Eurasian water milfoil (*Myriophyllum spicatum*) Rapid Assessment Survey and Dive Delineation Gilmore Lake Washburn County, Wisconsin WBIC: 2695800

Project Sponsored by:
Wisconsin Department of Natural Resources, and the
Gilmore Lake Association

Survey Conducted by and Report Prepared by:

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St. Croix Falls, Wisconsin

September 19-20, October 9, 2009

TABLE OF CONTENTS

ABSTRACT

Gilmore Lake (WBIC 2695800) is a 389-acre drainage water body in north central Washburn County, WI. It is oligotrophic in nature with average summer Secchi readings of 8.5ft, and a littoral zone that extends to 16ft. In August 2009, the Gilmore Lake Association and the Wisconsin Department of Natural Resources confirmed the presence of Eurasian water milfoil (*Myriophyllum spicatum*) in the lake and commissioned a rapid exotic species assessment and dive survey to determine the extent of the infestation prior to chemical treatment. The resulting survey identified a total of 47 native plants to species in and immediately adjacent to the lake that produced a mean Coefficient of Conservatism of 6.8 and a very high Floristic Quality Index value of 46.4. We found EWM growing in an area totaling less than one acre surrounding the point it was originally discovered at on the southwestern shoreline of the lake's southern basin. Future management goals should include preserving the lake's diverse and rare plant community by aggressively working to control Eurasian water milfoil; considering to continue spot herbicide applications and careful hand removal to maintain EWM at its current low level; reevaluating the control area and performing another meandering shoreline survey in spring 2010 to aid in developing a management plan for the rest of 2010; continuing to monitor for EWM on a regular basis throughout the 2010 growing season to determine if control methods are having the desired effect or need to be augmented; completing an Aquatic Plant Management Plan (APMP) and accompanying full lake plant survey; continuing the established Clean Boats/Clean Water Program at the lake's boat landing to prevent the spread of other exotics into/out of Gilmore Lake; and, whenever possible, refraining from removing native plants from the lake manually or with herbicides as this provides a place for exotic species like EWM to more easily establish and colonize.

ACKNOWLEDMENTS

We wish to thank the Wisconsin Department of Natural Resources, and the Gilmore Lake Association for funding this project; and Rebecca, Mitchel and Noah Berg for assistance in conducting the survey. Thanks also to Jessica Ilgen, Kyle Johnson, William Lauer, Brent Myers, Jon Radtke and Aimee Van Tatenhove for volunteering to do a dive swimover of the treatment area and adjacent NWM beds post chemical treatment.

LIST OF FIGURES AND TABLES

INTRODUCTION:

Gilmore Lake (WBIC 2695800) is a 389 acre, fishhook-shaped, drainage lake in north-central Washburn County, Wisconsin in the Town of Minong (T42N R12W S09 SE NW). It achieves a maximum depth of 36ft in the north-central basin, and has an average depth of approximately 16ft. Gilmore Lake is oligotrophic in nature with good water clarity. From 1991 to 2009, summer Secchi readings have ranged from 5.5-12ft with an average of 8.5ft (WDNR 2009). At the time of the survey, the littoral zone extended to approximately 16ft. The bottom substrate is predominately sand, and sandy muck. The only thick organic muck occurs in the northwest end of Little Gilmore and in the northeast bay of Gilmore where the lake drains to the Totagatic River.

Figure 1: Gilmore Lake Aerial Photo

In August 2009, the Wisconsin Department of Natural Resources confirmed the presence of Eurasian water milfoil (*Myriophyllum sibiricum*) in the lake. Because of this finding, the Gilmore Lake Association commissioned an exotic species rapid assessment point intercept survey in September 2009. The survey was conducted using the Wisconsin Department of Natural Resources statewide guidelines for systematic point intercept macrophyte sampling. The immediate goals of the survey were to determine the extent of the EWM infestation, delineate an area to be chemically treated, and use these data to develop an initial management plan for 2010. These data also provide a baseline for long-term monitoring of the lake's milfoil infestation.

METHODS:

We conducted an exotic species point intercept survey of Gilmore Lake. Using a standard formula that takes into account the shoreline shape, distance and total lake acres, Michelle Naulte (Wisconsin Department of Natural Resources) generated a sampling grid of 538 points that covered the entire lake (Appendix I). We sampled all points in the lake's littoral zone and immediately adjacent to the littoral zone for exotic species and similar looking native water milfoils (*Myriophyllum* sp.). We located each survey point using a handheld mapping GPS unit (Garmin 76CSx). At each of these points, we used a rake (either on a pole or a throw line depending on depth) to sample a 1 meter section of the bottom. We compiled a species list for the lake by identifying all plants found on the rake, as well as any that were dislodged by the rake (Voss 1996; Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006)(Appendix II). If there were exotic species or similar looking native milfoils in the sample, they where assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of target species within six feet of the sample point. Following the point intercept survey, we conducted a meandering shoreline survey across and through the visible littoral zone to look for exotic species.

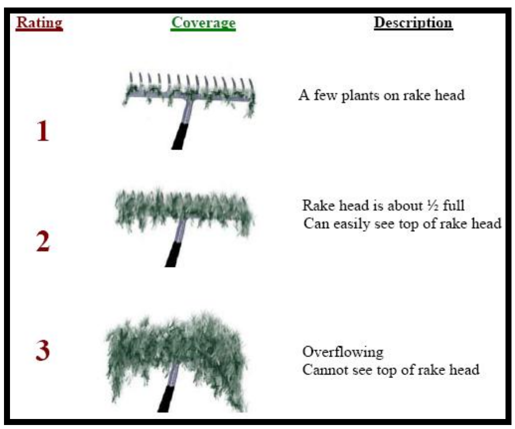

Figure 2: Rake Fullness Ratings (UWEX, 2009)

From the total species found, we calculated a Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. Species in the index are assigned Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and often exploit these changes to the point where they crowd out other more sensitive species. The FQI is calculated by averaging the conservatism value for each species found in the lake. In general, the higher the index value, the healthier the lake's macrophyte community. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain, and recommended comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Gilmore Lake is in the Northern Lakes and Forests Ecoregion.

At the site of the known infestation, we conducted a boat survey to develop an approximation of where EWM plants were growing. Following this, we used SCUBA and a boat to more accurately delineate the edges of the known infestation and littoral zone. Hand/tug signals were used to let the boat crew know when to mark a GPS coordinate and how many plants were at the location. We dove transects through and along side the know infestation area as well as approximately 100m beyond on each end.

Following the herbicide application, we conducted a swimover/boatover of the treatment area to look for any EWM that was missed. All plants found were removed by the roots, bagged underwater, and disposed of away from the lake upon returning to shore.

RESULTS:

We surveyed a total of 361 out of the 538 points provided by the WDNR (all points within the lake that were in the littoral zone/adjacent to the littoral zone) for Eurasian water milfoil, Curly-leaf pondweed (*Potamogeton crispus*), and other native milfoils that look similar to EWM (Figure 3).

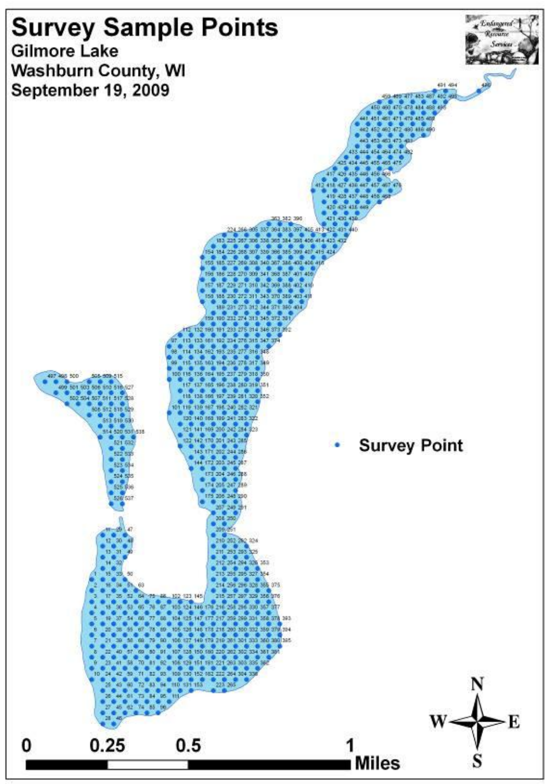

Figure 3: Survey Sample Points

We found Northern water milfoil (*Myriophyllum spicatum*) at 12 points and it was a visual at five other points (Figure 4). Despite being found at a low percentage of points, NWM was common in a narrow but often dense ribbon in 3-8 feet of water. Although widely distributed throughout, NWM was most abundant along the east, west and south shorelines of the south basin. Whorled water milfoil (*Myriophyllum verticillatum*) was much more restricted being found at only three sites in the northeast bay over thick organic muck in generally stagnant water among beds of Pickerelweed (*Pontederia cordata*) (Figure 4) We did not find it anywhere else during the boat survey.

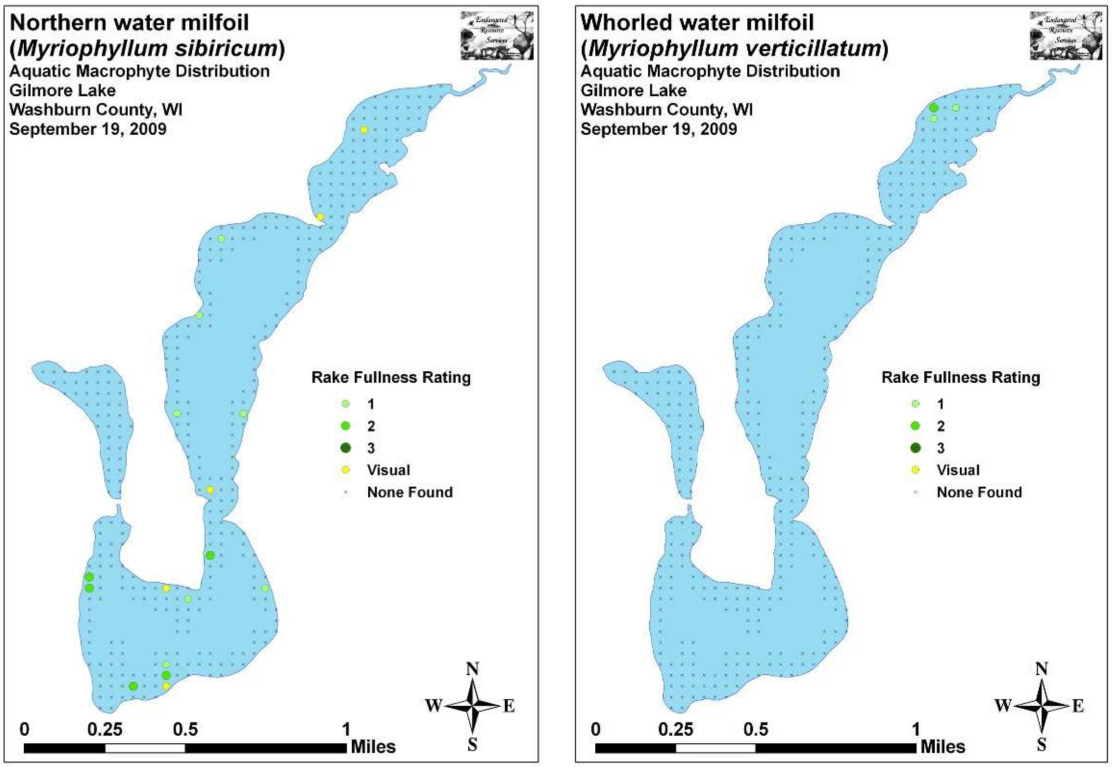

Figure 4: Northern and Whorled Water Milfoil Distribution

No Eurasian water milfoil or Curly-leaf pondweed plants were found at any of the survey points. We did not locate any additional EWM during the meandering shoreline survey beyond the initial discovery area west of the three buoys (Figure 5). During the dive delineation survey, we marked and hand removed 14 single stemmed plants. We also marked ten additional clusters of plants and six small beds (approximately 5ft X 5ft each) for chemical treatment. Most plants were located among Northern water milfoil in shallow water from 2-7ft deep. With only one exception, these plants were located on the inshore side of the NWM ribbon. We estimated that the infestation was approximately 2-2 ½ years old based on the size of the biggest plants found and the limited spread. In total, the area where we confirmed EWM's presence covered approximately 0.70 acres. The areas immediately adjacent that potentially had pioneer EWM fragments added another 0.25 acres for a total suspected infestation of slightly less than 1 acre.

EWM's tendency to outgrow surrounding NWM plants coupled with their bright red top leaves helped us locate and identify the plants; however, NWM in Gilmore lake has an unusually rusty orange growth point making separating the two more difficult than in other lakes. Because of this, and because both EWM and NWM prefer the same habitat, volunteers would be wise to count leaflets to confirm identification. Whorled water milfoil's restricted range in the lake makes it unlikely to be confused with EWM at the current time. Dwarf water milfoil (*Myriophyllum tenellum*) is also common in the lake, but it has no leaflets, and is not easily recognizable as a water milfoil. (For more information on Milfoil identification, see Appendix V). Unfortunately, by this point time of the summer, we noticed many EWM plants had been prop clipped or had naturally fragmented. We did find and remove two fragments floating in the control area.

On our October 9th swimover following the chemical treatment, we found that the main beds were dying, but not yet completely dead. Because plants were disintegrating, we decided against swimming through the beds as we did not want to cause dispersal. We found and removed three single plants around a dock on the north end of the treatment zone that did not appear to have been hit chemically and then terminated the dive.

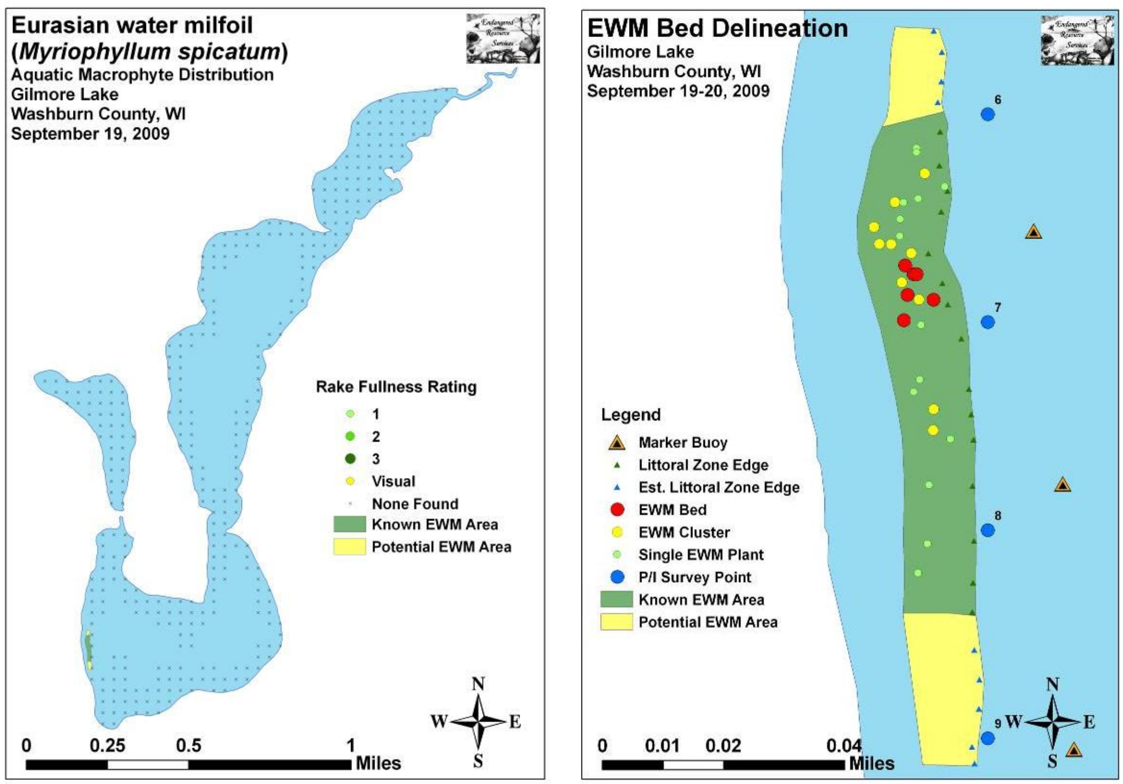

Figure 5: Eurasian Water Milfoil Distribution

We identified a total of 47 native plants to species in and immediately adjacent to Gilmore Lake. They produced a mean Coefficient of Conservation of 6.8 and a Floristic Index of 46.4 (Table 1). Nichols (1999) reported an Average mean C for the Northern Lakes and Forest Region of 6.7 putting Gilmore Lake slightly above average for this part of the state. However, the FQI was almost double the mean FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). This very high FQI is likely a result of the lake's variable substrate/habitats, good clarity and patches of undeveloped shoreline. All of these factors create a variety of microhabitats which offer a wide variety of plants suitable growing conditions.

Table 1: Floristic Quality Index of Aquatic Macrophytes
Gilmore Lake, Washburn County
September 19, 2009

Species	Common Name	C
Brasenia schreberi	Watershield	7
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Cladium mariscoides	Smooth sawgrass	10
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Eriocaulon aquaticum	Pipewort	9
Heteranthera dubia	Water star-grass	6
Isoetes echinospora	Spiny-spored quillwort	8
Juncus pelocarpus f. submersus	Brown-fruited rush	8
Megalodonta beckii	Water marigold	8
Myriophyllum sibiricum	Northern water milfoil	7
Myriophyllum tenellum	Dwarf water milfoil	10
Myriophyllum verticillatum	Whorled water milfoil	8
Najas flexilis	Bushy pondweed	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Phragmites australis	Common reed	1
Polygonum amphibium	Water smartweed	5
Pontederia cordata	Pickerelweed	9
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Robbins (fern) pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	Stiff water crowfoot	7
Ranunculus flammula	Creeping spearwort	9
Satittaria cristata	Crested arrowhead	9
Schoenoplectus acutus	Hardstem bulrush	5
Schoenoplectus pungens	Three-square	5
Schoenoplectus tabernaemontani	Softstem bulrush	4

Table 1 (cont'): Floristic Quality Index of Aquatic Macrophytes
Gilmore Lake, Washburn County
September 19, 2009

Species	Common Name	C
Sparganium eurycarpum	Common bur-reed	5
Typha latifolia	Broad-leaved cattail	1
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia minor	Small bladderwort	10
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Zizania palustris	Northern wild rice	8
N		47
mean C		6.8
FQI		46.4

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Gilmore Lake has a diverse plant community that includes many rare and sensitive species such a Smooth sawgrass (*Cladium mariscoides*), Dwarf water milfoil (*Myriophyllum tenellum*), Creeping spearwort (*Ranunculus flammula*) and Small bladderwort (*Utricularia minor*). Preserving this plant community by aggressively working to control Eurasian water milfoil should be the top management goal for the lake. Native plants are the base of the aquatic food pyramid, provide habitat for fish and other aquatic organisms, are important food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve water clarity by absorbing excess nutrients from the water. The loss of diversity that could occur if EWM continues to spread will likely have far reaching impacts on the entire lake ecosystem as well as negatively impacting esthetic and economic considerations.

Because the infestation is apparently isolated to an area that is approximately only an acre in size, and because plants are currently scattered, spot herbicide applications will likely be the method of choice to maintain EWM at its current low level. Careful hand removal of plants by the roots into bags that will prevent fragmentation of plants could also be used as an additional method of control. Because plants are in water up to 8ft deep, SCUBA may be necessary to successfully eliminate plants, but for many locations, wading to or snorkeling to remove plants will be feasible. Keeping track of how many plants are removed, and where they were taken from will aid in future management decisions by helping to determine whether current methods of control are succeeding or if other options need to be considered.

As soon as plants are actively growing in spring 2010, we strongly recommend a reevaluation of the control area and another meandering shoreline survey that focuses extra time on the west shore of the south basin and the milfoil beds throughout. Locating and eliminating plants in the spring will be easier than in summer/fall because the milfoil begins growing faster than other plants, is less likely to fragment when picked early in the growing season, and because plants will be easier to find as water clarity is generally better in late spring than in late summer. This should not, however, prevent the aggressive pursuit of plants during the remainder of 2010.

Completing an Aquatic Plant Management Plan (APMP) and a full lake plant survey will help the lake clarify a management plan moving forward. Lake owners should understand that EWM will likely never be eliminated from the lake, but maintaining it at its current low levels would likely be easier and much less expensive than ignoring the problem and trying to control an extensive infestation in the future.

The Clean Boats/Clean Waters program should continue to provide education and reeducation for lake owners/users. In addition to monitoring for new invasive species, the program now also has the task of helping to prevent the further spread of EWM out of Gilmore Lake to neighboring lakes.

Whenever possible, lake shore owners should refrain from removing native plants from the lake as these patches of barren substrate provide an easy place for invasive plants like EWM to take root and become established. Reducing or eliminating fertilizer and pesticide applications will also contribute to improved water quality. Where possible, shoreline restoration and buffer strips of native vegetation would enhance water quality by preventing erosion as well as improve the aesthetic value of highly developed shoreline areas.

MANAGEMENT RECOMMENDATIONS SUMMARY:

- Preserve the lake's diverse and rare plant community by aggressively working to control Eurasian water milfoil.
- Consider spot herbicide applications and careful hand removal to maintain EWM at its current low level.
- Reevaluate the control area and perform another meandering shoreline survey in spring 2010 to aid in developing a management plan for the rest of 2010.
- Continue monitoring for EWM on a regular basis throughout the 2010 growing season to determine if control methods are having the desired effect or need to be augmented.
- Complete an Aquatic Plant Management Plan (APMP) and accompanying full lake plant survey.
- Continue the established Clean Boats/Clean Water Program at the lake's boat landing to prevent the spread of other exotics into/out of Gilmore Lake.
- Whenever possible, refrain from removing native plants from the lake manually or with herbicides as this provides a place for exotic species like EWM to more easily establish and colonize.
- Reduce and, wherever possible, eliminate fertilizer applications as their runoff encourages excessive plant growth.
- Encourage shoreline restoration that establishes native vegetation buffer strips along the lakeshore to help prevent runoff.

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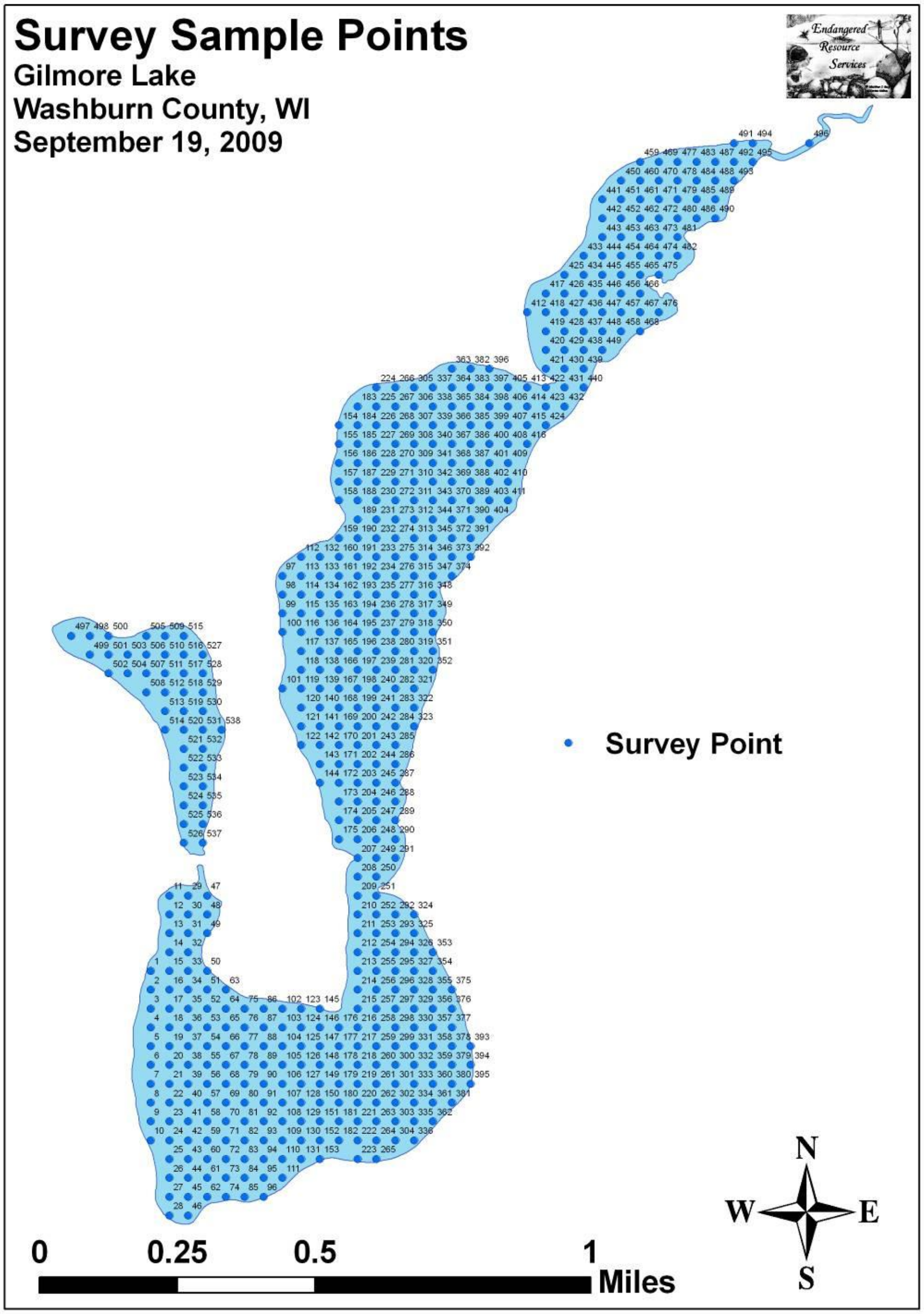
Appendix I: Gilmore Lake Map with Survey Sample Points


Survey Sample Points
Gilmore Lake
Washburn County, WI
September 19, 2009
Endangered Resource Services
Survey Point
0
0.25
0.5
1
Miles
N
W
E
S

Appendix II: Point Intercept Survey Data Sheet

Observers for this lake: names and hours worked by each:																									
Lake:									**WBIC**									**County**						**Date:**	
Site #	**Depth (ft)**	**Muck (M), Sand (S), Rock (R)**	**Rake pole (P) or rake rope (R)**	**EWM**	**CLP**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1																									
2																									
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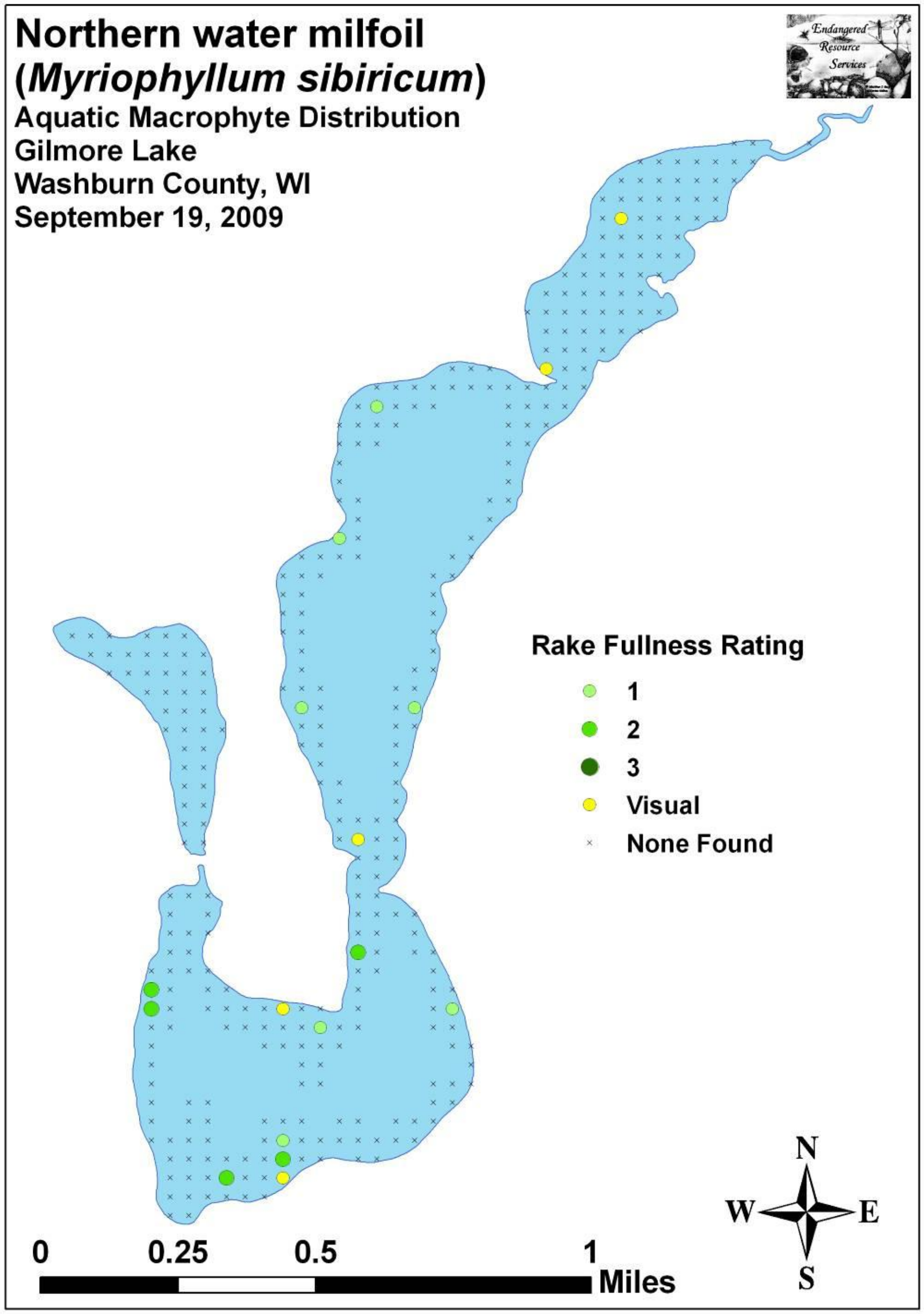
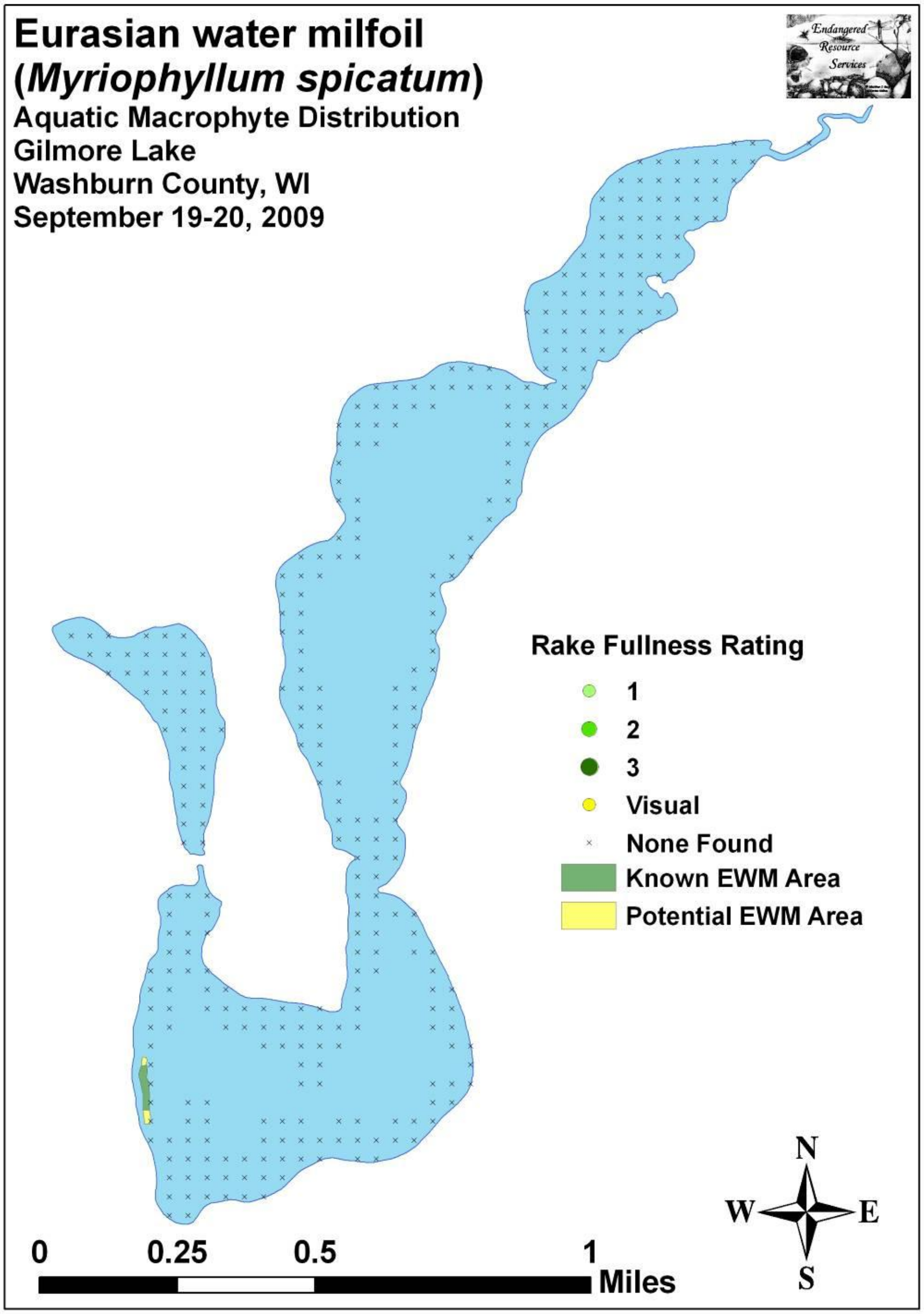
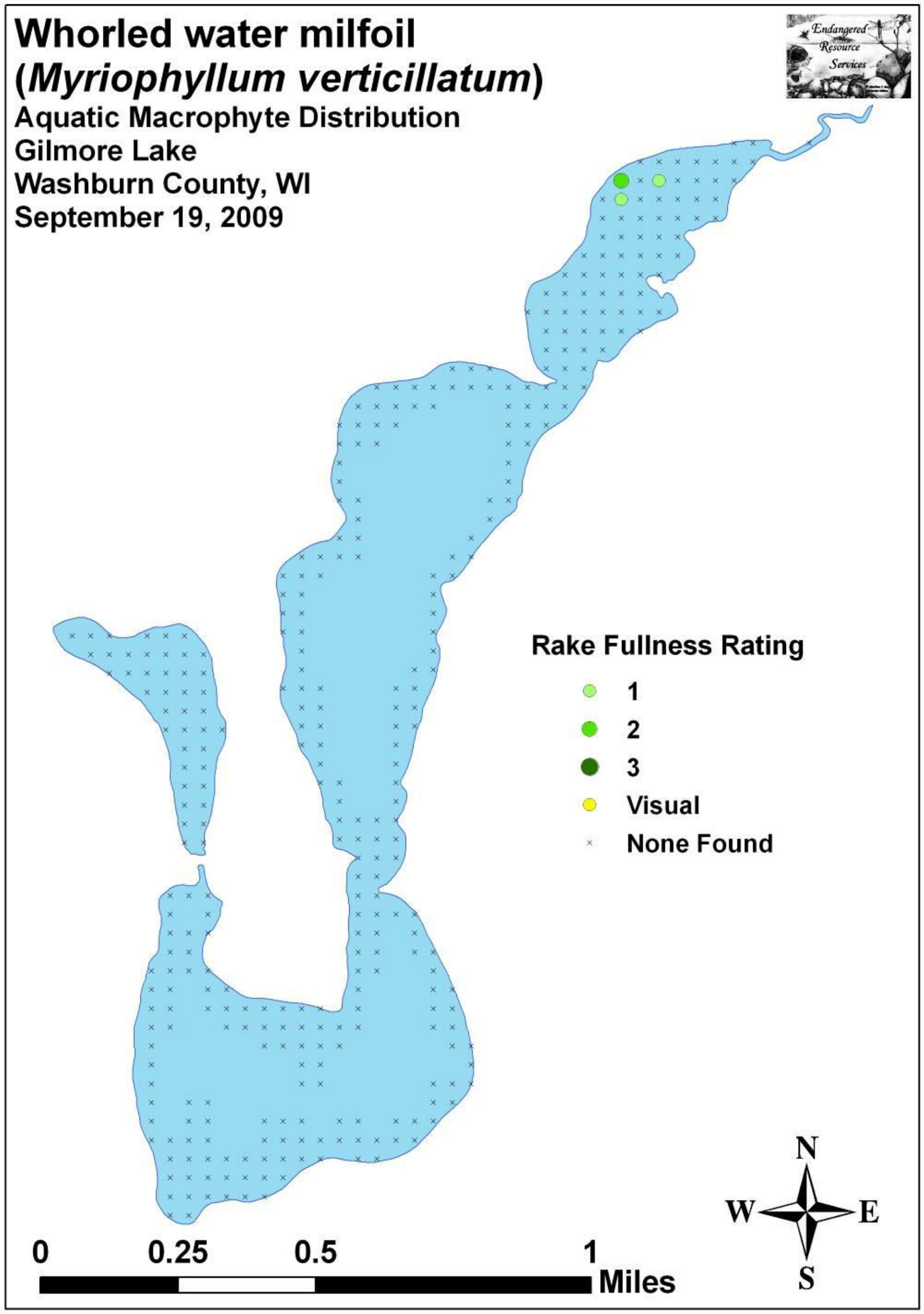
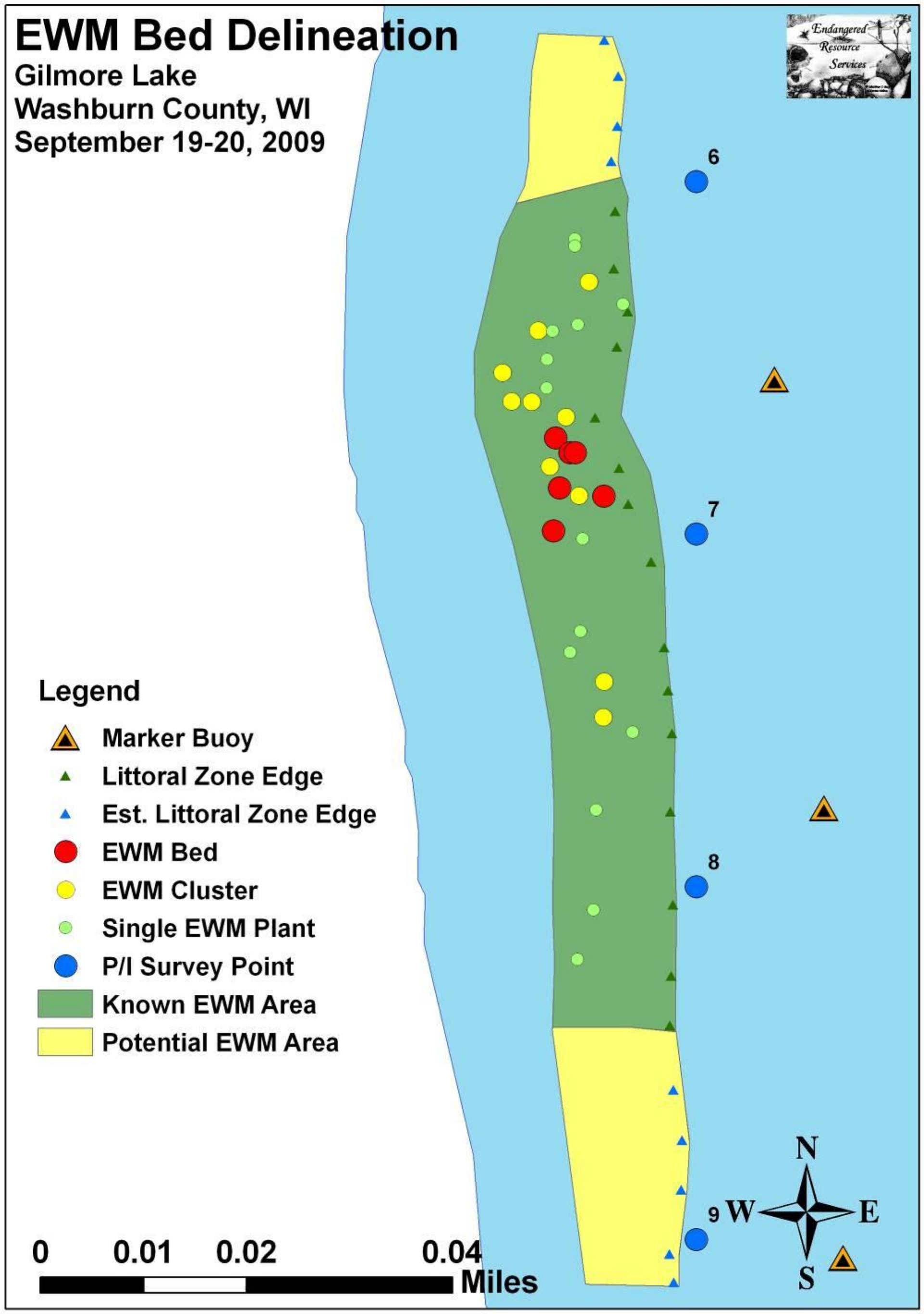
Appendix III: Milfoil Species Distribution Maps


Northern water milfoil
(Myriophyllum sibiricum)
Aquatic Macrophyte Distribution
Gilmore Lake
Washburn County, WI
September 19, 2009
Endangered Resource Services
Rake Fullness Rating
1
2
3
Visual
None Found
0
0.25
0.5
1
Miles
N
W
E
S


Eurasian water milfoil
(Myriophyllum spicatum)
Aquatic Macrophyte Distribution
Gilmore Lake
Washburn County, WI
September 19-20, 2009
Endangered Resource Services
Rake Fullness Rating
1
2
3
Visual
None Found
Known EWM Area
Potential EWM Area
0
0.25
0.5
1
Miles
N
W
E
S


Whorled water milfoil
(Myriophyllum verticillatum)
Aquatic Macrophyte Distribution
Gilmore Lake
Washburn County, WI
September 19, 2009
Endangered Resource Services
Rake Fullness Rating
1
2
3
Visual
None Found
N
W
E
S
0
0.25
0.5
1
Miles


EWM Bed Delineation
Gilmore Lake
Washburn County, WI
September 19-20, 2009
Endangered Resource Services
6
7
8
9
Legend
Marker Buoy
Littoral Zone Edge
Est. Littoral Zone Edge
EWM Bed
EWM Cluster
Single EWM Plant
P/I Survey Point
Known EWM Area
Potential EWM Area
0 0.01 0.02 0.04
Miles
N
W
E
S

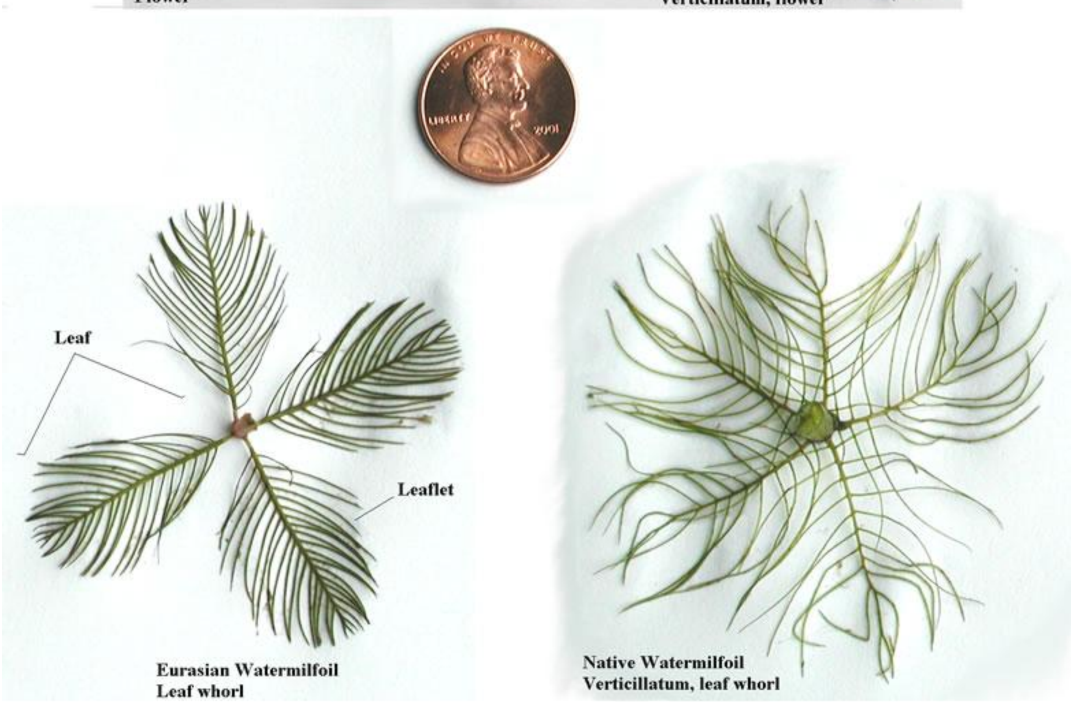
Appendix IV: Milfoil Identification Guide

Eurasian water milfoil vs. Northern water milfoil

EWM Leaflets >26 NWM Leaflets < 22

EWM Leaflets Limp out of Water   NWM Leaflets Stiff Out of Water

Eurasian water milfoil vs. Whorled water milfoil



Dwarf water milfoil

Plants spread by rhizomes, have no leaflets and are usually <6in.

Appendix V: Glossary of Biological Terms

Aquatic:
organisms that live in or frequent water.

Cultural Eutrophication:
accelerated eutrophication that occurs as a result of human activities in the watershed that increase nutrient loads in runoff water that drains into lakes.

Dissolved Oxygen (DO):
the amount of free oxygen absorbed by the water and available to aquatic organisms for respiration; amount of oxygen dissolved in a certain amount of water at a particular temperature and pressure, often expressed as a concentration in parts of oxygen per million parts of water.

Diversity:
number and evenness of species in a particular community or habitat.

Drainage lakes:
Lakes fed primarily by streams and with outlets into streams or rivers. They are more subject to surface runoff problems but generally have shorter residence times than seepage lakes. Watershed protection is usually needed to manage lake water quality.

Ecosystem:
a system formed by the interaction of a community of organisms with each other and with the chemical and physical factors making up their environment.

Eutrophication:
the process by which lakes and streams are enriched by nutrients, and the resulting increase in plant and algae growth. This process includes physical, chemical, and biological changes that take place after a lake receives inputs for plant nutrients--mostly nitrates and phosphates--from natural erosion and runoff from the surrounding land basin. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile).

Exotic:
a non-native species of plant or animal that has been introduced.

Habitat:
the place where an organism lives that provides an organism's needs for water, food, and shelter. It includes all living and non-living components with which the organism interacts.

Limnology:
the study of inland lakes and waters.

Littoral:
: the near shore shallow water zone of a lake, where aquatic plants grow.

Macrophytes:
: Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Nutrients:
: elements or substances such as nitrogen and phosphorus that are necessary for plant growth. Large amounts of these substances can become a nuisance by promoting excessive aquatic plant growth.

Organic Matter:
: elements or material containing carbon, a basic component of all living matter.

Photosynthesis:
: the process by which green plants convert carbon dioxide (CO2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

Phytoplankton:
: microscopic plants found in the water. Algae or one-celled (phytoplankton) or multicellular plants either suspended in water (Plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species occur. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short.

Plankton:
: small plant organisms (phytoplankton and nanoplankton) and animal organisms (zooplankton) that float or swim weakly though the water.

ppm:
: parts per million; units per equivalent million units; equal to milligrams per liter (mg/l)

Richness:

Number of species in a particular community or habitat.

Rooted Aquatic Plants:

(macrophytes) Refers to higher (multi-celled) plants growing in or near water. Macrophytes are beneficial to lakes because they produce oxygen and provide substrate for fish habitat and aquatic insects. Overabundance of such plants, especially problem species, is related to shallow water depth and high nutrient levels.

Runoff:

water that flows over the surface of the land because the ground surface is impermeable or unable to absorb the water.

Secchi Disc:

An 8-inch diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days.

Seepage lakes:

Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Seepage lakes lose water through evaporation and groundwater moving on a down gradient. Lakes with little groundwater inflow tend to be naturally acidic and most susceptible to the effects of acid rain. Seepage lakes often have long ,residence times. and lake levels fluctuate with local groundwater levels. Water quality is affected by groundwater quality and the use of land on the shoreline.

Turbidity:

degree to which light is blocked because water is muddy or cloudy.

Watershed:

the land area draining into a specific stream, river, lake or other body of water. These areas are divided by ridges of high land.

Zooplankton:

Microscopic or barely visible animals that eat algae. These suspended plankton are an important component of the lake food chain and ecosystem. For many fish, they are the primary source of food.

Appendix VI: Aquatic Invasive Species Information

Curly-leaf pondweed

DESCRIPTION: Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves 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

DISTRIBUTION AND HABITAT: Curly-leaf pondweed is commonly found in alkaline and high nutrient waters, preferring soft substrate and shallow water depths. It tolerates low light and low water temperatures. It has been reported in all states but Maine

LIFE HISTORY AND EFFECTS OF INVASION: Curly-leaf pondweed 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 curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring.

It 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. In mid-summer, when most aquatic plants are growing, curly-leaf pondweed 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. Curly-leaf pondweed forms surface mats that interfere with aquatic recreation. (Taken in its entirety from WDNR, 2009 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Eurasian water milfoil

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

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

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

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

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

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. (Taken in its entirety from WDNR, 2009 http://www.dnr.state.wi.us/invasives/fact/milfoil.htm)

Reed canary grass

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

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

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

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

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

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

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites. (Taken in its entirety from WDNR, 2009 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife

DESCRIPTION: Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 5-6 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

This species may be confused with the native wing-angled loosestrife (*Lythrum alatum*) found in moist prairies or wet meadows. The latter has a winged, square stem and solitary paired flowers in the leaf axils. It is generally a smaller plant than the Eurasian loosestrife.

By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

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

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. 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.

Life History and Effects of Invasion: Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring and early summer when temperatures are high.

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. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

Any sunny or partly shaded wetland is susceptible to purple loosestrife invasion. Vegetative disturbances such as water drawdown or exposed soil accelerate the process by providing ideal conditions for seed germination. Invasion usually begins with a few pioneering plants that build up a large seed bank in the soil for several years. When the right disturbance occurs, loosestrife can spread rapidly, eventually taking over the entire wetland. The plant can also make morphological adjustments to accommodate changes in the immediate environment; for example, a decrease in light level will trigger a change in leaf morphology. The plant's ability to adjust to a wide range of environmental conditions gives it a competitive advantage; coupled with its reproductive strategy, purple loosestrife tends to create monotypic stands that reduce biotic diversity.

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways. (Taken in its entirety from WDNR, 2009 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)