



# **Report**

## **Aquatic Plant Management Plan**

### **Horsehead Lake**

#### **Presque Isle Town Lakes Committee**

September 30, 2011

Project Number 004010-09002-0

1203 Storbeck Drive  
Waupun, WI 53963

Tel 920-324-8600  
Fax 920-324-3023

www.bonestroo.com



## **AQUATIC PLANT MANAGEMENT PLAN**

### **HORSEHEAD LAKE**

September 30, 2011

Prepared For:

Presque Isle Town Lakes Committee  
7595 Annabelle Lake Road  
Presque Isle, Wisconsin 54557

Prepared By:

Bonestroo  
1203 Storbeck Drive  
Waupun, Wisconsin 53963

Project Number: 004010-09002-0

A handwritten signature in blue ink, appearing to read "James T. Scharl".

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James T. Scharl  
Graduate Scientist

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# 1.0 Executive Summary

The Presque Isle Town Lakes Committee (PITLC) was formed in 2005 to address resource management concerns in lakes within the Town of Presque Isle. The Committee has been active in a number of lake management activities on Horsehead Lake including: aquatic plant management, water quality sampling, invasive species sampling, and community education activities. The Committee contracted Northern Environmental (now Bonestroo, Inc.) to help develop an aquatic plant management (APM) plan for Horsehead Lake. The Horsehead Lake APM Plan includes a review of available lake information, an aquatic plant survey, and an evaluation of feasible physical, mechanical, biological, and chemical management alternatives if deemed appropriate. The APM plan also recommends specific prevention activities for aquatic invasive species (AIS) in the lake system, which are discussed below.

Northern Environmental completed an aquatic plant survey on Horsehead Lake in 2008, which identified twenty six aquatic plant species. The most abundant aquatic plants identified during the survey were common waterweed (*Elodea canadensis*), fern pondweed (*Potamogeton robbinsii*), and flat-stem pondweed (*Potamogeton zosteriformis*). The Floristic Quality Index (FQI) is an index that uses the aquatic plant community as an indicator of lake health. Horsehead Lake exhibited an FQI of 32.16, higher than the state northern ecoregion average (24.3).

## RECOMMENDED AQUATIC PLANT MANAGEMENT PLAN

No aquatic invasive plants were found during the aquatic plant survey in 2008. If an invasive plant were found the Wisconsin Department of Natural Resources (WDNR) recommends that Horsehead Lake's residents work with WDNR and aquatic plant professionals to determine extent of AIS after discovery and to then determine appropriate management. The fact that the native plant community has an above average FQI score illustrates that there is a unique and diverse plant community in Horsehead Lake. Such a plant community is worthy of protection from human disturbance and from the impact aquatic invasive species would have if introduced to this system. Because of that, the following Recommended Action Plan focuses on conservation and plant protection.

The following Active Goals form the structure of the Horsehead Lake Aquatic Plant Management Plan:

**Active Goal:** To initiate the WDNR Clean Boats, Clean Waters program on Horsehead Lake.

**Active Goal:** To provide visitors with educational information concerning the potential impact their activities could have on introduction of aquatic invasive species, wildlife, habitats and Horsehead Lake water quality.

**Active Goal:** To implement and maintain an aquatic invasive species monitoring program that will survey for invasive species, and if found, monitor their locations and extent of population spread.

**Active Goal:** To continue the Horsehead Lake comprehensive water quality monitoring program through the WDNR Citizen Lake Monitoring Network.

- Active Goal:** To work in concert with the WDNR staff and representatives of fishing related businesses to evaluate Horsehead Lake fish management practices and develop goals in order to maintain and enhance a quality family sport fishery.
- Active Goal:** To enforce the Town of Presque Isle's 200 foot no-wake areas (from shoreline and islands) ordinances in order to minimize recreational impacts on the plant community, shoreline habitats, and to promote safe boating.
- Active Goal:** To support the identification and preservation of critical species and critical habitat lands, and wetlands within the watershed. (These are areas with rare vegetation, important habitat for wildlife, or important spawning and nursery areas for fish. Preservation of these lands has a direct impact on the water quality of the lake).
- Active Goal:** To provide education and information to shoreline property owners regarding how native aquatic plant protection and shoreline management can slow the spread of aquatic invasive plants (if they become introduced), improve the lake fishery, improve wildlife habitat and affect the quality of the water in the lake (including development of a *shoreline restoration packet* that could be given to landowners who's property has development categorized as Moderate or Major).
- Active Goal:** To encourage the incorporation of water quality protection measures in the design, construction and maintenance of all lake access sites on Horsehead Lake (e.g. storm water control, site drainage control, appropriate plant matter disposal, and watercraft wash down facilities if found to be needed).
- Active Goal:** To meet on a regular basis with local government agencies and representatives of lakes located within the Town of Presque Isle, to identify essential and new lake management issues and determine collaborative solutions.

## 2.0 Introduction

Horsehead Lake is a 234 acre drainage lake located in northern Vilas County. The lake has a 15,000 acre (23.44 square miles) watershed. Horsehead Lake exhibits good water clarity and, according to the Wisconsin Trophic State Index, is a mesotrophic lake.

Lake residents have become concerned about the possibility of the introduction of Eurasian watermilfoil (*Myriophyllum spicatum* - EWM), curly-leaf pondweed (*Potamogeton crispus* - CLP) and other AIS into the aquatic plant community of Horsehead Lake. Although no AIS were recorded during the aquatic plant survey in 2008, this APM Plan includes strategies for detection, monitoring, and management/removal of EWM and CLP from Horsehead Lake if ever established.

This document is the APM Plan for Horsehead Lake and discusses the following:

- Lake morphology and lake watershed characteristics
- Historical aquatic plant management activities
- Stakeholder's goals and objectives
- Aquatic plant ecology
- 2008 baseline aquatic plant survey
- Feasible aquatic plant management alternatives
- Selected suite of aquatic plant management options

## 3.0 Baseline Information

### 3.1 LAKE HISTORY AND MORPHOLOGY

Horsehead Lake is located in the Town of Presque Isle in the northern Vilas County, Wisconsin. The lake is part of the headwaters area of the Presque Isle-Black River Watershed, which drains north to Lake Superior. Figure 1 depicts the lake location. The following summarizes the lake’s physical attributes:

Lake Name	Horsehead
Lake Type	Drainage
Surface Area (acres)	234
Maximum depth (feet)	24
Mean depth (feet)	13
Public Landing	Yes

Source: Wisconsin Lakes, WDNR 2005 and WDNR Lake Survey map, 2005

Figure 2 illustrates the lake bathymetries. Horsehead Lake provides year-round recreation activities ranging from, fishing, swimming, waterskiing, pleasure boating, snowmobiling, and more.

### 3.2 WATERSHED OVERVIEW

The Horsehead Lake watershed encompasses approximately 15,000 acres in northern Vilas County and southern Gogebic County, Michigan and is primarily forested and undeveloped. Horsehead Lake is connected by waterways to Armour, Crab, Annabelle, and Oxbow Lakes before draining into Little Horsehead Lake and the Presque Isle River. Horsehead Lake is listed as a Priority Navigable Water (PNW) on the Wisconsin list of Designated Waters. Priority Navigable Waters include waters with self-sustaining walleye populations in ceded territories and waters with self-sustaining musky populations. Horsehead Lake contains both a self-sustaining walleye population and a self-sustaining muskellunge population within the Ceded Territories.

The Horsehead Lake area consists mainly of Gogebic and Pence soil types. Gogebic and Pence soils are well drained sandy loamy soils formed in glacial till and moraines. A fragipan layer sometimes occurs within Gogebic soils. Fragipans are loamy, brittle subsurface horizons consisting of clay, silt and sand that appear cemented and can restrict plant root growth. (USDA, 1988).

### 3.3 WATER QUALITY

WDNR Lake Water Quality Database indicates that the following water quality information is available:

- Water clarity (Secchi depth): 1991-1992, 1998 - present (Citizen Lake Monitoring)
- Total phosphorus: 2000 - present (Citizen Lake Monitoring)
- Chlorophyll-a: 2000 - present (Citizen Lake Monitoring)

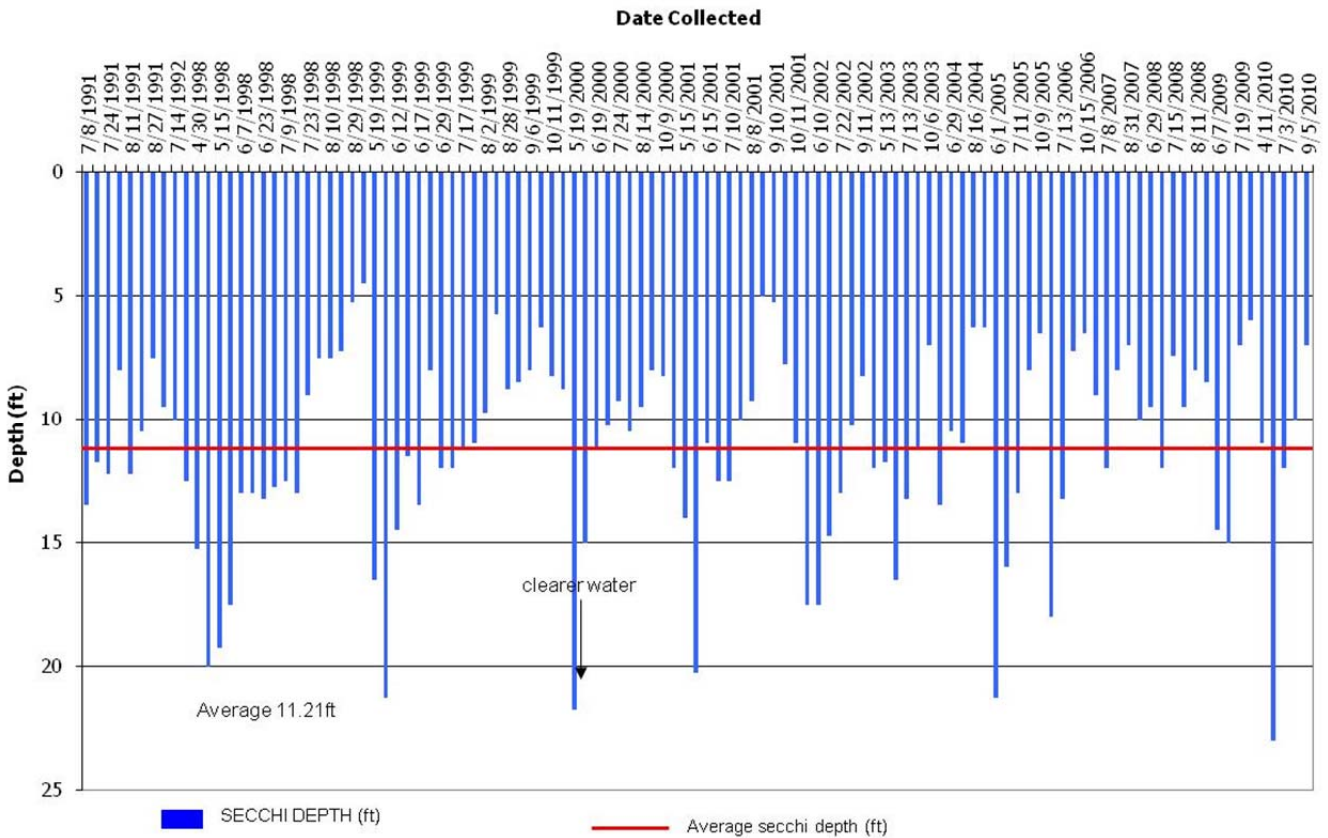


The above referenced data was used in creating the Horsehead APM Plan. Higher Secchi depth readings indicate clearer water and deeper light penetration. Total Phosphorus is a measure of nutrients available for plant growth. Chlorophyll-a is green pigment present in all plant life and necessary for photosynthesis. The amount present in lake water depends on the amount of algae suspended in the water column of a lake. Chlorophyll-a is used as a common indicator of water quality (Shaw et al, 2004). Higher chlorophyll-a values indicate lower water qualities

### 3.3.1 WATER CLARITY

The historical water clarity average based on Secchi Disk readings is 11.21 feet (2.68 meters) and ranges from 4.3 to 23 feet. The Wisconsin average Secchi Disk reading in 2005 was 10 feet (Larry Bresina, The Secchi Disk and Our Eyes - Working Together To Measure Clarity of Our Lakes; internet document). The following graph illustrates the historical water clarity measurements on Horsehead Lake; data collected up to 2010 is included.

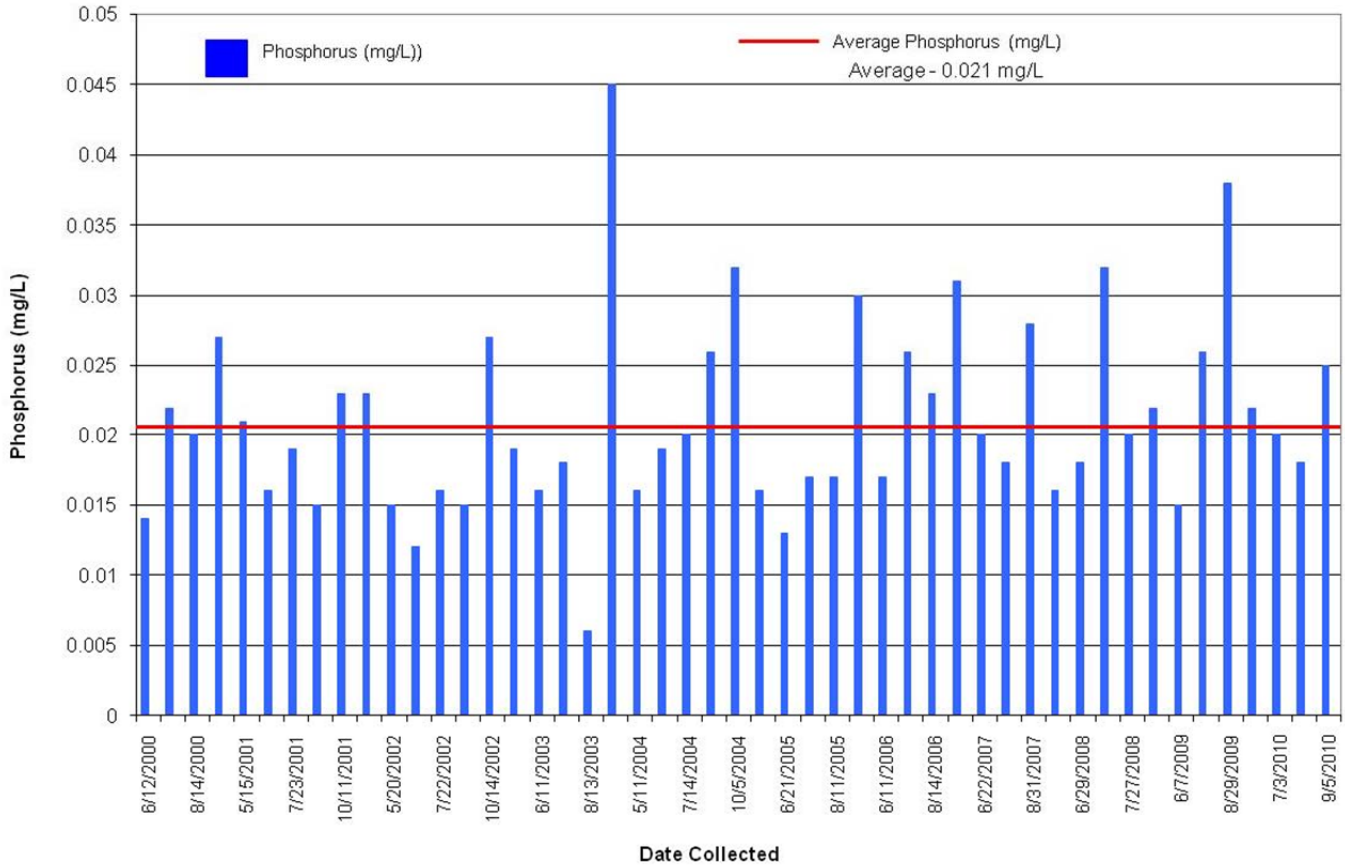
**Horsehead Lake Secchi Readings**



### 3.3.2 TOTAL PHOSPHORUS AND CHLOROPHYLL-A

Historically Horsehead Lake has an average phosphorus reading of 0.021 milligrams per liter (parts per million – ppm). Total phosphorus has varied from 2000 through 2010 from 0.006 ppm to 0.045 ppm. The following graph illustrates the historical phosphorus measurements on Horsehead Lake.

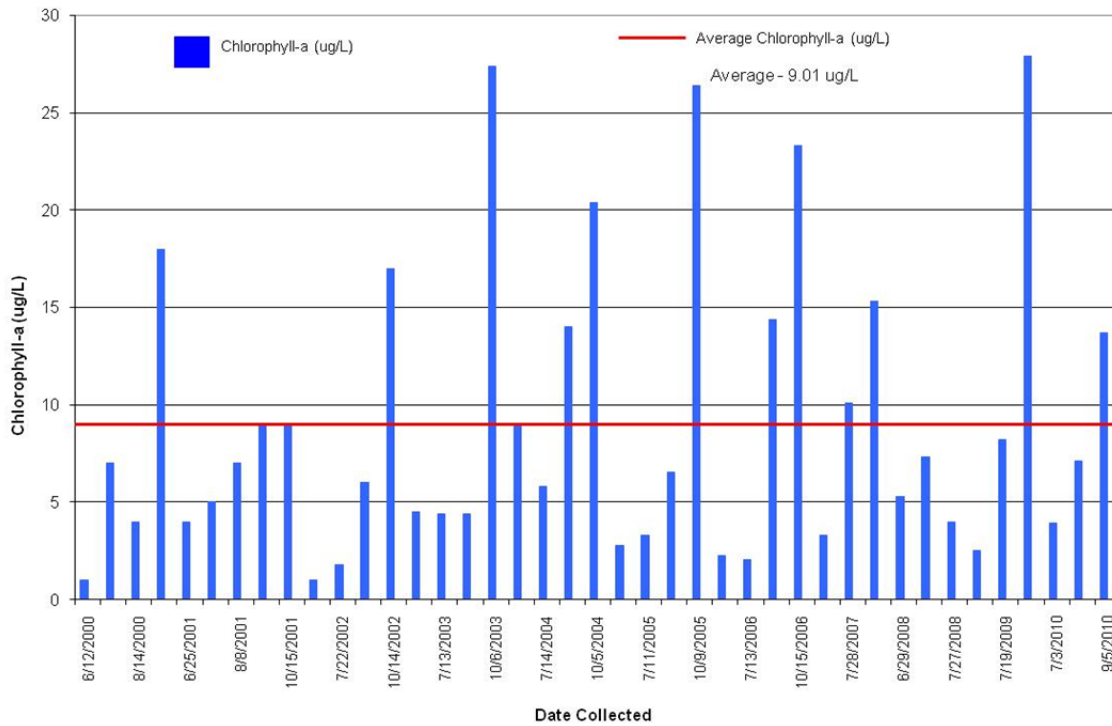
### Horsehead Lake Phosphorus Readings



Chlorophyll-a measurements started in 2000 and continued through 2010, showing an average of 9.01 micrograms per liter (parts per billion – ppb). Data ranged from 1.00 ppb to 27.9 ppb. A spike in algae growth during 2009 prompted some concern among lake residents. Horsehead Lake is downstream from and connected too many other lakes within its watershed and can receive additional nutrient loads from these lakes. Additional nutrients within the lake can lead an increase in algae bloom occurrences and severity. However, the algae bloom that occurred during 2009 is a natural phenomenon and should not be cause for concern of degraded lake quality or an increase in its incoming nutrient load.

Values of chlorophyll-a are dependant on the amount of algae within the lake. Higher values indicate higher amounts of algae, and in turn, a potential algae bloom. When looking at Horsehead Lake’s historical chlorophyll-a readings, high values similar to that found in 2009 have occurred in the past (2003, 2005, & 2006). The following graph illustrates the historical chlorophyll-a measurements on Horsehead Lake.

### Horsehead Lake Chlorophyll-a Readings



### 3.3.3 DISSOLVED OXYGEN AND TEMPERATURE

In conjunction with Citizen Lake Monitoring, volunteers on Horsehead Lake have been recording temperature profiles. Data are recorded at three foot intervals over the deepest portion of the lake down to 24 feet below the surface. Profiles collected indicate the formation of a thermocline during summer stratification around 18 – 19 feet below the surface. Dissolved oxygen was recorded at one-foot intervals during the 2008 aquatic plant survey and showed sufficient oxygen to support a majority of fish species to 15 feet. Results of the temperature and dissolved oxygen profile collection can be found in Appendix I.

### 3.3.4 TROPHIC STATE INDEX

Trophic State Index (TSI) values are assigned to a lake based on total phosphorus, chlorophyll-a, and water clarity values. The TSI is a measure of a lake's biological productivity. The TSI used for Wisconsin lakes is described below.

Category	TSI	Lake Characteristics	Total P (ug/L)	Chlorophyll-a (ug/L)	Water Clarity (feet)
Oligotrophic	1-40	Clear water; oxygen rich at all depths, except if close to mesotrophic border; then may have low or no oxygen; cold-water fish likely in deeper lakes.	< 12	<2.6	>13
Mesotrophic	41-50	Moderately clear; increasing probability of low to no oxygen in bottom waters.	12 to 24	2.6 to 7.3	13 to 6.5
Eutrophic	51-70	Decreased water clarity; probably no oxygen in bottom waters during summer; warm-water fisheries only; blue-green algae likely in summer in upper range; plants also excessive.	> 24	>7	<6.5
<b>Horsehead Lake</b>	<b>47.5</b>	<b>Mesotrophic</b>	<b>21.0</b>	<b>9.01</b>	<b>11.21</b>

Adopted from Carlson 1977, Lillie and Mason, 1983, and Shaw 1994 et. al.

The historical water clarity, total phosphorus, and chlorophyll-a data indicate that Horsehead Lake is a mesotrophic lake. Data collected by Citizen Lake Monitors is current up to 2010 and is included in the above averages.

### 3.4 SUMMARY OF LAKE FISHERY

The following table identifies the fish species the WDNR lists as being present in Horsehead Lake.

Fish Species	Present	Common	Abundant
Muskellunge		X	
Northern Pike	X		
Walleye		X	
Largemouth Bass	X		
Smallmouth Bass	X		
Panfish		X	

Source: WDNR Wisconsin Lakes Publication # PUB-FH-800, 2005

The WDNR website presents records of fish stocked in Horsehead Lake (WDNR Fish stocking website, 2010). All walleye stocked in Horsehead Lake were fingerling in size and used to supplement natural reproduction.

Year	Walleye
1974	11940
1976	11000
1978	11000

All fisheries in Horsehead Lake are currently sustained through natural reproduction. Horsehead Lake is located in the Ceded Territories of Wisconsin. The Ceded Territories was ceded to the United States by the Lake Superior Chippewa Tribes in 1837 and 1842. The WDNR describes Native American fishing in the Ceded Territories this way: "The six Chippewa tribes of Wisconsin are legally able to harvest walleyes using a variety of high efficiency methods, but spring spearing is the most frequently used method. In spring each tribe declares how many walleyes and muskellunge they intend to harvest from each lake. Harvest begins shortly after ice-out, with nightly fishing permits issued to individual tribal spearers. Each permit allows a specific number of fish to be harvested, including one walleye between 20 and 24 inches and one additional walleye of any size. All fish that are taken are documented each night with a tribal clerk or warden present at each boat landing used in a given lake. Once the declared harvest is reached in a given lake, no more permits are issued for that lake and spearfishing ceases (<http://dnr.wi.gov/fish/ceded/tribalharvest.html>)."

All fishing regulations and bag limits for Horsehead Lake are concurrent with standard WDNR regulations in the Ceded Territories except for walleye and bass. For non-Chippewa anglers there is no minimum size limit for walleye with a three (3) fish daily bag limit, but only one may be over 15 inches. For both largemouth and smallmouth bass, the daily bag limit is 1 with a minimum size of 18". In the Ceded Territories the WDNR works to establish "safe harvest limits" set so there is less than a 1-in-40 chance that more than 35% of the adult walleye population will be harvested in any given lake by either tribal or recreational fishermen, or both combined.

### 3.5 LAKE MANAGEMENT HISTORY

Past management activities on Horsehead Lake are limited to fish stocking by the WDNR. The historical WDNR stocking data is presented in the previous section.

The Town of Presque Isle has adopted several ordinances that help protect lakes and shorelines. Town of Presque Isle ordinances 500, 902, 908, and 909 all protect lakes in one way or another. Ordinance 501.03(2) mandates no wake on lakes less than 50 acres. 501.03(3), (a) requires no wake within 200 feet of any shoreline. 501.03(4) limits waterskiing and other like activities to the hours between 10 AM and 5 PM. The above mentioned ordinances in the 900 category, zoning, all limit minimum lot frontage to 200 feet, and 300 feet minimum on lots created after March 25<sup>th</sup>, 2001. Other watershed related ordinances are included in the zoning ordinances.

### 3.6 GOALS AND OBJECTIVES

PITLC identified the following goals for aquatic plant management on Horsehead Lake.

- Maintain and improve recreational opportunities
- Protect and improve fish and wildlife habitat

- Preserve native aquatic plants
- Prevent the introductions of AIS
- Identify and Protect sensitive areas
- Identify sources of financial assistance for aquatic plant management activities
- Coordinate sound aquatic plant management practices where needed within Horsehead Lake
- Educate the Horsehead Lake community on proper AIS identification and prevention efforts
- Gather citizen input
- Increase citizen participation in lake management

## 4.0 Project Methods

To accomplish the project goals, the PITLC needs to make informed decisions regarding APM on the lake. To make informed decisions, PITLC proposed to:

- Collect, analyze, and interpret basic aquatic plant community data
- Recommend practical, scientifically-sound aquatic plant management strategies

Offsite and onsite research methods were used during this study. Offsite methods included a thorough review of available background information on the lake, its watershed, and water quality. An aquatic plant community survey was completed onsite to provide the data needed to evaluate aquatic plant management alternatives.

### 4.1 EXISTING DATA REVIEW

Bonestroo researched a variety of information resources to develop a thorough understanding of the ecology of the Lake. Information sources included:

- Local and regional geologic, limnologic, hydrologic, and hydrogeologic research
- Discussions with lake members
- Available topographic maps and aerial photographs
- Data from WDNR files

These sources were essential to understanding the historic, present, and potential future conditions of the lake, as well as to ensure that previously completed studies were not unintentionally duplicated. Specific references are listed in Section 8.0 of this report.

### 4.2 AQUATIC PLANT SURVEY AND ANALYSIS

The aquatic plant community of the lake was surveyed on July 13 and 14, 2008 by Northern Environmental. The survey was completed according to the point intercept sampling method described by Madsen (1999) and as outlined in the WDNR draft guidance entitled "Aquatic Plant Management in Wisconsin" (WDNR, 2005).

WDNR research staff determined the sampling point resolution in accordance with the WDNR guidance and provided a base map with the specified sample point locations. The sample resolution was a 41 meter grid with 594 pre-determined intercept points (Figure 3). Latitude and longitude coordinates and sample identifications were assigned to each intercept point on the grid (Appendix A). Geographic coordinates were uploaded into a global positioning system (GPS) receiver. The GPS unit was then used to navigate to intercept points. At each intercept point, plants were collected by tossing a specialized rake on a rope and dragging the rake along the bottom sediments. All collected plants were identified to the lowest practicable taxonomic level (e.g., typically genus or species) and recorded on field data sheets. Visual observations of aquatic plants were also recorded. Water depth and, when detectable, sediment types at each intercept point were also recorded on field data sheets.

The point intercept method was used to evaluate the existing emergent, submergent, floating-leaf, and free-floating aquatic plants. If a species was not collected at a specific point, the space

on the datasheet was left blank. For the survey, the data for each sample point was entered into the WDNR "Worksheets" (i.e., a data-processing spreadsheet) to calculate the following statistics:

- **Taxonomic richness** (the total number of taxa detected)
- **Maximum depth of plant growth**
- **Community frequency of occurrence** (number of intercept points where aquatic plants were detected divided by the number of intercept points shallower than the maximum depth of plant growth)
- **Mean intercept point taxonomic richness** (the average number of taxa per intercept point)
- **Mean intercept point native taxonomic richness** (the average number of native taxa per intercept point)
- **Taxonomic frequency of occurrence within vegetated areas** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points where vegetation was present)
- **Taxonomic frequency of occurrence at sites within the photic zone** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the total number of intercept points which are equal to or shallower than the maximum depth of plant growth)
- **Relative taxonomic frequency of occurrence** (the number of intercept points where a particular taxon (e.g., genus, species, etc.) was detected divided by the sum of all species' occurrences)
- **Mean density** (the sum of the density values for a particular species divided by the number of sampling sites)
- **Simpson Diversity Index (SDI)** is an indicator of aquatic plant community diversity. SDI is calculated by taking one minus the sum of the relative frequencies squared for each species present. Based upon the index of community diversity, the closer the SDI is to one, the greater the diversity within the population.
- **Floristic Quality Index (FQI)** (This method uses a predetermined [Coefficient of Conservatism](#) (C), that has been assigned to each native plant species in Wisconsin, based on that species' tolerance for disturbance. Non-native plants are not assigned conservatism coefficients. The aggregate conservatism of all the plants inhabiting a site determines its floristic quality. The mean C value for a given lake is the arithmetic mean of the coefficients of all native vascular plant species occurring on the entire site, without regard to dominance or frequency. The FQI value is the mean C times the square root of the total number of native species. This formula combines the conservatism of the species present with a measure of the species richness of the site.

#### 4.3 SHORELINE CHARACTERIZATION

The point intercept method described above may not accurately identify emergent and floating leaved aquatic plants in near shore areas. Therefore, a boat tour was completed traveling the entire perimeter of the lake's shoreline. During the boat tour, visual observations of the emergent and floating leaved plant communities were located and recorded. The boat tour also included a



shoreline characterization, which provides an evaluation of shoreline development on the Lake. The following scale was used to rate the level of shoreline development.

**1: Undeveloped** (i.e. Forested or wetland)

**2: Minor development** (i.e. Properties may have mostly natural shoreline, sparse structures set further away from the lake, one pier, and little or no clearing of natural vegetation).

**3: Moderate development** (i.e. Properties may exhibit clearing and/or manipulation to the shore and lawn areas but not to waters edge. More elaborate piers or boathouses may be present).

**4: Major development** (i.e. Properties may include large lawn areas extending to the shoreline, which contains little or no natural shoreline vegetation. Increased building density, possibly close to the shore, multiple docks or boathouses, and significant shoreline alteration such as seawalls or rip rap may be present).

#### **4.4 PUBLIC INVOLVEMENT AND PLAN REVIEW**

Public involvement and education efforts included a presentation by Northern Environmental with the PITLC members on June 26, 2007 to discuss and kick off the APM Plan project. Draft copies of the APM Plan for Horsehead Lake, and other Presque Isle Town lakes, were submitted to the WDNR and the PITLC for distribution to, and comments from, lake residents. Comments from PITLC and the Vilas County Land and Water Conservation Department will be applied to the documents and completed based on the comments received.

## 5.0 Discussion of Project Results

### 5.1 AQUATIC PLANT ECOLOGY

Aquatic plants are vital to the health of a water body. Unfortunately, people all too often refer to rooted aquatic plants as “weeds” and ultimately wish to eradicate them. This type of attitude, and the misconceptions it breeds, must be overcome in order to properly manage a lake ecosystem. Rooted aquatic plants (macrophytes) are extremely important for the well being of a lake community and possess many positive attributes. Despite their importance, aquatic macrophytes sometimes grow to nuisance levels that hamper recreational activities. This is especially prevalent in degraded ecosystems. The introduction of certain aquatic invasive species (AIS), such as EWM, often can exacerbate nuisance conditions, particularly when they compete successfully with native vegetation and occupy large portions of a lake.

When managing aquatic plants, it is important to maintain a well-balanced, stable, and diverse aquatic plant community that contains high percentages of desirable native species. To be effective, aquatic plant management in most lakes must maintain a plant community that is robust, species rich, and diverse. Appendix B includes a discussion about aquatic plant ecology, habitat types and relationships with water quality.

### 5.2 AQUATIC INVASIVE SPECIES

Aquatic Invasive Species (AIS) are aquatic plants and animals that have been introduced by human action to a location, area, or region where they did not previously exist. AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new home. Some AIS have aggressive reproductive potential and contribute to a decline of a lake’s ecology and interfere with recreational use of a lake. Common Wisconsin AIS include:

- Eurasian Watermilfoil
- Curly Leaf Pondweed
- Zebra Mussels
- Rusty Crayfish
- Spiny Water Flea
- Purple Loosestrife

Appendix C provides additional information on these AIS.

### 5.3 2008 AQUATIC PLANT SURVEY

The survey was carried out July 13 and 14, 2008, and included sampling at 594 intercept points. The aquatic macrophyte community of the Lake included 26 floating leaved, emergent, and submerged aquatic vascular plant species during 2008. Table 1 lists the taxa identified during the 2008 aquatic plant survey. Figures 4A through Figure 4G illustrate the locations of each species identified.

Vegetation was identified to a maximum depth of 17 feet (photic zone). Aquatic vegetation was detected at 25.66 percent (%) of photic zone intercept points. A diverse plant community inhabited the lake during 2008; Simpson Diversity Index value of the community was 0.91, taxonomic richness was 26 species, and there was an average of 0.51 species identified at points

that were within the photic zone. There was an average of 1.97 species present at points with vegetation present. Table 2 summarizes these overall aquatic plant community statistics.

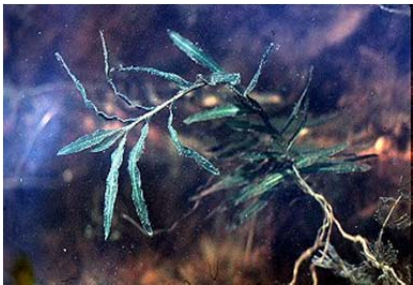
The most abundant aquatic plant identified during the aquatic plant survey was common waterweed (*Elodea canadensis*). It exhibited a 7.19% frequency of occurrence (percent of photic zone intercept points at which the taxa was detected). It was present at 28.04% of the sites with vegetation, and had a 14.22% relative frequency of occurrence. Table 3 includes the abundance statistics for each species.

Elodea is an abundant native plant species that is distributed statewide. It prefers soft substrate and water depths to 15 feet (Nichols, 1999). Elodea reproduces by seed and sprigs (USDA, 2002). The stems of elodea offer shelter and grazing to fish, but very dense elodea can interfere with fish movement. Elodea can be considered invasive at times and out-competes other more desirable plants. Note: *Elodea nuttalli* (slender waterweed) was also noted in the lake.



Elodea  
Source: UW Herbarium Website

Fern pondweed (*Potamogeton robbinsii*) was the second most abundant species occurring at 6.24% of the photic zone. It was present at 24.30% of sites with vegetation and had a 12.32% relative frequency of occurrence.



Fern Pondweed  
Source: UW Herbarium Website

Fern Pondweed is a submergent pondweed with robust stems and strongly two-ranked leaves, creating a feather or fern-like appearance while in the water. Fern pondweed sprouts in the spring and thrive in deeper water. Fern pondweed provides habitat for invertebrates that are grazed by waterfowl and also offers good cover for fish, particularly northern pike (Borman, et al., 1997).

Flat-stem pondweed (*Potamogeton zosteriformis*) was the third most abundant vascular plant species occurring at 6% of the photic zone. It was present at 23.36% of sites with vegetation and had an 11.85% relative frequency of occurrence.

Flat-Stem Pondweed is a submergent pondweed with freely-branched flattened stems. Flat stem pondweed is commonly confused with water stargrass (*Zosterella dubia*) but Flat-stem Pondweed can be distinguished by its prominent mid-vein and many fine, parallel veins.



Flat- Stem Pondweed  
Source: UW Herbarium Website

### 5.3.1 FLOATING-LEAF PLANTS

The following three floating-leaf aquatic plant species were identified during the 2008 aquatic plant survey.

- *Brasenia schreberi* (watershield)
- *Nuphar variegata* (spatterdock)
- *Nymphaea odorata* (white water lily)

### 5.3.2 SUBMERGENT PLANTS

The following 14 submergent aquatic plant species were identified during the 2008 aquatic plant survey.

- *Bidens beckii* (water marigold)
- *Elodea canadensis* (elodea or common waterweed)
- *Elodea nuttallii* (slender waterweed)
- *Myriophyllum sibiricum* (northern watermilfoil)
- *Najas flexilis* (bushy pondweed or slender naiad)
- *Nitella sp.* (Nitella) [algal]
- *Potamogeton amplifolius* (large-leaf pondweed)
- *Potamogeton gramineus* (Variable-leaf pondweed)
- *Potamogeton pusillus* (small pondweed)
- *Potamogeton richardsonii* (clasping-leaf pondweed)
- *Potamogeton robinnsii* (fern pondweed)
- *Potamogeton vaseyii* (Vasey's pondweed)
- *Potamogeton zosteriformis* (flat-stem pondweed)
- *Vallisneria americana* (wild celery)

### 5.3.3 EMERGENT PLANTS

The following nine emergent aquatic plant species were identified during the 2008 aquatic plant survey.

- *Decodon verticillatus* (swamp loosestrife)
- *Eleocharis palustris* (creeping spikerush)
- *Equisetum fluviatile* (water horsetail)
- *Phragmites australis* (giant reed)
- *Pontederia chordata* (pickerel weed)
- *Sagittaria latifolia* (common arrowhead)
- *Schoenoplectus acutus* (hardstem bulrush)
- *Sparganium eurycarpum* (common bur-reed)
- *Sparganium fluctuans* (floating-leaf bur-reed)

Table 1 lists the species identified. Appendix D includes brief descriptions of all aquatic plants identified.

## 5.4 FLORISTIC QUALITY INDEX

Higher FQI numbers indicate higher floristic quality and biological integrity and a lower level of disturbance impacts. FQI varies around the state of Wisconsin and ranges from 3.0 to 44.6 with the average FQI of 22.2 (WDNR, 2005). The FQI calculated from the 2008 aquatic plant survey data was 32.16. This FQI value is higher than Wisconsin's northern region mean of 24.3 and suggests that Horsehead Lake exhibits very good water quality when using aquatic plants as an indicator. Table 4 summarizes the coefficient of conservatism.

## 5.5 SHORELINE CHARACTERIZATION

Emergent and floating leaved plants identified along the shoreline outside of formal grid sample points included: *Decodon verticillatus* (swamp loosestrife), *Schoenoplectus acutus* (hardstem bulrush), *Equisetum fluviatile* (water horsetail), *Iris versicolor* (wild iris), *Myrica gale* (sweet gale), (*Sagittaria sp.* (arrowhead), *Nuphar variegata* (spatterdock), *Nymphaea odorata* (white water lily) *Eleocharis palustris* (creeping spikerush), *Pontederia cordata* (pickerelweed), *Typha sp.* (cattail), *Carex sp.* (sedges species) and *Sparganium sp.* (bur-reed). Refer to Appendix D for descriptions of these plants. Figure 5 illustrates the floating leaved and emergent plant locations identified during the boat survey. Plants identified during the shoreline survey but not during the point-intercept method were not included in the community statistics or calculation of the FQI.

The majority of the shoreline was moderately developed with residences. Some scattered blocks of undeveloped woodlands were present on the lakeshore. Figure 5 illustrates the level of shoreline development.

## 6.0 Management Alternatives and Recommendations

Based on the goals of the stakeholders as mentioned in section 3.6, several management alternatives are available for this APM plan. Some general alternatives are discussed below. More information on management alternatives is included in Appendix E. Currently, the Northern Region of the WDNR is working under an aquatic plant management strategy that is officially titled Aquatic Plant Management Strategy, Northern Region WDNR, Summer, 2007 (working draft), or commonly referred to the NOR Region APM Strategy (Appendix H). This strategy lays out an approach for acceptable aquatic plant management in Northern Region lakes. The strategy protects native aquatic plant communities in northern Wisconsin and does not allow permits to control native plants unless documented circumstances of nuisance levels exist. The following management alternatives are based on the approaches described in the NOR Region APM Strategy, and incorporate recommendations of Bonestroo.

### 6.1 AQUATIC PLANT MAINTENANCE ALTERNATIVES

The maintenance alternative may be used at a lake in which a healthy aquatic plant community exists and invasive and non-native plant species are generally not present. The maintenance alternative is a protection-oriented management alternative because no significant plant problems exist or no active manipulation is required. This alternative can include an educational plan to inform lake shore owners of the value of a natural shoreline and encourage the protection of the lake water quality and the native aquatic plant community.

#### 6.1.1 AQUATIC INVASIVE SPECIES MONITORING

No AIS were identified during the 2008 survey in Horsehead Lake. In order to monitor for AIS in the future a strong Citizen Lake Monitoring program that surveys for AIS is highly recommended. In some lake systems, native aquatic plants “hold their own” and AIS never grow to nuisance levels, in others however, vigilant and active management is required. This can be based on several things including water quality. Data provided on the WDNR Citizen Lake Monitoring website indicates monitoring of water clarity continues and is current as of 2011. Currently, Horsehead Lake residents are also active Citizen Lake Monitors for water quality (Secchi depth, total phosphorus and chlorophyll-a).

Assuming AIS were to become established in the next several years, the most likely species would be EWM or CLP. If these or other AIS are found a sample should be collected and taken to the DNR for proper confirmation. The University of Wisconsin-Extension Lake’s Program provides training and coordinates the Citizen Lake Monitoring Program. More information about the program is available by contacting Laura Herman, Citizen Lake Monitoring Network Education Specialist, (715) 346-3989, email: [lherman@uwsp.edu](mailto:lherman@uwsp.edu), website: <http://www.uwsp.edu/cnr/uwexlakes/clmn/>.

Bonestroo also recommends completing lake-wide aquatic plant surveys every 5 years (essentially repeating the 2008 point intercept aquatic plant survey) to monitor changes in the overall aquatic plant community and the effects of the APM activities. Aquatic plant communities

may change with varying water levels, water clarity, nutrient levels, and aquatic plant management actions.

### **6.1.2 CLEAN BOATS/CLEAN WATERS CAMPAIGN**

Measures for the prevention of the introduction of AIS to the lake should be a priority. To prevent the spread of AIS into Horsehead Lake, a monitoring program such as Clean Boats/Clean Waters is an excellent choice. There is one public landing on Horsehead Lake and lake residents are not currently participating in Clean Boats/Clean Waters (CB/CW) program. This program is carried out by trained volunteers who inspect the incoming boats at public launches. Signage also accompanies the use of CB/CW to inform lake users of proper identification of AIS and boat inspection procedures. Education of the public, along with private property and resort owners, about inspecting watercraft for AIS before launching a boat or leaving access sites on other lakes could help prevent new AIS infestations. Contact with lake users at this time is a great way to distribute other educational materials. Initiation of this program is recommended and should be promoted by the current CB/CW coordinator on the lake.

### **6.1.3 AQUATIC PLANT PROTECTION AND SHORELINE MANAGEMENT**

Protection of the native aquatic plant community is needed to slow the spread of EWM from lake to lake and within a lake once established. Therefore, riparian landowners should refrain from removing native vegetation. Additionally, EWM can thrive in nutrient (phosphorus and nitrogen) enriched waters or where nutrient rich sediments occur. Two simple actions can prevent excessive nutrients and sediments from reaching the lake.

The first activity is the restoration of natural shorelines, which act as a buffer for runoff containing nutrients and sediments. Properties classified in the shoreland survey as having a level 3: Moderate Development or level 4: Major Development, would be good candidates for shoreland restorations. Establishing natural shoreline vegetation can sometimes be as easy as not mowing to the waters edge. Native plants can also be purchased from nurseries for restoration efforts. Shoreline restoration has the added benefits of providing wildlife habitat and erosion prevention. A vegetated buffer area can also prevent surface water runoff from roads, parking areas and lawns from carrying nutrients to the lake.

The Vilas County Land and Water Conservation Department offers a cost-share program for county landowners. The primary emphasis of the program continues to be to restore native vegetation to shoreland property. For shoreline restoration projects and other conservation practices involving revegetation activities, landowners are reimbursed up to 70% of the costs of planting and purchasing native trees, shrubs, and wildflowers. Interested landowners can contact the Vilas County Land & Water Conservation Department at (715) 479-3648 to request an application form for the program. Another avenue to fund shoreland restoration is the WDNR Lake Protection Grant program. This program offers 75% of the project cost covered by the state up to \$200,000. For more information on the Lake Protection Grant program contact the Lake Management Coordinator at the WDNR Rhinelander Service Center by calling (715) 365-8937.

The second easy nutrient prevention effort is to use lawn fertilizers only when a soil test shows a lack of nutrients. Phosphorus free fertilizers should be used when possible. The fertilizers commonly used for lawns and gardens have three major plant macronutrients: Nitrogen, Phosphorus, and Potassium. These are summarized on the fertilizer package by three numbers.

The middle number represents the amount of phosphorus. Since most Wisconsin lakes are “Phosphorus limited”, meaning additions of phosphorus can cause increased aquatic plant or algae growth, preventing phosphorus from reaching the lake is a good practice. Landowners should be encouraged to use phosphorus free fertilizers on lakeshore lawns. Local retailers and lawn care companies can provide soil test kits to determine a lawn’s nutrient needs. Of course, properties with an intact natural buffer require very little maintenance, and no fertilizers.

Another possible source of nutrients to a lake is the septic systems surrounding the lake. Septic systems should be properly installed and maintained in order to prevent improperly treated wastewater, which carries a lot of nutrients, from reaching the lake. Property owners who are not sure if their septic system is adding nutrients to the lake should contact a professional inspector and have their system assessed.

#### **6.1.4 PUBLIC EDUCATION AND INVOLVEMENT**

The PITLC should continue to keep abreast of current AIS issues throughout the County. The County Land and Water Resource Conservation Department and the WDNR Lakes Coordinator, and the UW Extension are good sources of information. Many important materials can be ordered at the following website:

<http://www.uwsp.edu/cnr/uwexlakes/publications/>

Appendix G includes resources for further information about public education opportunities.

If the above hyperlink to web address becomes inactive, please contact Bonestroo for appropriate program and contact information.

## **6.2 AQUATIC PLANT MANIPULATION ALTERNATIVES**

The management alternative may be used when aquatic plants present some sort of problem that must be dealt with or manipulated by human action. The WDNR NOR Region APM Strategy states “Newly-discovered infestations, if found on a lake with an approved lake management plan, the invasive species can be controlled via an amendment to the approved plan.” The following alternatives are based on the assumption that the PITLC will meet in consultation with the WDNR before pursuing manipulation of AIS populations.

### **6.2.1 MANUAL REMOVAL**

Native plants may be found at nuisance levels at individual properties. Manual removal efforts, including hand raking or hand pulling unwanted plants, are allowed under Wisconsin law, to a maximum width of 30 feet (recreational zone). The intent is to provide pier, boatlift or swimming raft access in the recreation zone. A permit is not required for hand pulling or raking if the maximum width cleared does not exceed this 30-foot recreation zone (manual removal of any native aquatic vegetation beyond the 30-foot area would require a permit from the WDNR that satisfies the requirements of Chapter NR 109, Wisconsin Administrative Code, see Appendix F). However manual removal is **not** recommended because it could open a niche for non-native invasive aquatic plants to occupy. Removal of native plants also destroys habitat for fish and wildlife.



If an Aquatic invasive plant is found in a small population hand pulling is a good first line of defense. If EWM or CLP ever becomes established within Horsehead Lake, manual (hand) removal of these plants in small, isolated populations, particularly in shallow water would be appropriate. No permit is required to remove non-native invasive aquatic vegetation, as long as the removal is conducted completely by hand with no mechanical assistance of any kind. All aquatic plant material must be removed from the water to minimize dispersion and re-germination of unwanted aquatic plants. Portions of the roots may remain in the sediments, so removal may need to be repeated periodically throughout the growing season. Before significant plant removal is undertaken, a sample of the species assumed to be EWM or CLP should be brought to and confirmed by the WDNR.

Manual removal of aquatic plants can be quite labor intensive and time consuming. This technique is well suited for small areas in shallow water where property owners can weed the aquatic garden. Hiring laborers to remove aquatic vegetation is an option, but also increases cost. Scuba divers can be contracted to remove unwanted vegetation in deeper areas. Benefits of manual removal by property owners include low cost compared to chemical control methods, quick containment of pioneering (new) populations of invasive aquatic plants, and the ability for a property owner to slowly and consistently work on active management. The drawback of this alternative is that pulling aquatic plants include the challenge of working in the water, especially deep water, the threat of letting fragments escape and colonize a new area, and the fact that control of any significant sized population is quite labor intensive. Again, hiring laborers to remove aquatic vegetation is an option, but also increases cost.

Landowners removing plants manually should learn to identify the aquatic plant species. If an individual has questions about a particular aquatic plant or what level of manual removal is allowed, they should talk to the Vilas County Land & Water Conservation Department at (715) 479-3648, or the Kevin Gauthier, Lakes Management Coordinator, Wisconsin Department of Natural Resources, 107 Sutliff Ave, Rhinelander, (715) 365-8937. Appendix F includes additional resources for plant identification.

### **6.2.2 AQUATIC INVASIVE PLANT SPECIES CHEMICAL HERBICIDE TREATMENT**

If Horsehead Lake becomes infested with EWM or CLP of areas of approximately ¼ acre or greater, a chemical herbicide treatment may be an appropriate way to conduct restoration of native plants. Before any specific course of action is undertaken the WDNR must be consulted. As of the time this report is written the consultation would begin with Kevin Gauthier, Lakes Management Coordinator in Rhinelander, (715) 365-8937. All herbicide treatments must be undertaken with a WDNR issued permit (NR 107 Wisconsin Administrative Code). A WDNR, AIS Early Detection and Rapid Response Grant are usually the best place for a lake group to receive financial assistance for chemical treatment of a newly discovered AIS population.

When using chemicals to control AIS it is a good idea to reevaluate the lake and the extent of the AIS conditions before, during and after chemical treatment. The WDNR may require another whole-lake plant survey and will certainly require a proposed treatment area survey. Along with the above mentioned survey, pre and post treatment monitoring should be included for all aquatic plant treatments and is typically a WDNR requirement in their Northern Region.

The science regarding what chemicals are most effective and how they can be used is constantly being updated. Currently EWM is the most common aquatic invasive plant species targeted for chemical treatment in the Northwoods. At present, granular 2,4-D is the most common herbicide used on EWM in the Northwood's area. In order to decrease damage to native plants and be as selective as possible for EWM, treatments are completed in the spring when native plant growth is minimal.

Chemical treatment is usually a long term commitment and requires a specific plan with a goal set for "tolerable" levels of the relevant AIS. One such landmark might be 10% or less of the littoral area being occupied by aquatic invasive plants. WDNR recommends conducting a whole-lake point-intercept survey on a five year bases (for Horsehead Lake the next would be 2012). Such a survey may reveal new AIS and at the very least would provide good trend data to see how the aquatic plant community is evolving.

Advantages of herbicides include broader control than hand pulling, and represents a true restoration effort, which harvesters do not (this is why harvesters are not discussed in this document). Disadvantages include negative public perception of chemicals in natural lakes, the potential to affect non-target plant species (if not applied at an appropriate application rate and/or time of year) and water use restrictions after application may be necessary.

## 7.0 Conclusion and Recommended Action Plan

No aquatic invasive plants were found during the aquatic plant survey in 2008. The fact that the native plant community had an above average plant FQI illustrates that there is a unique and diverse plant community in Horsehead Lake. Such a plant community is worthy of protection for human disturbance and the potential impact aquatic invasive species would have if introduced to this system. Because of that, the following recommended action plan focuses on maintenance of the current plant community and conservation of native plants.

### 7.1 RECOMMENDED ACTIVE GOALS

The recommended action plan includes actions for Horsehead Lake based on the Maintenance Alternative listed above in Section 6. The PITLC president has approved the following active goals. It will be up to residents of Horsehead Lake and the PITLC to determine the actions, find the funding, and gather the individuals needed to implement the active goals.

**Active Goal:** To initiate the WDNR Clean Boats, Clean Waters program on Horsehead Lake.

**Active Goal:** To provide visitors with educational information concerning the potential impact their activities could have on introductions of aquatic invasive species, wildlife, habitats and Horsehead Lake water quality.

**Active Goal:** To implement and maintain an aquatic invasive species monitoring program that will survey for invasive species, and if any are found, monitor their locations and extent of populations spread.

**Active Goal:** To continue the Horsehead Lake comprehensive water quality monitoring program through the WDNR Citizen Lake Monitoring Network.

**Active Goal:** To work in concert with the WDNR staff and representatives of fishing related businesses to evaluate Horsehead Lake fish management practices and develop goals in order to maintain and enhance a quality family sport fishery.

**Active Goal:** To enforce the Town of Presque Isle's 200 foot no-wake areas (from shoreline and islands) ordinances in order to minimize recreational impacts on the plant community, shoreline habitats, and to promote safe boating.

**Active Goal:** To support the identification and preservation of critical species and critical habitat lands, and wetlands within the watershed. (These are areas with rare vegetation, important habitat for wildlife, or important spawning and nursery areas for fish. Preservation of these lands has a direct impact on the water quality of the lake).

**Active Goal:** To provide education and information to shoreline property owners regarding how native aquatic plant protection and shoreline management can slow the

spread of aquatic invasive plants (if they become introduced), improve the lake fishery, improve wildlife habitat and affect the quality of the water in the lake (including development of a *shoreline restoration packet* that could be given to landowners who's property has development categorized as Moderate or Major).

**Active Goal:** To encourage the incorporation of water quality protection measures in the design, construction and maintenance of all lake access sites on Horsehead Lake (e.g. storm water control, site drainage control, appropriate plant matter disposal, and watercraft wash down facilities if found to be needed).

**Active Goal:** To meet on a regular basis with local government agencies and representatives of lakes located within the Town of Presque Isle, to identify essential and new lake management issues and determine collaborative solutions.

## 7.2 CLOSING

This APM Plan was prepared in cooperation with the Presque Isle Town Lakes Committee. It includes the major components outlined in the WDNR Aquatic Plant Management guidance. The "Recommended Action Plan" section of this report can be used as a stand alone document to facilitate EWM management activities for the lake. This section outlines important monitoring and management activities. The greater APM Plan document and appendices provides a central source of information for the lake's aquatic plant community information, the overall lake ecology, and sources of additional information. If there are any questions about how to use this APM Plan or its contents, please contact Bonestroo.

This APM Plan should be updated periodically to reflect current aquatic plant problems, and the most recent acceptable APM methods. Information regarding aquatic plant management and protection is available from the WDNR website:

<http://dnr.wi.gov/org/water/fhp/lakes/aquaplan.htm> or from Bonestroo upon request.

## 8.0 References

While not all references are specifically cited, the following resources were used in preparation of this report.

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# Figures

# Tables



# Appendices

## Appendix A - Point Intercept Sample Coordinates

## Appendix B – Importance of Aquatic Plants to Lake Ecosystem

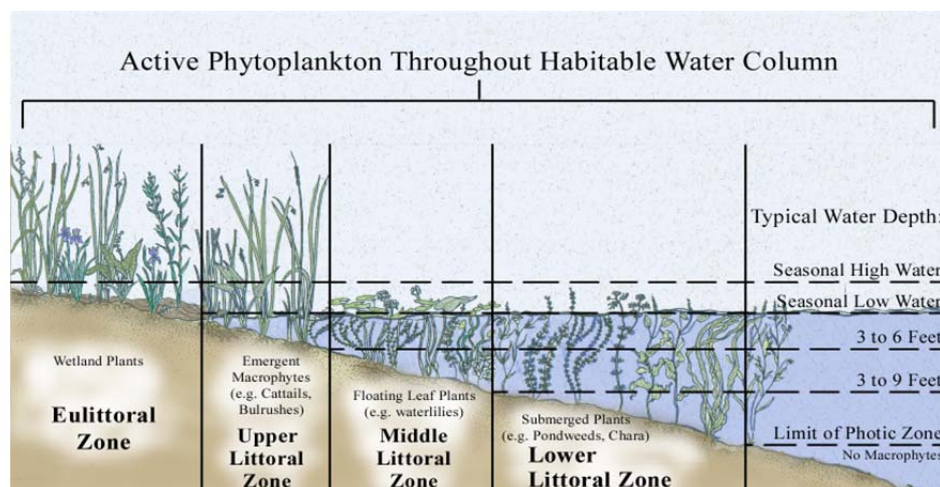
## AQUATIC PLANT TYPES AND HABITAT

Aquatic plants can be divided into two major groups: microphytes (phytoplankton and epiphytes) composed mostly of single-celled algae, and macrophytes that include macro algae, flowering vascular plants, and aquatic mosses and ferns. Wide varieties of macrophytes co-inhabit all habitable areas of a lake. Their abundance depends on light, nutrient availability, and other ecological factors.

In contrast, macrophytes are predominantly found in distinct habitats located in the littoral (i.e., shallow near shore) zone where light sufficient for photosynthesis can penetrate to the lake bottom. The littoral zone is subdivided into four distinct transitional zones: the eulittoral, upper littoral, middle littoral, and lower littoral (Wetzel, 1983).

- Eulittoral Zone:** Includes the area between the highest and lowest seasonal water levels, and often contains many wetland plants.
- Upper Littoral Zone:** Dominated by emergent macrophytes and extends from the shoreline edge to water depths between 3 and 6 feet.
- Middle Littoral Zone:** Occupies water depths of 3 to 9 feet, extending deeper from the upper littoral zone. The middle littoral zone is often dominated by floating-leaf plants.
- Lower Littoral Zone:** Extends to a depth equivalent to the limit of the photic zone, which is the maximum depth that sufficient light can support photosynthesis. This area is dominated by submergent aquatic plant types.

The following illustration depicts these particular zones and aquatic plant communities.



**Aquatic Plant Communities Schematic**



The abundance and distribution of aquatic macrophytes are controlled by light availability, lake trophic status as it relates to nutrients and water chemistry, sediment characteristics, and wind energy. Lake morphology and watershed characteristics relate to these factors independently and in combination (NALMS, 1997).

### **AQUATIC PLANTS AND WATER QUALITY**

In many instances aquatic plants serve as indicators of water quality due to the sensitive nature of plants to water quality parameters such as water clarity and nutrient levels. To grow, aquatic plants must have adequate supplies of nutrients. Macrophytes and free-floating macrophytes (e.g., duckweed) derive all their nutrients directly from the water. Rooted macrophytes can absorb nutrients from water and/or sediment. Therefore, the growth of phytoplankton and free-floating aquatic plants is regulated by the supply of critical available nutrients in the water column. In contrast, rooted aquatic plants can normally continue to grow in nutrient-poor water if lake sediment contains adequate nutrient concentrations. Nutrients removed by rooted macrophytes from the lake bottom may be returned to the water column when the plants die. Consequently, killing too many aquatic macrophytes may increase nutrients available for algal growth.

In general, an inverse relationship exists between water clarity and macrophyte growth. That is, water clarity is usually improved with increasing abundance of aquatic macrophytes. Two possible explanations are postulated. The first is that the macrophytes and epiphytes out-compete phytoplankton for available nutrients. Epiphytes derive essentially all of their nutrient needs from the water column. The other explanation is that aquatic macrophytes stabilize bottom sediment and limit water circulation, preventing re-suspension of solids and nutrients (NALMS, 1997).

If aquatic macrophyte abundance is reduced, then water clarity may suffer. Water clarity reductions can further reduce the vigor of macrophytes by restricting light penetration. Studies have shown that if 30 percent or less of a lake areas occupied by aquatic plants is controlled, water clarity will generally not be affected. However, lake water clarity will likely be reduced if 50 percent or more of the macrophytes are controlled (NALMS, 1997).

Aquatic plants also play a key role in the ecology of a lake system. Aquatic plants provide food and shelter for fish, wildlife and invertebrates. Plants also improve water quality by protecting shorelines and the lake bottom, adding to the aesthetic quality of the lake and impacting recreational activities.

## Appendix C – Aquatic Invasive Species

## INVASIVE AQUATIC PLANTS

Invasive species have invaded our backyards, forests, prairies, wetlands, and waters. Invasive species are often transplanted from other regions, even from across the globe. "A species is regarded as invasive if it has been introduced by human action to a location, area, or region where it did not previously occur naturally (i.e., is not native), becomes capable of establishing a breeding population in the new location without further intervention by humans, and spreads widely throughout the new location " (Source: WDNR website, Invasive Species, 2007). AIS include plants and animals that affect our lakes, rivers, and wetlands in negative ways. Once in their new environment, AIS often lack natural control mechanisms they may have had in their native ecosystem and may interfere with the native plant and animal interactions in their new "home". Some AIS have aggressive reproductive potential and contribute to ecological declines and problems for water based recreation and local economies. AIS often quickly become a problem in already disturbed lake ecosystems (i.e. one with relatively few native plant species). While native plants provide numerous benefits, AIS can contribute to ecological decline and financial constraints to manage problem infestations.

### Eurasian Watermilfoil (*Myriophyllum spicatum*)

EWM is the most common AIS found in Wisconsin lakes. EWM was first discovered in southeast Wisconsin in the 1960s. During the 1980s, EWM began to spread to other lakes in southern Wisconsin and by 1993 it was common in 39 Wisconsin counties. EWM continues to spread across Wisconsin and is now found in the far northern portion of the state including Vilas County.

Unlike many other plants, EWM 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. EWM is readily dispersed by boats, motors, trailers, bilges, live wells, or bait buckets, and can stay alive for weeks if kept moist (WDNR website, 2007).

Once established in an aquatic community, EWM reproduces from shoot fragments and stolons (runners that creep along the lake bed). As an opportunistic species, EWM 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 EWM 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 (WDNR website, 2007).



Dense stands of EWM also inhibit recreational uses like swimming, boating, and fishing. 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 EWM may lead to deteriorating water quality and algae blooms of infested lakes (WDNR website, 2007).

### **Curly leaf pondweed (*Potamogeton crispus*)**

Curly-leaf pondweed (CLP) spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making CLP one of the first nuisance aquatic plants to emerge in the spring.

The leaves of curly-leaf pondweed are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early July.



CLP becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out-compete native plants in the spring. CLP forms surface mats that interfere with aquatic recreation in mid-summer, when most aquatic plants are growing, CLP plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches (WDNR website, 2007).



### **Purple Loosestrife (*Lythrum salicaria*)**

Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth form. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

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. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.





This plant's optimal habitat includes marshes, stream margins, alluvial 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. Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months (WDNR website, 2007).

#### **OTHER AQUATIC INVASIVE SPECIES**

The following AIS are not plants, but are mentioned here because they also can significantly disrupt healthy aquatic ecosystems.

**Rusty Crayfish (*Orconectes rusticus*)** are large crustaceans that feed aggressively on aquatic plants, small invertebrates, small fish, and fish eggs. They can remove nearly all the aquatic vegetation from a lake, offsetting the balance of a lake ecosystem. More information about this invader can be found at <http://dnr.wi.gov/invasives/fact/rusty.htm>.

**Zebra Mussels (*Dreissena polymorpha*)** are small freshwater mussels that can attach to hard substrates in water bodies, often forming large masses of thousands of individual mussels. They are prolific filter feeders, removing valuable phytoplankton from the water, which is the base of the food chain in an aquatic ecosystem. More information about this invader can be found at <http://dnr.wi.gov/invasives/fact/zebra.htm>.

**Spiny Water Fleas (*Bythotrephes cederstoemi*)** are predatory zooplankton (tiny aquatic animals) that have a barbed tail making up most of their body length (one centimeter average). They compete with small fish for food supplies (zooplankton) and small fish cannot swallow the spiny water flea due to the long spiny appendage. More research is being completed to determine the potential impacts of the spiny water flea. More information about this invader can be found at <http://dnr.wi.gov/invasives/fact/spiny.htm>.

## Appendix D – Descriptions of Aquatic Plants

## Appendix E – Summary of Aquatic Plant Management Alternatives

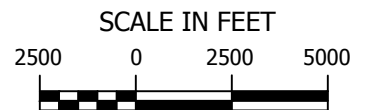
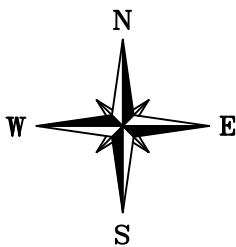
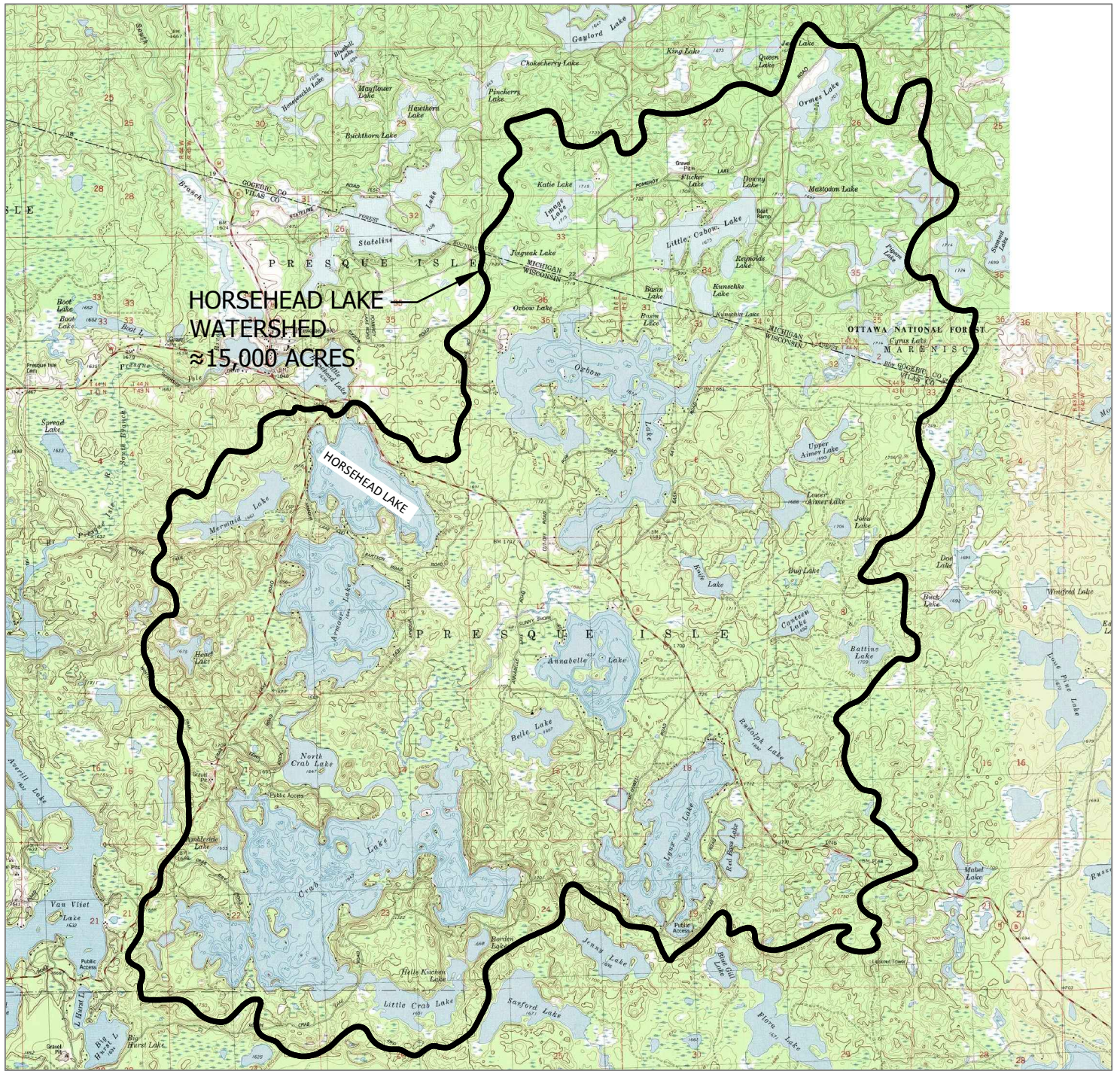
# Appendix F – NR 107 and NR 109 Wisconsin Administrative Code

## Appendix G – Resource for Additional Information

## Appendix H – Aquatic Plant Management Strategy, Northern Region WDNR, Summer, 2007 (working draft)

# Appendix I – Dissolved Oxygen and Temperature Readings





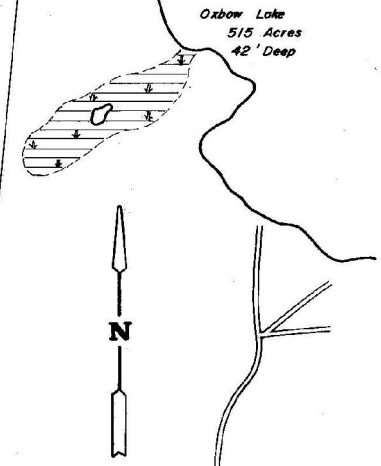
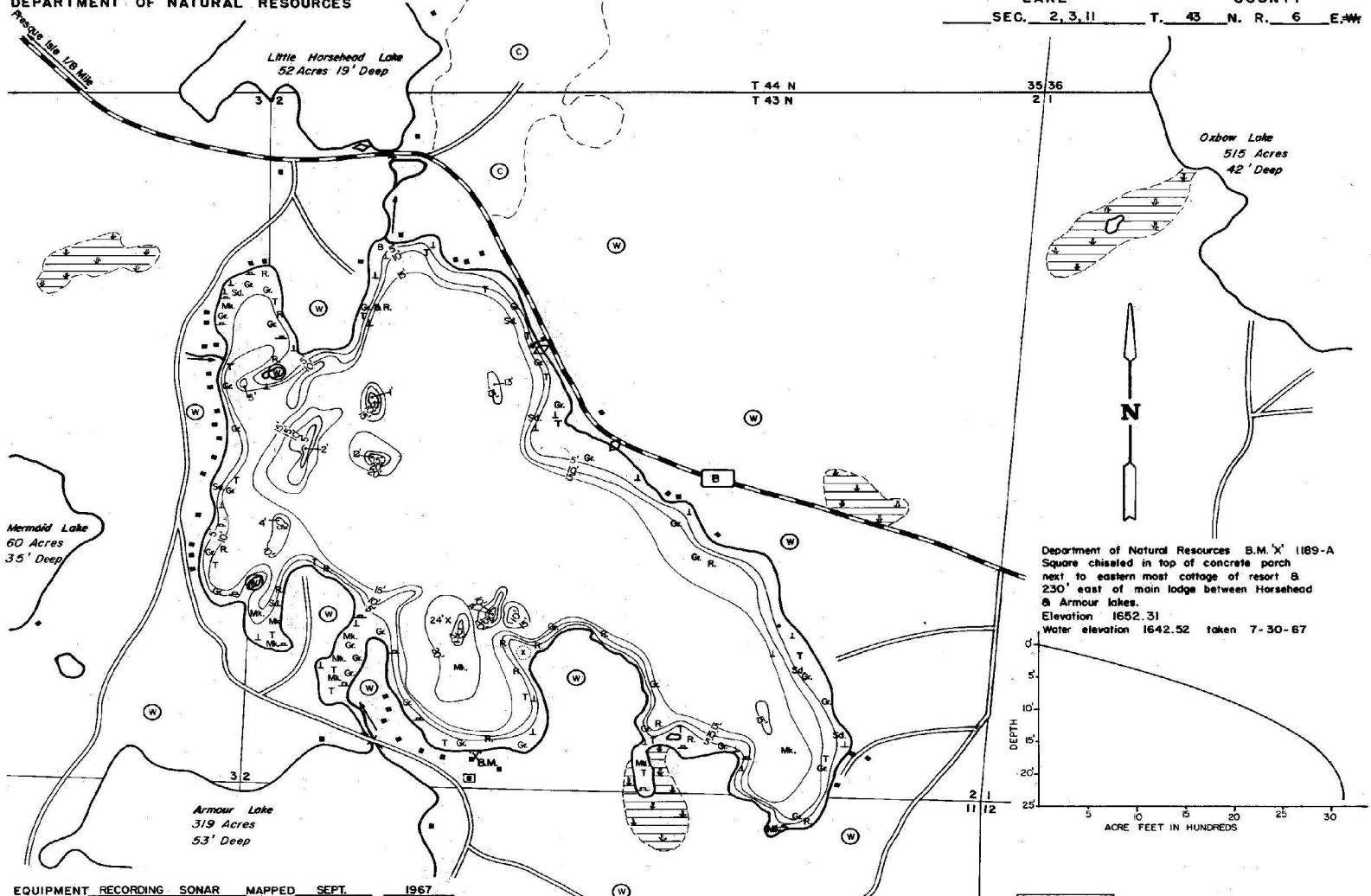
**HORSEHEAD LAKE REGIONAL WATERSHED**

LAKE WATERSHEDS - PRESQUE ISLE  
 VILAS COUNTY, WISCONSIN

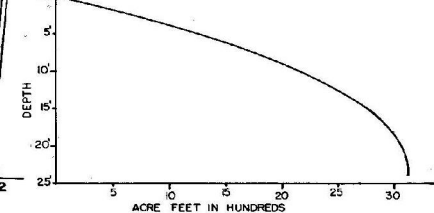
**FIGURE 1**







Department of Natural Resources B.M. X' (189-A)  
Square chiseled in top of concrete porch  
next to eastern most cottage of resort B  
230' east of main lodge between Horsehead  
& Armour lakes.  
Elevation 1652.31  
Water elevation 1642.52 taken 7-30-67



- |   |                               |                    |                           |
|---|-------------------------------|--------------------|---------------------------|
| <b>EQUIPMENT RECORDING SONAR MAPPED</b> | <b>SEPT 1967</b>              | <b>LAKE BOTTOM</b> | <b>SYMBOLS</b>            |
| <b>TOPOGRAPHIC SYMBOLS</b>              |                               |                    |                           |
| (B) Brush                               | (     ) Steep slope           | P. Peat            | B Boulders                |
| (PW) Partially wooded                   | (---) Indefinite shoreline    | Mk. Muck           | Stumps & Snags            |
| (W) Wooded                              | (---) Marsh                   | C. Clay            | Rock danger to navigation |
| (C) Cleared                             | (---) Spring                  | M. Marl            | T Submergent vegetation   |
| (P) Pastured                            | (---) Intermittent stream     | Sd. Sand           | I Emergent vegetation     |
| (A) Agricultural                        | (---) Permanent inlet         | Sl. Silt           | Floating vegetation       |
| B.M. Bench Mark                         | (---) Permanent outlet        | Gr. Gravel         | Brush shelters            |
| (#) Dwelling                            | (---) Dam                     | R. Rubble          |                           |
| (R) Resort                              | (---) D.N.R. State owned land | Bc Bedrock         |                           |
| (C) Camp                                |                               |                    |                           |

500' 0' 500' 1000' 1500' 2000'  
SCALE  
◆ Access ◆ Access with Parking ◆ Boat Livery  
Drawn by R.A. Burnham  
Field work by P. Michelson, J. Smith

SPECIES OF FISH	Abundance		
	Common	Present	
Muskie			
N. Pike	X	X	X
Walleye	X	X	X
L. N. Bass	X	X	X
S. M. Bass	X	X	X
Panfish	X	X	X
Trout			

WATER AREA 234.3 ACRES  
UNDER 3 FT. 10 %  
OVER 20 FT. 4 %  
MAX. DEPTH 24 FEET.  
TOTAL ALK. 31 P.P.M.  
VOLUME 3115.1 ACRE FT.  
SHORELINE 4.07 MILES

**2010 AQUATIC PLANT SURVEY**  
**HORSEHEAD LAKE**  
**TOWN OF PRESQUE ISLE - PITLC**  
**VILAS COUNTY, WISCONSIN**

FIGURE 2





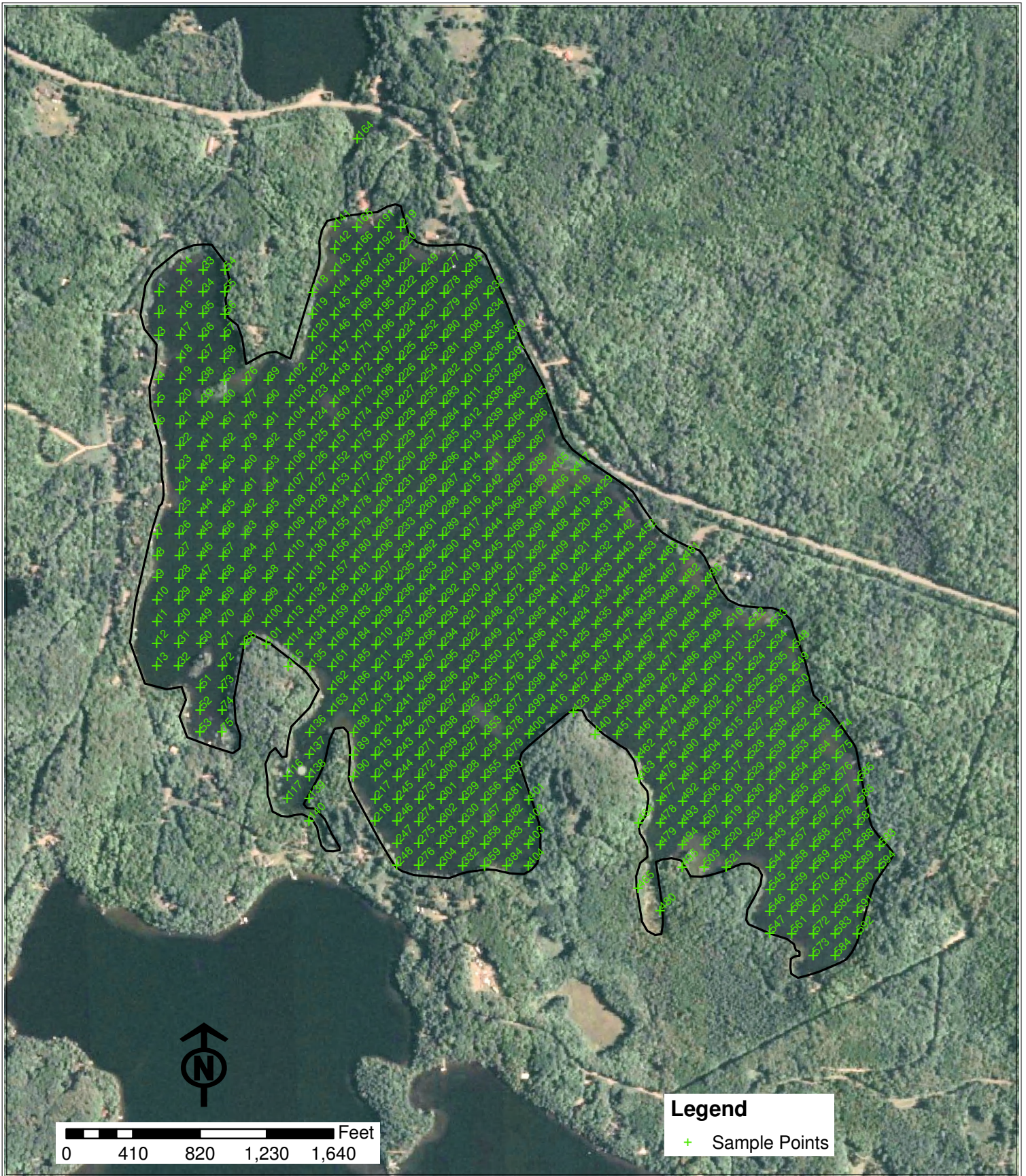
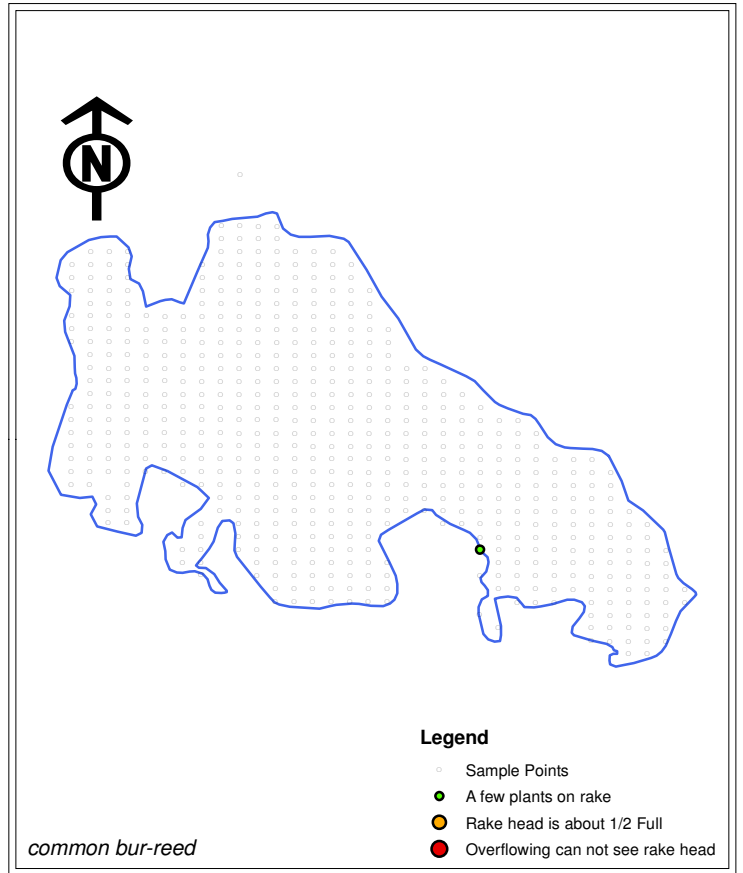
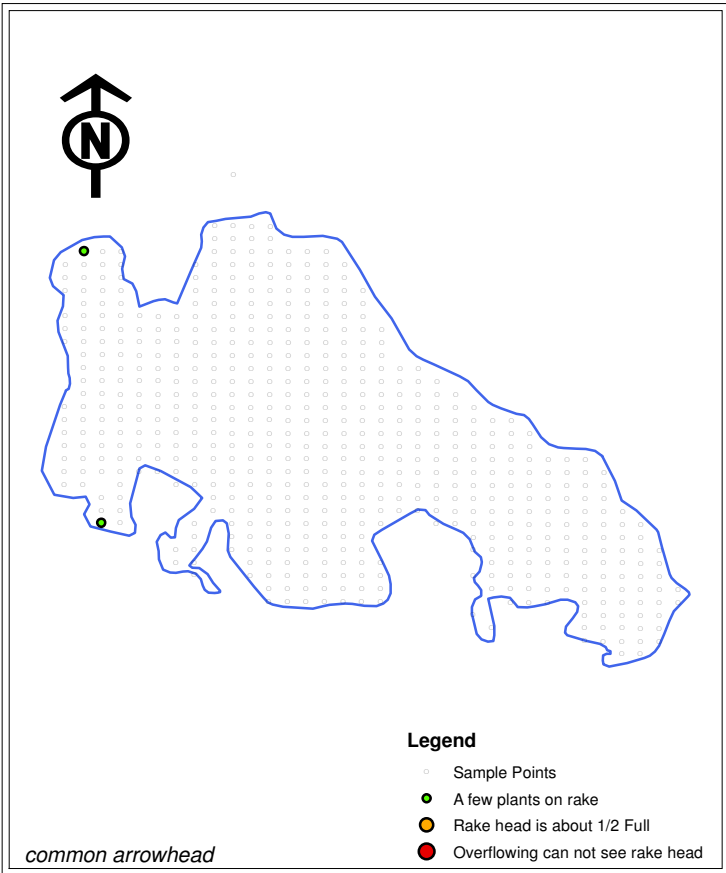
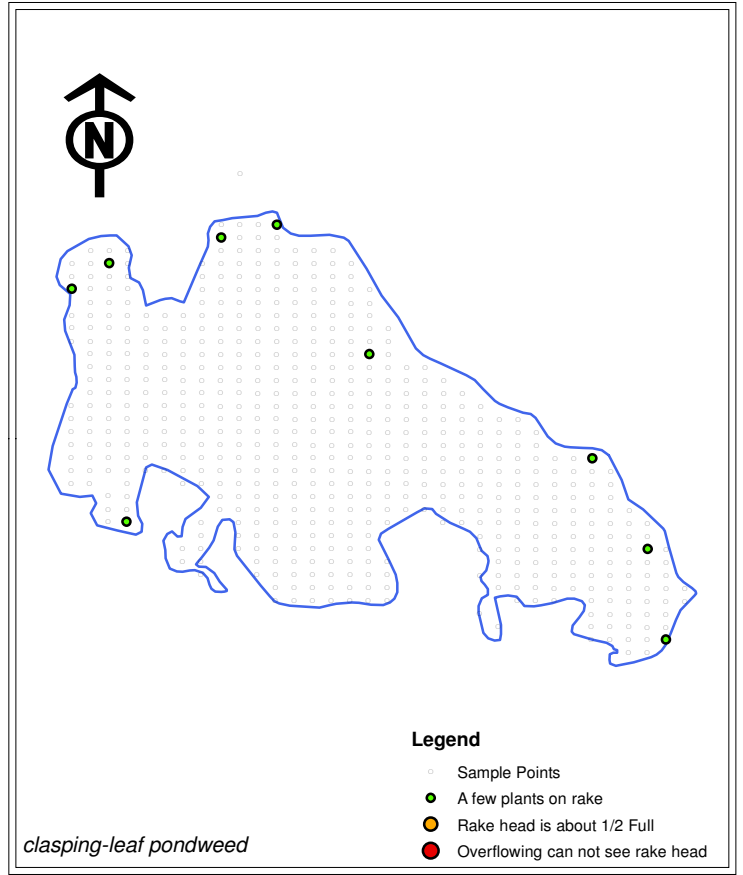
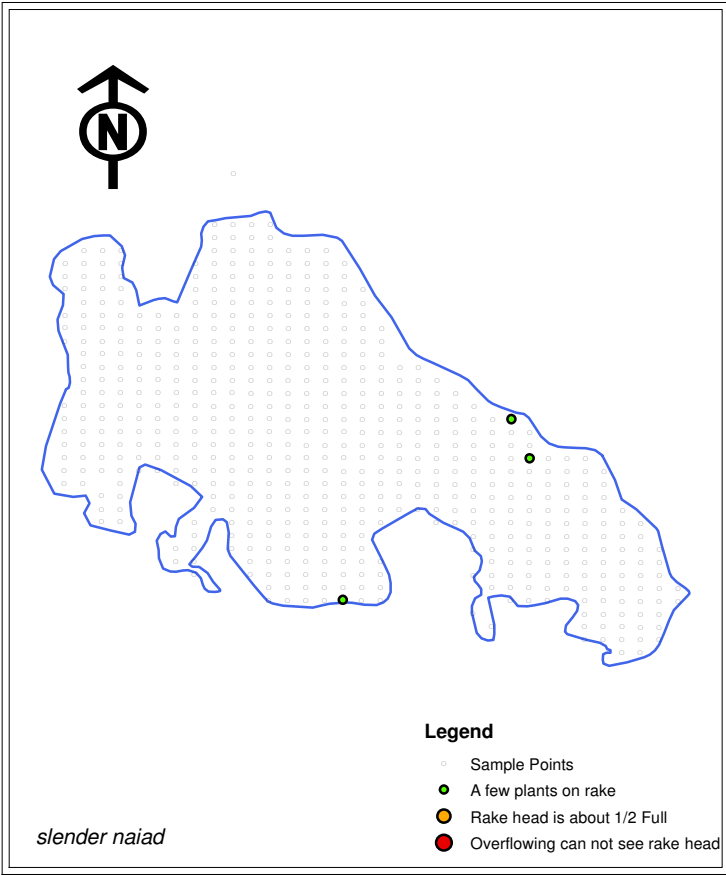


FIGURE 3

**2010 AQUATIC PLANT SURVEY**  
**HORSEHEAD LAKE**  
**TOWN OF PRESQUE ISLE - PITLC**  
**VILAS COUNTY, WISCONSIN**





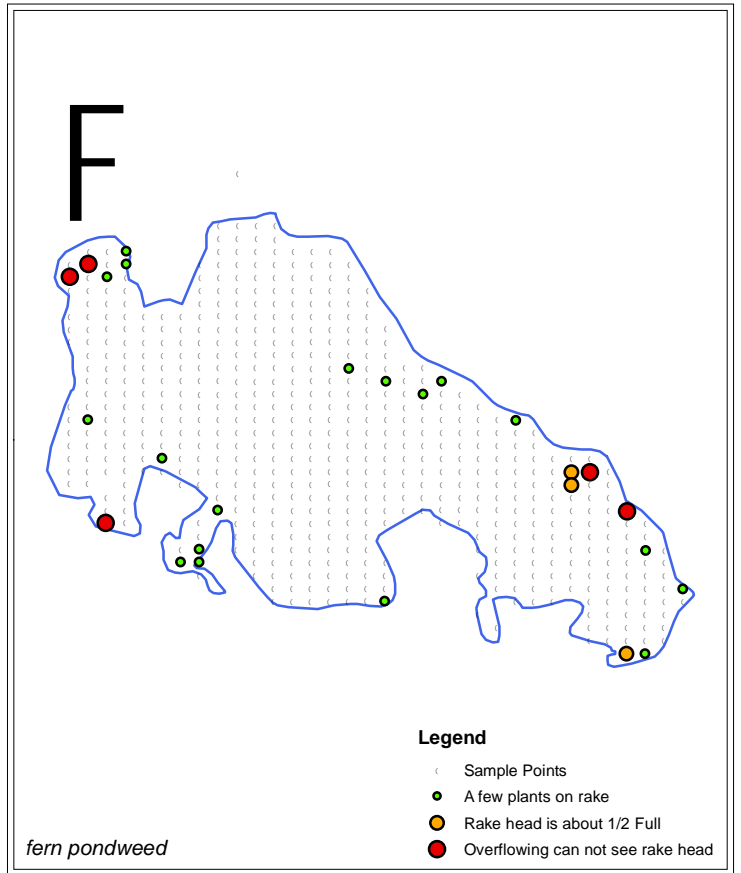
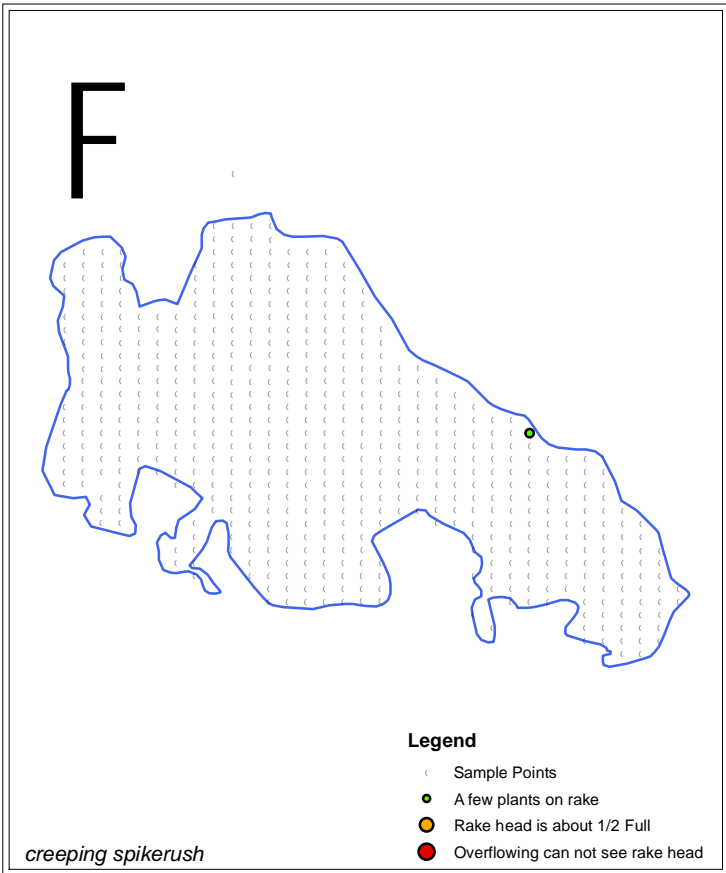
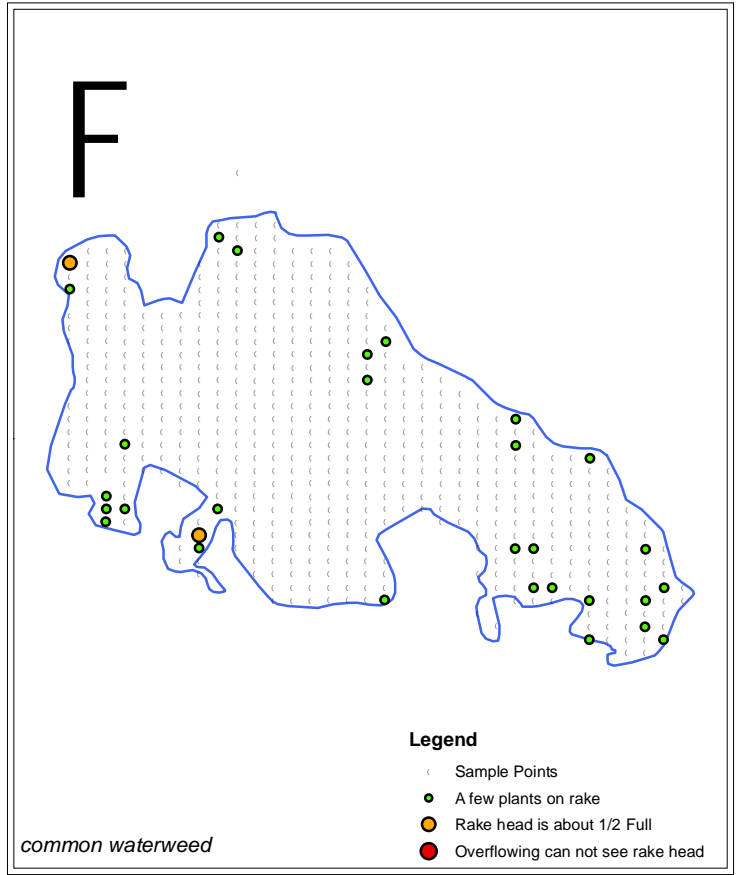
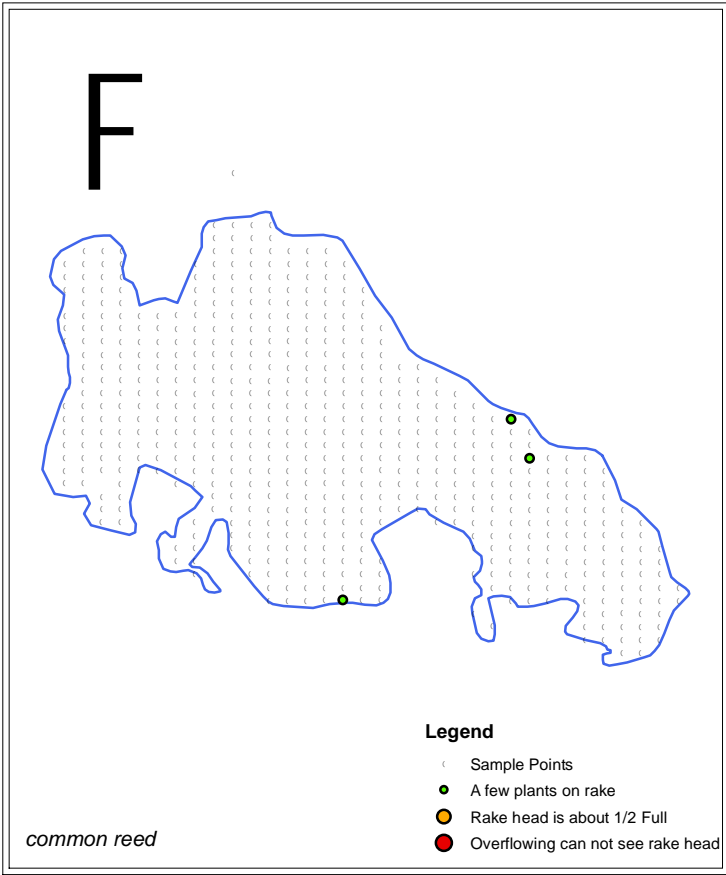


# **AQUATIC PLANT DISTRIBUTION MAP**

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4A



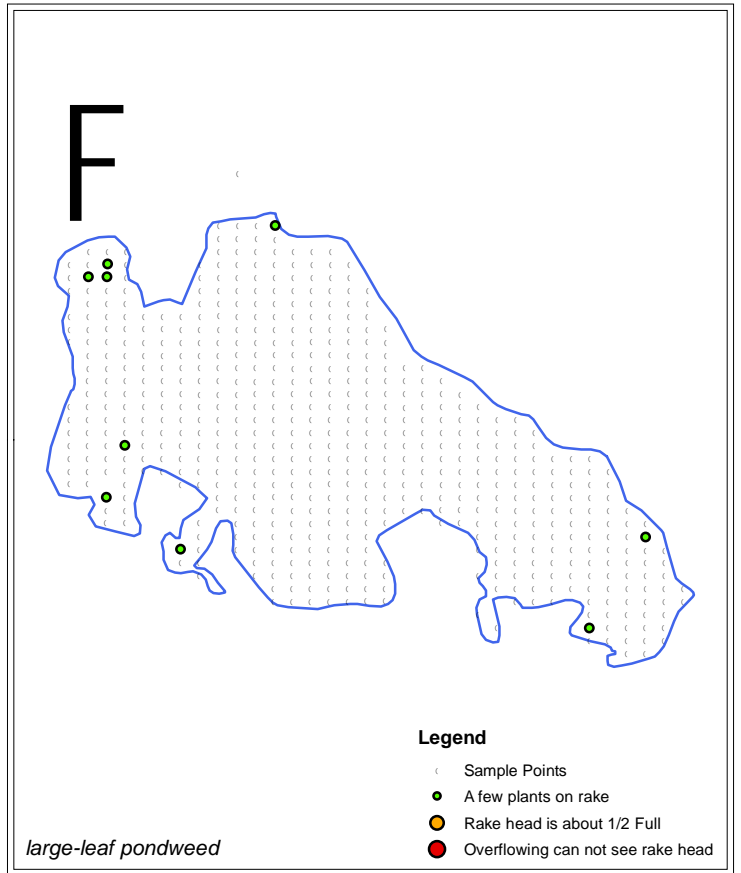
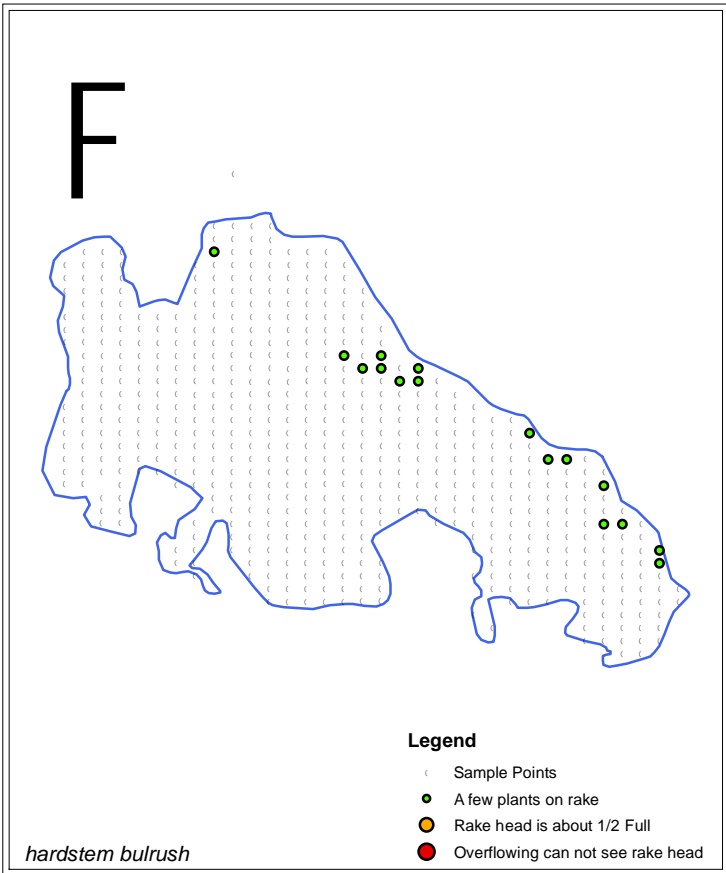
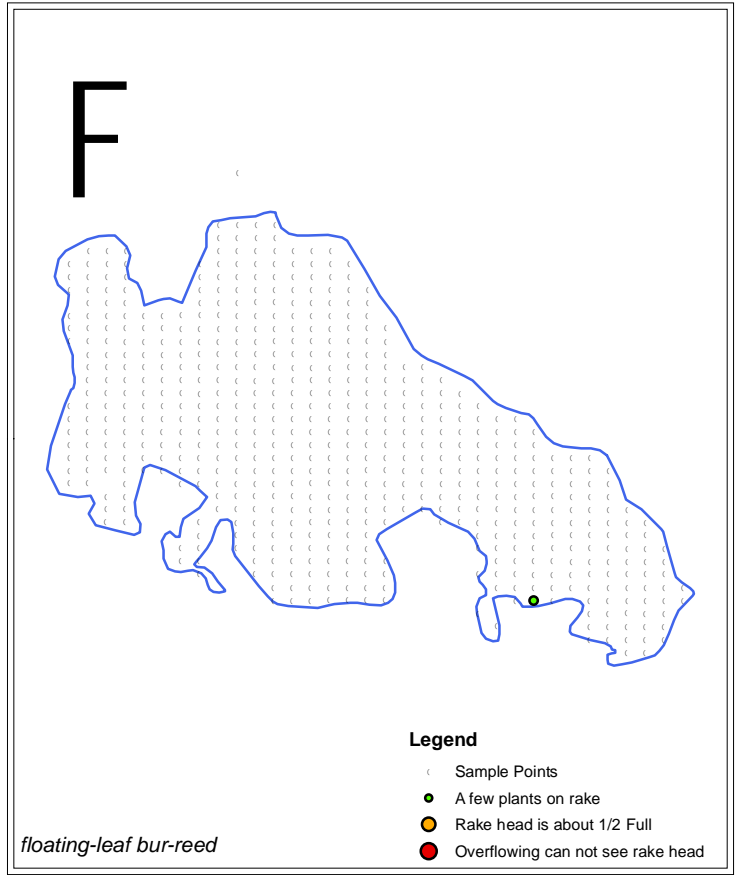
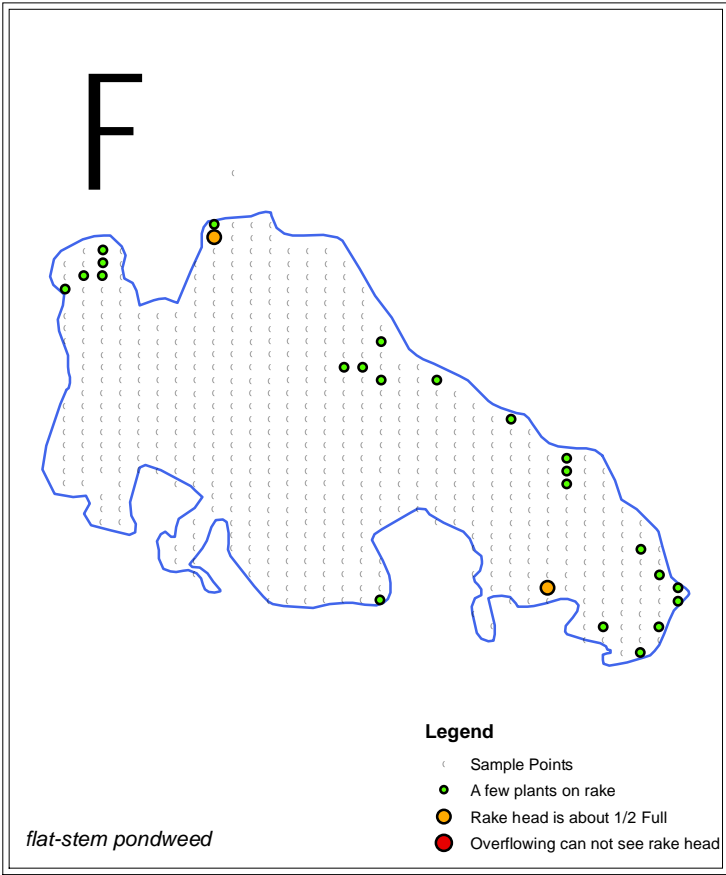


## AQUATIC PLANT DISTRIBUTION MAP

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4B



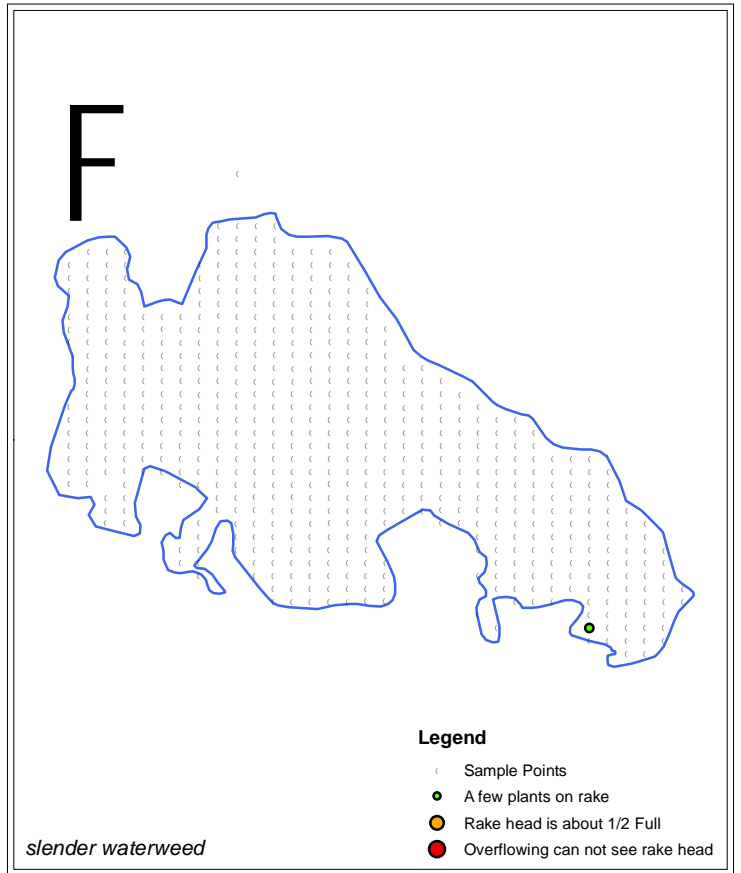
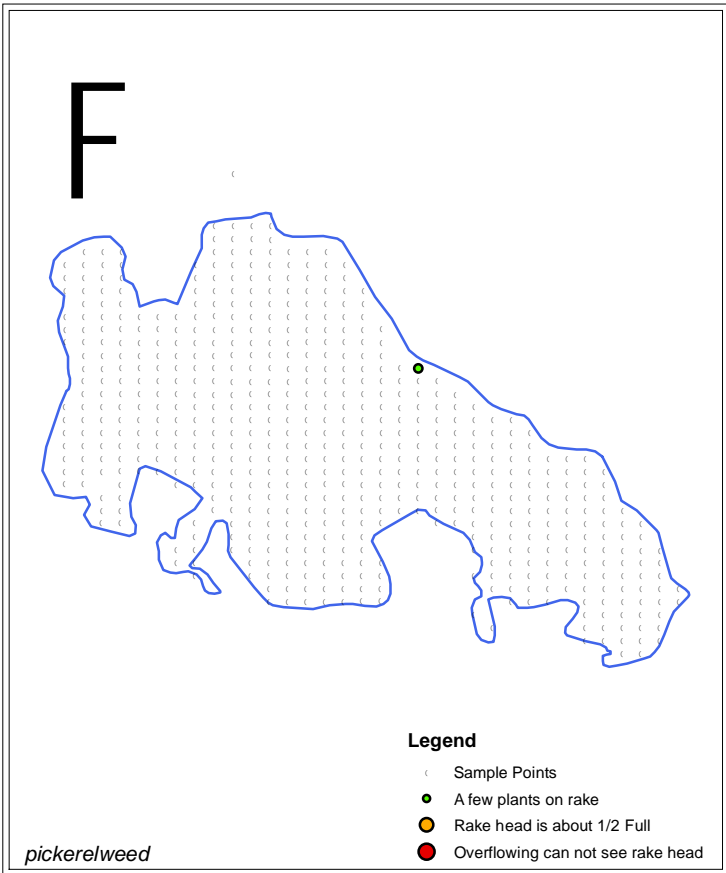
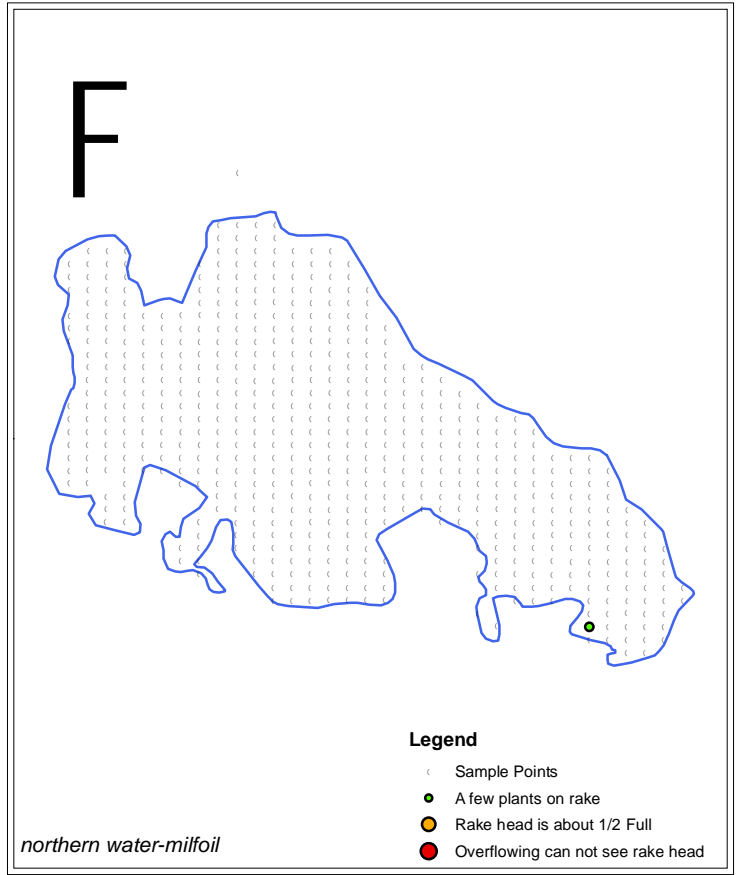
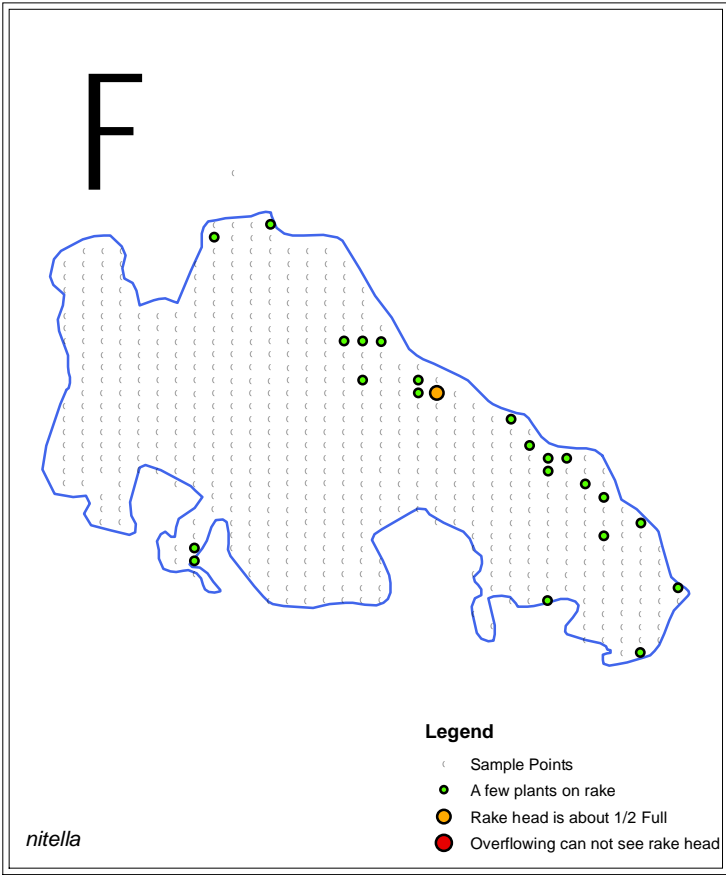


## AQUATIC PLANT DISTRIBUTION MAP

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4C



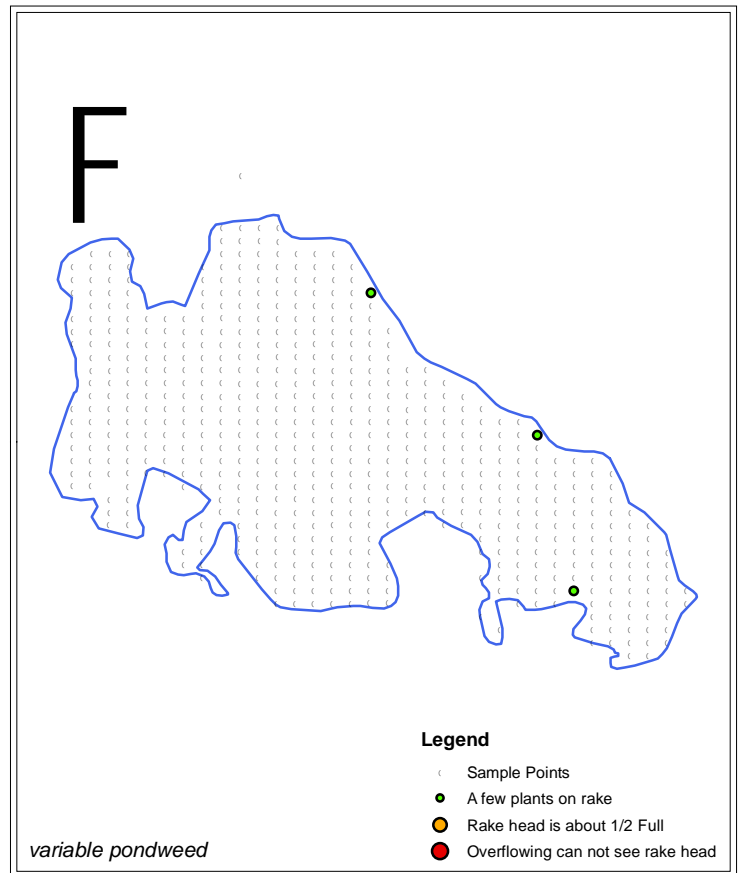
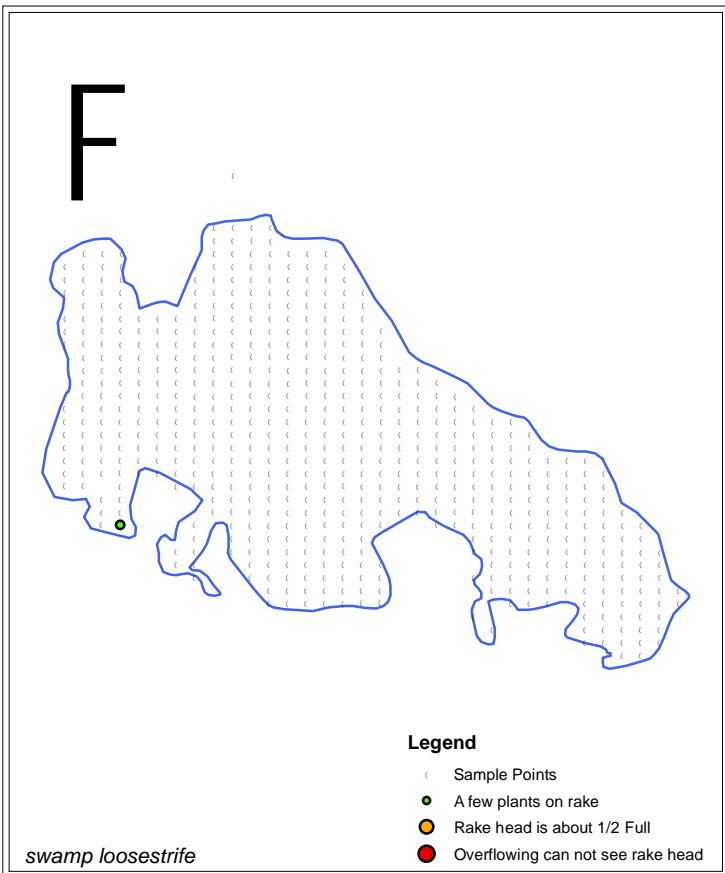
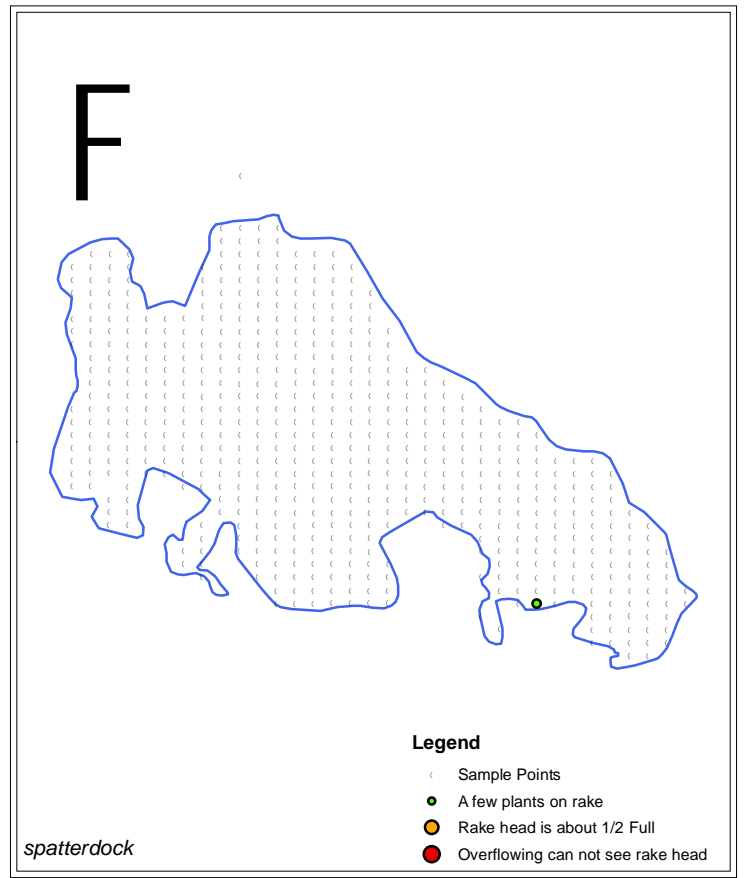
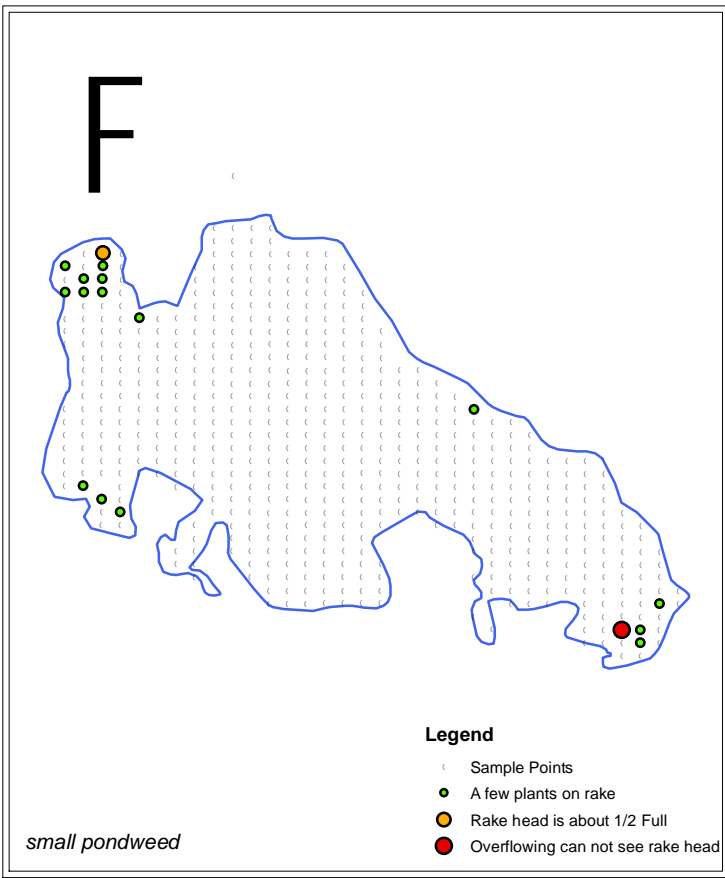


**AQUATIC PLANT DISTRIBUTION MAP**

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4D



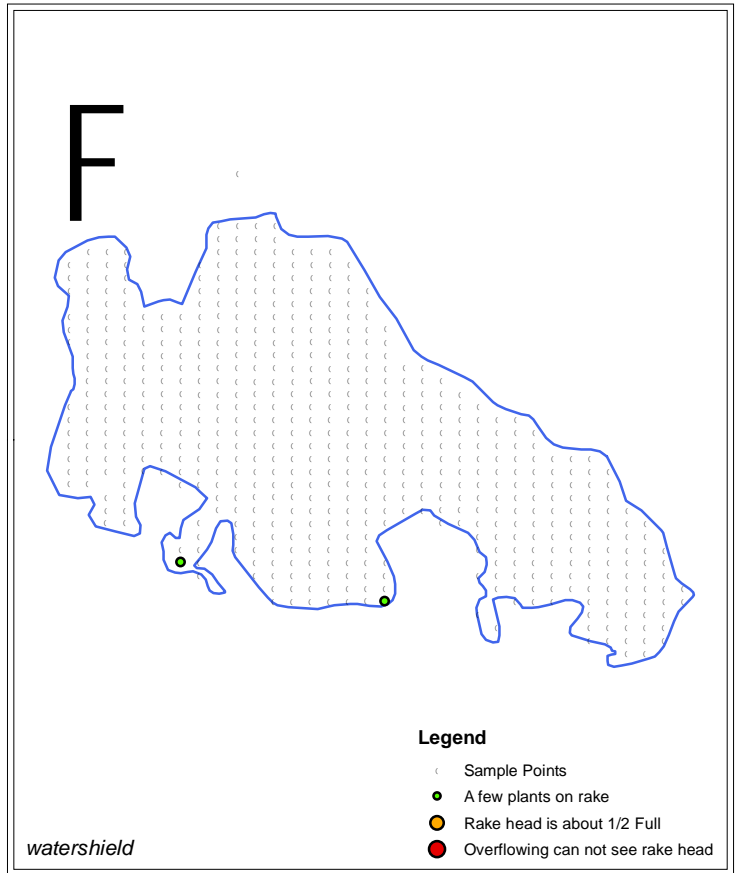
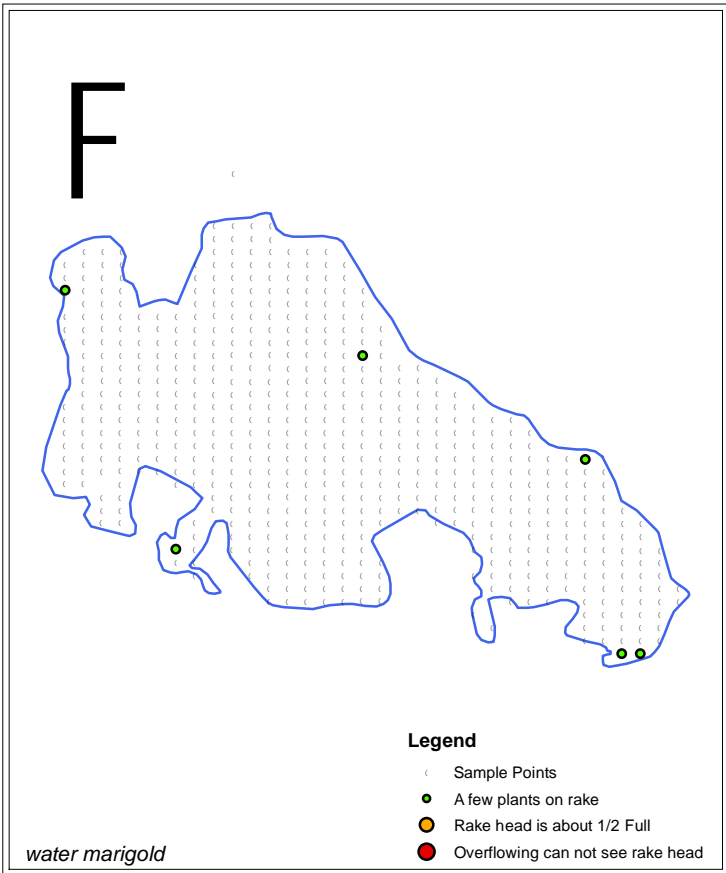
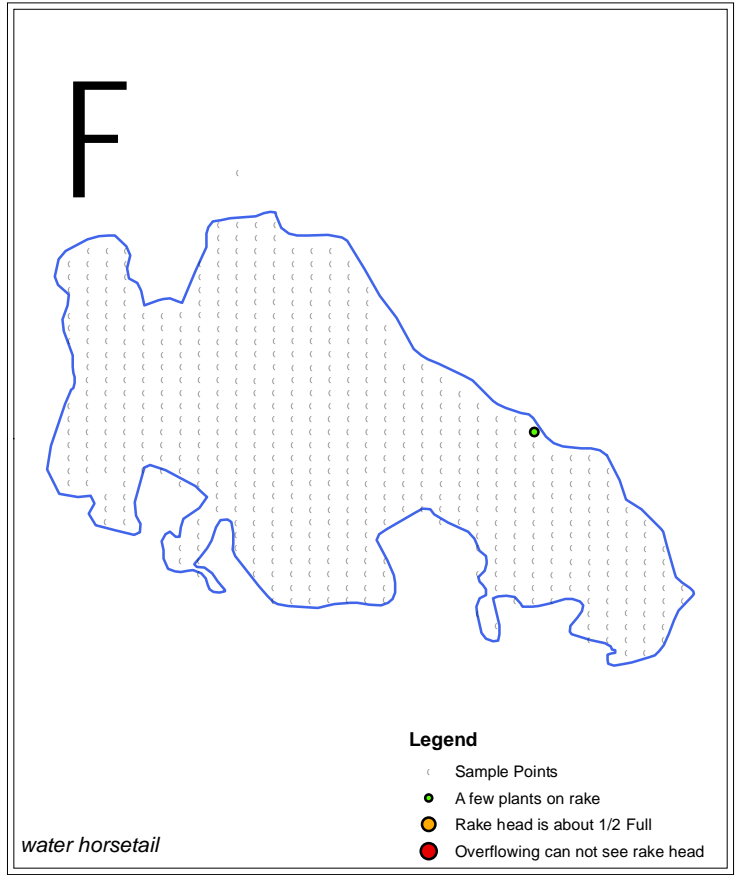
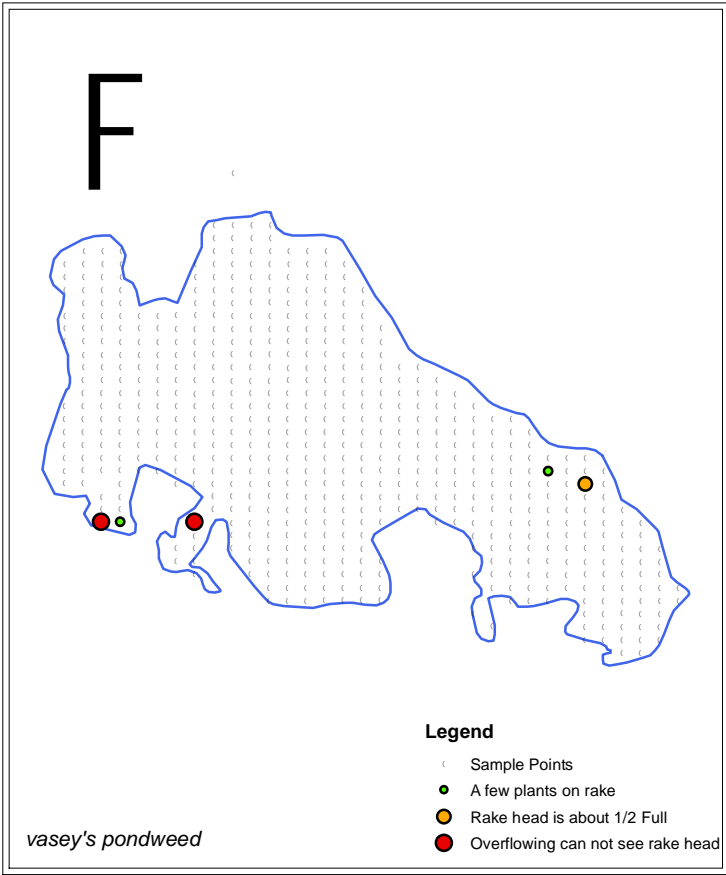


**AQUATIC PLANT DISTRIBUTION MAP**

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4E





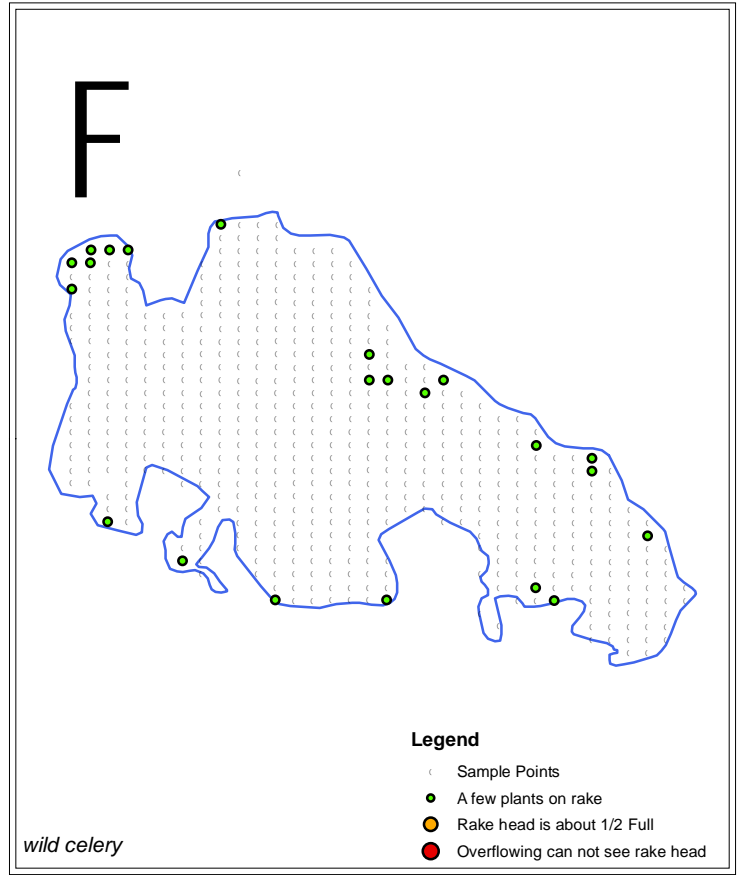
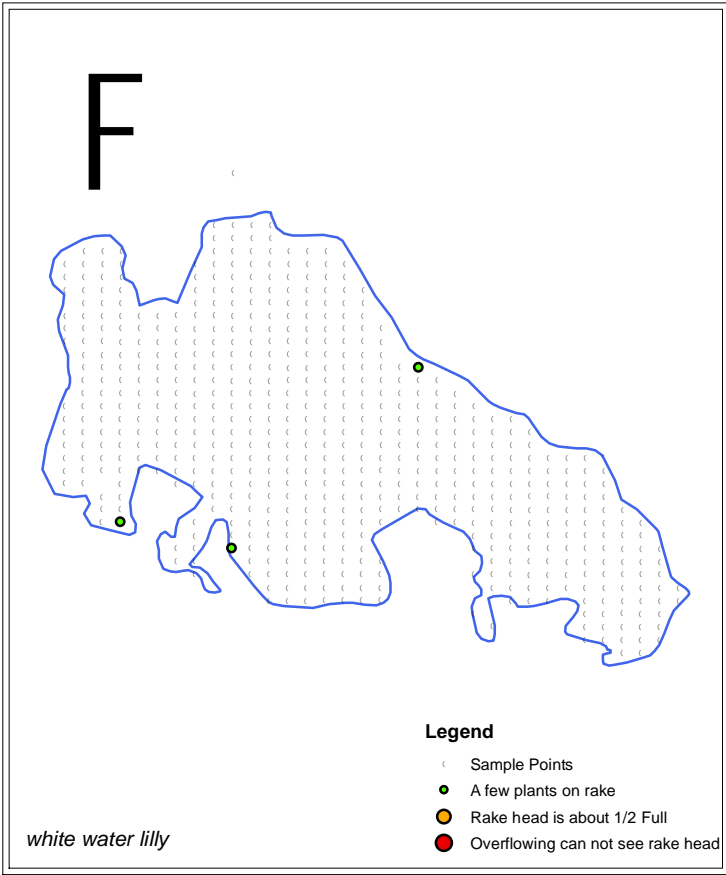
**AQUATIC PLANT DISTRIBUTION MAP**

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLC  
VILAS COUNTY, WISCONSIN**

FIGURE 4F



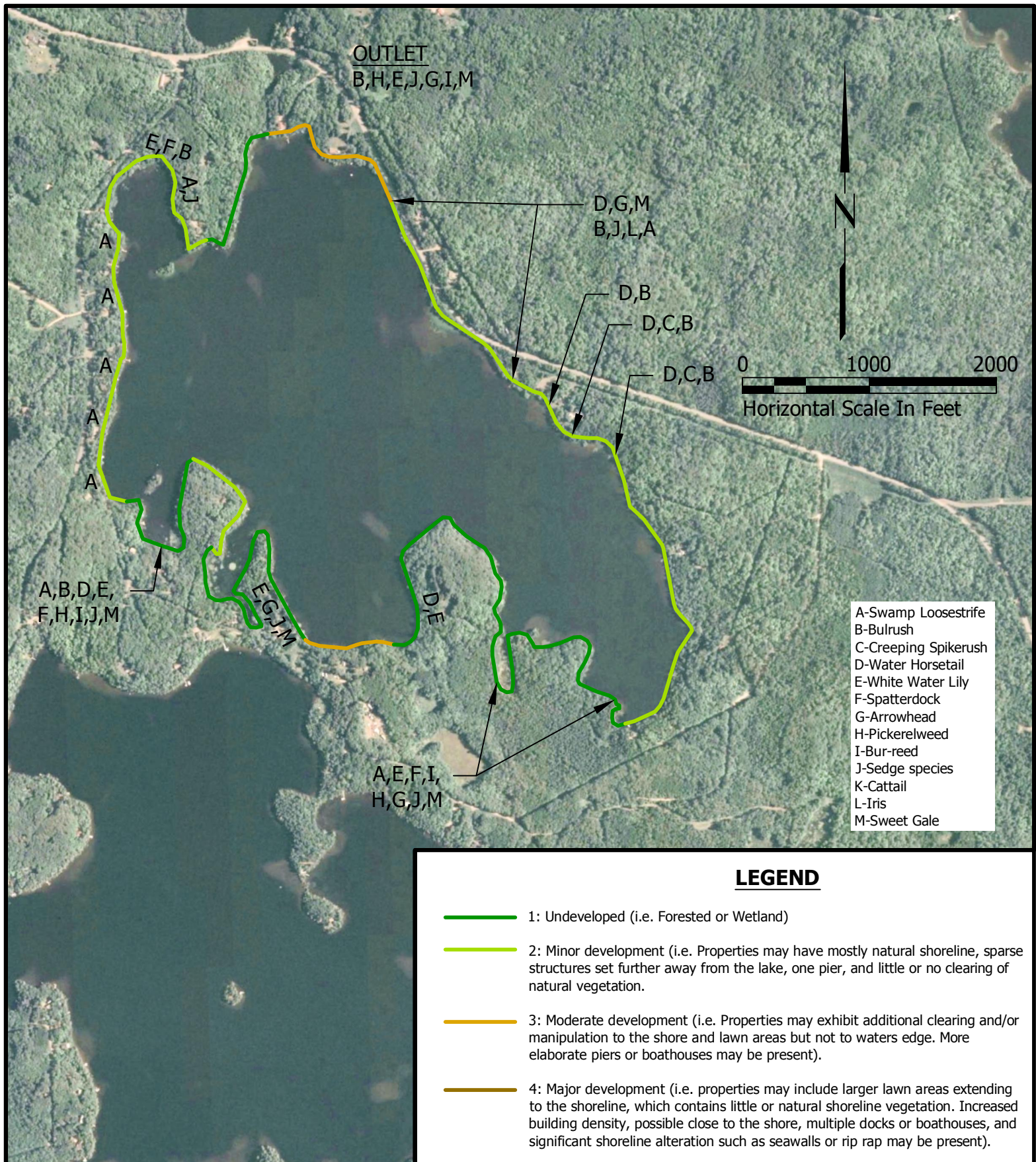




## AQUATIC PLANT DISTRIBUTION MAP

**HORSEHEAD LAKE  
TOWN OF PRESQUE ISLE - PITLCC  
VILAS COUNTY, WISCONSIN**

FIGURE 4G



## SHORELINE CHARACTERIZATION

TOWN OF PRESQUE ISLE  
HORSEHEAD LAKE, VILAS COUNTY, WISCONSIN

FIGURE: 5



**Table 1: Taxa Detected During 2008 Aquatic Plant Survey, Horsehead Lake, Vilas County, WI**

<b>Genus</b>	<b>Species</b>	<b>ID</b>	<b>Common Name</b>	<b>Category</b>
<i>Bidens</i>	<i>beckii</i>	1	Water marigold	Submersed
<i>Brasenia</i>	<i>schreberi</i>	2	Watershield	Floating-leaf
<i>Decodon</i>	<i>verticillatus</i>	3	Swamp loosestrife	Emergent
<i>Eleocharis</i>	<i>palustris</i>	4	Creeping spikerush	Emergent
<i>Elodea</i>	<i>canadensis</i>	5	Common waterweed	Submersed
<i>Elodea</i>	<i>nuttalli</i>	6	Slender waterweed	Submersed
<i>Equisetum</i>	<i>fluviatile</i>	7	Water horsetail	Emergent
<i>Myriophyllum</i>	<i>sibiricum</i>	8	Northern water milfoil	Submersed
<i>Najas</i>	<i>flexilis</i>	9	Slender naiad	Submersed
<i>Nitella</i>	<i>sp.</i>	10	Nitella	Submersed
<i>Nuphar</i>	<i>variegata</i>	11	Spatterdock	Floating-leaf
<i>Nymphaea</i>	<i>odorata</i>	12	White water lily	Floating-leaf
<i>Phragmites</i>	<i>australis</i>	13	Giant reed	Emergent
<i>Pontederia</i>	<i>cordata</i>	14	Pickerelweed	Emergent
<i>Potamogeton</i>	<i>amplifolius</i>	15	Large-leaf pondweed	Submersed
<i>Potamogeton</i>	<i>gramineus</i>	16	Variable-leaf pondweed	Submersed
<i>Potamogeton</i>	<i>pusillus</i>	17	Small pondweed	Submersed
<i>Potamogeton</i>	<i>richardsonii</i>	18	Clasping-leaf pondweed	Submersed
<i>Potamogeton</i>	<i>robbinsii</i>	19	Fern pondweed	Submersed
<i>Potamogeton</i>	<i>vaseyii</i>	20	Vasey's pondweed	Submersed
<i>Potamogeton</i>	<i>zosteriformis</i>	21	Flat-stem pondweed	Submersed
<i>Sagittaria</i>	<i>latifolia</i>	22	Common arrowhead	Emergent
<i>Schoenoplectus</i>	<i>acutus</i>	23	Hardstem bulrush	Emergent
<i>Sparganium</i>	<i>eurycarpum</i>	24	Common bur-reed	Emergent
<i>Sparganium</i>	<i>fluctuans</i>	25	Floating-leaf bur-reed	Emergent
<i>Vallisneria</i>	<i>americana</i>	26	Wild celery	Submersed

**Table 2: 2008 Aquatic Plant Community Statistics, Horsehead Lake, Vilas County, WI**

<b>Aquatic Plant Community Statistics</b>	<b>2008</b>
Frequency of occurrence at sites shallower than maximum depth of plants	25.66%
Simpson Diversity Index	0.91
Maximum Depth of Plants (Feet)	17
Taxonomic Richness (Number Taxa)	26
Average Number of Species per Site (sites less than max depth of plant growth)	0.51
Average Number of Species per Site (sites with vegetation)	1.97
Average Number of NATIVE Species per Site (sites less than max depth of plant growth)	0.51
Average Number of NATIVE Species per Site (sites with vegetation)	1.97



**Table 3: 2008 Aquatic Plant Taxa-Specific Statistics, Horsehead Lake, Vilas County, WI**

Genus	Species	Common Name	Percent Frequency of Occurrence within vegetated areas	Percent Frequency of Occurrence at sites shallower than max depth of plants	Percent Relative Frequency of Occurrence	Number of Intercept Points Where Detected	Average Density
<i>Bidens</i>	<i>beckii</i>	Water marigold	5.61	1.44	2.84	6	1
<i>Brasenia</i>	<i>schreberi</i>	Watershield	1.87	0.48	0.95	2	1
<i>Decodon</i>	<i>verticillatus</i>	Swamp loosestrife	0.93	0.24	0.47	1	1
<i>Eleocharis</i>	<i>palustris</i>	Creeping spikerush	0.93	0.24	0.47	1	1
<i>Elodea</i>	<i>canadensis</i>	Common waterweed	28.04	7.19	14.22	30	1
<i>Elodea</i>	<i>nuttalli</i>	Slender waterweed	0.93	0.24	0.47	1	1
<i>Equisetum</i>	<i>fluviatile</i>	Water horsetail	0.93	0.24	0.47	1	1
<i>Myriophyllum</i>	<i>sibiricum</i>	Northern water milfoil	0.93	0.24	0.47	1	1
<i>Najas</i>	<i>flexilis</i>	Slender naiad	2.80	0.72	1.42	3	1
<i>Nitella</i>	<i>sp.</i>	Nitella	21.50	5.52	10.90	23	1
<i>Nuphar</i>	<i>variegata</i>	Spatterdock	0.93	0.24	0.47	1	1
<i>Nymphaea</i>	<i>odorata</i>	White water lily	2.80	0.72	1.42	3	1
<i>Phragmites</i>	<i>australis</i>	Giant reed	0.93	0.24	0.47	1	1
<i>Pontederia</i>	<i>cordata</i>	Pickerelweed	0.93	0.24	0.47	1	1
<i>Potamogeton</i>	<i>amplifolius</i>	Large-leaf pondweed	8.41	2.16	4.27	9	1
<i>Potamogeton</i>	<i>gramineus</i>	Variable-leaf pondweed	2.80	0.72	1.42	3	1
<i>Potamogeton</i>	<i>pusillus</i>	Small pondweed	15.89	4.08	8.06	17	1
<i>Potamogeton</i>	<i>richardsonii</i>	Clasping-leaf pondweed	8.41	2.16	4.27	9	1
<i>Potamogeton</i>	<i>robbinsii</i>	Fern pondweed	24.30	6.24	12.32	26	2
<i>Potamogeton</i>	<i>vaseyii</i>	Vasey's pondweed	4.67	1.20	2.37	5	2
<i>Potamogeton</i>	<i>zosteriformis</i>	Flat-stem pondweed	23.36	6.00	11.85	25	1
<i>Sagittaria</i>	<i>latifolia</i>	Common arrowhead	1.87	0.48	0.95	2	1
<i>Schoenoplectus</i>	<i>acutus</i>	Hardstem bulrush	14.95	3.84	7.58	16	1
<i>Sparganium</i>	<i>eurycarpum</i>	Common bur-reed	0.93	0.24	0.47	1	1
<i>Sparganium</i>	<i>fluctuans</i>	Floating-leaf bur-reed	0.93	0.24	0.47	1	1
<i>Vallisneria</i>	<i>americana</i>	Wild celery	20.56	5.28	10.43	22	1

**Table 4: 2008 Floristic Quality Index, Horsehead Lake, Vilas County, WI**

Genus	Species	Common Name	Coefficient of Conservatism C
<i>Bidens</i>	<i>beckii</i>	Water marigold	8
<i>Brasenia</i>	<i>schreberi</i>	Watershield	6
<i>Decodon</i>	<i>verticillatus</i>	Swamp loosestrife	7
<i>Eleocharis</i>	<i>palustris</i>	Creeping spikerush	6
<i>Elodea</i>	<i>canadensis</i>	Common waterweed	3
<i>Elodea</i>	<i>nuttalli</i>	Slender waterweed	7
<i>Equisetum</i>	<i>fluviatile</i>	Water horsetail	7
<i>Myriophyllum</i>	<i>sibiricum</i>	Northern water milfoil	6
<i>Najas</i>	<i>flexilis</i>	Slender naiad	6
<i>Nitella</i>	<i>sp.</i>	Nitella	7
<i>Nuphar</i>	<i>variegata</i>	Spatterdock	6
<i>Nymphaea</i>	<i>odorata</i>	White water lily	6
<i>Phragmites</i>	<i>australis</i>	Giant reed	1
<i>Pontederia</i>	<i>cordata</i>	Pickerelweed	8
<i>Potamogeton</i>	<i>amplifolius</i>	Large-leaf pondweed	7
<i>Potamogeton</i>	<i>gramineus</i>	Variable-leaf pondweed	7
<i>Potamogeton</i>	<i>pusillus</i>	Small pondweed	7
<i>Potamogeton</i>	<i>richardsonii</i>	Clasping-leaf pondweed	5
<i>Potamogeton</i>	<i>robbinsii</i>	Fern pondweed	8
<i>Potamogeton</i>	<i>vaseyii</i>	Vasey's pondweed	10
<i>Potamogeton</i>	<i>zosteriformis</i>	Flat-stem pondweed	6
<i>Sagittaria</i>	<i>latifolia</i>	Common arrowhead	3
<i>Schoenoplectus</i>	<i>acutus</i>	Hardstem bulrush	6
<i>Sparganium</i>	<i>eurycarpum</i>	Common bur-reed	5
<i>Sparganium</i>	<i>fluctuans</i>	Floating-leaf bur-reed	10
<i>Vallisneria</i>	<i>americana</i>	Wild celery	6

N 26

Mean C 6.307692308

**Floristic Quality Index (FQI) 32.16304616**

Please note: There is no Coefficient of Conservatism for exotic species such as Eurasian Water-Milfoil.

Coefficient of Conservatism C

0-3 taxa found in wide variety of plant communities and very tolerant of disturbance.

4-6 taxa typically associated with specific plant communities and tolerate moderate disturbance.

7-8 taxa found in narrow range of plant communities and tolerate minor disturbance.

9-10 taxa restricted to a narrow range of ecological conditions, with low tolerance of disturbance.

Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
1	46.23837261	-89.72289458	52	46.23136	-89.7219
2	46.23800361	-89.72289644	53	46.23099	-89.7219
3	46.23763462	-89.72289829	54	46.23874	-89.7213
4	46.23689663	-89.72290201	55	46.23837	-89.7213
5	46.23652764	-89.72290386	56	46.238	-89.7213
6	46.23615864	-89.72290572	57	46.23763	-89.7213
7	46.23431367	-89.72291501	58	46.23726	-89.7213
8	46.23394467	-89.72291686	59	46.23689	-89.7213
9	46.23357568	-89.72291872	60	46.23652	-89.7213
10	46.23320669	-89.72292058	61	46.23615	-89.7213
11	46.23283769	-89.72292244	62	46.23579	-89.7213
12	46.2324687	-89.72292429	63	46.23542	-89.7213
13	46.2320997	-89.72292615	64	46.23505	-89.7213
14	46.23874031	-89.72236094	65	46.23468	-89.7213
15	46.23837132	-89.7223628	66	46.23431	-89.7213
16	46.23800232	-89.72236466	67	46.23394	-89.7213
17	46.23763333	-89.72236652	68	46.23357	-89.7213
18	46.23726434	-89.72236838	69	46.2332	-89.7213
19	46.23689534	-89.72237024	70	46.23283	-89.7213
20	46.23652635	-89.72237211	71	46.23246	-89.7213
21	46.23615735	-89.72237397	72	46.2321	-89.7213
22	46.23578836	-89.72237583	73	46.23173	-89.7213
23	46.23541936	-89.72237769	74	46.23136	-89.7213
24	46.23505037	-89.72237955	75	46.23099	-89.7213
25	46.23468137	-89.72238141	76	46.23689	-89.7208
26	46.23431238	-89.72238327	77	46.23652	-89.7208
27	46.23394338	-89.72238513	78	46.23615	-89.7208
28	46.23357439	-89.72238699	79	46.23578	-89.7208
29	46.2332054	-89.72238885	80	46.23542	-89.7208
30	46.2328364	-89.72239071	81	46.23505	-89.7208
31	46.23246741	-89.72239257	82	46.23468	-89.7208
32	46.23209841	-89.72239443	83	46.23431	-89.7208
33	46.23873902	-89.72182916	84	46.23394	-89.7208
34	46.23837003	-89.72183102	85	46.23357	-89.7208
35	46.23800103	-89.72183289	86	46.2332	-89.7208
36	46.23763204	-89.72183475	87	46.23283	-89.7208
37	46.23726304	-89.72183662	88	46.23246	-89.7208
38	46.23689405	-89.72183848	89	46.23689	-89.7202
39	46.23652505	-89.72184035	90	46.23652	-89.7202
40	46.23615606	-89.72184221	91	46.23615	-89.7202
41	46.23578707	-89.72184408	92	46.23578	-89.7202
42	46.23541807	-89.72184594	93	46.23541	-89.7203
43	46.23504908	-89.7218478	94	46.23505	-89.7203
44	46.23468008	-89.72184967	95	46.23468	-89.7203
45	46.23431109	-89.72185153	96	46.23431	-89.7203
46	46.23394209	-89.7218534	97	46.23394	-89.7203
47	46.2335731	-89.72185526	98	46.23357	-89.7203
48	46.2332041	-89.72185713	99	46.2332	-89.7203
49	46.23283511	-89.72185899	100	46.23283	-89.7203
50	46.23246611	-89.72186085	101	46.23246	-89.7203
51	46.23172812	-89.72186458	102	46.23689	-89.7197

Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
103	46.23651986	-89.71971331	154	46.23467	-89.7187
104	46.23615086	-89.71971519	155	46.2343	-89.7187
105	46.23578187	-89.71971707	156	46.23393	-89.7187
106	46.23541288	-89.71971895	157	46.23357	-89.7187
107	46.23504388	-89.71972083	158	46.2332	-89.7187
108	46.23467489	-89.7197227	159	46.23283	-89.7187
109	46.23430589	-89.71972458	160	46.23246	-89.7187
110	46.2339369	-89.71972646	161	46.23209	-89.7187
111	46.2335679	-89.71972834	162	46.23172	-89.7187
112	46.23319891	-89.71973022	163	46.23135	-89.7187
113	46.23282991	-89.7197321	164	46.24094	-89.7181
114	46.23246092	-89.71973398	165	46.23947	-89.7181
115	46.23209193	-89.71973585	166	46.2391	-89.7181
116	46.23024695	-89.71974524	167	46.23873	-89.7181
117	46.22987796	-89.71974712	168	46.23836	-89.7181
118	46.23836353	-89.71917214	169	46.23799	-89.7181
119	46.23799453	-89.71917402	170	46.23762	-89.7181
120	46.23762554	-89.71917591	171	46.23725	-89.7181
121	46.23725654	-89.71917779	172	46.23688	-89.7181
122	46.23688755	-89.71917967	173	46.23652	-89.7181
123	46.23651855	-89.71918155	174	46.23615	-89.7181
124	46.23614956	-89.71918344	175	46.23578	-89.7181
125	46.23578057	-89.71918532	176	46.23541	-89.7181
126	46.23541157	-89.7191872	177	46.23504	-89.7181
127	46.23504258	-89.71918908	178	46.23467	-89.7181
128	46.23467358	-89.71919096	179	46.2343	-89.7181
129	46.23430459	-89.71919285	180	46.23393	-89.7181
130	46.23393559	-89.71919473	181	46.23356	-89.7181
131	46.2335666	-89.71919661	182	46.23319	-89.7181
132	46.2331976	-89.71919849	183	46.23283	-89.7181
133	46.23282861	-89.71920037	184	46.23246	-89.7181
134	46.23245962	-89.71920226	185	46.23209	-89.7181
135	46.23209062	-89.71920414	186	46.23172	-89.7181
136	46.23098364	-89.71920978	187	46.23135	-89.7181
137	46.23061464	-89.71921166	188	46.23098	-89.7181
138	46.23024565	-89.71921355	189	46.23061	-89.7181
139	46.22987665	-89.71921543	190	46.23024	-89.7182
140	46.22950766	-89.71921731	191	46.23947	-89.7176
141	46.2394692	-89.71863471	192	46.2391	-89.7176
142	46.23910021	-89.71863659	193	46.23873	-89.7176
143	46.23873121	-89.71863848	194	46.23836	-89.7176
144	46.23836222	-89.71864037	195	46.23799	-89.7176
145	46.23799322	-89.71864225	196	46.23762	-89.7176
146	46.23762423	-89.71864414	197	46.23725	-89.7176
147	46.23725524	-89.71864602	198	46.23688	-89.7176
148	46.23688624	-89.71864791	199	46.23651	-89.7176
149	46.23651725	-89.71864979	200	46.23615	-89.7176
150	46.23614825	-89.71865168	201	46.23578	-89.7176
151	46.23577926	-89.71865357	202	46.23541	-89.7176
152	46.23541026	-89.71865545	203	46.23504	-89.7176
153	46.23504127	-89.71865734	204	46.23467	-89.7176



Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
205	46.23430066	-89.71759763	256	46.23614	-89.7165
206	46.23393166	-89.71759953	257	46.23577	-89.7165
207	46.23356267	-89.71760142	258	46.23541	-89.7165
208	46.23319368	-89.71760331	259	46.23504	-89.7165
209	46.23282468	-89.71760521	260	46.23467	-89.7165
210	46.23245569	-89.7176071	261	46.2343	-89.7165
211	46.23208669	-89.71760899	262	46.23393	-89.7165
212	46.2317177	-89.71761088	263	46.23356	-89.7165
213	46.2313487	-89.71761278	264	46.23319	-89.7165
214	46.23097971	-89.71761467	265	46.23282	-89.7165
215	46.23061071	-89.71761656	266	46.23245	-89.7165
216	46.23024172	-89.71761845	267	46.23208	-89.7165
217	46.22987272	-89.71762034	268	46.23172	-89.7165
218	46.22950373	-89.71762224	269	46.23135	-89.7165
219	46.23946526	-89.71703935	270	46.23098	-89.7166
220	46.23909627	-89.71704124	271	46.23061	-89.7166
221	46.23872728	-89.71704314	272	46.23024	-89.7166
222	46.23835828	-89.71704504	273	46.22987	-89.7166
223	46.23798929	-89.71704693	274	46.2295	-89.7166
224	46.23762029	-89.71704883	275	46.22913	-89.7166
225	46.2372513	-89.71705073	276	46.22876	-89.7166
226	46.2368823	-89.71705262	277	46.23872	-89.716
227	46.23651331	-89.71705452	278	46.23836	-89.716
228	46.23614432	-89.71705642	279	46.23799	-89.716
229	46.23577532	-89.71705831	280	46.23762	-89.716
230	46.23540633	-89.71706021	281	46.23725	-89.716
231	46.23503733	-89.7170621	282	46.23688	-89.716
232	46.23466834	-89.717064	283	46.23651	-89.716
233	46.23429934	-89.7170659	284	46.23614	-89.716
234	46.23393035	-89.71706779	285	46.23577	-89.716
235	46.23356136	-89.71706969	286	46.2354	-89.716
236	46.23319236	-89.71707159	287	46.23503	-89.716
237	46.23282337	-89.71707348	288	46.23467	-89.716
238	46.23245437	-89.71707538	289	46.2343	-89.716
239	46.23208538	-89.71707727	290	46.23393	-89.716
240	46.23171638	-89.71707917	291	46.23356	-89.716
241	46.23134739	-89.71708107	292	46.23319	-89.716
242	46.23097839	-89.71708296	293	46.23282	-89.716
243	46.2306094	-89.71708486	294	46.23245	-89.716
244	46.2302404	-89.71708675	295	46.23208	-89.716
245	46.22987141	-89.71708865	296	46.23171	-89.716
246	46.22950241	-89.71709055	297	46.23134	-89.716
247	46.22913342	-89.71709244	298	46.23098	-89.716
248	46.22876442	-89.71709434	299	46.23061	-89.716
249	46.23872596	-89.71651136	300	46.23024	-89.716
250	46.23835696	-89.71651326	301	46.22987	-89.716
251	46.23798797	-89.71651516	302	46.2295	-89.716
252	46.23761898	-89.71651706	303	46.22913	-89.716
253	46.23724998	-89.71651896	304	46.22876	-89.716
254	46.23688099	-89.71652086	305	46.23872	-89.7154
255	46.23651199	-89.71652276	306	46.23835	-89.7154

Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
307	46.23798533	-89.71545161	358	46.22913	-89.715
308	46.23761633	-89.71545352	359	46.22876	-89.715
309	46.23724734	-89.71545543	360	46.23761	-89.7144
310	46.23687835	-89.71545734	361	46.23724	-89.7144
311	46.23650935	-89.71545924	362	46.23688	-89.7144
312	46.23614036	-89.71546115	363	46.23651	-89.7144
313	46.23577136	-89.71546306	364	46.23614	-89.7144
314	46.23540237	-89.71546497	365	46.23577	-89.7144
315	46.23503337	-89.71546687	366	46.2354	-89.7144
316	46.23466438	-89.71546878	367	46.23503	-89.7144
317	46.23429539	-89.71547069	368	46.23466	-89.7144
318	46.23392639	-89.71547259	369	46.23429	-89.7144
319	46.2335574	-89.7154745	370	46.23392	-89.7144
320	46.2331884	-89.71547641	371	46.23355	-89.7144
321	46.23281941	-89.71547831	372	46.23319	-89.7144
322	46.23245041	-89.71548022	373	46.23282	-89.7144
323	46.23208142	-89.71548213	374	46.23245	-89.7144
324	46.23171242	-89.71548403	375	46.23208	-89.7144
325	46.23134343	-89.71548594	376	46.23171	-89.7144
326	46.23097443	-89.71548785	377	46.23134	-89.7144
327	46.23060544	-89.71548975	378	46.23097	-89.7144
328	46.23023645	-89.71549166	379	46.2306	-89.7144
329	46.22986745	-89.71549357	380	46.23023	-89.7144
330	46.22949846	-89.71549547	381	46.22986	-89.7144
331	46.22912946	-89.71549738	382	46.2295	-89.7144
332	46.22876047	-89.71549929	383	46.22913	-89.7144
333	46.238353	-89.71491793	384	46.22876	-89.7144
334	46.237984	-89.71491984	385	46.23651	-89.7139
335	46.23761501	-89.71492175	386	46.23614	-89.7139
336	46.23724601	-89.71492366	387	46.23577	-89.7139
337	46.23687702	-89.71492557	388	46.2354	-89.7139
338	46.23650803	-89.71492749	389	46.23503	-89.7139
339	46.23613903	-89.7149294	390	46.23466	-89.7139
340	46.23577004	-89.71493131	391	46.23429	-89.7139
341	46.23540104	-89.71493322	392	46.23392	-89.7139
342	46.23503205	-89.71493513	393	46.23355	-89.7139
343	46.23466305	-89.71493704	394	46.23318	-89.7139
344	46.23429406	-89.71493895	395	46.23282	-89.7139
345	46.23392507	-89.71494086	396	46.23245	-89.7139
346	46.23355607	-89.71494277	397	46.23208	-89.7139
347	46.23318708	-89.71494468	398	46.23171	-89.7139
348	46.23281808	-89.71494659	399	46.23134	-89.7139
349	46.23244909	-89.7149485	400	46.23097	-89.7139
350	46.23208009	-89.71495041	401	46.22986	-89.7139
351	46.23171111	-89.71495232	402	46.22949	-89.7139
352	46.2313421	-89.71495423	403	46.22913	-89.7139
353	46.23097311	-89.71495614	404	46.22876	-89.7139
354	46.23060412	-89.71495805	405	46.2354	-89.7133
355	46.23023512	-89.71495996	406	46.23503	-89.7133
356	46.22986613	-89.71496187	407	46.23466	-89.7133
357	46.22949713	-89.71496378	408	46.23429	-89.7133

Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
409	46.23392108	-89.71334566	460	46.23133	-89.7112
410	46.23355208	-89.71334758	461	46.23096	-89.7112
411	46.23318309	-89.7133495	462	46.23059	-89.7112
412	46.23281409	-89.71335142	463	46.23023	-89.7112
413	46.2324451	-89.71335334	464	46.22949	-89.7112
414	46.23207611	-89.71335527	465	46.22838	-89.7112
415	46.23170711	-89.71335719	466	46.23391	-89.7107
416	46.23133812	-89.71335911	467	46.23355	-89.7107
417	46.23539572	-89.71280623	468	46.23318	-89.7107
418	46.23502673	-89.71280815	469	46.23281	-89.7107
419	46.23465773	-89.71281008	470	46.23244	-89.7107
420	46.23428874	-89.712812	471	46.23207	-89.7107
421	46.23391974	-89.71281393	472	46.2317	-89.7107
422	46.23355075	-89.71281585	473	46.23133	-89.7107
423	46.23318175	-89.71281778	474	46.23096	-89.7107
424	46.23281276	-89.7128197	475	46.23059	-89.7107
425	46.23244377	-89.71282163	476	46.23022	-89.7107
426	46.23207477	-89.71282355	477	46.22986	-89.7107
427	46.23170578	-89.71282547	478	46.22949	-89.7107
428	46.23133678	-89.7128274	479	46.22912	-89.7107
429	46.23502539	-89.71227641	480	46.22801	-89.7107
430	46.23465639	-89.71227834	481	46.23391	-89.7102
431	46.2342874	-89.71228027	482	46.23354	-89.7102
432	46.23391841	-89.71228219	483	46.23318	-89.7102
433	46.23354941	-89.71228412	484	46.23281	-89.7102
434	46.23318042	-89.71228605	485	46.23244	-89.7102
435	46.23281142	-89.71228798	486	46.23207	-89.7102
436	46.23244243	-89.71228991	487	46.2317	-89.7102
437	46.23207343	-89.71229183	488	46.23133	-89.7102
438	46.23170444	-89.71229376	489	46.23096	-89.7102
439	46.23133545	-89.71229569	490	46.23059	-89.7102
440	46.23096645	-89.71229762	491	46.23022	-89.7102
441	46.23465506	-89.7117466	492	46.22985	-89.7102
442	46.23428606	-89.71174853	493	46.22949	-89.7102
443	46.23391707	-89.71175046	494	46.22912	-89.7102
444	46.23354807	-89.71175239	495	46.22875	-89.7102
445	46.23317908	-89.71175432	496	46.23354	-89.7096
446	46.23281008	-89.71175626	497	46.23317	-89.7096
447	46.23244109	-89.71175819	498	46.2328	-89.7096
448	46.2320721	-89.71176012	499	46.23244	-89.7096
449	46.2317031	-89.71176205	500	46.23207	-89.7096
450	46.23133411	-89.71176398	501	46.2317	-89.7096
451	46.23096511	-89.71176591	502	46.23133	-89.7096
452	46.23428472	-89.71121679	503	46.23096	-89.7096
453	46.23391572	-89.71121873	504	46.23059	-89.7096
454	46.23354673	-89.71122066	505	46.23022	-89.7096
455	46.23317774	-89.7112226	506	46.22985	-89.7096
456	46.23280874	-89.71122453	507	46.22948	-89.7096
457	46.23243975	-89.71122647	508	46.22911	-89.7096
458	46.23207075	-89.7112284	509	46.22875	-89.7097
459	46.23170176	-89.71123034	510	46.2328	-89.7091

Point ID	Latitude	Longitude	Point ID	Latitude	Longitude
511	46.23243436	-89.70909959	562	46.23132	-89.707
512	46.23206536	-89.70910154	563	46.23095	-89.707
513	46.23169637	-89.70910349	564	46.23058	-89.707
514	46.23132737	-89.70910544	565	46.23021	-89.707
515	46.23095838	-89.70910739	566	46.22985	-89.707
516	46.23058938	-89.70910934	567	46.22948	-89.707
517	46.23022039	-89.70911129	568	46.22911	-89.707
518	46.2298514	-89.70911324	569	46.22874	-89.707
519	46.2294824	-89.70911519	570	46.22837	-89.707
520	46.22911341	-89.70911714	571	46.228	-89.707
521	46.22874441	-89.70911909	572	46.22763	-89.707
522	46.232802	-89.70856592	573	46.22726	-89.707
523	46.232433	-89.70856787	574	46.23095	-89.7064
524	46.23206401	-89.70856983	575	46.23058	-89.7065
525	46.23169501	-89.70857178	576	46.23021	-89.7065
526	46.23132602	-89.70857373	577	46.22984	-89.7065
527	46.23095702	-89.70857569	578	46.22948	-89.7065
528	46.23058803	-89.70857764	579	46.22911	-89.7065
529	46.23021904	-89.70857959	580	46.22874	-89.7065
530	46.22985004	-89.70858155	581	46.22837	-89.7065
531	46.22948105	-89.7085835	582	46.228	-89.7065
532	46.22911205	-89.70858545	583	46.22763	-89.7065
533	46.23280064	-89.7080342	584	46.22726	-89.7065
534	46.23243165	-89.70803616	585	46.23021	-89.7059
535	46.23206265	-89.70803811	586	46.22984	-89.7059
536	46.23169366	-89.70804007	587	46.22947	-89.7059
537	46.23132466	-89.70804203	588	46.22911	-89.7059
538	46.23095567	-89.70804398	589	46.22874	-89.7059
539	46.23058667	-89.70804594	590	46.22837	-89.7059
540	46.23021768	-89.7080479	591	46.228	-89.7059
541	46.22984868	-89.70804985	592	46.22763	-89.7059
542	46.22947969	-89.70805181	593	46.2291	-89.7054
543	46.2291107	-89.70805376	594	46.22873	-89.7054
544	46.2287417	-89.70805572			
545	46.22837271	-89.70805768			
546	46.22800371	-89.70805963			
547	46.22763472	-89.70806159			
548	46.23243029	-89.70750444			
549	46.23206129	-89.7075064			
550	46.2316923	-89.70750836			
551	46.2313233	-89.70751032			
552	46.23095431	-89.70751228			
553	46.23058531	-89.70751424			
554	46.23021632	-89.7075162			
555	46.22984733	-89.70751816			
556	46.22947833	-89.70752012			
557	46.22910934	-89.70752208			
558	46.22874034	-89.70752404			
559	46.22837135	-89.707526			
560	46.22800235	-89.70752796			
561	46.22763336	-89.70752992			

## **Free-Floating Plants**

There were no free-floating plants identified on Horsehead Lake during the 2008 aquatic plant survey.

## **Floating-Leaf Plants**

*Brasenia schreberi* (Watershield) has floating leaves with elastic stems with the leaf stalk attaching to the middle of the leaves. All submersed portions of the plant are usually covered with a gelatinous coating. Watershield is commonly identified by the lack of a leaf notch and the central location of the petiole. Watershield is most commonly found growing in soft sediments that contain partially decomposed organic matter. The seeds, leaves, stem and buds are a source of food by waterfowl. The floating leaves also offer shelter and shade for fish and invertebrates (Borman, et al., 1997). Watershield is a sensitive aquatic plant this is not tolerant of pollutants and adverse human impacts to the lake ecosystem (Nichols, 1999).



Watershield

Source: University of Florida Website



White Water Lily

Source: UW Herbarium Website

*Nymphaea odorata* (White Water Lily) has a flexible stalk with a round floating leaf. White Water Lily can be found growing in a variety of sediment types in less than 6 feet of water. Fragrant white flowers occur throughout the summer. The floating leaves provide shelter and shade for fish as well as habitat for invertebrates (Borman, et al., 1997).

*Nuphar variegata* (Spatterdock) has a flexible stalk and an oval shaped leaf. It grows in water less than 6 feet deep and prefers soft sediment. Yellow flowers occur throughout the summer. Floating leaves provide cover and shade for fish as well as habitat for invertebrates (Borman, et al., 1997).



Spatterdock

Source: UW Herbarium Website

## **Submergent Plants**



Elodea

Source: UW Herbarium Website

*Elodea canadensis* (Elodea or common waterweed) is an abundant native plant species that is distributed statewide. It prefers soft substrate and water depths to 15 feet (Nichols, 1999). Elodea reproduces by seed and sprigs (USDA, 2002). The stems of elodea offer shelter and grazing to fish, but very dense elodea can interfere with fish movement. Elodea can be considered invasive at times and out-competes other more desirable plants.



Slender water-weed  
Source: UW Herbarium Website

*Elodea nuttallii* (slender water-weed) is usually small leaved and delicate compared to *E. canadensis*. *E. nuttallii* is branching with bright green stems usually 40 inches in length. It is found in quiet waters in fine sediment soils (Nichols, 1999).

*Bidens beckii* (Watermarigold) has submersed leaves that are finely divided into thread-like divisions. This plant also produces aerial leaves that are lance-shaped and toothed. When blooming, the yellow flower is similar in appearance to a daisy. Water marigold is found mainly in shallower water, but can be found up to 10 feet deep in soft-sediment areas. The submerged leaves provide shade and shelter for fish (Borman, et al., 1997).



Water marigold  
Source: UW Herbarium Website



Northern watermilfoil  
Source: UW Herbarium Website

*Myriophyllum sibiricum* (Northern watermilfoil) is usually found growing in soft sediment in fairly clear-water lakes. Leaves are divided like a feather, with five to twelve pairs of thread-like leaflets. Leaves are arranged in whorls. Northern watermilfoil is more desirable than its invasive cousin, Eurasian watermilfoil. Waterfowl eat the foliage and fruit, while beds of this plant provide cover and foraging opportunities for fish and invertebrates (Borman, et al., 1997).

*Najas flexilis* (slender naiad) has fine branched stems that emerge from a slight rootstalk. Slender Naiad can grow in both shallow and deep water. Waterfowl, marsh birds, and muskrats consume the stems, leaves, and seeds of naiad. The foliage produces forage and shelter opportunities for fish and invertebrates (Borman, et al., 1997).



Slender Naiad  
Source: UW Herbarium Website



Nitella sp.  
Source: UW Herbarium Website

*Nitella sp.* (Nitella) is another type of macroalgae that looks like a vascular plant. Nitella is similar in appearance to muskgrass and is often found in similar habitats. However, Nitella can be distinguished from muskgrass by its smooth stems and branches, which are smooth (Borman, et al., 1997).



Large-leaf Pondweed  
Source: UW Herbarium Website

*Potamogeton amplifolius* (Large-leaf Pondweed) is also often referred to as musky weed or cabbage by anglers. Large leaf pondweed has robust stems and broad submersed leaves, which are slightly folded and lined with many veins. Floating leaves are oval and on long stalks. It is found mainly in soft sediments in water one to several feet deep and is sensitive to increased turbidity. The plant is commonly grazed by waterfowl, offers habitat for invertebrates, and foraging opportunities for fish (Borman, et al., 1997).

*Potamogeton gramineus* (Variable Pondweed) is usually found in more firm sediment in water that is about 3 feet deep. Variable pondweed overwinters by hardy rhizomes and winter buds. Flowering usually occurs early in the growing season and fruit is produced during mid summer. The fruits and tubers are grazed by waterfowl and the extensive network of leafy branches offers invertebrate habitat and foraging opportunities for fish (Borman, et al., 1997).



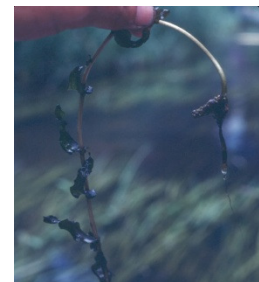
Variable Pondweed  
Source: UW Herbarium Website



Small Pondweed  
Source: UW Herbarium Website

*Potamogeton pusillus* (Small Pondweed) has small slender stems, and branches repeatedly near its ends. There is some limited reproduction by seed. Small pondweed can be locally important as a food source for a variety of wildlife. Waterfowl feed on small pondweed as well as deer, muskrat, and some small fish (Borman, et al., 1997).

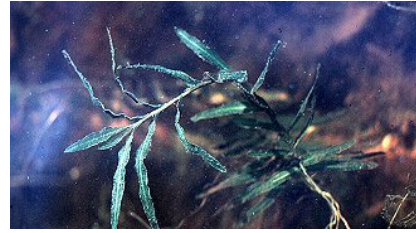
*Potamogeton richardsonii* (Clasping Leaf Pondweed) is a submergent aquatic plant with lance-shaped leaves that clasp the stem. Clasping leaf pondweed can be found growing in a variety of sediment types in water up to 12 feet deep and can tolerate disturbed conditions. It is often found growing with Coontail and Small Pondweed (Borman, et al., 1997).



Clasping Leaf Pondweed  
Source: UW Herbarium Website

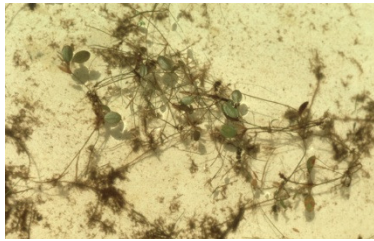


*Potamogeton robbinsii* (Fern Pondweed) is a submergent pondweed with robust stems and strongly two-ranked leaves, creating a feather or fern-like appearance while in the water. Fern pondweed sprouts in the spring and thrive in deeper water. Fern pondweed provides habitat for invertebrates that are grazed by waterfowl and also offers good cover for fish, particularly northern pike (Borman, et al., 1997).



Fern Pondweed

Source: UW Herbarium Website



Vasey's Pondweed

Source: UW Herbarium Website

*Potamogeton vaseyi* (Vasey's Pondweed) is a rare aquatic plant in Wisconsin. Its fine, hair-like leaves may be confused with Water-Thread Pondweed (*Potamogeton diversifolius*) and/or Small Pondweed (Borman, et al., 1997). It is generally found in water 6 feet deep or less and produces small, elliptical floating leaves (Nichols, 1999). Vasey's pondweed provides food for waterfowl, invertebrate habitat, and foraging opportunities for fish (Borman, et al., 1997).

*Potamogeton zosteriformis* (Flat-Stem Pondweed) is a submergent pondweed with freely-branched flattened stems. Flat stem pondweed is commonly confused with water stargrass (*Zosterella dubia*) but Flat-stem Pondweed can be distinguished by its prominent mid-vein and many fine, parallel veins.



Flat- Stem Pondweed

Source: UW Herbarium Website



Wild Celery

Source: UW Herbarium Website

*Valisneria americana* (Wild Celery) also known as eel-grass or tape-grass, and has ribbon-like leaves that tend to grow until they emerge in clusters along the water's surface. Wild celery is a premiere source of food for waterfowl. All portions of the plant are consumed. Beds of wild celery are also considered good fish habitat providing shade, shelter and feeding opportunities (Borman, et al., 1997).



## **Emergent Plants**

Plants identified during the shoreline survey are included.



Sedge  
Source: UW Herbarium Website

Carex sp. (Sedge species) are grass-like at first glance but the leaves come off the stems at three angles as opposed to two angles like grasses. The definitive characteristic is the sac-like structure call a perigynium that surrounds the ovary and nutlet. This structure is unique and distinguishes it from grasses but it also separates it from other genera in the sedge family. (Borman, et al., 1997).

Decodon verticillatus (Swamp loosestrife) has angled, woody stems, up to several feet long, emerging from buried rhizomes. The leaves are lance-shaped and arrange in pairs or whorls of three. It develops magenta flowers, which then produce fruit which is grazed by waterfowl. Swamp loosestrife is usually found in shallow water with a much sediment and can form floating mats (Borman, et al. 1997).



Swamp loosestrife  
Source: UW Herbarium Website



Creeping spikerush  
Source: UW Herbarium Website

Eleocharis palustris (Creeping spikerush) has stems that rise either singly or in small clusters. Stems are topped with a spikelet that tapers to a point. Its shape resembles a burning match (Borman, et al., 1997). The spikelet is covered with scales. It prefers hard substrates (Nichols, 1999). The beds of this species provide food for a variety of waterfowl and helps anchor near shore sediments.

Equisetum fluviatile L. (Water horsetail) has jointed stems that emerge from a buried rhizome. The hollow stems are ridged and stiff. Water horsetail can be found in marshes and shallow water of lakes and ponds in water less than 3 feet. It provides a food source for waterfowl, ruffed grouse and moose where they occur. It is a prominent food source for trumpeter swans. (Borman, et al., 1997)



Water horsetail  
Source: UW Herbarium Website

*Iris versicolor* (blue flag) has leaves and flower stalks that emerge from a stout rhizome that is very shallow and sometimes exposed above the sediment. It is found in wetlands, stream banks and shallow water of ponds and lakes. The flowers range from indigo blue to lavender. Blue flag is grazed by muskrats and a variety of waterfowl including canvasback. It also provides cover for waterfowl and wildlife.



Blue flag  
Source: UW Herbarium Website



Sweet Gale

*Myrica gale* (Sweet gale) is a small shrub commonly found in wetlands and bogs. Sweet gale has leaves that are spirally arranged and is able to grow in nitrogen poor conditions. The plant gives off a sweet smell and can be used as an insect repellent or in perfumes.

*Phragmites australis* (giant reed) is a tall plant (up to 10 feet) with stout stems that grow out of rhizomes. Giant reed is typically found on disturbed sites and can grow on a variety of sites, but requires wet soil and can grow in water up to six feet deep. Giant reed can grow very dense and create nuisance problems (Borman, et al., 1997).



Giant Reed  
Source: UW Herbarium Website



Pickerelweed  
Source: James Scharl

*Pontederia cordata* (Pickerelweed) can commonly be mistaken for Arrowhead (*Sagittaria spp.*) when not in bloom. The leaves are glossy and heart-shaped and originate from a large rhizome and have many fine veins. However, when in bloom, its blue-flowered spike is distinctive. Pickerelweed is located in shallower water in a variety of sediments and often forms large colonies in protected bays which helps stabilize shorelines. The seeds are consumed by waterfowl (Borman, et al., 1997).

*Sagittaria latifolia* (Common arrowhead) is an emergent plant that usually produces leaves that are true to its name – shaped like an arrowhead. The size and shape of the leaf is highly variable with blades that range from a slender "A" shape to a broad wedge. Arrowhead is found in the shallow water of lakes, ponds, streams and marshes and usually found in water only ankle-deep, but will sometimes grow in water about 3 feet deep. Arrowhead is one of the highest value aquatic plants for wildlife and waterfowl depend on the high-energy tubers during migration. The seeds are also consumed by a wide variety of ducks, geese, marsh birds and shore birds. (Borman, et al., 1997).



Sagittaria spp.  
Source: UW Herbarium website



Hardstem Bulrush

Source: UW Herbarium Website

*Schoenoplectus acutus* (Hardstem bulrush) has tall cylindrical olive-green sturdy stems. The firm stems are hard when pressed between ones fingers, while softstem bulrush can easily be crushed with the fingers. This plant is mainly found growing in water less than 7 feet and is an important food and habitat plant for invertebrates, northern pike, and marsh birds (Borman et al., 1997).

*Sparganium eurycarpum* (Common Bur-reed) has emergent leaves, up to 5 feet tall, that are rather spongy and look triangle in cross section. Common bur-reed can be distinguished from other bur-reeds by its two stigmas on each female flower and wide, flat-topped fruit. It can be found in marshes and along lake, pond, and river margins. Colonies of bur-reed help anchor sediment and provide nesting sites for birds and waterfowl. (Borman, et al., 1997)



Common Bur-reed

Source: UW Herbarium Website



Floating-leaf bur-reed

Source: UW Herbarium Website

*Sparganium fluctuans* (Floating-leaf bur-reed) has flat, wide floating leaves. The flower stalk is branched with 2-4 fruiting heads. The leaves of bur-reed can be recognized by holding one up to the light to see the very fine checkerboard of veins. Colonies of bur-reed help anchor sediment and provide nesting sites for waterfowl and shorebirds.

*Typha latifolia* (Broad-leaf Cattail) has pale green, sword-like leaves that are sheathed around one another at the base. Broad-leaved cattail can be distinguished from narrow-leaved cattail by somewhat wider and flatter leaves and the presence of male and female flower spikes immediately adjacent to each other. Cattails can grow to nuisance levels, but do provide nesting habitat for many marsh birds and cover for small fish (Borman, et al., 1997).



Broad-leaf Cattail

Source: UW Herbarium Website

## Management Options for Aquatic Plants

Option	Permit Needed?	How it Works	PROS	CONS
<b>No treatment</b>	N	Do not treat plants	<p>Protects native species that can prevent spread of invasive or exotic species, enhance water quality, and provide habitat for aquatic fauna</p> <p>No financial cost</p> <p>No system disturbance</p> <p>No harmful effects of chemicals</p> <p>Permit not required</p>	<p>May allow small population of invasive plants to become larger, more difficult to control later</p>
<b>Mechanical Control</b>	Required under NR 109	<p>Plants reduced by mechanical means</p> <p>Wide range of techniques, from manual to highly mechanized</p>	<p>Flexible control</p> <p>Can balance habitat and recreational needs</p>	<p>Must be repeated, often more than once per season</p> <p>Can suspend sediments and increase turbidity and nutrient release</p>
a. Handpulling/Manual raking	Y/N	<p>SCUBA divers or snorkelers remove plants by hand or plants are removed with a rake</p> <p>Works best in soft sediments</p>	<p>Little to no damage done to lake or to native plant species</p> <p>Can be highly selective</p> <p>Can be done by shoreline property owners without permits within an area &lt;30 ft wide OR where selectively removing EWM or CLP</p> <p>Can be very effective at removing problem plants, particularly following early detection of an invasive exotic species</p>	<p>Very labor intensive</p> <p>Needs to be carefully monitored</p> <p>Roots, runners, and even fragments of some species (including EWM) will start new plants, so all of plant must be removed</p> <p>Small-scale control only</p>

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
			Usually minimal impact to the lake	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	
<b>Biological Control</b>	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 fluctuates
			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
b. Pathogens	Y	Fungal/bacterial/viral pathogen introduced to target species to induce mortality	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 ( <i>Eleocharis</i> 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.	Restoration of native plants	N; strongly recommend plan and consultation with DNR	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 more repellant to invasive species	Nuisance invasive plants may outcompete plantings
				Supplements removal techniques	Largely experimental; few well-documented cases

<b>Physical Control</b>		Required under Ch. 30 / NR 107	Plants are reduced by altering variables that affect growth, such as water depth or light levels		
a.	Drawdown	Y, May require Environmental Assessment	<p>Lake water lowered; plants killed when sediment dries, compacts or freezes</p> <p>Must have a water level control device or siphon</p> <p>Season or duration of drawdown can change effects</p>	<p>Can be effective, especially when done in winter, provided drying and freezing occur. Sediment compaction is possible over winter</p> <p>Summer drawdown can restore large portions of shoreline and shallow areas as well as provide sediment compaction</p> <p>Emergent plant species often rebound near shore providing fish and wildlife habitat, sediment stabilization, and increased water quality</p> <p>Success for EWM, variable success for CLP*</p> <p>Restores natural water fluctuation important for all aquatic ecosystems</p>	<p>Plants with large seed bank or propagules that survive drawdown may become more abundant upon refilling</p> <p>Species growing in deep water (e.g. EWM) that survive may increase, particularly if desirable native species are reduced</p> <p>May impact attached wetlands and shallow wells near shore</p> <p>Can affect fish, particularly in shallow lakes if oxygen levels drop or if water levels are not restored before spring spawning</p> <p>Winter drawdown must start in early fall or will kill hibernating reptiles and amphibians</p> <p>Controversial</p>
b.	Dredging	Y	<p>Plants are removed along with sediment</p> <p>Most effective when soft sediments overlay harder substrate</p> <p>For extremely impacted systems</p> <p>Extensive planning required</p>	<p>Increases water depth</p> <p>Removes nutrient rich sediments</p> <p>Removes soft bottom sediments that may have high oxygen demand</p>	<p>Expensive</p> <p>Increases turbidity and releases nutrients</p> <p>Exposed sediments may be recolonized by invasive species</p> <p>Sediment testing is expensive and may be necessary</p> <p>Removes benthic organisms</p> <p>Dredged materials must be disposed of</p> <p>Severe impact on lake ecosystem</p>

c.	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
					Affects to microscopic organisms unknown
d.	Mechanical circulation (Solarbees)	Y	Water is circulated and oxygenated	Reduces blue-green algae	Method is experimental; no published studies have been done
			Oxygenation of water decreases ammonium-nitrogen, which is a preferred nutrient source of EWM, theoretically limiting EWM growth (has not been demonstrated scientifically)	May reduce levels of ammonium-nitrogen in the water and at the sediment interface, which could reduce EWM growth	Although EWM prefers ammonium-nitrogen to nitrate, it will uptake nitrate efficiently, so EWM growth may not be affected
				Oxygenated water may reduce phosphorus release from sediments if mixing is complete	Units are aesthetically displeasing
				Reduces chance of fish kills by aerating water	Units could be a navigational hazard
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)	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	Expensive
				Native plants may be able to compete invasive species better in low-nutrient conditions	Requires landowner cooperation and regulation
					Improved water clarity may increase plant growth



<b>Chemical Control</b>	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
			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
				Controversial
a. 2,4-D (Weedar, Navigate)	Y	Systemic <sup>1</sup> herbicide selective to broadleaf <sup>2</sup> 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.	Cannot be used in combination with copper herbicides (used for algae)
			Can be used in synergy with endothall for early season CLP and EWM treatments	Toxic to fish
			Widely used aquatic herbicide	
b. Endothall (Aquathol)	Y	Broad-spectrum <sup>3</sup> , contact <sup>4</sup> 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
			Can be selective depending on concentration and seasonal timing	Not to be used in water supplies
			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	3-day post-treatment restriction on fish consumption

c.	Diquat (Reward)	Y	Broad-spectrum, contact herbicide that disrupts cellular functioning  Applied as liquid, can be combined with copper treatment	Mostly used for water-milfoil and duckweed  Rapid action  Limited direct toxicity on fish and other animals	May impact non-target plants, especially native pondweeds, coontail, elodea, naiads  Toxic to aquatic invertebrates  Needs to be reapplied several years in a row  Ineffective in muddy or cold water (<50°F)
d.	Fluridone (Sonar or Avast)	Y; special permit and Environmental Assessment may be required	Broad-spectrum, systemic herbicide that inhibits photosynthesis; some reduction in non-target effects can be achieved by lowering dosage  Must be applied during early growth stage  Available with a special permit only; chemical applications beyond 150 ft from shore not allowed under NR 107	Effective on EWM for 1 to 4 years with aggressive follow-up treatments  Applied at very low concentration  Slow decomposition of plants may limit decreases in dissolved oxygen  Low toxicity to aquatic animals	Affects many non-target plants, particularly native milfoils, coontails, elodea, and naiads, even at low concentrations. These plants are important to combat invasive species  Requires long contact time: 60-90 days  Demonstrated herbicide resistance in hydrilla subjected to repeat treatments, EWM has the potential to develop resistance  Unknown effect of repeat whole-lake treatments on lake ecology
e.	Glyphosate (Rodeo)	Y	Broad-spectrum, systemic herbicide that disrupts enzyme formation and function  Usually used for purple loosestrife stems or cattails  Applied as liquid spray or painted on loosestrife stems	Effective on floating and emergent plants such as purple loosestrife  Selective if carefully applied to individual plants  Non-toxic to most aquatic animals at recommended dosages	Effective control for 1-5 years  Ineffective in muddy water  Cannot be used near potable water intakes  RoundUp is often illegally substituted for Rodeo  Associated surfactants of RoundUp believed to be toxic to reptiles and amphibians  No control of submerged plants

f.	Triclopyr (Renovate)	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
				Results 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 (Cutrine Plus)	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
				Herbicidal action on hydrilla, an invasive plant not yet present in Wisconsin	Precipitates rapidly in alkaline waters
					Small-scale control only, because algae are easily windblown
					Toxic to invertebrates, trout and other fish, depending on the hardness of the water
					Long-term effects of repeat treatments to benthic organisms unknown
					Clear water may increase plant growth

h.	Lime slurry	Y	Applications of lime temporarily raise water pH, which limits the availability of inorganic carbon to plants, preventing growth	Appears to be particularly effective against EWM and CLP	Relatively new technique, so effective dosage levels and exposure requirements are not yet known
				Prevents release of sediment phosphorus, which reduces algal growth	Short-term increase in turbidity due to suspended lime particles
				Increases growth of native plants beneficial as fish habitat	High pH detrimental to aquatic invertebrates
					May restrict growth of some native plants
i.	Alum (aluminum sulfate)	Y	Removes phosphorus from water column and creates barrier on sediment to prevent internal loading of phosphorus	Most often used against algal problems	Must not eat fish for 30 days from treatment area
			Dosage must consider pH, hardness and water volume	Improves water clarity	Minimal effect on aquatic plants, or increased light penetration may increase aquatic plants
					Toxic to aquatic animals, including fish at some concentrations
<p>*EWM - Eurasian water-milfoil  *CLP - Curly-leaf pondweed  <sup>1</sup>Systemic herbicide - Must be absorbed by the plant and moved to the site of action. Often slower-acting than contact herbicides.  <sup>2</sup>Broadleaf herbicide - Affects only dicots, one of two groups of plants. Aquatic dicots include waterlilies, bladderworts, watermilfoils, and coontails.  <sup>3</sup>Broad-spectrum herbicide - Affects both monocots and dicots.  <sup>4</sup>Contact herbicide - Unable to move within the plant; kills only plant tissue it contacts directly.</p>					

## Techniques for Aquatic Plant Control Not Allowed in Wisconsin

Option	How it Works	PROS	CONS
<b>Biological Control</b>			
a. Carp	Plants eaten by stocked carp	Effective at removing aquatic plants	Illegal to transport or stock carp in Wisconsin
		Involves species already present in Madison lakes	<p>Carp cause resuspension of sediments, increased water temperature, lower dissolved oxygen levels, and reduction of light penetration</p> <p>Widespread plant removal deteriorates habitat for other fish and aquatic organisms</p> <p>Complete alteration of fish assemblage possible</p> <p>Dislodging of plants such as EWM or CLP turions can lead to accelerated spreading of plants</p>
b. Crayfish	Plants eaten by stocked crayfish	Reduces macrophyte biomass	Illegal to transport or stock crayfish in Wisconsin
			<p>Control not selective and may decimate plant community</p> <p>Not successful in productive, soft-bottom lakes with many fish predators</p> <p>Complete alteration of fish assemblage possible</p>
<b>Mechanical Control</b>			
a. Cutting (no removal)	Plants are "mowed" with underwater cutter	Creates open water areas rapidly	Root system remains for regrowth
		Works in water up to 25 ft	<p>Fragments of vegetation can re-root and spread infestation throughout the lake</p> <p>Nutrient release can cause increased algae and bacteria and be a nuisance to riparian property owners</p> <p>Not selective in species removed</p> <p>Small-scale control only</p>
b. Rototilling	Sediment is tilled to uproot plant roots and stems	Decreases stem density, can affect entire plant	Creates turbidity
	Works in deep water (17 ft)	Small-scale control	Not selective in species removed
		May provide long-term control	<p>Fragments of vegetation can re-root</p> <p>Complete elimination of fish habitat</p> <p>Releases nutrients</p> <p>Increased likelihood of invasive species recolonization</p>

c.	Hydroraking	Mechanical rake removes plants from lake	Creates open water areas rapidly	Fragments of vegetation can re-root
		Works in deep water (14 ft)		May impact lake fauna
				Creates turbidity
				Plants regrow quickly
				Requires plant disposal
<b>Physical Control</b>				
a.	Fabrics/ Bottom Barriers	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

## Aquatic Plant Management

Aquatic plants are a critical component in an aquatic ecosystem. Any management of an ecosystem can have negative or even detrimental effects on the whole ecosystem. Therefore, the practice of managing aquatic plants should not be taken lightly. The concept of Aquatic Plant Management (APM) is highly variable since different aquatic resource users want different things. Ideal management to one individual may mean providing prime fish habitat, for another it may be to remove surface vegetation for boating. The practice of APM is also highly variable. There are numerous APM strategies designed to achieve different plant management goals. Some are effective on a small scale, but ineffective in larger situations. Others can only be used for specific plants or during certain times of the growing season. Of course, the types of plants that are to be managed will also help determine which APM alternatives are feasible. The following paragraphs discuss the APM methods used today. The discussion is largely adopted from *Managing Lakes and Rivers, North American Lake Management Society, 2001*, supplemented with other applicable current resources and references. The methods summarized here are largely for management of rooted aquatic plants, not algae. While some methods may also have effects on nuisance algae blooms, the focus is submergent rooted aquatic macrophytes. This information is provided to allow the user to gain a basic understanding of the APM method, it is not designed to an all-inclusive APM decision-making matrix. APM alternatives can be divided into the following categories: Physical Controls, Chemical Controls, and Biological Controls.

### Physical Controls

Physical APM controls include various methods to prevent growth or remove part or all of the aquatic plant. Both manual and mechanical techniques are employed. Physical APM methods include:

- ▲ Hand pulling
- ▲ Hand cutting
- ▲ Bottom barriers
- ▲ Light limitation (dyes, covers)
- ▲ Mechanical harvesting
- ▲ Hydorraking/rototilling
- ▲ Suction Dredging
- ▲ Dredging
- ▲ Drawdown

Each of these methods are described below. The costs, benefits, and drawbacks of each APM strategy are provided.

**Hand Pulling:** This method involves digging out the entire unwanted plant including stems and roots with a hand tool such as a spade. This method is highly selective and suitable for shallow areas for removing invasive species that have not become well established. This technique is obviously not for use on large dense beds of nuisance aquatic plants. It is best used in areas less than 3 feet, but can be used in deeper areas with divers using scuba and snorkeling equipment. It can also be used in combination with the suction dredge method. In Wisconsin, hand pulling may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

**Advantages:** This technique results in immediate clearing of the water column of nuisance plants. When a selective technique is desired in a shallow, small area, hand pulling is a good choice. It is also useful in sensitive areas where disruption must be minimized.

Disadvantages: This method is labor intensive. Disturbing the substrate may affect fish habitat, increase turbidity, and may promote phosphorus re-suspension and subsequent algae blooms.

Costs: The costs are highly variable. There is practically no cost using volunteers or lakeshore landowners to remove unwanted plants, however, using divers to remove plants can get relatively expensive. Hand pulling labor can range from \$400 to \$800 per acre.

**Hand Cutting:** This is another manual method where the plants are cut below the water surface. Generally the roots are not removed. Tools such as rakes, scythes or other specialized tools are pulled through the plant beds by boat or several people. This method is not as selective as hand pulling. This method is well suited for small areas near docks and piers. Plant material must be removed from the water. In Wisconsin, hand cutting may be completed outside a designated sensitive area without a permit but is limited to 30 feet of shoreline frontage. Removal of exotic species is not limited to 30 feet.

Advantages: This technique results in immediate clearing of the water column of nuisance plants. Costs are minimal.

Disadvantages: This is also a fairly time consuming and labor intensive option. Since the technique does not remove the entire plant (leaves root system and part of plant), it may not result in long-term reductions in growth. This technique is not species specific and results in all aquatic plants being removed from the water column.

Costs: The costs range from minimal for volunteers using hand equipment up to over \$1,000 for a hand-held mechanized cutting implement. Hand cutting labor can range from \$400 to \$800 per acre.

**Bottom Barriers:** A barrier material is applied over the lake bottom to prevent rooted aquatics from growing. Natural barriers such as clay, silt, and gravel can be used although eventually plants may root in these areas again. Artificial materials can also be used for bottom barriers and anchored to the substrate. Barrier materials include burlap, nylon, rubber, polyethylene, polypropylene, and fiberglass. Barriers include both solid and porous forms. A permit is required to place any fill or barrier structure on the substrate of a waterbody. This method is well suited for areas near docks, piers, and beaches. Periodic maintenance may be required to remove accumulated silt or rooting fragments from the barrier.

Advantages: This technique does not result in production of plant fragments. Properly installed, it can provide immediate and multiple year relief.

Disadvantages: This is a non-selective option, all plants beneath the barrier will be affected. Some materials are costly and installation is labor intensive. Other disadvantages include limited material durability, gas accumulation beneath the cover, or possible re-growth of plants from above or below the cover. Fish and invertebrate habitat is disrupted with this technique. Anchored barriers can be difficult to remove.

Costs: A 20 foot x 60 foot panel cost \$265, while a 30 foot x 50 foot panel cost \$375 (this does not include installation costs). Costs for materials vary from \$0.15 per square foot (ft<sup>2</sup>) to over \$0.35/ ft<sup>2</sup>. The costs for installation range from \$0.25 to \$0.50/ ft<sup>2</sup>. Barriers can cost \$20,000 to \$50,000 per acre.



**Light Limitation:** Limiting the available light in the water column can prevent photosynthesis and plant growth. Dark colored dyes and surface covers have been used to accomplish light limitation. Dyes are effective in shallow water bodies where their concentration can be kept at a desired concentration and loss through dilution is less. This method is well suited for small, shallow water bodies with no outlets such as private ponds.

Surface covers can be a useful tool in small areas such as docks and beaches. While they can interfere with aquatic recreation, they can be timed to produce results and not affect summer recreation uses.

**Advantages:** Dyes are non-toxic to humans and aquatic organisms. No special equipment is required for application. Light limitation with dyes or covers method may be selective to shade tolerant species. In addition to submerged macrophyte control, it can also control the algae growth.

**Disadvantages:** The application of water column dyes is limited to shallow water bodies with no outlets. Repeated dye treatments may be necessary. The dyes may not control peripheral or shallow-water rooted plants. This technique must be initiated before aquatic plants start to grow. Covers inhibit gas exchange with the atmosphere.

**Costs:** Costs for a commercial dye and application range from \$100 to \$500 per acre.

**Mechanical Harvesting:** Mechanical harvesters are essentially cutters mounted on barges that cut aquatic plants at a desired depth. Maximum cutting depths range from 5 to 8 feet with a cutting width of 6.5 to 12 feet. Cut plant materials require collection and removal from the water. Conventional harvesters combine cutting, collecting, storing, and transporting cut vegetation into one piece of equipment. Transport barges and shoreline conveyors are also available to remove the cut vegetation. The cut plants must be removed from the water body. The equipment needs are dictated by severity of the aquatic plant problem. Contract harvesting services are available in lieu of purchasing used or new equipment. Trained staff will be necessary to operate a mechanical harvester. To achieve maximum removal of plant material, harvesting is usually completed during the summer months while submergent vegetation is growing to the surface. The duration of control is variable and re-growth of aquatic plants is common. Factors such as timing of harvest, water depth, depth of cut, and timing can influence the effectiveness of a harvesting operation. Harvesting is suited for large open areas with dense stands of exotic or nuisance plant species. Permits are now required in Wisconsin to use a mechanical harvester.

**Advantages:** Harvesting provides immediate visible results. Harvesting allows plant removal on a larger scale than other options. Harvesting provides flexible area control. In other words, the harvester can be moved to where it is needed and used to target problem areas. This technique has the added benefit of removing the plant material from the water body and therefore also eliminates a possible source of nutrients often released during fall decay of aquatic plants. While removal of nutrients through plant harvesting has not been quantified, it can be important in aquatic ecosystem with low nutrient inputs.

**Disadvantages:** Drawbacks of harvesting include: limited depth of operation, not selective within the application area, and expensive equipment costs.

Harvesting also creates plant fragments, which can be a concern since certain plants have the ability to reproduce from a plant fragment (e.g. Eurasian watermilfoil). Plant fragments may re-root and spread a problem plant to other areas. Harvesting can have negative effects on non-target plants, young of year fish, and invertebrates. The harvesting will require trained operators and maintenance of equipment. Also, a disposal site or landspreading program will be needed for harvested plants.

Costs:

Costs for a harvesting operation are highly variable dependent on program scale. New harvesters range from \$40,000 for small machines to over \$100,000 for large, deluxe models. Costs vary considerably, depending on the model, size, and options chosen. Specially designed units are available, but may cost more. The equipment can last 10 to 15 years. A grant for ½ the equipment cost can be obtained from the Wisconsin Waterways Commission and a loan can be obtained for the remaining capital investment. Operation costs include insurance, fuel, spare parts, and payroll. Historical harvesting values have been reported at \$200 up to \$1,500 per acre. A survey of recent Wisconsin harvesting operations reported costs to be between \$100/acre and \$200/acre.

A used harvester can be purchased for \$10,000 to \$20,000. Maintenance costs are typically higher.

Contract harvesting costs approximately \$125/per hour plus mobilization to the water body. Contractors can typically harvest ¼ to ½ acre per hour for an estimated cost of \$250 to \$500/per acre.

**Hydroraking/rototilling:** Hydroraking is the use of a boat or barge mounted machine with a rake that is lowered to the bottom and dragged. The tines of the rake rip out roots of aquatic plants. Rototilling, or rotovation, also rips out root masses but uses a mechanical rotating head with tines instead of a rake. Harvesting may need to be completed in conjunction with these methods to gather floating plant fragments. This application would best be used where nuisance populations are well established and prevention of stem fragments is not critical. A permit would be required for this type of aquatic plant management and would only be issued in limited cases of extreme infestations of nuisance vegetation. In Wisconsin, this method is not looked upon favorably or at all by the WDNR.

Advantages:

These methods have the potential for significant reductions in aquatic plant growth. These methods can remove the plant stems and roots, resulting in thorough plant disruption. Hydroraking/rototilling can be completed in “off season” months avoiding interference with summer recreation activities.

Disadvantages:

Hydroraking/rototilling are not selective and may destroy substrate habitat important to fish and invertebrates. Suspension of sediments will increase turbidity and release nutrients trapped in bottom sediments into the water column potentially causing algal blooms. These methods can cause floating plant and root fragments, which may re-root and spread the problem. Hydroraking/rototilling are expensive and not likely to be permitted by regulatory agencies.

Costs: Bottom tillage costs vary according to equipment, treatment scale, and plant density. For soft vegetation costs can range from \$2,000 to \$4,000 per acre. For dense, rooted masses, costs can be up to \$10,000 per acre. Contract bottom tillage reportedly ranges from \$1,200 to \$1,700 per acre (Washington Department of Ecology, 1994).

**Suction Dredging:** Suction dredging uses a small boat or barge with portable dredges and suction heads. Scuba divers operate the suction dredge and can target removal of whole plants, seeds, and roots. This method may be applied in conjunction with hand cutting where divers dislodge the plants. The plant/sediment slurry is hydraulically pumped to the barge through hoses carried by the diver. Its effectiveness is dependent on sediment composition, density of aquatic plants, and underwater visibility. Suction dredging may be best suited for localized infestations of low plant density where fragmentation must be controlled. A permit will be required for this activity.

Advantages: Diver suction dredging is species –selective. Disruption of sediments can be minimized. These methods can remove the plant stems and roots, resulting in thorough plant disruption and potential longer term control. Fragmentation of plants is minimized. This activity can be completed near and around obstacles such as piers or marinas where a harvester could not operate.

Disadvantages: Diver suction dredging is labor intensive and costly. Upland disposal of dredged slurry can require additional equipment and costs. Increased turbidity in the area of treatment can be a problem. Release of nutrients and other pollutants can also be a problem.

Costs: Suction dredging costs can be variable depending on equipment and transport requirements for slurry. Costs range from \$5,000 per acre to \$10,000 per acre.

**Dredging:** Sediment removal through dredging can work as a plant control technique by limiting light through increased water depth or removing soft sediments that are a preferred habitat to nuisance rooted plants. Soft sediment removal is accomplished with drag lines, bucket dredges, long reach backhoes, or other specialized dredging equipment. Dredging has had mixed results in controlling aquatic plant, however it can be highly effective in appropriate situations. Dredging is most often applied in a major restructuring of a severely degraded system. Generally, dredging is an activity associated with other restoration efforts. Comprehensive pre-planning will be necessary for these techniques and a dredging permit would be required.

Advantages: Dredging can remove nutrient reserves which result in nuisance rooted aquatic plant growth. Dredging, when completed, can also actually improve substrate and habitat for more desirable species of aquatic plants, fish, and invertebrates. It allows the complete renovation of an aquatic ecosystem. This method has the potential for significant reductions in aquatic plant growth. These methods can be completed in “off season” months avoiding interference with summer recreation activities.

Disadvantages: Dredging can temporarily destroy important fish and invertebrate habitat. Suspension of sediments usually increases turbidity significantly and can possibly release nutrients causing algae blooms. Dredging is extremely expensive and requires significant planning. Dredged materials may contain toxic materials (metals, PCBs). Dredged material transportation and disposal of toxic materials are additional management considerations and are potentially expensive. It could be difficult and costly to secure regulatory permits and approvals.

Costs: Dredging costs depend upon the scale of the project and many other factors. It is generally an extremely expensive option.

**Drawdown:** Water level drawdown exposes the plants and root systems to prolonged freezing and drying to kill the plants. It can be completed any time of the year, however is generally more effective in winter, exposing the lake bed to freezing temperatures. If there is a water level control structure capable of drawdown, it can be an in-expensive way to control some aquatic plants. Aquatic plants vary in their susceptibility to drawdown, therefore, accurate identification of problem species is important. Drawdown is often used for other purposes of improving waterfowl habitat or fishery management, but sometimes has the added benefit of nuisance rooted aquatic plant control. This method can be used in conjunction with a dredging project to excavate nutrient-rich sediments. This method is best suited for use on reservoirs or shallow man-made lakes. A drawdown would require regulatory permits and approvals.

Advantages: A drawdown can result in compaction of certain types of sediments and can be used to facilitate other lake management activities such as dam repair, bottom barrier, or dredging projects. Drawdown can significantly impact populations of aquatic plants that propagate vegetatively. It is inexpensive.

Disadvantages: This method is limited to situations with a water level control structure. Pumps can be used to de-water further if groundwater seepage is not significant. This technique may also result in the removal of beneficial plant species. Drawdowns can decrease bottom dwelling invertebrates and overwintering reptiles and amphibians. Drawdowns can affect adjacent wetlands, alter downstream flows, and potentially impair well production. Drawdowns and any water level manipulation are often highly controversial since shoreline landowners access and public recreation are limited during the drawdown. Fish populations are vulnerable during a drawdown due to over-harvesting by fisherman in decreased water volumes.

Costs: If a suitable outlet structure is available then costs should be minimal. If dewatering pumps would be required or additional management projects such as dredging are completed, additional costs would be incurred. Other costs would include recreational losses and perhaps loss in tourism revenue.

## Chemical Controls

Using chemical herbicides to kill nuisance aquatic plants is the oldest APM method. However, past pesticides uses being linked to environmental or human health problems have led to public wariness of chemicals in the environment. Current pesticide registration procedures are more stringent than in the past. While no chemical pesticide can be considered 100 percent safe, federal pesticide regulations are based on the premise that if a chemical is used according to its label instructions it will not cause adverse environmental or human health effects.

Chemical herbicides for aquatic plants can be divided into two categories, systemic and contact herbicides. Systemic herbicides are absorbed by the plant, translocated throughout the plant, and are capable of killing the entire plant, including the roots and shoots. Contact herbicides kill the plant surface in which it comes in contact, leaving roots capable of re-growth. Aquatic herbicides exist under various trade names, causing some confusion. Aquatic herbicides include the following:

- ▲ Endothall Based Herbicide
- ▲ Diquat Based Herbicide
- ▲ Fluridone Based Herbicide
- ▲ 2-4 D Based Herbicide
- ▲ Glyphosate Based Herbicide
- ▲ Triclopyr Based Herbicide
- ▲ Phosphorus Precipitation

Each of these methods are described below. The costs, benefits, and drawbacks of each chemical APM alternative are provided.

**Endothall Based Herbicide:** Endothall is a contact herbicide, attacking a wide range of plants at the point of contact. The chemical is not readily transferred to other plant tissue, therefore regrowth can be expected and repeated treatments may be needed. It is sold in liquid and granular forms under the trade names of Aquathol<sup>®</sup> or Hydrothol<sup>®</sup>. Hydrothol is also an algaecide. Most endothall products break down easily and do not remain in the aquatic environment. Endothall products can result in plant reductions for a few weeks to several months. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

**Advantages:** Endothall products work quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

**Disadvantages:** The entire plant is not killed when using endothall. Endothall is non-selective in the treatment area. High concentrations can kill fish easily. Water use restrictions (time delays) are necessary for recreation, irrigation, and fish consumption after application.

**Costs:** Costs vary with treatment area and dosage. Average costs for chemical application range between \$400 and \$700 per acre.

**Diquat Based Herbicide:** Diquat is a fast-acting contact herbicide effective on a broad spectrum of aquatic plants. It is sold under the trade name Reward<sup>®</sup>. Diluted forms of this product are also sold as private label products. Since Diquat binds to sediments readily, its effectiveness is reduced by turbid water. Multi-season effectiveness is not typical. A permit is required for use of this herbicide.

Advantages: Diquat works quickly and exhibit moderate to highly effective control of floating and submersed species. This herbicide has limited toxicity to fish at recommended doses.

Disadvantages: The entire plant is not killed when using diquat. Diquat is non-selective in the treatment area. Diquat can be inactivated by suspended sediments. Diquat is sometimes toxic to zooplankton at the recommended dose. Limited water used restrictions (water supply, agriculture, and contact recreation) are required after application.

Costs: Costs vary with treatment area and dosage. A general cost estimate for treatment is between \$200 and \$500 per acre.

**Fluoridone Based Herbicide:** Fluoridone is a slow-acting systemic herbicide, which is effectively absorbed and translocated by both plant roots and stems. Sonar<sup>®</sup> and Avast!<sup>®</sup> is the trade name and it is sold in liquid or granular form. Fluoridone requires a longer contact time and demonstrates delayed toxicity to target plants. Eurasian watermilfoil is more sensitive to fluoridone than other aquatic plants. This allows a semi-selective approach when low enough doses are used. Since the roots are also killed, multi-season effectiveness can be achieved. It is best applied during the early growth phase of the plants. A permit and extensive planning is required for use of this herbicide.

Advantages: Fluoridone is capable of killing roots, therefore producing a longer lasting effect than other herbicides. A variety of emergent and submersed aquatics are susceptible to this herbicide. Fluoridone can be used selectively, based on concentration. A gradual killing of target plants limits severe oxygen depletion from dead plant material. It has demonstrated low toxicity to aquatic fauna such as fish and invertebrates. 3 to 5 year control has been demonstrated. Extensive testing has shown that, when used according to label instructions, it does not pose negative health affects.

Disadvantages: Fluoridone is a very slow-acting herbicide sometimes taking up to several months for visible effects. It requires a long contact time. Fluoridone is extremely soluble and mixable, therefore, not effective in flowing water situations or for treating a select area in a large open lake. Impacts on non-target plants are possible at higher doses. Time delays are necessary on use of the water (water supply, irrigation, and contact recreation) after application.

Costs: Costs vary with treatment area and dosage. Treatment costs range from \$500 to \$2,000 per acre.

**2,4-D Based Herbicide:** 2,4-D based herbicides are sold in liquid or granular forms under various trade names. Common granular forms are sold under the trade names Navigate<sup>®</sup> and Aqua Kleen<sup>®</sup>. Common liquid forms include DMA 4<sup>®</sup> and Weedar 64<sup>®</sup>. 2,4-D is a systemic herbicide that affects broad leaf plants. It has been demonstrated effective against Eurasian watermilfoil, but it may not work on many aquatic plants. Since the roots are also killed, multi-season effectiveness may be achieved. It is best applied during the early growth phase of the plants. Visible results are evident within 10 to 14 days. A permit is required for use of this herbicide.

Advantages: 2,4-D is capable of killing roots, therefore producing a longer lasting effect than some other herbicides. It is fairly fast and somewhat selective, based on application timing and concentration. 2,4-D containing products are moderately to highly effective on a few emergent, floating, or submersed plants.

Disadvantages: 2,4-D can have variable toxicity effects to aquatic fauna, depending on formulation and water chemistry. 2,4-D lasts only a short time in water, but can be detected in sediments for months after application. Time delays are necessary on use of the water (agriculture and contact recreation) after application. The label does not permit use of this product in water used for drinking, irrigation, or livestock watering.

Costs: Costs vary with treatment area and dosage. Treatment costs range from \$300 to \$800 per acre.

**Glyphosate Based Herbicide:** Glyphosate has been categorized as both a contact and a systemic herbicide. It is applied as a liquid spray and is sold under the trade name Rodeo® or Pondmaster®. It is a non-selective, broad based herbicide effective against emergent or floating leaved plants, but not submergents. It's effectiveness can be reduced by rain. A permit is required for use of this herbicide.

Advantages: Glyphoshate is moderately to highly effective against emergent and floating-leaf plants resulting in rapid plant destruction. Since it is applied by spraying plants above the surface, the applicator can apply it selectively to target plants. Glyphosate dissipates quickly from natural waters, has a low toxicity to aquatic fauna, and carries no restrictions or time delays for swimming, fishing, or irrigation.

Disadvantages: Glyphoshate is non-selective in the treatment area. Wind can dissipate the product during the application reducing it's effectiveness and cause damage to non-target organisms. Therefore, spray application should only be completed when wind drift is not a problem. This compound is highly corrosive, therefore storage precautions are necessary.

Costs: Costs average \$500 to \$1,000 per acre depending on the scale of treatment.

**Triclopyr Based Herbicide:** Triclopyr is a systemic herbicide. It is registered for experimental aquatic use in selected areas only. It is applied as a liquid spray or injected into the subsurface as a liquid. Triclopyr is sold under the trade name Renovate® or Restorate®. Triclopyr has shown to be an effective control to many floating and submersed plants. It has been demonstrated to be highly effective against Eurasian watermilfoil, having little effect on valued native plants such as pondweeds. Triclopyr is most effective when applied during the active growth period of younger plants.

Advantages: This herbicide is fast acting. Triclopyr can be used selectively since it appears more effective against dicot plant species, including several difficult nuisance plants. Testing has demonstrated low toxicity to aquatic fauna.

Disadvantages: At higher doses, there are possible impacts to non-target species. Some forms of this herbicide are experimental for aquatic use and restrictions on use of the treated water are not yet certain.

## **Biological Controls**

There has been recent interest in using biological technologies to control aquatic plants. This concept stems from a desire to use a “natural” control and reduce expenses related to equipment and/or chemicals. While use of biological controls is in its infancy, potentially useful technologies have been identified and show promise for integration with physical and chemical APM strategies. Several biological controls that are in use or are under experimentation include the following:

- ▲ Herbivorous Fish
- ▲ Herbivorous Insects
- ▲ Plant Pathogens
- ▲ Native Plants

Each of these methods are described below. The costs, benefits, and drawbacks of each biologic APM method are provided.

**Herbivorous Fish:** A herbivorous fish such as the non-native grass carp can consume large quantities of aquatic plants. These fish have high growth rates and a wide range of plant food preferences. Stocking rates and effectiveness will depend on many factors including climate, water temperature, type and extent of aquatic plants, and other site-specific issues. Sterile (triploid) fish have been developed resulting in no reproduction of the grass carp and population control. This technology has demonstrated mixed results and is most appropriately used for lake-wide, low intensity control of submersed plants. Some states do not allow stocking of herbivorous fish. In Wisconsin, stocking of grass carp is prohibited.

Advantages: This technology can provide multiple years of aquatic plant control from a single stocking. Compared to other long-term aquatic plant control techniques such as bottom tillage or bottom barriers, costs may be relatively low.

Disadvantages: Sterile grass carp exhibit distinct food preferences, limiting their applicability. Grass carp may feed selectively on the preferred plants, while less preferred plants, including milfoil, may increase. The effects of using grass carp may not be immediate. Overstocking may result in an impact on non-target plants or eradication of beneficial plants, altering lake habitat. Using grass carp may result in algae blooms and increased turbidity. If precautions are not taken (i.e. inlet and outlet control structures to prevent fish migration) the fish may migrate and have adverse effects on non-target vegetation.

Costs: Costs can range from \$50/acre to over \$2,000/acre, at stocking rates of 5 fish/acre to 200 fish/acre.



**Herbivorous Insects:** Non-native and native insect species have been used to control rooted plants. Using herbivorous insects is intended to selectively control target species. These aquatic larvae of moths, beetles, and thrips use specific host aquatic plants. Several non-native species have been imported under USDA approval and used in integrated pest management programs, a combination of biological, chemical, and mechanical controls.

These non-native insects are being used in southern states to control nuisance plant species and appear climate-limited, their northern range being Georgia and North Carolina. While successes have been demonstrated, non-native species have not established themselves for solving biological problems, sometimes creating as many problems as they solve. Therefore, government agencies prefer alternative controls.

Native insects such as the larvae of midgeflies, caddisflies, beetles, and moths may be successful APM controls in northern states. Recently however, the native aquatic weevil *Euhrychiopsis lecontei* has received the most attention. This weevil has been associated with native northern water milfoil. The weevil can switch plant hosts and feed on Eurasian watermilfoil, destroying its growth points. While the milfoil weevil is gaining popularity, it is still experimental.

**Advantages:** Herbivorous insects are expected to have no negative effects on non-target species. The insects have shown promise for long term control when used as part of integrated aquatic plant management programs. The milfoil weevils do not use non-milfoil plants as hosts.

**Disadvantages:** Natural predator prey cycles indicate that incomplete control is likely. An oscillating cycle of control and re-growth is more likely. Fish predation may complicate controls. Large numbers of milfoil weevils may be required for a dense stand and can be expensive. The weevil leaves the water during the winter, may not return to the water in the spring, and are subject to bird predation in their terrestrial habitat. Application is manual and extremely time consuming. Introducing any species, especially non-native ones, into an aquatic ecosystem may have undesirable effects. Therefore, it is extremely important to understand the life cycles of the insects and the host plants.

**Costs:** Reported costs of herbivorous insects range from \$300/acre to \$3,000/acre.

Specifically, the native milfoil weevils cost approximately \$1.00 per weevil. It is generally considered appropriate to use 5 to 7 weevils per stem. Dense stands of milfoil may contain 1 to 2 million stems per acre. Therefore, costs of this new technology are currently prohibitive.

**Plant Pathogens:** Using a plant pathogen to control nuisance aquatic plants has been studied for many years, however, plant pathogens still remain largely experimental. Fungi are the most common pathogens, while bacteria and viruses have also been used. There is potential for highly specific plant applications.

**Advantages:** Plant pathogens may be highly species specific. They may provide substantial control of a nuisance species.

Disadvantages: Pathogens are experimental. The effectiveness and longevity of control is not well understood. Possible side effects are also unknown.

Costs: These techniques are experimental therefore a supply of specific products and costs are not established.

**Native Plants:** This method involves removing the nuisance plant species through chemical or physical means and re-introducing seeds, cuttings, or whole plants of desirable species. Success has been variable. When using seeds, they need to be planted early enough to encourage the full growth and subsequent seed production of those plants. Transplanting mature plants may be a better way to establish seed producing populations of desirable aquatics. Recognizing that a healthy, native, desirable plant community may be resistant to infestations of nuisance species, planting native plants should be encouraged as an APM alternative. Non-native plants can not be translocated.

Advantages: This alternative can restore native plant communities. It can be used to supplement other methods and potentially prevent future needs for costly repeat APM treatments.

Disadvantages: While this appears to be a desirable practice, it is experimental at this time and there are not many well documented successes. Nuisance species may eventually again invade the areas of native plantings. Careful planning is required to ensure that the introduced species do not themselves become nuisances. Hand planting aquatic plants is labor intensive.

Costs: Costs can be highly variable depending on the selected native species, numbers of plants ordered, and the nearest dealer location.

### **Aquatic Plant Prevention**

The phrase “an ounce of prevention is worth a pound of cure” certainly holds true for APM. Prevention is the best way to avoid nuisance aquatic plant growth. Prevention of the spread of invasive aquatic plants must also be achieved. Inspecting boats, trailers, and live wells for live aquatic plant material is the best way to prevent nuisance aquatic plants from entering a new aquatic ecosystem. Protecting the desirable native plant communities is also important in maintaining a healthy aquatic ecosystem and preventing the spread of nuisance aquatics once they are present.

Prolific growth of nuisance aquatic plants can be prevented by limiting nutrient (i.e. phosphorus) inputs to the water body. Aeration or phosphorus precipitation can achieve controls of in-lake cycling of phosphorus, however, if there are additional outside sources of nutrients, these methods will be largely ineffective in controlling algae blooms or intense aquatic macrophyte infestations. Watershed management activities to control nutrient laden storm water runoff are critical to controlling excessive nutrient loading to the water bodies. Nutrient loading can be prevented/minimized by the following:

- ▲ Shoreline buffers
- ▲ Using non-phosphorus fertilizers on lawns
- ▲ Settling basins for storm water effluents

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## Chapter NR 107

### AQUATIC PLANT MANAGEMENT

NR 107.01	Purpose.
NR 107.02	Applicability.
NR 107.03	Definitions.
NR 107.04	Application for permit.
NR 107.05	Issuance of permit.
NR 107.06	Chemical fact sheets.

NR 107.07	Supervision.
NR 107.08	Conditions of the permit.
NR 107.09	Special limitation.
NR 107.10	Field evaluation use permits.
NR 107.11	Exemptions.

**Note:** Chapter NR 107 as it existed on February 28, 1989 was repealed and a new Chapter NR 107 was created effective March 1, 1989.

**NR 107.01 Purpose.** The purpose of this chapter is to establish procedures for the management of aquatic plants and control of other aquatic organisms pursuant to s. 227.11 (2) (a), Stats., and interpreting s. 281.17 (2), Stats. A balanced aquatic plant community is recognized to be a vital and necessary component of a healthy aquatic ecosystem. The department may allow the management of nuisance-causing aquatic plants with chemicals registered and labeled by the U.S. environmental protection agency and labeled and registered by firms licensed as pesticide manufacturers and labeled with the Wisconsin department of agriculture, trade and consumer protection. Chemical management shall be allowed in a manner consistent with sound ecosystem management and shall minimize the loss of ecological values in the water body.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89; correction made under s. 13.93 (2m) (b) 7., Stats., Register, December, 2000, No. 540.

**NR 107.02 Applicability.** Any person sponsoring or conducting chemical treatment for the management of aquatic plants or control of other aquatic organisms in waters of the state shall obtain a permit from the department. Waters of the state include those portions of Lake Michigan and Lake Superior, and all lakes, bays, rivers, streams, springs, ponds, wells, impounding reservoirs, marshes, watercourses, drainage systems and other ground or surface water, natural or artificial, public or private, within the state or its jurisdiction as specified in s. 281.01 (18), Stats.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89; correction made under s. 13.93 (2m) (b) 7., Stats., Register, December, 2000, No. 540.

**NR 107.03 Definitions. (1)** "Applicator" means the person physically applying the chemicals to the treatment site.

**(2)** "Chemical fact sheet" means a summary of information on a specific chemical written by the department including general aquatic community and human safety considerations applicable to Wisconsin sites.

**(3)** "Department" means the department of natural resources.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.04 Application for permit. (1)** Permit applications shall be made on forms provided by the department and shall be submitted to the district director for the district in which the project is located. Any amendment or revision to an application shall be treated by the department as a new application, except as provided in s. NR 107.04 (3) (g).

**Note:** The DNR district headquarters are located at:

1. Southern — 3911 Fish Hatchery Road, Fitchburg 53711
2. Southeast — 2300 N. Dr. Martin Luther King Jr. Dr., Box 12436, Milwaukee 53212
3. Lake Michigan — 1125 N. Military Ave., Box 10448, Green Bay 54307
4. North Central — 107 Sutliff Ave., Box 818, Rhinelander 54501
5. Western — 1300 W. Clairemont Ave., Call Box 4001, Eau Claire 54702
6. Northwest — Hwy 70 West, Box 309, Spooner 54801

**(2)** The application shall be accompanied by:

(a) A nonrefundable permit application fee of \$20, and, for proposed treatments larger than 0.25 acres, an additional refundable acreage fee of \$25.00 per acre, rounded up to the nearest whole acre, applied to a maximum of 50.0 acres.

1. The acreage fee shall be refunded in whole if the entire permit is denied or if no treatment occurs on any part of the permitted treatment area. Refunds will not be prorated for partial treatments.

2. If the permit is issued with the proposed treatment area partially denied, a refund of acreage fees shall be given for the area denied.

(b) A legal description of the body of water proposed for treatment including township, range and section number;

(c) One copy of a detailed map or sketch of the body of water with the proposed treatment area dimensions clearly shown and with pertinent information necessary to locate those properties, by name of owner, riparian to the treatment area, which may include street address, local telephone number, block, lot and fire number where available. If a local address is not available, the home address and phone number of the property owner may be included;

(d) A description of the uses being impaired by plants or aquatic organisms and reason for treatment;

(e) A description of the plant community or other aquatic organisms causing the use impairment;

(f) The product names of chemicals proposed for use and the method of application;

(g) The name of the person or commercial applicator, and applicator certification number, when required by s. NR 107.08 (5), of the person conducting the treatment;

(h) A comparison of alternative control methods and their feasibility for use on the proposed treatment site.

**(3)** In addition to the information required under sub. (2), when the proposed treatment is a large-scale treatment exceeding 10.0 acres in size or 10% of the area of the water body that is 10 feet or less in depth, the application shall be accompanied by:

(a) A map showing the size and boundaries of the water body and its watershed.

(b) A map and list identifying known or suspected land use practices contributing to plant-related water quality problems in the watershed.

(c) A summary of conditions contributing to undesirable plant growth on the water body.

(d) A general description of the fish and wildlife uses occurring within the proposed treatment site.

(e) A summary of recreational uses of the proposed treatment site.

(f) Evidence that a public notice of the proposed application has been made, and that a public informational meeting, if required, has been conducted.

1. Notice shall be given in 2 inch x 4 inch advertising format in the newspaper which has the largest circulation in the area affected by the application.

2. The notice shall state the size of the proposed treatment, the approximate treatment dates, and that the public may request within 5 days of the notice that the applicant hold a public informational meeting on the proposed application.

a. The applicant will conduct a public informational meeting in a location near the water body when a combination of 5 or more individuals, organizations, special units of government, or local units of government request the meeting in writing to the applicant

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with a copy to the department within 5 days after the notice is made. The person or entity requesting the meeting shall state a specific agenda of topics including problems and alternatives to be discussed.

b. The meeting shall be given a minimum of one week advance notice, both in writing to the requestors, and advertised in the format of subd. 1.

(g) The provisions of pars. (a) to (e) shall be repeated once every 5 years and shall include new information. Annual modifications of the proposed treatment within the 5-year period which do not expand the treatment area more than 10% and cover a similar location and target organisms may be accepted as an amendment to the original application. The acreage fee submitted under sub. (2) (a) shall be adjusted in accordance with any proposed amendments.

(4) The applicant shall certify to the department that a copy of the application has been provided to any affected property owners' association, inland lake district, and, in the case of chemical applications for rooted aquatic plants, to any riparian property owners adjacent to and within the treatment area.

(5) A notice of the proposed treatment shall be provided by the department to any person or organization indicating annually in writing a desire to receive such notification.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.05 Issuance of permit.** (1) The department shall issue or deny issuance of the requested permit between 10 and 15 working days after receipt of an acceptable application, unless:

(a) An environmental impact report or statement is required under s. 1.11, Stats. Notification to the applicant shall be in writing within 10 working days of receipt of the application and no action may be taken until the report or statement has been completed; or

(b) A public hearing has been granted under s. 227.42, Stats.

(2) If a request for a public hearing is received after the permit is issued but prior to the actual treatment allowed by the permit, the department is not required to, but may, suspend the permit because of the request for public hearing.

(3) The department may deny issuance of the requested permit if:

(a) The proposed chemical is not labeled and registered for the intended use by the United States environmental protection agency and both labeled and registered by a firm licensed as a pesticide manufacturer and labeler with the Wisconsin department of agriculture, trade and consumer protection;

(b) The proposed chemical does not have a current department aquatic chemical fact sheet;

(c) The department determines the proposed treatment will not provide nuisance relief, or will place unreasonable restrictions on existing water uses;

(d) The department determines the proposed treatment will result in a hazard to humans, animals or other nontarget organisms;

(e) The department determines the proposed treatment will result in a significant adverse effect on the body of water;

(f) The proposed chemical application is for waters beyond 150 feet from shore except where approval is given by the department to maintain navigation channels, piers or other facilities used by organizations or the public including commercial facilities;

(g) The proposed chemical applications, other than those conducted by the department pursuant to ss. 29.421 and 29.424, Stats., will significantly injure fish, fish eggs, fish larvae, essential fish food organisms or wildlife, either directly or through habitat destruction;

(h) The proposed chemical application is in a location known to have endangered or threatened species as specified pursuant to s. 29.604, Stats., and as determined by the department;

(i) The proposed chemical application is in locations identified by the department as sensitive areas, except when the applicant demonstrates to the satisfaction of the department that treatments can be conducted in a manner that will not alter the ecological character or reduce the ecological value of the area.

1. Sensitive areas are areas of aquatic vegetation identified by the department as offering critical or unique fish and wildlife habitat, including seasonal or lifestage requirements, or offering water quality or erosion control benefits to the body of water.

2. The department shall notify any affected property owners' association, inland lake district, and riparian property owner of locations identified as sensitive areas.

(4) New applications will be reviewed with consideration given to the cumulative effect of applications already approved for the body of water.

(5) The department may approve the application in whole or in part consistent with the provisions of subs. (3) (a) through (i) and (4). Denials shall be in writing stating reasons for the denial.

(6) Permits may be issued for one treatment season only.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89; corrections in (3) (g) and (h) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 2000, No. 540.

**NR 107.06 Chemical fact sheets.** (1) The department shall develop a chemical fact sheet for each of the chemicals in present use for aquatic nuisance control in Wisconsin.

(1m) Chemical fact sheets for chemicals not previously used in Wisconsin shall be developed within 180 days after the department has received notice of intended use of the chemical.

(2) The applicant or permit holder shall provide copies of the applicable chemical fact sheets to any affected property owners' association and inland lake district.

(3) The department shall make chemical fact sheets available upon request.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.07 Supervision.** (1) The permit holder shall notify the district office 4 working days in advance of each anticipated treatment with the date, time, location, and proposed size of treatment. At the discretion of the department, the advance notification requirement may be waived.

(2) Supervision by a department representative may be required for any aquatic nuisance control project involving chemicals. Supervision may include inspection of the proposed treatment area, chemicals, and application equipment before, during or after treatment. The inspection may result in the determination that treatment is unnecessary or unwarranted in all or part of the proposed area, or that the equipment will not control the proper dosage.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.08 Conditions of the permit.** (1) The department may stop or limit the application of chemicals to a body of water if at any time it determines that chemical treatment will be ineffective, or will result in unreasonable restrictions on current water uses, or will produce unnecessary adverse side effects on nontarget organisms. Upon request, the department shall state the reason for such action in writing to the applicant.

(2) Chemical treatments shall be performed in accordance with label directions, existing pesticide use laws, and permit conditions.

(3) Chemical applications on lakes and impoundments are limited to waters along developed shoreline including public parks except where approval is given by the department for projects of public benefit.

(4) Treatment of areas containing high value species of aquatic plants shall be done in a manner which will not result in adverse long-term or permanent changes to a plant community in a specific aquatic ecosystem. High value species are individual species of aquatic plants known to offer important values in spe-

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cific aquatic ecosystems, including *Potamogeton amplifolius*, *Potamogeton Richardsonii*, *Potamogeton praelongus*, *Potamogeton pectinatus*, *Potamogeton illinoensis*, *Potamogeton robbinsii*, *Eleocharis spp.*, *Scirpus spp.*, *Valisneria spp.*, *Zizania aquatica*, *Zannichellia palustris* and *Brasenia schreberi*.

(5) Treatment shall be performed by an applicator currently certified by the Wisconsin department of agriculture, trade and consumer protection in the aquatic nuisance control category whenever:

(a) Treatment is to be performed for compensation by an applicator acting as an independent contractor for hire;

(b) The area to be treated is greater than 0.25 acres;

(c) The product to be used is classified as a "restricted use pesticide"; or

(d) Liquid chemicals are to be used.

(6) Power equipment used to apply liquid chemicals shall include the following:

(a) Containers used to mix and hold chemicals shall be constructed of watertight materials and be of sufficient size and strength to safely contain the chemical. Measuring containers and scales for the purpose of measuring solids and liquids shall be provided by the applicator;

(b) Suction hose used to deliver the chemical to the pump venturi assembly shall be fitted with an on-off ball-type valve. The system shall also be designed to prevent clogging from chemicals and aquatic vegetation;

(c) Suction hose used to deliver surface water to the pump shall be fitted with a check valve to prevent back siphoning into the surface water should the pump stop;

(d) Suction hose used to deliver a premixed solution shall be fitted with an on-off ball-type valve to regulate the discharge rate;

(e) Pressure hose used to discharge chemicals to the surface water shall be provided with an on-off ball-type valve. This valve will be fitted at the base of the hose nozzle or as part of the nozzle assembly;

(f) All pressure and suction hoses and mechanical fittings shall be watertight;

(g) Equipment shall be calibrated by the applicator. Evidence of calibration shall be provided at the request of the department supervisor.

(h) Other equipment designs may be acceptable if capable of equivalent performance.

(7) The permit holder shall be responsible for posting those areas of use in accordance with water use restrictions stated on the chemical label, but in all cases for a minimum of one day, and with the following conditions:

(a) Posting signs shall be brilliant yellow and conspicuous to the nonriparian public intending to use the treated water from both the water and shore, and shall state applicable label water use restrictions of the chemical being used, the name of the chemical and date of treatment. For tank mixes, the label requirements of the most restrictive chemical will be posted;

(b) Minimum sign dimensions used for posting shall be 11 inches by 11 inches or consistent with s. ATCP 29.15. The department will provide up to 6 signs to meet posting requirements. Additional signs may be purchased from the department;

(c) Signs shall be posted at the beginning of each treatment by the permit holder or representing agent. Posting prior to treatment may be required as a permit condition when the department determines that such posting is in the best interest of the public;

(d) Posting signs shall be placed along contiguous treated shoreline and at strategic locations to adequately inform the public. Posting of untreated shoreline located adjacent to treated shoreline and noncontiguous shoreline shall be at the discretion of the department;

(e) Posting signs shall be made of durable material to remain up and legible for the time period stated on the pesticide label for water use restrictions, after which the permit holder or representing agent is responsible for sign removal.

(8) After conducting a treatment, the permit holder shall complete and submit within 30 days an aquatic nuisance control report on a form supplied by the department. Required information will include the quantity and type of chemical, and the specific size and location of each treatment area. In the event of any unusual circumstances associated with a treatment, or at the request of the department, the report shall be provided immediately. If treatment did not occur, the form shall be submitted with appropriate comment by October 1.

(9) Failure to comply with the conditions of the permit may result in cancellation of the permit and loss of permit privileges for the subsequent treatment season. A notice of cancellation or loss of permit privileges shall be provided by the department to the permit holder accompanied by a statement of appeal rights.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89; correction in (7) (b) made under s. 13.93 (2m) (b) 7., Stats., Register, September, 1995, No. 477.

**NR 107.09 Special limitation.** Due to the significant risk of environmental damage from copper accumulation in sediments, swimmer's itch treatments performed with copper sulfate products at a rate greater than 10 pounds of copper sulfate per acre are prohibited.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.10 Field evaluation use permits.** When a chemical product is considered for aquatic nuisance control and does not have a federal label for such use, the applicant shall apply to the administrator of the United States environmental protection agency for an experimental use permit under section 5 of the federal insecticide, fungicide and rodenticide act as amended (7 USC 136 et seq.). Upon receiving a permit, the permit holder shall obtain a field evaluation use permit from the department and be subject to the requirements of this chapter. Department field evaluation use permits shall be issued for the purpose of evaluating product effectiveness and safety under field conditions and will require in addition to the conditions of the permit specified in s. NR 107.08 (1) through (9), the following:

(1) Treatment shall be limited to an area specified by the department.

(2) The permit holder shall submit to the department a summary of treatment results at the end of the treatment season. The summary shall include:

(a) Total chemical used and distribution pattern, including chemical trade name, formulation, percent active ingredient, and dosage rate in the treated water in parts per million of active ingredient;

(b) Description of treatment areas including the character and the extent of the nuisance present;

(c) Effectiveness of the application and when applicable, a summary comparison of the results obtained from past experiments using the same chemical formulation;

(d) Other pertinent information required by the department; and

(e) Conclusions and recommendations for future use.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89.

**NR 107.11 Exemptions.** (1) Under any of the following conditions, the permit application fee in s. NR 107.04 (2) (a) will be limited to the basic application fee:

(a) The treatment is made for the control of bacteria on swimming beaches with chlorine or chlorinated lime;

(b) The treatment is intended to control algae or other aquatic nuisances that interfere with the use of the water for potable purposes;



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(c) The treatment is necessary for the protection of public health, such as the control of disease carrying organisms in sanitary sewers, storm sewers, or marshes, and the treatment is sponsored by a governmental agency.

**(2)** The treatment of purple loosestrife is exempt from ss. NR 107.04 (2) (a) and (3), and 107.08 (5).

**(3)** The use of chemicals in private ponds is exempt from the provisions of this chapter except for ss. NR 107.04 (1), (2), (4) and (5), 107.05, 107.07, 107.08 (1), (2), (8) and (9), and 107.10.

(a) A private pond is a body of water located entirely on the land of an applicant, with no surface water discharge or a discharge that can be controlled to prevent chemical loss, and without access by the public.

(b) The permit application fee will be limited to the non-refundable \$20 application fee.

**(4)** The use of chemicals in accordance with label instructions is exempt from the provisions of this chapter, when used in:

(a) Water tanks used for potable water supplies;

(b) Swimming pools;

(c) Treatment of public or private wells;

(d) Private fish hatcheries licensed under s. 95.60, Stats.;

(e) Treatment of emergent vegetation in drainage ditches or rights-of-way where the department determines that fish and wildlife resources are insignificant; or

(f) Waste treatment facilities which have received s. 281.41, Stats., plan approval or are utilized to meet effluent limitations set forth in permits issued under s. 283.31, Stats.

**History:** Cr. Register, February, 1989, No. 398, eff. 3-1-89; **corrections in (4) (d) and (f) made under s. 13.93 (2m) (b) 7., Stats., Register, December, 2000, No. 540.**

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## Chapter NR 109

### AQUATIC PLANTS: INTRODUCTION, MANUAL REMOVAL and MECHANICAL CONTROL REGULATIONS

NR 109.01	Purpose.
NR 109.02	Applicability.
NR 109.03	Definitions.
NR 109.04	Application requirements and fees.
NR 109.05	Permit issuance.
NR 109.06	Waivers.

NR 109.07	Invasive and nonnative aquatic plants.
NR 109.08	Prohibitions.
NR 109.09	Plan specifications and approval.
NR 109.10	Other permits.
NR 109.11	Enforcement.

**NR 109.01 Purpose.** The purpose of this chapter is to establish procedures and requirements for the protection and regulation of aquatic plants pursuant to ss. 23.24 and 30.715, Stats. Diverse and stable communities of native aquatic plants are recognized to be a vital and necessary component of a healthy aquatic ecosystem. This chapter establishes procedures and requirements for issuing aquatic plant management permits for introduction of aquatic plants or control of aquatic plants by manual removal, burning, use of mechanical means or plant inhibitors. This chapter identifies other permits issued by the department for aquatic plant management that contain the appropriate conditions as required under this chapter for aquatic plant management, and for which no separate permit is required under this chapter. Introduction and control of aquatic plants shall be allowed in a manner consistent with sound ecosystem management, shall consider cumulative impacts, and shall minimize the loss of ecological values in the body of water. The purpose of this chapter is also to prevent the spread of invasive and non-native aquatic organisms by prohibiting the launching of watercraft or equipment that has any aquatic plants or zebra mussels attached.

**History:** CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.02 Applicability.** A person sponsoring or conducting manual removal, burning or using mechanical means or aquatic plant inhibitors to control aquatic plants in navigable waters, or introducing non-native aquatic plants to waters of this state shall obtain an aquatic plant management permit from the department under this chapter.

**History:** CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.03 Definitions.** In this chapter:

- (1) "Aquatic community" means lake or river biological resources.
- (2) "Beneficial water use activities" mean angling, boating, swimming or other navigational or recreational water use activity.
- (3) "Body of water" means any lake, river or wetland that is a water of this state.
- (4) "Complete application" means a completed and signed application form, the information specified in s. NR 109.04 and any other information which may reasonably be required from an applicant and which the department needs to make a decision under applicable provisions of law.
- (5) "Department" means the Wisconsin department of natural resources.
- (6) "Manual removal" means the control of aquatic plants by hand or hand-held devices without the use or aid of external or auxiliary power.
- (7) "Navigable waters" means those waters defined as navigable under s. 30.10, Stats.
- (8) "Permit" means aquatic plant management permit.
- (9) "Plan" means aquatic plant management plan.
- (10) "Wetlands" means an area where water is at, near or above the land surface long enough to be capable of supporting

aquatic or hydrophytic vegetation and which has soils indicative of wet conditions.

**History:** CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.04 Application requirements and fees.**

(1) Permit applications shall be made on forms provided by the department and shall be submitted to the regional director or designee for the region in which the project is located. Permit applications for licensed aquatic nursery growers may be submitted to the department of agriculture, trade and consumer protection.

**Note:** Applications may be obtained from the department's regional headquarters or service centers. DATCP has agreed to send application forms and instructions provided by the department to aquatic nursery growers along with license renewal forms. DATCP will forward all applications to the department for processing.

(2) The application shall be accompanied by all of the following unless the application is made by licensed aquatic nursery growers for selective harvesting of aquatic plants for nursery stock. Applications made by licensed aquatic nursery growers for harvest of nursery stock do not have to include the information required by par. (d), (e), (h), (i) or (j).

(a) A nonrefundable application fee. The application fee for an aquatic plant management permit is:

1. \$30 for a proposed project to manage aquatic plants on less than one acre.
2. \$30 per acre to a maximum of \$300 for a proposed project to manage aquatic plants on one acre or larger. Partial acres shall be rounded up to the next full acre for fee determination. An annual renewal of this permit may be requested with an additional application fee of one-half the original application fee, but not less than \$30.

(b) A legal description of the body of water including township, range and section number.

(c) One copy of a detailed map of the body of water with the proposed introduction or control area dimensions clearly shown. Private individuals doing plant introduction or control shall provide the name of the owner riparian to the management area, which includes the street address or block, lot and fire number where available and local telephone number or other pertinent information necessary to locate the property.

(d) One copy of any existing aquatic management plan for the body of water, or detailed reference to the plan, citing the plan references to the proposed introduction or control area, and a description of how the proposed introduction or control of aquatic plants is compatible with any existing plan.

(e) A description of the impairments to water use caused by the aquatic plants to be managed.

(f) A description of the aquatic plants to be controlled or removed.

(g) The type of equipment and methods to be used for introduction, control or removal.

(h) A description of other introduction or control methods considered and the justification for the method selected.

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(i) A description of any other method being used or intended for use for plant management by the applicant or on the area abutting the proposed management area.

(j) The area used for removal, reuse or disposal of aquatic plants.

(k) The name of any person or commercial provider of control or removal services.

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

(b) Within 30 days of receipt of the plan, the department shall notify the applicant of any additional information or modifications to the plan that are required. If the applicant does not submit the additional information or modify the plan as requested by the department, the department may dismiss the aquatic plant management permit application.

(c) The department shall approve the aquatic plant management plan before an application may be considered complete.

**(4)** The permit sponsor may request an annual renewal in writing from the department under s. NR 109.05 if there is no change proposed in the conditions of the original permit issued.

**History:** CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.05 Permit issuance.** **(1)** The department shall issue or deny issuance of the requested permit within 15 working days after receipt of a completed application and approved plan as required under s. NR 109.04 (3).

**(2)** The department may specify any of the following as conditions of the permit:

(a) The quantity of aquatic plants that may be introduced or controlled.

(b) The species of aquatic plants that may be introduced or controlled.

(c) The areas in which aquatic plants may be introduced or controlled.

(d) The methods that may be used to introduce or control aquatic plants.

(e) The times during which aquatic plants may be introduced or controlled.

(f) The allowable methods used for disposing of or using aquatic plants that are removed or controlled.

(g) Annual or other reporting requirements to the department that may include information related to pars. (a) to (f).

**(3)** The department may deny issuance of the requested permit if the department determines any of the following:

(a) Aquatic plants are not causing significant impairment of beneficial water use activities.

(b) The proposed introduction or control will not remedy the water use impairments caused by aquatic plants as identified as a part of the application in s. NR 109.04 (2) (e).

(c) The proposed introduction or control will result in a hazard to humans.

(d) The proposed introduction or control will cause significant adverse impacts to threatened or endangered resources.

(e) The proposed introduction or control will result in a significant adverse effect on water quality, aquatic habitat or the aquatic community including the native aquatic plant community.

(f) The proposed introduction or control is in locations identified by the department as sensitive areas, under s. NR 107.05 (3) (i) 1., except when the applicant demonstrates to the satisfaction of the department that the project can be conducted in a manner that will not alter the ecological character or reduce the ecological value of the area.

(g) The proposed management will result in significant adverse long-term or permanent changes to a plant community or a high value species in a specific aquatic ecosystem. High value species are individual species of aquatic plants known to offer important values in specific aquatic ecosystems, including *Potamogeton amplifolius*, *Potamogeton Richardsonii*, *Potamogeton praelongus*, *Stuckenia pectinata* (*Potamogeton pectinatus*), *Potamogeton illinoensis*, *Potamogeton robbinsii*, *Eleocharis* spp., *Scirpus* spp., *Valisneria* spp., *Zizania* spp., *Zannichellia palustris* and *Brasenia schreberi*.

(h) If wild rice is involved, the stipulations incorporated by *Lac Courte Oreilles v. Wisconsin*, 775 F. Supp. 321 (W.D. Wis. 1991) shall be complied with.

(i) The proposed introduction or control will interfere with the rights of riparian owners.

(j) The proposed management is inconsistent with a department approved aquatic plant management plan for the body of water.

**(4)** The department may approve the application in whole or in part consistent with the provisions of sub. (3). A denial shall be in writing stating the reasons for the denial.

**(5)** (a) The department may issue an aquatic plant management permit on less than one acre in a single riparian area for a 3-year term.

(b) The department may issue an aquatic plant management permit for a one-year term for more than one acre or more than one riparian area. The permit may be renewed annually for up to a total of 3 years in succession at the written request of the permit holder, provided no modifications or changes are made from the original permit.

(c) The department may issue an aquatic plant management permit containing a department-approved plan for a 3 to 5 year term.

(d) The department may issue an aquatic plant management permit to a licensed nursery grower for a 3-year term for the harvesting of aquatic plants from a publicly owned lake bed or for a 5-year term for harvesting of aquatic plants from privately owned beds with the permission of the property owner.

**(6)** The approval of an aquatic plant management permit does not represent an endorsement of the permitted activity, but represents that the applicant has complied with all criteria of this chapter.

**History:** CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03; reprinted to restore dropped language from rule order, Register October 2003 No. 574.

**NR 109.06 Waivers.** The department waives the permit requirements under this chapter for any of the following:

**(1)** Manual removal or use of mechanical devices to control or remove aquatic plants from a body of water 10 acres or less that is entirely confined on the property of one person with the permission of that property owner.

**Note:** A person who introduces native aquatic plants or removes aquatic plants by manual or mechanical means in the course of operating an aquatic nursery as authorized under s. 94.10, Stats., on privately owned non-navigable waters of the state is not required to obtain a permit for the activities.

**(2)** A riparian owner who manually removes aquatic plants from a body of water or uses mechanical devices designed for cutting or mowing vegetation to control plants on an exposed lake bed that abuts the owner's property provided that the removal meets all of the following:

(a) 1. Removal of native plants is limited to a single area with a maximum width of no more than 30 feet measured along the



**Unofficial Text (See Printed Volume). Current through date and Register shown on Title Page.**

shoreline provided that any piers, boatlifts, swimrafts and other recreational and water use devices are located within that 30-foot wide zone and may not be in a new area or additional to an area where plants are controlled by another method; or

2. Removal of nonnative or invasive aquatic plants as designated under s. NR 109.07 when performed in a manner that does not harm the native aquatic plant community; or

3. Removal of dislodged aquatic plants that drift on-shore and accumulate along the waterfront.

(b) Is not located in a sensitive area as defined by the department under s. NR 107.05 (3) (i) 1., or in an area known to contain threatened or endangered resources or floating bogs.

(c) Does not interfere with the rights of other riparian owners.

(d) If wild rice is involved, the procedures of s. NR 19.09 (1) shall be followed.

(4) Control of purple loosestrife by manual removal or use of mechanical devices when performed in a manner that does not harm the native aquatic plant community or result in or encourage re-growth of purple loosestrife or other nonnative vegetation.

(5) Any aquatic plant management activity that is conducted by the department and is consistent with the purposes of this chapter.

(6) Manual removal and collection of native aquatic plants for lake study or scientific research when performed in a manner that does not harm the native aquatic plant community.

*Note:* Scientific collectors permit requirements are still applicable.

(7) Incidental cutting, removal or destroying of aquatic plants when engaged in beneficial water use activities.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.07 Invasive and nonnative aquatic plants.**

(1) The department may designate any aquatic plant as an invasive aquatic plant for a water body or a group of water bodies if it has the ability to cause significant adverse change to desirable aquatic habitat, to significantly displace desirable aquatic vegetation, or to reduce the yield of products produced by aquaculture.

(2) The following aquatic plants are designated as invasive aquatic plants statewide: Eurasian water milfoil, curly leaf pondweed and purple loosestrife.

(3) Native and nonnative aquatic plants of Wisconsin shall be determined by using scientifically valid publications and findings by the department.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.08 Prohibitions.** (1) No person may distribute an invasive aquatic plant, under s. NR 109.07.

(2) No person may intentionally introduce Eurasian water milfoil, curly leaf pondweed or purple loosestrife into waters of this state without the permission of the department.

(3) No person may intentionally cut aquatic plants in public/navigable waters without removing cut vegetation from the body of water.

(4) (a) No person may place equipment used in aquatic plant management in a navigable water if the person has reason to

believe that the equipment has any aquatic plants or zebra mussels attached.

(b) This subsection does not apply to equipment used in aquatic plant management when re-launched on the same body of water without having visited different waters, provided the re-launching will not introduce or encourage the spread of existing aquatic species within that body of water.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.09 Plan specifications and approval.**

(1) Applicants required to submit an aquatic plant management plan, under s. NR 109.04 (3), shall develop and submit the plan in a format specified by the department.

(2) The plan shall present and discuss each of the following items:

(a) The goals and objectives of the aquatic plant management and protection activities.

(b) A physical, chemical and biological description of the waterbody.

(c) The intensity of water use.

(d) The location of aquatic plant management activities.

(e) An evaluation of chemical, mechanical, biological and physical aquatic plant control methods.

(f) Recommendations for an integrated aquatic plant management strategy utilizing some or all of the methods evaluated in par. (e).

(g) An education and information strategy.

(h) A strategy for evaluating the efficacy and environmental impacts of the aquatic plant management activities.

(i) The involvement of local units of government and any lake organizations in the development of the plan.

(3) The approval of an aquatic plant management plan does not represent an endorsement for plant management, but represents that adequate considerations in planning the actions have been made.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.10 Other permits.** Permits issued under s. 30.12, 30.20, 31.02 or 281.36, Stats., or under ch. NR 107 may contain provisions which provide for aquatic plant management. If a permit issued under one of these authorities contains the appropriate conditions as required under this chapter for aquatic plant management, a separate permit is not required under this chapter. The permit shall explicitly state that it is intended to comply with the substantive requirements of this chapter.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

**NR 109.11 Enforcement.** (1) Violations of this chapter may be prosecuted by the department under chs. 23, 30 and 31, Stats.

(2) Failure to comply with the conditions of a permit issued under or in accordance with this chapter may result in cancellation of the permit and loss of permit privileges for the subsequent year. Notice of cancellation or loss of permit privileges shall be provided by the department to the permit holder.

*History:* CR 02-061: cr. Register May 2003 No. 569, eff. 6-1-03.

## Online References for More Information

### **General Information**

<http://www.dnr.state.wi.us/org/water/fhp/lakes/aquaplan.htm>

Wisconsin Department of Natural Resources - Aquatic Plant Management

<http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp>

UW Extension Lakes Program – Aquatic Plant Management in Wisconsin

<http://www.wisconsinlakes.org/>

Wisconsin Association of Lakes

<http://www.uwsp.edu/cnr/uwexlakes/>

UW Extension Lakes Program – Homepage

<http://datcp.state.wi.us/index.jsp>

Wisconsin Department of Agriculture, Trade and Consumer Protection

<http://el.erdc.usace.army.mil/aqua/>

Army Corps of Engineers – Aquatic Plant Control Research Program

<http://www.nalms.org/>

North American Lake Management Society

<http://www.apms.org/>

Aquatic Plant Management Society

<http://www.fapms.org/>

Florida Aquatic Plant Management Society

<http://www.mapms.org/>

Midwest Aquatic Plant Management Society

<http://www.epa.gov/>

Environmental Protection Agency

<http://web.fisheries.org/main/>

American Fisheries Society

<http://www.botany.wisc.edu/herbarium/>

Wisconsin State Herbarium – Aquatic Plant Identification

<http://www.uwsp.edu/cnr/uwexlakes/CBCW/default.asp>

UW Extension Lakes Program – Clean Boats Clean Waters

## **Aquatic Invasive Species**

<http://www.dnr.state.wi.us/invasives/aquatic/>

Wisconsin Department of Natural Resources – Aquatic Invasive Species

<http://www.uwex.edu/erc/invasives.html>

UW Extension- Environmental Resources Center

<http://www.ipaw.org/>

Invasive Plants Association of Wisconsin

<http://www.seagrant.wisc.edu/ais/>

University of Wisconsin Sea Grant Institute– Aquatic Invasive Species

<http://www.anstaskforce.gov/default.php>

Aquatic Nuisance Species Task Force

<http://www.invasivespeciesinfo.gov/aquatics/databases.shtml>

United States Department of Agriculture – Invasive Species Information Center

<http://aquat1.ifas.ufl.edu/welcome.html>

University of Florida - Center for Aquatic and Invasive Plants

## **Grants**

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Lakes/Largelake.html>

Lake Management Planning – Large Scale Grants

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Lakes/smalllake.html>

Lake Management Planning – Small Scale Grants

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Lakes/invasivespecies.html>

Aquatic Invasive Species

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Lakes/lakeprotection.html>

Lake Protection and Classification Grants

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/recboat.html>

Recreation Boating Facilities

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Rivers/riverplanning.html>

River Protection Planning

<http://www.dnr.state.wi.us/org/caer/cfa/Grants/Rivers/riverprotection.html>

River Protection Management

# **AQUATIC PLANT MANAGEMENT STRATEGY**

**Northern Region WDNR  
Summer, 2007  
(working draft)**

# AQUATIC PLANT MANAGEMENT STRATEGY

## Northern Region WDNR

### ISSUES

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

### BACKGROUND

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

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

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

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

### **GOALS OF STRATEGY:**

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

### **BASIS OF STRATEGY IN STATE STATUTE AND ADMINISTRATIVE CODE**

**State Statute 23.24 (2)(c)** states:

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

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

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

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

**State Statute 23.24(3)(b)** states:

“The department may require that an application for an aquatic plant management permit contain a plan for the department’s approval as to how the aquatic plants will be introduced, removed, or controlled.”

**Wisconsin Administrative Code NR 109.04(3)(a)** states:

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

# AQUATIC PLANT MANAGEMENT STRATEGY

## Northern Region WDNR

### APPROACH

1. After January 1, 2009\* no individual permits for control of native aquatic plants will be issued. Treatment of native species may be allowed under the auspices of an approved lake management plan, and only if the plan clearly documents “impairment of navigation” and/or “nuisance conditions”. Until January 1, 2009, individual permits will be issued to previous permit holders, only with adequate documentation of “impairment of navigation” and/or “nuisance conditions”. No new individual permits will be issued during the interim.
2. Control of aquatic plants (if allowed) in documented sensitive areas will follow the conditions specified in the report.
3. Invasive species must be controlled under an approved lake management plan, with two exceptions (these exceptions are designed to allow sufficient time for lake associations to form and subsequently submit an approved lake management plan):
  - a. Newly-discovered infestations. If found on a lake with an approved lake management plan, the invasive species can be controlled via an amendment to the approved plan. If found on a lake without an approved management plan, the invasive species can be controlled under the WDNR’s Rapid Response protocol (see definition), and the lake owners will be encouraged to form a lake association and subsequently submit a lake management plan for WNDR review and approval.
  - b. Individuals holding past permits for control of *invasive* aquatic plants and/or “mixed stands” of native and invasive species will be allowed to treat via individual permit until January 1, 2009 if “impairment of navigation” and/or “nuisance conditions” is adequately documented, unless there is an approved lake management plan for the lake in question.
4. Control of invasive species or “mixed stands” of invasive and native plants will follow current best management practices approved by the Department and contain an explanation of the strategy to be used. Established stands of invasive plants will generally use a control strategy based on Spring treatment. (typically, a water temperature of less than 60 degrees Fahrenheit, or approximately May 31st, annually).
5. Manual removal (see attached definition) is allowed (Admin. Code NR 109.06).

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



# AQUATIC PLANT MANAGEMENT STRATEGY

## Northern Region WDNR

### DOCUMENTATION OF IMPAIRED NAVIGATION AND/OR NUISANCE CONDITIONS

Navigation channels can be of two types:

- Common use navigation channel. This is a common navigation route for the general lake user. It often is off shore and connects areas that boaters commonly would navigate to or across, and should be of public benefit.
- Individual riparian access lane. This is an access lane to shore that normally is used by an individual riparian shore owner.

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

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

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

**Documentation of the *nuisance*** must include:

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

# **AQUATIC PLANT MANAGEMENT STRATEGY**

## **Northern Region WDNR**

### **DEFINITIONS**

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

Date	Depth	Water Temp (F)	D/O (mg/l)
5/26/1994	1	66	---
5/26/1994	3	64	---
5/26/1994	6	63	---
5/26/1994	9	60	---
5/26/1994	15	58	---
5/26/1994	22	57	---
5/26/1994	25	55	---
6/27/1994	1	74	---
6/27/1994	3	72	---
6/27/1994	6	70	---
6/27/1994	9	69	---
6/27/1994	15	65	---
6/27/1994	20	63	---
7/24/1994	1	75	---
7/24/1994	3	74	---
7/24/1994	6	71	---
7/24/1994	9	66	---
7/24/1994	15	65	---
7/24/1994	20	64	---
8/28/1994	1	68	---
8/28/1994	3	68	---
8/28/1994	6	67	---
8/28/1994	9	66	---
8/28/1994	15	65	---
8/28/1994	20	64	---
11/14/1994	1	44	---
11/14/1994	3	43	---
11/14/1994	6	43	---
11/14/1994	9	42	---
11/14/1994	15	42	---
11/14/1994	20	41	---
5/25/2003	3	60	---
5/25/2003	6	60	---
5/25/2003	9	59.7	---
5/25/2003	12	59.3	---
5/25/2003	15	59.3	---
5/25/2003	18	58.8	---
5/25/2003	21	55.7	---
6/11/2003	0	75	---
6/11/2003	3	70.8	---
6/11/2003	6	69.2	---
6/11/2003	9	68	---
6/11/2003	12	65.8	---
6/11/2003	15	63.1	---
6/11/2003	18	62	---
6/11/2003	21	61.5	---
7/12/2003	3	71.6	---
7/12/2003	6	71.4	---
7/12/2003	9	71.2	---
7/12/2003	12	70.1	---
7/12/2003	15	67.4	---
7/12/2003	18	65.1	---
7/12/2003	21	60.2	---

Date	Depth	Water Temp (F)	D/O (mg/l)
6/15/2004	3	69.2	---
6/15/2004	6	67.8	---
6/15/2004	9	67.4	---
6/15/2004	12	66	---
6/15/2004	15	65.3	---
6/15/2004	18	64.4	---
6/15/2004	21	63.6	---
6/29/2004	0	66.7	---
6/29/2004	3	65.4	---
6/29/2004	6	65.3	---
6/29/2004	9	65.1	---
6/29/2004	12	63.8	---
6/29/2004	15	63.3	---
6/29/2004	18	63.1	---
6/29/2004	21	62.9	---
7/15/2004	3	71.9	5.75
7/15/2004	6	71.6	6.59
7/15/2004	9	71	7.30
7/15/2004	12	66.2	10.32
7/15/2004	15	64.7	6.23
7/15/2004	18	64.2	12.17
7/15/2004	21	63.5	9.47
8/29/2004	3	68.9	6.79
8/29/2004	6	68.7	6.80
8/29/2004	9	66.3	7.86
8/29/2004	12	65.6	7.66
8/29/2004	15	65.4	7.24
8/29/2004	18	64.4	9.82
8/29/2004	21	64	5.38
9/28/2004	3	65.6	7.29
9/28/2004	6	65.4	7.31
9/28/2004	9	65.3	6.96
9/28/2004	12	65.1	12.66
9/28/2004	15	64.5	7.36
9/28/2004	18	65.4	6.81
9/28/2004	21	63.3	7.20
5/24/2005	3	62.6	8.96
5/24/2005	6	62.4	9.11
5/24/2005	9	62.2	9.28
5/24/2005	12	62	8.77
5/24/2005	15	61.8	8.75
5/24/2005	18	61.7	9.15
5/24/2005	21	61.5	8.21
5/31/2005	3	58.4	8.33
5/31/2005	6	57.7	8.27
5/31/2005	9	57.3	8.20
5/31/2005	12	56.4	7.43
5/31/2005	15	55.7	6.18
5/31/2005	18	55.2	5.95
5/31/2005	21	53.6	2.58
6/16/2005	15	63.2	5.87
6/16/2005	18	62.8	0.20
6/16/2005	21	62.6	0.10

Date	Depth	Water Temp (F)	D/O (mg/l)
7/7/2005	3	61	6.11
7/7/2005	6	60.3	6.66
7/7/2005	9	58.2	5.66
7/7/2005	12	55.4	5.25
7/7/2005	15	70	5.16
7/7/2005	18	63	4.42
7/7/2005	21	59	0.18
7/19/2005	3	74	5.72
7/19/2005	6	73	5.71
7/19/2005	9	70.7	5.72
7/19/2005	12	70.6	5.26
7/19/2005	15	70.4	2.68
7/19/2005	18	70.2	0.40
7/19/2005	21	68.2	0.60
8/14/2005	3	79.1	5.38
8/14/2005	6	78.9	4.88
8/14/2005	9	77.8	5.02
8/14/2005	12	74	5.31
8/14/2005	15	71.8	5.24
8/14/2005	18	69.7	0.07
8/14/2005	21	67.5	0.09
10/16/2005	3	74	9.30
10/16/2005	6	74	9.29
10/16/2005	9	73.8	9.37
10/16/2005	12	73.8	9.34
10/16/2005	15	73.6	9.17
10/16/2005	18	72	9.47
10/16/2005	21	68.6	9.28
5/31/2006	3	54.1	8.21
5/31/2006	6	53.9	8.06
5/31/2006	9	53.8	9.41
5/31/2006	12	53.7	10.58
5/31/2006	15	53.4	9.47
5/31/2006	18	53.4	8.38
5/31/2006	21	53.3	5.55
6/30/2006	3	72	7.80
6/30/2006	6	71.8	7.91
6/30/2006	9	69.8	7.81
6/30/2006	12	62.5	7.78
6/30/2006	15	59.3	5.02
6/30/2006	18	57.9	1.76
6/30/2006	21	57.1	0.94
7/13/2006	3	72.9	7.68
7/13/2006	6	72.6	7.28
7/13/2006	9	71.8	7.46
7/13/2006	12	71.2	6.71
7/13/2006	15	70.2	4.91
7/13/2006	18	65.9	1.33
7/13/2006	21	60.4	1.01
8/15/2006	3	78.3	6.99
8/15/2006	6	76.5	6.85
8/15/2006	9	74.2	7.02
8/15/2006	12	73.4	7.04
8/15/2006	15	72.3	6.57
8/15/2006	18	70.7	6.33
8/15/2006	21	62.1	0.98

Date	Depth	Water Temp (F)	D/O (mg/l)
10/10/2006	3	72.9	9.37
10/10/2006	6	72.6	9.37
10/10/2006	9	72.5	9.38
10/10/2006	12	72.2	9.19
10/10/2006	15	72	9.00
10/10/2006	18	71.8	9.32
10/10/2006	21	64.9	9.12
5/11/2007	3	53.4	10.30
5/11/2007	6	53.4	10.28
5/11/2007	9	53.3	10.37
5/11/2007	12	53.2	10.28
5/11/2007	15	53.1	10.01
5/11/2007	18	53	10.12
5/11/2007	21	52.9	10.02
6/22/2007	3	72.9	12.27
6/22/2007	6	72.2	10.07
6/22/2007	9	72	10.59
6/22/2007	12	71.6	9.81
6/22/2007	15	68	9.69
6/22/2007	18	65.4	5.47
6/22/2007	21	63.6	5.41
7/18/2007	3	73.3	7.93
7/18/2007	6	70.8	7.73
7/18/2007	9	69.9	7.30
7/18/2007	12	69.1	5.76
7/18/2007	15	68.8	5.18
7/18/2007	18	68	1.89
7/18/2007	21	67.6	1.38
8/14/2007	3	75.3	7.05
8/14/2007	6	75.3	7.05
8/14/2007	9	75.2	6.98
8/14/2007	12	75.3	7.13
8/14/2007	15	75	6.76
8/14/2007	18	74.4	6.56
8/14/2007	21	70.3	1.92
9/24/2007	3	61.7	8.93
9/24/2007	6	61.7	8.93
9/24/2007	9	61.6	8.76
9/24/2007	12	61.6	8.76
9/24/2007	15	61.5	9.05
9/24/2007	18	61.5	9.05
9/24/2007	21	61.6	6.36
5/8/2008	3	51.3	11.93
5/8/2008	6	50.2	11.99
5/8/2008	9	50.1	12.01
5/8/2008	12	49.8	11.63
5/8/2008	15	48.9	11.23
5/8/2008	18	48.6	11.05
5/8/2008	21	48.4	10.76
6/19/2008	3	67	8.67
6/19/2008	6	66.9	8.68
6/19/2008	9	66.6	8.71
6/19/2008	12	66.1	8.58
6/19/2008	15	65.9	8.07
6/19/2008	18	65.6	7.40
6/19/2008	21	65	2.66

Date	Depth	Water Temp (F)	D/O (mg/l)
7/15/2008	1	71.5	8.05
7/15/2008	2	71.3	7.88
7/15/2008	3	71	7.86
7/15/2008	4	70.9	7.82
7/15/2008	5	70.7	7.67
7/15/2008	6	70.7	7.78
7/15/2008	7	70.7	7.57
7/15/2008	8	70.7	7.28
7/15/2008	9	70.2	7.41
7/15/2008	10	70.1	7.53
7/15/2008	11	69.7	7.43
7/15/2008	12	69.5	7.05
7/15/2008	13	69.1	6.83
7/15/2008	14	68.9	7.14
7/15/2008	15	68.9	5.78
7/15/2008	16	68.8	5.94
7/15/2008	17	68.6	5.79
7/15/2008	18	68.5	5.56
7/15/2008	19	67.9	1.5
7/15/2008	20	67.6	1.32
7/15/2008	21	67.6	1.28
7/16/2008	3	74.5	8.07
7/16/2008	6	73.2	8.26
7/16/2008	9	70.7	7.32
7/16/2008	12	70.2	5.77
7/16/2008	15	69.8	4.96
7/16/2008	18	69.5	3.20
7/16/2008	21	69.8	1.34
8/18/2008	3	74	9.00
8/18/2008	6	73.6	8.90
8/18/2008	9	73.1	8.80
8/18/2008	12	71.5	6.40
8/18/2008	15	71.2	4.97
8/18/2008	18	70.8	3.46
8/18/2008	21	67.3	0.13
5/4/2009	3	52.8	12.10
5/4/2009	6	52.7	12.00
5/4/2009	9	51.5	11.90
5/4/2009	12	49.7	12.70
5/4/2009	15	49.6	12.40
5/4/2009	18	49.1	12.10
5/4/2009	21	48.9	10.80
7/5/2009	3	69.9	9.67
7/5/2009	6	69.9	9.58
7/5/2009	9	69.5	9.81
7/5/2009	12	67.9	9.15
7/5/2009	15	65.2	6.90
7/5/2009	18	64.2	3.41
7/5/2009	21	63.9	2.43
7/23/2009	3	70	10.30
7/23/2009	6	69.4	9.86
7/23/2009	9	68.5	9.73
7/23/2009	12	67.1	8.24
7/23/2009	15	65.9	5.41
7/23/2009	18	65.6	3.05
7/23/2009	21	65.4	2.41

<b>Date</b>	<b>Depth</b>	<b>Water Temp (F)</b>	<b>D/O (mg/l)</b>
8/31/2009	3	64.4	8.49
8/31/2009	6	64.3	8.40
8/31/2009	9	64.2	9.05
8/31/2009	12	64.1	8.90
8/31/2009	15	64	8.60
8/31/2009	18	64	9.40
8/31/2009	21	63.9	7.70