Aquatic Plant Management Plan
Deer Lake
Polk County, Wisconsin

July 2017

Photo by Tom McBride

Sponsored By
Deer Lake Improvement Association

Prepared By
Harmony Environmental — Plan Writing and Facilitation
Environmental Integrity Services, LLC — Aquatic Plant Survey and Mapping

Funded By
Deer Lake Improvement Association
A Wisconsin Department of Natural Resources Grant

Table of Contents

Appendices

Tables

Figures

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 2021. The plan also covers a response to zebra mussels, an aquatic invader found in the lake in late 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 2016. Aquatic plant surveys were also completed in 2003, 2006, and 2010. 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 and 2017 plans.

Plan Goals

1) Protect and restore healthy native aquatic plant communities.
2) Prevent the introduction of aquatic invasive species.
3) Rapidly and aggressively respond to any newly introduced aquatic invasive species.
4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.
5) Reduce levels of nuisance aquatic plants to allow safe, enjoyable recreation such as swimming, fishing, 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 2012. 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 also covers a response to zebra mussels, an aquatic invader found in the lake in late 2016. 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 2017 through 2021).

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 January 8, 2017 when they reviewed aquatic plant management planning requirements, aquatic plant management goals, and aquatic plant management efforts to date. At meetings in February and May, the committee provided guidance for a public opinion survey and made recommendations for ongoing management strategies.

The DLIA board announced the availability of the draft Aquatic Plant Management Plan for review with a public notice in the Polk County Ledger. 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 July 30th, 2017. None were received.

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 330 residences around the lake, this is a response rate of about 15 percent. A 2007 mail survey yielded a response rate of 41 percent. 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, was 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 both 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 July and August secchi depths averaging 19 feet in the East Deep Hole in the past five years (2012-2016). The littoral zone (the depth to which plants grow) reached a depth of 26 feet in 2016. This littoral zone depth is much higher than surrounding lakes in the region. Past littoral zone depths were 28 feet in 2010, 27 feet in 2007 and 24 feet in 2003. 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)	26
Average summer Secchi depth (feet)	19

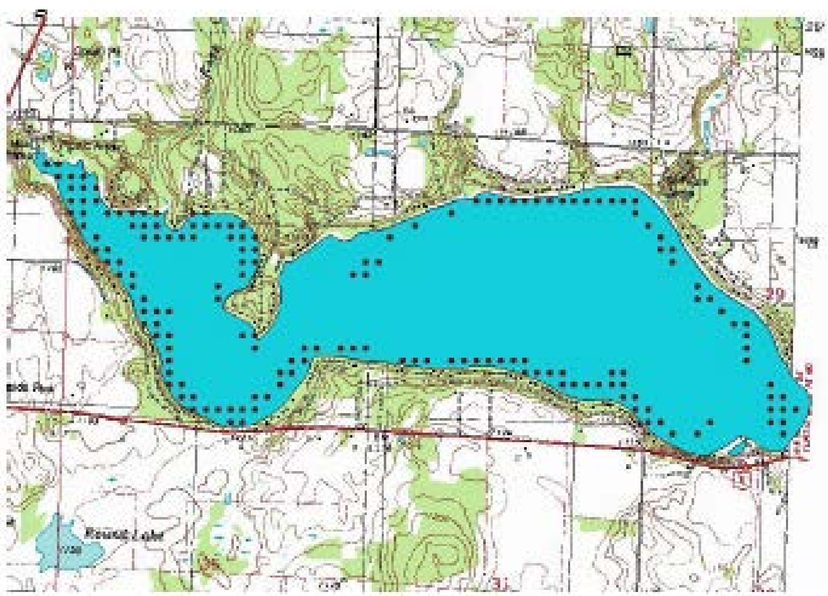


Figure 1. Dominant Sediment Muck

Figure 2. Dominant Sediment Sand

A lake map which illustrates public and private access points is found as Figure 3. Areas shaded in light green indicate properties owned by the Deer Lake Conservancy.

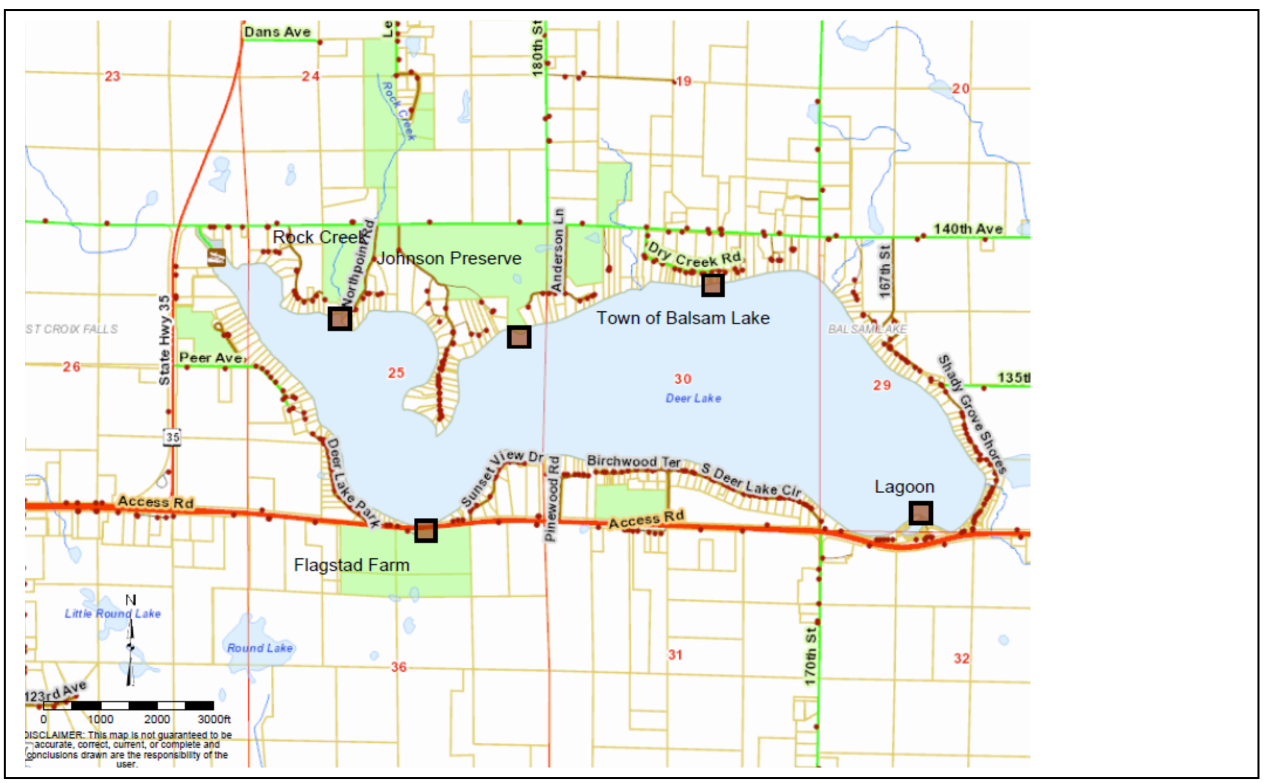


Figure 3. Deer Lake Map with Public Access Points

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 with higher numbers representing more nutrient-rich lakes. 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. Volunteers measured secchi depth 10 times and collected water samples for total phosphorus and chlorophyll tests 3 times in 2016. 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 15-16 feet in 2016, the average for the Northwest Wisconsin region is about eight feet. Over the past five years (2012-2016), secchi depths averaged 19 feet in the East Deep Hole. Water quality testing results for 2016 indicated lower water clarity than in recent years, perhaps because of more runoff from large rain events in the summer.

Table 2. Citizen Lake Monitoring Results July and August 2016[1]

	East Deep Hole	West
Secchi Depth (ft)	16	15
Total Phosphorus (µg/l)	15	18.5
Chlorophyll (µg/l)	4.7	6.2
Trophic State Index (TSI based on Secchi)	38	38
TSI (based on Chl.)	47	49
TSI (based on TP)	49	51

[1] *Reports and Data: Polk County*. WDNR website. December 2016. http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/

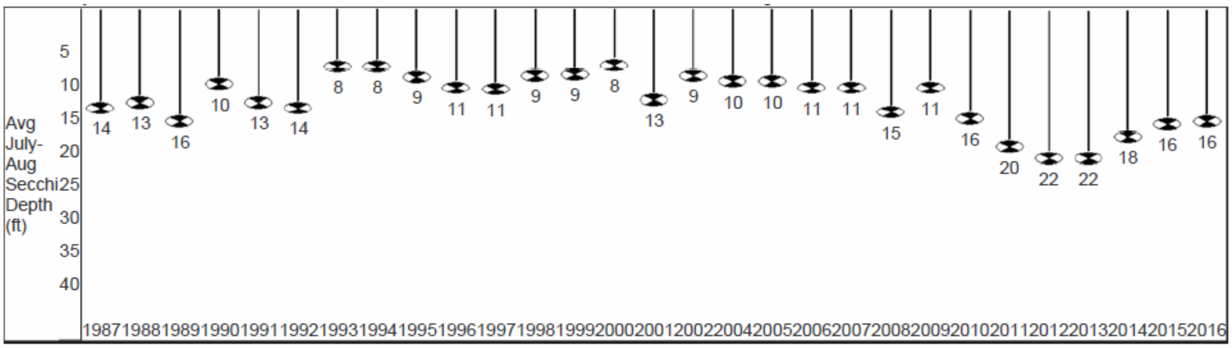


Figure 4. Deer Lake East Deep Hole July and August Average Secchi Depths

Figure 4 illustrates the secchi depth averages for the East Deep Hole. Figure 5 graphs the Trophic State Index (TSI) 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 TSI, respectively. Water clarity improvement and declines in algae growth may be influenced by grazing of algae by zooplankton or some factor in addition to phosphorus levels.

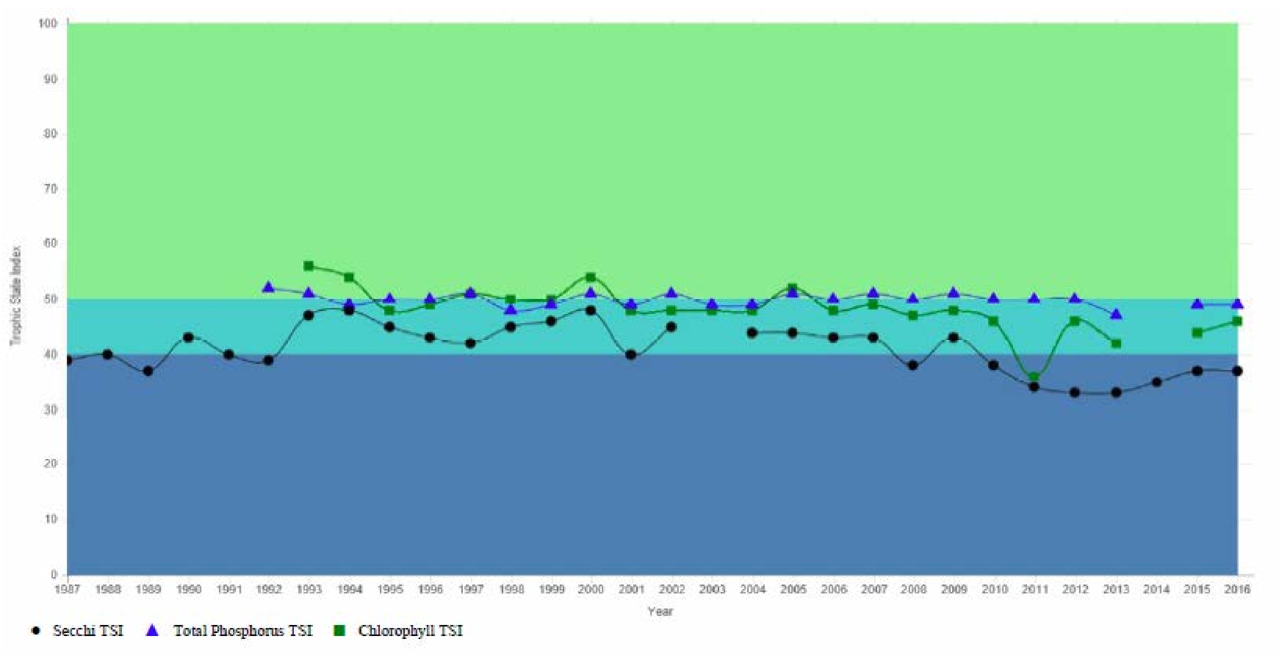


Figure 5. Deer Lake East Deep Hole July and August Average Trophic State

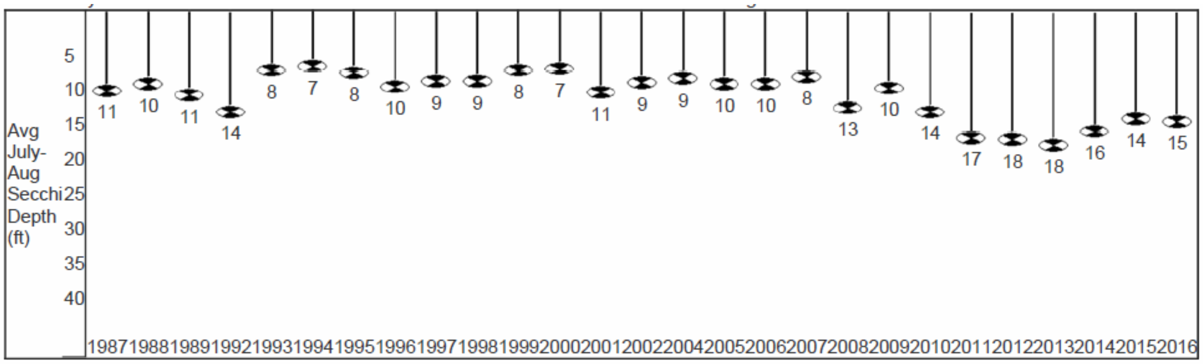


Figure 6. West Basin July and August Average Secchi Depths

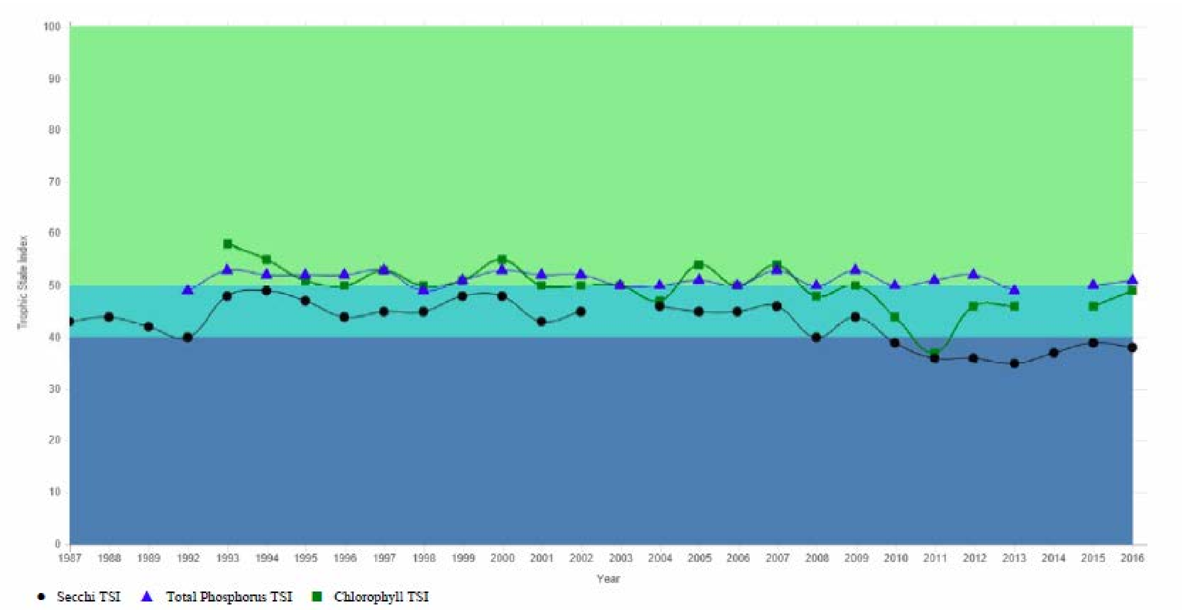


Figure 7. West Basin July and August Average Trophic State

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 gathered 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. Even with declines in water clarity in 2016, the phosphorus goal was reached with July and August levels averaging 15 ug/L in the east basin and 18.5 ug/L in the west basin. In recent years (since 2010) summer phosphorus concentrations have been even lower.

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 decreased this reduction further to 56% of watershed P loading. These figures do not include the direct drainage area.

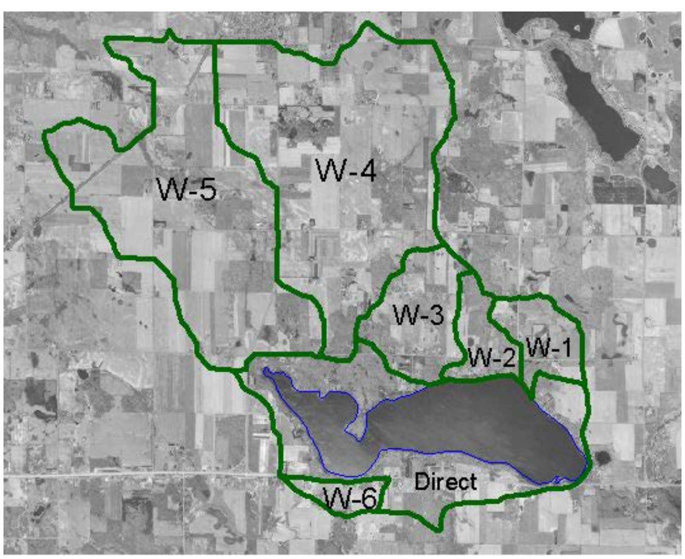


Figure 8. Deer Lake Watersheds

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
St. Croix River Association Stewardship Award	2011
Direct Drainage projects installed	2010 to 2016
W1 Outlet installed	2015
NALMS Lake Management Success award	2015
Lower Rock Creek acquisition	2016
Johnson Preserve acquisition	2017

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. It is also a popular local destination. According to Heath Benike, former 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 Town of Balsam Lake owns a walk in access on Dry Creek Road.

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 26 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.* The Deer Lake Conservancy purchased a large portion of this sensitive area in October 2016.

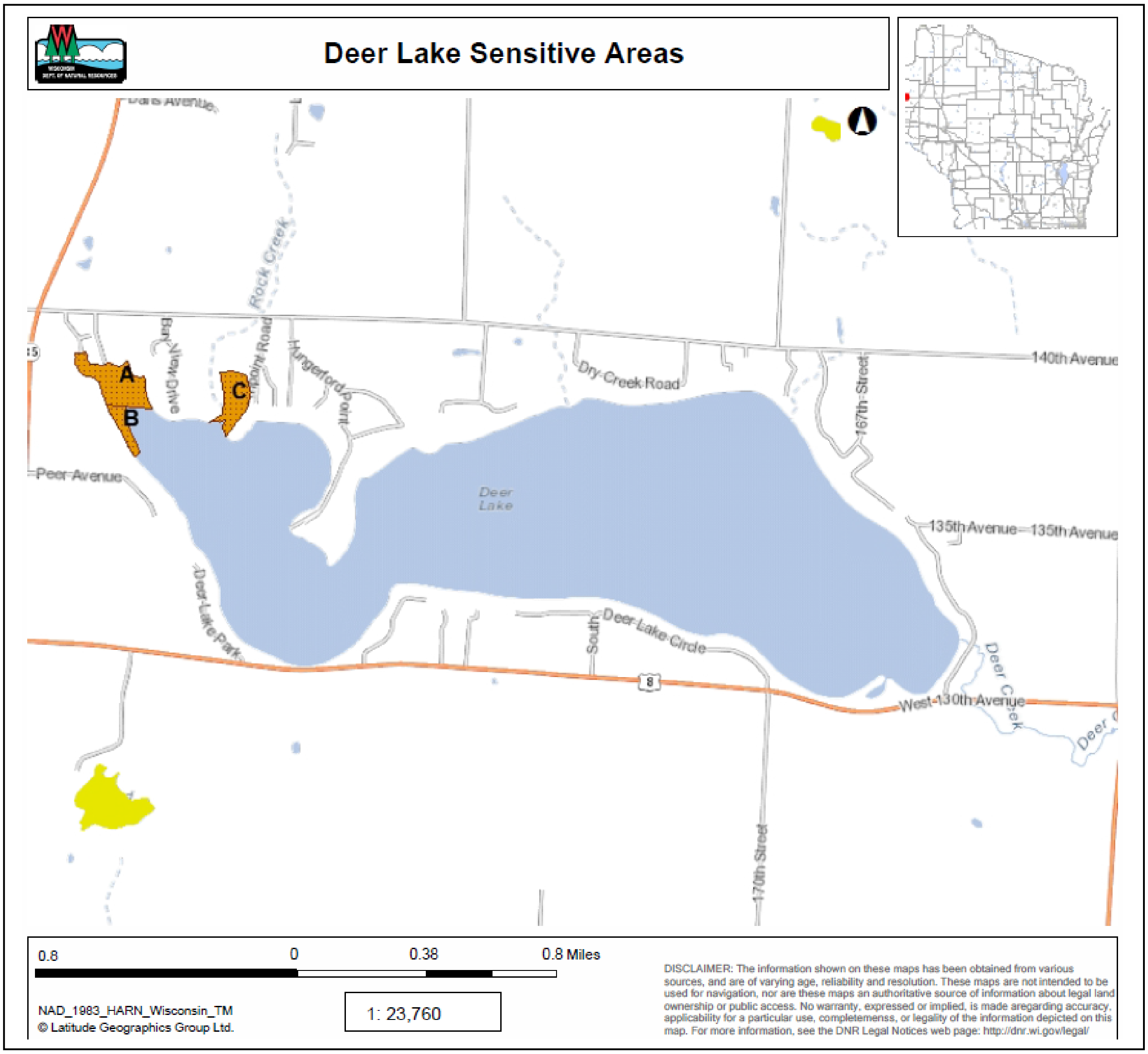


Figure 9. Deer Lake Sensitive Areas (Critical Habitat Areas)

Deer Lake Fishery[2]

Deer Lake has a diverse fish community that is comprised of muskellunge, northern pike, largemouth bass, bluegill, black crappie, yellow perch, green sunfish, rock bass, white sucker, bullhead species, as well as various species of minnows. Deer Lake is not managed for or stocked with walleye, but walleye are occasionally present in fisheries surveys. There is known natural reproduction of walleye in Deer Lake.

Deer Lake has an exceptional muskellunge fishery, with moderate abundance and size structure. The muskellunge fishery is dependent upon stocking, as no natural reproduction is known to occur. Besides musky, all other fish species present in Deer Lake have naturally-reproducing populations and do not require supplemental stocking. Maintaining natural spawning habitats is critical for the future of the primary sport fish populations in Deer Lake.

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 and submergent vegetation in 0.5-3 feet of water	Eggs are broadcasted and adhere to vegetation
Yellow Perch	Mid 40s – low 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 – low 60s	Nests are built in 1-6 feet of water.	Nest builders
Largemouth Bass Bluegills	Mid 60s – low 70s	Nests are built in 1-6 feet of water.	Nest builders

[2] Fisheries information provided by Aaron Cole, DNR Fish Biologist. December 2016.

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. No rare aquatic species are noted in the town of Balsam Lake (T34N, R17W). Several species are listed in the town of St. Croix Falls (T34N, R18W). 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] In addition, the on-line lists of species and natural features on the Natural Heritage Working List do not include bald eagles, and sensitive species have been removed, where applicable, including cave bats. However, the Polk County Natural Heritage Inventory map (2010) indicated that the west half of Deer Lake has aquatic occurrences of NHI species.[4]

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

Red Shouldered Hawk	*Buteo lineatus*	Threatened
Lake Sturgeon	*Acipenser fulvescens*	Special Concern
Blue Sucker	*Cycleptus elongates*	Threatened
Western Sand Darter	*Etheostoma clarum*	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. Northern Dry Mesic Forest and Southern Dry Forest are also listed.

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

[3] Natural Heritage data for Wisconsin is found at http://dnr.wi.gov/topic/NHI/Data (last revised May 13, 2016).
[4] Map was generated with NHI data as of 9/15/2010.

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. 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]

[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 April, June, and July 2016, according to the WDNR-specified point intercept method. This survey was a follow-up to a survey completed in July 2010.

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 Polk County, Wisconsin,* July 2016, 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 10 below shows the distribution of these sampling points. Once the depth at which plants grow is determined, points deeper are not sampled.

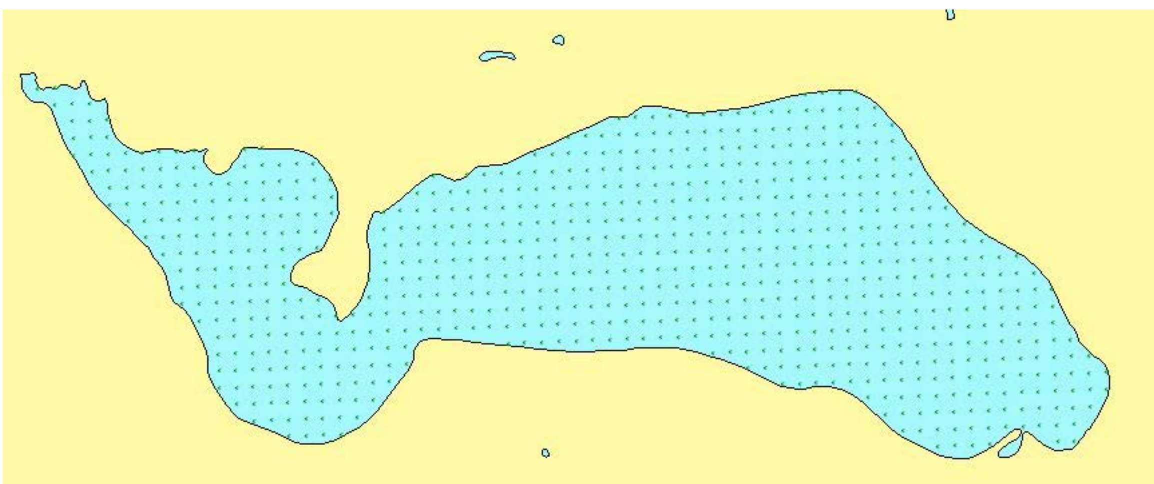


Figure 10. Sampling Point Grid

The point intercept survey results show a healthy plant community. Within the littoral zone (areas where plants live in the lake), 88% of the area had plants growing. The littoral zone is quite limited covering only approximately 34% of the lake. The plant coverage within the entire lake is 30%. See Figure 11 for the defined littoral zone map.

The density rating of the rake samples varied 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, plants are quite dense in some areas. Most areas with low nutrient, sandy sediment had lower density ratings.

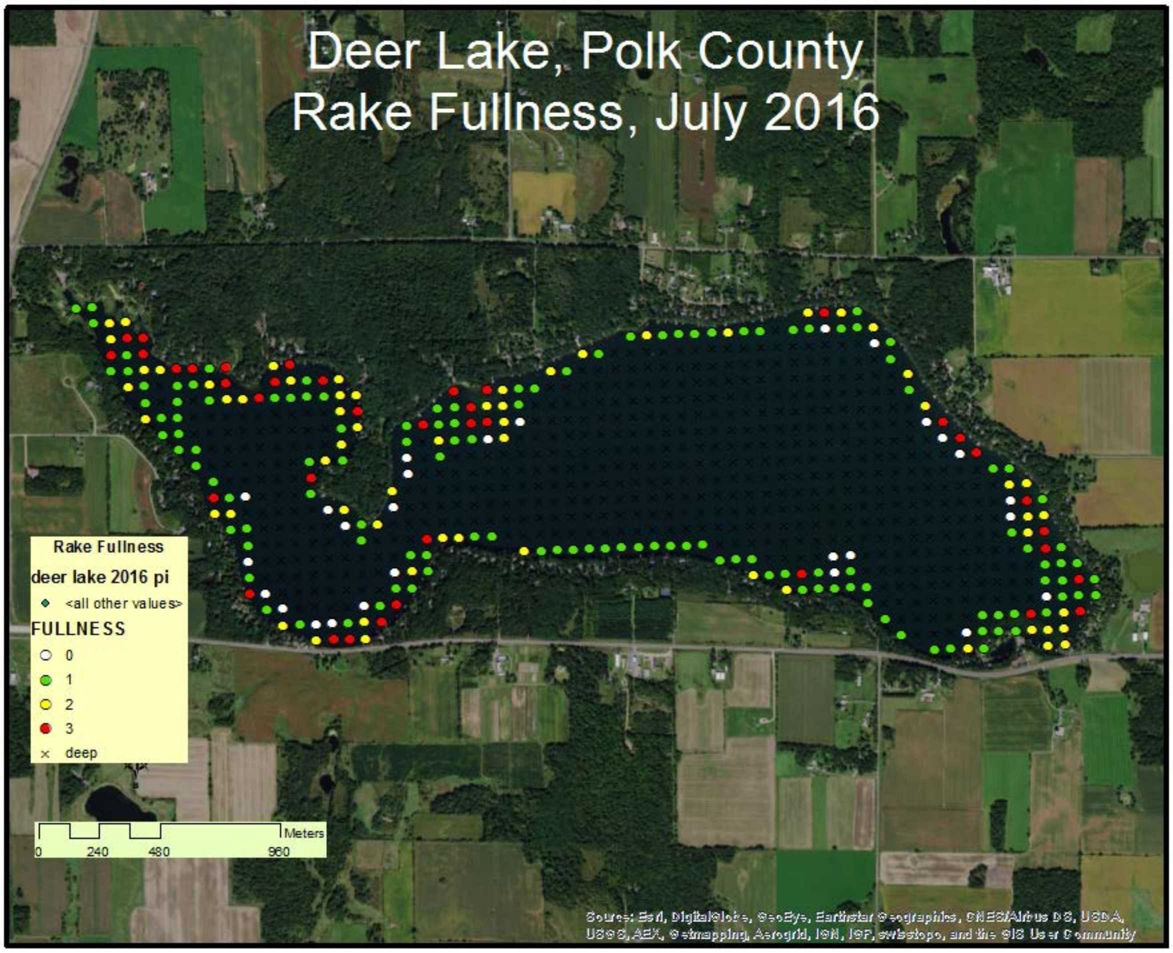


Figure 11. Littoral Zone Plant Density

Plant diversity was very high in Deer Lake with a Simpson Diversity Index of 0.90. 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 32 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 33, and if the boat survey species are included, the total is 43.

Table 4. Aquatic Macrophyte Survey Summary Statistics

Total number of points sampled	
Total number of sites with vegetation	223
Total number of sites shallower than the maximum depth of plants	254
Frequency of occurrence at sites shallower than maximum depth of plants	87.8
Simpson Diversity Index	0.90
Maximum depth of plants (feet)	26.2
Mean depth of plants (feet)	10.74
Average number of all species per site (shallower than max depth)	2.32
Average number of all species per site (sites w/vegetation only)	2.70
Average number of native species per site (shallower than max depth)	2.37
Average number of native species per site (sites w/vegetation only)	2.70
Species richness	32
Species richness (including visuals)	33
Species richness (including visuals and boat survey)	43

[7] If filamentous algae and aquatic moss are included, there are 33 species. The Wisconsin DNR point intercept data spreadsheet does not include these in the species richness total.

Table 5. Deer Lake Species Frequency and Mean Rake Fullness

Species	Freq. Veg.	Freq Littoral	Relative Freq	# Pts Sampled	Mean Density
Ceratophyllum demersum, Coontail	59.19	51.97	21.5	132	1.3
Lemna trisulca, Forked duckweed	34.98	30.71	12.7	78	1.0
Myriophyllum sibiricum, Northern water milfoil	25.11	22.05	9.1	56	1.1
Chara sp., Muskgrasses	21.52	18.90	7.8	48	1.4
Vallisneria americana, Wild celery	21.08	18.50	7.7	47	1.1
Potamogeton richardsonii, Clasping-leaf pondweed	17.49	15.35	6.4	39	1.1
Elodea canadensis, Common waterweed	12.56	11.02	4.6	28	1.1
Heteranthera dubia, Water star-grass	11.21	9.84	4.1	25	1.1
Potamogeton gramineus, Variable pondweed	10.76	9.45	3.9	24	1.1
Potamogeton robbinsii, Fern pondweed	7.62	6.69	2.8	17	1.0
Stuckenia pectinata, Sago pondweed	7.62	6.69	2.8	17	1.0
Nitella sp., Nitella	7.17	6.30	2.6	16	1.3
Potamogeton praelongus, White-stem pondweed	6.73	5.91	2.4	15	1.0
Potamogeton zosteriformis, Flat-stem pondweed	6.73	5.91	2.4	15	1.0
Ranunculus aquatilis, White water crowfoot	4.93	4.33	1.8	11	1.0
Najas flexilis, Slender naiad	4.04	3.54	1.5	9	1.0
Bidens beckii, Water marigold	2.69	2.36	1.0	6	1.0
Potamogeton crispus, Curly-leaf pondweed	2.69	2.36	1.0	6	1.0
Potamogeton friesii, Fries' pondweed	1.79	1.57	0.6	4	1.0
Lemna minor, Small duckweed	1.35	1.18	0.5	3	1.0
Nymphaea odorata, White water lily	1.35	1.18	0.5	3	1.0
Spirodela polyrhiza, Large duckweed	1.35	1.18	0.5	3	1.0
Wolffia columbiana, Common watermeal	1.35	1.18	0.5	3	1.0
Elatine minima, Waterwort	0.90	0.79	0.3	2	1.0
Eleocharis acicularis, Needle spikerush	0.90	0.79	0.3	2	1.0
Potamogeton alpinus, Alpine pondweed	0.90	0.79	0.3	2	1.0
Potamogeton amplifolius, Large-leaf pondweed	0.90	0.79	0.3	2	1.0
Sagittaria sp., Arrowhead rosette	0.90	0.79	0.3	2	1.0
Potamogeton foliosus, Leafy pondweed	0.45	0.39	0.2	1	1.0
Potamogeton illinoensis, Illinois pondweed	0.45	0.39	0.2	1	1.0
Potamogeton pusillus, Small pondweed	0.45	0.39	0.2	1	1.0
Sparganium eurycarpum, Common bur-reed	0.45	0.39	0.2	1	1.0
Aquatic moss	0.45	0.39		1	1.0
Filamentous algae	26.01	22.83		58	1.0
Isoetes echinospora, Spiny spored-quillwort	Viewed only				

The most common plants sampled were coontail (*Ceratophyllum demersum*), forked duckweed (*Lemna triscula*), and northern water mifoil (*Myriophyllum sibiricum*). Figures 12 to 14 show the distribution of these three plants.

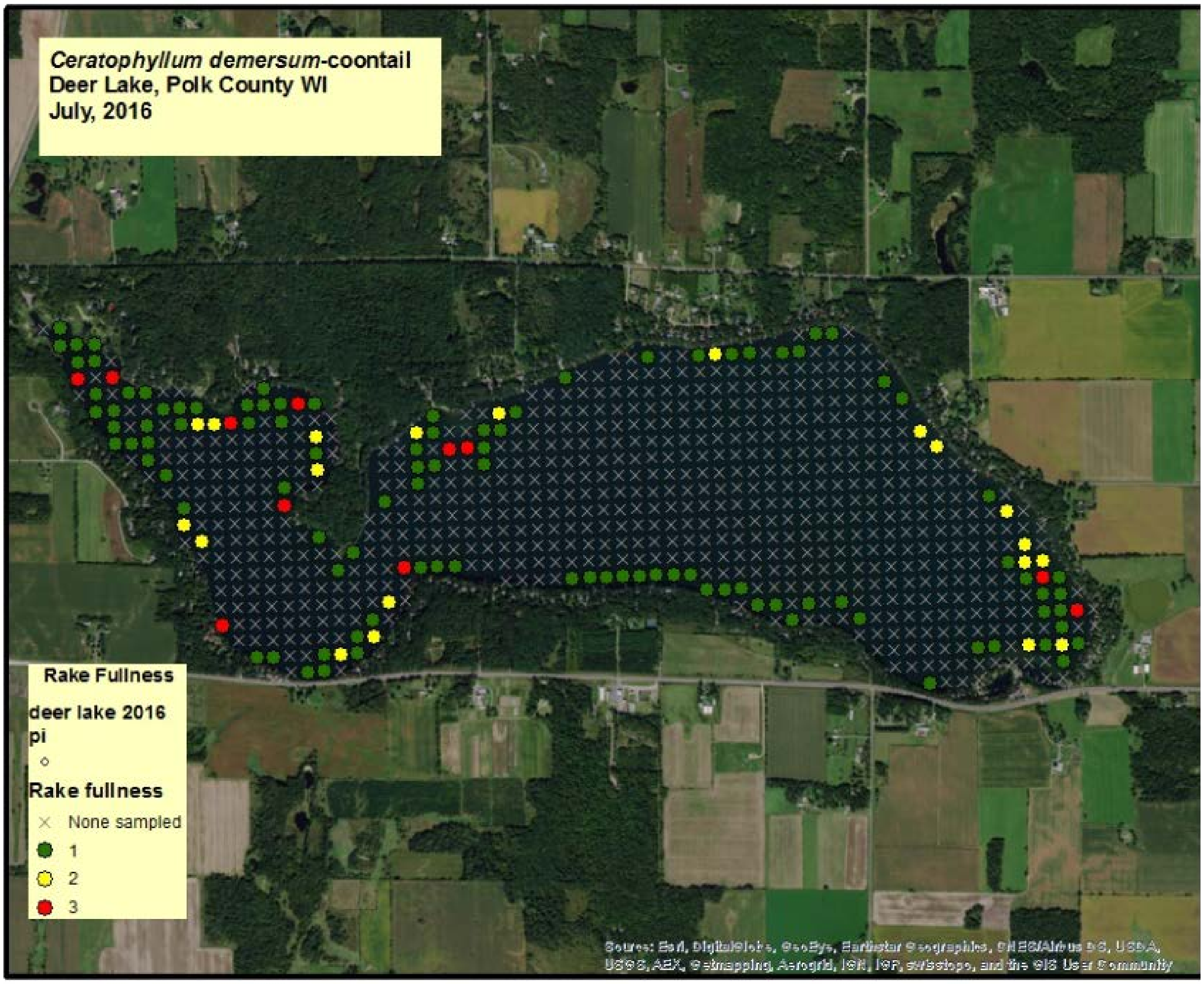


Figure 12. Distribution map of Ceratophyllum demersum (coontail)

Coontail is a very common aquatic plant in Wisconsin lakes. The plant has many fine leaves whorled around the petiole that provide excellent habitat for plankton and invertebrates. This provides good forage areas for small fish and larger fish. Coontail also can absorb nutrients directly from the water column.

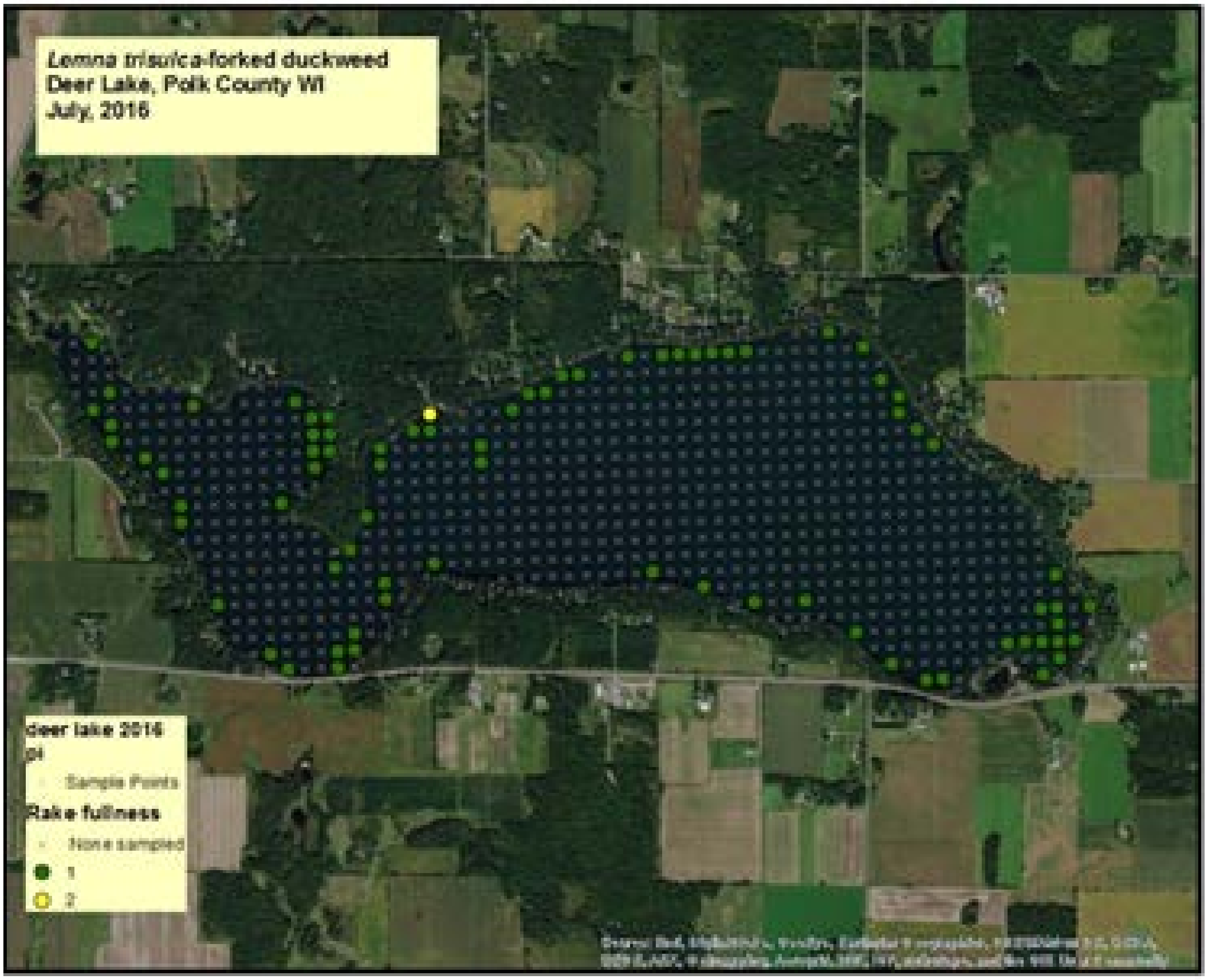


Figure 13. Distribution map of Lemna trisulca (forked duckweed)

Forked duckweed is a free floating plant (not rooted but tends to live on the bottom or on other plant material). It is a common, desirable plant in Wisconsin lakes. Forked duckweed provides good food for waterfowl and in high enough density, it can provide cover for fish and invertebrates. Since it is free floating, it absorbs nutrients directly from water and can only grow if nutrient content of the water is adequate.

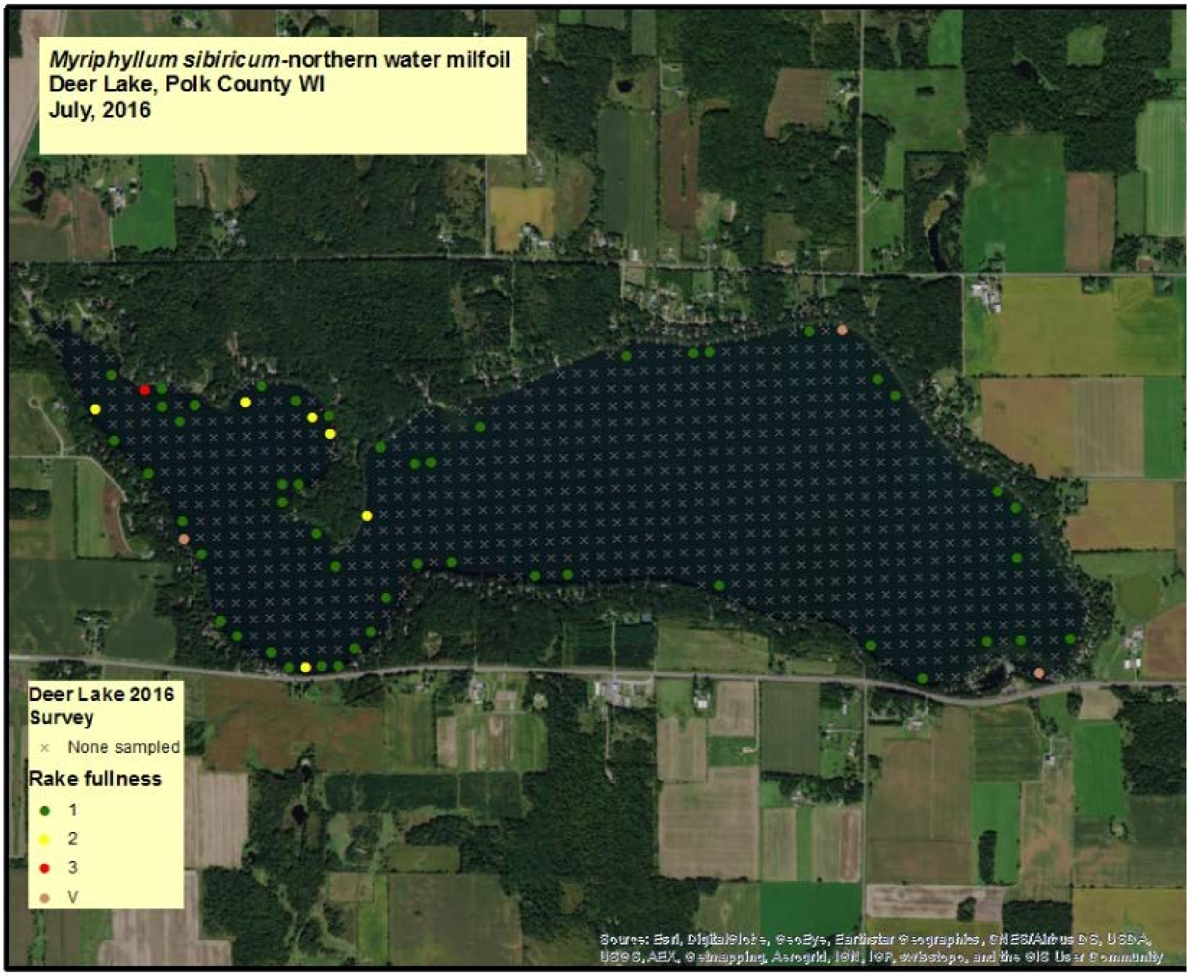


Figure 14. Distribution map of Myriophyllum sibiricum (northern water milfoil)

Northern water milfoil is another common aquatic plant in Wisconsin lakes that has fine leaflets making up each leaf. This provides excellent areas for plankton to grow, leading to great forage areas for fish. Northern water milfoil is closely related to the non-native Eurasian water milfoil. The native northern water milfoil is desirable in a lake and can help (along with other native plants) keep invasive species such as Eurasian water milfoil from becoming established.

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.

A boat survey was completed in areas not represented by the sample point grid, largely to identify additional plant species – especially invasive species or rare plants. Numerous species were observed in this part of the survey not sampled in the sample grid points.

Calla palustris - wild calla
Iris pseudacorus - yellow iris (invasive)
Myosotis scorpioides - aquatic forget me not (invasive)
Nuphar variegate - spatterdock
Phalaria arundincea - reed canary grass (invasive)
Sagittaria latifolia - common arrowhead
Sagittaria rigida- sessile fruited arrowhead
Schoenoplectus tabernaemontani - softstem bulrush
Typha augustifolia - narrow leaf cattail (invasive)
Typha latifolia-broad leaf cattail

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 2016 was higher than the median for similar lakes within the eco-region (33.8 compared to 20.9). The mean conservatism is also higher than the median for lakes within the ecoregion (6.17 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.

Table 6. Deer Lake Floristic Quality Index

FQI Parameter	Deer Lake 2016	Ecoregion median
Number of species in FQI	30	14
Mean conservatism	6.17	5.6
FQI	33.8	20.9

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, or 2016).

Comparison of 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 than in 2006, and the FQI calculated as a result is slightly higher. The littoral zone had higher plant coverage in 2010 and 2016 than in 2006.

Table 7. Comparison between the 2006 and the 2010 Plant Surveys

Parameter	**2006**	**2010**	**2016**
Species richness	26*	30	32
Dominant species	Coontail (*Ceratophyllum demersum)*	Forked duckweed (*Lemna triscula*)	Coontail (*Ceratophyllum demersum)*
FQI	33.73*	34.02	33.8
Simpson's diversity index	0.91	0.89	0.90
Native species per site	3.1	3.42	2.7
Littoral zone with plants	79.1%	88.4%	87.8%
Maximum depth with plants	27.2 feet	28 feet	26 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 years. Coontail has increased in frequency over the years (2006: 50%, 2010: 53% and 2016: 59%). The third most dominant plant in each plant survey was northern water milfoil (native plant). However, the 23% frequency of occurrence (FOC) in 2006 doubled to 46% FOC in 2010. It was back down to 25% FOC in 2016. Water celery was the second most dominant plant in 2006 with a 50% FOC. Water celery decreased to a 33% FOC in 2010 and 21% in 2016.

Two sensitive species were sampled in 2006 and not in 2010 or 2016. 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 samples.

These differences are small and don't strongly indicate any major changes in the plant community. There were significant changes in the number of some native plant species. Four native plant species increased and 3 native plant species decreased. A more detailed description of these changes is included in the plant survey reports.

Potential concerns are raised with significant decreases in native plant species. The causes of the decreases are unknown, but reduction due to herbicide used in curly leaf pondweed management is of potential concern. Since the herbicide used is broad spectrum, all plants growing at the time of treatment may be susceptible to the herbicide. Because there were four species with significant increases, the potential for herbicide as the cause of the decrease is low. Also, most native plants in Deer Lake did not appear to form widespread beds, but rather small clumps of different species. A minor fluctuation in sampling location can change the possibility of sampling or not sampling a plant, leading to frequency changes in the data.

Aquatic Invasive Species

Three species of aquatic invasive plants not native to Wisconsin lakes were observed in the 2016 aquatic plant survey. They are curly leaf pondweed (*Potamogeton crispus*), reed canary grass (*Phalaris arundinacea),* narrow leaf cattail (*Typha augustifolia),* yellow iris *(Iris psuedacorus),* and aquatic forget-me-not (*Myosotis scorpioides*). More information about several aquatic invasive species is included in Appendix B.

All of the above species are restricted species in Wisconsin. According to NR 40, restricted invasive species are already established in the state and cause or have the potential to cause significant environmental or economic harm or harm to human health. Restricted species are subject to a ban on transport, transfer and introduction, but possession is allowed with the exception of fish and crayfish.

Reed canary grass, narrow leaf cattail, yellow iris, and aquatic forget-me-not were observed near the boat landing. Reed canary grass covered a small, dense area. Yellow iris was observed in the bay just southeast of the boat landing. Narrow leaf cattail was also observed in a couple of bays around the lake. Aquatic forget-me-not is covering quite a large area both east and west of the boat landing.

Curly leaf pondweed (CLP) has been mapped and managed through herbicide treatments over the past several years. Twenty-three acres of CLP were treated in late April 2016. There were also a few untreated areas where CLP formed small, dense beds in 2016. CLP growth had been less dense and more scattered in previous years. It is typical for CLP growth to vary from year to year.

Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Polygonum sachalinense*) are a concern for riparian areas of Deer Lake. The Polk County Land and Water Resources Department located several riparian locations throughout Polk County including where giant knotweed was found intentionally planted on private property along Deer Lake Park Road during an invasive species survey in 2017.

There is a high risk that Eurasian water milfoil (EWM) 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 and other AIS on boats and motors is very real.

In Polk County, EWM is found in Pike Lake, Long Trade, and Horseshoe Lakes. 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).

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.[9]

Curly leaf pondweed beds were first 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. 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 16. Because muck is widespread around the lake, this does not seem to be the greatest determinant of 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 15) have brought sediment to the lake over many years.

---

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

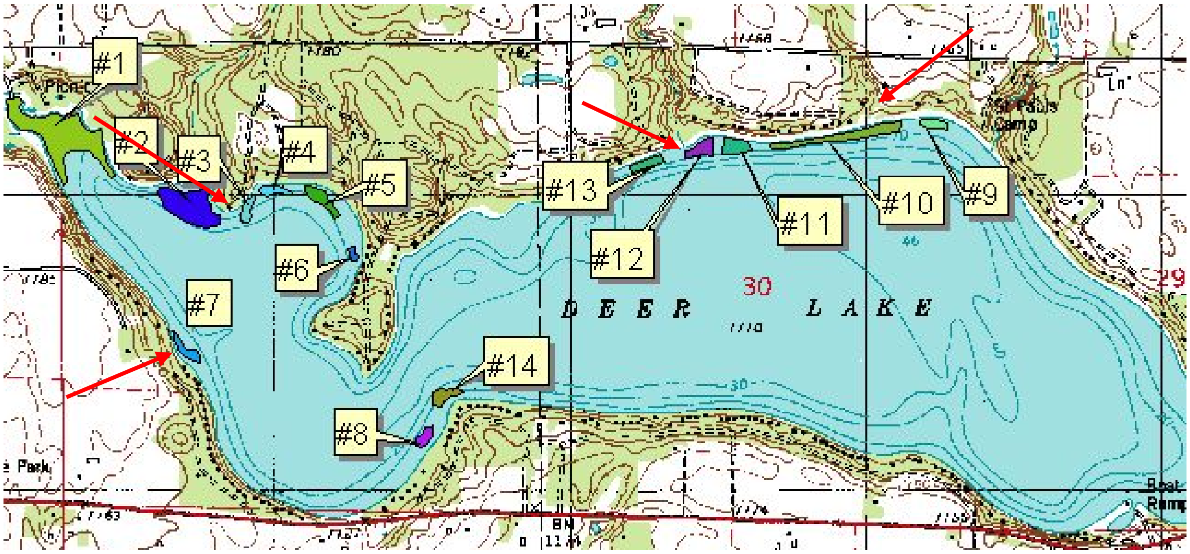


Figure 15. Curly Leaf Pondweed Beds on Deer Lake 2005 (arrows indicate intermittent stream outlets to the lake).

Figure 16. Deer Lake Mucky Sediments

Curly leaf pondweed (CLP) has been mapped and monitored several times since 2005. In addition, there were early season herbicide treatments of CLP from 2006-2016. In May 2016, nuisance curly leaf pondweed beds totaling 23 acres were treated. This represents about nine 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 in this plan.

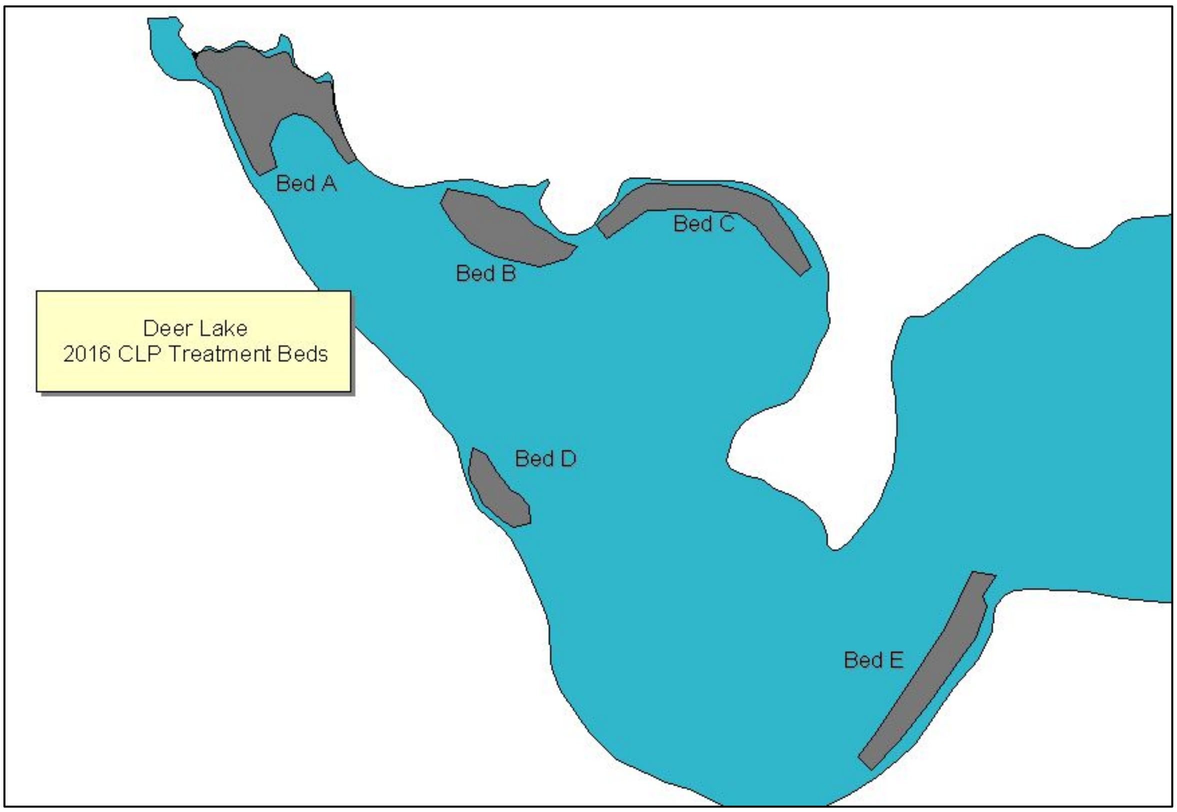


Figure 17. *Curly Leaf Pondweed Treatment Areas 2016*

Zebra Mussels

While zebra mussels are invertebrates rather than plants, they are invasive species of concern that will be covered in this aquatic plant management plan. A single adult zebra mussel was found by a lake homeowner's guest on the northeast shore of Deer Lake on September 2, 2016. The substrate was rocky. Later that same week Katelin Anderson and Jeremy Williamson (Polk County), Jim Miller (Deer Lake resident), and Dave Wedan (USFWS) searched shallow water in the vicinity and the public access on the northwest side of the Deer Lake. A veliger (larval form of zebra mussels) tow taken by Byron Karns (USNPS) in July 2016 was negative. Plate samplers placed at the public boat landing and monitored by Dave Wedan (USFWS) also had no zebra mussels present in 2016.

The Deer Lake Improvement Association (DLIA) sent out email notices to about 75% of lake residents and mailed a notice to all lake residents by October 1. The notice let residents know a zebra mussel was found, provided a description, and encouraged them to check docks and boats as they were pulled out of the water for the season.

Zebra mussels attach to hard surfaces like piers, docks, boats, and rocks. The DLIA also informed dock service providers about the zebra mussel discovery in early fall of 2016 and requested that they check any docks or equipment pulled out of Deer Lake. John Wright (DLIA) coordinated this effort. On October 20, 2016 Jim Miller and Cheryl Clemens (Harmony Environmental) checked docks and lifts pulled out of the water. Jeremy Williamson reviewed suspect mussels brought in for identification. No additional zebra mussels were found in the lake.

Zebra mussels can clog water intakes and pipes, encrust piers, boats, and motors, and their sharp shells can cut the feet of swimmers. Zebra mussels have been found in less than 5% of Wisconsin lakes predicted to be suitable for zebra mussels. In Deer Lake, calcium levels are at the low end of concentrations where zebra mussels thrive, so that may limit their growth and spread.[10]

Monitoring

A Polk County Zebra Mussel Task force was formed as part of the response to zebra mussel discovery in Deer Lake. The Task Force included representatives from the Deer Lake Improvement Association, the Bone Lake Management District, Polk County, the St. Croix River Association, the WDNR, the National Park Service, and the United States Fish and Wildlife Service. Recommendations were developed for zebra mussel monitoring and outreach for Deer Lake and other lakes in Polk County. The task force recommendations are adopted as part of this plan and are included in the implementation section and summarized in Table 15.

Control

The Deer Lake Improvement Association is investigating control measures available and the likely results. Control efforts may be reasonable if zebra mussels are identified within a discreet area following extensive monitoring efforts. A containment curtain would be needed to separate the treatment area from the rest of the lake to be able to maintain concentration of chemical for

---

[10] To learn more about zebra mussels or Wisconsin aquatic invasives species regulations visit: dnr.wi.gov keyword "invasive species."

the desired exposure time. All of the control options listed in Table 7 have been tried in Minnesota with some success.[11] In Christmas Lake, treatment with various control measures was found to be effective within a treatment area, only to have zebra mussels discovered outside of the area multiple times. The Christmas Lake treatments cost a total of $64,000. Because of cost and effects on non-target organisms, whole lake treatment is not a viable option for Deer Lake.

Table 8. Zebra Mussel Control Options

Method	**Action**	**Permit**	**Comments**
Potash (potassium chloride)	Molluscicide	EPA permit required (may take 2-3 months)	Target concentration 100 ppm potassium. Christmas Lake (10/14, 12/14, 6/15, 7/15). Application did not work well under ice.[12]
Copper compounds (Cu^{2+}) (e.g. Earth TechQZ)	Molluscicide	WNDR permit	Multiple applications may be necessary to maintain 0.3 - 0.5 ppm copper concentration for 8-14 days. Lake Minnewashta 29-acre bay (9/16) – target concentration 0.3 – 0.5 ppm for 10 days. Also used in Christmas Lake (10/14, 12/14).
Zequanox	Biocide (dead bacterial cells)	WDNR permit	Settles to the bottom, impacts to native mussels, DO drop. Used in Christmas Lake 9/14. Leave barrier in place maximum of 24 hours because of nontarget impacts.[12] Likely highest cost of chemical treatments.
Tarps and benthic barriers	Smothers everything, destroys habitat	WDNR permit	Lake Tahoe (from Cattoor presentation). Leave in place 3 weeks to 1 1/2 years.
Drawdown, dewatering	Long exposure time required	WDNR permit	May not be practical for Deer Lake
Predation	Fish eat ZM: sunfish, common carp, sheepshead		Little research, no strong success indicated

[11] McComas, Steve. *Zebra Mussel Early Detection, Rapid Response, and Control Plan for Forest Lake, Washington Co, Minnesota.* April 2015.
Kylie Cattoor, Minnesota WDNR, Presentation Joint Minnesota Wisconsin Zebra Mussel Workshop. St. Croix Falls, WI. April 24, 2017.
http://www.minnehahacreek.org/project/lake-minnewashta-zebra-mussel-treatment

[12] https://www.maisrc.umn.edu/news/lessons-learned-xmas

In Lake Minnewashta in Carver County, Minnesota a zebra mussel rapid response project and report provides important control information.[13] *Zebra mussels were first discovered in Minnewashta by the MCWD's early detection monitoring program on August 18, 2016. Through further surveys, the population appeared to be localized to the public access area and a rapid response was initiated. Partners in the response included MCWD, Carver County and the Lake Minnewashta Preservation Association. A 29 acre bay was cordoned off with barriers, and treated with EarthTec QZ for 10 days at a target copper concentration of 0.3 to 0.5 ppm. An additional 0.61 acre area, within the 29 acre area and surrounding the boat launch where the infestation occurred, was also cordoned off with barriers and treated with EarthTec QZ. Bump treatments were necessary to maintain target concentration, and occurred on days 1, 3, 6 & 8.100% mortality of zebra mussels was observed by day 10. Other parameters monitored included dissolved oxygen, pH, conductivity, water temperature and observations on non-target impacts. A survey of docks and lifts taken out of the water by residents was also conducted on October 28, 2016 with no zebra mussels found.*

EarthTec QZ was chosen as the product of choice due to costs; the cost of Potash was quoted as 3 times as expensive. Timeliness was also a consideration, Potash would have required an amended or new emergency authorization from the US EPA, whereas EarthTec QZ already had an EPA approved label for zebra mussels. A lower Copper concentration range of 0.3 to 0.5 ppm was proposed for the EarthTec QZ treatment based previous data from the manufacturer and previous lab trials by MCWD that showed 100% mortality of zebra mussels with EarthTec QZ at 0.5 and 1.0 ppm at 8 days exposure.

Zebra mussel sampling and copper monitoring methods are included in the report. Dissolved oxygen levels were very low during the treatment period but increased after the containment curtain was removed. A minor fish kill occurred in the area during the treatment with species detailed in the report. Native mussels that were installed in cages for monitoring purposes were likely killed by the treatment. Native plants were damaged within the treatment area.

Not including staff time for monitoring and supervising the treatment, the project cost including containment curtain and 29 acres of treatment totaled $31,936.

Table 9. Lake Minnewashta Zebra Mussel Treatment Costs (29-acre bay)

Item	**Cost**
Enclosure Curtain	$9,000
EarthTecQz	$17,861
Applicator	$5,075
	$31,936.00

[13] Rapid Response to Zebra Mussel Infestation Lake Minnewashta Carver County, MN. Eric Fieldseth and Jill Sweet, Minnehaha Creek Watershed District, December 30, 2016

The manufacturer of EarthTecQZ recommends a slightly lower initial concentration of copper in its treatment protocol.[14]

For effective control of adult and juvenile mussels, apply an initial dose at the rate of 4 parts per million EarthTec QZ (i.e., 4 gallons of EarthTec QZ per million gallons of water treated), equivalent to 0.240 mg/L (ppm) metallic copper. Monitor the copper concentration in the treated water and reapply a dose of 2 ppm QZ (equivalent to 0.120 mg/L as copper) every two days or as necessary to maintain a dissolved copper concentration of no less than 0.1 mg/L in the treated water for at least 14 days, or for at least 3 days beyond the day the last live mussel was detected. Do not exceed a concentration of 1.0 mg/L as copper in any single dose or at any time in the treated water (background + applied). Shorter treatments may be effective in warm water, e.g., >25°C or 77°F.

[14] EarthTec QZ Treatment Protocol Mussel Control in Open Waters. Earth Science Laboratories, Inc. www.earthsciencelabs.com

Table 10. Countywide Zebra Mussel Monitoring and Prevention Outreach[15]

Method and Messages	**Target Audience**	**Lead Organization**
Presenters and Canned Presentation: All topics below	Lake Organizations at annual meetings	Polk County LWRD
Handout: ZM ID, methods for monitoring, emphasize cinder blocks – build your own, shoreline surveys	Lake Organizations to Lake Residents	Polk County LWRD PCALR (?) DLIA
Cinder Block guidance: Pictures and description, ID contacts, monitoring log	Lake Residents	DLIA
Example Newsletter Articles: All topics (could follow presentation, or break up into several articles)	Lake Organizations to Lake Residents	Polk County LWRD
Press Release, handout: List ZM waters, explain decontamination procedures, don't have carpeting on boats, waiting times/temps. after removing boats and equipment from these lakes. (MN protocol for guidance)	General Public Dock Service Providers	Polk County LWRD
Clean Boats, Clean Waters Contacts: Provide information about ZM lakes (map/list), emphasize draining and checking if boaters came from or leaving these lakes	Boaters at CBCW Landings CBCW staff receiving training	Polk County LWRD to Lake Organizations w/ CBCW
Coordination with tournament organizers: Drain live wells, drop motors; don't bring your boat here if you've been these (ZM waters) without decontamination; decontamination procedures	June Jam: Muskies, Inc.; Indianhead Musky Tournament; anglers participating in fishing tournaments (If <20 participants no permits, otherwise on WNDR web site)	DLIA Bone Lake MD (Friday night Indianhead mtg.)
Public Meeting with Press Release: Recent ZM discoveries, monitoring, all prevention topics		
Presentations and Curriculum	Schools SCF 5th grad camp (DLIA)	LWRD, other agencies, lake organizations
Signs	Post where ZM have been discovered – e.g. Deer Lake	DLIA

[15] Existing AIS grants or new Rapid Response grants might fund these activities

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[16] 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.[17]

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.

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

[17] 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[18]

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.

[18] 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[19]

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.

[19] 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[20] 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[21]

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

[20] *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use*. Wisconsin Department of Natural Resources. July 2006.
[21] 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.[22]

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.

[22] 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 11. 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.[23]

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 three weeks in water but can be as short as one 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.

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

Diquat
When applied to enclosed ponds for submersed weed control, diquat is rarely found longer than 10 days after application and is often below detection levels 3 days after application. The most important reason for the rapid disappearance of diquat from water is that it is rapidly taken up by 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 three months but can remain up to nine months. It may remain in bottom sediment between four months and one 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.[24] 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.[25] However, it could be used to target Eurasian water milfoil by treating the plant early in the year before many native plants are growing.[26] 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.[27] 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). WDNR studies show that granular and liquid formulations dissipate similarly when applied at a small-scale. With small scale treatments, herbicides can dissipate off treatment sites rapidly. Treatment of many small areas on a lake can sometimes result in lake-wide effects due to rapid dissipation and dilution off multiple sites.[28] 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.[29] 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,

---

24 Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.
25 Frank Koshere. Wisconsin DNR. email communication 3/03/10.
26 Scott Provost, Wisconsin DNR, telephone communication 12/7/16.
27 Nault 2010.
28 WDNR Bureau of Science Services. 2014.
29 Nault 2010.

swimming and fish consumption 0 days, irrigation 1-5 days, and animal use 1 day. Endothall (Aquathol K) has the following use restrictions: drinking water 7 – 25 days, irrigation of turf and ornamentals, swimming and fish consumption 0 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 life cycle can prevent turion formation.[30] 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. These methods are accepted as standard operating procedures being approved in Wisconsin for aquatic invasive species control projects.[31]

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.[32] Steep drop-off, high winds, and other factors that increase herbicide dilution and contact time can decrease treatment effectiveness.[33] 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.

---

[30] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[31] Plan comments, Frank Koshere, September 16, 2010.
[32] WDNR Bureau of Science Services. 2014.
[33] *Draft Report Following April 2008 Aquatic Herbicide Treatments of Three Bays on Lake Minnetonka*. Skogerboe, John. Us Army engineer Research and Development Center.

Preventing Invasive Species

There are five major elements the Deer Lake Improvement Association and others can consider to prevent invasive species: education to lake users, Clean Boats Clean Waters program, landing surveillance cameras, lake monitoring, and a rapid response strategy for any new invasive species.

Education to Lake Users

Education efforts focus on identification and prevention of new invasive species. Activities might include aquatic invasive species (AIS) information presented at annual meetings and workshops, signage at the public landings and private boat launch areas, lake maps and brochures with AIS messages, and web site and newsletter information.

Clean Boats Clean Waters (CBCW) Program

Clean Boats Clean Waters educators provide boaters with information on the threat posed by Eurasian Milfoil and other invasive species. They offer tips on how to keep boats, trailers, and equipment free of aquatic hitchhikers. They also collect information on boater behavior, concerns, and knowledge of existing local and state laws related to anti-AIS measures. A WDNR Clean Boats, Clean Waters grant can currently provide 75% funding as long as a minimum of 200 hours are covered at the landings.

Landing Surveillance Cameras

Some lake organizations use video cameras at public landings to record landing activity. Videos are reviewed, and if watercraft are launched with vegetation attached, action is taken. Violations of the ordinance and state rule which prohibits transporting and launching boats and trailers with vegetation attached can be enforced by local law enforcement officers. The camera also serves as a reminder for boaters to check their equipment. Surveillance cameras are in place at nearby Bass Lake in St. Croix County and Bone and Church Pine Lakes in Polk County. WDNR AIS Education, Prevention and Planning grants can be used to support camera installation (up to $4,000 in grant funds for each). Maintenance and video/photo review are not grant-eligible expenses.

Boat Washing/Decontamination

A boat decontamination unit trial was offered to the DLIA in 2016 by the Wisconsin Department of Natural Resource water guard. The trial was declined because there wasn’t a practical means to divert wash water away from the lake.

Lake Monitoring

The objective of lake monitoring is to look for new invasive species. Monitoring for invasive species is generally focused around boat landings and other areas of high public use. Trained volunteers or consultants may complete the monitoring. Divers may be used. It is critical to complete aquatic invasive species visual surveys when algae growth is low and visibility is good.

Rapid Response for New Invasive Species

The activity is intended to control any new invasive species that are found in the lake. Rapid response protocols include the following:

- monitoring for invasive species
- education of lake residents and visitors
- contacts to confirm invasive species identification
- procedures for notification
- plans for removal and control
- funding contingencies and grants.

Invasive Species Information is available on the DNR website http:/dnr.wi.gov/invasives.

A Rapid Response protocol is included as Appendix F.

Deer Lake Curly Leaf Pondweed Management

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

Curly Leaf Pondweed Goals and Objectives (2010 APM Plan)

Goal. 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 = 2 or 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)

The endothall treatments were 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.

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.

CLP Treatment Results

Deer Lake CLP treatments and general results are summarized in Table 12. 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 – 2009. Seven acres were treated in 2006, and about 10 acres were treated in 2007 and 2008. Because of a miscommunication, only 7 acres were treated in 2009. A permit was granted to add additional nuisance beds and treat 32.5 acres in 2010. 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.

Table 12. Deer Lake Curly Leaf Pondweed Treatment[34]

	Acres	Date of Treatment	Target Concen-tration of Endothall[35]	Water Temperature	Wind Speed	Significant decrease in CLP/Effective Control	Significant decrease in natives from previous year
2006	7.35	May 30	0.75 ppm	60 F	5-10 mph	**No**	None detected
2007	9.99	May 22	0.75 ppm	58 F[36]	10-15 mph	**No**	None detected
2008	9.95	May 20	0.75 ppm	52 F (49?)		**Maybe** – lower densities, Bed 2 decreased in area by 25%	None detected
2009	7	May 21	0.75 ppm	?	18 mph, gusts to 28	**No**	None detected
2010	32.5	May 18	1.25 ppm	56 F	5 mph	**Yes**	Yes
2011	24.61	May 29	<1 ppm	56 F	0 to 5 mph	**No**	Uncertain
2012	23.4	May 9	1.5 ppm	58 F	4 mph	**Yes**	None detected
2013	21	May 28	1.5 ppm	57 F	5-6 mph	**Yes**	Yes, 4 species decreased
2014	23	May 29	1.5 ppm	?	?	**Yes**	No
2015	23	May 8	1.5 ppm	56 F	4-7 mph	**Yes**	Yes, Coontail
2016	23	April 29	1.5 ppm	49 F	0-3 mph	**Yes**	Increase (2) Decrease (2)
2017	23	May 5	2.0 ppm	51 F	calm	**Yes**	Increase (1) Decrease (3)

[34] Information Aquatic Plant Management Herbicide Treatment Records submitted by the applicator to DNR.
[35] Treatment concentrations have been adjusted from gal/acre to ppm for comparison.
[36] Not recorded on permit report. Information from applicator.

The target concentration of herbicide was originally 2.6 gallons per acre or about 0.75 ppm. Beginning in 2010, the target concentration was increased to 1.5 ppm endothall, then to 2.0 ppm in 2017. 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.

The 2017 *Herbicide Treatment Analysis* is included as Appendix D. More detailed results and pre- and post-monitoring methods are described in that report. Herbicide treatments have resulted in significant reductions in the frequency of occurrence before and after treatments each year from 2012 – 2017. In addition, nearly the same areas have been treated as illustrated in Figure 18. CLP treatment results from each year are shown in Figure 19. While treatment success has varied each year, reductions in CLP have all been significant.

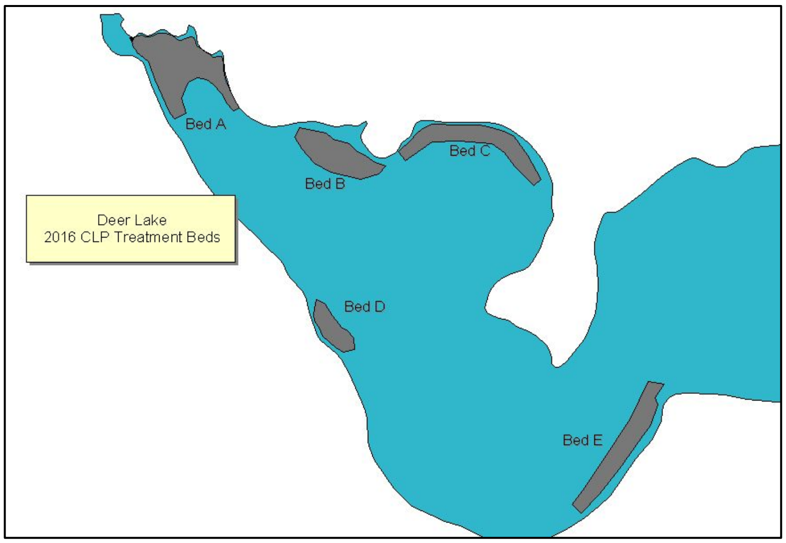


Figure 18. Curly Leaf Pondweed Treatment Areas 2016

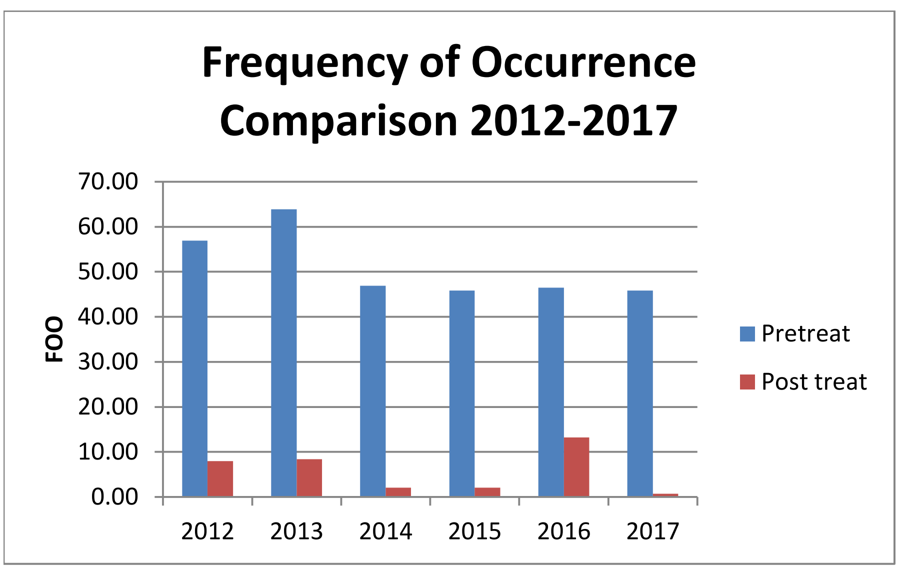


Figure 19. CLP Pre- and Post-Treatment Frequency of Occurrence (2012-2017)

DNR grants have supported CLP control efforts since 2007 paying 50% of the cost of treatment and monitoring. The DLIA covered 100% of the cost in 2015, then again received a grant for 2016 and 17.

Table 13. Deer Lake WDNR AIS Control Grants

Grant Number	Dates Covered	Grant Amount	% State Grant
ACEI-024-07	4/1/07 – 12/31/09	$16,612.50	50
ACEI-105-12	10/01/11-12/31/14	$39,875.00	50
ACEI-18116	4/15/16 – 6/30/19*	$22,025.00	50

*Expected to be depleted by 12/31/17

Turion Monitoring

Turions are the reproductive structures from which new CLP plants will germinate in 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 in the fall 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 has been conducted since 2013. While initial decreases in turion densities were observed, they increased from 2014-16 then decreased to lowest levels in 2017.

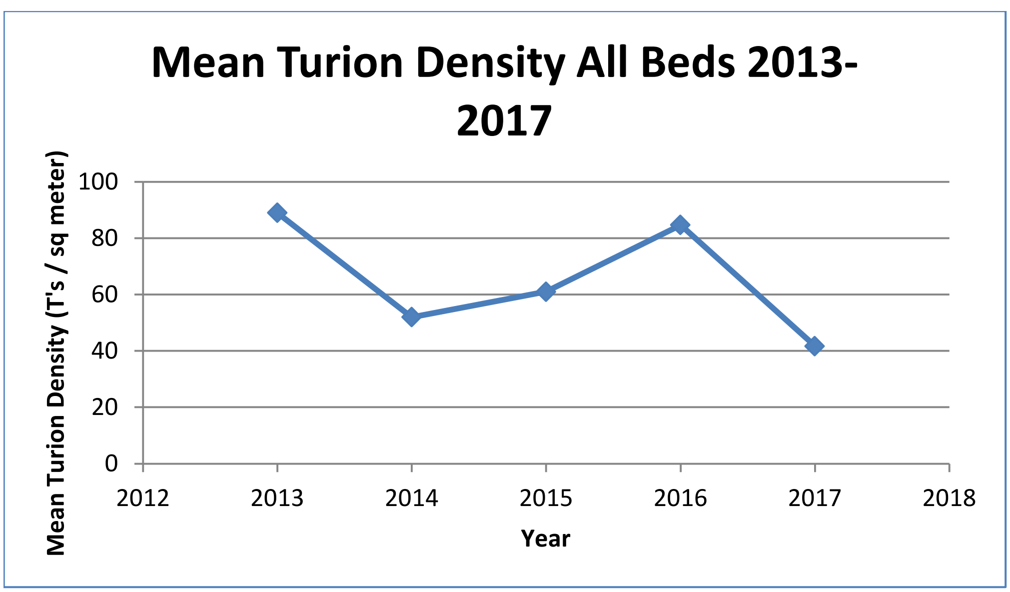


Figure 20. Mean Turion Density 2013-2017

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.

Filamentous Algae Treatment

The Deer Lake Improvement Association has used copper sulfate compounds to alleviate nuisances caused by filamentous algae for many years on Deer Lake. Algae treatments were managed by the Deer Lake Improvement Association Environmental Committee Chair. Up to 15 acres of treatment area were allowed at any one time. From 1993 – 2000 up to five acres were treated for filamentous algae control at a time. In recent years, treatment frequency has decreased drastically. 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. In 2008 there were seven occasions when copper sulfate was used to treat filamentous algae. In 2009 0.45 acres were treated.

The 2010 aquatic plant management plan included the following nuisance conditions to authorize the control of filamentous algae:

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

Filamentous algae treatment according to WDNR treatment records was as follows: 2010: 2.78 acres, 2011: 1.7 acres, and 2012 – 5 acres. Copper sulfate treatments were 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.[37] A Cutrine Plus application rate of 0.6 ppm copper is recommended for a medium density filamentous algae growth. The maximum application rate is 1 ppm copper.[38]

Copper in Deer Lake sediments

A study completed by MacDonald et al. (2000) developed consensus based numerical sediment quality guidelines for metals in freshwater ecosystems. This study provides guidelines for metals in freshwater ecosystems that reflect threshold effect concentrations (TECs, below which harmful effects are unlikely to be observed) and probable effect concentrations (PECs, above which harmful effects are likely to be observed). **The consensus based TEC for copper is 31.6 mg/kg and the consensus based PEC for copper is 149 mg/kg.** (from the Long Lake Management Plan 2013)

<u>Deer Lake sediment copper levels:</u>

Deer Lake - West	120	MG/KG	5/23/2000
Deer Lake – East	94	MG/KG	5/23/2000

[37] J. Aquat. Plant Manage. 34:39-40. 1996.
[38] Cutrine Plus Specimen Label.

Boat Landing

In 2003 the boat landing area was treated with herbicides with the express purpose of preventing the introduction of Eurasian water milfoil 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 permits were issued for the purpose of allowing boats to pass each other and navigate from the boat landing.

Individual Access Corridors

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 was designated in an approved aquatic plant management plan.[39] 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 corridors 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.

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 2016 with the exception of 2008 when multiple interns who were offered the job did not accept it. The boat landing is generally staffed on weekends from Memorial Day through late August or early September. The hours the landing was staffed each year are included in Figure 21, and the number of boats inspected is shown in Figure 22. Interns are paid $10/hour and volunteer about 1/5 of their time to match the grant. The Town of St. Croix Falls provides payroll services for the program.

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

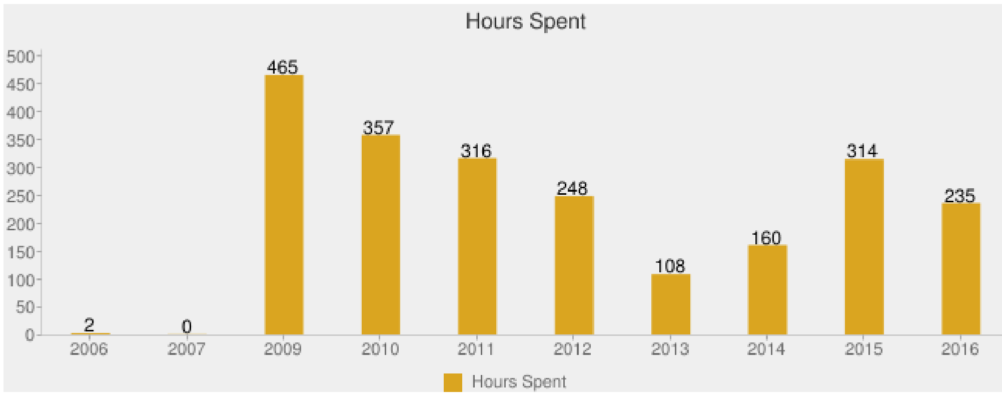


Figure 21. Clean Boats, Clean Waters Hours 2006-2016

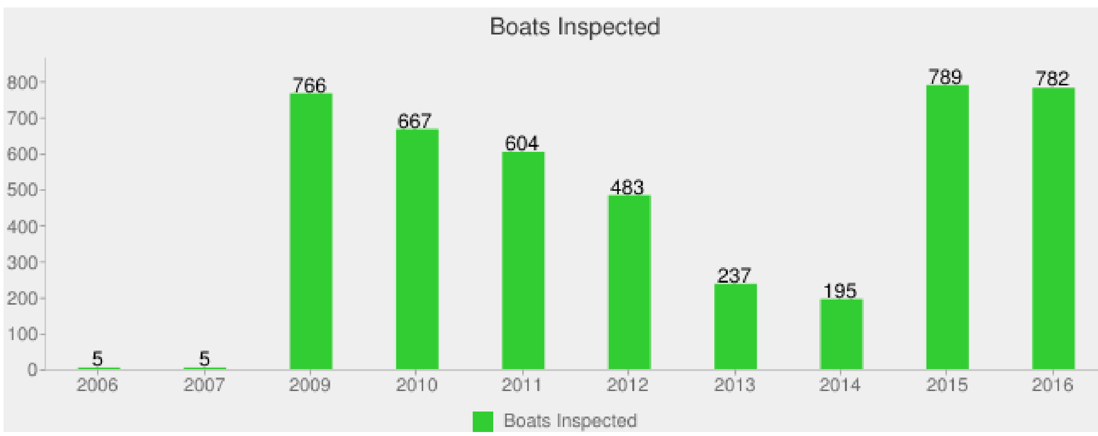


Figure 22. Clean Boats, Clean Waters Boats Inspected 2006-2016

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 Schieffer 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 monitored the boat landing for invasive species including Eurasian water milfoil (EWM) monthly from May to September through about 2012. Monitoring was visual from a boat. Deer Lake has also 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.

The APM Monitor, Steve Schieffer conducted an AIS meandering survey of the littoral zone in June, August, and September of 2016. The entire littoral zone was surveyed with special attention near boats, in high traffic areas, near landings, and in high nutrient bays/points. No AIS were found. A lake visitor found zebra mussels along the northeast shore of Deer Lake in September 2016. No additional zebra mussels or larvae were confirmed in the lake with previous or subsequent monitoring.

Rapid Response

The DLIA approved a rapid response policy at a board meeting June 12, 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. Clean Boats, Clean Waters staff and volunteers will be trained at workshops provided by 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.

Implementation

Plan Timeframe

This plan covers a five year time frame: from 2017 to 2021. As new knowledge is acquired and events unfold, actions will be updated as appropriate.

Implementation Plan Updates

An implementation plan table is found in the following section. The implementation plan or work plan details how action steps will be carried out. This implementation plan will be updated annually in June to keep actions and budgets current. The Environmental Committee Chair will facilitate this effort in cooperation with Deer Lake Improvement Association Board.

Funding Plan Implementation

The implementation charts later in this section list potential funding sources for plan implementation.

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. AIS Education, Prevention (AEPP), and Planning and Clean, Boats Clean Waters (CBCW) grants are due December 10 of each year. AIS Control (ACEI) grants are due February 1 of each year.

Current Deer Lake Improvement grants are shown in Table 14 below. Although the ACEI grant lists an expiration date of 6/30/19, grant funds are expected to be nearly depleted by the end of 2017.

Table 14. Current DLIA Grants

Grant Number	Dates Covered	Amount	% State Grant
AEPP-46216	2/15/16 – 12/31/17	$11,479.50	75
CBCW-36817	2/15/17 – 12/31/17	$3999.75	75
ACEI-18116	4/15/16 – 6/30/19	$22,025.00	50

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.

Objectives are the (preferably measurable) 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.

The **Educational Strategy** prioritizes desired behaviors, lists messages, and provides a range of methods to reach lake residents and visitors.

Plan Goals

1) Protect and restore healthy native aquatic plant communities.
2) Prevent the introduction of aquatic invasive species.
3) Rapidly and aggressively respond to any newly introduced invasive, non-native aquatic plant and animal species.
4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.
5) Reduce levels of nuisance aquatic plants to allow safe, enjoyable recreation such as swimming, fishing, 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 chair will have interns, volunteers, and consultants to assist in these activities. The DLIA Environment Committee Chair is currently Joan Leedy.
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 Joan Leedy.
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 Northern Aquatic Services.
APM Monitor– a consultant hired to complete monitoring under the direction of the Environment Committee Chair 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.

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 remove plants from 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 area is a no-wake zone according to state regulation for jet skis (it is 100 feet for other watercraft), 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

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 can remove 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 as 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. Follow the Educational Strategy to provide residents with information regarding aquatic plant values, and methods to limit impacts to them.

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

3. Follow the Educational Strategy to 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 will be emphasized.

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.

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 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. Emphasize zebra mussel observation in Deer Lake.

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

5. Follow the Educational Strategy to gather and provide public information materials about invasive species prevention for distribution to Deer Lake residents.

6. Work with the Town of St. Croix Falls to pursue installation of a landing camera. (2018)

Goal 3) Rapidly respond to eliminate any newly introduced aquatic invasive 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 and aquatic animals.
  - Seek full time lake residents (minimum of five).
  - Provide pictures and supplemental information.

- Continue professional monitoring for invasive species at the public boat landing and along the littoral zone in June and August.

- Continue professional monitoring at the Lagoon private boat landing.

- Maintain a non-lapsing contingency fund of at least $15,000 for removal of invasive species.

- Management strategies may include manual, chemical, and biological control measures. A rapid response for giant knotweed will be developed by the DLIA in 2018.

- Designate 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.

ZEBRA MUSSEL RESPONSE

Action

Implement the Zebra Mussel Monitoring and Outreach Strategies developed by the Polk County Zebra Mussel Task Force and adopted by the DLIA. While monitoring will be sought throughout the lake, areas such as within 1500 feet of initial discovery area and in areas with rocky substrate around Deer Lake will be targeted.

Action

Consider zebra mussel control measures if monitoring results in discovery of a discreet population where control measures are likely to be effective.

Table 15. Deer Lake Zebra Mussel Monitoring Plan

Method	**Responsible Party**	**Cost**	**Comments**	**Needs**
Shoreline Search	DLIA	Printed guidance Email announcements	Assign shoreline monitoring areas. Secure lake residents to perform shoreline search	Provide guidance: Pictures and description, ID contacts, monitoring log, target rocky shorelines
Cinder blocks/bricks	DLIA		Encourage lake residents to place blocks beneath docks and monitor regularly	Cinder block kits (distribute at annual meeting) Cinder block guidance: Pictures and description, ID contacts, monitoring log
PVC Plate Sampler	USFWS To be installed at boat landing and at initial discovery location Check 2X/month	\$11-\$50/each Plans also available (Dave Wegan, USFWS)	Install at additional locations (DLIA?) Plate from USFWS installed by LWRD at site where ZM found in 2016	
SCUBA Divers	Examine substrate looking for adult ZM	If volunteers are available, target rocky shorelines		ZM ID
Net Tows for Veligers	DLIA USNPS (1X)	Net: \$4-600 Sample analysis: \$75-\$95/each	Best time is early July. Collect samples 2X/week from mid-June to mid-July	
Smart Prevention (Meander, veliger tow, boat landing check)	Polk LWRD		Polk County LWRD will complete for Deer Lake	

Figure 23. Monitoring Equipment: Cinder Blocks, Sampling Plates and Nets for Veliger Tows

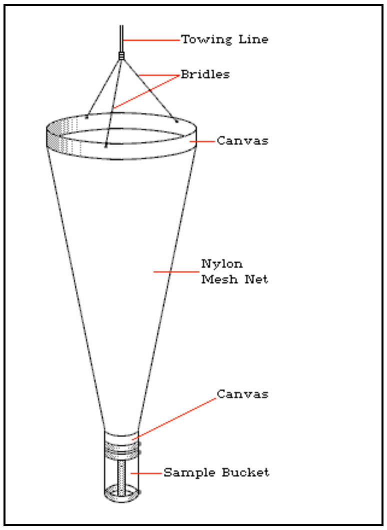


Table 16. DLIA Zebra Mussel Monitoring and Prevention Outreach[39]

Method and Messages	**Target Audience**	**Lead Organization**
Presentations	DLIA	Polk County LWRD
Handout: ZM ID, methods for monitoring, emphasize cinder blocks – build your own, shoreline surveys	Lake Organizations to Lake Residents	Polk County LWRD PCALR (?) DLIA
Cinder Block guidance: Pictures and description, ID contacts, monitoring log	Lake Residents	DLIA
Articles in Deer Tales	DLIA	Polk County LWRD
Coordination with tournament organizers: Drain live wells, drop motors; don't bring your boat here if you've been these (ZM waters) without decontamination; decontamination procedures	June Jam: Muskies, Inc.; Indianhead Musky Tournament; anglers participating in fishing tournaments (If <20 participants no permits, otherwise on WNDR web site)	DLIA Bone Lake Management District (Friday night Indianhead mtg.)
Presentations and Curriculum	Schools SCF 5th grade camp (DLIA)	LWRD, other agencies, lake organizations
Signs	Post where ZM have been discovered – e.g. Deer Lake	DLIA

[39] Existing AIS grants or new Rapid Response grants might fund these activities. Additional outreach activities to be completed by other entities (see **Error! Reference source not found.**).

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

Objectives

- Success will be attained when treatment measures significantly reduce CLP bed acreage and rake density with minimal damage to native plants.
- Facilitate the growth of native species.

Defining curly leaf pondweed beds

- May/June mean percent coverage = 30 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 (currently 2.0 ppm) endothall treatment.
    - Apply for APM permit
    - Verify CLP bed boundaries with pre-monitoring in April or May
    - Complete post monitoring as required by WDNR.
    - Complete early season herbicide treatment when water temperatures are between 50º and 60º F and wind is calm.

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

3. Conduct annual monitoring of sediment CLP turions each fall. Sediment turion monitoring will help to predict CLP growth in the following year.

4. 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 with Diver Assisted Suction Harvesting.

The endothall treatment will occur when water temperatures are approximately 50º Fahrenheit or greater to target this invasive species before significant native plant growth has occurred. To limit impacts to native plants, no herbicide treatment will occur above 60º F. Treatment locations will be located using GPS equipment, and herbicide application amounts and concentrations will be recorded. Pre and post monitoring will be completed according to standardized DNR methods. Monitoring results and research results from other projects will guide potential additional treatments of nuisance curly leaf pondweed areas.

Goal 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 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/raking 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 treatments for navigation in the Lagoon area (southeast corner of the lake) were permitted in 2008 through 2012. The DLIA Environment Committee Chair was asked to evaluate plant growth the 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. If nuisance aquatic plant growth is controlled in late summer, manual means such as plant rakes must be used. Plant fragments should be removed from the lake and placed on an upland area such as a garden or compost pile.
5. 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 currently 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.
6. The DNR will provide inspection and direction for any native plant management.

EDUCATIONAL STRATEGY

DESIRED BEHAVIORS (in priority order with messages in bullets following each)

Lake Residents – priority behaviors

1. Prevent runoff and erosion from your property.

   Message: Erosion and runoff from waterfront property may alter sediment characteristics and encourage the spread of invasive plants.
   Message: Controlling phosphorus prevents severe algae blooms, including surface mats of filamentous algae
   Message: Deer Lake Conservancy (partner) efforts have removed an estimated amount of over 3,200 pounds of phosphorus that formerly flowed to the lake each year. Each pound of phosphorus can lead to 500 pounds of algae growth in the lake. That represents 800 tons of algae! Your efforts can help to keep additional phosphorus out of the lake and prevent excessive algae growth into the future.
   Messages:
   - *Cut branches not trees*
   - *Don't mow grass all the way to the lake*
   - *Install construction site erosion control practices when soil is disturbed*
   - *Don't alter vegetation right after you purchase a lake property*

2. Deer Lake residents understand and support DLIA aquatic plant management efforts

   Message: Provide updates of the curly leaf pondweed control program.
   Message: Provide updates of the zebra mussel monitoring program.
   - *Encourage searching the shoreline for zebra mussels.*
   - *Encourage "a block under every dock" and check regularly for zebra mussels.*

   Message: Explain aquatic plant management plan and its recommendations

3. Pay $$$$ to support DLIA invasive species and other management efforts.

   Message: Describe programs with more specific language – not just "water quality." List costs and need for each program.
   Message: Reasons to support DLIA efforts

4. Quarantine equipment like docks and lifts for at least one month prior to moving them from one lake or river to another.

   Message: Keep docks and equipment out of the water at least one month before transporting between lakes

5. No-wake boating within 200 feet of the shoreline

   Messages: Discourage traveling above no-wake speed within 200 feet of 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*
- *State no-wake rules = 100 feet from shoreline for boats, 200 feet from shoreline for jet skis*
- *Wake boats should stay in the middle, deeper areas of the lake to prevent sediment disturbance and shoreline erosion*
- *How far is 200 feet? (Give examples around the lake)*

6. Allow native aquatic plants next to the shoreline to grow. If you must remove plants to navigate, use hand removal methods like raking.

   Messages: Native aquatic plants are important to the lake. They help to keep the water clear; provide food for fish, waterfowl, and other animals; keep lake bottom sediments in place; and prevent establishment of invasive species.
   Messages: Communicate the distinction between "good native plants" and "bad non-native invasive 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.

7. Inspect boats, trailers and equipment; remove vegetation; and drain live wells upon entering and when leaving the lake – INFORM VISITING FRIENDS

   Message: Tell your family and friends AIS prevention messages: inspect, remove, drain
   Message: Drain live wells, drop motors; don't bring your boat here if you've been to these (ZM waters) without decontamination; decontamination procedures

<u>Lake Residents – additional behaviors</u>
Pull curly leaf pondweed along your shoreline
   Message: Provide ID information for curly leaf pondweed. Let residents know it is ok to remove this aquatic plant along the entire shoreline. Chemical treatment does not work where there is a drop off and is not used with very scattered plants.
Know how to identify common aquatic invasive species

Join the volunteer AIS monitors
   Message: Volunteers can make a difference. Training is available to identify aquatic invasive species. Provide pictures and supplemental information.

Monitor your shoreline for zebra mussels and report back to the DLIA

   Messages: Zebra mussels have been discovered in Deer Lake. We need to know where they are to develop an effective control plan if it is needed.

<u>Lake Visitors</u>
Inspect boats, trailers and equipment; remove vegetation; and drain live wells upon entering and when leaving the lake
   Message: AIS prevention messages: inspect, remove, drain

Message: Zebra mussels have been discovered in Deer Lake, use special effort to follow recommendations to prevent transport to other lakes.

Fishing Tournament Participants
Drain live wells, drop motors; follow decontamination procedures if coming from a lake with AIS present

Youth
Influence adults. Grow up to be responsible lake stewards.

METHODS *(need to use multiple methods and repeated messages)*

Deer Lake Residents

Annual meeting presentations

Handouts used at annual meeting

Deer Tales newsletter

DLIA website

Deer Lake Facebook account

DLIA email list

New homeowner packet

Landowner guide

Neighborhood meetings

House parties with short program

Young-adult led activities

Deer Lake Conservancy Report

Deer Lake Conservancy website

Homeowner technical assistance for controlling waterfront runoff

Deer Lake Visitors

Clean Boats, Clean Waters (and handouts distributed)

Landing Camera

Signs

Fishing Tournament Participants

Coordination with tournament organizers

Youth

Presentations and curriculum at schools, St. Croix Falls 5th grade camp

Table 17. Implementation Plan for DLIA[41]

Goal 1) Protect and restore healthy native aquatic plant communities.					
Actions[42]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[43]
See EDUCATIONAL STRATEGY	Ongoing				DLIA
Whole Lake Aquatic Plant Survey	July/August 2021	$6,000	0	APM Monitor	AIS AEPP grant (apply 2020)
Update the Aquatic Plant Management Plan	2022	$4,000	40	DLIA Board Plan Consultant	AIS AEPP grant (apply 2020)

[41] Costs are annual costs estimated for initial implementation. These costs will be reviewed each year during the DLIA budgeting process.
[42] See previous pages for action 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

Goal 2) Prevent the introduction of Eurasian water milfoil and other invasive, non-native aquatic species.					
Actions[44]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[45]
Clean Boats, Clean Waters	May to September	$5,500 (annually)	125	CBCW Lead Town of St. Croix Falls CBCW Interns	CBCW grant ($4,000 – apply by Dec 10 each year)
Maintain/add boat landing signs	As needed	$750	10	CBCW Lead Plan Consultant	AIS AEPP grant
Investigate landing camera				Town of St. Croix Falls	AIS AEPP grant (up to $4,000)
See EDUCATIONAL STRATEGY					

[44] See previous pages for action item detail.

[45] 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[46]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[47]
Train lake resident volunteers	As needed	$0	10	Lake Volunteers	AEPP
AIS monitoring at the boat landing, Lagoon, and littoral area	June to September	$1,000	20	Environment Committee Chair APM Monitor Lake Resident Volunteers (at least 5)	AEPP (through 12/31/17)
Maintain non-lapsing contingency fund	Ongoing	$40,000	5	DLIA Board	DLIA
Review rapid response plan	Annually		5	DLIA Board	NA

[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 2017.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2017.
DLIA = Deer Lake Improvement Association

ZEBRA MUSSEL RESPONSE					
Actions[48]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[49]
Develop monitoring reporting system					
Develop monitoring guidance: shoreline and cinder block monitoring					
Assign shoreline monitoring segments					
Distribute cinder blocks					
Purchase net for veliger tow. Assign volunteer to collect samples. Establish lab account. Sample		Net: $4-600 Sample analysis: $75-$95/each			
Purchase and install plate samplers					

[48] See previous pages for action item detail.
[49] 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 4) Minimize curly leaf pondweed, prevent its spread, and restore healthy native plant communities in its place.					
Actions[50]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources[51]**
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	$21,000	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
Project coordination	Ongoing	$500	0	Plan Consultant	ACEI
Apply for AIS Control Grant	02/01/18	$800			
Subtotal GOAL 5		$25,025	15		

[50] See previous pages for action item detail.
[51] 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 2017.
DLIA = Deer Lake Improvement Association

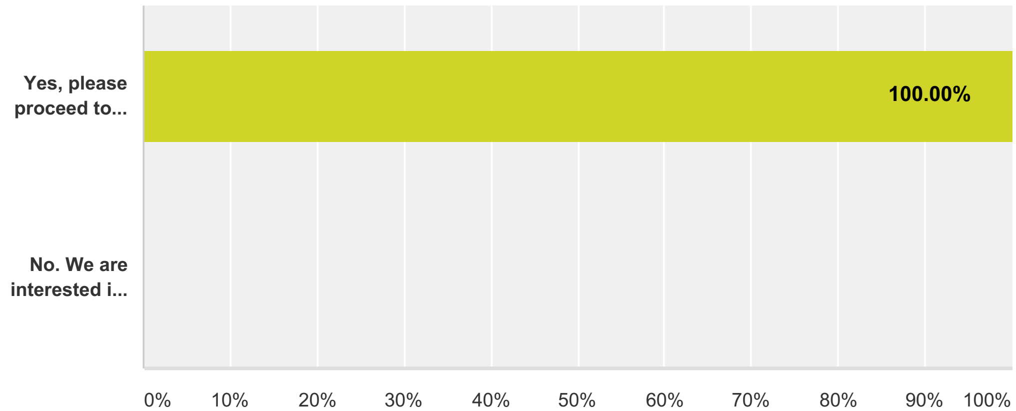
EDUCATIONAL STRATEGY					
Methods and Specific Actions[52]	**Timeline**	**$ Estimate**	**Vol. Hours**	**Responsible Parties**	**Funding Sources**[53]
Resident education - website	Ongoing	$0	As needed	DLIA Website Lead	DLIA
Resident education – annual meetings	July each year	$50 (for handouts)	10	Environment Committee Chair	DLIA
Resident education – newsletter					

[52] See previous pages for action detail.
[53] 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

Appendix A. Public Opinion Survey Results

Q1 Do you own waterfront property on Deer Lake?

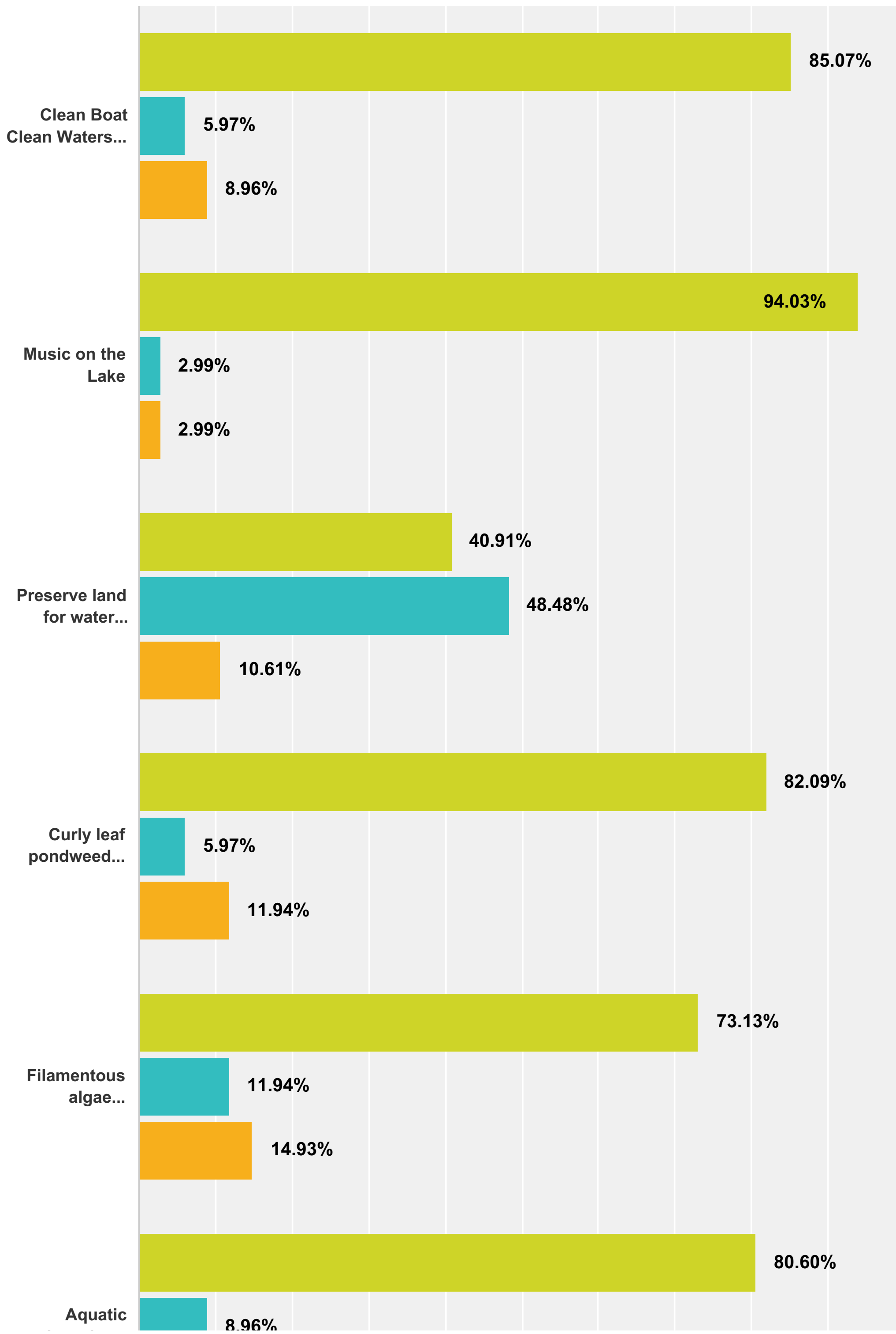
Answered: 67 Skipped: 0

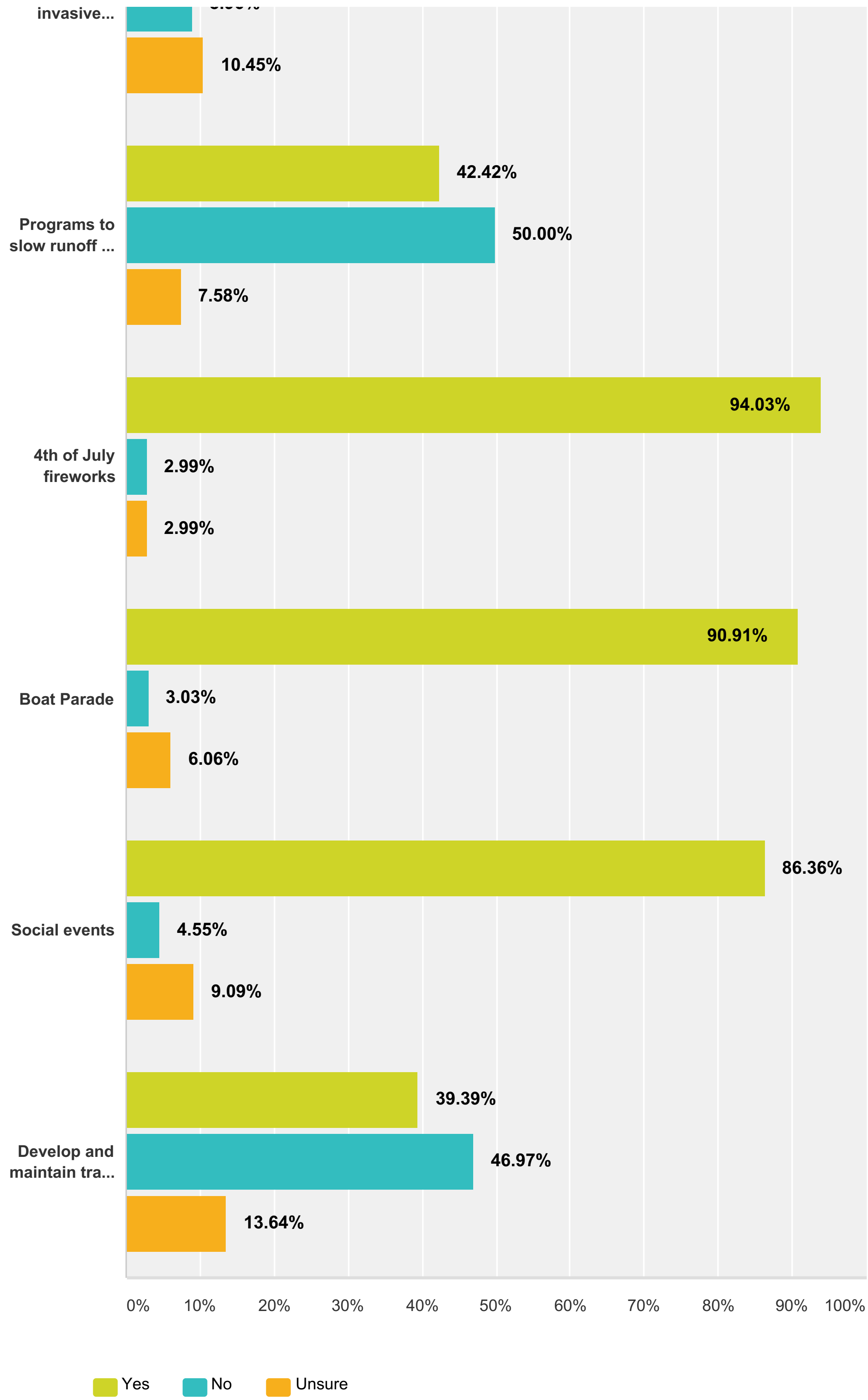


Answer Choices	Responses	
Yes, please proceed to questions below	100.00%	67
No. We are interested in lake residents' responses for this survey. If you are interested in providing feedback on the Deer Lake Aquatic Plant Management Plan and are not a lake resident, please do not complete the survey but rather send an email to harmonyenv@amerytel.net.	0.00%	0
Total		**67**

Q2 What is your understanding of the activities of the Deer Lake Improvement Association? (Please check yes, no, or unsure to reflect your understanding of the Deer Lake Improvement Association leadership for each activity)

Answered: 67 Skipped: 0



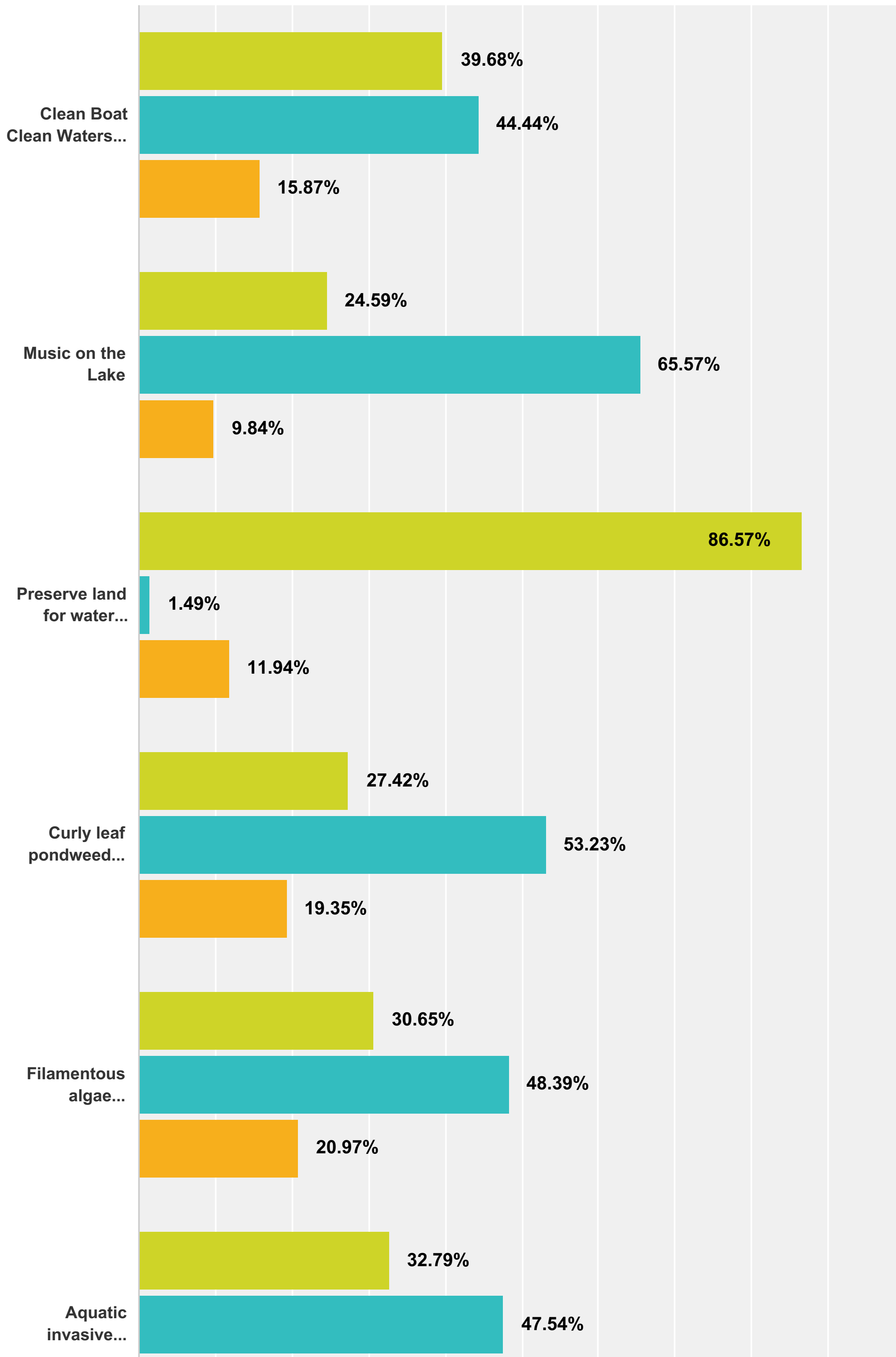


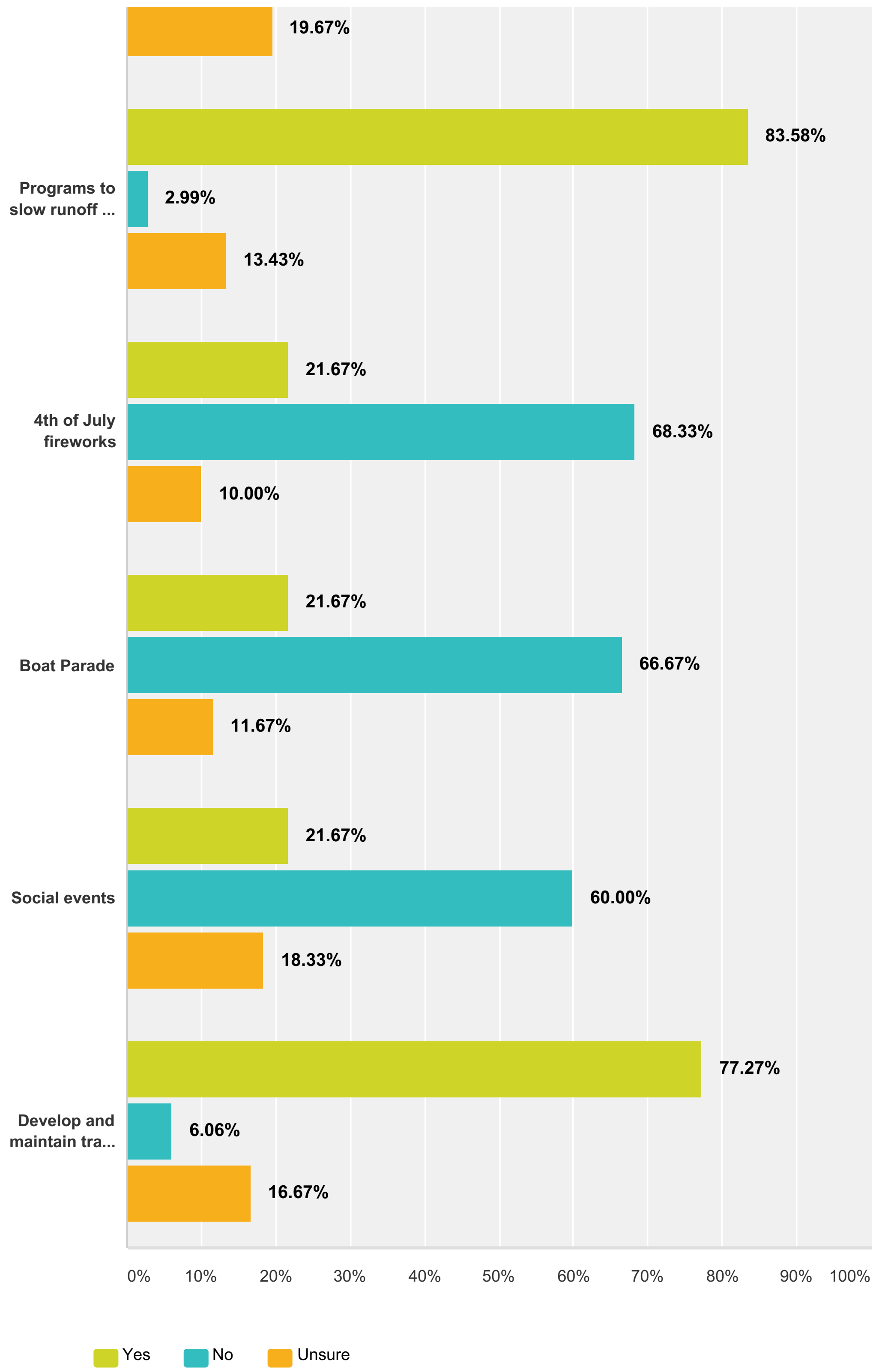
	Yes	No	Unsure	Total
Clean Boat Clean Waters Program	85.07% 57	5.97% 4	8.96% 6	67

Music on the Lake	**94.03%** 63	**2.99%** 2	**2.99%** 2	67
Preserve land for water quality protection	**40.91%** 27	**48.48%** 32	**10.61%** 7	66
Curly leaf pondweed treatment Program	**82.09%** 55	**5.97%** 4	**11.94%** 8	67
Filamentous algae monitoring and treatment	**73.13%** 49	**11.94%** 8	**14.93%** 10	67
Aquatic invasive species monitoring	**80.60%** 54	**8.96%** 6	**10.45%** 7	67
Programs to slow runoff and prevent nutrients from entering the lake	**42.42%** 28	**50.00%** 33	**7.58%** 5	66
4th of July fireworks	**94.03%** 63	**2.99%** 2	**2.99%** 2	67
Boat Parade	**90.91%** 60	**3.03%** 2	**6.06%** 4	66
Social events	**86.36%** 57	**4.55%** 3	**9.09%** 6	66
Develop and maintain trails in Deer Lake watersheds	**39.39%** 26	**46.97%** 31	**13.64%** 9	66

Q3 What is your understanding of the activities of the Deer Lake Conservancy? (Please check yes, no, or unsure to reflect your understanding of the Deer Lake Conservancy leadership for each activity)

Answered: 67 Skipped: 0



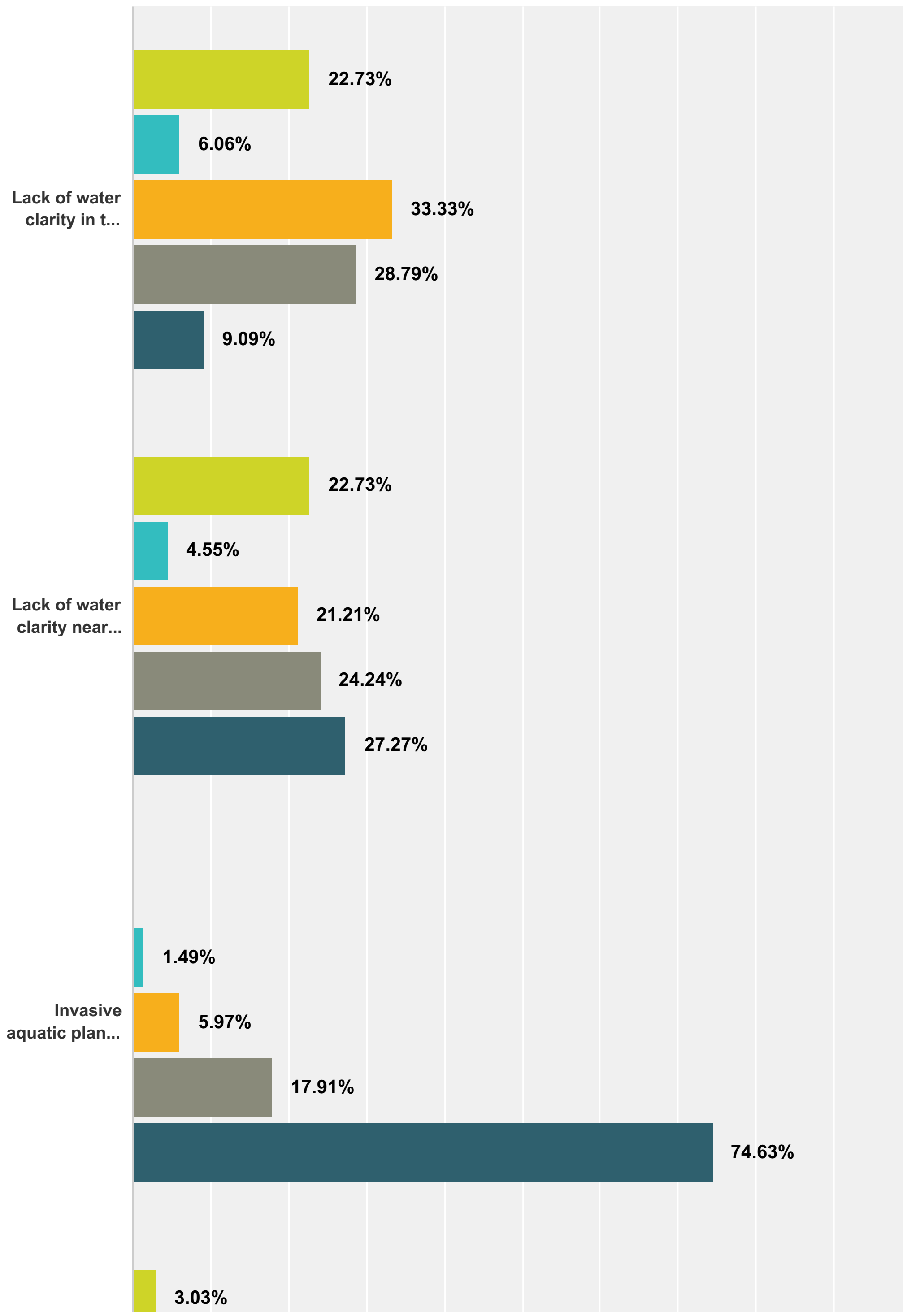


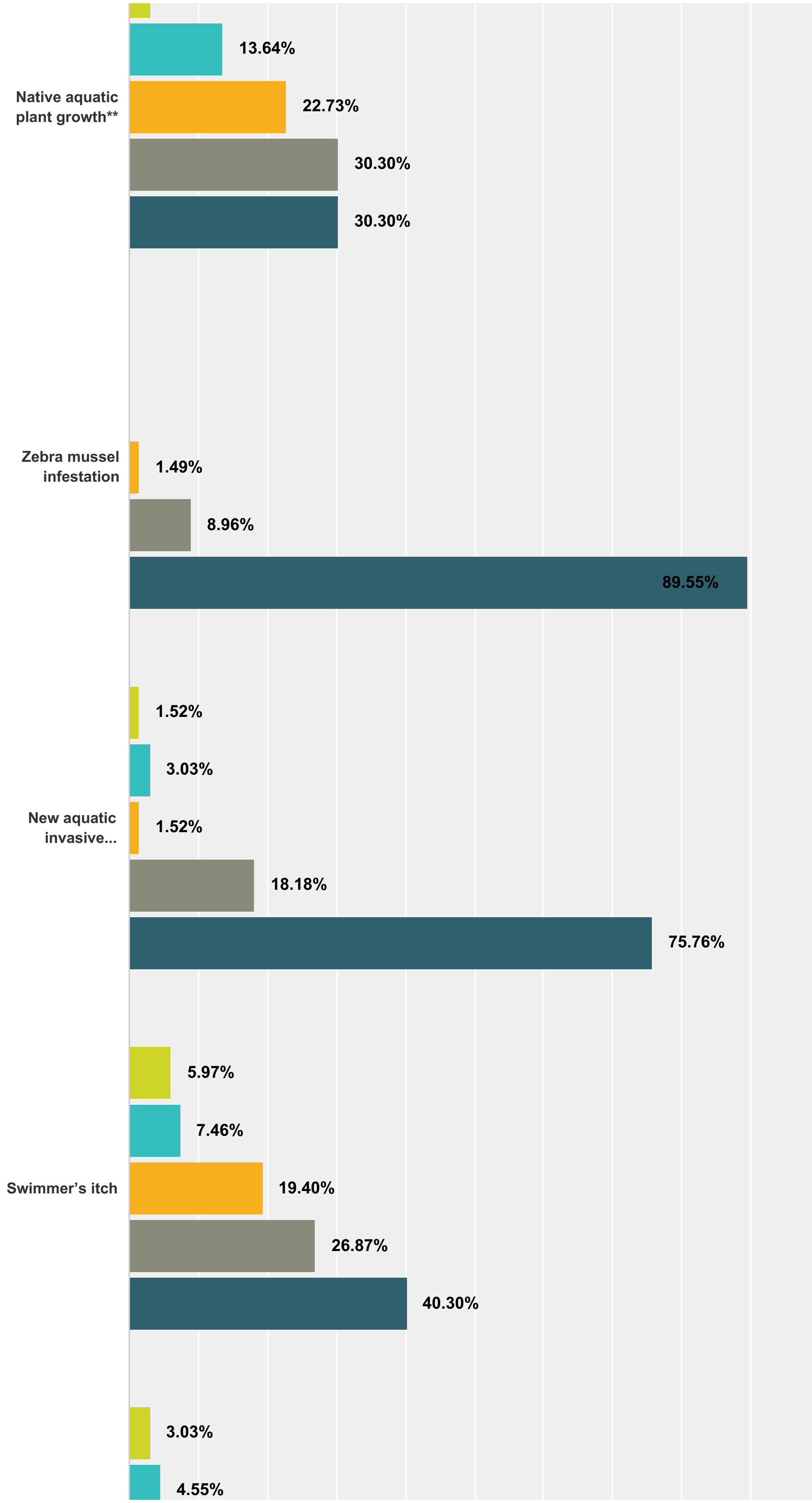
	Yes	No	Unsure	Total
Clean Boat Clean Waters Program	**39.68%** 25	**44.44%** 28	**15.87%** 10	63
Music on the Lake	**24.59%** 15	**65.57%** 40	**9.84%** 6	61

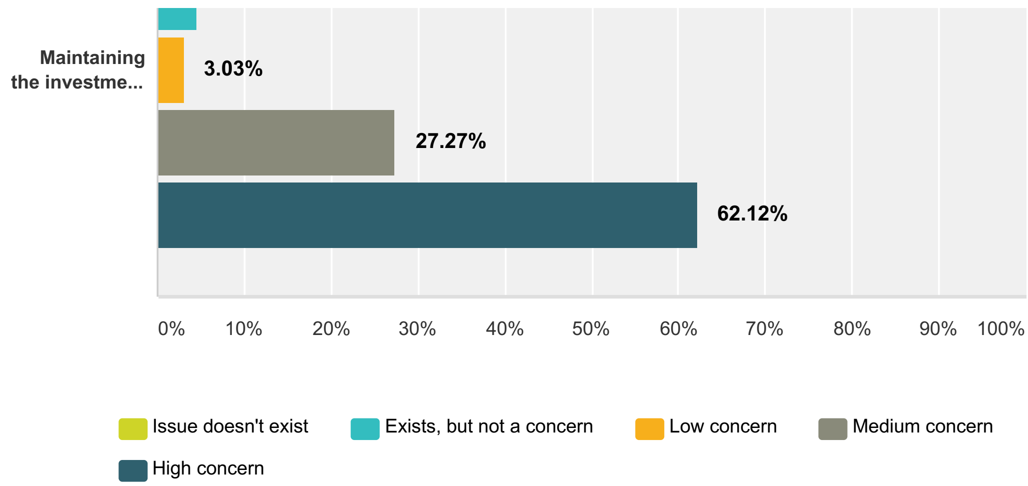
Preserve land for water quality protection	**86.57%** 58	**1.49%** 1	**11.94%** 8	67
Curly leaf pondweed treatment Program	**27.42%** 17	**53.23%** 33	**19.35%** 12	62
Filamentous algae monitoring and treatment	**30.65%** 19	**48.39%** 30	**20.97%** 13	62
Aquatic invasive species monitoring	**32.79%** 20	**47.54%** 29	**19.67%** 12	61
Programs to slow runoff and prevent nutrients from entering the lake	**83.58%** 56	**2.99%** 2	**13.43%** 9	67
4th of July fireworks	**21.67%** 13	**68.33%** 41	**10.00%** 6	60
Boat Parade	**21.67%** 13	**66.67%** 40	**11.67%** 7	60
Social events	**21.67%** 13	**60.00%** 36	**18.33%** 11	60
Develop and maintain trails in Deer Lake watersheds	**77.27%** 51	**6.06%** 4	**16.67%** 11	66

Q4 To what extent are the following issues of concern to you? If you believe the issue doesn't exist, check the first column; if you believe the issue exists but is not a concern check the second column; and if the issue concerns you please rank your concern as low, medium, or high.

Answered: 67 Skipped: 0



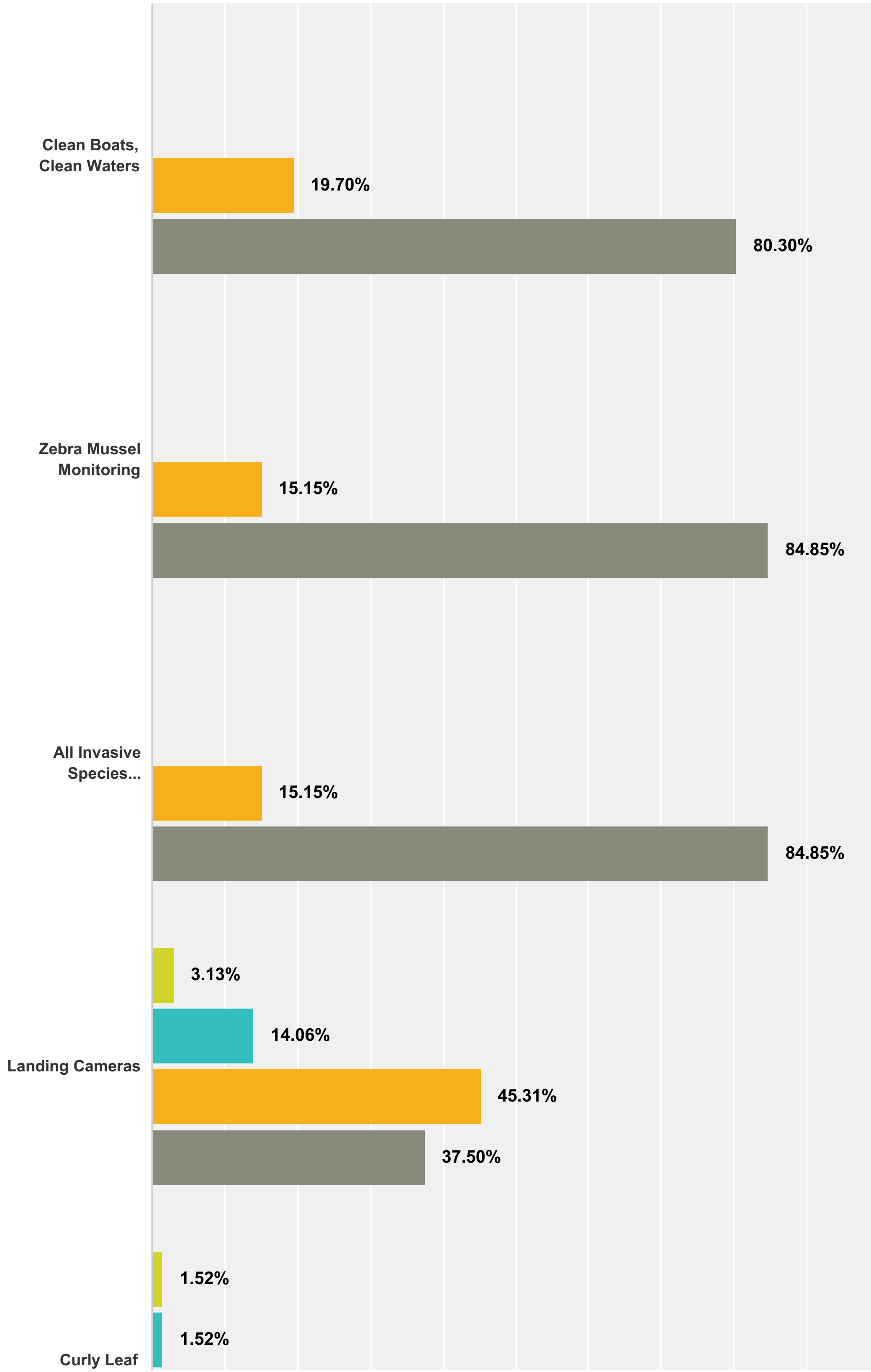

13.64%
Native aquatic plant growth**
22.73%
30.30%
30.30%
Zebra mussel infestation
1.49%
8.96%
89.55%
1.52%
3.03%
New aquatic invasive...
1.52%
18.18%
75.76%
5.97%
7.46%
Swimmer's itch
19.40%
26.87%
40.30%
3.03%
4.55%

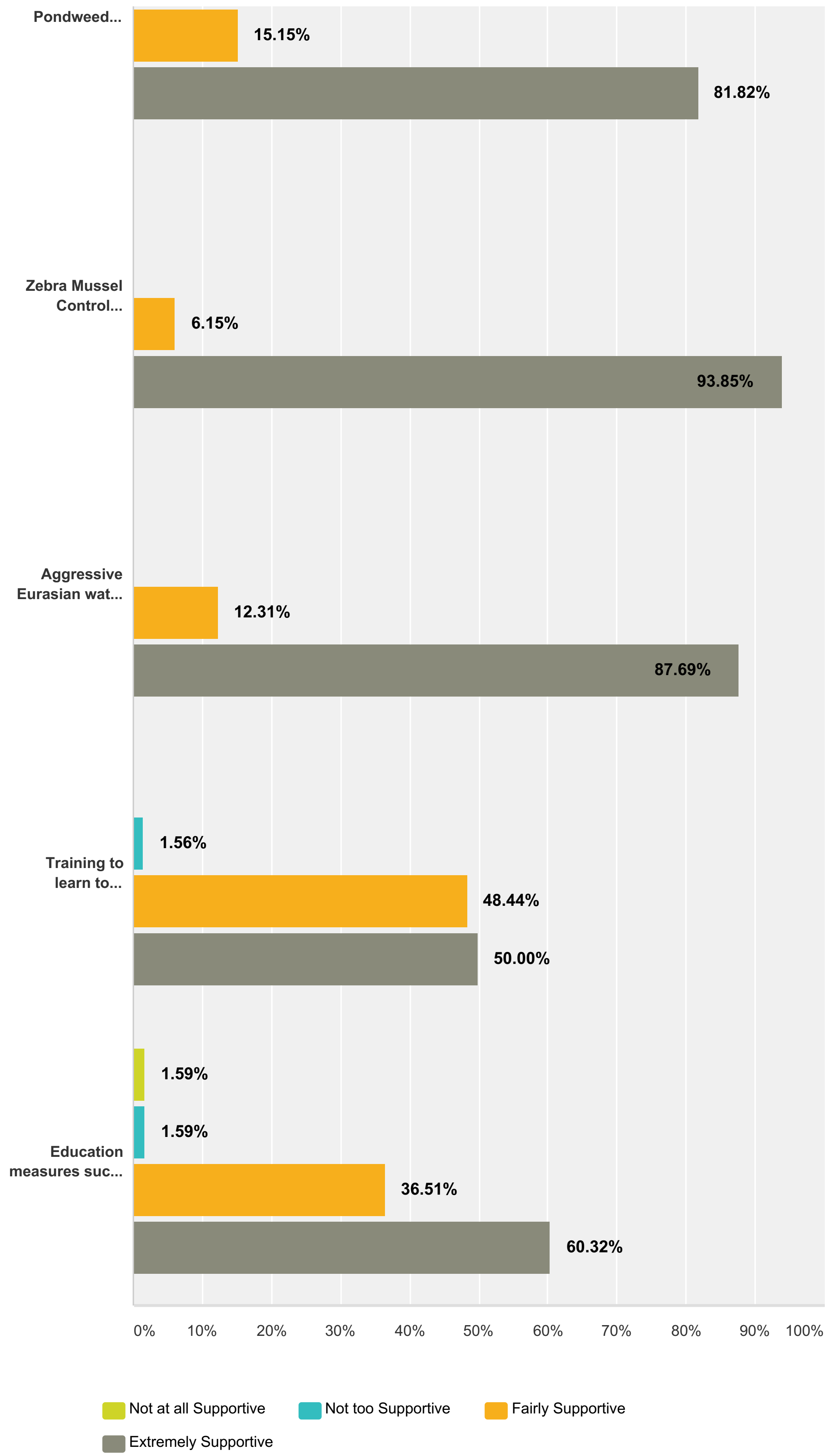


	Issue doesn't exist	Exists, but not a concern	Low concern	Medium concern	High concern	Total
Lack of water clarity in the middle of the lake	**22.73%** 15	**6.06%** 4	**33.33%** 22	**28.79%** 19	**9.09%** 6	66
Lack of water clarity near my shoreline	**22.73%** 15	**4.55%** 3	**21.21%** 14	**24.24%** 16	**27.27%** 18	66
Invasive aquatic plant growth*	**0.00%** 0	**1.49%** 1	**5.97%** 4	**17.91%** 12	**74.63%** 50	67
Native aquatic plant growth**	**3.03%** 2	**13.64%** 9	**22.73%** 15	**30.30%** 20	**30.30%** 20	66
Zebra mussel infestation	**0.00%** 0	**0.00%** 0	**1.49%** 1	**8.96%** 6	**89.55%** 60	67
New aquatic invasive species introductions	**1.52%** 1	**3.03%** 2	**1.52%** 1	**18.18%** 12	**75.76%** 50	66
Swimmer's itch	**5.97%** 4	**7.46%** 5	**19.40%** 13	**26.87%** 18	**40.30%** 27	67
Maintaining the investment value of my property	**3.03%** 2	**4.55%** 3	**3.03%** 2	**27.27%** 18	**62.12%** 41	66

Q5 In the table below please rank your level of support for the following activities from 0 (not at all) to 3 (very supportive).

Answered: 66 Skipped: 1

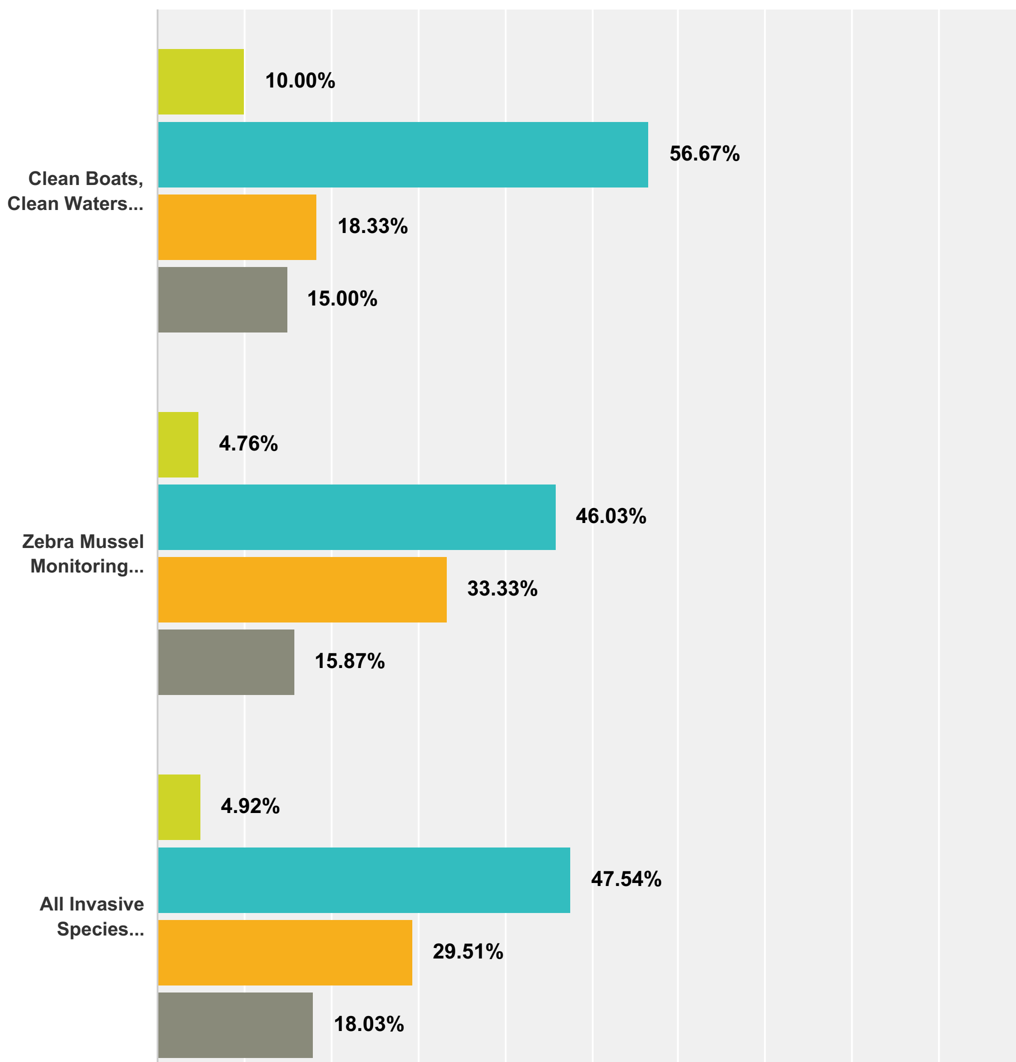


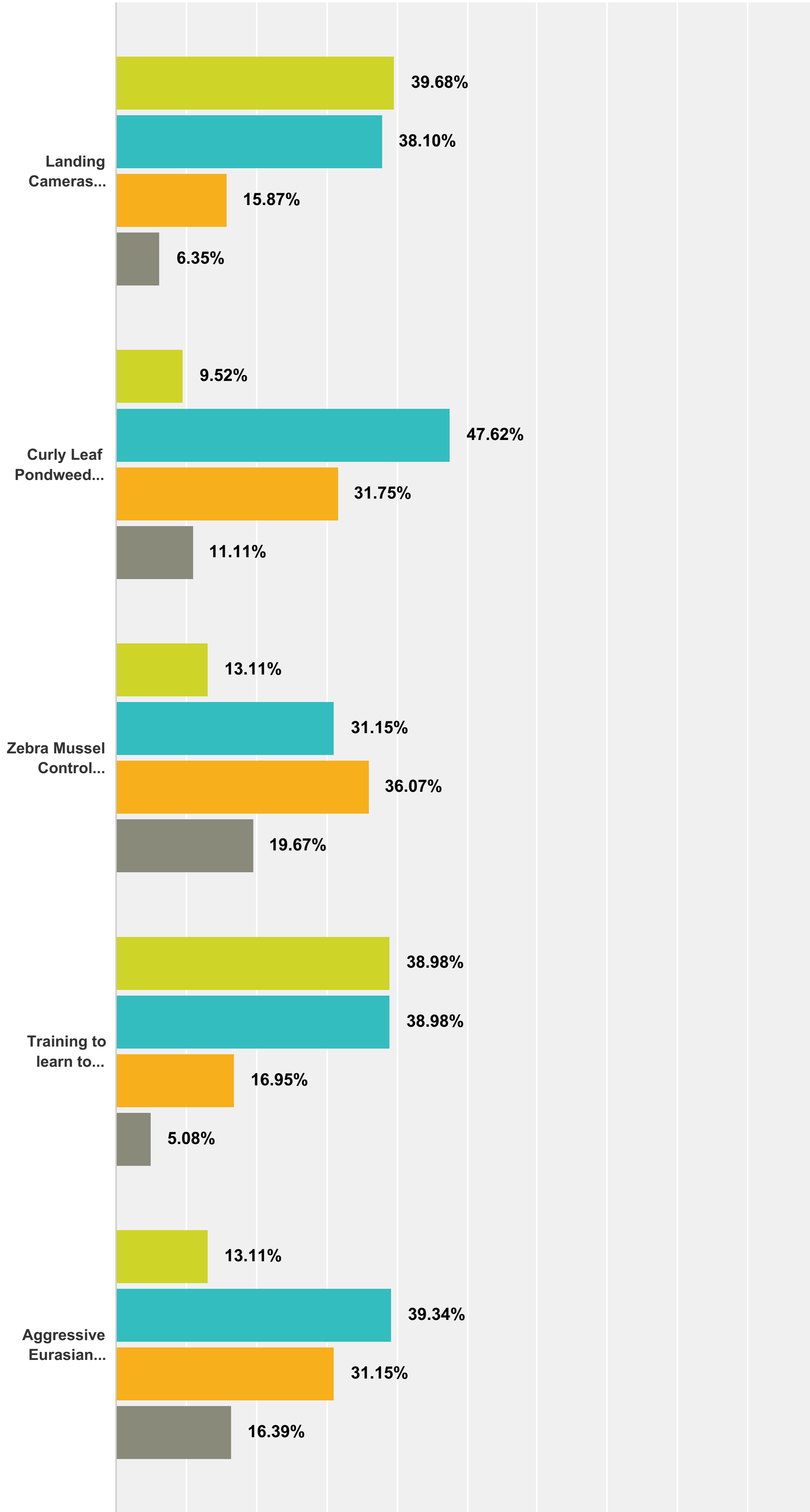

Pondweed...
15.15%
81.82%
Zebra Mussel Control...
6.15%
93.85%
Aggressive Eurasian wat...
12.31%
87.69%
Training to learn to...
1.56%
48.44%
50.00%
Education measures suc...
1.59%
1.59%
36.51%
60.32%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Not at all Supportive
Not too Supportive
Fairly Supportive
Extremely Supportive

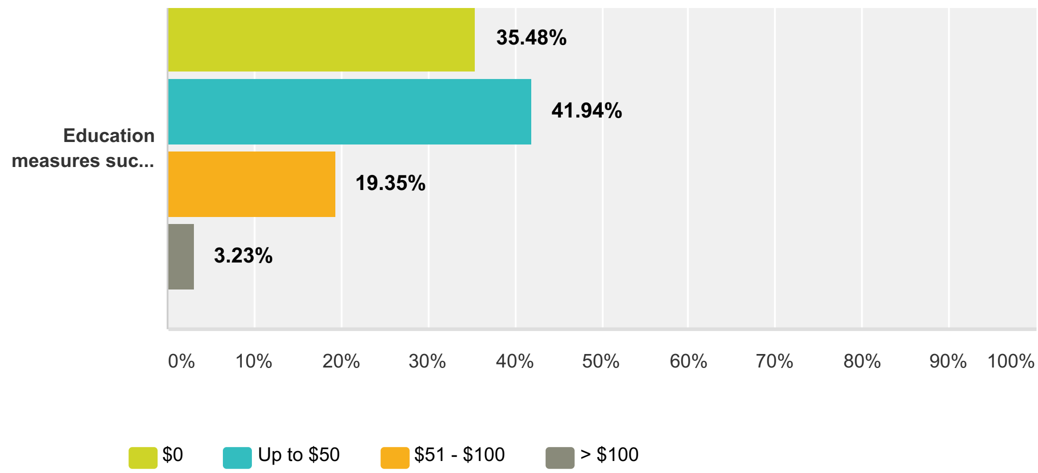
	Not at all Supportive	Not too Supportive	Fairly Supportive	Extremely Supportive	Total
Clean Boats, Clean Waters	**0.00%** 0	**0.00%** 0	**19.70%** 13	**80.30%** 53	66
Zebra Mussel Monitoring	**0.00%** 0	**0.00%** 0	**15.15%** 10	**84.85%** 56	66
All Invasive Species Monitoring	**0.00%** 0	**0.00%** 0	**15.15%** 10	**84.85%** 56	66
Landing Cameras	**3.13%** 2	**14.06%** 9	**45.31%** 29	**37.50%** 24	64
Curly Leaf Pondweed Treatment	**1.52%** 1	**1.52%** 1	**15.15%** 10	**81.82%** 54	66
Zebra Mussel Control Measures	**0.00%** 0	**0.00%** 0	**6.15%** 4	**93.85%** 61	65
Aggressive Eurasian water milfoil control measures (if discovered)	**0.00%** 0	**0.00%** 0	**12.31%** 8	**87.69%** 57	65
Training to learn to identify invasive species	**0.00%** 0	**1.56%** 1	**48.44%** 31	**50.00%** 32	64
Education measures such as newsletters, presentations, and workshops.	**1.59%** 1	**1.59%** 1	**36.51%** 23	**60.32%** 38	63

Q6 How much are you willing to pay for prevention and control of aquatic invasive species each year above the base dues of $50 per year? Estimated annual costs are included following the listed activity. Wisconsin DNR grant funds are available on a competitive basis to pay a portion of the cost of some activities. Please check the box that indicates your likely support after each activity. This is just a measure of potential support and not a commitment. The Deer Lake Improvement Association currently requests $50 for dues and $50 for lake water quality. Most "water quality" expenses are related to aquatic invasive species prevention and control.

Answered: 63 Skipped: 4



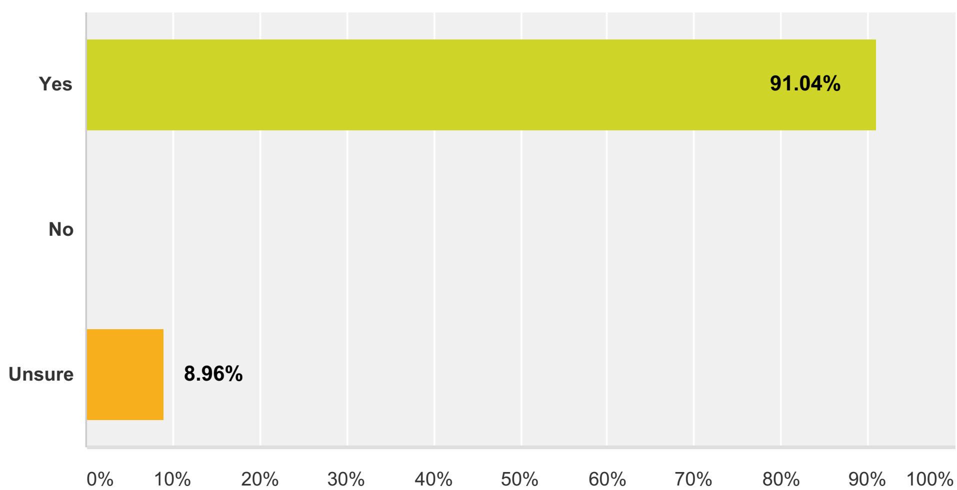

Landing Cameras...
39.68%
38.10%
15.87%
6.35%
Curly Leaf Pondweed...
9.52%
47.62%
31.75%
11.11%
Zebra Mussel Control...
13.11%
31.15%
36.07%
19.67%
Training to learn to...
38.98%
38.98%
16.95%
5.08%
Aggressive Eurasian...
13.11%
39.34%
31.15%
16.39%



	$0	Up to $50	$51 - $100	> $100	Total
Clean Boats, Clean Waters ($5,000 -75% grant funding)	**10.00%** 6	**56.67%** 34	**18.33%** 11	**15.00%** 9	60
Zebra Mussel Monitoring ($2,000 – 75% grant funding)	**4.76%** 3	**46.03%** 29	**33.33%** 21	**15.87%** 10	63
All Invasive Species Monitoring ($1,500 – 50-75% grant funding)	**4.92%** 3	**47.54%** 29	**29.51%** 18	**18.03%** 11	61
Landing Cameras (Installation: $7,500 installation - $4,000 grant funding; Annual video monitoring: $1,500 - no grant funding)	**39.68%** 25	**38.10%** 24	**15.87%** 10	**6.35%** 4	63
Curly Leaf Pondweed Treatment ($23,000 – currently 50% grant funding – may not be funded in the future)	**9.52%** 6	**47.62%** 30	**31.75%** 20	**11.11%** 7	63
Zebra Mussel Control Measures (Unknown cost)	**13.11%** 8	**31.15%** 19	**36.07%** 22	**19.67%** 12	61
Training to learn to identify invasive species ($100)	**38.98%** 23	**38.98%** 23	**16.95%** 10	**5.08%** 3	59
Aggressive Eurasian Watermilfoil Control Measures (if discovered – Unknown costs)	**13.11%** 8	**39.34%** 24	**31.15%** 19	**16.39%** 10	61
Education measures such as newsletters, presentations, and workshops.	**35.48%** 22	**41.94%** 26	**19.35%** 12	**3.23%** 2	62

Q7 The DLIA has been treating curly leaf pondweed with herbicides for the past seven years. Our treatment efforts have been successful in significantly reducing the density of these weed beds without damaging native plants but have not eliminated this invasive species from the lake. Industry results indicate that our results are similar to what other lake organizations have been able to achieve. In 2017, we anticipate spending $23,000 on treating this invasive species. About 50% of the cost is covered by grant funds. This grant funding may not be available in the future. Should we continue to treat this weed? (Please check one)

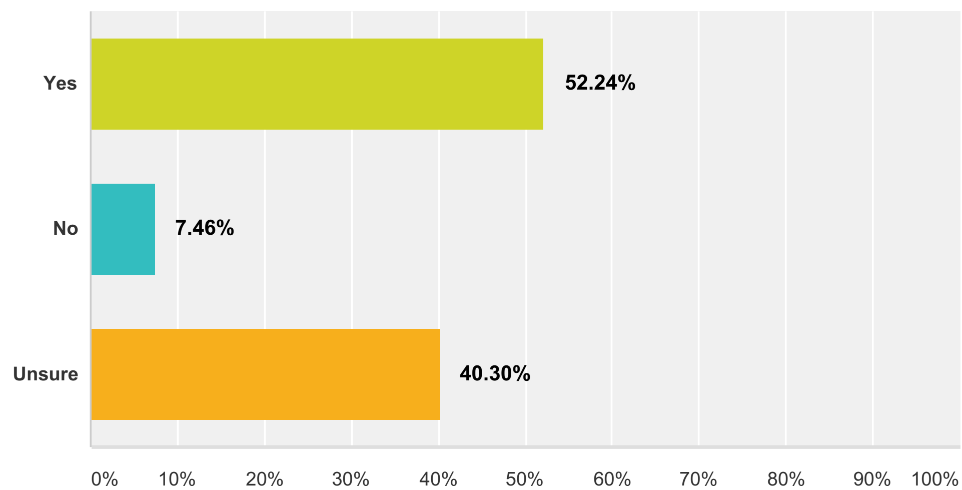
Answered: 67 Skipped: 0



Answer Choices	Responses	
Yes	**91.04%**	61
No	**0.00%**	0
Unsure	**8.96%**	6
Total		**67**

Q8 Should the DLIA explore adding supplemental control efforts such as hand pulling with SCUBA divers in hopes of finding a more effective curly leaf pondweed treatment program? (Please check one)

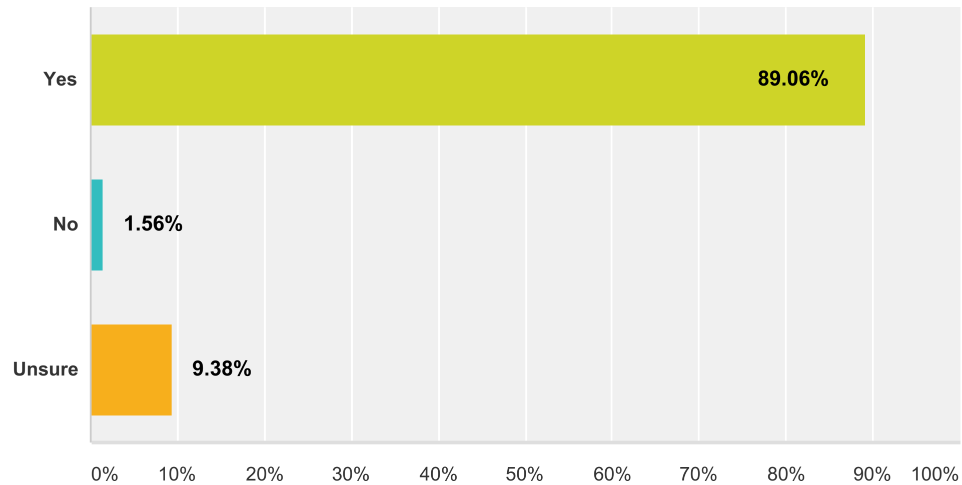
Answered: 67 Skipped: 0



Answer Choices	Responses	
Yes	52.24%	35
No	7.46%	5
Unsure	40.30%	27
Total		**67**

Q9 If the DLIA, lake residents, and partners confirm that zebra mussels are present in Deer Lake, should we pursue treatment options in an effort to control the spread of this invasive species? (annual treatment expense could run $25,000+) (Please check one)

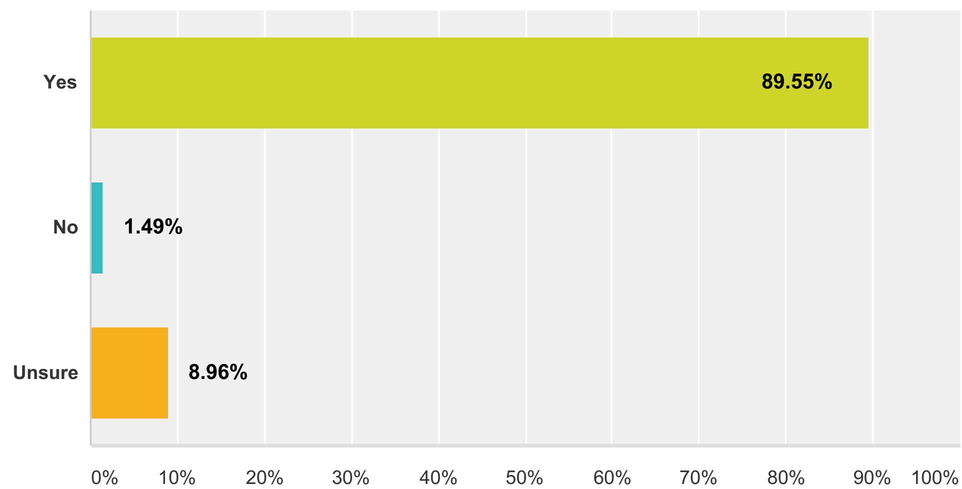
Answered: 64 Skipped: 3



Answer Choices	Responses	
Yes	**89.06%**	57
No	**1.56%**	1
Unsure	**9.38%**	6
Total		**64**

Q10 The DLIA has been administering the Clean Boats, Clean Waters program for several years. The goal of this program is to educate boaters to clean vegetation from their boats and drain water each time they take their boat out of the lake in an effort to reduce the spread of invasive species. You may have talked to some of the young people at the boat landing that do this work for us. Should we continue to administer this program? (Please check one)

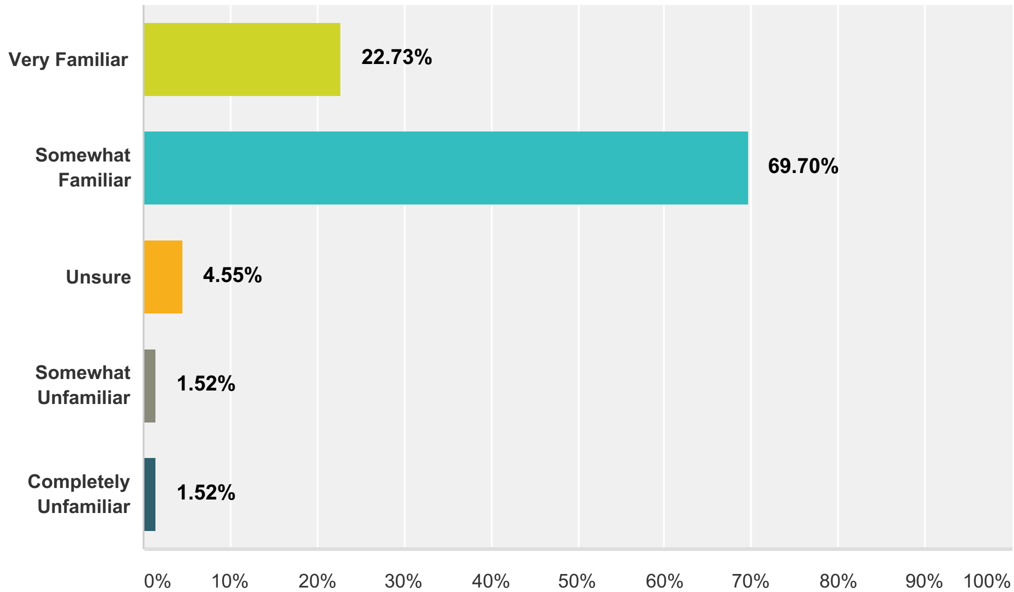
Answered: 67 Skipped: 0



Answer Choices	Responses	
Yes	**89.55%**	60
No	**1.49%**	1
Unsure	**8.96%**	6
Total		**67**

Q11 How familiar are you with how aquatic invasive species such as Eurasian water milfoil or zebra mussels can be introduced to Deer Lake? (Please check one)

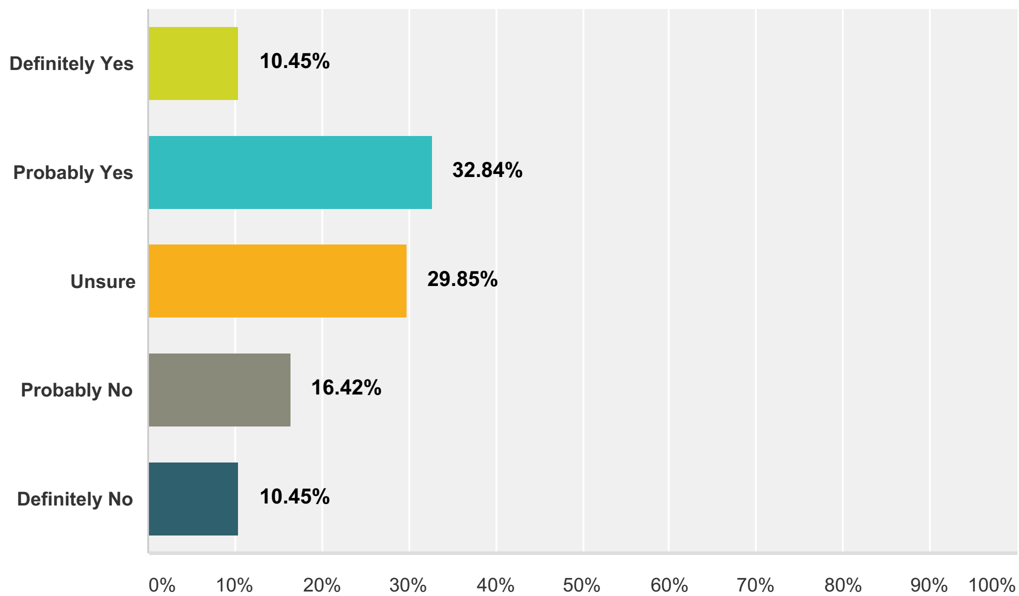
Answered: 66 Skipped: 1



Answer Choices	Responses	
Very Familiar	22.73%	15
Somewhat Familiar	69.70%	46
Unsure	4.55%	3
Somewhat Unfamiliar	1.52%	1
Completely Unfamiliar	1.52%	1
Total		**66**

Q12 Curly leaf pondweed is an aquatic invasive species that in past years created nuisance conditions in Deer Lake by forming dense beds of vegetation that interfered with lake uses in the spring. Curly leaf pondweed is currently managed to reduce those nuisances each year. Do you think you would recognize curly leaf pondweed if you saw it? (Please check one)

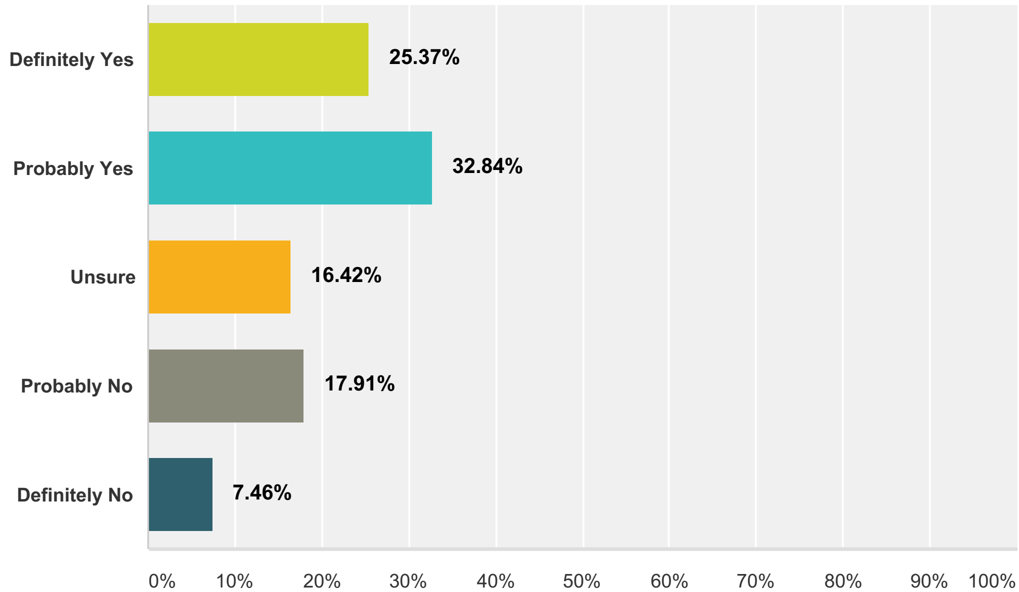
Answered: 67 Skipped: 0



Answer Choices	Responses	
Definitely Yes	10.45%	7
Probably Yes	32.84%	22
Unsure	29.85%	20
Probably No	16.42%	11
Definitely No	10.45%	7
Total		67

Q13 Are you aware of the control measures that the DLIA uses to minimize the impacts of curly leaf pondweed on Deer Lake? (Please check one)

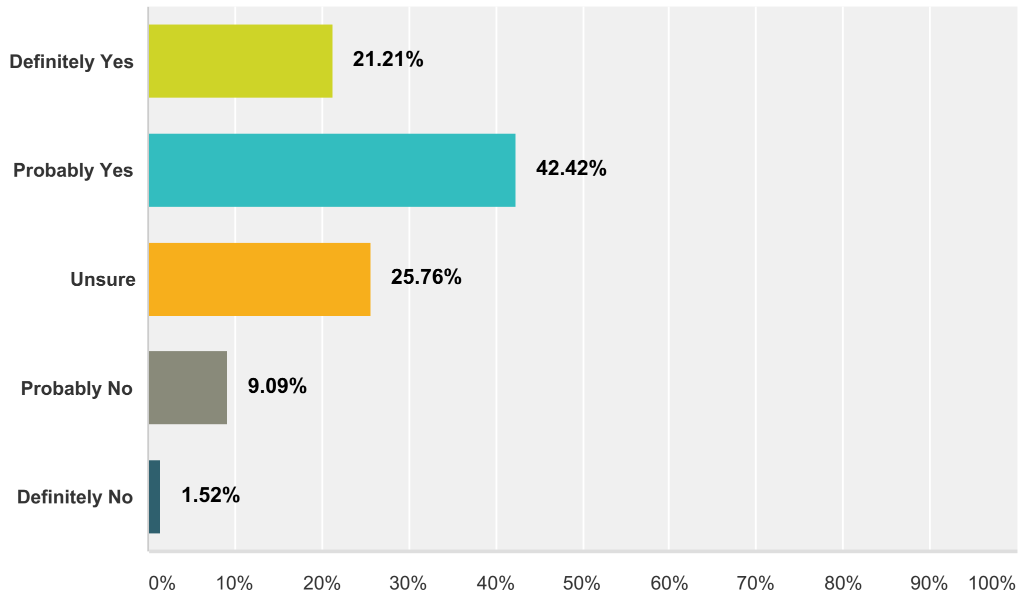
Answered: 67 Skipped: 0



Answer Choices	Responses	
Definitely Yes	25.37%	17
Probably Yes	32.84%	22
Unsure	16.42%	11
Probably No	17.91%	12
Definitely No	7.46%	5
Total		67

Q14 A single zebra mussel was observed in Deer Lake in the fall of 2016. Zebra mussels are present in the St. Croix River below Stillwater and in many Minnesota lakes. Do you think you would recognize a zebra mussel if you saw it? (Please check one)

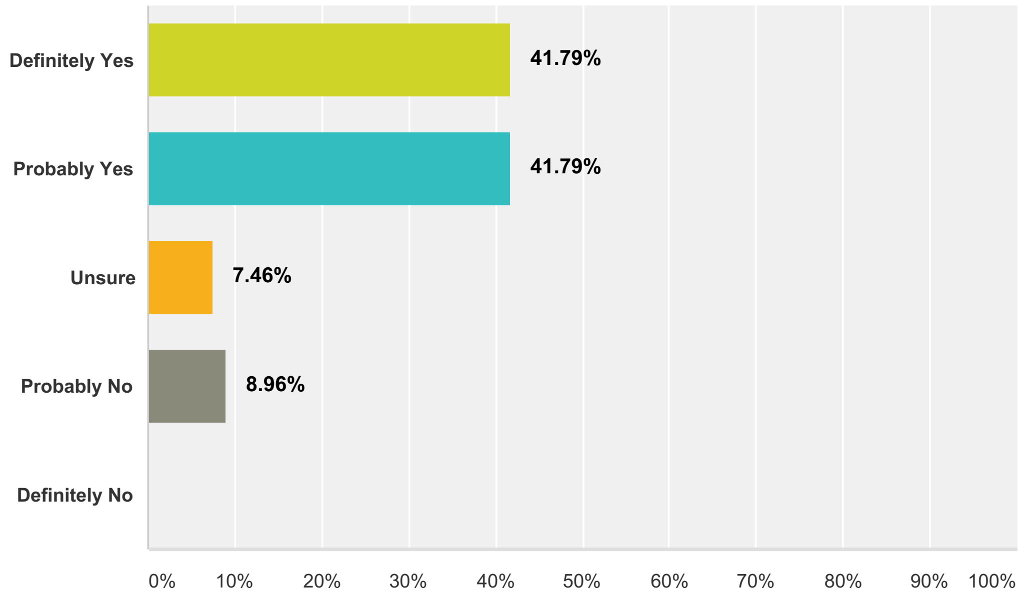
Answered: 66 Skipped: 1



Answer Choices	Responses	
Definitely Yes	21.21%	14
Probably Yes	42.42%	28
Unsure	25.76%	17
Probably No	9.09%	6
Definitely No	1.52%	1
Total		**66**

Q15 Are you interested in learning more about invasive species? (Please check one)

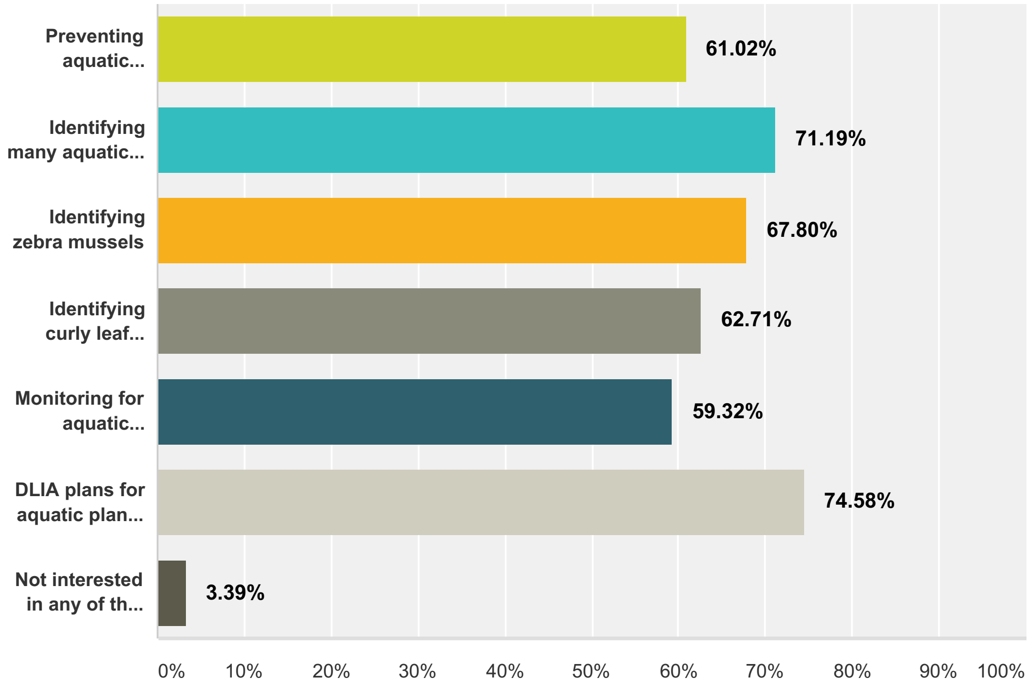
Answered: 67 Skipped: 0



Answer Choices	Responses	
Definitely Yes	41.79%	28
Probably Yes	41.79%	28
Unsure	7.46%	5
Probably No	8.96%	6
Definitely No	0.00%	0
Total		67

Q16 Please check topics about which you would like more information. (Please check all that apply.)

Answered: 59 Skipped: 8



Answer Choices	Responses	
Preventing aquatic invasive species introduction	**61.02%**	36
Identifying many aquatic invasive species	**71.19%**	42
Identifying zebra mussels	**67.80%**	40
Identifying curly leaf pondweed	**62.71%**	37
Monitoring for aquatic invasive species	**59.32%**	35
DLIA plans for aquatic plant management	**74.58%**	44
Not interested in any of these topics	**3.39%**	2
Total Respondents: 59		

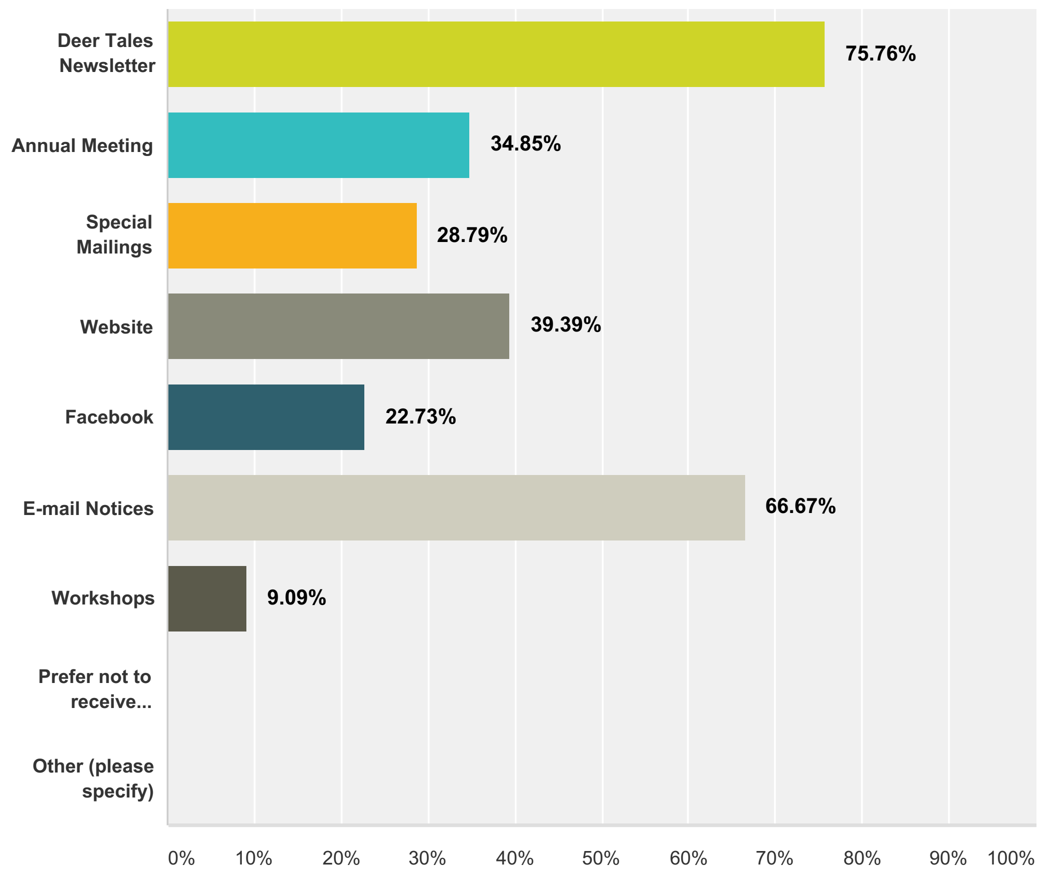
Q17 Aquatic invasive species prevention and monitoring efforts require volunteer support. If you are willing to help with one of the following activities, please let us know by writing your email address or telephone number following the activities where we need assistance.

Answered: 19 Skipped: 48

Answer Choices	Responses	
Monitoring for Zebra Mussels.	**94.74%**	18
Monitoring for other invasive species such as Eurasian Water Milfoil	**68.42%**	13
Finding staff for Clean Bats, Clean Waters Program	**5.26%**	1

Q18 How do you prefer to get information from the Deer Lake Improvement Association? (Check all that apply.)

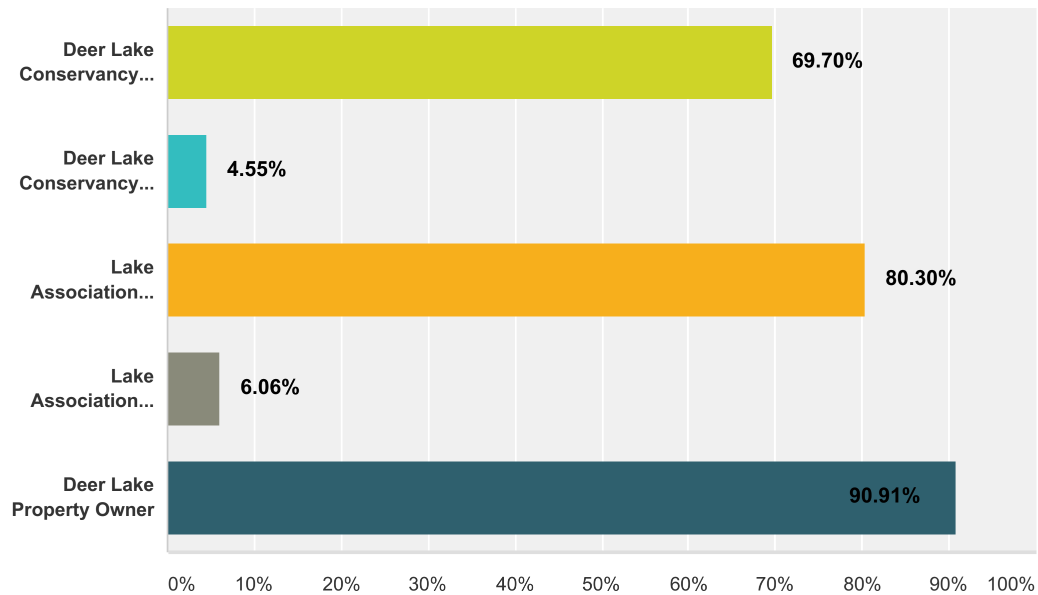
Answered: 66 Skipped: 1



Answer Choices	Responses	
Deer Tales Newsletter	**75.76%**	50
Annual Meeting	**34.85%**	23
Special Mailings	**28.79%**	19
Website	**39.39%**	26
Facebook	**22.73%**	15
E-mail Notices	**66.67%**	44
Workshops	**9.09%**	6
Prefer not to receive information	**0.00%**	0
Other (please specify)	**0.00%**	0
Total Respondents: 66		

Q19 Please indicate your membership. (Check all that apply.)

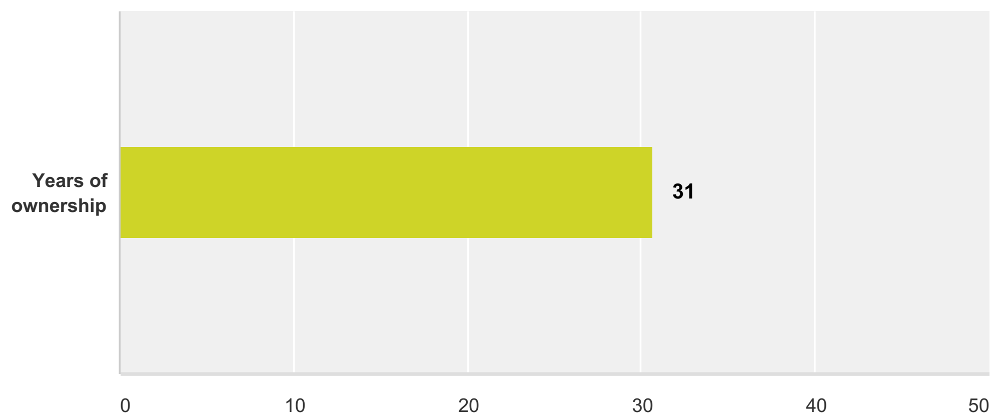
Answered: 66 Skipped: 1



Answer Choices	Responses	
Deer Lake Conservancy Member	**69.70%**	46
Deer Lake Conservancy Board Member	**4.55%**	3
Lake Association Member	**80.30%**	53
Lake Association Board Member	**6.06%**	4
Deer Lake Property Owner	**90.91%**	60
Total Respondents: 66		

Q20 How long have you, or your family (immediate or extended), owned your Deer Lake property? Note: If you own more than one property, please answer all questions for the property you have owned the longest.

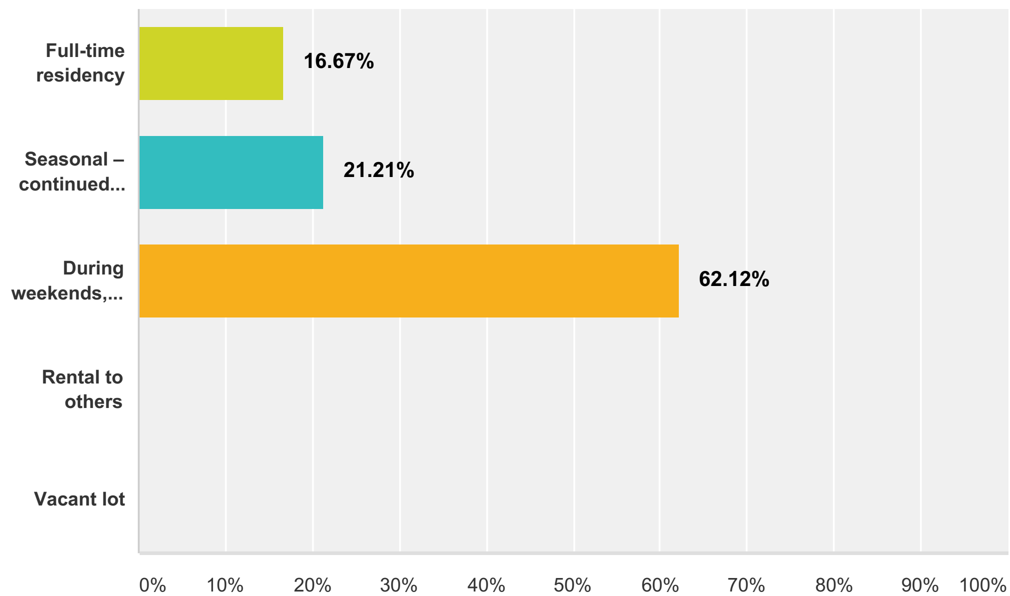
Answered: 67 Skipped: 0



Answer Choices	Average Number	Total Number	Responses
Years of ownership	31	2,058	67
Total Respondents: 67			

Q21 Which of the following best describes how often you use your Deer Lake home/property? (Choose one.)

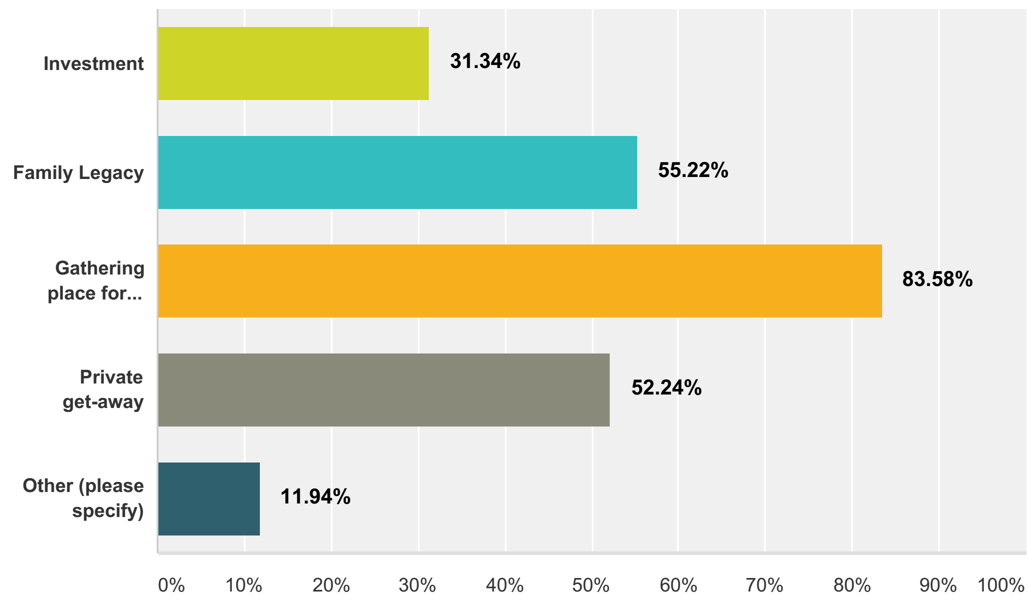
Answered: 66 Skipped: 1



Answer Choices	Responses	
Full-time residency	16.67%	11
Seasonal – continued occupancy for months at a time	21.21%	14
During weekends, vacations and/or holidays	62.12%	41
Rental to others	0.00%	0
Vacant lot	0.00%	0
Total		66

Q22 What are your reasons for owning property on Deer Lake? (Check all that apply)

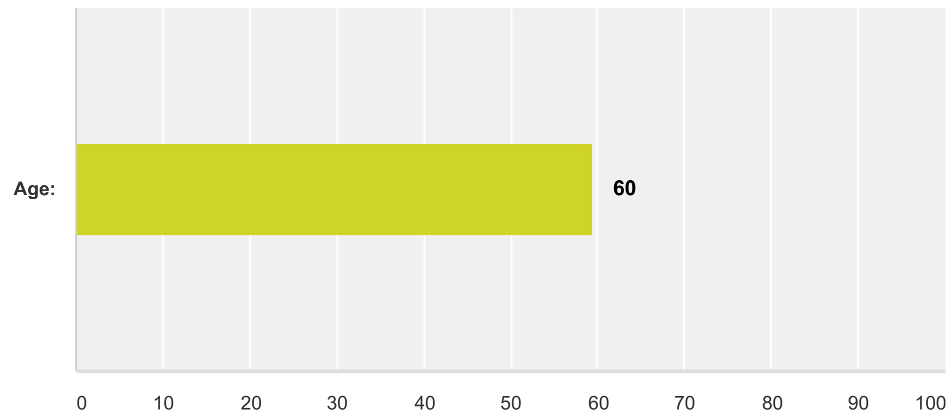
Answered: 67 Skipped: 0



Answer Choices	Responses	
Investment	31.34%	21
Family Legacy	55.22%	37
Gathering place for family and friends	83.58%	56
Private get-away	52.24%	35
Other (please specify)	11.94%	8
Total Respondents: 67		

Q23 What is your age? (list for person answering survey)

Answered: 63 Skipped: 4



Answer Choices	Average Number	Total Number	Responses
Age:	60	3,755	63
Total Respondents: 63			

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.[54]

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.[55]

[54] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species*. Prepared by Wisconsin DNR. September 2003.
[55] 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*)[56]

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

[56] 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.

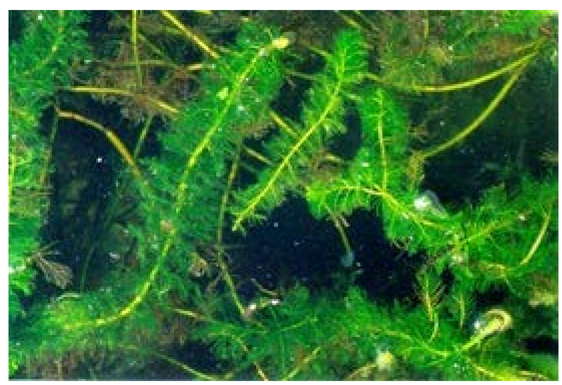
Control

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. [57]

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

Zebra Mussels[58]

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

Table 18. Zebra Mussel Establishment Potential and Life History Traits

1. Temperature:	Range: 32 - 86 deg. F (0 - 30 deg. C); limited by summer temps. above 81 deg. F or below 54 deg. F
2. Spawning Temperature:	Range: Starts when temps. reach 54 deg. F (12 deg. C), peaks at 68 deg. F (20 deg. C), stops when temps. fall back to 54 deg. F
3. Number of Eggs:	Range: mature females may produce up to 1 million eggs per season
4. Preferred Spawning Substrate:	Adults can colonize any hard surface that's not toxic, including other zebra mussels
5. Hybridization Potential:	Hybridization with quagga mussels is of some concern. Has worked in lab setting, but is thought to be rare in nature and, if present, hybrids will likely make up a very small percentage of the dreissenid community.
6. Salinity Tolerance:	Fresh, Marine, Brackish
7. Oxygen Regime Range:	prefer high DO, high potential for colonization at DO 8 - 10 ppm, intermediate potential at DO 6 - 8 ppm
8. Water Hardness Tolerance Range:	high potential for colonization at >90 mg/L calcium carbonate, intermediate potential at 45 - 90 mg/L
9. Easily confused for Native Species?	None found, is easily confused with invasive quagga mussel

[58] Information from WDNR website accessed 12/16/16: http://dnr.wi.gov/topic/Invasives/

Control Methods

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

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

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.[59]

Purple Loosestrife (Lythrum salicaria)[60]

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, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

---

[59] Taken from WDNR, 2008. (http://www.dnr.state.wi.us/invasives/fact/reed canary.htm).

[60] Wisconsin DNR invasive species factsheets.(http:/dnr.wi.gov/invasives).

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).

---

* *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 for *Potamogeton crispus* (Curly-leaf pondweed)

Deer Lake, Polk County Wisconsin

WBIC: 2619400

October, 2017

Survey and analysis conducted by: Ecological Integrity Service, LLC

Amery, WI

Abstract

On May 5, 2017 22.6 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) were treated with endothall(broad spectrum herbicide) to reduce the frequency and density of the CLP within 5 different beds. The treatment resulted in a significant reduction (based upon chi-square analysis) comparing the frequency of occurrence before treatment from April 2017 to after treatment surveyed June 2017. There was also a significant reduction comparing the post treatment survey frequency in 2016 to the post treatment frequency in 2017. There was a slight reduction (not significant) from the 2016 to 2017 in pretreatment frequency. There was a significant reduction in three native species and an increase in one species. Only 0.04 acres of CLP were observed outside of the treatment areas in the entire lake. The turion analysis resulted in a mean turion density decrease in all beds from 84.7 turions/m^2 in 2016 to 41.7 turions/m^2 in 2017.

Introduction

On May, 2017 an herbicide treatment targeting curly-leaf pondweed (*Potamogeton crispus*) was conducted using endothall. This analysis will outline the areas treated, describe the treatment protocol, and analyze the effectiveness of the treatment.

The treatment areas for Deer Lake were made up of five beds, labeled A-E (totaling 22.6 acres). Those beds, with their areas, are shown in figures 1 and 2. Portions or all of beds B, C and D have been treated annually since 2006, while beds A and E have been treated annually since 2010.

The herbicide endothall was used in the treatment of the CLP. The water temperature was 51 degrees F and winds were reported as calm at the time of application.

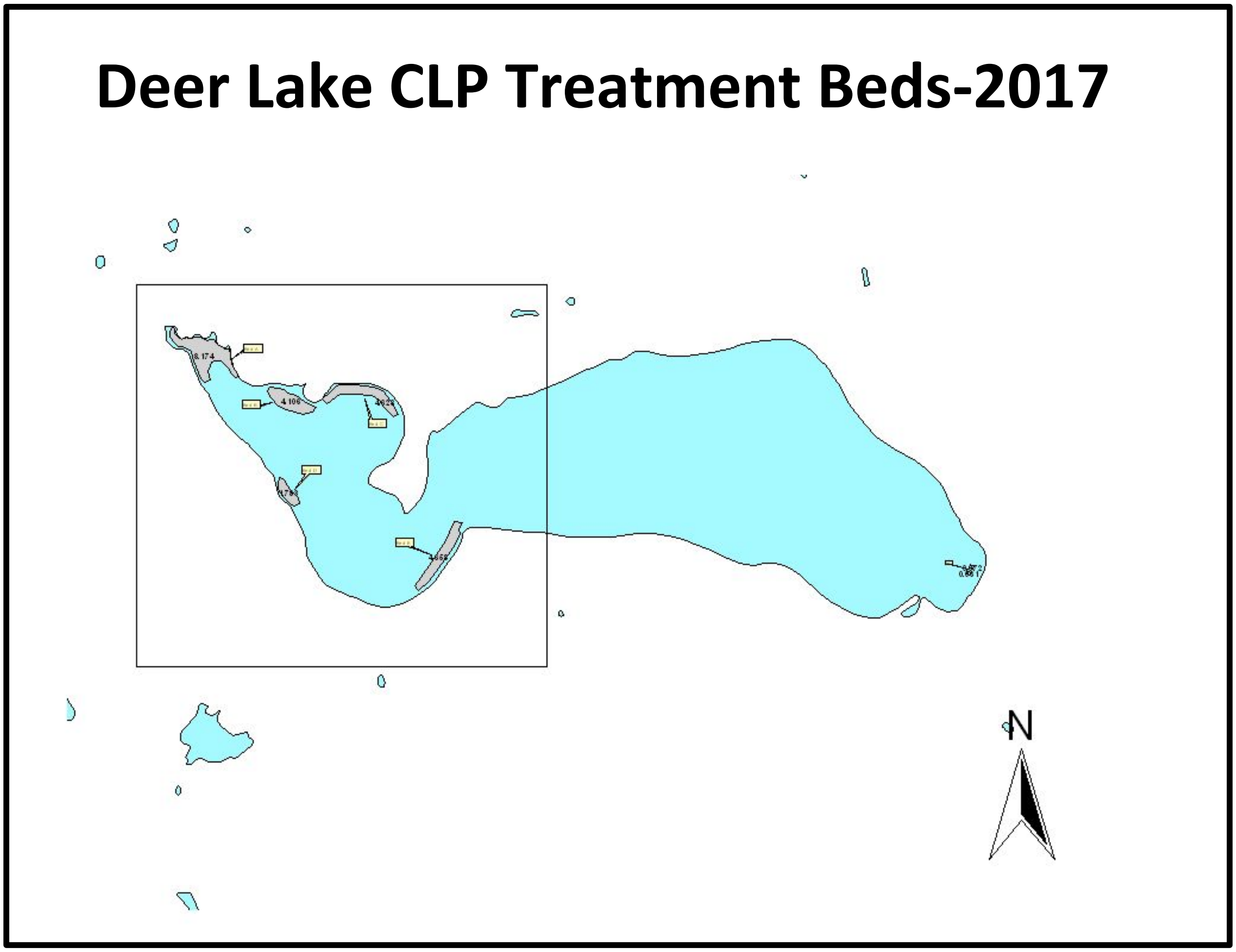


Figure 1: Large map showing the location of the treatment beds relative to the remaining lake in 2017.

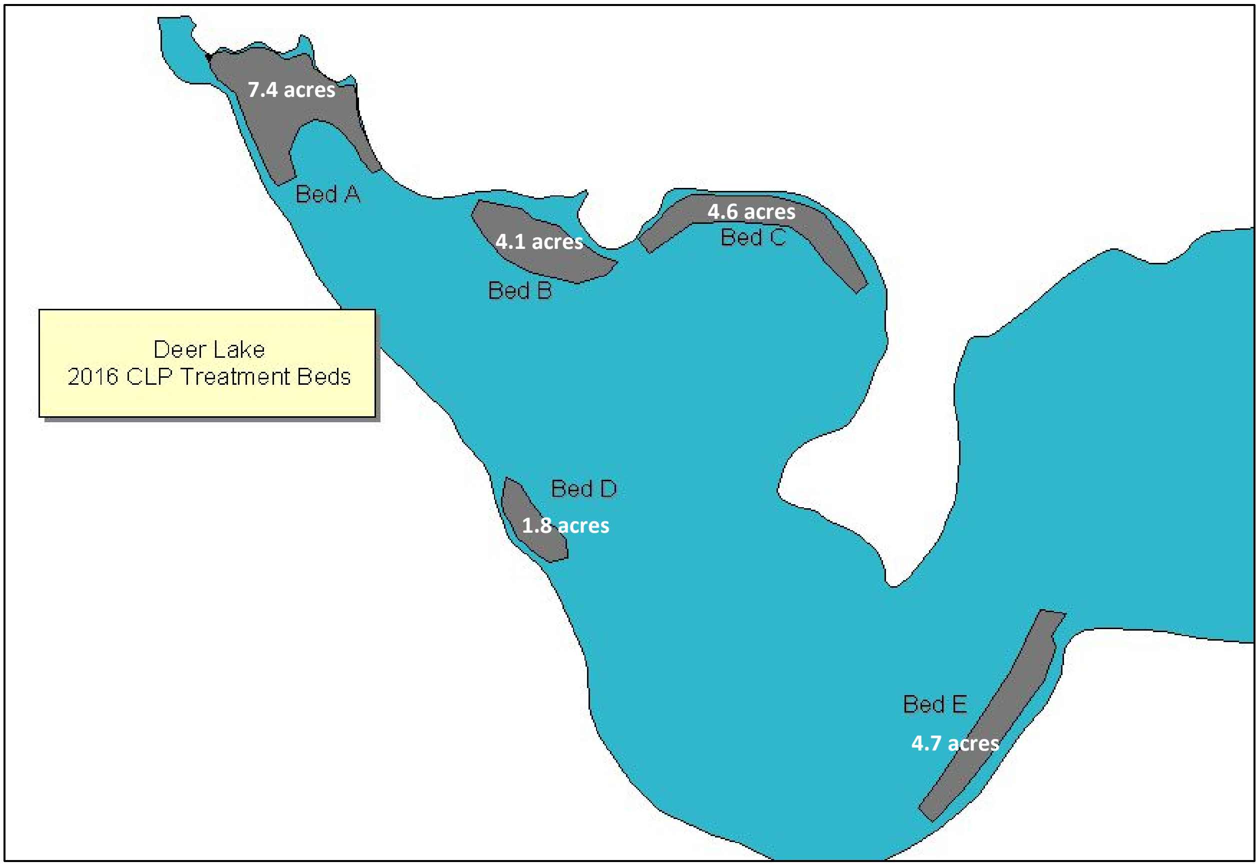


Figure 2: Close map of 2017 CLP treatment beds.

Deer Lake CLP Beds (Treatment on May 5, 2017)						
2017 Beds	**Area (acres)**	**Mean Depth**	**Acre-Feet**	**Application Rate*(ppm)**	**Wind conditions***	**Water Temp*(^{o}F)**
Bed A	7.4	5.2	38.48	2.0	Calm	51
Bed B	4.1	6.8	27.88	2.0	Calm	51
Bed C	4.6	7.8	35.88	2.0	Calm	51
Bed D	1.8	7.9	14.22	2.0	Calm	51
Bed E	4.7	8.1	38.07	2.0	Calm	51
Total	22.6		154.53			

Reported from applicator treatment records.

Table 1: Summary of treatment beds, 2017.

Treatment Bed	Description
Bed A	Bed A is near the landing and extends out from the landing quite a distance. The area in the middle is too deep causing the CLP to spit the bed into two forks. The CLP has been quite dense except for the area just near the landing. The eastern fork of the bed has quite a large amount of floating vegetation. The bed had successful treatment in 2012, 2013, 2014 and 2015. It has been treated since 2010. The bed was reduced in 2016 adjacent to boat landing as no CLP has been found for 2 years.
Bed B	Bed B is located on the east shoreline just south of Bed A. This bed has been notoriously dense and has been treated since 2006. The bed has white-stem pondweed, forked duckweed and coontail in fairly high frequency. The bed gets quite scattered with CLP in the more shallow areas and is then quite dense in deeper water. The boundary has been very well defined. The treatment was successful in 2012, 2013, 2014 and 2015.
Bed C	This bed is south and east of Bed B. The bed is quite long curving along the shoreline to the north and west. This bed is narrow but long, bordered on the lake side by deeper water, creating a well defined boundary. The bed has been very dense in the 6-8 ft depths, with less density on the shore side of the bed. The ends have been sporadic, but very dense just inside. The treatment was successful on Bed C in 2012-2015. This bed has been treated since 2006 in half of the bed and then the bed was increased in size and treated in 2010.
Bed D	This is a small bed on the western shore, just south of the landing. It changes in depth greatly over a rather short distance across the bed. It has been very dense in the middle and toward the north portion of the bed. The treatment was successful in 2012, 2013, 2014 and 2015. This bed was one of the original beds treated starting in 2006.
Bed E	Bed E is a long and very narrow bed that changes from 2.5 feet to 12+ feet on the lake side boundary. The highest density has been on the eastern ½ of the bed, but it is quite dense throughout. This bed has a fairly large amount of northern milfoil present throughout the bed. This bed had successful 2012, 2013, 2014 and 2015 treatments and has been treated since 2010.

Table 2: Treatment bed descriptions.

Methods

To conduct and analyze the treatment, two surveys are conducted following the Wisconsin DNR treatment protocol outlined in 2009 by the Wisconsin DNR. The first survey is referred to a pretreatment survey. This involves going to predetermined GPS coordinates within the proposed treatment area. A high definition underwater camera as well as a rake is used to determine the presence of CLP at that sample point. Density is not measured as the plants are typically very small and density is subjective, but is rated low/high density based upon relative number of CLP plants. The presence of CLP is simply determined. There are many points checked outside of the bed delineation to assure the boundary is correct.

The second survey is referred to as the post treatment survey. This survey involves going to the same GPS coordinates as the pre-treatment survey and doing a rake sample at the point. If any CLP is on the rake, the density of the CLP is recorded (see Figure 3 for reference). All other species are also recorded from the rake sample in order to verify no damage to the native plants.

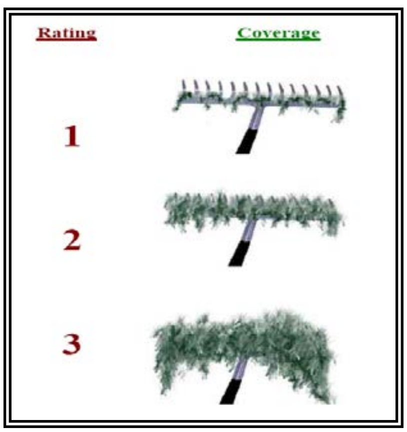


Figure 3: Density rating system and example CLP rake sample.

When the surveys are complete, the frequency of occurrence is determined as well as the mean density for each bed as well as all beds combined. The frequency of occurrence for each native plant species sampled is also calculated. A chi-square analysis is then used to determine if the change in frequency is statistically significant ($p<0.05$). The goal is to find the chi-square analysis show that the frequency of CLP is significantly reduced and the native plants are not significantly reduced.

The comparison for reduction can involve three evaluations. First, the result from the previous year's post treatment survey is compared to the present year post treatment survey. This reflects a long-term effectiveness. As more treatments are done in annual succession, these frequency values can become very similar since the CLP growth is reduced so much. This can make it appear the treatment is not progressing successfully since the frequency appears to not be reduced. Each year, new turions can germinate in the fall/winter and create new growth. The result from turion germination is a low frequency in the post treatment survey, but in the next spring the CLP has grown immensely, and results in a high frequency.

In order to reflect that new growth and the effect the treatment has on it, a second comparison is done. This compares the frequency of CLP in the spring, pre-treatment survey to the post treatment results in that same year. This shows what the CLP growth was just before treating and the result after treatment.

The third method is to evaluate the pretreatment survey frequency from year to year. Since the pretreatment survey frequency reflects new growth from turion germination, a reduction from year to year in this frequency can show long-term reduction since it reflects the new CLP growth resulting from turions. If the CLP frequency goes down each year, there must be less turions germinating each year.

In the end, we want to see a statistically significant reduction when comparing the pre-treatment frequency to the post treatment frequency. We would also like to see a consistent frequency reduction from year to year, depending on how low it is, in the pre and post treatment surveys in successive years. If the frequency in any post treatment survey is very low (less than 10% as an example), then lowering it even more may not be realistic, but is the goal. Comparing the pretreatment surveys from year to year can show the progress being made as it reflects growth after turion germination, thus reflecting potential overall reduction. Turions can remain viable for several years, which can affect reduction amounts achieved.

In order to further reflect potential future growth and the cumulative success of treatments, a turion analysis is conducted. This analysis involves going to sample points near the middle of the CLP bed (assuming this will reflect the highest density). At each sample point a sediment sampler is lowered to the lake sediment and a sediment sample is obtained. Two samples are obtained from each side of the boat at each location. The samples are then separated with a screened bucket to isolate the turions. The turions are then counted and the density of turions is calculated in turions/square meter. Consistently successful treatments should show a trend of reduced turion density each year. This way we know the treatments are killing plants prior to turion production, resulting in overall reduction in CLP in those beds.

a

b

C

Figure 4: Pictures showing turion density methods. A shows sediment sample; b shows separation; c Shows separated turions.

Results

The results of the pretreatment and post treatment surveys from 2017 are summarized in table 3. The pretreatment survey was conducted on April 13, 2017 and the post treatment survey was conducted on June 9, 2017. CLP was dense in other area lakes when the post treatment survey was completed, thus demonstrating post survey was near peak CLP growth. The tables also contain information from 2016 to show changes between years of treatment.

Treatment Bed	Pre-treat freq (2016)	Post treat freq (2016)	Pre treat freq (2017)	Post treat freq (2017)	Mean density 2016	Mean density 2017
Bed A	60.4%	4.6%	48.9%	0%	0.05	0
Bed B	45.8%	20.8%	33.3%	0%	0.38	0
Bed C	38.7%	19.4%	41.9%	3.0%	0.32	0.03
Bed D	50.0%	0.0%	41.7%	0%	0.00	0
Bed E	37.9%	20.7%	56.7%	0%	0.28	0
All beds	47.5%	13.7%	45.8%	0.7%	0.2	0.007

Table 3: Summary of CLP growth frequency pre and post treatment 2016-2017.

As stated in the methods, a chi-square analysis is conducted on the frequency data. The results of this are summarized in table 4 (all beds combined).

Survey Comparison	Statistically significant reduction?	Chi-square result (reduction)
2017 pretreatment freq/2016 post treatment freq.	Yes	$P=9.5 \times 10^{-10}$
2016 post treatment freq/2017 post treatment freq.	Yes	$P= 3.0 \times 10^{-5}$
2016 pretreatment freq/2017 pretreatment freq.	No (slight reduction)	P=0.81

Table 4: Summary of frequency reduction and significance after treatment.

The chi-square analysis shows a statistically significant reduction from before treatment to after treatment in 2017. There was also a statistically significant decrease from the post treatment frequency 2016 to post treatment frequency 2017. There was a slight decrease from pretreatment frequency 2016 to pretreatment frequency 2017, but was not significant. The overall density from 2016 to 2017 decreased. There was only one location in all of the beds that had CLP growth. Based upon these data, the herbicide treatment seems to have effectively reduced the CLP growth.

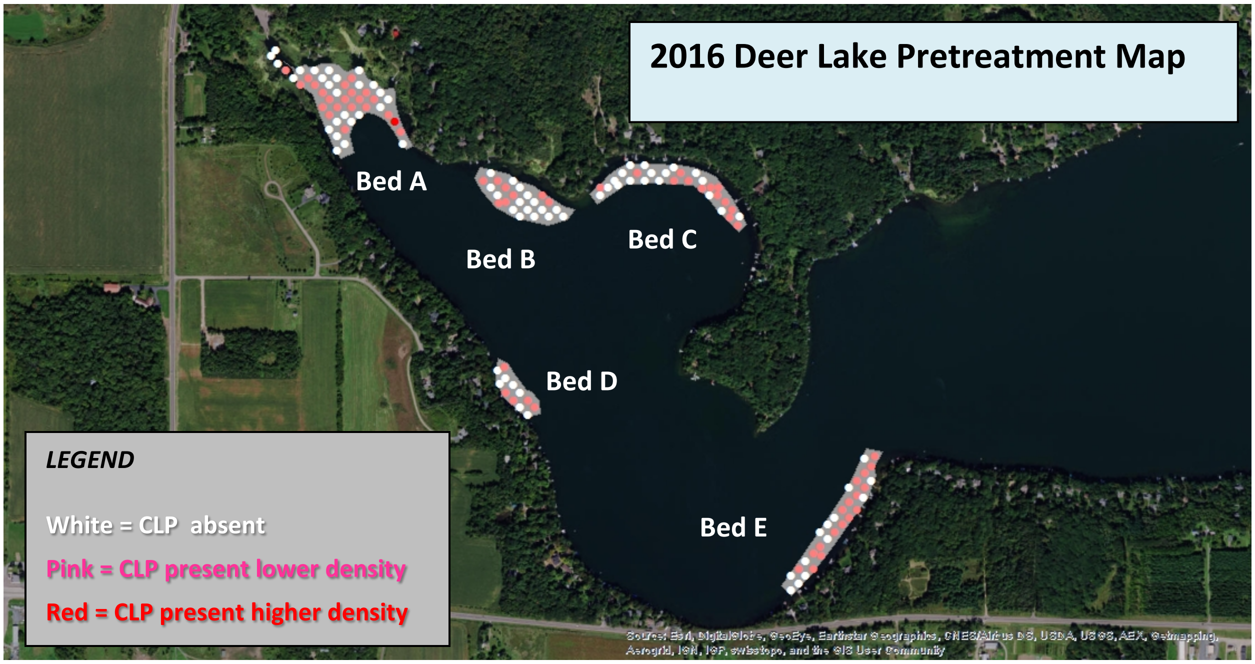


Figure 5: Pre-treatment map from 2017 pretreatment survey showing presence/absence of CLP.

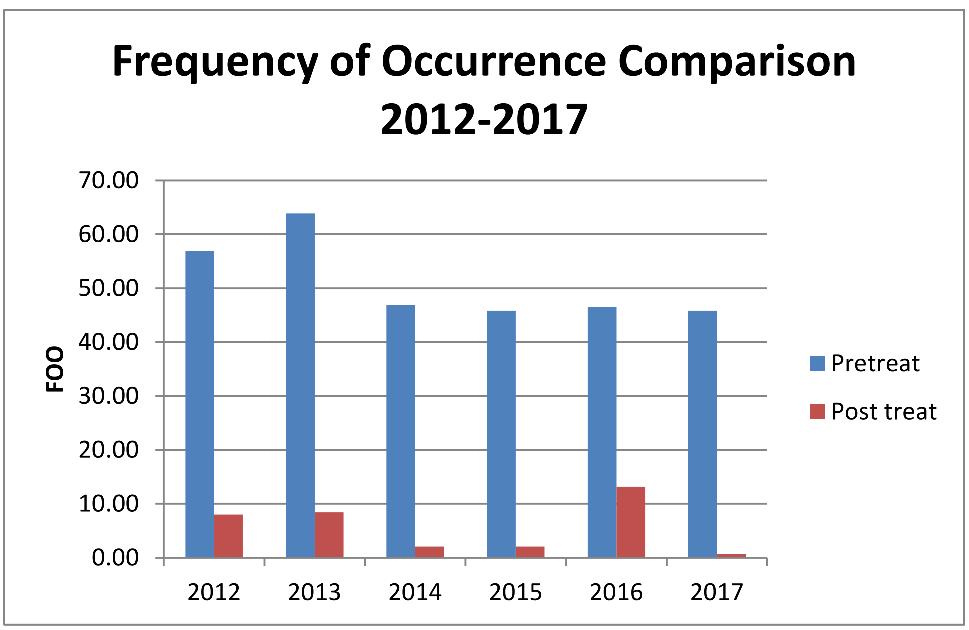


Figure 6: Graph showing the pre/post treatment frequency comparison from 2012 and 2017-all beds treated.

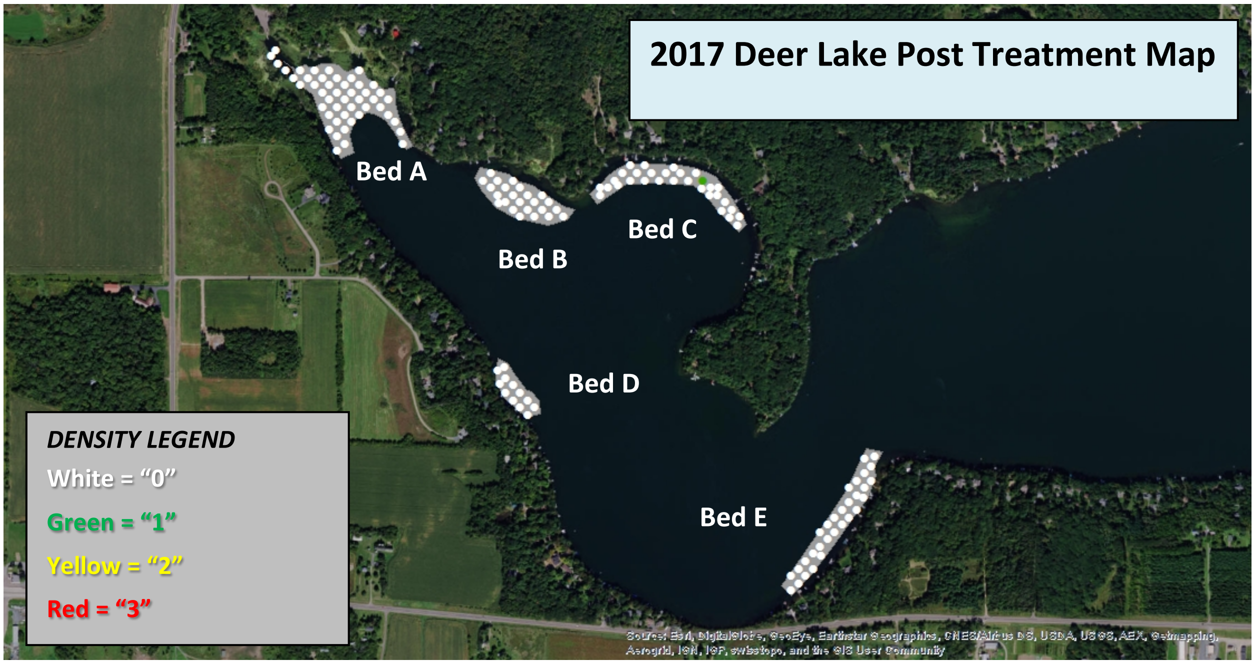


Figure 7: Map showing CLP sampled and density in 2017 post treatment survey.

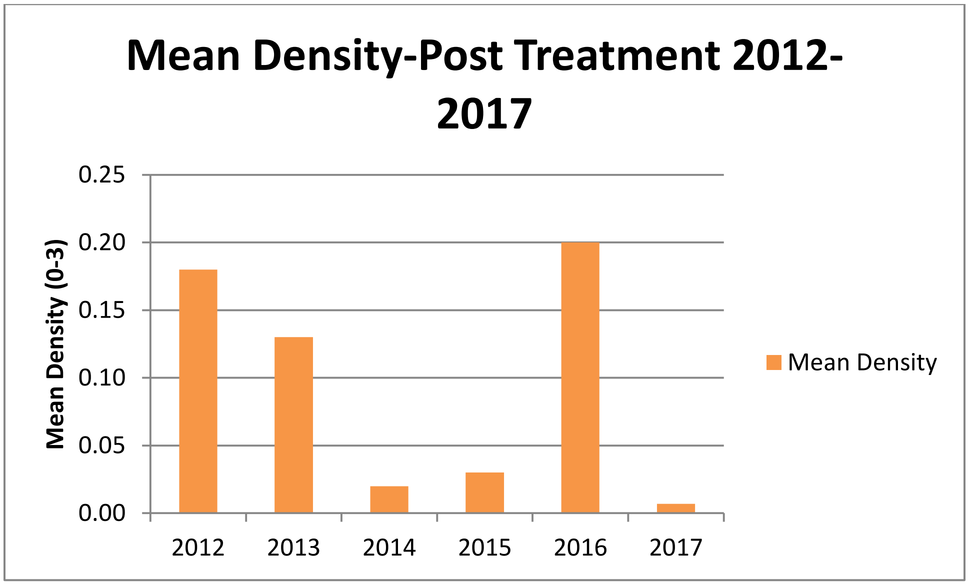


Figure 8: Comparison of post treatment mean density all beds, 2012-2017.

In conjunction with the frequency decreases, the mean density after treatment was very low. In 2016, the mean density had increased from 2015 to 0.2 (scale of 0-3). In 2017 the mean density was only 0.007, with only one location in all of the beds with CLP and that was a density of "1".

Figures 9 and 10 show the maps of the pretreatment and post treatment surveys from 2016 for comparison to 2017 maps.

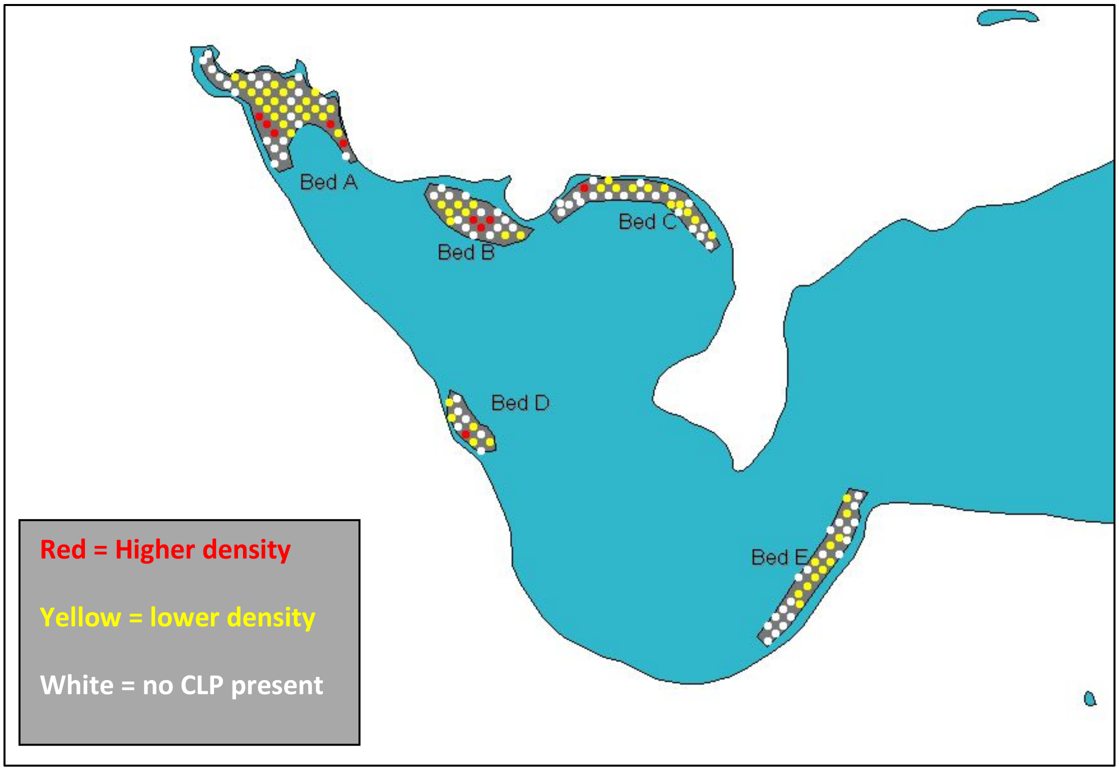


Figure 9: Pretreatment survey map, 2016

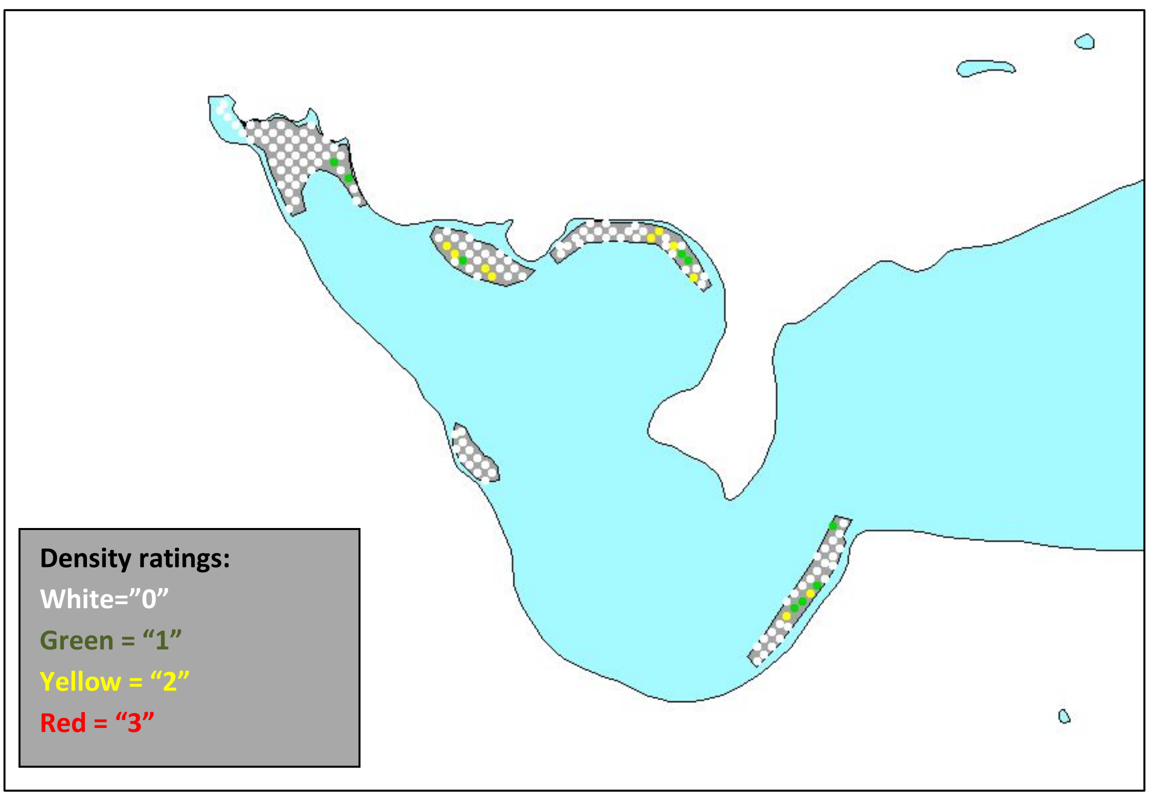


Figure 10: Post treatment survey map, 2016.

Native Plant Changes

The native plant frequencies were evaluated during the post treatment survey. Table 5 summarizes those results and the chi-square analysis that determines the significance of any reductions, potentially to herbicide exposure from the 2017 treatment.

Native species	Frequency 2016	Frequency 2017	P value	Significant reduction
Lemna trisulca,forked duckweed	0.12	0.11	0.85	No
Potamogeton praelongus,White-stem pondweed	0.03	0.11	0.005	n/a (increase)
Ceratophyllum demersum, Coontail	0.51	0.58	0.15	n/a
Myriophyllum sibiricum, Northern milfoil	0.43	0.19	$2X10^{-5}$	Yes
Potamogeton richardsonii, Clasping pondweed	0.24	0.10	0.002	Yes
Elodea canadensis, elodea	0.22	0.19	0.66	No
Heteranthera dubia, water stargrass	0.17	0.09	0.05	No
Ranunculus aquatilis, stiff water crowfoot	0.11	0.11	1.0	No
Chara sp., muskgrasses	0.09	0.13	0.25	n/a
Nymphaea odorata, white lily	0.05	0.07	0.45	n/a
Stuckenia pectinata, sago pondweed	0.05	0.06	0.79	n/a
Nitella sp., Stonewort	0.01	0.0	0.32	No
Bidens beckii,Water marigold	0.05	0.0	0.007	Yes
Potamogeton epihydrous, ribbon pondweed	0.0	0.01	0.32	n/a
Spirodela polyrhiza,Large duckweed	0.0	0.01	0.32	n/a
Lemna minor, small duckweed	0.0	0.01	0.32	n/a

Table 5: Native species frequency and chi-square analysis-2016 to 2017.

The native plant survey data shows a reduction in three native species, which were significant (*Potamogeton richardsonii*-clasping pondweed, *Myriophyllum sibiricum*-northern water milfoil, and *Bidens beckii*-water marigold). The source of this reduction is unknown. It could be due to natural variation, sampling variation or herbicide application. There was also a statistically significant increase in one native species (*Potamogeton praelongus)* so this may indicate it isn't due to herbicide since the broad spectrum herbicide used can kill all plants. *Potamogeton praelongus* had a significant reduction from 2015 to 2016, so it appears to have rebounded. If the native plants are out of dormancy at the time of application, they are more susceptible to the herbicide.

CLP mapping

After the post treatment survey is completed, the entire lake is surveyed looking for CLP beds. A bed is defined as an area of CLP that is dominated by CLP, has a mean CLP density >2, and can be delineated by sight. In order to be delineated by sight, the CLP must be growing at or near the lake surface. There were three CLP beds seen outside of treatment and no beds within the treatment areas. Figure 11 shows the location of the CLP observed out of the treatment beds. Figure 12 and 13 are the maps of the CLP beds observed on the north shoreline and in the lagoon. These beds totaled 0.04 acres. There was no other CLP observed in the lake.

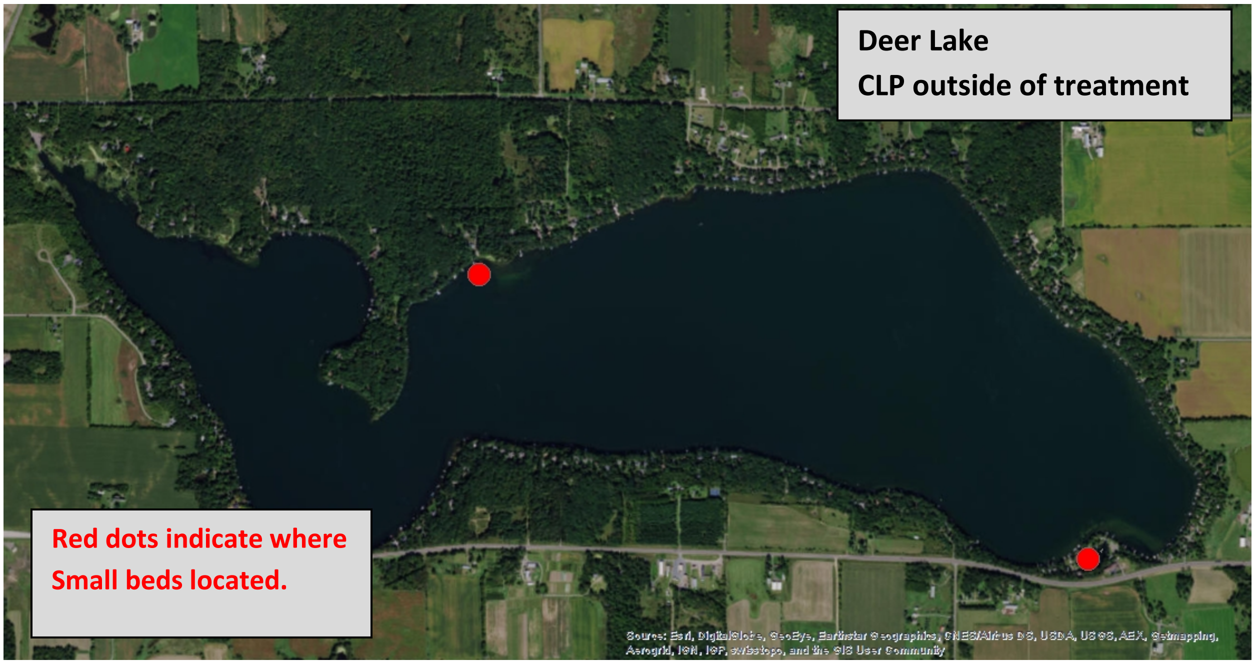


Figure 11: Map of the CLP bed locations outside of the treatment area.

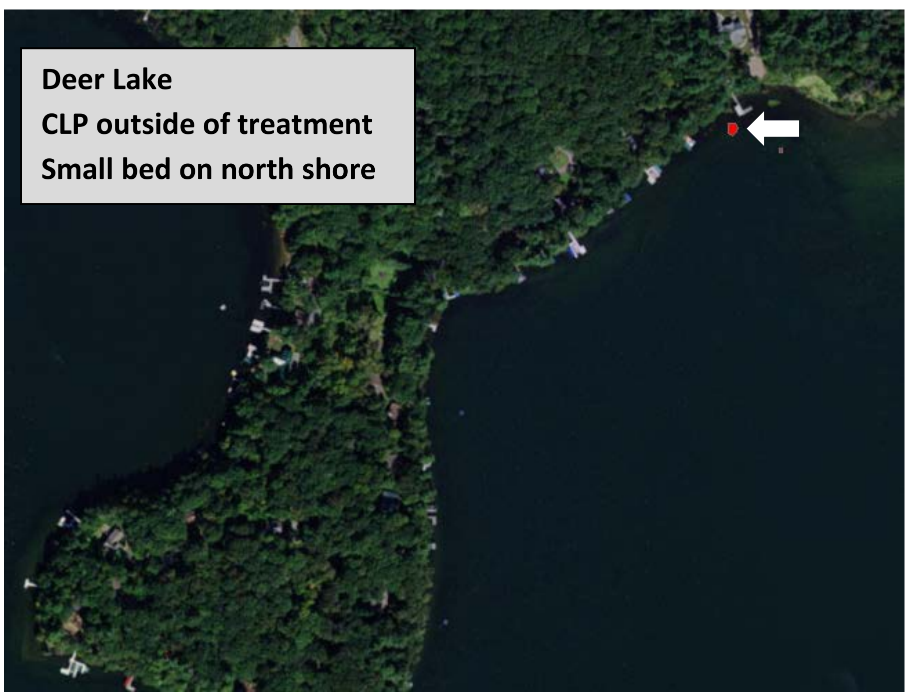


Figure 12: Small CLP bed observed on the north shoreline Deer Lake-June, 2017.

Figure 13: CLP beds observed in the lagoon area of Deer Lake-June, 2017.

Turion Analysis

The turion analysis was conducted on October 7, 2017. Table 6 summarizes the turion density comparison from 2013 to 2017. Figures 14 and 15 graphically show the changes.

Bed	2013 Mean (T/m^2)	2014 Mean (T/m^2)	2015 Mean (T/m^2)	2016 Mean (T/m^2)	2017 Mean (T/m^2)
A	77.7	63.1	39.1	83	47.8
B	153.6	46.1	96.75	122	49
C	91.8	89.5	75.25	136	67.75
D	15.0	16.3	32.25	5	16.25
E	71.0	18.6	55.3	31	9.3
All Beds	88.8	52.0	61.1	84.7	41.7

Table 6: Turion density in each bed 2013 through 2017.

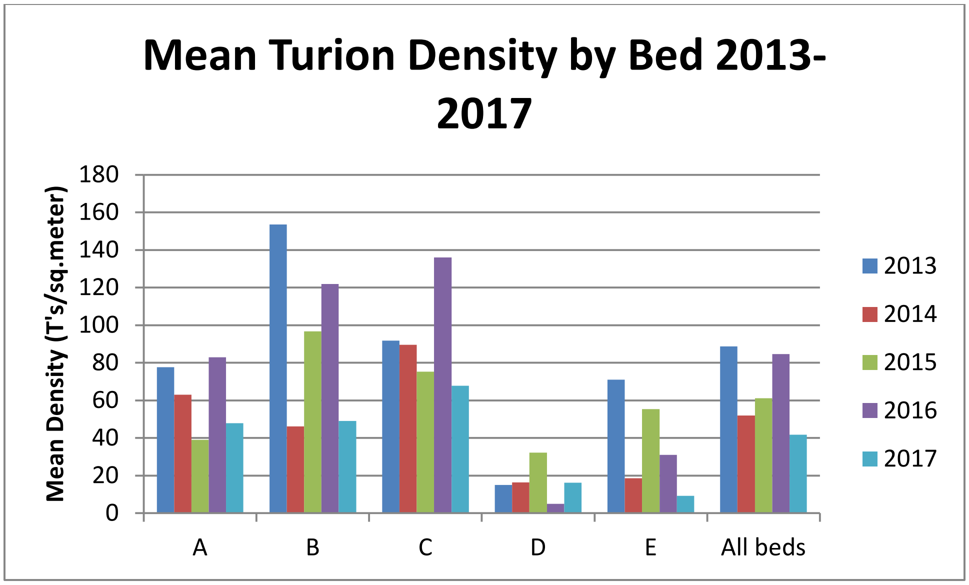


Figure 14: Turion densities by bed for comparison 2013 through 2017.

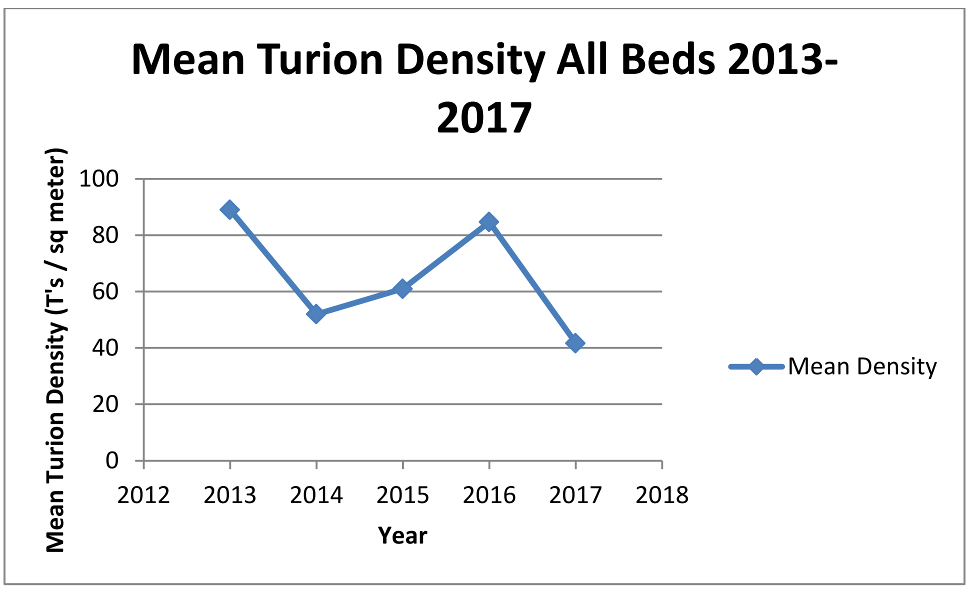


Figure 15: Change in turion density, all beds 2013 through 2017.

As the data shows, the mean turion density in all beds combined declined from 2016 to 2017. This follows increases in 2015 and 2016. It is desired to see annual reduction in turion density. If any treatment areas are not successful in killing the CLP, these plants can produce turions, which can germinate the following year. The mean turion density did increase slightly in bed D.

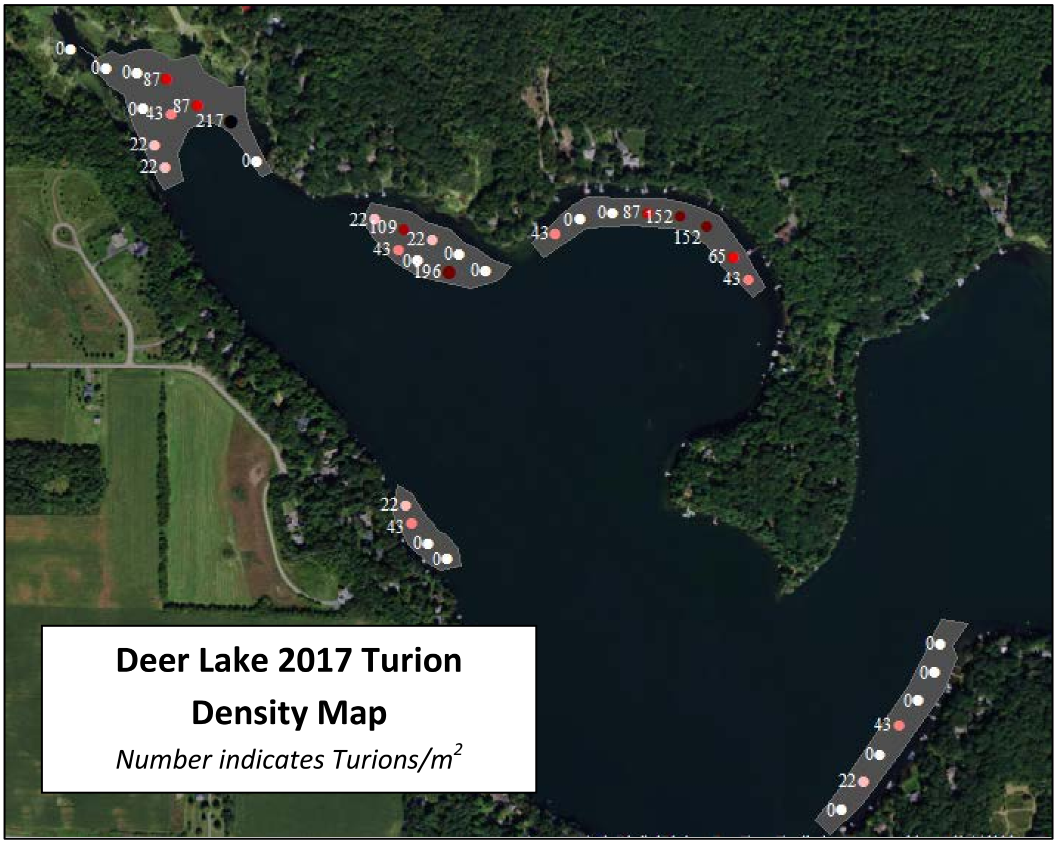


Figure 16: Map of turion density by bed, 2017.

Discussion

The 2017 CLP herbicide treatment was very successful at reducing CLP growth occurring in 2017. The frequency of occurrence of CLP was significantly reduced according to a chi-square analysis. When comparing the frequency of CLP just before treatment (pre -treatment survey 2017) it was much higher than after treatment (post treatment survey 2017) with a reduction of from 45.8% to 0.7%. See Figure 6 for graphic representation.

When comparing the post treatment frequency in 2016 to the post treatment frequency in 2017, there was a significant reduction from 13.7% to 0.7%. This shows that overall reduction from the previous year did occur, with more CLP growing after treatment in 2016 than in 2017. The density also decreased from 0.3 in 2016 to 0.007 in 2017.

Since the beds tend to fill in from turion germination, comparing the pretreatment surveys from year to year can reflect the progress that is being made. If the CLP frequency is reduced from pretreatment to pretreatment survey, then overall reduction of CLP is occurring. Comparing the pretreatment frequency in 2016 to 2017 showed a small decrease but was not significant. The CLP is returning each spring, but the frequency is staying lower. Pretreatment frequency decreases show long-term reduction in CLP and the goal is for this to continue to decrease.

The native plant species did show a reduction in three species. This reduction could be due to the herbicide application, sample location variation and/or natural variation. There was one significant increase in native species. The goal is for no species to decrease and the main concern is reduction due to herbicide. This cause cannot be ruled out in 2017 and continued monitoring of native species with full lake surveys every 5 years should continue.

Following the post treatment survey of the treatment beds, the CLP was mapped in all areas. Any areas that constituted a bed, the area was delineated. In years past, very little to no CLP was observed outside of the treatment area. In June, 2016, more CLP was observed than in previous years, resulting in the delineation of four beds outside of the treatment areas. In 2017, there were only three small beds, totaling 0.04 acres observed. No CLP beds were present within the treatment areas. There was very little CLP observed in Deer Lake in 2017.

The turion data analysis shows that the turion density decreased from 2016 to 2017. The density is the lowest it has been in collected turion data in 2013. This shows long term reduction in CLP and should result in lower CLP growth in spring 2018.

References

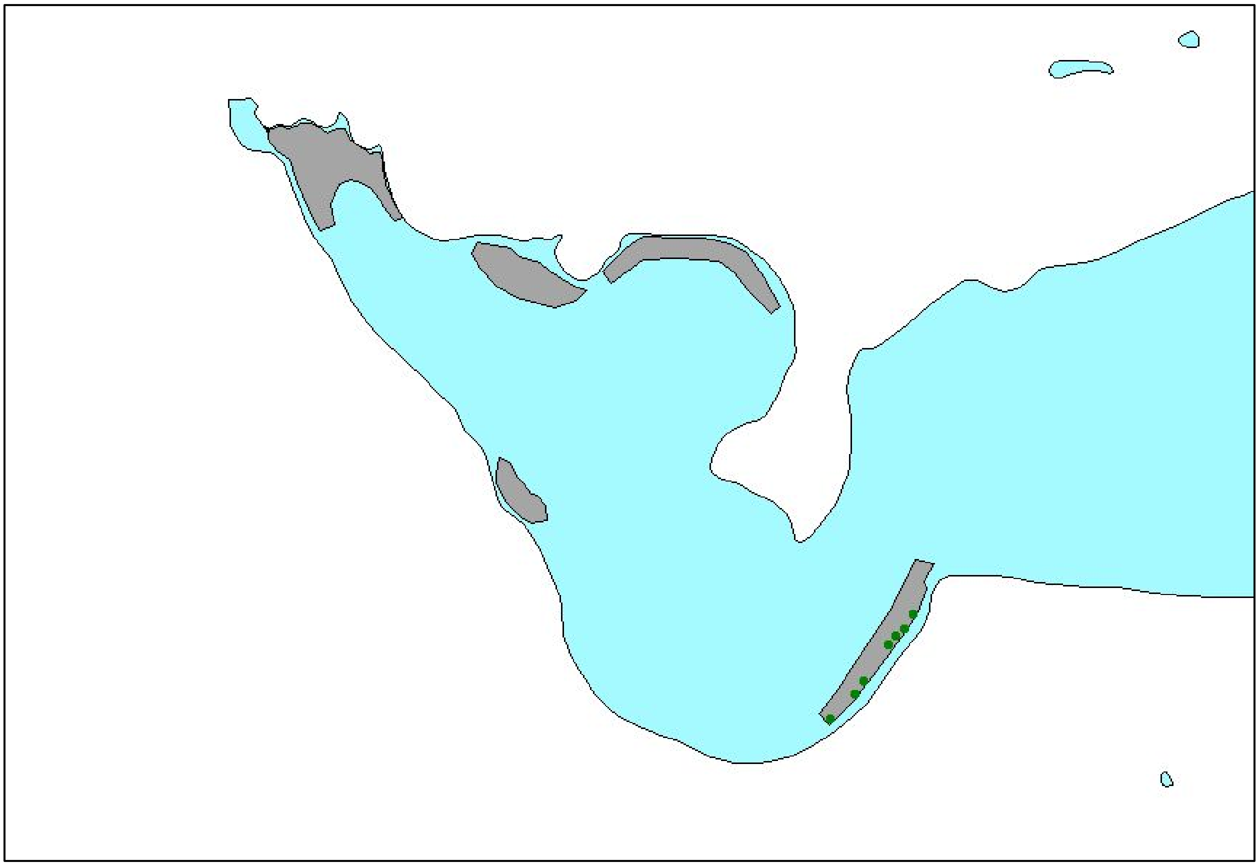
Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass.* University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America.* The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin.* April 2006 Draft. 46 p.

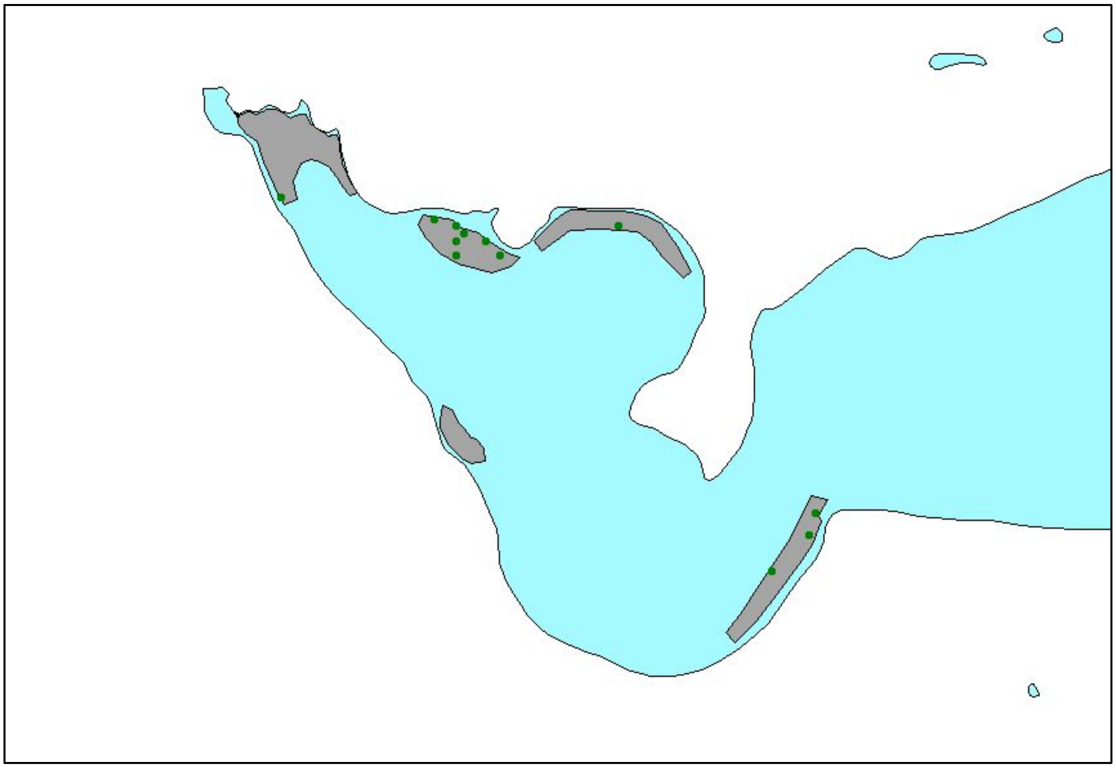
UW-Extension. Aquatic Plant Management website.
http://www4.uwsp.edu/cnr/uwexlakes/ecology/apmguide.asp appendix d.

Appendix-Native plant maps from 2015 and 2016.



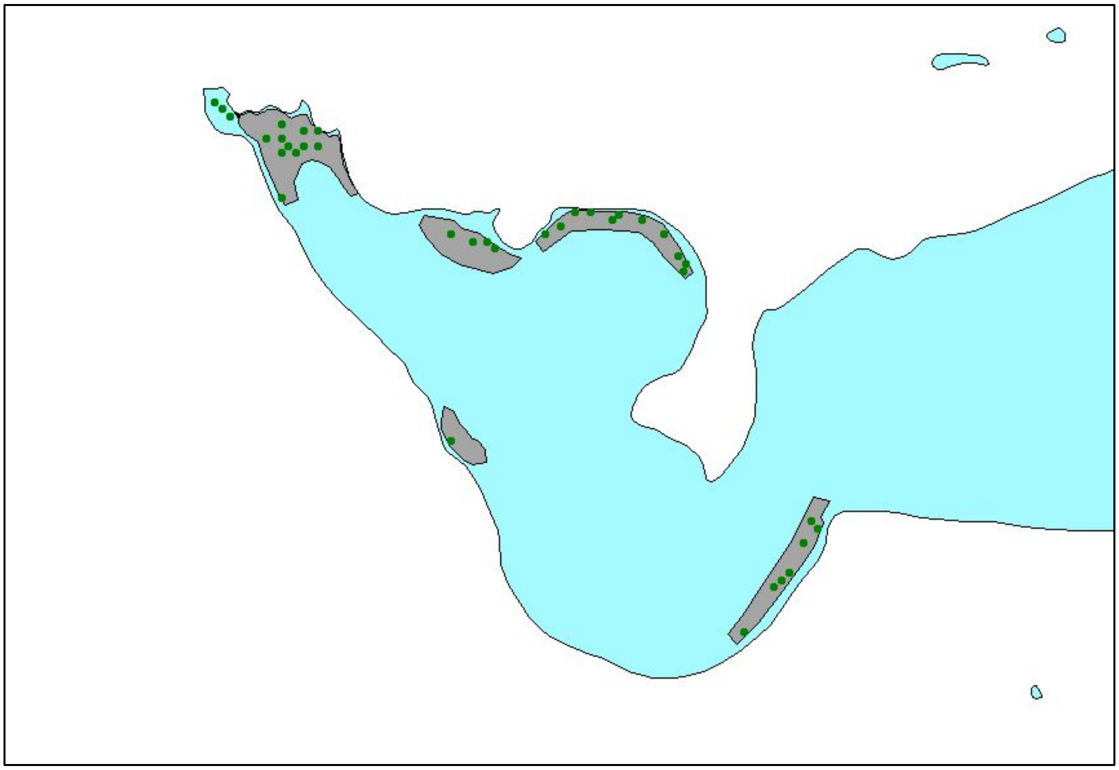
Bidens beckii-Water marigold-2016

Not sampled in 2017



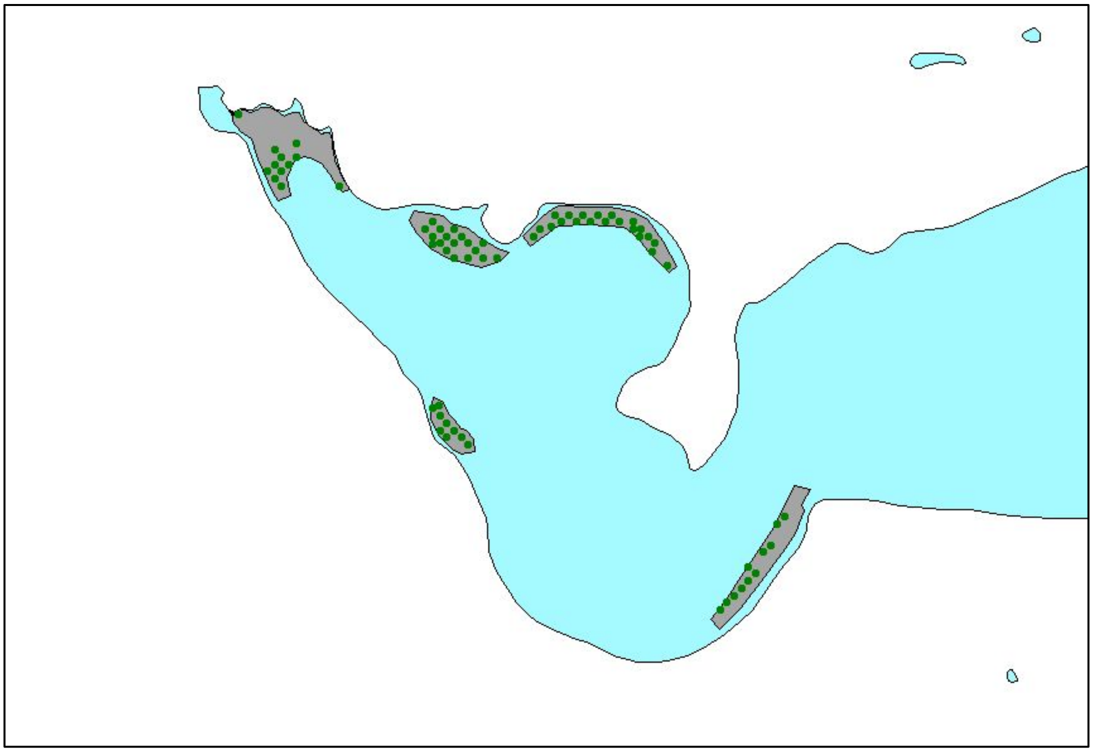
Chara sp.-Muskgrass-2016

Chara sp.-Muskgrass-2017



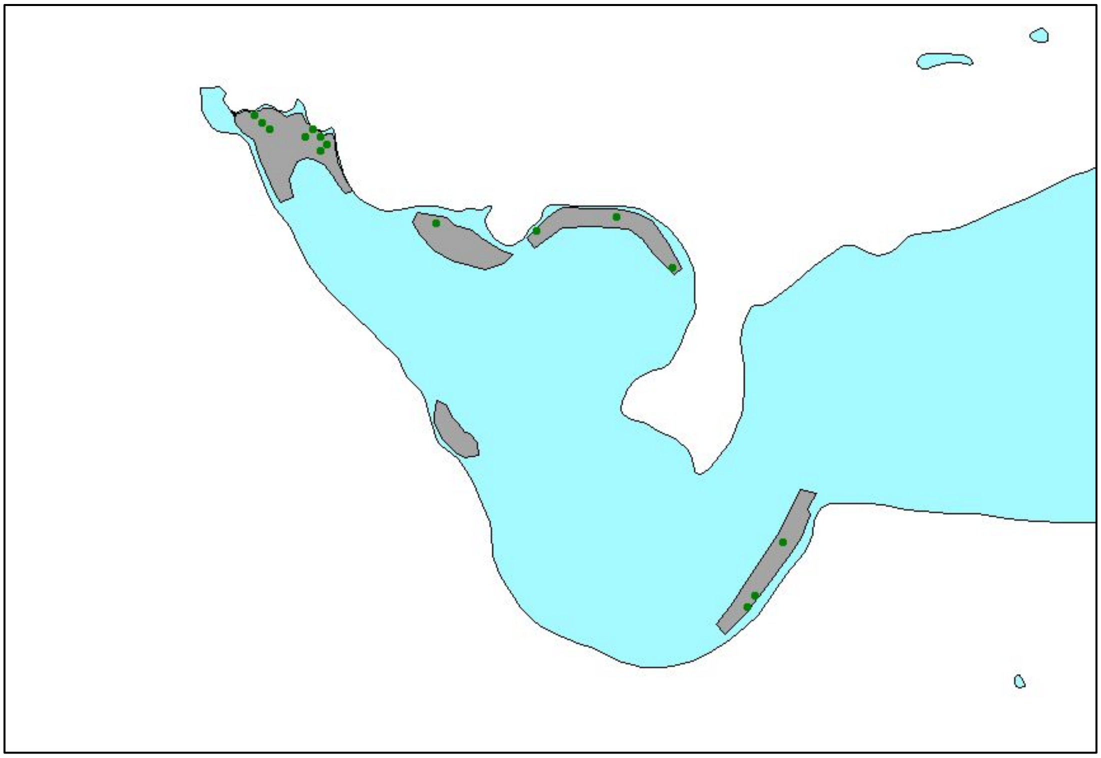
Potamogeton richardsonii-Clasping pondweed-2016

Potamogeton richardsonii-Clasping pondweed-2017



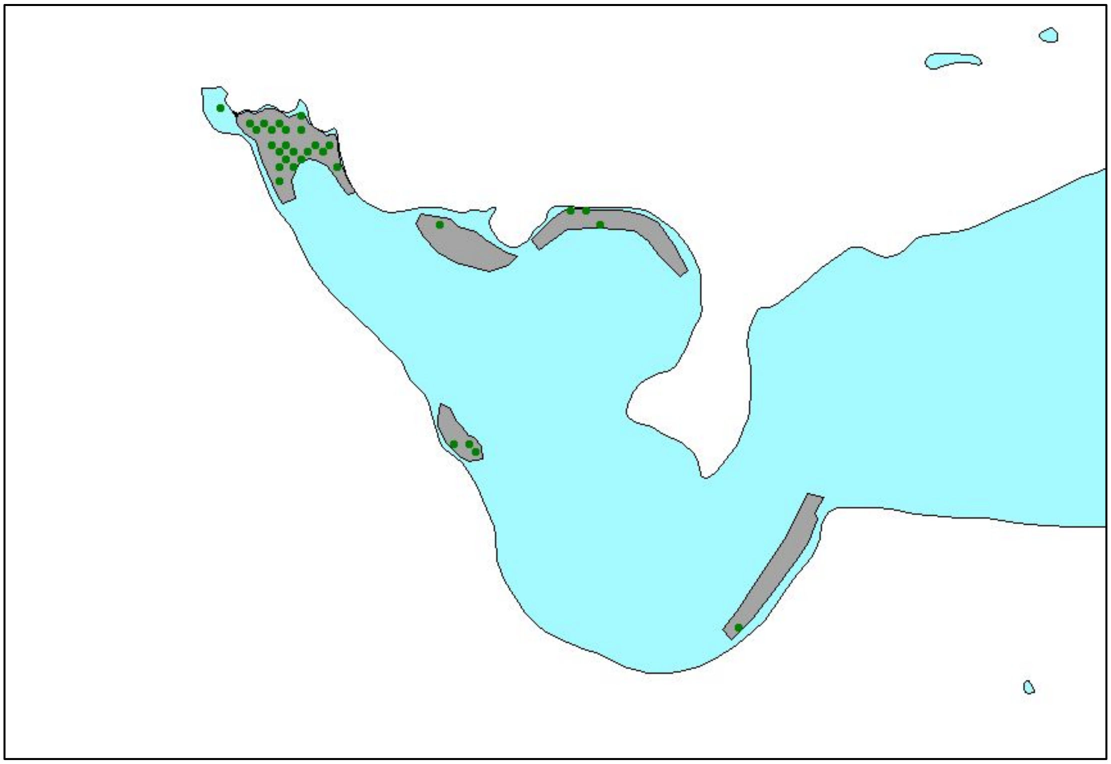
Ceratophyllum demersum-Coontail-2016

Ceratophyllum demersum-Coontail-2017



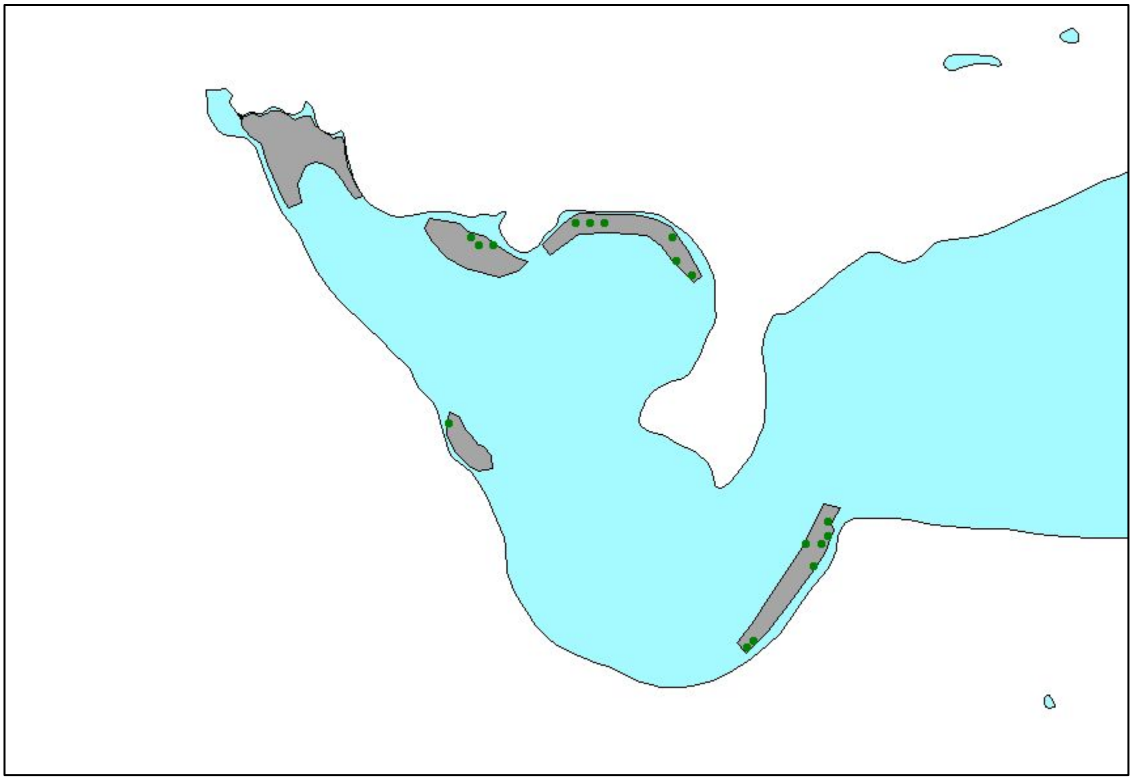
Rununculus aquatilis-Whitewater Crowfoot-2016

Rununculus aquatilis-Whitewater Crowfoot-2017



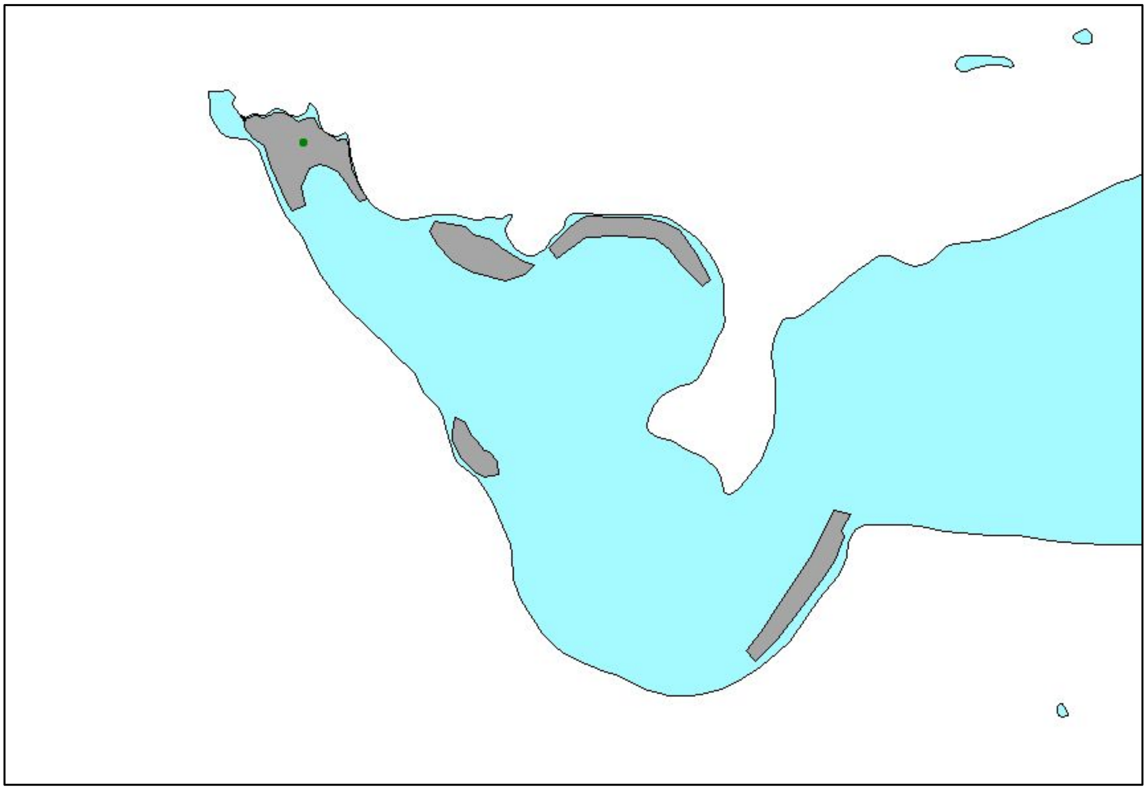
Elodea canadensis-Common waterweed-2016

Rununculus aquatilis-Whitewater Crowfoot-2017



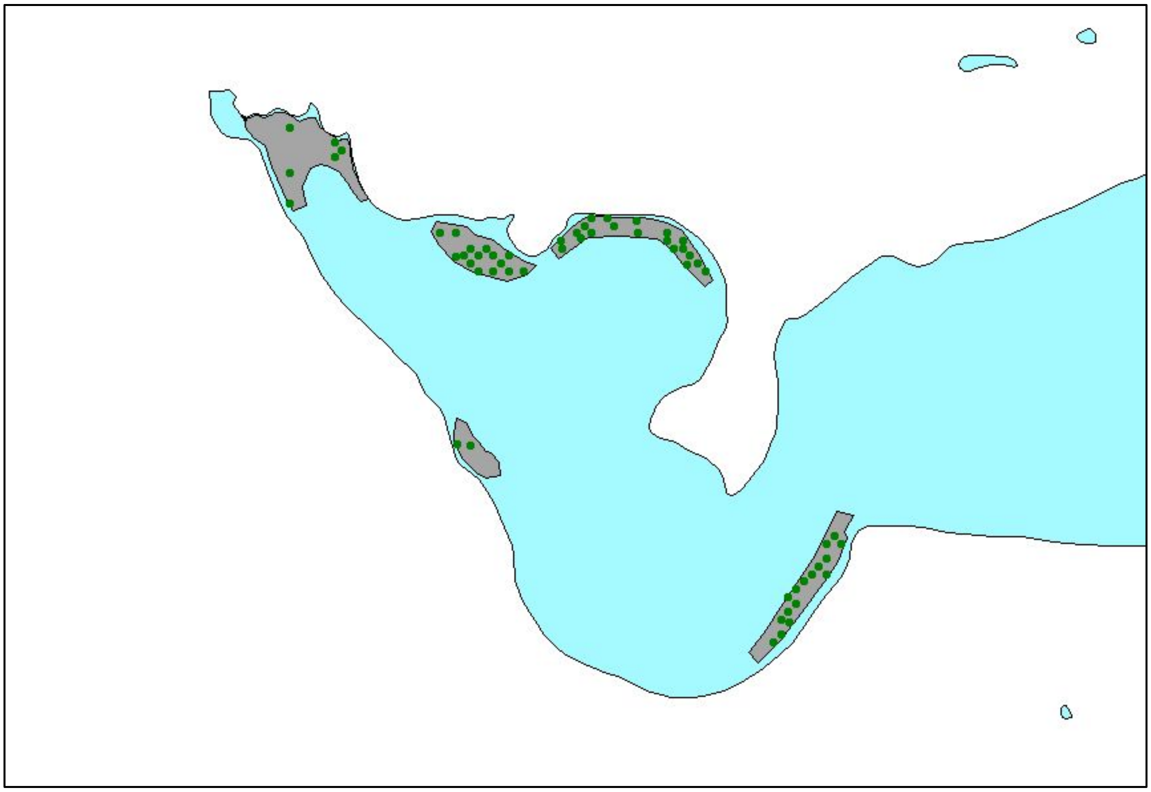
Lemna triscula-Forked duckweed-2016

Lemna triscula-Forked duckweed-2017



Nitella sp.-Stonewort-2016

Nitella not sampled in 2017

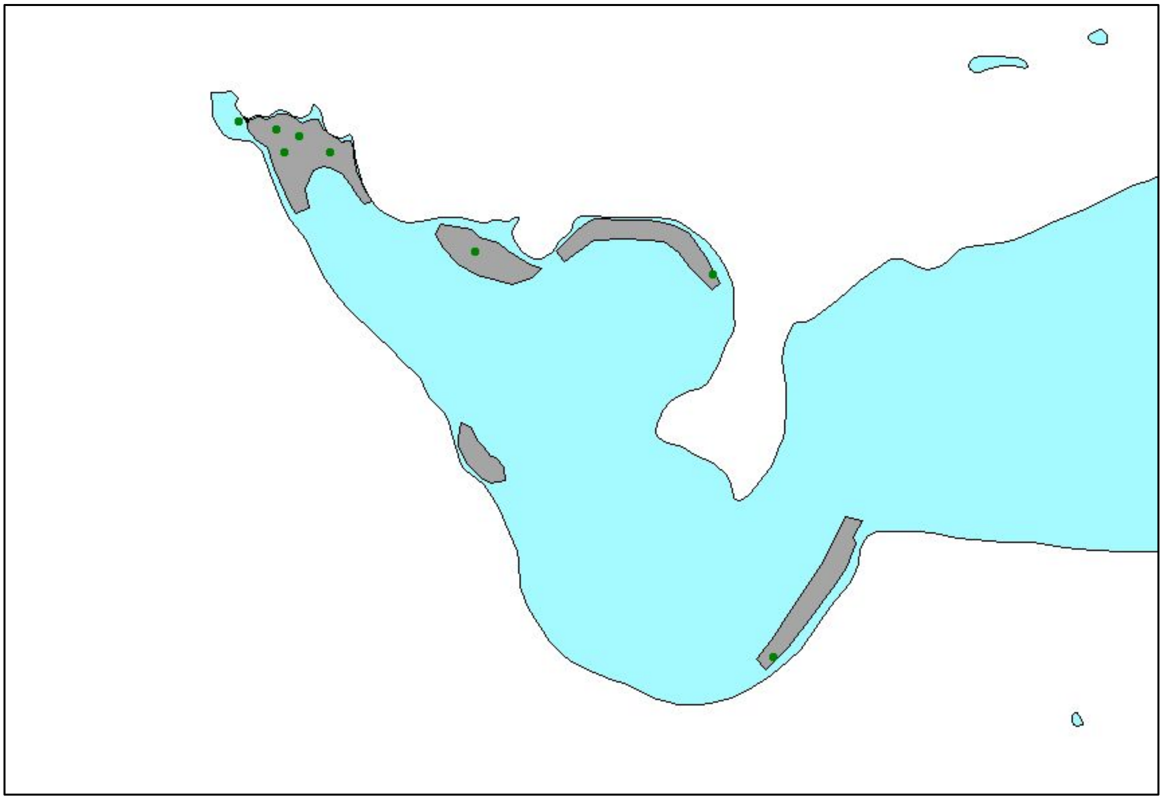


Myriophyllum sibiricum-Northern water milfoil-2016

Myriophyllum sibiricum-Northern water milfoil-2017

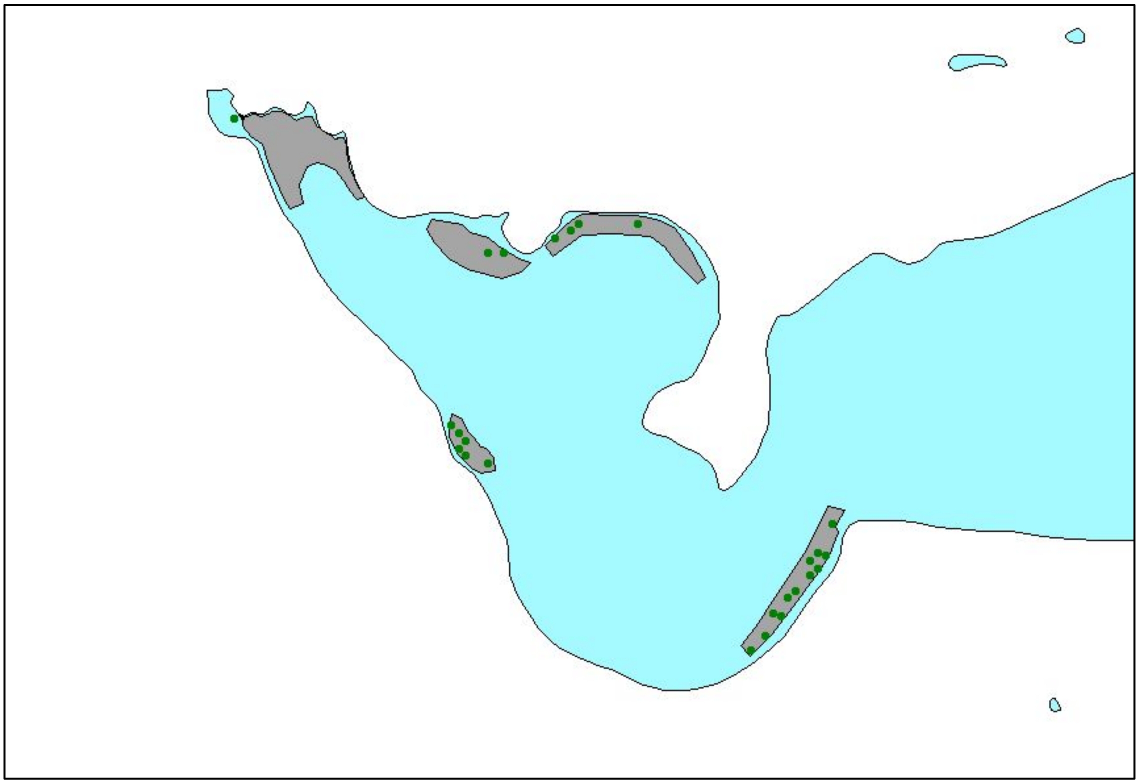
Potamogeton epihydrous-Ribbon leaf pondweed not sampled in 2016

Potamogeton epihydrous-Ribbon leaf pondweed-2017



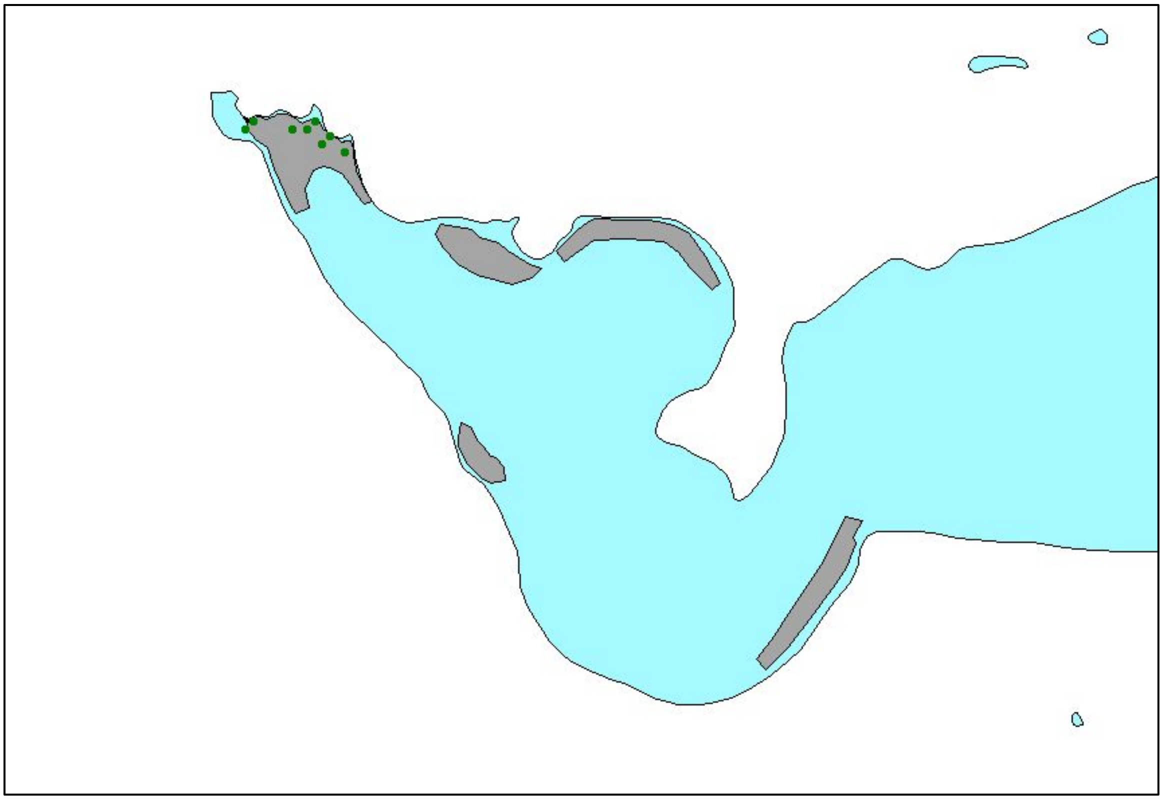
Stuckenia pectinate-Sago pondweed-2016

Stuckenia pectinate-Sago pondweed-2017



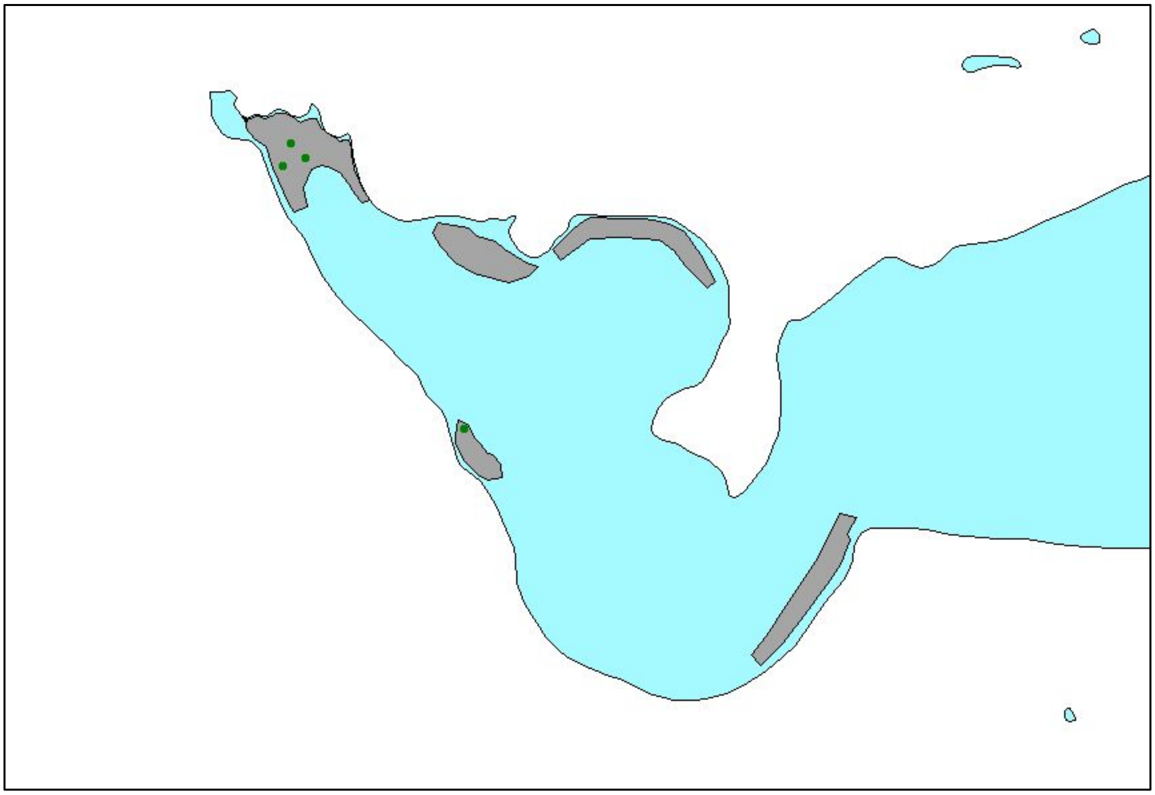
Heteranthera dubia-Water Stargrass-2016

Heteranthera dubia-Water Stargrass-2017



Nymphaea odorata-White water lily-2016

Nymphaea odorata-White water lily-2017



Potamogeton praelongus-Whitestem pondweed-2016

Potamogeton praelongus-Whitestem pondweed-2017

Lemna minor-small duckweed-2017 (not sampled in 2016)

Spirodela polyrhiza-large duckweed-2017 (not sampled in 2016)

Appendix E. References

Aquatic Ecosystem Restoration Foundation. *Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat.* 2005. http://www.aquatics.org/aquatic_bmp.pdf

Aquatic Engineering. *2003 Deer Lake Aquatic Plant Management Technical Report.*

Barr. *Deer Lake Planning Grant Report. Polk County Wisconsin*. Prepared for the Deer Lake Improvement Association. Barr Engineering Company. June 1993.

Barr. *Deer Lake Planning Grant II Report. Polk County Wisconsin*. Prepared for the Deer Lake Improvement Association. Barr Engineering Company. January 1993.

Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass*. University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997.

Cattoor, Katie, Minnesota WDNR, Presentation Joint Minnesota Wisconsin Zebra Mussel Workshop. St. Croix Falls, WI. April 24, 2017.

Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000.

Deer Lake Conservancy. *Online Survey Results*. November 2009.

Ecological Integrity Service, LLC. *2007 Deer Lake Pre/Post Curly Leaf Pondweed (CLP) Treatment Summary.*

Ecological Integrity Service, LLC. *2008 Deer Lake Pre/Post Curly Leaf Pondweed (CLP) Treatment Monitoring Results.*

Ecological Integrity Service, LLC. *Aquatic Macrophyte Survey*. *Deer Lake Polk County, Wisconsin.* July 2010 and 2016.

Ecological Integrity Service, LLC. *Deer Lake CLP Treatment Report-2009.*

Ecological Integrity Service, LLC. *Herbicide Treatment Analysis for Potamogeton crispus-curly-leaf pondweed. Deer Lake, Polk County Wisconsin.* July 2010.

Ecological Integrity Service, LLC. *Herbicide Treatment Analysis on Potamogeton crispus.* August 2011.

Fieldseth, Eric and Jill Sweet. *Rapid Response to Zebra Mussel Infestation Lake Minnewashta Carver County, MN.* Minnehaha Creek Watershed District, December 30, 2016

JEO. *Qualitative and Quantitative Analysis of Identified Deer Lake Tributaries*. JEO Consulting Group, Inc. March 2003.

Harmony Environmental. Schieffer, Steve. *Aquatic Plant Survey. Deer Lake WBIC: 2619400 Polk County, WI. August 2006.*

Harmony Environmental. *Balsam Lake Aquatic Plant Management Plan. Polk County, Wisconsin.* October 2010.

Harmony Environmental. Schieffer, Steve. *Deer Lake Pre/Post Curly Leaf Pondweed Treatment Summary 2006.*

Madsen, John D. *Aquatic Plant Management Guidelines for Wisconsin Lakes.* March 22, 2003 Draft.

McComas, Steve. *Zebra Mussel Early Detection, Rapid Response, and Control Plan for Forest Lake, Washington Co, Minnesota.* April 2015.

Nault, Michelle. *Effects of Whole Lake Early Season 2,4-D on Eurasian Watermilfoil (Myriophyllum spicatum).* Presentation at Minnesota-Wisconsin Invasive Species Conference. St. Paul, Minnesota. November 2010.

Nichols, Stanley A. *Distribution and Habitat Descriptions of Wisconsin Lake Plants*. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison, Wisconsin. 1999.

Nichols, Stanley A. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications.* Journal of Lake and Reservoir Management 15 (2): 133-141. 1999.

North American Lake Management Society. *Managing Lakes and Reservoirs*. 2001.

Osgood, Dick. *Lake and Watershed Planning and Analysis. Deer Lake Management Plan.* February 2004.

Schieffer, Steve and Robert Bursik. *Macrophyte Survey. Deer Lake, Polk County Wisconsin.* Summer 2003.

Skogerboe, John. *Sampling of Herbicide Residuals Confirms Extended Exposure to Low Concentrations of 2,4-D and Triclopyr can Control Eurasian Watermilfoil.* Presentation at Minnesota-Wisconsin Invasive Species Conference. St. Paul, Minnesota. November 2010.

Skogerboe, John and Michael Netherland. *Draft Report Following April 2008 Aquatic Herbicide Treatments of Three Bays on Lake Minnetonka.* US Army Engineer Research and Development Center.

University of Wisconsin-Extension. *Citizen Lake Monitoring Manual*. Revised 2006.

University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft.

University of Wisconsin – Madison. Wisconsin State Herbarium. *WISFLORA: Wisconsin Vascular Plant Species.* www.botany.wisc.edu/wisflora/

U.S. Army Corps of Engineers. *Aquatic Plant Information System (APIS).* 2005.

Vilas County Land and Water Conservation Department. *Aquatic Invasive Species: A Guide for Proactive & Reactive Management.* 2006. http://wisconsinlakes.org/AboutLakes/PDFs/aisguidevc06.pdf

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

Wisconsin Department of Natural Resources. Eau Claire, WI. *Designation of Critical Habitat Areas. Bear Lake, Portage County.* March 2007.

Wisconsin Department of Natural Resources. *Fisheries in the Wisconsin Ceded Territory.* Last revised March 27, 2009.

Wisconsin Department of Natural Resources. *Natural Heritage Inventory County Data by Township: Polk County.* Last revised September 2010.

Wisconsin Department of Natural Resources. Northern Region. *Aquatic Plant Management Strategy.* Summer 2007.

Wisconsin Department of Natural Resources. *Reports and Data: Polk County*. December 2010. http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/.

Wisconsin Department of Natural Resources. Rick Cornelius, Mark Sundeen, and Kurt Roblek. *Deer Lake (Polk Co.) Integrated Sensitive Area Survey Report and Management Guidelines.* July 1992.

Wisconsin Department of Natural Resources. *The State of the St. Croix River Basin.* 2002.

Wisconsin Department of Natural Resources. *Tomahawk and Sand Bar Lake Aquatic Plant Management Plans. Bayfield County, WI.* July 2010 Draft.

Wisconsin Department of Natural Resources. *Walleye Bag Limits Revised on 255 Northern Lakes.* May 19, 2009.

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

Wisconsin Department of Natural Resources Bureau of Science Services. *Small-Scale Herbicide Treatments for Control of Invasive Aquatic Plants*. PUB-SS-1143. 2014.

Appendix F. Rapid Response for Early Detection of Aquatic Invasive Species

Definition: Aquatic Invasive Species (AIS) are non-native plant and animal species that can out-compete and overtake native species damaging native lake habitat and sometimes creating nuisance conditions. AIS currently in Deer Lake include curly leaf pondweed (CLP), zebra mussels (one individual identified), and Chinese mystery snail. Additional AIS threaten the lake and will be monitored throughout the lake by volunteers and consultants.

1. Maintain a contingency fund for rapid response to EWM or other invasive species (DLIA Board).

2. Conduct volunteer 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 or Board Contact.

3. Direct lake residents and visitors to contact the Environment Committee Chair or Board Contact if they see a plant or animal in the lake they suspect might be an AIS. Signs at the public boat landings, web pages, handouts at annual meeting, and newsletter articles will provide photos and descriptions of AIS that have a high likelihood of threatening Deer Lake, contact information, and instructions.

4. If a volunteer locates a likely AIS, instructions will request that the volunteer record the location of suspected AIS using GPS, if available, or mark the location with a small float. *Provide instructions on marking with float.* Note that cell phone applications are available to identify GPS point.

   If a plant:

   a. Take a digital photo of the plant in the setting where it was found (if possible). Then collect 5 to 10 intact specimens. Try to get the root system, and all leaves as well as seed heads and flowers when present. Place in a zip lock bag with no water. Place on ice and transport to refrigerator.
   b. Inform Environment Committee Chair or Board Contact.

   If an animal other than a fish:

   a. Take a digital photo of the animal in the setting where it was found (if possible). Then collect up to five specimens. Place in a jar with water; put on ice and transport to refrigerator. Transfer specimen to a jar filled with rubbing alcohol (except for Jellyfish – leave in water).

   b. Inform Environment Committee Chair or Board Contact.

5. The Environment Committee Chair or Board Contact will tentatively confirm identification of plant or animal AIS with Polk County LWRD or lake management consultant then,

   If a plant:

   a. Fill out plant incident form http://dnr.wi.gov/lakes/forms/3200-125-plantincident.pdf
   b. Contact WDNR staff, then deliver collected plants to the WDNR (810 W. Maple St., Spooner, WI 54801) as soon as possible (or to the location they specify).

   If an animal:

   a. Be sure the suspected invasive species has not been previously found on the waterbody
   b. If a zebra mussel report to WDNR and Polk County
   c. Fill out form 3200-126 – Aquatic Invasive Animal Incident Report

6. If identification is positive:
   a. Inform the person who reported the AIS and the board (Environment Committee Chair), who will then inform Polk County LWRD, and lake management consultant.

   b. Mark the location of AIS 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 AIS and provide appropriate means to avoid its spread (DLIA Board).

7. Determine the extent of the AIS introduction (DLIA in cooperation with Polk County LWRD and WDNR). Divers may be used. If small amounts of AIS are found during this assessment, divers may be directed to identify locations with GPS points and hand pull plants/remove animals 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 AIS 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 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 AIS to determine the effectiveness of the treatment and whether additional treatment is necessary (APM monitor, WNDR and/or other agency representatives).

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	Joan Leedy: 651-230-1177 joan@dyneusa.com
Board Contact	John Wright: 651-442-5598 skishop@trollhaugen.com

POLK COUNTY LAND AND WATER RESOURCES DEPARTMENT

AIS Coordinator	Jeremy Williamson: 715-485-8639 jeremyw@co.polk.wi.us
Director	Tim Ritten: 715-485-8631 TIMR@co.polk.wi.us

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Permits	Mark Sundeen: 715-635-4074 sundem@dnr.state.wi.us
Grants, EWM Identification and Notice	Alex Smith: 715-635-4124 Alex.Smith@wisconsin.gov

APM MONITOR

Ecological Integrity Services	Steve Schieffer: 715-554-1168 ecointegservice@gmail.com

APM COORDINATION

Harmony Environmental	Cheryl Clemens: 715-268-9992 harmonyenv@amerytel.net

HERBICIDE CONTRACTOR

Northern Aquatic Service	Dale Dressel ddressel@centurytel.net

DIVERS

Ecological Integrity Services	Steve Schieffer: 715-554-1168 ecointegservice@gmail.com

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

ADDITIONAL REFERENCES

WDNR websites on AIS
http://dnr.wi.gov/lakes/invasives/GoalsNew.aspx?show=emerging
http://dnr.wi.gov/lakes/invasives/AISDiscoveryCommunicationProtocol.pdf

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

Draft updated Oct 2006

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

Management Options for Aquatic Plants

Draft updated Oct 2006

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

Management Options for Aquatic Plants

Draft updated Oct 2006

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

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