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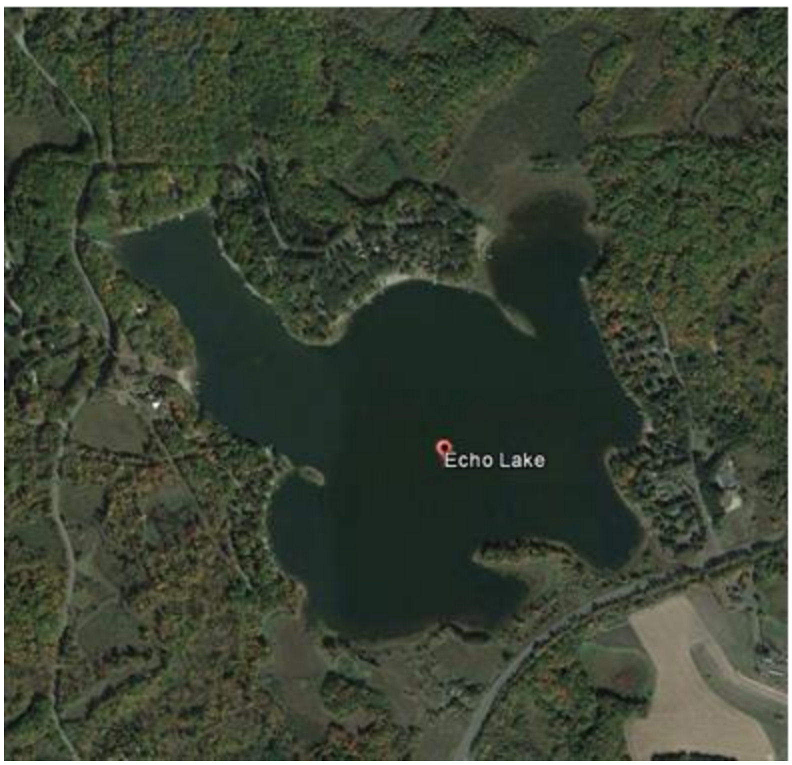
ECHO LAKE, BARRON COUNTY

2020-24 AQUATIC PLANT MANAGEMENT PLAN
WDNR WBIC: 2630200



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January 3, 2020

ECHO LAKE ASSOCIATION
TURTLE LAKE, WI 54889

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PREPARED FOR THE ECHO LAKE ASSOCIATION

INTRODUCTION

In 2004, Eurasian Watermilfoil (EWM) was discovered near the Echo Lake boat landing. This resulted in the formation of the Echo Lake Association (ELA) to manage this new invasive within the lake. A whole-lake, point-intercept aquatic plant survey completed in 2007 by the Wisconsin Department of Natural Resources (WDNR) and a littoral zone mapping by Blue Water Science documented EWM in more than 40 acres of the lake's littoral zone (Figure 1).

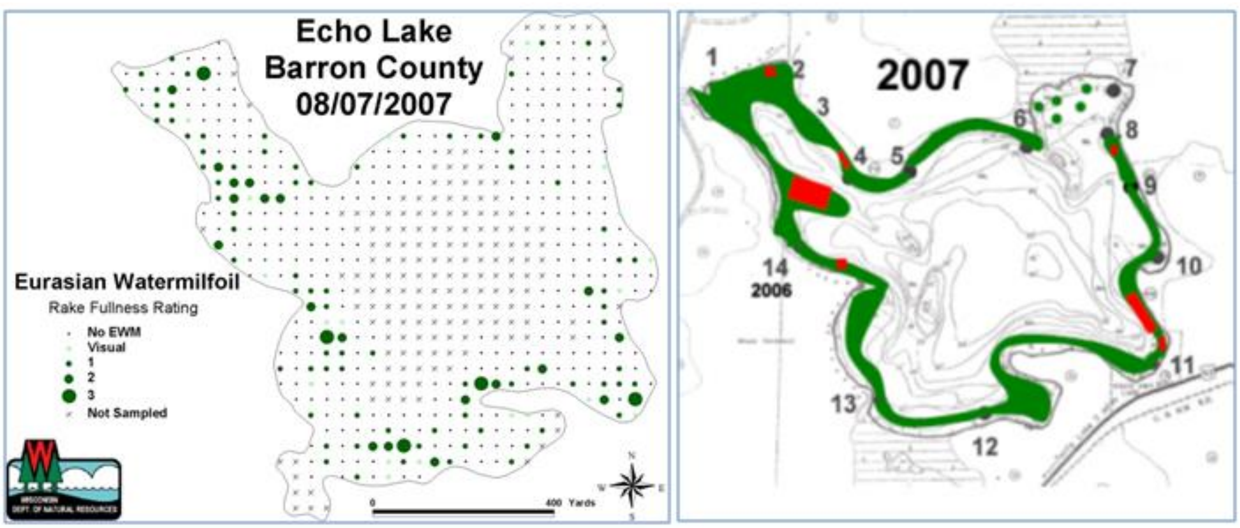


Figure 1: WDNR point-intercept survey (left) and Blue Water Science littoral zone mapping of EWM

An Aquatic Plant Management (APM) Plan was written in 2007 by an individual working with the WDNR on behalf of the Echo Lake Association (ELA). The main EWM management goal in the 2007 APM Plan was to reduce annual management actions to <10 acres. In 2008, the ELA completed a small-scale herbicide application followed by a much larger herbicide application of 28 acres in 2009. The purpose of the large-scale application in 2009 was to take out as much of the existing EWM as possible, leading to small-scale chemical treatments and physical removal as the main control method. This management scenario worked and continues to work, with small-scale herbicide application of 5.2, 0.63, and 3.37 acres in 2010, 2011, and 2012 respectively.

In 2012, the ELA contracted with SEH Inc. to update the 2007 APM Plan. Having met the <10 acres annually set in the 2007 APM Plan, the 2012 APM Plan set a new goal of <2.0 acres of EWM management annually.

To reach this level, the 2012 APM Plan established five goals to guide management. These goals were:

- Protect, preserve, and enhance the native plant species community in and around the lake.
- Monitor and manage EWM and other AIS in and around the lake and adjacent wetlands.

- Prevent the introduction of new aquatic invasive species and the spread of EWM from the lake to other lakes by implementing monitoring, inspection and education programs.
- Educate and inform the lake community about the importance of aquatic plants in the lake ecosystem and about management alternatives and appropriate management actions.
- Develop a better understanding of the lakes and the factors affecting lake water quality through continued and expanded monitoring efforts.

The goals, objectives, and actions in the 2012 APM Plan succeeded in meeting the ultimate goal of <2.0 acres annually. From 2013 through 2017, with the exception of 2014, the amount of EWM managed did not exceed 2 acres. In both 2015 and 2016 the only physical removal was used to control EWM in the lake. In 2017, less than an acre of EWM was chemically treated, and in 2018 only 1.49 acres was chemically treated.

2017 was the fifth year of management implementation for the 2012 APM Plan. So in 2017, the ELA received an AIS Education, Prevention, and Planning grant to repeat the whole-lake, point-intercept, aquatic plant survey and to rewrite 2012 APM Plan. This document is the updated APM Plan for Echo Lake covering management from 2020-2024.

ECHO LAKE ASSOCIATION

The Echo Lake Association (ELA) was formed around 2005 in response to finding EWM in the lake in 2004. Initially, its focus was on managing EWM only but has since expanded to include support for water quality testing, shoreland improvement, fish stocking, AIS education, and watercraft inspection through the Clean Boats, Clean Waters program. Membership has been fairly consistent since its formation with somewhere around 40 of the 70 plus property owners on the lake being members. The ELA holds its annual meeting on the Sunday of Memorial Day Weekend at the end of the Cul-de-sac on 16-1/2 Ave. During the meeting, the ELA Board updates the constituency on management issues, presents the budget, conducts an AIS identification demonstration, and conducts any other business that may need attending too. In 2019, 35 people attended the meeting which is pretty consistent with past years.

In addition to the annual meeting, the ELA Board meets at least two other times during the year, once in the spring and once in the fall.

PUBLIC PARTICIPATION AND STAKEHOLDER INPUT

A draft of the 2020-2024 APM Plan has been placed on the LEAPS project webpage at www.leapsllc.com for review by the ELA Constituency. The LEAPS webpage also has the results of the last whole-lake, point-intercept survey, 2019 EWM management plans, and the WDNR permit for chemical treatment in 2019. Several ELA Board Members have had a chance to review the APM Plan and management recommendations made within it. Management actions in the APM Plan were presented to the ELA board in the fall of 2018. This plan has been reviewed and approved for use by the WDNR.

OVERALL MANAGEMENT GOAL

The overall management goal for Echo Lake is to maintain or enhance the quality and usability of the lake through AIS management, educational outreach, and shoreland best management practices. Aquatic plant management on Echo Lake will be focused on maintaining or reducing the level of EWM within the lake. Increasing the quality of the shoreland habitat and reduction of nutrient loading through property owner outreach and education is also a large part of this plan.

IMPLEMENTATION GOALS

The following is a list of goals defined in this Aquatic Plant Management Plan for Echo Lake. These can also be found in Appendix A along with the objectives and actions associated with each goal.

Goal 1: Support and implement EWM management efforts that minimize negative impacts to the native plant communities

Goal 2: AIS education and prevention

Goal 3: Promote and support nearshore, riparian, and watershed best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Echo Lake.

Goal 4: Engage lake residents and visitors to be active lake stewards.

Goal 5: Implement the Echo Lake Management Plan effectively and efficiently.

WISCONSIN AQUATIC PLANT MANAGEMENT STRATEGY

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

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

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

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

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

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

In many cases, the development of long-term, integrated aquatic plant management strategies to identify important plant communities and manage nuisance aquatic plants in lakes, ponds or rivers is required by the State of Wisconsin. To promote the long-term sustainability of our lakes, the State of Wisconsin endorses the development of APMPs and supports that work through various grant programs.

There are many techniques for the management of aquatic plants in Wisconsin. Often management may mean protecting desirable aquatic plants by selectively hand pulling the undesirable ones. Sometimes more intensive management may be needed such as using harvesting equipment, herbicides or biological control agents. These methods require permits and extensive planning.

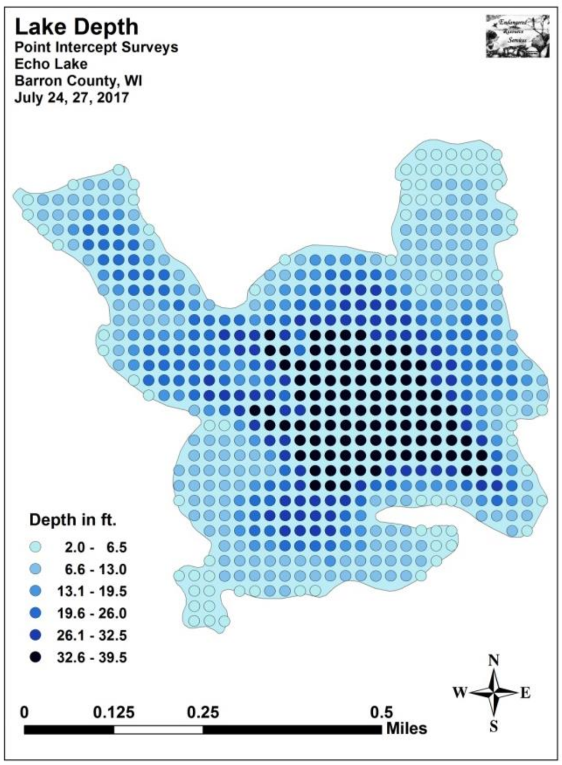
While limited management on individual properties is generally permitted, it is widely accepted that a lake will be much better off if plants are considered on a whole lake scale. This is routinely accomplished by lake organizations or units of government charged with the stewardship of individual lakes.

LAKE CHARACTERISTICS

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

PHYSICAL CHARACTERISTICS

Echo Lake is a 172 acre seepage lake in west central Barron County located in the Town of Almena. The lake reaches its maximum depth of 41ft in the southeast corner of the central basin and has an average depth of 20ft. Bottom substrate is variable with sandy muck bottoms in most bays and rock/sand bars along most points and around the lake's islands (Figure 2).



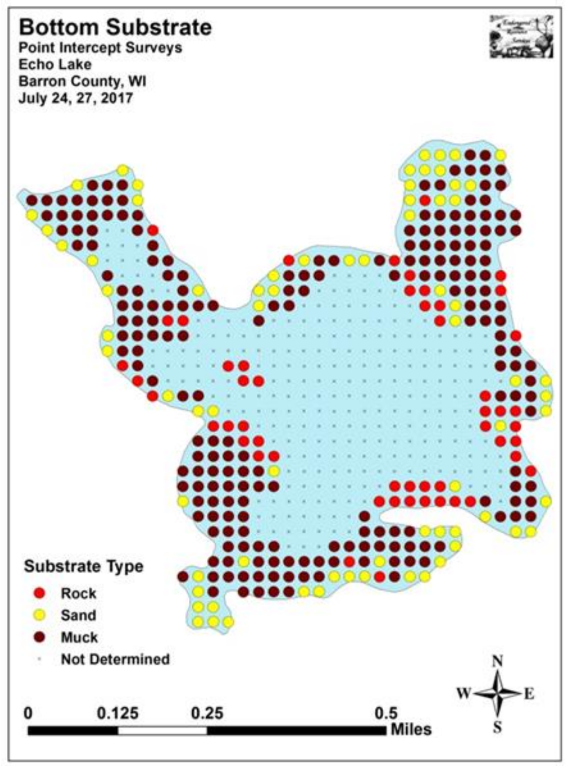


Figure 2: Lake depth and bottom substrate

WATER QUALITY

Water clarity and water chemistry are important indicators of water quality. Secchi disk readings of water clarity have been collected by Wisconsin Citizen Lake Monitoring Network (CLMN), formerly the Self-help Lake Monitoring Program, volunteers since 2004. The WDNR website indicates CLMN volunteers have collected water quality data from 2004-2017 with a few years lacking any or sufficient data, for Secchi readings of water clarity. Lake levels have varied greatly from incredibly low in 2010 because of an extended drought period to incredibly high in 2017 due to several years of abnormally high precipitation (Figure 3).

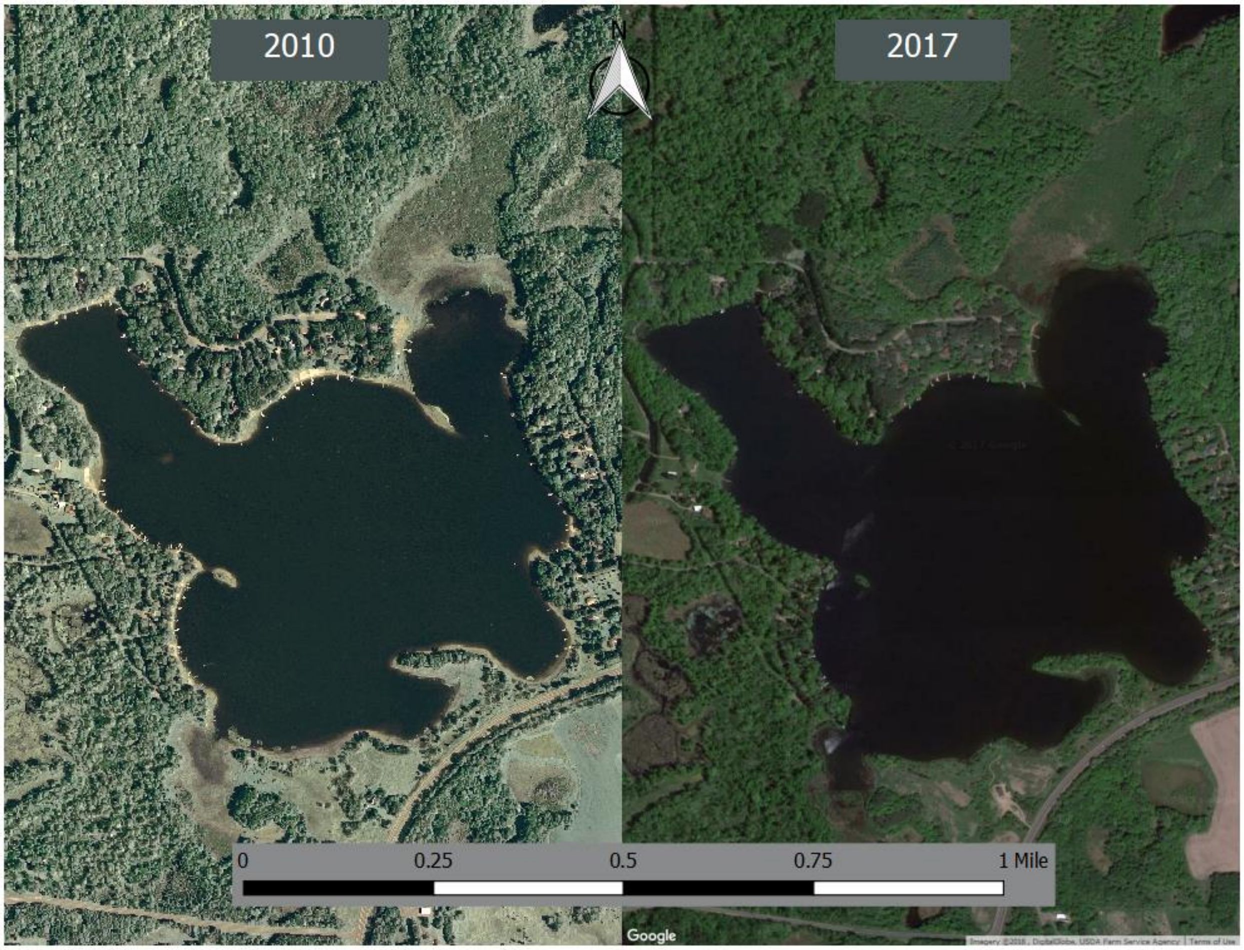


Figure 3: Lake level comparison, 2010 and 2017

The appearance of the water in the lake is predominately clear with a few murky readings. The color of the water ranged from blue to green to brown with green being the predominant reported coloration. Perception is based on a volunteers' familiarity with lake conditions at any given time of year and was predominantly listed as being "beautiful, could not be nicer" or "very minor aesthetic problems". 2012 was the only year that appears in the CLMN data where the lake appeared to be impaired by algae growth.

WATER CLARITY

Water clarity is a measurement of how deep sunlight can penetrate into the waters of a lake. It can be measured in a number of ways, the most common being an 8" disk divided into four sections, two black and two white, lowered into the lake water from the surface by a rope marked in measurable increments (Figure 4). The water clarity reading is the point at which the Secchi disk when lowered into the water can no longer be seen from the surface of the lake. Water color (like dark water stained by tannins from nearby bogs and wetlands), particles suspended in the water column (like sediment or algae), and weather conditions (cloudy, windy, or sunlight) can impact how far a Secchi disk can be seen down in the water. Some lakes have Secchi disk readings of water clarity of just a few inches, while other lakes have conditions that allow the Secchi disk to be seen for dozens of feet before it disappears from view.

Figure 4: Black and white Secchi disk

Figure 5 shows the average summer (June-August) Secchi disk readings since CLMN began in 2004. In 2017, the average summer (June-Aug) Secchi disk reading for Echo Lake at the Deep Hole was 8.67 feet. The average for the Northwest Georegion was 8.1 feet putting Echo Lake just above average for the area. The Secchi readings have a fairly wide range from as low as 8.0 feet in 2012 up to 18.9 feet in 2010, but the trend line in Figure 5 shows a strong downward trend suggesting that overall water quality declined since monitoring first began.

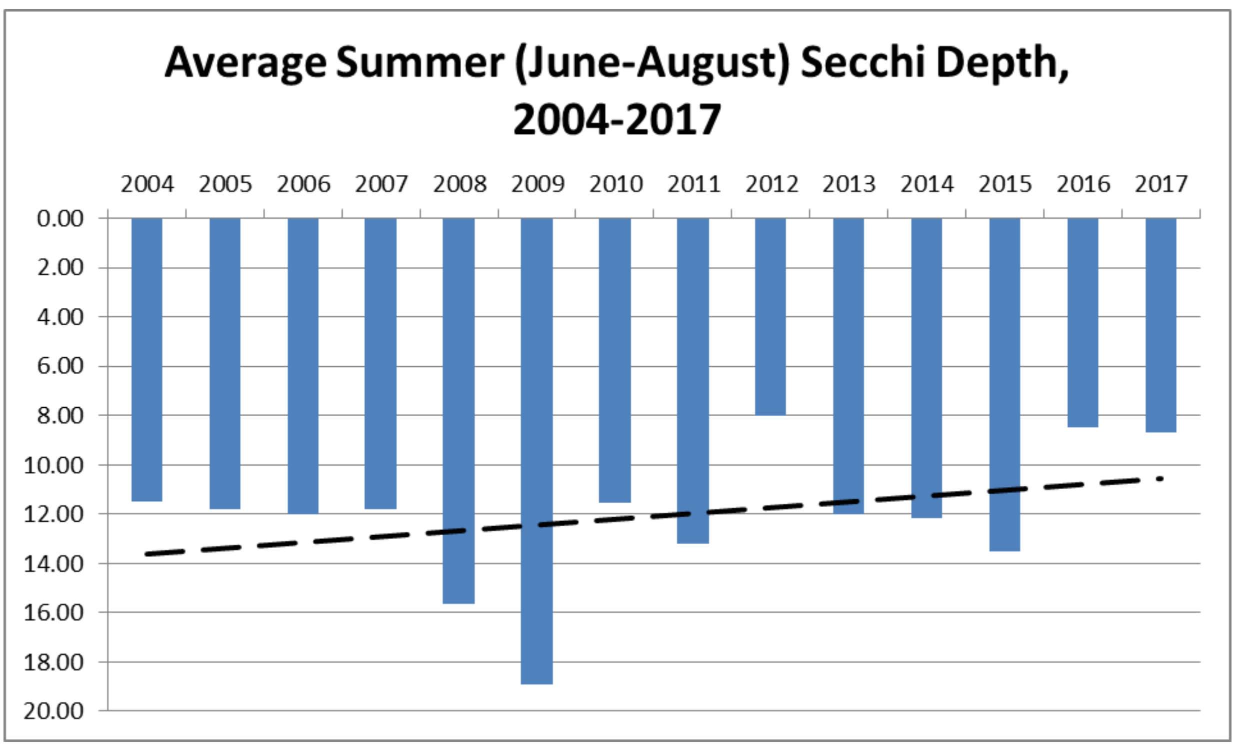


Figure 5: Average summer (June- August) Secchi disk readings at the Deep Hole

Typically the summer (June-Aug) water was reported as CLEAR and GREEN. This suggests that the Secchi depth may be mostly impacted by algae. Algal blooms are generally considered to decrease the aesthetic appeal of a lake because people prefer clearer water to swim in and look at. However, the overall perception of Echo Lake, as reported by volunteers, is rarely considered negative with only 3 of the total 91 reports being "5-Enjoyment substantially impaired (algae)" while the rest are either "1-beautiful, could not be nicer" or "2-very minor aesthetic problems." Algae are always present in a balanced lake ecosystem. They are the photosynthetic basis of the food web. Algae are eaten by zooplankton, which are in turn eaten by fish.

TROPHIC STATE INDEX

One of the most commonly used metrics of water quality is the trophic state of a lake. The trophic state is defined as the total load of biomass in a waterbody at any given time (Carlson & Simpson, 1996). To determine the trophic state of any given lake, the Tropic State Index (TSI) is generally used. This index uses the three main variables of Secchi depth, total phosphorus, and chlorophyll concentration. TSI values are technically limitless, but when applied, they almost always fall between 0 and 100. To make sense of these values, they are broken into different trophic states. The four main trophic states are oligotrophic (TSI<40), mesotrophic (TSI 40-50), eutrophic (TSI 50-70), and hypereutrophic (TSI>70) (Figure 6). Oligotrophic lakes are usually very clear, clean lakes with low nutrient levels. Mesotrophic lakes are moderately clear with some nutrients and more plants present within the system. Eutrophic lakes have excess nutrients that support a great deal of algae growth, and may have a large aquatic plant community. Hypereutrophic lakes are typically very green with dense algae and limited plant growth.

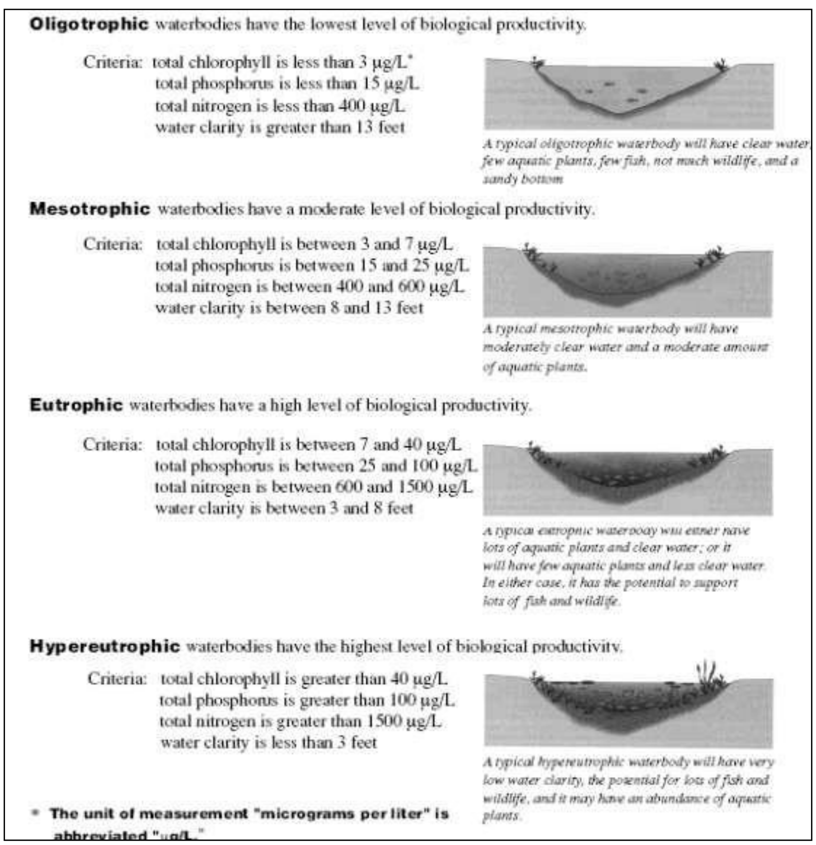


Figure 6: Trophic status in lakes

From 2004-2017, Echo Lake has bounced between being oligotrophic and mesotrophic depending on the year (Figure 7). Secchi depth data has been collected on a consistent basis since 2004. The Secchi depth TSI has varied from 34.9 in 2009 up to 47.5 in 2012. The overall average for Secchi TSI depth is 41.6 which suggests a mesotrophic system that is bordering an oligotrophic state. Based on the Secchi depth data, Echo Lake is considered to be a mesotrophic lake which borders on oligotrophic conditions fairly regularly.

Other chemical variables, most commonly total phosphorus and chlorophyll-a concentrations, are considered more accurate representations of the trophic state of a lake. With the exception of 2010, water chemistry data has been collected on a monthly basis during the summer since 2008. This includes chlorophyll-a concentrations and total phosphorus levels. This data shows annually higher TSI values than the Secchi data alone. The seasonal average for total phosphorus concentrations was 50 with a high of 53 in 2017 and a low of 48 in 2008. This suggests Echo Lake is on the border between a mesotrophic system and a eutrophic one. Chlorophyll values are generally considered the most accurate representation of a lake's trophic state because it is an indirect measurement of how much algae is present within the lake. In Echo Lake, the chlorophyll- a TSI values fall somewhere between the total phosphorus values and the Secchi values. The average seasonal TSI for chlorophyll-a was 45.9 with a high of 49.5 in 2012 and a low of 42.3 in 2009. This means Echo Lake is a fairly stable mesotrophic lake. Trend lines for total phosphorus and chlorophyll-a reflect a slight increase in concentration with total phosphorus increasing at a noticeably higher rate (Figure 7). Increasing phosphorus levels can be indicative of deteriorating water quality which may lead to increased levels of algae and visibly more green water. The direct and indirect sources of phosphorus in the lake have not been quantified, but future studies could do this.

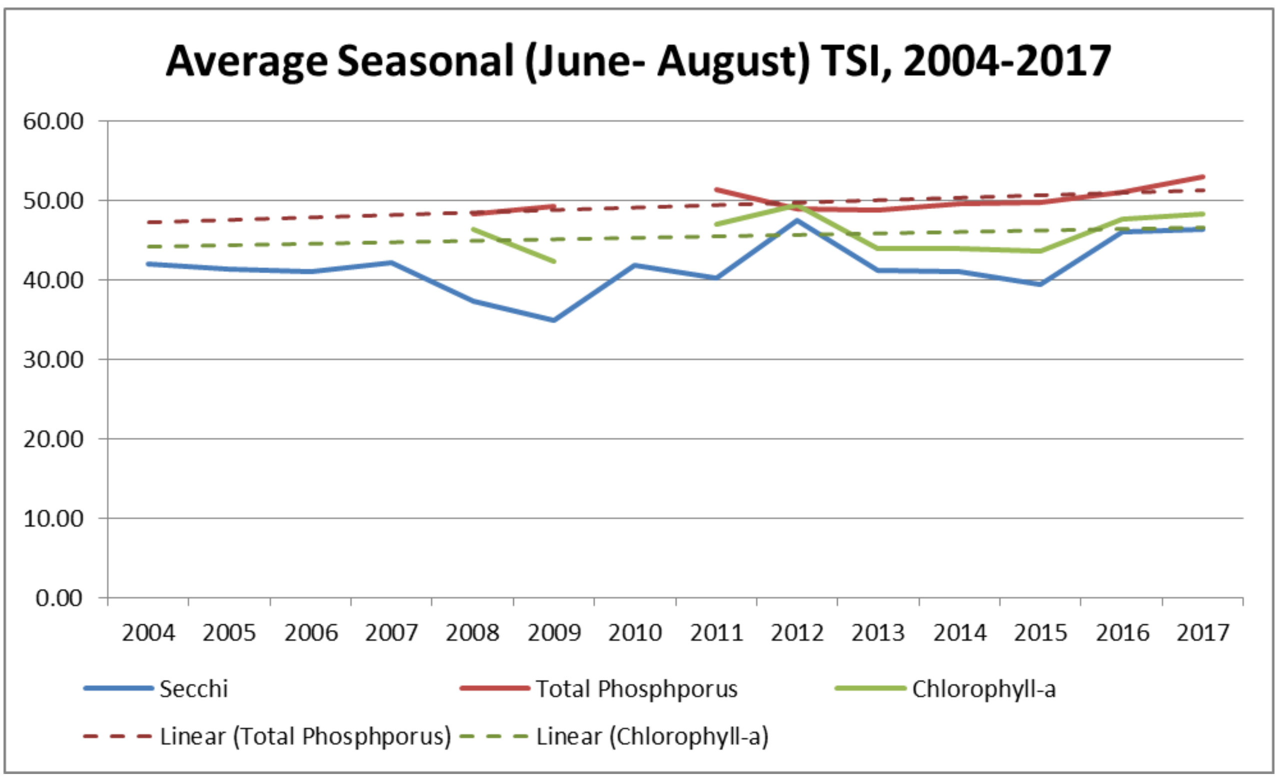


Figure 7: Average Seasonal Trophic State Index

TEMPERATURE AND DISSOLVED OXYGEN

Temperature and dissolved oxygen are important factors that influence aquatic organisms and nutrient availability in lakes. As temperature increases during the summer in deeper lakes, the colder water sinks to the bottom and the lake develops three distinct layers as shown in Figure 8. This process, called stratification, prevents mixing between the layers due to density differences which limits the transport of nutrients and dissolved oxygen between the upper and lower layers. In most lakes in Wisconsin that undergo stratification, the whole lake mixes in the spring and fall when the water temperature is between 53 and 66°F, a process called overturn. Overturn begins when the surface water temperatures become colder and therefore denser causing that water to sink or fall through the water column. Below about 39°F, colder water becomes less dense and begins to rise through the water column. Water at the freezing point is the least dense which is why ice floats and warmer water is near the bottom (called inverse stratification) throughout the winter.

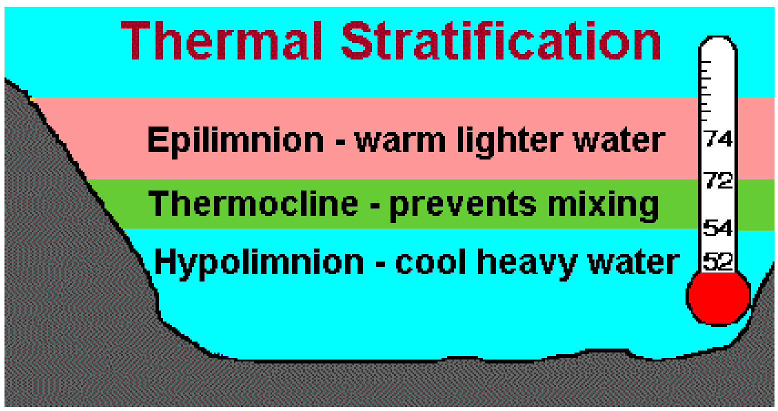


Figure 8: Summer thermal stratification

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

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

Echo Lake stratifies, at the deep hole, relatively late in the summer and remains stratified fairly late into the fall with several years having data that shows the lake remaining clearly stratified well into October. The thermocline at the Deep hole sets up at approximately 20-ft deep, so for a large portion of the season the hypolimnion (Figure 8) remains anoxic.

FISHERIES AND WILDLIFE

Echo Lake is considered a northern pike, largemouth bass, and panfish fishery. WDNR Fish Managers report that the bass population has typically been strong with fish averaging 9 to 13 inches. Northern pike are common but appear to have slow growth rates and populations fluctuate with lake level. Panfish are abundant with bluegill and black crappies present. Yellow perch are present but in very low numbers. Historically, bluegills in Echo Lake have been slow-growing with an over-abundance of small, stunted fish. White suckers are present in low numbers, but rough fish like carp are not.

Walleye fingerlings and fry have been introduced to Echo Lake numerous times since the 1940's to increase predator fish in the lake. More continuous stocking of walleyes began in the mid-eighties and continues in the current year. In the late eighties and early nineties stocking of larger walleye fingerlings helped to maintain a moderately low population of walleyes in Echo Lake. During this same time frame bluegill size and growth rates increased suggesting that walleye stocking to increase predation on smaller bluegills was having a positive effect on the lake. Since then, only small walleye fingerlings in the 1-2 inch range have been stocked in the lake. A WDNR baseline shocking survey in October of 2007 did not recover any walleyes even though over 37,000 fingerlings have been stocked since 2001.

A 2007 WDNR Fisheries report suggested bluegill populations had reverted back to pre-nineties conditions of stunted, slow-growing fish. The same report recommended that larger size walleyes be stocked in Echo Lake for several years in a row. The WDNR last stocked the lake in 2007 with the Walleye Club, which is not affiliated with the ELA, assuming that role in 2009. The Walleye Club has stocked between 1,000 and 4,400 large fingerling walleye every year since 2009 except 2012. These larger fish likely have better survival rates in the lake. It is conceivable that the number of stunted bluegills in the lake would decrease and growth rates would increase with the introduction of larger fingerlings. There is currently no survey data to determine if the larger walleye fingerlings have been able to decrease the number of small panfish within Echo Lake, but the next WDNR fisheries survey is scheduled to occur in 2018.

Historically, northern pike populations in Echo Lake seem to decline under low water conditions. Protection of shallow, weedy, spawning habitat around the lake is important if northern pike populations are to rebound naturally. Since walleye do not appear to be naturally reproducing in the lake, protection of gravel beds specifically for this purpose is not required.

Echo Lake is home to at least one pair of nesting loons and a pair of eagles. Beavers frequent the lake and usually maintain a hutch. Waterfowl may pass through but do not remain on the lake for any length of time. Bald eagles and spiny hornwort (an aquatic plant species of special concern in Wisconsin) are found within the immediate lake area. Echo Lake is classified as a "shallow, hard bottom, seepage lake" making it a community of interest in Wisconsin. The Natural Heritage Inventory (NHI) database contains recent and historic observations of rare species and plant communities. These observations are current as of July 18, 2017. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). There are seven plant species: Long-stem water-wort, Robbins' spikerush, snail-seed pondweed, water-thread pondweed, spotted pondweed, Vasey's pondweed, Torrey's bulrush; and four northern communities: (dry-mesic forest, mesic forest, sedge meadow, and wet forest) that have been documented in or near the Echo Lake watershed. The plant species are all aquatic plants, and three of these species (long-stem waterwort, water-thread pondweed, and Vasey's pondweed) have been specifically identified in the lake during aquatic plant surveys.

The Echo Lake Watershed is one of several smaller watersheds which make up the larger Beaver Brook Watershed. The Beaver Brook Watershed is relatively small at 65 square miles (44,483 acres) and is located in southeastern Polk County extending into a portion of Barron County (Figure 9). It consists of 75 miles of streams and rivers, 1,801 acres of lakes and 5,965 acres of wetlands. The watershed is dominated by forest (31%), agriculture (26%) and grassland (22%) and is ranked high for nonpoint source (indirect pollution discharges) issues affecting streams and medium for nonpoint source issues affecting lakes and groundwater. Beaver Brook is a tributary to the Apple River below the Apple River Flowage. Streams in this watershed are impacted by agricultural land uses and may respond to nonpoint source pollution controls.

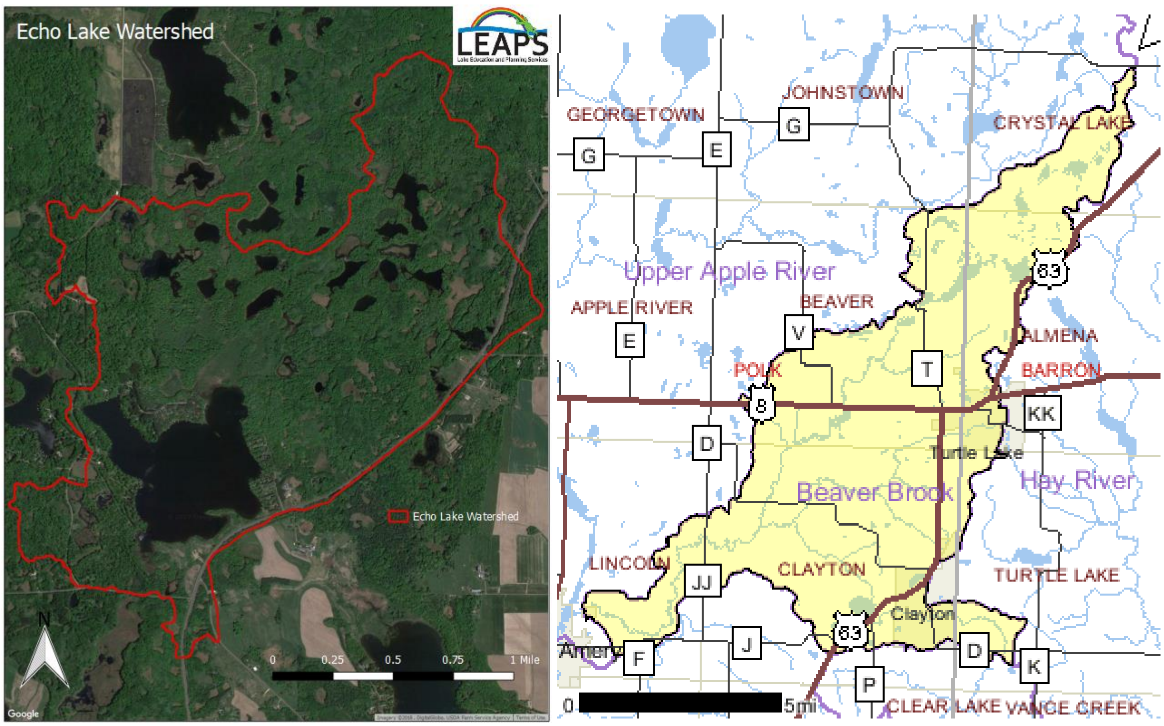


Figure 9: Echo Lake Watershed (left) and Beaver Brook Watershed (right)

The Echo Lake Watershed covers 2.54 square miles which accounts for approximately 4% of the entire Beaver Brook watershed. The land use within the Echo Lake Watershed is dramatically different than the land use throughout the entire watershed (Figure 10).79 % of the Echo Lake Watershed is covered by forest land with the next largest portion coming from wetlands. This is likely due to a large part of the watershed being covered by the Loon Lake Wildlife Area which has prevented this area from being developed or used for agriculture.

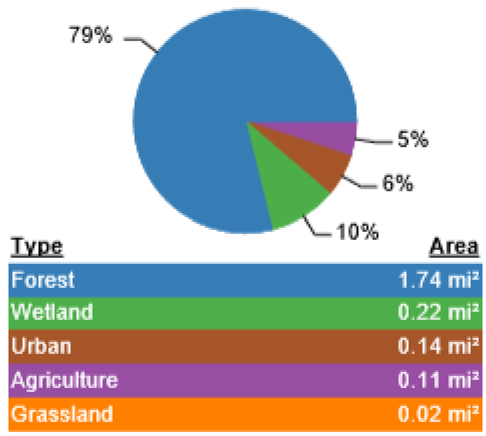


Figure 10: Land use in the Echo Lake Watershed

SOILS

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

There are also three sub groups (A/D, B/D, and C/D) these indicated the infiltration rate of the soils with respect to the water table. If the water table is high and blocking infiltration, these soils are considered to have a high runoff potential and placed into group D, but when the water table is lower, these soils are similar to the first grouping. The majority (79%) of the Echo Lake watershed fall into Group C soils. The remaining areas consist of 15% open water, 5% Group A/D, and 1% Group B soils (Figure 11). Group C soils usually have a fairly high amount of organic material which makes it easy for plant growth. However these soils also have a slow infiltration rate which makes for a high runoff potential when there is no buffer around the lake.

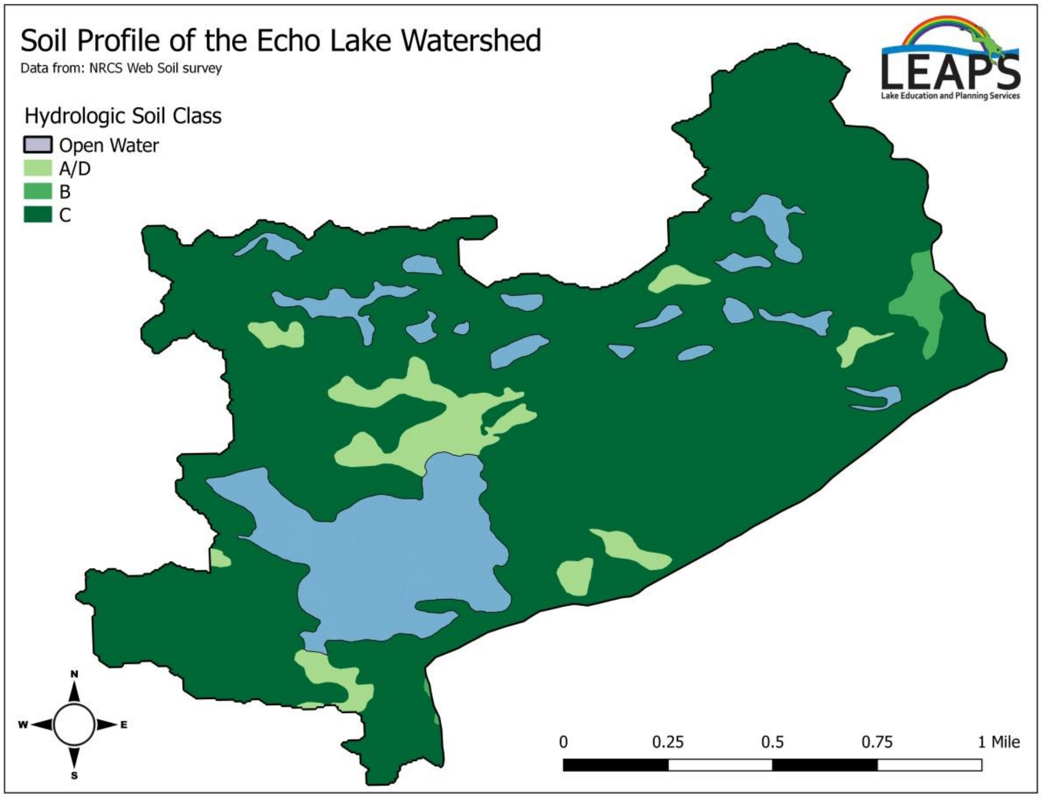


Figure 11: Hydrologic Soil Profile for Echo Lake Watershed

WETLANDS

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

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

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

There is a fair amount of wetland areas within the Echo Lake Watershed (Figure 12), but there are only two areas that border the lake. These areas are a large wetland complex along the northeast corner and a smaller wetland complex along the southwest corner of the lake. These wetland areas, particularly the northeast one, help filter out nutrients from other areas of the watershed. The areas without wetlands are fairly developed with residential lots. With minimal wetland areas to protect the lake if property owners decide to remove the buffers that protect the lake, runoff containing nutrients, sediments, and other pollutants from rainfall and snowmelt will be able to enter the lake more readily. This can lead to a reduction in water quality.

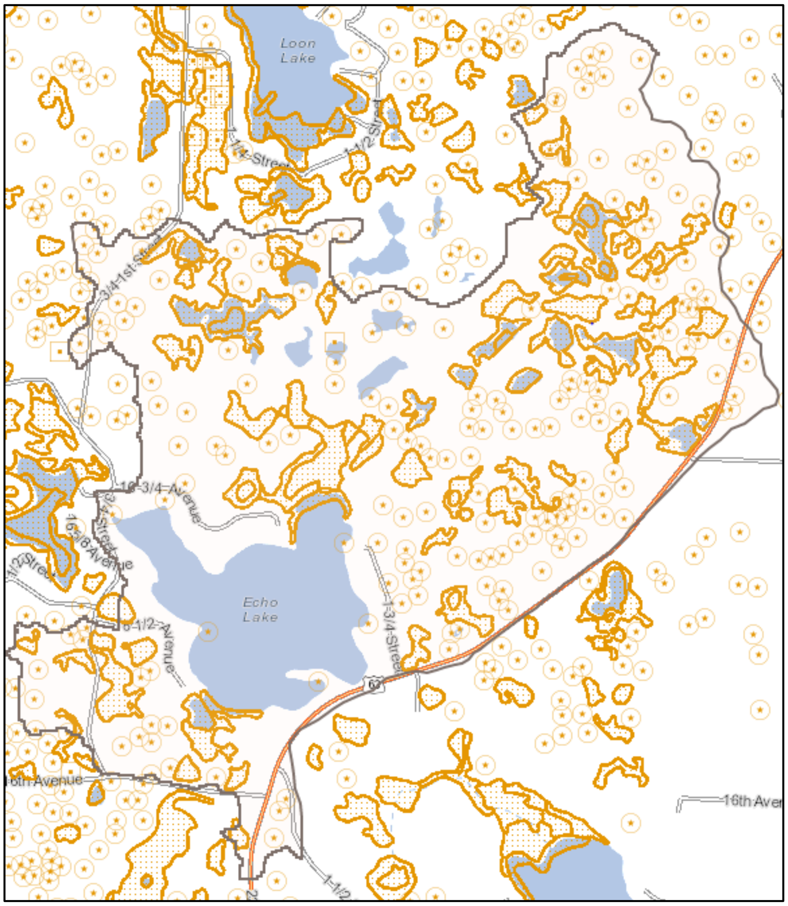


Figure 12: Wetlands within the Echo Lake Watershed

COARSE WOODY HABITAT (WOLTER, 2012)

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

CWH is often removed by shoreline residents to improve aesthetics or select recreational opportunities (swimming and boating). Jennings et al. (2003) found a negative relationship between lakeshore development and the amount of CWH in northern Wisconsin lakes. Similarly, Christensen et al. (1996) found a negative correlation between density of cabins and CWH present in Wisconsin and Michigan lakes. While it is difficult to make precise determinations of natural densities of CWH in lakes it is believed that the value is likely on the scale of hundreds of logs per mile. The positive impact of CWH on fish communities have been well documented by researchers, making the loss of these habitats a critical concern.

Fortunately, remediation of this habitat type is attainable on many waterbodies, particularly where private landowners and lake associations are willing to partner with county, state, and federal agencies. Large-scale CWH projects are currently being conducted by lake associations and local governments with assistance from the WDNR where hundreds of whole trees are added to the near-shore areas of lakes. For more information on this process visit: http://dnr.wi.gov/topic/fishing/outreach/fishsticks.html (last accessed on 1-4-2018). These types of projects are more formally called "tree drops" but now are called "fish sticks" (Figure 13).

Figure 13: Coarse woody habitat-Fishsticks projects

In June of 2017, the ELA sponsored a shoreline survey which included an assessment of the woody debris surrounding the lake. In this survey, woody debris was considered to be in no more than 2-ft of water, at least 5-ft long, and 4 inches in diameter. The survey only found 15 pieces of qualifying woody debris around the entire lake (Figure 14). The majority of the woody debris was found along the northwestern shoreline which has little development. Woody debris along the shoreline can help stabilize sediments, reduce the impact of wave action, and provide important habitat for fish, turtles, and birds. Fish sticks projects could have a positive impact on the lake as a whole and, if the ELA wishes to sponsor the grants, could be funded through the WDNR Healthy Lakes Initiative grant program.

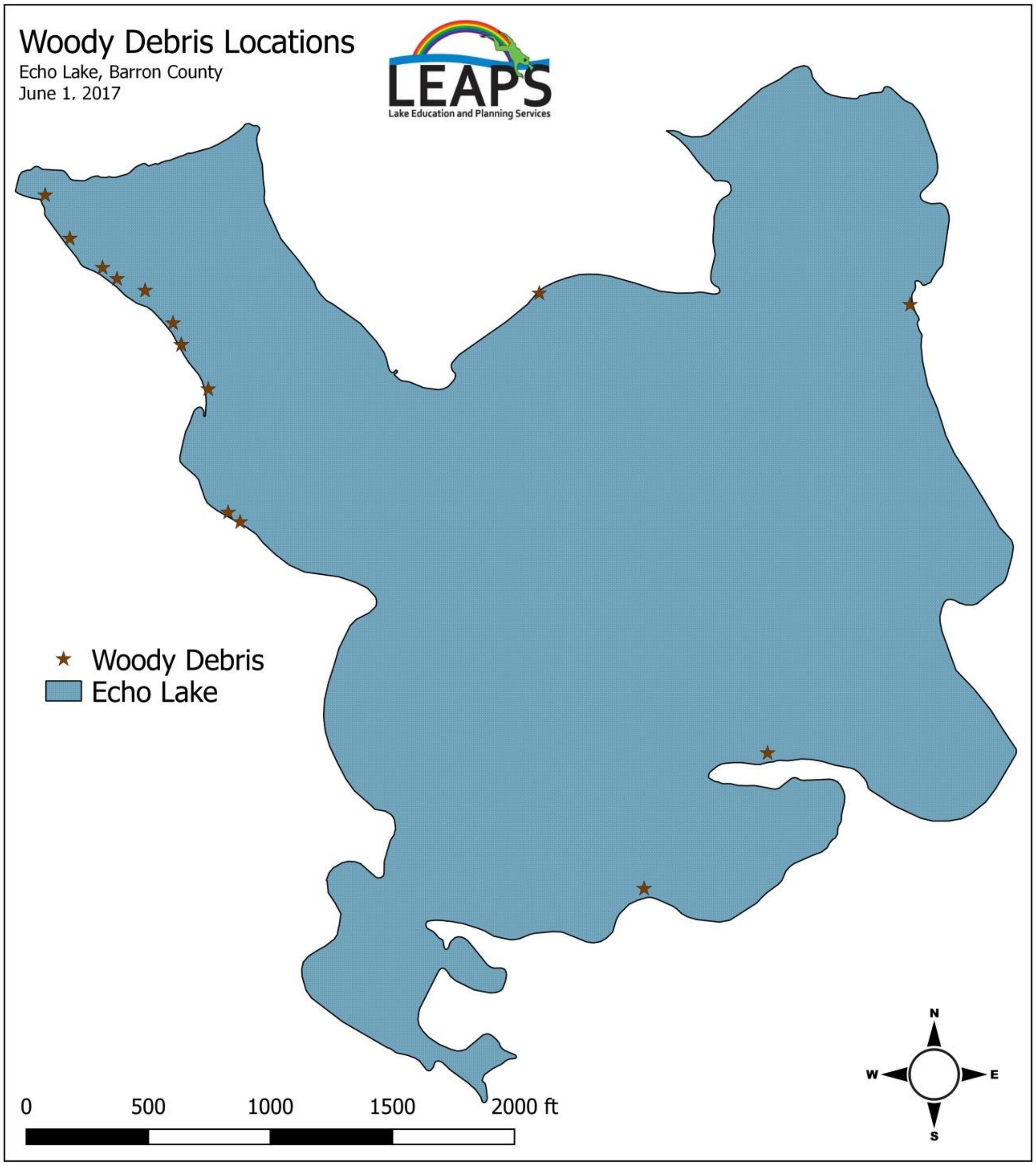


Figure 14: Woody debris within Echo Lake

SHORELANDS

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

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

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

Shorelands are critical to a lake's health. Activities such replacing natural vegetation with lawns, clearing brush and trees, importing sand to make artificial beaches, and installing structures such as piers, can cause water quality decline and change what species can survive in the lake.

PROTECTING WATER QUALITY

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

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

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

NATURAL SHORELANDS ROLE IN PREVENTING AQUATIC INVASIVE SPECIES

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

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

THREATS TO SHORELANDS

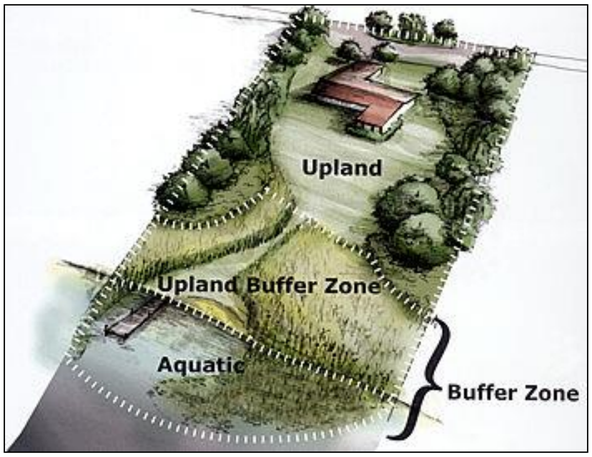
When a landowner develops a waterfront lot, many changes may take place including the addition of driveways, houses, decks, garages, sheds, piers, rafts, wells, septic systems, lawns, sandy beaches and more (Figure 15). These changes typically result in the compaction of soil, the removal of trees and native plants, and the addition of impervious (hard) surfaces, all of which alter the path that precipitation/runoff takes to the water. These changes can also harm important habitat for fish and wildlife, send more nutrients into the lake, and contribute to the decline of water quality.

Figure 15: Changes caused by shoreland development (predevelopment-left, post-development right)

Changing one waterfront lot in this fashion may not result in a measurable change in the water quality of the lake or stream. But cumulative effects when several or many lots are developed in a similar way can be enormous. A lake's response to stress depends on what condition the system is in to begin with, but bit by bit, the cumulative effects of each and every developed lake property reduces the ability of the shoreland to protect the lake. The good news is that there are proven shoreland best management practices that can minimize the negative impacts of shoreland development.

SHORELAND PRESERVATION AND RESTORATION

Native shoreland buffers on a given property can be maintained or preserved. Care can be taken to minimize disturbances to native shorelands when new development is contemplated. If a shoreline has already been altered, it can be restored. Shoreline restoration involves recreating buffer zones of natural plants and trees. Quality native shorelines can create higher property values, be more aesthetically pleasing, prevent the shore from eroding, and improve healthy fish and wildlife by providing habitat that supports the insects, invertebrates and amphibians which feed fish, birds and other creatures. Figure 16 shows the difference between a natural and unnatural shoreline adjacent to a lake home. More information about healthy shorelines can be found at the following website: http://wisconsinlakes.org/index.php/shorelands-a-shallows (last accessed 1-4-2018).



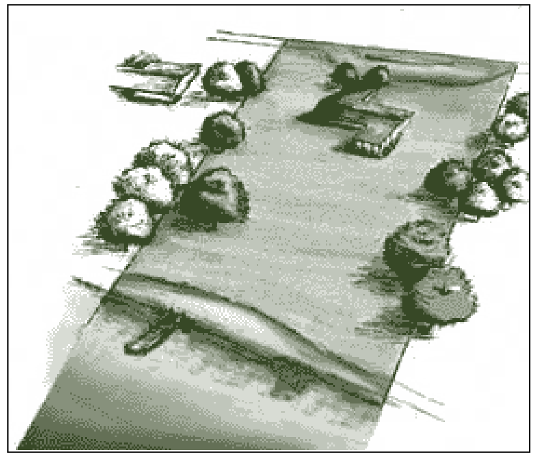


Figure 16: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

ECHO LAKE SHORELAND HABITAT ASSESSMENT

A shoreline habitat assessment survey completed in 2017 evaluated a 35-ft riparian area (from the waterline back inland for 35-ft) for each parcel surrounding Echo Lake. The parameters assessed included percentage of canopy cover, as well as the percentage of undisturbed vegetation and a summed percentage of ground covered by manicured lawn, impervious surfaces, and easily eroded surfaces such as exposed soil or shredded vegetation (pine needles, loose leaves, small branches, etc.) also known as duff. Additional consideration was given to the number of buildings present in the riparian zone and lawns that sloped directly to the lake. For each parameter that was considered, a value range was assigned to determine a color ranking. The color to be assigned and the value ranges associated with it for each parameter can be seen in Table 1. Values that fall within the red range were worth 2 points, values in the yellow range were worth 1 point, and values in the white range were not given any points. The points were then summed and the properties prioritized based on the point range for the entire lake.

Table 1: Value ranges for color assignments of each parameter of concern.

Parameter	Red range (2 points)	Yellow Range (1 Point)	White (No points)
Percent canopy cover	0-33%	34-66%	>66%
Percent shrub and herbaceous (undisturbed)	0-33%	34-66%	>66%
Percent lawn, impervious, and other surfaces	>66%	34-66%	0-33%
Number of buildings and other human structures	>1	1	0
Trail to lake	N/A	1 (Present)	0 (Absent)
Presence/ Absence of lawn or soil sloping to lake	N/A	1 (Present)	0 (Absent)
Presence/Absence of bare soil/sand deposits	1 (Present)	N/A	0 (Absent)
Presence/ Absence of other runoff concerns	1 (Present)	N/A	0 (Absent)

To establish priority rankings for Echo Lake, it was important to consider the entire lake. The maximum possible score was 16 points, but the highest scoring parcel only scored 10 points. From here, four levels of concern were established: red, orange, yellow, and white. These colors correspond to the priority of concern. Red properties are of high concern, orange are moderate, yellow is low, and white parcels are of almost no concern. Table 2 and Figure 17 summarize the survey results for the entire lake.

Table 2: Score ranges and priority rankings for the 87 parcels surrounding Echo Lake

Color	Overall Score	Priority	Number of Parcels
Red	8-10 Points	High	14
Orange	6-7 Points	Moderate	25
Yellow	3-5 Points	Low	13
White	0-2 Points	No Concern	35

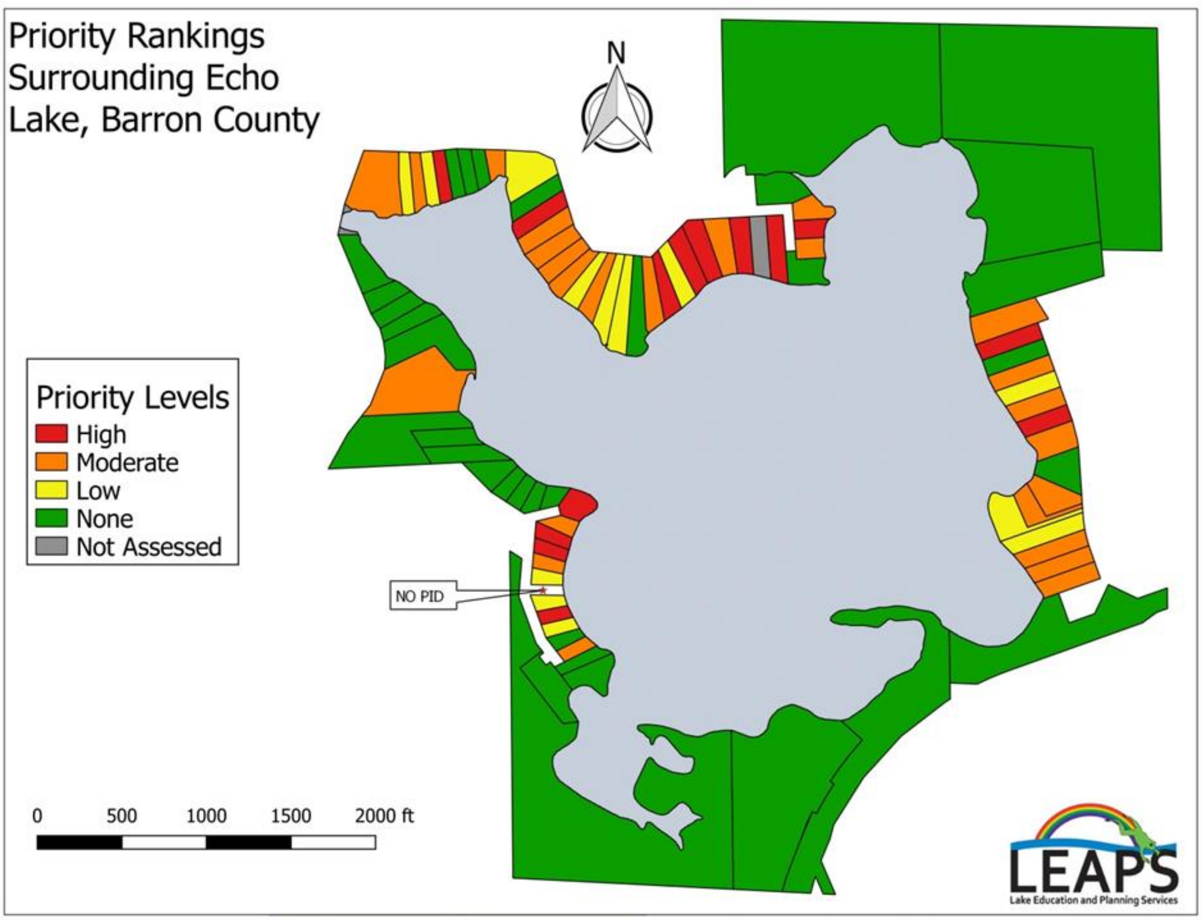


Figure 17: Priority Rankings for Parcels surrounding Echo Lake

The parcels were also given recommendations for how to improve the shoreland habitat. The recommendations were based on the WDNR Healthy Lake Initiative and included projects such as native plantings to provide buffer strips, installation of rain gardens, surface water runoff diversions, and infiltration trenches. These projects help increase quality shoreland habitat, reduce rainwater runoff, and help prevent the establishment of shoreland invasive species. All of the projects recommended are eligible for Healthy Lakes Grant funding through the WDNR if the ELA wants to sponsor some of these projects.

When EWM was discovered in Echo Lake, management remained focused on the area near the boat landing for the first two years. In 2007, the original APM Plan expanded management to a larger scale. This began in 2007 with a 5.9 acre treatment that included several different bays outside of the areas near the boat landing. This treatment was followed in 2008 with a 9.9 acre treatment scattered throughout various beds of EWM. The largest chemical treatment occurred in 2009 and covered 28.1 acres of the lake. Since the large-scale treatment in 2009, chemical treatment has been significantly smaller (Table 3). The small-scale treatments have generally used granular 2,4-D (Navigate) while the large-scale treatments have generally used liquid 2,4-D.

Table 3: EWM Treatment History 2005-2017

Year	Acreage	Area Treated
2005	0.95	Near Boat Landing
2006	1.88	Near Boat Landing
2007	5.90	SE, EC, WC and NW Bays
2008	9.90	Scattered Throughout
2009	28.10	NW Bay and Border of Majority of Central Basin
2010	5.20	Primarily NW, SC, SW, and WC Bays
2011	1.66	South-central and West-central Bays
2012	3.37	Northwest and South-central Bays
2013	1.43	Western Midlake Flat and East-central Bay
2014	3.67	NW Bay and Many Small Beds around Central Basin
2015	0	Manual Removal Only
2016	0	Manual Removal Only
2017	0.37	Northwest Corner of Northwest Boat Landing Bay
Total Acres	**62.43**	

In addition to the annual herbicide application, there have been physical removal efforts by both rake and SCUBA divers on a regular basis. Overall, these efforts have been successful in reducing and maintaining a low EWM population. The 2014 and 2015 fall bed mapping surveys did not show any EWM within Echo Lake. This meant that there was no chemical treatment conducted in 2015 or 2016. In 2016, the fall bed mapping survey showed a single area of EWM totaling 0.32 acres east of the boat landing. This area was treated in June of 2017. In the 2017 fall bed mapping survey, no EWM was found in the area treated, but five different areas of EWM were found totaling over half an acre (Table 4).

Table 4: EWM bed size and description 2012-2017

Bed Number	2017 Fall HDA Acreage	2016 Fall HDA Acreage	2015 Fall Bed Acreage	2014 Fall Bed Acreage	2013 Fall Bed Acreage	2012 Fall Bed Acreage	Years Treated	2017 Bed /HDA Characteristics And Field Notes
1	0	0.32	0	0	0	0	2010, 2014, 2017	Scattered EWM throughout
2	0	0	0	0	0	0	2010	No EWM found
3	0	0	0	0	0	0	2010	No EWM found
4	0	0	0	0	0	0	2010	No EWM found
4B	0	0	0	0	0	0	2014	No EWM found
5	0	0	0	0	0	0	2010	Single plant of point.
5A	0.03	0	0	0	0	0	None	Super cluster of large plants
5B	0.16	0	0	0	0	0	None	Regular small towers
6	0	0	0	0	0	0	2010, 2013	No EWM found
6A	0.06	0	0	0	0	0	None	Super cluster of large plants
7	0	0	0	0	0	0	2010	No EWM found
8	0	0	0	0	0.02	0.09	'10, '11, '13, '14	No EWM found
8A, B, C, D	0	0	0	0	0.02	0.05	2012, 2013	No EWM found
9	0	0	0	0	0	0	2010, 2011	No EWM found
10	0	0	0	0	0	0	2010	No EWM found
11	0	0	0	0	0	0	'10, '11, '12, '14	No EWM found
11A	0.01	0	0	0	0	0	None	Super cluster of large plants
12	0	0	0	0	0	0	2010, 2014	No EWM found
12A	0.33	0	0	0	0	0.03	None	Regular low density plants
12B	0	0	0	0	0	0.04	None	No EWM found
13	0	0	0	0	0	0	2010, 2014	No EWM found
14	0	0	0	0	0	0	2010	No EWM found
15	0	0	0	0	0	0	2010, 2014	No EWM found
Total	**0.59**	**0.32**	**0.00**	**0.00**	**0.04**	**0.21**		

Despite the recent uptick in EWM, this is not unusual nor does it mean there is a need to completely change the management approach. Because EWM was present in almost the entire littoral zone in 2007, it can pop up basically anywhere within the lake. Overall the current approach of surveying and managing yearly has been able to keep EWM in check within the lake while causing little damage to the native plant communities.

AQUATIC PLANT SURVEYS

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth and total acreage, Jennifer Hauxwell (WDNR) generated a 599 point sampling grid for Echo Lake prior to the original 2007 WDNR survey. Using this same grid in 2012, Endangered Resource Services, LLC (ERS) conducted a warm water point-intercept survey in preparation for the 2013 revision of the original 2007 Aquatic Plant Management Plan. In 2017, in preparation for the 2018 revision of the management plan and to compare how the lake's vegetation may have changed since the last point-intercept surveys, the ELA and the WDNR authorized Curly-leaf pondweed (CLP) density and bed mapping surveys on June 23rd, and a full point-intercept survey for all aquatic plants on July 24, 27, 2017.

WARM-WATER FULL POINT-INTERCEPT MACROPHYTE SURVEYS

Warm-water point-intercept surveys were conducted in 2007, 2012, and 2017 in preparation for future management planning. Table 5 shows a brief comparison of summary statistics for all three surveys. The original 2007 survey was conducted by the WDNR while the ELA contracted with Endangered Resource Services, LLC (ERA) to complete the 2012 and 2017 warm-water point-intercept surveys as well as annual early season CLP and fall EWM surveys.

Table 5: Comparison of Survey Statistics for 2007, 2012, and 2017

Summary Statistics:	2007	2012	2017
Total number of points sampled	428	581	599
Total number of sites with vegetation	347	371	273
Total number of sites shallower than the max. depth of plants	374	423	322
Freq. of occurrence at sites shallower than max. depth of plants	92.78	87.71	84.78
Simpson Diversity Index	0.81	0.90	0.90
Maximum depth of plants (ft.)	21.5	22.5	19.5
Mean depth of plants (ft.)	8.9	9.1	9.2
Median depth of plants (ft.)	7.5	7.0	9.0
Ave. number of all species per site (shallower than max depth)	1.88	2.11	2.00
Ave. number of all species per site (veg. sites only)	2.03	2.41	2.36
Ave. number of native species per site (shallower than max depth)	1.60	2.11	1.99
Ave. number of native species per site (sites with native veg. only)	1.73	2.41	2.34
Species richness	23	45	38
Species richness (including visuals)	28	47	39
Species richness (including visuals and boat survey)	33	53	45
Mean rake fullness (veg. sites only)	2.30	2.10	1.53

In 2017, plant richness was relatively high with 38 species being found in the rake which jumped to 45 when including visuals and plants seen during the preliminary boat survey. This was down from 45 in the rake and 53 totals in 2012. Along with the drop in overall richness, mean native species at sites with native vegetation fell from 2.41/site in 2012 to 2.34/site in 2017; although this was not a significant decline ($p=0.35$). Visual analysis of the maps suggested most localized declines occurred in shallow shoreline areas. Several other parts of the lake appeared to have generally increased in localized richness; especially in the northeast and southwest bays (Figure 18). It is likely that the significant change in lake levels was the primary cause for the changes seen in many areas.

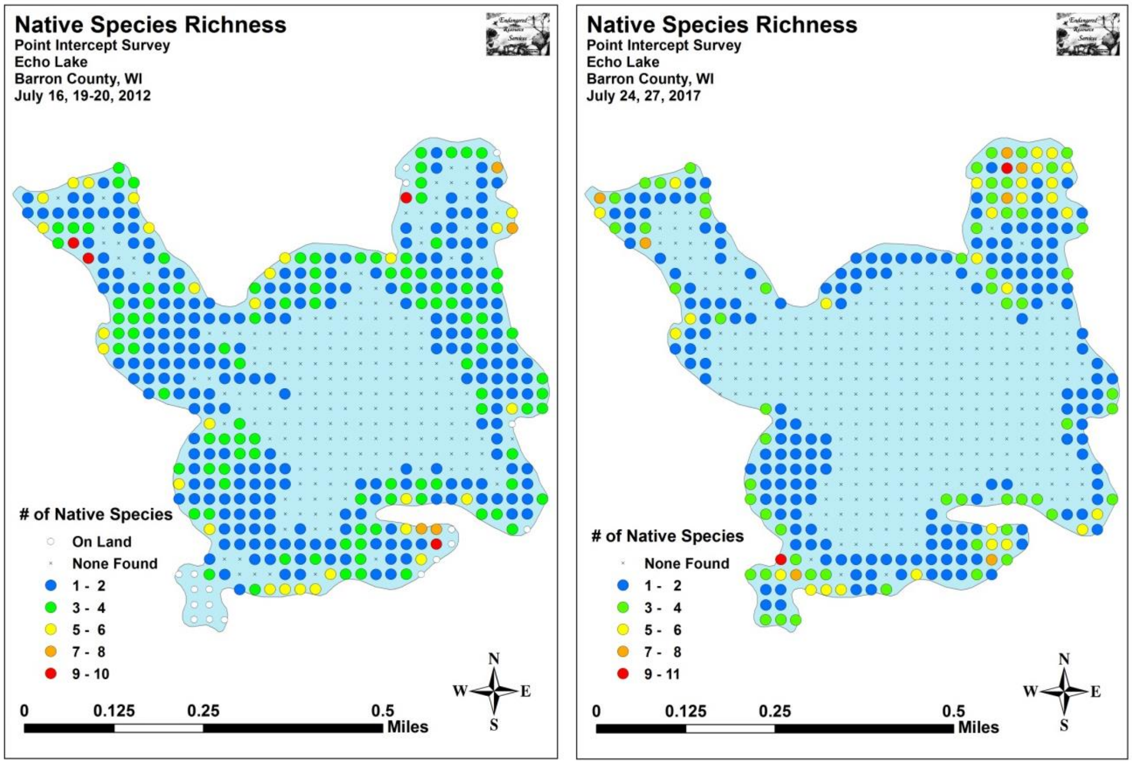


Figure 18: Native Species Richness in 2012 and 2017

In addition to a decrease in overall richness, there was a highly significant decline in total rake fullness ($p<0.001$) from a moderate 2.10 in 2012 to a low/moderate 1.52 in 2017. This decrease was shown to be a lakewide trend (Figure 19). As with the declines in richness, this decreased density could simply be due to plants struggling to adjust to the rapid changes in water depth and the accompanying loss of clarity caused by the rapid fluctuations in water levels.

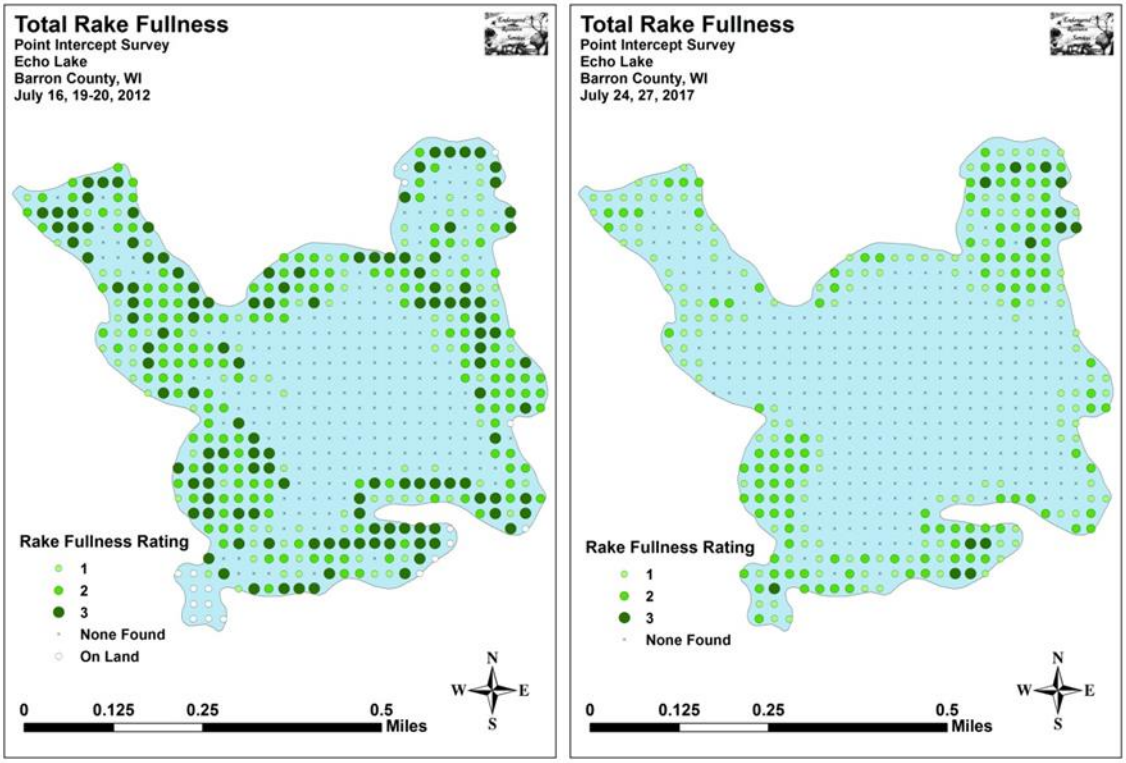


Figure 19: Total Rake Fullness in 2012 and 2017

Growth in 2017 was slightly skewed to deep water as the mean depth of 9.2ft was higher than the median of 9.0ft. The mean was similar to the 2012 survey (9.1ft), but the median was much higher (7.0ft in 2012) suggesting a shift in growth patterns. Looking at the depths of plant coverage for the three surveys (Figure 20) showed that the 2007 and 2012 surveys exhibited a bimodal (twin peak) distribution. In 2017, the entire graph demonstrated a shift of approximately 2-3ft to the right that mirrored the lake's rise in water. The formerly diverse and nearly universal shoreline community in water <2ft was absent in 2017; apparently not having the ability to keep up with rapidly rising water levels. In the 9-12ft range where most vascular plants disappeared in the past, surveyors found many pondweeds "hanging on" although they were visibly stressed with dead or dying leaves. Areas deeper than 12ft were often devoid of any vegetation. This was a dramatic difference from 2012 when the surveyors often found beds of Nitella that were several feet thick in a mat covering the bottom.

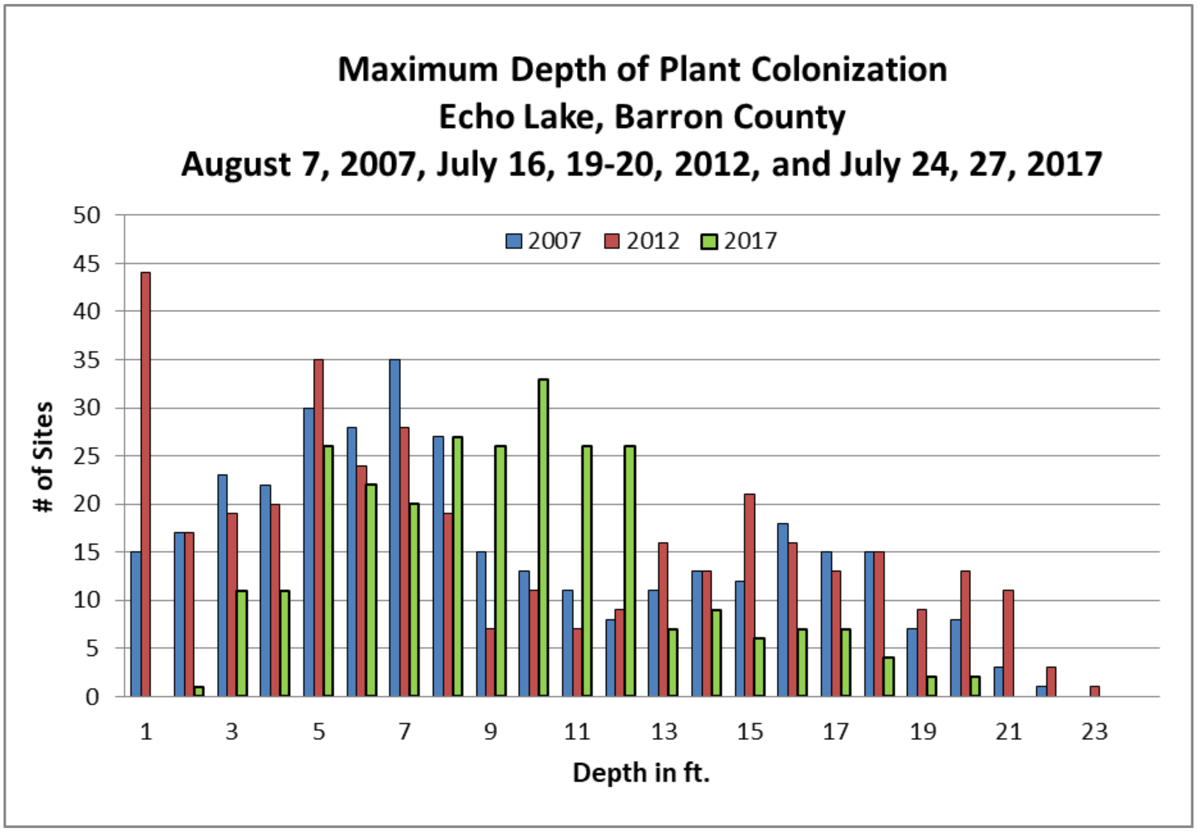


Figure 20: Plant Colonization Depth in 2007, 2012, and 2017

The dramatic rise in lake levels also caused a notable reduction in the littoral area. In 2012, 371 of the 581, or 64%, of the points surveyed contained vegetation this dropped to 273 of 599, or 46%, of the points surveyed in 2017 (Figure 21). This is a direct result of the rapidly fluctuating water levels within the lake. In 2012, 18 of the planned survey points were on dry land due to the extended drought. These points were again under water for the 2017 survey. The deep edges of the 2012 littoral zone were too deep and turbid to support plants in 2017.

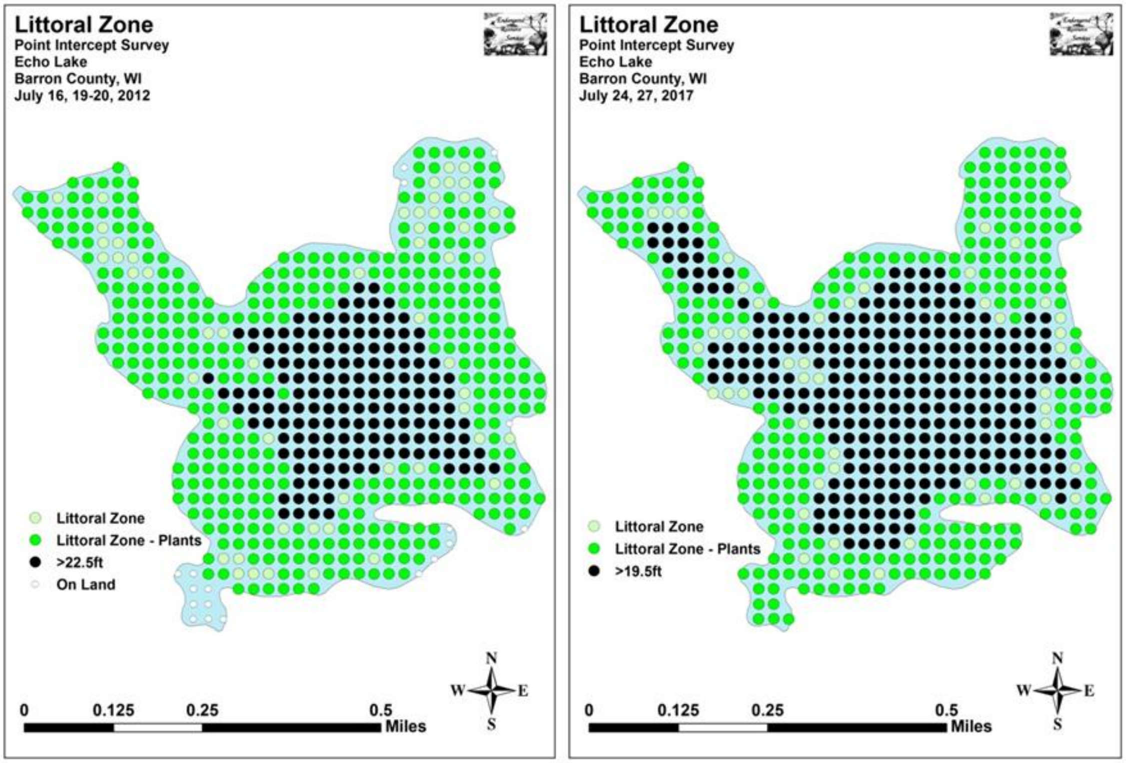


Figure 21: Littoral Zone in 2012 and 2017

Lakewide, 17 species showed significant changes in distribution from 2012 to 2017 (Figure 22). Common waterweed, nitella, needle spikerush, and waterwort all suffered highly significant declines; Pickerelweed and wool grass experienced moderately significant declines; and branched bur-reed, greater waterwort, and softstem bulrush showed significant declines. Conversely, fern pondweed, wild celery, northern naiad, Vasey's pondweed, creeping bladderwort, blunt-leaf pondweed, and water smartweed demonstrated highly significant increases; and common bladderwort saw a significant increase.

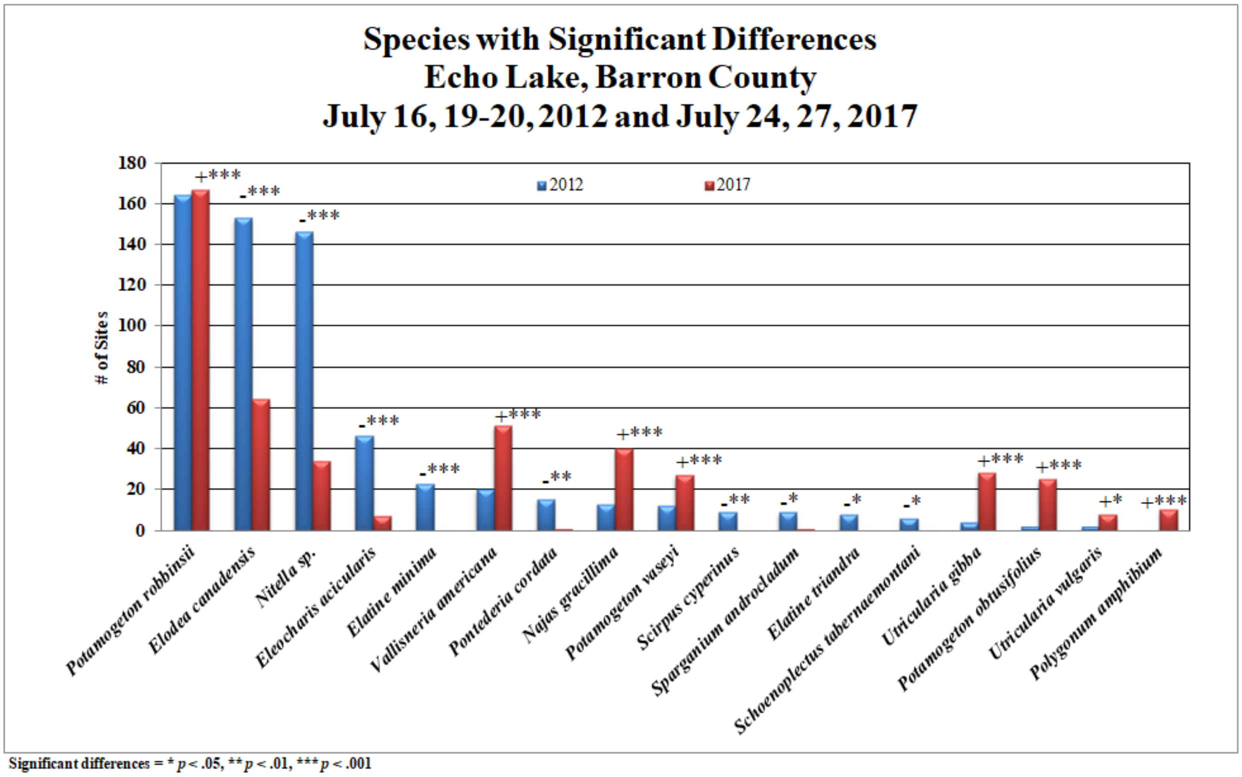


Figure 22: Plant species with significant changes from 2012 to 2017

SIMPSON'S DIVERSITY INDEX

A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's Diversity Index, the index value represents the probability that two individual plants (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be more resistant to invasion by exotic species. In Echo Lake, diversity was very high in 2017 with a Simpson Index value of 0.90 which was identical to 2012. Both of these surveys were notably higher than the 0.81 seen in the original 2007 survey.

FLORISTIC QUALITY INDEX (FQI)

This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake. Statistically speaking, the higher the index value, the healthier the lake's aquatic plant community is assumed to be. Nichols (1999) identified four eco-regions in

Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Echo Lake is in the Northern Central Hardwood Forests Region.

In 2012, a total of 39 native index species were identified in the rake during the point-intercept survey. They produced a mean C of 7.3 and a FQI of 45.6. In 2017, a total of 37 native index plants were identified in the rake during the point-intercept survey, of which ten species had a C of 9 or 10. The index plants found produced a mean C of 7.4 and a FQI of 45.2 (Berg M. , Curly-leaf pondweed (Potamogeton crispus) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Echo Lake - WBIC 2630200 Barron County, Wisconsin, 2017). Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Echo Lake well above average, for this part of the state in 2017. Similarly, the FQI of 45.2 was more than double the mean FQI of 20.9 for the North Central Hardwood Forests Region (Nichols, 1999).

EARLY-SEASON CLP SURVEYS

During the initial early-season point-intercept CLP survey in 2012, CLP was only found in the rake at one point with visual sightings at two nearby points. The single point CLP was found at only contained a rake fullness rating of one. In June of that year ERS conducted a survey of the entire visible littoral zone and found no true beds of CLP, but found and mapped 88 individual plants. The majority of these plants were contained in an area along the west central bay that covered 1.49 acres. This was considered to be a "high density" area by the surveyor (Figure 23).

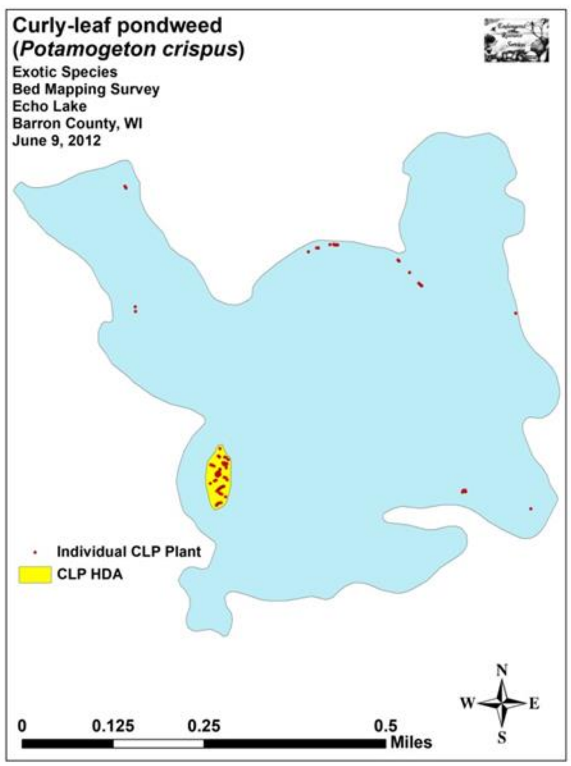


Figure 23: 2012 CLP bed mapping Survey

In 2017, surveyors spent extensive time searching the west-central bay where the "high density area" had been found in 2012 in addition to surveying the rest of the visible littoral zone and found absolutely no CLP plants within Echo Lake. The strange conditions of late-winter and the spring of 2017 provided ideal conditions for

CLP across the region with many lakes near Echo Lake experiencing explosions in their CLP populations. Despite this, Echo Lake did not appear to contain any CLP plants. This suggests that CLP is not likely to become an issue in Echo Lake. While the ELA should still aim to prevent CLP from spreading, it is unlikely to become an issue that is large enough to require active management.

FALL EWM BED MAPPING SURVEYS

Each year a fall EWM bed mapping survey is completed to be used for the following year's management planning. The fall bed mapping surveys in both 2014 and 2015 showed small areas of EWM within Echo Lake with only a few plants, which surveyors rake removed, scattered throughout the lake. Chemical treatment for the more concentrated areas of EWM was planned for the following years, but pre-treatment plant surveys showed the rake removal to be effective in these areas, so chemical treatment in 2015 and 2016 was not completed. The fall bed mapping survey in 2016 showed a single high density area of EWM in the northwest corner of the lake which was chemically treated in 2017. The 2017 fall bed mapping survey showed no EWM in the area that had been treated, but it had popped back up in several different areas of the lake (Figure 24). Overall, there was a slight increase of 0.27 acres of EWM between 2016 and 2017, but there have still not been any true beds discovered. The areas in the 2016 and 2017 are considered "high density areas" not true beds.

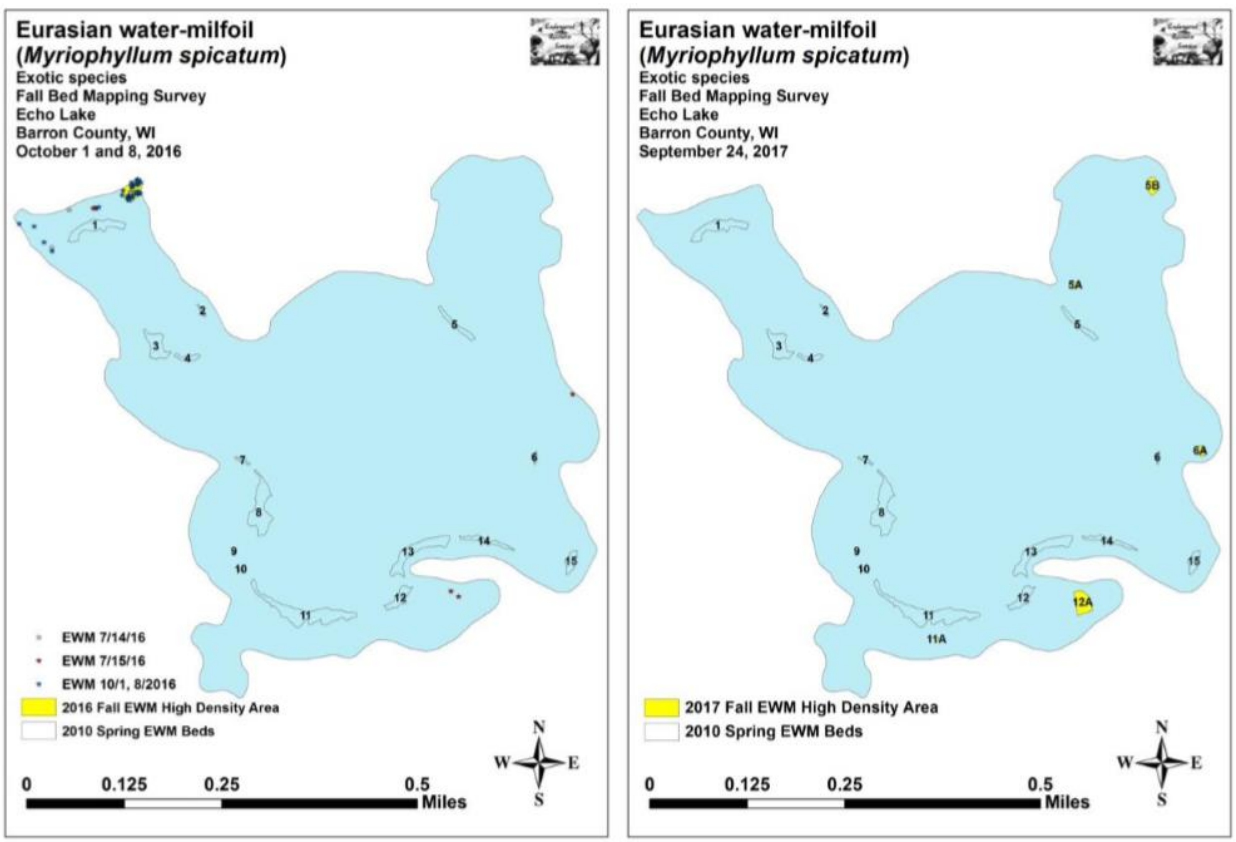


Figure 24: 2016 and 2017 Fall bed mapping surveys

There were a total of five high density areas that were established in the 2017 fall bed mapping survey. These were located in the eastern and south central portions of Echo Lake and ranged in size from 0.01 up to 0.33 acres (Figure 25). The area that was chemically treated in the spring of 2017 was no longer a high density area and only contained three individual plants which were removed by surveyors.

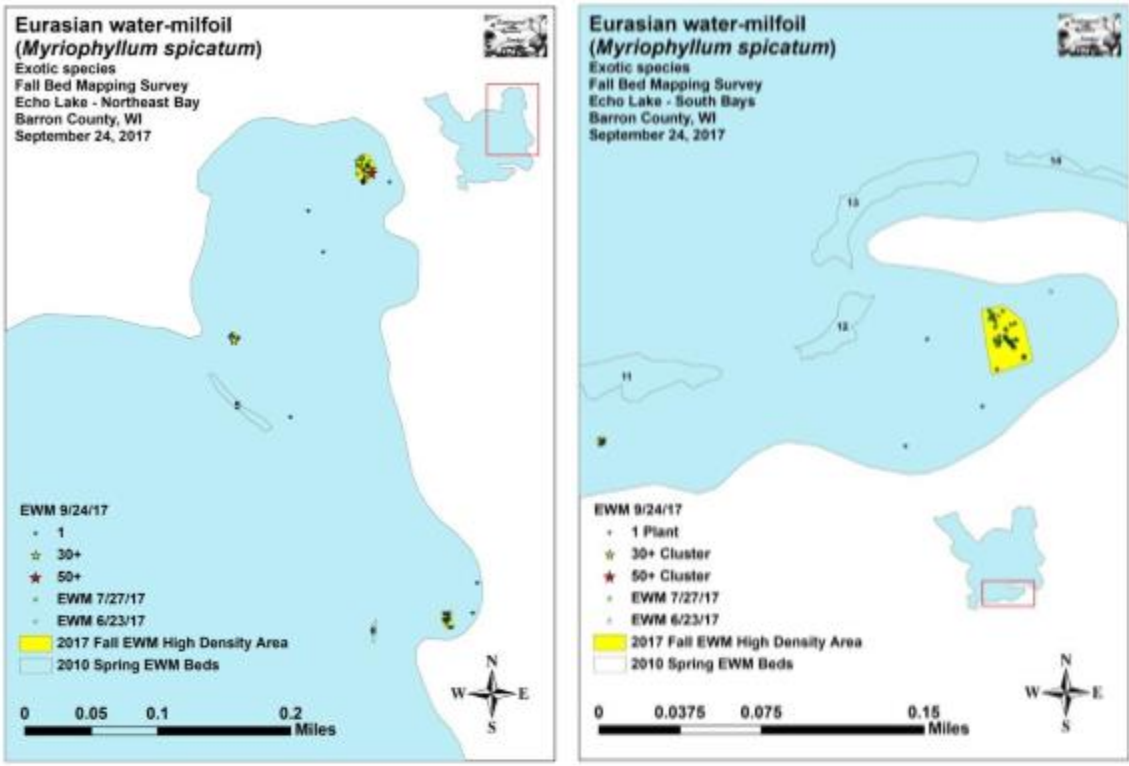
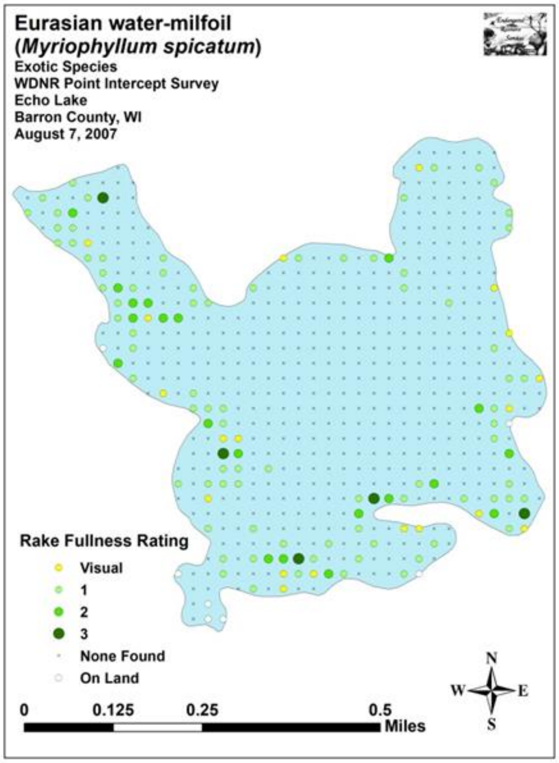
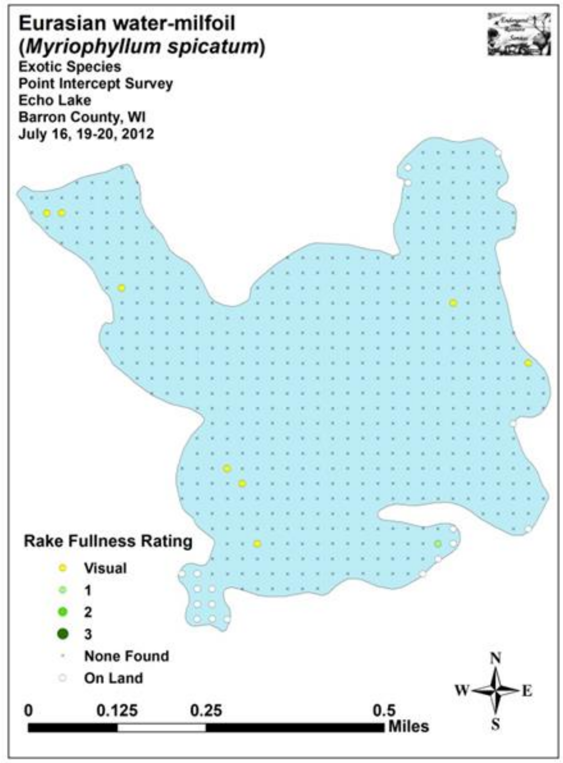


Figure 25: 2017 EWM in eastern and southern lake portions

In addition to the fall bed mapping surveys, EWM is accounted for in the larger whole-lake point-intercept surveys conducted each year prior to management plan revisions. The 2007 survey showed EWM to be spread throughout almost the entire littoral zone with very dense beds in some areas. After several years of large-scale management, the EWM became significantly less widespread in 2012. With the continued small scale-management, the only EWM found during the point-intercept survey was visual with none being found in the rake (Figure 26).





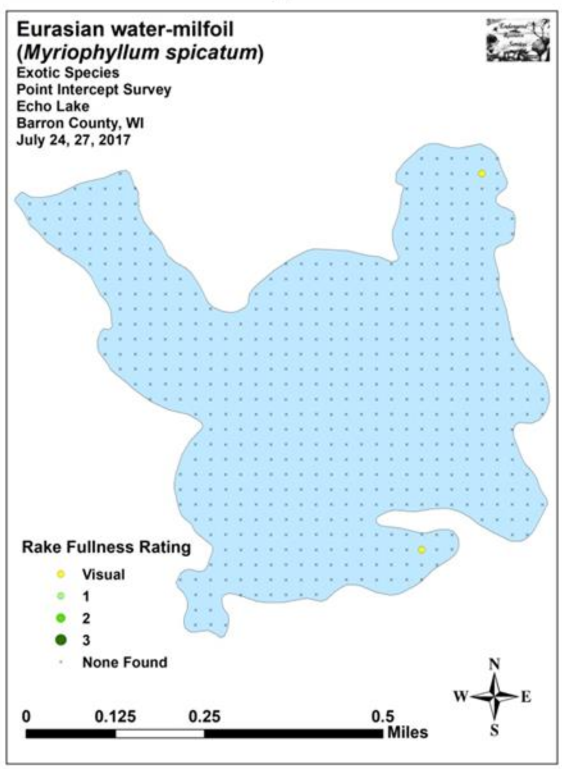


Figure 26: point-intercept EWM density and distribution, 2007, 2012, and 2017

WILD RICE

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

AQUATIC INVASIVE SPECIES

In 2004 Eurasian watermilfoil was found in Echo Lake. Since then, small patches of curly-leaf pondweed have also been found as well as several Chinese mystery snails. In addition to the species already present within Echo Lake, there are many others that could be introduced. Most of these species are considered aquatic, although some are also considered shoreland or wetland type invasive species.

NON-NATIVE, AQUATIC INVASIVE PLANT SPECIES

Eurasian watermilfoil (EWM) and curly-leaf pondweed are the only known aquatic invasive plant species in the lake. EWM and CLP are submerged vegetation species (rooted to the bottom of the lake and growing under the surface of the water) that have the potential to outcompete more desirable native aquatic plants. Reed canary grass can be found in some of the wetlands surrounding Echo Lake. Reed canary grass is a shoreland or wetland plant not generally problematic within the lake, but can be very problematic on the shores and in the wetlands adjacent to the lake. More information is given for each non-native species in the following sections.

EURASIAN WATERMILFOIL

EWM (Figure 27) is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits,

EWM is difficult to distinguish from Northern water milfoil. EWM has 9-21 pairs of leaflets per leaf, while Northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

EWM grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Unlike many other plants, EWM does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, and bait buckets; and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of EWM provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by EWM may lead to deteriorating water quality and algae blooms in infested lakes.

Figure 27: EWM fragment with adventitious roots and EWM in a bed

EWM is the most problematic invasive species within Echo Lake. When managed properly, it can be kept to a low frequency of occurrence in the littoral zone. If left unmanaged, it has and will spread throughout the lake.

CURLY-LEAF PONDWEED

Curly-leaf pondweed (CLP) is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 28). It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early August. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all states but Maine.

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

CLP has been found within Echo Lake, but these were very small areas that do not appear to be spreading. In 2017 no CLP found during survey work. This pattern suggests it is unlikely that CLP will become a large issue within Echo Lake, but it should still be monitored for any changes.

Figure 28: CLP Plants and Turions

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 29) is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers that vary from purple to magenta possess 5-6 petals aggregated into numerous long spikes, and bloom from August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, more than 20 states, including Wisconsin have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats, and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways.

Purple loosestrife has been found as individual plants and small clumps on the shoreland of Echo Lake, but when found it has been physically removed by volunteers or resource personnel. Purple loosestrife has also been found in several nearby wetlands including those surrounding Upper Turtle Lake and Horseshoe Lake that is connected to Echo Lake. Monitoring efforts should include purple loosestrife.

Figure 29: Purple Loosestrife in Echo Lake (circa 2012)

REED CANARY GRASS

Reed canary grass (Figure 30) is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades 3 1/2 to 10 inches long and 1/4 to 3/4 inch in width. Blades are flat and have a rough texture on both surfaces. The lead ligule is membranous and long. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

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

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

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

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

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

Reed canary grass is located in a few locations along the shoreland of Echo Lake, but these have not become monotypic stands that impair the normal function of wetlands. While this should be monitored with other AIS, this is not considered an issue at this time.

Figure 30: Reed Canary Grass (not from Echo Lake)

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Currently, there is only one non-native animal species, Chinese mystery snails, believed to be found in Echo Lake. Several additional non-vegetative, aquatic, invasive species are in nearby lakes, but have not been identified in Echo Lake. It is important for lake property owners and users to be knowledgeable of these species in order to identify them if and when they show up in Echo Lake.

CHINESE MYSTERY SNAILS

Chinese mystery snails have been found within Echo Lake, but these populations have not been confirmed.

The Chinese mystery snails and the banded mystery snails (Figure 31) are non-native snails that have been found in a number of Wisconsin lakes. There is not a lot yet known about these species, however, it appears that they have a negative effect on native snail populations. The mystery snail's large size and hard operculum (a trap door cover which protects the soft flesh inside), and their thick hard shell make them less edible by predators such as rusty crayfish.

The female mystery snail gives birth to live crawling young. This may be an important factor in their spread as it only takes one impregnated snail to start a new population. Mystery snails thrive in silt and mud areas although they can be found in lesser numbers in areas with sand or rock substrates. They are found in lakes, ponds, irrigation ditches, and slower portions of streams and rivers. They are tolerant of pollution and often thrive in stagnant water areas. Mystery snails can be found in water depths of 0.5 to 5 meters (1.5 to 15 feet). They tend to reach their maximum population densities around 1-2 meters (3-6 feet) of water depth. Mystery snails do not eat plants. Instead, they feed on detritus and in lesser amounts algae and phytoplankton. Thus removal of plants in your shoreline area will not reduce the abundance of mystery snails.

Lakes with high densities of mystery snails often see large die-offs of the snails. These die-offs are related to the lake's warming coupled with low oxygen (related to algal blooms). Mystery snails cannot tolerate low oxygen levels. High temperatures by themselves seem insufficient to kill the snails as the snails could move into deeper water.

Many lake residents are worried about mystery snails being carriers of the swimmer's itch parasite. In theory they are potential carriers, however, because they are an introduced species and did not evolve as part of the lake ecosystem, they are less likely to harbor the swimmer's itch parasites.

Figure 31: Chinese Mystery Snails (not from Echo Lake)

RUSTY CRAYFISH

Rusty crayfish have not been identified in Echo Lake, but they can be found in several nearby waters including Upper Turtle Lake and the Apple River.

Rusty crayfish (Figure 32) live in lakes, ponds and streams, preferring areas with rocks, logs and other debris in water bodies with clay, silt, sand or rocky bottoms. They typically inhabit permanent pools and fast moving streams of fresh, nutrient-rich water. Adults reach a maximum length of 4 inches. Males are larger than females upon maturity and both sexes have larger, heartier, claws than most native crayfish. Dark "rusty" spots are usually apparent on either side of the carapace, but are not always present in all populations. Claws are generally smooth, with grayish-green to reddish-brown coloration. Adults are opportunistic feeders, feeding upon aquatic plants, benthic invertebrates, detritus, juvenile fish and fish eggs.

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

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

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

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

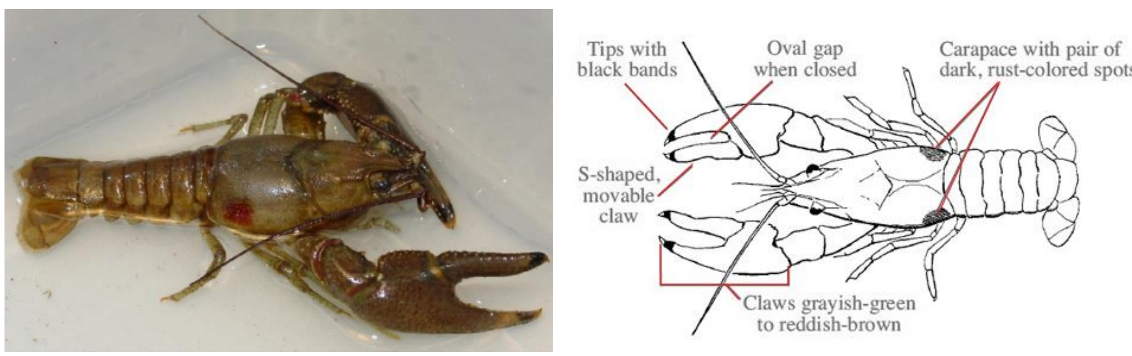


Figure 32: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels have not been identified in Echo Lake.

Zebra mussels (Figure 33) are an invasive species that have inhabited Wisconsin waters and are displacing native species, disrupting ecosystems, and affecting citizens' livelihoods and quality of life. They hamper boating, swimming, fishing, hunting, hiking, and other recreation, and take an economic toll on commercial, agricultural, forestry, and aquacultural resources. The zebra mussel is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them since that time. They were most likely brought to North America as larvae in ballast water of ships that traveled from fresh-water Eurasian ports to the Great Lakes. Zebra mussels look like small clams with a yellowish or brownish D-shaped shell, usually with alternating dark- and light-colored stripes. They can be up to two inches long, but most are under an inch. Zebra mussels usually grow in clusters containing numerous individuals.

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

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

Once zebra mussels are established in a water body, very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Some of the preventative and physical control measures include physical removal, industrial vacuums, and back flushing.

Chemical applications include solutions of chlorine, bromine, potassium permanganate and even oxygen deprivation. An ozonation process is under investigation (patented by Bollyky Associates Inc.) which involves the pumping of high concentrations of dissolved ozone into the intake of raw water pipes. This method only works in controlling veligers, and supposedly has little negative impacts on the ecosystem. Further research on effective industrial control measures that minimize negative impacts on ecosystem health is needed.

Figure 33: Zebra Mussels

While zebra mussels have not been identified in Echo Lake, they have were found in western Washburn County in 2016. This was the first time that zebra mussels had been found in Northwestern Wisconsin. This discovery led to the development of a suitability model for zebra mussel habitat. While the suitability of Echo Lake is currently unknown, monitoring and prevention should remain a top priority for the ELA.

AIS PREVENTION STRATEGY

Echo Lake currently has several established AIS, but there are many more that could be introduced to the lake. The ELA has and will continue to implement a watercraft inspection and AIS Signage program at the public access point on the lake (Figure 34). Information will be shared with lake residents and users in an effort to expand the watercraft inspection message. In addition to the watercraft inspection program, an in-lake and shoreland AIS monitoring program will be implemented. Both of these programs will follow UW-Extension Lakes and WDNR protocol through the Clean Boats, Clean Waters program and the Citizen Lake Monitoring Network Aquatic Invasive Species Monitoring program.

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

Figure 34: AIS Signage at the Echo Lake boat landing.

MANAGEMENT ALTERNATIVES

Nuisance aquatic plants can be managed a variety of ways in Wisconsin. The best management strategy will be different for each lake and depends on which nuisance species needs to be controlled, how widespread the problem is, and the other plants and wildlife in the lake. In many cases, an integrated approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species such as EWM or CLP is generally not feasible, but preventing them from becoming a more significant problem is an attainable goal. It is important to remember however, that regardless of the plant species targeted for control, sometimes no manipulation of the aquatic plant community is the best management option. Plant management activities can be disruptive to a lake ecosystem and should not be done unless it can be shown they will be beneficial and occur with minimal negative ecological impacts.

Management alternatives for nuisance aquatic plants can be grouped into four broad categories: manual and mechanical removal, chemical application, biological control, and physical habitat alteration. Manual and mechanical removal methods include pulling, cutting, raking, harvesting, suction harvesting, and other means of removing the physical plant from the water. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant. Biological control methods include organisms that use the plant for a food source or parasitic organisms that use the plant as a host, killing or weakening it. Biological control may also include the use of species that compete successfully with the nuisance species for resources. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. It may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

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

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

NO MANAGEMENT

When evaluating the various management techniques, the assumption is erroneously made that doing nothing is environmentally neutral. In dealing with nonnative species like EWM, the environmental consequences of doing nothing may be high, possibly even higher than any of the effects of management techniques. Unmanaged, these species can have severe negative effects on water quality, native plant distribution, abundance and diversity, and the abundance and diversity of aquatic insects and fish (Madsen, 1997). Nonindigenous aquatic plants are the problem, and the management techniques are the collective solution. Nonnative plants are a biological pollutant that increases geometrically, a pollutant with a very long residence time and the potential to "biomagnify" in lakes, rivers, and wetlands (Madsen, 2000).

Foregoing any management of EWM in Echo Lake is not a recommended option. To keep EWM from causing greater harm, some form of EWM management will need to be implemented.

HAND-PULLING/MANUAL REMOVAL

Manual or physical removal of aquatic plants by means of a hand-held rake or cutting implement; or by pulling the plants from the lake bottom by hand is allowed by the WDNR without a permit per NR 109.06 Waivers under the following conditions:

- Removal of native plants is limited to a single area with a maximum width of no more than 30 feet measured along the shoreline provided that any piers, boatlifts, swim rafts and other recreational and water use devices are located within that 30-foot wide zone and may not be in a new area or additional to an area where plants are controlled by another method (Figure 35)
- Removal of nonnative or invasive aquatic plants as designated under s. NR 109.07 is performed in a manner that does not harm the native aquatic plant community
- Removal of dislodged aquatic plants that drift on-shore and accumulate along the waterfront is completed.
- The area of removal is not located in a sensitive area as defined by the department under s. NR 107.05 (3) (i) 1, or in an area known to contain threatened or endangered resources or floating bogs
- Removal does not interfere with the rights of other riparian owners
- If wild rice is involved, the procedures of s. NR 19.09 (1) are followed.

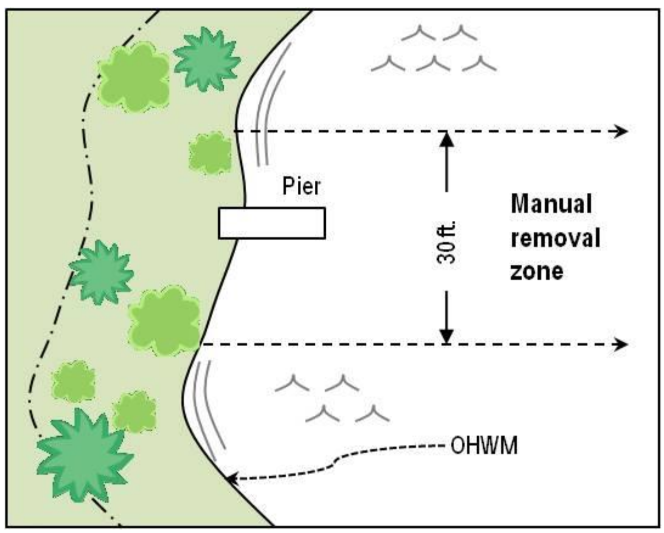


Figure 35: Aquatic vegetation manual removal zone

Although up to 30 feet of aquatic vegetation can be removed, removal should only be done to the extent necessary. There is no limit as to how far out into the lake the 30-ft zone can extend, however clearing large swaths of aquatic plants not only disrupts lake habits, it also creates open areas for non-native species to establish. Physical removal of aquatic plants requires a permit if the removal area is located in a “sensitive” or critical habitat area previously designated by the WDNR. Manual or physical removal can be effective at controlling individual plants or small areas of plant growth. It limits disturbance to the lake bottom, is inexpensive, and can be practiced by many lake residents. In shallow, hard bottom areas of a lake, or where impacts to fish spawning habitat need to be minimized, this is the best form of control. If water clarity in a body of water is such that aquatic plants can be seen in deeper water, pulling aquatic invasive species while snorkeling or scuba diving is also allowable without a permit according to the conditions in NR 106.06(2) and can be effective at slowing the spread of a new aquatic invasive species infestation within a lake when done properly.

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

In Echo Lake, many of the areas of EWM may be and have been best managed by hand-pulling/manual removal. The ELA should work with residents on the lake to teach them how to identify non-native aquatic plant species and how to properly remove them from around their docks and in their swimming areas.

DIVER ASSISTED SUCTION HARVESTING

Diver assisted suction harvesting or DASH, as it is often called, is a fairly recent aquatic plant removal technique. It is called "harvesting" rather than "dredging" because, although a specialized small-scale dredge is used, bottom sediment is not removed from the system. The operation involves hand-pulling of weeds from the lake bed and inserting them into an underwater vacuum system that sucks up plants and their root systems taking them to the surface. It requires water pumps on the surface (generally on a pontoon system) to move a large volume of water to maintain adequate suction of materials that the divers are processing (Figure 36). Only clean water goes through the pump. The material placed by the divers into the suction hose along with the water is deposited into mesh bags on the surface with the water leaving through the holes in the bag. The bags have a large enough 'mesh' size so that silts, clay, leaves and other plant material being collected do not immediately clog them and block water movement. If a fish or other living marine life is sucked into the suction hose it comes out the discharge unharmed and is returned to the body of water. It can have some negative impacts to other nearby non-target plants if not done carefully, particularly those plants that are perennials and expand their populations by sub-sediment runners (Eichler, Bombard, Sutherland, & Boylen, Suction harvesting of Eurasian watermilfoil and its effect on native plant communities, 1993).

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

Figure 36: DASH - Diver Aided Suction Harvest (Chuck Druckery, 2016 Wisconsin Lakes Convention Presentation)

DASH could be an effective way to manage small areas of EWM in Echo Lake, provided the conditions for harvest are conducive to it. At this time DASH removal would be excessive because of how well managed the EWM has been in Echo Lake. The current combination of annual rake removal, SCUBA, and herbicide treatment has been fairly successful in keeping EWM in small-scale areas.

MECHANICAL REMOVAL

Mechanical management involves the use of devices not solely powered by human means to aid removal. This includes gas and electric motors, ATV's, boats, tractors, etc. Using these instruments to pull, cut, grind, or rotovate aquatic plants is illegal in Wisconsin without a permit. DASH is also considered mechanical removal. To implement mechanical removal of aquatic plants a Mechanical/Manual Aquatic Plant Control Application is required annually. The application is reviewed by the WDNR and other entities and a permit awarded if required criteria are met. Using repeated mechanical disturbance such as bottom rollers or sweepers can be effective at control in small areas, but in Wisconsin these devices are illegal and generally not permitted.

LARGE-SCALE MECHANICAL HARVESTING

Large-scale mechanical harvesting is more traditionally used for control of CLP, but can be an effective way to reduce EWM biomass in a water body. It is typically used to open up channels through existing beds of EWM to improve access for both human related activities like boating, and natural activities like fish distribution and mobility on lakes in maintenance mode where EWM is well-established and restoration efforts have been discontinued.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water (Figure 37). The size, and consequently the harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight). Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

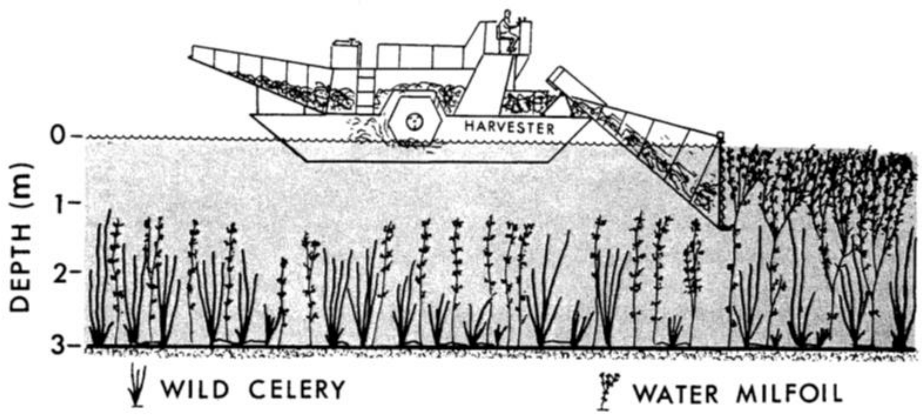


Figure 37: How a Harvester Works *(Engle, 1987)*

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

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. The removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, including sediment stabilization and wave absorption. Shoreline erosion may therefore increase. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on these organisms' populations as well as the lake ecosystem as a whole.

While the results of harvesting aquatic plants may be short term, the negative consequences are not so short lived. Much like mowing a lawn, harvesting must be conducted numerous times throughout the growing season. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species to propagate and colonize in new, previously unaffected areas of the lake. Harvesting may also result in re-suspension of contaminated sediments and the excess nutrients they contain.

Disposal sites are a key component when considering the mechanical harvesting of aquatic plants. The sites must be on shore and upland to make sure the plants and their reproductive structures don't make their way back into the lake or to other lakes. The number of available disposal sites and their distance from the targeted harvesting areas will determine the efficiency of the operation, in terms of time as well as cost.

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For CLP, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. There is currently only one harvesting contractor in Northwestern Wisconsin, so there is little flexibility in terms of scheduling.

Using mechanical harvesting to manage EWM is not recommended on Echo Lake. The level of EWM in Echo Lake does not warrant management at this scale, and would likely do nothing more than exacerbate the issue by aiding in the spread

SMALL-SCALE MECHANICAL HARVESTING

There are a wide range of small-scale mechanical harvesting techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with all mechanical harvesting, removing the cut plants is required. Commercial rakes and cutters range in prices from $200 for rakes to around $3000 for electric cutters with a wide range of sizes and capacities. Using a weed rake or cutter that is run by human power is allowed without a permit, but the use of any device that includes a motor, gas or electric, would require a permit. Dragging a bed spring or bar behind a boat, tractor or any other motorized vehicle to remove vegetation is also illegal without a permit. Although not truly considered mechanical management, incidental plant disruption by normal boat traffic is a legal method of management. Active use of an area is often one of the best ways for riparian owners to gain navigation relief near their docks. Most aquatic plants won't grow well in an area actively used for boating and swimming. It should be noted that purposefully navigating a boat to clear large areas is not only potentially illegal it can also re-suspend sediments, encourage aquatic invasive species growth, and cause ecological disruptions.

Small-scale harvesting by human power can be used to help manage EWM on Echo Lake, but no form of mechanical harvesting should take place because it would only aide in the spread of EWM throughout the lake.

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce EWM growth would eliminate all plants, inhibit fish spawning, affect benthic invertebrates, and could cause anaerobic conditions which may release excess nutrients from the sediment. Gas build-up beneath these barriers can cause them to dislodge from the bottom and sediment can build up on them allowing EWM to re-establish. Bottom barriers are typically used for very small areas and provide only limited relief. Currently the WDNR does not permit this type of control.

Creating conditions in a lake that may serve to shade out EWM growth has also been tried with mixed success. The general intention is to reduce light penetration in the water which in turns limits the depth at which plants can grow. Typically dyes have been added to a small water body to darken the water. Bottom barriers and attempts to further reduce light penetration in Echo Lake are not recommended.

DREDGING

Dredging is the removal of bottom sediment from a lake. Its success is based on altering the target plant's environment. It is not usually performed solely for aquatic plant management but rather to restore lakes that have been filled in with sediment, have excess nutrients, inadequate pelagic and hypolimnetic zones, need deepening, or require removal of toxic substances (Peterson, 1982). In shallow lakes with excess plant growth, dredging can make areas of the lake too deep for plant growth. It can also remove significant plant root structures, seeds turions, rhizomes, tubers, etc. In Collins Lake, New York the biomass of curly-leaf pondweed remained significantly lower than pre-dredging levels 10-yrs after dredging (Tobiessen, Swart, & Benjamin, Dredging to control curly-leaf pondweed: a decade later, 1992). Dredging is very expensive, requires disposal of sediments, and has major environmental impacts. It is not a selective procedure so it can't be used to target any one particular species with great success except under extenuating circumstances. Very limited dredging is allowed without a permit if certain requirements are met (Appendix B). Normally, dredging should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen, 2000).

Dredging is not a recommended management action for Echo Lake.

DRAWDOWN

Drawdown, like dredging, alters the plant environment by removing all water in a water body to a certain depth, exposing bottom sediments to seasonal changes including temperature and precipitation. A winter drawdown is a low cost and effective management tool for the long-term control of certain susceptible species of nuisance aquatic plants. Winter drawdown has been shown to be an effective control measure for EWM, but typically only provides 2-3 years of relief before EWM levels return to pre-drawdown levels. A winter drawdown controls susceptible aquatic plants by dewatering a portion of the lake bottom over the winter, and subsequently exposing vascular plants to the combined effect of freezing and desiccation (drying). The effectiveness of drawdown to control plants hinges on the combined effect of the freezing and drying. If freezing and dry conditions are not sustained for 4-6 weeks, the effectiveness of the drawdown may be reduced.

It is not possible to draw down Echo Lake as there is no viable outlet. As a seepage lake, the water level in Echo Lake can fluctuate greatly with the environmental conditions present at any given time. Under drought conditions the lake level will be very low. Under more normal conditions the lake level may be normal or even high.

BIOLOGICAL CONTROL

Biological control involves using one plant, animal, or pathogen as a means to control a target species in the same environment. The goal of biological control is to weaken, reduce the spread, or eliminate the unwanted population so that native or more desirable populations can make a comeback. Care must be taken however, to insure that the control species does not become as big a problem as the one that is being controlled. A special permit is required in Wisconsin before any biological control measure can be introduced into a new area.

EWM WEEVILS

While many biological controls have been studied, only one has proven to be effective at controlling EWM under the right circumstances. Euhrychiopsis lecontei is an aquatic weevil native to Wisconsin that feed on aquatic milfoils (Figure 38). Their host plant is typically northern watermilfoil, however they seem to prefer EWM when it is available. Milfoil weevils are typically present in low numbers wherever northern or Eurasian water milfoil is found. They often produce several generations in a given year and over winter in undisturbed shorelines around the lake. All aspects of the weevil's life cycle can affect the plant. Adults feed on the plant and lay their eggs. The eggs hatch and the larva feed on the plant. As the larva mature they eventually burrow into the stem of the plant. When they emerge as adults later, the hole left in the stem reduces buoyancy often causing the stem to collapse. The resulting interruption in the flow of carbohydrates to the root crowns reduces the plant's ability to store carbohydrates for over wintering reducing the health and vigor (Newman, Holmberg, Biesboer, & Penner, Effects of the potential biological control agent, Euhrychiopsis lecontei, on Eurasian watermilfoil in experimental tanks, 1996).

Figure 38: EWM Weevil (https://klsa.wordpress.com/published-material/milfoil-weevil-guide/)

The weevil is not a silver bullet. They do not work in all situations. The extent to which weevils exist naturally in a lake, adequate shore land over wintering habitat, the population of bluegills and sunfish in a system, and water quality characteristics are all factors that have been shown to affect the success rate of the weevil. Weevil rearing is not recommended, but would not hurt if there were interested people to do so on the lake.

OTHER BIOLOGICAL CONTROLS

There are other forms of biological control being used or researched. It was thought at one time that the introduction of plant eating carp could be successful. It has since been shown that these carp have a preference list for certain aquatic plants. EWM is very low on this preference list (Pine & Anderson, Plant preferences of Triploid grass carp, 1991). Use of "grass carp" as they are referred to in Wisconsin is illegal as there are many other environmental concerns including what happens once the target species is destroyed, removal of the carp from the system, impacts to other fish and aquatic plants, and preventing escapees into other lakes and rivers. Several pathogens or fungi are currently being researched that when introduced by themselves or in combination with herbicide application can effectively control EWM and lower the concentration of chemical used or the time of exposure necessary to kill the plant (Sorsa, Nordheim, & Andrews, Integrated control of Eurasian wataer milfoil by a fungal pathogen and herbicide, 1988). None of these have currently been approved for use in Wisconsin and are not recommended for use on Echo Lake.

CHEMICAL CONTROL

Aquatic herbicides are granules or liquid chemicals specifically formulated for use in water to kill plants or cease plant growth. Herbicides approved for aquatic use by the U.S. Environmental Protection Agency (EPA) are considered compatible with the aquatic environment when used according to label directions. Some individual states, including Wisconsin, also impose additional constraints on herbicide use.

The WDNR evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The WDNR frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also means that, in most cases, the herbicide will be degraded by the time peak recreation on the water starts.

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

The advantages of using chemical herbicides for control of aquatic plant growth are the speed, ease and convenience of application, the relatively low cost, and the ability to somewhat selectively control particular plant types with certain herbicides. Disadvantages of using chemical herbicides include possible toxicity to aquatic animals or humans, oxygen depletion after plants die and decompose which can cause fishkills, a risk of increased algal blooms as nutrients are released into the water by the decaying plants, adverse effects on desirable aquatic plants, loss of fish habitat and food sources, water use restrictions, and a need to repeat treatments due to existing seed/turion banks and plant fragments. Chemical herbicide use can also create conditions favorable for non-native aquatic invasive species to outcompete native plants (for example, areas of stressed native plants or devoid of plants).

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

HOW CHEMICAL CONTROL WORKS

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

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

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

Endothall, therefore, has the potential to selectively control CLP and/or EWM in sites where native pondweeds do not dominate the plant community (Skogerboe and Getsinger, 2006).

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

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

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

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

Endothall and diquat are considered broad spectrum contact herbicides. They destroy the outer cell membrane of the material they come in contact with and therefore kill a plant very quickly. Neither of these is considered selective and has the potential to kill all of the plant material that they come in contact with regardless of the species. As such, great care should be taken when using these products. Certain plant species like CLP begin growing very early in the spring, even under the ice, and are often the only growing plant present at that time. This is a good time to use a contact herbicide like Aquathol, as few other plants would be impacted. Using these products later in the season, will kill all vegetation in contact with the herbicide and can provide substantial nuisance relief from a variety of aquatic plants.

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

EFFICACY OF AQUATIC HERBICIDES

The efficacy of aquatic herbicides is dependent on both application concentration and exposure time, and these factors are influenced by two separate but interconnected processes - dissipation and degradation. Dissipation is the physical movement of the active herbicide within the water column both vertically and horizontally. Dissipation rates are affected by wind, water flow, treatment area relative to untreated area, and water depths. Degradation is the physical breakdown of the herbicide into inert components. Depending on the herbicide utilized, degradation occurs over time either through microbial or photolytic (chemical reactions caused by sunlight exposure) processes.

MICRO AND SMALL-SCALE HERBICIDE APPLICATION

The determining factor in designating chemical treatments as micro or small-scale is the size of the area being treated. Small-scale herbicide application involves treating areas less than 10 acres in size. The dividing line between small-scale and micro treatments is not clearly defined, but is generally considered to be less than an acre. Small-scale chemical application is usually completed in the early season (April through May). Micro treatments are as well, but may be used as follow-up spot treatments after an early season application, or in instances where a new infestation has been identified in a lake with EWM already or a in a completely new lake. Recent research related to micro and small-scale herbicide application generally shows that these types of treatment are less effective than larger scale treatments due to rapid dilution and dispersion of the herbicide applied. Some suggested ways to increase the effectiveness is to increase the concentration of herbicide used, use a contact herbicide like diquat that does not require as long a contact time to effective, or in some manner contain the herbicide in the treated area by artificial means. If combined micro or small-scale treatments exceed 10 acres or 10% of the littoral zone of a lake it is considered a large-scale treatment.

LARGE-SCALE HERBICIDE APPLICATION

Large-scale herbicide application involves treating areas more than 10 acres in size. Like small-scale applications, this is usually completed in the early-season (April through May) for control of non-native invasive species like EWM and CLP while minimizing impacts on native species. It is generally accepted that lower concentration of herbicide can be used in large-scale applications as the likelihood of the herbicide staying in contact with the target plant for a longer time is greater. If the volume of water treated is more than 10% of the volume of the lake, or the treatment area is ≥160 acres, or 50% of the lakes littoral zone, effects can be expected at a whole-lake scale. Large-scale herbicide application can be extended in some lakes to include whole bay or even whole lake treatments. The bigger the treatment area, the more contained the treatment area, and the depth of the water in the treatment area, are factors that impact how whole bay or whole lake treatments are implemented.

Pre- and post-treatment aquatic plant surveying and having an approved Aquatic Plant Management Plan are required by the WDNR when completing large-scale chemical treatments. Residual testing is not required by the WDNR, but highly recommended to gain a better understanding of the impact and fate of the chemical used. Due to the small-scale nature of EWM that has been found within Echo Lake in recent years, large-scale applications will not likely be necessary in the foreseeable future unless there is a dramatic shift in the EWM population.

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

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

The WDNR protocol assumes that an Aquatic Plant Management Plan has identified specific goals for non-native invasive species and native plants species. Such goals could include reducing coverage by a certain percent, reducing treatments to below large-scale application designations, and/or reducing density from one level to a lower level. A native plant goal might be to see no significant negative change in native plant diversity, distribution, or density. Results from pre and post treatment surveying are used to improve consistency in analysis and reporting, and in making the next season's management recommendations.

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

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

CHEMICAL CONCENTRATION TESTING

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

Chemical concentration testing has never been done on Echo Lake, and it is not recommended unless at some future point management efforts exceed 10% of the littoral zone. Chemical concentration testing done on other lakes has shown that application of herbicides in micro or small-scale treatment areas is less effective than treating large areas. Furthermore, chemical application in deep water or along deep water edges reduces the success of chemical management. All of the EWM that has been treated recently in Echo Lake was done in micro or small-scale beds. Documenting the success rate of these treatments through aquatic plant surveys is important for making appropriate management decisions.

HERBICIDE USE IN ECHO LAKE

2,4-D and Triclopyr are systemic herbicides approved for use in WI to control submersed aquatic vegetation like EWM. Systemic herbicides are meant to kill the entire plant by being absorbed into it. Presently triclopyr based herbicides are more expensive than 2, 4-D based herbicides, but could be used in a similar fashion to control undesirable AIS. ProcellaCOR could be used as well, should it prove to be more effective than either 2,4-D and triclopyr for small EWM treatments.

Research done with triclopyr in 2014 (Vassios, Nissen, Koschnick, & Heilman, 2014) suggest that there is a difference between how the target plant is affected when using liquid or granular formulations of triclopyr. In short, liquid applications of triclopyr tend to build up quicker in the meristem or growing tip of EWM, while granular applications tend to build up more in the root crown of EWM. The indication was that perhaps treating a body of water with both the granular and liquid formulation of the herbicide would affect a greater area of the plant providing better results than either formulation alone. This research was only completed using triclopyr, but it may have some application with 2,4-D as well, and it would be interesting to complete a test treatment using this method.

In order to effectively manage EWM, herbicides should be applied early in the season. This will allow EWM to be heavily impacted while native plants, which have not yet begun to grow, will be minimally affected. Through 2017, the only herbicides used on Echo Lake have been either liquid or granular 2,4-D. During the large-scale treatments, liquid was used because it is cheaper, and the increased area covered meant the herbicide would still have enough contact time at the appropriate concentration to kill the EWM. When completing small-scale treatments, granular 2,4-D has been used to ensure the herbicide would have enough contact time to kill the plant before dissipating.

MANAGEMENT DISCUSSION

This APM Plan for Echo Lake is intended to guide management implementation beginning in 2020 through the 2024 open water season. The original APM Plan for Echo Lake was written in 2008 with the goal of maintaining less than 10 acres of treatable EWM The 2013 APM Plan aimed to keep the level of treatable EWM within Echo Lake to <2 acres annually. As with the 2008 goal, the EWM was held well below the target levels each year. This plan seeks to keep the level of treatable EWM within the lake at or below 1 acre. The following five goals are included in the 2020-2024 APM Plan for Echo Lake. Specific objectives and actions associated with each goal can be viewed in Appendix A. A timeline for implementation is located in Appendix C.

1. Support and implement EWM management efforts that minimize negative impacts to the native plant communities.
2. AIS education and prevention.
3. Promote and support nearshore, riparian, and watershed best management practices that will improve fish and wildlife habitat, reduce runoff, and minimize nutrient loading into Echo Lake.
4. Encourage and engage lake residents and visitors to be active lake stewards.
5. Implement the Echo Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.

In recent years, the ELA has used a combination of chemical treatment and physical removal to control EWM levels within the lake. This tandem has been quite successful at keeping EWM levels significantly below the levels seen prior to active management. By continuing this active management regimen along with educating and prevention the ELA can reduce or maintain current levels of EWM while also minimizing damage to the native plants within the lake.

APPLICATION OF AQUATIC HERBICIDES

Several herbicides are used for control of EWM in a lake. Most common is the use of any aquatic herbicide that has the active ingredient 2,4-D in it – either in a granular or a liquid formulation. Granular forms should be used when treating small areas of a half-acre or less. Larger areas can be treated with liquid formulations. 2,4-D is considered a systemic herbicide, meaning it is drawn into the plant through the roots and vegetative parts of the plant, usually killing the entire plant if applied at an appropriate rate and an appropriate contact time between the herbicide and target plant is reached. Since one of the expected results of applying systemic herbicides is killing of the entire plant, systemic herbicides may provide longer-term results, perhaps even multiple years versus just one season. The active ingredient triclopyr is similar to 2,4-D and could also be used in Echo Lake. ProcellaCOR, which acts in a similar fashion to 2,4-D and triclopyr with a shorter contact time, could also be considered. All three of these herbicides can be somewhat selective in which plant species they kill, having the most impact on fine leaf plants like the watermilfoils (native and non-native), coontail, and floating-leaf species like white waterlily. Broad-leaf, submersed aquatic plants like the Potamogeton (pondweed) species are generally less susceptible to these herbicides.

Another aquatic herbicide that is commonly used to treat EWM contains the active ingredient diquat. Diquat is considered a contact herbicide that will kill the vegetative plant parts it comes in contact with. In some cases this may mean the root (buried in the sediment) is not entirely killed, which may allow regrowth from existing root structures. The benefit of using a contact herbicide like diquat is its rapid killing of the vegetative part of the plant. Diquat can kill the target plant with as little as 3-hrs contact time. At the concentrations used when chemically treating with 2,4-D and triclopyr, 18-24 hours of contact time are needed to kill the target plant. One disadvantage is that a contact herbicide like diquat is not plant selective. It will kill all plants that it comes in contact with.

It should be recognized that any aquatic herbicide will kill target and non-target species assuming either the contact time is long enough or the concentration of the herbicide applied to the water is high enough. To reduce the impacts of herbicide use on non-target plant species, these herbicides are mostly applied at times during open-water when native aquatic plant species are not actively growing – either in the early spring or very late fall. Invasive species like EWM and curly-leaf pondweed usually grow earlier in the season than most native plants, and at least EWM usually continues active growth much later into the fall.

Depending on the results of its initial use in WI, ProcellaCOR® should be reviewed and considered for future use in the Echo Lake.

EWM in shallow areas of the lake, or that forms larger beds (>0.5 acres) can be chemically treated with liquid formulations of 2,4-D or triclopyr and at lesser concentrations. Liquid formulations of 2,4-D and triclopyr based herbicides are usually much cheaper than their granular counterparts. And at least in treating larger areas, results from using liquid or granular herbicides are mostly the same. Chemical treatment in areas of the lake that may be protected from prevailing winds may also allow the use of lesser concentrations of herbicides that will still provide control of EWM. Diquat may also be used, but it may cause greater harm to native plants in the treated areas, and may not provide longer-term control, only seasonal control. This plan recommends applying aquatic herbicides based on annual conditions presented in the lake and as a compliment to physical and diver removal.

In some EWM management plans, same areas with EWM are not chemically treated two or more years consecutively. This concept provides an opportunity to evaluate long-term results of chemical treatments. This concept is not being incorporated in this APM Plan as EWM has been known to dominate the littoral zone when left unmanaged. Chemical treatments should take place on an as-needed basis with yearly fall bed mapping surveys and early spring readiness surveys to determine yearly need for treatment.

Annual chemical treatment proposals should be based on the results of prior year treatments, prior year aquatic plant and EWM surveys, new information about available aquatic herbicides, and input from the ELA, WDNR, and other stakeholders.

AQUATIC PLANT SURVEYING

Echo Lake has a very healthy and diverse native aquatic plant community. It also has EWM, a potentially problematic non-native aquatic invasive species. Both native and non-native aquatic plant species need to be monitored to determine the desired and undesired impacts of management implementation. There are at least three levels of aquatic plant surveying that help better assess and understand how management actions affect the lake and the aquatic plants within it.

MEANDERING SURVEYS

Meandering surveys of the littoral zone (plant-growing zone) looking for a specific plant species like EWM are important as they generally are the first indicator that there is something that does not belong. Meandering surveys help find target plant species, document the location where target plants are found using GPS technology or general mapping, and provides an opportunity to physically remove the target plant or make it a part of another management action. Fall bed-mapping of EWM is considered a meandering survey and serves to identify areas of concern for management in the following spring. The ELA does several meandering surveys each season and will continue to do so as a part of this new plan.

PRE AND POST TREATMENT POINT-INTERCEPT SURVEYS

Pre and post-treatment, point-intercept surveys are more quantifiable and document short-term changes in those areas under management. They consist of a set of points that can be surveyed at multiple times, usually before and after a chemical treatment. Statistical information can be gathered from the data collected during one of these surveys. The WDNR only requires pre and post-treatment, point-intercept aquatic plant surveying when greater than 10 acres of the littoral zone are proposed for treatment, or if a chemical treatment is grant funded. Pre- and post-treatment survey work was completed on Echo Lake while the lake was undergoing large-scale management of the, then widespread EWM. However, in recent years, chemical treatments in Echo Lake have rarely exceeded 1 acre and as a result, pre and post-treatment surveys have not been completed. Unless a single proposed treatment area exceeds 2.5 acres or is funded by a grant, pre and post-treatment surveys will not be completed. Should the size of a proposed chemical treatment reach or exceed 2.5 acres in a single treated area, the ELA will complete pre and post-treatment survey work.

WHOLE LAKE, POINT INTERCEPT AQUATIC PLANT SURVEYS

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

The last whole-lake, point-intercept survey of Echo Lake was completed in 2017 in 2023 at the end of this current plan.

OTHER AIS MONITORING AND MANAGEMENT

While EWM is the biggest problem within Echo Lake, there are several other AIS within and around the lake. Curly-leaf pondweed (CLP) has been found in Echo Lake, and purple loosestrife (PL) has been found in the surrounding wetlands. While CLP has never reached levels that warrant active management, regular monitoring will continue as a part of this plan. The ELA has worked with volunteers to survey for and remove PL where that is possible. This should also be continued.

In addition to monitoring and managing CLP and PL, the ELA will participate in Citizen Lake Monitoring Network Aquatic Invasive Species Monitoring Program annually looking for zebra mussels, rusty crayfish, and other AIS not already in the lake.

COARSE WOODY HABITAT

In the summer of 2017, the coarse woody habitat was quantified within Echo Lake as a part of the shoreline habitat assessment completed by ELA volunteers and LEAPS employees. This survey only found 15 pieces of that met the WDNR specifications for coarse woody habitat. In addition to the active management of AIS within and around Echo Lake, the ELA should look to install two or more Healthy Lakes Initiative Best Management Practices, including fishsticks, annually.

AQUATIC PLANT MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

GOAL 1: SUPPORT AND IMPLEMENT EWM MANAGEMENT EFFORTS THAT MINIMIZE NEGATIVE IMPACTS TO THE NATIVE PLANT COMMUNITIES

An integrated approach to management including physical removal and the use of herbicides will be implemented between 2020 and 2024 to prevent EWM growth and subsequent management from reaching or one acre through an integrated management strategy. EWM management actions will be completed in ways proven to cause the least harm to non-target plant species.

OBJECTIVE 1: MAINTAIN EWM COVERAGE IN THE LAKE AT LESS THAN ONE ACRE ANNUALLY

Action Item: Continue conducting annual fall EWM bed mapping surveys.

Action Item: Continue use of early-season herbicide treatments on "hotspot" or "high density" areas determined by annually fall EWM bed mapping surveys with granular 2,4-D as well as reviewing and considering any new herbicides approved for EWM control by the WDNR.

Action Item: Continue annual rake, snorkel, and/or SCUBA diver physical removal of EWM.

Note: Successfully meeting this objective will be measured by the results of EWM management over the five years of this plan.

OBJECTIVE 2: MAINTAIN OR IMPROVE MEASUREMENTS OF THE HEALTH OF THE NATIVE AQUATIC PLANT COMMUNITY

Action Item: Repeat the whole-lake, early and warm-water, point-intercept aquatic plant survey in five years (2022).

Action Item: Compare previous and current aquatic plant community health parameters including the Simpson's Diversity Index, Floristic Quality Index, number of plant species identified, and frequency of occurrence.

Note: Successfully meeting this objective will be measured by documenting few or no significant negative changes.

GOAL 2: SUPPRT AND IMPLEMENT AIS EDUCATION AND PREVENTION EFFORTS

Echo Lake can be a source lake for EWM being carried out attached to boats and/or trailers and taken to other lakes. Echo Lake is at risk of new AIS being introduced in the lake. The ELA will continue to implement a watercraft inspection program according to WDNR/UW-Extension Lakes protocol. This program will either be volunteer-based, or paid for by the ELA through a small-scale CBCW grant. Watercraft inspection data will be entered into the WDNR SWIMS database annually.

Appropriate AIS signage will be maintained at the public access on Echo Lake to improve the AIS awareness of many lake users.

AIS monitoring will be completed to monitor for possible new AIS following WDNR/UW-Extension Lakes protocol through the Citizen Lake Monitoring Network (CLMN) AIS Monitoring Program. Zebra mussels, spiny waterflea, hydrilla, banded mystery snails, and other species will be watched for and survey data entered into the WDNR SWIMS database annually.

OBJECTIVE 1: PREVENT NEW AIS FROM ENTERING AND EXISTING AIS FROM LEAVING ECHO LAKE

Action Item: Continue implementation of Clean Boat Clean Waters watercraft inspection with 100-200 hours paid and/or volunteer with grant funding and exclusively volunteer without.

Action Item: Install, maintain, and/or improve AIS signage at the public access point.

OBJECTIVE 2: MAINTAIN THE PUBLIC PARTICIPATION AND COMMUNICATION PROGRAM AND IMPLEMENT AN AIS EDUCATION AND INFORMATION PROGRAM

Action Item: Continue distribution of annual newsletters updating AIS and other ELA activities.

Action Item: Host an annual event to promote public awareness, knowledge, and involvement in lake and AIS education activities. This can be combined with the annual picnic, other planned event, or with another entity.

Action Item: Create and maintain an Echo Lake Association webpage.

OBJECTIVE 3: MAINTAIN AIS MONITORING EFFORTS

Action Item: Establish and maintain an in-lake and shoreline AIS monitoring program following CLMN guidelines.

Action Item: Establish an AIS rapid response plan in case any new AIS are introduced to Echo Lake.

GOAL 3: PROMOTE AND SUPPORT NEARSHORE, RIPARIAN, AND WATERSHED BEST MANAGEMENT PRACTICES THAT WILL IMPROVE FISH AND WILDLIFE HABITAT, REDUCE RUNOFF, AND MINIMIZE NUTRIENT LOADING INTO ECHO LAKE

An important part of controlling undesirable aquatic plant growth and the production of algae is reducing the amount of nutrients (mainly phosphorus) that enters the lake. The ELA will promote and encourage the implementation of simple and generally inexpensive best management practices including but not limited to shoreland buffers and the installation of rain gardens to reduce nutrient loading from the nearshore area.

Trees and other vegetation that naturally fall into a lake or that is intentionally placed in the lake by permit, is known as coarse woody habitat (CWH). CWH provides many benefits to fish and wildlife. Like aquatic vegetation, CWH is essential to the overall health of a lake and should be protected and enhanced, not eliminated. The ELA will provide information about and encourage property owner participation in protecting and/or enhancing CWH.

The ELA will strive to install one or more Healthy Lakes Best Management Practices annually through property owner outreach and education.

OBJECTIVE 1: INSTALL ONE OR MORE HEALTHY LAKES BEST MANAGEMENT PRACTICES ANNUALLY

Action Item: Adopt the State of Wisconsin Healthy Lakes Initiative for Echo Lake.

Action Item: Identify property owners interested in Heathy Lakes shoreland habitat improvement projects.

Action Item: Apply for Healthy Lakes grant funding to support projects that improve shoreland habitats and reduce runoff into the lake.

Action Item: Work with property owners on the installation of Healthy Lakes Projects.

OBJECTIVE 2: INCREASE THE AMOUNT OF WOODY HABITAT IN EHCO LAKE

Action Item: Provide educational and informational materials to lake property owners that promote the benefits of CWH in a lake.

Action Item: Encourage property owners not to remove woody debris that falls naturally into the lake from their shoreline unless it presents a dangerous and/or undesirable condition.

Action Item: Install a demonstration Fishsticks project in Echo Lake

GOAL 4: ENGAGE LAKE RESIDENTS AND VISITORS TO BE ACTIVE LAKE STEWARDS

Active management is a vital part of this management plan, but the efficacy of that management can be increase through an educated and involved constituency. The ELA will work to encourage both lake residents and visitors to do their part in improving and maintaining Echo Lake. This will be done through educational outreach and the dissemination of educational materials and resources.

OBJECTIVE 1: ENCOURAGE BEHAVIOR CHANGES IN RESIDENTS IN THE FOLLOWING AREAS: SHORELAND DEVELOPMENT, AIS, AQUATIC VEGETATION, RECREATIONAL PRACTICES, AND RESPONSIBILITY FOR THE LAKE

Action Item: Encourage lake residents to understand AIS concerns, identify and help monitor for AIS within the lake and report and/or remove what they find.

Action Item: Encourage boaters to implement appropriate AIS prevention strategies on their watercraft.

Action Item: Disseminate educational material related to the benefits of native plants within the lake and along the shoreline. This includes the creation and distribution of welcome packets, newsletters, informational/ educational displays, regular Facebook and/or web site updates, ELA meetings, and other resources to increase the level of public awareness and interest in the lake.

OBJECTIVE 2: ENCOURAGE AND SUPPORT CONSTITUENT PARTICIPATION IN ANNUAL LAKE AND AIS CONFERENCES IN WI AND MN

Action Item: Research and share dates and times for various lake and AIS conferences in MN and WI.

OBJECTIVE 3: CONTINUE WATER QUALITY TESTING FOR WATER CLARITY, TEMPERATURE, DISSOLVED OXYGEN, TOTAL PHOSPHORUS, AND CHLOROPHYLL-A AS A PART OF THE CLMN EXPANDED MONITORING PROGRAM

Action Item: Provide trained volunteers to complete water quality monitoring following CLMN Guidelines.

GOAL 5: IMPLEMENT THE ECHO LAKE MANAGEMENT PLAN EFFECTIVELY AND EFFICIENTLY.

This APM Plan is not intended to be a static document, but rather a plan that makes room for management changes that still fall under the guise of the stated goals, but that may make attaining those goals easier and more efficient. Management actions implemented in each year of this plan will be evaluated for how well they helped meet stated goals and objectives. Small changes will be made automatically if it is determined they will improve outcomes. Larger management changes will be presented to the ELA, WDNR, and other Stakeholders for approval before implementation.

An end of project report summarizing the success and failures after five years of management will be completed. This report will be completed by the ELA and its retainers and shared with property owners, lake users, WDNR, and other Stakeholders. A whole-lake, summer, PI, aquatic plant survey will be repeated in the third year included in this plan (2022) to help determine if management actions are accomplishing the goals set for them and that the health of the native aquatic plant community is not being negatively impacted. Results from all PI surveys will be compared to each other with the results leading to development of the next five years of EWM management in Echo Lake.

OBJECTIVE 1: COMPLETE ANNUAL PROJECT ACTIVITY AND ASSESSMENT REPORTS

Action Item: Use reports to make recommendation for annual revisions and updates to the APMP

OBJECTIVE 2: COMPLETE AN END-OF-PROJECT SUMMARY REPORT

Action Item: Overall review of project successes and failures.

Action Item: Review the goals, objectives, and actions in the 2020-2024 APM Plan for successful implementation.

Action Item: Revise or rewrite APM Plan on the established 5-year basis.

IMPLEMENTATION AND EVALUATION

This plan is intended to be a tool for use by the ELA to move forward with aquatic plant management actions that will maintain the health and diversity or Echo Lake and its aquatic plant community. This plan is not intended to be a static document, but rather a living document that will be evaluated on an annual basis and updated as necessary to ensure goals and community expectations are being met. This plan is also not intended to be put up on a shelf and ignored. Implementation of the actions in this plan through funding obtained from the WDNR and/or ELA funds is highly recommended. An Implementation and Funding Matrix is provided in Appendix D.

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

There are several different WDNR grant programs that may be applicable to and/or support the goals, objectives, and actions in this Aquatic Plant Management Plan.

AQUATIC INVASIVE SPECIES GRANTS

Aquatic Invasive Species grants can be used to support education, prevention, and planning projects, Clean Boats, Clean Waters programs, aquatic plant survey costs, plant management permitting costs, and many other actions. In some cased they can be used to support management implementation as well. Currently these grants require that 25% of a total projects cost be covered by the sponsor through volunteer time, donated services and/or equipment, and/or cash. Application due dates are December 10 and February 1.

LAKE MANAGEMENT PLANNING GRANTS

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

SMALL SCALE LAKE MANAGEMENT PROJECTS

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

LARGE SCALE LAKE MANAGEMENT PROJECTS

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

Currently these grants require that 33% of a total projects cost be covered by the sponsor through volunteer time, donated services and/or equipment, and/or cash. The application due date is December 10.

LAKE PROTECTION GRANTS

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

HEALTHY LAKES PROJECTS

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

Eligible best practices with pre-set funding limits are defined in the Wisconsin Healthy Lakes Implementation Plan, which local sponsors can adopt by resolution and/or integrate into their own local planning efforts. By adopting the Wisconsin Healthy Lakes Implementation Plan, a lake organization is immediately eligible to implement the specified best practices. The intent of the Healthy Lakes grants is to fund shovel-ready projects that are relatively inexpensive and straight-forward. The Healthy Lakes grant category is not intended for large, complex projects, particularly those that may require engineering design. All Healthy Lake grants require a 25% sponsor match and have a standard 2-year timeline. Applications are due on February 1 each year.

For more information about these or any other lake related WDNR grant, visit the WDNR's Surface Water Grants page at https://dnr.wi.gov/aid/surfacewater.html.

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Appendix A

Goals, Objectives, and Actions

Appendix B

WDNR Dredging Guidelines

Appendix C

Timeline for Management Actions

Appendix D

Implementation and Funding Matrix