Aquatic Plant Management Plan

Long Lake

Polk County, Wisconsin

August 2012

Prepared By

Harmony Environmental	Plan Writing and Facilitation
Endangered Resource Services, LLC	Aquatic Plant Survey and Mapping

Funded By

Long Lake Protection and Rehabilitation District
A Wisconsin Department of Natural Resources Grant

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Executive Summary

This Aquatic Plant Management Plan updates the 2007 Long Lake Aquatic Plant Management Plan through 2017. The strategies for controlling curly leaf pondweed, protecting native plant populations, and allowing navigation through aquatic plant beds were updated. A strategy for preventing establishment of invasive species was developed with this update. The plan includes data about the plant community, watershed, and water quality of the lake. It also reviews a history of aquatic plant management on Long Lake.

An aquatic plant point intercept survey was first completed for Long Lake in 2007. Subsequent surveys were completed in 2010 and 2011. The Department of Natural Resources required comprehensive surveys three times each year because of extensive treatment of curly leaf pondweed in 2010 and 2011. The herbicide treatment resulted in nearly complete initial removal of curly leaf pondweed with some late season growth each year. Native plants density increases through the growing season following the herbicide treatment. However, there have been some changes in the presence and frequency of some native plant species.

The aquatic plant surveys found that Long Lake has moderately low plant community diversity. Highest diversity is found in the shallow bays at either end of the lake. Native plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of non-native invasive plants – all critical functions for the lake.

This Aquatic Plant Management Plan, developed with input from an advisory committee including lake property owners, will help the Long Lake Protection and Rehabilitation District carry out activities to meet plan aquatic plant management goals. The implementation plan describes the actions that will be taken toward achieving these goals.

A special thank you is extended to the aquatic plant management advisory committee for assistance with plan development.

Advisory Committee Members
Monica Brengman (LLPRD Board)
Keith Campbell (LLPRD Board)
Jeff Larson (LLPRD Board)
Patti Langer
Jerry Prokop
Lonny Thimjon

Plan Advisors
Jeremy Williamson, Polk County Land and Water Resources Department
Katelin Holm, Polk County Land and Water Resources Department

Introduction

The Aquatic Plant Management Plan for Long Lake is sponsored by the Long Lake Protection and Rehabilitation District (LLPRD) with partial funding from a Wisconsin Department of Natural Resources Aquatic Invasive Species grant.

This aquatic plant management plan updates the 2007 Long Lake Aquatic Plant Management Plan through 2017. The strategies for controlling curly leaf pondweed, protecting native plant populations, and allowing navigation through aquatic plant beds were updated. A strategy for preventing establishment of invasive species was developed. The plan includes data about the plant community, watershed, and water quality of the lake. It also reviews a history of aquatic plant management on Long Lake. This plan will guide the Long Lake P&R District and the Wisconsin Department of Natural Resources in aquatic plant management for Long Lake over the next five years (from 2013 through 2017). A plan update will begin in 2016.

Public Input for Plan Development

The LLPRD Aquatic Plant Management (APM) Advisory Committee provided input for the development of this plan. The APM Advisory Committee met four times. At the first meeting on March 28, 2012, the committee reviewed aquatic plant management planning requirements, plant survey results, aquatic plant management efforts to date, and discussed aquatic plant management concerns. At a second meeting on April 25, 2012, and a third meeting on May 23, 2012, the committee reviewed goals, developed objectives, and updated action steps. The committee reviewed the status of comments at a meeting August 8, 2012. The APM Advisory Committee concerns are reflected in the goals and objectives for aquatic plant management in this plan.

The Long Lake P&R District board announced the availability of the draft Aquatic Plant Management Plan for review with a public notice in the Polk County Ledger the weeks of June 25, and July 2, 2012. Copies of the plan were made available to the public on the Polk County web site www.co.polk.wi.us/landwater and at the Balsam Lake Public Library. Comments were accepted through August 25, 2012 when a presentation was made at the annual meeting.

Staff of the Voigt Intertribal Task Force and the St. Croix Tribe were invited to participate in plan development as well as in review of draft versions of the plan. Both declined because wild rice is not present in Long Lake.

Resident Concerns

The APM Committee expressed a variety of concerns that are reflected in the goals for aquatic plant management in this plan. Management concerns included addressing prevention of aquatic invasive species, and developing a response plan if they become introduced. Education was also very important to committee members.

Plan Goals

1) Improve water quality and clarity.

2) Protect and restore healthy rooted native aquatic plant communities.

3) Balance recreation and riparian needs with protection of native plants and the fishery.

4) Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.

5) Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.

Resident Survey
The LLPRD distributed a public opinion survey to Long Lake property owners on April 1, 2012. Responses received through May 21 are included in Appendix A. With 103 surveys returned out of the 169 mailed, the response rate was 61 percent. Results especially important to the aquatic plant management plan are summarized in Figures 1 to 3 below.

Invasive plants are viewed as having a negative impact on the lake, and residents support management efforts to prevent additional invasive species and control curly leaf pondweed. Education is viewed as an important management effort, as is protecting sensitive habitat areas in the lake.

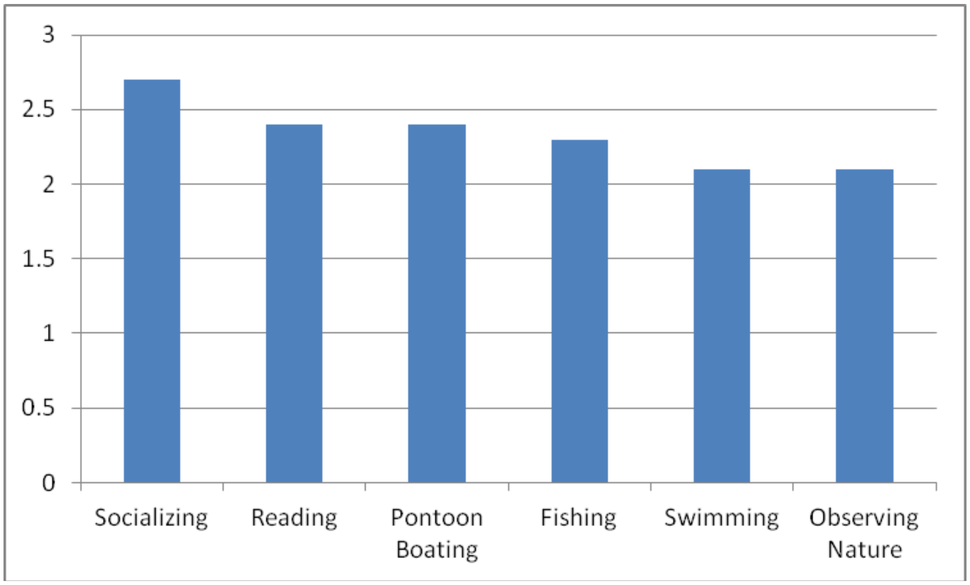


Figure 1. Lake Activities with Highest Participation (Scale 0 to 4)

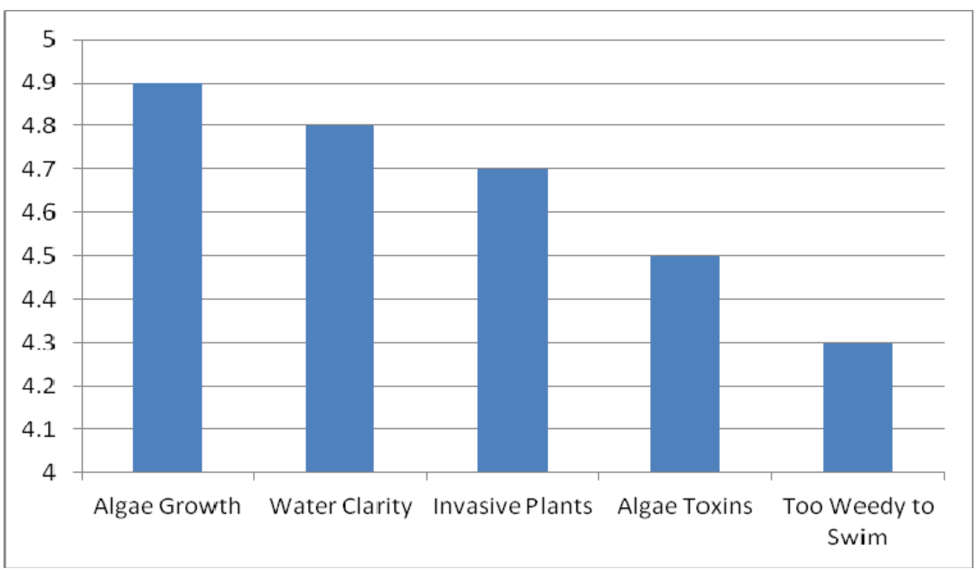


Figure 2. Greatest Negative Impact (Scale 0 to 6)

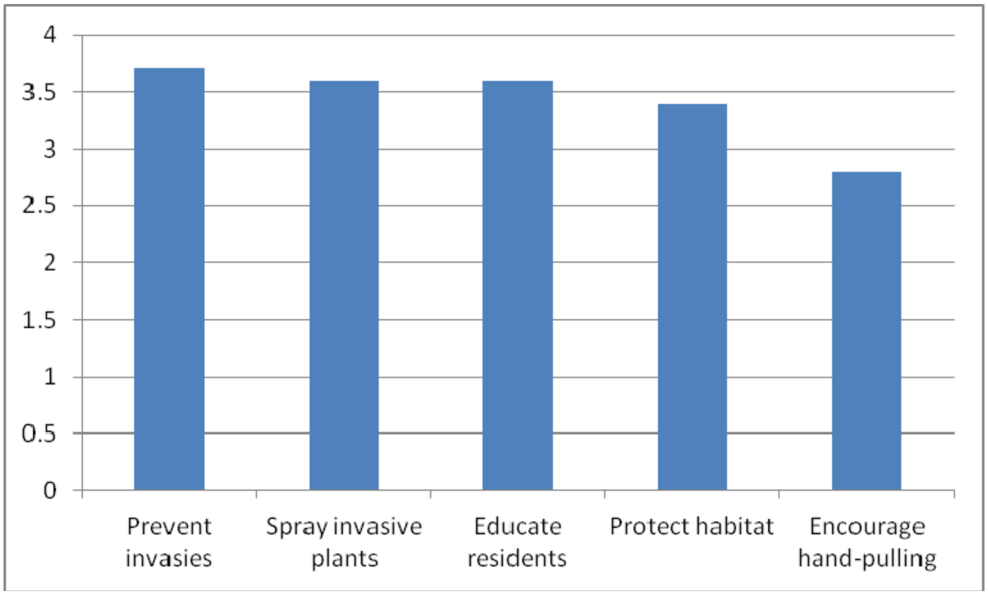


Figure 3. Management Activities Supported (Scale 0 to 4)

Lake Information

The Lake

Long Lake is a 272-acre lake located in Polk County, Wisconsin in the town of Balsam Lake (S6, S7, and S8, T34N, R17W). Its water body identification code is 2478200. The maximum depth of the lake is 17 feet and the mean depth is 11 feet. Its direct watershed is about 1,279 acres.[1] The lake is a seepage lake with no streams entering or leaving the lake. A ditch on the north end and another on the south end, flow to the lake during and after storm events.

Long Lake is a eutrophic to hypereutrophic lake with 2011 summer secchi depths averaging 4.6 feet. The 2011 littoral zone (the depth to which plants grow) ranged from 10 to 12 feet. The bottom substrate is composed of muck (75%), rock (13%) or sand (11%) as shown in Figure 4 below.[2] A lake map is found on the following page as Figure 5.

Table 1. Long Lake Information

Size (acres)	272
Mean depth (feet)	11
Maximum depth (feet)	17
Littoral zone depth (feet)	11
Average summer secchi depth (feet) 1992-2011	4.9

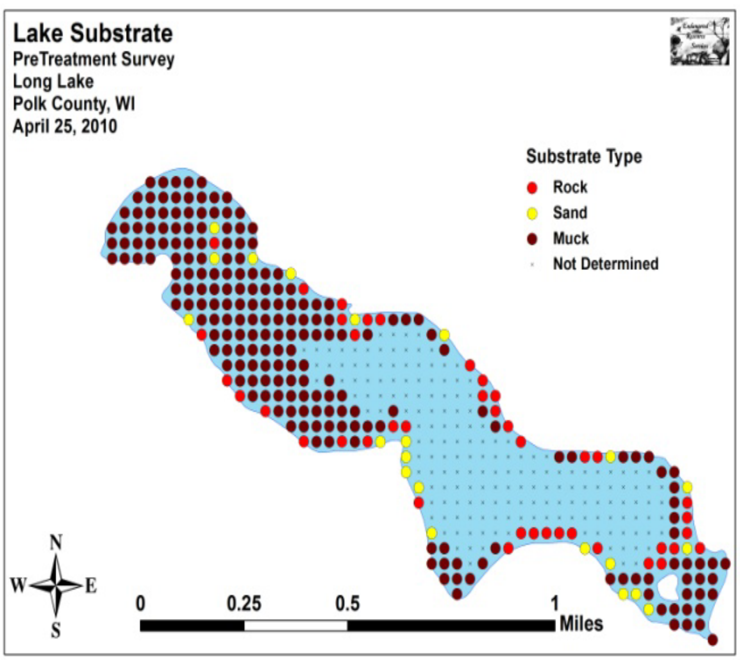


Figure 4. Sediment Type

[1] Barr. 2003.
[2] Berg. 2011.

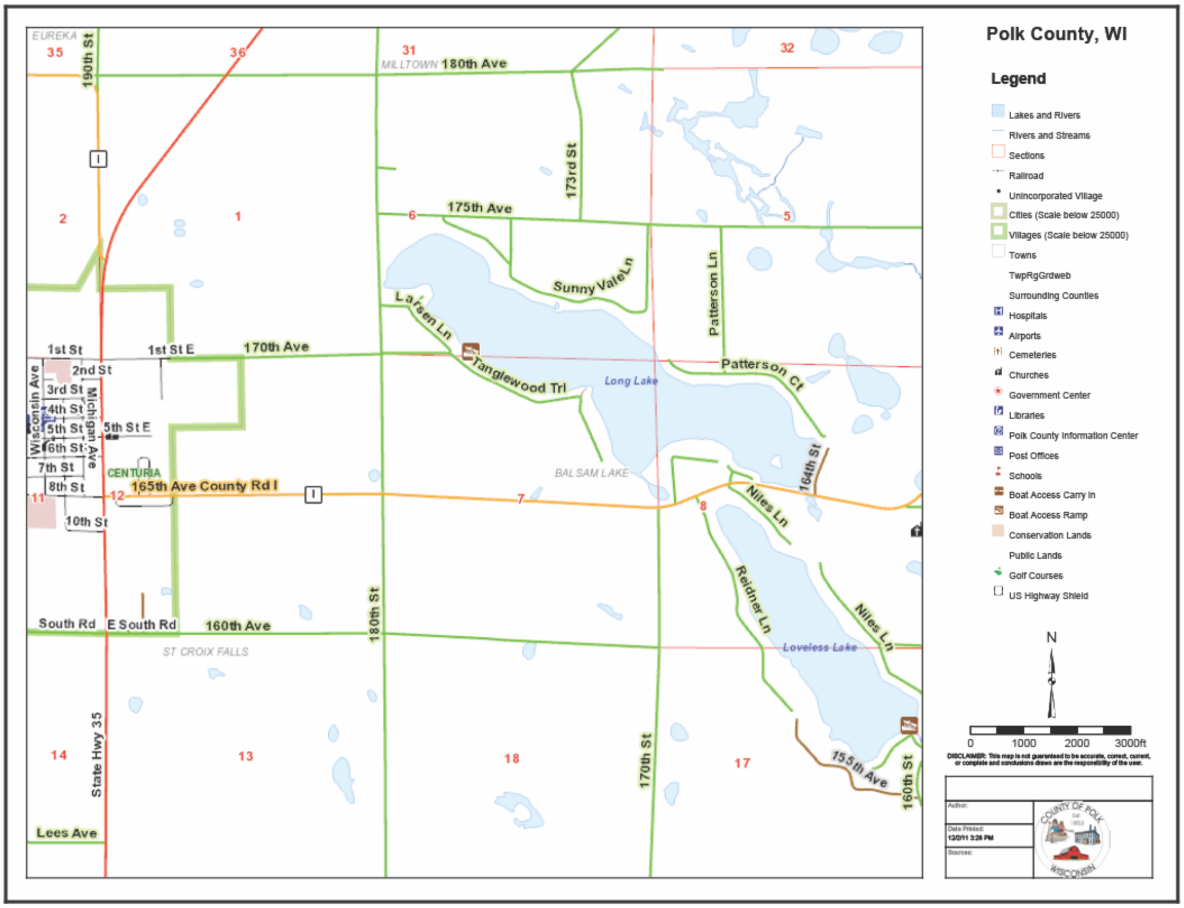


Figure 5. Long Lake Boating Access

Water Quality

Water quality is frequently reported by the trophic state or nutrient level of the lake. Nutrient-rich lakes are classified as eutrophic. These lakes tend to have abundant aquatic plant growth and low water clarity due to algae blooms. At the high end of the eutrophic scale blue-green algae dominate and algae scums are present, sometimes throughout the summer. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms. Oligotrophic lakes are nutrient-poor with little growth of plants and algae.

Secchi depth readings are one way to assess the trophic state of a lake. The Secchi depth is the depth at which the black and white Secchi disk is no longer visible when it is lowered into the water. Greater Secchi depths occur with greater water clarity. Secchi depth readings, phosphorus concentrations, and chlorophyll measurements can each be used to calculate a Trophic State Index (TSI) for lakes. TSI values range from 0 – 110. Lakes with TSI values greater than 50 are considered eutrophic. Those with values in the 40 to 50 range are mesotrophic. Lakes with TSI values below 40 are considered oligotrophic. Monitoring results place Long Lake in the eutrophic TSI range.

Citizen lake monitoring volunteers have collected data from the lake annually at the deep hole of Long Lake since 1992. The lake was sampled 9 times during 2011 with an average reported secchi depth of 4.63. The TSI for this level is 55 – a eutrophic value. Results are available from the WDNR website.[3] For better comparison between lakes, only July and August results are summarized and reported in the figures that follow.

Figure 6 illustrates the annual summer Secchi depth averages for the lake. Figure 7 graphs the Trophic State Index for Long Lake, based upon Secchi depth, chlorophyll, dissolved oxygen, and total phosphorus results.

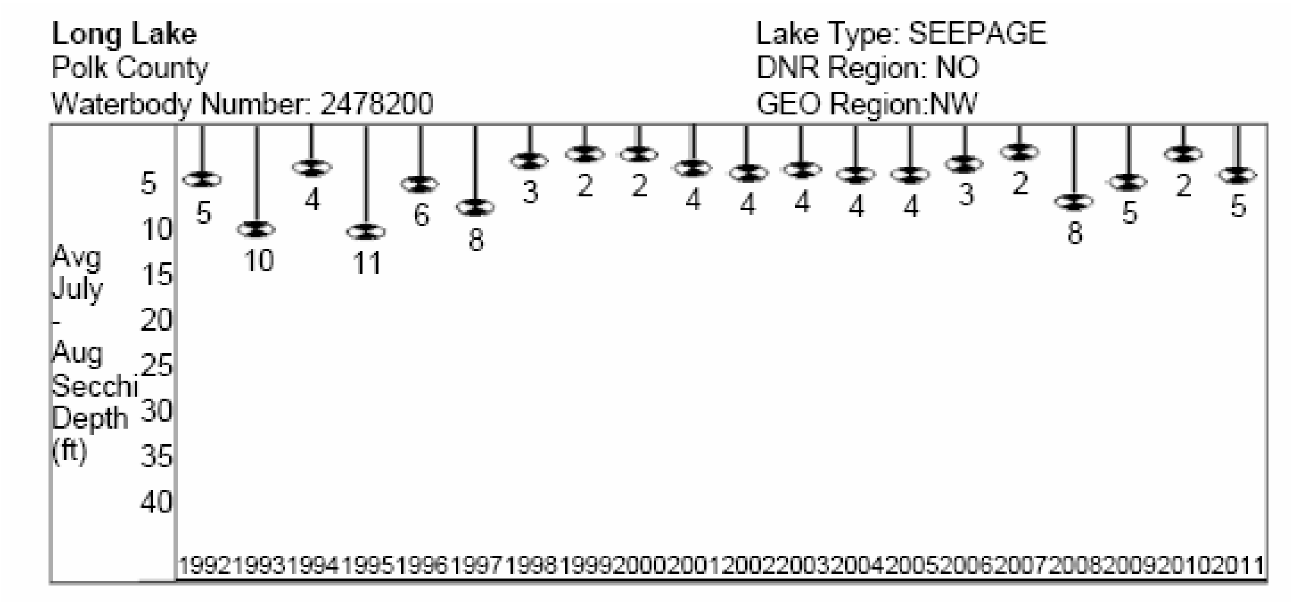
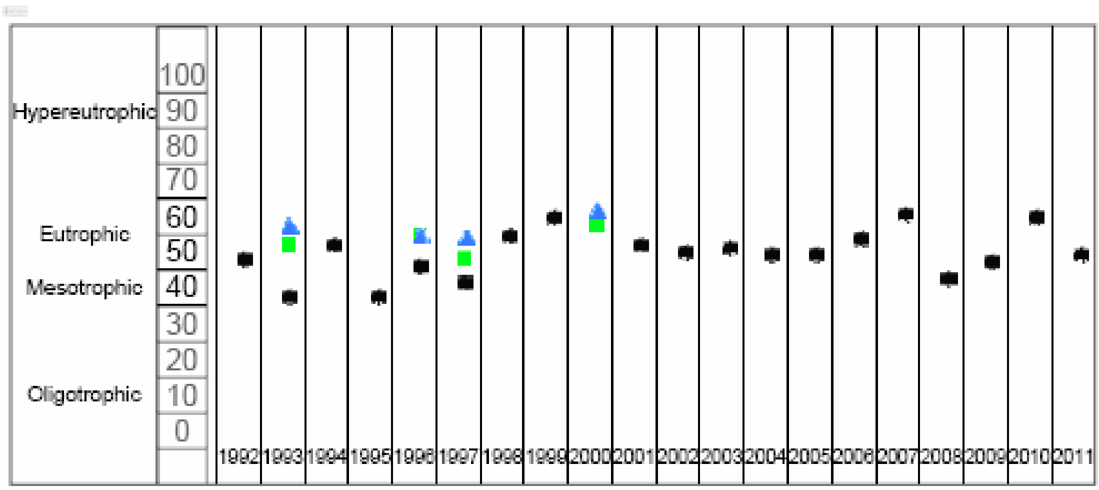


Figure 6. Long Lake Secchi Depths 1992-2011

[3] www.dnr.state.wi.us/lakes/clmn/



= Secchi = Chlorophyll = Total Phosphorus

Figure 7. Average Trophic State 1992-2011

Citizen monitoring results show good early summer water clarity with increasing algae growth and declining water clarity later in the summer. The trend of 2011 summer secchi depth readings shown in Figure 8 below is a typical summer trend.

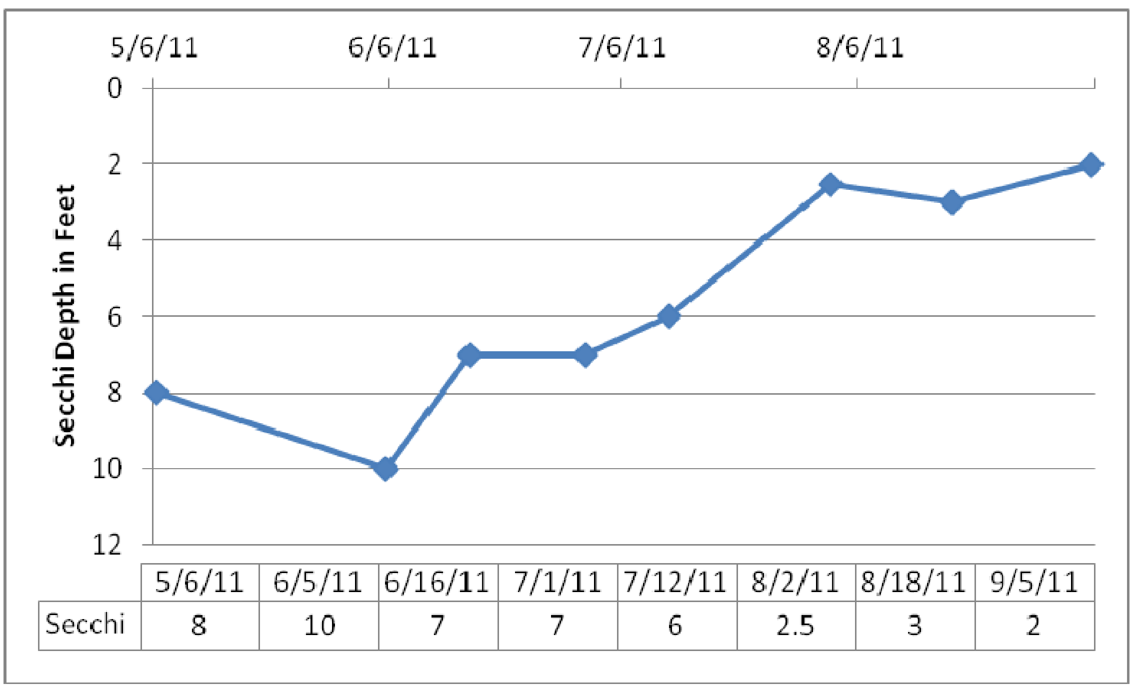


Figure 8. Long Lake Summer 2011 Secchi Depth Trend

Algae Study

The Polk County Land and Water Resources Department measured cyanobacteria (blue-green algae), the toxins they produce, and water quality parameters in 2010 and 2011. This study was prompted by the death of a dog in 2009, and other incidents suspected to be caused by cyanobacteria toxins. Cyanobacterial concentration was highest in late July. This spike in growth included a high concentration of *Aphinzomenon issatschenkoi*. This species produces anatoxin-A which was measured at high levels during this time period. Anatoxin-A affects nerve synapses. As shown in Figure 9, a spike in microcystin liver toxins occurred in late September 2010. This spike corresponded with fall lake mixing when high phosphorus concentrations held in bottom waters during the summer are released to the surface.[4] The World Health Organization established a level of 1ug/L mycrocystin-LR for long term consumption of drinking water.[5] The level of mycrocystin-LR in Long Lake in September of 2010 was 79, with other mycrocystin toxins at even higher levels.

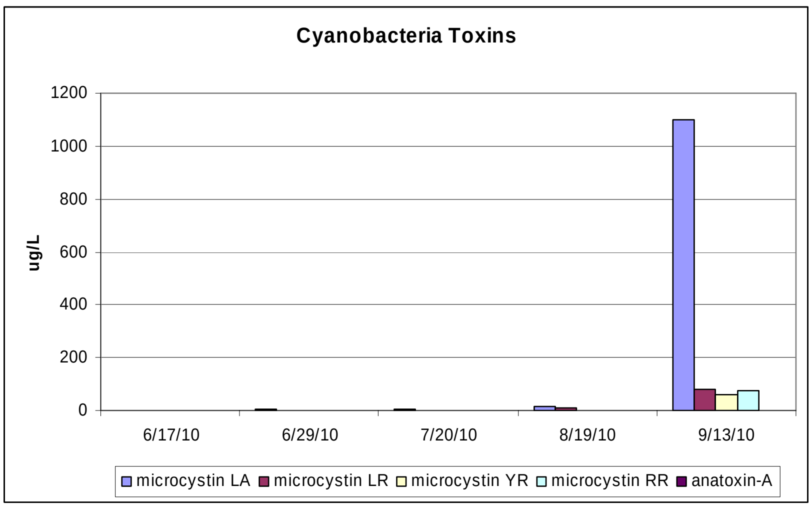


Figure 9. Cyanobacteria Toxins 2010

Water Quality Study

Barr Engineering completed a water quality study and management plan from 2000 through 2003.[6] The six phase study included the following steps:

Phase I:	Transect aquatic macrophyte survey (mid-June 2000) Inflow monitoring from south side ditch
Phase II:	Inflow monitoring from north side ditch
Phase III:	In-lake water quality samples, lake levels and precipitation measurement Membership survey (2000)
Phase IV:	Watershed phosphorus and total phosphorus budgets
Phase V:	Long-term water quality management goal (suggested) Management scenarios to reach this goal (evaluated) Sediment core experiments to determine appropriate alum/lime slurry doses.
Phase VI:	Lake management plan report

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4 Williamson. 2010.
5 1 ug/L is equivalent to .135 ounces in 1 million gallons of water.
6 Barr. 2003.

Watershed

A watershed map is included in Figure 10 below. The entire Long Lake watershed is over 2,000 acres. The area draining directed to the lake was reported to be about 1,279 acres in the water quality study. The watershed is largely agricultural (74%) with significant amounts of residential land (17%) and open space (8%). Watershed sources were estimated to contribute about 31% of the lake's total phosphorus budget in 2000. Other sources included lake sediments (20%), curly leaf pondweed dieback (32%), septic systems (5%), and rainfall on lake (12%).[7]

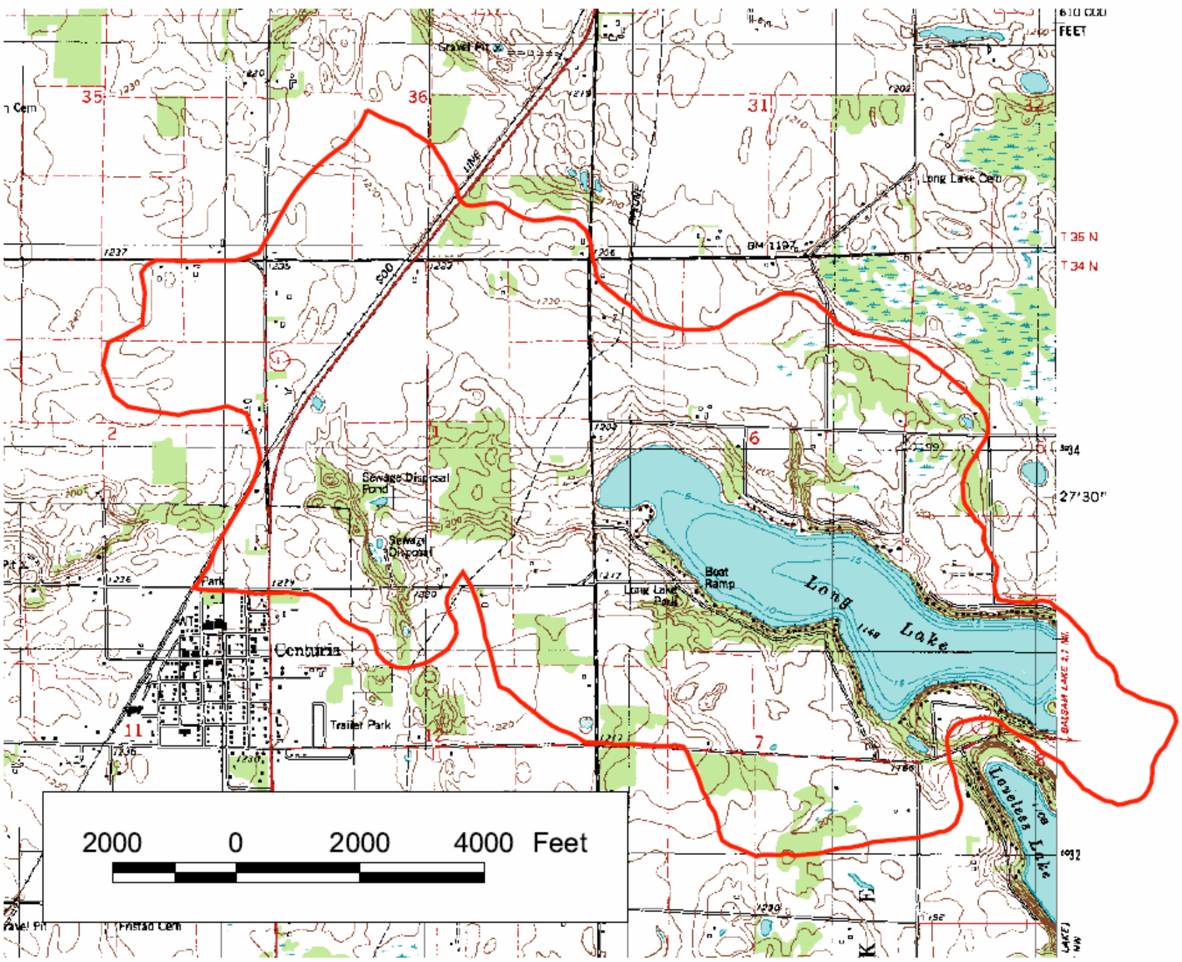

Figure 10. Long Lake Watershed Map

[7] Barr 2003.

Water Quality Study Conclusions

The 2003 water quality suggested a water quality goal of 45 *u*g/L average summer total phosphorus for upper surface water.

> *This goal has not been adopted by the Long Lake District.*[8] *The average summer TP in 2000 was 92 ug/L. Total phosphorus has not been measured since 2000, but water clarity has increased in recent years.*

Recommended management actions to reach proposed management goal included:

- A lime slurry/alum treatment to control phosphorus loads from the lake sediments. A test of appropriate dosing was recommended as a first step because of a very soft lake bottom.
  This recommendation was not adopted by the Long Lake District because cost would be high and Department of Natural Resources support was uncertain at the time.

- Early season herbicide treatment of curly leaf pondweed.
  This recommendation was formally adopted by the Long Lake District with the approval of Long Lake Aquatic Plant Management Plan in 2007.

- Control of watershed sources through a county stormwater ordinance, shoreland gardens, a septic system ordinance, and watershed best management practices.
  A stormwater ordinance that exceeds state minimum standards was adopted by Polk County in 2005. Best management practices including nutrient management planning for farmers were implemented in the watershed through the Balsam Branch Priority Watershed Project. This project was in place from 1995 through 2005.

[8] Personal communication Monica Brengman. December 2011.

Aquatic Habitats

Primary Human Use Areas

A public boat landing operated by the Village of Centuria is located on the northwest side of the lake. The boat landing includes space for parking nine vehicles and trailers. The landing is used heavily in the summer. Anglers frequently park along the road when the boat landing parking area is full. There is another public landing on the north side of lake that is used less frequently. The landing is not paved, and there are no parking spaces. It is used as an access for ice fishing.[9]

The shoreline of Long Lake is largely developed for residential use with about 169 residences. There are 178 parcels in the lake district.[10] Lake residents' use focuses around their docks placed in the relatively shallow, littoral zone of the lake.

Habitat Areas

The littoral, or plant supporting, zone of the lake provides critical habitat for fish, waterfowl, and other wildlife. It is found in a narrow band around Long Lake at depths up to 10 feet. More extensive littoral zones are found in the northwest and southeast bays.

Sensitive Area Study

The DNR sensitive area study (1989) identified two areas that merit special protection of aquatic habitat. "These areas of aquatic vegetation on Long Lake offer critical or unique fish and wildlife habitat. This habitat provides the necessary seasonal or life stage requirements of the associated fisheries while offering water quality or erosion control benefits to the body of water." In the designated sensitive areas, aquatic vegetation removal is limited to navigational channels no greater than 25 feet wide. Chemical treatments are discouraged and if navigational channels must be cleared, pulling by hand is preferable.

Resource Value of Area A

This area consists of the northwestern bay. It provides important habitat for bass and panfish and northern pike spawning and nursery areas. The area also provides important habitat for forage species. Wildlife also are reliant upon this area for habitat. Eagles, loons, herons, waterfowl, songbirds, furbearers, turtles, and amphibians benefit from this valuable habitat.

Resource Value of Area B

This area consists of the southeastern bay.

Values are the same as those described above for Area A.

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[9] Personal email communication. Monica Brengman. LLPRD Board Chair.

[10] Personal email communication Jeff Larson, LLPRD Treasurer. December 14, 2011.

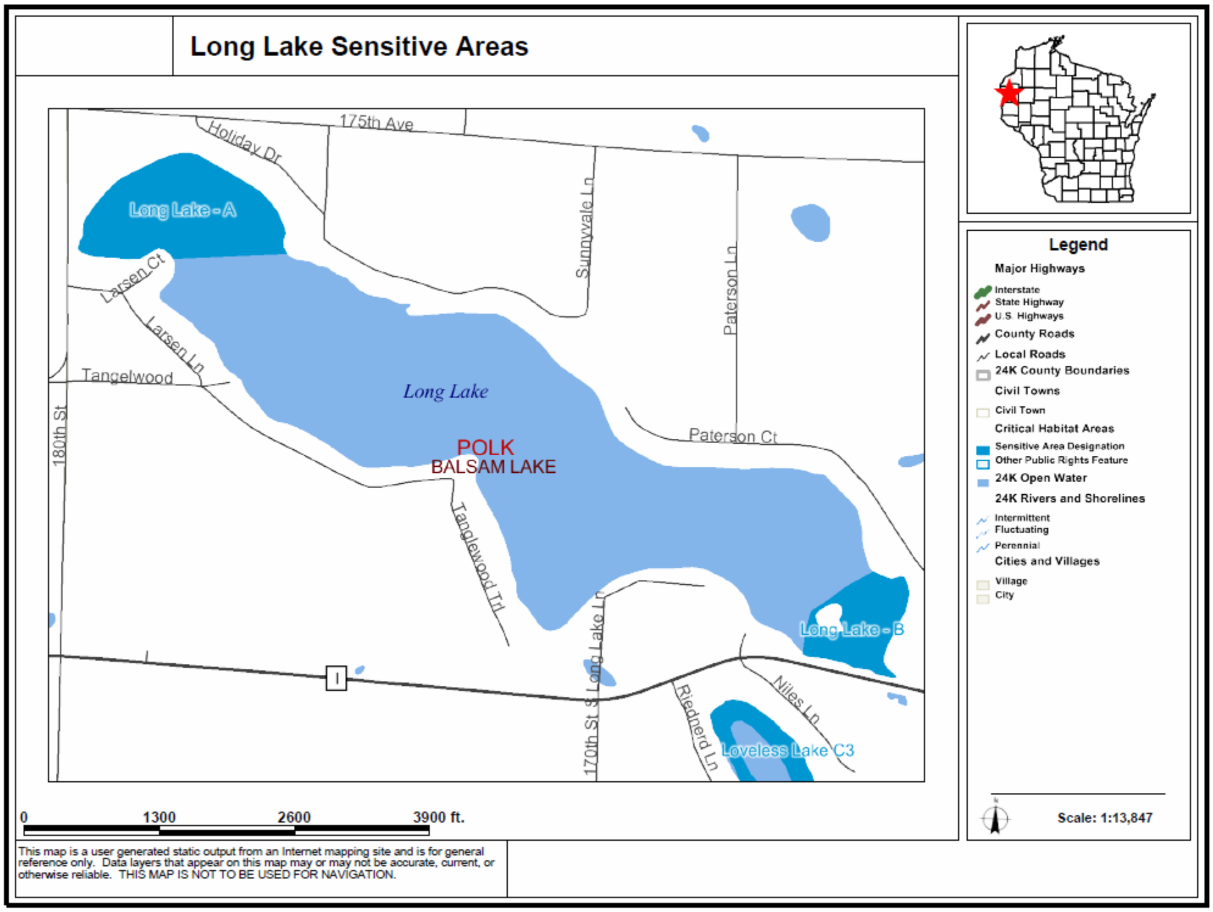

Figure 11. Long Lake Sensitive Areas

Long Lake Fishery

Long Lake's fish community consists of northern pike, largemouth bass, and panfish.[11] The Department of Natural Resources stocked northern pike in the lake most years from 1980 through 2010. In some years from 250,000 to 500,000 inch fry were stocked. In other years from 500 to 3,000 fingerlings (4 to 11 inches) were stocked.

The DNR last completed a night electro-fishing survey in October of 2006. The survey captured 13 black crappie (5-10.5 inches), 122 blue gill (3-8.5 inches), 376 largemouth bass (6-8.5 inches), and 38 northern pike (12-27.5 inches).[12]

Fish spawning times are listed in Table 2 to consider for potential plant management activities.

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[11] Wisconsin Lakes Book.

[12] Personal email communication. Mark Stanley, DNR Fisheries Technician. December 7, 2011.

Table 2. Fish Spawning Considerations

Fish Species	**Spawning Temp. (Degrees F)**	**Spawning Substrate / Location**	**Comments**
Northern Pike	Upper 30s – mid 40s (right after ice-out)	Emergent vegetation 6-10 inches of water	Eggs are broadcast
Black Crappie	Upper 50s to lower 60s	Nests are built in 1-6 feet of water.	Nest builders
Largemouth Bass Bluegills	Mid 60s to lower 70s	Nests are built in water less than 3 feet deep.	

Rare, Endangered, or Protected Species Habitat

Long Lake is located in the town of Balsam Lake (T34N, R17W) in sections 6 and 7. Natural Heritage Inventory records are provided to the public by town and range rather than section, so there is no indication if the incidences of these species occur in and immediately surrounding Long Lake.[13] Committee members report an active bald eagle nest east of the island on County Road I in 2012.

Species listed in the Town of Balsam Lake (T34N, R17W):

Bald Eagle	*Haliaeetus leucocephalus*	Special Concern

The proposed actions within the plan are not anticipated to affect native plants and wildlife including the natural heritage species listed above.

Functions and Values of Native Aquatic Plants

Naturally occurring native plants are extremely beneficial to the lake. They provide a diversity of habitats, help maintain water quality, sustain fish populations, and support common lakeshore wildlife such as loons and frogs.

Water Quality

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algae growth. Some plants can even filter and break down pollutants. Plant roots and underground stems help to prevent re-suspension of sediments from the lake bottom. This is especially important in shallow areas with mucky bottoms such as found in Long Lake as shown in Figure 12. Stands of emergent plants (with stems that protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline. Poor water clarity can limit aquatic plant growth by limiting light penetration.

[13] Natural Heritage data for Wisconsin is found at http://dnr.wi.gov/org/land/er/nhi. (data current as of 11/04/11)

Fishing
Habitat created by aquatic plants provides food and shelter for both young and adult fish. Invertebrates living on or beneath plants are a primary food source for many species of fish. Other fish, such as bluegills, graze directly on the plants themselves. Plant beds in shallow water provide important spawning habitat for many fish species.

Waterfowl
Plants offer food, shelter, and nesting material for waterfowl. Birds eat both the invertebrates that live on plants and the plants themselves.[14]

Protection against Invasive Species
Non-native invasive aquatic species threaten native plants in Northern Wisconsin. The most common are Eurasian water milfoil (EWM) and curly leaf pondweed (CLP). These species are described as opportunistic invaders. This means that they take over openings in the lake bottom where native plants have been removed. Without competition from other plants, these invasive species may successfully become established and spread in the lake. This concept of opportunistic invasion can also be observed on land, in areas where bare soil is quickly taken over by weeds.

Removal of native vegetation not only diminishes the natural qualities of a lake, but it increases the risk of non-native species invasion and establishment. The presence of invasive species can change many of the natural features of a lake and often leads to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native plants may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.[15]

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[14] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.
[15] *Aquatic Plant Management Strategy. DNR Northern Region.* Summer 2007.

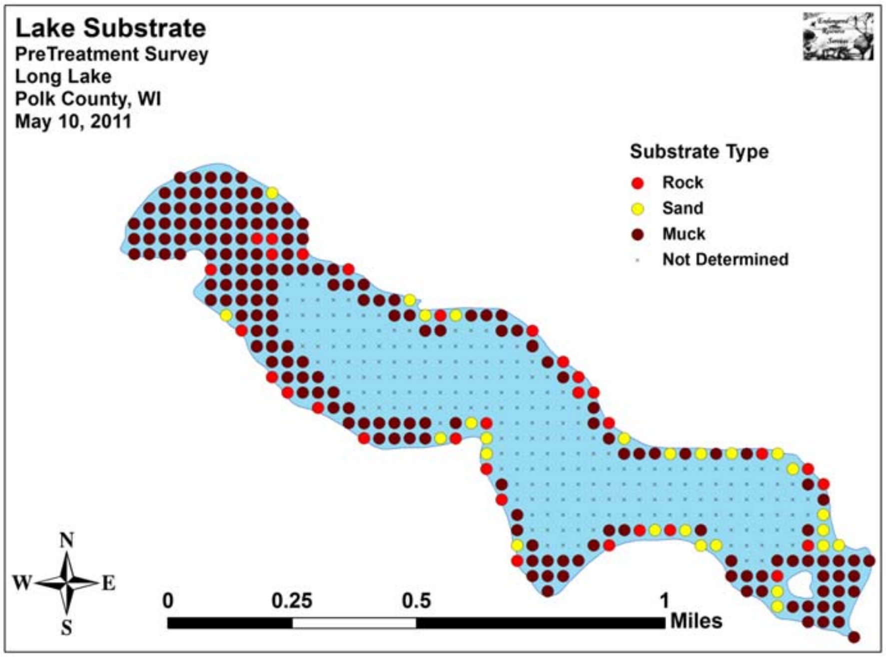

Figure 12. Lake Bottom Sediment

Plant Community

Aquatic Plant Survey Results

Aquatic plant surveys were completed for Long Lake in 2007, 2010, and 2011 according to the WDNR-specified point intercept method. The survey results presented here first summarize the results of the most recent survey completed in July 2011. Next, results are compared between surveys completed in 2007, 2010, and 2011. Because the 2007 survey was completed in early June the comparison focuses on this time period for more recent surveys.

The results discussed below are summarized or taken directly from the aquatic plant surveys. The survey and data analysis methods for the aquatic macrophyte survey are found in the following report prepared in both 2010 and 2011: *Curly-leaf pondweed (Potamogeton crispus) Bed Mapping, Pre/Post Herbicide, and Warm Water Point Intercept Surveys Long Lake – Polk County, Wisconsin WBIC: 2478200* conducted and prepared by Matt Berg, Endangered Resource Services, LLC. Extensive additional data and maps are included in these reports. Barr Engineering completed the 2007 aquatic plant survey, which is summarized in the 2007 *Long Lake Aquatic Plant Management Plan*.

Using a standard formula based on a lake's shoreline shape and length, islands, water clarity, depth, and size, the Wisconsin Department of Natural Resources (WDNR) generated the sampling point grid of 453 points. Figure 13 below shows the distribution of these sampling points. The 231 points on the base grid that were within or adjacent to the lake's known littoral area were sampled for the point intercept points in 2011. An additional 210 points were sampled to assess the impacts of the curly leaf pondweed herbicide treatment.

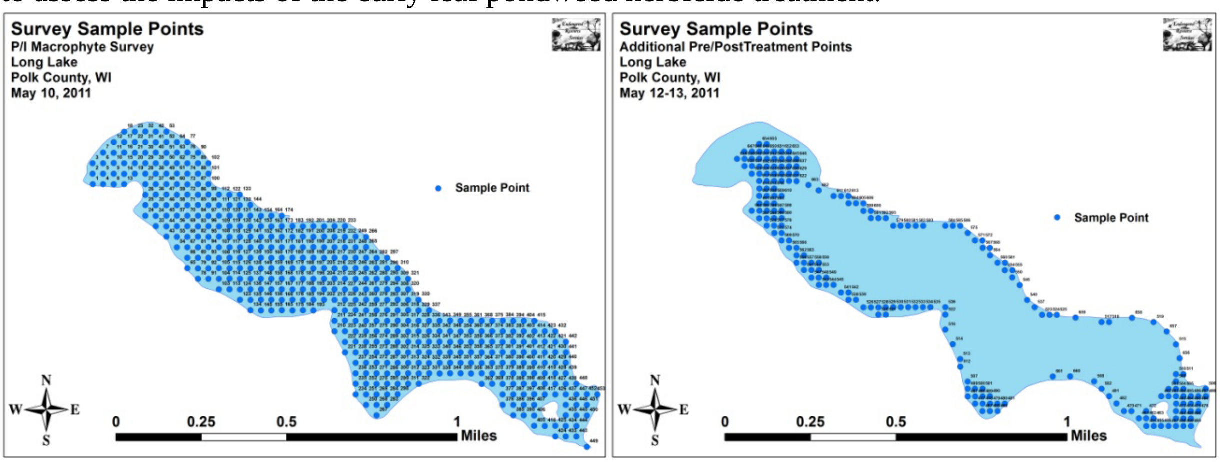

Figure 13. Sampling Point Grid

In July 2011, plants were found growing on approximately 71% of the littoral zone (the depth at which plants can grow). The littoral zone is shown in Figure 14 below. The depth of the littoral zone fluctuates seasonally and between years on Long Lake with plants growing deepest early in the growing season. The littoral zone ranged from a low of 10 feet to a maximum of 14 feet in 2010 and 2011. The northwest and southeast bays are the largest littoral zone areas and represent the highest density of plant growth.

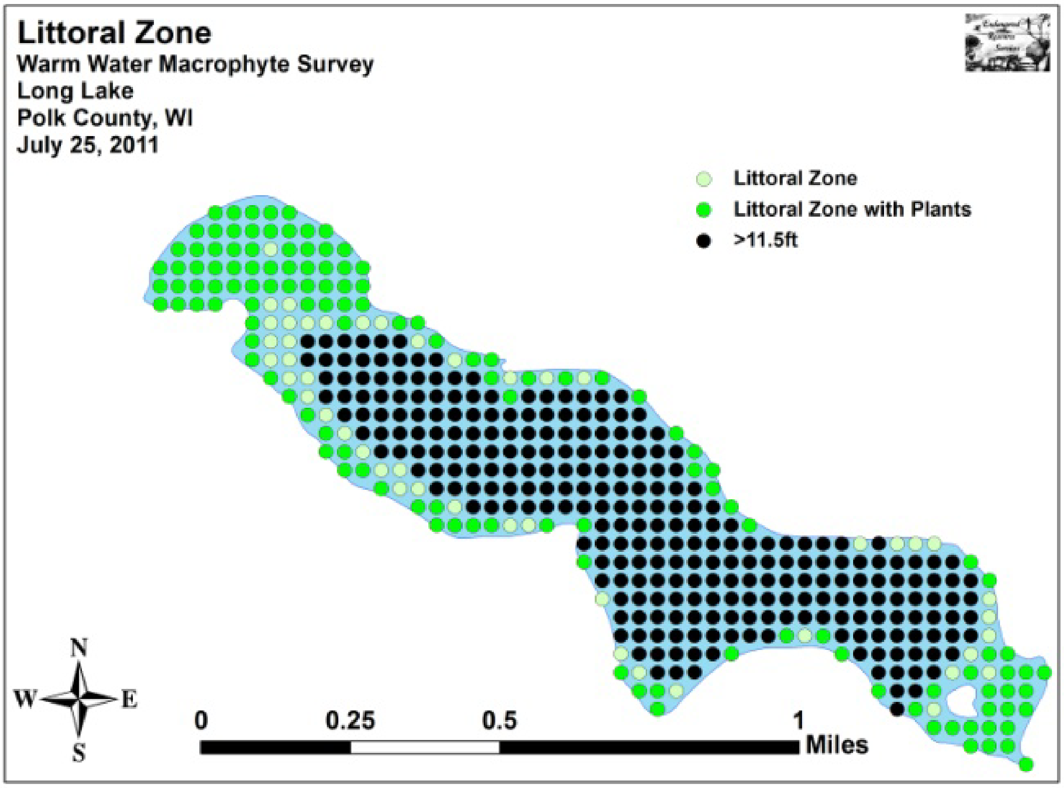

Figure 14. Long Lake Littoral Zone July 2011

Species totals are low on Long Lake when compared with other lakes in the region. Only 18 different species where found in July of 2011, while 22 species were found in July 2010. The number and types of species have changed in recent years. Mean native species richness at sites with vegetation was also low. In July 2011 there were 2.45 species per site down slightly from a maximum of 2.61 species per vegetative site in July 2010. Native species richness was highest in the northwest bay (Figure 15). The lake exhibited moderate diversity with Simpson Index Values ranging from 0.74-0.88 over the course of the growing season.[16]

Figure 16 illustrates plant density based on fullness of the vegetation on the sample rake. The density rating of the rake sampled varied between one and three (from low to high density). Highest plant density occurs in the northwest and southeast bay.

[16] The Simpson Diversity Index is a measure of the likelihood that a different species of plant will be found each time a grab sample is taken. The highest Simpson Diversity Index is 1.0.

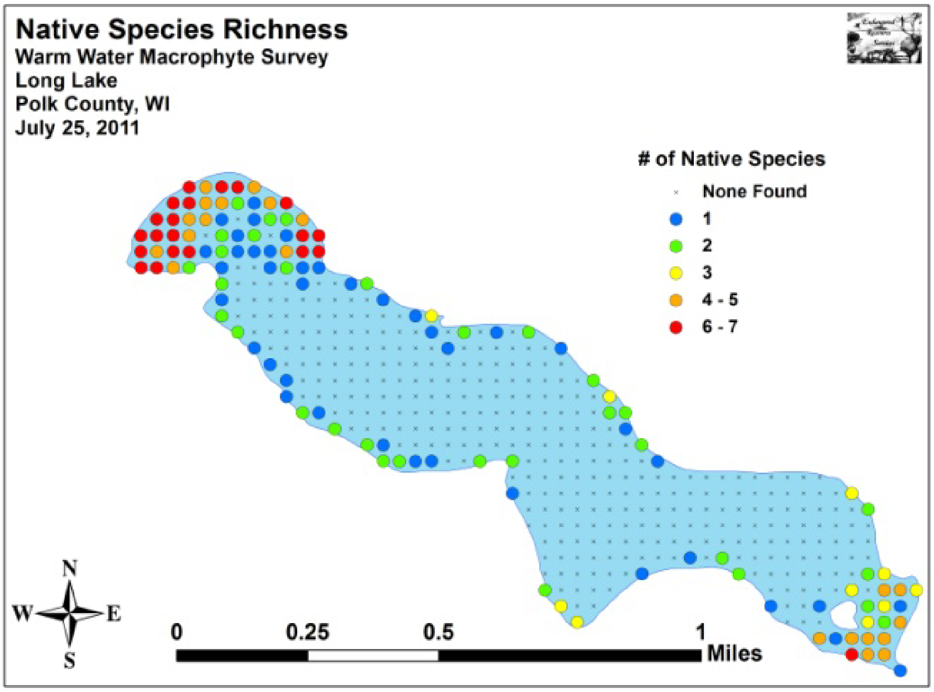

Figure 15. Native Species Richness July 2011

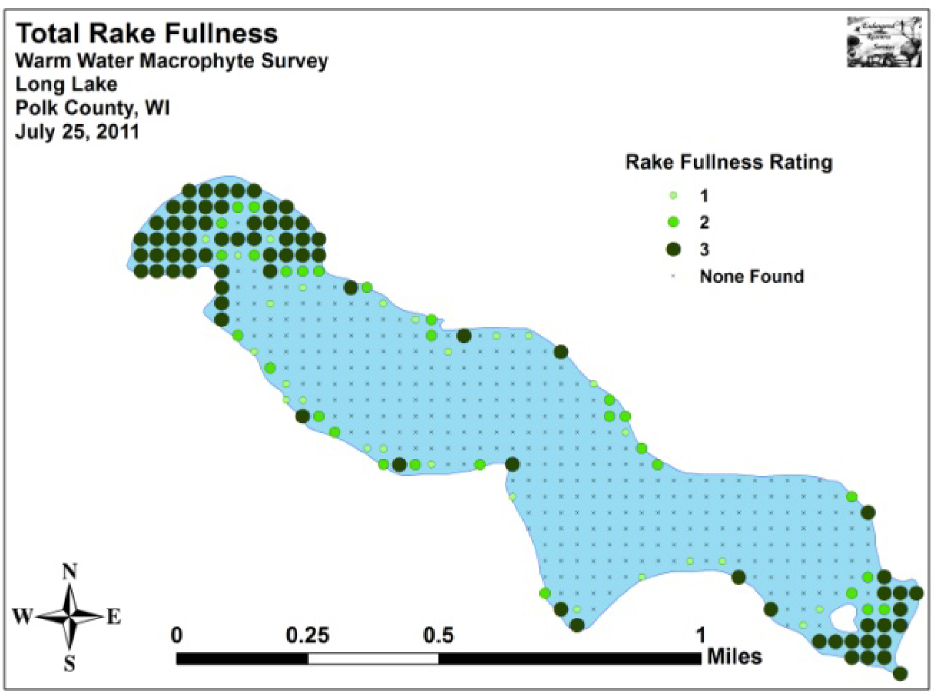

Figure 16. Total Rake Fullness July 2011

For comparison between years, early June summary statistics are presented in Table 3 below. All surveys were completed by the point intercept method in early June. Changes have occurred in floristic quality, maximum depth of plants (the littoral zone), and species richness. Some differences may occur simply because of varying expertise in plant identification between the 2007 survey and the 2010/11 surveys.

The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community response to development and human influence on the lake. It takes into account the species of aquatic plants present and their tolerance for changing water quality and habitat characteristics. A plant's tolerance is expressed as a coefficient of conservatism (C). Native plants in Wisconsin are assigned a conservatism value between 0 and 10. A plant with a high conservatism value has more specialized habitat requirements and is less tolerant of disturbance and/or water quality changes. Those with lower values are more able to adapt to disturbance or changing conditions, and can therefore be found in a wider range of habitats. The FQI is calculated using the number of species present and these plants' species conservatism values. A higher FQI generally indicates a healthier aquatic plant community.

The FQI for Long Lake was lower than the median 20.9 for similar lakes within the eco-region as measured in June 2010 and 2011. The mean conservatism is also lower than the median for lakes within the ecoregion (5.6). This result shows changes in the plant community as a result of human impacts on the lake.

Table 3. Aquatic Macrophyte Survey Comparison

	2007 (early June)	2010 (June 2,3)	2011 (June 3,7)
Total number of points sampled	332	453	441
Mean coefficient of conservatism[17]	5.0	4.7	4.9
FQI (Floristic Quality Index)	21.8	15.7	19.1
Simpson Diversity Index[18]	0.87	0.80	0.79
Maximum depth of plants (ft)	12	14	10
Species richness (including visuals and boat survey)	22	12[19]	16[20]
Average summer (July/August) secchi depth (ft.)	2.0	2.1	4.6

[17] Nichols (1999) reported an average mean C for the Northern Central Hardwood Forests Region of 5.6.
[18] The Simpson Diversity Index is a measure of the likelihood that a different species of plant will be found each time a grab sample is taken. The highest Simpson Diversity Index is 1.0.
[19] This number increased to 22 during the late July survey.
[20] This number increased to 18 during the late July survey.

The most frequent aquatic macrophyte species have remained the same in recent years although their percent frequency has changed as reported in Table 4. Major declines in the curly leaf pondweed frequency resulted from early season herbicide treatments in 2010 and 2011. The frequency of other top species fluctuates within the growing season and between years. While coontail growth increased in frequency each year between early June and late July, it has declined in frequency overall. Common waterweed growth has increased as coontail declined.

Additional notable changes occurred in Northern water milfoil reported in 17 percent of points sampled in 2007, and not found at all in July 2011. Northern water milfoil was also noted in the 1989 sensitive area report. Similarly, pondweed species found in 12.8 percent of points sampled in 2007, were not found in either 2010 or 2011. Flat stem pondweed was also noted in the 1989 sensitive area report. However, flat stem pondweed (*Potamogeton zostiformis*) is a species that is frequently confused with water star-grass (*Heteranthera dubia*) - Figure 19.[21] Slender/bushy naiad growth increased dramatically from very low frequency (2% or less) to over 20% in July 2011.

Table 4. Most Frequent Aquatic Macrophyte Species

Early June Results	Curly leaf pondweed *(Potamogeton crispus)*	Coontail *(Ceratophyllum demersum)*	Star/Forked duckweed *(Lemna trisulca)*	White waterlily *(Nymphaea tuberosaa)*	Canada/common waterweed *(Elodea canadensis)*	Water star-grass *(Heteranthera dubia)*
2007 early June Frequency[22] (%)	72.2	52.4	29.9	28.3	20.3	Not reported
2010 early June Frequency (%)[23]	0.6	38.8	70.8	6.0	54.4	14.0
2010 late July Frequency	6.49	43.7	79.2	19.9	48.5	12.1
2011 early June Frequency (%)[16]	1.25	22.9	55.0	19.7	52.9	4.2
2011 late July Frequency (%)[16]	19.5	27.7	34.8	21.7	63.3	10.5

[21] Borman. 1997. *Through the Looking Glass*, pg. 202.
[22] Frequency = percentage of sample points where species occurs.
[23] Frequency = percent of sample points with vegetation where species occurs.

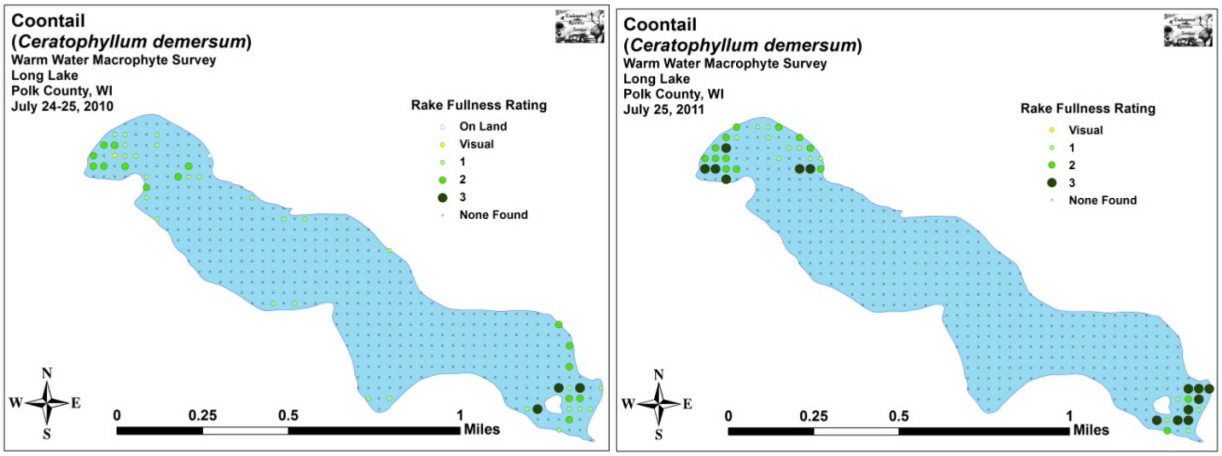

Figure 17. Coontail Rake Fullness July 2010 and 2011

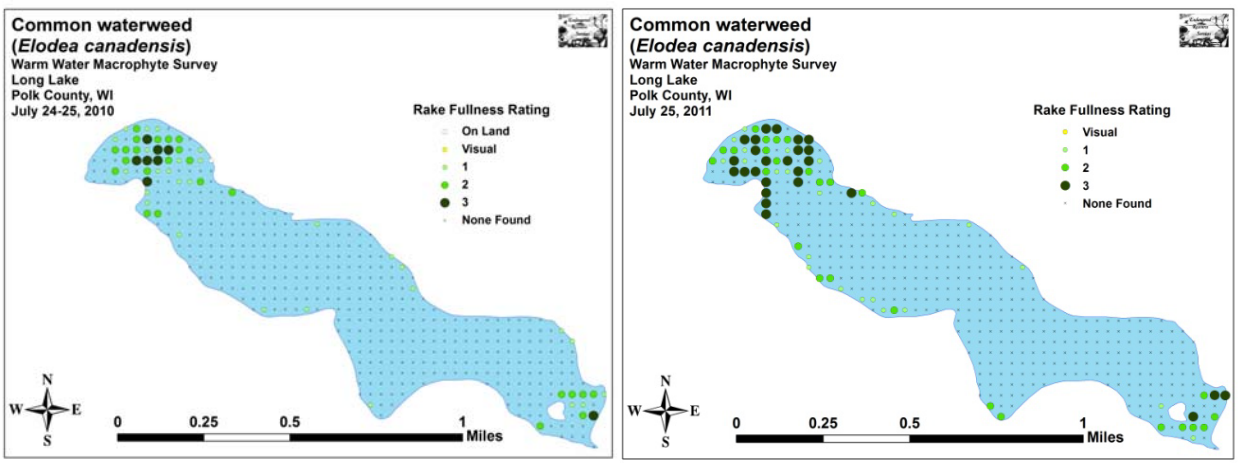

Figure 18. Common Waterweed Rake Fullness July 2010 and 2011

Table 5. Major Changes in Aquatic Plant Species

	Northern water milfoil *(Myriophyllum sibiricum)*	Slender/bushy naiad (*Najas flexilis*)	Pondweeds *(Potamogeton sp.)*
2007 early June Frequency (%)[15]	17.1	1.1	12.8
2010 early June Frequency (%)[16]	11.22	0	0
2010 late July Frequency (%)	3.9	2.16	0
2011 early June Frequency (%)[16]	0.4	2.1	0
2011 late July Frequency (%)[16]	0.0	22.5	0

Figure 19. Potamogeton zostformis (Hipp)

Heteranthera dubia (Freckman)[24]

Northern Wild Rice

Wild rice (*Zizania palustris*) is an aquatic plant with special significance to Native American Tribes. It was not found in Long Lake in any of the aquatic plant surveys (2000, 2007, 2010, 2011).

[24] Photographs from the University of Wisconsin Herbarium web site: www.botany.edu

Aquatic Invasive Species

Two species of aquatic invasive plants not native to Wisconsin lakes were observed in the aquatic plant surveys. They are curly leaf pondweed (*Potamogeton crispus*) and reed canary grass (*Phalaris arundinacea)*. More information about several common aquatic invasive species is included in Appendix B.

Curly leaf pondweed (CLP) grows extensively throughout the littoral zone of Long Lake. Curly leaf pondweed growth and recent management targeting CLP are summarized in subsequent pages.

Reed canary grass was observed in the July 2010 survey. It was also noted in the 1989 DNR sensitive area report. This plant is common and well-established adjacent to shorelines in northwest Wisconsin, and is difficult to control.

Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Polygonum sachalinense*) are a potential concern for riparian areas of Long Lake. The Polk County Land and Water Resources Department 2010 rapid response project found several riparian locations throughout Polk County.

There is a high risk that Eurasian water milfoil and other aquatic invasive species may become established in Long Lake. With Eurasian water milfoil present in many urban Twin Cities lakes, the danger of transporting plant fragments on boats and motors is very real.

Department of Natural Resource scientists have also found Eurasian water milfoil in the nearby Wisconsin counties of Burnett (Ham, Little Trade, Shallow, and Round Lakes), Barron (Beaver Dam, Horseshoe, Sand, Kidney, Shallow, Duck, and Echo Lakes), and St. Croix (Bass Lake, Goose Pond, Little Falls Lake, Lake Mallalieu, and Perch Lake). In Polk County, EWM is found in Long Trade, Horseshoe and Pike Lakes.

Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c))."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[25]

Curly leaf pondweed beds were estimated to cover 97 acres or 75 percent of the littoral zone and 35 percent of the lake in 2007. This coverage was estimated to contribute 32 percent of the annual total phosphorus budget. An early season herbicide treatment to control CLP was recommended and adopted in the plan. In 2008 and 2009, the northwest and southeast bays were treated. A more comprehensive treatment program began in 2010. Because of the high percentage of the littoral zone to be treated, extensive monitoring was required: one survey prior to treatment and surveys twice following treatment each year. As described previously, all point intercept points at appropriate depths along with additional points within the curly leaf pondweed beds were sampled.

The pre treatment monitoring included mapping beds of curly leaf pondweed growth for potential treatment. In 2010, 65.1 acres of curly leaf pondweed growth was designated for treatment. In 2011, the area had declined to 56.5 acres. A summary of treatment acreage and a map of treatment areas (Figure 20) are included below.

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[25] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species.* Prepared by Wisconsin DNR. September 2003.

Table 6. Spring CLP Treatment Area Summary

Polygon Number	2011 Acreage	2010 Acreage	Change in Acreage
1	8.89	5.51	3.38
2	8.15	10.02	-1.87
3	6.82	8.17	-1.35
4	8.11	11.92	-3.81
5	6.35	10.39	-4.04
6	5.55	7.39	-1.84
7	12.64	11.69	0.95
Total Acres	56.51	65.09	-8.58

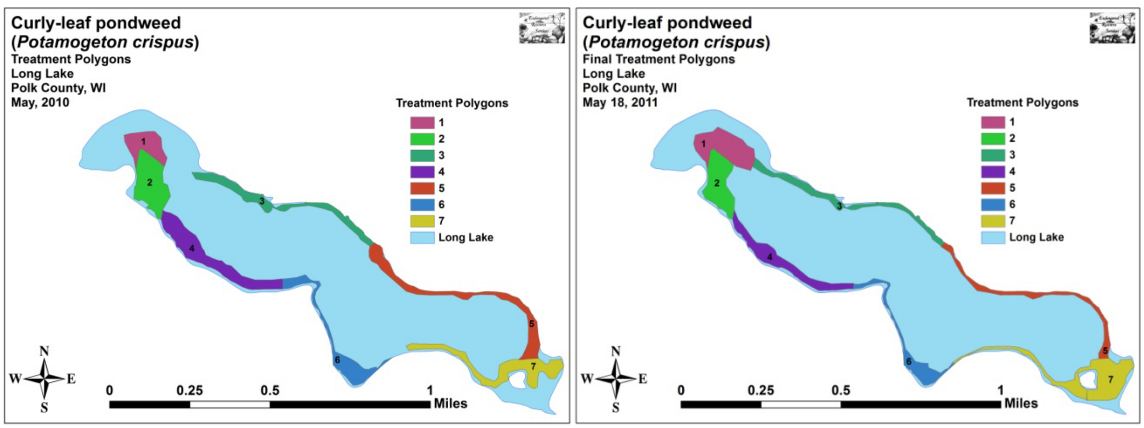

Figure 20. Curly Leaf Pondweed Treatment Areas

Aquatic Plant Management

This section reviews the potential management methods available and reports recent management activities on the lakes.

Discussion of Management Methods

Permitting Requirements

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107 – Aquatic Plant Management. **A permit is required for any aquatic chemical application in Wisconsin.** Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) due, in the case of Long Lake, to the designation of sensitive areas.

The requirements for manual and mechanical plant removal are described in *NR 109 – Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, (with the exception of wild rice) from his/her shoreline up to a 30-foot corridor. For designated sensitive areas on Long Lake, that corridor is limited to 25 feet. A map of Long Lake sensitive areas is included as Figure 11. A riparian landowner may also manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[26]

The *Department of Natural Resources Northern Region Aquatic Plant Management Strategy* (May 2007) requires documentation of impaired navigation or nuisance conditions before native plants may be managed with herbicides. Severe impairment or nuisance will generally mean that vegetation grows thickly and forms mats on the water surface.

Techniques to control the growth and distribution of aquatic plants are discussed in the following text. The application, location, timing, and combination of techniques must be considered carefully. A summary table of Management Options for Aquatic Plants from the WDNR is found in Appendix F.

Manual Removal[27]

Manual removal—hand pulling, cutting, or raking—will effectively remove plants from small areas. It is likely that plant removal will need to be repeated more than once during the growing season. The best timing for hand removal of herbaceous plant species is after flowering but

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[26] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR web site: www.dnr.state.wi.us.

[27] Information from APIS (Aquatic Plant Information System). U.S. Army Corps of Engineers. 2005. and the *Wisconsin Aquatic Plant Management Guidelines.*

before seed head production. For plants with rhizomatous (underground stem) growth, pulling roots is not generally recommended since this may stimulate new shoot production.
Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil establishment and for private landowners who wish to remove small areas of curly leaf pondweed growth. Care must be taken to ensure that all Eurasian water milfoil plant fragments are removed from the lake. Hand pulling may also be used in Long Lake for small areas of late season curly leaf pondweed growth to prevent formation and distribution of turions.

SCUBA divers may also manually remove invasive species. Manual removal with divers is recommended for shallow areas if sporadic EWM growth occurs and for late season removal of curly leaf pondweed. Care will be taken to avoid exposure to algae toxins with manual removal.

Raking is recommended to clear nuisance growth in riparian area corridors up to thirty feet wide. Permits for chemical removal in front of individual properties have not been issued since 2007.

Mechanical Control

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver-operated suction harvesting, and rotovating (tilling) are the most common forms of mechanical control available. WDNR permits under Chapter NR 109 are required for mechanical plant removal.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cuts to depths from one to six feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

The size, and consequently the harvesting capabilities, of these machines vary greatly. As they move, harvesters cut a swath of aquatic plants that is between 4 and 20 feet wide, and can be up to 10 feet deep. The on-board storage capacity of a harvester ranges from 100 to 1,000 cubic feet (by volume) or 1 to 8 tons (by weight).

In some cases, the plants are transported to shore by the harvester itself for disposal, while in other cases, a barge is used to store and transport the plants in order to increase the efficiency of the cutting process. The plants are deposited on shore, where they can be transported to a local farm to be used as compost (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. 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 decaying of this plant matter is prevented. Additionally, repeated treatments may result in thinner, more scattered growth.

Aside from the obvious effort and expense of harvesting aquatic plants, there are many environmentally-detrimental consequences to consider. The removal of aquatic species during harvesting is non-selective. Native and invasive species alike are removed from the target area. This loss of plants results in a subsequent loss of the functions they perform, which include 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.

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 curly leaf pondweed, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting is conducted too early, the plants will not be close enough to the surface, and the cutting will not do much damage to them. If too late, turions may have formed and may be spread, and there may be too much plant matter on the surface of the lake for the harvester to cut effectively. Harvesting has been used to control curly leaf pondweed with some success on nearby lakes including Big Blake Lake.[28]

If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. If these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. Harvesting contractors are not readily available in northwestern Wisconsin, so harvesting contracts are likely to be very expensive. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The dredge hoses are from 3 to 5 inches in diameter and are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver

[28] Jeremy Williamson. Personal communication. 2011. Report forthcoming.

dredging is especially effective against the pioneering establishment of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology can be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can result from diver dredging, but fragmentation is not as great a problem when infestations are small. Diver dredging operations may need to be repeated more than once to be effective. When applied to a pioneering infestation, control can be complete. However, periodic inspections of the lake should be performed to ensure that all the plants have been found and collected.

Lake substrates play an important role in the effectiveness of a diver dredging operation. Soft substrates are very easy to work in. Divers can remove the plant and root crowns with little difficulty. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment. Diver dredging will be considered as a rapid response control measure for Eurasian water milfoil if discovered in the lake, and could be used to remove late season growth of curly leaf pondweed. To ensure diver safety, algae toxins must be monitored prior to diver dredging in Long Lake.

Rotovation involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of 20 feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling contaminated sediments could possibly release toxins into the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine the potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

Biological Control[29]

Biological control is the purposeful introduction of parasites, predators, and/or pathogenic microorganisms to reduce or suppress populations of plant or animal pests. Biological control counteracts the problems that occur when a species is introduced into a new region of the world without a complex or assemblage of organisms that feed directly upon it, attack its seeds or progeny through predation or parasitism, or cause severe or debilitating diseases. With the introduction of pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

The effectiveness of biocontrol efforts varies widely (Madsen, 2000). Beetles are commonly and successfully used to control purple loosestrife populations in Wisconsin. Weevils are used as an experimental control for Eurasian water milfoil once the plant is established. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, an herbivorous fish, is

[29] Information from APIS (Aquatic Plant Information System). U.S. Army Corps of Engineers. 2005.

sometimes used to feed on pest plant populations, but grass carp introduction is not allowed in Wisconsin.

Weevils[30] have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations with weevil present. In these cases, EWM was not eliminated but its abundance was reduced enough so that it did not achieve dominance. These declines are attributed to an ample population of native milfoil weevils (*Euhrychiopsis lecontei*). Weevils feed on native milfoils but will shift preference over to EWM when it is present. Lakes where weevils can become an effective control have an abundance of native northern water milfoil and fairly extensive natural shoreline where the weevils can over winter. Any control strategy for EWM that would also harm native milfoil may hinder the ability of this natural bio-control agent. Lakes with large bluegill populations are not good candidates for weevils because bluegills feed on the weevils. The presence and efficacy of stocking weevils in EWM lakes is being evaluated in Wisconsin lakes. So far, stocking weevils has not been clearly shown to be effective.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, and plant-specific control. On the other hand there are several disadvantages to consider, including very long control times (years instead of weeks), a lack of available biological control agents for particular target species, and relatively specific environmental conditions necessary for success. Biological control is not without risks; new non-native species introduced to control a pest population may cause problems of its own.

Re-vegetation with Native Plants

Another aspect to biological control is native aquatic plant restoration. The rationale for re-vegetation is that restoring a native plant community should be the end goal of most aquatic plant management programs (Nichols 1991; Smart and Doyle 1995). However, in communities that have only recently been invaded by nonnative species, a propagule (seed) bank probably exists that will restore the community after nonnative plants are controlled (Madsen, Getsinger, and Turner, 1994). Re-vegetation following plant removal may be necessary on Long Lake because there is low native plant diversity. Replacement of declining pondweed species and northern water milfoil will be considered once curly leaf pondweed populations are controlled effectively.

A pilot project to establish submergent native aquatic plants such as northern water milfoil is recommended. However, few submergent native aquatic plant species are available commercially. Sources for water celery, sago pondweed, and coontail were found. However, coontail is already very abundant in Long Lake. It may also be possible to use nearby lakes as plant sources. Techniques for establishing these include mesh bags weighted with rocks and cages around planted aquatics.

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[30] *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use*. Wisconsin Department of Natural Resources. July 2006.

Physical Control[31]

In physical management, the environment of the plants is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, drawdown, benthic (lake bottom) barriers, and shading or light attenuation. Because each involves placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 WDNR permit would be required. Such permits are not commonly granted.

Dredging removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson 1982). Lakes that are very shallow due to sedimentation tend to have excess plant growth. Dredging can form an area of the lake too deep for plants to grow, thus creating an area for open water use (Nichols 1984). By opening more diverse habitats and creating depth gradients, dredging may also create more diversity in the plant community (Nichols 1984). Results of dredging can be very long term. However, due to the cost, environmental impacts, and the problem of disposal, dredging should not be performed for aquatic plant management alone. It is best used as a lake remediation technique. Dredging is not suggested for Long Lake as part of the aquatic plant management plan.

Drawdown, or significantly decreasing lake water levels can be used to control nuisance plant populations. With drawdown, the water body has water removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns need to be at least one month long to ensure thorough drying and effective removal of target plants (Cooke 1980a). In northern areas, a drawdown in the winter that will ensure freezing of sediments is also effective. Although drawdown may be effective for control of hydrilla for one to two years (Ludlow 1995), it is most commonly applied to Eurasian water milfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980).

Although drawdown can be inexpensive and have long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function (e.g., power generation or drinking water supply) of the water body during the drawdown period. Lastly, species respond in very different manners to drawdown and individual species responses can be inconsistent (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals. Drawdown requires a mechanism to significantly lower water levels which Long Lake does not have.

Benthic barriers or other bottom-covering approaches are another physical management technique. The basic idea is to cover the plants with a layer of a growth-inhibiting substance. Many materials have been used, including sheets or screens of organic, inorganic, and synthetic materials; sediments such as dredge sediment, sand, silt or clay; fly ash; and various combinations of the above materials (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with synthetic sheeting is that the gases evolved from plant and sediment decomposition collect underneath and lift the barrier (Gunnison and Barko 1992).
The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984).

[31] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.

Benthic barriers will typically kill the plants under them within 1 to 2 months, after which time they may be removed (Engel 1984). Sheet color is relatively unimportant; opaque (particularly black) barriers work best, but even clear plastic barriers will work effectively (Carter et al. 1994). Sites from which barriers are removed will be rapidly re-colonized (Eichler et al. 1995). Synthetic barriers, if left in place for multi-year control, will eventually become sediment-covered and will allow colonization by plants. Benthic barriers may be best suited to small, high-intensity use areas such as docks, boat launch areas, and swimming areas. However, they are too expensive to use over widespread areas, and heavily affect benthic communities by removing fish and invertebrate habitat. A WDNR permit would be required for a benthic barrier, and these barriers are not recommended.

Shading or light attenuation reduces the amount of light plants have available for growth. Shading has been achieved by fertilization to produce algae growth, application of natural or synthetic dyes, shading fabric, or covers, and establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general these techniques are only of limited applicability. Physical control is not currently proposed for management of aquatic plants in Long Lake.

Herbicide and Algaecide Treatments

Herbicides are chemicals used to kill plant tissue. Currently, no product can be labeled for aquatic use if it poses more than a one in a million chance of causing significant damage to human health, the environment, or wildlife resources. In addition, it may not show evidence of biomagnification, bioavailability, or persistence in the environment (Joyce, 1991). Thus, there are a limited number of active ingredients that are assured to be safe for aquatic use (Madsen, 2000).

An important caveat is that these products are considered safe when used according to the label. The U.S. Environmental Protection Agency (EPA)-approved label gives guidelines protecting the health of the environment, the humans using that environment, and the applicators of the herbicide. WDNR permits under Chapter NR 107 are required for herbicide application.

General descriptions of herbicide classes are included below.[32]

Contact herbicides

Contact herbicides act quickly and are generally lethal to all plant cells they contact. Because of this rapid action, or other physiological reasons, they do not move extensively within the plant and are effective only where they contact plants directly. They are generally more effective on annuals (plants that complete their life cycle in a single year). Perennial plants (plants that persist from year to year) can be defoliated by contact herbicides, but they quickly resprout from unaffected plant parts. Submersed aquatic plants that are in contact with sufficient concentrations of the herbicide in the water for long enough periods of time are affected, but regrowth occurs

[32] This discussion is taken from: *Managing Lakes and Reservoirs*. North American Lake Management Society.

from unaffected plant parts, especially plant parts that are protected beneath the sediment. Because the entire plant is not killed by contact herbicides, retreatment is necessary, sometimes two or three times per year. **Endothall, diquat,** and **copper** are contact aquatic herbicides.

Systemic herbicides
Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as soil active herbicides and those that are absorbed by leaves are referred to as foliar active herbicides. **2,4-D, dichlobenil, fluridone, and glyphosate** are systemic aquatic herbicides. When applied correctly, systemic herbicides act slowly in comparison to contact herbicides. They must move to the part of the plant where their site of action is. Systemic herbicides are generally more effective for controlling perennial and woody plants than contact herbicides. Systemic herbicides also generally have more selectivity than contact herbicides.

Broad spectrum herbicides
Broad spectrum (sometimes referred to as nonselective) herbicides are those that are used to control all or most species of vegetation. This type of herbicide is often used for total vegetation control in areas such as equipment yards and substations where bare ground is preferred. **Glyphosate** is an example of a broad spectrum aquatic herbicide. **Diquat, endothall, and fluridone** are used as broad spectrum aquatic herbicides, but can also be used selectively under certain circumstances.

Selective herbicides
Selective herbicides are those that are used to control certain plants but not others. Herbicide selectivity is based upon the relative susceptibility or response of a plant to an herbicide. Many related physical and biological factors can contribute to a plant's susceptibility to an herbicide. Physical factors that contribute to selectivity include herbicide placement, formulation, timing, and rate of application. Biological factors that affect herbicide selectivity include physiological factors, morphological factors, and stage of plant growth.

Environmental considerations
Aquatic communities consist of aquatic plants including macrophytes (large plants) and phytoplankton (free floating algae), invertebrate animals (such as insects and clams), fish, birds, and mammals (such as muskrats and otters). All of these organisms are interrelated in the community. Organisms in the community require a certain set of physical and chemical conditions to exist such as nutrient requirements, oxygen, light, and space. Aquatic weed control operations can affect one or more of the organisms in the community, and in turn affect other organisms or weed control operations. These operations can also impact water chemistry which may result in further implications for aquatic organisms.

Table 7. Herbicides Used to Manage Aquatic Plants

Brand Name(s)	Chemical	Target Plants
Cutrine Plus, $CuSO_4$, Captain, Navigate, Komeen	Copper compounds	Filamentous algae, coontail, wild celery, elodea, and pondweeds
Reward	Diquat	Coontail, duckweed, elodea, water milfoil, and pondweeds
Aquathol, Aquathol K, Aquathol Super K, Hydrothol 191	Endothall	Coontail, water milfoil, pondweeds, and wild celery as well as other submersed weeds and algae
Rodeo	Glyphosate	Cattails, grasses, bulrushes, purple loosestrife, and water lilies
Navigate, Aqua-Kleen, DMA 4 IVM, Weed-Rhap	2, 4-D	Water milfoils, water lilies, and bladderwort

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[33]

Copper

Copper is a naturally occurring element that is essential at low concentrations for plant growth. It does not break down in the environment, but it forms insoluble compounds with other elements and is bound to charged particles in the water. It rapidly disappears from water after application as an herbicide. Because it is not broken down, it can accumulate in bottom sediments after repeated or high rates of application. Accumulation rarely reaches levels that are toxic to organisms or significantly above background concentrations in the sediment.

2,4-D

2,4-D photodegrades on leaf surfaces after being applied to leaves, and is broken down by microbial degradation in water and in sediments. Complete decomposition usually takes about 3 weeks in water but can be as short as 1 week. 2,4-D breaks down into naturally occurring compounds.

A recent study in Tomahawk Lake in Bayfield County, Wisconsin illustrated a much slower breakdown time of 2,4-D than described above. Following a whole lake treatment of .5 mg/L 2,4-D, the chemical was still present 160 days after treatment. While there was successful removal of the target plant, Eurasian water milfoil, there were also significant declines in native plant biomass. A potential explanation was the low nutrient conditions in Lake Tomahawk which was described as an oligo-mesotrophic lake. (Nault 2010, Toshner 2010)

Diquat

When applied to enclosed ponds for submersed weed control, diquat is rarely found longer than 10 days after application and is often below detection levels 3 days after application. The most important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by

[33] These descriptions are taken from Hoyer/Canfield: *Aquatic Plant Management*. North American Lake Management Society. 1997.

aquatic vegetation and bound tightly to particles in the water and bottom sediments. When bound to certain types of clay particles, diquat is not biologically available. When diquat is bound to organic matter, it can be slowly degraded by microorganisms. When diquat is applied foliarly, it is degraded to some extent on the leaf surfaces by photodegradation. Because it is bound in the plant tissue, a proportion is probably degraded by microorganisms as the plant tissue decays.

Endothall
Like 2,4-D, endothall is rapidly and completely broken down into naturally occurring compounds by microorganisms. The by-products of endothall dissipation are carbon dioxide and water. Complete breakdown usually occurs in about 2 weeks in water and 1 week in bottom sediments.

Fluridone
Dissipation of fluridone from water occurs mainly by photodegradation. Metabolism by tolerant organisms and microbial breakdown also occurs, and microbial breakdown is probably the most important method of breakdown in bottom sediments. The rate of breakdown of fluridone is variable and may be related to time of application. Applications made in the fall or winter, when the sun's rays are less direct and days are shorter, result in longer half-lives. Fluridone usually disappears from pondwater after about 3 months but can remain up to 9 months. It may remain in bottom sediment between 4 months and 1 year.

Glyphosate
Glyphosate is not applied directly to water for weed control, but when it does enter the water it is bound tightly to dissolved and suspended particles and to bottom sediments and becomes inactive. Glyphosate is broken down into carbon dioxide, water, nitrogen, and phosphorus over a period of several months.

Copper Compounds
Copper-based compounds are generally used to treat filamentous algae. Common chemicals used are copper sulfate and Cutrine Plus, a chelated copper algaecide.

Herbicide Used to Manage Invasive Species

Eurasian Water Milfoil
The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian water milfoil (EWM): 2,4-D, diquat, endothall, fluridone, and triclopyr.[34] All of these herbicides with the exception of diquat are available in both granular and liquid formulations. It is possible to target invasive species by using the appropriate herbicide and timing of application. Diquat is used infrequently in Wisconsin because it is nonspecific.[35] The herbicide 2,4-D is most commonly used to treat EWM in Wisconsin. This herbicide kills dicots including native aquatic species such as northern water milfoil, coontail, water lilies, spatterdock, and watershield. A project in Bayfield County on Lake Tomahawk also found unexpected impacts on pondweeds which are monocots.[36] Early season (April to May) treatment of Eurasian water milfoil is recommended to limit the impact on native aquatic plant populations because EWM tends to grow before native aquatic plants.

Granular herbicide formulations are more expensive than liquid formulations (per active ingredient). However, granular formulations are generally thought to release the active ingredient over a longer period of time. Granular formulations, therefore, may be more suited to situations where herbicide exposure time will likely be limited, as is the case of treatment areas in small bands or blocks. In large, shallow lakes with widespread EWM, a whole lake treatment with a low rate of liquid herbicide may be most cost effective because exposure time is greater. Factors that affect exposure time are size and configuration of treatment area, water flow, and wind. Application rates for liquid and granular formulations are not interchangeable. A rate of 1 to 1.5 mg/L 2,4-D applied as a liquid is a moderate rate that will require a contact time of 36 to 48 hours. Negative impacts to native plants have occurred at whole-lake dosage rates as low as 0.5 mg/L.[37] Application rates recommended for Navigate (granular 2,4-D) are 100 pounds per acre for depths of 0 to 5 feet, 150 pounds per acre for 5 to 10 feet depths, and 200 pounds per acre for depths greater than 10 feet. Allowed and recommended application rates are found on herbicide labels.

Curly Leaf Pondweed
The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies three herbicides for control of curly leaf pondweed: diquat, endothall, and fluridone. Fluridone requires exposure of 30 to 60 days making it infeasible to target a discreet area in a lake system. The other herbicides act more rapidly. Herbicide labels provide water use restriction following treatment. Diquat (Reward) has the following use restrictions: drinking water 1-3 days, swimming and fish consumption 0 days. Endothall (Aquathol K) has the following use restrictions: drinking water 7 – 25 days, swimming 0 days, fish consumption 3 days.

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[34] Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.
[35] Frank Koshere. Wisconsin DNR. email communication. 3/03/10.
[36] Nault 2010.
[37] Nault 2010.

Studies have demonstrated that curly leaf pondweed can be controlled with Aquathol K (a formulation of endothall) in 50 to 60 degree F water, and that treatments of CLP this early in its life cycle can prevent turion formation.[38] Since curly leaf pondweed is actively growing at these low water temperatures and many native aquatic plants are still dormant, early season treatment selectively targets curly leaf pondweed. Staff from the Minnesota Department of Natural Resources and the U.S Army Engineer Research and Development Center have conducted trials of this method. These methods are accepted as standard operating procedures being approved in Wisconsin for aquatic invasive species control projects.[39]

Because the dosage is at lower rates than the dosage recommended on the label, a greater herbicide residence time is necessary. To prevent drift of herbicide and allow greater contact time, application in shallow bays is likely to be most effective. Herbicide applied to a narrow band of vegetation along the shoreline is likely to drift, rapidly decrease in concentration, and be rendered ineffective.[40] Steep drop-off, high winds, and other factors that increase herbicide dilution and contact time can decrease treatment effectiveness.[41] Early season treatment similar to that described above can be used to treat corridors for navigation purposes. Because of potential for drift, a higher concentration of endothall is generally used in navigation corridors.

Efforts are also made to treat as early in the season as possible and to absolutely not treat when temperatures reach 60 degrees F. Lake volunteers help to ensure that specified treatment conditions are followed. Because CLP is a monocot like many other aquatic plants, it is not possible to target its control later in the season when many other native plants are growing.

Long Lake Curly Leaf Pondweed Management

The 2007 Long Lake Aquatic Plant Management Plan recommended an early season Endothall treatment for curly leaf pondweed throughout the littoral zone using a low dose of 1 to 1.5 mg/L. The ultimate goal was reduce CLP coverage to less than 10 acres. Full scale treatments were delayed because of lack of sufficient grant or district funding in 2008 and 2009. However, treatments did continue in 2008 with treatment of 10 acres and in 2009 with treatment of 20 acres. The 2008 and 2009 treatments occurred in the northwest and southeast bays. Early season CLP Endothall treatments also occurred prior to the 2007 plan approval. In 2004 and 2005 there was a total of 17 acres treated along shorelines of Long Lake.

An extensive three-year treatment program began in 2010 when the LLPRD approved district funding of treatment. CLP treatment beds are delineated as any areas where significant CLP was present. Treatment acres and maps for 2010 and 2011 are shown in Table 6 and Figure 20. Sixty five acres were treated in 2010, 56.5 acres were treated in 2011, and 58 acres were treated in 2012. Much of the area along the shoreline of the lake was treated in addition to the bays. Comprehensive pre and post monitoring of aquatic vegetation began when treatment acreage increased in 2010. The target treatment using Aquathol K (a liquid form of Endothall) was 1.5

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[38] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[39] Plan comments, Frank Koshere, September 16, 2010.
[40] Personal communication, Frank Koshere. March 2005.
[41] *Draft Report Following April 2008 Aquatic Herbicide Treatments of Three Bays on Lake Minnetonka.* Skogerboe, John. US Army Engineer Research and Development Center.

ppm. In 2011 the treatment occurred on May 18 when water temperatures reached 56 degrees F. Monitoring results showed effective treatment in 2010 and 2011 with very little CLP growing following treatment in June. In 2011, however, CLP with small turions present was found in the late season survey. The maps below illustrate CLP growth at various times in 2011 (Figure 21 through Figure 23). The monitoring report is not yet available for 2012, but effective results are reported.

Potential impacts to native plants are described previously. It is difficult to ascertain causes of aquatic plant changes in Long Lake where water clarity and nutrient levels also appear to have considerable impact on aquatic plant growth.

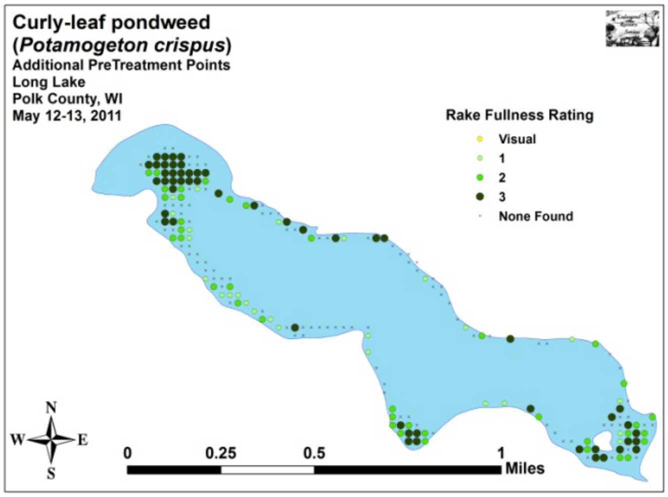

Figure 21. CLP Pretreatment Survey May 2011

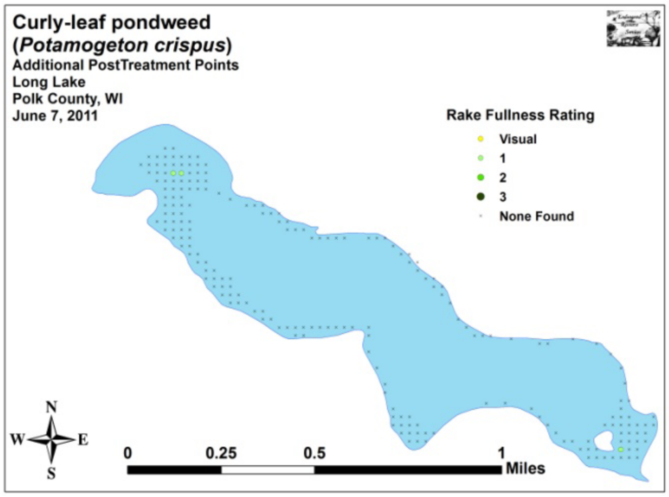

Figure 22. CLP Posttreatment Survey June 2011

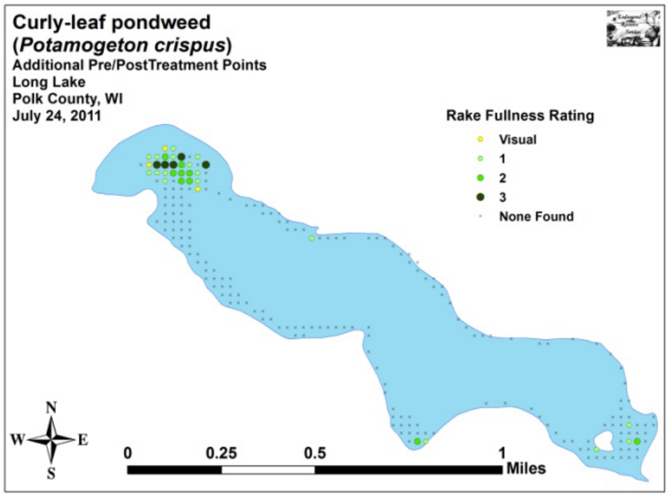

Figure 23. CLP Late Season Survey July 2011

Sediment turion monitoring will be completed beginning in 2012. Turion monitoring will occur following the post-treatment survey. Numbers of turions in the sediment will provide an indication of potential CLP growth in subsequent seasons. Turion monitoring will continue with the implementation of this plan update.

Past Aquatic Plant Management[42]

The DNR reports that Long Lake has a history as one of the most chemically treated lakes in the state for aquatic plant management.[43] Algae and aquatic plant treatments occurred in channels from 50 to 150 feet wide along much of the lake shoreline. The northwest and southeast bays tended to have narrower, 25 foot wide channels. The overall acreage and frequency of algae treatments decreased over the years as shown in Table 8. From 1959 through 1981 chemical treatment for algae control included literally tons of sodium arsenite and copper sulfate generally treating about 80 acres of the lake. From 1983 to 2002 frequent algae treatments covered from 19 to 59 acres.

Herbicides were used to treat 5-13 acres of aquatic plants from 1959-1982. DNR treatment records reviewed from 1983-2002 also show regular herbicide treatments for aquatic plants (20-30 acres, 4 to 6 times per year). A wide variety of herbicides were used over the years including endothall, 2,4-D, glyphosate, and diquat (with various trade names).

[42] Information from Wisconsin Department of Natural Resources Files. Spooner Office.
[43] Nonpoint Source Control Plan for the Balsam Branch Priority Watershed Project. DNR. 1995.

Table 8. Algae Treatment along Lake Shoreline

Years	**Chemicals Used**	**Area Generally Treated/Permitted**	**Frequency Annually (when known)**
1959 - 1981	Sodium arsenite Copper sulfate	80 acres	Up to 9 times
1982 – 1987	Copper sulfate	53 – 58 acres	6 – 14 times
1988 - 2002	Copper sulfate	19 – 22 acres	5 – 10 times (8.6 ave.)
2003 – 2007	Copper sulfate Cutrine plus	3 – 9 acres	Up to 6 times

Table 9. Aquatic Plant Treatment in Navigation Channels

Year	**Total Area Permitted**	**Frequency (when known)**
1959-1981	5-13 acres	2-6 times
1982 - 1984	29.7 acres	4 times
1985 - 1988	20.7 acres (6,000 ft. by 150 ft.)	4 -5 times
1989 - 1993	19.15 acres	3-8 times
1994-2003	22 acres	1-10 times (5.5 ave.)
2004-2007	17-20 acres	1-7 times (4.25 ave.)

Table 10. Aquatic Plant Contractors

Names	**Years (when known)**
The Lake Biologist, Inc.	1977-1978
Lindberg Aquatic Services	1979-1981, 1985-1987
Aquatic Nuisance Control	1989, 1993-1994
Lake Management, Inc.	1998-2003
Aquatic Engineering	2004-2005
Northern Aquatic Service	2005-2011

The DNR Northern Region released an Aquatic Plant Management Strategy (Appendix C) in the summer of 2007 to protect the important functions of aquatic plants in lakes. As part of this strategy, the DNR prohibited management of native aquatic plants in front of individual lake properties after 2008 unless management is designated in an approved aquatic plant management plan.[44] Because of the importance of the native plant population for habitat, protection against erosion, and as a guard against invasive species infestation, plant removal with herbicides as an option for individual property owners must be carefully reviewed before permits are issued. The DNR will not allow removal after January 1, 2009 unless the "impairment of navigation" and/or "nuisance" conditions are clearly documented.

[44] Aquatic Plant Management Strategy. DNR Northern Region. Summer 2007.

Common and Individual Corridor Management

The 2007 plan indicates that treatment of native species will be restricted to areas with impairment of navigation and nuisance conditions. It also indicates that owner request for plant control would be coordinated with the district plan. No herbicide records for late season treatment of native plants for navigation channels were found after 2007. Plant surveyor, Matt Berg, noted that it was a nearly solid bed of coontail that made July navigation difficult southeast of the island in 2011.[45]

Common navigation channels will not be pursued for this plan update. Areas of the lake which are not navigable with heavy plant growth (NW and SE bays) are also very shallow and designated sensitive areas. These sensitive areas are important brooding areas for fish. Plants hold sediments in place. The LLPRD does not want to encourage boating in shallow waters where sediments can be stirred up. Shallow water makes boating impractical.

The plan will allow for maintenance of individual corridors. This means that individuals will be able to pursue permits to maintain an opening of up to 30 feet around their docks. Aquatic herbicides can only be applied by licensed applicators, and a DNR permit is always required. Permits are issued only where navigation is severely impaired. The LLPRD will review navigation impairment to consider these permits on the lake. The LLPRD will not pay the cost of individual permits and herbicide applications. Instead, owners will cover the cost. Owners (or someone they hire) are allowed to clear up to a 30 foot opening in front of their property using hand methods. In designated sensitive areas this opening is limited to 25 feet. A map of sensitive areas is shown in Figure 11. This does not include use of any mechanical means such as boats, ATVs, or mowers. Mechanical control requires a DNR permit.

LLPRD Information and Education

The LLPRD currently distributes information through its website longlakepolk.org. A LLPRD newsletter is distributed in early to mid April each year. It is generally two pages, and additional information can be inserted into the newsletter. The Long Lake Association sends out a newsletter later in the summer, and has been willing to include information from the LLPRD.

Clean Boats Clean Waters

Clean Boats, Clean Waters (CBCW) programs inspect boats for invasive species, educate boaters on invasive species and the local and state Aquatic Invasive Species (AIS) rules, and gather data. There is currently no CBCW on Long Lake. Nearby lakes train students or volunteers to staff landings and educate boaters. These programs also include volunteer in-lake monitoring for invasive species. The Polk County Land and Water Resources Department has assisted these programs by providing training and aquatic plant identification.

Do Not Transport Ordinance

Polk County recently passed a Do Not Transport Ordinance and have placed signs at public landings to remind lake users about its requirements. It is illegal to transport aquatic vegetation on boats and equipment in Polk County.

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[45] Berg. 2011. Pg. 16.

Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for Long Lake. It also presents a strategy of actions that will be used to reach aquatic plant management plan goals.

Goals are broad statements of direction.

Objectives are measurable steps toward the goal.

Actions are the activities to accomplish objectives.

The **Implementation Plan** outlines a timeline, resources needed, partners, and funding sources for each action item.

Education of lake residents and anglers who visit the lake is important to each of the Aquatic Plant Management Plan goals. An education and information plan is also included in this section.

Plan Goals

1) Improve water quality and clarity.
2) Protect and restore healthy rooted native aquatic plant communities.
3) Balance recreation and riparian needs with protection of native plants and the fishery.
4) Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.
5) Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.

Responsible Parties for APM Implementation and Monitoring

Long Lake Protection and Rehabilitation Board (LLPRD) – elected representatives responsible for oversight of lake management district. Some actions such as hiring a contractor or consultant require a vote of the board.
APM Lead – makes day-to-day APM decisions and directs contractors in herbicide treatments and related monitoring. The director may have interns, volunteers and consultants to assist in these activities. The Board APM Lead will be designated at the fall 2012 annual meeting.
AIS Lead – leads and coordinates volunteer AIS education activities including Clean Boats, Clean Waters monitoring and education at the boat landings and lake monitoring. The AIS Lead is currently Keith Campbell.
Herbicide Contractor – the herbicide applicator hired by the LLPRD Board to complete herbicide treatment as permitted by the Wisconsin Department of Natural Resources. The herbicide contractor is currently Northern Aquatic Services.
APM Monitor– a consultant hired to complete monitoring under the direction of the APM Lead and the LLPRD Board. The APM monitor is currently Endangered Resource Services.
DNR – APM staff will review aquatic plant management permit applications and enforce permit conditions.
Polk County LWRD – Staff from the Polk County Land and Water Resources Department assist with education and plant identification.

Goal 1. Improve water quality and clarity.

Objectives

- Reduce phosphorus loading from curly leaf pondweed by reducing beds to less than 20 acres and preventing CLP spread.
- Increase native aquatic plant rooting depth.
- Assess curly leaf pondweed impacts to water quality.

Discussion

CLP beds identified for treatment went from 65 acres in 2010 to 56.5 acres in 2011 and to 58 acres in 2012. CLP treatment beds are delineated as any areas where significant CLP is present. While acreage increased a bit in 2012, the density of CLP growth decreased – except in areas that re-germinated in late summer where CLP was very dense. Turion sediment monitoring will be added in 2012 to give an indication of future CLP growth potential.

Because declines in CLP area are slow, the advisory committee decided to increase the ultimate goal for CLP from 10 to 20 acres and to continue intensive treatment for 2 more years – a total of 5 years. At this point (following evaluation of the 2014 treatment) CLP targets and treatment methods will be re-evaluated, and new targets for CLP acreage in beds and the density of these beds will be developed. It was acknowledged that some level of CLP will remain in the lake, and long-term costs and effectiveness need to be considered. Effectiveness will be judged, in part, by a consideration of the impacts to water quality from release of phosphorus with CLP dieback.

Ongoing sediment turion monitoring is included in the plan. The plan will also allow for consideration of volunteer or professional hand-pulling of late season CLP. It will be important to be aware of potential algae toxins with exposure to lake water late in the summer.

Actions

1. Continue intensive early season curly leaf pondweed treatment using a low-dose Endothall treatment through 2014.
    - Apply for APM permit (APM lead with assistance from Herbicide Contractor and APM Monitor)
    - Identify treatment areas with pre-monitoring in April or May. Intensive CLP treatment beds are delineated as any areas where significant CLP is present. (APM Monitor, Herbicide Contractor and APM lead)
    - Complete early season herbicide treatment

2. Complete extensive CLP pre and post monitoring as required by the Department of Natural Resources.

3. Conduct annual monitoring of sediment CLP turions in early to mid summer.

4. Remove late season (June – August) curly leaf pondweed growth by encouraging hand-pulling by residents or hiring SCUBA divers.

5. Assess phosphorus loading from the die-back of curly leaf pondweed as part of a comprehensive water quality study.

6. Evaluate curly leaf pondweed treatment results late in 2014, and develop new targets for curly leaf pondweed beds and density of beds. Consider cost and effectiveness of the treatment, results of turion monitoring, water quality impacts, and impacts to native plants when updating curly leaf pondweed objectives.

Goal 2. Protect and restore healthy rooted native aquatic plant communities.

Objectives

- Restore the lake's ecosystem by promoting the replacement of curly leaf pondweed with native aquatic plants.
- Maintain native aquatic plant functions including stabilizing sediments, reducing erosion, using nutrients, and providing habitat.

Discussion

Native plants play a critical role in the lake ecosystem, and removing native plants can lead to adverse effects on the lake. Rooted aquatic plants in the lake stabilize bottom sediments and prevent re-suspension of nutrients. This is especially important in mucky, shallow areas – characteristic of much of the area where plants grow in Long Lake. Emergent plants with stems reaching above the water level protect against shoreline erosion. All types of aquatic plants provide habitat for fish and other aquatic creatures. Healthy native plant populations prevent colonization by invasive plants such as Eurasian water milfoil. Erosion and runoff from waterfront property may alter sediment characteristics and encourage spread of invasive plants. Boating disturbance near the shoreline can remove aquatic plants and the valuable functions they provide.

Actions

1. Assess impacts of early season curly leaf pondweed herbicide treatments to native plants through extensive pre and post monitoring (covered in Goal 1).

2. Consider completing a small scale pilot project to re-introduce native plants to the lake. Wild celery and northern water milfoil are possibilities. There may be potential for Ducks Unlimited and/or North American Waterfowl Conservation Act (NAWCA) funding for such a project.

3. Educate lake residents about the values of native aquatic plants. (More information on page 51).

Goal 3. Balance recreation and riparian needs with protection of native plants and the fishery.

Objectives

- Avoid disturbing shallow water spawning beds with chemical treatments.
- Avoid plant removal in areas of shallow water.
- Minimize curly leaf pondweed growth to allow for navigation (actions covered in Goal 1).
- Allow owners to maintain individual access corridors to their properties by manual or chemical means as permitted by state regulations.

Actions

1. Support individual corridor management through LLPRD verification of nuisance plant conditions and navigation impairment.

Discussion- Protecting Fish Habitat

Common navigation channels will not be pursued. Areas of the lake which are not navigable with heavy plant growth (NW and SE bays) are also very shallow and are designated sensitive areas. These sensitive areas are important brooding areas for fish. Plants hold sediments in place. The LLPRD does not want to encourage boating in shallow waters where sediments can be stirred up. Shallow water makes boating impractical.

Discussion: Individual Access Corridors

The only time a permit is not required to control aquatic plants is when a waterfront property owner manually removes (i.e., hand-pulls or hand rakes), or gives permission to someone to manually remove, plants (except wild rice) from his/her shoreline in an area that is 30 feet or less in width along the shore and is not within a designated sensitive area. In sensitive areas the opening is limited to 25 feet. The non-native invasive plants (Eurasian water milfoil, curly leaf pondweed, and purple loosestrife) may be manually removed beyond 30 feet without a permit, as long as native plants are not harmed. Wild rice removal always requires a permit.

Individual Access Corridors are the openings from a waterfront property owner's shoreline out into the lake. These corridors may be a maximum of thirty feet wide and must remain in the same location from year to year. Herbicide treatment or harvesting may be permitted for individual corridors in front of waterfront property to control invasive or native plants.

Invasive Plant Control for Individual Corridors

Currently the only invasive aquatic plant prevalent in Long Lake is curly leaf pondweed. Curly leaf pondweed grows early in the summer, then dies back by early July. Nuisance conditions must be verified for herbicide treatment. All curly leaf pondweed beds in the lake are currently mapped and treated. As long as treatment continues, there is no need for individual corridor treatment of invasive plants. If lake-wide treatment is discontined, the most recent curly leaf pondweed bed map will verify nuisance conditions for the following year's treatment. Once treatments are initiated, they may continue for three years if needed. An aquatic plant management permit is required each year.

Areas on curly leaf pondweed bed map

- Early season endothall treatment may be permitted for 3 years
- Nuisance conditions must be verified beyond this treatment period

Areas outside of curly leaf pondweed bed map

- Nuisance conditions created by curly leaf pondweed must be verified the year before treatment
- Early season endothall treatment may be permitted for a 3 year period following this verification

The LLPRD will inform waterfront property owners of the process and limits of individual corridor access management options.

Procedure for Individual Corridor Permitting and Monitoring

Document nuisance conditions (landowner/ herbicide contractor provide in permit application in February/March)

- Indicate when plants cause problems and how long problems persist.
- Include dated photos of nuisance conditions from previous season (or location relative to curly leaf pondweed bed map).
- List depth at end of dock.
- Provide examples of specific activities that are limited because of presence of nuisance aquatic plants.
- Describe practical alternatives to herbicide use or harvesting that were considered. These might include:
  - Hand removal/hand raking of aquatic plants
  - Extending dock to greater depth
  - Altering the route to and from the dock
  - Use of another type of watercraft or motor, i.e., is the type of watercraft used common to other sites with similar conditions on this lake?
- Herbicide use for curly leaf pondweed may occur along the entire length of a waterfront property owner's shoreline. Herbicide use in areas with wild rice will not be permitted. Wild rice is not known to be present in Long Lake.
- Aquatic Herbicide Contractor to provide this information in permit application based on information from the landowner.

Verify/refute nuisance conditions and/or navigation impairment

- Landowners will document conditions with photographs and submit request for review by the APM Lead or designee.
- Landowner requests LLPRD APM Lead review of their property prior to submitting a permit application to DNR.
- The APM Lead or designee visits site, reviews documentation and provides a written opinion of navigation impairment i.e., is herbicide treatment potentially warranted?
- Landowner/applicator applies for permit to WDNR including photographic documentation, identification of plants causing navigation problems, and LLPRD evaluation.
- For curly leaf pondweed treatment, verification must occur the year before treatment in May or June. Once CLP nuisance is verified and a permit is approved, additional verification is not needed for three subsequent years (although permit applications must be completed each year). Treatment for CLP must occur with water temperatures from 50 - 58 degrees F.
- WDNR will contact herbicide contractor and owner with a notice to proceed with treatment or denial of permit application.

Goal 4. Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.

Objectives

- Provide invasive species education and monitoring at the boat landings.
- 100% enforcement of Polk County's Do Not Transport Ordinance.
- Raise awareness of lake residents and visiting anglers.

Actions

1. Use the Clean Boats, Clean Waters program process and materials at the boat landings with volunteers or paid staff. Investigate a partnership with the Village of Centuria.

2. Work with the Polk County Sheriff's Department to encourage enforcement of the Do Not Transport Ordinance.

3. Educate lake residents and visiting anglers by conveying the messages with the methods described below.

   <u>Audience</u>
   Lake Residents (30% fulltime, 57% weekends, vacations, holidays)
   Anglers (most frequent visitors to the lake)

   <u>Messages</u>
   PAY ATTENTION TO INVASIVE PLANT CONCERNS
   - Know how to identify Eurasian water milfoil (EWM), curly leaf pondweed, and Zebra Mussels (ZM) and others
   - Impacts of invasive plants and animals
   - Proximity to lakes with EWM and ZM
   - Clean boats and trailers and drain live wells to prevent invasive plant and animal spread
   - It is illegal to transport aquatic plants on boats, trailers and equipment in WI

   <u>Methods – use more than one method to deliver messages</u>
   Aquatic Plant Management Plan summary (May 2012)
   EWM, ZM other invasive photos for identification
   LLPRD and Long Lake Association newsletters
   Handouts/brochures
   Presentations (annual meeting)
   Website – upgrade with lake volunteer or contracted service

Goal 5. Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.

Objectives

- Monitor to detect newly introduced invasive species.
- The LLPRD is ready to respond to invasive threats which are discovered.

Actions

Follow the Rapid Response Plan in Appendix E.

- Train and support lake resident volunteers to identify Eurasian water milfoil and other invasive plants.
- Continue consultant monitoring for invasive species at least on an annual basis.
- Establish a non-lapsing contingency fund of at least $5,000 for removal of invasive species.
- Designate board and resident responsibilities for the Rapid Response Plan. (should be identified within this plan)

Additional educational plans

Messages targeting lake residents.

- Explain what, where, why, when, how much of APM plan including CLP treatment results to date
- What are the potential impacts of the CLP herbicide treatment
- Importance of aquatic plants to Long Lake – stabilize sediments, reduce erosion, take up nutrients, provide fish and wildlife habitat
- Distinguish between rooted and free-floating native aquatic plants
- Explain shallow lakes – no plants and algae dominated vs. native plants with clear water
- Shoreline restoration can improve water quality and habitat

Methods

APM plan summary
EWM, ZM other invasive photos for ID
Newsletters
Handouts/brochures
Presentation (annual meeting)
Treatment result maps
Website – upgrade with lake volunteer or contracted service

Implementation Plan for LLPRD (2013-2014)[46]

Goal 1. Improve water quality and clarity.				
Actions[47]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties[48]**
Permit application	February	$1,260		LLPRD APM Lead WDNR
Temperature monitoring	May		10	Lake Volunteer
CLP monitoring (3 Point Intercept surveys)	May, June, July	$5,000		Endangered Resource Services, LLC
CLP turion monitoring	June	$750		Endangered Resource Services, LLC
CLP herbicide treatment	Late May	$40,000		Northern Aquatic Services
SCUBA removal of late season CLP	June-July (2014?)	?		LLPRD
Water quality study – evaluate phosphorus contribution of CLP	2012-2013	$4,300 match (LPL Grant)	120/yr	LLPRD Polk County LWRD
Re-evaluate CLP treatment	October 2014		40	LLPRD
SUBTOTAL GOAL 1		$51,310	170	

[46] Costs are annual costs estimated for initial implementation. These costs will be reviewed each year during the LLPRD budgeting process.
[47] See previous pages for action item detail.
[48]LLPRD = Long Lake Protection and Rehabilitation District
LWRD = Land and Water Resources Department
WDNR = Wisconsin Department of Natural Resources

Goal 2. Protect and restore healthy native aquatic plant communities.				
Actions[49]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**[50]
Small-scale native aquatic planting	2014	$3,000	80	LLPRD (AIS or NAWCA grant)
SUBTOTAL GOAL 2		$3,000	80	

Goal 3. Balance recreation and riparian needs with protection of native plants and the fishery.				
Actions[51]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**
Review nuisance and navigation conditions for individual corridors	June – August		40	LLPRD
SUBTOTAL GOAL 3			40	

49 See previous pages for action item detail.
50 LLPRD = Long Lake Protection and Rehabilitation District
LWRD = Land and Water Resources Department
WDNR = Wisconsin Department of Natural Resources
51 See previous pages for action item detail.

Goal 4. Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species. AND ADDITIONAL EDUCATION ACTIVITIES				
Actions[52]	**Timeline**	**$ Estimate (annually)**	**Vol. Hours**	**Responsible Parties**[53]
Clean Boats, Clean Waters	May – Sept.	$2,500 (w/paid staff)	40	LLPRD Polk County LWRD (training) Village of Centuria
Sheriff's Department Liaison	Ongoing	$0	20	LLPRD Polk County Sheriff
Handouts, brochures and invasive plant photos		$400		LLPRD Polk County LWRD
LLPRD Newsletter		$600		LLPRD
Annual meeting presentations	May and August		10	LLPRD
Website (upgrades)	Ongoing	$300		LLPRD
SUBTOTAL GOAL 5		$3,800	70	

[52] See previous pages for action item detail.
[53]LLPRD = Long Lake Protection and Rehabilitation District
LWRD = Land and Water Resources Department
WDNR = Wisconsin Department of Natural Resources

Goal 5. Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.

Actions[54]	Timeline	$ Estimate	Vol. Hours	Responsible Parties[55]
Lake resident volunteer monitoring and training	Ongoing	$500	40	LLPRD Polk County LWRD
AIS Contingency Fund	2013	$5,000	0	LLPRD
Subtotal GOAL 6		$5,500	40	

[54] See previous pages for action item detail.
[55] LLPRD = Long Lake Protection and Rehabilitation District
LWRD = Land and Water Resources Department
WDNR = Wisconsin Department of Natural Resources

Monitoring and Assessment

Aquatic Plant Surveys

Aquatic plant (macrophyte) surveys are the primary means for tracking achievement toward plan goals. The Long Lake Aquatic Plant Management Plan has used aquatic plant surveys to assess the impact of CLP treatment on native plants.

Action. Because of the extensive curly leaf pondweed treatments, whole lake surveys are required three times per year.

The whole lake surveys will be conducted in accordance with the guidelines established by the Wisconsin DNR. Any new species sampled will be saved, pressed, and mounted for voucher specimens.

Aquatic Invasive Species Grants

Department of Natural Resources Aquatic Invasive Species (AIS) grants are available to assist in funding some of the action items in the implementation plan. Maintaining navigation channels to alleviate nuisance conditions are an exception. Grants provide up to 75 percent funding. Applications are accepted twice each year with postmark deadlines of February 1 and August 1. With completion and approval of the aquatic plant management plan, funds will be available not only for education and planning, but also for control of aquatic invasive species.

The LLPRD received an AIS grant for monitoring and education work which began April 1, 2012. The grant provides $9,176 for the monitoring work required for the curly leaf pondweed herbicide treatment and the public involvement required for this aquatic plant management plan update. Volunteer inspections, education, and monitoring at the public boat landing provide much of the match for the project.

Appendix A. Long Lake P&R District Residential Survey

Response rate: 103/169; 61%

1. Which of the following best describes when you use your Long Lake home/property? (Please consider the property you use most if you own more than one.) **102, 99%**
   Full-time residency: 26, 25%
   Seasonal – continued occupancy for months at a time: 14, 14%
   During weekends, vacations, and/or holidays: 62, 61%
   Rental to others: 0, 0%
   Land Only: 0, 0%

2. How long have you owned property on Long Lake? (Check one) **102, 99%**
   0 to 2 years: 4, 4%
   2+ to 5 years: 10, 10%
   5+ to 10 years: 12, 12%
   10+ to 20 years: 25, 25%
   More than 20 years: 51, 50%

3. Please indicate your degree of participation in the following activities on Long Lake? (Circle appropriate number for degree of participation for each item.) **101, 98%**

ACTIVITY	NONE	A LITTLE	SOME	QUITE A BIT	A GREAT DEAL	Total points, average
Power Boating	0	1	2	3	4	164, **1.8**
Canoeing	0	1	2	3	4	39, **0.4**
Hiking	0	1	2	3	4	85, **1.0**
Ice Fishing	0	1	2	3	4	72, **0.8**
Reading	0	1	2	3	4	210, **2.4**
Socializing	0	1	2	3	4	237, **2.7**
Water Skiing	0	1	2	3	4	96, **1.1**
Wake Boarding	0	1	2	3	4	54, **0.6**
Jet Skiing	0	1	2	3	4	52, **0.6**
Swimming	0	1	2	3	4	202, **2.1**
Scuba Diving	0	1	2	3	4	6, **0.1**
Snowmobiling	0	1	2	3	4	55, **0.6**
Fishing	0	1	2	3	4	221, **2.3**
Hunting	0	1	2	3	4	20, **0.2**
Sail boating	0	1	2	3	4	9, **0.1**
Pontoon Boating	0	1	2	3	4	228. **2.4**
Snow shoeing	0	1	2	3	4	11, **0.1**
Winter skiing	0	1	2	3	4	25, **0.3**
Kayaking	0	1	2	3	4	26, **0.3**
Hunting	0	1	2	3	4	16, **0.2**
Ice skating	0	1	2	3	4	23, **0.3**
Nature/Bird Watching	0	1	2	3	4	199, **2.1**

Running	0	1	2	3	4	51, **0.6**
Tubing	0	1	2	3	4	142, **1.6**
Other: Walking	0	1	2	3	4	15, 3.8
Other: Relaxing						3, 3
Other: Yard Work						11, 3.7
Other: Campfires						5, 2.5
Other: Fireworks						2, 2
Other: Yard games						3, 3
Other: Paddleboats						5, 2.5
Other: Gardening						4, 4
Other: Computers						4, 4

4. Please indicate how much each of the following **negatively** impacts your use of the lake. If you believe the concern is not present on the lake, circle "0".
(Circle appropriate level of negative impact for each item) **101, 98%**

Level of Negative Impact

	Not present	No impact	Unsure	A little	Some	Quite a bit	A great deal	
Algae growth	0	1	2	3	4	5	6	461, **4.9**
Algae Toxins	0	1	2	3	4	5	6	404, **4.5**
Not enough fish	0	1	2	3	4	5	6	241, **2.7**
Lake level too high	0	1	2	3	4	5	6	99, **1.1**
Lake level too low	0	1	2	3	4	5	6	347, **3.7**
Native aquatic plant* growth	0	1	2	3	4	5	6	324, **3.4**
Invasive aquatic plant** growth	0	1	2	3	4	5	6	441, **4.7**
Loss of wildlife habitat	0	1	2	3	4	5	6	243, **2.7**
Too small fish	0	1	2	3	4	5	6	239, **2.7**
Loss of natural scenery	0	1	2	3	4	5	6	225, **2.5**
Too many fishing tournaments	0	1	2	3	4	5	6	173, **1.9**
Fewer Loons	0	1	2	3	4	5	6	256, **2.8**
Water Clarity	0	1	2	3	4	5	6	457, **4.8**
Muck	0	1	2	3	4	5	6	364, **3.9**
Garbage in Lake	0	1	2	3	4	5	6	240, **2.8**
Too weedy to boat	0	1	2	3	4	5	6	360, **3.8**
Too weedy to swim	0	1	2	3	4	5	6	420, **4.3**
Other: Too many snails	0	1	2	3	4	5	6	12, 6.0
Other: Taking water from the lake	0	1	2	3	4	5	6	6, 3.0

***Native aquatic plants –** plants which grow submerged in water, floating on the water, or in shallow water. Native aquatic plants are naturally present in the lake. They provide food and cover for fish and wildlife and stabilize lake sediments and shorelines.

**** Invasive aquatic plants** - Invasive plants are "out of place." They are usually introduced by human action to a location where they did not previously occur naturally and then dominate their new location. Eurasian water milfoil and curly-leaf pondweed are examples of aquatic invasive species.

QUESTIONS RELATED TO AQUATIC PLANT MANAGEMENT FOLLOW

Note that aquatic plants are rooted in the lake bottom or floating on the lake surface. Particles of algae floating in the lake are not considered aquatic plants.

5. How would you describe the overall amount of aquatic plants in the lake? (Check one) **99, 96%**
   Not sure: 21, 21%
   Too few: 4, 4%
   Right amount: 16, 16%
   Too many: 59, 60%

6. Which best describes the amount of rooted aquatic plants near the shore (in the water)? **85, 98%** (Check one) **101, 98%**
   Not sure: 19, 19%
   Too few: 4, 4%
   Right amount: 18, 18%
   Too many: 60, 59%

7. At what time period during the year do you consider the aquatic plant growth in Long Lake to be excessive? (Check all that apply) **100, 97%**
   May – June: 13, 13%
   July – August: 74, 74%
   August – September: 50, 50%
   September – October: 13, 13%
   I don't know: 5, 5%
   Aquatic plant growth is always excessive: 8, 8%
   _Aquatic plant growth is never excessive: 1, 0%

8. During the past few years how much, if at all, have aquatic plants limited participation for you or your family in the following activities? (Circle the appropriate response for each item) **101, 98%**

	Do not participate	Not at all	A little	Somewhat	Quite a bit	A great deal	
Swimming	0	1	2	3	4	5	333, **3.3**
Fishing	0	1	2	3	4	5	211, 2.2
Motorized boating	0	1	2	3	4	5	246, 2.5
Non-motorized boating	0	1	2	3	4	5	102, 1.1
Enjoying the view	0	1	2	3	4	5	219, 2.3
Water skiing or tubing	0	1	2	3	4	5	182, 1.9
Jet skiing	0	1	2	3	4	5	79, 0.8

9. Curly leaf pondweed is an aquatic invasive plant that is found in many lakes in Wisconsin. Do you believe that you can identify this plant? (Check one) **102, 99%**
   Definitely no: 12, 12%
   Probably no: 18, 18%
   Not sure: 11, 11%
   Probably yes: 43, 42%
   Definitely yes: 18, 18%

10. How much of a problem, if at all, do you consider curly leaf pondweed growth in Long Lake? (Check one) **101, 98%**
   Large problem: 41, **41%**
   Moderate problem: 33, **33%**
   Unsure: 22, 22%
   Small problem: 4, 4%
   No problem: 0, 0%

11. Curly leaf pondweed has been found in Long Lake. The potential impacts of this invasive plant include overtaking native plants, impeding navigation in early summer, and increasing phosphorus levels in the water when the plant dies in June or July. The Lake District has previously used the herbicide Aquathol K to control the growth of curly leaf pondweed early in the season to avoid impacts to native plants. Should the Lake District continue control efforts for curly leaf pondweed? (Check one) **103, 100%**
   Definitely no: 1, 1%
   Probably no: 0, 0%
   Not sure: 9, 9%
   Probably yes: 13, **13%**
   Definitely yes: 80, **78%**
   No Response: 0, 0%

12. Below is a list of management activities that could be used to manage aquatic plants on Long Lake. Please tell us if you think each activity should be pursued by the Lake District.

(Circle a response for each item.) **101, 98%**

	Definitely no	Probably no	Unsure	Probably yes	Definitely yes	
Spray native aquatic plants	0	1	2	3	4	211, **2.3**
Harvest native aquatic plants	0	1	2	3	4	165, **1.8**
Spray invasive aquatic plants	0	1	2	3	4	359, **3.6**
Harvest invasive aquatic plants	0	1	2	3	4	213, **2.2**
Educate residents about lake issues	0	1	2	3	4	337, **3.6**
Prevent invasive species introduction	0	1	2	3	4	350, **3.7**
Protect sensitive habitat areas	0	1	2	3	4	315, **3.4**
Expand "slow no-wake" area	0	1	2	3	4	188, **2.0**
Encourage individuals to hand pull/rake invasive plants	0	1	2	3	4	271, **2.8**
Allow individuals to hire contractors to spray up to 30 ft. around docks	0	1	2	3	4	227, **2.4**
No management	0	1	2	3	4	43, **0.5**
Other: Allow man made limited sandy beaches	0	1	2	3	4	8, 4.0
Other: Increase lake water level	0	1	2	3	4	4, 4.0

13. Which of the following methods(s) have been used to control aquatic plants in the lake in front of your lakeshore property within the past 5 years? Please consider the property you use most if you own more than one**.** (Check all that apply) **95, 92%**
  - Removal by hand-pulling or raking myself: 72, 76%
  - Hired someone to hand pull or rake: 1, 1%
  - Applied chemical myself: 4, 4%
  - Physical removal aided by a boat, ATV, lawn-mower, or similar machine: 13, 14%
  - I don't know: 5, 5%
  - None: 14, 15%
  - Other: District has sprayed for CLP on our shoreline and dock area: 3, 3%

QUESTIONS RELATED TO THE WATERFRONT RUNOFF PROGRAM FOLLOW

14. Below is a list of landscaping practices designed to protect and improve lake water quality. Please tell us which practices, if any, you use at your Long Lake property or whether or not you are familiar with the practice. (Check one for each line) **95, 92%**

	Already use	Familiar but not used	Not familiar
Rain gardens	3, 3%	43, 45%	34, 36%
Rain barrels	6, 6%	63, 66%	15, 16%
Shoreline buffer zones	44, 46%	29, 31%	12, 13%
Native plants anywhere on lake property	42, 44%	25, 26%	14, 15%
Infiltration pits or trenches	5, 5%	28, 29%	48, 51%
Water diversions	12, 13%	37, 39%	30, 32%
Not fertilizing or using zero phosphorus fertilizer	85, 89%	6, 6%	4, 4%
Other: Replaced blacktop driveway with crushed rock			

15. In the following list, please indicate which water quality landscaping practice, if any, you would consider putting in place on your Long Lake property. Please see the definitions below. If you already use the practice, please check . (Check all that are of interest) **85, 83%**
  - Rain gardens: 23, 27%
  - Rain barrels: 30, 35%
  - Shoreline buffer zone: 40, 47%
  - Native plants anywhere on lake property: 39, 46%
  - Water diversions: 30, 35%
  - Not fertilizing or using zero phosphorus fertilizer: 62, 73%

Other, please list
Would consider anything that helps the lake
Impact of sewer system for lake, addressing septic system on the lake (2 responses)

Rain gardens – Rain gardens are depressions in the landscape planted with flowers and grasses. A rain garden is positioned to capture runoff from rain events and absorb the water over several hours to a few days.
Rain barrels – Rain barrels capture water from a rain gutter downspout for watering gardens and potted plants.
Shoreline buffer zone – Areas of planted or naturally-growing native vegetation beginning at the water's edge and extending upland. Shoreline buffer zone minimum depths generally extend 35 feet back from the high water mark.
Water diversion – A practice that directs water flow to a place where it can soak into the ground rather than flow to the lake. Arranging gutters and downspouts to direct water so that it doesn't flow to the lake is an example. Berms (low ridges), drain tile, and channels are other means to divert water.

16. Would you take advantage of free information/visits offered by the Lake District to lake residents to address waterfront property runoff? **87, 84%**
    Yes: 65, 75%
    No: 22, 25%

17. The Long Lake District sends out information regarding its management activities and living on the lake. How do you prefer to receive information from the Long Lake District?
(Check all that apply) **96, 93%**
    I do not wish to receive information from the Lake District: 2, 2%
    Dockside Newsletter: 24, 25%
    Annual meeting: 40, 42%
    Special mailings: 52, 54%
    E-mail notices: 58, 60%
    Other, please specify: Kiosk at boat landing

Name (Optional): ____

Comments/Concerns:

- *58 years ago in 1954, Gordon and Agnes Paulsen, Marlys' parents, purchased 3 lakeshore lots (#25, #26, and #27) for $450 each. Marlys and I (married in 1958) and family (5 children) would visit them in their summer cabin and later (1974) visit her parents in their retirement home they built on lot 27--the begin in on lat 26 and was purchased by Marlys' brother and wife Wayne and Liz Paulsen. I can remember Gordon with a bar of soap bathing in the lake; the lake water was clear and weed free for swimming during those early years. We purchased the lake home in 1994 from Agnes when she moved into an apartment in Balsam Lake when she no longer was able to drive. The special assessment dollars spent in those earlier years to remove weeds and spraying hasn't seemed to improve lake clarity at all. Now that Matt Berg with his expertise and Northern Aquatic Services doing a better job eradicating more CLP weeds the last to years, I am hopeful we are finally getting our moneys worth after all these years of getting worse. After reading Matt Berg's detailed study/report last year I have a lot more confidences that our special assessment dollars are finally seeing positive results in controlling the weed problem after all these years of our lake quality getting worse, not better. Also, your future plants for projects to follow and some grant dollars is a good sign that you are going in the right direction. Thanks to you, Matt Berg, Northern Aquatic services, and those responsible for obtaining the grant money for your time and effort in this endeavor.*
- *Access from our dock is impeded by excessive weeds. This has become worse over the years.*
- *Appreciate all the time and effort of those working on behalf of all of us. An information station (kiosk) at the boat landing would encourage all lake residents to visit this site and perhaps encourage volunteering there to monitor boats. Sponsor a Long Lake only residents, families, and friends annual fishing contest that incorporates education at the boat landing. Upgrading the Long Lake website for education and links to more education. Offer free or (cheap) septic system appraised, assessment and education on expanded or alternative system. Assessment of well system (aquifer) around Long Lake. Determine if there is any runoff from local farms. Issue Long Lake mandate that no one can take (pump) water from lake for watering lawns, etc.*
- *Being we are on the fish hatchery end of the lake and spraying is regulated. This allows weeds to dominate the landscape and thus greatly effects our enjoyment of the use of the lake. Comment about protecting sensitive habitat areas: If weeds are overtaking these areas and chemicals can't be used the property owners next to these areas would have the harvesting of these weeds subsidized by all of the lake residents since it is the hatchery for the whole lake.*

- *Consider increasing the water level of the lake on the shallow west end to allow easier access to docks. We are new residents however have been visiting the lake for 10+ years. We would like to have the LLPRD add weed management to our area of the lake.*
- *Do not want to loose great pan-fish fishing potential*
- *Due to low lake levels over the past 5 years, I'm concerned about water being pumped from the lake to water lawns, flower beds, and landscaping*
- *Excessive speed too close to shoreline*
- *Great job the last two years. The lake quality has improved immensely. Thanks for the hard work. Jan*
- *I believe much progress has been made the past few years. Thanks to all involved.*
- *I live near the north west day. They do nothing. I work hard to get in and out with my pontoon. The old prayers used to spray a path for us.*
- *I would like a reconsideration of the discussion to asses 1/2 lots at the same rate as full lots*
- *In the past 62 years the rehabilitation district has improved the lake very much. We have had good years and bad, but the current officers have made great improvements this past year. If we keep going like last year, I believe all will be able to enjoy the lake and keep the water and fish quality good.*
- *Keep up the good work!*
- *Lake levels have been very low due to natural causes. Leading to large increases in native species on the east end of the lake. Do we have any options for increasing lake levels through artificial means? Or is it strictly wait and pray for snow/rain?*
- *Let the State take over, and stop letting the lake owner pay for it's clean up!! It's a state lake!*
- *My brother John Yates and I own the cabin on Long Lake. He passes away in October 2011. I don't know how much I will use the cabin in coming years or even if I will keep it. I use very little of the activities listed in question 3. Sorry I haven't been much help with this survey. My brother was more involved with the cabin and lake.*
- *My thanks to every one on the committee for all their hard work to improve the lake.*
- *Our biggest concern at this time is management on non-native weeds and water quality. We would like to see continued efforts to remove CLP, more emphases on improving the water quality/clarity, and efforts put towards ensuring no new non-native plants are introduced into Long Lake. Of particular concern over the last few years is the increase in fibrous algae and the blue/green algae blooms.*
- *Our primarily issue is algae, which keeps the kids out of the water for a substantial part of the summer. I would like to know if fertilizers, runoff, even phosphorus free, contributes to this algae problem. If it did, I think education may be useful in convincing some residents to fertilize less.*
- *Please note our address has changed: 1694 Patterson Ct, Centuria, WI 54824 is currently our primary residence. Thank you!*
- *Stocking of the Northerns by DNR length limit works! Lake level seems to work our long-term, DNR has means to control when necessary. Continue to make strides in improvement of lake quality! It's important and makes a difference! Work with DNR in lake studies, etc and long-term management plants for Long Lake. Need to review costs, etc involved in expanding AIS.*
- *Stop the pumping of water from lake for lawn watering especially during drought conditions.*
- *Thank you Monica, Jeff, and Keith for all you are doing! I'd consider soil sample collection volunteer duty for the 20 sites, please let me know by email.*
- *The lake is not spring fed. It is fed by runoff. Too much agricultural runoff. We need to reduce the agricultural runoff water quality--large pond for ag runoff. Check the ag runoff.*
- *The lake quality did improve last year after the spraying. Prior years had been awful. An embarrassment to most cabin owners. The algae is still an issue. By end of the summer swimming and water sports are not an option. Boating is not as pleasurable, the lake smells. Monica Bergman and the rehab team have been*

doing a great job to reach a balance with the weeds and water clarity so that all residents and visitors can have a great experience on and in the lake. I have faith that it will get better.

- *The lake quality is improving. Now is the time to get more aggressive to improve the weeds and algae. Keep up the great efforts. We are getting there but more work is needed.*
- *The last two years the lakefront has been treated through the current program in place. There are vey few weeds, even natives, present.*
- *The only time we have problems on the lake with algae, etc is late July-August. If we can keep the lake level up it helps diminish the algae and weeds. Can we try to raise the lake level by raising the level at the outlet?*
- *Water level and clarity and muck*
- *We are new to Long Lake as owners but have visited relatives for many years. We feel very fortunate to be on Long Lake. It is a real gem. Thanks to all who work on the water quality management. Dan and Sue Goodin*
- *We are very glad for the leadership of Monica Brengman. Thanks too to Jeff Larson and Keith Campbell. In 2009, our lake was in terrible shape. We have seen slow and steady improvement since Monica became chair. The spraying for curly pond weed has helped tremendously. We look forward to learning more about how we can improve the water quality of our beautiful lake.*
- *We can no longer get to the water as it has gone down so much. It has become a burden for us now with these conditions.*
- *We live on the Northwest bay on Long Lake along Holiday Drive. Out bay is always weedy. My Long Lake assessment is only going for the benefit of other people who live on Long Lake proper (main lake). As far as water run off (rain), it is the only way our lake is to maintain any decent water level. Some years I haven't enough water at my lot to even get water to my dock. Some years I have trouble getting through the curly pondweed to get to the main lake. The fishing is not as good as when I bought here in 1998. Crappies and blue gills are smaller and fewer in numbers.*
- *We love the lake, our neighbors, and this year after 3 years we are selling our dream! We can not deal with the lake anymore--the kids can no swim, not sure if is safe--even the dog can not go in it! We are so sad :(that this great lake and area has some many issues!! Also, it has impacts on property values and the local economy.*
- *We would appreciate any help in making our lakeshore useable. We don't swim, can't fish. We have rakes, pulled, used goats to churn up the weeds but to no avail. We are on the end of the lake where the wild blows everything our way. Weeds, trash, lots of dead fish. We have asked the DNR for approval, but we are always denied. We have hired Lakeshore Restorable Companies to help us, we have never been granted permission to do anything. We ride around the lake and see these beautiful homes and cabins where familiar are swimming and fishing with a nice sandy beach and rock-lined shore. We would like that too. If you can give us any information, and assistance, with our lakeshore we would be grateful.*
- *What effects will farming around our lake have on water quality? IF framing is a negative on water quality what can or should be done to prevent the negative impact?*
- *Would like more control of weeds in lake and lily pads keep under control also.*
- *You're all doing a great job! Thanks.*

Appendix B. Invasive Species Information

Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c)."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[56]

The state of Minnesota DNR web site explains that curly leaf pondweed often causes problems due to excessive growth. At the same time, the plant provides some cover for fish, and some waterfowl species feed on the seeds and winter buds.[57]

[56] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species.* Prepared by Wisconsin DNR. September 2003.
[57] Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants).

The following description is taken from a Great Lakes Indian Fish and Wildlife Commission handout.

Curly Leaf Pondweed (*Potamogeton crispus*)[58]

Identification

Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters one to three meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as two meters. The stems are dark reddish-green to reddish-brown, with the mid-vein typically tinged with red. Curly leaf pondweed is native to Eurasia, Africa, and Australia and is now spread throughout most of the United States and southern Canada.

Characteristics

New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter form can grow beneath the ice and is highly shade-tolerant. Rapid growth begins with warming water temperatures in early spring – well ahead of native aquatic plants.

Reproduction and Dispersal

Curly leaf pondweed reproduces primarily vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions are typically 1.0 – 1.7 cm long and 0.8 to 1.4 cm in diameter. Turions separate from the plant by midsummer, and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, turions germinate in the fall, over-wintering as a small plant. The next summer plants mature, producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

Ecological Impacts

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely affect fish

[58] Information from GLIFWC Plant Information Center (http://www.glifwc.org/epicenter).

populations. The foliage of curly leaf pondweed is relatively high in alkaloid compounds possibly making it unpalatable to insects and other herbivores.

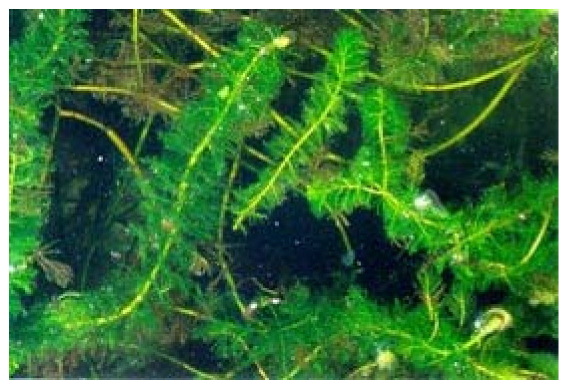
Control

Small populations of curly leaf pondweed in otherwise un-infested water bodies should be attacked aggressively. Hand pulling, suction dredging, or spot treatments with contact herbicides are recommended. Cutting should be avoided because fragmentation of plants may encourage their re-establishment. In all cases, care should be taken to remove all roots and plant fragments, to keep them from re-establishing.

Control of large populations requires a long-term commitment that may not be successful. A prudent strategy includes a multi-year effort aimed at killing the plant before it produces turions, thereby depleting the seed bank over time. It is also important to maintain, and perhaps augment, native populations to retard the spread of curly leaf and other invasive plants. Invasive plants may aggressively infest disturbed areas of the lake, such as those where native plant nuisances have been controlled through chemical applications.

Eurasian Water Milfoil *(Myriophyllum spicatum)*

Introduction



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

Distribution and Habitat

Eurasian milfoil first arrived in Wisconsin in the 1960's. During the 1980's, it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. As of 1993, Eurasian milfoil was common in 39 Wisconsin counties (54%) and at least 75 of its lakes, including shallow bays in Lakes Michigan and Superior and Mississippi River pools.

Eurasian water milfoil 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.

Life History and Effects of Invasion

Unlike many other plants, Eurasian water milfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively 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. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or 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, Eurasian water milfoil 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 Eurasian milfoil 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 Eurasian water milfoil 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 Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. [59]

[59] Taken in its entirety from WDNR, 2008 (http://www.dnr.state.wi.us/invasives/fact/milfoil.htm)

Reed Canary Grass (*Phalaris arundinacea*)

Description

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

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

Reed canary grass also resembles non-native orchard grass (*Dactylis glomerata*), but can be distinguished by its wider blades, narrower, more pointed inflorescence, and the lack of hairs on glumes and lemmas (the spikelet scales). Additionally, bluejoint grass (*Calamagrostis canadensis*) may be mistaken for reed canary in areas where orchard grass is rare, especially in the spring. The highly transparent ligule on reed canary grass is helpful in distinguishing it from the others. Ensure positive identification before attempting control. The ligule is a transparent membrane found at the intersection of the leaf stem and leaf.

Distribution and Habitat

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

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

Life History and Effects of Invasion

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, then spreads laterally. Growth peaks in mid-June and declines in mid-July. 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 less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, 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.[60]

Purple Loosestrife (*Lythrum salicaria*)[61]

Description

Purple loosestrife is a non-native plant common in Wisconsin. 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 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 vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes (underground stems) that form a dense mat.

Characteristics

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, about 24 states 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,

[60] Taken from WDNR, 2008. (http://www.dnr.state.wi.us/invasives/fact/reed canary.htm).
[61] Wisconsin DNR invasive species factsheets.(http:/dnr.wi.gov/invasives).

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. This plant's optimal habitat includes marshes, stream margins, river 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.

Reproduction and Dispersal

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. 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 disturbance is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. 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. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland.

Ecological Impacts

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.

Mechanical Control

Purple loosestrife (PL) can be controlled by cutting, pulling, digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow than before. If done too late, seed may have already fallen. Since lower pods can drop seed while upper flowers are still blooming, check for seed. If none, simply bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding it upright, then bend it over into a bag to catch any dropping seeds. Dispose of plants/seeds in a capped landfill, or dry and burn them. Composting will not kill the seeds. Keep clothing and equipment seed-free to prevent its spread. Rinse all equipment used in infested areas before moving into uninfested areas, including boats, trailers, clothing, and footwear.

Pulling and digging can be effective, but can also create disturbed bare spots, which are good sites for PL seeds to germinate, or leave behind root fragments that grow into new plants. Use these methods primarily with small plants in loose soils, since they do not usually leave behind large gaps nor root tips, while large plants with multiple stems and brittle roots often do. Dispose of plants as described above.

Mowing has not been effective with loosestrife unless the plants can be mowed to a height where the remaining stems will be covered with water for a full twelve months. Burning has also proven largely ineffective. Mowing and flooding are not encouraged because they can contribute to further dispersal of the species by disseminating seeds and stems.

Follow-up treatments are recommended for at least three years after removal.

Chemical Control

This is usually the best way to eliminate PL quickly, especially with mature plants. The chemicals used have a short soil life. Timing is important. Treat in late July or August, but before flowering to prevent seed set. Always back away from sprayed areas as you go, to prevent getting herbicide on your clothes. The best method is to cut stems and paint the stump tops with herbicide. The herbicide can be applied with a small drip bottle or spray bottle, which can be adjusted to release only a small amount. Try to cover the entire cut portion of the stem, but not let the herbicide drip onto other plants since it is non-selective and can kill any plant it touches.

Glyphosate herbicides: Currently, glyphosate is the most commonly used chemical for killing loosestrife. Roundup and Glyfos are typically used, but if there is any open water in the area use Rodeo, a glyphosate formulated and listed for use over water. Glyphosate must be applied in late July or August to be most effective. Since you must treat at least some stems of each plant and they often grow together in a clump, all stems in the clump should be treated to be sure all plants are treated.

Another method is using very carefully targeted foliar applications of herbicide (NOT broadcast spraying). This may reduce costs for sites with very high densities of PL, since the work should be easier and there will be few other plant species to hit accidentally. Use a glyphosate formulated for use over water. A weak solution of around 1% active ingredient can be used and it is generally necessary to wet only 25% of the foliage to kill the plant.

You must obtain a permit from WDNR before applying any herbicide over water. The process has been streamlined for control of purple loosestrife and there is no cost. Contact your regional Aquatic Plant Management Coordinator for permit information.

Biological Control

Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective in controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations. The WDNR, in cooperation with the U.S. Fish and Wildlife Service, is introducing several natural insect enemies of purple loosestrife from Europe. A species of weevil (*Hylobius transversovittatus*) has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue. In addition, two species of leaf eating beetles

(*Galerucella calmariensis* and *G. pusilla*) are being raised and released in the state, and another weevil that feeds on flowers (*Nanophyes marmoratus*) is being used to stress the plant in multiple ways. Research has shown that most of these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants, although one species showed some cross-over to native loosestrife. These insects will not eradicate loosestrife, but may significantly reduce the population so cohabitation with native species becomes a possibility.

Appendix C. Aquatic Plant Management Strategy WDNR

AQUATIC PLANT MANAGEMENT STRATEGY

Northern Region WDNR
Summer, 2007

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

ISSUES

- Protect desirable native aquatic plants.
- Reduce the risk that invasive species replace desirable native aquatic plants.
- Promote "whole lake" management plans
- Limit the number of permits to control native aquatic plants.

BACKGROUND

As a general rule, the Northern Region has historically taken a protective approach to allow removal of native aquatic plants by harvesting or by chemical herbicide treatment. This approach has prevented lakes in the Northern Wisconsin from large-scale loss of native aquatic plants that represent naturally occurring high quality vegetation. Naturally occurring native plants provide a *diversity of habitat* that *helps maintain water quality*, helps *sustain the fishing* quality known for Northern Wisconsin, supports common lakeshore wildlife from loons to frogs, and helps to provide the *aesthetics* that collectively create the "up-north" appeal of the northwoods lake resources.

In Northern Wisconsin lakes, an inventory of aquatic plants may often find 30 different species or more, whereas a similar survey of a Southern Wisconsin lake may often discover less than half that many species. Historically, similar species diversity was present in Southern Wisconsin, but has been lost gradually over time from stresses brought on by cultural land use changes (such as increased development, and intensive agriculture). Another point to note is that while there may be a greater variety of aquatic vegetation in Northern Wisconsin lakes, the vegetation itself is often *less dense*. This is because northern lakes have not suffered as greatly from nutrients and runoff as have many waters in Southern Wisconsin.

The newest threat to native plants in Northern Wisconsin is from invasive species of aquatic plants. The most common include Eurasian Water Milfoil (EWM) and CurlyLeaf Pondweed (CLP). These species are described as *opportunistic invaders*. This means that these "invaders" benefit where an opening occurs from removal of plants, and without competition from other plants may successfully become established in a lake. Removal of native vegetation not only diminishes the natural qualities of a lake, it *may increase the risk that an invasive species can successfully invade onto the site where native plants have been removed*. There it may more easily establish itself without the native plants to compete against. This concept is easily observed on land where bared soil is quickly taken over by replacement species (often weeds) that crowd in and establish themselves as new occupants of the site. While not a providing a certain guarantee against invasive plants, protecting and allowing the native plants to remain may reduce the success of an invasive species becoming established on a lake. Once established, the invasive species cause far more inconvenience for all lake users, riparian and others included; can change many of the natural features of a lake; and often lead to *expensive annual control plans*. Native vegetation may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm.

To the extent we can maintain the normal growth of native vegetation, Northern Wisconsin lakes can continue to offer the water resource appeal and benefits they've historically provided. A regional position on removal of aquatic plants that carefully recognizes how native aquatic plants benefit lakes in Northern Region can help prevent a gradual decline in the overall quality and recreational benefits that make these lakes attractive to people and still provide abundant fish, wildlife, and northwoods appeal.

GOALS OF STRATEGY:

1. Preserve native species diversity which, in turn, fosters natural habitat for fish and other aquatic species, from frogs to birds.
2. Prevent openings for invasive species to become established in the absence of the native species.
3. Concentrate on a" whole-lake approach" for control of aquatic plants, thereby fostering systematic documentation of conditions and specific targeting of invasive species as they exist.
4. Prohibit removal of wild rice. WDNR – Northern Region will not issue permits to remove wild rice unless a request is subjected to the full consultation process via the Voigt Tribal Task Force. We intend to discourage applications for removal of this ecologically and culturally important native plant.
5. To be consistent with our WDNR Water Division Goals (work reduction/disinvestment), established in 2005, to "not issue permits for chemical or large scale mechanical control of native aquatic plants – develop general permits as appropriate or inform applicants of exempted activities." This process is similar to work done in other WDNR Regions, although not formalized as such.

BASIS OF STRATEGY IN STATE STATUTE AND ADMINISTRATIVE CODE

State Statute 23.24 (2)(c) states:

"The requirements promulgated under par. (a) 4. may specify any of the following:

1. The **quantity** of aquatic plants that may be managed under an aquatic plant management permit.
2. The **species** of aquatic plants that may be managed under an aquatic plant management permit.
3. The **areas** in which aquatic plants may be managed under an aquatic plant management permit.
4. The **methods** that may be used to manage aquatic plants under an aquatic plant management permit.
5. The **times** during which aquatic plants may be managed under an aquatic plant management permit.
6. The **allowable methods** for disposing or using aquatic

plants that are removed or controlled under an aquatic plant management permit.

7. The requirements for plans that the department may require under sub. (3) (b). “

State Statute 23.24(3)(b) states:
“The department may require that an application for an aquatic plant management permit contain a plan for the department’s approval as to how the aquatic plants will be introduced, removed, or controlled.“

Wisconsin Administrative Code NR 109.04(3)(a) states:
“The department may require that an application for an aquatic plant management permit contain an aquatic plant management plan that describes how the aquatic plants will be introduced, controlled, removed or disposed. Requirements for an aquatic plant management plan shall be made in writing stating the reason for the plan requirement. In deciding whether to require a plan, the department shall consider the potential for effects on protection and development of diverse and stable communities of native aquatic plants, for conflict with goals of other written ecological or lake management plans, for cumulative impacts and effect on the ecological values in the body of water, and the long-term sustainability of beneficial water use activities.”

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

APPROACH

1. After January 1, 2009* no individual permits for control of native aquatic plants will be issued. Treatment of native species may be allowed under the auspices of an approved lake management plan, and only if the plan clearly documents "impairment of navigation" and/or "nuisance conditions". Until January 1, 2009, individual permits will be issued to previous permit holders, only with adequate documentation of "impairment of navigation" and/or "nuisance conditions". No new individual permits will be issued during the interim.

2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report.

3. Invasive species must be controlled under an approved lake management plan, with two exceptions (these exceptions are designed to allow sufficient time for lake associations to form and subsequently submit an approved lake management plan):
   a. Newly-discovered infestations. If found on a lake with an approved lake management plan, the invasive species can be controlled via an amendment to the approved plan. If found on a lake without an approved management plan, the invasive species can be controlled under the WDNR's Rapid Response protocol (see definition), and the lake owners will be encouraged to form a lake association and subsequently submit a lake management plan for WNDR review and approval.
   b. Individuals holding past permits for control of *invasive* aquatic plants and/or "mixed stands" of native and invasive species will be allowed to treat via individual permit until January 1, 2009 if "impairment of navigation" and/or "nuisance conditions" is adequately documented, unless there is an approved lake management plan for the lake in question.

4. Control of invasive species or "mixed stands" of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on Spring treatment. (typically, a water temperature of less than 60 degrees Fahrenheit, or approximately May 31st, annually).

5. Manual removal (see attached definition) is allowed (Admin. Code NR 109.06).

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* *Exceptions to the Jan. 1, 2009 deadline will be considered only on a very limited basis and will be intended to address unique situations that do not fall within the intent of this approach.*

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DOCUMENTATION OF IMPAIRED NAVIGATION AND/OR NUISANCE CONDITIONS

Navigation channels can be of two types:

- Common use navigation channel. This is a common navigation route for the general lake user. It often is off shore and connects areas that boaters commonly would navigate to or across, and should be of public benefit.

- Individual riparian access lane. This is an access lane to shore that normally is used by an individual riparian shore owner.

Severe impairment or nuisance will generally mean vegetation grows thickly and forms mats on the water surface. Before issuance of a permit to use a regulated control method, a riparian will be asked to document the problem and show what efforts or adaptations have been made to use the site. (This is currently required in NR 107 and on the application form, but the following helps provide a specific description of what impairments exist from native plants).

Documentation of *impairment of navigation* by native plants must include:

a. Specific locations of navigation routes (preferably with GPS coordinates)
b. Specific dimensions in length, width, and depth
c. Specific times when plants cause the problem and how long the problem persists
d. Adaptations or alternatives that have been considered by the lake shore user to avoid or lessen the problem
e. The species of plant or plants creating the nuisance (documented with samples or a from a Site inspection)

Documentation of the *nuisance* must include:

a. Specific periods of time when plants cause the problem, e.g. when does the problem start and when does it go away.
b. Photos of the nuisance are encouraged to help show what uses are limited and to show the severity of the problem.
c. Examples of specific activities that would normally be done where native plants occur naturally on a site but can not occur because native plants have become a nuisance.

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DEFINITIONS

Manual removal:	Removal by hand or hand-held devices without the use or aid of external or auxiliary power. Manual removal cannot exceed 30 ft. in width and can only be done where the shore is being used for a dock or swim raft. The 30 ft. wide removal zone cannot be moved, relocated, or expanded with the intent to gradually increase the area of plants removed. Wild rice may not be removed under this waiver.
Native aquatic plants:	Aquatic plants that are indigenous to the waters of this state.
Invasive aquatic plants:	Non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.
Sensitive area:	Defined under s. NR 107.05(3)(i) (sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water).
Rapid Response protocol:	This is an internal WDNR document designed to provide guidance for grants awarded under NR 198.30 (Early Detection and Rapid Response Projects). These projects are intended to control pioneer infestations of aquatic invasive species before they become established.

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Wisconsin Department of Natural Resources. *Wisconsin Lakes*. PUB-FH-800. 2009.

Appendix E. Rapid Response for Early Detection of Eurasian Water Milfoil

1. Develop and maintain a contingency fund for rapid response to EWM or other invasive species (LLPRD Board).

2. Conduct volunteer (Clean Boats, Clean Waters Crew) and professional monitoring (Herbicide Contractor) at designated public boat landings and other likely areas of AIS introduction. If a suspected plant is found, contact the EWM ID Volunteers.

3. Direct lake residents and visitors to contact the EWM ID Volunteers if they see a plant in the lake they suspect might be Eurasian water milfoil (EWM). Signs at the public boat landings, web pages, handouts at annual meeting, and newsletter articles will provide plant photos and descriptions, contact information, and instructions.

4. If plant is likely EWM, EWM ID Volunteers will confirm identification with Polk County LWRD and the WDNR and inform the rest of the LLPRD Board. Two entire intact rooted adult specimens of the suspect plants will be collected and bagged and delivered to the WDNR, (810 West Maple Street, Spooner, WI 54801). WDNR may confirm identification with the herbarium at the University of Wisconsin – Stevens Point or the University of Wisconsin – Madison.

5. Mark the location of suspected EWM (EWM ID Volunteers). Use GPS points, if available, or mark the location with a small float.

6. If identification is positive:
    a. Inform the person who reported the EWM and the board (EWM ID Volunteers), who will then inform Polk County LWRD, and lake management consultant.

    b. Mark the location of EWM with a more permanent marker. Special EWM buoys are available. (EWM ID Volunteers).

    c. Post a notice at the public landing (DNR has these signs available) and include a notice in the next newsletter. Notices will inform residents and visitors of the approximate location of EWM and provide appropriate means to avoid its spread (LLPRD Board).

7. Hire a consultant to determine the extent of the EWM introduction (LLPRD Board). A diver may be used. If small amounts of EWM are found during this assessment, the consultant will be directed to identify locations with GPS points and hand pull plants found. All plant fragments will be removed from the lake when hand pulling.

8. Select a control plan in cooperation with the WDNR (LLPRD Board). The goal of the rapid response control plan will be eradication of the EWM. Additional guidance regarding EWM treatment is found in DNR's *Response for Early Detection of Eurasian Water Milfoil Field Protocol*.

   Control methods may include hand pulling, use of divers to manually or mechanically remove the EWM from the lake bottom, application of herbicides, and/or other effective and approved control methods.

9. Implement the selected control plan including applying for the necessary permits. Regardless of the control plan selected, it will be implemented by persons who are qualified and experienced in the technique(s) selected.

10. LLPRD funds may be used to pay for any reasonable expense incurred during the implementation of the selected control plan, and implementation will not be delayed by waiting for WDNR to approve or fund a grant application.

11. The LLPRD Board will work with the WDNR to confirm, as soon as possible, a start date for an Early Detection and Rapid Response AIS Control Grant. Thereafter, the LLPRD shall formally apply for the grant.

12. Frequently inspect the area of the EWM to determine the effectiveness of the treatment and whether additional treatment is necessary (LLPRD Board, APM Monitor).

13. Review the procedures and responsibilities of this rapid response plan on an annual basis. Changes may be made with approval of the LLPRD Board.

EXHIBIT A[1]

APPLE RIVER PROTECTION AND REHABILITATION DISTRICT

EWM ID Volunteers	INSERT NAME AND CONTACT
Board Contact	INSERT NAME AND CONTACT

POLK COUNTY LAND AND WATER RESOURCES DEPARTMENT

AIS Coordinator	Jeremy Williamson: 715-485-8639
Director	Tim Ritten: 715-485-8631

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Grants and EWM Notice	Pamela Toshner: 715-635-4073
Permits	Mark Sundeen: 715-635-4074
EWM Identification and Notice	Spooner Lakes Team: 715-635-4073

APM MONITORS

Endangered Resource Services	Matt Berg: 715-483-2847

DIVERS

Ecological Integrity Services	Steve Schieffer: 715-554-1168
Blue Water Science	Steve McComas: 651-690-9602

[1] This list will be reviewed and updated each year.

Appendix F. Management Options for Aquatic Plants

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
No Management	N	Do not actively manage plants	Minimizing disturbance can protect native species that provide habitat for aquatic fauna; protecting natives may limit spread of invasive species; aquatic plants reduce shoreline erosion and may improve water clarity	May allow small population of invasive plants to become larger, more difficult to control later
			No immediate financial cost	Excessive plant growth can hamper navigation and recreational lake use
			No system disturbance	May require modification of lake users' behavior and perception
			No unintended effects of chemicals	
			Permit not required	
Mechanical Control	May be required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season
		Wide range of techniques, from manual to highly mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase turbidity and nutrient release
a. Handpulling/Manual raking	Y/N	SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive
		Works best in soft sediments	Can be highly selective	Needs to be carefully monitored
			Can be done by shoreline property owners without permits within an area <30 ft wide OR where selectively removing exotics	Roots, runners, and even fragments of some species, particularly Eurasian watermilfoil (EWM) will start new plants, so all of plant must be removed
			Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species	Small-scale control only

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
b. Harvesting	Y	Plants are "mowed" at depths of 2-5 ft, collected with a conveyor and off-loaded onto shore	Immediate results	Not selective in species removed
		Harvest invasives only if invasive is already present throughout the lake	EWM removed before it has the opportunity to autofragment, which may create more fragments than created by harvesting	Fragments of vegetation can re-root
			Minimal impact to lake ecology	Can remove some small fish and reptiles from lake
			Harvested lanes through dense weed beds can increase growth and survival of some fish	Initial cost of harvester expensive
			Can remove some nutrients from lake	
Biological Control	Y	Living organisms (e.g. insects or fungi) eat or infect plants	Self-sustaining; organism will over-winter, resume eating its host the next year	Effectiveness will vary as control agent's population fluctates
			Lowers density of problem plant to allow growth of natives	Provides moderate control - complete control unlikely
				Control response may be slow
				Must have enough control agent to be effective
a. Weevils on EWM	Y	Native weevil prefers EWM to other native water-milfoil	Native to Wisconsin: weevil cannot "escape" and become a problem	Need to stock large numbers, even if some already present
			Selective control of target species	Need good habitat for overwintering on shore (leaf litter) associated with undeveloped shorelines
			Longer-term control with limited management	Bluegill populations decrease densities through predation

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
b.	Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortalitiy	May be species specific	Largely experimental; effectiveness and longevity unknown
				May provide long-term control	Possible side effects not understood
				Few dangers to humans or animals	
c.	Allelopathy	Y	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long-term, maintenance-free control	Initial transplanting slow and labor-intensive
				Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermilfoil growth	Spikerushes native to WI, and have not effectively limited EWM growth
					Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d.	Planting native plants	Y	Diverse native plant community established to repel invasive species	Native plants provide food and habitat for aquatic fauna	Initial transplanting slow and labor-intensive
				Diverse native community may be "resistant" to invasive species	Nuisance invasive plants may outcompete plantings
				Supplements removal techniques	Largely experimental; few well-documented cases
					If transplants from external sources (another lake or nursury), may include additional invasive species or "hitchhikers"

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Physical Control	Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Fabrics/ Bottom Barriers	Y	Prevents light from getting to lake bottom	Reduces turbidity in soft-substrate areas	Eliminates all plants, including native plants important for a healthy lake ecosystem
			Useful for small areas	May inhibit spawning by some fish
				Need maintenance or will become covered in sediment and ineffective
				Gas accumulation under blankets can cause them to dislodge from the bottom
				Affects benthic invertebrates
				Anaerobic environment forms that can release excessive nutrients from sediment
b. Drawdown	Y, May require Environmental Assessment	Lake water lowered with siphon or water level control device; plants killed when sediment dries, compacts or freezes	Winter drawdown can be effective at restoration, provided drying and freezing occur. Sediment compaction is possible over winter	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Season or duration of drawdown can change effects	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	May impact attached wetlands and shallow wells near shore
			Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced
			Success demonstrated for reducing EWM, variable success for curly-leaf pondweed (CLP)	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning
			Restores natural water fluctuation important for all aquatic ecosystems	Winter drawdawn must start in early fall or will kill hibernating reptiles and amphibians
				Navigation and use of lake is limited during drawdown

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
c.	Dredging	Y	Plants are removed along with sediment	Increases water depth	Severe impact on lake ecosystem
			Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
			For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
			Extensive planning required		Sediment testing may be necessary
					Removes benthic organisms
					Dredged materials must be disposed of
d.	Dyes	Y	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity	Appropriate for very small water bodies
				Usually non-toxic, degrades naturally over a few weeks	Should not be used in pond or lake with outflow
					Impairs aesthetics
					Effects to microscopic organisms unknown
e.	Non-point source nutrient control	N	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use) thereby providing fewer nutrients available for plant growth	Attempts to correct source of problem, not treat symptoms	Results can take years to be evident due to internal recycling of already-present lake nutrients
				Could improve water clarity and reduce occurrences of algal blooms	Requires landowner cooperation and regulation
				Native plants may be able to better compete with invasive species in low-nutrient conditions	Improved water clarity may increase plant growth

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Chemical Control	Y, Required under NR 107	Granules or liquid chemicals kill plants or cease plant growth; some chemicals used primarily for algae	Some flexibility for different situations	Possible toxicity to aquatic animals or humans, especially applicators
		Results usually within 10 days of treatment, but repeat treatments usually needed	Some can be selective if applied correctly	May kill desirable plant species, e.g. native water-milfoil or native pondweeds; maintaining healthy native plants important for lake ecology and minimizing spread of invasives
		Chemicals must be used in accordance with label guidelines and restrictions	Can be used for restoration activities	Treatment set-back requirements from potable water sources and/or drinking water use restrictions after application, usually based on concentration
				May cause severe drop in dissolved oxygen causing fish kill, depends on plant biomass killed, temperatures and lake size and shape
				Often controversial
a. 2,4-D	Y	Systemic[1] herbicide selective to broadleaf[2] plants that inhibits cell division in new tissue	Moderately to highly effective, especially on EWM	May cause oxygen depletion after plants die and decompose
		Applied as liquid or granules during early growth phase	Monocots, such as pondweeds (e.g. CLP) and many other native species not affected	May kill native dicots such as pond lilies and other submerged species (e.g. coontail)
			Can be selective depending on concentration and seasonal timing	Cannot be used in combination with copper herbicides (used for algae)
			Can be used in synergy with endotholl for early season CLP and EWM treatments	Toxic to fish
			Widely used aquatic herbicide	

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
b.	Endothall	Y	Broad-spectrum[3], contact[4] herbicide that inhibits protein synthesis	Especially effective on CLP and also effective on EWM	Kills many native pondweeds
			Applied as liquid or granules	May be effective in reducing reestablishment of CLP if reapplied several years in a row in early spring	Not as effective in dense plant beds; heavy vegetation requires multiple treatments
				Can be selective depending on concentration and seasonal timing	Not to be used in water supplies; post-treatment restriction on irrigation
				Can be combined with 2,4-D for early season CLP and EWM treatments, or with copper compounds	Toxic to aquatic fauna (to varying degrees)
				Limited off-site drift	
c.	Diquat	Y	Broad-spectrum, contact herbicide that disrupts cellular functioning	Mostly used for water-milfoil and duckweed	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads
			Applied as liquid, can be combined with copper treatment	Rapid action	Toxic to aquatic invertebrates
				Limited direct toxicity on fish and other animals	Must be reapplied several years in a row
					Ineffective in muddy or cold water (<50°F)
d.	Fluridone	Y; special permit and Environmental Assessment may be required	Broad-spectrum, systemic herbicide that inhibits photosynthesis	Effective on EWM for 1 to 4 years with aggressive follow-up treatments	Affects non-target plants, particularly native milfoils, coontails, elodea, and naiads, even at low concentrations
			Must be applied during early growth stage	Some reduction in non-target effects can be achieved by lowering dosage	Requires long contact time at low doses: 60-90 days
			Available with a special permit only; chemical applications beyond 150 ft from shore not allowed under NR 107	Slow decomposition of plants may limit decreases in dissolved oxygen	Demonstrated herbicide resistance in hydrilla subjected to repeat treatments
			Applied at very low concentration at whole lake scale	Low toxicity to aquatic animals	In shallow eutrophic systems, may result in decreased water clarity
					Unknown effect of repeat whole-lake treatments on lake ecology

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
e.	Glyphosate	Y	Broad-spectrum, systemic herbicide that disrupts enzyme formation and function	Effective on floating and emergent plants such as purple loosestrife	RoundUp is often incorrectly substituted for Rodeo - Associated surfactants of RoundUp believed to be toxic to reptiles and amphibians
			Usually used for purple loosestrife stems or cattails	Selective if carefully applied to individual plants	Cannot be used near potable water intakes
			Applied as liquid spray or painted on loosetrife stems	Non-toxic to most aquatic animals at recommended dosages	Ineffective in muddy water
				Effective control for 1-5 years	No control of submerged plants
f.	Triclopyr	Y	Systemic herbicide selective to broadleaf plants that disrupts enzyme function	Effective on many emergent and floating plants	Impacts may occur to some native plants at higher doses (e.g. coontail)
			Applied as liquid spray or liquid	More effective on dicots, such as purple loosestrife; may be more effective than glyphosate	May be toxic to sensitive invertebrates at higher concentrations
				Control of target plants occurs in 3-5 weeks	Retreatment opportunities may be limited due to maximum seasonal rate (2.5 ppm)
				Low toxicity to aquatic animals	Sensitive to UV light; sunlight can break herbicide down prematurely
				No recreational use restrictions following treatment	Relatively new management option for aquatic plants (since 2003)
g.	Copper compounds	Y	Broad-spectrum, systemic herbicide that prevents photosynthesis	Reduces algal growth and increases water clarity	Elemental copper accumulates and persists in sediments
			Used to control planktonic and filamentous algae	No recreational or agricultural restrictions on water use following treatment	Short-term results
			Wisconsin allows small-scale control only	Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Long-term effects of repeat treatments to benthic organisms unknown
					Toxic to invertebrates, trout and other fish, depending on the hardness of the water
					Clear water may increase plant growth

[1]Systemic herbicide - Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.
[2]Broadleaf herbicide - Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.
[3]Broad-spectrum herbicide - Affects both monocots and dicots.
[4]Contact herbicide - Unable to move within the plant; kills only plant tissue it contacts directly.
Specific effects of herbicide treatments dependent on timing, dosage, duration of treatment, and location.
References to registered products are for your convenience and not intended as an endorsement or criticism of that product versus other similar products.
This document is intended to be a guide to available aquatic plant control techniques, and is not necessarily an exhaustive list.
Please contact your local Aquatic Plant Management Specialist when considering a permit.