Hybrid Water Milfoil (*Myriophyllum spicatum* X *Myriophyllum sibiricum*) Rapid Assessment Survey and Diver Hand Removal Results for Horseshoe Lake Polk/Barron County, Wisconsin WBIC: 2630100


(Koshere, 2007)

Project Sponsored by:
Horseshoe Lake Improvement Association


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ABSTRACT

Horseshoe Lake (WBIC 2630100) is a 398-acre, mesotrophic, stratified, seepage lake located on the border of Polk and Barron Counties in northwest Wisconsin. In 2006, the Wisconsin Department of Natural Resources identified the presence of Hybrid water milfoil – a cross between Northern and Eurasian water milfoils (*Myriophyllum sibiricum* X *Myriophyllum spicatum*) in the lake. Because of this finding, the Horseshoe Lake Improvement Association commissioned an exotic species point intercept survey to determine the extent of infestation in the lake in preparation for the possibility of applying for a rapid response grant. The resulting survey found Hybrid water milfoil at only 8 of the 131 survey sites (6.11%), with the worst infestation occurring in three bays near points 145, 466 and 547. Although Curly-leaf pondweed (*Potamogeton crispus*), another aquatic invasive, was also found, it was relatively rare being found at only 4 sites (1.05%) with a mean rakefull rating of 1. This survey also identified a total of 37 native macrophyte species in and directly adjacent to the lake that produced a high Floristic Quality Index of 42.50, and had an average Coefficient of Conversation of 7.08. Two of these species, Filament-leaf pondweed (*Potamogeton bicupulatus*) and Water bulrush (*Schoenoplectus subterminalis*) represent the only know populations in either Polk or Barron County. Filament-leaf pondweed and Farwell's water milfoil (*Myriophyllum farwellii*) are also listed as state species of Special Concern. Future management goals should include maintaining the lake's healthy and diverse plant community while eliminating as much Hybrid water milfoil as possible, monitoring the impact of control methods on established milfoil areas, and consideration for completing an Aquatic Plant Management Plan.

ACKNOWLEDMENTS

We wish to thank Dave Bloomer and the Wisconsin Department of Natural Resources for background information; Kelly Wagoner, Jennifer Hauxwell, and Steve Schieffer for technical advice in survey protocol; Jena Segelstrom, Mitchel and Noah Berg for assistance in conducting the survey; and Bill Smith for assistance in generating ArcView maps.

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INTRODUCTION:

Horseshoe Lake (WBIC 2630100) is a 398-acre, mesotrophic, stratified, seepage lake located on the border of Polk and Barron Counties in northwest Wisconsin in the Town of Beaver (T34N R14W S06). The lake achieves a maximum depth of 57ft in the central basin, and has an average depth of approximately 25ft. The bottom is predominately sand and rock in the central basin with scattered patches of muck located throughout. Muck bottoms are more common, and have a higher organic content (brown in color) in the lake's sheltered bays on the northeast end. Water clarity is good with Secchi visibility at depths of up to 18ft. under normal summer conditions (WDNR 2007).

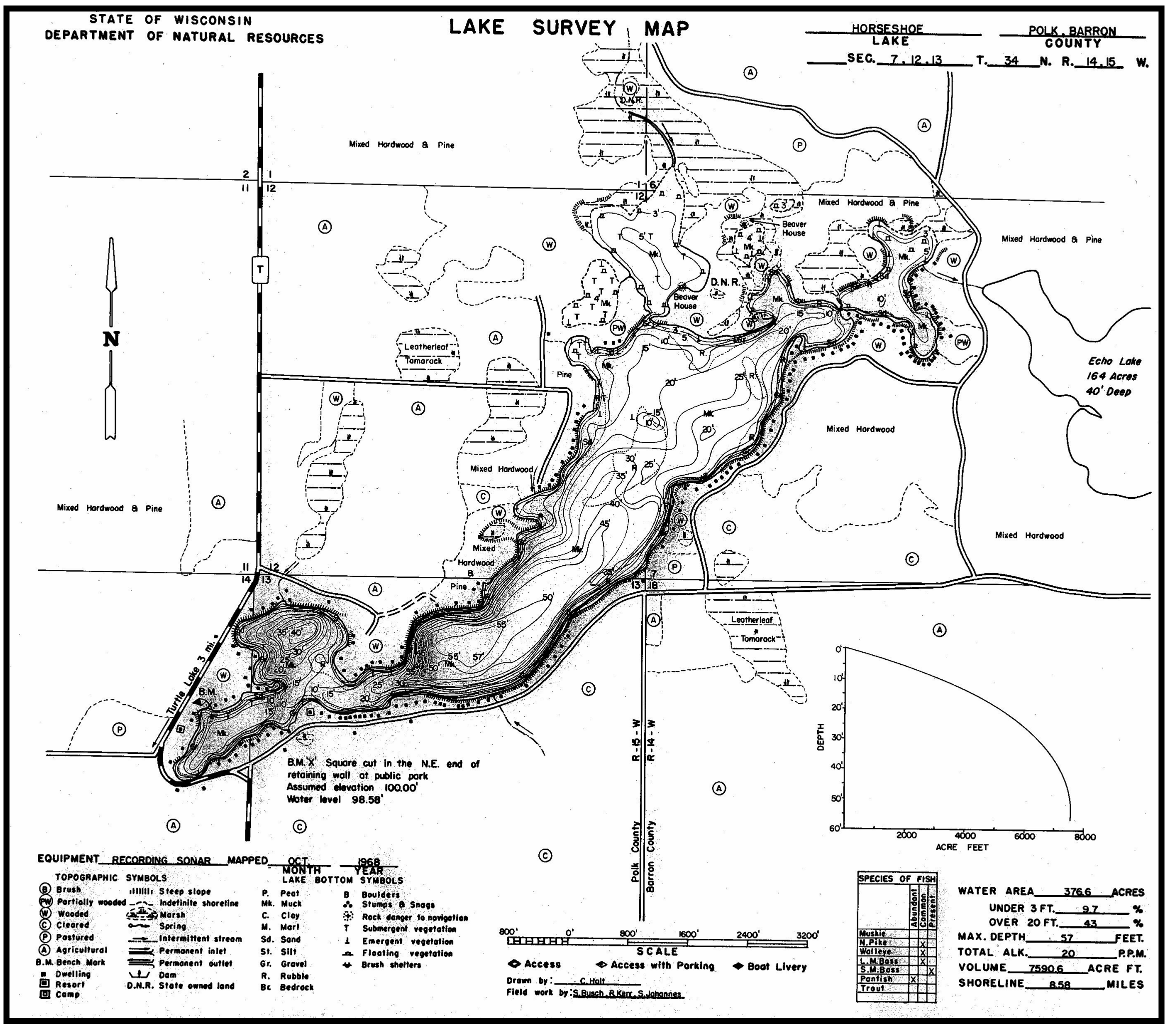

Figure 1: Horseshoe Lake Map (Busch, C., et al. 1968).

In 2006, the Wisconsin Department of Natural Resources identified the presence of Hybrid water milfoil (HWM)– a cross between Northern and Eurasian water milfoils (*Myriophyllum sibiricum* X *Myriophyllum spicatum*) in the lake. Because of this finding, the Horseshoe Lake Improvement Association commissioned an exotic species rapid assessment point intercept survey in June 2007. The survey was conducted using the

Wisconsin Department of Natural Resources statewide guidelines for systematic point intercept macrophyte sampling. The guidelines ensure that all sampling in the state will be conducted in the same manner, thus allowing data to be compared across time and space. The immediate goals of the project were to determine the extent of the HWM infestation, use this data to develop a management plan going forward, and possibly apply for a rapid response grant to help cover control/removal costs. 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 Horseshoe Lake (Schieffer and Hauxwell 2007). Using a standard formula that takes into account the shoreline shape and distance, islands and total lake acres, Jennifer Hauxwell (Wisconsin Department of Natural Resources) generated a sampling grid of 548 points that covered the entire lake (Appendix I). From these points, 120 sites in the lake's littoral zone were randomly selected to sample for exotic species. If a target species was found, we expanded the survey to include all adjacent points in the littoral zone. We located each survey point using a handheld mapping GPS unit (Garmin 76Cx). 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 (Appendix II) (Boreman et al. 1997; Chadde 2002). All plants on the rake, as well as any that were dislodged by the rake were identified. If there were exotic species 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 exotic species within six feet of the sample point (Appendix III). When removing plants for vouchers, we covered them with Ziploc bags, dug out the roots, and sealed the bags before removing them from the lake. We tried not to touch the plants at all during the process so as to prevent leaf fragments from escaping and regrowing new plants elsewhere.

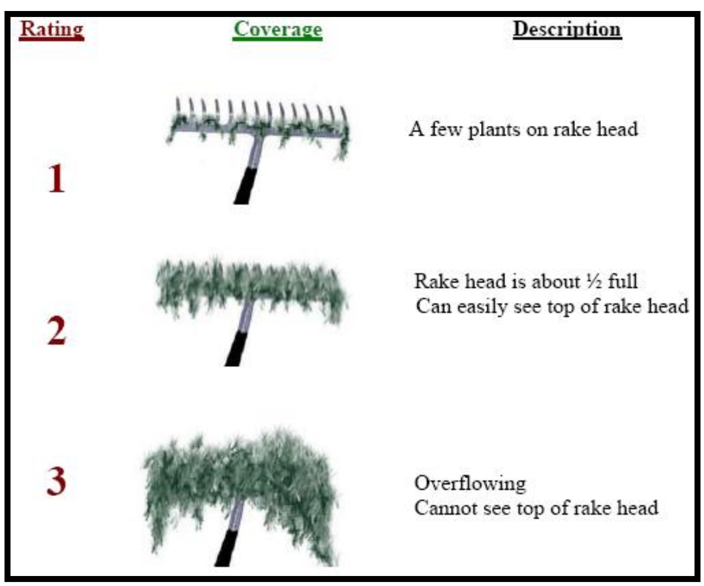

Figure 2: Rake Fullness Ratings (UWEX, 2007)

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 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. Horseshoe Lake is in the Northern Central Hardwoods Ecoregion.

Manual Removal of Hybrid Water Milfoil:

On July 18th and July 24th, 2007, volunteers from the Horseshoe Lake Improvement Association, and students from the Grantsburg High School Dive Team joined forces to remove as much HWM as possible (Appendix IV). Teams of divers were ferried to HWM areas identified by the previous survey. Using SCUBA gear, divers swam transects parallel to the shoreline in the established area of infestation until they reached the edge of the littoral zone in approximately 12-14ft of water. Once they visually located HWM plants, they gently extracted the root crowns from the sediment, wound the plants around their hands and carefully inserted the mass into Ziploc baggies if the plants were long, or placed the baggies directly over the plant if they were short (<3ft). Divers made every effort to prevent leaflet fragmentation which could have lead to plant dispersal and vegetative propagation. Volunteers from the lake association assisted them in this effort by netting any fragments that were accidentally dislodged from the main plants and subsequently floated to the surface. Baggies and their plants were dumped into large tubs on the pontoon escorts, and removed from the lake for disposal.

RESULTS:

We surveyed 131 points (Figure 3) for Hybrid water milfoil and Curly-leaf pondweed (*Potamogeton crispus*).

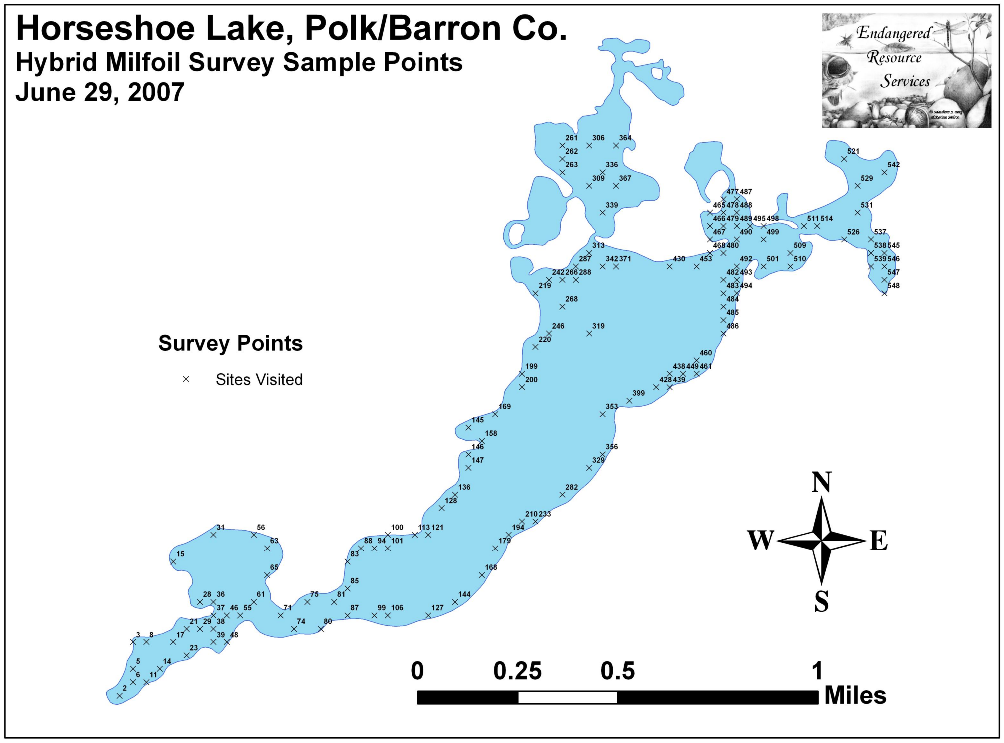

Figure 3: Rapid Survey Sample Points

Although no Eurasian water milfoil (*Myriophyllum spicatum*) was found, we did find HWM at eight (6.11%) sample sites (Figure 4). Of these, all but two were visual (no plants in rake). Boat surveys between points also located only widely scattered individual plants or small clusters. The exception to this was the areas directly around points 145, 466 and 547. In these muck-bottomed, sheltered bays, plants were still scattered, but numbered in the low hundreds instead of the tens. Most plants were located in shallow water from 2-7ft deep. Canopy plants, those that have reached the surface and are growing horizontally along the surface, were also rare. We found most plants growing above Fern pondweed (*Potamogeton robbinsi*) beds with only a few areas in the previously mentioned bays also having a few plants growing among the lily pad (*Nuphar variegate* and *Nymphaea odorata*) beds. Their tendency to outgrow surrounding plants coupled with their bright red top leaves and pinkish stems made them easy to locate and identify. The lack of similar looking Water milfoils (*Myriophyllum* sp.) in the lake also aiding identification for lake residents and volunteers. Although Farwell's water milfoil (*Myriophyllum farwellii*) can look similar, it was only located in the bay near point 468. Dwarf water milfoil (*Myriophyllum tenellum*) is common in the lake, but it has leaves that are much reduced, and is not easily recognizable as a water milfoil. Unfortunately, by this time of the summer, we noticed some plants have started to fragment allowing them to spread and reproduce vegetatively. A very few fragments were found floating in the higher density bays. When found, they were scooped up and removed.

Figure 4: Hybrid Water Milfoil Distribution

We also found Curly-leaf pondweed (CLP), another exotic invasive at 4 sites (1.05%) scattered along the drop-off on the north shore of the lake (Figure 5). This lack of plants is likely a combination of the tendency for most CLP plants to die and decompose rapidly in Mid-June as well as a lack of the deeper water (5-12ft) over rich muck bottom habitat that this species prefers.

Figure 5: Curly-leaf Pondweed Distribution

Manual Removal of Hybrid Water Milfoil:

Divers removed approximately 330 plants/stem clusters from 12 general areas on the lake over a two day period (Figure 6). Similar to the previous survey, divers found that HWM plants were widely distributed throughout the lake, but plant density was extremely low. With few exceptions, divers reported that plants were single or in small groups. Most were found growing in 3-12ft of water over muck bottoms. Common associate species include Fern pondweed (*Potamogeton robbinsii*), Small pondweed (*Potamogeton pusillus*), and Clasping-leaf pondweed (*Potamogeton richardsonii*). Two points of concern that should be revisited early in the 2008 growing season were the areas around sites 466 and 488 where scattered individuals were found growing among the lilypads. Looking before the lilypads canopy would make it easier to asses the level of HWM at these points. This bay also contained the lake's only known population of the state listed species Farwell's water milfoil.

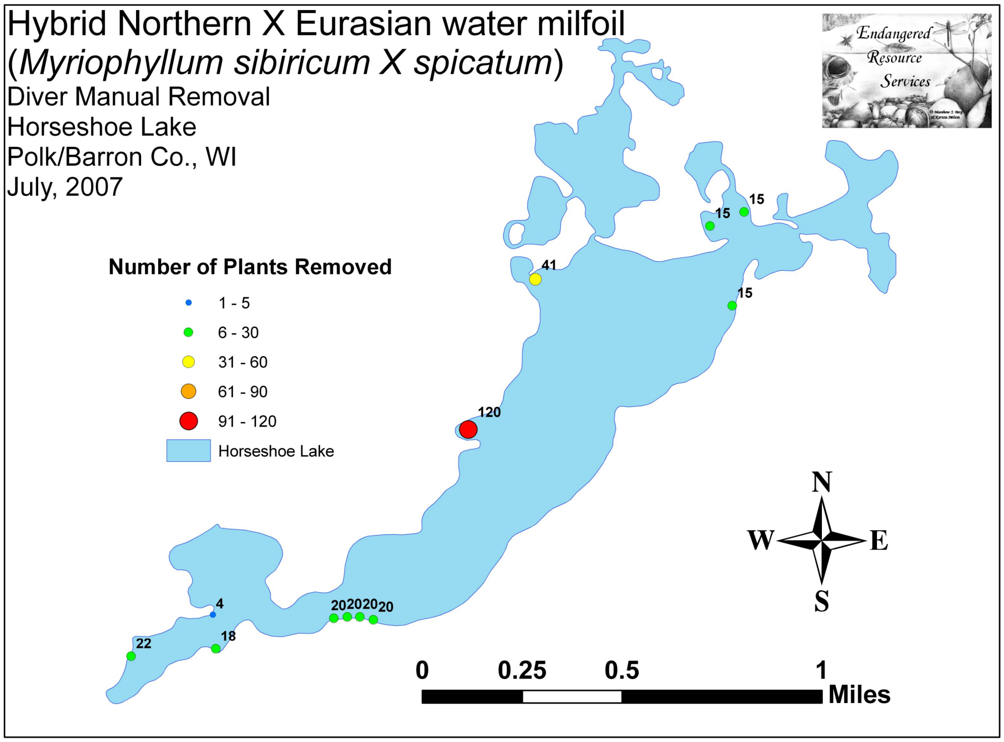

Figure 6: Hybrid Water Milfoil Removal Sites

Boat survey data indicated a total of 37 native macrophytes (not including the two exotic macrophytes, or filamentous algae) in and directly adjacent to the lake (Table 1). This total produced a mean Coefficient of Conservation 7.08 and a Floristic Index of 42.50. Nichols (1999) reported an Average Mean C for the Northern Central Hardwood Region of 5.6 putting Horseshoe Lake well above average for this part of the state. The FQI was also more than double the mean FQI of 20.9 for the Northern Central Hardwood Forest Region (Nichols 1999). Two species, Filament-leaf pondweed (*Potamogeton bicupulatus*) and Water bulrush (*Schoenoplectus subterminalis*) represent the only know populations in either Polk or Barron County. In addition to Farwell's water milfoil, Filament-leaf pondweed is also listed as a state species of Special Concern**.

** "Special Concern" species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Table 1: Floristic Quality Index of Aquatic Macrophytes
Horseshoe Lake, Polk/Barron County
June 29, 2007

Species	Common Name	C
Brasenia schreberi	Watershield	7
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea nuttallii	Slender waterweed	7
Eriocaulon aquaticum	Pipewort	9
Isoetes lacustris	Lake quillwort	8
Juncus pelocarpus f. submersus	Brown-fruited rush	8
Myriophyllum farwellii	Farwell's water milfoil	9
Myriophyllum tenellum	Dwarf water milfoil	10
Najas flexilis	Bushy pondweed	6
Najas gracillima	Slender water-nymph	7
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	9
Potamogeton alpinus	Alpine pondweed	9
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton bicupulatus	Filament-leaf pondweed	9
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Robbins pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Sagittaria graminea	Grass-leaved arrowhead	9
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus subterminalis	Water bulrush	9
Typha angustifolium	Narrow-leaved cattail	1
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Zosterella dubia	Water star-grass	6

Discussion and Considerations for Management:

Horseshoe Lake has a diverse plant community that includes several species which are unique to west-central Wisconsin. Preserving and maintaining this plant community by aggressively removing Hybrid 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 an 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 would occur if HWM continues to spread will likely have far reaching impacts on the entire lake ecosystem as well as negatively impacting esthetic and economic considerations.

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 HWM out of Horseshoe Lake to neighboring lakes.

Because the HWM plants are currently so dispersed, herbicide applications will likely be unsuccessful with the possible exception of the far eastern bays. Careful hand pulling using bags to prevent fragmentation of plants will likely represents the most efficient and cost effective method of control at this time. Because plants are in water up to 7ft deep, SCUBA may be necessary to successfully eliminate plants, but for many locations, wading to or snorkeling to plants will be feasible. It will also be important to record how many plants are removed, and where they are removed from so future management decisions can determine whether current methods of control are succeeding or if other options need to be considered. Locating and eliminating plants in the spring of 2008 will be easier than in summer/fall of 2007 because the milfoil begins growing faster than other plants, is less likely to fragment when picked early in the growing season, and because water clarity is much better in late spring than in late summer. This should not, however, prevent the aggressive pursuit of plants during the remainder of 2007.

Completing an Aquatic Plant Management Plan (APM) and/or applying for a rapid response grant will help the lake clarify a management plan moving forward. The plan might also allow the lake to tap state funds to help with control efforts. Lake owners should understand that HWM 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.

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 HWM 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.

Conclusions:

- Preserve and maintain Horseshoe Lake's diverse native plant community by working to control and locally eliminate Hybrid water milfoil.
- Continue the established Clean Boats/Clean Water Program at the lake's boat landing to prevent the spread of other exotics into/out of Horseshoe Lake.
- Educate lake owners how to identify and carefully remove HWM in front of their property, and wherever they encounter it.
- Continue monitoring for aquatic invasive species on a regular basis to determine if control methods are having the desired effect.
- Consider completing an Aquatic Plant Management Plan (APM) and/or applying for a rapid response grant to help cover the cost of control efforts.
- Whenever possible, refrain from removing native plants from the lake manually or with herbicides as this provides a place for exotic species 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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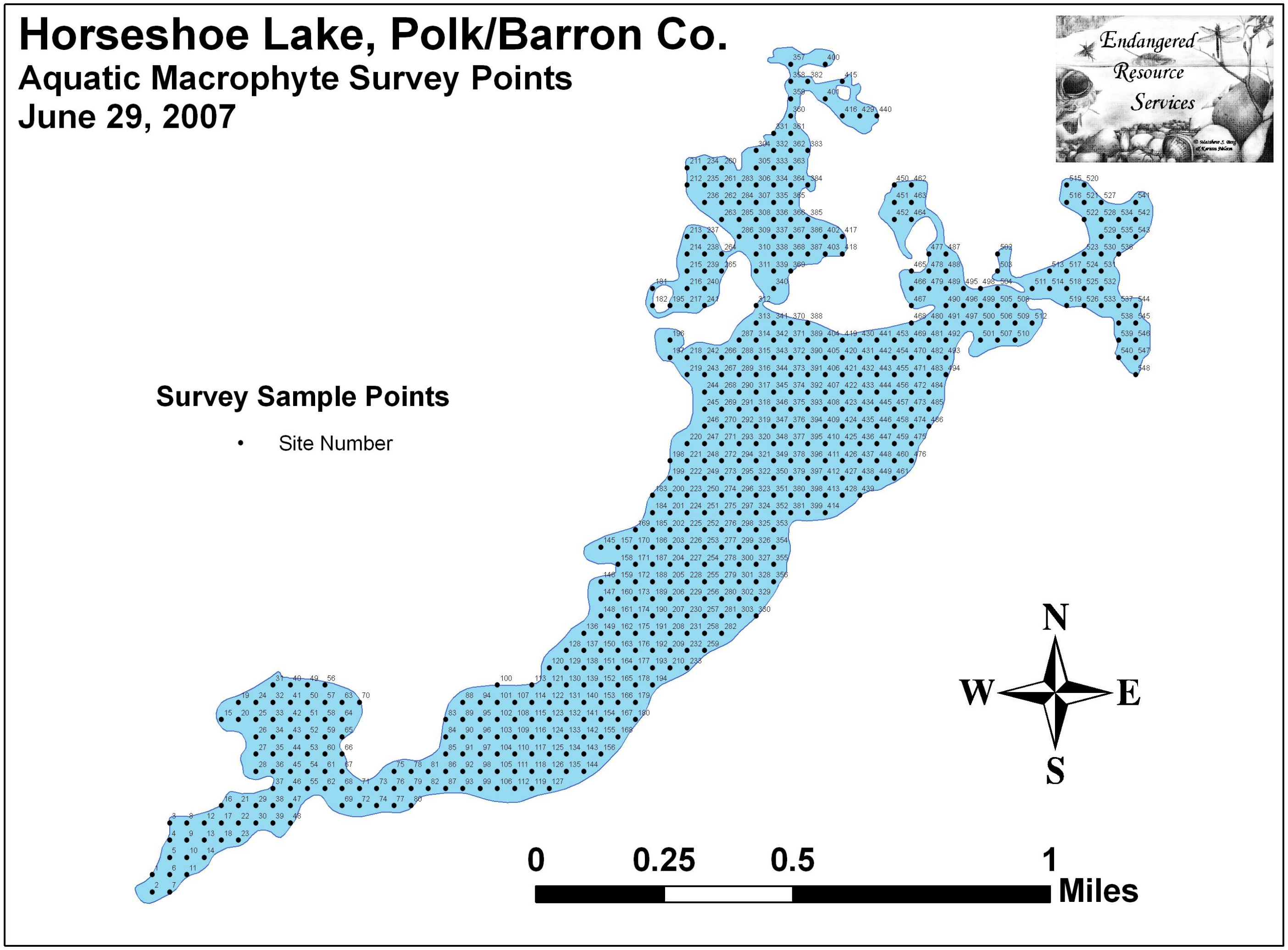
Appendix I: Horseshoe Lake Map with Sample Points

Horseshoe Lake, Polk/Barron Co.
Aquatic Macrophyte Survey Points
June 29, 2007



Appendix II: Boat Survey Data Sheet

Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	Species seen, habitat information

Appendix III: Species Distributions

Appendix IV: Diver Removal Plant Numbers and Locations

Appendix V: Glossary of Biological Terms
(Adapted from UWEX 2007)

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 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)

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, 2007 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, 2007 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, 2007 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, 2007 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)