 held at the LEAPS office in Chetek. Several members of the UTLA Board and several property owners were present at this meeting. After this meeting, LEAPS presented two agreements for services to the UTLA: one for updating the APM Plan; and the other for preparing an Aquatic Invasive Species Grant to support implementation of the updated plan in 2018.

Throughout the remainder of July, August, and September multiple emails were exchanged between UTLA Board members that were part of the CLP planning team, and LEAPS. Topics of these emails were all related to the update of the APM Plan and the content therein. During this time, the WDNR Regional Lakes Coordinator was kept abreast of the exchanges and the updates being made to the existing APM Plan.

The updated APM Plan was completed in draft form in early October 2017 and a subsequent in person discussion was had on October 6th, 2017. The APM Plan was put on the UTLA webpage for review at https://sites.google.com/site/upperturtlelakeassociation/ ; distributed to UTLA Board Members and the CLP planning team; and a meeting was scheduled for October 28th to present the plan in its entirety to the Upper Turtle Lake Constituency. At this meeting, which was attended by 40 or more property owners on the lake, a vote was taken by the people present to approve the updated APM Plan and its submittal to the WDNR for review and approval. Some desire was expressed by a portion of the constituency to look more into the possibility of harvesting CLP in cooperation with or in lieu of chemical treatment. As additional CLP management planning elements are completed in 2018, harvesting will get some additional consideration.

The updated Upper Turtle Lake APM Plan came up for a brief discussion with the Lower Turtle Lake Management District meeting held on October 14, 2017, with no opposition to the proposed planning effort.

Throughout November and early December 2017, an AIS Education, Planning, and Prevention grant application was prepared, with a meeting to discuss the project with the WDNR and the UTLA held on November 15, 2017. On December 10, 2017 the AIS Education grant application was submitted to the WDNR. In late December 2017, the WDNR Regional Lake Coordinator indicated that he would approve the APM Plan, once the Public Participation and Stakeholder Input section was completed.

Table 1 presents the main "in-person" meetings related to the CLP management planning project for Upper Turtle Lake.

Table 1: In-person meetings of the Upper Turtle Lake Association related to CLP management planning and update of the APM Plan

Meeting Date	Topic of Meeting	Attendees
July 10, 2017	1st contact with LEAPS	Sherry Warrick
July 21, 2017	Initial meeting of CLP Committee	Warrick, Dunneman, Stoffel, and Timmerman
October 6, 2017	APM Planning Discussion	UTLA Board Members
October 28, 2017	Presentation of APM Plan	UTLA Constituency
November 15, 2017	AIS Education Grant Discussion	UTLA Board and WDNR

In early November 2017, Barron County accepted the request from the UTLA to form a Lake District. Throughout the remainder of 2017 and into 2018, the Lake District Planning Committee will set-up the details of the Lake District.

LEAPS would like to recognize the following people for their significant contributions to this updated APM Plan.

Carol Timmerman, President of the Upper Turtle Lake Association
Sharon Dunemann, CLP Planning Committee
Sherry Warrick, CLP Planning Committee
Dan Stoffel, CLP Planning Committee
Gary Taxdahl, CLP Planning Committee
Rick Zellmer, CLP Planning Committee

Alex Smith, WDNR Regional Lakes Coordinator

OVERALL MANAGEMENT GOAL

The overall management goal for Upper Turtle Lake is to maintain or enhance the quality and usability of the lake through AIS management and educational outreach. Aquatic plant management on Upper Turtle Lake will be focused on returning CLP levels to those seen in the 2010 survey. Maintaining or improving the native plant populations will also be a part of this plan. Improving or maintaining water quality is also included as a means to protect and enhance the native plant population.

The following is a list of the goals defined in this update of the 2011 Aquatic Plant Management Plan.

Goal 1 – Support and propagate AIS management efforts that minimize negative impacts to native plant communities.

Goal 2 – Protect and enhance the native species populations within and around Upper Turtle Lake.

Goal 3 – AIS education and prevention.

Goal 4 – Promote and support nearshore, riparian, and watershed best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Upper Turtle Lake

Goal 5 – Encourage and engage lake residents and visitors to be active lake stewards.

Goal 6 – Implement the Upper Turtle Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement

Each of these goals has one or more objectives to meet and actions to be implemented if the goal is to be met. Goals, Objectives, and Management Actions are included as Appendix F. An Implementation Matrix is included as Appendix G, and a Calendar of Events is included in Appendix H.

The waters of Wisconsin belong to all people. Their management becomes a balancing act between the rights and demands of the public and those who own property on the water's edge. This legal tradition called the Public Trust Doctrine dates back hundreds of years in North America and thousands of years in Europe. Its basic philosophy with respect to the ownership of waters was adopted by the American colonies. The US Supreme Court has found that the people of each state hold the right to all their navigable waters for their common use, such as fishing, hunting, boating and the enjoyment of natural scenic beauty.

The Public Trust Doctrine is the driving force behind all management in Wisconsin lakes. Protecting and maintaining that resource for all of Wisconsin's people are at the top of the list in determining what is done and where. In addition to the Public Trust Doctrine, two other forces have converged that reflect Wisconsin's changing attitudes toward aquatic plants. One is a growing realization of the importance of a strong, diverse community of aquatic plants in a healthy lake ecosystem. The other is a growing concern over the spread of AIS, such as EWM. These two forces have been behind more recent changes in Wisconsin's aquatic plant management laws and the evolution of stronger support for the control of invasive plants.

To some, these two issues may seem in opposition, but on closer examination they actually strengthen the case for developing an APMPs as part of a total lake management picture. Planning is a lot of work, but a sound plan can have long-term benefits for a lake and the community living on and using the lake.

The impacts of humans on Wisconsin's waters over the past five decades have caused public resource professionals in Wisconsin to evolve a certain philosophy toward aquatic plant management. This philosophy stems from the recognition that aquatic plants have value in the ecosystem, as well as from the awareness that, sometimes, excessive growth of aquatic plants can lessen our recreational opportunities and our aesthetic enjoyment of lakes. In balancing these, sometimes competing objectives, the Public Trust Doctrine requires that the State's public resource professionals be responsible for the management of fish and wildlife resources and their sustainable use to benefit all Wisconsin citizens. Aquatic plants are recognized as a natural resource to protect, manage, and use wisely.

Aquatic plant protection begins with human beings. We need to work to maintain good water quality and healthy native aquatic plant communities. The first step is to limit the amount of nutrients and sediment that enter the lake. There are other important ways to safeguard a lake's native aquatic plant community. They may include developing motor boat ordinances that prevent the destruction of native plant beds and reduce shoreline erosion and sediment disturbance caused by boat wakes, limiting aquatic plant removal activities, designating certain plant beds as critical habitat sites and preventing the spread of non-native, invasive plants, such as EWM.

If plant management is needed, it is usually in lakes that humans have significantly altered. If we discover how to live on lakes in harmony with natural environments and how to use aquatic plant management techniques that blend with natural processes rather than resist them, the forecast for healthy lake ecosystems looks bright. To assure no harm is done to the lake ecology, it is important that plant management is undertaken as part of a long range and holistic plan.

In many cases, 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 required by the State of Wisconsin. To promote the long-term sustainability of our lakes, the State of Wisconsin endorses the development of APMPs and supports that work through various grant programs.

There are many techniques for the management of 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. These methods require permits and extensive planning. Often using and Integrated Pest Management (IPM) strategy that incorporates multiple management actions/alternatives works the best.

While limited management on individual properties is generally permitted, it is widely accepted that a lake will be much better off if plants are considered on a whole lake scale. This is routinely accomplished by lake organizations or units of government charged with the stewardship of individual lakes.

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.

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 Upper Turtle Lake watershed is 2,117 acres which includes the 427 acre lake area. The Upper Turtle Lake 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 1). 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).

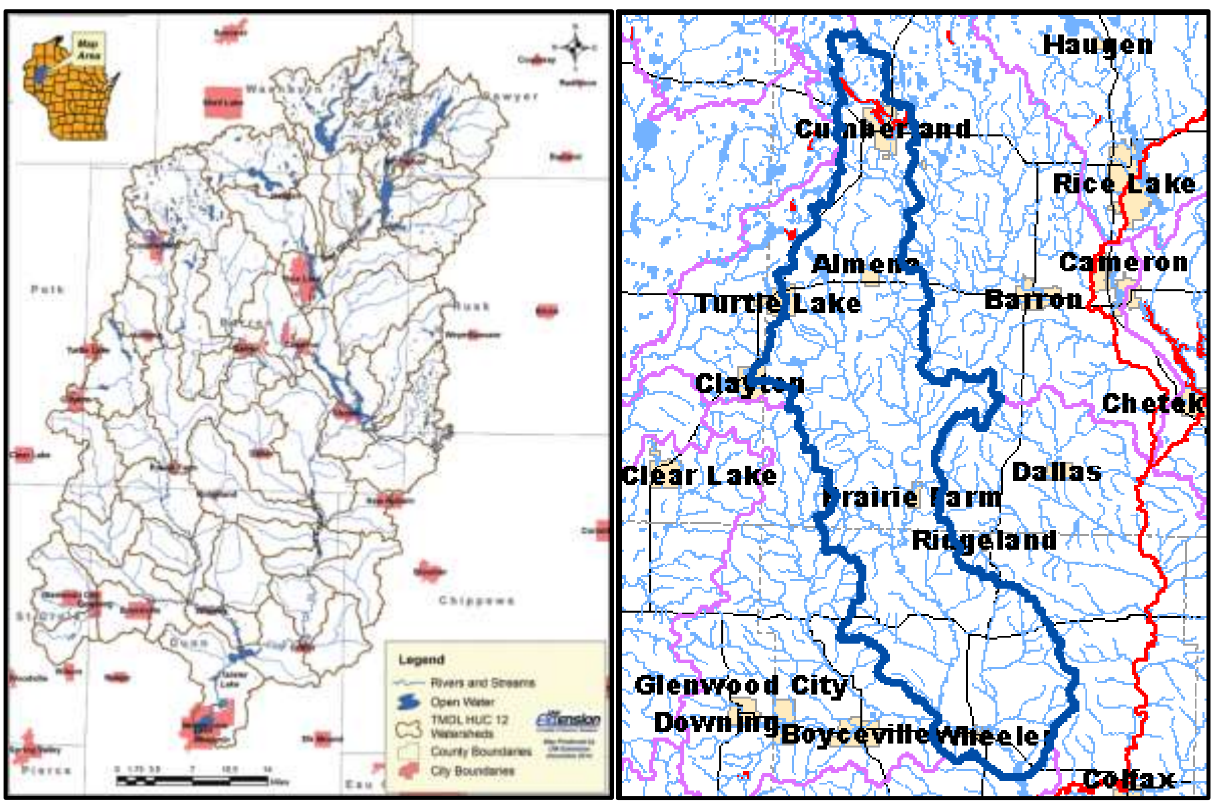

Figure 1: Left- Red Cedar River Watershed *(Red Cedar River Water Quality Partnership, 2015)* **Right- Hay River Sub-watershed** *(WDNR, 1996)*

The land use in the Upper Turtle Lake 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.

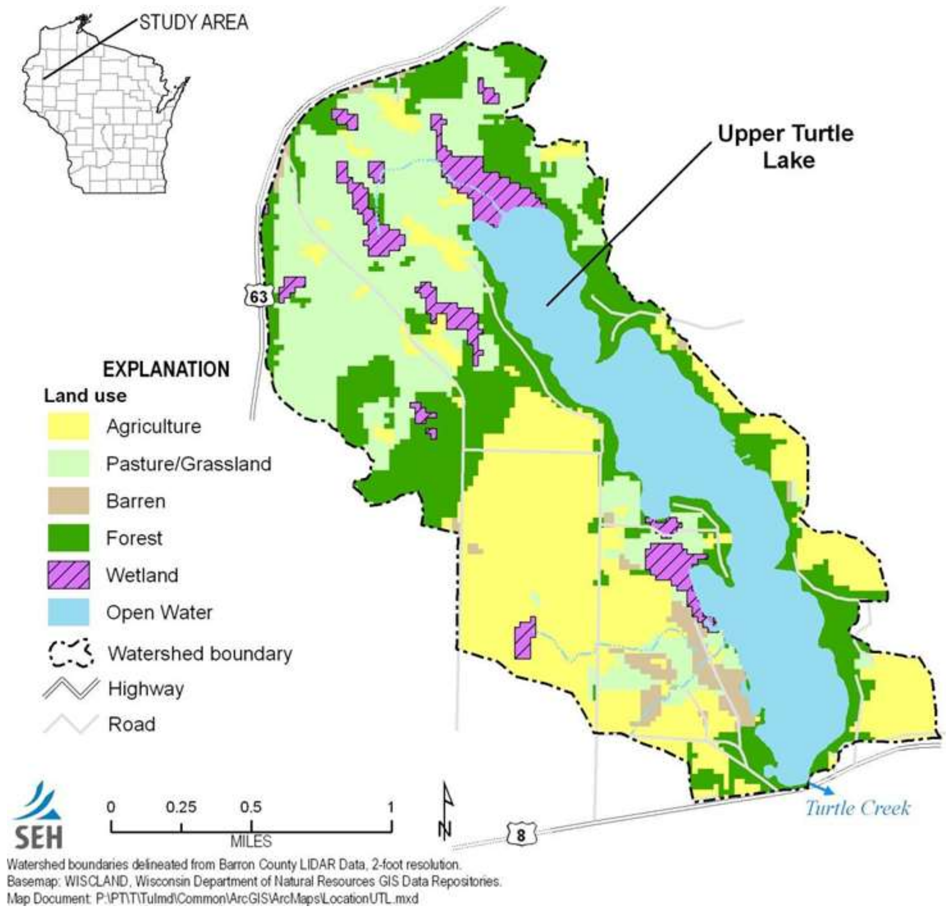

Figure 2: Location and Land Use of Upper Turtle Lake Watershed (SEH, 2011)

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 Upper Turtle Lake and its tributary streams. The removal of riparian, i.e., nearshore, vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to the lake during rain events.

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, and there is a thin band around the rest of the lake where plants are able to grow (Figure 3).

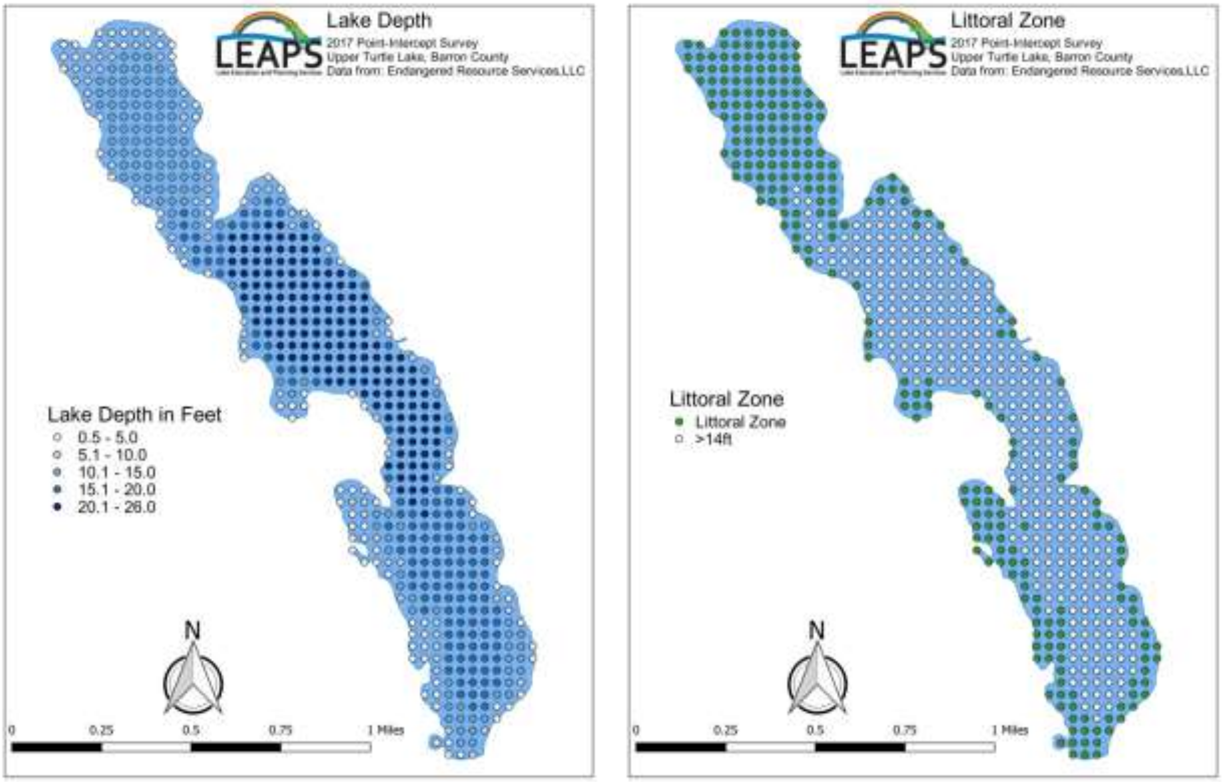

Figure 3: Depth and Littoral Zone of Upper Turtle Lake

Turtle Creek, which flows from Upper Turtle Lake, is the main tributary to Lower Turtle Lake. The lake is fed by intermittent streams and groundwater and is the headwaters of Turtle Creek which begins at the southern end of the lake. Turtle Creek flows through Lower Turtle Lake which drains into the Hay River.

As part of the Clean Water Act, states must produce a list of waters that do not meet water quality standards every two years. This list is known as the 303d Impaired Waters List. Water quality standards include the acceptable levels of total phosphorus, algae growth, and/or any number of miscellaneous pollutants. In 2014, Upper Turtle Lake was listed as 303d impaired water due to excess algae growth. The cause of this excess growth was originally listed as an unknown pollutant, but this is currently under review with a proposed change to excess phosphorus. This excess phosphorus likely comes from some entering the lake from the watershed as well as the phosphorus that is released when curly-leaf pondweed dies off mid-summer. The majority of the lake bottom consists of muck with some rock and sand interspersed throughout (Figure 4). The large amount of organic muck could be another source of additional phosphorus that leads to the excessive algae blooms which impair Upper Turtle Lake.

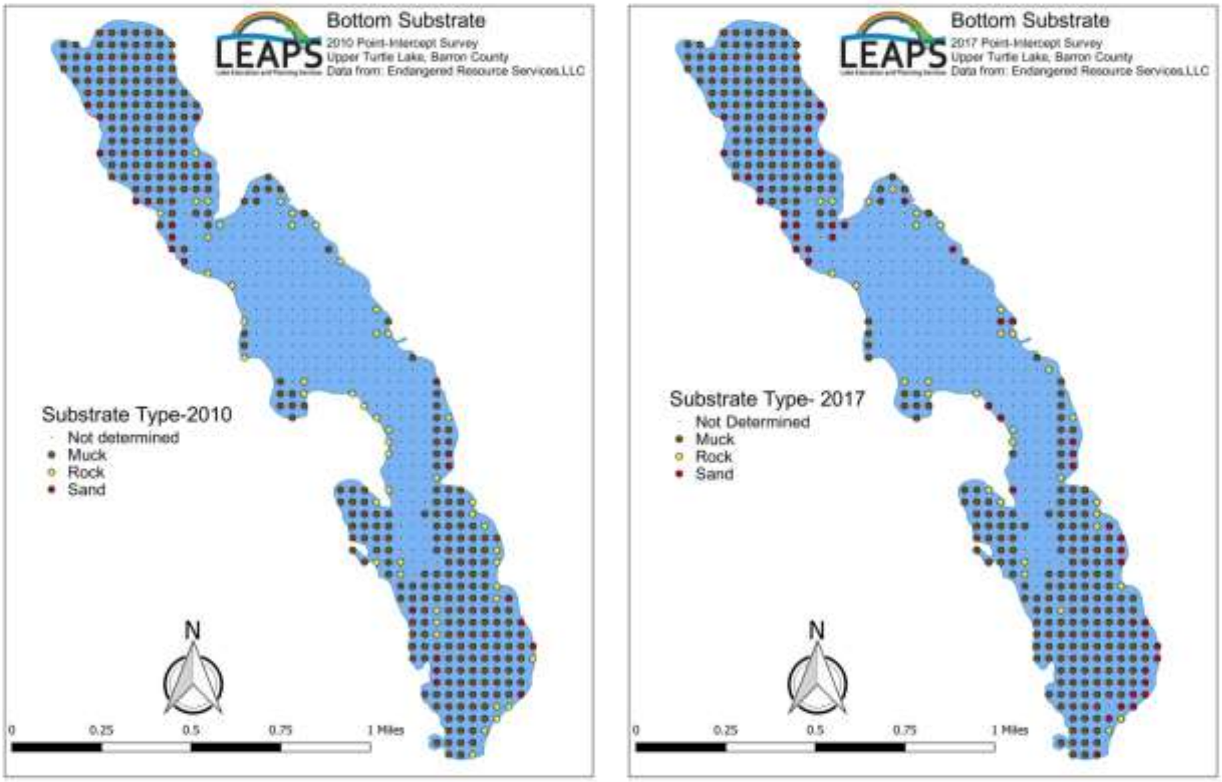

Figure 4: Lake Substrate in 2010 (Left) and 2017 (Right)

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 5 shows the sensitive areas identified by the WDNR (2001) in Upper Turtle Lake. Aquatic habitat areas provide the basic needs (e.g. habitat, food, nesting areas) for waterfowl, fish, and wildlife. Disturbance to these areas during mechanical harvesting should be avoided or minimized and chemical treatment is generally not allowed. Areas of rock and cobble substrate with little or no fine sediment are considered high quality walleye spawning habitat. No dredging, structures, or deposits should occur in these sensitive areas. Further details for each sensitive area can be found in the Upper Turtle Lake Sensitive Area Designation (WDNR, 2001) (Appendix A).

Figure 5: Sensitive Areas and Water Quality Sampling Sites in Upper Turtle Lake (SEH, 2011)

WATER QUALITY

Water quality data has been collected by Citizen Lake Monitoring Network (CLMN) volunteers since 1994 through 2017 with the exception of 2006. All of the data from 1994 through 1998 was Secchi depth data, but water chemistry for total phosphorus and chlorophyll-*a* concentration was added in 1999, with the exception of 2006-2009.

The water quality of a lake influences the aquatic plant community, which in turn can influence the chemistry of a lake. Water clarity, total phosphorus and chlorophyll a are measures of water quality 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 6). Oligotrophic lakes, on the other end of the spectrum, are nutrient poor and have little plant and algae growth (Figure 6). Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms (Figure 6).

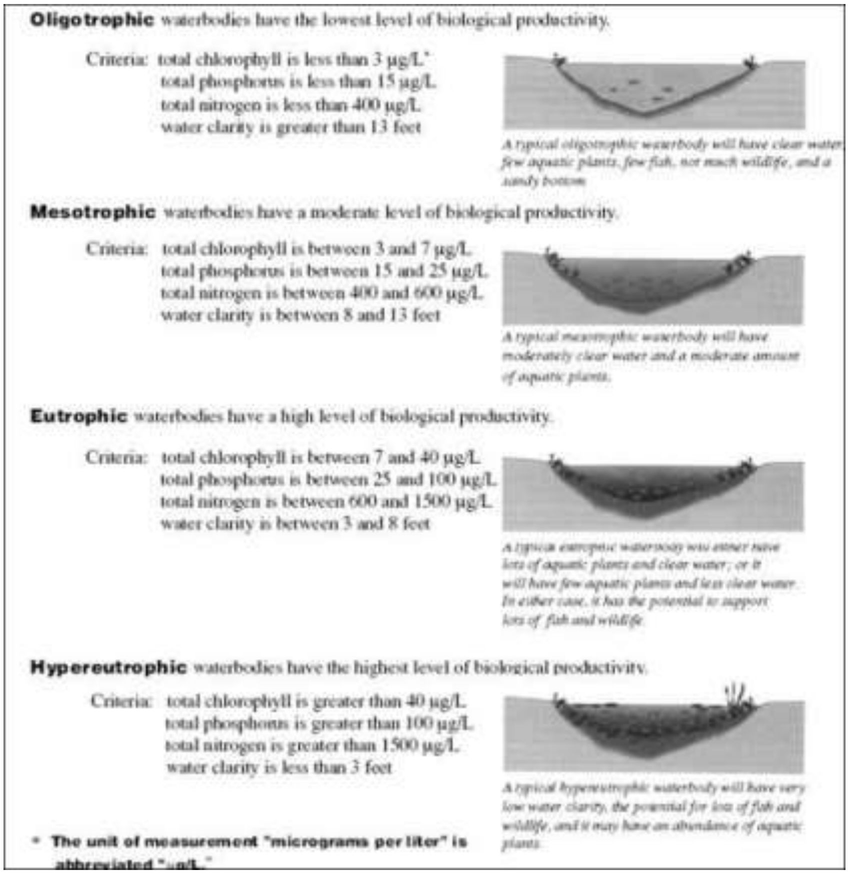

Figure 6: Trophic States in Lakes

Generally, TSI values from 0-30 are considered oligotrophic, 30-50 are mesotrophic, 50-70 are eutrophic, and anything above 70 is considered to be hypereutrophic. In Upper Turtle Lake, the average Secchi TSI value is 52, the average total phosphorus TSI is 57, and the average chlorophyll-*a* TSI is 56 (Figure 7). These values mean that Upper Turtle Lake is a eutrophic lake with a high level of biological productivity. These values have remained fairly steady, usually falling between 50 and 60; however it is worth noting that these values have been on the higher end of that range in recent years than they were the first few years that water chemistry data was collected. With 2017 being the first year that any of the values yearly averages generated TSI values higher than 60. While this could be an anomaly, it is something to pay attention to in the coming years.

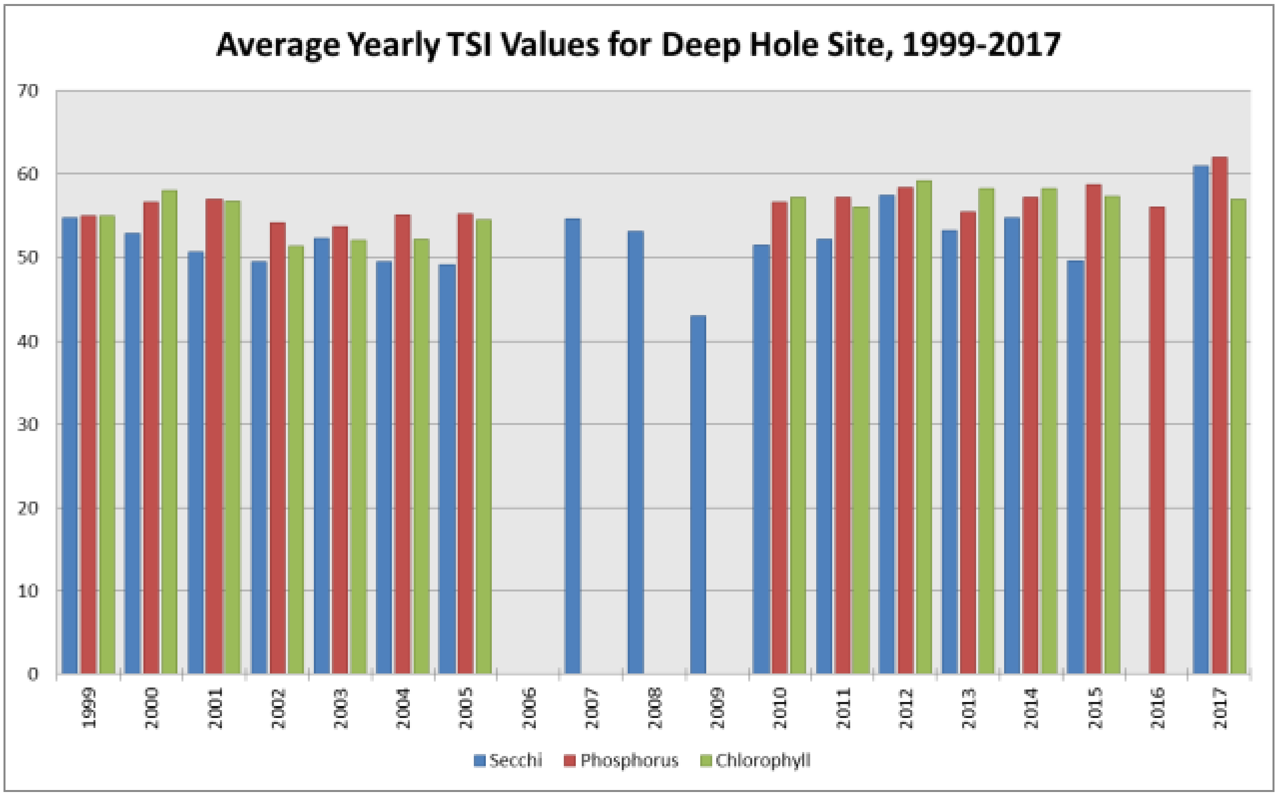

Figure 7: Yearly TSI Values

The actual Secchi values on Upper Turtle Lake show a more noticeable pattern of decreased water quality in recent years. The total yearly averages for the Secchi depths have stayed relatively constant since 1994, hovering just under 7-ft of depth. However there is a noticeable downward trend in the summer averages despite 2009 being the best recorded year for Secchi depth (Figure 8). 2015 and 2017, in particular, show the dramatic drop in water clarity over the summer. While a decrease in clarity from spring to summer is somewhat expected, this decrease is concerning when it is significantly more dramatic than past years.

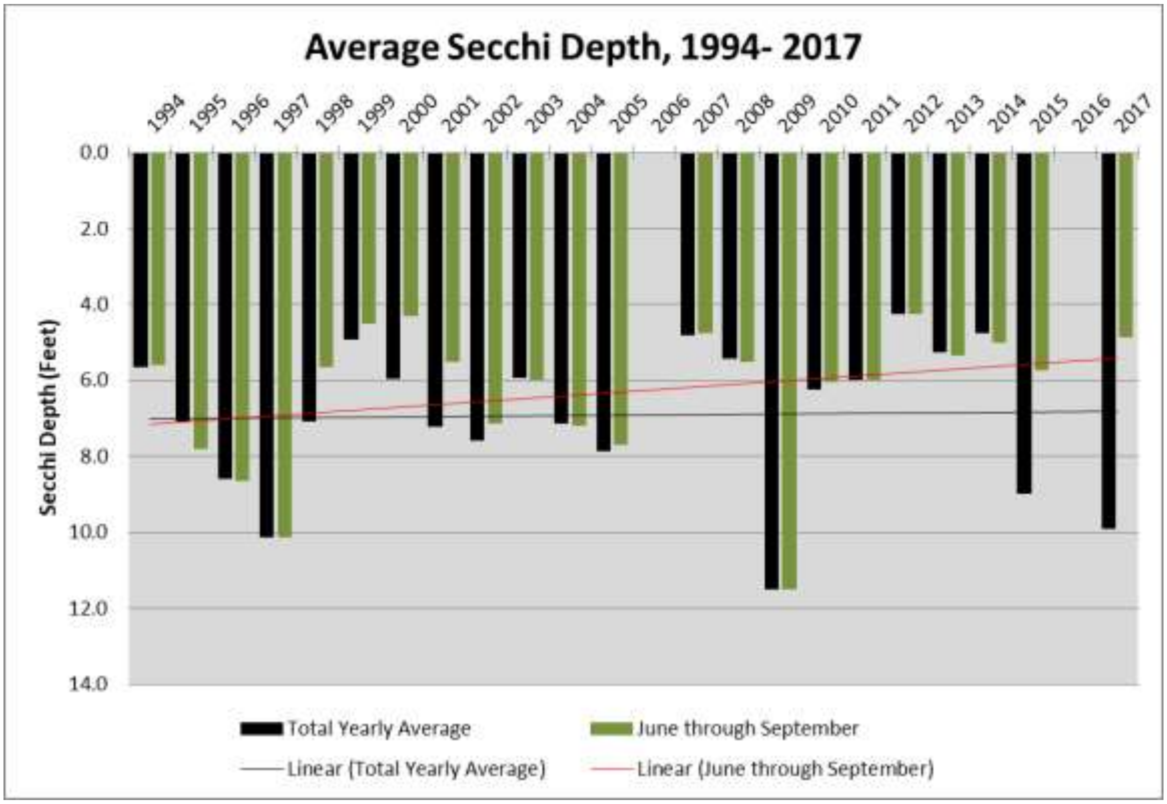

Figure 8: Secchi Depth Averages and Trendlines

The water chemistry data shows the most noticeable decrease in water quality (Figure 9). Since 1999, there has been a steady increase in both total phosphorus and chlorophyll- a concentration throughout the lake. While it appears to drop in 2016, it should be noted that there was only one sample collected for the entire season that year, and this sample was taken in May which is when lower phosphorus concentrations could be expected due to the lack of impacts from either snowmelt or other watershed activities. Aside from the small spike in 2012, the chlorophyll-a concentrations have remained fairly steady since 2010, though they are somewhat higher than the concentrations found in 1999-2005.

Since 2003, total phosphorus levels appear to be increasing. While the spike of almost 80μg/L, shown in 2017, is probably the result of incomplete data, with only one sample being collected during the spring turnover, there is still a noticeable pattern of increased phosphorus levels within the lake. It is interesting that despite the increase in total phosphorus levels, the chlorophyll-a levels have remained relatively constant. This is likely due to a healthy and diverse plant community within Upper Turtle Lake.

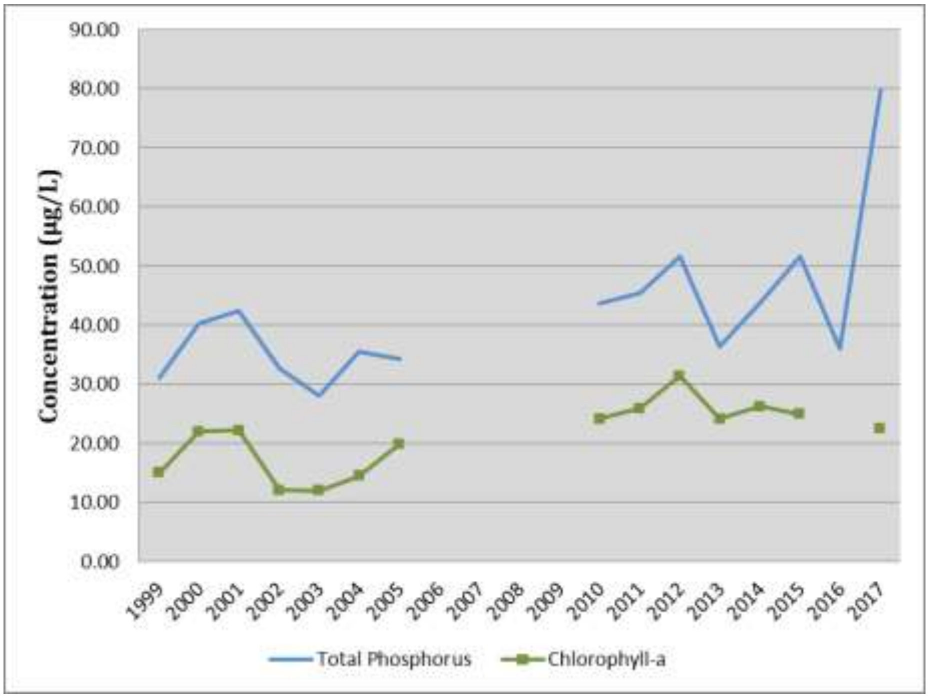

Figure 9: Yearly Average Total Phosphorus and Chlorophyll-a Concentrations

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 10. 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, colder 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.

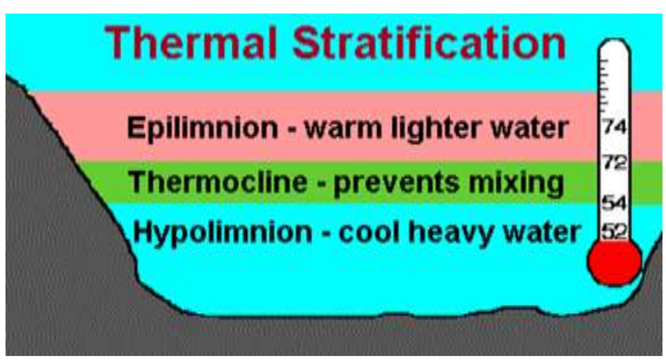

Figure 10: Summer thermal stratification

Upper Turtle Lake does not usually stratify until July which means the lake remains fairly mixed through a good portion of the season. While the stratification allows nutrients that are stirred up by the moving water to settle out into the sediments, it also causes oxygen levels in the lowest parts of the lake to drop dramatically.

This lack of oxygen can release additional nutrients into the water from the sediments which can decrease water quality.

FISHERIES AND WILDLIFE

Overall, there are a wide variety of warm water fisheries that can be found within Upper Turtle Lake. The 2011 late spring fisheries assessment showed bluegills, pumpkinseed, perch, crappies, rock bass, largemouth and smallmouth bass, northern pike, and walleye (Table 1). The largest fisheries within Upper Turtle Lake were the panfish, but there was also a good amount of bass, walleye, and other predatory fish.

Table 2: 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

Upper Turtle Lake 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.

Upper Turtle Lake 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 Upper Turtle Lake in 2014. Before this, small walleye fingerling were stocked pretty regularly from 1975-2004. 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 11).

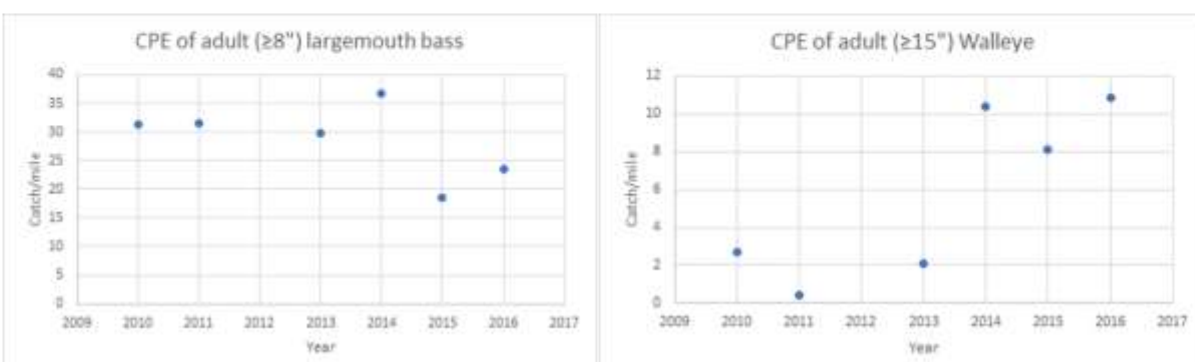

Figure 11: Yearly Catch per Effort of Largemouth Bass and Walleye

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 Upper Turtle Lake. One of these species, spotted pondweed, is endangered (WDNR, 2017).

The only invasive animal species that has been verified within Upper Turtle Lake 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.

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 Upper Turtle Lake. Wetlands with a higher floral diversity of native species support a greater variety of native plants and are more likely to support regionally scarce plants and plant communities. Wetlands provide fish and wildlife habitat for feeding, breeding, resting, nesting, escape cover, travel corridors, spawning grounds for fish, and nurseries for mammals and waterfowl.

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

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

There are not a lot of wetlands in the Upper Turtle Lake watershed (Figure 12). 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 to between the fields and the lake in addition to helping absorb many of the excess nutrients that would otherwise run from the farm into Upper Turtle Lake.

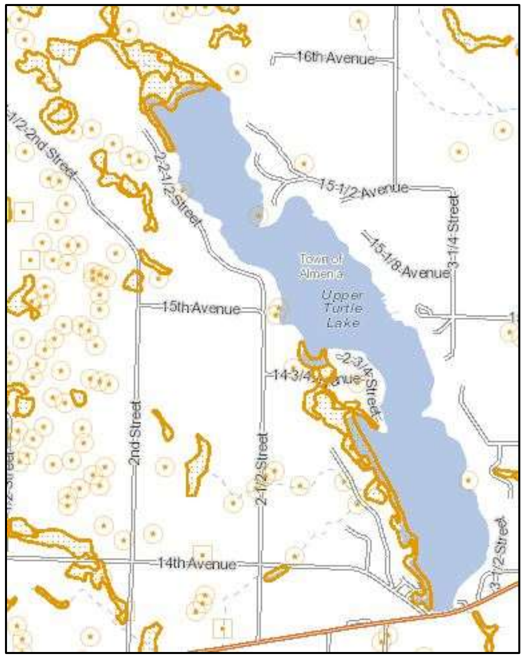

Figure 12: Upper Turtle Lake Wetlands (Wisc. Wetlands Inventory August 23, 2017)

SOILS

Soils are classified into four main hydrologic soil groups (A, B, C, and D) to indicate their potential for producing runoff based off of the rate of infiltration. Group A soils have a high infiltration rate which makes the potential amount of runoff very low. These soils are, generally very sandy and allow water to pass through unimpeded. Conversely, group D soils have a very low infiltration rate making their runoff potential fairly high. Group D soils are generally very dense with high amounts of organic material. This causes water to move slowly through group D soils often resulting in standing water on flat surfaces and flowing water over sloped surfaces. Group D soils are generally found within wetland areas, but they can be problematic in areas that lack the hydrophitic vegetation found within those areas.

There are also three sub groups (A/D, B/D, and C/D) these indicated the infiltration rate of the soils with respect to the water table. If the water table is high and blocking infiltration, these soils are considered to have a high runoff potential and placed into group D, but when the water table is lower, these soils are similar to the first grouping (A, B, or C). Most of the soils, 69.5%, within the Upper Turtle Lake watershed fall into groups B, B/D, or C (Table 2) (NRCSa, 2017). These soils have moderate to slow infiltration rates, so if these areas are not properly managed, there is relatively high runoff potential. The area directly surrounding Upper Turtle Lake are comprised primarily of group B soils reducing the runoff potential in that area, but the majority of the northern half of the watershed are group C which could result in runoff coming in from these areas (Figure 13).

Table 3: Hydrologic soil profile of Upper Turtle Lake watershed

Soil Group	Percentage of Watershed	Infiltration Rate
A	0	High
B	22.5	Moderate
C	28.6	Slow
D	0	Very Slow
A/D	3.3	High when drained, very slow when undrained
B/D	18.4	Moderate when drained, very slow when undrained
C/D	6.3	Slow when drained, very slow when undrained
Water	20.9	N/A

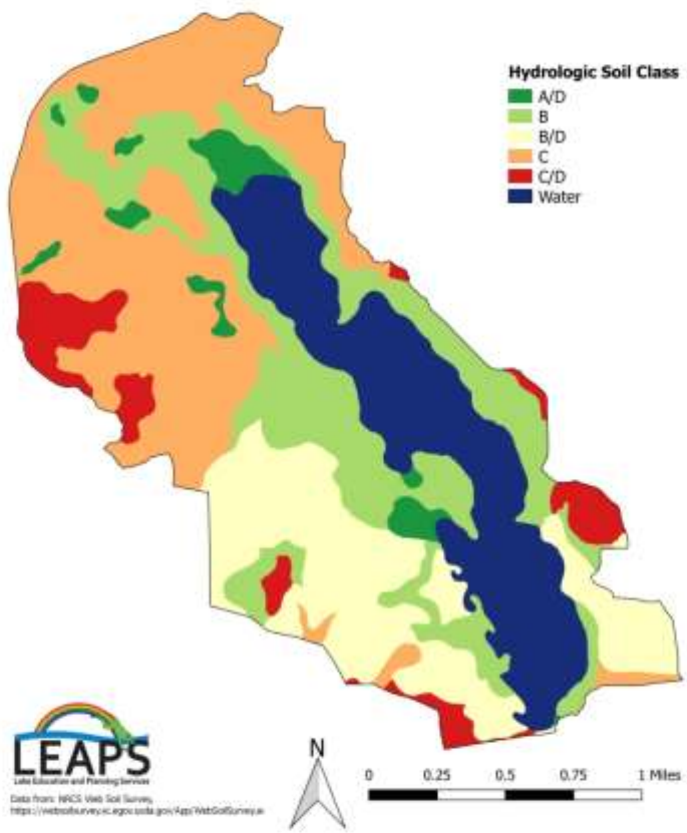

Figure 13: Soil Type and Locations within the Upper Turtle Lake watershed

COARSE WOODY HABITAT (WOLTER, 2012)

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

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

The amount of CWH within Upper Turtle Lake has not been quantified.

SHORELANDS

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

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

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

Shorelands are critical to a lake's health. Activities such 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. Because the majority of the shoreland surrounding Upper Turtle Lake has been developed into residential property, some amount of nutrients entering the lake will come from individual property owners. This impact can be minimized by increasing native plant buffers and making a conscious effort to reduce development of the riparian zone.

PROTECTING WATER QUALITY

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

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

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

NATURAL SHORELANDS ROLE IN PREVENTING AIS

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

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

THREATS TO SHORELANDS

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

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

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

SHORELAND PRESERVATION AND RESTORATION

If a native buffer of shoreland plants exists on a given property, it can be preserved and care taken to minimize impacts when future lake property projects are contemplated. If a shoreline has been altered, it can be restored. Shoreline restoration involves recreating buffer zones of natural plants and trees. Not only do quality wild shorelines create higher property values, but they bring many other values too. Some of these are aesthetic in nature, while others are essential to a healthy ecosystem. Healthy shorelines mean healthy fish populations, varied plant life, and the existence of the insects, invertebrates and amphibians which feed fish, birds and other creatures. Figure 14 shows the difference between a natural and unnatural shoreline adjacent to a lake home. More information about healthy shorelines can be found at the following website: http://wisconsinlakes.org/index.php/shorelands-a-shallows (last accessed 8-24-2017).

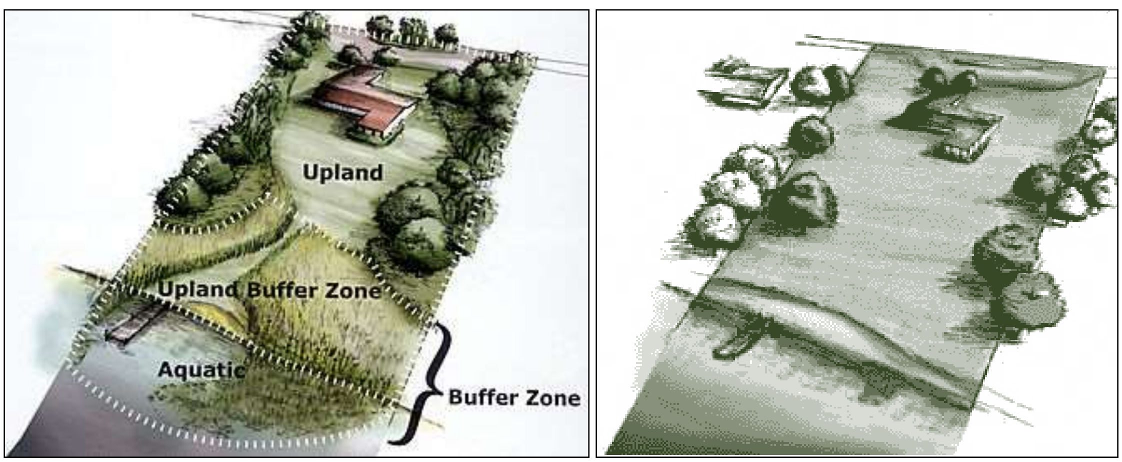

Figure 14: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

Most of the shoreland surrounding Upper Turtle Lake is covered by residential development. While it is likely that many properties are not entirely developed to the shore, many properties are. 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. Several property owners around Upper Turtle Lake have put in best management practices as a part of the 2010-2016 lake protection project. UTLA could sponsor some more of these projects for individual property owners who are interested in improving their shorelines.

2009 AND 2016 WHOLE LAKE POINT INTERCEPT AQUATIC PLANT SURVEYS

An initial Aquatic Plant Management Plan was developed in 2011 using data from the first whole lake point-intercept survey completed in 2010. As a prerequisite to updating the 2011 plan in 2017, another point-intercept survey using the same points and procedure from the 2010 survey was completed. Results from the 2017 survey were compared to the 2010 survey to determine how the lake's vegetation may have changed since the last point-intercept survey. The 2017 survey included an early-season CLP bed mapping survey and a full point-intercept survey for all aquatic plants on in mid-summer.

WARM-WATER FULL POINT-INTERCEPT AQUATIC PLANT SURVEY

During the 2017 warm-water point-intercept survey, plants were found plants growing to 14-ft (up, slightly from 13.5-ft in 2010) The 163 points with vegetation (approximately 27.4% of the entire lake bottom and 59.7% of the littoral zone) was a 0.4% decline from 2010 when plants were found growing at 166 points (27.8% of the bottom and 62.4% of the littoral zone). Growth in 2017 was slightly skewed to deep water as the mean plant depth of 4.5-ft was more than the median depth of 4.0ft. These values were essentially identical to 2011 values.

Plant diversity was fairly high in 2017 with a Simpson Index value of 0.88 – but down slightly from 0.89 in 2010. Species richness was moderate with 28 species found in the rake (down from 31 in 2010) although this total increased to 38 species when including visuals and plants seen during the boat survey. This number was also slightly down from the 40 total species documented in 2010. Similar to the overall species richness, there was a slight decrease in mean native species per site from 3.01 in 2010 to 2.97 in 2016 (Figure 15). A comparison of statistical values from 2010 and 2017 is given in Table 3.

Lower species richness in all three categories: rake, rake including visuals, and rake including visuals and boat survey could be the result of an over-abundance of CLP growth in the spring of the year.

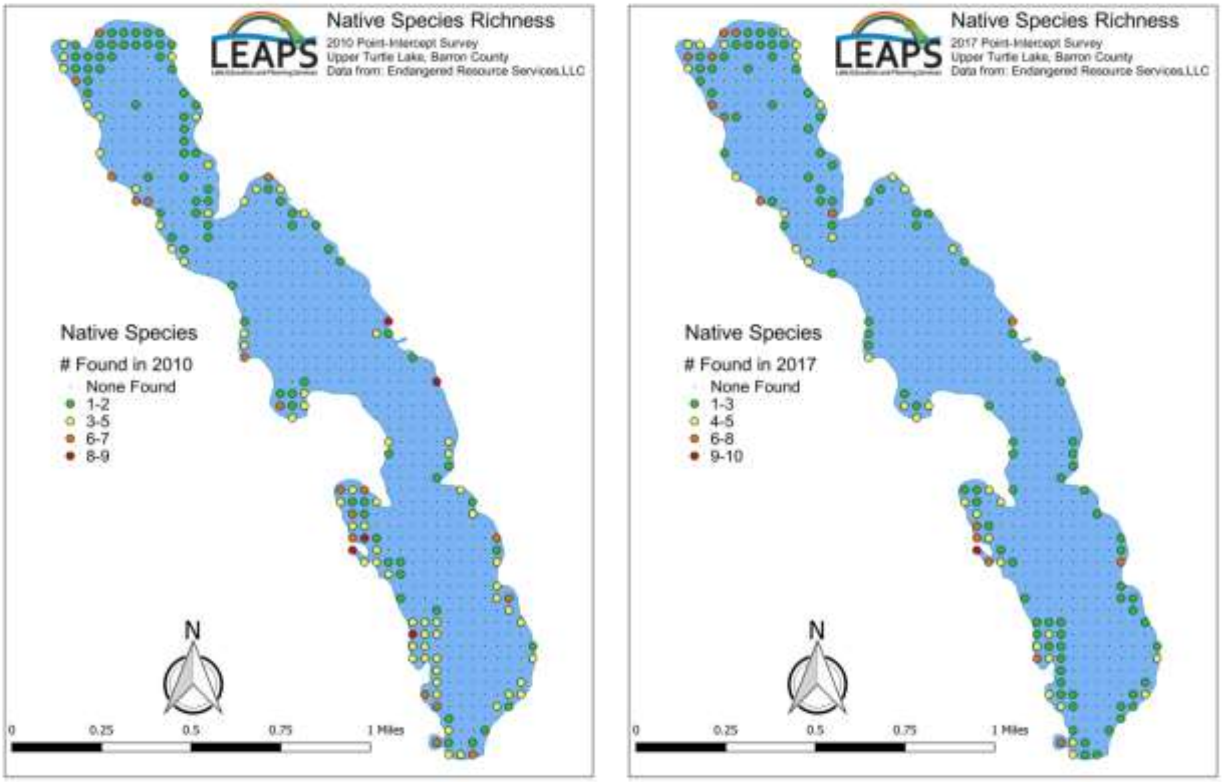

Figure 15: 2010 and 2017 Native Species Richness

Table 4: Aquatic Macrophyte P/I Survey Summary Statistics 2010 and 2017

SUMMARY STATS	2010	2017
Total number of sites visited	595	595
Total number of sites with vegetation	166	163
Total number of sites shallower than maximum depth of plants	265	273
Frequency of occurrence at sites shallower than maximum depth of plants	62.64	59.71
Simpson Diversity Index	0.89	0.88
Maximum depth of plants (ft)**	13.50	14.00
Number of sites sampled using rake on Rope (R)	0	182
Number of sites sampled using rake on Pole (P)	297	413
Average number of all species per site (shallower than max depth)	1.92	1.70
Average number of all species per site (veg. sites only)	3.07	2.84
Average number of native species per site (shallower than max depth)	1.87	1.59
Average number of native species per site (veg. sites only)	3.01	2.97
Species Richness	31	28
Species Richness (including visuals)	35	29
Species Richness (including visuals and boat survey)	40	38
Mean depth of plants (ft)	5.24	5.55
Median depth of plants (ft)	4.00	4.50

CLP 2010-2017

When the initial 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. Since then, the CLP has expanded to a point of dominating the majority of the littoral zone, impeding navigation, and negatively impacting native plants. The survey conducted in 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.

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 16). While this large increase may not be a yearly occurrence, it still suggests that the CLP population is much larger than it was when the 2010 survey was conducted.

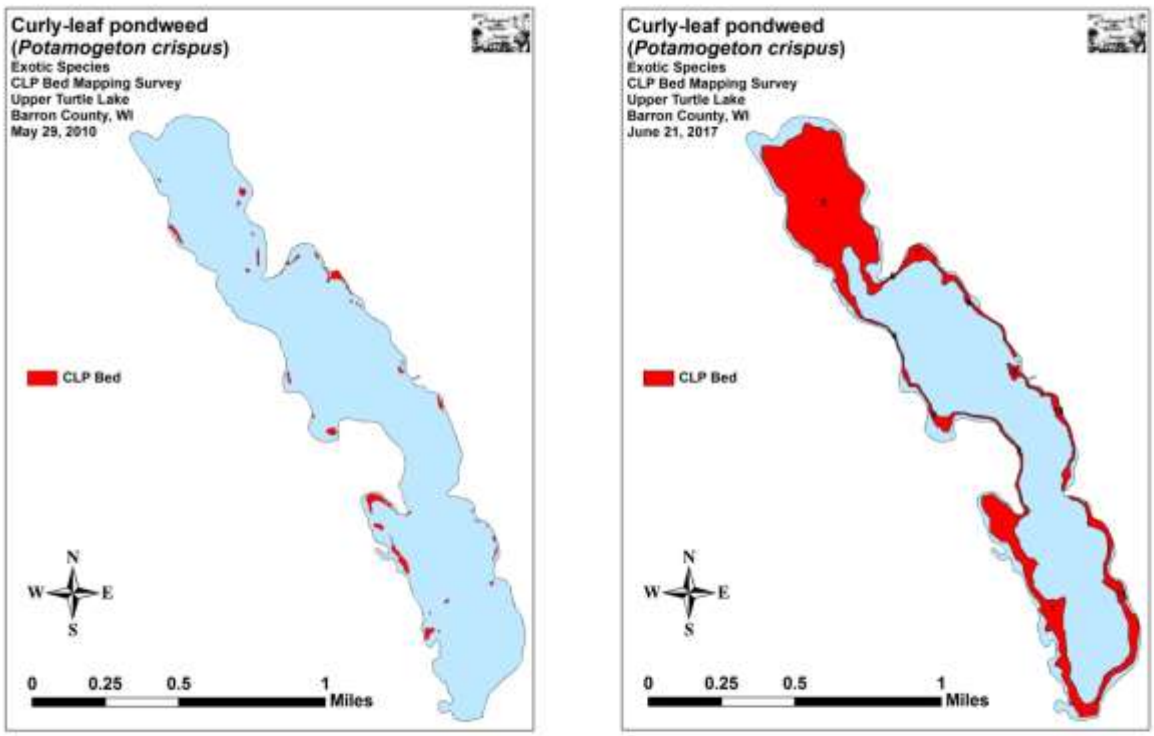

Figure 16: CLP Bed Maps 2010 (left) and 2017(right)

The large increase in CLP documented in 2017 was likely greatly assisted by the unusual winter and spring of 2017. While it is unknown if the incredibly large CLP beds are the new norm in the lake, anecdotal evidence (comments from property owners) suggests the CLP population has been expanding for several years. Dense growth CLP is likely to continue expanding, negatively impacting the native aquatic plant community, water quality, and lake use unless there is some active management undertaken.

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.

NON-NATIVE, AQUATIC INVASIVE PLANT 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. More information is given for each non-native species in the following sections.

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 17). 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 17), 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 17: CLP Plants and Turions

EWM

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 18). 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 18: EWM

EWM is not currently found on Upper Turtle Lake, but it can be found nearby in Echo, Beaver Dam and Lower Vermillion Lakes less than ten miles from Upper Turtle Lake. 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 Upper Turtle Lake. 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 Upper Turtle Lake, prevention and monitoring for this AIS should be a large part of future management.

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 19) 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 Upper Turtle Lake, 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 19: Purple Loosestrife

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 20). 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 not been found around Upper Turtle Lake. There are several lakes, including Rice Lake and Sand Lake, northwest of Cumberland, where knotweed has been observed, but these populations have not been verified by the WDNR.

Figure 20: Japanese Knotweed

REED CANARY GRASS

Reed canary grass (Figure 21) is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades 3 1/2 to 10 inches long and 1/4 to 3/4 inch in width. Blades are flat and have a rough texture on both surfaces. The lead ligule is membranous and long. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

Both Eurasian and native ecotypes of reed canary grass are thought to exist in the U.S. The Eurasian variety is considered more aggressive, but no reliable method exists to tell the ecotypes apart. It is believed that the vast majority of our reed canary grass is derived from the Eurasian ecotype. Agricultural cultivars of the grass are widely planted.

Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to temperate regions of Europe, Asia, and North America. The Eurasian ecotype has been selected for its vigor and has been planted throughout the U.S. since the 1800's for forage and erosion control. It has become naturalized in much of the northern half of the U.S., and is still being planted on steep slopes and banks of ponds and created wetlands.

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

Reed canary grass reproduces by seed or creeping rhizomes. It spreads aggressively. The plant produces leaves and flower stalks for 5 to 7 weeks after germination in early spring and then spreads laterally. Growth peaks in mid-June and declines in mid-August. A second growth spurt occurs in the fall. The shoots collapse in mid to late summer, forming a dense, impenetrable mat of stems and leaves. The seeds ripen in late June and shatter when ripe. Seeds may be dispersed from one wetland to another by waterways, animals, humans, or machines.

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in just a few years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, and deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.

Reed canary grass is located in many locations along the shoreland of Upper Turtle Lake, but the wetlands around the lake have not been overrun by this plant. Currently there is no need for active management of the reed canary grass around Upper Turtle Lake, but AIS monitoring volunteers should be aware and note if it begins to overrun the wetlands.

Figure 21: Reed Canary Grass

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Several non-vegetative, aquatic, invasive species are in nearby lakes, but have not been identified in Upper Turtle Lake. One species, Chinese mystery snails have been verified while rusty crayfish have been observed. It is important for lake property owners and users to be knowledgeable of these species in order to identify them if and when they show up in Upper Turtle Lake.

CHINESE MYSTERY SNAILS

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

The Chinese mystery snails and the banded mystery snails (Figure 22) 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 22: Chinese Mystery Snails (not from Upper Turtle Lake)

RUSTY CRAYFISH

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

Rusty crayfish (Figure 23) 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.

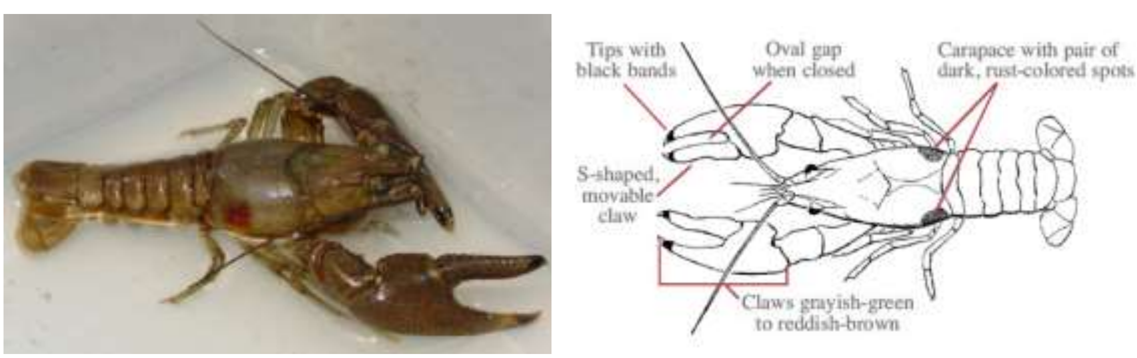

Figure 23: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels (Figure 24) 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.

Zebra mussels attach to the shells of native mussels in great masses, effectively smothering them. A survey by the Army Corps of Engineers in the East Channel of the Mississippi River at Prairie du Chien revealed a substantial reduction in the diversity and density of native mussels due to Zebra Mussel infestations. The East Channel provides habitat for one of the best mussel beds in the Upper Mississippi River. Future efforts are being considered to relocate such native mussel beds to waters that are less likely to be impacted by zebra mussels.

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 24: Zebra Mussels

In the fall of 2016, zebra mussels were found in a northwest Wisconsin lake for the first time. With this discovery, it increases 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. Upper Turtle Lake is listed as suitable, so it is possible that a population would easily become established if they are ever introduced to the lake (Center for Limnology, 2016).

AIS PREVENTION STRATEGY

Upper Turtle Lake already has several established AIS. However there are many more that could be introduced to the lake. The UTLA will begin implementing a watercraft inspection and AIS Signage program at the public access point on the lake. Information will be shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program will be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network AIS Monitoring program.

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

An AIS Rapid Response Plan has been developed as a part of this APM Plan. It details actions to implement to minimize the potential introduction of a new AIS, and provides an overview of actions to take if a new AIS is identified (Appendix J).

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

Each of the above control categories are regulated by the WDNR and most activities require a permit from the WDNR to implement. Mechanical harvesting of aquatic plants and under certain circumstances, physical removal of aquatic plants, is regulated under Wisconsin Administrative Rule NR 109 (Appendix B). The use of chemicals and biological controls are regulated under Administrative Rule NR 107 (Appendix C). Certain habitat altering techniques like the installation of bottom covers and dredging require a Chapter 30/31 waterway protection permit. In addition, anytime wild rice is involved one or more of these permits will be required.

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

NO MANAGEMENT

When evaluating the various management techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with nonnative species 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, 1997). Nonindigenous aquatic plants are the problem, and the management techniques are the collective solution. Nonnative plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "biomagnify" in lakes, rivers, and wetlands (Madsen, 2000).

Foregoing any management of CLP in Upper Turtle Lake is not a recommended option. To keep CLP from causing greater harm, active management strategies will need to be implemented on Upper Turtle Lake.

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 Waivers under the following conditions:

- Removal of native plants is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline provided that any piers, boatlifts, swim rafts and other recreational and water use devices are located within that 30-foot wide zone and may not be in a new area or additional to an area where plants are controlled by another method (Figure 25)
- Removal of nonnative or invasive aquatic plants as designated under s. NR 109.07 is performed in a manner that does not harm the native aquatic plant community
- Removal of dislodged aquatic plants that drift on-shore and accumulate along the waterfront is completed.
- The area of removal is not located in a sensitive area as defined by the department under s. NR 107.05 (3) (i) 1, or in an area known to contain threatened or endangered resources or floating bogs
- Removal does not interfere with the rights of other riparian owners
- If wild rice is involved, the procedures of s. NR 19.09 (1) (Appendix D) are followed.

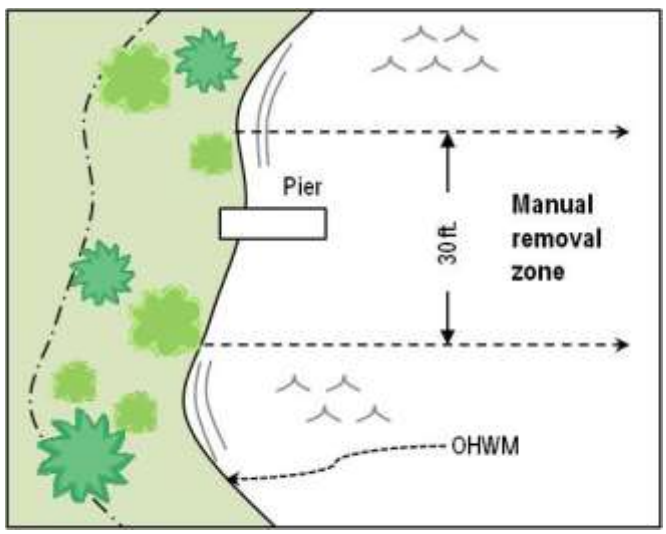

Figure 25: Aquatic vegetation manual removal zone

Although up to 30 feet of aquatic vegetation can be removed, removal should only be done to the extent necessary. 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. Physical removal of aquatic plants requires a permit if the removal area is located in a "sensitive" or critical habitat area previously designated by the WDNR. Manual or physical removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this is the best form of control. If water clarity in a body of water is such that aquatic plants can be seen in deeper water, pulling AIS while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2) and can be effective at slowing the spread of a new AIS infestation within a lake when done properly.

In Upper Turtle Lake, 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. The UTLA will work with residents on the lake to teach them how to identify CLP and how to properly remove it from around their docks and in their swimming areas.

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.

DIVER ASSISTED SUCTION HARVESTING

Diver assisted suction harvesting or DASH, as it is often called, is a fairly recent aquatic plant removal technique. It is called "harvesting" rather than "dredging" because, although a specialized small-scale dredge is used, bottom sediment is not removed from the system. The operation involves hand-pulling of the target plants from the lake bed and inserting them into an underwater vacuum system that sucks up plants and their root systems taking them to the surface. It requires water pumps on the surface (generally on a pontoon system) to move a large volume of water to maintain adequate suction of materials that the divers are processing (Figure 26). Only clean water goes through the pump. The material placed by the divers into the suction hose along with the water is deposited into mesh bags on the surface with the water leaving through the holes in the bag. The bags have a large enough 'mesh' size so that silts, clay, leaves and other plant material being collected do not immediately clog them and block water movement. If a fish or other living marine life is sucked into the suction hose it comes out the discharge unharmed and is returned to the body of water. It can have some negative impacts to other nearby non-target plants if not done carefully, particularly those plants that are perennials and expand their populations by sub-sediment runners (Eichler, Bombard, Sutherland, & Boylen, 1993).

Figure 26: DASH - Diver Assisted Suction Harvest (Aquacleaner Environmental, http://www.aquacleaner.com/index.html); Many Waters, LLC)

DASH is best suited for managing small areas of AIS which means this option is not recommended for CLP management on Upper Turtle Lake. The extent and density of the CLP within Upper Turtle Lake prevent DASH from being a viable management option at this time.

LARGE-SCALE MECHANICAL HARVESTING

Large-scale mechanical harvesting is a fairly traditional method of controlling of CLP. It is typically used to open up channels through existing beds of vegetation to improve access for both human related activities like boating, and natural activities like fish distribution and mobility. When it is done before the plants are able to for new turions, this method helps deplete the extensive CLP seed bank that builds up over time.

Mechanical harvesters are large machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites.

Harvesting is usually performed in late spring, summer, and early fall when aquatic plants have reached or are close to the water's surface. Harvesters can cut and collect several acres per day depending on weed type, plant density, and storage capacity of the equipment. Harvesting speeds for typical machines range from 0.5 to 1.5 acres per hour. Depending on the equipment used, the plants are cut from three to five feet below the water's surface in a swath 4 to 20 feet wide. Harvesting can be an excellent way to create open areas of water for recreation and fishing access.

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. 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 with them, and facilitate the spread of AIS from one body of water to another.

Mechanical harvesting of aquatic plants has advantages and disadvantages (State of Washington, 2016):

Advantages

- Harvesting results in immediate open areas of water.
- Removing plants from the water removes the plant nutrients, such as nitrogen and phosphorus, from the system. (Harvesting aquatic plants is not an effective tool for reducing nutrient loads in a lake and it is unlikely that any operational harvesting program will significantly impact the internal nutrient balance of the system (Madsen, 2000).
- Harvesting as aquatic plants are dying back for the winter can remove organic material and help slow the sedimentation rate in a waterbody.
- Since the lower part of the plant remains after harvest, habitat for fish and other organisms is not eliminated.
- Harvesting can be targeted to specific locations, protecting designated conservancy areas from treatment.

Disadvantages

- Harvesting is similar to mowing a lawn; the plant grows back and may need to be harvested several times during the growing season.
- There is little or no reduction in plant density with mechanical harvesting.
- Off-loading sites and disposal areas for cut plants must be available. On heavily developed shorelines, suitable off-loading sites may be few and require long trips by the harvester.
- Some large harvesters are not easily maneuverable in shallow water or around docks or other obstructions.
- Significant numbers of small fish, invertebrates, and amphibians are often collected and killed by the harvester.

- Harvesting creates plant fragments which may increase the spread of invasive plant species such as EWM throughout the waterbody.
- Although harvesters collect plants as they are cut, not all plant fragments or plants may be picked up. These may accumulate and decompose on shore.
- Harvesters are expensive and require routine maintenance.
- Harvesting may not be suitable for lakes with many bottom obstructions (stumps, logs) or for very shallow lakes (3-5 feet of water) with loose organic sediments.
- Harvesters brought into the waterbody from other locations need to be thoroughly cleaned and inspected before being allowed to launch. Otherwise new exotic species could be introduced to the waterbody.

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 as well as cost.

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. The purchase price of harvesters ranges from $45,000 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.

Prior to 2017, contracted harvesting services have not been readily available in NW Wisconsin. While there are many companies offering contracted services in Minnesota, most will not contract across the border into WI. There is at least one company out of northern Illinois that would consider offering services in NW Wisconsin, but this has not happened yet. In 2017, a new company out of Chippewa Falls, WI will be offering contracted harvesting services. The company owns two 5-ft Harvesters each with a capacity to hold about 220 cubic feet or 6,500 lbs. of cut vegetation on board.

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, not maintenance and storage costs, and there are reduced costs or no costs to the UTLA 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 Upper Turtle Lake however this would have to be a long-term option that is used in conjunction with other management options such as chemical treatment and hand removal.

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.

Small-scale harvesting by human power that is completed in a way such that all of the CLP plant and root structure is removed is recommended for limited control of AIS in the lake. Through information and training, property owners will be instructed on proper physical removal methods.

HABITAT ALTERATION

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 Upper Turtle Lake are not recommended.

DREDGING

Dredging is the removal of bottom sediment from a lake. Its success is based on altering the target plant's environment. It is not usually performed solely for aquatic plant management but rather to restore lakes that have been filled in with sediment, have excess nutrients, inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson, 1982). In shallow lakes with excess plant growth, dredging can make areas of the lake too deep for plant growth. It can also remove significant plant root structures, seeds/turions, rhizomes, tubers, etc. 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, 2000).

Dredging is not a recommended management action for Upper Turtle Lake.

DRAWDOWN

Dropping the lake level to allow for the desiccation, aeration, and freezing of lake sediments has been shown to be an effective aquatic plant management technique. Repeated drawdowns lasting 4 to 6 months that include a freezing period are the most effective.

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 Upper Turtle Lake. The lack of an outlet structure and the presence of a diverse aquatic plant community make water level manipulation impractical.

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.

GALURECELLA BEETLES

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 27). 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 27: 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. This allows the wetlands near Upper Turtle Lake to be diverse plant communities instead of purple loosestrife monocultures.

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 recommended for Upper Turtle Lake in this management plan, but if there are lake residents who wish to do so it has the potential to benefit the lake.

NATIVE PLANT RESTORATION

A healthy population of native plants might slow invasion or reinvasion of non-native aquatic plants. It should be the goal of every management plan to protect existing native plants and restore native plants after the invasive species has been controlled. In many cases, a propagule bank probably exists that will help restore native plant communities after the invasive species is controlled (Gettsinger, Turner, Madson, & Netherland, 1997). This is certainly the case in Upper Turtle Lake where native plants have been fairly diverse and abundant in the recent past. The goal of this plan is to enhance, protect, and restore native plant populations while controlling CLP and other non-native invasive species.

OTHER BIOLOGICAL CONTROLS

Currently, there are no biological control methods available for CLP management. Galerucella beetle rearing could be undertaken by interested lake residents for purple loosestrife management, but this is not a recommended management action. Weevils are another biological control that is occasionally used in Wisconsin with mixed results. However, these insects are only used for EWM management, making them inappropriate for Upper Turtle Lake.

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. Some individual states, including Wisconsin, also impose additional constraints on herbicide use.

The Wisconsin Department of Natural Resources 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 WDNR encourages minimal herbicide use by requiring a strategic Aquatic Plant Management (APM) Plan for management projects over 10 acres or 10% of the water body or any projects receiving state grants. WDNR also requires consideration of alternative management strategies and integrated management strategies on permit applications and in developing an APM plan, when funding invasive species prevention efforts, and by encouraging the use of best management practices when issuing a permit. The Department also supervises treatments, requires that adjacent landowners are notified of a treatment and are given an opportunity to request a public meeting if they want, requires that the water body is posted to notify the public of treatment and usage restrictions, and requires reporting after treatment occurs.

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).

When properly applied, the possible negative impacts of chemical herbicide use can be minimized. Early spring to early summer applications are preferred because exotic species are actively growing and many native plants are dormant, thus limiting the loss of desirable plant species; plant biomass is relatively low minimizing the impacts of de-oxygenation and contribution of organic matter to the sediments; fish spawning has ceased; and recreational use is generally low limiting human contact. The concentration and amount of herbicides can be reduced because colder water temperatures enhance the herbicidal effects. Selectivity of herbicides can be increased with careful selection of application rates and seasonal timing. Lake hydro-dynamics must also be considered; steep drop-offs, inflowing waters, lake currents and wind can dilute chemical herbicides or increase herbicide drift and off-target injury. This is an especially important consideration when using herbicides near environmentally sensitive areas or where there may be conflicts with other water uses in the treatment vicinity.

HOW CHEMICAL CONTROL WORKS

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.

Sonar® whose active ingredient is fluridone, is a broad spectrum herbicide that interferes with the necessary processes in a plant that create the chlorophyll needed to turn sunlight into plant food through a process called photo-synthesis. Rodeo® whose active ingredient is glyphosate is another broad spectrum herbicide that prevents an aquatic plant from making the protein it needs to grow. As a result the treated plant stops growing and eventually dies.

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

Aquathol whose active ingredient is endothall; Reward whose active ingredient is diquat; and Cutrine whose active ingredient is a form of copper are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. None of these three are considered selective and have the potential to kill all of the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like curly-leaf pondweed begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide like Aquathol, as few other plants would be impacted. Using these products later in the season, will kill all vegetation in contact with the herbicide and can provide substantial nuisance relief from a variety of aquatic plants.

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

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.

MICRO AND SMALL-SCALE HERBICIDE APPLICATION

The determining factor in designating chemical treatments as micro or small-scale is the size of the area being treated. Small-scale herbicide application involves treating areas less than 10 acres in size. The dividing line between small-scale and micro treatments is not clearly defined, but is generally considered to be less than 3 acres. Small-scale chemical application is usually completed in the early season (April through May). Micro treatments are as well, but may be used as follow-up spot treatments after an early season application for EWM, or in instances where a new infestation has been identified in a lake with EWM already or a in a completely new lake. Recent research related to micro and 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.

Some suggested ways to increase the effectiveness of this management strategy are to increase the concentration of herbicide used, use a contact herbicide like diquat that does not require as long a contact time to be effective, or in some manner contain the herbicide in the treated area by artificial means.

Pre- and post-treatment aquatic plant surveys and testing for herbicide residuals are not required by the WDNR for small-scale treatments. Nor is an approved APMP if the organization sponsoring the application is not using grant funding to help defer the costs. Even though not required by the WDNR, participating in these activities is recommended as it helps to gain a better understanding of the impact and fate of the chemical used.

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 EWM and CLP while minimizing impacts on native species. It is generally accepted that lower concentration of herbicide can be used in large-scale applications as 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.

Pre- and post-treatment aquatic plant surveying and having an approved APMP are required by the WDNR when completing large-scale chemical treatments. Residual testing is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used.

WHOLE-LAKE, AND/OR EPILIMNION APPLICATION

Whole-lake or whole-basin treatments are those where the herbicide may be applied to specific sites, but the goal of the strategy is for the herbicide to reach a target concentration when it equally distributes throughout the entire volume of the lake (or lake basin, or within the epilimnion of the lake or lake basin). The application rate of whole-lake treatments is dictated by the volume of water in with which the herbicide will reach equilibrium. Because exposure time is expected to be so much longer, effective herbicide concentrations for whole-lake treatments are significantly less than required for small-scale or micro treatments. Whole-lake treatments are typically conducted when the target plant is spread throughout the majority of the lake or basin.

If the herbicide exposure time of the target aquatic plant can be extended, the concentration of the herbicide applied can be lowered. If the contact time between the applied herbicide and the target plant in a whole body of water or protected bay can be increased to, or is already expected to be several days to a week or more, the concentration of herbicide can be in the range of 0.25-0.5 ppm instead of the 2-4 or more ppm that is typically used in small-scale or micro treatments.

Planning to treat the whole lake can be further designed to minimize the herbicide needed to affect the desired outcome. The method used to implement whole-lake treatments changes with the type of lake. Herbicide applied to a shallow, mixed lake is expected to mix throughout the entire volume of the lake. In deep water lakes that stratify, herbicide can be applied at such a time when it is expected that it will only mix with the surface water above the thermocline in an area known as the epilimnion (Figure 28). For this to be a viable management alternative, a lake has to stratify early enough in the open water season to coincide with the optimal time for early season chemical application.

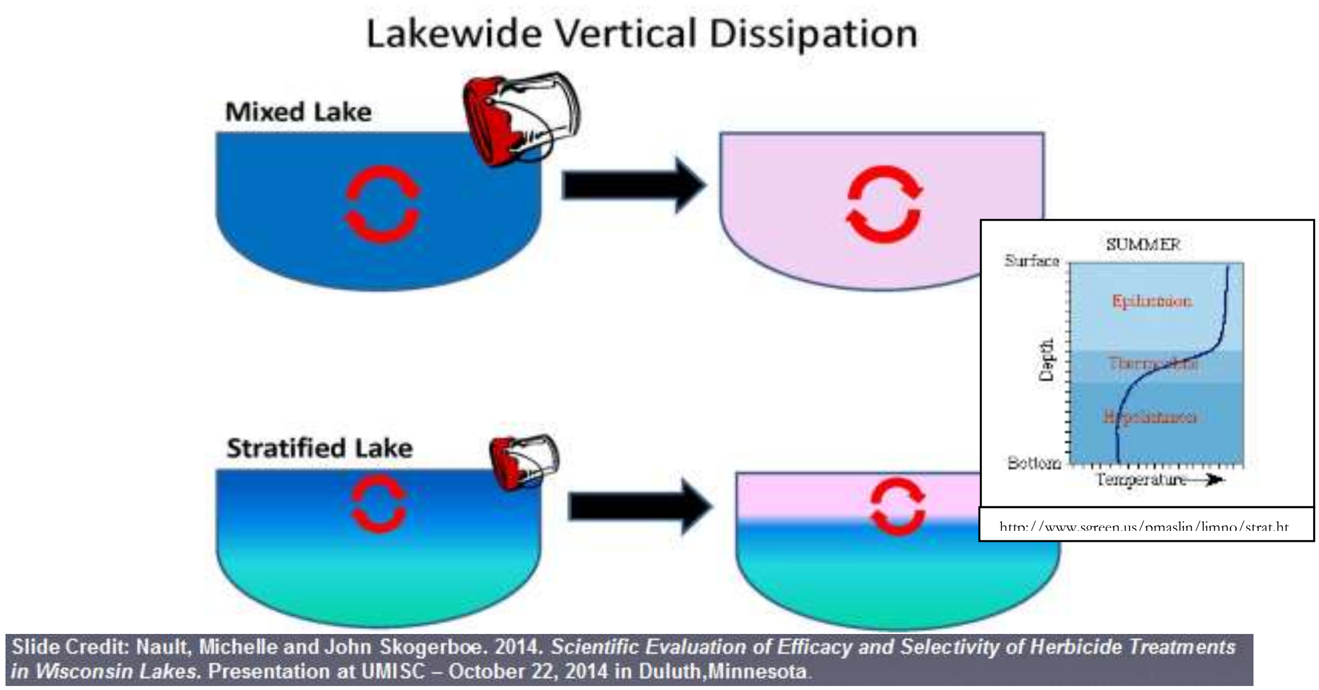

Figure 28: Lake-wide (whole-lake) dissipation of aquatic herbicides in Mixed and Stratified Lakes (Carlson, 2015). Inset: Summer thermal stratification.

EFFECTS OF WHOLE-LAKE TREATMENTS ON NATIVE AQUATIC PLANT SPECIES

Treating an entire lake with a chemical herbicide does have some concerns. One is particular is the effect on native aquatic plant vegetation in the treated body of water. Based on study results published by the WDNR in 2012 (Nault, et al., 2012) looking at nine different lakes that had whole-lake treatments completed, "year of treatment" effects on native plants were mostly negative, and on aggregate, 34 of the total 38 significant differences between species frequency of occurrence pre- and post-treatment were reductions, affecting 38 percent to 78 percent of the number of native species within a lake. Short-term reductions in native littoral frequency of occurrence occurred even at low concentrations of 2, 4-D if exposure times were long. Native dicots such as the watermilfoils (esp. northern watermilfoil), water marigold, and bladderworts are known to be susceptible to 2, 4-D, and displayed statistically-significant decreases in some of the case studies. At long-term exposures (across a range of concentrations) adverse impacts to relatively tolerant monocots such as naiads, several narrow leaf pondweeds, wild celery, and common waterweed were also observed. Water quality may also be affected by large-scale treatments. For example, in two lakes for which Secchi data was collected pre- and post-treatment (Sandbar and Tomahawk), a 40-percent reduction in water clarity was observed when comparing pre-treatment averages to year-of treatment averages. In another Wisconsin lake not part of this study (Bridge Lake), dissolved oxygen levels declined following a large-scale treatment that occurred relatively late in the season when water temperatures were higher.

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

When introducing new chemical treatments to lakes where the treatment size is greater than ten acres or greater than 10% of the lake littoral area and more than 150-ft from shore, the WDNR requires pre and post chemical application aquatic plant surveying. The protocol for pre and post treatment survey is applicable for chemical treatment of CLP and EWM.

The WDNR protocol assumes that an APMP 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.

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

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

CHEMICAL CONCENTRATION TESTING

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

In some lakes, rhodamine dye is added to the herbicide at the time of application in amounts equal to the expected concentration of the herbicide and a fluorimeter is used to sample the dye as it moves around the system. Both systems for tracking the movement of the herbicide, concentration attained, and contact time maintained can be used effectively to help better current and future planning.

Because chemical management has not been undertaken on Upper Turtle Lake, concentration testing has not been conducted. Chemical concentration testing done on other lakes has shown that application of herbicides in micro or small-scale treatment areas is less effective than treating large areas. Furthermore, chemical application in deep water or along deep water edges reduces the success of chemical management. While the CLP within Upper Turtle Lake was widespread in 2017, many of these areas will likely be smaller in the coming years. Because of this chemical concentration testing should be done as a means to determine which areas are best suited to be treated and which areas would require a different management strategy or no management at all.

DYE STUDIES

One of the keys to controlling noxious and invasive aquatic weed species with aquatic herbicides is understanding how water exchange within the treatment sites might affect performance of the herbicide applied. In the mid to late 1980's US Army Corps of Engineers Aquatic Plant Management Researchers started to think about how these products uptake within target weeds, how much time the target weeds need to be exposed to the particular herbicide and how water exchange impacts efficacy. This research has led to operational improvements in using these technologies to impact invasive aquatic species and to help operational aquatic plant managers plan treatments. One tool that was used, and continues to be used is substituting Rhodamine WT dye in the role of an aquatic herbicide. This dye can be applied at a known concentration, and it can be measured with an instrument called a flurometer. Sampling grids can then be set up within the treatment plot to monitor how long the dye remains and at what concentrations. Sampling stations outside the plot can be set up to see where a potential herbicide might go and at what concentrations. These are very useful data to have when planning CLP herbicide control projects as it makes it possible to predict with much greater certainty how much herbicide will be needed in a given situation to control the target plant. Because the dye is relatively inexpensive, using it to simulate how much herbicide should be applied, is much cheaper, and much less damaging than experimenting with the herbicide itself. It also allows management planners to more accurately predict what impacts there might be to other plants of concern. Simulated dye treatments are often done prior to completing actual herbicide treatments, but occasionally the dye is added to an actual herbicide application to make it easier to track the movement of the herbicide, particularly in a situation where there may be moving water.

The ultimate goal of this plan is to improve the usability and maintain water quality of Upper Turtle Lake through the reduction of CLP levels. Currently, there is not enough numeric data to determine if the 2017 CLP levels are the norm on Upper Turtle Lake or if the ideal conditions afforded to CLP during the winter and spring of 2017 resulted in the vast expansion of CLP from the levels seen in 2010. If the CLP levels seen in 2017 are repeated on a regular basis the best way to reach this goal will be through active management of CLP.

ESTABLISHING AND MAINTAINING AN AIS MANAGEMENT PROGRAM

Anecdotal evidence suggests that the CLP population has been showing significant growth each year since the 2010 plant survey was done, but there is not yet enough empirical data to justify a large-scale or whole-lake treatment. Additionally, it is not known how much the water moves throughout the system. Because of this, a rhodamine dye study is recommended before any large-scale or whole-lake treatment should be considered.

Annual CLP bed mapping should be conducted to determine the extent of the CLP population and allow any changes in population density or extent to be observed. Annual monitoring of CLP will result in more effective management planning and better interpretation of results. It is also recommended to regularly complete a full suite of water quality testing , TP, chlorophyll A, DO, temperature, and Secchi, in order to monitor for any changes that occur within the lake be it natural or due to management actions.

POTENTIAL AIS MANAGEMENT ACTIONS

If additional data shows that 2017 CLP levels are now the norm, a large-scale herbicide treatment may be necessary. Endothall is usually the active ingredient in herbicides used for CLP management. This is a contact herbicide which is applied early in the season before most of the native plants have begun growing. The amount of herbicide necessary would greatly depend on the amount of water movement throughout the lake. Table 4 breaks down the yearly costs of the herbicide that would be needed for a large-scale treatment. In addition to the cost for herbicide, there would be costs associated with pre- and post- treatment plant surveys which are required for any treatment greater than 10 acres. For CLP management to be effective, the herbicide would have to be applied for a minimum of three consecutive years.

Table 5: Large-scale treatment costs

Upper Turtle Lake Potential Large-Scale Treament						
Treatment Characteristics				Curly-leaf Pondweed Control Treatment application		
Treatment Site	Acreage	Mean Depth (feet)	Volume (acre-feet)	Treatment a.i. ppm	gallons†	Yearly Cost
2017 CLP Beds	132.35	9.91	1311.59	0.5	393.5	$47,217.19
	132.35	9.91	1311.59	0.75	590.2	$70,825.78
	132.35	9.91	1311.59	1.0	787.0	$94,434.37
	132.35	9.91	1311.59	1.5	1311.6	$157,390.62
* Aquathol K® liquid aquatic herbicide (a.i. endothall)						
When Treatment Concentration= 0.5 ppm, Whole Lake Concentration = 0.16 ppm						

Table 4 contains estimates of herbicide costs for several different concentrations because it is still unknown how quickly the herbicide would dissipate throughout the lake. After the completion of a dye study, the appropriate concentration can be determined. If the data collected during the initial year suggests it is appropriate, a whole-lake treatment could be done. For this treatment method, the herbicide is applied at a higher concentration to the affected areas with the expectation that the entire lake will reach the target concentration that is lower than the concentrations that would be used in a large-scale treatment. Due to the fact that Upper Turtle Lake does not stratify until relatively late in the season, an epilimnion treatment would not be possible. If a whole lake treatment is necessary, it would be significantly more expensive with the lowest concentration of 0.25 ppm costing over $110,000 per year which would also need to be maintained for a minimum of three years, maybe longer.

Another possible management strategy could be mechanical harvesting. If it is determined that this is the most viable option, UTLA would have to determine if they would like to contract this service or purchase and operate a harvester. The costs associated with contracted harvesting would vary greatly depending on the level of support provided by the UTLA including hauling away of harvested aquatic plants. To do this a dump site for the harvested vegetation would have to be identified.

It would also be possible to use a mixture of chemical and physical treatment to manage CLP. This could be done by treating smaller areas with herbicide while doing some mechanical harvesting to maintain navigation lanes. Additional manual removal of CLP by property owners should be encouraged to supplement the management actions of the UTLA.

2018-2022 GOALS, OBJECTIVES, AND ACTIONS

The following are the goals, objectives, and actions that accompany this plan. They can also be found in Appendix F.

1. Goal 1: Support and propagate AIS management efforts that minimize negative impacts to the native plant communities
    a. Objective 1: Prepare for a management program to reduce CLP levels to those seen in 2010.
        i. Action 1: Conduct a rhodamine dye study to determine potential impacts of a herbicide application in Upper Turtle Lake
            1. Mimic a proposed treatment
            2. Administer spring of the year prior to the proposed treatment
        ii. Action 2: Conduct smaller test treatments with concentration testing to determine efficacy of herbicide treatments on CLP beds.
        iii. Action 3: CLP bed mapping surveys
            1. Conducted the spring prior to the proposed treatment.
            2. Conducted on an annual basis each spring to determine changes in CLP levels and the efficacy of any management actions.
        iv. Action 4: Conduct CLP turion density studies.
            1. Completed in the fall of the year prior to or immediately following the first year of a proposed treatment.
            2. Repeated after three years of treatment.
        v. Action 5: Complete a full suite of water quality testing
            1. Purchase a dissolved oxygen/ temperature meter
            2. Collect Temperature and Dissolved Oxygen profiles, TP, ChlorA, Secchi disk data.
            3. Monthly in accordance with the CLMN protocol.
        vi. Action 6: Determine the appropriate scale and method of CLP management.
            1. Review all data to determine when, where, and how to best manage CLP within Upper Turtle Lake.
            2. Areas that are 2.0 acres or larger will be considered for treatment.
    b. Objective 2: Implement a multi-year, native restoration and CLP control plan.
        i. Action 1: Apply liquid endothall at appropriate concentrations when the size of CLP beds warrant.
            1. Complete pre- and post-treatment aquatic plant surveys in the treated areas each year of treatment.
        ii. Action 2: Complete summer littoral point-intercept surveys to determine impacts of management actions on the native plant communities.
            1. All plants surveyed in the entire littoral zone
            2. Done in July or August
    c. Objective 3: Evaluate the use of harvesting In the absence of any herbicide application
        i. Action 1: Gather more data related to the costs and benefits associated with a CLP and native plant harvesting plan.
2. Goal 2: AIS education and prevention.

    a. Objective 1: Prevent new AIS from entering and becoming established within Upper Turtle Lake
        i. Action 1: Implement Clean Boat Clean Waters
            1. 200 hours annually with grant funding
            2. Volunteer hours only without grant funding
    b. Objective 2: Set up and maintain a public participation and communication program and an AIS education and information program
        i. Action 1: Develop and distribute at least two newsletters updating AIS and other UTLA activities
        ii. Action 2: Host at least one annual meeting and maintain open UTLA Board meetings
        iii. Action 3: Host an Annual Lake Fair to promote public involvement in lake activities
            1. Can be combined with the Annual Picnic or other planned event, or with another entity
        iv. Action 4: Maintain an Upper Turtle Lake Association webpage
    c. Objective 3: Set up and maintain AIS monitoring efforts
        i. Action 1: Install, maintain, and/or improve AIS signage at both public access points
        ii. Action 2: Establish and maintain an in-lake and shoreline AIS monitoring program following CLMN guidelines
        iii. Action 3: Follow established EWM early detection and response plan
            1. See AIS Rapid Response Plan (Appendix J)
3. Goal 3: Promote and support nearshore, riparian, and watershed best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Upper Turtle Lake.
    a. Objective 1: Adopt State of Wisconsin Healthy Lakes Initiative
        i. Action 1: Officially adopt the Wisconsin Healthy Lakes Initiative during the next annual meeting of the UTLA.
        ii. Action 2: Apply for Healthy Lakes grant funding to support projects that improve shoreland habitats and reduce runoff into the lake.
4. Goal 4: Encourage and engage lake residents and visitors to be active lake stewards.
    a. Objective 1: Encourage behavior changes in residents in the following areas: shoreland development, AIS, aquatic vegetation, recreational practices, and responsibility for the lake.
        i. Action 1: Encourage lake residents to understand AIS concerns, identify and help monitor for AIS within the lake, and report and/or remove what they find.
        ii. Action 2: Encourage boaters to implement appropriate AIS prevention strategies on their watercraft.
        iii. Action 3: Disseminate educational material related to the benefits of native plants within the lake and along the shoreline.
            1. Create and distribute welcome packets, newsletters, information/educational displays, Facebook and/or webpage, UTLA meetings, and other resources to increase the level of public awareness and interest in the lake.
    b. Objective 2: Encourage and develop volunteer action and leadership
        i. Action 1: Recruit new UTLA members, board members, and volunteers.
        ii. Action 2: Encourage lake volunteer involvement in "lake leaders" training

        iii. Action 3: Recognize good lake stewards and good examples of shoreland practices.

5. Goal 5: Implement the Upper Turtle Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.
    a. Objective 1: Complete annual project activity and assessment reports
        i. Action 1: Use reports to make recommendation for annual revisions and updates to the APM Plan
    b. Objective 2: Complete an End-of-project Summary Report
        i. Action 1: Overall review of project successes and failures.
        ii. Action 2: Complete early and mid-season whole-lake point-intercept survey of all plants.
        iii. Action 3: Revise or rewrite APM Plan as needed.
    c. Objective 3: Develop partnerships to support management implementation
        i. Action 1: Communicate with local, county, and state entities; schools and local business; clubs and organizations, etc. to generate support for management actions.
        ii. Action 2: Share results with partners from Action 1

IMPLEMENTATION AND EVALUATION

This plan is intended to be a tool for use by the UTLA 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 UTLA funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix G.

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

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

There are several WDNR grant programs that may be able to assist the UTLA in implementing its new APMP. 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. WDNR Healthy Lakes grants are part of the Lake Protection program.

AIS PREVENTION AND CONTROL GRANTS

The AIS (AIS) Prevention and Control grants are a cost-share effort by the WDNR to provide information and education on types of existing and potential AIS in Wisconsin, the threats that invasive species pose to the state's aquatic resources, and available techniques for invasive species control. These grants also assist in the planning and implementation of projects that will prevent the introduction of invasive species into waters where they currently are not present, controlling and reducing the spread of invasive species from waters where they are present, and restoring native aquatic communities.

There are five AIS Prevention and Control grants subprograms:

- Education, Prevention and Planning Projects (including Clean Boats Clean Waters)
- Early Detection and Response Projects
- Established Population Control Projects
- Maintenance and Containment Projects
- Research and Demonstration Projects

Education, Prevention, and Planning; Clean Boats, Clean Waters, and Maintenance and Containment grants are applicable to Upper Turtle Lake and the UTLA.

EDUCATION, PREVENTION AND PLANNING PROJECTS

Education projects are intended to broaden the public's awareness and understanding of, and ability to identify, AIS; the threats that AIS pose to the health of aquatic ecosystems; the measures to prevent the spread of AIS; and the management practices used for control of AIS. Prevention projects are intended to prevent the introduction of new AIS into a waterbody/wetland, or prevent the spread of an AIS population from one waterbody to another unpopulated waterbody/wetland. Planning projects are intended to assist in the development of plans for the prevention and control of AIS. Eligible projects include:

- Educational programs including workshops, training sessions, or coordinated volunteer monitors. Projects will be reviewed for consistency with the DNR's statewide education strategy for controlling AIS including the use of existing publications and outreach materials.
- Development of AIS prevention and control plans
- Monitoring, mapping, and assessing waterbodies for the presence of AIS or other studies that will aid in the AIS prevention and control.
- Watercraft inspection and education projects following the guidelines of the DNR's Clean Boats, Clean Waters program.

This subprogram is not intended to provide support for any management action that may be taken.

Funding Possibilities

Maximum amount of grant funding is 75% of the total project costs, not to exceed $150,000. Applications will be separated into two classes: less than $50,000 in state funding and between $50,001 and $150,000 in state funding. Clean Boats Clean Waters projects are limited to $4,000 per public boat launch facility but may be a component of a larger project.

ESTABLISHED POPULATION CONTROL PROJECTS

Established population control grants are intended to assist applicants in eradicating or substantially reducing established populations of AIS to protect and restore native species communities. Established populations are defined as substantial reproducing populations of AIS that are not pioneer populations. Eligible projects include activities recommended in a DNR-approved control plan including monitoring, education, and prevention activities. Ineligible projects include the following:

- Dredging
- Chemical treatments or mechanical harvesting of aquatic plants to provide single season nuisance or navigational relief.
- Maintenance and operation of aeration systems and mechanical structures used to suppress aquatic plant growth.
- Structural facilities for providing boat washing stations. Equipment associated with boat washing facilities is eligible if included in a management plan.

Funding Possibilities

Maximum amount of the grant funding is 75% of the total project costs, not to exceed $200,000.

MAINTENANCE AND CONTAINMENT PROJECTS

Maintenance and containment grants are intended to provide sponsors limited financial assistance for the ongoing control of established AIS population without the assistance of an Established Population Control grant. These projects are intended for waters where management activity has achieved the target level of control identified in an approved plan that meets the criteria of s. NR 198.43, Wis. Adm. Code. Ongoing maintenance is needed to contain these populations so they do not re-establish throughout the waterbody, spread to other waters, or impair navigation and other beneficial uses of the waterbody.

Funding Possibilities

Maximum amount of grant funding will be determined by DNR based on the sponsor's permit application fee, specified monitoring and reporting requirements in the permit, or DNR-approved management plan. The maximum grant amount shall not exceed the cost of the permit application fee.

LAKE MANAGEMENT PLANNING GRANTS

Lake management planning grants are intended to provide financial assistance to eligible applicants for the collection, analysis, and communication of information needed to conduct studies and develop management plans to protect and restore lakes and their watersheds. Projects funded under this subprogram often become the basis for implementation projects funded with Lake Protection grants. There are two categories of lake management planning grants: small-scale and large-scale.

SMALL SCALE LAKE MANAGEMENT PROJECTS

Small-scale projects are intended to address the planning needs of lakes where education, enhancing lake organizational capacity, and obtaining information on specific lake conditions are the primary project objectives. These grants are well suited for beginning the planning process, conducting minor plan updates, or developing plans and specification for implementing a management recommendation. Eligible projects include:

- Collect and report chemical, biological, and physical data about lake ecosystems for a Tier I assessments, Tier II diagnostic or Tier III project evaluation.
  - Tier I if initial basic monitoring is needed to assess the general condition or health of the lake.
  - Tier II if an assessment has been conducted and more detailed data collection is needed to diagnose suspected problems and identify management options.
  - Tier III if the monitoring and assessment will be used to evaluate the effectiveness of a recently implemented project or lake management strategy.
- Collecting and disseminating existing information about lakes for the purpose of broadening the understanding of lake use, Lake Ecosystem conditions and lake management techniques.
- Conducting workshops or trainings needed to support planning or project implementation.
- Projects that will assist management units as defined in s. NR191.03 (4) & s. NR 190.003 (4) the formation of goals and objectives for the management of a lake or lakes.

Funding Possibilities

Maximum amount of grant funding is 67% of the total project costs, not to exceed $3,000.

LARGE SCALE LAKE MANAGEMENT PROJECTS

Large-scale projects are intended to address the needs of larger lakes and lakes with complex and technical planning challenges. The result will be a lake management plan; more than one grant may be needed to complete the plan. Eligible projects include:

- Collection of new or updated, physical, chemical and biological information about lakes or lake ecosystems.
- Definition and mapping of Lake Watershed boundaries, sub-boundaries and drainage system components.
- Descriptions and mapping of existing and potential land conditions, activities and uses within lake watersheds that may affect the water quality of a lake or its ecosystem.
- Assessments of water quality and of fish, aquatic life, and their habitat.
- Institutional assessment of lake protection regulations - review, evaluation or development of ordinances and other local regulations related to the control of pollution sources, recreational use or other human activities that may impact water quality, fish and wildlife habitat, natural beauty or other components of the lake ecosystem.
- Collection of sociological information through surveys or questionnaires to assess attitudes and needs and identify problems necessary to the development of a long-term lake management plan.
- Analysis, evaluation, reporting and dissemination of information obtained as part of the planning project and the development of management plans.
- Development of alternative management strategies, plans and specific project designs, engineering or construction plans and specifications necessary to identify and implement an appropriate lake protection or improvement project.

Funding Possibilities

Maximum amount of grant funding is 67% of the total project costs, not to exceed $25,000. Multiple grants in sequence may be used to complete a planning project, not to exceed $100,000 for each lake. The maximum grant award in any one year is $50,000 for each lake. If phasing is necessary, all phases should be fully identified and a timeline identified in the initial application.

LAKE PROTECTION GRANTS

Lake protection and classification grants assist eligible applicants with implementation of lake protection and restoration projects that protect or improve water quality, habitat or the elements of lake ecosystems. There are four basic Lake Protection subprograms: a) Fee simple or Easement Land Acquisition b) Wetland and Shoreline Habitat Restoration c) Lake Management Plan Implementation d) Healthy Lakes Projects.

HEALTHY LAKES PROJECTS

The Healthy Lakes grants are a sub-set of Plan Implementation Grants intended as a way to fund increased installation of select best management practices (BMPs) on waterfront properties without the burden of developing a complex lake management plan. Details on the select best practices can be found in the Wisconsin Healthy Lakes Implementation Plan and best practice fact sheets.

Eligible best practices with pre-set funding limits are defined in the Wisconsin Healthy Lakes Implementation Plan, which local sponsors can adopt by resolution and/or integrate into their own local planning efforts. By adopting the Wisconsin Healthy Lakes Implementation Plan, your lake organization is immediately eligible to implement the specified best practices. Additional technical information for each of the eligible practices is described in associated factsheets. The intent of the Healthy Lakes grants is to fund shovel-ready projects that are relatively inexpensive and straight-forward. The Healthy Lakes grant category is not intended for large, complex projects, particularly those that may require engineering design. All Healthy Lake grants have a standard 2-year timeline.

Funding Possibilities

Maximum amount of grant funding is 75% of the total project cost, not to exceed $25,000. Grants run for a 2-year time period. Maximum costs per practice are also identified in the Wisconsin Healthy Lakes Implementation Plan.

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Appendix A

WDNR Upper Turtle Sensitive Areas Report

Appendix B

NR 109

Appendix C

NR 107

Appendix D

NR 19

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