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RICE LAKE, BARRON COUNTY

2021-25 AQUATIC PLANT MANAGEMENT PLAN
WDNR WBIC: 2103900

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November, 2020

RICE LAKE PROTECTION & REHABILITATION DISTRICT
RICE LAKE, WI 54868

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PREPARED FOR THE RICE LAKE PROTECTION & REHABILITATION DISTRICT

INTRODUCTION

Rice Lake (WBIC 2103900) is located in Barron County in northwestern Wisconsin (Figure 1). The lake is an impoundment of the Red Cedar River. The water level in the lake is controlled by a dam operated by Barron County. The lake narrows at the Sawyer Street (County Road C) Bridge creating two basins, each with its own distinct set of characteristics. The maximum depth of the larger part of the lake which includes both the north basin and central basins (locally referred to as Upper Rice Lake) is 15 feet and it receives inflow from the Red Cedar River and Bear Creek, the primary tributaries to the lake. The smaller south basin (Lower Rice Lake) has a maximum depth of 19 feet and has a number of bays including Clearwater Bay which has a high diversity of aquatic plant life.

The lake has established colonies of curly-leaf pondweed (CLP). In 2018, a small population of hybrid watermilfoil (Eurasian watermilfoil x northern watermilfoil) was found in Clearwater Bay, but has not been detected elsewhere in the lake. Purple loosestrife, Chinese mystery snails, and rusty crayfish are also present. The Rice Lake, Lake Protection and Rehabilitation District (Lake District) has an active aquatic plant management program including herbicide application and harvesting of CLP, aquatic herbicide application and diver removal of hybrid watermilfoil (HWM), and harvesting of native plant species throughout the open water season to maintain navigation and recreation channels.

The City of Rice Lake is adjacent to the lake and both are substantially impacted by each other. The lakeshore is nearly fully developed. Downtown Rice Lake is along the west shore and a significant portion of the urban storm sewer from the city drains directly to the lake. Numerous public boat launch facilities exist around the lake, with the most frequented launch facilities off Orchard Beach Lane and at the downtown launch site at the Lumbering Hall of Fame Park off Stein Street. Several private residences on the lakes are operated as vacation rental units. Tourist and locals use the lake for boating, fishing, waterfowl hunting, water skiing, cross country skiing, wildlife watching, and general recreation. The main attraction to Rice Lake is the fishing, including trophy muskellunge.

Rice Lake was listed as a Wisconsin 303(d) impaired water in 2012. The Lake is listed for recreational use due to excess algal growth. Total phosphorus, a pollutant in Rice Lake, falls within the limits of the Phosphorus Total Maximum Daily Load (TMDL) Plan for Tainter and Menomin Lakes downstream on the Red Cedar River from Rice Lake in central Dunn County, WI.

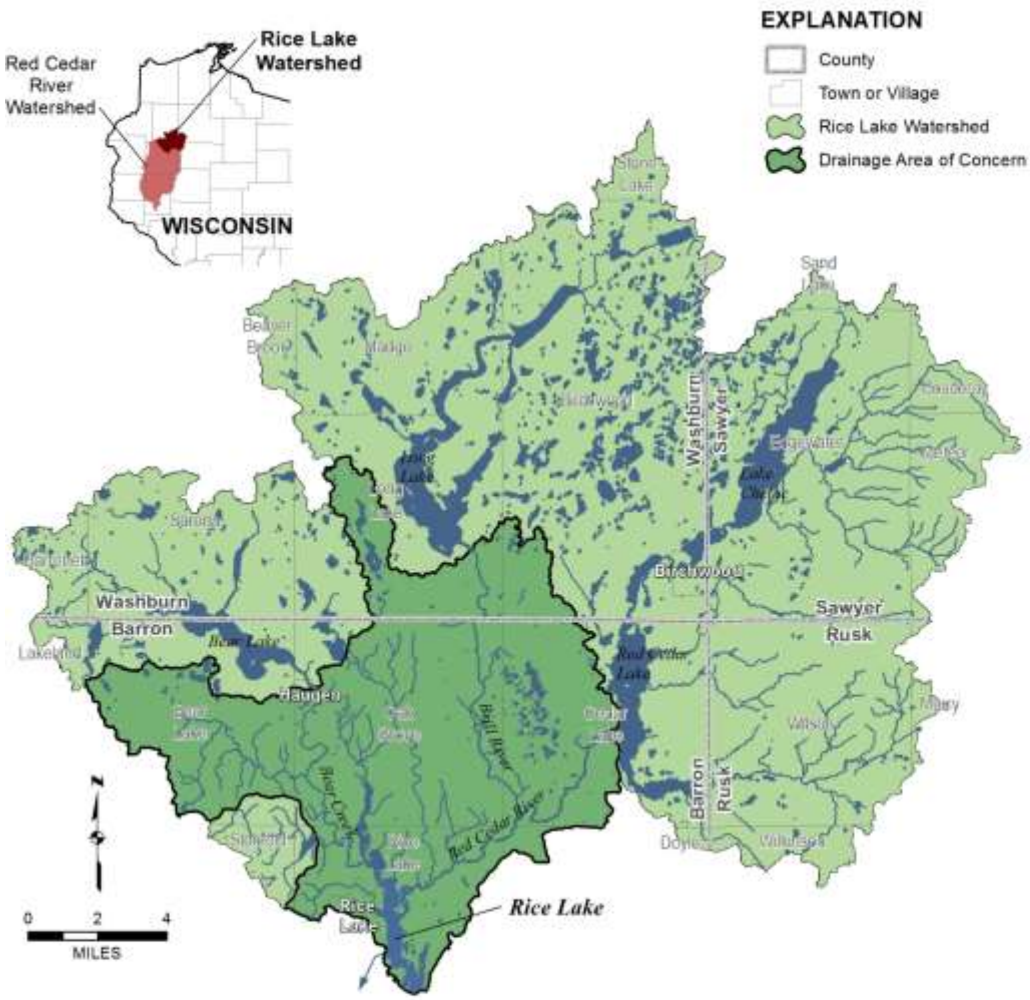


Figure 1: Location of Rice Lake and its watershed

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

Since HWM was discovered in Clearwater Bay off the south basin prompting the update of the 2015 Aquatic Plant Management (APM) Plan, a public education and input campaign has been undertaken. In 2018, newspaper articles were published in the Rice Lake Chronotype and the finding was hi-lighted during the 2018 annual meeting. Watercraft inspectors working the Orchard Beach Lane landing informed lake users of the finding.

Management actions to control the spread of HWM were discussed with the Lake District Board and harvester operators and a plan of action for control was determined. It included physical removal, diver removal, and application of herbicides. Harvesting in Clearwater Bay was suspended until a full bay and lake point-intercept survey was completed to better document the extent of the new infestation. Property owners in Clearwater Bay were informed of the planned management actions and given an opportunity to comment if they chose to do so. No one did.

Updates to the existing APM Plan were discussed with the Lake District Board during its development and was presented at the December 2020 board meeting. The new APM Plan was placed on their consultant's and Lake District webpage and instructions for viewing sent to the constituency through the Facebook page. The new APM Plan was approved by the Rice Lake – Lake Protection and Rehabilitation District at its December 2020 board meeting.

OVERALL MANAGEMENT GOAL

The Mission of the Rice Lake, Lake Protection and Rehabilitation District is to represent and protect the interests of the residents and property owners of the Town and City of Rice Lake. To this end, the Rice Lake, Lake Protection and Rehabilitation District seeks to protect the ecology of the lake, enhance the natural scenic beauty, control invasive species, and promote responsible boating, swimming, fishing, and recreational opportunities that beautiful Rice Lake offers all residents and visitors to our shores. That is the overall goal of this new APM Plan.

WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY

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 is 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 Aquatic Invasive Species (AIS), such as Eurasian water milfoil (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 APM Plan 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, 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.

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.

LAKE CHARACTERISTICS

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

PHYSICAL CHARACTERISTICS

Rice Lake has an estimated size ranging from 859 acres up to 940 acres. This is an impoundment lake located in northeastern Barron County. It reaches a maximum depth of 19ft in the south basin has an average depth of 9ft. The majority of the shoreline falls within the City of Rice Lake, and is heavily developed as a result. There are two small islands in the west central portion of the lake which are publically owned and maintained for public use.

CRITICAL HABITAT

Every body of water has areas of aquatic vegetation or other features that offer critical or unique aquatic plant, fish and wildlife habitat. Such areas can be mapped by the WDNR and designated as Critical Habitat. Critical Habitat areas include important fish and wildlife habitat, natural shorelines, physical features important for water quality (for example, springs) and navigation thoroughfares. These areas, which can be located within or adjacent to the lake, are selected because they are particularly valuable to the ecosystem or would be significantly and negatively impacted by most human induced disturbances or development. Critical Habitat areas include both Sensitive Areas and Public Rights Features. Sensitive Areas offer critical or unique fish and wildlife habitat, are important for seasonal or life-stage requirements of various animals, or offer water quality or erosion control benefits.

The WDNR designated eighteen Sensitive Areas in Rice Lake in 1997 (Figure 2). Management recommendations for these critical habitats include limiting macrophyte removal and littoral zone alterations, and minimizing sediment and nutrient inputs from lawns and septic systems. The Sensitive Areas report also recommends that coarse woody structure be left in the lake, promoting shoreline buffer zones, enforcing zoning ordinances, implementing “slow-no-wake” zones for watercraft, and encouraging the District to acquire property near sites D, L, and P for conservation purposes.

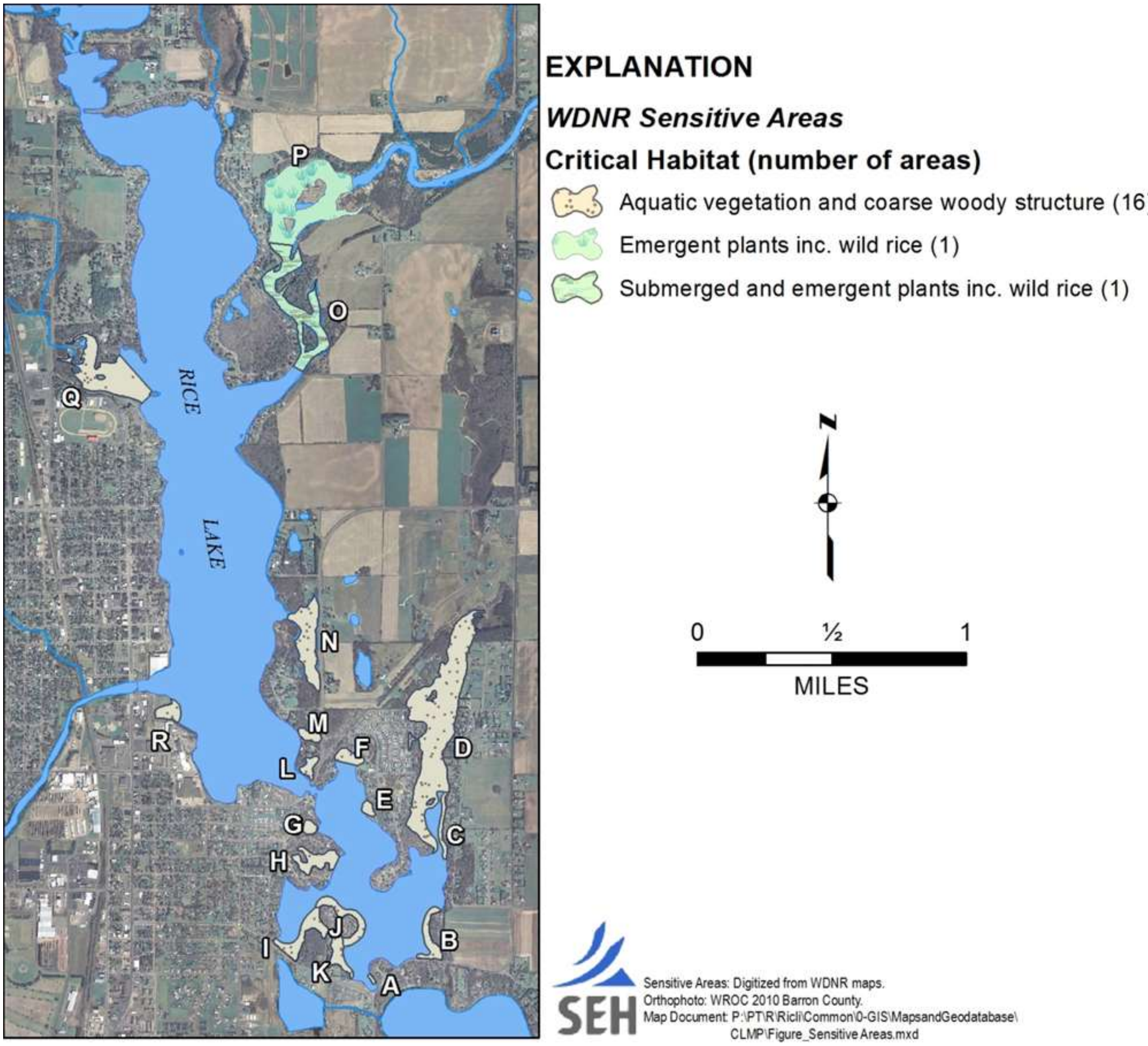


Figure 2: Sensitive Areas in Rice Lake

WATER QUALITY

Within Rice Lake, there are three different basins that are being monitored for water quality. The north basin and the central basin make up the largest percentage of the lake. Both are impacted by large amounts of water coming into Rice Lake. Bear Creek and waters from Stump Lake enter the north basin of Rice Lake under the Hwy 48 Bridge. The Red Cedar River enters from the east midway down the central basin. The outlet of the lake to the Red Cedar River below the dam is also located in the central basin.

The south basin is separated from both the central and north basins of the lake by a “narrows” defined by a narrow channel and bridge on Sawyer St/Hwy O. There is no inlet to the south basin. It is fed primarily by groundwater and some runoff from the land around it. The south basin is the deepest part of Rice Lake reaching over 20ft. The maximum depth in the north and central basins is only 15ft. The south basin stratifies in mid to late June and remains stratified until sometime in September. The north and central basin do not stratify due to their shallow nature and water moving through from the inlets to the outlet. The water in the south basin moves from the south basin into the central basin on its way to the outlet. The fact that the south basin stratifies and is separated from the north and central basins essentially makes it act as a separate lake. Water quality monitoring confirms this. The south basin has better water clarity than the other two basins into August but then internal loading of phosphorus leads to more algal growth reducing clarity, occasionally worse than what is documented in the north and central basins at the same time.

Large storm events impact the north and central basins more than they do the south basin. The Red Cedar River and Bear Creek bring in more sediment and other pollutants during these events reducing clarity. The good news is that during these events, the water passes through and over the dam more rapidly often reducing residence time to only a few hours. The south basin doesn't receive as many flushing events so may hold onto sediment and nutrient longer. The south basin also receives the majority of recreational lake use (water skiing and tubing) which stirs up additional sediment and nutrients.

Within Rice Lake, there are three main basins where water quality data is collected. The north basin site is located near the northeast boat launch; the central basin site is southeast of Knight's Island out from the Elks Club; and the south basin site is located north of the Veteran's Memorial boat launch off Orchard Beach Lane. Data from the north basin is primarily Secchi depth readings and perceptions of the lake by the person collecting the data. The central and south basin sites both have Secchi and perception data, and they have chemistry data (chlorophyll-a and total phosphorus) collected since 2008. Secchi disk readings of water clarity have been collected at all of the sites, consistently, since 2008. The WDNR Surface Water Integrated Monitoring System (SWIMS) website indicates water chemistry data started being collected in 2008.

In the north basin, the appearance of the water is predominately murky. The color of the water is primarily reported as green. User perception of the north basin is predominantly listed as being with "very minor aesthetic problems" or "enjoyment somewhat impaired".

In the central basin, the appearance of the water is predominately murky. The color of the water is primarily reported as green. User perception of the central basin is predominantly listed as being with "very minor aesthetic problems" or "enjoyment somewhat impaired".

In the south basin, the appearance of the water is predominately murky. The color of the water is primarily reported as green. User perception of the south basin is predominately listed as "beautiful, could not be nicer" or "very minor aesthetic problems".

The south basin generally receives more favorable comments related to public perception, particularly early in the season.

WATER CLARITY

Water clarity is a measurement of how deep sunlight can penetrate into the waters of a lake. It can be measured in a number of ways, the most common being an 8" disk divided into four sections, two black and two white, lowered into the lake water from the surface by a rope marked in measurable increments (Figure 3). The water clarity reading is the point at which the Secchi disk when lowered into the water can no longer be seen from the surface of the lake. Water color (like dark water stained by tannins from nearby bogs and wetlands), particles suspended in the water column (like sediment or algae), and weather conditions (cloudy, windy, or sunlight) can impact how far a Secchi disk can be seen down in the water. Some lakes have Secchi disk readings of water clarity of just a few inches, while other lakes have conditions that allow the Secchi disk to be seen for dozens of feet before it disappears from view.

Figure 3: Black and white Secchi disk

Figure 4 shows the mean monthly (April - October) Secchi disk readings for all three basins since CLMN began in 1991. The figure clearly shows how the south basin holds water clarity longer into the season. In 2019, the average summer (July-Aug) Secchi disk reading for the south basin was 5.5ft. For the central basin it was 4.63ft. For north basin it was 3.5ft. The average in 2019 for the Northwest Georegion was 8.5ft. Figures 5-7 show the average summer (July-Aug) Secchi disk readings for the south, central, and north basins respectively.

Tributary monitoring in the watershed upstream on both Bear Creek and the Red Cedar River indicate that more sediment is brought in by Bear Creek per acre-foot of water which could explain why water clarity in the north basin is consistently the lowest of all three sites.

Figure 8 reflects the mean annual Secchi disk reading of water clarity on all three basins from 2010-2020 when CLMN data collection was pretty consistent. Again, the figure clearly shows the difference between the south basin and the other two basins that make up the main part of Rice Lake. Long-term trend lines generally suggest that water clarity has remained fairly constant since 2010.

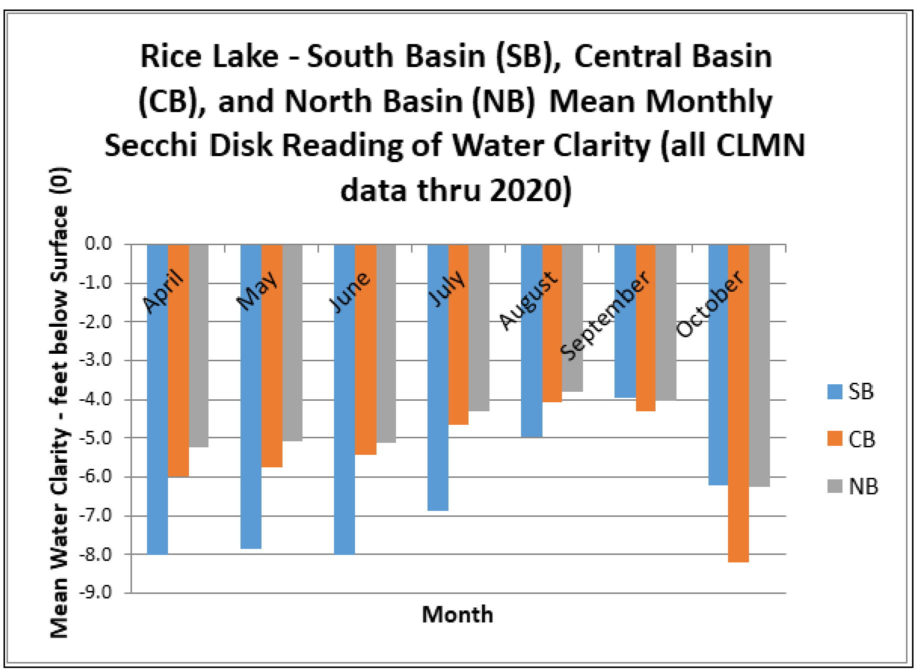


Figure 4: Average monthly Secchi disk readings from the three basins in Rice Lake (all CLMN data through 2020)

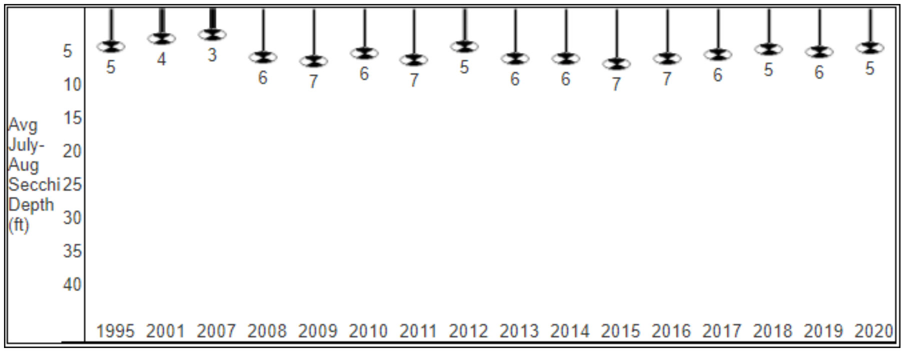


Figure 5: Average summer (July-August) Secchi disk readings of water clarity in the South Basin

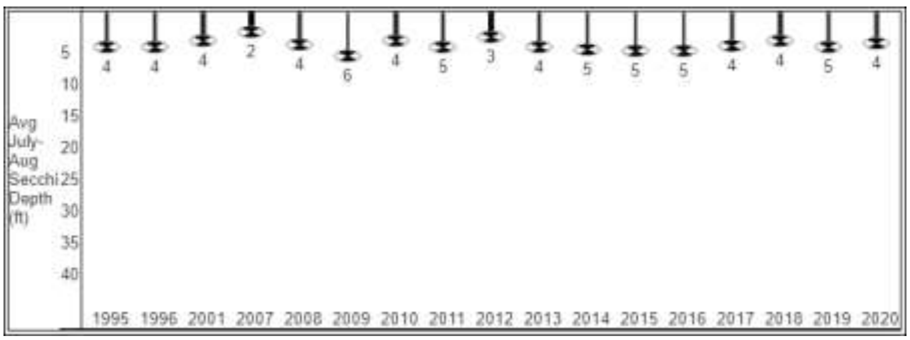


Figure 6: Average summer (July-August) Secchi disk readings of water clarity in the Central Basin

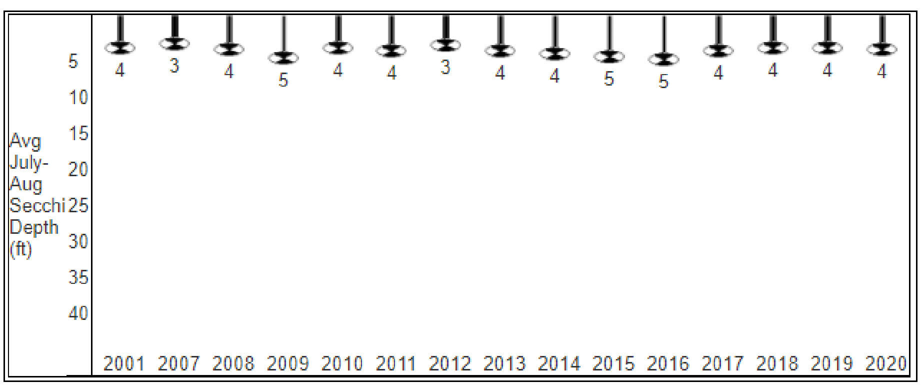


Figure 7: Average summer (July-August) Secchi disk readings of water clarity in the North Basin

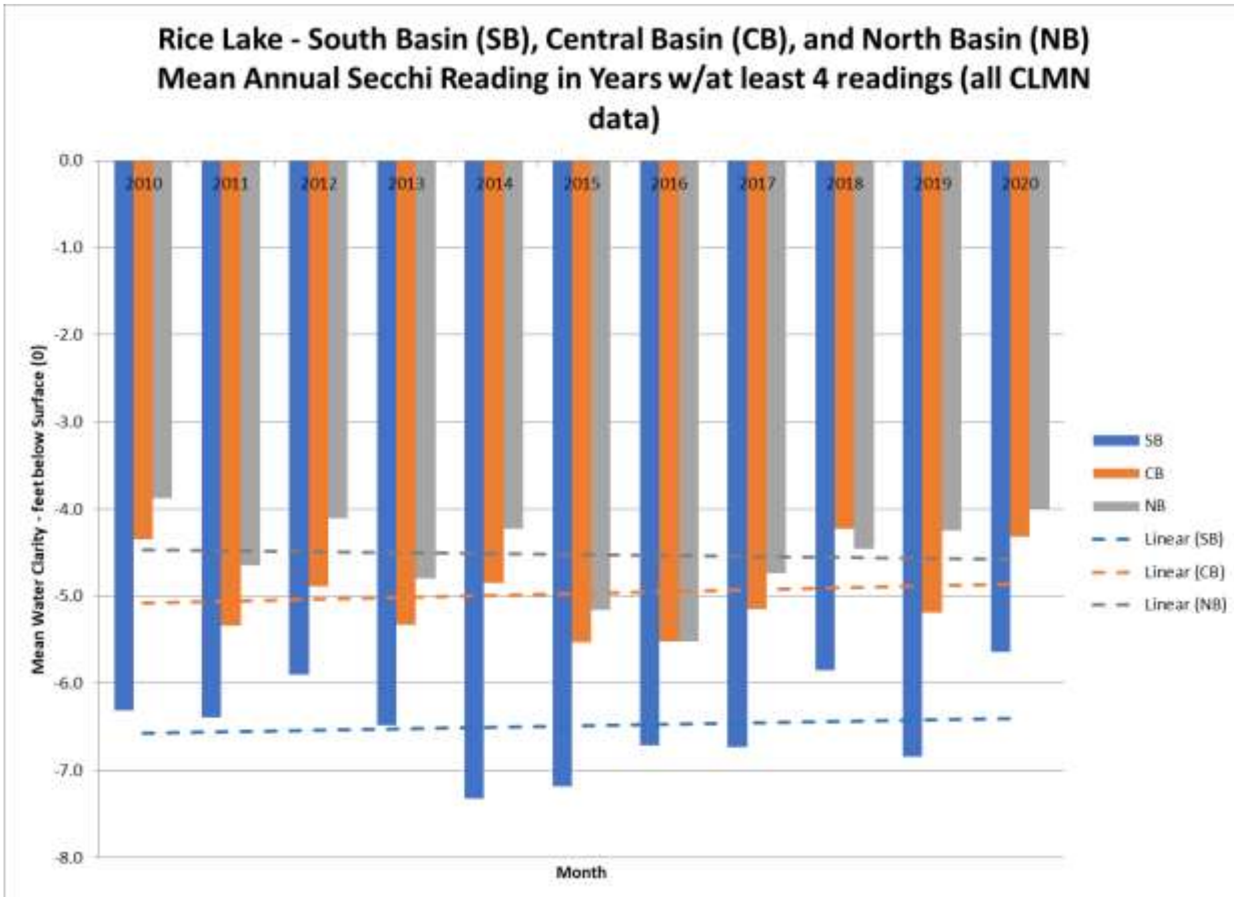


Figure 8: Annual Secchi disk readings of water clarity for all three basins w/trend lines 2010-2020

TOTAL PHOSPHORUS AND CHLOROPHYLL-A

Phosphorus is a nutrient that promotes excessive aquatic plant and algae growth. In more than 80% of Wisconsin's lakes, phosphorus is the key nutrient affecting the amount of algae and weed growth. Phosphorus originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland or lawns. An analysis of phosphorus often includes both soluble reactive phosphorus and total phosphorus (TP). Soluble reactive phosphorus dissolves in the water and readily aids plant growth. Its concentration varies widely in most lakes over short periods of time as plants take it up and release it. TP is considered a better indicator of a lake's nutrient status because its levels remain more stable than soluble reactive phosphorus.

TP includes soluble phosphorus and the phosphorus in plant and animal fragments suspended in lake water. Ideally, soluble reactive phosphorus concentrations should be 10µg/l (micrograms per liter or parts per billion (ppm)) or less at spring turnover to prevent summer algae blooms. A concentration of TP below 30µg/l for impoundments and 20µg/l for lakes should be maintained to prevent nuisance algal blooms.

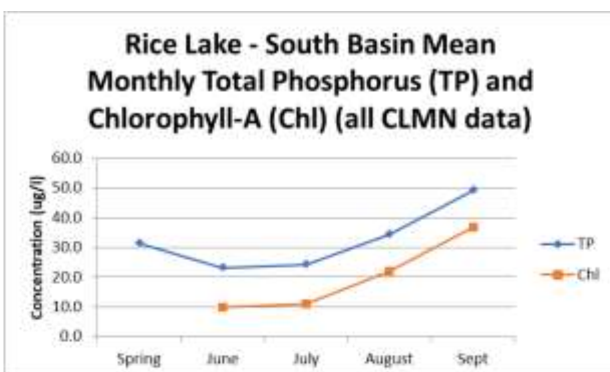
Phosphorus does not dissolve easily in water. It forms insoluble precipitates (particles) with calcium, iron, and aluminum. Iron is fairly common in northern Wisconsin lakes but will only form sediment particles that store phosphorus if oxygen is also present in the water. When lakes lose oxygen in winter or when the deep water (hypolimnion) loses oxygen in summer, like the south basin of Rice Lake, iron and phosphorus again dissolve in water. Strong summer winds, lake use, or spring and fall turnover may mix iron and phosphorus with surface water enabling an algae bloom, the rapid and visible increase in algae growth that may turn the water green.

Shallow and windswept lakes, like the north and central basins of Rice Lake, stay mixed and do not experience oxygen depletion. But because they remain mixed, levels of phosphorus may be higher due to disturbed bottom sediments suspended in the water. Impoundments that remain mixed, like the north and central basins of Rice Lake generally have higher phosphorus levels than natural lakes. Deep stratified lakes, or portions of lakes that act like natural lakes, like the south basin, generally have the lowest levels.

Chlorophyll is the pigment found in all green plants, including phytoplankton. Phytoplankton is very small free-floating aquatic plants such as algae. Their abundance, as measured by the amount of chlorophyll-A (ChlA) in a water sample is commonly used to classify the trophic status of a lake, discuss in a later section of this plan.

Through the Citizen Lake Monitoring Network (CLMN) in WI, water chemistry volunteers on many lake measure total phosphorus levels, chlorophyll-A concentrations, and temperature and dissolved oxygen profiles from the top to the bottom of the lake. This type of monitoring is done four times per year, and requires several hours of time during each monitoring event. Chemistry monitoring helps determine if nutrient pollution is occurring in a lake, or if seasonal fish die-offs may be a possibility due to low oxygen levels. Soluble phosphorus is not measured as a part of CLMN.

As previously mentioned, the three basins that are sampled in Rice Lake show characteristics of both mixed (north and central basins), and stratified (south basin) lakes. Lake District volunteers have collected chemistry data in the central and south basins regularly since 2008. Total phosphorus concentrations in the south basin generally increase in the late summer due to stratification and internal release (Figure 9) but are lower than concentrations in the north and central basin. Mean annual concentrations are generally at or below 30μ/l meeting the criteria for impoundments, but not the criteria for natural lakes (Figure 9). ChlA generally follows the trends exhibited by total phosphorus as the concentration of ChlA represents the amount of algae in the water. In a lake where aquatic plant and algae growth is limited by available phosphorus, small additions of phosphorus can cause dramatic increases in both. In the south basin there appears to be a trend toward less of both TP and ChlA (Figure 9) that suggests water quality is getting better.



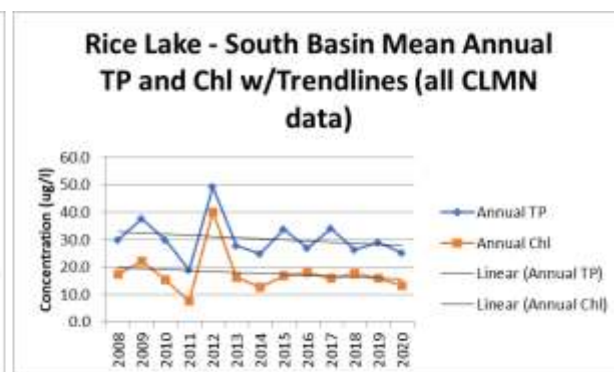
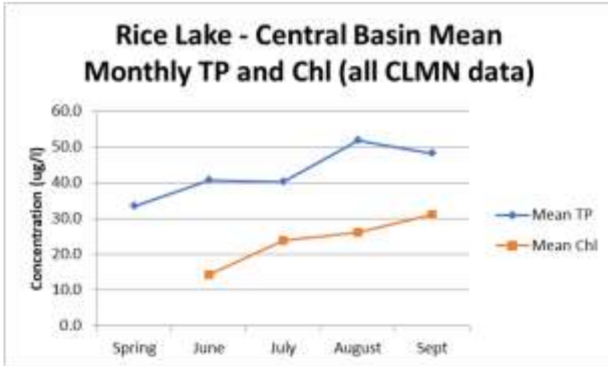


Figure 9: Mean monthly TP and ChlA concentrations (left), and Mean annual TP and ChlA concentrations w/trend lines (right) for Rice Lake South Basin (all CLMN data)

Monthly concentrations of TP in the central basin are higher than those in the south basin, increasing more regularly from the spring to the fall (Figure 10). Mean annual concentrations of TP are well above the 30μ/l standard for impoundments suggesting there is greater potential for algae blooms that turn the water green, reducing its aesthetic appeal for recreational activities that require full body immersion (Figure 10). Still when assessing trends over the last 10 years, the central basin, like the south basin appears to be exhibiting a decreasing trend at least in TP suggesting improving water quality (Figure 10).



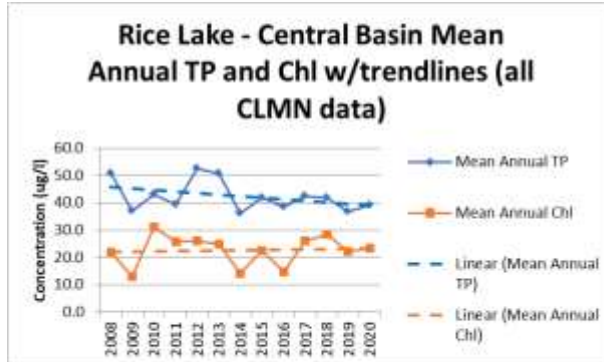


Figure 10: Mean monthly TP and ChlA concentrations (left), and Mean annual TP and ChlA concentrations w/trend lines (right) for Rice Lake Central Basin (all CLMN data)

TP and ChlA data can be looked at annually with numbers compared to other lakes in the region. In 2019, the average summer ChlA in the south basin was 15.1µg/l, higher than the regional summer average of 13.2µg/l. The summer TP average was 30.7µg/l. Lakes, or portions of a lake as in the south basin, that have more than 20µg/l TP may experience noticeable algae blooms. This is true for the south basin.

In 2019, the average summer ChlA in the central basin was 19.3µg/l, even higher than what was documented in the south basin. The summer TP average was 41.2µg/l. Impoundments that have more than 30µg/l of TP may experience noticeable algae blooms. Again, this is true for the south basin.

In the north basin, chemistry data was only collected in 2010. One year of data only provides a snapshot of conditions, it does not allow for the establishment of trends. In 2010, the mean annual TP in north basin was 67µg/l and the mean annual ChlA was 27.9µg/l, both exceeding regional average and higher than what was documented in the central and south basins (Figure 11).

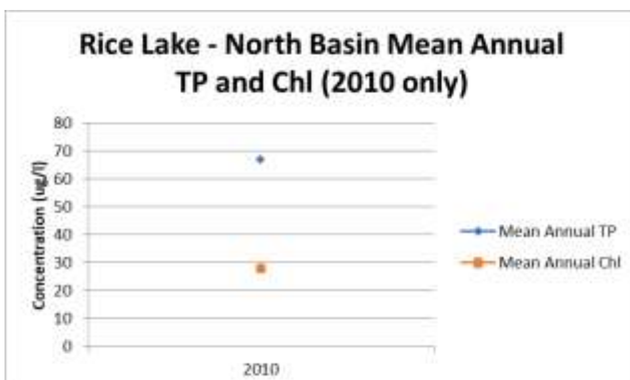


Figure 11: 2010 CLMN chemistry data from the north basin

TROPHIC STATE INDEX

One method of classifying lakes is by the lake productivity, or trophic status. The most commonly used index of lake productivity is the Carlson's Trophic State Index (TSI), which is based on the near-surface concentrations of ChlA and TP, and on Secchi depth. The Carlson's TSI was modified in the early 1990s by the WDNR to create an index that better represents Wisconsin lakes, the Wisconsin TSI (WTSI).

Oligotrophic lakes (clear, nutrient-poor) have WTSI values <40, mesotrophic lakes (moderate supply of nutrients, moderate clarity) have values between 40 and 50, and eutrophic lakes (productive, nutrient-rich lakes) have values >50. Hyper-eutrophic lakes have values >70. Higher WTSI values are often associated with poorer water quality. Figure 12 provides greater detail related to what conditions might exist in a lake in each of these trophic states.

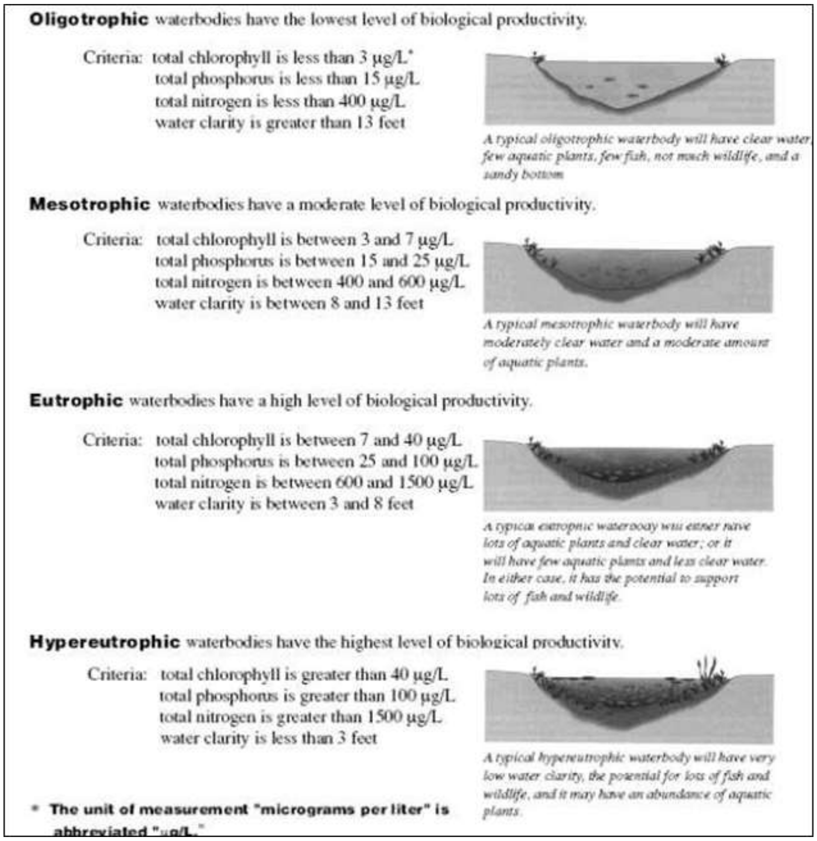


Figure 12: Trophic status in lakes

The WTSI is a prediction of algal biomass, and therefore the ChlA index ($WTSI_{CHL}$) is a better predictor of trophic status than the other two indices (total phosphorus, $WTSI_{TP}$; Secchi depth, $WTSI_{SD}$). The south basin of Rice Lake is considered eutrophic based on a mean annual summer $WTSI_{CHL}$ of 54.8. Both the central and north basins are also considered eutrophic with mean annual summer $WTSIS_{CHL}$ of 56.6 and 58.8 respectively. Figure 13 reflects WTSI values for TP, ChlA, and Secchi disk readings of water clarity for the summer months (July and August) in all three basins. All three basins have remained fairly consistent since data collection around 2007.

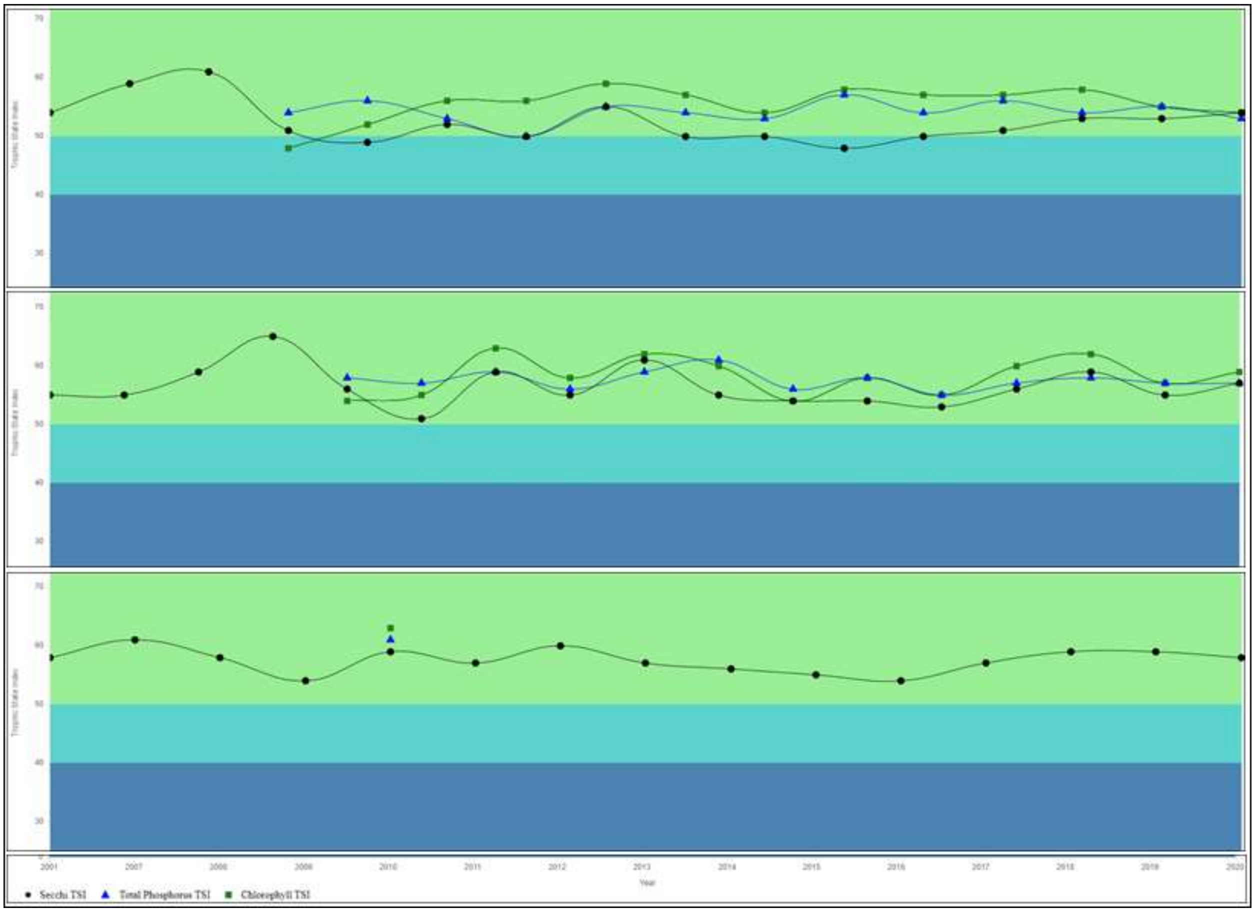


Figure 13: Trophic State Index (TSI) graph for Rice Lake South Basin (top), Central Basin (middle), and North Basin (bottom) based on all summer (July and August) CLMN data (light green-eutrophic, light blue-mesotrophic, blue-oligotrophic)

TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen are important factors that influence aquatic organisms and nutrient availability in lakes. As temperature increases during the summer in deeper lakes, the colder water sinks to the bottom and the lake develops three distinct layers as shown in Figure 14. This process, called stratification, prevents mixing between the layers due to density differences which limits the transport of nutrients and dissolved oxygen between the upper and lower layers. In most lakes in Wisconsin that undergo stratification, the whole lake mixes in the spring and fall when the water temperature is between 53 and 66°F, a process called overturn. Overturn begins when the surface water temperatures become colder and therefore denser causing that water to sink or fall through the water column. Below about 39°F, 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.

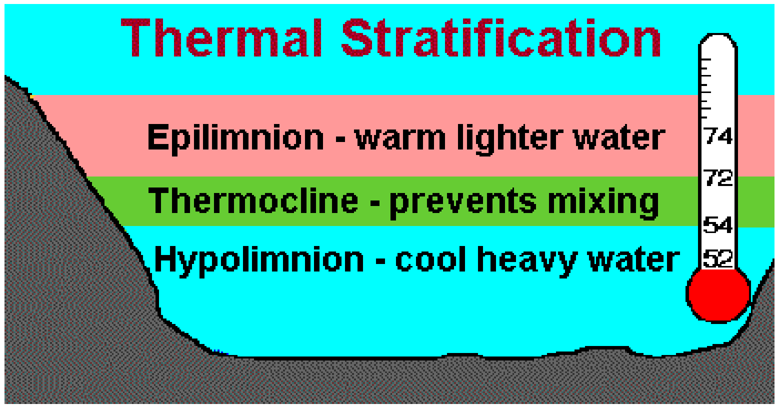


Figure 14: Summer thermal stratification

During the summer months, the upper warm layer, called the epilimnion, remains well oxygenated due to wind and wave action and photosynthesis. The middle layer, called the metalimnion or thermocline, is where changes in temperature and dissolved oxygen are greatest. This middle layer acts as a barrier that prevents warmer, oxygen rich waters in the upper layer from mixing with colder, deeper waters. It is common for dissolved oxygen levels to be depleted in the lower layer, called the hypolimnion, as there is no source of new oxygen and the decomposition of organic matter consumes oxygen.

A dissolved oxygen level of 2mg/l or less, called hypoxia is an important criterion of sediment phosphorus release. When near-bottom dissolved oxygen is at 2mg/l or less the sediment-water interface is likely anoxic (no oxygen). This lack of oxygen causes the chemical bonds between phosphorus and the iron in the sediments to break which releases free phosphorus back into the water column. If the phosphorus released from sediments reaches the upper part of the lake through spring or fall overturn or when natural or human induced wave action mixes the lake, it can provide a significant internal source of phosphorus to fuel algae blooms.

The south basin of Rice Lake stratifies sometime in mid to late June. The thermocline usually establishes at around 3-4 meters (9.8-13.1 feet) and stays there through about mid-September. The area below the thermocline generally becomes devoid of oxygen sometime in July increasing in TP as a result. Mixing events caused by increased boater use and/or summer storms could cause just enough of a disturbance to bring some of that phosphorus to the surface where it supports the growth of algae. As the south basin of the lake enters into fall turnover, more phosphorus is made available for algae growth.

WATERSHED CHARACTERISTICS

The total Rice Lake watershed is a very large area which contains lakes that are managed by organizations separate from the Lake District (Figure 15). As a result of this, the Lake District focuses management efforts on the immediate drainage basin within the watershed that are not currently managed by other organizations. Within the Rice Lake immediate drainage basin, the vast majority (70%) of land use is either cropland (34%) or forest land (36%). After forest and cropland, 16% is grassland and pastures with the remaining 15% being comprised of a mix of open water, light development (i.e. roads and residential property), and wetlands (Table 1). The forested areas are concentrated to the northern reaches while the areas closest to the lake are primarily agriculture, pasture/ grassland, and development within the City of Rice Lake.

Table 1: Land use within the Rice Lake Immediate Drainage Watershed

Watershed Land Use		
	Acres	Percent of Area
Developed	2,337.37	3.44%
Agriculture	23,273.15	34.23%
Grassland	10,579.31	15.56%
Forest	24,180.97	35.57%
Open Water	1,533.63	2.26%
Wetland	6,076.27	8.94%
Barren	79.39	0.12%

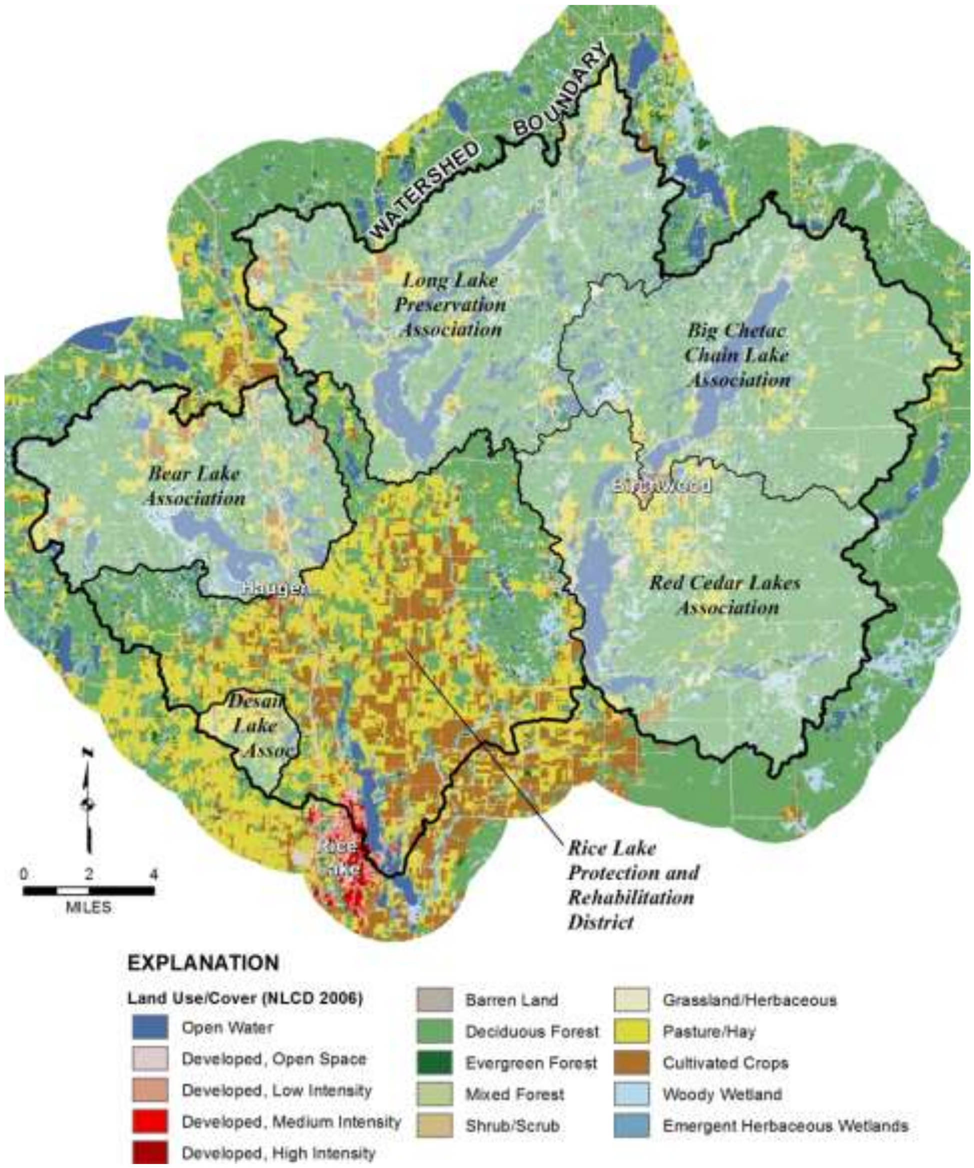


Figure 15: Land use within the Rice Lake Watershed

INFILTRATION AND SOILS

Infiltration is the downward entry of water into the soil. The velocity at which water enters the soil is infiltration rate. Infiltration rate is typically expressed in inches per hour. Water from rainfall or irrigation must first enter the soil for it to be of value. Infiltration is an indicator of a soil's ability to allow water movement into and through the soil profile. Soil temporarily stores water, making it available for root uptake, plant growth and habitat for soil organisms.

When water is supplied at a rate that exceeds the soil's infiltration capacity, like during spring snowmelt or during large precipitation events, specific problems can occur. Surface water can move downslope as runoff on sloping land or it may ponds on the surface of level land. When runoff occurs on bare or poorly vegetated soil, erosion takes place. Runoff carries nutrients, chemicals, and soil with it, resulting in decreased soil productivity, off-site sedimentation of water bodies and diminished water quality.

A high infiltration rate is generally desirable for plant growth and the environment. However, in some cases, soils that have unrestricted water movement through their profile can contribute to environmental concerns if misapplied nutrients and chemicals reach groundwater and surface water resources via subsurface flow.

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

There are also three sub groups of soil (A/D, B/D, and C/D). These indicate 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. The majority (57.7%) of soils within the Rice Lake immediate drainage area fall into either Group B or C. The remainder of the soils is relatively evenly split between groups A, B/D, and C/D with a very small portion in group A/D (Table 2). While most of the watershed is covered with soils that have moderate to slow infiltration rates, the areas closest to Rice Lake fall into groups A and B which have high to moderate infiltration rates (Figure 16).

High infiltration rates may reduce overland runoff, but they also increase the potential for leaching of nitrogen, phosphorus, and other pollutants from the soil into surface water.

Table 2: Soil classes within the Rice Lake immediate drainage basin

Soil Group	Percentage of Watershed	Infiltration Rate
A	10.1%	High
B	32.3%	Moderate
C	25.4%	Slow
D	0.0%	Very Slow
A/D	3.7%	High when drained, very slow when undrained
B/D	10.2%	Moderate when drained, very slow when undrained
C/D	14.8%	Slow when drained, very slow when undrained
Water	3.5%	N/A

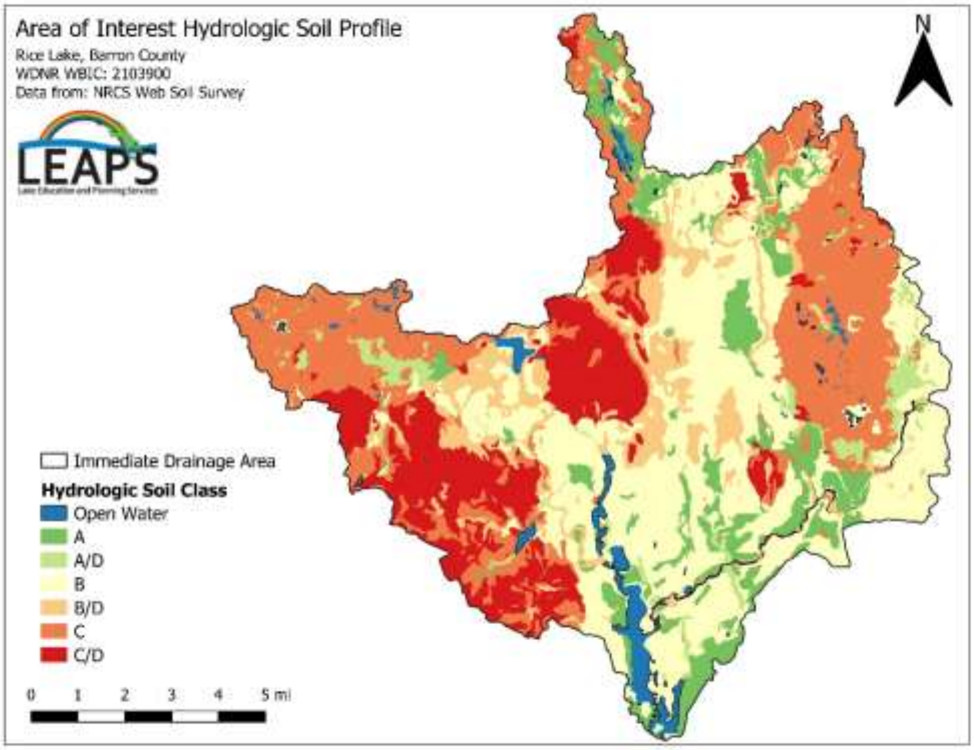


Figure 16: Hydrologic soil profile of the Rice Lake drainage basin

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 Rice 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 Rice Lake by acting as buffers between land and water. This is particularly true in the wetlands that line the Red Cedar River and Bear Creek as they enter the lake. 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.

Within the immediate drainage basin of Rice Lake, approximately 6,000 acres or just fewer than 10% of the total area is comprised of wetlands. The largest concentrations of wetland areas are found in the far east of the drainage basin and the far west. However, the two largest sources of water coming into Rice Lake, Bear Creek and Red Cedar River) are lined with wetlands along their lengths (Figure 17).

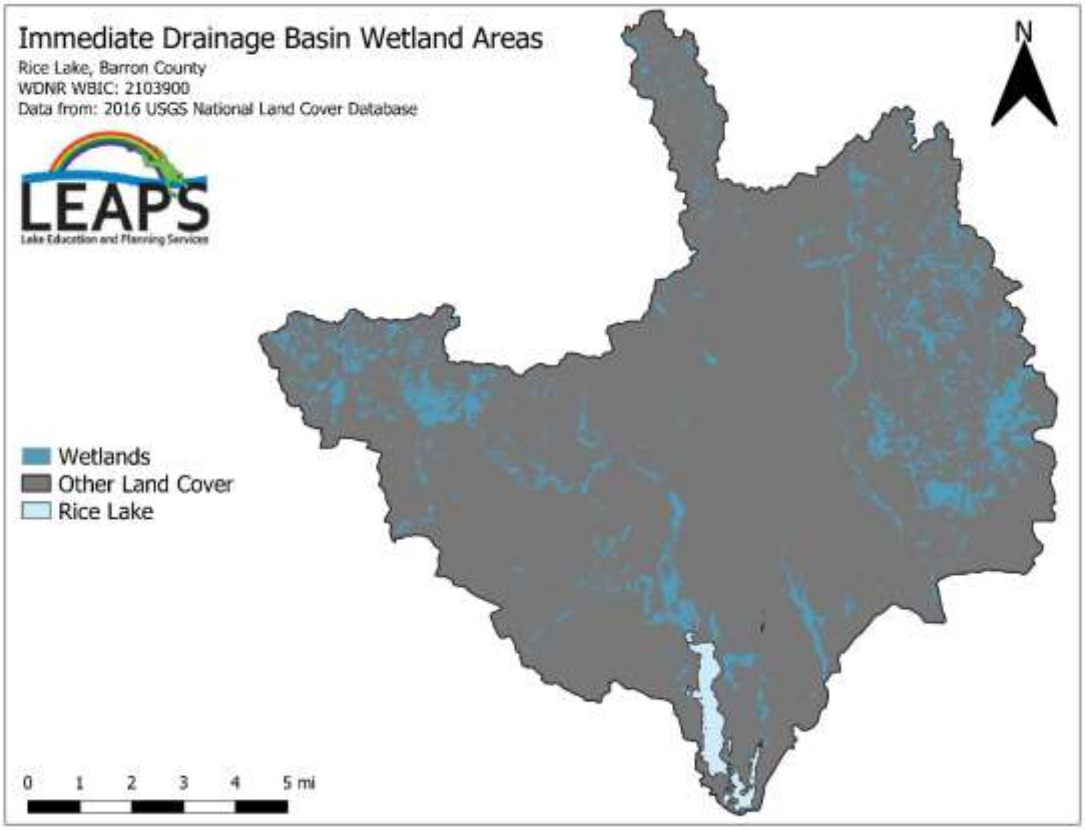


Figure 17: Wetland areas within the immediate Rice Lake drainage basin

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.

Fortunately, remediation of this habitat type is attainable on many waterbodies, particularly where private landowners and lake associations are willing to partner with county, state, and federal agencies. Large-scale CWH projects are currently being conducted by lake associations and local governments with assistance from the WDNR where hundreds of whole trees are added to the near-shore areas of lakes. For more information on this process visit: http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html (last accessed on 1-4-2018). These types of projects are more formally called "tree drops" but are popularly are called "fish sticks" (Figure 18).

Figure 18: Coarse woody habitat-Fishsticks projects

The woody habitat within Rice Lake has not been quantified, but interested property owners are still able to install fish sticks projects in the lake adjacent to their property if they follow the proper channels for permitting and obtaining the trees.

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 aquatic invasive species 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.

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 AQUATIC INVASIVE SPECIES

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

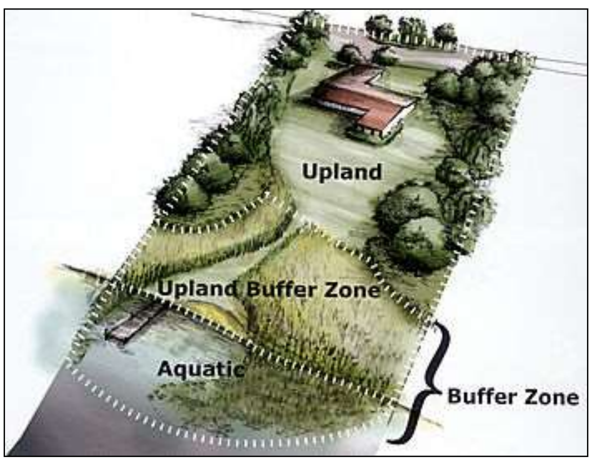
When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, houses, decks, garages, sheds, piers, rafts and other structures, wells, septic systems, lawns, sandy beaches and more. Many of these changes result in the compaction of soil and the removal of 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 19 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: https://healthylakeswi.com/ (last accessed 3-17-2020).



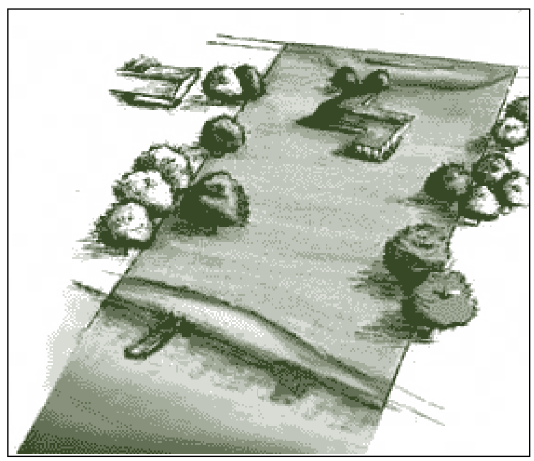


Figure 19: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

The habitat surrounding Rice Lake has not been assessed, so the condition is not currently known, but it is known to be relatively heavily developed due to large portions of the lake being located well within the city limits of the City of Rice Lake. If property owners are interested in ways to improve their lake shore property, information on WDNR grant eligible projects can be found at https://healthylakeswi.com/. Additionally, the Lake District currently offers up to $500 aide for individual property owners wishing to install rain gardens, shoreline plantings, and other shoreline restoration projects on their property through their Residential and Riparian Owners Best Management Practices Program. In the past, individual property owners, local businesses, and the City of Rice Lake have benefitted from funding provided by the Lake District through this program.

AQUATIC PLANT SURVEYS

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth and total acreage, the Wisconsin Department of Natural Resources generated an 843 point sampling grid for Rice Lake Ecological Integrity Service, LLC (EIS) completed warm-water, point-intercept (PI) surveys in 2008, 2013, and 2018. These three surveys provide the means to compare changes in the aquatic plant community over time. Changes are driven by lake conditions, weather conditions, and management implementation.

WARM-WATER FULL POINT-INTERCEPT MACROPHYTE SURVEYS

Warm-water point-intercept surveys were conducted in 2008, 2013, and 2018 in preparation for future management planning. Table 3 shows a comparison of summary statistics from all three surveys. The Lake District contracted with EIS to complete these warm-water point-intercept surveys.

Table 3: Comparison of Point-intercept Survey Statistics for 2008, 2013, and 2018

	2008	2013	2018
Total number of sites in full lake grid	843	843	843
Total number of sites shallower than maximum depth of plants	677	621	653
Total number of sites with vegetation	368	342 (362)	303 (325)
% of sample points shallower than maximum depth of plants	55.93	58.29%	77.5%
Simpson Diversity Index	0.89	0.89	0.87
Maximum depth of plants (feet)	16.2	14.10	13.50
Mean depth of plants (feet)		4.68	4.1
Average number of all species per site (shallower than max depth)	1.97	1.71	1.19
Average number of all species per site (veg. sites only)	3.52	3.03	2.74
Average number of native species per site (shallower than max depth)	1.81	1.46	1.17
Average number of native species per site (veg. sites only)	3.42	2.88	2.72
Species Richness	41	41	42
Species Richness (including visuals)	55	47	46

Total plant richness was fairly high with 42 species found in the rake, up from 41 in both 2008 and 2013. This is the only basic statistic that is better than those from the two previous PI surveys. The maximum depth of plant growth was down by more than 2.5ft from 2008. However, it was reported in the 2008 plant survey report that plant growth for the most part was kept under 12ft as only a couple of points in deeper water had vegetation on the rake. Water quality does not appear to have changed drastically between 2008 and 2020, yet all statistics for plant growth per point are lower.

MOST FREQUENTLY OCCURRING AQUATIC PLANTS

Back in 2008, nine aquatic plant species had a frequency of occurrence in sites with vegetation >10%. Four of these species maintained a frequency of occurrence >10% through both 2013 and 2018: coontail, common waterweed, flat-stem pondweed, and white water lily. Two plant species with a frequency of occurrence >10% in 2008 dropped out of the list in both 2013 and 2018: Robbins pondweed and small pondweed. These two species were replaced in the list by clasping-leaf pondweed, fern-leaf pondweed, and water celery. In 2008, CLP had a frequency of occurrence >10%, but dropped off the list in both 2013 and 2018. In both 2008 and 2013, there were nine different aquatic plant species with a frequency >10%. In 2018, only five species had frequency of occurrences >10%.

Since 2010, the District has incorporated the use of aquatic herbicides along with mechanical harvesting to manage CLP and native aquatic plants. Harvesting is still the main action implemented to manage both CLP and native plants, but the use of herbicides was added to improve control of CLP along the City of Rice Lake shoreland and in the south basin. Small pondweed and Robbins pondweed are both susceptible to the herbicide that is used for CLP control. The frequency of occurrence of wild celery has also increased in each of the last two PI surveys.

SIMPSON'S DIVERSITY INDEX (SDI)

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

In the first two PI surveys, the SDI remained the same at 0.89, not real high, but decent. In 2018 the SDI was lower at 0.87. This is not surprising when considering the change in frequency of occurrence from 2008 and 2013. In those two years, nine species were most frequent. In 2018, only five were.

FLORISTIC QUALITY INDEX (FQI)

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

The FQI and associated values are all higher in 2018 than they were in both 2008 and 2013 suggesting that despite changes, the aquatic plant community in Rice Lake is healthier now than it has been since before 2008 (Table 4). In 2018, a total of 42 native index plants were identified in the rake during the point-intercept survey. The index plants found produced a mean C of 6.1 and a FQI of 39.7. Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 and an average FQI of 20.6, putting Rice Lake well above average for this part of the state.

Table 4: Floristic Quality Index, Mean C, and # of Species for the three PI surveys completed on Rice Lake

	2008	2013	2018
FQI	39.8	38.59	39.66
Mean C	6.07	6.2	6.12
# of Species	43	39	42

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, Rice Lake is not wild rice water; however the section of the Red Cedar River as it enters Rice Lake is noted as having wild rice. In both the 2013 and the 2018 point-intercept surveys, wild rice was found in a very limited area near the Red Cedar River inlet (Figure 20).

Figure 20: 2011 Wild Rice near the Red Cedar River Inlet

Wild rice flourished in 2020 with sizable beds along both sides of the river for at least a quarter mile upstream. The author of this Plan has been working on Rice Lake for better than 15 years and this is the first time he has seen wild rice with this amount of density. Photos of the rice were sent to Peter David, Manoomin Biologist with the Great Lakes Indian Fish and Wildlife Commission (Figure 21). His comment was "You rock my world! It does seem more abundant than my past impressions." This was the first time wild rice in this area produced some potential for harvest. Anecdotally though, one person who attempted harvest said that actual rice was spotty with much of it being consumed by wildlife.

WILD RICE IMPACTS ON AQUATIC PLANT MANAGEMENT

The presence of wild rice must be taken into consideration when planning aquatic plant control. The use of aquatic herbicides is highly discouraged in any area where rice is present. Mechanical harvesting must avoid incidental take of wild rice. Even physical removal of wild rice is technically illegal in WI. Aquatic plant management planning in Rice Lake takes into account locations where wild rice is known to have a presence. No use of aquatic herbicides is recommended in these areas, and limited harvesting is only done in the open channels of the river. It does not target any wild rice. This practice will continue for the foreseeable future to prevent plant management of any kind from damaging the wild rice populations.

Figure 21: August 13, 2020 Wild rice in the Red Cedar River just upstream of Rice Lake. Purple dots indicate all the places sizable beds were located.

CURLY-LEAF PONDWEED IN RICE LAKE

In 2008, EIS did the first formal mapping of CLP in Rice Lake. At that time, 33 areas with CLP were mapped totaling 200 acres (Figure 22). In 2013, CLP was again mapped, this time using a point-intercept grid (Figure 22). By laying the point-intercept grid used in 2013 over the bed mapping done in 2008, a reasonable estimate of CLP acreage per point can be made. Based on the 2008 and 2013 data, 200 acres would equate to 235 points. The 153 points mapped in 2013 would equate to 130 acres of CLP. CLP bedmapping was done in both 2018 and 2019 (Figure 23). In 2018, 23 areas totaling 30.3 acres were mapped. In 2019, 28 areas totaling 34.6 acres were mapped. CLP bedmapping in 2013, 2018, and 2019 reflect a significant change in total acreage of CLP.

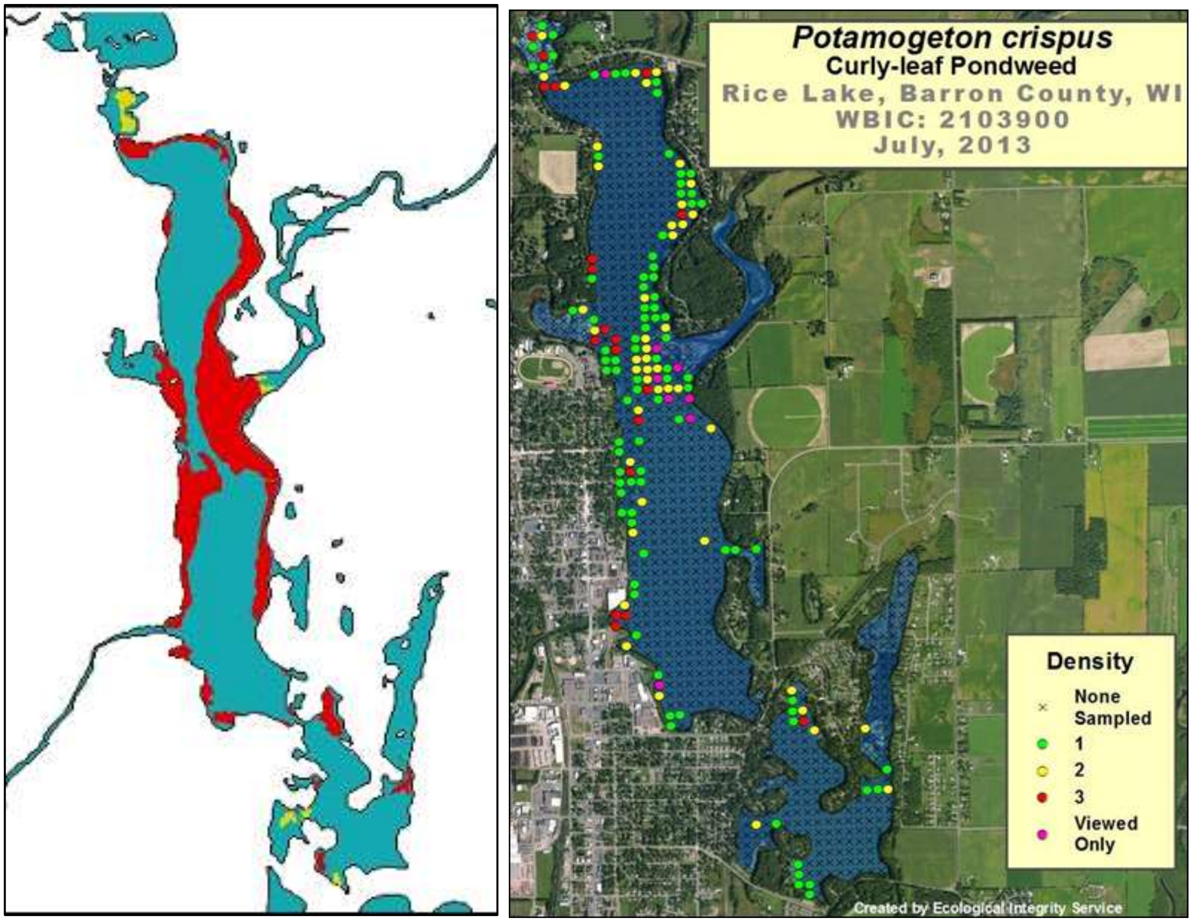


Figure 22: Extent of CLP in 2009 (left) and 2013 (right)

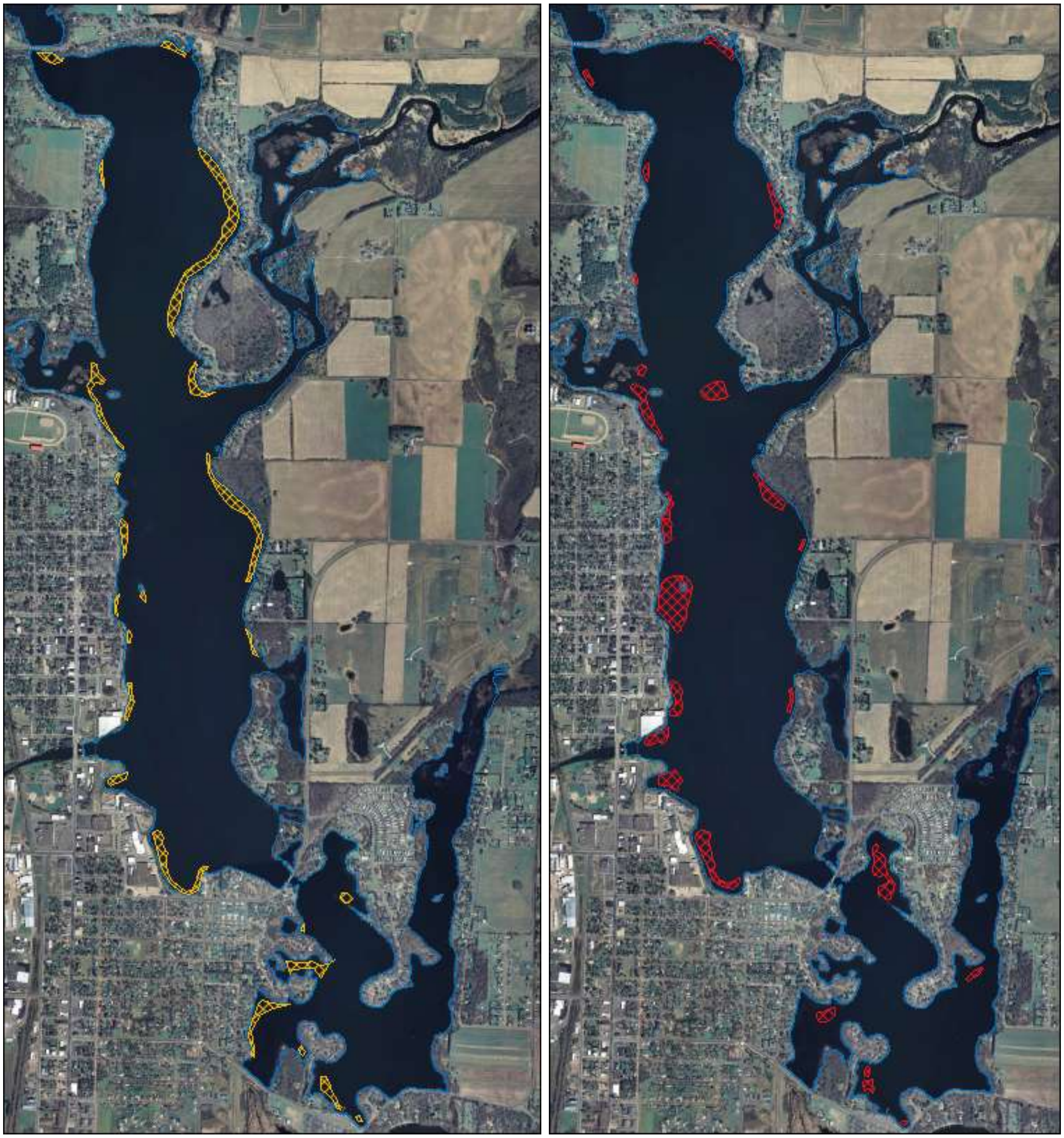


Figure 23: 2018 (left) & 2019 (right) CLP bed mapping Surveys

The Lake District has been managing CLP since the 1970s, primarily with the use of mechanical harvesters of which they currently own three. Prior to 2010, harvesting was not done following recommendations in an aquatic plant management plan. In 2010, the first APM Plan was completed. It recommended a combination of mechanical harvesting and the use of herbicide to control CLP. It also made recommendations as to the extent of removal and the best timing to do harvesting. Since 2010, the amount of CLP harvested or chemically treated has gone down, but the amount of native aquatic plant harvesting to open up navigation lanes and reduce nuisance growth has increased (Figure 24). CLP mapping seems to support the notion that there is not as much CLP in the system now as there was in 2009.

In 2021, chemical management of CLP is recommended along the west shore of Rice Lake adjacent to Lakeshore Dr. It will also be considered in the south basin again.

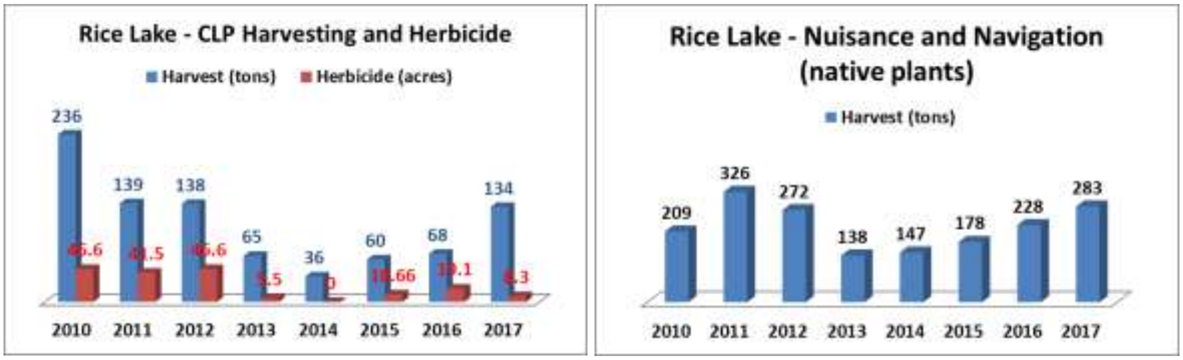


Figure 24: Changes in the tonnage of CLP and native aquatic plants harvested between 2010 and 2017 on Rice Lake

HYBRID WATERMILFOIL IN RICE LAKE

In June of 2018, hybrid watermilfoil (HWM) (Figure 25) was discovered in Clearwater Bay in the south basin of Rice Lake (Figure 26). The Lake District took an aggressive, integrated approach to management which included rake removal, diver removal, and chemical control followed by multiple recon and mapping surveys with rake removal. Management in 2018 was very successful with no HWM found in the rest of the 2018 season, and through most of the 2019 season. In the fall of 2019, recon and mapping located what was believed to be multiple sites with HWM (Figure 26). Another recon and mapping survey in May 2020 (Figure 26) found 100's of plants leading to another round of rake removal, diver removal, and herbicide use in 2020. To date, no HWM has been found in any other area of Rice Lake.

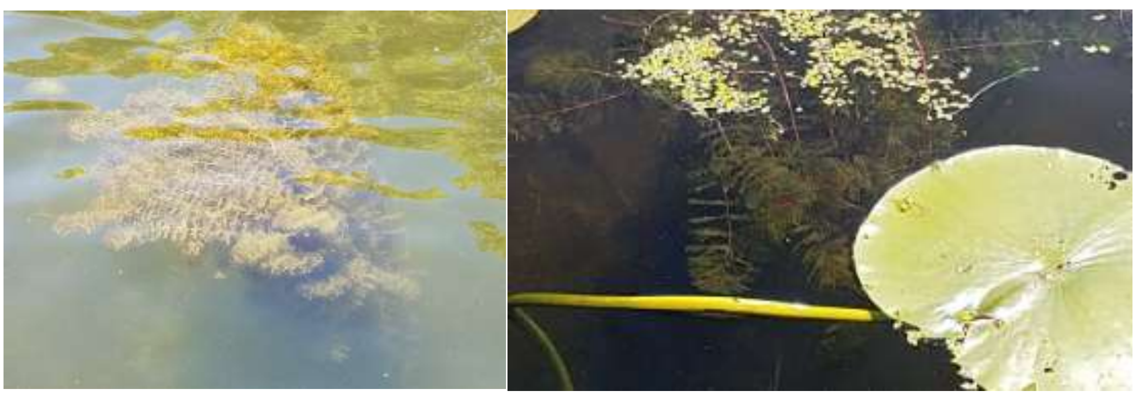


Figure 25: HWM in Rice Lake, June 2018

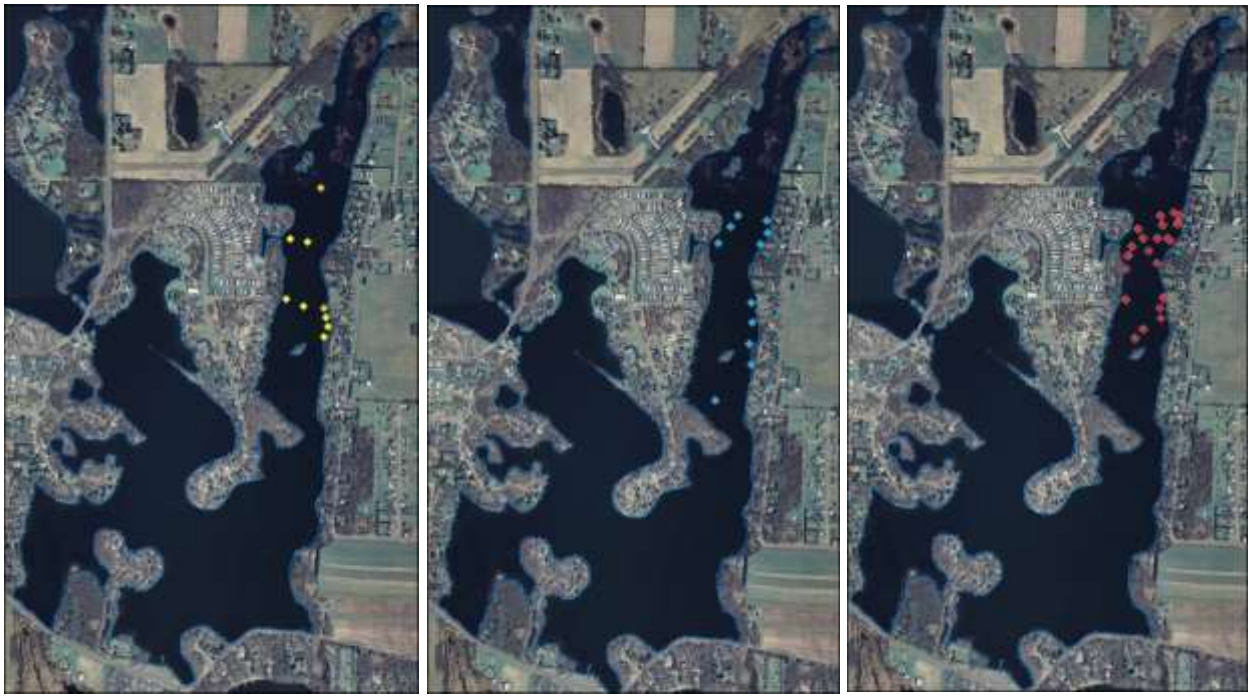


Figure 26: Hybrid watermilfoil locations in Clearwater Bay June 2018 (left), October 2019 (middle), and June 2020 (right)

The issue with milfoil in Rice Lake is that several of the native species are located in the same areas where HWM has been found. Figure 27 shows three species that are abundant in Rice Lake: Northern watermilfoil (*Myriophyllum sibiricum*), Whorled watermilfoil (*Myriophyllum verticillatum*), and Farwell's watermilfoil (*Myriophyllum farwellii*). HWM is a cross between Northern watermilfoil (native) and Eurasian watermilfoil (non-native) (*Myriophyllum spicatum*) (Figure 28). The Lake District will continue regular survey work throughout the open water season each year to ensure the HWM that is found is managed appropriately.

Figure 27: Northern watermilfoil (left), Whorled watermilfoil (middle), Farwell's watermilfoil (right)

Figure 28: Northern watermilfoil (left), Hybrid watermilfoil (middle), Eurasian watermilfoil (right)

AQUATIC INVASIVE SPECIES

Currently there are at least five established aquatic invasive species in Rice Lake. Curly-leaf pondweed and Chinese mystery snails were both vouchered in 2007 but have been in the lake much longer. Over the last few years, the population of Chinese mystery snails has exploded in the lake. Rusty crayfish are established in the Red Cedar River and Rice Lake. Purple loosestrife is located in the south basin of Rice Lake. Hybrid watermilfoil was found and vouchered in Clearwater Bay off the south basin in 2018. Japanese knotweed is located near the Lumbering Hall of Fame Park on the central basin of the lake. While this list is long, there are still other species that could get into the lake, most prominently is zebra mussels.

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

CURLY-LEAF PONDWEED

CLP is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 29). 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. The plant usually drops to the lake bottom by early August. 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 states but Maine.

CLP spreads through burr-like winter buds (turions), 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. 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.

CLP has been found throughout Rice Lake, and has been managed primarily with the use of large-scale mechanical harvesters for many years. When the population gets too large, CLP management does include a multi-year chemical control plan to reduce the turion population. Management will be an ongoing process each year into the foreseeable future.

Figure 29: CLP Plants, Turions, and Mats (not from Rice Lake)

EURASIAN WATERMILFOIL & HYBRID WATERMILFOIL

Eurasian watermilfoil (EWM) (see Figure 28) is a submersed aquatic plant native to Europe, Asia, and northern Africa. 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 watermilfoil. EWM has 9-21 pairs of leaflets per leaf, while Northern watermilfoil 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.

In some lakes, EWM has combined with the native northern watermilfoil to create a hybrid which has traits of both species. There is a wide variety of hybrids which are grouped together and classified simply as hybrid watermilfoil (HWM). These hybrid strands are managed the same way as the invasive EWM.

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 30) 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 found around Rice Lake in several areas in the south basin. It is not currently a large-scale problem around the lake, but it is important to educate lakeshore owners about the negative impacts to minimize the impact.

Figure 30: Purple Loosestrife

YELLOW FLAG IRIS

Yellow flag iris (Figure 31) is a showy perennial plant that can grow in a range of conditions from drier upland sites, to wetlands, to floating aquatic mats. A native plant of Eurasia, it can be an invasive garden escapee in Wisconsin's natural environments. It can grow in wetlands, forests, bogs, swamps, marshes, lakes, streams and ponds. Yellow flag iris can produce many seeds that can float from the parent plant, or plants can spread vegetatively via rhizome fragments. Once established, it forms dense clumps or floating mats that can alter wildlife habitat, species diversity, and even water hydrology.

All parts of this plant are poisonous, which results in lowered wildlife food sources in areas where it dominates.

Broad, sword-shaped leaves grow upright, tall and stiff. They are green with a slight blue-grey tint and are very difficult to distinguish from other ornamental or native iris species. Flowers are produced on a stem that can grow 3-4 feet tall among leaves that are usually as tall or taller. The flowers are showy and variable in color from almost white to a vibrant dark yellow. Flowers are between 3-4 inches wide and bloom from April to June. Three upright petals are less showy than the larger three downward pointing sepals, which may have brown to purple colored streaks.

Seeds are produced in fruits that are 6-angled capsules, 2-4 inches long. Each fruit may have over 100 seeds that start pale before turning dark brown. Each seed has a hard outer casing with a small air space underneath, which allows the seeds to float. The roots are thick, fleshy pink-colored rhizomes spread extensively in good conditions, forming thick mats that can float on the surface of the water.

When not flowering, yellow flag iris could be easily confused with the native blue flag iris as well as other ornamental irises that are not invasive. Blue flag iris is usually smaller and does not tend to form as dense clumps or floating mats. When not flowering or showing fruiting bodies, yellow flag iris may be confused with other wetland plants such as cattails or sweet flag species.

Small populations may be successfully removed using physical methods. Care should be taken if hand-pulling plants as some people show skin sensitivity to plant sap and tissues. All parts of the plant should be dug out – particularly rhizomes and disposed of in a landfill or by burning. Cutting the seed heads may help decrease the plant spreading. Aquatic formulas of herbicides may be used to control yellow flag iris, however, permits may be needed. Foliar spray, cut-stem/leaf dabbing, and wicking applications have all shown effectiveness.

Figure 31: Yellow Flag Iris (https://dnr.wisconsin.gov/topic/Invasives/fact/YellowFlagIris.html)

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Currently, only one non-native animal species, Chinese mystery snails, has been confirmed in within Rice Lake. While it is likely that rusty crayfish, are present, this has not been officially verified by the WDNR. Several additional non-vegetative, aquatic, invasive species are in nearby lakes, but have not been identified in Rice Lake. 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 Rice Lake.

MYSTERY SNAILS

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

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 algae and phytoplankton. Thus removal of plants in your 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 32: Chinese Mystery Snails (not from Rice Lake)

RUSTY CRAYFISH

Rusty crayfish have not been officially identified in Rice Lake, but they are found in the segments of the Red Cedar River both upstream and downstream of the lake. This means that it is likely there is at least a small population of rusty crayfish near or within Rice Lake.

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

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

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

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

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

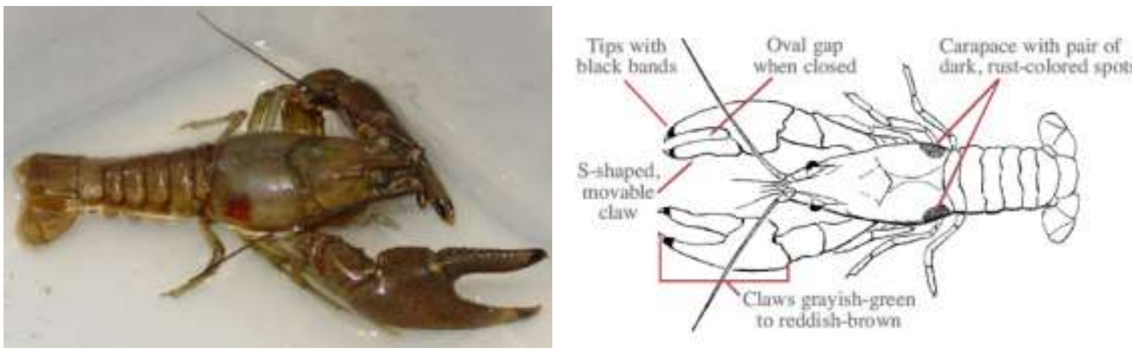


Figure 33: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels have not been identified in Rice Lake.

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

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

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 34: Zebra Mussels

While zebra mussels have not been identified in Rice Lake, they were found in western Washburn County in 2016. This was the first time that zebra mussels had been found in Northwestern Wisconsin. This discovery heightens the importance of monitoring and prevention activities for all northwestern Wisconsin lakes. Several years prior to this discover, the Center for Limnology out of UW-Madison began to develop a model to determine the suitability of Wisconsin's lakes to sustain a population of various AIS. This project has resulted in a web application that allows users to see the level of suitability for any given lake if there is enough data to run the model. According to this model, Rice Lake is suitable for zebra mussels (Center for Limnology, 2019). This means that if zebra mussels are introduced to the lake, it is likely they would be able to create a self-sustaining population with little trouble. Due to this, it is important for the Lake District to continue monitoring and prevention efforts to reduce the risk of introduction.

AIS PREVENTION STRATEGY

Other AIS that are present in Rice Lake include red canary grass and Japanese knotweed. Red canary grass is generally not managed. Japanese knotweed adjacent to the Lumbering Hall of Fame Park is managed by Barron County. The Lake District has and will continue to implement a watercraft inspection and AIS Signage program at several of the public access points on the lake. AIS information is shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program has and will continued to be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the

Clean Boats, Clean Waters (CBCW) program and the Citizen Lake Monitoring Network (CLMN) Aquatic Invasive Species Monitoring program.

In addition, the Lake District has worked cooperatively with the Rice Lake Chronotype, the local newspaper, to publish articles about AIS. The Lake District also has a Facebook page and a webpage that feature AIS.

PAST MANAGEMENT

The Lake District currently owns three 10ft Aquarius harvesters. Their primary management action for CLP and nuisance native aquatic plants is harvesting and they have been doing it since the late 1960's with the first harvester purchased by the City of Rice Lake. The year 1984 was the first year that the WDNR stated that they felt harvesting was the best way for excessive plant growth in Rice Lake to be dealt with. Around 1985, the City of Rice Lake turned the harvesting operation over to the Lake District which was formed in 1977, as one of the first Lake Districts in WI. In 1985, the Lake District added a second harvester. These two harvesters were used until 1992, when a large indoor storage shed was built to house all of the harvesters, a pontoon boat and a Lake District owned truck. Also in 1993, two new harvesters were purchased. In 1996, an elevator was also purchased and Jeff Smith was hired as the foreman in charge of the harvesting operation. Jeff held that position until 2019.

In 2006, the WDNR informed that Lake District that they would need an aquatic plant management plan if they were to continue harvest. Other conversations with the WDNR were had about what kind of a study needed to be done to get a new APM Plan. In 2008, the Lake District contracted with a consultant to complete what was necessary to get a new APM Plan. CBCW inspection began on Rice Lake in 2008. Through 2008, the Lake District was struggling to find places to deposit harvested vegetation and began contracting with a local farmer for disposal. In 2009, management of CLP and native plants continued while the APM Plan was in development. 2009 was the first year in decades that herbicides were used on the lake along with harvesting. In 2010, the first official APM Plan was completed and guided plant management until now. Also in 2010, the Lake District hired its first Lake Educator and purchased 17 acres north of the lake near Brill to dispose of their harvested weeds.

From 2010 to the present, the Lake District has been operating under the 2010 APM Plan. In 2018, hybrid watermilfoil was found in the Clearwater Bay area of the south basin. As a result, no harvesting was completed in Clearwater Bay in 2018. Instead, 0.80 acres of HWM and 5.58 acres of native aquatic vegetation in navigation channels in the bay were chemically treated with Aquastrike, a combination of diquat and endothall. Table 5 reflects harvesting and herbicide activities since 1996. Between 1996 and 2009, before the new APM Plan was implemented in 2010, the average tonnage of vegetation that was harvested equaled 992 tons. After the 2010 APM Plan was implemented and herbicide was used in combination with harvesting, the average tonnage of plants from 2010 to 2019 fell to 322 acres. Harvesting numbers were back up again in 2020 to a reported 1500 tons, but this value was reported by a new Operation's Manager for the Lake District so there may be some variance between methods of measurement.

The increase in aquatic plants harvested in 2020 has prompted a plan for limited use of aquatic herbicides along Lakeshore Dr. and in the south basin in 2021. The treatment proposal will include both early season CLP and early season HWM management. Harvesting will also continue in 2021.

Table 5: CLP and nuisance and navigation harvesting records, CLP chemical treatments, and HWM chemical treatments 1996-2020

1996-2020 CLP and Native Aquatic Plant Harvesting Totals (Tons of plant material)				Herbicide Treatments (acres)		
	CLP	**Nui&Nav**	Total	**CLP**	**HWM**	**Native**
1996	1008		1008			
1997	1104		1104			
1998	1432		1432			
1999	972		972			
2000	1122		1122			
2001	804		804			
2002	966		966			
2003	1128		1128			
2004	912		912			
2005	1056		1056			
2006	1008		1008			
2007	Missing Data		Missing Data			
2008	744		744			
2009	644		644	18.7		
2010	236	209	445	49.76		
2011	139	326	465	41.76		
2012	138	272	410	46.65		
2013	65	138	203	5.5		
2014	36	147	183			
2015	60	178	238	10.66		
2016	68	228	296	19.1		
2017	134	283	417	8.3		
2018	228		228		0.8	5.58
2019	89.5	245.5	335			
2020	1505		1505		3.97	
2010 APM Plan Implementation						
2018 Hybrid water milfoil found in Clearwater Bay, harvesting curtailed						

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is an ecosystem-based management strategy that focuses on long-term prevention and/or control of species of concern or their damage. IPM considers all the available control practices such as: prevention, biological control, biomanipulation, nutrient management, habitat manipulation, substantial modification of cultural practices, pesticide application, water level manipulation, mechanical removal and population monitoring (Figure 35). Integrated pest management projects should be informed by current, comprehensive information on pest life cycles and the interactions among pests and the environment.

Groups should focus their efforts to keep the species of concern from becoming a problem by looking into the environmental factors that affect the species and its ability to thrive. Once groups understand the species of concern, they can create conditions that are either unfavorable or less beneficial for it.

Monitoring means checking the waterbody to identify what species are present, how many there are and what their impacts are on each other and on water use. Correctly identifying the species of concern and other species in the waterbody is key to knowing whether it is likely to become a problem and determining the best management strategy.

After monitoring and considering the information about the target species' life cycle and environmental factors, groups can decide whether the species' impacts can be tolerated or whether those impacts warrant control. If control is needed, the data collected on the species and the waterbody will also help groups select the most effective management methods and the best time to use them.

The most effective, long-term way to manage species of concern is by using a combination of methods that work better together than separately. Approaches for managing pests are often grouped in the following categories:

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

IPM isn't a single solution to species of concern problems. It's a process that combines common-sense methods and practices to provide long-term, economic pest control. Over time, a good IPM program should adapt whenever new information is provided on the target species or monitoring shows changes in control effectiveness, habitat composition and/or water quality.

While each situation is different, eight major components should be established in a group's IPM program:

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

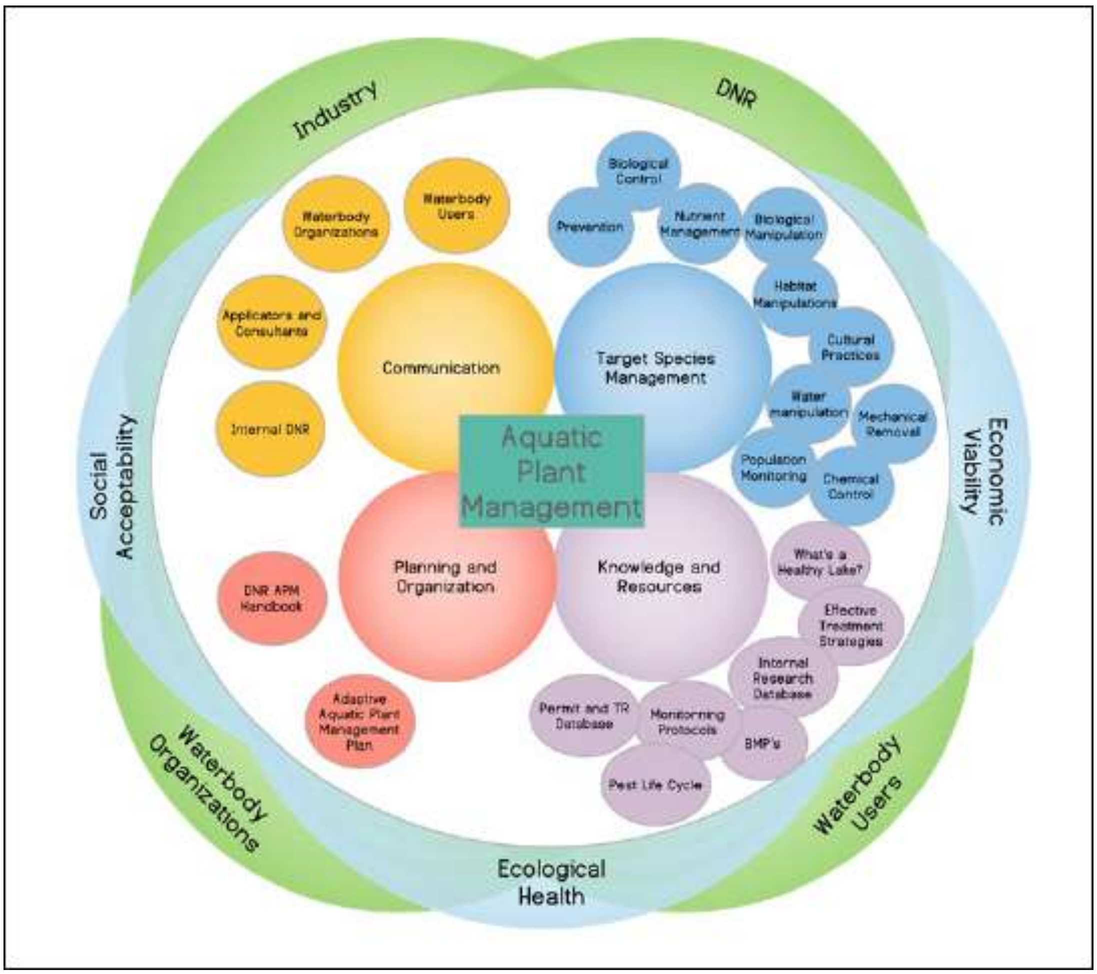


Figure 35: Wisconsin Department of Natural Resources: Wisconsin Waterbodies – Integrated Pest Management March 2020

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 approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species such as EWM or CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. It is important to remember however, that regardless of the plant species targeted for control, sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to a lake ecosystem and should not be done unless it can be shown they will be beneficial and occur with minimal negative ecological impacts.

Management alternatives for nuisance aquatic plants can be grouped into four broad categories: manual and mechanical removal, chemical application, biological control, and physical habitat alteration. Manual and mechanical removal methods include pulling, cutting, raking, harvesting, suction harvesting, and other means of removing the physical plant from the water. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant. 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 resources. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. 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. The use of chemicals and biological controls are regulated under Administrative Rule NR 107. 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 aquatic invasive 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 or HWM in Rice Lake is not a recommended option. Despite many years of active management of CLP, there are still areas where CLP is able to form monoculture beds. Forgoing management would likely only allow these dense monocultures to become more common and decrease summer water quality. HWM management is relatively new to the Lake District, but is necessary to reduce the amount of HWM in the lake and to minimize its spread.

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, swimrafts 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 36)
- 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) are followed.

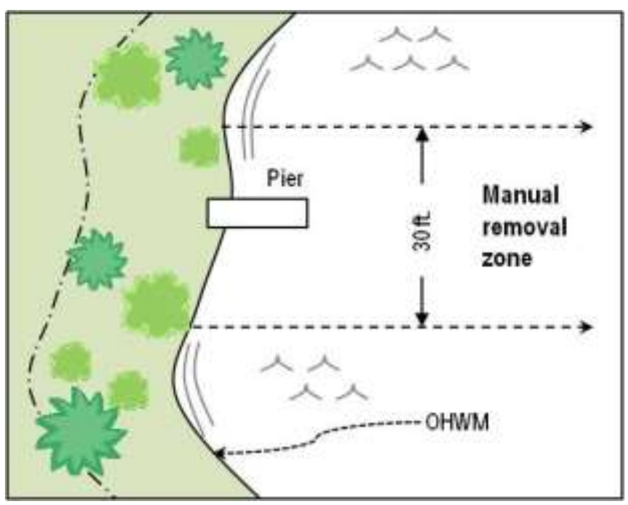


Figure 36: Aquatic vegetation manual removal zone

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 30ft 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 aquatic invasive species 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 aquatic invasive species infestation within a lake when done properly.

Larger scale hand or diver removal projects have had positive impacts in temporarily reducing or controlling aquatic invasive species. Typically hand or diver removal is used when AIS has been newly identified and still exists as single plants or isolated small beds, but at least in one lake in New York State, it was used as a means to control a large-scale infestation of EWM. Kelting and Laxson (2010) reported that from 2004 to 2006 an "intensive management effort" which involved "the selective removal of Eurasian water milfoil using diver hand harvesting of the entire littoral zone of the lake at least twice each summer for three years" followed by three years of maintenance management successfully reduced the overall distribution of EWM in the lake.

This method of control is part of the integrated management strategy being used to control HWM within Rice Lake. In combination with the chemical controls, hand pulling is a recommended management action for HWM. The CLP within Rice Lake is far too dense and widespread to make hand pulling a viable method of control, so it is not recommended to be used for CLP control. However, property owners around the lake should be encouraged to hand pull CLP near their property if they wish to.

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 weeds 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 37). 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).

In Wisconsin and Michigan, suction harvesting of unwanted aquatic plants is gaining popularity as a treatment method. There are several companies in the mid-west that are offering DASH services. Some of these companies are also building equipment that lake organizations and consultants can purchase to start up their own DASH program. There is one local company out of the Chippewa Falls, WI area that offers contracted DASH services.

Figure 37: DASH - Diver Aided Suction Harvest (Chuck Druckery, 2016 Wisconsin Lakes Convention Presentation)

Any form of CLP management has to be completed several years in a row in order to reduce the turion supply within the treated areas. Because of this, the cost of contracting DASH services or purchasing DASH equipment would likely outweigh the level of CLP control it offers. However, due to the limited nature of the HWM population within Clearwater Bay, DASH could become part of the integrated management plan for HWM. This could be used in place of or in combination with the current methods of rake removal, diver removal, and chemical control of HWM.

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. DASH is also considered mechanical removal and requires a permit. 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.

LARGE-SCALE MECHANICAL HARVESTING

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

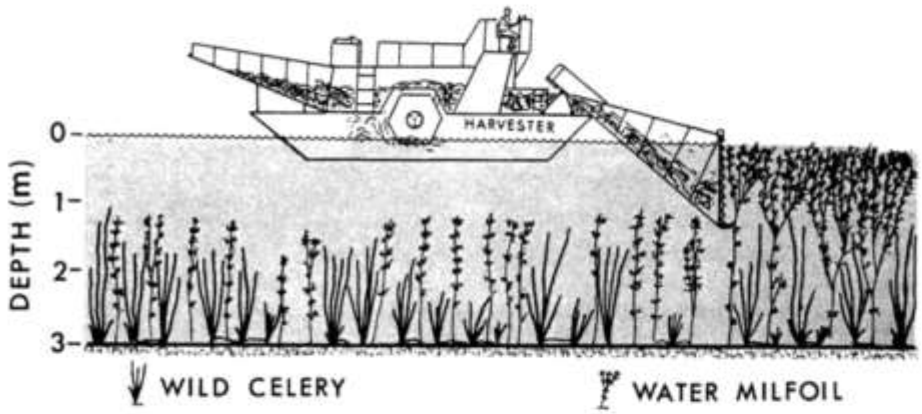


Figure 38: How a Harvester Works (Engle, 1987)

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Its results - open water and accessible boat lanes - are immediate, and can be enjoyed without the restrictions on lake use which follow herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic plants. The nutrients stored in the plants are also removed from the lake, and the sedimentation that would normally occur as a result of the decaying of this plant matter is prevented. Additionally, repeated treatments may result in thinner, more scattered growth.

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. The removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, including sediment stabilization and wave absorption. Shoreline erosion may therefore increase. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on these organisms' populations as well as the lake ecosystem as a whole. While the results of harvesting aquatic plants may be short term, the negative consequences are not so short lived. Harvesting aquatic plants is a little like mowing the lawn. Some plants may grow back quickly and have to be harvested again in the same season. This is usually dependent on the amount of use a harvested area gets once harvesting has been completed, particularly when harvesting access channels. If these channels are used frequently by boaters, then they will likely be kept open. If they are not frequented by boaters, the plants will likely grow back. If this happens, it probably means it was not necessary to harvest the channel in the first place, and the benefits of doing so should be reevaluated. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species to propagate and colonize in new, previously unaffected areas of the lake. Harvesting may also result in re-suspension of contaminated sediments and the excess nutrients they contain.

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.

Timing is also important. The ideal time to harvest CLP is just before the plant sets turions (reproductive structures) as this will reduce the risk of spreading new turions within the lake, remove the most biomass, and has the most potential for removing excess nutrients added from decaying CLP. Harvesting can begin sooner, but may have to be repeated in those early areas. Harvesting of Eurasian watermilfoil and hybrid watermilfoil is generally not recommended due to the fragmentation that is inherently a part of harvesting. CLP spreads by turions, milfoil generally by fragmentation.

HARVESTING IN RICE LAKE

The Lake District currently owns and operates three large-scale harvesters, the latest purchased in 2019 to replace an older machine, to control CLP populations in early summer and maintain navigation lanes throughout the rest of the season. With the discovery of HWM in Clearwater Bay, the District has adjusted the harvesting plan to avoid areas where HWM is found to minimize the spread. The issue for the Lake District is that one of the three harvesters has a docking and harvested plant material unloading station in Clearwater Bay on the south basin. At the present time, the population of HWM has not prevented piloting the harvester in and out of Clearwater Bay to the south basin. However, it has changed the patterns and pathways used by the harvesters in Clearwater Bay. In 2018, no harvesting was done in Clearwater Bay until a complete survey identified all locations where HWM was located. Removal by scuba diver and herbicide application were used in 2018 with no HWM being found again until the fall of 2019.

The population of HWM expanded its distribution in Clearwater Bay in 2020, which may further change where harvesting takes place. Clearwater Bay is a shallow bay averaging no more than 5-ft in depth. As the name suggests, the water is general clearer in the bay than it is in the rest of the lake due to the large amount of vegetation. Furthermore, there are property owners along the east shore well up into the northeast tip of the bay where only a navigation channel is kept open. A significant amount of vegetation is removed from Clearwater Bay and the south basin through the harvesting program. If harvesting is stopped as a result of expanding HWM, the use of aquatic herbicides to control HWM and, to keep navigation lanes open will be needed.

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 (Figure 39) 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 aquatic invasive species growth, and cause ecological disruptions.

Figure 39: Aquatic Mower & Weedshear Weed Cutter (weedersdigest.com)

The density and distribution of the CLP within Rice Lake makes small-scale harvesting unable to effectively manage CLP. Mechanical harvesting of any size would be of no benefit to control HWM populations. The primary method of spread for HWM is fragmentation, so harvesting would likely only aide in spreading HWM around Clearwater Bay and eventually, throughout the rest of the lake.

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce plant growth may provide temporary relief, but also inhibits fish spawning, affects 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 vegetation 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 aquatic 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 Rice 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 CLP remained significantly lower than pre-dredging levels 10yrs 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. Very limited dredging is allowed without a permit if certain requirements are met.

Normally, dredging should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen, 2000).

While in general, dredging is not recommended for Rice Lake, there are a couple of places where at some point in the future limited dredging may be necessary. One area is in the navigation channel that follows the east shore of Clearwater Bay. Currently, aquatic harvesting operations occasionally remove bogs that float in or break free from the edge to block the navigation channel. There are also several smaller bays that have narrow access sites that may need dredging to maintain boating access in the future.

DRAWDOWN

Drawdown, like dredging, alters the plant environment by removing water in a water body to a certain depth, exposing bottom sediments to seasonal changes including temperature and precipitation. A winter drawdown is a low cost and effective management tool for the long-term control of certain susceptible species of nuisance aquatic plants. A winter drawdown controls susceptible aquatic plants by dewatering a portion of the lake bottom over the winter, and subsequently exposing vascular plants to the combined effect of freezing and desiccation (drying). The effectiveness of drawdown to control plants hinges first on being able to draw the water down far enough to dewater the areas of most concern; and then on the combined effect of the freezing and drying. If freezing and dry conditions are not sustained for 4-6 weeks, the effectiveness of the drawdown may be reduced. Winter drawdowns are most effective for plants like EWM and lily pads that reproduce from rhizomes and vegetative runners under the sediment. They are much less effective for controlling plants that grow annually from seeds or turions like CLP and other pondweeds. In some cases, pondweed species may actually benefit from a winter drawdown, as competition with other plants species may be reduced following a drawdown. This can aide certain native species like wild rice, but it could also result in CLP doing better in a lake.

Rice Lake is controlled by a dam near Stein Street, but a drawdown is not a recommended management action. Drawdowns can he used to control HWM, but the area of the lake where HWM is found would likely be minimally impacted by a drawdown. Additionally, the HWM is found in an area with a large number of native species that would also be negatively impacted, outweighing any benefit gained. A drawdown would also likely cause an increase in the density of the CLP throughout the lake. Turions can stay viable when buried in lake sediment for several years. This means that while several native species would see population declines, CLP will likely see a population spike due to more space from natives that died off and a solid turion base.

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.

Currently, there are no biological controls available for CLP. It was thought at one time that the introduction of plant eating carp could help control CLP and EWM. It has since been shown that these carp have a preference list for certain aquatic plants. CLP is very low on this preference list (Pine & Anderson, 1991). Use of "grass carp" as they are referred to in Wisconsin is illegal as there are many other environmental concerns including what happens once the target species is destroyed, removal of the carp from the system, impacts to other fish and aquatic plants, and preventing escapees into other lakes and rivers. Several pathogens or fungi are currently being researched that when introduced by themselves or in combination with herbicide application can effectively control CLP and lower the concentration of chemical used or the time of exposure necessary to kill the plant (Sorsa, Nordheim, & Andrews, 1988).

Biological controls do exist for EWM and purple loosestrife. The milfoil weevil (*Euhrychiopsis lecontei*) is a small, herbivorous aquatic beetle that is native to North America (Figure 40). It is a watermilfoil specialist, meaning that it feeds and develops only on plants in this genus. Its original host before the introduction of EWM was the native northern watermilfoil. The weevil completes all life stages fully submersed, feeding and developing on milfoil, and the larvae are stem miners. These characteristics make it unique, as specialist herbivores are very rare among aquatic insects (Newman, 2020). These characteristics are why the milfoil weevil has shown the most promise as a potential biocontrol agent for EWM and why it has been the subject of much research. Unfortunately, though these insects have been used in WI, the process of rearing and distributing them is very difficult and time consuming involving harvest of EWM from the lake the weevils are to be put in, setting up of rearing stations that consist of large water tanks and live EWM, tending and refreshing the tanks, collecting weevils in the field, and distributing them once they have propagated. This consultant is also not aware of any research that has been done to test the effectiveness of the weevils on hybrid watermilfoil.

To control purple loosestrife, the WDNR has been using four of its insect enemies, also from Europe, since 1994. Careful research has shown that all four control species depend only on loosestrife and do not threaten native plants. This is classic biocontrol, and it is likely the best long-term control for loosestrife, reducing the need for other more costly and disruptive controls, such as herbicides. Two beetle species in particular (*Galerucella calmariensis* and *G. pusilla*) have proven extremely effective at control (Figure 40). Both species of beetles feed almost exclusively on leaves, shoots, and stems of purple loosestrife during all of their life stages. Galerucella beetles monitored in the state and elsewhere have decreased the vigor, size and seed output of purple loosestrife, allowing native plants to survive and increase naturally by competing better against smaller loosestrife plants.

The length of time required for effective biocontrol of purple loosestrife in any particular wetland typically ranges from one to several years, depending on such factors as site size and loosestrife density. Though loosestrife elimination is rare, this process offers effective and environmentally sound control of the plant without herbicides. Furthermore, unlike EWM weevils, the process of rearing and releasing purple loosestrife beetles is a lot easier. However, both processes require permitting from the WDNR. The use of biological controls for EWM and purple loosestrife aims to reduce pest populations to tolerable levels but it is also important to keep a low density of the offending plant species in order to maintain control agent populations. Successful biocontrol of EWM and purple loosestrife will reduce their abundance, eliminate large areas, and will promote healthier native plant communities but will not eliminate them from the lake environment.

Figure 40: Milfoil weevil (left) and purple loosestrife beetle (right)

It is not recommended that the Lake District use weevils as a control measure for HWM, however the use of purple loosestrife beetles will be considered if the population of purple loosestrife in and around Rice Lake increases past just a few plants that can be physically removed and/or treated with aquatic herbicides.

CHEMICAL CONTROL

Aquatic herbicides are granules 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 WDNR evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The WDNR frequently places conditions on permits that limit the type and amount of herbicide and when that herbicide can be applied to the target species 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.

As previously mentioned, integrated pest management involves the use of many different management alternatives, rather than relying on one method only. To ensure that other methods are being evaluated, the WDNR generally requires the development of an Aquatic Plant Management Plan for management projects on lakes that cover >10 acres or 10% of the water body or any projects receiving state grants. The WDNR requires that adjacent landowners to a treatment area be notified of that treatment and given an opportunity to request a public meeting if they want. The WDNR requires that physical signs be posted on the water body before the treatment begins to notify the public. The WDNR also requires reporting to the state after treatment occurs. The WDNR may even supervise the treatment in person.

ADVANTAGES AND DISADVANTAGES

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 aquatic invasive species to outcompete native 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 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 EWM, will be affected by selective herbicides whereas monocots, such as the many pondweeds will be less affected. The selectivity of a particular herbicide can be influenced by the method, timing, formulation, and concentration used.

Endothall is considered primarily a contact herbicide. Its common trade name is Aquathol K® (liquid) or Super K® (granular). Endothall is a broad spectrum herbicide most commonly used to kill pondweeds like curly-leaf. Because CLP is an annual plant not dependent on existing root structure to grow, a contact herbicide like endothall can be very effective. It is not effective on roots, rhizomes, or tubers. Endothall has been described as a broad spectrum contact-type, membrane-active herbicide. Native aquatic plant sensitivity varies greatly among species. EWM and pondweeds such as CLP, Illinois pondweed, southern naiad, and sago pondweed are very sensitive to endothall, while coontail is moderately sensitive. Other plants such as common waterweed, wild celery, water stargrass, and many floating-leaf and emergent species are more tolerant of endothall. Endothall, therefore, has the potential to selectively control CLP and/or EWM in sites where native pondweeds do not dominate the plant community (Skogerboe and Getsinger, 2006).

Diquat is a non-selective, contact herbicide that will kill or injure a wide variety of plants by damaging cell tissues when absorbed by the foliage. It will not kill parts of the plant it does not come into direct contact with. Its common trade name is Reward® or Tribune®. Diquat is not effective in lakes or ponds with muddy water or plants covered with silt because it is strongly attracted to clay particles in the water. Bottom sediments must not be disturbed when this herbicide is used. At approved application rates Diquat does not appear to have any long or short term effects on most aquatic organisms.

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.

2,4D and triclopyr are active ingredients in several selective herbicides including Sculpin G®, Shredder Amine 4®, 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, 2,4D, 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.

ProcellaCOR® is a relatively new herbicide that acts similar to both 2,4D and triclopyr, with less contact time needed. The active ingredient in ProcellaCOR® is an organic compound which mimics the plant hormone auxin. The auxins that are produced naturally within plants stimulate stem elongation while suppressing bud growth. However when auxin concentrations within plant tissues reach a certain threshold, the growth response is completely reversed. The plant begins to, essentially, prepare for a dormant period by stopping growth altogether and abscising leaves. At this point, additional auxins (or their mimics) will become toxic to the plant and result in cell death. This herbicide has just recently been approved for use in Wisconsin, but it is currently still considered to be in a testing phase.

Endothall and diquat are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. Neither of these is considered selective and has the potential to kill all of the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like CLP begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide 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.

SMALL-SCALE HERBICIDE APPLICATION

The determining factor in designating chemical treatments as small-scale is the size of the area being treated. Small-scale herbicide application involves treating areas less than 10 acres in size. Small-scale chemical application is usually completed in the early season (April through May), but may be used as follow-up spot treatments after an early season application, 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 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 is 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. If combined small-scale treatments exceed 10 acres or 10% of the littoral zone of a lake it is considered a large-scale treatment.

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 bigger the treatment area, the more contained the treatment area, the depth of the water in the treatment area, and whether the lake stratifies or not, are factors that impact how whole bay or whole lake treatments are implemented.

Pre- and post-treatment aquatic plant surveying and having an approved Aquatic Plant Management Plan are required by the WDNR when completing large-scale chemical treatments. Residual testing, or testing the fate of the herbicide once placed in the water is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used. Large-scale treatments have occasionally been used within Rice Lake when the CLP density gets too high, but this is not an annual treatment. The current size of the HWM population in Clearwater Bay is much too small and concentrated, and contained in a very diverse and sensitive area, that it is unlikely to be able to justify large-scale treatment for control. However, if the distribution of HWM increases past just a few acres – particularly outside of Clearwater Bay, large-scale herbicide application will be considered.

CUT-STEM AND WICKING APPLICATION

Cut-stem dabbing (Figure 41) is carried out by cutting stems of target species within two to four inches of the ground followed by application of herbicide to the cut surface. Treatment should occur immediately following cutting to ensure proper absorption of herbicide. A colored dye is usually added to the solution so that it is apparent as to where the herbicide has been applied.

Hand wicking (Figure 41) involves spraying an herbicide solution on an absorbent glove and carefully wiping the herbicide onto the surface of a leaf. It's important to wear an herbicide resistant glove beneath the absorbent glove, to protect skin from the herbicide. This method is appropriate when controlling small populations of invasive species that are growing in a high-quality area, or when controlling invasive species in close proximity of endangered or threatened native species (https://muskegonlake.org/habitat-management-plan/invasive-species-control/, last accessed on August 6, 2020).

Figure 41: Herbicide application using "Cut-stem dabbing" (top) and "wicking" (bottom)

Several emergent, wetland, or dry ground non-native plant species have been identified in Rice Lake including purple loosestrife, yellow iris, reed canary grass, and common forget-me-nots. Of these, purple loosestrife is likely the one to be most concerned about. Over the last few years, only individual plants have been found along the shore. Management has consisted only of the removal of flower heads before seeding. Annual monitoring for purple loosestrife should be completed. Plants that are found can be physically pulled – roots and all, or dug out. At a minimum, when a plant is found the flowering heads should be removed to prevent seeding. Plant herbicides can also be used when the entire plant is on dry ground. Cut-stem dabbing and hand wicking are most commonly used for small-scale, chemical control of purple loosestrife. Similar methods could be used for yellow iris. Reed canary grass and aquatic forget-me-nots will likely not be managed.

Japanese knotweed has been identified on Rice Lake. Management of this species is primarily completed by the Barron County Soil and Water Conservation Department.

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 150ft 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 Aquatic Plant Management Plan has identified specific goals for non-native invasive species and native plants species control. 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.

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 Aquatic Plant Management Plan 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.

HERBICIDE USE IN RICE LAKE

Endothall is the primary herbicide used in Rice Lake to control CLP. A combination of endothall and diquat was use for one year in 2018, to control multiple aquatic plants within Clearwater Bay when harvesting could not be completed. 2,4D based products were used in 2020 to control HWM in Clearwater Bay. In this plan, it is recommended that the Lake District use several different herbicides including endothall, diquat, 2,4D, and ProcellaCOR to control non-native aquatic plant species, and if the need arises, to chemically treat native aquatic plants. When and where these different aquatic herbicides would be used depends on the conditions presenting themselves each year. Herbicides would only be used to control native aquatic vegetation if the expansion of HWM/EWM prevents the use of large-scale mechanical harvesting.

Traditionally when herbicide is used to control CLP in a lake, it is used for a minimum of three years in a row with the intent to reduce both the amount of CLP in the lake and to reduce the number of CLP turions in the sediment beneath the treated area. This was done in Rice Lake beginning in 2009 and lasting through about 2012. Since then, herbicides to control CLP have only been used a couple of times with the goal of knocking back the abundance of CLP to a level where harvesting once again becomes the better alternative. There are locations in Rice Lake where large-scale mechanical harvesting of large, dense beds of CLP causes more issues than good.

One such location is along Lakeshore Drive in mid-June. Rice Lake Aquafest celebrates the lake and occurs the second weekend of June. Many people flock to the lakefront to see events which include a local waterskiing show. In the past harvesting of CLP during this time period has left large amounts of escaped fragments washed into the shore along Lakeshore Drive. The early season application of herbicides reduces the amount of CLP to be harvested along this shore, leaving better conditions for Aquafest.

A second location is in the south basin. There are only a few small areas of CLP in the south basin. Generally, a harvester is not launched into the south basin until mid to late June. Instead the harvester is used in the main basin to improve CLP management there early in the season. It is not possible to drive one of the harvesters between the south basin and the main basin of Rice Lake. It has to be carried overland and launched directly into the south basin. As such, when the distribution and density of CLP causes navigation issues or negatively competes with native vegetation, single year application of herbicide is used to reduce the impacts.

A combination of small-scale herbicide application, diver removal, DASH, and rake and snorkel removal is completed to control HWM. All of these alternatives will be evaluated each year and implemented as determined necessary.

MANAGEMENT DISCUSSION

This APM Plan for Rice Lake is intended to guide management implementation beginning in 2021 through the 2025 open water season. The most recent APM Plan for Rice Lake was written in 2015 with these eleven goals:

- Reduce the total amount of Curly-leaf Pondweed in Rice Lake by combining the use aquatic herbicides and large-scale mechanical harvesting
- Prevent the spread and establishment of aquatic invasive species already present along the shores of and in the wetlands adjacent to Rice Lake
- Eurasian watermilfoil rapid response planning
- Provide native aquatic plant management that protects and enhances native plant growth and diversity in Rice Lake.
- Record keeping, monitoring, and assessment for all plant management activities
- Maintain public availability
- Continue development of a Residential and Riparian Owner Best Management Practices (BMP) Program
- Increase public awareness of and involvement in the District
- Implement the activities associated with this APM Plan through a combination of District and State of Wisconsin grant funding
- Complete annual project summaries and a final project evaluation

The first goal was met over the course of the last five years. Unfortunately, hybrid watermilfoil was found in Clearwater Bay in the south basin in 2018, so the second goal was only partially met with controlling the spread of existing AIS like CLP and purple loosestrife and to some degree, HWM. The third goal helped in the response to finding HWM in the lake. Overall, goal four was met; however there was some reduction in parameters that indicate a healthy aquatic plant community – though not anything overly "concerning". The Lake District could have done a better job with Goal five. Records were kept, but turnover in both Lake District Board Members and the Operations Committee Chair, and the loss of the main harvesting employee after about 30 years impacted the record keeping. Public availability is what it has always been. All meetings are open to the public. The new Facebook page has really increased public viewing. The Residential and Riparian Owners Best Management Practices Program is in full swing with multiple projects completed. As mentioned, the Facebook page has increased public awareness surrounding the Lake District. The 2015 APM Plan has been implemented to the best ability of the Lake District and their management consultant. Summaries have been completed and reimbursements for existing grants completed and finalized.

The following sections discuss how the Lake District is going to move forward with aquatic plant management (native and non-native in the next five years (through 2025).

AQUATIC PLANT HARVESTING

Harvesting plans will be designed to enhance both the ecological balance and recreational uses of the lake. For Rice Lake, this means no harvesting will be completed in the areas that support wild rice growth. Harvesting programs will be focused on removing dense growth CLP in the north and central basins in the spring through about the 4th of July. After the 4th, harvesting will focus on improving access to the lake by creating navigation lanes for boat traffic. For the most part these lanes are parallel shore or cut through dense aquatic plant beds in the delta of the Red Cedar River. Harvesting also keep a navigation channel open along the eastern shore of Clearwater Bay and into several other smaller bays.

The Lake District owns three large-scale mechanical harvesters, and in a normal year two are launched in early May on the main body of the lake to harvest CLP. The third is launched into the south basin and not used for harvesting CLP unless CLP is still present in large beds when launched. Harvesting also removes floating debris/mats of dead and dying floating vegetation and rafts of break-away bogs that block navigation. Clear-cutting of aquatic vegetation adjacent to riparian shoreline for the purpose of creating weed free areas for swimming or other recreational purposes is not an approved harvesting action in Rice Lake. Landowners, however, are not prohibited from physically removing aquatic vegetation in these areas, provided guidelines presented in NR 109 are followed. In addition, plants raked out by riparian owners and piled on the shore can be picked up by the harvesters.

With the introduction of EWM/HWM in the Clearwater Bay of the south basin, mechanical harvesting operations have been and continue to be adapted based on how much EWM/HWM is found and where. Great efforts are made to keep mechanical harvesters out of areas where EWM/HWM has been identified, at least until these areas have been managed by other means including physical removal and application of aquatic herbicides.

APPLICATION OF AQUATIC HERBICIDES

Several herbicides are used for control of CLP in a lake. The most commonly used are liquid or granular endothall based herbicides. Diquat based herbicides have also been used. Both are considered to be contact herbicides that will kill the vegetative plant parts it comes in contact with. In some cases this may mean the root (buried in the sediment) is not entirely killed, which may allow regrowth from existing root structures. One disadvantage is that contact herbicides like diquat and endothall are not plant selective. Both can kill all plant material they come in contact with.

To control EWM/HWM, systemic herbicides such as 2,4D, triclopyr, or ProcellaCOR® are used. These herbicides are absorbed into the plant and dispersed throughout to kill the entire plant. Contact herbicides like endothall and diquat will also kill EWM/HWM at higher concentrations. The only time aquatic herbicides have been used to control native aquatic vegetation is in 2018 after the initial finding of HWM in Clearwater Bay. Instead of harvesting, predetermined navigation lanes were chemically treated. These treatments were seen as less effective than harvesting but may be used again if EWM/HWM continues to expand in Clearwater Bay or into other parts of the lake.

It should be recognized that any aquatic herbicide will kill target and non-target species assuming either the contact time is long enough or the concentration of the herbicide applied to the water is high enough. To reduce the impacts of herbicide use on non-target plant species, these herbicides are mostly applied at times during open-water when native aquatic plant species are not actively growing. CLP is one of the first aquatic plants that begins to actively grow in the very early spring, often before the winter ice is even out. Chemical treatments in early to mid-May can target CLP when it has minimal growth leaving less plant material to die and decay at the bottom of the lake. EWM/HWM also grows early and can be effectively treated in mid-May to early June. Unless, new EWM/HWM is identified in sensitive or navigation areas, it is not expected that chemical treatment of any aquatic vegetation will occur after about June 15.

The only exception to this would be if herbicides are needed to keep pre-determined navigation lanes open once EWM/HWM has been identified. Herbicide application may occur later in the season up to July 31st, to insure the most benefit to navigation.

LAKESHORE DRIVE AND SOUTH OF THE RED CEDAR RIVER INLET

Lakeshore Drive in downtown Rice Lake follows the western edge of the lake from Newton St. to Hwy 48 near the Barron County Fairgrounds. This stretch of Lakeshore Drive contains several parks and other interesting community and public attractions and is considered a celebration of the history of the area and of Rice Lake. Parks include the Beach Walk Restored Shoreland, Veteran's Memorial Park and City Band Shell, and Indian Mounds Park. Several iron sculptures commemorating the history or the area including Wooly-Mammoth (glacial times), Rusty-The Draft Horse (the logging era), and soon a third sculpture to serve as a tribute to the Native American communities that used to make their homes along the Red Cedar River and Rice Lake. A historic information sculpture commemorating what was called the Bayfield Trail (from Lake Superior through Rice Lake to points south traveled by Native Americans, Fur Traders, and Settlers is also in the works.

Nearly all of the shoreland between Lakeshore Drive and the body of water known as Rice Lake is owned by the city and is frequented daily by community residents and travelers. There are several public fishing piers along this stretch of Lakeshore Drive. Lakeshore Drive is adjacent to Fireworks Island where 4th of July Fireworks are celebrated each year. Lakeshore Drive is also the focal point during the annul Rice Lake Aquafest Celebration in early June. During this event, many activities including a children's fishing contest, rubber duck race, and a waterski show utilize the lake front. Veteran's Memorial Park and Band Shell is one of the focal points of Aquafest activities. There is also a summer "Music in the Park" scene that runs for several months. The Elks Lodge and Moose Club are also along Lakeshore Drive, as is the Heritage Manor Lakeside – a senior living community.

Water depth in this area of the lake ranges from 3 to 10 feet deep with bottom substrates of sand, gravel, and rock, covered with a thin layer of muck. The area supports abundant native plants growth when not overrun by CLP. Lake District harvesters work strenuously in this area throughout the season, but particularly so during late May and early June with the goal of keeping the area in good shape for Aquafest and other summer events. While harvesting is effective, when the amount of CLP reaches higher density levels, it is difficult to maintain the area. When there is a lot of CLP, harvesting leaves abundant fragments that wash into shore and decay. About every 3-5 years, a limited herbicide treatment is applied to parts of the lake along Lakeshore Drive. This helps reduce the amount of harvesting needed during those years in-between herbicide application.

In more recent years, the area of the Rice Lake lakeshore on the eastern shore of the lake south of the Red Cedar River Inlet has become more problematic. Though not used as a public place of gathering, there is small watercraft/walk-on access point in this area off Zabel Road. It is expected that herbicide use in this area to control CLP would only be used every 5-10 years, and only the year after a survey has documented dense CLP growth.

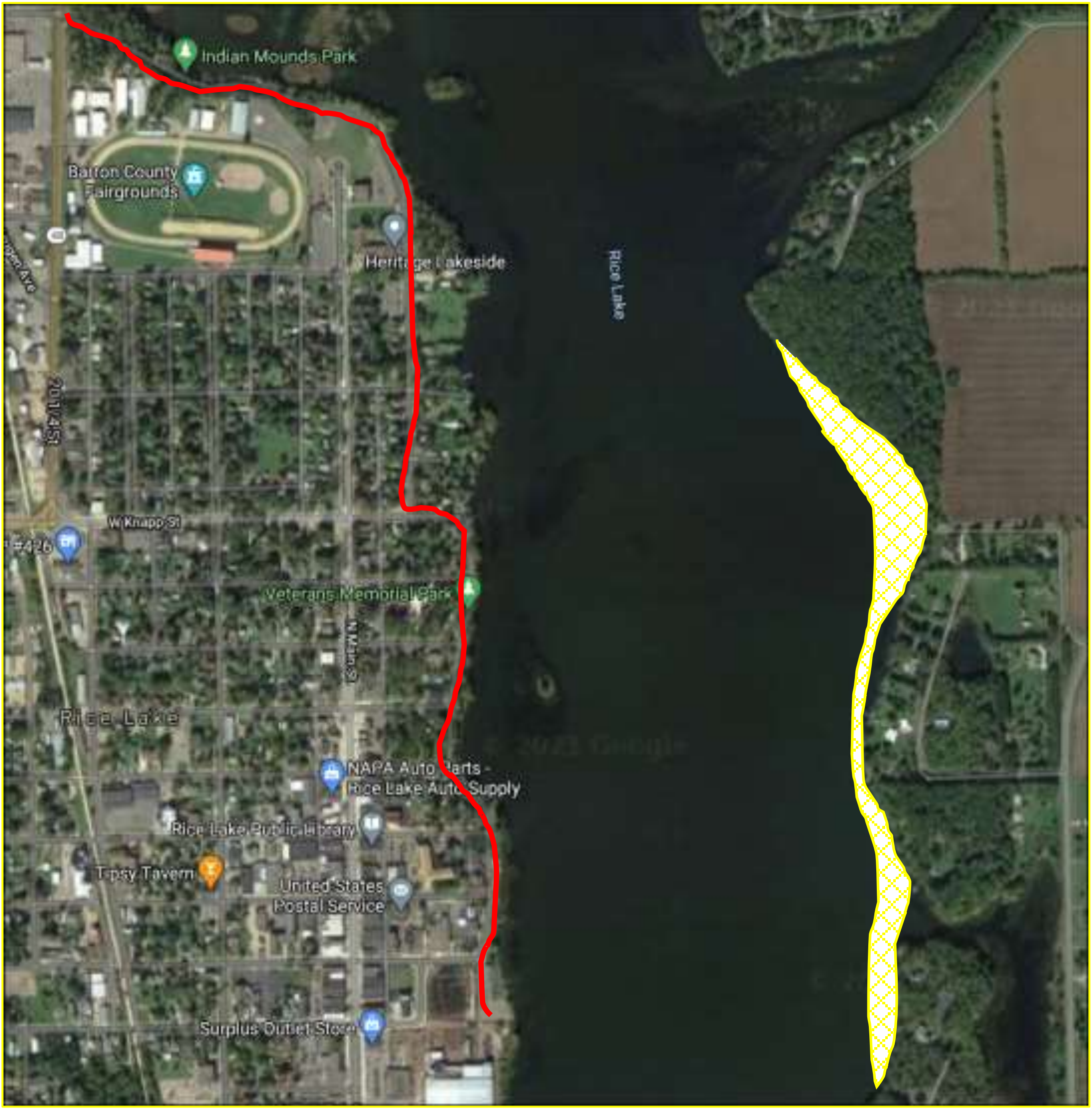


Figure 42: Lakeshore Drive (red line) and South of Red Cedar River Inlet (yellow)

AQUATIC PLANT SURVEYING

Rice Lake has a healthy and diverse native aquatic plant community. Management of non-native, invasive species and areas of dense growth native vegetation will cause changes in that community. There are at least three levels of aquatic plant surveying that will be implemented to better assess and understand how management actions affect aquatic plants and the lake as a whole.

RECON AND MAPPING SURVEYS

Recon and mapping surveys within the littoral zone, also known as meandering, bedmapping surveys, look specific plant species like CLP or EWM/HWM and are important as they are generally the first indicator that there is something that does not belong. These surveys help find target plant species, document the location where target plants are found using GPS technology, and provide an opportunity to physically remove the target plant or make it a part of another management action. Annual bedmapping of CLP is considered a recon and mapping survey and serves to identify areas of concern for management in the following spring.

AIS monitoring as a part of the CLMN AIS monitoring program is also an examples of recon and mapping surveys. These are completed at least monthly during the open water season and look for AIS including EWM/HWM, purple loosestrife, and yellow flag iris. The Lake District will complete recon and mapping surveys annually to help define management actions and impacts.

PRE AND POST-TREATMENT POINT-INTERCEPT SURVEYS

Pre and post-treatment, point-intercept surveys are more quantifiable and document short-term changes in areas that are chemically managed. These surveys consist of a set of points that can be surveyed multiple times, usually before and after a chemical treatment. Statistical information can be gathered from the data collected during one of these surveys. The WDNR only requires pre and post-treatment, point-intercept aquatic plant surveying when greater than 10 acres of the littoral zone are proposed for treatment, or if a chemical treatment is grant funded. Should these conditions be met, pre and post-treatment point-intercept surveys will be completed as a part of management. Harvesting operations generally do not require pre and post-treatment point-intercept surveys.

WHOLE-LAKE, POINT-INTERCEPT, AQUATIC PLANT SURVEYS

Whole-lake, PI surveys are intended to track changes to the aquatic plant community over time. Typically in a lake where management of aquatic plants (non-native or native) takes place, whole-lake surveys are recommended at least every five years using the same set of pre-designated points each time. The first time a whole-lake PI survey is completed, the results serve as a baseline for future comparisons. After the first survey, the results from any future surveys can be compared to the first survey for changes. If any changes are identified, it is then possible to analyze what might have caused the changes. While changes naturally occur in most lakes from one year to another, management actions including management of CLP can also be a reason for change.

Whole-lake, PI surveys were completed in Rice Lake in 2008, 2015, and 2018. The 2018 point-intercept survey was completed early due to finding HWM. The next whole-lake PI survey will need to be completed in 2023 or 2024.

COARSE WOODY HABITAT

Coarse woody habitat has never been formally quantified within Rice Lake. One recommendation in this plan is to complete a coarse woody habitat survey to help identify places along the shore where "fishsticks" or fish cribs could be installed to augment the fishery. Once locations have been identified, property owners can be approached to discuss installation. Funding of up to $1,000.00 per fishsticks project is available through the Healthy Lakes and Rivers Initiative, but any grant request would have to be prepared by the Lake District.

Nearly 20 years ago, the Lake District partnered with the WDNR, Rice Lake High School and several local businesses to build and install dozens of 4-ft by 4-ft wooden fish cribs in groups of five throughout the lake. These cribs have deteriorated over time and new one may benefit fishing in the lake. Building and placing fish cribs could be done as part of a larger project that improves both fish and wildlife habitat with fishsticks and improves fishing with cribs.

AIS AWARENESS, EDUCATION, AND PREVENTION

Rice Lake currently has many different AIS including CLP, purple loosestrife, rusty crayfish, Japanese knotweed, yellow flag iris, Chinese mystery snails, and most recently – hybrid watermilfoil, a cross between native northern watermilfoil and non-native Eurasian watermilfoil. Zebra mussels and spiny waterflea have not been discovered in the lake. The presence of AIS impacts the lake, how it is managed, lake use, and habitat. As a Lake District with taxing authority, nearly $100,000.00 annually is collected from upwards of 8,000 property owners with the primary function of managing AIS.

Preventing new AIS from entering the lake, and keeping existing AIS from leaving the lake and expanding its abundance and density is a primary goal of this APM Plan. Rice Lake is one of 300 lakes on a WDNR list of lakes with high potential to be source waters for AIS going to other lakes, simply due to the amount of boating pressure it receives. The Lake District has been sponsoring a watercraft inspection program following Clean Boats, Clean Waters protocol. Each year they apply for $8,000.00 to support 400 or more hours of inspection at the two main boat landings off Stein Street and Orchard Beach Lane. In 2020, Arnolds Landing off Lakeshore Drive and 22-1/4 Ave., was improved with a new blacktop leading to a new ramp in the lake so it is expected that this landing will start seeing more use and will be added to the watercraft inspection list during this plan. Rice Lake has several other walk-in or small craft landings that are not monitored and receive limited use. In addition to watercraft inspection, AIS signage has been installed near these landings. That signage is inventoried nearly every year to determine if changes or improvements are needed.

The Lake District posts information about existing AIS in the lake and potential new invaders on their Facebook and webpage. At least one article is published in the Rice Lake Chronotype, the local newspaper, highlighting AIS. The status of AIS in the lake is one of the agenda items discussed monthly during regular board meetings and the annual constituency meeting each year. A newsletter is sent out with the notice for the annual meeting that includes information about AIS and AIS management in the lake.

In 2021, the Lake District is planning on hiring a "lake educator" or "lake coordinator" to spent more time monitoring for AIS, meeting with property owners and the general public, collecting water quality data, and promoting the action/projects that the Lake District sponsors.

RICE LAKE AQUATIC PLANT MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

When the 2015 APM Plan was written, the CLP population in Rice Lake was, and remains well controlled by a combination of large-scale mechanical harvesting and chemical controls. Maintaining or further reducing the current abundance of CLP is one goal of this plan. Native plant management that maintains lake use and access similar to what was outlined in the 2015 plan and that has been added to since, is also a goal in this plan. Preventing the spread of HWM in the lake is a new goal in this plan. Education, outreach, and AIS prevention are also goals. These five goals will guide aquatic plant management through the 2024 open water season:

- Maintain a level of aquatic plant growth (native and non-native) that supports a healthy lake and multiple lake uses.
- Reduce the threat and impact of AIS to and in Rice Lake.
- Improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Rice lake
- Implement monitoring and evaluation that supports adaptive management of aquatic plants and water quality.
- Assess the progress and results of this project annually and report to and involve other stakeholders in planning efforts.

Specific objectives and actions associated with each goal can be viewed in Appendix A. An Implementation Matrix is provided as Appendix B. An annual timeline for implementation is covered in Appendix C.

IMPLEMENTATION AND EVALUATION

This plan is intended to be a tool for use by the Lake District to move forward with aquatic plant management actions that will maintain the health and diversity of Rice Lake and its aquatic plant community. Management actions will also maintain lake access and aide navigation in areas of dense growth native vegetation. 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 following Integrated Pest Management Strategies that will ensure that the goals of this plan 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 Lake District funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix B. A Calendar of Actions is provided in Appendix C. A harvesting plan for CLP and native aquatic plants for navigational purposes is included in Appendix D.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

In 2020, all WDNR surface water grant programs were combined into one new program. Grant funding is still available under several different categories including surface water education and planning, surface water restoration and management, and AIS prevention and management. These sources of grant funding are explained in more detail in Appendix E. Actions in this APM Plan that are eligible for one or more of these funding sources are identified in the Implementation and Funding Matrix, Appendix B.

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Appendix A

Rice Lake APM Plan Goals, Objectives, and Actions

Appendix B

Rice Lake APM Plan Implementation and Funding Matrix

Appendix C

Rice Lake APM Plan Calendar of Actions

Appendix D

Rice Lake CLP and Navigation Lanes Harvesting Map

Appendix E

2020 WDNR Surface Water Grants Programs