NAMAKAGON LAKE AQUATIC PLANT MANAGEMENT PLAN

BAYFIELD COUNTY, WI

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INTRODUCTION

This Aquatic Plant Management Plan for Lake Namakagon, Garden Lake, and Jackson Lake in Bayfield County, Wisconsin presents a strategy for managing aquatic plants by protecting native plant populations, controlling the growth of hybrid Eurasian Northern watermilfoil (HWM), and preventing establishment of additional invasive species. The plan includes data about the plant community, watershed, and water quality of the lakes. Based on this information and public input, goals and strategies for the management of aquatic plants in the lakes are presented. This plan will guide the Namakagon Lake Association and the Wisconsin Department of Natural Resources in aquatic plant management for the lakes over the next five years (from 2018 through 2022).

PUBLIC INPUT FOR DEVELOPMENT

The Lake Namakagon Aquatic Plant Management (APM) Committee provided input for the development of this aquatic plant management plan in the winter of 2018. The plan was then reviewed by the Namakagon Lake Association (the Lake Association) board on April 21, 2018 and released for public review May 25, 2018. The public comment period ran through June 18, 2018 and no substantive comments were received.

STAKEHOLDER SURVEYS

Stakeholder use and perception of the Namakagon Chain have been assessed through a variety of surveys (Shiffered and Judd, 1998 and Foth, 2008). These studies suggest that the most common activities on the Namakagon Chain include motorized boating, entertaining, relaxation, fishing, wildlife observation and swimming. Of these activities, motorized boating was most highly valued, followed by relaxation, scenic enjoyment, and fishing. In general, survey respondents indicate that the Namakagon Chain is a peaceful site to live and recreate and is generally in good health as both a fishery and ecological resource. A detailed shoreland health survey was conducted in a recent lake management planning effort. (Northland, 2016)

LAKE MANAGEMENT CONCERNS

The APM Committee expressed a variety of concerns that are reflected goals and objectives for aquatic plant management in this plan. Aquatic plant management concerns and opportunities included the following: need for AIS prevention, avoiding unintended impacts from control measures, identifying best management practices for monitoring and control, effective communication and coordination, recruiting and supporting volunteers, and identifying and maintaining partnerships.

MANAGEMENT PLAN – NAMAKAGON CHAIN OF LAKES

A public involvement process for the Namakagon Chain of Lakes Management Plan (Northland, 2016) included collaborative input from the Namakagon Lake Association, the Wisconsin Department of Natural Resources, and Bayfield County. The plan was informed by the user survey administered by Northland College. Lake plan goals include the following:

- Maintain Current Levels of Motorized and Non-motorized Use
- Maintain Scenic Beauty of the Namakagon Chain
- Protect and Restore Nearshore and Shoreline Habitat
- Maintain Existing Water Levels and Hydrologic Processes
- Maintain Existing Water Quality Conditions
- Maintain Diverse Native Plant Communities
- Maintain Diverse Native Fish Communities
- Maintain Walleye Population Densities
- Maintain Access for Tribal Fish Harvest

A two-year study assessed current conditions of the Namakagon Chain. Results of the study related to aquatic plant management and planning requirements are included and referenced in this Aquatic Plant Management Plan.

Recommendations from the plan related to aquatic plants and habitats include the following:

- Continue and expand efforts to monitor, prevent, rapidly detect and respond to invasive species in the Namakagon Chain.

- Implement efforts to restore areas of localized shoreline habitat degradation.

LAKE INFORMATION

Namakagon Lake (WBIC 2732600) is a 2,897 acre drainage lake located in Bayfield County, Wisconsin mostly within the Town of Namakagon. It has a maximum depth of 51 feet and a mean depth of 16 feet. The Namakagon Chain also includes Garden Lake (WBIC 2735500) – a 558 acre drainage lake with a maximum depth of 23 feet and Jackson Lake (WBIC 2734200) – a 149 acre drainage lake with a maximum depth of 13 feet. Lake information is summarized in Table 1. The lakes with are shown with WNDR sensitive areas and access points indicated in Figure 4.

Table 1. Namakagon Chain Lake Characteristics

Lake	WBIC	Size (acres)	Maximum Depth	Trophic State	Lake Classification
Namakagon	2732600	2,897	51	Eutrophic	Deep, drainage
Garden	2735500	558	23	Eutrophic	Shallow, drainage
Jackson	2734200	149	13	Eutrophic	Shallow, drainage

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.

Citizen Volunteers monitored lake water quality for many years on the Namakagon Chain. Figures 1-3 illustrate mean July and August Secchi depths for project lakes (WDNR, http://dnr.wi.gov/lakes/CLMN/). There is no particular trend in water clarity over the years. In general, clearest water is found in Lake Namakagon.

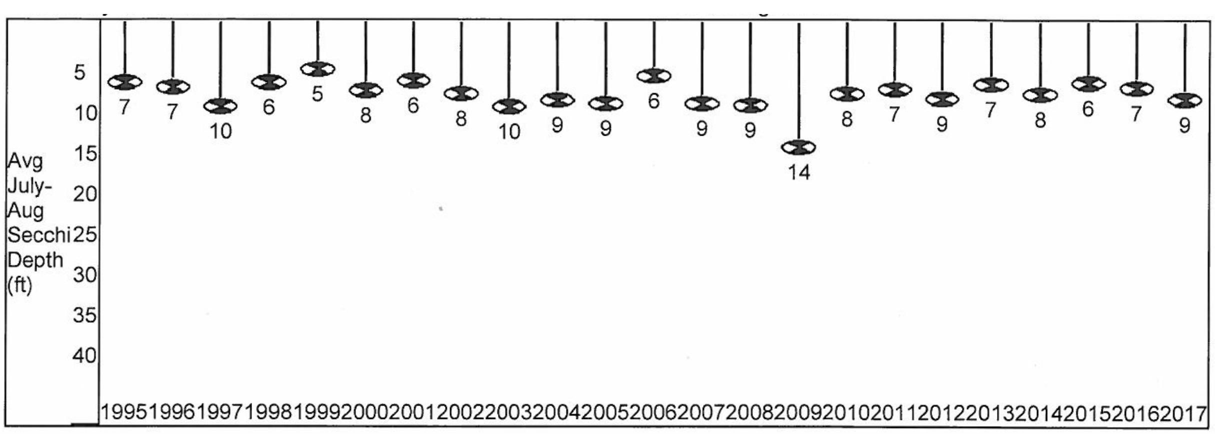


Figure 1. Lake Namakagon July – August Secchi Depth (1995-2017)

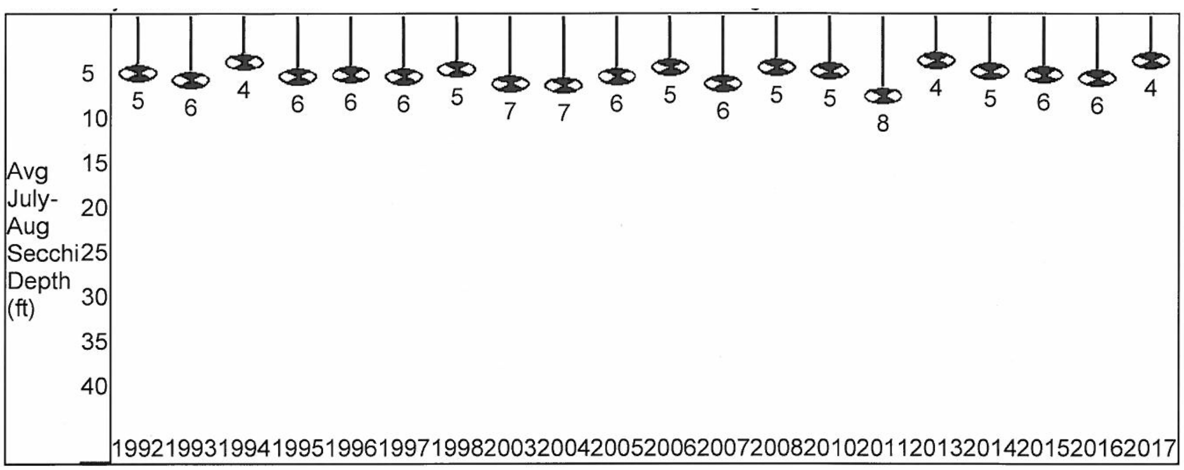


Figure 2. Garden Lake July – August Secchi Depth (1992-2017)

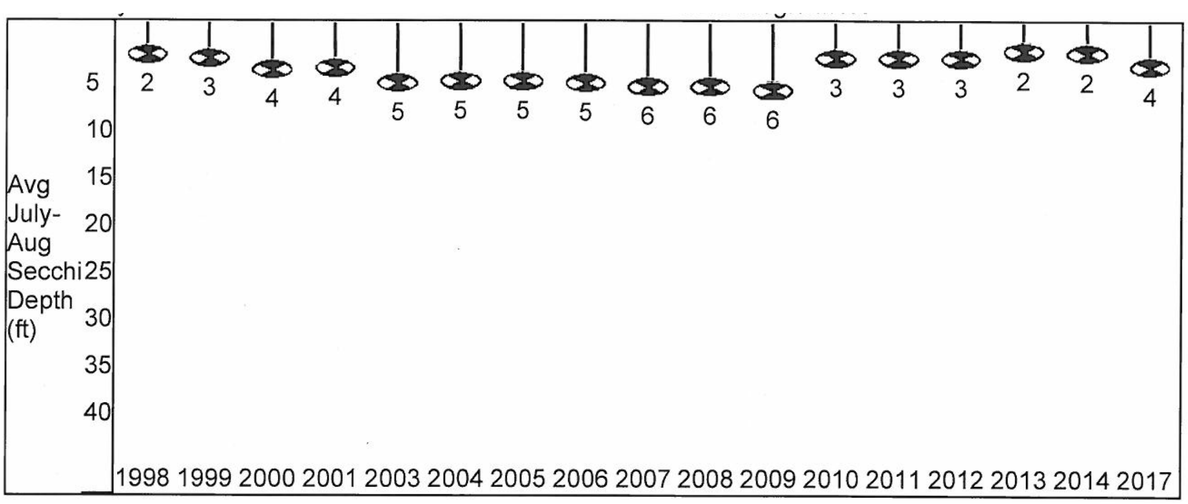


Figure 3. Jackson Lake July-August Secchi Depth (1998-2017)

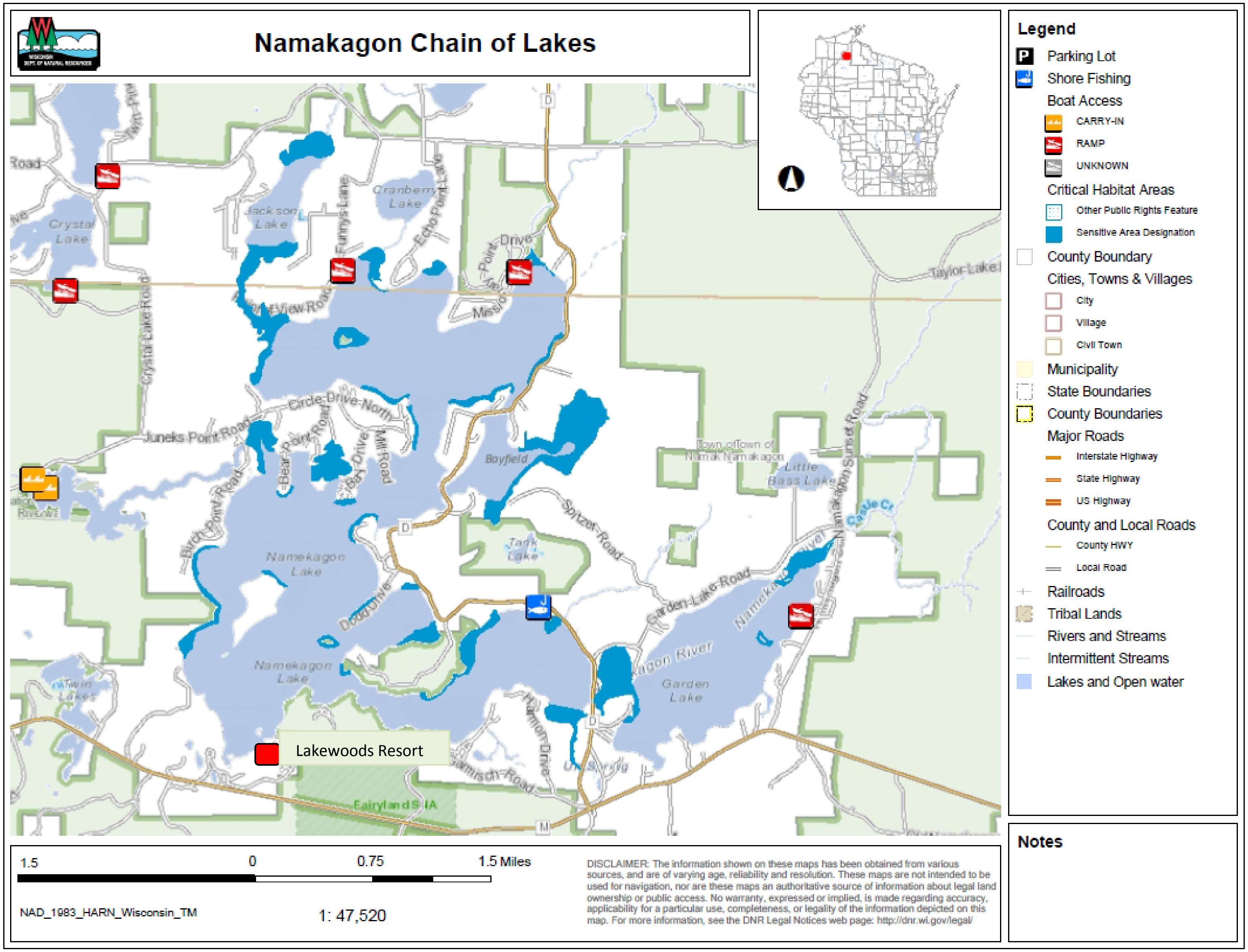


Figure 4. Map of Namakagon Chain of Lakes

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 lakes based on Wisconsin Department of Natural Resources (WDNR) records for July and August are shown in Figures 5-7 below. The WDNR characterizes each of the lakes as eutrophic based on this information. However, the 2016 Northland College study characterized Lake Namakagon as mesotrophic considering historical water quality data based on mean summer total phosphorus and Secchi data (although the time period was not specifically indicated). Based on the TSI results shown below, Namakagon and Garden TSI values are considered GOOD and Jackson Lake values are considered FAIR.

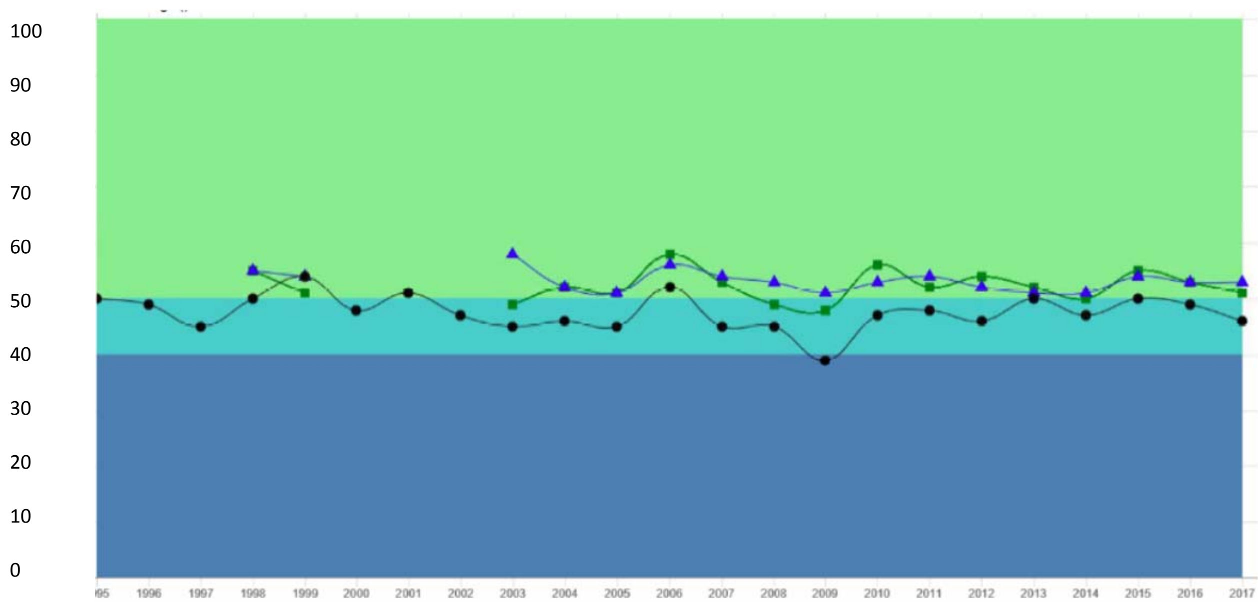


Figure 5. Trophic State Index for Namakagon Lake (1995 – 2017)

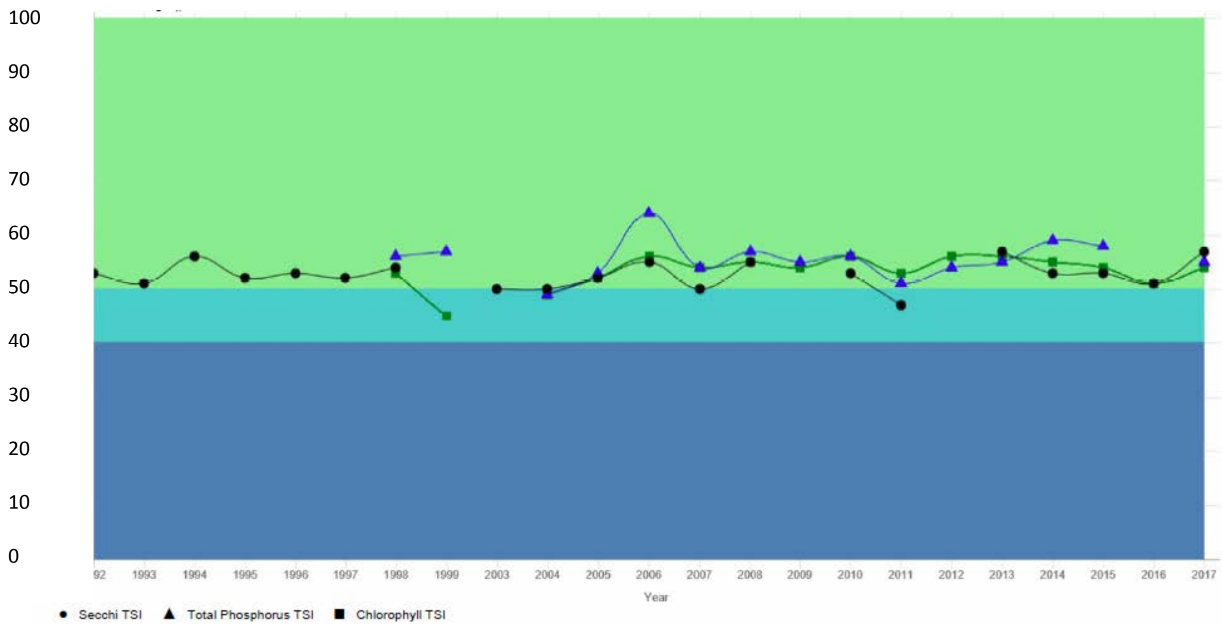


Figure 6. Trophic State Index for Garden Lake (1992-2017)

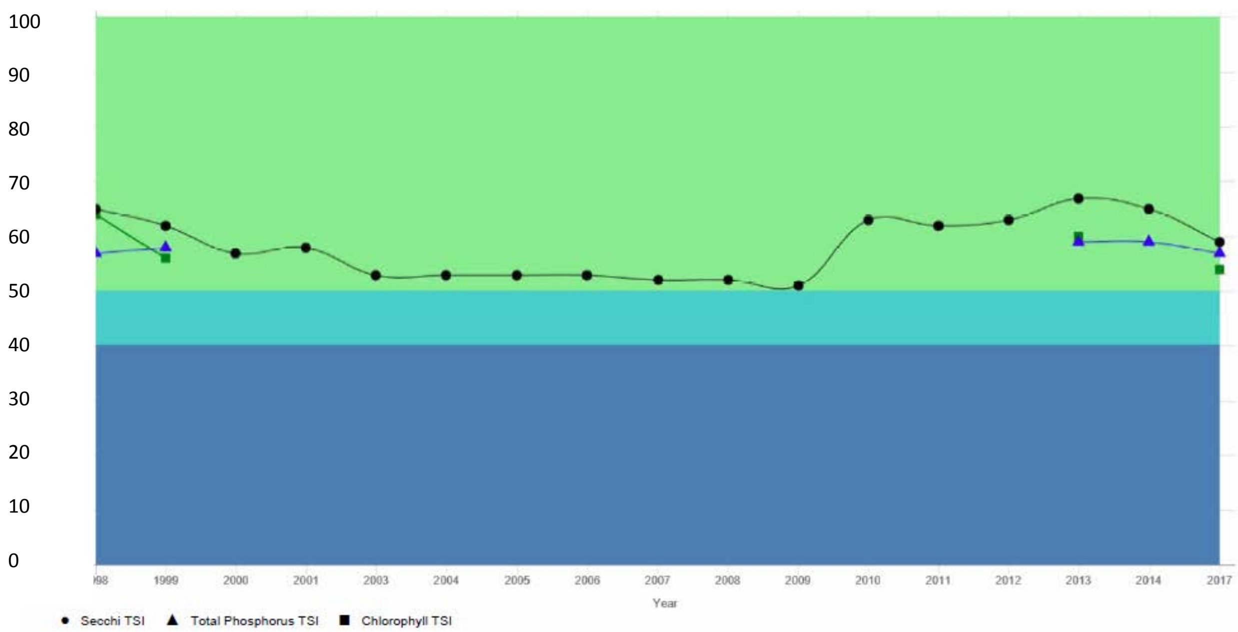


Figure 7. Trophic State Index for Jackson Lake (1998-2017)

LAKE CLASSIFICATION

The Wisconsin Department of Natural Resources sets water quality standards for lakes based on total phosphorus (TP) in NR 102.06(4). The TP standard for stratified drainage lakes is 30 ug/L. A lake with surface water inflow/outflow from a river or stream is classified as a drainage lake. Stratified lakes exhibit thermal layering throughout the summer or they undergo intermittent stratification. The summer index period for these measurements is July 15 – September 15. (WDNR, 2014) The WDNR confirms Lake Namakagon meets standards for a stratified drainage lake in its 2018 proposed impaired waters list.

The TP standard for non-stratified (shallow) drainage lakes is 40 ug/L. A non-stratified, shallow lake, results in a value of less than 3.8 according to the following equation:

$$\frac{\text{Maximum Depth (feet)}*0.3048 - 0.1}{\text{Log 10 (Lake Area (acres)}*0.40469)}$$

(WDNR, 2014)

Jackson Lake is a shallow lake according to this equation with a result of 2.6. Northland College investigators also identified Jackson Lake as mixed in their water quality study (Northland, 2016). If TP results from Jackson Lake for only the summer index period are considered, Jackson Lake does not meet the total phosphorus standard of 40 ug/L (Average of 6 readings from July 15 – September 15, 2014-2017 Citizen Lake Monitoring data = 49.0 ug/L).

Garden Lake is also a shallow lake according to this equation with a result of 3.0. If TP results from Garden Lake for only the summer index period are considered, Garden Lake meets the total phosphorus standard for a shallow drainage lake (Average of 11 readings from July 15 – September 15, 2013-2017 Citizen Lake Monitoring data = 33.9 ug/L).

WATERSHED

The watershed of the Namakagon Chain is about 62 square miles, not including the lakes themselves. A lake's water quality is influenced by land cover in its watershed. Watershed land cover shown in Figure 8 and summarized in Figure 9 was based on a combination of 2011 data from the National Land Cover Dataset (NLCD) and parcel specific shoreland habitat assessments (Northland, 2016). Historical, current, and anticipated future land use and land cover information were used to calculate annual phosphorus loads to the Namakagon Chain. Total acreages of land covers were multiplied by expected annual pound/acre/year phosphorus runoff values. Current land cover is largely undeveloped and shoreland and road development has resulted in a relatively small estimated increase in phosphorus loading from estimates of loading from the mid-nineteenth century. However, phosphorus loading is predicted to increase and water quality to decline if the watershed's private forests are converted into residential uses. (Northland, 2016)

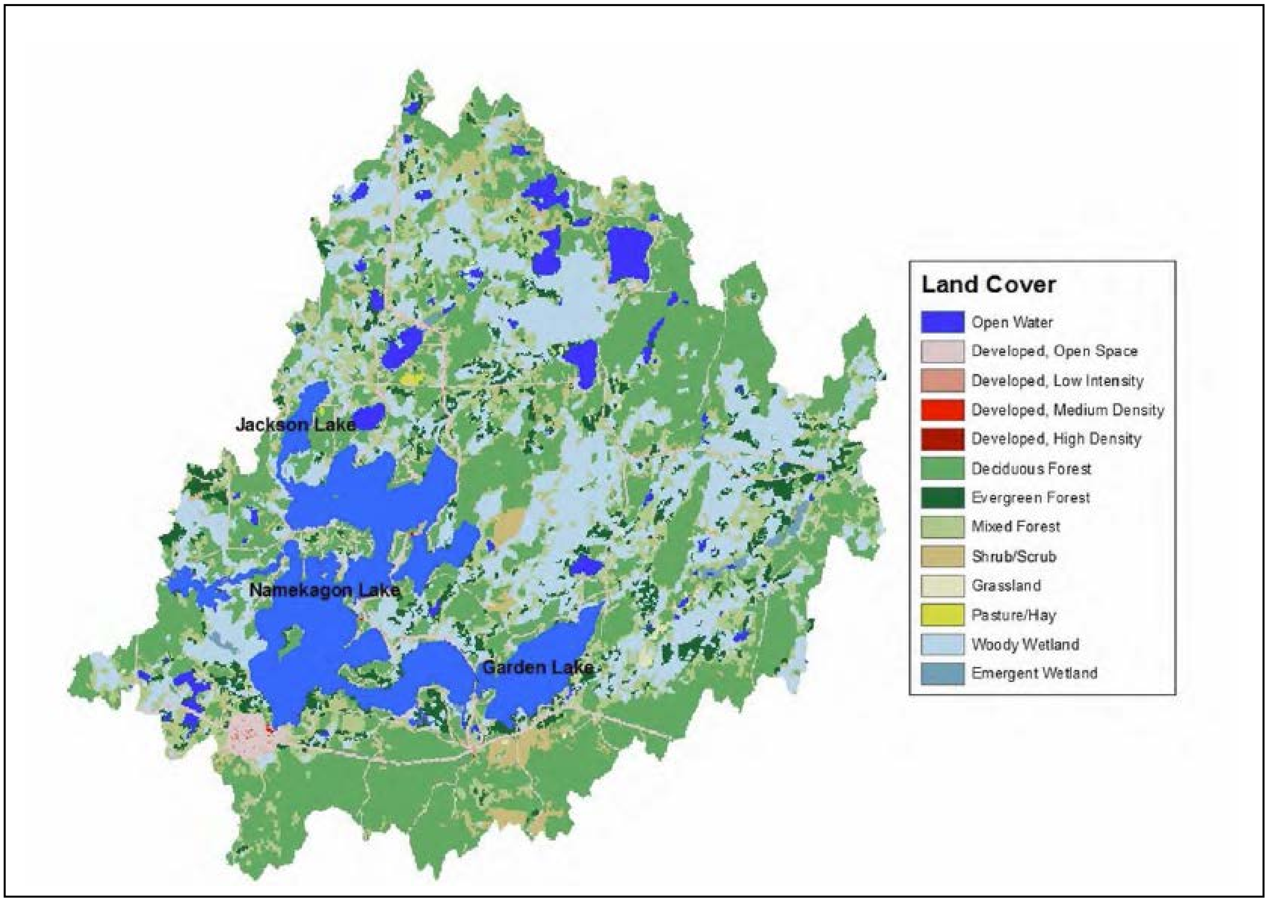


Figure 8. Namakagon Lake Watershed Land Cover (Northland, 2016)

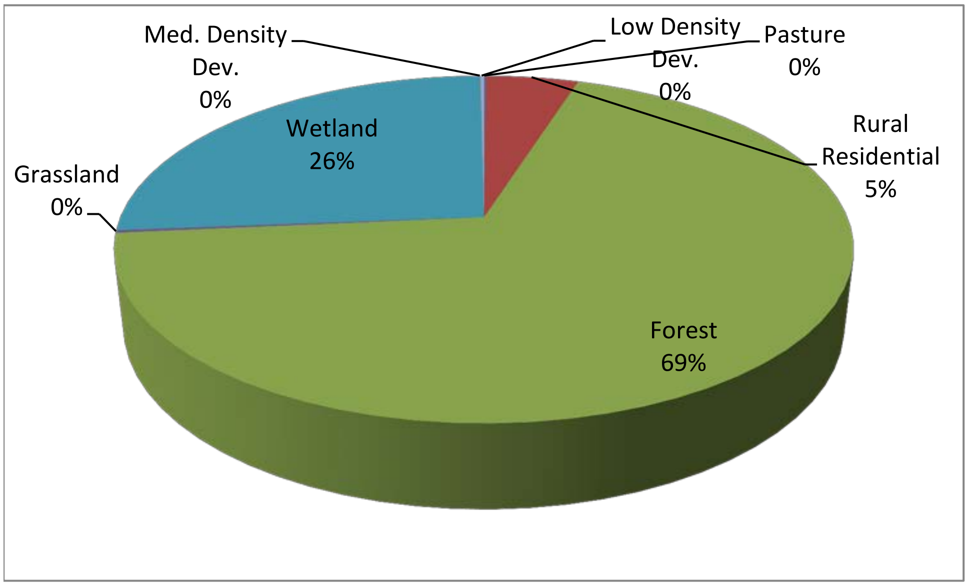


Figure 9. Watershed Land Cover Composition: based on information from (Northland, 2016)

AQUATIC USE AND HABITAT

PRIMARY HUMAN USE AREAS

The Namakagon Chain has three public and 7 private launches, two public swimming beaches, and a number of walk/carry-in access points as shown in Figure 4. The Namakagon Lake Association reports the following on its web site:

With over 3,000 acres of water, there is plenty of room to explore by boat, kayak or canoe. Sailing and water skiing are also popular, and there are boat rentals and several public boat launches. Quiet boats can explore Lake Namakagon's many bays and islands, including Paines Island where local pairs of eagles nest in the spring.

A Class A muskie lake, Lake Namakagon is one of only three lakes in Wisconsin managed as a trophy muskie lake. There are also healthy populations of walleye, northern pike, bluegill, crappie, and largemouth and smallmouth bass. In the winter there is ice fishing.

WATER BODIES WITH EWM AND HYBRID EWM PRESENT

Lake Namakagon is the one of only a few lakes in adjacent counties where hybrid Eurasian-northern watermilfoil has been confirmed, although there are several with Eurasian watermilfoil as shown in Figure 10 and listed in Table 2.

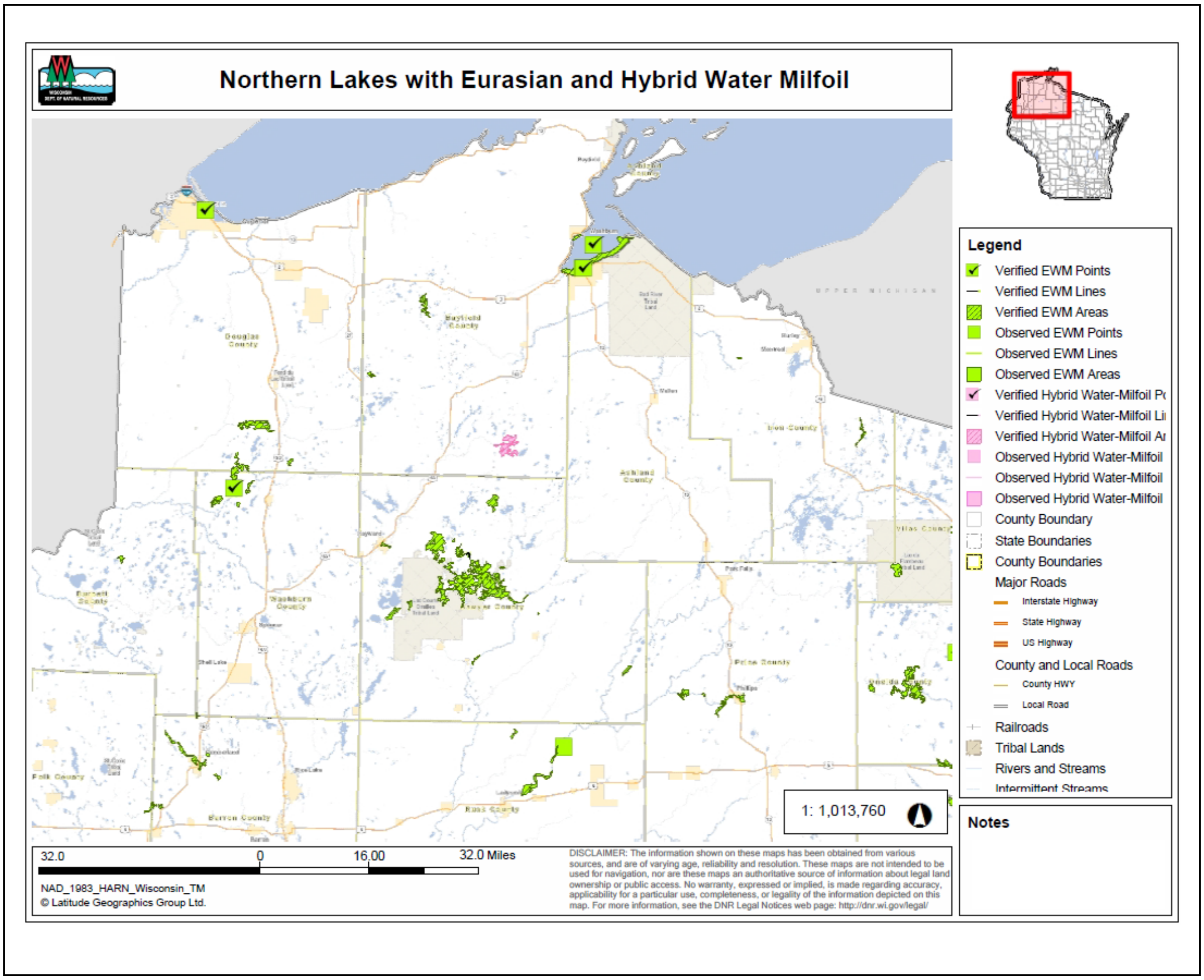


Figure 10. Northern Wisconsin Lakes with Eurasian and Hybrid Watermilfoil

Table 2. Eurasian Watermilfoil (EWM) and Hybrid Eurasian-Northern Watermilfoil Locations

Bayfield County			
Buskey Bay	EWM	Verified and Vouchered	2007
Eagle Lake (Pike Chain)	EWM	Verified and Vouchered	2005
Fish Creek Sloughs	EWM	Verified and Vouchered	2012
Flynn Lake	EWM	Verified and Vouchered	2014
George Lake	EWM	No Longer Observed	2011
Hart Lake	EWM	Verified and Vouchered	2004
Lake Millicent	EWM	Verified and Vouchered	2008
McCarry Lake	EWM	Verified and Vouchered	2017
Namakagon Lake	Hybrid	Verified	2016
Sand Bar Lake	EWM	Verified and Vouchered	2004
Tomahawk Lake	EWM	Verified and Vouchered	2004
Twin Bear Lake	EWM	Verified and Vouchered	2004
Washburn Harbor	EWM	Verified	1992
Sawyer County			
Callahan Lake	EWM	Verified and Vouchered	2005
Chippewa Lake (N of CTH B)	EWM	Verified	2006
Clear Lake	EWM	Verified and Vouchered	1999
Connors Lake	EWM	Verified and Vouchered	2002
Hayward	Hybrid	Verified	2012
Hayward Lake	EWM	Verified	2011
Lake Chippewa (Chippewa Flowage)	EWM	Verified and Vouchered	1991
Little Lac Courte Oreilles	EWM	Verified and Vouchered	2015
Little Round Lake	EWM	Verified and Vouchered	1999
Lost Land Lake	EWM	Verified and Vouchered	2013
Lost Land Lake	Hybrid	Verified	2014
Mud Lake	EWM	Verified and Vouchered	2005
Mud Lake	EWM	Verified and Vouchered	2005
North Fork Chief River (From Lake Chippewa to Callahan Lake)	EWM	Verified and Vouchered	2006
Osprey Lake	EWM	Verified and Vouchered	2005
Radisson Flowage	EWM	Verified and Vouchered	2003
Round Lake (Big Round)	EWM	Verified and Vouchered	1993
Tiger Cat Flowage	EWM	No Longer Observed	2013
Whitefish Lake	EWM	Verified and Vouchered	2008
Ashland County			
Chequamegon Bay (at Ashland marina)	EWM	Verified	1997
Kakagon Slough	EWM	Verified	2011
Douglas County			
Cranberry Lake	EWM	Verified and Vouchered	2006
Hog Island Inlet	EWM	Verified	2016
Minong Flowage	EWM	Verified and Vouchered	2002
Red Lake	EWM	Verified and Vouchered	2016
St. Croix (Gordon) Flowage	EWM	Verified and Vouchered	2007
Superior Bay, Lake Superior	EWM	Verified	2006

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.

Emergent plants are found on sand and gravel bars and around Lake Namakagon's numerous islands. The emergent community is dominated by creeping spikerush (*Eleocharis palustris*), hardstem bulrush (*Schoenoplectus acutus*), and common bur-reed (*Sparganium eurycarpum*). Emergents are also found in shallow sandy muck areas. Floating-leaf species dominate just beyond the emergents in up to 4 feet of water in sheltered areas like Sugar Bay with nutrient-rich organic muck bottoms. (Berg, 2016)

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)

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 those 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.

SENSITIVE AREAS

Wisconsin Department of Natural Resources staff conducted the Namakagon Lake sensitive area designation survey in July and August of 2000. (WDNR, 2000) Survey participants identified a total of 33 sensitive area sites in Lake Namakagon. Sensitive area sites are shown in Figure 4. These sites include approximately 17.5 miles, or about 40%, of Namakagon Lake shoreline. The sites were selected primarily because of two major habitat features: 1) aquatic vegetation or 2) gravel/rubble substrate.

RECOMMENDATIONS: SENSITIVE AREA SITES BASED ON AQUATIC VEGETATION HABITAT

The twenty-two aquatic vegetation-based sites contain aquatic plant communities that provide critical habitat for fish and wildlife, as well as for shoreline erosion prevention and bank stabilization.

<u>Management Recommendations:</u>

1. Limit the removal of aquatic vegetation to the construction of navigation channels only. If navigation channels are necessary, minimize the length and width of the channel. Note that at some sensitive area sites, removal of any aquatic vegetation is not recommended.

2. Control the spread of exotic species such as purple loosestrife. Contact a WDNR aquatic plant specialist for assistance in controlling exotic species.

3. Prohibit littoral zone alterations covered by Chapter 30 Wisconsin Statutes, unless there is clear evidence that such alterations would benefit the lake's ecosystem. Examples of such alterations regulated in Chapter 30 Wisconsin Statutes include: placement of rip-rap on lake beds or banks with the intent to improve stability; dredging of lake bottom material with the intent to improve recreational habitat or navigable access; and placement of fish cribs or similar devices with the intent to improve fishing habitat.

4. Do not remove large woody cover such as logs, downed trees, and stumps within the littoral zone in order to provide cover habitat for fish, wildlife, and other organisms.

5. Preserve/restore the terrestrial vegetation for shoreline cover. Keep lake view corridors to 30 feet or less. Natural vegetative cover acts as a buffer against shoreline erosion and silt runoff. Rock rip-rap is often not required for shoreline stabilization if a healthy plant community already exists.

6. Use best management practices within the lake's watershed (such as those covered in *Wisconsin's Forestry Best Management Practices for Water Quality*, WDNR publication # FR093) to reduce the potential of silt, debris, or nutrients from entering the lake system.

7. Encourage local contractors and town and county road crews to learn and implement best management practices in road design, maintenance, and construction to protect water quality.

RECOMMENDATIONS: SENSITIVE AREA SITES BASED ON GRAVEL/RUBBLE SUBSTRATE HABITAT

The eleven fishery-based sensitive area designation sites contain gravel and rubble lake bottom substrate that provides important seasonal habitat for successful walleye and/or smallmouth bass spawning. Walleyes require areas of clean gravel/rubble substrate void of sediment for natural reproduction to occur in a lake. The ideal spawning habitat for smallmouth bass is an area of gravel/rubble substrate containing a shallow layer of fine sediments. The bass clears away a small portion of the fine sediment layer to expose gravel, therein constructing a "nest" in which to spawn. If these types of habitat are degraded, the natural walleye and smallmouth bass populations may decline or be lost altogether.

Management Recommendations:

1. Prohibit alterations of gravel/rubble substrate at these sites, unless alterations would improve fish spawning success. Chapter 30 Wisconsin Statutes requires permits for such alterations.

2. Utilize proper erosion control measures to preserve gravel/rubble habitat if near-shore construction should occur in these areas. Uncontrolled or poorly conducted construction activities would threaten important fish spawning habitat.

3. Preserve/restore natural vegetative buffers along the shoreline to provide the best long-term and natural protection against shoreline erosion and silt runoff.

4. Aquatic plant management may be appropriate in certain circumstances (e.g., exotic species control). In general, however, aquatic vegetation removal is not advisable because aquatic plants provide protective cover, shade, food sources, and reproductive areas for fish, macroinvertebrates, and/or wildlife.

RARE AND ENDANGERED SPECIES HABITAT

The lakes are located in T43N R5W, T43N R6W, and T44N R6W. The Wisconsin Natural Heritage Inventory lists for this geographical area are shown in Table 3. (WDNR, Natural Heritage Inventory Lists, 2017) Bald eagles are not represented, and sensitive species have been removed. The listing does not provide enough detail to know if these species are found on the lakes themselves.

Table 3. Wisconsin Natural Heritage Inventory Species Lists (T43N R5W, T43N R6W AND T44N R6W)[1]

Scientific Name	Common Name	WI Status	Federal Status	Group	Location
Alasmidonta marginata	Elktoe	SC/P		Mussel	T43N R6W
Boechera missouriensis	Missouri Rock-cress	SC		Plant	T44N R6W
Buteo lineatus	Red-shouldered Hawk	THR		Bird	T43N R5W
Callitriche hermaphroditica	Autumnal Water-starwort	SC		Plant	T43N R5W T43N R6W T44N R6W
Equisetum palustre	Marsh Horsetail	SC		Plant	T44N R6W
Etheostoma microperca	Least Darter	SC/N		Fish	T43N R5W
Falcipennis canadensis	Spruce Grouse	THR		Bird	T43N R5W T43N R6W
Glaucomys sabrinus	Northern Flying Squirrel	SC/P		Mammal	T43N R5W T43N R6W T44N R6W
Glyptemys insculpta	Wood Turtle	SOC	THR	Turtle	T43N R5W
Isogenoides olivaceus	A Perlodid Stonefly	SC/N		Stonefly	T44N R6W
Martes americana	American Marten	END		Mammal	T43N R5W
Napaeozapus insignis	Woodland Jumping Mouse	SC/N		Mammal	T43N R5W
Potamogeton confervoides	Algae-leaved Pondweed	THR		Plant	T44N R6W
Sceptridium rugulosum	Rugulose Grape-fern	SC		Plant	T43N R6W
Sorex palustris	Water Shrew	SC/N		Mammal	T43N R6W

[1] Wisconsin Department of Natural Resources and federal regulations regarding special concern species range from full protection to no protection. The current categories and their respective level of protection are SC/P = fully protected; SC/N = no laws regulating use, possession, or harvesting; SC/H = take regulated by establishment of open closed seasons; SC/FL = federally protected as endangered or threatened, but not so designated by DNR; SC/M = fully protected by federal and state laws under the Migratory Bird Act. Federal protection status designated by the U.S. Fish and Wildlife Service's Endangered Species Program indicating the biological status of a species in Wisconsin.SOC = species of concern.

Table 4. Wisconsin Natural Heritage Inventory Community Lists (T43N R5W, T43N R6W AND T44N R6W)

Community	Location
Bird Rookery	T44N R6W
Lake--soft bog	T43N R5W
Lake--deep, soft, seepage	T43N R6W
Lake--deep, soft, drainage	T44N R6W
Northern dry-mesic forest	T43N R6W
Northern mesic forest	T43N R5W T43N R6W
Northern wet forest	T43N R6W
Open bog	T43N R5W T43N R6W

FISHERY

As described in a 2004 WDNR fisheries survey for Namakagon and Jackson Lakes, the fish community is highly diverse, consisting of walleye (*Sander vitreus)*, muskellunge (*Esox masquinongy)*, northern pike (*E. Lucius)*, largemouth bass (*Micropterus salmoides)*, smallmouth bass (*M. dolomieui)*, bluegill (*Lepomis macrochirus)*, pumpkinseed (*Lepomis gibbosus)*, rock bass (*Ambloplites rupestris)*, black crappie (*Pomoxis nigromaculatus)*, yellow perch (*Perca flavescens)*, white sucker (*Catostomus commersoni)*, yellow bullhead (*Ictalurus natalis)*, black bullhead (*I. melas)*, trout perch (*Percopsis omniscomaycus)*, tadpole madtom (*Noturus gyrinus)*, common shiner (*Notropis cornutlus)*, golden shiner (*Notemigonus crysoleucas)*, and spottail shiner (*N. hudsonius)*.

Both walleye and muskellunge densities had declined as measured in the most recent WDNR fish survey, although walleye densities of 5.2 adults/acre (in 2003) were still above the state objective of 3 adults/acre. Muskellunge density was 0.12 fish/acre (> 30 in) - considered low in comparison to northern Wisconsin muskellunge lakes. (Toshner S. , 2004)

WALLEYE POPULATION ESTIMATES

Walleye population estimates were completed by WDNR in 1976, 1989, 1993 and 2002 using fyke netting for marking walleye and electrofishing for recapture. GLIFWC completed walleye estimates in 2000, 2011 and 2017 using electrofishing for both mark and recapture (Figure 11). Walleye density has declined over time and decreased below the Wisconsin statewide walleye management objective in 2017 of 3 adult walleye/acre. Walleye declines have been widespread in Bayfield and Douglas County walleye lakes in the past 15 years. The reasons for these declines are likely multifaceted and are the subject of extensive study.

Although the 2017 walleye population estimate was lower than previous surveys, age 1 walleye abundance from fall electrofishing surveys indicate that strong year classes were produced in 2015 and 2016. These recruits reach maturity at approximately age 4. Therefore, if survival of these year classes continues into the years 2019 and 2020, the corresponding adult walleye density should increase. A WDNR comprehensive survey is scheduled for 2023. This survey will continue tracking walleye density as well as population metrics for other species using the same methods as the 2002-2003 survey. Upon completion of that survey a fisheries survey report will be written which will compare historic data and provide management recommendations. (Toshner S. , 2018)

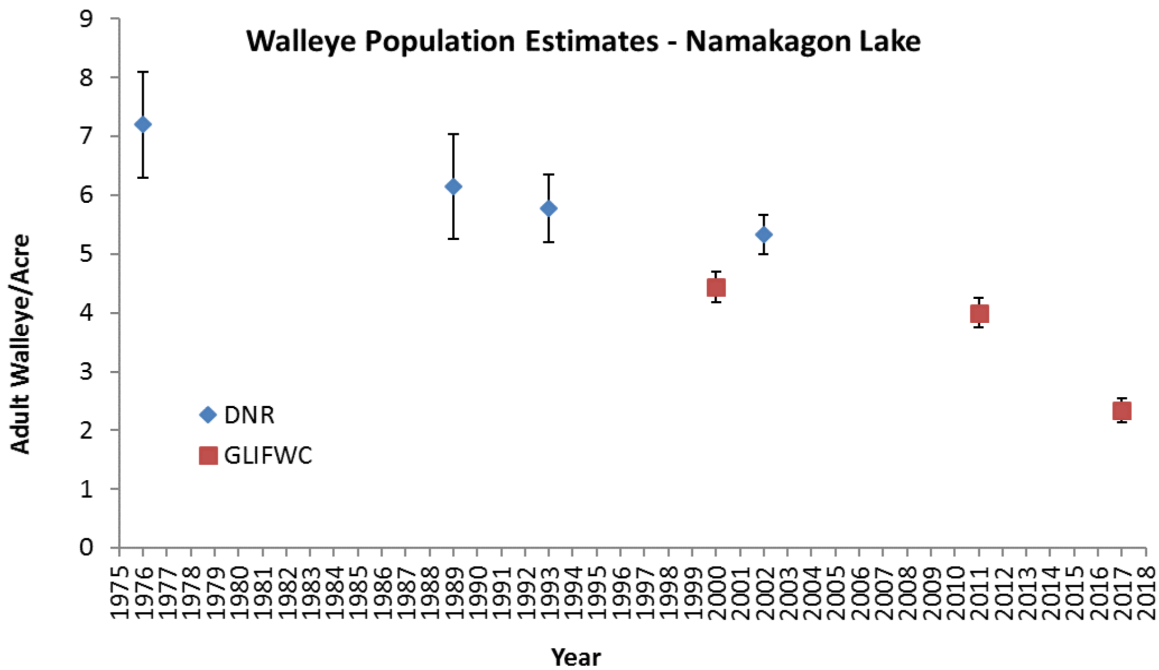


Figure 11. Walleye Population Estimates with 95% CI, Namakagon Lake.

FISH MANAGEMENT

WDNR fish management efforts have focused on walleye and muskellunge. The lake chain is listed as a Class A muskellunge fishery and a walleye water. The WDNR stocked large fingerling musky every other year in Lake Namakagon since 1997. Fingerling musky were stocked from 1983-1993 (Table 5).

Management recommendations from the 2004 fisheries plan included, 1) maintain existing walleye regulations, 2) maintain muskellunge stocking rates at 0.8 fish/acre/biannually, and 3) work with local residents, associations and groups to develop a lake management plan that addresses fisheries management goals, habitat protection and rehabilitation as well education of users and riparian residents.

Table 5. WDNR Fish Stocking Lake Namakagon

Year	Species	Age Class	Number Stocked	Avg Length (in.)
2015	MUSKELLUNGE	LARGE FINGERLING	2,500	12.4
2013	MUSKELLUNGE	LARGE FINGERLING	2,500	11.57
2011	MUSKELLUNGE	LARGE FINGERLING	2,500	10
2009	MUSKELLUNGE	LARGE FINGERLING	2,500	10.5
2007	MUSKELLUNGE	LARGE FINGERLING	2,491	12.1
2005	MUSKELLUNGE	LARGE FINGERLING	2,500	12
2003	MUSKELLUNGE	LARGE FINGERLING	2,500	12
2001	MUSKELLUNGE	LARGE FINGERLING	3,227	10.2
1999	MUSKELLUNGE	LARGE FINGERLING	2,500	11.25
1997	MUSKELLUNGE	LARGE FINGERLING	2,500	10.8
1993	MUSKELLUNGE	FINGERLING	3,300	11.93
1992	MUSKELLUNGE	FINGERLING	2,500	10
1991	MUSKELLUNGE	FINGERLING	2,500	11
1990	MUSKELLUNGE	FINGERLING	1,250	11
1989	MUSKELLUNGE	FINGERLING	2,500	10
1988	MUSKELLUNGE	FINGERLING	5,000	10.33
1987	MUSKELLUNGE	FINGERLING	3,246	9
1986	MUSKELLUNGE	FINGERLING	2,500	9
1985	MUSKELLUNGE	FINGERLING	4,000	11.5
1984	MUSKELLUNGE	FINGERLING	1,000	11
1983	MUSKELLUNGE	FINGERLING	1,000	10
1992	WALLEYE	FINGERLING	11,250	5.1
1977	WALLEYE	FRY	384,000	

FISHERY CONCERNS RELATED TO PLANT MANAGEMENT

When treating plants with herbicides, fish may be negatively impacted as fish and their eggs may be susceptible to the herbicides. A recent study found that formulations of the herbicide 2,4-D had different toxicological profiles than pure 2,4-D in fathead minnows. These included depressed male tubercles, depressed egg cell maturation in females and decreased larval survival. The authors suggest that based upon their findings, use of 2,4-D formulations in lakes should perhaps be reconsidered. (Karasov, 2015). Musky could have newly distributed eggs during an early season EWM treatment, so caution regarding repeated use may be warranted.

A study of the effects of the herbicides diquat, fluridone, and endothall on the early life stages of walleye, largemouth bass, and smallmouth bass indicated that diquat is more toxic to the fish tested than fluridone which is more toxic than endothall (Paul, 1994). Very early life stages of walleye were found to be the most sensitive, and walleye were more sensitive than bass to all herbicides tested. The study reported a 96-hour LC-50[2] ranging from 0.74-4.9 mg/L, depending upon the species and lifestage. Application rates of 2 gallons per acre in 4 feet of water (as applied at Lakewoods in April 2017) predict a concentration of 0.37 mg/L. However, as described above, herbicides rapidly dissipate and diquat also binds to sediments with predicted concentrations reported to decrease to 0.1 mg/L in 24 hours and .001 mg/L in 48 hours. (Syngenta)

[2] An **LC50** value is the concentration of a material in air that will kill 50% of the test subjects when administered as a single exposure.

AQUATIC PLANT SURVEY RESULTS

LAKE NAMAKAGON 2016

An aquatic plant inventory was completed for Lake Namakagon in August 2016 according to the WDNR-specified point intercept method (Appendix A). A full description of the survey and results are found in the report: *Point-intercept Macrophyte Survey and Hybrid Eurasian water-milfoil (Myriophyllum spicatum X sibiricum) Shoreline Survey/Manual Removal Namekagon Lake – WBIC: 2732600 - Bayfield County, Wisconsin.* Results and figures in this section are taken directly from this report. (Berg, 2016)

The survey collected data on the richness, diversity, abundance and distribution of native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's aquatic plant community as well as a way to measure any impacts on the lake's plants if active management occurs in the future. Other goals included documenting the current density of hybrid watermilfoil (HWM) within its known distribution, removing as many of these plants as possible, searching for additional HWM populations, and reporting any other exotic (also referred to as invasive in this document and other sources) species found. A general boat survey was conducted prior to the point intercept survey to gain familiarity with the lakes and the species present on them.

The WDNR developed the 1,291 point survey sampling grid for Lake Namakagon using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total acreage. Lake Namakagon has extremely varied underwater topography with numerous flats, saddles, and sunken islands. With the exception of Sugar and Mumm's Bay, the north bays of the upper lake, and the finger bay near the Namakagon River outlet, most shorelines dropped off rapidly into over 15 feet of water (Figure 12).

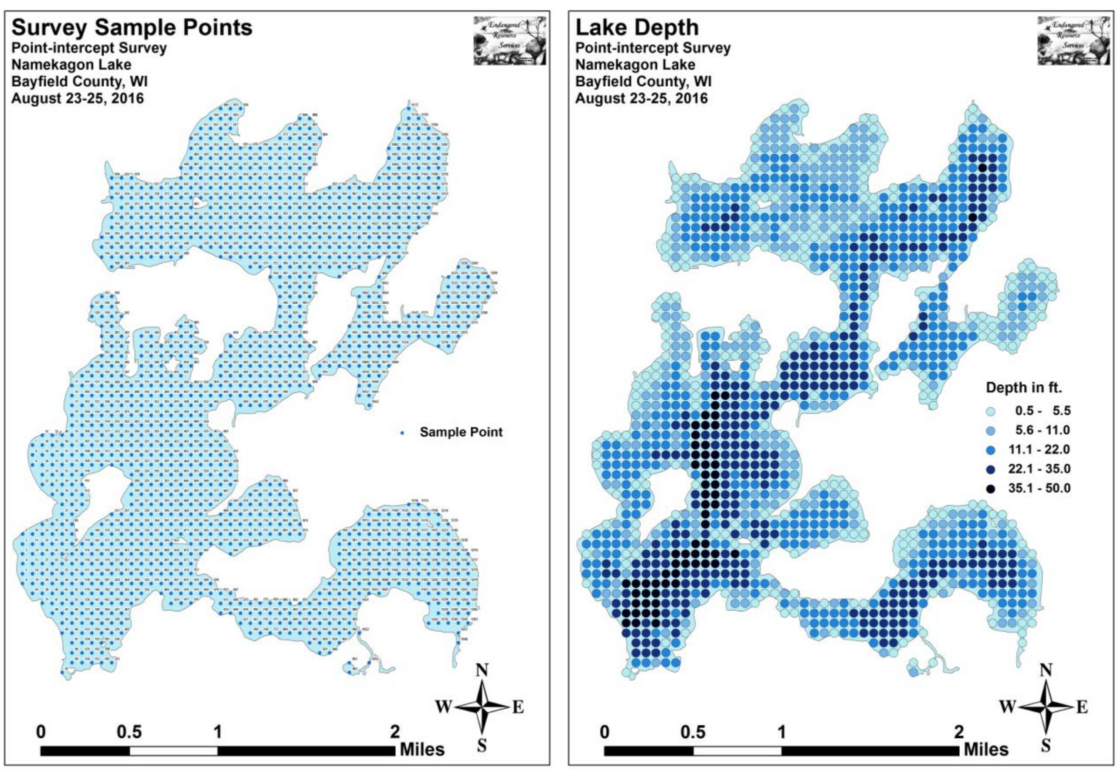


Figure 12. Survey Sample Points and Lake Depth

Nutrient poor sand and sandy muck dominated the majority of the littoral (depths at which plants can grow) lake bottom. Most rock areas occurred around islands, on sunken islands, or along the immediate shoreline. Nutrient rich organic muck dominated Sugar Bay, the northwest bays of the upper lake near the Jackson Lake Channel, the bay in the lower lake near the Garden Lake Channel, and near the river outlet (Figure 13). The bottom substrate of the littoral zone consisted of 55.7% pure sand, 34.0% sandy and organic muck, and 10.3% rock. The littoral zone extended to 11.0 feet. Plant coverage was spotty with 387 out of 515 points (75.2%) having at least some macrophytes present (Figure 13).

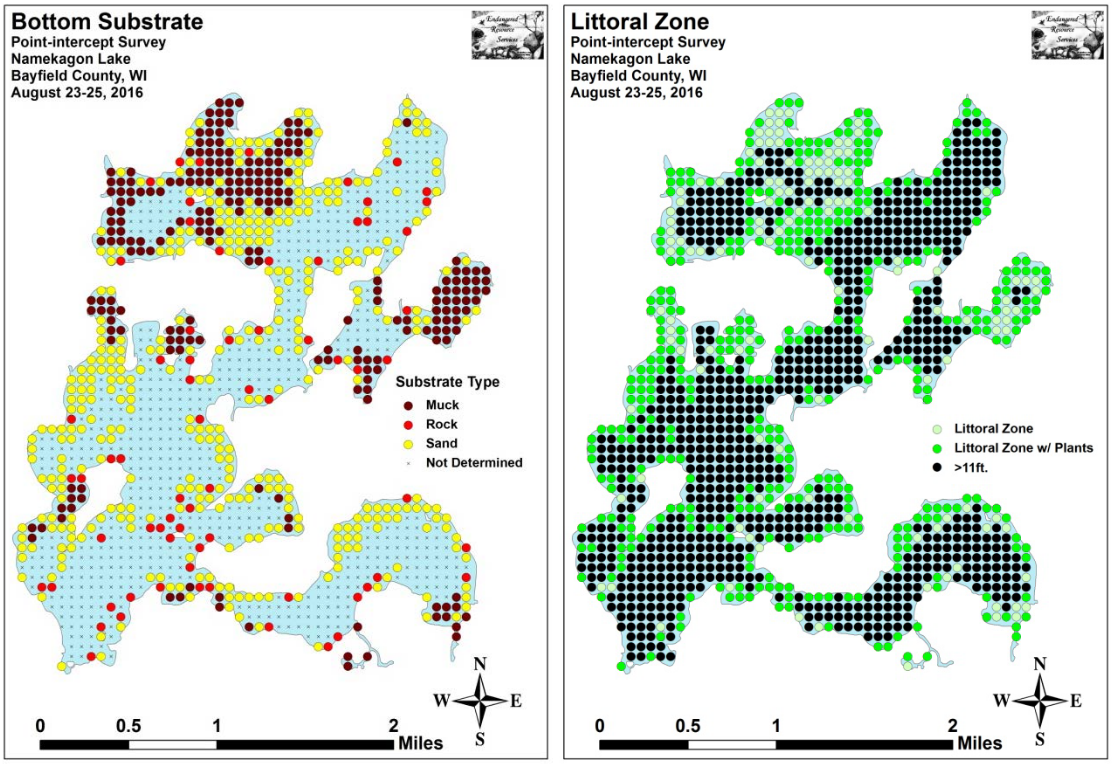


Figure 13. Bottom Substrate and Littoral Zone (Berg, 2016)

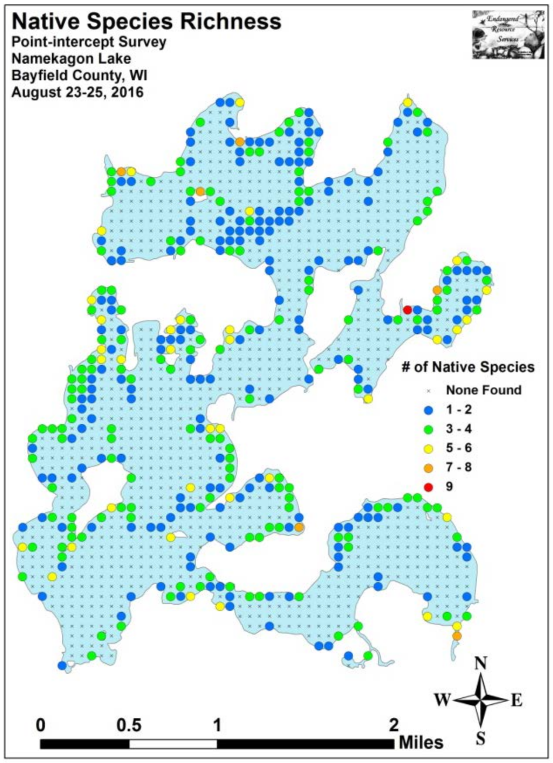
Table 6. Lake Namakagon Aquatic Macrophyte P/I Survey Summary Statistics

Summary Statistics	2016	2009[3]
Total number of points sampled	1,291	596
Total number of sites with vegetation	387	486
Total number of sites shallower than the maximum depth of plants	515	574
Frequency of occurrence at sites shallower than maximum depth of plants	75.15	84.67
Simpson Diversity Index	0.90	0.90
Maximum depth of plants (ft)	11.0	14.2
Mean depth of plants (ft)	5.4	
Median depth of plants (ft)	5.5	
Average number of all species per site (shallower than max depth)	2.01	2.31
Average number of all species per site (vegetative sites only)	2.68	2.72
Average number of native species per site (shallower than max depth)	2.01	2.28
Average number of native species per site (sites with native species only)	2.68	2.72
Species richness	48	21
Species richness (including visuals)	51	23
Species richness (including visuals and boat survey)	60	
Mean total rake fullness (vegetative sites only)	1.73	

Overall diversity in the lake was high with a Simpson Index value of 0.90. Species richness, however, was only moderate for such a large lake with 48 species found in the rake. When including plants recorded as visuals or during the boat survey, this total jumped to 60 species growing in and immediately adjacent to the lake. Localized species richness was also moderate as the mean species richness/site was 2.68 species at sites with vegetation. As no exotic species were found in the rake at any point, the mean native species/site was identical. Overall, plant density was moderately low with a mean rake fullness of 1.73 at sites with vegetation (Figure 14).

The Namakagon Lake ecosystem is home to a rich and diverse plant community that is primarily a function of the local water depth and substrate. This community can be subdivided into four distinct zones (emergent, floating-leaf, shallow submergent, and deep submergent) with each zone having its own characteristic functions in the lake ecosystem. Depending on the local bottom type (sand, rock, firm nutrient poor sandy muck, or soft nutrient rich organic muck (boggy)), these zones often had somewhat different species present. Descriptions of the various plant community zones with example aquatic plant photographs are found in the full plant survey report.

[3] (Foth, 2010)



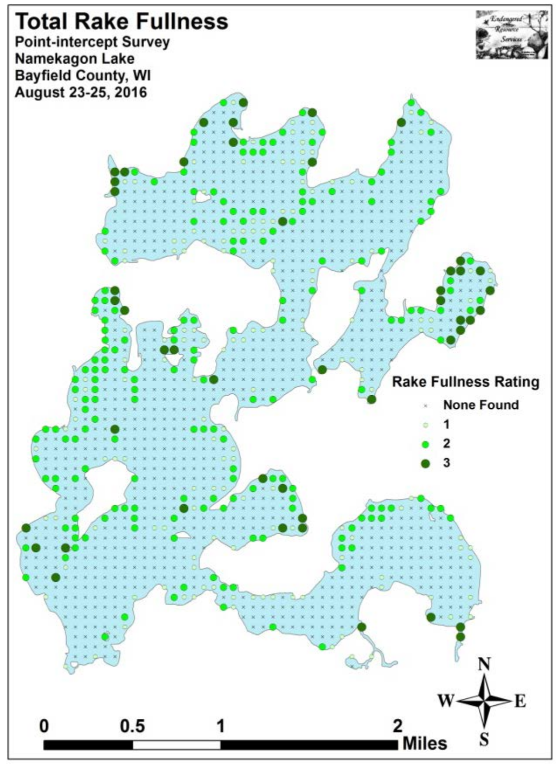


Figure 14. Native Species Richness and Total Rake Fullness (Berg, 2016)

When considering the lake as a whole, wild celery, variable pondweed, clasping-leaf pondweed, and northern watermilfoil were the most common species (Table 7). They were present at 73.64%, 19.38%, 18.35%, and 15.50% of survey points with vegetation, and, collectively they accounted for 47.35% of the total relative frequency (Figure 15). Fern pondweed (5.01), Water marigold (4.24), and Common waterweed (4.05), were the only other species that had relative frequencies over 4%.

A total of 43 native index species sampled in the rake during the point-intercept survey produced a mean Coefficient of Conservatism (C) of 6.5 and a Floristic Quality Index of 42.5. Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Lake Namakagon slightly below average for the region. The FQI was, however, much above the median FQI of 24.3 for this part of the state (Nichols 1999). Plants included three-way sedge, a state Species of Special Concern.[4]

[4] 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.

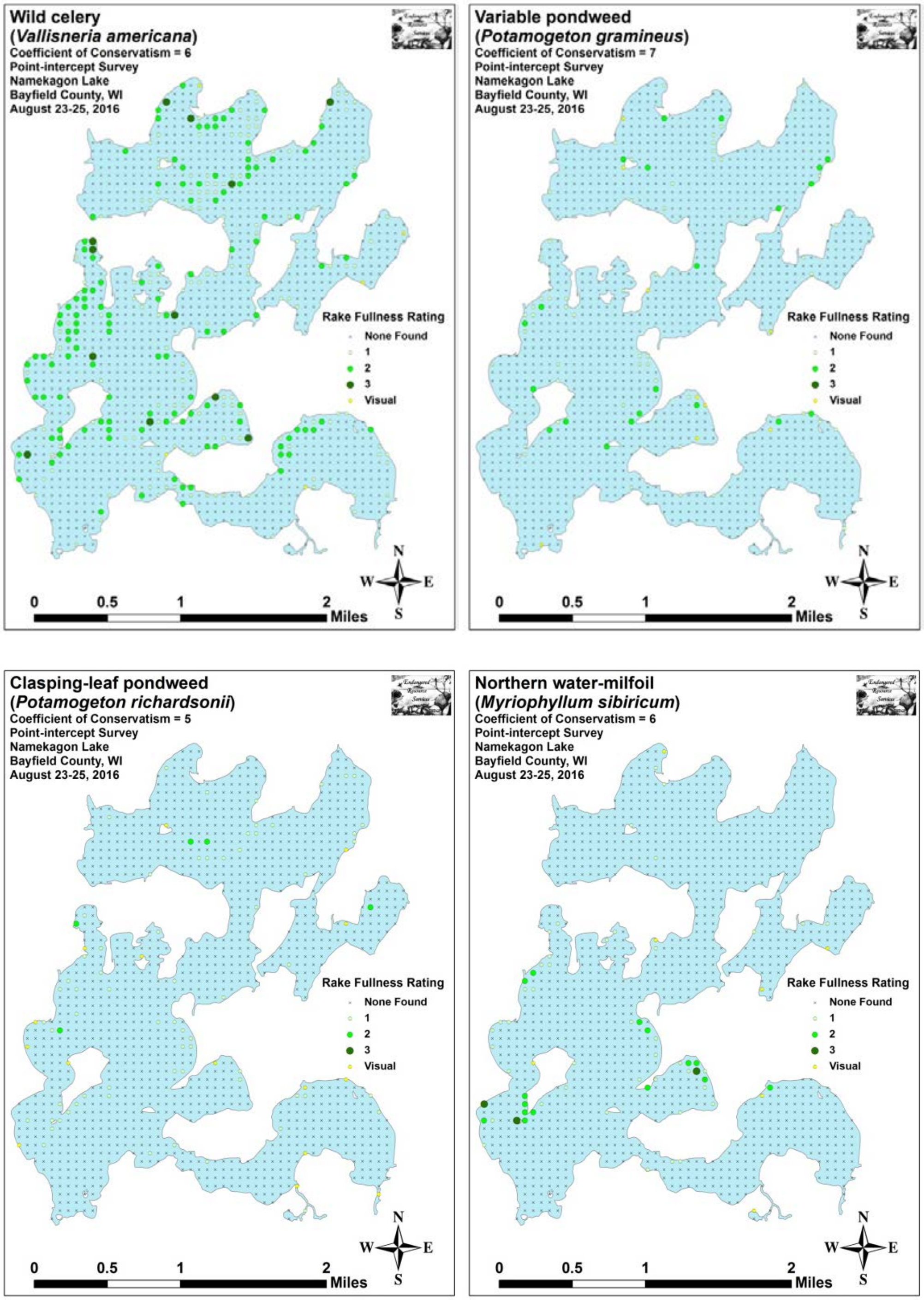


Figure 15. Namakagon Lake's Most Common Species

Table 7. Lake Namakagon Frequencies and Mean Rake Sample of Aquatic Macrophytes

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Vallisneria americana	Wild celery	285	27.48	73.64	55.34	1.52	5
Potamogeton gramineus	Variable pondweed	75	7.23	19.38	14.56	1.28	9
Potamogeton richardsonii	Clasping-leaf pondweed	71	6.85	18.35	13.79	1.07	15
Myriophyllum sibiricum	Northern water-milfoil	60	5.79	15.50	11.65	1.35	7
Potamogeton robbinsii	Fern pondweed	52	5.01	13.44	10.10	1.33	1
Bidens beckii	Water marigold	44	4.24	11.37	8.54	1.20	4
Elodea canadensis	Common waterweed	42	4.05	10.85	8.16	1.10	0
Potamogeton pusillus	Small pondweed	39	3.76	10.08	7.57	1.03	2
	Freshwater sponge	38	*	9.82	7.38	1.00	0
Ceratophyllum demersum	Coontail	37	3.57	9.56	7.18	1.11	1
Potamogeton amplifolius	Large-leaf pondweed	37	3.57	9.56	7.18	1.32	5
Najas flexilis	Slender naiad	32	3.09	8.27	6.21	1.03	0
Nymphaea odorata	White water lily	26	2.51	6.72	5.05	1.69	12
Chara sp.	Muskgrass	23	2.22	5.94	4.47	1.00	0
Potamogeton zosteriformis	Flat-stem pondweed	23	2.22	5.94	4.47	1.00	12
Pontederia cordata	Pickerelweed	17	1.64	4.39	3.30	2.29	4
Potamogeton praelongus	White-stem pondweed	16	1.54	4.13	3.11	1.31	0
Eleocharis palustris	Creeping spikerush	13	1.25	3.36	2.52	1.38	4
	Filamentous algae	13	*	3.36	2.52	1.46	0
Nuphar variegata	Spatterdock	10	0.96	2.58	1.94	1.30	7
Sparganium fluctuans	Floating-leaf bur-reed	10	0.96	2.58	1.94	1.80	2
Eleocharis acicularis	Needle spikerush	9	0.87	2.33	1.75	1.00	0
Isoetes echinospora	Spiny spored-quillwort	9	0.87	2.33	1.75	1.00	0
Schoenoplectus acutus	Hardstem bulrush	9	0.87	2.33	1.75	1.89	2
Utricularia vulgaris	Common bladderwort	9	0.87	2.33	1.75	1.11	3
Sparganium emersum	Short-stemmed bur-reed	8	0.77	2.07	1.55	1.38	4
Brasenia schreberi	Watershield	8	0.77	2.07	1.55	1.75	5
Equisetum fluviatile	Water horsetail	7	0.68	1.81	1.36	1.29	1
Potamogeton friesii	Fries' pondweed	7	0.68	1.81	1.36	1.00	0
Potamogeton spirillus	Spiral-fruited pondweed	7	0.68	1.81	1.36	1.00	3
Dulichium arundinaceum[5]	Three-way sedge	6	0.58	1.55	1.17	1.67	0
Nitella sp.	Nitella	6	0.58	1.55	1.17	1.00	0

* Excluded from the Relative Frequency Calculation

[5] A state special concern species. 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.

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Sagittaria graminea	Grass-leaved arrowhead	6	0.58	1.55	1.17	1.00	0
Sagittaria latifolia	Common arrowhead	4	0.39	1.03	0.78	1.00	2
Heteranthera dubia	Water star-grass	3	0.29	0.78	0.58	1.00	1
Ranunculus aquatilis	White water crowfoot	3	0.29	0.78	0.58	1.00	0
Sparganium eurycarpum	Common bur-reed	3	0.29	0.78	0.58	1.67	2
Typha latifolia	Broad-leaved cattail	3	0.29	0.78	0.58	1.00	2
Carex lasiocarpa	Narrow-leaved woolly sedge	3	0.29	0.78	0.58	3.00	0
Lemna trisulca	Forked duckweed	2	0.19	0.52	0.39	1.00	0
Sagittaria cristata	Crested arrowhead	2	0.19	0.52	0.39	1.00	0
	Aquatic moss	2	*	0.52	0.39	1.00	0
Carex utriculata	Common yellow lake sedge	2	0.19	0.52	0.39	1.00	0
Potamogeton X *scoliophyllus*	Large-leaf X Illinois pondweed hybrid (likely)	2	0.19	0.52	0.39	1.50	0
Carex comosa	Bottle brush sedge	1	0.10	0.26	0.19	1.00	0
Decodon verticillatus	Swamp loosestrife	1	0.10	0.26	0.19	1.00	0
Potamogeton epihydrus	Ribbon-leaf pondweed	1	0.10	0.26	0.19	2.00	1
Potamogeton vaseyi	Vasey's pondweed	1	0.10	0.26	0.19	1.00	1
Schoenoplectus tabernaemontani	Softstem bulrush	1	0.10	0.26	0.19	2.00	2
Stuckenia pectinata	Sago pondweed	1	0.10	0.26	0.19	1.00	0
Carex sp. likely *pellita* – not in fruit	Sedge	1	0.10	0.26	0.19	1.00	0
Utricularia intermedia	Flat-leaf bladderwort	**	**	**	**	**	1
Bolboschoenus fluviatilis	River bulrush	**	**	**	**	**	1
Myriophyllum verticillatum	Whorled water-milfoil	**	**	**	**	**	1
Acorus americanus	Sweet-flag	***	***	***	***	***	***
Glyceria borealis	Northern manna-grass	***	***	***	***	***	***
Lythrum salicaria	Purple loosestrife	***	***	***	***	***	***
Myosotis scorpioides	Common forget-me-not	***	***	***	***	***	***
Myriophyllum spicatum X *sibiricum*	Hybrid water-milfoil	***	***	***	***	***	***
Phragmites australis	Common reed	***	***	***	***	***	***
Potamogeton alpinus	Alpine pondweed	***	***	***	***	***	***
Potamogeton natans	Floating-leaf pondweed	***	***	***	***	***	***
Typha X *glauca*	Hybrid cattail	***	***	***	***	***	***

** Visual Only   *** Boat Survey Only

AQUATIC PLANT SURVEYS: NAMAKAGON, JACKSON, AND GARDEN LAKES 2009

Foth Infrastructure and Environmental LLC (Foth) completed point intercept aquatic plant surveys for the Namakagon Chain Lakes in 2009 as part of the aquatic plant management plan. (Foth, 2010) As in the 2016 Lake Namakagon survey, plants were sampled at WDNR-specified sample points for each lake (Namakagon = 1291 points, Jackson = 368 points, and Garden = 734 points).

Summary results for 2009 for Lake Namakagon are shown in Table 6 to include them alongside 2016 survey results. Summary results for Jackson Lake and Garden Lake are shown in Table 8 and Table 9. No invasive species were found during these plant surveys.

Table 8. Jackson Lake Aquatic Macrophyte P/I Survey Summary Statistics (Foth, 2010)

Summary Statistics	**2009** (Foth, 2010)
Total number of points sampled	176
Total number of sites with vegetation	145
Total number of sites shallower than the maximum depth of plants	162
Frequency of occurrence at sites shallower than maximum depth of plants	89.51
Simpson Diversity Index	0.85
Maximum depth of plants (ft)	8.80
Average number of all species per site (shallower than max depth)	2.35
Average number of all species per site (vegetative sites only)	2.63
Species richness	16
Species richness (including visuals)	19

Table 9. Garden Lake Aquatic Macrophyte P/I Survey Summary Statistics (Foth, 2010)

Summary Statistics	**2009** (Foth, 2010)
Total number of points sampled	233
Total number of sites with vegetation	168
Total number of sites shallower than the maximum depth of plants	219
Frequency of occurrence at sites shallower than maximum depth of plants	76.71
Simpson Diversity Index	0.85
Maximum depth of plants (ft)	11.00
Average number of all species per site (shallower than max depth)	1.87
Average number of all species per site (vegetative sites only)	2.43
Species richness	15
Species richness (including visuals)	20

INVASIVE SPECIES: HYBRID EURASIAN NORTHERN WATERMILFOIL

Plant surveyors found and rake removed approximately 89 individual hybrid watermilfoil plants from the Lakewoods Resort Marina during the August survey (Figure 16). Almost all of these were growing over organic muck in 2-5 feet of water although a couple plants at the north end of the area were growing in 7-8 feet at the edge of the local littoral zone. Most of the plants were submerged, 1-2 foot long, new sprouts mixed in with the bay's moderately dense native vegetation - making them difficult to see. The survey occurred after volunteers removed all mature, canopied plants the morning of August 23rd. Surveyors found only a handful of stems that had been broken off during the initial search of the area. There were also some floating fragments mixed in with other uprooted plants floating near shore and among the moored boats.

The only HWM found outside of the marina were three large canopied plants with multiple stems that were removed in the area southwest of Paine's Island (Figure 16). They were growing in 5-7 feet of water over sandy muck imbedded within a dense northern water-milfoil bed. This made it difficult to get the roots.

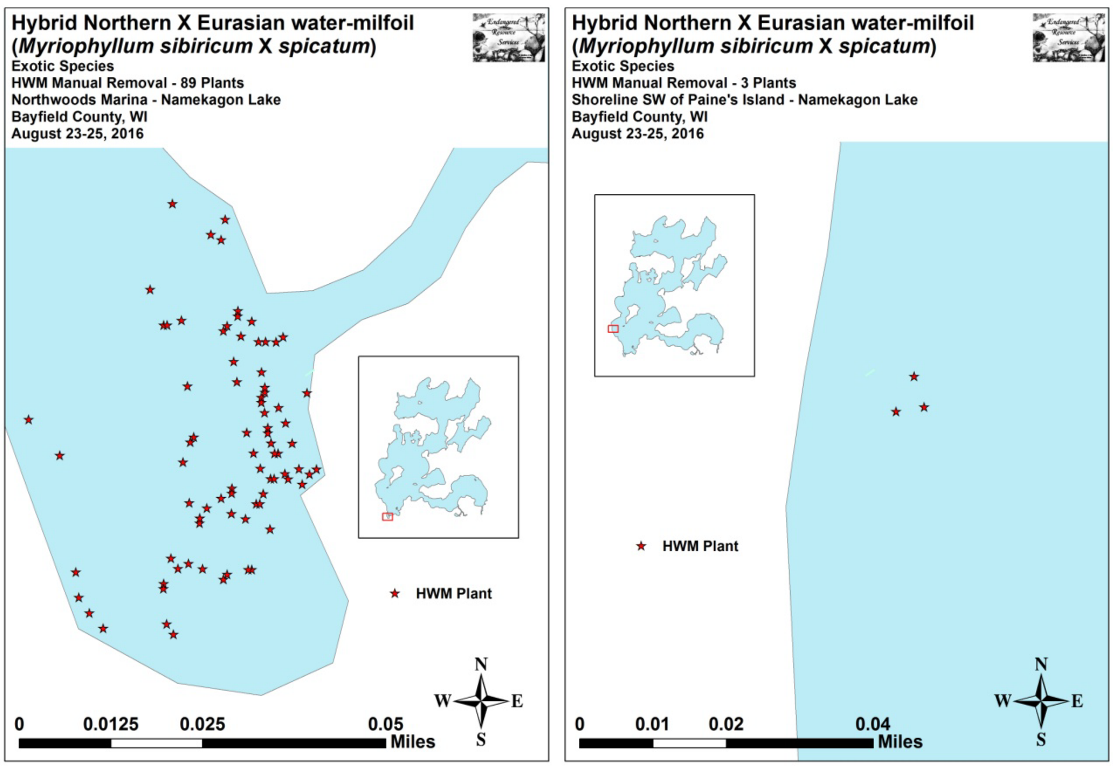


Figure 16. Hybrid Watermilfoil Distribution and Manual Removal Areas Lakewoods Resort Marina and the Bay Southwest of Paine's Island (Berg, 2016)

OTHER NON-NATIVE INVASIVE SPECIES

PURPLE LOOSESTRIFE

A single purple loosestrife (*Lythrum salicaria*) plant in a wetland immediately adjacent to the lake near the river outlet was located and removed in the plant survey (Figure 17). A few more plants were seen in ditches within a mile of the lake, but these tended to occur as individuals or in small clusters mixed in with sedges and cattails rather than in monotypic stands. Volunteers also report finding and removing individual plants in Funnys Bay, most recently in 2016.

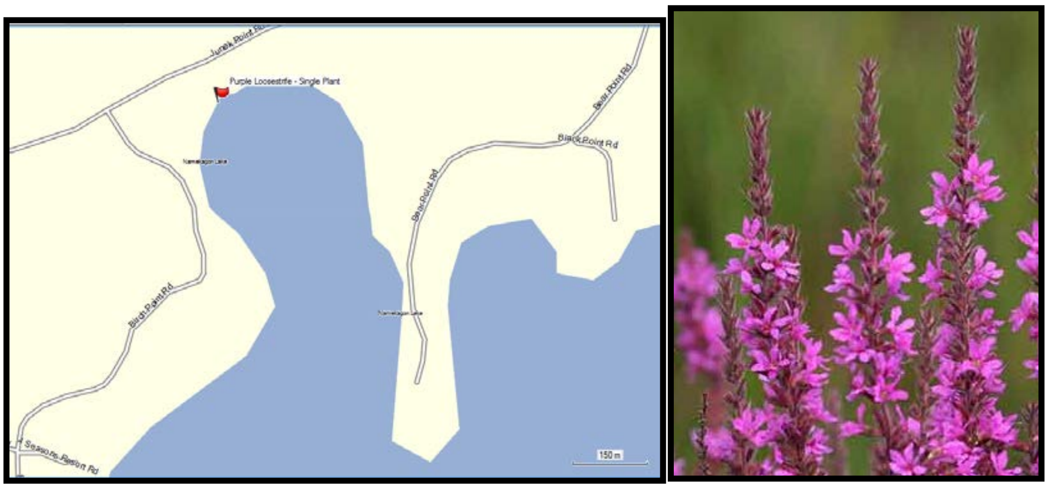


Figure 17. Purple Loosestrife Distribution (Berg, 2016)

FORGET-ME-NOT

Common forget-me-not (*Myosotis scorpioides*) was found at the Lakewoods Resort Marina along the cold-water seeps that are bubbling up due east of the landing (Figure 18). A common exotic in this habitat throughout northern Wisconsin, it is likely that an exhaustive search for this species would find it in many other places along the lakeshore.

Figure 18. Common Forget-me-not Distribution (Berg, 2016)

NARROW LEAF CATTAIL

Native to southern but not northern Wisconsin, narrow-leaved cattail (*Typha angustifolia*) and its hybrids with broad-leaved cattail are becoming increasingly common in northern Wisconsin where they also tend to be invasive. A single stand of approximately 50 individual hybrid cattails was located in shallow water along the north entrance to Mumm's Bay (Figure 19).

Figure 19. Hybrid Cattail Distribution (Berg, 2016)

YELLOW IRIS

Yellow iris (*Iris pseudacorus*) is present throughout the Namakagon River corridor, and it appears to be increasing in both density and distribution (M. Berg, unpublished data). Once established, the plants tend to quickly spread, and they can eventually take over entire wetlands (Figure 20). Although there are unconfirmed reports of this species on the lake, none were located during the plant survey. However, as the plants finish blooming in June, if they occur at low levels, they could have been easily overlooked.

Figure 20. Yellow Iris Bloom and Cluster of Plants on Nearby Waterbody (Berg, 2016)

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.

Techniques to control the growth and distribution of aquatic plants are discussed in Appendix C. Permitting requirements and herbicide use to manage invasive species 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 AND HWM 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 good enough water clarity 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 has been used in Lake Namakagon.

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 21. 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 trial might be considered for Lake Namakagon. 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. (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 AND HWM 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. (Cornell Research Ponds Facility)

Eurasian watermilfoil declines have been associated with the occurrence of the milfoil weevil and other herbivorous insects at numbers 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 the herbivores 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. Weevil biocontrol may be considered for Lake Namakagon in the future, especially if plant growth becomes widespread and chemical treatment and hand pulling effectiveness is limited. However, 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 Namakagon.

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.

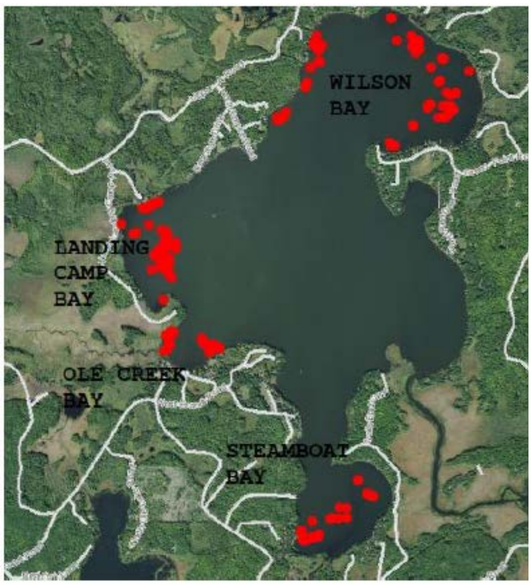
To look at the current frequency of EWM in waterbodies across the state, researchers compiled the most recent aquatic plant point-intercept data on 397 lakes and flowages with EWM populations. Analysis of these data found that the majority of lakes surveyed had very low frequencies (less than 10 percent) 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.

HYBRID WATERMILFOIL MANAGEMENT IN LOST LAND LAKE

The Teal, Lost Land and Ghost Lakes Improvement Association documents planned hybrid watermilfoil (HWM) treatment methods for Lost Land Lake in an Aquatic Plant Management Plan Update May 2017. Hybrid Eurasian watermilfoil was discovered in 1,267-acre Lost Land Lake during a 2013 survey by the Great Lakes Indian Fish and Wildlife Commission. Through 2017, HWM had spread within Lost Land Lake despite an attempt at chemical control with 2,4-D in 2015. The plan recommended mechanical removal of HWM in late spring (and perhaps early fall) when this invasive plant is expected to be taller than most native plants and would therefore be vulnerable to selective mechanical removal without major impact to native plants. Stopgap chemical control of HWM was recommended for spring of 2017 in order to minimize spread until harvest equipment (described as a mechanical plant puller) could be purchased or contracted for hire and placed into operation starting in 2018.



The June 20, 2017 treatment used diquat herbicide (Reward) on 9.9 acres in Lost Land Lake at a cost of $6,023. A qualitative post treatment survey by lake volunteers led by retired fisheries biologist Dave Neuswanger revealed just a few scattered plants following treatment. They further reported that several desirable native species assumed dominance as vegetative growth redeveloped in post-treatment sample areas. As a result of treatment effectiveness, the board executive committee voted to delay fund-raising efforts for purchase of a harvester. A 2018 diquat treatment is planned only for a small area of Steamboat Bay that was not treated in 2017. Follow-up monitoring of Lost Land Lake is planned to determine if chemical treatments have had a lasting effect.[6] (Neuswanger, 2017)

Figure 22. Hybrid Watermilfoil in Lost Land Lake Summer 2016

HYBRID WATERMILFOIL IN LAKE HAYWARD

Eurasian watermilfoil was discovered in Lake Hayward in 2011. Plants were verified as HWM in 2012. Management efforts were coordinated by Sawyer County. An unsuccessful liquid 2,4-D herbicide treatment was completed in 2013 with no significant change in HWM growth pre and post treatment (Berg, 2013) . Residual herbicide monitoring found peak concentrations of 2.4-D in water samples at various sites ranging well below the target treatment concentrations (Skogerboe, 2015). No permitted herbicide treatments have occurred since 2014 on Lake Hayward. Systematic point intercept surveys have not been completed since 2013 for Lake Hayward, but current Sawyer County AIS Coordinator reports that both EWM/HWM and curly leaf pondweed growth is variable

[6] For more detailed information: http://www.quietlakes.org/qla-board-members-assess-efficacy-62017-herbicide-treatment/

each year. A drawdown was contemplated for EWM/HWM control, but was not pursued due to fisheries, power generation, well supply, and additional concerns. (Brown, 2018)

HYBRID WATERMILFOIL MANAGEMENT IN LAKE NAMAKAGON

2016 DISCOVERY AND RESPONSE

In June 2016, hybrid Eurasian X northern watermilfoil (*Myriophyllum spicatum* X *sibiricum*) (HWM) was discovered at the Lakewoods Resort Marina Landing. Following DNA confirmation in July, hand removal efforts were completed several times throughout the summer and early fall by WDNR (Pamela Toshner – Regional Lake Biologist), BCLWCD (Andrew Teal – Bayfield County Land and Water Conservation Department Aquatic Invasive Species Coordinator), volunteers from the Namakagon Lake Association (NLA), and employees from Lakewoods Resort. At one of the hand pulling events, professionals and volunteers worked together and had Ashland Daily Press coverage. WDNR, BCLWCD, and others completed a shoreline survey of the lake on August 15, 2016 as part of a Wisconsin Lakes Partnership meeting (Figure 23). They found a few scattered plants in the bay southwest of Paines Island and two additional plants in the bay near the river outlet (although one was later identified as northern rather than hybrid watermilfoil). (WDNR, 2016) A total of about 10-12 garbage bags of HWM were removed from Lake Namakagon in 2016.

As described previously, Matthew Berg of Endangered Resource Services completed a full point intercept survey of Lake Namakagon in August 2016 (Figure 16). At the time of the survey, Matt and a student removed 89 HWM plants from the Lakewoods Resort Marina (Berg, 2016) - approximately 5-20 lbs. of wet plant material (WDNR, 2016).

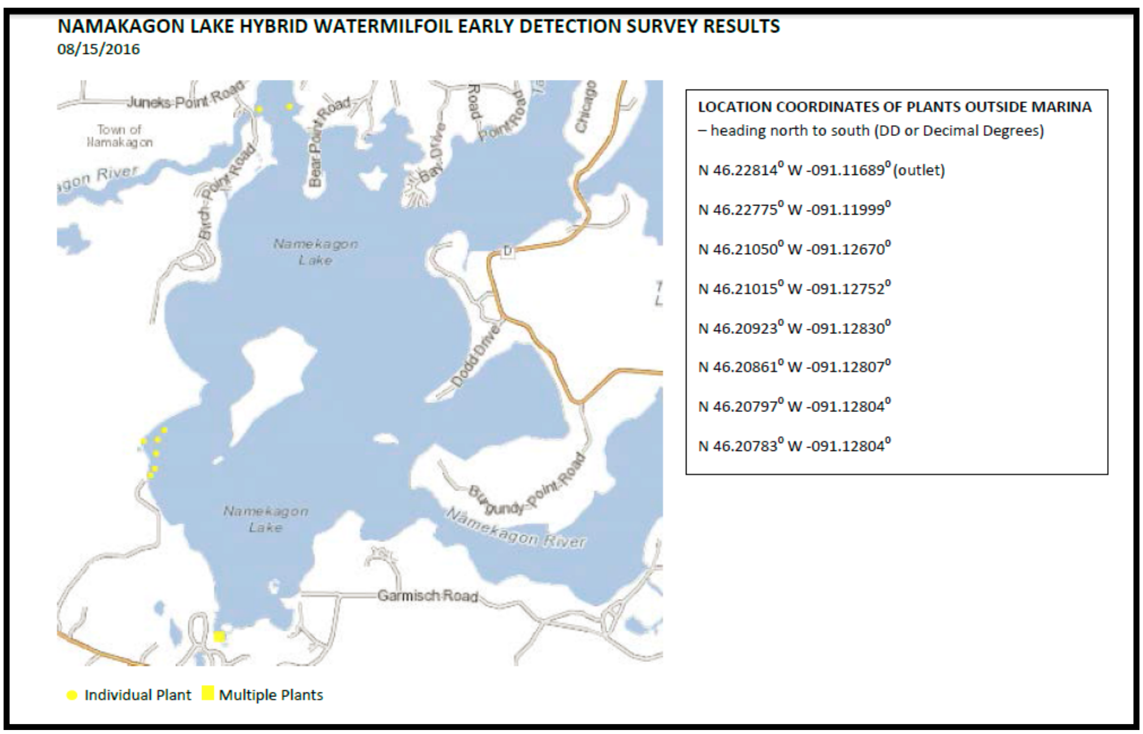


Figure 23. Namakagon Lake Hybrid Watermilfoil Early Detection Survey Results

VOLUNTEER MONITORING GUIDANCE

Plant surveyor, Matt Berg, offered the following suggestions for volunteer monitors in the aquatic plant survey report:

Because the native northern watermilfoil is widely distributed throughout the lake and closely resembles HWM, finding and identifying HWM will likely be challenging for volunteers. To assist in identification, surveyors should remember that northern watermilfoil has leaflets numbering <24 whereas EWM normally has >26 with HWM tends to have leaflet numbers that range from 20-30 – intermittent between both parent species (Figure 24). EWM and HWM also tend to have a bright red growth tip on the top of the plant whereas NWM has a bright lime green growth tip. In the fall, NWM also forms winter buds on the tips of shoots whereas EWM/HWM have none (Figure 25). Hybrid and Eurasian watermilfoil tend to grow in similar habitats as northern watermilfoil, so knowledge of locations of northern watermilfoil growth can be helpful.

Eurasian Watermilfoil **Hybrid Watermilfoil** **Northern Watermilfoil**

Figure 24. Eurasian, Hybrid, and Northern Watermilfoil Identification (Berg, 2016)

Figure 25. Limp Nature of EWM/HWM Leaflets along Stem – Stiff Nature of NWM Leaflets along Stem and Overwintering Turions October 2016 (Berg, 2016)

2017 HERBICIDE TREATMENT

The Namakagon Lake Association completed an herbicide treatment to control HWM in the Lakewoods Marina area on April 17, 2017 when the water temperature was 46 degrees F. The treatment covered 2.3 acres using 4.6 gallons of diquat (Reward) herbicide. Wind speed was low at 7 miles per hour from the NNW during treatment (blowing into the bay). (Dressel, 2017) Rhodamine dye was used as a tracer for the herbicide. Dye monitoring verified there was little or no drift outside of the bay where herbicide treatment occurred. (Toshner P. , 2018)

The treatment area encompassed the entire bay where the Lakewoods marina is located. The marina includes a boat launch and mooring for rentals and private boats. The deepest point of the bay is approximately 10 feet. The water is heavily stained, and there is groundwater seepage into the bay. The substrate is highly silty (and turns to sand a few feet from shore). (WDNR, 2016) The ice goes out in this bay before the rest of the lake, and the treatment occurred about 2 weeks after ice-out in 2017. (Toshner P. , 2018)

Species richness lists were created for the bay pretreatment (fall 2016) and post treatment (summer 2017). Results indicated that the native plant community did not experience negative impacts with similar species richness and thriving plants. A successful treatment was evidenced by low HWM plant growth during the remainder of the summer 2017 as described below.

FOLLOW UP HAND PULLING

NLA volunteers and Department of Natural Resources staff returned to the herbicide treatment area more than 10 times during the summer of 2017. During these visits volunteers and staff pulled an estimated less than 100 HWM plants – perhaps a total of one garbage bag. (Toshner P. , WDNR Lakes Biologist, 2017) Hybrid watermilfoil plants were first observed growing in the bay again in June, especially in mucky areas. By late summer 2017, there were just a few clumps of healthy plants. (Figure 26)

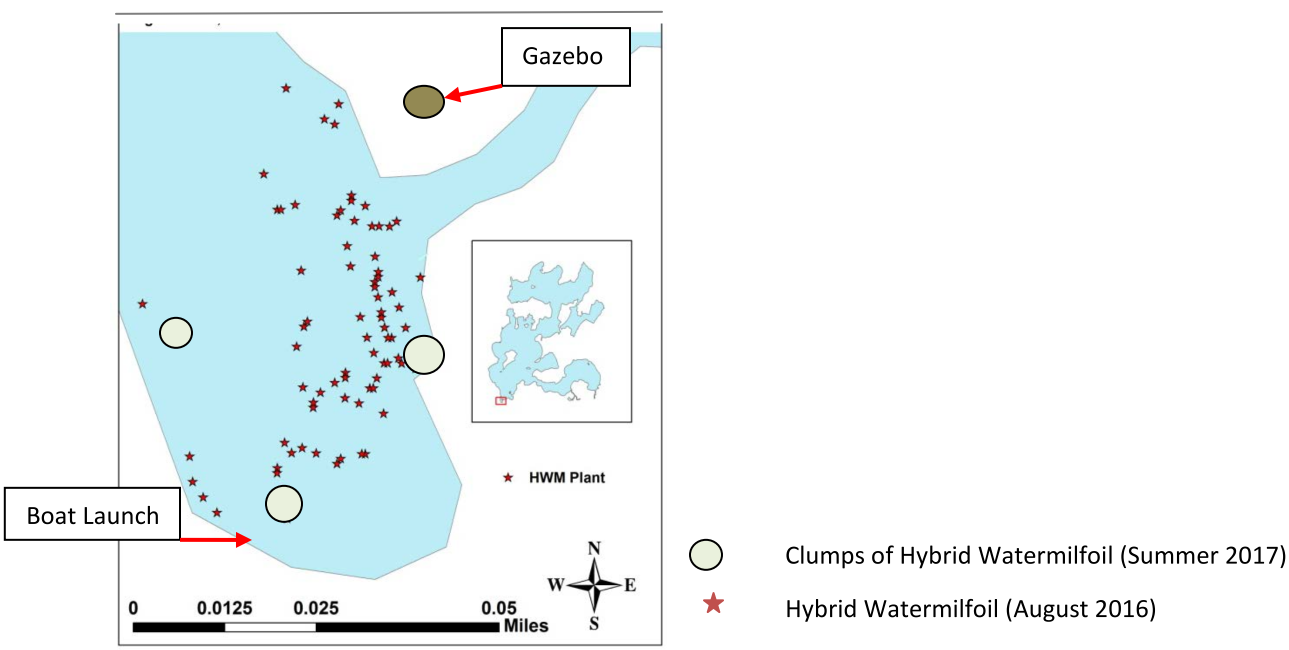


Figure 26. Lakewoods Bay Hybrid Watermilfoil Clumps

FOLLOW UP MONITORING

In October 2017, staff from Bayfield County and Lake Association Volunteers completed an AIS survey of Lake Namakagon focusing on locations where EWM or HWM was previously found. They found widespread suspected HWM plants near the Namakagon River outlet on the lakeside of the bridge and a few near Paines Island. Unfortunately, the lab lost plants sent in for DNA verification. About 2 hours were spent hand pulling the plants found during this survey. GPS points were not recorded. (Teal, 2017) Lake volunteers generated a comprehensive map where suspected HWM has been found on Lake Namakagon in 2016 and 2017, at a meeting at the Namakagon Town Hall December 18, 2017. (Figure 27) However, the plants were not verified by DNA testing in all locations.

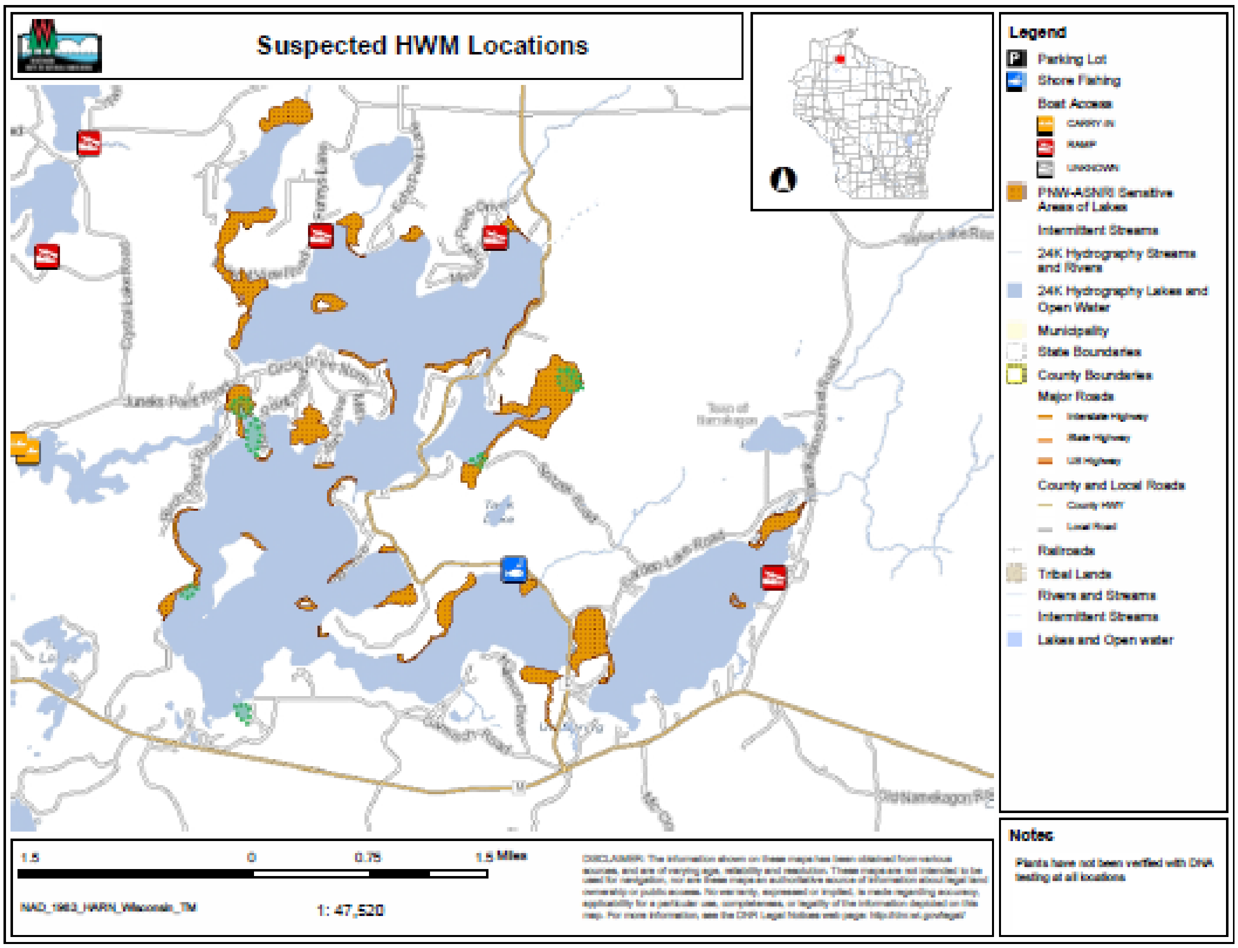


Figure 27. Hybrid Watermilfoil Suspected Locations (2016 and 2017)

PREVENTING INVASIVE SPECIES

There are several methods the Lake Namakagon Association and others can consider to prevent invasive species introduction: education to lake users, Clean Boats Clean Waters program, landing surveillance cameras, boat decontamination, 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 might include aquatic invasive species (AIS) information presented at annual meetings and workshops, signage at the public landings and private boat launch areas, lake maps and brochures with AIS messages, and web site and newsletter information.

CLEAN BOATS CLEAN WATERS (CBCW) PROGRAM

Clean Boats Clean Waters educators provide boaters with information on the threat posed by Eurasian 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.

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 ordinance and state rule which prohibits 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.

BOAT WASHING/DECONTAMINATION

Boat and equipment decontamination may use hot water or stream (>140 degrees F), pressure washing, or chemicals such as chlorine to prevent transfer of invasive species. WDNR portable Water Guard boat washing demonstrations may be available. Boat decontamination is not required for the public in Wisconsin. Nearby Burnett and Washburn Counties are considering ordinance updates to include mandatory decontamination requirements if offered at a public landing. (Ferris, Dave, personal communication 12/21/17)

LAKE MONITORING

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

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 B and is available on the WDNR website http:/dnr.wi.gov/invasives.

A rapid response plan is included as Appendix D.

LAKE NAMAKAGON ASSOCIATION AIS PREVENTION ACTIVITIES

CLEAN BOATS, CLEAN WATERS

The Namakagon Lake Association received funding to support landing monitors at three public landings (County D, Funnys Bay, and Lakewood Resort) in 2017. The number of hours these landings were staffed in recent years are reported in Figure 28 to Figure 30. The program uses a combination of students hired through Northland College (Memorial Day through Labor Day at County D and Lakewoods) and adults hired by the NLA to staff the landings. The CBCW coordinator is a volunteer. The Bayfield County Sheriff's Department provides enforcement as needed.

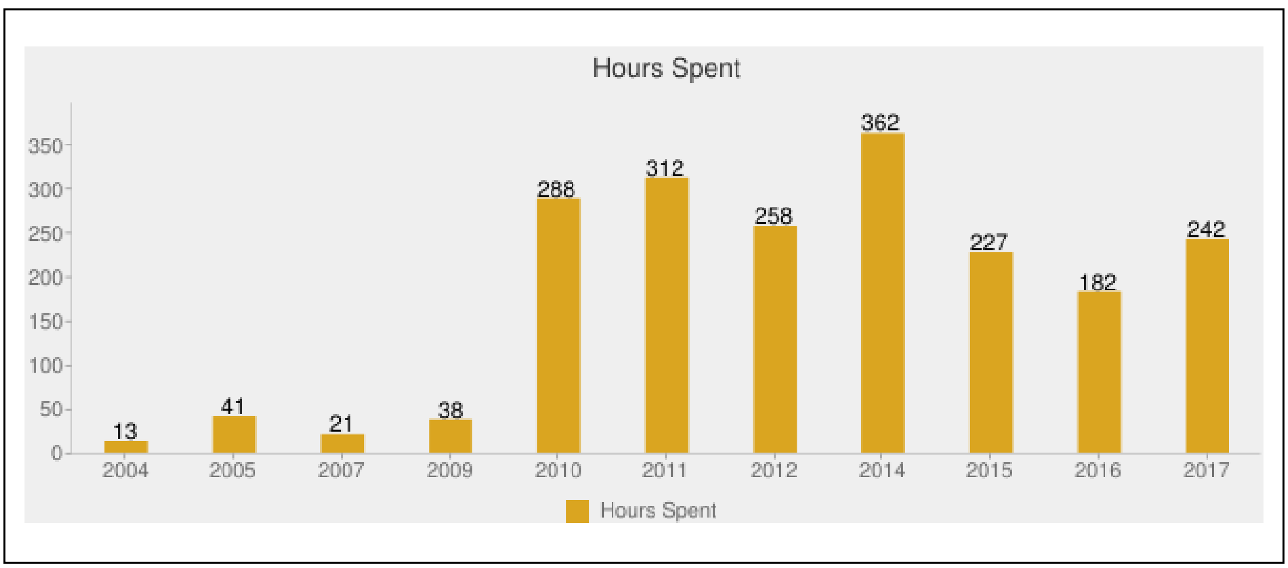


Figure 28. Clean Boats, Clean Waters Staffing County D Landing

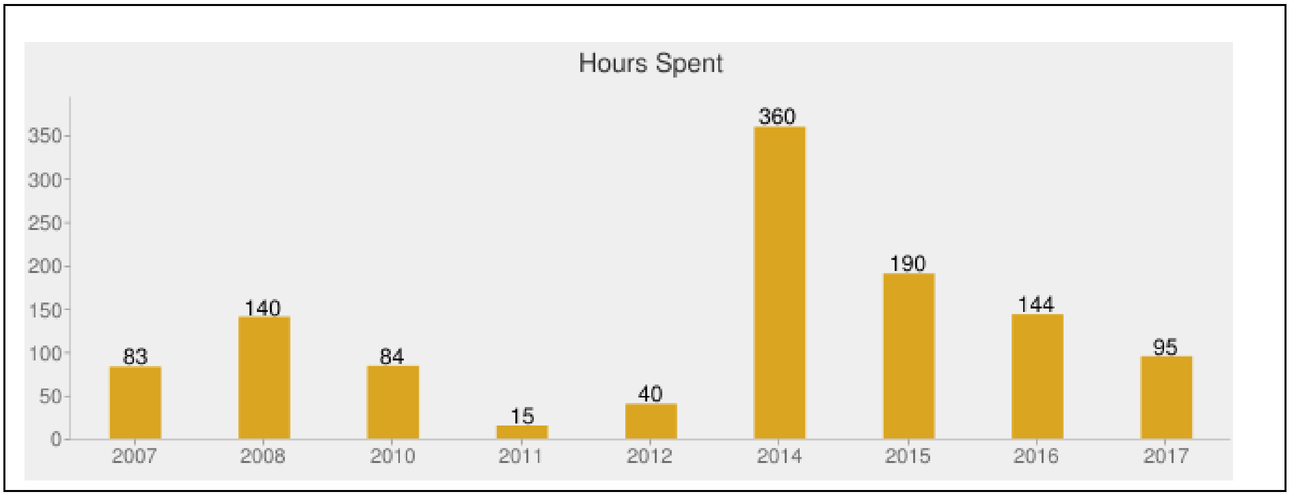


Figure 29. Clean Boats, Clean Waters Staffing Funnys Bay

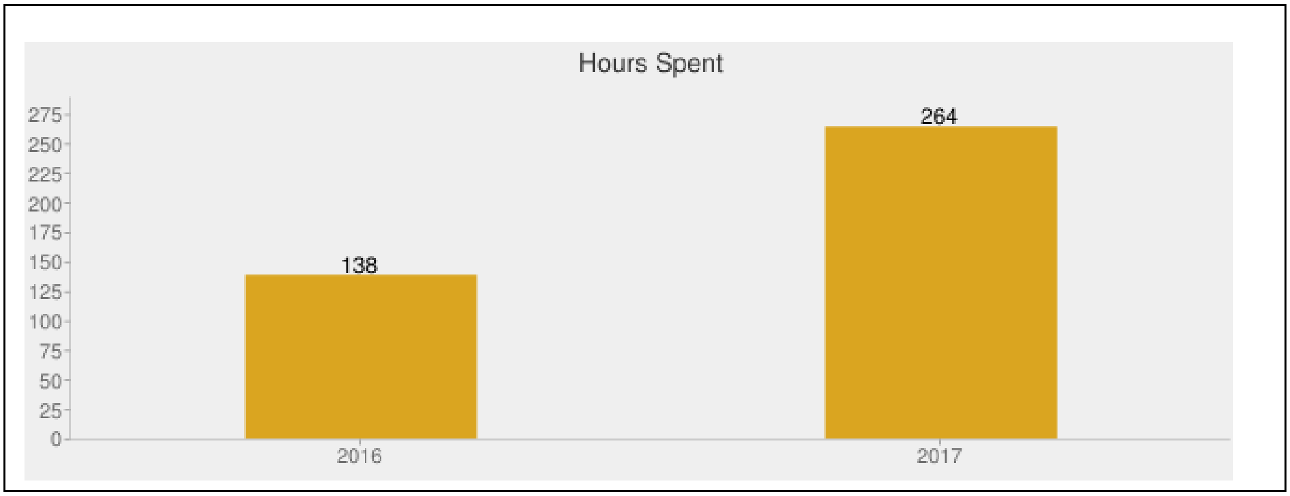


Figure 30. Clean Boats, Clean Waters Staffing Lakewoods Resort

LANDING CAMERAS

Landing Monitoring Cameras were installed at two landings (County D and Funnys Bay) with WNDR grant AEPP-211-10 in 2010. Cameras are also in place at Lakewoods Resort and Garden Lake. Volunteers review the video from the cameras. The Bayfield County Sheriff's Department issued two citations resulting from video evidence.

MONITORING

NLA volunteer monitoring occurs adjacent to public access sites and in strategic bays.

COMMUNICATION METHODS

Annual meeting presentations

Newsletter – distributed by mail (about 450 addresses)

Email list – (about 220 addresses of NLA members)

NLA website

Signs at boat landings (installed at boat landings with WDNR grant SPL-234-10)

Lake association board meetings and annual meetings

Conferences and workshops

Written information: APM Plan Summary, Mailings, NLA brochure

Private road association meetings

PLAN GOALS AND STRATEGIES

Namakagon Lake Association Mission Statement

THE NAMAKAGON LAKE ASSOCIATION, INC. WAS FORMED IN 1995 FOR THE PURPOSE OF PRESERVING AND PROTECTING LAKE NAMAKAGON AND ITS ENVIRONS. THE NAMAKAGON LAKE ASSOCIATION, INC. (NLA) IS A NOT FOR PROFIT ORGANIZATION THAT RELIES ON THE CONTRIBUTIONS AND MEMBERSHIP FEES OF LAND OWNERS AND OTHER CONCERNED CITIZENS FOR ITS FUNDING. IT IS OUR GOAL TO PRESERVE AND PROTECT LAKE NAMAKAGON AS AN ENVIRONMENTALLY HEALTHY WATERSHED, BY SPONSORING EDUCATIONAL PROGRAMS, ADOPTING A PROACTIVE ROLE IN THE FORMULATION OF WATER AND SHORE LAND REGULATIONS, AND RESPONSIBLE USE OF THIS UNIQUE AND IRREPLACEABLE RESOURCE FOR ALL CITIZENS.

GOAL 1. *PROTECT* THE NATURAL FUNCTIONS THAT DIVERSE NATIVE PLANTS PROVIDE BOTH IN THE WATER AND ON THE SHORE.

GOAL 2. *PREVENT* THE INTRODUCTION OF AQUATIC INVASIVE PLANTS AND ANIMALS.

GOAL 3. *EDUCATE* LAKE RESIDENTS AND VISITORS ABOUT THE IMPORTANCE OF NATIVE AQUATIC AND SHORELAND PLANTS, THE THREATS FROM INVASIVE SPECIES, AND THE PLAN MANAGEMENT STRATEGIES.

GOAL 4. *ID, CONTROL, AND CONTAIN* AQUATIC AND SHORELAND INVASIVE SPECIES.

GOAL 5. *COORDINATE AND COMMUNICATE* WITH OUR PARTNERS.

GOAL 1. *PROTECT* THE NATURAL FUNCTIONS THAT DIVERSE NATIVE PLANTS PROVIDE BOTH IN THE WATER AND ON THE SHORE.

OBJECTIVE

A. Control measures result in minimal damage to native species (no statistically significant decline in native plant frequency of occurrence[7] within treatment areas, and throughout Lake Namakagon, Jackson, and Garden Lakes).

ACTION

1. Be aware of potential native plant and animal impacts and modify treatment strategies to address proven concerns.

EVALUATION

Conduct whole lake aquatic plant point intercept aquatic plant surveys every 3-5 years.

Conduct pre and post monitoring where control measures occur (see goal 4).

Note: WNDR may not require pre- and post-monitoring for small scale herbicide treatments (<10 acres) for issuance of APM permits. However, such monitoring can be beneficial to understanding management effectiveness and may be required when WDNR grant funding is provided for projects of any size.

GOAL 2. *PREVENT* THE INTRODUCTION OF AQUATIC INVASIVE PLANTS AND ANIMALS.

OBJECTIVE

A. Protective measures are established, and people take preventative action at likely invasive species points of entry.

ACTIONS

1. Continue the Clean Boats, Clean Waters program at three public landings (County D, Funnys Bay, and Lakewoods Resort).

2. Operate landing monitoring cameras at four landings (County D and Funnys Bay, Lakewoods Resort, and Garden Lake). Volunteers review the video from the cameras.

3. Consider boat decontamination at landings and other locations.

[7] Frequency of occurrence is the percentage of points out of all points sampled where a particular plant species is found.

GOAL 3. *EDUCATE* LAKE RESIDENTS AND VISITORS ABOUT THE IMPORTANCE OF NATIVE AQUATIC AND SHORELAND PLANTS, THE THREATS FROM INVASIVE SPECIES, AND THE PLAN MANAGEMENT STRATEGIES.

OBJECTIVES

A. Residents and lake users understand the role and importance of native plants, the threats from invasive species, and the rationale for invasive species management.

B. Residents and lake users prevent introduction of invasive species.

C. Lake residents preserve and restore shoreland buffers of native vegetation.

D. Volunteers support aquatic plant management plan implementation.

ACTIONS

Behaviors to Encourage

Volunteer to help celebrate and protect Lake Namakagon.

Talk to your neighbors about invasive species prevention and volunteering for activities. Quarantine docks, lifts, and other equipment for at least one month when moved from another lake or river.

INSPECT, REMOVE, DRAIN, NEVER MOVE

Learn invasive plant identification with resources from the lake association, county, and WDNR.

Check docks, lifts, rafts, and other equipment for zebra mussels when removed from water in the fall.

Maintain native aquatic plants for the benefits they provide: protection against invasive species, breaking the force of waves along the shoreline, lake health, fish and waterfowl habitat, etc.

Maintain native shoreland plants for the benefits they provide: habitat for shoreland species, protection against erosion, and natural beauty.

When you plant or have landscaping projects completed - know what you are planting; be sure not to introduce invasive plants.

Messages

ALL OF THE ABOVE RELATED TO ENCOURAGING SPECIFIC BEHAVIORS

The lakes are central to the community. We need more people to help support important lake protection work.

Sources of native plants for your shoreland area.

Target Audiences

Lake residents
Dock service providers
Resort owners and other businesses
Fishing tournament organizers
Landing users
Visitors who are out on the lake

Communication Methods

- Annual meeting presentations
- Newsletter – distributed by mail (about 450 addresses including resorts and realtors)
- Email list – (about 220 addresses of NLA members)
- NLA website
- Signs at boat landings (installed at boat landings with WDNR grant SPL-234-10)
- Lake association board meetings and annual meetings
- Conferences and workshops
- Written information: APM Plan Summary, Mailings, NLA brochure
- Private road association and other organization meetings

Citizen Engagement Strategies

1. Volunteer Monitoring Training

2. Community Events – celebrate the lakes, discuss the threats to our valued resource and what each person or organization can do about them, provide hands-on volunteer plant ID training. Coordinate with businesses including Lakewoods.

3. Encourage volunteers with events and appreciation measures
   - Provide food and drink, encourage socializing
   - Recognize volunteers at least annually

4. Appoint and support a volunteer coordinator
   - Provide a list of volunteer activities and the approximate time commitment required for each
   - Develop a sign-up sheet, perhaps make available for sign up on-line
   - Initial list of volunteer activities: board members, monitoring/ID, viewing landing camera footage, attending educational events
   - Recruit volunteers from other partner organizations

GOAL 4. *ID, CONTROL AND CONTAIN* AQUATIC AND SHORELAND INVASIVE SPECIES.

OBJECTIVES

A. Rapidly identify and respond to new aquatic and shoreland invasive species.

B. Contain Hybrid Watermilfoil
   - Seek >90% reduction in frequency of occurrence with each control measure.
   - Use multiple control measures in sequence if reduction objective is not met.
   - No expansion of HWM to additional areas of the Namakagon Lake chain.

C. Assess spread of HWM and resulting impacts to native plants if control measures are not implemented.

D. Control shoreland invasive species (see Appendix B: USFS Non-native Invasive Species List)
   - Purple loosestrife
   - Yellow iris
   - Garlic mustard

E. Minimize unintended consequences of management/control efforts.
   - Avoid fragments which may spread plants when hand-pulling.
   - Consider timing and location of chemical treatments to avoid negative impacts to spawning and fish nursery habitat.
   - Equipment used for monitoring is decontaminated if used on any other water body.

ACTIONS

1. Develop a Rapid Response Plan for invasive species (Objective A). See Appendix D.

2. Follow monitoring strategy for potential new Aquatic Invasive Species and Hybrid Watermilfoil (Obj A, B, C).

ID priority locations for monitoring

- public and private landings and consider characteristics (depth, bottom substrate)
- suspected locations (previous ID)
- NWM locations

Volunteer Monitoring

- Provide volunteers with information and training to ID and distinguish between other species such as NWM
  - o Trained lead volunteers will interact directly with agency and consultant experts to gain additional experience with plant identification. Their contact information (email/phone) will be provided to other lake residents to verify identification.
- Develop reporting and tracking systems for volunteer monitoring – RECORD GPS POINTS AND MAP IF POSSIBLE – consider Avenza or Google Earth Pro (free) for monitoring

- Coordinate volunteer monitoring efforts (location and reporting)
    - Lead volunteers are assigned by lake area. Four board members currently serve as lead volunteers – more are needed.
    - Lead volunteers will coordinate lab/DNA verification of HWM by lake area (may need new lab for testing)

Zebra Mussel Monitoring

Table 10. Zebra Mussel Monitoring Plan

Method	Responsible Party	Cost	Comments	Needs
Cinder blocks/bricks	NLA		Encourage lake residents to place blocks beneath docks and monitor regularly	Cinder block guidance: Pictures and description, ID contacts, monitoring log
Net Tows for Veligers	NLA USNPS		Best time is early July. Collect samples 2X/week from mid-June to mid-July	Volunteer to participate in NPS project

Figure 31. Monitoring Equipment: Cinder Blocks, Sampling Plates and Nets for Veliger Tows

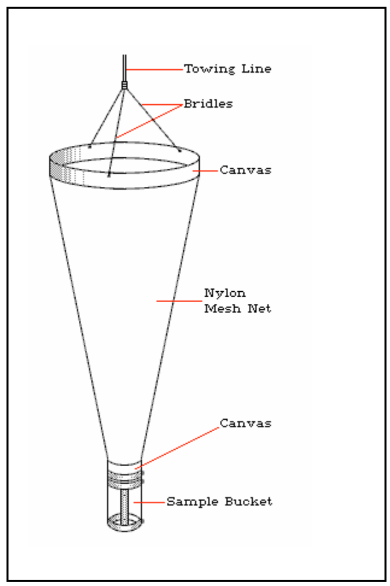


Table 11.NLA Zebra Mussel Monitoring and Prevention Outreach

Method and Messages	**Target Audience**	**Lead Organization**
Cinder Block guidance: Pictures and description, ID contacts, monitoring log	Lake Residents	NLA
Articles in newsletter	DLA residents, resorts	Bayfield County
Coordination with tournament organizers: Drain live wells, drop motors; don't bring your boat here if you've been these (ZM waters) without decontamination; decontamination procedures	Tournament organizers	NLA
Letters, newsletters – check docks and trailers when removed from the water. Keep docks, lifts, equipment from another lake out of the water at least one month before installing in Namakagon Lake system.	Dock service providers Residents	NLA
Newsletters, presentation, annual meeting	Residents	

Professional Monitoring

Complete point intercept survey of Jackson and Garden Lakes (2018)

Complete annual AIS meander survey

Provide financial support for DNA testing to confirm HWM samples if needed (University of Montana or other qualified lab).

Partner Monitoring

The US Forest Service monitors public landings every year for AIS and lake wide every three years.

3. Conduct control measures for HWM – see Table 12. Containment Decision Matrix (Objective B and E)
   - Identify appropriate responses with various conditions
   - Document efficacy of various control measures with pre and post monitoring
   - Adaptive Management – there is no silver bullet. Make adjustments to management strategy with new information and experience

4. Develop protocol to study spread on HWM where no control measures are used and implement study (Objective C).

5. Implement control measures for shoreland invasive species. (Objective D).

Table 12. Namakagon Lake Hybrid Watermilfoil Containment Decision Matrix[8]

HWM Growth Condition	Control Methods[9]	Monitoring	Considerations	Lead /Partners
Scattered growth no defined edge <4 feet deep	**Hand pulling** Plant ID – guidance to lead volunteers, lab verification of HWM (sample each area where suspected, locate lab)	Volunteer Monitoring (ongoing/monthly) Professional Meandering Survey (annually)	Pilot no-pull location(s) to assess HWM and native plant growth. Establish transects or GPS points to monitor HWM and native plants. *Choose area where herbicide treatment success is likely if needed as back-u (enclosed bay).*	Volunteers Paid summer help (?)
Scattered growth >4 feet deep OR <10% FOO and >½ acre beds OR bed (10-20% or > FOO) in flowing water	**DASH** – Diver assisted suction harvesting (contracted)	GPS points to map HWM locations for harvesting	Conduct a survey to see if weevils are already present Pilot weevil establishment	
Dense growth in beds: >1/2 acre (contained bay), larger minimum treatment beds (3-5 acres), or DASH may be needed in areas where current exists	**Contact herbicide treatment:** Diquat or other; Procellacor trial?	Pre and post quantitative monitoring (professional)	Minimum bed size for effective herbicide treatment will vary with site conditions and herbicide chosen. Consider containment measures for very small treatment areas. Consider a dye study prior to proposed herbicide treatment to evaluate water currents and flow and predict efficacy of herbicide treatment. Note: maximum label rate treatment area for Diquat = 10 acres	
Lakewide scattered growth of HWM	**Weevil establishment** depending upon results of trial	Weevil stem counts, HWM meandering or PI survey (annually)	Sunfish populations may limit weevil survival	Uncertain results
Lakewide dense growth of HWM (tentative thresholds: 5% of lake surface area =145 acres. *It might also be possible to consider lake basins separately.*)	**Whole lake herbicide treatment** (fluridone) For follow-up clean up see above procedures	Pre and post quantitative monitoring (professional)	Fluridone: treatment can be very effective for 1-4 years for EWM. However, native plants are impacted for a similar time period. [10] Triclopyr: A water body should not be treated with triclopyr if there is an outlet, or in moving waters such as rivers or streams.[11]	

[8] This matrix is meant to be a starting point for discussion, not to provide conclusive recommendations for HWM management for Lake Namakagon. Any containment matrix should be regularly evaluated and adapted depending upon control results.
[9] Control methods considered but eliminated as an option for the Namakagon Lake system include benthic barriers and harvesting.
[10] http://dnr.wi.gov/lakes/plants/research/Project.aspx?project=111623277
[11] http://dnr.wi.gov/lakes/plants/factsheets/TriclopyrFactsheet.pdf

Definitions

HWM Bed: 10-20% or > FOO, defined edge

Scattered growth : <10% FOO, no defined edge

Objective measures: FOO (frequency of occurrence = HWM plants/total plants sampled), Rake Density

GOAL 5. *COORDINATE AND COMMUNICATE* WITH OUR PARTNERS.

OBJECTIVES

A. Keep up with evolving technology and best practices

B. Enhance response time – e.g., DNA test turn-around, permit review, grant cycles

C. Maintain communication channels with partners

D. Identify and encourage new stakeholder involvement

E. Avoid duplication of efforts by project partners

ACTIONS

1. Continue Advisory Committee to support implementation of the aquatic plant management plan

   Initial Advisory Committee List (*Encourage organizations to sign onto/adopt the plan).*
   - Namakagon Lake Association
   - Bayfield County
   - Great Lakes Indian Fish and Wildlife Commission
   - US Forest Service
   - Wisconsin Department of Natural Resources
   - Town of Namakagon

2. Maintain list of potential partners and encourage participation through letters, presentations, one-on-one outreach, etc.

   Stakeholders/Partners

   - Sportsman's groups
   - Tournament sponsors
   - Chamber of Commerce
   - Towns of Namakagon and Grandview
   - Business such as Lakewoods and other resorts, taverns, restaurants, lake service providers
   - Namakagon Community Club
   - Cable Chamber of Commerce
   - Cable Natural History Museum
   - Lions Club (current environmental focus)
   - Youth clubs such as Boy Scouts

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 Namakagon Lake Association currently has a 75 percent WDNR Rapid Response Grant. AIRR 21817 provides $20,000 from June 19, 2016 through December 31, 2019. The grant project scope includes professional monitoring and plant surveys, chemical treatment, equipment, and the update of the aquatic plant management plan. Volunteer monitoring and hand pulling provide grant match.

APPENDIX A. AQUATIC PLANT SURVEY METHODS

Prior to beginning the August 2016 point-intercept survey, a general boat survey of the lake was conducted to gain familiarity with the species present. All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006, Skawinski 2014), and a field datasheet was developed.

The 1,291 point survey sampling grid for Namakagon Lake was developed by the WDNR using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total acreage. Using this grid, plant surveyors located each point using a handheld mapping GPS unit (Garmin 76CSx), recorded a depth reading with a metered pole rake or hand held sonar (Vexilar LPS-1), and used a rake to sample an approximately 2.5 foot section of the bottom. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 32). Visual sightings of all plants were also recorded within six feet of the sample point not found in the rake. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

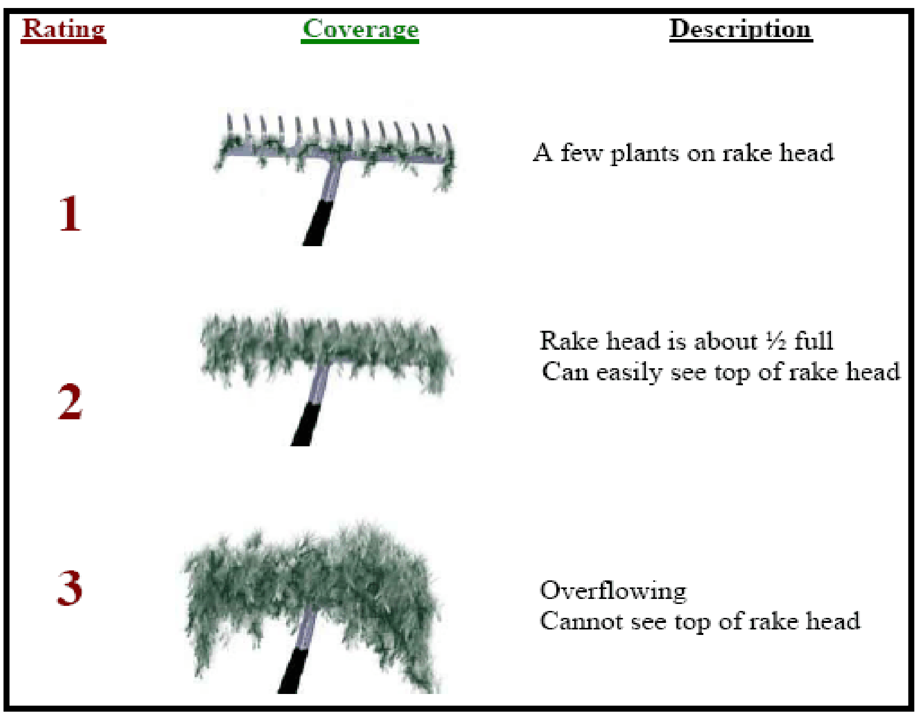


Figure 32. Rake Fullness Ratings (UWEX 2010)

DATA ANALYSIS

Following the survey, data was entered into the standard APM spreadsheet (UWEX 2010), and the following were calculated:

Total number of sites visited: This included the total number of points on the lake that were accessible to be surveyed by boat.

Total number of sites with vegetation: These included all sites where vegetation was found in a rake sample. For example, if 20% of all sample sites have vegetation, it suggests that 20% of the lake has plant coverage.

Total number of sites shallower than the maximum depth of plants: This is the number of sites that are in the littoral zone. Because not all sites that are within the littoral zone actually have vegetation, this value estimates how prevalent vegetation is throughout the littoral zone. For example, if 60% of the sites shallower than the maximum depth of plants have vegetation, then 60% of the littoral zone has plants.

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences within the littoral zone. It can also be reported as a percentage of occurrences at sample points with vegetation.

Frequency of occurrence example:

Plant A is sampled at 70 out of 700 total littoral points = 70/700 = .10 = 10%
This means that Plant A's frequency of occurrence = 10% when considering the entire littoral zone.

Plant A is sampled at 70 out of 350 total points with vegetation = 70/350 = .20 = 20%
This means that Plant A's frequency of occurrence = 20% when only considering the sites in the littoral zone that have vegetation.

From these frequencies, we can estimate how common each species was at depths where plants could grow, and at points where plants actually were growing.
Note: the second value will be greater as not all the points (in this example, only ½) had plants growing at them.

Simpson's Diversity Index: A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's Diversity Index, the index value represents the probability that two individual plants (randomly selected) will be different species. The index values range from 0 - 1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be more resistant to invasion by exotic species.

<u>Maximum depth of plants:</u> This indicates the deepest point that vegetation was sampled. In clear lakes, plants may be found at depths of over 20 feet, while in stained or turbid locations, they may only be found in a few feet of water. While some species can tolerate very low light conditions, others are only found near the surface. In general, the diversity of the plant community decreases with increased depth.

<u>Mean and median depth of plants:</u> The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value.

<u>Number of sites sampled using rope/pole rake:</u> This indicates which rake type was used to take a sample. We use a 20 foot pole rake and a 35 foot rope rake for sampling.

<u>Average number of species per site:</u> This value is reported using four different considerations. 1) **shallower than maximum depth of plants** indicates the average number of plant species at all sites in the littoral zone.
2) **vegetative sites only** indicate the average number of plants at all sites where plants were found. 3) **native species shallower than maximum depth of plants** and 4) **native species at vegetative sites only** excludes exotic species from consideration.

<u>Species richness:</u> This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include those seen at a sample point during the survey but not found in the rake, and those that were only seen during the initial boat survey or inter-point. Note: Per WDNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.

<u>Average rake fullness:</u> This value is the average rake fullness of all species in the rake at all sites. It only takes into account those sites with vegetation.

<u>Relative frequency:</u> This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value gives us an idea of which species are most important within the macrophyte community.

Relative frequency example:

Suppose that we sample 100 points and found 5 species of plants with the following results:

Plant A was located at 70 sites. Its frequency of occurrence is thus 70/100 = 70%

Plant B was located at 50 sites. Its frequency of occurrence is thus 50/100 = 50%

Plant C was located at 20 sites. Its frequency of occurrence is thus 20/100 = 20%

Plant D was located at 10 sites. Its frequency of occurrence is thus 10/100 = 10%

To calculate an individual species' relative frequency, we divide the number of sites a plant is sampled at by the total number of times all plants were sampled. In our example that would be 150 samples (70+50+20+10).

Plant A = 70/150 = .4667 or 46.67%

Plant B = 50/150 = .3333 or 33.33%

Plant C = 20/150 = .1333 or 13.33%

Plant D = 10/150 = .0667 or 6.67%

This value tells us that 46.67% of all plants sampled were Plant A.

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point intercept survey**, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Namakagon Lake is in the Northern Lakes and Forests Ecoregion.

** Species that were only recorded as visuals or during the boat survey, and species found in the rake that are not included in the index are excluded from FQI analysis.

APPENDIX B. INVASIVE SPECIES INFORMATION

EURASIAN WATERMILFOIL (*MYRIOPHYLLUM SPICATUM*) [12]

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 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.

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

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 watermilfoil 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.

Because hybrid northern Eurasian watermilfoil has been introduced into Lake Namakagon, additional control methods should (and have been) considered including mechanical control, chemical control, and biological control. As always, prevention is the best approach to invasive species management.

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*)[13]

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; 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.

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

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*)[14]

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.

[14] http://dnr.wi.gov/topic/Invasives/fact/NarrowLeavedCattail.html. Photo by Robert Frechman.

YELLOW FLAG IRIS (*IRIS PSEUDACORUS*)

Yellow flag iris is a showy perennial plant that can grow in a range of conditions from drier upland sites, to wetlands, to floating aquatic mats. A native plant of Eurasia, it can be an invasive garden escapee in Wisconsin's natural environments.

ECOLOGICAL THREAT

- Yellow flag iris can produce many seeds that can float from the parent plant or plants can spread vegetatively via rhizome fragments. Once established it forms dense clumps or floating mats that can alter wildlife habitat and species diversity.
- All parts of this plant are poisonous, which results in lowered wildlife food sources in areas where it dominates.
- This species has the ability to escape water gardens and ponds and grow in undisturbed and natural environments. It can grow in wetlands, forests, bogs, swamps, marshes, lakes, streams, and ponds.
- Dense areas of this plant may alter hydrology by trapping sediment.

Yellow iris a proposed restricted plant 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

Yellow flag iris is easily identified by its appearance when flowering. The plant has broad, sword-shaped leaves which grow upright, tall and stiff. They are green with a slight blue-grey tint and are very difficult to distinguish from other ornamental or native iris species. Flowers are produced on a stem that can grow 3-4 feet tall amongst leaves that are usually as tall or taller.

The flowers are **s**howy and variable in color from almost white to a vibrant dark yellow. Flowers are between 3-4 inches wide and bloom from April to June.

CONTROL

Small populations may be successfully removed using physical methods. Care should be taken if hand-pulling plants, as some people show skin sensitivity to plant sap and tissues. All parts of the plant should be dug out – particularly rhizomes and disposed of in landfill or burned. Cutting the seed heads may help decrease spreading.

Aquatic formulas of herbicides may be used to control yellow flag iris, however, permits may be needed. Foliar spray, cut stem/leaf and application and hand swiping of herbicide have all shown effectiveness.

CHEQUAMEGON-NICOLET NATIONAL FOREST NON-NATIVE INVASIVE SPECIES LIST

Category A: Species of immediate concern, documented on the CNNF (or within proclamation boundary) and are currently invading native plant communities. A-list includes those WI DNR NR-40-listed plants that have been found on CNNF as of 2015. Control is warranted (for some species initiating control depends on location).

	Category A		Namekagon Vicinity?	NR-40 Class
1	Bishop's goutweed	*Aegopodium podagraria*	**Yes**	R*
2	Garlic mustard	*Alliaria petiolata*	**Yes**	R
3	Wild chervil	*Anthriscus sylvestris*		P (most of CNNF) R (Taylor Co.)
4	Japanese barberry	*Berberis thunbergii*	**Yes**	R*
5	Siberian pea	*Caragana arborescens*		R* w/ exceptions
6	Oriental bittersweet	*Celastrus orbiculata*		R
7	Spotted knapweed	*Centaurea biebersteinii*	**Yes**	R
8	Canada Thistle	*Cirsium arvense*	**Yes**	R
9	European Marsh thistle	*Cirsium palustre**		P/R
10	Bull Thistle	*Cirsium vulgare*	**Yes**	? (old noxious list)
11	Purple crown vetch	*Coronilla varia (Securigera varia)*		R*
12	Autumn olive	*Elaeagnus umbellata*		R
13	Cypress spurge	*Euphorbia cyparissias*		R
14	Leafy Spurge	*Euphorbia esula*		R
15	Japanese knotweed	*Fallopia japonica (Polygonum cuspidatum)*		R
16	Brittle-stem hemp-nettle	*Galeopsis tetrahit (added 2008)*	**Yes**	R
17	White bedstraw	*Galium mollugo*		R*
18	Dame's rocket	*Hesperis matronalis*		R
19	Pale yellow iris	*Iris pseudacorus*	**Yes**	R*
20	Field scabiosa	*Knautia arvensis*	**Yes**	R*
21	Asiatic honeysuckles	*Lonicera tatarica, L. morrowii and L. x bella*	**Yes**	R (all)
22	Creeping jenny	*Lysimachia nummularia*	**Yes**	R w/ exceptions
23	Purple Loosestrife	*Lythrum salicaria*	**Yes**	R
24	True forget-me-not	*Myosotis scorpioides*	**Yes**	R*

25	Woodland forget-me-not	*Myosotis sylvatica*	**Yes**	R*
26	Eurasian watermilfoil Hybrid	*Myriophyllum spicatum*	**Yes**	R
27	Wild parsnip	*Pastinaca sativa*	**Yes**	R
28	Reed canary grass	*Phalaris arundinacea*	**Yes**	N/A
29	Common Reed	*Phragmites australis*	**Yes**	R
30	Solidstem burnet saxifrage	*Pimpinella saxifraga*		R*
31	Curly Pondweed	*Potamogeton crispus*	**?**	R
32	Buckthorn, Common	*Rhamnus cathartica*	**Yes**	R
33	Buckthorn, Glossy	*Rhamnus frangula*	**Yes**	R
34	Rose acacia	*Robinia hispida*		R*
35	Black locust	*Robinia pseudoacacia*	**Yes**	R*
36	Common tansy	*Tanacetum vulgare (exceptions below)*	**Yes**	R
37	Japanese hedge-parsley	*Torilis japonica (see restricted list)*		P most of CNNF R Oconto & Langlade
38	Garden valerian	*Valeriana officinalis*		R*
39	Common mullein	*Verbascum thapsus*	**Yes**	N/A

Chapter NR-40 WI State Rule Adopted April 22, 2009 and updated May, 2015

* NR-40 update May 2015 http://dnr.wi.gov/invasives/classification/

***R= Restricted**: banned from transport, transfer (sale), and introduction; no control requirements*
***P=Prohibited**: banned from transport, transfer (sale), introduction, and possession. DNR may enter property with permission to inspect or control; may issue control orders and bill for same.*
Exceptions:
Caragana arborescens- except the cultivars Lorbergii, Pendula, and Walkerii
Cirsium palustre - restricted in: Ashland, Bayfield, Chippewa, Clark, Door, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Menominee, Oconto, Oneida, Price, Rusk, Sawyer, Shawano, Taylor, and Vilas counties. Prohibited elsewhere.
Tanacetum vulgare - except cultivars Aureum and Crispum
Torilis japonica – Prohibited in all counties of CNNF except Restricted in Oconto, Langlade

Category B Species known to be invasive and present within the forest; invasion in natural communities uncertain. Record and map all sites, monitor, control under certain circumstances such as high priority sites (see NNIS Strategy Chapter C). These species are not listed by WI DNR NR-40. This list will change as new species are discovered.

	Category B		Namekagon Vicinity?	NR 40 class
	Lesser Burdock	*Arctium minus* *(we added 2010)*	**Yes**	N/A
	Tuberous sweetpea	*Laythrus tuberosus*	**Yes**	N/A
	Common periwinkle	*Vinca minor*	**Yes**	N/A
	Sweetwilliam	*Dianthus barbatus*	**Yes**	N/A
	Orange Hawkweed	*Hieracium aurantiacum* *(added 2011)*	**Yes**	N/A
	Yellow Hawkweed	*Hieracium caespitosum* *(added 2011)*	**Yes**	N/A
	Common St. John's-wort	*Hypericum perforatum*	**Yes**	N/A
	Butter-and-eggs	*Linaria vulgaris*	**Yes**	N/A
	White Sweetclover	*Melilotus alba* *(added 2011)*	**Yes**	N/A
	Yellow sweetclover	*Melilotus officinalis* *(added 2010)*	**Yes**	N/A

Category C "Watch List" Species known to be ecologically invasive, but are not yet documented on the Forest. If found on the Forest they need to be documented and mapped. If detected they will likely be added to the "A List".

	Category C		*NR 40 Class*	*notes*
	Tree of Heaven	*Ailanthus altissima* *(added 2011)*	*R*	
	Porcelain berry	*Ampelopsis brevipedunculata*	*P*	
	Flowering Rush	*Butomus umbellatus*	*R*	
	Creeping bellflower	*Campanula rapunculoides*	*R**	
	Musk Thistle	*Carduus nutans* *(added 2011)*	*R*	*none recorded in TESP*
	Brownray knapweed	*Centaurea jacea*	*R**	*unsure if on CNNF*
	Black swallow-wort	*Cynanchum louiseae (syn. Vincetoxicum nigrum)*	*P (R So. WI)*	
	Pale Swallow-wort	*Cynanchum rossicum (syn. Vincetoxicum rossicum)*	*R*	
	Hound's-tongue	*Cynoglossum officinale* *(added 2011)*	*R*	*none recorded in TESP*
	Common Teasel	*<u>Dipsacus fullonum</u>*	*R*	
	Cut Leaved Teasel	*<u>Dipsacus laciniatus</u>*	*R*	
	Russian Olive	*Elaeagnus angustifolia* *(added 2011)*	*R*	
	Giant hogweed	*Heracleum mantegazzianum*	*P*	
	Japanese Hops	*Humulus japonicus*	*P CNNF area*	
	Dalmatian Toadflax	*Linaria dalmatica* *(added 2011)*		*none recorded in TESP*
	Japanese stiltgrass	*Microstegium vimineum*	*P*	
	Centaurea (others)	*other Centaurea on State NR-40 list*		
	Giant Knotweed	*Polygonum sachalinense* *(added 2011)*	*P*	

	White poplar	*Populus alba*	*R**	*none recorded in TESP*
	Multiflora Rose	*Rosa multiflora*	*R*	
	Narrow-leaved cattail	*Typha angustifolia* & *Typha x glauca*	*R*	*none recorded in TESP*
		Any other species known to be invasive in natural communities or listed per the 2015 WI NR-40 law		

Control Objectives: One or more may apply to each "A" list species.

- **Eradicate** - Species that are able to be eliminated by various methods; may take a long time.
- **Suppress** - There are small populations that are able to be eradicated but there may also be widespread populations that are large and beyond reasonable eradication methods. We will accept low levels of these weeds.
- **Contain** (confine) - We will prevent the spread of these species beyond the perimeter of certain areas. These species will be suppressed or eradicated in some areas but tolerated outside those areas.
- **Tolerate** - Accept the continued presence of established infestations and the probable spread to ecological limits for certain species. We will try to exclude new infestations through prevention practices.

APPENDIX C. 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[15]

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. Volunteers have hand pulled Hybrid EWM in Lake Namakagon.

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 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

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

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 Namakagon 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.[16]

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.[17] 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 33. TLA Hydraulic Conveyor System (Greedy)

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 Namakagon. A

[16] Wisconsin Lakes Convention Presentation. 2016.

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

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.[18]

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.

BIOLOGICAL CONTROL[19]

Biological control is the purposeful introduction of parasites, predators, and/or pathogenic microorganisms to reduce or suppress populations of plant or animal pests. Biological control counteracts the problems that occur when a species is introduced into a new region of the world without a complex 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

[18] TSB Lakefront Restoration Email Communication. January 2017.
[19] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005 except as otherwise noted.

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.[20]

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. Weevil biocontrol may be considered for Lake Namakagon in the future, especially if chemical treatment effectiveness is limited.

Purple Loosestrife Biocontrol[21]

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 Namakagon.

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 Namakagon because a healthy, diverse native plant population is present.

[20] *Euhrychiopsis lecontei* fact sheet. Cornell University Research Ponds Facility.
< http://www.eeb.cornell.edu/ponds/weevil.htm>
[21] http://dnr.wi.gov/topic/Invasives/loosestrife.html

PHYSICAL CONTROL[22]

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 Namakagon 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 Lake Namakagon does have ability to control water levels with a dam at the outlet, drawdown is not contemplated in this management plan.

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 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,

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

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 Namakagon.

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 Namakagon.

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.[23]

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.

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

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

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.[24] Chemicals commonly used in Wisconsin lakes are listed and described in Table 13 below.

Table 13. 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[25]

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 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.

[24] These descriptions are taken from Hoyer/Canfield: Aquatic Plant Management. North American Lake Management Society. 1997.
[25] Copper background information is from the Long Lake Management Plan prepared by the Polk County Land and Water Resources Department March 2013.

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.

<u>Early season herbicide treatment:</u>[26]

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 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.[27]

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

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

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.[28] 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. 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.

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

APPENDIX D. EARLY DETECTION AND RAPID RESPONSE TO AIS

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. Hybrid watermilfoil is currently present in Lake Namakagon. Shoreland invasive species present include purple loosestrife, forget-me-not, narrow-leaf cattail, and yellow iris. Point intercept surveys will be completed for Jackson and Garden Lakes in 2018. 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 HWM or other invasive species (NLA Board).

2. Conduct volunteer and professional monitoring (APM Monitor) at the public landings and other likely areas of AIS introduction. If a suspected plant 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 NLA 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 NLA Board.

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

   If a plant:

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

   If an animal:

   a. Be sure the suspected invasive species has not been previously found on the waterbody
   b. If a zebra mussel report to WDNR and Bayfield 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 Bayfield County and lake management consultant.
   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 (NLA Board).

7. Determine the extent of the AIS introduction (NLA in cooperation with Bayfield 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 (NLA 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.

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

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

EXHIBIT A[29]

NAMAKAGON LAKE ASSOCIATION

Board Contacts:	Jim DeRoma, jimd@dalyderoma.com
	Jim Krueger, bearptrd@cheqnet.net
	Greg Dehring
	Add PHONE NUMBERS

BAYFIELD COUNTY LAND AND WATER RESOURCES DEPARTMENT

AIS Coordinator	Andrew Teal: (715) 373-6167
	ATeal@bayfieldcounty.org

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Permits	Mark Sundeen: 715-635-4074
	sundem@dnr.state.wi.us
Grants, EWM Identification and Notice	Pamela Toshner: 715-635-4073
	Pamela.Toshner@Wisconsin.gov

APM MONITOR

Endangered Resource Services	Matt Berg: 715-483-2847
	saintcroixdfly@gmail.com

ADDITIONAL REFERENCES

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

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

29 This list is current as of 2018. Refer to the Namakagon Lake web site http://nlaonline.org/ for updated information.

APPENDIX E.

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APPENDIX F. IMPLEMENTATION CHARTS

GOAL 1. *PROTECT* THE NATURAL FUNCTIONS THAT DIVERSE NATIVE PLANTS PROVIDE BOTH IN THE WATER AND ON THE SHORE.

Actions[30]	Timeline	$ Estimate	Vol. Hours	Responsible Parties	Funding Sources[31]
Whole Lake Aquatic Plant Survey Garden Lake Jackson Lake	July 2018	 $3,975 $3,500	0	NLA Board APM Monitor	WDNR Grant: AIRR 21817
AIS Meander Survey	2018 (Annually)	$1,770	0	NLA Board APM Monitor	
Whole Lake Aquatic Plant Survey Lake Namakagon	2021	$?		NLA Board APM Monitor	AIS AEPP grant (apply 2020)
Update the Aquatic Plant Management Plan	2022	$4,000	40	NLA Board Plan Consultant	AIS AEPP grant (apply 2020)

30 See previous pages for action detail.
31 AEPP = Aquatic Education, Prevention, and Planning Aquatic Invasive Species Grant
NLA = Namakagon Lake Association

GOAL 2. *PREVENT* THE INTRODUCTION OF AQUATIC INVASIVE PLANTS AND ANIMALS.

Actions[32]	Timeline	$ Estimate	Vol. Hours	Responsible Parties	Funding Sources[33]
Clean Boats, Clean Waters – 3 public landings	May to September	$? (annually)	?	CBCW Lead Northland College	CBCW grant ($4,000 – apply by Dec 10 each year)
Landing monitoring cameras - 4 landings. Volunteers review the video from the cameras. Investigate landing camera				NLA Board Volunteer video review	NLA

32 See previous pages for action item detail.
33 AEPP = Aquatic Education, Prevention and Planning Aquatic Invasive Species Grant currently funded at 75% state share for 2012 and 2013.
ACEI = Aquatic Control Invasive Species Grant currently funded at 50% state share for 2012 to 2014.