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LONG TRADE LAKE, POLK COUNTY

2018-2022 APMP
WDNR WBIC: 2640500

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AQUATIC PLANT MANAGEMENT PLAN-LONG TRADE LAKE

PREPARED FOR THE ROUND-TRADE LAKE IMPROVEMENT ASSOCIATION

INTRODUCTION

Long Trade Lake is a 151 acre lake in Watertown Township in Polk County. Long Trade Lake is located in the Trade River watershed (Figure 1). The Trade River Watershed is approximately 124,754 acres in size and contains 167 miles of streams and rivers, 2,902 acres of lakes and 21,757 acres of wetlands. The watershed is dominated by forest (46%), grassland (19%) and wetlands (17%), and is ranked medium for nonpoint source issues affecting streams.

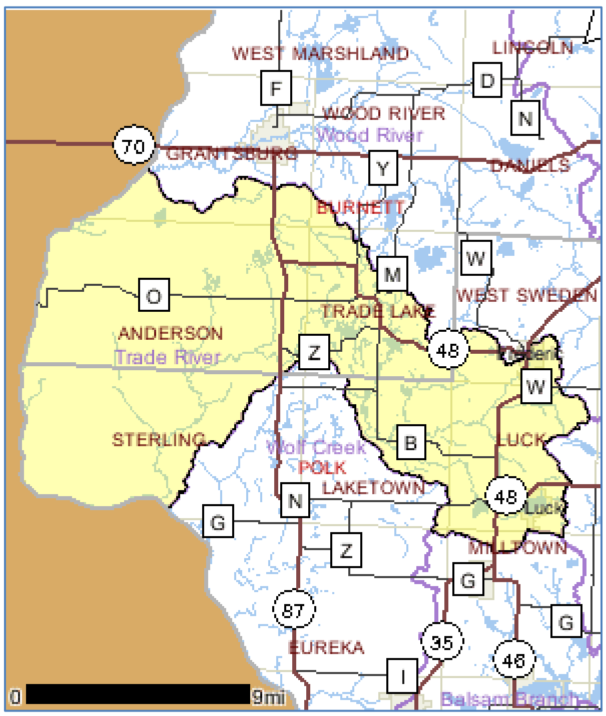

Figure 1 – Trade River Watershed (SC10)

Within the watershed, the Trade River begins in Polk County near Luck, WI, flows north in Burnett County and loops back to the south into the northwest of Polk County and then discharges into the St. Croix River (Figure 2). The Trade River flows through a chain of four lakes: Long Trade (Polk County), Round, Little Trade, and Big Trade (Burnett County). Long Trade Lake is the first lake in a chain that the Trade River flows through on its way to the St. Croix River.

These four lakes have been united under a common lake association for many years. The Round - Trade Lake Improvement Association (RTLIA) has been an active and enthusiastic leader in the pioneering efforts at lake management in Wisconsin. The four lakes along the Trade River have exhibited signs of excess fertility for decades. The signs of eutrophication are evident on these waters but a definitive nutrient and hydraulic budget has not been documented. A feasibility study to evaluate the hydraulic and nutrient loading to the lakes as well as in-lake monitoring to determine recycling and profile characteristics is a high priority for these lakes.

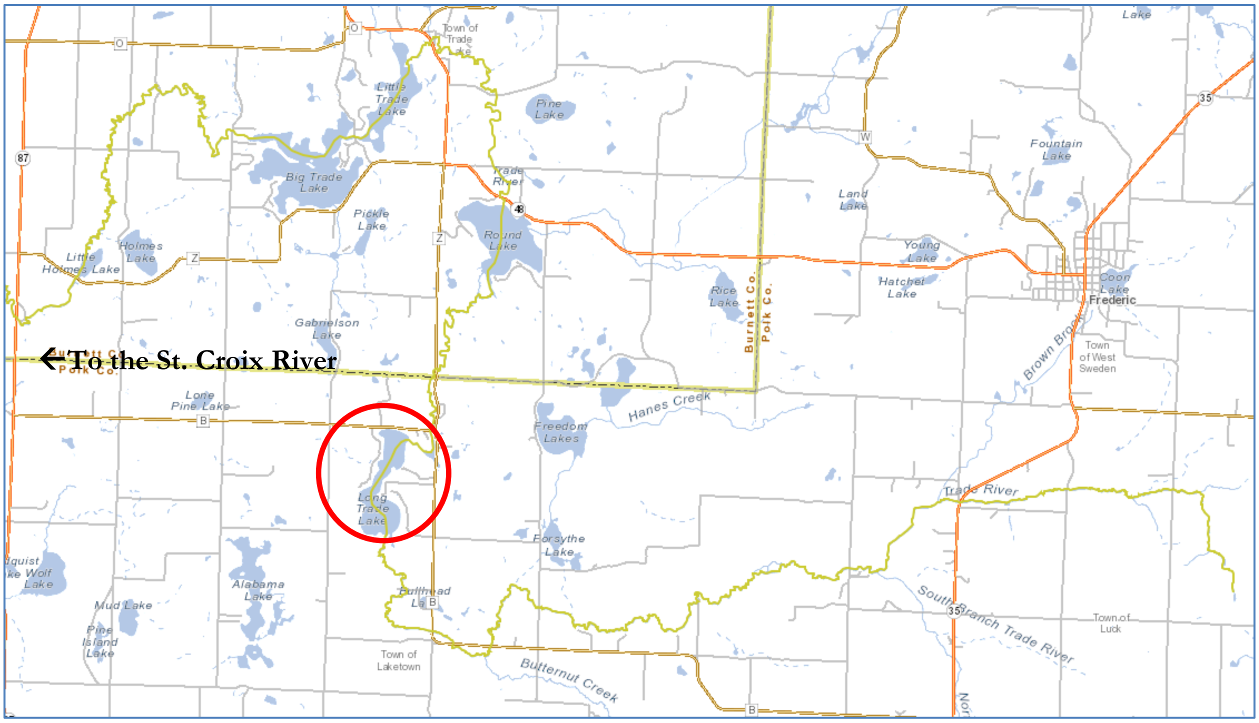

Figure 2 – Trade River Map – Long Trade Lake (circled in red)

Long Trade Lake is considered a "Reservoir" under the state's Natural Community Determinations. As such it is not considered a natural lake, but rather an impoundment created by an 11-ft dam on the Trade River. Still, Long Trade Lake is a shallow lake generally remaining mixed throughout the summer season. Stated lake uses for Long Trade Lake are fishing and swimming. These uses are not being met, and the lake was added to the Wisconsin Impaired Waters list in 2012 for Total Phosphorus, Excess Algal Growth, and Eutrophication. During the assessment process for the 2018 impaired waters list, water quality data continued to exceed thresholds for recreation use and fish and aquatic life.
WDNR Watersheds http://dnr.wi.gov/water/waterDetail.aspx?key=16674)

Eurasian watermilfoil (EWM) was identified in Long Trade Lake in 1995. Curly-leaf pondweed (CLP), another aquatic invasive species (AIS) has been in the lake for a longer period of time. From 1995 through 2002 between 10 and 30 properties totaling 1-4 acres were chemically treated twice a year. These treatments included EWM, CLP, algae, and native plants. From 2003 to 2012 no chemical treatment occurred in the lake. During that time CLP and EWM expanded to the point where they were the dominant plant species in the littoral zone with CLP early, followed by EWM when CLP senesced in late June. In 2010, the extent of EWM exceeded 25 acres, nearly 93% of the littoral or plant growing zone, then identified to be about 27 acres (Polk County, 2011).

THE ROUND-TRADE LAKE IMPROVEMENT ASSOCIATION

The Lake Improvement Association is a non-profit, state incorporated, association comprised of Round Lake, Big and Little Trade Lakes, Long Trade Lake, and Spirit Lake (Spirit Lake is no longer part of the Association). These lakes are located in both Burnett and Polk counties in Wisconsin. The official name is the Round-Trade Lake Improvement Association, Inc., however, it is referred to as the Lake Improvement Association, or more recently the RTLIA. The RTLIA was originally incorporated March 26, 1974, by residents of Round and Trade Lakes with its official offices located in the Township of Trade Lake. The RTLIA is comprised of officers: President, Vice-President, Secretary-Treasurer. Each of the officers is elected through the nomination and vote process of the association's members. There are four board members representing each of the lakes in the association and there is also a lake chairman from each of the four lakes. Regular funding is generated from annual membership dues, with additional funding coming from grants obtained through the state of Wisconsin. Four annual association open meetings are held where members of the association or the public can present ideas or concerns.

The following is a list of actions the RTLIA have implemented over the years. This list should not be considered a complete list, but does reflect the reasons for the efforts made.

- Installed larger culverts on Trade Lake in order to control the lake water levels and reduce flooding of the lakeshore.
- Initiated a plan to control the number of rough fish in Round and Trade Lakes.
- Funded aquatic plant management actions in an effort to control the weed growth for recreational users of the lakes.
- Worked with the DNR to mark hazardous areas with buoys on Trade and Round Lakes.
- Successfully defeated the development of an asphalt plant that was to be located on the Trade River, just north of Round Lake.
- Fought to deter the development of back lot access to Round Lake.
- Introduced weevils into Long Trade Lake in an effort to control the spread of Eurasian watermilfoil.
- Completed Aquatic Plant Management Plans for all four lakes
- Applied for and received State grant funding for planning and control of EWM and CLP
- Completed a study of the water chemistry, macrophytes, and lake sediment of Round Lake.
- Is working to complete a study of the watershed of Long Trade Lake
- Participated in annual state conservation conferences, contributed financially to local causes, and disseminated information to local lakeshore owners on various conservation methods.

Membership in the RTLIA requires payment of dues in the sum of $30.00 annually. Completed membership forms and investment can be given to any of the officers, board members, lake chairman, or it can be mailed. A current listing of all the officers, board members, and chairman is available by visiting the RTLIA web site at www.tradelakeassoc.org. Minutes from meetings, additional information about the RTLIA, and many other resources are available on the webpage. The RTLIA is also on Facebook. Some current and future goals for the RTLIA include but are not limited to the following:

- Complete water quality studies of the lakes in the Trade River system
- Develop long-term strategies to maintain and improve the water quality of the lakes in the Trade River system
- Control or reduce the spread of exotic plant species in the lakes and on the surrounding lakeshores.
- Increase active membership in the Lake Improvement Association.

OVERALL MANAGEMENT GOAL

The overall management goal for Long Trade Lake is to maintain EWM at low levels that do not interfere with lake use. For the purposes of this management plan, that level is less than two acres as identified annually during a late summer point-intercept aquatic plant survey. A secondary goal is to reduce the amount of moderate to dense growth CLP in the lake by 50% in five years based on point-intercept survey data within the littoral or plant growing zone of the lake; and to reduce the number of turions in the sediment of management areas by 50% after three years of active management.

In the previous Trade Lakes Aquatic Plant Management Plan (2011), management objectives for EWM in the entire system included:

1. 75% reduction in dense growth EWM over five years;
2. Preventing EWM from spreading into Big Trade Lake;
3. Preventing EWM from leaving the lake via boat traffic; and
4. Getting property owners to take action to control EWM near their docks and shoreland.

Of these objectives, only the first and last can be said to have been fully reached. Based on 2016 totals, EWM in all four lakes combined showed an 80% reduction. However, it did spread from Little Trade Lake into Big Trade Lake during this time period. Property owners on Long Trade Lake have taken an active interest in controlling EWM by their own accord. Public access on Long Trade Lake is available on the east side of the lake on property owned by Polk County, with at least 104 hours of watercraft inspection recorded in the WDNR SWIMS database since 2015.

EURASIAN WATERMILFOIL (EWM)

There are only three whole lake summer surveys of the vegetation in Long Trade Lake. A summer point-intercept survey was completed by Polk County in 2006; a summer bed mapping survey was conducted by Polk County in 2010, and a whole-lake summer point-intercept survey was done by Endangered Resource Sciences in 2016. During the 2006 survey, no EWM was documented. During the 2010 survey, more than 25 acres of EWM was identified, and in 2016 EWM was identified at only two points for a total less than 1.0 acres (Figure 3).

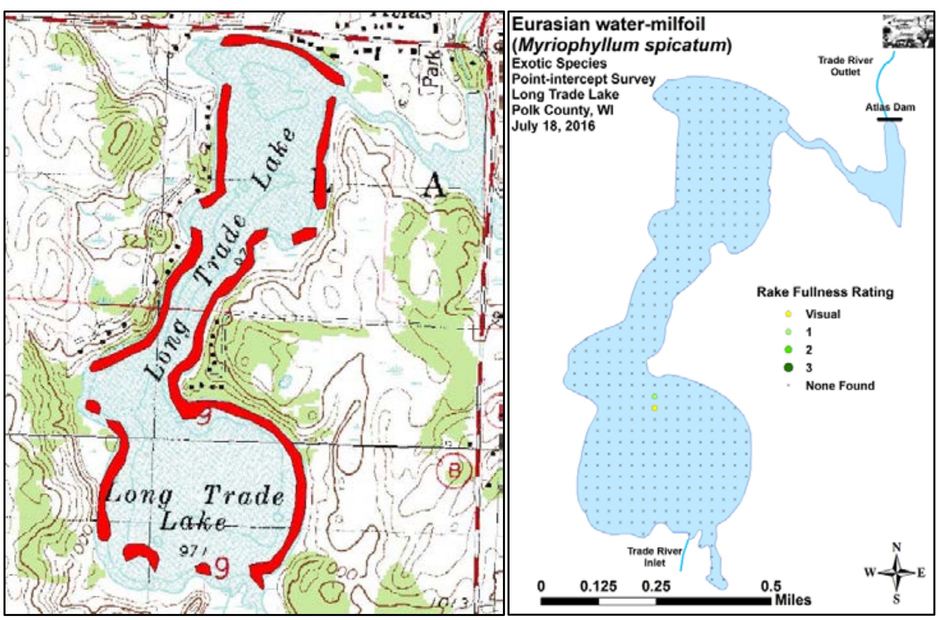

Figure 3 – 2010 (Polk County) and 2016 (ERS) Summer EWM

CURLY-LEAF PONDWEED (CLP)

One of the goals in the 2011 Trade Lakes APM Plan was to document the extent of CLP in each of the four lakes, and then to create an addendum to the existing plan focused on control of CLP. This goal was met, with a CLP management plan for all four lakes being completed in 2012. At the time of the CLP bed-mapping survey on Long Trade Lake, most of the lake's littoral zone was dominated by nearly monotypic canopied beds of CLP covering more than 33 acres of the lake (Figure 4). Point-intercept survey work done in 2012 identified 93 of 376 survey points with CLP – 62 of those points had a rake fullness rating of 2 or 3 on a 1-3 scale (Figure 5). The overall density rating for CLP in 2012 was 2.16 (Table 1).

Once the extent of CLP in Long Trade Lake was known, several scenarios for management were proposed. The excepted scenario, which was first implemented in 2013, targeted a partial lake restoration through limited CLP management along with a goal of managing all EWM that was in the lake. Application of herbicides targeted all areas of EWM, and treated CLP in the same areas that EWM was managed. Once CLP management began, it was planned to be continued for a minimum of three years.

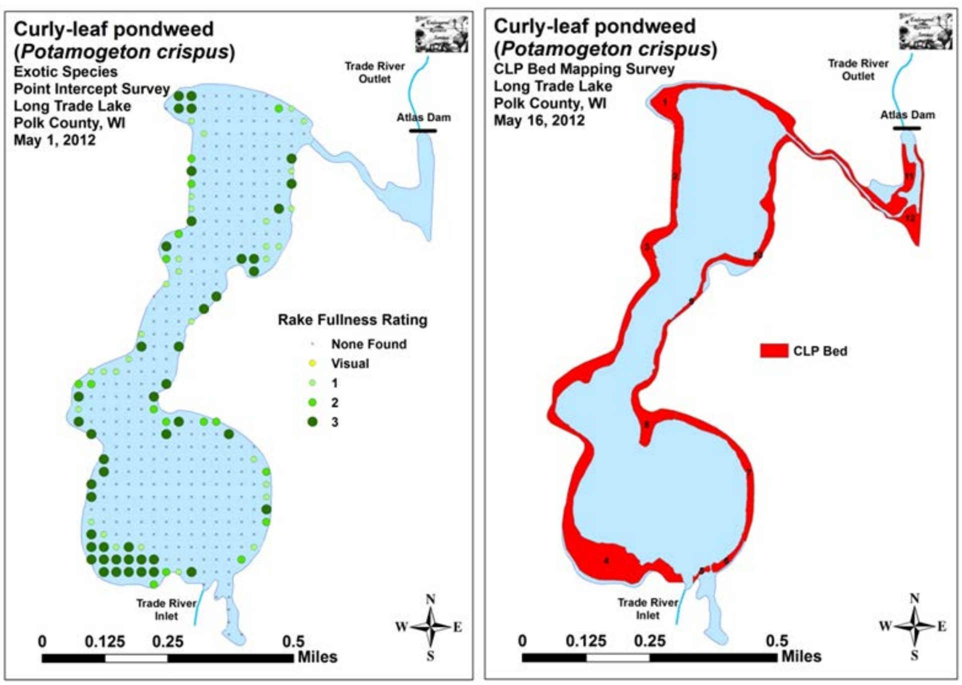

Figure 4 – 2012 CLP Point-Intercept Survey and Bed-mapping

Table 1 – 2012/2016 CLP Comparisons

Long Trade Lake 2012/16 Comparison				
Year	Total Acres	Pts w/CLP	Mod/Dense	AveRakeDens
2012	33	93/376	62	2.16
2016	26	65/376	47	1.98

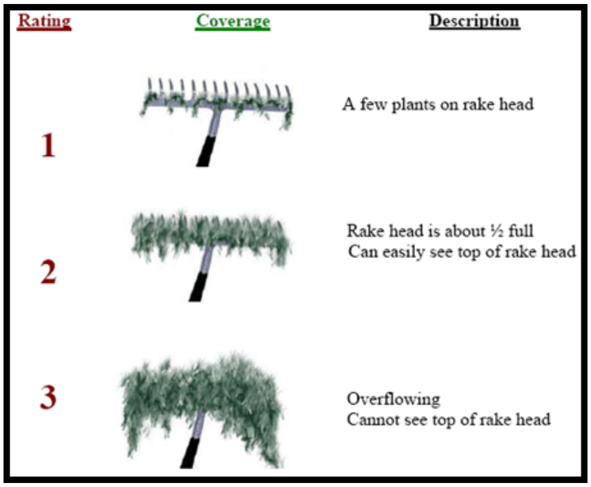

Figure 5 - Rake Fullness Ratings

In 2013, 5.63 acres of EWM, and 9.31 acres of CLP were treated using a combined treatment of endothall and 2,4-D. Only CLP was treated in 2014 and 2015 because EWM was essentially eliminated from Long Trade Lake after the 2013 treatment. It did not make a return until late summer 2015. Management of EWM and CLP resumed in 2016 again with endothall and 2,4-D together yielding outstanding results. A very limited EWM and CLP treatment was completed in 2017 due to the success of the 2016 treatment (Table 2).

Table 2 – 2013-2017 CLP/EWM Management on Long Trade Lake

AIS Management on Long Trade Lake, 2013-2017					
Task	2013	2014	2015	2016	2017
APM Plan					P
AIS Control Grant				X	X
AIS Rapid Response Grant					
Spring EWM Treatment (acres)	5.63			11.46	2.56
Fall EWM Bed Mapping	X	X	X	X	P
EWM Physical Removal	X	X	X	X	X
CLP Bed Mapping	X	X	X	X	
Spring CLP Treatment (acres)	9.31	4.89	3.78	11.46	2.16
Pre-treatment Plant Survey	X	X	X	X	
Post Treatment Plant Survey	X	X	X	X	
Whole-lake PI Survey				X	
X= Completed, P=Proposed					

Point-intercept survey work in 2016 identified 65 of 376 points with CLP, with 47 of those points having a rake fullness rating of 2 or 3. The overall density rating for CLP was 1.98. CLP bed-mapping in 2016 identified approximately 26.0 acres of CLP left in the lake after treatment. Of that acreage, nearly 19 aces were considered moderate or dense with an average rake fullness 1.98 on a 1-3 scale (Table 1, Figures 5 & 6). CLP management in 2018 and beyond will target both the CLP located in the same areas as proposed EWM treatments, and additional acreage along developed shores with the intent of reducing the total presence of CLP (actual plant acreage and turions) to 50% or less of 2016 levels within five years. A continued goal would be to reduce the total presence of CLP by at least another 50% within ten years. Turion reductions would be based off of 2018 survey numbers.

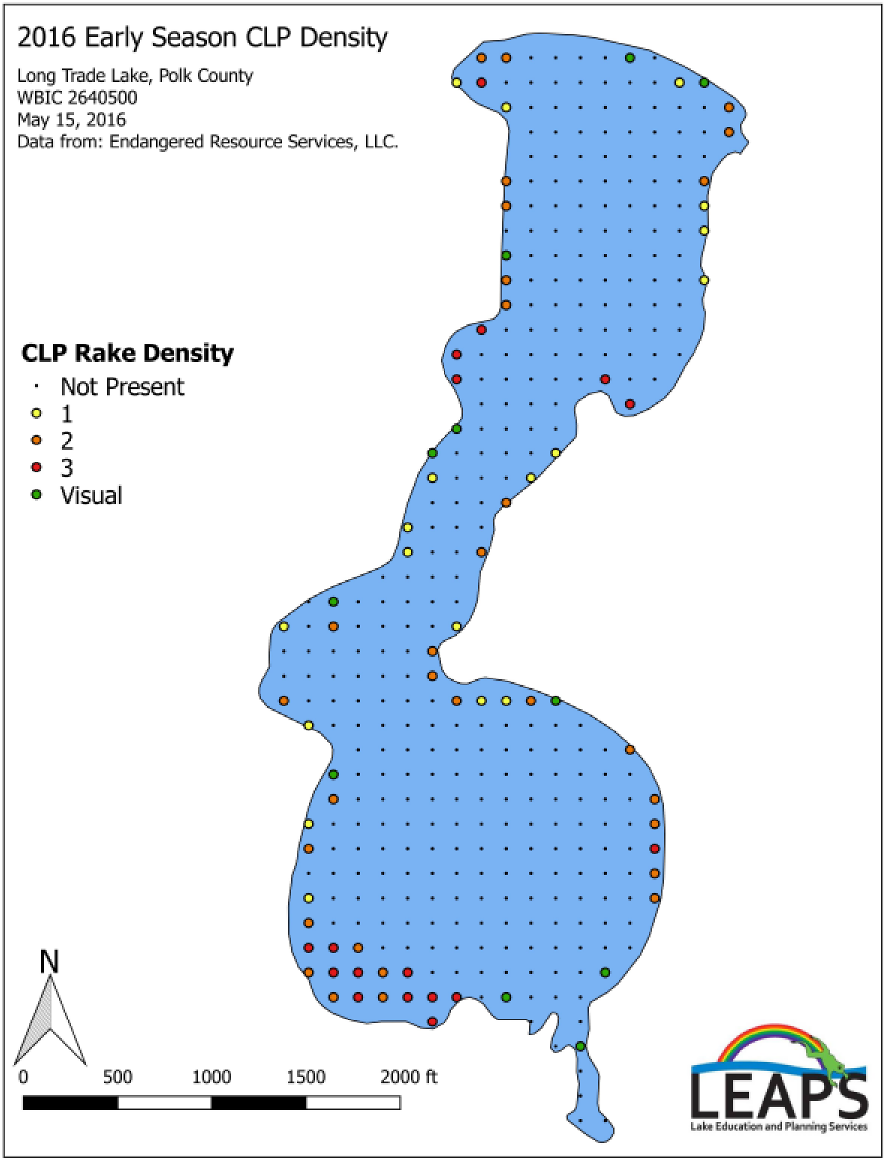

Figure 6 – 2016 CLP Point Intercept-Survey and Bed-mapping

ADDITIONAL MANAGEMENT GOALS FROM THE 2011 APM PLAN

Additional management recommendations made in the 2011 APM Plan included preventing the spread and introduction of other aquatic invasive species; preserving, protecting, and enhancing the lake's native aquatic plant community; and minimizing runoff of pollutants, nutrients, and sediment from the Trade River Watershed. In an effort to reach these goals and meet the objectives stated for them, the RTLIA continued participation in a purple loosestrife biological control program by raising beetles; sponsored several AIS educational events; participated in AIS monitoring; and encouraged property owners to leave native aquatic plants in place along their shorelines. Developing a nutrient budget and watershed management plan was also included as a management objective, however the process to begin doing this has only been started since 2016, and then only for Long Trade Lake at the top of the Trade River system that includes Long Trade, Round, Little Trade, and Big Trade Lakes.

WISCONSIN'S AQUATIC PLANT MANAGEMENT STRATEGY

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

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

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

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

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

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

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

There are many techniques for the management of aquatic plants in Wisconsin. Often management may mean protecting desirable aquatic plants by selectively hand pulling the undesirable ones. Sometimes more intensive management may be needed such as using harvesting equipment, herbicides or biological control agents. These methods require permits and extensive planning. Often using and Integrated Pest Management (IPM) strategy that incorporates multiple management actions/alternatives works the best.

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

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

PHYSICAL CHARACTERISTICS

Long Trade Lake (WBIC 2640500) is a drainage reservoir in northwestern Polk County, about ten miles southeast of Grantsburg, Wisconsin. Long Trade Lake is the first in a series of four lakes that are connected by the Trade River. The water level is controlled by an 11 foot dam owned by Polk County at the Trade River outlet. According to the Wisconsin Department of Natural Resources, Long Trade Lake is 153 acres with a maximum depth of 13-ft. Physical characteristics of the lake, derived from GIS and other sources, are provided in Figure 7 and Table 3.

The land use in the Long Trade Lake watershed is primarily classified as forests which make up 42% of the 30,371 acre watershed, followed by agricultural land uses (row crops, pasture, etc.) which cover 37% of the land surface. The remainder of the land is classified as wetlands (7%), open water (3%), grasslands and scrub (3%) and developed areas including residential areas and businesses (8%) (U.S. Geological Survey, 2011). Developed areas are fairly sparce around Long Trade Lake, but much of the land around the lake as well as along the shores of Trade River which flows directly into Long Trade Lake is used for agriculture. While this is not the sole source of nutrients entering Long Trade Lake, these areas likely have a significant impact on the water quality of the lake.

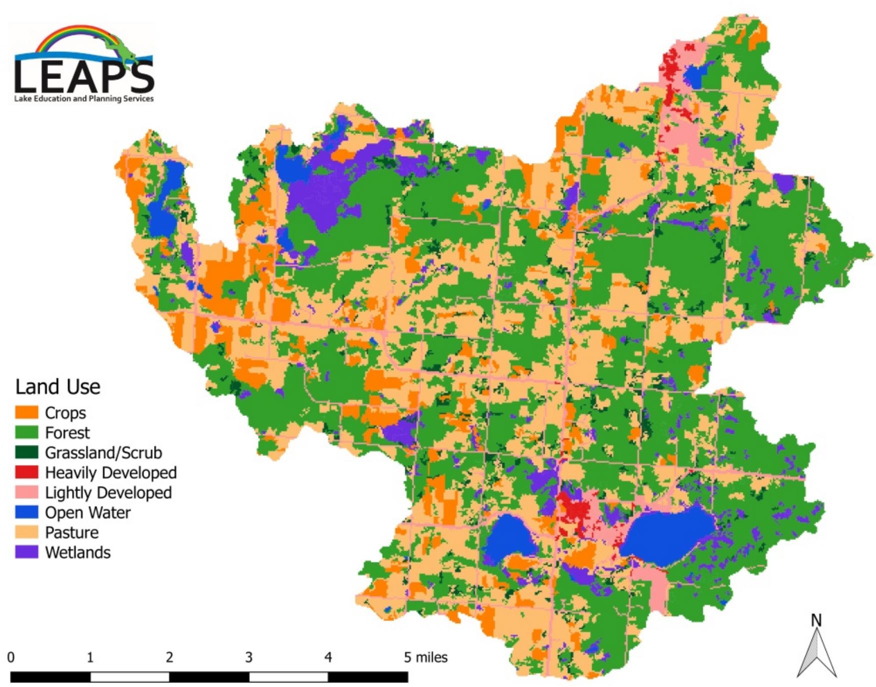

Figure 7: Watershed Land Use for Long Trade Lake, Polk County (LEAPS, 2016)

Table 3: Physical Characteristics of Long Trade Lake, Polk County

Lake Characteristics	
Lake Area (Acres)	161
Watershed Area (Acres)	30,371
Maximum Depth (feet)	13
Mean Depth (feet)	8
Miles of Shoreline	4.6
Lake Type	Drainage

Watershed Land Use (acres)	
Open Water	940
Forest	13,070
Agriculture	11,462
Developed	2,345
Wetlands	1,756
Grasslands/ Scrub	798

Land cover and land use management practices have a strong influence on water quality. Increases in impervious surfaces, such as roads, rooftops and compacted soils, associated with residential and agricultural land uses can reduce or prevent the infiltration of runoff. This can lead to an increase in the amount of rainfall runoff that flows directly into Long Trade Lake and its tributary streams. The removal of riparian, i.e., near shore, vegetation causes an increase in the amount of nutrient-rich soil particles transported directly to the lake during rain events.

Long Trade Lake is the only one of the four lakes in the system that is impacted by a dam. As such, early in the first years the 2011 APM Plan was implemented, a thorough evaluation of using a drawdown to control AIS was completed (SEH Inc, 2012). While it is possible to do a draw down of the lake, blockage in the stream/channel between the main lake and the millpond immediately above the dam limits how far down the water can be taken to about 3.5 feet. In order to be effective, the water level would need to be drawn down at least 5-ft. Furthermore, in a vote taken in 2012 after the results of the drawdown evaluation were reported, the Long Trade Lake constituency decided not to pursue a drawdown as a management action.

CRITICAL HABITAT

Every body of water has areas of aquatic vegetation that offers critical or unique fish and wildlife habitat. Such areas can be identified by the WDNR and recognized as Sensitive Areas per Ch. NR 107. The WDNR has not identified sensitive areas on Long Trade Lake, but this does not mean they do not exist. There are areas of the lake that should be left in an undisturbed state to provide aquatic habitat and ecosystem services necessary for a healthy lake. Aquatic habitat areas provide the basic needs (e.g. habitat, food, nesting areas) for waterfowl, fish, and wildlife. Disturbance to these areas during mechanical harvesting should be avoided or minimized and chemical treatment is generally not allowed. Areas of rock and cobble substrate with little or no fine sediment are considered high quality walleye spawning habitat. No dredging, structures, or deposits should occur in these sensitive areas.

WATER QUALITY

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, mesotrophic, eutrophic, and hypereutrophic (Figure 8). 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 very green with dense algae and limited plant growth. Long Trade Lake is considered to be a eutrophic lake, reaching hypereutrophic conditions nearly every open water season.

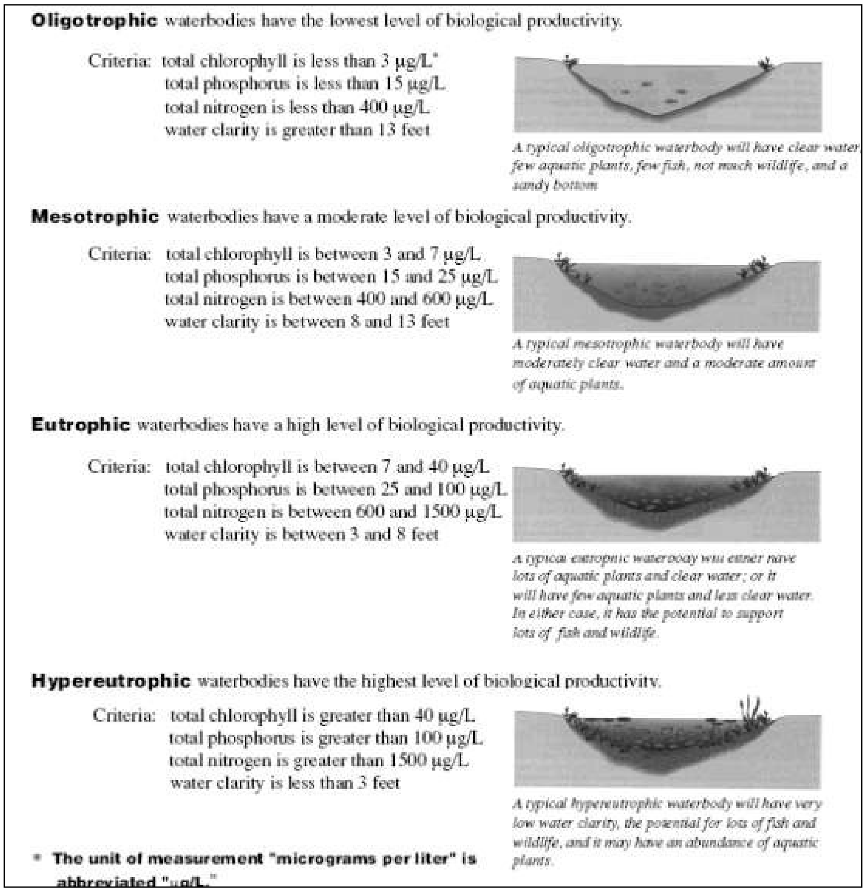

Figure 8 – Trophic status in lakes

Long Trade Lake has been classified as an "Impaired Water" by the WDNR. The Clean Water Act mandates that every even numbered year the WDNR (and all other states) must prepare a list of waters that do not meet the water quality standards established by the state. A waterbody is defined as impaired if it is shown that one or more pollutant criteria are met and if it "does not support full use by humans, wildlife, fish, and other aquatic life" (WDNRa, 2015). Long Trade Lake has received this designation due to excess algal growth, total phosphorus content, and eutrophication. All water quality data in this section were retrieved from the WDNR Long Trade Lake webpage.

Water quality data has been collected on Long Trade Lake since 1986 by Citizen Lake Monitoring Network (CLMN) volunteers. Citizen lake monitoring plays a critical role in collecting data to determine water quality trends over time. For Long Trade Lake, all data has been collected at the Deep Hole site in the South Basin. Average summer water clarity, or Secchi depth, data range from 1.5 feet in 2005 up to 4.1 feet in 1993. It should be noted that there were only two measurements taken in 2005 which were both collected late in the summer. The overall average summer Secchi depth for all sites from 1986 to 2016 is 2.8 feet, which suggests the lake is eutrophic bordering on being hypereutrophic from a water clarity perspective (Figure 9).

Average summer total phosphorus data range from 58.7-µg/l in 2012 to 187-µg/l in 2005. The overall average summer total phosphorus from 2005-2016 is 125.5-µg/l, which suggests Long Trade Lake is hypereutrophic from a phosphorus perspective (Figure 9). The average summer phosphorus in 2005 was abnormally high at 187-µg/l, but the only two samples for that year were taken late in the summer. In 2011 only one phosphorus sample was taken, but this yielding a fairly average 113-µg/l despite being taken very late in the season. No explanation for the high phosphorus levels are offered in the CLMN field notes for these dates.

Average summer Trophic State Index (TSI_{CHL}) values for chlorophyll range from 66.3 in 2007 to 69 in 2015 at the Deep Hole site. The overall average summer TSI_{CHL} from 2005-2016 is 67.6, which suggests Long Trade Lake is almost hypereutrophic from a chlorophyll standpoint (Figure 9).

One positive note is that linear trend lines placed on top of the limited data, suggest that water quality in the lake is getting better, not worse over time.

Figure 9: Secchi Depth, Total Phosphorus, and Chlorophyll Yearly Averages with Trend Lines (red dash)

FISHERIES AND WILDLIFE

Panfish, largemouth bass, and northern pike are all listed as common species in Long Trade Lake, while walleye are thought to be present. Carp are also found in Long Trade Lake, but the population is small enough that it does not seem to be causing problems within the lake (WDNRc, 1992). There is no fish stocking data from the WDNR suggesting that fish stocking has not occurred in the lake since 1972. The most recent WDNR fish surveys were conducted in 2003 and 2008. The 2003 survey was aimed at establishing a baseline while the 2008 survey was a late spring survey meant to assess bass and pan fish populations. Table 4 summarizes these surveys.

Table 4: 2003 and 2008 fisheries surveys

2003 Baseline Survey				
Species	Relative Abundance (Catch per Mile)	Minimum Length (inches)	Maximum Length (inches)	Average Length (inches)
Black crappie	4	4.5	6.5	6
Bluegill	322	3	8.5	6.18
Largemouth Bass	35.67	7.5	18.5	13.61
Northern Pike	4	19	24.5	21.42
Pumpkinseed	3	5	6.5	6.08
Yellow Perch	12	6	9.5	8.42

2008 Late Spring Bass/ Panfish Assesment				
Species	Relative Abundance (Catch per Mile)	Minimum Length (inches)	Maximum Length (inches)	Average Length (inches)
Black Crappie	26	7	10	8.1
Bluegill	334	3	8.5	6.15
Largemouth Bass	40	6.5	19	12.47
Pumpkinseed	18	5	7	6.58
Yellow Perch	2	8	9	8.75

Both surveys show a large population of bluegills within Long Trade Lake as well as a healthy population of largemouth bass. There were noticeably more black crappies and pumpkinseeds found during the 2008 survey, but this is likely due to the timing of the survey more than any sort of drastic change in those populations. This is also the likely cause for the difference in yellow perch and northern pike that were found.

While the lake does not suffer greatly from winter fishkills due to oxygen depletion under the ice, it does suffer from spring fishkills caused by the fish virus "columnaris". In nature, delays in spring fish spawning caused by changes in normal spring weather patterns can weaken fish enough to make them susceptible to the virus, which always present in the water. Columnaris outbreaks may also occur in lakes and streams during oxygen depravation times such as droughts and high temperatures of the summer months. However, if the fish are healthy it's not a problem. In August 2017 there was a large die-off of 4-6" crappies blamed on the virus (Personal Communication Aaron Cole, WDNR). Summer columnaris outbreaks are not common on this lake, but warm temperatures and possible oxygen depravation likely triggered the outbreak. This outbreak, coupled with suffering water quality in the lake at the same time, made for extremely undesirable conditions on Long Trade Lake in August.

No non-native animal species have been observed in Long Trade Lake. There are currently two species, Chinese mystery snails and rusty crayfish, have been observed in the Trade River, but they are not yet found in Long Trade Lake. Little is known about Chinese mystery snails though they seem to cause negative impacts on the native snail populations. Rusty crayfish are substantially more aggressive than their native counterparts, and reproduce rapidly which is why they can be incredibly harmful to plant populations and fisheries in the lakes they inhabit.

The Natural Heritage Inventory (NHI) database contains recent and historic observations of rare species and plant communities. Each species has a state status including Special Concern (SC), Threatened (THR) or Endangered (END). There is one plant (Brittle Prickly-pear [THR]) and one reptile species (Blanding's turtle [SC]) that are found within the same township and range as Long Trade Lake (T36N, R18W).

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

There are a several wetlands within the Long Trade Lake watershed. There is a narrow wetland area surrounding the lake which can help with erosion control and water quality. There is also a large wetland complex on the southern portion of Long Trade Lake which follows the Trade River as it flows into Long Trade Lake. This large complex helps prevent some of the runoff from entering the river which will subsequently enter the lake. The southern complex also provides a large area of undisturbed habitat for wildlife that relies on these areas (Figure 10).

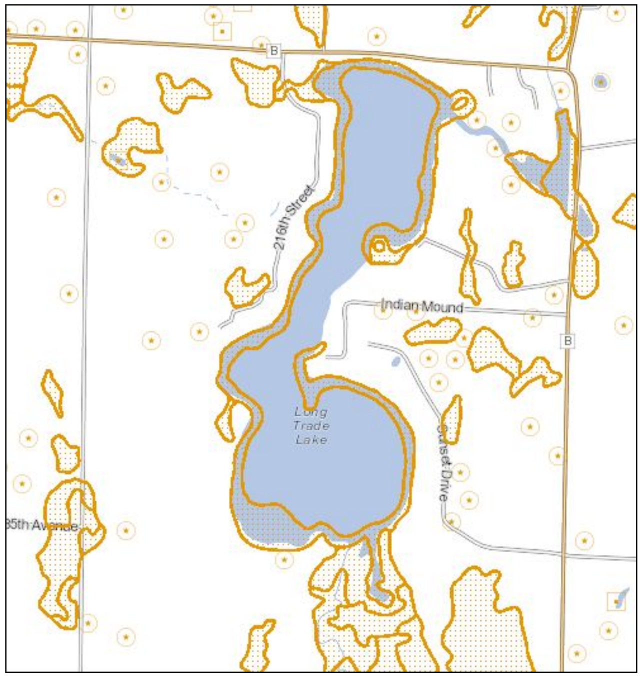

Figure 10: Long Trade Lake Wetlands (Wisc. Wetlands Inventory December 14, 2016)

SOILS

Soils are classified into hydrologic soil groups 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. Most of the soils within the Long Trade Lake watershed fall into groups C and C/D (NRCSa, 2016) (Figure 11). These soils are very good for agriculture, but they also have a fairly high runoff potential. If managed appropriately, the runoff can be minimized in these areas.

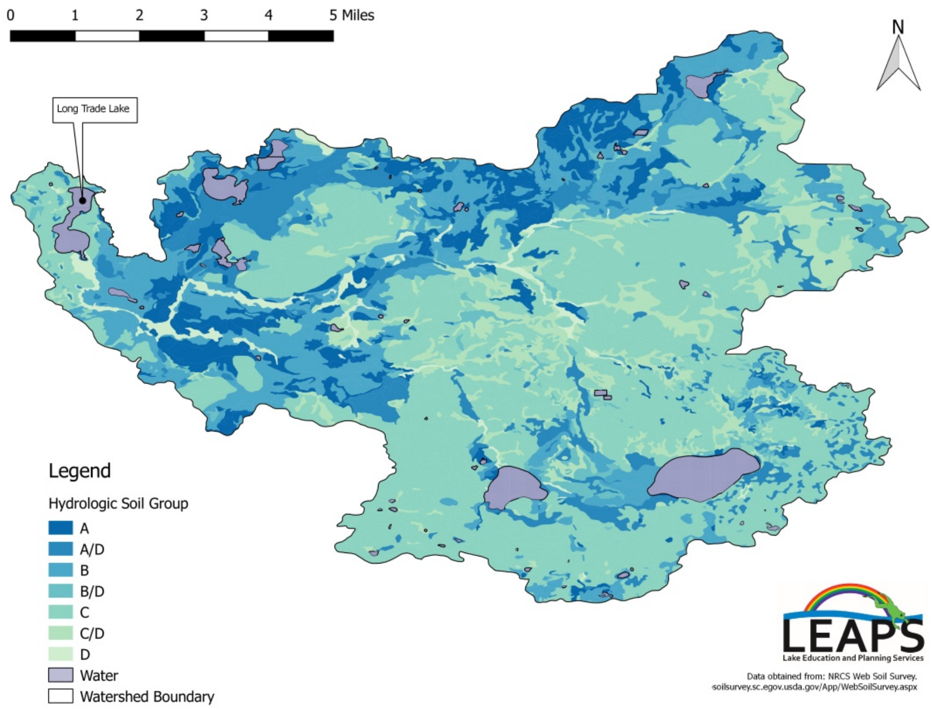

Figure 11: Hydrologic Soil Group Classification in the Long Trade Lake Watershed

COARSE WOODY HABITAT (WOLTER, 2012)

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

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

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 12-29-2016).

Small-scale CWH projects, more commonly referred to as "fishsticks," can also be done by individual property owners, and are eligible for grant assistance through the WNDR Healthy Lakes program. This program is intended to help individual property owners make a positive impact on their lake's ecosystem through small-scale projects such as fishsticks (Figure 12).

Figure 12: Coarse woody habitat-Fishsticks projects

SHORELANDS

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

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

Lakes are buffered by shorelands that extend into and away from the lake. These shoreland buffers include shallow waters with submerged plants (like coontail and native 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. In addition to being potentially damaging, some of these undertakings require permits and approval. Most changes to lakebed exposed by fluctuating water levels (removal of sediments, additions of beach sand, etc.), often require permits and approval. The only exceptions to this are manual removal of a 30 foot corridor of native plants or the removal of non-native invasive plants. These regulations have been put in place to encourage property owners to responsibly manage their shorelands to improve and maintain the quality of the lake as a whole.

PROTECTING WATER QUALITY

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

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

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

NATURAL SHORELANDS ROLE IN PREVENTING AIS

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

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

THREATS TO SHORELANDS

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

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

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

SHORELAND PRESERVATION AND RESTORATION

If a native buffer of shoreland plants exists on a given property, it can be preserved and care taken to minimize impacts when future lake property projects are contemplated. If a shoreline has been altered, it can be restored. Shoreline restoration involves recreating buffer zones of natural plants and trees. Not only do quality wild shorelines create higher property values, but they bring many other values too. Some of these are aesthetic in nature, while others are essential to a healthy ecosystem. Healthy shorelines mean healthy fish populations, varied plant life, and the existence of the insects, invertebrates and amphibians which feed fish, birds and other creatures. Figure 13 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 12-29-2016).

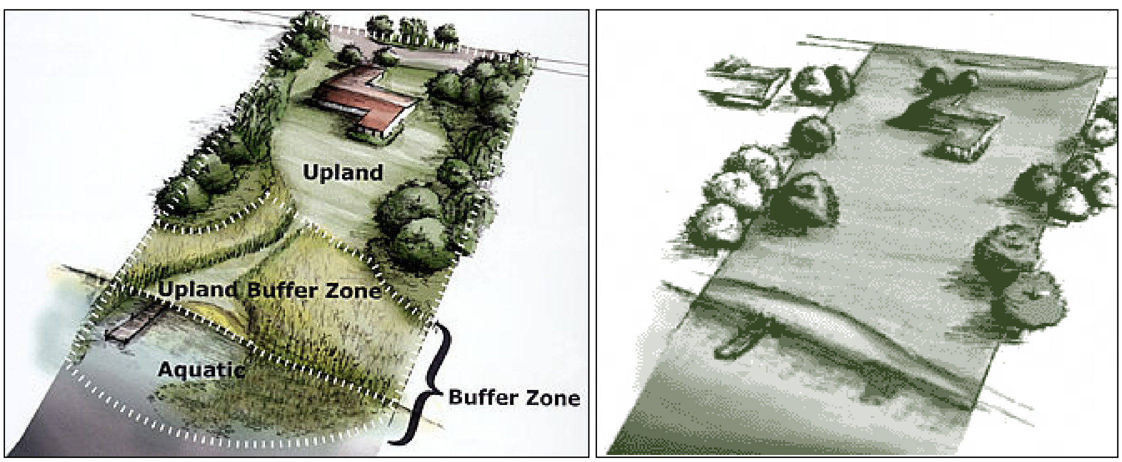

Figure 13: Healthy, AIS Resistant Shoreland (left) vs. Shoreland in Poor Condition

A good amount of the property surrounding Long Trade Lake has been left natural. However, there are some areas that have been heavily developed. In these areas, the natural shoreland buffer has been disturbed which contributes negatively to lake health by preventing rainwater and snowmelt from being filtered before entering the lake. Improvements to the shoreline in these areas can help lessen human impact on the lake, and many of these projects are fairly easy to do.

EWM was first identified in Long Trade Lake in 1995. Management efforts between 1995 and 2013 were limited with biological control (weevils), drawdown, and limited chemical application considered, but not implemented. Lake monitoring through CLMN volunteers has been fairly consistent since 1986, but active management didn't begin until 2007 when the Polk County Land and Water Resources Department (LWRD) conducted a whole-lake point-intercept survey on Long Trade Lake in an effort to establish baseline data on the plant community of the lake. Table 5 shows all management that has been completed within Long Trade Lake since 2007 when active management first started on the lake. In 2011, Polk County Land and Conservation Department completed an APM plan for the Trade Lakes system which was focused primarily on management of EWM. In 2012, RTLIA contracted Short Elliot Hendrickson, Inc. (SEH) and Endangered Resources Services, LLC. (ERS) to develop a CLP management plan as an addition to the existing APM Plan.

With the completion of the APM plan, RTLIA volunteers began doing yearly EWM physical removal beginning in 2012. Since 2013, early spring treatments for CLP have been done yearly while EWM has been treated three times (2013, 2016, and 2017). Table 6 shows the chemical treatments since 2013. In 2013, there was an early spring herbicide treatment for both EWM and CLP. 9.31 acres of CLP were treated, and 5.24 acres of EWM were treated. There was no need to treat for EWM again until the spring of 2016.

Table 5: AIS Management on Long Trade Lake, 2007-2017

AIS Management on Long Trade Lake, 2007-2017											
Task	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
APM Plan					X					X	X
AIS Control Grant					X	X				X	X
AIS Rapid Response Grant				X							
Spring EWM Treatment (acres)							5.24			11.46	2.56
Fall EWM Bed Mapping					X	X	X	X	X	X	P
EWM Physical Removal						X	X	X	X	X	X
CLP Bed Mapping						X	X	X	X	X	
Spring CLP Treatment (acres)							9.31	4.89	3.78	11.46	2.16
Pre-treatment Plant Survey							X	X	X	X	
Post Treatment Plant Survey							X	X	X	X	
Whole-lake PI Survey	X									X	
X= Completed, P=Proposed											

Table 6: 2013-2017 CLP and EWM Herbicide Treatment Details

Year	# of Beds	Total Area Treated (acres)	Range of Bed Size	Herbicide	Concentration	Results- AIS	Results- Native Plants
2013	16 -CLP 9 - EWM	9.31	0.12-1.4	Aquathol K DMA-4	2.0 ppm 3.0 ppm	CLP- Significant decrease EWM- No change	5 species showed significant increases.
2014	5 - CLP	4.25	0.52-1.07	Aquathol K	2.0 ppm	CLP- Significant decrease	White water lily- Significant increase. Common waterweed- Significant decrease. All other plants- No change
2015	9 - CLP	3.78	0.21-1.0	Aquathol super K	2.0 ppm	CLP- Significant decrease EWM- No change	No significant changes
2016	8 - EWM 6 - CLP	12.86	0.29-4.58	Aquathol K DMA-4	2.0 ppm 3.0 ppm	Significant decrease in both CLP and EWM	No significant changes
2017	3 - EWM 2-CLP	2.56	0.40-1.25	Aquathol K, DMA-4	2.0 ppm 3.0 ppm	Data incomplete	Data incomplete

Chemical residual testing was completed on Long Trade following the 2013 herbicide application. Endothall concentrations in the treated areas ranged from less than the detection limit to 0.077 micrograms per liter (µg/L or parts per billion (ppb)) a.e. at 3 hours after treatment (HAT) indicating the rapid dissipation in small treatment areas that have been observed previously in other lakes. The mean lake wide concentration was 0.018 ppb a.e. at 24 HAT compared to the calculated mean lake wide concentration of 0.026 ppb a.e. and the detection limit of 10 ppb a.e. Concentrations in samples collected at 24 HAT indicated the significant, measurable, lake or basin wide herbicide concentrations did not occur. Lab analysis of samples collected by volunteers after 24 hrs was discontinued as it was not expected that concentrations would exceed 0.10 ppm a.e. These results question the efficacy of the CLP treatment; however, in-lake observed results indicate that the 2013 treatment in Long Trade Lake was very successful. Fall EWM survey work in 2013 found only three rooted EWM plants in the entire lake, nearly a 100% decline in coverage and total individual plants. It is likely that the herbicide alone did not affect this highly significant change as other factors like water quality may have created unfavorable growing conditions at the same time.

There was some controversy related to ending lab analysis of samples collected after 24 hours when samples were collected through 35 days after treatment. One explanation for ending lab analysis after 24 hours (other than concentrations were below levels of concern) is the fact that at this time (2013) lab analysis was not completed in WI, but rather out-of-state, and that Army Corp lab took on more analysis than it could do. Another issue with the 2013 chemical residual testing program was that no samples were collected near the dam. The dam on Long Trade Lake and the adjacent millpond are separated from the main body of the lake by a stream/channel nearly a half mile long (Figure 14). In fact, no management planning, aquatic plant survey work, water quality testing, or treatment of AIS has ever intentionally occurred in the millpond adjacent to the dam. This new APM Plan recommends that this area be included in all present and future planning.

Figure 14: Long Trade Lake Dam, Millpond, and connecting Stream Channel

A prerequisite to updating the APMP for Long Trade Lake was to compare how the lake's vegetation had changed since the last point intercept survey. In 2006, a warm-water, whole-lake, point-intercept survey of aquatic plants was completed by the Polk County Land and Water Conservation Department on July 12. This survey was repeated in 2016 by Endangered Resource Sciences (ERS) on July 18. During the 2006 survey EWM was not documented, despite having been identified in the lake in 1995. In addition, only the points in the PI survey grid that were considered to be in the littoral or plant growing zone were sampled in 2006. In both surveys the littoral or plant growing zone of the lake covers about 125 acres or 82% of the total surface area of the lake.

WARM-WATER FULL POINT-INTERCEPT AQUATIC PLANT SURVEY

Plant survey statistics from 2006 and 2016 show some differences (Table 7). The biggest differences are in terms of the number of different plant species identified during the two surveys. The total number of species in 2016 is basically double what it was in 2006 (Figure 15). The most likely reason for this change is the experience of the entity completing the survey. Likely related to the number of different species identified is the number of different species per site in all species per site parameters. With this explanation considered, when comparing aquatic plant species that were identified in both the 2006 and 2016 surveys, there is a greater number of points with these plants in 2016, then there were in 2006 with the exception of CLP. The number of points with CLP in 2016 is much less than in 2006 (Figure 15).

Table 7 – 2006 (Polk County) and 2016 (ERS) Point-Intercept Aquatic Plant Survey Statistics

2006 & 2016 Point-Intercept Aqautic Plant Survey Statistics	2006	2016
Total number of sites visited	130	376
Total number of sites with vegetation	58	79
Total number of sites shallower than maximum depth of plants	99	125
Frequency of occurrence at sites shallower than maximum depth of plants	58.59	63.20
Simpson Diversity Index	0.85	0.87
Maximum depth of plants (ft)**	7.50	7.50
Number of sites sampled using rake on Rope (R)	0	0
Number of sites sampled using rake on Pole (P)	129	376
Average number of all species per site (shallower than max depth)	1.89	2.22
Average number of all species per site (veg. sites only)	3.22	3.53
Average number of native species per site (shallower than max depth)	1.63	2.15
Average number of native species per site (veg. sites only)	3.10	3.55
Species Richness	11	24
Species Richness (including visuals)	13	26
Species Richness (including visuals and boat survey)	15	30
Mean depth of plants (ft)	3.12	3.13
Median depth of plants (ft)	3.00	3.00
Mean rake fullness (veg. sites only)	NA	2.28

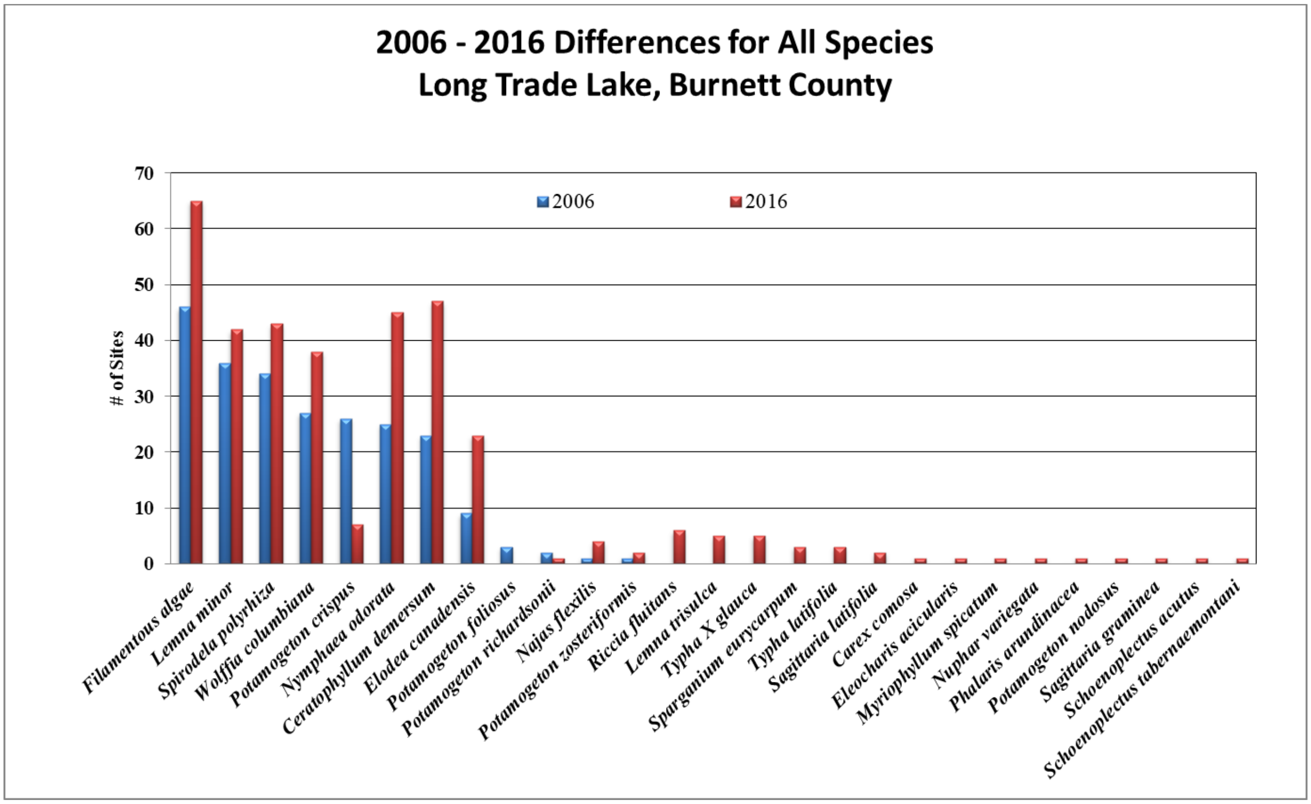

Figure 15 – Changes in aquatic plant species identified during the 2006 and 2016 Point-Intercept Aquatic Plant Surveys

Three measurements of the health of the aquatic plant community outside of these survey statistics are the Simpson's Diversity Index (SDI), Floristic Quality Index (FQI), and Coefficient of Conservatism.

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.

The SDI in 2006 was 0.85. In 2016 the value was just slightly higher at 0.87. These values are both fairly average for similar lakes in the area. As an example, Upper Vermillion Lake in Barron County is about 100 acres in size and has an average depth of about 9-ft. It has an SDI of 0.81. Upper Vermillion Lake also has a large population of CLP, like Long Trade Lake. 2016 plant survey statistics for each lake are shown in Table 8.

Table 8 – 2016 Aquatic Plant Survey Statistics for Long Trade Lake, Polk County; and Upper Vermillion Lake, Barron County

Summary Statistics Comparison: Long Trade and Upper Vermillion Lakes	2016 Long Trade	2016 Up. Vermillion
Total number of points sampled	376	286
Total number of sites with vegetation	79	182
Total number of sites shallower than the maximum depth of plants	125	270
Frequency of occurrence at sites shallower than maximum depth of plants	63.2	67.41
Simpson Diversity Index	0.87	0.81
Maximum depth of plants (ft)	7.5	8
Mean depth of plants (ft)	NA	4.5
Median depth of plants (ft)	NA	5
Average number of all species per site (shallower than max depth)	2.22	1.87
Average number of all species per site (veg. sites only)	3.53	2.77
Average number of native species per site (shallower than max depth)	2.15	1.84
Average number of native species per site (sites with native veg. only)	3.55	2.74
Species richness	24	14
Species richness (including visuals)	26	19
Species richness (including visuals and boat survey)	30	25
Mean rake fullness (veg. sites only)	2.28	2.32

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. Long Trade Lake is in the North Central Hardwood Forests Ecoregion.

In 2006, a total of 10 native index species were identified in the rake during the point-intercept survey. They produced a mean C of 4.9 and a FQI of 15.5. These values are both well below the average values for the North Central Hardwood Forests. In 2016, a total of 22 native index plants were identified in the rake during the point-intercept survey. They produced a mean C of 4.9 and a FQI of 23.0. Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Long Trade Lake below average for this part of the state. The FQI was just slightly above the median FQI of 20.9 for the North Central Hardwood Forests (Nichols 1999).

2016 values for the FQI and C from Upper Vermillion Lake were 16.7 and 4.8 with 12 species included.

Overall, the aquatic plant community in Long Trade Lake appears to be of slightly higher quality in 2016 than it was in 2006. The amount of CLP is less than it was in 2006, and the amount of EWM is down significantly from where it was in 2010.

WILD RICE

According to the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), Long Trade, Round, Little Trade and Big Trade lakes are not wild rice waters. Additionally, wild rice was not found during the aquatic plant surveys of the lakes or during the Sensitive Areas survey. Although wild rice is not present in these lakes, it warrants attention due to its ecologic and cultural significance and its abundance in nearby lakes and streams (for example, the Grettum Flowage, Rice Lake, Spirit Lake, and the Clam Lakes). Any activity included in a comprehensive lake or aquatic plant management plan that could potentially impact the growth of wild rice in any body of water that has in the past, currently has, or potentially could have wild rice in the future requires consultation with the Tribal Nations. This consultation is completed by the Department of Natural Resources during their review of lake management documents. When present in a lake, wild rice is afforded numerous protections due to its ecological and cultural significance and management is therefore focused on harvest goals and protection rather than removal.

Wild rice is an annual aquatic grass that produces seed that is a nutritious source of food for wildlife and people (Figure 16). As a native food crop, it has a tremendous amount of cultural significance to the Wisconsin and Minnesota Native American Nations. Wild rice pulls large amounts of nutrients from the sediment in a single year and the stalks provide a place for filamentous algae and other small macrophytes to attach and grow. These small macrophytes pull phosphorous in its dissolved state directly from the water. Wild rice can benefit water quality, provide habitat for wildlife, and help minimize substrate re-suspension and shoreland erosion.

In Wisconsin, wild rice has historically ranged throughout the state. Declines in historic wild rice beds have occurred statewide due to many factors, including dams, pollution, large boat wakes, and invasive plant species. Renewed interest in the wild rice community has led to large-scale restoration efforts to reintroduce wild rice in Wisconsin's landscape. There is the potential for planting wild rice at shoreline restoration and rehabilitation sites in the Trade Lakes system however this should not be done without full constituent support as the presence of wild rice will limit certain aquatic plant management actions. Extensive information is available on wild rice from GLIFWC and the WDNR.

Figure 16 - Wild Rice on Clam Lake in Burnett County (Photos by John Haack)

Past invasive species monitoring efforts have identified several different plant and animal non-native, invasive species in Long Trade Lake. 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 (CLP) are the most problematic invasive species found in Long Trade Lake. In addition purple loosestrife and reed canary grass have been identified along the shores of Long Trade Lake. Purple loosestrife and reed canary grass are shoreland or wetland plants 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.

EWM

EWM is a submersed aquatic plant native to Europe, Asia, and northern Africa (Figure 17). 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 17: EWM

In some lakes, EWM has hybridized with the native northern milfoil. This hybrid milfoil is believed to be less sensitive to chemical management than the parental strands which make management much more difficult (LaRue, Zuelling, & Thum, 2012). The milfoil present in Long Trade Lake is not believed to be a hybrid strand, but regular EWM is present and causing issues within Long Trade Lake.

CURLY-LEAF PONDWEED

Curly-leaf pondweed (CLP) has been found in a large portion of the littoral zone around Long Trade Lake.
CLP is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia (Figure 18). It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. CLP is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported, at various extents, in all of the continental United States.

CLP spreads through burr-like winter buds (turions) (Figure 18), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring. It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. In mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. CLP forms surface mats that interfere with aquatic recreation.

Figure 18: CLP Plants and Turions

PURPLE LOOSESTRIFE

Purple loosestrife (Figure 19) is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers that vary from purple to magenta possess 5-6 petals aggregated into numerous long spikes, and bloom from August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

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

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

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

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

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

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

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

Figure 19: Purple Loosestrife

REED CANARY GRASS

Reed canary grass (Figure 20) 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 can be found in along the southern shore of Long Trade Lake as well as in the Trade River about half a mile upstream of the Atlas dam around Long Trade Lake.

Figure 20: Reed Canary Grass

NON-NATIVE AQUATIC INVASIVE ANIMAL SPECIES

Several non-vegetative, aquatic, invasive species are very likely to be present within Long Trade Lake. The two species that are believed to be present within Long Trade Lake are Chinese mystery snails and rusty crayfish. It is important for property owners to be able to identify these species if they are encountered in Long Trade Lake; there are also several other species that property owners should be familiar with that are not currently present within Long Trade Lake, but could easily become established.

CHINESE MYSTERY SNAILS

Chinese mystery snails have been identified near the Atlas dam within Long Trade Lake. While this is a single observation, there is a possibility for these snails to easily spread with the help of the river itself or an unwary person.

The Chinese mystery snails and the banded mystery snails (Figure 21) are non-native snails that have been found in a number of Wisconsin lakes. There is not a lot yet known about these species, however, it appears that they have a negative effect on native snail populations. The mystery snail's large size and hard operculum (a trap door cover which protects the soft flesh inside), and their thick hard shell make them less edible by predators.

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

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

Many people 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 21: Chinese Mystery Snails

RUSTY CRAYFISH

Rusty crayfish have been identified along the lengths of the Trade River which makes it very likely that they are present within Long Trade Lake, but their presence in Long Trade Lake has not been verified.

Rusty crayfish (Figure 22) 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.

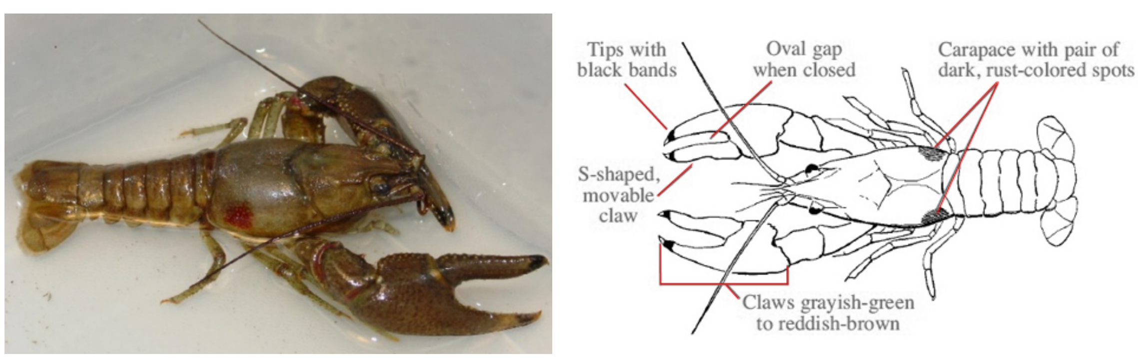

Figure 22: Rusty Crayfish and identifying characteristics

ZEBRA MUSSELS

Zebra mussels (Figure 23) 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.

In 2009, a study was conducted on Wisconsin waters to determine their suitability for zebra mussel invasion. This study used several different variables and ran statistical models to determine if lakes were suitable, borderline suitable, or not suitable. In the fall of 2016, one of the lakes deemed suitable by the 2009 study was found to have zebra mussels. McKenzie Lake, in Burnett County was the first lake in Northwestern Wisconsin to have zebra mussels become established. Long Trade Lake did not have enough data for this study to make conclusions about the suitability, but Round Lake, downstream of Long Trade Lake was determined to be borderline suitable while most other lakes in the region were deemed suitable. There are also two other lakes on the Trade River (Big Trade Lake and an unnamed lake further downstream) that are considered to be suitable. Taking this into consideration, it is fairly likely that Long Trade Lake is borderline suitable or suitable.

Zebra mussels have not been found in Long Trade Lake, but AIS monitoring and prevention efforts should include zebra mussels.

Figure 23: Zebra Mussels

AIS PREVENTION STRATEGY

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

Additionally, having an educated and informed lake resident population is the best way to keep non-native AIS at bay in Long Trade Lake. To foster this, the RTLIA 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.

Nuisance aquatic plants can be managed a variety of ways in Wisconsin. The best management strategy will be different for each lake and depends on which nuisance species needs to be controlled, how widespread the problem is, and the other plants and wildlife in the lake. In many cases, an integrated pest management (IPM) approach to aquatic plant management that utilizes a number of control methods is necessary. The eradication of non-native aquatic invasive plant species such as 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 and in most cases will require a WDNR permit. Chemical application is typified by the use of herbicides that kill or impede the growth of the aquatic plant and always requires a WDNR permit. Biological control methods include organisms that use the plant for a food source or parasitic organisms that use the plant as a host, killing or weakening it. Biological control may also include the use of species that compete successfully with the nuisance species for available resources. This activity may require a WDNR permit. Physical habitat alteration includes dredging, installing lake-bottom covers, manipulating light penetration, flooding, and drawdown. These activities may require permits under the WDNR waterways and wetlands program. It may also include making changes to or in the watershed of a body of water to reduce nutrients going in.

Each of the above control categories are regulated by the WDNR and most activities require a permit from the WDNR to implement. Mechanical harvesting of aquatic plants and under certain circumstances, physical removal of aquatic plants, is regulated under Wisconsin Administrative Rule NR 109 (Appendix A). The use of chemicals and biological controls are regulated under Administrative Rule NR 107 (Appendix B). 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, 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 or CLP in Long Trade Lake is not a recommended option. To keep these plants from causing greater harm, management will continue 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 24)
- 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.

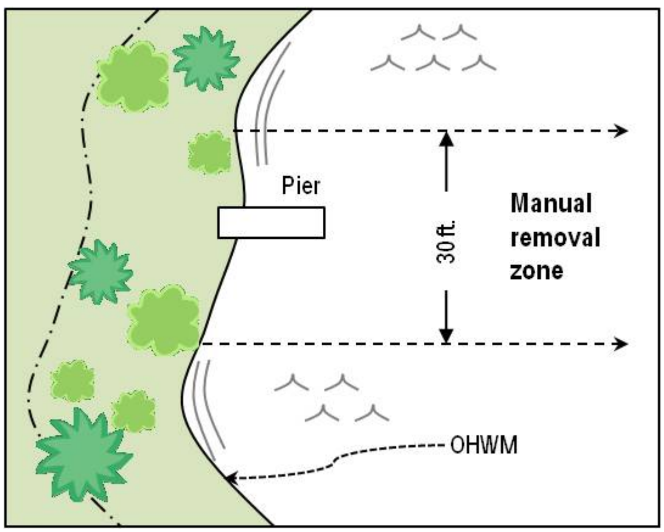

Figure 24: Aquatic vegetation manual removal zone

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

Larger scale hand or diver removal projects have had positive impacts in temporarily reducing or controlling AIS. 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 some areas of Long Trade Lake, EWM and CLP may be best managed by hand-pulling/manual removal. However it is not suitable to manage all of the AIS in the lake this way. A renewed effort to continue to teach property owners to identify, and then physically remove EWM and CLP growing in the lake near their property is included as an activity in this plan. The RTLIA will work with residents on the lake to teach them how to identify EWM and how to properly remove it 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 the target plants from the lake bed and inserting them into an underwater vacuum system that sucks up plants and their root systems taking them to the surface. It requires water pumps on the surface (generally on a pontoon system) to move a large volume of water to maintain adequate suction of materials that the divers are processing (Figure 25). Only clean water goes through the pump. The material placed by the divers into the suction hose along with the water is deposited into mesh bags on the surface with the water leaving through the holes in the bag. The bags have a large enough 'mesh' size so that silts, clay, leaves and other plant material being collected do not immediately clog them and block water movement. If a fish or other living marine life is sucked into the suction hose it comes out the discharge unharmed and is returned to the body of water. It can have some negative impacts to other nearby non-target plants if not done carefully, particularly those plants that are perennials and expand their populations by sub-sediment runners (Eichler, Bombard, Sutherland, & Boylen, 1993).

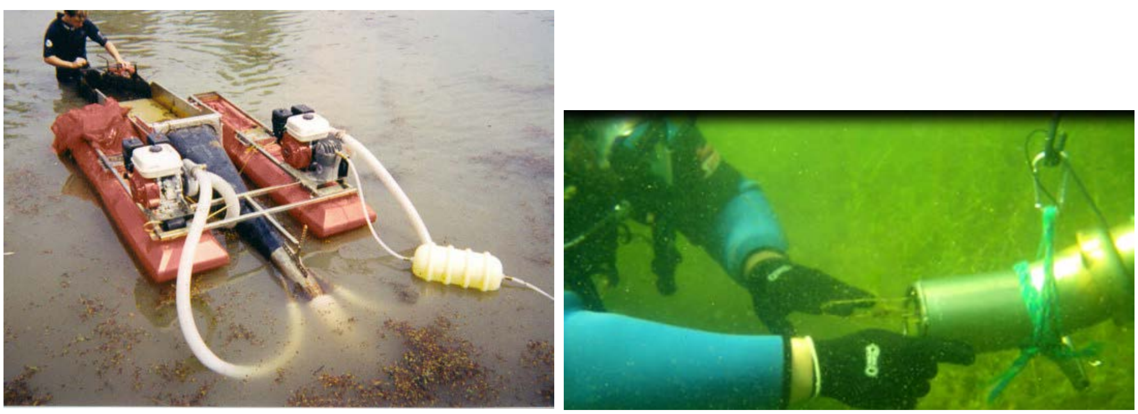

Figure 25: DASH - Diver Assisted Suction Harvest (Aquacleaner Environmental, http://www.aquacleaner.com/index.html); Many Waters, LLC)

In Wisconsin and Michigan, suction harvesting of invasive species 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. Aquacleaner Environmental, out of Lancaster, NY sells a DASH system with a 5" suction hose for about $30,000.00 plus extras. The same company offers DASH services at a rate of $200.00/hour, with an acre of vegetation removal averaging $15,000.00. Another company, Naturally DASH and Dredge, LLC (http://www.naturallydash.com), builds a system with a single pump and 3" hose for about $6,000.00.

More locally, Many Waters, LLC out of Iron River, MI has been providing DASH services in northeastern WI. During the Northern Great Lakes Invasive Species Conference in Marquette, MI on November 4, 2014, Many Waters, LLC presented DASH results from Lac Vieux Desert in Vilas County. During that presentation it was reported that 1,033.5 lbs. of EWM was removed from the lake with 17 hours of DASH. During the harvest, there was a14.6% bi-catch of other plants sucked up at the same time. No report of costs was given. In this presentation, Many Waters, LLC reported that the efficiency of DASH was negatively impacted by obstacles/structures in the water, water clarity, sediment type, EWM density, native aquatic plant density, and time of year.

In a similar report filed for 2013 DASH services on Lake Elwood in Florence County, 2,322 lbs. of hybrid EWM was removed from the lake in 21 hours. In this lake, there was only a 1.85% bi-catch of native plants. According to documents on the Lake Ellwood Association webpage $4,530.00 was spent on DASH services in 2013. Four areas in the lake totaling 0.7 acres were included in the DASH project. Based on these numbers, cost per lb. of EWM harvested was $1.95; cost per hour for DASH services was $215.71; and cost per acre was $6,471.43. Lake Ellwood is a clear-water lake; however, the report mentions that DASH results were hampered by the presence of woody debris in the area of EWM harvest.

From a 2014 report for DASH services on Virgin Lake in Oneida County, 144 lbs. of EWM were removed in 2.5 hours with a bi-catch of 23%. On Virgin Lake, dense growth native vegetation and water clarity issues impacted the success of the DASH project. No report of cost was given.

More recently, June 2016, DASH was implemented on the St. Croix Flowage in Douglas County to remove approximately 2.0 acres of EWM, some dense, and some just scattered plants mixed in with many native plants. A new company TSB Lake Restoration was hired out of Chippewa Falls, WI for two days of DASH services. Approximately 16 hours of on the water time removed EWM from about 1.5 acres. The cost for the DASH services only was $3,900.00 for the entire job. Broken down, the cost per acre was $2,600.00; per hour was $244.00; and per day was $1,950.00. Consultant support costs added another $1,800.00.

No formal documentation or measurement was made of lbs. of EWM removed or native species collateral damage, but observations by the Consultant estimate 500-800 lbs. of vegetation was removed and that up to about 30% of the plant material removed was non-target species, primarily common waterweed which dominated much of the bottom of the managed area. Collateral damage was the result of bringing the suction dredge too close to the bottom when feeding EWM into the tube.

Provided the conditions are conducive to DASH, this could be an effective management strategy for some areas of either EWM or CLP on Long Trade Lake. It should be noted that while this could work, the low water clarity could have a large impact on the effectiveness of DASH removal within Long Trade Lake. Furthermore, the cost would likely be prohibitive, particularly with physical removal by property owners proven to be an effective supportive management method.

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

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The size and harvesting capabilities of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and 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.

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 decay of this plant matter is prevented. Additionally, repeated harvesting 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 AIS from one body of water to another. Harvesting contractors are not readily available in northern Wisconsin, so harvesting contracts are likely to be very expensive.

Using large-scale mechanical harvesting to manage EWM and CLP is not recommended on Long Trade Lake. The level of these AIS in the lake does not warrant management at this scale.

SMALL-SCALE CUTTING WITH REMOVAL

There are a wide range of small-scale cutting techniques, most of which involve the use of boat mounted rakes, scythes, and electric cutters. As with mechanical harvesting, obtaining permits and 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. Any of these, if they are not human powered, require a permit.

Using a weed rake or cutter that is run by human power is allowed without a permit, but the use of any device that includes a motor, gas or electric, would require a permit. Dragging a bed spring or bar behind a boat, tractor or any other motorized vehicle to remove vegetation is also illegal without a permit. Although not truly considered mechanical management, incidental plant disruption by normal boat traffic is a legal method of management. Active use of an area is often one of the best ways for riparian owners to gain navigation relief near their docks. Most aquatic plants won't grow well in an area actively used for boating and swimming. It should be noted that purposefully navigating a boat to clear large areas is not only potentially illegal it can also re-suspend sediments, encourage AIS growth, and cause ecological disruptions.

Small-scale harvesting by human power that is completed in a way such that all of the EWM or CLP plant and root structure is removed is recommended for limited control of AIS in the lake. When removing aquatic plants manually, there is a restriction of no more than 30 feet wide for property owners to remove native vegetation, but there is no such limit on AIS. If done in a way that is entirely human powered, there is no limit on the amount of AIS that can be removed from the system. Any plants that are cut or pulled must still be removed from the lake. Through information and training, property owners will be instructed on proper physical removal methods. Small-scale cutting and removal is recommended for individual property owners or as a volunteer fair activity that is sponsored by the RTLIA.

BOTTOM BARRIERS AND SHADING

Physical barriers, fabric or other, placed on the bottom of the lake to reduce invasive plant 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 AIS 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 Long Trade 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, 1992). Dredging is very expensive, requires disposal of sediments, and has major environmental impacts. It is not a selective procedure so it can't be used to target any one particular species with great success except under extenuating circumstances. Dredging at any level must be permitted by the WDNR if done through mechanical means. Manual dredging of up to 100 cubic feet for may be done without a permit by property owners if all criteria found in the WDNR's exemption checklist (Appendix C) are met. It should not be performed for aquatic plant management alone. It is best used as a multipurpose lake remediation technique (Madsen, 2000).

Dredging is not a recommended management action for Long Trade 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 diminished.

As with any form of management there is a mixed bag of effects from a drawdown. Due to physical constraints the lake could only be drawn down 3 feet. While this could result in a 50-75% reduction in EWM, a 5-ft drawdown would be necessary to reach all of the EWM present within the spring littoral zone which extends to about 7-ft of water (Blumer, 2012). A winter drawdown could also impact populations of other, native plants. Some of these are likely to be beneficial for plants such as native pondweeds, and detrimental to other plants such as white water lily. There is an issue of exacerbating the CLP issue by providing more habitat for CLP to invade. Only 8 different species of aquatic plants were found at more than five points during the 2006 and 2016 point-intercept aquatic plant surveys, and one of these was CLP. Table 9 shows the species that would likely be impacted by a winter drawdown.

Table 9: Aquatic plant species likely to be impacted by a winter drawdown in Long Trade Lake

Plant Species	Common Name	Increase or Decrease
Potamogeton crispus	Curly-leaf pondweed	Increase
Myriophyllum spicatum	Eurasian water milfoil	Decrease
Ceratophyllum demersum	Coontail	Decrease
Elodea canadensis	Common waterweed	variable
Nymphaea odorata	White water lily	Decrease
Najas flexilis	Bushy pondweed	Increase
Potamogeton foliosis	Leafy pondweed	Increase
Potamogeton Richardsonii	Clasping-leaf pondweed	Increase
Potamogeton zosteriformis	Flat-stem pondweed	Increase
Scripus sp.	Softstem bullrush	increase

During a drawdown, the water level would be lowered slow enough to allow fish, turtles, and other mobile aquatic creatures to move with the water which means this would have a minimal direct impact on the species that are able to move, however some species like mussels and snails would likely be impacted. This could also have an indirect impact on the fisheries by forcing the fish into a smaller area. While this could reduce the population numbers, it would likely improve the health of the fisheries by allowing increased predation of forage fish. For most fish, a winter drawdown would not be likely to have a significant impact on spawning because the water levels would be back to normal by the time they would normally spawn. Northern pike could experience some impact on spawning because they generally spawn as soon as the ice goes out, and the water would not be restored to normal levels by this point.

In 2012, a drawdown viability study was conducted by SEH. This study determined that a drawdown could be an effective management strategy for EWM on Long Trade Lake. However, this is not a recommended management strategy due to the lack of support it received from the RTLIA in 2012.

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 feeds on aquatic milfoils (Figure 26). 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, 1996).

Figure 26: 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. A weevil survey was completed on Long Trade Lake in 1996. This survey determined that while weevils are present in Long Trade Lake, there is not a sufficient number to effectively control EWM. The use of weevils is not recommended in this management plan, particularly since the process necessary to do so has changed significantly in the last few years. There is no longer a company that "raises" weevils for EWM control. Weevils can still be raised by volunteers in cooperation with an overseeing entity, but requires that all EWM used in the rearing process be secured from the host lake, and only weevils reared on host lake EWM can be released into the host lake. Further monitoring and possible weevil rearing is not recommended for Long Trade Lake in this management plan, but would not hurt if there were interested people to do so on the lake.

GALERUCELLA BEETLES

Two species of Galerucella beetles are currently approved for the control of purple loosestrife in Wisconsin (Figure 27). The entire lifecycle of Galerucella beetles is dependent on purple loosestrife. In the spring, adults emerge from the leaf litter below old loosestrife plants. The adults then begin to feed on the plant for several days until they begin to reproduce. Females lay their eggs on loosestrife leaves and stems. When the larvae emerge from these eggs they begin feeding on the leaves and developing shoots. When water levels are high these larvae will burrow into the loosestrife stems to pupate into adult beetles. These new adults emerge and begin feeding on the loosestrife again (Sebolt, 1998). Galerucella beetles do not forage on any plants other than purple loosestrife. Because of this the populations, once established, are self-regulating. When the purple loosestrife population drops off, the beetle population also declines. When the loosestrife returns, the beetle numbers will usually increase.

Figure 27: Galerucella beetle

These beetles will not eradicate purple loosestrife entirely. This is true of almost all forms of biological control. Galerucella beetles will help regulate loosestrife which will allow native plants to also become established. This allows the wetlands near Long Trade Lake to be diverse plant communities instead of purple loosestrife monocultures.

Beetles can be obtained from the WDNR, private vendors, or many of the public wetlands around Wisconsin. Because rearing these beetles requires the cultivation of a restricted species, a permit is necessary. Beetle rearing and release is not recommended for Long Trade Lake in this management plan, but if there are lake residents who wish to do so it has the potential to benefit 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, 1988). None of these have currently been approved for use in Wisconsin and are not recommended for use in Long Trade Lake.

NATIVE PLANT RESTORATION

A healthy population of native plants might slow invasion or reinvasion of non-native aquatic plants. It should be the goal of every management plan to protect existing native plants and restore native plants after the invasive species has been controlled. In many cases, a propagule bank probably exists that will help restore native plant communities after the invasive species is controlled (Gettsinger, Turner, Madson, & Netherland, 1997). However, in some lakes like Long Trade, where AIS have been the dominant plant species for a long time, the propagule bank may be limited. As a result, re-introducing additional native aquatic plants could benefit the lake. In Long Trade Lake native aquatic plant restoration projects began in the fall of 2016 with the introduction of northern watermilfoil and water celery. In the spring of 2017, many of the sites where northern watermilfoil was planted showed survival and regrowth. Reestablishing the native plants within the lake could slow the spread of CLP and EWM across Long Trade Lake, and it is highly recommended that this practice be continued.

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

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

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

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

Although done less frequently, herbicides can be applied in the late fall when most native plants have begun to die on their own, or have already gone dormant for the season. Typically invasive plant species like EWM will continue to grow well into the fall. Timing of a fall application of herbicides can be such that few native plants are expected to be killed. In some bodies of water, particularly those where wild rice is present, it may be possible to treat later in the fall, having no effect on wild rice that has already completed its life cycle. Wild rice in the seedling stage below the surface of the water is very susceptible to herbicides including 2, 4-D, endothall, and others. In most cases, herbicides are not used where wild rice is present. But in extreme cases, where the presence of EWM is actually causing great harm to the wild rice, fall treatments have been completed.

In some lakes, poor water clarity in the summer months may limit the growth of EWM, until the water clears in the fall and EWM all of a sudden gets more of the light needed to begin accelerated growth. The herbicide applied in the fall may be the same herbicide as applied in the spring and may be applied at the same concentration. One drawback is that the results of a fall treatment cannot be quantified until the next season.

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.

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

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

Research done with triclopyr in 2014 (Vassios, et al., 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, given that both herbicides affect the target plant in a similar way.

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

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

EFFICACY OF AQUATIC HERBICIDES

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

MICRO AND SMALL-SCALE HERBICIDE APPLICATION

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

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

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

LARGE-SCALE HERBICIDE APPLICATION

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

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

WHOLE-LAKE, AND/OR EPILIMNION APPLICATION

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

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

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

Long Trade Lake is a mixed lake which means an epilimnion treatment is not possible because there is no stratification of the lake, however whole lake treatments are possible.

EFFECTS OF WHOLE-LAKE TREATMENTS ON NATIVE AQUATIC PLANT SPECIES

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

PRE AND POST TREATMENT AQUATIC PLANT SURVEYING

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

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

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

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

CHEMICAL CONCENTRATION TESTING

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

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

Chemical concentration testing was completed on Long Trade Lake in 2013. It indicated quick dissipation of the herbicide that was applied but this did not apparently negatively affect the treatment results, as they were outstanding in 2013. Additional concentration testing or a rhodamine dye study is not required by the WDNR for chemical treatments, but this is recommended that a study be repeated to gain a better understanding of the fate of the herbicide that is applied, particularly as it pertains to the millpond above the dam.

HERBICIDE USE IN LONG TRADE LAKE

Long Trade Lake has a fairly limited community of native plants. As such, efforts should be made to minimize the impact of management on these plants. However, CLP and EWM both pose a great threat to the native plant community and need to be managed effectively. One of the most effective methods of control that has been used in Long Trade Lake has been the application of herbicide to the heavily infested areas of the lake. The majority of the littoral zone has become infested with CLP and/or EWM (Figure 29).

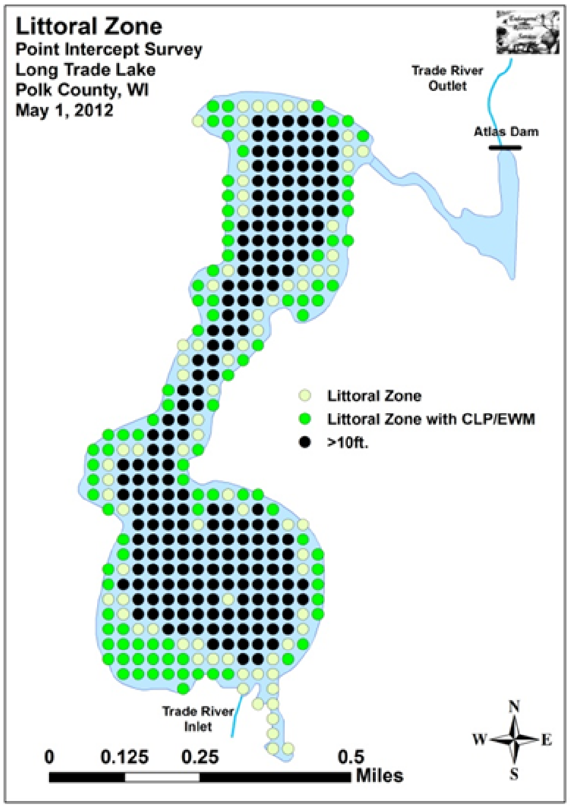

Figure 28: 2012 Long Trade Lake Littoral (plant growing) Zone

CLP

Small-scale treatments on Long Trade Lake since 2013 have been fairly effective at reducing CLP populations in the areas that have been treated. These yearly treatments have made a noticeable impact on the distribution and density of CLP within Long Trade Lake (Figure 30). While small-scale treatments should not be the only management action for CLP on Long Trade Lake, they should continue to be a part to an integrated plant management strategy.

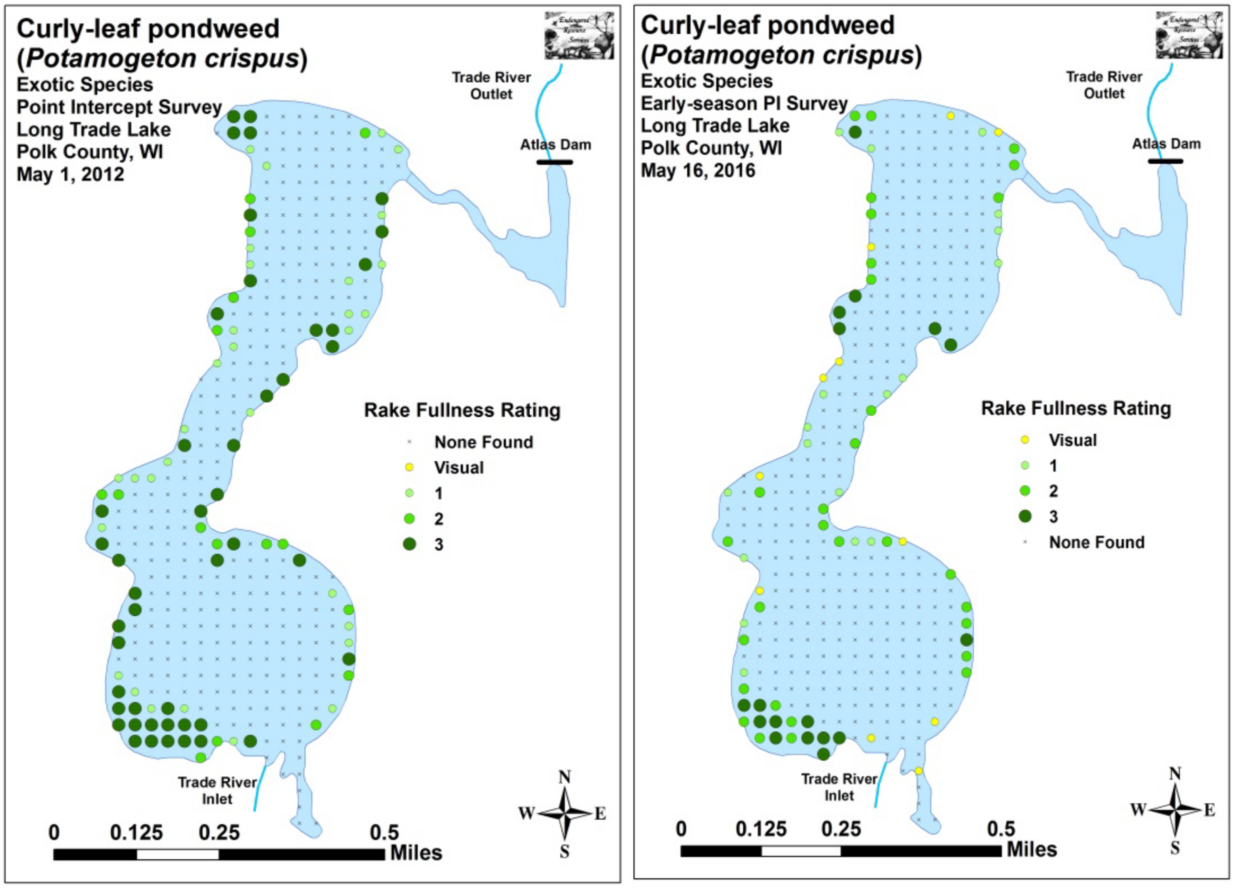

Figure 29: Early season CLP PI survey results from 2012 (left) and 2016 (right)

EWM

Past chemical management of EWM in Long Trade Lake has been completed using either a granular or liquid version of a commercial herbicide with 2, 4-D as the active ingredient. Liquid formulations are less expensive than granular formulations, but in small or micro treatments granular herbicide may be more effective. 2,4-D is considered a systemic herbicide, expected to kill all parts of the plant, not just what it comes in contact with.

Triclopyr (Trade name Renovate) is another systemic herbicide approved for use in WI to control submersed aquatic vegetation like EWM. It too comes in granular or liquid formulations, and could be used instead of 2, 4-D based herbicides at comparable concentrations. Presently triclopyr based herbicides are more expensive than 2, 4-D based herbicides.

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.

Procellacor® is a new herbicide that acts similar to both contact and systemic herbicides. This allows for it to be effective with a shorter amount of contact time. 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 and 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 is not currently approved for use within Wisconsin, but it is currently under review by through the Wisconsin Environmental Policy Act (WEPA). There is little information on the recommended time-frame or concentrations of treatments with Procellacor® due to the lack of State approval; however if approved for use within Wisconsin, this herbicide should be reviewed and considered for use in the Trade River system.

In the three years that EWM was treated under the 2011 APM Plan, both CLP and EWM were treated either at the same time or within a few days of each other. This means that two different herbicides were applied – endothall (for CLP) and 2,4-D (for EWM) – at the same time. This combination of herbicides seems to have been very effective in providing extended control of EWM, and annual control of CLP.

The 2013 EWM treatment was highly effective. The herbicide application allowed the lake two years of respite before EWM again reached treatable levels in 2016. Results from the 2016 treatment exhibited similar results to 2013, with EWM levels being very low in the summer and fall of 2016. This led to a much smaller herbicide treatment in 2017. Ideally, EWM treatments will only need to happen every 2-3 years on Long Trade Lake.

EWM

The littoral (plant growing) zone of Long Trade Lake in 2016 was approximately 125 acres (82% of the total surface area). Since 2011, the amount of EWM in Long Trade Lake as identified by bed-mapping surveys has fluctuated between 0.00 and 12.97 acres in beds (>50% EWM with a defined edge) and/or high density areas (>25% EWM with a defined edge) (Table 10). In 4 of the 6 years where there are fall bed-mapping results, the total acreage of EWM has been <2.0 acres. This value represents 1.6% of the littoral zone. Based on these numbers it is a reasonable goal to keep EWM in Long Trade Lake as identified in a fall bed mapping survey, at or below this level – 2.0 acres or 1.6% of the littoral zone in any given year. This is also similar to the goal to be set for Little Trade Lake - 1.0 acre or 1.4% of the littoral zone in any given year.

Table 10: EWM Distribution based on Fall Bed-mapping Surveys

Fall Bed Mapping Results - Long Trade Lake		
Year	Total Acres	Notes
2011	12.97	No treatment
2012	1.6	No treatment
2013	0	Treated with 2,4-D and endothall, outstanding results
2014	0.22	No treatment
2015	11.33	No treatment
2016	0.34	Treated with 2,4-D and endothall, outstanding results
2017	NA	Treated with 2,4-D and endothall, results pending

APPLICATION OF AQUATIC HERBICIDES

If the total amount of EWM identified during a late summer point-intercept survey within the littoral zone reaches or exceeds 2.0 acres or 1.6% of the littoral zone then the application of herbicide will be considered. Proposed treatment areas will not be less than 1.0 acres in size. Any bed or high density area of EWM that exceeds 0.02 acres (approximately 900-ft^2) will be included in a preliminary early season treatment proposal for the given year. A buffer of 25-50 feet will be established around identified beds. Gaps between beds may also be included in proposed treatment areas if the two beds in question are close to one another, or if the area between the two beds has been known to support EWM growth based on past mapping actions. If herbicides are incorporated in a treatment plan for a given year, both CLP and EWM will be targeted at the same time using endothall at 1.0-3.0 ppm and 2,4-D at 2.0-4.0 ppm. Assuming treatment areas are at least one acre in size, liquid formulations of these herbicides will be used.

CLP

CLP is well established in Long Trade Lake covering as much as 34 acres or more than 27% of the littoral zone. In 2016, CLP covered only 26 acres suggesting management from 2013-2016 did succeed in reducing the amount of CLP. However, 26 acres is still nearly 21% of the littoral zone. The majority of this growth is considered moderate to dense in nature interfering with native aquatic plant growth in the spring, causing navigation and nuisance conditions in parts of the lake in the late spring and early summer, and then contributing to nutrient loading and organic material build up in the sediment mid-summer. Reducing the amount of moderate to dense growth CLP by 50% from 2016 levels would lessen the undesirable impacts of the plant in the lake.

CLP management to date has included both treatment of CLP in areas treated for EWM, and in areas adjacent to developed areas or in areas that cause potential navigation issues. This approach has been successful at reducing the amount of CLP in the lake and will be continued. Any area of CLP that is targeted for chemical treatment should be treated for a minimum of 3 years, regardless of the presence of EWM or not.

APPLICATION OF AQUATIC HERBICIDES

To accomplish this goal, it is recommended that CLP be managed in two ways. First, since CLP and EWM usually are present in the same areas in the spring, it is recommended that both plants be treated at the same time applying herbicide specific to each species back to back. Previous results in Long Trade Lake (2013 & 2016) have shown this approach to be highly successful at controlling both species, for multiple years. Second, since there is a limited amount of EWM in Long Trade Lake, and a previous objective aims to keep it this way, treating additional CLP outside of the proposed EWM treatment areas is necessary to reduce the overall abundance by 50%. Large beds of dense growth CLP (>3.0 acres) that are present near developed areas of the lake or that impede navigation within the lake will also be targeted in the spring. Proposed CLP treatment areas outside of the areas where EWM is treated will be no smaller than 3 acres and will be treated with endothall based herbicides at a concentration of 1.0-3.0 ppm. Should all combined treatment areas exceed 10 acres or approximately 8% of the littoral zone, official pre and post treatment, point-intercept, aquatic plant surveys will be completed. Once an area has been treated for the first time, treatment in that area will be continued for a minimum of two years more.

The success of these treatments will be measured by annual spring CLP bed-mapping, and by comparing turion density counts in the first year of treatment in this new plan (2018) with counts taken after a minimum of three years' worth of active management.

AQUATIC PLANT SURVEYING

Beginning in 2018, following year EWM treatment proposals will be based on late summer point-intercept survey work in the entire littoral zone of the lake. All aquatic plants in the littoral zone will be identified. If areas of EWM identified in beds and/or high density areas exceed 2.0 acres of the littoral zone or are causing a navigational impairment, a chemical treatment proposal will be made. If the size of the proposed treatment area reaches or exceeds 10 acres or 8% of the littoral zone, pre and post treatment point-intercept aquatic plant surveys will be completed within the treated areas. If the proposed treatment area is less than 10 acres, pre and post treatment point-intercept aquatic plant surveys are not required but will be considered if resources are available to support it. If pre and post treatment survey work is not done, a EWM Readiness survey will be completed in the proposed treatment areas prior to actual treatment to determine if an appropriate amount and level of CLP and EWM growth has been attained to implement the treatment. After any survey work, modifications to the initial treatment proposal will be made if necessary. The late summer/early fall point-intercept survey of the entire littoral zone will be used to make annual comparisons of treatment impacts on target and non-target aquatic plant species from year to year.

OTHER AIS MONITORING AND MANAGEMENT

RTLIA volunteers will continue to monitor the shoreline for purple loosestrife, removing what is found if possible. The RTLIA will be involved in rearing beetles for biological control of purple loosestrife however where those beetles are released each year will be determined by the location and most dense areas of purple loosestrife. For at least the last 5 years biological control beetles have been released on Round Lake, as the other lakes to date do not have large areas of purple loosestrife.

No formally recognized management of reed canary grass or Chinese mystery snails is expected, although shoreland improvement projects completed during the time span of this plan might impact the level of reed canary grass along the shore.

RTLIA volunteers will participate in the CLMN AIS Monitoring Program annually looking for zebra mussels, rusty crayfish, hydrilla, and other AIS not already in the lake.

COARSE WOODY HABITAT

Coarse woody habitat has never been quantified in Long Trade Lake. At some point during the implementation of this 5-year plan, the amount of CWH will be quantified and willing property owners sought for the installation of one or more CWH projects. Increasing the level of CWH in the lake would likely improve the overall fishery in the lake.

SHORELAND IMPROVEMENT

As increasing nutrients and sediment to the lake are a concern, and have led to Long Trade Lake being placed on the EPA/State of Wisconsin Impaired Waters list, making improvements to the nearshore area around the lake and the watershed upstream of the lake in the Trade River could benefit the lake.

To that end, the WDNR has begun implementing a new Lake Shoreland and Shallows Habitat Monitoring Field Protocol (Appendix D) that involves assessing a 35-ft buffer area around the entire lake, documents shoreland condition through digital photography, and documents coarse woody debris in a lake. Polk County will be completing this assessment in 2017, the results of which can be used to target additional Healthy Lake's projects.

WATER QUALITY

Long Trade Lake is listed as impaired for total phosphorus and eutrophication and regularly experiences nuisance algae blooms. A study was last completed on Long Trade Lake in 2007; and, although the study documents management recommendations, these goals were not developed with lake resident input through a public planning process. As a result, it is critical that a comprehensive lake management plan for Long Trade Lake be developed with input from a diverse array of stakeholders. The RTLIA determined in the summer of 2015 that they would like to move forward with a lake planning grant to create a lake management plan that enhances knowledge of aquatic habitats, watershed conditions, and water quality and forms a roadmap to improve Long Trade Lake and downstream lakes. With this in mind, the RTLIA in cooperation with the Polk County Land and Water Resources Department applied for and was awarded a lake management planning grant to begin developing a new water quality management plan for the lake. This project started in 2016 and is expected to be completed in 2018.

In this project, watershed delineation and land use will be significantly updated and improved with the use of LiDAR. Additional actions recommended in the 2007 study, including the collection of a sediment core, determination of tributary loading, and the development of a nutrient budget for the lake will also be completed. The project is aimed primarily at watershed and in-lake management actions and shoreline habitat protection/restoration.

The main deliverable of this project is an updated comprehensive lake management plan for Long Trade Lake consistent with the requirements of NR 191.45(2). The plan will identify and prioritize lake management needs for Long Trade Lake and set goals with a long term focus, including the removal of the lake from the Impaired Waters List. A strategy for implementing the planning effort will be included in the report and will detail actions, timelines, cost estimate, volunteer needs, partners, and possible funding sources for each goal of the plan. The plan will include specific objectives for water quality (consistent with WISCALM), watershed management (loading reduction strategies), aquatic life and habitat management (phytoplankton and shoreline habitat), and sociological management. The plan will include historical data, as well as data collected through this grant.

This study implements the recommendations of the Round and Long Trade Lakes Water Quality and Watershed Assessment Report (2008); implements recommendations in the 2011 Aquatic Plant Management Plan; and addresses Goals 1-3 of the Polk County Land and Water Resource Management Plan (2009).

2018-2022 AQUATIC PLANT MANAGEMENT GOALS, OBJECTIVES, AND ACTIONS

Based on the information shared in this document the following aquatic plant management goals, objectives, and actions are recommended. The Goals, Objectives, and Actions are also available in Appendix E.

Goal 1 – Promote and support aquatic plant management strategies that will control the spread of aquatic invasive species without negatively impacting native vegetation in Long Trade Lake.

1) Objective 1 – Keep level of EWM to below 2.0 acres or 1.6% of the littoral zone (125 acres) as indicated by annual late summer point-intercept (PI) aquatic plant survey within the littoral zone
   a) Action – Early season small-scale (<10 acres) or large-scale (>10 acres) herbicide application
      i) Treated areas must be ≥1 acre
      ii) Combine EWM and CLP treatments if in the same proposed area
      iii) Herbicide concentration/dispersion monitoring within the treated area and at the outlet of the lake will be completed if large-scale management is proposed
   b) Action – Physical Removal of EWM
      i) Summer littoral visual surveys with removal
      ii) Property owner removal near docks
   c) Action – EWM surveys
      i) Mid to late summer PI aquatic plant surveys within the littoral zone
         (1) Include the millpond
      ii) Treatment readiness survey – mid-April to mid-May
      iii) Pre- and post-treatment aquatic plant survey work
         (1) Only implemented if proposed treatment areas exceeds 10 acres or 8% of the littoral zone
2) Objective 2 – Minimize negative impacts caused by dense growth CLP
   a) Action – Early season small-scale herbicide application (w/EWM)
      i) Treated areas must be ≥1 acres
      ii) Combine EWM and CLP treatments if in the same proposed area
      iii) Herbicide concentration/dispersion monitoring within the treated area and at the outlet of the lake will be completed if large-scale management is proposed
   b) Action – Early season small or large-scale CLP treatment outside of EWM treatment areas
      i) Treated areas must be ≥3 acres, with a rakehead density of 3
      ii) Must be in areas with significant nuisance or navigation issues
      iii) Once implemented, must be completed for a minimum of three years
   c) Action – CLP surveys
      i) CLP bed-mapping – June
         (1) Include the millpond
      ii) Treatment readiness survey – mid-April to mid-May
      iii) Pre- and post-treatment aquatic plant survey work
         (1) Only implemented if proposed treatment areas exceed 10 acres
      iv) Fall turion density sampling – 2018, and again after three years of active management
3) Objective 3 – Annual Summer Aquatic Plant Surveying
   a) Action – Summer Littoral Point-Intercept Survey
      i) All plants, entire littoral zone, point-intercept survey
      ii) Mid to late summer
      iii) Year to year comparisons
   b) Action - Expand aquatic plant survey work to the millpond behind the dam
      i) All plants, entire littoral zone, point-intercept survey
      ii) Mid to late summer
      iii) Year to year comparisons
4) Objective 4 – Native Plant Restoration

a) Action – Fall planting of different native plant species including northern watermilfoil, water celery, chara, and several emergents
    i) Planting should occur between late September and mid October once water clarity begins to get better
    ii) Continue to expand native planting area along the east shore between the boat landing and outlet
    iii) Plantings should come from other lakes in the system (lakes with the Trade River flowing through) when possible

Goal 2 – Reduce the threats that existing AIS will leave the lake; that new aquatic invasive species will be introduced into the lake; and that new AIS introduced to the lake will go undetected in the lake.

1) Objective 1 – Clean Boats, Clean Waters
    a) Action - 100 hours annually with grant funding
    b) Action - Volunteer hours only without grant funding
2) Objective 2 – AIS Monitoring
    a) Action – Participate in CLMN AIS monitoring
    b) Action – Implement fall dock and boatlift zebra mussel survey
    c) Action – Maintain and/or improve AIS signage at landing
3) Objective 3 – AIS Education
    a) Action – Distribute AIS education and identification materials
    b) Action – Plan and implement AIS identification and physical removal workshops
4) Objective 4 – AIS Control
    a) Action – Implement physical removal or other approved management techniques when necessary

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

1) Objective 1 – Implement State of Wisconsin Healthy Lakes Initiative
    a) Action - Promote Healthy Lakes projects based on 2016 Shoreland Habitat Assessment results
    b) Action – Apply for Healthy Lake grant funding to support projects that improve shoreland habitat and reduce runoff into the lake

Goal 4 – Develop a Comprehensive Lake Management Plan for Long Trade Lake

1) Objective 1 – Work with Polk County and/or a consultant to develop a larger water quality focused management plan for Long Trade Lake
    a) Action – Continue support for lake management planning projects that will ultimately end with an approved Comprehensive Lake Management Plan
        i) State Approved
        ii) Federally approved (9-Key Elements) be used to Use existing and new watershed data to determine water and nutrient budgets for Long Trade Lake
2) Objective 2 – Explore relations with local agricultural producers in the watershed to encourage continued or increased use of BMPs in the watershed.
    a) Action – Work with Polk County to identify and implement agricultural projects throughout the watershed.

Goal 5 – Complete appropriate and on-going tracking, monitoring, and management strategy modification to allow for thorough evaluation of management actions, and determinations that those management actions are on target, on track, on schedule, on budget, and within expected parameters.

1) Objective 1 – Continue water quality testing for Secchi, temperature, dissolved oxygen, total phosphorus, and chlorophyll a at the Deep Hole in Long Trade Lake

    a) Action – Continue involvement in the Citizen Lake Monitoring Network (CLMN)
    b) Action – Purchase a Temp/DO meter to support water quality testing on Long Trade Lake
        i) Monitor DO throughout the entire year
2) Objective 2 – Add a CLMN monitoring site in the millpond
3) Objective 3 – Complete Annual Project Activity and Assessment Reports
    a) Action – The RTLIA and their Consultant will prepare end-of-year reports summarizes the management actions taken and how they impacted the lake.
    b) Action – Review end of year summary reports with the RTLIA and WDNR to determine following year management actions.

Goal 6 – Encourage and engage lake residents and visitors to be active lake stewards.

1) Objective 1 – Promulgate behavior change in residents in the following areas: AIS, shoreland development, aquatic vegetation, and responsibility for the lake.
    a) Action – Encourage lake residents to understand AIS concerns, learn to identify AIS, watch for and identify AIS in the lake, and report what they find and/or remove it
    b) Action – Encourage boaters to implement appropriate AIS prevention strategies on their watercraft; observe no-wake rules for boats and PWC close to shore and to each other; and be considerate of others on the lake
    c) Action – Encourage lake residents to let vegetation in the water grow and to plant native plants along their shore
    d) Action – Encourage lake residents to care for their lake, not just their lawn
        i) Provide education materials, welcome packets, newsletters, information/education displays, Facebook, webpage, meetings and other resources to increase the level of public awareness on the lake
        ii) Establish and develop volunteer lake leadership
            (1) Attend conferences
            (2) Recruit new RTLIA members and board members
            (3) Encourage lake volunteer involvement in "lake leaders" training
        iii) Strive to engage the youth in preserving the future health of the lake
        iv) Highlight examples of good shoreland practices on the lake
        v) Recognize good lake stewards for the efforts they extend

Goal 7 – Implement the Long Trade Lake Management Plan effectively and efficiently with a focus on community and constituent education, information, and involvement.

1) Objective 1 - Build and support partnerships.
    a) Action – Work with WDNR, Polk County, Town of Laketown, local businesses, contractors, and other resources to support management actions
2) Objective 2 – Keep lake residents are informed about plan activities
    a) Action – Continue supporting Long Trade Lake involvement in the RTLIA, or in lieu of this, consider formation of a Long Trade Lake Association or District.
    b) Action – Continue additional meetings of Long Trade Lake constituency to inform and seek input for management actions
3) Objective 3 - Select cost effective implementation actions
    a) Action – Work within the budget constraints to establish the best management actions to implement annually
    b) Action – Apply for State of Wisconsin grant funding to support education, planning, and management implementation

IMPLEMENTATION AND EVALUATION

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

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

WISCONSIN DEPARTMENT OF NATURAL RESOURCES GRANT PROGRAMS

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

AIS PREVENTION AND CONTROL GRANTS

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

There are five AIS Prevention and Control grants subprograms:

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

Education, Prevention, and Planning; Established Population Control, Clean Boats, Clean Waters, and Maintenance and Containment grants are applicable to Long Trade Lake and the RTLIA.

EDUCATION, PREVENTION AND PLANNING PROJECTS

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

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

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

Funding Possibilities

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

ESTABLISHED POPULATION CONTROL PROJECTS

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

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

Funding Possibilities

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

MAINTENANCE AND CONTAINMENT PROJECTS

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

Funding Possibilities

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

LAKE MANAGEMENT PLANNING GRANTS

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

SMALL SCALE LAKE MANAGEMENT PROJECTS

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

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

Funding Possibilities

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

LARGE SCALE LAKE MANAGEMENT PROJECTS

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

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

Funding Possibilities

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

LAKE PROTECTION GRANTS

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

HEALTHY LAKES PROJECTS

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

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

Funding Possibilities

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

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Appendix A – NR 109

Appendix B – NR 107

Appendix C – WDNR Dredging Exemptions Checklist

Appendix D – WDNR Shoreland and Shallows Habitat Assessment Guidelines

Appendix E – Goals, Objectives, and Actions

Appendix F – Funding and Implementation Matrix

Appendix G – Calendar of Actions