Aquatic Plant Management Plan

Lake Nancy, Washburn County, Wisconsin

December 2018

Photo by Nancy Votava

Sponsored By

Lake Nancy Protective Association

Aquatic Plant Advisory Committee Members

Prepared By

Harmony Environmental — Plan Writing and Facilitation

Ecological Integrity — Aquatic Plant Survey and Mapping

Funded By

Lake Nancy Protective Association

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WISCONSIN DEPT. OF NATURAL RESOURCES

February 13, 2019

Mr. Jim Splan
2821 East 2nd Street
Duluth MN 55812
VIA EMAIL

Subject: Nancy Lake Aquatic Plant Management Plan

Dear Mr. Splan:

Thank you for your efforts to understand and manage Nancy Lake, Washburn County. This letter is to notify you that the DNR approves the December 2018 Nancy Lake Aquatic Plant Management Plan (Plan). Management recommendations specified below are eligible for funding under Lake Management Planning, Lake Protection and Classification, and Aquatic Invasive Species (AIS) grants subject to the application requirements of those programs.

Approved management recommendations include the following:

1. AIS prevention activities, including watercraft inspection and volunteer monitoring.
2. Aquatic plant and water quality monitoring.
3. Educational activities, including AIS workshops, signage, etc.
4. AIS control.

Thanks to you and the lake community for your continued efforts. Please contact me (715-635-4073) if you have any questions.

Sincerely yours,

Pamela Toshner

Pamela Toshner
Lake Biologist

CC: Cheryl Clemens, Harmony Environmental
Mark Sundeen, WDNR

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EXECUTIVE SUMMARY

This Aquatic Plant Management Plan for Lake Nancy presents strategies for preventing establishment of zebra mussels and other invasive species, reducing runoff of pollutants from the watershed, protecting native plant populations, and controlling the growth of Eurasian watermilfoil (EWM) through the year 2023. The plan includes data about the plant community, watershed, and water quality of the lakes.

The aquatic plant survey found that Lake Nancy has a very diverse native aquatic plant community. This is especially true in the shallow areas of the lake like Pecos Bay, Shallow Lake, and Lost Lake. Native plants provide fish and wildlife habitat, stabilize bottom sediments, reduce the impact of waves against the shoreline, and prevent the spread of the non-native invasive plant Eurasian watermilfoil – all critical functions for the lake. Eurasian watermilfoil was first discovered in Lake Nancy in 1991. Its growth is generally limited to the Big Lake and Deep Lake basins of Lake Nancy. Because of limited growth, no Eurasian watermilfoil control efforts were completed in 2018.

With experience and success in control the invasive plant Eurasian watermilfoil, this plan focuses efforts on other priorities as indicated by the plan goals listed in priority order below:

GOAL 1) EDUCATE LAKE RESIDENTS AND VISITORS ABOUT THE THREATS FROM INVASIVE SPECIES, THE IMPORTANCE OF NATIVE AQUATIC AND SHORELAND PLANTS, AND THE PLAN MANAGEMENT STRATEGIES.

GOAL 2) PREVENT THE INTRODUCTION AND SPREAD OF ZEBRA MUSSELS AND OTHER AQUATIC INVASIVE SPECIES.

GOAL 3) MINIMIZE RUNOFF OF POLLUTANTS FROM THE LAKE NANCY WATERSHED.

GOAL 4) PRESERVE THE LAKE'S DIVERSE NATIVE PLANT COMMUNITIES.

GOAL 5) PREVENT THE SPREAD OF EURASIAN WATERMILFOIL.

The implementation plan describes the actions that will be taken toward achieving these goals.

A special thank you is extended to the Aquatic Plant Advisory Committee for assistance with plan development. Members of the Lake Nancy Protective Association have a strong volunteer ethic and significant dedication to lake protection efforts. This plan relies on that tradition and the knowledge of the board and volunteers with assistance from local, state, and federal project partners.

INTRODUCTION

This Aquatic Plant Management Plan for Lake Nancy presents strategies for preventing establishment of zebra mussels and other invasive species, reducing runoff of pollutants from the watershed, protecting native plant populations, and controlling the growth of Eurasian watermilfoil (EWM) through the year 2023. 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 preventing establishment of invasive species and sound management of aquatic plants are presented. This plan will guide the Lake Nancy Protective Association (LNPA), Washburn County, and the Wisconsin Department of Natural Resources in aquatic plant management for Lake Nancy over the next five years (from 2019 through 2023).

PUBLIC INPUT FOR PLAN DEVELOPMENT

The Lake Nancy Aquatic Plant Advisory Committee provided input for the development of this aquatic plant management plan. The Aquatic Plant Advisory Committee met three times. At the first meeting August 18, 2018 the committee reviewed aquatic plant management planning requirements, existing plan goals, plant survey results, and EWM management efforts to date. At a second meeting September 15, 2018 the committee reviewed zebra mussel prevention and monitoring and updated the plan's educational strategies. At a third meeting September 29, 2018 the committee updated the plan implementation strategy. The APM Committee expressed a variety of concerns that are reflected in the goals and objectives for aquatic plant management in this plan.

The Lake Nancy Protective Association (LPNA) board announced the availability of the draft Aquatic Plant Management Plan for review in the October 2018 newsletter which is distributed to all lake residents. Announcements were also sent to the Washburn County Lakes and Rivers Association, Town of Minong, and Washburn County. The plan was approved by the LNPA board October 21, 2018.

Copies of the plan were made available to the public on the Lake Nancy Protective Association web site (https://lakenancyminong.wordpress.com/) and at the Minong Town Hall. Comments were accepted through December 1, 2018. All comments received were supportive of the plan contents.

LAKE INFORMATION

Lake Nancy is a 772-acre lake with a water body identification code of 269150. Its maximum depth is 39 feet. Lake Nancy is a drainage lake with inflow from a channel that originates from the Kimball Lakes chain. The lake is separated into three main basins: Big Lake, Deep Lake, and Shallow Lake. Information about each basin is reported in Table 1 below. A map of Lake Nancy is shown as Figure 1. Lake Nancy is located in Washburn County in the Town of Minong (T42N, R13W).

Table 1. Lake Information

	Big Lake	**Deep Lake**	**Shallow Lake**	**Lake Nancy**
Size (acres)	400	90	282	772
Mean depth (feet)	16	20	4	12
Maximum depth (feet)	28	39	6	39

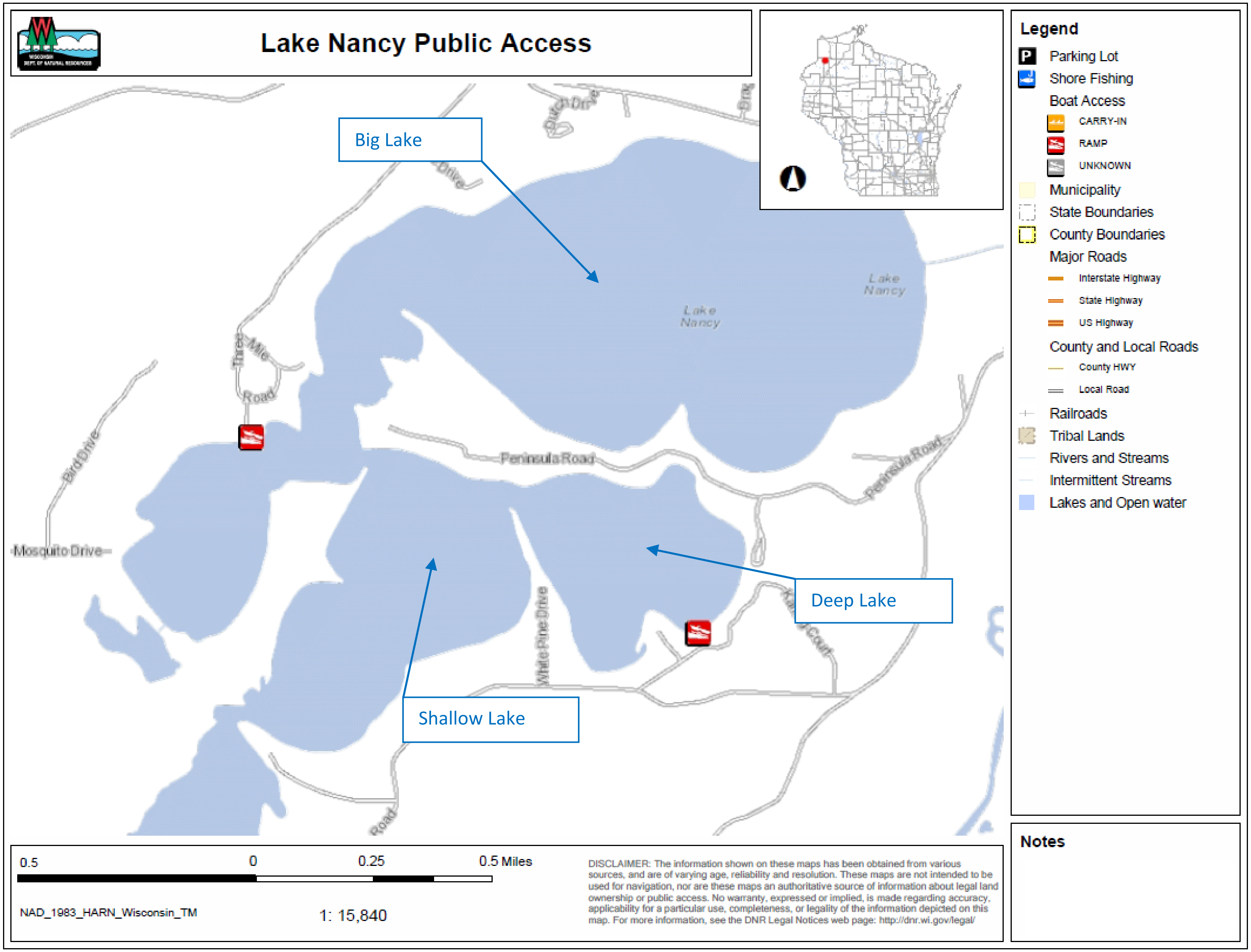

Figure 1. Lake Nancy Map

WATER QUALITY

Water quality is frequently reported by the trophic state or nutrient level of the lake. Nutrient rich lakes are classified as eutrophic. These lakes tend to have abundant aquatic plant growth and low water clarity due to algae blooms. Mesotrophic lakes have intermediate nutrient levels and only occasional algae blooms. Oligotrophic lakes are nutrient poor with little growth of plants and algae.

Secchi depth readings are one way to assess the trophic state of a lake. The Secchi depth reported 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. It is important to note that factors other than nutrient status (such as tannins in the water) may reduce water clarity and influence Secchi depth results.

Secchi depth readings, phosphorus concentrations, and chlorophyll measurements can each be used to calculate a Trophic State Index (TSI) for lakes. TSI values range from 0 – 110. TSI values from 40 to 50 characterize mesotrophic lakes. Lakes with TSI values greater than 50 are considered eutrophic, and lakes with TSI values below 40 are considered oligotrophic.

TSI values for project lake basins based on Wisconsin Department of Natural Resources (WDNR) records for July and August are shown in Figures 2-5 below. Volunteers have collected lake data on a regular basis since 2002 from the Big Lake and Deep Lake basins of Lake Nancy. Figure 2 illustrates Secchi depth averages from 2002 through 2017 for the Big Lake basin. Figure 3 graphs trophic state based upon Secchi, chlorophyll, and total phosphorus results. Figure 4 illustrates Secchi depth averages for the Deep Lake basin, and Figure 5 graphs trophic state results for Deep Lake. Based on these results, Lake Nancy is a mesotrophic lake.

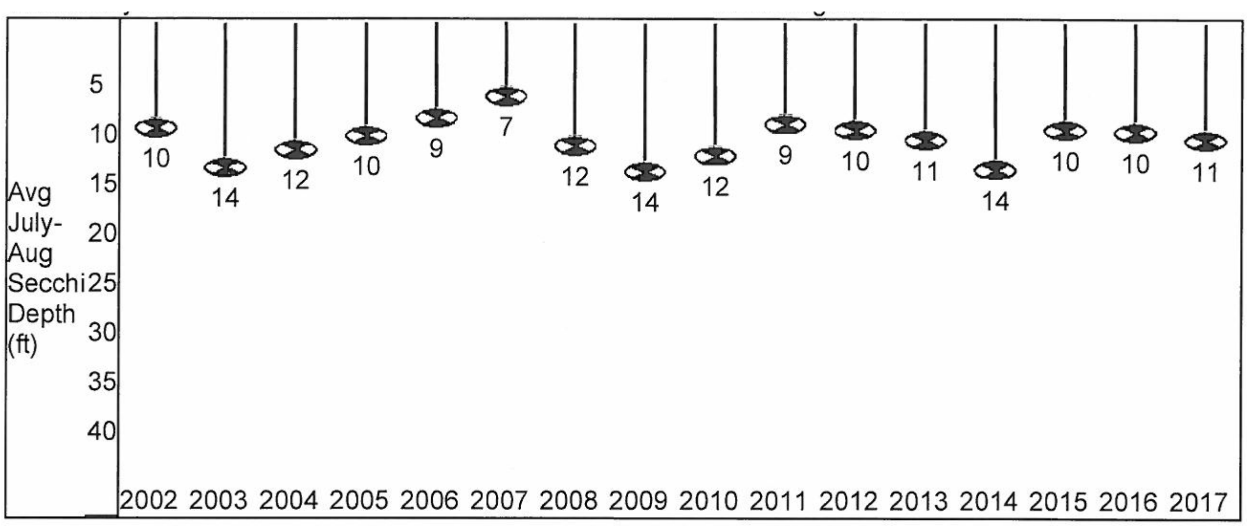

Figure 2. Big Lake Secchi Depth 2002 - 2017

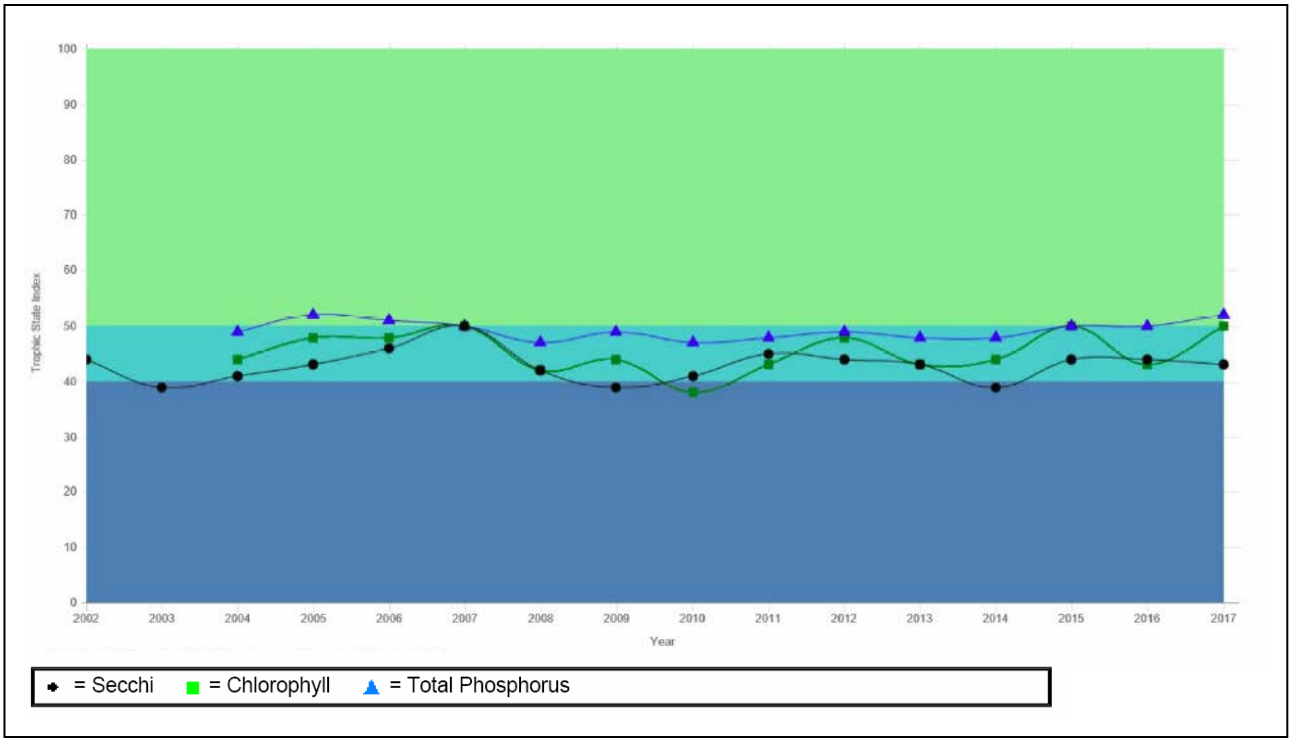

Figure 3. Big Lake Trophic State Index July/August 2002 - 2015

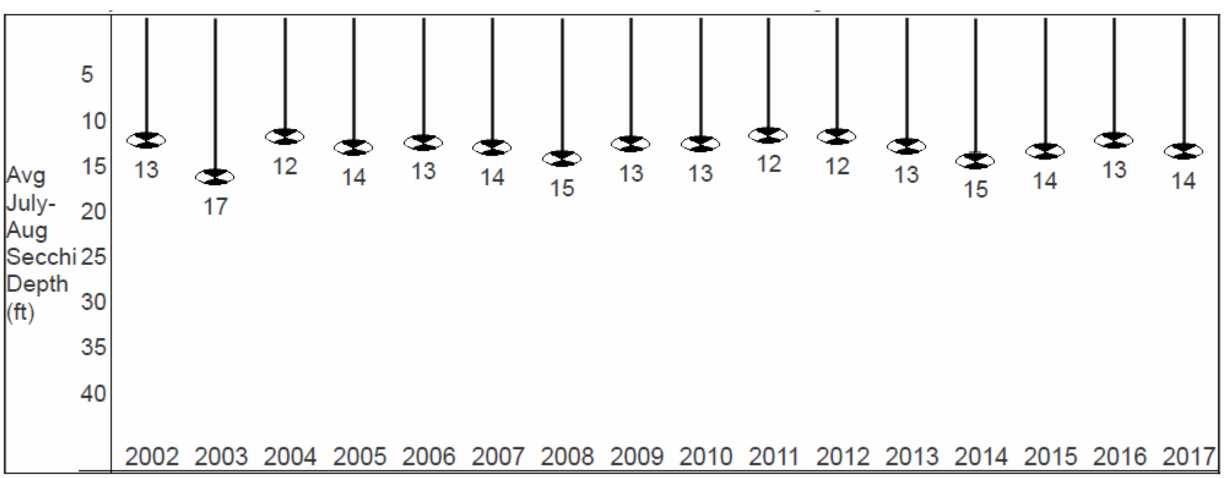

Figure 4. Deep Lake July/August Secchi Depth Averages

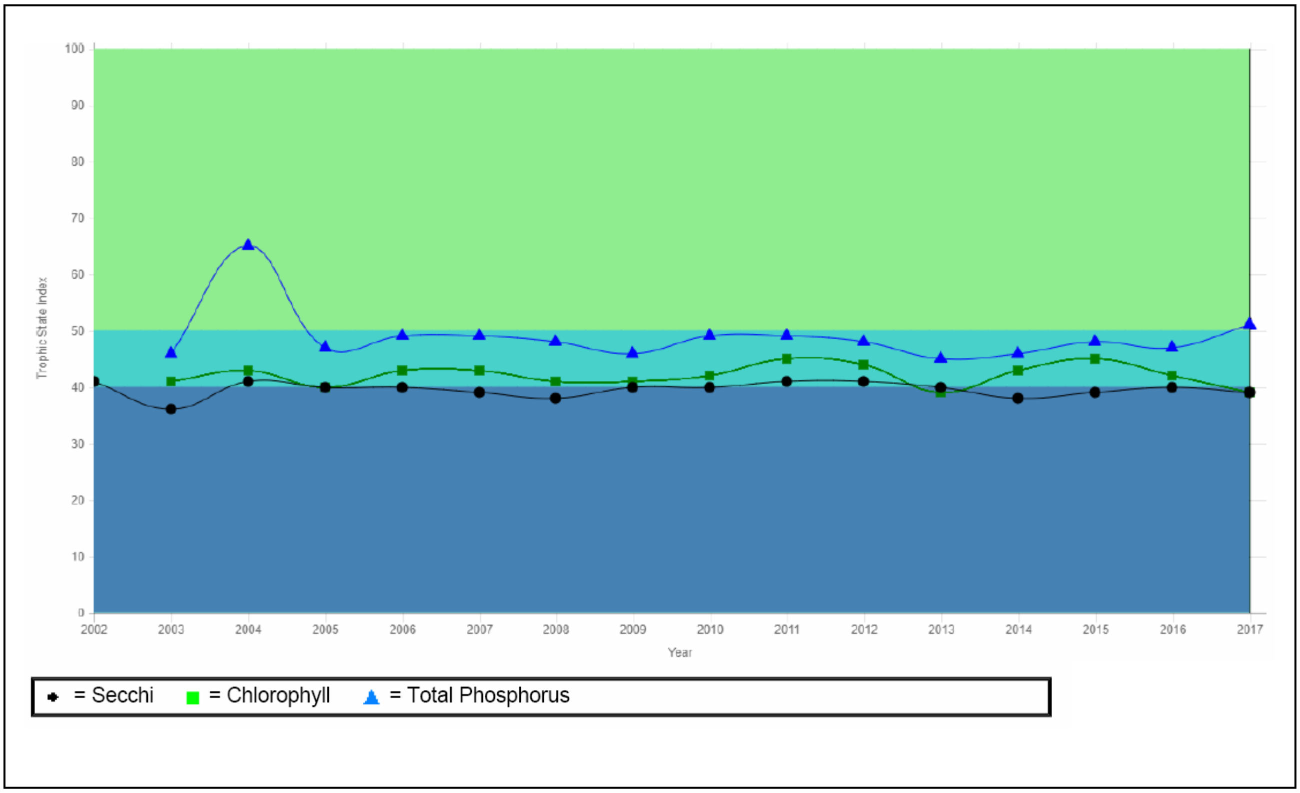

Figure 5. Deep Lake Trophic State July/August 2002-2017

The Shallow Lake basin does not have recorded regular monitoring. However, this area was monitored as part of a 2000 Lake Management Plan study. This basin consistently had Secchi depth readings of 5 feet, with the lake bottom visible. Total phosphorus readings were very similar to the Deep Lake and Big Lake basins.

WATERSHED

The lakes' watershed is part of the Lower Namekagon River watershed (Watershed Identification Key SC19) in the St. Croix River Basin. Lake Nancy has an outflow creek which empties into the Totogatic River and subsequently joins the Namekagon. Watershed data reported below was developed as part of the Lake Nancy Lake Management Plan.[1] Another view of the watershed and its land use is presented in the WDNR's PRESTO-Lite Watershed Report in Appendix A. The watershed map illustrated in Figure 6 is from this report.

The Lake Nancy watershed consists of forested (60%), wetland (34%), and residential shoreland (6%) cover. The watershed (or drainage area) of Nancy Lake is 3,125 acres not including the lakes' surface. Watershed area is broken down in Table 2 below.

Table 2. Lake Nancy Watershed Area

Watershed Component	Acres
Big Lake Basin	663
Wetland/Kimball Lake Channel	1609
Deep Lake Basin	242
Shallow Lake Basin	611
Lake Nancy Watershed	3,125

PHOSPHORUS FROM WATERSHED RUNOFF

Phosphorus is the pollutant that most influences the clarity of Lake Nancy because it is the limited ingredient for algae growth.[2] For Lake Nancy, almost half of the phosphorus loading comes from rain and particles falling on the lake. Table 3 summarizes phosphorus loading calculated for the lake management plan.

Phosphorus is also carried in runoff from the watershed both dissolved in the water and carried in soil particles that erode from bare soil. Phosphorus runoff from the watershed is determined by how land is used in the lake's watershed along with watershed soils and topography.

When a watershed is maintained in natural vegetation, there is less runoff of pollutants that impact the lake. Agricultural and residential land tends to contribute greater amounts of phosphorus in runoff. Soil erosion is reduced when there is good vegetative cover. Water flow is slowed by tall vegetation, and forest groundcovers and fallen leaves allow runoff water to soak into the ground. In summary, anything that reduces soil erosion and/or the amount of nutrient-rich runoff water flowing from a portion of the watershed reduces pollution to the lake.

[1] McComas, Steve, Blue Water Science. Lake Nancy, Washburn County, Wisconsin Lake Management Plan. May 2001.

[2] Based on nitrogen to phosphorus ratios from sample results for both lakes from 2000.

Shoreland areas are important contributing areas of lake watersheds, and as described above, those in a natural state generally result in less runoff and phosphorus loading to lakes. Volunteers completed a shoreland inventory as part of the lake management study in 2000. The inventory focused on the shoreline areas back to about 15 feet from the water's edge. Volunteers looked at 217 parcels on the lake, and found 41, or 19 percent, of parcels undeveloped. They also found that 80% had at least 50% of the first 15 feet of shoreline buffer in natural vegetation. Fewer residents (72 %) had at least 75% of the first 15 feet of shoreline buffer in natural vegetation. The lake management plan reported that this compared favorably with other Wisconsin and Minnesota lakes. However, this does not necessarily mean that Lake Nancy parcels meet local standards for shoreland buffer zones. Washburn County standards generally require natural vegetation back at least 35 feet for 65% of the shoreline.

Table 3. Lake Nancy Phosphorus Inputs (2000)

Phosphorus (P) Source	Area or Quantity	Pounds/Year	Percent of P Load
Rainfall on the lake	772 acres	205	48
Forests	915 acres	73	17
Wetlands	516 acres	47	11
Residential shorelands	85 acres	9	2
Septic systems	100 systems[3]	21	5
Kimball chain	1609 acres	73	17
TOTAL P INPUT		428	100

[3] Although the LNPA board reports that there are about 175 septic systems in 2008, 100 is the number of systems used in the calculation for the year 2000 phosphorus loading. There is no explanation of why this number was used in the McComas plan.

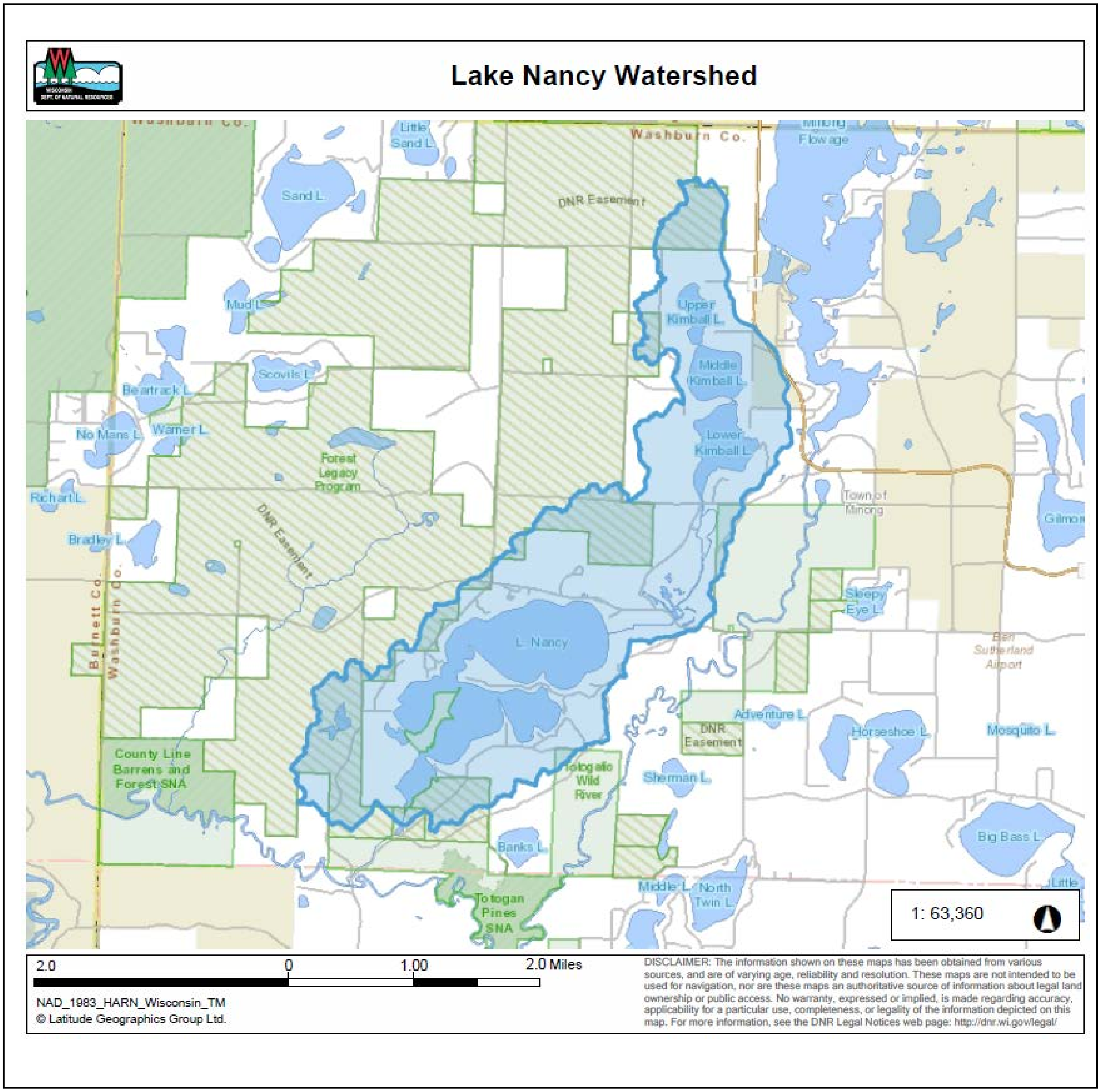

Figure 6. Lake Nancy Watershed

AQUATIC HABITATS

PRIMARY HUMAN USE AREAS

Lakeshore property owners and the general public utilize the lake for a wide variety of activities including fishing, boating, skiing, swimming, kayaking, and viewing wildlife. Public access points (boat landings) are located on the map in Figure 1.

Over the decades the usage of Lake Nancy has changed. In the 1950-60's there were ten small fishing resorts on the lake. As of 2018, there was just one. Most of the resort properties have been converted into single family homes - some in their original condition, but many have been modified or torn down and replaced with large homes. There used to be many small fishing boats with small motors used by resort visitors. Now, most boat traffic is made up of fishing and pontoon boats with larger motors. There are also many water skiers and tubers and personal watercraft.[4]

EWM STATUS

There are several waterbodies in Washburn County and nearby Burnett County with EWM present (see Table 4 below). Some lakes in Northern Wisconsin have confirmed hybrids of Eurasian and northern water milfoil including in Sawyer County (Hayward and Lost Land Lakes) and Bayfield County (Lake Namekagon) (Figure 7).

Table 4. Nearby Waterbodies with Eurasian Watermilfoil Present[5]

Waterbody	Waterbody ID Code (WBIC)	County	First Found	Distance from Nancy (miles)
Chippewa Flowage	2414500	Sawyer	2006	34
Gilmore Lake	2695800	Washburn	2009	7
Ham Lake	2467700	Burnett	2003	15
Lake Hayward	2725500	Sawyer	2011	24
Lac Courte Oreilles	2390800	Sawyer	2017	28
Minong Flowage	2692900	Douglas, Washburn	2002	2
Osprey Lake	2395100	Sawyer	2005	33
Red Lake	2492100	Douglas	2016	11
Round Lake	2395600	Sawyer	1993	30
St. Croix Flowage	274030	Douglas	2007	10

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4 Personal communication. Sam Lewis. LNPA Board. October 2008.

5 https://dnr.wi.gov/lakes/invasives/ accessed 5/14/18.

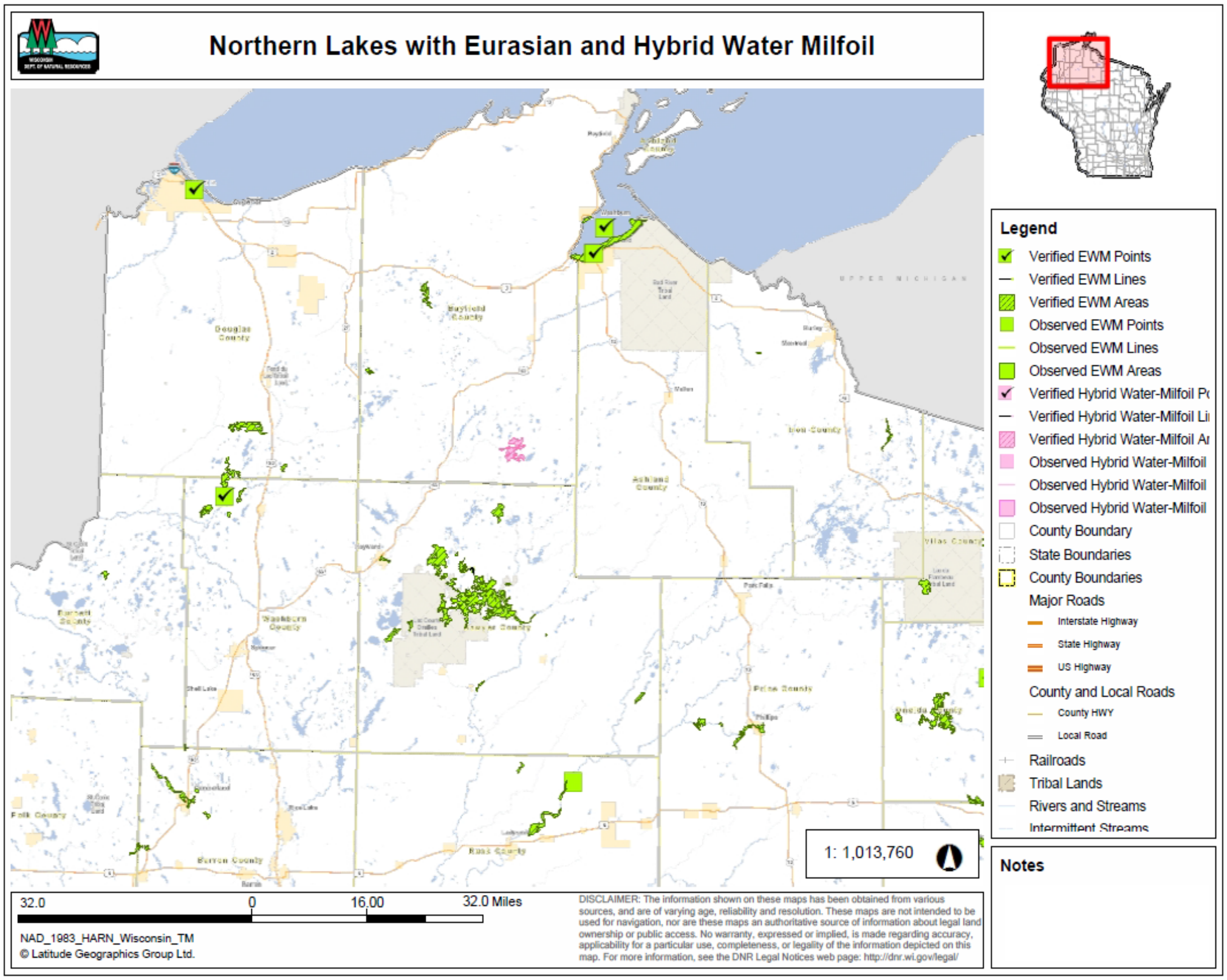

Figure 7. Northern Wisconsin Lakes with Eurasian and Hybrid Water Milfoil

FUNCTIONS AND VALUES OF NATIVE AQUATIC PLANTS

Naturally occurring native plants are extremely beneficial to the lake. They provide a diversity of habitats, help maintain water quality, sustain fish populations, and support common lakeshore wildlife such as loons and frogs. (Borman, 1997)

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.

PROTECTION AGAINST INVASIVE SPECIES

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

Removal of native vegetation not only diminishes the natural qualities of a lake, but it increases the risk of non-native species invasion and establishment. The presence of invasive species can change many of the natural features of a lake and often leads to expensive annual control plans. Allowing native plants to grow may not guarantee protection against invasive plants, but it can discourage their establishment. Native plants may cause localized concerns to some users, but as a natural feature of lakes, they generally do not cause harm. (WDNR, 2007)

CRITICAL HABITAT AREAS

The Department of Natural Resources designates Critical Habitat areas that include both Sensitive Areas and Public Rights Features. 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 character and qualities of the lake. These sites are sensitive and fragile areas that support wildlife and fish habitat, provide the mechanisms that protect the water quality in the lake, harbor quality plant communities, and preserve the places of serenity and aesthetic beauty for the enjoyment of lake residents and visitors.

Critical Habitat areas include Sensitive Areas that 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 lake in this code. 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. Protecting these Critical Habitat areas requires the protection of shoreline and in-lake habitat.

Designation of Critical Habitat aims to serve four primary purposes:

1) Resource protection through science based regulatory review.

2) Community-based resource protection through community education, planning, and zoning.

3) A guide to land-trusts and others acquiring land and conservation easements.

4) A mechanism to track long-term changes in these habitats.

The Department of Natural Resources completed a Critical Habitat survey for Nancy Lake in the summer of 2008, and the critical habitat designation was finalized in April 2013. Recommendations from that report are included below. (Smith, 2013)

LAKE WIDE RECOMMENDATIONS

Most of these actions will be good for the lake whether the site is within a designated Critical Habitat area or not. For example, planting native vegetation along shorelines will generally be beneficial to the lake and property owner. Shorelines that are dominated by established lawn, however, may be out of compliance with current zoning standards and higher priority for restoration since those areas tend to pollute the resource more while simultaneously being devoid of natural fish and wildlife habitat.

PERMANENT LAND PROTECTION

Permanently protect designated Critical Habitat areas. Permanent land protection tools include: land acquisition, conservation easements, and mutual covenants. Competitive funding opportunities exist for parcels that are large and of particular conservation value. Voluntary protection or private funding sources may be the primary protection methods for smaller parcels. Specific site recommendations emphasize priority areas for permanent land protection.

SHORELINE HABITAT PROTECTION

Maintain and protect large, mature pine, oak, and maple trees for nesting species such as eagles and ospreys. Unless there is a safety hazard, leave dead standing trees for cavity nesting wildlife. Wood ducks will nest up to a mile from the shoreline and prefer old oak and pine trees. Allow downed trees and branches to remain on the forest floor.

SHORELINE RESTORATION

Leave natural shorelines undisturbed in accordance with local shoreline zoning rules. If the shoreline buffer does not exist or is disturbed, it should be replanted with native vegetation. Discontinue mowing lawn areas along the shore to allow native vegetation to grow back. The Washburn County Land & Water Conservation Department may provide shoreline restoration technical and funding assistance. Additionally, the Wisconsin Department of Natural Resources offers competitive shoreline restoration grants. Some local landscaping businesses may be able to assist landowners with site planning, including native plant selection.

RUNOFF CONTROL

Implement lake and river water quality protection tools like rainwater gardens, rain barrels, infiltration pits and trenches, grass swales, etc. that divert and/or infiltrate water before it enters the lake or river. Similar to shoreline restoration, the Washburn County Land & Water Conservation Department may provide technical and funding assistance for these practices. Additionally, the Wisconsin Department of Natural Resources offers competitive lake protection grants. Some local landscaping businesses may be able to assist landowners with site planning, including plant selection.

SEPTIC SYSTEMS

Inspect and maintain septic systems to prevent excess nutrient addition while protecting present water quality conditions. Ideally, a public sanitary sewer system should be constructed. Septic systems are not designed to remove the nutrients (i.e., phosphorous and nitrogen) that pollute water resources. Furthermore, septic water quickly moves through the local sandy soils and speeds delivery of potentially polluted water to the lake.

IN-LAKE HABITAT PROTECTION

Consider local recreational boating ordinances (i.e., slow-no-wake) within designated critical habitat areas. Update: A Town of Minong ordinance establishes a no-wake zone in critical habitat site 12 as recommended in the report. Further, state boating regulations make it illegal to operate a vessel within 100 feet of any shoreline, any dock, raft, pier, or restricted area on any lake at greater than slow no-wake speed. (WDNR, 2018)

In general, native aquatic plants should not be actively managed (i.e., no raking, herbicide use, or mechanized removal) and, if within a designated critical habitat site, will require a permit for manual removal as well as chemical control. Aquatic plants are vital to a lake's ecosystem because they provide shelter for aquatic insects, invertebrates, amphibians, and fish, provide food for muskrats and waterfowl, and protect shorelines by absorbing and dissipating wave energy.

Near shore trees that fall into the water should be left in the water. These trees offer areas for turtles and amphibians to bask in the sun, a place for muskrats to feed, and protection for fish. There are opportunities with the DNR and Washburn County Land & Water Conservation Department to implement a project that replaces this valuable habitat in areas where wood has been removed from the lake.

INVASIVE SPECIES CONTROL

Eurasian Water Milfoil (EWM) treatments should only occur in developed areas and also be restricted to only navigation channels and monotypic stands of EWM. Treating areas that are home to native aquatic plants opens the door to the spread of EWM.

SPECIFIC SITE RECOMMENDATIONS

These management actions, included in the full report, are specific to the given site and only supersede general and specific lake wide recommendations if explicitly stated.

LAKE NANCY CRITICAL HABITAT SITES

Seventeen areas are designated as Critical Habitat on Nancy Lake for a total of 337.3 acres. Twelve areas are classified as Sensitive Areas (SA) for rushes, emergent and floating leaf aquatic plants, and/or submergent aquatic plants. Five areas are classified as Public Rights Features (PRF) for spawning substrate and woody habitat. Lake Nancy Critical Habitat Areas are mapped in Figure 8 and described in Table 5 and Table 6. The report also includes a detailed assessment of vegetative cover for the bank and shoreland buffer areas (called riparian zone in the report) within each Critical Habitat Area.

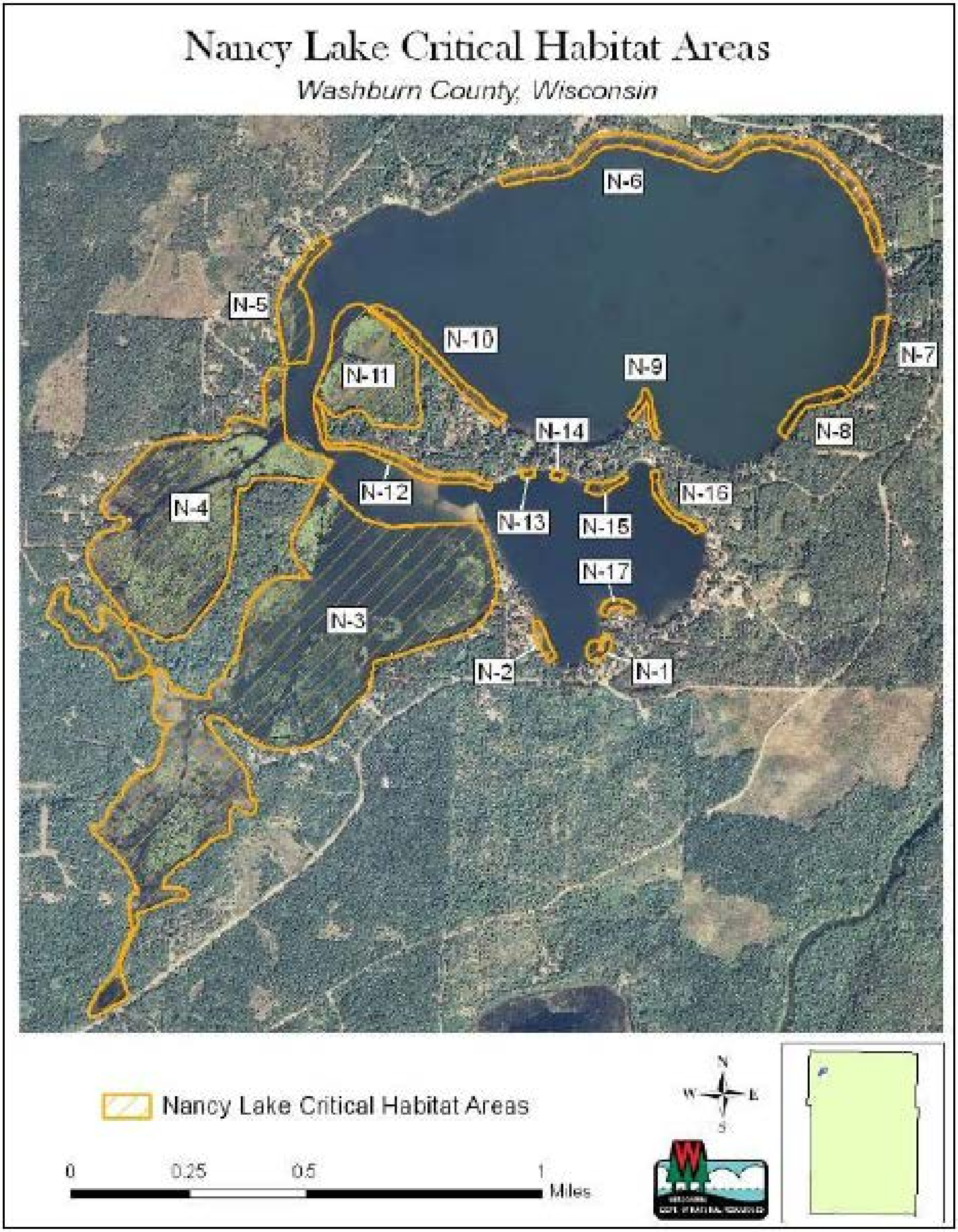

Figure 8. Lake Nancy Critical Habitat Areas Map

Table 5. Nancy Lake Critical Habitat Area Justifications

Critical Habitat Area ID	Acreage	Justification	Justification	Justification	Classification
N-1	1.18	3	2	0	SA
N-2	1.15	3	2	4	SA
N-3	174.24	3	2	4	SA
N-4	90.25	3	2	4	SA
N-5	8.27	3	2	4	SA
N-6	16.52	3	2	4	SA
N-7	2.49	4	3	2	SA
N-8	2.50	8	7	0	PRF
N-9	1.26	8	0	0	PRF
N-10	4.67	4	3	2	SA
N-11	25.87	3	6	2	SA
N-12	4.77	3	4	0	SA
N-13	0.27	4	3	2	SA
N-14	0.33	3	0	0	SA
N-15	1.06	8	0	0	PRF
N-16	1.56	8	7	0	PRF
N-17	0.94	8	0	0	PRF

Table 6. Critical Habitat Justification Descriptions

Justifications	Justification Feature	Classification
1	Bio-diverse Submerged Aquatic Vegetation (SAV)	Sensitive Area
2	SAV Important to Fish and Wildlife Habitat	Sensitive Area
3	Emergent and Floating Leaf Vegetation	Sensitive Area
4	Rush Beds	Sensitive Area
5	Wild Rice Bed	Sensitive Area
6	Extensive Riparian Wetland	Sensitive Area
7	Woody Habitat	Public Rights Feature
8	Spawning Substrate	Public Rights Feature
9	Water Quality (springs, etc.)	Public Rights Feature
10	Natural Scenic Beauty	Public Rights Feature
11	Navigational Thoroughfare	Public Rights Feature

RARE AND ENDANGERED SPECIES HABITAT

Lake Nancy is located in T42N, R13W. The Wisconsin Natural Heritage Inventory lists the following species for this area. The listing does not provide enough detail to know if these species are found on the lake itself. The Wisconsin Natural Heritage Inventory list for this geographical area is shown in Table 7. (WDNR, Natural Heritage Inventory Lists, 2018) Bald eagles are not represented, and sensitive species have been removed.

Table 7. Rare and Endangered Species T42N R13W[6]

Scientific Name	Common Name		State Status[7]
Alasmidonta marginata	Elktoe	Mussel	SC/P
Asclepias ovalifolia	Dwarf Milkweed	Plant	THR
Chordeiles minor	Common Nighthawk	Bird	SC/M
Clemmys insculpta	Wood Turtle	Turtle	THR SOC
Cyclonaias tuberculata	Purple Wartyback	Mussel	END
Emydoidea blandingii	Blanding's Turtle	Turtle	SC/P SOC
Etheostoma microperca	Least Darter	Fish	SC/N
Oporornis agilis	Connecticut Warbler	Bird	SC/M
Percina evides	Gilt Darter	Fish	THR
Plestiodon septentrionalis	Prairie Skink	Lizard	SC/H
Potamogeton diversifolius	Water-thread Pondweed	Plant	SC
Potamogeton vaseyi	Vasey's Pondweed	Plant	SC
Spermophilus franklinii	Franklin's Ground Squirrel	Mammal	SC/N
Utricularia resupinata	Northeastern Bladderwort	Plant	SC

[6] https://dnr.wi.gov/topic/NHI/Data updated 7/18/2017

[7] THR = Threatened, END = endangered, SC/FL = Special Concern (federally protected as endangered or threatened), SC/N = Special Concern (no laws regulating use, possessions, or harvesting), and SC/H = Special Concern (take regulated by establishment of open closed seasons).

NANCY LAKE FISHERY

The sport fishery of Nancy Lake has undergone substantial changes in the past 40 years. A 1976 survey (Johannes 1978) found walleye as the most abundant gamefish species followed by northern pike, largemouth bass, and smallmouth bass. A 1965 survey found high density walleye and panfish populations (Johannes 1978). Since those surveys, largemouth bass have steadily increased in numbers while walleye densities have declined.

The Wisconsin Department of Natural Resources conducted a comprehensive survey of Lake Nancy during 2012. The primary objective of this study was to assess the status of the walleye population, as well as sport and tribal exploitation of walleye on Lake Nancy. Secondary objectives were to assess muskellunge, largemouth bass, northern pike, and panfish populations.

Largemouth bass size structure was poor and growth rates were below statewide averages. The bluegill population was found to be high density with poor size structure. Northern pike size structure improved since the previous survey. The adult walleye population in Lake Nancy was too low density to calculate a population estimate in 2012. Catch rates of young of the year walleye have been very low in both stocked and non-stocked year surveys. No muskellunge or smallmouth bass were captured during the 2012 survey.

Management recommendations include: 1) Monitor impacts of liberalized bass regulations on bluegill populations, 2) Maintain largemouth bass as the primary gamefish in Lake Nancy and continue with the no minimum size limit, 3) Focus walleye stocking efforts on large fingerlings and consider discontinuing walleye stocking if survival is poor, 4) Continue consumptive opportunities for northern pike, 5) Protect and enhance critical fish habitat, 6) Continue efforts to maintain and enhance habitat diversity whenever possible, and 7) Continue exotic species monitoring and control programs. Inputs of coarse woody debris, protection of aquatic vegetation, and maintenance or restoration of vegetative buffers are some examples of work that can increase habitat complexity. (Wendel, 2012)

Wisconsin Department of Natural Resources walleye stocking since 1972 is listed in Table 8.

Table 8. WDNR Walleye Stocking on Lake Nancy

Year	Species	Strain	Age Class	Number Stocked	Average Fish Length (inches)
2016	WALLEYE	MISSISSIPPI HEADWATERS	LARGE FINGERLING	15,140	7.30
2014	WALLEYE	MISSISSIPPI HEADWATERS	LARGE FINGERLING	15,145	6.30
2012	WALLEYE	MISSISSIPPI HEADWATERS	LARGE FINGERLING	7,720	7.50
2008	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	27,061	1.40
2006	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	33,881	2.20
2004	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	38,597	1.30
2002	WALLEYE	MISSISSIPPI HEADWATERS	SMALL FINGERLING	38,595	1.40
2000	WALLEYE	UNSPECIFIED	SMALL FINGERLING	38,136	1.80
1998	WALLEYE	UNSPECIFIED	SMALL FINGERLING	38,600	2.00
1994	WALLEYE	UNSPECIFIED	FINGERLING	54,080	2.13
1993	WALLEYE	UNSPECIFIED	FINGERLING	38,600	2.00
1992	WALLEYE	UNSPECIFIED	FINGERLING	38,600	2.00
1991	WALLEYE	UNSPECIFIED	FINGERLING	19,300	3.00
1990	MUSKELLUNGE	UNSPECIFIED	FINGERLING	2,294	9.00
1989	WALLEYE	UNSPECIFIED	FINGERLING	38,674	3.67
1988	WALLEYE	UNSPECIFIED	FINGERLING	31,522	2.33
1987	MUSKELLUNGE	UNSPECIFIED	FINGERLING	258	9.00
1986	WALLEYE	UNSPECIFIED	FINGERLING	39,450	3.00
1983	WALLEYE	UNSPECIFIED	FRY	512,000	1.00
1982	WALLEYE	UNSPECIFIED	FRY	400,000	
1974	WALLEYE	UNSPECIFIED	FINGERLING	40,020	3.00
1973	WALLEYE	UNSPECIFIED	FINGERLING	10,047	3.00
1972	WALLEYE	UNSPECIFIED	FINGERLING	9,105	4.00

PLANT COMMUNITY

AQUATIC PLANT SURVEY RESULTS

Aquatic Integrity Services conducted an aquatic plant inventory according to the DNR-specified point intercept method for Lake Nancy in 2017. (Schieffer, 2017) The results discussed below are from that survey. Survey methods are found in Appendix B.

A June survey was conducted to determine the frequency of curly leaf pondweed - CLP - (*Potamogeton crispus)* since this plant tends to die back before the later season survey. No CLP was sampled or observed during the June survey. A July survey was also conducted when aquatic plants were actively growing.

The 2017 point intercept survey for Lake Nancy results showed an extensive, healthy aquatic plant community. The diversity was high with 48 species (47 native) sampled on the rake and a Simpson's diversity index of 0.94. Plant coverage extended to all but the deepest areas of the lake. The mean rake density where plants were growing was 1.64.Table 9 summarizes the statistics of the survey and Figure 9 shows the rake fullness at each point. The maximum depth of plants was 23.8 feet, demonstrating that the water clarity allows for adequate light penetration for plant growth at a substantial depth.

Table 9. Lake Nancy Plant Survey Summary Statistics

Total number of sample sites in grid	701
Total number of sites with vegetation	416
Total number of sites shallower than maximum depth of plants	540
Frequency of vegetation in entire lake surface	59.3%
Frequency of occurrence at sites shallower than maximum depth of plants	77.04%
Simpson Diversity Index	0.94
Maximum depth of plants	23.80 feet
Mean depth of plants	7.23 feet
Average number of native species per site (shallower than max depth)	2.03
Average number of native species per site (vegetated sites only)	2.66
Species richness	48
Species richness (including visuals)	49
Mean rake fullness where plants sampled (scale of 1-3)	1.64

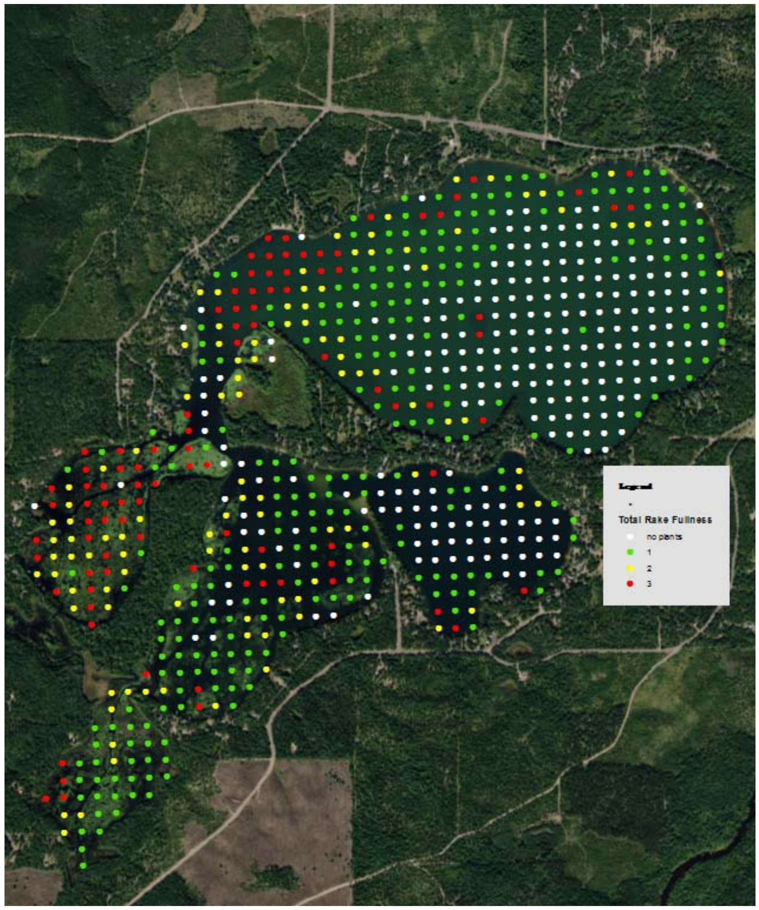

Figure 9. Rake Fullness at each Sample Point

Table 10 provides data for each aquatic plant species sampled or viewed. Of the 45 species, no one plant dominated. The most common plants sampled were fern pondweed (*Potamogeton robbinsii*), common waterweed (*Elodea Canadensis*), large-leaf pondweed (*Potamogeton amplifolius)*, and watershield (*Brasenia schreberi*). All are common, highly desirable, native aquatic plants found in Wisconsin lakes. They provide key habitat for small invertebrates, which make up the lower trophic levels of the food web. They also provide cover for fish to forage. Fern pondweed can grow all winter, providing oxygen for the lake. Watershield offers a canopy which creates shade and cover for fish and other organisms in addition to reducing the energy of waves.

Robbin's spikerush (*Eleocharis robbinsii*), a species of special concern, was sampled during the plant survey. Wisconsin special concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Table 10. Aquatic Plants Surveyed in Lake Nancy

Species	FOO[8] Vegetated	FOO Littoral	Relative Frequency	Number Sampled	Mean Density	Number Viewed
Potamogeton robbinsii, Fern pondweed	35.82	27.59	13.52	149	1.37	0
Elodea canadensis, Common waterweed	25.00	19.26	9.44	104	1.18	0
Potamogeton amplifolius, Large-leaf pondweed	24.52	18.89	9.26	102	1.15	5
Brasenia schreberi, Watershield	21.88	16.85	8.26	91	1.21	5
Nymphaea odorata, White water lily	18.03	13.89	6.81	75	1.04	5
Eleocharis robbinsii, Robbins' spikerush	13.22	10.19	4.99	55	1.24	1
Najas flexilis, Slender naiad	12.02	9.26	4.54	50	1.04	1
Vallisneria americana, Wild celery	11.54	8.89	4.36	48	1.00	3
Nuphar variegata, Spatterdock	10.58	8.15	3.99	44	1.00	5
Potamogeton gramineus, Variable pondweed	9.62	7.41	3.63	40	1.00	3
Utricularia intermedia, Flat-leaf bladderwort	8.17	6.30	3.09	34	1.00	1
Eleocharis acicularis, Needle spikerush	7.93	6.11	2.99	33	1.09	0
Nitella sp., Nitella	7.69	5.93	2.90	32	1.13	0
Ceratophyllum demersum, Coontail	6.73	5.19	2.54	28	1.18	0
Chara sp., Muskgrasses	6.49	5.00	2.45	27	1.00	0
Potamogeton praelongus, White-stem pondweed	5.53	4.26	2.09	23	1.00	5
Potamogeton pusillus, Small pondweed	4.57	3.52	1.72	19	1.05	1
Utricularia vulgaris, Common bladderwort	3.37	2.59	1.27	14	1.00	1
Potamogeton natans, Floating-leaf pondweed	3.13	2.41	1.18	13	1.00	2
Schoenoplectus acutus, Hardstem bulrush	3.13	2.41	1.18	13	1.00	3
Pontederia cordata, Pickerelweed	2.88	2.22	1.09	12	1.17	2
Sagittaria sp., Arrowhead	2.64	2.04	1.00	11	1.00	0
Schoenoplectus subterminalis, Water bulrush	2.64	2.04	1.00	11	1.09	1
Bidens beckii, Water marigold	2.16	1.67	0.82	9	1.00	0
Juncus pelocarpus f. submersus, Brown-fruited rush	2.16	1.67	0.82	9	1.00	0
Myriophyllum tenellum, Dwarf water-milfoil	2.16	1.67	0.82	9	1.00	0
Eleocharis palustris, Creeping spikerush	1.92	1.48	0.73	8	1.00	0
Potamogeton zosteriformis, Flat-stem pondweed	1.68	1.30	0.64	7	1.14	1
Utricularia purpurea, Large purple bladderwort	1.20	0.93	0.45	5	1.00	1
Ranunculus flammula, Creeping spearwort	0.96	0.74	0.36	4	1.25	0
Elodea nuttallii, Slender waterweed	0.72	0.56	0.27	3	1.00	0
Eriocaulon aquaticum, Pipewort	0.72	0.56	0.27	3	1.00	1
Heteranthera dubia, Water star-grass	0.72	0.56	0.27	3	1.00	0

[8] FOO = Frequency of Occurrence

Species	FOO[8] Vegetated	FOO Littoral	Relative Frequency	Number Sampled	Mean Density	Number Viewed
Utricularia gibba, Creeping bladderwort	0.72	0.56	0.27	3	1.00	1
Myriophyllum spicatum, Eurasian watermilfoil	0.48	0.37	0.18	2	1.50	0
Potamogeton illinoensis, Illinois pondweed	0.48	0.37	0.18	2	1.00	2
Carex comosa, bottle brush sedge	0.24	0.19	0.09	1	1.00	0
Carex utriculata, Common yellow lake sedge	0.24	0.19	0.09	1	1.00	0
Ceratophyllum echinatum, Spiny hornwort	0.24	0.19	0.09	1	1.00	0
Cladium marscoides, smooth sawgrass	0.24	0.19	0.09	1	1.00	0
Dulichium arundinaceum, three-way sedge	0.24	0.19	0.09	1	1.00	0
Elatine minima, Waterwort	0.24	0.19	0.09	1	1.00	0
Myriophyllum alterniflorum, Alternate-flowered watermilfoil	0.24	0.19	0.09	1	1.00	0
Myriophyllum sibiricum, Northern watermilfoil	0.24	0.19	0.09	1	1.00	0
Potamogeton friesii, Fries' pondweed	0.24	0.19	0.09	1	1.00	0
Potamogeton spirillus, Spiral-fruited pondweed	0.24	0.19	0.09	1	1.00	0
Ranunculus aquatilis, White water crowfoot	0.24	0.19	0.09	1	1.00	0
Sagittaria cuneata, Arum-leaved arrowhead	0.24	0.19	0.09	1	1.00	0
Aquatic moss	0.48	0.37	n/a	2	1.00	
Filamentous algae	3.61	2.78	n/a	15	1.00	
Sparganium natans, Small bur-reed						1

Table 11 lists the species observed during the boat survey which allows observation in under-represented areas of the lake not included in the sample grid. One species, narrow leaf cattail (*Typha augustifolia*), is a Wisconsin restricted invasive species. All others are native.

Table 11. Species Observed Outside of Sample Grid

Typha latifolia, broad leaf cattail
Typha augustifolia, narrow leaf cattail
Polygonum amphibium, water smartweed
Carex comosa, bottle brush sedge
Sparganium eurycarpum, common bur-reed
Asclepias incarnata, swamp milkweed
Schoenoplectus tabernaemontani, softstem bulrush
Sagittaria latifolia, common arrowhead
Sagittaria rigida, sessile fruited arrowhead

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 found and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant to disturbance and/or water quality changes while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes. Both are largely due to human influence.

The FQI is calculated using the number of species and the average conservatism value of all species used in the index. A higher FQI generally indicates a healthier aquatic plant community. Not all species found in Lake Nancy have conservatism values assigned to them.

The FQI of Lake Nancy is 47.12. An FQI this high indicates that the plant community is healthy and has changed little in response to human impact on water quality and habitat (lake sediment) changes. In fact, the FQI increased since 2008. The high FQI in Lake Nancy is due both to high species richness and a rather high mean conservatism value. The Lake Nancy FQI values are also high when compared to the median values for lakes in this ecoregion (Northern Lakes and Forests) (Nichols 1999).

Table 12. Floristic Quality Index Values

	Lake Nancy-2017	Ecoregion median	Lake Nancy-2008
Number of species in index	43	13	44
Mean conservatism value	7.19	6.7	6.72
FQI	47.12	24.3	44.62

COMPARISON OF 2008 AND 2017 SURVEYS

Point intercept aquatic plant surveys allow evaluation of changes that may occur over time. These changes could be the result of activities around the lake including but not limited to plant management. EWM control using herbicide has occurred on Lake Nancy for several years. Table 13 compares various survey statistics for 2008 and 2017.

Table 13. Comparison between 2008 and 2017 Point Intercept Survey Results

	2008	2017
Species Richness	47	48
Simpson's Diversity Index	0.94	0.94
FQI	44.62	47.12
Dominant Species	*Potamogeton robbinsii* Fern pondweed	*Potamogeton robbinsii* Fern pondweed
Maximum Depth of Plants	24.1 ft	23.8 ft
Percent of Littoral Zone with Plants	79.29%	77.04%

A Chi-square analysis was used for comparison of the frequency of occurrence of each species between 2008 and 2017. If the P value from the Chi-square is below 0.05, it indicates a significant change not due to random variation. As indicated in Table 14, there was a statistically significant reduction in six native species. However, there was also a significant increase in eight native species. The causes of reductions are unknown, but the concern is potential negative effects from herbicide use. Small pondweeds are especially susceptible to herbicide. Small pondweed (*Potamogeton pusillus)* did significantly decrease as did slender naiad (*Najas flexilis).* Both of these species have been shown to be reduced from use of 2,4-D EWM management (Nault et al, 2017). Since there were significant increases in other species, the likely cause for change is natural variation within the population. If herbicide use continues in Lake Nancy, native plant frequency changes should be monitored.

Table 14. Species with Statistically Significant Changes between 2008 and 2017

Native species reduction(P<0.05)	Native species increase(P<0.05)	Invasive species reduction(P<0.05)
Najas flexilis Slender naiad	*Brasenia schreberi* Watershield	*Myriophyllum spicatum* Eurasian watermilfoil
Potamogeton pusillus Small pondweed	*Vallisneria americana*, Wild celery	
Myriophyllum tenellum Dwarf water-milfoil	*Potamogeton gramineus* Variable pondweed	
Potamogeton zosteriformis Flat-stem pondweed	*Utricularia intermedia* Flat-leaf bladderwort	
Potamogeton illinoensis Illinois pondweed	*Eleocharis acicularis* Needle spikerush	
Sagittaria graminea Grass leaved arrowhead	*Potamogeton natans* Floating-leaf pondweed	
	Schoenoplectus subterminalis Water bulrush	
	Utricularia purpurea Large purple bladderwort	

One desirable significant reduction was in the invasive species Eurasian watermilfoil (EWM) *(Myriophyllum spicatum*). The FOO in 2008 for EWM was 8.94% and in 2017 the FOO was 0.48%, with only two sample points with EWM present. Surveyors observed little EWM when traveling between sample points during the 2017 survey. There were no discernable beds of EWM observed anywhere on the lake. This reduction may be due to management and/or natural variation, but is an improvement in Lake Nancy.

INVASIVE SPECIES

Two species of non-native plants were found in Lake Nancy during the 2017 plant survey: Eurasian watermilfoil, (*Myriophyllum spicatum*) and narrow leaf cattail (Typha angustifolia) Purple loosestrife (*Lythrum salicaria*), banded mystery snail, Chinese mystery snail, and curly leaf pondweed are also listed by the WDNR Lakes Pages as found in the lake.[9] However, curly leaf pondweed was not viewed in either the 2008 or 2017 early season (June) surveys. Detailed invasive aquatic plant information is included in Appendix C.

EURASIAN WATERMILFOIL

The Lake Nancy Protective Association has managed EWM in Lake Nancy for several years. There were only two locations that EWM was sampled in 2017. Some EWM was observed in various locations, but no beds were observed and only a scattering of plants were seen. Figure 10 shows the locations the EWM was sampled in 2017.

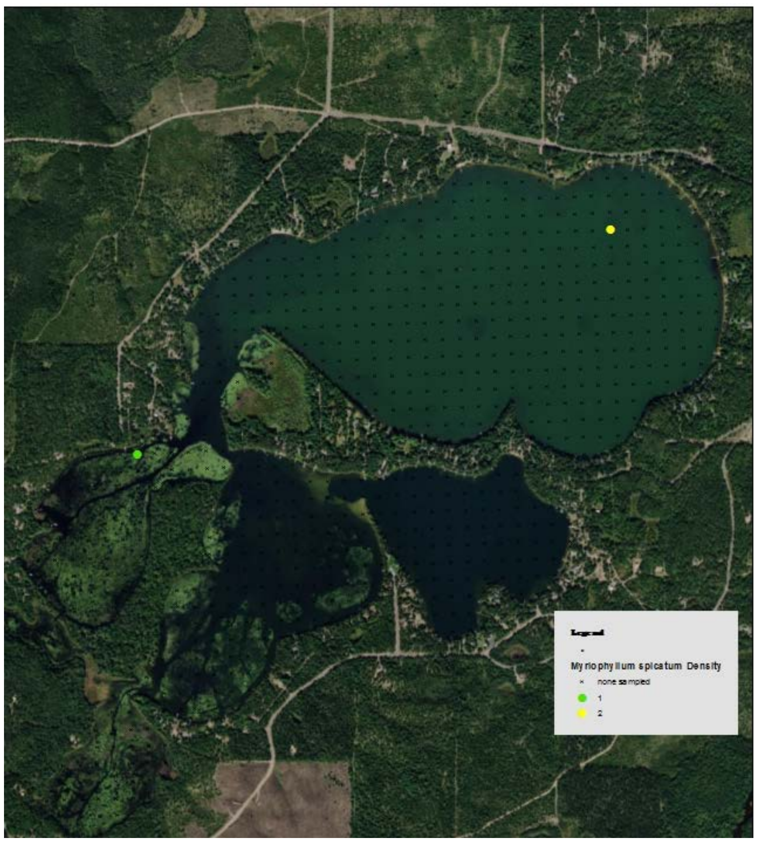

Figure 10. Eurasian Watermilfoil Sampled on Rake (2017)

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[9] https://dnr.wi.gov/lakes/LakePages/LakeDetail.aspx?wbic=2691500&page=facts

NARROW LEAF CATTAIL

Plant surveyors viewed another invasive species (restricted species in Wisconsin) narrow leaf cattail (*Typha augustifolia)* during the boat survey. This plant occurs along with the native cattail *Typha latifolia*. It is becoming common for cattail beds to transition to the invasive species, especially in deeper water. The invasive species may compete with the native, but the plants serve similar functions in the ecosystem. Figure 11 shows the locations where narrow leaf cattail was observed.

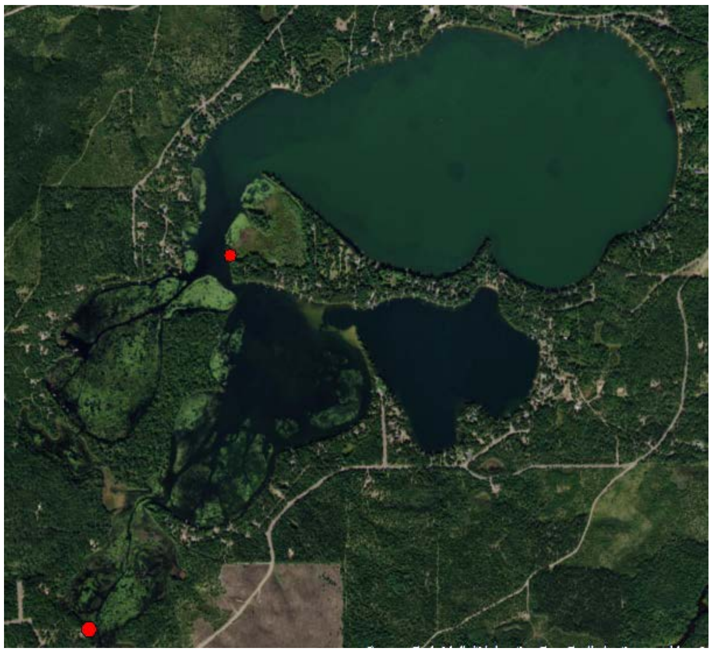

Figure 11. Narrow Leaf Cattail Observations (2017)

Purple Loosestrife

Purple loosestrife was found in only one location along the narrow point straight west of the boat landing in 2008. There were approximately twelve plants present. All of these plants were pulled and removed from the lake. This area should be checked each year to make sure no plants return.

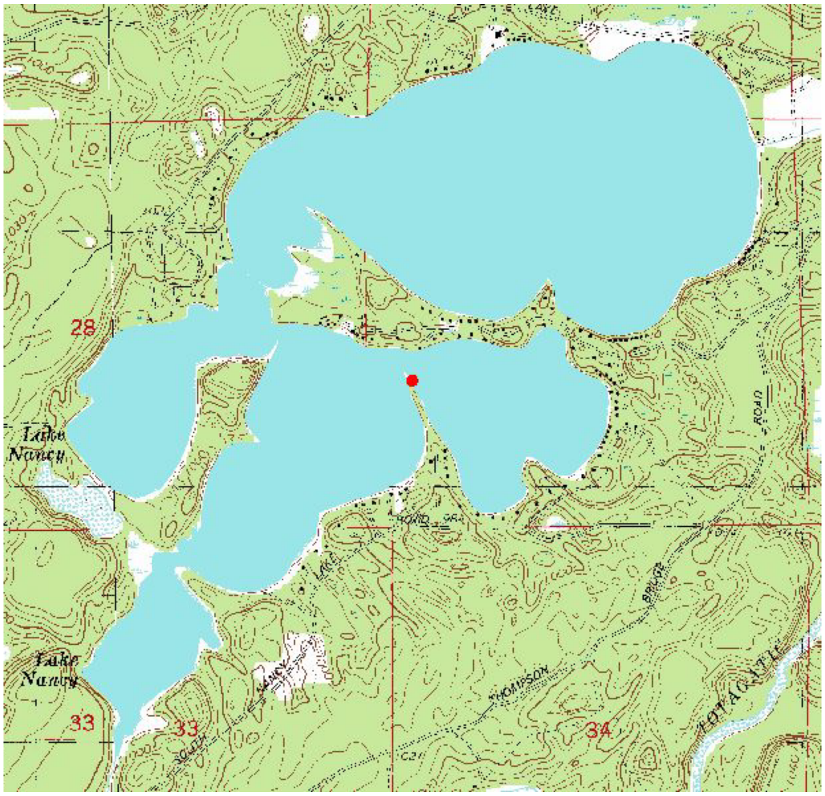

Figure 12. Purple Loosestrife Location (2008)

ZEBRA MUSSELS

While not an aquatic plant, zebra mussels are an invasive species that will be addressed in this plan. Zebra mussels were discovered in nearby Big and Middle McKenzie Lake in Burnett and Washburn County in 2016. Information about zebra mussels is found in Appendix C. Prevention and monitoring methods for zebra mussels are discussed in subsequent pages.

AQUATIC PLANT MANAGEMENT

This section reviews the potential management methods available to reach plan goals, existing management activities, and presents aquatic plant management goals and strategies for Lake Nancy.

Techniques to control the growth and distribution of aquatic plants are discussed in Appendix D. Permitting requirements and management methods for Eurasian watermilfoil are discussed below. The application, location, timing, and combination of techniques must be considered carefully because of potential impacts to native plants and aquatic habitats.

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 30 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. This includes granular herbicides available through mail order and internet purchase. A Department of Agriculture, Trade, and Consumer Protection pesticide applicator certification (aquatic nuisance control category) is required to apply liquid chemicals in the water.

The requirements for manual and mechanical plant removal are described in NR 109 – Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations. A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants (with the exception of wild rice) from his/her shoreline limited to a 30-foot corridor. A riparian landowner may also manually remove the invasive plants Eurasian watermilfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal means the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.

EURASIAN WATERMILFOIL MANAGEMENT

HAND PULLING

Hand pulling is a strategy recommended for rapid response to a Eurasian watermilfoil and Hybrid EWM establishment, for private landowners and organizations that wish to remove small areas of growth, and to remove scattered growth following an herbicide treatment. EWM growth is generally deep enough that snorkel or SCUBA gear is required. Recent costs for hand-pulling EWM using divers on Minocqua and Kawaguesaga Lakes in Oneida County were about $28,000 to remove an estimated <4,000 lbs.

Hand pulling requires clear enough water to identify plants prior to pulling. In Cedar Lake (St. Croix County) hand pulling of EWM was not an option in 2015 because of poor clarity. In 2016, SCUBA divers hand pulled some plants following the herbicide treatment. However, water clarity was very limited, and plants were difficult to find. Hand pulling might be used to a limited degree where there is sparse growth of EWM in Lake Nancy.

DIVER ASSISTED SUCTION HARVESTING (DASH)

With Diver Assisted Suction Harvesting (DASH) divers hand pull aquatic invasive plants from the lake-bed. A suction line transports removed plants to the surface. This method is probably most appropriate for relatively small and less dense areas of invasive plant growth. Poor water clarity would also make it more difficult to use DASH. (Convention, 2016)

The Tomahawk Lake Association (TLA) developed and has used a DASH system for several years, although they call their system a hydraulic conveyor system (HCS). HCS is an automated system that removes, filters, and bags harvested EWM after it has been hand harvested from the lake bed by divers. The TLA HCS includes a floating chassis, a “jet pump” water system, a three tiered separation system, and a Hookah diver air supply system. (Greedy, 2014) Use of the TLA HCS began in the summer of 2007. A second generation HCS began operation in 2011. Capital costs for the system are just over $25,000 and annual operating costs are about $31,000. The TLA harvested about 20,000 lbs. each year through 2014.

Figure 13. TLA Hydraulic Conveyor System (Greedy)

Because of the mechanical elements of the system, a WDNR aquatic plant management harvesting permit is required for DASH. Contracted DASH systems are available. Decontamination of the system is especially important with a contracted DASH system that moves between lakes. A DASH might be considered for Lake Nancy. A 2017 estimate from a contractor was $2,500/day with harvesting amounts varied with total EWM acreage and density. With high density, the contractor reported removing 3,000 pounds in a single day. (Restoration, 2017) On Cedar Lake in St. Croix County a contractor removed 5,000 pounds in 2 days. (Schieffer, Cedar Lake 2017 EWM Management Analysis, 2017)

EURASIAN WATERMILFOIL BIOCONTROL

A potential management method for EWM is the use of the native weevil *Euhrychiopsis lecontei*. This weevil has a larvae stage that feeds on both native milfoils and Eurasian watermilfoil. The larvae tunnel into the stem causing the plant to presumably lose the ability to transport nutrients and gases. *E. lecontei* adults swim and climb from plant to plant, feeding on leaflets and stem material. After mating, the female lays an average of 1.9 eggs a day, usually 1 egg per watermilfoil apical meristem (growing tip). One female may lay hundreds of eggs in her lifetime. The eggs hatch, and the larvae first feed on the apical meristem and then mine down into the stem of the plant, consuming internal stem tissue. Weevils pupate inside the stem in the pupal chamber, a swelled cavity in the stem. Adults emerge from the pupal chamber to mate and lay eggs. In the autumn, adults travel to the shore where they over-winter on land. In the laboratory, *E. lecontei* take 20 to 30 days to complete a life cycle, depending on water temperatures. For complete development, weevils require about 310 degree-days with temperatures above 10 degrees C. Two to four generations per year are generally observed in the field. (Cornell Research Ponds Facility)

Eurasian watermilfoil declines have been associated with the occurrence of the milfoil weevil and other herbivorous insects at numerous locations including several lakes in Vermont, New York, Massachusetts, Minnesota, and Illinois and in Fish Lake, Wisconsin. (MAISRC, 2018) Herbivory by aquatic insects can be substantial, resulting in 50–95% reductions in plant biomass and shifts in macrophyte community structure. In Otter Lake, MN significant declines in HWM were associated with weevil densities of 0.1 to 0.8/stem. (Newman, 2004) Recent work from Ontario indicates that hybrid is not resistant to weevils and they impact HWM as well or almost as well as EWM. (K. R. Borrowman, 2015)

Since this weevil naturally occurs in many Wisconsin Lakes, its use involves the augmentation of the natural population of weevils present in the lake. This augmentation can significantly increase the population of larvae per stem of milfoil. The premise is that this increase will lead to more destruction of the plants. Predation by sunfish (Lepomis) is likely an important factor limiting densities of adult weevils and other herbivores (Newman, 2004) which would likely influence weevil predation success in Lake Nancy. The LPNA has also participated in experimental use of weevils to control EWM with no evident success.

CONTROL WITH HERBICIDES

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian watermilfoil: complexed copper, 2,4-D, diquat, endothall, fluridone, and triclopyr. Early season treatment of Eurasian watermilfoil is also recommended by the Department of Natural Resources to limit the impact on native aquatic plant populations. 2,4-D is frequently used to target EWM (a dicot) over many other native plants (monocots). However, there is evidence that hybrid EWM can acquire resistance to 2,4-D (LaRue, 2012). Researchers have found an apparent association between taxonomic composition (EWM, HWM and NWM) and treatment history and hypothesized that intensively managed lakes may be more likely to become dominated by HWM and less likely to harbor native NWM. (Ryan Thum, 2017)

Large-scale treatments can result in significant damage to both monocots and dicots.

- Dicots susceptible to both 2,4-D and fluridone include native watermilfoils (particularly northern), bladderworts, water lilies, and coontail.
- Monocot species such as elodea, several narrow leaf pondweeds, and naiads are also impacted by fluridone and some 2,4-D use.

- Fewer natives are affected at lower dosages of herbicides. (WDNR, 2011)

Wisconsin DNR research indicates that larger scale herbicide treatments seem to have more consistent reduction of both EWM and native plants than smaller treatments. These results are based upon data collection in many Wisconsin lakes where herbicides were used for EWM control. (Nault M. , 2015)

Herbicides can dissipate off of a small treatment site very rapidly. 2,4-D dissipated rapidly after treatment after it was applied to 98 small (0.1-10 acre) treatment areas across 22 study lakes with application rates of 2-4 ppm. The following results were found:

- Initial 2,4-D concentrations detected in the water column were well below application targets.
- Herbicide moved quickly away from treatment sites within a few hours after treatment.
- The rapid dissipation of herbicide indicates that the concentrations in target areas may be lower than what is needed for effective EWM control. (Nault M. , 2012)

Recent studies indicate a need to consider the long-term effects of 2,4-D use. One is the effect of 2,4-D variants on the endocrine system and reproduction of fat head minnows (Karasov, 2015).

STATEWIDE EURASIAN WATERMILFOIL MANAGEMENT RESULTS (NAULT M. , AUGUST 2016)

Of the lakes with Eurasian watermilfoil, the majority currently have populations at low frequencies, with relatively few lakes exhibiting very dense EWM growth. Historically, once EWM was first reported in a waterbody, many lake users perceived the waterbody as “infested” or “diseased” and were fearful that the invasive plant would quickly “kill” the lake or make it unusable.

To look at the current frequency of EWM in waterbodies across the state, researchers compiled the most recent aquatic plant point-intercept data on 397 lakes and flowages with EWM populations. Analysis of this data found that the majority of lakes surveyed had very low frequencies (less than 10 percent) of EWM observed in the littoral zone (area of the lake where there is enough light for plants to grow). This low frequency is below the level where most lake users would consider the plant to be a “nuisance.” Many of the waterbodies with very low frequencies were following aquatic plant management plans which included regular monitoring and control to prevent EWM spread.

However, other lakes with very low EWM populations had not undergone any active management, providing evidence that in certain lakes there may be environmental conditions that limit EWM’s ability to spread. In contrast, relatively few lakes had EWM observed as a dominant plant species, which could likely cause recreational and ecological impairments. Examination of lakes with high EWM frequencies revealed that while some of these lakes were not being actively managed, there were other lakes that were. The actively managed lakes with poor results should explore alternative management strategies.

In general, higher EWM populations tended to occur on reservoirs and flowages versus natural lakes, lakes in the south versus the north, and in lakes where EWM had been established longer versus newly established populations in lakes. This statewide data analysis illustrates that while EWM can undoubtedly become a dominant species capable of causing recreational and aesthetic nuisances in certain lakes, more often than not it does not exhibit these tendencies. Interestingly, this trend of nonnative species being “rarely common and commonly rare” has also been documented across many other invasive species, many for which control is not attempted.

CURRENT AND PAST PLANT MANAGEMENT ACTIVITIES

EURASIAN WATERMILFOIL MANAGEMENT[10]

Eurasian watermilfoil (EWM) was first identified in Lake Nancy in 1991. Since then, the Lake Nancy Protective Association actively sought to control the EWM population by seeking permits for treatment beginning in the mid to late 1990s. It took approximately two years of communication with DNR and Wisconsin legislators for the lake association to be able to actively pursue EWM control.

In 1996-7 Nancy participated along with eleven other lakes in the *Wisconsin Milfoil Weevil Project* conducted by the DNR and UW Stevens Point Wisconsin Cooperative Fishery Research Unit. Weevils were sampled on the EWM in 1996. In 1997, 3,870 weevils and larvae were stocked in the lake in EWM beds. Data subsequently collected over a three-year period showed a slight overall increase in the number of weevils in the EWM beds, but the number of weevils varied greatly from time to time. The major conclusion of the study was "EWM biomass decreased slightly from 1996 to 1998, however, this change was not significant." The authors of the report concluded that 1) even though there was some growth in weevil numbers in Nancy, they could not keep up with the spread of EWM and 2) that stocking more weevils would not be an effective method of control. Among the eleven other study lakes no significant increases in weevil density or significant declines in EWM were found.

In 2000 LNPA attempted to "deep cut" EWM using a bladed cutter in the "mother bed" (largest area) of EWM. Staff from Blue Water Science cut the milfoil, and LNPA volunteers raked it together and loaded it into boats. Volunteers then transported the weeds to the shore and to a local farm for disposal. Volunteers felt that the work needed to do this in just one bed of EWM in the lake was excessive, and they stated that they would not undertake such a project again. Also, they were concerned that uncollected plant fragments would spread milfoil around the lake.

The Lake Nancy Management Plan (McComas, 2001) recommended treating EWM with herbicides. The Department of Natural Resources approved the plan and treatment method, and the LNPA began treatment of EWM beds with the herbicide 2,4-D beginning in 2001. This treatment was at a rate of 100 pounds of granular herbicide per acre until 2008 when the rate was increased to 150 pounds per acre.[11]

The Lake Nancy Protective Association (LNPA) currently treats up to 9 acres per year for Eurasian watermilfoil. Treatment methods were changed in 2014 to direct liquid application via a tremi-tube and at a rate based on acre feet (volume) rather than square footage (area). Volunteers survey the lake and record GPS coordinates every fall to guide the following late spring application. EWM herbicide treatment is summarized in Table 15 below and illustrated in Figure 14 (for the years 2003-2008) on the following page.

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[10] Information from Sam Lewis, President, Lake Nancy Protective Association. October 2008.

[11] Personal communication. Pat Wier, LNPA. October 2008.

Table 15. EWM Treatment Records for Lake Nancy[12]

Year	Date of Treatment	Applicator	Locations	Total Acres	Herbicide
2001	8/06/01	Midwest AquaCare	3 locations (Big) Deep (Map w/permit)	0.8	
2002			Six Areas	2.5	
2003	7/08/03	Midwest AquaCare	Near Marsh Creek (Big) Scattered in Deep (Map w/permit)	9.8	
2004	6/28/04	Midwest AquaCare	7 Areas (No Map)	5.9	
2005	6/29/05	Midwest AquaCare	8 Areas, Big Lake (Map w/permit)	5.2	
2006	6/22/06	Midwest AquaCare	8 Areas (No Map)	5.3	
2007	6/28/07	Midwest AquaCare	9 Areas (Map w/permit)	6.5	
2008	6/27/08	Midwest AquaCare		7.4	2,4-D granular
2009	6/03/09	Lake Restoration	Scattered Locations	9.5	2,4-D granular
2010	Unknown (from permit)	Lake Restoration	Scattered Locations	9.5	2,4-D granular
2011	Unknown (from permit)	Lake Restoration	Scattered Locations mostly Big Lake	4.8	2,4-D granular
2012	Unknown (from permit)	Lake Restoration	Scattered Locations	4.4	2,4-D granular
2013	6/12/13	Lake Restoration	24 sites	8.65 acres	
2014	7/10/14	Lake Restoration	7 sites	3.5	2,4-D liquid 4ppm
2015	6/24/15 6/25/15	Lake Restoration	12 sites 20 sites	9	2,4-D liquid 4ppm
2016	6/08/16	Lake Restoration	10 sites	8	2,4-D liquid 4ppm
2017	6/9/17	Lake Restoration	Four sites	2	2,4-D liquid 4ppm

[12] Where treatment dates are shown, information is from DNR permit records or memos. There was no treatment in 2018.

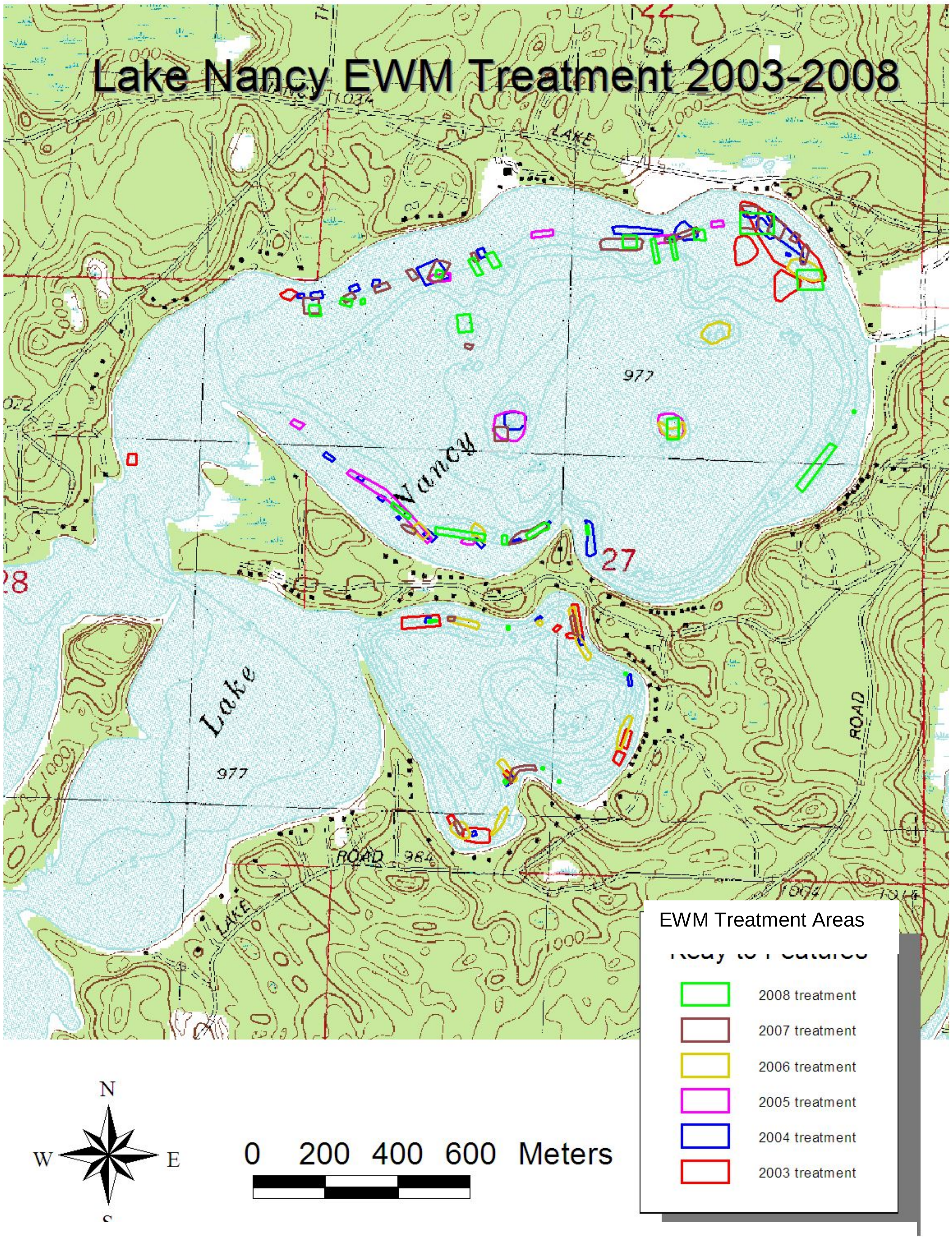


Figure 14. EWM Treatment Areas 2003 - 2008

Milfoil monitors did not locate any beds of EWM in the summer of 2017, and therefore, there was no treatment in 2018. Lake Nancy Protective Association (LNPA) milfoil monitors will continue to survey the lake annually for beds of EWM. Location of any beds will be documented for treatment the following summer. LPNA members have been asked to notify the monitors of any EWM bed sightings.

PREVENTING INVASIVE SPECIES

There are several methods available to the Lake Nancy Protective Association to prevent invasive species introduction and establishment: education to lake users, Clean Boats Clean Waters inspection program, boat decontamination, landing surveillance cameras, and lake monitoring. A rapid response strategy for any new invasive species is also recommended.

EDUCATION TO LAKE USERS

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

In 2007 LNPA initiated an effort to educate shoreline property owners about good lakeshore practices. Board members assessed shoreline parcels to identify concerns such as trailers parked illegally, malfunctioning septic systems, and locations of shoreline erosion, runoff, and clear cutting of lakefront. LNPA board members also hand delivered materials relating to good shoreline practices to all owners around the lake. The LNPA spring and annual association meetings included talks given by DNR staff and county conservation officials about AIS and good shoreline practices. LNPA newsletter and handouts have included information about similar topics. Newsletters are sent to all owners regardless of if they have joined the LNPA.

CLEAN BOATS CLEAN WATERS (CBCW) PROGRAM

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

Paid staff monitored boats and trailers and educated boaters since 2006 as part of the Clean Boats, Clean Waters Program. Most of the monitoring has been provided at the Deep Lake landing off Karling Court as illustrated in Figure 15 and Figure 16.

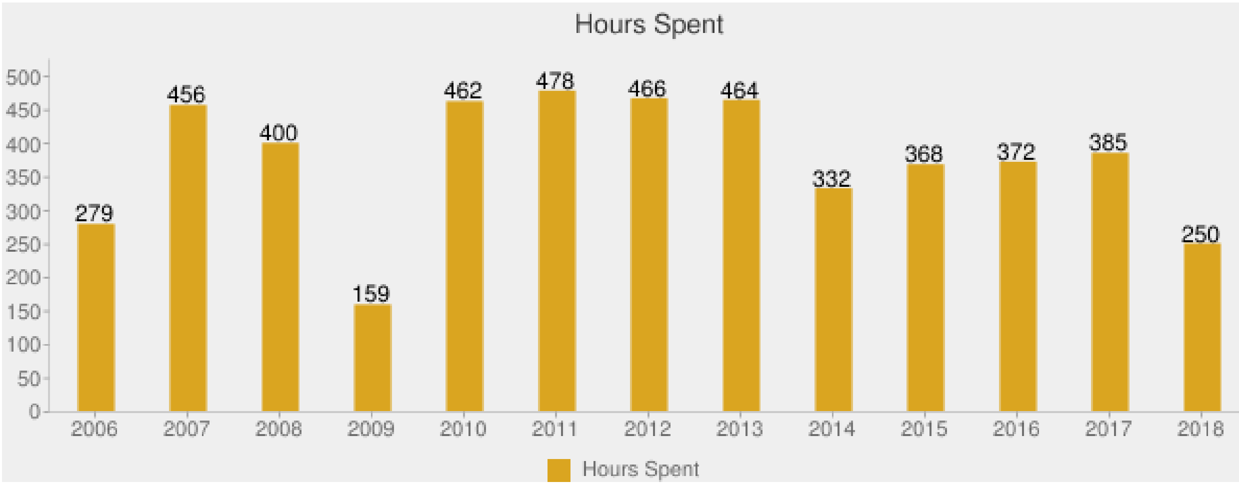


Figure 15. Clean Boats, Clean Waters Hours Spent Access off Karling Court (2006-2018)

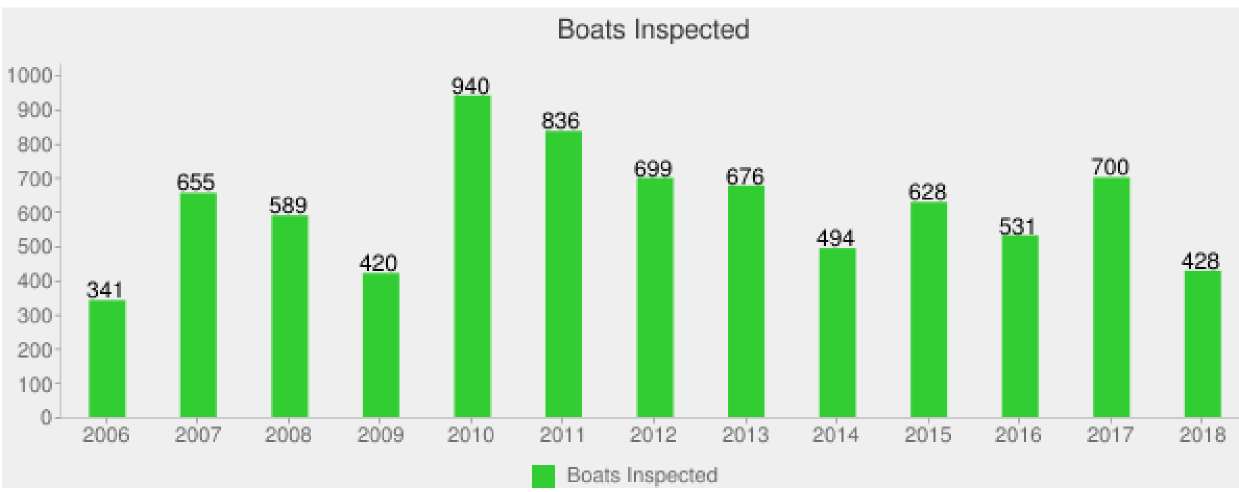


Figure 16. Clean Boats, Clean Waters Boats Inspected Access off Karling Court (2006-2018)

BOAT WASHING/DECONTAMINATION

Boat and equipment decontamination can use hot water or steam (>140 degrees F), pressure washing, and/or chemicals such as chlorine to prevent transfer of invasive species. WDNR portable Water Guard boat washing demonstrations may be available. Burnett and Washburn Counties have ordinances in place which require decontamination if offered at a public or private water access.

LNPA installed a decontamination station which uses a mild bleach solution along with appropriate signage and tools at the public landing on Deep Lake. Maintenance of the bleaching station is performed daily by LNPA volunteers.

Figure 17. Boat Cleaning and Decontamination Station on Deep Lake

LAKE MONITORING

The objective of lake monitoring is to look for new invasive species. Monitoring for invasive aquatic plant species is generally focused around boat landings and other areas of high public use. Trained volunteers or consultants may complete the monitoring. Divers may be used.

ZEBRA MUSSEL MONITORING

Because zebra mussels attach to hard surfaces, cinder blocks or plate samplers placed in shallow water and checked regularly provide a good monitoring method. Net tows aim to collect zebra mussel veligers (the larval stage). Early July is the best time to collect veliger tows. LNPA installed three sets of zebra mussel plate samplers on docks in Deep and Big Lakes in 2018 (Figure 19).

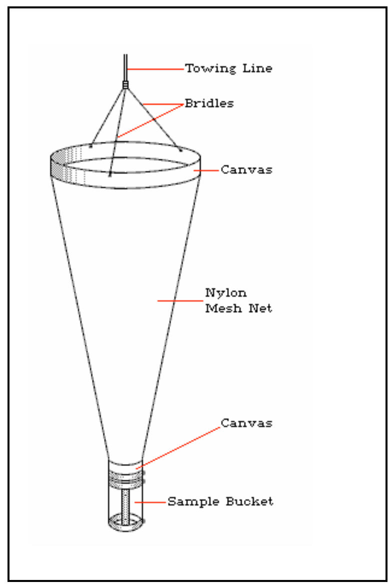


Figure 18. Monitoring Equipment: Cinder Blocks, Sampling Plates and Nets for Veliger Tows

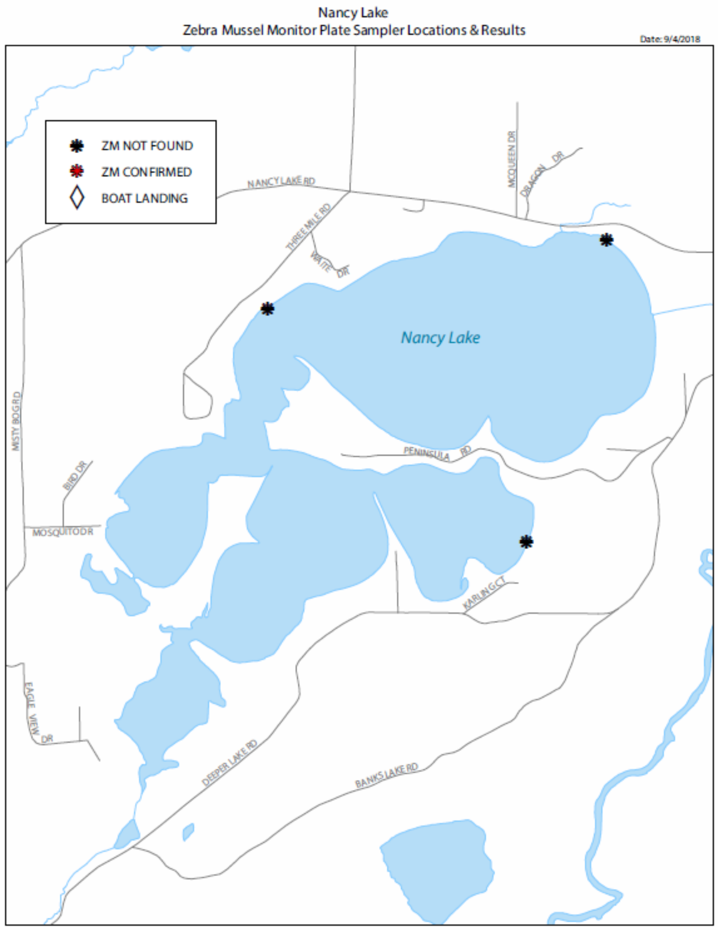


Figure 19. Lake Nancy Zebra Mussel Plate Sampler Locations (2018)

RAPID RESPONSE FOR NEW INVASIVE SPECIES

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

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

Invasive species information is included in Appendix C and is available on the WDNR website http:/dnr.wi.gov/invasives.

A rapid response plan is included as Appendix E.

LANDING SURVEILLANCE CAMERAS

Some lake organizations use video cameras at public landings to record landing activity. Videos are reviewed, and if a watercraft is launched with vegetation attached, action is taken. Violations of the county ordinance and state rule which prohibit transporting and launching boats and trailers with vegetation attached (NR 40) can be enforced by local law enforcement officers. The camera also serves as a reminder for boaters to check their equipment. WDNR AIS Education, Prevention and Planning grants can be used to support camera installation (up to $4,000 in grant funds for each). Maintenance and video/photo review are not grant-eligible expenses.

MAINTAINING BOATING AND SWIMMING ACCESS CORRIDORS

No records were found of property owners maintaining an opening in front of their waterfront by using herbicides on Lake Nancy. Using herbicides to maintain a waterfront access corridor is not recommended in this plan. The DNR recommends (and may require) that residents who wish to maintain an opening for boating and swimming use rakes or other hand methods.

The Department of Natural Resources Northern Region Aquatic Plant Management Strategy (May 2007) requires documentation of severely 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.

PLAN GOALS AND STRATEGIES

This section of the plan lists goals for aquatic plant management for Lake Nancy. It also presents a detailed strategy of actions to reach Aquatic Plant Management Plan goals. Educational strategies that outline audience and messages are included under each goal.

An implementation table is included to track progress toward carrying out plan actions. The LNPA relies upon the strong commitment of lake volunteers including an all-volunteer board of directors. The plan actions are prioritized and targeted to work well with volunteer implementation. Training and recognition for volunteers will provide the needed foundation for volunteer success. Supporting project partners including the Wisconsin Department of Natural Resources, Washburn County, Washburn County Lakes and Rivers Association, Town of Minong, and the Town Lakes Committee will be critical for successful plan implementation.

OVERALL PURPOSE

PRESERVE THE LAKE NANCY ECOSYSTEM FOR FUTURE GENERATIONS.

PLAN GOALS

GOAL 1) EDUCATE LAKE RESIDENTS AND VISITORS ABOUT THE THREATS FROM INVASIVE SPECIES, THE IMPORTANCE OF NATIVE AQUATIC AND SHORELAND PLANTS, AND THE PLAN MANAGEMENT STRATEGIES.

GOAL 2) PREVENT THE INTRODUCTION AND SPREAD OF ZEBRA MUSSELS AND OTHER AQUATIC INVASIVE SPECIES.

GOAL 3) MINIMIZE RUNOFF OF POLLUTANTS FROM THE LAKE NANCY WATERSHED.

GOAL 4) PRESERVE THE LAKE’S DIVERSE NATIVE PLANT COMMUNITIES.

GOAL 5) PREVENT THE SPREAD OF EURASIAN WATERMILFOIL.

GOAL 1) EDUCATE LAKE RESIDENTS AND VISITORS ABOUT THE THREATS FROM INVASIVE SPECIES, THE IMPORTANCE OF NATIVE AQUATIC AND SHORELAND PLANTS, AND THE PLAN MANAGEMENT STRATEGIES.

Detailed educational strategies including audience and messages are included under each of the plan goals which follow. Messages should be repeated using a variety of methods. The strategies use common methods which are listed below. Cooperation with the Town of Minong Lakes Committee will be sought for many of these methods.

Education and Outreach Methods

Newsletters

Brochures and other print materials

- Publication: responsible lake management (good project for Minong Town Lakes Committee)
- Welcome packet with information, including LNPA membership
- Written information should be concise
- Information packet including specific information for rental owners, renters, and guests.

Boat landing signs and kiosks

Annual meetings presentations

Website and Facebook: Investigate methods to encourage greater use such as photo contest, interesting posts

Email lists and distribution

GOAL 2) PREVENT THE INTRODUCTION AND SPREAD OF ZEBRA MUSSELS AND OTHER AQUATIC INVASIVE SPECIES (AIS).

OBJECTIVES

RESIDENTS, RENTERS, AND VISITORS UNDERSTAND THE IMPACTS OF AIS AND THE ACTIONS THEY CAN TAKE TO PREVENT THEIR INTRODUCTION.

AIS INTRODUCTIONS ARE PREVENTED

IF INTRODUCED, AQUATIC INVASIVE SPECIES ARE DISCOVERED EARLY

ACTIONS

Carry out Clean Boats, Clean Waters program at boat landings using paid inspectors (led by Town of Minong Lakes Committee). Support additional training and tracking for use of boat decontamination stations.

Monitor for zebra mussels and other invasive species as information and methods become available.

Support training and recognition for lake volunteers. Consider web-based training and encourage state and county to do the same.

Rapidly respond to discovered introductions of invasive species. Review and update Early Detection and Rapid Response AIS Plan (Appendix E) annually.

Explore centralized decontamination station(s) using hot water/power washing or other advanced methods. Coordinate with Town of Minong Lakes Committee and Washburn County Lakes and Rivers Association.

Consider and potentially implement additional methods for AIS prevention, such as remote camera monitoring, as methods become available.

Consider professional monitoring for aquatic invasive species which might include an annual AIS meandering survey.

Action: Carry out a comprehensive AIS prevention education program as outlined below.

Audience

Lake residents
Renters
Visitors
Town of Minong
Clean Boats, Clean Waters inspectors
Dock service providers (Whitetail Waterworks, etc.)

Messages

Inspect, Remove, Drain, Dry (inform visitors)
Use mild bleach solution available at the landing to decontaminate your boat and trailer (inform visitors)
Check docks and lifts when removed from the water in the fall
Report status of existing and potential Aquatic Invasive Species. Explain why AIS are a concern.
Washburn County has a do not transport ordinance that requires decontamination of boats and equipment if available at public and private access points.
Control of zebra mussels once established in a lake may not be possible.

GOAL 3) MINIMIZE RUNOFF OF POLLUTANTS FROM THE LAKE NANCY WATERSHED.

OBJECTIVES

LAKE RESIDENTS RESTORE AND PRESERVE SHORELINE BUFFERS OF NATIVE VEGETATION.

LAKE RESIDENTS INSTALL HEALTHY LAKES RUNOFF CONTROL PRACTICES SUCH AS RAIN GARDENS, ROCK INFILTRATION AND DIVERSIONS.

Action: Implement Healthy Lakes (or other available) WDNR grant-supported native planting program.

Action: Continue implementation of shoreline owners' education program.

Audience
Waterfront property owners

Messages
More frequent, large rain events increase runoff and its impacts.
Shoreline buffers protect water quality and provide fish and wildlife habitat. Lake Nancy has clear water because of the natural vegetation surrounding the lake and in the watershed.
Describe ways to restore shoreline buffers (natural recovery, stop mowing, plant natives).
Cost sharing for restoration shoreline buffers may be available from Washburn County.
Describe the Washburn County shoreline buffer requirements and how to report violations of these requirements.
Highlight good examples of shoreline buffers on private waterfront property.
Don't use fertilizers and pesticides on lawns.
Use visuals: show the deep roots of native plants.

Measurement
Ask who has changed buffer zones or other shoreline practices as a result of educational efforts.
Consider repeating shoreland survey (last done in 2000)

Figure 20. The deep roots of native plants help to infiltrate water and hold soil in place

GOAL 4) PRESERVE THE LAKE'S DIVERSE NATIVE PLANT COMMUNITIES.

OBJECTIVES

PREVENT DISTURBANCE OF NATIVE PLANTS FROM WATERCRAFT

LIMIT DISTURBANCE OF NATIVE PLANTS FROM HOMEOWNER REMOVAL

EDUCATE PEOPLE REGARDING FUNCTIONS AND VALUES OF NATIVE PLANTS

Action: Consider permanent land protection of Critical Habitat Areas through donations of fee title, conservation easements, and other tools.

Action: Implement an education strategy aimed at preserving native plants in Lake Nancy.

Audience

Lake residents
Renters
Visitors
Town of Minong

Messages

No wake zones are in place within 100 feet of the shoreline and other boats. This zone is extended to 200 feet for personal watercraft.
Shallow bays are important for wildlife diversity.
Healthy populations of native plants help to prevent introduction and spread of invasive species.
Diverse native plants provide diverse habitat for wildlife.
Invasive plants reduce plant and animal diversity.
Abundant plants keep the water clear, especially in shallow areas of the lake.
Native plant removal is discouraged because disturbance provides areas for invasive species to grow.
If you believe you have EWM, please call a board member to confirm identification.
Request/suggest that boaters and personal watercraft operators travel at no wake in certain areas to prevent plant removal and introduction of EWM and other invasive aquatic plants.
Manage waterfront properties with minimal plant removal.
If you need to remove plants in front of your property, rake to a maximum opening of no more than thirty feet. Less is better.

GOAL 5) PREVENT THE SPREAD OF EURASIAN WATERMILFOIL (EWM).

OBJECTIVES

TOTAL GROWTH OF EWM IN LAKE NANCY IS LIMITED TO LESS THAN TWO ACRES IN MATTED, TOPPED-OUT BEDS.

EWM DOES NOT SPREAD AND ESTABLISH IN SHALLOW LAKE BASIN, PECOS BAY, OR LOST LAKE.

EWM FROM LAKE NANCY DOES NOT SPREAD TO OTHER LAKES.

LAKESHORE OWNERS AND VISITORS UNDERSTAND APPROPRIATE ACTIONS TO TAKE TO CONTROL EWM GROWTH IN LAKE NANCY.

ACTIONS

Monitor Lake Nancy and Deep Lake for EWM and locate using GPS (Volunteers)

Treat EWM beds according to plan standards.

Send EWM samples to a qualified laboratory to conduct DNA testing for potential hybridization.

Consider new treatment methods based upon experience from other Wisconsin and Minnesota lakes.

Place yellow milfoil buoys around significant areas of EWM infestation if necessary.

Note that if WDNR grant funds are used for aquatic plant control, specific quantitative pre and post monitoring methods will be required. Such monitoring is usually completed by professional consultants.

Action
Inform Lake Nancy residents and visitors about EWM programs.

Audience
Lake owners
Lake renters
Visitors

Message
AIS identification: pictures and information
Contact a Lake Nancy board member if you find suspected EWM.
Describe EWM control program and effectiveness

EWM TREATMENT STANDARDS AND METHODS FOR LAKE NANCY

STANDARDS FOR TREATMENT

Herbicide treatment will be considered with matted/topped-out beds (visual and navigation concerns identified by lake residents and volunteers)

TREATMENT METHODS

HERBICIDE TREATMENT

- Treat Eurasian watermilfoil beds early in the season when new EWM growth is from 1 – 3 inches (late May to early June).
- Use liquid 2,4-D injected using a tremi-tube at 4 ppm or other chemicals and treatment methods that may become available.
- Treat EWM early in the day when the winds are calm.

SCHEDULE AND ROLES FOR HERBICIDE TREATMENTS

FEB/MARCH PRECEDING TREATMENT

Contract with herbicide applicator (if treatment is planned). (LNPA Board)

Apply for aquatic plant management permit from DNR. Permit will be based upon potential acreage mapped in late summer of preceding year using standards for treatment of EWM areas listed previously.

ONGOING

Ask residents to notify board members or volunteers of potential EWM locations via email or telephone. Board member or volunteer checks for presence of EWM in suspected locations and records boundaries of EWM beds using GPS equipment. This mapping will focus in and near areas where EWM has been found previously.

PRIOR TO TREATMENT (LATE MAY)

Volunteers will map treatment areas and provide specific treatment area and location to contractor, lake association, and DNR permit staff.

Note that if WDNR grant funds are used for aquatic plant control, specific quantitative pre and post monitoring methods will be required. Such monitoring is usually completed by professional consultants.

EARLY SEASON TREATMENT (LATE MAY TO EARLY JUNE)

Contractor to apply herbicide according to permit conditions when new EWM growth is from 1-3 inches. Board EWM lead or designee will supervise contractor, notifying contractor and DNR when new EWM growth reaches one inch and overseeing permit conditions such as location and timing of treatment, and wind conditions that preclude treatment.

MEASURE EFFECTIVENESS OF TREATMENT (FOUR WEEKS FOLLOWING TREATMENT OR LATE JUNE TO EARLY JULY)

Develop simple monitoring methods for volunteers to assess effectiveness of treatment and potential impacts of chemical treatment on native plants.

Note that if WDNR grant funds are used for aquatic plant control, specific quantitative pre and post monitoring methods will be required. Such monitoring is usually completed by professional consultants.

IDENTIFY NEXT YEAR TREATMENT LOCATIONS (LATE SUMMER/EARLY FALL)

Identify additional potential EWM treatment locations using a map of previous EWM locations– note where EWM is present/suspected with GPS equipment. (Volunteer)

ADAPTIVE MANAGEMENT APPROACH

The EWM 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 Nancy Protective Association Board and the Department of Natural Resources.

IMPLEMENTATION PLAN

Action Items[14]	Timeline	Annual Cost	Annual Volunteer Hours	Responsible Parties or Individual
EDUCATE LAKE RESIDENTS AND VISITORS				
Newsletter production				
Welcome packet: develop and distribute to all owners: choose contents and distribution methods				
Information packet: for distribution to rental owners, renters and guests				
Boat landing signs and kiosks				
Website and Facebook: update regularly, investigate ways to encourage use				
Email list and distribution				

[14] See previous pages for action item detail. Implementation plan to be developed by the LPNA board and reviewed and updated annually.

Action Items[14]	Timeline	Annual Cost	Annual Volunteer Hours	Responsible Parties or Individual
PREVENT ZEBRA MUSSELS AND OTHER AIS				
Clean Boats, Clean Waters inspections	May through September	$8,000		LNPA, Minong Lakes Committee
Zebra mussel monitoring: plate samplers, resident education				
Volunteer training and recognition				
Review Early Detection and Rapid Response Plan for AIS	Annually			
Explore centralized decontamination station(s) and other AIS prevention methods				
Consider professional monitoring for AIS				
MINIMIZE RUNOFF OF POLLUTANTS				
Shoreland owners' education: select and develop materials for distribution				
Cost sharing for native planting (Healthy Lakes grant application and support)				

Action Items[14]	Timeline	Annual Cost	Annual Volunteer Hours	Responsible Parties or Individual
PRESERVE NATIVE PLANT COMMUNITIES				
Consider permanent land protection				LNPA, DNR
Educational program: select and develop materials for distribution	Ongoing			LNPA, Town
Prevent Spread of EWM				
Locate EWM and map treatment areas	Late Summer		16 hours	LNPA Volunteers
Treat EWM beds according to plan standards	May			LNPA Treatment Contractor
Test EWM for hybridization				Laboratory

Action Items[14]	Timeline	Annual Cost	Annual Volunteer Hours	Responsible Parties or Individual
ADMINISTRATION				
Assign individual and committees to take responsibility for plan actions and report regularly to the LNPA board				
Ensure funding is available to implement plan	Ongoing		20 hours	LNPA Board
Apply for AIS grant funding	?		?	LNPA Board
Update point intercept survey and APM plan	2022			LNPA Board Consultant

MONITORING AND ASSESSMENT

AQUATIC PLANT SURVEYS

Aquatic plant (macrophyte) surveys are the primary means to track achievement toward plan goals.

Action: Conduct whole lake aquatic plant surveys approximately every five years to track plant species composition and distribution.

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

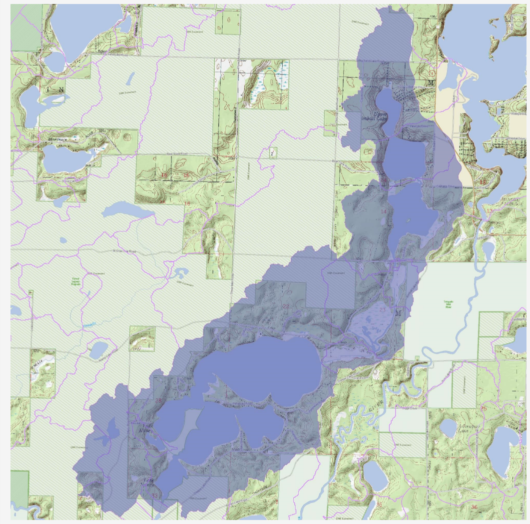
Department of Natural Resources Aquatic Invasive Species grants are available to assist in funding the action items in the implementation plan. Grants provide up to 75 percent funding. AIS Education, Prevention, and Planning (AEPP), and Clean Boats, Clean Waters (CBCW) grants are due December 10 of each year. AIS Control (ACEI) grants are due February 1 of each year.

The Lake Nancy Protective Association currently has a Department of Natural Resources Small Scale Planning grant for the update of the aquatic plant management plan.

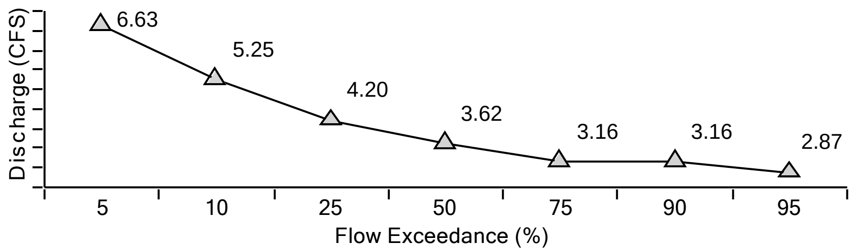
APPENDIX A. LAKE NANCY PRESTO LITE WATERSHED REPORT

PRESTO-Lite Watershed Delineation Report

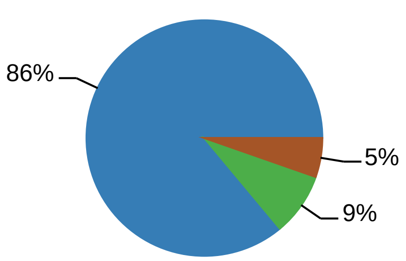
Reach ID: 200191416	
Watershed Name: Totagatic River	
Waterbody Name: Unnamed	
HUC08: Namekagon River	
Watershed Area: 6.91 mi²	
Average Annual Precipitation: 30.91in	



Stream Flow

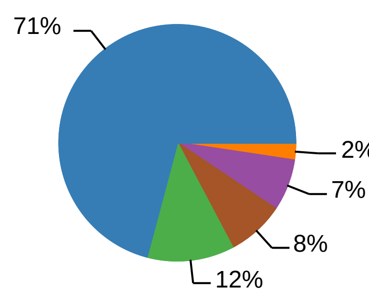


Tributary Stream Type



Type	Length
Cold Headwater	2671 ft
Macroinvertebrates	267 ft
Warm Mainstem	166 ft
Coldwater	0 ft
Cool-Cold Headwater	0 ft
Cool-Cold Mainstem	0 ft
Cold Mainstem	0 ft
Large River	0 ft
Warm Headwater	0 ft

Landcover



Type	Area
Forest	3.7 mi²
Wetland	0.62 mi²
Urban	0.41 mi²
Barren	0.37 mi²
Agriculture	0.12 mi²
Grassland	0.01 mi²

PRESTO Phosphorus Load Estimate

Avg. Annual Nonpoint Phosphorous Load (80% Confidence Interval)	107 (53 - 214) lbs
Number of Facilities (Individual Facility Information below)	0
Avg. Annual Point-source Phosphorous Load (2010 - 2012 total of all facilities)	0lbs
Most Likely Point : Nonpoint Phosphorous Ratio	0% : 100%
Low Estimate Point : Nonpoint Phosphorous Ratio (Adaptive Management)	0% : 100%

Watershed Analysis Limitations

- This analysis relies on pre-defined catchments from the Wisconsin Hydrography Data-Plus and may not delineate from the exact location required. When assessing phosphorus loads for specific facility in support of efforts such as adaptive management, care should be taken to ensure that additional downstream point sources do not exist. For adaptive management information related to specific facilities please reference the PRESTO website http://dnr.wi.gov/topic/surfacewater/presto.html
- Delineation of watersheds is based on a topographic assessment and therefore do not account for modified drainage networks such as stormwater sewer systems and ditched agriculture.
- If a watershed requires delineation from an exact location the user may use the desktop version of PRESTO that requires ESRI ArcGIS. The PRESTO tool and default datasets can be downloaded at http://dnr.wi.gov/topic/surfacewater/presto.html
- Data sources for this report originate from the WDNR's Wisconsin Hydrography Data-Plus value-added dataset and the point and non-point source loading information including in the WDNR's PRESTO model.
- If you have questions about the report generated from the PRESTO-Lite application please contact: DNRWATERQUALITYMODELING@wisconsin.gov

APPENDIX B. AQUATIC PLANT SURVEY METHODS

Ecological Integrity Service employed a point intercept method for aquatic macrophyte sampling. The Wisconsin Department of Natural Resources (Wisconsin DNR) generated the sampling point grids. All points were initially sampled for depth only. Once the maximum depth of plant growth was established, only points at that depth (or less) were sampled. If no plants were sampled, one point beyond that was sampled. In areas such as bays that appear to be under-sampled, a boat or shoreline survey was conducted to record plants that may have otherwise been missed. This involved surveying that area for plants and recording the species viewed and/or sampled. The type of habitat was also recorded. These data were not used in the statistical analysis nor is the density recorded. Only plants sampled at predetermined points were used in the statistical analysis. In addition, any plant within 6 feet of the boat was recorded as "viewed." A handheld Global Positioning System (GPS) located the sampling points in the field. The Wisconsin DNR guidelines for point location accuracy were followed with an 80 foot resolution window and the location arrow touching the point.

A June survey was conducted to determine the frequency of *Potamogeton crispus*-curly leaf pondweed since this plant tends to senesce before the later season survey. The later season survey was conducted in July in which the plants are actively growing.

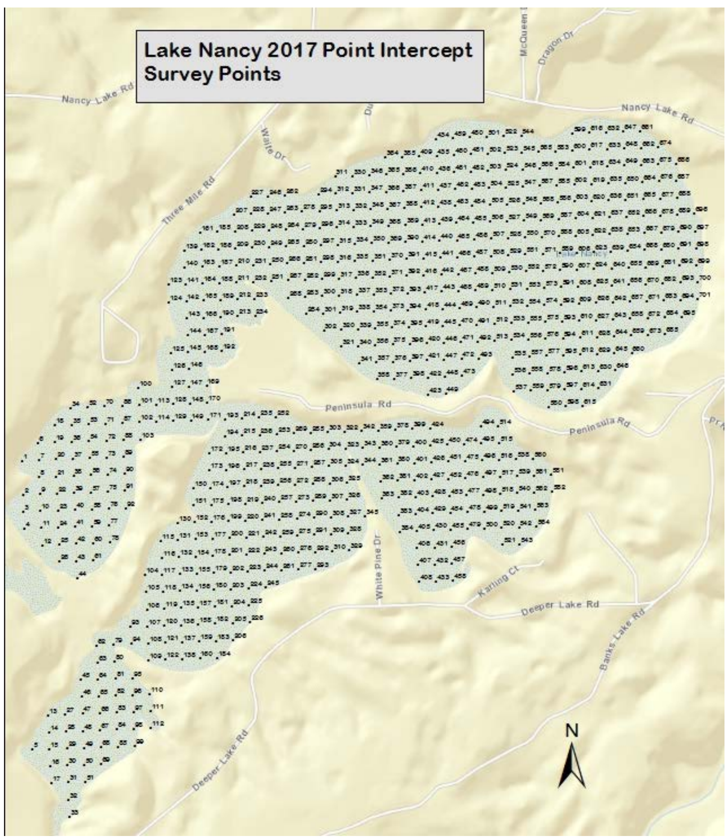
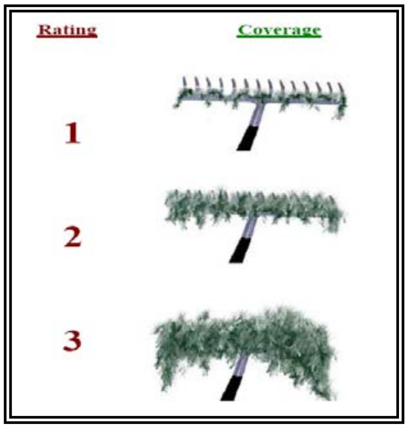


Figure 21. Lake Nancy Point Intercept Sample Grid

At each sample location, a double-sided fourteen-tine rake was used to rake a 1-meter tow off the bow of the boat. All plants present on the rake and those that fell off the rake were identified and rated for rake fullness. The rake fullness value was used based on the criteria contained in the diagram and table below. Those plants that were within 6 feet were recorded as "viewed," but no rake fullness rating was given. Any under-surveyed areas such as bays and/or areas with unique habitats were monitored. These areas are referred to as a "boat survey or shoreline survey."

The rake density criteria used:



Rake fullness rating	Criteria for rake fullness rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

The depth and predominant sediment type was also recorded for each sample point. Caution must be used in using the sediment type data in deeper water as it is difficult to discern between muck and sand with a rope rake. All plants needing verification were bagged and cooled for later examination. Each species was mounted and pressed for a voucher collection and submitted to the Freckmann Herbarium (UW-Stevens Point) for review. On rare occasions a single plant may be needed for verification, not allowing it to be used as a voucher specimen and may be missing from the collection.

DATA ANALYSIS METHODS

Data collected and analyzed resulting in the following information:

- Frequency of occurrence in sample points with vegetation (littoral zone)
- Relative frequency
- Total points in sample grid
- Total points sampled
- Sample points with vegetation
- Simpson's diversity index
- Maximum plant depth
- Species richness
- Floristic Quality Index

Frequency of occurrence for each species - Frequency is expressed as a percentage by dividing the number of sites the plant is sampled by the total number of sites, which calculates to two values. The first value is the percentage of all sample points that a particular plant was sampled at depths less than maximum depth plants (littoral zone), regardless if vegetation was present. The second is the percentage of sample points that a particular plant was sampled at only points containing vegetation. The first value shows how often the plant would be encountered in the defined littoral zone (by depth), while the second value shows how frequent the plant is only where plants grow. In either case, the greater this value, the more frequent the plant is present in the lake. When comparing frequency in the littoral zone, plant frequency is observed at maximum depth. This frequency value is used to analyze the occurrence and location of plant growth based on depth. Frequency of occurrence is usually reported using sample points where vegetation was present.

Frequency of occurrence example:

Plant A sampled at 35 of 150 littoral points = 35/150 = 0.23 = 23%

Plant A's frequency of occurrence = 23% considering littoral zone depths.

Plant A sampled at 12 of 40 vegetated points = 12/40 = 0.3 = 30% considering vegetated points

These two frequencies will show how common the plant was sampled in the littoral zone or how common the plant was sampled at points plants actually grow. Generally the second will have a higher frequency since that is where plants are actually growing as opposed to where they could grow. This analysis will consider vegetated sites for frequency of occurrence only.

Relative frequency - This value shows, as a percentage, the frequency of a particular plant relative to other plants. This is not dependent on the number of points sampled. The relative frequency of all plants total 100%. If plant A had a relative frequency of 30%, it occurred 30% of the time compared to all plants sampled or makes up 30% of all plants sampled. This value demonstrates which plants are the dominant species in the lake. The higher the relative frequency, the more common the plant compared to the other plants and thus more frequent in the plant community.

Relative frequency example:

Suppose 10 points were sampled in a very small lake and got the following results:

	Frequency sampled
Plant A present at 3 sites	3 of 10 sites
Plant B present at 5 sites	5 of 10 sites
Plant C present at 2 sites	2 of 10 sites
Plant D present at 6 sites	6 of 10 sites

Results show Plant D is the most frequent sampled plant at all points with 60% (6/10) of the sites having plant D. However, the relative frequency displays what the frequency is compared the other plants, without taking into account the number of sites. It is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If all frequencies are added (3+5+2+6), the sum is 16. In this case, the relative frequency calculated by dividing the individual frequencies by 16.

Plant A = 3/16 = 0.1875 or 18.75%

Plant B = 5/16 = 0.3125 or 31.25%

Plant C = 2/16 = 0.125 or 12.5%

Plant D = 6/16 = 0.375 or 37.5%

In comparing plants, Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because although Plant D was sampled at 6 of 10 sites, many other plants were sampled too, thereby giving a lower frequency when compared to those other plants. This shows the true value of the dominant plants present.

Total points in sample grid - The Wisconsin DNR establishes a sample point grid that covers the entire lake. Each GPS coordinate is mapped and used to locate the points.

Sample sites less than maximum depth of plants - The maximum depth at which a plant is sampled is recorded. This defines the depth plants can grow (littoral zone). Any sample point with a depth less than, or equal to this depth is recorded as a sample point less than the maximum depth of plants. This depth is used to determine the potential littoral zone and is therefore referred to as the littoral zone.

Sample sites with vegetation - This is the number of sites where plants were actually sampled providing a projection of plant coverage on the lake. Vegetation in 10% of all sample points implies about 10% coverage of plants in the whole lake, assuming an adequate number of sample points have been established. The littoral zone is observed for the number of sample sites with vegetation. If 10% of the littoral zone had sample points with vegetation, then the estimated plant coverage in the littoral zone is 10%.

Simpson's diversity index - Simpson's diversity index is used to measure the diversity of the plant community. This value can run from 0 to 1.0. The greater the index value, the more diverse the plant community. In theory, the value is the chance that two species sampled are different. An index of "1" indicates that the two will always be different (diverse) and a "0"indicates that the species will never be different (only one found). The higher the diversity in the native plant community, the healthier the lake ecosystem.

Simpson's diversity example:

If a lake was sampled and observed just one plant, the Simpson's diversity would be "0" because if two plants were randomly sampled, there would be a 0% chance of them being different, since there is only one plant.

If every plant sampled were different, then the Simpson's diversity would be "1." This is because if two plants were randomly sampled, there would be a 100% chance they would be different since every plant is different.

These are extreme and theoretical scenarios, but they demonstrate how this index works. The greater the Simpson's index for a lake, the more likelihood two plants sampled are different.

Maximum depth of plants - This depth indicates the greatest depth that plants were sampled. Generally, clear lakes have a greater depth of plants, while lower water clarity limits light penetration and reduces the depth at which plants are found.

Species richness - The number of different individual species found in the lake. There is a value for the species richness of plants sampled and another value that documents plants viewed but not sampled during the survey.

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 in response to development (and human influence) on the lake. It considers the species of aquatic plants sampled and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A higher conservatism value indicates that a plant is intolerant, while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes, largely due to human influence (Nichols, 1999). The FQI is calculated using the number of species and the average conservatism value of all species used in the index.

The formula is: $FQI = \text{Mean } C \cdot \sqrt{N}$

Where C is the conservatism value and N is the number of species (sampled on rake only).

Therefore, a higher FQI indicates a healthier aquatic plant community, which is an indication of better plant habitat. This value can then be compared to the median for other lakes in the assigned eco-region. There are four eco-regions used throughout Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area, and Southeastern Wisconsin Till Plain. The 2008 and 2017 values from past aquatic plant surveys are compared in this analysis.

Summary of Northern Lakes and Forests for Floristic Quality Index:

(Nichols, 1999)

	Northern Lakes and Forests
Median species richness	14
Median conservatism	5.6
Median Floristic Quality	20.9

*Floristic Quality has a significant correlation with area of lake (+), alkalinity(-), conductivity(-), pH(-), and Secchi depth(+). In a positive correlation, as that value increases so will FQI. With a negative correlation, as a value decreases, the FQI will decrease.

APPENDIX C. INVASIVE SPECIES INFORMATION

EURASIAN WATERMILFOIL (*MYRIOPHYLLUM SPICATUM*) [15]

The following Eurasian watermilfoil information is taken from a Wisconsin DNR fact sheet.

IDENTIFICATION

Eurasian watermilfoil 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 watermilfoil is nearly impossible to distinguish from northern watermilfoil. Eurasian watermilfoil 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.

CHARACTERISTICS

Eurasian watermilfoil 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 lakebeds, 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.

REPRODUCTION AND DISPERSAL

Unlike many other plants, Eurasian watermilfoil 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

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[15] Wisconsin DNR Invasive Species Factsheets from http:/dnr.wi.gov/invasives. Photo by Elizabeth Czarapata.

downstream by water currents or inadvertently picked up by boaters. Milfoil is readily spread attached to boats, motors, trailers, bilges, live wells, and bait buckets. It 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 wate rmilfoil is adapted for rapid growth early in spring.

ECOLOGICAL IMPACTS

Eurasian watermilfoil's 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 watermilfoil 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 watermilfoil may lead to deteriorating water quality and algae blooms in infested lakes. Hybrids of Eurasian and northern watermilfoil are also found in Wisconsin Lakes. Like pure Eurasian watermilfoil, EWM-NWM hybrids grow very quickly and can choke waterways, hampering boat access, fish passage, and water supply intakes.

CONTROL METHODS

Preventing a Eurasian watermilfoil invasion requires various efforts. The first component is public awareness of the necessity to remove weed fragments at boat landings. Inspection programs should provide physical inspections as well as a direct educational message. Native plant beds must be protected from disturbance caused by boaters and indiscriminate plant control that disturbs these beds. A watershed management program should decrease nutrients reaching the lake and reduce the likelihood that Eurasian milfoil colonies will establish and spread.

Monitoring is also important, so introduced plants can be controlled immediately. The lake association and lakeshore owners should check for new colonies and control them before they spread. The plants can be hand pulled or raked. It is imperative that all fragments be removed from the water and the shore.

A good strategy for a systematic monitoring program is to target areas where the native northern watermilfoil (*Myriophyllum sibiricum)* is found. This plant is often confused with Eurasian watermilfoil, which looks somewhat similar. Hybrid versus Eurasian watermilfoil identification is even more difficult. Unlike Eurasian watermilfoil (EWM), northern watermilfoil is native and a desirable plant to have in the lake. It has very fine leaves that provide habitat for small planktonic organisms, which make up an important part of the food chain. From a management perspective, the location of northern watermilfoil can be important, because EWM and northern watermilfoil and their hybrids grow in similar conditions.

PURPLE LOOSESTRIFE (*LYTHRUM SALICARIA*)[16]

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 to 7 feet tall with a dense bushy growth of 1 to 50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 5 to 6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes (underground stems) that form a dense mat.

CHARACTERISTICS

Purple loosestrife is a wetland herb that was introduced as a garden perennial from Europe during the 1800's. It is still promoted by some horticulturists for its beauty as a landscape plant, and by beekeepers for its nectar-producing capability. Currently, about 24 states have laws prohibiting its importation or distribution because of its aggressively invasive characteristics. It has since extended its range to include most temperate parts of the United States and Canada. The plant's reproductive success across North America can be attributed to its wide tolerance of physical and chemical conditions characteristic of disturbed habitats and its ability to reproduce prolifically by both seed dispersal and vegetative propagation. The absence of natural predators, like European species of herbivorous beetles that feed on the plant's roots and leaves, also contributes to its proliferation in North America.

Purple loosestrife was first detected in Wisconsin in the early 1930s, but remained uncommon until the 1970s. 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 to 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;

[16] Wisconsin DNR invasive species factsheets from http:/dnr.wi.gov/invasives.

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.

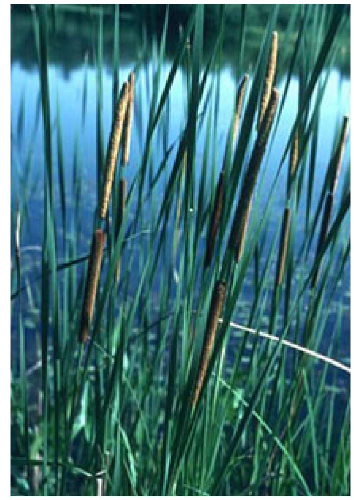
You must obtain a permit from WDNR before applying any herbicide over water. The process has been streamlined for control of purple loosestrife, and there is no cost. Contact your regional Aquatic Plant Management Coordinator for permit information.

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.

NARROW LEAF CATTAIL (*TYPHA ANGULSTIFOLIA*)

ECOLOGICAL THREAT



Narrow-leaved cattail can invade freshwater marshes, wet meadows, fens, roadsides, ditches, shallow ponds, stream, and lake shores. While cattails play an important role as a source of food and shelter for some marsh-dwelling animals, large mono-specific stands of invasive cattails exclude some less common species. Narrow-leaved cattail is listed as a restricted species in Wisconsin. Restricted invasive species are already established in the state and cause or have the potential to cause significant environmental or economic harm or harm to human health.

IDENTIFICATION

Leaves are erect, linear, and flat with leaf blades 0.15-0.5” wide, and up to 3’ long. About 15 leaves emerge per shoot. They are dark green in color and rounded on the back of the blade.

The plant has numerous tiny flowers densely packed into a cylindrical spike at end of stem, divided into upper section of yellow, male flowers and lower brown, sausage-shaped section of female flowers. The gap between male and female sections is about 0.5-4” in narrow-leaved cattail.

The plants reproduce vegetatively by means of starchy underground rhizomes to form large colonies.

CONTROL

Narrow-leaved cattail can be controlled mechanically by cutting all stems, both green and dead in mid to late summer or early fall. If possible, maintain a water level of a minimum of three inches above the cut stems for the entire growing season. Chemical control is by a foliar spray with an aquatic approved imazypr.

CURLY LEAF PONDWEED (*POTAMOGETON CRISPUS*)

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian watermilfoil 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.[17]

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.[18]

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

[18] 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.[19]

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.

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

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 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.

ZEBRA MUSSELS (*Dreissena polymorpha*)

ECOLOGICAL THREAT

Zebra mussels are an invasive species that have inhabited Wisconsin waters and are displacing native species, disrupting ecosystems, and affecting citizens' livelihoods and quality of life. They hamper boating, swimming, fishing, hunting, hiking, and other recreation, and take an economic toll on commercial, agricultural, forestry, and aquacultural resources.[20]

IDENTIFICATION

The zebra mussel (*Dreissena polymorpha*) is a tiny (1/8-inch to 2-inch) bottom-dwelling clam native to Europe and Asia. Zebra mussels were introduced into the Great Lakes in 1985 or 1986, and have been spreading throughout them and to inland lakes 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.[21]

PREVENTION AND MONITORING

The characteristics of zebra mussels provide guidance for prevention and monitoring efforts. They attach to hard surfaces, so inspecting boats and trailers before they enter the lake is critical.

Used boats, lifts, and docks should be quarantined (kept out of the water) for at least a month and inspected carefully to prevent transfer of zebra mussels from infested waters.

Examining docks and lifts when they are pulled out of the water can help to locate zebra mussels soon after they are introduced into a lake. Sampling devices such as cinder blocks or plate samplers can be placed in shallow water and monitored by volunteers.

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[20] https://dnr.wi.gov/topic/invasives/fact/zebra.html

[21] https://dnr.wi.gov/topic/invasives/fact/zebra.html

Zebra mussels are microscopic in early life states. Females can produce one million eggs each season. Critical prevention efforts include draining water from boats. Larval stages, called veligers, are monitored using specialized nets which are pulled through the water.

CONTROL

Physical/Mechanical: Once zebra mussels are established in a water body, very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Some of the physical control measures include removal by SCUBA, industrial vacuums, or backflushing. Blankets or barriers can prevent establishment in specific areas and drawdowns can be used.

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

Biological control using dead bacterial cells is also used.

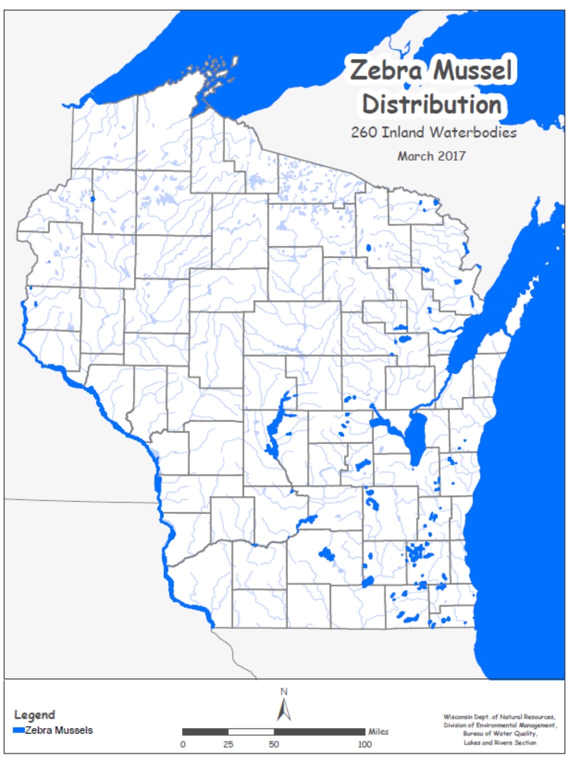

Figure 22. Zebra Mussel Distribution (March 2017)

APPENDIX D. AQUATIC PLANT MANAGEMENT METHODS

Techniques to control the growth and distribution of aquatic plants are discussed in following text. The application, location, timing, and combination of techniques must be considered carefully.

MANUAL REMOVAL[22]

Manual removal involving hand pulling, cutting, or raking plants will effectively remove plants from small areas. It is likely that plant removal will need to be repeated during the growing season. The best timing for hand removal of herbaceous plant species is after flowering but before seed head production. For plants that possess 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 watermilfoil establishment and for private landowners who wish to remove small areas of curly leaf pondweed growth. Raking can be used to clear nuisance growth in riparian area corridors up to 30 feet wide. Recent costs for hand-pulling EWM using divers on Minocqua and Kawaguesaga Lakes in Oneida County were about $28,000 to remove an estimated <4,000 lbs.

MECHANICAL CONTROL

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver assisted suction harvesting, and rotovating (tilling) are the most common forms of mechanical control available. Department of Natural Resources 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 1 to 6 feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. A harvester can also be used to gather dislodged, free-floating plant fragments such as from coontail or wild celery. Once full, the harvester travels to shore to discharge the load of weeds off of the vessel.

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

In some cases, the plants are transported to shore by the harvester itself for disposal, while in other cases, a barge is used to store and transport the plants in order to increase the efficiency of the cutting process. The plants are deposited on shore, where they can be transported to a local farm to be used as compost (the nutrient content of composted aquatic plants is comparable to that of cow manure) or to an upland landfill for proper disposal. Most

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

harvesters can cut between 2 and 8 acres of aquatic vegetation per day, and the average lifetime of a mechanical harvester is 10 years.

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

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

While the results of harvesting aquatic plants may be short term, the negative consequences are not so short lived. Much like mowing a lawn, harvesting must be conducted numerous times throughout the growing season. Although the harvester collects most of the plants that it cuts, some plant fragments inevitably persist in the water. This may allow the invasive plant species such as Eurasian watermilfoil 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 do not 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 time 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 contracted machines travel from lake to lake, they may carry plant fragments with them, and facilitate the spread of aquatic invasive species from one body of water to another. One must also consider prevailing winds, since cut vegetation can be blown into open areas of the lake or along shorelines. Harvesting is not recommended for Lake Nancy at this time.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The dredge hoses are from 3 to 5 inches in diameter and are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver dredging is especially effective against 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 be formed from this type of operation. Fragmentation is not as great a problem when infestations are small. Diver dredging operations may need to be repeated to be effective. When applied toward 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 can play an important part in the effectiveness of a diver dredging operation. Soft substrates allow easy harvesting. Divers can remove the plant and root crowns with little problem. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment.

Diver Assisted Suction Harvesting (DASH)

With Diver Assisted Suction Harvesting (DASH) divers hand pull aquatic invasive plants from the lake-bed. A suction line transports removed plants to the surface. This method is probably most appropriate for relatively small and less dense areas of invasive plant growth. Poor water clarity will make it more difficult to use DASH.[23]

The Tomahawk Lake Association (TLA) developed and has used a DASH system for several years, although they call their system a hydraulic conveyor system (HCS). HCS is an automated system that removes, filters, and bags harvested EWM after it has been hand harvested from the lake bed by divers. The TLA HCS includes a floating chassis, a “jet pump” water system, a three tiered separation system, and a Hookah diver air supply system.[24] Use of the TLA HCS began in the summer of 2007. A second generation HCS began operation in 2011. Capital costs for the system are just over $25,000, and annual operating costs are about $31,000. The TLA harvested about 20,000 lbs. each year through 2014.

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[23] Wisconsin Lakes Convention Presentation. 2016.

[24] Wisconsin Lakes Convention presentation, TLA Hydraulic Conveyor System. Ned Greedy, 2014.

Figure 23. DASH Contract Harvesting

Because of the mechanical elements of the system, a WDNR aquatic plant management harvesting permit is required. Contracted DASH systems are available. Decontamination of the system is especially important with a contracted DASH system that moves between lakes. A DASH trial might be considered for Lake Nancy if EWM growth increases in the future. A recent estimate for 2017 from a contractor was $2,500/day with harvesting amounts varied with total EWM acreage and density. With high density, the contractor reported removing 3,000 pounds in a single day.[25]

Rotovation involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of 20 feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling sediments that are contaminated could possibly release toxins to the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine 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.

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[25] TSB Lakefront Restoration Email Communication. January 2017.

BIOLOGICAL CONTROL[26]

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 native pests to the target invasive organism, the exotic invasive species may be maintained at lower densities.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control relative to other technologies, lower overall costs, as well as plant-specific control. On the other hand, there are several disadvantages to consider, including very long control times of years instead of weeks, lack of available agents for particular target species, and relatively narrow environmental conditions for success.

While this theory has worked in practice for control of some nonnative aquatic plants, results have been varied (Madsen, 2000). Beetles are commonly used to control purple loosestrife populations in Wisconsin with good success. Weevils are used as an experimental control for Eurasian watermilfoil once the plant is established. Tilapia and carp are used to control the growth of filamentous algae in ponds. Grass carp, an herbivorous fish, is sometimes used to feed on pest plant populations. Grass carp introduction is not allowed in Wisconsin.

Eurasian Watermilfoil Biocontrol

A potential management method for EWM is the use of the native weevil *Euhrychiopsis lecontei*. This weevil has a larvae stage that feeds on both native milfoils and Eurasian watermilfoil. The larvae tunnel into the stem causing the plant to presumably lose the ability to transport nutrients and gases. *E. lecontei* adults swim and climb from plant to plant, feeding on leaflets and stem material. After mating, the female lays an average of 1.9 eggs a day, usually 1 egg per watermilfoil apical meristem (growing tip). One female may lay hundreds of eggs in her lifetime. The eggs hatch, and the larvae first feed on the apical meristem and then mine down into the stem of the plant, consuming internal stem tissue. Weevils pupate inside the stem in the pupal chamber, a swelled cavity in the stem. Adults emerge from the pupal chamber to mate and lay eggs. In the autumn, adults travel to the shore where they over-winter on land. In the laboratory, *E. lecontei* take 20 to 30 days to complete 1 life cycle, depending on water temperatures. For complete development, weevils require about 310 degree-days with temperatures above 10 degrees C. Two to four generations per year are generally observed in the field.[27]

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[26] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005 except as otherwise noted.

[27] *Euhrychiopsis lecontei* fact sheet. Cornell University Research Ponds Facility.

Since this weevil naturally occurs in many Wisconsin Lakes, its use involves the augmentation of the natural population of weevils present in the lake. This augmentation can significantly increase the population of larvae per stem of milfoil. The premise is that this increase will lead to more destruction of the plants.

Purple Loosestrife Biocontrol[28]

Biocontrol may be the most viable long term control method for purple loosestrife control. The WDNR and University of Wisconsin-Extension (UWEX), along with hundreds of citizen cooperators, have been introducing natural insect enemies of purple loosestrife, from its home in Europe to infested wetlands in the state since 1994. Careful research has shown that these insects are dependent on purple loosestrife and are not a threat to other plants. Insect releases monitored in Wisconsin and elsewhere have shown that these insects can effectively decrease purple loosestrife size and seed output, thus letting native plants reduce its numbers naturally through enhanced competition.

A suite of four different insect species has been released as biological control organisms for purple loosestrife in North America and Wisconsin. Two leaf beetle species called "Cella" beetles that feed primarily on shoots and leaves were the first control insects to be released in Wisconsin, and are the insects available from WDNR for citizens to propagate and release into their local wetlands. A root-mining weevil species and a type of flower-eating weevil have also been released and are slowly spreading naturally. The Purple Loosestrife Biocontrol Program offers cooperative support, including free equipment and starter beetles from WDNR and UWEX, to all state citizens who wish to use these insects to reduce their local purple loosestrife.

The length of time required for effective biological control of purple loosestrife in any particular wetland ranges from one to several years depending on factors such as site size and loosestrife densities. The process offers effective and environmentally sound control of the plant, not elimination, in most cases. It is also typically best done in some combination with occasional use of more traditional control methods such as digging and herbicide use. Biocontrol with beetles may be appropriate at some point in time should purple loosestrife become established around Lake Nancy.

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 Lake Nancy because a healthy, diverse native plant population is present.

< http://www.eeb.cornell.edu/ponds/weevil.htm>

[28] http://dnr.wi.gov/topic/Invasives/loosestrife.html

PHYSICAL CONTROL[29]

In physical management, the environment of the plants is manipulated, which in turn acts upon the plants. Several physical techniques are commonly used: dredging, drawdown, benthic (lake bottom) barriers, and shading or light attenuation. Because they involve placing a structure on the bed of a lake and/or affect lake water level, a Chapter 30 or 31 WDNR permit would be 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 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 Lake Nancy as part of the aquatic plant management plan.

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

Although drawdown is inexpensive and has long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function (e.g., power generation or drinking water supply) of the water body during the drawdown period. Lastly, species respond in very different manners to drawdown and often not in a consistent fashion (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 that the plants are covered over 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 combinations of the above (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with using sediments is that new plants establish on top of the added layer (Engel

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

and Nichols 1984). The problem with synthetic sheeting is that the gasses evolved from decomposition of plants and sediment decomposition collect under and lift the barrier (Gunnison and Barko 1992). Benthic barriers will typically kill plants under them within 1 to 2 months, after which 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, benthic barriers are too expensive to use over widespread areas, and they heavily affect benthic communities by removing fish and invertebrate habitat. A Department of Natural Resources permit would be required for a benthic barrier and is not recommended for Lake Nancy.

Shading or light attenuation reduces the light plants need to grow. Shading has been achieved by fertilization to produce algal growth, by application of natural or synthetic dyes, shading fabric, or covers, and by 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 in Lake Nancy.

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. Wisconsin Department of Natural Resources permits under Chapter NR 107 are required for herbicide application. **Aquatic herbicides must be applied only by licensed applicators.**

General descriptions of herbicide classes are included below.[30]

CONTACT HERBICIDES

Contact herbicides act quickly and are generally lethal to all plant cells that 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. 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 re-sprout 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 because they must move within the 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 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 they 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.

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

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 that can, in turn, affect other organisms. Or, weed control operations can affect water chemistry that, in turn, affects organisms.

General descriptions of the breakdown of commonly used aquatic herbicides are included below.[31] Chemicals commonly used in Wisconsin lakes are listed and described in Table 16 below.

Table 16. Herbicides Used to Manage Aquatic Plants in Wisconsin

Brand Name(s)	Chemical	Target Plants
Captain, Nautique, Cutrine Plus	Copper compounds	Free floating and filamentous algae, also coontail, curly leaf pondweed, water celery, pondweeds
Aquathol K, Hydrothal	Endothall	Curly leaf pondweed also other submergent plants: coontail, milfoil, pondweed, water celery
Reward	Diquat	Pondweeds, coontail, Eurasian watermilfoil
Aquakleen, Navigate	2,4-D	Eurasian and other milfoils

COPPER[32]

Copper is an essential trace element that tends to accumulate in sediments and can be toxic to aquatic life at elevated concentrations (United States Environmental Protection Agency, June 2008).

A study completed by MacDonald et al. (2000) developed consensus based numerical sediment quality guidelines for metals in freshwater ecosystems. This study provides guidelines for metals in freshwater ecosystems that reflect threshold effect concentrations (TECs, below which harmful effects are unlikely to be observed) and

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

[32] Copper background information is from the Long Lake Management Plan prepared by the Polk County Land and Water Resources Department March 2013.

probable effect concentrations (PECs, above which harmful effects are likely to be observed). The consensus based TEC for copper is 31.6 mg/kg and the consensus based PEC for copper is 149 mg/kg.

2,4-D

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

Recent WDNR studies contradict the above information. Under certain conditions, residual concentrations of 2,4-D above 100 ug/L may be present well past label irrigation restriction guidelines of 21 days. Degradation takes longer in some lakes:

- Oligotrophic (low-nutrient) lakes
- Low alkalinity lakes
- Lakes with no history of herbicide usage
- When water temperatures are cool. (WDNR, 2011)

Granular formulations of 2,4-D and other herbicides dissipate at about the same rate as liquid formulations of herbicides (WDNR, 2011).

Some recent studies indicate a need to consider the long-term effects of 2,4-D use. One is the effect on the endocrine system and reproduction of fat head minnows (DeQuattro, 2015). There is also some evidence that hybrid EWM can acquire resistance to 2,4-D (LaRue et al, 2013).

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 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. 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.

With the aquatic herbicide fluridone (Sonar®), hybrid tolerance appears to be limited to fewer hybrid lineages. While hybrid resistance to fluridone has been observed in a small percentage of lakes, hybridity does not necessarily infer fluridone tolerance. (Tony Groves, 2015)

GLYPHOSATE

Glyphosate is not applied directly to water for weed control. However, 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.

ALGAECIDE TREATMENTS FOR FILAMENTOUS ALGAE

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

HERBICIDE USE TO MANAGE AQUATIC INVASIVE SPECIES

CURLY LEAF PONDWEED

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

Early season herbicide treatment:[33]

Studies have demonstrated that curly leaf can be controlled with Aquathol K (a formulation of endothall) in 50 - 60 degree F water, and treatments of curly leaf this early in its life cycle can prevent turion formation. Since curly leaf pondweed is actively growing at these low water temperatures and many native aquatic plants are yet dormant, this early season treatment selectively targets curly leaf pondweed.

Because the dosage is at lower rates than 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

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

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.[34]

EURASIAN WATERMILFOIL

The Army Corps of Engineers Aquatic Plant Information System (APIS) identifies the following herbicides for control of Eurasian watermilfoil: complexed copper, 2,4-D, diquat, endothall, fluridone, and triclopyr. Early season treatment of Eurasian watermilfoil is also recommended by the Department of Natural Resources to limit the impact on native aquatic plant populations. 2,4-D is frequently used to target EWM (a dicot) over many other native plants (monocots).

However, large-scale treatments can result in significant damage to both monocots and dicots.

- Dicots susceptible to both 2,4-D and fluridone include native watermilfoils (particularly northern), bladderworts, water lilies, and coontail.
- Monocot species such as elodea, several narrow leaf pondweeds, and naiads are also impacted by fluridone and some 2,4-D use.
- Fewer natives are affected at lower dosages. (WDNR, 2011)

Wisconsin DNR research indicates that larger scale treatments seem to have more consistent reduction from herbicide use than smaller treatments. These results are based upon data collection in many Wisconsin lakes where herbicides were used for EWM control. (Nault, 2015)

Herbicides can dissipate off of a small treatment site very rapidly. 2,4-D dissipated rapidly after treatment after it was applied to 98 small (0.1-10 acre) treatment areas across 22 study lakes with application rates of 2-4 ppm. The following results were found:

- Initial 2,4-D concentrations detected in the water column were well below application targets.
- Herbicide moved quickly away from treatment sites within a few hours after treatment.
- The rapid dissipation of herbicide indicates that the concentrations in target areas may be lower than what is needed for effective EWM control. (Nault, Herbicide Treatment in Wisconsin Lakes., 2012)

NATIVE PLANT AQUATIC PLANT MANAGEMENT

The WDNR Northern Region released an Aquatic Plant Management Strategy in the summer of 2007 to protect the important functions aquatic plants provide in lakes. As part of this strategy, the WDNR prohibited management of native aquatic plants in front of individual lake properties after 2008 unless management is designated in an approved aquatic plant management plan.[35] Permits for waterfront corridors were issued in 2008 only for formerly permitted sites where impairment of navigation and/or nuisance conditions were demonstrated. 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 is carefully reviewed.

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

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

The WDNR has not allowed removal after January 1, 2009 unless the “impairment of navigation” and/or “nuisance” conditions are clearly documented.

The WDNR recommends (and may require) that residents who wish to maintain an opening for boating and swimming use rakes or other hand methods.

APPENDIX E. RAPID RESPONSE FOR EARLY DETECTION OF AQUATIC INVASIVE SPECIES

Definition: Aquatic Invasive Species (AIS) are non-native plant and animal species that can out-compete and overtake native species damaging native lake habitat and sometimes creating nuisance conditions. Additional AIS threaten the lakes and will be monitored throughout the lake by volunteers and consultants.

1. Maintain a non-lapsable contingency fund for rapid response to zebra mussels or other invasive species (LNPA Board).

2. Conduct monitoring (Volunteers) at the public landings and other likely areas of AIS introduction. If a suspected plant or animal is found, contact the AIS Identification Volunteer(s).

3. Direct lake residents and visitors to contact the AIS Identification Volunteer(s) if they see a plant or animal in the lake they suspect might be an AIS. Signs at the public boat landings, web pages, handouts at annual meetings, and newsletter articles will provide photos and descriptions of AIS that have a high likelihood of threatening project lakes, contact information, and instructions.

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

   If a plant:

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

   b. Inform LPNA Board.

   If an animal other than a fish:

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

   b. Inform LPNA Board.

5. The AIS Identification Volunteer(s) will tentatively confirm identification of plant or animal AIS with Washburn County then,

   If a plant:

   a. Fill out plant incident form http://dnr.wi.gov/lakes/forms/3200-125-plantincident.pdf

   b. Contact WDNR staff, then deliver collected plants to the WDNR (810 W. Maple St., Spooner, WI 54801) as soon as possible (or to the location they specify).

   If an animal:

   a. Be sure the suspected invasive species has not been previously found on the waterbody

   b. If a zebra mussel report to WDNR and Washburn County

   c. Fill out form 3200-126 – Aquatic Invasive Animal Incident Report

6. If identification is positive:

   a. Inform the person who reported the AIS and the board, who will then inform Washburn County.

   b. Mark the location of AIS with a more permanent marker and GPS points. (AIS Identification Volunteer(s)).

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

7. Determine the extent of the AIS introduction (LPNA in cooperation with Washburn County and WDNR). Divers may be used. If small amounts of AIS are found during this assessment, divers may be directed to identify locations with GPS points and hand pull plants/remove animals found. All plant fragments will be removed from the lake when hand pulling.

8. Select a control plan in cooperation with the WDNR (LPNA Board). The goal of the rapid response control plan will be eradication of the AIS.

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

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

10. The NLA will work with the WDNR to apply for an Early Detection and Rapid Response AIS Control Grant if deemed necessary.

11. Frequently inspect the area of the AIS to determine the effectiveness of the treatment and whether additional treatment is necessary (Volunteers, WNDR and/or other agency representatives).

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

EXHIBIT A[1]

LAKE NANCY PROTECTIVE ASSOCIATION

Board Contacts:

Add NAMES, EMAILS, PHONE NUMBERS

AIS Identification Volunteer(s)

WASHBURN COUNTY LAND AND WATER RESOURCES DEPARTMENT

Conservation Coordinator	Lisa Burns: (715) 468-4654
	lburns@co.washburn.wi.us

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Permits	Mark Sundeen: 715-635-4074
	Mark.sundeen@wisconsin.gov
AIS Identification and Notice	Kris Larsen: 715-635-4072
	Kris.larsen@wisconsin.gov
Grants	Pamela Toshner: 715-635-4073
	Pamela.Toshner@Wisconsin.gov

DIVERS

[1] This list is current as of 2018. Refer to the Lake Nancy web site https://lakenancyminong.wordpress.com/ for updated information.

ADDITIONAL REFERENCES

WDNR websites on AIS

http://dnr.wi.gov/lakes/invasives/GoalsNew.aspx?show=emerging

http://dnr.wi.gov/lakes/invasives/AISDiscoveryCommunicationProtocol.pdf

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