Aquatic Plant Management Plan

Deer Lake

Polk County, Wisconsin

December 2012

Sponsored By

Deer Lake Improvement Association

Aquatic Plant Advisory Committee

Prepared By

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Executive Summary

This Aquatic Plant Management Plan for Deer Lake presents a strategy for managing aquatic plants by protecting native plant populations, managing curly leaf pondweed, and preventing establishment of invasive species through the year 2016. 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 Deer Lake.

An aquatic plant point intercept survey was completed most recently for Deer Lake in 2010. Aquatic plant surveys were also completed in 2003 and 2006. More species were found in the lake each year, and plants grew at greater depths, perhaps because of water clarity improvement. The aquatic plant surveys found that Deer Lake has a healthy, abundant, and diverse aquatic plant community. Native aquatic 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.

The Deer Lake Aquatic Plant Management Plan will help the Deer Lake Improvement Association carry out activities to meet plan aquatic plant management goals. These goals were established in the 2006 Deer Lake Aquatic Plant Management Plan and reviewed for the 2012 plan.

Plan Goals

1) Protect and restore healthy native aquatic plant communities.

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

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

4) Reduce filamentous algae density.

5) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

6) Reduce levels of nuisance aquatic plants to allow safe, enjoyable recreation such as swimming and boating.

Introduction

The Aquatic Plant Management Plan for Deer Lake is sponsored by the Deer Lake Improvement Association (DLIA). The plan is an update of a plan approved by the DNR in 2006. The plan update was funded by Wisconsin Department of Natural Resources Aquatic Invasive Species grants and the DLIA.

Two organizations are involved in management of Deer Lake: the Deer Lake Improvement Association which addresses immediate in-lake water quality issues and aquatic plant management, and the Deer Lake Conservancy which addresses long-range water quality issues through watershed management. Because both immediate and long term management affect aquatic plants in the lake, activities of both organizations are reported in this management plan.

This aquatic plant management plan presents a strategy for managing aquatic plants by protecting native plant populations, managing curly leaf pondweed, and preventing the establishment of additional invasive species. The plan includes data about the plant community, watershed, and water quality of the lake. Based on this data and public input, goals and strategies for the sound management of aquatic plants in the lake are presented. This plan will guide the DLIA and the Wisconsin Department of Natural Resources in aquatic plant management for Deer Lake over the next five years (from 2012 through 2016).

Public Input for Plan Development

The DLIA Aquatic Plant Management (APM) Advisory Committee provided input for the development of this plan. The APM Advisory Committee met on June 26, 2012 when they reviewed aquatic plant management planning requirements, aquatic plant management goals, aquatic plant management efforts to date, and made recommendations for an ongoing management strategy.

The DLIA board announced the availability of the draft Aquatic Plant Management Plan for review with a public notice in the Polk County Ledger the week of July 16, 2012. Copies of the plan were made available to the public on the DLIA web site: deerlakewi.com and at the St. Croix Falls Public Library. Comments were accepted through August 10, 2012.

Staff of the St. Croix Tribe Environmental Department and the Voigt Intertribal Task Force were invited to participate in plan development as well as in review of draft versions of the plan.

Property Owner Surveys

An on-line survey of lake residents was conducted late in 2009 in preparation for the Deer Lake Conservancy strategic planning process. Fifty lake residents responded to the survey. With about 280 residences around the lake, this is a response rate of about 18%. A 2007 mail survey yielded a response rate of 41%. Selected results of the on-line survey are discussed below, and full results are found in Appendix A. While neither survey was prepared to guide the aquatic plant management plan, the results provide some helpful information.

Popular lake activities, rated in the chart below by degree of enjoyment from "Not At All" to "A Great Deal", demonstrate potential conflicts for aquatic plant management. Enjoying the view, appreciating peace and tranquility, and observing wildlife are the most enjoyed activities. These activities are supported by aquatic plants in the lake. However, motor boating and swimming - which may be limited by aquatic plant growth - follow as the top activities enjoyed on the lake. Fishing, which is highly dependent upon aquatic plants, is close behind.

7. How much do you enjoy the following recreational activities?

	Not at all	Some	Quite a Bit	A Great Deal
Appreciating peace & tranquility	2%	2%	25%	71%
Enjoying the view	0%	6%	10%	83%
Observing wildlife	0%	23%	26%	51%
Wind surfing	91%	9%	0%	0%
Scuba diving or snorkeling	87%	9%	0%	4%
Swimming	4%	34%	28%	34%
Fishing	10%	31%	25%	33%
Jet skiing	80%	9%	11%	0%
Motor boating	2%	9%	52%	37%
Non-motorized boating	24%	48%	24%	4%
Water skiing/Wakeboarding/Tubing	21%	21%	32%	26%
Using Deer Lake trails	15%	54%	20%	11%

Additional survey results indicate a range of concerns of lake residents. Respondents report that invasive and native plant growth are at the top of their concerns. Financial considerations (maintaining investment value and the cost of property taxes), are close behind on the list of concerns. Respondents also rank invasive and native aquatic plant management as the top issues affecting the lake.

9. To what extent are the following issues of concern to you?

	Not at all	Some	Quite a Bit	A Great Deal
Lack of water clarity in the middle of the lake	24%	30%	30%	15%
Lack of water clarity near my shoreline	20%	20%	20%	41%
Excessive invasive aquatic plant growth*	0%	11%	15%	74%
Excessive native aquatic plant growth**	2%	29%	18%	51%
Swimmer's itch	15%	30%	15%	40%
Protecting the lake environment	2%	2%	25%	71%
Maintaining the investment value of my property	2%	7%	30%	61%
Minimizing maintenance needs	9%	27%	44%	20%
The cost of property taxes	0%	10%	33%	56%

Lake Information

The Lake

Deer Lake is an 812-acre lake located in Polk County, Wisconsin in the Towns of St. Croix Falls (S25, T34N, R18W) and Balsam Lake (S29 and S30, T34N, R17W). The maximum depth of the lake is 46 feet and the mean depth is 26 feet. Its subwatersheds, primarily on the north side of the lake, total almost 5,800 acres. The lake is fed by intermittent streams mostly entering on the north side of the lake. There is a single outlet in the southeast corner.

Deer Lake is mesotrophic with 2011 July and August Secchi depths averaging 19.7 feet in the East Deep Hole and 17.5 feet in the West Basin. The littoral zone (the depth to which plants grow) reached a depth of 28 feet in 2010. This littoral zone depth is much higher than surrounding lakes in the region. The littoral zone depth increased slightly from 2006 when it was 27 feet. In 2003 the littoral zone reached up to 23.9 feet. This increase in littoral zone depth may be the result of increased water clarity. The bottom substrate is muck or sand as shown in Figures 1 and 2 below.

Table 1. Deer Lake Information

Size (acres)	812
Mean depth (feet)	26
Maximum depth (feet)	46
Littoral zone depth (feet)	28
Average summer Secchi depth (feet)	20

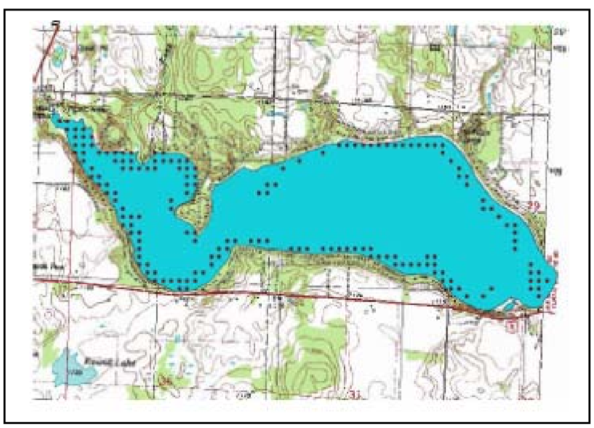

Figure 1. Dominant Sediment Muck

Figure 2. Dominant Sediment Sand

A lake map is found on the following page as Figure 3.

Figure 3. Deer Lake Access and Sensitive Areas (A, B, and C)

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. 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 Deer Lake in the mesotrophic to oligotrophic TSI range.

Citizen lake monitoring volunteers have collected data from the lake almost annually since 1987. There are two data collection sites on Deer Lake: one at the East Deep Hole and one in the West Basin. Each of the sites was sampled ten times during 2011. Results are available from the WDNR website. For better comparison between lakes, only July and August results are summarized and reported in the table and figures that follow. While the Deer Lake summer Secchi depths averaged nearly 20 and 17.5 feet, the average for the Northwest Wisconsin region is about 8 feet.

Table 2. Citizen Lake Monitoring Results July and August, 2011[1]

	East Deep Hole	**West**
Secchi Depth (ft)	19.7	17.5
Total Phosphorus (µg/l)	17	20
Chlorphyll (µg/l)	1.2	1.3
Trophic State Index (TSI based on Secchi)	34	36
TSI (based on Chl.)	36	37
TSI (based on TP)	50	51

[1] *Reports and Data: Polk County*. WDNR website. December 2010. http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/

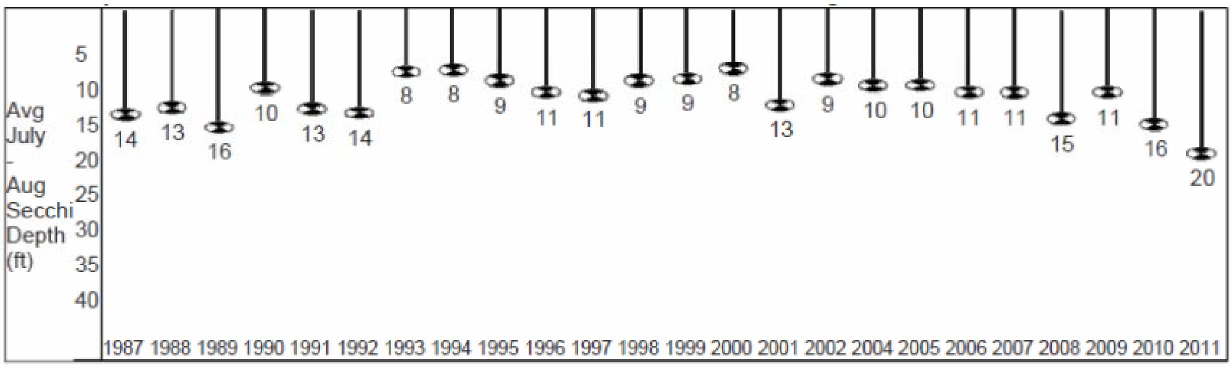

Figure 4. Deer Lake East Deep Hole July and August Average Secchi Depths

Figure 4 illustrates the Secchi depth averages for the East Deep Hole. Figure 5 graphs the Trophic State Index for the same location, based upon Secchi depth, chlorophyll, dissolved oxygen, and total phosphorus results. Figures 6 and 7 depict results for the West Basin Secchi depth and Trophic State Index, respectively. Water clarity improvement and declines in algae growth may be influenced by grazing of algae by zooplankton or some factor other than phosphorus levels.

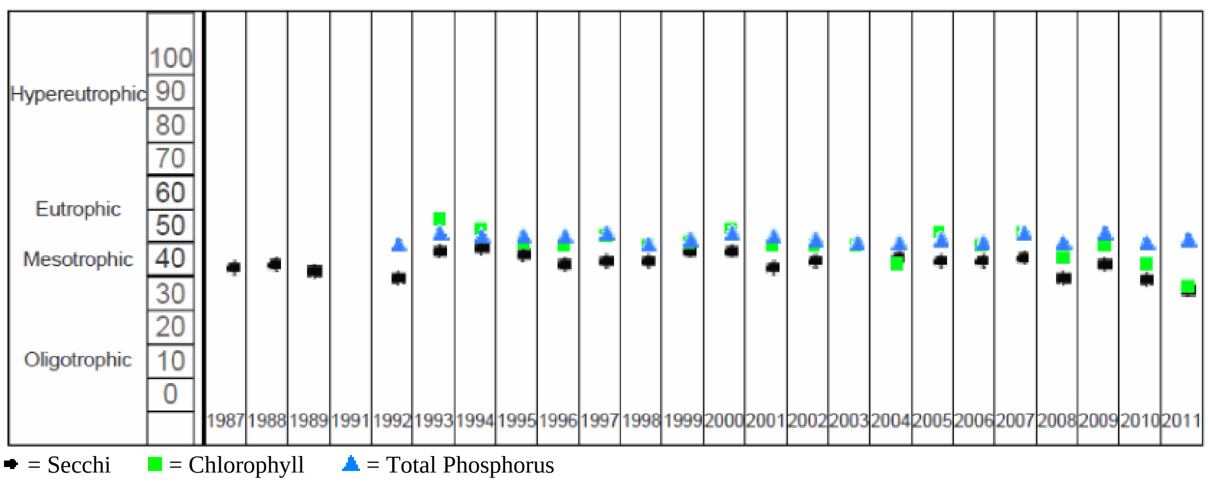

Figure 5. Deer Lake East Deep Hole July and August Average Trophic State

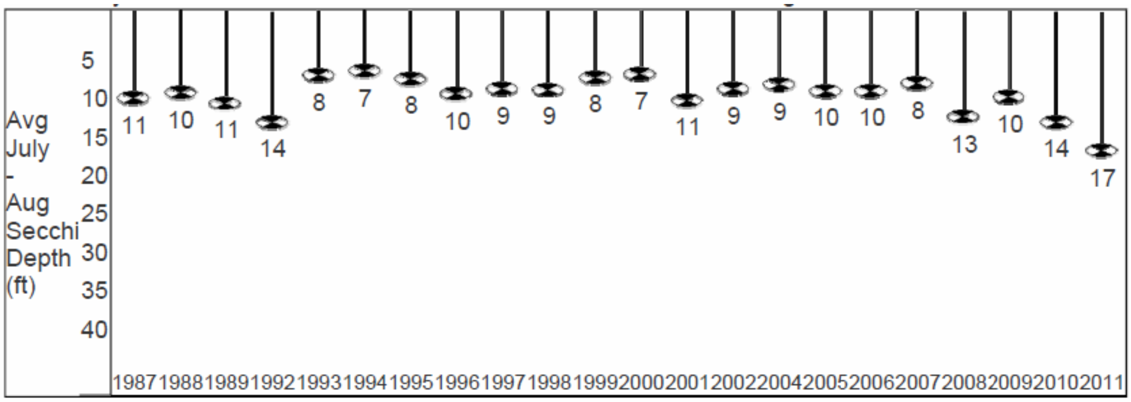

Figure 6. West Basin July and August Average Secchi Depths

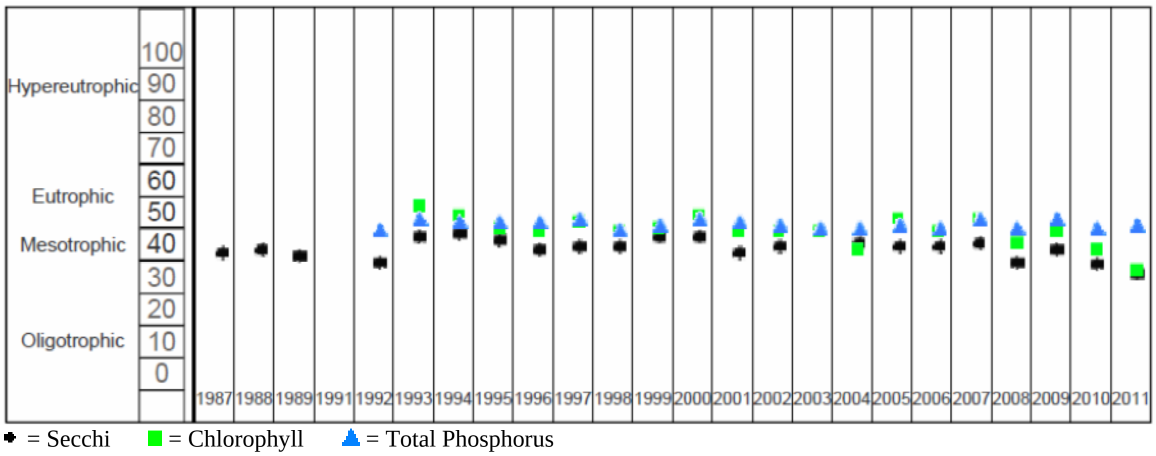

Figure 7. West Basin July and August Average Trophic State

Water Quality Studies

The Deer Lake Conservancy and Deer Lake Improvement Association together sponsored a comprehensive in-lake study in 2003 with assistance from Department of Natural Resources planning grant funds. A major initiative of the Conservancy has been to implement the recommendations of two water quality studies commissioned by the Deer Lake Improvement Association in the early nineties (Barr Engineering 1993 and 1995). The studies sought to identify causes and solutions for the perceived decline in Deer Lake water quality in preceding decades. The studies concluded the following:

> *Based on the runoff water quality data, water quality of Deer Lake's tributary streams could be considered poor. The potential increase in nutrient loading from agricultural watersheds into Deer Lake is the single biggest threat to the long-term health of Deer Lake. Specifically, Deer Lake should focus its attention on the following issues related to the agricultural watersheds.*

1. *Promote the retention/detention of stormwater runoff within Deer Lake's watershed. This activity includes protection of any existing depressions and wetlands.*

Additionally, creation of new detention areas, especially within the direct watershed and watersheds 2 and 3 should be encouraged.

2. *Promote the stabilization and restoration of stream beds within Deer Lake's watershed.*

Watersheds

In the early 1990's, the Polk County Land Conservation Department and the Department of Natural Resources were gathering information for the development of the Balsam Branch Priority Watershed Plan. The plan established an in-lake water quality goal of 19 ug/l summer phosphorus concentration. According to lake models, achieving this goal required a total phosphorus loading reduction of 36 percent (equivalent to 65% reduction of watershed loading) from levels in the early 1990s. The Conservancy adopted these goals and has emphasized watershed practices to achieve them. In 2010 and 2011, the summer phosphorus concentration goal was, in fact, exceeded by reaching 17 ug/l.

Conservancy efforts have largely focused on reducing phosphorus carried in runoff from Deer Lake watersheds. These watersheds are illustrated in the map below. A timeline of project installation is included on page 10.

A 2003 study estimated current watershed phosphorus loading, phosphorus loading reductions from installation of conservation practices since 1996, and remaining loading from the direct drainage area (JEO 2003). From 1996 to 2000, the estimated annual watershed phosphorus loading to Deer Lake decreased by 51%. Installed practices at the Flagstad Farm increased this total reduction to 56% of watershed P loading. These figures do not include the direct drainage area.

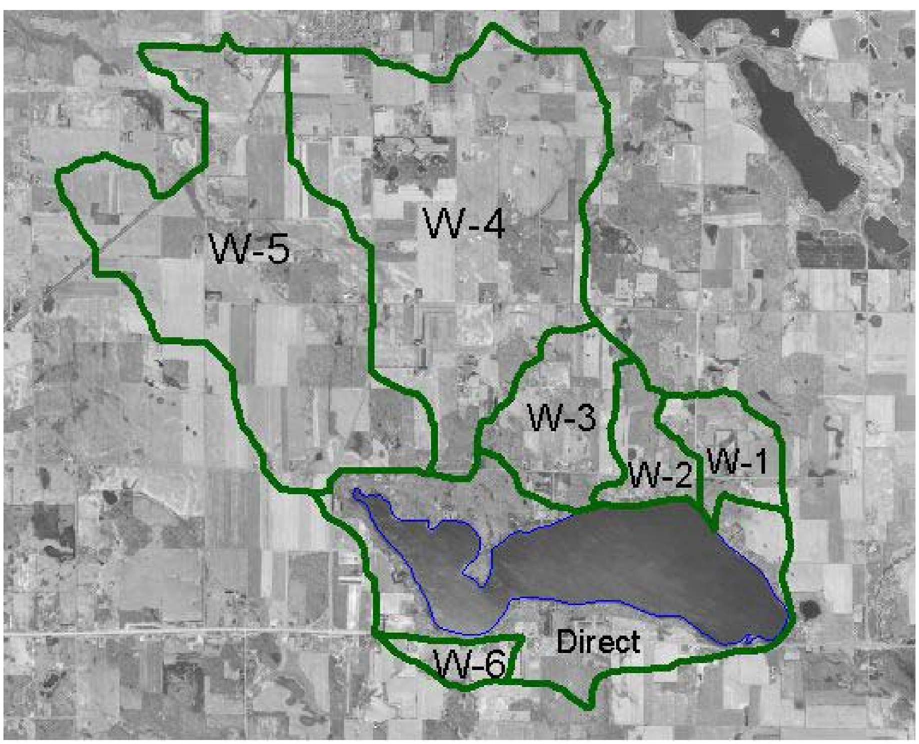

Figure 8. Deer Lake Watersheds

Deer Lake Conservancy Project Timeline

Organization is incorporated	1995
W2 Basin Construction	1997
W2 Prairie Planting	1998
Dry Creek (W3) Prairie acquired	1998
W3 Sediment Basins	1998
W3 Tire Removal	1998
W3 Wetland Restorations	1998
Rock Creek (W4) Prairie acquired	1998
W4 Gravel Pit Restoration	1998
W3 Prairie Planting	1999
Rock Creek (W4) Woodland acquired	1999
W4 Prairie Planting	1999
Blakeman Hill (W1) Easements	1999
W1 Wetland Restoration	1999
Trail system developed	2000
Flagstad Farm acquired	2002
Flagstad Farm Prairie	
Flagstad Farm Well Closure	
Flagstad Farm Prairie Maintenance (NRCS)	
Flagstad Farm Gravel Pits	
Maple Cove Prairie donated	2003
Foussard Kane Forest donated	2006
Direct Drainage project begins	2006
WDOT releases Highway 8 EIS	2007
Prokop Stormwater Ponds and Easement	2008
McKenzie Forest acquired	2009
Schletty Stormwater Ponds and Rock Waterway	2009
Direct Drainage projects installed	2010 through 2012

Aquatic Habitats

Primary Human Use Areas

A public boat landing owned by the Town of St. Croix Falls is located at the northwest corner of the lake. The boat landing includes space for parking 25 vehicles and trailers. Many anglers travel from the Twin Cities, Minnesota metropolitan area, and access the lake at this boat landing. According to Heath Benike, DNR fisheries biologist, "Deer Lake is one of the most important and popular musky fisheries in the state of Wisconsin. Many resident as well as non-resident anglers use Deer Lake, and this is the only public landing on the lake." The Town of St. Croix Falls boat landing on Deer Lake is used extensively throughout the year. While there are only 25 parking spots on the lake, a busy weekend brings an estimated use by over 200 vehicles. Daily weekday use is about 15 – 25 vehicles.

A private boat launch is located at the southeast corner of the lake near the outlet. This area is referred to as the Lagoon.

The shoreline of Deer Lake is largely developed for residential use with about 330 residences. Many are large homes constructed for year-round use. 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 Deer Lake at depths up to 28 feet. This depth extends horizontally from the shore to approximately 115 to 1700 feet into the lake.

Sensitive Area Study

The DNR sensitive area study (1992) identified three areas that merit special protection of aquatic habitat. These areas are shown in Figure 3. In the same report, they describe all of Deer Lake as unique. "Areas of aquatic vegetation provide the necessary seasonal or life stage requirements of the associated fisheries, and the aquatic vegetation offers 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

Sensitive Area A is located at the northwestern end of Deer Lake and includes the public boat launch. This area encompasses approximately 2,500 feet of shoreline. The area provides important habitat for centrarchid (bass and panfish) and esocid (northern pike and muskellunge) spawning and nursery areas. This 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
Sensitive Area B is located adjacent to Area A, extending along the western shoreline of Deer Lake. This area encompasses approximately 1,200 feet of shoreline. *The habitat values of Site B mirror those described for Area A above.*

Resource Value of Area C
Sensitive Area C encompasses a small bay at the northwestern corner of Deer Lake. This bay comprises the entrance of Rock Creek. Approximately 600 feet of shoreline are located in this sensitive area. *The habitat values of Site C mirror those described for Area A above.*

Deer Lake Fishery[2]

Deer Lake's fish community consists of northern pike, muskellunge, walleye, largemouth bass, bluegill, black crappie, yellow perch, and white sucker as well as various species of minnows. Deer Lake has an exceptional muskellunge fishery, however the fishery is dependent on stocking; no known natural reproduction is present. All other fish species present in Deer Lake are reproducing on their own and do not require supplemental stocking.

Table 3. Fish Spawning Times and 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
Walleye	Low to upper 40s – (about one week after ice-out)	Rocky shorelines with rubble/gravel 0.5 – 3 feet of water	Eggs are broadcast
Yellow Perch	Mid 40s to lower 50s	Submergent vegetation or large woody debris	Broadcast spawn Eggs resemble a helical strand that drapes over vegetation or woody debris
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.	

[2] Fisheries information provided by Heath Benike, DNR Fish Biologist. March 2006 Confirmed by Benike, December 2010.

Rare, Endangered, or Protected Species Habitat

The west half of Deer Lake is in Sections 25 and 34 of the town of St. Croix Falls. The east half is located in Sections 29 and 30 in the town of Balsam Lake. Rare species are noted in the town of St. Croix Falls (T34N, R18W) and in the town of Balsam Lake (T34N, R17W). 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 Deer Lake.[3] However, the Polk County Natural Heritage Inventory map indicates that the west half of Deer Lake has aquatic occurrences of NHI species.[4]

<u>Selected Species listed in the Town of St. Croix Falls (T34N, R18W):</u>

Red Shouldered Hawk	*Buteo lineatus*	Threatened
Bald Eagle	*Haliaeetus leucocephalus*	Special Concern
Lake Sturgeon	*Acipenser fulvescens*	Special Concern
Blue Sucker	*Cycleptus elongates*	Threatened
Western Sand Darter	*Etheostoma clarum*	Special Concern
Banded Killifish	*Fundulus diaphanous*	Special Concern
River Redhorse	*Moxostoma carinatum*	Threatened

There is a long list of additional species within this Town and Range which includes natural areas along the St. Croix River.

<u>Species listed in the Town of Balsam Lake</u> (T34N, R17W):

Bald Eagle	*Haliaeetus leucocephalus*	Special Concern
Osprey	*Pandion haliaetus*	Threatened
Banded Killifish	*Fundulus diaphanous*	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 algal 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. Stands of emergent plants (whose stems protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline.

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[3] Natural Heritage data for Wisconsin is found at http://dnr.wi.gov/org/land/er/nhi.

[4] Map is generated with NHI data as of 9/15/2010.

There are very few stands of emergent plants around Deer Lake, making protection of these areas particularly important.

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.[5]

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.[6]

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

Plant Community

Aquatic Plant Survey Results

An aquatic plant inventory was completed for Deer Lake in July of 2010, according to the WDNR-specified point intercept method. This survey was a follow-up to a survey completed in August 2006. A general boat survey was conducted prior to the point intercept survey to gain familiarity with the lake and the species present in it.

The results discussed below are summarized or taken directly from the aquatic plant survey. The survey and data analysis methods for the aquatic macrophyte survey are found in the following report: *Aquatic Macrophyte Survey, Deer Lake (WBIC: 2619400) Polk County, Wisconsin,* July 2010, conducted and prepared by Steve Schieffer, Ecological Integrity Services, Inc.

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 752 points. Figure 9 below shows the distribution of these sampling points. Once the depth at which plants grow is determined, points deeper are not sampled.

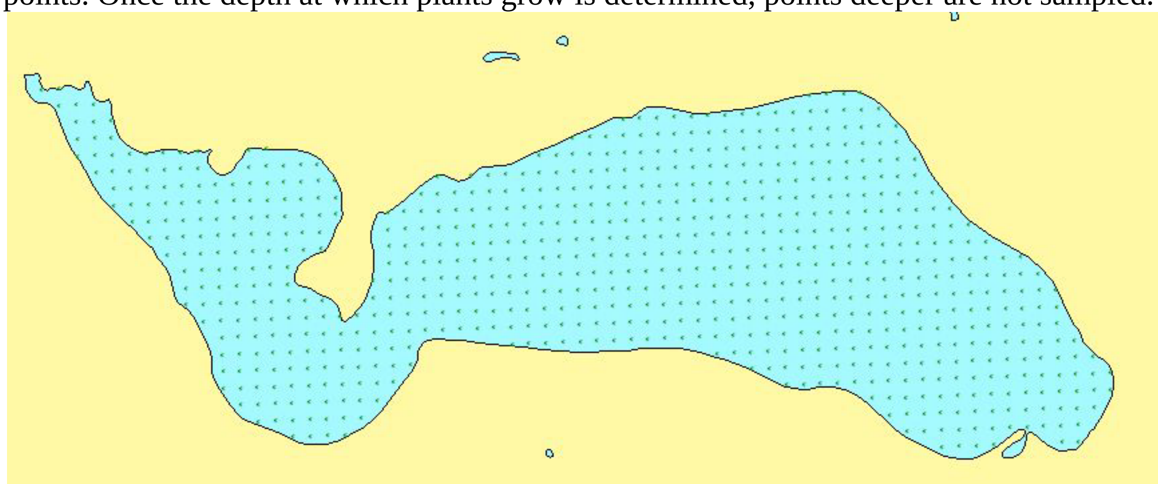


Figure 9. Sampling Point Grid

In July 2010, plants were found growing on approximately 30% of the lake bottom (225 of 752 sampling points) and 88% of the littoral zone (the depth at which plants can grow). The littoral zone, which is very narrow around most of Deer Lake, is represented in Figure 10 below. In most areas of the lake, there is a dramatic drop off close to shore increasing to depths beyond which plants can grow in a short distance. The bay near the boat landing and the eastern most bay are the largest littoral zone areas and represent the highest plant growth.

The density rating of the rake samples varied often between one and three (from low to high density). There were many sites with a density rating of three, showing extensive plant growth. Although the littoral zone is very narrow in Deer Lake, where plants are growing, they are quite dense in some areas. Most areas with low nutrient, sandy sediment had lower density ratings.

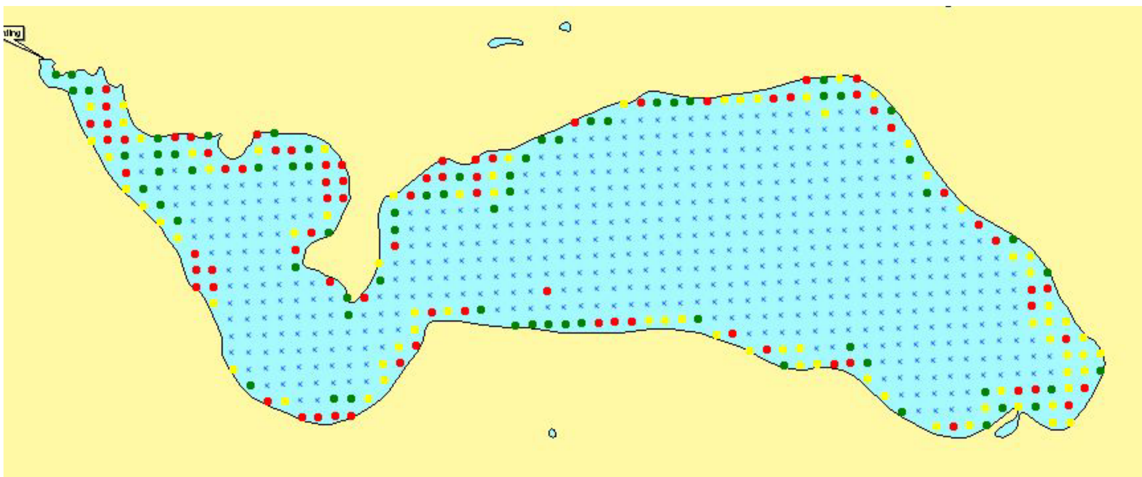


Figure 10. Littoral Zone Plant Density. From low (1) to high (3): green=1, yellow=2, and green=high

Plant diversity was very high in Deer Lake with a Simpson Diversity Index of 0.89. 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.

There were 30 species of aquatic plants (and algae) sampled on the rake at specified sample points.[7] Two of the species are an algae (*Chara sp*. and *Nitella sp*.) and one species is non-native (curly leaf pondweed). The remaining species are native, vascular aquatic plants. When viewed species are included, the species richness increases to 37, and if the boat survey species are included, the total is 44.

[7] If filamentous algae and aquatic moss are included, there are 32 species. The Wisconsin DNR point intercept data spreadsheet does not include these in the species richness total.

Table 4. Aquatic Macrophyte Survey Summary Statistics

Total number of points sampled	273
Total number of sites with vegetation	225
Total number of sites shallower than the maximum depth of plants	255
Frequency of occurrence at sites shallower than maximum depth of plants	88.24
Simpson Diversity Index	0.89
Maximum depth of plants (feet)	28.00
Average number of all species per site (shallower than max depth)	2.94
Average number of all species per site (sites w/vegetation only)	3.45
Average number of native species per site (shallower than max depth)	2.92
Average number of native species per site (sites w/vegetation only)	3.42
Species richness	30
Species richness (including visuals)	37
Species richness (including visuals and boat survey)	44

Table 5. Deer Lake Species Frequency and Mean Rake Fullness

Species	Freq. of occurrence (%)	Relative Frequency (%)	Number of Sites Species Found	Average Rake Fullness
Lemna trisulca, Forked duckweed	70.22	20.36	158	1.25
Ceratophyllum demersum, Coontail	53.33	15.46	120	1.54
Myriophyllum sibiricum, Northern water-milfoil	46.67	13.53	105	1.32
Vallisneria americana, Wild celery	32.89	9.54	74	1.36
Heteranthera dubia, Water star-grass	22.67	6.57	51	1.27
Potamogeton praelongus, White-stem pondweed	19.56	5.67	44	1.14
Potamogeton robbinsii, Fern pondweed	16.00	4.64	36	1.17
Elodea canadensis, Common waterweed	14.67	4.25	33	1.21
Chara sp., Muskgrasses	12.44	3.61	28	1.14
Potamogeton zosteriformis, Flat-stem pondweed	11.11	3.22	25	1.04
Potamogeton richardsonii, Clasping-leaf pondweed	8.00	2.32	18	1.00
Nitella sp., Nitella	7.56	2.19	17	1.53
Najas flexilis, Slender naiad	5.33	1.55	12	1.42
Ranunculus aquatilis, White water crowfoot	3.56	1.03	8	1.00
Potamogeton pulcher, Spotted pondweed	3.11	0.90	7	1.43
*Potamogeton crispus,*Curly leaf pondweed	2.67	0.77	6	1.00
Eleocharis acicularis, Needle spikerush	2.67	0.77	6	1.00
Potamogeton pusillus, Small pondweed	2.22	0.64	5	1.20
Potamogeton gramineus, Variable pondweed	1.78	0.52	4	1.00
Nymphaea odorata, White water lily	1.33	0.39	3	1.00
Potamogeton illinoensis, Illinois pondweed	1.33	0.39	3	1.00
Lemna minor, Small duckweed	0.89	0.26	2	1.00
Potamogeton amplifolius, Large-leaf pondweed	0.89	0.26	2	1.00
Spirodela polyrhiza, Large duckweed	0.89	0.26	2	1.00
Wolffia columbiana, Common watermeal	0.89	0.26	2	1.00
Bidens beckii , Water marigold	0.44	0.13	1	1.00
Elatine minima, Waterwort	0.44	0.13	1	1.00
Isoetes sp., Quillwort	0.44	0.13	1	1.00
Potamogeton friesii, Fries' pondweed	0.44	0.13	1	1.00
Sagittaria sp., Arrowhead	0.44	0.13	1	1.00
Aquatic moss	0.44		1	3.00
Filamentous algae	53.33		120	1.26
Schoenoplectus tabernaemontani, Softstem bulrush	Viewed only			
Sparganium eurycarpum, Common bur-reed	Viewed only			
Nuphar variegate, spatterdock	Viewed only			
Carex sp.	Viewed only			
Stuckenia pectinata, Sago pondweed	Viewed only			
Typha latifolia, Broad-leaved cattail	Viewed only			
Utricularia gibba, Creeping bladderwort	Viewed only			

Forked duckweed (*Lemna triscula)* is the most abundant plant in Deer Lake. Seventy percent of the sites with plants present had forked duckweed. This desirable native plant is very small and not rooted. The second most abundant aquatic plant is coontail (*Ceratophyllum demersum*), followed by northern water milfoil (*Myriophyllum sibiricum*). Both are common native plants in Wisconsin lakes.

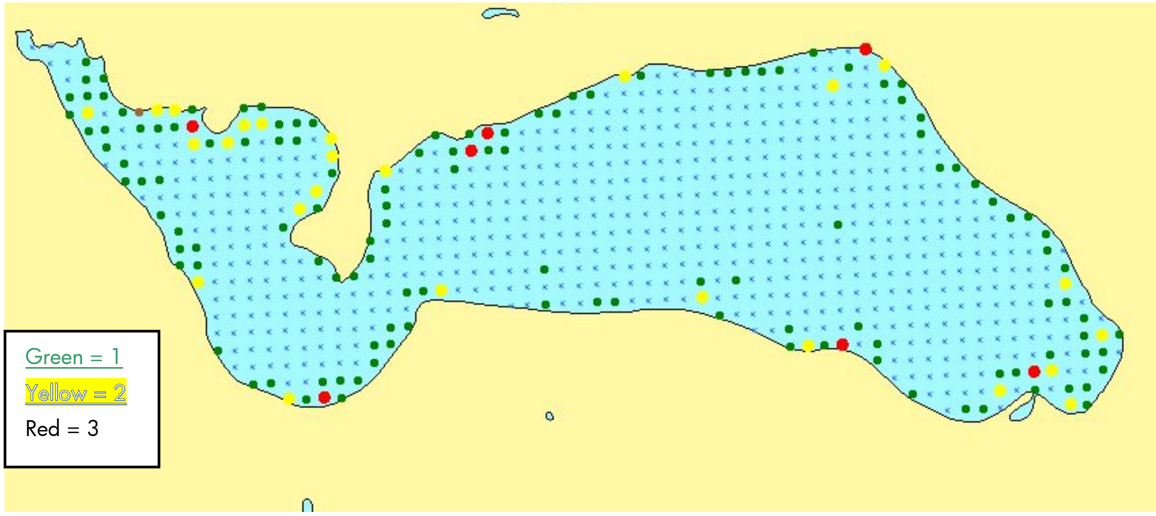


Figure 11. Distribution of Forked Duckweed (Lemna triscula); Most Abundant Plant

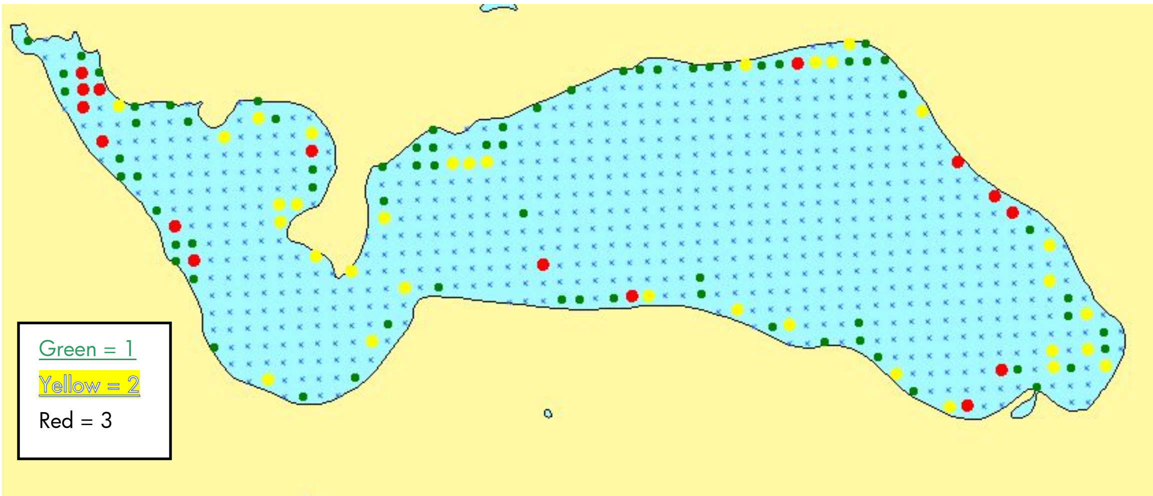


Figure 12. Distribution of Coontail (Certaphyllum demersum); Second Most Abundant Plant

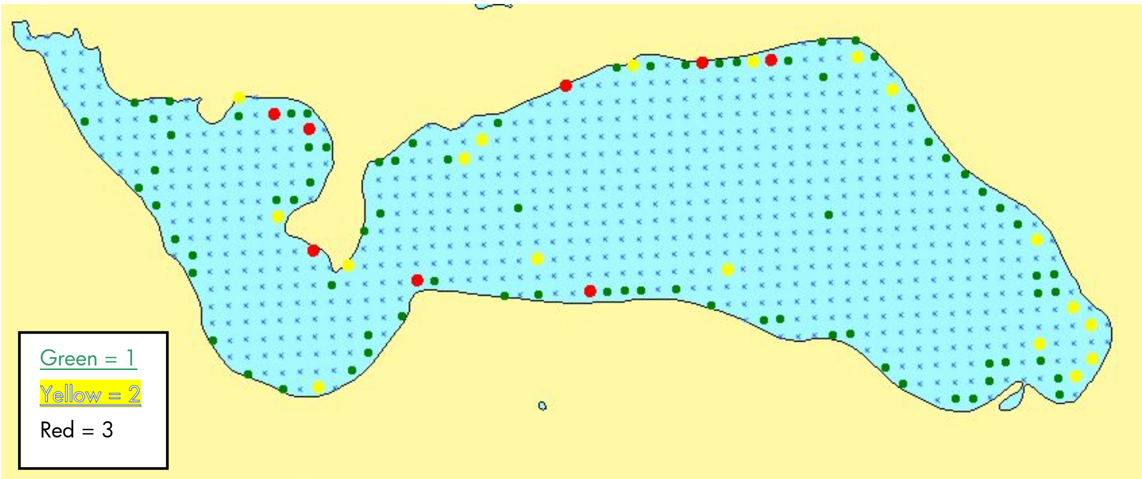


Figure 13. Distribution of Northern Water Milfoil (Myriophyllum sibiricum); Third Most Abundant Plant

The distribution of northern water milfoil is worth noting when looking for potential locations where the non-native invasive Eurasian water milfoil may become established. Widespread growth of Northern water milfoil indicates that Deer Lake has suitable growing conditions for Eurasian water milfoil.

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.

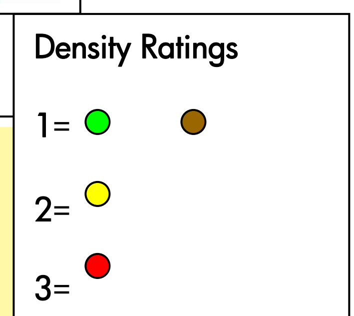
The FQI for Deer Lake in 2010 was higher than the median for similar lakes within the eco-region (34.02 compared to 20.9). The mean conservatism is also higher than the median for lakes within the ecoregion (6.43 compared to 5.6). This shows that the plant habitat is healthy and appears to have responded very little to human impacts on the lake.

Northern Wild Rice
Wild rice is an aquatic plant with special significance to Native American Tribes. It was not found in Deer Lake in any of the aquatic plant surveys (2003, 2006, 2010).

Filamentous Algae
Filamentous algae have been a target for management in previous years. Filamentous algae are masses of long, stringy, hair-like strands that attach to plants, rocks, and docks. They are usually

green, but may become yellow, grey, or brown. Two types of filamentous algae were documented on the lake in the 2006 survey: spirogyra and cladophora. Nuisance growth of filamentous algae may indicate that a lake has excessive nutrients, although some amount of filamentous algae will grow in low nutrient conditions. Filamentous algae locations and density were documented in both the 2006 and 2010 plant surveys. A density rating of "1" indicates a small amount of algae and a "3" indicates a large amount of algae. In 2010, the average filamentous algae density or rake fullness was 1.26. It was found at 53 percent of the sample points in 2010. The average filamentous algae density in 2006 was 1.46. It was found at 30 percent of sample points. In 2003 filamentous algae was found at 66 percent of the sample points, but density was not recorded. Because filamentous algae abundance can vary from week to week, these annual measurements are not indicative of any trend. The Deer Lake Improvement Association representative who monitors filamentous algae for potential treatment reports general declines in matted filamentous algae over recent years.[8]

Figure 14. Filamentous Algae Density August 2006



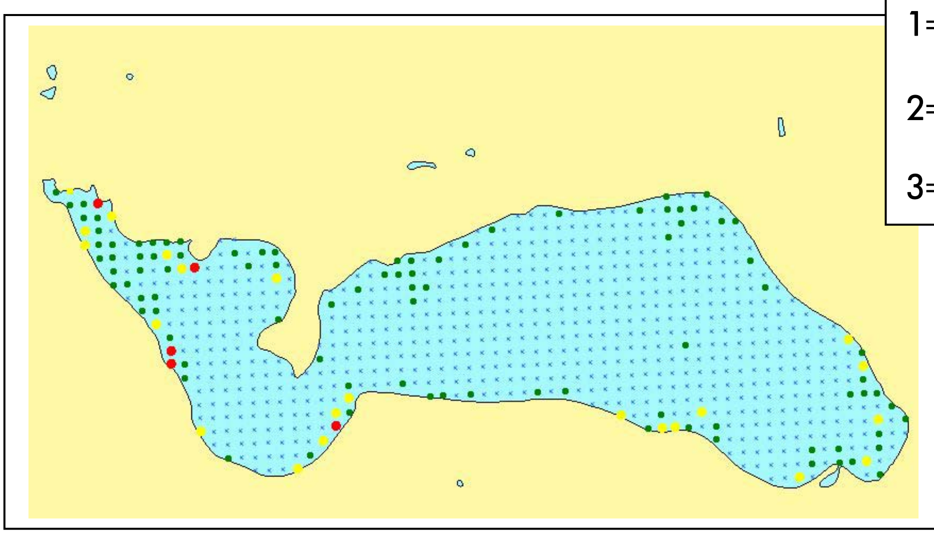


Figure 15. Filamentous Algae Density July 2010

[8] Personal communication. Mark Thayer. December 22, 2010.

Comparison of 2006 and 2010 Plant Surveys

Plant survey results show some changes in aquatic plant composition and density in Deer Lake in recent years. Four more species were sampled in 2010, and the FQI calculated as a result is slightly higher. The littoral zone had higher plant coverage in 2010 than in 2006.

Table 6. Comparison Statistics between the 2006 and the 2010 Plant Surveys

Statistic	**2006**	**2010**
Species richness	26*	30
Dominant species	Coontail (*Ceratophyllum demersum)*	Forked duckweed (*Lemna triscula*)
FQI	33.73*	34.02
Simpson's diversity index	0.91	0.89
Native species per site	3.1	3.42
Littoral zone with plants	79.1%	88.4%
Maximum depth with plants	27.2 feet	28 feet

**Adjustments were made to match new statistics the Wisconsin DNR uses for survey results. The species richness does not include filamentous algae or aquatic moss. Also, the FQI only includes plants actually sampled.*

The dominant species are very similar between the two years. Coontail had nearly the same frequency of occurrence in 2006 as compared to 2010 (50% and 53% respectively). The third most dominant plant both years was northern water milfoil (native plant). However, the 23% frequency of occurrence in 2006 doubled to 46% frequency of occurrence in 2010. Water celery was the second most dominant plant in 2006 with a 49.74% frequency of occurrence. Water celery decreased to a 32.89% frequency of occurrence in 2010.

Two sensitive species were sampled in 2006 and not in 2010. They are pipewort (*Eriocaulon aquaticum*) and dwarf water milfoil (*Myriophyllum tenellum*). Pipewort was only viewed once in 2006, and dwarf water milfoil was sampled six times. It is likely that pipewort is very limited in growth and just happened to be seen in 2006. The dwarf water milfoil may have actually decreased growth because of habitat changes. It is also possible that dwarf water milfoil is unchanged but was missed in the random rake sample.

These differences are small and don't strongly indicate any major changes in the plant community. The higher plant coverage and higher diversity may be due to conditions such as lower lake level, water temperature changes, as well as water clarity and light intensity increases.[9] Summer water clarity has, in fact, increased as shown in Secchi depth records.

[9] Schieffer 2010.

Aquatic Invasive Species

Three species of aquatic invasive plants not native to Wisconsin lakes were observed in the 2010 aquatic plant survey. They are curly leaf pondweed (*Potamogeton crispus*), reed canary grass (*Phalaris arundinacea)*, and aquatic forget-me-not (*Myosotis scorpioides*). More information about several aquatic invasive species is included in Appendix B.

Reed canary grass and aquatic forget-me-not were observed near the boat landing. The reed canary grass covered what appeared to be a small area. The aquatic forget-me-not is covering quite a large area to the east of the boat landing on the north shore, making up what appears to be a monoculture of this plant.

Curly leaf pondweed (CLP) has been mapped several times on Deer Lake. In addition, this plant has been managed through herbicide treatments over the last several years. Twenty-three acres of CLP were treated in May of 2012. This encompassed most of the nuisance level curly leaf beds.

Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Polygonum sachalinense*) are a potential concern for riparian areas of Deer Lake. The Polk County Land and Water Resources 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 Deer Lake. The lake is a popular lake for musky fishing and tournament fishing. Many fishermen travel from the Twin Cities, Minnesota area, and access the lake at the boat landing. With Eurasian water milfoil present in many urban Twin Cities lakes, the danger of transporting plant fragments on boats and motors is very real. According to the Minnesota Sea Grant Office:

> *Eurasian water milfoil can form dense mats of vegetation and crowd out native aquatic plants, clog boat propellers and make water recreation difficult. Eurasian water milfoil has spread to over 150 lakes [in Minnesota], primarily in the Twin Cities area.*

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.

Suitable habitat for northern water milfoil, which is spread throughout Deer Lake, is another factor that increases susceptibility to invasion by Eurasian water milfoil.

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.[10]

As expected, curly leaf pondweed (CLP) was found in few locations in the July 2010 point intercept survey. This is because most of the curly leaf pondweed plants would have died back by early July.

Curly leaf pondweed beds were mapped and inventoried in detail in mid June 2005. These beds had coverage of at least 50 percent CLP, and growth had topped out at the surface. The resulting map is included as Figure 16. The Deer Lake Improvement Association funded the surveys. Additional CLP beds were subsequently located near the Lagoon in the southeast portion of the lake. Aside from the northern shore on the east part of the lake, these beds have been the focus of CLP treatment efforts since that time. Curly leaf pondweed tends to grow in mucky sediments, and locations of mucky sediments are indicated in the map in Figure 17. Because muck is widespread around the lake, this does not seem to be the greatest factor to determine where curly leaf pondweed grows. It is interesting to note that many of the beds are located near where intermittent streams and other runoff (as indicated by red arrows in Figure 16) have brought sediment to the lake over many years.

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

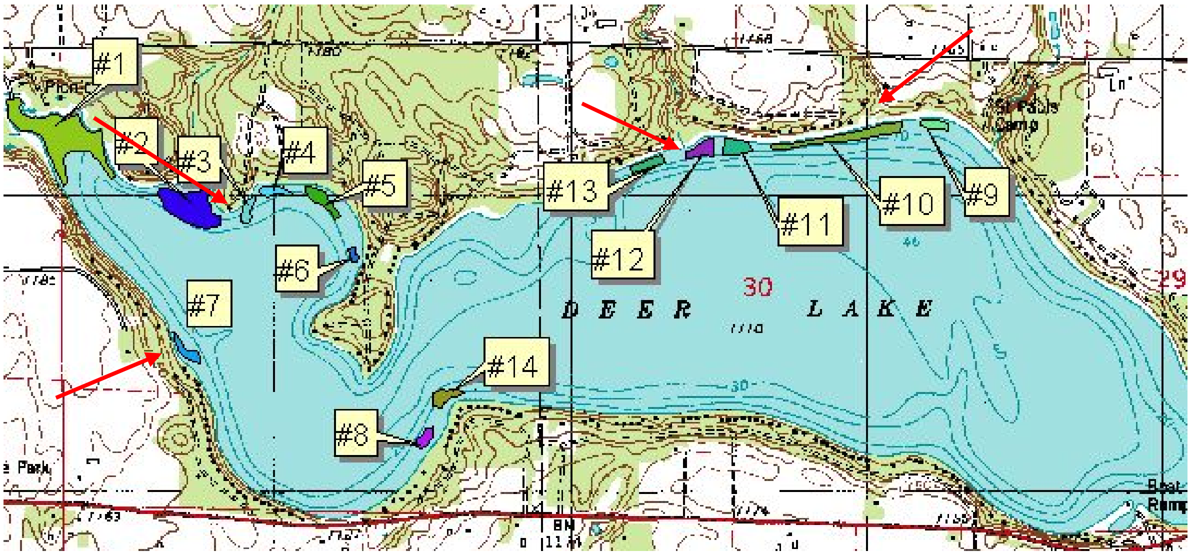

Figure 16. Curly Leaf Pondweed Beds on Deer Lake 2005 (arrows indicate intermittent stream outlets to the lake).

Figure 17. Deer Lake Mucky Sediments 2006

Curly leaf pondweed (CLP) has been mapped and monitored several times since 2005. In addition, this plant was treated with herbicide from 2006-2012. In May 2012, nuisance curly leaf pondweed beds totaling 23 acres were treated. This represents about 9 percent of the littoral area. More information about recent curly leaf pondweed management efforts on Deer Lake follows a general description of management methods available for aquatic plants.

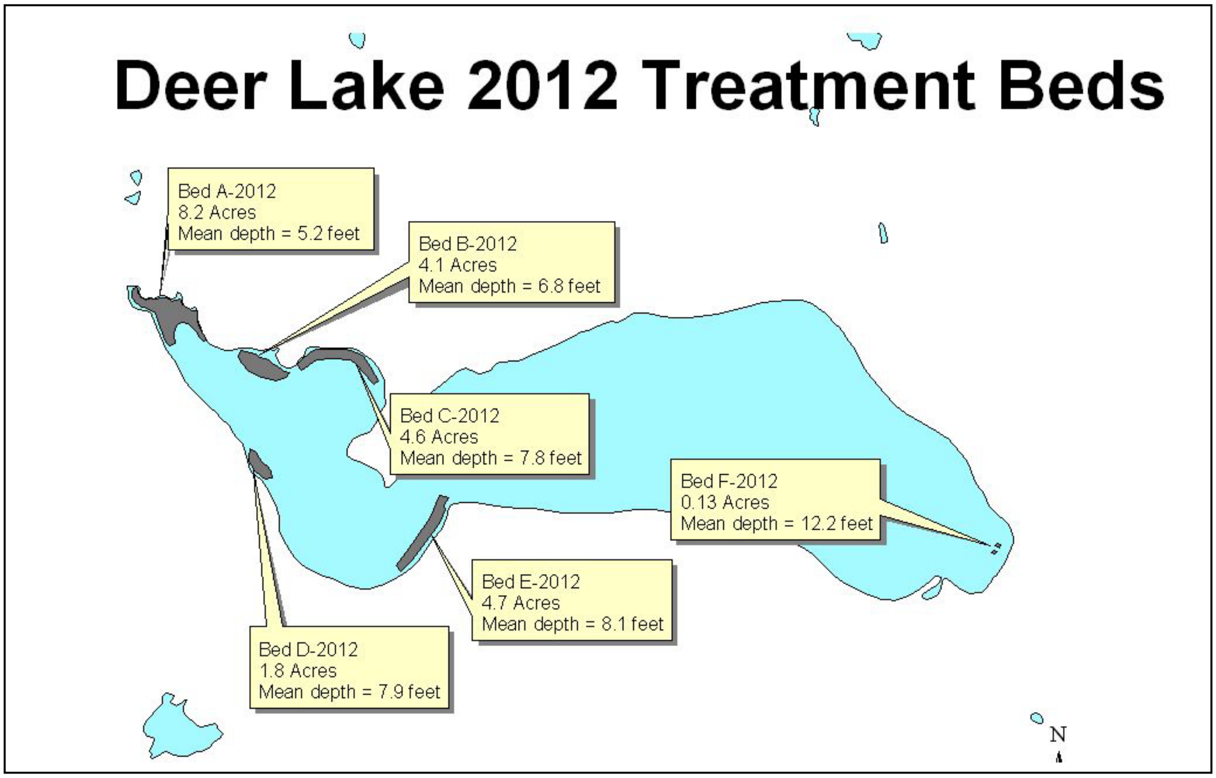

Figure 18. Curly Leaf Pondweed Treatment Areas 2012

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[11] 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 Deer 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[11] corridor. 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.[12]

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 G.

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[11] Because Deer Lake is designated a sensitive area all around the lake's perimeter, the width is reduced to 25 feet or greater.

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

Manual Removal[13]

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 before seed head production. For plants with rhizomatous (underground stem) growth, pulling roots is not generally recommended since it may stimulate new shoot production. Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil introduction and for private landowners who wish to remove small areas of curly leaf pondweed growth. Raking is recommended to clear nuisance growth in riparian area corridors up to thirty feet wide. This is the only form of native plant management supported by the Deer Lake Aquatic Plant Management Plan. Permits for chemical removal in front of individual properties have not been issued since 2007.

SCUBA divers may engage in manual removal for invasive species like Eurasian water milfoil. Care must be taken to ensure that all plant fragments are removed from the lake. Manual removal with divers is recommended for shallow areas if sporadic EWM growth occurs.

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 cut 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.

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

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

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

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

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

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For 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.

If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. 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.

Harvesting is not recommended for Deer Lake. There are very few areas where native plants create navigation problems. Because of contracting and timing difficulties, harvesting is not recommended for curly leaf pondweed management on Deer Lake.

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 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 part 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.

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[14]

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 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.

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

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

Weevils[15] 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 does not appear 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 is probably not necessary on Deer Lake because a healthy, diverse native plant population is present.

Physical Control[16]

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 they involve placing a structure on

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

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

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 Deer 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 Deer 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).

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 algal 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 Deer 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.[17]

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 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.

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

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	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	2,4-D	Water milfoils, water lilies, and bladderwort

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[18]

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) Based on Secchi measurements in Lake Tomahawk and Deer Lake, Deer Lake is in this same nutrient range.

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

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

important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by aquatic vegetation and bound tightly to particles in the water and bottom sediments. When bound to certain types of clay , 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.[19] 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.[20] 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.[21] 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.[22] 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, 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.

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

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[19] Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.
[20] Frank Koshere. Wisconsin DNR. email communication. 3/03/10.
[21] Nault 2010.
[22] Nault 2010.

life cycle can prevent turion formation.[23] 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.[24]

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.[25] Steep drop-off, high winds, and other factors that increase herbicide dilution and contact time can decrease treatment effectiveness.[26] 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.

Early season low-dose endothall treatment for curly leaf pondweed has been used and its effectiveness studied on nearby lakes including Balsam Lake, Bone Lake, and Lake Wapogasset. Efforts guided by consultants common to these lakes, have led to more effective treatment as measured by pre and post monitoring. These efforts include limiting when herbicide application can occur by contact according to wind speed, adding a treatment area surrounding the CLP beds, and increasing the chemical concentration. 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.

Deer Lake Curly Leaf Pondweed Management

The 2006 Deer Lake Aquatic Plant Management Plan recommends an early season endothall treatment for curly leaf pondweed nuisance areas including the boat landing and specific locations along the northeast shore. Areas along the northeast shore have not been treated to date because of steep drop offs that will likely disperse and dilute herbicide.

Three nuisance areas were identified in 2005. These sites are shown as site #2, site #5, and site #7 in Figure 19. Site #1 (the boat landing) was also identified as a nuisance, but originally eliminated for treatment because of its status as a sensitive area. This area had been monitored as the "non-treatment sample site" through 2009. In 2010, it was added as a treatment area. Additional nuisance treatment areas have been identified since 2005, and bed numbers were changed to letters in 2010. The most significant new treatment area is Bed F near the Lagoon in the southeast corner of the lake. This treatment area is shown in Figure 20. The actual sizes of the treatment areas are refined following April/early May pretreatment surveys.

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[23] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.

[24] Plan comments, Frank Koshere, September 16, 2010.

[25] Personal communication, Frank Koshere. March 2005.

[26] *Draft Report Following April 2008 Aquatic Herbicide Treatments of Three Bays on Lake Minnetonka.* Skogerboe, John. Us Army engineer Research and Development Center.

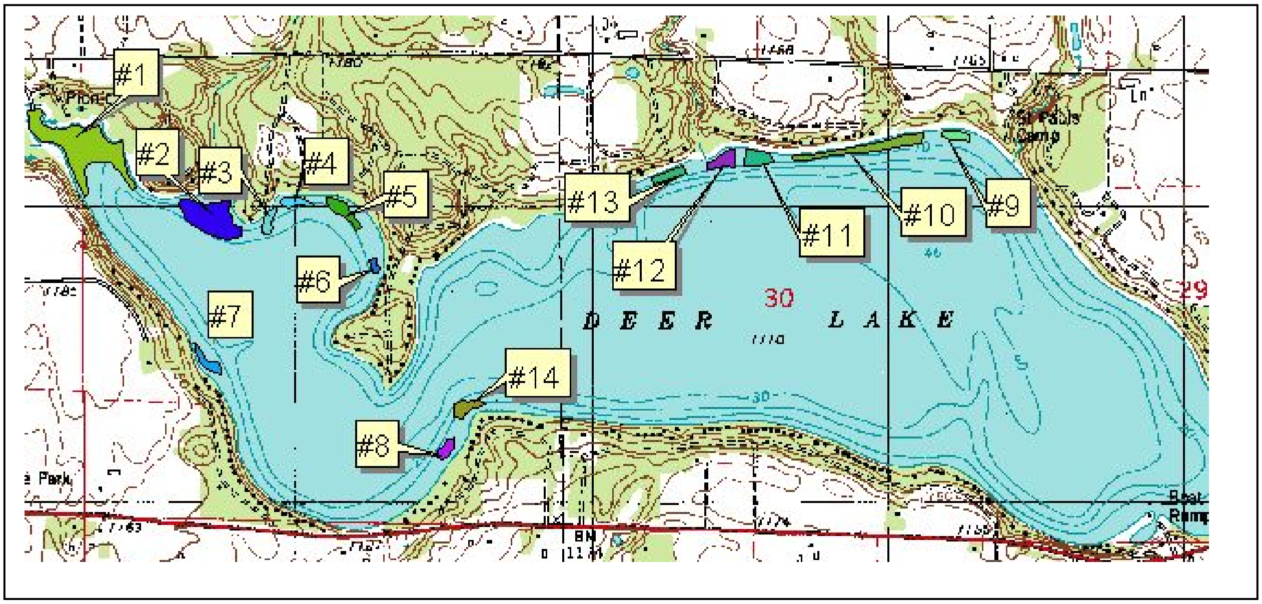

Figure 19. Curly Leaf Pondweed Beds 2005

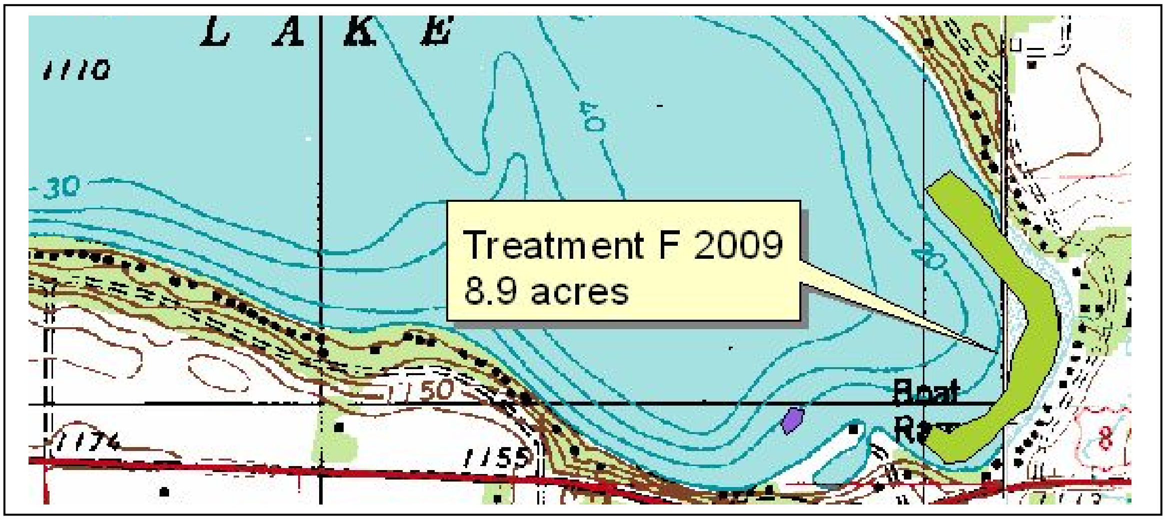

Figure 20. Curly Leaf Pondweed East Treatment Area

Defining nuisance curly leaf pondweed beds (from 2006 APM Plan)
May/June mean density = 4.5 or greater
May/June mean percent coverage = 80 percent or higher
May/June curly leaf pondweed stem growth reaches surface and is thick enough to impede navigation (stem height > 1 meter)

Table 8. Nuisance Curly Leaf Pondweed Beds 2006[27]

Plot #	Mean density	Mean % Coverage	Area
1	4.5	66.25	8.42
2	4.5	85	4.138
5	5	93.3	0.26
7	4.5	82.5	0.61

According to the 2006 aquatic plant management plan, the objectives of the treatment are to 1) reduce the density of curly leaf pondweed below nuisance levels. (The ultimate objective is to remove curly leaf pondweed from these areas. Interim success will be attained when June mean density of curly leaf pondweed is <3 and mean coverage <50%) and 2) to facilitate the growth of native species.

The endothall treatment was planned to occur when water temperatures range from 55 degrees Fahrenheit or greater (to 60 degrees) to target this invasive species before significant native plant growth has occurred and to be above the temperatures when yellow perch are nesting. To limit impacts on black crappie that nest in shallow waters, spraying occurs only at depths greater than 1 meter. Treatment locations are located using GPS equipment, and herbicide application amounts and concentrations are recorded in permit records. The concentration of herbicide used originally was 2.6 gallons per acre or about 0.75 ppm. Beginning in 2010, the target concentration was increased to 1.5 ppm endothall. There was also more emphasis on treating only under calm wind conditions, and the size of some beds was expanded up to 20 feet beyond the extent of CLP growth.

Treatment is preceded and followed by monitoring as specified in DNR pre and post monitoring procedures. Herbicide treatments and pre- and post-treatment monitoring will occur for a minimum of three years following initial treatment success. Monitoring results and research results from other projects will guide potential additional treatments of nuisance curly leaf pondweed areas.

Actual CLP Treatment

The Deer Lake Improvement Association received a permit to treat up to 10 acres of curly leaf pondweed beds according to the Deer Lake Aquatic Plant Management Plan in 2006, 2007, 2008

[27] At the time of the 2006 plan, standardized monitoring methods were not available and a rake density scale from 0 to 5 was used. It was continued throughout implementation of the 2006 plan. Rake density will be changed to a scale from 0 to 3 to be consistent with other lakes in the state with the implementation of this plan.

and 2009. Seven acres were treated in 2006, and about 10 acres were treated in 2007 and 2008. Because of communication challenges, only 7 acres were treated in 2009. A permit was granted to add additional nuisance beds and treat 32.5 acres in 2010. Treatments and results are summarized in Table 9. Pre and post-treatment monitoring was conducted each year according to standard DNR methods once available. Early monitoring in 2005 and 2006 preceded availability of standardized methods. A DNR grant (ACEI-024-07) supported CLP control efforts from 2007-2010.

The 2010 treatment was effective with significant reductions in frequency and density of CLP compared to 2009 in each treatment bed. However, post monitoring results indicate some minor changes in native plant abundance and diversity following the 2010 herbicide treatment, especially in shallow waters. Treatment concentration will be carefully checked in these shallow areas, and changed as needed.

In 2011, treatment concentrations were below targeted application rates. In 2012, treatment concentrations were as specified, and the treatment results were good. Figure 21 illustrates the CLP beds that were treated in 2012. The analysis of the treatment shows that from 2011 to 2012, CLP was significantly reduced in all beds. The frequency of occurrence of CLP went down from 0.49 in 2011 (after treatment) to 0.11 in 2012 (after treatment) for a decrease of 0.38. The 2012 Herbicide Treatment Analysis is included as Appendix D.

Table 9. Deer Lake Curly Leaf Pondweed Treatment[28]

	Acres	Date of Treatment	Concen-tration of Endothall	Water Temperature	Wind Speed	Effective Control?	Impacts to Natives
2006	7.35	May 30	2.5 gal/acre[29]	60 F	5-10 mph	**No**	None detected
2007	9.99	May 22	2.5 gal/acre	58 F[30]	10-15 mph	**No**	None detected
2008	9.95	May 20	2.6 gal/acre	52 F (49?)		**Maybe** – less density than control area; Bed 2 decreased in area by 25%	None detected
2009	7	May 21	2.6 gal/acre	?	18 mph, gusts to 28	**No**	None detected
2010	32.5	May 18	4.9 gal/acre[31]	56 F	5 mph	**Yes**	Yes
2011	24.61	May 29	3.3 gal/acre[32]	56 F	0 to 5 mph	**No**	Uncertain
2012	23.4	May 9	6.8 gal/acre[33]	58 F	4 mph	**Yes**	None detected

[28] Information Aquatic Plant Management Herbicide Treatment Records submitted by the applicator to DNR.
[29] At an average depth of 6 feet, this is equivalent to about 0.75 ppm application rate.
[30] Not recorded on permit report. Information from applicator.
[31] At an average depth of 6 feet, this is equivalent to about 1.25 ppm application rate.
[32] At an average depth of 6 feet, this is equivalent to about .5 gal/acre feet or < 1ppm
[33] At an average depth of 6.4 feet, this is equivalent to about 1.5 ppm application rate

Figure 21. Curly Leaf Pondweed Treatment Areas 2012

Turion Monitoring

Turions are the reproductive structures from which new CLP plants will germinate in late fall and early spring. CLP turions can live in lake sediments for many years. A primary objective of the CLP herbicide treatment program is to kill CLP plants before they can form turions, thereby depleting the turion bank in the sediments and preventing future CLP growth.

Turion monitoring measures the density of turions in the sediment. Turion sediment monitoring is conducted late in the summer after CLP plants die back. A sediment sampler is used to collect bottom sediment at several randomly selected sample points within the treatment beds. The sample is then filtered with a filter bucket, and the turions are counted. Because the sample collection area is known, the number of turions per square meter of lake bed can be estimated.

Repeated years of turion density measurements provide a means to predict the following year's CLP growth and to evaluate the long term effectiveness of the herbicide treatment program. The data will aid in decisions regarding continuation or suspension of herbicide treatment. Turion monitoring is recommended for Deer Lake CLP management.

Filamentous Algae Treatment

The Deer Lake Improvement Association used copper sulfate compounds to alleviate nuisances caused by filamentous algae for many years on Deer Lake. In recent years, treatment frequency has decreased drastically. In 2008, there were 7 occasions when copper sulfate was used to treat filamentous algae, in 2009 there was 1, and in 2010 and 2011 no filamentous algae treatments occurred. Reductions in treatment are a result of both different treatment standards and reductions in filamentous algae growth. The conditions of the 2006 aquatic plant management plan required that filamentous algae must be matted at the surface rather than attached to plants near bottom sediments before treatment is authorized.

Past Aquatic Plant Management

As reported in the 2006 aquatic plant management plan, the Deer Lake Improvement Association contracted with an herbicide applicator to conduct inspections for the presence of Eurasian water milfoil near the boat landing and for filamentous algae along the littoral zone from 2000-2005.

Nuisance levels of filamentous algae were treated with copper compounds. Up to 15 acres of treatment area were allowed at any one time. From 1993 – 2000 up to five acres at a time were treated for filamentous algae control. Algae treatments are managed by the Deer Lake Improvement Association Environmental Committee Chair. No treatment is permitted unless floating mats exceed one thousand square feet. There was no filamentous algae treatment in 2010 or 2011, 2.2 acres treated in 2009, and 2.8 acres treated in 2008. Copper sulfate treatments are at a rate of 10 pounds per acre. Chelated forms of copper sulfate such as Cutrine Plus may be advantageous because they tend to stay in solution longer than copper sulfate.[34]

In 2003 the boat landing area was treated with herbicides with the express purpose of preventing the introduction of Eurasian watermilfoil in this area. More recent analysis has shown this practice unacceptable for invasive species prevention. Instead, education and monitoring efforts are stressed. The Department of Natural Resources permitted the treatment for the purpose of allowing boats to pass each other and navigate from the boat landing. Individual access corridors (limited to a 25 foot width) were treated with herbicide only at a landowner's request and expense. Many years ago the treatments were allowed for the entire riparian frontage. In 2007, 49 owners received permits for 25 foot wide herbicide treatments. From the early 1980’s through 2006, there were 40 to 69 owners who received permits.

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.[35] 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.

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[34] J. Aquat. Plant Manage. 34:39-40. 1996.

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

Herbicide treatments for navigation in the lagoon area (southeast corner of the lake) were permitted in 2008 through 2012. These treatments extended 30 feet beyond the docks. Herbicides used include Cutrine (copper sulfate), Aquathal K (liquid endothall) and Reward. These treatments were privately managed by the Lagoon Association. Any future treatments need to be reviewed and authorized according to guidance in this aquatic plant management plan.

Clean Boats Clean Waters

The Clean Boats, Clean Waters (CBCW) program inspects boats for invasive species, educates boaters on invasive species and the local and state Aquatic Invasive Species (AIS) rules, and gathers data.

A Clean Boats, Clean Waters program began at the Town of St. Croix Falls boat landing on Deer Lake in 2006. It has continued through 2012 with the exception of 2008 when multiple interns who were offered the job did not accept it. The boat landing was generally staffed on weekends from Memorial Day through late August or early September. Anglers who generally come to the landing during the week seem to do a good job following requirements. Staffing highlights are included in the Table 11. Interns are paid $12/hour and volunteer about 1/3 of their time to match the grant. The Town of St. Croix Falls provides payroll services for the program.

Table 10. Clean Boats Clean Waters Program Summary

	2006	**2007**	**2009**	**2010**
Students Involved	College Intern	College Intern	College Intern; HS Students	High School Students
Total Inspection Hours	275	154	465	352
Paid Hours	275	154	420	219
Volunteer Hours	0	0	45	133
Number of Inspections	750	698	766	659

College interns were trained by the program consultant, Steve Schieffer in 2006 and 2007. In 2009 and 2010 students attended training sponsored by the Balsam Lake P&R District and Polk County Land and Water Resources Department. Those students who did not attend the training were trained by those who did attend. In 2011 and 2012 the adult supervisor and returning interns trained new staff.

Aquatic Invasive Species Monitoring

Interns also monitored the boat landing and other areas around the lake for potential introduction of invasive species. In 2006 and 2007, the monitoring focused on areas near the boat landing and the Lagoon a private boat landing on the southeast shore of the lake. In 2008 consultant Steve Scheiffer conducted this monitoring. In 2009, the college intern checked 50 GPS points around the lake to look for invasive species. The focus of the monitoring each year was to check for Eurasian water milfoil in the lake and purple loosestrife along the shoreline. No invasive species other than curly leaf pondweed were found in any of the sampling.

The herbicide applicator monitors the boat landing for invasive species including Eurasian water milfoil (EWM) monthly from May to September. Monitoring is visual from a boat. Deer Lake has had volunteers who regularly look for EWM and other invasive species, but has not documented these hours. Volunteer training, monitoring and recording will be expanded with the implementation of this plan. It will be backed by professional monitoring twice each year.

Rapid Response

The DLIA approved a rapid response policy at a board meeting June12, 2010. It authorizes the DLIA Environment Committee Chair to spend up to $15,000 for rapid response for Eurasian water milfoil. Further spending can be authorized with approval of two DLIA officers.

Polk County Land and Water Resources Department (LWRD)

The DLIA can obtain assistance with training and educational activities from the Polk County Land and Water Resources Department and the Polk County Lakes and Rivers Association. Volunteers will be trained through Clean Boats, Clean Waters workshops in cooperation with the Polk County LWRD. County staff is also willing to provide plant identification assistance.

Polk County has a Do Not Transport Ordinance and will be placing 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.

Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for Deer 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. The goals remain unchanged from the 2006 APM plan.

Objectives are the steps toward the goal.

Actions are taken to accomplish objectives and ultimately goals.

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

Plan Goals

1) Protect and restore healthy native aquatic plant communities.

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

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

4) Reduce filamentous algae density.

5) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

6) Reduce levels of nuisance aquatic plants to allow safe, enjoyable recreation such as swimming and boating.

Responsible Parties for APM Implementation and Monitoring

Deer Lake Improvement Association Board (DLIA) – elected representatives responsible for oversight of the lake association. Some actions may require a vote of the board.
Environment Committee Chair – makes day-to-day APM decisions and directs contractors in herbicide treatments and aquatic plant monitoring. The director will have interns, volunteers and consultants to assist in these activities. The DLIA Environment Committee Chair is currently Steve Schletty.
CBCW Lead – leads and coordinates volunteer AIS education activities including Clean Boats, Clean Waters monitoring and education at the boat landings and lake monitoring. The CBCW Lead is currently Mark Thayer.
Herbicide Contractor – the herbicide applicator hired by the DLIA Board to complete herbicide treatment as permitted by the Wisconsin Department of Natural Resources. The current Herbicide Contractor is Lake Management.
APM Monitor– a consultant hired to complete monitoring under the direction of the APM Lead and the DLIA Board. The current APM Monitor is Steve Schieffer with Ecological Integrity Service.
Plan Consultant – facilitates public involvement and writes the APM plan. The plan consultant also assists the Environment Committee Chair in managing plan actions as needed. The current plan consultant is Cheryl Clemens with Harmony Environmental.
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 will help with education and plant identification.

Aquatic Plant Management Plan Outreach

Plan Action
Deer Lake residents will be aware of this aquatic plant management plan and its recommendations through newsletter articles and handouts and presentations at annual meetings.

Goal 1) Protect and restore healthy native aquatic plant communities.

Discussion
Deer Lake supports a healthy and diverse native plant community that is well-above average when compared to other lakes within the North Central Hardwoods Ecoregion of Wisconsin. The littoral zone, which contains all of the aquatic vegetation, occurs in a relatively narrow band around the lake margins. If waterfront property owners spray even narrow corridors in front of their properties, the result would be significant negative effects on healthy, desirable native stands of plants. Native aquatic plants are responsible for the lake's excellent fisheries and they help to sustain high water quality. Removing extensive areas of native plants would remove the benefits they provide and potentially hasten the spread of undesirable non-native plants such as curly pondweed or even Eurasian watermilfoil (if introduced). Public information and education will remain important for successful native aquatic plant protection.

Aquatic plant habitat and ecosystem values
The management challenge for Deer Lake is to control aquatic plant nuisances without unduly damaging native plants and their benefits in the lake. For this to occur, residents must understand the values of aquatic plants in Deer Lake. An important educational message will be communicating the distinction between "good plants" and "bad plants." Most plants are good: in fact, a diverse native plant community is essential for a healthy lake ecosystem. Others are bad: invasive species may displace native aquatic plants and their benefits.

Waterfront activities
Another important message will be to discourage boating disturbance within 200 feet of the shoreline. Although this is a no-wake zone according to state regulation, many boaters still travel above wake speed close to the shoreline. This activity is strongly discouraged for the following reasons:

- Boats may uproot native plants and break aquatic plants into fragments
- Bare substrate is more likely to be colonized by non-native species
- Plant fragments contribute phosphorus to the water as they decay
- Curly leaf pondweed fragments broken up by boat propellers may root and encourage further spread of this invasive plant.

Waterfront residences can also negatively affect native plant communities by causing disturbance of existing plant beds and altering sediment characteristics. Regular waterfront use like boating, swimming, and clearing removes native aquatic plants. Erosion and runoff from waterfront property may alter sediment characteristics and encourage the spread of invasive plants.

Large-scale management of curly leaf pondweed
Continued early season herbicide treatment of curly leaf pondweed is recommended as long a treatment success is demonstrated. Success is measured by the reduction in curly leaf pondweed without statistically significant damage to native plant populations. Success of curly leaf pondweed treatment and impact to native plants will be measured through standard DNR pre and post monitoring methods.

Curly leaf pondweed awareness
Resident understanding of the distinction between curly leaf pondweed and native aquatic plants is critical. With a better understanding of curly leaf pondweed's growth characteristics and negative impacts to the lake, residents may be encouraged to change their purpose from removing all aquatic plants (weeds) to a desire to control the invasive curly leaf pondweed. Poorly informed lake residents may chose wholesale control of "weeds" if unable to distinguish between aquatic plant nuisances of invasive plants from the relative values of native aquatic plants. Better understanding and promotion of reasons for controlling curly leaf pondweed may reduce the desire for complete plant removal.

Objectives

- Lake residents understand the benefits of native aquatic plants and the means to protect them.
- Lake residents can distinguish between native plants and invasive species such as curly leaf pondweed and Eurasian water milfoil.
- Restore the lake's ecosystem by promoting the replacement of curly leaf pondweed with native aquatic plants. (Detailed control actions under Goal 5)

Actions

1. Provide residents with written materials and present information regarding aquatic plant values, and methods to limit impacts to them, at annual meetings and in newsletters.

2. Conduct an early season, low dose endothall treatment to reduce curly leaf pondweed growth (methods covered under Goal 5).

3. Clearly communicate the curly leaf pondweed strategy to lake residents. The DLIA will provide residents with the information needed to accurately identify curly leaf pondweed. Residents will be encouraged to hand-pull small stands in the lake in front of their property. The importance of positive identification and removal of plant fragments will be emphasized. Residents will be asked to let the DLIA Committee Chair know if they pulled CLP, so that their site may be monitored in future years.

4. Conduct whole lake aquatic plant surveys every five years to track plant species composition and distribution. These surveys are conducted using standardized DNR methods and assigned GPS points. Whole lake plant surveys will include identification and measurement of relative abundance of filamentous algae at each sample point.

Goal 2) Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.

Discussion
With many Twin Cities lakes infested with Eurasian water milfoil, the threat of introduction to Deer Lake is high. Many other invasive species such as zebra mussels, Asian carp, and purple loosestrife also pose a threat to Deer Lake.

A Clean Boats Clean Waters (CBCW) Program has been present at the Deer Lake public landing since 2006. Program activities include inspecting watercraft and educating residents and visitors regarding identification, threats, and control of aquatic invasive 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. Continue the Clean Boats Clean Waters Program at the Town of St. Croix Falls public boat landing to educate boaters entering Deer Lake and encourage voluntary inspection and compliance. Continue the successful partnership with the Town of St. Croix Falls for payroll services.

2. Maintain invasive species prevention signs at the boat landings.

3. Request that the fishing tournament sponsors provide boat and trailer inspections using accepted invasive species prevention techniques.

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

5. Gather and assemble public information materials about invasive species prevention for distribution to Deer Lake residents. Residents will be provided with written materials and presented with information at annual meetings and in newsletters.

Goal 3) Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.

Objectives

- Detect newly introduced invasive species early.
- The DLIA is ready to respond to invasive threats which are discovered.

Actions

Follow the Rapid Response Plan in Appendix F.

- Train and support lake resident volunteers to identify Eurasian water milfoil and other invasive plants.
- Continue professional monitoring for invasive species at the public boat landing in June and August.
- Expand professional monitoring to the private boat landing at the Lagoon.
- Establish a non-lapsing contingency fund of at least $15,000 for removal of invasive species.
- Designate board and resident responsibilities for the Rapid Response Plan annually.

Discussion Regarding Monitoring

Monitoring for the presence of Eurasian water milfoil and other aquatic invasive species is critical for a successful rapid response program. The public boat landing at the northwest corner of the lake and the private landing on the southeastern shore will be the focal points for monitoring. Invasive species introduction is most likely here in these high use locations. Deer Lake inflows are not connected to other lake systems, so these areas will not be targeted. Instead, lake residents will be encouraged to learn to identify Eurasian water milfoil and purple loosestrife, and a contact for positive identification of potential specimens will be made available.

4) Reduce filamentous algae density.

Discussion

The long-term strategy for filamentous algae management is to reduce watershed inputs of phosphorus. Significant decreases in watershed inputs of phosphorus have greatly reduced the need for filamentous algae treatments. However, occasional nuisance growth of filamentous algae still occurs. The DLIA wishes to maintain the flexibility to treat nuisance levels of filamentous algae with copper compounds as a last resort.

Objectives

- Maintain navigation and aesthetic values of Deer Lake.
- Eventually eliminate the need for algaecide treatments.

Actions

1. Use algaecide treatments to alleviate the impacts of nuisance algae blooms. Filamentous algae treatments will be used to control nuisances only when needed in the near-term. Reducing lake phosphorus may reduce these nuisances in the long-term.

Identifying nuisance growth of filamentous algae:
100% of rake samples have filamentous algae present
Floating mats exceed 1,000 square feet in aerial coverage
Algaecide treatment will occur only when total mats identified exceed 1 acre

2. The DLIA Environment Committee Chair or board member designee will continue to check for the presence of filamentous algae. The Herbicide Contractor will use GPS equipment to map locations of nuisance occurrence prior to chemical (copper compound) applications. Extent of nuisance occurrence will be related to in-lake phosphorus levels as collected by self-help monitor volunteers.

3. Monitor effectiveness of chemical filamentous algae treatment. Rake samples will be collected to assess abundance of filamentous algae and the aerial extent of floating mats in treatment and nearby control areas also identified with nuisance conditions. Effectiveness will be measured at two days and one week following treatment.

4. Potentially assess levels of copper in Deer Lake sediments.

5) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

Objectives

- Success will be attained when treatment measures eliminate CLP beds as defined below with minimal damage to native plants.
- In recent years all CLP growth in dense beds is limited to treatment areas.
- Facilitate the growth of native species.

Defining curly leaf pondweed beds
May/June mean rake density = 2or greater (CLP rake density is measured on a scale from 0 to 3)
May/June mean percent coverage = 50 percent or higher
May/June curly leaf pondweed stem growth reaches surface and is thick enough to impede navigation (stem height > 1 meter)

Actions

1. Continue intensive early season curly leaf pondweed treatment using a low-dose Endothall treatment.
    - Apply for APM permit
    - Verify CLP bed boundaries with pre-monitoring in April or May
    - Complete early season herbicide treatment when water temperatures are between 55º and 60º F and wind is calm.

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

3. Map CLP beds each year at or near the time of the post monitoring survey. This mapping will define nuisance CLP beds for treatment in following year(s). All nuisance CLP beds with likely treatment success will be identified for treatment.

4. Conduct annual monitoring of sediment CLP turions in early to mid summer. Sediment turion monitoring will help to predict CLP growth in the following year.

5. As bed densities and acreage decline, consider removing late season (June – August) curly leaf pondweed growth by encouraging hand-pulling by residents or hiring SCUBA divers.

The endothall treatment will occur when water temperatures are approximately 55º Fahrenheit or greater to target this invasive species before significant native plant growth has occurred, and following spawning times for yellow perch. To limit impacts to native plants, no herbicide treatment will occur above 60º F. To limit impacts on black crappie that nest in shallow waters, spraying will occur only at depths greater than 1 meter. Treatment locations will be located using GPS equipment, and herbicide application amounts and concentrations will be recorded. The concentration of herbicide is 1.5 ppm endothall. Pre and post monitoring will be completed according to standardized DNR methods. Herbicide treatments and pre and post treatment monitoring will occur for a minimum of three years. Monitoring results and research results from other projects will guide potential additional treatments of nuisance curly leaf pondweed areas.

6) Reduce levels of nuisance aquatic plants to allow safe, enjoyable recreation such as swimming and boating.

Individual Access Corridor Management

Discussion

Aquatic plants sometimes create nuisances for residents attempting to swim and boat from the shoreline. However, it is important that residents are aware of the risks of complete clearing of access corridors. Native aquatic plants provide critical habitat for fish and other aquatic creatures. Corridors cleared of native plants may provide sites for colonization by invasive, non-native species.

Herbicide treatment of individual access corridors has been allowed in only a few cases on Deer Lake since the DNR Northern Region office changed its native plant management policy in 2007. Hand pulling is allowed in an area up to 25 feet wide on Deer Lake. (This is 30 feet wide on most lakes, but on Deer Lake the entire lake fringe is considered a sensitive area.) Because native plants prevent the establishment of Eurasian water milfoil and provide important water quality and habitat benefits, there is no plan to open up herbicide treatment for individual corridors around Deer Lake. A channel out from the public boat landing is generally navigable as a result of boat traffic.

Herbicide and algaecide treatment has been allowed at the Lagoon for the past three years. The DLIA Environment Committee Chair was asked to evaluate plant growth that first year of treatment to see if the DLIA had any objections to the use of herbicide there. Since then, the DNR has allowed herbicide treatment with no DLIA overview. The threshold to allow treatment according to DNR policy is "severe navigation impairment." Navigation is deemed impaired when it is not possible to navigate through an area with a motor boat.

The only time a permit is <u>not</u> 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 25 feet or less in width along the shore. The non-native invasive plants (Eurasian water milfoil, curly leaf pondweed, and purple loosestrife) may be manually removed beyond 25 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 twenty-five feet wide and must remain in the same location from year to year.

Guidance for Deer Lake Property Owners

1. Herbicide control of nuisance aquatic plants for boat access and swimming is discouraged because of potential damage to this critical habitat zone.
2. The DNR currently restricts any native plant removal in the littoral zone (area where plants grow) adjacent to private residences to a width of no more than 25 feet.
3. Residents wishing to control curly leaf pondweed with hand pulling may do so throughout their shoreline area, but must be confident of plant identification and remove all plant fragments.
4. Residents who pull curly leaf pondweed should notify the DLIA Environment Committee Chair by June 1 of the same year, so that these sites can be noted in the plant survey. An annual mailing from the lake association will remind residents of the desired control methods and request notification.
5. Nuisance aquatic plant growth in July and August should be controlled in the access corridors using manual means such as plant rakes. Plant fragments should be removed from the lake and placed on an upland area such as a garden or compost pile.
6. Herbicide treatment of access corridors should be used as a last resort for areas with severe navigation impairment. The only potential area of the lake that may meet this threshold is the Lagoon on the southeast corner of the lake. DLIA representatives may assist the DNR in monitoring navigation impairment from native aquatic plants in the Lagoon.
7. The DNR will provide inspection and direction for any native plant management.

Implementation Plan for DLIA[37]

Goal 1) Protect and restore healthy native aquatic plant communities.					
Actions[38]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources[39]**
Resident education - newsletter	Annually	$500 for printing and postage	10 hours for APM information	DLIA Newsletter Lead Environment Committee Chair Plan consultant (as requested)	AEPP ACEI DLIA
Resident education - website	Ongoing	$0	As needed	DLIA Website Lead	AEPP DLIA
Resident education – annual meetings	July each year	$50 (for handouts)	10	Environment Committee Chair	DLIA
Whole Lake Aquatic Plant Survey	July/August 2015	$6,000	0	APM Monitor	AIS grants (not included yet)
Update the Aquatic Plant Management Plan	2016	$4,000	40	DLIA Board Plan Consultant	AIS grants (not included yet)
Apply for AIS Education Grant	August 2013 or Feb. 2014	$1,000		Plan Consultant	DLIA
Apply for AIS Control Grant	Feb or August 2014	$1,000		Plan Consultant	DLIA
SUBTOTAL GOAL 1					

[37] Costs are annual costs estimated for initial implementation. These costs will be reviewed each year during the DLIA budgeting process.
[38] See previous pages for action detail.
[39] AEPP = Aquatic Education, Prevention, and Planning Aquatic Invasive Species Grant currently funded at 75% state share for 2012 and 2013.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2012 to 2014.
DLIA = Deer Lake Improvement Association

Goal 2) Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.					
Actions[40]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[41]
Clean Boats, Clean Waters	May to September	$4,000 (annually)	125	CBCW Lead Town of St. Croix Falls CBCW Interns	AEPP
Maintain/add boat landing signs	As needed	$750	10	CBCW Lead Plan Consultant	ACEI
Tournament CBCW education	Fishing tournaments	$0	As needed	DNR Balsam Lake Rod and Gun Club	Balsam Lake Rod and Gun Club
Encourage Do Not Transport Ordinance enforcement	May to September	$0	20	Environment Committee Chair CBCW Lead	
Education actions – see Goal 1					
SUBTOTAL GOAL 2					

[40] See previous pages for action item detail.

[41] AEPP = Aquatic Education, Prevention and Planning Aquatic Invasive Species Grant currently funded at 75% state share for 2012 and 2013.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2012 to 2014.

Goal 3) Rapidly respond to eliminate any newly introduced invasive, non-native aquatic plant species.					
Actions[42]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources[43]**
Train lake resident volunteers	As needed	$0	10	Lake Volunteers	AEPP
AIS Monitoring at the boat landing	May to September	$500	20	Environment Committee Chair	AEPP (need to add task to grant)
AIS Monitoring at the Lagoon	June to September	$500	20	DLIA	AEPP
Establish non-lapsing contingency fund	2012	$30,000	5	DLIA Board	DLIA
Review rapid response plan	Annually		5	DLIA Board	NA
SUBTOTAL GOAL 3					

[42] See previous pages for action item detail.
[43] AEPP = Aquatic Education, Prevention and Planning Aquatic Invasive Species Grant currently funded at 75% state share for 2012 and 2013.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2012 to 2014.
DLIA = Deer Lake Improvement Association

4) Reduce filamentous algae density.					
Actions[44]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources[45]**
Use algaecide treatments to control nuisance algae blooms	Up to 7 times each year	Up to $8,100	0	Herbicide Contractor Environment Committee Chair DLIA Board	DLIA
Monitor for filamentous algae	Weekly		40	DLIA Board	DLIA
Monitor effectiveness of filamentous algae treatments	Up to 7 times each year		40	DLIA Board	DLIA
Test copper in Deer Lake sediments	?	$300	20	DLIA Board	DLIA
Subtotal GOAL 4					

[44] See previous pages for action item detail.
[45] DLIA = Deer Lake Improvement Association

5) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.

Actions[46]	Timeline	$ Estimate	Vol. Hours	Responsible Parties	Funding Sources[47]
Review navigation impairment at the Lagoon	As needed		10	DNR DLIA Board	
CLP – Apply for permit	Jan or Feb	$525	5	Herbicide Contractor Environment Committee Chair	ACEI DLIA
CLP - Verify treatment beds	April/May	$500	0	APM Monitor	ACEI
CLP – Herbicide treatment	May	$14,000 to $20,000	0	Herbicide Contractor	ACEI
CLP- Treatment inspection	May/June	$300	0	APM Monitor	ACEI
CLP – Post monitoring	June	$500	0	APM Monitor	ACEI
CLP – CLP bed mapping	June	$400	0	APM Monitor	ACEI
CLP – Turion monitoring	July/August	$500	0	APM Monitor	ACEI (need to add grant task)
Project coordination	Ongoing	$500	0	Plan Consultant	ACEI
Subtotal GOAL 5		$17,225 - $22,225	15		

46 See previous pages for action item detail.
47 AEPP = Aquatic Education, Prevention and Planning Aquatic Invasive Species Grant currently funded at 75% state share for 2012 and 2013.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2012 to 2014.
DLIA = Deer Lake Improvement Association

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. Native plant and filamentous algae management are not eligible grant activities. 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 DLIA currently has an AIS grant for implementation of the Clean Boats, Clean Waters program and related educational activities. The grant (AEPP-308-12) provides $9,987 in grant funds for 2012 and 2013. A second grant (ACEI-105-12) is in place to support curly leaf pondweed control and monitoring for 2012 through 2014. This grant provides $39,875. It is a 50% grant.

Appendix A. Public Opinion Survey Results

DEER LAKE CONSERVANCY
Online Survey Results

Total Respondents = 50

1. Please indicate your membership. (Check all that apply.)

Choices	Percentage	Count
Deer Lake Property Owner	32.12%	44
Lake Association Member	29.93%	41
Deer Lake Conservancy Member	29.20%	40
Deer Lake Conservancy Board Member	5.11%	7
Lake Association Board Member	3.65%	5
	Unanswered	*1*

2. How long have you, or your family (immediate or extended), owned your Deer Lake property? (Choose one.)

Choices	Percentage	Count
20 or more years	46.00%	23
10 - 14 years	22.00%	11
5 - 9 years	12.00%	6
15 - 19 years	12.00%	6
0 - 4 years	8.00%	4
	Total	**50**
	Unanswered	*1*

3. Please list the number of people who regularly use your property?

	Adults	Children
Average #	4	2
Highest	28	18

4. Which of the following best describes how often you use your Deer Lake home/property? (Choose one.)

Choices	Percentage	Count
During weekends, vacations and/or holidays	60.42%	29
Full-time residency	25.00%	12
Seasonal - continued occupancy for months at a time	14.58%	7
	Total	**48**
	Unanswered	*3*

5. **Why do you own property on Deer Lake?** (Check all that apply)

Choices	Percentage	Count
Gathering place for family and friends	44.21%	42
Family legacy	23.16%	22
Private getaway	20.00%	19
Investment	12.63%	12
	Unanswered	6

Other:

- Full time residence
- Full time home
- I have always wanted to live on a lake.
- Great water ski lake and fishing lake!

6. **If you purchased your property within the last 3 years, why did you choose Deer Lake over other properties?** (Check all that apply.)

Choices	Percentage	Count
Proximity to Minneapolis/ St. Paul	50.00%	6
Water quality is better than other lakes	33.33%	4
Better value for the money	8.33%	1
Looked more natural/less developed than other lakes	8.33%	1
	Unanswered	45

7. **How much do you enjoy the following recreational activities?**

	Not at all	Some	Quite a Bit	A Great Deal
Appreciating peace & tranquility	2%	2%	25%	71%
Enjoying the view	0%	6%	10%	83%
Observing wildlife	0%	23%	26%	51%
Wind surfing	91%	9%	0%	0%
Scuba diving or snorkeling	87%	9%	0%	4%
Swimming	4%	34%	28%	34%
Fishing	10%	31%	25%	33%
Jet skiing	80%	9%	11%	0%
Motor boating	2%	9%	52%	37%
Non-motorized boating	24%	48%	24%	4%
Water skiing/Wakeboarding/Tubing	21%	21%	32%	26%
Using Deer Lake trails	15%	54%	20%	11%

Other:

- Walking, enjoying Polk County area

8. Which Deer Lake trails do you use? (Check all that apply.)

Choices	Percentage	Count
Flagstad Farm	37.50%	24
Rock Creek Trail	28.12%	18
Dry Creek Trail	20.31%	13
I use the trails but don't know their names	14.06%	9
	Unanswered	*14*

9. To what extent are the following issues of concern to you?

	Not at all	Some	Quite a Bit	A Great Deal
Lack of water clarity in the middle of the lake	24%	30%	30%	15%
Lack of water clarity near my shoreline	20%	20%	20%	41%
Excessive invasive aquatic plant growth*	0%	11%	15%	74%
Excessive native aquatic plant growth**	2%	29%	18%	51%
Swimmer's itch	15%	30%	15%	40%
Protecting the lake environment	2%	2%	25%	71%
Maintaining the investment value of my property	2%	7%	30%	61%
Minimizing maintenance needs	9%	27%	44%	20%
The cost of property taxes	0%	10%	33%	56%

Other:

- I would like to see rules and fines enforced more. It also helps the value of property.
- Low water level. It has been significantly low. boats getting stuck on lifts???? Even after considerable and countable rainfalls, no improvement. Why???
- Increased native weeds being blown to our shoreline, presumably torn up from the boats at the public boat landing. It is inappropriately located in Tipperary. It is clear that native plants with roots are being torn up by the boats--dramatic increase in the last couple of years.
- Swimmers itch was a great concern to me this year.
- My family and I are very worried about the taxes and whether it will price us out of living on the lake. We also have a great deal of lake stuff that come in and it takes a lot of work to remove the floating weeds, leaves, dead fish and other lake items so that we not have a smelly property and can swim or ski from in front of our home.
- No consistency in the enforcement of zoning codes.

* **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.

****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.

10. Please indicate how much each of the following <u>negatively</u> impacts your use of the lake.

	Not at all	Some	Quite a Bit	A Great Deal
Algae growth	11%	34%	23%	32%
Small fish size	57%	35%	7%	2%
Not enough fish	62%	27%	7%	4%
Lake level too high	86%	14%	0%	0%
Lake level too low	22%	20%	26%	33%
Native aquatic plant growth	11%	36%	31%	22%
Invasive aquatic plant growth	11%	17%	17%	54%
Loss of wildlife habitat	27%	24%	24%	24%
Boat congestion	22%	41%	20%	17%
Noise from motorized vehicles	28%	40%	15%	17%
Noise from people	37%	46%	11%	7%
Loss of natural scenery	27%	36%	18%	20%

Other:

- 1) illumination at night. cabins with constant (solar??) lights on at night disturbing the beauty of the sky (star gazing, etc.). 2) Boats with the speakers mounted and music disturbing others. there should be some regulation as this is VERY DISTURBING. they are self serving and having no regard for others. 3) barking dogs....sound on a lake is amplified.
- I am concerned about the native plants being pulled up by their roots presumably by the boats at the boat landing. Aside from messing our shoreline, it opens the way for invasive species.
- Swimmers itch has kept us from swimming this year, all summer
- I think the muskies have caused the lake's pan fish size to really suffer. I don't think it is something that can be changed, but I wish they had never been introduced to the lake's habitat. I would much rather see walleyes or more northerns.
- Light pollution
- Not sure of "loss of natural scenery" implies. I took it to mean "suburban-type" yards. Not natural.
- The noise from both hwy 8 & 35 is at times annoying. The car races in Centuria can be loud - depending on the direction of the wind. I'm most concerned about the highway noise with in ever increasing number of vehicles.

11. Rank current potential sources of phosphorus to Deer Lake, in order of importance, as you understand them.

	Least Imp.					Most Imp.
Agricultural runoff	20%	4%	7%	4%	9%	57%
Septic systems	10%	5%	14%	18%	32%	23%
Decaying plant material in the lake	11%	27%	18%	23%	7%	14%
Runoff from waterfront property	11%	11%	13%	20%	24%	20%
Highway and road runoff	10%	16%	14%	27%	14%	20%

12. Which of the following landscaping practices are you familiar with, and which do you use?

	Not familiar with	Familiar with, but don't use	Use on my property
Rain gardens[1]	20%	67%	13%
Rain barrels[2]	13%	84%	2%
Shoreline buffer zones[3]	7%	26%	67%
Infiltration pits[4]	47%	42%	11%
Water diversions[5]	28%	33%	39%
Not fertilizing or using zero phosphorus fertilizer	7%	9%	85%

Other:

- I don't know enough to rank the rest. I can not finish this as the page ends here and I can't go on.

[1]**Rain garden** – 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.

[2]**Rain barrel** – Rain barrels capture water from a rain gutter downspout for watering gardens and potted plants.

[3]**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 water.

[4]**Infiltration pit or trench** – A depression lined with filter fabric and filled with rock. Runoff is directed to the pit or trench for temporary storage until it soaks into the ground.

[5]**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.

13. How many years since your septic system was installed?

Average: 10 years — 22% of respondents' septic systems are at least 20 years old
Oldest: 34 years

14. Are you aware of the free visits offered to lake residents, to address waterfront property runoff?

Yes	62%
No	32%
No response	6%

Have you taken advantage of these services?

Yes	32%
No, but I plan to	10%
No	50%
No response	8%

15. What do you believe are the most important issues that Deer Lake will face in the next 5 years?

Nbr of Responses

Lake and Shoreline

17	Weeds, excessive aquatic plant growth (native & invasive)
1	Algae
1	Keeping milfoil and zebra mussels out of the lake.
11	Maintaining, improving water quality/clarity
3	Water levels
1	Encouraging owners to restore/maintain a natural shoreline, not put grass lawns down to the lakeshore
1	Conservation and preservation.
1	Building awareness of the importance of the environment to the lake with new residents.
5	Swimmer's itch
1	Shoreline development
1	Understanding of lawn chemicals and septic use and effect they have on the lake.
1	Education about what a healthy lake looks like so the focus is on making the lake really healthy and not just cosmetically "clean." Education, education, education!

Taxes, Zoning, & Development

10	High property taxes. High property taxes - we have seen an 80% increase in 8 years. There is a strong bias in taxing lake owners over other property in the county. Taxes above the value received from the town or county.
1	High Home Values
1	City sewer and water
1	Compliance with zoning codes
1	Over usage
1	Co-existence and respect of economically different properties next to each other.
4	Controlling development on the lake, limiting the size of houses. Restricting owners to using their own property, not renting it out continuously to unknown people. Turnover on cabin sales - new buyers razing cabins and builing oversize homes. Homeowners and rentals not respecting the environment but putting their "wants" first. Restrictions on rental property. Over development, scrape and bake McMansions, back lot development.
1	Urban sprawl - crowded, affecting lake quality as well as overall enjoyment of the lake.
1	Discouraging multiple housing development
1	Building codes so new buildings fit into the land with regard to the run off and health of the lake. New construction/remodeling of homes (people building bigger homes and adding more blacktop areas) which will create more surface runoff issues.
1	Intergenerational property transfers
1	Intrusion and encroachment of Development (light from Walmart and Menards)
1	Keeping industrial enterprises from polluting lake
1	Lumsden farm
6	Highway traffic, traffic on Hwy 8, Moving of Highway 8 behind the conservancy owned property to open up more trails and have access to the shoreline currently blocked by Hwy 8. The heavy traffic on Highway 8 is of great concern. I was hoping the proposed re-routing would be taking place soon, now I'm not sure if we will ever see it happen. Traffic is terrible along the south side of the lake and extremely dangerous. Increased traffic on both highway 8 & 35.

Motorized Watercraft

2	Jet skis
2	Too much noise - loud music on boats. Noise pollution from water skiers/wake boarders before sun up and after sunset.
1	Too many motor boats
1	Inexperienced drivers - driving too fast and close to shore

Other

1	Continuation and staffing of Deer Lake Association and Conservancy
1	Continued funding at levels needed to maintain the treatment for and management of lake water quality

16. In your opinion, what are the Deer Lake Conservancy's greatest strengths?

A list of strengths will be compiled from all sources (online survey, board E-mails, and phone interviews) and distributed at the meeting.

17. In your opinion, how could the Deer Lake Conservancy's programs/services/operations be improved?

A list of improvements will be compiled from all sources (online survey, board E-mails, and phone interviews) and distributed at the meeting.

18. How do you prefer to get information from the Deer Lake Conservancy? (Choose one.)

Choices	Percentage	Count
Deer Lake Conservancy Report Newsletter	*38.30%*	18
E-mail notices	*34.04%*	16
Annual Meeting	*12.77%*	6
Web site	*8.51%*	4
Special mailings	*6.38%*	3
	Total	**47**
	Unanswered	*4*

19. Other comments:

- All of the above.
- I have actually used all of the above ways to get information. I do not often think to look at the website, but the other 4 are all equal in my mind.
- Web site is highly impressive. Use of web and email should help save money from newsletter.
- Would read report online if notified and linked through e-mail.

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.[47]

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.[48]

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[47] *Wisconsin’s Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species*. Prepared by Wisconsin DNR. September 2003.
[48] 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*)[49]

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

[49] 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.

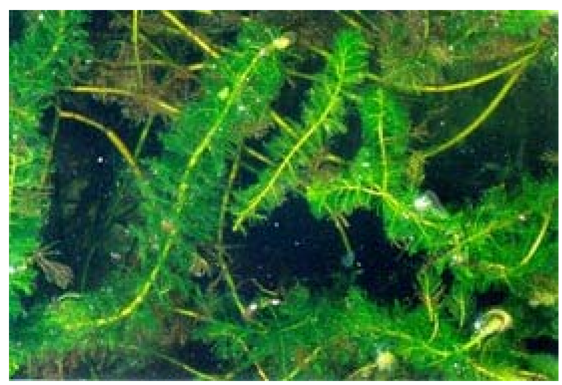
Control

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. [50]

[50] 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.[51]

Purple Loosestrife (*Lythrum salicaria*)[52]

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,

[51] Taken from WDNR, 2008. (http://www.dnr.state.wi.us/invasives/fact/reed canary.htm).
[52] 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 or 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 Northern Region 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.

Appendix D. Herbicide Treatment Analysis on Potamogeton Crispus.

Herbicide Treatment Analysis on *Potamogeton crispus*

Deer Lake, Polk County Wisconsin

2012

Prepared by: Ecological Integrity Service, LLC
Amery, WI

Abstract

In May 2012, five Potamogeton crispus beds totaling 23.5 acres were treated with endothall (Aquathol K). The analysis of the treatment shows that from 2011 to 2012, the CLP was significantly reduced in all beds. The frequency of occurrence of CLP went down from 0.49 in 2011 (after treatment) to 0.11 in 2012 (after treatment) for a decrease of 0.38. Comparing the pre-treatment survey from 2012 to the post treatment survey, the CLP decreased in all beds. The native plant community had statistically significant reductions in two species and one species had a statistically significant increase (when comparing 2011 to 2012). One native plant species reduced was a very small sample to begin with (in 2011), so this data may not be valid claim a significant reduction.

Introduction

In May 2012, *Potamogeton crispus* (curly-leaf pondweed aka CLP) was treated in five plots. This report will evaluate the effectiveness of this treatment. The plots treated are mapped in Figure 1. All of these treatment sites involved an early season treatment in order to better target the AIS plant curly-leaf pondweed. A summary of the treatment protocol is contained in table 1.

The following map shows the CLP beds in Deer Lake for 2012. The acreage is the area herbicide was applied.

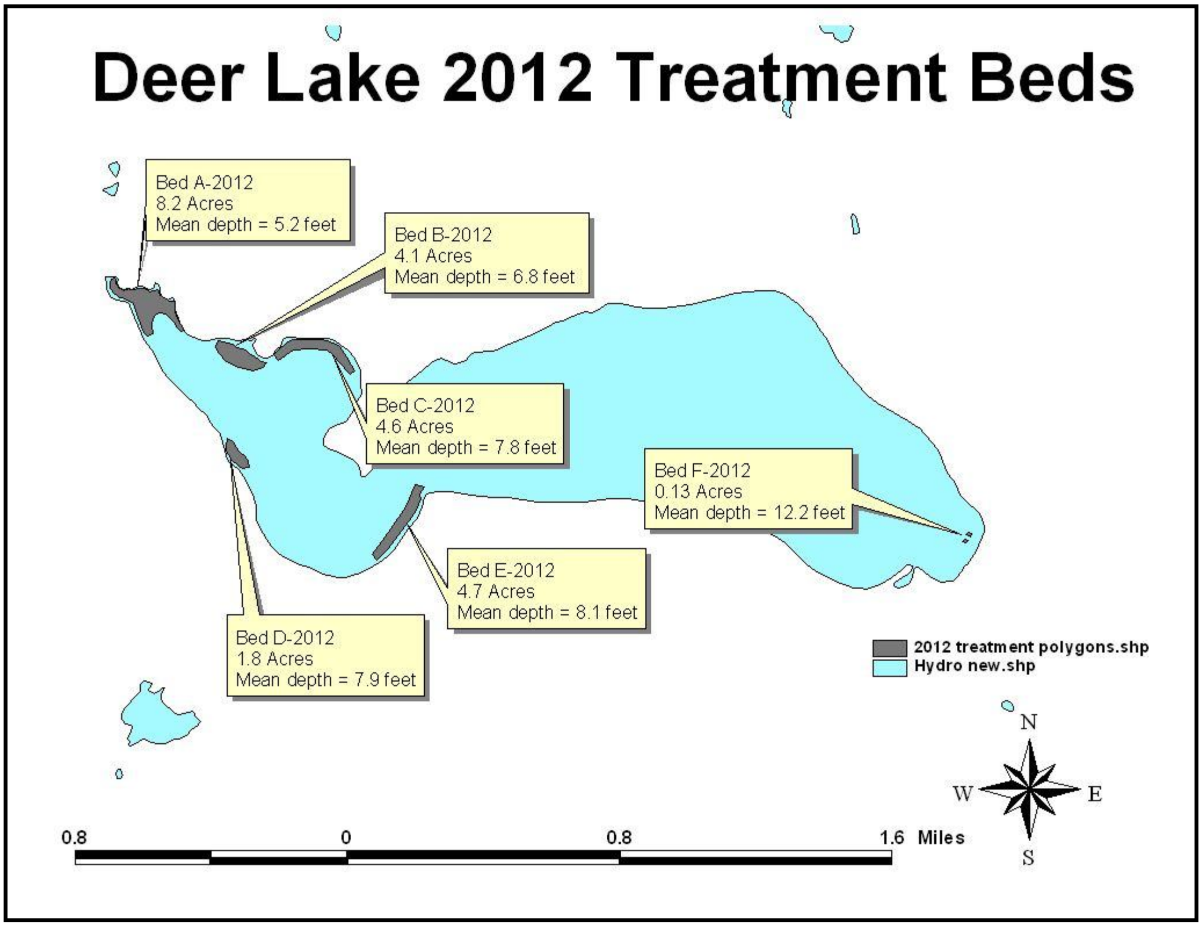

Figure 1: Map of CLP treatment beds-2012.

Deer Lake CLP Beds				
2012	Area	Mean Depth	Acre-Feet	Gallons @ 1.5 ppm
Bed A	8.2	5.2	42.64	42.64
Bed B	4.1	6.8	27.88	27.88
Bed C	4.6	7.8	35.88	35.88
Bed D	1.8	7.9	14.22	14.22
Bed E	4.7	8.1	38.07	38.07
Bed F	0.13	12.2	1.59	1.59
Total	23.53		160.28	160.28

Table 1: Summary of 2012 CLP treatment beds.

Pre-treatment survey methods

A survey prior to treatment (early season verification) was conducted on April 1, 2012. The purpose of a "pre-treatment survey" is to verify that the AIS target species is indeed present. Any necessary adjustments to the treatment polygons are also done at this time. Since Bed-F lacked any CLP growth, it was eliminated from treatment.

Figure 2 shows the sample points of each plot, with a presence/absence point. White indicates no CLP present and black indicates presence. No density is given to the CLP samples since the plant size can be so variable, making this record very inconsistent.

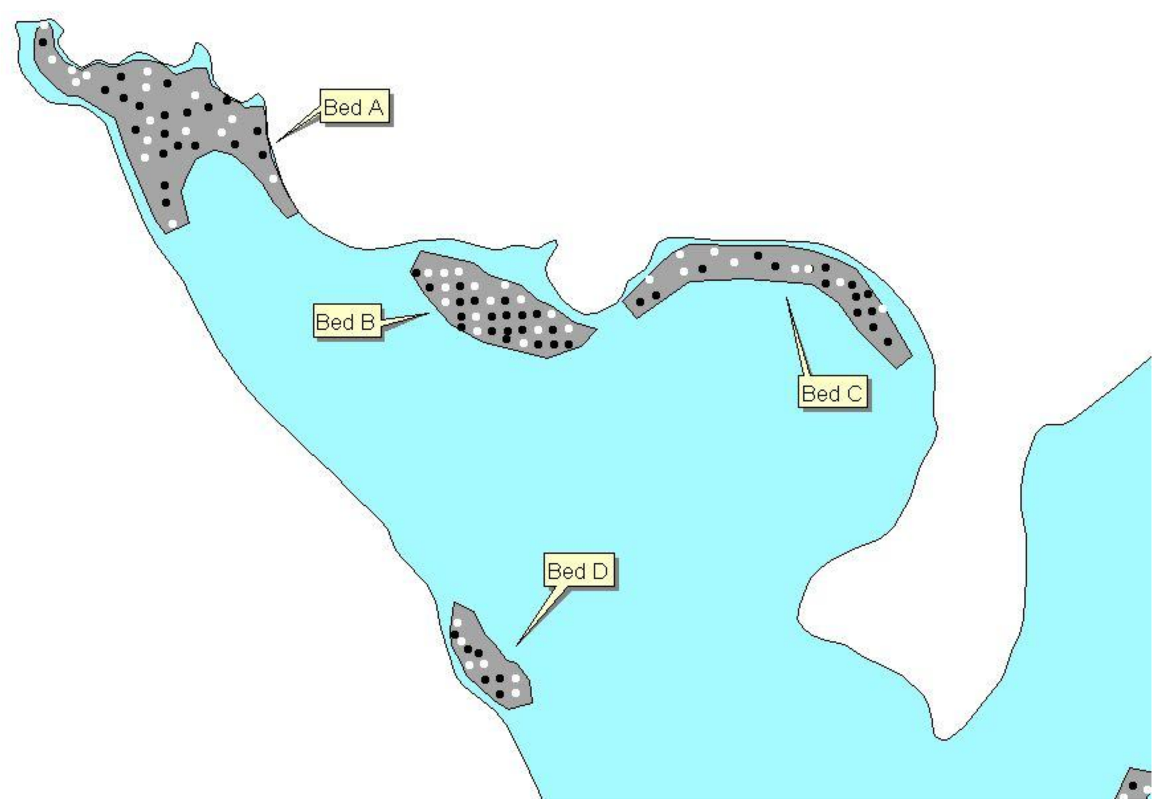

Figure 2: Pre-treatment survey map for Beds A-D-2012.

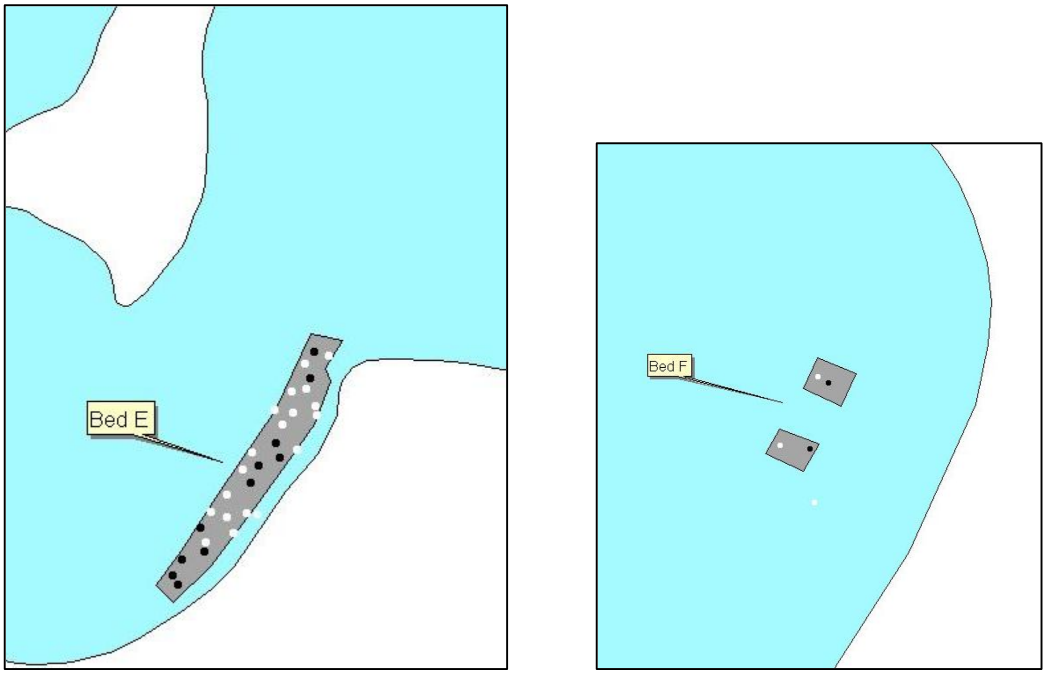

Figure 3: Pre-treatment survey map for Beds E and F-2012.

Post-treatment survey methods

A post-season treatment survey was conducted approximately 4 weeks after treatment (June 8, 2012 it was conducted). This was prior to senescence of the CLP and should have given the herbicide time to act upon the CLP. A rake sample was taken in four directions at the sample point. The CLP was given a density rating of 0-5 and each native was also identified, given a density rating of 0-3[1] on the first rake. A density of 1-5 counts as CLP being present and that frequency (number of samples points with CLP divided by the total sample points in the bed) is compared from the surveys (2011 and 2012) to determine effectiveness of the treatment.

A density of 1-4 is the incidence of CLP on the rake in the four rake samples (directions). A "5" means CLP was sampled in all 4 directions and was overloading the rake in each direction.

[1] This is the DNR protocol. A 1 is present on rake, 2 takes up ½ to all of tine space and 3 is overflowing the rake.

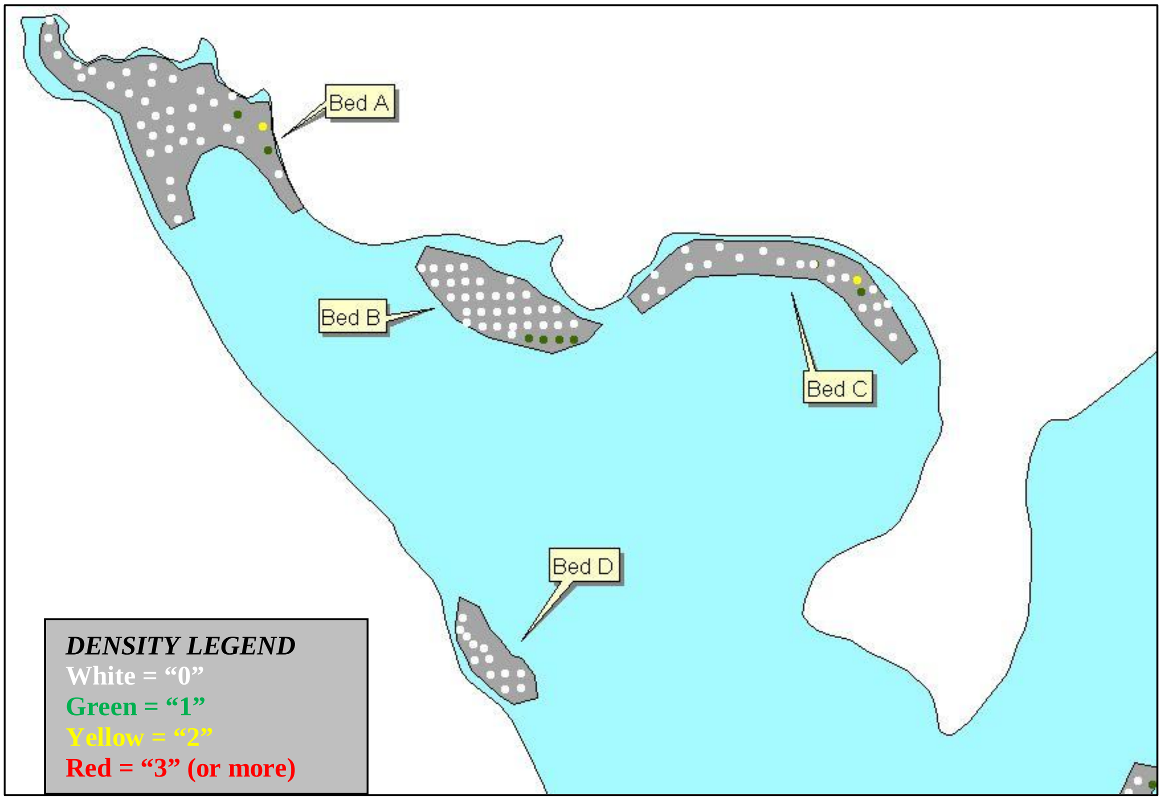

Figure 4: Post treatment survey map, Beds A-D,2012.

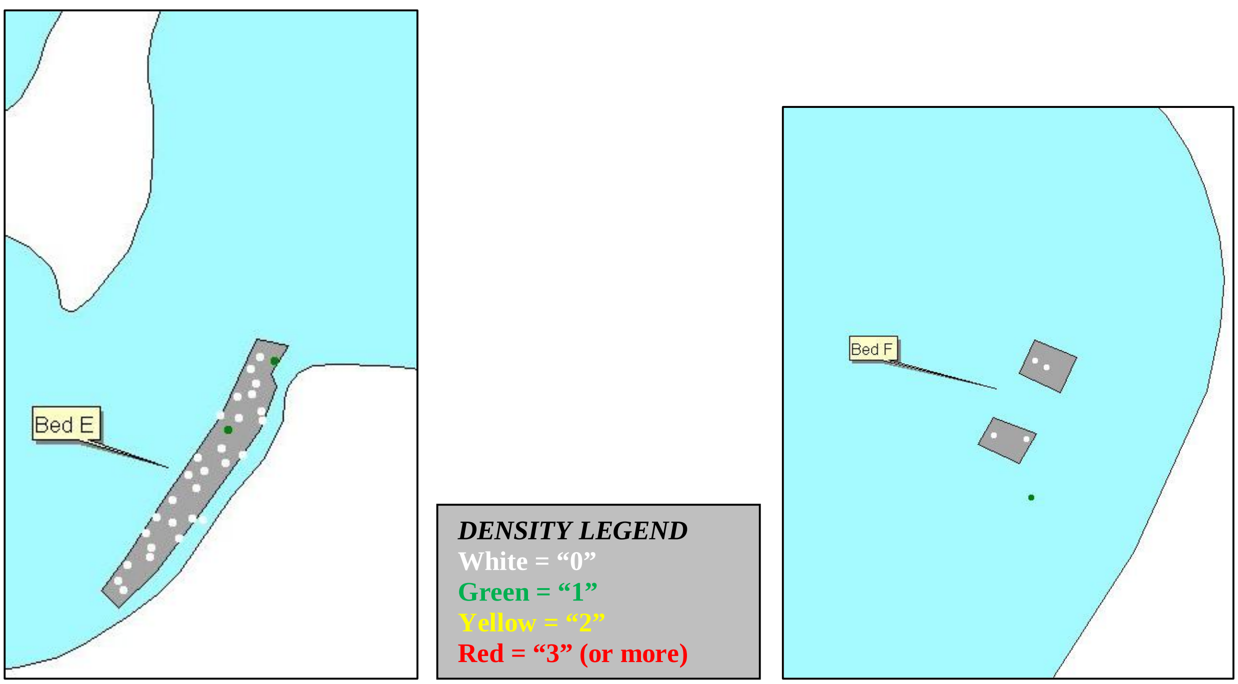

Figure 5: Post treatment survey map Beds E and F, 2012

Treatment results

Generally the CLP frequency from one-year prior is compared to the CLP frequency from treatment year post treatment survey. The table below (table 2) shows the frequency from 2011 and from the post treatment of 2012 for each bed and all beds combined. The decrease is noted as a yes or no and the significance based upon a chi-square analysis that compares the frequencies of the two survey results. If P<0.05 it is considered statistically significant.

	2011 post	2012 post	Decrease?	Significant?
Bed A	**0.18**	**0.08**	**YES**	**---**
Bed B	**0.58**	**0.11**	**YES**	**---**
Bed C	**0.61**	**0.09**	**YES**	**---**
Bed D	**0.50**	**0.00**	**YES**	**---**
Bed E	**0.69**	**0.07**	**YES**	**---**
Bed F	**0.50***	**0.00**	**YES**	
All Beds	**0.49**	**0.08**	**YES**	**YES (p<0.01)**

Table 2: Frequency of CLP by bed 2011 and 2012. *Bed F not treated in 2011, this is the pre-treat frequency before treatment in 2012.

As the data in table 2 shows, there was a decrease in all beds from 2011 to 2012 with all frequencies combined being statistically significant.
The reproductive turions of CLP in the sediment will tend to germinate in the fall and grow throughout the winter. As a result, these turions will give rise to new plants that weren't present in the prior year. Therefore, in the 2011 post survey, plants may not have been sampled but turions in that area could germinate later, resulting in CLP growth shown in that same sample point in the 2012 survey done just before treatment. This can show if new growth occurred. The frequency of CLP in the survey just prior to treatment was higher than the 2011 frequency, but there is no need to evaluate this reduction since the reduction from 2011 to 2012 was reduced, so would this comparison, only more.

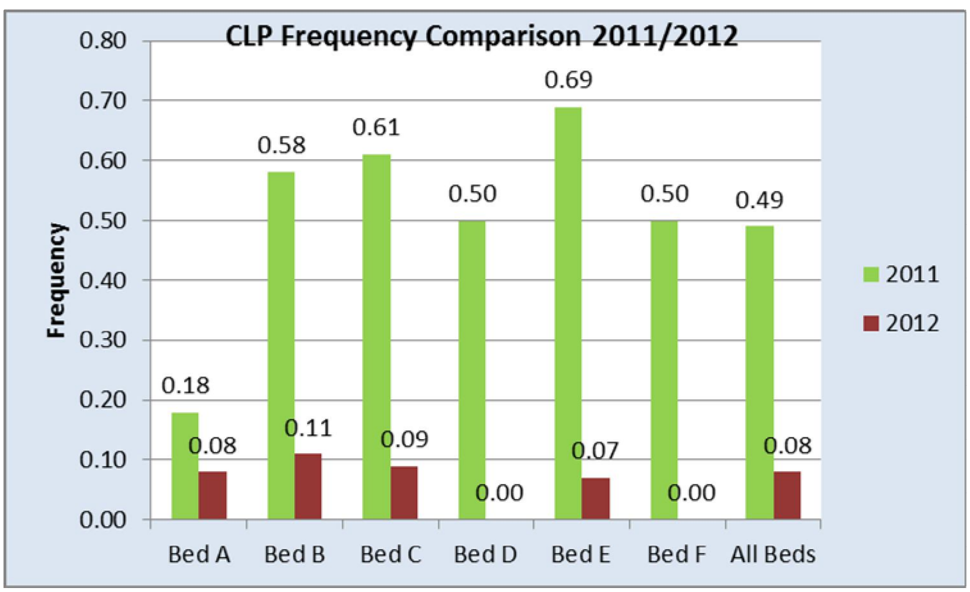

Figure 5: Frequency of CLP comparison-2011 post, 2012 post surveys.

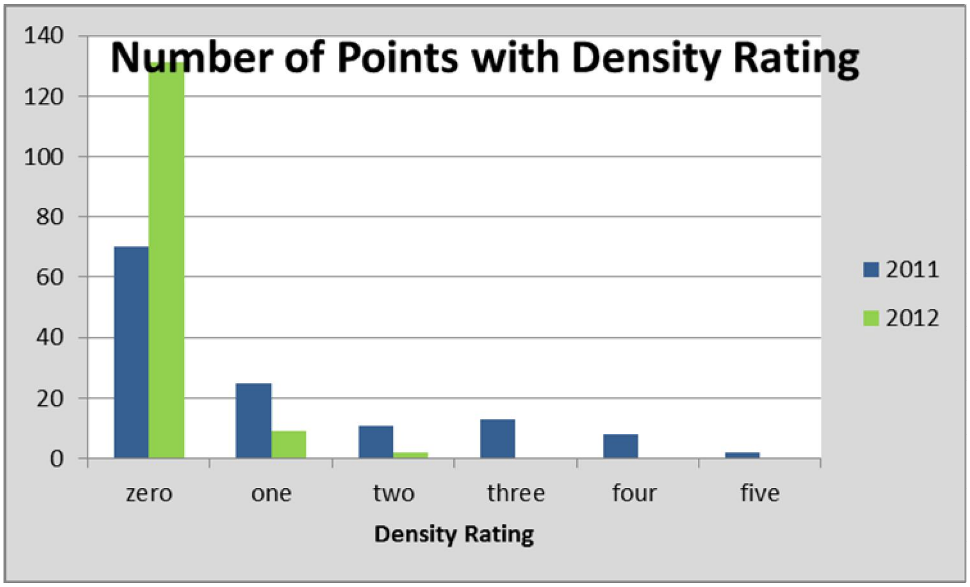

Figure 6: Sample point density comparison between 2011 and 2012 (from post treatment surveys each year).

The density also decreased from 2011 to 2012. The mean density for each year from the post treatment surveys were:

2011 mean density = 0..99 (rating of 0-5)

2012 mean density = 0.08[2] (rating of 0-5)

In addition to evaluating the CLP, the native plants within each treatment bed were evaluated. A chi-square analysis was conducted on the native plants sampled in each bed. This compares the frequency of native species in 2011 to 2012. Any significant changes (positive or negative) are determined. The treatment bed F data was not used as this area was not treated in 2011.

As table 3 shows, there was a statistically significant reduction in two native species (*Lemna triscula and Bidens beckii)*. These reductions may or may not be due to the herbicide treatment. The *Bidens beckii* frequency was very low in 2012, so this reduction may not be a valid concern. One might expect more species' reductions if herbicides were the cause. Other reasons for the reduction could be seasonal variation (not out of dormancy at the survey time) and sampling location differences (sampling doesn't take place at the exact locations each year due to GPS precision).

[2] This value being the same as frequency is correct and coincidental.

Native species	Frequency 2011	Frequency 2012	P value	Significance	Change
Lemna triscula,forked duckweed	**0.40**	**0.23**	**0.004**	**yes**	**-**
P. Robbinsii, Robbin's pondweed	**0.015**	**0.00**	**0.14**	**no**	**-**
P. amplifolius,Large-leaf pondweed	**0.008**	**0.00**	**0.29**	**no**	**-**
P. praelongus, White-stem pondweed	**0.22**	**0.19**	**0.48**	**no**	**-**
C. demersum, Coontail	**0.20**	**0.53**	**0.000**	**yes**	**+**
M. sibiricum, Northern milfoil	**0.13**	**0.16**	**0.48**	**no**	**+**
P. richardsonii, Clasping pondweed	**0.13**	**0.17**	**0.39**	**no**	**+**
V. americana, Wild celery	**0.04**	**0.06**	**0.36**	**no**	**+**
filamentous algae	**0.87**	**0.01**	**0.000**	**yes**	**-**
Elodea canadensis, elodea	**0.12**	**0.18**	**0.18**	**no**	**+**
Heteranthera dubia, water stargrass	**0.15**	**0.23**	**0.10**	**no**	**+**
Ranunculus aquatilis, stiff water crowfoot	**0.10**	**0.15**	**0.24**	**no**	**-**
P. pusillus, small pondweed	**0.0**	**0.03**	**0.18**	**no**	**+**
Bidens beckii, water marigold	**0.05**	**0.00**	**0.009**	**yes**	**-**
P. illinoensis, Illinois pondweed	**0.008**	**0.01**	**0.62**	**no**	**+**
Nymphaea odorata, white lily	**0.05**	**0.08**	**0.29**	**no**	**+**
S. Pectinatus, sago pondweed	**0.0**	**0.01**	**0.34**	**no**	**+**

Table 3: Native species frequency data with chi-square analysis summary.

Discussion

The herbicide treatment of CLP on Deer Lake in 2012 appears to be very effective. The frequency and density from 2011 to 2012 (comparing post treatment surveys of all beds combined) both show a decrease with the frequency being statistically significant. The pretreatment survey in 2012 (done just before treatment) found a slight increase in frequency from the 2011 post treatment survey, reflecting germination of turions (from 0.49 to 0.52). However, the survey after treatment showed that growth was reduced to just 0.09 or 9% of all point sampled with CLP.

The native plant community did have a statistically significant frequency reduction from 2011 to 2012 in two species (*L. triscula* and *B. beckii*) . This reduction could be variation in growth and/or sampling locations or could be due to herbicide. The frequency of *B. beckii* in 2011 was very small, so although the reduction was statistically significant, the small number sample points is a cause for caution in this data. This makes a reduction in only one species and if herbicide caused this, one would expect other species' reduction as well. There was a statistically significant frequency increase in two species. This may support the seasonal variation/sampling variation cause of the changes.

The reduced growth of CLP after treatment in 2012 should carry over into 2013. Depending on the turion density in these beds, the growth should be somewhat less. However, if there are still large numbers of turions in the beds, the growth could increase. This is the reason it is important to have a few years of successful treatments in succession. As the turion density is reduced, the new growth will also be reduced, making the overall CLP management a success.

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Appendix F. 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 (DLIA Board).

2. Conduct volunteer (Clean Boats, Clean Waters Crew) and professional monitoring (Herbicide Contractor and/or APM Monitor) at the public landing, the private landing at the Lagoon, and other likely areas of AIS introduction. If a suspected plant is found, contact the Environment Committee Chair.

3. Direct lake residents and visitors to contact the Environment Committee Chair 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, the Environment Committee Chair will confirm identification with Polk County LWRD and the WDNR and inform the rest of the DLIA 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 (Environment Committee Chair). 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 (Environment Committee Chair), 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. (Environment Committee Chair).

    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 (DLIA Board).

7. Hire a consultant to determine the extent of the EWM introduction (DLIA 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 (DLIA 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. DLIA 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 DLIA 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 DLIA 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 (DLIA, 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 DLIA Board.

EXHIBIT A[1]

DEER LAKE IMPROVEMENT ASSOCIATION

Environment Committee Chair	Steve Schletty: 715-483-3376 or 715-294-2986
Board Contact	Bob Spinner: 612-332-0161 or 612-961-6257

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

Permits	Mark Sundeen: 715-635-4074
Grants, EWM Identification and Notice	Alex Smith: 715-635-4124

APM MONITOR

Ecological Integrity Services	Steve Schieffer: 715-554-1168

HERBICIDE CONTRACTOR

Lake Management Incorporated	Mike O'Connell: 651-433-3283 or 651-295-1852 (cell)

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 G. 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

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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

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	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

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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.