Staples Lake Aquatic Plant Harvesting Plan

Barron and Polk County, WI

May 2016

Advisory Committee

Anthony Fehlen
Dan Fisher
Julie Fisher
Jim Gores
Ralph Kolstad
Adam Leavitt
Karen Lindholm
Jerald Scherer
Theresa Smiley
Karl Trusinksy

Advisors

Alex Smith, Wisconsin Department of Natural Resources
Jeremy Williamson, Polk County Land and Water Resources

Prepared by

Harmony Environmental

Staples Lake Aquatic Plant Harvesting Plan

WBIC: 2631200

Prepared to meet the requirements of NR 109.08

Contents

Figures

Tables

Appendices

Introduction

Staples Lake Protection and Rehabilitation District

The Lake District is located entirely in Barron County where parcels are riparian to the lake. There are 77 parcels in the district.

Plan Development Process and Local Government Involvement

An advisory committee guided the development of the plan. Local and state government representatives participated in planning meetings. The advisory committee met twice to develop the plan contents.

Public and WDNR Review

The aquatic plant management plan will be made available for public review on the Barron and Polk County websites. A hard copy of the plan will be made available at a location open to the public of the advisory committee's choosing.

Goals and Objectives for Aquatic Plant Management

The APM plan will guide aquatic plant management for harvesting for navigation impairment relief.

The Lake

Staples Lake is a 340 acre drainage lake that crosses the Polk County (town of Johnston) and Barron County (town of Crystal Lake) border. It is located about 6.5 miles southwest of the city of Cumberland. The lake is a shallow water lake with a maximum depth is 17 feet and a mean depth of 10 feet. The bottom is characterized by 45% sand, 20% gravel, 30% rock, and 5% muck. [1]

[1] WDNR Lakes Pages http://dnr.wi.gove/lakes/LakePages September 2015.

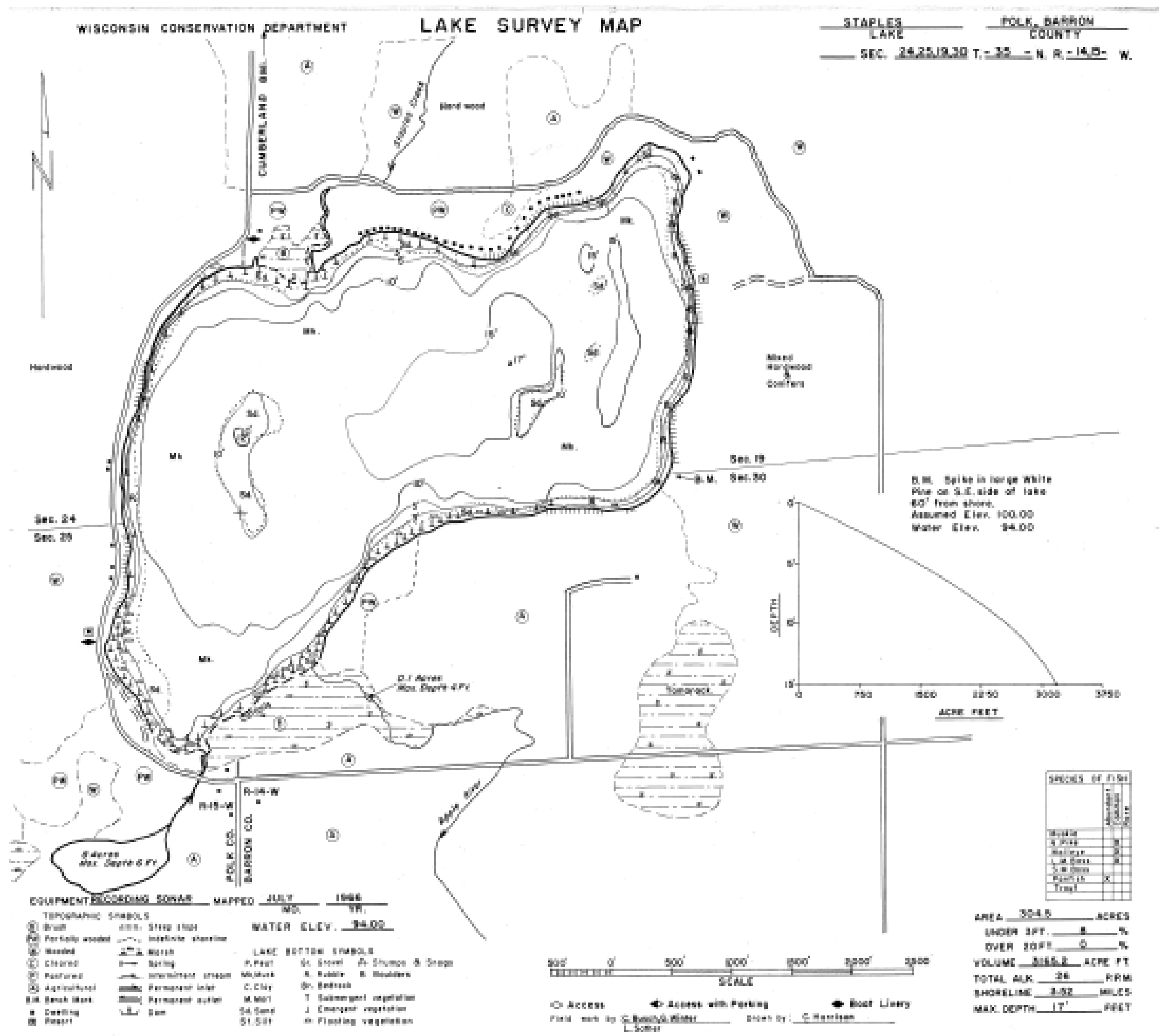


Figure 1. Staples Lake Topographic Map

The Watershed[2]

The map below shows the watershed or drainage area for Staples Lake. Land uses in the watershed influence the water quality of the lake.

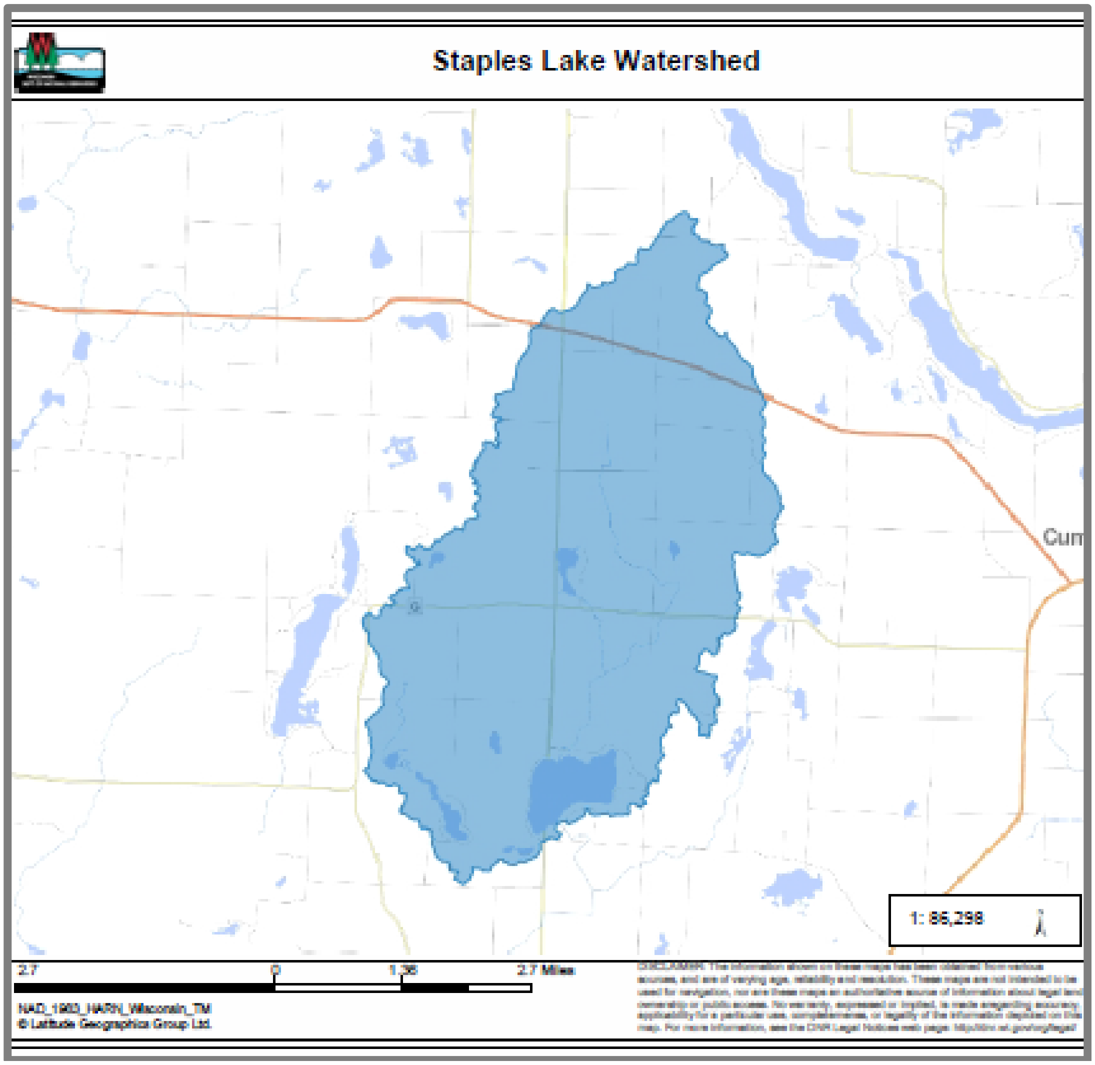


Figure 2. Staples Lake Watershed

Water Quality

Citizen volunteers have collected lake water clarity information since 2001 and water chemistry since 2013. The lake is eutrophic with low water clarity. The July/August mean secchi depth averaged only 2 feet from 2007 to 2015 with only slightly better measured clarity from 2003-2006 (3-4 feet) as shown in Figure 3. Average 2014 chlorophyll and total phosphorus were 62.7µg/L and 91.9µg/L, respectively. Algae blooms are common on Staples Lake. Blue green algae blooms were evident in 2015. These blooms present a risk for algae toxin production.

[2] http://www.dnr.wi.gov/water/purdue.asp

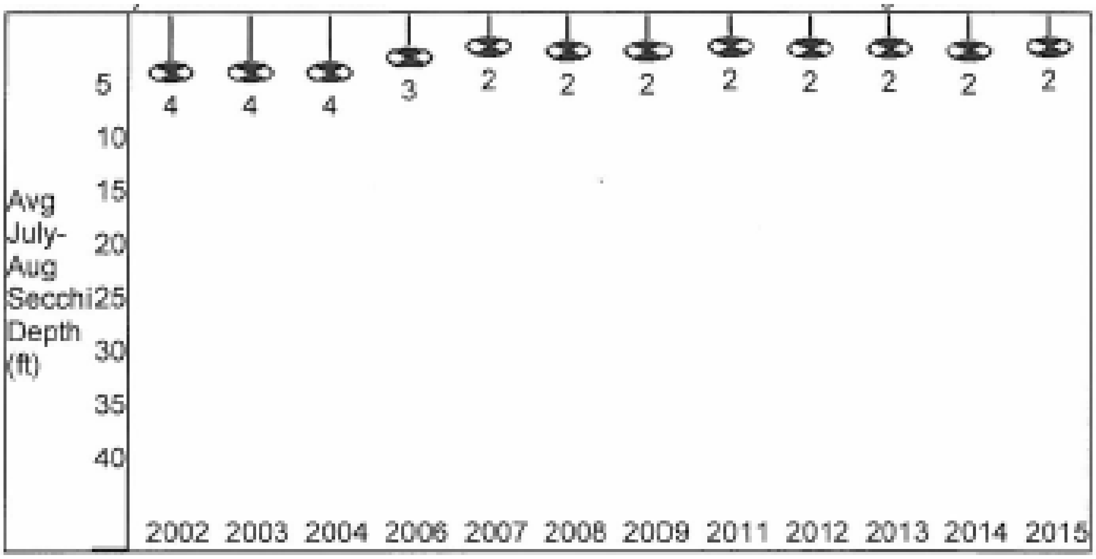


Figure 3. Staples Lake Average July and August Secchi Depth (2002-2015)

Figure 4. Algae Bloom Shown along Staples Lake Shoreline in 2015

While water quality problems are evident, coordinated water quality management efforts have not occurred since a cooperative Barron County/Staples Lake Protection & Rehabilitation District project in the early 1980s. At that time over $100,000 was invested in cost sharing to address agricultural sources of nonpoint source pollution in the watershed. The cost share rate was 80% provided by the state. [3]

WI Special Concern species Trumpeter Swan have been located in the Town of Johnston, and Blandings Turtle was found in both Johnston and Crystal Lake.

Staples Lake Fishery

Fish present include panfish, largemouth bass, northern pike, and walleye.[4] Wisconsin Department of Natural Resources fish survey reports are available from 1981, 1984, 1988 and 1993. Fisheries information below is from the 1993 report. Electrofishing and shocking data which records largemouth bass numbers and size is available from 2008.

A winter fish kill from low oxygen levels occurred in 1997. Recovery of the fishery was complete by 1993. Both walleye and largemouth bass were present in good numbers and had desirable size distributions. The walleye population appeared to be the product of a combination of stocking and natural reproduction. Continued walleye stocking was recommended at the rate of 50 fingerlings per acre on alternate years.

Staples Lake has the ability to produce large northern pike, although northern pike numbers were only moderate. Habitat conditions for largemouth bass were good, and a strong bass population was expected to be sustained through natural reproduction as long as winter dissolved oxygen levels are adequate.

The 1984, 1988, and 1993 reports included maps of northern and walleye spawning areas in the lake. Because natural reproduction can be significant in some years, it is very important that walleye spawning areas not be altered or degraded. The same is true with northern pike spawning areas.

Northern pike spawning areas are most relevant to this harvesting plan because northern spawn in emergent vegetation in 6-10 inches of water.[5] Current harvesting areas overlap northern spawning areas, however not to water that shallow (Figure 5).

The Lake District seasonally installs and supports the operation of an aerator to avoid winter fish kills in the lake. It was first installed late in 1998.[6]

---

[3] Letter and report from the Barron County Land Conservation Department. August 31, 1983.
[4] WDNR Lakes Pages.
[5] Fisheries spawning information provided by Heath Benike, DNR Fish Biologist. March 2006. Confirmed by Benike, December 2010.
[6] Letter to lake district residents October 25, 1998.

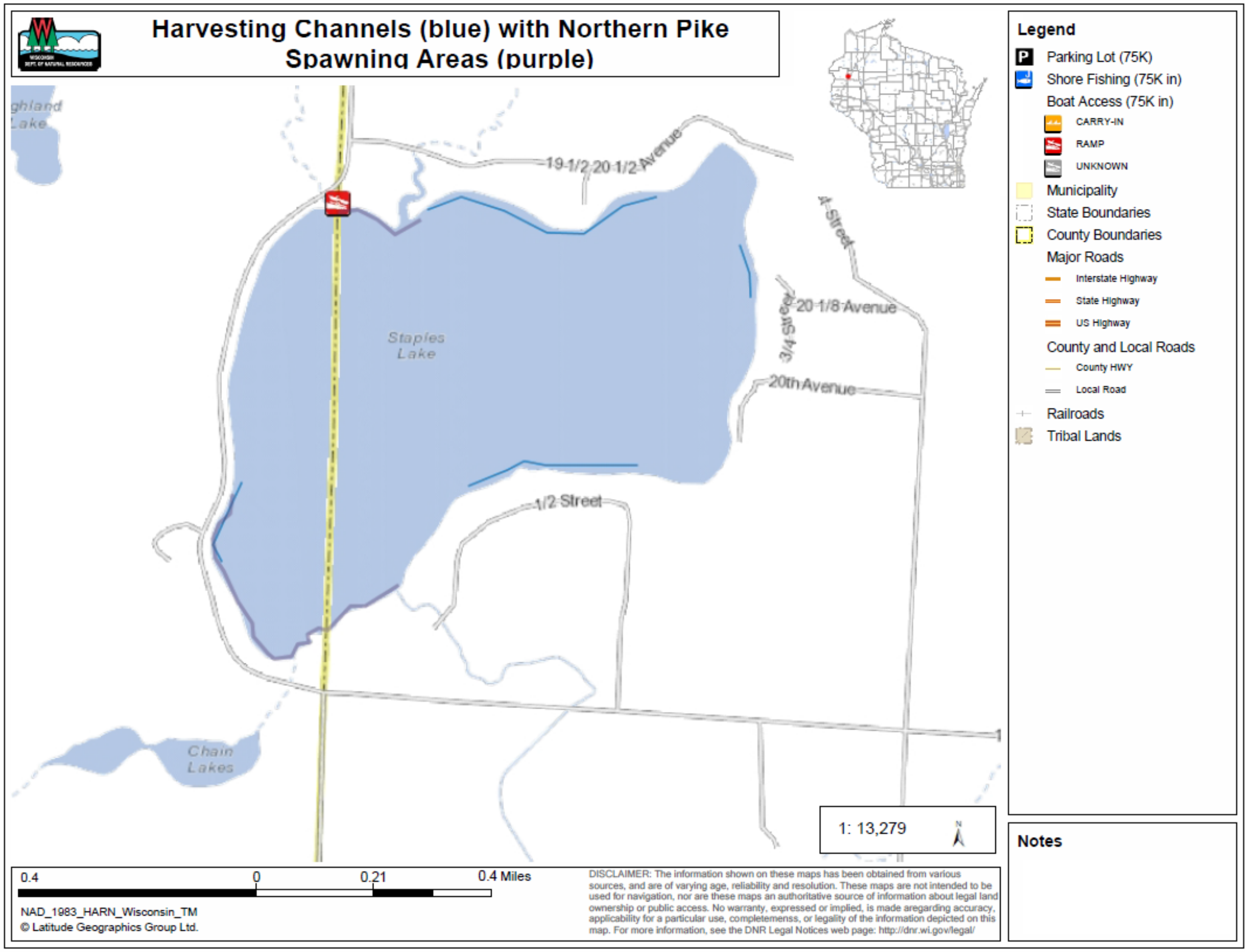


Figure 5. Staples Lake Harvesting Channels (blue) and Northern Spawning Areas (purple)

Functions and Values of Native Aquatic Plants

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

Water Quality

Aquatic plants can improve water quality by absorbing phosphorus, nitrogen, and other nutrients from the water that could otherwise fuel nuisance algal growth. Some plants can even filter and break down pollutants. Plant roots and underground stems help to prevent re-suspension of sediments from the lake bottom. Stands of emergent plants (whose stems protrude above the water surface) and floating plants help to blunt wave action and prevent erosion of the shoreline.

Fishing

Habitat created by aquatic plants provides food and shelter for both young and adult fish. Invertebrates living on or beneath plants are a primary food source for many species of fish. Other fish such as bluegills graze directly on the plants themselves. Plant beds in shallow water provide important spawning habitat for many fish species.

Waterfowl

Plants offer food, shelter, and nesting material for waterfowl. Birds eat both the invertebrates that live on plants and the plants themselves.[7]

Protection against Invasive Species

Non-native invasive species threaten native plants in Northern Wisconsin. The most common are Eurasian water milfoil (EWM) and curly leaf pondweed (CLP). These species are described as opportunistic invaders. This means that they take over openings 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.[8]

---

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

Intensity of Water Use

There are two public access points on the lake. The north end access is owned by Polk County (5 boat and trailer spaces). Another landing is located on the west shoreline with parking shared with the Buck Horn Bar. Public parking is allowed at the bar (8 boat and trailer spaces) and there is no charge. The Staples Lake Resort is a back lot to the bar and landing area. There is also public access along the road right of way along Barron Polk Street adjacent to the lake. A 40-acre WDNR parcel is found at the outflow along the Apple River.

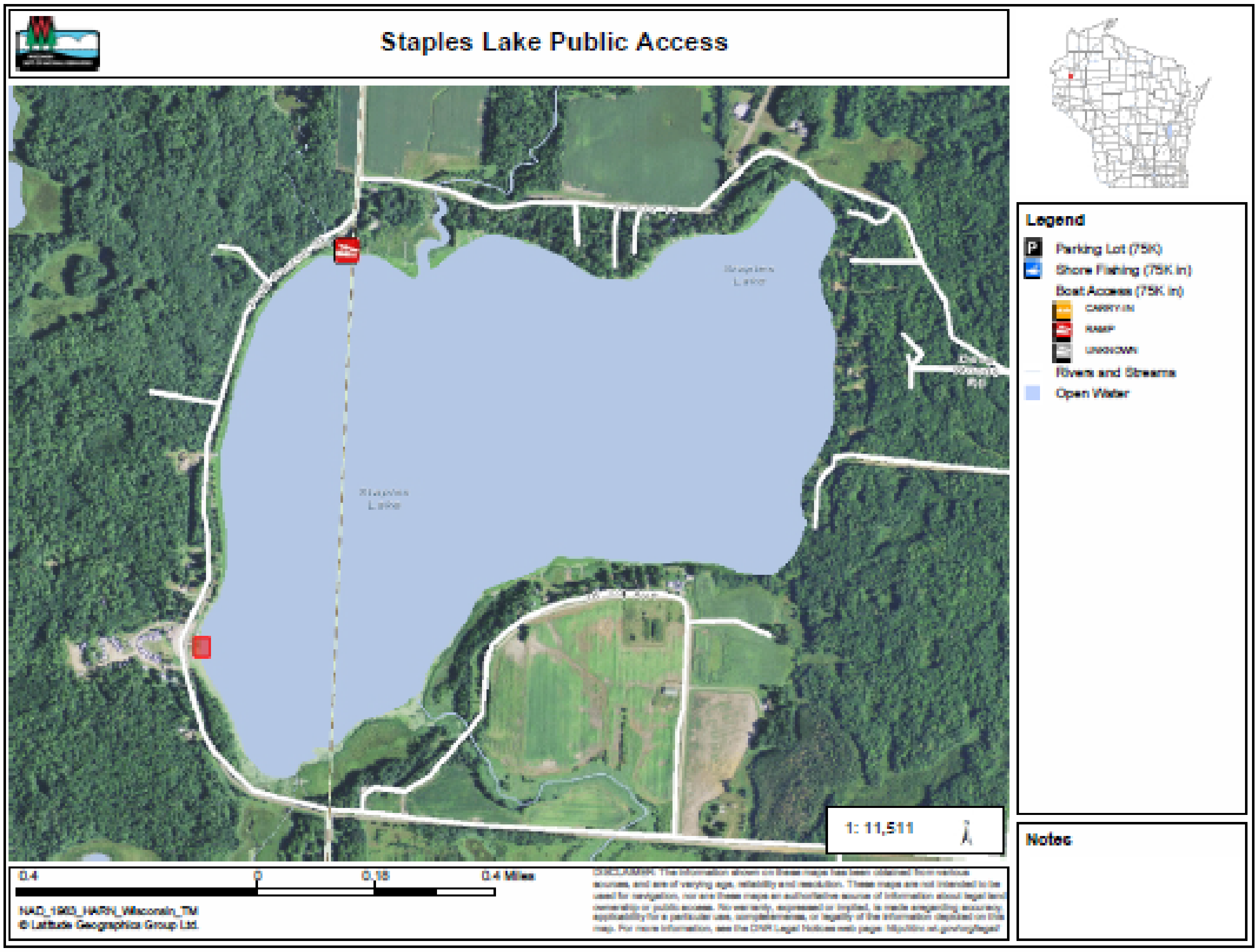
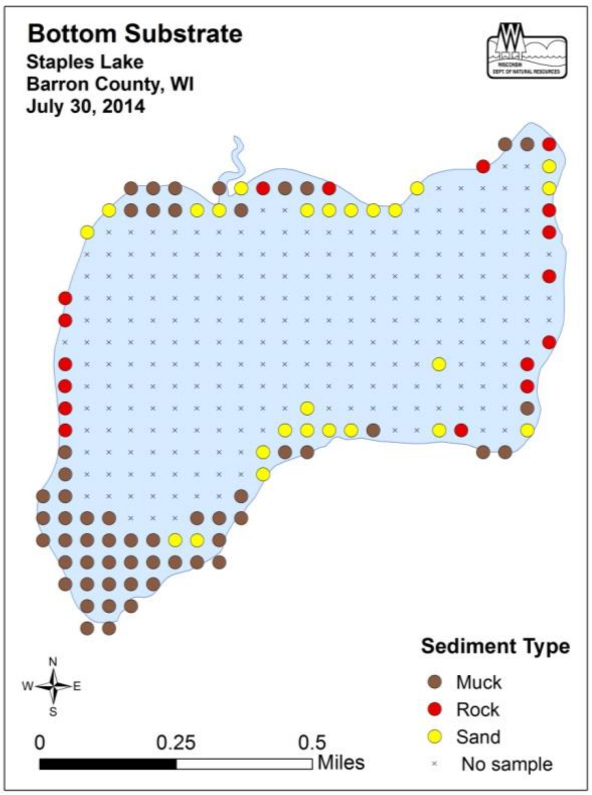


Figure 6. Staples Lake Public Access

Aquatic Plant Survey Results

The WDNR completed an aquatic plant point intercept survey of Staples Lake in 2014. Plant survey methods are found in Appendix A. Plants grew around the perimeter of the lake to a depth of 8 feet (this is the defined littoral zone). Most plants were concentrated in the southern tip of the lake where water is shallow and mucky substrates are dominant. Aquatic plants were found at 54 of the 81 sites within the littoral zone, a frequency of occurrence of 66.7% at sample points and 16.3% of the total lake bottom. This does not include visual sightings. The average depth where native plants were found was 4.1 feet. Lake sediment type and native species richness are shown in Figure 7 below.



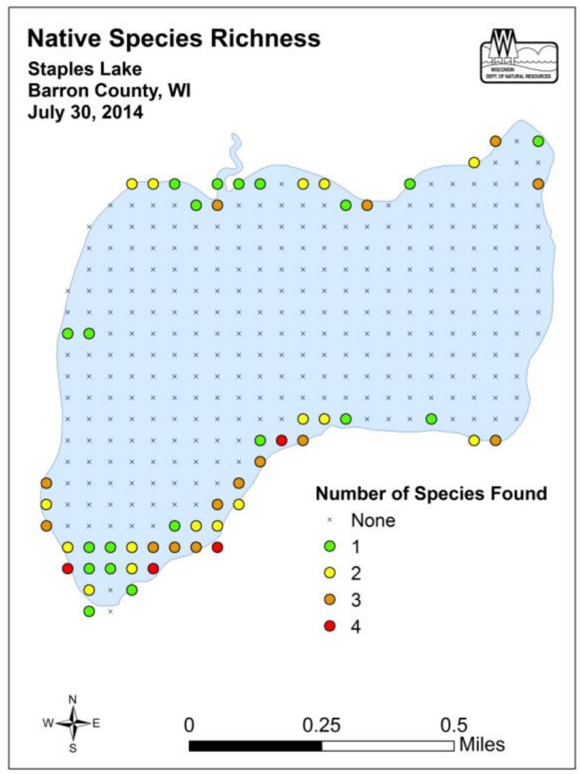


Figure 7. Bottom Substrate and Native Species Richness

A total of 13 native species were sampled along with the non-native curly leaf pondweed. With visually observed plants, there were 20 species on the lake. The FQI was 21.1, slightly above the ecoregion average of North Central Hardwood Forest value of 20.9.

Table 1. Summary Information for Staples Lake Point Intercept Survey

Total number of points sampled	106
Total number of sites with vegetation	54
Total number of sites shallower than maximum depth of plants	81
Frequency of occurrence at sites shallower than maximum depth of plants	66.7
Simpson Diversity Index	0.84
Maximum depth of plants (ft)	8.0
Number of sites sampled using rake on rope	0
Number of sites sampled using rake on pole	106
Average number of all species per site (shallower than max depth)	1.4
Average number of all species per site (veg. sites only)	2.1
Average number of native species per site (shallower than max depth)	1.4
Average number of native species per site (veg. sites only)	2.0
Species Richness	14
Species Richness including visuals	20

The Simpson's Diversity Index value was 0.84 meaning that two randomly sampled individuals were different species 84% of the time. The five species with the highest relative frequency were Common waterweed (*Elodea canadensis*) (28.9%), Coontail (*Ceratophyllum demersum*) (19.3%), White water lily (*Nymphaea odorata*) (12.3%), Wild celery (*Vallisneria americana*) (8.8%), and White-stem pondweed (*Potamogeton praelongus*) (7.0%) (Table 2).

Table 2. Aquatic Plant Species Information from July 2014 Survey

Species	Common Name	Relative Frequency (%)	Frequency in Vegetated Sites (%)	Frequency in Littoral Zone Sites (%)	Total Rake Samples	Mean Rake Fullness	Number of Visual Sightings
Elodea canadensis	Common waterweed	28.9	61.1	40.7	33	2.0	1
Ceratophyllum demersum	Coontail	19.3	40.7	27.2	22	1.7	4
Nymphaea odorata	White water lily	12.3	25.9	17.3	14	2.3	12
Vallisneria americana	Wild celery	8.8	18.5	12.3	10	1.8	2
Potamogeton praelongus	White-stem pondweed	7.0	14.8	9.9	8	1.4	2
Potamogeton richardsonii	Clasping-leaf pondweed	5.3	11.1	7.4	6	1.3	5
Potamogeton robbinsii	Fern pondweed	5.3	11.1	7.4	6	1.7	1
Nuphar variegata	Spatterdock	3.5	7.4	4.9	4	1.5	5
Potamogeton crispus	Curly-leaf pondweed	3.5	7.4	4.9	4	1.0	2
Pontederia cordata	Pickerelweed	1.8	3.7	2.5	2	3.0	6
Najas flexilis	Slender naiad	1.8	3.7	2.5	2	1.5	1
Lemna minor	Small duckweed	0.9	1.9	1.2	1	2.0	3
Lemna trisulca	Forked duckweed	0.9	1.9	1.2	1	1.0	
Potamogeton pusillus	Small pondweed	0.9	1.9	1.2	1	1.0	
Filamentous algae			31.5	21.0	17	1.8	
Sagittaria graminea	Grass-leaved arrowhead						7
Schoenoplectus tabernaemontani	Softstem bulrush						4
Typha latifolia	Broad-leaved cattail						3
Sparganium sp.	Bur-reed						2
Eleocharis acicularis	Needle spikerush						1
Schoenoplectus acutus	Hardstem bulrush						1

Aquatic Invasive Species

Curly leaf pondweed is known to be present in the lake, but prevention, monitoring, or control efforts for aquatic invasive species are not coordinated.

A CLP monitoring survey was completed on June 5, 2014 to document the abundance of CLP within Staples Lake. One-hundred sixteen sample points were surveyed (Table 3) (Figure 8). CLP was present at thirty-six (36) sites with an average rake fullness was 2. Dense CLP, with a rake fullness of 3, was only found at 4 sites. CLP was found at a maximum depth of 7.5 ft. The frequency of occurrence of CLP within the littoral zone was 48%.

Table 3. Summary Information for CLP Point Intercept Survey

Total number of points sampled	116
Total number of sites with vegetation	36
Total number of sites shallower than maximum depth of plants	75
Frequency of occurrence at sites shallower than maximum depth of plants	48
Maximum depth of plants (ft)	7.5
Mean rake fullness	2
Number of sites sampled using rake on rope	0
Number of sites sampled using rake on pole	338

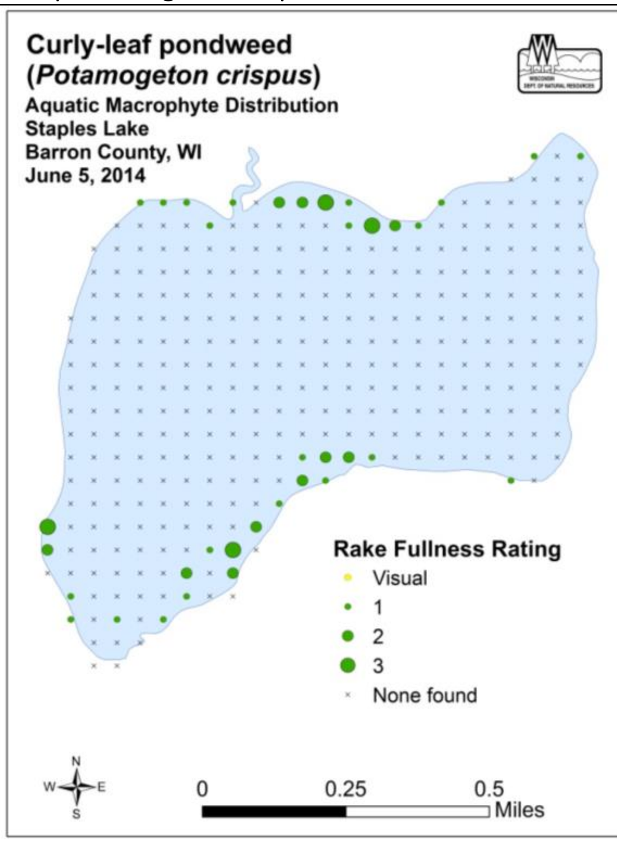


Figure 8. Curly-leaf Pondweed (*Potamogeton crispus*) Distribution

According to the WDNR report conclusions, at 2014 levels CLP doesn't appear to be causing direct negative impacts to either navigation or native aquatic plants. Future management may be necessary if CLP expands to the point of causing navigation or native aquatic plant impacts.

Banded and Chinese mystery snails are confirmed in the lake. Rusty crayfish are found in the Apple River downstream of the lake.

Figure 9. An Aquatic Plant Harvester

Aquatic Plant Management

The Lake District has owned and operated a harvester to alleviate navigation concerns at least since 1985.[9] However, there has been no aquatic plant management plan to guide harvesting efforts.

Past Aquatic Plant Management

At the 1985 Staples Lake annual meeting it was announced that the weed cutter was available to members in 4 hour increments. At the 1988 meeting, Clyde Tomczik reported that 300 cubic yards of weeds had been removed by early July. The machine carried 3 cubic yards and offloaded at 4 different places on the shore. Areas around docks were cut first followed by additional cutting along the shoreline. Some residents reported concerns with plant fragments along their shoreline, although cause was not clearly identified (boat traffic could have uprooted plants as well).

[9] Annual meeting minutes of the Staples Lake P&R District. June 1985.

Discussion of Management Methods

Permitting Requirements

The Department of Natural Resources regulates the removal of aquatic plants when chemicals are used, when plants are removed mechanically, and when plants are removed manually from an area greater than 30 feet in width along the shore.

The requirements for manual and mechanical plant removal are described in NR 109 – *Aquatic Plants: Introduction, Manual Removal & Mechanical Control Regulations*. A permit is required for manual and mechanical removal except for when a riparian (waterfront) landowner manually removes or gives permission to someone to manually remove plants, from his/her shoreline up to a 30-foot corridor. Wild rice may not be removed, even with hand methods. A riparian landowner may manually remove the invasive plants Eurasian water milfoil, curly leaf pondweed, and purple loosestrife along his or her shoreline without a permit. Manual removal refers to the control of aquatic plants by hand or hand–held devices without the use or aid of external or auxiliary power.[10]

The requirements for chemical plant removal are described in Administrative Rule NR 107 – *Aquatic Plant Management*. A permit is required for any aquatic chemical application in Wisconsin. Additional requirements exist when a lake is considered an ASNRI (Area of Special Natural Resource Interest) as designated by the Department of Natural Resources.

The Department of Natural Resources *Northern Region Aquatic Plant Management Strategy* (May 2007) requires documentation of impaired navigation or nuisance conditions before native plants may be managed with herbicides each time a permit is issued. Severe impairment or nuisance will generally mean that vegetation grows thickly and forms mats on the water surface. **This harvesting plan may not address all requirements for an aquatic plant management plan under NR107.**

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

Manual Removal[11]

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

---

[10] More information regarding DNR permit requirements and aquatic plant management contacts is found on the DNR web site: http://dnr.wi.gov/lakes/plants/

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

small areas of curly leaf pondweed growth. Raking is recommended if owners wish to clear nuisance growth in riparian area corridors up to 30 feet wide.

SCUBA divers may engage in manual removal for invasive species like Eurasian water milfoil. Care must be taken to ensure that all plant fragments are removed from the lake.

Mechanical Control

Larger-scale control efforts require more mechanization. Mechanical cutting, mechanical harvesting, diver-operated suction harvesting, and rotovating (tilling) are the most common forms of mechanical control available. WDNR permits under Chapter NR 109 are required for mechanical plant removal.

Aquatic plant harvesters are floating machines that cut and remove vegetation from the water. The cutter head uses sickles similar to those found on farm equipment, and generally cut to depths from 1 to 6 feet. A conveyor belt on the cutter head brings the clippings onboard the machine for storage. Once full, the harvester travels to shore to discharge the load of harvested plants off of the vessel.

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

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

Mechanical harvesting of aquatic plants presents both positive and negative consequences to any lake. Its results—open water and accessible boat lanes—are immediate, and can be enjoyed without the restrictions on lake use which follow herbicide treatments. In addition to the human use benefits, the clearing of thick aquatic plant beds may also increase the growth and survival of some fish. By eliminating the upper canopy, harvesting reduces the shading caused by aquatic 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 aquatic plants perform, including sediment stabilization and wave absorption. Shoreline erosion may therefore increase. Other organisms such as fish, reptiles, and insects are often displaced or removed from the lake in the harvesting process. This may have adverse effects on these organisms' populations as well as on the lake ecosystem as a whole.

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

Disposal sites are a key component when considering the mechanical harvesting of aquatic plants. The sites must be on shore and upland to make sure the plants and their reproductive structures 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 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. Curly leaf pondweed grows early in the year before native plants. However, because of various factors such as snow cover in winter and water temperature in the spring, growth varies considerably from year to year. Peak CLP growth tends to be from late May to sometime in June in northwest Wisconsin.

If the harvesting work is contracted, the equipment should be inspected before and after it enters the lake. Since these machines travel from lake to lake, they may carry plant fragments with them, facilitating the spread of aquatic invasive species from one body of water to another. Prevailing winds may also blow cut vegetation into open areas of the lake or along shorelines.

Harvesting is currently used to address navigation impairment on Staples Lake.

Diver dredging operations use pump systems to collect plant and root biomass. The pumps are mounted on a barge or pontoon boat. The 3 to 5 inch diameter dredge hoses are handled by one diver. The hoses normally extend about 50 feet in front of the vessel. Diver dredging is especially effective against the pioneering establishment of submersed invasive plant species. When a weed is discovered in a pioneering state, this methodology can be considered. To be effective, the entire plant, including the subsurface portions, should be removed.

Plant fragments can result from diver dredging, but fragmentation is not as great a problem when infestations are small. Diver dredging operations may need to be repeated more than once to be effective. When applied to a pioneering infestation, control can be complete. However, periodic inspections of the lake should be performed to ensure that all the plants have been found and collected.

Lake substrates play an important part in the effectiveness of a diver dredging operation. Soft substrates are very easy to work in. Divers can remove the plant and root crowns with little difficulty. Hard substrates, however, pose more of a problem. Divers may need hand tools to help dig the root crowns out of hardened sediment. Diver dredging could be considered as a rapid response control measure for Eurasian water milfoil if discovered in the lake.

Rotovation involves using large underwater rototillers to remove plant roots and other plant tissue. Rotovators can reach bottom sediments to depths of twenty feet. Rotovating may significantly affect non-target organisms and water quality as bottom sediments are disturbed. However, the suspended sediments and resulting turbidity produced by rotovation settles fairly rapidly once the tiller has passed. Tilling contaminated sediments could release toxins into the water column. If there is any potential of contaminated sediments in the area, further investigation should be performed to determine the potential impacts from this type of treatment. Tillers do not operate effectively in areas with many underwater obstructions such as trees and stumps. If operations are releasing large amounts of plant material, harvesting equipment should be on hand to collect this material and transport it to shore for disposal.

Biological Control[12]

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

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

Weevils[13] have potential for use as a biological control agent against Eurasian water milfoil. There are several documented "natural" declines of EWM infestations. In these cases, EWM was not eliminated, but its abundance was reduced enough so that it did not achieve dominance. These declines are attributed to an ample population of native milfoil weevils (*Euhrychiopsis lecontei*). Weevils feed on native milfoils but will shift preference over to EWM when it is present. Lakes where weevils can become an effective control measure have an abundance of native northern water milfoil and fairly extensive natural shoreline where the weevils can over winter. Any control strategy for EWM that would also harm native milfoil may hinder the ability of this natural bio-control agent. Lakes with large bluegill

[12] Information from APIS (Aquatic Plant Information System) U.S. Army Corps of Engineers. 2005.
[13] *Control of Eurasian Water Milfoil & Large-scale Aquatic Herbicide Use*. Wisconsin Department of Natural Resources. July 2006.

populations are not good candidates for weevils, because bluegills feed on the weevils. The presence and efficacy of stocking weevils in EWM lakes is being evaluated in Wisconsin lakes.

Purple Loosestrife Biocontrol[14]

Biocontrol may be the most viable long term control method for purple loosestrife control.

The DNR 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's 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 DNR 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 DNR and UWEX, to all state citizens who wish to use these insects to reduce 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 such factors 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 is recommended for large inaccessible patches of purple loosestrife growth.

There are advantages and disadvantages to the use of biological control as part of an overall aquatic plant management program. Advantages include longer-term control compared to other technologies, lower overall costs, and plant-specific control. On the other hand, there are several disadvantages to consider, including very long control times (years instead of weeks), a lack of available agents for particular target species, and relatively specific environmental conditions necessary for success. Biological control is not without risks; new non-native species introduced to control a pest population, may cause problems of its own.

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

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

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).

Physical Control[15]

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

Dredging removes accumulated bottom sediments that support plant growth. Dredging is usually not performed solely for aquatic plant management but to restore lakes that have been filled in with sediments, have excess nutrients, need deepening, or require removal of toxic substances (Peterson 1982). Lakes that are very shallow due to sedimentation tend to have excess plant growth. Dredging can form an area of the lake too deep for plants to grow, thus creating an area 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 Staples Lake as part of the aquatic plant management plan.

Drawdown, or significantly decreasing lake water levels, can be used to control nuisance plant populations. With drawdown, the water is removed to a given depth. It is best if this depth includes the entire depth range of the target species. Drawdowns need to be at least one month long to ensure thorough drying and effective removal of target plants (Cooke 1980a). In northern areas, a drawdown in the winter that will ensure freezing of sediments is also effective. Although drawdown may be effective for control of hydrilla for one to two years (Ludlow 1995), it is most commonly applied to Eurasian water milfoil (Geiger 1983; Siver et al. 1986) and other milfoils or submersed evergreen perennials (Tarver 1980). Drawdown requires a mechanism to lower water levels. Staples Lake does not have such a mechanism.

Although drawdown can be inexpensive and have long-term effects (2 or more years), it also has significant environmental effects and may interfere with use and intended function of the water body during the drawdown period. Lastly, species respond in very different manners to drawdown and responses can be inconsistent (Cooke 1980a). Drawdowns may provide an opportunity for the spread of highly weedy species, particularly annuals.

Benthic barriers, or other bottom-covering approaches, are another physical management technique. The basic idea is to cover the plants with a layer of a growth-inhibiting substance. Many materials have been used, including sheets or screens of organic, inorganic, and synthetic materials; sediments such as dredge sediment, sand, silt or clay; fly ash; and various combinations of the above materials (Cooke 1980b; Nichols 1974; Perkins 1984; Truelson 1984). The problem with synthetic sheeting is that the gases evolved from plant and sediment decomposition collect underneath and lift the barrier (Gunnison

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

and Barko 1992). The problem with using sediments is that new plants establish on top of the added layer (Engel and Nichols 1984).

Benthic barriers will typically kill the plants under them within 1 to 2 months, after which time they may be removed (Engel 1984). Sheet color is relatively unimportant; opaque (particularly black) barriers work best, but even clear plastic barriers will work effectively (Carter et al. 1994). Sites from which barriers are removed will be rapidly re-colonized (Eichler et al. 1995). Synthetic barriers, if left in place for multi-year control, will eventually become sediment-covered and will allow colonization by plants. Benthic barriers may be best suited to small, high-intensity use areas such as docks, boat launch areas, and swimming areas. However, they are too expensive to use over widespread areas, and heavily affect benthic communities by removing fish and invertebrate habitat. A WDNR permit would be required for a benthic barrier, and these barriers are not recommended.

Shading or light attenuation reduces the amount of light available for plant growth. Shading has been achieved by fertilization to produce algal growth; application of natural or synthetic dyes, shading fabric, or covers; and establishing shade trees (Dawson 1981, 1986; Dawson and Hallows 1983; Dawson and Kern-Hansen 1978; Jorga et al. 1982; Martin and Martin 1992; Nichols 1974). During natural or cultural eutrophication, algae growth alone can shade aquatic plants (Jones et al. 1983). Although light manipulation techniques may be useful for narrow streams or small ponds, in general, these techniques are of only limited applicability.

Physical control is not currently proposed for management of aquatic plants on Staples Lake.

Herbicide and Algaecide Treatments

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

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

General descriptions of herbicide classes are included below.[16]

Contact Herbicides

Contact herbicides act quickly and are generally lethal to all plant cells they contact. Because of this rapid action, or other physiological reasons, they do not move extensively within the plant and are effective only where they contact plants directly. They are generally more effective on annuals (plants that complete their life cycle in a single year). Perennial plants (plants that persist from year to year) can

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

be defoliated by contact herbicides, but they quickly resprout from unaffected plant parts. Submersed aquatic plants that are in contact with sufficient concentrations of the herbicide in the water for long enough periods of time are affected, but regrowth occurs from unaffected plant parts, especially plant parts that are protected beneath the sediment. Because the entire plant is not killed by contact herbicides, retreatment is necessary, sometimes two or three times per year. **Endothall, diquat,** and **copper** are contact aquatic herbicides.

Systemic Herbicides

Systemic herbicides are absorbed into the living portion of the plant and move within the plant. Different systemic herbicides are absorbed to varying degrees by different plant parts. Systemic herbicides that are absorbed by plant roots are referred to as soil active herbicides and those that are absorbed by leaves are referred to as foliar active herbicides. **2,4-D, dichlobenil, fluridone, and glyphosate** are systemic aquatic herbicides. When applied correctly, systemic herbicides act slowly in comparison to contact herbicides. They must move to their site of action within the plant. Systemic herbicides are generally more effective for controlling perennial and woody plants than contact herbicides. Systemic herbicides also generally have more selectivity than contact herbicides.

Broad Spectrum Herbicides

Broad spectrum (sometimes referred to as nonselective) herbicides are those that are used to control all or most species of vegetation. This type of herbicide is often used for total vegetation control in areas such as equipment yards and substations where bare ground is preferred. **Glyphosate** is an example of a broad spectrum aquatic herbicide. **Diquat, endothall, and fluridone** are used as broad spectrum aquatic herbicides, but can also be used selectively under certain circumstances.

Selective Herbicides

Selective herbicides are those that are used to control certain plants but not others. Herbicide selectivity is based upon the relative susceptibility or response of a plant to an herbicide. Many related physical and biological factors can contribute to a plant's susceptibility to an herbicide. Physical factors that contribute to selectivity include herbicide placement, formulation, timing, and rate of application. Biological factors that affect herbicide selectivity include physiological factors, morphological factors, and stage of plant growth.

Environmental Considerations

Aquatic communities consist of aquatic plants including macrophytes (large plants) and phytoplankton (free floating algae), invertebrate animals (such as insects and clams), fish, birds, and mammals (such as muskrats and otters). All of these organisms are interrelated in the community. Organisms in the community require a certain set of physical and chemical conditions to exist such as nutrient requirements, oxygen, light, and space. Aquatic plant control operations can affect one or more of the organisms in the community, and in turn, affect other organisms. These operations can also impact water chemistry which may result in further implications for aquatic organisms.

Aquatic Plant Management Implementation Strategy

Harvesting Goals

Allow navigation in common channels (where depths allow).

Limit removal of native aquatic plants to preserve the important lake functions they provide.

Harvester Operation

Permit applications: The board will complete and submit to WDNR. The harvesting map included with the 2016 application is included as Figure 9.

Harvesting locations/limits: Harvesting can occur only at depths = or >3 feet.

Harvesting requests:

Only channels included on permit application will be harvested.

Requests will be considered for subsequent year harvesting.

Operators:

Volunteer operators will be trained in plant identification and permit record keeping requirements. Record keeping requirements will include a daily record of:

- Date
- Amount harvested (volume estimates ok)
- Species harvested
- Location
- Hours spent harvesting

Plant disposal sites and reuse:

The board will identify potential sites. Site locations are subject to change.

Maintenance:

The Lake District is responsible for harvester and related equipment maintenance and insurance. Staples Lake harvesting equipment currently includes: a harvester with a 4 foot cutter, conveyor/trailer, dock, and tractor. Operation and maintenance costs include parts, labor (although sometimes completed by volunteers), gasoline, and winter storage rental. Recent operation and maintenance costs have been low because much of the maintenance has been completed by volunteers.

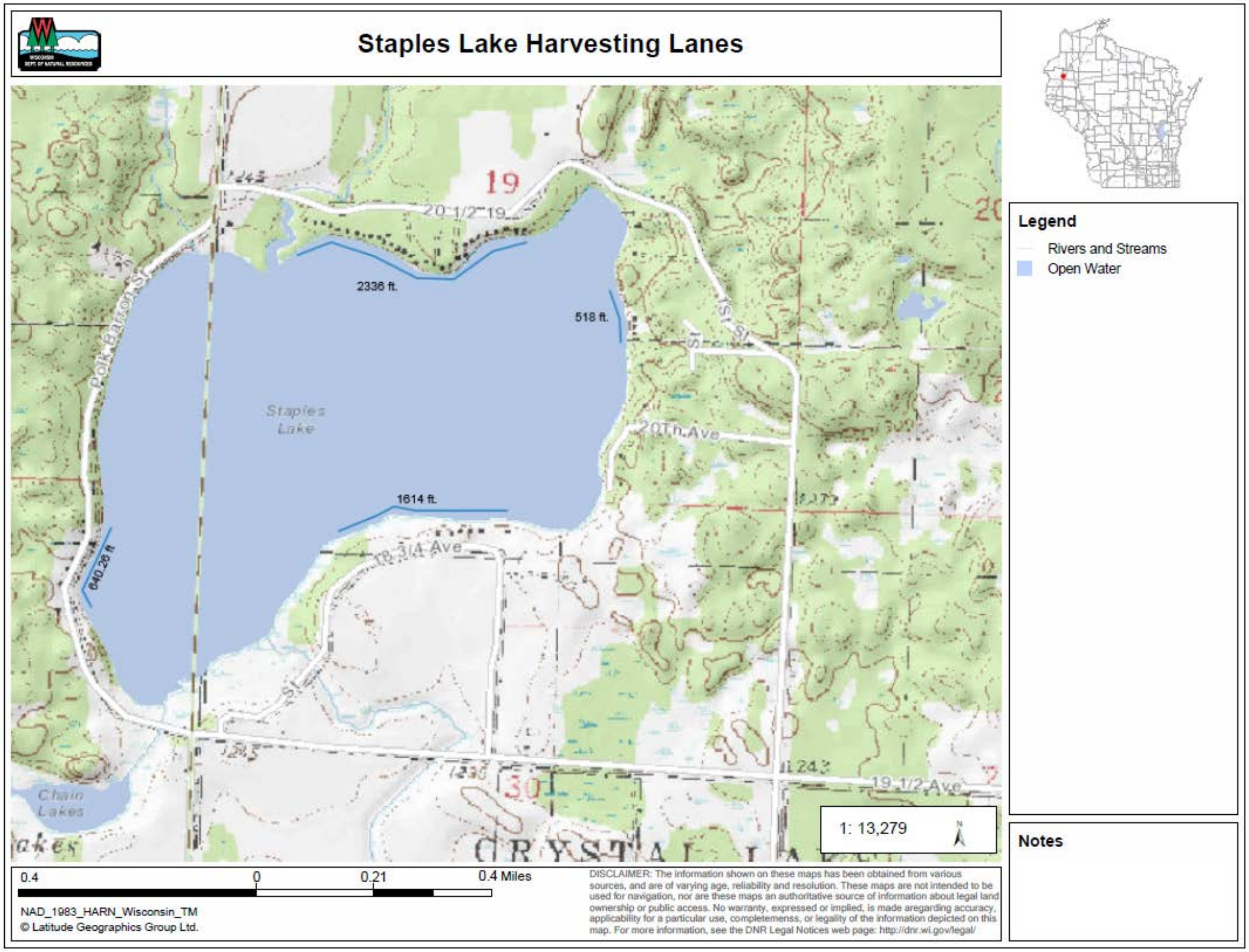


Figure 10. Staples Lake Potential Harvesting Areas 2016

Information and Education Goal

Property owners and harvester operators understand Staples Lake harvesting goals and follow guidelines for aquatic plant management.

For lake residents

Best methods to get information to them

- Plan summary
- Brochures
- Plan document – provide copies and link to Facebook page

Messages/information to share

- Importance of native plants, reasons for limits to harvesting
- Why was the plan needed?
- Lake district provides funding for harvesting from assessments, operators are volunteer
- A permit guides harvesting. Any changes need to be made for following year.
- Once permit is issued, it is good for one year
- Harvesting map
- Harvesting can occur only in areas 3 feet and deeper to establish common navigation channels
- Owners can remove aquatic vegetation using hand removal methods in an opening up to 30 feet wide (including the dock)

For harvester operators

Best methods to get information to them

- Plant identification sheets
- Log sheets
- WDNR permit oversight

Messages/information to share

- Native and invasive plant identification
- Permit requirements
    - Harvesting map
    - Harvesting can occur only in areas 3 feet and deeper to establish common navigation channels

Harvester capital costs

The Lake District purchased the current harvester around 2005. While harvester lifespan is expected to be 10 years, the previous harvester was operated for more than 20 years. Capital and operation and maintenance costs are financed by Lake District special assessment which is currently $75 per owner in the district year. (Others in Polk County are voluntary members.)

A small harvester with a 4 foot blade cost $75,000. Costs for additional equipment with the 4 foot unit are estimated to be $35,000.[17]

Harvester Plan Updates

A plan update will be required approximately every five years. A point intercept survey is a required part of the plan update. It is likely that this will need to be completed by a private consultant in future years. WDNR surface water grants can currently fund these surveys and plan updates.

Table 4. Harvesting Timeline

Task	Responsible Party	Month/Season	Year	Cost
Submit harvesting permit	Board	February	Annually	$90
Train operators	Board/Operators	April	Annually	
Distribute educational materials	Board	Ongoing	Ongoing	
Maintain harvesting equipment	Operators/Board	Ongoing	Ongoing	?
Complete point intercept survey	Board/Contractor	Summer	2020	$2,500 (? Get estimate)
Update harvesting plan	Board, Advisory Committee, and Consultant	Winter	2020/2021	$4,000 (? Get estimate)
Replace harvesting equipment	Board		2020 +	$30,000 - $100,000

[17] Aquarius Systems. March 2011.

References

Cornelius, Rick. *Fish Survey, Staples Lake (2631200), Barron County.* 1981, 1984, 1988, and 1993.

Environmental Resource Assessments. *Final Report on the Staples Lake Study. Barron County, WI. Part II.* 1979.

Smith, Alex, Mark Sundeen, and Rachel Preacher. *Staples Lake Aquatic Macrophyte Survey Report. June 5 & July 30, 2014.*

Appendix A. Plant Survey Methods

A grid of lake sampling points were generated using a standard formula that takes into account the estimated size of the littoral zone and the shape of the lake (Hauxwell et al., 2010). 338 sampling points were created using GIS and located in the field using GPS.

At each sampling point, several measurements were collected. A rake with a double rake head attached to a long pole was drug along the bottom for 2.5 feet in order to detach and bring up plants growing in the sediment. The rake was then brought to the surface and given a total fullness rating (1, 2, or 3) based on the amount of plant matter collected (Figure 1). Each species was also given a fullness rating based on the amount of that species collected on the rake. A voucher was collected for each species. Any plant seen within 6 feet of the boat was recorded as a "visual" on the data sheet. (For the June 5 CLP survey, only CLP amounts were recorded. No visual observations were recorded.)

Rake Fullness Rating	Description	Rake Coverage
1	There are not enough plants to entirely cover the length of the rake head in a single layer.	
2	There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines.	
3	The rake is completely covered and tines are not visible.	

Figure 1. Rake fullness ratings are based on the amount of plant matter collected at each sampling point (Hauxwell, et. al, 2010).

Lake depth was measured up to 12 feet using the plant rake, which has graduated 1 foot markings on the pole. Sediment was assigned a category of muck, rock, or sand. The plant rake was used to feel the bottom and distinguish the texture. (Depth and sediment data was collected during both surveys, but only the July 30th data was used in this report.)

Key statistics calculated from the plant occurrence data are described below:

- *Frequency of occurrence* – A percentage calculated to describe how frequently plants were found at sample points within the littoral zone (depths where plants grow in Staples Lake). Calculated by dividing the number of points where plants were found by the total number of points in the littoral zone.
- *Species richness* – Total number of species observed.
- *Relative frequency* - A percentage calculated by dividing the number of times a species was found by the number of total findings for all plants. The sum of the relative frequencies of all species is 100%.
- *Simpson's Index of Diversity* – Represents the probability that two randomly selected individuals will be different species. The closer the value is to 1, the more diverse the community, while 0 indicates that all plants sampled are the same species.
- *Floristic Quality Index* (*FQI*) – designed to evaluate the closeness of the flora in an area to that of undisturbed conditions (Nichols, 1999). The method uses previously assigned Coefficients of Conservatism (C) ranging from 0 to 10. The value is based on the species' tolerance for disturbance and its membership to a particular pre-settlement plant community type (UW-Stevens Point Freckmann Herbarium, 2012). A value of 0 indicated that the plant would not be found in an unaltered pre-settlement landscape whereas a value of 10 indicates the plant is only found in an undegraded natural community. Species' C values used to calculate FQI were determined by the Wisconsin State Herbarium (University of Wisconsin-Madison, 2001). Non-native plants are not assigned C values, and there are some native plants that have not been assigned a C value. To calculate FQI, multiply mean C by the square root of the total number of native species inventoried on the site (UW-Stevens Point Freckmann Herbarium, 2012).

Statistics are based on rake findings and do not include visual observations unless otherwise noted. Statistics also do not include aquatic moss, freshwater sponges, filamentous algae, or liverworts.

Appendix B. Management Options for Aquatic Plants

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
No Management	N	Do not actively manage plants	Minimizing disturbance can protect native species that provide habitat for aquatic fauna; protecting natives may limit spread of invasive species; aquatic plants reduce shoreline erosion and may improve water clarity	May allow small population of invasive plants to become larger, more difficult to control later
			No immediate financial cost	Excessive plant growth can hamper navigation and recreational lake use
			No system disturbance	May require modification of lake users' behavior and perception
			No unintended effects of chemicals	
			Permit not required	
Mechanical Control	May be required under NR 109	Plants reduced by mechanical means	Flexible control	Must be repeated, often more than once per season
		Wide range of techniques, from manual to highly mechanized	Can balance habitat and recreational needs	Can suspend sediments and increase turbidity and nutrient release
a. Handpulling/Manual raking	Y/N	SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake	Little to no damage done to lake or to native plant species	Very labor intensive
		Works best in soft sediments	Can be highly selective	Needs to be carefully monitored
			Can be done by shoreline property owners without permits within an area <30 ft wide OR where selectively removing exotics	Roots, runners, and even fragments of some species, particularly Eurasian watermilfoil (EWM) will start new plants, so all of plant must be removed
			Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species	Small-scale control only

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
b. Harvesting	Y	Plants are "mowed" at depths of 2-5 ft, collected with a conveyor and off-loaded onto shore	Immediate results	Not selective in species removed
		Harvest invasives only if invasive is already present throughout the lake	EWM removed before it has the opportunity to autofragment, which may create more fragments than created by harvesting	Fragments of vegetation can re-root
			Minimal impact to lake ecology	Can remove some small fish and reptiles from lake
			Harvested lanes through dense weed beds can increase growth and survival of some fish	Initial cost of harvester expensive
			Can remove some nutrients from lake	
Biological Control	Y	Living organisms (e.g. insects or fungi) eat or infect plants	Self-sustaining; organism will over-winter, resume eating its host the next year	Effectiveness will vary as control agent's population fluctates
			Lowers density of problem plant to allow growth of natives	Provides moderate control - complete control unlikely
				Control response may be slow
				Must have enough control agent to be effective
a. Weevils on EWM	Y	Native weevil prefers EWM to other native water-milfoil	Native to Wisconsin: weevil cannot "escape" and become a problem	Need to stock large numbers, even if some already present
			Selective control of target species	Need good habitat for overwintering on shore (leaf litter) associated with undeveloped shorelines
			Longer-term control with limited management	Bluegill populations decrease densities through predation

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
b.	Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortalitiy	May be species specific	Largely experimental; effectiveness and longevity unknown
				May provide long-term control	Possible side effects not understood
				Few dangers to humans or animals	
c.	Allelopathy	Y	Aquatic plants release chemical compounds that inhibit other plants from growing	May provide long-term, maintenance-free control	Initial transplanting slow and labor-intensive
				Spikerushes (*Eleocharis* spp.) appear to inhibit Eurasian watermilfoil growth	Spikerushes native to WI, and have not effectively limited EWM growth
					Wave action along shore makes it difficult to establish plants; plants will not grow in deep or turbid water
d.	Planting native plants	Y	Diverse native plant community established to repel invasive species	Native plants provide food and habitat for aquatic fauna	Initial transplanting slow and labor-intensive
				Diverse native community may be "resistant" to invasive species	Nuisance invasive plants may outcompete plantings
				Supplements removal techniques	Largely experimental; few well-documented cases
					If transplants from external sources (another lake or nursury), may include additional invasive species or "hitchhikers"

Management Options for Aquatic Plants

Draft updated Oct 2006

Option	Permit Needed?	How it Works	PROS	CONS
Physical Control	Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a. Fabrics/ Bottom Barriers	Y	Prevents light from getting to lake bottom	Reduces turbidity in soft-substrate areas	Eliminates all plants, including native plants important for a healthy lake ecosystem
			Useful for small areas	May inhibit spawning by some fish
				Need maintenance or will become covered in sediment and ineffective
				Gas accumulation under blankets can cause them to dislodge from the bottom
				Affects benthic invertebrates
				Anaerobic environment forms that can release excessive nutrients from sediment
b. Drawdown	Y, May require Environmental Assessment	Lake water lowered with siphon or water level control device; plants killed when sediment dries, compacts or freezes	Winter drawdown can be effective at restoration, provided drying and freezing occur. Sediment compaction is possible over winter	Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling
		Season or duration of drawdown can change effects	Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction	May impact attached wetlands and shallow wells near shore
			Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality	Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced
			Success demonstrated for reducing EWM, variable success for curly-leaf pondweed (CLP)	Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning
			Restores natural water fluctuation important for all aquatic ecosystems	Winter drawdawn must start in early fall or will kill hibernating reptiles and amphibians
				Navigation and use of lake is limited during drawdown

Management Options for Aquatic Plants

Draft updated Oct 2006

	Option	Permit Needed?	How it Works	PROS	CONS
c.	Dredging	Y	Plants are removed along with sediment	Increases water depth	Severe impact on lake ecosystem
			Most effective when soft sediments overlay harder substrate	Removes nutrient rich sediments	Increases turbidity and releases nutrients
			For extremely impacted systems	Removes soft bottom sediments that may have high oxygen demand	Exposed sediments may be recolonized by invasive species
			Extensive planning required		Sediment testing may be necessary
					Removes benthic organisms
					Dredged materials must be disposed of
d.	Dyes	Y	Colors water, reducing light and reducing plant and algal growth	Impairs plant growth without increasing turbidity	Appropriate for very small water bodies
				Usually non-toxic, degrades naturally over a few weeks	Should not be used in pond or lake with outflow
					Impairs aesthetics
					Effects to microscopic organisms unknown
e.	Non-point source nutrient control	N	Runoff of nutrients from the watershed are reduced (e.g. by controlling construction erosion or reducing fertilizer use) thereby providing fewer nutrients available for plant growth	Attempts to correct source of problem, not treat symptoms	Results can take years to be evident due to internal recycling of already-present lake nutrients
				Could improve water clarity and reduce occurrences of algal blooms	Requires landowner cooperation and regulation
				Native plants may be able to better compete with invasive species in low-nutrient conditions	Improved water clarity may increase plant growth

Management Options for Aquatic Plants

Draft updated Oct 2006

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

Management Options for Aquatic Plants

Draft updated Oct 2006

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

Management Options for Aquatic Plants

Draft updated Oct 2006

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

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

Appendix C. Aquatic Invasive Species Information

Curly Leaf Pondweed

Curly leaf pondweed is specifically designated as an invasive aquatic plant (along with Eurasian water milfoil and purple loosestrife) to be the focus of a statewide program to control invasive species in Wisconsin. Invasive species are defined as a "non-indigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health (23.22(c)."

The Wisconsin Comprehensive Management Plan for Aquatic Invasive Species describes curly leaf pondweed impacts as follows:

> It is widely distributed throughout Wisconsin lakes, but the actual number of waters infested is not known. Curly-leaf pondweed is native to northern Europe and Asia where it is especially well adapted to surviving in low temperature waters. It can actively grow under the ice while most plants are dormant, giving it a competitive advantage over native aquatic plant species. By June, curly-leaf pondweed can form dense surface mats that interfere with aquatic recreation. By mid-summer, when other aquatic plants are just reaching their peak growth for the year, it dies off. Curly-leaf pondweed provides habitat for fish and invertebrates in the winter and spring when most other plants are reduced to rhizomes and buds, but the mid-summer decay creates a sudden loss of habitat. The die-off of curly-leaf pondweed also releases a surge of nutrients into the water column that can trigger algal blooms and create turbid water conditions. In lakes where curly-leaf pondweed is the dominant plant, the summer die-off can lead to habitat disturbance and degraded water quality. In other waters where there is a diversity of aquatic plants, the breakdown of curly-leaf may not cause a problem.[18]

The state of Minnesota DNR web site explains that curly leaf pondweed often causes problems due to excessive growth. At the same time, the plant provides some cover for fish, and some waterfowl species feed on the seeds and winter buds.[19]

---

[18] *Wisconsin's Comprehensive Management Plan to Prevent Further Introductions and Control Existing Populations of Aquatic Invasive Species*. Prepared by Wisconsin DNR. September 2003.
[19] Information from Minnesota DNR (www.dnr.state.mn.us/aquatic_plants)

The following description is taken from a Great Lakes Indian Fish and Wildlife Commission handout.

Curly Leaf Pondweed (Potamogeton crispus)[20]

Identification

Curly leaf pondweed is an invasive aquatic species found in a variety of aquatic habitats, including permanently flooded ditches and pools, rivers, ponds, inland lakes, and even the Great Lakes. Curly leaf pondweed prefers alkaline or high nutrient waters one to three meters deep. Its leaves are strap-shaped with rounded tips and undulating and finely toothed edges. Leaves are not modified for floating, and are generally alternate on the stem. Stems are somewhat flattened and grow to as long as two meters. The stems are dark reddish-green to reddish-brown, with the mid-vein typically tinged with red. Curly leaf pondweed is native to Eurasia, Africa, and Australia and is now spread throughout most of the United States and southern Canada.

Characteristics

New plants typically establish in the fall from freed turions (branch tips). The winter form is short, with narrow, flat, relatively limp, bluish-green leaves. This winter form can grow beneath the ice and is highly shade-tolerant. Rapid growth begins with warming water temperatures in early spring – well ahead of native aquatic plants.

Reproduction and Dispersal

Curly leaf pondweed reproduces primarily vegetatively. Numerous turions are produced in the spring. These turions consist of modified, hardened, thorny leaf bases interspersed with a few to several dormant buds. The turions are typically 1.0 to1.7 cm long and 0.8 to 1.4 cm in diameter. Turions separate from the plant by midsummer and may be carried in the water column supported by several leaves. Humans and waterfowl may also disperse turions. Stimulated by cooler water temperatures, turions germinate in the fall, over-wintering as a small plant. The next summer plants mature producing reproductive tips of their own. Curly leaf pondweed rarely produces flowers.

Ecological Impacts

Rapid early season growth may form large, dense patches at the surface. This canopy overtops most native aquatic plants, shading them and significantly slowing their growth. The canopy lowers water temperature and restricts absorption of atmospheric oxygen into the water. The dense canopy formed often interferes with recreational activities such as swimming and boating.

In late spring, curly leaf pondweed dies back, releasing nutrients that may lead to algae blooms. Resulting high oxygen demand caused by decaying vegetation can adversely affect fish populations. The foliage of curly leaf pondweed is relatively high in alkaloid compounds possibly making it unpalatable to insects and other herbivores.

---

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

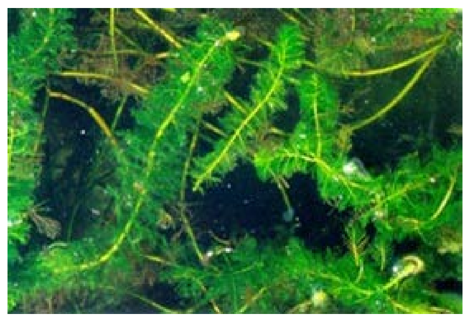
Control

Small populations of curly leaf pondweed in otherwise un-infested water bodies should be attacked aggressively. Hand pulling, suction dredging, or spot treatments with contact herbicides are recommended. Cutting should be avoided because fragmentation of plants may encourage their re-establishment. In all cases, care should be taken to remove all roots and plant fragments, to keep them from re-establishing.

Control of large populations requires a long-term commitment that may not be successful. A prudent strategy includes a multi-year effort aimed at killing the plant before it produces turions, thereby depleting the seed bank over time. It is also important to maintain, and perhaps augment, native populations to retard the spread of curly leaf and other invasive plants. Invasive plants may aggressively infest disturbed areas of the lake, such as those where native plant nuisances have been controlled through chemical applications.

Eurasian Water Milfoil (Myriophyllum spicatum)

Introduction



Eurasian water milfoil is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts, and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, Eurasian water milfoil is nearly impossible to distinguish from northern water milfoil. Eurasian water milfoil has 9-21 pairs of leaflets per leaf, while northern milfoil typically has 7-11 pairs of leaflets. Coontail is often mistaken for the milfoils, but does not have individual leaflets.

Distribution and Habitat

Eurasian milfoil first arrived in Wisconsin in the 1960s. During the 1980s, it began to move from several counties in southern Wisconsin to lakes and waterways in the northern half of the state. As of 1993, Eurasian milfoil was common in 39 Wisconsin counties (54%) and at least 75 of its lakes, including shallow bays in Lakes Michigan and Superior and Mississippi River pools.

Eurasian water milfoil grows best in fertile, fine-textured, inorganic sediments. In less productive lakes, it is restricted to areas of nutrient-rich sediments. It has a history of becoming dominant in eutrophic, nutrient-rich lakes, although this pattern is not universal. It is an opportunistic species that prefers highly disturbed lake beds, lakes receiving nitrogen and phosphorous-laden runoff, and heavily used lakes. Optimal growth occurs in alkaline systems with a high concentration of dissolved inorganic carbon. High water temperatures promote multiple periods of flowering and fragmentation.

Life History and Effects of Invasion

Unlike many other plants, Eurasian water milfoil does not rely on seed for reproduction. Its seeds germinate poorly under natural conditions. It reproduces vegetatively by fragmentation, allowing it to disperse over long distances. The plant produces fragments after fruiting once or twice during the summer. These shoots may then be carried downstream by water currents or inadvertently picked up by boaters. Milfoil is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist.

Once established in an aquatic community, milfoil reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, Eurasian water milfoil is adapted for rapid growth early in spring. Stolons, lower stems, and roots persist over winter and store the carbohydrates that help milfoil claim the water column early in spring, photosynthesize, divide, and form a dense leaf canopy that shades out native aquatic plants. Its ability to spread rapidly by fragmentation and effectively block out sunlight needed for native plant growth often results in monotypic stands. Monotypic stands of Eurasian milfoil provide only a single habitat, and threaten the integrity of aquatic communities in a number of ways; for example, dense stands disrupt predator-prey relationships by fencing out larger fish, and reducing the number of nutrient-rich native plants available for waterfowl.

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. [21]

Eurasian water milfoil is likely to become established especially in areas where northern water milfoil grows. Northern water milfoil was not found during the 2014 plant survey. However, that does not mean that Eurasian water milfoil cannot become established.

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

Reed Canary Grass (Phalaris arundinacea)

Description

Reed canary grass is a large, coarse grass that reaches 2 to 9 feet in height. It has an erect, hairless stem with gradually tapering leaf blades 3 1/2 to 10 inches long and 1/4 to 3/4 inch in width. Blades are flat and have a rough texture on both surfaces. The lead ligule is membranous and long. The compact panicles are erect or slightly spreading (depending on the plant's reproductive stage), and range from 3 to 16 inches long with branches 2 to 12 inches in length. Single flowers occur in dense clusters in May to mid-June. They are green to purple at first and change to beige over time. This grass is one of the first to sprout in spring, and forms a thick rhizome system that dominates the subsurface soil. Seeds are shiny brown in color.

Both Eurasian and native ecotypes of reed canary grass are thought to exist in the U.S. The Eurasian variety is considered more aggressive, but no reliable method exists to tell the ecotypes apart. It is believed that the vast majority of our reed canary grass is derived from the Eurasian ecotype. Agricultural cultivars of the grass are widely planted.

Reed canary grass also resembles non-native orchard grass (*Dactylis glomerata*) but can be distinguished by its wider blades, narrower, more pointed inflorescence, and the lack of hairs on glumes and lemmas (the spikelet scales). Additionally, bluejoint grass (*Calamagrostis canadensis*) may be mistaken for reed canary in areas where orchard grass is rare, especially in the spring. The highly transparent ligule on reed canary grass is helpful in distinguishing it from the others. Ensure positive identification before attempting control. The ligule is a transparent membrane found at the intersection of the leaf stem and leaf.

Distribution and Habitat

Reed canary grass is a cool-season, sod-forming, perennial wetland grass native to temperate regions of Europe, Asia, and North America. The Eurasian ecotype has been selected for its vigor and has been planted throughout the U.S. since the 1800s for forage and erosion control. It has become naturalized in much of the northern half of the U.S. and is still being planted on steep slopes and banks of ponds and created wetlands.

Reed canary grass can grow on dry soils in upland habitats and in the partial shade of oak woodlands, but does best on fertile, moist organic soils in full sun. This species can invade most types of wetlands, including marshes, wet prairies, sedge meadows, fens, stream banks, and seasonally wet areas; it also grows in disturbed areas.

Life History and Effects of Invasion

Reed canary grass reproduces by seed or creeping rhizomes. It spreads aggressively. The plant produces leaves and flower stalks for 5 to 7 weeks after germination in early spring, then spreads laterally. Growth peaks in mid-June and declines in mid-July. A second growth spurt occurs in the fall. The shoots collapse in mid to late summer, forming a dense, impenetrable mat of stems and leaves. The seeds ripen in late June and shatter when ripe. Seeds may be dispersed from one wetland to another by waterways, animals, humans, or machines.

This species prefers disturbed areas but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites.[22]

Purple Loosestrife (Lythrum salicaria)[23]

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

[22] Taken from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm

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

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.

Ecological Impacts

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

Mechanical Control

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

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

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

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

Chemical Control

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

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

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

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

Biological Control

Conventional control methods like hand pulling, cutting, flooding, herbicides, and plant competition have only been moderately effective in controlling purple loosestrife. Biocontrol is now considered the most viable option for more complete control for heavy infestations. The WDNR, in cooperation with the U.S. Fish and Wildlife Service, is introducing several natural insect enemies of purple loosestrife from Europe. A species of weevil (*Hylobius transversovittatus*) has been identified that lays eggs in the stem and upper root system of the plant; as larvae develop, they feed on root tissue. In addition, two species of leaf-eating beetles (*Galerucella calmariensis* and *G. pusilla*) are being raised and released in the state, and another weevil that feeds on flowers (*Nanophyes marmoratus*) is being used to stress the plant in multiple ways. Research has shown that most of these insects are almost exclusively dependent upon purple loosestrife and do not threaten native plants, although one species showed some cross-over to native loosestrife. These insects will not eradicate loosestrife, but may significantly reduce the population so cohabitation with native species becomes a possibility.

*Zebra Mussels (*Dreissena polymorpha*)*

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

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

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

Once zebra mussels are established in a water body; very little can be done to control them. It is therefore crucial to take all possible measures to prevent their introduction in the first place. Be sure to follow the Clean Boats, Clean Waters procedure in preventing the spread of aquatic hitchhikers. In addition to these measures, boaters can take specific precautions in protecting their motors from zebra mussels.

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

Giant Knotweed (Polygonum sachalinense)

Giant knotweed is a perennial that can reach up to 20 feet tall with erect, hollow stems that resemble bamboo. Plants die back each year; the dried stalks remain standing into winter. Stems are smooth and arching with swollen nodes and twigs that zigzag from node to node.

Ecological Threat

Invades riparian areas where it prevents streamside tree regeneration

- Increases soils erosion along streambanks
- Often found in floodplain forests, disturbed areas, roadsides, and vacant lots
- Plants forms dense stands that crowd and shade out native vegetation
- Plants alter soil chemistry and may be allelopathic (exude chemical compounds toxic to native vegetation)
- Plant fragments as small as one inch have the potential to resprout
- Japanese and giant knotweed are known to hybridize

Giant Knotweed is a prohibited species in Wisconsin.

Description

Leaves: Alternate, simple, dark green. Leaves are 6 to 14 inches long and have a heart-shaped base coming narrow to a point.

Flowers: Numerous small, greenish-white flowers appear in the leaf axils of the upper stems. Blooms are up to 4 inches long and occur during August to October. Giant knotweed blooms have both male and female parts in the same flower.

Fruits & seeds: Fruits are papery and broadly winged. Each fruit contains a 3-sided achene that is small, shiny, and brown. Small amounts of seed are viable and have no dormancy requirement.

Roots: Rhizomes that extend deeply into the soil creating a dense impenetrable mat.

Similar species: Japanese knotweed (*P. cuspidatum*) and Bohemian (hybrid) knotweed (*P. cuspidatum x P. sachalinense*) look very similar but can be distinguished by the type of hair on the veins on the undersides. Each species are equally as invasive. Japanese knotweed leaves are abruptly squared at base, and the flowers are dioecious. It has hollow stems with distinct raised nodes that give it the appearance of bamboo, though it is not related. Young plants are most commonly mistaken for rhubarb.

Control

Mechanical Control: Hand pull, mow, or cut plants. Repeated cutting is needed to stimulate regrowth and exhaust root reserves. Digging up plants is difficult, because roots can extend so deeply into the soil. Discard plant debris cautiously as this plant aggressively reproduces vegetatively.

Chemical Control: Treat plants in the summer when there is a large amount of leaf surface to absorb and translocate systemic herbicides. Plants are more susceptible to herbicides if they are cut when 4 to 5 feet tall and the regrowth treated is around 3 feet tall. Foliar spray with 0.15% a.i. aminopyralid, 0.3 % a.i. Imazapyr, or either 2% a.i. glyphosate or triclopyr. Cut-stump treatment with 25% a.i. glyphosate or triclopyr.

Appendix D. Aquatic Invasive Species Photographic Identification

Regulated Aquatic Invasive Plants in WI

Please report any **prohibited** species (as indicated by the red frame box) to the WDNR.

Report by email to: Invasive.Species@wi.gov or **by phone at: (608) 266-6437**

OR to find out more information, for information on reporting restricted species and whom to contact go to:

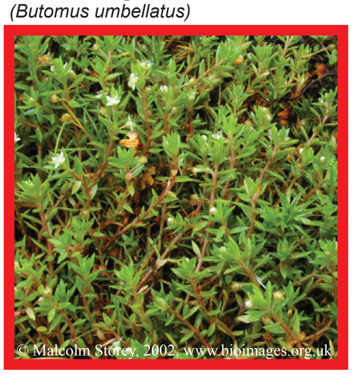
http://dnr.wi.gov/invasives/aquatic/whattodo/

Flowering rush
(Butomus umbellatus)

Purple loosestrife
(Lythrum salicaria)

Curly-leaf pondweed
(Potamogeton crispus)

Eurasian water milfoil
(Myriophyllum spicatum)



Australian swamp stonecrop *(Crassula helmsii)*

Brazilian waterweed
(Egeria densa)

Hydrilla
(Hydrilla verticillata)

European frog-bit
(Hydrocharis morsus-ranae)

African elodea
(Lagarosiphon major)

Parrot feather
(Myriophyllum aquaticum)

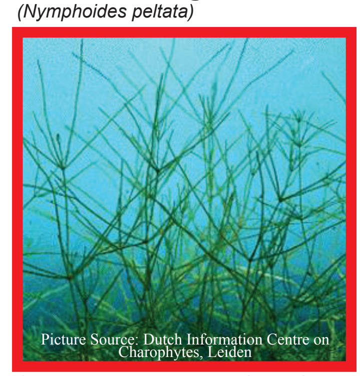
Brittle waternymph
(Najas minor)

Yellow floating heart
(Nymphoides peltata)

Water chestnut
(Trapa natans)

Fanwort
(Cabomba caroliniana)

Didymo or rock snot (alga)
(Didymosphenia geminata)



Starry stonewort (alga)
(Nitellopsis obtusa)

Restricted Species | Prohibited Species

For more information about NR 40 (WI's Invasive Species Rule), Restricted, or Prohibited species please visit: www.dnr.wi.gov/invasives/classification

Bureau of Watershed Management
Wisconsin Department of Natural Resources
Box 7921
Madison, WI 53707-7921

DNR PUB-WT-960-2011

PRINTED ON RECYCLED PAPER

WISCONSIN DEPT. OF NATURAL RESOURCES

Design and Layout by Bonnie Reichert

Chapter NR 40:
Invasive Species Identification Classification and Control
Aquatic Invasive Plants Summary

The Invasive Species Rule (Chapter NR 40) went into effect on September 1, 2009. The rule establishes a comprehensive, science-based way to classify and regulate invasive species in Wisconsin. The rule divides species into 2 categories, "Prohibited" and "Restricted," with different regulations and control requirements. The rule also establishes "Preventative Measures" to show what actions we can take to slow the spread of invasive species. Chapter NR 40 covers over 128 species, including plants, animals, and microorganisms.

WI Statute 23.22 defines **Invasive Species** as "nonindigenous species whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Not all nonnative plants are harmful, so NR 40 helps us determine which ones are invasive.

Prohibited Invasive Plants *

- These species are not yet in the state or only in a few places
- These species are likely to cause environmental and/or economic harm
- It is still possible to eradicate these species and prevent their spread statewide

Regulations: **Cannot transport, possess, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is required. DNR may order or conduct a control effort

Restricted Invasive Plants *

- These species are already widely established in the state
- High environmental and/or economic impacts are evident with these species
- Complete eradication of these species is unlikely

Regulations: **Cannot transport, transfer (buy or sell), or introduce without a permit**
Control Authority: Control is encouraged but not required

*All viable part of the species (including seeds) are covered by these regulations.

What This Means for You

The primary goal of NR 40 is to slow the spread of invasive species in Wisconsin. The Department is using a "stepped enforcement" protocol, which emphasizes education and voluntary compliance. However, citations may be issued for aquatic invasive species violations. Remember:

- **It is illegal to buy, sell, give away, or barter any species listed under Chapter NR 40.**
- **Please become familiar with the listed plants and their regulated status for your county.**
- **You are responsible to comply with all elements of Chapter NR 40.**

Regulations differ slightly for certain species. Please go to the WDNR website to see listed exemptions for NR40, as well as the rule's implications for aquatic invertebrates, fish, and terrestrial species:

www.dnr.wi.gov/invasives/classification

STOP AQUATIC HITCHHIKERS!
Prevent the spread of invasive species, it's the law

For more information contact the WDNR
Invasive Species Project Coordinator at:
Email: Invasive.Species@wi.gov
Phone: (608) 266-6437

CS.v.8/30/11