Aquatic Macrophyte Survey for
Horseshoe Lake
Polk/Barron County, Wisconsin
WBIC: 2630100

(White water lily)

(Farwell's water-milfoil)

Project Initiated by:
Wisconsin Department of Natural Resources and the
Horseshoe Lake Improvement Association

Survey Conducted by and Report Prepared by:
Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
Summer 2008

TABLE OF CONTENTS

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. Water clarity is good with mean Secchi visibility around 10ft under normal summer conditions. In 2008, the WDNR and the Horseshoe Lake Improvement Association commissioned a cold-water exotic species survey, systematic point/intercept macrophyte survey, and fall Hybrid water milfoil bed mapping survey in preparation for developing an Aquatic Plant Management Plan for the lake. The full point intercept survey found macrophytes at 325 of the 515 total survey sites. We identified a total of 51 native plant species including five Wisconsin Special Concern Species (Spiny hornwort, Robbins spikerush, Farwell's water milfoil, Filament-leaf pondweed, and Vasey's pondweed) in and directly adjacent to the lake. This produced a mean Coefficient of Conservatism of 6.9 and a very high Floristic Quality Index of 49.1. Common waterweed and Fern pondweed were the most common species being found at 50.15% and 45.85% of survey points with vegetation respectively. Fall bed mapping found HWM growing in 27 distinct areas that covered 6.22 acres or approximately 1.6% of the lake's total surface area. We believe choosing control methods (hand, rake, dive or chemical removal) on a bed by bed basis, prioritizing management efforts based on a bed's proximity to sensitive habitat and high boat traffic areas, and striving for local eradication before moving on to the next bed will likely provide the best long term control of HWM at the most economical price. We also suggest establishing a "milfoil free zone" around the boat landing should be a priority to help prevent the spread of HWM to other lakes in the area.

ACKNOWLEDMENTS

We wish to thank the Wisconsin Department of Natural Resources and the Horseshoe Lake Improvement Association for funding this project; Jennifer Hauxwell, WDNR for technical assistance, and Lydia Benge-Briggs, Brian Collins, Nicole Davis and Mitchel and Noah Berg for assistance in conducting this survey.

LIST OF FIGURES

LIST OF TABLES

Page #

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 Towns of Beaver/Almena (T34N R14W S06 SW SW) (Figure 1). 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 mean Secchi visibility around 10ft under normal summer conditions (WDNR 2008).

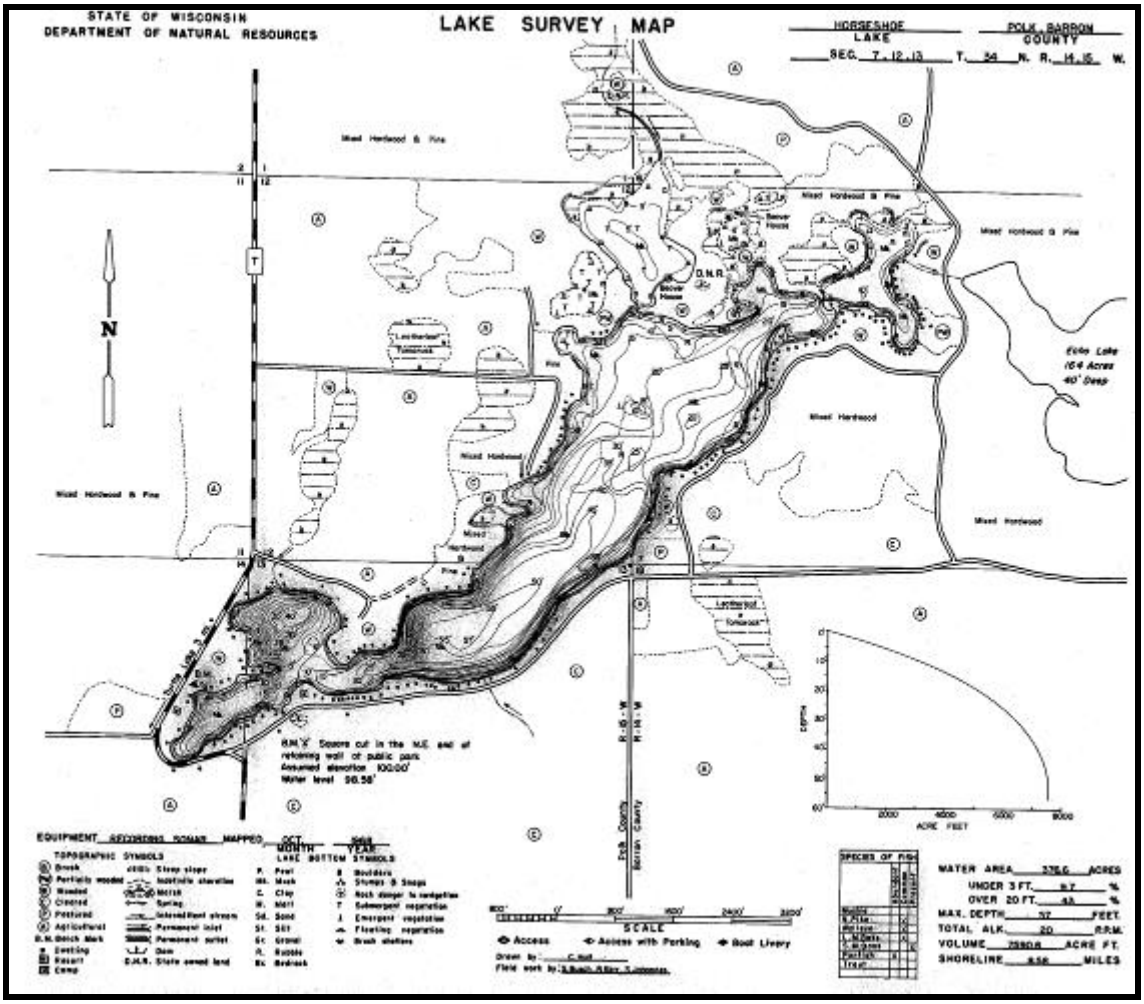


Figure 1: Horseshoe Lake Map (Busch, C., et al. 1968).

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 to determine the distribution and density

of HWM. In 2008, two full point/intercept surveys and a fall bed mapping survey of HWM were requested to provide the baseline data needed to develop an Aquatic Plant Management Plan (APMP) for the lake. The initial goal of the June cold water survey was to document the level of the exotic invasive species Curly-leaf pondweed (CLP) (*Potamogeton crispus*) before it senesced in late June. This survey was also used to determine if HWM had increased in either distribution or density since 2007 and to develop a rapid response prescription to deal with HWM in summer 2008. The immediate goals of the August warm water survey were to provide baseline data on the abundance and distribution of all native aquatic plant species in the lake and to determine if HWM had spread during the summer of 2008. We used the fall HWM bed mapping to provide an estimate of total HWM acreage on the lake, to determine the effectiveness 2008 of control methods and to assist in developing control strategies for 2009. This report represents the summary analysis of the data collected during these three 2008 surveys.

PLANT SURVEY METHODS:

June Cold Water Rapid Assessment Survey:

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth and total lake acres, Jennifer Hauxwell (WDNR) generated a sampling grid for Horseshoe Lake (Appendix I). On June 3rd and 4th, we conducted an early season invasive species survey of all points in the estimated littoral zone to document cold water density of HWM and CLP. This survey normally results in detection, rake density and approximate mapping of any infestation. However, because HWM was found at low densities, we did not feel the point intercept survey was adequately capturing the infestation. Because of this, we decided that adding a meandering shoreline survey was necessary. As we circled the perimeter of the entire lake in the zone where we found HWM, we logged a GPS waypoint and recorded the approximate number of stems at each location where we found HWM.

August Warm Water Full Point/Intercept Survey:

Prior to beginning the point intercept survey on August 2nd, we conducted a general boat survey of Horseshoe Lake to gain familiarity with the species present (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006), and two vouchers were pressed and retained for herbarium specimens – one to be retained by the Horseshoe Lake Improvement Association, and one to be sent to the state for identification confirmation. During the point intercept survey, we located each survey point using a handheld mapping GPS unit (Garmin 76Cx). At each point, we recorded a depth reading with a Polar Vision hand held sonar unit. Following the establishment of the littoral zone at a maximum of 24.5ft, we sampled for plants within the depth range of plant growth. At each of these points, we used a rake to sample an approximately 2.5ft. section of the bottom. All plants on the rake, as well as any that were dislodged by the rake were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of plants within six feet of the sample point. Substrate (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

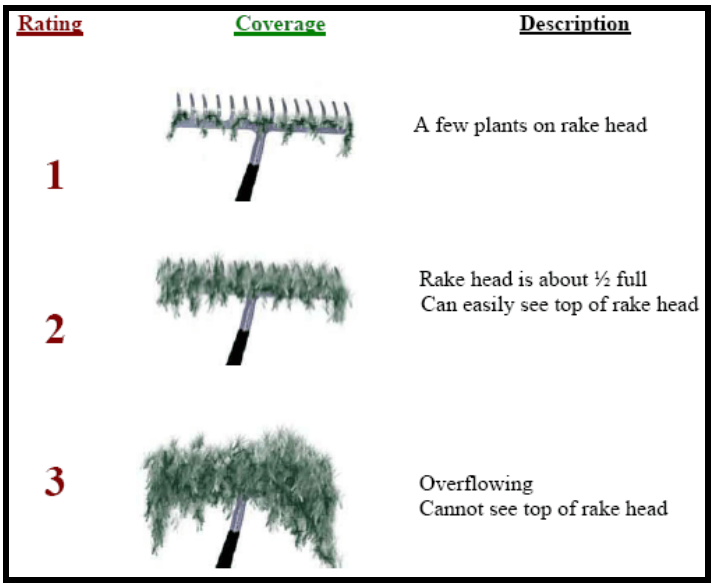


Figure 2: Rake Fullness Ratings (UWEX, 2008)

Fall Hybrid Water Milfoil Bed Mapping:

On October 12th, we mapped all known beds of HWM on the lake. A bed was determined to be any area where we visually estimated that HWM made up approximately >25% of the area's plants and was essentially continuous. After we located a bed, we motored around the perimeter of the area, took GPS coordinates at regular intervals, and estimated the average rakefull rating of HWM within the bed. It is important to note that, although HWM was widely distributed throughout the lake, it was seldom a dominant plant and almost never formed monotypic stands. Because of this, we had to lower our usual criteria for what a "bed" was from the usual >50% of an area's plants to the >25% we used. Had we not done this, there would have been almost no areas to map.

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix III) (UWEX, 2008). From this, we calculated the following:

Total number of points sampled: This included the total number of points on the lake coverage that were within the littoral zone (0-maximum depth where plants are found) Initially, we continued to sample points whose depth were several feet beyond the littoral zone, but once we established this maximum depth with confidence, most points beyond this depth were not rake sampled.

Total number of sites with vegetation: These included all sites where we found vegetation after doing a rake sample. For example, if 20% of all sample sites have vegetation, it suggests that 20% of the lake has plant coverage.

Total number of sites shallower than the maximum depth of plants: This is the number of sites that are in the littoral zone. Because not all sites that are within the littoral zone actually have vegetation, we use this value to estimate how prevalent vegetation is throughout the littoral zone. For example, if 60% of the sites shallower than the maximum depth of plants have vegetation, then we estimate that 60% of the lake's littoral zone has plants.

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences at all sample points. It can also be reported as a percentage of occurrences at sample points within the littoral zone.

Frequency of occurrence example:

Plant A is sampled at 70 out of 700 total points = 70/700 = .10 = 10%
This means that Plant A's frequency of occurrence = 10% considering the entire lake sample.

Plant A is sampled at 70 out of 350 total points in the littoral zone = 70/350 = .20 = 20%
This means that Plant A's frequency of occurrence = 20% when only considering the littoral zone.

From these frequencies, we can estimate how common each species was throughout the lake, and how common the species was at depths where plants were able to grow. Note the second value will be greater as not all the points (in this example, only ½) occur at depths shallow enough for plant growth.

Simpson's diversity index: A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's diversity index, the index value represents the probability that two individuals (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be **more resistant** to invasion by exotic species.

Maximum depth of plants: This indicates the deepest point that vegetation was sampled. In clear lakes, plants may be found at depths of over 20ft, while in stained or turbid locations, they may only be found in a few feet of water. While some species can tolerate very low light conditions, others are only found near the surface. In general, the diversity of the plant community decreases with increased depth.

Number of sites sampled using rope/pole rake: This indicates which rake type was used to take a sample. Protocol suggests a 15ft pole rake, and a 25ft rope rake for sampling (Wagoner personal communication).

Average number of species per site: This value is reported using four different considerations. 1) **shallower than maximum depth of plants** indicates the average number of plant species at all sites in the littoral zone. 2) **vegetative sites only** indicate the average number of plants at all sites where plants were found. 3) **native species shallower than maximum depth of plants** and 4) **native species at vegetative sites only** excludes exotic species from consideration.

Species richness: This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include those seen during the point intercept survey and the initial boat survey.

Mean and median depth of plants: The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value.

Relative frequency: This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value (Table 3) gives us an idea of which species are most important within the macrophyte community.

Relative frequency example:

Suppose that we sample 100 points and found 5 species of plants with the following results:

Plant A was located at 70 sites. Its frequency of occurrence is thus 70/100 = 70%
Plant B was located at 50 sites. Its frequency of occurrence is thus 50/100 = 50%
Plant C was located at 20 sites. Its frequency of occurrence is thus 20/100 = 20%
Plant D was located at 10 sites. Its frequency of occurrence is thus 10/100 = 10%

To calculate an individual species' relative frequency, we divide the number of sites a plant is sampled at by the total number of times all plants were sampled. In our example that would be 150 samples (70+50+20+10).

Plant A = 70/150 = .4667 or 46.67%
Plant B = 50/150 = .3333 or 33.33%
Plant C = 20/150 = .1333 or 13.33%
Plant D = 10/150 = .0667 or 6.67%

This value tells us that 46.67% of all plants sampled were Plant 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 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 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 species found in the lake during the point intercept and boat surveys, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's 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. Horseshoe Lake is in the Northern Central Hardwood Forests ecoregion.

RESULTS:

June Cold-water and Shoreline Survey:

Although we raked Curly-leaf pondweed at three sites and saw it at another during the 2007 rapid assessment survey, we were unable to locate any plants despite visiting all points in the lake during the June 3-4 survey. We could not relocate the small beds we found near point 342 in 2007 even though we spent considerable time looking for them. Dave Blumer reported that he had encouraged lake residents to eliminate these known areas of CLP in 2007 (personal communication), and this may explain why we failed to locate any. We did not record Hybrid water milfoil in any of the rake samples, and only recorded it as a visual in five out of the lake's 515 survey points (Figure 3) (Appendix IV). This was down slightly from the two points were we rake sampled it in the east bay and six additional points where we recorded it as a visual sighting in 2007 (Table 1).

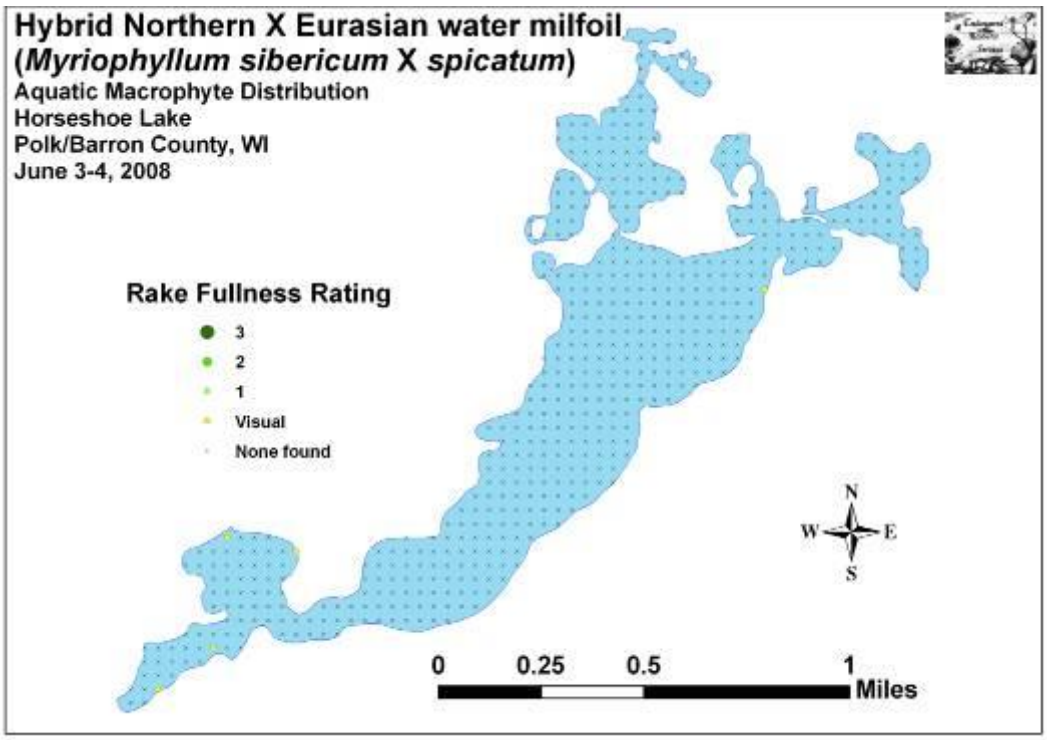


Figure 3: HWM Cold-water Point/Intercept Survey

Table 1: CLP/HWM Distribution and Density Statistics June 2007-2008

Species, Common Name	Total Sites	Visual	Rake 1	Rake 2	Rake 3	Mean Rake
Potamogeton crispus Curly-leaf pondweed – June, 2007	4	1	3	0	0	1.00
Potamogeton crispus Curly-leaf pondweed – June, 2008	0	0	0	0	0	0.00
Myriophyllum sibiricum X *spicatum* Hybrid water-milfoil – June, 2007	8	6	1	2	0	1.50
Myriophyllum sibiricum X *spicatum* Hybrid water-milfoil – June, 2008	5	5	0	0	0	0.00

The meandering shoreline survey was more effective in locating HWM plants. Using this method, we documented 143 points with HWM (Figure 4) (Appendix IV). The mean number of stems/site was 12.2, but this was greatly skewed by several sites having over 50 stems (median stems/site was 3.0). In reality, most sites had fewer than ten stems and could have easily been eliminated by hand pulling. The areas with the heaviest infestation were located in the bay near the boat landing where HWM was widely distributed but not dense; the bay on the north side of the boat landing peninsula where HWM was both relatively dense and widely distributed; and in the areas near points 82, 414, and 494. In general, the south shoreline of the lake had more of the soft sandy/silt habitat that HWM seems to prefer. In this habitat, we found it scattered almost continuously along the southern shoreline. However, it never really formed dense monotypic stands except at the three point previously mentioned. Interestingly, in the bays where divers performed hand removal in summer 2007, HWM had been almost totally eliminated. (For more information on exotic invasive species, see Appendix XI).

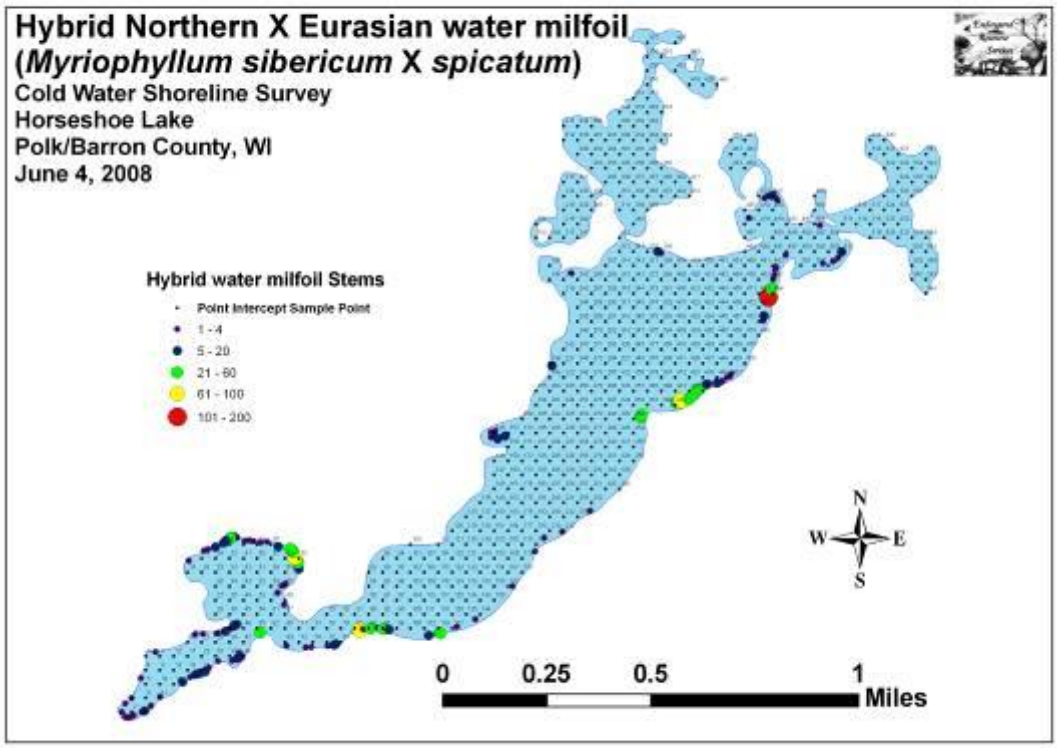


Figure 4: HWM Shoreline Survey

August Warm Water Full Point/Intercept Survey:

We surveyed 515 points for depth (Figure 5) (Appendix V). "Mud Lake" and the lake's east bays are relatively shallow. These bays gently but steadily slope into the deep (57ft) central basin. The north shore of this basin drops off sharply while the southern shore slopes more gradually. A shallow channel connects the main lake to the two southwest bays - the northern most of which also drops off sharply from all sides to 40+ft.

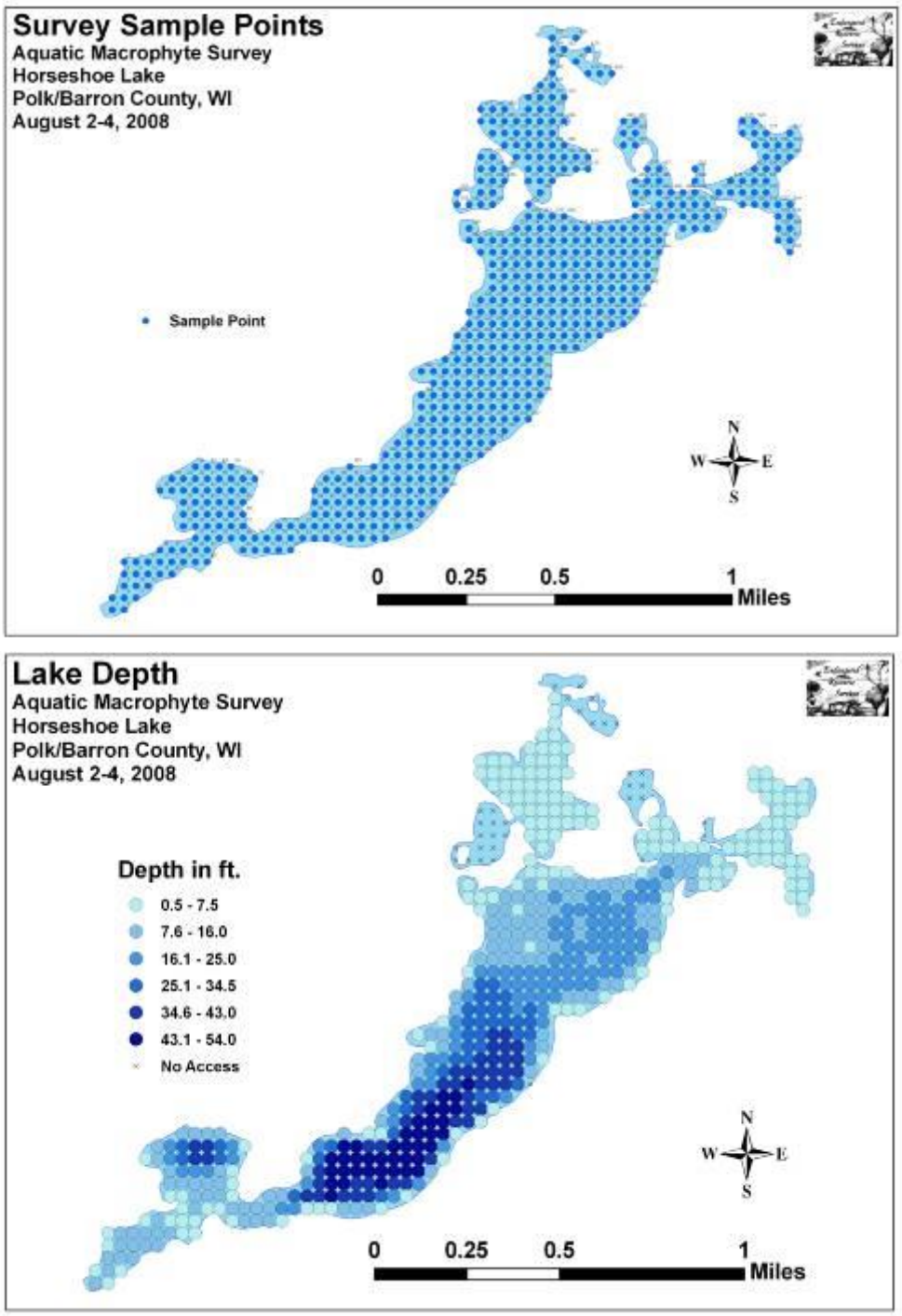
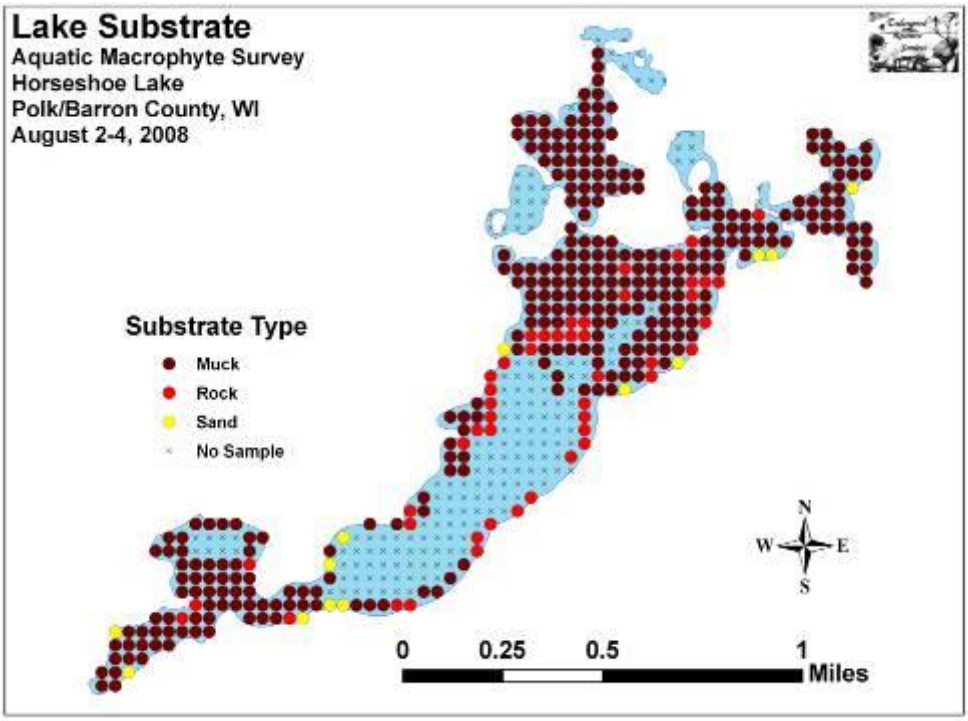


Figure 5: Survey Sample Points and Lake Depth

Of the 389 points were we could determine the substrate, 84.4% were muck, 12.3% were rock, and 3.3% were sand (Figure 6) (Appendix V). The east bays and "Mud Lake" supported expansive submergent, floating and emergent plant beds. Their shallow water and thick organic muck promoted both density and species richness. The sandy/rocky bottom and relatively narrow littoral zone along the sides of the central basin and west bays supported fewer species in lower densities albeit ones unique to these habitats.



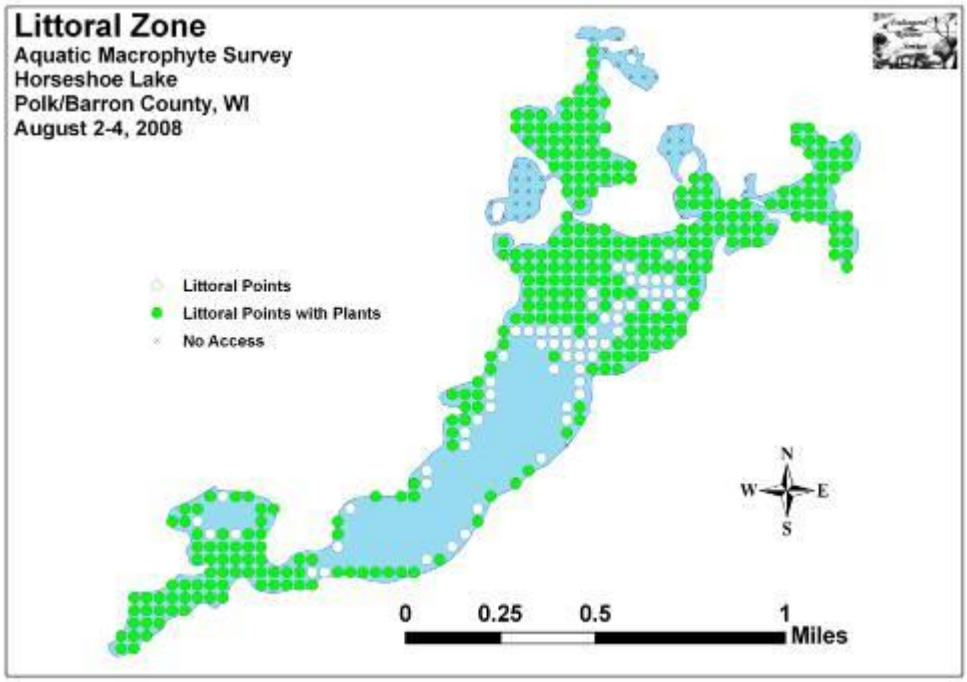


Figure 6: Lake Bottom Substrate and Littoral Zone

We found plants growing on approximately 63.1% of the entire lake bottom, and in 83.6% of the littoral zone (Table 2). Overall diversity was very high with a Simpson Diversity Index value of 0.93. Species richness was also very high with 57 total species found growing in and immediately adjacent to the lake (Appendix VI and VII). The majority of aquatic macrophytes were found growing in relatively deep water with a mean depth of 8.4ft, and a median depth 7.0ft. Although we determined the littoral zone went to 24.5 feet, the "weedline" ended at approximately 18ft in most parts of Horseshoe. Species richness and diversity also dropped rapidly at deeper locations.

Table 2: Aquatic Macrophytes P/I Survey Summary Statistics Horseshoe Lake, Polk/Barron Counties August 2-4, 2008

Summary Statistics:

Total number of points sampled	515
Total number of sites with vegetation	325
Total number of sites shallower than the maximum depth of plants	389
Frequency of occurrence at sites shallower than maximum depth of plants	83.6
Simpson Diversity Index	0.93
Maximum depth of plants (ft)	24.50
Number of sites sampled using rope rake (R)	113
Number of sites sampled using pole rake (P)	278
Average number of all species per site (shallower than max depth)	2.87
Average number of all species per site (veg. sites only)	3.44
Average number of native species per site (shallower than max depth)	2.86
Average number of native species per site (veg. sites only)	3.42
Species Richness	50
Species Richness (including visuals)	54
Species Richness (including visuals and boat survey)	57
Mean depth of plants (ft)	8.4
Median depth of plants (ft)	7.0

Common waterweed (*Elodea canadensis*), and Robbins (fern) pondweed (*Potamogeton robbinsii*) were the most common macrophyte species (Table 3). We found them at 50.15% and 45.85% of survey points with vegetation respectively (Figure 7). Together, they combined for almost 28% of the total relative frequency. Although many other species were common and widely distributed, no other species had relative frequencies over 8%. This indicates there was high evenness among species in most areas throughout the lake with no one species dominating at the expense of others.

In general, we found bottom substrate and depth to be the best predictor of the plant community at any given location in Horseshoe Lake. In the clear water areas of the main basin, turf like mats of Needle spikerush (*Eleocharis acicularis*), Dwarf water milfoil (*Myriophyllum tenellum*) and Brown-fruited rush (*Juncus pelocarpus*) with scattered patches of Filament-leaf pondweed (*Potamogeton bicupulatus*) dominated shallow sandy/rocky areas. In 2-8ft over sandy muck, Spiral-fruited pondweed (*Potamogeton*

spirillus), Vasey's pondweed (*Potamogeton vaseyi*), Ribbon-leaf pondweed (*Potamogeton epihydrus*), Clasping-leaf pondweed (*Potamogeton richardsonii*), Wild celery (*Vallisneria americana*), Hybrid water-milfoil and Large-leaf pondweed (*Potamogeton amplifolius*) were common. From 8-18ft, Small pondweed (*Potamogeton pusillus*) over mixed substrate, and Robbins (fern) pondweed, Common waterweed and Coontail (*Ceratophyllum demersum*) over organic muck were common to abundant. Nitella (*Nitella* sp.) and Aquatic moss occurred over varied bottoms and were the only species we consistently found growing at depths over 18ft. These low light specialists generally grow horizontally, and do not provide much in the way of vertical structure for fish.

In the stained water bays of "Mud Lake" and the eastern bays, Pickerelweed (*Pontederia cordata*), Robbins spikerush (*Eleocharis robbinsii*), Narrow-leaved bur-reed (*Sparganium emersum*), Whorled water-milfoil (*Myriophyllum verticillatum*), and Water bulrush (*Schoenoplectus subterminalis*) were common in <1ft of water. From 1-4ft, we found White water lily (*Nymphaea odorata*), Spatterdock (*Nuphar variegata*), Watershield (*Brasenia schreberi*), Farwell's water-milfoil (*Myriophyllum farwellii*), Spiny hornwort (*Ceratophyllum echinatum*), Northern naiad (*Najas gracillima*), and Flat-stem pondweed (*Potamogeton zosteriformis*) to be the most common species. Because of the dark water and low light penetration, few plants were located in waters deeper than 4ft. However, three species of carnivorous bladderworts, the "Venus flytraps" of the lake, were present throughout the bays floating among other plants and over open water. Despite its small size, Creeping bladderwort (*Utricularia gibba*) was by far the most widespread and abundant. Common bladderwort (*Utricularia vulgaris*) and Flat-leaf bladderwort (*Utricularia intermedia*), although locally common, were more scattered in their distribution. Each of these distinct plant communities, located in the different zones of the lake, provided unique habitats and food sources for mammals, birds, fish, aquatic insects and other invertebrates.

Horseshoe Lake has many species of plants that are common in lakes throughout northern Wisconsin. In addition to these, we found several species that are known from only a handful of lakes in the Central Hardwood Ecoregion. We identified a total of five "Special Concern"** species including Spiny hornwort, Robbins spikerush, Farwell's water milfoil, Filament-leaf pondweed, and Vasey's pondweed. The presence of these species along with other species such as Dwarf water milfoil, Northern naiad, Water bulrush and Narrow-leaved bur-reed that are highly sensitive to pollution and human disturbance is a testament to a history of good water quality that Horseshoe Lake have apparently enjoyed.

** "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 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Horseshoe Lake, Polk/Barron Counties
August 2-4, 2008

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Elodea canadensis	Common waterweed	163	14.59	50.15	41.90	2.06
Potamogeton robbinsii	Robbins (fern) pondweed	149	13.34	45.85	38.30	2.25
Nitella sp.	Nitella	85	7.61	26.15	21.85	1.79
	Aquatic moss	80	7.16	24.62	20.57	1.80
Utricularia gibba	Creeping bladderwort	58	5.19	17.85	14.91	1.40
Potamogeton pusillus	Small pondweed	57	5.10	17.54	14.65	1.35
Ceratophyllum demersum	Coontail	45	4.03	13.85	11.57	1.64
Nymphaea odorata	White water lily	45	4.03	13.85	11.57	2.24
Potamogeton zosteriformis	Flat-stem pondweed	43	3.85	13.23	11.05	1.40
Brasenia schreberi	Watershield	34	3.04	10.46	8.74	2.26
Utricularia vulgaris	Common bladderwort	34	3.04	10.46	8.74	1.56
Potamogeton spirillus	Spiral-fruited pondweed	29	2.60	8.92	7.46	1.76
Potamogeton vaseyi	Vasey's pondweed	26	2.33	8.00	6.68	1.46
Utricularia intermedia	Flat-leaf bladderwort	24	2.15	7.38	6.17	1.92
Vallisneria americana	Wild celery	20	1.79	6.15	5.14	2.05
Lemna minor	Small duckweed	19	1.70	5.85	4.88	1.16
Najas gracillima	Northern naiad	18	1.61	5.54	4.63	1.61
Spirodela polyrhiza	Large duckweed	18	1.61	5.54	4.63	1.28
Potamogeton amplifolius	Large-leaf pondweed	15	1.34	4.62	3.86	1.33
Sagittaria latifolia	Common arrowhead	13	1.16	4.00	3.34	1.85
	Filamentous algae	11	0.98	3.38	2.83	2.09
Typha latifolia	Broad-leaved cattail	11	0.98	3.38	2.83	2.73
Elatine minima	Waterwort	10	0.90	3.08	2.57	1.80
Nuphar variegata	Spatterdock	9	0.81	2.77	2.31	1.56

Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Horseshoe Lake, Polk/Barron Counties
August 2-4, 2008

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Pontederia cordata	Pickerelweed	9	0.81	2.77	2.31	2.00
Potamogeton epihydrus	Ribbon-leaf pondweed	9	0.81	2.77	2.31	1.33
Potamogeton richardsonii	Clasping-leaf pondweed	8	0.72	2.46	2.06	1.63
Eleocharis acicularis	Needle spikerush	7	0.63	2.15	1.80	1.57
Eleocharis robbinsii	Robbins spikerush	7	0.63	2.15	1.80	2.86
Chara sp.	Muskgrass	6	0.54	1.85	1.54	1.17
Heteranthera dubia	Water star-grass	6	0.54	1.85	1.54	1.00
Myriophyllum sibiricum X *spicatum*	Hybrid water-milfoil	5	0.45	1.54	1.29	1.60
Sagittaria rigida	Sessile-fruited arrowhead	5	0.45	1.54	1.29	1.00
Dulichium arundinaceum	Three-way sedge	4	0.36	1.23	1.03	1.25
Ceratophyllum echinatum	Spiny hornwort	3	0.27	0.92	0.77	1.00
Isoetes echinospora	Spiny-spored quillwort	3	0.27	0.92	0.77	1.33
Leersia oryzoides	Rice cut-grass	3	0.27	0.92	0.77	1.33
Myriophyllum tenellum	Dwarf water-milfoil	3	0.27	0.92	0.77	1.67
Phalaris arundinacea	Reed canary grass	3	0.27	0.92	0.77	1.33
Potamogeton illinoensis	Illinois pondweed	3	0.27	0.92	0.77	1.00
Riccia fluitans	Slender riccia	3	0.27	0.92	0.77	1.33
Schoenoplectus tabernaemontani	Softstem bulrush	3	0.27	0.92	0.77	1.33
Myriophyllum farwellii	Farwell's water-milfoil	2	0.18	0.62	0.51	1.00
Najas flexilis	Bushy pondweed	2	0.18	0.62	0.51	1.00
Potamogeton bicupulatus	Filament-leaf pondweed	2	0.18	0.62	0.51	1.50
Alisma triviale	Water plantain	1	0.09	0.31	0.26	1.00
Eriocaulon aquaticum	Pipewort	1	0.09	0.31	0.26	1.00
Lythrum salicaria	Purple loosestrife	1	0.09	0.31	0.26	1.00

Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes Horseshoe Lake, Polk/Barron Counties August 2-4, 2008

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Myriophyllum verticillatum	Whorled water-milfoil	1	0.09	0.31	0.26	1.00
Schoenoplectus subterminalis	Water bulrush	1	0.09	0.31	0.26	2.00
Eleocharis ovatus	Oval spikerush	**	**	**	**	**
Juncus pelocarpus	Brown-fruited rush	**	**	**	**	**
Schoenoplectus purshianus	Pursh's bulrush	**	**	**	**	**
Sparganium emersum	Narrow-leaved bur-reed	**	**	**	**	**
Eleocharis palustris	Creeping spikerush	***	***	***	***	***
Juncus effusus	Common rush	***	***	***	***	***
Potamogeton amplifolius X *illinoensis?*	Large-leaf "like" Pondweed Possible hybrid	***	***	***	***	***

** Visual Only

*** Boat Survey Only

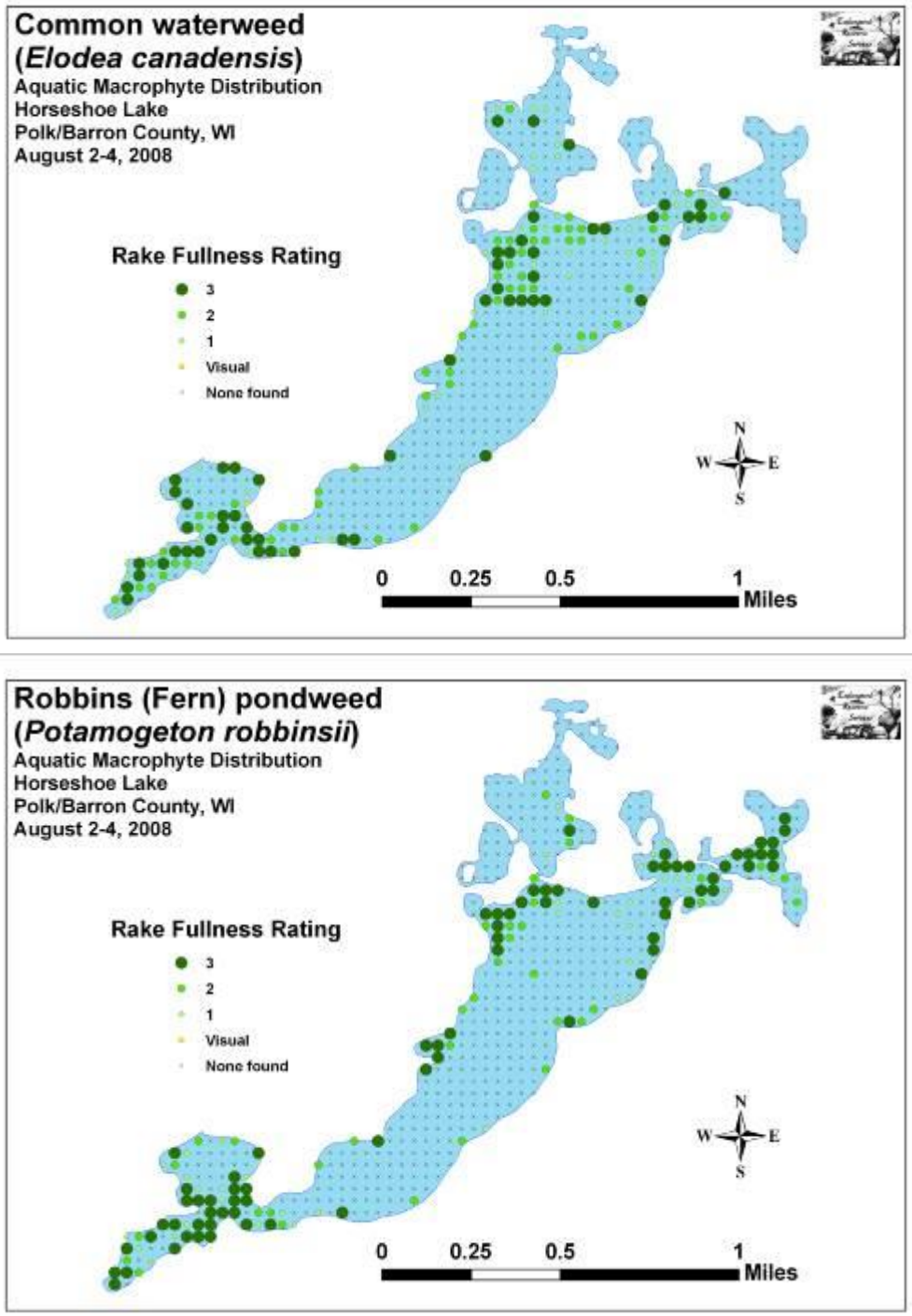


Figure 7: Horseshoe Lake's Most Common Species

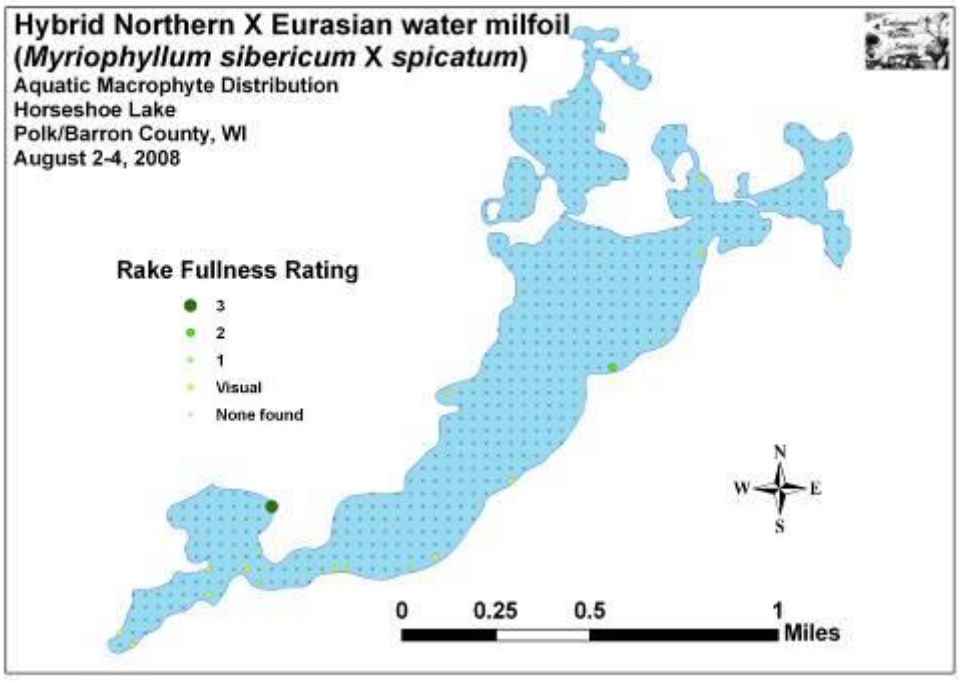


Figure 8: HWM August Distribution

We found Hybrid water-milfoil at five rake sample points in August and recorded it as a visual at an additional 12 locations (Figure 8). The relative frequency of .45 was very low, and it was only found at 1.29% of sites with vegetation (1.54% of the total littoral zone). We recorded a rakefull rating of "3" and "2" at only one point each. Although this was more than the zero raked points and five visual sightings in early June 2008, and the two raked points and six visuals in late June 2007, it was still a relatively small percentage of the total lake surface showing an infestation. We noticed plants continued to be primarily in clusters rather than in large, area dominating beds. We also noticed that the areas where divers had removed plants in summer 2007 continued to have very few HWM plants.

Purple loosestrife (*Lythrum salicaria*), another invasive species, was noted at several shoreline locations including the far east bays, the entrance to "Mud Lake", and along the north shore on the west end of the main basin just before the broad channel that leads into the west bays. Plants were few in number with the exception of a couple of cattail areas in the east bay where their numbers were in the 10's (For more information on exotic invasive species, see Appendix XI).

Table 4: Floristic Quality Index of Aquatic Macrophytes
Horseshoe Lake, Polk/Barron Counties
August 2-4, 2008

Species	Common Name	C
Alisma triviale	Water plantain	4
Brasenia schreberi	Watershield	7
Ceratophyllum demersum	Coontail	3
Ceratophyllum echinatum	Spiny hornwort	10
Chara sp.	Muskgrass	7
Dulichium arundinaceum	Three-way sedge	9
Elatine minima	Waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis ovata	Oval spikerush	8
Eleocharis palustris	Creeping spikerush	6
Eleocharis robbinsii	Robbins spikerush	10
Elodea canadensis	Common waterweed	3
Eriocaulon aquaticum	Pipewort	9
Heteranthera dubia	Water star-grass	6
Isoetes echinospora	Spiny-spored quillwort	8
Juncus effusus	Common rush	4
Juncus pelocarpus f. submersus	Brown-fruited rush	8
Leersia oryzoides	Rice cut-grass	3
Lemna minor	Small duckweed	5
Myriophyllum farwellii	Farwell's water milfoil	9
Myriophyllum tenellum	Dwarf water milfoil	10
Myriophyllum verticillatum	Whorled water milfoil	8
Najas flexilis	Bushy pondweed	6
Najas gracillima	Northern naiad	7
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	9
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton bicupulatus	Filament-leaf pondweed	9
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Robbins (fern) pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Potamogeton vaseyi	Vasey's pondweed	10
Potamogeton zosteriformis	Flat-stem pondweed	6
Riccia fluitans	Slender riccia	7
Sagittaria latifolia	Common arrowhead	3
Sagittaria rigida	Sessile-fruited arrowhead	8
Schoenoplectus purshianus	Pursh's bulrush	9
Schoenoplectus subterminalis	Water bulrush	9

Table 4 cont': Floristic Quality Index of Aquatic Macrophytes Horseshoe Lake, Polk/Barron Counties August 2-4, 2008

Species	Common Name	C
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium emersum	Narrow-leaved bur-reed	8
Spirodela polyrhiza	Large duckweed	5
Typha latifolia	Broad-leaved cattail	1
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
N		51
mean C		6.9
FQI		49.1

We identified a total of 51 native plants to species in and immediately adjacent to Horseshoe Lake. They produced a mean Coefficient of Conservatism (C) of 6.9 and a very high Floristic Quality Index of 49.1 (Table 4). Nichols (1999) reported Average Mean C for the North Central Hardwood Forests 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 North Central Hardwood Forests Region (Nichols 1999). These numbers indicate the lake has many species, such as the previously mentioned species of "Special Concern", that are highly sensitive to disturbance or pollution, and a much higher than average number of species overall. This exceptionally high FQI is likely a result of Horseshoe Lake's history of generally good water quality, highly variable substrates, mixed clarity (clear in main basin/tannic "root beer" water in "Mud Lake" and the east bays), and diverse water flow conditions. All of these factors create a variety of microhabitats which offer a wide variety of plants suitable growing conditions.

Fall Hybrid Water Milfoil Bed Mapping:

We identified and mapped a total of 27 areas throughout the lake that had a relatively significant amount of Hybrid water-milfoil (Figure 9) (Appendix VIII). Of these, all but four areas (7, 11, 13, and 22) would have been better characterized as macrophyte beds with a significant HWM component rather than HWM beds. "Beds" ranged in size from <.01 acres (essentially a small patch of plants) to over 1.3 acres. All combined, they added up to 6.22 acres or 1.6% of the total surface area of the lake (Table 5). Anecdotal observation seemed to indicate that many new satellite plants had sprung up along the south shore of the lake since the June and August surveys. We also found plants in the far east bay and in "Mud Lake" where we had not previously seen them. Although we would still describe beds 7, 13 and 22 as some of the worst areas of the lake, they seemed to have many fewer plants than we remembered previously in the summer. This was just the opposite for bed 11 which seemed to have many more plants than we previously noticed. We again noted that areas where dive removal had occurred in 2007 continued to have very few HWM plants.

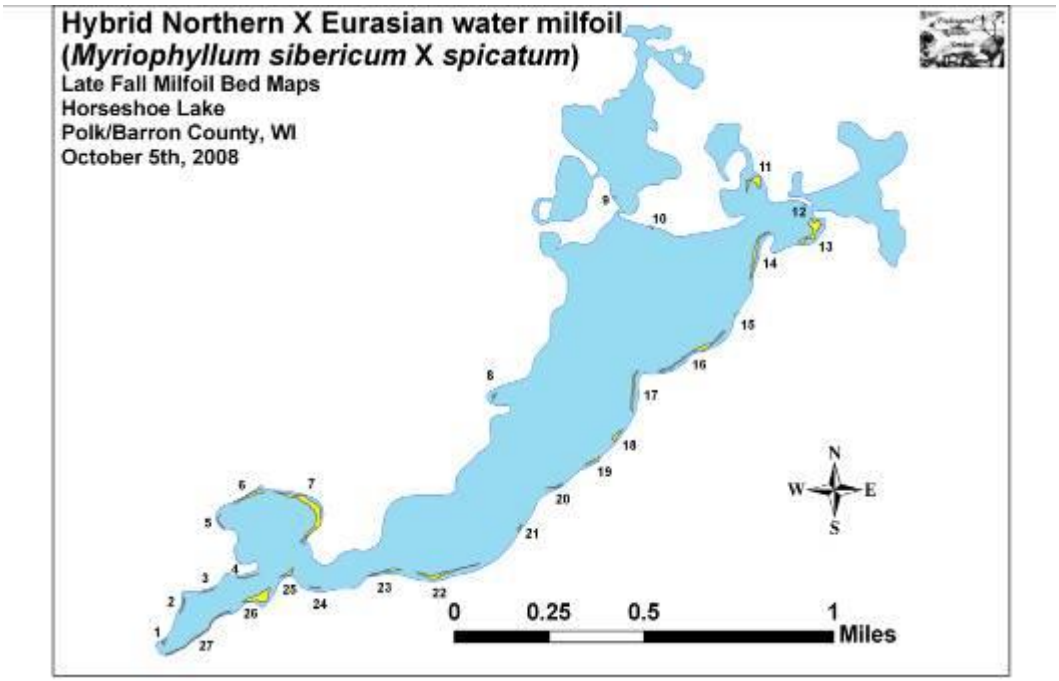


Figure 9: Late Fall HWM Beds

Table 5: Late Fall Hybrid water-milfoil Bed Mapping Data
Horseshoe Lake, Polk/Barron
October 12, 2008

Bed Number	Area in Acres	Estimated Mean Rakefull	Bed Characteristics
1	0.03	<1	A narrow ribbon of scattered plants parallel to shore.
2	0.05	<1	A narrow ribbon of scattered plants parallel to shore.
3	0.02	<1	A narrow ribbon of scattered plants parallel to shore.
4	0.05	<1	A narrow ribbon of scattered plants parallel to shore.
5	0.02	<1	A narrow ribbon of scattered plants parallel to shore.
6	0.28	1	Regular plants scattered among natives.
7	1.33	1-2	Much reduced from the June survey. Herbicide?
8	0.03	<1	A very few widely scattered plants throughout the area.
9	0.01	1	A few pioneer clusters.
10	0.00	<1	A few pioneer clusters.
11	0.40	1-3	Regular plants forming almost monotypic stands.
12	0.00	<1	A few pioneer clusters.
13	0.69	0-2	Ranging from nothing to dense clusters throughout.
14	0.48	1-2	A narrow ribbon of scattered plants parallel to shore.
15	0.00	<1	A few pioneer clusters.
16	0.49	1-2	A narrow ribbon of scattered plants parallel to shore.
17	0.24	1-2	A narrow ribbon of scattered plants parallel to shore.
18	0.15	1	A narrow ribbon of scattered plants parallel to shore.
19	0.10	1	A narrow ribbon of scattered plants parallel to shore.
20	0.07	1	A narrow ribbon of scattered plants parallel to shore.
21	0.05	1	A narrow ribbon of scattered plants parallel to shore.
22	0.48	1-2	Regular plants in a narrow ribbon parallel to shore.
23	0.19	1-2	Regular plants in a narrow ribbon parallel to shore.
24	0.03	1	A narrow ribbon of scattered plants parallel to shore.
25	0.12	1	Regular plants in patchy clusters throughout.
26	0.64	<1	Widely scattered plants throughout the area.
27	0.26	<1	A narrow ribbon of scattered plants parallel to shore.
Total Acres	6.22		

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Horseshoe Lake has an abundant, diverse and rare plant community which provides a variety of high quality habitats for fish, waterfowl, and other wildlife. Unfortunately, Hybrid water-milfoil poses a significant and increasing threat to that diversity and the resource as a whole. A team approach that uses all available data from this report, fisheries data, and lake usership surveys coupled with open and frank communication between the WDNR, interested citizens and SEH, Inc. will be critical in formulating the best aquatic plant management plan (APMP) possible for the lake.

June Cold-water Rapid Assessment Survey:

Based on our two years worth of June surveys, we believe Curly-leaf pondweed is likely present in the lake's central basin, but could hardly be considered even a nuisance at this time. The low nutrient, sand/muck soils that dominate the main basin are not ideal habitat for CLP which can tolerate and may even prefer turbid, nutrient rich, degraded areas (Voss 1996, Borman et al. 1997). "Mud Lake" and the east bays would seem to offer ideal habitat for CLP establishment, but we did not locate any evidence of live plants or turions in these areas. Because of its apparent rarity, it is unlikely CLP will need to be addressed directly in the APMP other than a possible footnote mention. That said, if new beds are discovered in the future, manual removal similar to what may have happened in summer 2007 or 2008 (Dave Blumer, personal communication) is highly recommended to prevent further spread and establishment.

Hybrid water-milfoil was particularly easy to locate during this time of the year. It starts growing more quickly than our native species making it easy to spot. With its distinct "red top" of new growth, and the lake's clarity at 15+ft at this time of the year, May and June offer a prime opportunity to locate and eliminate individual plants and small clusters before they can spread, and before other native species fill in around them making detection and removal much more difficult. As many native plants are not yet actively growing, it may also offers a window for herbicide application that will minimize damage to the native plant community while still eliminating HWM. A multifaceted effort at this time of the year involving wading/hand removal, SCUBA/dive removal and, if warranted, chemical application would likely maximize total numbers of plants removed, reduce the fragmentation and colonization that will inevitably happen during normal summer use of the lake, and minimize damage to the lake's sensitive and rare plant communities.

August Warm Water Full Point/Intercept Survey:

Following the late summer survey, we were impressed that Hybrid water-milfoil was not more abundant than what we found it to be. Although the plant was widely distributed, for the most part, HWM was still not forming dense monotypic beds. Because of this, weed cutters and/or expansive chemical control do not appear to be viable options at this time. It was evident the HWM was continuing to spread as it was more common in the boat landing area and along the south shore of the main basin. The highest density areas identified in the June shoreline survey showed a reduction in plant bed size and numbers, but individual plants and clusters were still common in these areas, and new HWM plant growth was evident. At least some of these areas had been treated with herbicide (Pam

Nelson, personal communication). The bays along the north shore of the main basin southwest from the "Mud Lake" channel, where divers had worked on total elimination of HWM in the summer of 2007, remained nearly completely free of HWM plants. Based on this observation, we feel the evidence supports attacking the problem on an area by area basis with the goal of total elimination in that area before moving elsewhere. In prioritizing areas for future hand/dive removal and/or chemical treatment, we believe the far east bays that were identified by WDNR surveyors (Cornelius et al., 2001) as sensitive areas (Appendix IX) should be strongly considered as starting points for control. These areas contain populations of the lake's rarest plants, serve as critical spawning and nursery habitats for game and forage fish (Cornelius et al., 2001), and provide important habitat for many other species of wildlife. We also feel that the far southwest bay of the lake, especially around the boat landing, should be high on the priority list for removal to prevent the spread of HWM to other area lakes.

By the first week of August, Purple loosestrife plants around the lake were in full bloom. Because this plant has the potential to invade and overtake large areas of undeveloped lowland marsh on the borders of the east bays, "Mud Lake" and elsewhere, and because plants are currently few in number (likely <200 total), we strongly recommend that an effort be made to eliminate plants during the August bloom in 2009.

Fall Hybrid Water-Milfoil Bed Mapping:

We identified beds 7, 11, 13, and 22 as being the most likely candidates to be considered for a spring herbicide treatment. Site 13 should receive special attention as it is located in sensitive area B, and many of the HWM plants here were mixed in with waterlilies and Watershield. The other beds may fall within the boundaries of treatment areas from last summer or be near by those treatment areas. Regardless, they were the most concentrated areas of plants on the lake. Because none of the other mapped "beds" had large or dense HWM populations, hand removal, rake removal, or dive removal would likely provide the best control with the least damage to native plants.

General Considerations:

Although HWM control has become and will likely continue to be the lake's top management priority, there are other management goals that could be undertaken concurrently. Improving water clarity and quality would not only add to the lake's esthetic value, but also make it easier to locate and eliminate HWM later into the summer. Secchi readings over the past 10 years appear to indicate stable clarity in Horseshoe Lake. Filamentous algae, a threat to many lakes' water clarity/quality, is normally associated with an abundance of nutrients in the water from failed septic systems, and lawn and field fertilizer runoff. It had a low relative frequency of 0.98 in Horseshoe Lake. Although there were few places that exhibited excessive algal growth, these levels could be lowered even further by testing septic systems around the lake, reducing or eliminating fertilizer applications near the lake, and developing native vegetation buffer strips to restore shorelines and limit nutrient runoff.

Throughout the lake, but especially around the boat landing, lakeshore owners should refrain from removing native plants from the lake unless absolutely necessary as these patches of barren substrate can provide an easy place for invasive plants like HWM to take root and become established. The lack of large noticeable signage at the boat landing is also an improvement to consider. By providing education, reeducation, and continual reminders of the dangers/impacts of aquatic invasive species to lake owners and visitors alike, and establishing a "milfoil free zone" around the boat landing, HWM can hopefully be prevented from spreading to other area lakes.

Management Considerations Summary:

- Preserve Horseshoe Lake's abundant, diverse and rare native plant community.
- When herbicide usage is required to control HWM, it should be the minimum amount required to meet management goals.
- Prioritize the elimination of HWM by area beginning with the lake's five "sensitive areas" on the east side which serve as fish nurseries and provide critical habitat for many of the lake's rarest plants.
- Work to eliminate HWM from directly around the boat landing to prevent its spread to other area lakes.
- Reduce and, wherever possible, eliminate fertilizer applications near the lakeshore.
- Establish native vegetation buffer strips along the lakeshore.
- Encourage shoreline restoration.
- Encourage owners to refrain from removing native plants from the lake – especially near the boat landing as they provide an easy place for HWM to establish.
- Improve signage at the boat landing about the HWM infestation to remind boaters to clean off their trailers.

LITERATURE CITED

Borman, S., R. Korth, and J. Temte 1997. Through the Looking Glass…A Field Guide to Aquatic Plants. Wisconsin Lakes Partnership. DNR publication FH-207-97.

Chadde, Steve W. 2002. A Great Lakes Wetland Flora: A complete guide to the aquatic and wetland plants of the Upper Midwest. Pocketflora Press; 2nd edition

Cornelius, Rick, Kevin Morgan, Gary Lund, Dan Harrington, Mark Sundeen, and Kurt Roblek. 2001. Horseshoe Lake (Barron and Polk Co.) Integrated Sensitive Area Survey Report. WDNR report provided by Jim Cahow, WDNR Barron Office.

Crow, G. E., C. B. Hellquist. 2006. Aquatic and Wetland Plants of Northeastern North America, Volume I + II: A Revised and Enlarged Edition of Norman C. Fassett's A Manual of Aquatic Plants. University of Wisconsin Press.

Nichols, Stanley A. 1999. Floristic Quality Assessment of Wisconsin Lake Plant communities with Example Applications. Journal of Lake and Reservoir Management 15 (2): 133-141.

UWEX Lakes Program. [online]. 2008. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp (2008, September).

Voss, Edward G. 1996. Michigan Flora Vol I-III. Cranbrook Institute of Science and University of Michigan Herbarium.

WDNR. [online]. 2008. Citizen Monitoring Lake Water Quality Database. Available from https://dnrx.wisconsin.gov/x10322/ViewData.asp (2008, September).

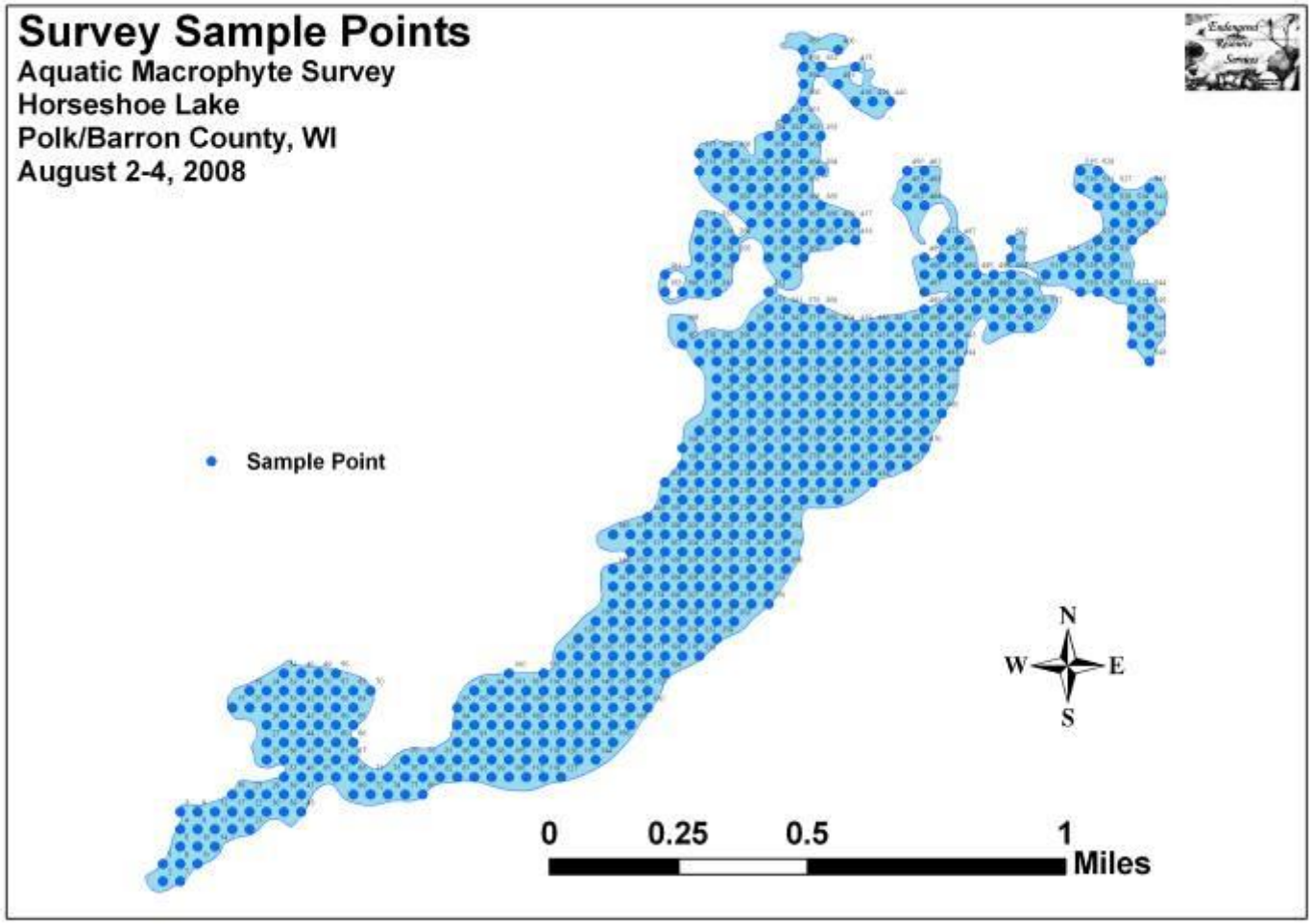
WDNR. [online]. 2008. Curly-leaf pondweed fact sheet. http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm (2008, September).

WDNR. [online]. 2008. Eurasian water milfoil fact sheet. http://www.dnr.state.wi.us/invasives/fact/milfoil.htm (2008, October).

WDNR. [online]. 2008. Purple loosestrife fact sheet. http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm (2008, October).

WDNR. [online]. 2008. Reed canary grass. http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm (2008, October).

Appendix I: Horseshoe Lake Map with Sample Points


Survey Sample Points
Aquatic Macrophyte Survey
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Sample Point
N
W
E
S
0
0.25
0.5
1
Miles

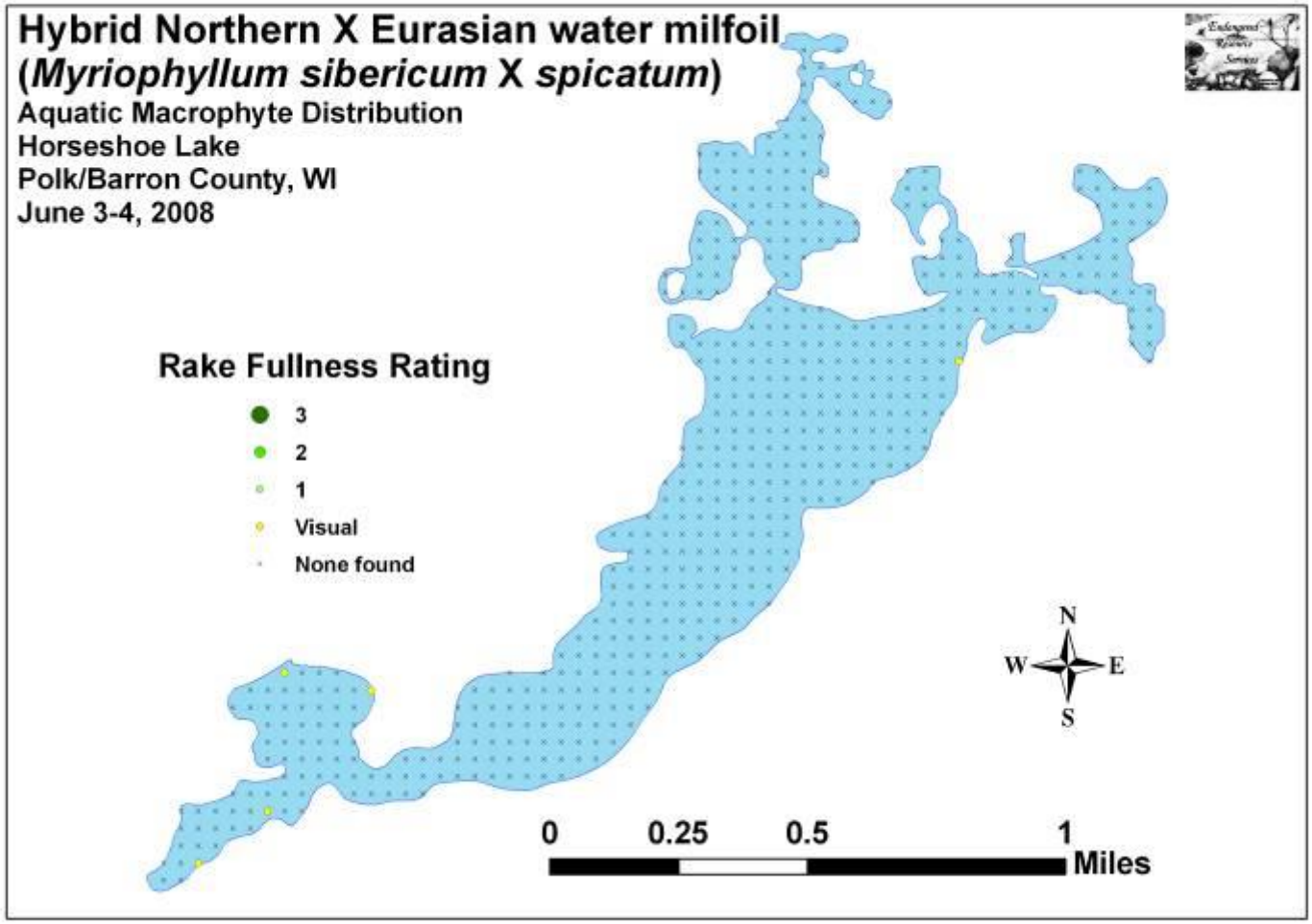
Appendix II: Boat Survey Data Sheet

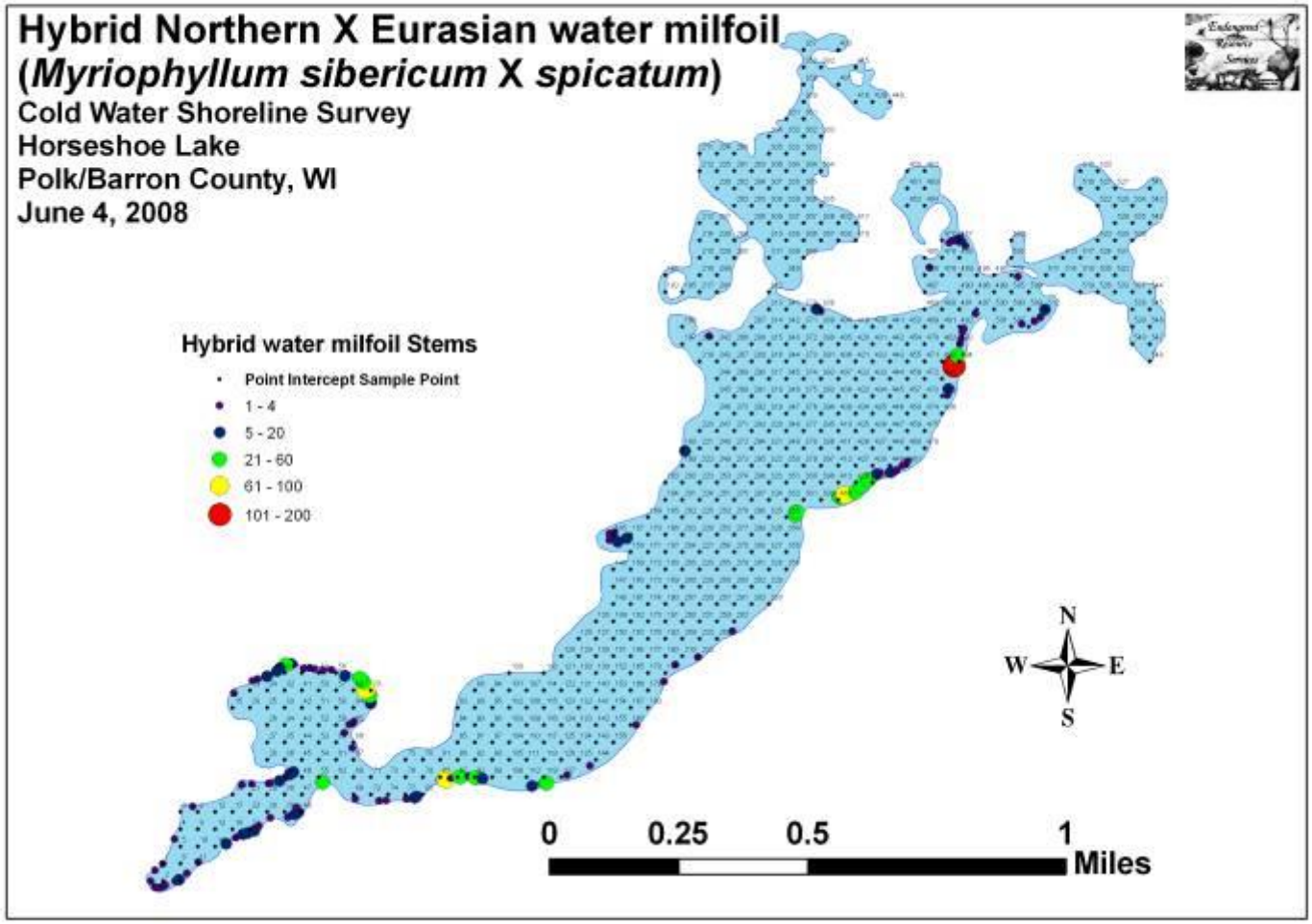
Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	**Species seen, habitat information**

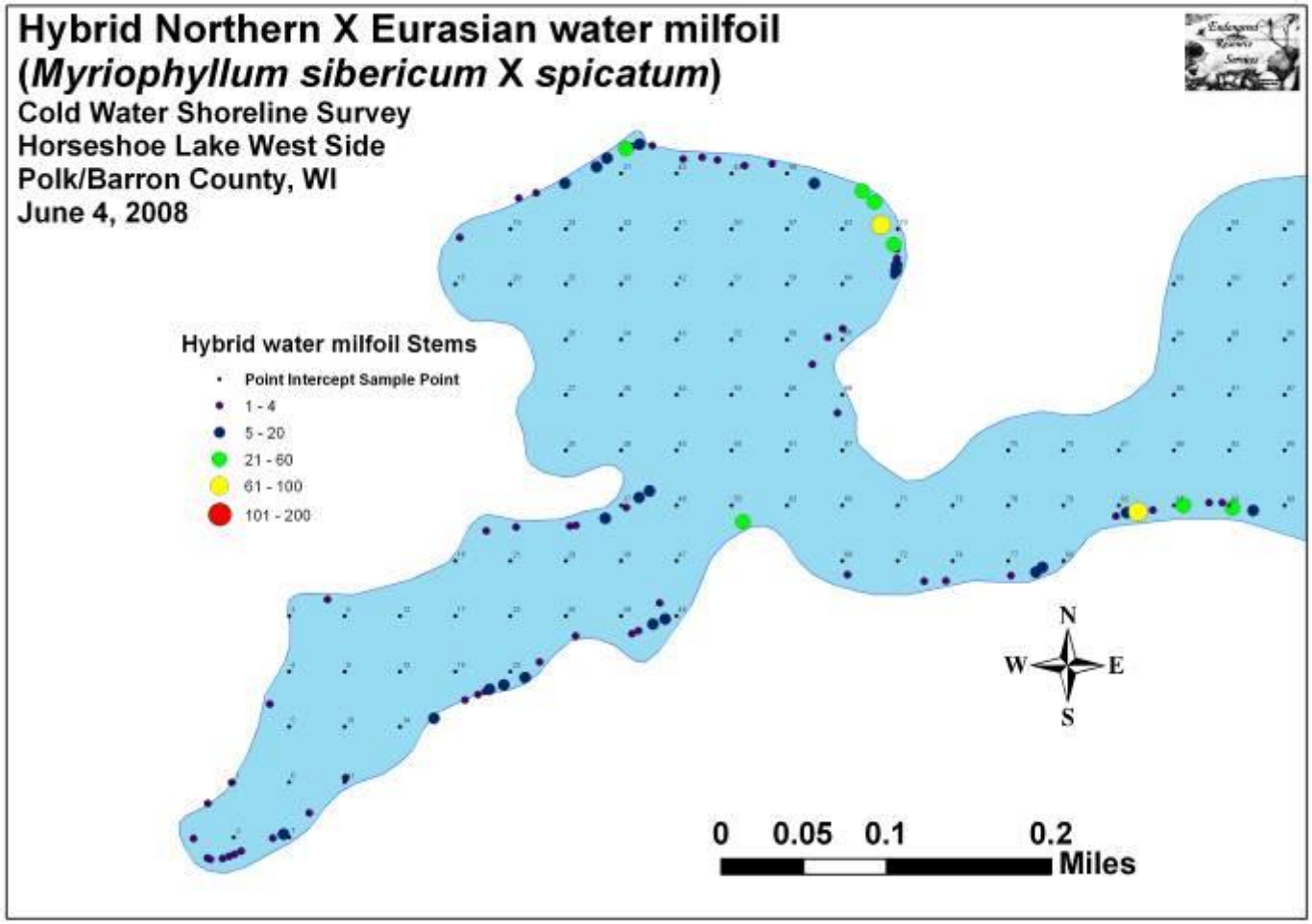
Appendix III: Vegetative Survey Data Sheet

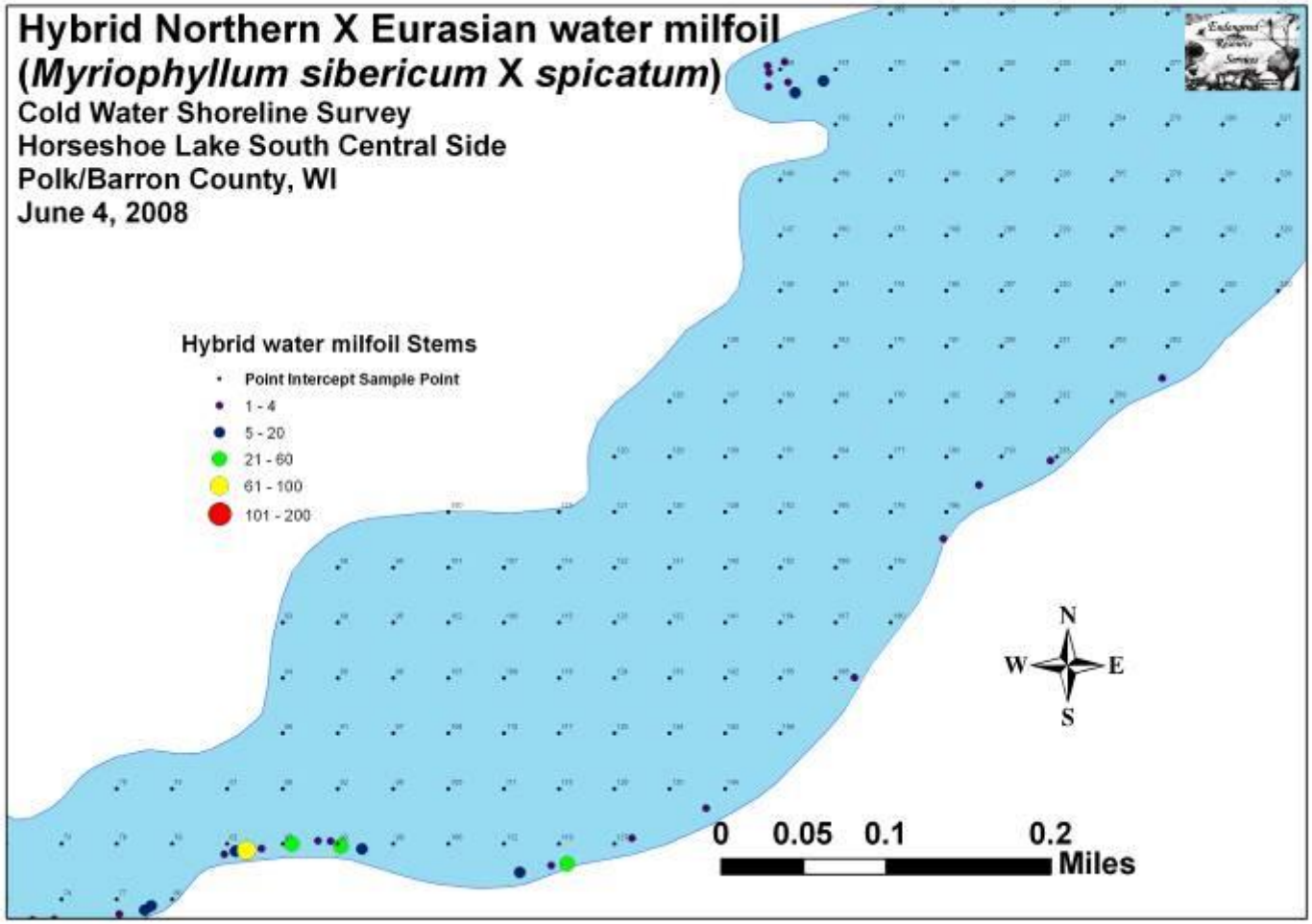
Observers for this lake: names and hours worked by each:																											
Lake:									WBIC									County						Date:		
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	HWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																									
2				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

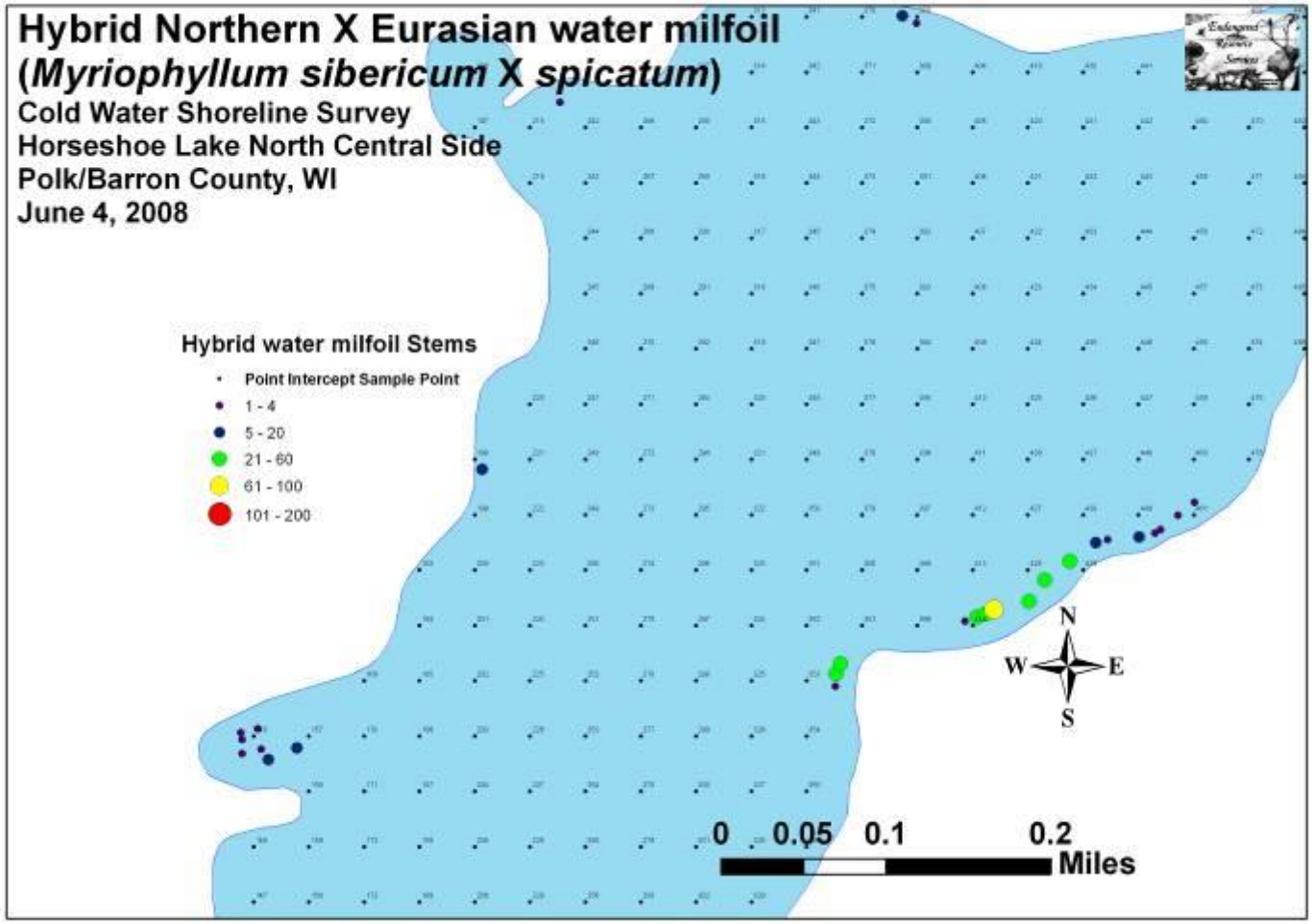
Appendix IV: June Cold Water and Shoreline Survey Maps

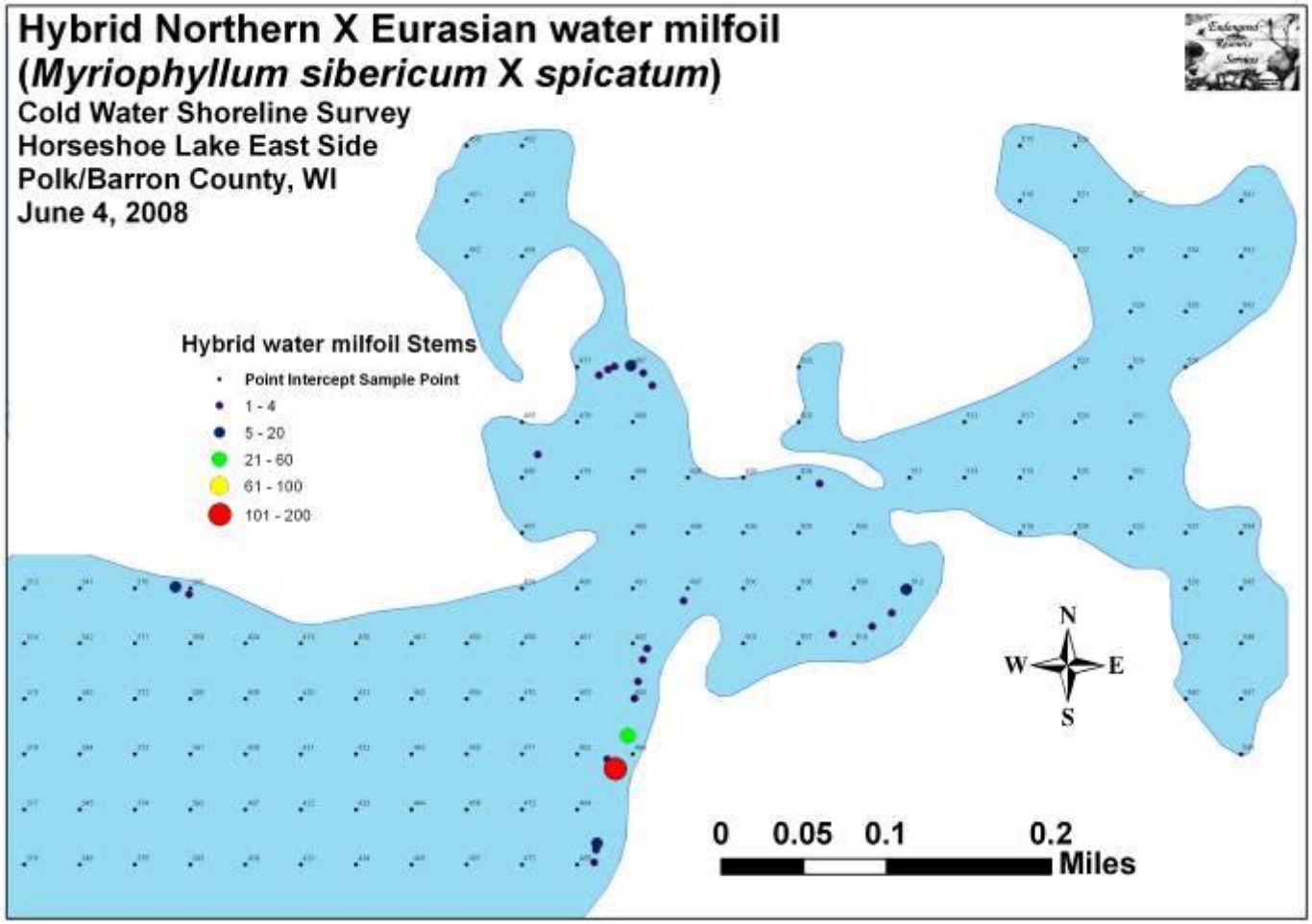

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
June 3-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Cold Water Shoreline Survey
Horseshoe Lake
Polk/Barron County, WI
June 4, 2008
Hybrid water milfoil Stems
Point Intercept Sample Point
1 - 4
5 - 20
21 - 60
61 - 100
101 - 200
N
W
E
S
0
0.25
0.5
1
Miles

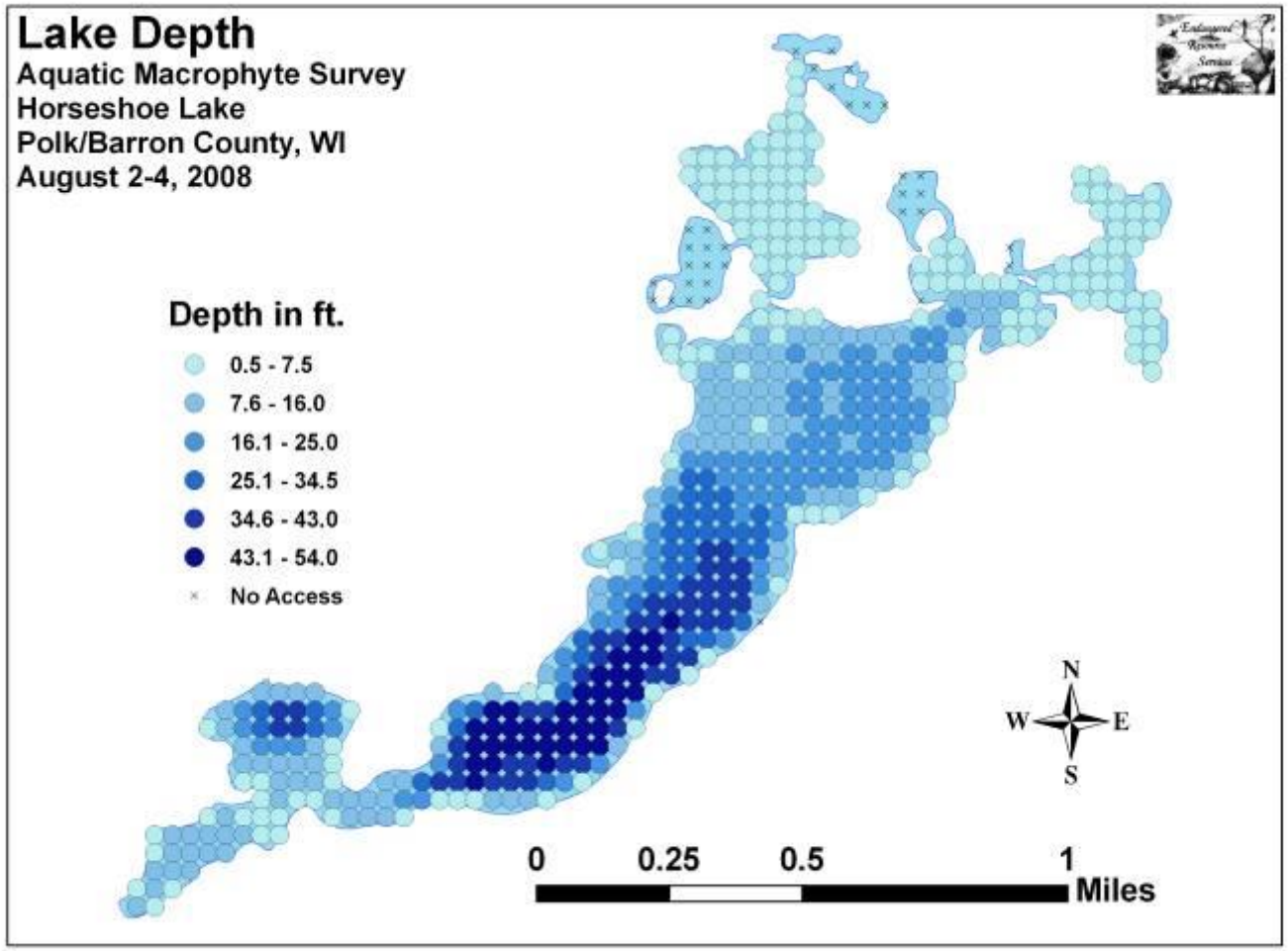

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Cold Water Shoreline Survey
Horseshoe Lake West Side
Polk/Barron County, WI
June 4, 2008
Hybrid water milfoil Stems
Point Intercept Sample Point
1 - 4
5 - 20
21 - 60
61 - 100
101 - 200
N
W
E
S
0 0.05 0.1 0.2
Miles

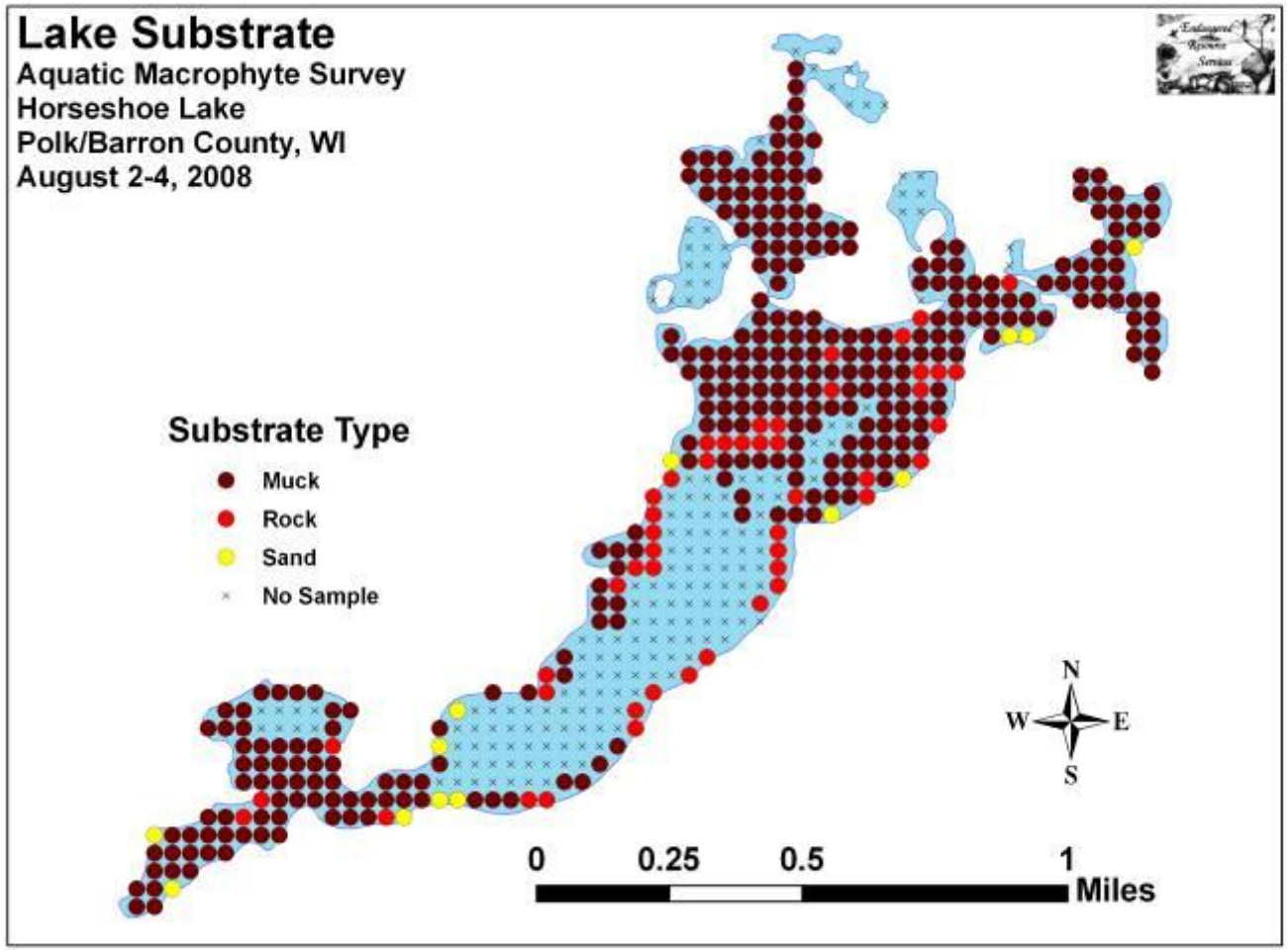

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Cold Water Shoreline Survey
Horseshoe Lake South Central Side
Polk/Barron County, WI
June 4, 2008
Hybrid water milfoil Stems
Point Intercept Sample Point
1 - 4
5 - 20
21 - 60
61 - 100
101 - 200
N
W
E
S
0 0.05 0.1 0.2
Miles

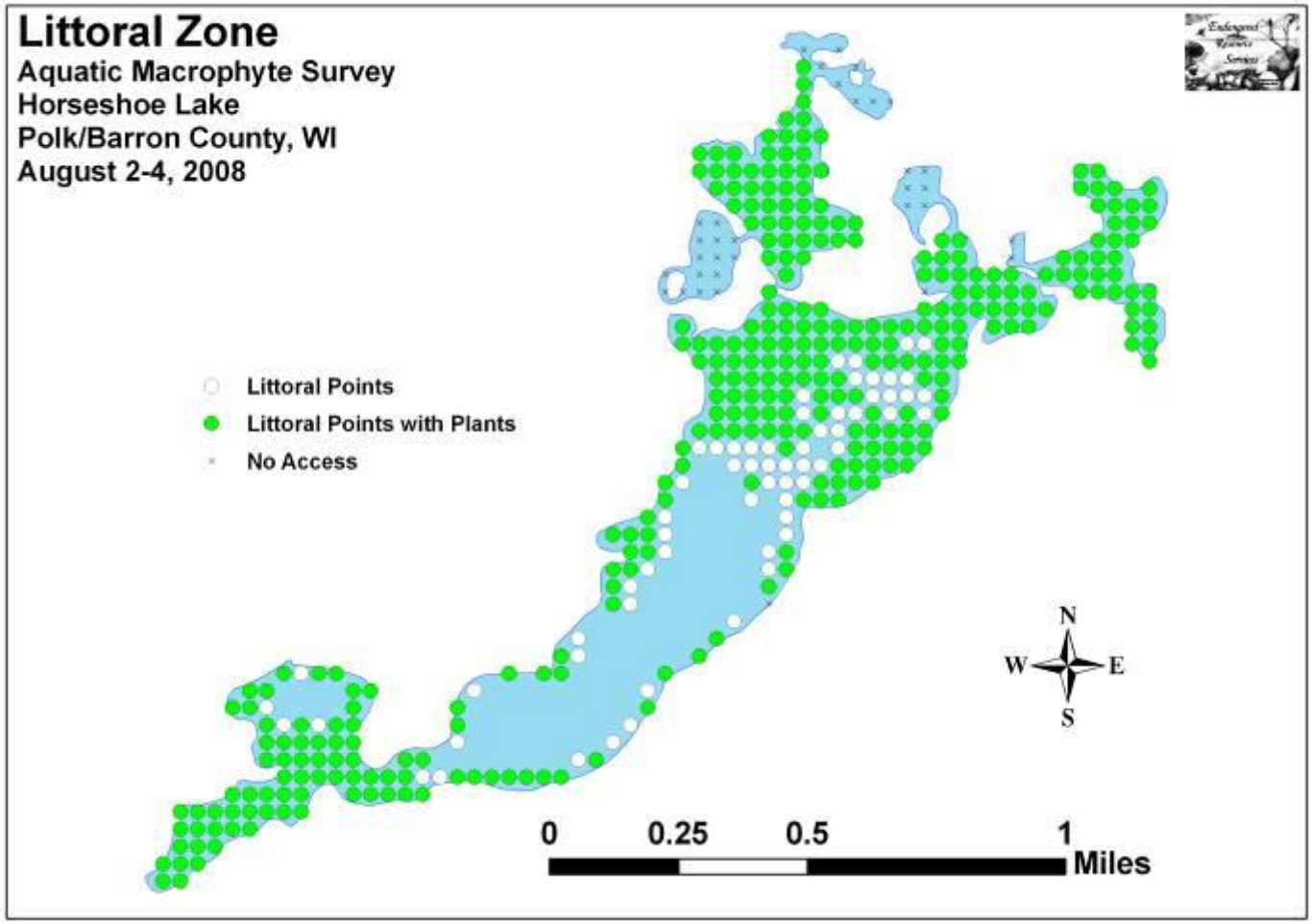

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Cold Water Shoreline Survey
Horseshoe Lake North Central Side
Polk/Barron County, WI
June 4, 2008
Hybrid water milfoil Stems
Point Intercept Sample Point
1 - 4
5 - 20
21 - 60
61 - 100
101 - 200
N
W
E
S
0 0.05 0.1 0.2
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Cold Water Shoreline Survey
Horseshoe Lake East Side
Polk/Barron County, WI
June 4, 2008
Hybrid water milfoil Stems
Point Intercept Sample Point
1 - 4
5 - 20
21 - 60
61 - 100
101 - 200
N
W
E
S
0 0.05 0.1 0.2
Miles

Appendix V: Habitat Variable Maps


Lake Depth
Aquatic Macrophyte Survey
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Depth in ft.
0.5 - 7.5
7.6 - 16.0
16.1 - 25.0
25.1 - 34.5
34.6 - 43.0
43.1 - 54.0
No Access
N
W
E
S
0
0.25
0.5
1
Miles


Lake Substrate
Aquatic Macrophyte Survey
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Substrate Type
Muck
Rock
Sand
No Sample
N
W
E
S
0
0.25
0.5
1
Miles


Littoral Zone
Aquatic Macrophyte Survey
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Littoral Points
Littoral Points with Plants
No Access
N
W
E
S
0
0.25
0.5
1
Miles

Appendix VI: Plant Species Accounts

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Alisma triviale*) **Water plantain**
Specimen Location: Horseshoe Lake; N45.44919°, W92.15656°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-300
Habitat/Distribution: Muck bottom at the shoreline. Rare with only a few individuals located in recently exposed muck just north of the bridge between the lakes.
Common Associates: (*Sagittaria latifolia*) Common arrowhead, (*Leersia oryzoides*) Rice cut-grass, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: Aquatic moss
Specimen Location: Horseshoe Lake; N45.43323°, W92.17804°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-301
Habitat/Distribution: Rocky and muck bottoms primarily in 4-7meters of water. Especially common in deep water at the edge of the littoral zone and in the east bay.
Common Associates: (*Nitella* sp.) Nitella, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton pusillus*) Small pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: Horseshoe Lake; N45.45022°, W92.15383°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-302
Habitat/Distribution: Muck and mucky sand bottom in 0-2 meters. Abundant in east muck bays and "Mud Lake".
Common Associates: (*Nymphaea odorata*) White water lily, (*Pontederia cordata*) Pickerelweed, (*Ceratophyllum demersum*) Coontail, (*Utricularia gibba*) Creeping bladderwort, (*Eleocharis robbinsii*) Robbins spikerush, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Najas gracillima*) Northern naiad, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Utricularia vulgaris*) Common bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Horseshoe Lake; N45.43223°, W92.17938°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-303
Habitat/Distribution: Muck bottom in 0-4m of water. Relatively common; especially in "Mud Lake".
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Brasenia schreberi*) Watershield, (*Nuphar variegata)* Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia vulgaris*) Common bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Ceratophyllum echinatum*) **Spiny hornwort**
Specimen Location: Horseshoe Lake; N45.45019°, W92.15521°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-304
Habitat/Distribution: Muck bottom in 0.5-1.5m. Rare; A few individual plants were found scattered throughout "Mud Lake".
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Utricularia gibba*) Creeping bladderwort, (*Ceratophyllum demersum*) Coontail

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: Horseshoe Lake; N45.43446°, W92.16428°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-305
Habitat/Distribution: Sand/rock/muck bottom areas in water from 1 – 5 meter deep. Uncommon in scattered locations in the central basin.
Common Associates: (*Potamogeton vaseyi*) Vasey's pondweed, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Vallisneria americana*) Wild celery, (*Elodea canadensis*) Common waterweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Myriophyllum sibiricum* X *spicatum*) Hybrid water milfoil

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Dulichium arundinaceum*) **Three-way sedge**
Specimen Location: Horseshoe Lake; N45.44919°, W92.15656°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-306
Habitat/Distribution: Located at the edge of the lake in mucky soil. Scattered locations in the east bays and around "Mud Lake".
Common Associates: (*Sagittaria latifolia*) Common arrowhead, (*Leersia oryzoides*) Rice cut-grass, *Lemna minor*) Small duckweed, (*Spirodela polyrhiza*) Large duckweed, (*Alisma triviale*) Water plantain**,** (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Elatine minima*) **Waterwort**
Specimen Location: Horseshoe Lake; N45.43320°, W92.17942°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-307
Habitat/Distribution: Rocky to sandy bottoms in 0-1.0m of water. Relatively common at scattered shoreline locations throughout
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Isoetes echinospora*) Spiny-spored quillwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Najas flexilis*) Bushy pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Eleocharis acicularis*) **Needle spikerush**
Specimen Location: Horseshoe Lake; N45.43446°, W92.16428°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-308
Habitat/Distribution: Rocky to sandy bottoms in 0-1.5m of water. Common throughout where it forms thick mats in shallow water. Emergent form located along shore interspersed among other emergents.
Common Associates: (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Isoetes echinospora*) Spiny-spored quillwort, (*Vallisneria americana*) Wild celery, (*Potamogeton vaseyi*) Vasey's pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Eleocharis ovata*) **Oval spikerush**
Specimen Location: Horseshoe Lake; N45.44718°, W92.15993°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-309
Habitat/Distribution: Located at the edge of the lake in mucky soil. Scattered locations along shore and on floating peat near the point.
Common Associates: (*Pontederia cordata*) Pickerelweed, (*Sagittaria latifolia*) Common arrowhead

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Eleocharis palustris*) **Creeping spikerush**
Specimen Location: Horseshoe Lake; N45.44889°, W92.14688°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-310
Habitat/Distribution: Rocky/sandy bottoms in 0-1 meter of water. Widely scattered reed beds primarily along exposed points.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Chara* sp.) Muskgrass, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Isoetes echinospora*) Spiny-spored quillwort, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Eleocharis robbinsii*) **Robbins spikerush**
Specimen Location: Horseshoe Lake; N45.45022°, W92.15383°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-311
Habitat/Distribution: Muck bottoms in 0-1 meter of water. Common to abundant in the north end of the east bay, and in scattered locations in "Mud Lake".
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Pontederia cordata*) Pickerelweed, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Najas gracillima*) Northern naiad, (*Utricularia vulgaris*) Common bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Horseshoe Lake; N45.43272°, W92.17940°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-312
Habitat/Distribution: Sandy/muck bottom in 0-5 meters of water. Abundant and widely distributed throughout.
Common Associates: (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Ceratophyllum demersum*) Coontail, (*Nitella* sp.) Nitella, Aquatic moss, (*Potamogeton pusillus*) Small pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Eriocaulon aquaticum*) **Pipewort**
Specimen Location: Horseshoe Lake; N45.43446°, W92.16428°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-313
Habitat/Distribution: Sandy to rocky bottoms in water < 1 meter deep to emergent on shore. Uncommon in scattered locations throughout.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Isoetes echinospora*) Spiny-spored quillwort, (*Vallisneria americana*) Wild celery, (*Potamogeton vaseyi*) Vasey's pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Horseshoe Lake; N45.44033°, W92.16243°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-314
Habitat/Distribution: Sandy to rocky bottoms in water < 2m. Uncommon and widely scattered throughout.
Common Associates: (*Myriophyllum sibiricum* X *spicatum*) Hybrid water milfoil, (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Elatine minima*) Waterwort, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Isoetes echinospora*) **Spiny-spored quillwort**
Specimen Location: Horseshoe Lake; N45.43446°, W92.16428°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-315
Habitat/Distribution: Rocky to sandy bottoms in 0-1.5 meters of water. Uncommon in widely scattered locations throughout.
Common Associates: (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Juncus effusus*) **Common rush**
Specimen Location: Horseshoe Lake; N45.44150°, W92.16265°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-316
Habitat/Distribution: Mucky sand bottoms at the shoreline. A single bed was located along a small spring/seep at the edge of the lake.
Common Associates: (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Juncus pelocarpus*) **Brown-fruited rush**
Specimen Location: Horseshoe Lake; N45.44397°, W92.15014°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-317
Habitat/Distribution: Rocky to sandy bottoms in 0-1.5 meters of water. Uncommon in scattered location throughout. Emergent form located along shore interspersed among other emergents.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Leersia oryzoides*) **Rice cut-grass**
Specimen Location: Horseshoe Lake; N45.44919°, W92.15656°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-318
Habitat/Distribution: Located at the edge of the lake in mucky soil, and in water <.5m deep. Scattered locations in the east bay and "Mud Lake".
Common Associates: (*Sagittaria latifolia*) Common arrowhead, (*Alisma triviale*) Water plantain**,** (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Horseshoe Lake; N45.45116°, W92.15524°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-319
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Almost exclusively located in "Mud Lake". Scattered individuals were interspersed between the lilypads.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Spirodela polyrhiza*) Large duckweed, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia vulgaris*) Common bladderwort, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Lythrum salicaria*) **Purple Loosestrife**
Specimen Location: Horseshoe Lake; N45.44822°, W92.15652°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-320
Habitat/Distribution: Muck bottom in water up to .5 meters in depth. A few widely scattered plants were located throughout the lake. **A concerted effort could quickly eliminate this exotic invasive from the lakeshore.**
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Myriophyllum farwellii*) **Farwell's water milfoil**
Specimen Location: Horseshoe Lake; N45.45093°, W92.14143°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-321
Habitat/Distribution: Muck bottom in water up to 1.5m. Scattered individuals and small beds in sheltered locations of several of the eastern bays.
Common Associates: (*Najas gracillima*) Northern naiad, (*Schoenoplectus subterminalis*) Water bulrush, (*Nymphaea odorata*) White water lily, (*Pontederia cordata*) Pickerelweed, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Utricularia gibba*) Creeping bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Myriophyllum sibiricum* X *spicatum*) **Hybrid water milfoil**
Specimen Location: Horseshoe Lake; N45.43446°, W92.16428°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-322
Habitat/Distribution: Found in almost any bottom type in 0-2.5m of water. Widespread and increasing in abundance throughout.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Myriophyllum tenellum*) **Dwarf water milfoil**
Specimen Location: Horseshoe Lake; N45.44889°, W92.14688°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-323
Habitat/Distribution: Preferred stable sand or rocky bottoms in 0-1 meter of water. Relatively common throughout; especially around the central basin.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Vallisneria americana*) Wild celery**,** (*Chara* sp.) Muskgrass

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Myriophyllum verticillatum*) **Whorled water milfoil**
Specimen Location: Horseshoe Lake; N45.45019°, W92.15521°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-324
Habitat/Distribution: Thick organic muck in 0.5-1.5m of water. Restricted to a few widely scattered individuals in "Mud Lake".
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Utricularia vulgaris*) Common bladderwort, (*Nymphaea odorata*) White water lily, (*Sparganium emersum*) Narrow-leaf bur-reed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Najas flexilis*) **Bushy pondweed**
Specimen Location: Horseshoe Lake; N45.44704°, W92.14197°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-325
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-1.5 meters of water. Uncommon but widely distributed; especially around the main basin.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton vaseyi*) Vasey's pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Najas gracillima*) **Northern naiad**
Specimen Location: Horseshoe Lake; N45.45045°, W92.14141°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-326
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-3 meters of water. Scattered locations in the eastern ½ of the lake. Becomes abundant in the east bay. Microscopic analysis of seeds used to confirm sp. id.
Common Associates: (*Brasenia schreberi*) Watershield, (*Pontederia cordata*) Pickerelweed, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Ceratophyllum demersum*) Coontail, (*Utricularia gibba*) Creeping bladderwort, (*Spirodela polyrhiza*) Large duckweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Nitella* sp.) **Nitella**
Specimen Location: Horseshoe Lake; N45.43323°, W92.17804°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-327
Habitat/Distribution: Sand/silt/muck bottom areas in water from 0 – 7 meter deep. Widespread; the dominant species at the edge of the littoral zone where if forms dense underwater tangles.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, Aquatic moss

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Nuphar variegata)* **Spatterdock**
Specimen Location: Horseshoe Lake; N45.45045°, W92.14141°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-328
Habitat/Distribution: Muck bottom in 0-1.5 meters of water where it often forms dense canopies. Relatively common in sheltered areas of the east bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Pontederia cordata*) Pickerelweed, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Ceratophyllum demersum*) Coontail, (*Najas gracillima*) Northern naiad

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Horseshoe Lake; N45.44670°, W92.15991°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-329
Habitat/Distribution: Muck bottom in 0-2 meters where it forms dense canopies with other floating leaf species. Common in sheltered bays, and "Mud Lake".
Common Associates: (*Brasenia schreberi*) Watershield, (*Pontederia cordata*) Pickerelweed, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Ceratophyllum demersum*) Coontail, (*Lemna minor*) Small duckweed, (*Utricularia gibba*) Creeping bladderwort, (*Spirodela polyrhiza*) Large duckweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Horseshoe Lake; N45.44922°, W92.15517°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-330
Habitat/Distribution: Firm to mucky bottom in 0-0.5 meters of water. Scattered undeveloped shore locations. It is more common away from the lake in some of the adjacent marshes.
Common Associates: Generally, this species exists in patches at the exclusion of other species. (*Sagittaria latifolia*) Common arrowhead, (*Typha latifolia*) Broad-leaved cattail, (*Pontederia cordata*) Pickerelweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Pontederia cordata*) **Pickerelweed**
Specimen Location: Horseshoe Lake; N45.44670°, W92.15991°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-331
Habitat/Distribution: Silt to muck bottom over firm substrate in 0-1.5 meters of water. Common in emergent beds throughout; especially in sheltered bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Sagittaria latifolia*) Common arrowhead, (*Typha latifolia*) Broad-leaved cattail, (*Dulichium arundinaceum*) Three-way sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Horseshoe Lake; N45.43272°, W92.17940°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-332
Habitat/Distribution: Variable substrate bottoms in 0.5-1.5m of water. Most common in areas that had some, but not thick muck. Fairly common in mixed species beds throughout.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Ceratophyllum demersum*) Coontail, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton bicupulatus*) **Filament-leaf pondweed**
Specimen Location: Horseshoe Lake; N45.44704°, W92.14197°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-333
Habitat/Distribution: Found in sandy bottom conditions in shallow water 0-1.0m. Relatively common throughout. This state species of Special Concern is sensitive to disturbance and pollution.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Najas flexilis*) Bushy pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: Horseshoe Lake; N45.45045°, W92.14141°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-334
Habitat/Distribution: Found in sandy muck bottom conditions in shallow water 0.5-1.5m deep. Relatively common throughout.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton pusillus*) Small pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton illinoensis*) **Illinois pondweed**
Specimen Location: Horseshoe Lake; N45.44691°, W92.14887°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-335
Habitat/Distribution: Found in sandy/muck bottom conditions in 1.0-1.5m deep water. Rare in mixed species beds, but several expansive beds of almost pure Illinois occurred in bays on the eastern end of the lake.
Common Associates: (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Utricularia gibba*) Creeping bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Horseshoe Lake; N45.43176°, W92.17867°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-336
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0-6 meters of water. Normally the deepest growing vascular plant. Relatively common and widely distributed; especially on the edge of the drop-off where it can form dense monospecific underwater "forests".
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Nitella* sp.) Nitella, Aquatic moss

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Horseshoe Lake; N45.44691°, W92.14887°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-337
Habitat/Distribution: Found in sandy/muck bottom conditions in 0-3m deep water. Relatively common throughout.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Vallisneria americana*) Wild celery, (*Elatine minima*) Waterwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton robbinsii*) **Robbins (fern) pondweed**
Specimen Location: Horseshoe Lake; N45.43272°, W92.17940°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-338
Habitat/Distribution: Can grow in variable substrate bottoms, but becomes dominant to the point of excluding all other species in its preferred substrate of organic muck. Abundant throughout - Grows in 0-5 meters of water, but prefers 2.5-3m.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Ceratophyllum demersum*) Coontail, (*Nitella* sp.) Nitella, Aquatic moss, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton spirillus*) **Spiral-fruited pondweed**
Specimen Location: Horseshoe Lake; N45.43320°, W92.17942°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-339
Habitat/Distribution: Common in sand bottoms in 0-4.5 meters of water. Widely distributed throughout. It is the dominant plant in many shoreline locations. Its coiled seeds/curved leaves and elliptical floating leaves separate it from other fine leaved species.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton vaseyi*) Vasey's pondweed, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton vaseyi*) **Vasey's pondweed**
Specimen Location: Horseshoe Lake; N45.43272°, W92.17940°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-340
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-2.5 meters of water. Common, and widely distributed throughout. Its small floating leaves and uncoiled seed help separate it from other fine-leaved species.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton pusillus*) Small pondweed, (*Vallisneria americana*) Wild celery

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Horseshoe Lake; N45.43176°, W92.17867°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-341
Habitat/Distribution: It prefers thick organic muck substrate. Widely distributed and common in stagnant bays; Normally in 0-2.5m of water.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Lemna minor*) Small duckweed, (*Utricularia gibba*) Creeping bladderwort, (*Spirodela polyrhiza*) Large duckweed, (*Utricularia vulgaris*) Common bladderwort

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Riccia fluitans*) **Slender riccia**
Specimen Location: Horseshoe Lake; N45.45116°, W92.15524°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-342
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Located exclusively in "Mud Lake". Scattered individuals were interspersed between Watershield and lilypads with "duckweeds".
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Lemna minor*) Small duckweed, (*Pontederia cordata*) Pickerelweed, (*Spirodela polyrhiza*) Large duckweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: Horseshoe Lake; N45.44670°, W92.15991°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-343
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Located throughout, but especially common at the shoreline around eastern bays and around "Mud Lake".
Common Associates: (*Nymphaea odorata*) White water lily, (*Phalaris arundinacea*) Reed canary grass, (*Typha latifolia*) Broad-leaved cattail, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Sagittaria rigida*) **Sessile-fruited arrowhead**
Specimen Location: Horseshoe Lake; N45.44945°, W92.14275°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-344
Habitat/Distribution: Submergent form was rare over sand and rock bottom areas while the emergent form was more common in muck bottom areas. Submergent to 4m; emergent 0-0.5m of water. Uncommon, but widely distributed throughout.
Common Associates: (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Leersia oryzoides*) Rice cut-grass, (*Potamogeton vaseyi*) Vasey's pondweed, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Filament-leaf pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Schoenoplectus purshianus*) **Pursh's bulrush**
Specimen Location: Horseshoe Lake; N45.45110°, W92.15870°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-345
Habitat/Distribution: Muck soil at the water's edge. A very few individuals were seen on floating peat and at the shoreline in "Mud Lake".
Common Associates: (*Pontederia cordata*) Pickerelweed, (*Sagittaria latifolia*) Common arrowhead, (*Eleocharis robbinsii*) Robbins spikerush

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Schoenoplectus subterminalis*) **Water bulrush**
Specimen Location: Horseshoe Lake; N45.45093°, W92.14143°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-346
Habitat/Distribution: Muck bottom in 0-1.5m of water. Restricted to the east bay; especially near the channel entrance to the bay.
Common Associates: (*Nymphaea odorata*) White water lily, (*Pontederia cordata*) Pickerelweed, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Najas gracillima*) Northern naiad, (*Myriophyllum farwellii*) Farwell's water milfoil

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Horseshoe Lake; N45.44922°, W92.15517°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-347
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Located throughout, but especially common at the shoreline around eastern bays and around "Mud Lake".
Common Associates: (*Nymphaea odorata*) White water lily, (*Phalaris arundinacea*) Reed canary grass, (*Typha latifolia*) Broad-leaved cattail, (*Pontederia cordata*) Pickerelweed, (*Sagittaria latifolia*) Common arrowhead

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Sparganium chlorocarpum*) **Short-stemmed bur-reed**
Specimen Location: Horseshoe Lake; N45.44670°, W92.15991°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-348
Habitat/Distribution: Uncommon over firm muck in water <1m. A large bed of plants was located along the shore at the point. The distinct fan shape leaves made for easy identification.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Pontederia cordata*) Pickerelweed, (*Sagittaria latifolia*) Common arrowhead
*ID based on Voss, and Borman et al. Other authors consider this taxon synonymous with *emersum*. Dr. Freckmann determined it is an emergent growth habit of emersum. Because of this, it was not figured in the FQI.

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Sparganium emersum*) **Narrow-leaved bur-reed**
Specimen Location: Horseshoe Lake; N45.45022°, W92.15383°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-349
Habitat/Distribution: Rare - found in a few locations in "Mud Lake". Plants were in still areas over muck in water <1m.
Common Associates: (*Eleocharis robbinsii*) Robbins spikerush, (*Utricularia vulgaris*) Common bladderwort, (*Brasenia schreberi*) Watershield, (*Utricularia gibba*) Creeping bladderwort, (*Myriophyllum verticillatum*) Whorled water-milfoil, (*Pontederia cordata*) Pickerelweed
*ID based on Crowe and Hellquist. Other authors consider this taxon synonymous with *Sparg. chlorocarpum*. It has many fewer leaves (erect and floating) but is simply an aquatic growth habit of *chlorocarpum*.

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Spirodela polyrhiza*) **Large duckweed**
Specimen Location: Horseshoe Lake; N45.45116°, W92.15524°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-350
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Restricted to north-central bay and "Mud Lake". Uncommon; scattered individuals occur interspersed between the lilypads.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Lemna minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia vulgaris*) Common bladderwort, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/4/08
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Horseshoe Lake; N45.44150°, W92.16265°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-351
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Scattered undeveloped shoreline locations; especially common along the shoreline of "Mud Lake" where it formed dense.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Dulichium arundinaceum*) Three-way sedge

County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Utricularia gibba*) **Creeping bladderwort**
Specimen Location: Horseshoe Lake; N45.45019°, W92.15521°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-352
Habitat/Distribution: Stagnant tannic (brown) water 0-2m deep. Common in the east bays and in "Mud Lake" where it was found floating in tangled clumps among floating leaf species over thick organic muck.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Lemna minor*) Small duckweed, (*Spirodela polyrhiza*) Large duckweed, (*Pontederia cordata*) Pickerelweed, (*Ceratophyllum demersum*) Coontail

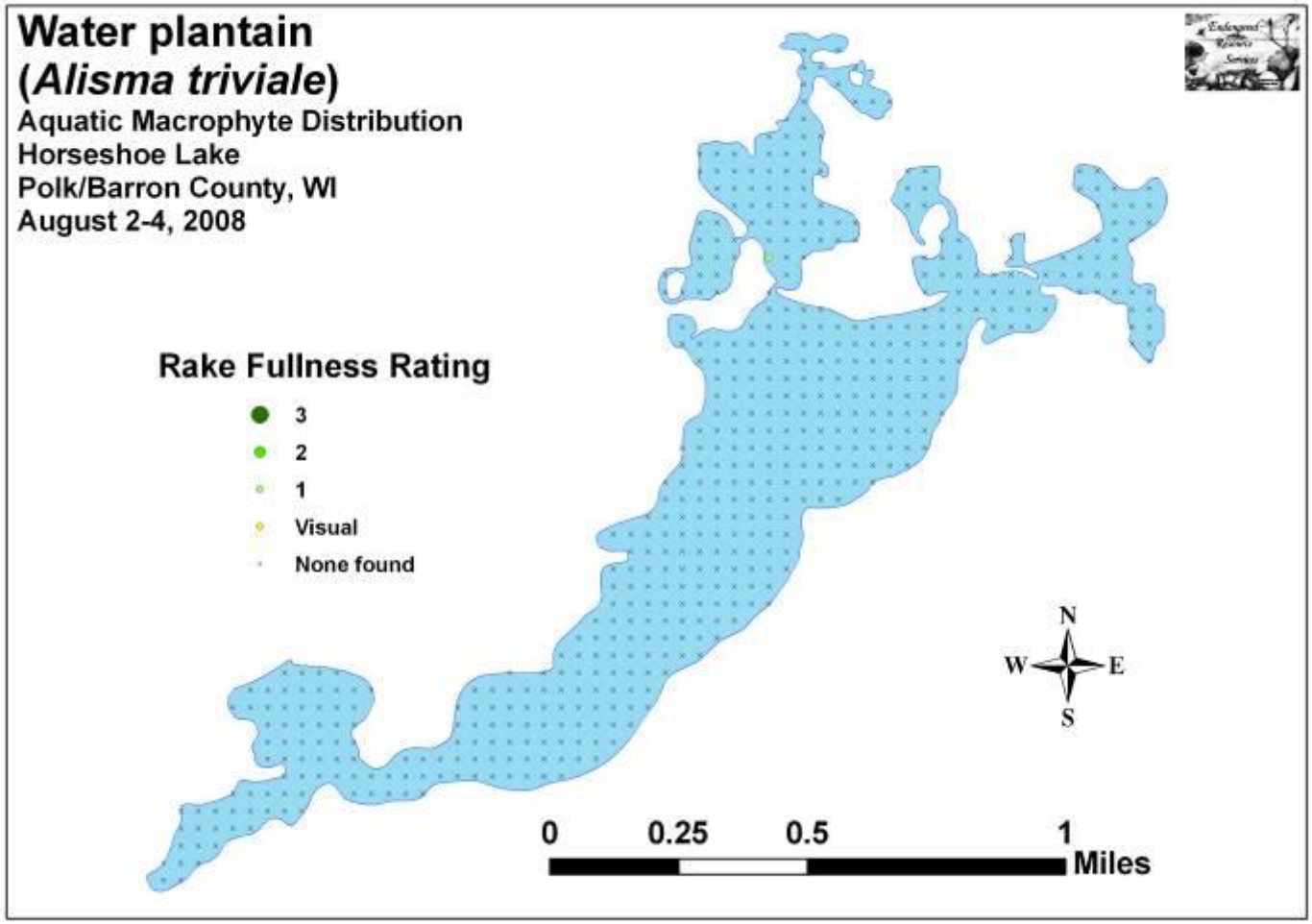
County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Utricularia intermedia*) **Flat-leaf bladderwort**
Specimen Location: Horseshoe Lake; N45.45093°, W92.14143°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-353
Habitat/Distribution: Stagnant tannic (brown) water 0-2m deep. Common in the east bays where it was found with other bladderwort species over thick organic muck.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Lemna minor*) Small duckweed, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail (*Utricularia gibba*) Creeping bladderwort, (*Eleocharis robbinsii*) Robbins spikerush

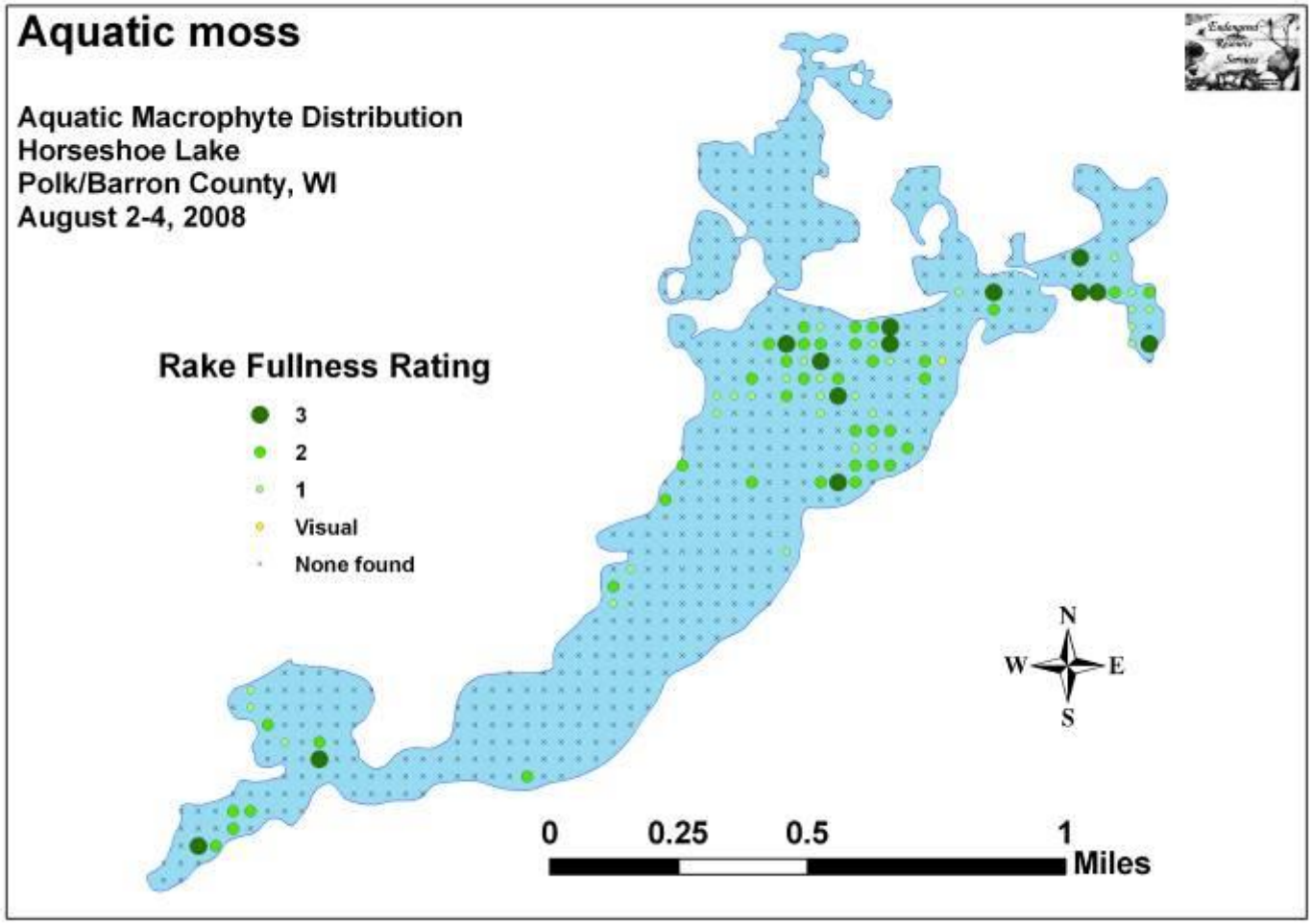
County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Horseshoe Lake; N45.44718°, W92.15993°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-354
Habitat/Distribution: Stagnant tannic (brown) water 0-2m deep. Common in the east bays and in "Mud Lake" where it was found with other bladderwort species over thick organic muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Lemna minor*) Small duckweed, (*Spirodela polyrhiza*) Large duckweed, (*Pontederia cordata*) Pickerelweed, (*Ceratophyllum demersum*) Coontail (*Utricularia gibba*) Creeping bladderwort, (*Eleocharis robbinsii*) Robbins spikerush, (*Utricularia intermedia*) Flat-leaf bladderwort

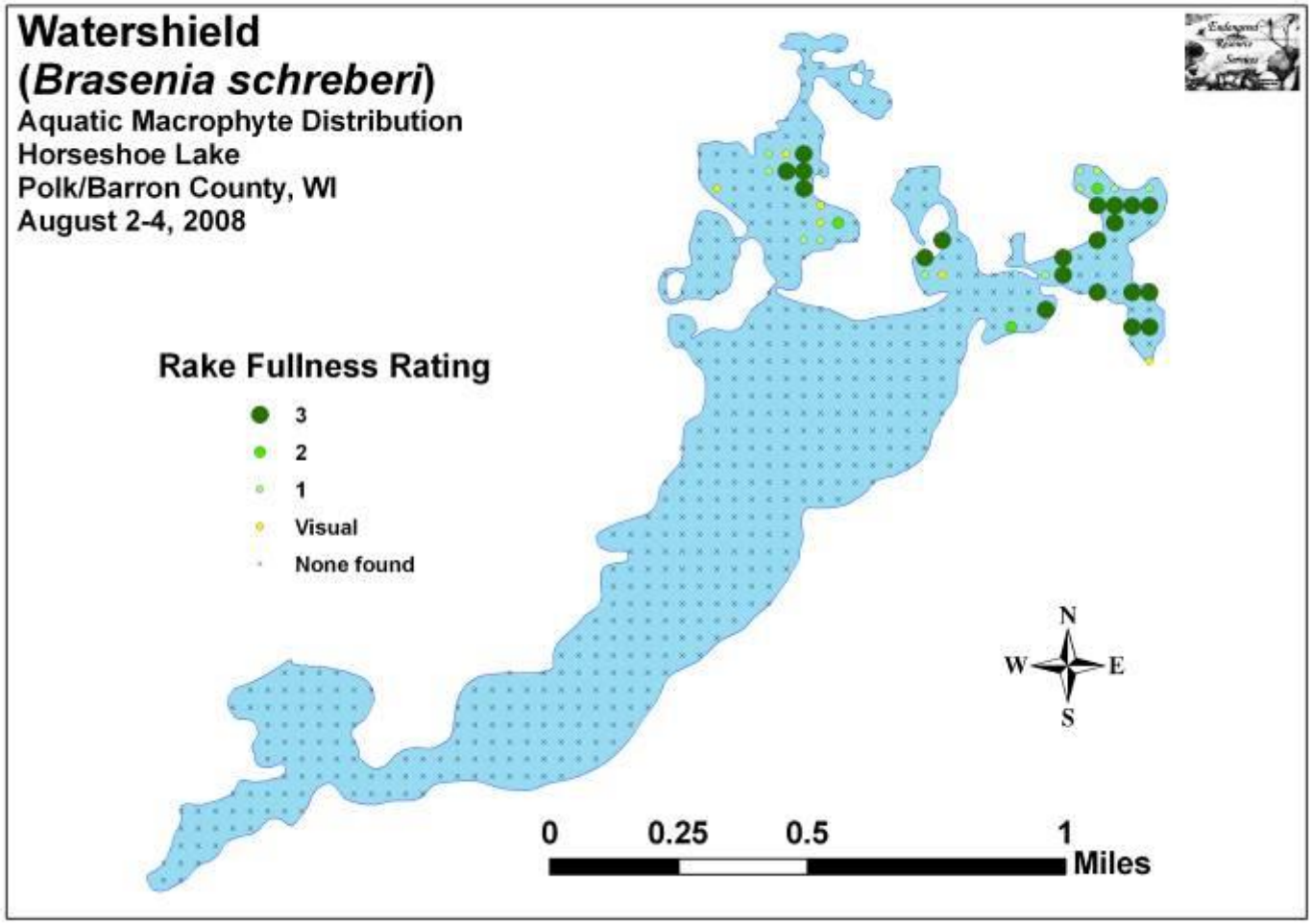
County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Horseshoe Lake; N45.43176°, W92.17867°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-355
Habitat/Distribution: Found in almost any bottom conditions, but grows best in sandy to sand/muck bottoms in 0.5-2m. Common and widely distributed throughout except in eastern bays.
Common Associates: (*Myriophyllum sibiricum* X *spicatum*) Hybrid water milfoil, (*Elodea canadensis*) Common waterweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton robbinsii*) Robbins (fern) pondweed, (*Potamogeton vaseyi*) Vasey's pondweed, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort

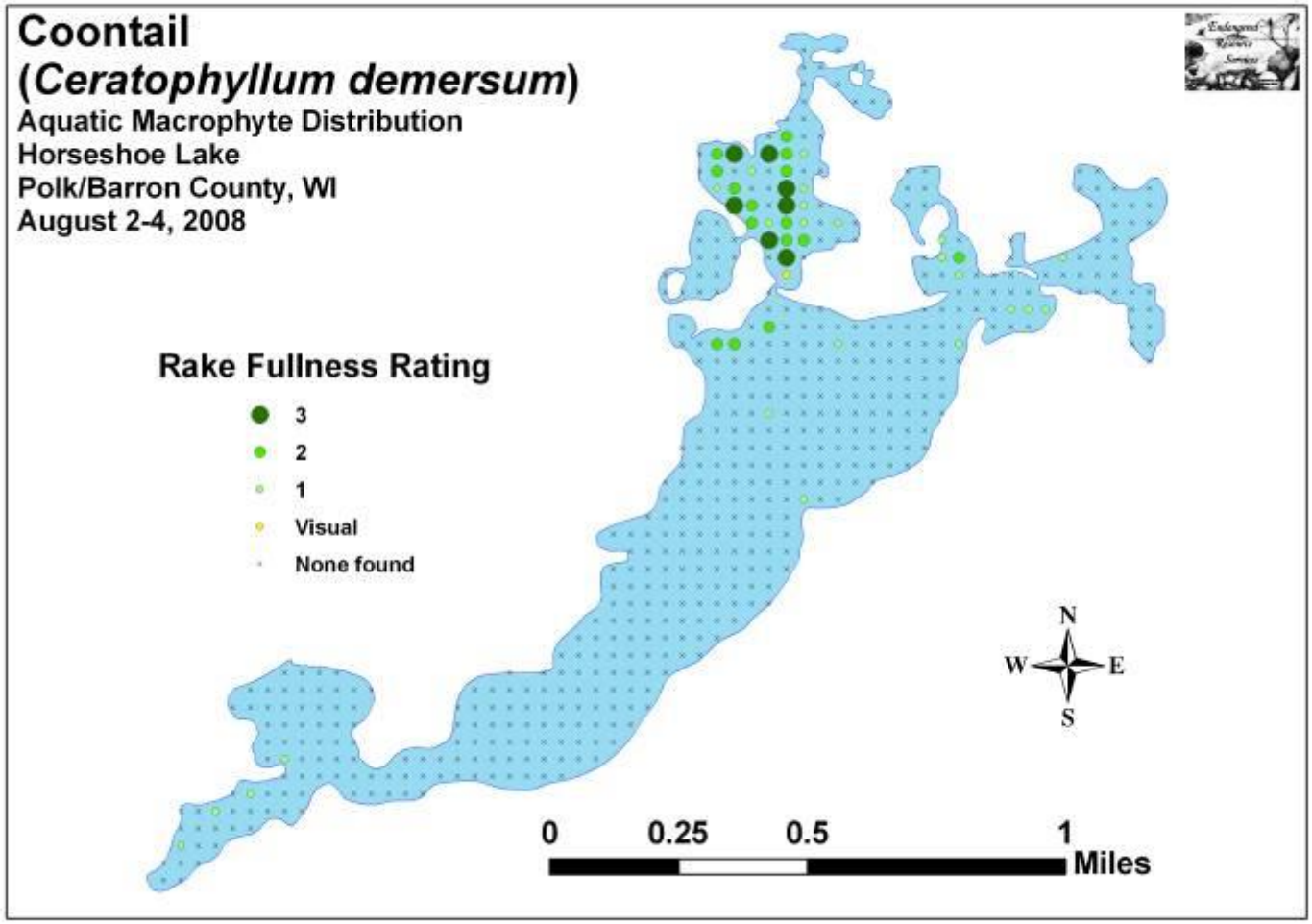
County/State: Polk/Barron Counties, Wisconsin **Date:** 8/3/08
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed hybrid? – small morph**
Specimen Location: Horseshoe Lake; N45.44848°, W92.14272°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-356
Habitat/Distribution: Several beds of this short, morphologically distinct "*amplifolius*" were collected in the south bay of the far east end of the lake. It is a possible *Potamogeton* hybrid between *amplifolius* and *illinoensis* or *gramineus* (Freckmann personal communication). In addition to its small size, the floating leaves seemed more linear than typical *amplifolius*, but the underwater leaves had the characteristic "crescent moon" shape. Ted Cochrane (UW-Madison) and Bill Smith (WDNR) collected Horseshoe in the 1970's. Dr. Cochrane reported Spotted pondweed (*Potamogeton pulcher*) from the lake. Mr. Smith did a follow up collection and reported that it was not in fact *pulcher*. He added that after reexamining the specimens, Dr. Cochrane changed his original determination of *pulcher* back to *amplifolius* (Smith, personal communication). We feel this specimen is likely what they were looking at.

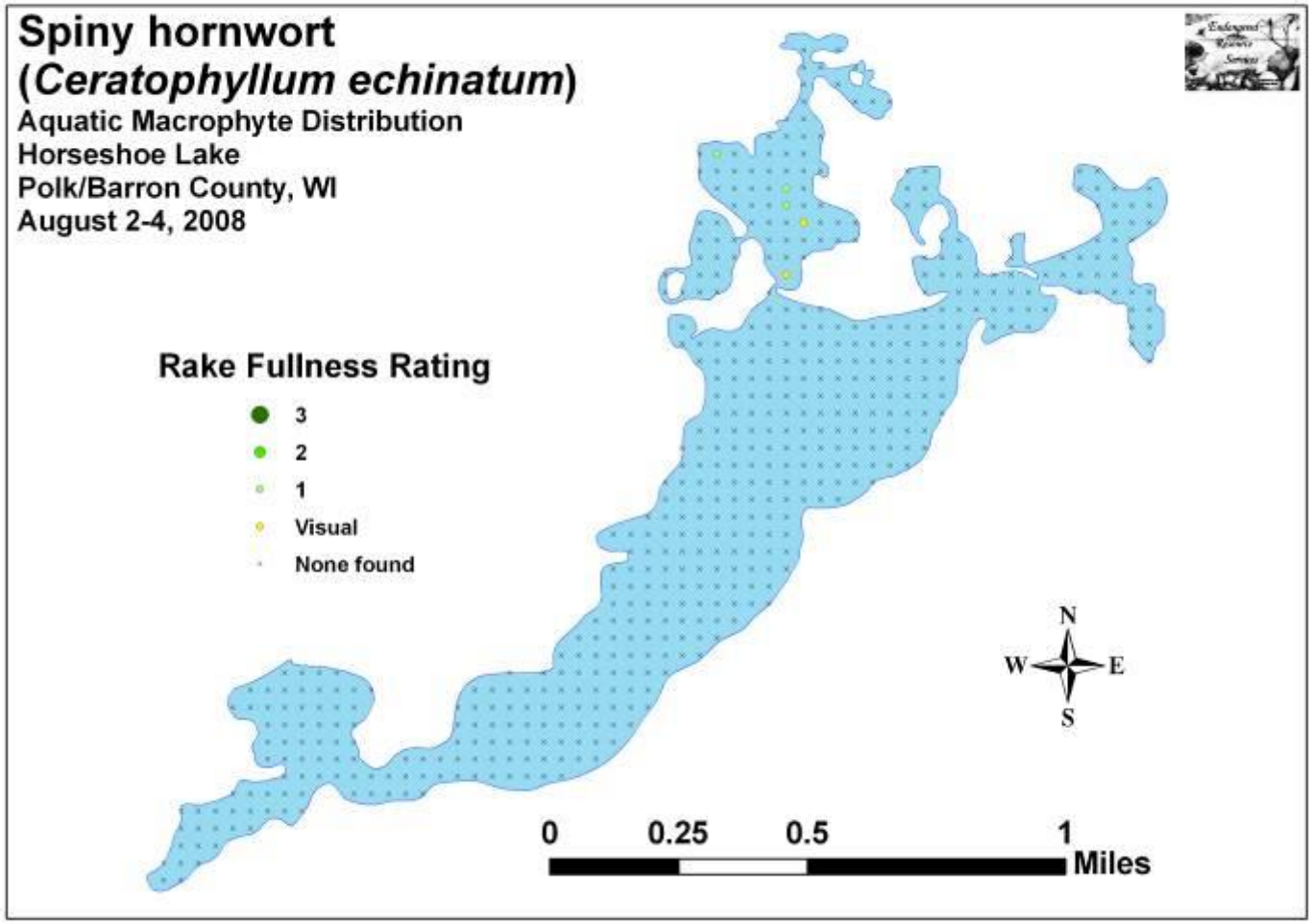
Appendix VII: Point Intercept Plant Species Distribution Maps

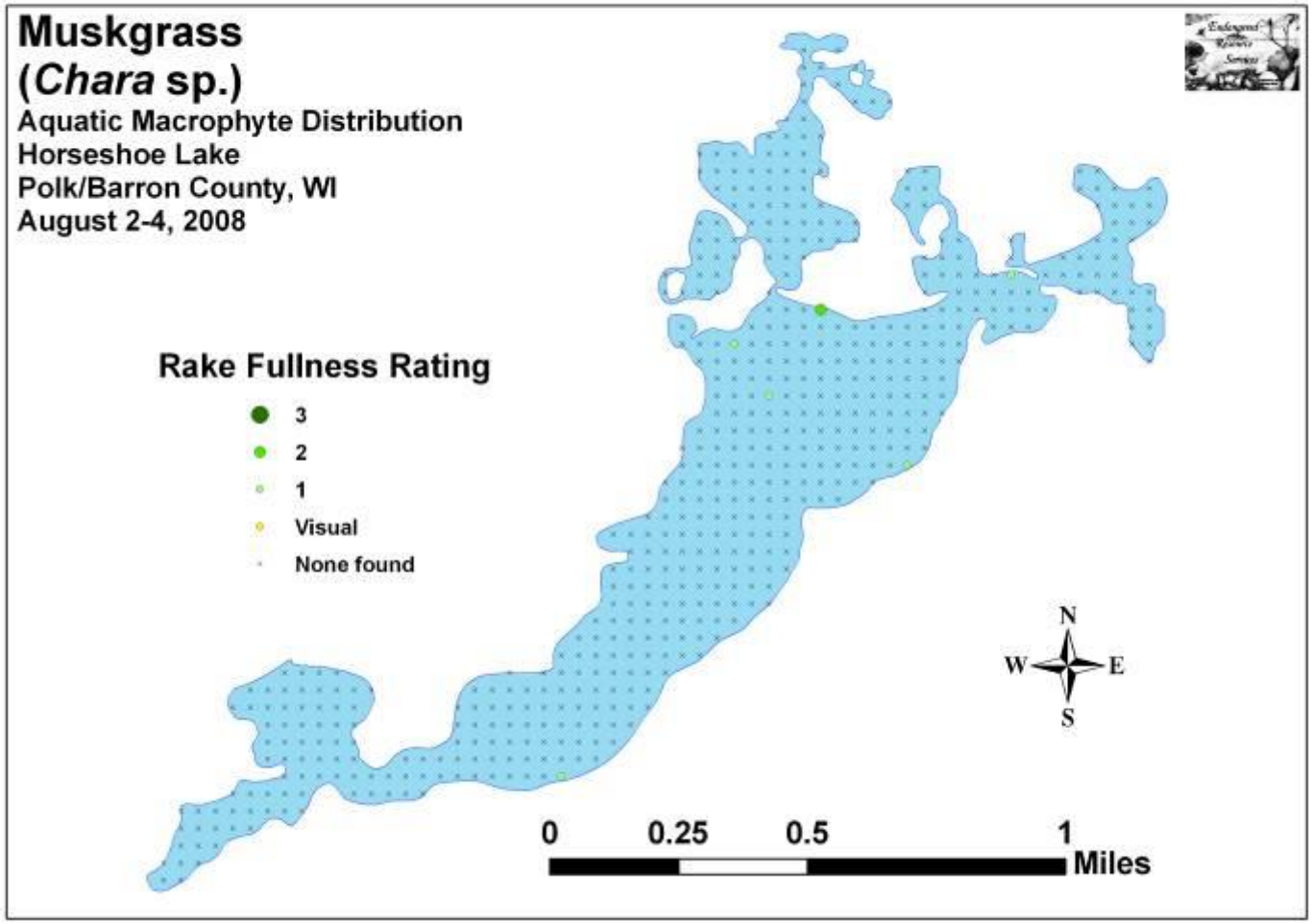

Water plantain
(Alisma triviale)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

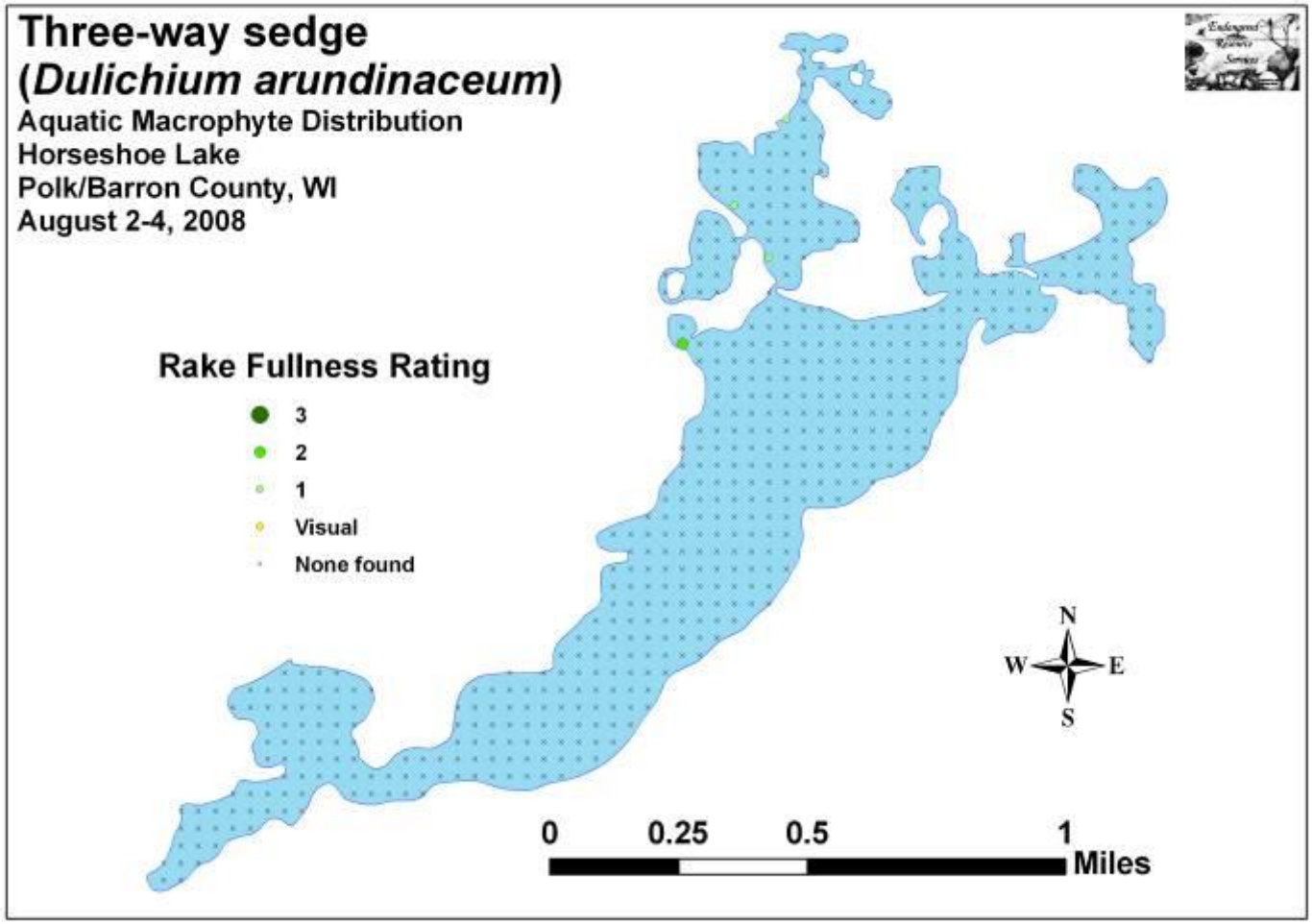

Aquatic moss
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

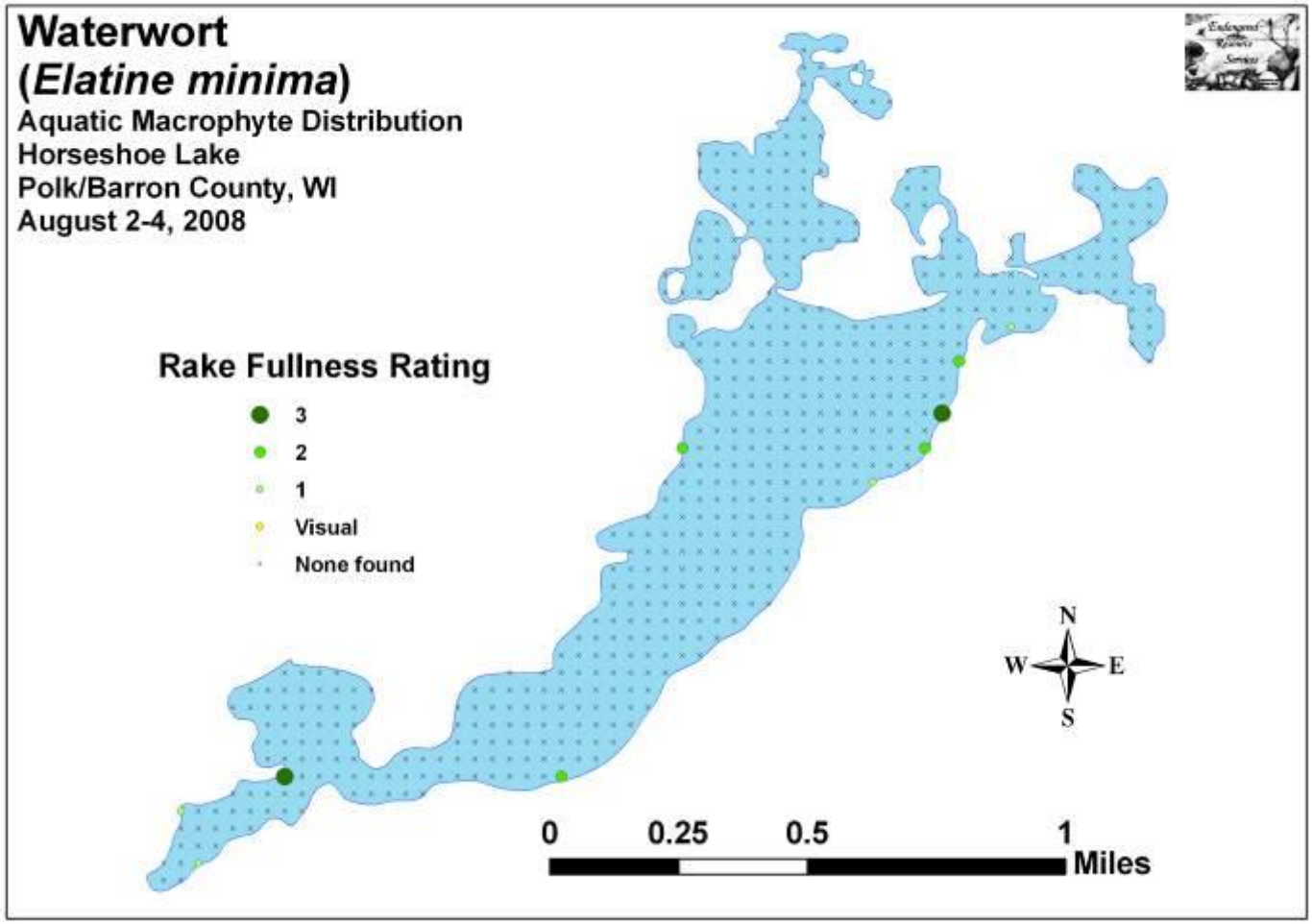

Watershield
(Brasenia schreberi)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

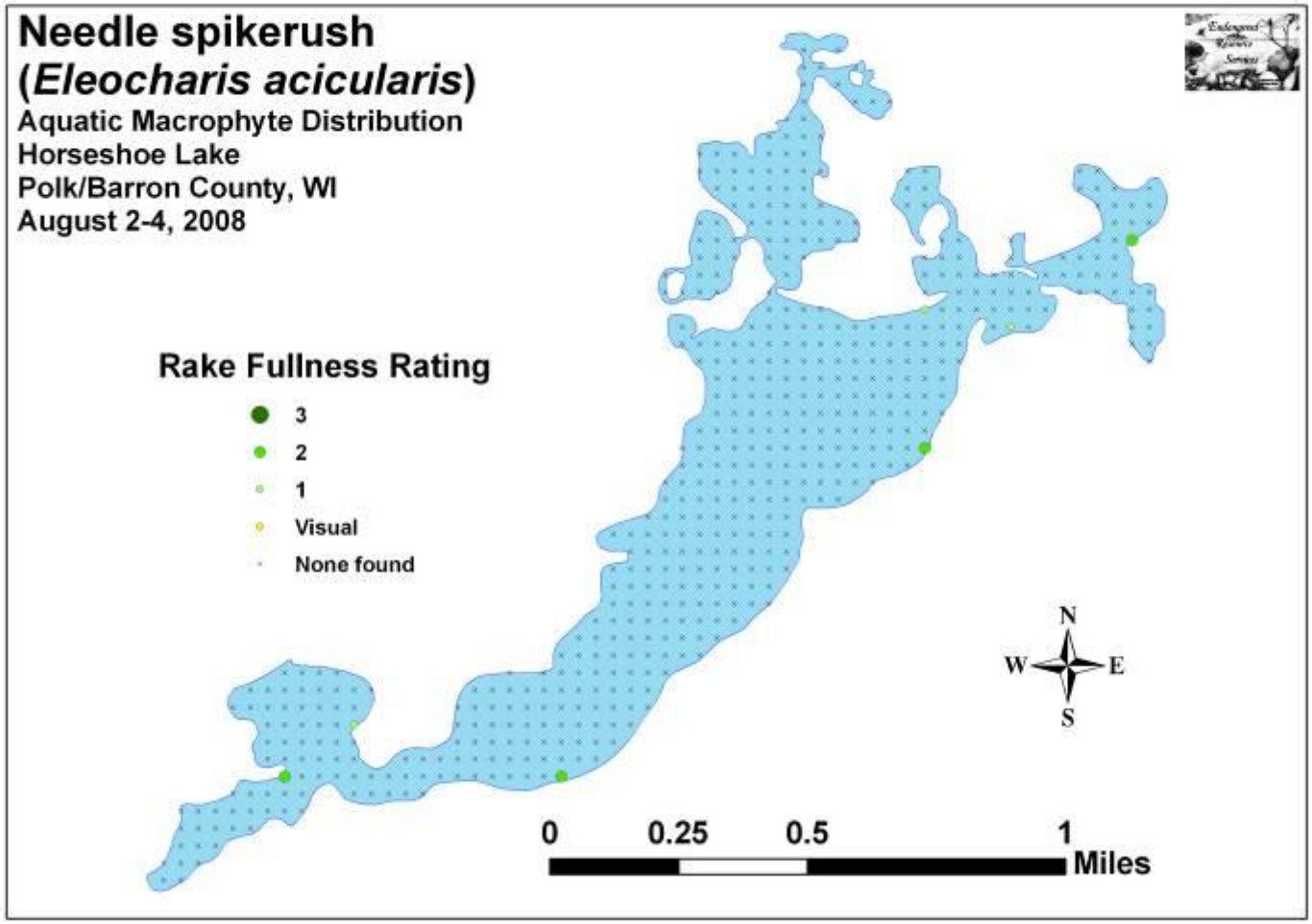

Coontail
(Ceratophyllum demersum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

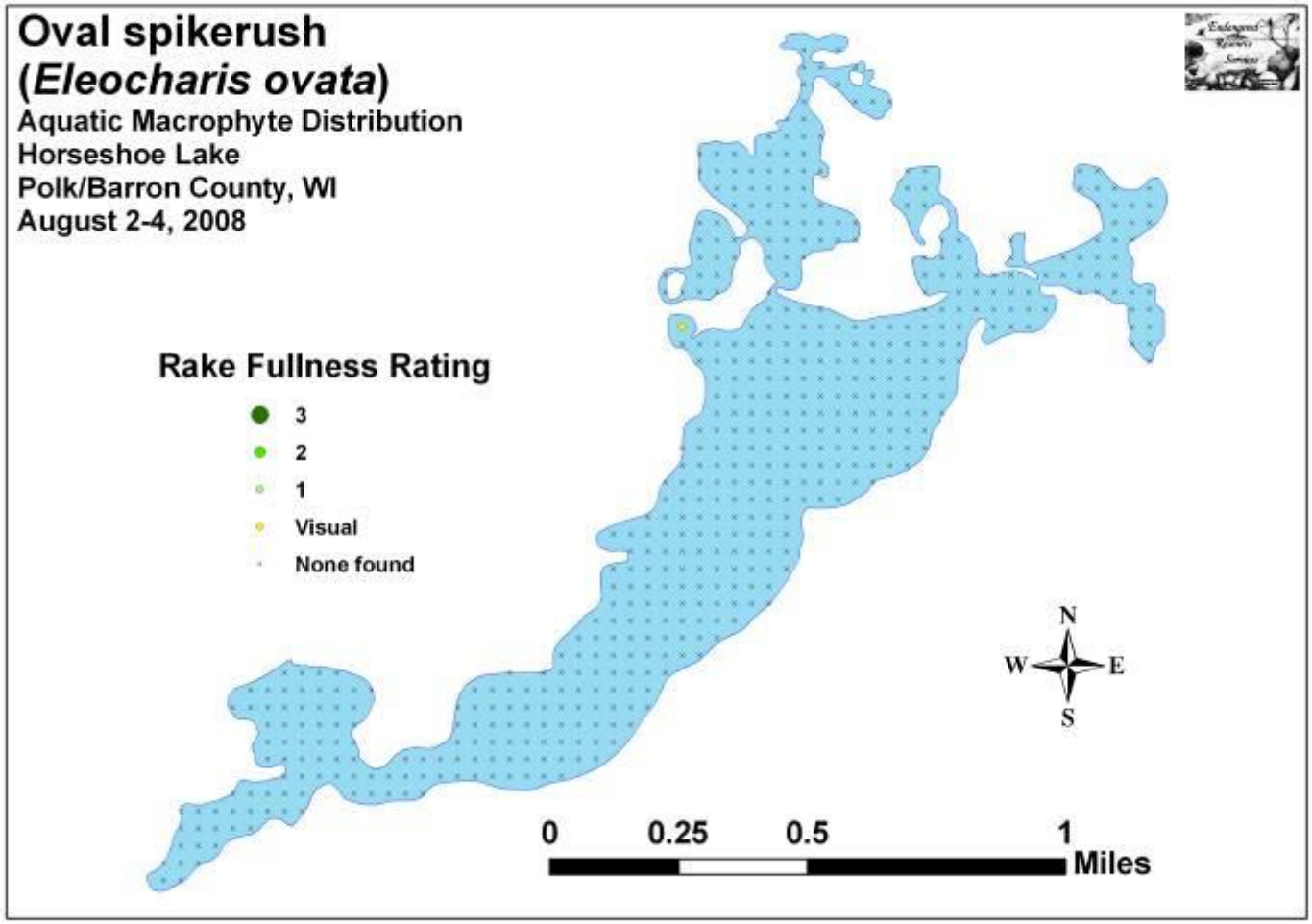

Spiny hornwort
(Ceratophyllum echinatum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

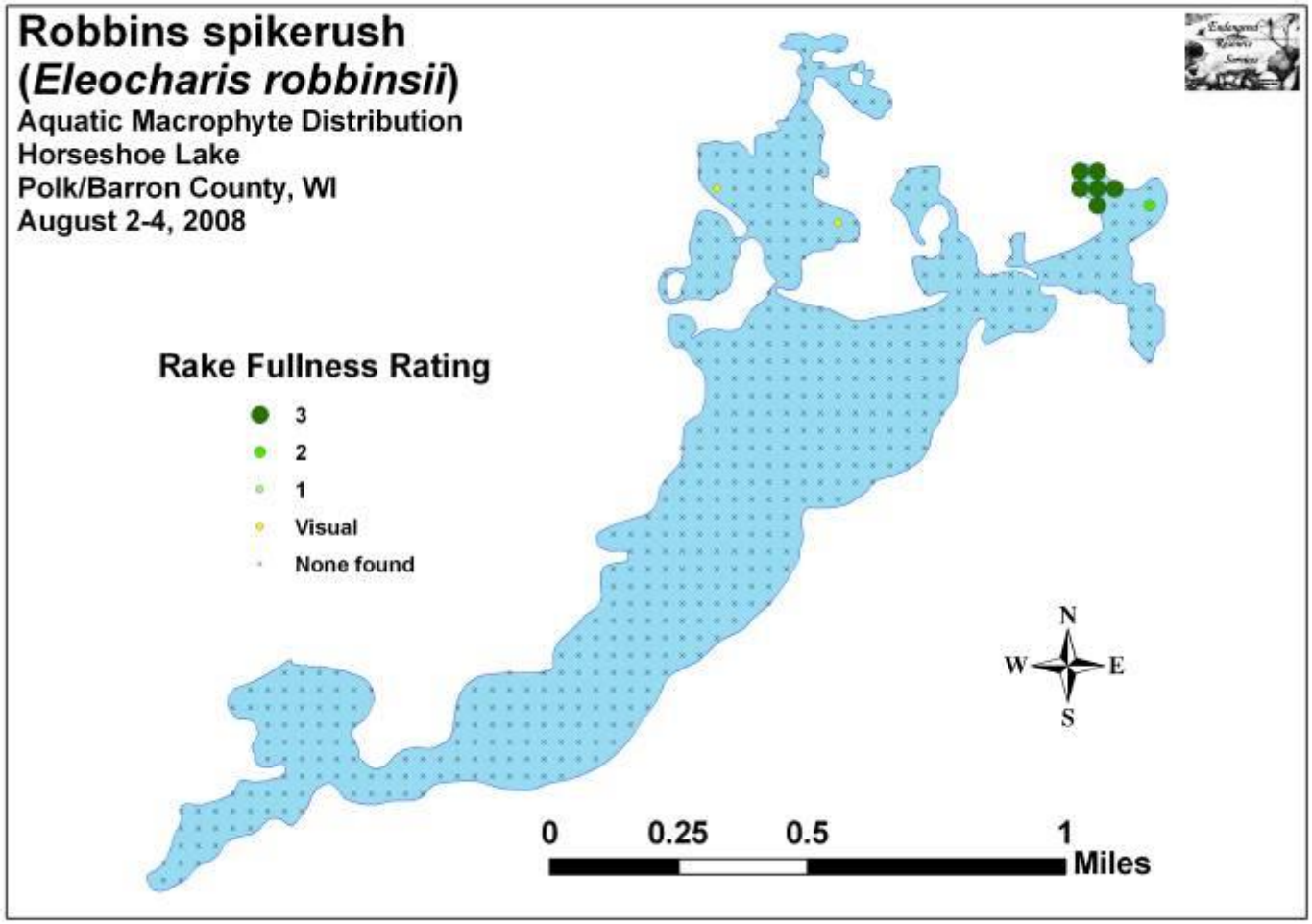

Muskgrass
(Chara sp.)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

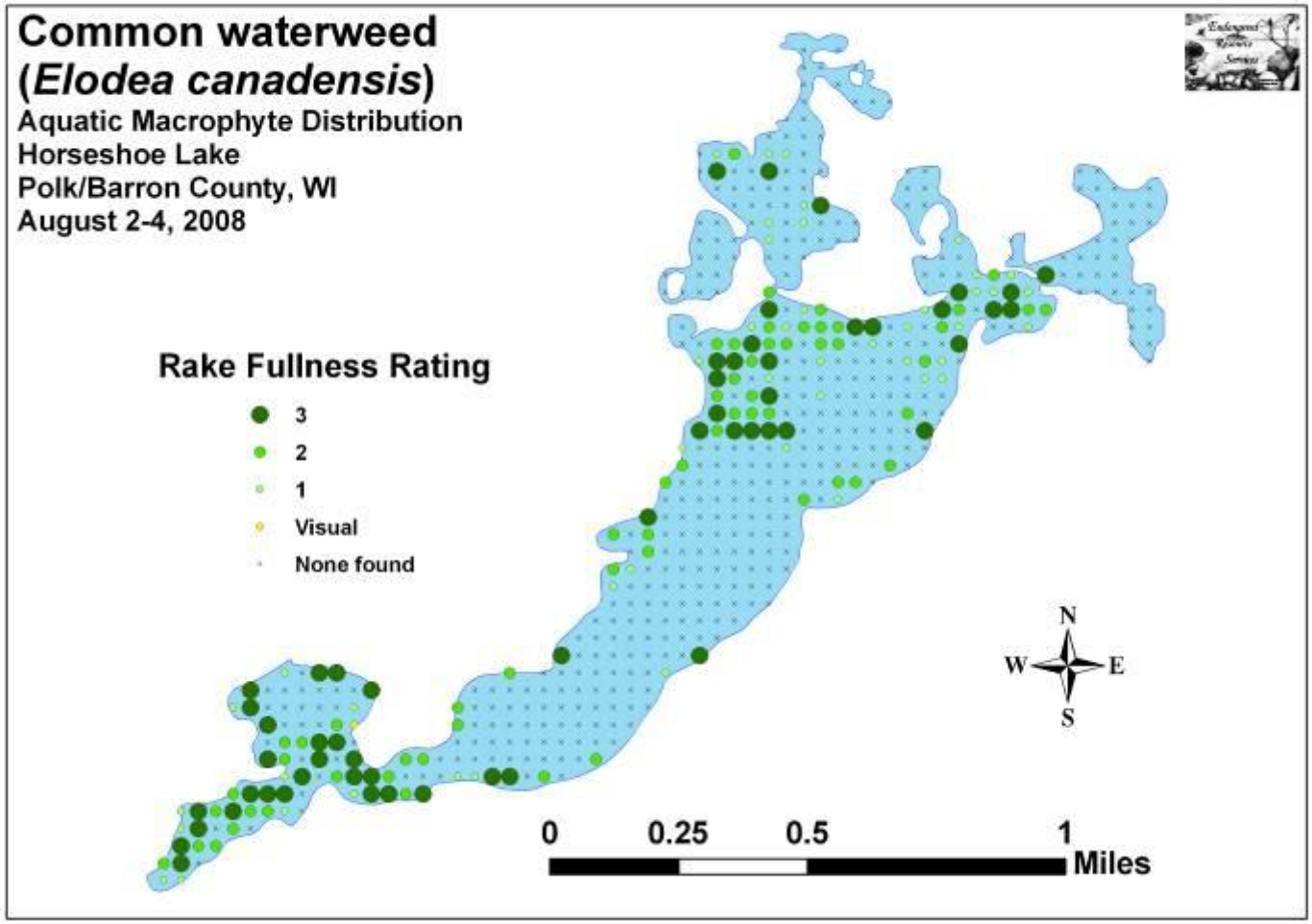

Three-way sedge
(Dulichium arundinaceum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

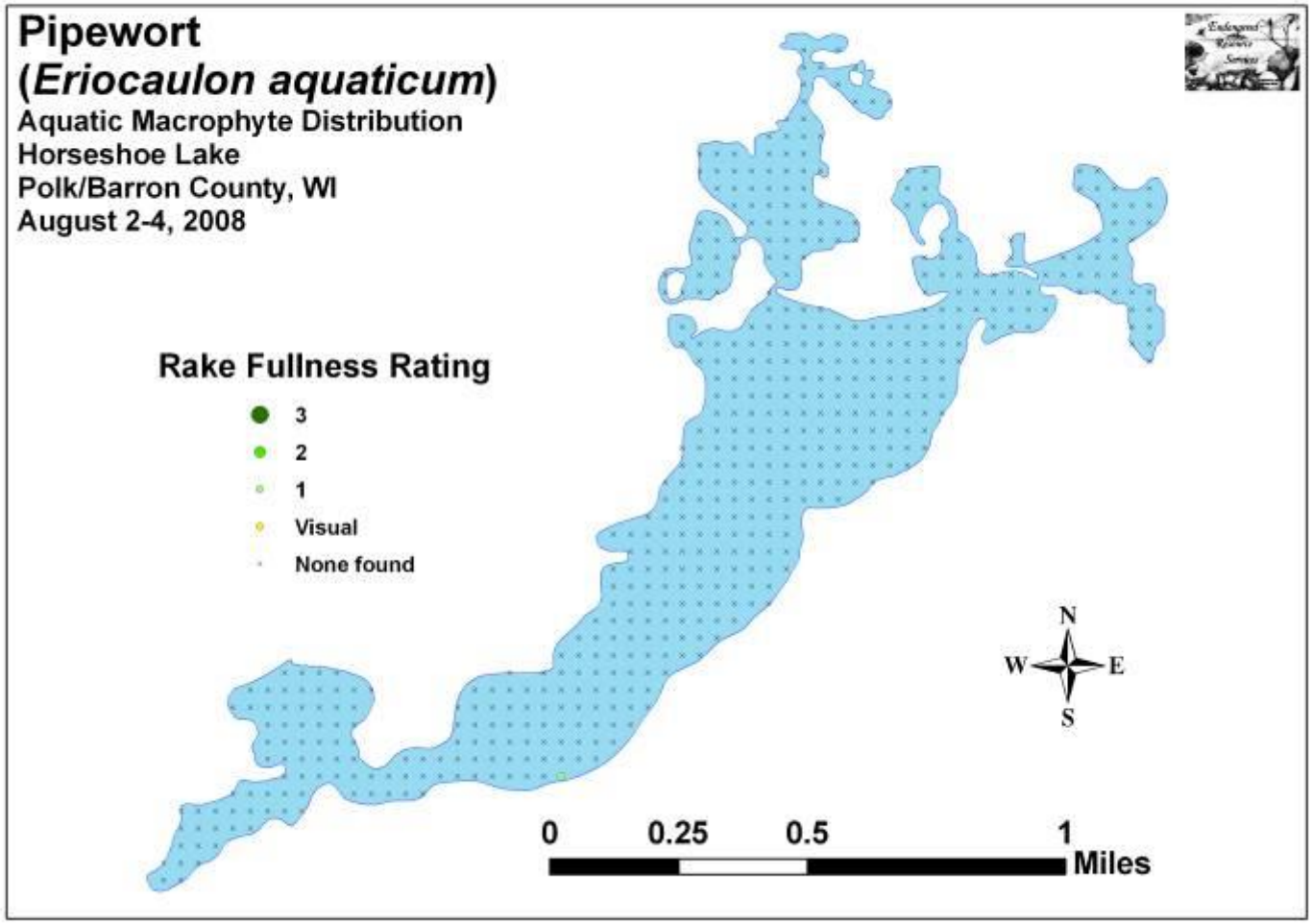

Waterwort
(Elatine minima)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

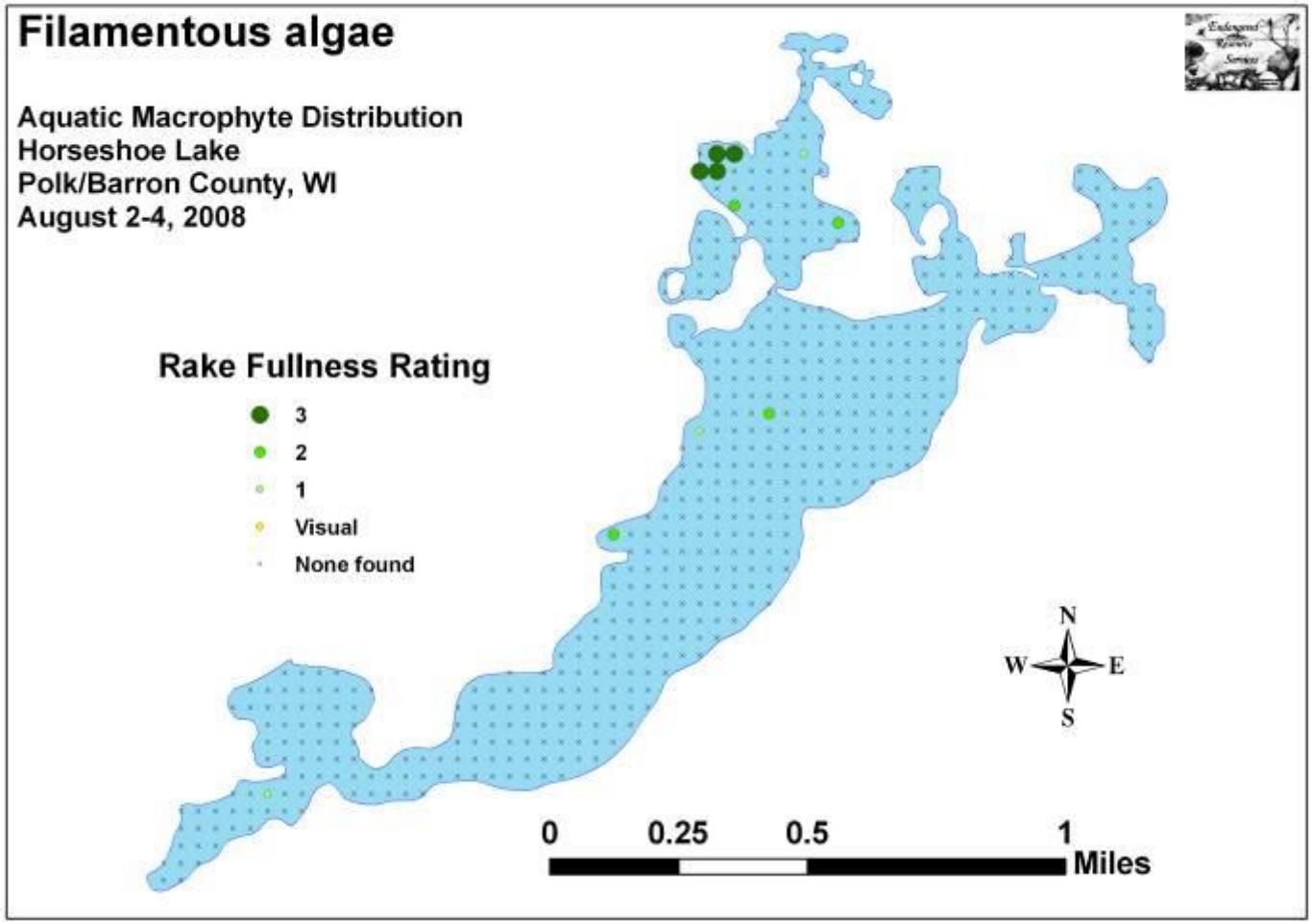

Needle spikerush
(Eleocharis acicularis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

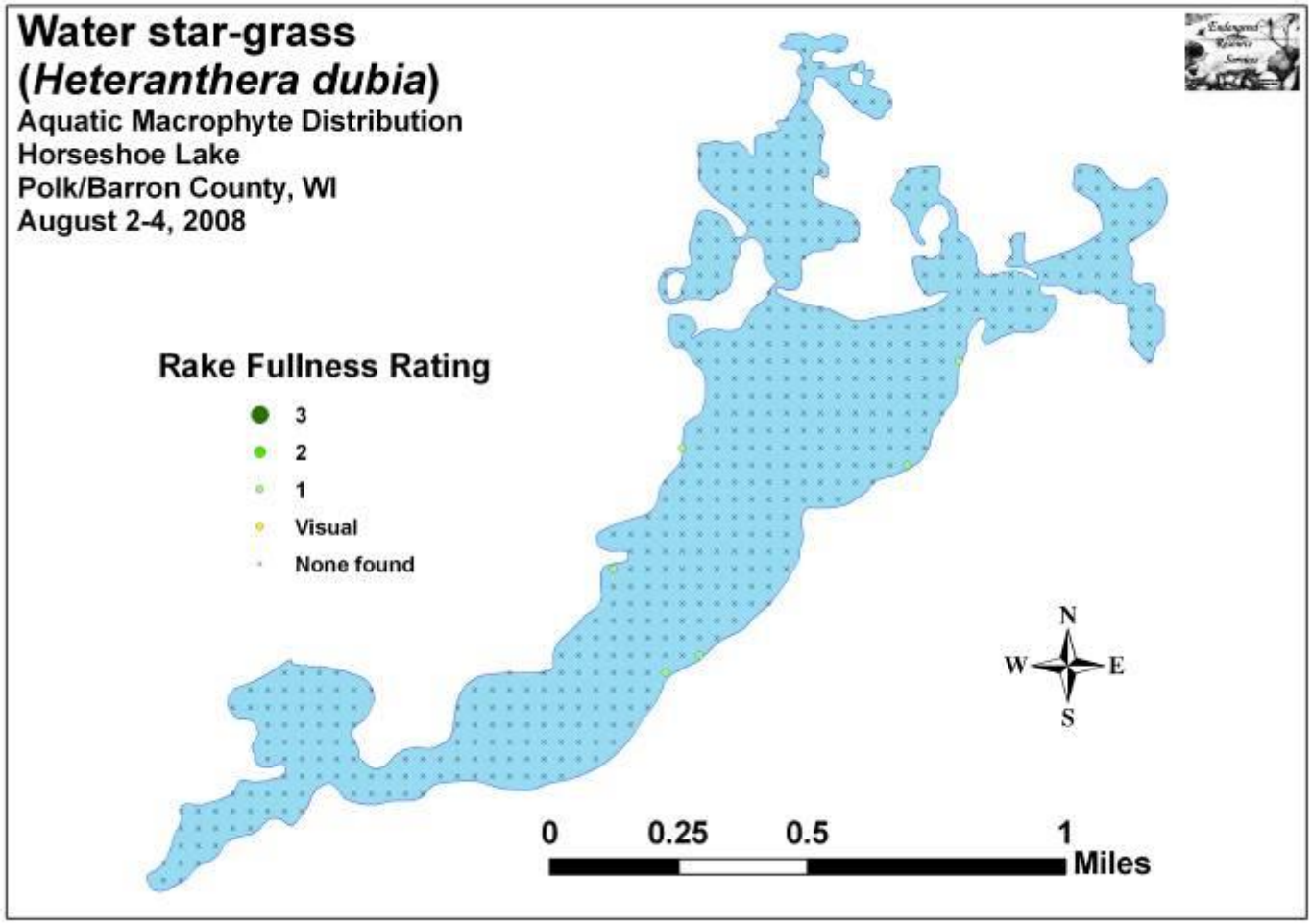

Oval spikerush
(Eleocharis ovata)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

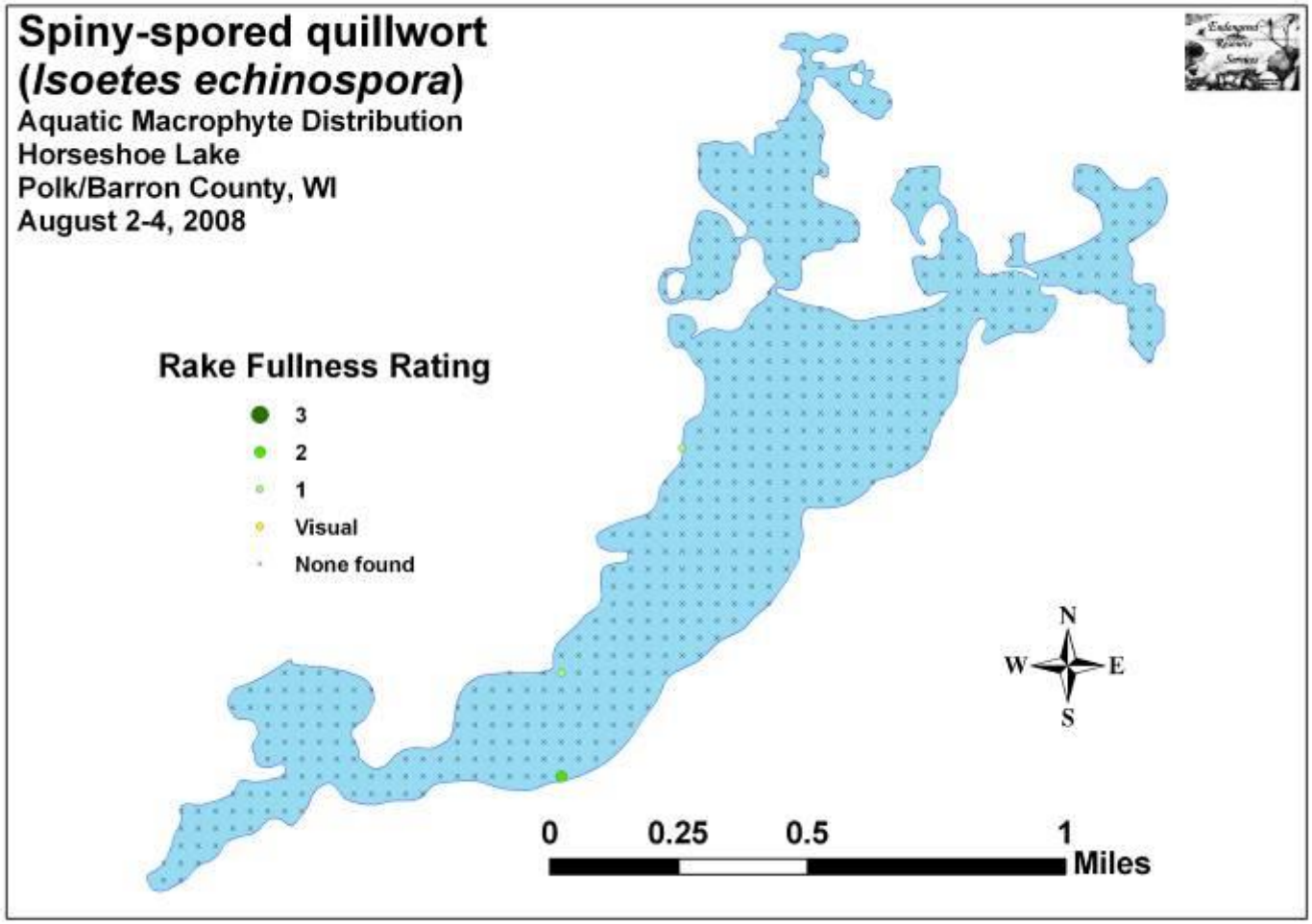

Robbins spikerush
(Eleocharis robbinsii)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

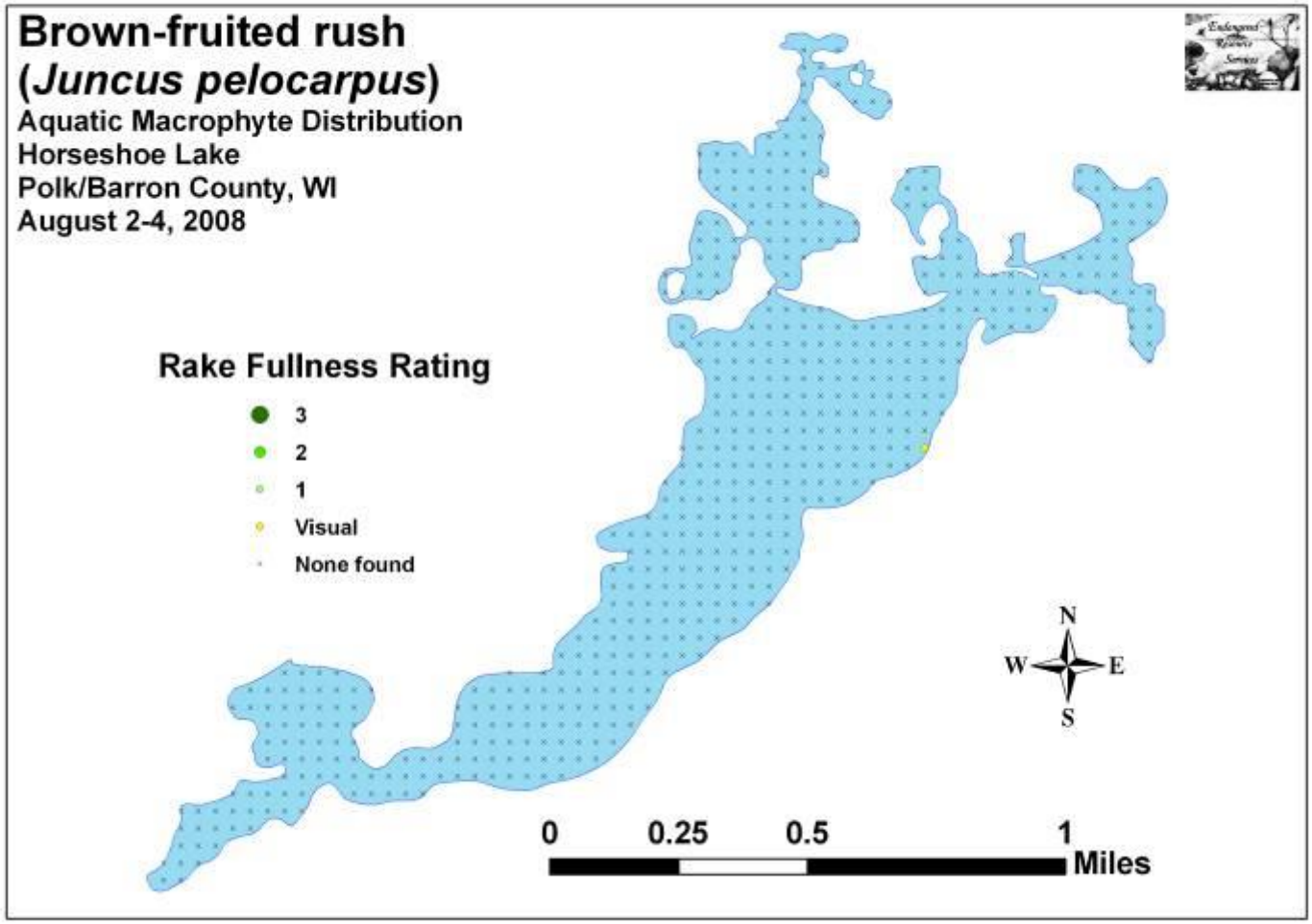

Common waterweed
(Elodea canadensis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

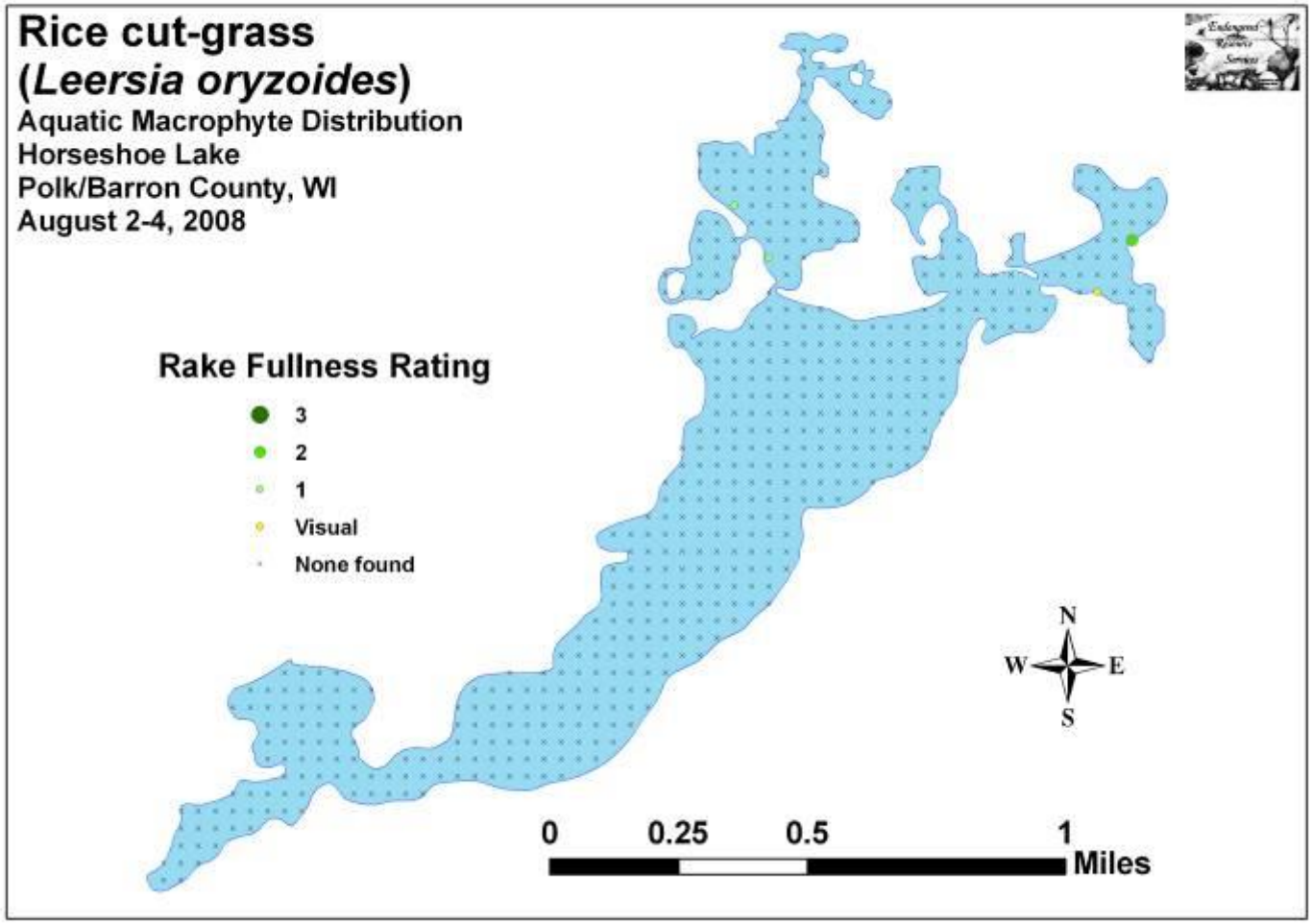

Pipewort
(Eriocaulon aquaticum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

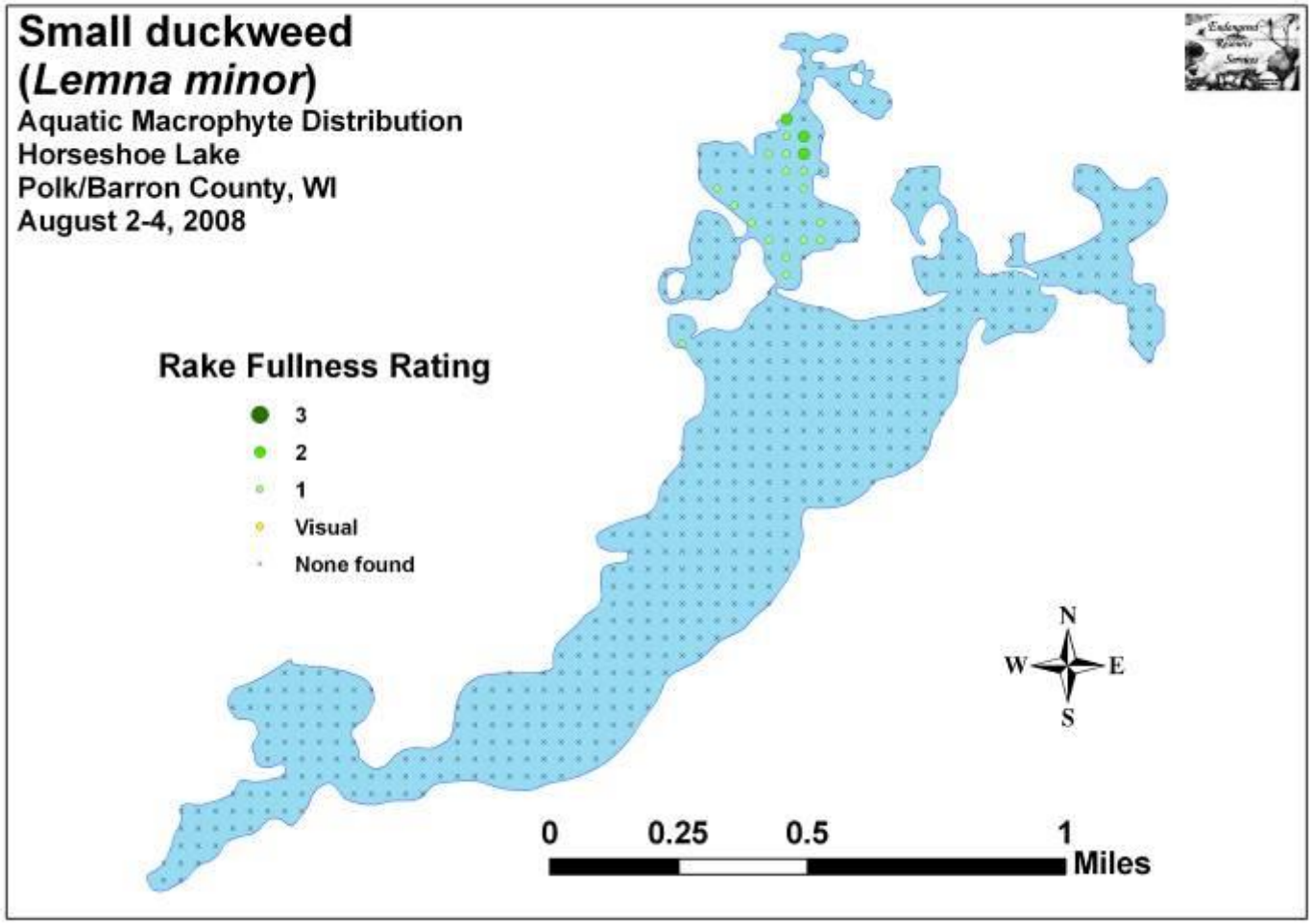

Filamentous algae
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

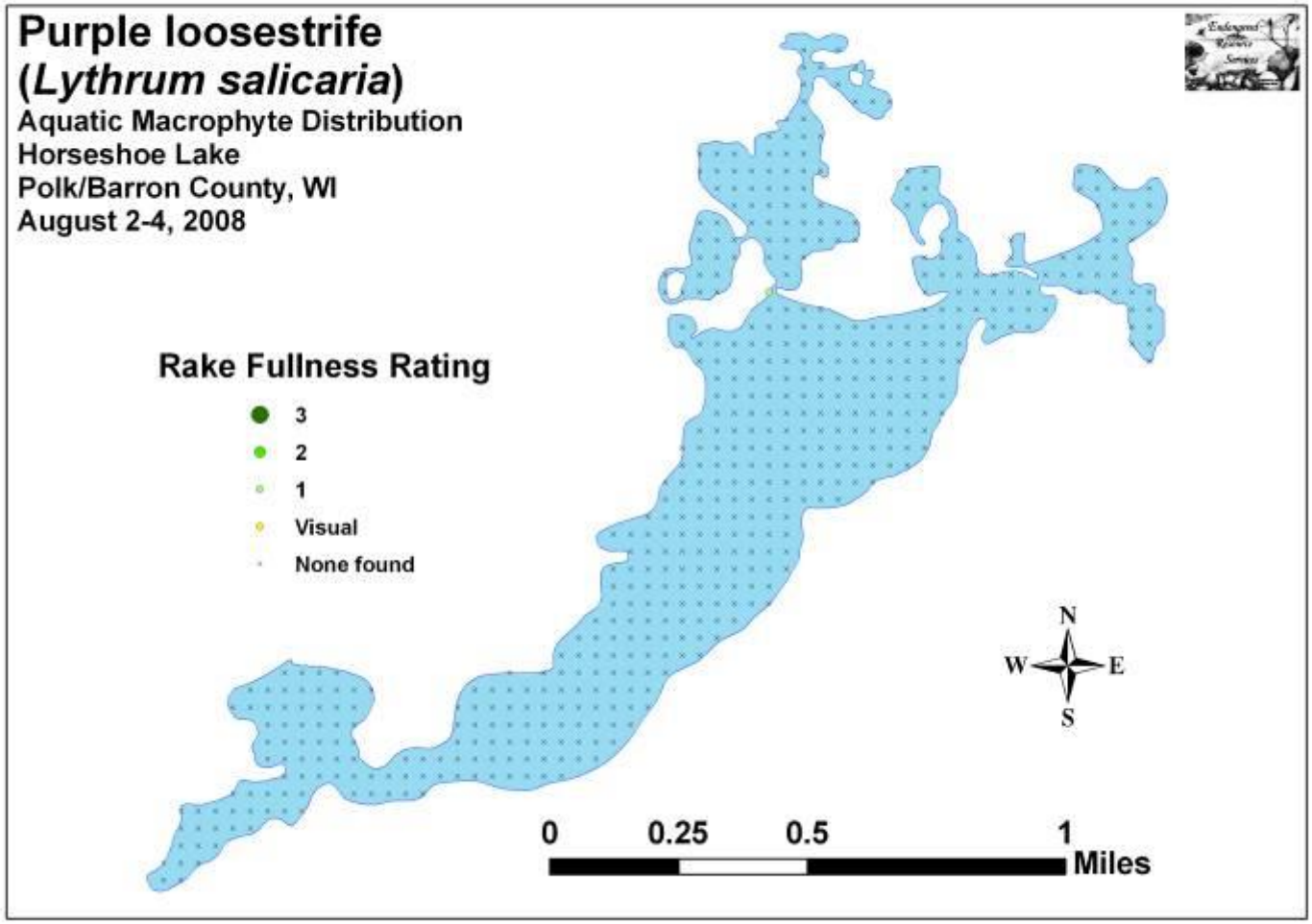

Water star-grass
(Heteranthera dubia)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

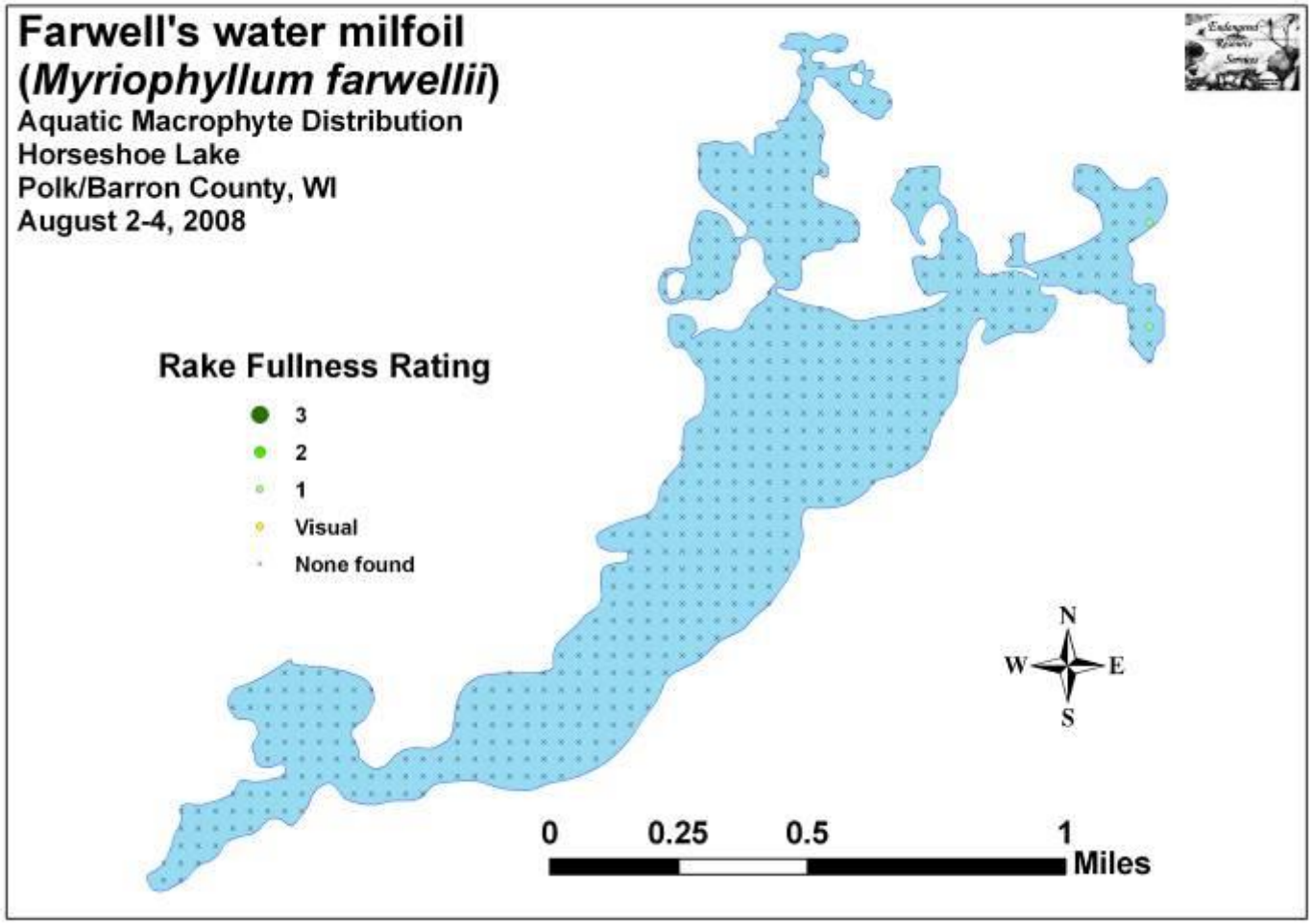

Spiny-spored quillwort
(Isoetes echinospora)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

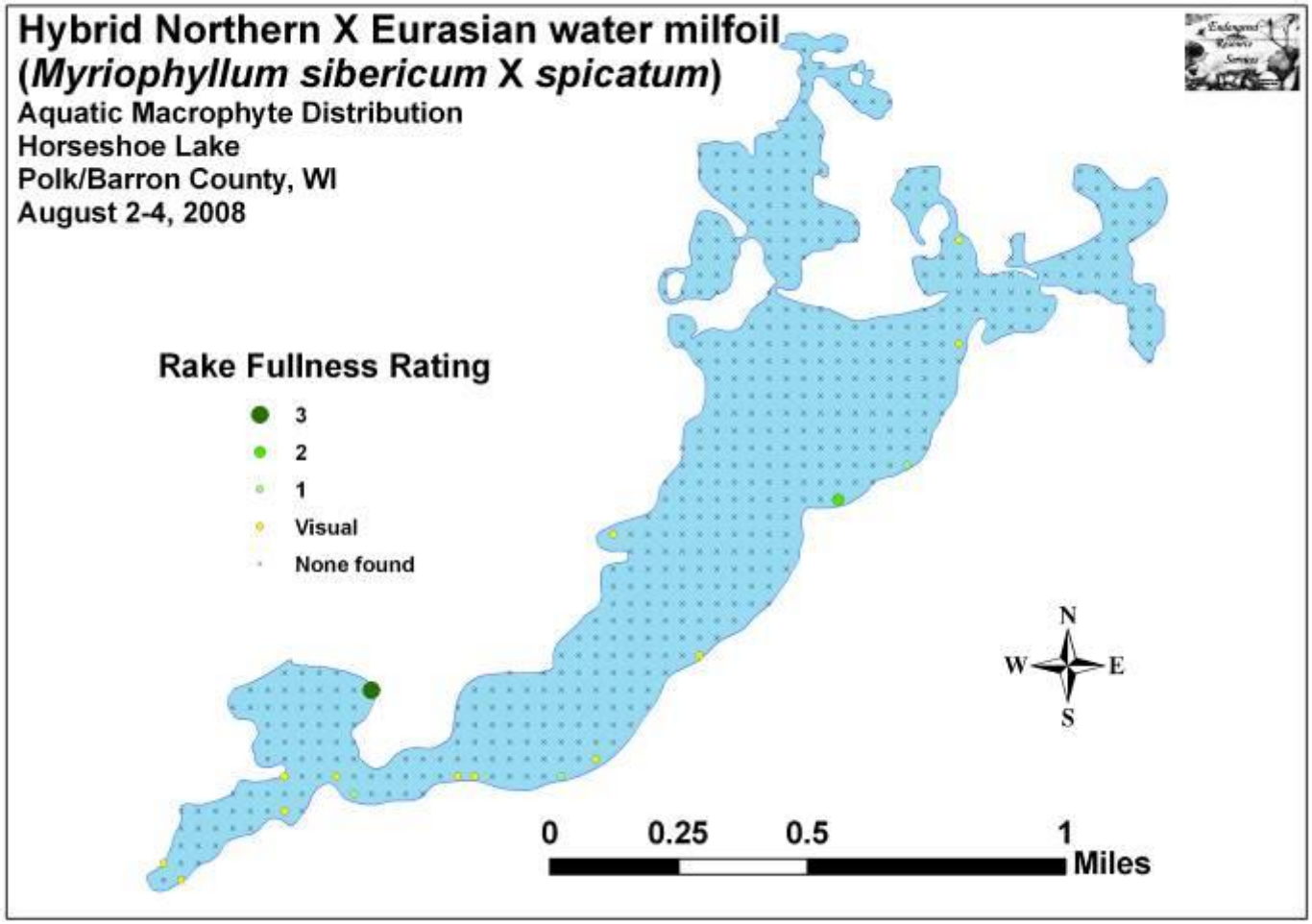

Brown-fruited rush
(Juncus pelocarpus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

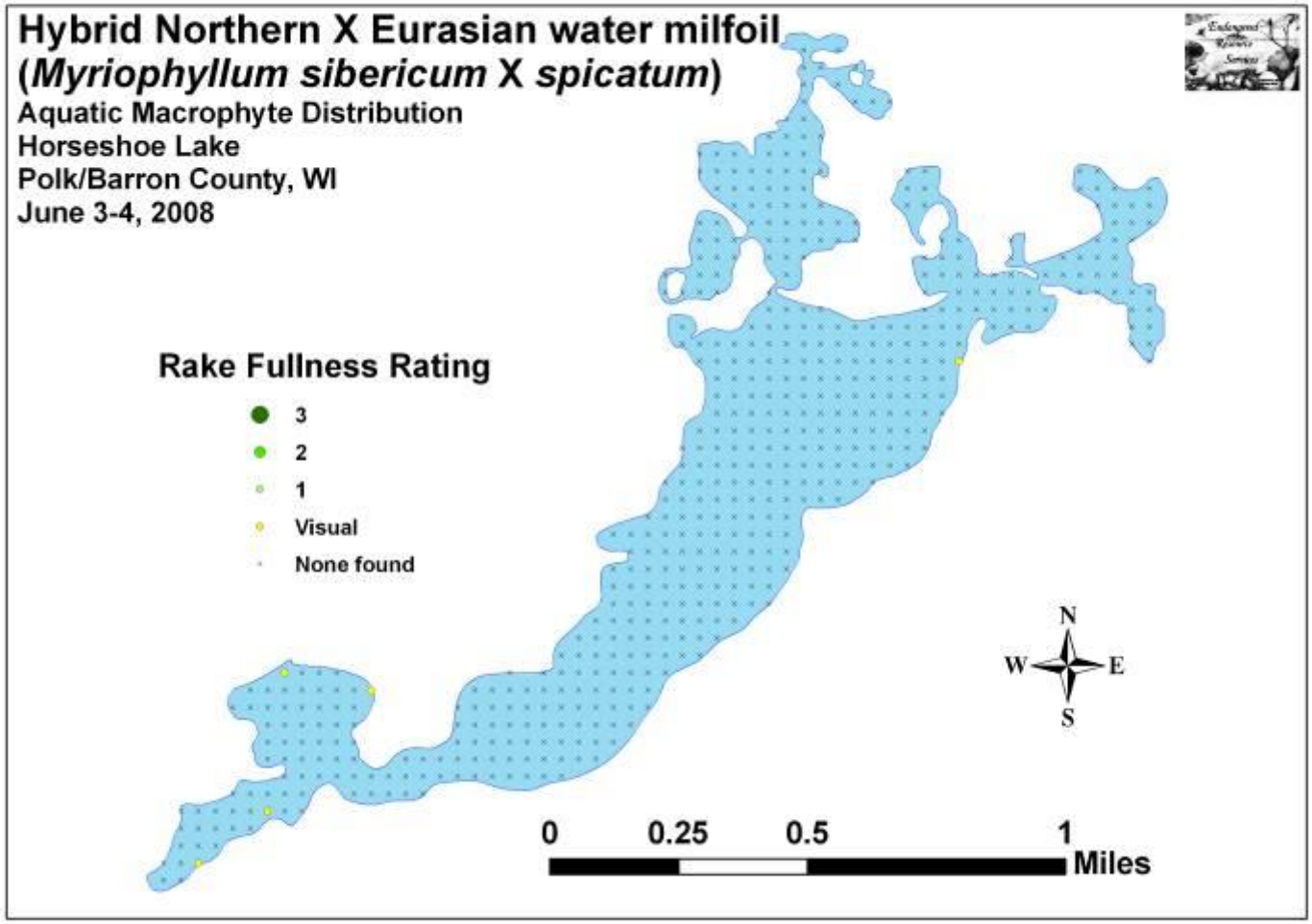

Rice cut-grass
(Leersia oryzoides)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

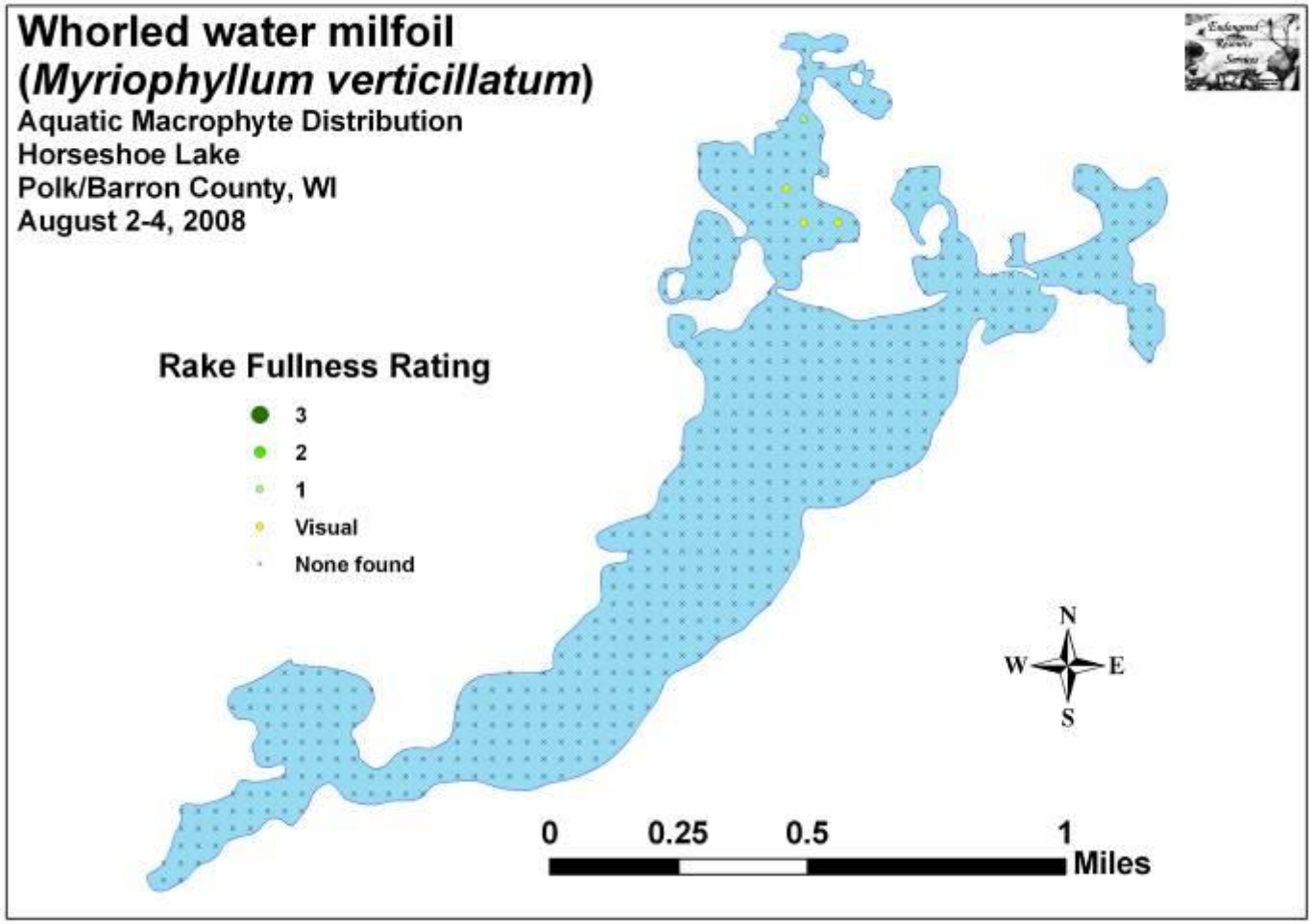

Small duckweed
(Lemna minor)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

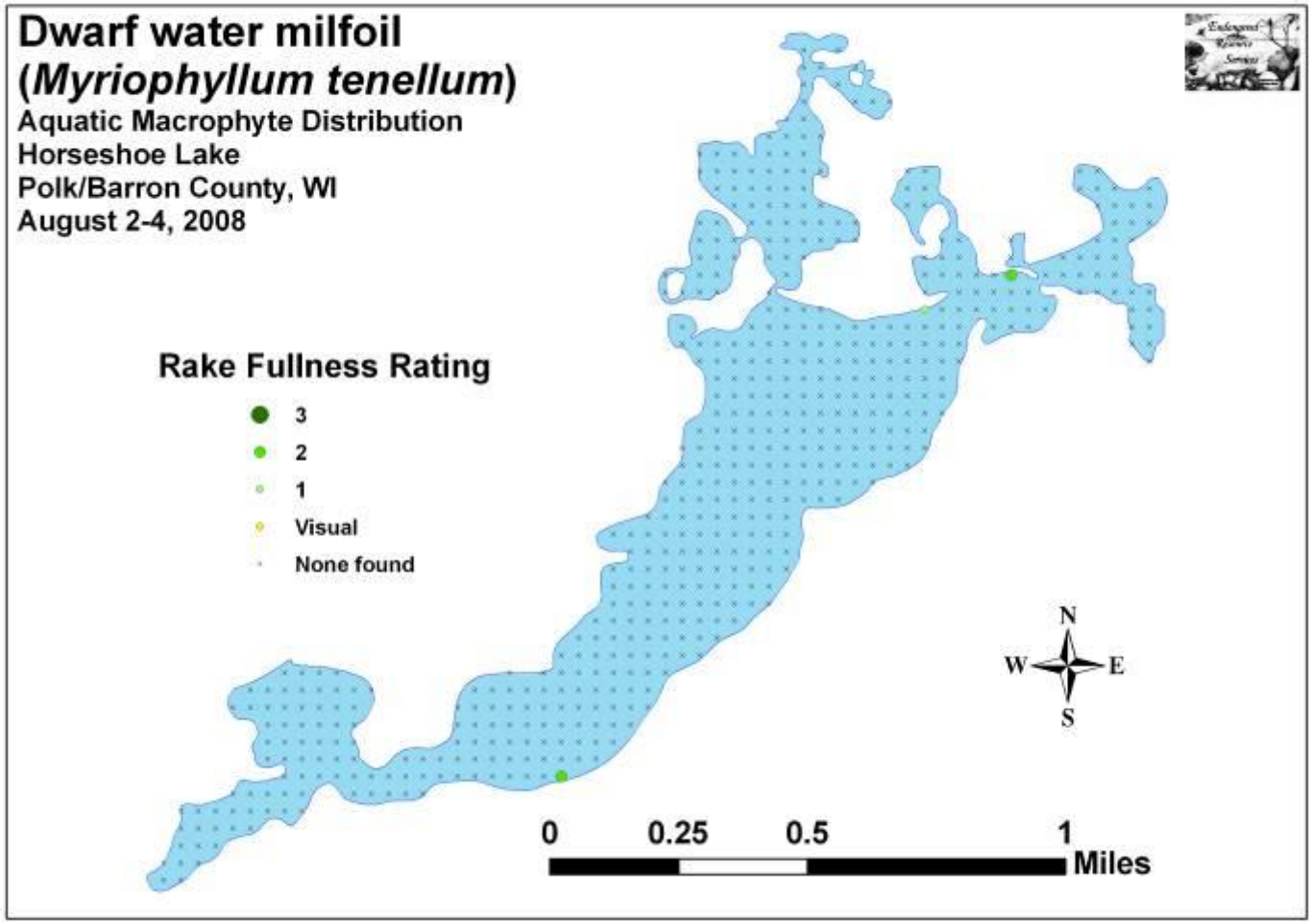

Purple loosestrife
(Lythrum salicaria)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

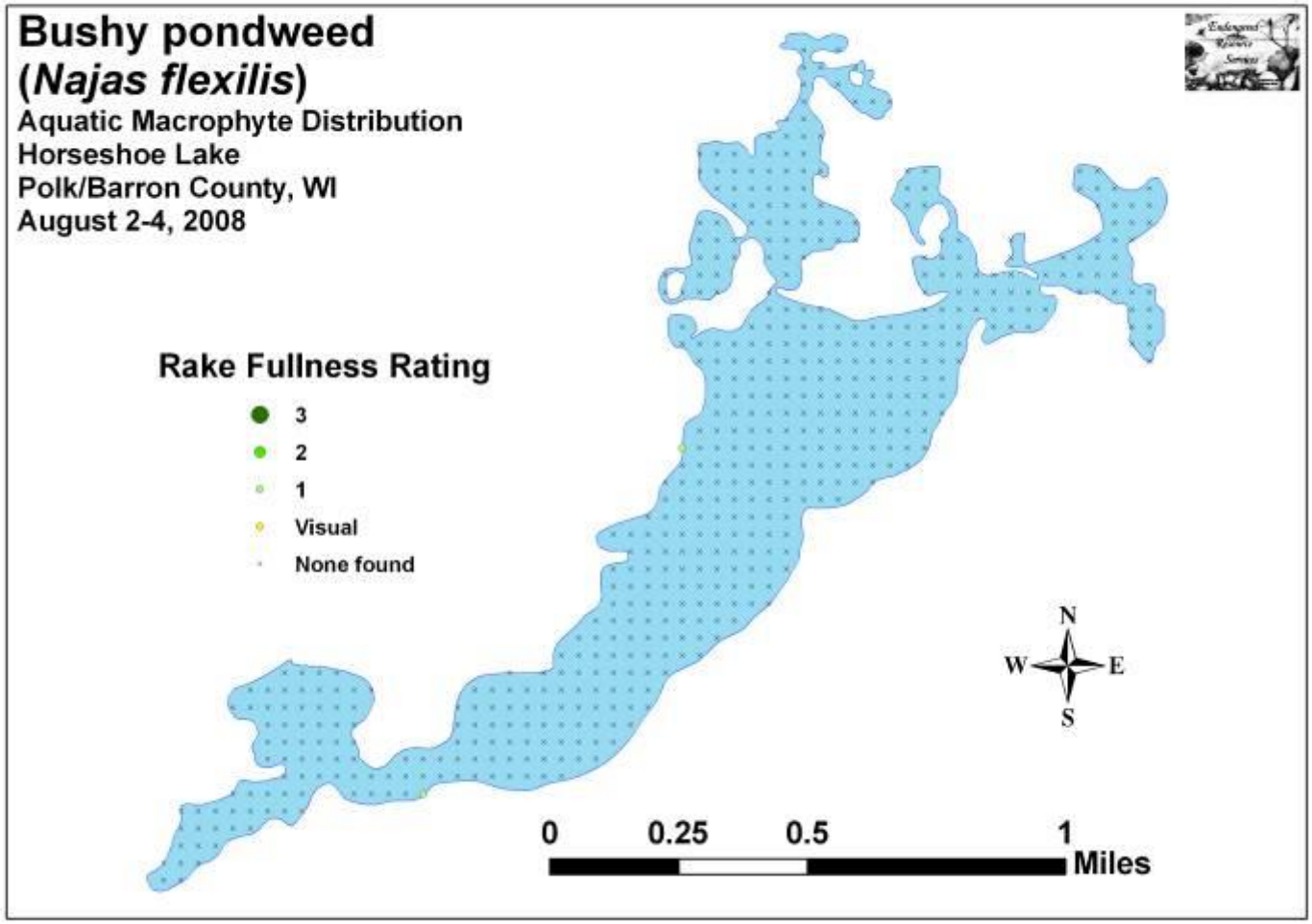

Farwell's water milfoil
(Myriophyllum farwellii)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

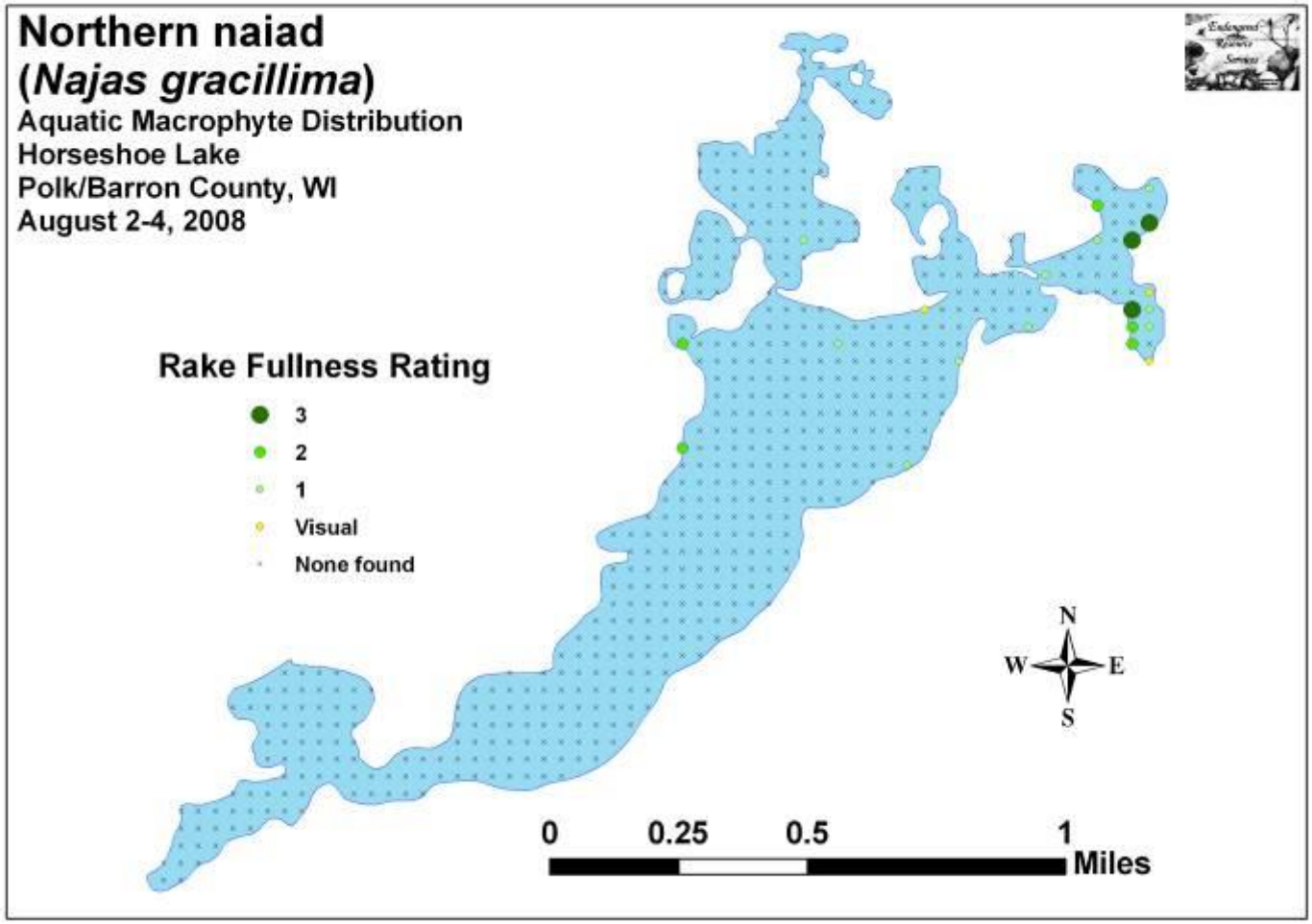

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

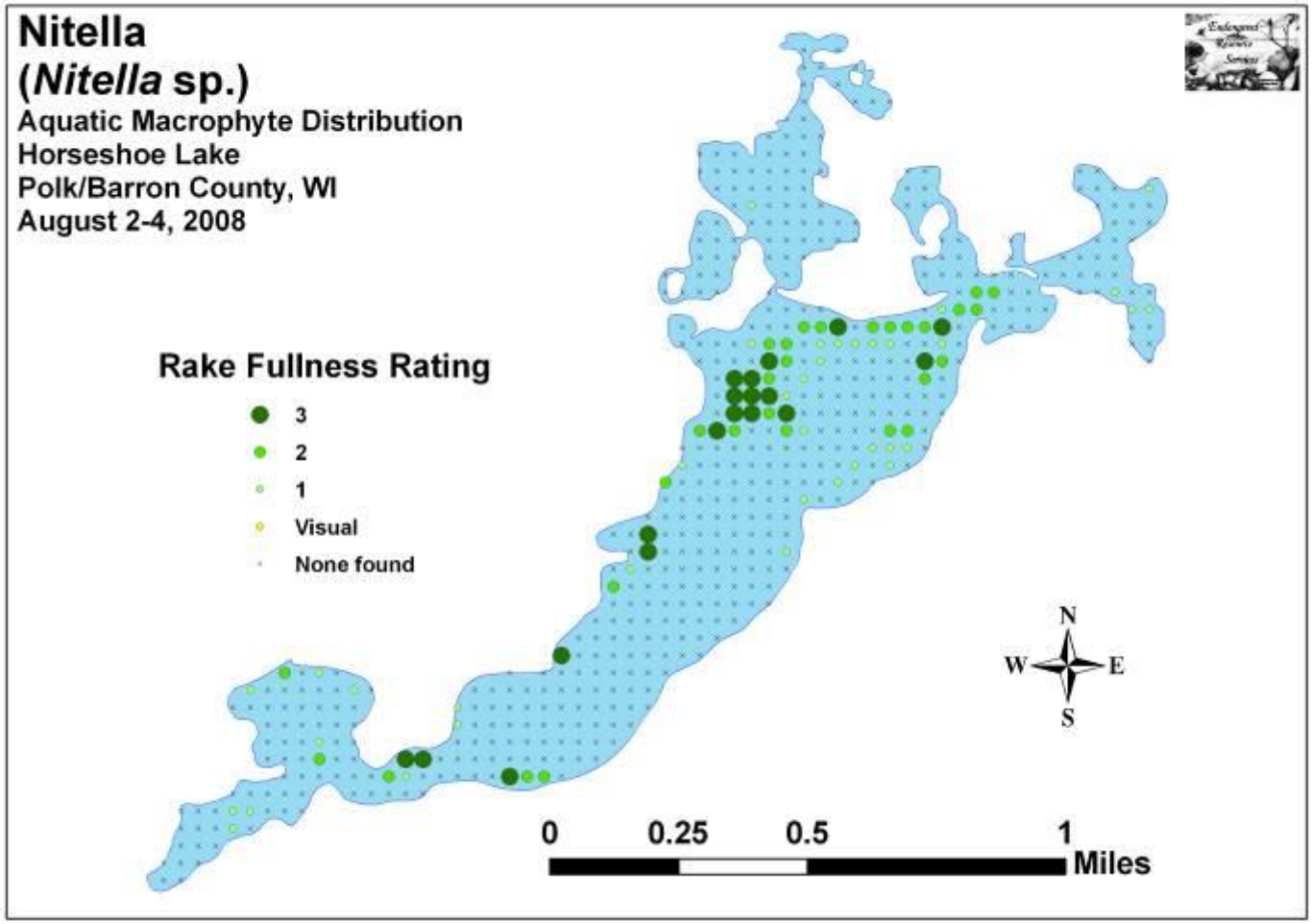

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
June 3-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

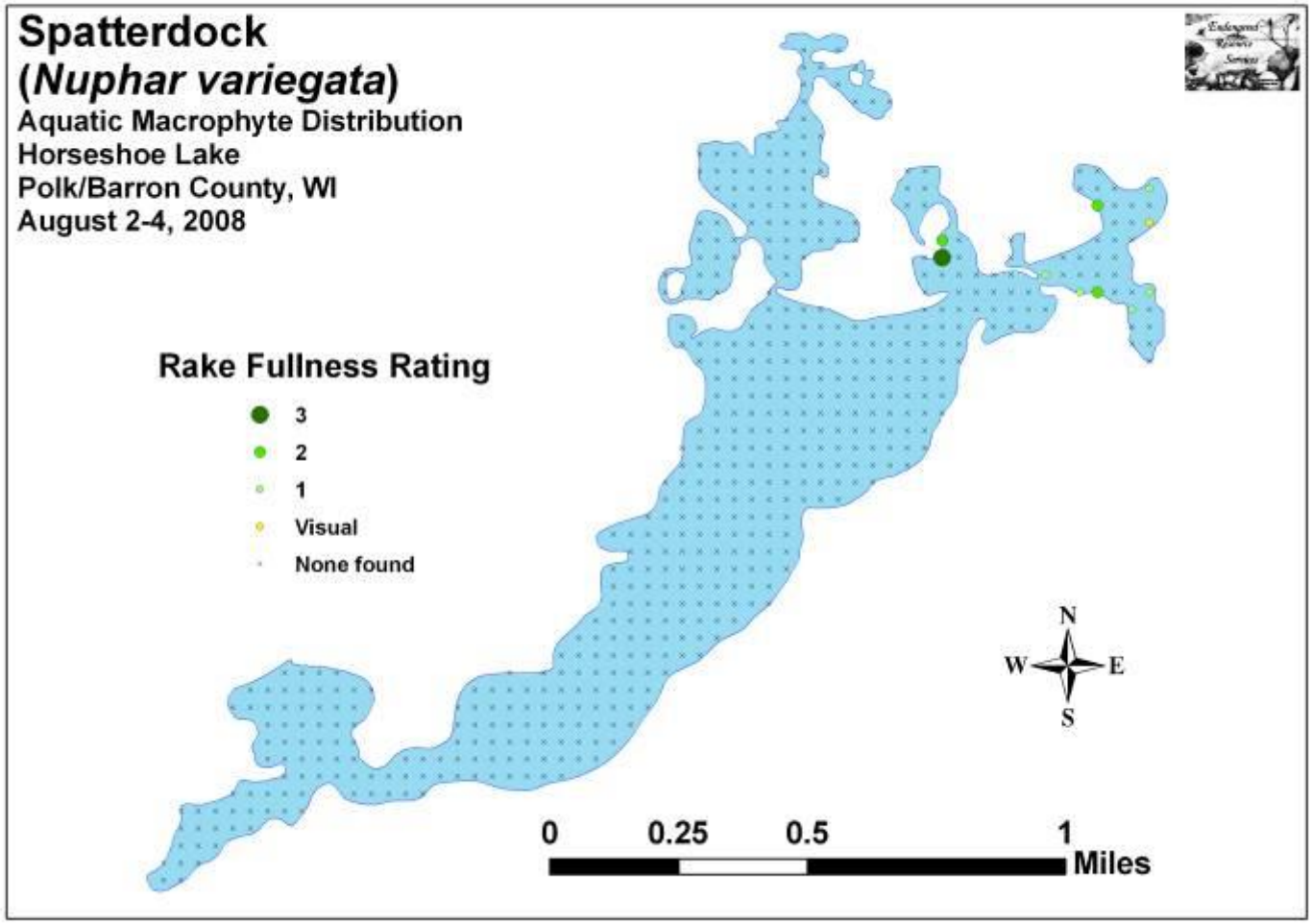

Whorled water milfoil
(Myriophyllum verticillatum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

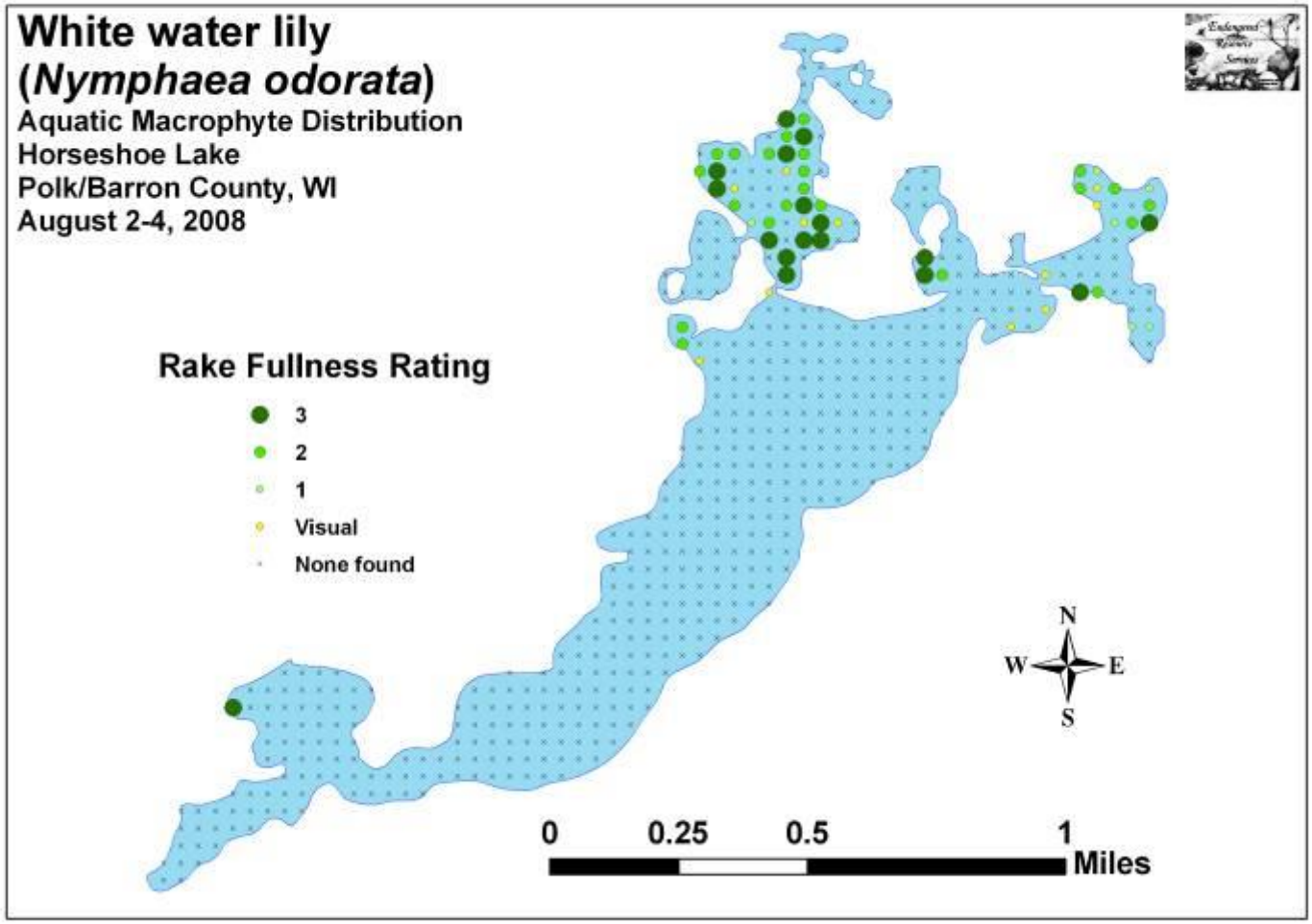

Dwarf water milfoil
(Myriophyllum tenellum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

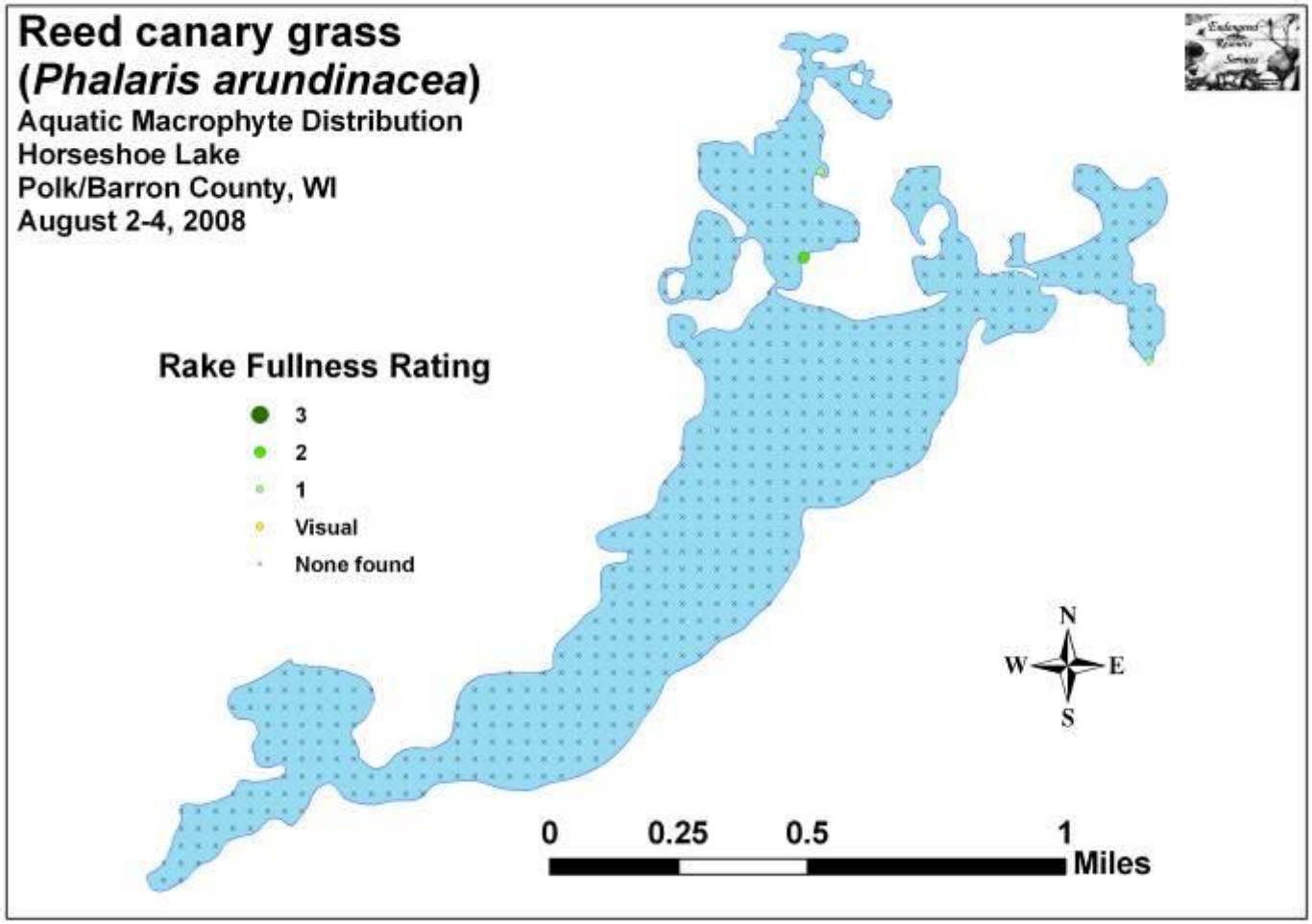

Bushy pondweed
(Najas flexilis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

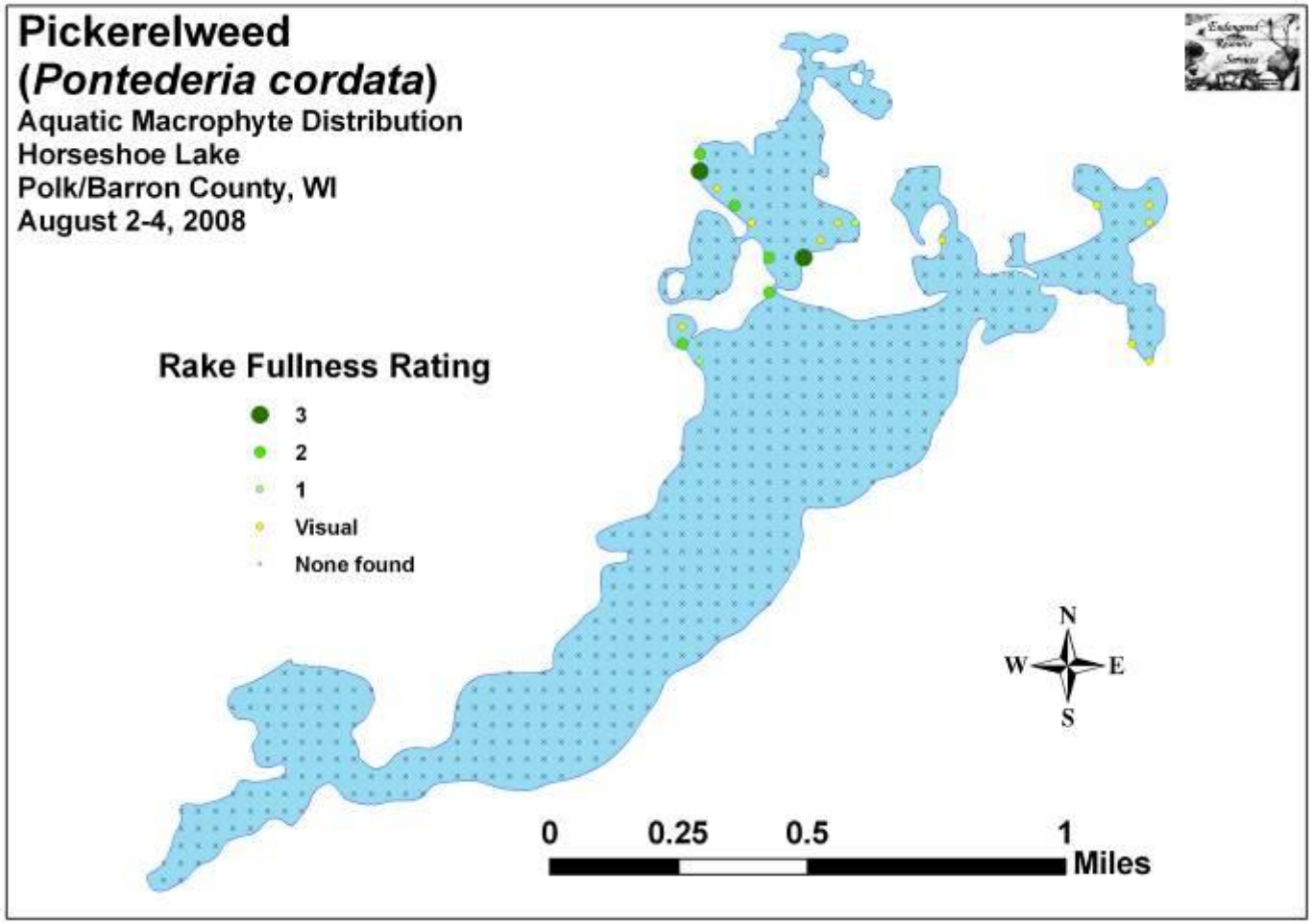

Northern naiad
(Najas gracillima)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

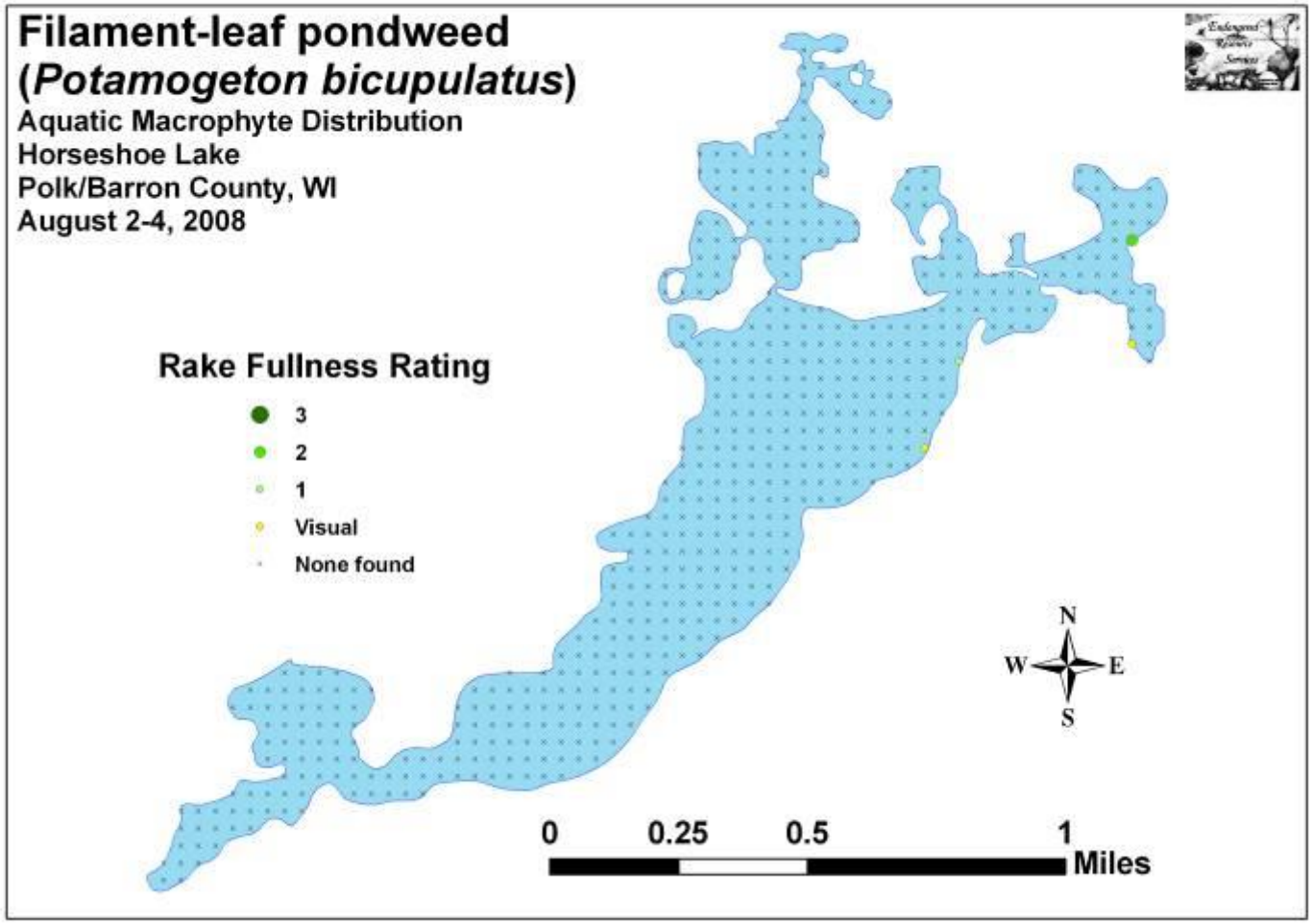

Nitella
(Nitella sp.)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

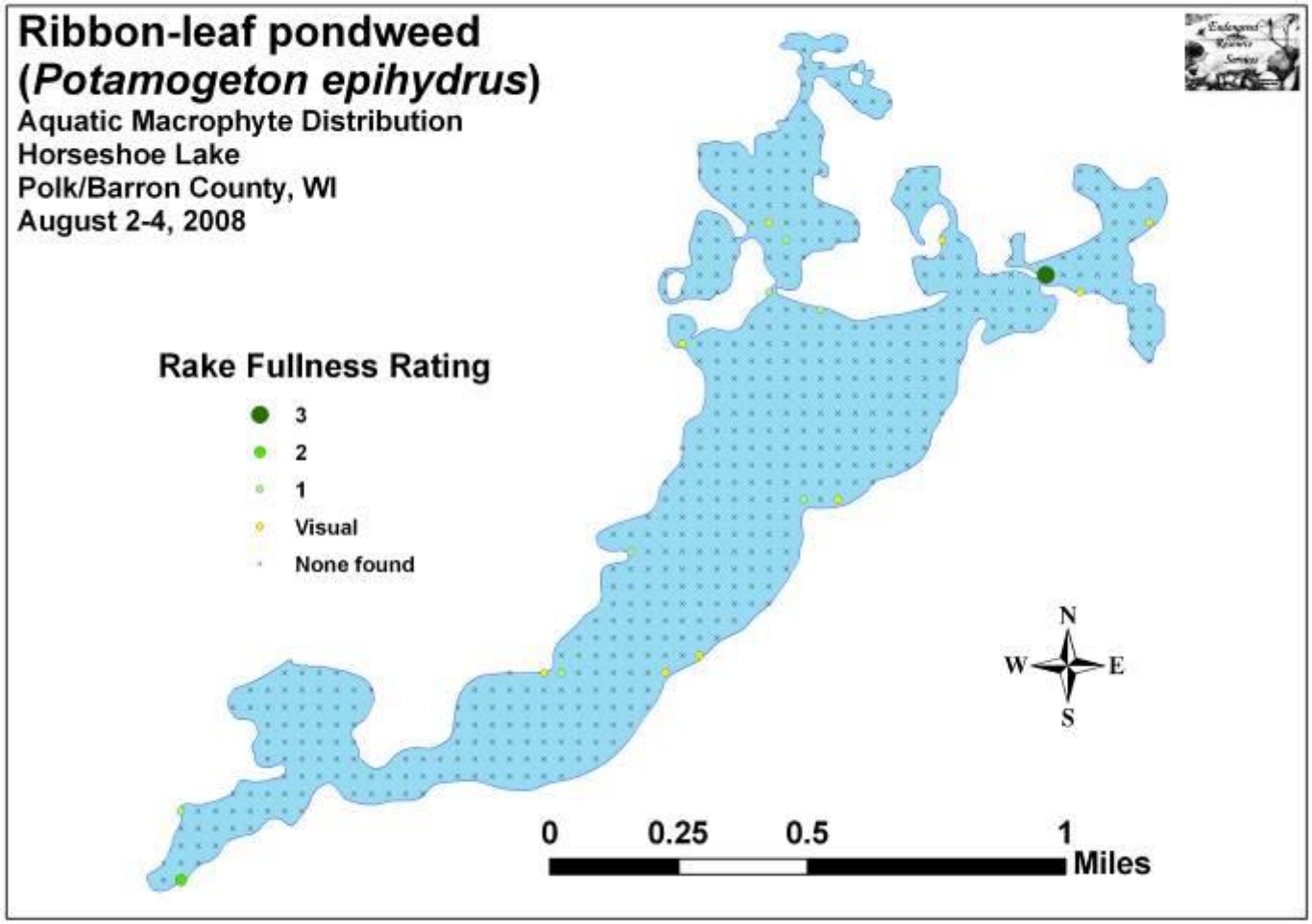

Spatterdock
(Nuphar variegata)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

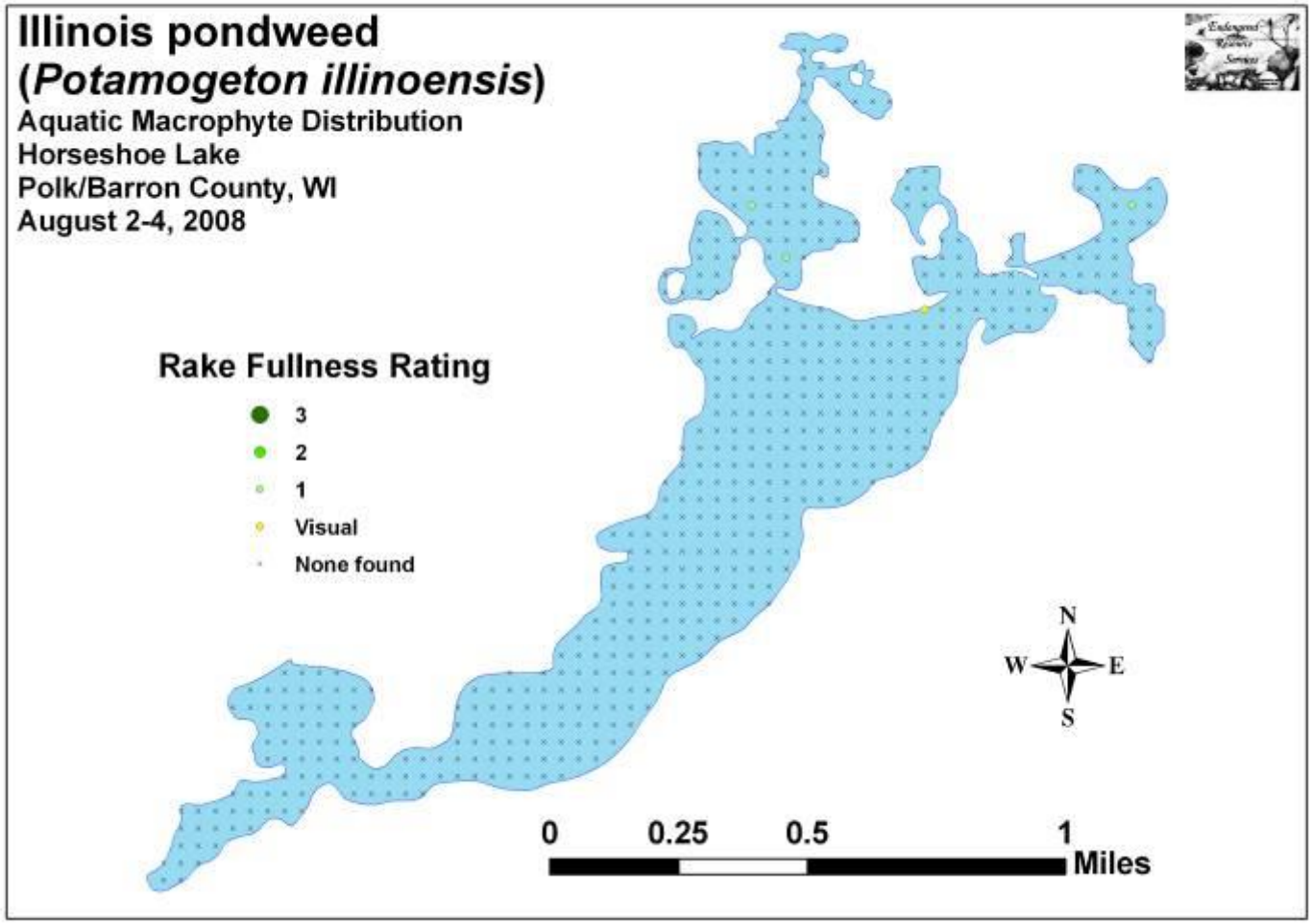

White water lily
(Nymphaea odorata)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

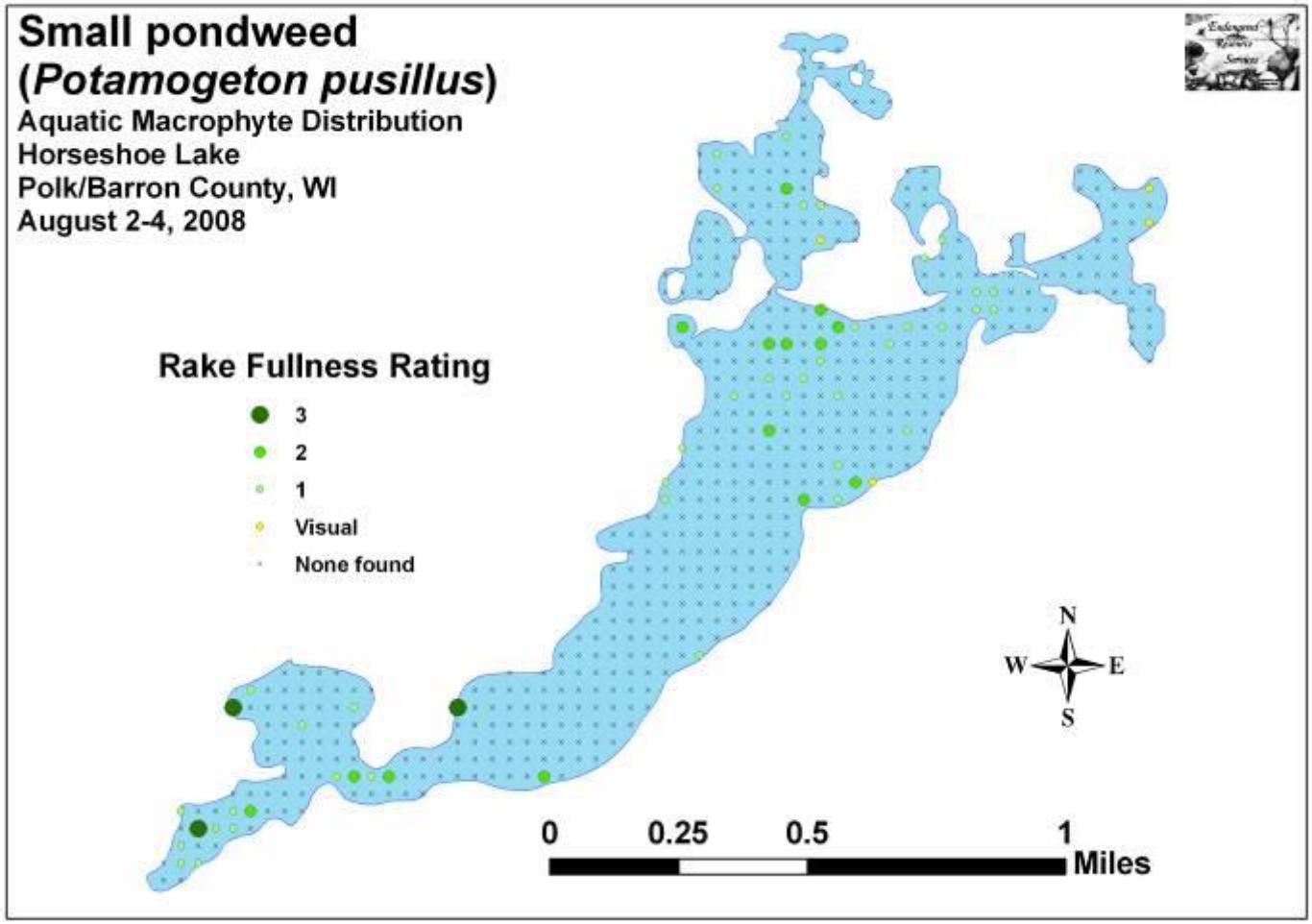

Reed canary grass
(Phalaris arundinacea)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

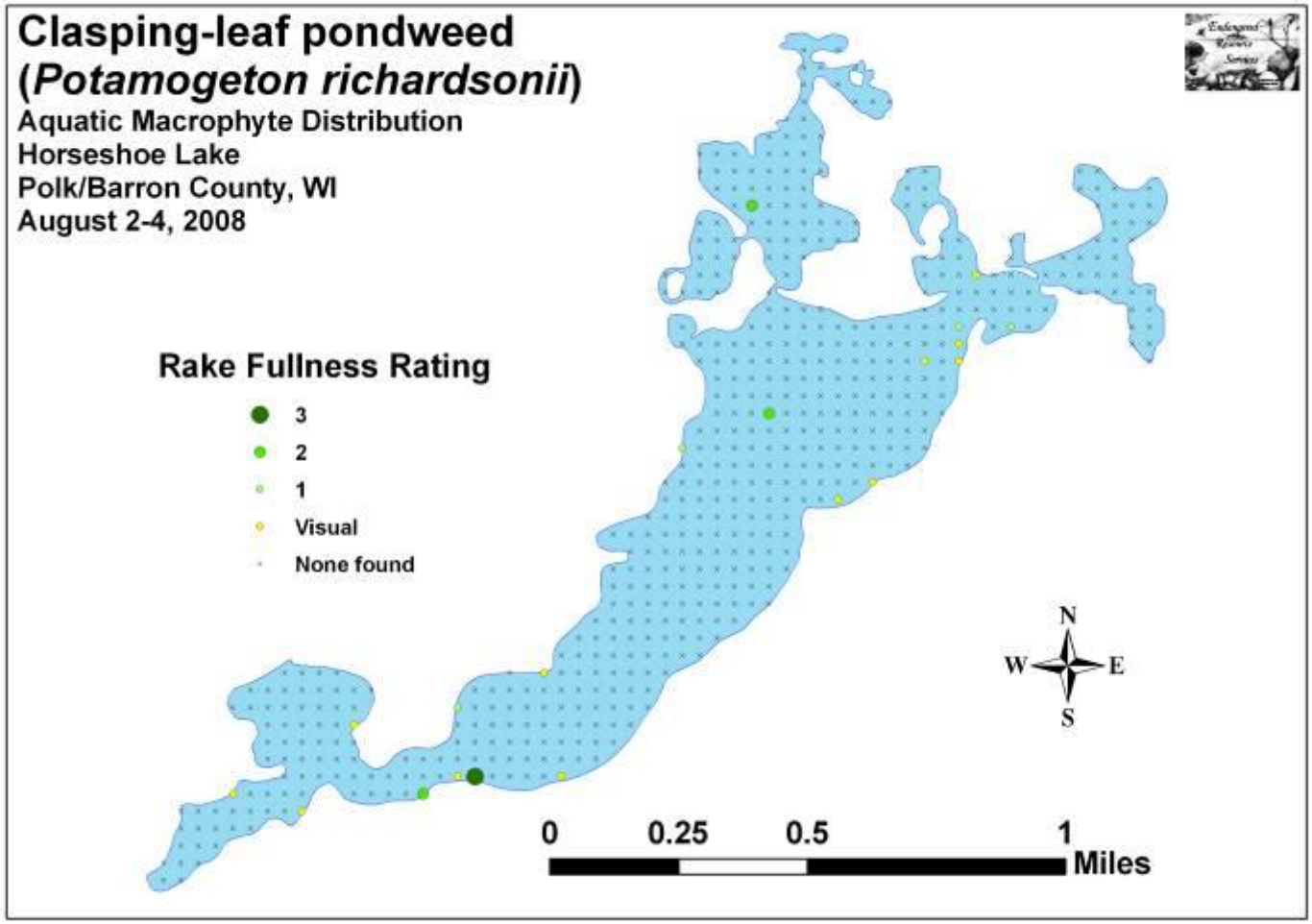

Pickerelweed
(Pontederia cordata)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

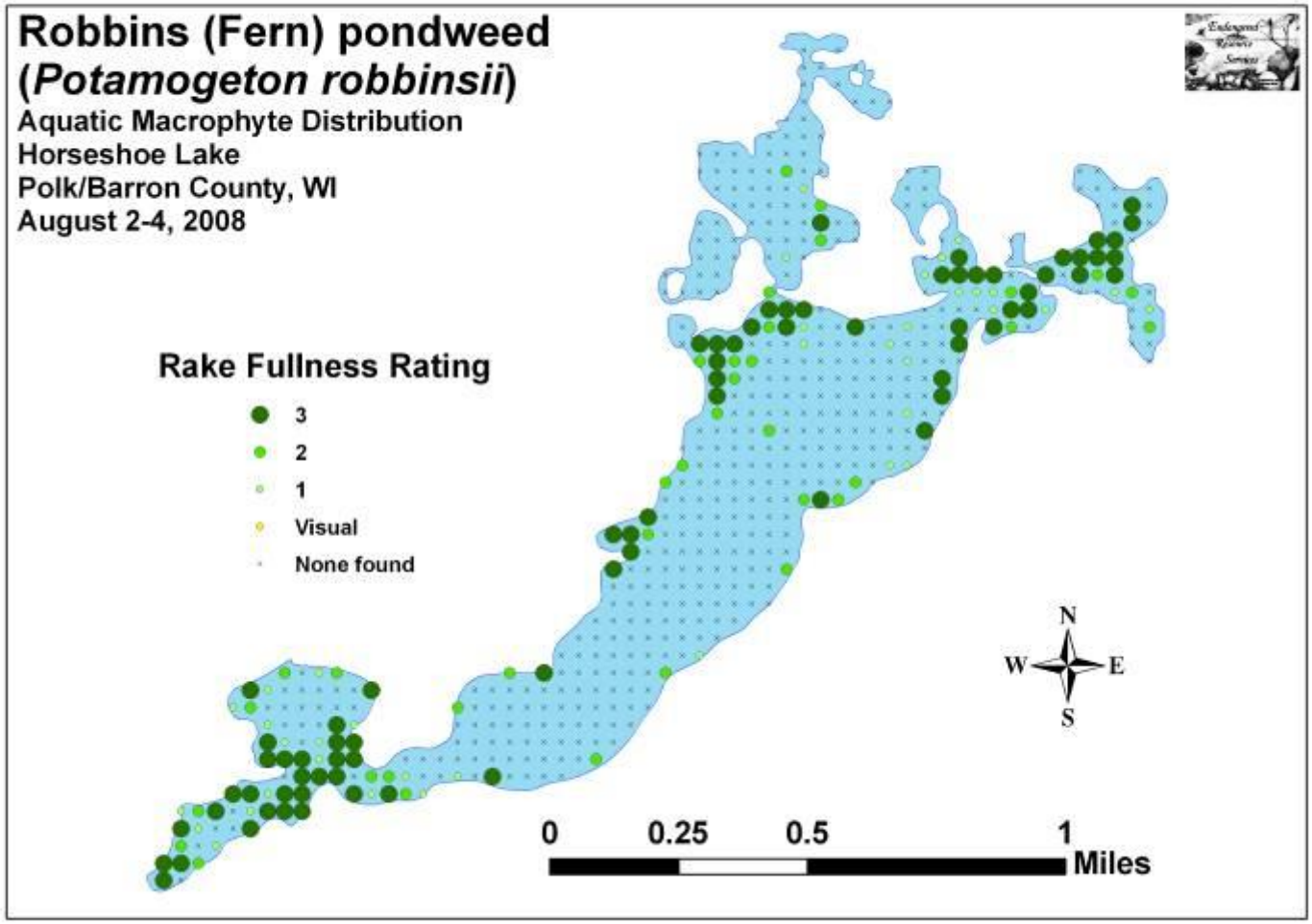

Filament-leaf pondweed
(Potamogeton bicupulatus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

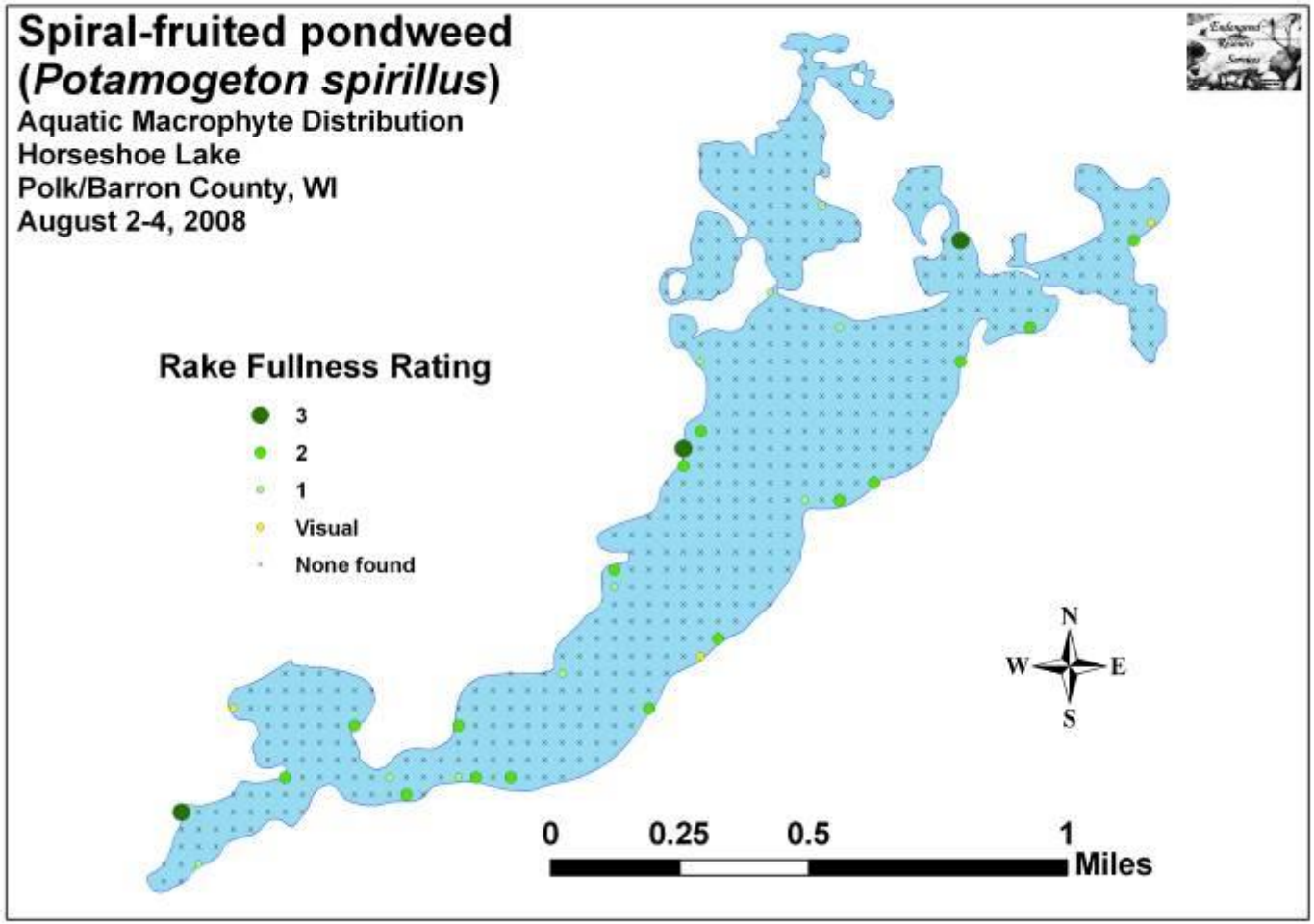

Ribbon-leaf pondweed
(Potamogeton epihydrus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

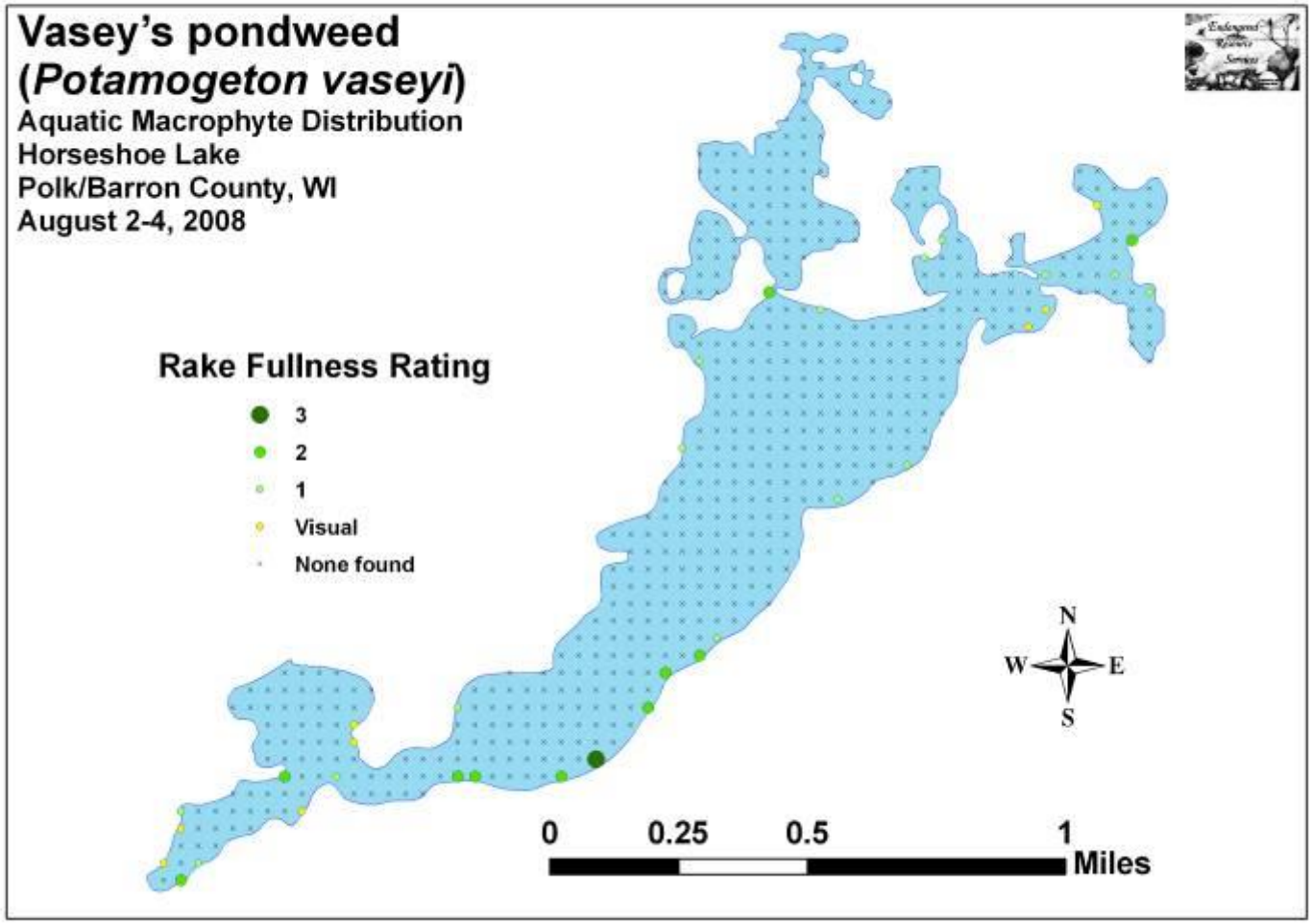

Illinois pondweed
(Potamogeton illinoensis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

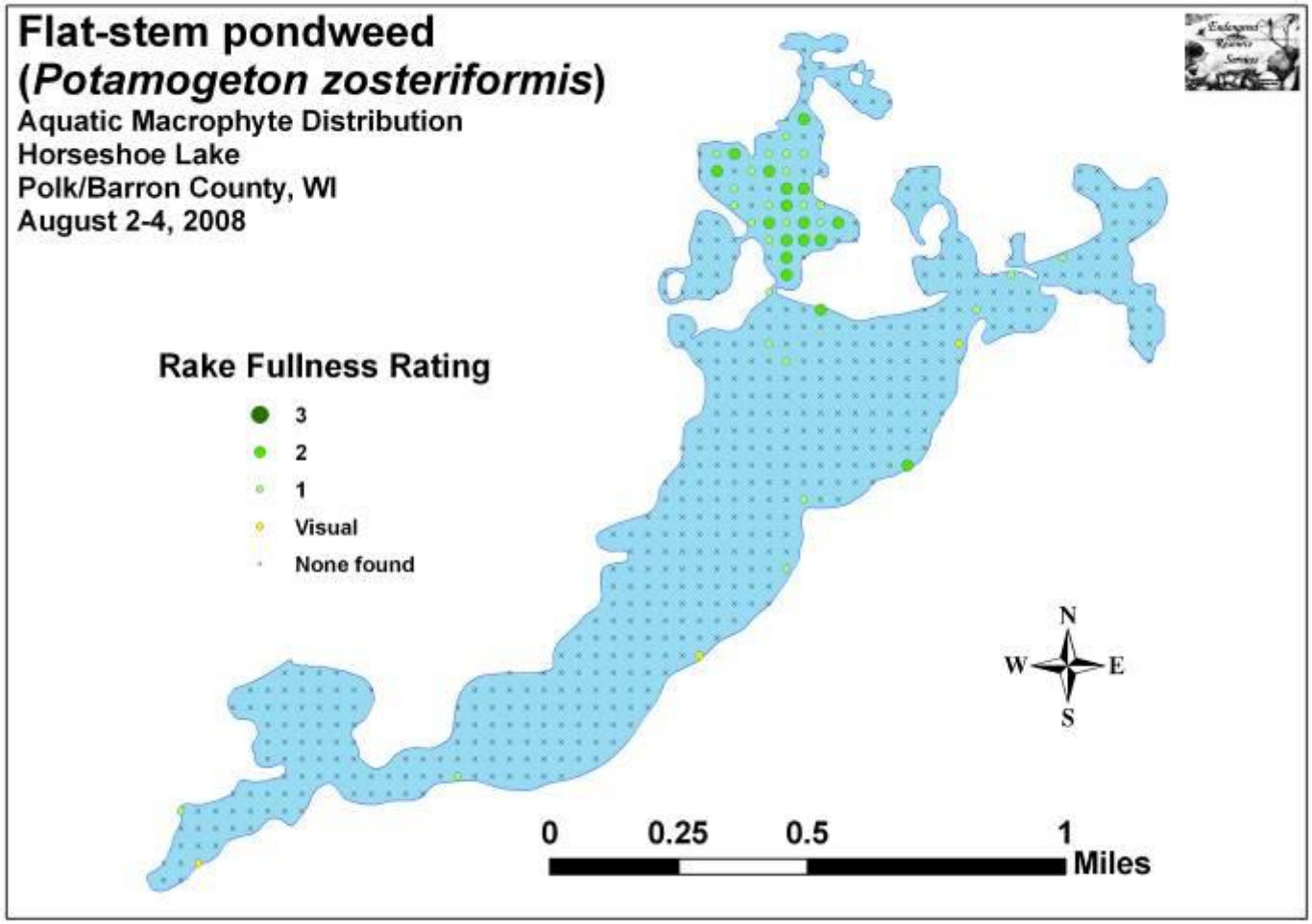

Small pondweed
(Potamogeton pusillus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

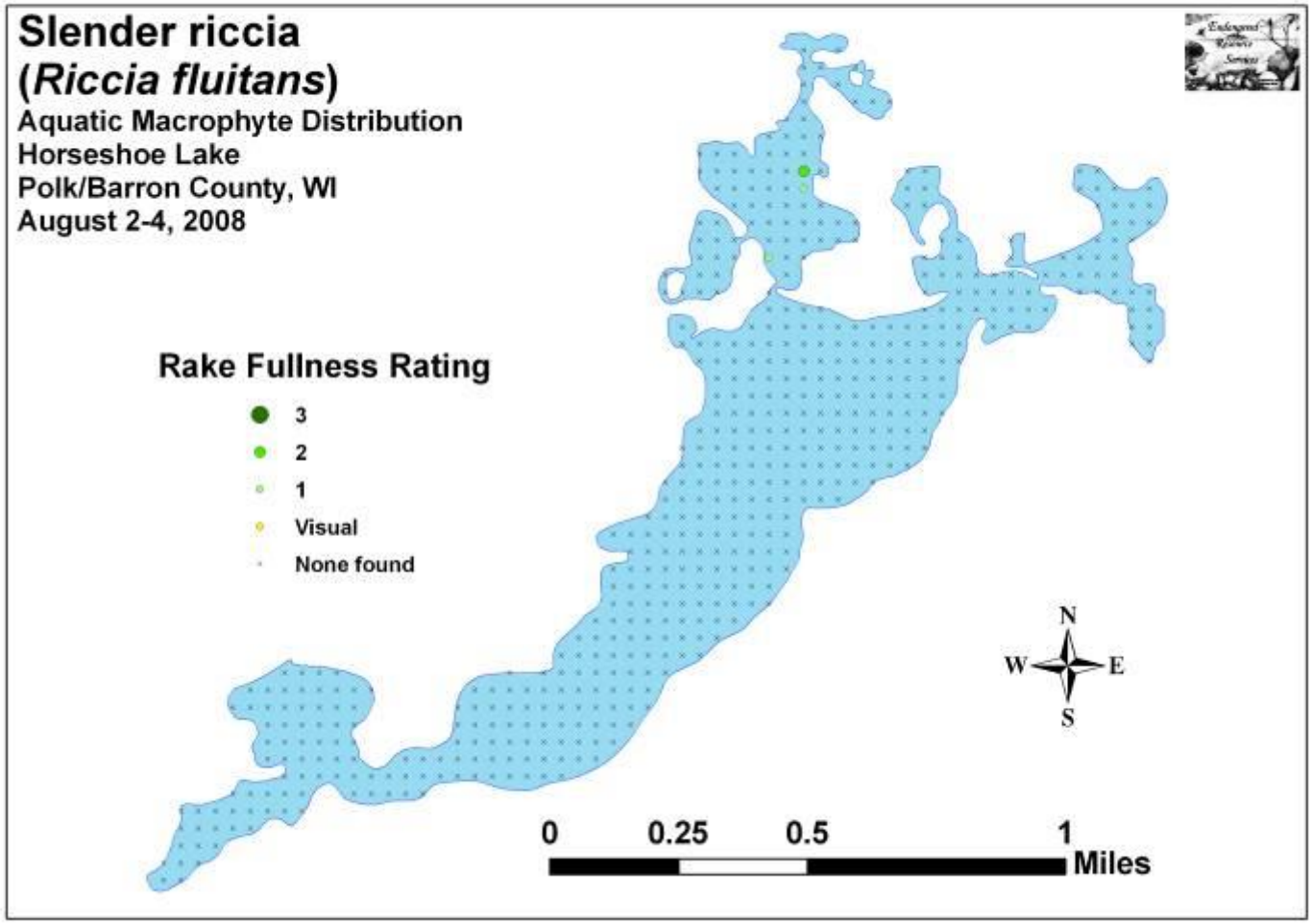

Clasping-leaf pondweed
(Potamogeton richardsonii)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

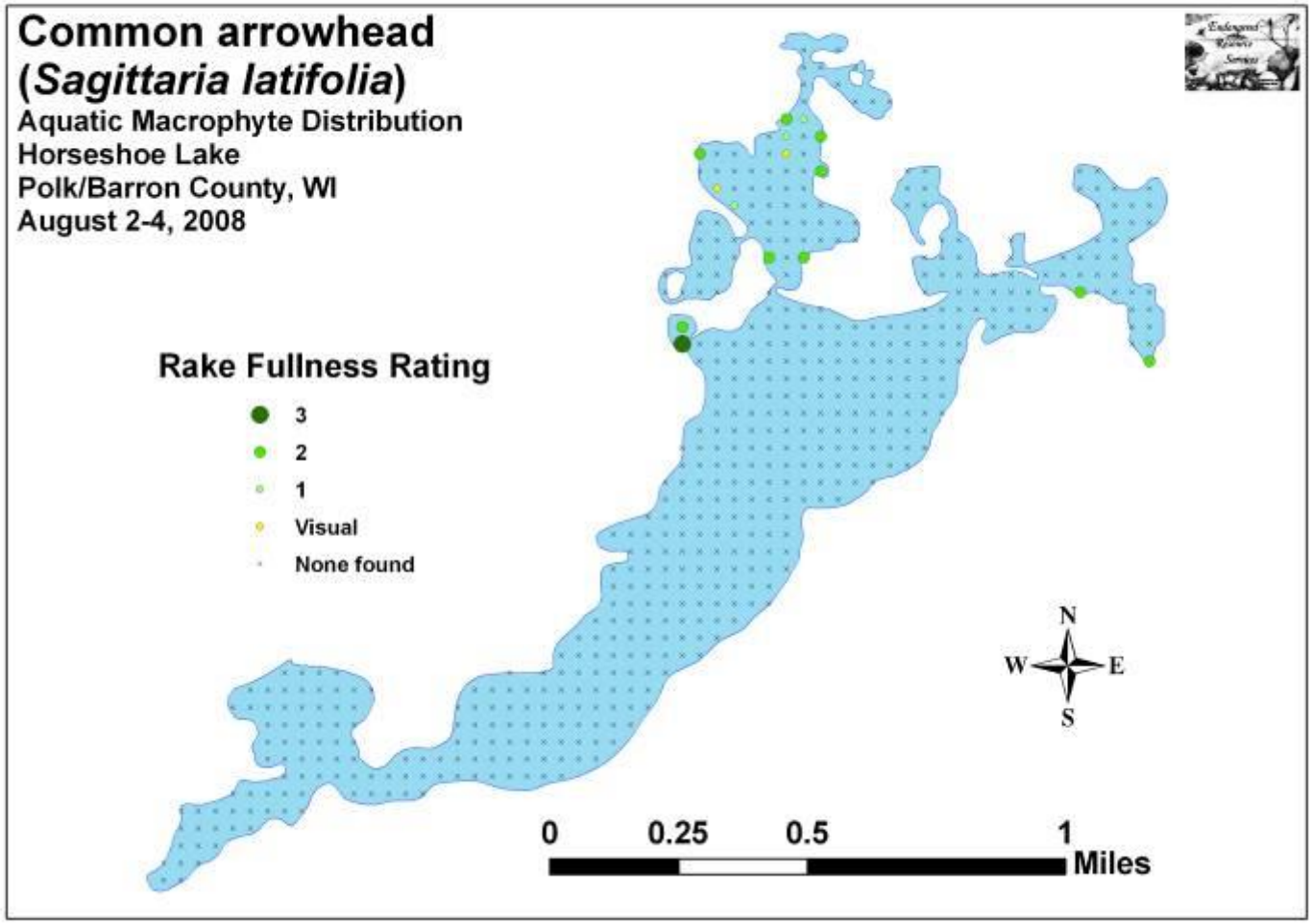

Robbins (Fern) pondweed
(Potamogeton robbinsii)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

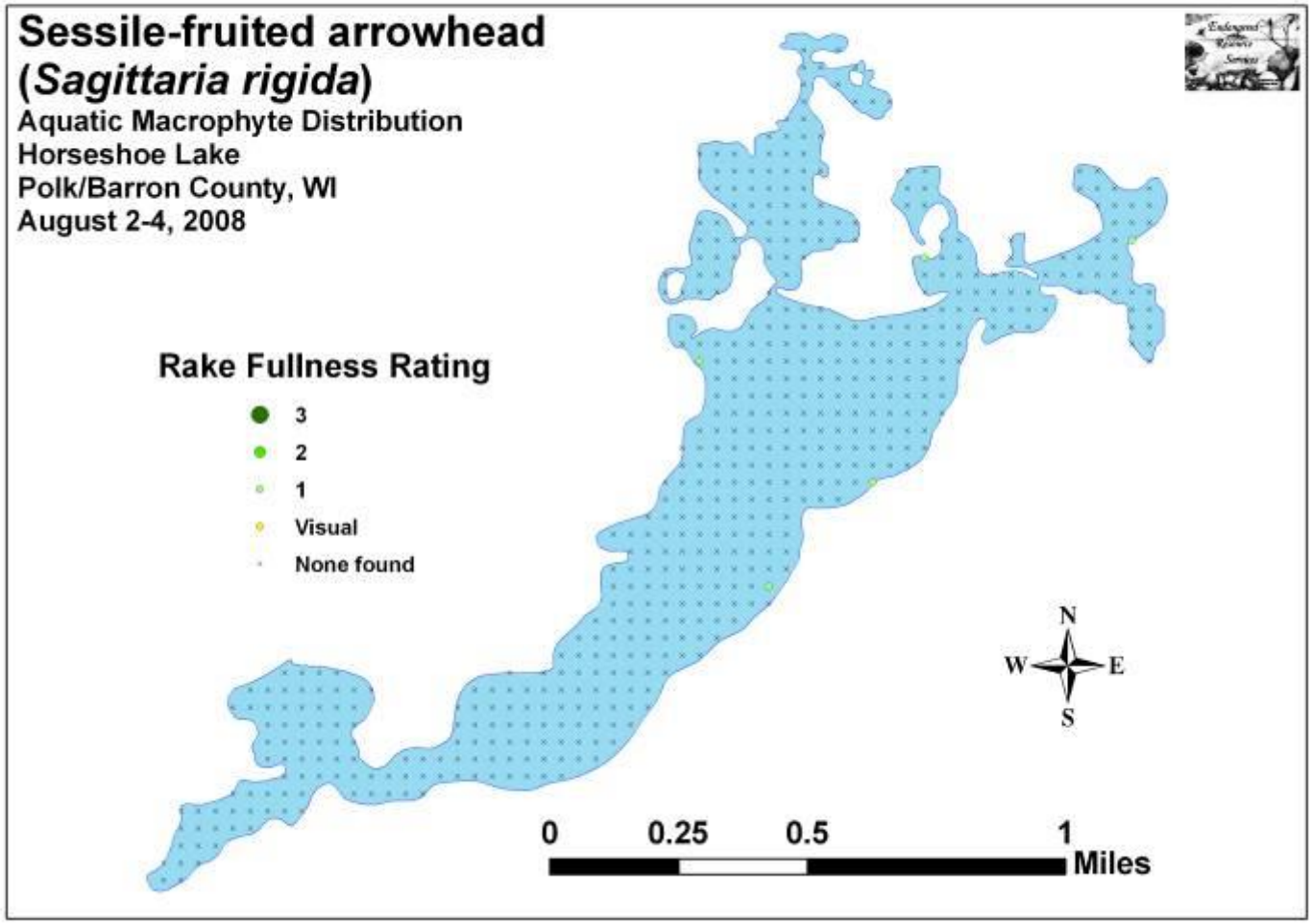

Spiral-fruited pondweed
(Potamogeton spirillus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

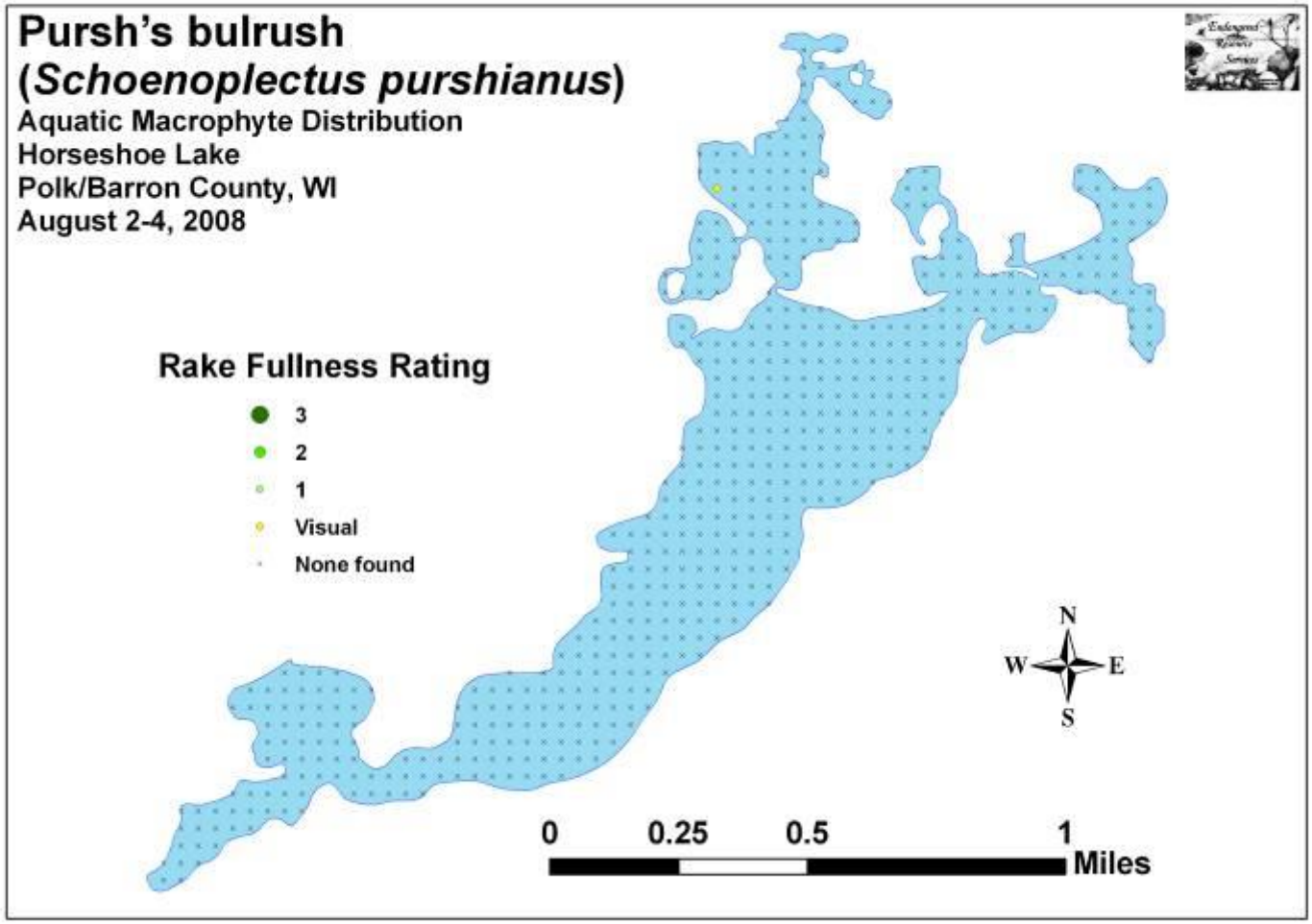

Vasey's pondweed
(Potamogeton vaseyi)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

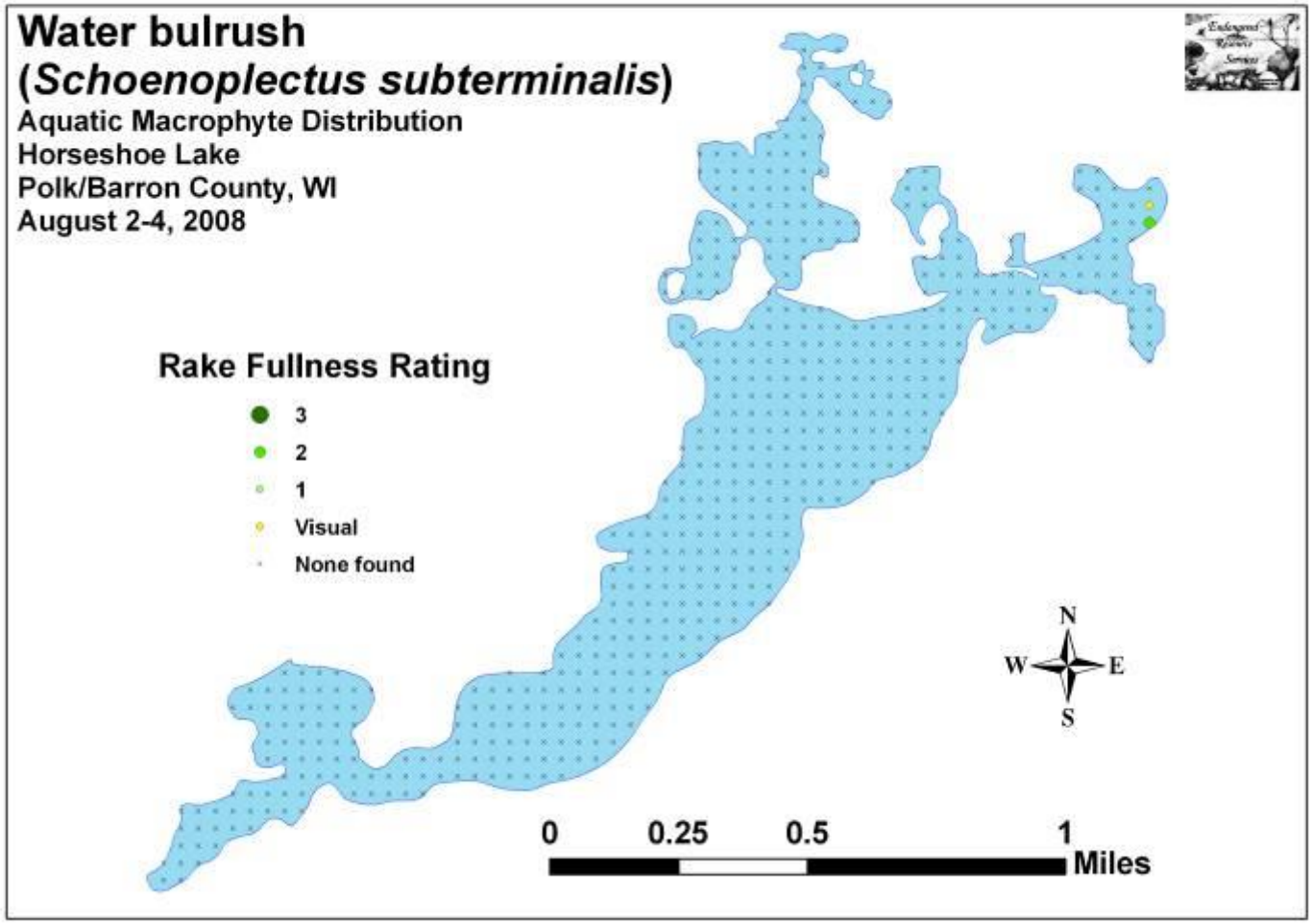

Flat-stem pondweed
(Potamogeton zosteriformis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

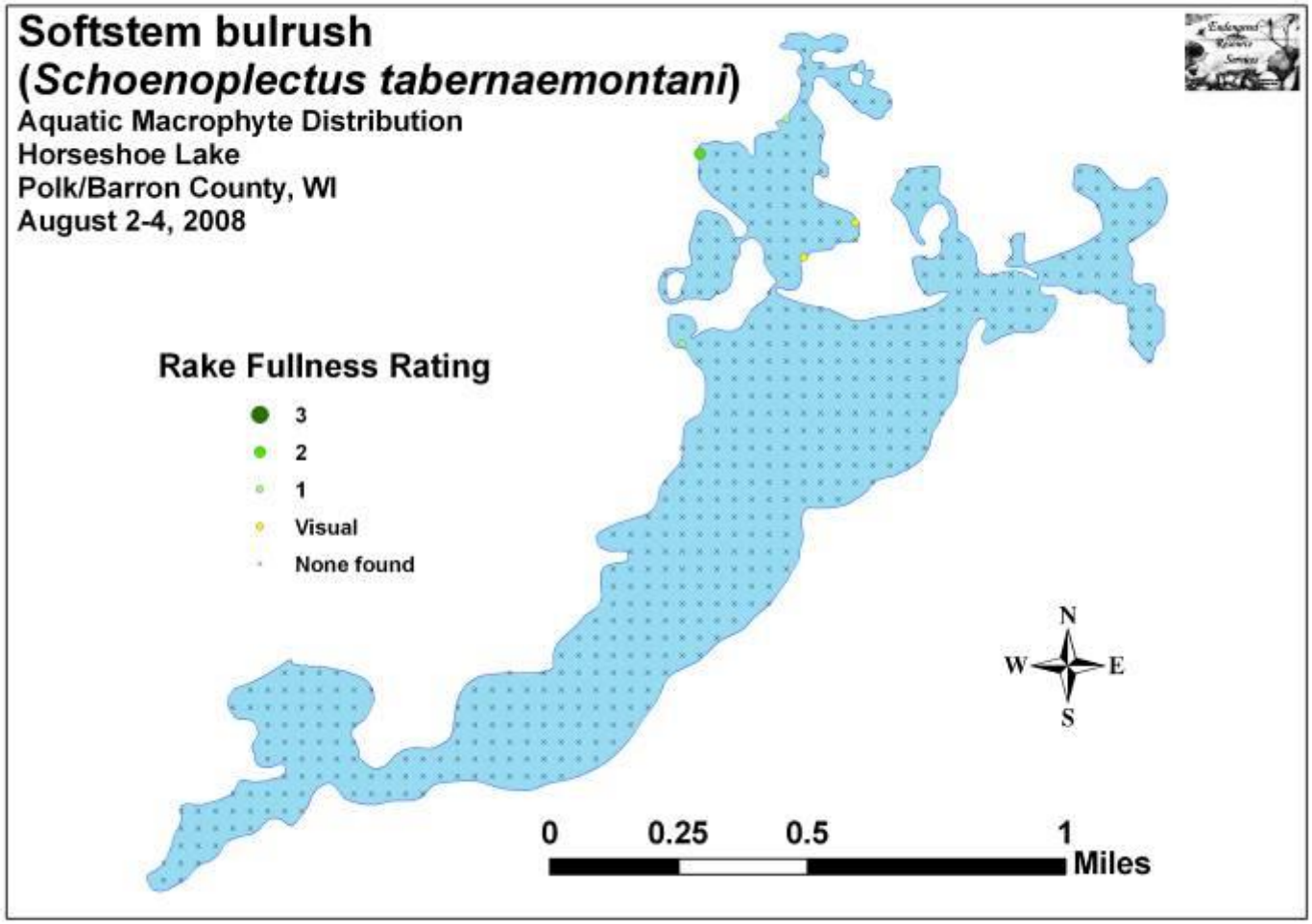

Slender riccia
(Riccia fluitans)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

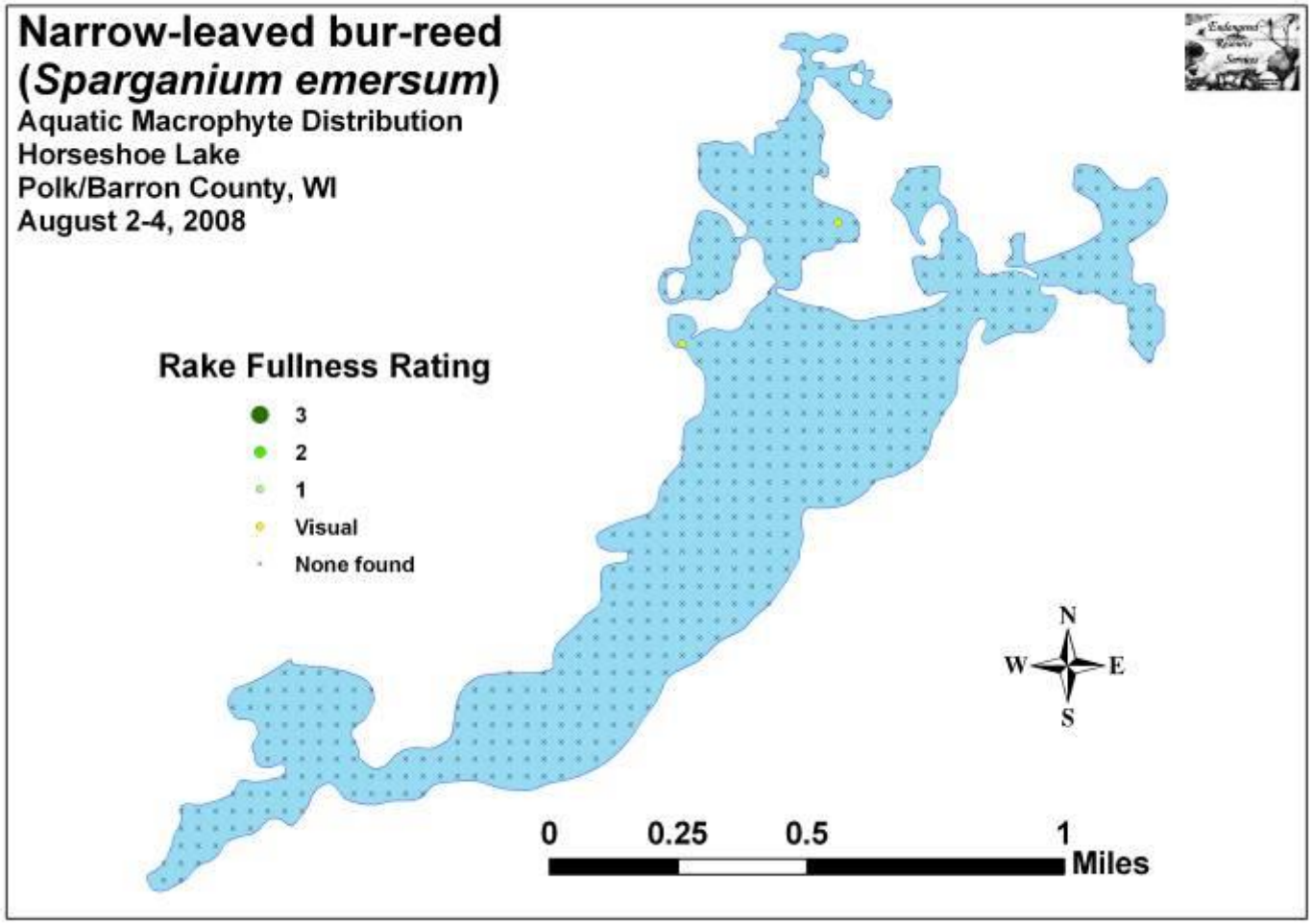

Common arrowhead
(Sagittaria latifolia)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

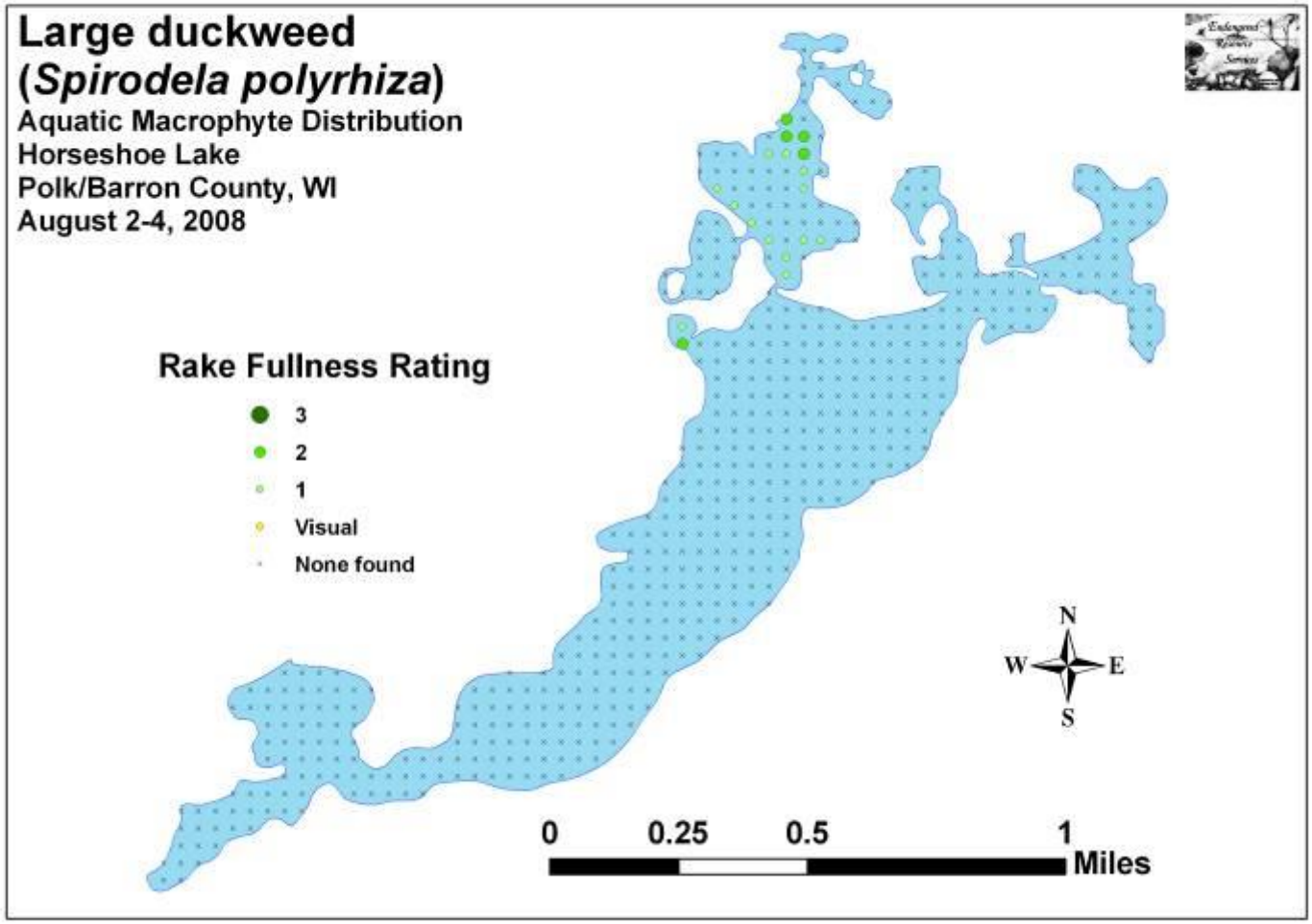

Sessile-fruited arrowhead
(Sagittaria rigida)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

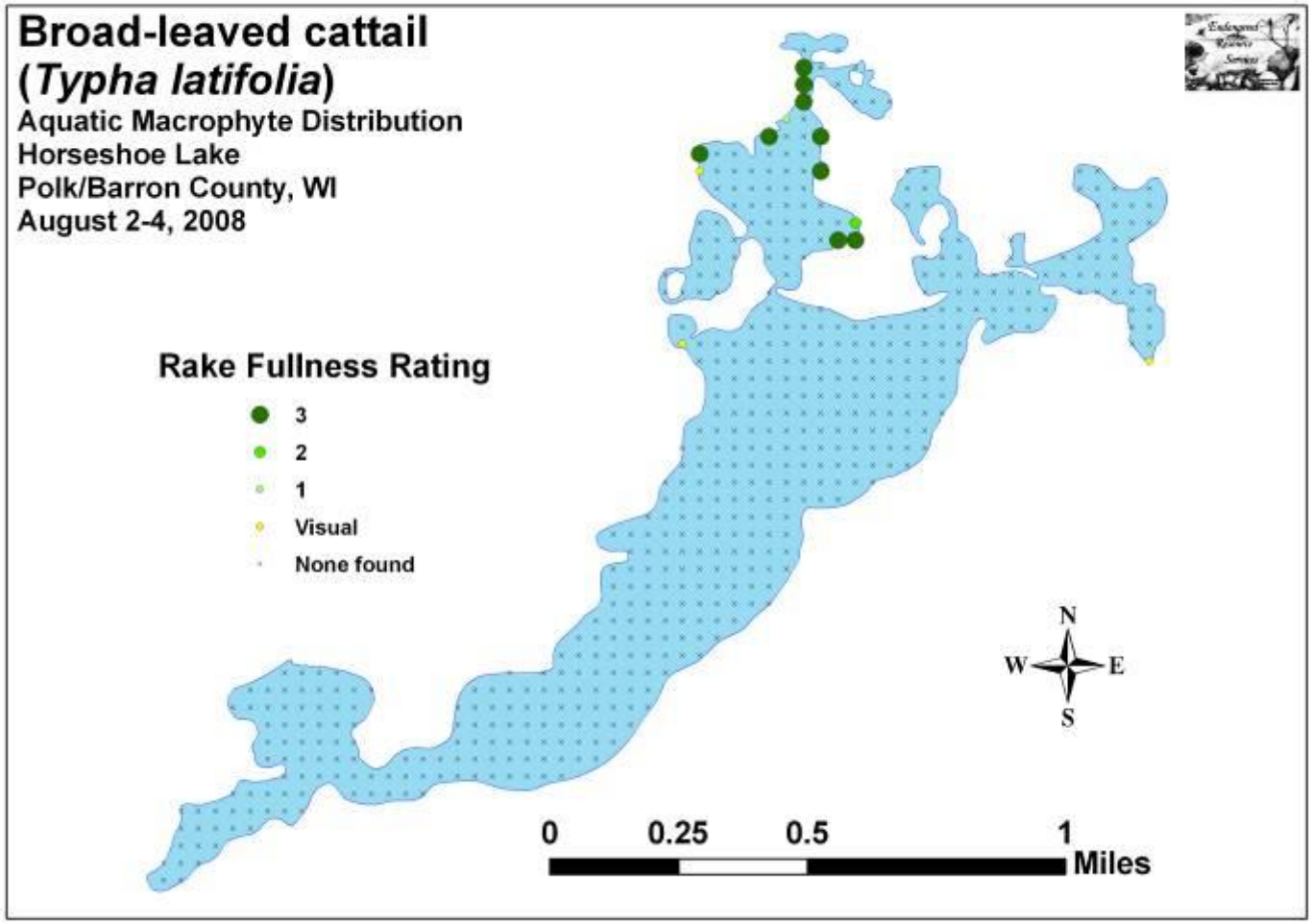

Pursh's bulrush
(Schoenoplectus purshianus)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

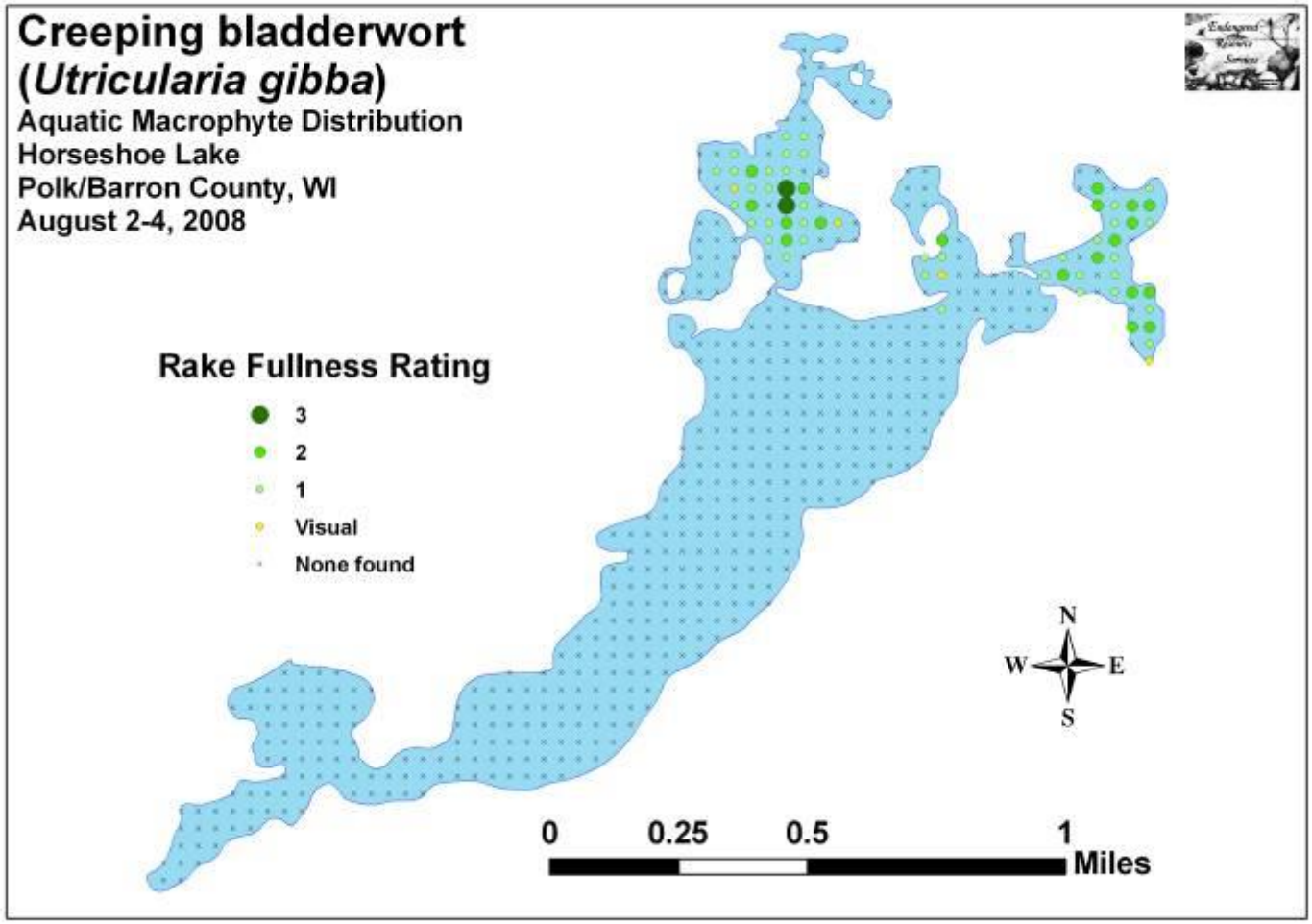

Water bulrush
(Schoenoplectus subterminalis)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

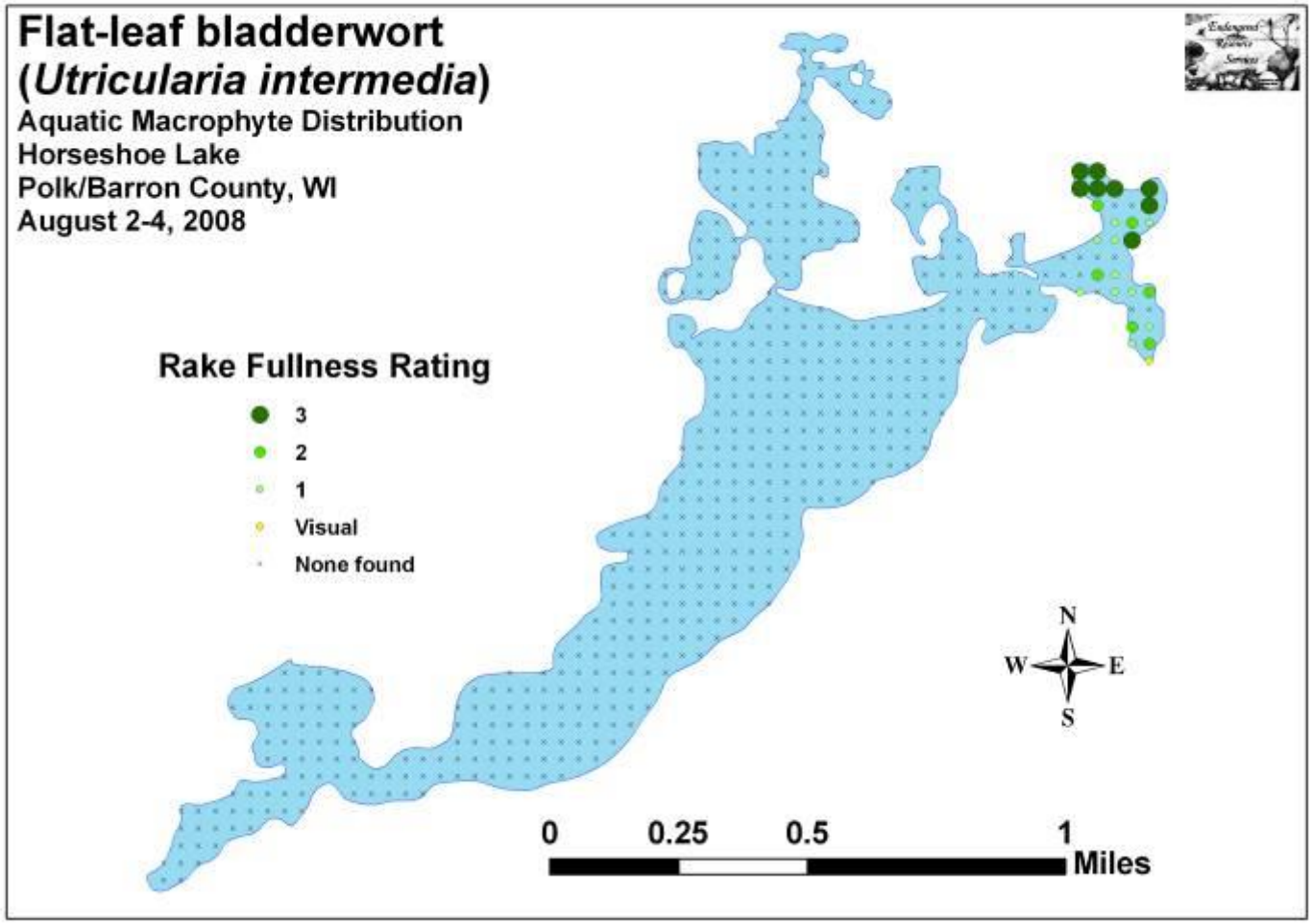

Softstem bulrush
(Schoenoplectus tabernaemontani)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

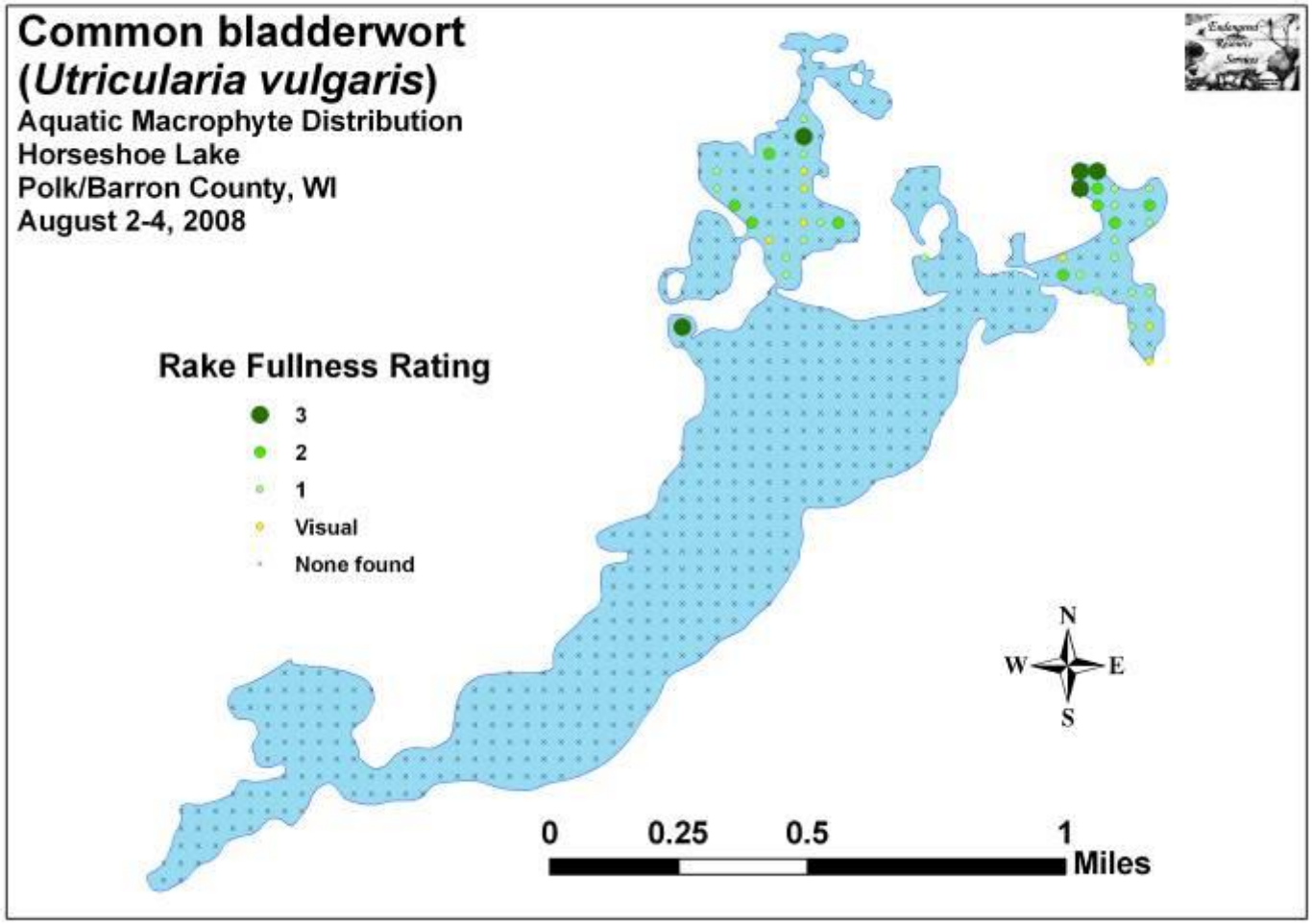

Narrow-leaved bur-reed
(Sparganium emersum)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

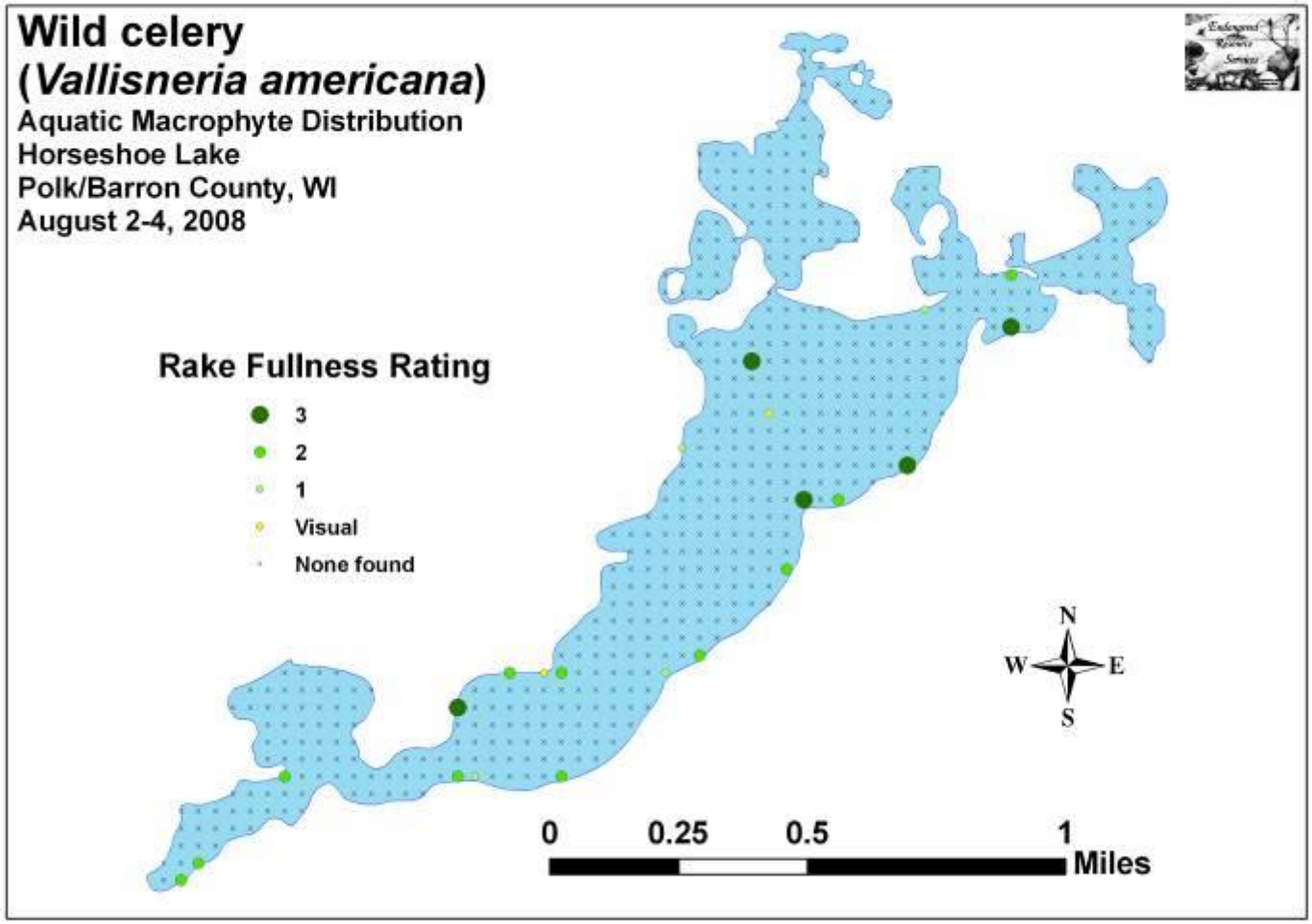

Large duckweed
(Spirodela polyrhiza)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles


Broad-leaved cattail
(Typha latifolia)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

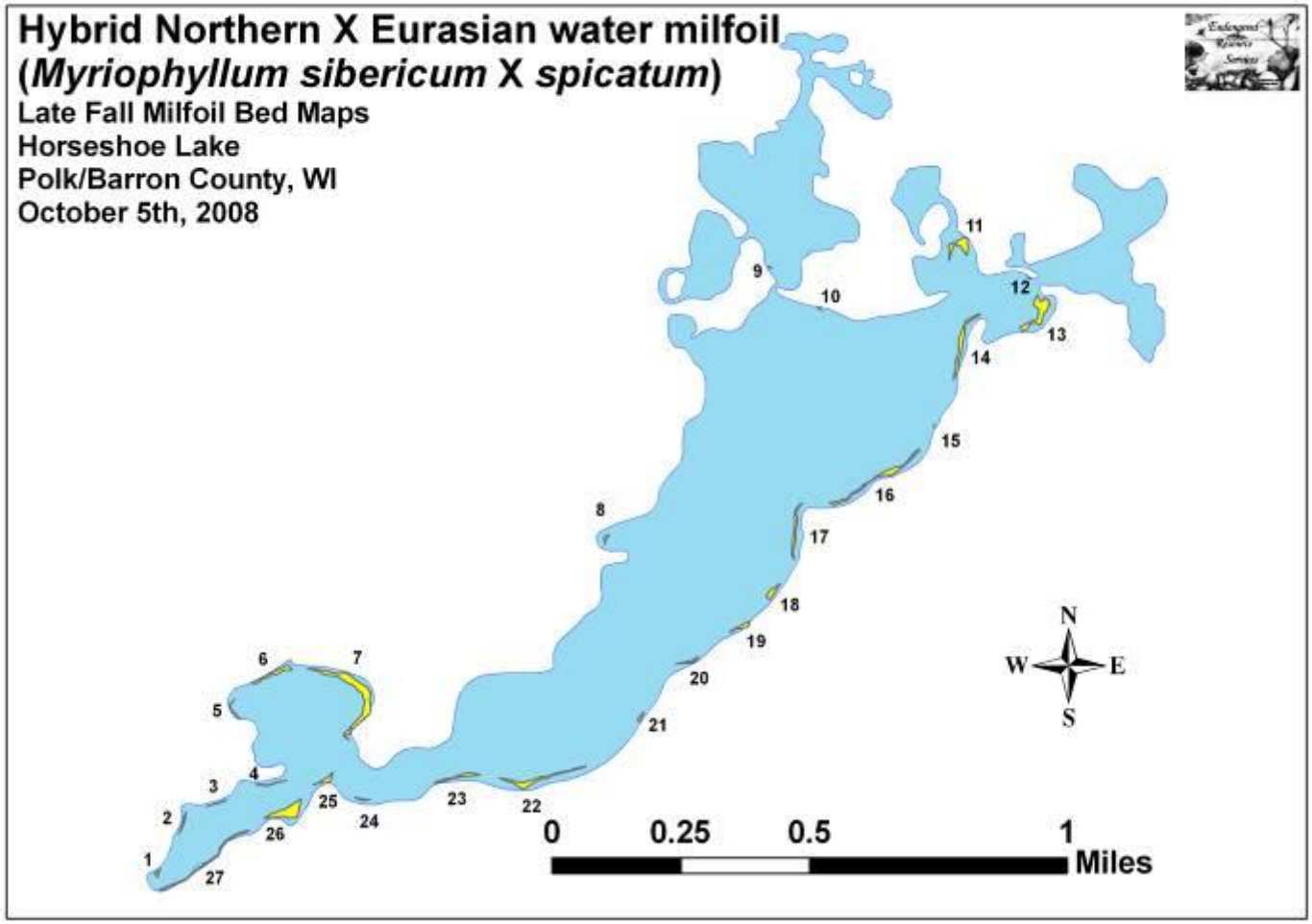

Creeping bladderwort
(Utricularia gibba)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

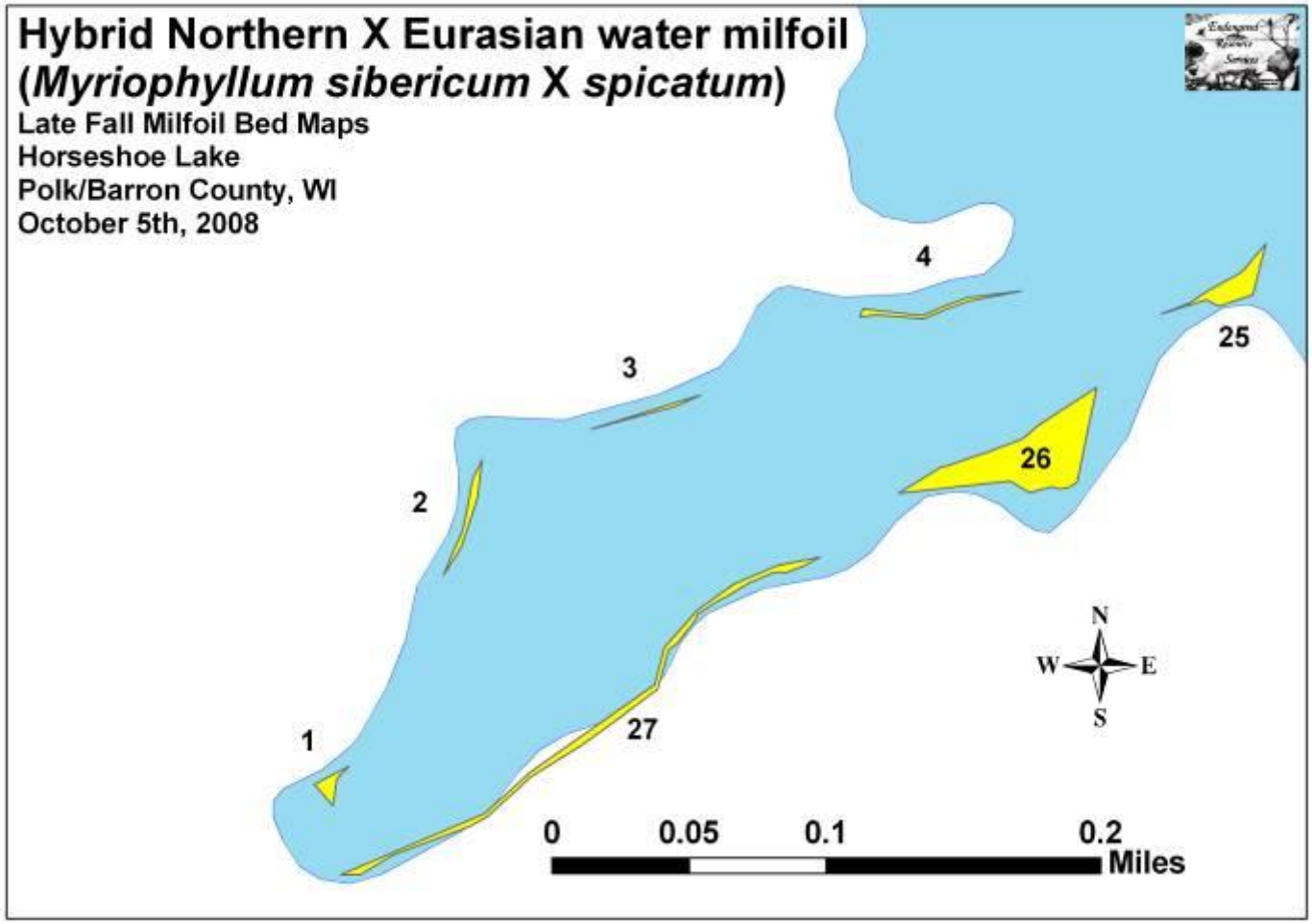

Flat-leaf bladderwort
(Utricularia intermedia)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

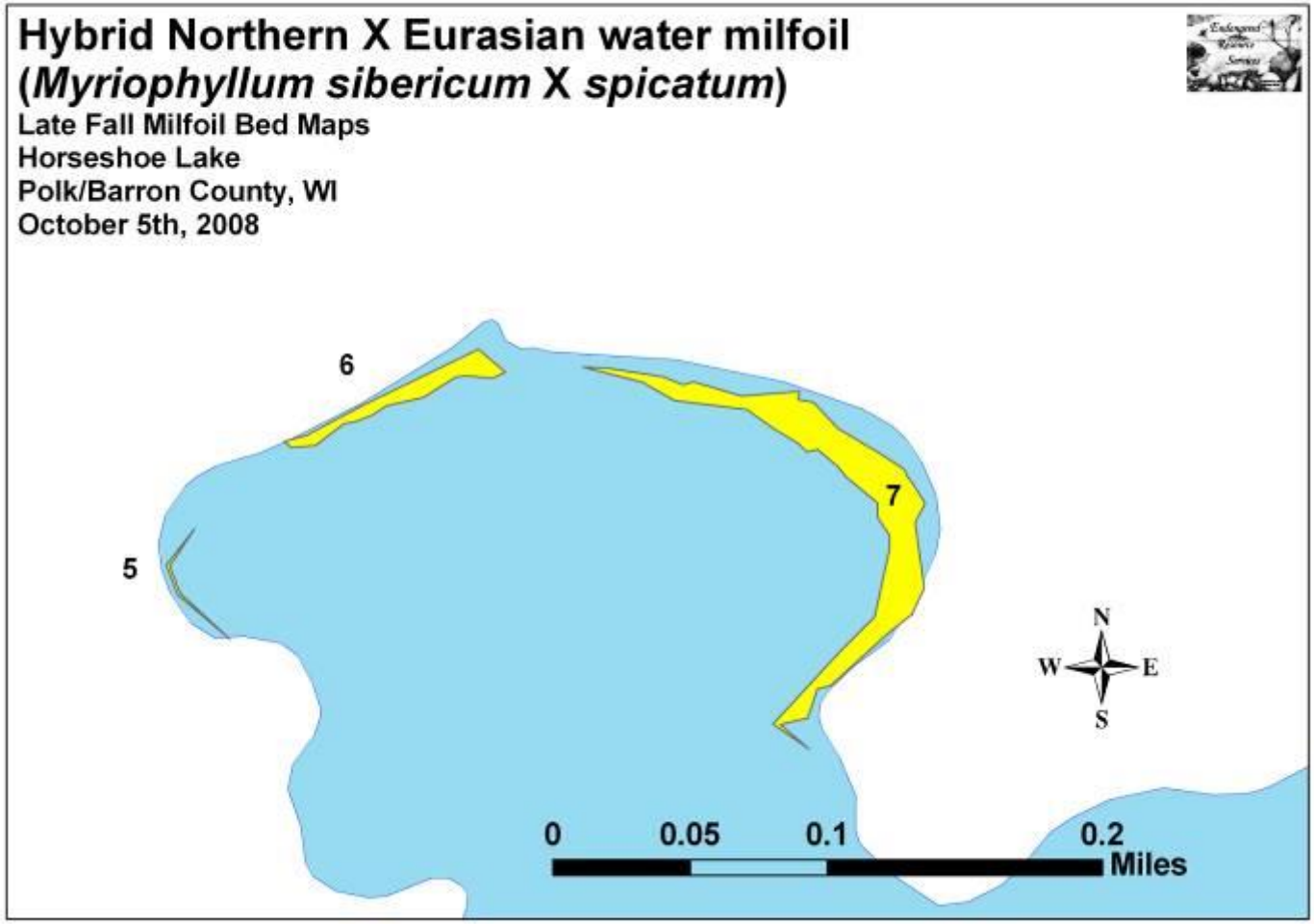

Common bladderwort
(Utricularia vulgaris)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

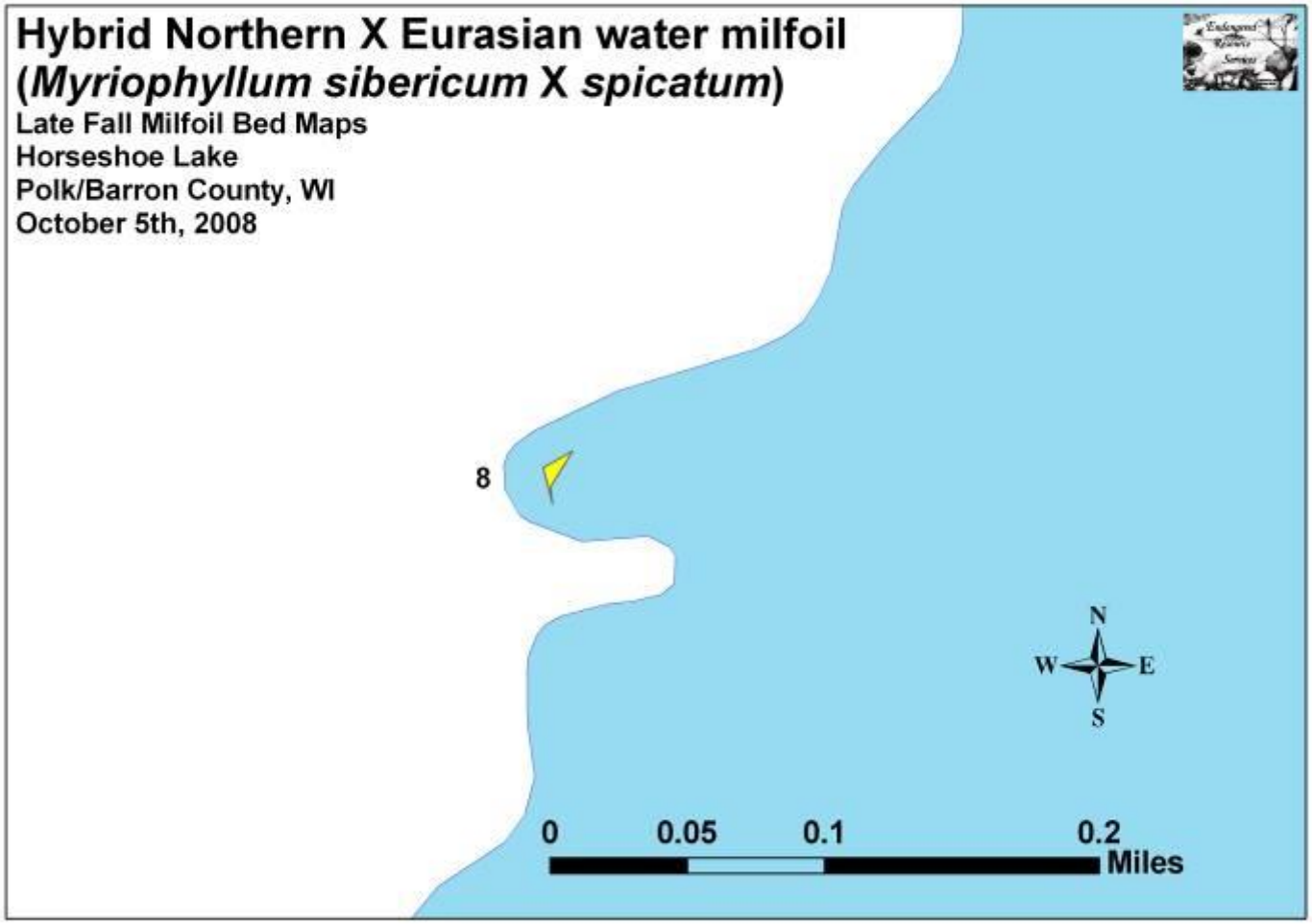

Wild celery
(Vallisneria americana)
Aquatic Macrophyte Distribution
Horseshoe Lake
Polk/Barron County, WI
August 2-4, 2008
Rake Fullness Rating
3
2
1
Visual
None found
N
W
E
S
0
0.25
0.5
1
Miles

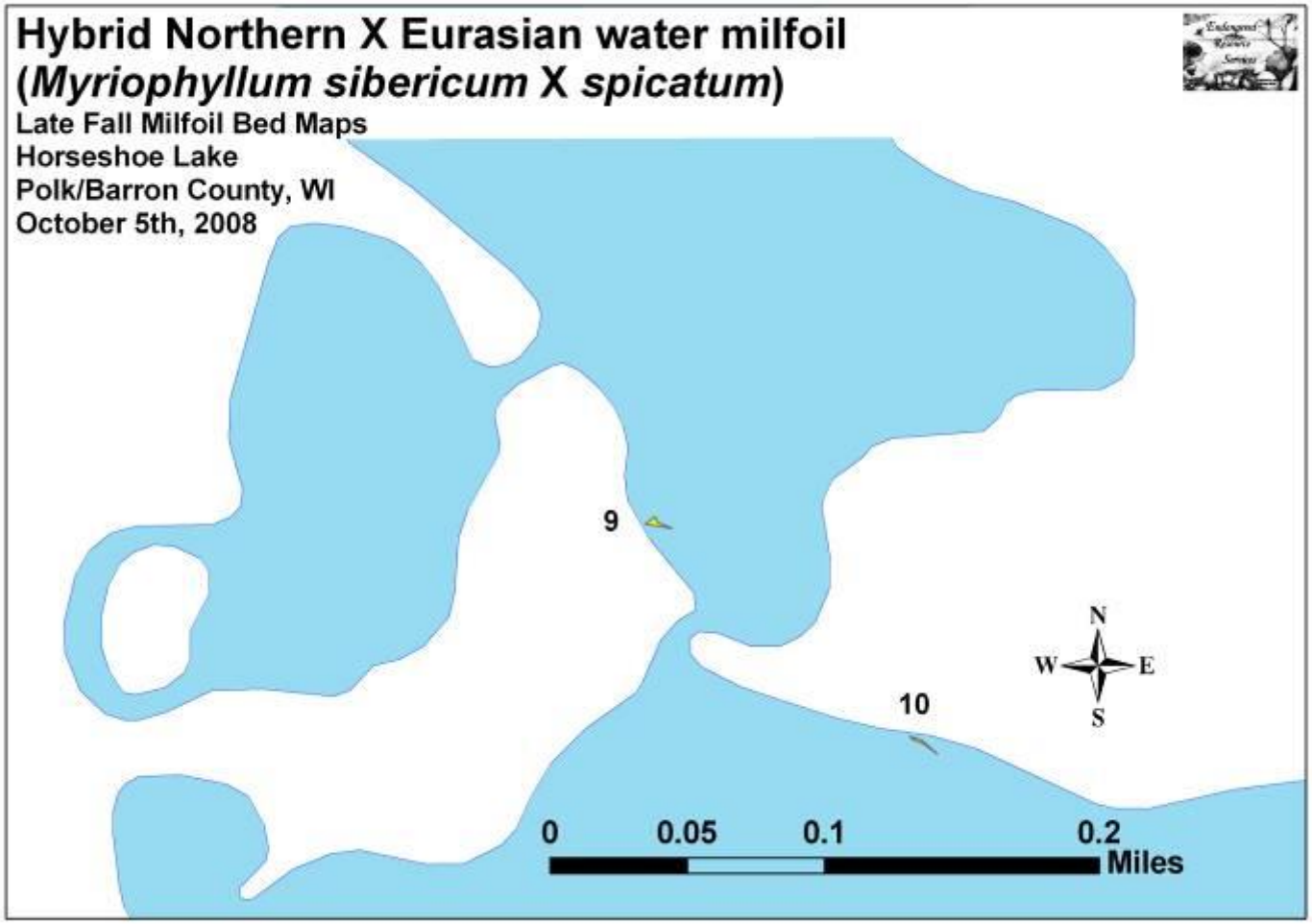
VIII: Fall Hybrid Water Milfoil Bed Maps

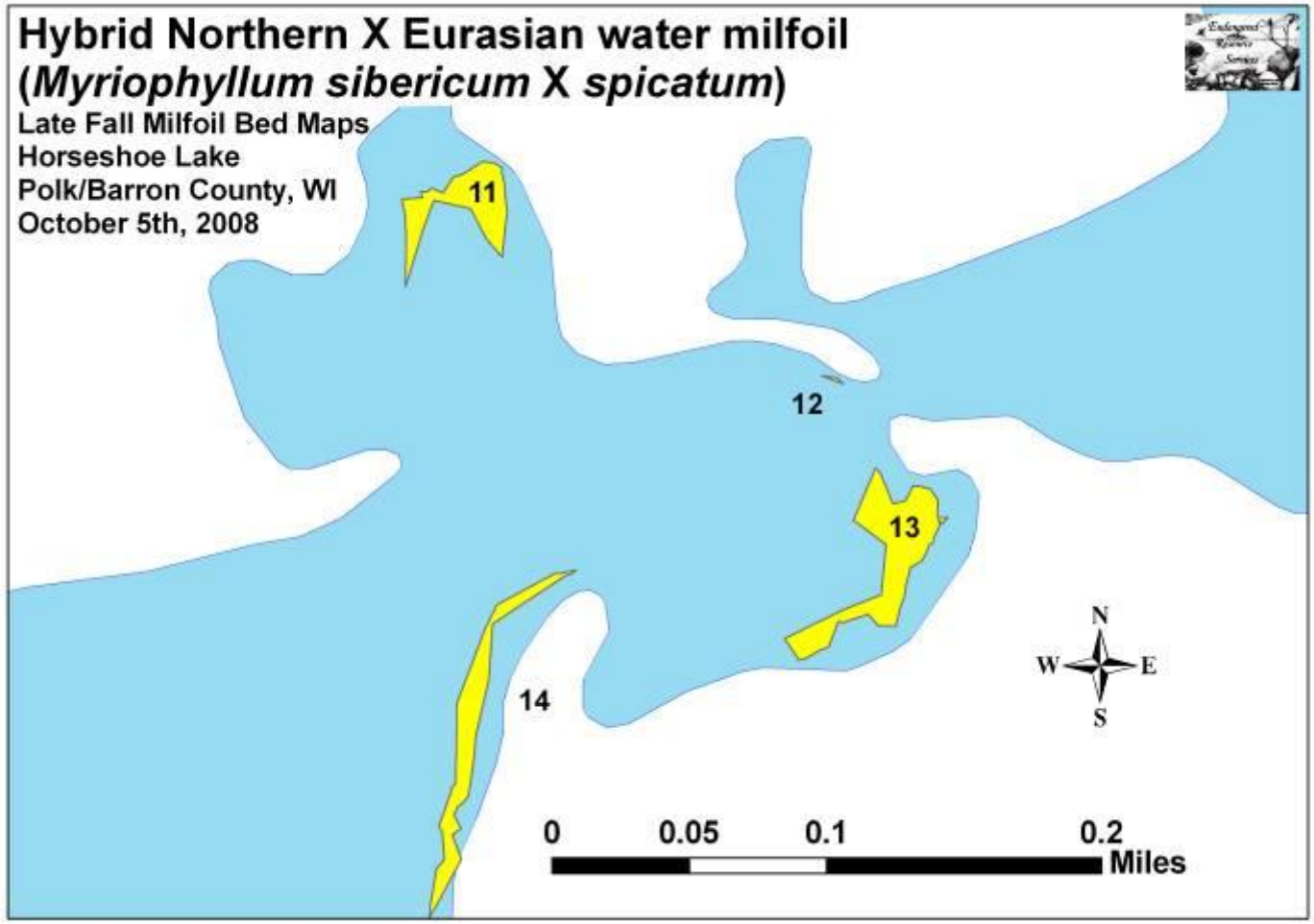

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
N
W
E
S
0
0.25
0.5
1
Miles

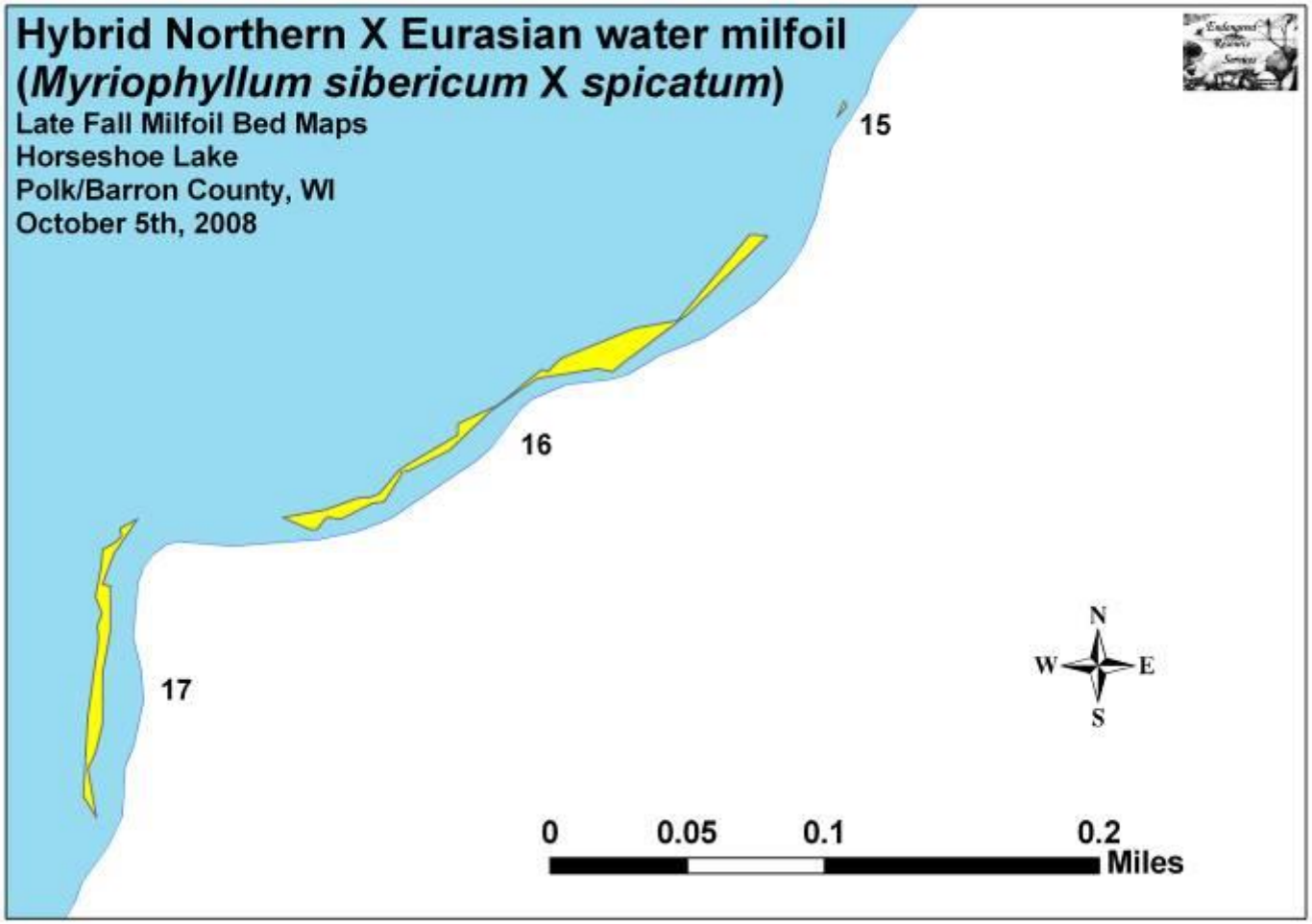

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
1
2
3
4
25
26
27
N
W
E
S
0
0.05
0.1
0.2
Miles

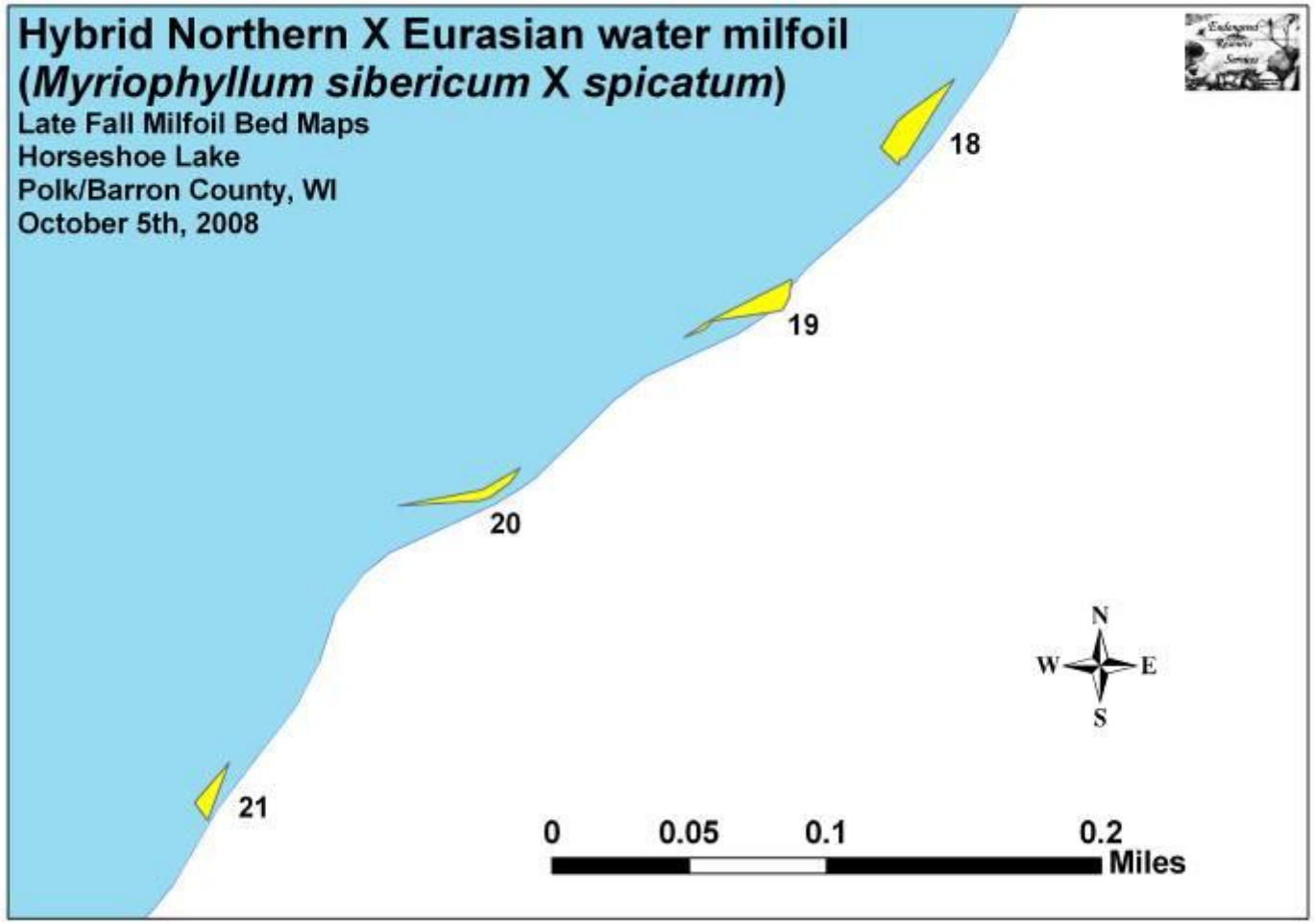

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
6
7
5
N
W
E
S
0
0.05
0.1
0.2
Miles

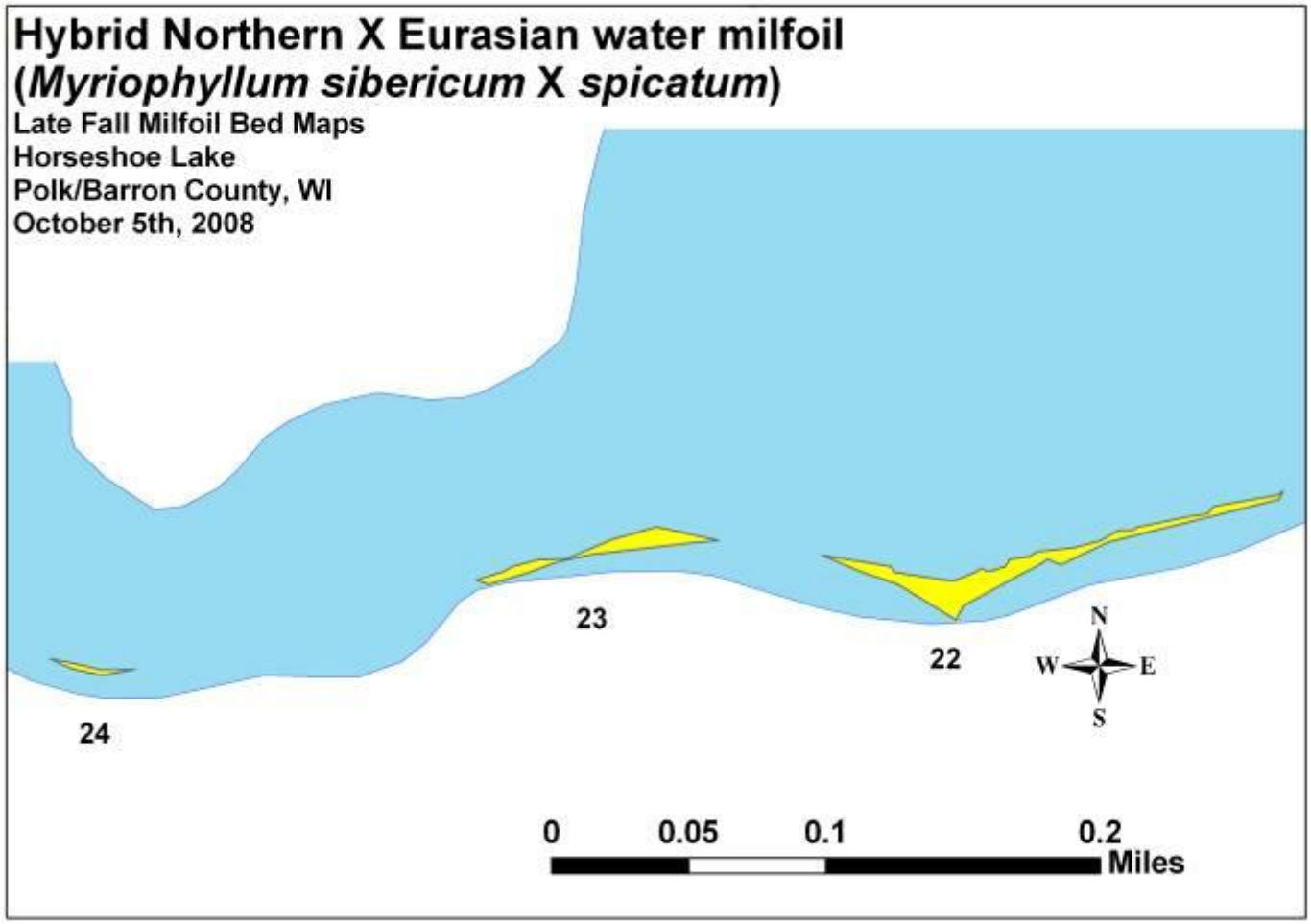

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
8
N
W
E
S
0
0.05
0.1
0.2
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
9
10
N
W
E
S
0
0.05
0.1
0.2
Miles

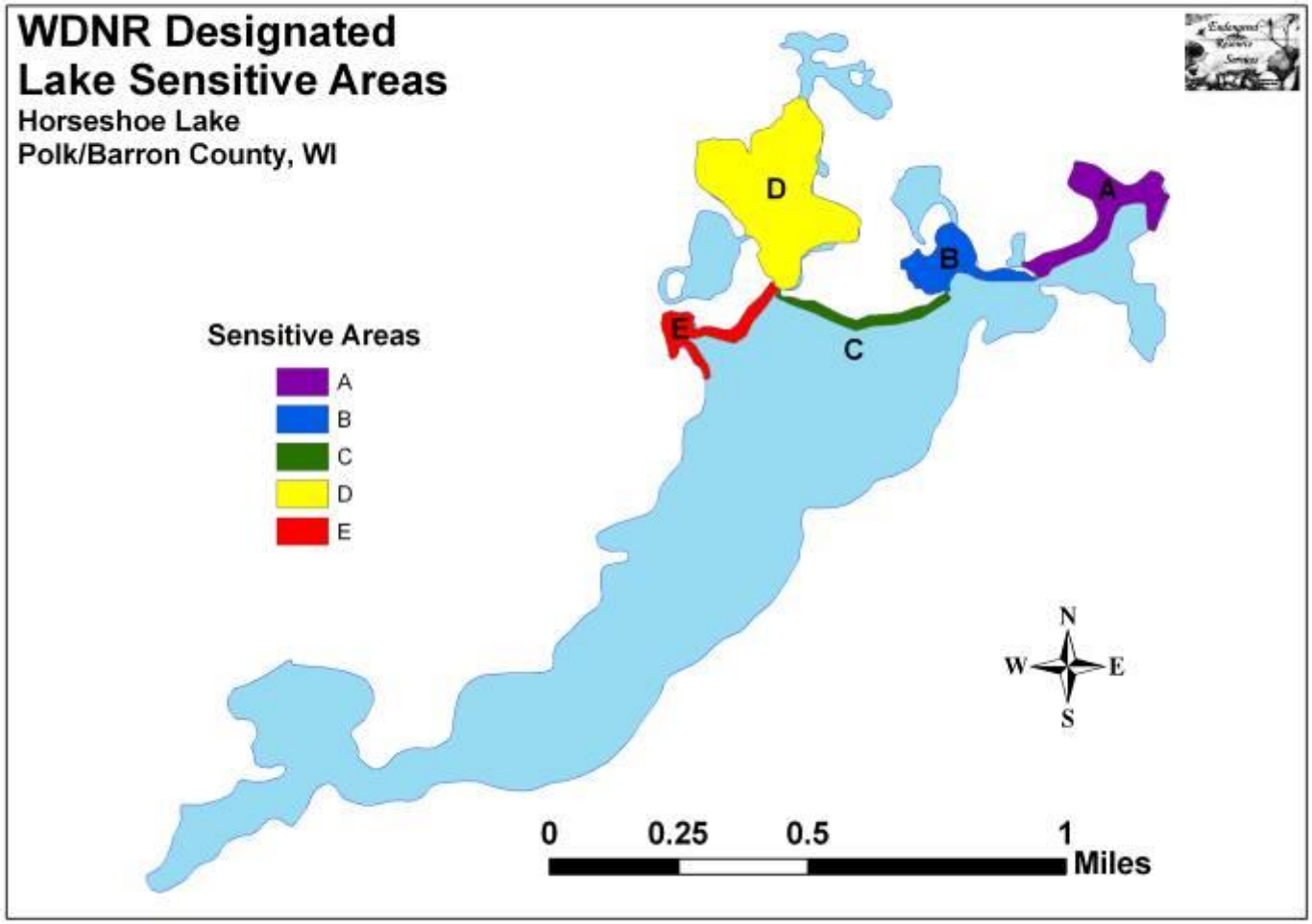

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
11
12
13
14
N
W
E
S
0
0.05
0.1
0.2
Miles

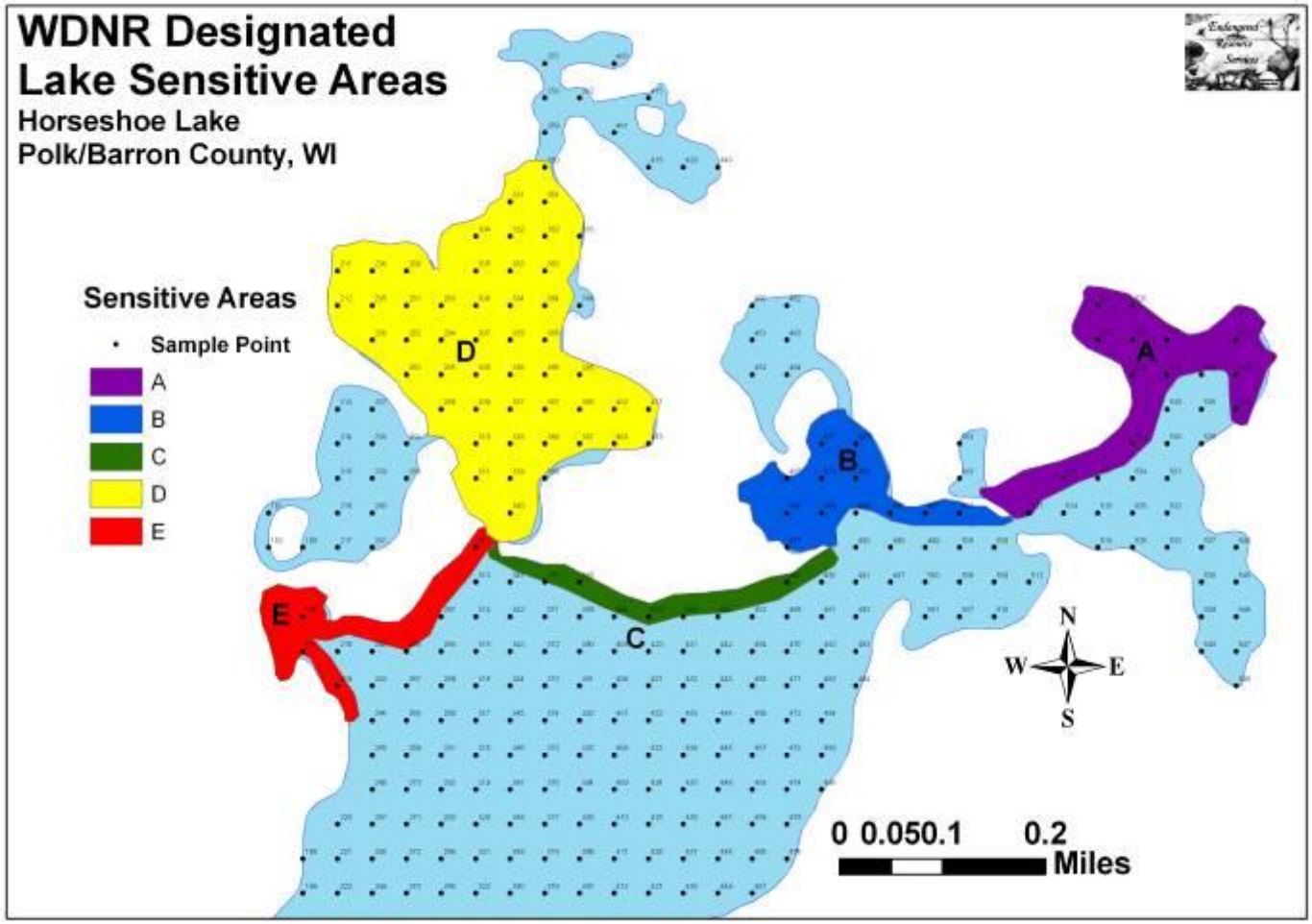

Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
15
16
17
N
W
E
S
0
0.05
0.1
0.2
Miles


Hybrid Northern X Eurasian water milfoil
(Myriophyllum sibericum X spicatum)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
18
19
20
21
N
W
E
S
0
0.05
0.1
0.2
Miles


Hybrid Northern X Eurasian water milfoil
(*Myriophyllum sibericum* X *spicatum*)
Late Fall Milfoil Bed Maps
Horseshoe Lake
Polk/Barron County, WI
October 5th, 2008
24
23
22
N
W
E
S
0
0.05
0.1
0.2
Miles

Appendix IX: Horseshoe Lake Sensitive Areas Maps


WDNR Designated
Lake Sensitive Areas
Horseshoe Lake
Polk/Barron County, WI
Sensitive Areas
A
B
C
D
E
N
W
E
S
0
0.25
0.5
1
Miles


WDNR Designated
Lake Sensitive Areas
Horseshoe Lake
Polk/Barron County, WI
Sensitive Areas
Sample Point
A
B
C
D
E
N
W
E
S
0 0.050.1 0.2
Miles

Appendix X: Glossary of Biological Terms
(Adapted from UWEX 2008)

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 XI: Aquatic Exotic 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, 2008 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, 2008 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, 2008 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, 2008 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)

Appendix XII: Raw Data Spreadsheets