Aquatic Plant Management Plan

Church Pine, Round (Wind) and Big Lakes

Polk County, Wisconsin
December 2010

Sponsored By

Church Pine, Round and Big Lakes Protection and Rehabilitation District

Prepared By

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Funded By

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Executive Summary

This Aquatic Plant Management Plan for Church Pine, Round and Big Lakes presents a strategy for managing aquatic plants through the year 2015 by protecting native plant populations, controlling curly leaf pondweed, and preventing establishment of invasive species. The plan includes data about the plant community, watershed, and water quality of the lakes. It also reviews a history of aquatic plant management on the lakes.

An aquatic plant point intercept survey and curly leaf pondweed bed mapping was completed for the lakes in 2009. The aquatic plant surveys found that the lakes have healthy, abundant, and diverse plant communities. Native plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of non-native invasive plants – all critical functions for the lake.

Plants grow at greater depths as water clarity increases from Big to Round to Church Pine Lakes. Plant diversity also increases in the lakes in the same order. Two aquatic invasive plants are found on Big and Round Lakes in the 2009 survey: curly leaf pondweed and purple loosestrife, with growth heaviest for both on Big Lake. Control efforts are recommended for both of these plants species along with prevention efforts against establishment of Eurasian water milfoil.

This Aquatic Plant Management Plan, developed with input from an advisory committee including lake property owners, will help the Church Pine, Round, and Big Lakes Protection and Rehabilitation District implement methods to meet plan aquatic plant management goals. The implementation plan describes the actions that will be taken toward achieving these goals.

A special thank you is extended to the Aquatic Plant Management Advisory Committee for assistance with plan development. The committee has offered to stay on in an advisory capacity as the plan is implemented. The board will take official action to establish the committee on a more permanent basis. The committee will help to review potential changes in aquatic plant management and develop a strategy for addressing runoff that contributes nutrients to the lakes.

Plan Goals

1. Prevent introduction of aquatic invasive species and pursue any new introductions aggressively.
2. Reduce the population and spread of curly leaf pondweed, purple loosestrife, and other invasive aquatic plants.
3. Maintain navigable routes for boating.
4. Preserve our diverse native aquatic plant community.
5. Reduce runoff of nutrients and sediment from the lakes' watershed.
6. Educate the public regarding aquatic plant management.

Introduction

This Aquatic Plant Management Plan is sponsored by the Church Pine, Round, and Big Lakes Protection and Rehabilitation District (Lake District). The planning project is funded by a Wisconsin Department of Natural Resources Aquatic Invasive Species Planning and Education grant and the Lake District.

The plan presents a strategy for managing aquatic plants by protecting native plant populations, controlling curly leaf pondweed, and preventing the establishment of additional invasive species. The plan includes data about the plant community, watershed, and water quality of the lakes. Based on this data and public input, goals and strategies for the sound management of aquatic plants in the lakes and river are presented. This plan will guide the Lake District and the Wisconsin Department of Natural Resources in aquatic plant management for project lakes over the next five years (from 2011 through 2015).

Public Input for Plan Development

The Aquatic Plant Management (APM) Advisory Committee provided input for the development of this plan. The APM Advisory Committee met four times. At the first meeting June 12, 2010, the committee reviewed aquatic plant management planning requirements, plant survey results, and discussed aquatic plant management concerns. At a second meeting June 26, 2010 and third meeting July 17, 2010, the committee reviewed aquatic plant management efforts to date, drafted goals, and developed objectives and action steps. The action steps were finalized at a fourth meeting July 29, 2010. The APM Advisory Committee concerns are reflected in the goals and objectives for aquatic plant management in this plan.

The BLPRD board announced the availability of the draft Aquatic Plant Management Plan for review with a mailing to all lake residents (along with the annual meeting notice) and a public notice in the Osceola Sun in early August 2010. Copies of the plan were available to the public on the Lake District web site: bigroundpine.com. Hard copies of the draft plan were available at the Horse Creek, Big Lake, and Nye Stores. Comments were accepted through August 28th. The plan was reviewed at the August 28 Lake District meeting with 64 lake residents in attendance. The lake district members approved the plan budget at this meeting.

Resident Concerns

The APM Advisory Committee expressed a variety of concerns that are reflected in objectives for plan development and in the goals for aquatic plant management in this plan. Management concerns ranged from being able to respond to resident desire to remove nuisance aquatic plants that impede navigation, to prevention of invasive species establishment and spread, to maintaining a natural lake environment and fishery.

Lake Information

The Lakes

The project area is in southwestern Polk County, Wisconsin in the towns of Alden and Garfield. Project lakes include Church Pine Lake (WBIC: 2616100), Round Lake (sometimes mapped and referred to as Wind Lake) (WBIC: 2616000), and Big Lake (WBIC: 2615900). Church Pine Lake is a 107-acre lake with a maximum depth of 45 feet. Round Lake is a 38-acre lake with a maximum depth of over 24 feet[2]. Big Lake is a 259-acre lake with a maximum depth of 24 feet. Development around the lakes is moderate to heavy with much of the lakeshore developed for residential use with native vegetation removed.

Water flows from Church Pine, to Round and then to Big Lake. North Creek flows into the north end of Big Lake and Forest Creek flows from Big Lake on its west side. A dam on Forest Creek regulates the water levels in Big Lake between an established legal level between 96.5 and 95.5 feet. A timber dam was first constructed ¼ mile from the Big Lake outlet on this tributary in 1883.[3]

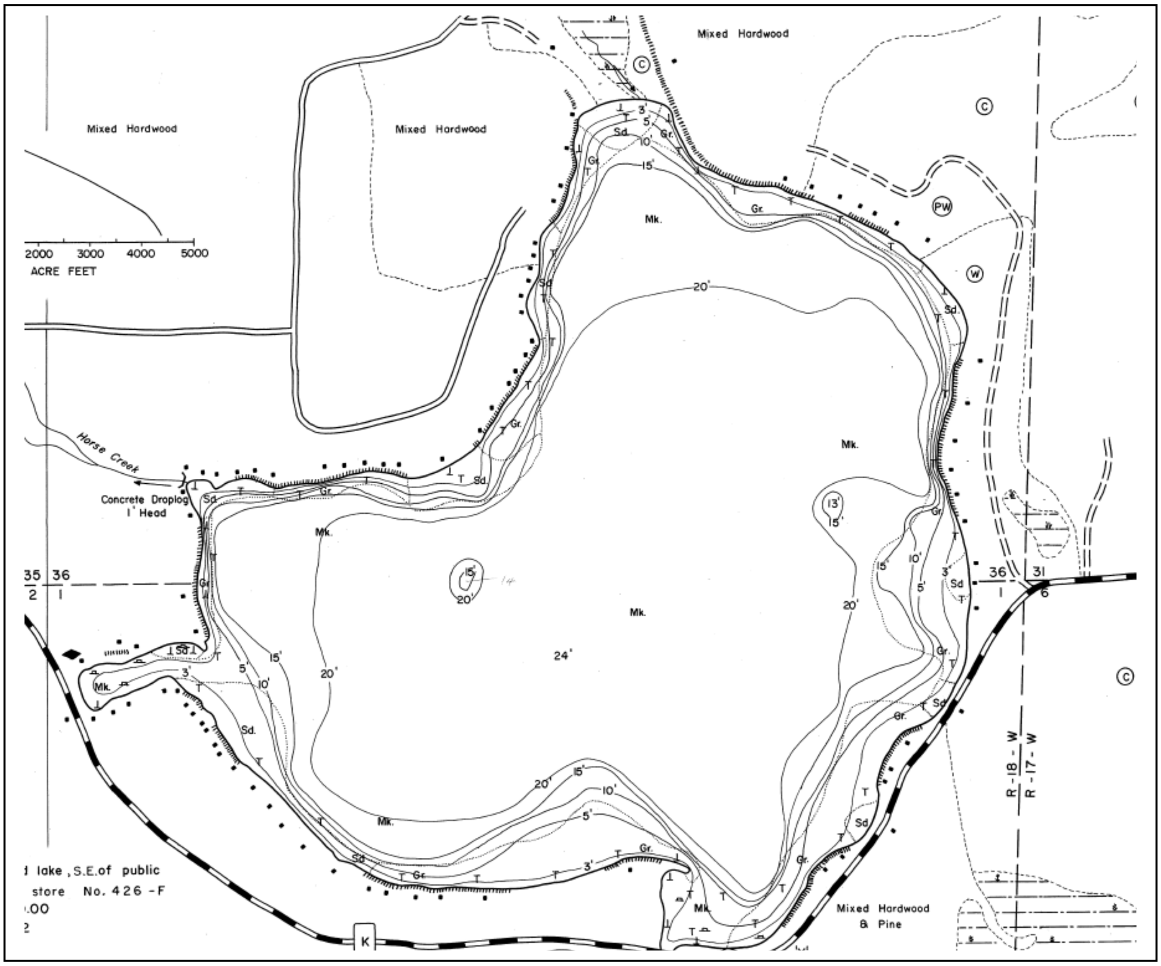
The maximum depth to which plants grow (the littoral zone) varies in project lakes. The littoral zone reached a depth of almost 26 feet in Church Pine Lake, 21 feet in Round Lake, and 16 feet in Big Lake. Table 1 summarizes information about project lakes.

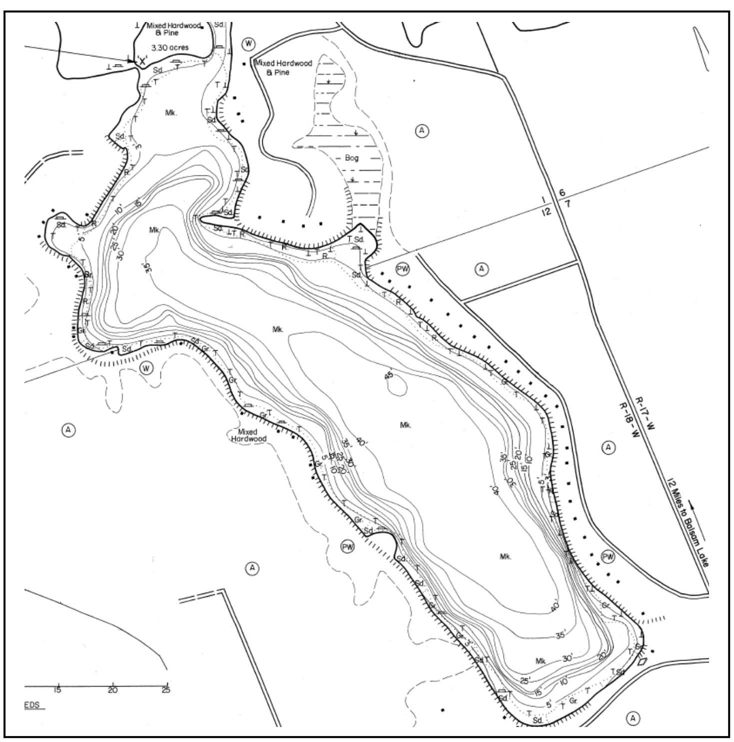
Table 1. Lake Information

	Church Pine	Round (Wind)	Big
Size (acres)	107	38	259
Mean depth (feet)	23		17
Maximum depth (feet)	45	24+	24
Littoral zone depth (feet)	25.7	21.1	16
Average summer secchi depth 2008 (feet)	15.75	9.75	6.75

A lake depth map is found on the following page as Figure 1. Boat landings are indicated with dot on the lake map in Figure 2.

[2] Although listed on Wisconsin DNR Lake Maps as 7 feet deep, the maximum depth recorded during the plant survey was in excess of 24 feet.
[3] Bigroundpine.com/history





LAKE BOTTOM SYMBOLS

P. Peat	Gr. Gravel	Stumps & Snags
Mk. Muck	R. Rubble	
C. Clay	Br. Bedrock	
M. Marl	T Submergent vegetation	
Sd. Sand	⊥ Emergent vegetation	
St. Silt	Floating vegetation	

Figure 1. Big Lake and Church Pine Lake Contour Maps from DNR Lake Maps 1967

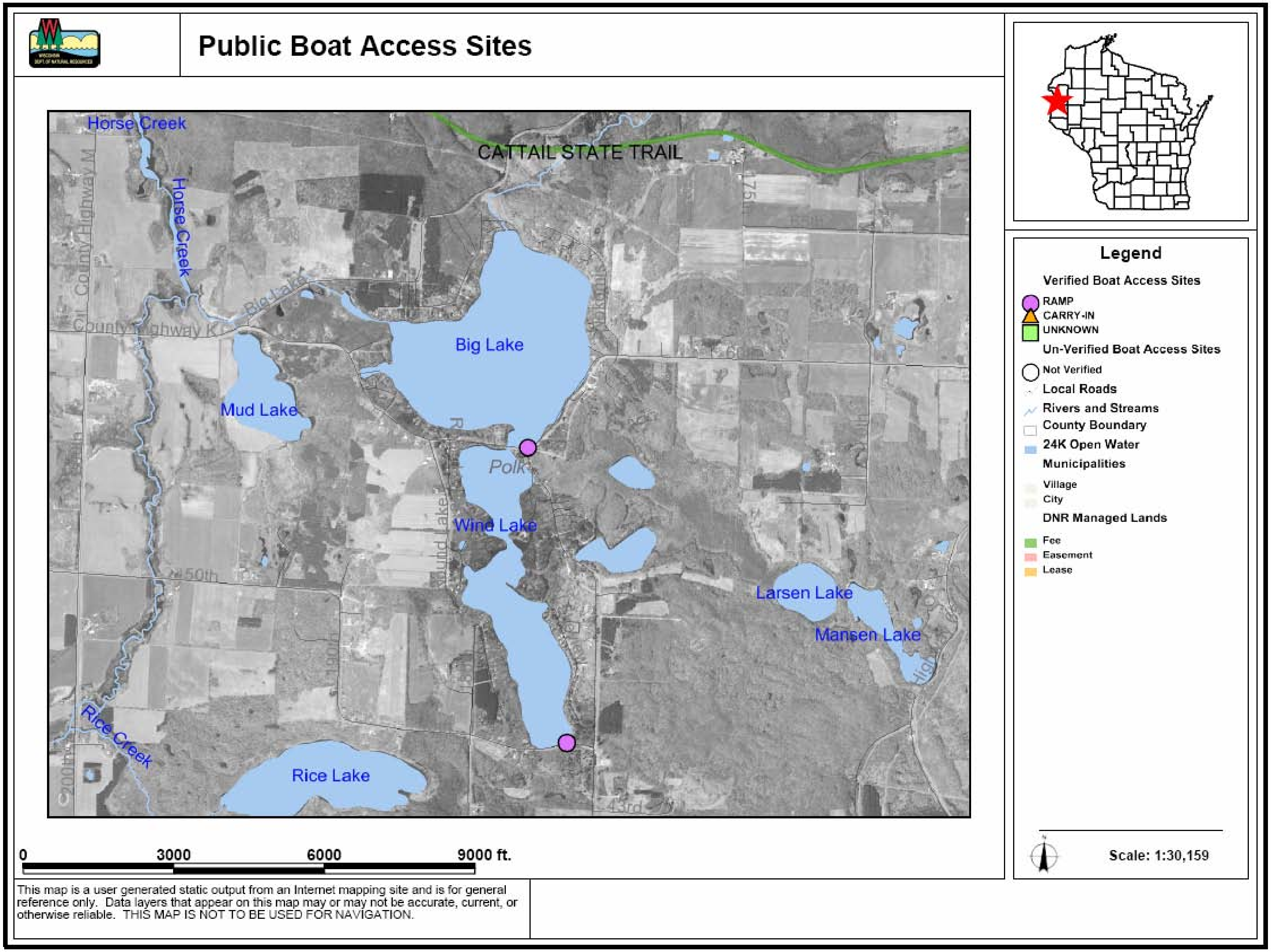


Figure 2. Project Lakes Boat Access Sites

Water Quality

Water quality is frequently reported by the trophic state or nutrient level of a 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.[3] TSI values range from 0 – 110. Lakes with TSI values greater than 50 are considered eutrophic. Those with values in the 40 to 50 range are mesotrophic. Lakes with TSI values below 40 are considered oligotrophic. Church Pine is classified as oligotrophic, Round Lake as mesotrophic, and Big Lake is a eutrophic lake based on 2008 chlorophyll data.

Citizen lake monitoring volunteers have collected data from the lakes almost annually since 1986. Data from 2009 is not available. There is a data collection location established for each lake.

Results from 2008 are available from the WDNR website. July and August results are reported in Table 2 below. The parameters sampled included water clarity, dissolved oxygen, total phosphorus, and chlorophyll. Trophic State Index classifications were determined based on the chlorophyll values. Lakes that have more than 20 µg/l of total phosphorus may experience noticeable algae blooms.

Table 2. Citizen Lake Monitoring Results, July and August 2008[4]

	Church Pine	Round (Wind)	Big
Number of samples	2	2	2
Secchi Depth (ft)	15.75	9.75	6.75
Total Phosphorus (µg/l)	11.5	21	28
Chlorphyll (µg/l)	2.1	6.5	14.4
Trophic State Index (TSI)	39.5	48.5	52.5
TSI Classification (based on Chl.)	Oligotrophic	Mesotrophic	Eutrophic

[3] TSI = 60 – 14.41 (ln * Sechhi depth in meters) and TSI = (9.81) (ln Chl a + 30.6).
[4] *Reports and Data: Polk County*. WDNR website. December 2009. http://www.dnr.state.wi.us/lakes/CLMN/reportsanddata/

Figure 3 illustrates the Secchi depth averages for Church Pine Lake. Figure 4 graphs the Trophic State Index for Church Pine Lake, based upon Secchi depth, chlorophyll, and total phosphorus results from 1986 to 2008. Figures 5 and 6 depict Round Lake's Secchi depth and Trophic State Index, respectively. Figures 7 and 8 show Big Lake results.

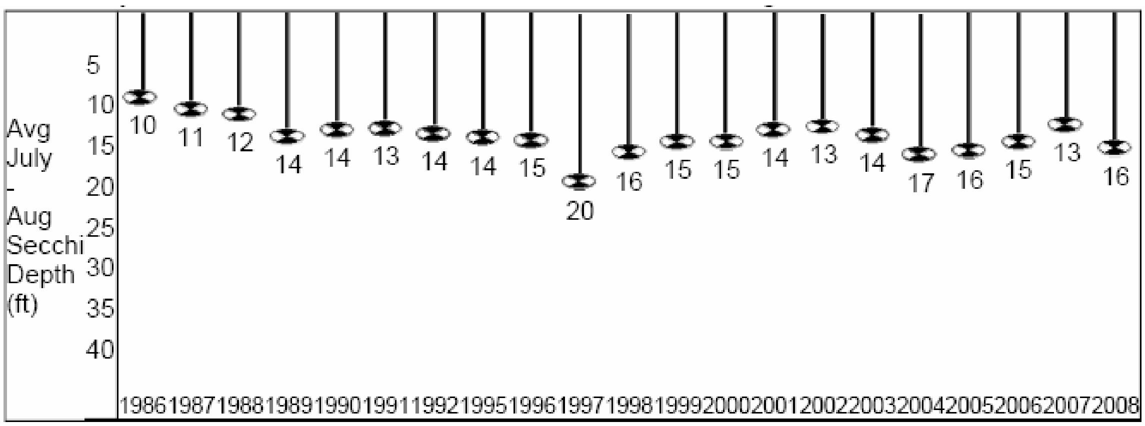


Figure 3. Church Pine Summer Average Secchi Depths 1986-2008

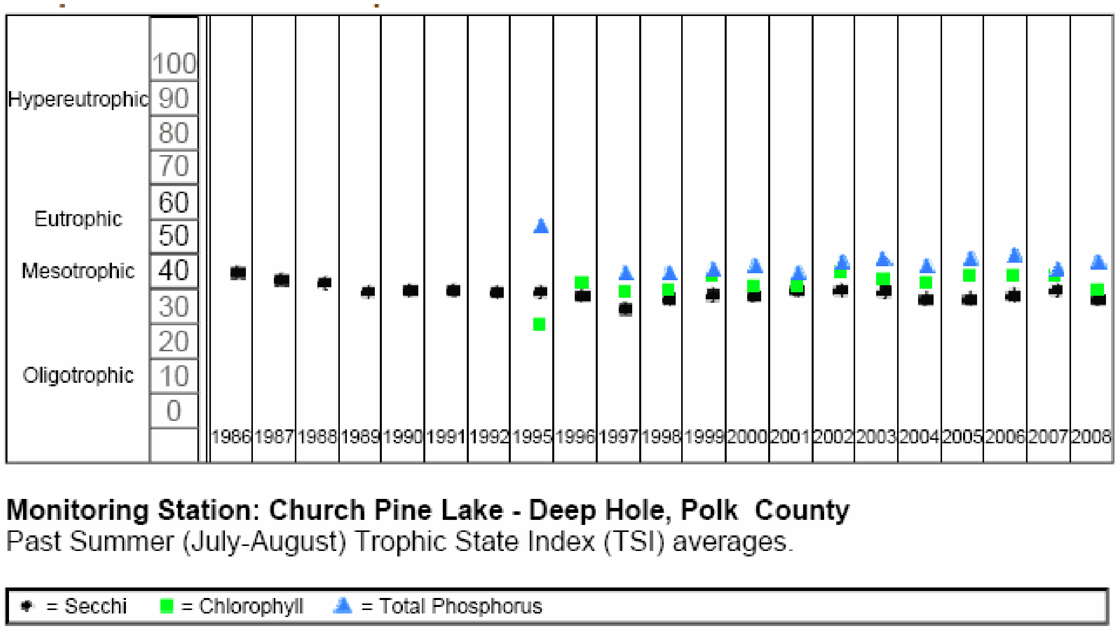


Figure 4. Church Pine Trophic State Index 1986-2008

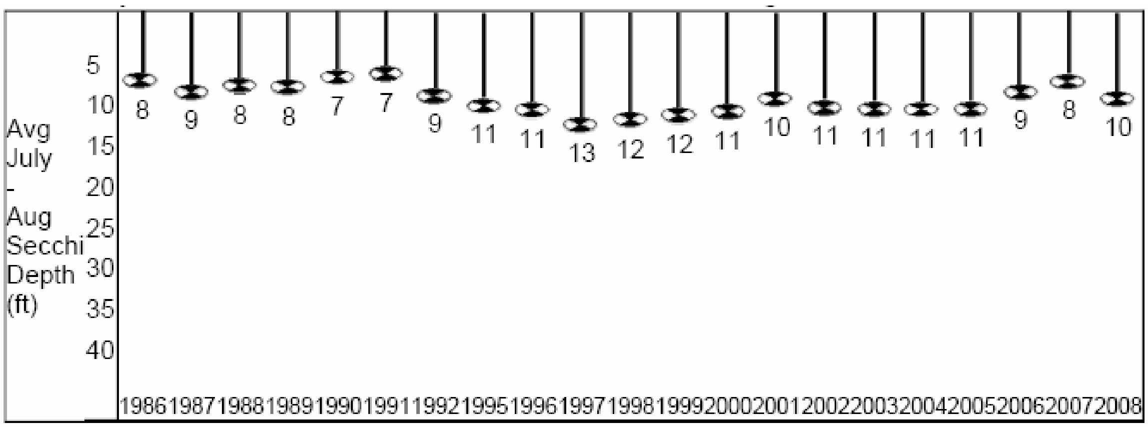


Figure 5. Round Summer Average Secchi Depths 1986-2008

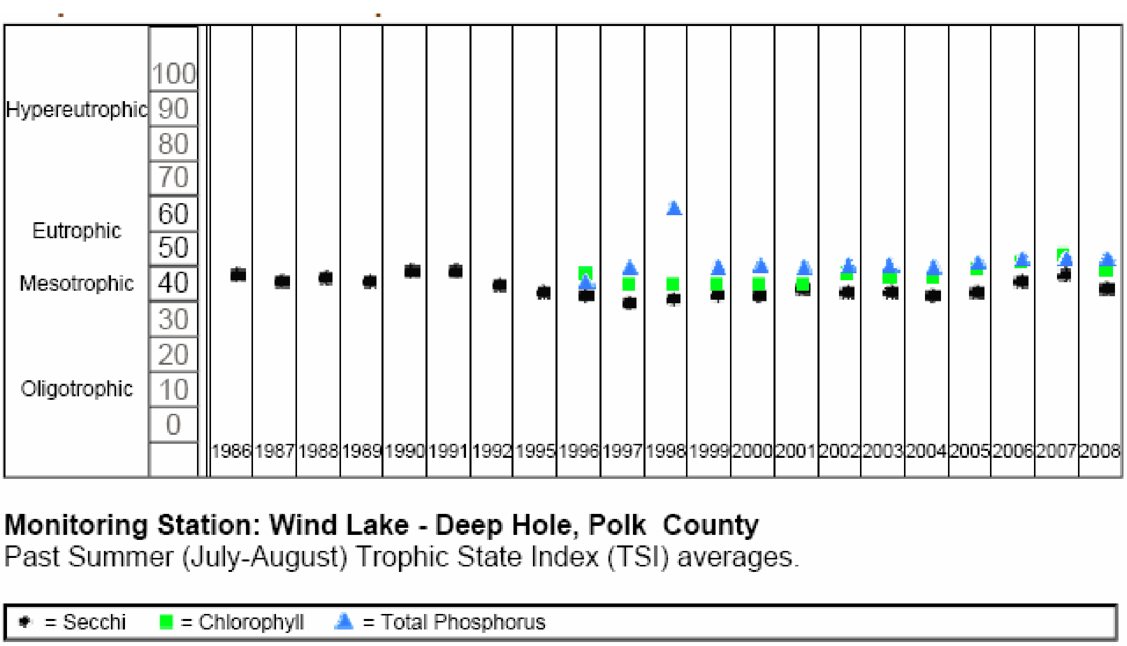


Figure 6. Round Trophic State Index 1986-2008

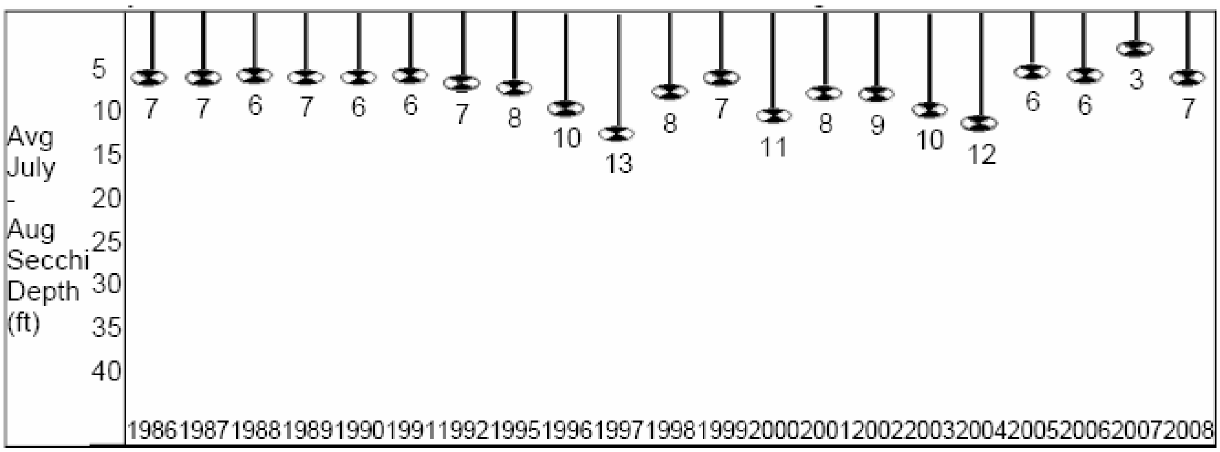


Figure 7. Big Lake Summer Average Secchi Depths 1986-2008

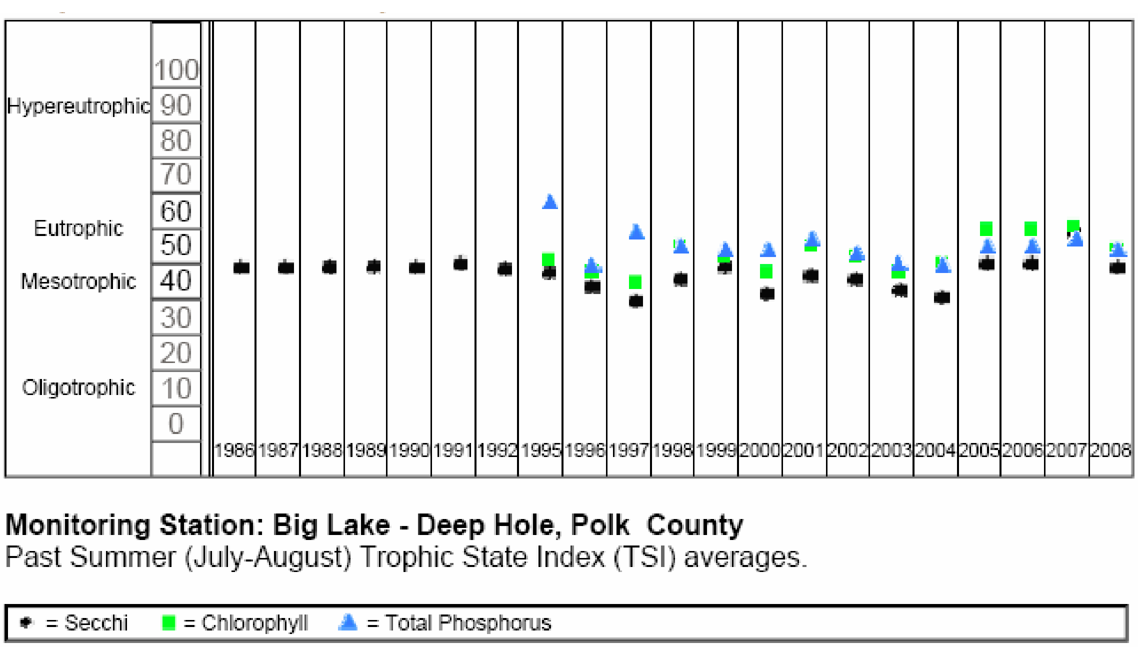


Figure 8. Big Lake Trophic State Index 1986-2008

Water Quality Studies

Water and total-phosphorus budgets assist in understanding nutrient and water dynamics that influence algae and aquatic plant growth. Water and total-phosphorus budgets were assessed in 1987. The 1987 study concluded that water quality problems in Big Lake primarily came from excessive phosphorus loading from North Creek. The study concludes that the water quality of Church Pine and Round Lakes was not negatively influenced by their watersheds. The study estimated water retention times as follows: Church Pine Lake: 7.8 years, Round Lake: 2.9 years and Big Lake 1.9 years. Declines in late summer water quality on Round and Big Lakes in 1985 were attributed to previous herbicide applications.

Water quality of the lakes was also analyzed in 1999 in the *Horse Creek Priority Watershed Water Resources Appraisal Report*. The Department of Natural Resources completed this report in preparation for the priority watershed project discussed later in this plan. The water quality appraisal used land cover and lake data to estimate the contributions of phosphorus and resulting water clarity impacts to the lakes. This region of Polk County has high levels of phosphorus in groundwater, and lakeshore wells were tested to assess the significance of phosphorus in groundwater. Results of phosphorus loading estimates are included in the subwatershed discussion for each lake.

Phosphorus from Watershed Runoff

Phosphorus is a primary nutrient essential for healthy plant and algae growth. However, increased phosphorus levels speed up the process of eutrophication - where excess nutrients stimulate plant growth and cause extensive algae blooms. Prolific plant growth may lower dissolved oxygen levels when plants decay and consume oxygen.

A 2002 State of the St. Croix River Basin identified three key priorities for the basin that apply to the project area, all of which are associated with water quality:[5]

1. Protection and restoration of shoreland habitat
2. Control of nonpoint source runoff contamination of surface waters
3. Restoration of grasslands, prairies, and wetlands to protect soil and water quality and to enhance wildlife habitat

Phosphorus loading in project lakes is the result of non-point sources. Non-point sources include rain falling on the lake and runoff from within the watershed. Phosphorus can be dissolved in the runoff water as well as carried in soil particles that erode from bare soil.

The amount of phosphorus in runoff from the watershed is determined by land use in the lake's watershed along with watershed soils and topography. Shoreland areas are particularly important areas of a lake's watershed. Agricultural and residential development tends to increase runoff and the amount of phosphorus that makes its way to the lake as a result. Land maintained in a natural, vegetated state, on the other hand, is beneficial to soil and water quality. Runoff from agricultural land is more likely to carry

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

high levels of phosphorus to the lake because of lack of ground cover and fertilizer use. With natural vegetation, soil erosion is reduced and fewer pollutants are able to enter and impact the lake via runoff. Tall vegetation slows the flow of water, while forest groundcover and fallen leaves allow runoff water to soak into the soil.

Watershed Description

The lakes' subwatersheds or drainage areas are within the Horse Creek Watershed. Information about the watersheds is available in the *Nonpoint Source Control Plan for the Horse Creek Priority Watershed Project*. This project, implemented by the Polk County Land and Water Resources Department and supported by the Department of Natural Resources and Department of Agriculture, Trade, and Consumer Protection, ended in 2009. The watershed plan included a land use classification based on 1992 and 1993 aerial photos. These are the subwatershed land use percentages reported on following pages. Watershed phosphorus loading is reported from the water quality appraisal completed by the Department of Natural Resources.

The water quality appraisal emphasized the importance of preserving and restoring buffers of native shoreline plants and aquatic plants to preserve or improve water quality. It also cautioned that development of the watershed open space could lead to increased nutrient loading to the lakes.

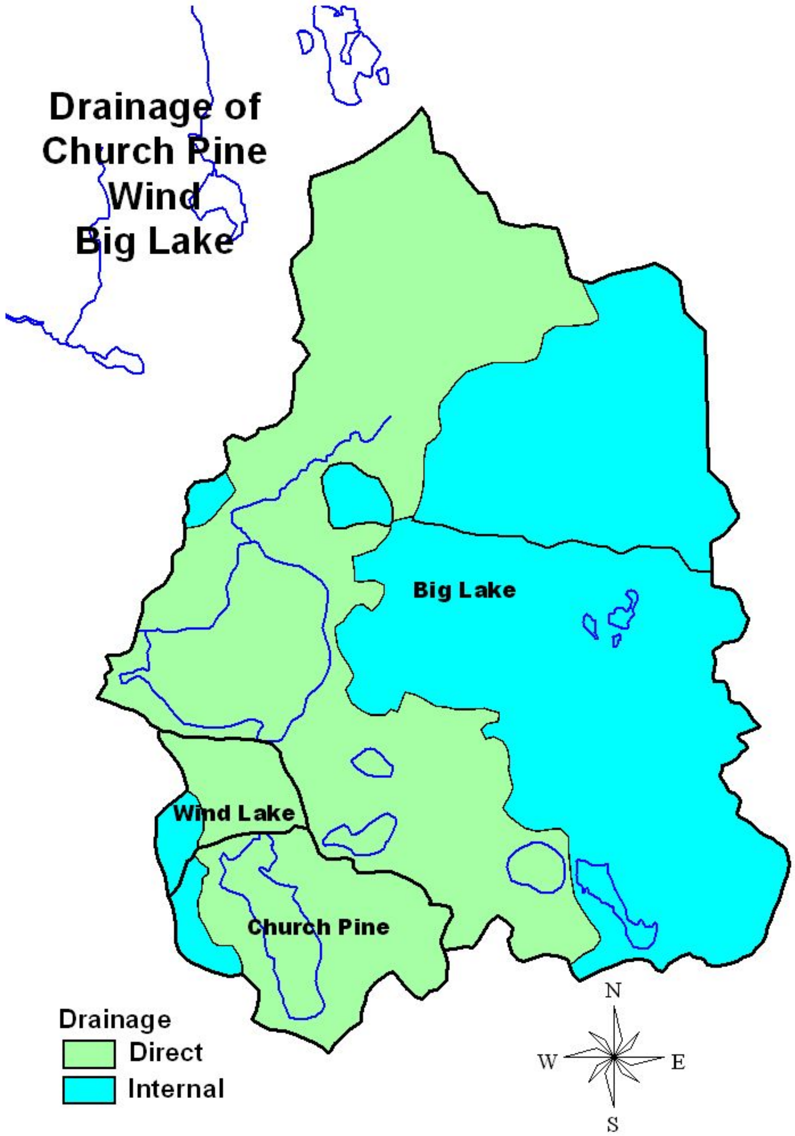


Figure 9. Project Area Subwatersheds

Church Pine Lake Subwatershed

The Church Pine Lake subwatershed is about 416 acres with about 376 acres of this draining directly to the lake. Remaining internally drained areas drain to isolated wetlands or closed depressions. Land use in the direct drainage area is 46% open space (wetlands, woodland, and grasslands), 24% the lake itself, 12% lakeshore residential, 13% rural residential, and 5% agricultural.

Nutrient modeling conducted for the water quality appraisal indicated that approximately 55.5% of the total phosphorus load is coming from developed land including 21% from cropland, 22% from residential development (lakeshore & rural), and 13% from septic systems. Groundwater phosphorus accounts for about 14% of the total phosphorus load, but there is no practical means to remove phosphorus from groundwater. Rainfall brings 17% of the phosphorus to the lake each year.

Round Lake Subwatershed

The Round Lake subwatershed is approximately 144 acres with about 111 acres draining directly to the lake. Land use in the direct drainage area is 29% open space, 12% rural residential, and 11% lakeshore residential. The lake itself makes up 39% of the watershed area. Cropland covers 9% of the subwatershed.

Nutrient modeling conducted for the water quality appraisal indicated that approximately 58% of the total phosphorus (P) load is coming from developed land including about 17% from cropland, 20% from septic systems, and 17% from residential land, and 4% from flow from Church Pine Lake. Groundwater phosphorus accounts for almost 16% of the total phosphorus budget but there is no practical means to remove phosphorus from groundwater. Rainfall on the lake brings 18% of the annual P load.

Big Lake Subwatershed

The Big Lake subwatershed is about 3,737 acres with 1,775 acres of this draining directly to the lake. A majority of the subwatershed is internally drained, draining first to isolated wetlands and closed depressions. Land use is the direct drainage area is 50% open space (wetlands, woodlands, and grasslands) and 22% agricultural. The shoreline of Big Lake is mostly developed with homes making up over 5% of the subwatershed. Remaining land use includes the lake itself (18%) and rural residential lands (5%).

Nutrient modeling conducted for Big Lake indicated that approximately 49% of the total phosphorus load is coming from developed land including 31% of phosphorus coming from cropland and the remainder from residential land. This is the largest controllable source of phosphorus. Groundwater phosphorus accounts for 34% of the total P load, but there is no practical means to remove phosphorus from groundwater. Rainfall on the lake brings 7% of the phosphorus.

The watershed project also established water quality goals and phosphorus reduction objectives for agricultural lands. These are shown in Table 3. Most of the financial support was for practices to reduce runoff from agricultural land.

Table 3. Horse Creek Priority Watershed Goals and Objectives

Subwatershed/Lake	Water Quality Goals	Agricultural Phosphorus Reduction Objective
Church Pine Lake	Maintain and protect water quality Reestablish shoreline buffers	5%
Round Lake	Maintain and protect water quality Reestablish shoreline buffers Protect aquatic plant sensitive areas	5%
Big Lake	Reduce in-lake total phosphorus from 22 to 20 ppm Restore shoreline habitat Protect aquatic plant sensitive areas	10%

Horse Creek Priority Watershed Project Results

The Horse Creek Priority Watershed Project was a project of the Polk County Land and Water Resources Department supported by state Department of Natural Resources (DNR) and Department of Agriculture, Trade, and Consumer Protection (DATCP) funding. Representatives from project lakes provided input as part of the citizen's advisory committee that assisted with plan development. Discussion of the watershed project is included here because of the importance of watershed management for lake water quality.

The following projects were completed within the project lakes watersheds as part of the priority watershed project through 2009. More information about these projects is available from the Polk County Land and Water Resources Department.

Nutrient/Pest Management	316 acres
High Residue Management	39 acres
Manure Storage Abandonment	2 facilities
Rain Gardens	5 gardens
Critical Area Stabilization	2 areas
Shoreline Habitat Restoration	3.5 acres

Curly Leaf Pondweed Dieback

Curly leaf pondweed (*Potamageton crispus*), a non-native, invasive plant found extensively in Big Lake, is another potential source of phosphorus that may fuel algae growth in the lake. Previous studies have pointed to dieback of curly leaf pondweed as a source of increasing lake phosphorus levels and therefore algae growth during the growing season in some lakes. The potential for significant in-lake phosphorus increases from curly leaf pondweed (CLP) in Big Lake was assessed for this plan using a range of data from the literature and maps of curly leaf pondweed growth. Literature values provided a range of density measurements of CLP and the phosphorus content of CLP tissue samples. In 2009 there were 23 acres of curly leaf pondweed in beds with a density of at least 50% in Big Lake. An estimate of the phosphorus content of CLP from the literature is 0.3%.[6] A density of 40 g/m^2 yields an estimate of 25 pounds of phosphorus, and a density of 120 g/m^2 yields an estimate of 74 pounds. This assumes that all of the phosphorus from decaying CLP reaches the water column to fuel algae growth, and this may not be the case. Lake sediments may capture a substantial amount of phosphorus released from CLP.

Watershed estimates from the water quality appraisal for the Horse Creek Priority Watershed project reported a 1033 pound annual load for Big Lake in 1999 based on aerial photos of an unknown date. The water quality data used for the model analysis was from 1996-1998. Details of the phosphorus load prediction are shown in Table 4.

It is important to note that the 468 kilogram (1033 pound) load is modeled to include watershed loading, septic systems, and groundwater. These numbers are adjusted so that the model accurately “predicts” the in-lake phosphorus levels at the time of the study. Because phosphorus release from CLP was not counted, this amount can’t be added to the total phosphorus loading numbers.

If 1033 pounds of phosphorus is assumed to be the total loading to Big Lake, CLP might contribute from 2 to 7 percent of the annual phosphorus load. However, there are many unknowns related to these figures.
1) How accurate is the phosphorus loading estimate from 1999 for 2009? Land uses and phosphorus sources may have changed.
2) What is the percentage of phosphorus in CLP plant tissue in Big Lake? This varies by lake.
3) How much of the phosphorus in plant tissue reaches the water column?

Studies currently underway on nearby Lake Wapogasset and Bone Lake may shed additional light on the question of the loading rates of phosphorus from CLP dieback. An updated water quality and watershed analysis would aid in understanding the significance of the estimated phosphorus (P) loading rates for Big Lake.

Two lake studies developed detailed summer P budgets that assessed all P sources, including CLP decomposition. For Half Moon Lake in the city of Eau Claire, WI (125

[6] Study information compiled by Craig Roesler – Wisconsin DNR – Hayward.

acres, maximum depth of 13 feet), CLP decomposition was estimated to be 20% of total summer (June-August) P loading (James et al. 2002). In the year of the study, one third of CLP biomass had been removed by harvesting prior to senescence. Sediment P release for Half Moon Lake was estimated to be 42% of summer P loading.

For McGinnis Lake, CLP decomposition was estimated to be 5% of the summer (May-Sept) P load in the north lobe of the lake, and 65% of the summer P load in the south lobe of the lake (James et al. 2007).

Only a few cases were found where CLP was managed with the goal of improving lake water quality. None of them provided any clear evidence that this could be or was accomplished. It was usually not possible to clearly separate the effects of CLP P release from other complicating factors such as changes in the fish/zooplankton community, drawdowns, or P inputs from stormwater inflow and sediment phosphorus release.[7]

Table 4. Big Lake Phosphorus Loading Budget and Sources

SOURCE	**% OF ANNUAL PHOSPHORUS LOAD**	**ANNUAL P LOAD IN Kg**	**ANNUAL P LOAD IN LBS**
CROPLAND	30.7	143.6	316.6
SEPTIC SYSTEMS	3.1	14.5	32.0
FARMSTEAD	1	4.7	10.4
LAKESHORE RESIDENTIAL	4.3	20.1	44.3
BARNYARDS	7.8	36.4	80.2
RURAL RESIDENTIAL	2.8	13.1	28.9
GROUNDWATER PHOSPHORUS	33.8	160.8	354.5
GRASSLAND	3.6	16.8	37.0
LAKE SURFACE	6.7	31.4	69.2
WOODLAND	2.4	11.2	24.7
WETLANDS	2.1	9.8	21.6
Round Lake Outflow	1.26	5	13
Church Pine Lake Outflow	0.5	2.3	5.1
TOTAL =	99.5%	468.4 KG	1032.6 LBS

7 Study information compiled by Craig Roesler – Wisconsin DNR – Hayward.

Aquatic Habitats

Primary Human Use Areas

There are two boat landings in the project area. One is at the southern end of Church Pine Lake. The second is at the southern end of Big Lake along County Highway K. Big Lake attracts around 250 anglers for an annual fishing tournament. Proceeds go toward fish stocking.

Residential development is prevalent on the lake. Waterfront property owners and the general public utilize the lakes for a wide variety of activities including fishing, boating, swimming, and viewing wildlife.

Functions and Values of Native Aquatic Plants

Naturally occurring native plants are extremely beneficial to lakes. 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.

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.[8]

Protection against Invasive Species

Non-native invasive 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

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[8] Above paragraphs summarized from *Through the Looking Glass*. Borman et al. 1997.

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.[9]

Aquatic Invasive Species Status

Purple loosestrife (*Lythrum salicaria*) have been observed on Round and Big Lake, but not Church Pine Lake. Curly leaf pondweed (*Potamogeton crispus*) has been observed on all of the project lakes. Information about invasive species identification and control is found in Appendix A.

Purple Loosestrife

Annual meeting reports in 2006 and 2007 confirm that purple loosestrife occurs on Big Lake in several areas and is present in fewer areas on Round Lake. None is reported on Church Pine Lake. There is also mention of beetles brought in a few years prior to 2006 by DNR, and there is an expectation that more will be introduced.

Curly Leaf Pondweed

Curly leaf pondweed is found in many locations around Big Lake and in a few locations in Round Lake. It was found in a 1997 survey in small amounts in Church Pine Lake.

Eurasian Water Milfoil

There is a risk that Eurasian water milfoil and other aquatic invasive species may become established in project lakes.
As described previously, there are two boat landings on the lake. The biggest threat of invasion by Eurasian water milfoil comes from anglers who travel from the Twin Cities, Minnesota metropolitan area, and access the lake at the boat landings. With Eurasian water milfoil present in many urban Twin Cities lakes, the danger of transporting plant fragments on boats and motors is very real. According to the Minnesota Sea Grant Office:

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

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

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

Sensitive Areas

The Wisconsin Department of Natural Resources (DNR) has completed sensitive area surveys to designate areas within aquatic plant communities that provide important habitat for game fish, forage fish, macroinvertebrates, and wildlife, as well as important shoreline stabilization functions. The DNR has transitioned to designations of *critical habitat areas* that include both *sensitive areas* and *public rights features*.

Sensitive areas offer critical or unique fish and wildlife habitat (including seasonal or life stage requirements) or offer water quality or erosion control benefits to the area (Administrative code 107.05(3)(1)(1)). The Wisconsin Department of Natural Resources is given the authority for the identification and protection of sensitive areas of the lakes. *Public rights features* are areas that fulfill the right of the public for navigation, quality and quantity of water, fishing, swimming, or natural scenic beauty.

The *critical habitat area* designation provides a holistic approach to ecosystem assessment and protection of those areas within a lake that are most important for preserving the very character and qualities of the lake. Protecting these *critical habitat areas* requires the protection of shoreline and in-lake habitat. The *critical habitat area* designation provides a framework for management decisions that impact the ecosystem of the lake.

Special Lake Designations

The map titled *Critical Habitat Areas* shows Sensitive Areas for Big Lake and Church Pine Lake. It also indicates that Big Lake and Round Lake are also classified as Areas of Special Natural Resource Interest (ASNRI).

The Department of Natural Resources completed Sensitive Areas Designations in September of 1998. Purple loosestrife was identified in Big Lake sensitive areas A, C, and D. Curly leaf pondweed was found in Big Lake sensitive area C.

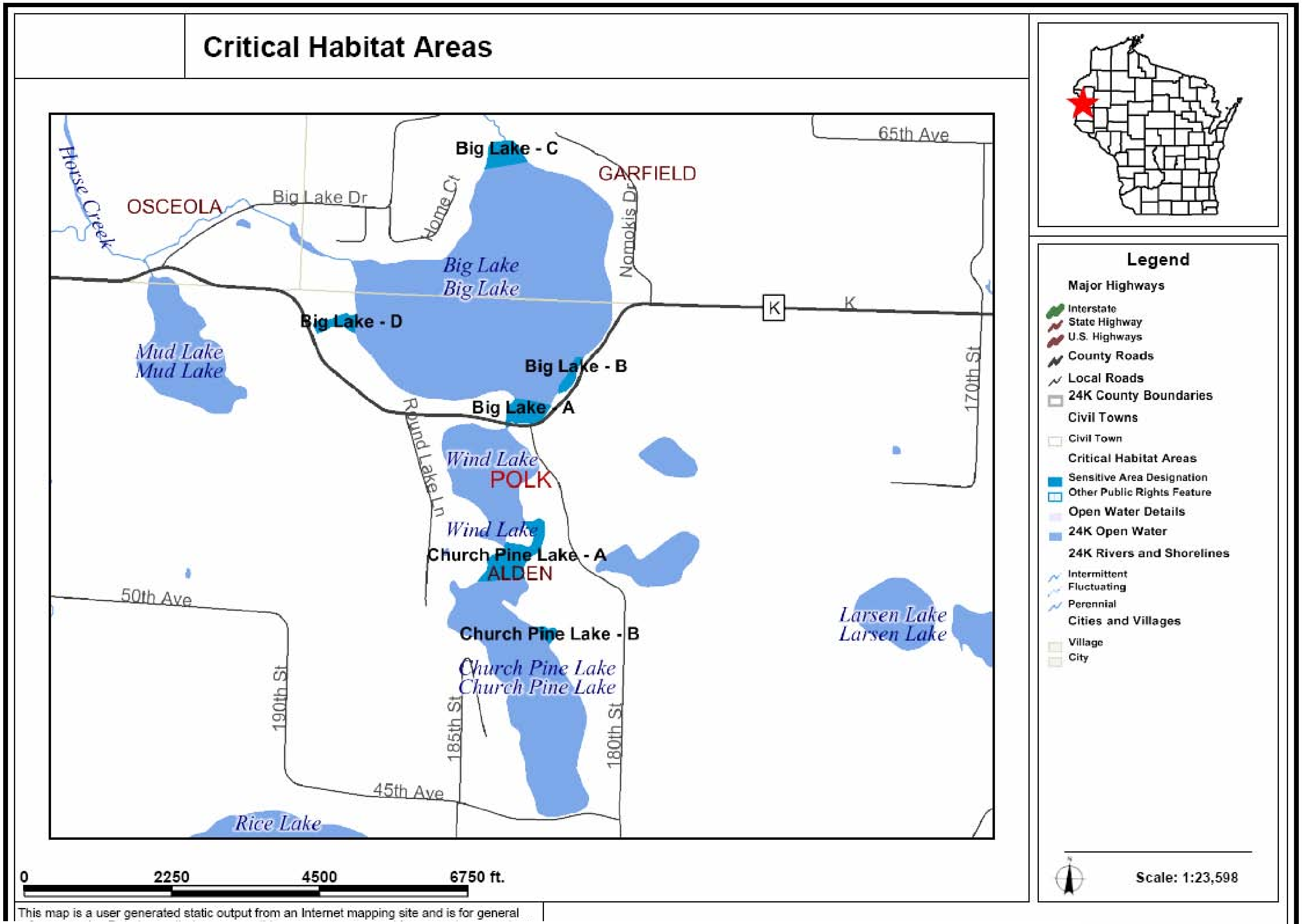

Figure 10. Sensitive Area/Critical Habitat Area Designations

Sensitive/Critical Habitat Area Recommendations

General

- Preserve/restore shoreline buffers at least 35 feet deep
- Limit aquatic vegetation removal to no more than 25 foot channels – hand pulling is the preferred method for management followed by harvesting and herbicide use
- Leave woody debris in place
- Prevent construction site erosion
- Limit rip rap for shoreline stabilization
- Strictly enforce zoning ordinances
- Control exotic species such as purple loosestrife

Church Pine

- Use conservation easements, deed restrictions or zoning to protect sensitive areas

Resource values of each lake sensitive area were each described in the same way: provides bass, panfish, and forage species habitat; northern spawning and nursery areas; and wildlife habitat. All major types of plants: emergent, floating, and submergent were recorded in each sensitive area.

Rare and Endangered Species Habitat

The Natural Heritage Inventory map of Polk County indicates occurrences of aquatic listed special concern species in the sections where project lakes are located. A species list is available to the public only by Town and Range. WDNR and federal regulations regarding special concern species range from full protection to no protection. The current categories and their respective level of protection are as follows: **SC/P** = fully protected, **SC/N** = no laws regulating use, possession, or harvesting

T32N R18W included the following aquatic species:

Cardamine pratensis	Cuckoo Flowers	Special Concern
Fundulus diaphanous	Banded Killifish	Special Concern/N
Senecio congestus	Marsh Ragwort	Special Concern

T 33N R18W also has the Banded Killifish present.

Lakes Fishery

The three lake chain has a naturally reproducing largemouth bass and pan fishery (bluegill, black crappie, pumpkinseed, and yellow perch). In addition, a stocked northern pike and walleye fishery is present. Northern pike are stocked by the WDNR during alternate years to provide a low density top predator to improve the overall angling experience.

Continued stocking will be necessary to maintain viable populations of both northern pike and walleye. Walleye were recently stocked by the Lake District and have survived to provide a fishable population at a low level. The main limiting factor likely affecting walleye is predation by other fishes. Northern pike reproduction is limited because of the lack of spawning habitat. Northern pike prefer to spawn on shallow-flooded emergent vegetation in the spring, and this is limited in the chain. Any efforts to restore potential northern pike spawning habitat would be a valuable management effort.

The Lake District also stocked brown trout in Church Pine in 2009 on an experimental basis. It is not known if the stocking was successful.

Table 5. Spawning Temperatures and Substrate Needs

Fish species[10]	**Spawning Temp in ^{o}F**	**Spawning substrates**
Black crappie	Upper 50's to lower 60's	Build nests in 1-6 feet on hard bottom
Bluegill, Largemouth bass and Pumpkin seed	Mid 60's to lower 70's	Build nests in less than 3 feet on hard bottom
Northern Pike	Upper 30's to mid 40's soon after ice-out	Broadcast eggs onto vegetation (eggs attach)
Smallmouth Bass	Usually between 62 and 64 but recorded as low as 53	Nests in circular, clean gravel
Walleye	Low 40's to 50 degrees.	Gravel/rocky shoals with moving or windswept water 1-6 feet deep
Yellow perch	Mid 40's to lower 50's	Broadcast eggs in submergent vegetation or large woody debris

Table 6. Fish Species of Project Lakes[11]

Lake	Northern Pike	Walleye	Largemouth Bass	Panfish
Church Pine	P	P	C	C
Round	P	P	C	C
Big	P	P	C	P

A = Abundant, P = Present, C = Common

[10] Information from Heath Benike. Wisconsin DNR Fisheries Biologist. 2006
[11] DNR Lakes Book. 2009.

Plant Community

Aquatic Plant Survey Results

An aquatic plant inventory was completed for project lakes in August of 2009, according to the WDNR-specified point intercept method. In late June a curly leaf pondweed (CLP) survey was conducted to identify the locations of this aquatic invasive species. Since CLP typically dies in early July, CLP surveys are usually done in early June while the CLP is robust.

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 Big Lake Churchpine Lake Wind Lake Polk County, Wisconsin 2009* conducted and written by Steve Schieffer of Ecological Integrity Services. Round Lake is consistently referred to as Wind Lake in project results and maps.

Using a standard formula based on the 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 322 points for Church Pine Lake, 145 points for Round Lake, and 410 points for Big Lake. The results of the survey are discussed separately for each lake.

Church Pine Lake

Figure 11 shows the distribution of sampling points for Church Pine Lake.

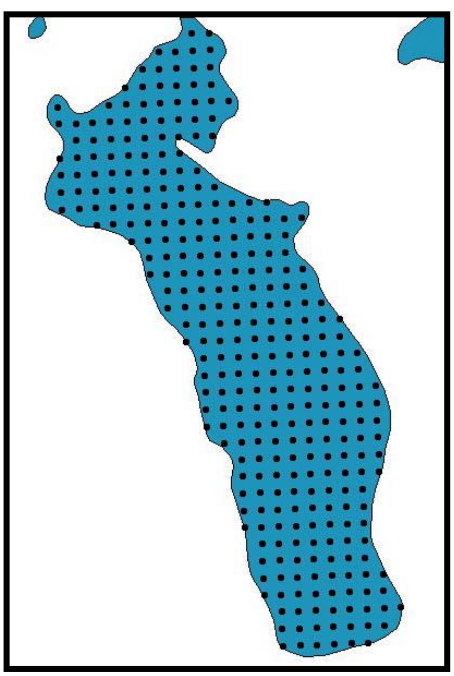

Figure 11. Church Pine Lake Sampling Point Grid

Vegetation was found at 132 of the 322 sampling points (about 43% of the lake). The greatest depth with plants – the limit of the littoral zone – was 25.7 feet. The littoral zone includes the depths at which plants can grow. Over 92% of the lake littoral zone had plants present. This very deep littoral zone indicates that Church Pine Lake has very high water clarity throughout the summer, which results in excellent light penetration for plant growth.

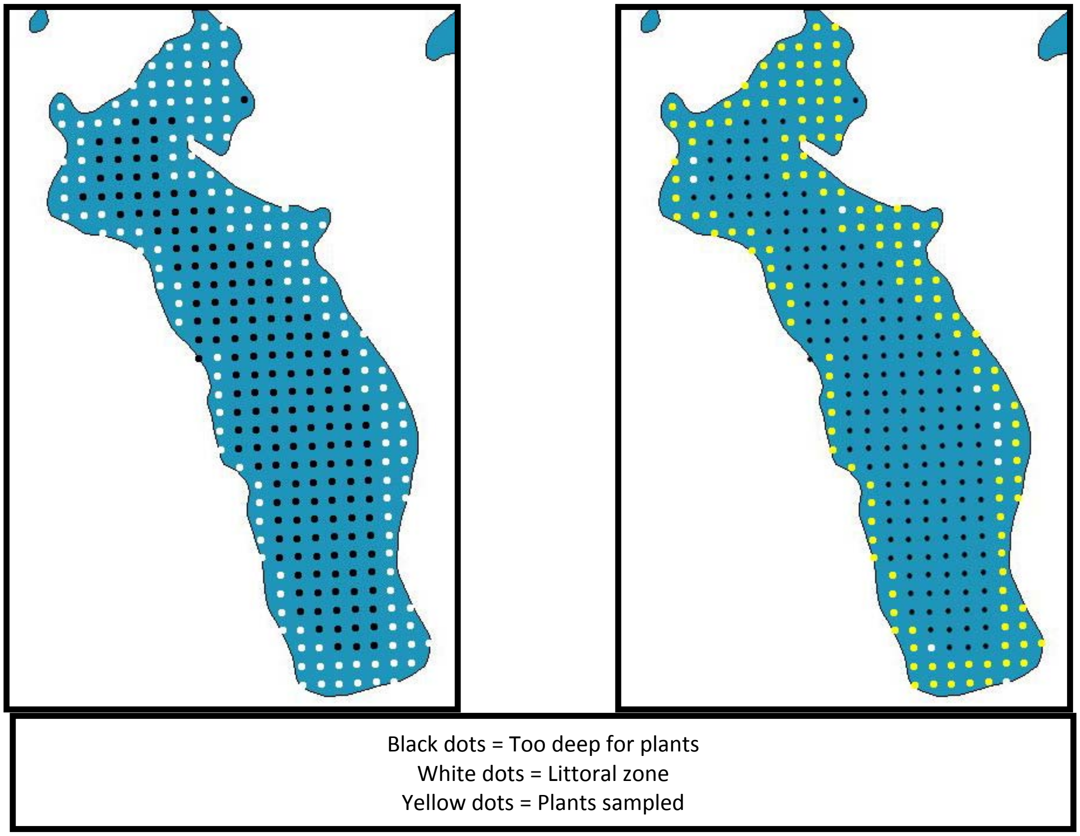

Figure 12. Church Pine Lake Littoral Zone

Some of the more shallow areas of the lake had fairly dense plant growth. However, most of the plant growth at sample points was moderate. The lake gets very deep quickly, and plant growth stops abruptly. Church Pine Lake has a very diverse plant community. The highest number of species sampled at any sample point was 9. There were 33 species sampled at points and 38 species including visually observed plants. The Simpson's diversity index is 0.91. This demonstrates high diversity with a 91% chance that two plants sampled at a point will be different.

Of the 38 species sampled or viewed, 3 are algae and 35 are native vascular plants. No non-native species were sampled or viewed in or near Church Pine Lake. The most common plants sampled were Robbin's pondweed (*Potamogeton robbinsii)*, wild celery (*Vallisneria Americana*), Illinois pondweed (*Potamogeton illinoensis*), and bushy pondweed (*Najas flexilis*). All of these are common native species found in Wisconsin lakes. Each of these plant species (as well as others sampled) is desirable and serves important roles or niches in the lake ecosystem. Maps of each species location are available in the full aquatic plant survey report.

Table 7. Church Pine Lake Aquatic Plant Survey Summary

Survey Statistic Summary- Church Pine Lake	
Total number of points in lake grid	**322**
Total number of points sampled	**179**
Total number of sites with vegetation	**138**
Total number of sites shallower than max. depth of plants (littoral zone)	**149**
Frequency of occurrence at sites shallower than maximum depth of plants	**92.62%**
Frequency of occurrence at all sites	**42.86%**
Simpson Diversity Index	**0.91**
Maximum depth of plants (ft)	**25.7**
Average number of all species per site (vegetated sites only)	**3.41**
Average number of native species per site (vegetated sites only)	**3.41**
Species Richness (number of species found)	**33**
Species Richness (including visuals)	**38**

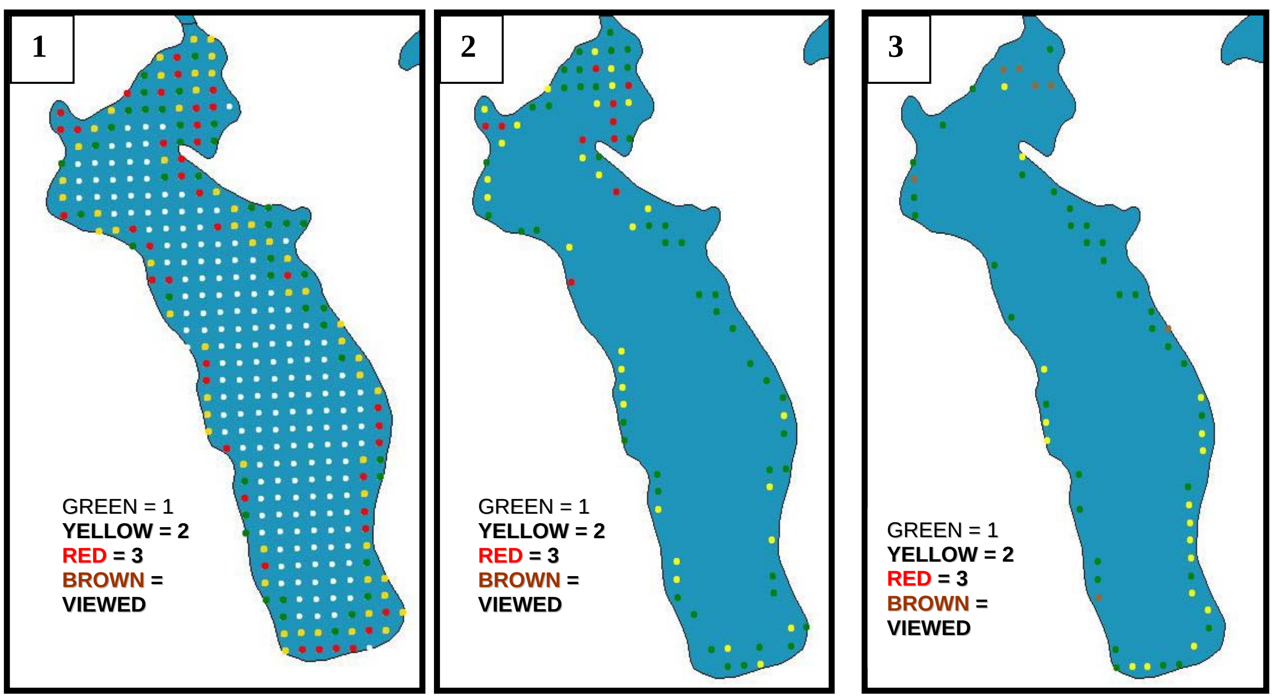

Figure 13. Rake Densities for 1: All Species Sampled; 2: Robbins Pondweed and 3: Wild Celery

Table 8. Aquatic Plant Species of Church Pine Lake

Species-Church Pine Lake	*Frequency of Occurrence*	*Relative Frequency*	*Number Sampled*	*Mean Density*	*Number Viewed*
Potamogeton robbinsii, **Robbins pondweed**	61.59	18.09	85	1.58	
Vallisneria americana, **Wild celery**	50.00	14.68	69	1.09	2
Potamogeton illinoensis, **Illinois pondweed**	37.68	11.06	52	1.33	7
Najas flexilis, **Bushy pondweed**	29.71	8.72	41	1.02	1
Ceratophyllum demersum, **Coontail**	21.74	6.40	30	1.07	
Elodea canadensis, **Common waterweed**	18.84	5.53	26	1.04	
Myriophyllum sibiricum, **Northern water milfoil**	17.39	5.11	24	1.04	6
Chara **, Muskgrasses**	12.32	3.62	17	1.18	
Potamogeton praelongis, **White-stem pondweed**	12.32	3.62	17	1.00	1
Potamogeton gramineus, **Variable pondweed**	10.87	3.19	15	1.00	
Nitella sp., **Nitella**	7.97	2.34	11	1.36	
Nymphaea odorata, **White water lily**	7.97	2.34	11	1.00	6
Potamogeton zosteriformis**, Flat-stem pondweed**	7.97	2.34	11	1.00	3
Filamentous algae	7.25	2.13	10	1.00	
Brasenia schreberi, **Watershield**	5.80	1.70	8	1.13	4
Potamogeton amplifolius, **Large-leaf pondweed**	5.07	1.49	7	1.00	6
Potamogeton natans, **Floating-leaf pondweed**	4.35	1.28	6	1.00	1
Potamogeton pusillus, **Small pondweed**	3.62	1.06	5	1.00	3
Aquatic moss	2.90	0.85	4	1.00	
Eleocharis acicularis, **Needle spikerush**	2.17	0.64	3	1.00	1
Lemna trisulca, **Forked duckweed**	1.45	0.43	2	1.00	
Megalodonta beckii, **Water marigold**	1.45	0.43	2	1.00	3
Myriophyllum tenellum, **Dwarf water milfoil**	1.45	0.43	2	1.00	1
Potamogeton richardsonii, **Clasping-leaf pondweed**	1.45	0.43	2	1.00	3
Sagittaria cuneata **, Arum-leaved arrowhead**	1.45	0.43	2	1.00	
Sagittaria rigida, **Stiff arrowhead**	1.45	0.43	2	1.00	
Isoetes echinospora, **Spinyspored quillwort**	0.72	0.21	1	1.00	
Lemna minor, **Small duckweed**	0.72	0.21	1	1.00	
Nuphar variegata, **Spatterdock**	0.72	0.21	1	1.00	
Pontederia cordata, **Pickerelweed**	0.72	0.21	1	1.00	2
Schoenoplectus subterminalis, **Water bulrush**	0.72	0.21	1	1.00	
Typha latifolia, **Broad-leaved cattail**	0.72	0.21	1	1.00	
Utricularia intermedia, **Flat-leaf bladderwort**	0.72	0.21	1	1.00	
Utricularia gibba, **Creeping bladderwort**	Viewed	Only	No stats		1
Heteranthera dubia, **Water star-grass**	Viewed	Only	No stats		2
Schoenoplectus acutus, **Hardstem bulrush**	Viewed	Only	No stats		1
Sparganium eurycarpum, **Common bur-reed**	Viewed	Only	No stats		1
Stuckenia pectinata, **Sago pondweed**	Viewed	Only	No stats		1

Round (Wind) Lake

Plant growth is widespread in Round Lake. Vegetation was found at 86 of the 145 sampling points (about 59% of the lake). The greatest depth with plants – the limit of the littoral zone – was 21.1 feet. Almost 80% of the lake littoral zone had plants present. The sample grid is shown in the maps of the littoral zone below.

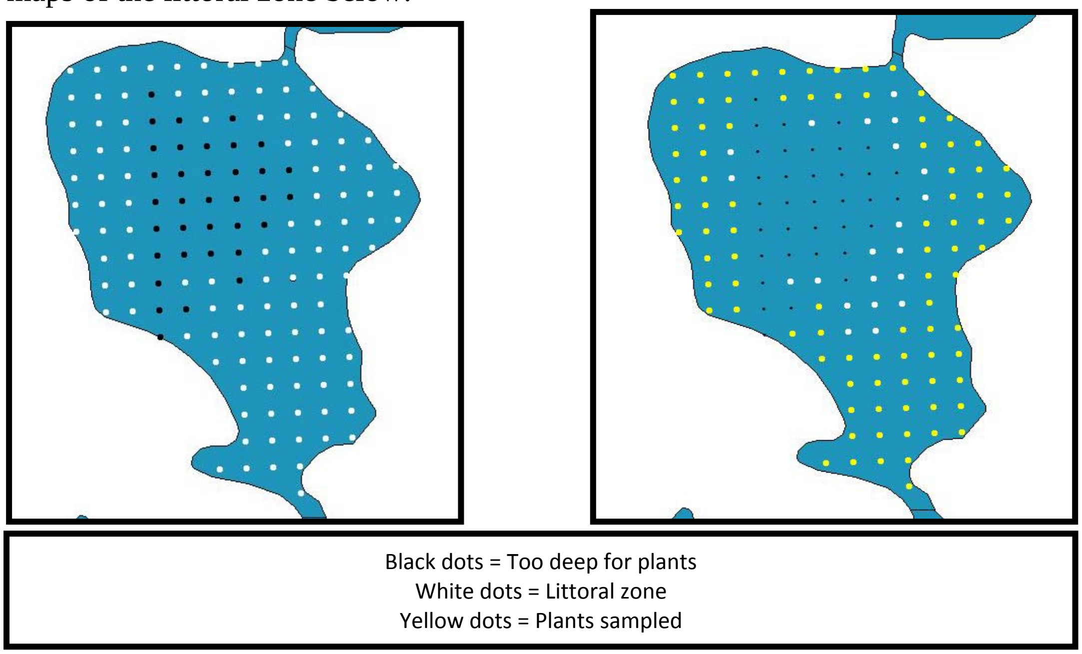

Figure 14. Round Lake Littoral Zone

Table 9. Round Lake Aquatic Plant Survey Summary

Survey Statistic Summary - Round Lake	
Total number of point in lake grid	**145**
Total number of points sampled	**135**
Total number of sites with vegetation	**86**
Total number of sites shallower than max. depth of plants (littoral zone)	**108**
Frequency of occurrence at sites shallower than maximum depth of plants	**79.63%**
Frequency of occurrence at all sites	**59.31%**
Simpson Diversity Index	**0.91**
Maximum depth of plants (ft)	**21.1**
Average number of all species per site (vegetated sites only)	**3.95**
Average number of native species per site (vegetated sites only)	**3.95**
Species Richness	**37**
Species Richness (including visuals)	**40**

The plant community in Round Lake is diverse and healthy. There were 37 species of plants sampled on the rake and 3 more viewed (for a total of 40). Of these 40 species, 3 are algae species, 35 are native vascular plants and 2 are non-native vascular plants. The most common plants sampled were Robbin's pondweed (*Potamogeton robbinsii)*, coontail (*Ceratophyllum demersum*), white water lily (*Nymphaea odorata*), and common waterweed (*Elodea canadensis*). No plant dominated the plant population with Robbin's pondweed having the highest relative density of 19.7%, followed by coontail at 17.9%, white water lily at 7.65%, and common waterweed at 5.6%. All of the native plants are balanced in frequency and are desirable to have in a lake ecosystem. Where plants were growing in Round Lake, the density was quite high. The map below shows the total rake density at sites with plants. Many of these sites have a rake density of three, which is the highest density rating.

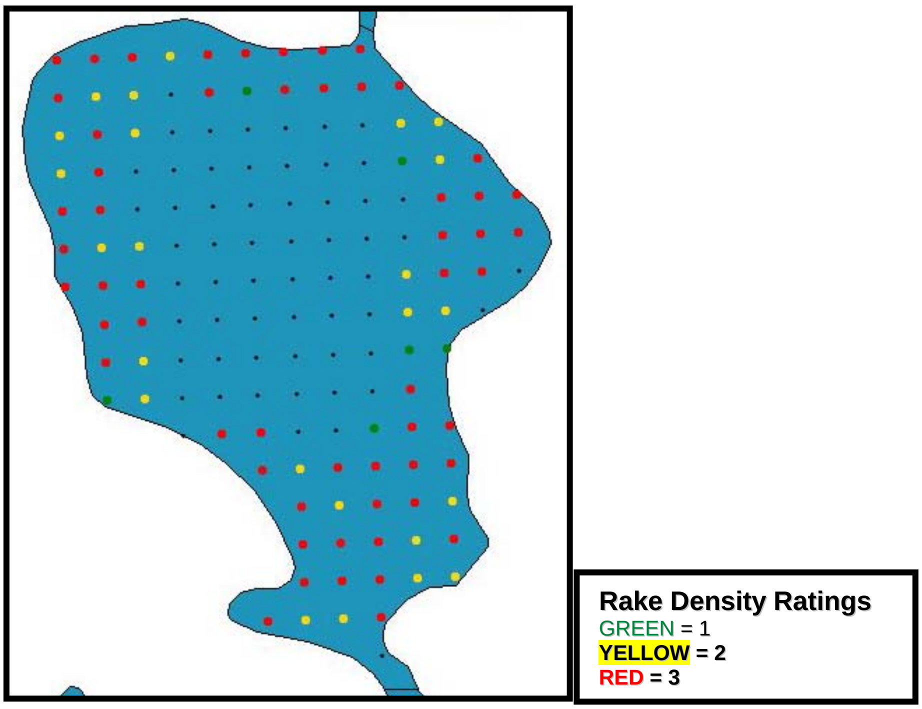

Figure15. Rake Density for all Species Sampled on Round Lake

Table 10. Aquatic Plant Species of Round Lake

Species - Round Lake	Frequency of Occurrence	Relative Frequency	Number Sampled	Mean Density	Number Viewed
***Potamogeton robbinsii*, Robbins pondweed**	77.91	19.71	67	1.76	
***Ceratophyllum demersum*, Coontail**	70.93	17.94	61	1.62	
***Nymphaea odorata*, White water lily**	30.23	7.65	26	1.00	14
***Elodea canadensis*, Common waterweed**	22.09	5.59	19	1.21	
***Brasenia schreberi*, Watershield**	20.93	5.29	18	1.00	2
***Potamogeton illinoensis*, Illinois pondweed**	20.93	5.29	18	1.11	4
***Myriophyllum sibiricum*, Northern water milfoil**	19.77	5.00	17	1.00	8
***Vallisneria americana*, Wild celery**	17.44	4.41	15	1.27	2
***Megalodonta beckii*, Water marigold**	13.95	3.53	12	1.00	1
***Najas flexilis*, Bushy pondweed**	9.30	2.35	8	1.13	
***Potamogeton amplifolius*, Large-leaf pondweed**	9.30	2.35	8	1.00	3
***Heteranthera dubia*, Water star-grass**	8.14	2.06	7	1.00	6
***Potamogeton pusillus*, Small pondweed**	8.14	2.06	7	1.00	1
***Spirodela polyrhiza*, Large Duckweed**	8.14	2.06	7	1.00	1
***Chara sp.* , Muskgrasses**	4.65	1.18	4	1.00	
***Nitella sp.* ,Nitella**	4.65	1.18	4	1.00	
***Nuphar variegata*, Spatterdock**	4.65	1.18	4	1.00	
***Potamogeton gramineus*, Variable pondweed**	4.65	1.18	4	1.00	
***Potamogeton zosteriformis*, Flat-stem pondweed**	4.65	1.18	4	1.00	3
***Potamogeton praelongis*, White-stem pondweed**	3.49	0.88	3	1.00	
***Sagittaria cuneata* , Arum-leaved arrowhead**	3.49	0.88	3	1.00	1
***Utricularia vulgaris*, Common bladderwort**	3.49	0.88	3	1.00	1
***Lemna trisulca*, Forked duckweed**	2.33	0.59	2	1.00	
***Potamogeton natans*, Floating-leaf pondweed**	2.33	0.59	2	1.00	1
***Potamogeton richardsonii*, Clasping-leaf pondweed**	2.33	0.59	2	1.00	
***Sagittaria rigida*, Stiff arrowhead**	2.33	0.59	2	1.00	
***Schoenoplectus acutus*, Hardstem bulrush**	2.33	0.59	2	1.00	3
***Typha latifolia*, Broad-leaved cattail**	2.33	0.59	2	1.00	
***Utricularia intermedia*, Flat-leaf bladderwort**	2.33	0.59	2	1.00	
Filamentous algae	1.16	0.29	1	1.00	
***Eleocharis acicularis*, Needle spikerush**	1.16	0.29	1	1.00	
***Isoetes echinospora*, Spinyspore quillwort**	1.16	0.29	1	1.00	
***Lemna minor*, Small duckweed**	1.16	0.29	1	1.00	
***Pontederia cordata*, Pickerelweed**	1.16	0.29	1	1.00	1
***Sparganium eurycarpum*, Common bur-reed**	1.16	0.29	1	1.00	1
***Stuckenia pectinata*, Sago pondweed**	1.16	0.29	1	1.00	
***Utricularia gibba*, Creeping bladderwort**	1.16	0.29	1	1.00	1
***Eleocharis palustris*, Creeping spikerush**	Viewed	only	No	stats	1
***Potamogeton crispus*, Curly-leaf pondweed**	Viewed	only	No	stats	1
***Lythrum salicaria*, Purple loosestrife**	Viewed	only	No	stats	13
***Calla palustris*, Wild calla**	*Boat survey*				

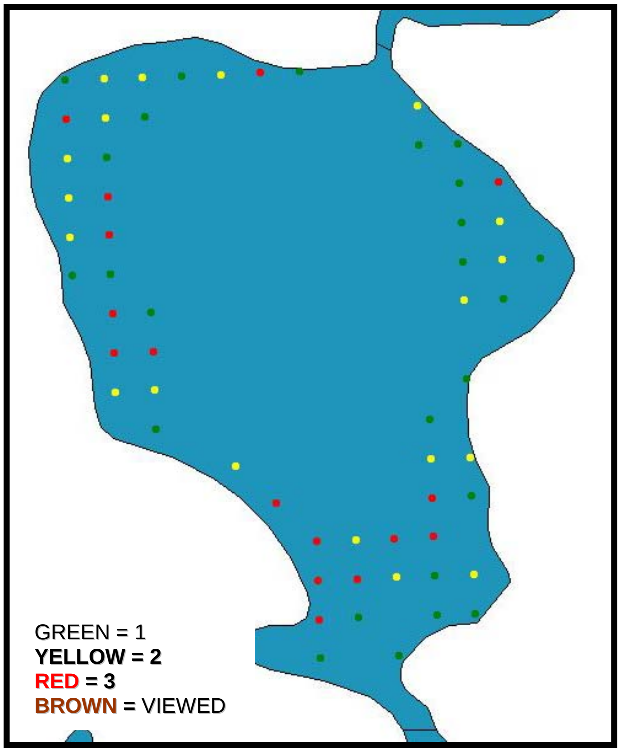

Figure 16. Round Lake Distribution Map of Robbins Pondweed

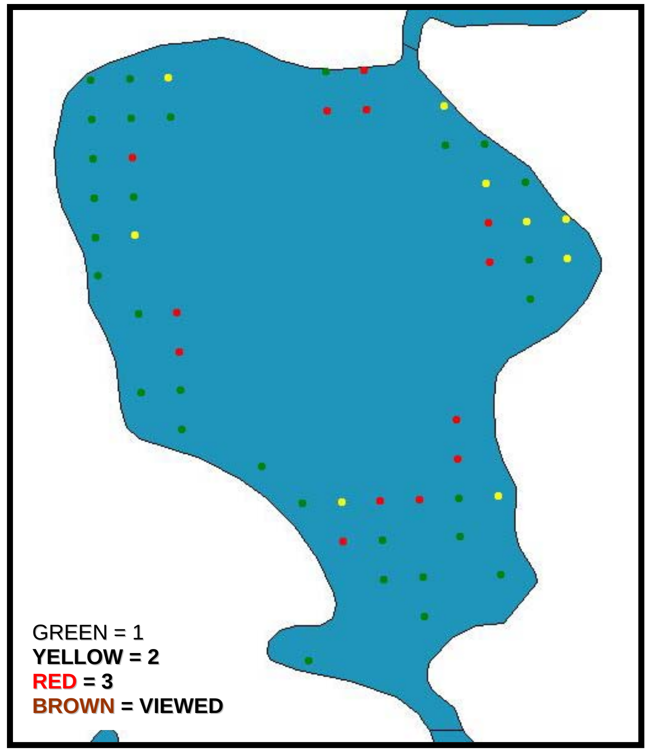

Figure 17. Round Lake Distribution Map of Coontail

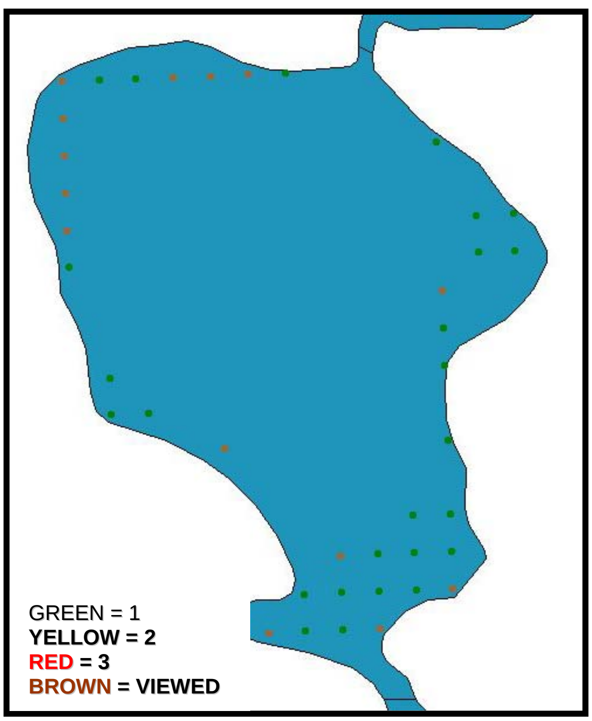

Figure 18. Round Lake Distribution Map of White Water Lily

Figure 19. Round Lake Distribution Map of Common Waterweed

Big Lake

There is rather low coverage of plants in Big Lake. Vegetation was found at 84 of the 410 sampling points (about 20% of the lake). The greatest depth with plants – the limit of the littoral zone – was 16 feet. In fact, most areas deeper than 12 feet had no plants. The plant coverage in the littoral zone was just under 73%. The rather shallow littoral zone is possibly due to limited water clarity in the later part of the summer. The sample grid is shown in the maps of the littoral zone below.

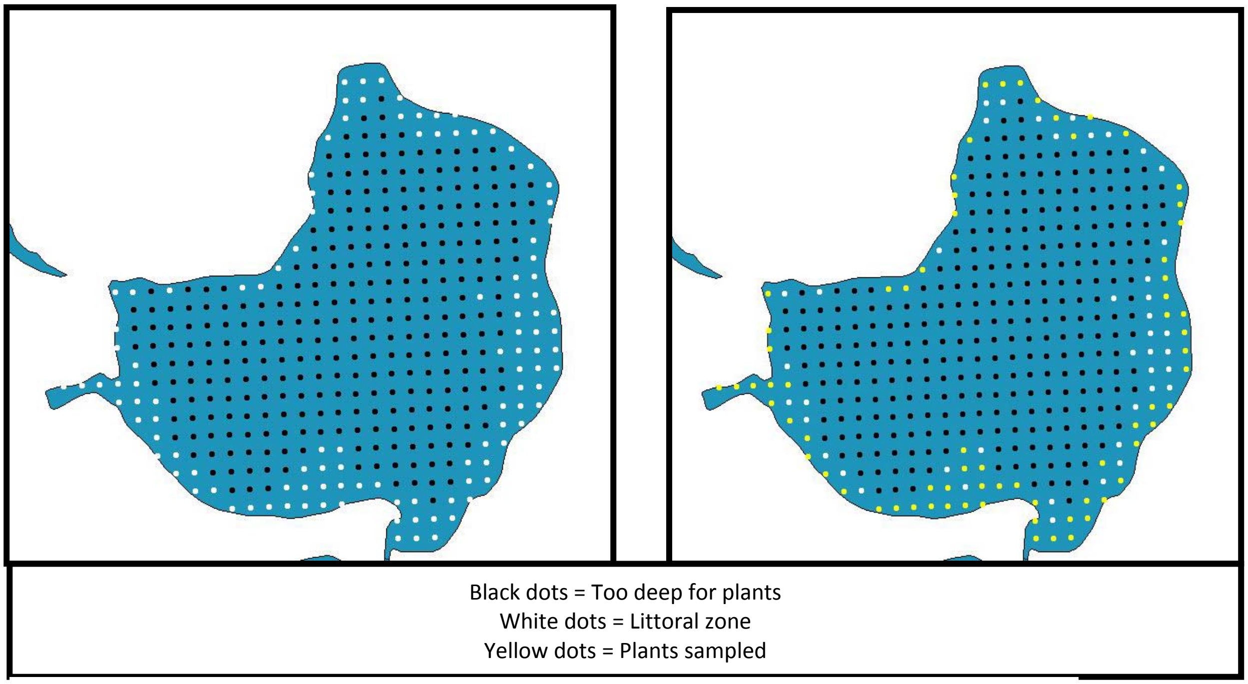

Figure 20. Big Lake Littoral Zone

Table 11. Big Lake Plant Summary Data

Survey Statistic Summary- Big Lake	
Total number of points in lake grid	**410**
Total number of points sampled	**178**
Total number of sites with vegetation	**84**
Total number of sites shallower than max. depth of plants (littoral zone)	**114**
Frequency of occurrence at sites shallower than maximum depth of plants	**73.68%**
Frequency of occurrence at all lake sites	**20.49%**
Simpson Diversity Index	**0.91**
Maximum depth of plants (ft)	**16**
Average number of all species per site (vegetated sites only)	**3.64**
Average number of native species per site (vegetated sites only)	**3.52**
Species Richness (number of plants found)	**27**
Species Richness (including visuals)	**32**

Big Lake has a fairly diverse plant community. The species richness was 27 plants sampled and 32 species including all plants viewed. The highest number of species at any sample point was seven. Another good measure of diversity is the Simpson's diversity index. The Simpson's diversity index from this survey was 0.91. Where there were plants growing, the coverage was quite dense. A map below (Figure 21) shows the density of plants sampled at points with plants. Many of these sample points have total rake density ratings of 3, which is the highest.

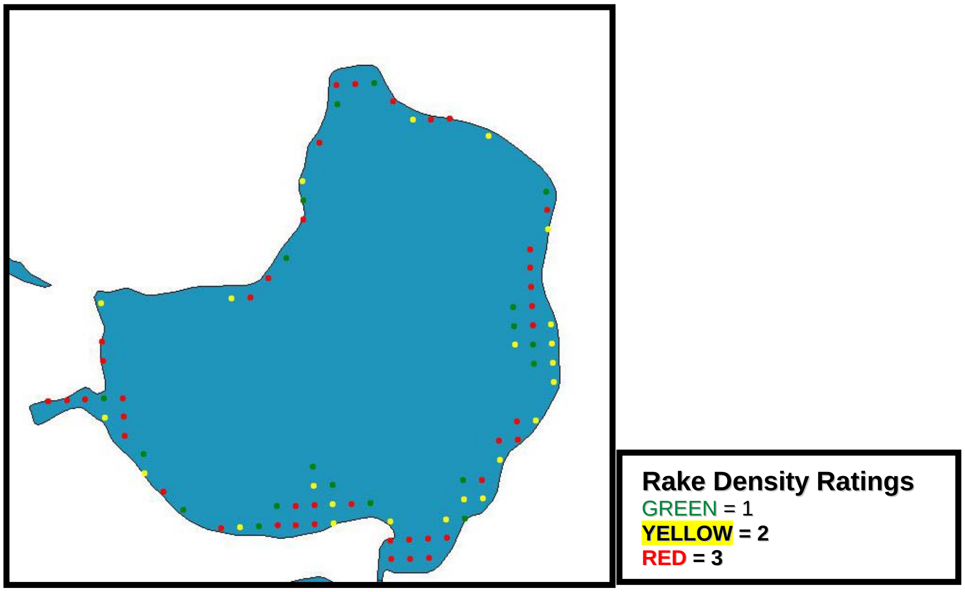

Figure 21. Big Lake Density for all Species Sampled

Of the 32 species sampled or viewed, 2 are algae, 2 are non-native and 28 are native vascular plants. The four most frequent plants sampled are coontail (*Ceratophyllum demersum*), wild celery (*Vallisneria Americana*), flat-stem pondweed (*Potamogeton zosteriformis*) and northern water milfoil (*Myriophyllum sibiricum*). All of these plants are native and common in Wisconsin lakes. They are desirable plants which serve very important roles in the lake ecosystem. Coontail has a relative frequency of 20.29%. This means one in every five plants sampled was coontail. The prevalence of coontail may indicate high nutrients in the lake and reduced water clarity because coontail can live in lower light conditions and can absorb high amounts of nutrients directly from the water.

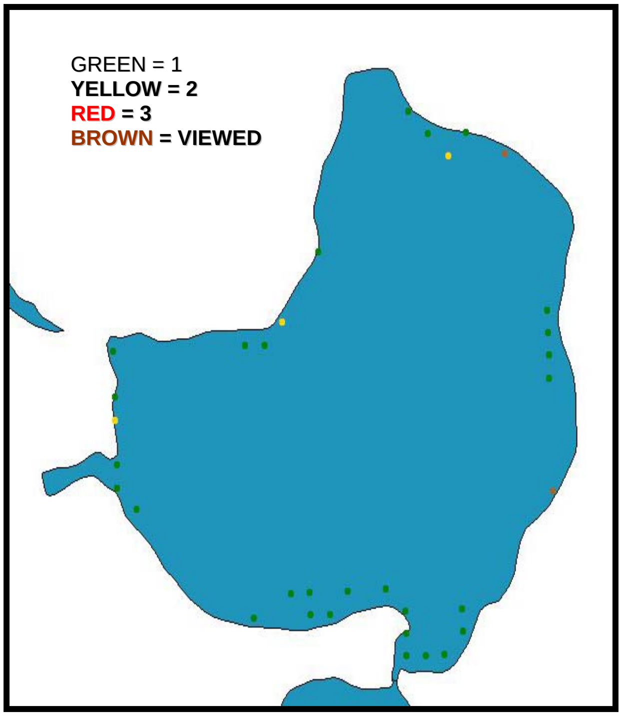

Figure 22. Big Lake Distribution Map of Coontail

Figure 23. Big Lake Distribution Map of Wild Celery

Figure 24. Big Lake Distribution Map of Flatstem Pondweed

Figure 25. Big Lake Distribution Map of Northern Water Milfoil

Table 12. Aquatic Plant Species of Big Lake

Species-Big Lake	Frequency of Occurrence	Frequency	Relative Frequency	Number	Mean Density	Viewed
Ceratophyllum demersum, **Coontail**	75.00	55.26	20.59	63	1.78	
Vallisneria americana, **Wild celery**	45.24	33.33	12.42	38	1.37	
Potamogeton zosteriformis, **Flat-stem pondweed**	38.10	28.07	10.46	32	1.09	2
Myriophyllum sibiricum, **Northern water milfoil**	32.14	23.68	8.82	27	1.15	6
Lemna trisulca, **Forked duckweed**	22.62	16.67	6.21	19	1.00	
filamentous algae	19.05	14.04	5.23	16	1.13	
Heteranthera dubia, **Water star-grass**	16.67	12.28	4.58	14	1.14	1
Elodea canadensis, **Common waterweed**	14.29	10.53	3.92	12	1.17	
Potamogeton crispus**, Curly-leaf pondweed**	11.90	8.77	3.27	10	1.00	
Potamogeton richardsonii, **Clasping-leaf pondweed**	11.90	8.77	3.27	10	1.00	1
Stuckenia pectinata, **Sago pondweed**	10.71	7.89	2.94	9	1.22	7
Nymphaea odorata, **White water lily**	7.14	5.26	1.96	6	1.00	3
Potamogeton praelongis, **White-stem pondweed**	7.14	5.26	1.96	6	1.00	
Najas flexilis, **Bushy pondweed**	5.95	4.39	1.63	5	1.40	3
Potamogeton amplifolius, **Large-leaf pondweed**	5.95	4.39	1.63	5	1.00	2
Potamogeton illinoensis, **Illinois pondweed**	5.95	4.39	1.63	5	1.00	2
Potamogeton pusillus, **Small pondweed**	5.95	4.39	1.63	5	1.20	
Potamogeton foliosus, **Leafy pondweed**	4.76	3.51	1.31	4	1.00	
Potamogeton friesii, **Frie's pondweed**	3.57	2.63	0.98	3	1.00	
Potamogeton robbinsii, **Robbins pondweed**	3.57	2.63	0.98	3	1.33	1
Spirodela polyrhiza**, Large duckweed**	3.57	2.63	0.98	3	1.00	
Chara **, Muskgrasses**	2.38	1.75	0.65	2	1.00	
Megalodonta beckii, **Water marigold**	2.38	1.75	0.65	2	1.50	
Ranunculus aquatilis, **Stiff water crowfoot**	2.38	1.75	0.65	2	1.50	1
Eleocharis acicularis, **Needle spikerush**	1.19	0.88	0.33	1	1.00	
Schoenoplectus acutus, **Hardstem bulrush**	1.19	0.88	0.33	1	1.00	
Wolffia columbiana, **Common watermeal**	1.19	0.88	0.33	1	1.00	
Decodon verticillatus, **Swamp loosestrife**	Viewed	Only	No	stats		1
Iris versicolor, **Northern Blue flag**	Viewed	Only	No	stats		1
Lythrum salicaria, **Purple loosestrife**	Viewed	Only	No	stats		6
Nuphar variegata, **Spatterdock**	Viewed	Only	No	stats		2
Typha latifolia, **Broad-leaved cattail**	Viewed	Only	No	stats		2

Floristic Quality Index

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 disturbed 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 each plant's species conservatism values. A higher FQI generally indicates a healthier aquatic plant community.

The Floristic Quality Index (FQI) was calculated for each lake. Only species sampled on the rake and listed in the Nichols FQI are used in determining the FQI. The list used for each lake FQI calculation is found in the plant survey results.

The FQI for each lake is higher than the median values for other lakes within the Northern Central Hardwoods ecoregion. In Big Lake, this is largely due to the higher number of species since the mean conservatism of the plants sampled is just slightly higher than the median within the ecoregion. In both Church Pine Lake and Round Lake all of the values (species, mean conservatism, and FQI) are substantially higher than the median within the ecoregion.

These values show the plant community is diverse with a large number of plants present that are intolerant to disturbance present. The habitat for plants is good and may show that human disturbance has had little impact on the plant community, especially in Church Pine Lake.

Table 13. FQI Comparison of Project Lakes to Ecoregion

Lake	*Species used FQI*	*Mean Conservatism*	*FQI*
Big Lake	24	5.96	29.2
Church Pine Lake	30	6.53	35.8
Round Lake	35	6.2	36.7
EcoRegion median	14	5.6	20.9

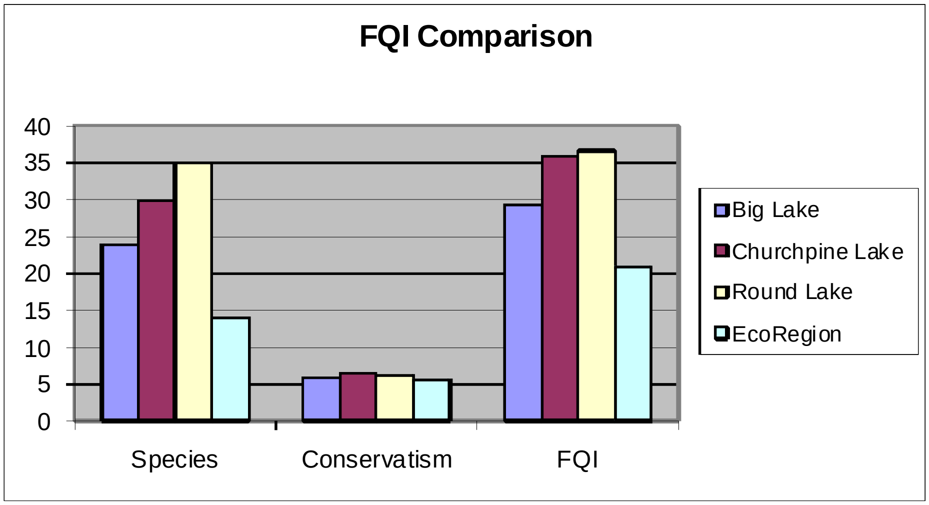

Figure 26. FQI Comparison Graph

Aquatic Invasive Species

Church Pine Lake

The 2009 plant surveys found no non-native aquatic invasive species in Church Pine Lake. All plants were native. However, curly leaf pondweed was reported in low densities in the northeast corner of lake along two transects in 1997. APM Advisory Committee members also reported a floating fragment of curly leaf pondweed in late June 2010 in the southern portion of the lake.

Round Lake

Two non-native species were surveyed in or around Round Lake in 2009. The species are:

Curly leaf pondweed (CLP): *Potamogeton crispus*
Purple loosestrife: *Lythrum salicaria*

Curly Leaf Pondweed

Several single plants or small clumps of CLP were sampled or viewed. One area that is 0.11 acres in size had several sporadic clumps. The mean density of this area is much less than 2. However, because this was an area with more consistent growth of CLP, it was delineated. It did not meet the criteria used to delineate beds on Big Lake where curly leaf pondweed was much more prevalent. This “bed” did not have extensive growth and would not be regarded as a nuisance level.

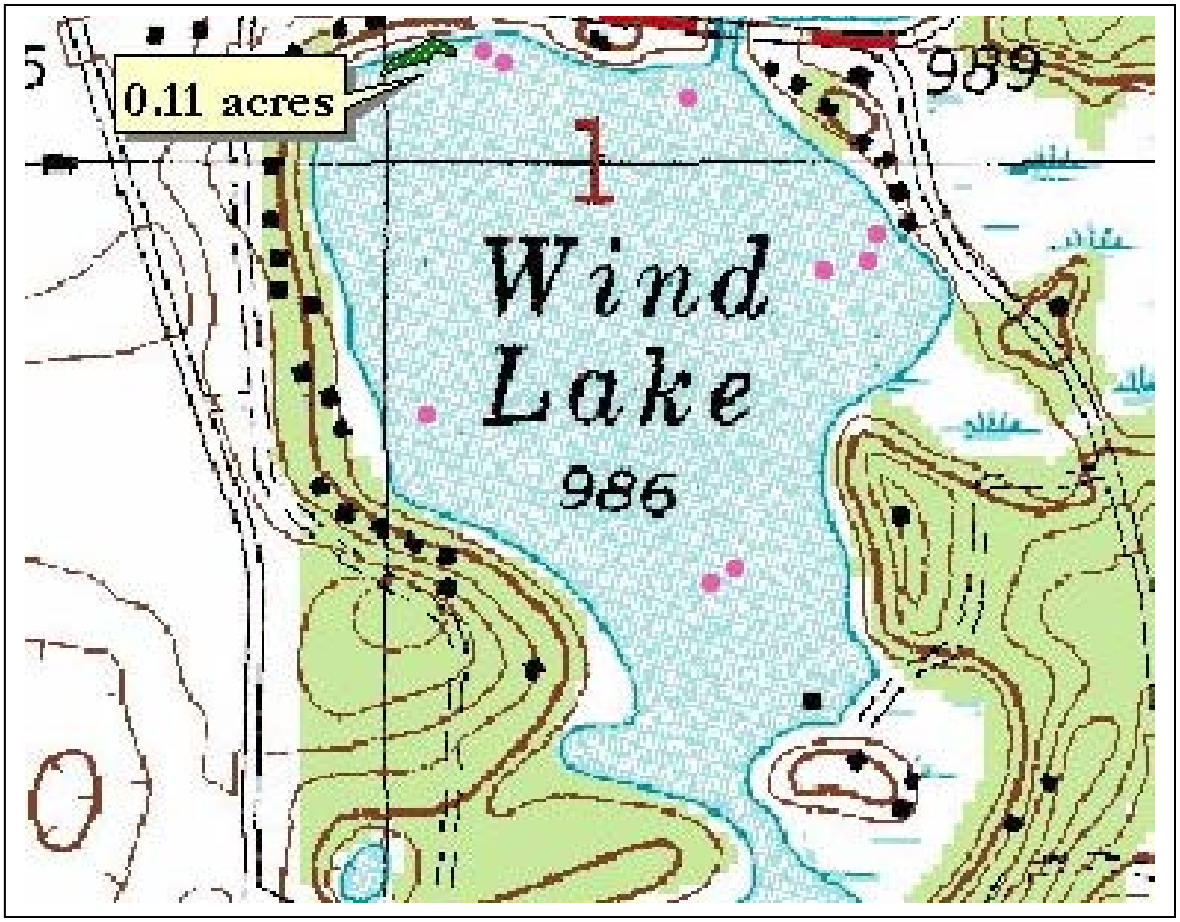

Figure 27. Round Lake CLP Locations 2009

Purple Loosestrife
There were numerous locations where purple loosestrife (PL) was observed along the shoreline of Round Lake. All were single plants or very few plants in small clumps. However, PL can spread rapidly, and the shallow bays of Round Lake are suitable habitat for purple loosestrife.

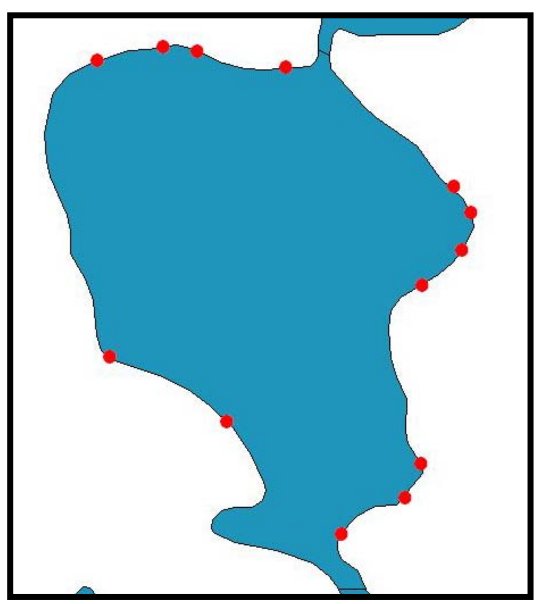

Figure 28. Round Lake Purple Loosestrife Locations 2009

Big Lake

Two non-native species were surveyed in or around Big Lake:

Curly leaf pondweed (CLP): *Potamogeton crispus*
Purple loosestrife: *Lythrum salicaria*

Curly Leaf Pondweed
Curly leaf pondweed was surveyed and mapped in June. The following maps show the coverage of the dense beds where the mean rake density is greater than 2 (on a scale of 0 - 3) and the plants were easily viewed from the surface. The coverage of dense CLP in Big Lake is quite extensive. There are approximately 23 total acres of dense CLP beds in Big Lake. There are numerous small clumps (red dots on map) that are not big enough to delineate as a bed. Many of the beds have plants at or near the surface and were reaching nuisance levels during the June survey in 2009.

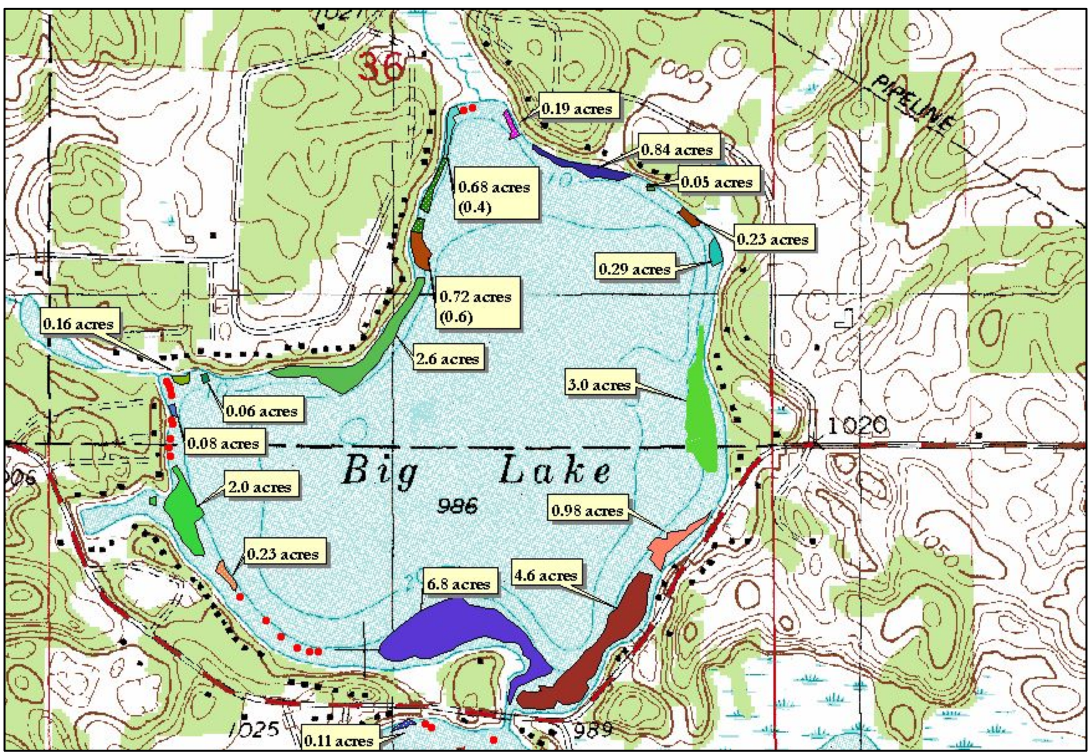

Figure 29. Curly Leaf Pondweed (CLP) Beds on Big Lake - 2009

Purple Loosestrife

Purple loosestrife was observed in a few locations on Big Lake. Two of these locations had growth that was large and quite dense. A bay near the landing has fairly extensive coverage and rather high density. Another large area of high density is across the road from Big Lake on the east shore. Committee members also described a large area of purple loosestrife growth along North Creek. Management options for purple loosestrife are discussed in later sections.

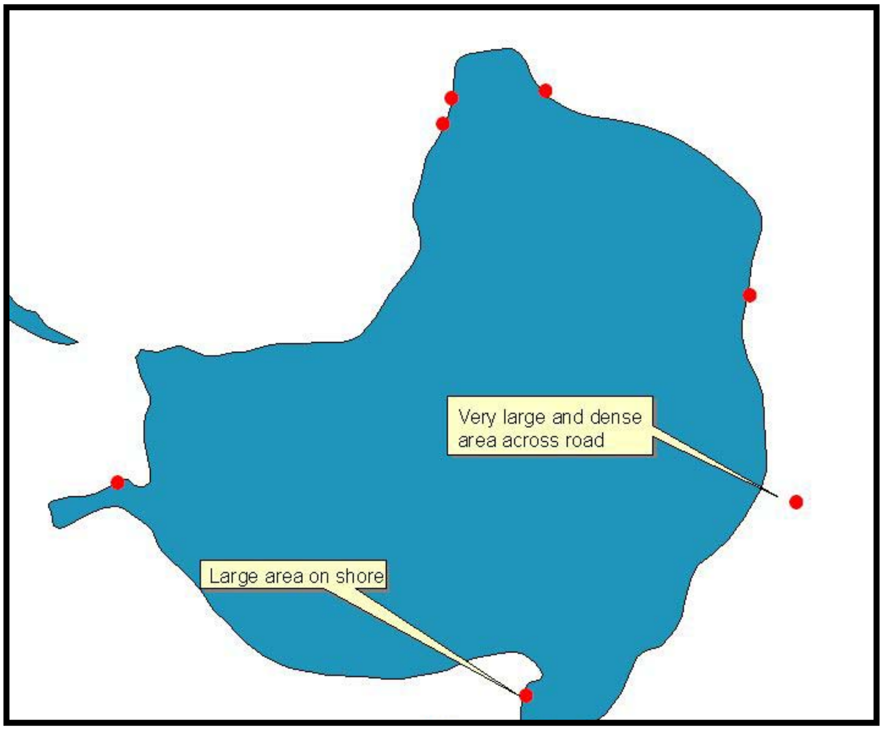

Figure 30. Big Lake Purple Loosestrife Locations 2009

Aquatic Plant Management

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

Discussion of Management Methods

Permitting Requirements

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and when plants are removed manually from an area greater than thirty feet in width along the shore. The requirements for chemical plant removal are described in Administrative Rule NR 107 – *Aquatic Plant Management*. A permit is required for any aquatic chemical application in Wisconsin. Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) due, in the case of project lakes, 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, from his/her shoreline up to a 30-foot corridor. Wild rice may not be removed, even with hand methods. A riparian landowner may manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[12]

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

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

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

Manual Removal[13]

Manual removal—hand pulling, cutting, or raking—will effectively remove plants from small areas. It is likely that plant removal will need to be repeated more than once during the growing season. The best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants with rhizomatous (underground stem) growth, pulling roots is not generally recommended since it may stimulate new shoot production. Hand pulling is a strategy recommended for rapid response to a Eurasian water milfoil establishment 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.

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 where 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. In other cases, a barge is used to store and transport the plants. The plants are deposited on shore, where they can be transported to a local farm for use as a soil amendment (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. Most harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Its results—open water and accessible boat lanes—are immediate, and can be enjoyed without the restrictions on lake use which follow herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic

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

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 aquatic plants 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 on 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 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 cost and efficiency of the operation.

Timing is also important. The ideal time to harvest, in order to maximize the efficiency of the harvester, is just before the aquatic plants break the surface of the lake. For curly leaf pondweed, it should also be before the plants form turions (reproductive structures) to avoid spreading the turions within the lake. If the harvesting is conducted too early, the plants will not be close enough to the surface, and the cutting will not do much damage to them. If too late, turions may have formed and may be spread, and there may be too much plant matter on the surface of the lake for the harvester to cut effectively.

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, facilitating the spread of aquatic invasive species from one body of water to another. Prevailing winds may also blow cut vegetation into open areas of the lake or along shorelines.

Harvesting may be an option worth considering for managing curly leaf pondweed on Big Lake if herbicide treatment is not effective.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The 3 to 5 inch diameter dredge hoses 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 lakes.

Rotovation involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of twenty 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 release toxins into the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine the potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

Biological Control[14]

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

The effectiveness of biocontrol efforts varies widely (Madsen, 2000). Beetles are commonly and successfully used to control purple loosestrife populations in Wisconsin. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, an herbivorous fish, is sometimes used to feed on pest plant populations, but grass carp introduction is not allowed in Wisconsin.

Weevils[15] have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations. In these cases, EWM

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

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 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 compared 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 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.

Biological control is proposed for large inaccessible patches of purple loosestrife growth in the project area.

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 project lakes because a healthy, diverse native plant population is present.

Physical Control[16]

In physical management, the environment of the plants is manipulated. Several physical techniques are commonly used: dredging, drawdown, benthic (lake bottom) barriers, and shading or light attenuation. Because these methods involve placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 WDNR permit is required.

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

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

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

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 the project lakes as part of the aquatic plant management plan. It is under consideration for increasing depth for navigation between the lakes.

Drawdown, or significantly decreasing lake water levels can be used to control nuisance plant populations. With drawdown, the water is 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). Drawdown requires a mechanism to lower water levels. Although Big Lake does have some control of water levels at the outflow, the ability to descrease water levels is minimal.

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 of the water body during the drawdown period. Lastly, species respond in very different manners to drawdown and responses can be inconsistent (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals.

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 available for plant 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 of only limited applicability.

Physical control is not currently proposed for management of aquatic plants on project lakes.

Herbicide and Algaecide Treatments

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

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

General descriptions of herbicide classes are included below.[17]

Contact Herbicides

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

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 their site of action within the

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

plant. 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. These operations can also impact water chemistry which may result in further implications for aquatic organisms.

Table 14. Herbicides Used for the Management of Aquatic Plants in Project Lakes.

Brand Name(s)	Chemical	Target Plants
Cultrine Plus, K-Tea, Copper Sulfate ($CuSO_4$), PLL tablets	Copper compounds	Milfoils, pondweeds, elodea, cattails, coontail, and algae
Reward	Diquat	Milfoils, pondweeds, elodea, cattails, coontail, and algae
Aquathol, Aquathol-K, Hydrothol	Endothall	Milfoils, pondweeds, elodea, cattails, coontail, white water lily, wild celery, and algae
Navigate, Aqua Kleen	2, 4-D	Milfoils, yellow and white water lily, watershield
Lime Slurry*	Calcium Hydroxide	Curly-leaf pondweed

*An experimental treatment was conducted to compare the selective control of curly-leaf pondweed using Reward (diquat) and a lime slurry treatment.

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

Copper

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

2,4-D

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

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 particles, diquat is not biologically available. When diquat is bound to organic matter, it can be slowly degraded by microorganisms. When diquat is applied foliarly, it is degraded to some extent on the leaf surfaces by photodegradation. Because it is bound in the plant tissue, a proportion is probably degraded by microorganisms as the plant tissue decays.

Endothall

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

Fluridone

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

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

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: 2,4-D, diquat, endothall, fluridone, and triclopyr.[19] All of these herbicides with the exception of diquat are available in both granular and liquid formulations. It is possible to target invasive species by using the appropriate herbicide and timing. Diquat is used infrequently in Wisconsin because it is nonspecific. 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. Early season (April to May) treatment of Eurasian water milfoil is recommended to limit the impact on native aquatic plant populations because EWM tends to grow before native aquatic plants.

Granular herbicide formulations are more expensive than liquid formulations (per active ingredient). However, granular formulations are generally thought to release the active ingredient over a longer period of time. Granular formulations, therefore, may be more suited to situations where herbicide exposure time will likely be limited, as is the case of treatment areas in small bands or blocks. In large, shallow lakes with widespread EWM, a whole lake treatment with a low rate of liquid herbicide may be most cost effective because exposure time is greater. Factors that affect exposure time are size and configuration of treatment area, water flow, and wind.

Application rates for liquid and granular formulations are not interchangeable. A rate of 1 to 1.5 mg/L 2,4-D applied as a liquid is a moderate rate that will require a contact time of 36 to 48 hours. 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.

[19] Additional information provided by John Skogerboe, Army Corps of Engineers, personal communication. February 14, 2008.

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 restrictions following treatment. Diquat (Reward) has the following use restrictions: drinking water 1-3 days, swimming and fish consumption 0 days. Endothall (Aquathol K) has the following use restrictions: drinking and irrigation water 7 – 25 days, swimming 0 days, fish consumption 3 days.

Studies and in-lake CLP control programs 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 (reproductive structure) formation.[20] 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. This method is commonly used to treat CLP in Wisconsin.

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.[21] Steep drop-off, high winds, and other factors may increase herbicide dilution and decrease contact time thereby decreasing treatment effectiveness. 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.

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[20] *Research in Minnesota on Control of Curly Leaf Pondweed.* Wendy Crowell, Minnesota Department of Natural Resources. Spring 2002.
[21] Personal communication, Frank Koshere. March 2005.

Previous Aquatic Plant Management Plans

Plant Surveys and Aquatic Plant Management Plans
The Lake District hired Barr Engineering to complete an aquatic plant survey in 1996 and a management plan in 1997 for Big Lake. Barr also completed plant surveys (1997) and an aquatic plant management plan (1998) for Church Pine and Round Lake. The Barr surveys followed transect survey protocols to assess the presence, frequency, and density of various plant species. The transect survey was an accepted aquatic plant survey method at the time. The Lake District applied for and received two DNR Lakes Planning Grants to support these projects. The initial grant application indicated that curly leaf pondweed (CLP) was present on project lakes in 1987 when a previous lake study was completed.

Problems identified for Big Lake included dense vegetation at the water surface and the presence of curly leaf pondweed. The plan proposed a phased, pilot approach whereby three CLP management methods would be tested prior to the development of a large scale control program. The pilot project used two, one acre treatment plots and two control plots to measure the effectiveness of each of the following methods to control CLP growth: the herbicide Reward, harvesting, and lime slurry. A program for preventing and monitoring Eurasian water milfoil introduction was also established.

The Round and Church Pine Lake surveys revealed much less extensive growth of CLP than found in Big Lake. The plan recommended navigation channels in two areas of dense vegetative growth in each lake. It also suggested using the results of the Big Lake pilot study to choose a control method for CLP.

The Lake District applied for grants to have Barr update the Big Lake plant survey and management plan in 2006. These projects were not funded or completed.

CLP Control Pilot Project
A lake protection grant project (LPT-67) evaluated the previously mentioned methods to control CLP and overall aquatic plant growth. These methods included herbicide treatment with Reward, harvesting, and lime slurry treatment.

The effectiveness of each treatment method was assessed by measuring stem density and biovolume of each macrophyte species present prior to treatment in early June 1998 and following treatment in mid June in both 1998 and 1999. Measurements were also made in mid June 2000 when no treatment occurred. The density of turions in lake sediments was measured in late June of the years mentioned above. The Lake District contributed extensive volunteer time and cash to match the grant and cover unanticipated project costs.

A project report was issued in July 2001. The report summarized the results of the pilot treatment program. The report concluded that the total stem density goal of 111 stems per square meter was not achieved. Effectiveness of the tested methods varied from year to year. In 1998 harvesting was the most effective treatment method, but it was not found effective in 1999 or 2000.

Lime slurry and herbicide treatments were judged to be effective in the report. Lime slurry appeared to be more effective in 1998, and herbicide treatment appeared to more effective in 1999 (even with a doubling of the lime slurry dose in 1999). Residual effects of both treatment methods were also evident in 2000. For herbicide treatment, it was noted that this was not necessarily a good thing because in 2000, CLP pondweed colonized areas where herbicide treatment previously occurred.

Large scale treatment of the entire littoral area of Big Lake in an 80 foot wide band was recommended - except in sensitive areas where a 20 foot wide band was advised. Lime slurry treatment of selected navigation channels in Church Pine and Round Lake was also recommended. The Lake District applied for a permit to implement the lime slurry treatment in 2007, and the permit was denied.

Current and Past Aquatic Plant Management

The DNR Northern Region released an Aquatic Plant Management Strategy (Appendix C) in the summer of 2007 to protect the important functions aquatic plants provide in lakes. As part of this strategy, the DNR prohibited management of native aquatic plants in front of individual lake properties after 2008 unless management is designated in an approved aquatic plant management plan. [22] Because of the importance of the native plant population for habitat, protection against erosion, and as a guard against invasive species infestation, plant removal with herbicides as an option for individual property owners must be carefully reviewed before permits are issued. The DNR will not allow removal after January 1, 2009 unless the "impairment of navigation" and/or "nuisance" conditions are clearly documented.

Individual Corridors

Some homeowners contracted with herbicide applicators to remove aquatic plants in front of their properties until 2006. A summary of recent treatments is included in Tables 15 and 16 below. Emergent, floating, and submerged water plants, and algae were targeted. The stated purpose of these treatments was threefold: to maintain shoreline access for boating, swimming, fishing, and to reduce nuisance algae accumulation.

Table 15. Recent Waterfront Herbicide Treatments on Church Pine Lake

Year	Individual Properties (#)	Acres Treated w/ Herbicide
1994	3	2.49
2000	6	0.57
2002	5	0.57
2003	2	0.34

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

Table 16. Recent Waterfront Herbicide Treatments on Big Lake

Year	Individual Properties (#)	Acres Treated w/ Herbicide
1985	24	4.26
1986	23	3.8
1987	24	3.98
1988	24	4.17
1990	15	2.87
1991	16	1.72
1992	16	1.72
1994	6	0.75
1995	28	1.29
1998	1	0.16
1999*		
2000	19	3.09
2001	9	1.34
2002	7	0.80
2003	2	0.34
2005	2	0.34
2006	4	0.68

*An experimental comparison treatment was conducted in this year, but did not occur on individual properties.

Lake District Education and AIS Prevention Activities

Although the proposed management program to reduce overall plant density and CLP density was not implemented, the Lake District has carried out the following recommendations from the aquatic plant management plans:

- Educate lake homeowners
- Prevent the establishment of other exotic [aquatic invasive] species in the lakes.

Education of lake homeowners occurs primarily through the Church Pine, Round, and Big Lakes web site (www.bigroundpine.com), spring and fall lake district meetings, and newsletters. Recent Lake District meeting topics have included water clarity, purple loosestrife, lime slurry treatment, aquatic plant harvesting, and authorization for funds for aquatic plant management. The Lake District also educates lake residents and visitors and provides boat and trailer inspections through a Clean Boats, Clean Waters program.

Clean Boats, Clean Waters
The Clean Boats, Clean Waters program educates lake users regarding actions that prevent invasive species from entering lakes and records lake users behavior. Because of the threat of introduction of invasive aquatic species, preparation for a Clean Boats, Clean Waters project began in 2006. In that year, two lake residents attended DNR training. The Lake District also acquired inspector T shirts and hats.

The Clean Boats Clean Waters inspections were launched in 2007. Residents who attended training in 2006 provided training for other volunteers. Coordinators were assigned for the Church Pine and Big Lake boat landings, and aquatic invasive species (AIS) signs were posted at these landings. Volunteers worked over 14 weekend days (57 hours) inspecting 57 boats with 2 potential AIS introductions avoided. Volunteers also looked for EWM at the boat landings in 2007. The program struggled in 2008 with fewer volunteers participating and deteriorating record keeping. Coverage at the boat landings went down to about 4 weekend days (22 hours) and 24 boat inspections.

In 2009, the Lake District hired 4 students working every weekend from 6 to 10 a.m. with 2 assigned per landing on Big Lake and Church Pine Lake. There were also ongoing “drop by” visits by the 16 volunteer adults. The Lake District funded the program without grant assistance in 2009.

Programs statistics through July 12, 2009: Boats inspected: 204, People contacted: 384 Total hours: 453

A Department of Natural Resources grant supports the Clean Boats Clean Waters program in 2010 and 2011. Grant support has allowed expansion of the program. Inspectors staff the boat landings one weeknight, Saturdays, Sundays, and holidays beginning the weekend before Memorial Day and ending the weekend after Labor Day. Teams of two student inspectors work at the landings. They are paid $8 per hour. Adult volunteers check in with the student inspectors periodically. Board members attend training and assist with data base entry and reporting. Heidi Hazzard coordinates the program and enters the data into the DNR database.

Program statistics through July 29, 2010: Boats inspected: 281, People contacted: 550, Total hours: 333

People use multiple methods to prevent aquatic invasive species introduction including inspect/remove plants (99%), dispose of bait (94%), drain boat and equipment (94%), and drain fish and live well (96%). Plants were not present on boats, trailers, and equipment 96% of the time during inspections. Visitors to the landings reported finding out about invasive species by signs or staff at the landings.

Polk County Land and Water Resources Department (LWRD)
The Lake District will continue to coordinate training and educational activities with the Polk County Land and Water Resources Department. County staff is also willing to provide plant identification assistance.

Polk County recently passed 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.

Selection of Management Strategies

The aquatic plant advisory committee carefully considered and evaluated the goals, objectives, and actions for aquatic plant management. Some of the crucial decisions are outlined below. Once priorities and desired activities were selected, costs were estimated and the budget reviewed. The 2011 budget approved at the August Lake District annual meeting is consistent with the aquatic plant management implementation plan.

The goals are listed in priority order with prevention of invasive species the top concern for the committee. Close behind in priority is to aggressively manage invasive species already present. The management methods chosen are commonly used in similar situations and not known to cause adverse impacts. Permits will be sought from the Department of Natural Resources when required.

Because of a high concern for invasion of Eurasian water milfoil and other aquatic invasives, the Clean Boats, Clean Waters program will remain at existing or increased levels at both landings. Diver and volunteer monitoring for invasive species will be added at the boat landings. Surveillance cameras will be installed at each landing given permission at the Church Pine landing and assurance of adequate enforcement.

Aggressive invasive species management includes early season Endothall treatment on all dense beds of curly leaf pondweed in Big and Round Lake. This will amount to about 25 acres of treatment in 2011. It is expected that treatment will need to occur for 3-5 years to have a significant impact on the curly leaf pondweed population. The intent is to decrease curly leaf pondweed growth and allow native plants to grow in these areas. Because of the concern for spread to Church Pine, hand pulling will be used if CLP is found there. Ongoing programs of contracted herbicide use and beetle rearing will continue for purple loosestrife control.

Managing native plants to allow navigation was perhaps the most difficult deliberation. There was a desire to allow residents to remove native plants to allow navigation in front of their properties. However, native plants play an important role in the lake ecosystem, and extensive removal of natives is a concern – especially in sensitive areas. The committee learned that hand removal in an area up to 30 feet wide in front of waterfront property, is allowed but herbicide or mechanical removal requires a permit. The DNR will not issue permits for herbicide use unless navigation is severely limited. The committee at first decided the Lake District should guide property owners regarding when navigation is severely limited and recommend alternatives for management. This option was withdrawn in the draft plan. When DNR review comments indicated that permits would not be issued without some Lake District involvement, the board decided to become involved as described on page 60.

Plan Goals and Strategies

This section of the plan lists goals and objectives for aquatic plant management for project lakes. It also presents a detailed strategy of actions that will be used to reach aquatic plant management plan goals. The implementation plan will be updated each year. Actions may be modified as new information becomes available. The Aquatic Plant Management Advisory Committee will review potential modifications and make recommended changes to the Lake District Board. The board will approve updated implementation plans included modified management actions.

Goals = broad statements of direction. Goals are listed in priority order.

Objectives = measurable steps toward the goal

Actions = actions to take to accomplish objectives.

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

Plan Goals

1. Prevent introduction of aquatic invasive species and pursue any new introductions aggressively.

2. Reduce the population and spread of curly leaf pondweed, purple loosestrife, and other invasive aquatic plants.

3. Maintain navigable routes for boating.

4. Preserve our diverse native aquatic plant community.

5. Reduce runoff of nutrients and sediment from the lakes' watershed.

6. Educate the public regarding aquatic plant management.

1. Prevent introduction of aquatic invasive species and pursue any new introductions aggressively.

Objectives

A. Boaters inspect, clean, and drain boats, trailers and equipment.

B. Identify new aquatic invasive species as soon as possible after introduction to the lakes.

C. Rapidly and aggressively respond to new introductions of invasive species such as Eurasian water milfoil.

Actions

1. Continue a successful Clean Boats, Clean Waters program. (Objective A)
2. Monitor regularly for invasive species introduction at areas of high public use such as the boat landings using volunteers, divers, and/or other comprehensive, reliable method. (Objective B)
3. Follow the Eurasian Water Milfoil Rapid Response plan (Appendix D). (Objective C)
4. Investigate and pursue available monitoring and control measures for priority invasive species such as Eurasian water milfoil and zebra mussels. (Objective B, C)
5. Install and monitor surveillance cameras at boat landings. (Objective A)
6. Investigate charging landing fees to carry out AIS prevention activities. (Objective A)
7. Investigate restricting access to one boat landing on the lakes (Objective A)

2. Reduce the population and spread of curly leaf pondweed, purple loosestrife, and other invasive aquatic plants.

Objectives: Curly leaf pondweed

Church Pine

A. Eradicate curly leaf pondweed if found in Church Pine Lake.

Round

B. Eliminate dense growth at the north end of Round Lake

Big (23 acres of CLP beds currently)

C. Priority 1: Reduce dense growth of curly leaf pondweed in beds near the boat landing to a mean rake density less than 1.

D. Priority 2: Reduce dense growth of curly leaf pondweed in remaining beds to a mean rake density of 1.

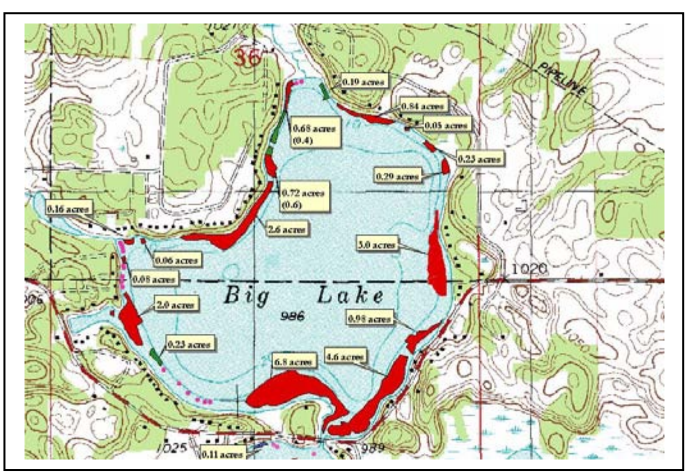
Actions: CLP

1. Hand pull any curly leaf pondweed found growing in Church Pine Lake. Use herbicide treatment only if hand pulling is not effective or practical. (Objective A)

2. Control CLP growing in dense beds using low-dose, early season Endothall treatment or other accepted method. (Objectives B, C, D)
   a. Select tentative beds for treatment in July of previous year (APM Lead or APM Advisory Committee)
   b. Select APM contractors (Herbicide Contractor, APM Monitor) in December (Board)
   c. Apply for APM permits in January or February (APM Lead with assistance from Herbicide Contractor)

3. Conduct DNR specified and required third-party pre and post herbicide monitoring for CLP herbicide treatment. (Objectives B, C, D)

4. Map beds of curly leaf pondweed annually. Look for curly leaf pondweed growth in Church Pine where reported in 1997 in transects 11 and 13. (Objective A-D)



Objectives: Purple loosestrife

A. Eradicate individual plants

B. Reduce populations in larger, established areas

Actions

1. Hire contractor to cut/apply herbicides to individual plants/patches. (Objective A and B)
2. Release beetles in inaccessible patches. (Objective B)
3. Map purple loosestrife growth (how often) to monitor progress toward objectives. (Objective A, B)

3. Maintain navigable routes for boating.

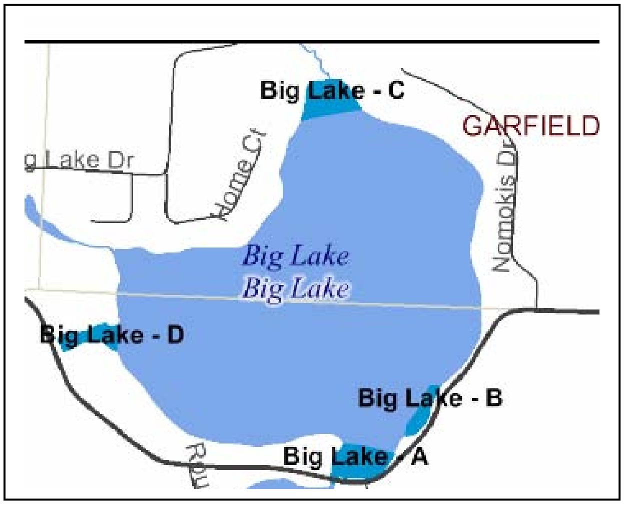
A. Reduce nuisance conditions when native plant growth creates problems/nuisances in identified areas. The area with navigation impairment currently identified is Sensitive Area D in Big Lake.

B. Allow access through native and invasive aquatic plants to individual waterfront corridors.

Action:

1. Monitor to identify navigation impairment. (Objective A)

2. Seek permit and address confirmed navigation impairment using appropriate method. (Objective A)
Herbicide application will generally be used to manage impaired navigation areas. The herbicide will target species present in problem area. Floating aquatic species such as water lilies may be addressed in subsequent years with preventative treatment measures (i.e., early June application).



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

Action

3. Allow individual landowners to apply for permits and treat individual access corridors. (Objective B)
   These treatments may focus on invasive or native plants. Landowners would bear the cost of these treatments. Hand removal methods are recommended as a first choice for navigation impairment created by native plants. Hand removal does generally not require a permit when limited to a 30-foot opening. Native plants provide an important shield against invasion by Eurasian water milfoil and other invasive aquatic plant species.

Procedure for Individual Corridor Permitting and Monitoring

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

- Indicate when plants cause problems and how long problems persist.
- Include dated photos of nuisance conditions from previous season (or location relative to curly leaf pondweed bed map).
- List depth at end of dock.
- Provide examples of specific activities that are limited because of presence of nuisance aquatic plants.
- Describe practical alternatives to herbicide use or harvesting that were considered. These might include:
  Hand removal/hand raking of aquatic plants
  Extending dock to greater depth
  Altering the route to and from the dock
  Use of another type of watercraft or motor, i.e., is the type of watercraft used common to other sites with similar conditions on this lake?
- Herbicide use for curly leaf pondweed may occur along the entire length of a waterfront property owner's shoreline.
- Aquatic Herbicide/Harvesting Contractor to provide this information in permit application based on information from the landowner.

Verify/refute nuisance conditions and/or navigation impairment

- Landowner requests Lake District APM Lead or designee review of their property prior to submitting a permit application to DNR.
- The Lake District APM Lead or designee visits site, reviews documentation and provides a written opinion of navigation impairment i.e., is herbicide treatment or harvesting warranted?
- Standards for Lake District review: degree of navigation impairment, narrow corridors may be recommended in sensitive areas or for lots less than 100 feet in width.
- Landowner/applicator applies for permit to WDNR including photographic documentation, and identification of plants causing navigation problems.
- For curly leaf pondweed treatment, verification must occur the year before treatment in May or June. Once CLP nuisance is verified and a permit is approved, additional verification is not needed for three subsequent years (although permit applications must be completed each year). Treatment for CLP must occur with water temperatures from 50 - 58 degrees F.
- WDNR will contact herbicide contractor and owner with a notice to proceed with treatment or denial of permit application.

4. Preserve our diverse native aquatic plant community.

Objectives

A. Maintain native plants to prevent AIS introduction.

B. Protect native plant sensitive/critical habitat areas – especially areas with emergent vegetation like rushes and cattails.

C. Increase residents' understanding of the role and importance of aquatic plants and their impacts on them.

Actions

1. Limit native plant management in sensitive areas to narrow corridors (30 feet maximum width). (Objective B)

2. Implement strict adherence with treatment standards (early CLP treatment prior to native plant growth) and monitoring methods prior to and following herbicide treatment. (Objective A, B)

3. Limit removal of native plants to areas with severe navigation problems or nuisance conditions. (Objective A, B, C)

4. Use methods outlined in Goal 6 to deliver messages regarding native plant values. (Objective C)

5. Reduce runoff of nutrients and sediment from the lakes' watershed.

Objectives

A. Reduce runoff from agricultural property.

B. Reduce runoff from waterfront property.

C. Better understand the lakes water and nutrient budgets and the sources of phosphorus from the watersheds.

Actions

1. Address loading of agricultural pollutants from the north end of Big Lake. (Objective A)

2. Encourage waterfront property owners to reduce runoff from their land. (Objective B)

3. Complete water quality and watershed studies to better understand nutrient loading to the lakes. (Objective C)

4. Identify best management practices to limit inputs of nutrients and sediment to the lakes. (Objective A, B)

6. Educate the public regarding aquatic plant management.

Audience
Lake residents (full time and part time)
Lake users/visitors

Messages
Aquatic plant management plan
Why we are implementing the plan; who is doing it; when it will be completed.
Report progress toward plan goals and objectives
Inform landowners of the process for applying for individual corridor permits.

Invasive species prevention
Identify CLP, PL and EWM with photos and descriptions.
Explain methods to avoid spread of invasive species.
Show maps of CLP and PL on the lakes.
Clean aquatic vegetation from boats and trailers.
Polk County and the state of Wisconsin prohibit transporting aquatic plants on boats and trailers.
Fines may result if you don't obey the law.
Recommend information to be included with DNR licenses – boat registration and operation.

Native plant values
Native plants prevent invasive species from getting established.
Residents should understand the need for a balance and not attempt to eliminate all aquatic plants.

Reducing runoff
Fertilizer use on fields and lawns can cause algae growth in lakes.
Lakeshores can be managed/landscaped to reduce runoff.
It is against the law to apply herbicide in the lake without a permit.
Homeowners may use hand removal methods such as raking to open access to docks and shoreline in a designated area up to thirty feet wide on their waterfront.

Methods

- Website (include pictures)
- Signs
- Clean Boats, Clean Waters inspectors
- Lake District meetings: annual meeting, special meetings
- Plant identification workshops
- Neighborhood/smaller group meetings
- Mailing: information/reports to all lake property owners. Consider door to door contact
- Personal visits to lake residents
- Flyers at Big Lake Store
- Pictures
- Handouts

Implementation Plan

1. Prevent introduction of aquatic invasive species and pursue any new introductions aggressively.						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
1. Clean Boats, Clean Waters (grant through 12/31/11)	Memorial Day through Labor Day	$9,691	248	$9,691	85	CBCW Committee
2. Monitor areas of high public use (grant eligible)	July/August	$1,000		$1,000		Consultant/Diver
3. Set up a Eurasian Water Milfoil Contingency Fund	2011 Budget	$2,500				Treasurer
4. Zebra mussel monitoring (grant eligible)	Annually	$0	5	$0	5	Polk LWRD
5. Install surveillance cameras at both boat landings (grant eligible - $4,000 limit per camera)	May	$19,952	10	$4,000	10	Environmental Sentry Protection, LLC
6. Investigate charging landing fees to fund prevention actions			20		20	Lake District Board
7. Investigate restricting access to reduce risk of invasive species introduction			20		20	Lake District Board
SUBTOTAL GOAL 1		**$33,143**	**303**	**$14,691**	**140**	
Existing grant funding		$8,500		$0		
Potential grant funding (@ 75%)		$4,750		$8,018		

2. Reduce the population and spread of curly leaf pondweed, purple loosestrife, and other invasive aquatic plants.						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
Curly Leaf Pondweed						
1. Hand pull curly leaf pondweed in Church Pine Lake	June		25		25	Board/Volunteers
2. Control CLP with low dose, early season Endothall application						
a. select beds for treatment	August (prev. Year)					Lake District Board
b. select APM contractors	January		20		20	Lake District Board
c. apply for APM permits	February	$645	5	$645	5	Board Herbicide Contractor
d. complete herbicide treatment	May	$15,000	5	$15,000	5	Board Herbicide Contractor
3. Conduct pre and post monitoring	May and June	$1,500		$1,500		Lake District Board Monitoring Consultant
4. Map beds of curly leaf pondweed	June	$1,000		$1,000		Lake District Board Monitoring Consultant
Purple Loosestrife						
1. Cut/treat plants	July/August	$1,000		$1,000		Herbicide Contractor
2. Grow and release beetles	May – July	0	40	0	40	Volunteer
3. Map purple loosestrife locations and extent	September	$250		$250		Monitoring Consultant or Herbicide Contractor
SUBTOTAL GOAL 2		**$19,395**	**95**	**$19,395**	**95**	
All activities are grant eligible @ 75% (not guaranteed)		$14,546		$14,546		

3. Maintain navigable routes for boating.						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
1. Monitor to identify navigation impairment[24]	July/August	$200	10	$200	10	Lake District Board Herbicide Contractor
2a. Seek permit if navigation problems identified		$45		$45		Lake District Board Herbicide Contractor
2b. Control nuisance plant growth with permitted method	Summer	$500		$500		Lake District Board Herbicide Contractor
3. Allow individuals to apply for permits to maintain access corridors	Summer	$0	0	$0	0	Lake Residents Herbicide Contractor
SUBTOTAL GOAL 3 Activities are not grant eligible		**$745**	**10**	**$745**	**10**	

4. Preserve our diverse native aquatic plant community. (All actions carried out as components of other goals.)						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
1. Sensitive area management limited to 30 foot corridors	Ongoing	$0	0	$0	0	Lake District Board Herbicide Contractor
2. Follow treatments standards and monitoring protocol	Ongoing	$0	0	$0	0	Lake District Board Herbicide Contractor Monitoring Consultant
3. Limit removal of native plants	Ongoing	$0	0	$0	0	DNR Lake District Board
4. Deliver educational messages	Ongoing	$0	0	$0	0	Lake District Board
SUBTOTAL GOAL 4		**$0**	**0**	**$0**	**0**	

[24] Navigation route will be identified in August 2010. Current bay (Sensitive Area D) is 600 feet long. A channel 30 feet wide would total .4 acres.

5. Reduce runoff of nutrients and sediment from the lakes' watershed.[25]						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
1. Consider methods to address agricultural pollution.						Lake District Board Polk County LWRD
2. Encourage waterfront property owners to reduce runoff.						Lake District Board
3. Complete water quality and watershed studies.						Lake District Board
4. Identify and implement preferred best management practices						Lake District Board
SUBTOTAL GOAL 5 All activities are grant eligible	?	?	?	?	?	

6. Educate the public regarding aquatic plant management.						
Actions	Timeline	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012	Responsible Parties
1. Update web site	Ongoing	$500	20	$500	20	Lake District Board
2. Annual meeting/special meetings	Summer/Fall	$20	20	$20	20	Lake District Board
3. Workshops/small group meetings	Summer	$200	20	$200	20	Lake District Board Volunteers DNR Polk LWRD
4. Mailings/handouts	Ongoing	$200	20	$200	20	Lake District Board Volunteers
SUBTOTAL GOAL 6 All activities are grant eligible		**$920**	**80**	**$920**	**80**	

[25] Implementation for this goal will be developed by the committee following plan approval.

GOAL	Cost 2011	Volunteer Hours 2011	Cost 2012	Volunteer Hours 2012
SUBTOTAL GOAL 1 (AIS prevention)	$33,143	303	$13,500	140
SUBTOTAL GOAL 2 (AIS control)	$19,395	95	$23,395	95
SUBTOTAL GOAL 3 (Navigation)	$745	10	$745	10
SUBTOTAL GOAL 4 (Native plant protection)	$0	0	$0	0
SUBTOTAL GOAL 5 (Runoff)	?	?	?	?
SUBTOTAL GOAL 6 (Education)	$920	80	$920	80
PLAN TOTAL	**$54,203**	**488**	**$35,751**	**325**
Existing grants	$8,500			
Potential grants	$19,986		$23,254	

Monitoring and Assessment

Aquatic Plant Surveys

Aquatic plant (macrophyte) surveys are the primary means for tracking achievement toward plan goals.

Action. Conduct whole lake aquatic plant surveys approximately once every five years to track plant species composition and distribution. The next survey is scheduled for 2014.

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

Aquatic Invasive Species Grants

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

The Lake District currently has three DNR grants for the development of this management plan and the implementation of the Clean Boats, Clean Waters program.

Grant	Amount	Purpose
Lake Management Planning (SPL-208-09)	$3,000	Plant Survey
Lake Management Planning (LPL-1299-09)	$10,000	CLP Survey APM Plan
Aquatic Invasive Species (AEPP-212-10)	$15,660	Clean Boats, Clean Waters

Adaptive Management Approach

The treatment areas, standards, and methods will be reviewed each year to see if they are effective and cost efficient. Changes may be made to the treatment approach based upon project results, the experience of other lake groups, and/or recommendations from the Department of Natural Resources. Significant changes will be documented as brief addendums to the aquatic plant management plan to be reviewed by the Lake District Board, the APM Advisory Committee, and the Department of Natural Resources.

Appendix A. Invasive and Nuisance 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.[26]

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.[27]

[26] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species*. Prepared by Wisconsin DNR. September 2003.
[27] 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*)[28]

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

[28] 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.

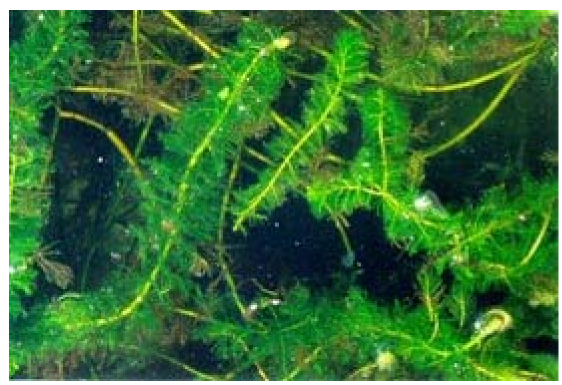
Control

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

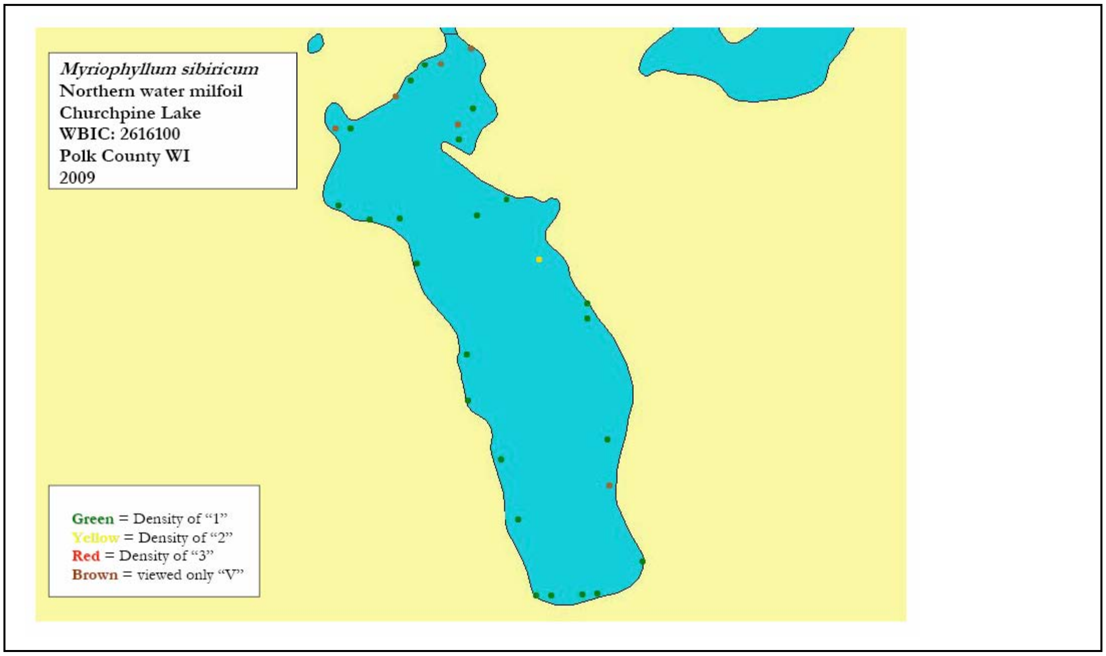
Unlike many other plants, Eurasian water milfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the 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.

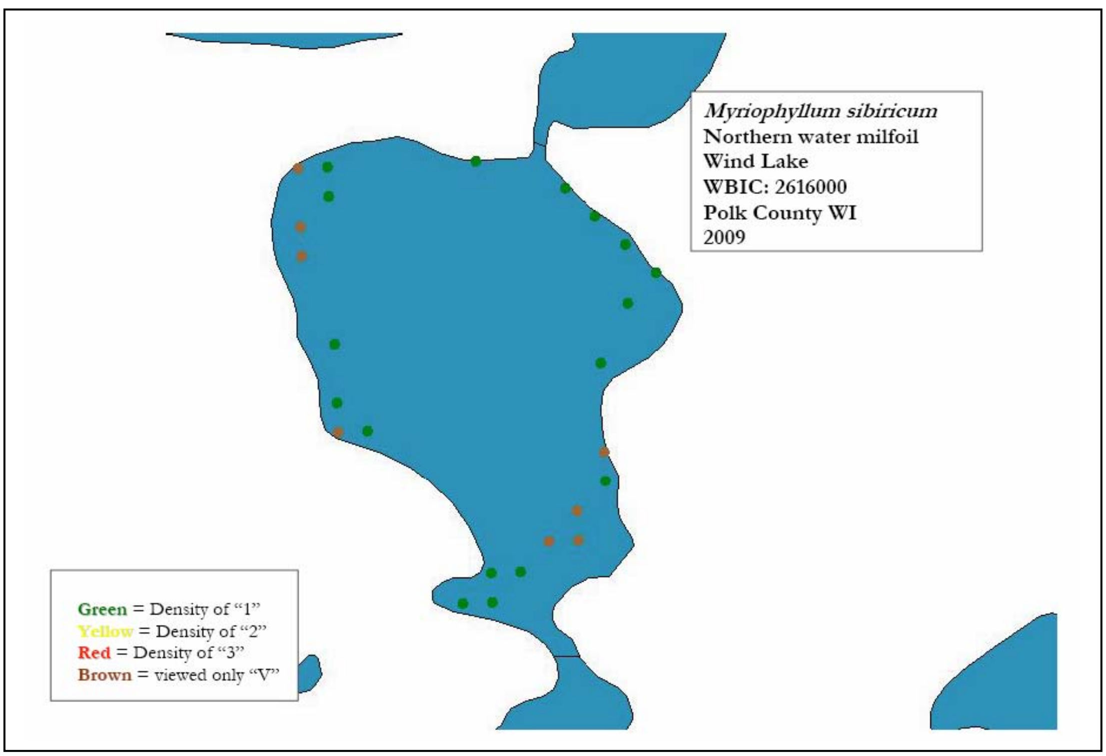
Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted 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. [29]

Eurasian water milfoil is likely to become established especially in areas where northern water milfoil grows. Maps on following pages indicated where northern water milfoil was found on project lakes.

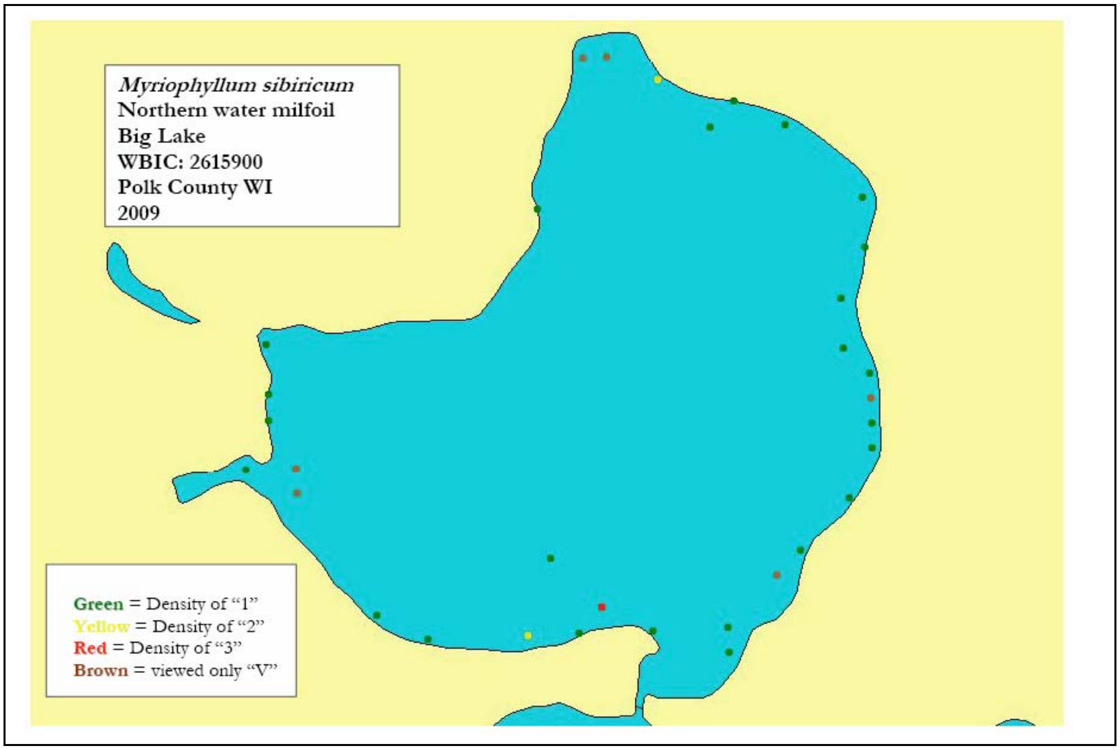
[29] Taken in its entirety from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/milfoil.htm



Northern water milfoil present on Churchpine Lake 2009.



Northern water milfoil present on Round (Wind) Lake 2009.



Northern water milfoil present on Big Lake 2009.

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.[30]

Purple Loosestrife (*Lythrum salicaria*)[31]

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,

[30] Taken from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm
[31] Wisconsin DNR invasive species factsheets from http:/dnr.wi.gov/invasives.

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

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. This plant's optimal habitat includes marshes, stream margins, river flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

Reproduction and Dispersal

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local disturbance is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland.

Ecological Impacts

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

Mechanical Control

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

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

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

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

Chemical Control

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

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

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

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

Biological Control

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

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

Zebra Mussels (*Dreissena polymorpha*)

The zebra mussel is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them since that time. They were most likely brought to North America as larvae in ballast water of ships that traveled from fresh-water Eurasian ports to the Great Lakes. Zebra mussels look like small clams with a yellowish or brownish D-shaped shell, usually with alternating dark- and light-colored stripes. They can be up to two inches long, but most are under an inch. Zebra mussels usually grow in clusters containing numerous individuals.

Zebra mussels were first found in Wisconsin waters of Lake Michigan in 1990. They are now found in a number of inland Wisconsin waters. Zebra mussels are the only freshwater mollusks that can firmly attach themselves to solid objects. They are generally found in shallow (6-30 feet deep), algae-rich water.

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

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. Be sure to follow the Clean Boats, Clean Waters procedure in preventing the spread of aquatic hitchhikers. In addition to these measures, boaters can take specific precautions in protecting their motors from zebra mussels.

No selective method has been developed that succeeds in controlling zebra mussels in the wild without also harming other aquatic organisms. To a certain extent, ducks and fish will eat small zebra mussels, but not to the point of effectively controlling their populations. As of yet, no practical and effective controls are known, again emphasizing the need for research and prevention.

Filamentous Algae

Filamentaous algae, sometimes called "moss" or "pond scum" is a common and troublesome native aquatic plant that forms dense, hair-like mats in shallow water. Mats of filamentous algae usually form at the sediment-water interface or in rooted plant beds in the presence of adequate light. Algae growth is nourished by nutrients released by decay processes and present in the lake water column from other sources. As filamentous algae grows, it produces oxygen that gets trapped in the entangled strands of algae. This entrapped oxygen makes the algae buoyant and causes it to rise to the surface. Some of the more common forms of filamentous algae can be identified by their texture, although microscopic examination is usually required for exact recognition. Cladophora feels "cottony," while spirogyra is bright green and very slimy to the touch, and pithophora (or "horse hair") has a very coarse texture like horse hair or steel wool.[32]

Filamentous algae control

Nuisance growth of filamentous algae may indicate that a lake has excessive nutrients, although some amounts of algae will grow in low nutrient conditions. The long-term management strategy for filamentous algae is to reduce nutrient flow into the lake. Short-term management methods may include raking to physically remove algae; introducing algae eaters such a grass carp and tilapia (although this is more practical and acceptable in ponds); and chemical controls such as copper sulfate. Harvesting is usually not practical. The best control is to prevent mats from forming by removing sediment or treating algae at an early stage (phosphorus inactivation or early algaecide application).[33] The best method for homeowners to remove filamentous algae is to rake out the floating clumps and limit the nutrients that reach the water from waterfront property. Filamentous algae can be composted or used as garden mulch. Chemical control always requires a permit from DNR.

Deer Lake, Polk County, WI[34]

Filamentous algae was noted at 66 percent of the sample sites in a June 2003 point intercept survey of Deer Lake. It was found at 29 percent of the sample sites in 2006. The aquatic plant survey will be repeated in 2010. The Deer Lake Improvement Association used copper sulfate to treat 15 acres of filamentous algae up to 7 times/year as recently as 2007. In 2009, there was one treatment of one acre. The threshold for filamentous algae treatment in the aquatic plant management plan is “a floating mat that covers at least 1000 square feet.” Significant reductions in watershed phosphorus loading (over 50% reduction since 1996) are a likely reason for the declines in filamentous algae growth.

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[32] Wisconsin DNR web site.

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

[34] *Deer Lake Aquatic Plant Management Plan and Surveys*. Harmony Environmental and Ecological Integrity Services. 2003 and 2006.
Deer Lake Conservancy and Deer Lake Association Annual Meeting Notes. July 10, 2010.

Frequency of occurrence of filamentous algae from 2009 plant survey

Church Pine: 7.25 percent

Round: 1.16 percent

Big: 19 percent

Appendix B. Aquatic Plant Management Strategy WDNR

AQUATIC PLANT MANAGEMENT STRATEGY

Northern Region WDNR
Summer, 2007

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

ISSUES

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

BACKGROUND

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

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

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

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

GOALS OF STRATEGY:

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

BASIS OF STRATEGY IN STATE STATUTE AND ADMINISTRATIVE CODE

State Statute 23.24 (2)(c) states:

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

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

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

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

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

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

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

APPROACH

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

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

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

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

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

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

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DOCUMENTATION OF IMPAIRED NAVIGATION AND/OR NUISANCE CONDITIONS

Navigation channels can be of two types:

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

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

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

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

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

Documentation of the *nuisance* must include:

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

AQUATIC PLANT MANAGEMENT STRATEGY
Northern Region WDNR

DEFINITIONS

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

Appendix C. References

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

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

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

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

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

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

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

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

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

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

8. Select a control plan in cooperation with the WDNR (Lake District Board). The goal of the rapid response control plan will be eradication of the EWM. Additional guidance regarding

EWM treatment is found in DNR's *Response for Early Detection of Eurasian Water Milfoil Field Protocol*.

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

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

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

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

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

EXHIBIT A[1]

CHURCH PINE, ROUND, AND BIG LAKE PROTECTION AND REHABILITATION DISTRICT

EWM ID Volunteers	Bruce Balck:	715-294-3136 (home)	651-303-3303 (mobile)
	Brent Martin:	715-294-4058 (home)	612- 209-6124 (mobile)
Board Contact	Gary Ovick:	715-294-3988 (home)	715-417-1770 (mobile)

POLK COUNTY LAND AND WATER RESOURCES DEPARTMENT

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

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

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

HERBICIDE APPLICATOR

Bid each December

APM MONITOR

Ecological Integrity Services	Steve Schieffer: 715-554-1168 (in 2009)

DIVERS

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

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

Appendix E. 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.