Eurasian water milfoil (*Myriophyllum spicatum*) Meandering Littoral Zone Survey Upper, Middle and Lower Kimball Lakes WBIC: 2692000, 2691900, and 2691800 Minong Township - Washburn County, Wisconsin

Project Sponsored by:

Wisconsin Department of Natural Resources, and the
Town of Minong

Survey Conducted by and Report Prepared by:

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August 7, 2011

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ACKNOWLEDMENTS

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LIST OF FIGURES AND TABLES

INTRODUCTION:

Upper, Middle, and Lower Kimball Lakes (WBIC 2692000, 2691900, and 2691800) combine to form a 263 acre (Upper 42 acres, Middle 96 acres, and Lower 125 acres) seepage lakes complex in north-central Washburn County, Wisconsin in the Town of Minong (T42N R13W S11 SE NW, T42N R13W S14 NE NE, and T42N R13W S14 NE NE) (Figure 1). Upper Kimball reaches a maximum depth of 11ft in the middle of the north basin and has an average depth of approximately 5ft; Middle Kimball reaches a maximum depth of 77ft in the middle of the central basin and has an average depth of approximately 31ft; and Lower Kimball reaches a maximum depth of 6ft throughout the majority of the lake and has an average depth of approximately 4ft. Upper and Lower Kimball are both mesotrophic in nature with fair to good water clarity while Middle Kimball is oligotrophic with very good clarity. Secchi data over the past 13 years have been nearly constant for all three lakes with the disc hitting the bottom on Upper and Lower and averaging approximately 18ft on Middle Kimball over that time (WDNR 2011). On the day of the survey, we could see the bottom clearly in 4ft, 12ft, and 5ft, and the littoral zone extended to 5ft, 20ft, and 6ft on Upper, Middle, and Lower respectively. The bottom substrate is predominately sandy at the shoreline of all three lakes before transitioning to sandy muck with increased depth. On Lower Kimball, areas bordered by bogs tended to have more organic rich muck (Busch et al. 1966).

Figure 1: Kimball Lakes Aerial Photo

Eurasian water milfoil (*Myriophyllum spicatum*) (EWM) is a highly invasive exotic species that is a growing problem in the lakes of northern Wisconsin. In the Town of Minong (TM), it has been found in Gilmore, Horseshoe and Nancy Lakes as well as the Minong Flowage. Because EWM can have negative ecological, recreational, and economic impacts if left unchecked and because a new isolated infestation is generally much cheaper and easier to control than an older established one, the TM and Wisconsin Department of Natural Resources (WDNR) commissioned a meandering shoreline survey to look for EWM in the Kimball Lakes. This report is the summary analysis of that survey conducted on August 7, 2011.

METHODS:

Using a standard formula that takes into account the shoreline shape, distance, islands, and total lake acres, Michelle Nault (WDNR – lake biologist) generated a sampling grid for each lake. The Upper Kimball grid had 151 points, the Middle Kimball grid 379 points, and Lower Kimball grid 229 points (Appendix I). These grids will be used for any future full lake plant surveys and serve as a location reference in case any new exotic species are located.

Early August was chosen as the target date for the survey as EWM has often canopied by this time of year making its bright red growth tips easy to see. It is also prone to fragment in late summer, and small pieces of EWM with white root sprouts are often found floating around established beds of milfoil (Figure 2).

Figure 2: Summer EWM Plant with New Growth Ready to Fragment

Because the most likely place for a new infestation to occur is the public boat landing, we initially conducted a transect survey of this area on Lower Kimball. Using multiple 150-200m parallel transects, we motored at idle speed looking for any evidence of EWM. Once we had finished the transects, we returned to our starting point using a stitch pattern that crossed back and forth over the other lines to look for any plants we may have missed between the transects. In addition to surveying the landing, we conducted a meandering survey of the lakes' entire visible littoral zone spacing transects close enough that our field of view overlapped from one transect to another. We paid special attention to the areas around docks as this is where EWM brought in on props is most likely to establish.

While we surveyed, we created a list of all aquatic macrophyte species found growing in and adjacent to the lakes. From the total species found, we calculated a hypothetical Floristic Quality Index Value (FQI) for the lakes. This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index** are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the survey, and multiplying it by the square root of the total number of plant species (N) in the lakes ($FQI=(\Sigma(c_1+c_2+c_3+\ldots c_n)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lakes' macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. The Kimball Lakes are in the Northern Lakes and Forests Ecoregion (Table 1).

**** Species not included in the index are excluded from FQI analysis, but they are listed separately to document their presence in the lakes (Table 2).**

RESULTS:

On August 7^{rda}, we surveyed 11.7 transect miles through the visible littoral zones of the Kimball Lakes (Figure 3) (Appendix II). No Eurasian water milfoil, Curly-leaf pondweed, or any other exotic plants were found. Northern water milfoil (*Myriophyllum sibiricum*), a closely related native species that is easily confused with EWM was common to abundant in parts of the lakes; especially in the south end of Middle Kimball, and in the southeast bay of Lower Kimball. Alternate-flowered milfoil (*Myriophyllum alterniflorum*) and Dwarf water milfoil (*Myriophyllum tenellum*), two other native milfoil species, were scattered in sandy shoreline areas. Another species in the lakes that looks "milfoil-like" is Water marigold (*Bidens beckii*). It was uncommon but widely distributed throughout Middle and Lower Kimball (Figure 4) (For more information on Milfoil identification, see Appendix III).

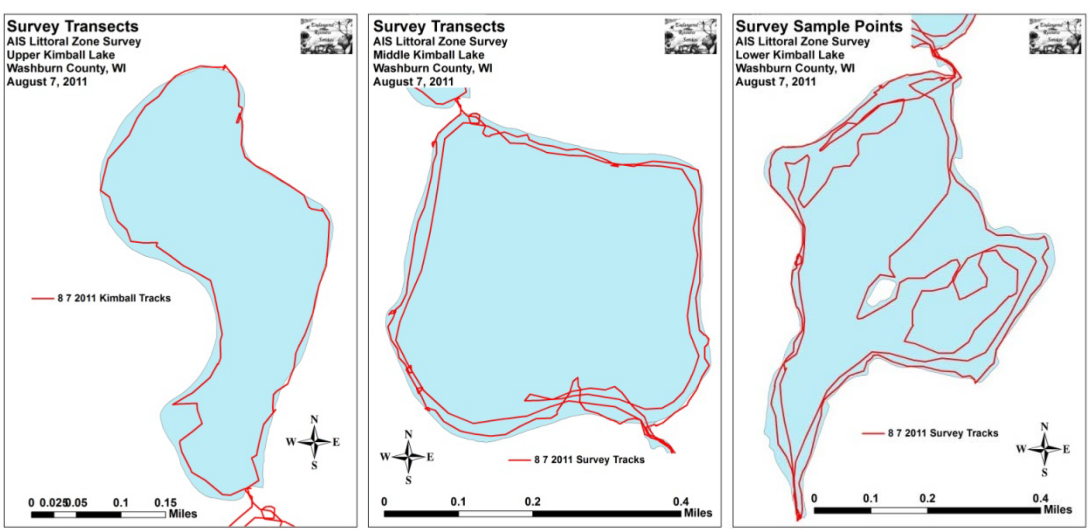

Figure 3: Survey Transects

Figure 4: Water marigold – Non-milfoil EWM Look-Alike

The Kimball Lakes have abundant, rich, and diverse native plant communities. Densities in the lakes' organic muck bottom bays, especially in Lower Kimball at the boat landing and on the east side, tend to be high while densities in the low nutrient sand and sandy muck bottom areas found throughout the majority of the lakes tend to be generally sparse (Figure 5). We identified 50 native plants to species growing in and immediately adjacent to the lakes. The 45 species in the index produced a mean Coefficient of Conservation of 6.6 and a Floristic Quality Value of 44.3 (Tables 1 and 2). Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting the Kimball Lakes slightly below average for this part of the state. The FQI was, however, well above the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). This very high FQI is likely a result of the lakes' 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.

Figure 5: Muck Bottom and Sandy Bottom Plant Communities

Table 1: Hypothetical Floristic Quality Index of Aquatic Macrophytes
Kimball Lakes, Washburn County
August 7, 2011

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Dulichium arundinaceum	**Three-way sedge**	**9**
Elatine minima	**Waterwort**	**9**
Eleocharis acicularis	Needle spikerush	5
Eleocharis erythropoda	Bald spikerush	3
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Equisetum fluviatile	Water horsetail	7
Eriocaulon aquaticum	**Pipewort**	**9**
Heteranthera dubia	Water star-grass	6
Juncus pelocarpus f. submersus	Brown-fruited rush	8
Lemna minor	Small duckweed	4
Littorella uniflora	**Littorella**	**10**
Myriophyllum alterniflorum	**Alternate-flowered water-milfoil**	**10**
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum tenellum	**Dwarf water-milfoil**	**10**
Najas flexilis	Slender naiad	6
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Phragmites australis	Common reed	1
Polygonum amphibium	Water smartweed	5
Pontederia cordata	Pickerelweed	8
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton obtusifolius	**Blunt-leaf pondweed**	**9**
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Ranunculus flammula	**Creeping spearwort**	**9**

Table 1 cont': Hypothetical Floristic Quality Index of Aquatic Macrophytes Kimball Lakes, Washburn County August 7, 2011

Species	Common Name	C
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus acutus	Hardstem bulrush	6
Schoenoplectus subterminalis	**Water bulrush**	**9**
Sparganium angustifolium	**Narrow-leaved bur-reed**	**9**
Sparganium emersum	Short-stemmed bur-reed	8
Typha latifolia	Broad-leaved cattail	1
Vallisneria americana	Wild celery	6
N		45
mean C		6.6
FQI		44.3

*** Litorella is listed as a **state species of special concern**. It is not currently threatened or endangered, but it is uncommon to rare in the state. Because it is so sensitive to pollution/human disturbance, there is concern it will become threatened or endangered in the future.

Table 2: Additional Non-Index Aquatic Macrophyte Species Found Kimball Lakes, Washburn County August 7, 2011

Species	Common Name	C
Carex lasiocarpa	**Narrow-leaved woolly sedge**	**9**
Cicuta bulbifera	Bulb-bearing water hemlock	7
Comarum palustre	Marsh cinquefoil	8
Sagittaria cristata	Crested arrowhead	9
Scirpus cyperinus	Woolgrass	4

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water milfoil are an increasing problem in the lakes of northern Wisconsin in general, and several nearby lakes in the Minong area in particular. Preventing their introduction into the Kimball Lakes with proactive measures is strongly encouraged. Especially around the boat landing, lakeshore owners should minimize the removal of native plants from the lake unless absolutely necessary as these patches of barren substrate can provide an easy place for invasive plants to take root and become established. The lakes currently have some minimal signage at the Lower Kimball landing, but this could be improved by making it brighter and generally more noticeable. When no landing monitors are present, this sign becomes the de facto guardian of the lake in charge of providing education, reeducation, and continual reminders of the dangers/impacts of aquatic invasive species to lake owners and visitors alike (Figure 6).

Figure 6: Sign at Lower Kimball Lake Landing

Training volunteers to recognize EWM and CLP is another low cost management strategy that we strongly encourage. Monthly volunteer transect surveys at the boat landing and at least biannual meandering shoreline surveys of the lakes could result in early detection if an AIS is introduced into the Kimball Lakes. The sooner an infestation is detected, the greater the chances it can be successfully and economically controlled.

The Kimball Lakes has moderate amounts of native Northern water milfoil (NWM). Because EWM and NWM favor the same habitat, it is likely EWM would find it easy to establish and proliferate if introduced into the lakes. One place that seems an especially likely place for a new infestation to establish is the southeast bay of Lower Kimball. It has NWM meaning the habitat is favorable, it is near the boat landing, and the prevailing southwesterly winds of summer would likely blow transplanted fragments into the bay.

If any lake resident or boater discovers a plant they even suspect may be EWM, they are invited to contact Matthew Berg, ERS, LLC Research Biologist at 715-338-7502 and/or Pamela Toshner, Regional Lakes Management Coordinator in the Spooner DNR office at 715-635-4073 for identification confirmation. If possible, a specimen, a jpg, and the accompanying GPS coordinates of the location it was found at should be included.

Native Aquatic Macrophytes, Algae and Water Clarity:

A lake's plants are the basis of the aquatic ecosystem, and they are as important to the aquatic environment as trees are to a forest. Because of this, preserving them is critical to maintaining a healthy lake environment. As the basis of the food pyramid, they provide habitat for 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 Kimball Lakes have rich, diverse, and rare native aquatic plant communities that appear to be positively affected by water clarity, quality, chemistry, and generally positive shoreline practices. The lakes currently supports eleven extremely high quality species (C value of 9 or 10), but several of them are very limited in both numbers and distribution on the lakes making them vulnerable to lake-wide extinction. For example, Littorella (*Litorella uniflora*), a state species of special concern known from only a handful of lakes in northern Wisconsin, was limited to a three tiny beds that number only a few 10's of plants each.

During our time on the lakes, we noticed that most of the residents are currently practicing generally good shoreline conservation. We also noticed that there were few filamentous or floating algae in the lake. This is likely not a coincidence. These algae proliferate in the presence of excessive nutrients in the water. Such things as internal loading from sediments, failed septic systems, and lawn and field fertilizer runoff are common causes of excess nutrients in surface water. Even small increases in nutrient input could tip the lakes' current balance allowing algae to proliferate and leading to a decline in both water clarity and quality.

Educating lake residents about reducing nutrient input directly along the lakes is one of the best ways to limit algal growth and maintain or even improve water clarity. Not mowing down to the lakeshore, bagging grass clippings, switching to a phosphorus-free fertilizer or eliminating fertilizer altogether, and avoiding motor start-ups in shallow water would all be positive steps to this end. Wherever possible, restoring shorelines, building rain gardens, and establishing buffer strips of native vegetation would also enhance water clarity and quality by preventing erosion and runoff (Figure 7).

Figure 7: Model Natural Shoreline on a Nearby Washburn Co. Lake

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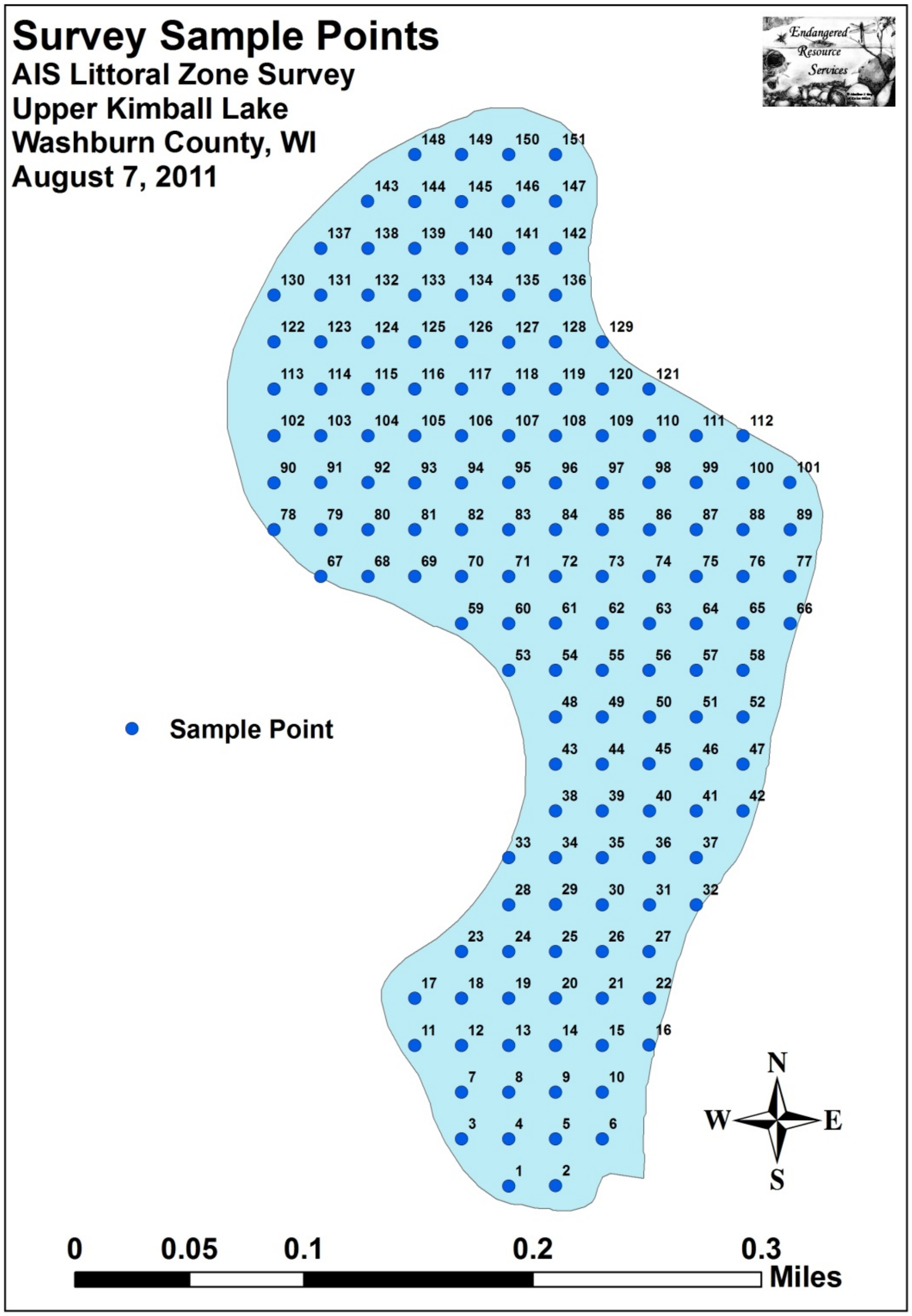
Appendix I: Kimball Lakes Map with Survey Sample Points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Washburn County, WI
August 7, 2011
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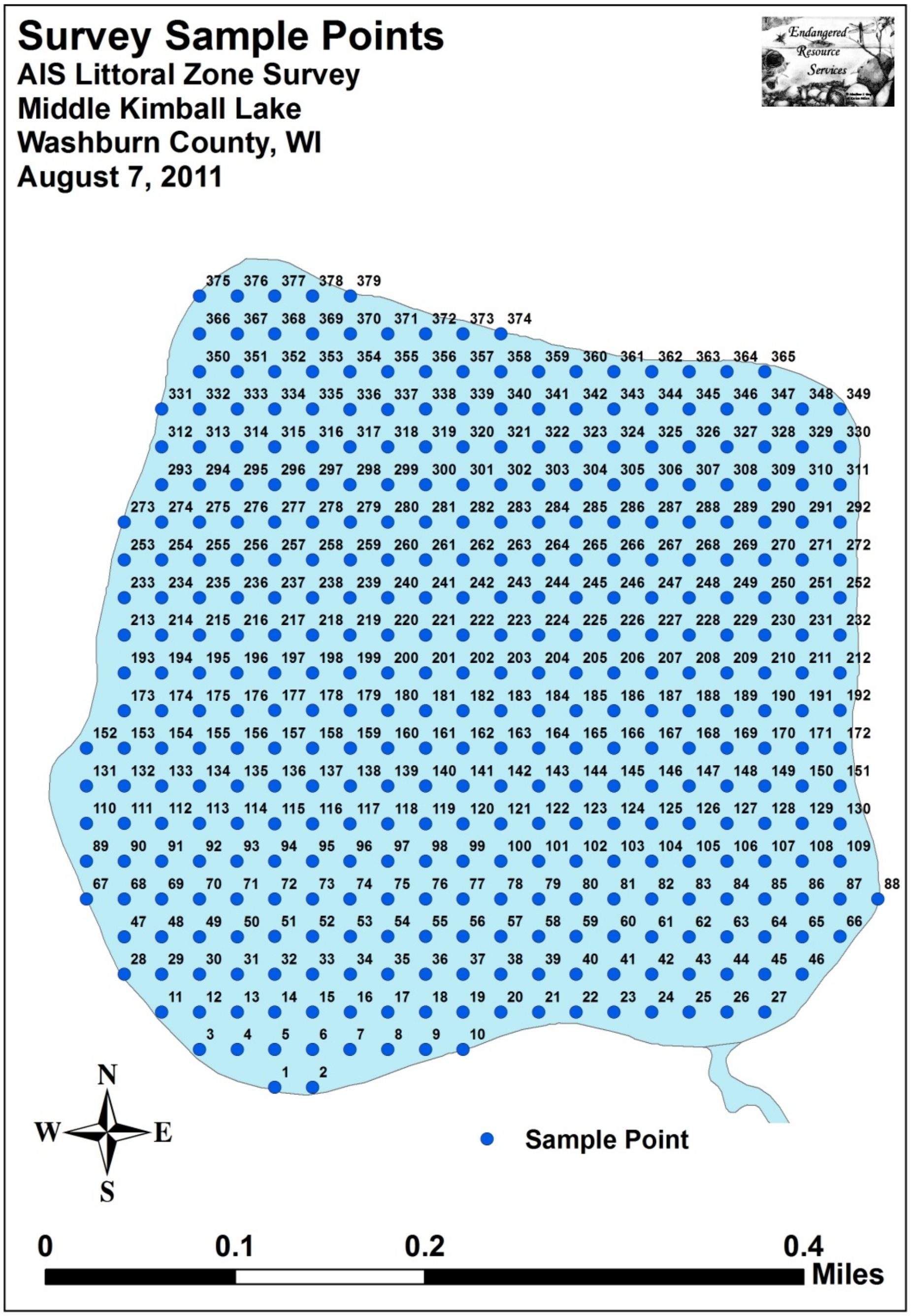
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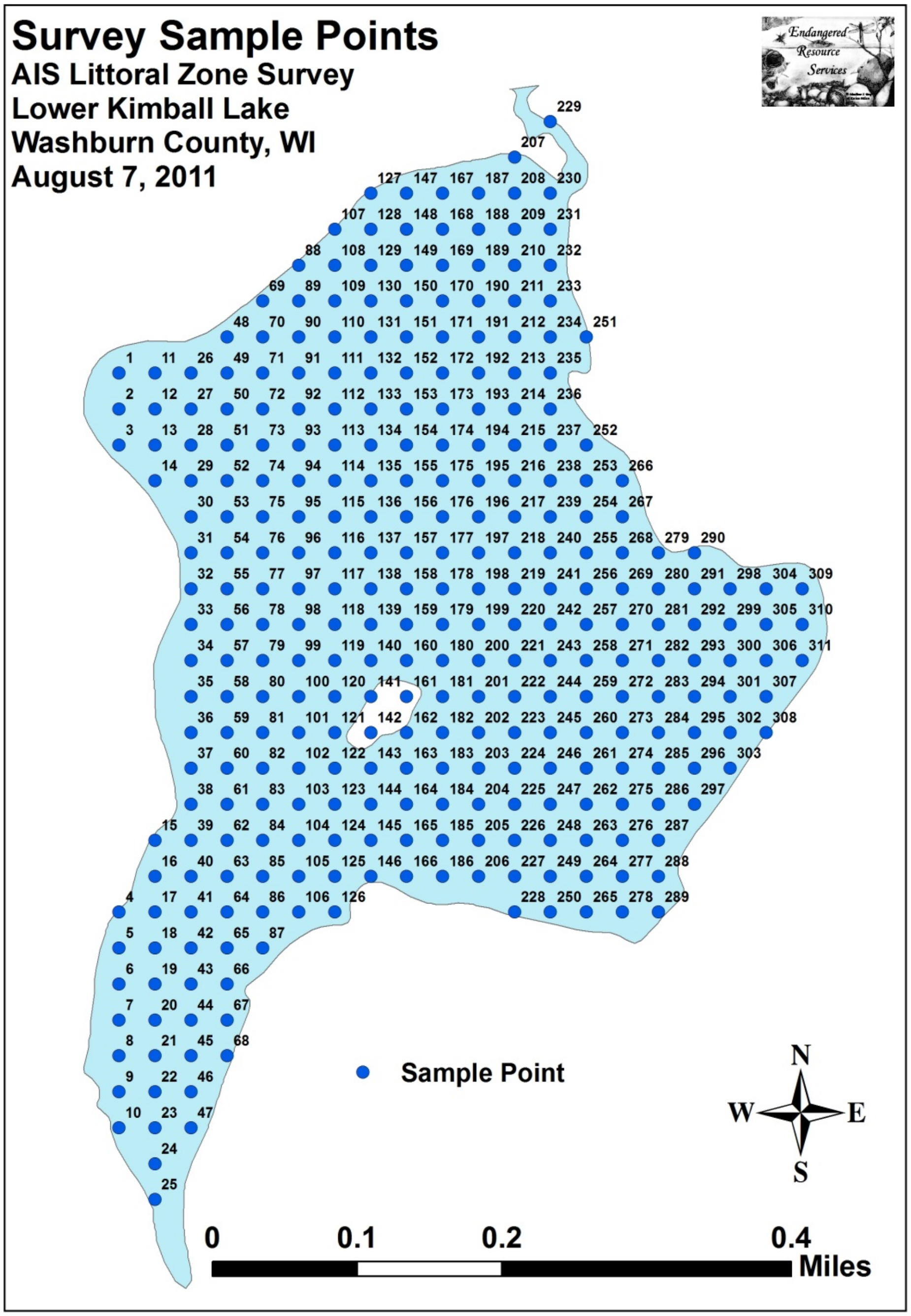
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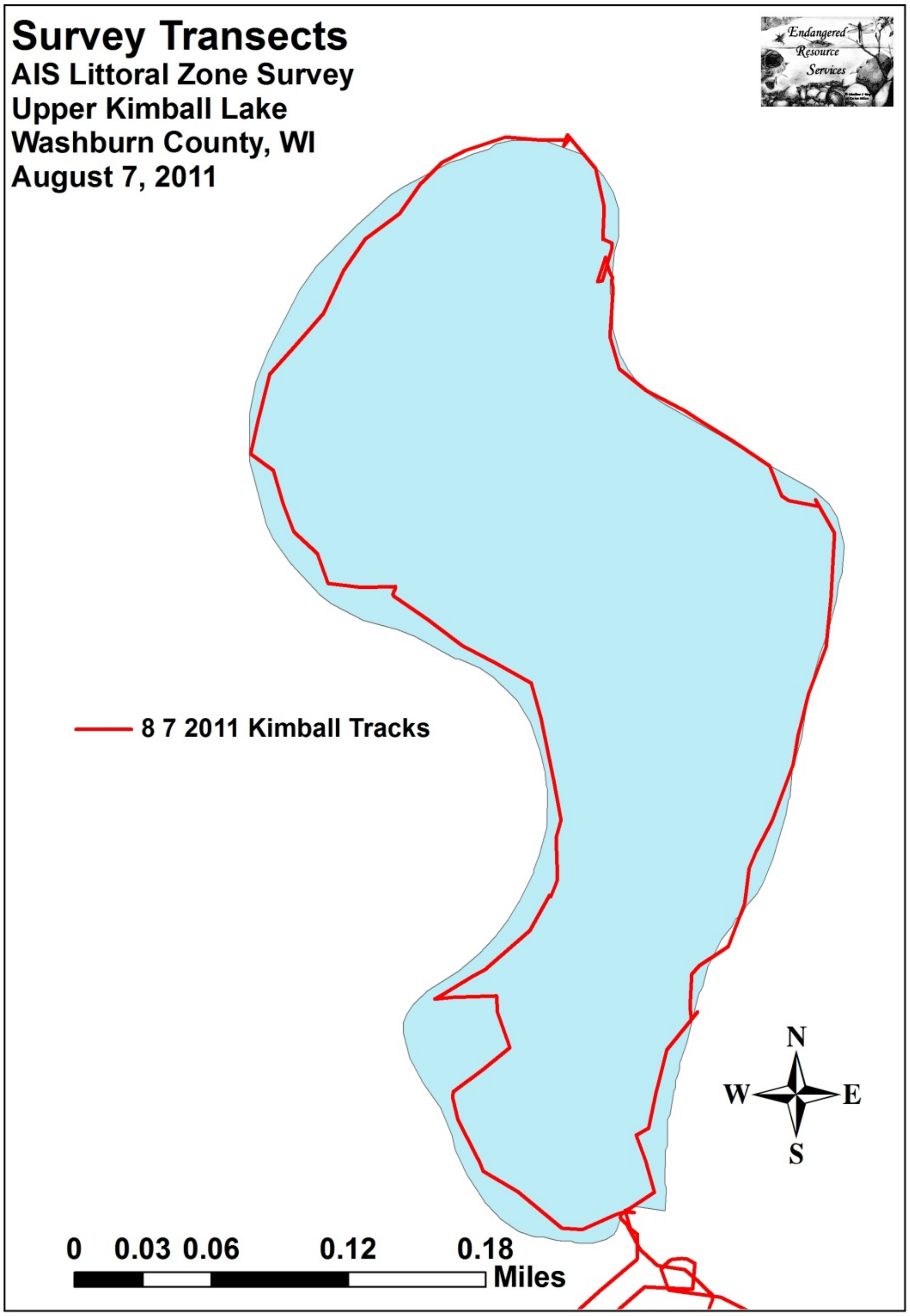
Appendix II: Kimball Lakes Maps with Survey Transects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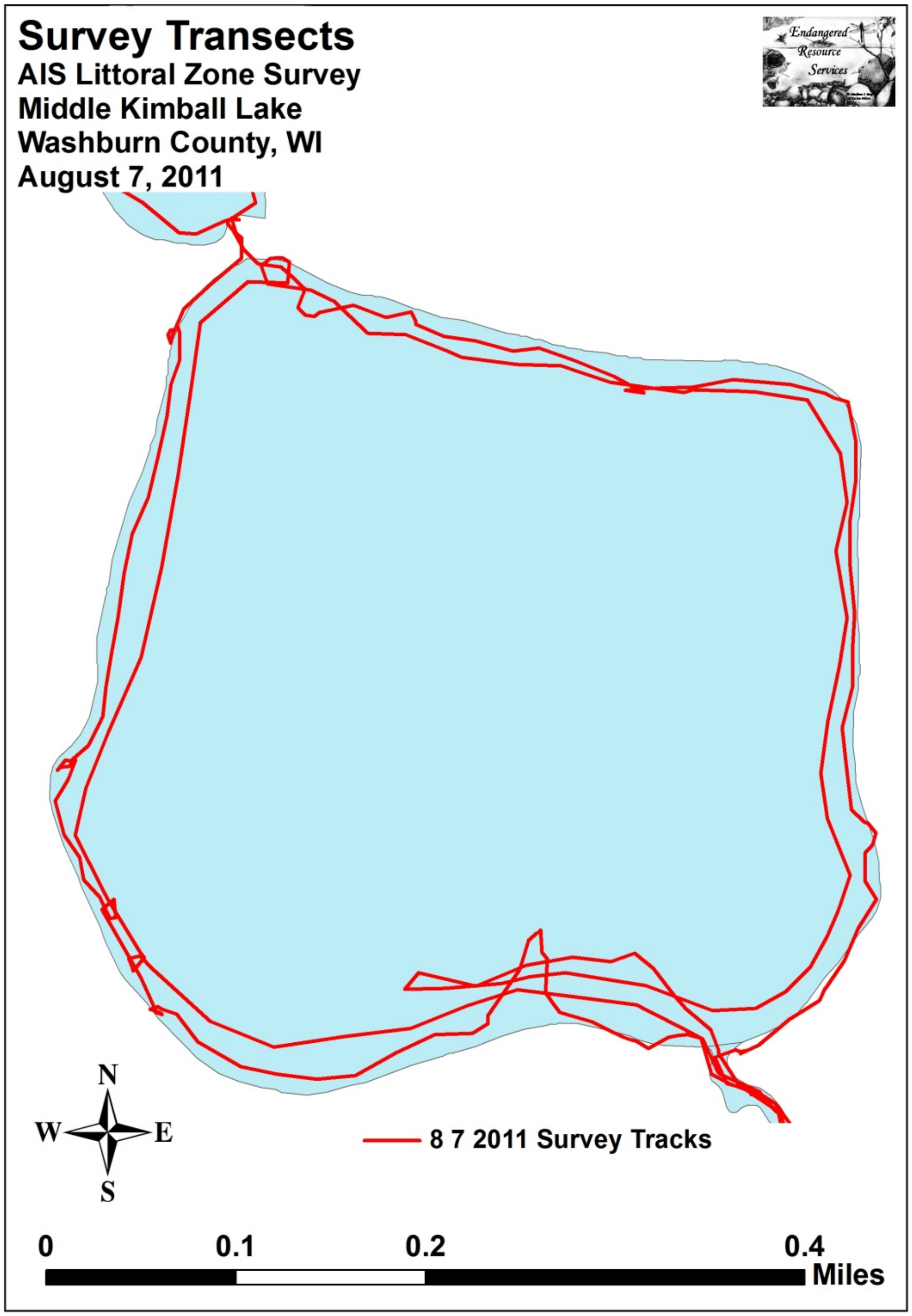

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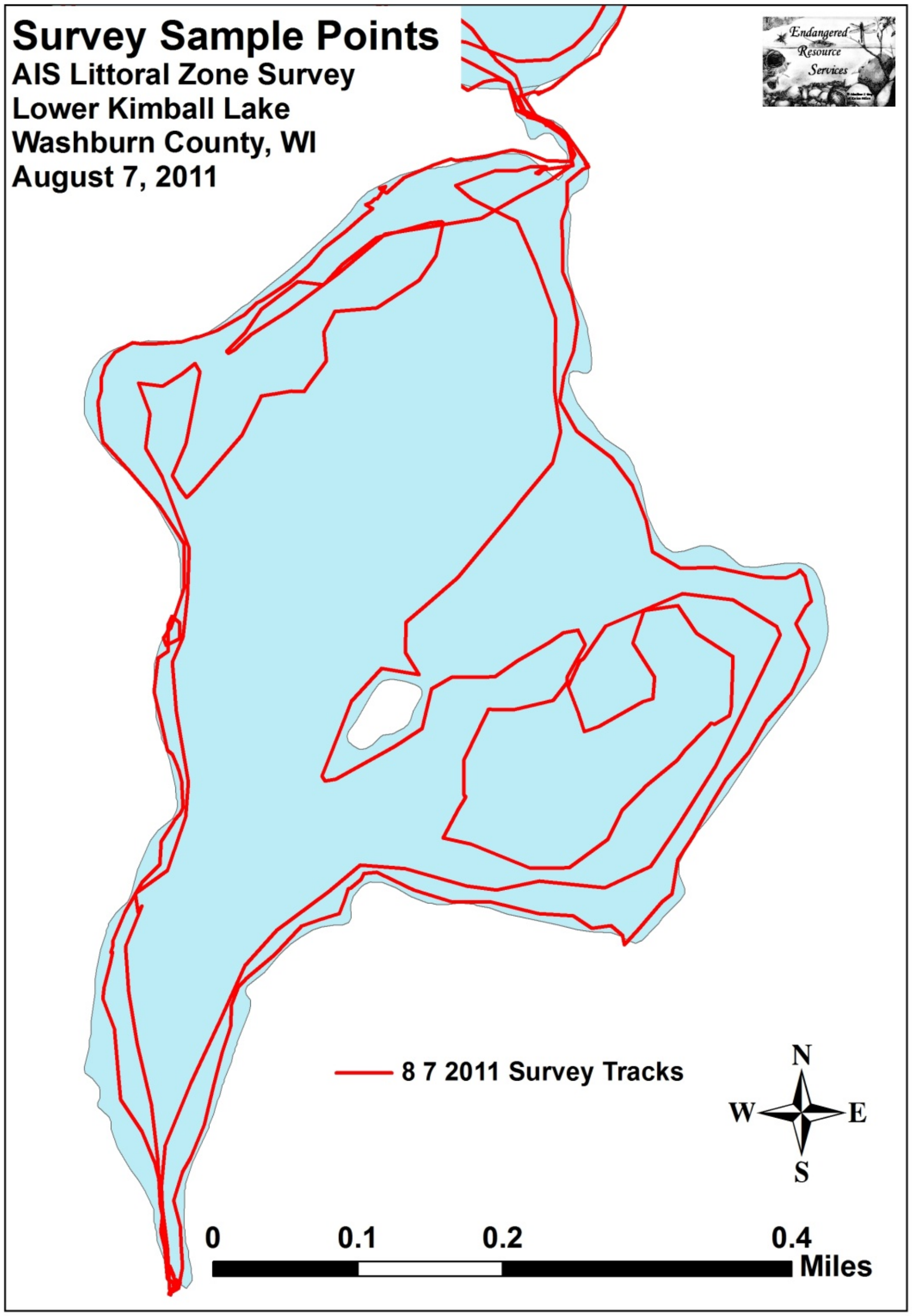
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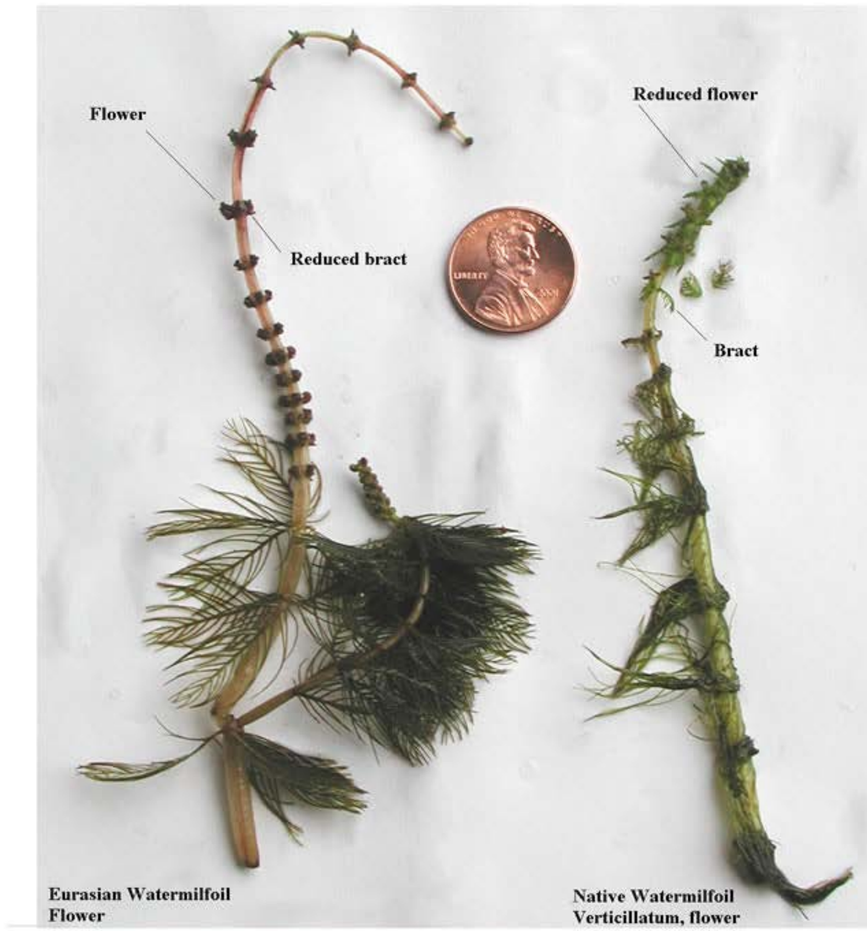
Appendix III: Milfoil Identification Guide

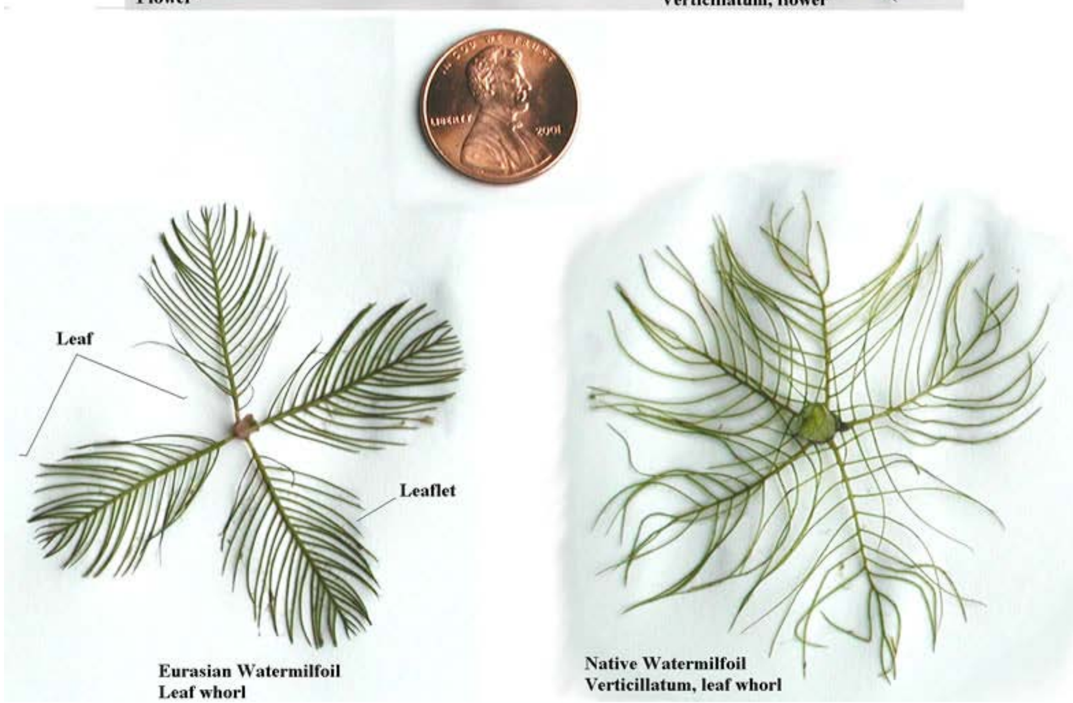
Eurasian water milfoil vs. Northern water milfoil

EWM Leaflets >26 NWM Leaflets < 22

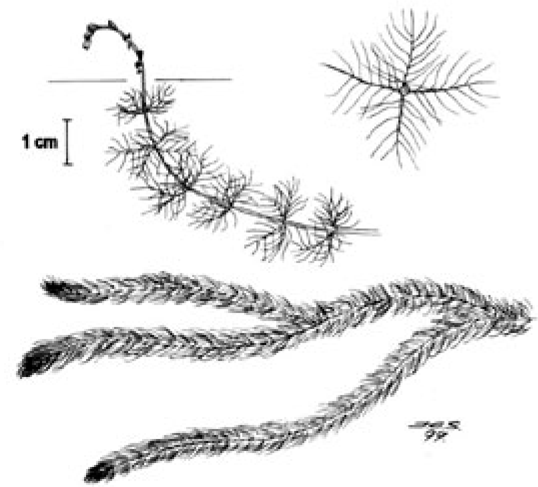
EWM Leaflets Limp out of Water   NWM Leaflets Stiff Out of Water

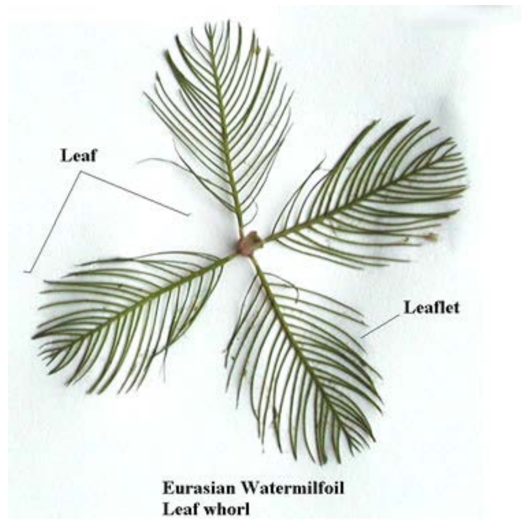
Eurasian water milfoil vs. Whorled water milfoil





Alternate-flowered water milfoil
Stems have a bushy bottle brush- like appearance
AFWM has <18 leaflets vs. EWM's >26)





Dwarf water milfoil

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

Aquatic:

Appendix IV: Glossary of Biological Terms

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 V: Aquatic Invasive Plant Species Information

Curly-leaf pondweed
(Photo Courtesy Paul Skawinski – Golden Sands RC&D)

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, 2011 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Eurasian water milfoil

(Photo M. Berg)

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, 2011 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, 2011 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife
(Photo Courtesy Brian M. Collins)

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, 2011 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)