Curly-leaf Pondweed and Full Warm Water Point/Intercept Macrophyte Surveys
Potato Lake (WBIC: 2714500)
Washburn County, Wisconsin

Wild Rice around springs in south bay (Berg 2010)

Project Initiated by:

Potato Lake Association, Short Elliot Hendrickson Inc., and the Wisconsin Department of Natural Resources

Flat-stem pondweed (Koshere 2002)

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May 22 and July 1-2, 2010

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ABSTRACT

Potato Lake (WBIC 2714500) is a 222-acre stratified, drainage lake located in central/east-central Washburn County. It is eutrophic in nature with summer Secchi readings averaging 7.4ft and a littoral zone that extends to 15ft. A desire to develop an Aquatic Plant Management Plan, determine if exotic species like Curly-leaf pondweed (*Potamogeton crispus*) or Eurasian water milfoil (*Myriophyllum spicatum*) had invaded the lake, and to establish baseline data on the richness, diversity, abundance and distribution of other native aquatic plant populations prompted members of the Potato Lake Association, Short, Elliot and Hendrickson, Inc., and the Wisconsin Department of Natural Resources to authorize a CLP density survey on May 22 and a full lake point intercept survey on July 1-2, 2010. Neither survey found evidence of CLP, EWM or any other exotic species. The full point intercept survey found macrophytes at 189 of the 307 survey points (61.6%) and identified a total of 39 native plants to species growing in and immediately adjacent to the lake. The 33 native index species found in the rake produced a mean Coefficient of Conservatism of 5.8 and resulted in a Floristic Quality Index of 33.6. Flat-stem pondweed (*Potamogeton zosteriformis*), Fern pondweed (*Potamogeton robbinsii*), Coontail (*Ceratophyllum demersum*), and Fries' pondweed (*Potamogeton friesii*) were the most common species being found at 77.25%, 37.04%, 33.86%, and 16.40% of survey points with vegetation. Future management goals should include maintaining the lake's native plant communities - especially the wild rice beds of the south bay that provide critical nursery habitat for the lake's fish populations; continuing to work on decreasing nutrient flow into the system by eliminating fertilizer applications near the lakeshore, bagging grass clippings, restoring shorelines, installing rain gardens, and maintaining/establishing native plant buffer strips to prevent runoff and erosion; continuing the lake's Clean Boats/Clean Waters Program; considering monthly transect monitoring at the east boat landing and lake wide meandering survey monitoring for AIS; and completing the Aquatic Plant Management Plan.

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INTRODUCTION:

Potato Lake (WBIC 2714500) is a 222-acre, stratified, drainage lake located in the Towns of Crystal and Madge in central/east-central Washburn County (T39N R11W S36 NE NW). The lake reaches its maximum depth of 20ft in the north-central basin southwest of the east side public boat landing and has an average depth of 11ft (WDNR 2010) (Figure 1). Potato Lake is eutrophic in nature and water clarity is fair with summer Secchi readings consistently averaging 7.4ft +/- 2ft over the past 12 years (WDNR 2010). The littoral zone reached approximately 15ft in both May and July, 2010. Bottom substrate was predominantly organic and sandy muck in the south bay as well as the majority of the main basin with a narrow ring of sand/rock along the north, east and west shorelines.

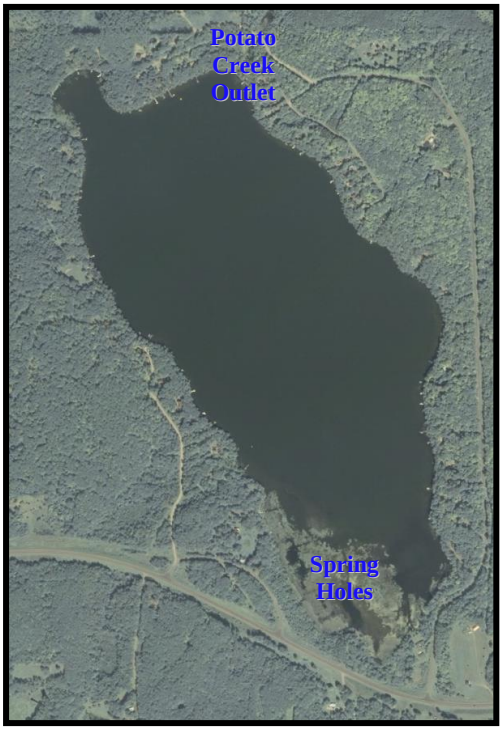

Figure 1: Potato Lake Aerial Photo

The Potato Lake Association (PLA), Short, Elliot and Hendrickson, Inc. (SEHI), and the Wisconsin Department of Natural Resources (WDNR) authorized a series of full lake plant surveys as a prerequisite to developing an Aquatic Plant Management Plan (APMP). On May 22nd, we completed a full lake Curly-leaf pondweed (*Potamogeton crispus*) density survey, and on July 1-2 we conducted a warm water point/intercept survey of all aquatic macrophytes. The surveys used the WDNR's statewide guidelines for conducting systematic point intercept macrophyte sampling. The guidelines ensure that all surveys in the state will be conducted in the same manner, thus allowing data to be compared across time and space. This report represents the summary analysis of the data collected during these surveys. The immediate goals of the project were to determine if Curly-leaf pondweed or Eurasian water milfoil (*Myriophyllum spicatum*) had invaded the lake, and to establish baseline data on the richness, diversity, abundance and distribution of other native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's macrophyte community.

PLANT SURVEY METHODS:

Cold Water Curly-leaf pondweed Density Survey:

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth and total lake acreage, Michelle Nault (WDNR) generated a 307 point sampling grid for Potato Lake (Appendix I). Using this grid, we completed a CLP density survey where we surveyed for CLP at each point in the lake's littoral zone. We located each survey point using a handheld Garmin 76CSx mapping GPS unit. 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 15ft., we sampled for CLP 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. CLP was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of CLP within six feet of the sample point.

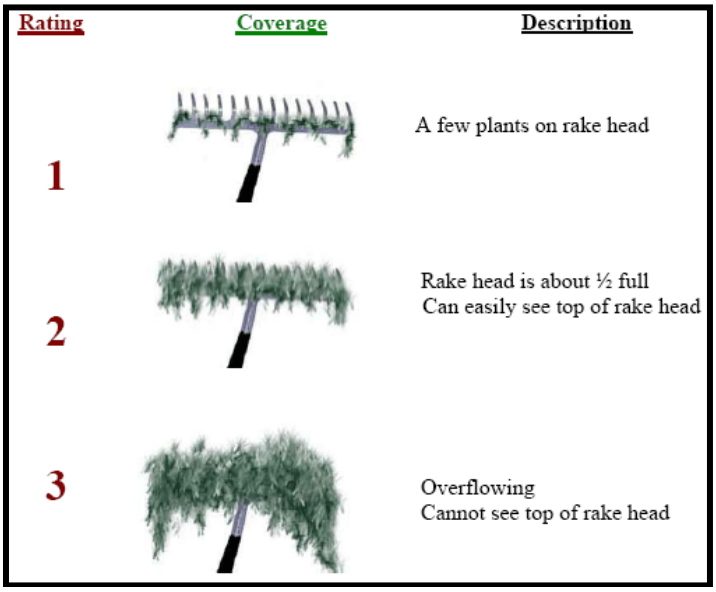

Figure 2: Rake Fullness Ratings (UWEX, 2010)

July Warm Water Full Point/Intercept Survey:

Prior to beginning the July full point intercept survey, we conducted a general boat survey of Potato 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 mounted for herbarium specimens – one to be retained by the Potato Lake Association, and one to be sent to the state herbarium in Stevens Point for identification confirmation. Rake sampling was completed as with the CLP density survey, but this time all plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix III) (UWEX, 2010). From this, we calculated the following:

Total number of sites visited: This included the total number of points on the lake that were accessible to be surveyed by boat.

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% when 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. As is standard protocol, we used a 15ft pole rake and a 25ft rope rake for sampling.

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.

Note: Per DNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.

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 (Table 1).

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 gives us an idea of which species are most important within the macrophyte community (Table 2).

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. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point intercept survey, 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. Potato Lake is in the Northern Lakes and Forests Ecoregion (Table 3).

**** Species that were only recorded as visuals or during the boat survey, and species found in the rake that are not included in the index are excluded from FQI analysis.**

RESULTS:

Cold Water Curly-leaf pondweed Density Survey:

On May 22nd, we surveyed Potato Lake for the presence and abundance of Curly-leaf pondweed. We rake sampled 220 points (the entire 15ft littoral zone and points adjacent to it), but did not find any evidence of CLP at or between points or during the meandering boat survey we conducted of the lake's visible littoral zone (Figure 3). Our experience has shown that CLP normally grows best over thick organic muck in sheltered bays of high nutrient lakes. Potato's sandy muck substrate and high mineral water (personal observation based on extensive marl on macrophytes) may not offer CLP favorable growing conditions or it may never have been introduced into the lake (For more information on Curly-leaf pondweed and other exotic species, see Appendix VIII).

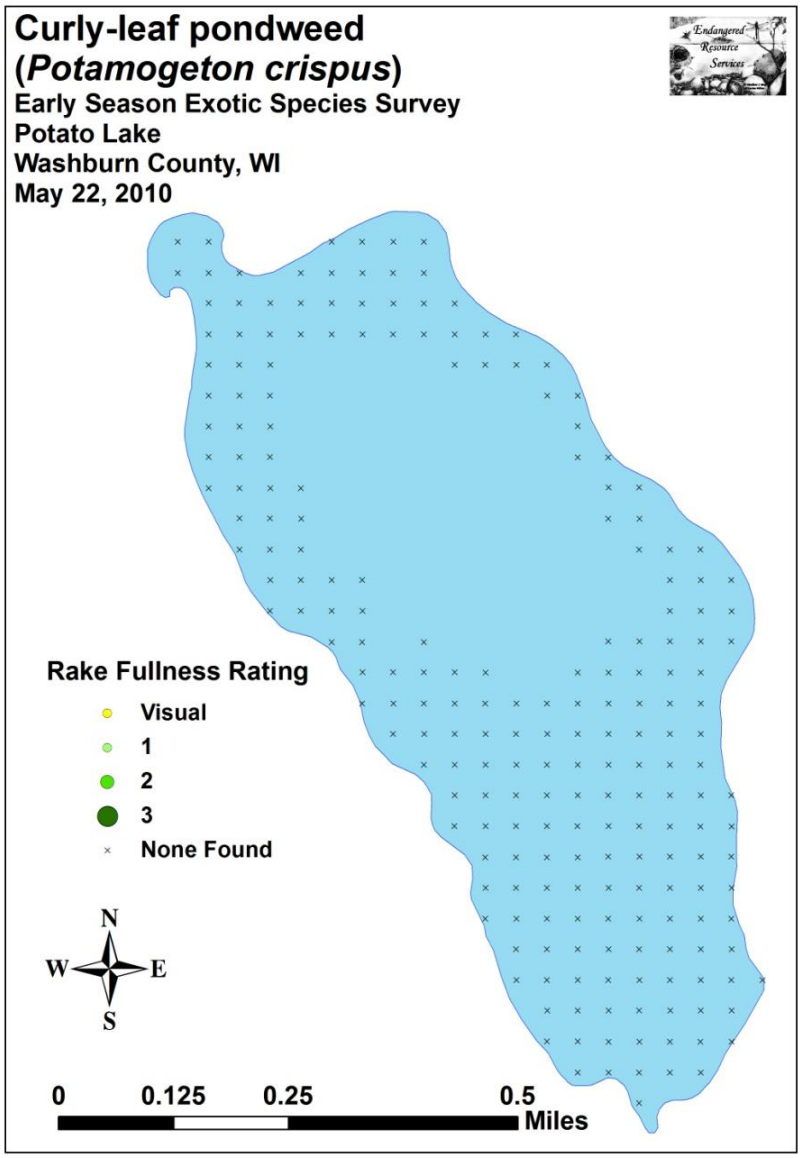

Figure 3: May 22, 2010 CLP Survey

July Warm Water Full Point/Intercept Survey:

Depth soundings taken at Potato Lake's 307 survey points revealed a fairly uniform elongated bowl (Figure 4) (Appendix IV). The main basin had relatively sharp drop offs on the north, east and west sides into 15ft+ of water, while the south end sloped much more gradual into the basin flat. In the south bay, numerous springs produced seemingly misfit deep points as the upwelling water carved out potholes in the lake bed.

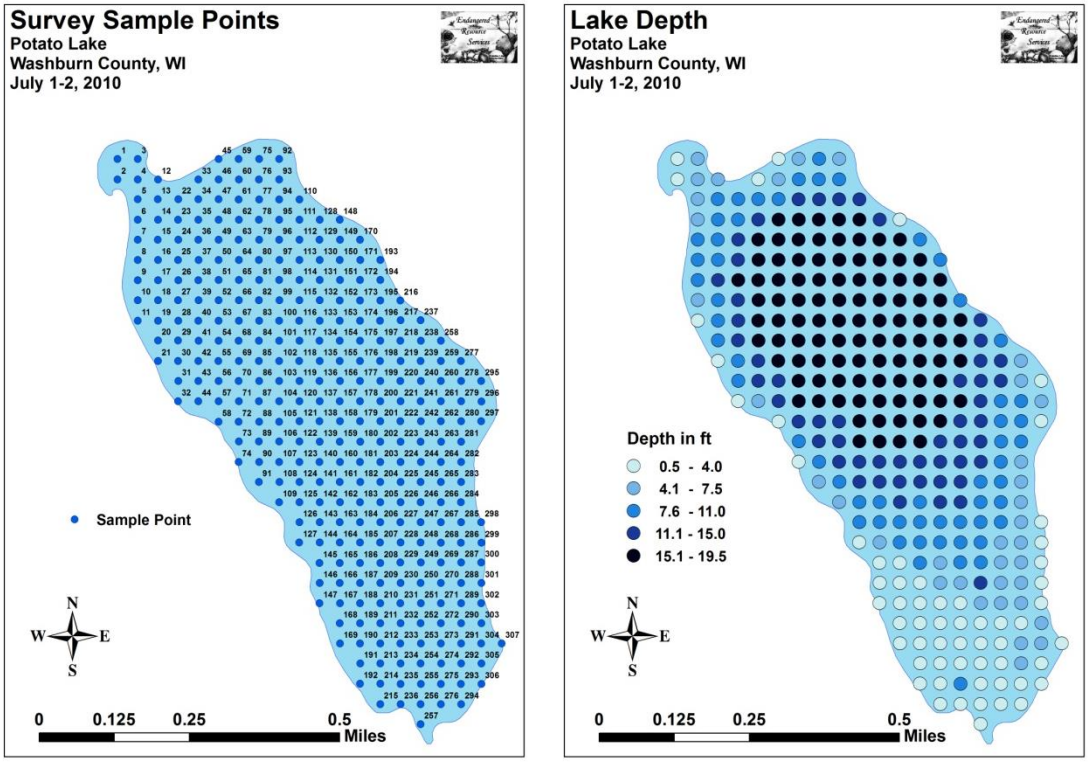

Figure 4: Potato Lake Survey Points and Lake Depth

Of the 210 points where we could determine the substrate, 92.9% were organic or sandy muck, 5.2% were pure sand, and 1.9% were rock. The entire south bay was thick organic muck while most of the rest of the basin and the northwest bay were predominantly sandy muck. A narrow ring of sand and rock occurred on the margins of the central basin on the north, east and west sides. We found plants growing on 61.6% of the entire lake bottom and in 91.7% of the littoral zone (Figure 5) (Table 1) (Appendix IV).

Overall diversity was relatively high with a Simpson Diversity Index value of 0.89. Species richness was also relatively high for such a small lake with 39 total species found growing in and immediately adjacent to the water. Plant growth was spread evenly throughout the littoral zone as the median depth of plants was 7.5ft. In general, species richness, diversity and total rake biomass declined with increasing depth (Figure 6) (Appendix V).

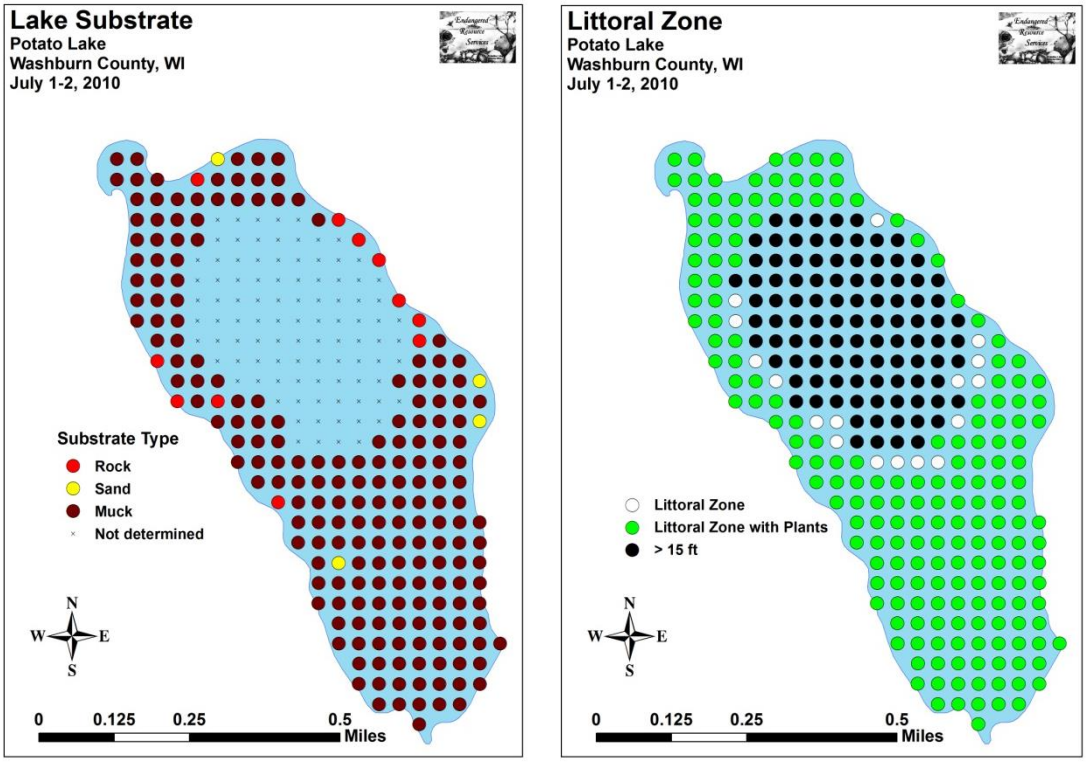

Figure 5: Bottom Substrate and Littoral Zone

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics
Potato Lake, Washburn County
July 1-2, 2010

Summary Statistics:

Total number of points sampled	307
Total number of sites with vegetation	189
Total number of sites shallower than the maximum depth of plants	206
Frequency of occurrence at sites shallower than maximum depth of plants	91.75
Simpson Diversity Index	0.89
Maximum depth of plants (ft)	15.0
Number of sites sampled using rope rake (R)	4
Number of sites sampled using pole rake (P)	206
Average number of all species per site (shallower than max depth)	2.73
Average number of all species per site (veg. sites only)	2.97
Average number of native species per site (shallower than max depth)	2.73
Average number of native species per site (veg. sites only)	2.97
Species Richness	33
Species Richness (including visuals)	33
Species Richness (including visuals and boat survey)	39
Mean depth of plants (ft)	7.3
Median depth of plants (ft)	7.5

The shallow organic muck bottom areas in the lake's south bay supported the richest and densest submergent, floating, and emergent plant beds. In this habitat, we found Northern wild rice (*Zizania palustris*), Coontail (*Ceratophyllum demersum*), Common waterweed (*Elodea canadensis*), White water lily (*Nymphaea odorata*), and the duckweeds to be the dominant species. In the sandy muck areas that ringed the central basin, dense underwater forests of Flat-stem pondweed (*Potamogeton zosteriformis*) dominated the macrophyte community. We also found Fern pondweed (*Potamogeton robbinsii*), Fries' pondweed (*Potamogeton friesii*), White-stem pondweed (*Potamogeton praelongus*), Small pondweed (*Potamogeton pusillus*), and Northern water milfoil (*Myriophyllum sibiricum*) scattered throughout this habitat.

The narrow sandy/rocky bottom margins generally supported much lower densities and fewer species albeit ones unique to these habitats. We identified Muskgrass (*Chara* sp.), Slender naiad (*Najas flexilis*), Variable pondweed (*Potamogeton gramineus*), Wild celery (*Vallisneria americana*), and Hardstem bulrush (*Schoenoplectus acutus*) as common associate species in these areas.

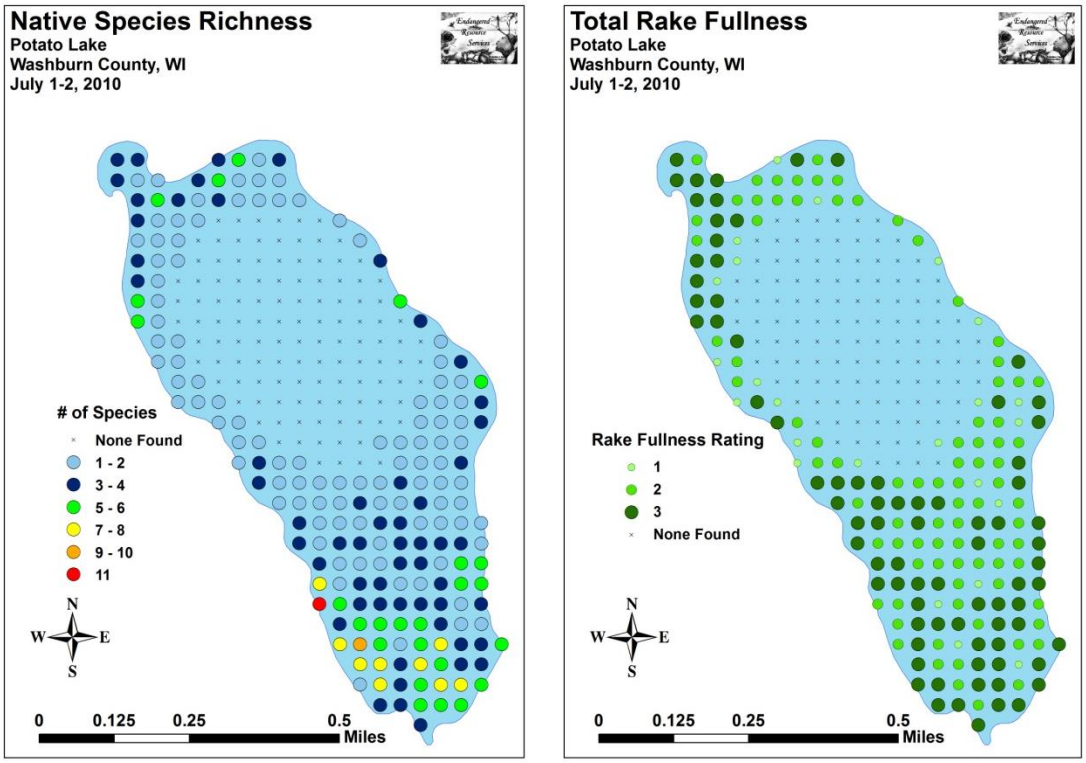

Figure 6: Native Species Richness and Total Rake Fullness

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Potato Lake, Washburn County
July 1-2, 2010

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton zosteriformis	Flat-stem pondweed	146	25.98	77.25	70.87	1.82
Potamogeton robbinsii	Fern pondweed	70	12.46	37.04	33.98	1.67
Ceratophyllum demersum	Coontail	64	11.39	33.86	31.07	1.64
	Filamentous algae	35		18.52	16.99	2.14
Potamogeton friesii	Fries' pondweed	31	5.52	16.40	15.05	1.32
Chara sp.	Muskgrass	25	4.45	13.23	12.14	1.96
Zizania palustris	Northern wild rice	25	4.45	13.23	12.14	1.52
Lemna minor	Small duckweed	23	4.09	12.17	11.17	1.35
Spirodela polyrhiza	Large duckweed	23	4.09	12.17	11.17	1.96
Potamogeton praelongus	White-stem pondweed	22	3.91	11.64	10.68	1.27
Wolffia columbiana	Common watermeal	21	3.74	11.11	10.19	1.00
Potamogeton pusillus	Small pondweed	19	3.38	10.05	9.22	1.21
Potamogeton gramineus	Variable pondweed	12	2.14	6.35	5.83	1.17
Nymphaea odorata	White water lily	11	1.96	5.82	5.34	1.36
Stuckenia pectinata	Sago pondweed	11	1.96	5.82	5.34	1.36
Elodea canadensis	Common waterweed	9	1.60	4.76	4.37	1.22
Potamogeton richardsonii	Clasping-leaf pondweed	8	1.42	4.23	3.88	1.63
Vallisneria americana	Wild celery	8	1.42	4.23	3.88	1.38
Najas flexilis	Slender naiad	6	1.07	3.17	2.91	1.33
Carex comosa	Bottle brush sedge	4	0.71	2.12	1.94	1.50
Typha latifolia	Broad-leaved cattail	4	0.71	2.12	1.94	2.25

Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Potato Lake, Washburn County
July 1-2, 2010

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Heteranthera dubia	Water star-grass	3	0.53	1.59	1.46	1.33
Myriophyllum sibiricum	Northern water milfoil	3	0.53	1.59	1.46	1.33
Nitella sp.	Nitella	2	0.36	1.06	0.97	1.50
Schoenoplectus tabernaemontani	Softstem bulrush	2	0.36	1.06	0.97	2.50
Utricularia vulgaris	Common bladderwort	2	0.36	1.06	0.97	1.50
Calla palustris	Wild calla	1	0.18	0.53	0.49	1.00
Eleocharis erythropoda	Bald spikerush	1	0.18	0.53	0.49	1.00
Lemna trisulca	Forked duckweed	1	0.18	0.53	0.49	1.00
Nuphar variegata	Spatterdock	1	0.18	0.53	0.49	2.00
Potamogeton foliosus	Leafy pondweed	1	0.18	0.53	0.49	1.00
Potamogeton illinoensis	Illinois pondweed	1	0.18	0.53	0.49	2.00
Ranunculus aquatilis	White water crowfoot	1	0.18	0.53	0.49	1.00
Sagittaria rigida	Sessile-fruited arrowhead	1	0.18	0.53	0.49	1.00
	Aquatic moss	***	***	***	***	***
Carex utriculata	Common yellow lake sedge	***	***	***	***	***
Juncus effusus	Common rush	***	***	***	***	***
Leersia oryzoides	Rice cutgrass	***	***	***	***	***
Sagittaria cristata	Crested arrowhead	***	***	***	***	***
Sagittaria latifolia	Common arrowhead	***	***	***	***	***
Schoenoplectus acutus	Hardstem bulrush	***	***	***	***	***

** Visual Only
*** Boat Survey Only

Flat-stem pondweed, Fern pondweed, Coontail and Fries' pondweed were the most common macrophyte species being found at 77.25%, 37.04%, 33.86%, and 16.40% of survey points with vegetation (Table 2) (Figure 7). Together, they combined for just over 55% of the total relative frequency. Muskgrass (4.45), Northern wild rice (4.45), Large duckweed (*Spirodela polyrhiza*) (4.09), and Small duckweed (*Lemna minor*) (4.09) were the only other species with a relative frequency over 4.0 (Appendix VI and VII).

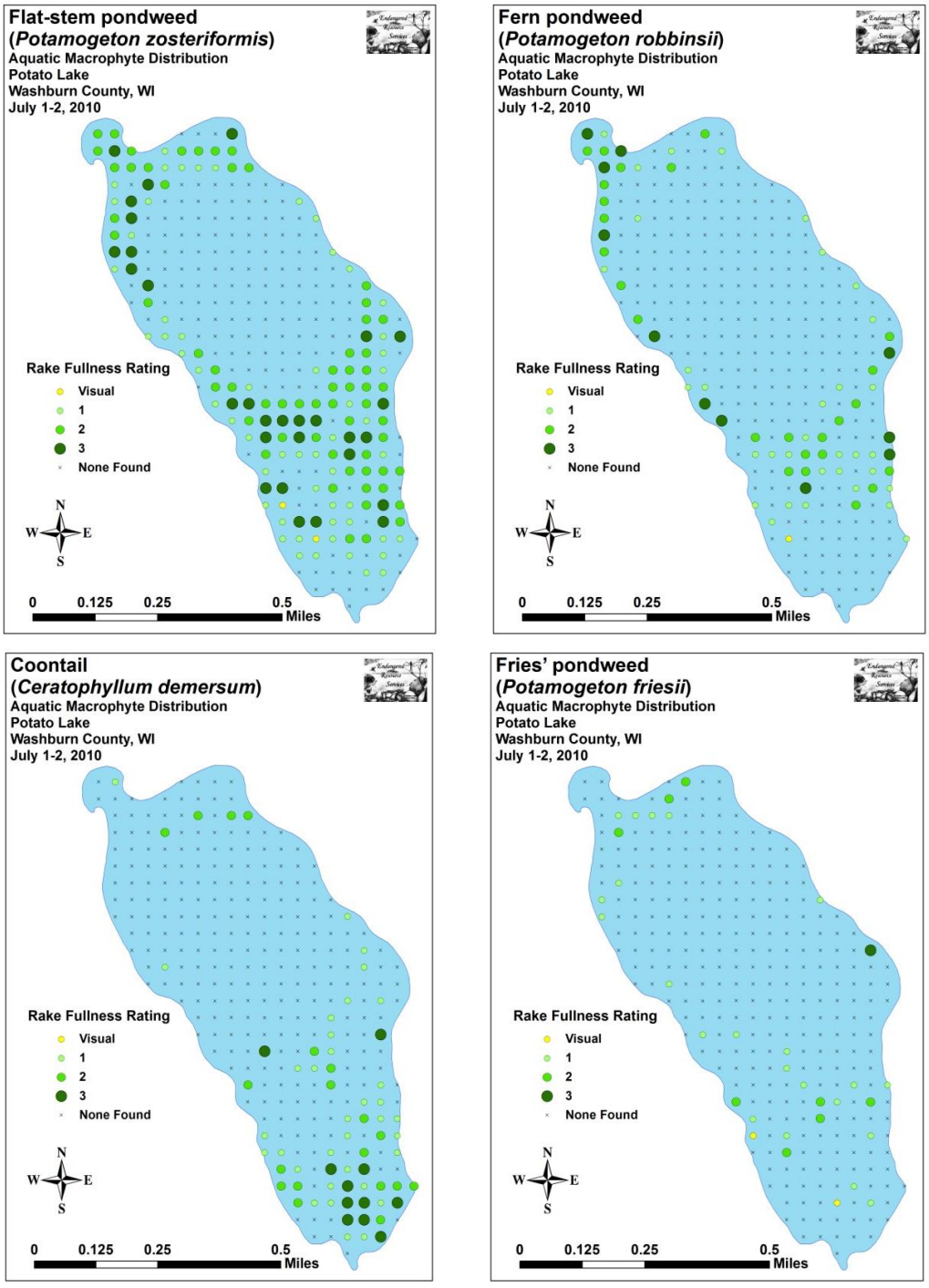

Figure 7: Potato Lake's Most Common Species

Table 3: Floristic Quality Index of Aquatic Macrophytes
Potato Lake, Washburn County
July 1-2, 2010

Species	Common Name	C
Calla palustris	Wild calla	9
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Eleocharis erythropoda	Bald spikerush	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Lemna trisulca	Forked duckweed	6
Myriophyllum sibiricum	Northern water milfoil	6
Najas flexilis	Slender naiad	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton foliosus	Leafy pondweed	6
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Sagittaria rigida	Sessile-fruited arrowhead	8
Schoenoplectus tabernaemontani	Softstem bulrush	4
Spirodela polyrhiza	Large duckweed	5
Stuckenia pectinata	Sago pondweed	3
Typha latifolia	Broad-leaved cattail	1
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8
N		33
Mean C		5.8
FQI		33.6

We identified a total of 33 native index plants to species on the rake during the point intercept survey. They produced a mean Coefficient of Conservatism of 5.8 and a Floristic Quality Index of 33.6 (Table 3). Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Potato Lake below average for this part of the state. The FQI was, however, well above the mean FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). This high FQI is likely a result of Potato Lake's varied littoral habitat, undeveloped shoreline areas, and high percentage of private lakeshore areas with vegetative buffer strips. These conditions offer a variety of high value plants like Fries' pondweed, White-stem pondweed, and Northern wild rice suitable growing conditions.

As in the May survey, we did NOT find any evidence of Eurasian water milfoil, Curly-leaf pondweed, Purple loosestrife or any other exotic species in Potato Lake. Although exotic species are not currently threatening the Potato Lake ecosystem, this could change rapidly in the future if one of these or some other exotic species is introduced into the lake (For more information on exotic invasive species, see Appendix VIII).

Of potentially greater immediate concern are the high levels of filamentous algae in the south bay; especially around the spring holes (Figure 8). Normally, these algae proliferate in environments where there are excessive nutrients in the water.

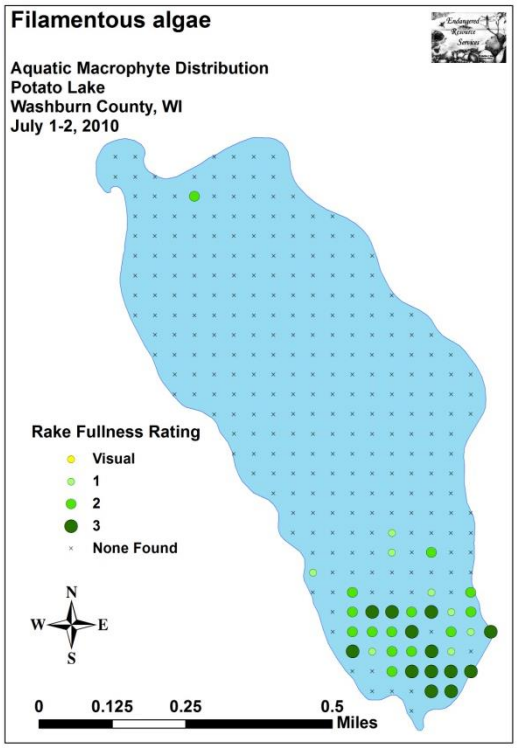

Figure 8: Filamentous algae in Potato Lake

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Native Aquatic Macrophytes:

Potato Lake has an abundant plant community that appears to be positively affected by water clarity, quality, and chemistry. Although the plants in the lake are not unique or rare, their community composition is. For example, Flat-stem pondweed is normally a common, but not abundant player in the overall community; however, on Potato it was easily the dominant plant species. Also of note was the abundant mineral marl on plants. This likely indicates unusually hard water which in turn impacts growing conditions.

Because the lake's macrophytes are the basis of the aquatic ecosystem, they are as important to the aquatic environment as trees are to a forest, and preserving them is critical to maintaining a healthy lake. As the basis of the food pyramid, they provide habitat for other aquatic organisms, are important food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve water clarity by absorbing excess nutrients from the water.

The uniqueness of the Potato Lake ecosystem was further evidenced to us shortly after launching our boat for the May survey. Pronghorn clubtails dragonflies were emerging from the water by the thousands at the shoreline (Figure 9). In Wisconsin, this Special Concern** species is known from only a handful of adults collected, and Potato Lake represents only the second documented reproducing population in the state (Bill Smith, WDNR Endangered Species Bureau – personal communication). Clubtail dragonflies in general are known as "indicator species" or "canaries in the coal mine" because they are so sensitive to negative changes in water quality. Besides being a striking beautiful insect, these tiny predators consume millions of pest insects like gnats and mosquitoes eating both the larvae of these pests when the dragonfly nymphs are underwater and the biting adults when the adult dragonflies are on the wing from May-July. The presence of this rare insect is another testament to the unique habitat combination created by Potato's plants, water and bottom substrate. It also indicates a history of good water quality that should be celebrated and preserved.

Figure 9: Pronghorn Clubtail (*Gomphus graslinellus*)

**** Special Concern species** - those that warrant special protection or consideration because they are vulnerability to habitat modification, environmental alteration, or human disturbance which, in the foreseeable future, may result in their becoming threatened or endangered.

Wild Rice:

Despite being largely off limits to human use and access because it is so shallow, the south bay's wild rice beds are probably the most important habitat on the lake for wildlife. Along with the lake's scattered bulrush/reed beds, the rice serves as the lake's "nursery" for both baitfish and juvenile gamefish – a place where they can feed on plankton and insects while avoiding most predators. Specifically, we noticed schools of young of the year and yearling bluegills, crappies and bass.

In addition to fish, rice shoots are fed on by geese and muskrats throughout the growing season, and the seeds are an important food sources for migrating birds. We also located a loon nest on a floating mat of plants in the heart of the bay during the May survey.

Filamentous Algae and Water Clarity:

Potato Lake residents are to be commended for their shoreline conservation and the lake could serve as a model for how to minimize negative human impacts on a lakeshore (Figure 10). The filamentous algae distribution map on Potato Lake is inversely correlated to human development, and this is exactly the opposite of what is found on most lakes. Normally, filamentous and floating algae proliferate in the presence of excessive nutrients in the water (Boedeltje et al. 2005). Such things as internal loading from sediments, failed septic systems, and lawn and field fertilizer runoff are common causes of excess nutrients in surface water (Barko and Smart 1980, Carignan and Kalff 1982, Moeller et al. 1988). The high algae levels that surround the spring holes in the south end of the lake may indicate that this is the main source of nutrient input for the system. A complete watershed study would be required to determine the source of the lake's nutrient load.

Figure 10: Model Natural Shoreline on the North Shore of Potato

Continually educating lake residents about reducing nutrient input directly along the lake is one of the best ways to decrease algal growth and improve water clarity. Not mowing down to the lakeshore, bagging grass clippings, switching to a phosphorus-free fertilizer or eliminating fertilizer altogether would all be positive steps to this end. Wherever possible, shoreline restoration, rain gardens and buffer strips of native vegetation would enhance water quality by preventing erosion and runoff.

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water milfoil are an increasing problem in the lakes of northern Wisconsin in general, and several nearby lakes in the Hayward area in particular. Preventing their introduction into Potato Lake with proactive measures is strongly encouraged. Especially around the boat landing, lakeshore owners should minimize the removal of native plants from the lake unless absolutely necessary as these patches of barren substrate can provide an easy place for invasive plants to take root and become established. Maintaining the current large, noticeable signage at the boat landing will offers a layer of protection against AIS by providing education, reeducation, and continual reminders of the dangers/impacts of aquatic invasive species to lake owners and visitors alike (Figure 11).

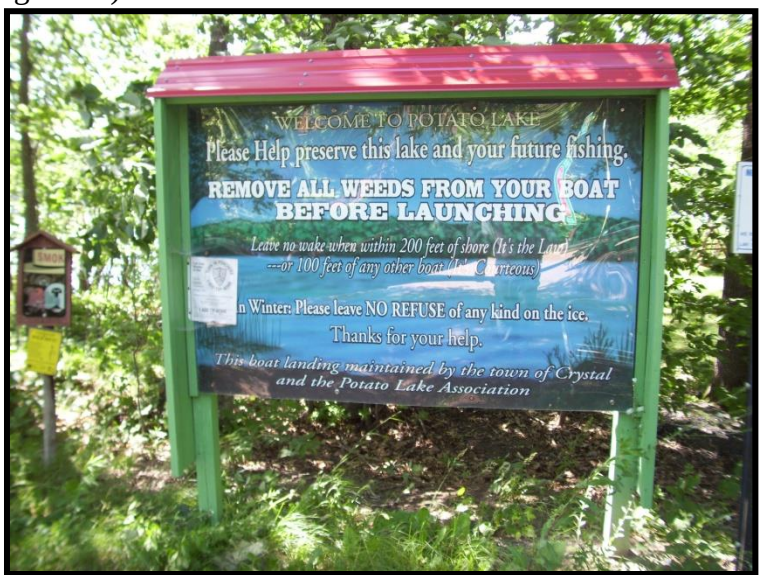

Figure 11: Sign at the East Side Public Landing

The lake's active Clean Boats/Clean Water Program also appears to be a model as there were volunteers on duty almost every time we worked on the lake. In addition to the education these volunteers offer, the physical checking of incoming/outgoing boat's provides an important safeguard for the lake (Figure 12). Conducting monthly or bimonthly transect surveys parallel to the shore near the lake's boat landing and at least biannual meandering shoreline surveys is a further suggestion as they could result in immediate detection if an AIS is introduced into the lake. The sooner an infestation is detected, the greater the chances it can be successfully controlled or even eliminated. Finally, completing an Aquatic Plant Management Plan prior to an infestation would help streamline an appropriate response if/when an infestation of EWM or some other AIS occurs.

Figure 12: PLA Clean Boats/Clean Waters Volunteers in Action

Management Considerations Summary:

- Preserve and maintain Potato Lake's unique native plant communities that provide habitat for rare species like the Pronghorn Clubtail dragonfly.
- Be aware that the south bay's wild rice beds serve as important habitat; especially for the lake's fish populations.
- Reduce and, wherever possible, eliminate fertilizer applications and other sources of nutrient input near the lakeshore.
- Encourage shoreline restoration, rain gardens and the establishment of native vegetation buffer strips along the lakeshore to prevent runoff and erosion.
- Encourage owners to minimize native plant removal from the lake as these areas provide Aquatic Invasive Species an ideal place to become established.
- Maintain signage and continue the CB/CW program at the boat landing to educate lake users about Aquatic Invasive Species like Eurasian water milfoil.
- Consider transect monitoring for invasive species at the lake's boat landing at least once a month and meandering shoreline surveys twice during the summer.
- Complete an Aquatic Plant Management Plan that would outline a course of action if EWM or some other invasive species is introduced into the lake.

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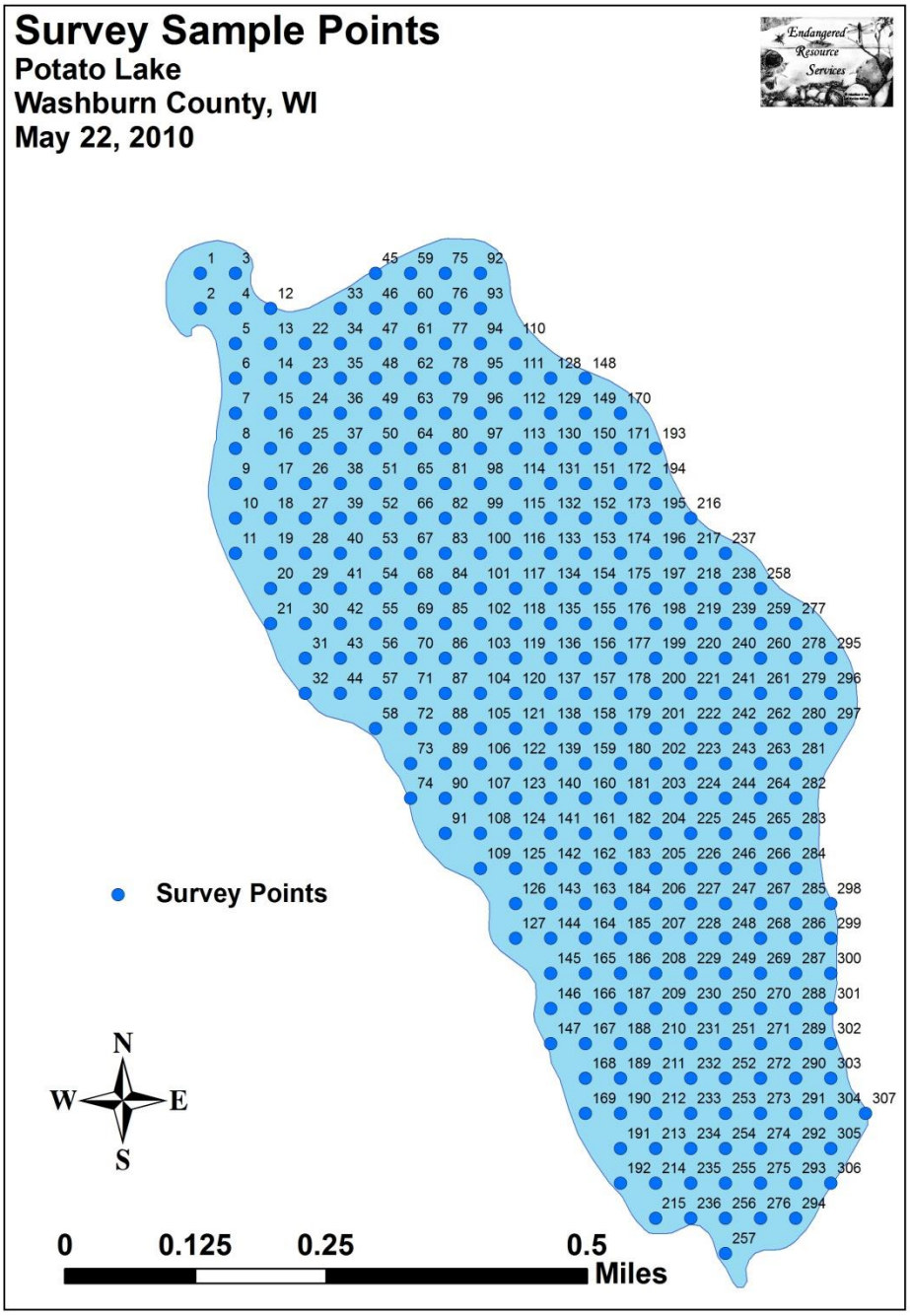
Appendix I: Potato Lake Survey Sample Points


Survey Sample Points
Potato Lake
Washburn County, WI
May 22, 2010
Endangered Resource Services
Survey Points
N
W
E
S
0
0.125
0.25
0.5
Miles

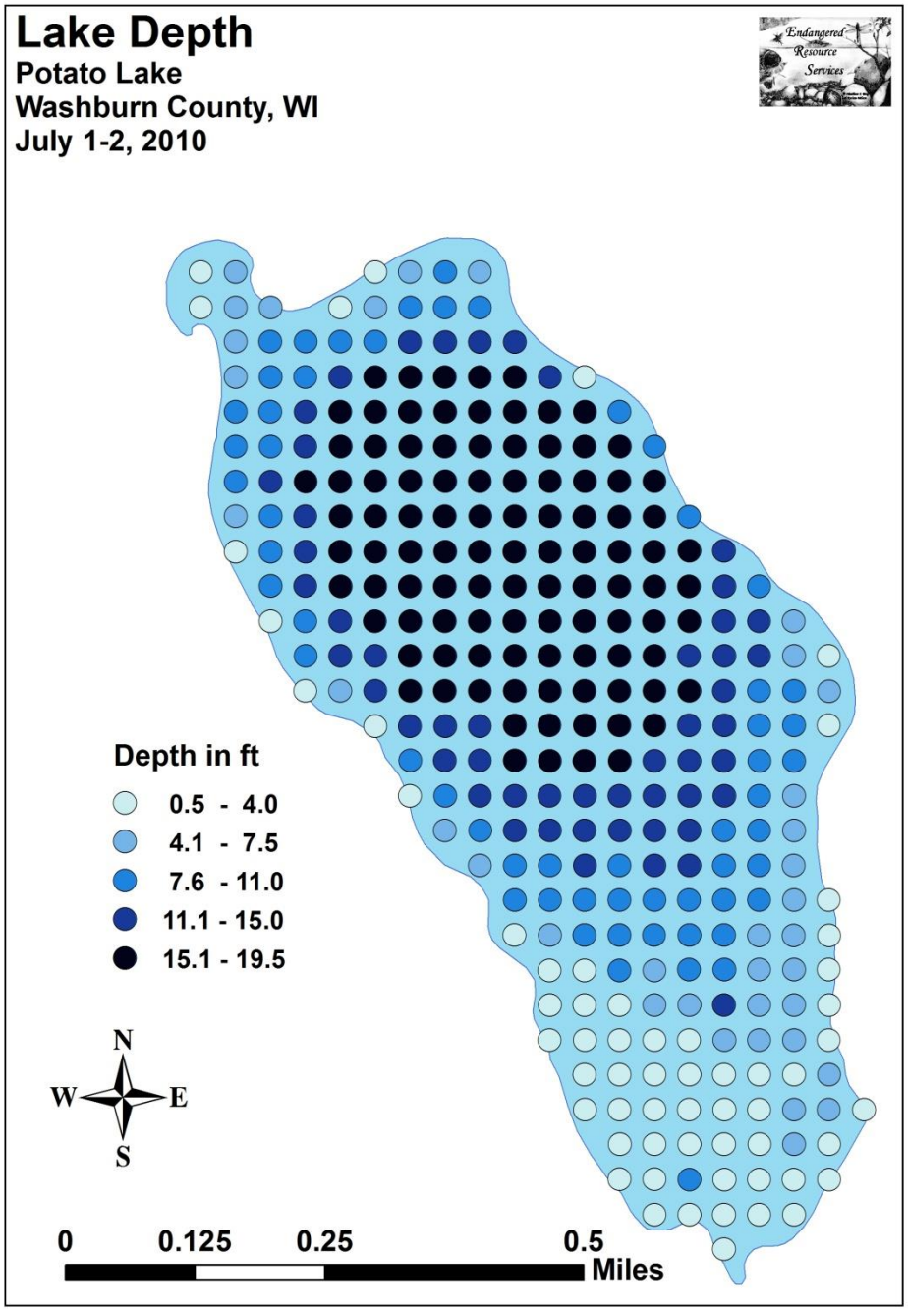
Appendix II: Boat Survey Data Sheet

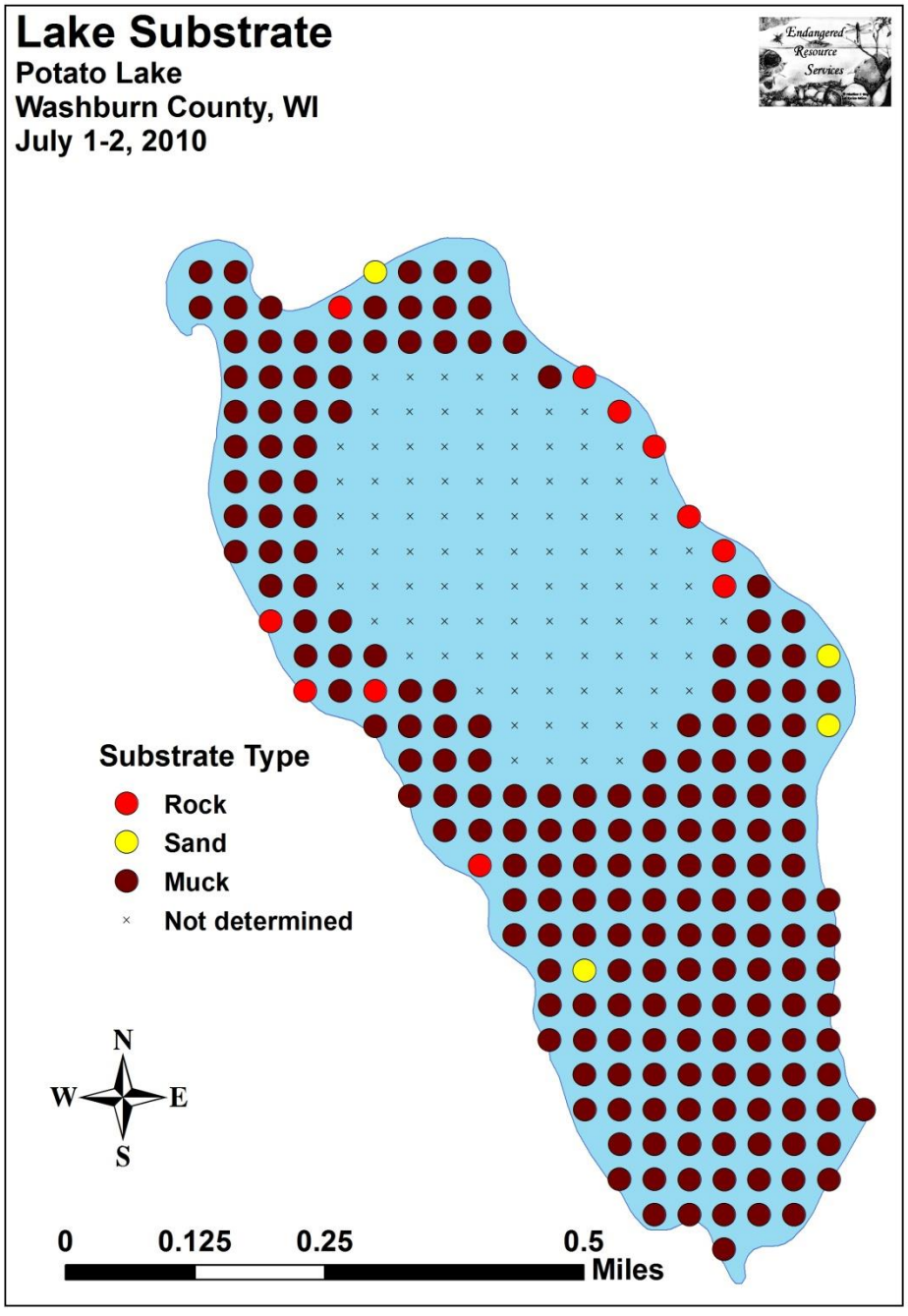
Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	**Species seen, habitat information**

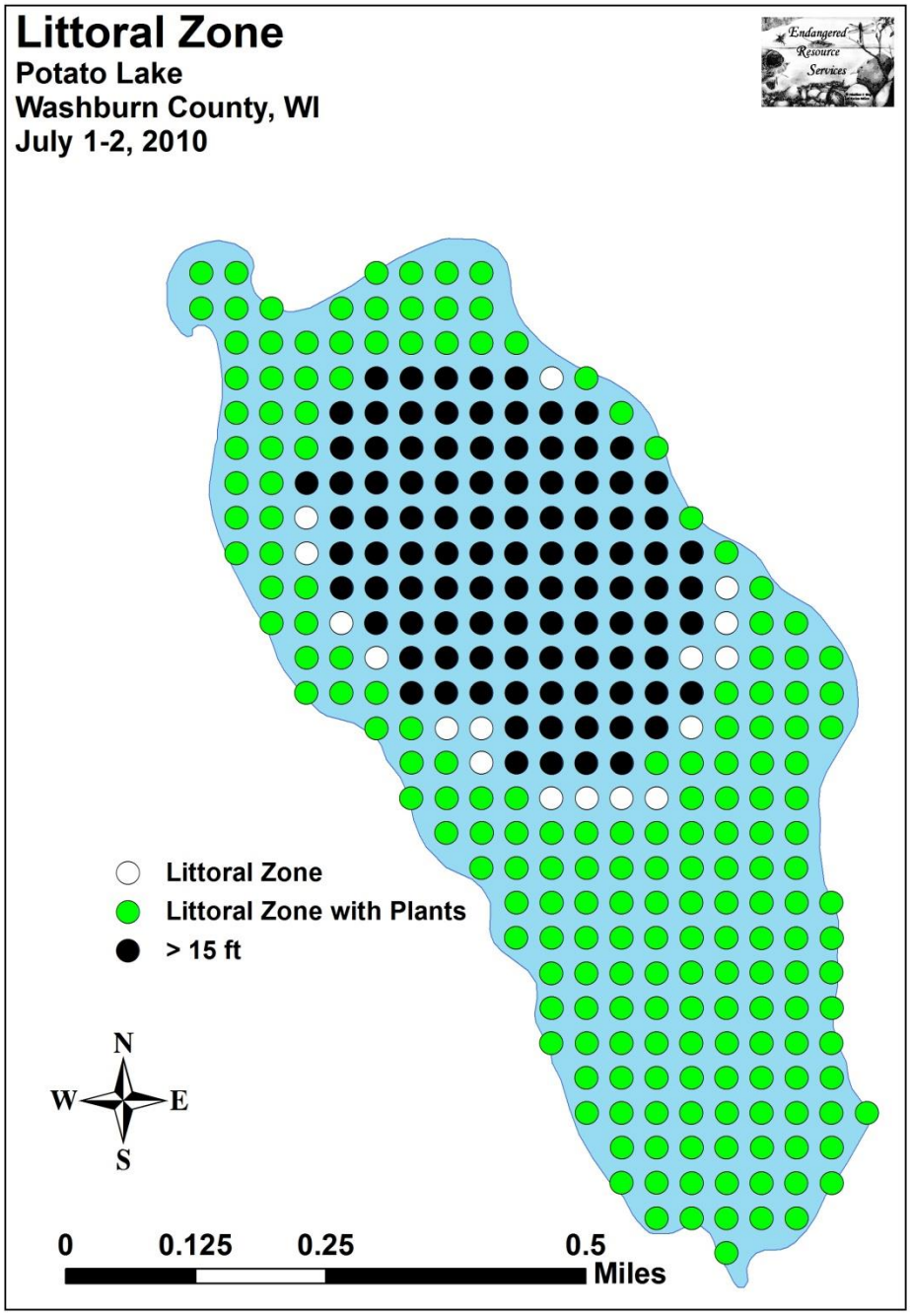
Appendix III: Vegetative Survey Data Sheet

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)	Total Rake Fullness	EWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									

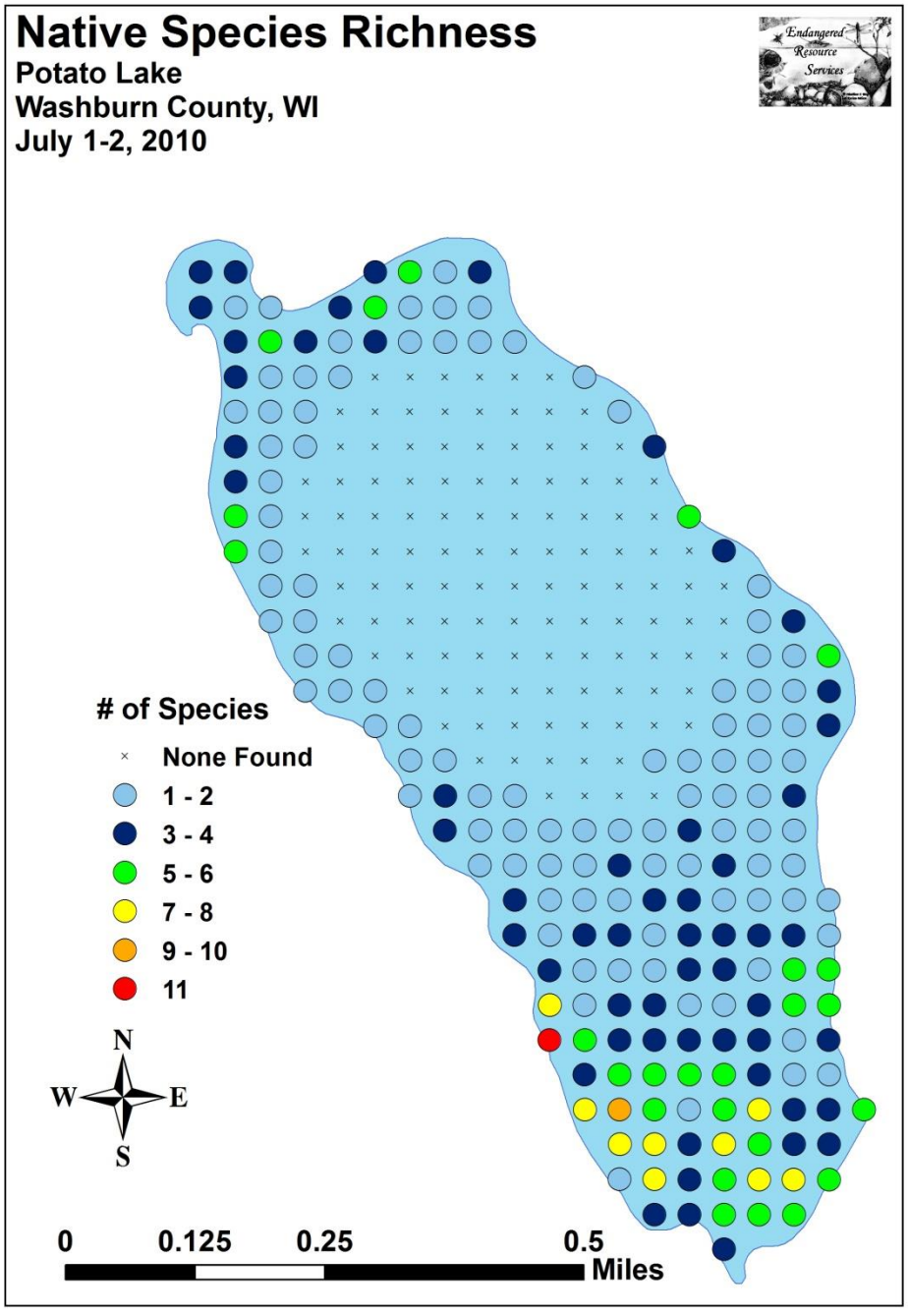
Appendix IV: Habitat Variable Maps

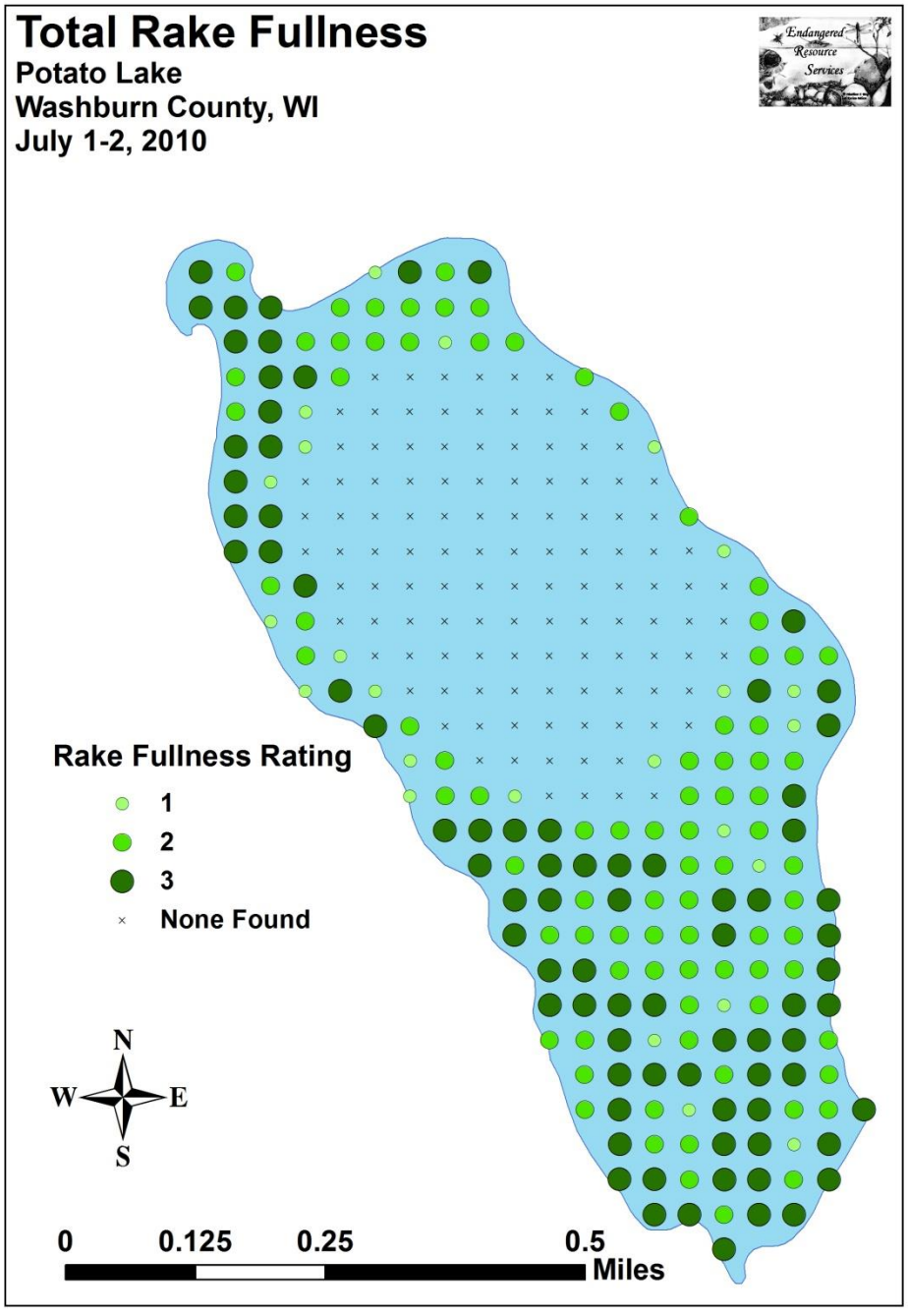

Lake Depth
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Depth in ft
0.5 - 4.0
4.1 - 7.5
7.6 - 11.0
11.1 - 15.0
15.1 - 19.5
N
W
E
S
0
0.125
0.25
0.5
Miles


Lake Substrate
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Substrate Type
Rock
Sand
Muck
Not determined
N
W
E
S
0
0.125
0.25
0.5
Miles


Littoral Zone
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Littoral Zone
Littoral Zone with Plants
> 15 ft
N
W
E
S
0
0.125
0.25
0.5
Miles

Appendix V: Native Species Richness and Total Rake Fullness Maps


Native Species Richness
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
# of Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11
N
W
E
S
0
0.125
0.25
0.5
Miles


Total Rake Fullness
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.125
0.25
0.5
Miles

Appendix VI: Plant Species Accounts

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Calla palustris*) **Wild calla**
Specimen Location: Potato Lake; N45.81372°, W91.66981°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-290
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Found in undeveloped shoreline areas throughout.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Eleocharis erythropoda*) Bald spikerush, (*Carex comosa*) Bottle-brush sedge

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Carex utriculata*) **Common yellow lake sedge**
Specimen Location: Potato Lake; N45.81324°, W91.66910°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-291
Habitat/Distribution: Muck soil at the shoreline in undeveloped areas near the creek inlet.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Juncus effusus*) Common rush, (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Carex comosa*) **Bottle-brush sedge**
Specimen Location: Potato Lake; N45.82573°, W91.67921°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-292
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Found in undeveloped shoreline areas throughout.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Juncus effusus*) Common rush, (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Potato Lake; N45.81910°, W91.66719°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-293
Habitat/Distribution: Muck bottom in 0-4.5 meters. Abundant in the far south bay – scattered elsewhere.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: Potato Lake; N45.82578°, W91.67574°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-294
Habitat/Distribution: Most common in sand/silt/rock bottom areas in water from 0 – 1 meter deep, although it was also found over muck in water up to3.5m. Most plants were growing along the east and west shorelines.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Stuckenia pectinata*) Sago pondweed, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Eleocharis erythropoda*) **Bald spikerush**
Specimen Location: Potato Lake; N45.82573°, W91.67921°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-295
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Found in undeveloped shoreline areas throughout.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Juncus effusus*) Common rush, (*Carex comosa*) Bottle-brush sedge

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Potato Lake; N45.81617°, W91.66850°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-296
Habitat/Distribution: Muck bottom in 0-4 meters of water.
Uncommon; restricted to the south bay where it occurred in dense, but widely scattered patches.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Spirodela polyrhiza*) Large duckweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal, (*Zizania palustris*) Northern wild rice

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Potato Lake; N45.81426°, W91.66635°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-297
Habitat/Distribution: Firm muck bottoms usually in water < 1 meter deep. Scattered individuals were located throughout the south bay.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Juncus effusus*) **Common rush**
Specimen Location: Potato Lake; N45.81324°, W91.66910°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-298
Habitat/Distribution: Muck soil at the shoreline in undeveloped areas near the creek inlet.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Typha latifolia*) Broad-leaved cattail, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Leersia oryzoides*) **Rice cutgrass**
Specimen Location: Potato Lake; N45.82573°, W91.67921°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-299
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Scattered locations in undeveloped shoreline areas.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Potato Lake; N45.81475°, W91.66567°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-300
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Common to abundant in the south bay where it was found interspersed between the lilypads and rice.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza*) Large duckweed, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Lemna trisulca*) **Forked duckweed**
Specimen Location: Potato Lake; N45.81424°, W91.66774°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-301
Habitat/Distribution: A single cluster of plants was found at the point entangled in other plants over muck in <1m of water.
Common Associates: (*Spirodela polyrhiza*) Large duckweed, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Ranunculus aquatilis*) White water crowfoot, (*Lemna minor*) Small duckweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: Aquatic moss
Specimen Location: Potato Lake; N45.82573°, W91.67921°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-302
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Scattered locations in undeveloped shoreline areas.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Myriophyllum sibiricum*) **Northern water milfoil**
Specimen Location: Potato Lake; N45.81811°, W91.66856°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-303
Habitat/Distribution: Muck to sand bottom in water up to 3.5m. Widespread throughout, but never common.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Nymphaea odorata*) White water lily, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Najas flexilis*) **Slender naiad**
Specimen Location: Potato Lake; N45.82578°, W91.67574°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-304
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-2.5 meters of water. Uncommon, but widely distributed throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Nitella* sp.) **Nitella**
Specimen Location: Potato Lake; N45.81373°, W91.66912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-305
Habitat/Distribution: Muck bottom in water generally less than 3 meters deep. Rare; only plants found were on the lip and walls of springs in the south bay.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-306
Habitat/Distribution: Muck bottom in <1 meters of water where it formed dense canopies. Rare; a few beds were located on the southwest side of the lake.
Common Associates: (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-307
Habitat/Distribution: Muck bottom in 0-1.5 meters. Relatively common in the south and northwest bays interspersed among the rice.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton foliosus*) **Leafy pondweed**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-308
Habitat/Distribution: Muck in <.5m of water. Rare; a handful of plants were found at the point in the southwest bay.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Utricularia vulgaris*) Common bladderwort

County/State: Washburn County, Wisconsin **Date:** 7/21/10
Species: (*Potamogeton friesii*) **Fries' pondweed**
Specimen Location: Potato Lake; N45.82578°, W91.67574°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-309
Habitat/Distribution: Variable substrate in 1-4 meters of water. Widespread and common throughout.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton gramineus*) **Variable pondweed**
Specimen Location: Potato Lake; N45.82578°, W91.67574°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-310
Habitat/Distribution: Most common in sandy/muck bottom conditions in shallow water 0.5-2.5 meter deep. Fairly common along the eastern and western shorelines. Plants appear to have keeled stipules like *illinoensis*, but all leaves had <9 veins. Plants were all rangy with many side shoots in typical *gramineus* fashion. It's possible these plants are a diminutive form of *illinoensis* or have at least some *illinoensis* alleles as plants seen in September had <9 veins on lower leaves, and >11veins on upper leaves.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Chara* sp.) Muskgrass, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton illinoensis*) **Illinois pondweed**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-311
Habitat/Distribution: Muck in <.5m of water. Rare; a handful of plants were found at the point in the southwest bay. Plants were all strongly keeled, stipules were >3cm, all leaves had >10 veins.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton foliosus*) Leafy pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Utricularia vulgaris*) Common bladderwort

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton praelongus*) **White-stem pondweed**
Specimen Location: Potato Lake; N45.82478°, W91.67779°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-312
Habitat/Distribution: Muck bottoms in 1.5-3.5 meters of water, but prefers 2-3. Present, but not abundant throughout in this narrow range.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Potato Lake; N45.82380°, W91.67846°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-313
Habitat/Distribution: Found in rock/ muck bottoms in 1-4.5 meters of water. Widely distributed, but never abundant.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Chara* sp.) Muskgrass, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Potato Lake; N45.81662°, W91.67060°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-314
Habitat/Distribution: Found in sandy/muck bottom conditions in shallow water 1.5-3 meter deep. Uncommon, but widely scattered throughout.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton praelongus*) White-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton robbinsii*) **Fern pondweed**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-315
Habitat/Distribution: Can grow in variable substrate bottoms, but prefers organic muck. Grows in 0-4 meters of water, but prefers 2.5-4. Widespread and common in throughout.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Potato Lake; N45.81763°, W91.66854°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-316
Habitat/Distribution: The dominant plant in the lake, Flat-stem grew in thick beds over muck in water from 1-4.5 meters deep.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Ranunculus aquatilis*) **White water crowfoot**
Specimen Location: Potato Lake; N45.81424°, W91.66774°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-317
Habitat/Distribution: Rare; found at only two points over muck in <1m of water.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Spirodela polyrhiza*) Large duckweed, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed, (*Elodea canadensis*) Common waterweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Sagittaria cristata*) **Crested arrowhead**
Specimen Location: Potato Lake; N45.81852°, W91.67413°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-318
Habitat/Distribution: A few scattered plants were located inshore from the point in water <1m deep over sandy muck.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Chara* sp.) Muskgrass, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: Potato Lake; N45.82573°, W91.67921°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-319
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Scattered locations in undeveloped shoreline areas.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Sagittaria rigida*) **Sessile-fruited arrowhead**
Specimen Location: Potato Lake; N45.81372°, W91.66981°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-320
Habitat/Distribution: Muck in <.5m of water. Rare; a handful of plants were found at two sites in the southwest bay.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton foliosus*) Leafy pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Schoenoplectus acutus*) **Hardstem bulrush**
Specimen Location: Potato Lake; N45.82627°, W91.67575°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-321
Habitat/Distribution: Much more common than the survey indicated. Many small beds were scattered around the lake; especially along the north shoreline. Plants were established over rock/firm sand in water <.5m deep.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Potato Lake; N45.81372°, W91.66981°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-322
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Found in undeveloped shoreline areas; especially on the south side of the lake.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Typha latifolia*) Broad-leaved cattail, (*Juncus effusus*) Common rush, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Spirodela polyrhiza*) **Large duckweed**
Specimen Location: Potato Lake; N45.81475°, W91.66567°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-323
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Common to abundant in the south bay where it was found interspersed between the lilypads and rice.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Nymphaea odorata*) White water lily, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Stuckenia pectinata*) **Sago pondweed**
Specimen Location: Potato Lake; N45.82628°, W91.67506°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-324
Habitat/Distribution: Uncommon to rare over sandy muck in water <2.5m deep. Most plants were found in the channels leading away from the spring holes on the south side of the lake.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Chara* sp.) Muskgrass, (*Potamogeton friesii*) Fries' pondweed, (*Ceratophyllum demersum*) Coontail, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Potato Lake; N45.81277°, W91.66840°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-325
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Found in undeveloped shoreline areas throughout.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Juncus effusus*) Common rush, (*Carex comosa*) Bottle-brush sedge, (*Eleocharis erythropoda*) Bald spikerush

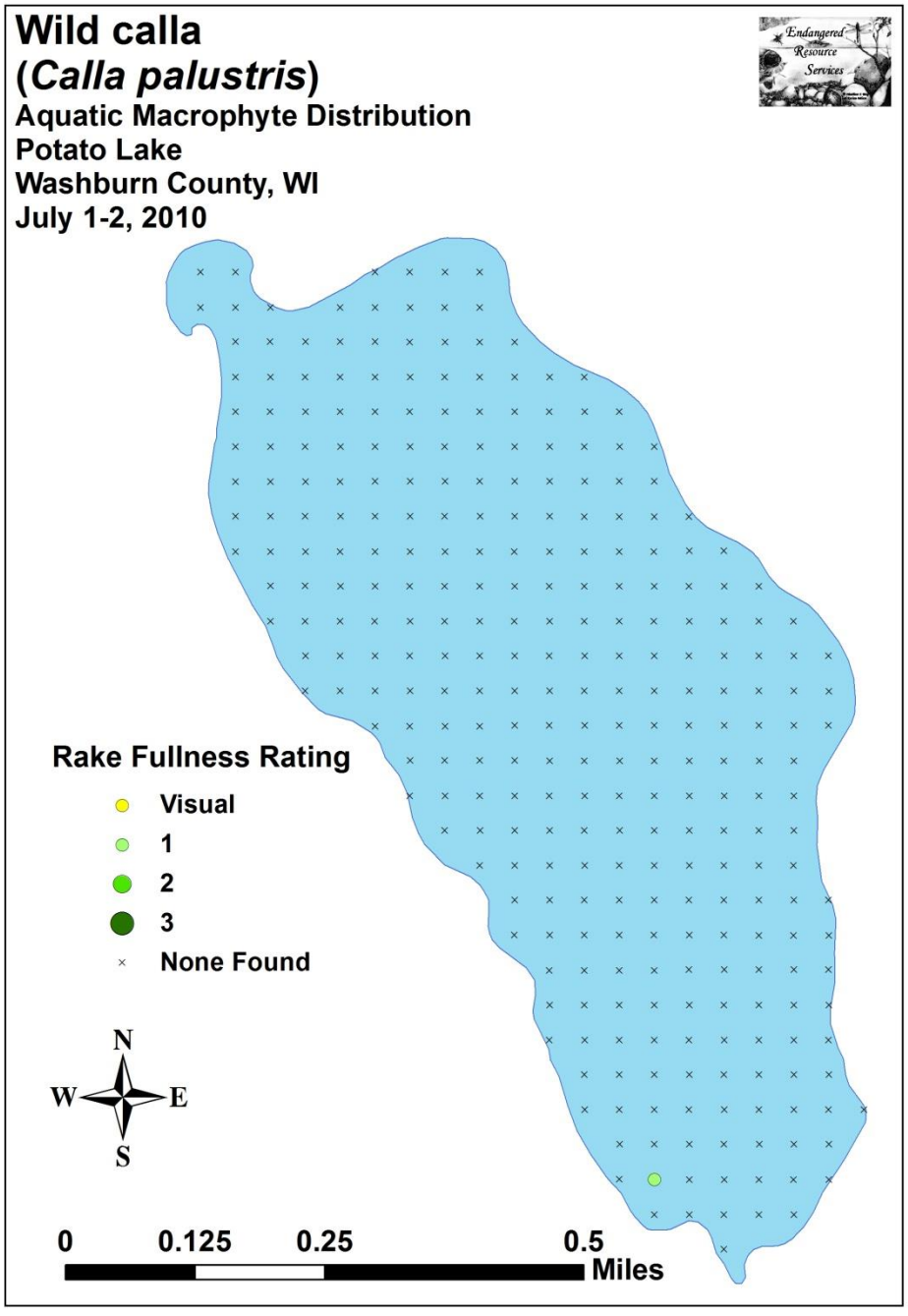
County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Potato Lake; N45.81563°, W91.67196°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-326
Habitat/Distribution: Muck in <.5m of water. Rare; a handful of plants were found at the point in the southwest bay.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton foliosus*) Leafy pondweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Potato Lake; N45.82009°, W91.66653°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-327
Habitat/Distribution: Found in almost any bottom conditions, but grows best in sandy to sand/muck bottoms in 0.5-2 meters of water. Uncommon, but widely distributed along the margins of the lake.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Chara* sp.) Muskgrass, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Wolffia columbiana*) **Common watermeal**
Specimen Location: Potato Lake; N45.81475°, W91.66567°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-328
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Common in the south bay where it was found interspersed between the lilypads and rice.
Common Associates: (*Zizania palustris*) Northern wild rice, (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed

County/State: Washburn County, Wisconsin **Date:** 7/2/10
Species: (*Zizania palustris*) **Northern wild rice**
Specimen Location: Potato Lake; N45.81475°, W91.66567°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2010-329
Habitat/Distribution: Abundant over muck in the south bay in water <1m deep. Scattered elsewhere.
Common Associates: (*Nymphaea odorata*) White water lily, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Lemna minor*) Small duckweed, (*Spirodela polyrhiza*) Large duckweed

Appendix VII: Point Intercept Plant Species Distribution Maps


Wild calla
(Calla palustris)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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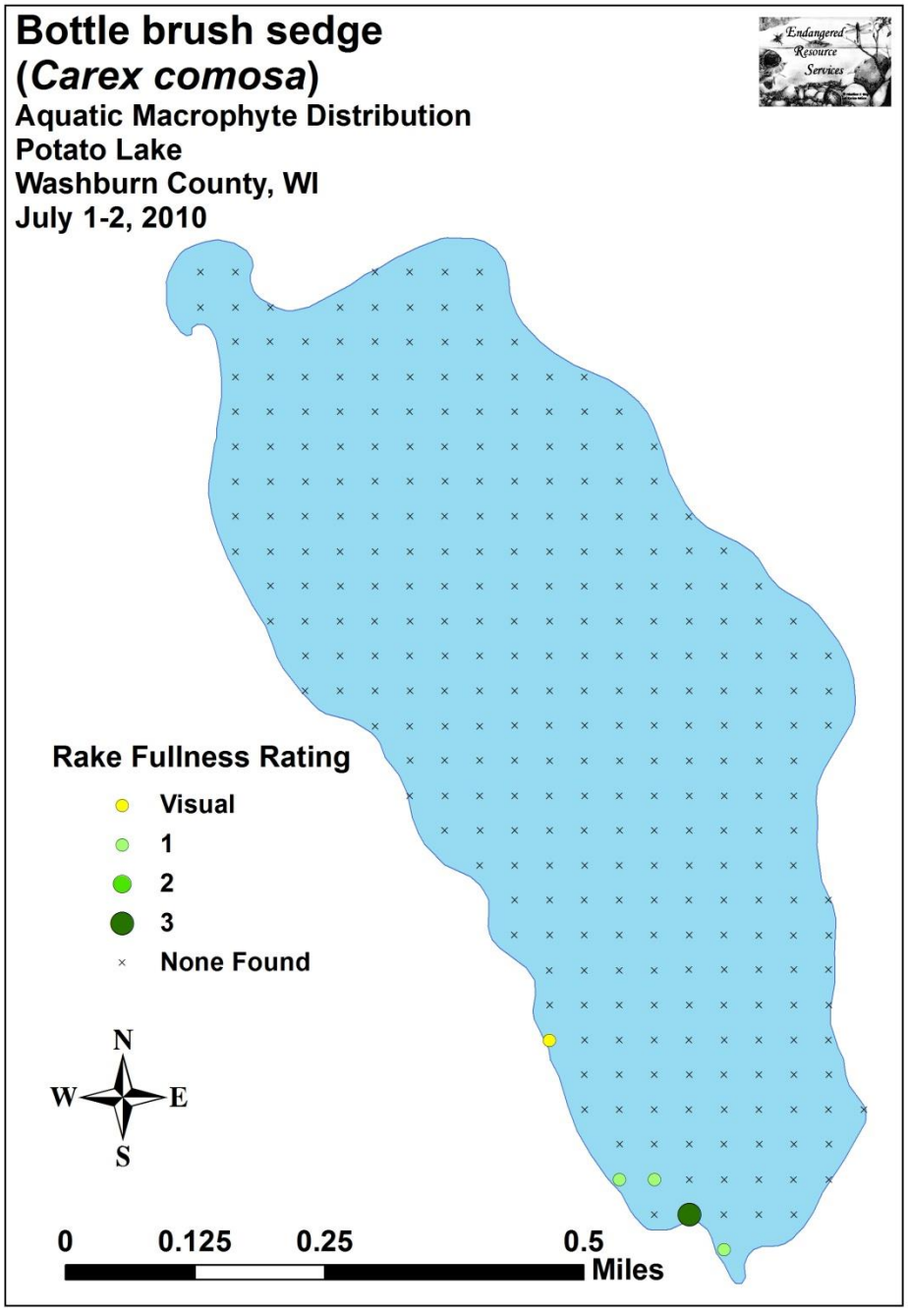
S
0
0.125
0.25
0.5
Miles


Bottle brush sedge
(Carex comosa)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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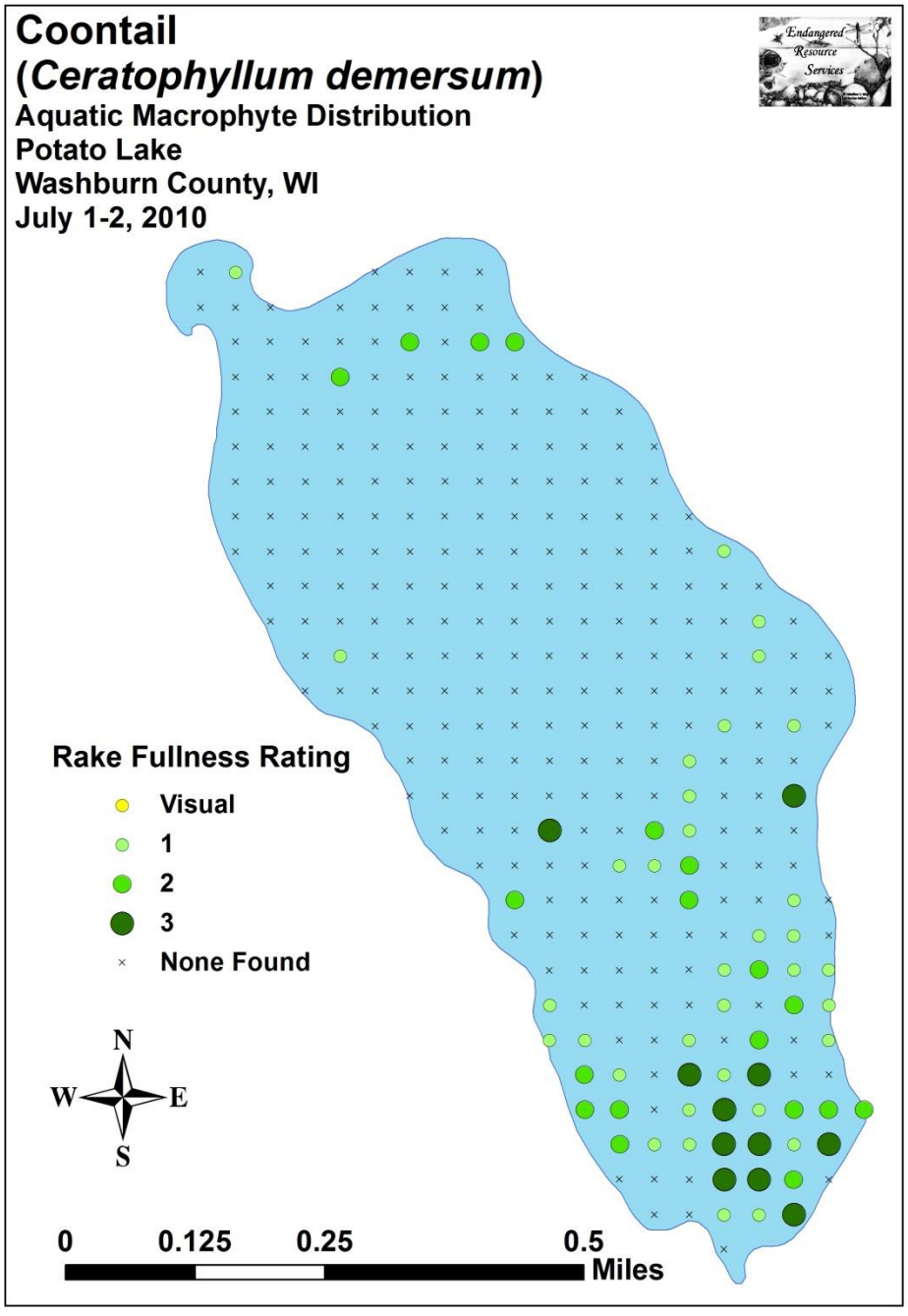
0
0.125
0.25
0.5
Miles


Coontail
(Ceratophyllum demersum)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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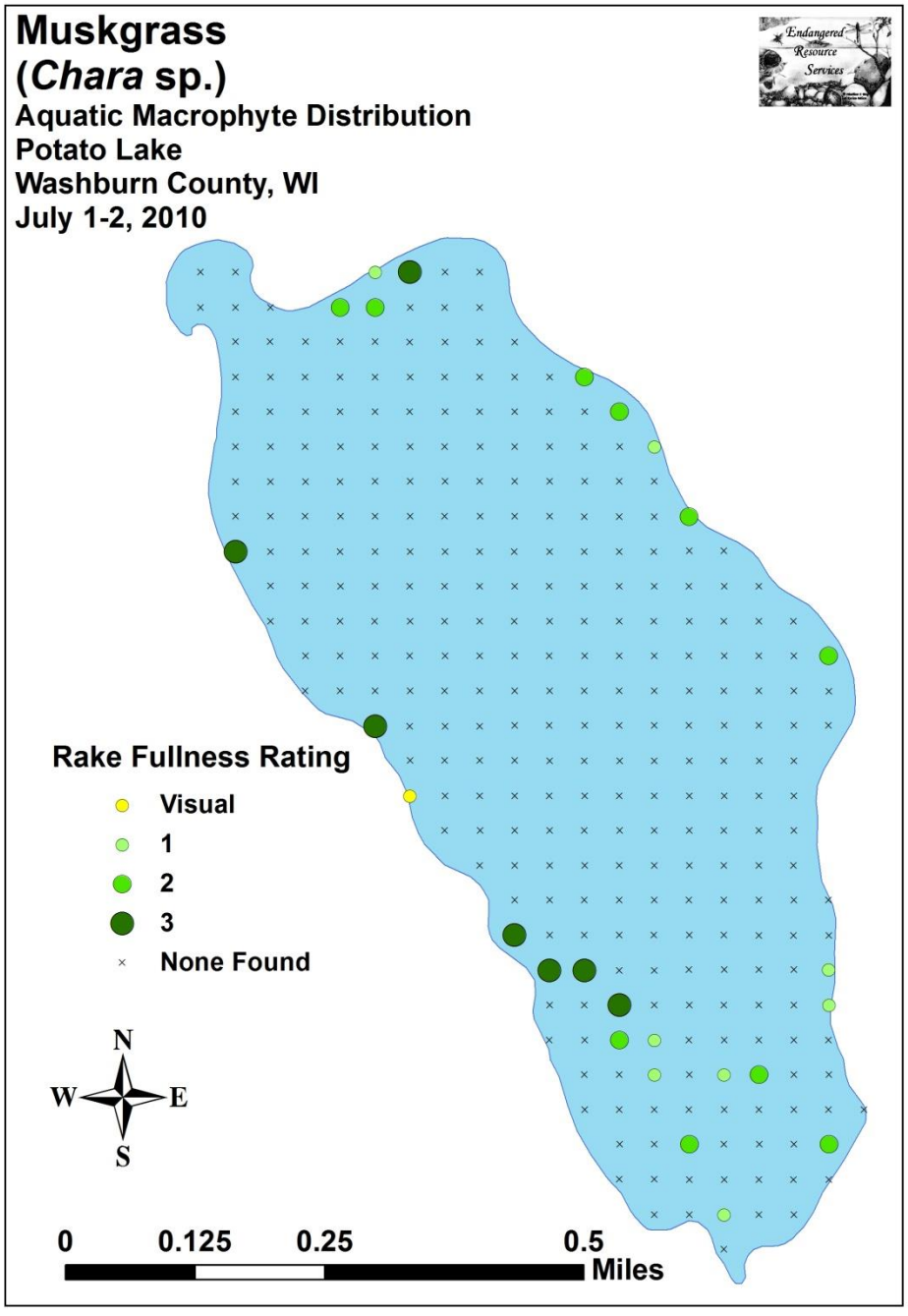
0
0.125
0.25
0.5
Miles


Muskgrass
(Chara sp.)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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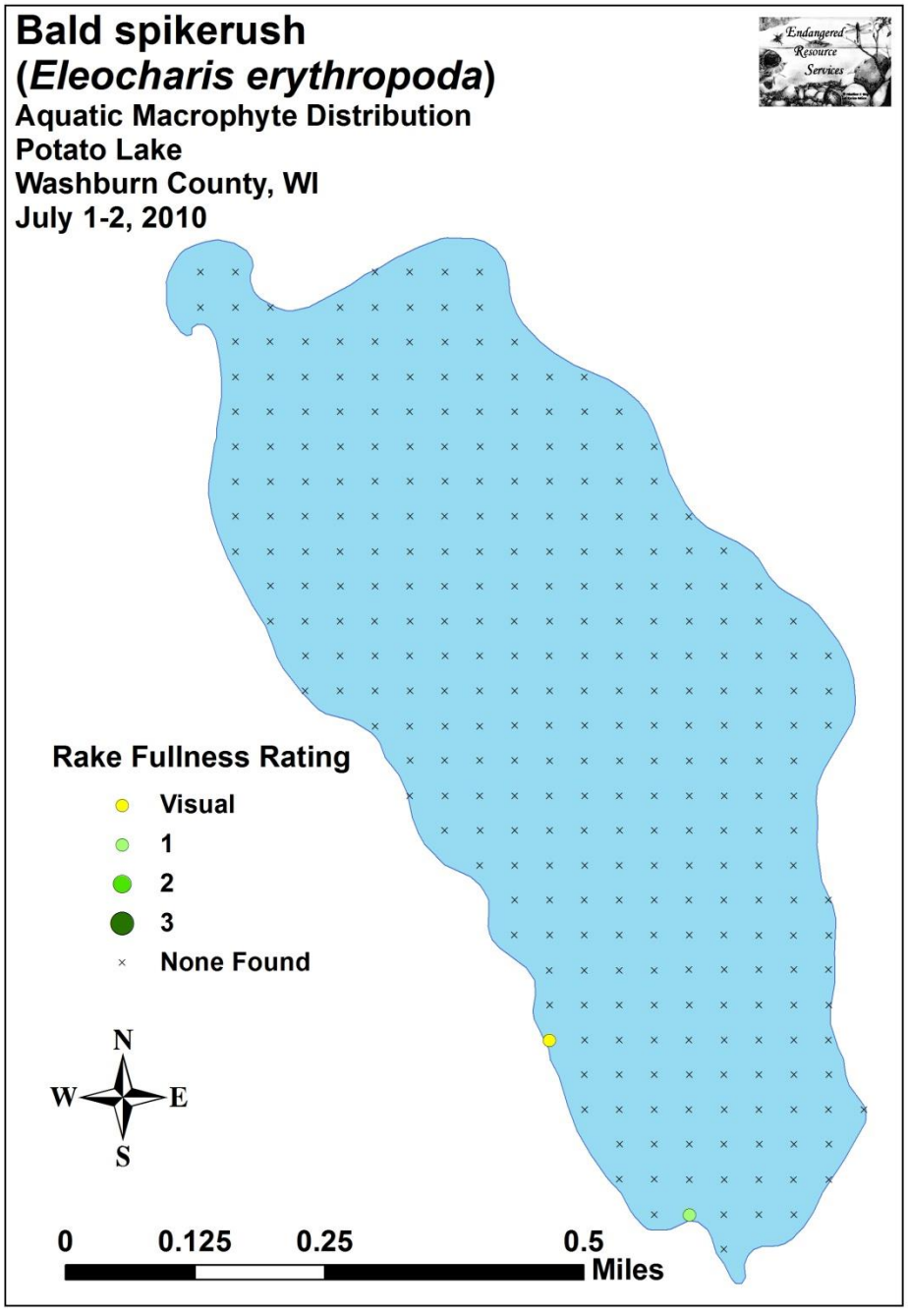
0.125
0.25
0.5
Miles


Bald spikerush
(Eleocharis erythropoda)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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0.125
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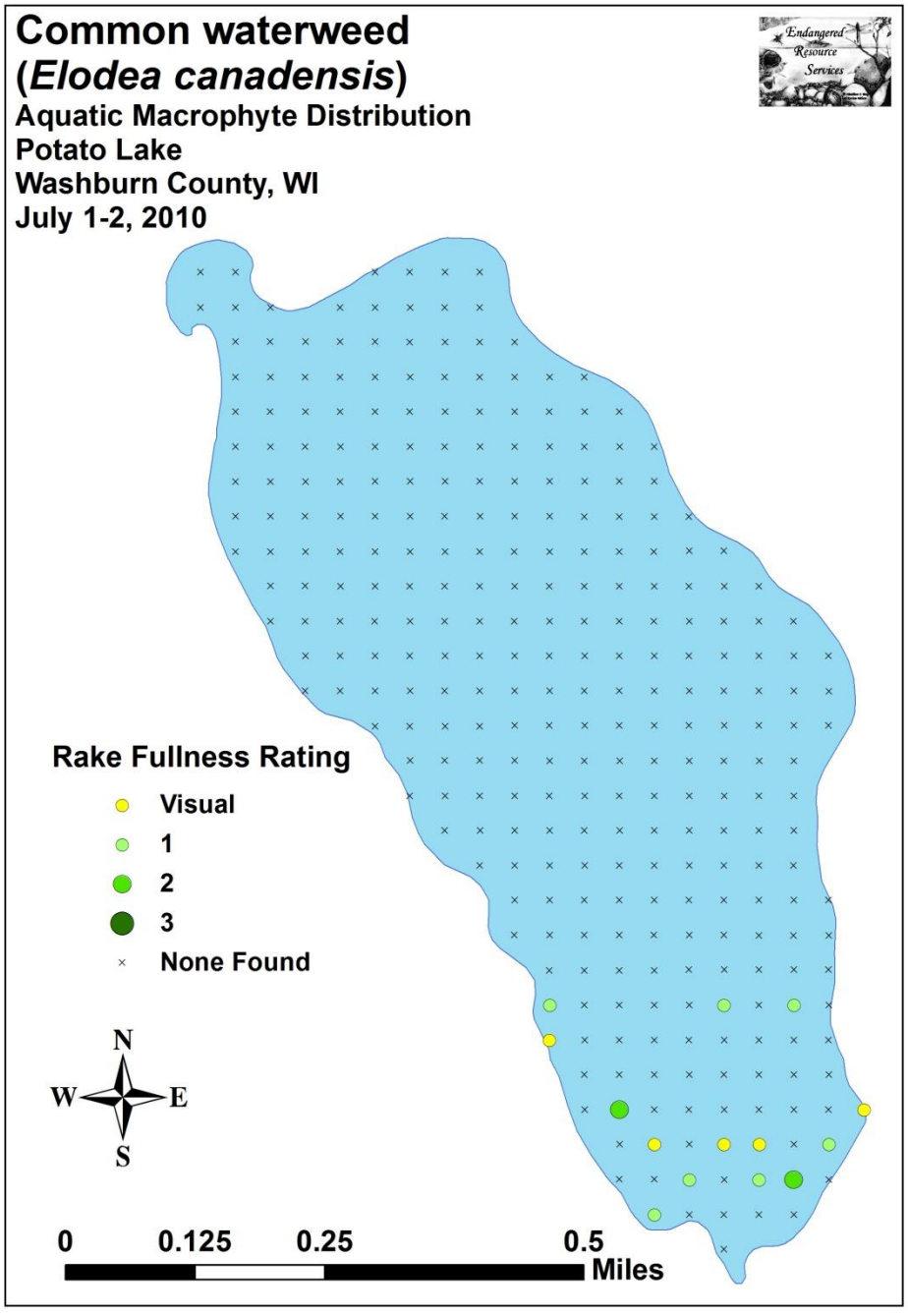
Miles


Common waterweed
(Elodea canadensis)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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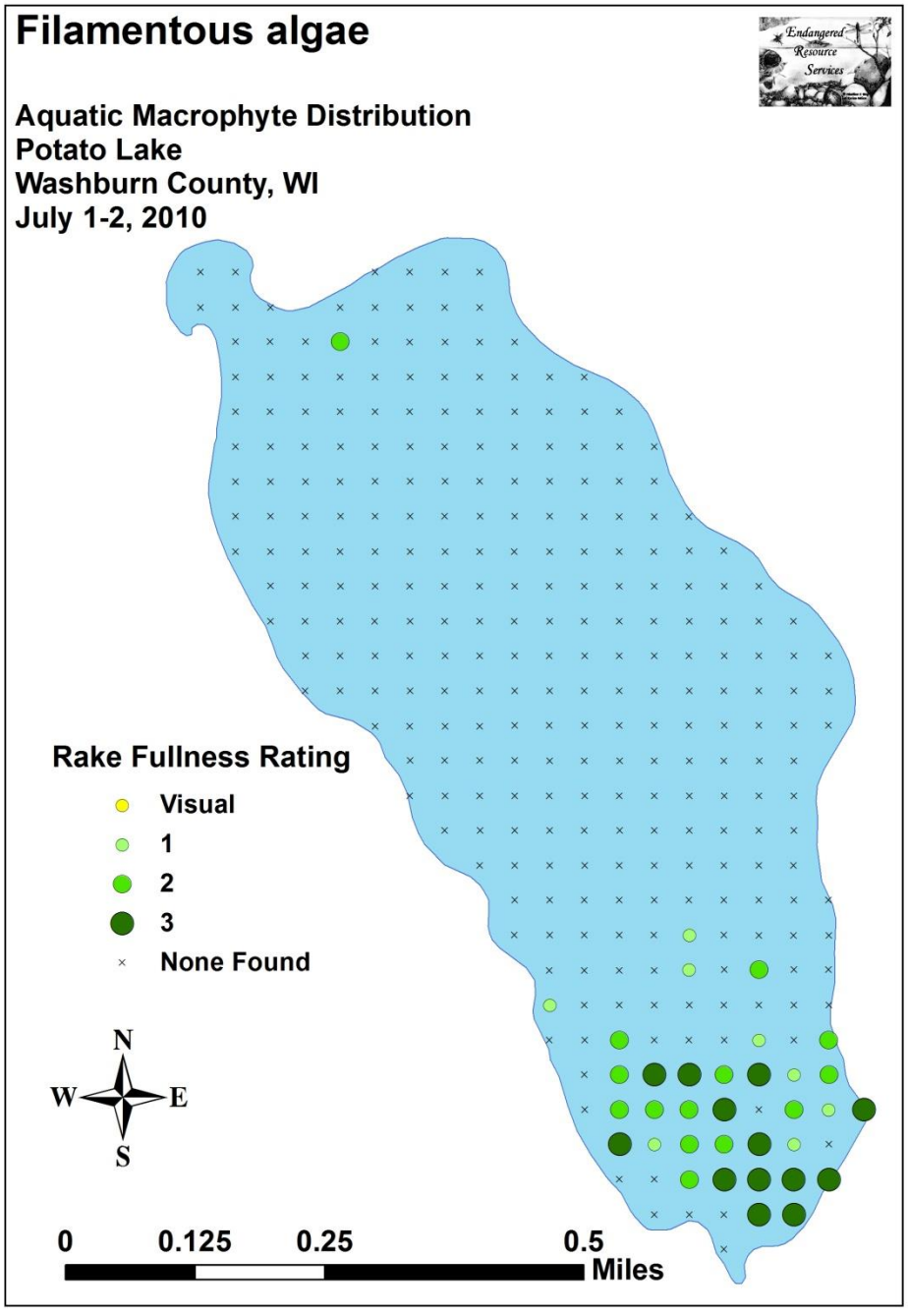
0.5
Miles


Filamentous algae
Endangered Resource Services
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Rake Fullness Rating
Visual
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None Found
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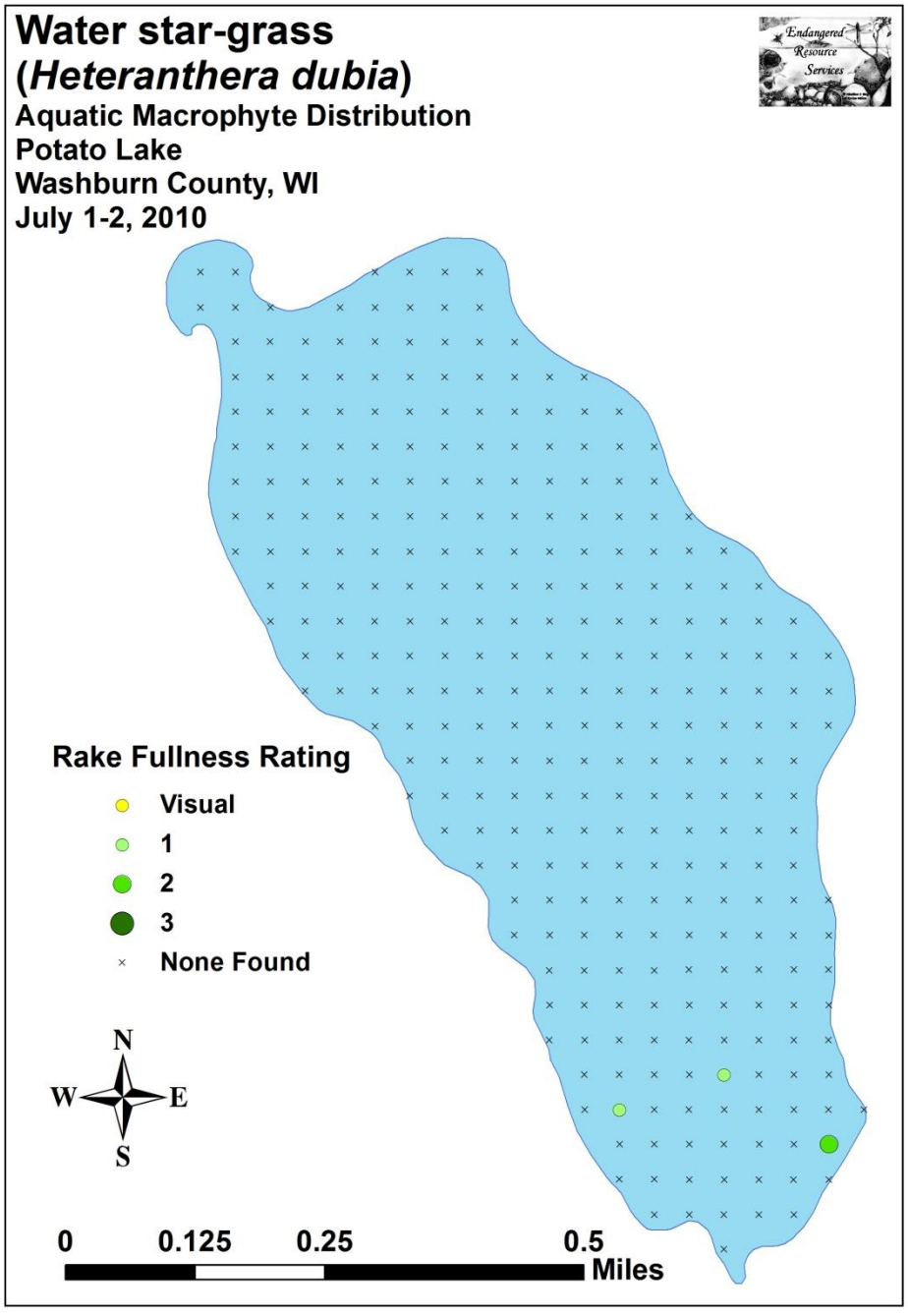
Miles


Water star-grass
(Heteranthera dubia)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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W
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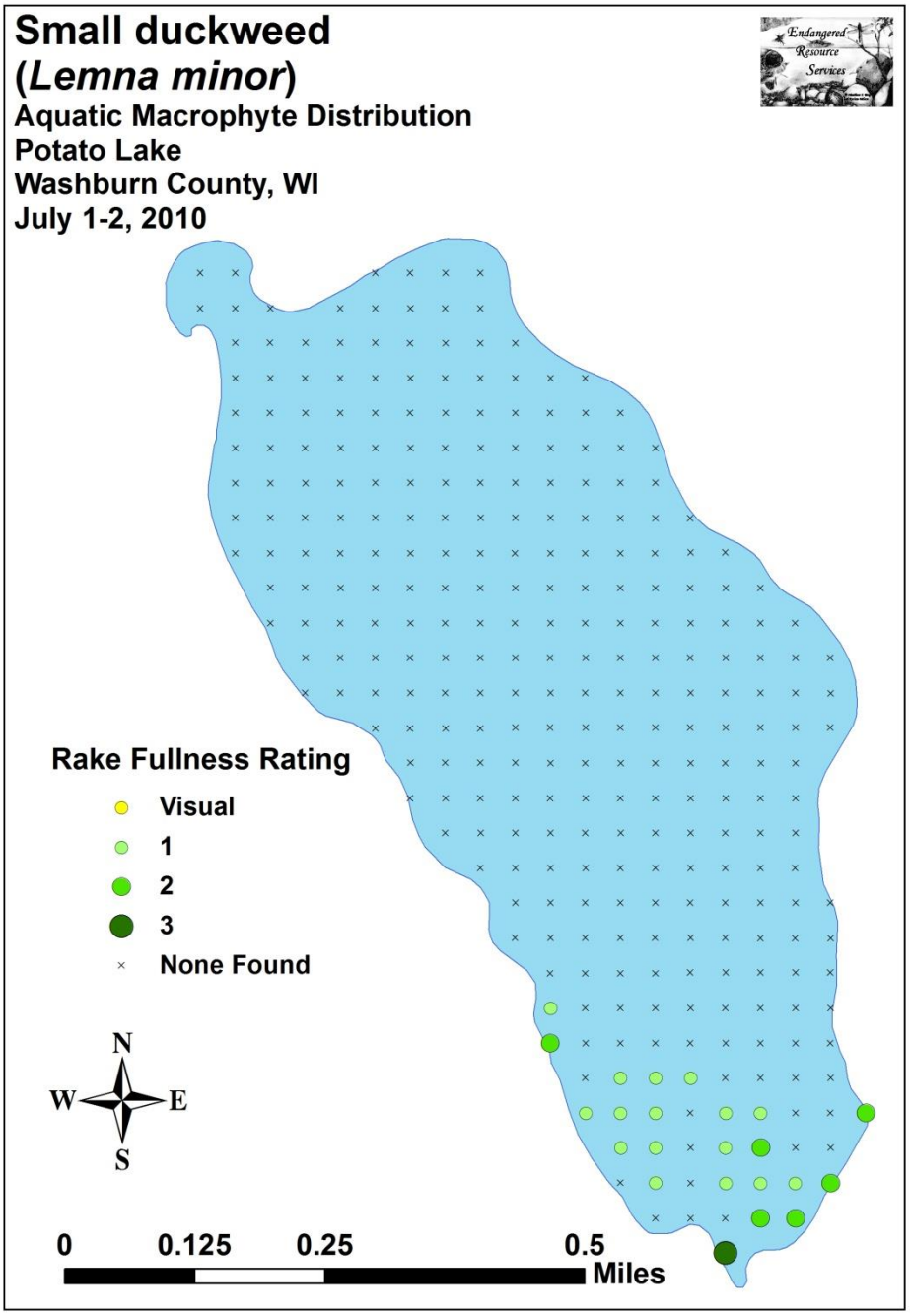
0.125
0.25
0.5
Miles


Small duckweed
(Lemna minor)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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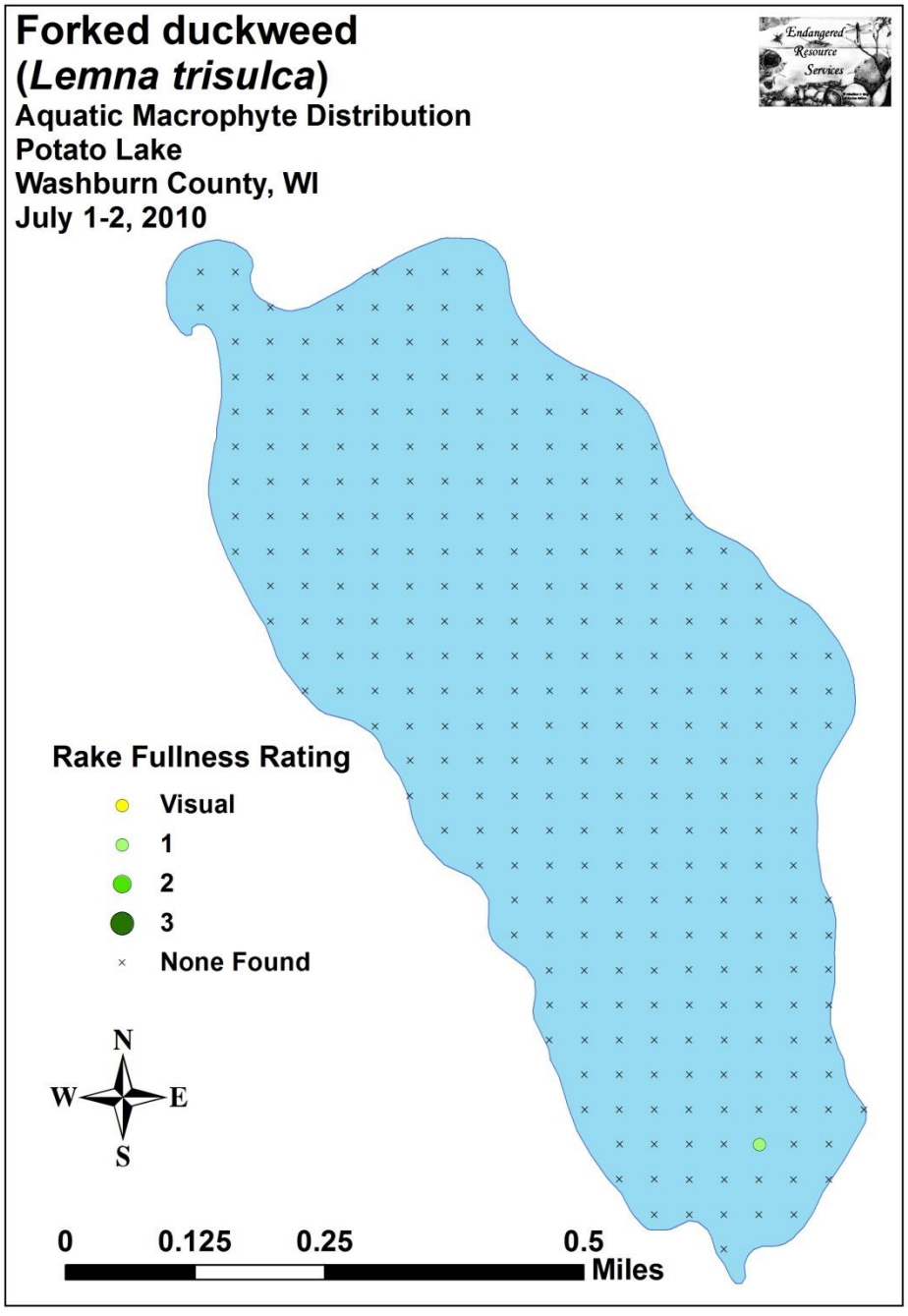
0.125
0.25
0.5
Miles


Forked duckweed
(Lemna trisulca)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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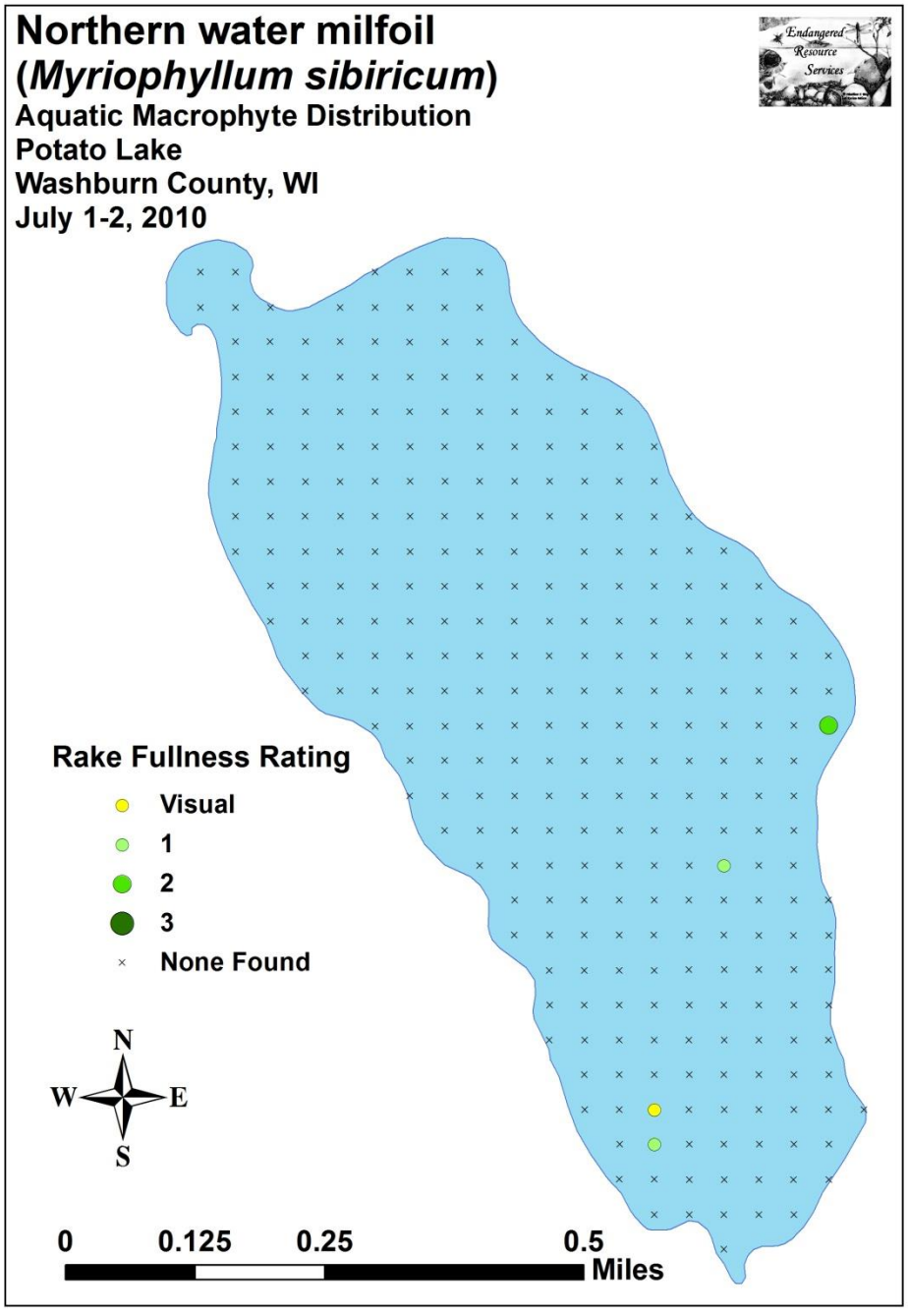
0.125
0.25
0.5
Miles


Northern water milfoil
(Myriophyllum sibiricum)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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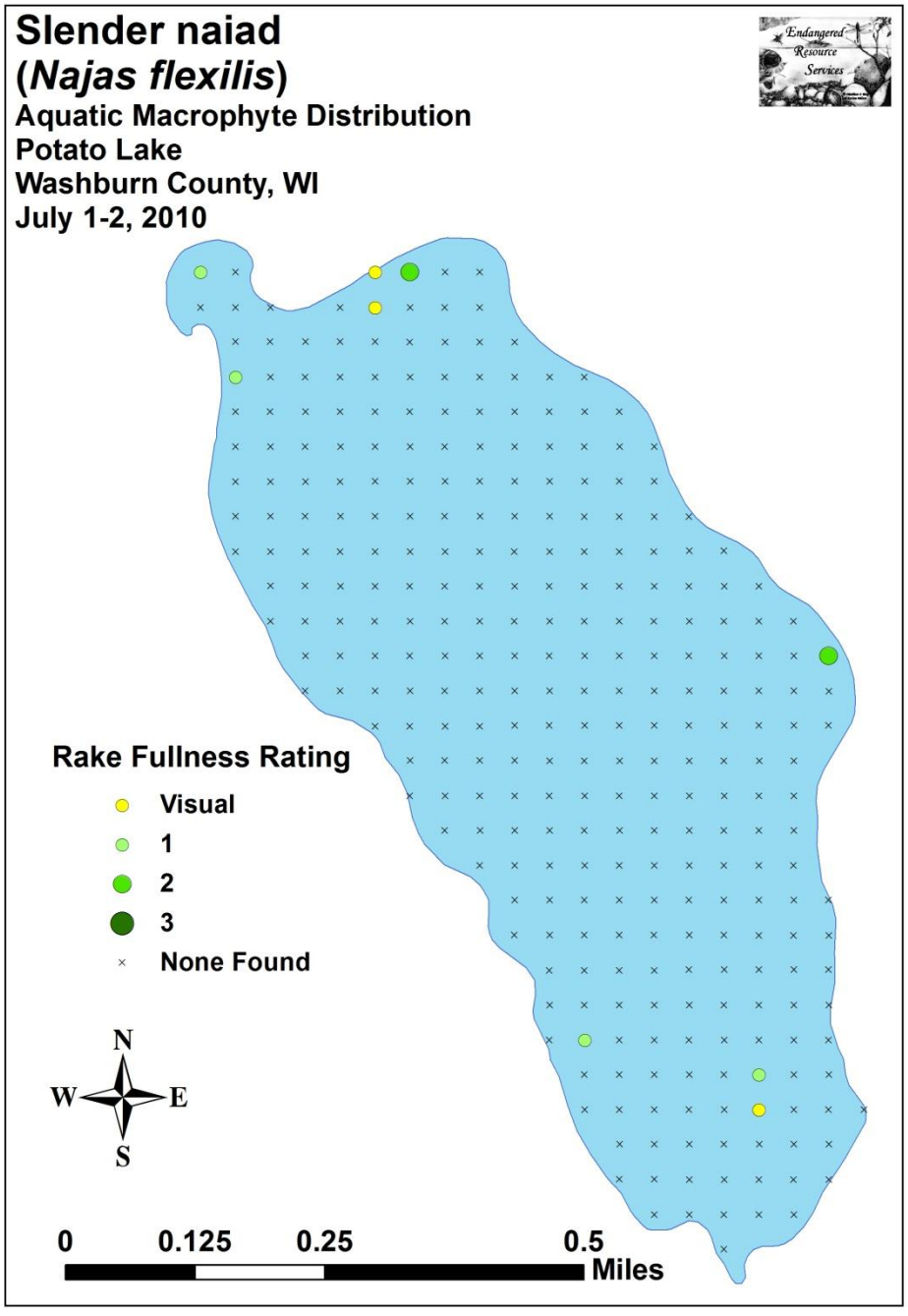
0.125
0.25
0.5
Miles


Slender naiad
(Najas flexilis)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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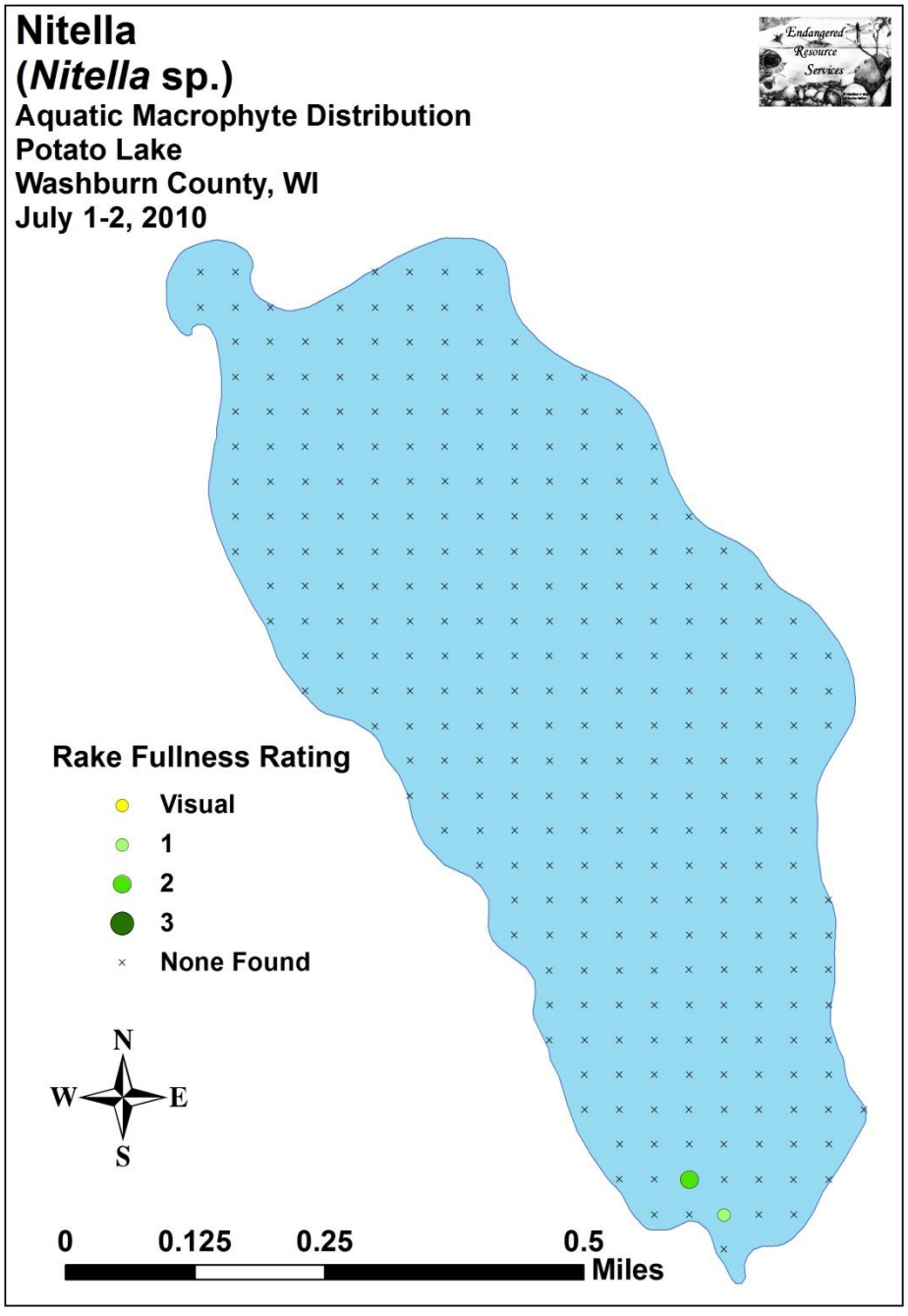
0.125
0.25
0.5
Miles


Nitella
(Nitella sp.)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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0.125
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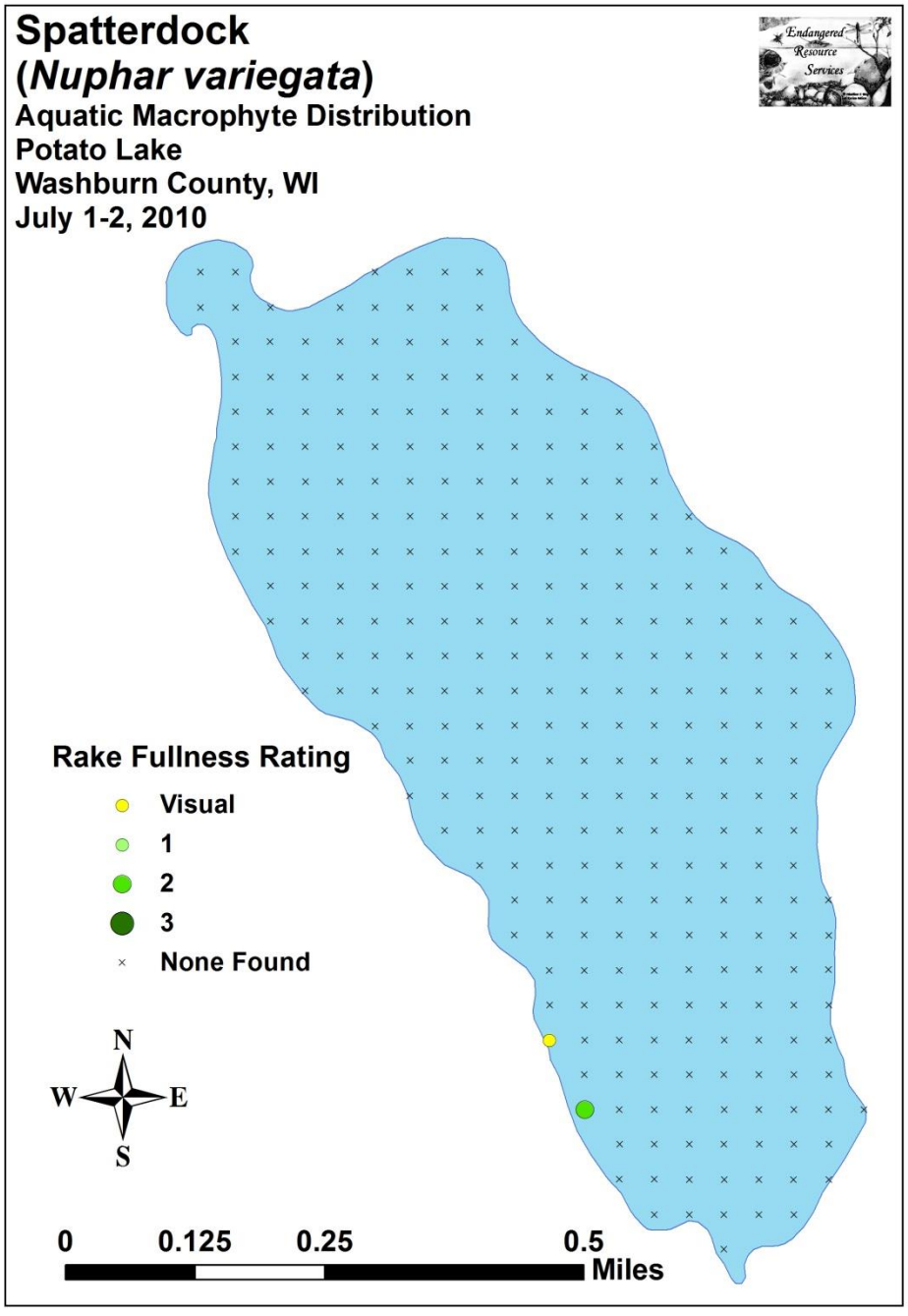
0.5
Miles


Spatterdock
(Nuphar variegata)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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3
None Found
N
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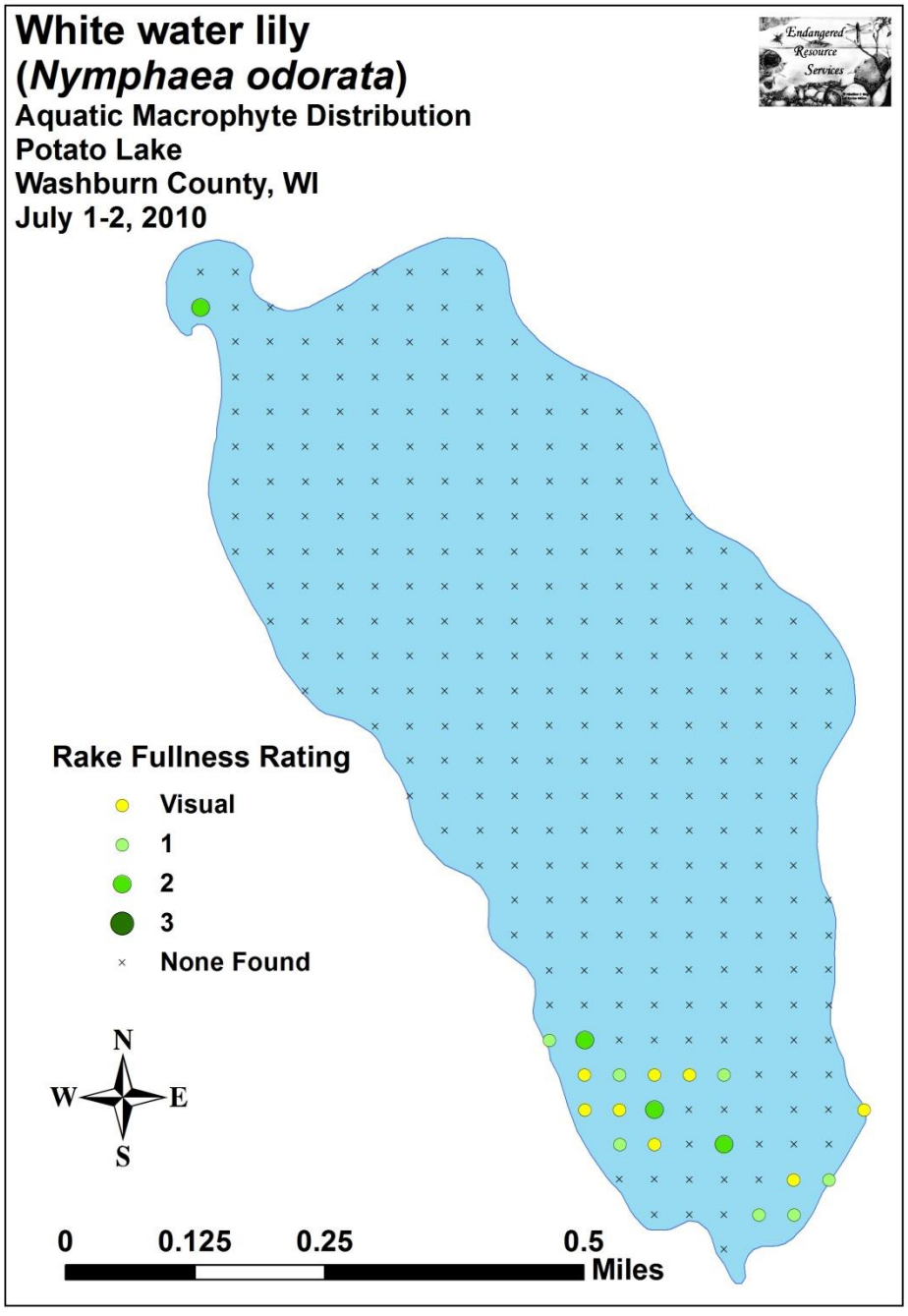
0.125
0.25
0.5
Miles


White water lily
(Nymphaea odorata)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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3
None Found
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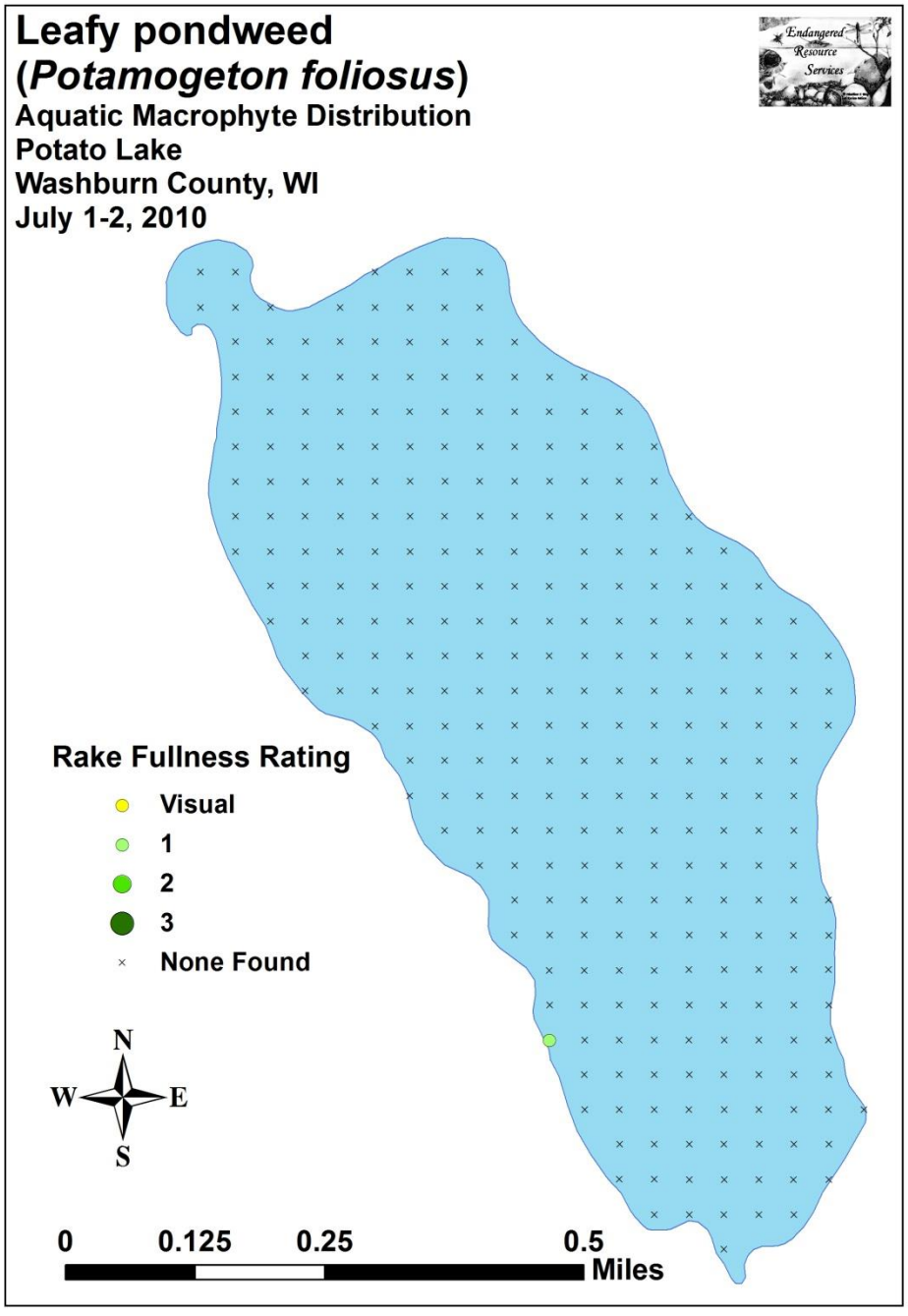
0.125
0.25
0.5
Miles


Leafy pondweed
(Potamogeton foliosus)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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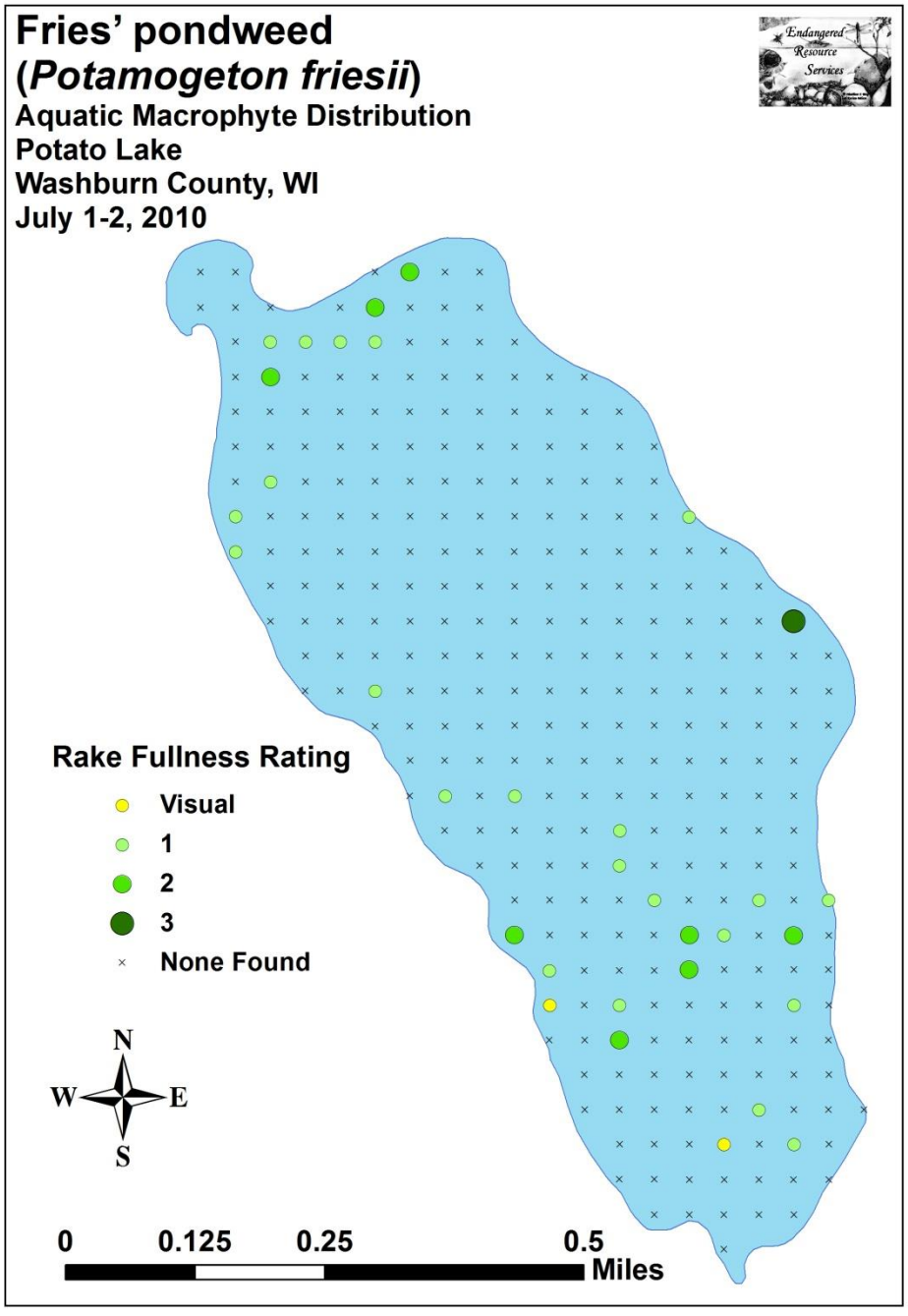
0.125
0.25
0.5
Miles


Fries' pondweed
(Potamogeton friesii)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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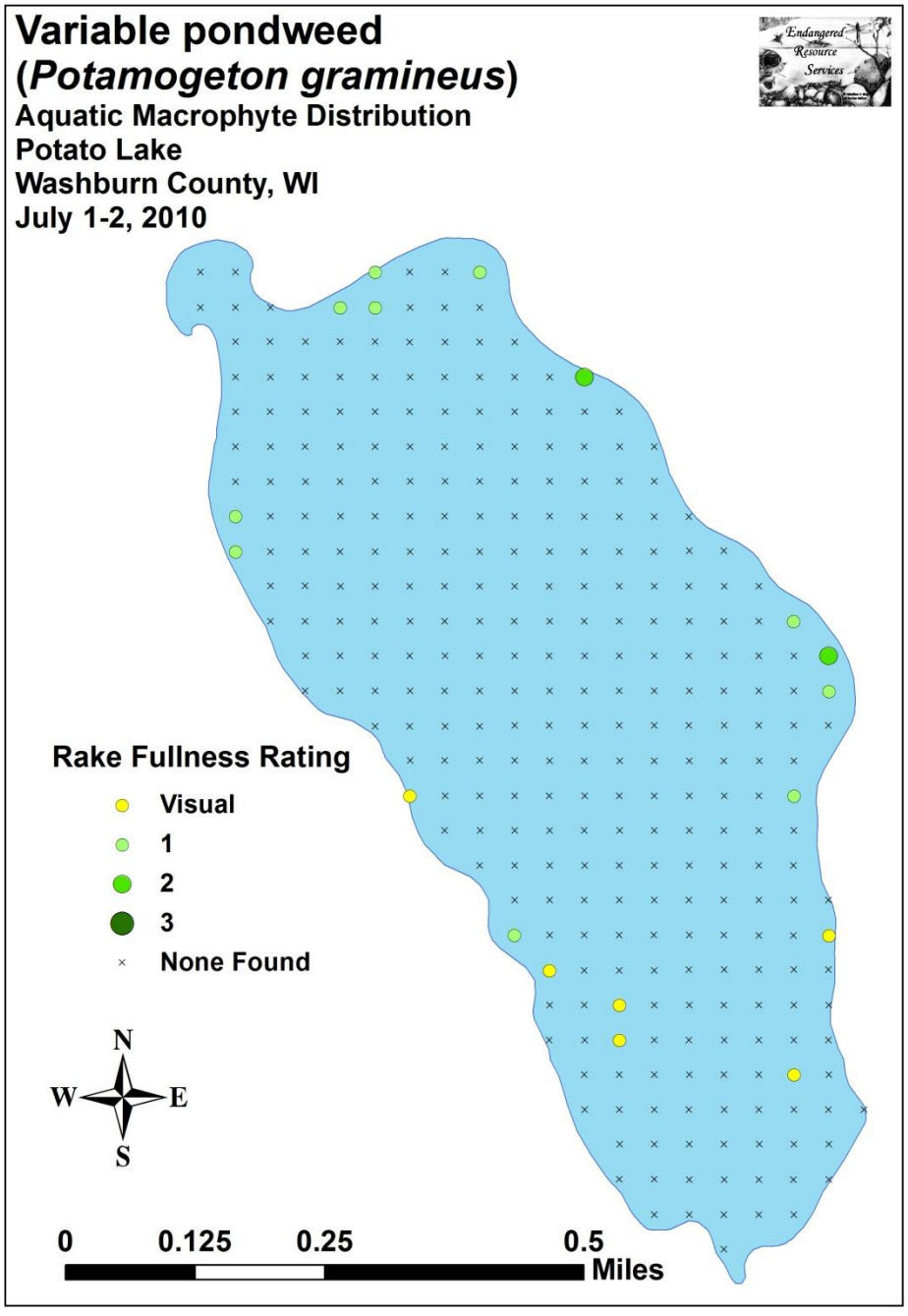
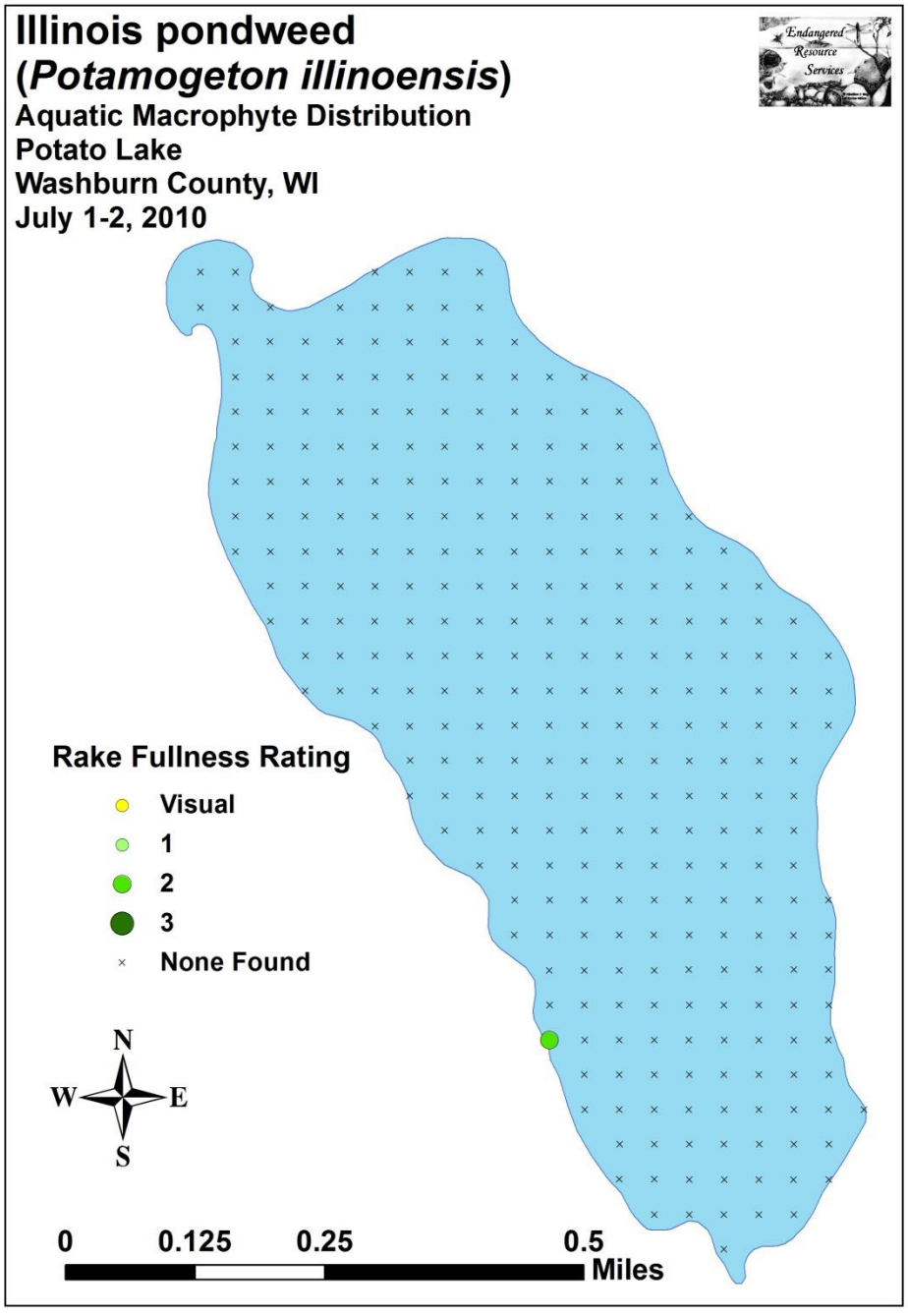
0.125
0.25
0.5
Miles


Variable pondweed
(Potamogeton gramineus)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.125
0.25
0.5
Miles


Illinois pondweed
(Potamogeton illinoensis)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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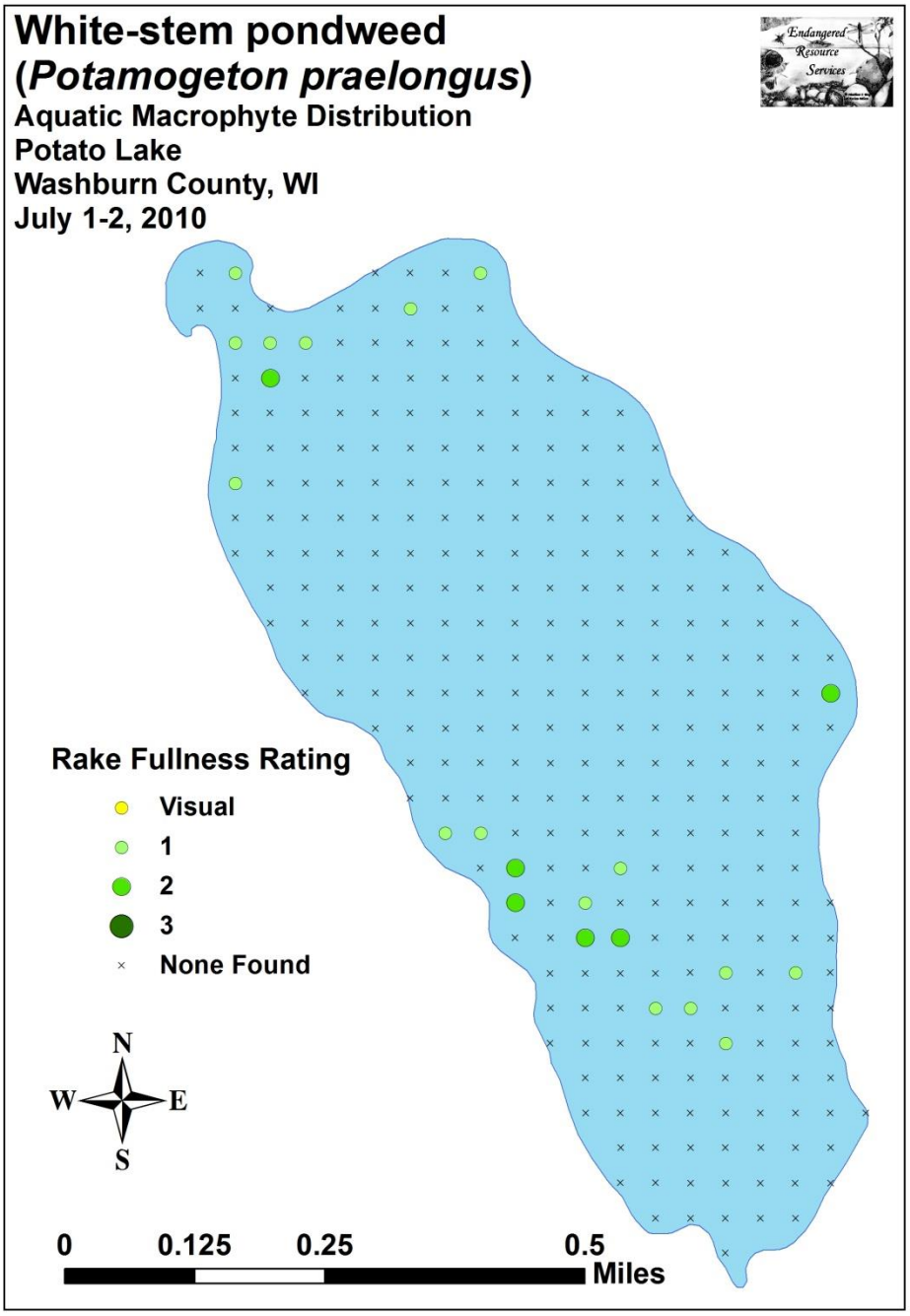
White-stem pondweed
(Potamogeton praelongus)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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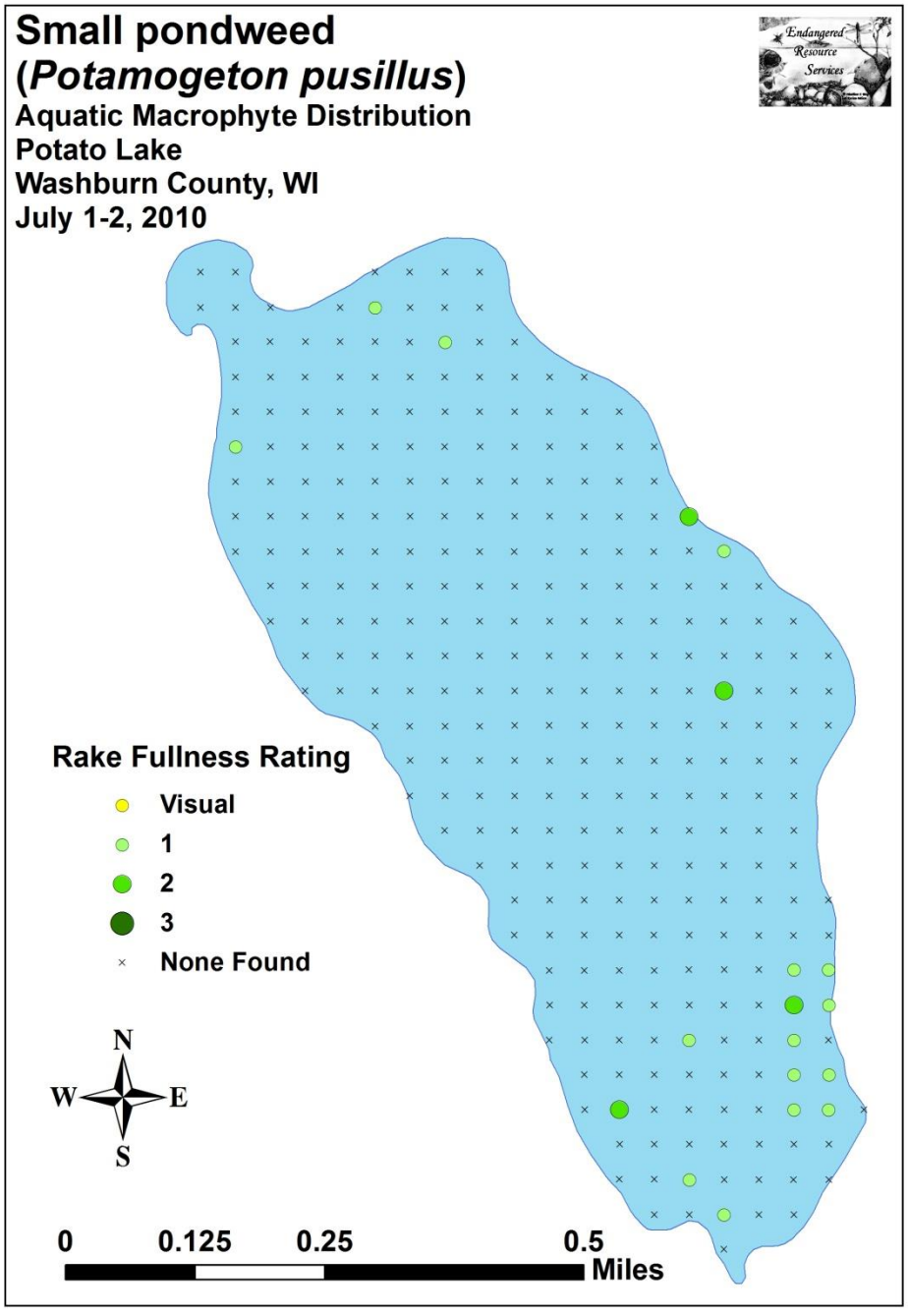
Small pondweed
(Potamogeton pusillus)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
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None Found
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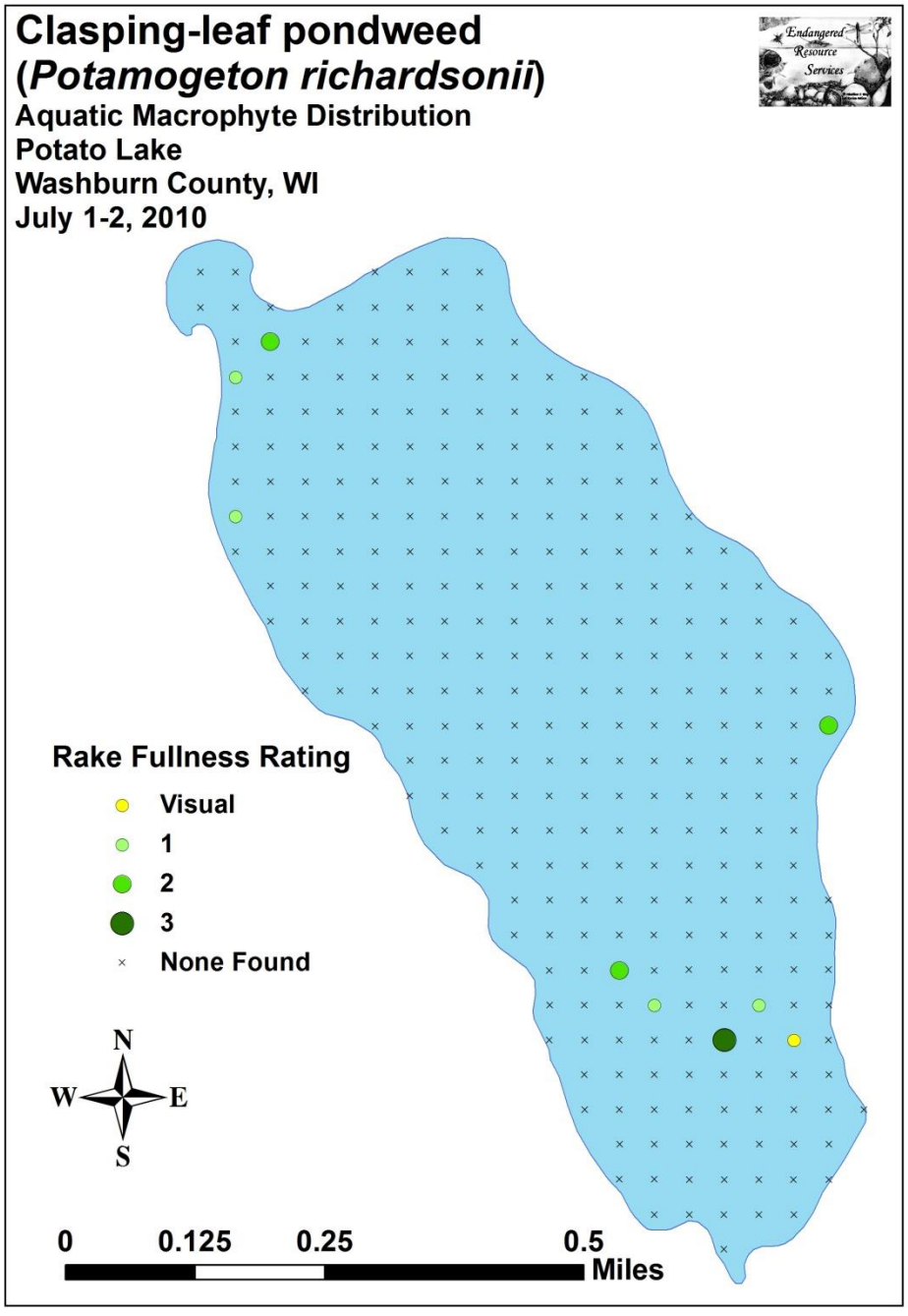
Clasping-leaf pondweed
(Potamogeton richardsonii)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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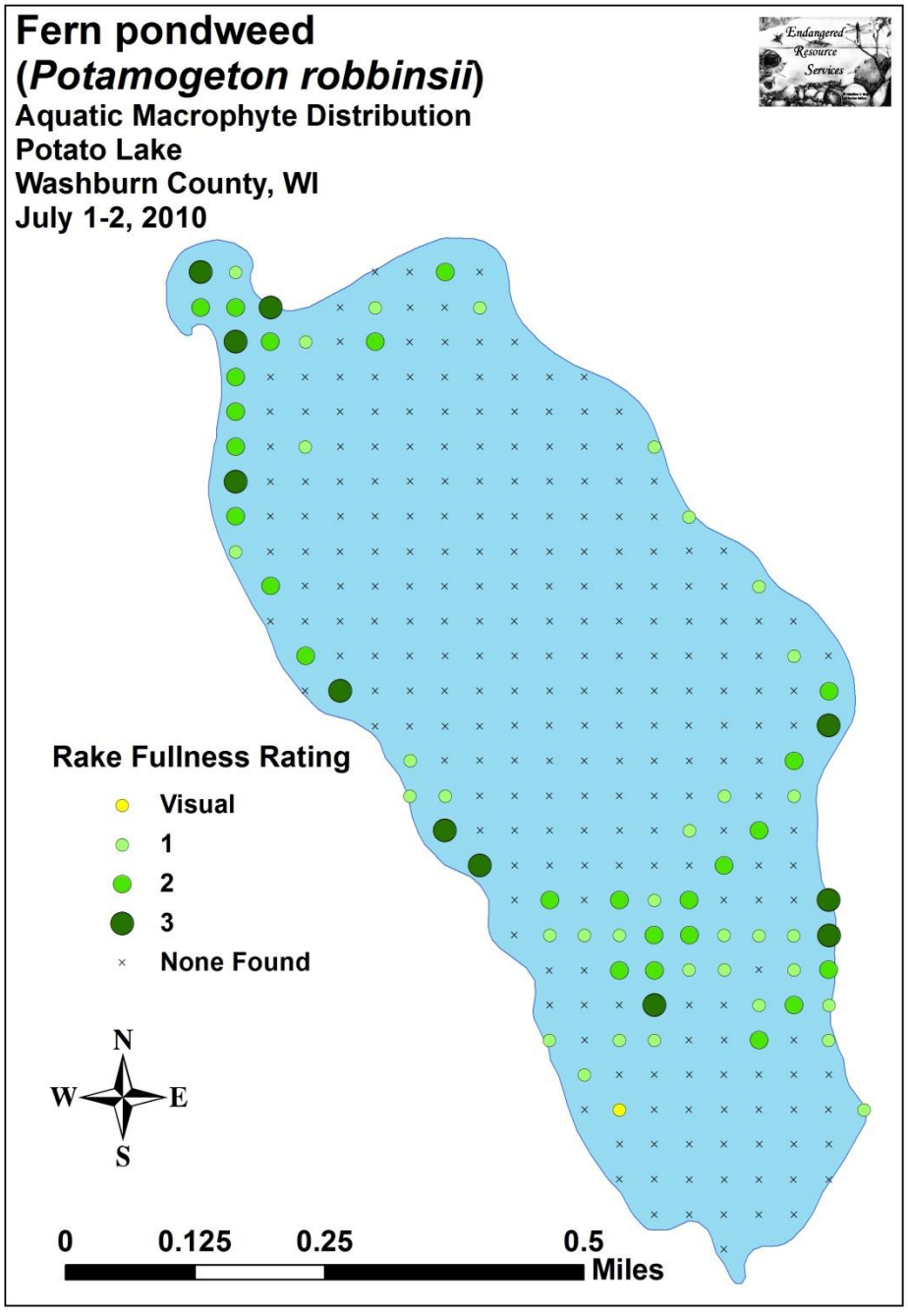
Fern pondweed
(Potamogeton robbinsii)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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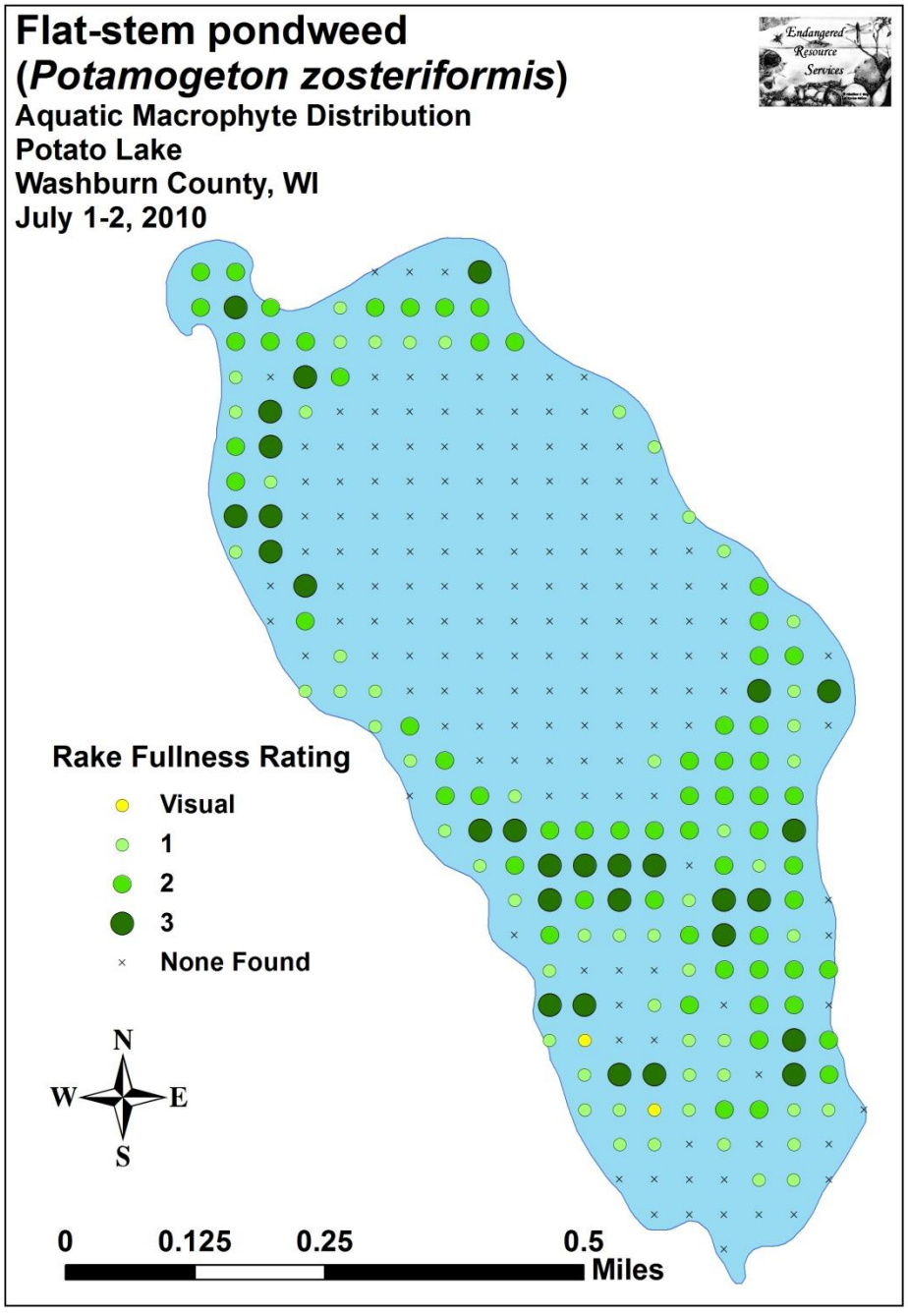
Flat-stem pondweed
(Potamogeton zosteriformis)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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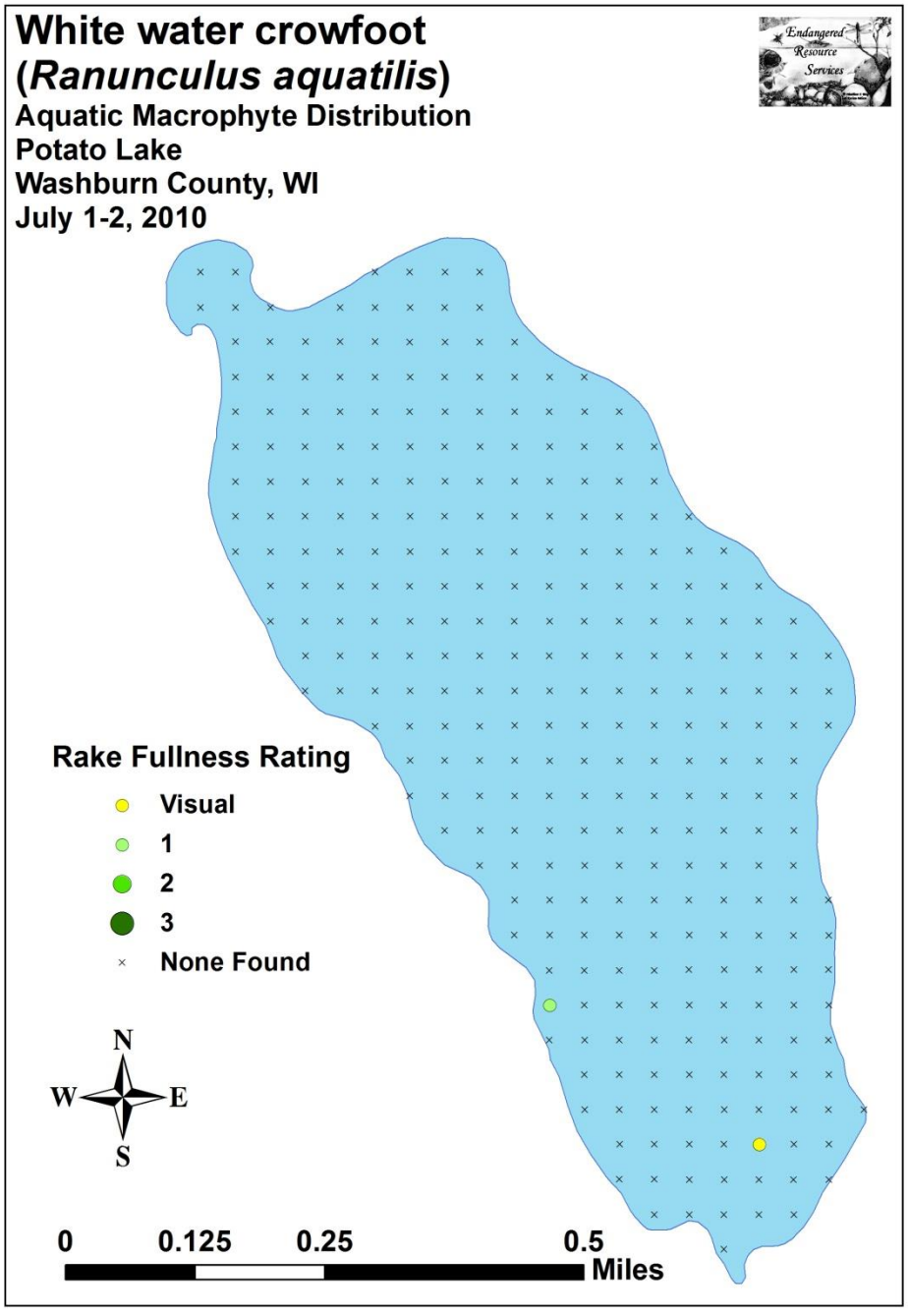
White water crowfoot
(Ranunculus aquatilis)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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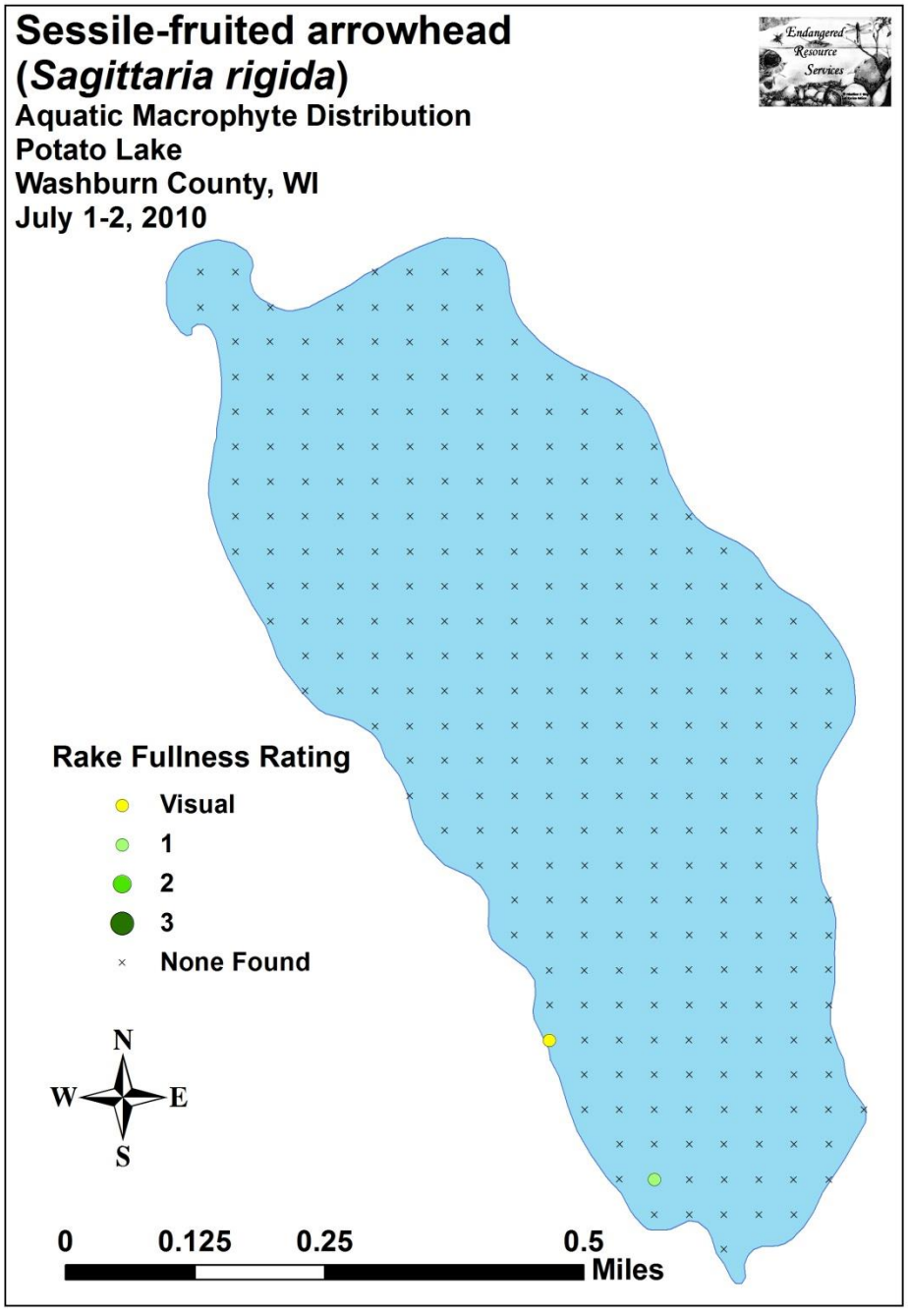
Sessile-fruited arrowhead
(Sagittaria rigida)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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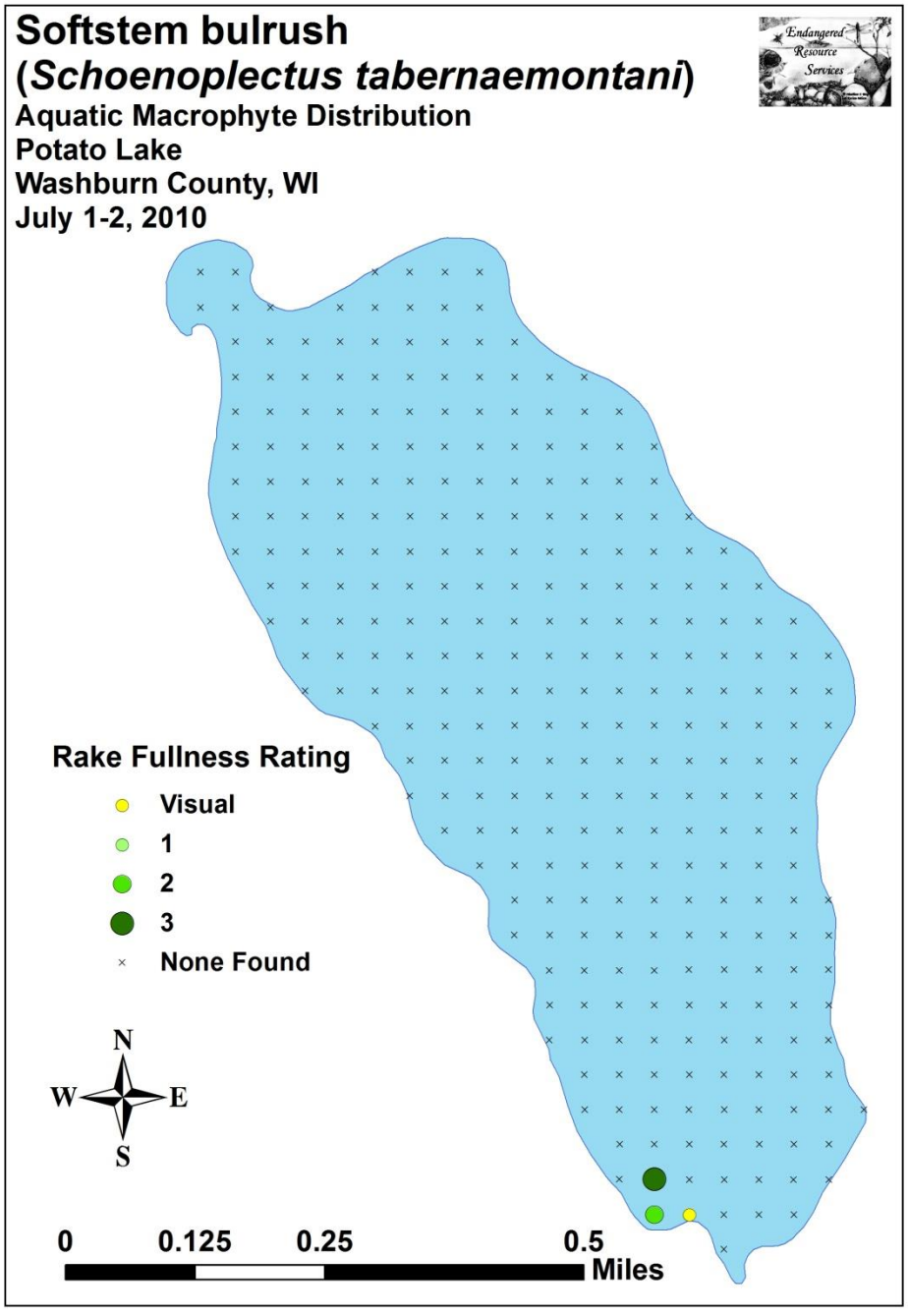
Softstem bulrush
(Schoenoplectus tabernaemontani)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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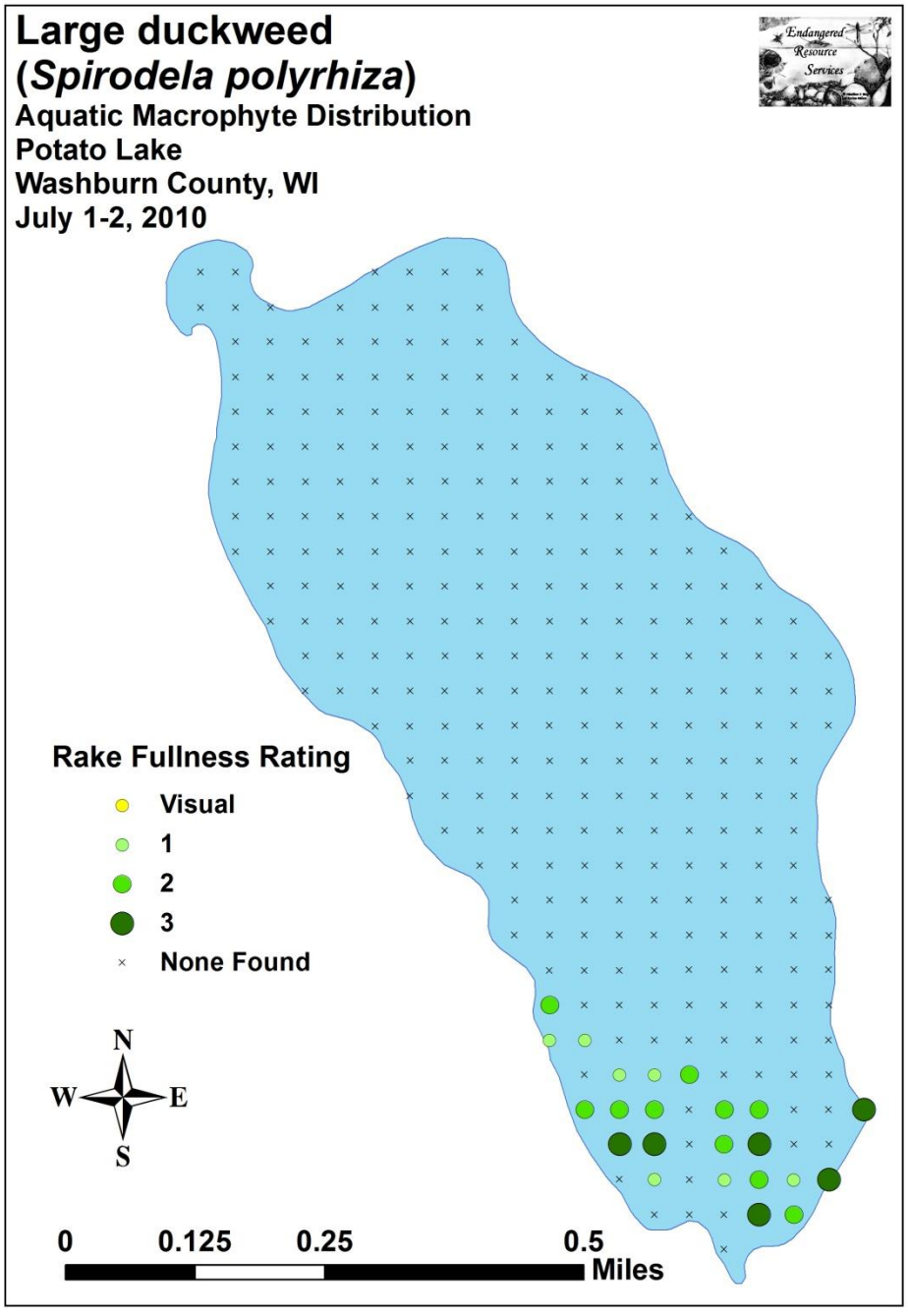
Large duckweed
(Spirodela polyrhiza)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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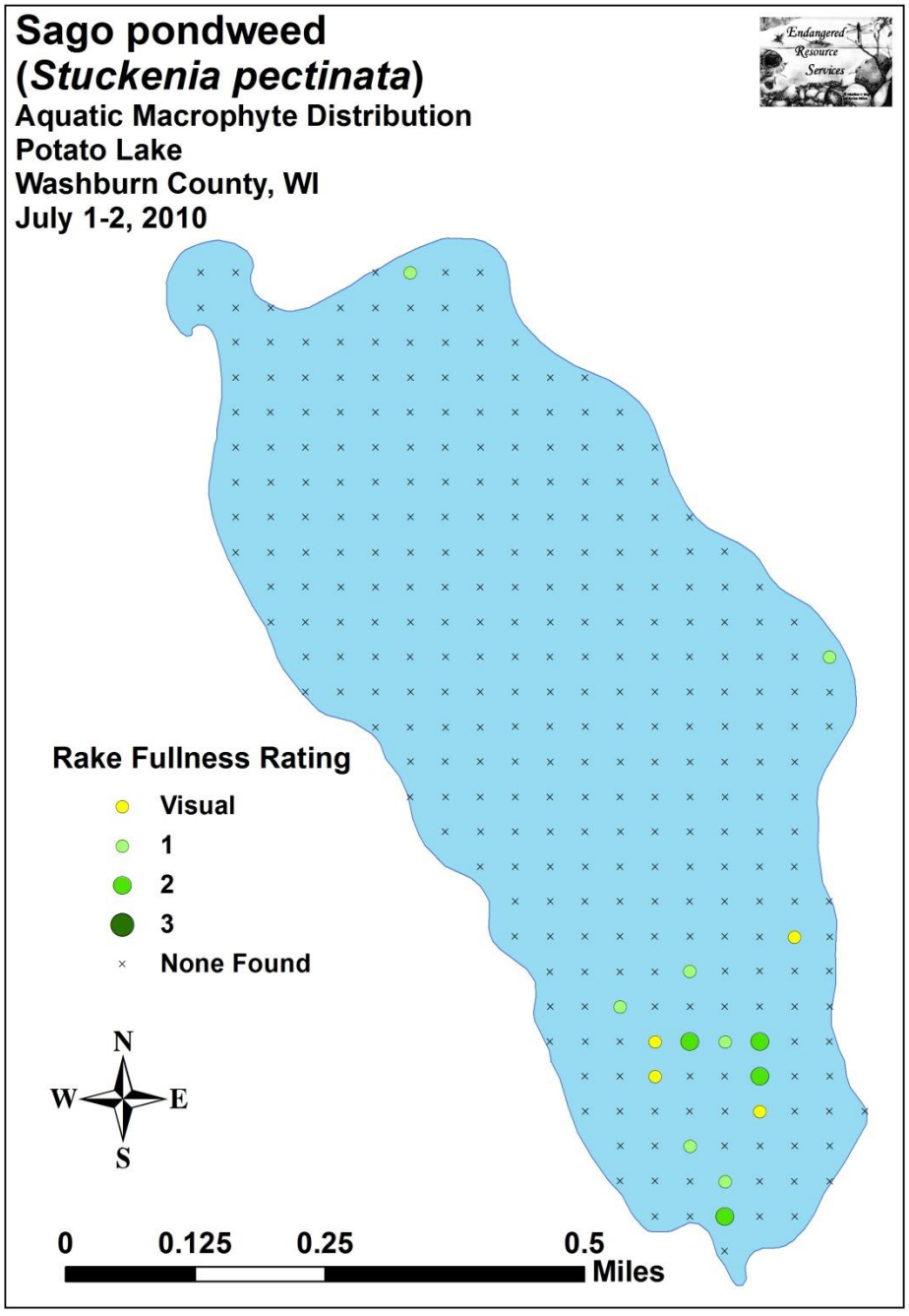
Sago pondweed
(Stuckenia pectinata)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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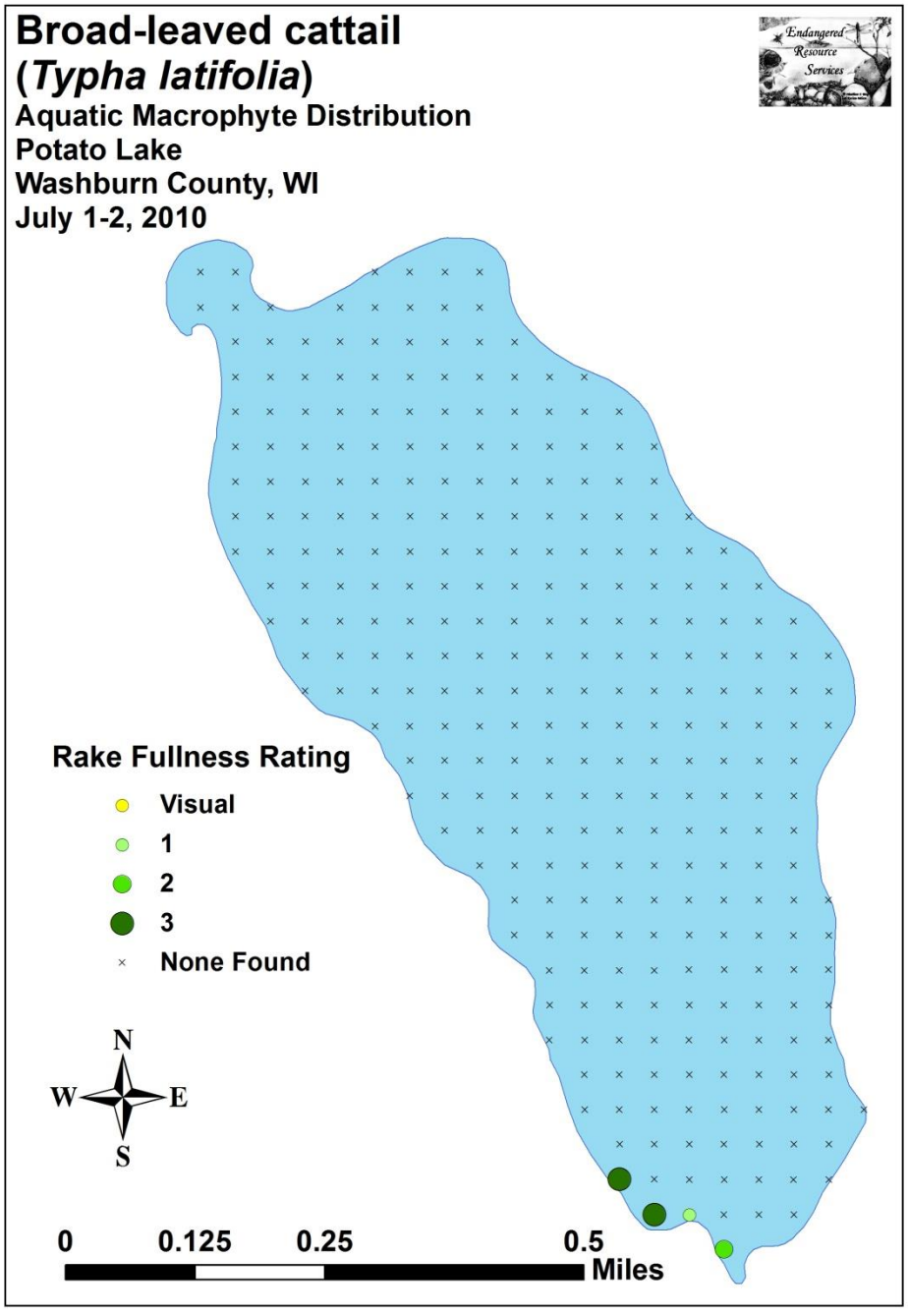
Broad-leaved cattail
(Typha latifolia)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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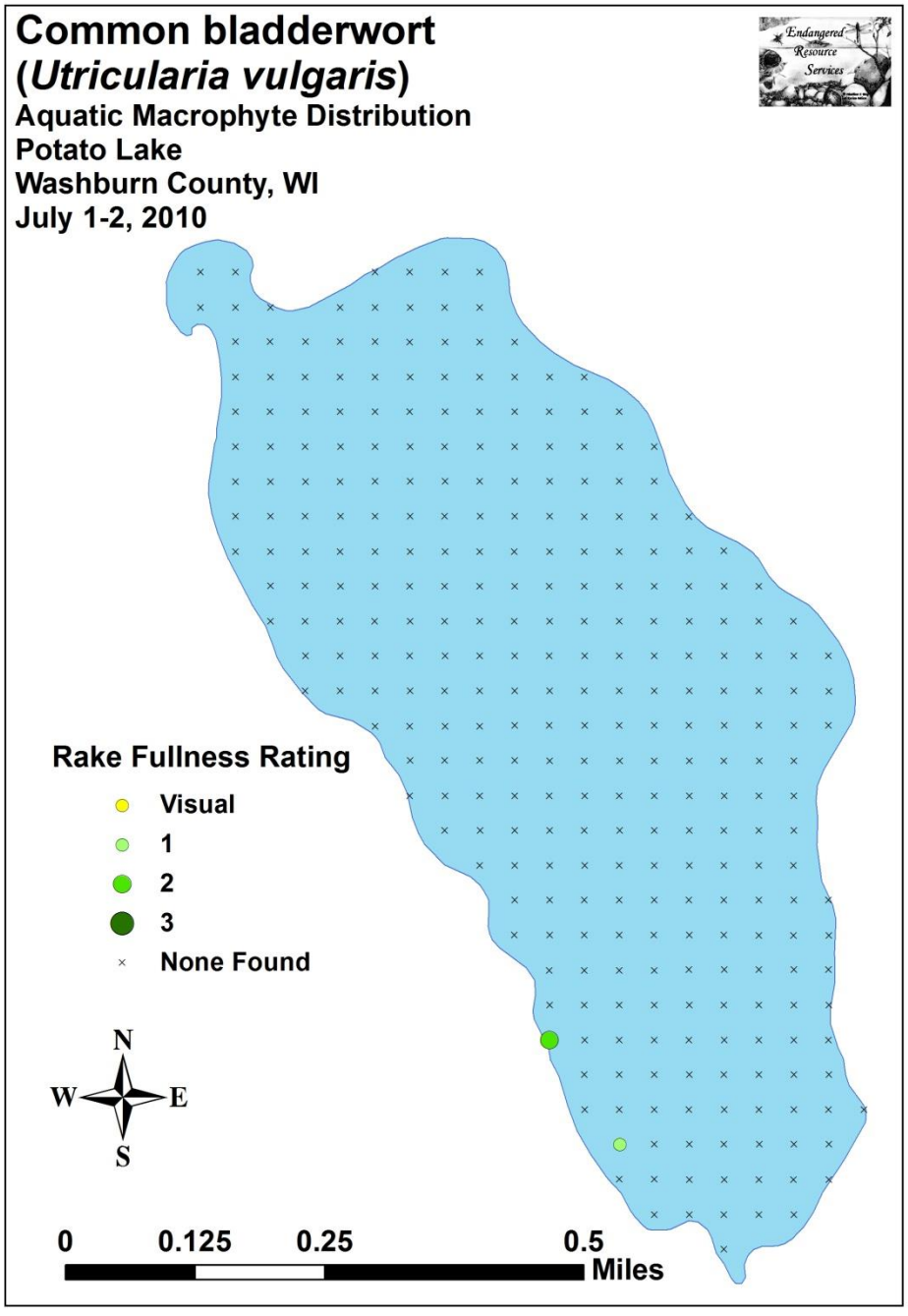
Common bladderwort
(Utricularia vulgaris)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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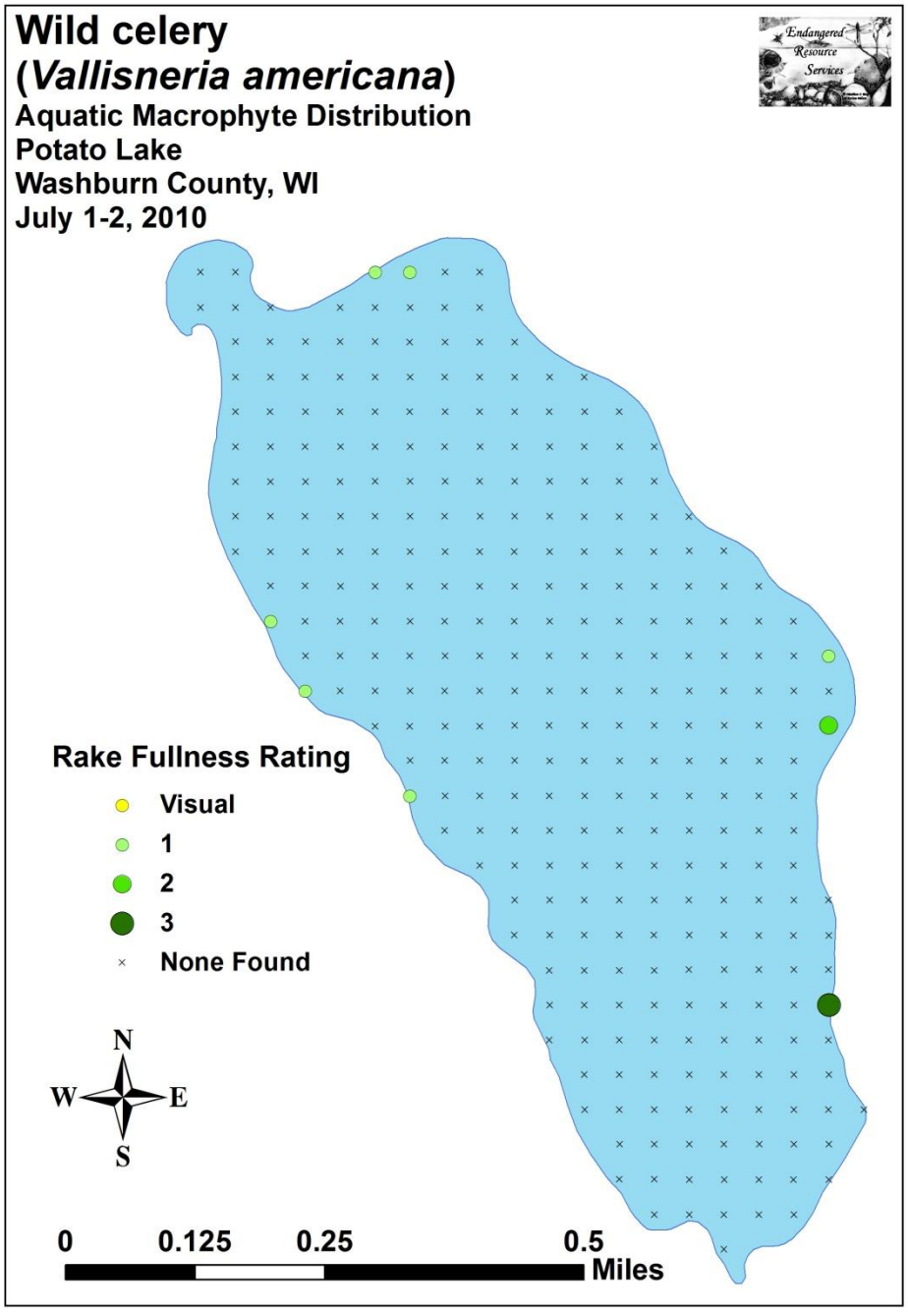
Miles


Wild celery
(Vallisneria americana)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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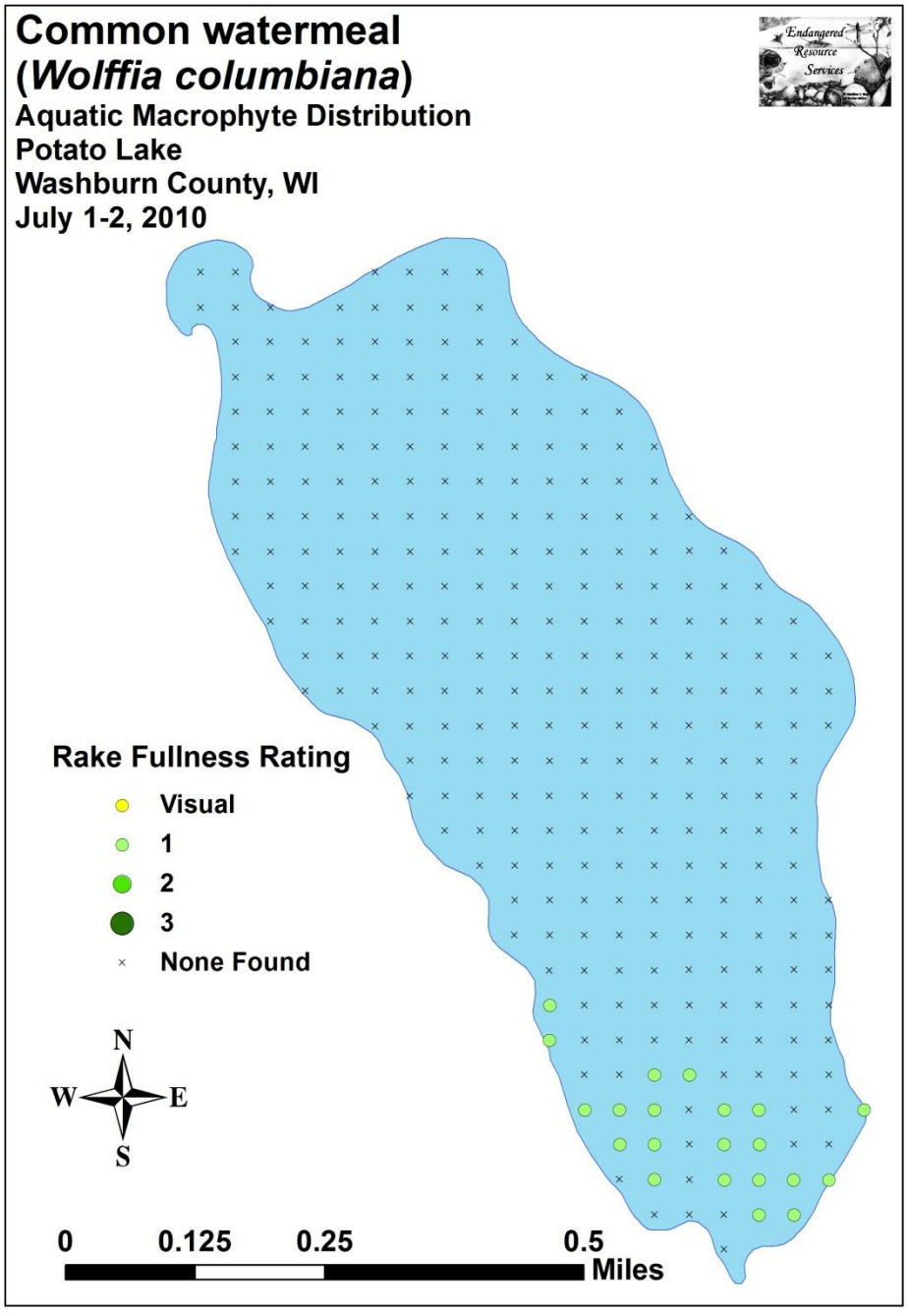
Common watermeal
(Wolffia columbiana)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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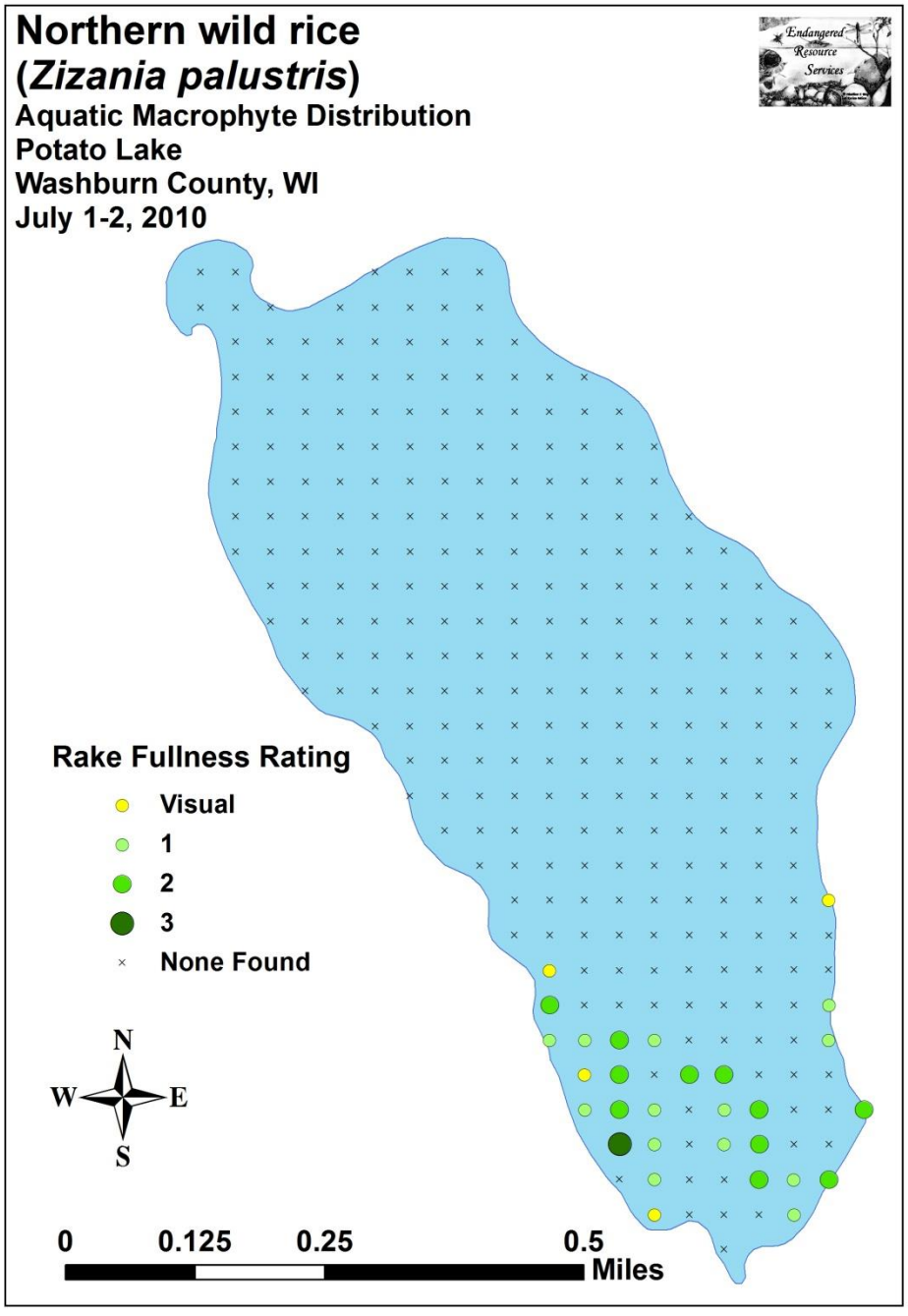
Northern wild rice
(Zizania palustris)
Aquatic Macrophyte Distribution
Potato Lake
Washburn County, WI
July 1-2, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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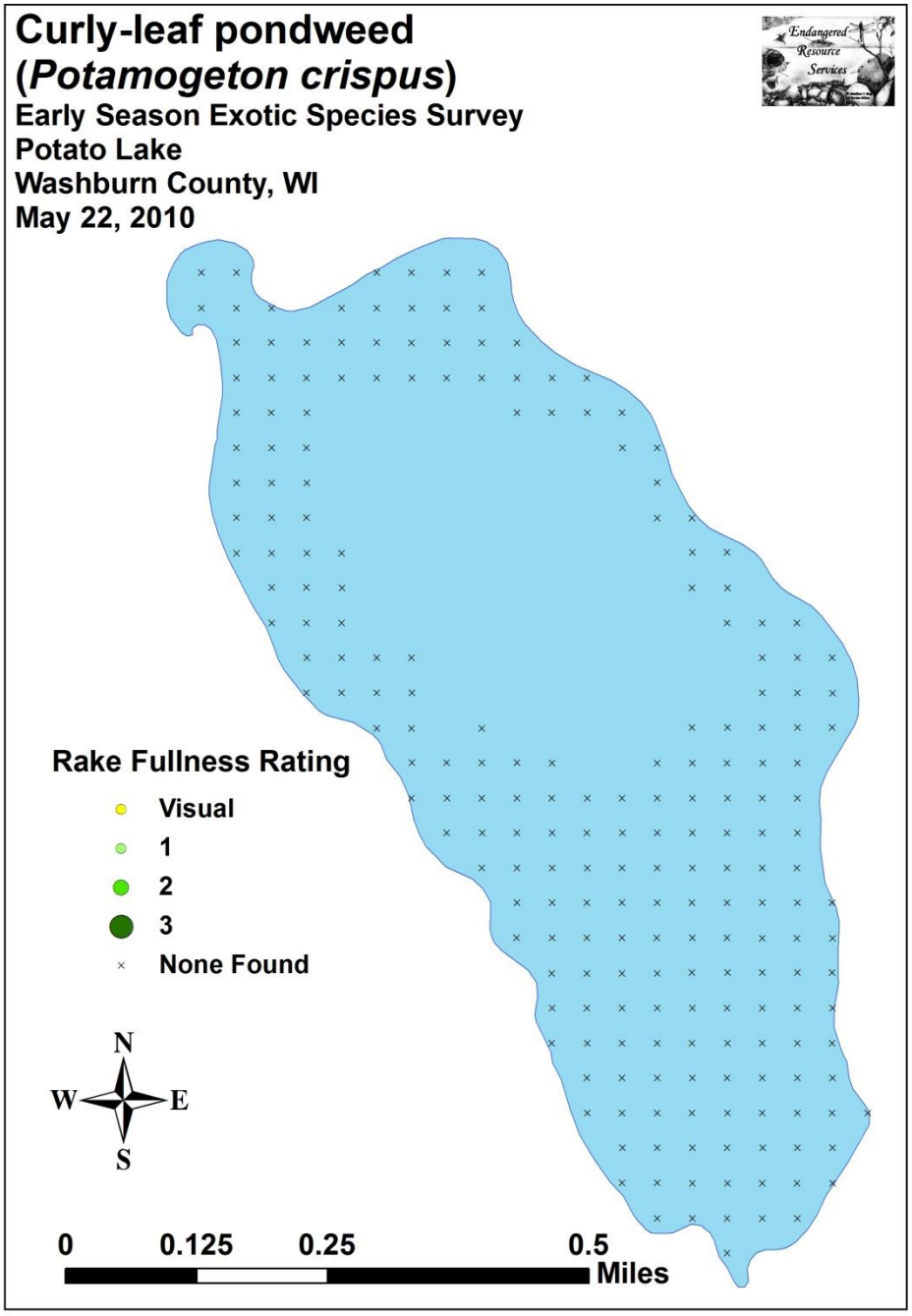
Appendix VIII: May CLP Survey Map and Additional Aquatic Exotic Species Information


Curly-leaf pondweed
(Potamogeton crispus)
Early Season Exotic Species Survey
Potato Lake
Washburn County, WI
May 22, 2010
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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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, 2010 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, 2010 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, 2010 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife
(Photo Courtesy Brian M. Collins)

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

This species may be confused with the native wing-angled loosestrife (*Lythrum alatum*) found in moist prairies or wet meadows. The latter has a winged, square stem and solitary paired flowers in the leaf axils. It is generally a smaller plant than the Eurasian loosestrife. By law, purple loosestrife is a nuisance species in Wisconsin. It is illegal to sell, distribute, or cultivate the plants or seeds, including any of its cultivars.

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

Purple loosestrife was first detected in Wisconsin in the early 1930's, but remained uncommon until the 1970's. It is now widely dispersed in the state, and has been recorded in 70 of Wisconsin's 72 counties. Low densities in most areas of the state suggest that the plant is still in the pioneering stage of establishment. Areas of heaviest infestation are sections of the Wisconsin River, the extreme southeastern part of the state, and the Wolf and Fox River drainage systems.

This plant's optimal habitat includes marshes, stream margins, alluvial flood plains, sedge meadows, and wet prairies. It is tolerant of moist soil and shallow water sites such as pastures and meadows, although established plants can tolerate drier conditions. Purple loosestrife has also been planted in lawns and gardens, which is often how it has been introduced to many of our wetlands, lakes, and rivers.

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

Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high and produce more than two million seeds a year. Germination is restricted to open, wet soils and requires high temperatures, but seeds remain viable in the soil for many years. Even seeds submerged in water can live for approximately 20 months. Most of the seeds fall near the parent plant, but water, animals, boats, and humans can transport the seeds long distances. Vegetative spread through local perturbation is also characteristic of loosestrife; clipped, trampled, or buried stems of established plants may produce shoots and roots. Plants may be quite large and several years old before they begin flowering. It is often very difficult to locate non-flowering plants, so monitoring for new invasions should be done at the beginning of the flowering period in mid-summer.

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

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways. (Taken in its entirety from WDNR, 2010 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)

Appendix IX: Glossary of Biological Terms
(Adapted from UWEX 2010)

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 X: Raw Data Spreadsheets