Curly-leaf pondweed (*Potamogeton crispus*) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Poskin Lake - WBIC: 2098000 Barron County, Wisconsin

Poskin Lake Aerial Photo (2015)   Canopied Coontail on south-central rock bar and typical Curly-leaf pondweed observed 5/23/18

Project Initiated by:

The Poskin Lake Association, the Wisconsin Department of Natural Resources, and Lake Education and Planning Services, LLC

Widely scattered Northern wild rice in the north bay 7/15/18

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ABSTRACT

Poskin Lake (WBIC 2098000) is a 154 acre drainage lake located in central Barron County, WI. Following our original point-intercept surveys in 2009, the Poskin Lake Association (PLA), under the direction of Dave Blumer (Lake Education and Planning Services, LLC) developed an initial Aquatic Plant Management Plan at which time they decided against actively managing Curly-leaf pondweed (*Potamogeton crispus*) (CLP). Increases in CLP levels since that time prompted the PLA to again consider active management. As a prerequisite to updating their plan in 2019 and to compare how the lake's vegetation had changed since the last point-intercept surveys, the PLA and the Wisconsin Department of Natural Resources authorized CLP density and bed mapping surveys on May 23rd and June 12th, and a full point-intercept survey of all aquatic macrophytes on July 15, 2018. During the initial 2009 early-season survey, we found CLP at 11 sites (2.7% coverage with a mean rake fullness of 2.09) of which nine had a rake fullness of 2 or 3 suggesting 2.2% of the lake had a significant infestation. In 2018, we found CLP at ten points (2.5% coverage with a mean rake fullness of 1.10) with only one of these having a rake fullness of 2 or 3 (0.2% of the lake had a significant infestation). This represented a non-significant **decline** in total CLP distribution (*p*=0.82), a significant **increase** in only rake fullness 1 **(*p*=0.03)**, and an overall **highly significant decrease (*p*<0.001)** in combined mean rake fullness. In 2018, we found three Curly-leaf pondweed beds. Totaling just 0.47 acre (0.31% coverage), they represented a 0.24 acre decline (-33.80%) over 2009 when we mapped a single bed that totaled 0.71 acre (0.46% of the lake). During the July 2018 full point-intercept survey, we found macrophytes growing at 84 sites which approximated to 20.8% of the entire lake bottom and 90.3% of the 9.0ft littoral zone. This was down slightly from 86 sites in 2009 (21.3% of the lake and 76.8% of the then 10.5ft littoral zone). Overall diversity was moderately high with a Simpson Index value of 0.87 – nearly identical to 0.88 in 2009. Total richness was low with just 19 species in the rake and 30 total found growing in and immediately adjacent to the water (also down from 26/35 species in 2009). There was an average of 3.44 native species/site with native vegetation – a non-significant decline (*p*=0.31) from 3.60/site in 2009. Total rake fullness experienced a moderately significant decline **(*p*=0.004)** from a high 2.52 (est.) in 2009 to a high/moderate 2.21 in 2018. Coontail (*Ceratophyllum demersum*), Small duckweed (*Lemna minor*), Large duckweed (*Spirodela polyrhiza*), and Common watermeal (*Wolffia columbiana*) were the most common macrophyte species in 2018. Found at 75.00%, 52.38%, 52.38%, and 52.38% of sites with vegetation, they captured 66.10% of the total relative frequency. In 2009, Coontail, Common watermeal, Small duckweed, and Large duckweed were the most common species (88.37%, 47.67%, 45.35%, and 44.19% of survey points with vegetation/60.63% of the total relative frequency). Lakewide, from 2009-2018, three species showed significant changes in distribution: Common waterweed (*Elodea canadensis*) suffered a moderately significant decline; and Coontail and White water crowfoot (*Ranunculus aquatilis*) saw significant declines. The 18 native index species found in the rake during the July 2018 survey (down from 25 in 2009) produced an exactly average mean Coefficient of Conservatism of 5.6 (identical to 2009). The Floristic Quality Index of 23.6 (down from 28.2 in 2009) was, however, slightly above the median FQI for this part of the state. Northern wild rice (*Zizania palustris*) was a visual at three points. There was no potential for human harvest as the lake's rice population likely didn't total more than a few 100 plants; and almost all were cropped by waterfowl making the population's long-term viability questionable. Filamentous algae (41 points with a mean rake fullness of 1.54) were common to abundant throughout the lake (similar to 38 points with a mean rake of 1.66 in 2009). Curly-leaf pondweed was still present at six points in July (down from 10 in 2009). Other than CLP, we found two other exotic species growing in and adjacent to Poskin Lake: Reed canary grass (*Phalaris arundinacea*) was present along shorelines throughout, and Narrow-leaved cattail (*Typha angustifolia*) was scattered along the south shoreline in the southwest bay. If active management of Curly-leaf pondweed does occur in the future, we strongly encourage the PLA to take a small-scale approach based on annual needs to relieve navigation impairment. By taking a measured approach, it is less likely that any treatments would collaterally damage the lake's very limited native plant community and the important habitat it provides. Proactively working to limit nutrients coming into the system as they feed both excessive algal and CLP growth; and educating lakeshore residents on ways to control erosion and nutrient runoff are other future management considerations worth exploring.

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INTRODUCTION:

Poskin Lake (WBIC 2098000) is a 154 acre, stratified, drainage lake located in the Town of Clinton in central Barron County (T34N R13W S15 NW SW). It reaches a maximum depth of 30ft in the central basin southwest of the Vermillion River Outlet and has an average depth of 16ft (WDNR 2018). The lake is eutrophic in nature with Secchi readings from 2003-2018 averaging 3.3ft (WDNR 2018). This poor water clarity produced a littoral zone that reached approximately 9.0ft in 2018. The lake's bottom substrate is predominantly organic muck, although a narrow ring of sand and rock occurs along most shorelines of the main basin (Figure 1) (Ripp et al. 1968).

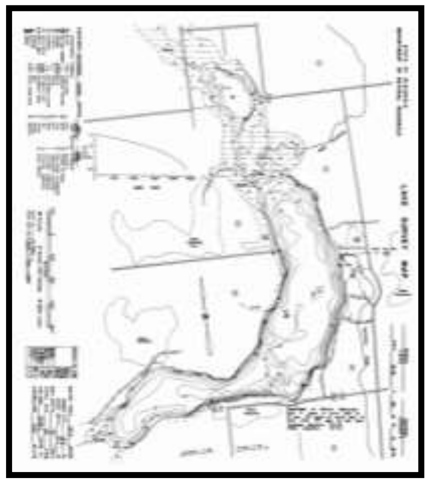


Figure 1: Poskin Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

In 2009, the Poskin Lake Association (PLA) and the Wisconsin Department of Natural Resources (WDNR) authorized a series of whole lake plant surveys as a prerequisite to developing the lake's initial 2010 Aquatic Plant Management Plan (APMP). Although those surveys found that the exotic invasive species Curly-leaf pondweed (*Potamogeton crispus*) (CLP) occurred throughout much of the lake's spring littoral zone, it was decided that the generally low growth levels did not justify active management at that time. However, following several years of high CLP density on the lake, the PLA decided to revisit active management. Per WDNR expectations, plant surveys are normally repeated every five to seven years to remain current (Pamela Toshner/Alex Smith, WDNR – pers. comm.). Because of this, the PLA was informed they needed to have the lake resurveyed so they could update their APMP prior to initiating any active management.

In anticipation of updating their plan in 2019, the PLA, under the direction of D. Blumer - Lake Education and Planning Services, LLC (LEAPS), authorized three lakewide surveys on Poskin Lake in 2018. On May 23rd, we conducted an early-season CLP point-intercept survey. This was followed by a CLP bed mapping survey on June 12th, and a warm-water point-intercept survey of all macrophytes on July 15th. The surveys' objectives were to document the current levels of CLP; determine if Eurasian water-milfoil (*Myriophyllum spicatum*) or any other new exotic plants had invaded the lake; and to compare data from the original 2009 surveys with the 2018 data to identify any significant changes in the lake's vegetation over this time. This report is the summary analysis of these three field surveys.

METHODS:

Curly-leaf Pondweed Point-intercept Survey:

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, and total acreage, Michelle Nault (WDNR) generated the original 403 point sampling grid for Poskin Lake in 2009 (Appendix I). Using this same grid in 2018, we completed a density survey where we sampled for Curly-leaf pondweed at each littoral point in the lake. We located each survey point using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. When found, CLP was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also noted visual sightings of CLP within six feet of the sample point.

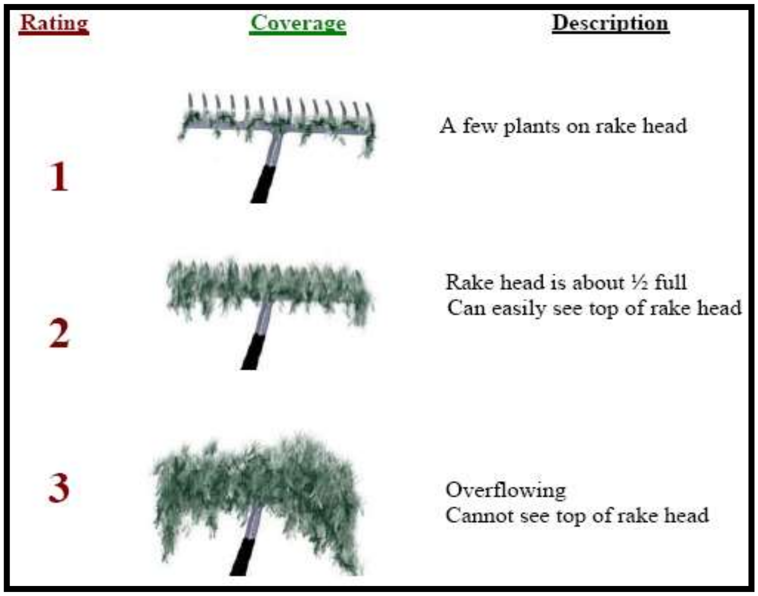


Figure 2: Rake Fullness Ratings (UWEX 2010)

Curly-leaf Pondweed Bed Mapping Survey:

During the bed mapping survey, we searched the lake's entire visible littoral zone. By definition, a "bed" was determined to be any area where we visually estimated that CLP made up >50% of the area's plants, was generally continuous with clearly defined borders, and was canopied, or close enough to being canopied that it would likely interfere with boat traffic. After we located a bed, we motored around the perimeter of the area taking GPS coordinates at regular intervals. We also estimated the rake density range and mean rake fullness of the bed (Figure 2), the maximum depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none** – easily avoidable with a natural channel around or narrow enough to motor through/**minor** – one prop clear to get through or access open water/**moderate** – several prop clears needed to navigate through/**severe** – multiple prop clears and difficult to impossible to row through). These data were then mapped using ArcMap 9.3.1, and we used the WDNR's Forestry Tools Extension to determine the acreage of each bed to the nearest hundredth of an acre (Table 1).

Warm-water Full Point-intercept Macrophyte Survey:

Prior to beginning the July point-intercept survey, we conducted a general boat survey to regain familiarity with the lake's macrophytes (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2009; Skawinski 2014), and a datasheet was built from the species present. We again located each survey point with a GPS, recorded a depth reading with a metered pole rake, and took a rake sample. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of all plants within six feet of the sample point not found in the rake. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (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 II) (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 littoral zone has plants.

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

Frequency of occurrence example:

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

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

From these frequencies, we can estimate how common each species was at depths where plants were able to grow, and at points where plants actually were growing. Note the second value will be greater as not all the points (in this example, only ½) had plants growing at them.

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 individual plants (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.

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.

Number of sites sampled using rope/pole rake: This indicates which rake type was used to take a sample. We use a 20ft pole rake and a 35ft 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 at a sample point during the survey but not found in the rake, and those that were only seen during the initial boat survey or inter-point. **Note: Per DNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.**

Average rake fullness: This value is the average rake fullness of all species in the rake. It only takes into account those sites with vegetation (Table 2).

<u>Relative frequency:</u> 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 (Tables 3 and 4).

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, North 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. Poskin Lake is in the North Central Hardwood Forests Ecoregion (Tables 5 and 6).

**** 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.**

Comparison to Past Surveys: We compared data from our 2009 and 2018 CLP point-intercept surveys (Figure 4) and warm-water point-intercept surveys (Figure 11) (Tables 3 and 4) to see if there were any significant changes in the lake's vegetation. For individual plant species as well as count data, we used the Chi-square analysis on the WDNR Pre/Post survey worksheet. For comparing averages (mean species/point and mean rake fullness/point), we used t-tests. Differences were considered significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$ (UWEX 2010). It should be noted that when comparing the CLP point-intercept surveys, we used the number of littoral points in 2018 (115 points) for each year as depths weren't recorded during the 2009 spring survey; however, for the warm-water point-intercept surveys, we used the number of littoral points with plants (86 in 2009/84 in 2018) as the basis for "sample points".

RESULTS:

Curly-leaf Pondweed Point-intercept Survey:

Because a single Curly-leaf pondweed was found growing to an estimated 13.5ft in 2009, we rake sampled every point in the lake <15ft during the 2018 early-season point-intercept survey. CLP was present at ten points which approximated to 2.5% of the entire lake and 8.7% of the spring littoral zone. Of these, we didn't find any with a rake fullness value of 3, just one was a 2, and the other nine were a 1 for a combined mean rake fullness of 1.10. We also noted CLP as a visual at three points (Figure 3) (Appendix III). The single point with a rake fullness of a 2 or a 3 extrapolated to 0.2% of the entire lake and 0.9% of the spring littoral zone having a significant infestation.

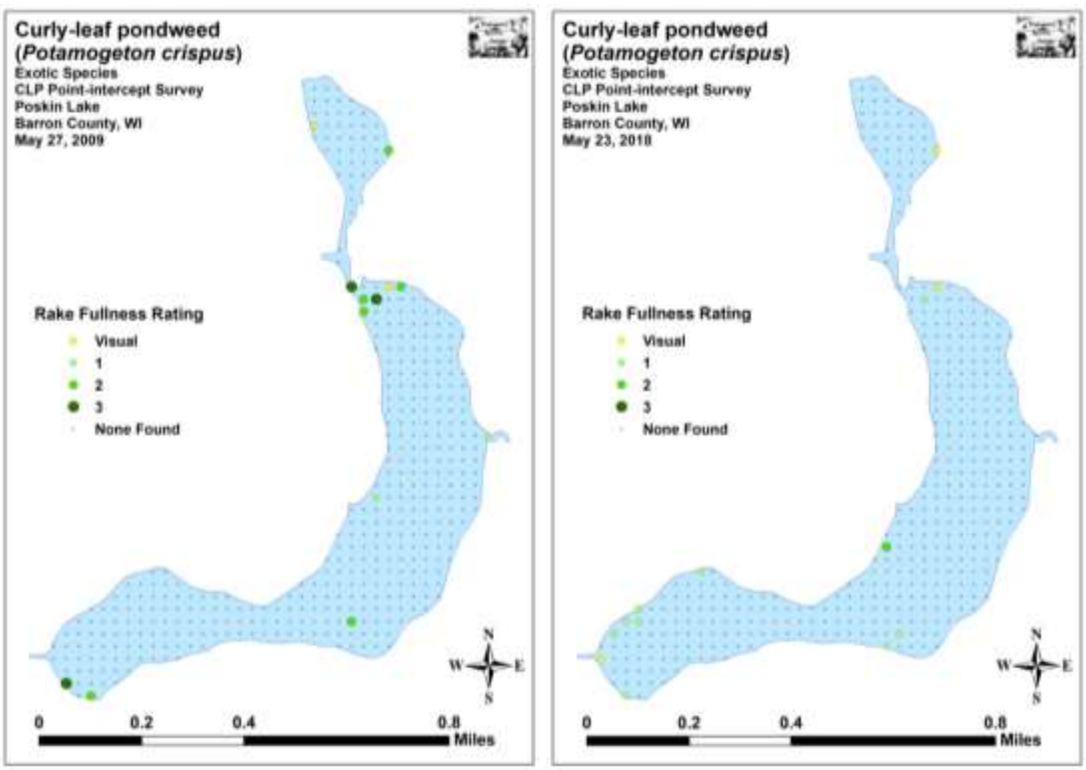
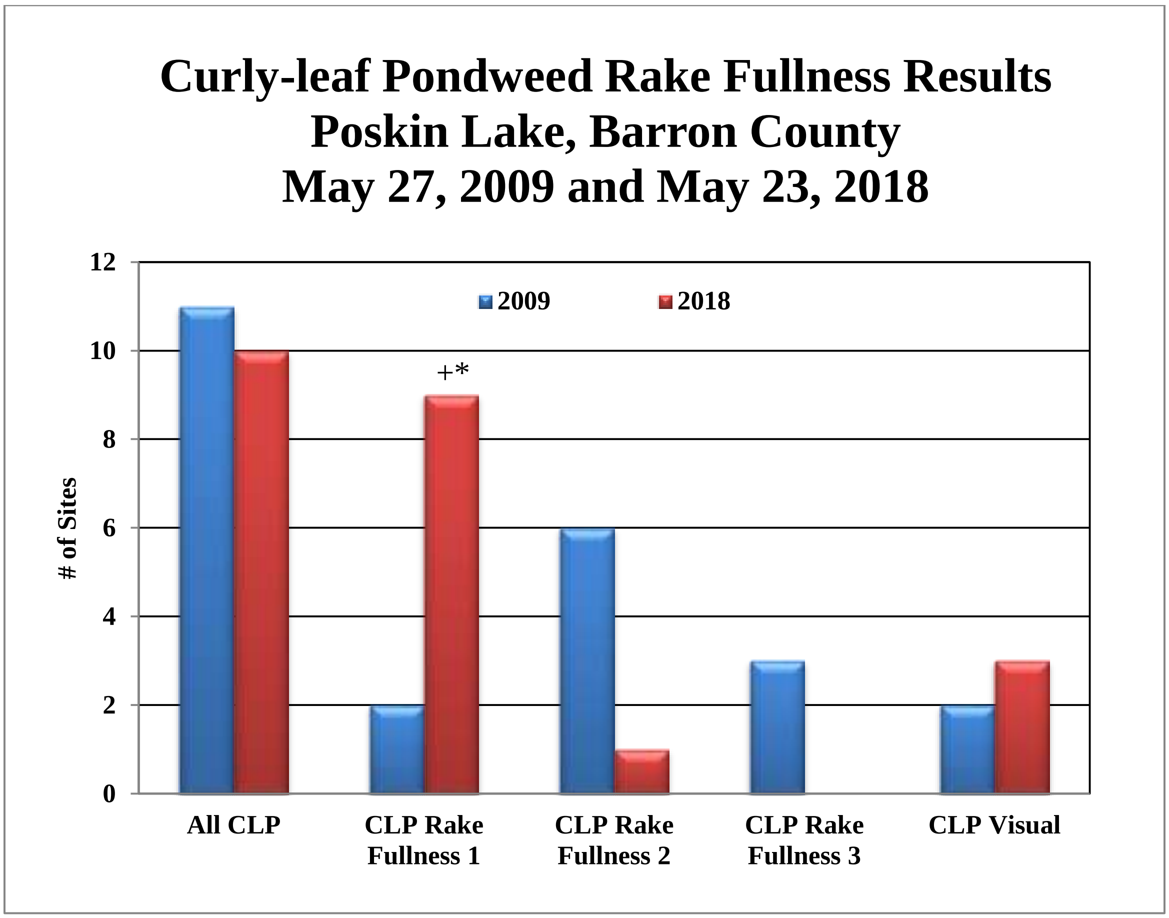


Figure 3: 2009 and 2018 Early-season Curly-leaf Pondweed Density and Distribution

Comparison of Curly-leaf Pondweed in 2009 and 2018:

The 2009 spring Curly-leaf pondweed point-intercept survey found CLP at 11 sites which approximated to 2.7% of the entire lake and 6.4% of the estimated 13.5ft spring littoral zone. Of these, we recorded a rake fullness value of 3 at three points, a 2 at six points, and a value of 1 at two points for a mean rake fullness of 2.09. We also recorded CLP as a visual at two points (Figure 3) (Appendix III). The combined nine points with a rake fullness of 2 or 3 extrapolated to 2.2% of the entire lake and 5.3% of the littoral zone having a significant infestation. From 2009-2018, our results suggest a non-significant **decline** in total CLP distribution (p=0.82), a significant **increase** in only rake fullness 1 **(p=0.03)** (Figure 4), and an overall **highly significant decrease (p<0.001)** in combined mean rake fullness.



Significant differences = * p<0.05, ** p<0.01, *** p<0.001

Figure 4: 2009 and 2018 Changes in Early-season CLP Rake Fullness

Curly-leaf Pondweed Bed Mapping Survey:

In 2009, we mapped a single Curly-leaf pondweed bed along the north shoreline of the main basin that stretched from the channel to Little Poskin east to the Vermillion River Inlet (Figure 5). Covering 0.71 acre (0.46% of the lake's 154 acres), it was mixed with canopied Coontail (*Ceratophyllum demersum*) and didn't occur in front of any residences making it unlikely to cause navigation impairment.

The 2018 bed-mapping survey located three beds totaling 0.47 acre (0.31% of the lake's surface area) (Table 1). This represented a 0.24 acre decline (-33.80%) from our 2009 bed mapping survey (Figure 5) (Appendix III).

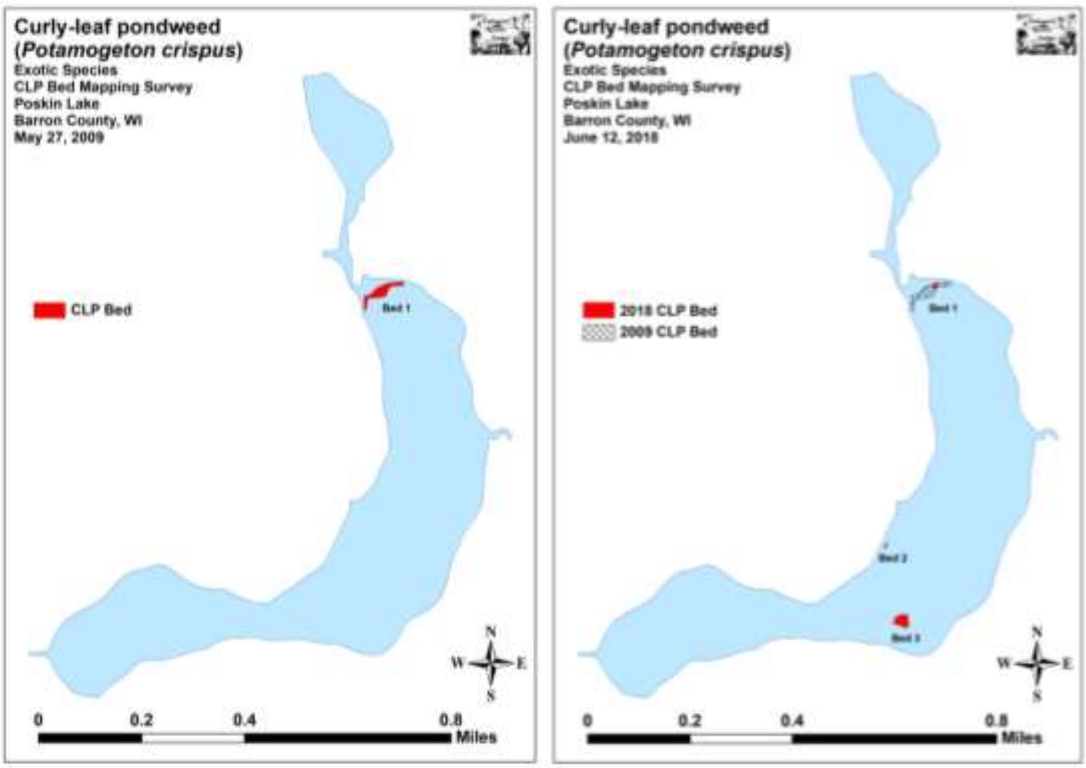


Figure 5: 2009 and 2018 Early-season Curly-leaf Pondweed Beds

Descriptions of Past and Present Curly-leaf Pondweed Beds:

Bed 1 – After having ringed the north end of the lake in 2009, Bed 1 shrunk to a small core area in <5ft of water in 2018. Even within the bed, Curly-leaf pondweed was often patchy and much of this part of the north bay was a barren silt flat with little vegetation of any kind. Outside of the bed, we found Coontail that extended to the edge of the littoral zone. This area seemed to be important fish habitat as we noted Bluegills (*Lepomis macrochirus*) throughout the area and had to wait for people to finish angling before we could complete the survey.

Bed 2 – CLP was canopied and monotypic, but the bed's extremely small size and mixed density made it more of a patch than a true bed. We also noted that, because it was so narrow, it was easily motored around or through making it a likely non-issue in regards to navigation.

Bed 3 – This area may have been better described as a "High Density Area" as Curly-leaf pondweed often wasn't the dominant plant and tended to occur more as patches imbedded within the native plant community. Although the CLP in the area wasn't terrible, the overall density of vegetation likely made it at least a minor navigation impairment. Tempering any navigation concerns is the fact that this area represents the best native plant bed on the lake, and, as such, was full of fish and surrounded by anglers during the survey.

Table 1: Curly-leaf Pondweed Bed Summary
Poskin Lake, Barron County – June 12, 2018

Bed Number	2018 Acreage	2009 Acreage	Diff.	Rake Range; Mean Rake	Depth Range; Mean Depth	Potential Navigation Impairment Level
1	0.07	0.71	-0.64	<1-3; 1	1-5; 4	Minor
2	0.03	0.00	0.03	1-3; 2	3-5; 4	None
3	0.37	0.00	0.37	<<1-3;1	4-8; 6	Minor
Total Acres	**0.47**	**0.71**	**-0.24**			

Warm-water Full Point-intercept Macrophyte Survey:

Depth readings taken at the lake's 403 survey points (Appendix I) revealed both the east and west sides of the main basin has sharp drop-offs into 20ft+ of water, while the southwest bay and the north end both have more gradual slopes into deeper water. A finger-shaped 5ft gravel flat extends into the lake from the southeast before dropping off sharply into deeper water. Just north of this flat, a small unmapped gravel hump that tops out at just over 8ft was the only other notable structure in the main lake. To the north, Little Poskin is a generally bowl-shaped basin that bottoms out at 15ft. In addition to being very shallow, thick silt and beaver activity make the channel between the Little Poskin and the main lake almost unnavigable (Figure 6) (Appendix IV).

Of the 141 points that were shallow enough to take a rake sample, we characterized the lake's substrate as 68.1% organic and sandy muck (96 points), 18.4% gravel and rock (26 points), and 13.5% pure sand (19 points). Thick nutrient-rich organic muck dominated Little Poskin, the north bay, and the southwest bay; while most of the pure sand and gravel areas occurred directly along shore, around exposed points, near the river outlet, and on the steep slopes of the central basin (Figure 6) (Appendix IV).

In July 2018, we found plants growing to 9.0ft (down from 10.5ft in 2009) (Table 2). The 84 points with vegetation (approximately 20.8% of the entire lake bottom and 90.3% of the littoral zone) were nearly identical to the 2009 survey when we found plants growing at 86 points (21.3% of the bottom and 76.8% of the littoral zone) (Figure 7) (Appendix V). Growth in 2018 was slightly skewed to deep water as the mean plant depth of 3.9ft was more than the median depth of 3.5ft. Both of these values were higher than in 2009 when the mean was 3.8ft and the median was 3.0ft (Figure 8).

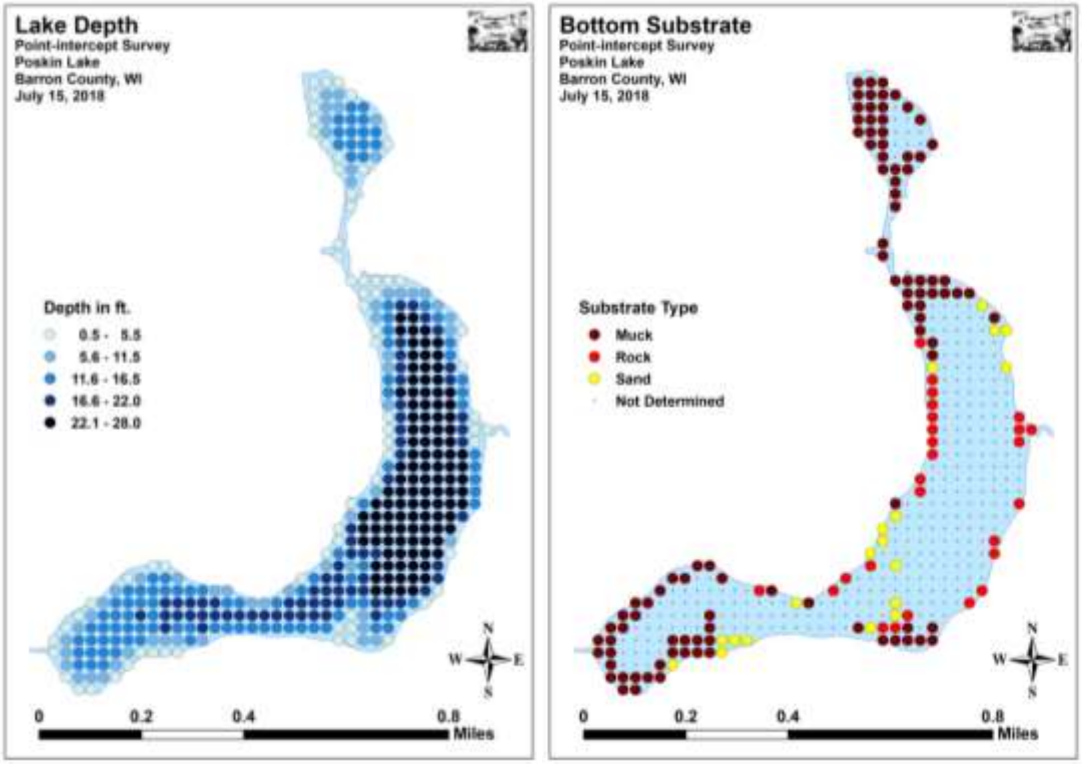


Figure 6: Lake Depth and Bottom Substrate

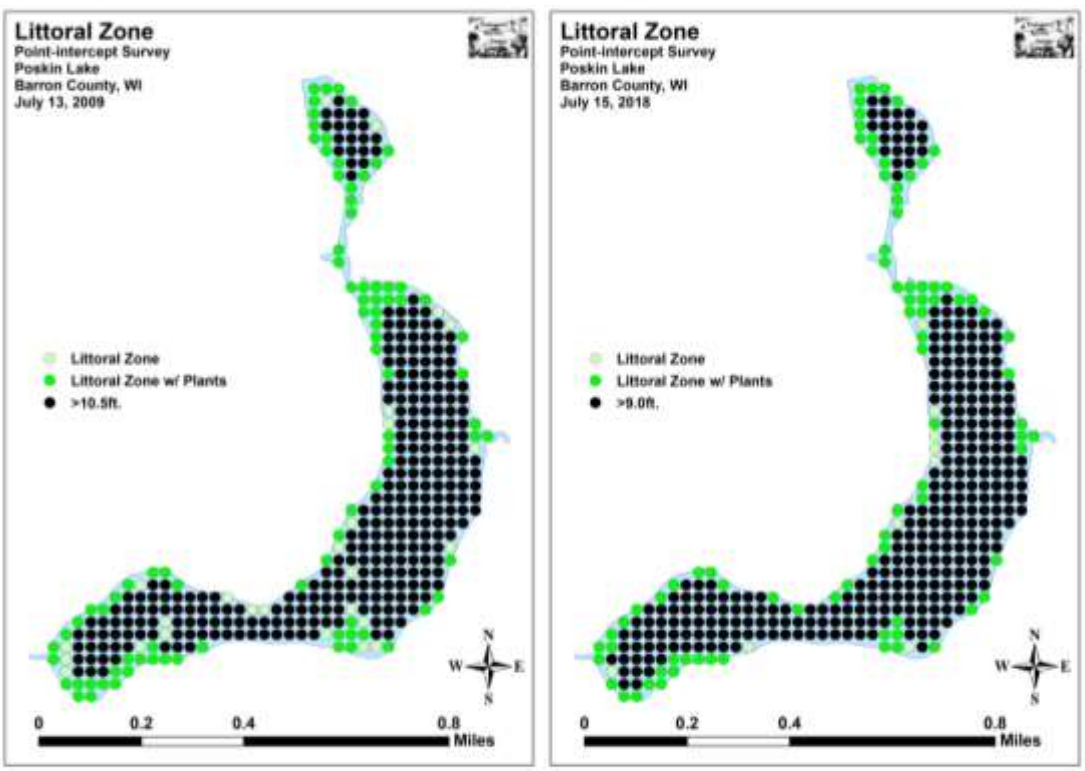


Figure 7: 2009 and 2018 Littoral Zone

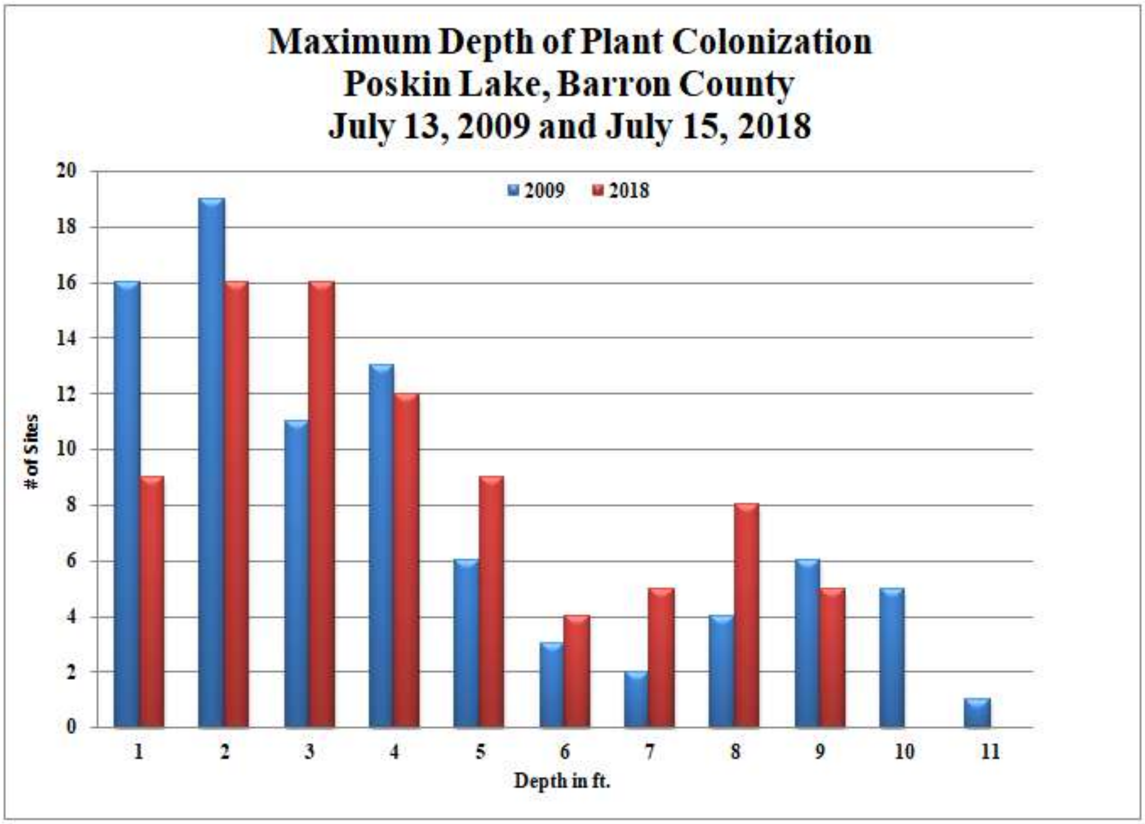


Figure 8: 2009 and 2018 Plant Colonization Depth Chart

Table 2: Aquatic Macrophyte P/I Survey Summary Statistics
Poskin Lake, Barron County
July 13, 2009 and July 15, 2018

Summary Statistics:	2009	2018
Total number of points sampled	403	403
Total number of sites with vegetation	86	84
Total number of sites shallower than the maximum depth of plants	112	93
Frequency of occurrence at sites shallower than maximum depth of plants	76.8	90.3
Simpson Diversity Index	0.88	0.87
Maximum depth of plants (ft)	10.5	9.0
Mean depth of plants (ft)	3.8	3.9
Median depth of plants (ft)	3.0	3.5
Average number of all species per site (shallower than max depth)	2.86	3.17
Average number of all species per site (veg. sites only)	3.72	3.51
Average number of native species per site (shallower than max depth)	2.77	3.11
Average number of native species per site (sites with native veg. only)	3.60	3.44
Species richness	26	19
Species richness (including visuals)	32	25
Species richness (including visuals and boat survey)	35	30
Mean rake fullness (veg. sites only)	Est. 2.52	2.21

Plant diversity was moderately high in 2018 with a Simpson Index value of 0.87 – down slightly from 0.88 in 2009. However, total richness was low with just 19 species found in the rake (down from 26 in 2009). This total increased to 30 species when including visuals and plants seen during the boat survey, but it was also down from the 35 total species we documented in 2009. Mean native species richness at sites with native vegetation also saw a non-significant decline (p=0.31) from 3.60 species/site in 2009 to 3.44/site in 2018 (Figure 9) (Appendix V).

Total rake fullness experienced a moderately significant decline **(p=0.004)** from a high 2.52 (est.) in 2009 to a high/moderate 2.21 in 2018. We noted that this decline was especially pronounced in Little Poskin (Figure 10) (Appendix V).

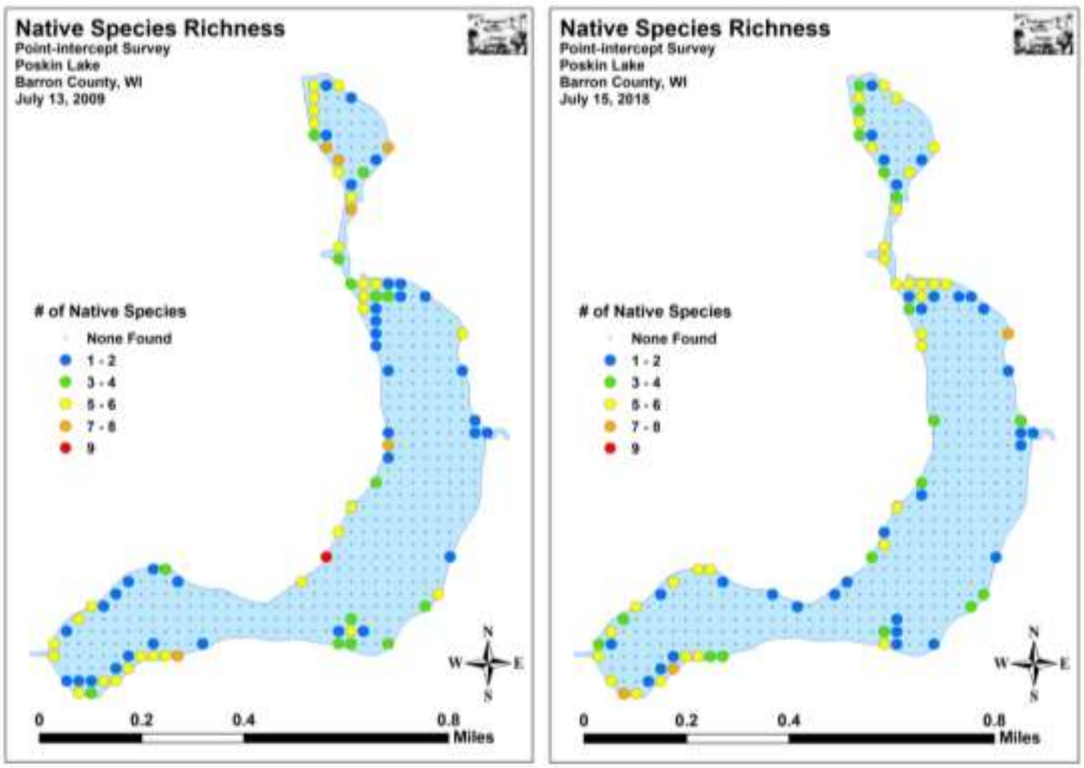


Figure 9: 2009 and 2018 Native Species Richness

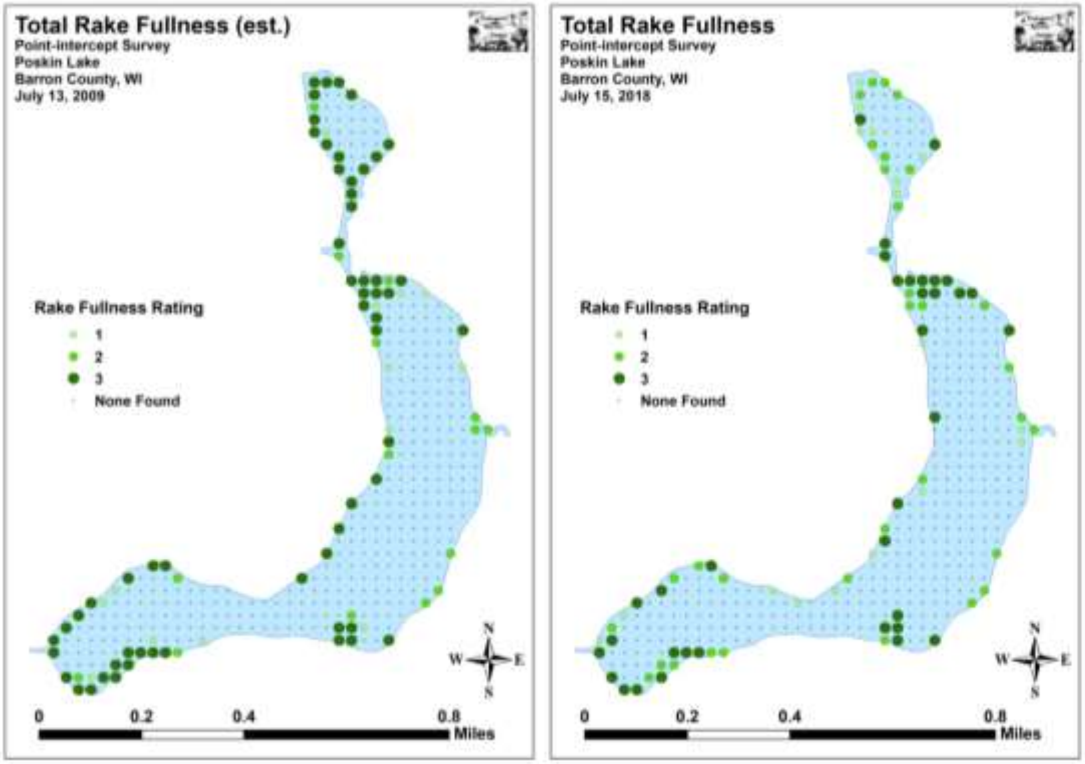


Figure 10: 2009 and 2018 Total Rake Fullness

Poskin Lake Plant Community:

The Poskin Lake ecosystem is home to a somewhat limited plant community that is typical of high-nutrient lakes with fair to poor water quality. This community can be subdivided into four distinct zones (emergent, shallow submergent, floating-leaf, and deep submergent) with each zone having its own characteristic functions in the aquatic ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient-rich organic muck), these zones often had somewhat different species present.

In shallow areas, beds of emergent plants prevent erosion by stabilizing the lakeshore, break up wave action, provide a nursery for baitfish and juvenile gamefish, offer shelter for amphibians, and give waterfowl and predatory wading birds like herons a place to hunt. These areas also provide important habitat for invertebrates like dragonflies and mayflies.

Exposed sandy and rocky areas at the shoreline had few emergents other than Reed canary grass (*Phalaris arundinacea*) and a couple of widely scattered patches of River bulrush (*Bolboschoenus fluviatilis*). On the margins of the lake's bays in areas with more organic muck, these species were replaced by Wild calla (*Calla palustris*), Bottle brush sedge (*Carex comosa*), Common arrowhead (*Sagittaria latifolia*), Softstem bulrush (*Schoenoplectus acutus*), and both Broad-leaved cattail (*Typha latifolia*) and Narrow-leaved cattail (*Typha angustifolia*). Away from the immediate shore, these shallow nutrient-rich areas in Little Poskin and along the channel near the entrance to the main lake supported limited numbers of Northern wild rice (*Zizania palustris*). In shallow gravel and sandy areas, we also found a few small beds of Hardstem bulrush (*Schoenoplectus acutus*) and Common bur-reed (*Sparganium eurycarpum*).

River bulrush (Ratzlaff 2008)

Common bur-reed (Raymond 2011)

Wild calla (Pierce 2001)

Bottle-brush sedge (Penta 2009)

Common arrowhead (Young 2006)

Softstem bulrush (Schwarz 2011)

Just beyond the emergents, in sheltered muck-bottomed areas in up to 4ft of water, the floating-leaf species White-water lily (*Nymphaea odorata*) and Spatterdock (*Nuphar variegata*) were common throughout the lake. We also found a limited number of Floating-leaf pondweed (*Potamogeton natans*) and Long-leaf pondweed (*Potamogeton nodosus*). The canopy cover these species provides is often utilized by panfish and bass for protection.

White water lily (Falkner 2009)

Spatterdock (CBG 2014)

Floating-leaf pondweed (Sein 2013)

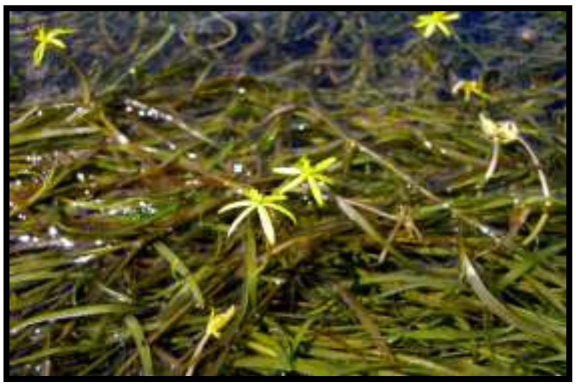
Long-leaf pondweed (Curtis 2010)

Growing amongst the lilypads, we also frequently encountered the submergent species Coontail, Common waterweed (*Elodea canadensis*), and to a lesser extent, Curly-leaf pondweed. In addition to these plants, a large number of "duckweeds" including Large duckweed (*Spirodela polyrhiza*), Small duckweed (*Lemna minor*), and Common watermeal (*Wolffia columbiana*) were often found floating among the lilypads and emergents.

Small duckweed and Common watermeal (Kieron 2009)

Large duckweed (Thomas 2018)

Shallow rocky areas were almost entirely devoid of plants, and many pure sand and sandy-muck areas were covered with a thick mat of filamentous algae which appeared to be limiting rooted plant growth. Even when plants were present, these nutrient-poor substrates tended to have low total biomass as they provide habitat most suited to fine-leaved species. Especially near the river outlet, in water from 2-5ft deep, we found limited numbers of Water star-grass (*Heteranthera dubia*), Northern water-milfoil (*Myriophyllum sibiricum*), Slender naiad (*Najas flexilis*), Clasping-leaf pondweed (*Potamogeton richardsonii*), White water crowfoot (*Ranunculus aquatilis*), and Wild celery (*Vallisneria americana*). The roots, shoots, and seeds of these plants are heavily utilized by waterfowl for food. They also provide important habitat for the lake's fish throughout their lifecycles, as well as a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.


Water star-grass (Mueller 2009)


Northern water-milfoil (Berg 2007)


Slender naiad (Apipp 2009)


Clasping-leaf pondweed (Cameron 2013)


White water crowfoot (Wasser 2013)


Wild celery (Dalvi 2009)

Organic muck areas in water greater than 5ft were dominated by Coontail, Common waterweed, White-stem pondweed (*Potamogeton praelongus*), Small pondweed (*Potamogeton pusillus*), Flat-stem pondweed (*Potamogeton zosteriformis*), and, in the early spring, Curly-leaf pondweed. Predatory fish like the lake's pike are often found along the edges of these deep beds waiting in ambush.


Coontail (Hassler 2011)


Common waterweed (Fischer 2009)


White-stem pondweed (Fewless 2005)


Small pondweed (Villa 2011)


Flat-stem pondweed (Fewless 2004)

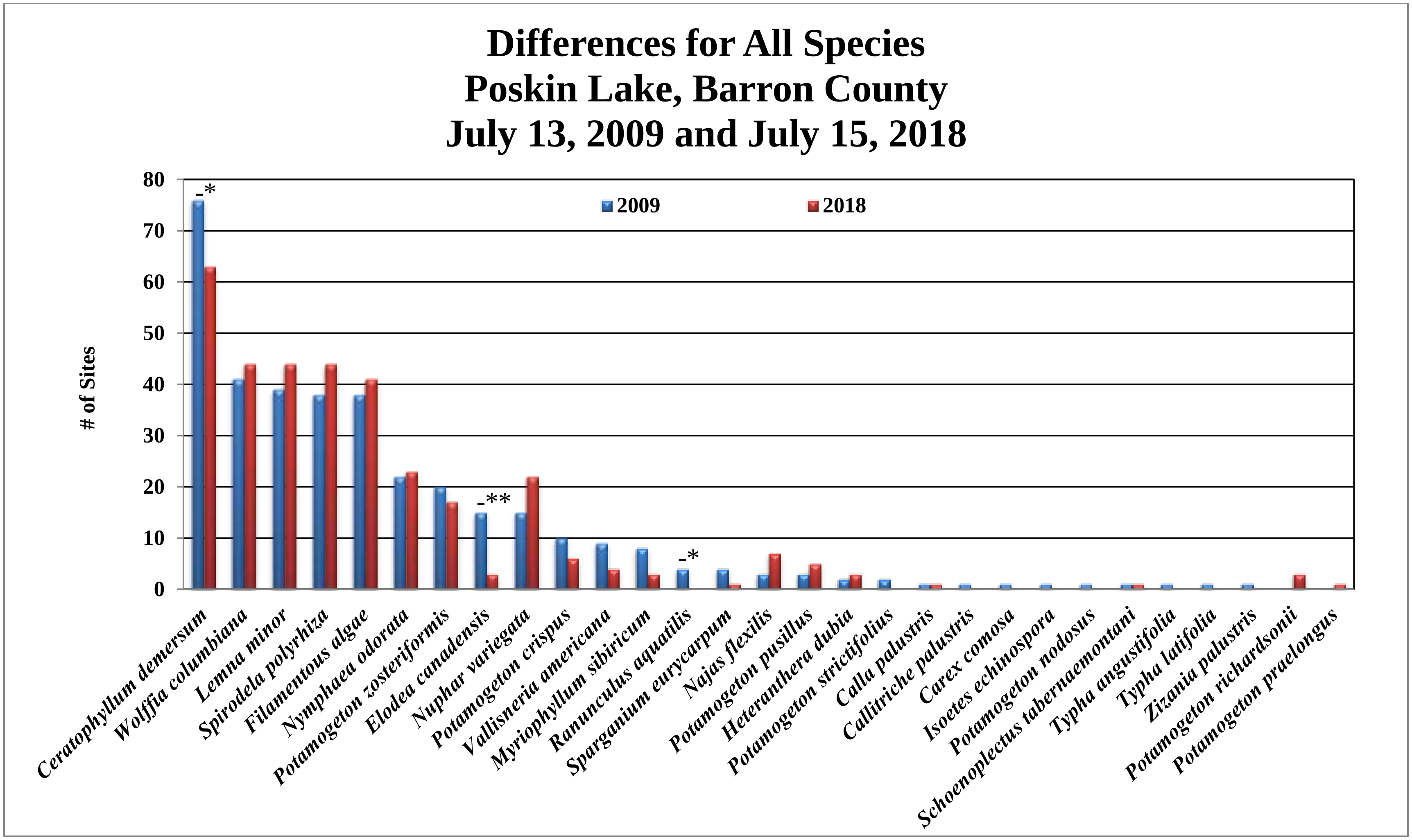

Curly-leaf pondweed (USGS 2018)

Comparison of Native Macrophyte Species in 2009 and 2018:

In July 2009, Coontail, Common watermeal, Small duckweed and Large duckweed were the most common macrophyte species (Table 3). They were present at 88.37%, 47.67%, 45.35%, and 44.19% of survey points with vegetation respectively and accounted for 60.63% of the total relative frequency. White water lily (6.68), Flat-stem pondweed (6.25), Common waterweed (4.69), and Spatterdock (4.69) also had relative frequencies over 4.0 (Maps for all species found in July 2009 are located in Appendix VI).

In 2018, Coontail, Small duckweed, Large duckweed, and Common watermeal were again the most common macrophyte species. We found them at 75.00%, 52.38%, 52.38%, and 52.38% of sites with vegetation (Table 4), and they captured 66.10% of the total relative frequency. White water lily (7.80), Spatterdock (7.46), and Flat-stem pondweed (5.76) also had relative frequencies over 4.0 (Species accounts for all macrophytes found in 2009 and 2018, and maps for all plants found in July 2018 can be found in Appendixes VII and VIII).

Lakewide, three species showed significant changes in distribution from 2009 to 2018 (Figure 11). Common waterweed suffered a moderately significant decline; and Coontail and White water crowfoot saw significant declines.



Significant differences = * *p*<0.05, ** *p*<0.01, * *p*<0.001**

Figure 11: Macrophytes Showing Significant Changes from 2009-2018

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Poskin Lake, Barron County
July 13, 2009

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Ceratophyllum demersum	Coontail	76	23.75	88.37	67.86	2.00	2
Wolffia columbiana	Common watermeal	41	12.81	47.67	36.61	2.05	1
Lemna minor	Small duckweed	39	12.19	45.35	34.82	1.62	1
Spirodela polyrhiza	Large duckweed	38	11.88	44.19	33.93	2.13	1
	Filamentous algae	38	*	44.19	33.93	1.66	1
Nymphaea odorata	White water lily	22	6.88	25.58	19.64	2.00	10
Potamogeton zosteriformis	Flat-stem pondweed	20	6.25	23.26	17.86	1.25	5
Elodea canadensis	Common waterweed	15	4.69	17.44	13.39	1.33	5
Nuphar variegata	Spatterdock	15	4.69	17.44	13.39	2.47	3
Potamogeton crispus	Curly-leaf pondweed	10	3.13	11.63	8.93	1.20	8
Vallisneria americana	Wild celery	9	2.81	10.47	8.04	1.56	2
Myriophyllum sibiricum	Northern water-milfoil	8	2.50	9.30	7.14	1.25	7
Ranunculus aquatilis	White water crowfoot	4	1.25	4.65	3.57	1.00	0
Sparganium eurycarpum	Common bur-reed	4	1.25	4.65	3.57	2.50	3
Najas flexilis	Slender naiad	3	0.94	3.49	2.68	2.00	1
Potamogeton pusillus	Small pondweed	3	0.94	3.49	2.68	1.67	0
Heteranthera dubia	Water star-grass	2	0.63	2.33	1.79	2.00	1
Potamogeton strictifolius	Stiff pondweed	2	0.63	2.33	1.79	2.50	0
Calla palustris	Wild calla	1	0.31	1.16	0.89	1.00	3
Callitriche palustris	Common water-starwort	1	0.31	1.16	0.89	1.00	0
Carex comosa	Bottle brush sedge	1	0.31	1.16	0.89	3.00	1
Isoetes echinospora	Spiny spored-quillwort	1	0.31	1.16	0.89	1.00	0
Potamogeton nodosus	Long-leaf pondweed	1	0.31	1.16	0.89	2.00	0
Schoenoplectus tabernaemontani	Softstem bulrush	1	0.31	1.16	0.89	1.00	1

* Excluded from relative frequency analysis

Table 3 (cont): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Poskin Lake, Barron County
July 13, 2009

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Typha angustifolia	Narrow-leaved cattail	1	0.31	1.16	0.89	3.00	0
Typha latifolia	Broad-leaved cattail	1	0.31	1.16	0.89	2.00	1
Zizania palustris	Northern wild rice	1	0.31	1.16	0.89	1.00	2
Lemna trisulca	Forked duckweed	**	**	**	**	**	1
Phalaris arundinacea	Reed canary grass	**	**	**	**	**	1
Potamogeton praelongus	White-stem pondweed	**	**	**	**	**	2
Potamogeton richardsonii	Clasping-leaf pondweed	**	**	**	**	**	2
Sagittaria latifolia	Common arrowhead	**	**	**	**	**	1
Sagittaria rigida	Sessile-fruited arrowhead	**	**	**	**	**	1
Potamogeton amplifolius	Large-leaf pondweed	***	***	***	***	***	***
Potamogeton obtusifolius	Blunt-leaf pondweed	***	***	***	***	***	***
Schoenoplectus acutus	Hardstem bulrush	***	***	***	***	***	***

** Visual only *** Boat survey only

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Poskin Lake, Barron County
July 15, 2018

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Ceratophyllum demersum	Coontail	63	21.36	75.00	67.74	1.79	0
Lemna minor	Small duckweed	44	14.92	52.38	47.31	1.43	0
Spirodela polyrhiza	Large duckweed	44	14.92	52.38	47.31	1.59	0
Wolffia columbiana	Common watermeal	44	14.92	52.38	47.31	2.20	0
	Filamentous algae	41	*	48.81	44.09	1.54	0
Nymphaea odorata	White water lily	23	7.80	27.38	24.73	1.96	9
Nuphar variegata	Spatterdock	22	7.46	26.19	23.66	2.41	5
Potamogeton zosteriformis	Flat-stem pondweed	17	5.76	20.24	18.28	1.00	8
Najas flexilis	Slender naiad	7	2.37	8.33	7.53	1.43	0
Potamogeton crispus	Curly-leaf pondweed	6	2.03	7.14	6.45	1.00	4
Potamogeton pusillus	Small pondweed	5	1.69	5.95	5.38	1.20	0
Vallisneria americana	Wild celery	4	1.36	4.76	4.30	1.25	0
Elodea canadensis	Common waterweed	3	1.02	3.57	3.23	2.33	0
Heteranthera dubia	Water star-grass	3	1.02	3.57	3.23	1.00	1
Myriophyllum sibiricum	Northern water-milfoil	3	1.02	3.57	3.23	1.67	3
Potamogeton richardsonii	Clasping-leaf pondweed	3	1.02	3.57	3.23	1.33	1
Calla palustris	Wild calla	1	0.34	1.19	1.08	1.00	1
Potamogeton praelongus	White-stem pondweed	1	0.34	1.19	1.08	1.00	0
Schoenoplectus tabernaemontani	Softstem bulrush	1	0.34	1.19	1.08	3.00	1
Sparganium eurycarpum	Common bur-reed	1	0.34	1.19	1.08	1.00	4

*Excluded from relative frequency analysis

Table 4 (cont): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Poskin Lake, Barron County
July 15, 2018

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Phalaris arundinacea	Reed canary grass	**	**	**	**	**	2
Potamogeton natans	Floating-leaf pondweed	**	**	**	**	**	1
Potamogeton nodosus	Long-leaf pondweed	**	**	**	**	**	2
Schoenoplectus acutus	Hardstem bulrush	**	**	**	**	**	1
Typha latifolia	Broad-leaved cattail	**	**	**	**	**	2
Zizania palustris	Northern wild rice	**	**	**	**	**	3
Bolboschoenus fluviatilis	River bulrush	***	***	***	***	***	***
Carex comosa	Bottle brush sedge	***	***	***	***	***	***
Ranunculus aquatilis	White water crowfoot	***	***	***	***	***	***
Sagittaria latifolia	Common arrowhead	***	***	***	***	***	***
Typha angustifolia	Narrow-leaved cattail	***	***	***	***	***	***

** Visual only   *** Boat survey only

Found throughout the lake's organic muck bottom bays, Coontail was the most common species in both 2009 and 2018. In addition to its significant decline **(*p*=0.02)** in overall distribution (76 points in 2009/63 in 2018), we documented a nearly significant decline (*p*=0.07) in density (mean rake fullness of 2.00 in 2009/1.79 in 2018). Visual analysis of the maps showed much of this loss occurred in Little Poskin (Figure 12).

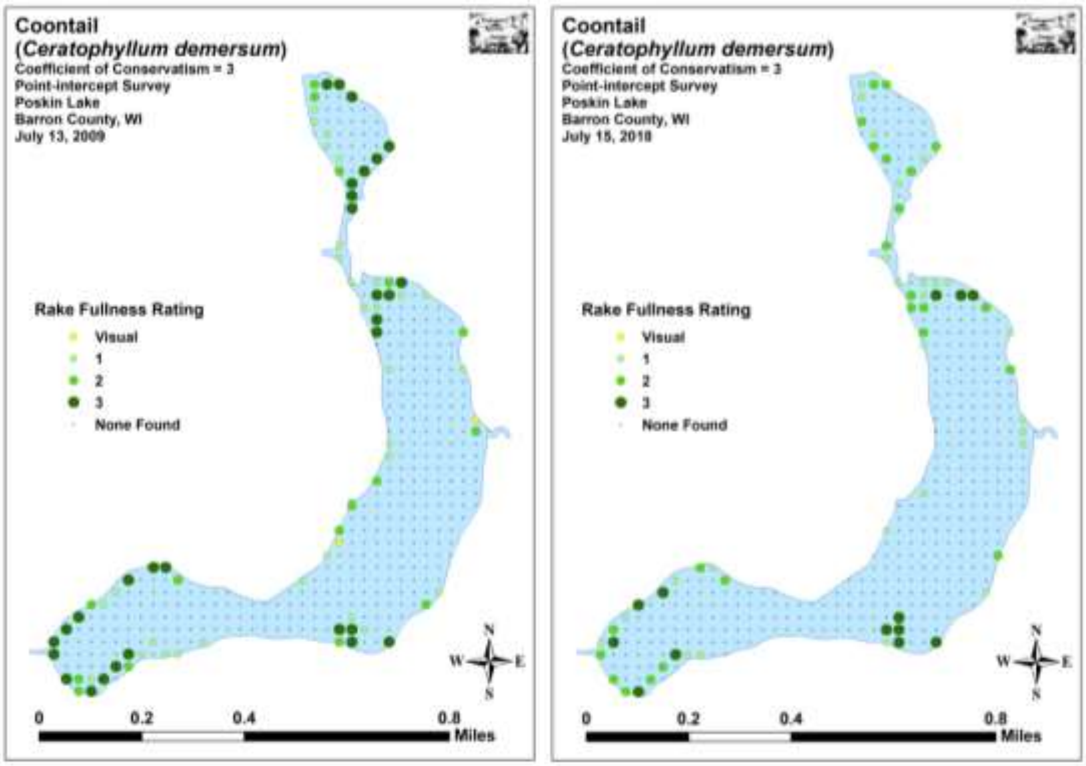


Figure 12: 2009 and 2018 Coontail Density and Distribution

White water lily was the fifth most common species during each survey. Although both its total distribution (22 sites in 2009/23 in 2018) and density (mean rake fullness of 2.00 in 2009/1.96 in 2018) were essentially unchanged, it showed expansion in the southwest bay while almost disappearing from Little Poskin (Figure 13). Spatterdock, the other dominant floating-leaf species, was the eighth most common plant in 2009 (15 sites) and the sixth most common in 2018 (22 sites). Neither the increase in distribution, nor the accompanying decline in density from a mean rake of 2.47 in 2009 to a mean of 2.41 in 2018 were significant (*p*=0.16/*p*=0.41) (Figure 14).

Flat-stem pondweed (the sixth most common species in 2009 and the seventh most common in 2018) exhibited a non-significant decline in distribution (*p*=0.63) from 20 sites in 2009 to 17 sites 2018. However, we found its decline in density from a mean rake of 1.25 in 2009 to a mean rake of 1.00 in 2018 was significant **(*p*=0.01)** (Figure 15).

We recorded Common waterweed throughout the lake in 2009 (15 sites/mean rake of 1.33), and it was especially common in Little Poskin. Surprisingly, in 2018 it suffered a moderately significant decline in distribution **(*p*=0.003)** and nearly disappeared from the lake (3 sites/mean rake 2.33) (Figure 16).

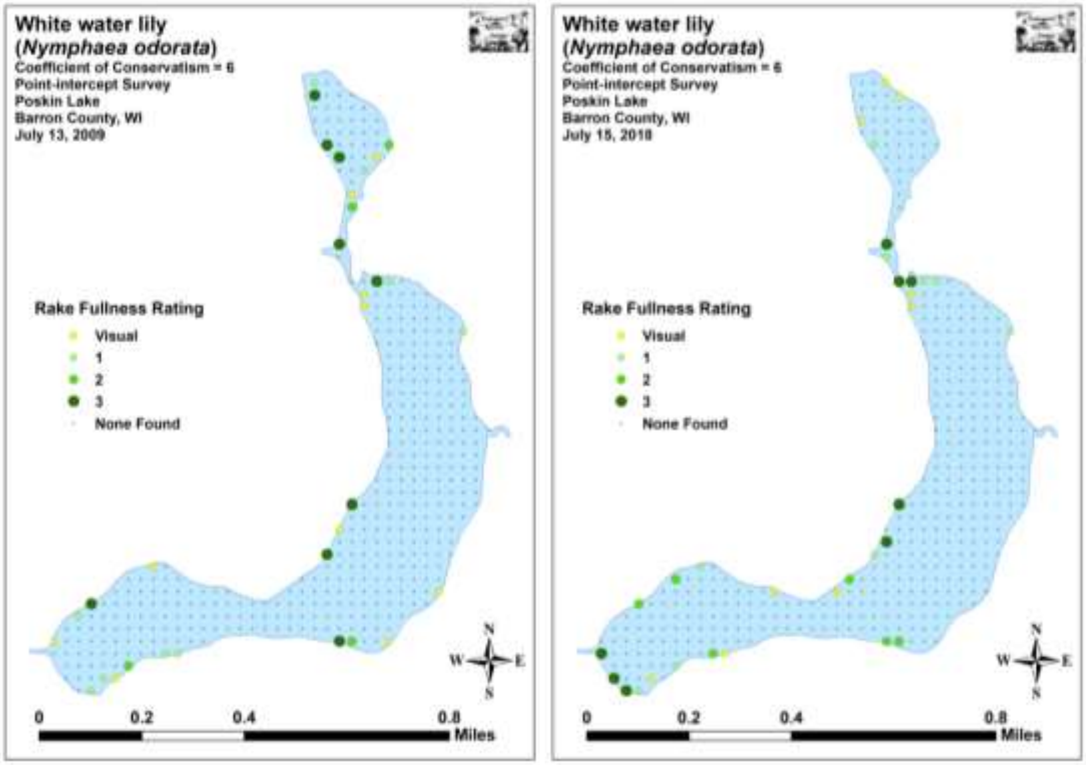


Figure 13: 2009 and 2018 White Water Lily Density and Distribution

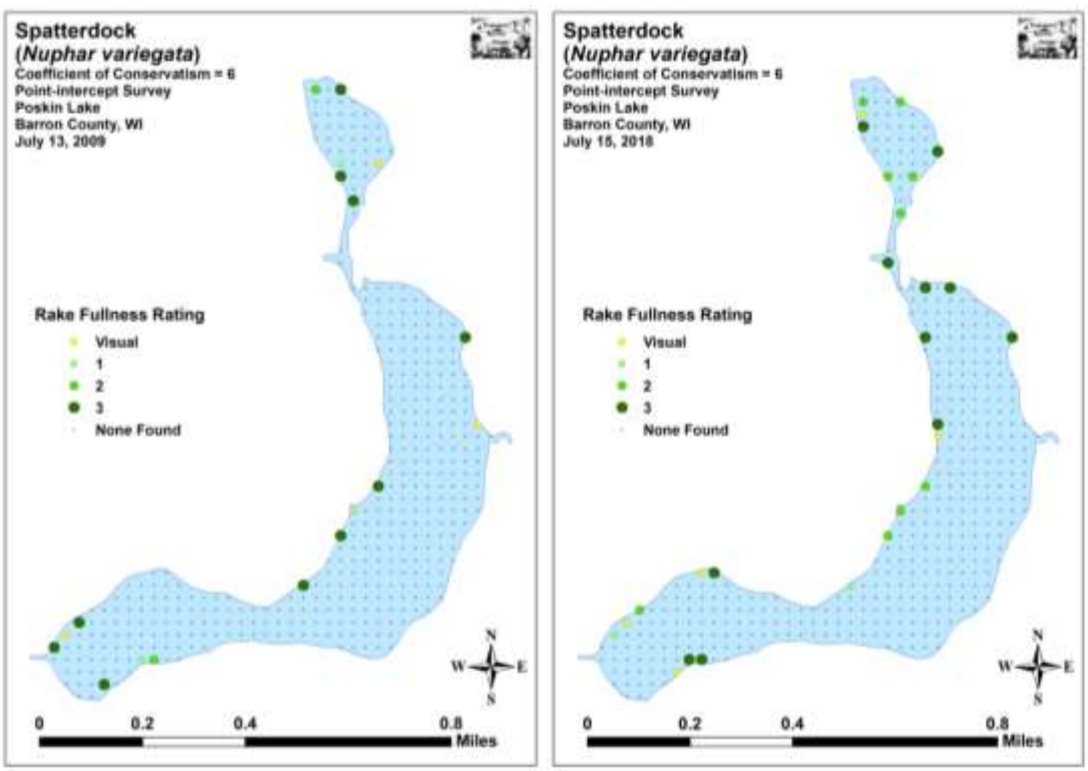


Figure 14: 2009 and 2018 Spatterdock Density and Distribution

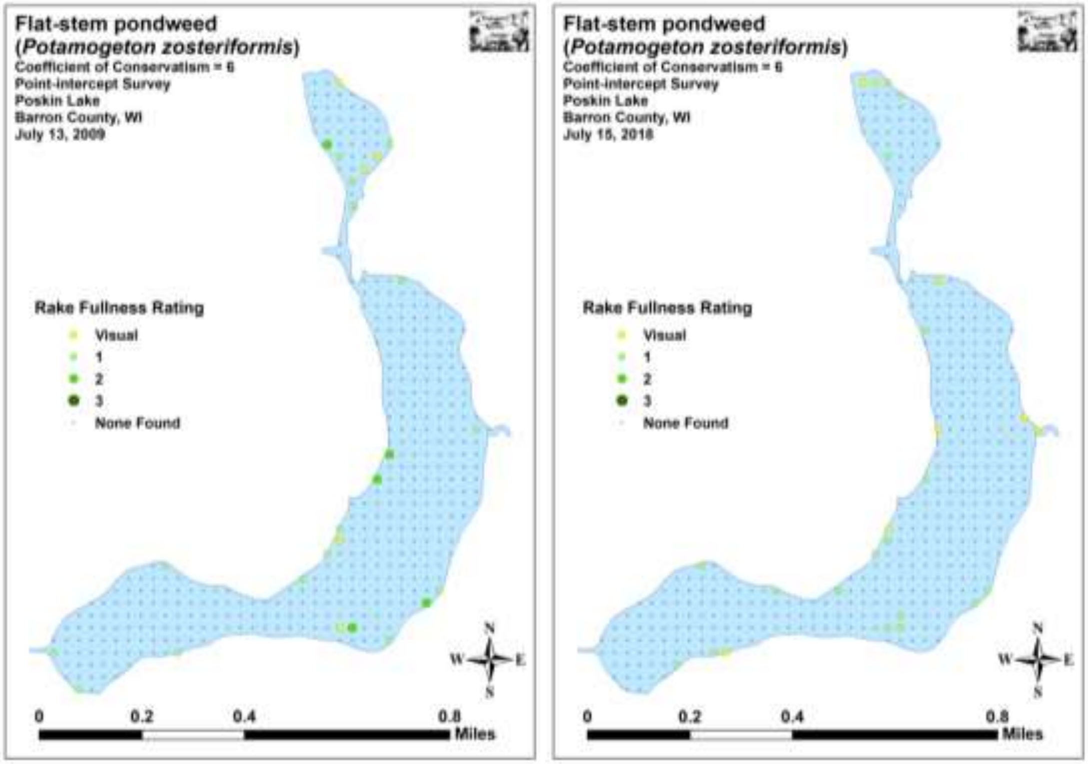


Figure 15: 2009 and 2018 Flat-stem Pondweed Density and Distribution

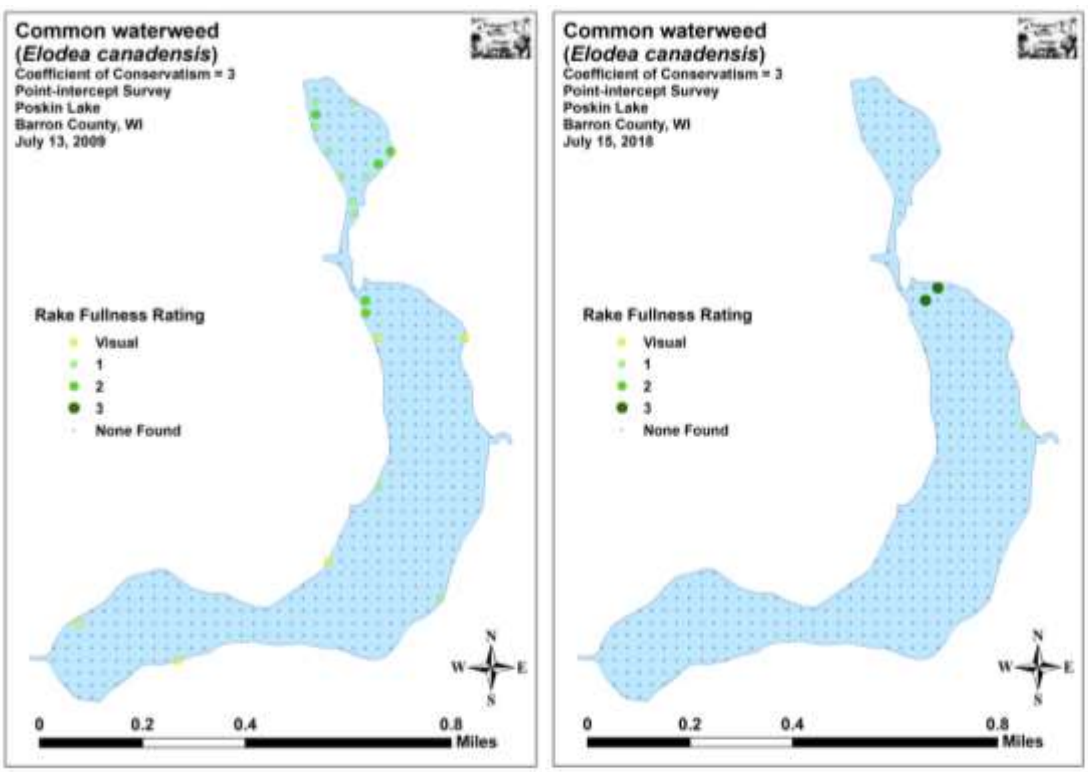


Figure 16: 2009 and 2018 Common Waterweed Density and Distribution

Comparison of Floristic Quality Indexes in 2009 and 2018:

In 2009, we identified a total of 25 **native index species** in the rake during the point-intercept survey (Table 5). They produced a mean Coefficient of Conservatism of 5.6 and a Floristic Quality Index of 28.2.

Table 5: Floristic Quality Index of Aquatic Macrophytes Poskin Lake, Barron County July 13, 2009

Species	Common Name	C
Calla palustris	Wild calla	9
Callitriche palustris	Common water-starwort	8
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Isoetes echinospora	Spiny-spored quillwort	8
Lemna minor	Small duckweed	4
Myriophyllum sibiricum	Northern water-milfoil	6
Najas flexilis	Slender naiad	6
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton nodosus	Long-leaf pondweed	7
Potamogeton pusillus	Small pondweed	7
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium eurycarpum	Common bur-reed	5
Spirodela polyrhiza	Large duckweed	5
Typha angustifolia	Narrow-leaved cattail	1
Typha latifolia	Broad-leaved cattail	1
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8
N		**25**
Mean C		**5.6**
FQI		**28.2**

In 2018, we identified a total of 18 **native index plants** in the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism of 5.6 and a Floristic Quality Index of 23.6 (Table 6). Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Poskin Lake exactly average for this part of the state. The FQI was, however, slightly above the median FQI of 20.9 for the North Central Hardwood Forests (Nichols 1999).

Table 6: Floristic Quality Index of Aquatic Macrophytes
Poskin Lake, Barron County
July 15, 2018

Species	Common Name	C
Calla palustris	Wild calla	9
Ceratophyllum demersum	Coontail	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Myriophyllum sibiricum	Northern water-milfoil	6
Najas flexilis	Slender naiad	6
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton zosteriformis	Flat-stem pondweed	6
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium eurycarpum	Common bur-reed	5
Spirodela polyrhiza	Large duckweed	5
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
N		**18**
Mean C		**5.6**
FQI		**23.6**

Comparison of Northern Wild Rice in 2009 and 2018:

Northern wild rice, a plant of significant wildlife and cultural value, is present as scattered individual plants throughout Little Poskin and in the channel leading to the main lake. In 2009, we found rice in the rake at a single point with a rake fullness of 1 and also recorded it as a visual at two points. During the 2018 survey, we didn't find it in the rake at any point, although it was a visual at three points (Figure 17).

We estimated the total rice population on the lake at a couple hundred plants, and there weren't any areas that were big enough or dense enough that they would offer profitable human harvest. In fact, we noticed that almost all individuals were covered with filamentous algae making it difficult for them to tip up out of the water (see picture on the front cover). For those plants that did emerge, we found the resident Canada goose (*Branta canadensis*) population had repeatedly cropped the leaves and stems down to within a few inches of the water's surface making it unlikely they would be able to grow big enough to flower and set seed. For both of these reasons, we are concerned the population is in danger of localized extinction.

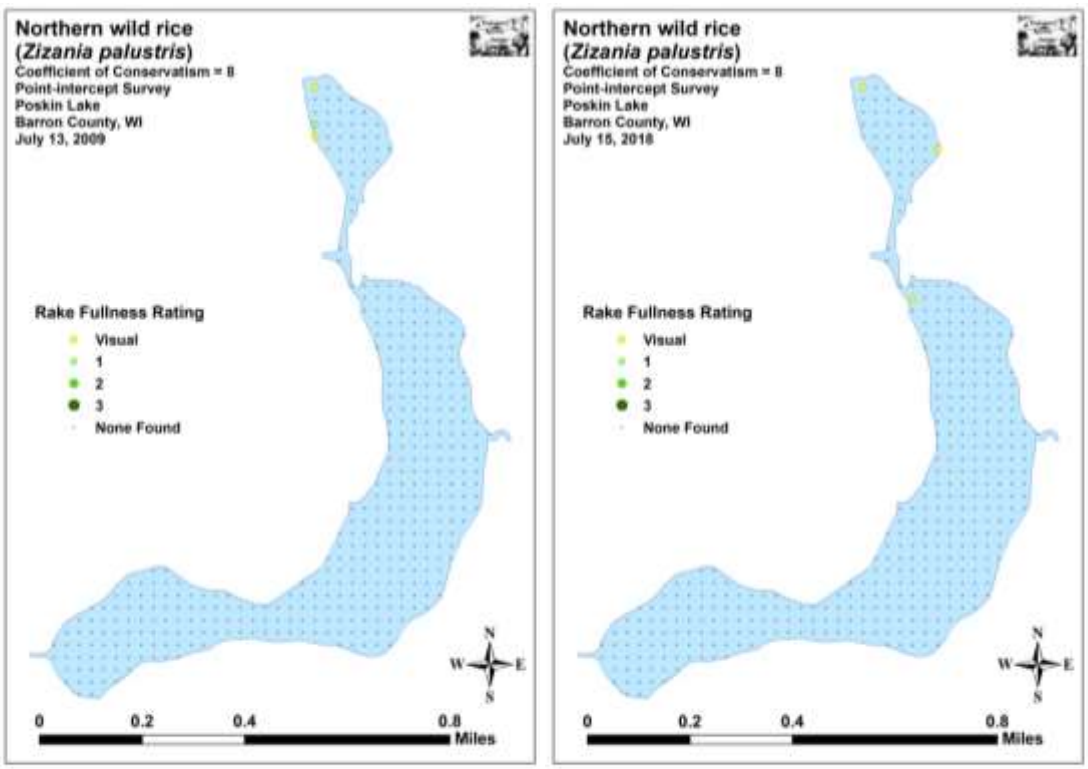


Figure 17: 2009 and 2018 Northern Wild Rice Density and Distribution

Comparison of Filamentous Algae in 2009 and 2018:

Filamentous algae, normally associated with excessive nutrients in the water column, were common to abundant throughout the lake during each survey (Figure 18). In 2009, we found these algae at 38 points with a mean rake fullness of 1.66. During the 2018 survey, we documented a slight expansion in distribution to 41 points and a slight decline in density to a mean rake fullness of 1.54; however, neither of these changes were significant (p=0.55/p=0.22).

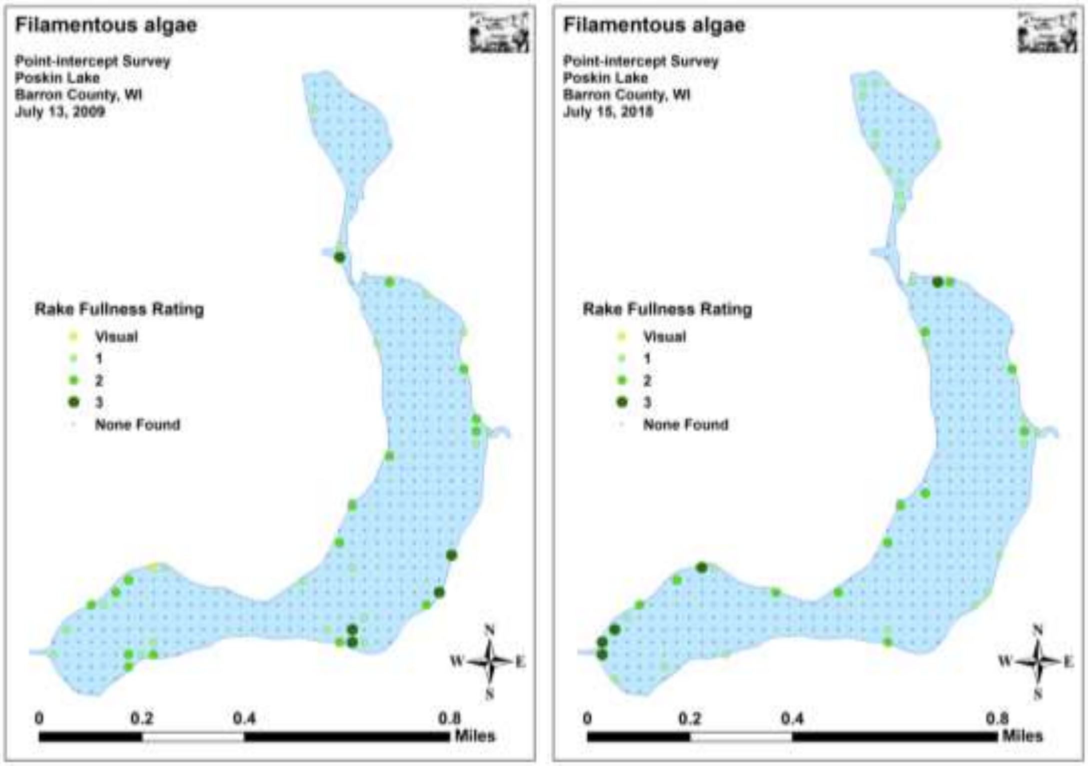


Figure 18: 2009 and 2018 Filamentous Algae Density and Distribution

Comparison of Midsummer Curly-leaf Pondweed in 2009 and 2018:

Curly-leaf pondweed normally completes its annual life cycle by late June, and most plants have set turions and senesced by early July. During our 2009 survey, CLP was still present at ten points (mean rake fullness 1.20) and was a visual at eight others. In 2018, we documented a non-significant decline (p=0.32) in distribution to six points, and a nearly significant decline (p=0.08) in density to a mean rake fullness of 1.00. We also recorded CLP as a visual at four points (Figure 19).

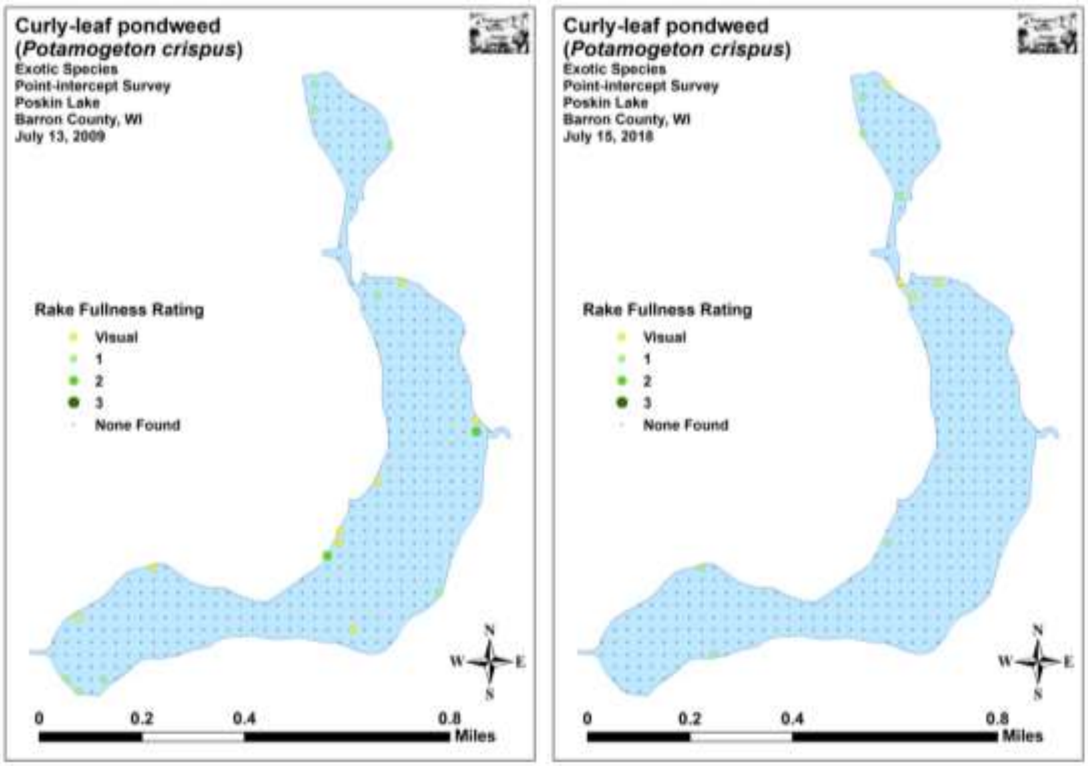


Figure 19: 2009 and 2018 Midsummer CLP Density and Distribution

Other Exotic Plant Species:

We did NOT find any evidence or Eurasian water-milfoil in Poskin Lake during any of our surveys. However, in addition to Curly-leaf pondweed, we documented two other exotic species growing around the lake: Reed canary grass and Narrow-leaved cattail. Despite only being recorded as a visual at two points (Figure 20), Reed canary grass was often a dominant plant just beyond the lakeshore in adjacent wetlands and next to mowed or otherwise disturbed shoreline areas. A ubiquitous plant in the state, there's likely little that can be done about it.

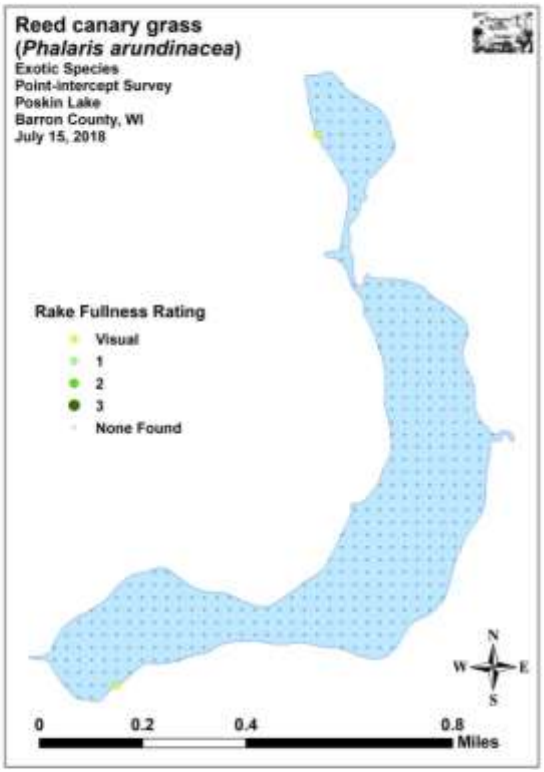


Figure 20: Reed Canary Grass Density and Distribution

Native to southern but not northern Wisconsin, Narrow-leaved cattail and its hybrids with Broad-leaved cattail are becoming increasingly common in northern Wisconsin where they also tend to be invasive. We found a few small stands of Narrow-leaved cattail/Hybrid cattail scattered along the south shoreline in the southwest bay where they appeared to be expanding in shallow water and crowding out other emergent species.

Besides having narrower leaves, the exotics can be told from our native cattails by having a relatively narrower and longer "hotdog-shaped" tan female cattail flower, whereas our native species tends to produce a fatter and shorter "bratwurst-shaped" dark chocolate colored female flower. Narrow-leaved cattail and its hybrids also have a male flower that is separated from the female flower by a thin green stem while the native Broad-leaved cattail has its male and female flowers connected (Figure 21) (For more information on a sampling of aquatic exotic invasive plant species, see Appendix IX).

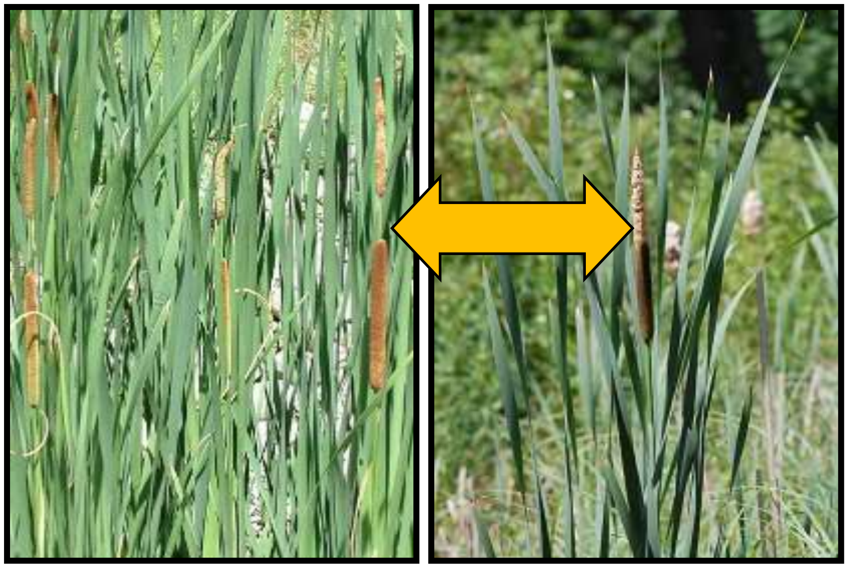


Figure 21: Exotic Hybrid and Native Broad-leaved Cattail Identification

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Water Clarity, Nutrient Inputs, and the Role of Native Macrophytes:

Like trees in a forest, a lake's native plants are the basis of the aquatic ecosystem. They capture the sun's energy and turn it into usable food, "clean" the water of excess nutrients, and provide habitat for other organisms like aquatic invertebrates and the lake's fish populations. Because of this, preserving them is critical to maintaining the lake's overall health. Unfortunately, when phosphorus and nitrogen levels exceed what the lake's macrophytes can utilize, it tends to promote algae blooms which impact these sensitive species as well as general lake esthetics.

Although upstream agricultural runoff can be a major contributor to a lake's overall nutrient load, soil erosion and nutrient inputs from along the immediate lakeshore can also have significant impacts. Because of this, all lake residents have the opportunity to help reduce runoff by evaluating how their shoreline practices may be affecting the lake. Simple things like establishing or maintaining their own buffer strip of native vegetation along the lake shore to prevent erosion, building rain gardens, bagging grass clippings, switching to a phosphorus-free fertilizer or preferably eliminating fertilizer near the lake altogether, collecting pet waste, and disposing of the ash from fire pits away from the lakeshore can all significantly reduce the amount of nutrients entering the ecosystem. Hopefully, a greater understanding of how all property owners can have lakewide impacts will result in more people taking appropriate conservation actions to not only help improve water clarity and quality, but also to benefit the lake's important habitat producing native plant species.

Curly-leaf Pondweed Management:

During both our 2009 and 2018 early-season Curly-leaf pondweed surveys, we found that CLP was present throughout the lake, but it was not acting overly invasive and appeared to be "just another plant species" in the lake's macrophyte community. We also noted during the July surveys that native species had recolonized most of the areas CLP occupied earlier in the growing season.

When considering future active management to control Curly-leaf pondweed on Poskin Lake, it's informative to know that the spring of 2017 brought near record early ice-out in late March and early April followed by prolonged cool weather that kept lake temperatures in the 40's and 50's through May. These conditions appeared to benefit CLP, and we found high levels on many of the lakes we surveyed that spring. Not surprisingly, this explosion in CLP growth resulted in heightened concerns among lake residents as dense canopied beds often severely impaired navigation. When these plants senesced in late June and floated to the surface, they often became rotting "haystacks" that washed ashore. They also appeared to be a contributing factor for the algal blooms and generally poor water clarity and quality observed later in the summer as these masses of plants rotted and sank back to the lake bottom.

The spring of 2018 again brought extreme weather. However, this time it was near record **late** ice-out followed by a dramatic stretch of warm weather that boosted lake temperatures from frozen to the upper 60's in less than two weeks. These conditions did not appear to favor Curly-leaf pondweed, and many lakes that annually treat CLP opted to avoid active management in 2018 due to low CLP levels. Because of these conditions, the low levels we observed on Poskin Lake in 2018 may have been atypical.

Ultimately, if mechanical removal and/or herbicide treatments are decided on to control Curly-leaf pondweed as part of the updated APMP, we strongly encourage the PLA to adopt management goals that, rather than planning a large-scale blanket treatment, focus on small-scale applications based on annual conditions and the need to relieve navigation impairment. By taking a measured approach to management, it is less likely that any treatments would collaterally damage the lake's very limited native vegetation and the important habitat it provides; especially as these plant beds relate to the lake's fish populations.

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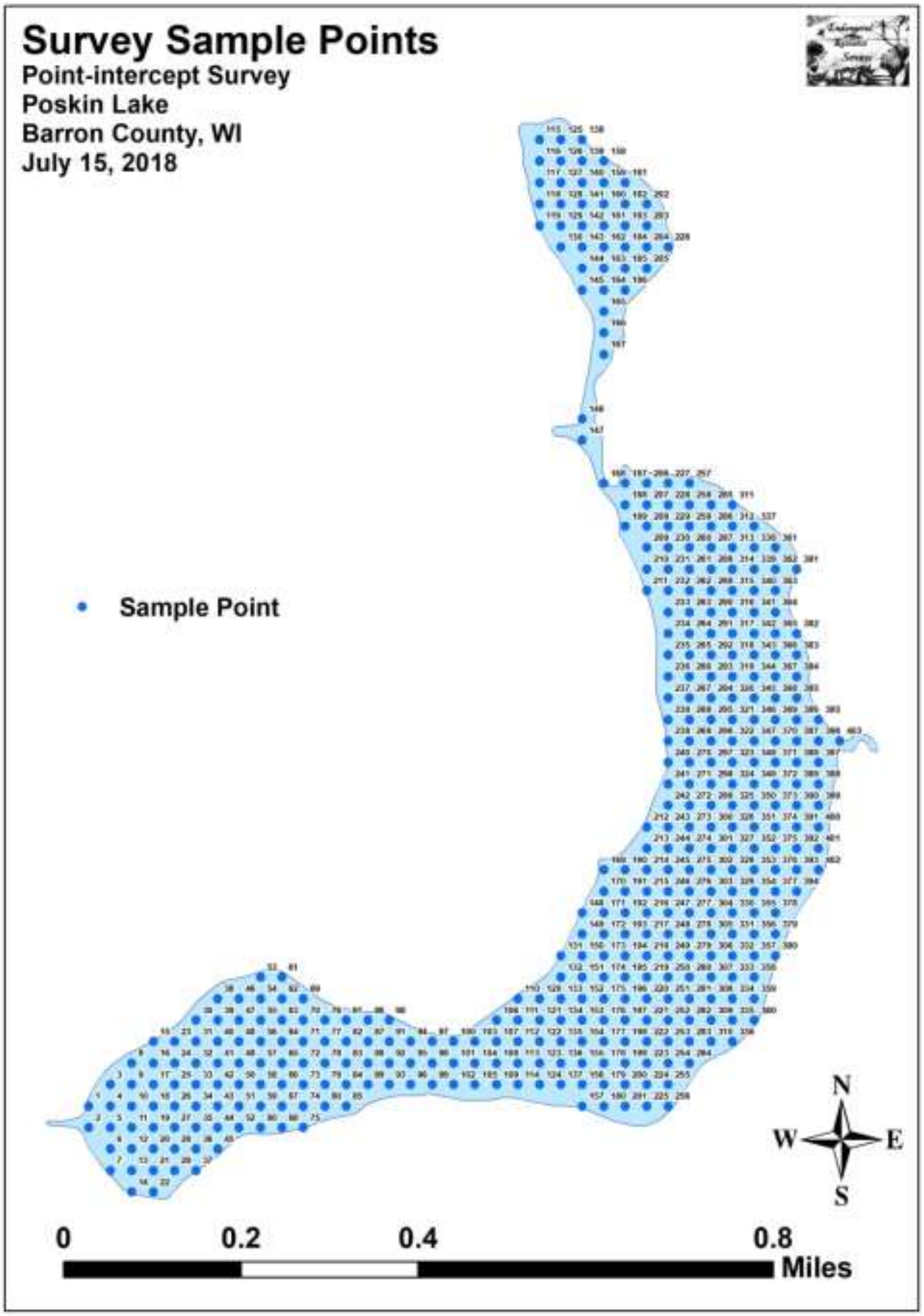
WDNR. [online]. 2010. Purple loosestrife fact sheet. http://dnr.wi.gov/invasives/fact/loosestrife.htm (2010, August).

WDNR. [online]. 2010. Reed canary grass fact sheet. http://dnr.wi.gov/invasives/fact/reed_canary.htm (2010, August).

Appendix I: Survey Sample Points Map

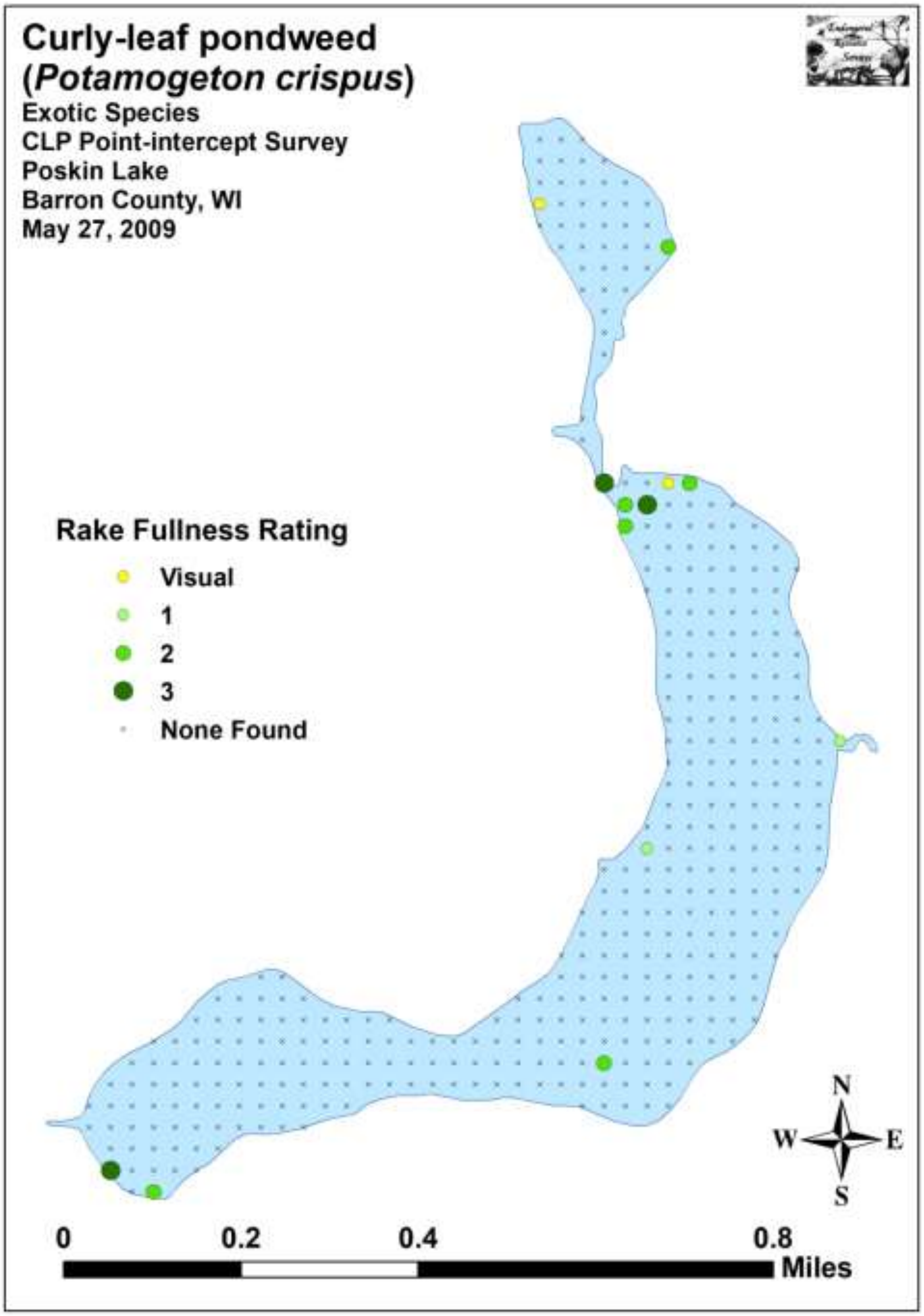

Survey Sample Points
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Sample Point
N
W
E
S
0
0.2
0.4
0.8
Miles

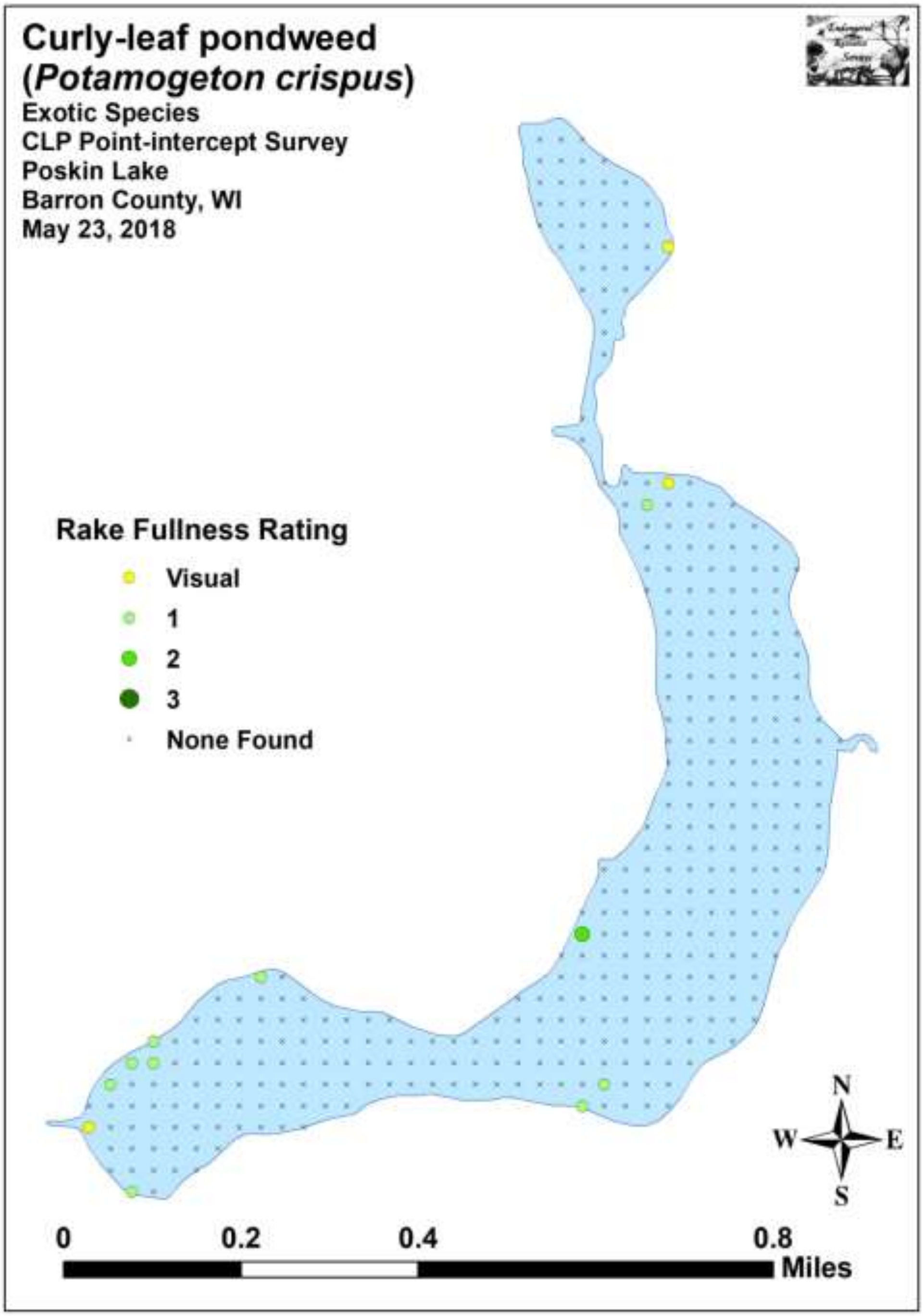
Appendix II: Boat and Vegetative Survey Datasheets

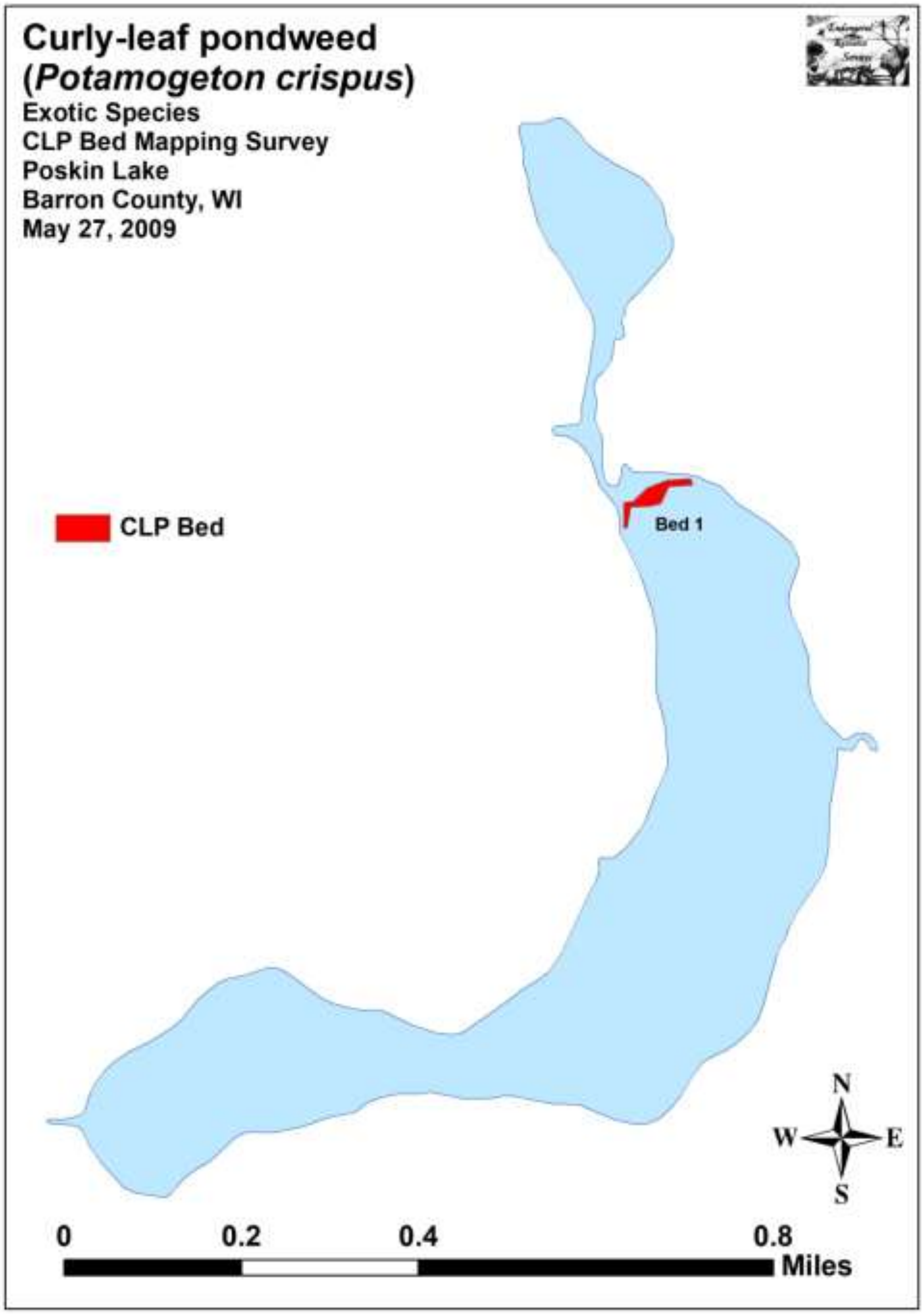
Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	**Species seen, habitat information**

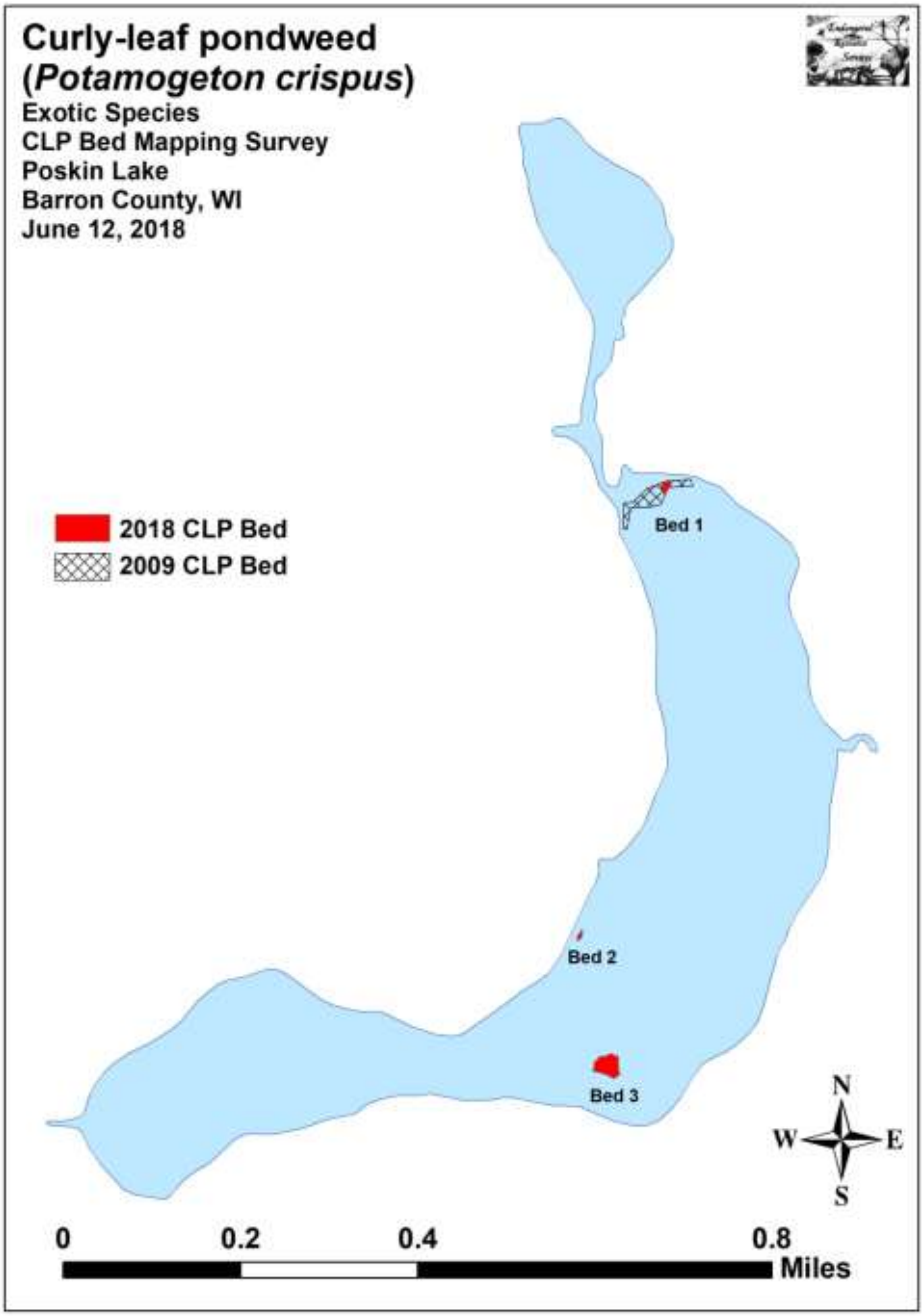
Observers for this lake: names and hours worked by each:																									
Lake:									WBIC									County						Date:	
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	Total Rake Fullness	EWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																	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

Appendix III: 2009 and 2018 Early-season CLP Density and Distribution and CLP Bed Maps

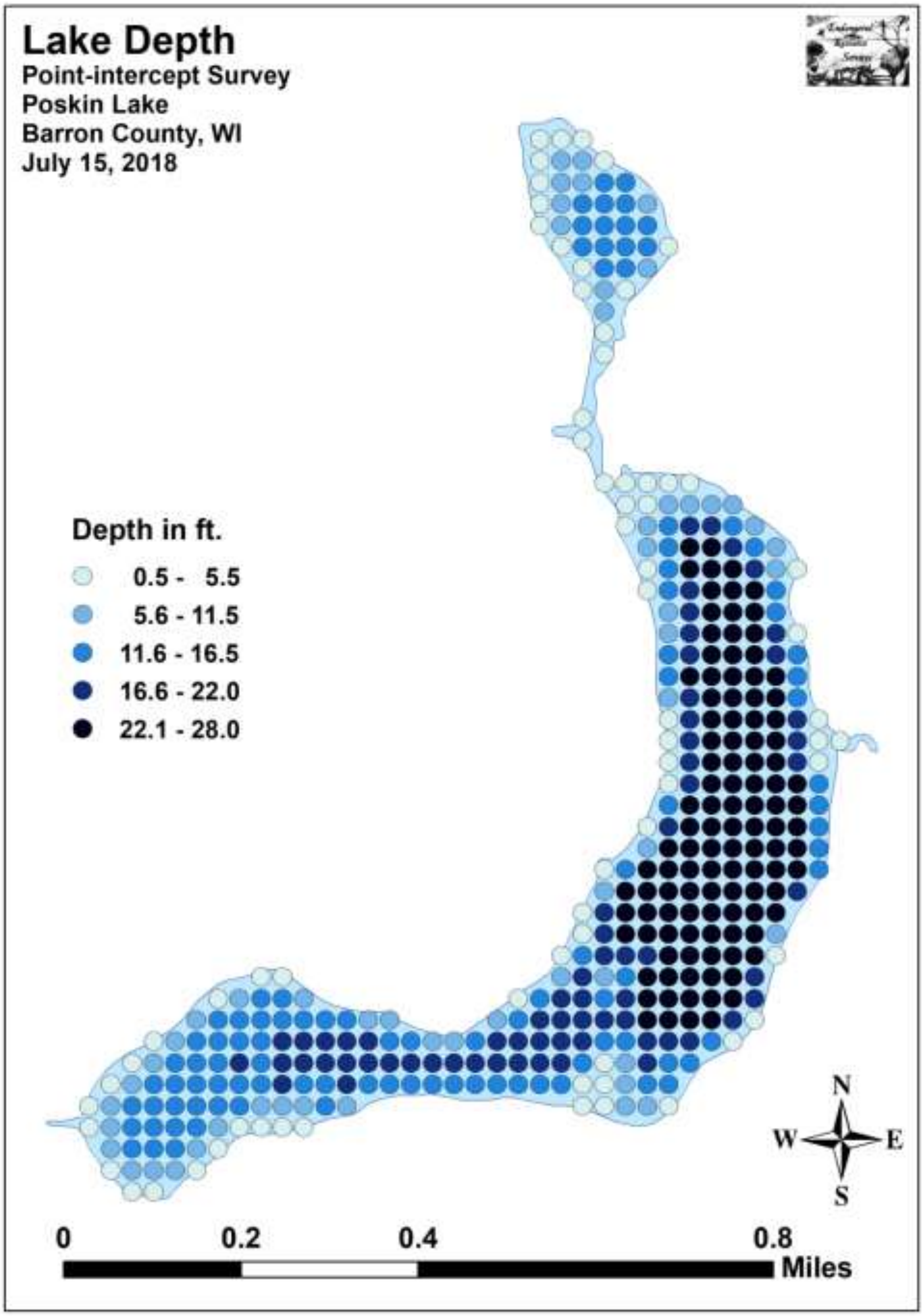

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
CLP Point-intercept Survey
Poskin Lake
Barron County, WI
May 27, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

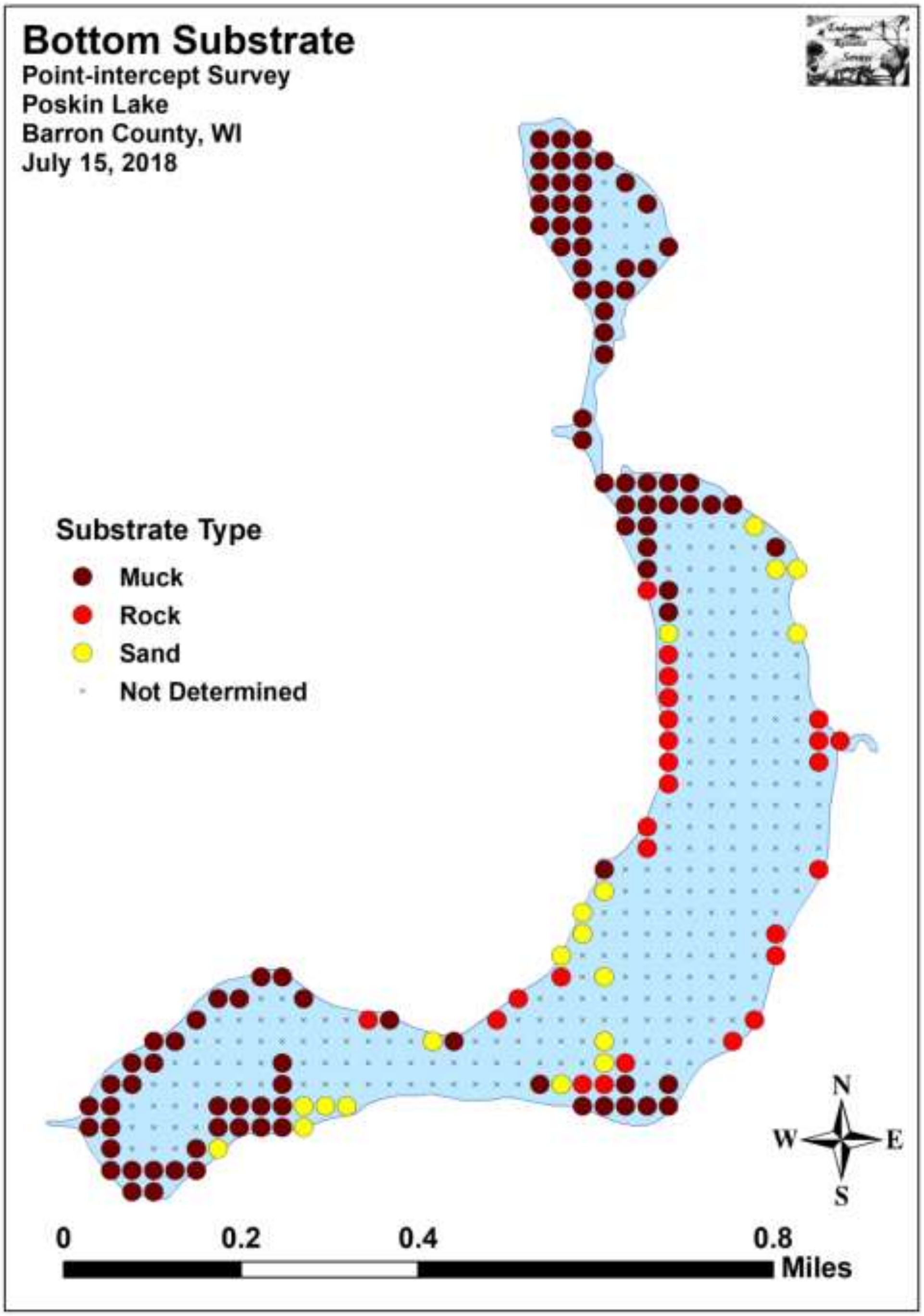

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
CLP Point-intercept Survey
Poskin Lake
Barron County, WI
May 23, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
CLP Bed Mapping Survey
Poskin Lake
Barron County, WI
May 27, 2009
CLP Bed
Bed 1
N
W
E
S
0
0.2
0.4
0.8
Miles

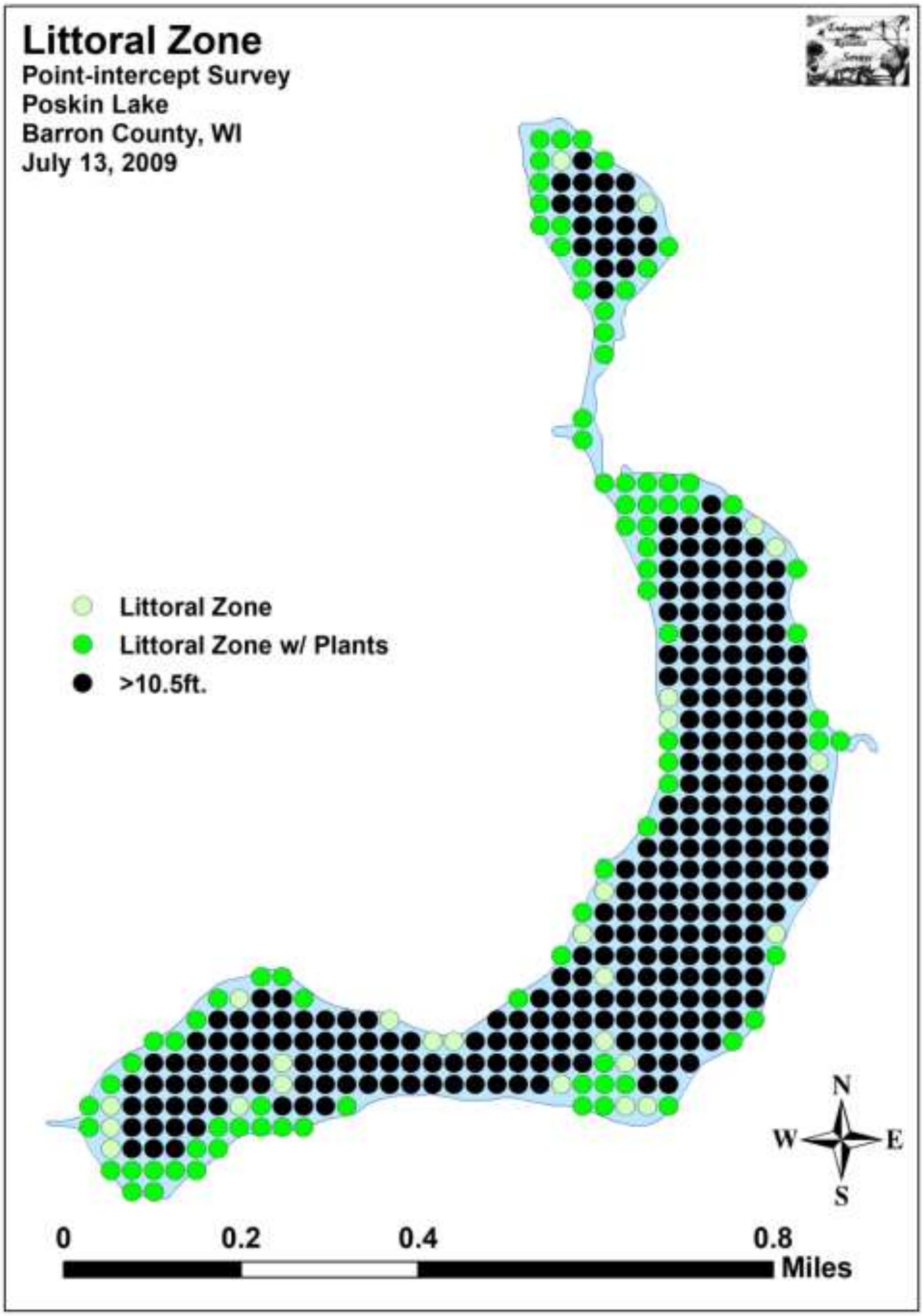

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
CLP Bed Mapping Survey
Poskin Lake
Barron County, WI
June 12, 2018
2018 CLP Bed
2009 CLP Bed
Bed 1
Bed 2
Bed 3
N
W
E
S
0
0.2
0.4
0.8
Miles

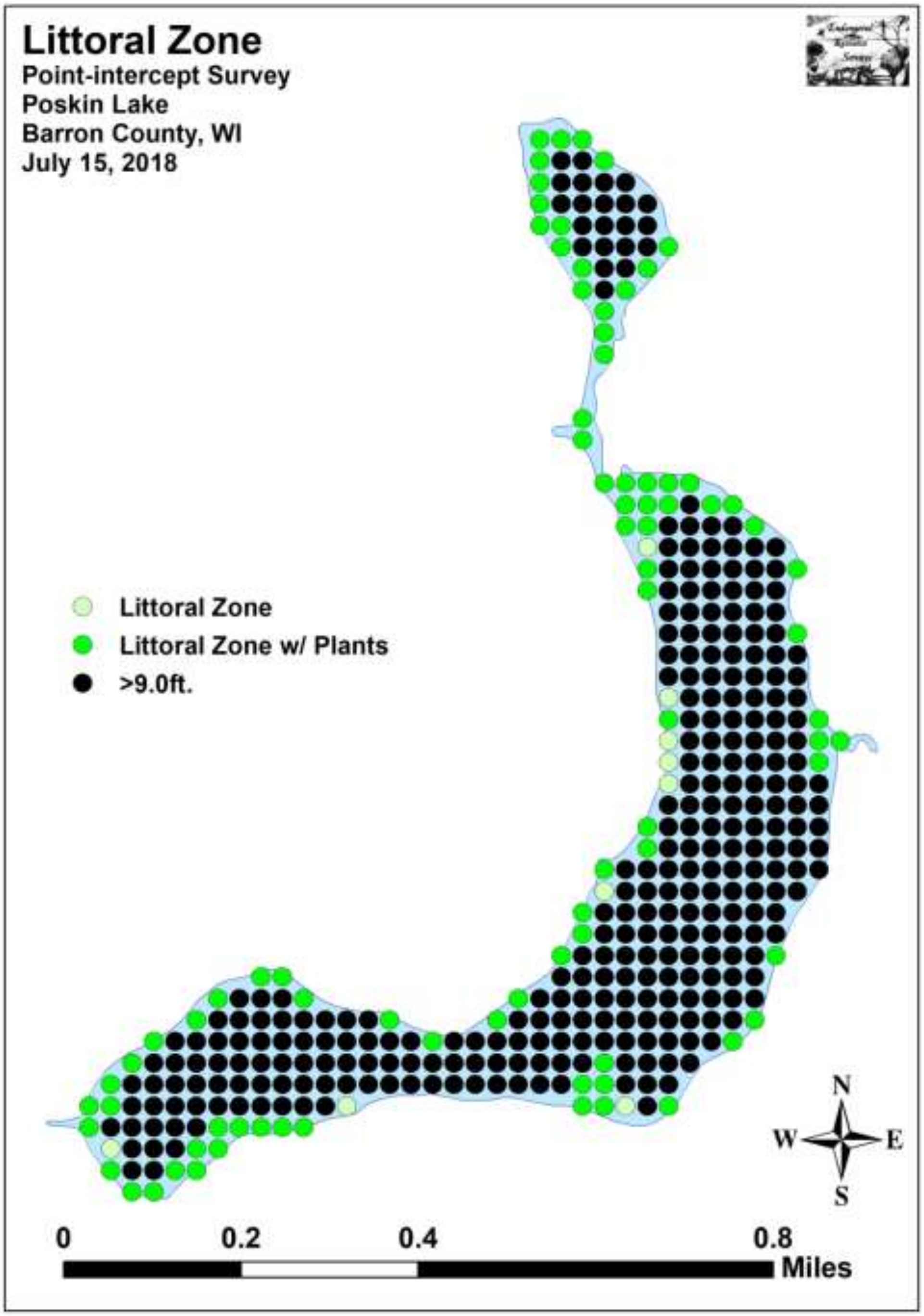
Appendix IV: Habitat Variable Maps

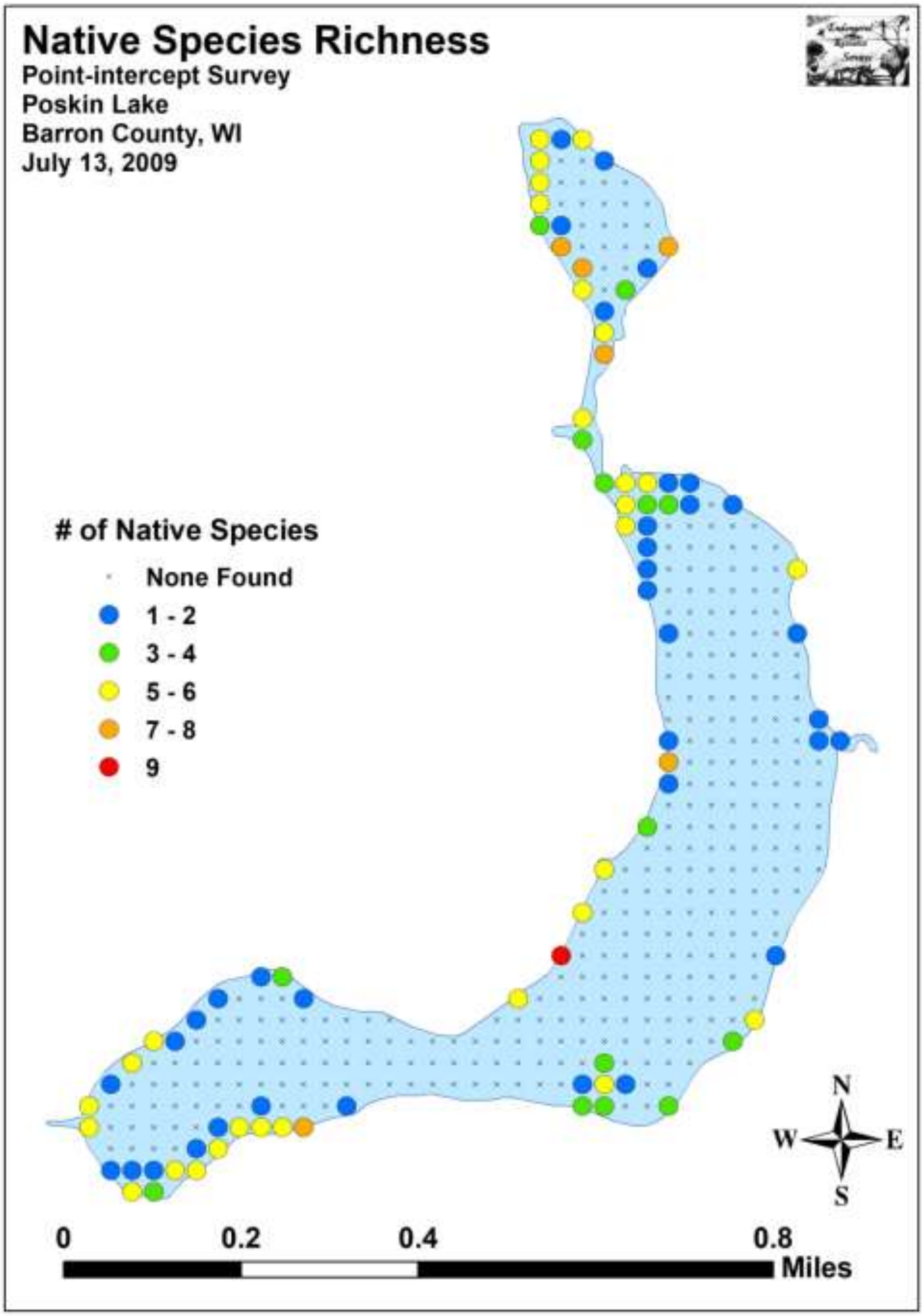

Lake Depth
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Depth in ft.
0.5 - 5.5
5.6 - 11.5
11.6 - 16.5
16.6 - 22.0
22.1 - 28.0
N
W
E
S
0
0.2
0.4
0.8
Miles

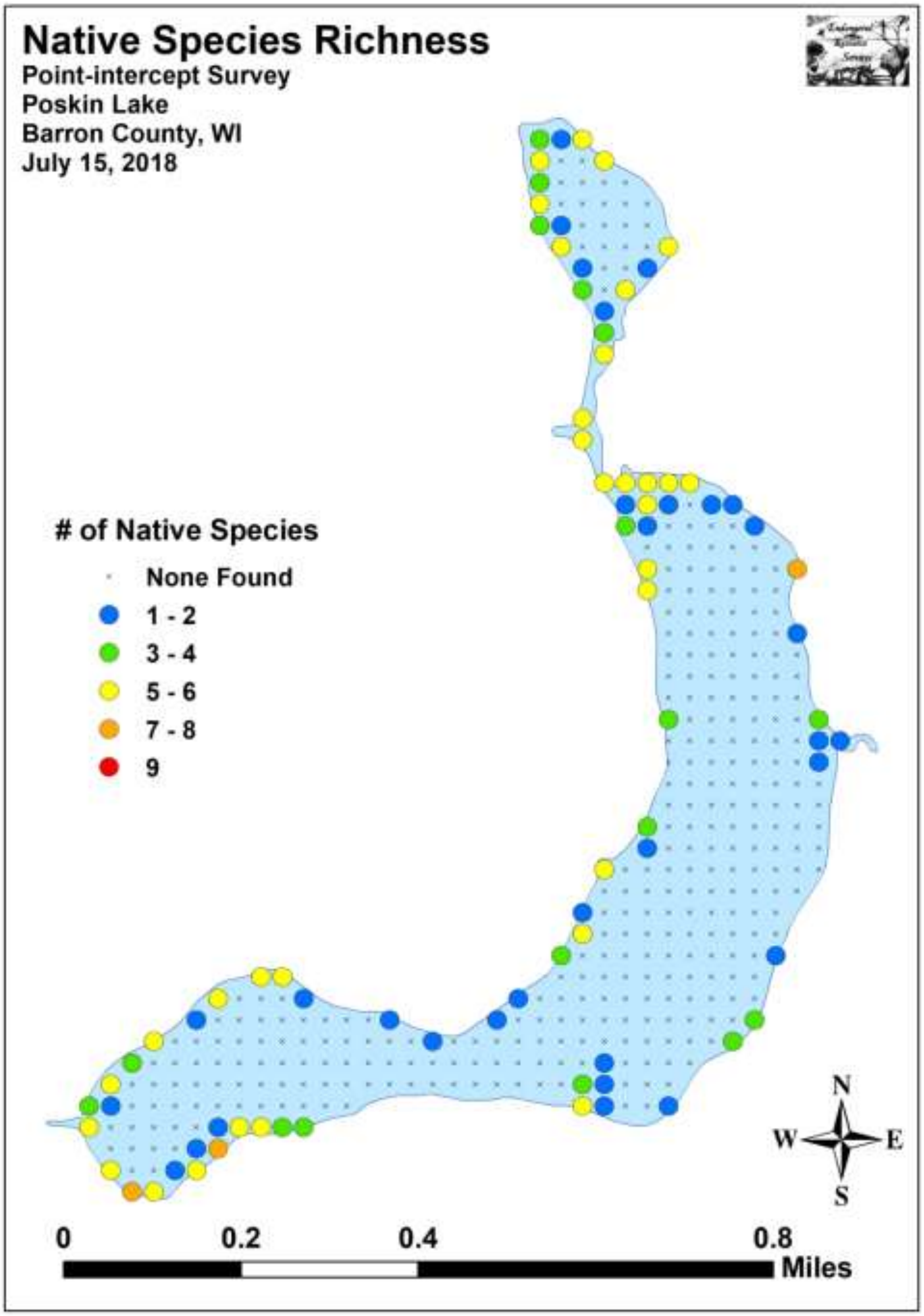

Bottom Substrate
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Substrate Type
Muck
Rock
Sand
Not Determined
N
W
E
S
0
0.2
0.4
0.8
Miles

Appendix V: 2009 and 2018 Littoral Zone, Native Species Richness and Total Rake Fullness Maps

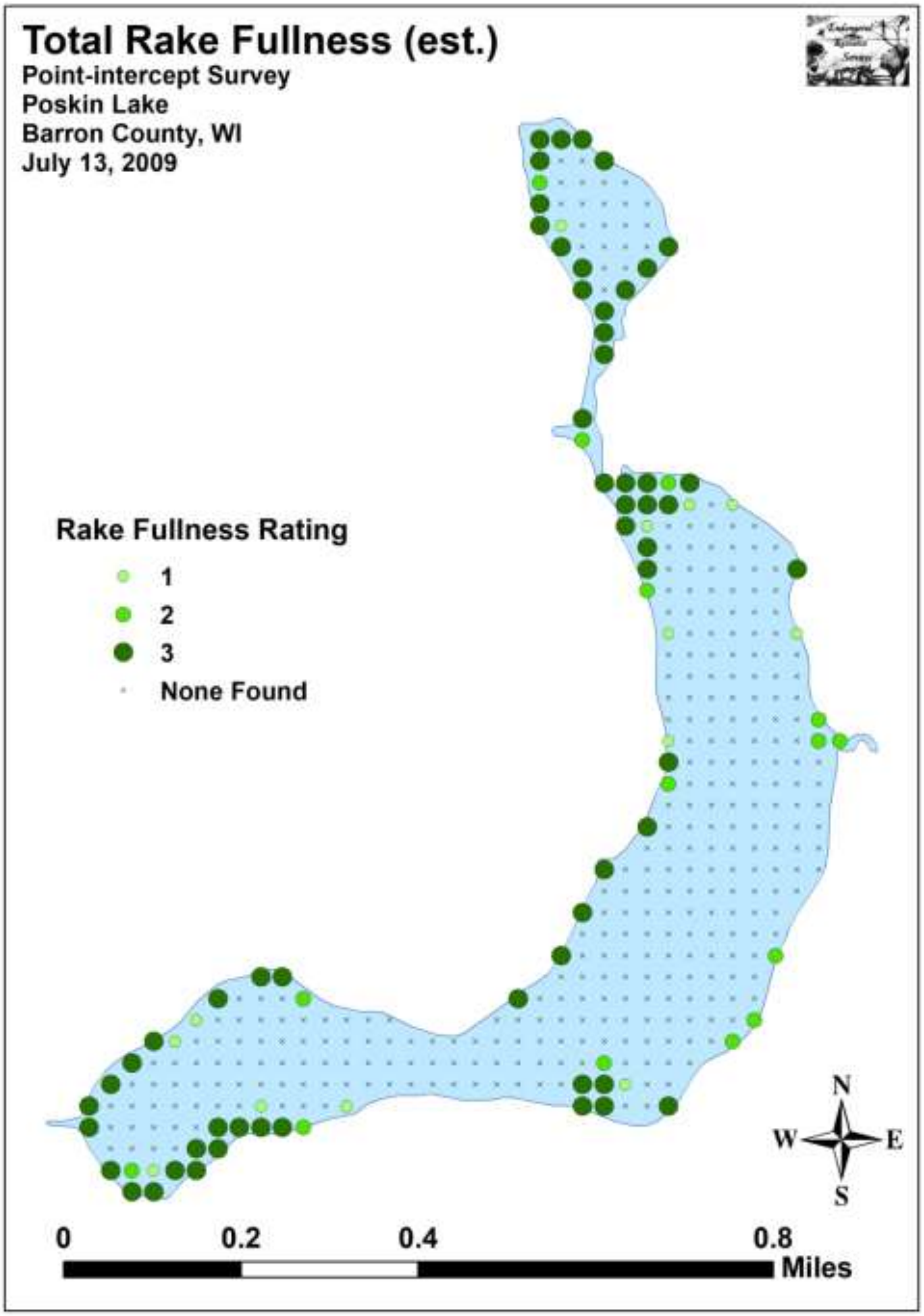

Littoral Zone
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Littoral Zone
Littoral Zone w/ Plants
>10.5ft.
N
W
E
S
0
0.2
0.4
0.8
Miles

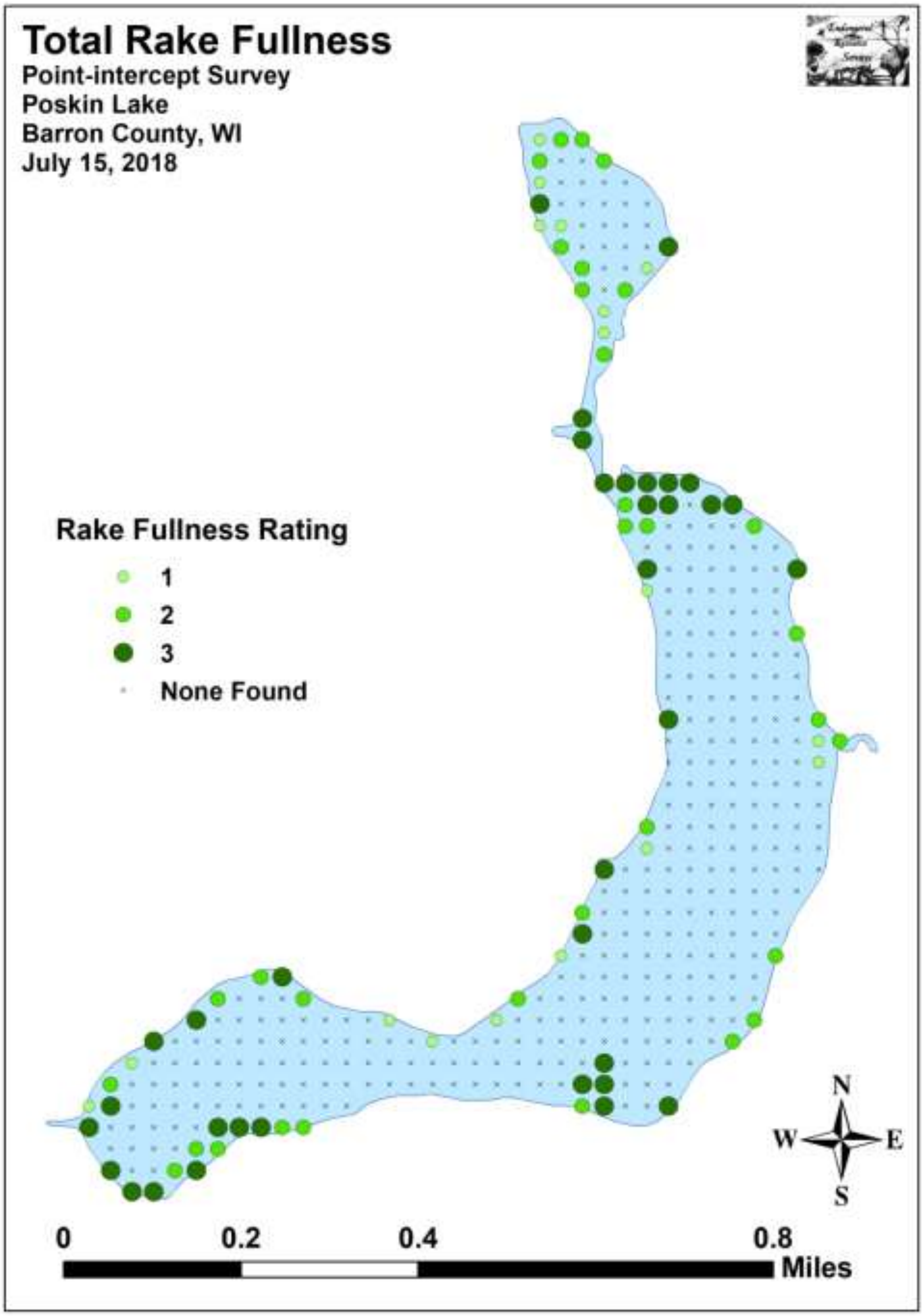

Littoral Zone
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Littoral Zone
Littoral Zone w/ Plants
>9.0ft.
N
W
E
S
0
0.2
0.4
0.8
Miles


Native Species Richness
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9
N
W
E
S
0
0.2
0.4
0.8
Miles

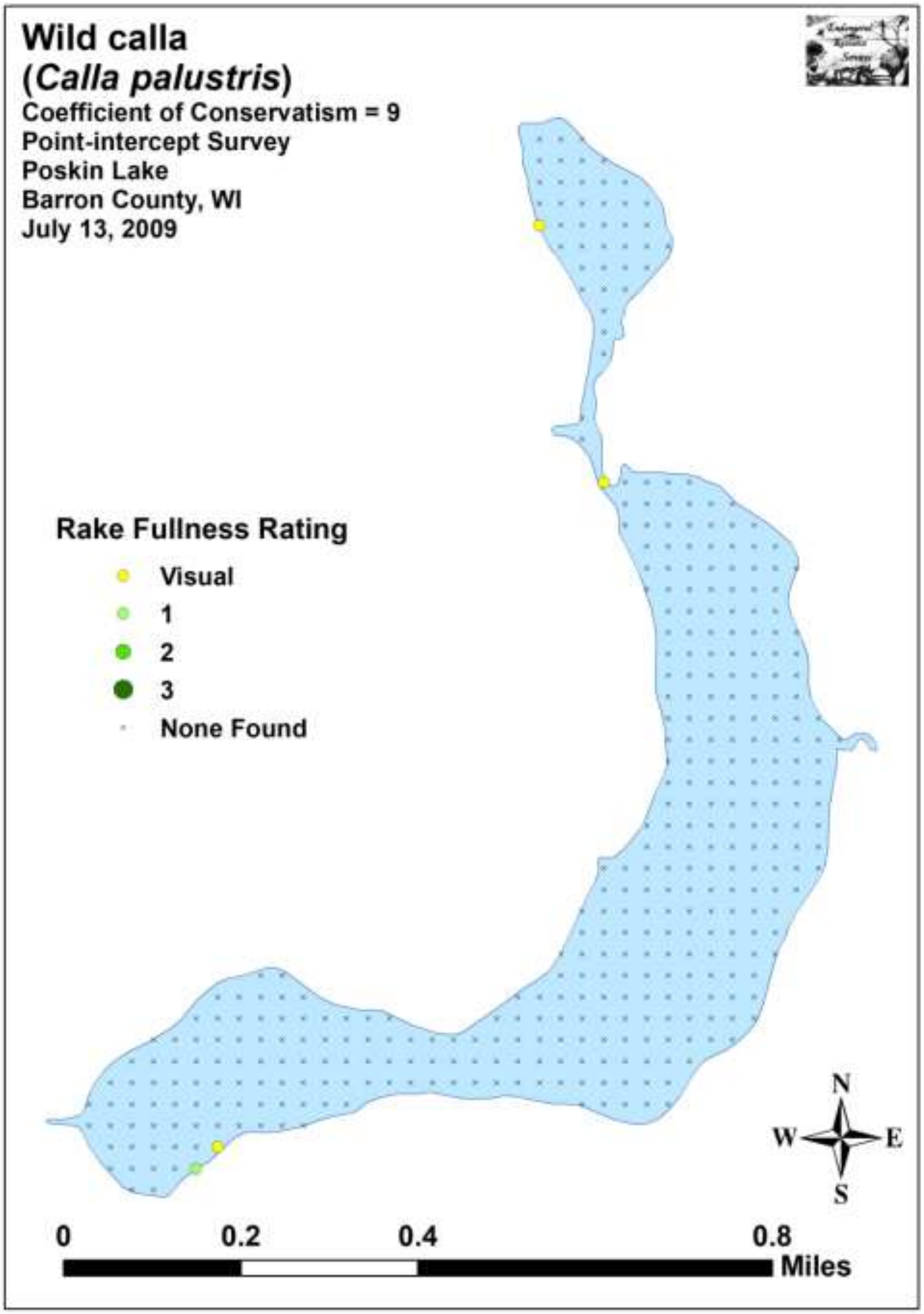


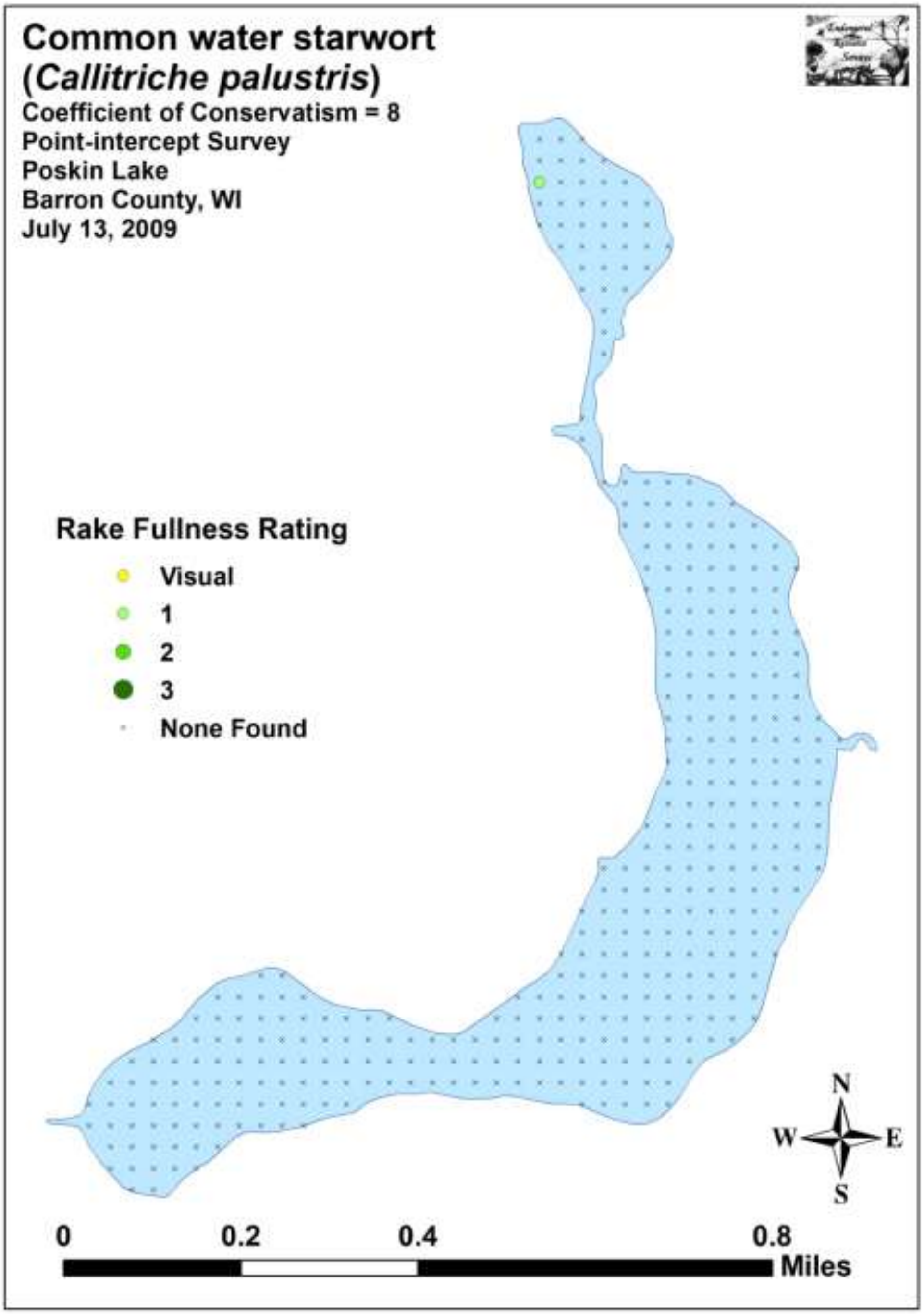
Native Species Richness
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9
N
W
E
S
0
0.2
0.4
0.8
Miles


Total Rake Fullness (est.)
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

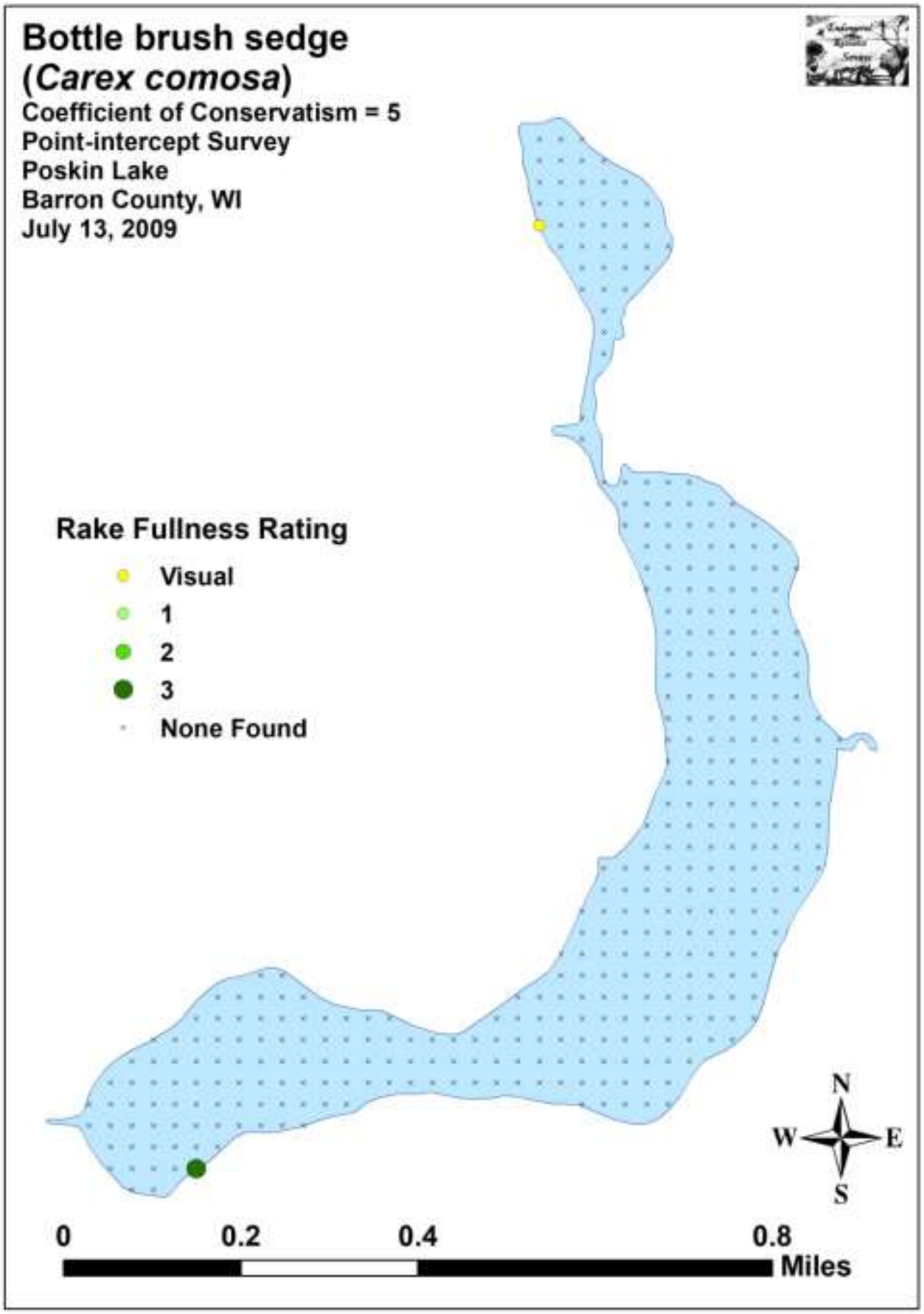

Total Rake Fullness
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

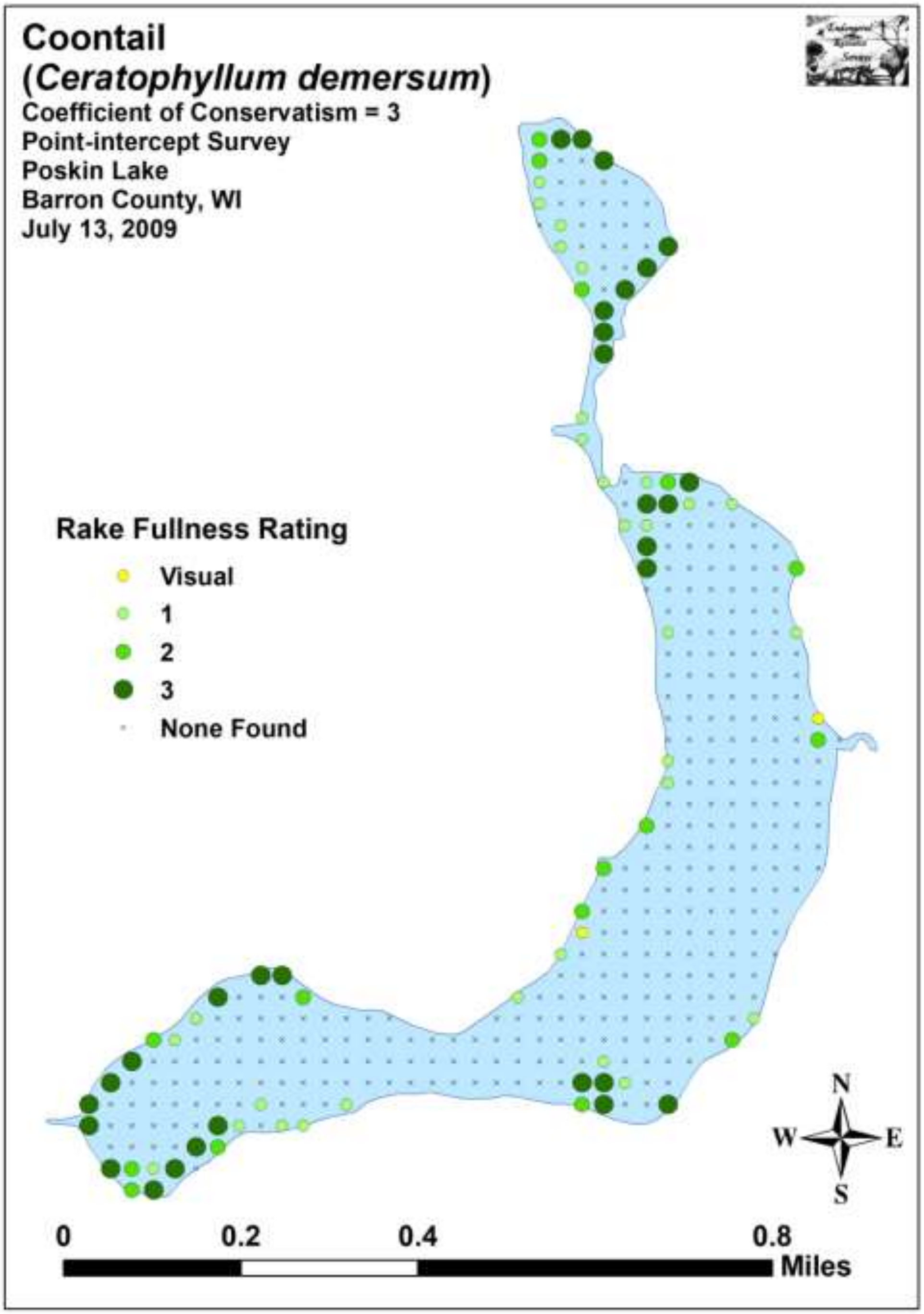
Appendix VI: July 2009 Species Density and Distribution Maps

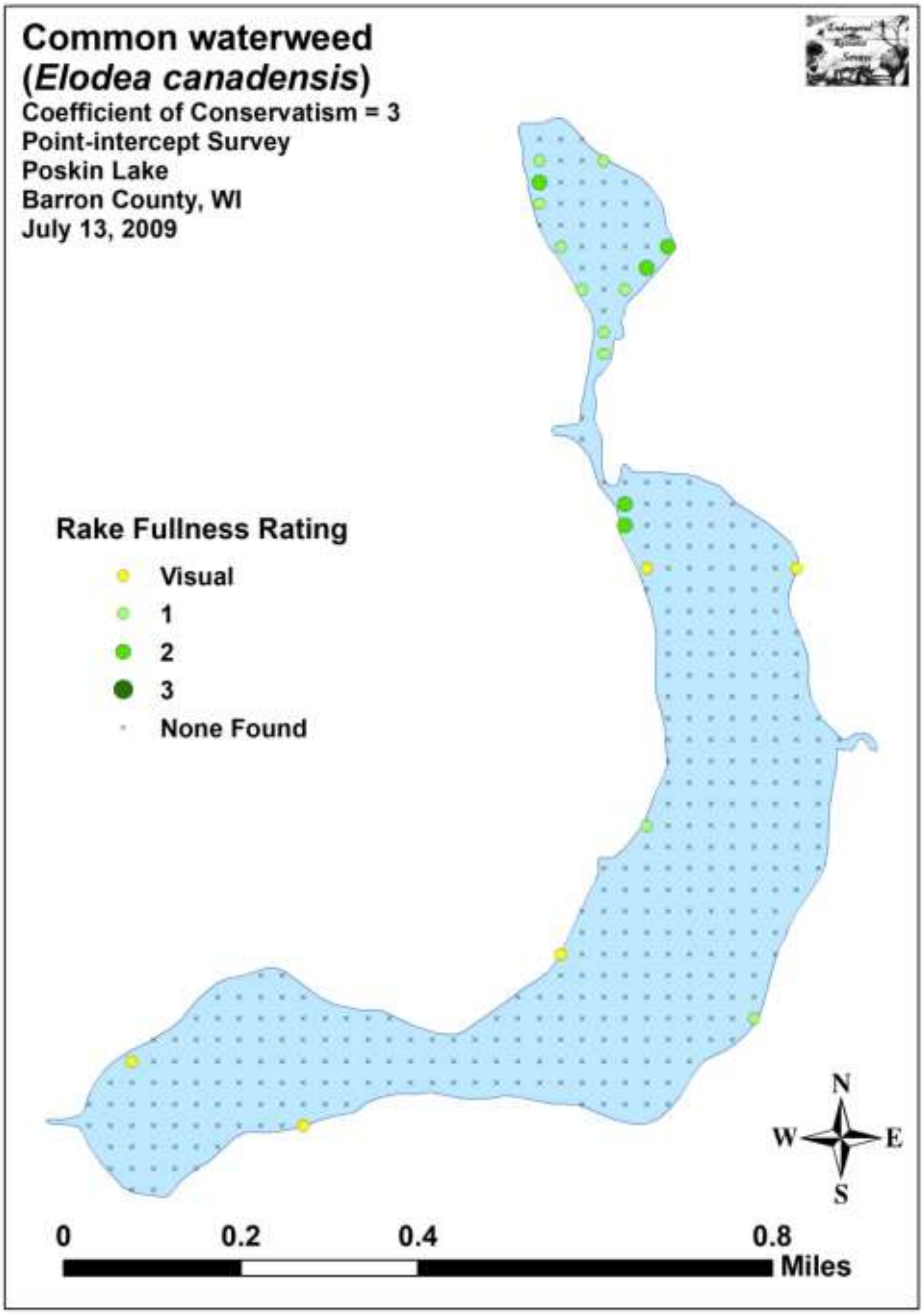

Wild calla
(Calla palustris)
Coefficient of Conservatism = 9
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

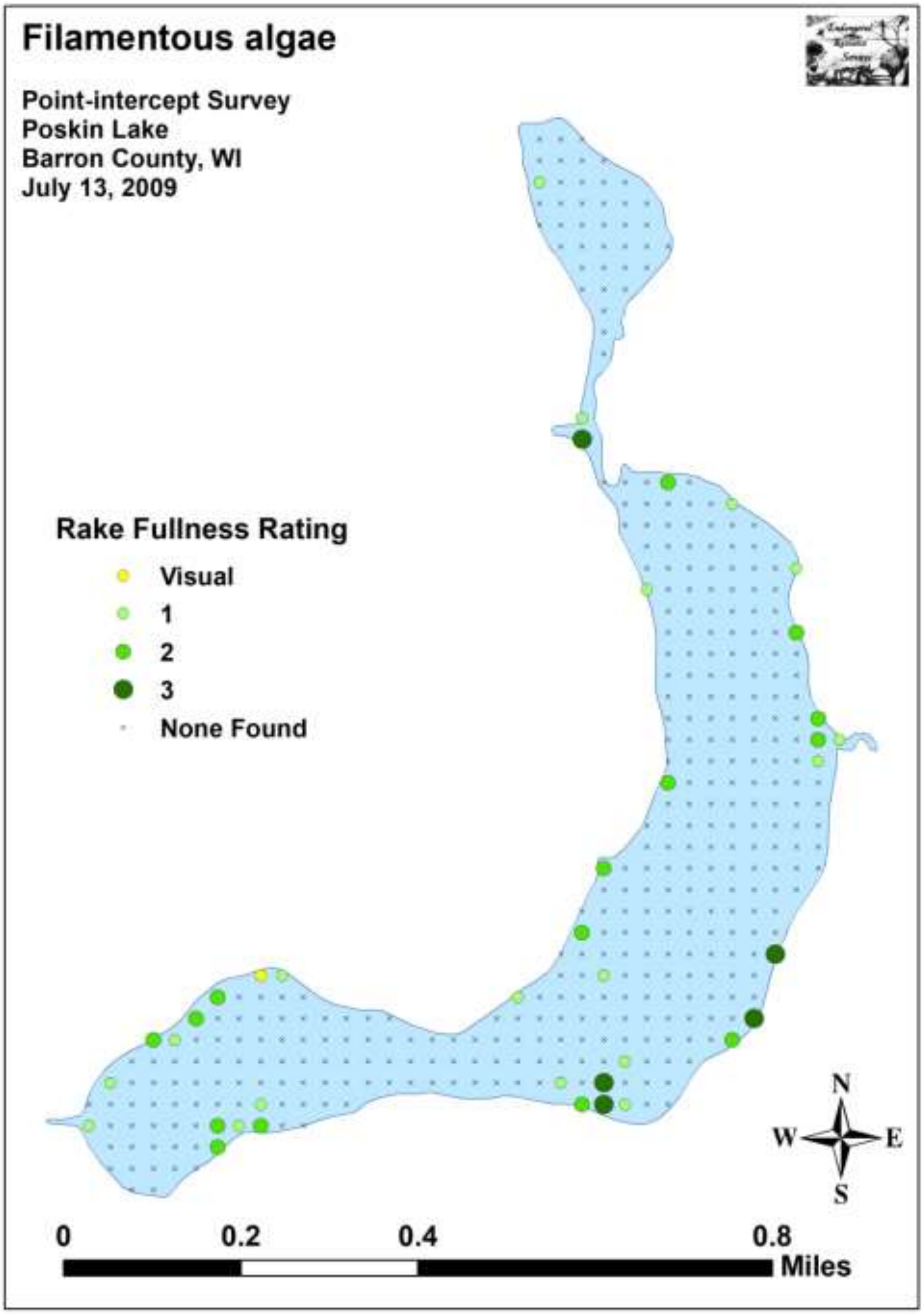


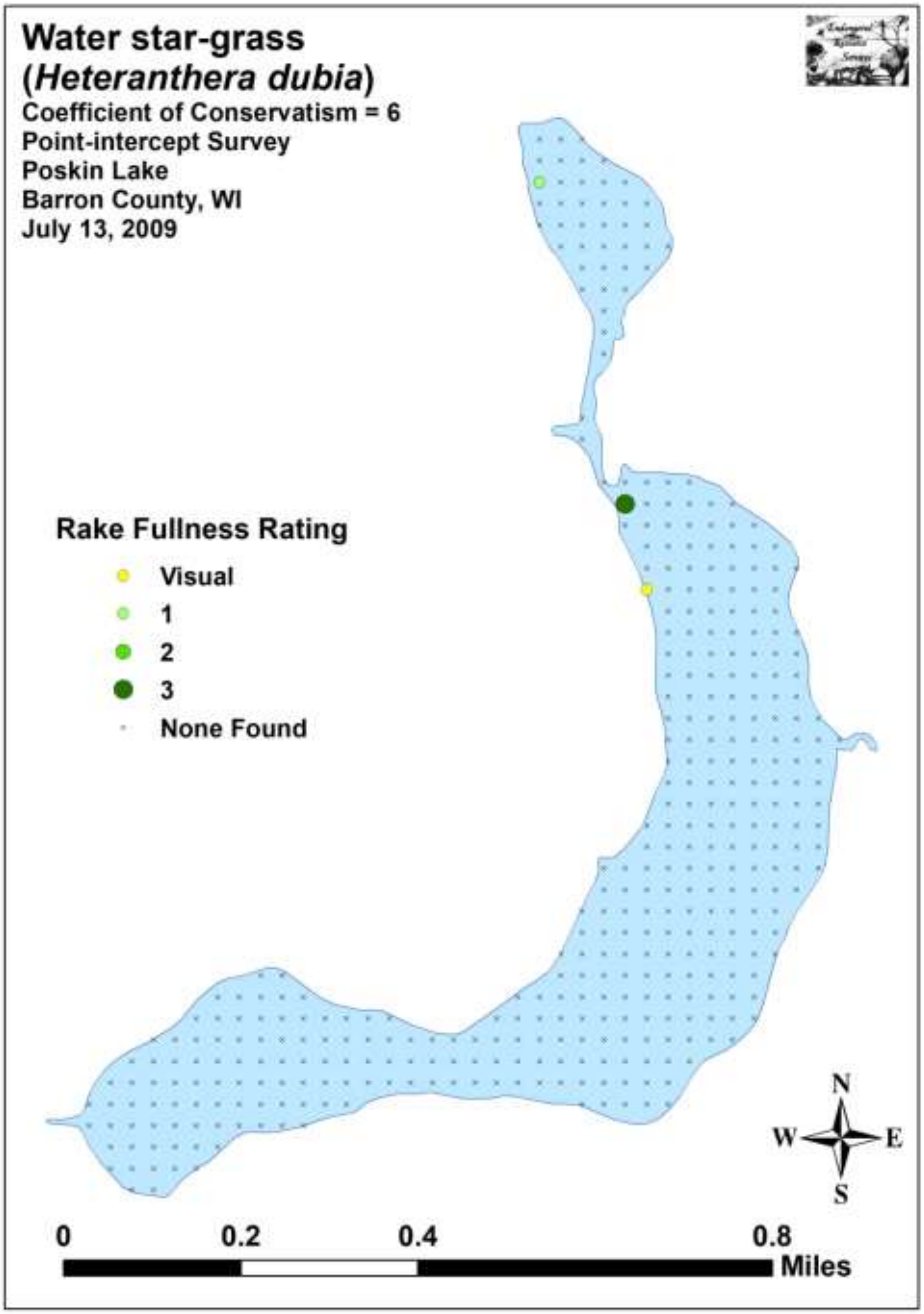
Common water starwort
(*Callitriche palustris*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

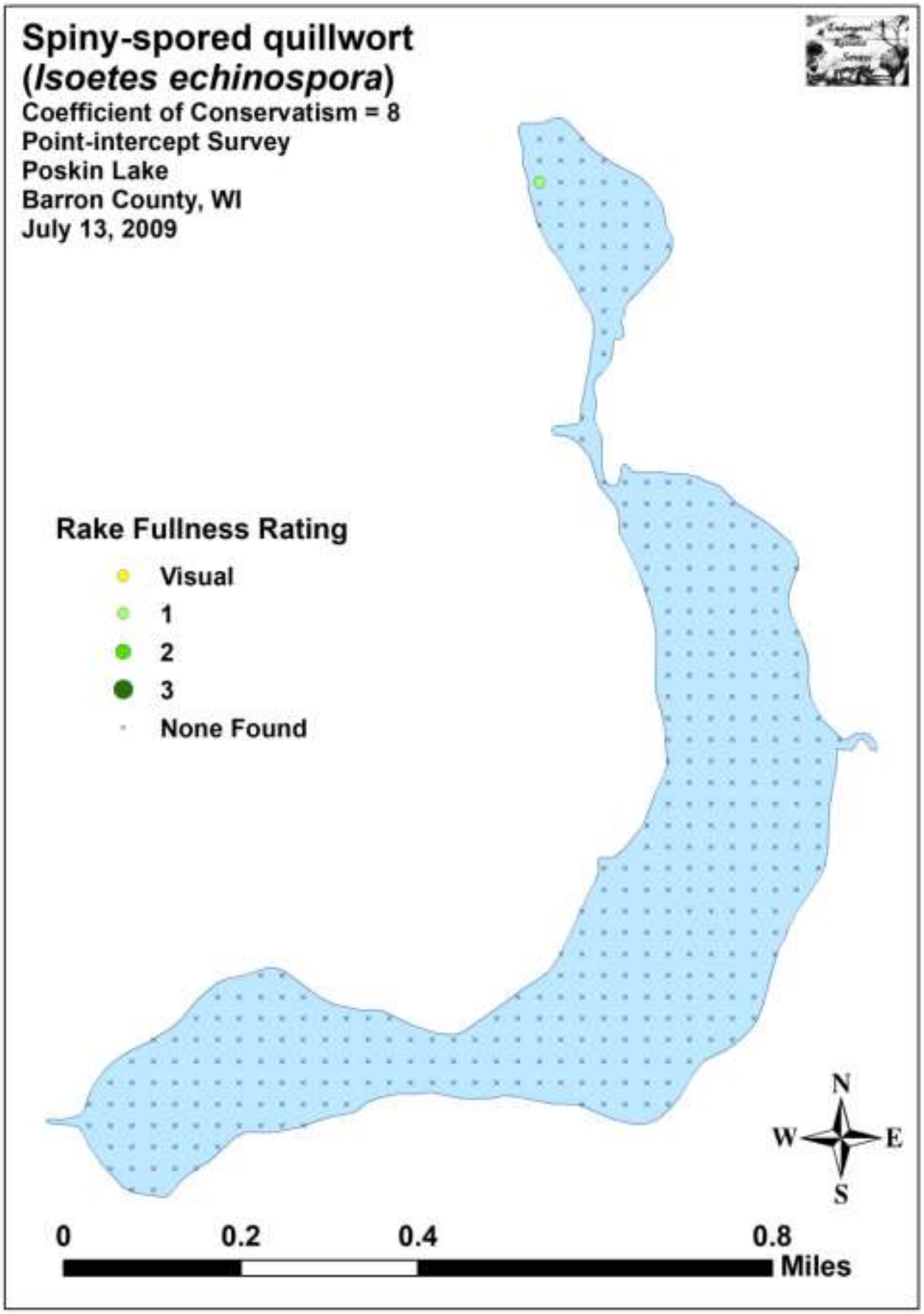

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

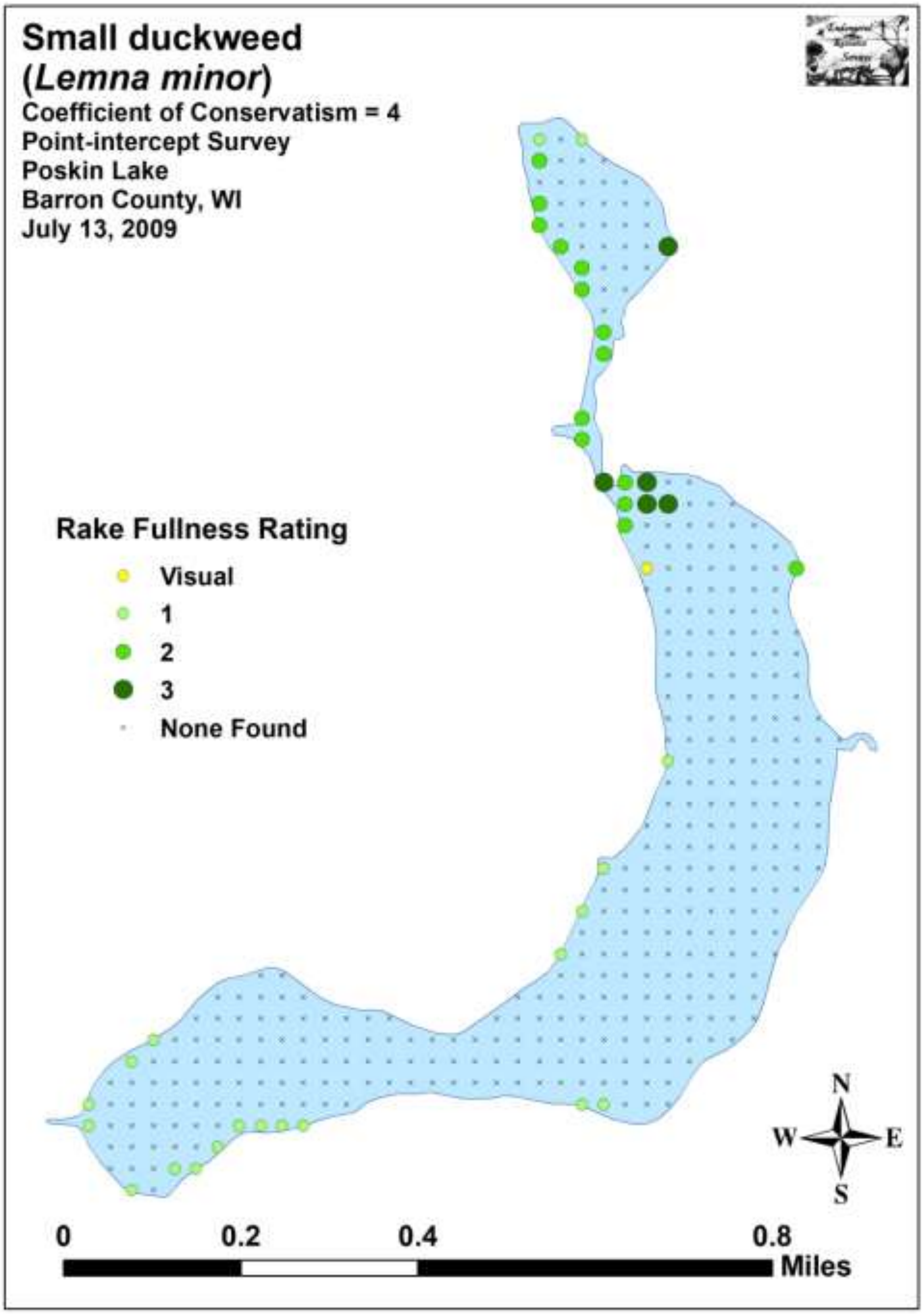

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

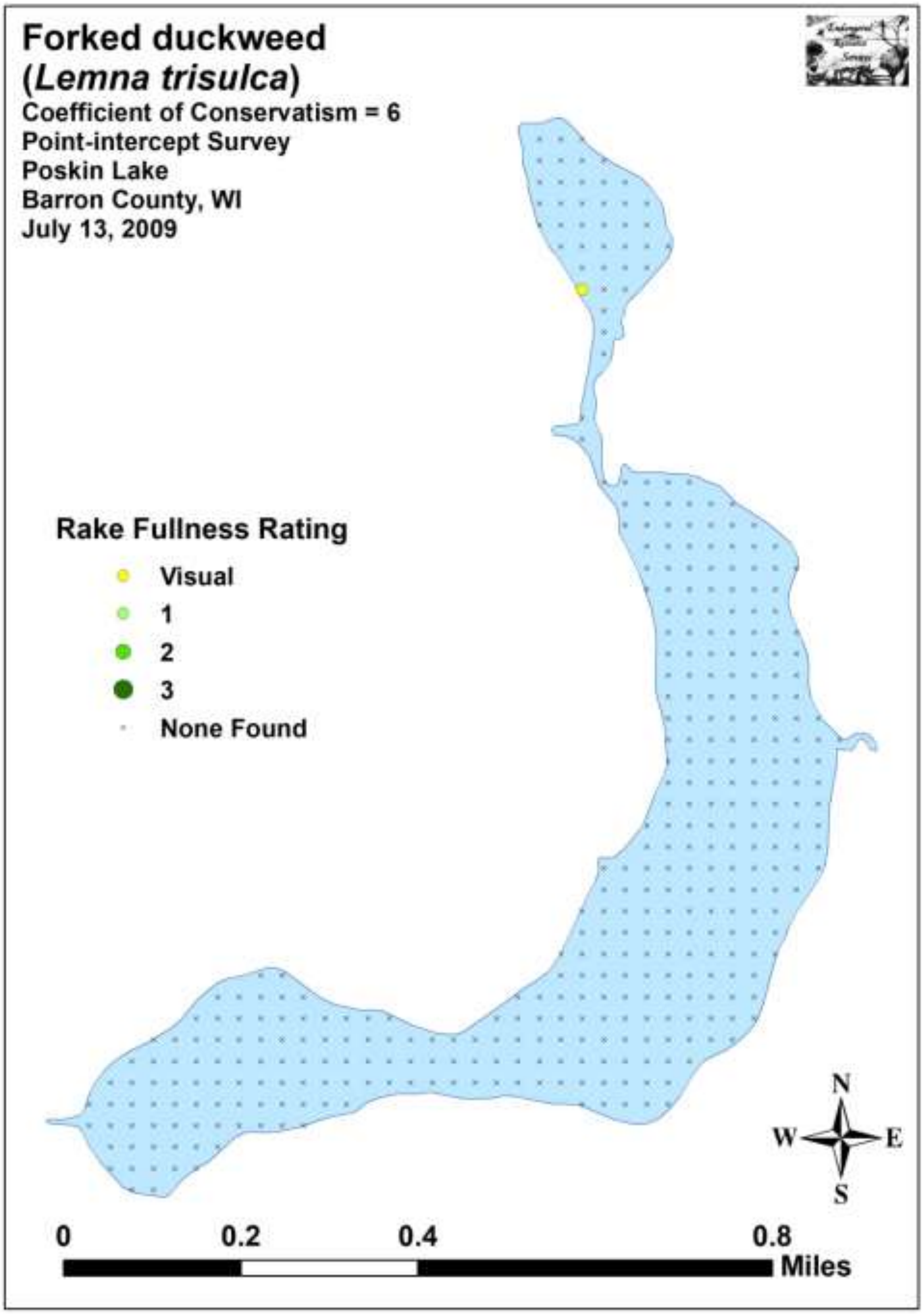

Filamentous algae
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles



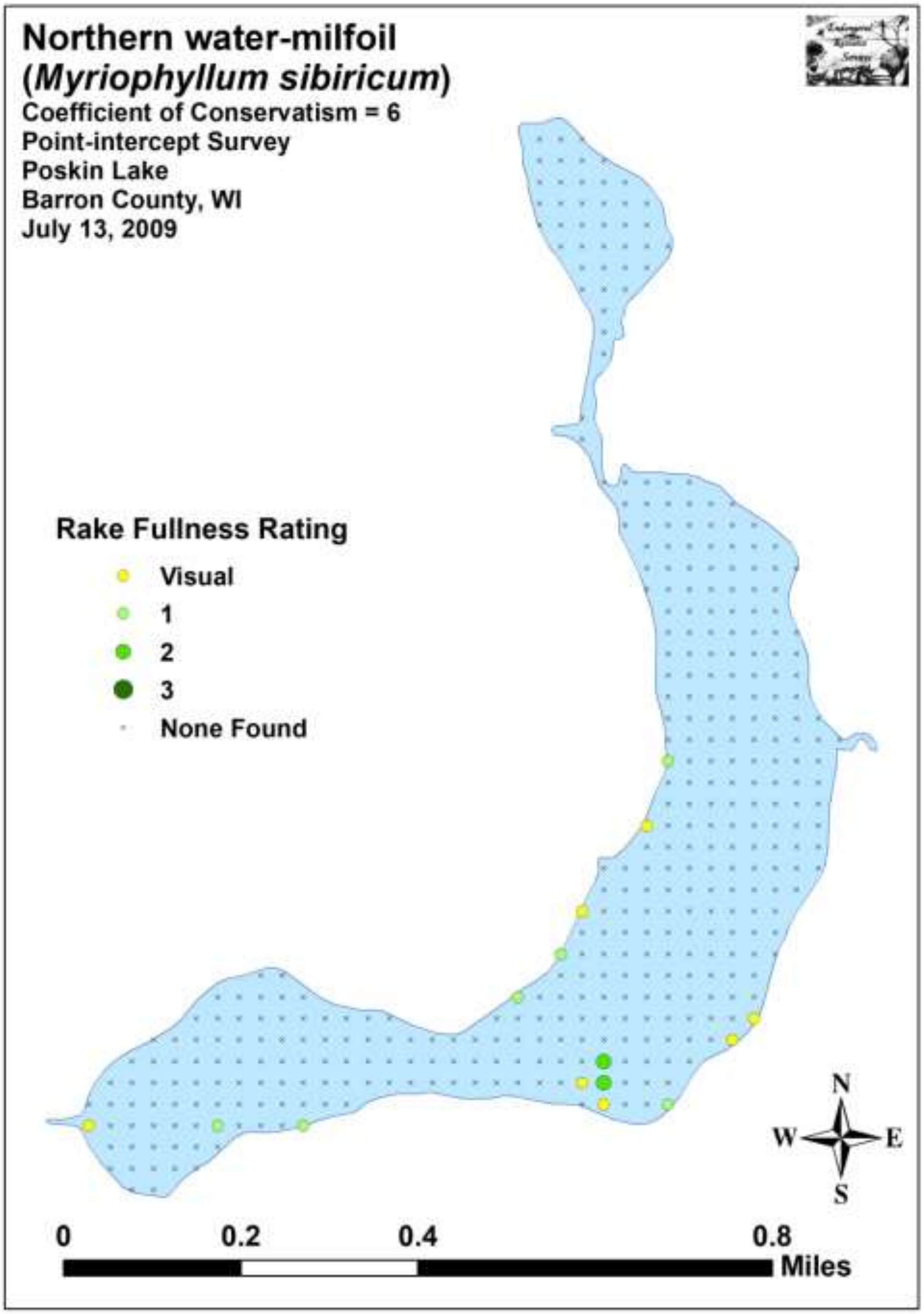
Water star-grass
(*Heteranthera dubia*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

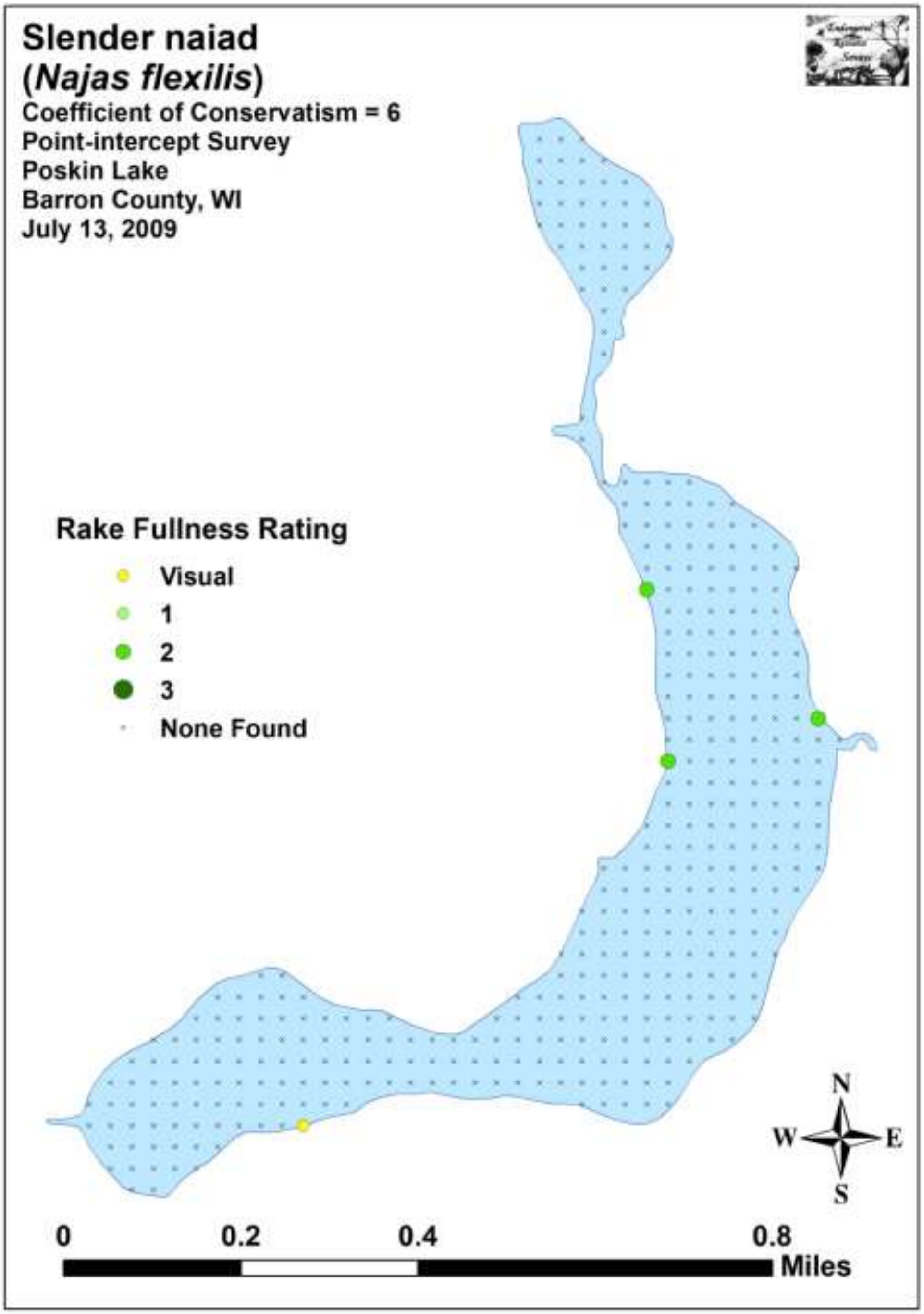

Spiny-spored quillwort
(*Isoetes echinospora*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles



Forked duckweed
(*Lemna trisulca*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Northern water-milfoil
(*Myriophyllum sibiricum*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
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0.2
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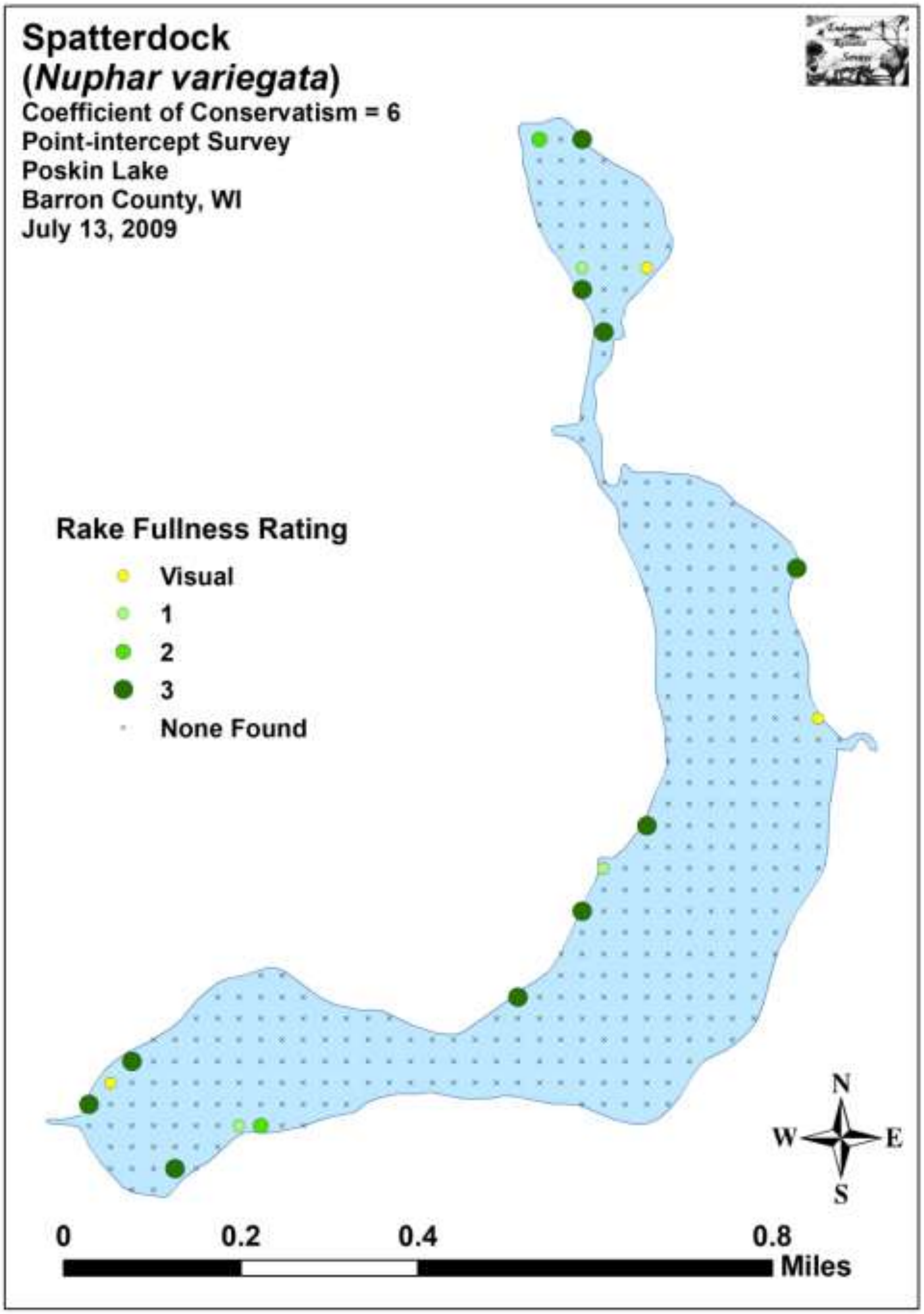
0.8
Miles


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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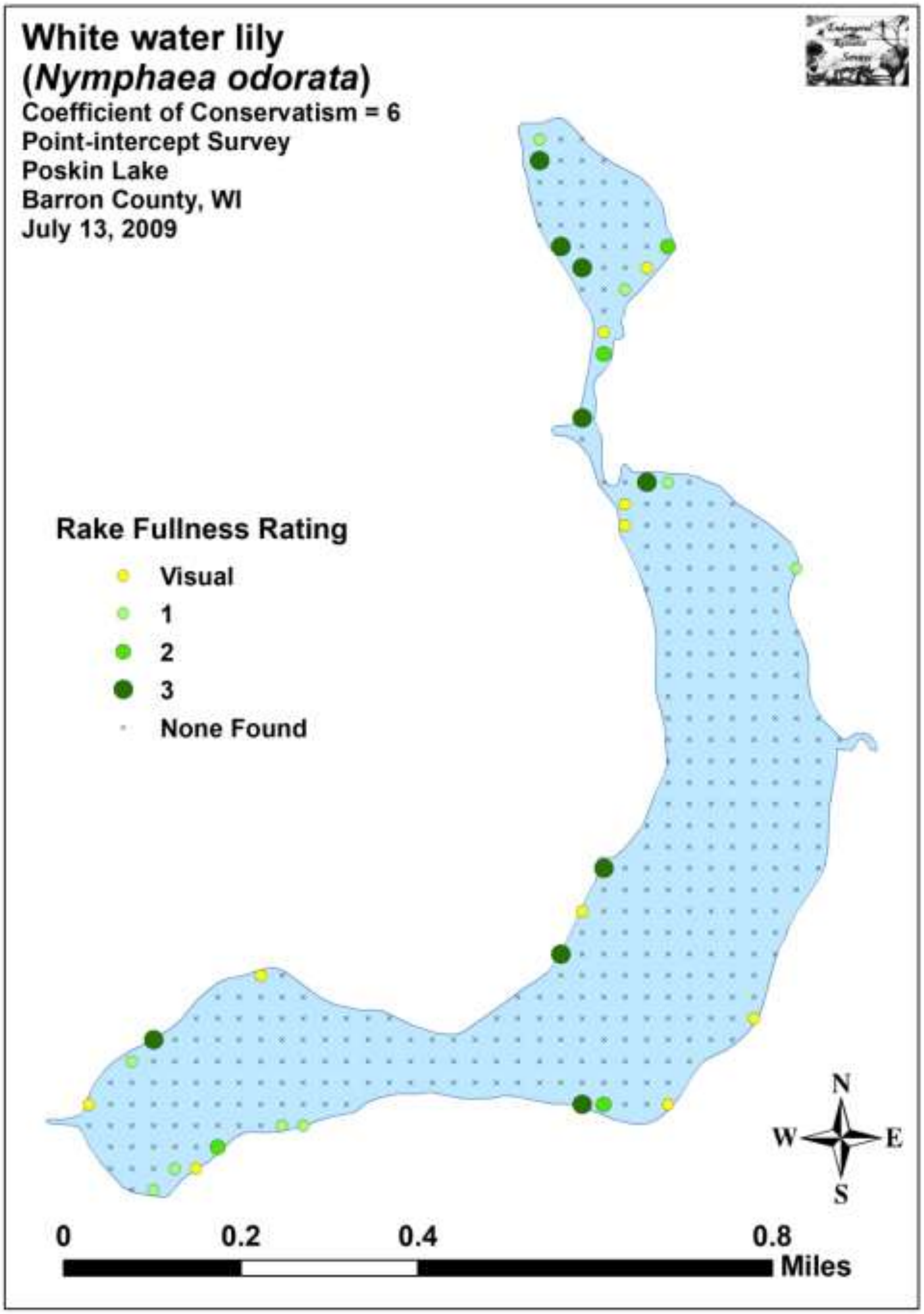
0.8
Miles


White water lily
(*Nymphaea odorata*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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0.2
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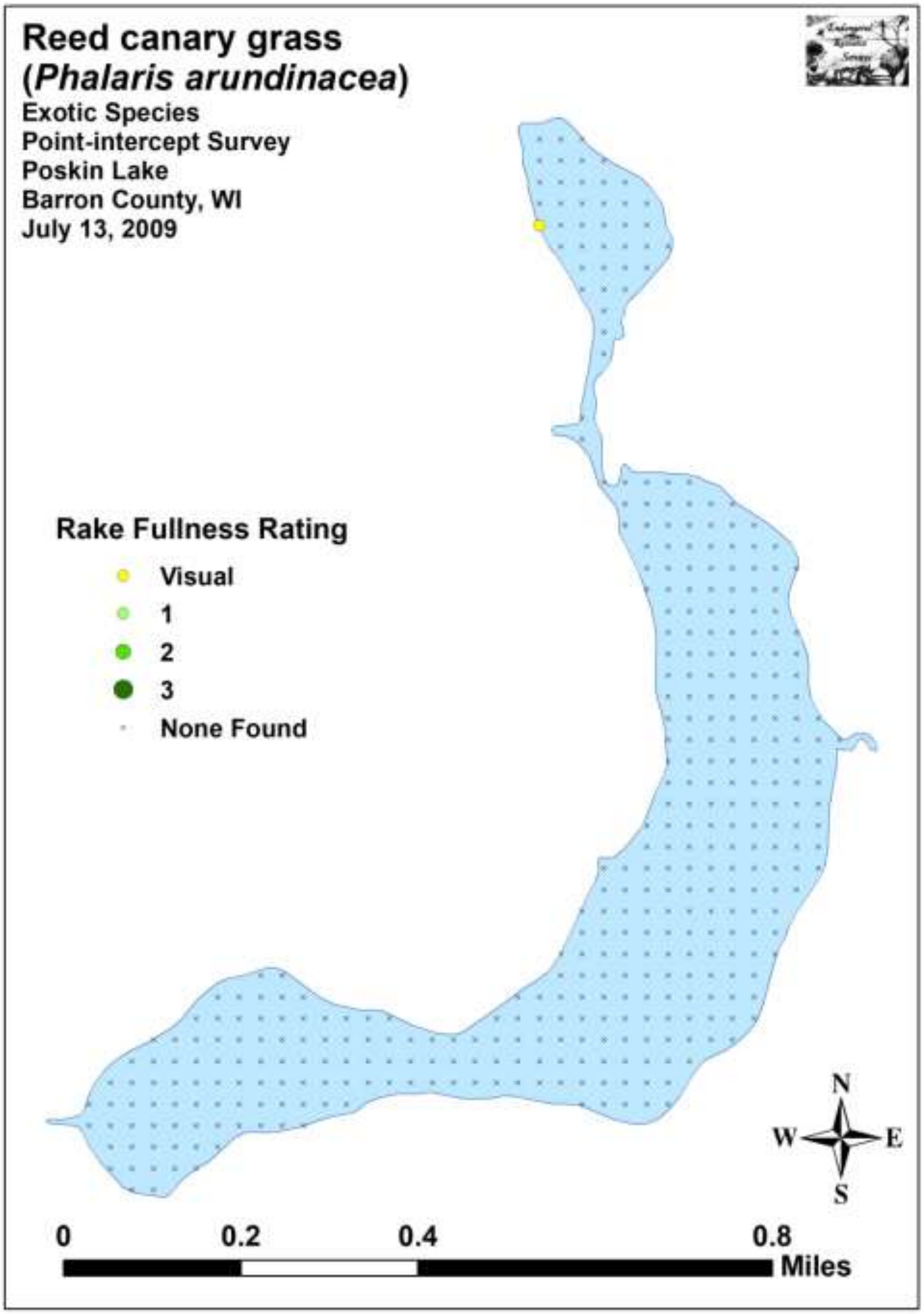
0.8
Miles


Reed canary grass
(*Phalaris arundinacea*)
Exotic Species
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
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None Found
N
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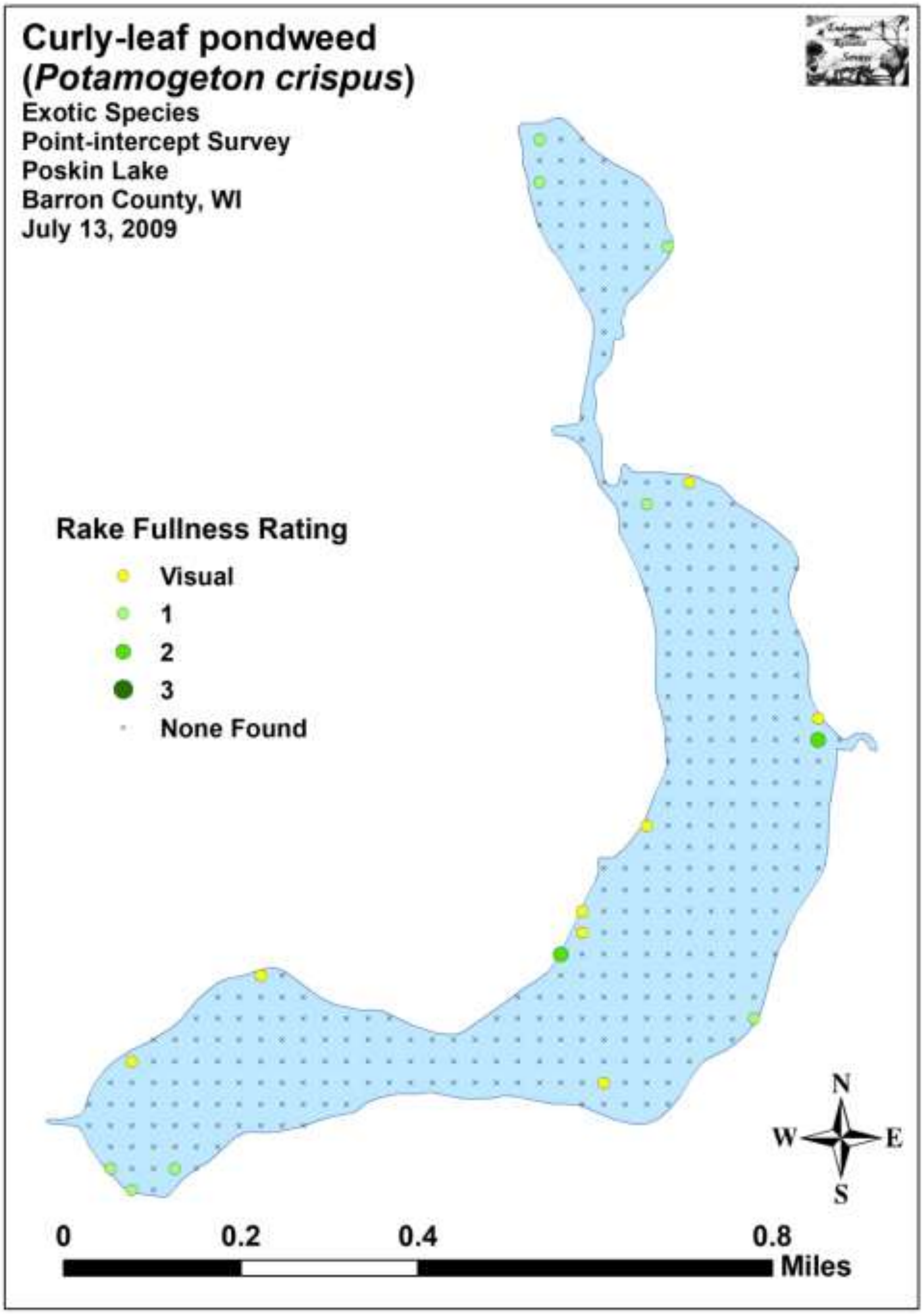
0.2
0.4
0.8
Miles


Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
3
None Found
N
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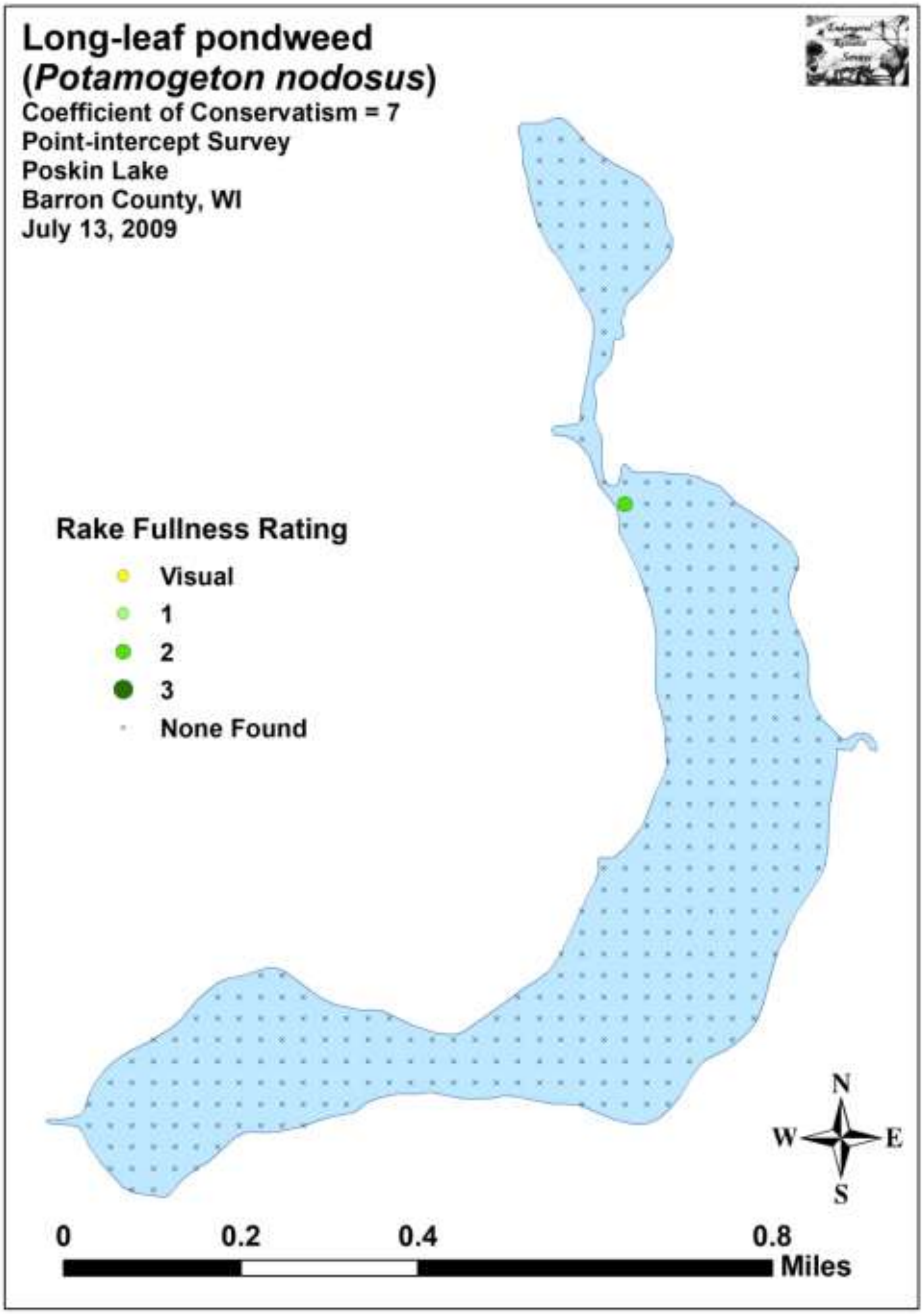
0.2
0.4
0.8
Miles


Long-leaf pondweed
(*Potamogeton nodosus*)
Coefficient of Conservatism = 7
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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0.2
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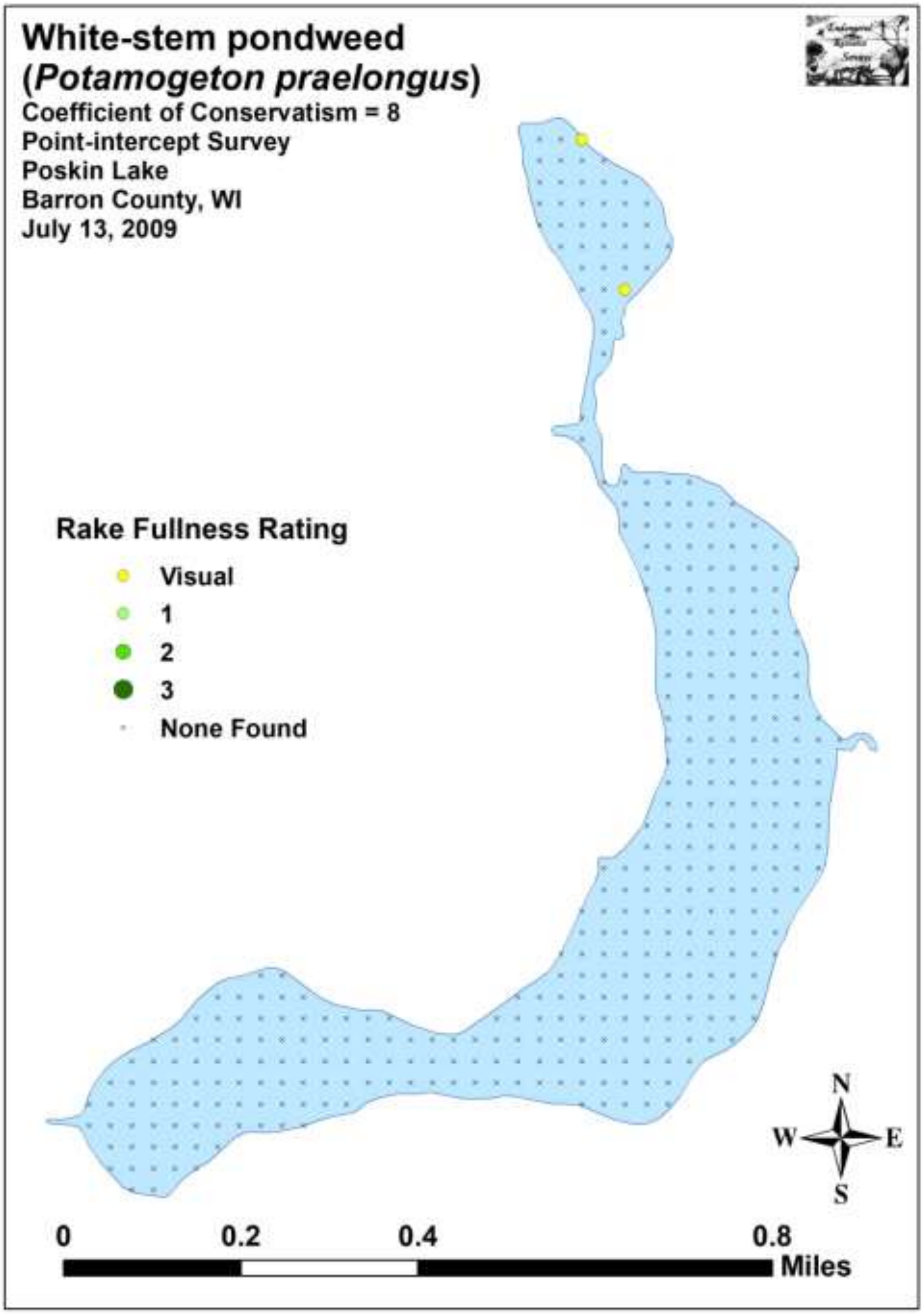
0.8
Miles


White-stem pondweed
(*Potamogeton praelongus*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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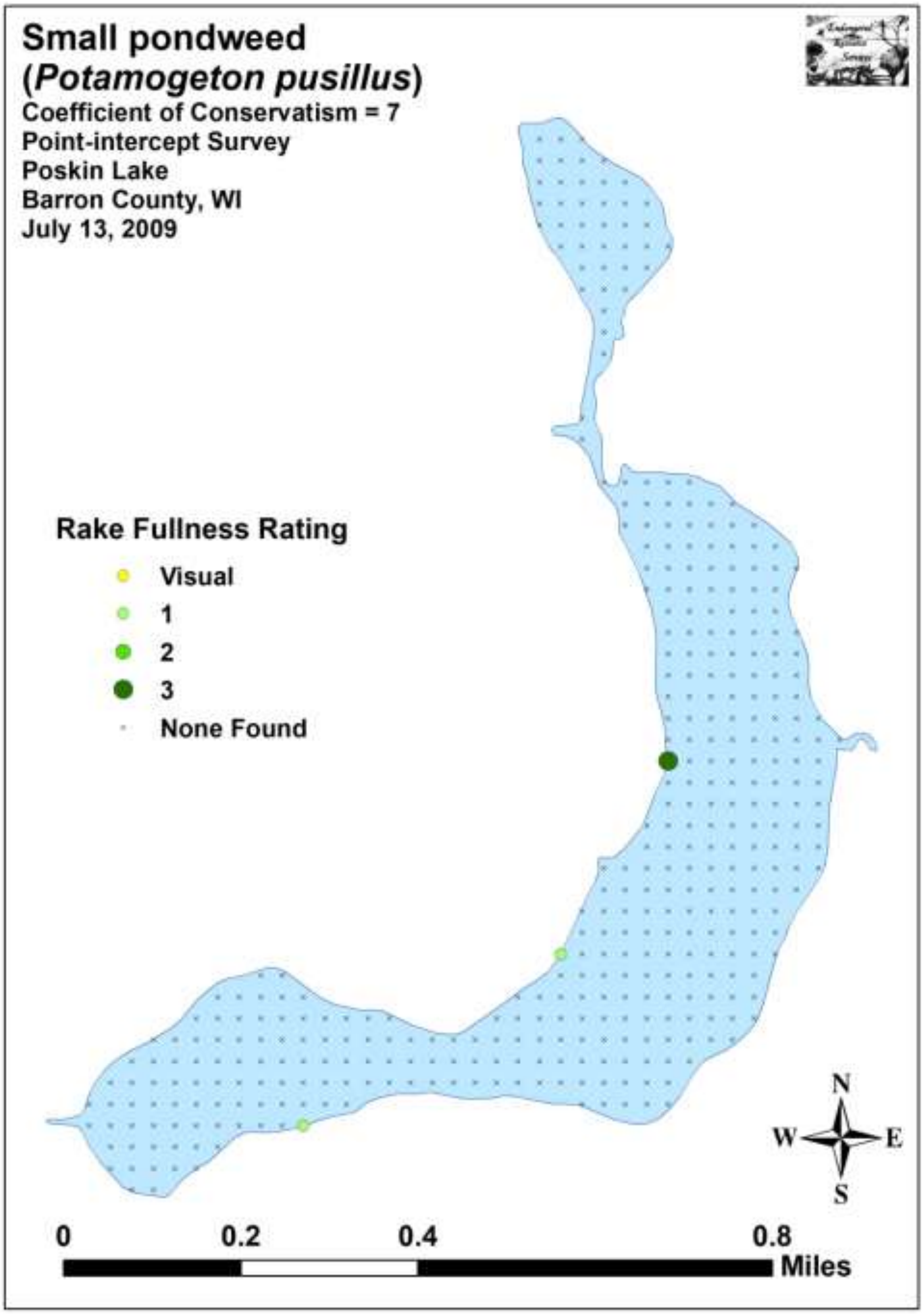
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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0.2
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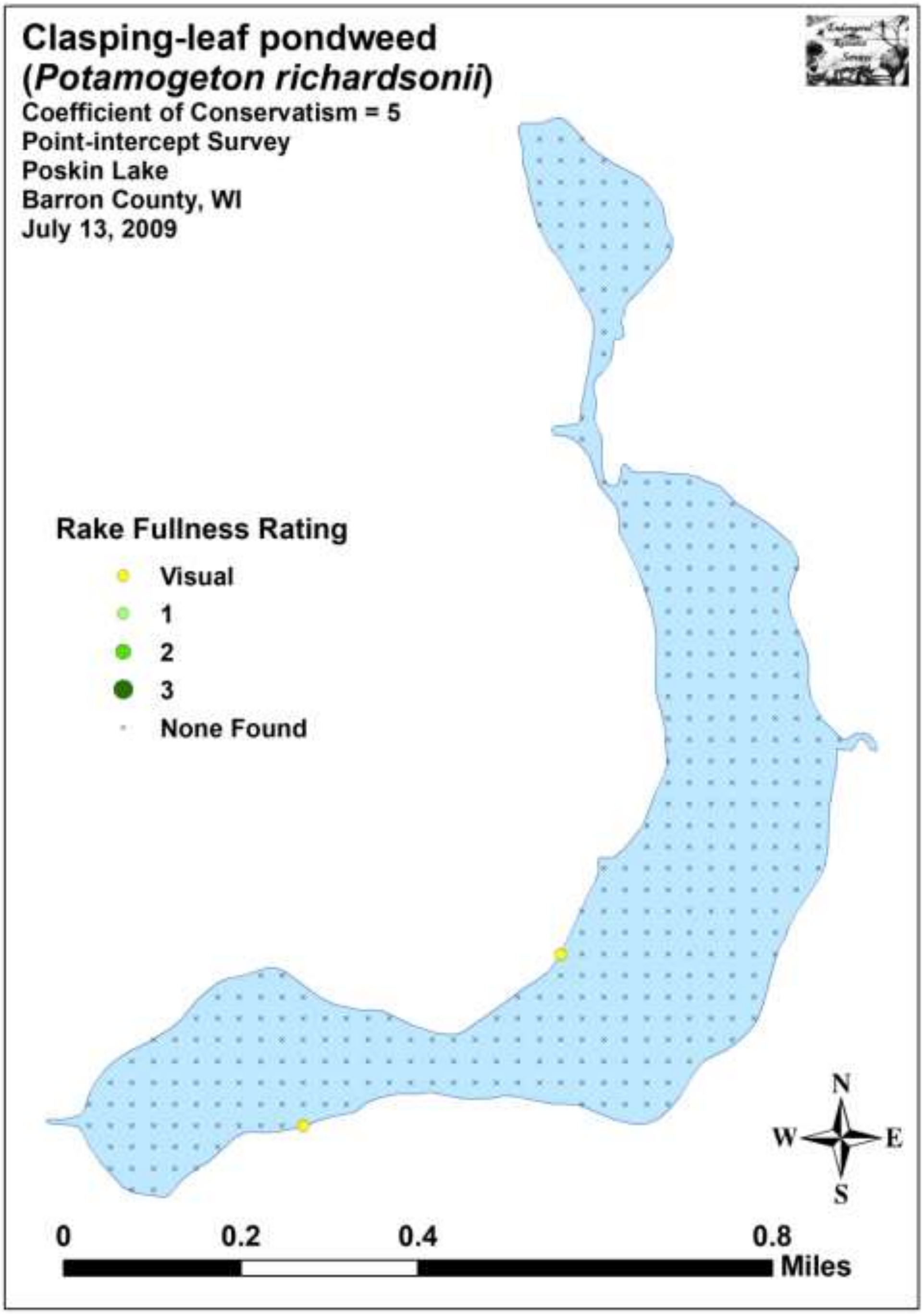
Miles


Clasping-leaf pondweed
(*Potamogeton richardsonii*)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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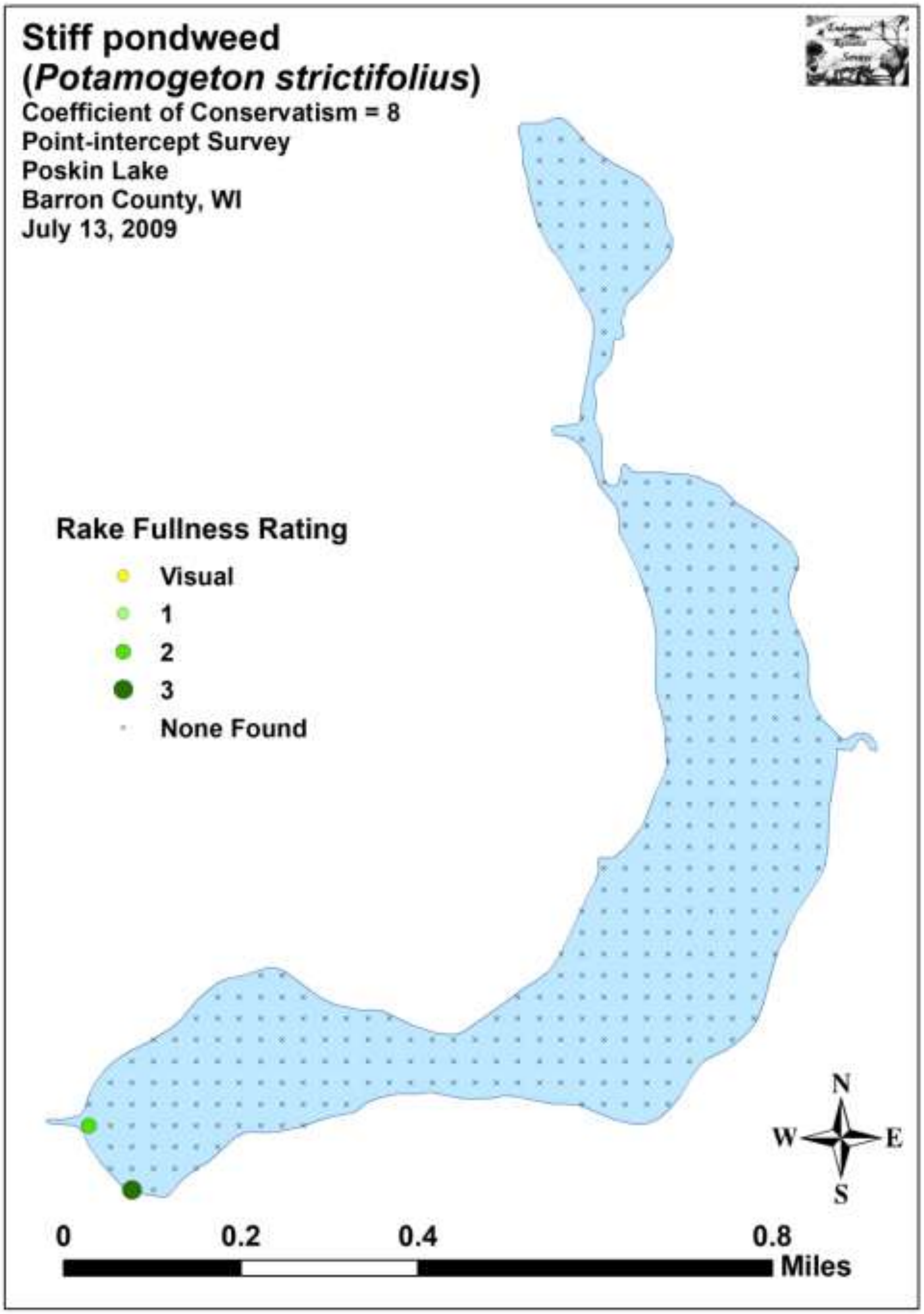
Miles


Stiff pondweed
(*Potamogeton strictifolius*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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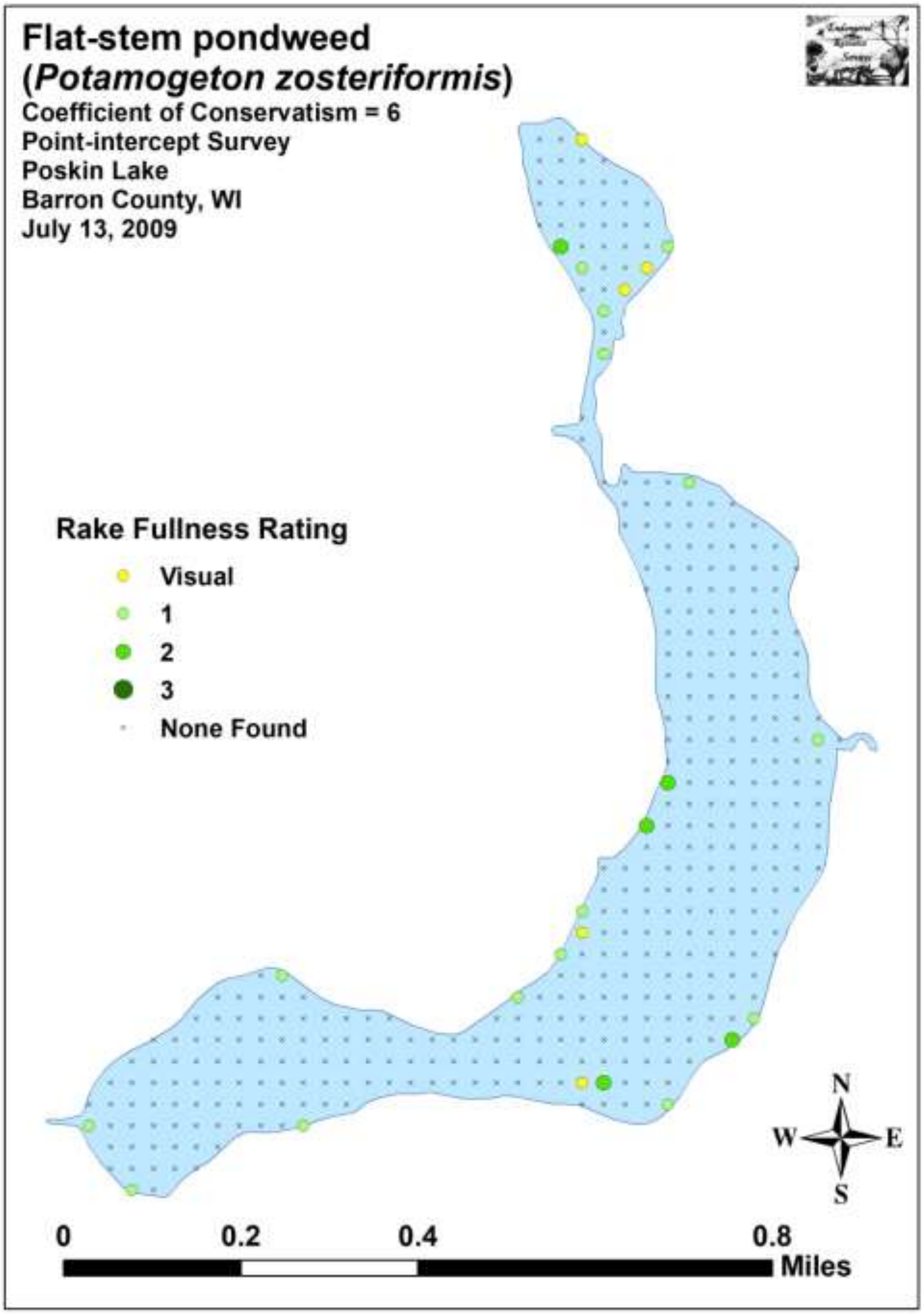
Miles



Flat-stem pondweed
(*Potamogeton zosteriformis*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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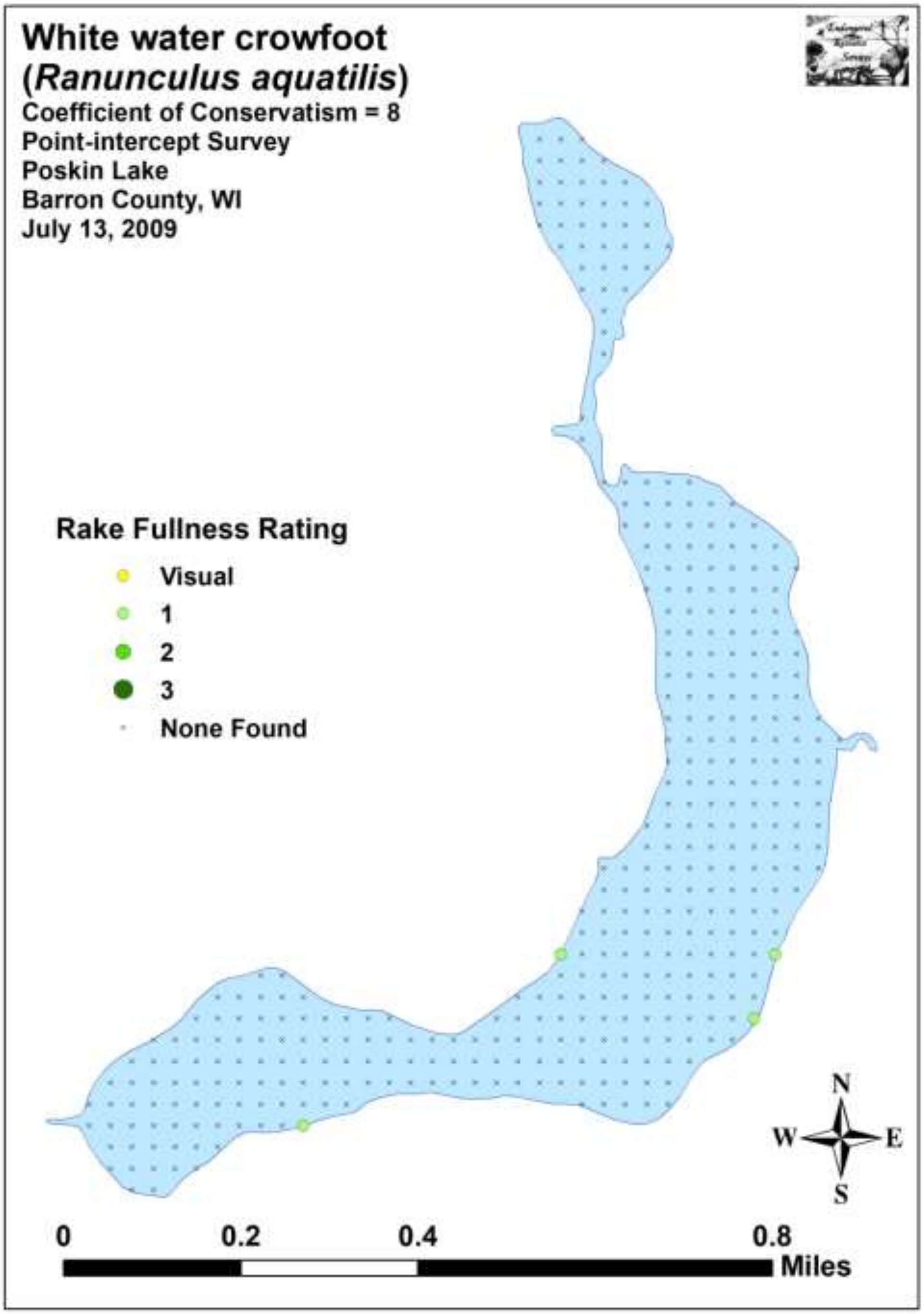
0.2
0.4
0.8
Miles


White water crowfoot
(*Ranunculus aquatilis*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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3
None Found
N
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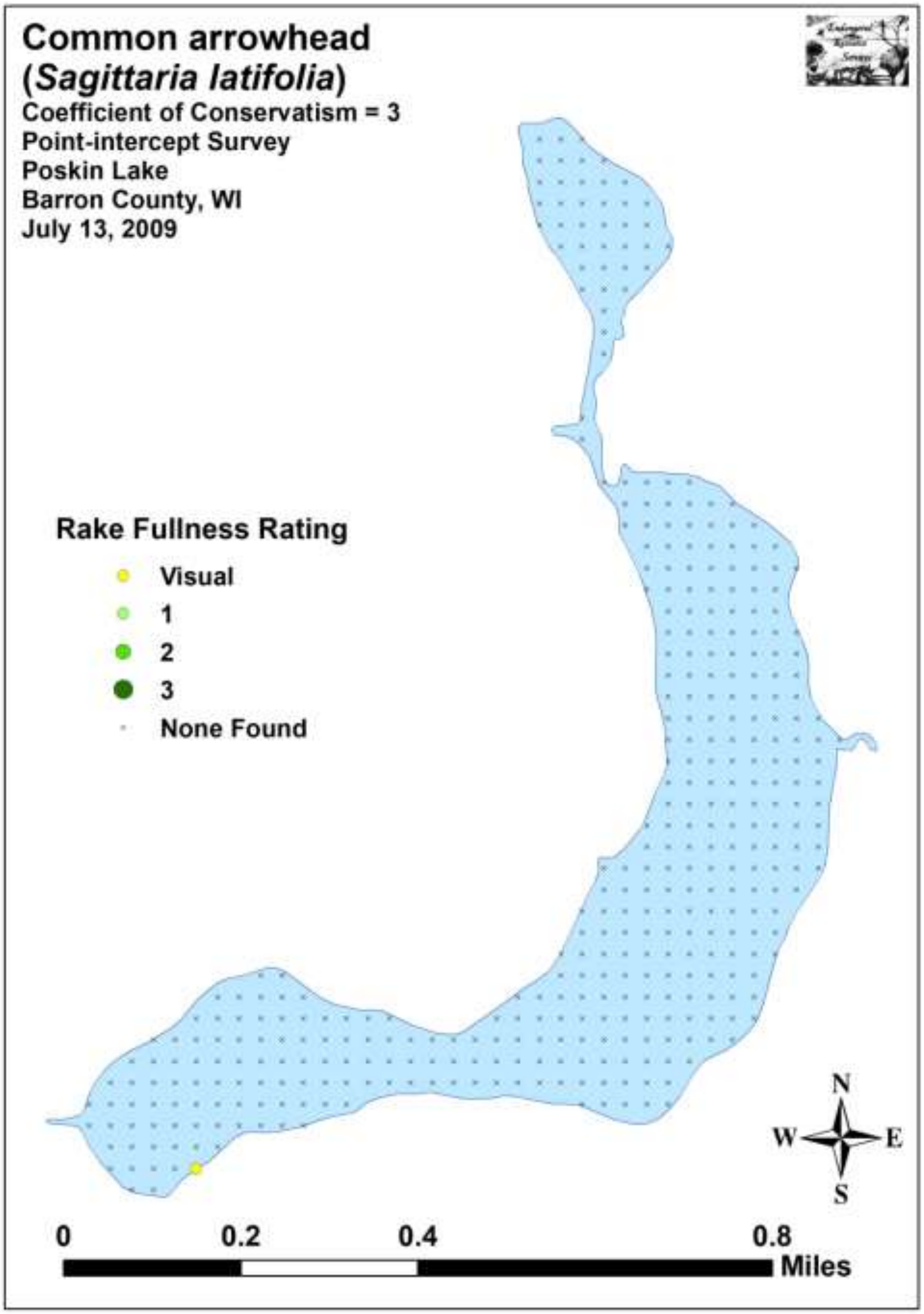
0.2
0.4
0.8
Miles


Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
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None Found
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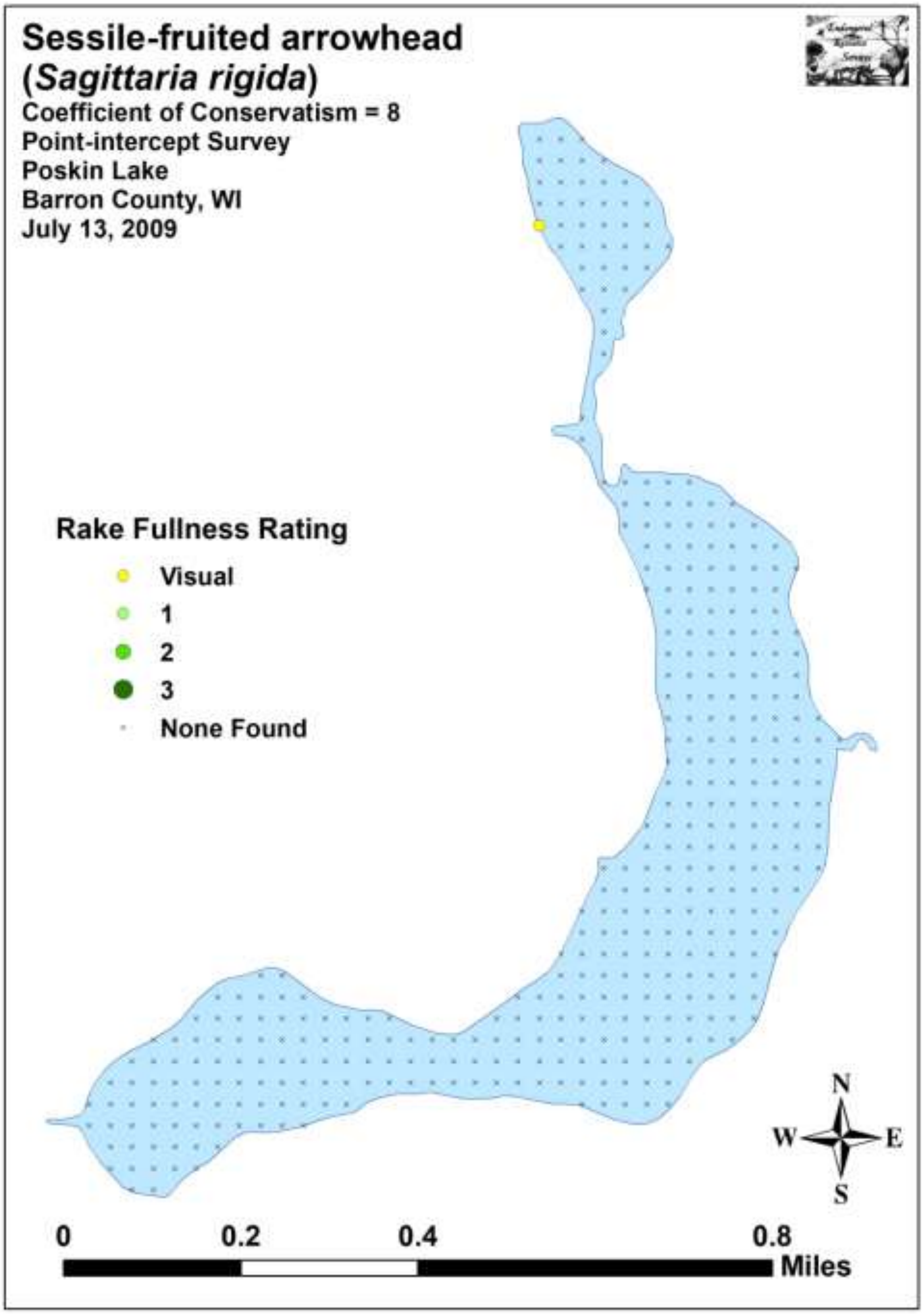
0.4
0.8
Miles


Sessile-fruited arrowhead
(Sagittaria rigida)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
N
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0.4
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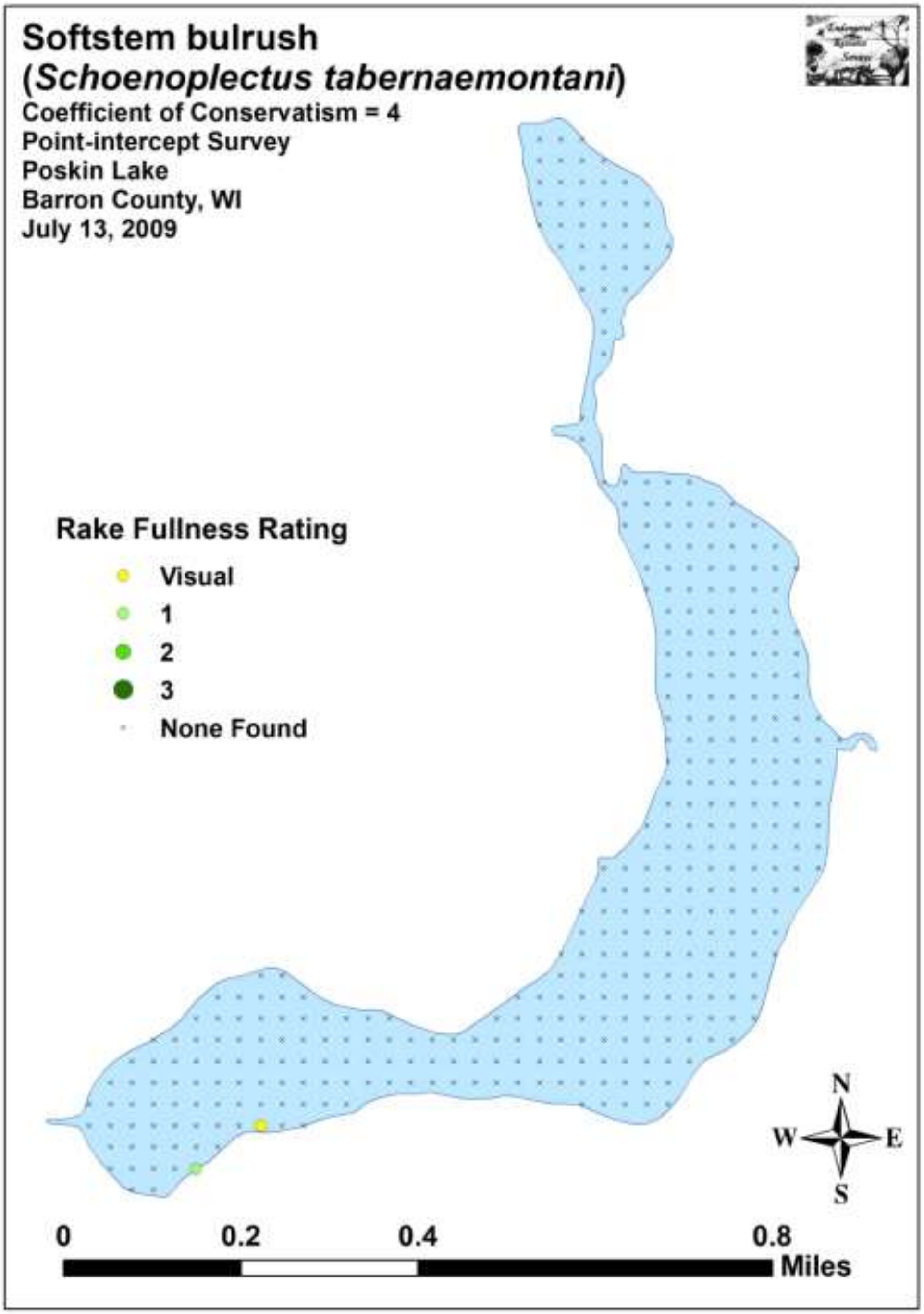
Miles


Softstem bulrush
(*Schoenoplectus tabernaemontani*)
Coefficient of Conservatism = 4
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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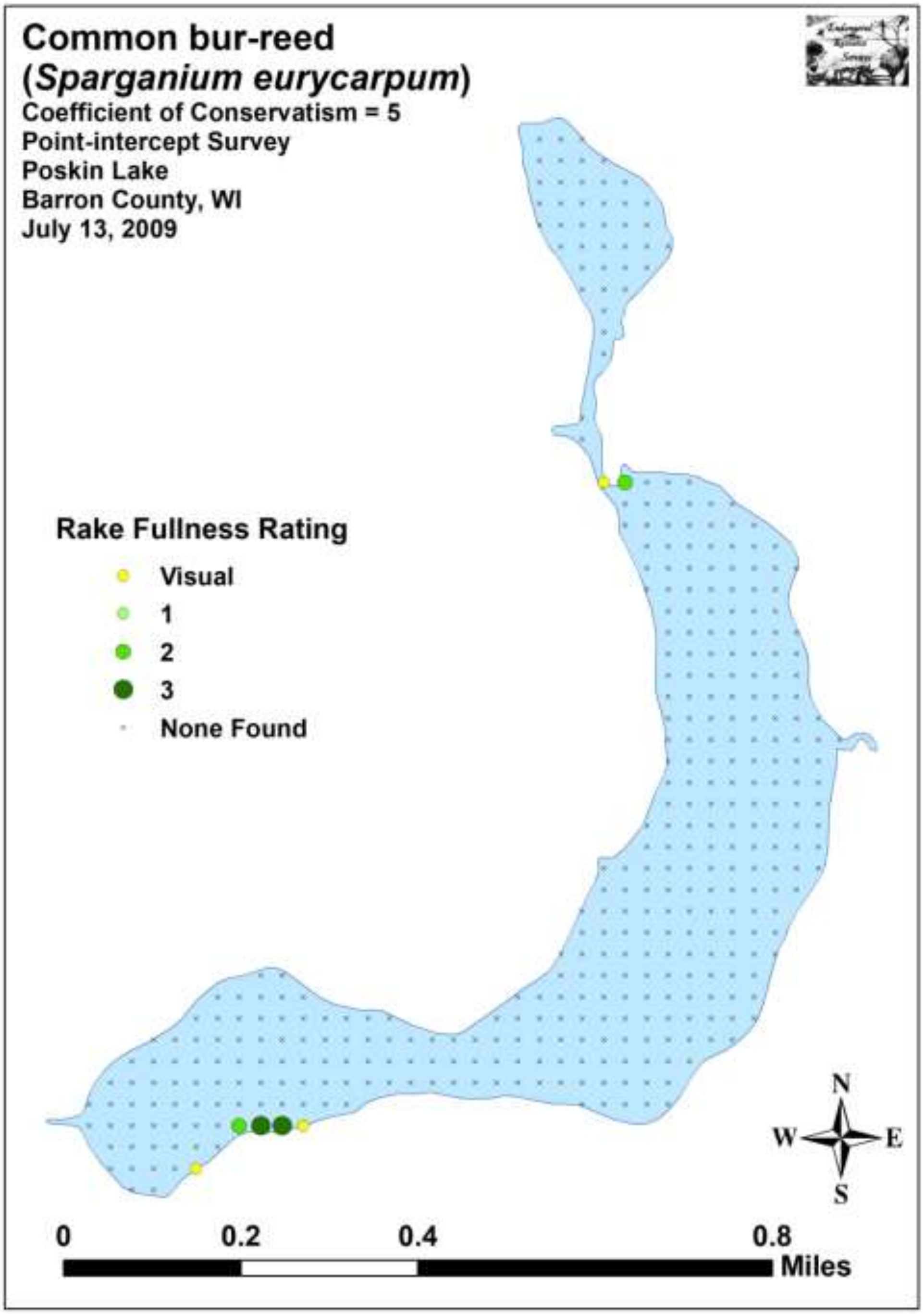
Miles


Common bur-reed
(*Sparganium eurycarpum*)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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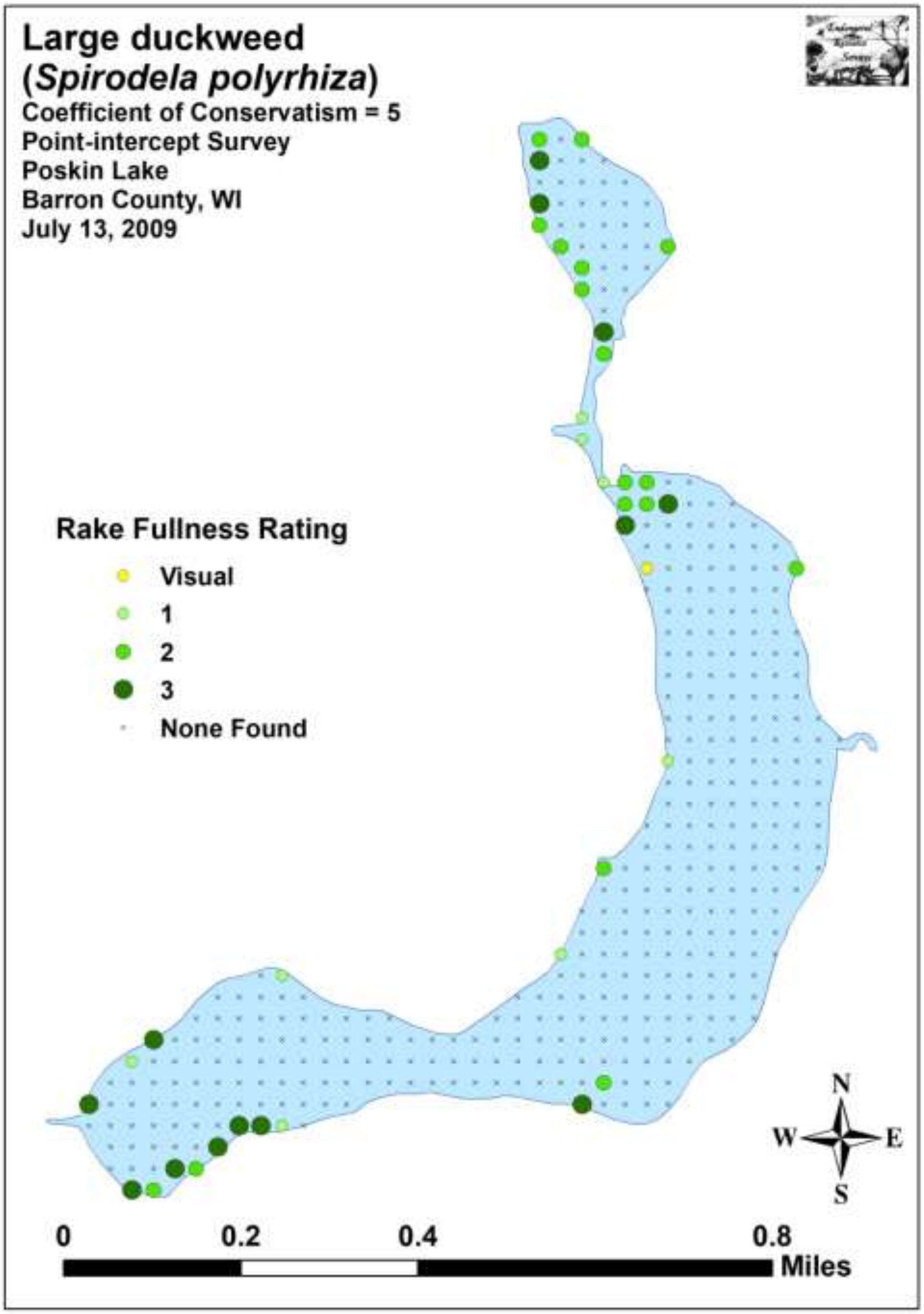
Miles


Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
N
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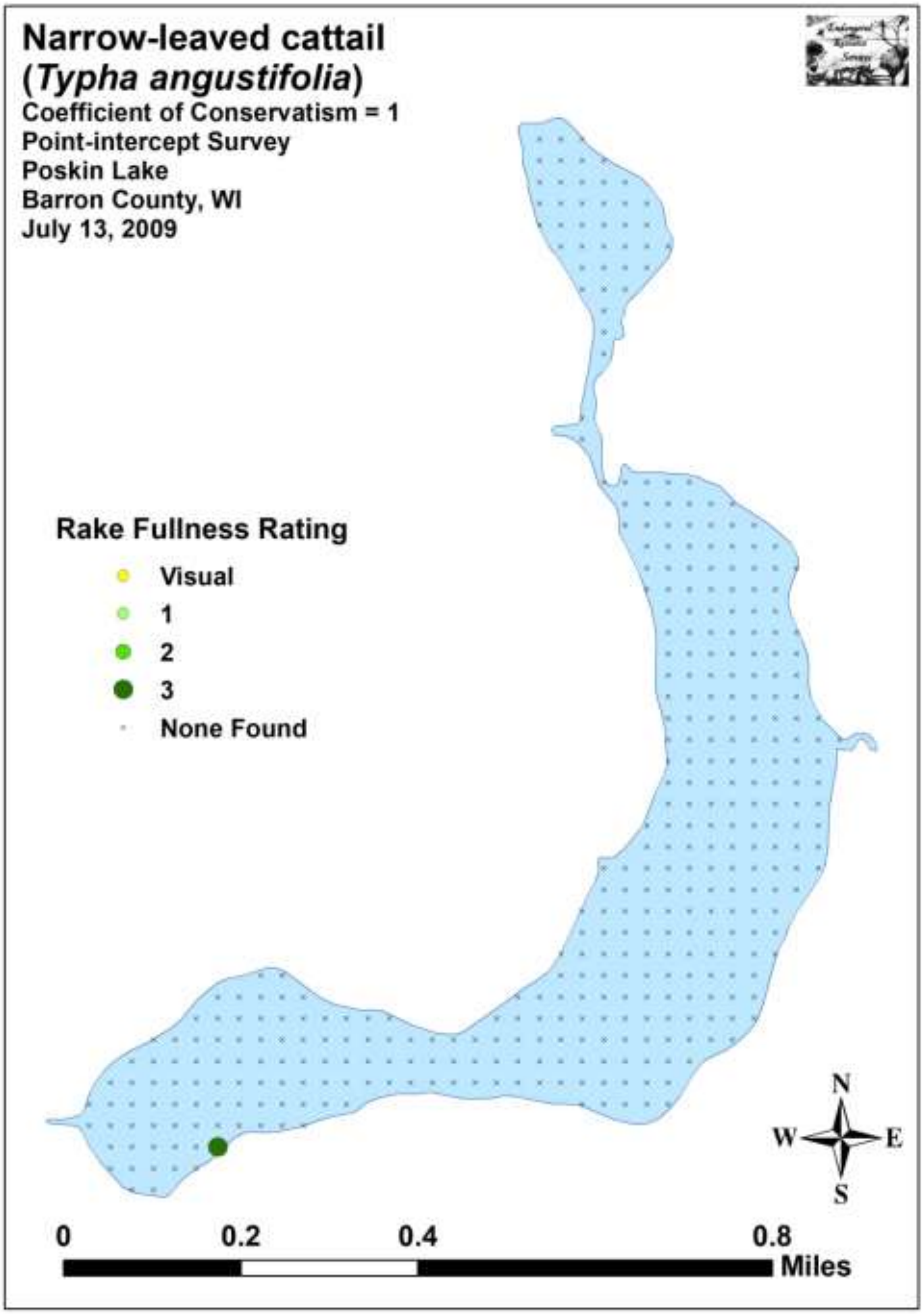
Miles



Narrow-leaved cattail
(*Typha angustifolia*)
Coefficient of Conservatism = 1
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
2
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None Found
N
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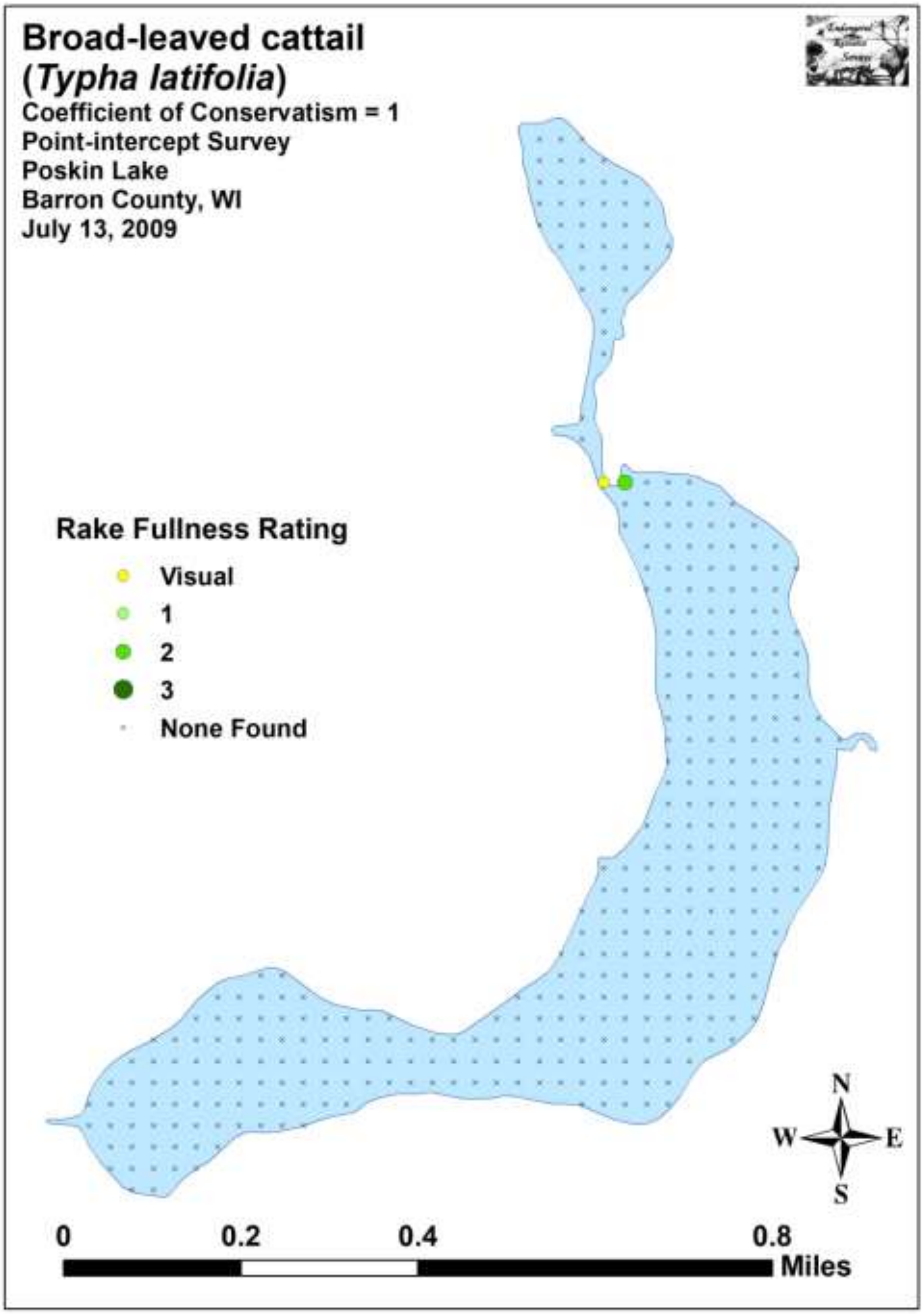
0.8
Miles


Broad-leaved cattail
(*Typha latifolia*)
Coefficient of Conservatism = 1
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
N
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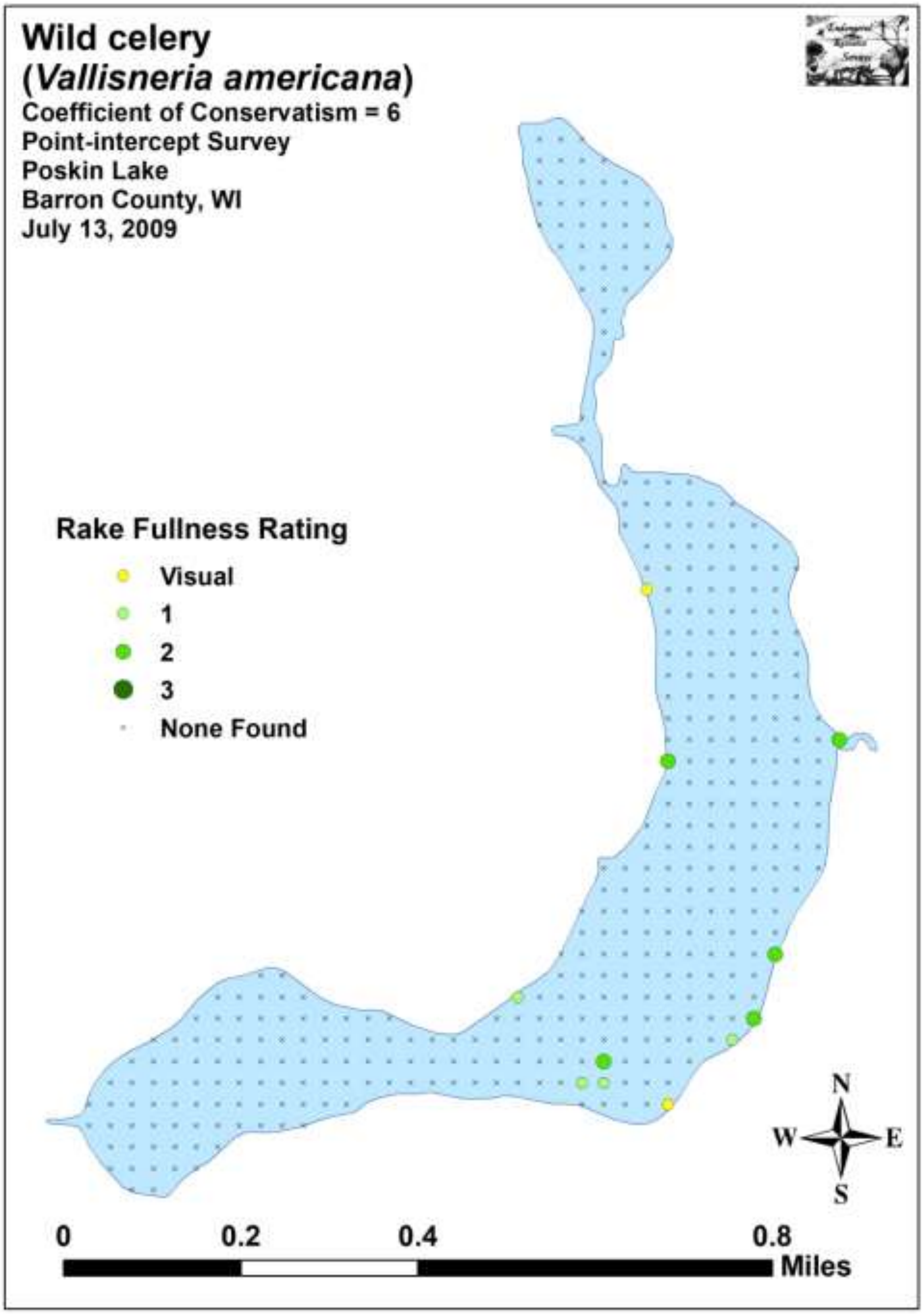
0.8
Miles


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
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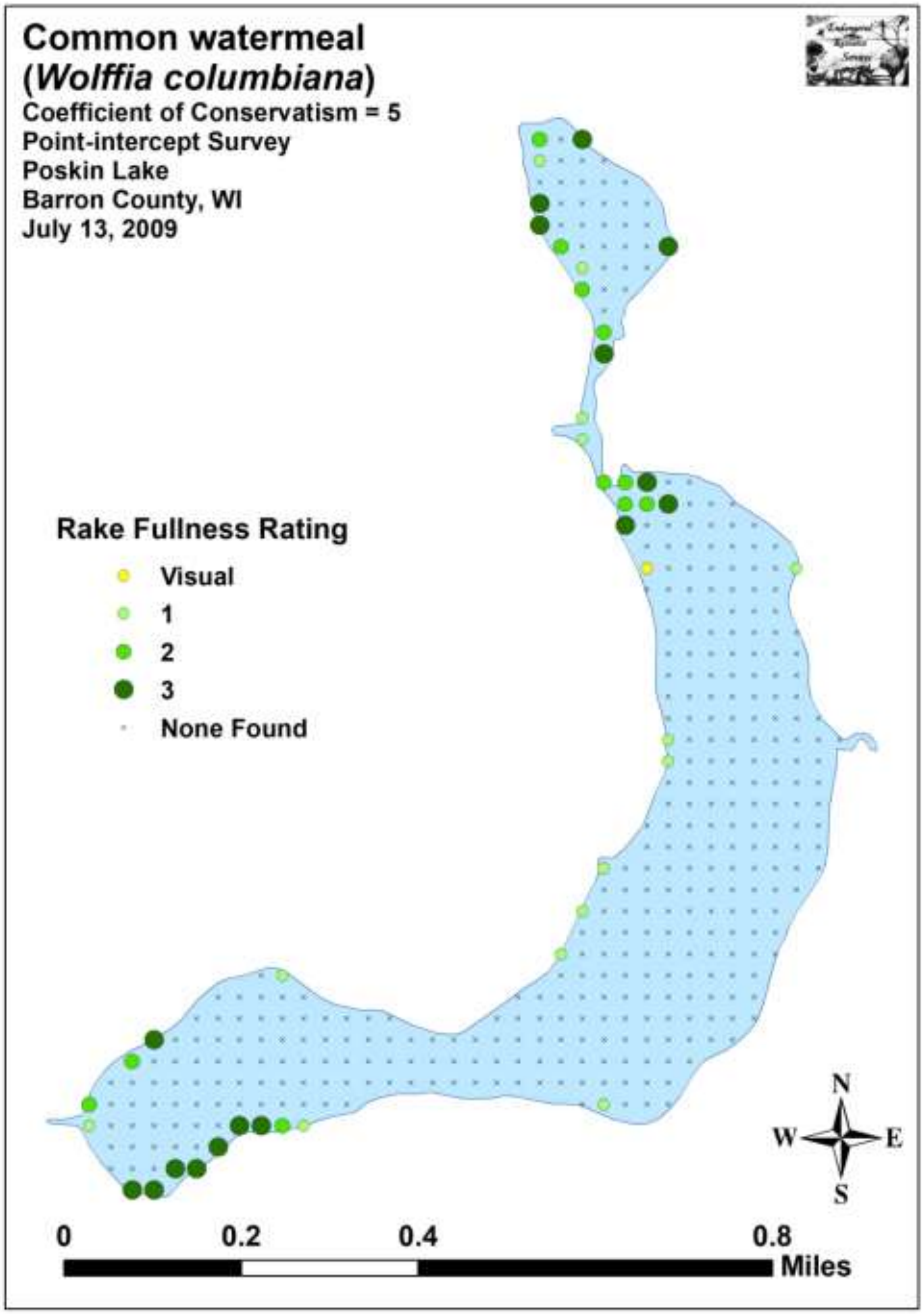
Miles


Common watermeal
(Wolffia columbiana)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
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None Found
N
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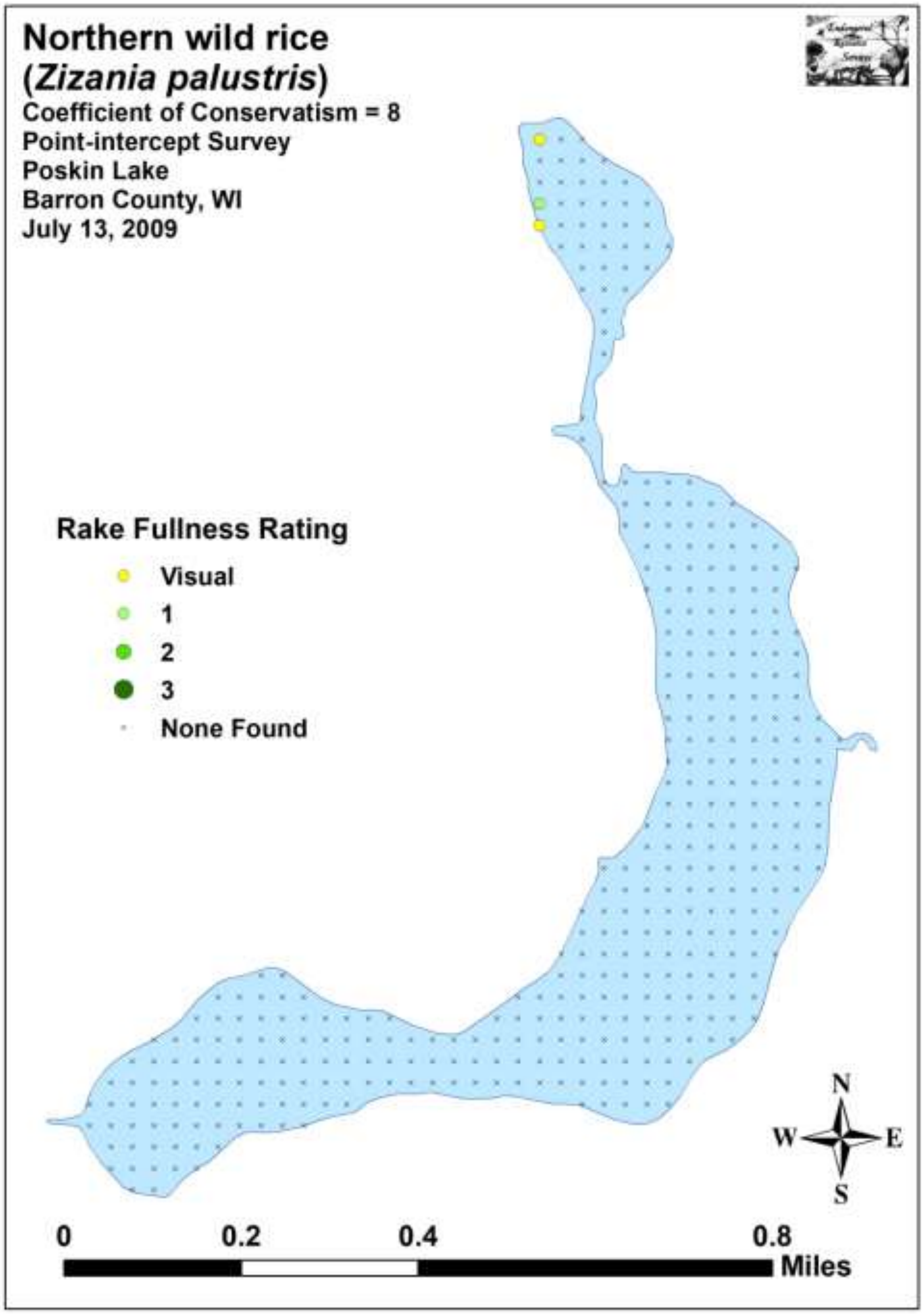
Miles


Northern wild rice
(Zizania palustris)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 13, 2009
Rake Fullness Rating
Visual
1
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None Found
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Miles

Appendix VII: Poskin Lake Plant Species Accounts

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Calla palustris*) **Water arum**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2009-145
Habitat/Distribution: Muck bottom at the shoreline in 0 – 0.25 meters of water. Rare **-** a few scattered individuals were located along shore in the southwest bay, the channel and the north bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Sparganium eurycarpum*) Common bur-reed, (*Phalaris arundinacea*) Reed canary grass

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Callitriche palustris*) **Common water starwort**
Specimen Location: Poskin Lake; N45.43921°, W91.97494°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2009-146
Habitat/Distribution: A single rake of plants was located at the point over a tiny gravel area in the north bay.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Elodea canadensis*) Common waterweed, (*Isoetes echinospora*) Spiny-spored quillwort

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Carex comosa*) **Bottle-brush sedge**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2009-147
Habitat/Distribution: Muck bottom along the shoreline. Uncommon with a few scattered individuals located along shore in the southwest bay, the channel and in the north bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Calla palustris*) Water arum, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Sparganium eurycarpum*) Common bur-reed, (*Phalaris arundinacea*) Reed canary grass

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Poskin Lake; N45.42290°, W91.98434°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2009-148
Habitat/Distribution: Muck bottom in 0-3.5 meters. Abundant in most muck bottom areas of the lake to the point of being invasive at the Vermillion River Inlet and in the southwest bay.
Common Associates: (*Potamogeton crispus*) Curly-leaf pondweed, (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Spirodela polyrhiza*) Large duckweed, (*Wolffia columbiana*) Common watermeal, (*Lemna minor*) Small duckweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2009-149
Habitat/Distribution: Muck bottom in 0.5-2 meters of water.
Uncommon in the main basin of Poskin – common in the north bay, the channel and at the Vermillion River Inlet.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Nymphaea odorata*) White water lily, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Poskin Lake; N45.43259°, W91.97222°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-150
Habitat/Distribution: Firm muck and sandy muck bottoms usually in water < 1 meter deep. Rare – only found at the three rake locations.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail, (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Isoetes echinospora*) **Spiny-spored quillwort**
Specimen Location: Poskin Lake; N45.43921°, W91.97494°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-151
Habitat/Distribution: A single rake of plants was located at the point over a tiny gravel area in the north bay. Spore analysis was used to confirm species.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Elodea canadensis*) Common waterweed, (*Callitriche palustris*) Common water starwort

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Poskin Lake; N45.42394°, W91.98488°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-152
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Common to abundant in the southwest and north bays and near the Vermillion River Inlet.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Wolffia columbiana*) Common watermeal, (*Ceratophyllum demersum*) Coontail

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Lemna trisulca*) **Forked duckweed**
Specimen Location: Poskin Lake; N45.43747°, W91.97388°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-153
Habitat/Distribution: A single specimen was located in the north bay among lilypads.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Myriophyllum sibiricum*) **Northern water-milfoil**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-154
Habitat/Distribution: Muck to sand bottom in water up to 2 meters. Widespread and relatively common on the borders of the main basin.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Ranunculus aquatilis*) Stiff water crowfoot, (*Potamogeton crispus*) Curly-leaf pondweed, (*Najas flexilis*) Slender naiad

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Najas flexilis*) **Slender naiad**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-155
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-1.0 meters of water. Uncommon on the margins of the central basin.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Myriophyllum sibiricum*) Northern water-milfoil

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: Poskin Lake; N45.43294°, W91.97223°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-156
Habitat/Distribution: Muck bottom in 0-1m of water where it often forms dense canopies. It prefers a firmer bottom than (*Nymphaea odorata*) and is more common in sandy areas.
Common Associates: (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Poskin Lake; N45.43294°, W91.97223°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-157
Habitat/Distribution: Muck bottom in 0-1m where it forms dense canopies with other floating leaf species. Common in all calm water bays.
Common Associates: (*Nuphar variegata*) Spatterdock,
(*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-158
Habitat/Distribution: Common but not abundant. Prefers thick muck soil in and out of water <0.5 meters. Primarily found on shore in undeveloped low areas. Present throughout.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Calla palustris*) Water arum, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Sparganium eurycarpum*) Common bur-reed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Poskin Lake; N45.43821°, W91.97192°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-159
Habitat/Distribution: Found growing over firm muck in 1-2 meters of water. Rare - restricted to the north bay at the edge of wild rice areas.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton praelongus*) White-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton crispus*) **Curly-leaf pondweed**
Specimen Location: Poskin Lake; N45.42290°, W91.98434°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-160
Habitat/Distribution: Found in most mucky bottom areas in water from 1-2m deep. Relatively common and widely distributed throughout in the May survey, but rare by the time of the July survey. The only sizable monotypic bed occurred on the north end of the main basin near the Vermillion River Inlet.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Nymphaea odorata*) White water lily

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton nodosus*) **Long-leaf pondweed**
Specimen Location: Poskin Lake; N45.43398°, W91.97277°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-161
Habitat/Distribution: Plants restricted to the channel between the north bay and the main basin. This species is more typical of rivers and apparently the water flow it prefers/requires is met at this location.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton obtusifolius*) **Blunt-leaf pondweed?**
Specimen Location: Poskin Lake; N45.43432°, W91.97328°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-162
Habitat/Distribution: A single patch of plants was growing just off the channel near the point. It seems too small for this species, but it is not like any other member of the "pusillus" group I have ever seen. If not *obtusifolius*, I would guess it is a *pusillus* X *obtusifolius* hybrid. Leaves have distinct lacunar cells, are five veined, slightly reddish at the node, and have small glands. They are narrower than typical *obtusifolius*, but fall in at the bottom range Voss gives for the species. They are also much brighter green than any other *obtusifolius* I have seen. The stipules seem to be obtusifolius-like in that they are fleshy, opaque and sheath the stem. Unfortunately, no plants were in fruit.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton nodosus*) Long-leaf pondweed, (*Elodea canadensis*) Common waterweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton praelongus*) **White-stem pondweed**
Specimen Location: Poskin Lake; N45.43749°, W91.97289°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-163
Habitat/Distribution: Found growing over firm muck in 1-2 meters of water. Restricted to the north bay at the edge of wild rice areas.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-164
Habitat/Distribution: Uncommon over sandy muck. Scattered in water <1m deep.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Najas flexilis*) Slender naiad

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-165
Habitat/Distribution: Found in sandy/muck bottom conditions in shallow water 0.5-1.0 meter deep. Relatively common and widespread throughout the main basin.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Elodea canadensis*) Common waterweed, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Najas flexilis*) Slender naiad

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton strictifolius*) **Stiff pondweed**
Specimen Location: Poskin Lake; N45.42256°, W91.98383°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-166
Habitat/Distribution: Restricted to the southwest bay where we found several large patches growing in shallow water <1m deep over muck. Narrow, pointed leaves with 3 veins and slightly curled under margins, much branched top leaves, 9mm flower stalk, achenes with little beak and a noticeable indent along the margin distinguished this from *pusillus*. That said, it was much smaller than other *strictifolius* I've seen.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Poskin Lake; N45.42368°, W91.97988°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-167
Habitat/Distribution: It prefers substrate of thick organic muck. Widely distributed throughout and common in all suitable habitat.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Potamogeton crispus*) Curly-leaf pondweed, (*Nymphaea odorata*) White water lily

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Ranunculus aquatilis*) **Stiff water crowfoot**
Specimen Location: Poskin Lake; N45.42659°, W91.97400°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-168
Habitat/Distribution: Widely distributed in shoreline areas around the central basin. Uncommon in water <1m over sand, rock and sandy muck.
Common Associates: (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton pusillus*) Small pondweed, (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad, (*Ceratophyllum demersum*) Coontail

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-169
Habitat/Distribution: Uncommon in scattered mucky shoreline.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Sparganium eurycarpum*) Common bur-reed, (*Phalaris arundinacea*) Reed canary grass, (*Calla palustris*) Water arum

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Sagittaria rigida*) **Sessile-fruited arrowhead**
Specimen Location: Poskin Lake; N45.43294°, W91.97223°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-170
Habitat/Distribution: A nearly monotypic bed of emergents was growing at the shore at the point. A few other individuals were scattered throughout the north bay growing over firm muck.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Schoenoplectus acutus*) **Hardstem bulrush**
Specimen Location: Poskin Lake; N45.43235°, W91.96895°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-171
Habitat/Distribution: Firm rock/sand bottoms in 0-.25m of water. A few bulrush beds occurred on the east side of the lake just north of the Vermillion River Outlet.
Common Associates: (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-172
Habitat/Distribution: Firm muck bottoms in 0-.25m of water. Scattered individuals were interspersed with cattails and bur-reeds.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Calla palustris*) Water arum, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Sparganium eurycarpum*) Common bur-reed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Sparganium eurycarpum*) **Common bur-reed**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-173
Habitat/Distribution: Fairly common in scattered undeveloped mucky shoreline locations; especially in the southwest bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Calla palustris*) Water arum, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Spirodela polyrhiza*) **Large duckweed**
Specimen Location: Poskin Lake; N45.42394°, W91.98488°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-174
Habitat/Distribution: Located floating at or just under the surface in stagnant bays. Common to abundant in the southwest and north bays and near the Vermillion River Inlet.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Wolffia columbiana*) Common watermeal, (*Lemna minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Typha angustifolia*) **Narrow-leaved cattail**
Specimen Location: Poskin Lake; N45.42329°, W91.98186°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-175
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. A single patch occurred in the southwest bay at the point.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Calla palustris*) Water arum, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Sparganium eurycarpum*) Common bur-reed

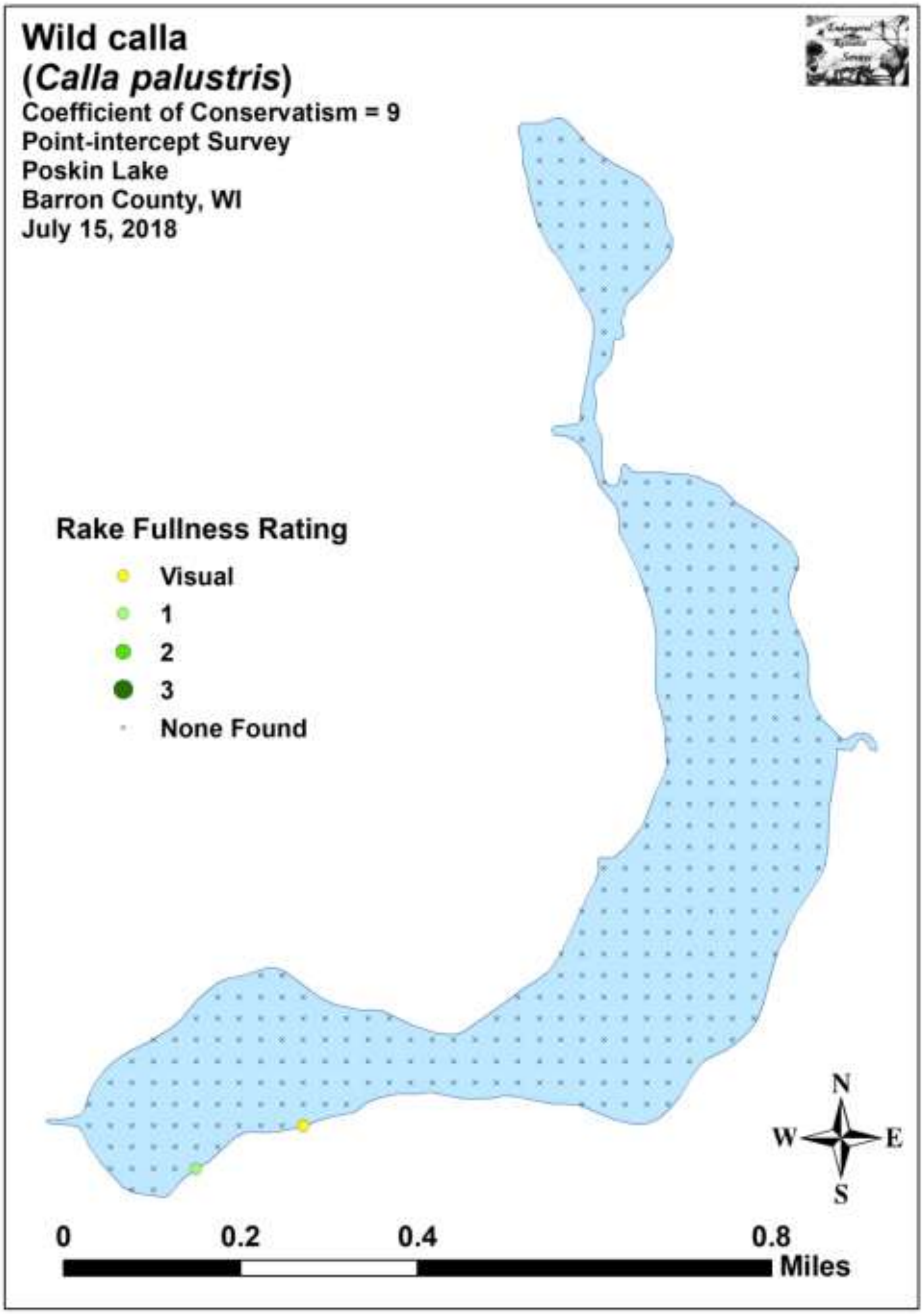
County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Poskin Lake; N45.42293°, W91.98235°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-176
Habitat/Distribution: Thick muck soil in and out of water <0.5 meters. Found in scattered undeveloped shoreline areas throughout.
Common Associates: (*Calla palustris*) Water arum, (*Typha angustifolia*) Narrow-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Sparganium eurycarpum*) Common bur-reed

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Poskin Lake; N45.42979°, W91.97162°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-177
Habitat/Distribution: Found in almost any bottom conditions, but grows best in sandy to sand/muck rock bottoms in 0.5-1.0 meters of water. Common and widely distributed on the borders of the main basin.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Myriophyllum sibiricum*) Northern water-milfoil

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Wolffia columbiana*) **Common watermeal**
Specimen Location: Poskin Lake; N45.42394°, W91.98488°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-178
Habitat/Distribution: Located floating at or just under the surface in stagnant bays among lilypads. Common to abundant in the southwest and north bays and near the Vermillion River Inlet.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Lemna minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail

County/State: Barron County, Wisconsin **Date:** 7/13/09
Species: (*Zizania palustris*) **Northern wild rice**
Specimen Location: Poskin Lake; N45.43921°, W91.97494°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2009-179
Habitat/Distribution: Restricted to the north bay. All plants had been clipped by geese making it seem doubtful any will produce seeds.
Common Associates: (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum*) Coontail, (*Nuphar variegata*) Spatterdock, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed

Appendix VIII: July 2018 Species Density and Distribution Maps


Wild calla
(*Calla palustris*)
Coefficient of Conservatism = 9
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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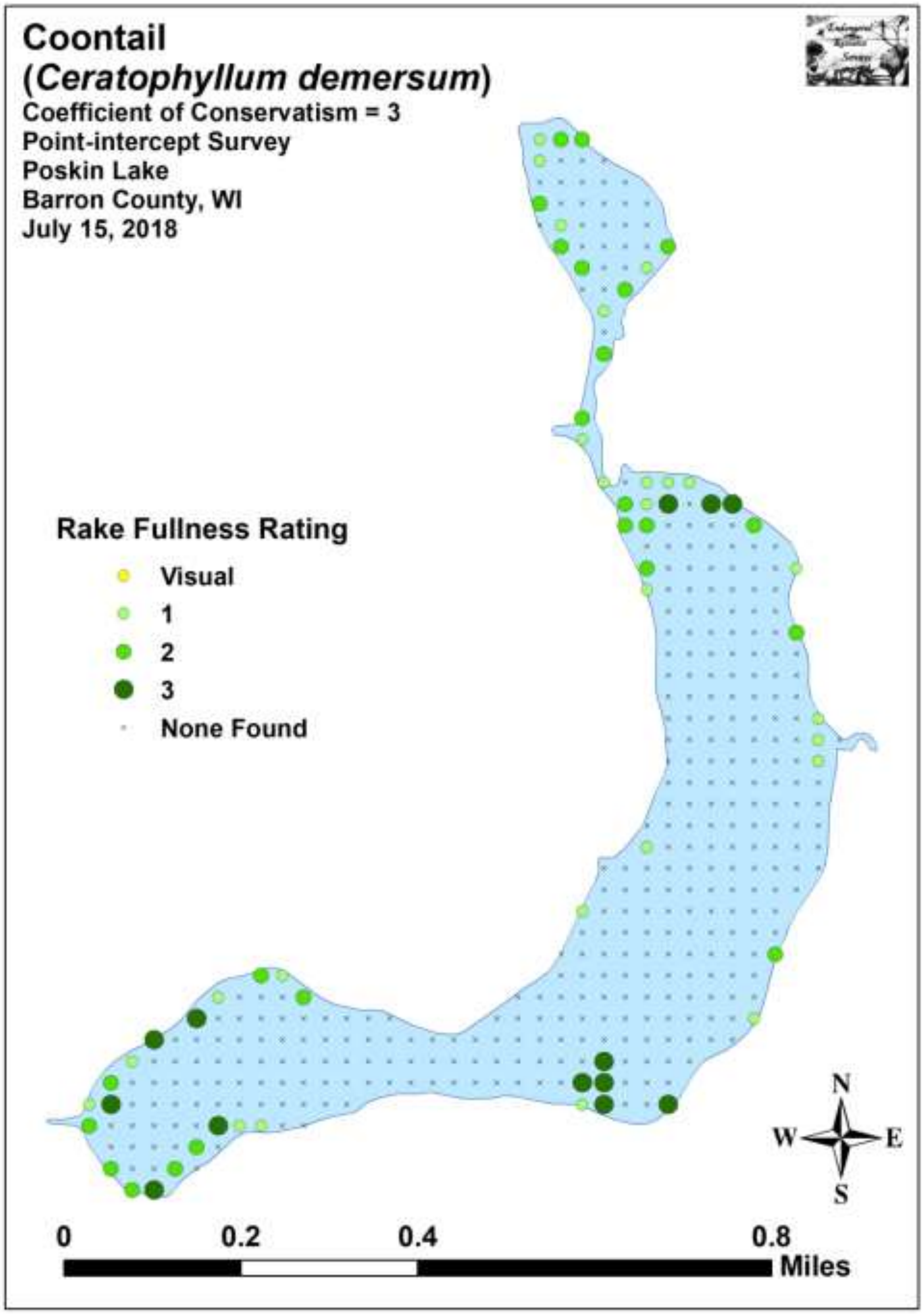
0
0.2
0.4
0.8
Miles



Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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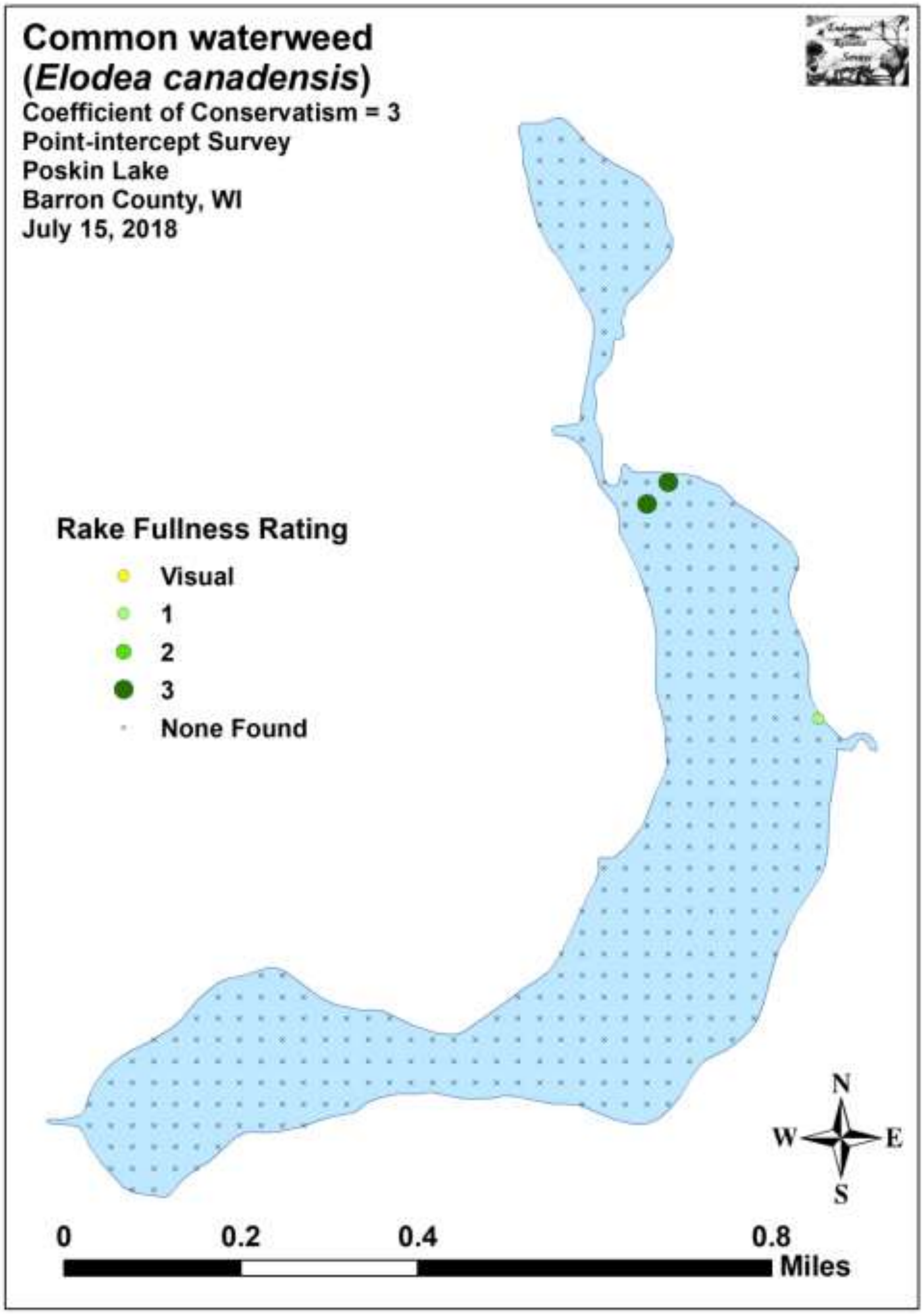
0
0.2
0.4
0.8
Miles


Common waterweed
(*Elodea canadensis*)
Coefficient of Conservatism = 3
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
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W
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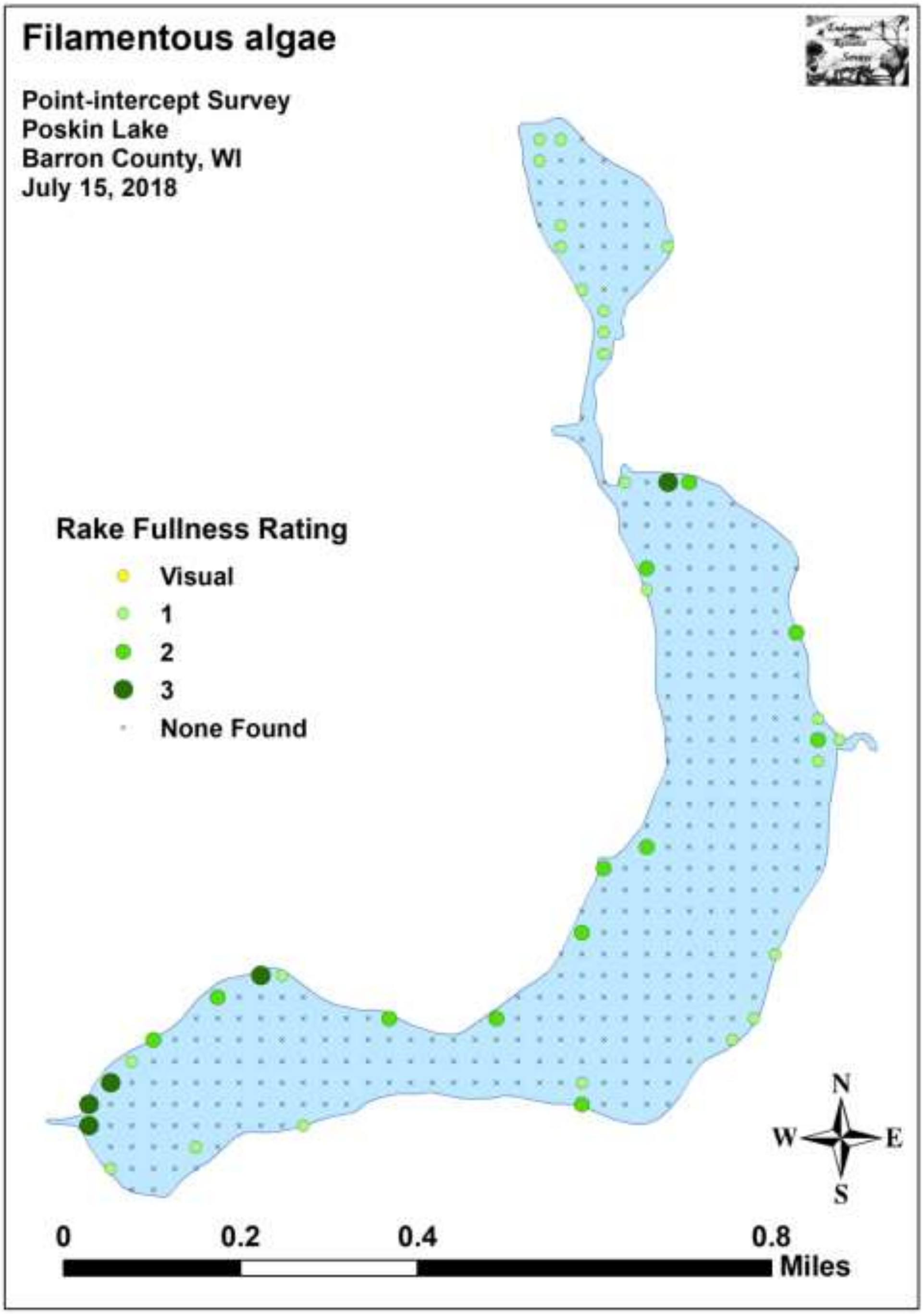
0.2
0.4
0.8
Miles


Filamentous algae
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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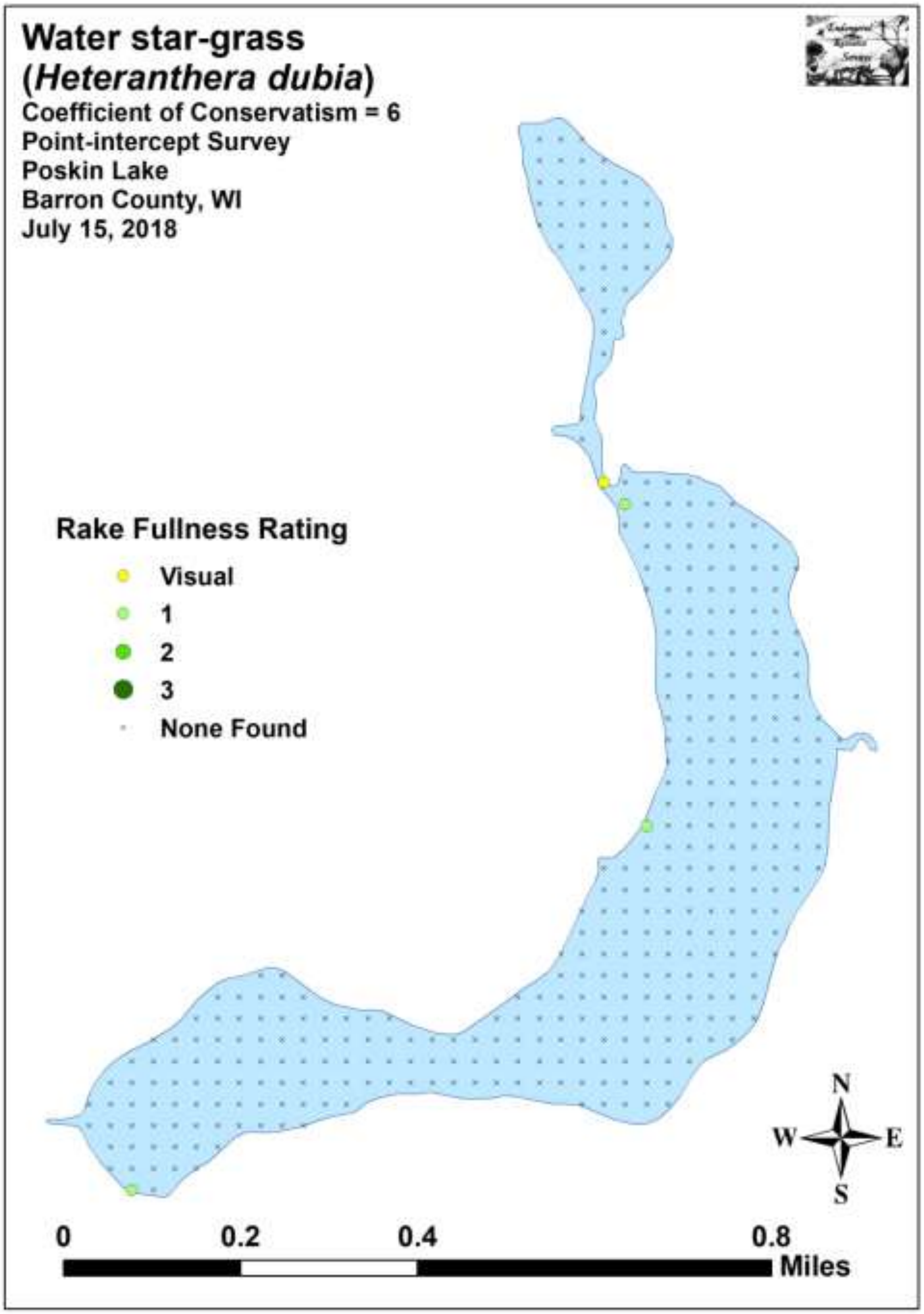
0.2
0.4
0.8
Miles


Water star-grass
(*Heteranthera dubia*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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3
None Found
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W
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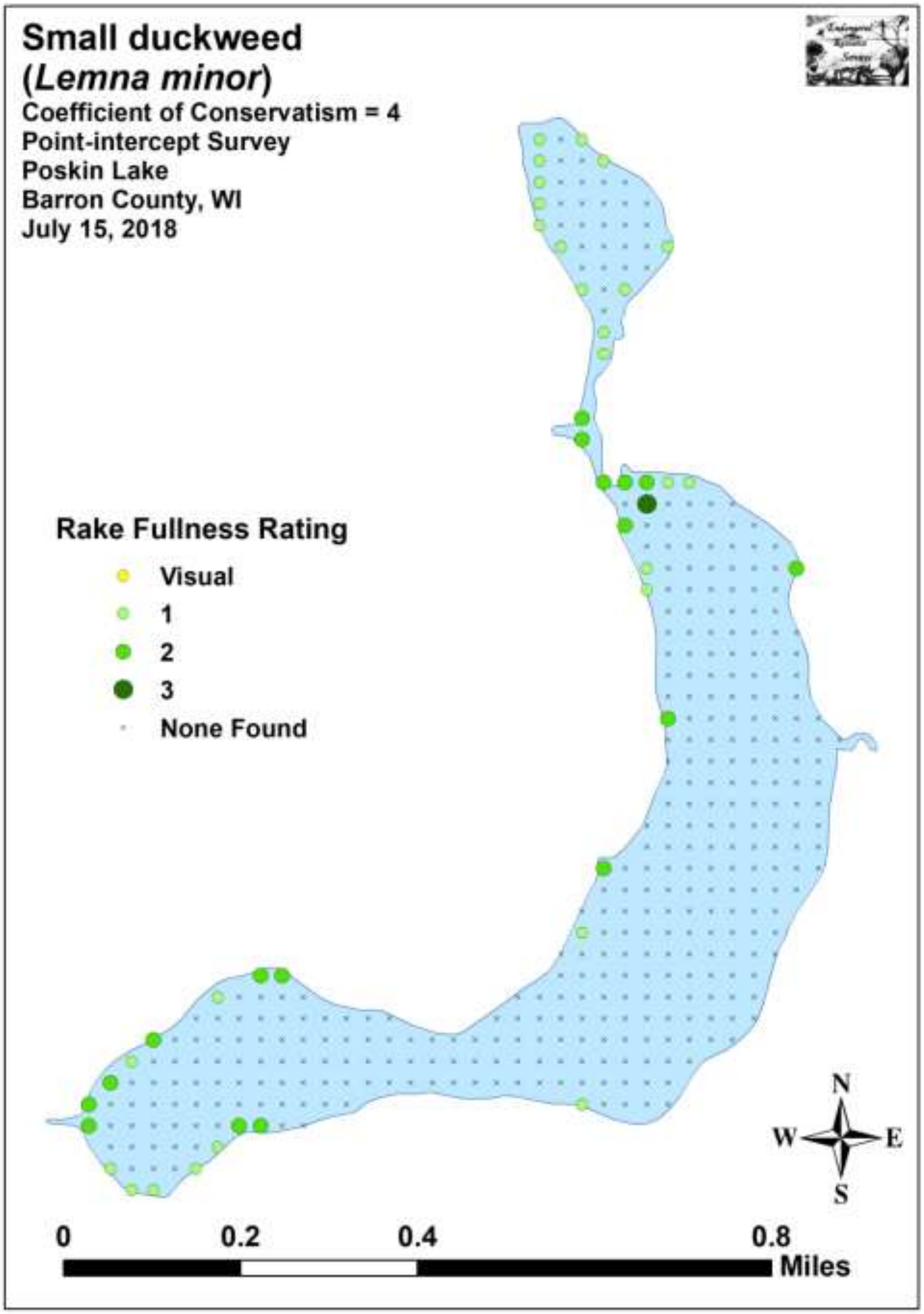
0.2
0.4
0.8
Miles


Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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None Found
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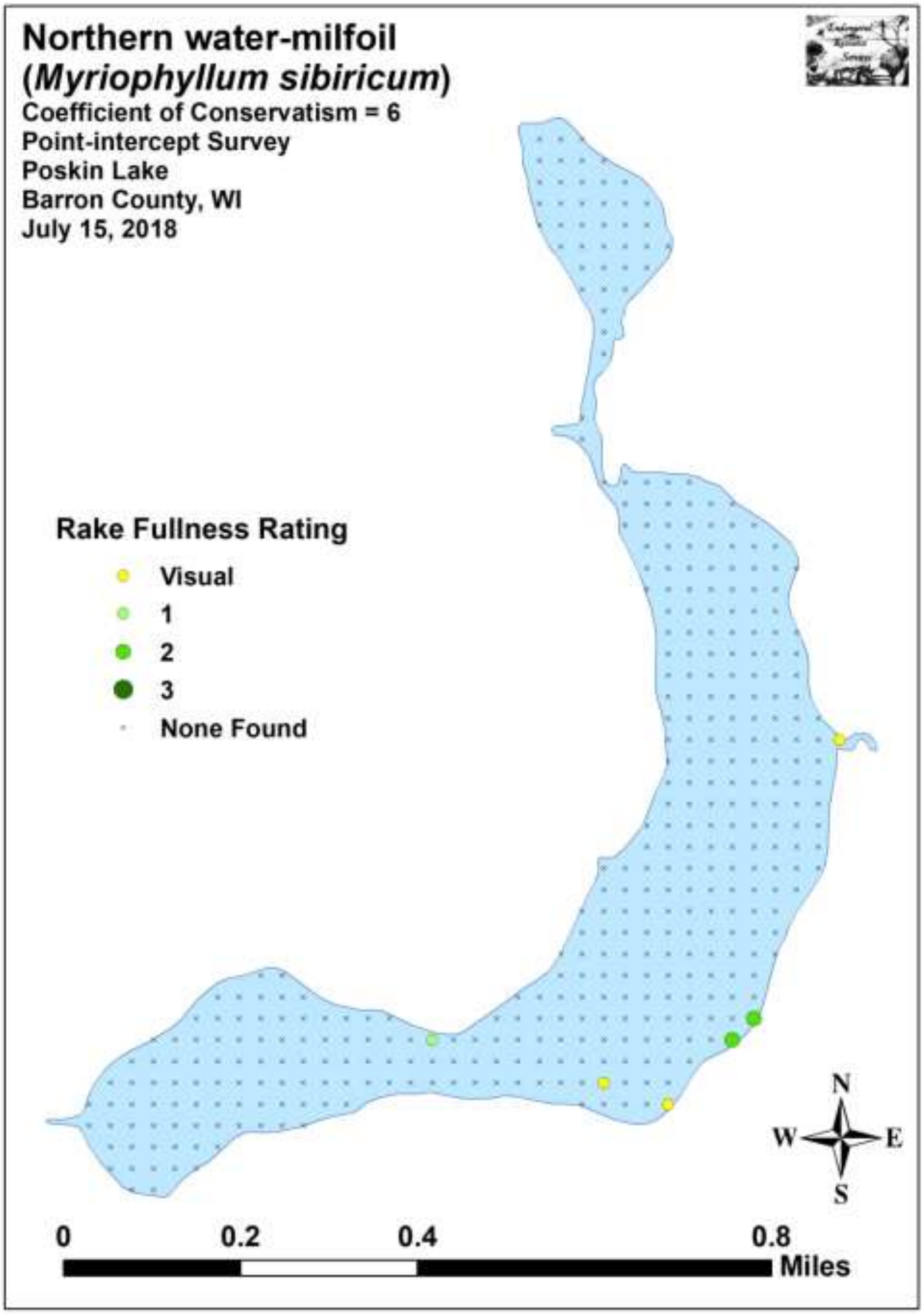
Miles



Northern water-milfoil
(*Myriophyllum sibiricum*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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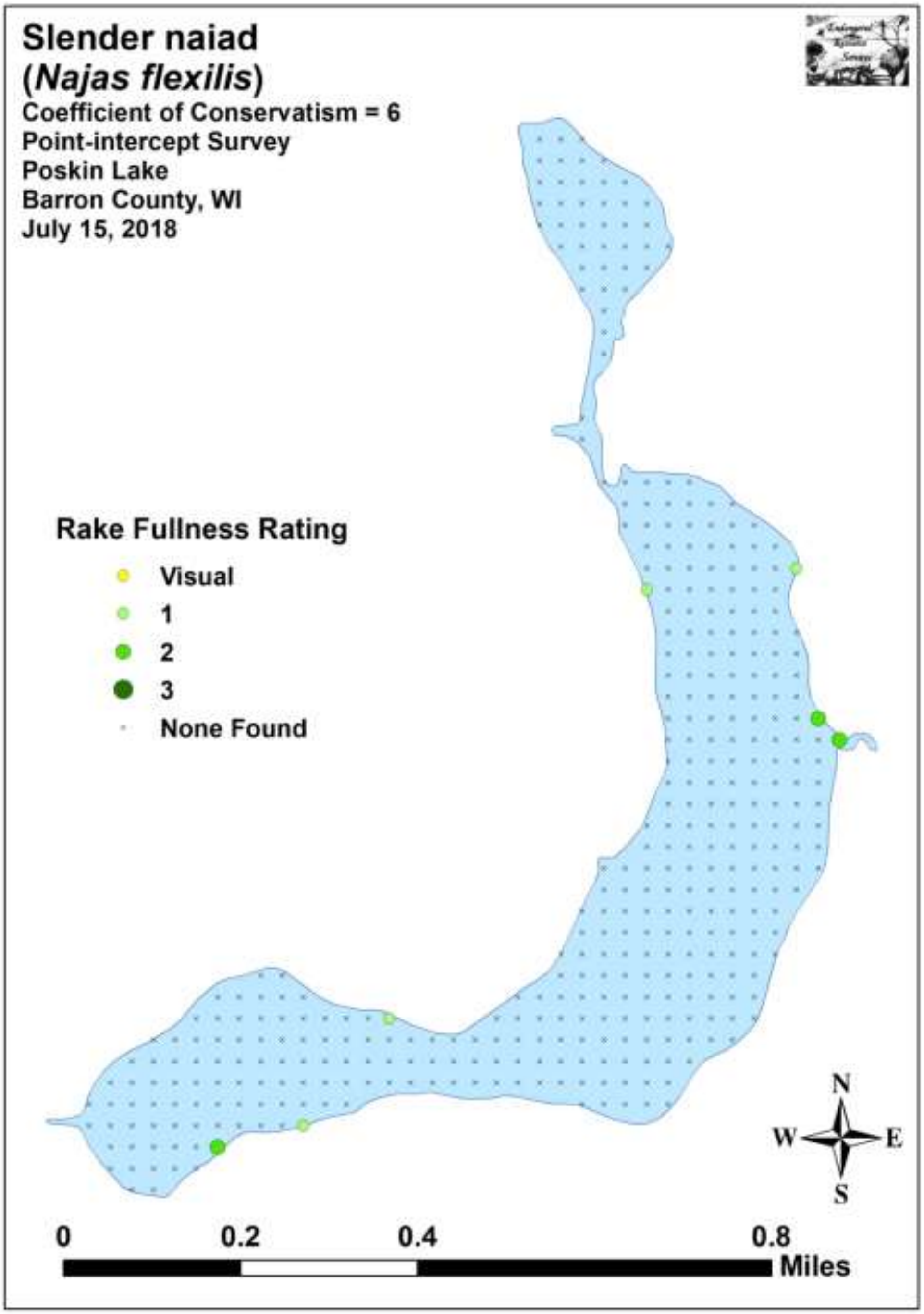
0.2
0.4
0.8
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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None Found
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0.2
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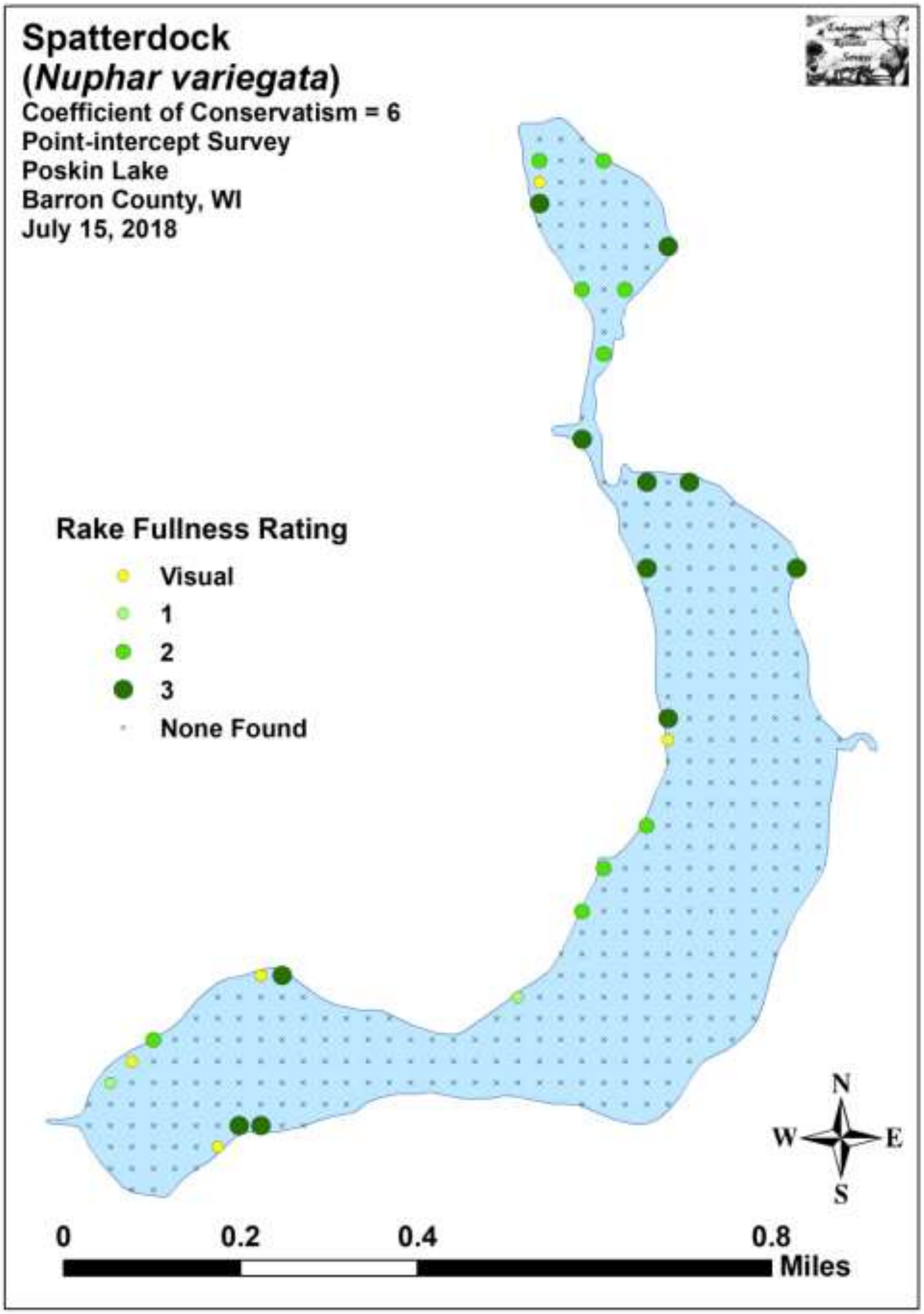
Miles


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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0.2
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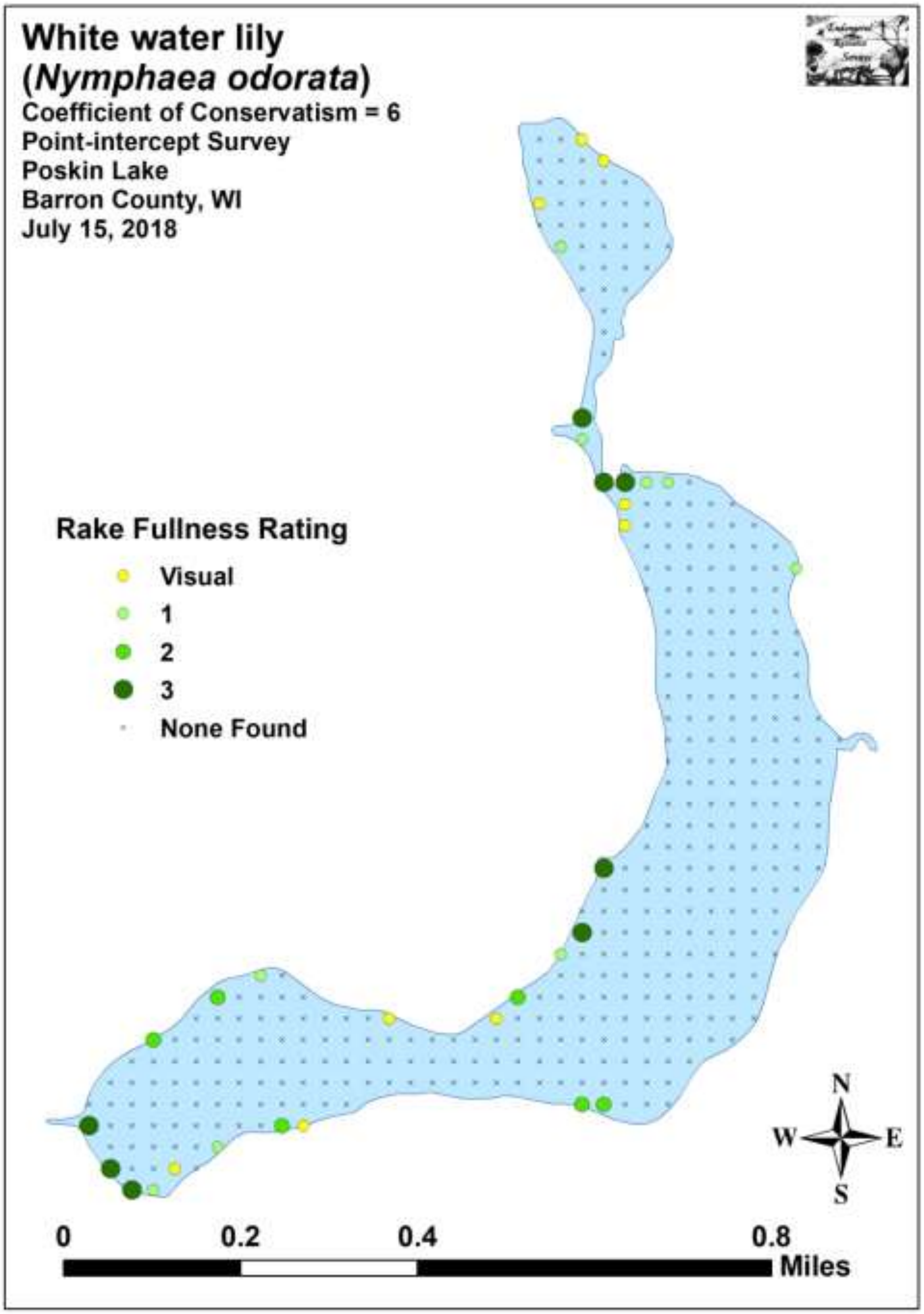
Miles


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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None Found
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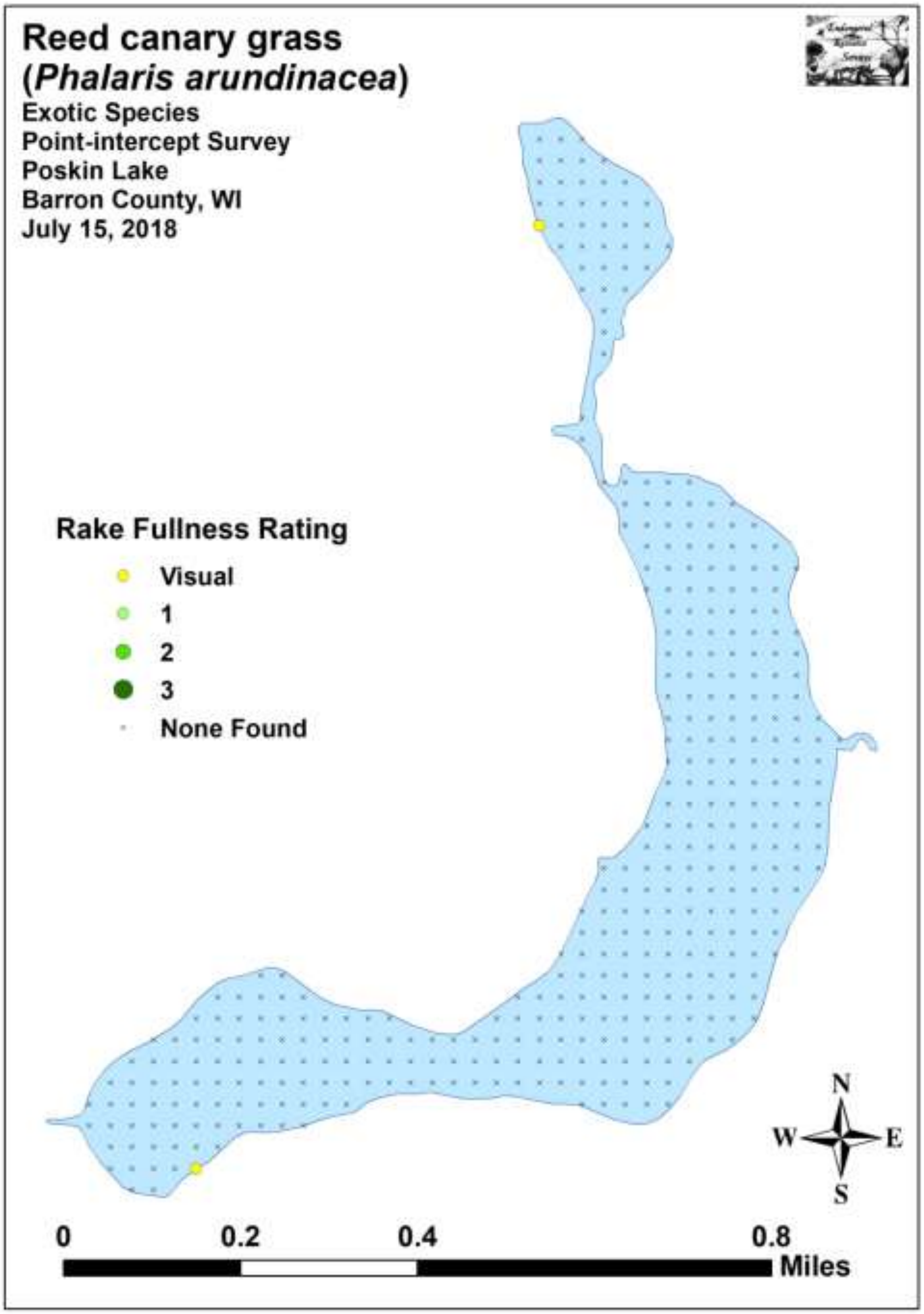
0.2
0.4
0.8
Miles


Reed canary grass
(*Phalaris arundinacea*)
Exotic Species
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
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None Found
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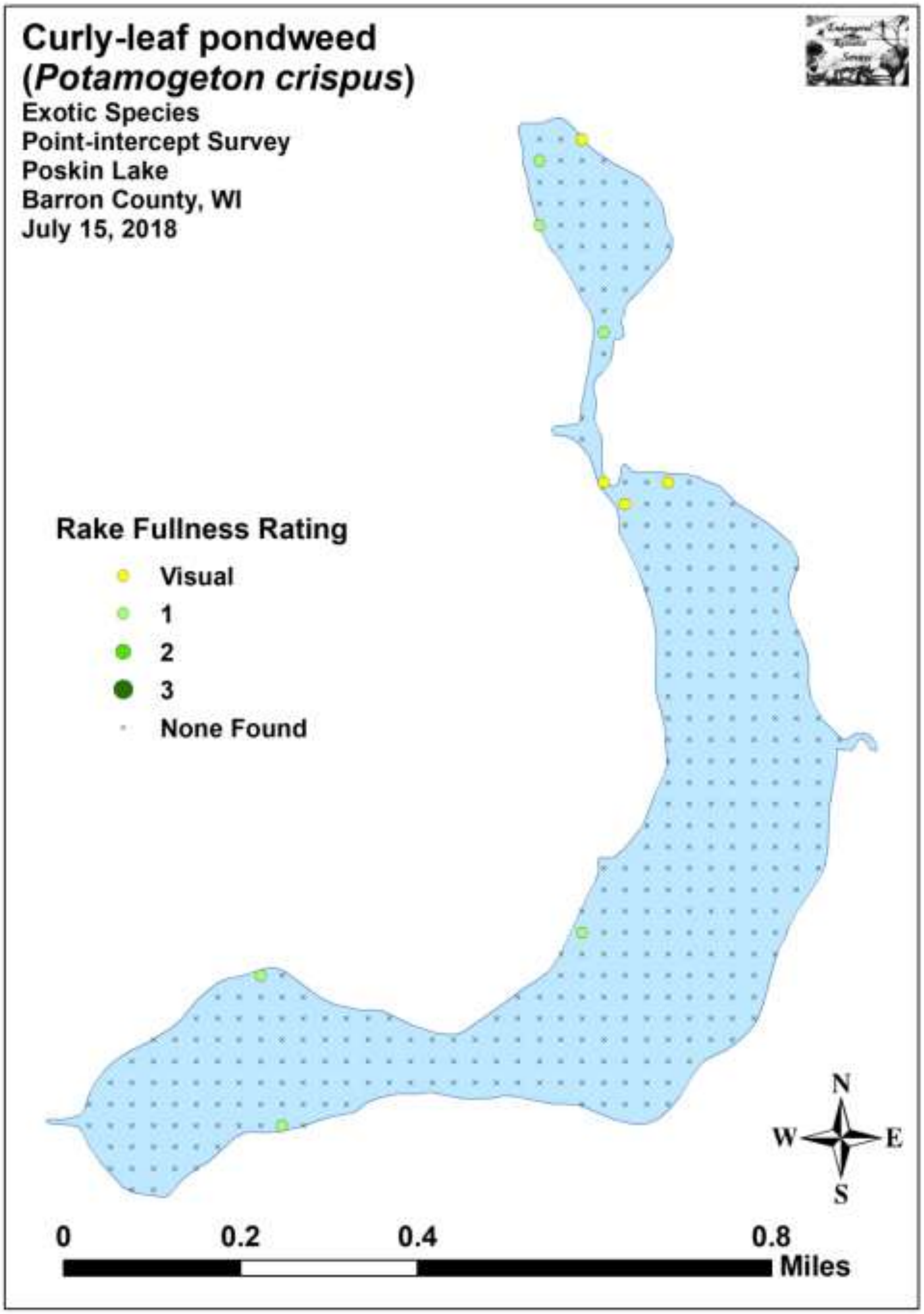
0.2
0.4
0.8
Miles



Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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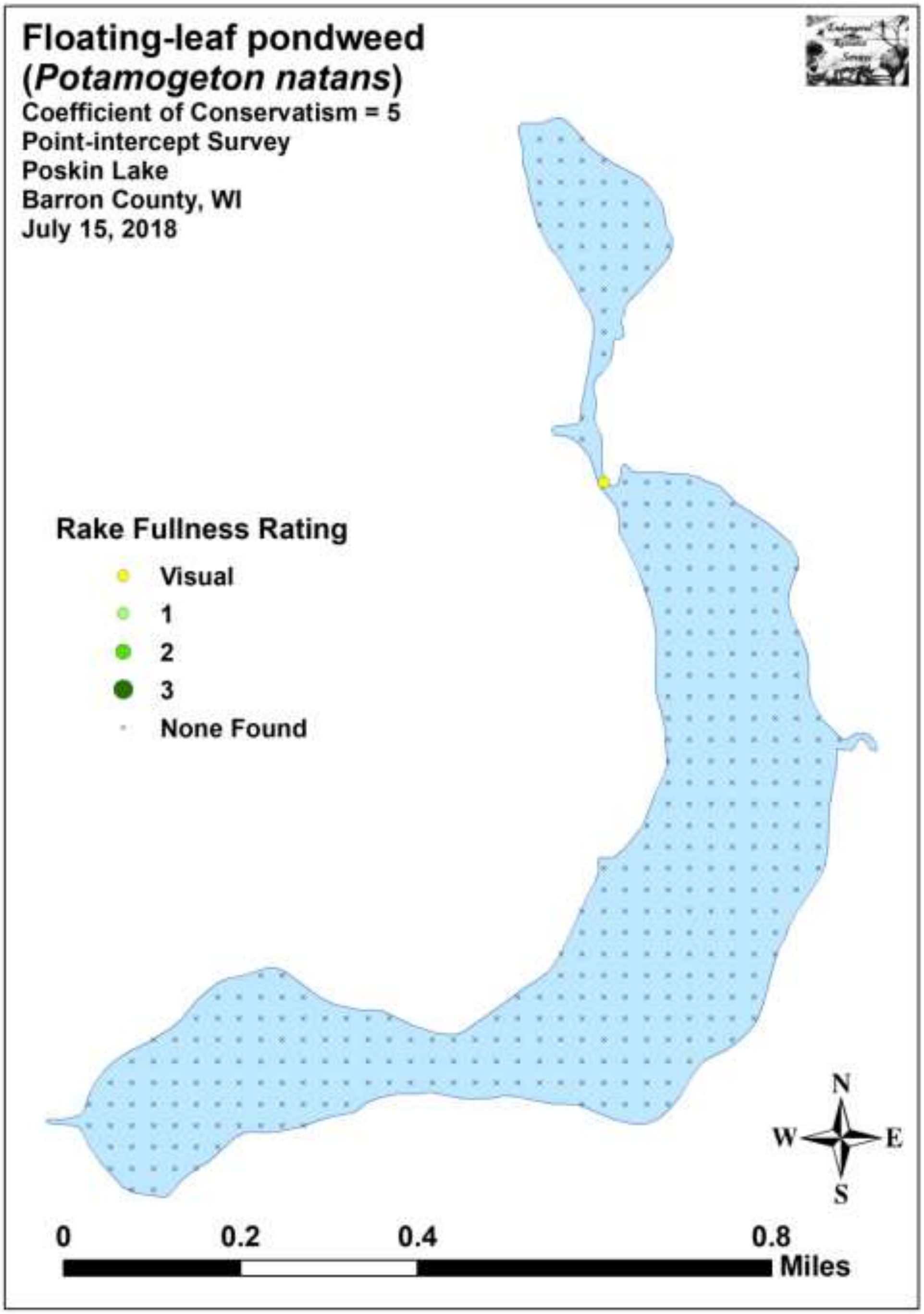
0.2
0.4
0.8
Miles


Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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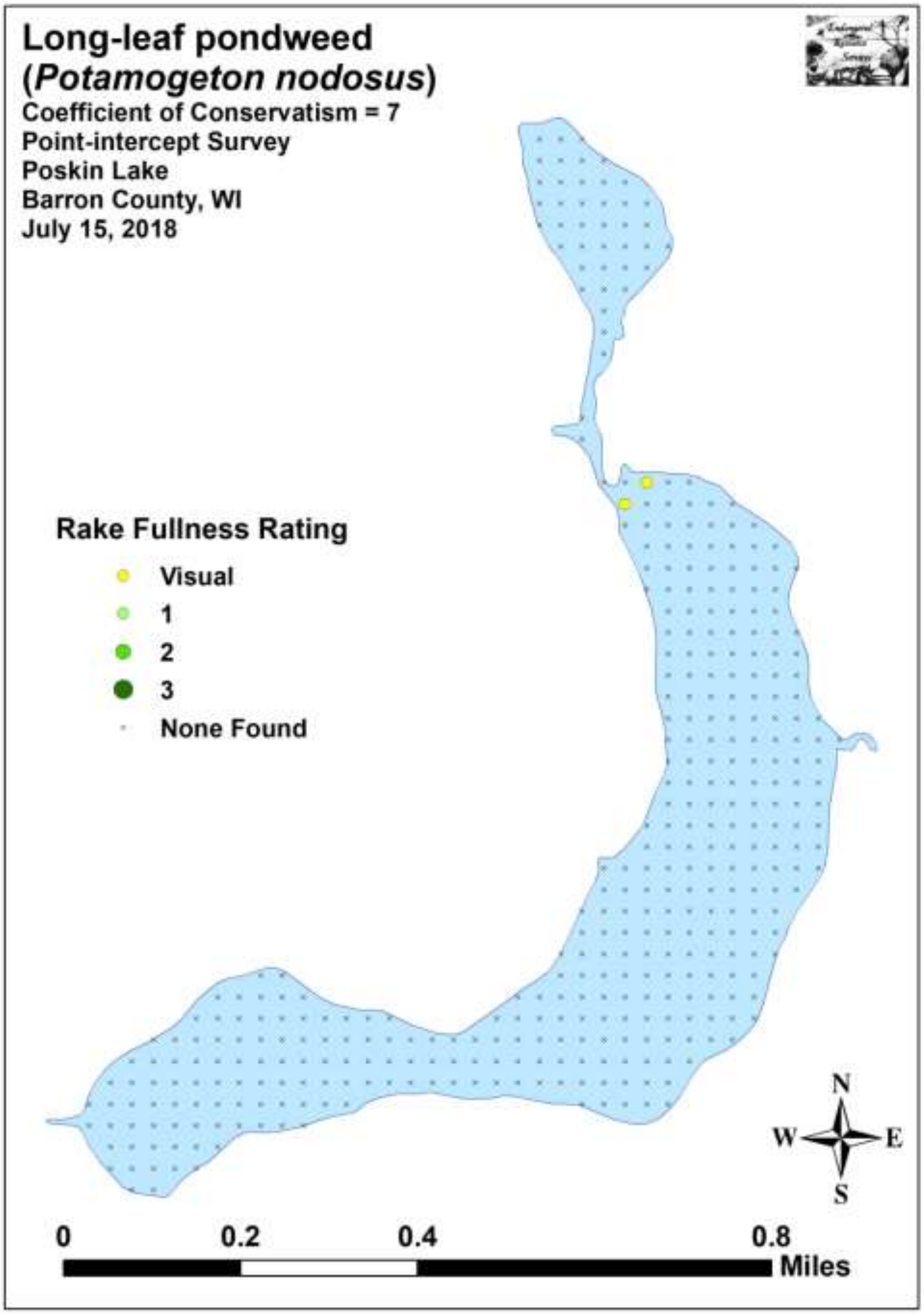
0.2
0.4
0.8
Miles


Long-leaf pondweed
(*Potamogeton nodosus*)
Coefficient of Conservatism = 7
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
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None Found
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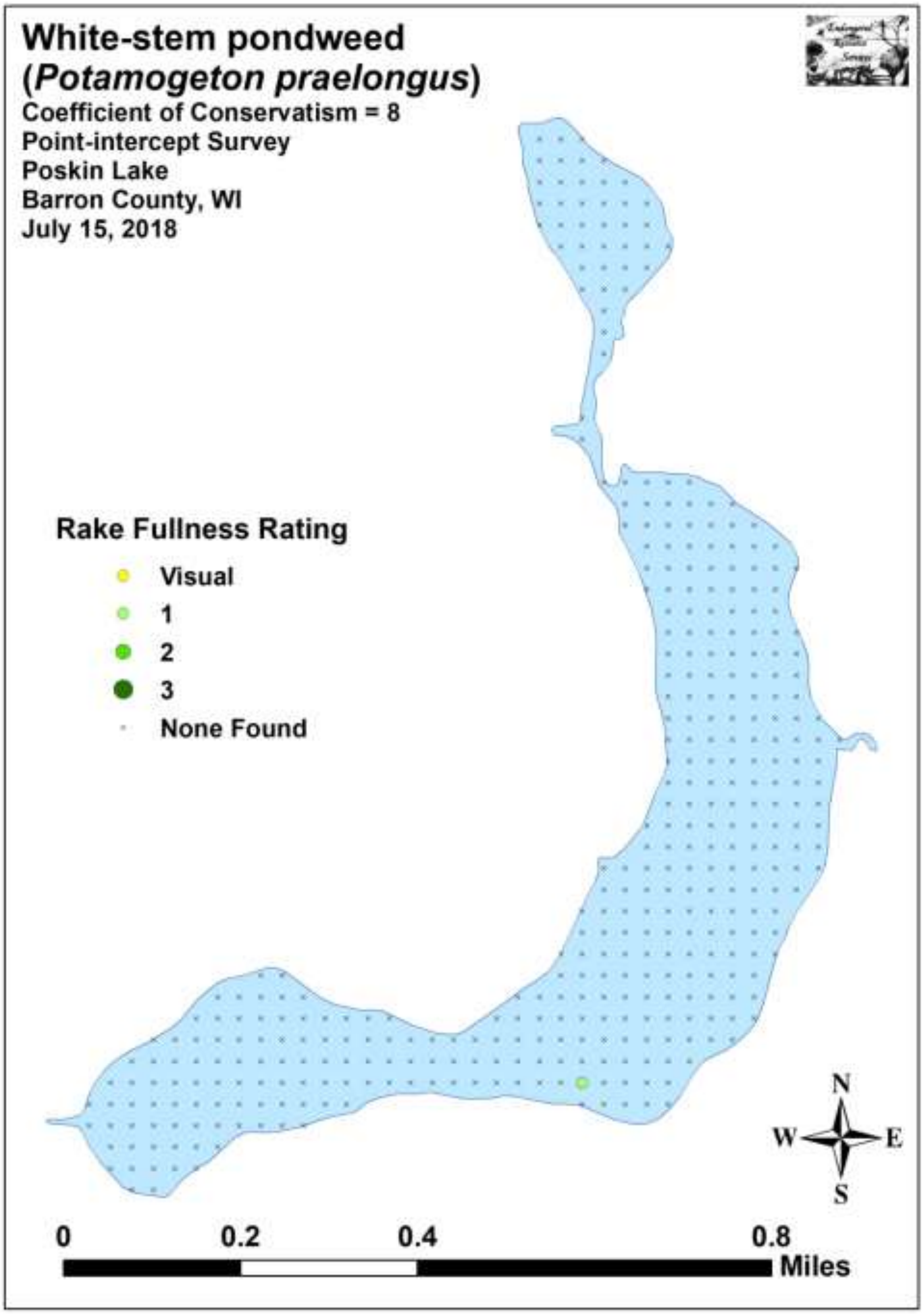
0.2
0.4
0.8
Miles


White-stem pondweed
(*Potamogeton praelongus*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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None Found
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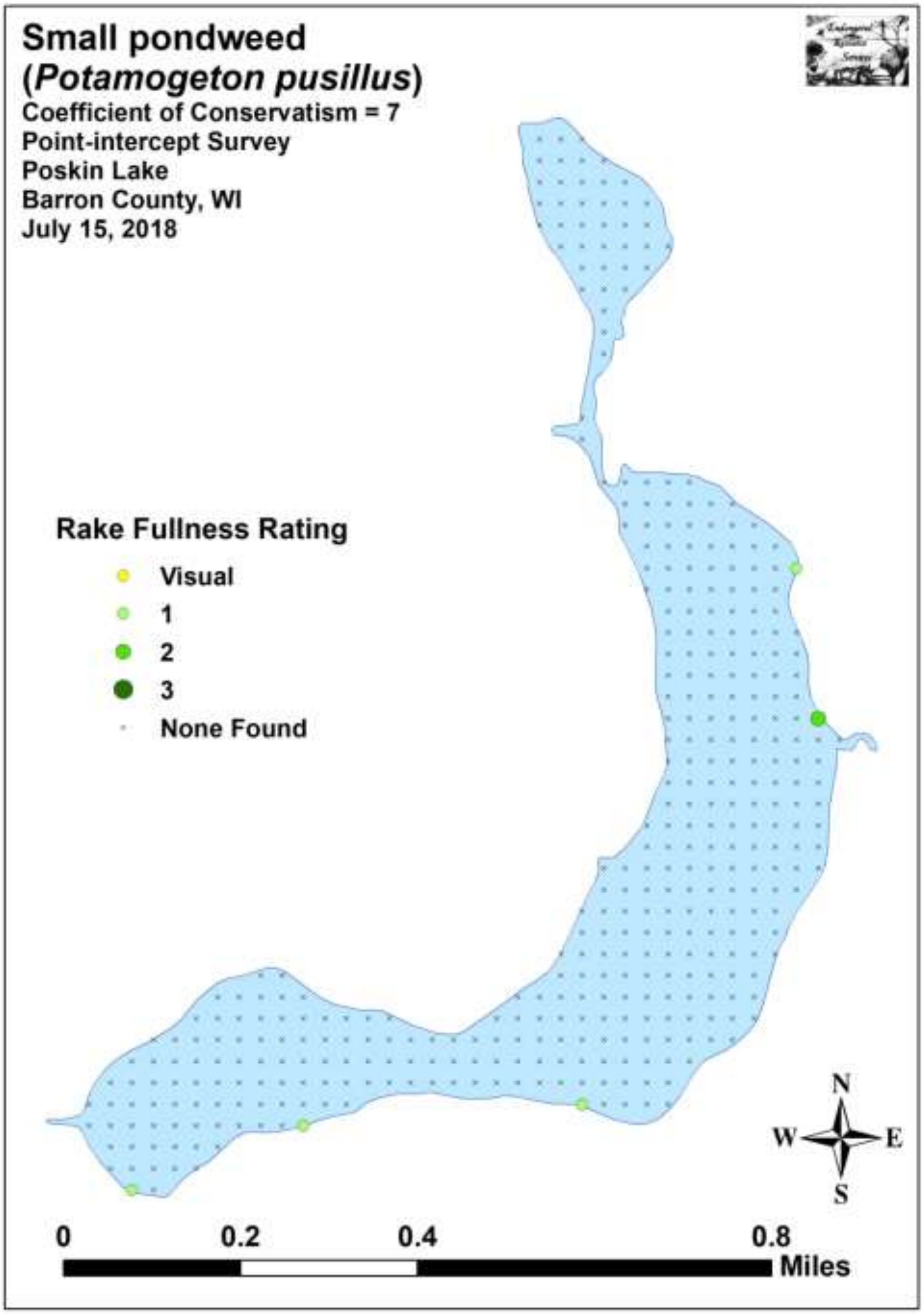
0.8
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
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None Found
N
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0.2
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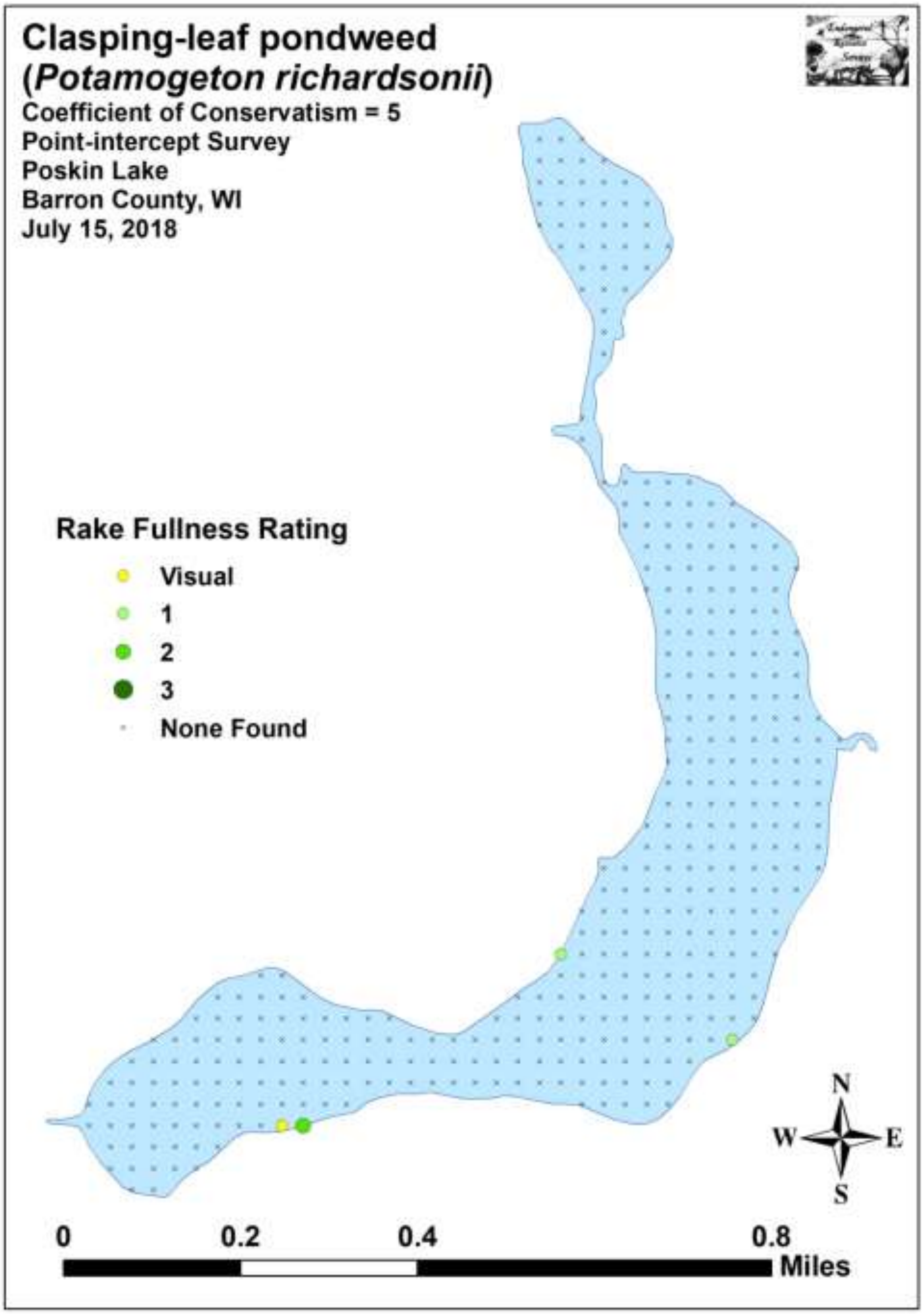
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
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0.2
0.4
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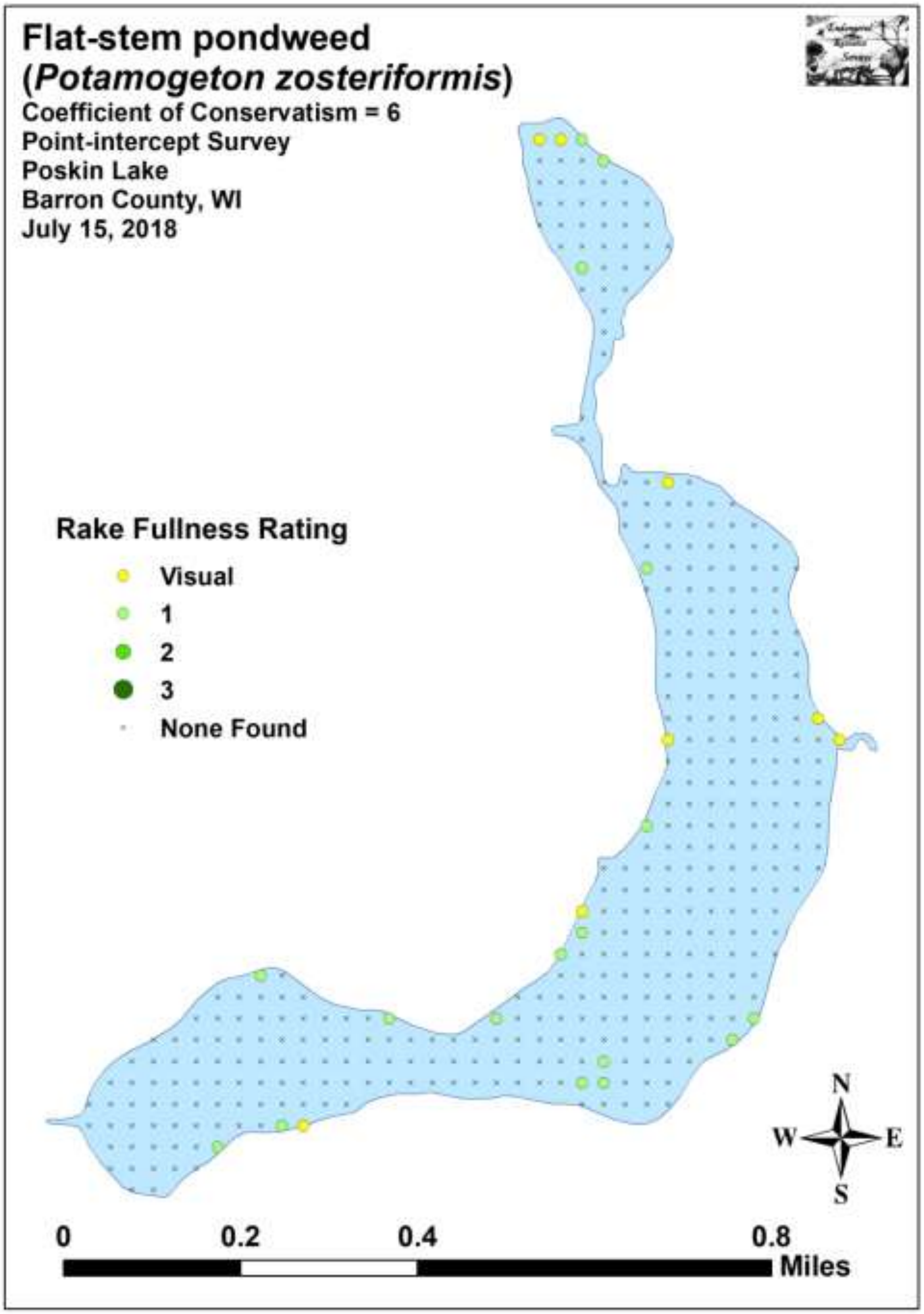
Miles


Flat-stem pondweed
(*Potamogeton zosteriformis*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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3
None Found
N
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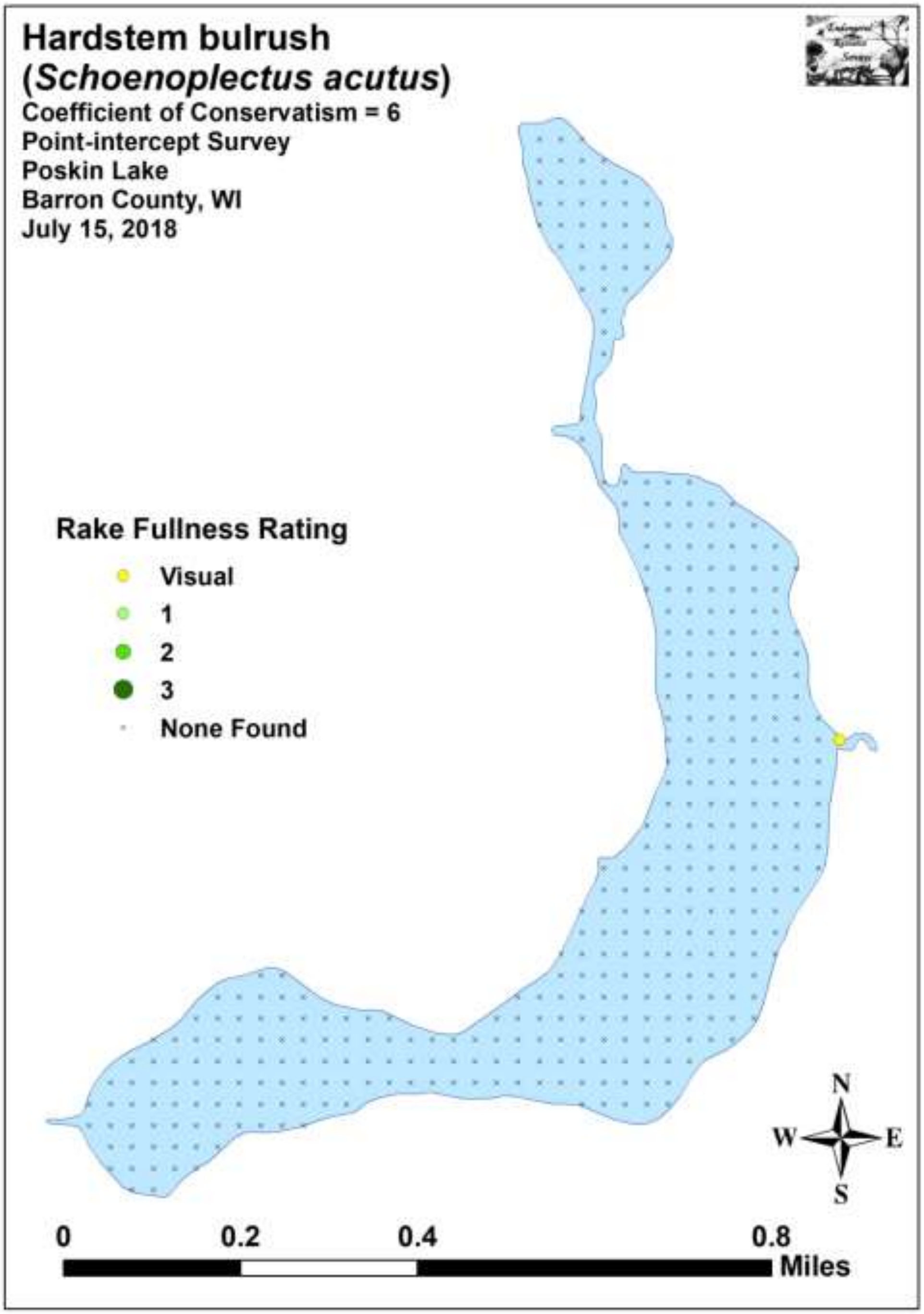
0.2
0.4
0.8
Miles



Hardstem bulrush
(*Schoenoplectus acutus*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
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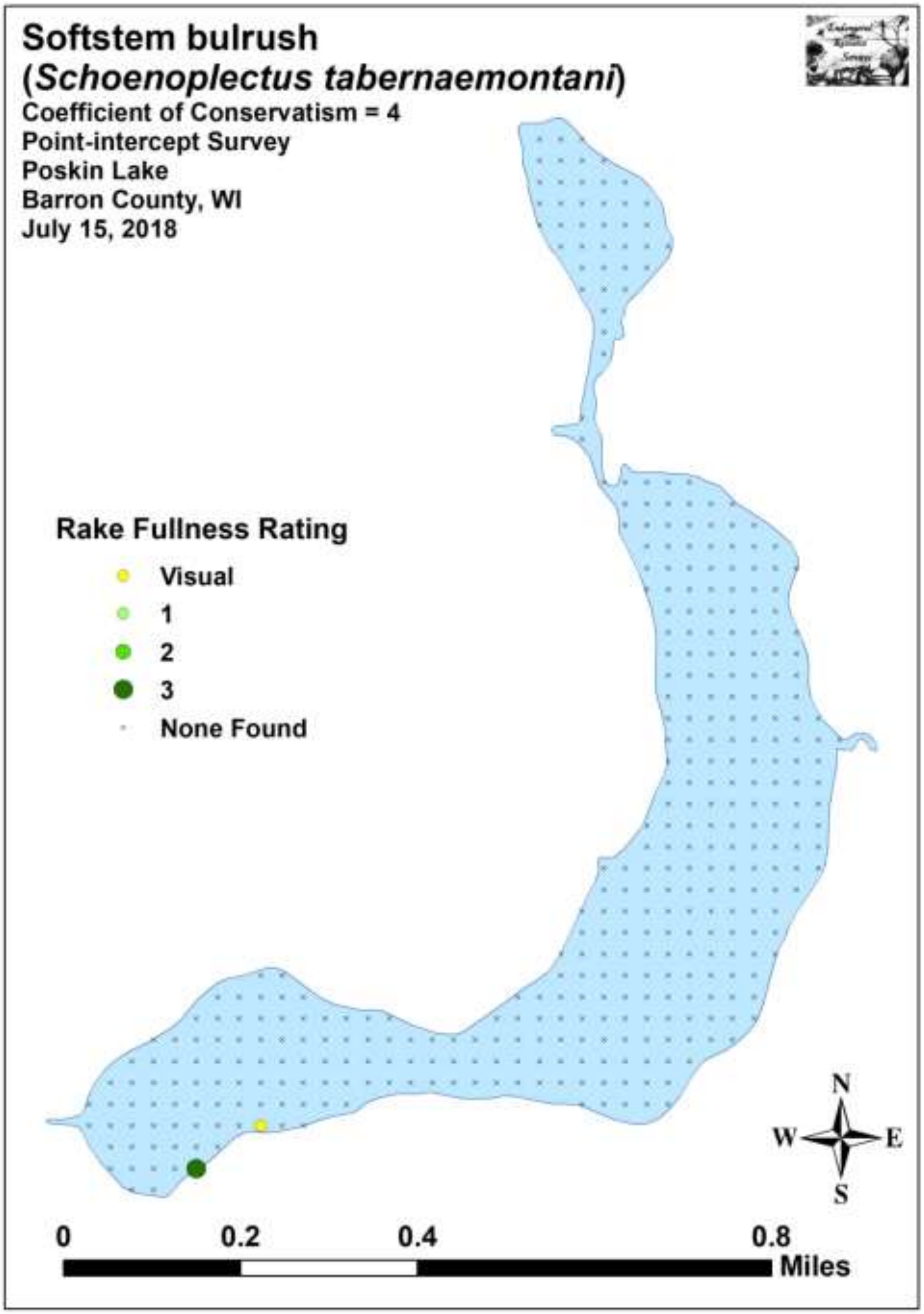
0.2
0.4
0.8
Miles


Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
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None Found
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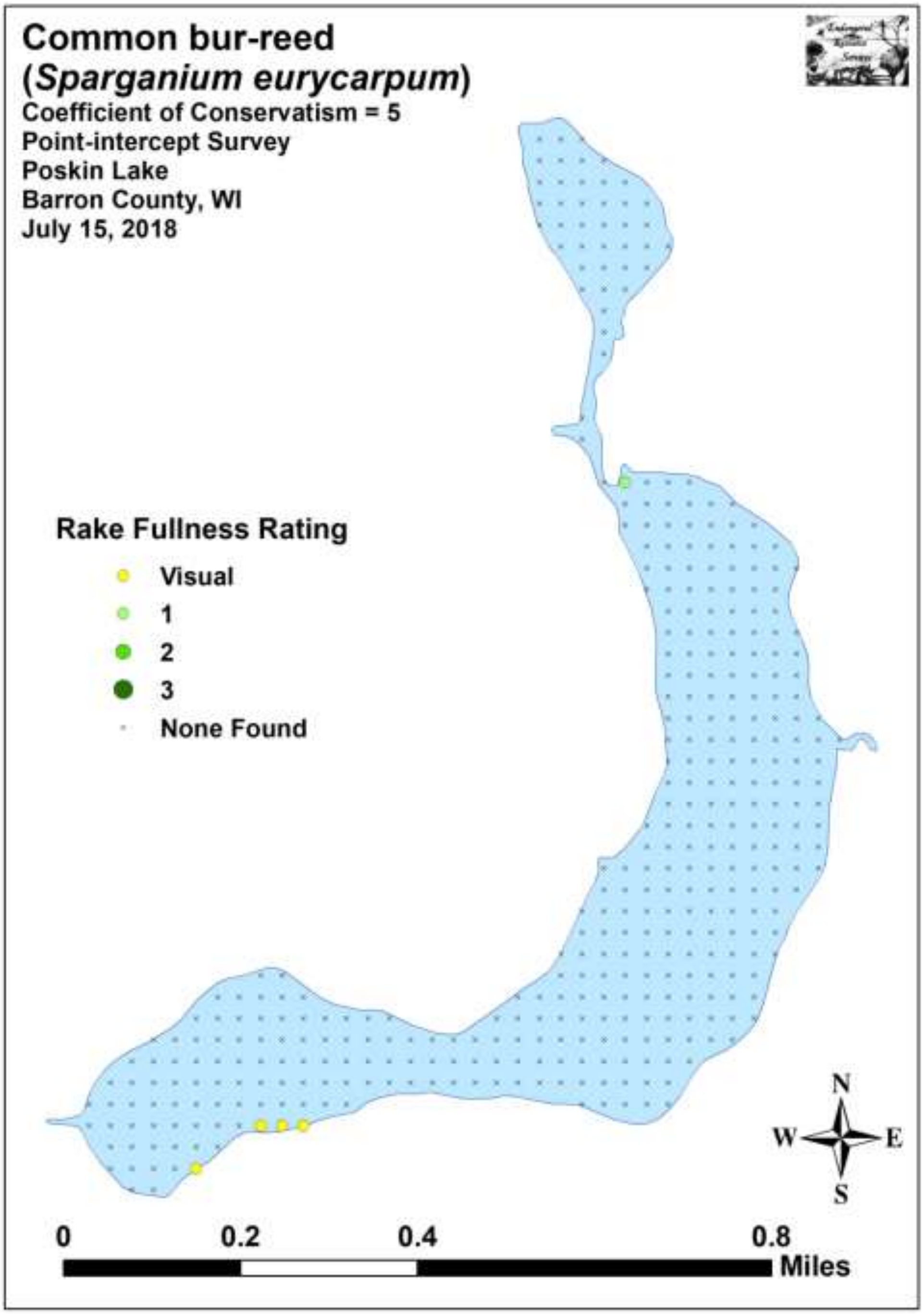
0
0.2
0.4
0.8
Miles


Common bur-reed
(*Sparganium eurycarpum*)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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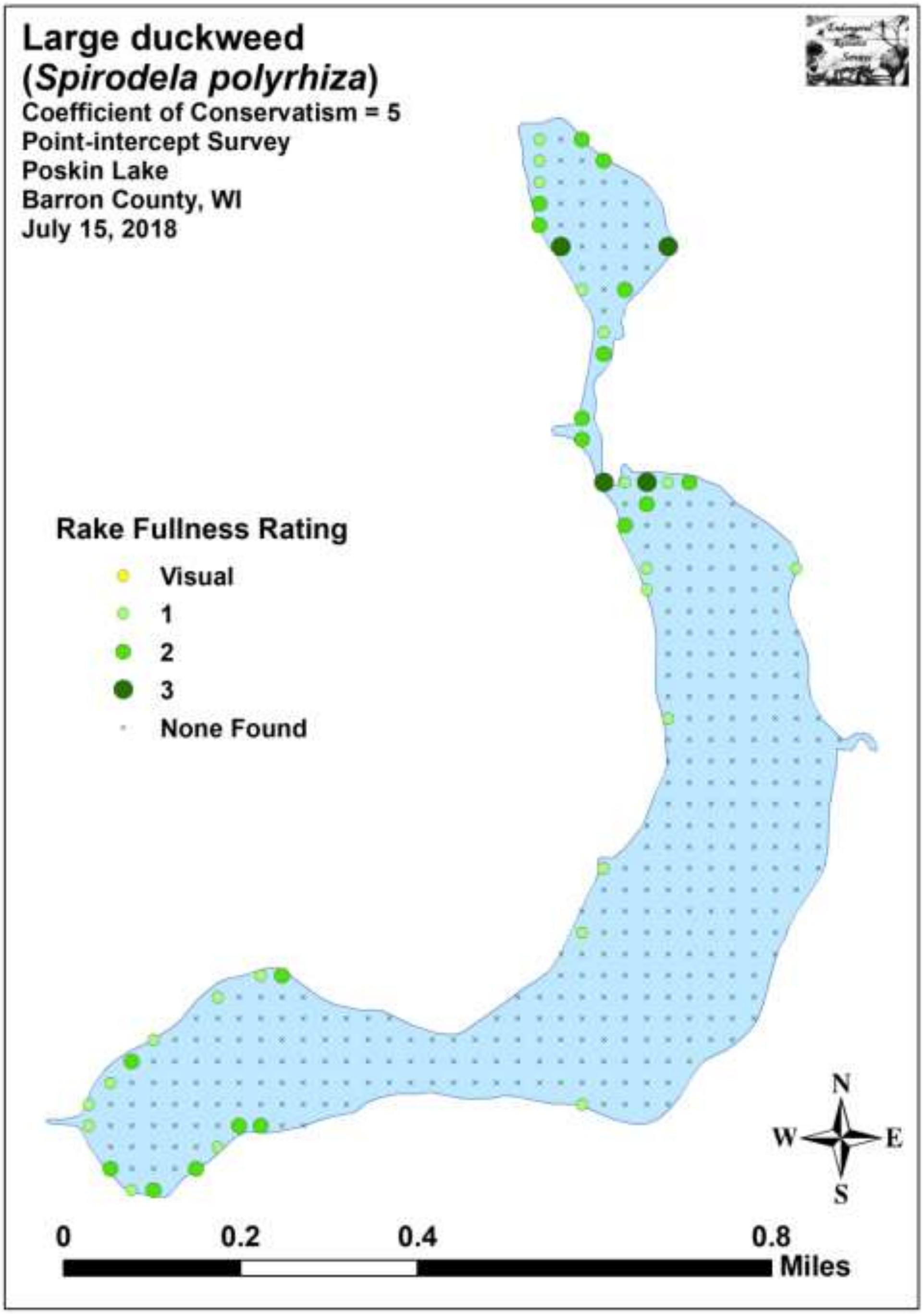
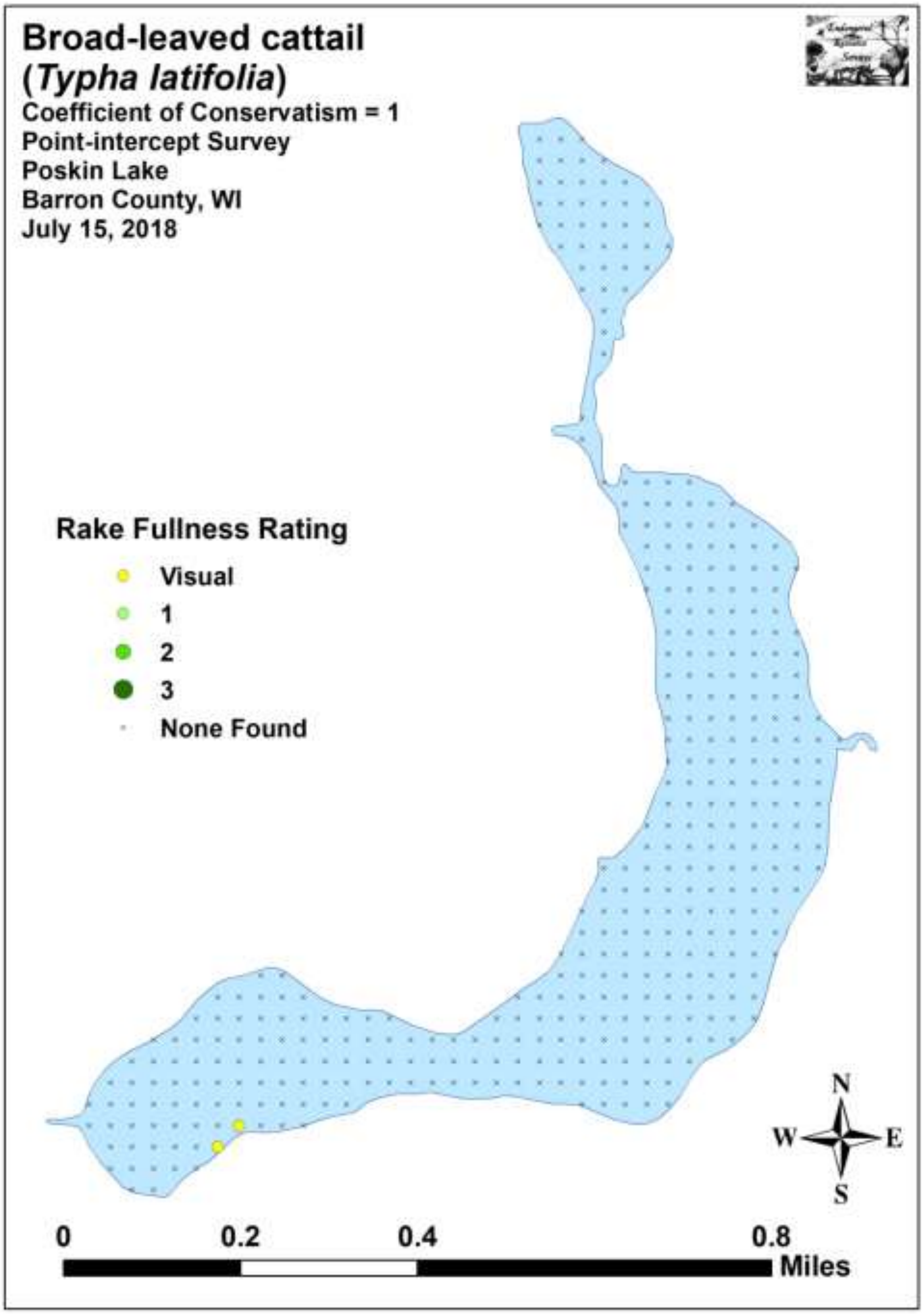
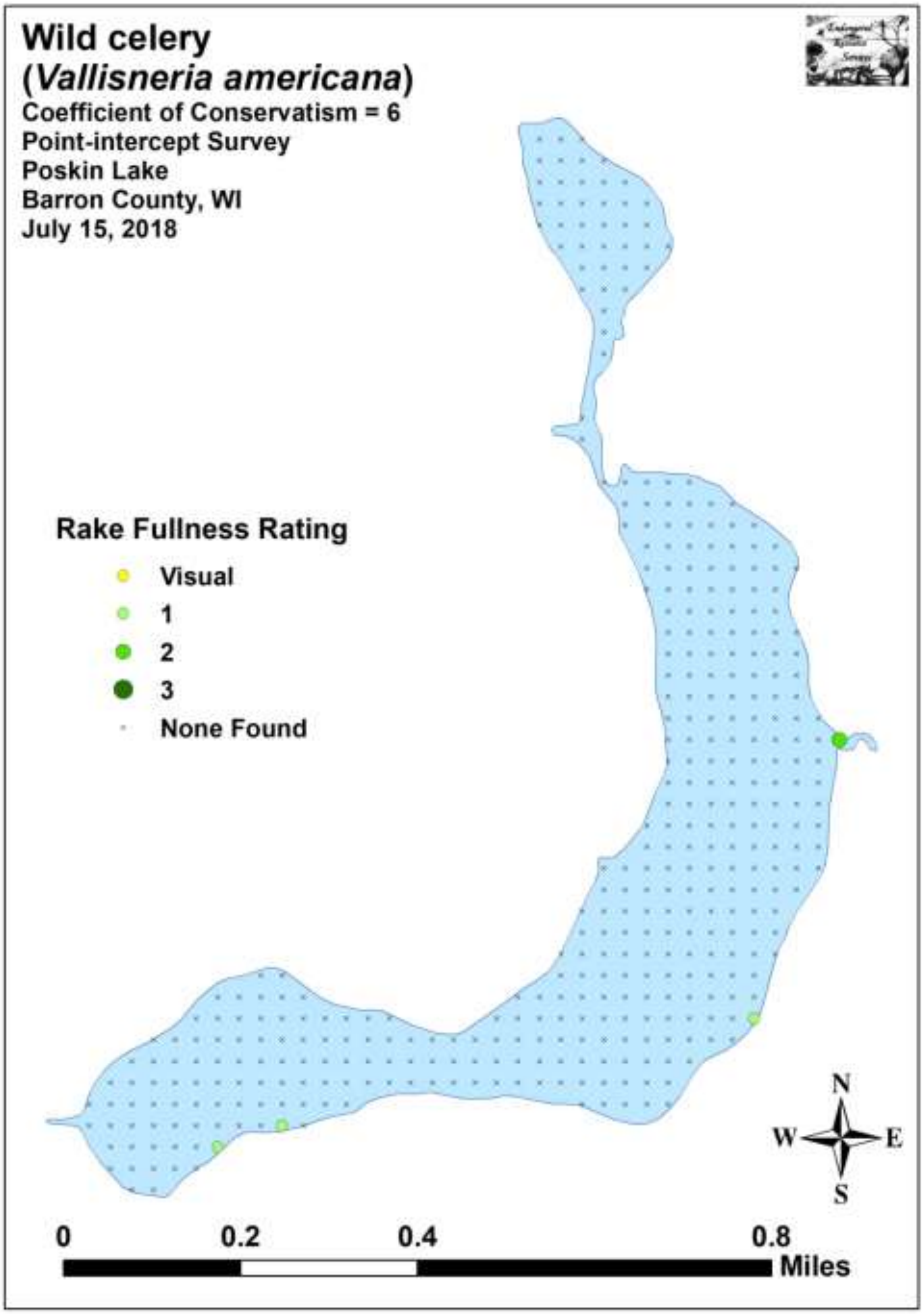
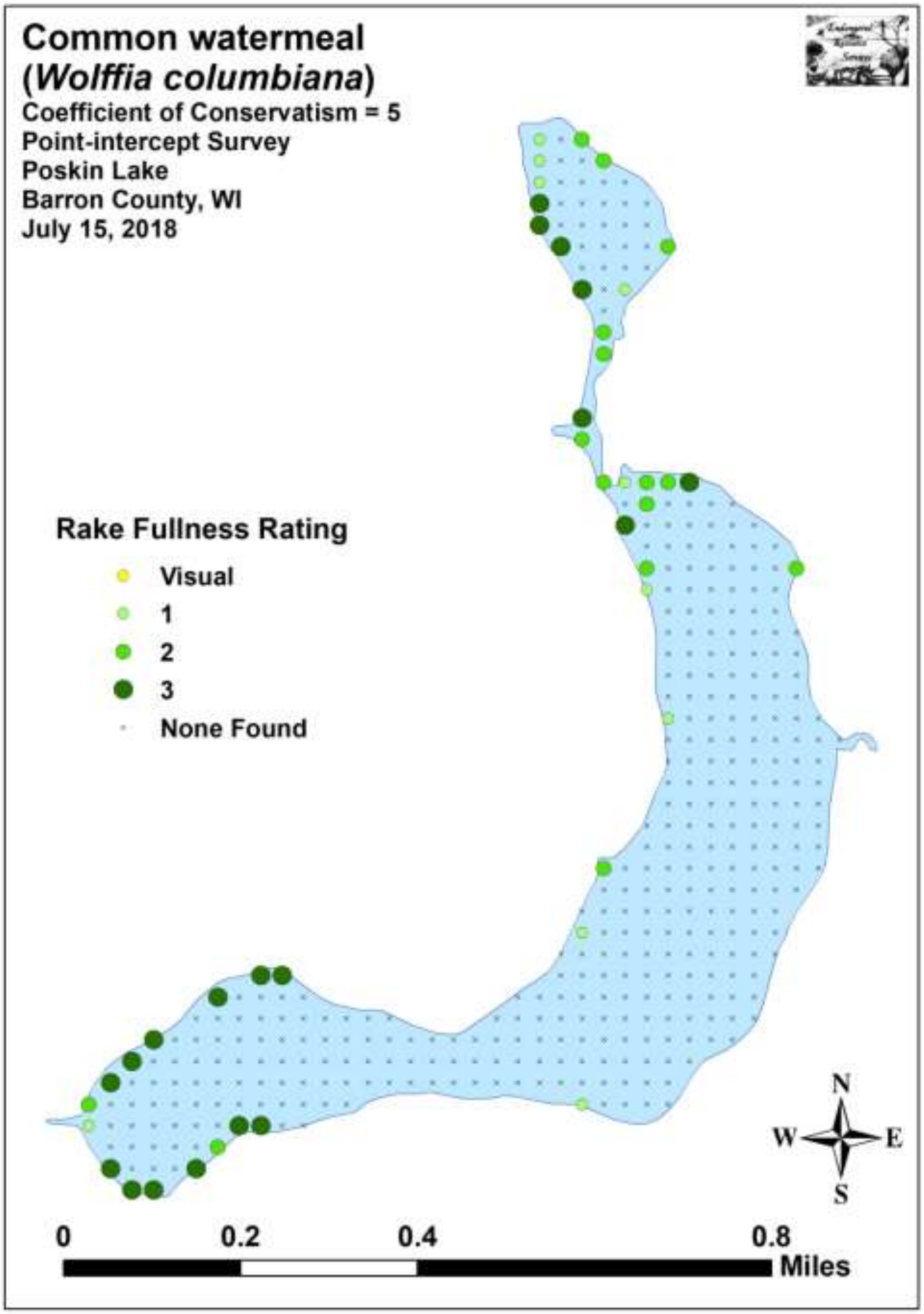
S
0
0.2
0.4
0.8
Miles

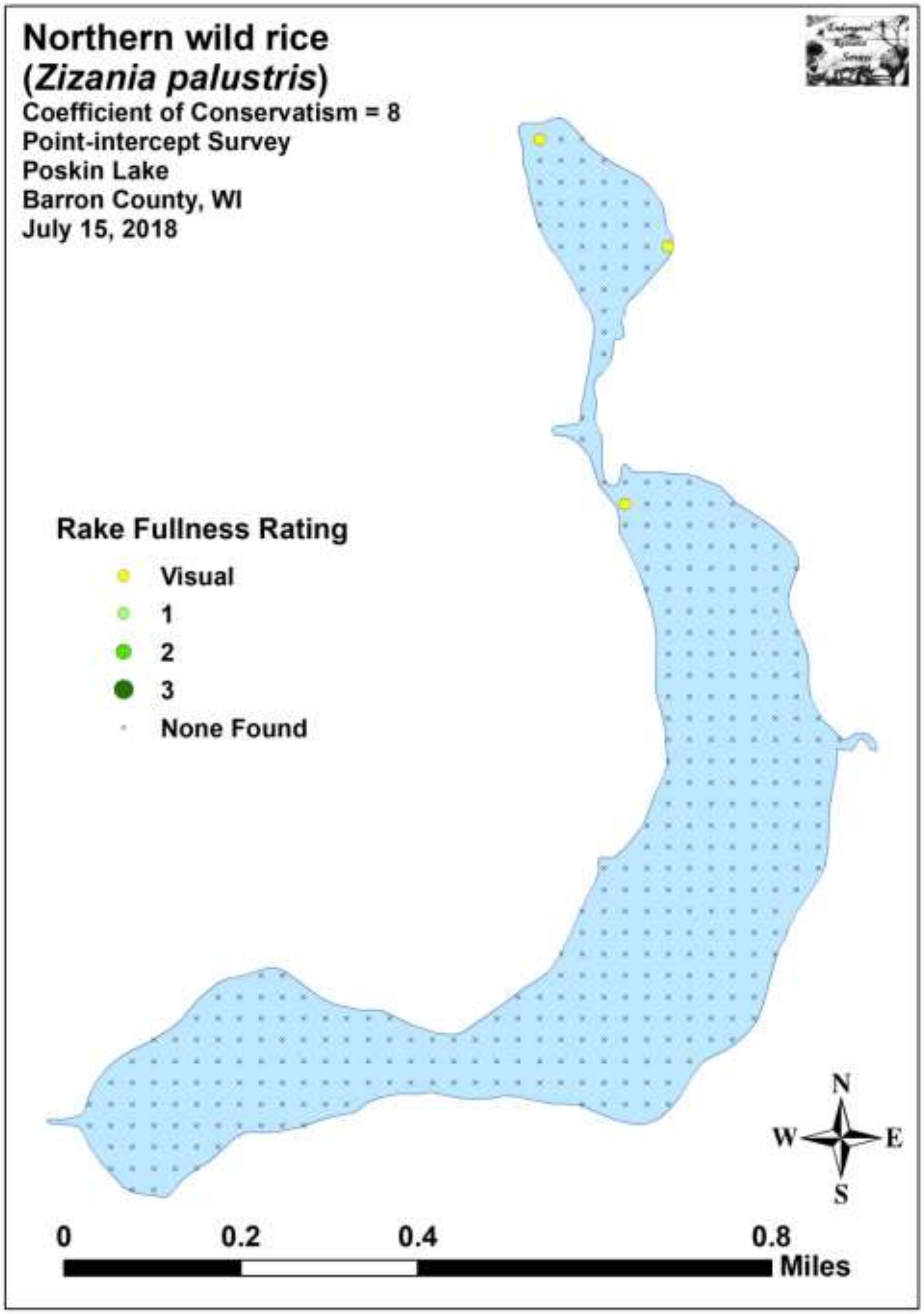


Large duckweed
(*Spirodela polyrhiza*)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Broad-leaved cattail
(*Typha latifolia*)
Coefficient of Conservatism = 1
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Wild celery
(*Vallisneria americana*)
Coefficient of Conservatism = 6
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Common watermeal
(Wolffia columbiana)
Coefficient of Conservatism = 5
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Northern wild rice
(*Zizania palustris*)
Coefficient of Conservatism = 8
Point-intercept Survey
Poskin Lake
Barron County, WI
July 15, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

Appendix IX: Aquatic Exotic Invasive Plant Species Information

Eurasian Water-milfoil

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

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

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

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

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

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

Curly-leaf pondweed

DESCRIPTION: Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early July.

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

LIFE HISTORY AND EFFECTS OF INVASION: Curly-leaf pondweed spreads through burr-like winter buds (turions), which are moved among waterways. These plants can also reproduce by seed, but this plays a relatively small role compared to the vegetative reproduction through turions. New plants form under the ice in winter, making curly-leaf pondweed one of the first nuisance aquatic plants to emerge in the spring.

It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out compete native plants in the spring. In mid-summer, when most aquatic plants are growing, curly-leaf pondweed plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. Curly-leaf pondweed forms surface mats that interfere with aquatic recreation. (Taken in its entirety from WDNR, 2009 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Reed canary grass

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

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

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

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

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

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

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

Purple loosestrife
(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 August to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

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

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

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

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

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

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

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

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

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

Appendix X: Glossary of Biological Terms
(Adapted from UWEX 2009)

Aquatic:

organisms that live in or frequent water.

Cultural Eutrophication:

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

Dissolved Oxygen (DO):

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

Diversity:

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

Drainage lakes:

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

Ecosystem:

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

Eutrophication:

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

Exotic:

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

Habitat:

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

Limnology:

the study of inland lakes and waters.

Littoral:

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

Macrophytes:

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

Nutrients:

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

Organic Matter:

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

Photosynthesis:

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

Phytoplankton:

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

Plankton:

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

ppm:

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

Richness:

number of species in a particular community or habitat.

Rooted Aquatic Plants:

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

Runoff:

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

Secchi Disc:

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

Seepage lakes:

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

Turbidity:

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

Watershed:

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

Zooplankton:

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

Appendix XI: 2018 Raw Data Spreadsheets