Lake Ripley Management District

Aquatic Plant Management Plan

February 2022

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CHAPTER 1- LAKE AND WATERSHED OVERVIEW

1.1 - Location of Lake Ripley and its Watershed

Lake Ripley is located in Township 6 North, Range 13 East, Sections 7-8, Town of Oakland, in western Jefferson County, Wisconsin. It is situated on the eastern edge of the Village of Cambridge (Dane County), and about 25 miles east of Madison. The Lake Ripley watershed covers just over seven square miles of the surrounding landscape within Sections 3 to 10 and 15 to 18. The mostly rural watershed includes the immediate lake area and extends 2.7 miles east of the lake. At its widest points, the watershed stretches four miles along its east-west axis, and three miles along its north-south axis (Figure 1).

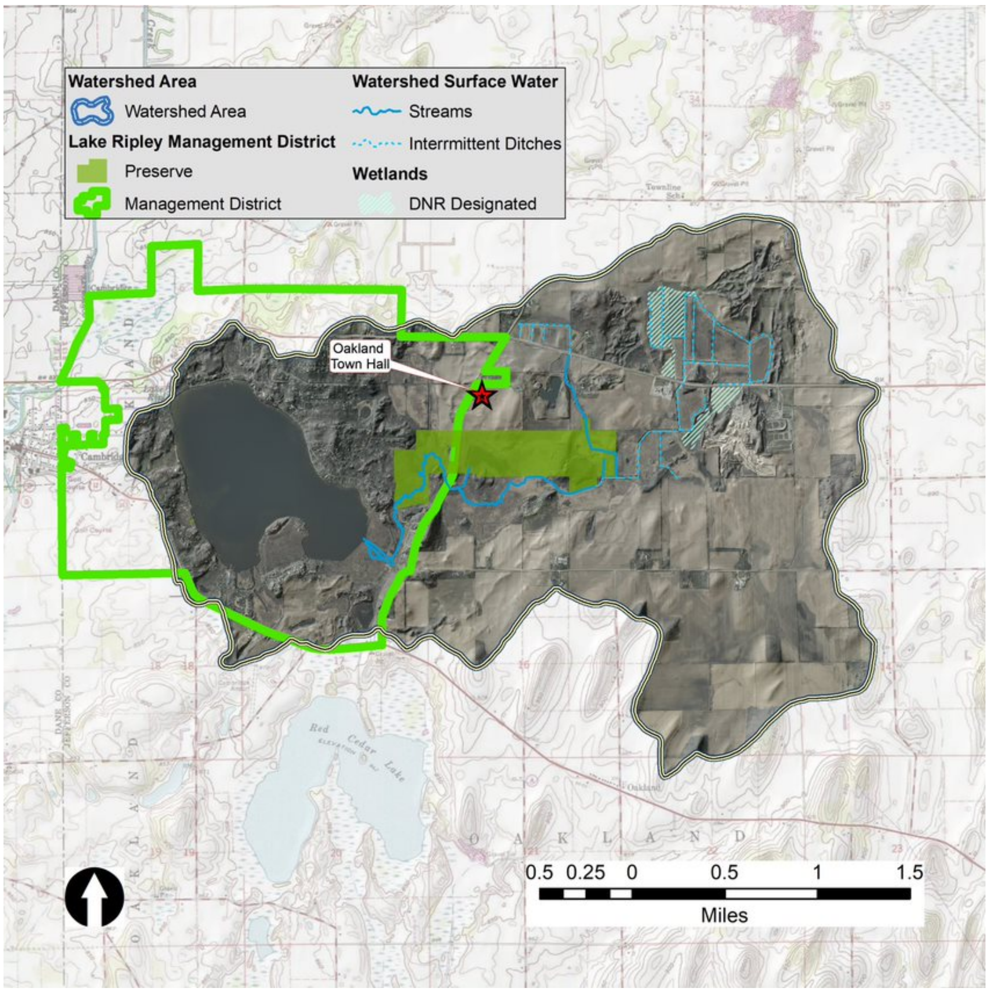


Figure 1: Map of the Lake Ripley Management District, the watershed, and the 207-acre preserve

1.2 - Overview of Lake and Watershed Characteristics

Lake Ripley is a natural, glacial kettle lake that formed approximately 12,000 years ago during the retreat of the last ice age. About a seven-square-mile watershed delivers surface water to the lake, predominantly as stream drainage. The lake, in turn, outflows to Koshkonong Creek and is part of the Lower Rock River and Upper Mississippi River Drainage Basins. Lake Ripley is classified as a drainage lake because it is fed by stream flow, groundwater, precipitation and runoff and is drained by a stream. Drainage lakes tend to be high in nutrients compared to other lake types, and their water quality is largely determined by watershed conditions.

Lake Ripley is a nutrient-rich mesotrophic lake. Its healthy diverse native aquatic plant community supports a diverse community of fish and wildlife. The 11:1 ratio of the watershed size to lake-size makes Lake Ripley particularly vulnerable to excess nutrient and sediment loading from its watershed. Lakes with watershed-to-lake size ratios greater than 10:1 more often experience water quality problems when compared to lakes with smaller ratios.

In pre-settlement time, the watershed landscape consisted of upland woodlands and prairies, which absorbed rainfall, above low-lying wetlands, which protected the lake's only inlet stream.

Groundwater provides about 30% of Lake Ripley's water. Groundwater is recharged by rainfall infiltrating the land. The inlet stream provides about 70% of the lake's water. Groundwater buffers the inlet stream, just as wetlands do, maintaining its baseline flow even in times of drought. Precipitation also contributes some water to the lake.

Development of residences around the lake has created a landscape dominated by impervious surfaces, preventing groundwater recharge and contributing runoff to the lake. Development of agriculture, transforming prairies and wetlands into cropland, with ditches draining into the inlet stream, has increased the nutrient and sediment load the stream carries to the lake.

In summary, in pre-settlement time the entire watershed maintained good water quality in Lake Ripley. Development in the watershed since 1850 has negatively affected the lake's water quality.

PHYSICAL AND HYDROLOGIC DESCRIPTORS	
Lake surface area	423.3 acres (main body); 1.7 acres (Vasby's ditch); 2.5 acres (dredged inlet channel)
Watershed area	4,688 acres (7.3 square miles)
Watershed-to-lake area ratio	11:1
Shoreline length	4.1 miles (main body); 0.57 mile (Vasby's ditch); 0.95 (dredged inlet)
Max. lake depth	44 ft.
Mean (average) depth	18 ft.
Lake volume	7,561 acre-feet **(WDNR, 1970)**
Water residence time	2.85 years (amount of time water resides in the lake before it is flushed out and replaced with new water)
Inlet stream length	4.25 miles (2.5 miles in 1907, prior to drainage ditching)
Ice-cover period	102 days (2014-2019 average)

Table 1: Summary of lake and watershed characteristics

CHAPTER 2 - RECREATIONAL LAKE USE

2.1 - Overview

Lake Ripley is a popular and accessible lake enjoyed by local residents and visitors. This small lake offers many recreational activities, including nature watching, fishing, swimming and boating. However, with just 423 acres of surface area, Lake Ripley faces growing and changing lake-use pressures. These pressures can impair lake health as well as diminish the quality of the experience enjoyed by its users.

According to the 2019 Public Opinion Survey, the six most enjoyed activities on Lake Ripley include (from best to least): 1) enjoying peaceful moments, 2) observing wildlife, 3) slow boat rides tied with hiking and biking around the lake, 4) family gatherings, 5) paddling/canoeing, and 6) fishing from a boat.

It follows that the survey respondents chose these as the top four "factors contributing to quality of life" as "very important" (from most to least): 1) safe water quality, 2) healthy aquatic plant community, 3) slow no wake policy tied with rule enforcement, and 4) presence of safety buoys. These would all support their choices of most enjoyed activities.

2.2 - Enjoying Peaceful Moments, Nature Watching, And Slow Boating

These activities can be enjoyed from one's home, while canoeing, kayaking or paddle boarding, especially during the quieter, slow-no-wake hours of 7 PM through 11 AM. Of particular interest for these activities will be the undeveloped, habitat rich Critical Habitat Areas (Figure 9) where beautiful plants and diverse wildlife can be observed in a slow-no-wake zone.

2.3 - Fishing

Fishing is a slow-boat activity that does not diminish other quiet activities. Good fishing depends on good fish habitat and appropriate spawning areas, which our Critical Habitat Areas currently provide.

Fishing boat access is from residents' piers, or at the Town of Oakland's public boat launch and/or the marina. Boats that enter Lake Ripley from the public launch or the marina increase the chance of invasive species entering the lake. Fishing from shore can be done from private shorelines and piers, or at the Town of Oakland public pier on the north shore of the lake. 70% of the respondents to the 2019 Public Opinion Survey thought that public access to fishing was "about right".

Half of the survey responders fish from a boat, and 45% find the fishing "fair" (21%) or "good" (24.7%), with no response from 41%. Fish species "liked" included (from most to least): 1) bluegills/sunfish, 2) largemouth bass, 3) walleye, and 4) smallmouth bass.

2.4 - Fast Boating and Carrying Capacity Issues

Carrying capacity is the amount of development and activity a body of water can handle before it starts to deteriorate. Lake Ripley is 423 acres, but when the 200-foot slow-no-wake areas and the Critical Habitat Areas are subtracted, only 378 acres are available for fast boating. This has implications for safely maneuvering at high speeds in hours of high fast boat traffic. These implications are called carrying capacity issues. At its most simple, this means that Lake Ripley can safely accommodate more slow boats than fast boats. Fast boats put more pressures on the lake than any other activity.

There appears to be a trend towards more slow boats owned by lake residents from the 2009 to 2019 survey, but the data is not completely comparable. There were more canoes, kayaks, and sailboats in 2019 than in 2009, and significantly fewer pontoon boats in 2019 than in 2009. The 2009 survey did not distinguish between motorboats with horsepower below or above 25 mph, while the 2019 survey did.

The 2019 survey included 182 slow boats (canoes, kayaks, paddleboards, sailboats), 191 medium-speed boats (pontoons and motorboats less than 25 mph), and 129 speed boats (jet skis and motorboats above 25 mph).

The 2019 Public Opinion Survey shows public concern about the number of boats on the lake; 51% thought there were "too many" boats on the lake on summer weekends after 11 AM, while 51% thought there were "just about right" number of boats on the lake on summer weekends before 11 AM. Speed seems to be a factor of their perception of "too many".

Fast boating pressures include:

- Increases in boat numbers, size, and horsepower
- Types of speed craft including jet skis and wake boats
- Too many boats on the lake traveling at fast speeds at one time increases the chance for accidents, and reduces the pleasure of all other users
- Boats failing to observe the 200-foot slow-no-wake ordinance can:
    - Create prop-chop, which is a nuisance to shoreline residents
    - Stir up bottom sediment, which reduces water quality
    - Create excessive waves near shore, causing erosion problems
    - Disturb and uproot aquatic plants

The District has received concerns about the growing number of wake boats that have been observed on Lake Ripley over the last few years. Residents owning lakeshore property and others who engage in recreational activities on Lake Ripley are increasingly concerned that the large wakes produced by "wake boats" impair the health, safety, and welfare of the general public and are calling for appropriate regulation. Their concerns were centered around the dangerousness of the height, speed, and roguery that artificial wakes can create. Safety for their children and family was their top priority, followed closely by the erosion that these wakes can cause after all of the hard work the District has put in to protect the shoreline of Lake Ripley. The District is currently looking into creating an ordinance that can help regulate artificial wake enhancement.

Some rules, ordinances and actions are already in place to help control carrying capacity and related issues. These include:

- The slow-no-wake hours of 7 PM to 11 AM
- The slow-no-wake zones for 200-feet from shoreline and Critical Habitat Areas
- Town ordinance to prohibit additional "key-hole" subdivisions
- Town ordinance prohibiting additional piers in Critical Habitat Areas
- Rules, fees, and parking spaces at the Town's public launch
- Town ordinance prohibiting the use of boats being propelled by motors in the man-made, Vasby's channel

CHAPTER 3- WATER QUALITY

3.1 - Historical Water Quality

How a lake's water quality has changed over time in response to land use changes in the watershed can be determined by examining the lake's sediment. This science is known as paleoecology and is useful because lakes act as partial sediment traps for particles that are created within the lake or delivered from the watershed. The sediments of the lake entomb a selection of fossil remains that are more or less resistant to bacterial decay or chemical dissolution. One of the most useful fossils is the algal group diatoms. The diatoms are especially useful in reconstructing a lake's ecological history because they are highly resistant to degradation and are ecologically diverse. The chemical composition of the sediments may indicate the composition of particles entering the lake as well as the past chemical environment of the lake itself. By collecting an intact sediment core, sectioning it into layers, and utilizing all of the information described above, paleoecologists can reconstruct changes in the lake ecosystem over any period of time since the establishment of the lake.

A sediment core was collected from the deep area in Lake Ripley on August 13, 2007 by Paul Garrison and Gina LaLiberte of the Wisconsin Department of Natural Resources and Paul Dearlove of the Lake Ripley Management District. The complete report can be found in Garrison and Pillsbury (Garrison and Pillsbury, 2009). The length of the core was 72 cm. The core was divided in 1 and 2 cm sections and the diatom community was analyzed to assess changes in nutrient levels and changes in the aquatic plant community. Geochemical elements were examined to determine the causes of changes in the water quality. The timeline of when various sections were deposited was determined using a radioisotope of lead. Changes in the lake's sedimentation rate over time was estimated.

The area around Lake Ripley was surveyed by the General Land Office in 1835. When the township was surveyed in 1835, there were already 15 lots around the lake. The landscape around the lake was diverse prairie, oak savanna and woodlands. Settlement in the area of the lake began in the 1840s as settlers arrived and started farming. One of the earliest settlers was George Dow, an immigrant from Scotland. The lake at that time was known as Lake Dow (Dow and Carpenter 1877). The principal crops at this time were corn, wheat, oats and rye. During the early years, two settlements existed near the lake. One was at the west end near the Village of Cambridge, and the other was south of the lake. During the early part of the twentieth century Lake Ripley became a popular summer resort area. In 1924 there were two large hotels, three smaller ones as well as a number of privately owned cottages (Scott, 1924). Since the 1920s the Lake Ripley area has increased in popularity for summer vacations. The number of resorts has declined, but the number of individual cottages has increased. Nearly all of these early cottages have been replaced by larger homes, and most are now occupied all year. The amount of impervious surface has consequently enlarged and manicured lawns are the norm. Agriculture has also changed in the last century. Following World War II, mechanization greatly increased and the use of synthetic fertilizers became common practice. This has resulted in increased land under cultivation and the application of increased amounts of nutrients onto the landscape. This has resulted in greater soil erosion and increased runoff of nutrients from the land and into the streams and lake.

The sediment core covers the time period of the last 250 years. From the middle of the eighteenth century until the beginning of the twentieth century the sedimentation rate (lake infilling rate) was unchanged and relatively low (Figure 2). With the increased development around the lake and more agriculture in the watershed in the early 1900s, the sedimentation rate began to increase. The highest sedimentation rate occurred around 1940. This likely was the direct result of the channelization of Ripley Creek and the drainage of the wetlands in the watershed, which resulted in a short-term pulse of sediment to the lake. It may have also been linked to conservation practices not yet being widely adopted following the Dust Bowl during the 1930s. For example, during this time a farming technique called moldboard plowing was in high use. The moldboard plowing technique turned the soil over completely, burying all plant material that was left on the ground after harvesting the crop, exposing the valuable topsoil. Leaving the soil surface vulnerable to erosion led to an increased loss of soil and fertilizer resources, subsequently polluting nearby waterbodies. By the late 1950s the sedimentation rate had declined, but remained higher than historical rates. Moldboard plowing was becoming a thing of the past, decreasing from 75-85% use in 1980 to less than 10% use in 1993 (Carter and McKyes 2005). It is likely the higher sedimentation rate was a direct result of increased residential development and agricultural activity in the watershed.

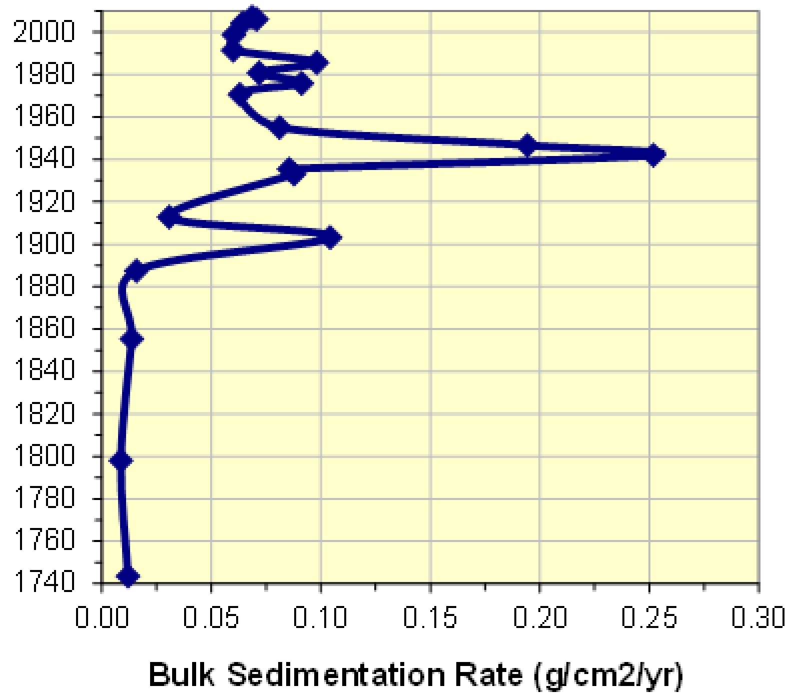


Figure 2 - Sediment accumulation rate in Lake Ripley. The peaks around 1900 and 1940 were largely the result of soil erosion from agricultural activities.

In 1993, Lake Ripley and its watershed became part of the Wisconsin Department of Natural Resource's Priority Watershed Program. This provided expertise and financial incentives to reduce sediment and nutrients entering the lake from shoreland development and agricultural activities in the watershed. Improvements included bioengineering to reduce shoreland erosion and nutrient runoff from homes. Improvements in the watershed also included breaking drainage tiles in previously farmed wetlands essentially reducing the export of nutrients from the wetlands. Conservation farming practices such as reduced tillage and no-till were also encouraged to further reduce runoff of sediment and nutrients. Agricultural practices have improved over the last 50 years to protect the soil and the water.

Part of the purpose of the paleoecological study was to determine if these conservation measures improved the lake's water quality. The various sediment reduction measures were successful in reducing the lake's sedimentation rate in the 1990s and the first part of the 2000s, which was confirmed with the sediment core that was extracted in 2007.

Some geochemical parameters were analyzed in the core to determine changes in soil erosion delivery to the lake, nutrient levels, and the primary productivity of the lake. Titanium is a good surrogate for soil erosion as it is only found in soil clay particles. The titanium accumulation rate was very low until the early twentieth century. As with the sedimentation rate, it peaked in the early 1940s (Figure 3) as a result of the channelization of the creek and drainage of the wetlands. Soil erosion declined throughout the 1960s, likely as a result of general conservation practices encouraged by state and federal soil conservation agencies. The reduction in the sedimentation rate beginning in the 1990s was the result of reduced soil erosion.

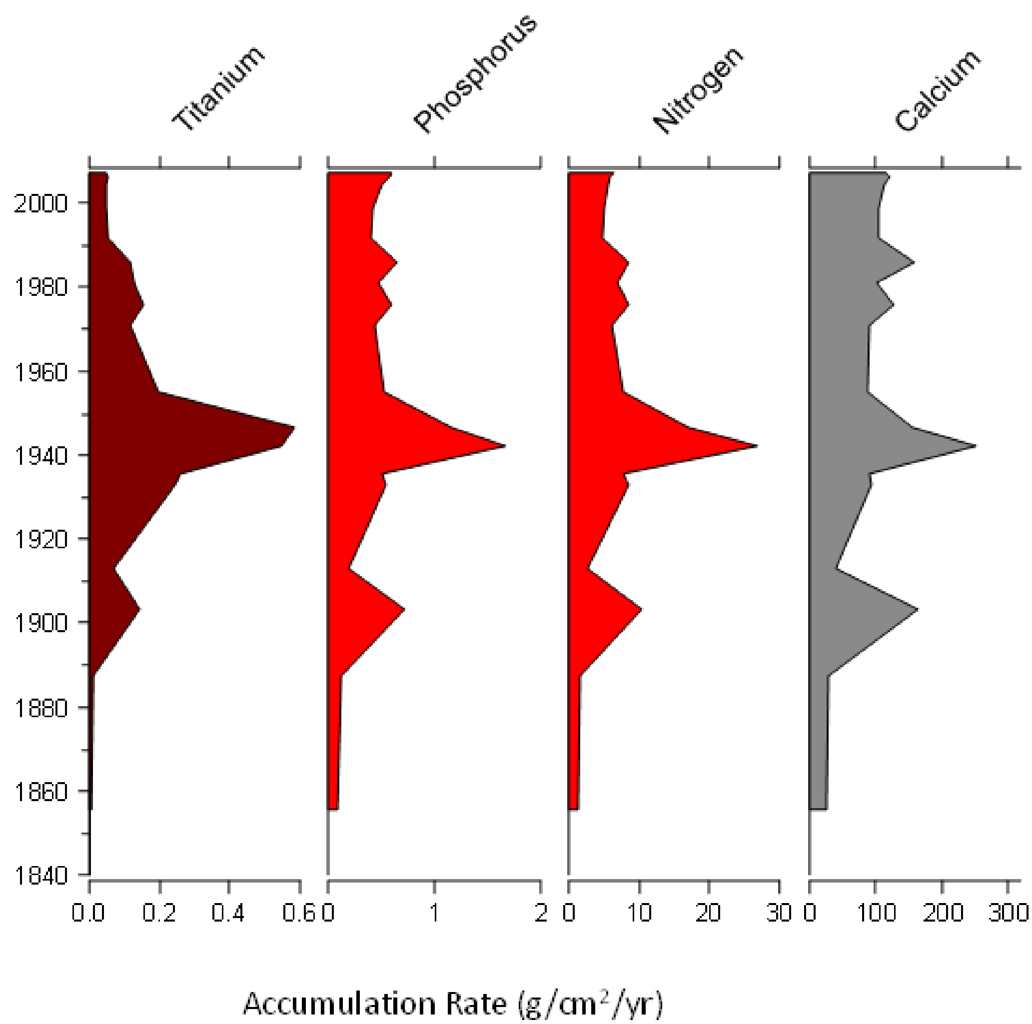


Figure 3 - Profiles of the accumulation rate of selected geochemical elements. Titanium is indicative of soil erosion. Phosphorus and nitrogen are essential nutrients for plant growth. Calcium is largely the result of marl formation and is an indication of the lake's productivity.

Although phosphorus and nitrogen accumulation rates during the last 250 years were similar to that of titanium through the first half of the twentieth century, the accumulation rates remained largely unchanged in the second half of the twentieth century. There was a small decrease after the lake became a participant in the priority lake program. The lack of reduction of nutrients since the 1950s is largely the result of increased usage of synthetic fertilizers following the end of World War II. This trend has been documented in a number of other Wisconsin lakes which have significant agriculture in their watersheds.

The calcium profile is mostly the result of calcium carbonate deposition or marl formation. This is very common in a hardwater lake like Lake Ripley. Marl formation increases with increased photosynthetic productivity of the lake. This can be from algae or aquatic plants. The peak calcium deposition in the early 1940s was likely the result of input of marl from the watershed and not in-lake formation of marl. Since 1950, calcium deposition has generally increased even after 1990. This indicates that the lake's productivity has increased. This may be from algal production or from aquatic plants.

The diatom community reflected many of the changes suggested by the sedimentation rate and geochemical profiles. The diatom community was unchanged from the middle of the eighteenth century through the middle of the nineteenth century. The diatom community indicates that the earliest settlers were already impacting the lake in the latter part of the eighteenth century, with changes in the composition of the diatoms even though this was not reflected in geochemistry. The greatest change in the diatom community occurred beginning about 1940 with an increase in diatoms that prefer higher phosphorus concentrations. The diatom community indicates that the highest phosphorus levels occurred during the 1970s.

In recent years, ecologically relevant statistical methods have been developed to infer environmental conditions from diatom assemblages. These methods are based on multivariate ordination and weighted averaging regression and calibration (Birks et al. 1990). Ecological preferences of diatom species are determined by relating modern limnological variables to surface sediment diatom assemblages. The species-environment relationships are then used to infer environmental conditions from fossil diatom assemblages found in the sediment core. The diatom community was used to estimate changes in the summer phosphorus levels throughout the core. Historical phosphorus levels were low, being about 12-13 µg/L (Figure 4). Phosphorus concentrations began increasing after the early episodic sedimentation event around 1900. Phosphorus levels continued to increase and reached their highest levels during 1940-1990. Since the priority watershed project in the 1990s, phosphorus levels have declined, although they are not as low as pre-settlement levels.

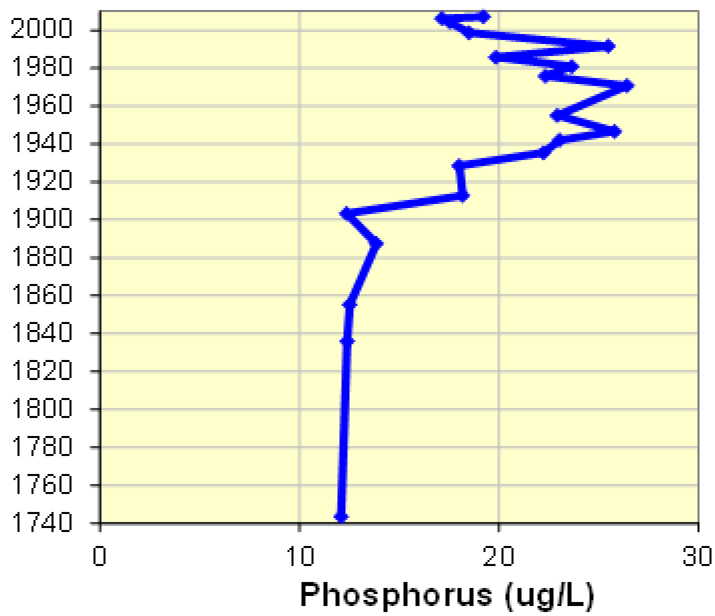


Figure 4- Diatom inferred summer phosphorus concentrations.

3.2 - Phosphorus

Plants need nutrients to grow and the most important nutrients are phosphorus and nitrogen. The nutrient that is in shortest supply is the one that controls plant growth. Usually this is phosphorus. Phosphorus is also easier to control than nitrogen as the latter has a gaseous component in the biogeochemical cycle. The ratio of nitrogen to phosphorus (N:P) is used to determine which element is limiting. A N:P ratio greater than 15:1 is indicative of phosphorus limitation while a ratio of 10:1 to 15:1 is considered a transition situation. The N:P ratio in Lake Ripley in July 2019 was 25:1 indicating that the lake is phosphorus limited. This is not surprising as in nearly all Wisconsin lakes, phosphorus is the limiting nutrient.

In order to compare the trophic parameters in Lake Ripley to other similar lakes, information in the Wisconsin 2018 Consolidated Assessment and Listing Methodology was used (Wisconsin Department of Natural Resources, 2017). The Wisconsin Department of Natural Resources classifies lakes into 10 natural communities based upon watershed size, hydrology, and lake depth. For most lakes, there are 6 classifications depending if the lake is a drainage or seepage lake, shallow or deep, and if the watershed is less than or greater than 4 square miles. Lake Ripley is classified as a deep lowland drainage lake because its watershed is greater than 4 square miles, it has an inflowing stream, and its maximum depth is greater than 20 feet. The Wisconsin Consolidated Assessment and Listing Methodology ranks each lake class into categories ranging from excellent to poor. Also, ecoregions have been delineated throughout the United States by the U.S. EPA based upon similar climate, physiography, hydrology, vegetation and wildlife potential. Wisconsin contains four main ecoregions and Lake Ripley is located within the Southeastern Wisconsin Till Plains (SWTP) ecoregion. State-wide median values for total phosphorus, chlorophyll-a, and Secchi disk transparency have been developed for six of the lake classifications (Garrison et al., 2008). They did not sample sufficient lakes to create median values for each classification within each of the state's ecoregions.

Summer mean phosphorus concentrations for the period 1986-2020 are shown in Figure 5. For the period 1986 through 2005, phosphorus concentrations were generally in the excellent range. The unusually high concentration in 1993 reflects the higher than normal rainfall that occurred that year. This resulted in larger than normal streamflow and phosphorus input from the watershed. This elevated value was noted in many other Wisconsin lakes that year. Since 2006 phosphorus concentrations have been higher, placing the lake in the good category. The average summer phosphorus concentration for the period 1986-2005 was 19 µg/L and for the period 2006-2020 the average summer concentration was higher at 25 µg/L. This increased phosphorus concentration was not noted in the 2010 management plan as it is difficult to detect trends for only a couple of years. The average summer phosphorus concentration for the period of record is nearly 22 µg/L, which places the lake in the "good" category. The average phosphorus concentration in Lake Ripley is very similar to the median value for other deep lowland drainage lakes, as well as all lake types in the SWTP ecoregion. The Wisconsin Department of Natural Resources has established phosphorus criteria for impairment for lakes, streams, and rivers. The impairment limit for lakes similar to Lake Ripley is 30 µg/L.

The 5-year summer total phosphorus average from 2016-2020 is 24.8 µg/L. The increasing trend in phosphorus over time is concerning. The District is constantly working towards better water quality for Lake Ripley by continuously testing water quality of the inlet stream and lake, encouraging landowners to use BMPs, and installing conservation practices wherever possible. During the summer of 2020, the summer total phosphorus was higher than the impairment threshold, averaging 31.9 µg/L. During the summer of 2021, the District is installing three gaging systems at the inlet, outlet, and in the lake to help us create a water budget. Creating a water budget will help us assess the effects of climate variability and human activities within our watershed.

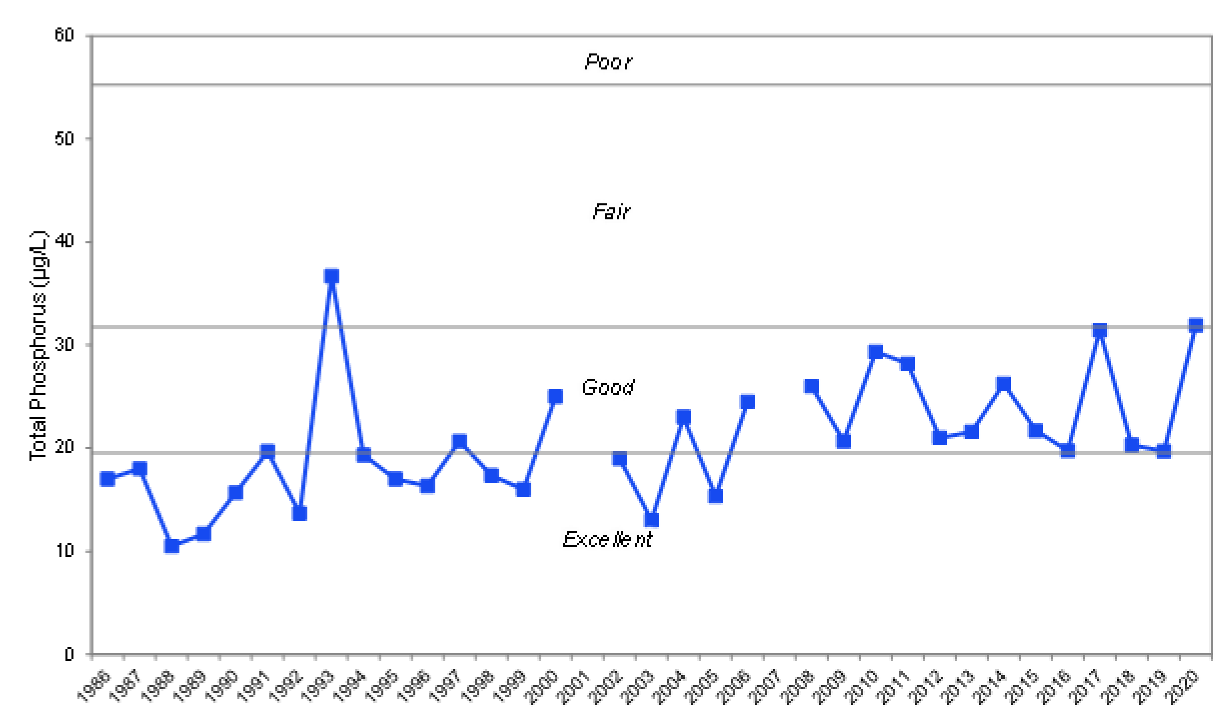


Figure 5 - Summer mean phosphorus concentrations for Lake Ripley for 1986-2020.

3.3 - Algae

Chlorophyll-a is the green pigment in plants used during photosynthesis. Chlorophyll-a concentrations are directly related to the abundance of free-floating algae in the lake. Chlorophyll-a values increase during algal blooms.

The chlorophyll-a concentrations in Lake Ripley for the period of record (1986-2020) place the lake in the good category. The highest value occurred in 1993 and was the result of higher than normal rainfall which caused high phosphorus runoff from the watershed. The average summer chlorophyll-a concentrations for the periods 1986-2005 and 2006-2020 were nearly the same at 8.6 and 8.3 µg/L, respectively. The average summer concentration for the period of record is 8.5 µg/L, which is well below the impairment threshold of 27 µg/L. The average chlorophyll-a concentration in Lake Ripley is slightly higher than the 7.0 µg/L median value for other lowland drainage lakes and the 5.3 µg/L median value for all lake types in the SWTP ecoregion.

Unlike phosphorus, chlorophyll-a concentrations during the last decade are not higher than the earlier two decades. This may be the result of the arrival of zebra mussels in Lake Ripley around 2005-2007. Zebra mussels (*Dreissena polymorpha*) are small bottom dwelling mussels, native to Europe and Asia, that found their way to the Great Lakes region in the mid-1980s. They are thought to have come into the region through ballast water of ocean-going ships entering the Great Lakes, and they have the capacity to spread rapidly. Zebra mussels are filter feeders; they pass water through their gills and extract particles, especially algae. It has been noted in other lakes that when a lake becomes infested with zebra mussels, phosphorus concentrations increase but algal levels may decline. This is because the mussels remove algae from the lake but when they defecate they release phosphorus into the water. Green, planktonic algae often declines in the open water areas, but non-palatable cyanobacteria and cladophora can increase, especially as they get blown into shore.

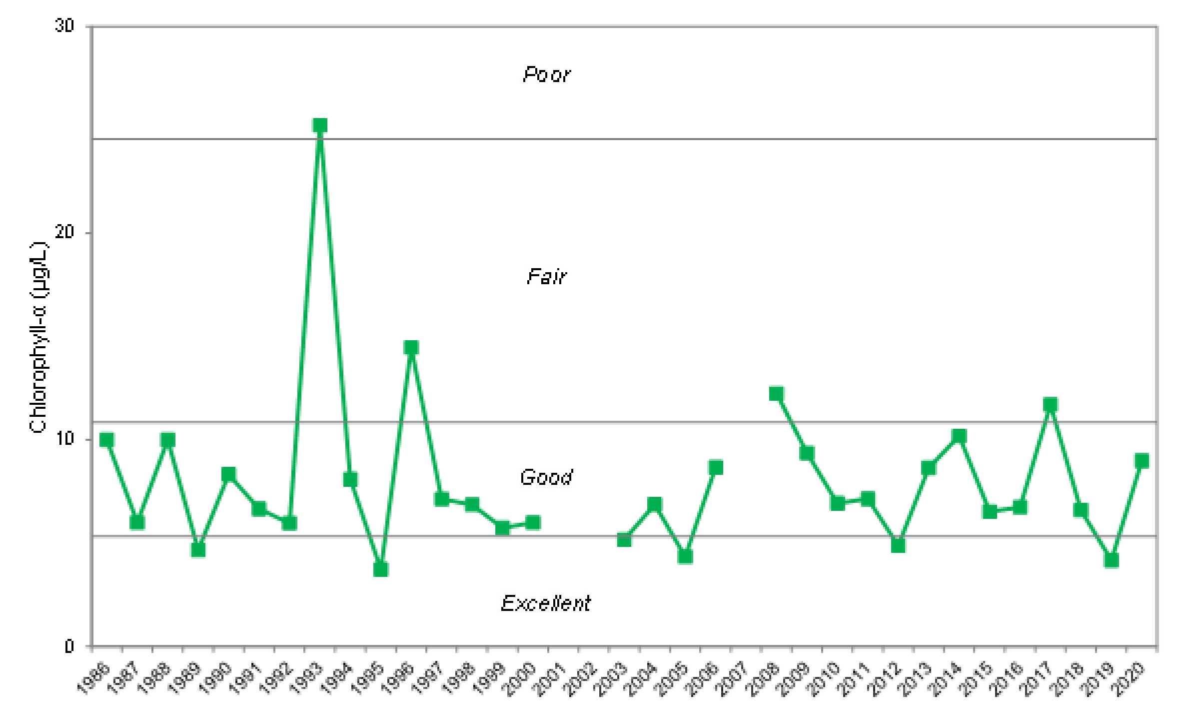


Figure 6 - Summer mean chlorophyll-a concentrations for Lake Ripley for 1986-2020.

3.4 - Water Clarity

Secchi disk transparency is a measurement of water clarity. The measurement is made by lowering a weighted, 20 cm diameter disk with alternating black and white quadrants into the water and recording the depth just before it disappears from sight.

The Secchi disk transparency for Lake Ripley has been generally in the excellent range since 1986 (Figure 7). In most lakes including Lake Ripley, the main determinant of the water clarity is the amount of algae that is present in the water column. For the period of 1987-2004 the average summer Secchi disk depth was 6.1 feet. For the period 2006-2020 water clarity was better with the average being 7.8 feet. It is likely this improvement is the result of the arrival of zebra mussels. They are very efficient at removing particles from the lake thus improving water clarity. The exceptional water clarity in 2005 may have been the result of an unusual appearance of the large zooplankton, *Daphnia*. *Daphnia* eat large amounts of algae, contributing to clear water. This was observed in many lakes throughout the Upper Midwest and may have been the result of an unusual occurrence of climate and low juvenile fish populations which feed on these zooplankters. The average summer Secchi disk transparency for the period of record was 7.2 feet, which is not as good as the median value for other deep lowland drainage lakes (8.5 feet) but is better than the median value for all lake types in the SWTP ecoregion (6.6 feet).

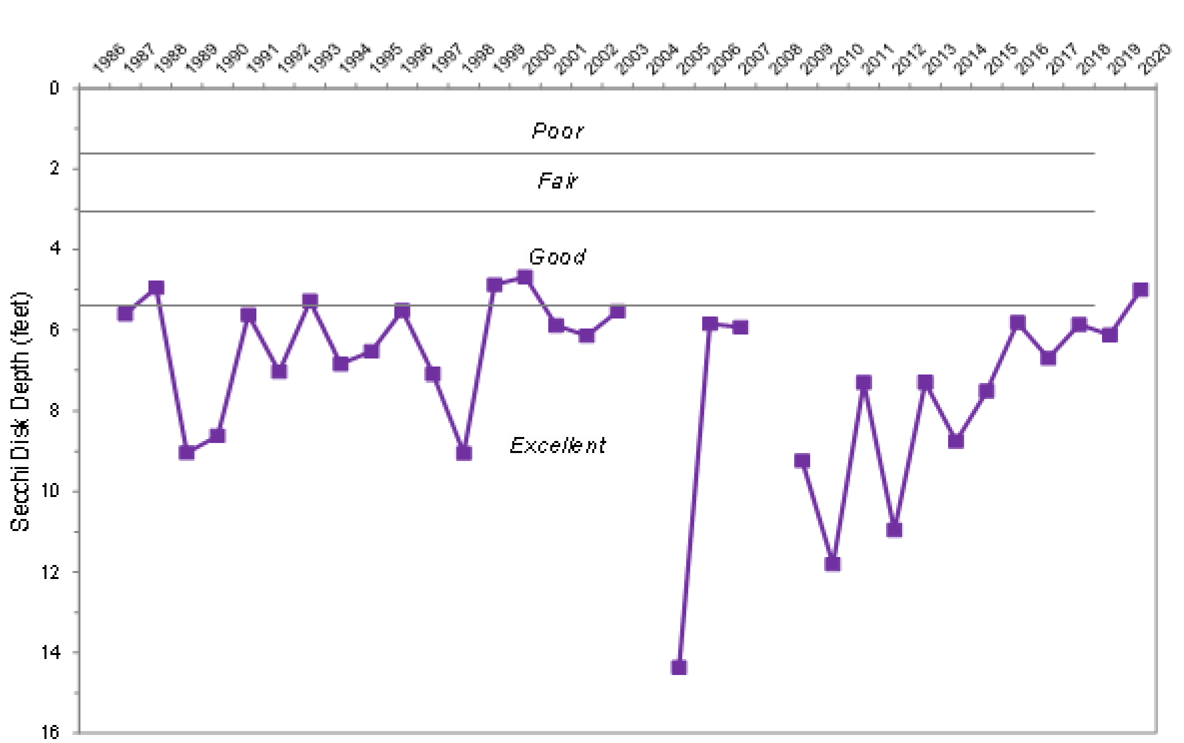


Figure 7- Summer Secchi disk transparency for Lake Ripley for 1986-2020.

3.5 - Trophic State

Trophic state describes the lake's ability to produce plant matter (production) and includes three continuous classifications: 1) oligotrophic lakes are the least productive lakes, 2) eutrophic lakes are the most productive, and 3) mesotrophic lakes fall between these two categories. Through the use of a trophic state index (TSI), an index number can be calculated using phosphorus, chlorophyll-a, and water clarity values that represent the lake's position within the eutrophication process. The TSI was developed by Carlson (Carlson, 1997).

Throughout the period of record, Lake Ripley's trophic state has generally stayed in the mesotrophic-eutrophic range (Figure 8). The only time it was clearly in the eutrophic range was in 1993, when there was much higher rainfall than normal. The degradation of the trophic state at this time emphasizes the importance of agricultural activity in the watershed as an important source of nutrients. The trophic state of the lake does not appear to have been altered with the invasion of zebra mussels in the mid-2000s. The average trophic state in both periods is on the border between mesotrophic and eutrophic. The District's goal is to maintain the status of a mesotrophic lake, by maintaining a TSI between 40-50. This will keep us within the mesotrophic state, with the hope of preventing the lake from reaching a eutrophic state.

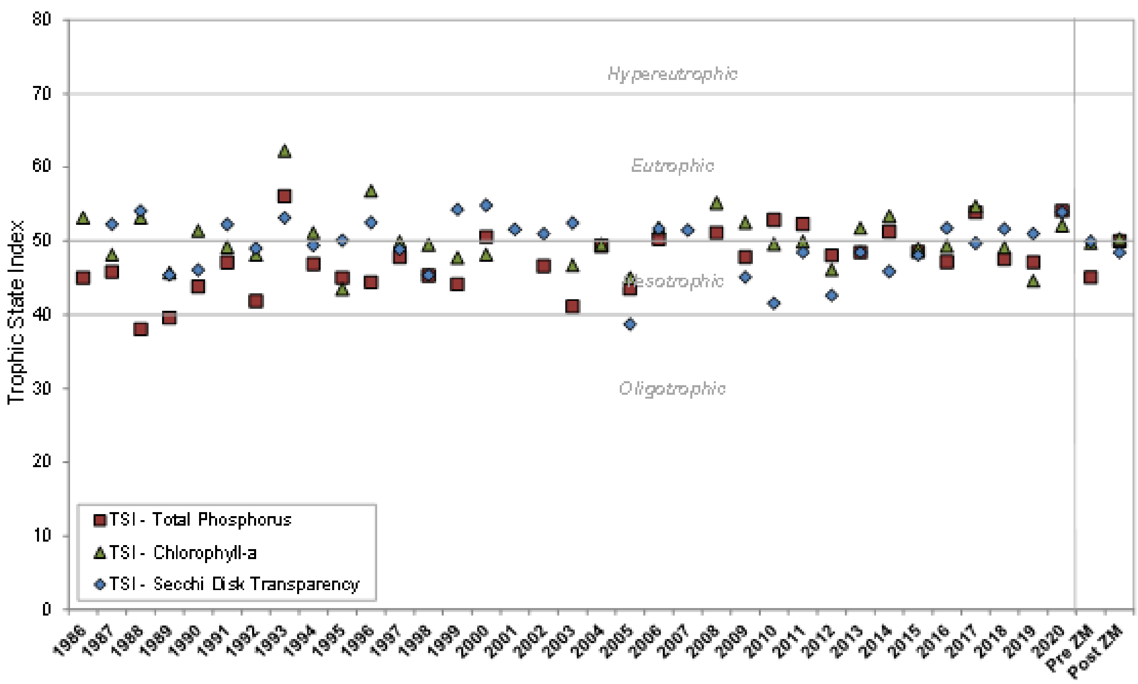


Figure 8- Trophic State Index (TSI) for Lake Ripley for 1986-2020.

3.6 - Water Quality Monitoring Efforts

The inlet stream has been monitored dating as far back as 1993. Temperature, dissolved oxygen, nitrogen, phosphorus, total suspended solids, conductivity and pH were the main parameters that were monitored. Over time, the parameters being measured changed as the data was analyzed and provided us with important information.

Starting in 2018, monitoring efforts at four specific sites along the inlet stream became a priority for the District. Concerned about the influx of phosphorus within the stream, the four sites were chosen to provide insight into what was happening within the stream. The four locations are as follows: 1) site one is located at the beginning of the inlet stream off of Highway 18, 2) the second site is nestled within the District's wetlands, 3) the third site is located off of County Road A, where the inlet stream runs underneath the road, 4) and the fourth location is located off of Ripley Road, in the wetlands next to the road. At these four sites, we monitor dissolved oxygen, turbidity, temperature, pH, conductivity, total suspended solids, and total phosphorus. The data from the last few years has shown that occasionally, the phosphorus levels are decreasing as the inlet stream travels through the surrounding lands, including the District's 207 acre Preserve.

However, there were a few exceptions. During a few of the summer sampling efforts, we observed phosphorus levels increasing after leaving our Preserve and traveling through an extensive wetland system. Testing at the deep hole showed that the phosphorus levels usually decreased once reaching that part of the lake. However, it is unusual to see higher phosphorus levels after moving through relatively undisturbed wetlands. We are currently conducting more research and monitoring within the stream and the lake to better understand the nutrient dynamics.

CHAPTER 4 - AQUATIC PLANTS

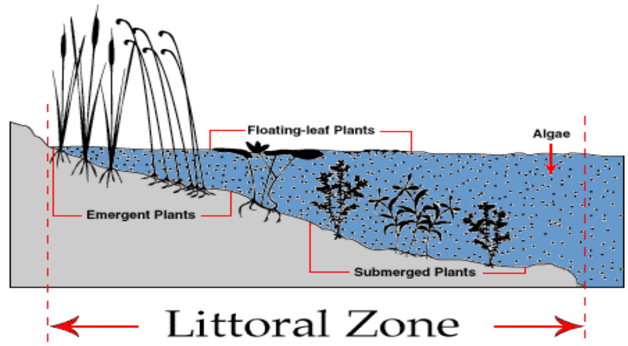
4.1 - The Value and Role of Aquatic Plants

A healthy and diverse native plant community is the foundation of a healthy lake ecosystem. Aquatic plants are essential for maintaining water quality and good habitat for wildlife.

All aquatic plants, and especially native aquatic plants:

- Filter runoff from uplands to protect lake water quality
- Keep algae in check by influencing nutrient dynamics
- Stabilize lake-bottom sediments
- Protect against shoreline erosion
- Oxygenate the water during photosynthesis, providing oxygen for fish and other animals
- Provide cover and spawning sites for fish
- Create shelter for zooplankton (algae grazers)
- Constitute an important part of the lake's food web
- Limit growth of invasive plants
- Build the lake's resiliency to the impacts of nutrient input and climate change

Lake residents do seem to understand the benefits of a healthy plant community. 66.9% of the respondents to our 2019 Public Opinion Survey chose a “healthy aquatic plant community” as “very important” to their quality of life. This was second only to “safe water quality”, which was the top pick, at 84.6%.



Aquatic plants can grow only in the littoral zone of a lake, where sunlight penetrates deeply enough for photosynthesis to occur.

Not all aquatic plants are as beneficial as native plants. The arrival and spread of the aquatic invasive species, Eurasian watermilfoil and curly-leaf pondweed, triggered the creation of the Lake Ripley Management District in 1991. In 1989, 40% of the lake’s surface was covered with Eurasian watermilfoil. Our mechanical harvesting program has been successful in reducing this aggressively problematic plant. The weed harvester aids in opening the canopies of Eurasian watermilfoil, allowing for the slower-growing natives to compete for sunlight and have a better chance to establish dominance.

4.2 - The Aquatic Plants of Lake Ripley

Aquatic plants, also called macrophytes, include all macroscopic plants (observable with the naked eye) found in aquatic environments. They are represented by a diverse group of aquatic and wetland plants, including flowering vascular plants, mosses, ferns and macroalgae. Aquatic vegetation is naturally present to some extent in all lakes, and represents an important component of a healthy ecosystem. There are four basic plant types: emergent, free-floating, floating-leaf and submersed.

Emergents (e.g. cattail and bulrush) are rooted in water-saturated or submerged soils, but have stems that grow above the water surface. These plants most often grow in shallow water along the lakeshore. Free-floating plants (e.g. duckweed) are not rooted in the lake bottom, but have extensive root systems that hang beneath floating leaves. Floating-leaf plants (e.g. water lilies) have leaves that float on the lake surface with a long rooted stem anchored to the lake bottom. Submersed plants (e.g. water celery and Illinois pondweed) grow primarily under the water surface in areas where there is sufficient sunlight penetration. They may or may not be rooted to the lake bottom.

Native species are those that were historically found in the surrounding, local area. An invasive species is a species that is often nonnative and was introduced by humans. Some native plants can exhibit aggressive, invasive behavior under certain conditions. The following aquatic plants have been identified in Lake Ripley. Descriptions of each species and their beneficial significance are presented here:

Aquatic Plant	**Ecological Significance**
Carex aquatilis, water sedge	Excellent source of cover in riparian and wetland communities for birds and small mammals; creates dense sod patches that can hang over streambanks, creating valuable cover and shade for many fish species
Ceratophyllum demersum, coontail	Good habitat for young fish and invertebrates; supports insects and invertebrates that are valuable as food for fish and ducklings; foliage and fruit are eaten by waterfowl; effective at removing phosphorus from the water column
Chara sp., muskgrass	A main source of food for fish, especially bluegill, smallmouth, and largemouth bass; valuable fish habitat; a favorite food for waterfowl; stabilizes bottom sediments; has softening effect on water by removing lime and carbon dioxide
Cicuta maculata, spotted water hemlock	The exposed nectar of the flowers attract primarily insects with short mouthparts, primarily bees, wasps and flies; exceptionally poisonous to most animals
Decodon verticillatus, swamp loosestrife	Seeds are grazed by waterfowl including mallards and wood ducks; a locally important source of food and cover for muskrats
Eleocharis acicularis, needle spikerush	Food for a wide variety of waterfowl as well as muskrats; spawning habitat and shelter for invertebrates
Elodea canadensis, common waterweed	Excellent habitat for fish and invertebrates; valuable food for muskrats and waterfowl
Equisetum laevigatum, smooth horsetail	Provides food for waterfowl, primarily geese
Heteranthera dubia, water star grass	Locally important source of food for geese and ducks; good cover and foraging opportunities for fish
Iris virginica, southern blue flag	Grazed by muskrats; provides food for a variety of waterfowl; provides good cover for wildlife and waterfowl; flower helps ensure cross-pollination by bees
Lemna minor, small duckweed	Rafts of small duckweed provide shade and cover for fish and invertebrates; food source for waterfowl and marsh birds (providing up to 90% of the dietary needs for a variety of ducks and geese); supports insects that are valuable as food for fish; consumed by muskrats, beaver and fish
Lemna trisulca, forked duckweed	Food source for waterfowl, and provides cover for fish and invertebrates
Myriophyllum sibiricum, northern watermilfoil	Provides shelter for fish, roots provide nesting habitat for fish; valuable food producer for fish supporting many insects; leaves and fruit eaten by waterfowl
Myriophyllum spicatum,	Invasive; waterfowl eat fruits and leaves to a limited extent; habitat for insects

Eurasian watermilfoil	
Najas flexilis, slender naiad	Food for waterfowl, marsh birds, and muskrats; cover for young largemouth bass, northern pike, small bluegills and perch; food for fish
Najas marina, spiny naiad	Provides food and shelter for fish, and is a food source for waterfowl; leaves and seeds are consumed by a wide variety of ducks
Nuphar variegata, spatterdock	Leaves, stems and flowers are eaten by deer; roots eaten by beaver and porcupine; seeds eaten by waterfowl; supports insects that are valuable as food for fish and ducklings; shade and shelter for fish
Nymphaea odorata, white water lily	Shade and shelter for fish; seeds eaten by marsh birds and waterfowl, rootstocks and stalks eaten by muskrat; roots eaten by deer, beaver, moose, and porcupine
Potamogeton crispus, curly-leaf pondweed,	Invasive; food, shelter and shade for some fish; food for waterfowl; habitat for invertebrates
Potamogeton foliosus, leafy pondweed	Fruit can be a locally important food source for geese and a variety of ducks; food for muskrats, deer and beaver; habitat for invertebrates; cover for fish
Potamogeton friesii, Fries' pondweed	Food for ducks and geese; provides fish habitat
Potamogeton gramineus, variable pondweed	Cover for panfish, largemouth bass, and northern pike; bluegills nest near this plant and eat insects on the leaves; supports insects that are valuable as food for fish and ducklings; fruit and tubers eaten by waterfowl
Potamogeton illinoensis, Illinois pondweed	Cover for panfish, largemouth bass, and northern pike; nesting grounds for bluegill; excellent source of shade for fish; large leaves offer good surface area for invertebrates; supports insects that are valuable as food for fish and ducklings; fruit eaten by ducks and geese; source of food for muskrat, deer, beaver and moose
Potamogeton natans, floating-leaf pondweed	Food for waterfowl; fruit eaten by ducks and geese; shade and foraging opportunities for fish
Potamogeton pusillus, small pondweed	Locally important food source for a variety of waterfowl; provides cover for bluegills, perch, northern pike and muskellunge, and good cover for walleyes; supports insects valuable as food for fish and ducklings
Potamogeton strictifolius*, stiff pondweed*	Eaten by ducks and geese; provides fish habitat
Potamogeton zosteriformis, flat-stem pondweed	Some cover for bluegills, perch, muskellunge and northern pike; food for waterfowl, muskrat, deer and beaver; supports insects that are valuable food for

	fish and ducklings
Ranunculus aquatilis White water crowfoot	When fruiting, beds of whitewater crowfoot become choice spots for dabbling ducks; both fruit and foliage are consumed by a variety of waterfowl and upland game birds including ruffed grouse; stems and leaves provide valuable invertebrate habitat; fair producer of food for trout
Sagittaria cuneata, arum-leaved arrowhead	Protects shorelines from wave erosion; provides cover for waterfowl and young fish; spawning areas for northern pike; produces flowers which attracts a variety of insects including honeybees and bumblebees; waterfowl eat their seeds and tubers; muskrats, beaver, turtles and other wildlife feed on the stalk bases, crowns, and tubers
Schoenoplectus acutus, hardstem bulrush	Provides habitat for invertebrates; shelter for young fish, especially northern pike; nutlets consumed by waterfowl, marsh birds and upland birds; stems and rhizomes eaten by waterfowl and muskrats; staple food for muskrats and other small mammals; valuable nesting material and cover for waterfowl, marsh birds, and other shallow marsh wildlife
Schoenoplectus tabernaemontani, softstem bulrush	Habitat for invertebrates and shelter for young fish; nutlets consumed by waterfowl, marsh birds and upland birds; nesting material and cover for waterfowl and muskrats
Schoenoplectus subterminalis, water bulrush	Provides invertebrate habitat and shelter for fish
Solanum dulcamara, climbing/bittersweet nightshade	Songbirds and crows eat fleshy portion; muskrats graze on stems
Spirodela polyrhiza Large duckweed	Good waterfowl food that is consumed by many ducks and geese. Also eaten by muskrat and some fish. Rafts of duckweed offer shade and cover for fish and invertebrates.
Stuckenia pectinata, sago pondweed	Provides limited cover for bluegills, perch, northern pike and muskellunge, and good cover for walleye; supports insects valuable as food for fish and ducklings; a top food producer for waterfowl; fruit and tubers are heavily grazed and considered critical for a variety of migratory waterfowl; provide escape cover for invertebrates
Typha angustifolia/latifolia, narrow-leaf & broad-leaf cattail	Stabilize marshy borders of lakes, protect shorelines from wave erosion; provide spawning sites for northern pike; provide cover and nesting sites for marsh birds and waterfowl; muskrat and beaver eat stalks and roots
Utricularia vulgaris, common bladderwort	Good food and cover for fish; provides needed fish habitat in areas that are not readily colonized by rooted plants; carnivorous plant, utilizes its touch-sensitive bladders to capture macroinvertebrates
Vallisneria americana, water celery	Premier source of food for waterfowl, especially canvasback ducks; all portions of the plant are consumed, including foliage, rhizomes, tubers and fruit;

	important food source for marsh birds, shore birds and muskrat; good fish habitat providing shade, shelter and feeding opportunities
Wolffia columbiana, watermeal	Good waterfowl food; food for muskrats and some fish; large floating rafts can prevent mosquito larvae from reaching the surface for oxygen
Zannichellia palustris, horned pondweed	Fruit and foliage are grazed by waterfowl; provides food for fish

Information obtained from: (Borman, Korth, and Temte, 2014) and (Skawinski, 2018)

Table 2: Ecological significance of aquatic plant species present in Lake Ripley

Filamentous algae *(Cladophora, Spirogyra)*: This type of macroalgae consists of single cells that are connected end-to-end. It appears as green-colored thin threads, branched filaments or an interwoven net. Filamentous algae do not have roots, stems or leaves. It begins growing along the shoreline or on the lake bottom, and later buoys to the surface forming green mats that frequently attach to rocks or other plants. Abundant growth identifies lakes polluted with excessive nutrients. Although filamentous algae provide cover for insects valuable as fish food, it is often viewed as an unsightly nuisance. Preventative actions that reduce the flow of nutrients into the lake are the best means of control.

Planktonic algae: These are microscopic, single-celled organisms that may form multicellular colonies or filaments. Common varieties include green algae, blue-green algae and diatoms. Abundant growth results in “blooms" that color the water green or brown. Surface scums of blue-green algae may form on the water surface during the summer. Abundant growth identifies lakes polluted with excessive nutrients such as nitrogen and phosphorus. Planktonic algae provide food for zooplankton and some food for fish fry. Preventative actions to reduce the flow of nutrients into the lake are the best means of control.

4.3 - Results of Past Inventories

Comprehensive inventories of Lake Ripley’s aquatic plant community were conducted in 1976, 1989, 1991, 1996, 2001, 2006, 2011, 2015 and 2020.

Only recent, comparable inventories are presented in this chapter; the 2011 and 2015 surveys are presented as summaries only and the 2020 survey is presented in its full report. The 1976-2015 surveys are available in full on our website (www.lakeripley.org). Please note that the surveys prior to 2006 employed a different methodology and comparisons of results from surveys using different methodologies are not statistically accurate.

The following is an abbreviated summary of inventory findings from recent years. The statistical summary from the 2020 inventory is presented for 23 aquatic plant species. Statistical measures for each species consist of frequency of occurrence, average density, relative frequency of occurrence, and importance value. Each of these measures is defined below:

Frequency of occurrence: the number of occurrences of a species divided by the number of sampling points within the defined littoral zone. It is the percentage of times a particular species occurred within areas capable of supporting plant growth. This measure is used to describe how widely distributed a particular species is found throughout the lake's littoral zone.

Relative frequency of occurrence: derived by dividing a particular species' frequency of occurrence by the sum total frequency of all species inventoried. The sum of the relative frequencies is equal to 100% when all documented species are included. This measure provides an indication of how the plants occur throughout the lake in relation to each other.

Average density: the sum of the density ratings for a species divided by the number of sampling points where vegetation was found. Density ratings are based on 1-3 rake-fullness scale for the point-intercept surveys. This measure provides an indication of how abundant the growth of a particular plant is throughout the lake.

Importance value: the product of the relative frequency and the average density, and is expressed as a percentage. This measure provides an indication of the dominance of a species within a community, and is based on both frequency and density values. It also somewhat addresses the challenge of comparing plants that have different physical statures.

2011 Plant Inventory Survey

This survey, and each thereafter, employed the point-intercept method in accordance with Wisconsin DNR's standard baseline protocols (Hauxwell et al. 2010). The point-intercept method results in an accurate assessment of species present and their abundance. Based on parameters specific to Lake Ripley, the DNR mapped a 725-point sampling grid over the entire lake. Using GPS, the field crew navigated to each of the predetermined grid points. Of the total 725 points, they sampled the 369 navigable points within the depth range of plant growth. At each of these points a two-sided rake was used to sample approximately 2.5 feet along the bottom to collect a sample. After pulling the plants to the surface, all plant species on the rake as well as any dislodged by the rake and floating were given rake fullness ratings of 1-3 to estimate abundance.

The field crew also recorded visual sightings of species within six feet of the sample point, water depth and sediment type at each point. Any additional species seen at the lake's edge during a general boat survey (noted as GS in the tables below) were recorded separately from the point-intercept data. The collected data are used for statistical analysis. Visuals and boat survey results are provided where applicable.

The inventory was conducted between June 7 and June 28, 2011, with actual sampling dates determined by weather conditions and field crew scheduling. A total of 21 aquatic plant species were found through point-intercept sampling, jumping to 23 when including visuals (common watermeal and floating-leaf pondweed). Plants were found at water depths extending to 21 feet.

The six dominant species in order of highest frequency of occurrence: muskgrass (*Chara sp.*), sago pondweed *(Stuckenia pectinata*), coontail *(Ceratophyllum demersum*), northern watermilfoil *(Myriophyllum sibiricum*), Fries' pondweed (*Potamogeton friesii*), and spiny naiad (*Najas marina*). Two native species, Fries' pondweed and northern watermilfoil, moved into the dominant-six-species list for the first time since surveying began in 1976. This survey represents the first time Eurasian watermilfoil was dislodged from the six dominant plant species found during a single survey.

The non-native Eurasian watermilfoil (*Myriophyllum spicatum*) continued its pattern of significant decline with a Relative Frequency of Occurrence of 1.6%, marking an all-time low since its 1989 peak (37.5%). During the point-intercept survey it was found at 15 sites compared to 25 sites in 2006. However, a suspected hybrid of Eurasian and northern watermilfoils was documented in both 2006 and 2011, and has shown an increase in frequency. Two samples were sent to the DNR for identification in 2014. Both of those samples were verified as hybrid watermilfoil (EWM x NWM). While still not gaining a dominant presence, the invasive curly-leaf pondweed appeared to be gaining in prominence, surpassing Eurasian watermilfoil for the first time in terms of Frequency of Occurrence.

Overall, species diversity was marginally higher compared to 2006, but significantly higher in comparison to earlier surveys. However, as stated in 2006, data may not be comparable to earlier surveys, given the change from transect-based to point-intercept based sampling methods.

2015 Plant Inventory Survey

The 2015 survey was completed using the point-intercept sampling method in accordance with protocols approved by the Wisconsin DNR. The inventory was conducted between August 11 and August 20, 2015, with actual sampling dates dictated by weather conditions and field crew scheduling. Total plant species found using point-intercept, visual, and boat survey methods was 34. A total of 24 aquatic plant species were found through point-intercept rake sampling. This number increases to 27 species when including visual observations (bulrush, small duckweed, and arum-leaved arrowhead). Plants were found at water depths extending to 15 feet. The six most dominant species from most to least documented were: sago pondweed (*Stuckenia pectinata*), fetid stonewort (*Chara contraria.),* spiny naiad (*Najas marina*), coontail (*Ceratophyllum demersum*), wild celery *(Vallisneria americana)* and northern watermilfoil (*Myriophyllum sibiricum*).

Eurasian watermilfoil (*Myriophyllum spicatum*) was still in a state of decline, being found at only 12 sites during this survey compared to 15 sites in 2011. Curly-leaf pondweed, an invasive species, had a frequency of occurrence of 1.4% in 2006, 8.9% in 2011, and 1.4% in 2015. The 2006 and 2011 surveys were performed in June when the curly-leaf pondweed is actively growing. The 2015 inventory was conducted in August when most curly-leaf pondweed plants would have died back and would not be as prevalent as in inventories conducted earlier in the year.

During the 2015 inventory, investigators were able to differentiate between two *Chara* species commonly referred to as muskgrass. This inventory catalogs two separate entries for *Chara: Chara contraria* (fetid stonewort) and *Chara globularis* (globular stonewort). Prior inventories categorized both species as the common stonewort, *Chara vulgaris.* A sample of *Chara globularis* was pressed, dried and submitted to the Wisconsin State Herbarium in Madison, where it was verified.

In prior inventories conducted in 2006 and 2011, a hybrid species of milfoil was recorded though not confirmed. Positive identification by the Wisconsin DNR of a hybrid species using genetic analysis occurred in 2014 and determined it is not reliable to visually distinguish hybrid watermilfoil from either Eurasian or northern watermilfoil. Current scientific knowledge on hybrid watermilfoils and their physical and environmental characteristics is emerging. Physical traits of hybrid plants can vary based on local ecological conditions and can mimic either parent plant (Moody and Les, 2007). It is yet unknown whether Lake Ripley's hybrid watermilfoil populations will display the invasive characteristics of its non-native parent.

2020 Plant Inventory Survey

This survey was completed using the point-intercept sampling method in accordance with protocols approved by the Wisconsin DNR. The inventory was conducted between June 15 and June 18, 2020. Total plant species found using the point-intercept and visual survey methods was 25. A total of 23 aquatic plant species were found through point-intercept rake sampling. Plants were found at water depths extending to 16 feet. The six most dominant plant species documented from most to least were: coontail (*Ceratophyllum demersum*), fetid stonewort (*Chara contraria*), Fries' pondweed (*Potamogeton friesii*), globular stonewort (*Chara globularis*), water celery (*Vallisneria americana*) and small pondweed (*Potamogeton pusillus*). Sago pondweed (*Stuckenia pectinata*) was a close runner-up of small pondweed, being found at only one less site.

Eurasian watermilfoil saw an increase in frequency, being found at 65 sites this year compared to only 12 sites in 2015. This could be due in part because of natural annual variation, seasonal variation, climate change, plants being transferred via boats/kayaks, increased runoff into the lake, and fragmented EWM colonizing new sites within the lake. Additional disturbances to the lake bottom, such as from shallow water motorboating, can increase the rate of colonization.

When this survey was last completed in 2015, the timing was such that curly-leaf pondweed's known active growing season was over and those specific plants had already begun to die back; only a small number of CLP plants were found at only five sites. In comparison, CLP was found at 30 sites in June 2020 compared to 5 in August 2015, and 36 in June 2011.

The timing of the survey compared to previous years could play a role in the plant species we found. In 2011 the survey took place over 3 weeks; that means the lake's plant composition continued to grow during the survey allowing different plants to flourish within that time. In 2015 the survey was completed in August, meaning some of the early-senescing plants, like CLP, would no longer be present. This can be important because it's possible to miss key plants that need data collection for continued management.

This 2020 survey was completed within a week, providing a snapshot of what the lake looks like at that specific point in time. The annual variation which we observe in plant communities from year to year is much greater than the variation we would have if a survey takes a couple of weeks to complete versus a week.

During the 2020 survey, we were able to find two new species in the lake. The first new species was large duckweed, *Spirodela polyrhiza*, a small, free-floating plant that provides great shade for fish and important food for waterfowl. The large duckweed was found in Marina Bay within the white water lilies and spatterdock lilies. We also found needle spikerush, *Eleocharis acicularis*, on the north end in a shallow, sandy, quiet part of the lake. This plant makes great fish habitat for fish to lay their eggs on. It is very exciting to find undocumented plants in our lake because that increases our species diversity. Increasing species diversity within a lake means the lake is healthy enough to support a wide variety of plants.

Species	Frequency of Occurrence (%)	Average Density** (1-3 scale)	Relative Frequency	Importance Value
Ceratophyllum demersum (coontail)	42.3	1.64	15.7	25.7
Chara contraria (fetid stonewort)	39.8	1.59	14.8	23.5
Chara globularis (globular stonewort)	31.8	1.77	11.8	20.9
Eleocharis acicularis (needle spikerush)	0.3	1.00	0.1	0.1

Elodea canadensis (waterweed)	1.9	1.00	0.7	0.7
Heteranthera dubia (water star grass)	3.9	1.00	1.4	1.4
Lemna minor (small duckweed)	0.8	1.00	0.3	0.3
**Myriophyllum spicatum* (Eurasian watermilfoil)	17.9	1.35	6.7	9.1
Najas marina (spiny naiad)	3.0	1.00	1.1	1.1
Nuphar variegata (spatterdock)	3.3	2.33	1.2	2.8
Nymphaea odorata (white water lily)	2.5	1.33	0.9	1.2
**Potamogeton crispus* (curly-leaf pondweed)	8.3	1.17	3.1	3.6
Potamogeton friesii (Fries' pondweed)	37.8	1.67	14.0	23.4
Potamogeton gramineus (variable pondweed)	6.4	1.13	2.4	2.7
Potamogeton illinoensis (Illinois pondweed)	0.8	1.33	0.3	0.4
Potamogeton pusillus (small pondweed)	16.3	1.36	6.1	8.3
Potamogeton strictifolius (stiff pondweed)	3.6	1.23	1.3	1.6
Ranunculus aquatilis (White water crowfoot)	2.8	1.00	1.0	1.0
Spirodela polyrhiza (Large duckweed)	0.3	3.00	0.1	0.1
Stuckenia pectinata (sago pondweed)	16.0	1.24	6.0	7.4
Utricularia vulgaris (common bladderwort)	7.5	1.15	2.8	3.2
Vallisneria americana (water celery)	19.9	1.08	7.4	8.0
Wolffia columbiana (common watermeal)	0.8	1.00	0.3	0.3
Filamentous algae	63.26	1.62	NA	NA
Freshwater sponge	0.28	1.00	NA	NA

Table 3: 2020 plant inventory findings

* = Species not native to Wisconsin

** = Average Densities and corresponding Importance Values are based on a 1-3 rake-fullness scale.

Aquatic Plant	Number of Sites Found	FREQ[a] [0-16'] (%)	FREQ[b] [Veg. Sites] (%)	RFREQ[c] (%)	ADEN[d] (1-3 scale)	IV[e]	C[f]
Coontail *Ceratophyllum demersum*	153	42.27	40.69	15.7	1.64	25.7	3
Fetid Stonewort *Chara contraria*	144	39.78	38.30	14.8	1.59	23.5	NA
Fries' Pondweed *Potamogeton friesii*	136	37.75	36.17	14.0	1.67	23.4	8
Globular Stonewort *Chara globularis*	115	31.77	30.59	11.8	1.77	20.9	3
Water Celery *Vallisneria americana*	72	19.89	19.15	7.4	1.08	8.0	6
*Eurasian watermilfoil *Myriophyllum spicatum*	65	17.96	17.29	6.7	1.35	9.1	0
Small pondweed *Potamogeton pusillus*	59	16.30	15.69	6.1	1.36	8.3	7
Sago pondweed *Stuckenia pectinata*	58	16.02	15.43	6.0	1.24	7.4	3

*Curly-Leaf Pondweed *Potamogeton crispus*	30	8.29	7.98	3.1	1.17	3.6	0
Common bladderwort *Utricularia vulgaris*	27	7.46	7.18	2.8	1.15	3.2	7
Variable Pondweed *Potamogeton gramineus*	23	6.35	6.12	2.4	1.13	2.7	7
Water Stargrass *Heteranthera dubia*	14	3.87	3.72	1.4	1.0	1.4	6
Stiff Pondweed *Potamogeton strictifolius*	13	3.59	3.46	1.3	1.2	1.6	8
Spatterdock *Nuphar variegata*	12	3.31	3.19	1.2	2.3	2.8	6
Spiny naiad *Najas marina*	11	3.04	2.93	1.1	1.0	1.1	0
White water crowfoot *Ranunculus aquatilis*	10	2.76	2.66	1.0	1.0	1.0	8
White Water Lily *Nymphaea odorata*	9	2.49	2.39	0.9	1.3	1.2	6
Common Waterweed *Elodea canadensis*	7	1.93	1.86	0.7	1.0	0.7	3
Northern watermilfoil *Myriophyllum sibiricum*	4	1.10	1.06	0.4	1.0	0.4	6
Common Watermeal *Wolffia columbiana*	3	0.83	0.80	0.3	1.0	0.3	5
Illinois Pondweed *Potamogeton illinoensis*	3	0.83	0.80	0.3	1.3	0.4	6
Small Duckweed *Lemna minor*	3	0.83	0.80	0.3	1.0	0.3	4
Needle spikerush *Eleocharis acicularis*	1	0.28	0.27	0.1	1.0	0.1	5
Large Duckweed *Spirodela polyrhiza*	1	0.28	0.27	0.1	1.0	0.1	5
Cattails *Typha sp.*	V	V	V	V	V	V	V
Softstem Bulrush *Schoenoplectus tabernaemontani*	V	V	V	V	V	V	V
Filamentous algae	229	NA	NA	NA	NA	NA	NA
Freshwater sponge	1	NA	NA	NA	NA	NA	NA

Table 4: Statistical summary for all plant species documented in the 2020 inventory

* = Species not native to Wisconsin

V = species observed visually during point-intercept survey

[a]FREQ [0-16'] = Frequency of Occurrence within depth zone defining extent of plant growth. The number of occurrences of a species divided by the number of sampling points in the 0-16' depth range.

[b]FREQ [Veg. Sites] = Frequency of Occurrence within sites where plants were collected. The number of occurrences of a species divided by the number of sampling points with documented plant growth.

[c]RFREQ = Relative Frequency of Occurrence.

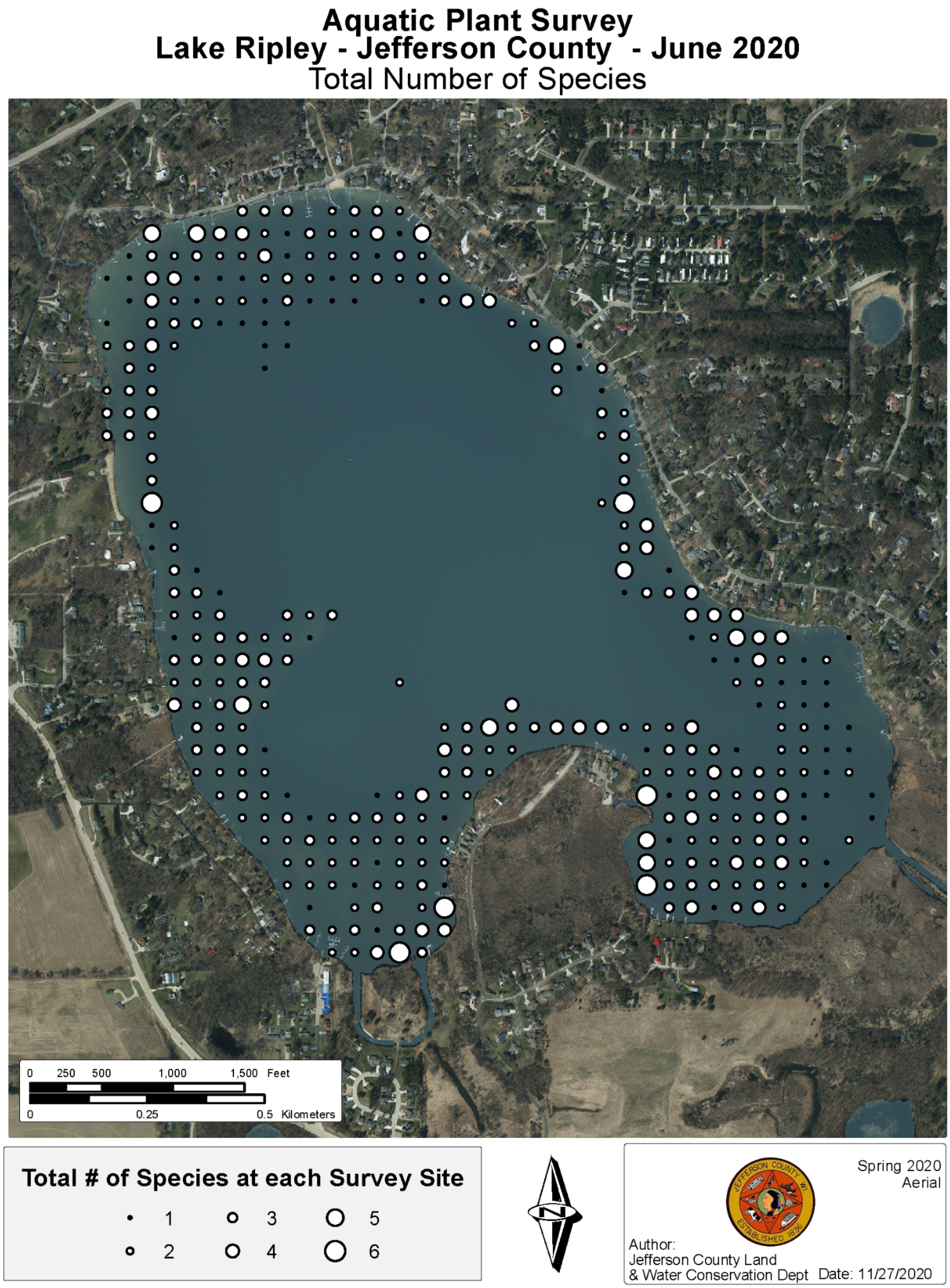
[d]ADEN = Average Density. The sum of the density ratings for a species (1-3 rake fullness scale) divided by the number of sampling points with vegetation.

[e]IV = Importance Value. The product of the relative frequency (RFREQ) and the average density, expressed as a percentage.
[f]C = Coefficient of Conservatism. Used to compute Floristic Quality Index. Values range from 0-10, with higher values indicative of plant species intolerant of habitat modification or water quality impairment caused by human disturbance.

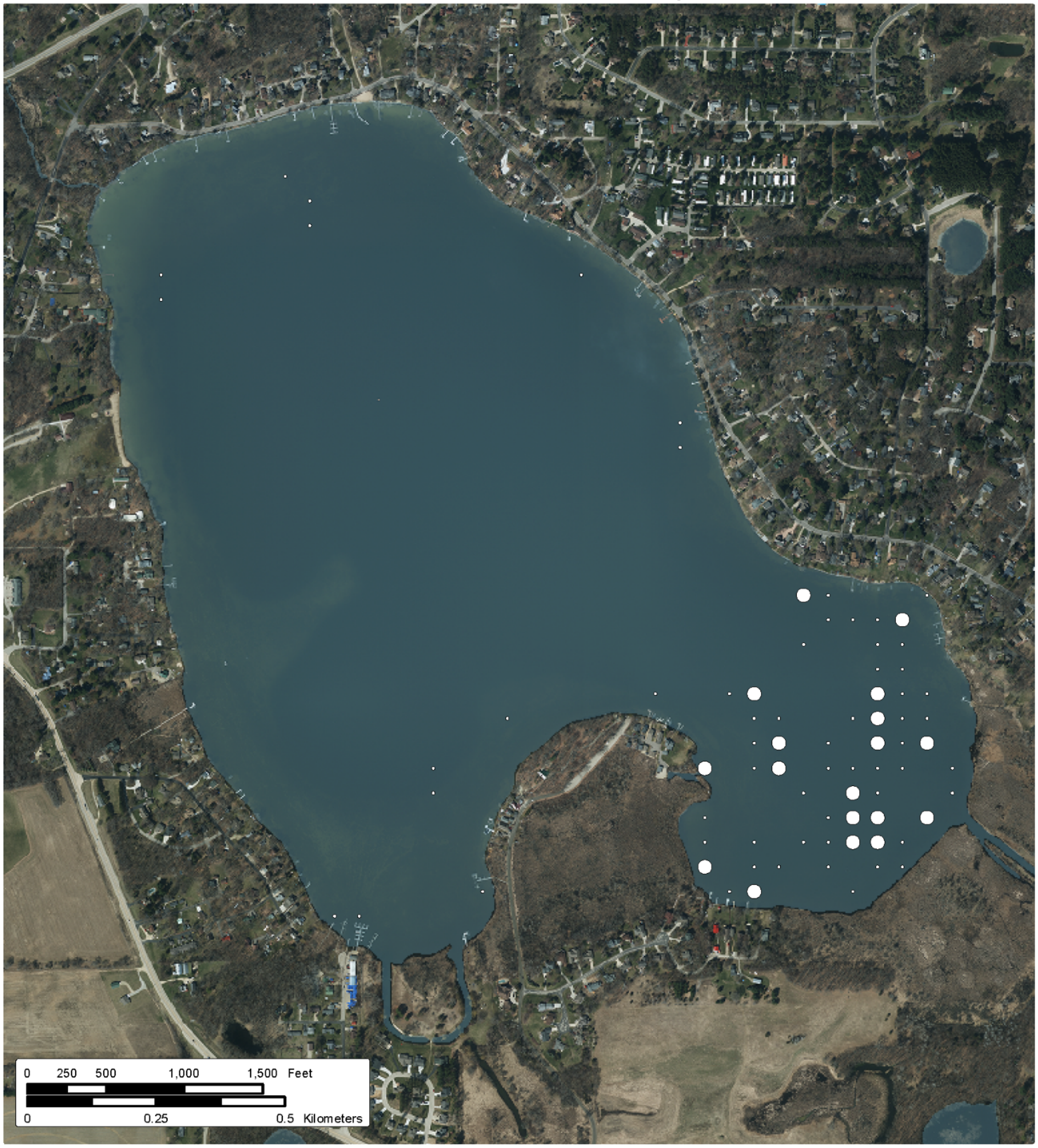
[a]Total Number of Points Sampled	378
[b]Number of Points Sampled within Depth Range of Potential Plant Growth (0-16’)	376
[c]Number of Points with Vegetation	362
[d]Maximum Depth of Plant Growth	16
[e]Frequency of Occurrence of Vegetation within Range of Plant Growth (0-16’)	96.28
[f]Simpson Diversity Index	0.90
[g]Species Richness	26
[h]Species Richness + Visuals	26
[i]Floristic Quality Index (FQI)	25.47
[j]Mean Coefficient of Conservatism (C)	5.84
Average Number of Species Sampled Per Site (0-16’)	2.58
Average Number of Species Sampled Per Site (Veg. Sites Only)	2.69
Average Number of Native Species Sampled Per Site (0-16’)	2.30
Average Number of Native Species Sampled Per Site (Veg. Sites Only)	2.41

Table 5: Statistical descriptions based on all plants inventoried (2020)

[a]Does not include sample points in depths beyond 16 ft. where plant growth could not be documented
[b]Includes all sample points within the 0-16-ft. littoral zone that were shown to support plant growth
[c]Includes all sample points where vegetation was found after taking a rake sample
[d]Represents deepest point where vegetation was sampled. This depth will fluctuate from year to year depending on changes in water clarity conditions.
[e]Percentage of occurrence that vegetation would be sampled within the 0-16-ft. littoral zone
[f]Simpson Diversity Index: One minus the sum of each of the relative frequencies squared ($SDI = 1 - \sum(RFREQ^2)$). The closer the SDI value is to one, the greater the diversity is between communities being compared. The index allows the plant community at one location to be compared to the plant community at another location. It also allows a single location’s plant community to be compared over time. The index value (on a scale of 0-1) represents the probability that two individuals (randomly selected) will be different species. The greater the index value, the higher the diversity in a given location. Plant communities with high diversity are usually representative of healthier lakes, and also tend to be more resistant to invasion by exotic species.
[g]Indicates the number of different plant species found in and directly adjacent to the lake (on the waterline). Species richness only counts those plants documented as part of the point-intercept data. It includes filamentous algae, freshwater sponge, and unidentified *Myriophyllum* and *Najas* species. This number does not include the species found during general boat surveys (GS).
[h]Indicates the number of different plant species found in and directly adjacent to the lake (on the waterline). This species richness count includes visuals found in the point-intercept survey. This number does not include the species found during general boat surveys (GS).
[i]Measures the impact of human development on a lake’s aquatic plant community. Species in the index are assigned a Coefficient of Conservatism (C), which ranges from 0-10 in Wisconsin. The higher the value, the more likely the plant is negatively influenced by human activities that affect water quality or habitat. Plants with low values are tolerant of human disturbances, and often exploit these impacts to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each species found in the lake, and then multiplying that value by the square root of the number of species ($FQI=meanC\sqrt{N}$). Consequently, a higher index value indicates a healthier macrophyte community.
[j]Mean Coefficient of Conservatism (C) among species documented during point-intercept survey. Does not include species observed during the follow-up boat survey.


Aquatic Plant Survey
Lake Ripley - Jefferson County - June 2020
Total Number of Species
0 250 500 1,000 1,500 Feet
0 0.25 0.5 Kilometers
Total # of Species at each Survey Site
1 3 5
2 4 6
N
Spring 2020
Aerial
Author:
Jefferson County Land
& Water Conservation Dept
Date: 11/27/2020

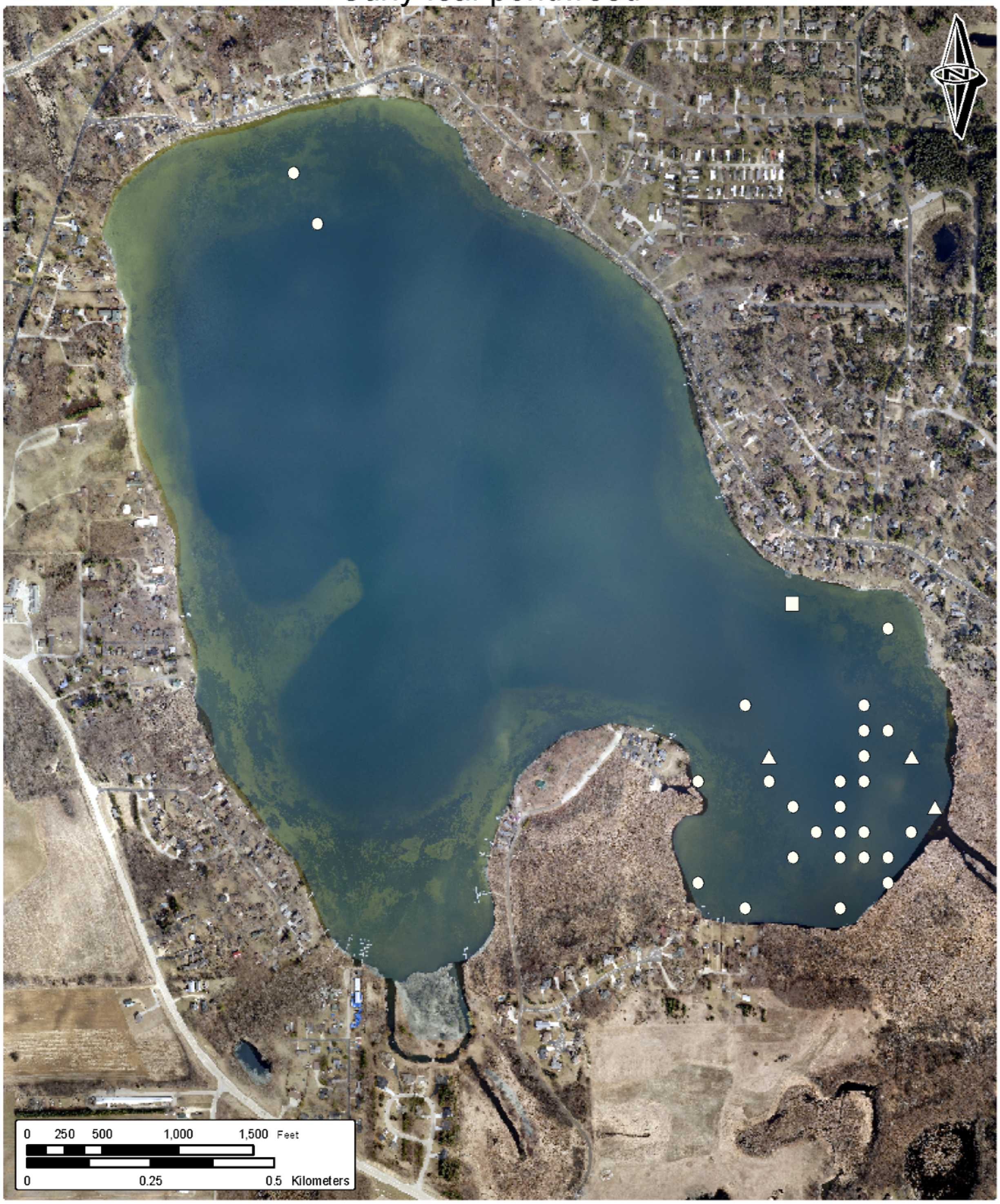
Aquatic Plant Survey
Lake Ripley - Jefferson County - June 2020
Total Number of Invasive Species



Total # of Species at each Survey Site

◦ 1 ○ 2

Aquatic Plant Survey
Lake Ripley - Jefferson County - June 2020
Curly-leaf pondweed



Rake Fullness Rating

○	1
△	2
□	3
◇	Visual

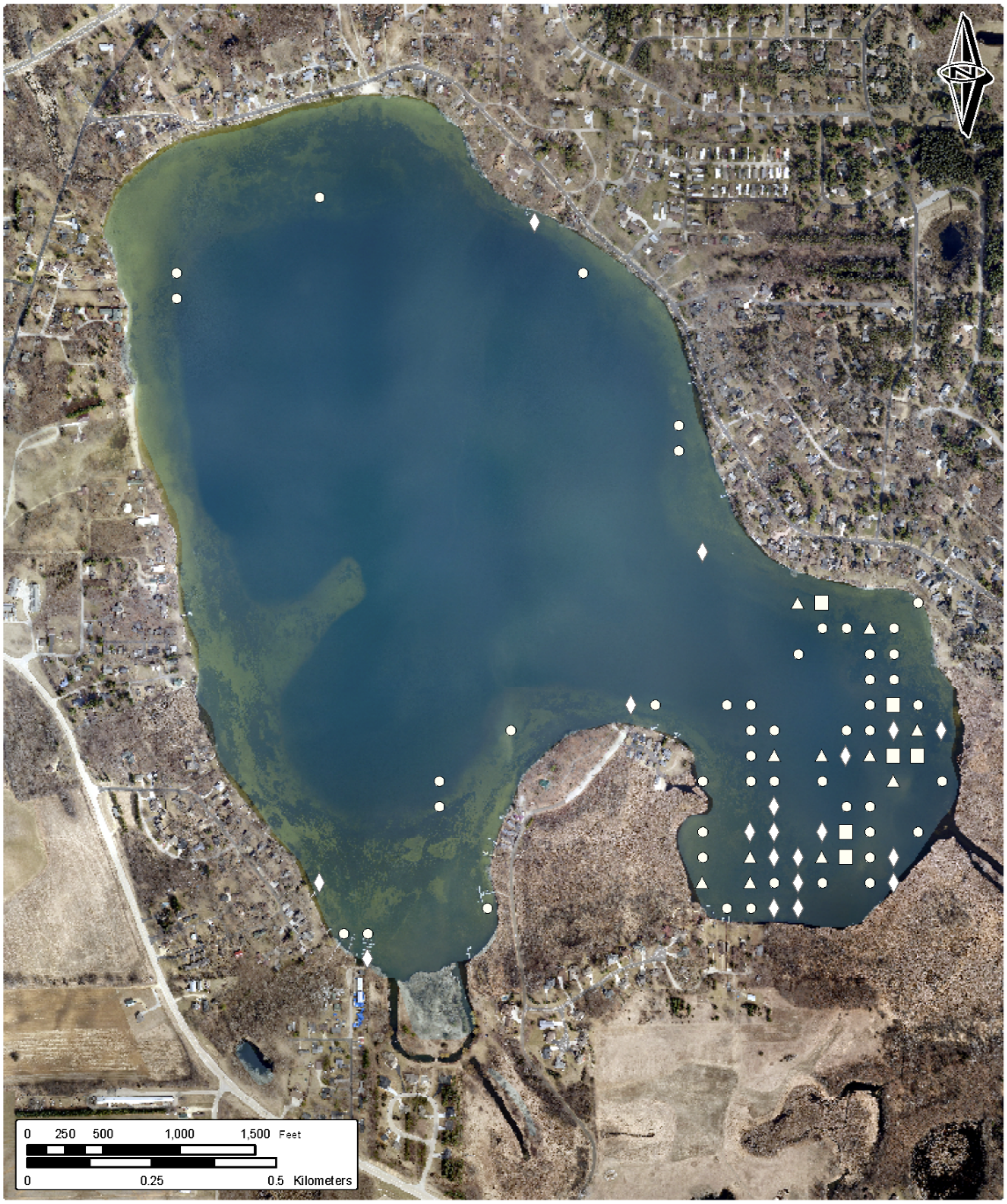
Spring 2015
Aerial

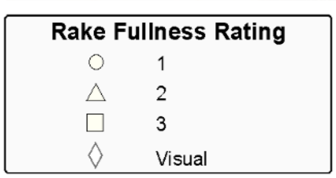
Author:
Jefferson County Land
& Water Conservation Dept

Date: 7/21/2020

Illustration of
Rake Fullness Rating

Aquatic Plant Survey
Lake Ripley - Jefferson County - June 2020
Eurasian water milfoil

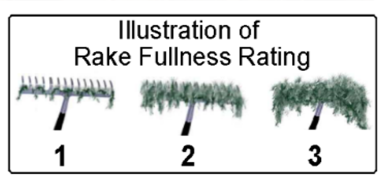




Spring 2015
Aerial

Author:
Jefferson County Land
& Water Conservation Dept

Date: 7/21/2020



Finally, a 44-year comparative analysis for the 1976-2020 monitoring period is provided in Tables 6, 7, and 8 below. During the 44-year period of record, the trend towards an increasing number of documented plant species is not considered significant when comparing 1976 to 2001 results. This is because of the change in point-intercept protocols in 2006. These results may reflect inter-annual variability, improvement in plant identification and sampling technique over time, and the influence of seasonality in plant growth consequent to the time of year during which the surveys were conducted.

Species	**Year**								
	1976	**1989**	**1991**	**1996**	**2001**	**2006^**	**2011^**	**2015^**	**2020^**
Arum-leaved arrowhead	--	--	--	--	--	--	--	V	--
Cattail	--	--	--	--	--	--	--	--	V
Chara sp.	47	7	18	23	45	196	--	--	--
Common bladderwort	6	--	2	2	1	--	11	6	27
Common watermeal	--	--	--	--	--	--	V	--	3
Common waterweed	2	--	2	1	3	3	40	2	7
Coontail	14	3	19	21	5	44	103	98	153
*Curly-leaf pondweed	1	1	--	--	1	5	36	5	30
*Eurasian watermilfoil	19	45	48	53	41	25	15	12	65
Fetid stonewort**	--	--	--	--	--	--	202	155	144
Flat-stem pondweed	--	--	--	--	8	--	--	1	--
Floating-leaf pondweed	10	8	--	--	1	--	V	2	--
Forked duckweed	--	--	--	--	--	1	--	--	--
Fries' pondweed	--	--	--	--	--	27	82	20	136
Globular stonewort**	--	--	--	--	--	--	--	21	115
Hardstem Bulrush	--	--	--	--	--	--	--	V	--
Horned pondweed	--	--	--	--	--	--	1	1	--
Hybrid watermilfoil	--	--	--	--	--	--	50	10	--
Illinois pondweed	--	13	--	1	--	18	30	3	3
Leafy pondweed	--	--	--	--	--	3	--	--	--
Naiad sp.	3	--	--	--	--	--	--	--	--
Needle spikerush	--	--	--	--	--	--	--	--	1
Northern watermilfoil	--	--	2	1	--	14	100	26	4
Potamogeton sp.(Hybrid)	7	--	5	7	--	--	--	10	--
Sago pondweed	12	3	12	18	20	62	133	174	58
Softstem bulrush	--	--	--	--	--	--	--	--	V
Slender naiad	--	7	8	11	13	4	8	25	--
Small duckweed	--	--	--	--	--	4	1	V	3
Small pondweed	--	13	--	--	--	1	2	3	59
Spatterdock	--	--	--	--	--	7	7	5	12
Spiny naiad	--	11	37	46	35	123	76	127	11
Stiff pondweed	--	--	--	--	--	--	--	1	13
Variable pondweed	--	2	--	--	8	--	1	4	23
Water bulrush	--	--	--	--	4	--	--	--	--
Water celery	25	7	7	10	21	11	43	79	72

Water stargrass	--	--	--	--	3	16	4	5	14
White water lily	--	--	--	--	--	6	5	3	9
Total Number of Species Documented:	11	12	11	12	15	19	23	28	24

Table 6: Number of littoral-zone sample sites where each species was found (1976-2020)

^ Surveys have a higher number of sample sites compared to previous years due to use of the point-intercept method
* = Species non-native to Wisconsin
** = 2015 inventory differentiated between *Chara* species

Species	**Year**								
	1976	**1989**	**1991**	**1996**	**2001**	**2006 ^**	**2011 ^**	**2015 ^**	**2020 ^**
Chara sp.	69.1	11.7	20.0	25.6	50.0	53.1	--	--	--
Common bladderwort	8.8	--	2.2	2.2	1.1	--	2.7	1.7	7.5
Common watermeal	--	--	--	--	--	--	--	--	0.8
Common waterweed	2.9	--	2.2	1.1	3.3	0.8	9.8	0.6	1.9
Coontail	20.6	5.0	21.1	23.3	5.6	12.2	25.3	27.3	42.3
*Curly-leaf pondweed	1.5	1.7	--	--	1.1	1.4	8.9	1.4	8.3
*Eurasian watermilfoil	29.9	75.0	53.3	58.9	45.6	6.8	3.7	3.3	17.9
Fetid stonewort	--	--	--	--	--	--	49.6	43.2	39.8
Flat-stem pondweed	--	--	--	--	8.9	--	--	0.3	--
Floating-leaf pondweed	14.7	13.3	--	--	1.1	--	--	0.6	--
Forked duckweed	--	--	--	--	--	0.3	--	--	--
Fries' pondweed	--	--	--	--	--	7.3	20.1	5.6	37.6
Globular stonewort	--	--	--	--	--	--	--	5.9	31.8
Horned pondweed	--	--	--	--	--	--	0.2	0.3	--
Hybrid watermilfoil	10.3	--	5.6	7.8	--	4.6	12.3	2.8	--
Illinois pondweed	--	21.7	--	1.1	--	--	7.4	0.8	0.8
Leafy pondweed	--	--	--	--	--	0.8	--	--	--
Naiad sp.	4.4	--	--	--	--	--	--	--	--
Needle spikerush	--	--	--	--	--	--	--	--	0.3
Northern watermilfoil	--	--	2.2	1.1	--	3.8	24.6	7.2	1.1
Potamogeton sp.	10.3	--	5.6	7.8	--	--	--	2.8	--
Sago pondweed	17.6	5.0	13.3	20.0	22.2	16.8	32.7	48.5	16.0
Slender naiad	--	11.7	8.9	12.2	14.4	1.1	2.0	7.0	--
Small duckweed	--	--	--	--	--	1.1	0.2	V	0.8
Small pondweed	--	21.7	--	--	--	0.3	0.5	0.8	16.3
Spatterdock	--	--	--	--	--	1.9	1.7	1.4	3.3
Spiny naiad	--	18.3	41.1	51.1	38.9	33.3	18.7	35.4	3.0
Stiff pondweed	--	--	--	--	--	--	--	0.3	3.6
Variable pondweed	--	3.3	--	--	8.9	--	0.2	1.1	6.4
Water bulrush	--	--	--	--	4.4	--	--	--	--
Water celery	36.8	11.7	7.8	11.1	23.3	3.0	10.6	22.0	19.9
Water star grass	--	--	--	--	3.3	4.3	1.0	1.4	3.9
White water crowfoot	--	--	--	--	--	--	--	--	2.8
White water lily	--	--	--	--	--	1.6	1.2	0.8	2.5

Table 7: Percent frequency of occurrence of aquatic plant species (1976-2020)

^ Surveys have a higher number of sample sites compared to previous years due to use of the point-intercept method
* = Species non-native to Wisconsin

Species	Year								
	1976	1989	1991	1996	2001	2006^	2011^	2015^	2020^
Chara sp.	32.2	5.8	11.3	11.9	21.5	30.1	--	--	--
Common bladderwort	4.1	--	1.3	1.0	0.5	--	1.2	0.8	2.8
Common watermeal	--	--	--	--	--	--	--	--	0.3
Common waterweed	1.4	--	1.3	0.5	1.4	0.5	4.2	0.3	0.7
Coontail	9.6	2.5	11.9	10.8	2.4	6.9	10.8	12.4	15.7
*Curly-leaf pondweed	0.7	0.8	--	--	0.5	0.8	3.8	0.6	3.1
*Eurasian watermilfoil	13.0	37.5	30.0	27.3	19.6	3.8	1.6	1.5	6.7
Fetid stonewort	--	--	--	--	0.0	--	21.3	19.7	14.8
Flat-stem pondweed	--	--	--	--	5.7	--	--	0.1	--
Floating-leaf pondweed	6.8	6.7	--	--	0.5	--	0.5	0.3	--
Forked duckweed	--	--	--	--	--	0.2	0.0	--	--
Fries' pondweed	--	--	--	--	--	4.1	8.6	2.5	14.0
Globular stonewort	--	--	--	--	--	--		2.7	11.8
Horned pondweed	--	--	--	--	--	--	0.1	0.1	--
Hybrid watermilfoil	--	--	--	--	--	2.6	5.3	1.3	--
Illinois pondweed	--	10.8	--	0.5	--		3.2	0.4	0.3
Leafy pondweed	--	--	--	--	--	0.5	--	--	--
Naiad sp.	2.1	--	--	--	--	--	--	--	--
Needle spikerush	--	--	--	--	--	--	--	--	0.1
Northern watermilfoil	--	--	1.3	0.5	--	2.2	10.5	3.3	0.4
Potamogeton sp.	4.8	--	3.1	3.6	--	--	--	1.3	--
Sago pondweed	8.2	2.5	7.5	9.3	9.6	9.5	14.0	22.1	6.0
Slender naiad	--	5.8	5.0	5.7	6.2	0.6	0.8	3.2	--
Small duckweed	--	--	--	--	--	0.6	0.1	--	0.3
Small pondweed	--	10.8	--	--	--	0.2	0.2	0.4	6.1
Spatterdock	--	--	--	--	--	1.1	0.7	0.6	1.2
Spiny naiad	--	9.2	23.1	23.7	16.7	18.9	8.0	16.1	1.1
Stiff pondweed	--	--	--	--	--	--	--	0.1	1.3
Variable pondweed	--	1.7	--	--	3.8	--	0.1	0.5	2.4
Water bulrush	--	--	--	--	1.9	--	--	--	--
Water celery	17.1	5.8	4.4	5.2	10.0	1.7	4.5	10.0	7.4
Water stargrass	--	--	--	--	1.4	2.5	0.4	0.6	1.4
White water crowfoot	--	--	--	--	--	--	--	--	1.0
White water lily	--	--	--	--	--	0.9	0.5	0.4	0.9

Table 8: Percent relative frequency of occurrence of aquatic plant species (1976-2020)

^ Surveys have a higher number of sample sites compared to previous years due to use of the point-intercept method
* = Species non-native to Wisconsin

4.4 - Condition Assessment

Lake Ripley's aquatic plants have been studied for over 65 years and overall have depicted a healthy, diverse native plant community. During the 2020 plant survey, field researchers were able to find two new species in the lake, large duckweed (*Spirodela polyrhiza*) and needle spikerush (*Eleocharis acicularis*), increasing our native plant diversity. EWM found its way back into the top six dominant plant species, being found at 65 sites. Even though 65 sites seems like a lot, the percentage of sample sites in which Eurasian watermilfoil was found has decreased from 75% in 1989 to 17.29% in 2020, revealing a precipitous decline in dominance by this non-native species. This may be in part due to the change of WDNR's point-intercept survey protocols. The relative frequency of occurrence for milfoil also decreased from 37.5% in 1989 to 6.7% in 2020.

Over the years, the plants within Lake Ripley have been found growing at different depths. In 2011, 2015, and 2020, plants were found growing at 21, 15, and 16 feet, respectively. The lake levels differed throughout these years, which would affect the depth of which plants were found.

With respect to the Wisconsin Floristic Quality Index, Lake Ripley's computed value of 25.93 (2020) continues to rank above the median for Wisconsin and the larger ecoregion. The Floristic Quality Index (FQI) was developed to help assess lake quality by evaluating the number and types of aquatic plants that live in a lake. The FQI for Wisconsin ranges from 3.0 to 44.6, with a median of 22.2. The FQI is particularly valuable for comparing lakes around the state or looking at a single lake over time. Generally, higher FQI numbers indicate better lake quality that can support more pollution-sensitive plant species. Lake Ripley's 2020 FQI of 25.93 is a marked improvement over prior years when the FQI averaged 18.82.

In terms of plant diversity, the Simpson Diversity Index has ranged from 0.85-0.90 (on a 0-1.00 scale) during the 44-year period of record. This suggests that the plant community has remained somewhat diverse throughout this period, indicating a healthy lake. The Simpson Diversity Index (SDI) is calculated as one minus the sum of each of the relative frequencies squared. The closer the SDI value is to one, the greater the diversity is between communities. The index allows the plant community at one location to be compared to the plant community at another location.

The SDI also allows a single location's plant community to be compared over time. The index value (on a scale of 0-1) represents the probability that two individuals (randomly selected) will be different species. The greater the index value, the higher the diversity in a given location. Plant communities with high diversity are usually representative of healthier lakes, and also tend to be more resistant to invasion by exotic species. In 2020 the SDI was 0.90, which was an increase from 0.86 in 2015.

In terms of importance values, coontail (*Ceratophyllum demersum*) and fetid stonewort (*Chara contraria*) were the two species with the highest value. Globular stonewort (*Chara globularis*) and Fries' pondweed (*Potamogeton friesii*) also had relatively high importance values. The overall decline in importance values among the different plant species suggests a shift toward a healthier lake ecosystem, with no one species becoming overly dominant. While the precise reasons for changes in the plant community are unclear, they are most likely related to a combination of factors. These factors include the implementation of aquatic plant management practices, changes in land use that affect nutrient supply and availability, alterations in lake-use patterns and behavior, climatic factors, and natural biological processes contributing to inter-annual variability among plant communities.

Recent inventory results are fairly encouraging, especially with respect to the overall decline in Eurasian watermilfoil dominance. Despite these positive observations, challenges still remain and suggest there is room for improvement. Challenges include the continued presence of nonnative organisms and plants, dominance of pollution/disturbance-tolerant species, and limited overall biodiversity. Expected challenges include increased storm events, increased days of high temperatures, and wave action from changes in recreational vessels.

These conditions are likely to change for the better as recommendations contained within this plan are implemented over time.

4.5 - Critical Habitat Areas

Every waterbody has critical habitat; these are the areas that are most important to the overall health of the aquatic plants and animals (WDNR, 2021). In 1989, Wisconsin DNR Administrative Code (NR 107) governing the Aquatic Plant Management Program went into effect. Recognizing that responsible management of aquatic plants and animals can enhance water recreation was only one aspect of the program. NR-107 also emphasized the value of native aquatic plants and animals to water quality and lake ecology, and recognized the need to protect them.

The Wisconsin DNR has the authority to identify ecologically important areas. These Critical Habitat Areas are designed to protect water quality, high-value native aquatic plants, critical fisheries and wildlife habitat, and shorelines susceptible to erosion. Remarkably, 80% of the plants and animals on the state's endangered and threatened species list spend all or part of their life cycle within the near shore zone (WDNR, 2021). Wisconsin law mandates special protections for these critical habitats. To ensure the long-term health of Lake Ripley, it is important to map these areas so that everyone knows which areas are most vulnerable to impacts from human activity.

On Lake Ripley, Critical Habitat Areas were first designated by Wisconsin DNR and incorporated into a Town pier ordinance in 1995 (Town of Oakland, 1995). They were most often associated with relatively undeveloped shorelines and wetlands within the South and East Bay, and were found to support excellent biodiversity. However, this designation did not follow modern standards of data collection and public input, so the designation is being re-done.

Water lilies, bulrush stands, and lakeshore wetland plants/biota are among the features that commonly characterize these area designations. These plants help protect the shoreline from erosion, provide habitat for fish and wildlife and protect water quality. Water celery (*Vallisneria americana*) and several submersed pondweeds (*Potamogeton* sp.) were also identified as deserving protection, but it was noted that these plants occur in low densities and are widely dispersed throughout the lake. Consequently, these species cannot be protected within defined areas.

Historically, important near-shore aquatic habitats were abundant around the lake, but have largely disappeared as a consequence of wetland drainage and shoreline development. The few remaining Critical Habitat Areas along the southern shoreline are protected, and herbicide treatments, dredging and sand blankets are prohibited within those locations. A Town of Oakland ordinance currently prohibits the placement of piers, wharves and swimming rafts within designated “sensitive” areas without a DNR permit (Town of Oakland, 1995). Town ordinance also provides for slow-no-wake buoyed restricted zones in each bay, a 200-feet-from-shore no-wake zone, and a prohibition on motor use of any kind in Vasby’s Channel. These ordinances are intended, in part, to better protect Critical Habitat Areas from frequent motor boat disturbance (Town of Oakland, 1995). While mechanical harvesting is allowed in accordance with Wisconsin DNR Administrative Code (NR 109) permit conditions, operations are governed by a harvesting plan that largely targets the invasive milfoil in high-traffic navigational corridors.

The Wisconsin DNR, the Jefferson County Land and Water Conservation Department, and the Lake District are currently in the process of re-evaluating and re-mapping Critical Habitat Areas on Lake Ripley. When completed, any key findings, re-delineations and recommendations from this effort shall be considered a part of this Lake Management Plan. A draft Critical Habitat Areas map is included as Figure 9.

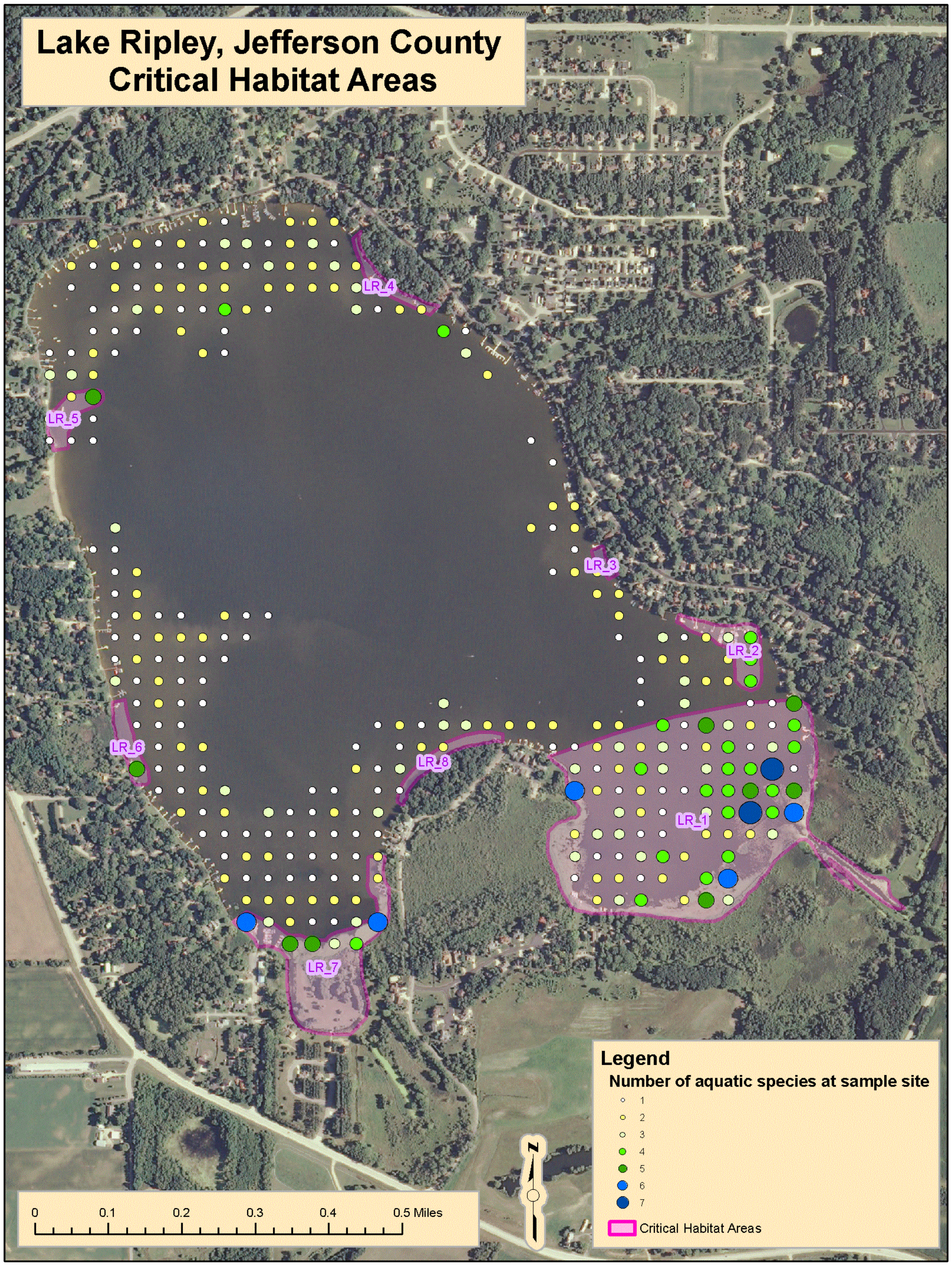


Figure 9: Critical Habitat Areas on Lake Ripley (DRAFT)

4.6 - Management for Aquatic Plants

The state of Wisconsin, through Section 23.24 of the Wisconsin Statutes, encourages the development of aquatic plant management (APM) plans to promote the long-term sustainability of lakes. An approved APM plan is also a prerequisite for obtaining various state grants and permit approvals, including those related to controlling nuisance plant growth through a mechanical harvesting program.

The first step toward implementing a successful aquatic plant management program is to recognize the important functions and values of a healthy plant community. Best management practices seek to do now what will benefit the lake in the future.

Aquatic plants are essential to the food web and health of the entire lake ecosystem, including good water quality. They may well provide some resilience to challenges associated with climate change such as: intense rainfall events, excessive heat, and few ice-on days.

Lake Ripley's invasive weed-harvesting program is a long-term commitment. Operations may vary year to year, depending on need. The program involves maintaining equipment, proper permitting, training operators, carrying insurance, and careful recordkeeping to ensure cost-effectiveness. The program strives to minimize damage to native plants while creating reasonable public access and navigational lanes for lake users.

CHAPTER 5 - MECHANICAL HARVESTING

5.1 The Value and Role of Mechanical Harvesting

Mechanical harvesting should be viewed as a long-term commitment where operational intensity may vary from year to year depending on actual need. An effective harvesting program involves maintaining, storing and deploying multiple pieces of equipment. It also involves: obtaining permits, training and supervising machine operators, carrying appropriate insurance coverage, locating disposal areas for harvested plant material, recordkeeping, and maintaining public relations. Once the capital equipment is acquired and a program is established, significant cost savings and other benefits are generally realized.

One role of a mechanical harvester is to cut and collect invasive or nuisance aquatic vegetation growing within a few feet of the water surface. Root systems remain in place after harvesting, allowing plants to quickly regenerate. About one acre of lake surface can typically be harvested per hour, and relief can last as little as several days or up to three months depending on growing conditions.

There are both selective and non-selective aspects to mechanical harvesting. Non-selectivity is demonstrated by the removal of all plant species that fall within the reach of the cutter bars. Some species selectivity is achieved by targeting monotypic stands of nuisance vegetation, operating at specific times during the growing season, and altering the depth of cut. It may be possible for harvesting to alter the composition of a plant community by encouraging the success of shorter-growing and disturbance-tolerant species, and by allowing additional sunlight to reach the understory.

5.2 Control Methods

Aquatic plant management measures can be classified into five different groups: 1) physical, 2) biological, 3) mechanical, 4) manual, and 5) chemical. All of these control measures are stringently regulated and most require a State of Wisconsin permit.

Physical Control

Physical control methods can refer to the use of a type of physical barrier including lake bottom blankets, synthetic screens, or a type of rock-substrate. These create a physical barrier between rooted submersed aquatic plants and plant-available sunlight, consequently preventing the plants from growing. For example, physical measures such as lake bottom covers are often used to create swimming beaches and pea gravel is used to create boat launches.

In the case of Lake Ripley, the need to encourage native aquatic plant growth while simultaneously controlling the growth of invasive species, often in the same location, suggests that physical management methods are not warranted. Therefore, physical control methods are not considered viable for Lake Ripley and are not recommended within this plan.

Biological Control

Biological control methods refer to insects, fish and pathogens that are used to decrease the density of invasive plants. These agents are deliberately released into a lake to weaken the invading population by increasing leaf mortality, decreasing plant size, reducing flow and seed production, and decreasing density (UW-Extension, 2022). A local example of a biological control is the milfoil weevil. This weevil is a native, small, herbivorous aquatic beetle that has been used in Wisconsin to reduce the density of Eurasian watermilfoil in a lake.

However, given that Lake Ripley has high boat activity and a developed shoreline which limits the existence of leaf-litter habitat preferred by the weevil, the use of the milfoil weevil is not considered viable on Lake Ripley and is not recommended within this plan. No biological control methods are recommended within this plan.

Mechanical Control

Mechanical control methods include rollers, aerators, harvesters and suction harvesters among other possible methods. A permit is required for all mechanical control methods. Using a mechanical harvester on a lake requires access to a weed harvester and educated harvester operators. This equipment consists of an adjustable cutting apparatus that cuts plants at selected depths from the surface down to roughly five feet below the water surface and a collection system that gathers most cut plant material. Mechanical harvesting can be a practical and efficient means of controlling sedimentation and plant growth, because it removes plant biomass that would otherwise decompose and release nutrients and sediments into a lake.

An advantage of mechanical harvesting is that the harvester, when properly operated, "mows" the tops of aquatic plants which can result in an overall reduction of plant abundance (UW-Extension, 2022). Therefore, this method typically leaves enough living plant material in a lake to provide shelter for aquatic wildlife and to stabilize lake-bottom sediments. Aquatic plant harvesting also has been shown to facilitate growth of native aquatic plants by allowing light to penetrate to the lakebed. This is particularly effective when controlling invasive plant species that commonly grow very early in the season when native plants have not yet emerged or appreciably grown. Finally, harvesting does not kill native plants in the way that other control methods do. Instead, this method simply cuts them back.

Given that mechanical harvesting has been in operation on Lake Ripley for 21 years and that the District has invested in its own harvesting equipment during that time, and since the District's mechanical harvesting has demonstrated the ability to provide navigation lanes, control nuisance and invasive species, and prevent sedimentation with minimal damage to the lake ecosystem, harvesting is considered viable and is recommended for Lake Ripley.

Manual Control

Manual control methods can include the use of a rake, manual cutter blade, or pulling of plants by hand. This option can be helpful when targeting a smaller population, or a specific invasive plant species (UW-Extension, 2022). Lakefront property owners are encouraged to collect and remove floating plant debris that washes to shore. Lake plants make ideal compost or mulch around trees, shrubs, flowers and vegetables or can be composted.

Floating plant debris may include Eurasian watermilfoil fragments that can re-shoot and grow into new plants. Decomposing plant debris also releases phosphorus and other nutrients that can contribute to algal blooms. Do not dispose of plants in a wetland or ditch as this will contribute to increased nutrients in the water.

Using manual methods, rooted plants can be removed from swimming/pier areas, without a permit, provided the following conditions are met:

- Eurasian water milfoil and curly-leaf pondweed may be removed if the native plant community is not harmed in the process.
- Manual removal is restricted to a 30-foot corridor extending from the shoreline out into the lake.
  - However, an exception applies to this when a property is within a Critical Habitat Designation (CHD) or an Area of Special Natural Resources Interest (ASNRI). In these instances, a permit is required to remove any vegetation (UW-Extension, 2022).
- Plant materials that drift onto the shoreline may be removed.
- The shoreline is not a designated sensitive area.
- All raked and hand-pulled plant material is removed from the lake.
- No other plant control methods are used.

Chemical Control

Chemical control methods refer to aquatic herbicide use. Applying aquatic herbicides in any lake is strictly regulated by the WDNR. Aquatic herbicides are used in an attempt to reduce the amount of invasive species in a lake, improve navigational access to lakes, and to control nuisance plant and algae growth. Using chemical herbicides is seen as a short-term method to control heavy growths of aquatic plants. They are seen as inexpensive, easy, convenient alternatives to other control options. However, these herbicides can irreversibly negatively affect the lake's ecosystem by drifting from the application area to areas of important native aquatic plant communities.

Herbicides aren't fully effective and do not provide long-term relief. Research has shown that both Eurasian watermilfoil and the hybrid milfoil are not as affected by herbicides as some other more vulnerable plants. Hybrid milfoil has shown resistance to chemical treatments, with research suggesting that certain strains may have higher tolerance to commonly utilized aquatic herbicides. Therefore, the use of aquatic herbicides to help reduce invasive species is not considered a viable option for Lake Ripley.

5.3 Permit Authority

The District carries out its mechanical harvesting program in accordance with an operating permit issued by the Wisconsin Department of Natural Resources. This permit must be renewed every five years and expired on 12/31/2021. The permit grants authority to the District to conduct harvesting operations under Section 23.24, Wisconsin Statutes, and Administrative Code NR 109. Harvesting is only allowed in approved locations and using approved methods. Annual reports must be submitted to the Wisconsin DNR by November 1st of each year. At a minimum, these reports should describe hours worked, locations harvested, total acres harvested, amount of plant material removed, and the types and relative amounts of each species harvested.

NOTE: A Wisconsin DNR permit is not currently required for manual cutting and raking if the area of plant removal is kept to a contiguous, maximum width of 30 feet along the shoreline and is not located within a designated sensitive area. Any piers, boat lifts, swim rafts, and other recreational devices must be located within the 30-foot zone. All cut plants must be removed from the water. A permit is presently required if the plant removal area is more than 30 feet wide along the shoreline, or if the area is within a designated sensitive area.

5.4 History of Harvesting

The District began the weed harvesting program in 2001 to decrease the growing populations of the two invasive species found in Lake Ripley: Eurasian watermilfoil and curly-leaf pondweed. The original purpose of the DNR's Mechanized Aquatic Plant Management Program was to focus on controlling known invasive aquatic species, but over the years the program has grown to include nuisance control.

In 2006, the District found a suspected hybrid of Eurasian and northern watermilfoils. By 2012, the hybrid was beginning to show a significant increase in frequency. Two samples were sent to the DNR for identification in 2014, and both samples were verified as hybrid watermilfoil. After 2012 the District began to see an increase in the amount of loads that were being harvested from the lake. EWM is a prolific grower, especially when there are nutrients available to support quick growth.

Since 2012, the District has focused on reducing the amount of EWM, CLP, and the hybrid milfoil in the lake. The crew honed in on the specific problem areas within the DNR-approved map, and over the next few years we began to notice a reduction in the amount of loads being harvested. In 2020, the District revised the harvesting map to include areas of nuisance plants, so community navigational lanes could be created for property owners along Lake Ripley. These navigational lanes are created to serve as a "two-way street" for vessels to easily get in and out of their pier clusters without damaging the plant community, resuspeding sediment, or creating prop-chop.

The revised map has created community navigational lanes and has reevaluated the areas in which the invasive plants are the most dense. This map has allowed the District to see improvements to the lake during the summer such as less prop-chop accumulating on the shores, community lanes being used, a small reduction in the summer's phosphorus level, and an increase in the amount of loads harvested since 2018.

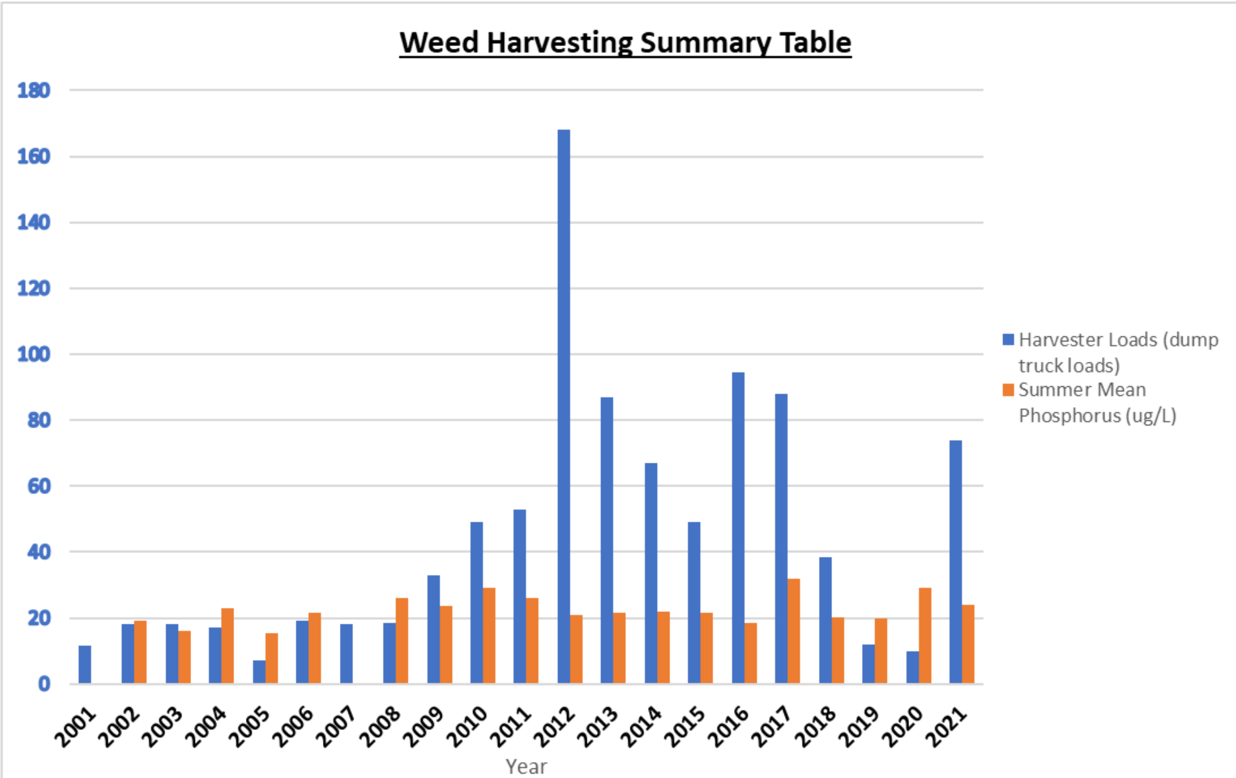


Figure 10: A table showing the amount of harvester loads

5.5 Equipment

The District currently owns and operates a 2015 Aquarius Systems' Model HM-420 mechanical harvester with a 7.0-foot cutting width, 5.5-foot cutting depth, 10.8-19.8" draft, and a 440 cubic feet capacity (10,000 lbs.). It was purchased new, for $129,000 with the help of a 50% matching grant through the Wisconsin Waterways Commission.

The harvester is constructed upon a low-draft barge controlled by side-mounted paddle wheels, and is equipped with one horizontal and two vertical cutter bars that can be hydraulically positioned. Hydraulic conveyors built into the harvester hoist cut plant debris onto the deck of the barge. When full, the plant material can be transported back to shore to be off-loaded into an awaiting dump truck using a shore-conveyor system.

Ancillary equipment presently includes an Aquarius SC-23 28.5-foot shore conveyor, purchased in 2015, a 1992 International dump truck, and a 2015 42-foot Aquarius Systems' TR-23 harvester trailer with a mounted electric winch. A Lowrance HDS12 Gen 3 GPS system was purchased new in 2018 for approximately $3,000 with a 50% matching grant through the WDNR.

At the close of each season, all equipment is cleaned, inspected, lubricated and winterized for storage purposes. The equipment is currently stored in a cold-storage shed located at the Oakland Town Hall.

The District rents storage from the Town of Oakland. The District has a month-to-month lease agreement with the Town of Oakland, renegotiated in 2020 for winter storage of the harvester and other equipment.

5.6 Staging Area and Disposal Site

During summer operations (approximately mid-June to late-October), the harvester, shore conveyor and dump truck are parked at the Hoard-Curtis Scout Camp on Lake Ripley. The District currently rents the Camp property during the operating season.

Many farmers are willing to accept aquatic plants as they are used as a source of nutrients (2.5% nitrogen, 0.6% phosphorus, and 2.3% potassium) and can add valuable, seed-free organic matter to the soil. Locating a disposal site in close proximity to the off-loading conveyor station is one of the keys to managing costs and increasing program efficiency. Harvested plant material is currently trucked to the Rude Farm, located at W9156 US Highway 12 in Cambridge, for composting. This location is ideal since it is less than a mile from the staging area.

5.7 Staff

Weed-harvesting staff currently consists of operators who are trained and supervised by the District's Lake Manager. All weed harvesting operators annually attend an "Aquatic Weed Harvesting Seminar" through Aquarius Systems to stay up to date on safety training, general harvester maintenance and equipment improvements.

These part-time, seasonal employees are in charge of operating and maintaining the machinery on an as-needed basis. They are paid on an hourly wage basis and are covered by Workers' Compensation Insurance. We offer a competitive wage. Operators are required to comply with a "Weed Harvesting Operations Plan" that was adopted in 2008 and is updated as needed. For more information about this program, please contact the District office.

5.8 Location of Plant Management Activities

Mechanical harvesting should be used to try to control the two known invasive species in Lake Ripley, Eurasian watermilfoil and curly-leaf pondweed, and also to create community navigational lanes for riparian owners to access the main body of the lake. The District's original weed harvesting map was created in 2006; the map had become inaccurate and was updated in 2021 with help from the Regional Lakes Biologist and the Fisheries Biologist for the southeast region of Wisconsin.

Our weed harvesting program's main two goals are, 1) to create accessible navigational lanes that lead to the main body of the lake, and 2) reduce the density of Eurasian watermilfoil and curly-leaf pondweed. All three of the lanes in the southeast bay are in proposed Critical Habitat Designation areas. The decision to create community navigational lanes within these areas was due to the heavy riparian traffic coming off multiple piers and creating their own access to the lake, consequently creating a large amount of propchop and harming the native plant community. By creating community lanes, the District has been able to reduce the amount of resuspended sediments, prop-chop, and reduce the amount of native plants being harmed.

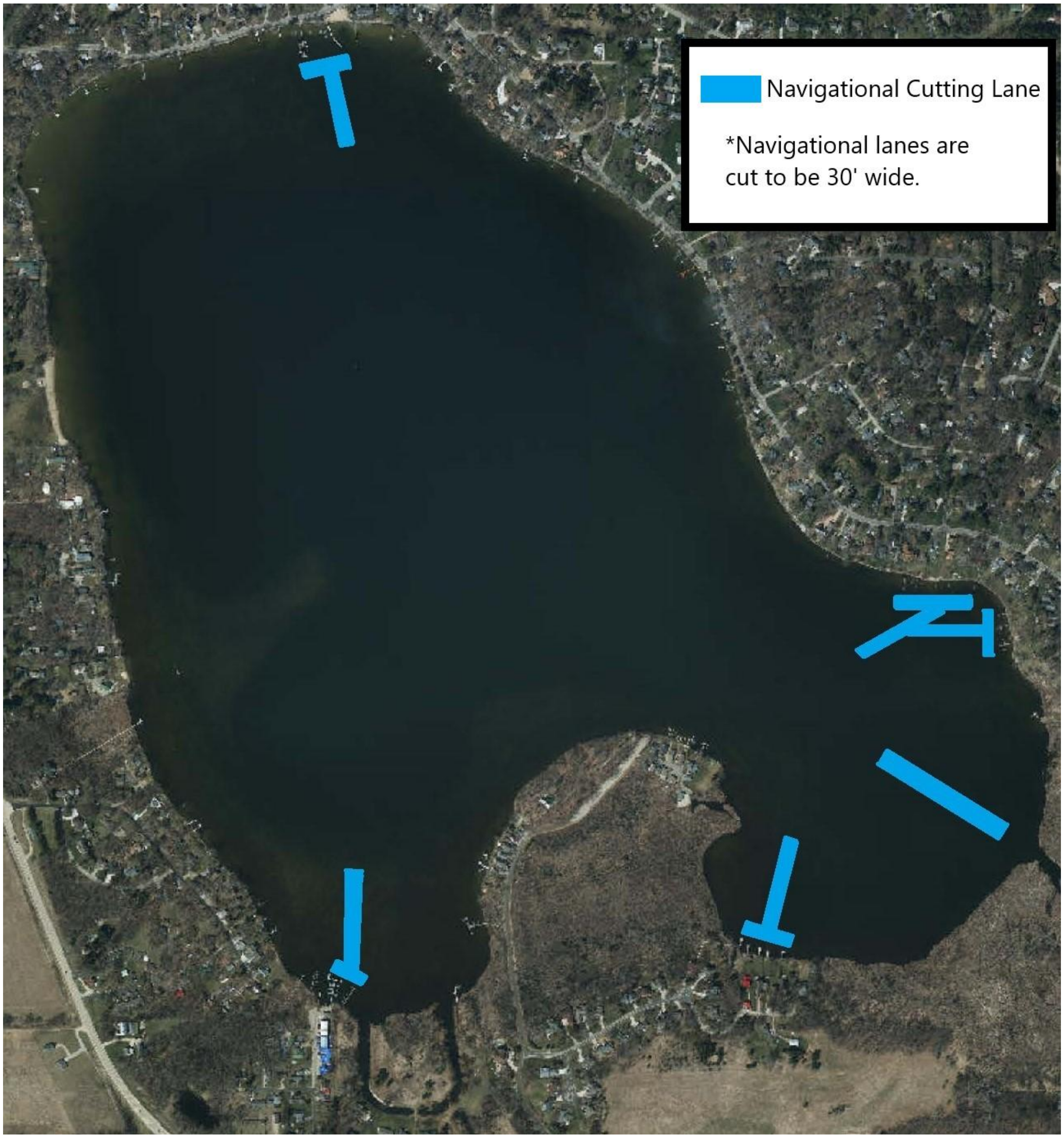


Figure 11: Community navigational lanes to be cut by the District's weed harvester.

CHAPTER 6 - MANAGEMENT GOALS AND RECOMMENDATIONS

Lake Recreational Goals

Recreational Lake Use Goal: Ensure safe and fair multipurpose, low-impact recreational use of the lake while protecting the lake's health and shorelines.

Recreational Lake Use Actions:

- Protect the full hours of the slow-no-wake ordinance by continuing to support the Oakland Police Department.
- Perform a boat census survey every summer to continue assessing the carrying capacity of the lake.
- Work with the Town of Oakland to pass an ordinance that "gives the lake a break" from speed boats, one day every week, preferably Mondays.
- Continue organizing and participating in a summer and/or fall "Pontoon Classroom" to teach students and adults about lake ecology.
- Conduct a public input survey every 10 years.

Fast Boating Goal: Maintain community navigational lanes and safety protocols for our recreational fast boat activities while protecting the lake, the shoreline, and other recreational opportunities.

Fast Boating Actions:

- Work with the Town of Oakland to pass an ordinance that restricts artificial wake enhancement on Lake Ripley to protect aquatic plant communities as well as protect the shorelines from erosion which would lessen water quality.

Water Quality Goals

Water Quality Goal: Maintain or enhance current water quality standards including: phosphorus summer mean concentration as close to 23 ug/L as possible, summer mean chlorophyll-a concentration 7 ug/L, summer Secchi-disk transparency at 7 feet or more, and a TSI average at 50 or below.

Water Quality Actions:

- Create a water budget to assess the effects of climate variability and human activities within our watershed.

- Use water loggers to monitor continuous flow within Lake Ripley to collect data on phosphorus loading, among other nutrient parameters.
- Continue educating boaters about invasive species through the Clean Boats, Clean Waters program at the public launch every summer.
- Work with the Town of Oakland to help address any problems associated with runoff concerns due to the rebuilding of Ripley Road in 2017-18.
- Designate additional Critical Habitat Designations or Sensitive Areas in Lake Ripley.
- Continue cost-share program which helps prevent shoreline erosion.
    - Continue promoting native plant buffers along shorelines through our native plant sale.
- Continue to use Ripples to inform the public about ongoing water quality issues.

Water Quality Sampling Goal: Measure the health of Lake Ripley's watershed with staff and volunteers, utilizing applicable technologies to track trends and identify sources of pollutants.

Water Quality Sampling Actions:

- Continue collecting water quality parameters for the inlet stream to pinpoint any point sources of pollution, and to assess stream and lake health.
    - Collect total suspended solids, total phosphorus, temperature, DO, pH, flow, turbidity, and conductivity at four different sites along the inlet stream.
- Perform macroinvertebrate surveys (2x/season) at the inlet and outlet to evaluate the current health of the streams within the watershed.
- Continue participating in the Citizen Lake Monitoring Network program through conducting monthly water quality monitoring at the deep hole, per DNR schedule and protocol. Parameters collected include chlorophyll-A, phosphorus, Secchi disk, temperature, and dissolved oxygen. This data is used to analyze lake trends and identify needs.

Habitat Goals

Aquatic Plants Management Goal: Protect and enhance the existing diverse native aquatic plant community while limiting the spread of invasive species in Lake Ripley.

Aquatic Plant Management Actions:

- Repeat the point-intercept aquatic plant inventory survey for Lake Ripley in 2025 and 2030 to keep track of community changes and the appearance or spread of invasive species.
- Complete genetic testing of milfoil from different areas around the lake to better understand the distribution of milfoils.
- Monitor aquatic plants in critical habitat areas annually per the DNR protocols.
- Repeat a shoreline and shallows survey following DNR protocols in 2025 and 2030 to track

any changes to the shoreline.

- Continue to educate landowners about the value of native aquatic plants and the removal laws. Critical habitat areas require permits for any plant control.
- Continue to use mechanical harvesting to manage invasive plant species in approved locations, per the DNR permit.
    - Build public support by clearly communicating the goals and objectives for the mechanical harvesting program and what is required to achieve desired outcomes.
- Update the Aquatic Plant Management plan in 2022.

Mechanical Harvesting Goals

Mechanical Harvesting Goal: Use mechanical harvesting to manage invasive or nuisance plant growth in approved locations. Mechanical harvesting is recommended as an effective method for removing Eurasian water-milfoil canopies, establishing edge habitat for fish, and opening boating lanes to improve access to open-water areas.

Mechanical Harvesting Actions:

- Selectively control invasive plant beds while minimizing disturbances to native and mixed-species plant communities. Target control efforts in a priority-driven manner that 1) preserves important ecological values of the larger plant community; 2) facilitates reasonable public access and navigation within high-traffic boating lanes, and 3) balances the needs of competing recreational uses.
- Analyze plant inventory data every five years (in 2025 and 2030) to determine if changes to the weed harvesting map are needed. Inventories are used to track changes in the aquatic plant community over time and to monitor harvesting impacts on species diversity, distribution, and densities within management zones.
- The Weed Harvesting Oversight Committee will meet at least two times a year to evaluate the efficacy and environmental impacts of the aquatic plant management activities.
    - Have the Weed Harvesting Oversight Committee meet with all harvesting employees at least twice a year to review and discuss the Weed Harvesting Operations Plan.
- Build public support and cooperation through our Ripples newsletter by clearly communicating the goals and objectives for managing aquatic plants, and the steps required to achieve the desired outcome.
    - Public-awareness campaigns should focus on the value of native aquatic plants, how to identify and control problem species, local and state rules related to the protection or control of aquatic plants, and the role and limitations of management programs.

- Encourage public to report observations and concerns as they occur, so concerns can be solved with all due speed

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