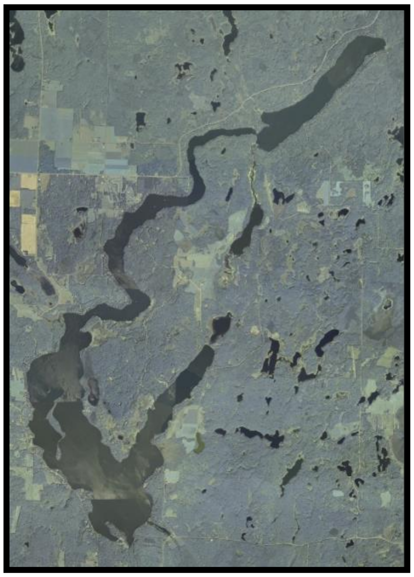
Curly-leaf pondweed Density and Bed Mapping, and Warm Water Point Intercept Macrophyte Surveys Long Lake - Washburn County, WI (WBIC: 2106800)



Aerial Photo of Long Lake (2010)

Cattails, wild rice and lilypads south of Rice Island on Long Lake (Berg 2011)

Project Initiated by:

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

Large-leaf and White-stem pondweed bed (Berg 2011)

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin

May 26, June 4-5, 11, and July 27-31, 2011

TABLE OF CONTENTS

ABSTRACT

Long Lake (WBIC 2106800) is a 3,478-acre, stratified, drainage lake in southeastern Washburn County, WI. The lake is primarily mesotrophic with a littoral zone that reached 14.5ft in May/June and 17.0ft in July, 2011. As a prerequisite to developing an APMP, the LLPA, SEH, and the WDNR authorized Curly-leaf pondweed (*Potamogeton crispus*) density and bed mapping surveys on May 26, June 4-5, and June 11, and a point intercept survey from July 27-31, 2011. We found CLP at eight sample points or approximately 0.4% of the lake. Of these, three (0.1%) had a rake fullness of 2 indicating a significant infestation. We also mapped 19 beds totaling 4.82 acres and covering 0.1% of the lake. During the July survey, there were macrophytes growing at 584 sites or approximately 27% of the entire lake and in 85% of the littoral zone. Overall diversity was extremely high with a Simpson Diversity Index value of 0.94. Of the 59 species found growing in and immediately adjacent to the lake, Flat-stem pondweed (*Potamogeton zosteriformis*), Coontail (*Ceratophyllum demersum*), Muskgrass (*Chara* sp.), and Wild celery (*Vallisneria americana*) were the most common macrophytes being found at 42.64%, 40.24%, 33.22%, and 31.34% of survey points with vegetation. The 51 native index species found in the rake during the July survey produced an above average mean Coefficient of Conservatism of 6.3 and a Floristic Quality Index of 44.9 that was more than double the median FQI for this part of the state. Other than CLP, Hybrid cattail (*Typha* X *glauca*) was the only other exotic species found. Future management considerations include working to preserve native plants and the critical habitat they provide for the whole lake ecosystem; improving water clarity and decreasing algal growth; encouraging all lakeshore property owners to proactively reduce nutrient runoff and erosion by not mowing down to the water, bagging grass clippings, eliminating fertilizer applications near the water, restoring shorelines, and establishing buffer strips of native vegetation; and preventing the spread of CLP by refraining from removing native plants and avoiding motor start ups in shallow water which can expose the lake substrate making it easy for CLP to establish. At the public boat landings, supporting the established Clean Boats/Clean Waters Program; maintaining the signage to remind boaters of the dangers/impacts of AIS; and conducting monthly landing and annual whole lake littoral zone surveys for AIS are all management strategies for the LLPA to consider as they develop their APMP for Long Lake.

LIST OF FIGURES

LIST OF TABLES

Page #

INTRODUCTION:

Long Lake (WBIC 2106800) is a 3,478-acre, stratified, drainage lake located in the Towns of Birchwood, Long Lake, and Madge in southeastern Washburn County (T37N R11W S24 SW SW). The lake reaches a maximum depth of 74ft in the northeast thumb and has an average depth of 26ft (WDNR 2009) (Figure 1). The northeast bay of Long Lake is eutrophic in nature with fair water clarity that produced average Secchi readings of 7.0ft from 1991-2011. Elsewhere during this time period, the lake was mesotrophic with fair to good water clarity and average Secchi readings that ranged from 8.7ft north of Kunz Island to 9.9ft in the northeast thumb (WDNR 2011). These conditions produced a 2011 littoral zone that varied from 14-17ft depending on location. Bottom substrate was predominantly organic muck in sheltered bays and a mixture of sand, rock, and sandy muck along the majority of the rest of the shoreline. Away from shore, most bottom areas were sandy muck with numerous midlake rock and sand bars (Miller et al. 1965).

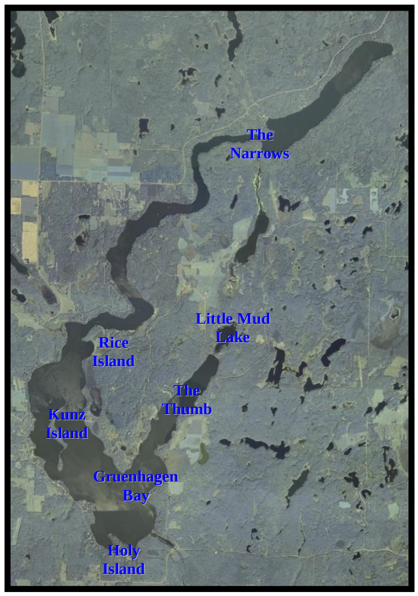


Figure 1: Long Lake Aerial Photo

The Long Lake Preservation Association (LLPA), Short Elliot Hendrickson, Inc. (SEH), and the Wisconsin Department of Natural Resources (WDNR) authorized a series of full lake plant surveys as a prerequisite to developing an Aquatic Plant Management Plan (APMP). On May 26, June 4-5, and June 11, 2011, we completed Curly-leaf pondweed (*Potamogeton crispus*) (CLP) density and bed mapping surveys. This was followed by a warm water point intercept survey of all aquatic macrophytes from July 27-31, 2011. All of these surveys used the WDNR's statewide guidelines for conducting systematic point intercept macrophyte sampling. These methods ensure that all sampling in the state will be conducted in the same manner, thus allowing data to be compared across time and space. The immediate goals of the surveys were to quantify the extent and density of the CLP infestation, determine if Eurasian water milfoil (*Myriophyllum spicatum*) had invaded the lake, and to establish data on the richness, diversity, abundance and distribution of other native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's macrophyte community as well as a way to measure any impacts on the lake's plants if active management occurs in the future.

METHODS:
Cold Water Curly-leaf pondweed Survey:
Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth and total lake acreage, Michelle Nault (WDNR) generated a 2,140 point sampling grid for Long Lake (Appendix I). Using this grid, we completed a density survey where we recorded the level of CLP at each point in the lake's early season littoral zone. 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. CLP was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of CLP within six feet of the sample point.

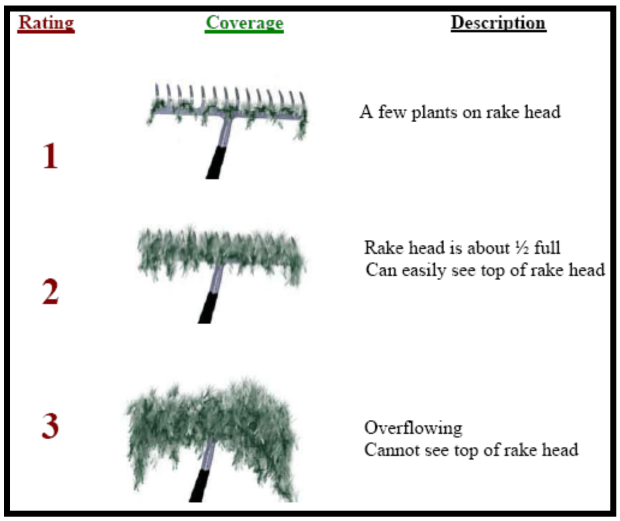


Figure 2: Rake Fullness Ratings (UWEX, 2011)

CLP Bed Mapping Survey:
Following the density survey, we used the resulting maps coupled with a meandering littoral zone search to locate and map all significant beds of CLP. We defined a bed based on the following two criteria: CLP plants made up greater than 50% of all aquatic plants in the area, and the CLP had canopied at the surface or was close enough to the surface that it would likely interfere with normal boat traffic.

Upon finding a bed, we circled around the perimeter and used a GPS unit to record waypoints at regular intervals. We then uploaded these points into ArcMap 9.3.1, created bed shapefiles using the WDNR Forestry Tools Extension, and determined the total acreage and perimeter of the beds to the nearest hundredth of an acre and meter respectively (Table 1).

Warm Water Point Intercept Macrophyte Survey:
Prior to beginning the July point intercept survey, we conducted a general boat survey of the lake to gain familiarity with the species present (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006), and two vouchers were pressed and mounted for herbarium specimens – one to be retained by the LLPA, and one to be sent to the state herbarium in Stevens Point for identification

confirmation. We again located each survey point with a GPS, recorded a depth reading with a Polar Vision hand held sonar unit, 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 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 (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix III) (UWEX, 2011). From this, we calculated the following:

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

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

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

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences 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.

<u>Simpson's Diversity Index:</u> 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.

<u>Maximum depth of plants:</u> 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.

<u>Mean and median depth of plants:</u> 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.

<u>Number of sites sampled using rope/pole rake:</u> This indicates which rake type was used to take a sample. As is standard protocol, we used a 15ft pole rake and a 25ft rope rake for sampling.

<u>Average number of species per site:</u> 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.

<u>Species richness:</u> 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.**

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

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

Relative frequency example:

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

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

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

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

This value tells us that 46.67% of all plants sampled were Plant A.

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point intercept survey, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Long Lake is in the Northern Central Hardwood Forests Ecoregion (Table 4).

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

RESULTS:
Cold Water Curly-leaf pondweed Survey:
Following the establishment of the May littoral zone at approximately 14.5ft of water, we sampled for Curly-leaf pondweed at all points in and adjacent to this zone (Figure 3) (Appendix IV). CLP was present in the rake at eight sample points or approximately 0.4% of the lake. Of these, we recorded a rake fullness value of 2 at three points and didn't find any with a rake fullness value of 3. This extrapolated to only 0.1% of the lake having a significant infestation. CLP was also a visual at two additional points.

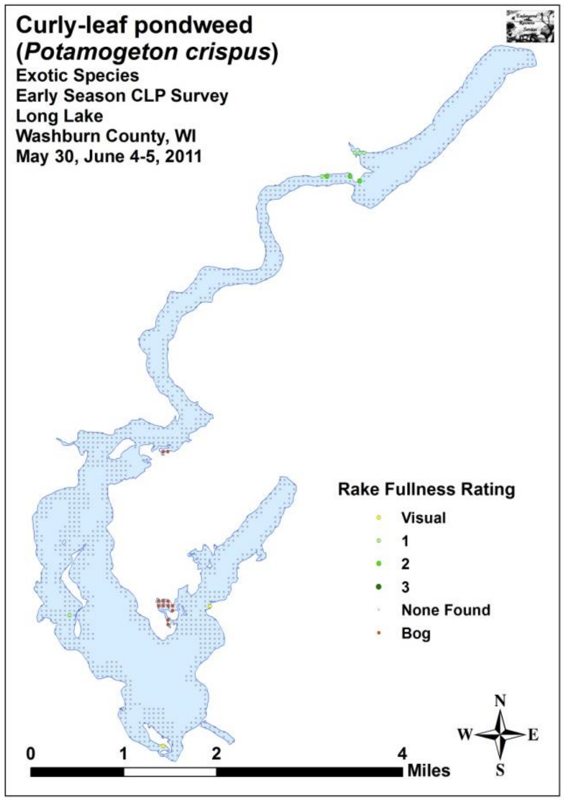


Figure 3: Long Lake's May-June CLP Distribution and Density

Long Lake CLP Bed Mapping Survey:
Curly-leaf pondweed was widely scattered throughout the lake's near shore littoral zone, and we never found it growing in water more than 8.5ft deep. Because it was primarily in these shallow areas, most plants were either canopied or nearing canopy at the time of the survey. Despite being an exotic species, CLP was generally not invasive in Long Lake, and, for the most part, was acting like "just another plant" interspersed among other native vegetation. Most CLP plants were found near boat landings or directly along docks. Interestingly, we never found any CLP plants on the pristine shoreline that bordered the majority of the Tomahawk Scout Reservation property. Ultimately, we located and mapped nineteen small areas that met the bed criteria or were at least close to it. The biggest (Bed 16) was 1.74 acres, and the smallest (Bed 11) was <0.01 acre (Appendix IV). Totaling 4.82 acres, these beds accounted for just 0.1% of the lake's approximately 3,478 total acres (Table 1).

Table 1: CLP Bed Summary
Long Lake, Washburn Co. June 11, 2011

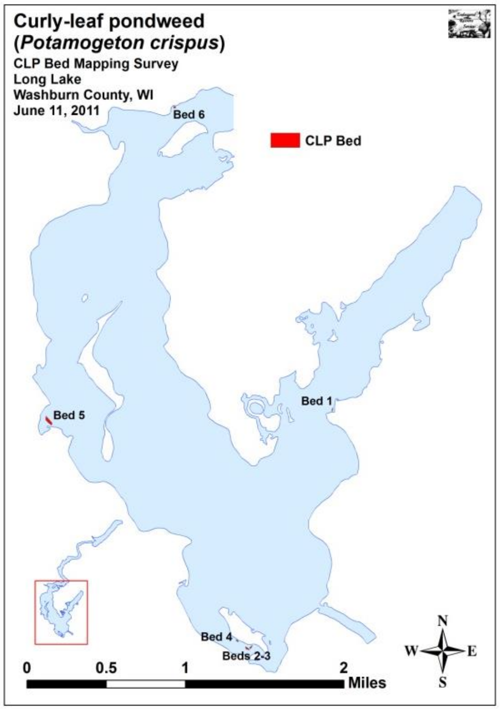
Bed Number	Acreage	Perimeter (m)	Est. Mean Rake Fullness
1	0.05	79	2
2	0.08	103	1-2
3	0.14	119	<1-1
4	0.06	74	<1-1
5	0.55	238	<1-1
6	0.07	70	<1-1
7	0.02	52	<1-1
8	0.02	35	1-2
9	0.13	128	<1
10	0.02	39	2
11	<0.01	3	3
12	0.03	74	1-2
13	0.01	20	<1-1
14	0.03	54	1-2
15	0.06	76	<1-1
16	1.74	813	2-3
17	1.00	281	3
18	0.03	45	3
19	0.78	402	<1-3
Total Acres	**4.82**		

Description of Beds and Notable Areas with CLP:

Bed 1 – This skinny bed ran approximately 90ft X 20ft starting just out from shore in the bay north of the Gruenhagen Bay boat landing. Plants were moderately dense, in 3-5ft of water, and canopied and monotypic in the bed. However, just beyond the bed, they disappeared completely (Figure 4).

Bed 2 – Located just west of the road to Holy "Island", Bed 2 had low to moderate densities of plants that were canopied in 3-5ft of water. The area barely qualified as a bed as CLP was not more than 50% of the plant community. A local resident we spoke to was concerned about plant growth and said plants (CLP?) historically has canopied throughout the entire area (Figure 5).

Beds 3 and 4 – Although they would probably have been better described as High Density Areas than Beds as CLP plants were definitely <50% of the macrophytes present, we opted to map the areas based on the local resident's concerns as stated above.



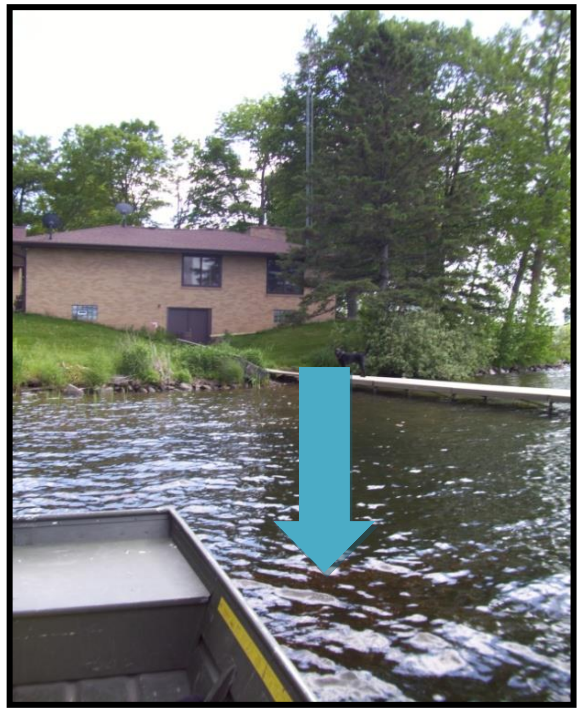


Figure 4: CLP Map of Beds 1-6 and Canopied Plants in Bed 1

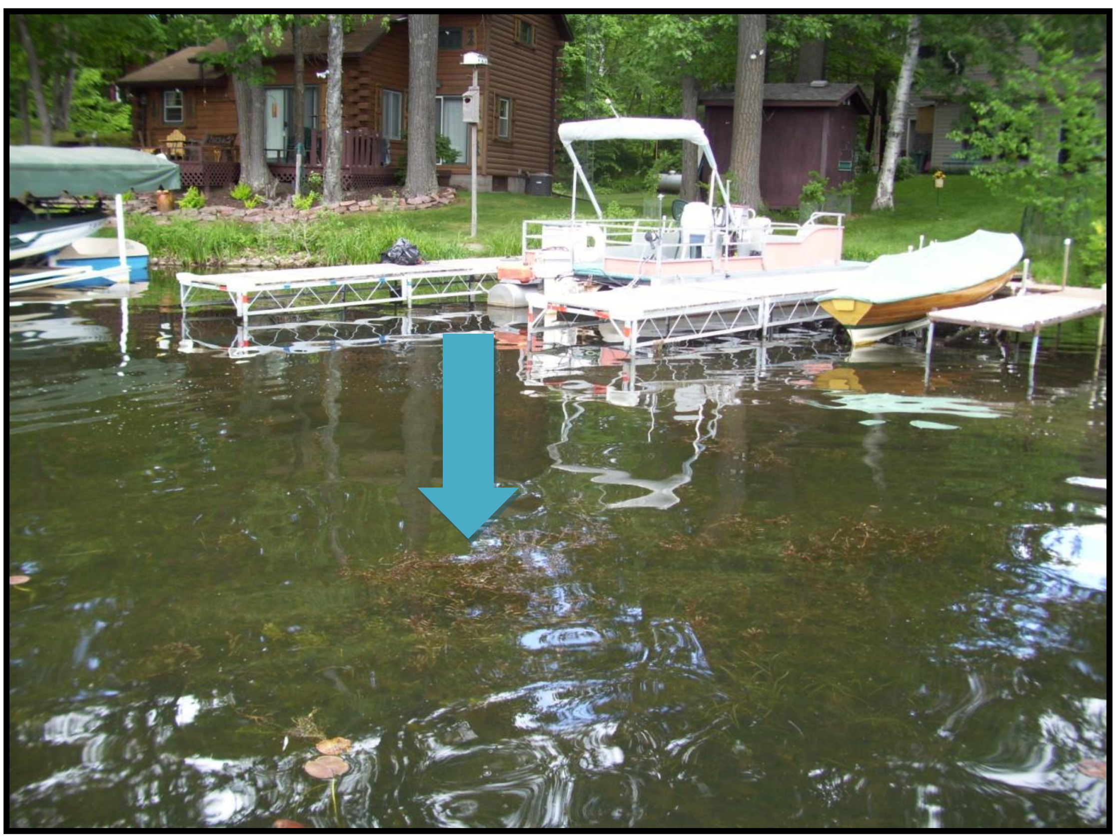


Figure 5: Canopied CLP Plants in Bed 2 South of Holy Island

Bed 5 – This area also was more of a High Density Area with canopied plants scattered throughout in 3-5ft of water. We decided to map it as it was located in front of the marina and likely gets a lot of in and out traffic.

Bed 6 – The area had a few 10's of plants. CLP was the dominant species and most plants were canopied, but in occurred in very low densities.

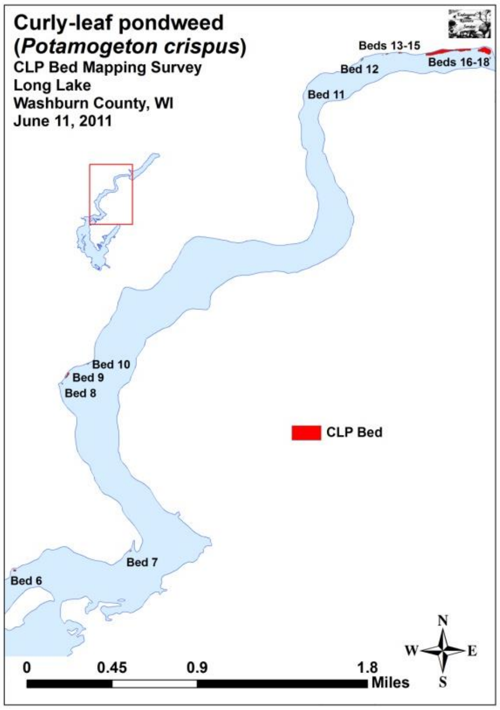


Figure 6: CLP Map of Beds 7-18 and Mature CLP with Turion in Bed 7

Bed 7 – This area occurred in front of a narrow inlet that led to several residences. We noted most CLP was canopied, but the total population was likely <100 plants. Because it occurred in low densities and appeared to be "just another plant" in the macrophyte community, this area may have been better described as a High Density Area. Plants had already set turions (Figure 6).

Bed 8 – Located just east of the boat landing, Bed 8 was established in 4-6ft of water and was nearly monotypic. The bed was not canopied, but still had growth to complete and was only 1ft below the surface.

Bed 9 – Bed 9 was nearly monotypic, but plants were widely scattered and only 2-3ft tall in 5ft of water. Turions had already formed indicating growth was completed. The area was almost exclusively sand/gravel which normally is poor CLP habitat; this is the most likely explanation for the minimal growth.

Beds 10 – Located directly in front of a series of docks, this bed was small in size and not canopied, but was moderately dense. Due to its narrow size, it did not appear to be interfering with boat traffic.

Beds 11 – Canopied and monotypic, Bed 11 was really nothing more than a 3ft super cluster of plants. Despite this, they were the only CLP plants in the area, and we felt it was worth noting.

Beds 12-15 – These four beds were scattered along the developed north shoreline on the west end of the channel region west of the Narrows just before the lake turns to the south. Plants ranged from scattered to a mean rake fullness value of 2. Few places were canopied, and the beds were often fragmentary with most parts of them being better described as High Density Areas.

Figure 7: Canopied CLP in Bed 16 West of the Narrows

Bed 16 – Stretching from approximately 400 yards down the shoreline, Bed 16 was monotypic, dense, and canopied on the inner half before becoming fragmentary and mixed with natives (primarily Coontail (*Ceratophyllum demersum*), Common waterweed (*Elodea canadensis*), Large-leaf pondweed (*Potamogeton amplifolius*), Fries pondweed (*Potamogeton friesii*), Clasping-leaf pondweed (*Potamogeton richardsonii*), and Flat-stem pondweed (*Potamogeton zosteriformis*)) on the outer half (Figure 7). The bed was likely an annoyance to local residents, but, due to its narrow nature, they probably would have had to clear their props only once to get to deeper water.

Figure 8: CLP Bed 17 West of the Narrows

Bed 17 – Located near Duffy's boat-up bar, Bed 17 was easily the worst CLP area on the lake. The bed was 120 yards long by 60 yards wide and was a rake fullness of 3 throughout. We noted numerous prop trails throughout the bed, and boaters likely had to clear their motors several times to navigate through the area. Other than CLP, White water lily (*Nymphaea odorata*) and blobs of filamentous algae were the only other common plants we documented (Figure 8).

Bed 18 – Bed 18 was similar in nature to and essentially a continuation of Bed 17. We did, however, note a distinct edge to both beds with only widely scattered CLP plants between so we decided to separate the two. If herbicide treatment were ever to occur in the future, we believe merging the two areas would be justified.

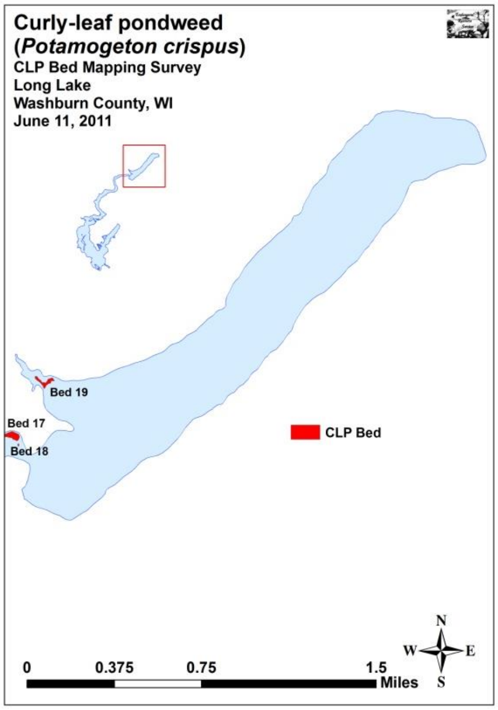


Figure 9: CLP Map of Beds 17-19 and Rice/CLP in Bed 19

Bed 19 – Located in the bay just around the corner from/north of the Narrows boat landing, Bed 19 barely qualified as a bed as the CLP was highly fragmented. Rake fullness values were also highly variable from <1-3 with the majority of areas rating a 1. Northern wild rice (*Zizania palustris*), Spatterdock (*Nuphar variegata*), and blobs of filamentous algae were mixed in throughout the area (Figure 9).

July Warm Water Full Point/Intercept Survey:

Depth soundings taken at Long Lake's 2,128 accessible survey points revealed both the northeast bay and the "thumb" were classic glacial lake areas with deep trenches and rapid drop-offs from shore. The channel region was also generally trench-like with sharp drop-offs, but the main basin had highly variable underwater topography with many bars projecting from shore, as well as several sunken islands (Figure 10) (Appendix V).

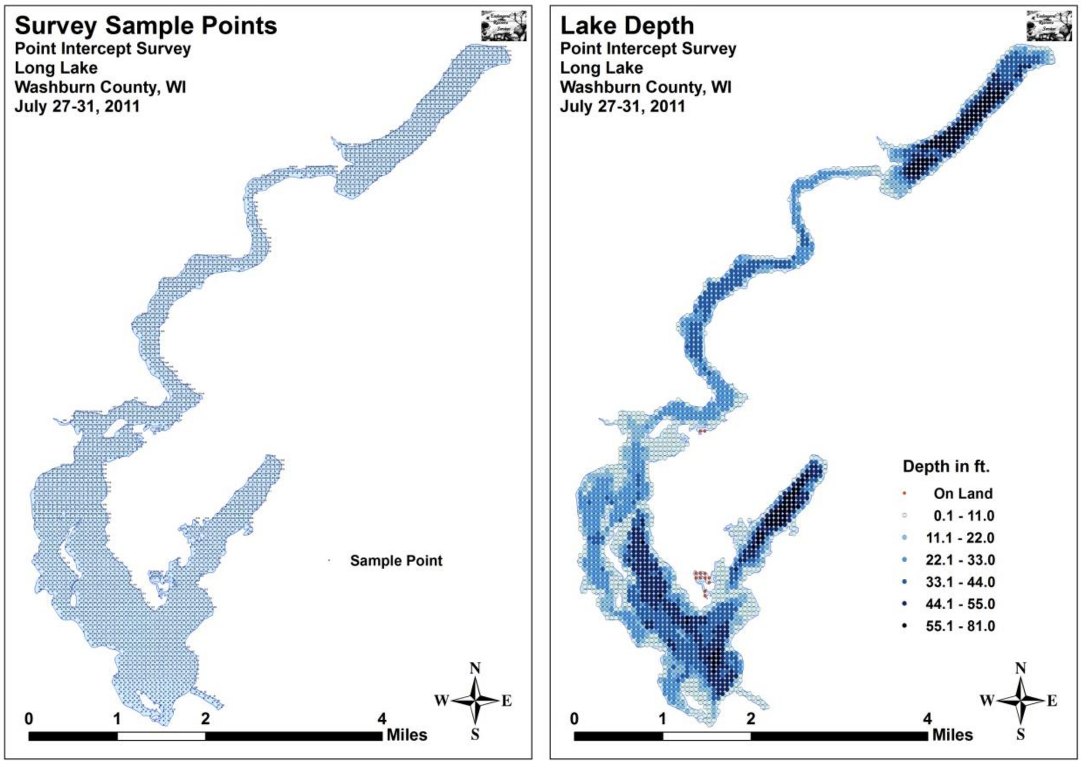


Figure 10: Survey Sample Points and Lake Depth

Of the 698 survey points where we could determine the substrate, 46.4% were muck, 27.0% were rock, and 26.6% were pure sand. Nutrient rich organic muck dominated the lake bottom in shallow side bays while sandy muck was common in deeper areas with limited plant growth. The lake shore was extremely variable, but we found most locations were some combination of sand and rock. In the main basin, most of the exposed points, bars, and islands were also sandy or rocky in nature (Figure 11). We found plants growing at 584 sites or approximately 27.4% of the entire lake bottom and in 84.8% of the littoral zone. Despite a lake wide littoral upper limit of 17.0ft, most plant growth ended in 14.0ft of water (Figure 11) (Table 2) (Appendix V).

Overall diversity was extremely high with a Simpson Diversity Index value of 0.94. Species richness was also quite high, even for a large lake, as we identified 59 total species growing in and immediately adjacent to the water. The mean and median depths of plant growth were both 6.0ft. Total rake fullness was moderately high averaging 2.32 at sights with vegetation. In general, species richness, diversity and total rake biomass declined rapidly at depths beyond 11ft (Figure 12) (Appendix VI).

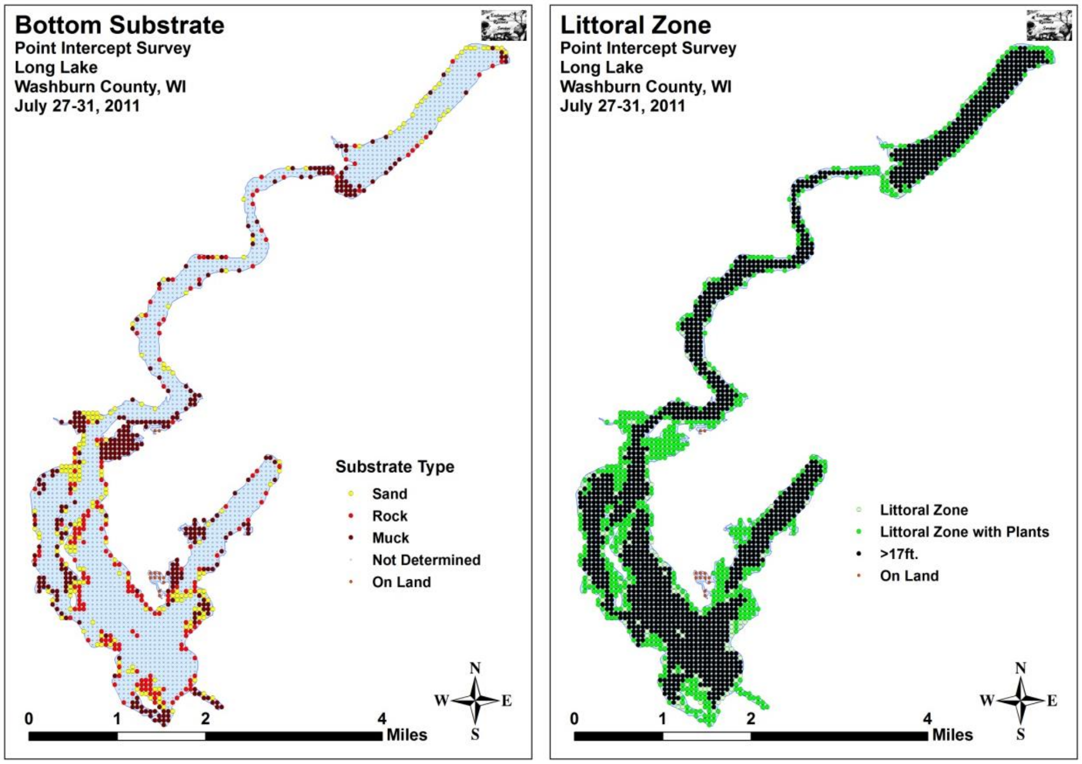


Figure 11: Bottom Substrate and Littoral Zone

Table 2: Aquatic Macrophyte P/I Survey Summary Statistics Long Lake, Washburn County July 27-31, 2011

Summary Statistics:

Total number of points sampled	2,128
Total number of sites with vegetation	584
Total number of sites shallower than the maximum depth of plants	689
Frequency of occurrence at sites shallower than maximum depth of plants	84.76
Simpson Diversity Index	0.94
Maximum depth of plants (ft)	17.0
Mean depth of plants (ft)	6.0
Median depth of plants (ft)	6.0
Number of sites sampled using rope rake (R)	35
Number of sites sampled using pole rake (P)	657
Average number of all species per site (shallower than max depth)	3.30
Average number of all species per site (veg. sites only)	3.89
Average number of native species per site (shallower than max depth)	3.29
Average number of native species per site (veg. sites only)	3.88
Species richness	52
Species richness (including visuals)	53
Species richness (including visuals and boat survey)	59
Average rake fullness (veg. sites only)	2.32

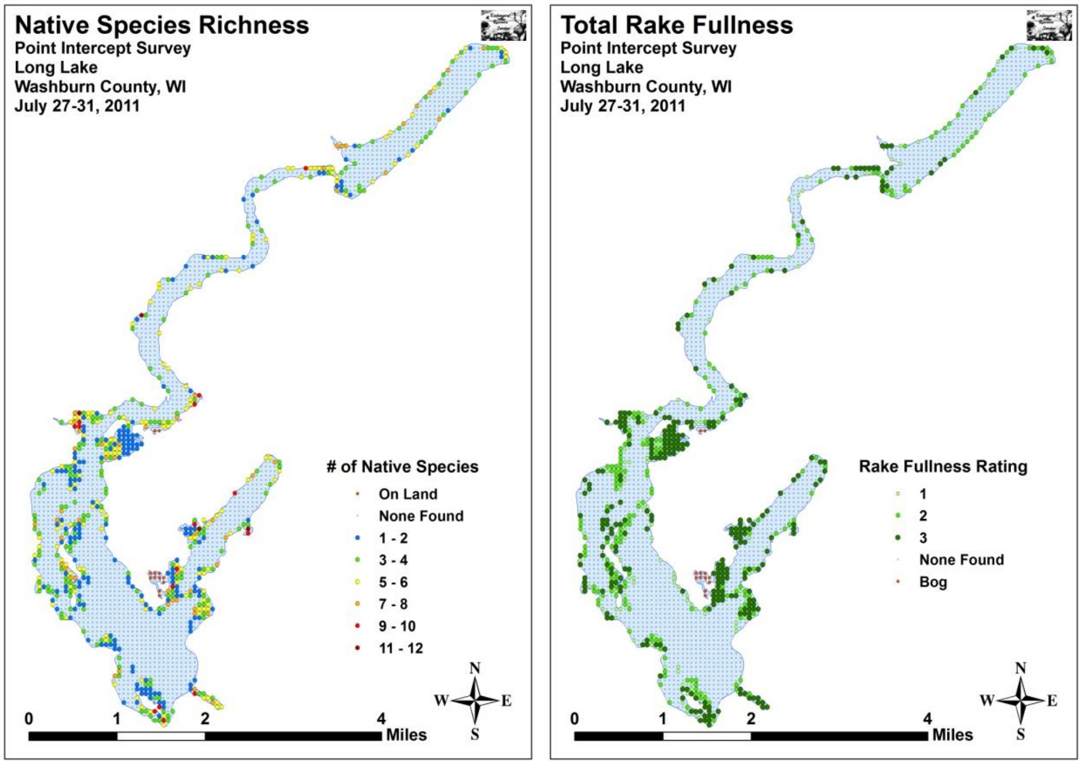


Figure 12: Native Species Richness and Total Rake Fullness

The Long Lake ecosystem is home to a rich and diverse plant community that is primarily a function of the local water depth and substrate. This community can be subdivided into four distinct zones (emergent, floating-leaf, shallow submergent, and deep submergent) with each zone having its own characteristic functions in the lake ecosystem. Depending on the local bottom type (rock, sand, firm muck, or soft muck (boggy), these zones often had somewhat different species present.

In shallow areas, beds of emergent plants stabilize 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. Wild rice shoots and grain are also prized for food by muskrats and waterfowl.

Over firm sand and gravel, Hardstem bulrush (*Schoenoplectus acutus*), Water horsetail (*Equisetum fluviatile*), Pickerelweed (*Pontederia cordata*), and Common bur-reed (*Sparganium eurycarpum*) were common species. They were replaced by Softstem bulrush (*Schoenoplectus tabernaemontani*) and Cattails (*Typha* spp.) in areas that had firm nutrient rich organic muck. In shallow boggy bay areas with stumps, Northern wild rice, Bald spikerush (*Eleocharis erythropoda*), Wild calla (*Calla palustris*), Short-stemmed bur-reed (*Sparganium emersum*), and tussocks of sedge (*Carex* spp.) were the most common emergent species.

Hardstem bulrush and Pickerelweed (Berg 2011)

Water horsetail (Elliot, 2007)

Softstem bulrush (Schwarz, 2011)

Common bur-reed (Raymond, 2011)

Northern wild rice and "Duckweeds" in the channel connecting Long and Mud Lakes (Berg, 2011)

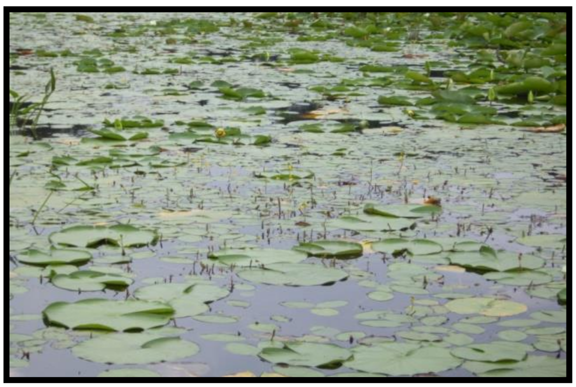
Short-stemmed bur-reed (Gmelin, 2009)

Just beyond the emergents, in up to 5ft of water, organic muck bottomed areas were dominated by the floating-leaf species Watershield (*Brasenia schreberi*), White-water lily, Spatterdock, Large-leaf pondweed, and Floating-leaf pondweed (*Potamogeton natans*). The protective canopy cover they provide is often utilized by panfish and bass.

Growing amongst these floating-leaf species, we also often found the submergent species Coontail, Common waterweed, Whorled water milfoil (*Myriophyllum verticillatum*), Blunt-leaved pondweed (*Potamogeton obtusifolius*), Small pondweed (*Potamogeton pusillus*), and Stiff pondweed (*Potamogeton strictifolius*). In addition to these rooted plants, were also frequently encountered at least a few Bladderworts (*Utricularia* spp.) and floating "duckweeds".


Spatterdock (Lind, 2011)


White water lily (Gmelin, 2009)


White water lily, Common bladderwort, Large-leaf pondweed and Watershield (Berg, 2011)


Watershield (Gmelin, 2009)


Flat-leaf bladderwort (Koshere, 2002)


Whorled water milfoil (Sulman, 2008)

In sand and sandy muck bottomed areas that didn't support nutrient dependent floating-leaved species, the submergent plants Muskgrass (*Chara* sp.), Needle spikerush (*Eleocharis acicularis*), Water star-grass (*Heteranthera dubia*), Northern water milfoil (*Myriophyllum sibiricum*), Slender naiad (*Najas flexilis*), Fries' pondweed, Variable pondweed (*Potamogeton gramineus*), Clasping-leaf pondweed, Crested arrowhead (*Sagittaria cristata*), Sago pondweed (*Stuckenia pectinata*), and Wild celery (*Vallisneria americana*) were common in water up to 7ft deep. These species are heavily utilized by waterfowl for food and larval insects and other invertebrates for habitat as well as providing a variety of fish habitat throughout their life cycles.

Muskgrass (Penuh, 2007)

Northern water milfoil (Berg, 2006)

Slender naiad (Koshere, 2002)

Variable pondweed (Koshere, 2002)

Clasping-leaf pondweed (Koshere, 2002)

Sago pondweed (Hilty, 2012)

Deeper areas in 7-17ft of water over sand and rock were often devoid of plants, but muck bottom areas were dominated by Coontail, Common waterweed, Large-leaf pondweed, Illinois pondweed (*Potamogeton illinoensis*), White-stem pondweed (*Potamogeton praelongus*), Small pondweed, and Flat-stem pondweed. Predatory fish like pike are often found along the edges of these beds waiting in ambush.

Coontail (Hassler, 2011)

Common waterweed (Fischer, 2011)

Large-leaf pondweed (Martin, 2002)

White-stem pondweed (Fewless, 2005)

Small pondweed (Villa, 2011)

Flat-stem pondweed (Fewless, 2004)

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Long Lake, Washburn County
July 27-31, 2011

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Potamogeton zosteriformis	Flat-stem pondweed	249	10.96	42.64	36.14	1.82	15
Ceratophyllum demersum	Coontail	235	10.35	40.24	34.11	1.60	1
Chara sp.	Muskgrass	194	8.54	33.22	28.16	1.91	1
Vallisneria americana	Wild celery	183	8.06	31.34	26.56	1.42	0
Potamogeton friesii	Fries' pondweed	167	7.35	28.60	24.24	1.60	6
Myriophyllum sibiricum	Northern water milfoil	142	6.25	24.32	20.61	1.46	4
Najas flexilis	Slender naiad	117	5.15	20.03	16.98	1.50	6
Elodea canadensis	Common waterweed	115	5.06	19.69	16.69	1.63	0
	Filamentous algae	107	*	18.32	15.53	1.54	0
Potamogeton pusillus	Small pondweed	103	4.54	17.64	14.95	1.50	0
Potamogeton richardsonii	Clasping-leaf pondweed	70	3.08	11.99	10.16	1.36	38
Potamogeton illinoensis	Illinois pondweed	65	2.86	11.13	9.43	1.26	13
Potamogeton gramineus	Variable pondweed	59	2.60	10.10	8.56	1.32	2
Nymphaea odorata	White water lily	54	2.38	9.25	7.84	2.24	8
Lemna trisulca	Forked duckweed	53	2.33	9.08	7.69	1.51	1
Stuckenia pectinata	Sago pondweed	47	2.07	8.05	6.82	1.28	10
Typha glauca	Hybrid cattail	32	1.41	5.48	4.64	2.84	2
Potamogeton amplifolius	Large-leaf pondweed	30	1.32	5.14	4.35	1.27	14
Spirodela polyrhiza	Large duckweed	28	1.23	4.79	4.06	1.86	0
Potamogeton strictifolius	Stiff pondweed	27	1.19	4.62	3.92	1.22	0
Heteranthera dubia	Water star-grass	26	1.14	4.45	3.77	1.23	2
Lemna minor	Small duckweed	25	1.10	4.28	3.63	1.28	0

* Excluded from Rel. Freq.

Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Long Lake, Washburn County
July 27-31, 2011

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Nuphar variegata	Spatterdock	24	1.06	4.11	3.48	2.38	5
Eleocharis acicularis	Needle spikerush	22	0.97	3.77	3.19	1.59	0
Potamogeton praelongus	White-stem pondweed	20	0.88	3.42	2.90	1.25	11
Potamogeton robbinsii	Fern pondweed	20	0.88	3.42	2.90	1.75	2
Zizania palustris	Northern wild rice	20	0.88	3.42	2.90	1.40	6
Wolffia columbiana	Common watermeal	17	0.75	2.91	2.47	1.35	0
Sagittaria cristata	Crested arrowhead	16	0.70	2.74	2.32	1.56	2
Schoenoplectus acutus	Hardstem bulrush	12	0.53	2.05	1.74	1.83	1
Potamogeton natans	Floating-leaf pondweed	10	0.44	1.71	1.45	2.00	3
Potamogeton obtusifolius	Blunt-leaf pondweed	9	0.40	1.54	1.31	1.67	0
Pontederia cordata	Pickerelweed	7	0.31	1.20	1.02	2.14	4
Sparganium emersum	Short-stemmed bur-reed	7	0.31	1.20	1.02	1.29	5
Utricularia vulgaris	Common bladderwort	7	0.31	1.20	1.02	1.14	4
Myriophyllum verticillatum	Whorled water milfoil	6	0.26	1.03	0.87	2.17	3
Nitella sp.	Nitella	6	0.26	1.03	0.87	1.17	0
Typha latifolia	Broad-leaved cattail	6	0.26	1.03	0.87	2.67	1
Ranunculus aquatilis	White water crowfoot	5	0.22	0.86	0.73	1.60	0
	Aquatic moss	4	*	0.68	0.58	1.75	0
Brasenia schreberi	Watershield	4	0.18	0.68	0.58	1.75	4
Potamogeton crispus	Curly-leaf pondweed	4	0.18	0.68	0.58	1.00	0
Utricularia minor	Small bladderwort	4	0.18	0.68	0.58	1.25	1
Bidens beckii	Water marigold	3	0.13	0.51	0.44	1.00	0

* Excluded from Rel. Freq.

Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Long Lake, Washburn County
July 27-31, 2011

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Carex comosa	Bottle brush sedge	3	0.13	0.51	0.44	1.33	1
Schoenoplectus tabernaemontani	Softstem bulrush	3	0.13	0.51	0.44	1.67	1
Sparganium eurycarpum	Common bur-reed	3	0.13	0.51	0.44	2.00	0
Utricularia gibba	Creeping bladderwort	3	0.13	0.51	0.44	1.33	1
Calla palustris	Wild calla	2	0.09	0.34	0.29	2.00	0
Eleocharis erythropoda	Bald spikerush	2	0.09	0.34	0.29	2.50	0
Utricularia intermedia	Flat-leaf bladderwort	2	0.09	0.34	0.29	1.50	0
Equisetum fluviatile	Water horsetail	1	0.04	0.17	0.15	1.00	0
Potamogeton foliosus	Leafy pondweed	1	0.04	0.17	0.15	1.00	0
Sagittaria rigida	Sessile-fruited arrowhead	1	0.04	0.17	0.15	2.00	0
Sagittaria latifolia	Common arrowhead	**	**	**	**	**	1
Bolboschoenus fluviatilis	River bulrush	***	***	***	***	***	***
Eleocharis palustris	Creeping spikerush	***	***	***	***	***	***
Juncus effusus	Common rush	***	***	***	***	***	***
Leersia oryzoides	Rice cut-grass	***	***	***	***	***	***
Polygonum amphibium	Water smartweed	***	***	***	***	***	***
Riccia fluitans	Slender riccia	***	***	***	***	***	***
Typha angustifolia	Narrow-leaved cattail	***	***	***	***	***	***

** Visual Only   *** Boat Survey Only

When considering all the plants on the lake, Flat-stem pondweed, Coontail, Muskgrass, and Wild celery were the most common macrophyte species being found at 42.64%, 40.24%, 33.22%, and 31.34% of survey points with vegetation (Table 3) (Figure 13). Together, they combined for a very low 37.91% of the total relative frequency which indicated a high level of evenness in the plant community (Normally the top four species in a lake are >50%). Fries' pondweed (7.35), Northern water milfoil (6.25), Slender naiad (5.15), and Common waterweed (5. 06) were the only other species with a relative frequency over 5.0 (Species accounts and distribution maps for all plants found are located in Appendices VII and VIII).

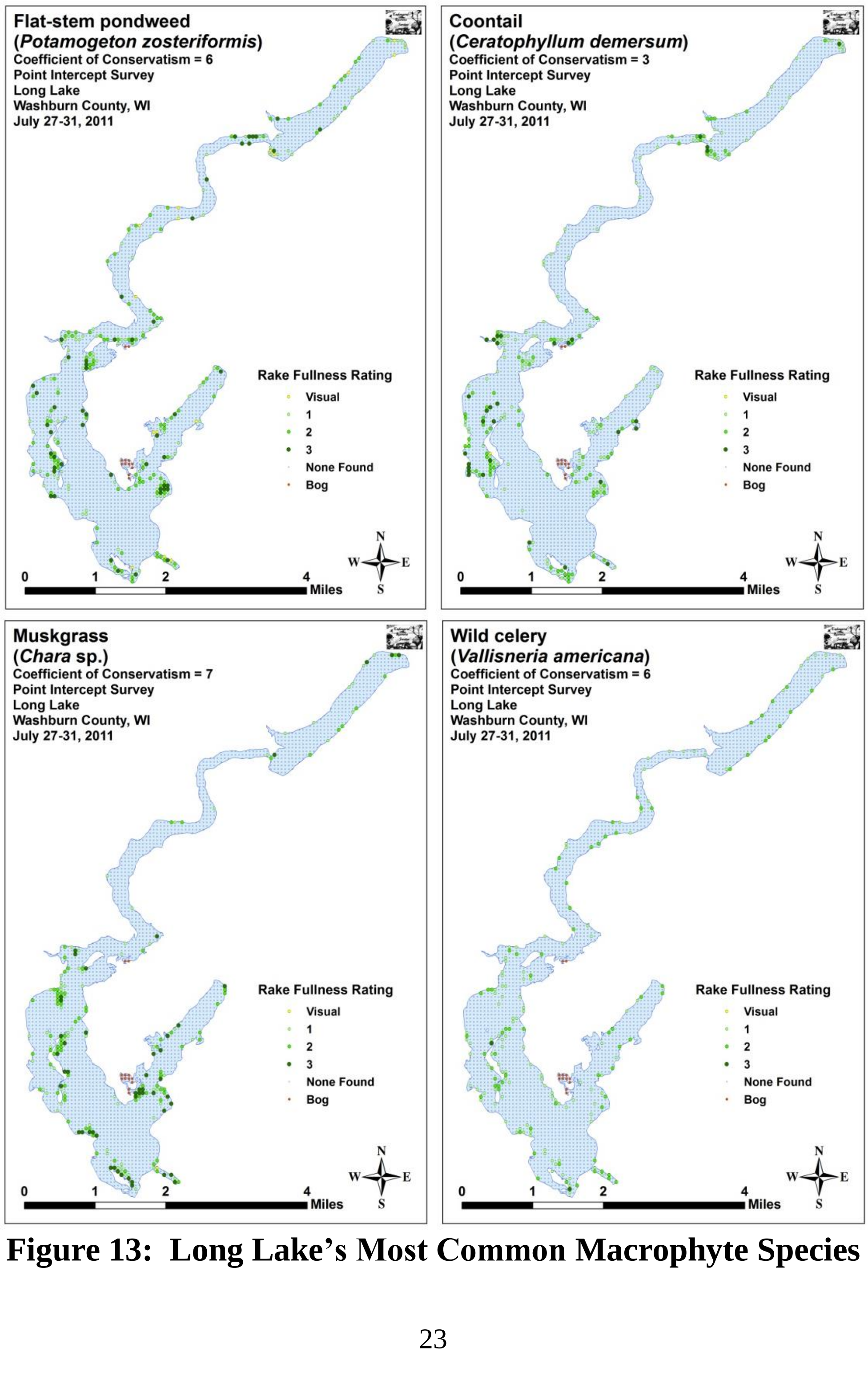


Figure 13: Long Lake's Most Common Macrophyte Species

Table 4: Floristic Quality Index of Aquatic Macrophytes
Long Lake, Washburn County
July 27-31, 2011

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Calla palustris	Wild calla	9
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Eleocharis acicularis	Needle spikerush	5
Eleocharis erythropoda	Bald spikerush	3
Elodea canadensis	Common waterweed	3
Equisetum fluviatile	Water horsetail	7
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Lemna trisulca	Forked duckweed	6
Myriophyllum sibiricum	Northern water milfoil	6
Myriophyllum verticillatum	Whorled water milfoil	8
Najas flexilis	Slender naiad	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	8
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton foliosus	Leafy pondweed	6
Potamogeton friesii	Fries' pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton illinoensis	Illinois pondweed	6
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton obtusifolius	Blunt-leaf pondweed	9
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6
Ranunculus aquatilis	White water crowfoot	8
Sagittaria cristata	Crested arrowhead	9
Sagittaria rigida	Sessile-fruited arrowhead	8
Schoenoplectus acutus	Hardstem bulrush	6
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium emersum	Short-stemmed bur-reed	8
Sparganium eurycarpum	Common bur-reed	5
Spirodela polyrhiza	Large duckweed	5
Stuckenia pectinata	Sago pondweed	3

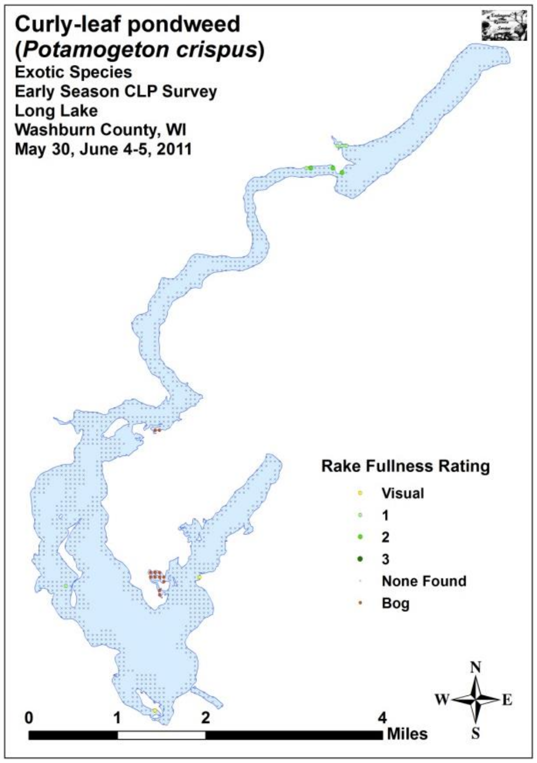
Table 4 (cont'): Floristic Quality Index of Aquatic Macrophytes
Long Lake, Washburn County
July 27-31, 2011

Typha latifolia	Broad-leaved cattail	1
Typha X *glauca*	Hybrid cattail	1
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia minor	Small bladderwort	10
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
Zizania palustris	Northern wild rice	8
N		51
Mean C		6.3
FQI		44.9

We identified a total of 51 **native index plants** to species on the rake during the point intercept survey. They produced a mean Coefficient of Conservatism of 6.3 and a Floristic Quality Index of 44.9 (Table 4). Nichols (1999) reported an average Mean C for the Northern Central Hardwood Forests Region of 5.6 putting Long Lake above average for this part of the state. The FQI was more than double the median FQI of 20.9 for the Northern Central Hardwood Forests Region (Nichols 1999). This exceptionally high value is likely a result of Long Lake's large size, variable substrate, large areas of undeveloped shoreline, and apparent good water quality and clarity. All of these factors create a diversity of microhabitats which offer a wide variety of plants suitable growing conditions. Specifically, the lake supported six extremely high value/sensitive species including Wild Calla (C = 9), Blunt-leaf pondweed (C = 9), Crested arrowhead (C = 9), Creeping bladderwort (*Utricularia gibba*) (C = 9), Flat-leaf bladderwort (*Utricularia intermedia*) (C = 9), and Small bladderwort (*Utricularia minor*) (C = 9).

We did NOT find any evidence of Eurasian water milfoil in Long Lake during the May/June Curly-leaf pondweed surveys or the July full point intercept survey. By July, the limited amount of CLP we had seen in May and June had almost entirely senesced as we found a single CLP plant at each of only three points (Figure 14).

Hybrid cattail (*Typha* X *glauca*) and its parent species Narrow-leave cattail (*Typha angustifolia*) are native to southern but not northern Wisconsin. It is potentially invasive and appeared to be excluding the native Broad-leaved cattail (*Typha latifolia*) from many places on the lake where the two were found together (Figure 15). Because of this, there is the potential that it will continue to spread beyond the three bays where it dominated the emergent plant community (For more information on aquatic exotic invasive plant species, see Appendix IX).



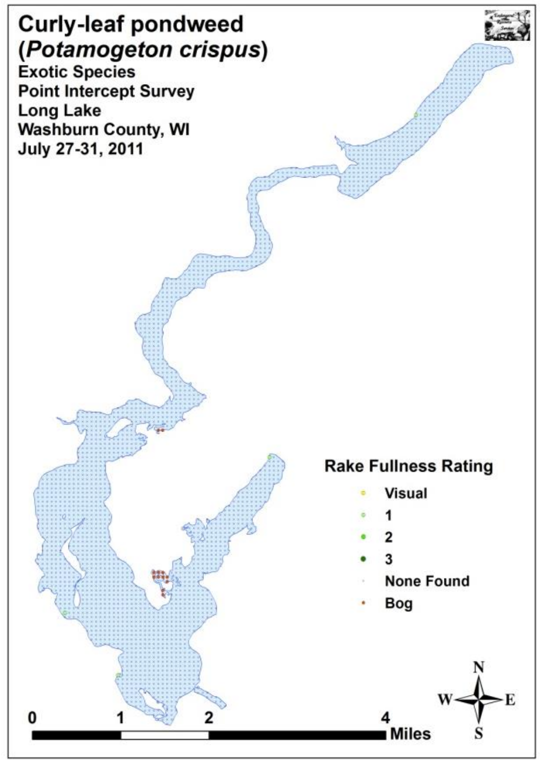


Figure 14: Long Lake's May-June/July CLP Distribution and Density

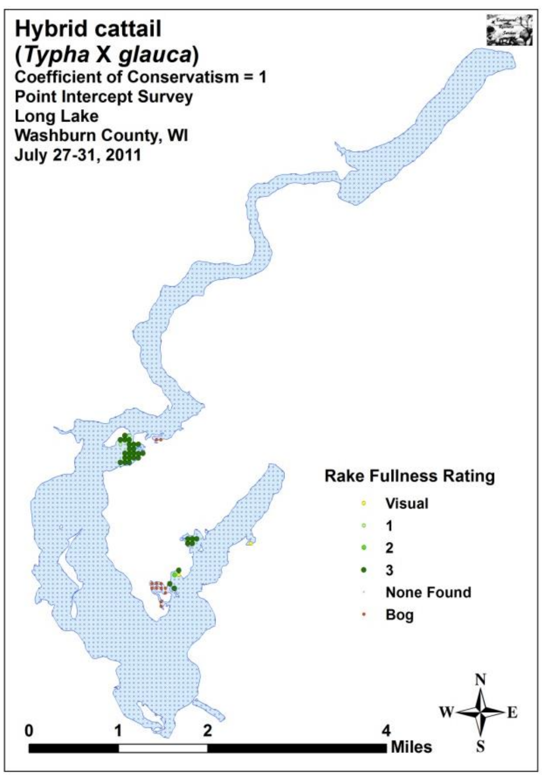


Figure 15: Long Lake's July Hybrid Cattail Distribution and Density

We located filamentous algae at 107 sites throughout Long Lake. It was present at approximately 18% of sites with vegetation and had an average rake fullness value of 1.54. With the exception of the muck bottomed bay located at the Mud Lake Channel Outlet, almost all of these sites were located in front of residences (Figure 16). Normally, these algae proliferate in environments where there are excessive nutrients in the water.

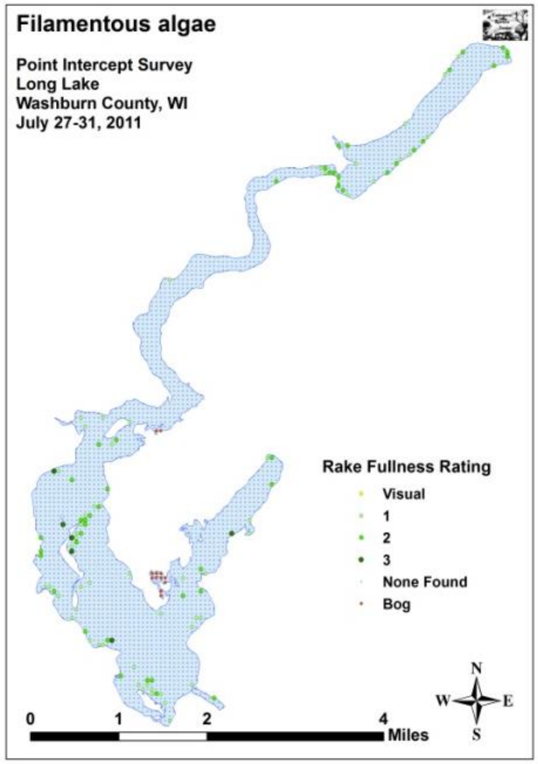


Figure 16: Long Lake's July Filamentous Algae Distribution and Density

Northern wild rice, a plant of significant wildlife and cultural value, was widely scattered throughout Long Lake. We found most rice plants were growing in creek and seep inlets as well as in sheltered muck bottomed bays; especially those that had stump fields (Figure 17). Lakewide, it was present in the rake at 20 points. Of these, none had a rake fullness value of 3, eight were a 2, and the rest were a one. We also recorded rice as a visual at six additional points. With the possible exception of the bed that was established in the inlet of the unnamed creek that drains the Devils/Twin Lakes System, most rice was extremely patchy and not fit for harvest (Figure 18).

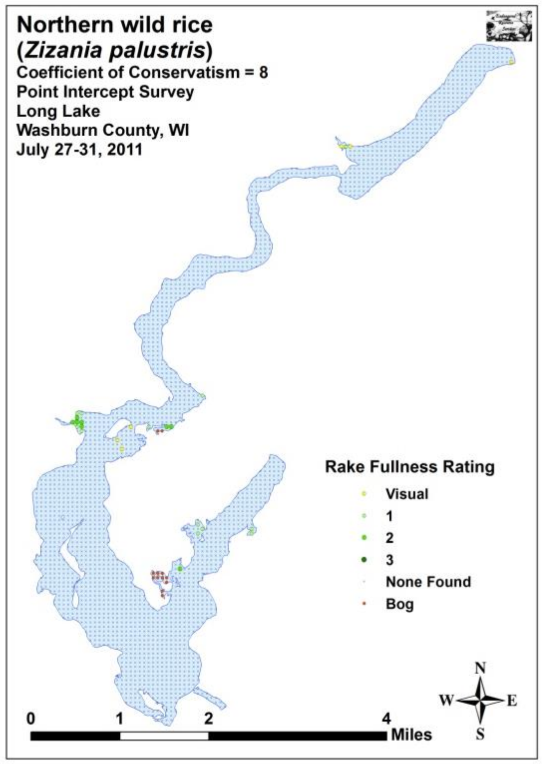


Figure 17: Long Lake's July Northern Wild Rice Distribution and Density

Figure 18: Low Density Wild Rice in the Bay North of the Narrows

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Water Clarity and the Role of Native Macrophytes:

Preserving Long Lake's truly exceptional native plant communities should be a top management priority. Macrophytes are the base of the aquatic food pyramid, provide habitat for other aquatic organisms, are important food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve water clarity by absorbing excess nutrients from the water. However, when nutrients in the water column increase to levels beyond what macrophytes can absorb, "duckweeds" and filamentous and floating algae tend to proliferate leading to declines in both water clarity and quality.

Long Lake currently has generally good water clarity, but the presence of scattered patches of thick filamentous algae along stretches of the lake's more developed shorelines indicate there is still room for improvement. Even if some of these nutrients are coming from internal sediment loading/recycling, or some other source beyond the lake owners' control, anything residents can do to limit nutrient input into the system could help further improve water clarity and quality.

Continually educating lake residents about reducing nutrient input directly along the lake is one of the easiest ways to decrease algal growth and improve water clarity. Not mowing down to the shoreline, bagging grass clippings, switching to a phosphorus-free fertilizer or eliminating fertilizer altogether would all be positive steps towards this end. Wherever possible, restoring shorelines, constructing rain gardens and creating buffer strips of native vegetation would also enhance water quality by preventing erosion and runoff. We consistently noted that property owners that implemented at least some of these conservation measures had improved water quality/clarity in front of their residences while owners who did not had noticeably higher filamentous algae growth (Figure 19). Hopefully, a greater understanding of how individual property owners can have lakewide impacts will result in more people taking appropriate conservation actions to ensure improved water quality for all.

Figure 19: Model Natural Shoreline on Another Nearby Washburn Co. Lake

Curly-leaf pondweed:

Curly-leaf pondweed was widespread but seldom abundant in Long Lake. Beds 16, 17 and 18 were the noticeable exceptions to this, and, in these areas, treatment may be warranted. However, outside these areas, CLP did not appear to be interfering with navigation and was seldom invasive. Based on this, we believe that focusing on limiting CLP's spread is likely the best management practice at the present time.

During our time on the lake, we noticed that most CLP plants/beds were established in areas along docks and landings. Conversely, CLP was completely absent from pristine shoreline areas that had robust native plant communities. This was not surprising as CLP is an opportunistic species that can rapidly exploit disturbed areas. Lakeshore residents can minimize CLP's opportunities to spread by maintaining the lake's native plants. To accomplish this, lakeshore owners should refrain from removing rooted plants from the lake unless absolutely necessary as these barren patches of substrate not only release nutrients into the water column, but also give CLP a new place to establish where it has a competitive advantage. Avoiding motor start ups in water <5ft deep would also help limit CLP's spread by not clipping or uprooting vegetation. This would also help keep nutrients out of the water column as the lake's soft sediments are easily stirred up by prop wash.

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water milfoil are an increasing problem in the lakes of northern Wisconsin in general, and several lakes in Washburn Co. in particular. During our time on the lake, we were impressed by Long Lake's established Clean Boats/Clean Waters program and the enthusiastic and knowledgeable volunteers that were working to prevent the introduction of new AIS into the system at the lake's boat landings. We strongly recommend continuing this program as CBCW provides the lake with a layer of protection by inspecting incoming/outgoing boats and educating lake visitors about not just AIS, but the resource as a whole. When volunteers aren't present, the signage at the boat landings provides education, reeducation, and continual reminders of the dangers/impacts of AIS to lake residents and visitors alike.

In the future, conducting monthly landing inspections and at least annual meandering shoreline surveys of the entire lake's littoral zone could also result in early detection if AIS are introduced into the lake. The sooner an infestation is detected, the greater the chances it can be successfully and economically controlled. Finally, formulating a potential response to the introduction of an AIS in the new APMP prior to an infestation would help streamline an appropriate response if/when an infestation of EWM or some other AIS occurs.

Management Considerations Summary:

- Preserve native plants and the critical habitat they provide for the whole lake ecosystem.
- Work to improve water clarity and reduce excess algal growth along developed shorelines by working to limit nutrient inputs.
- Specifically, avoid mowing down to the lakeshore and reduce or, if possible, eliminate grass clippings runoff, fertilizer applications, and other sources of nutrients near the lakeshore.
- Encourage shoreline restoration and the establishment of native vegetation buffer strips along the lakeshore to further prevent runoff and erosion.
- Refrain from removing native plants from the lake unless absolutely necessary and avoid motor start ups in shallow water as these practices create patches of barren substrate that make it easier for CLP and new AIS to establish.
- Continue the Long Lake Preservation Association's established Clean Boats/Clean Waters program which serves to inspect incoming/outgoing boats and educate lake residents and visitors about the dangers of AIS.
- Consider carrying out monthly landing inspections and at least annual meandering shoreline surveys of the lake's littoral zone to look for new AIS.
- Complete an Aquatic Plant Management Plan that clarifies a potential response to a new AIS, such as Eurasian water milfoil, if one becomes established in the lake.

LITERATURE CITED

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

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

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

Miller, G., C. Olson, L. Sather, and E. Eaton. [online]. 1965. Long Lake Bathymetric Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2106800a.pdf (2011, December).

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

Sullman, Josh. [online] 2010. Sparganium of Wisconsin Identification Key and Description. Available from University of Wisconsin-Madison http://www.botany.wisc.edu/jsulman/Sparganium%20identification%20key%20and%20description.htm (2011, November).

UWEX Lakes Program. [online]. 2011. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APM/Appendix-C.xls (2011, December).

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

WDNR. [online]. 2011. Curly-leaf pondweed fact sheet. http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm (2011, November).

WDNR. [online]. 2011. Eurasian water milfoil fact sheet. http://www.dnr.state.wi.us/invasives/fact/milfoil.htm (2011, November).

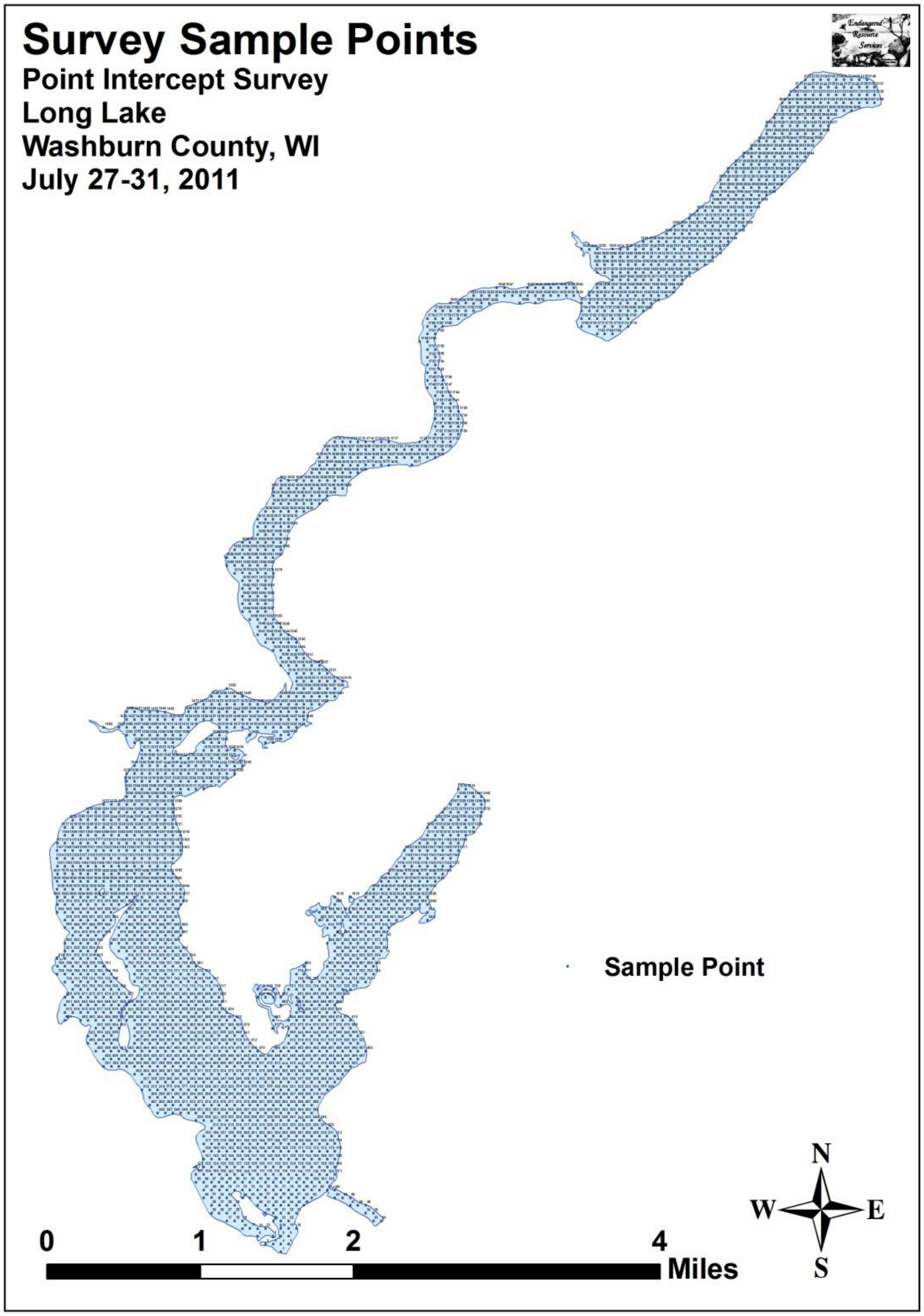
WDNR. [online]. 2011. Purple loosestrife fact sheet. http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm (2011, November).

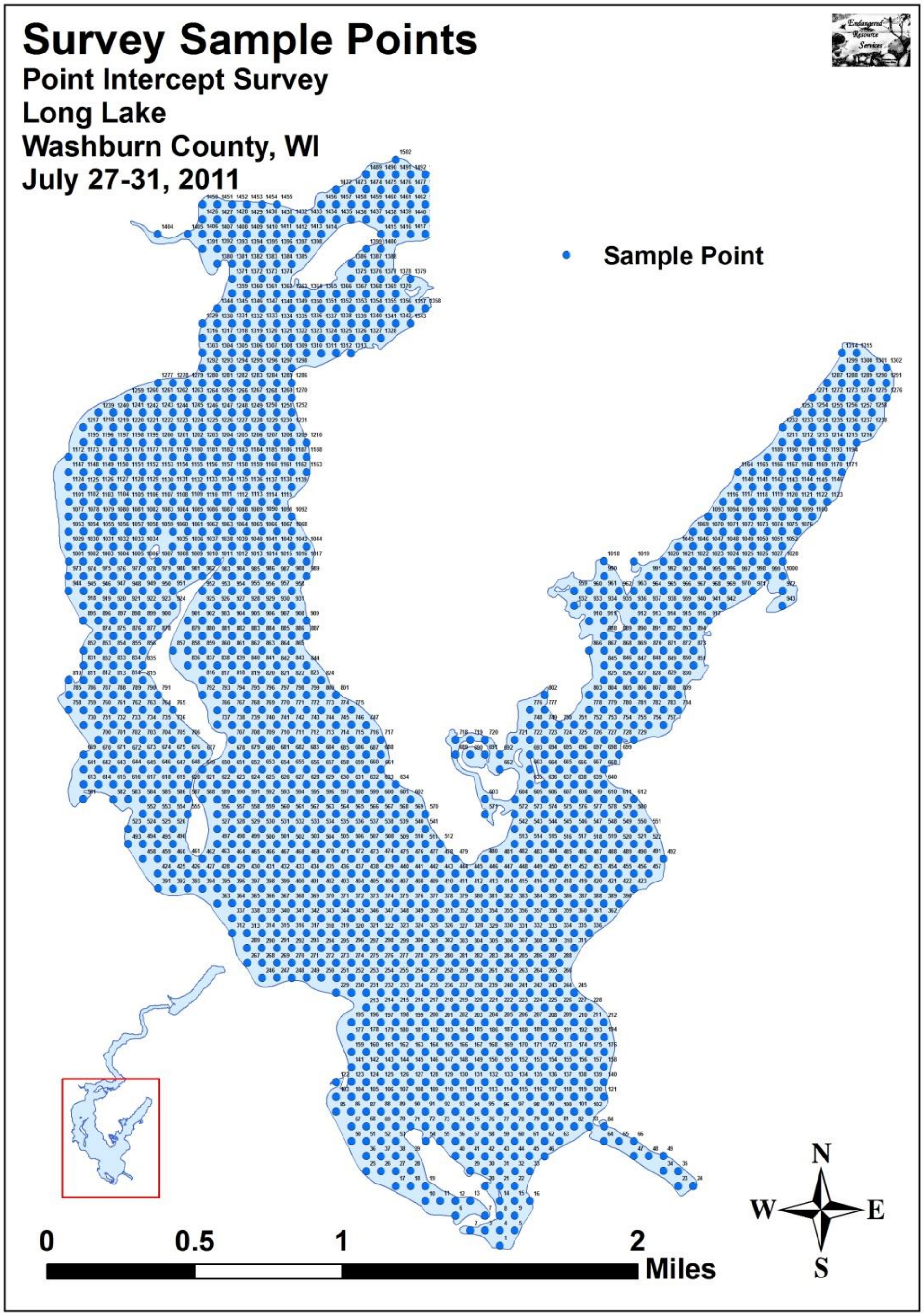
WDNR. [online]. 2011. Reed canary grass fact sheet. http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm (2011, November).

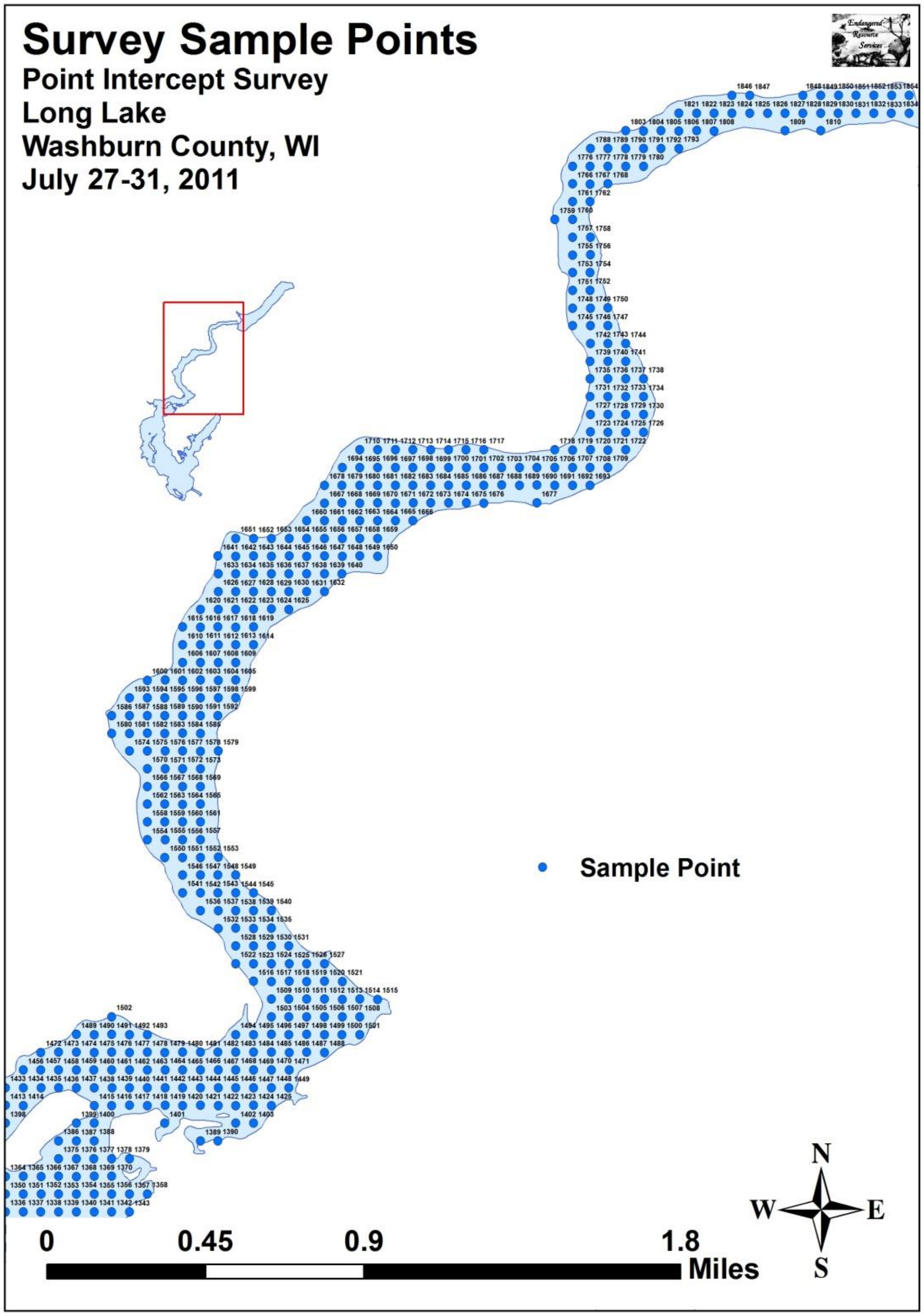
WDNR. [online]. 2009. Wisconsin Lakes. PUB-FH-800 2009. Available from http://dnr.wisconsin.gov/lakes/lakebook/wilakes2010bma.pdf (2011, November).

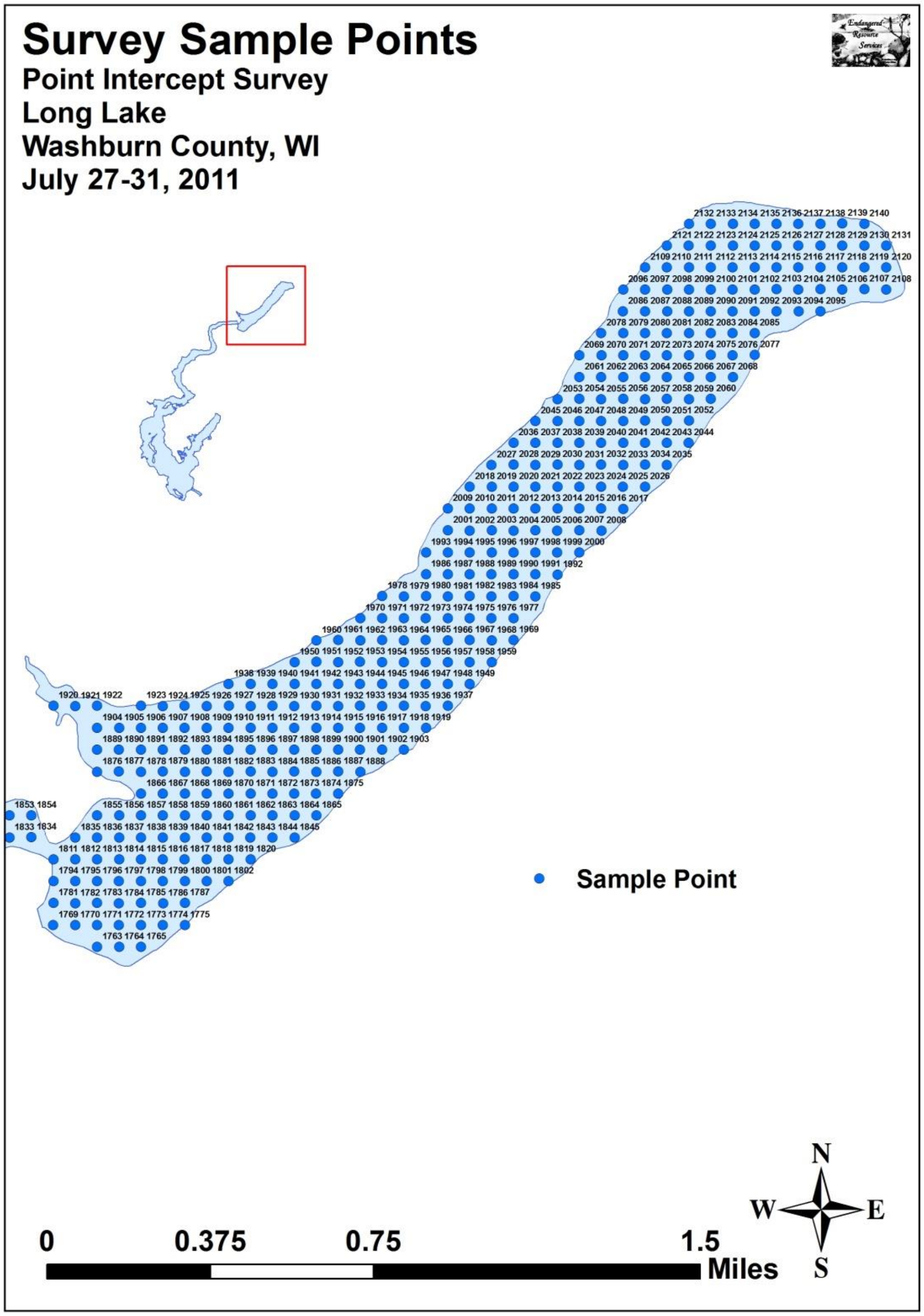
WDNR. [online]. 2011. Wisconsin Lake Citizen Monitoring Data for Washburn County. Available from http://dnr.wi.gov/lakes/clmn/Stations.aspx?Location=66&year=2011 (2011, November).

Appendix I: Long Lake Map with Sample Points


Survey Sample Points
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Sample Point
0
1
2
4
Miles
N
W
E
S


Survey Sample Points
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Sample Point
0
0.5
1
2
Miles
N
W
E
S


Survey Sample Points
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Sample Point
0
0.45
0.9
1.8
Miles
N
W
E
S


Survey Sample Points
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Sample Point
N
W
E
S
0
0.375
0.75
1.5
Miles

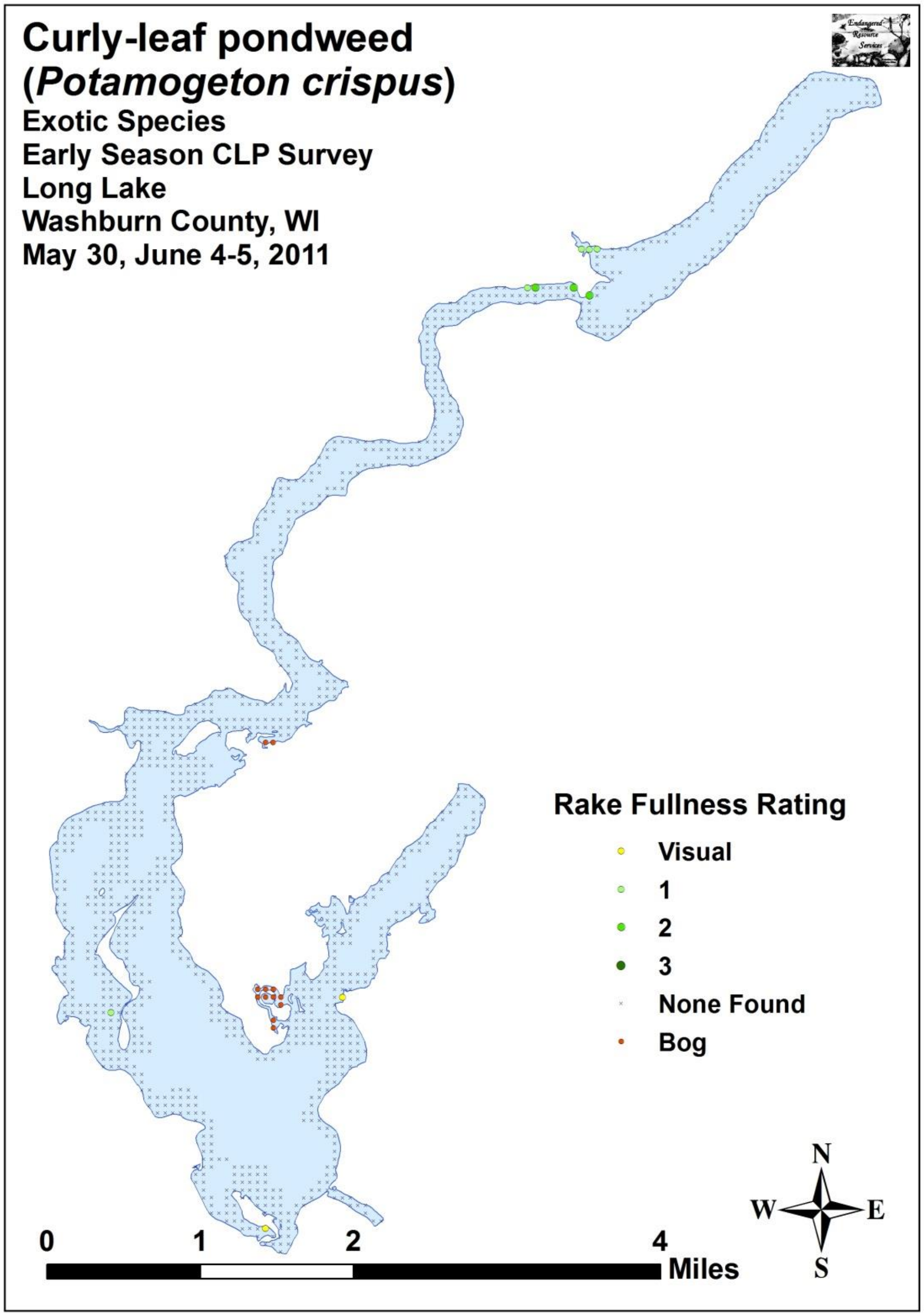
Appendix II: Boat Survey Data Sheet

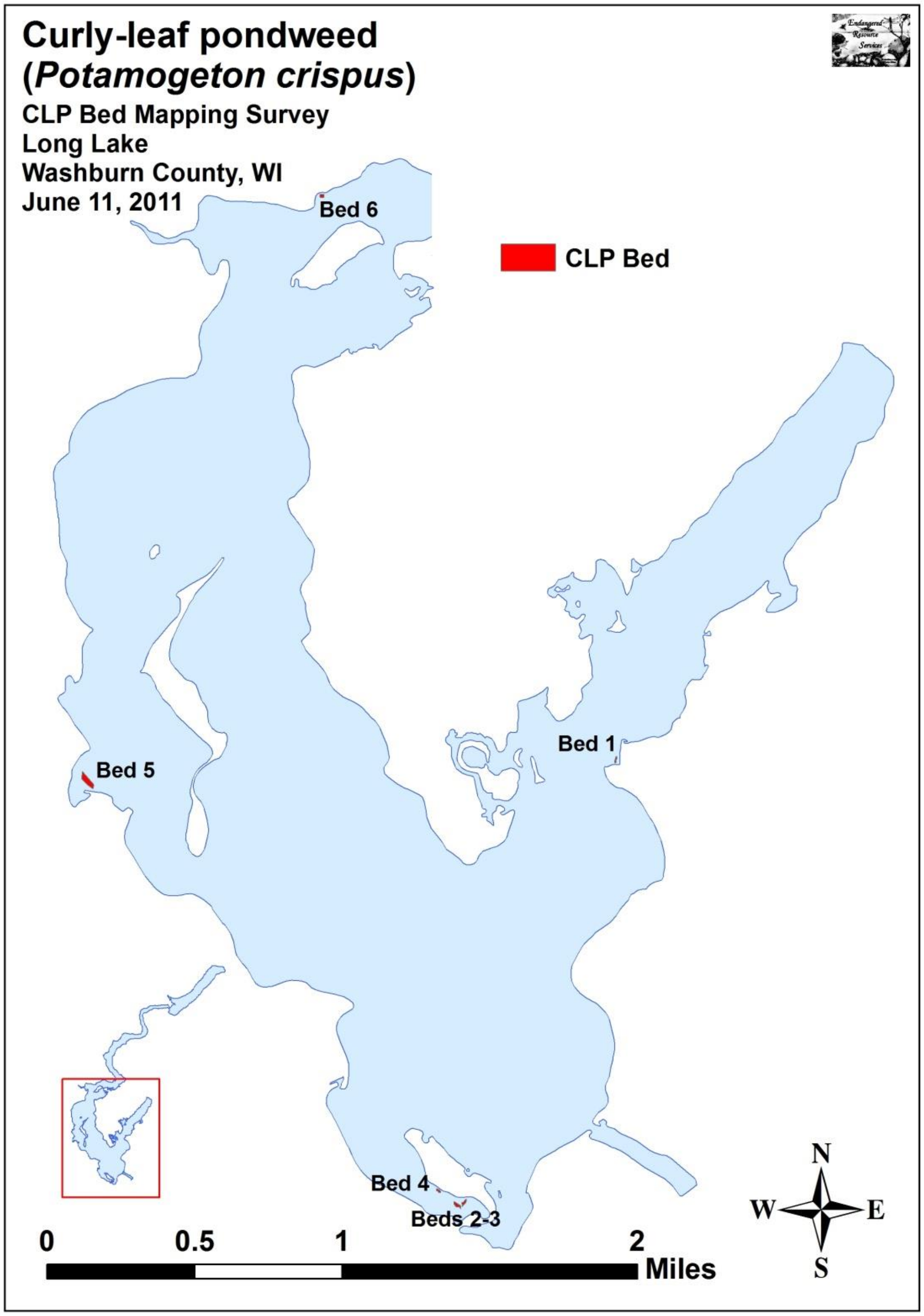
Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	**Species seen, habitat information**

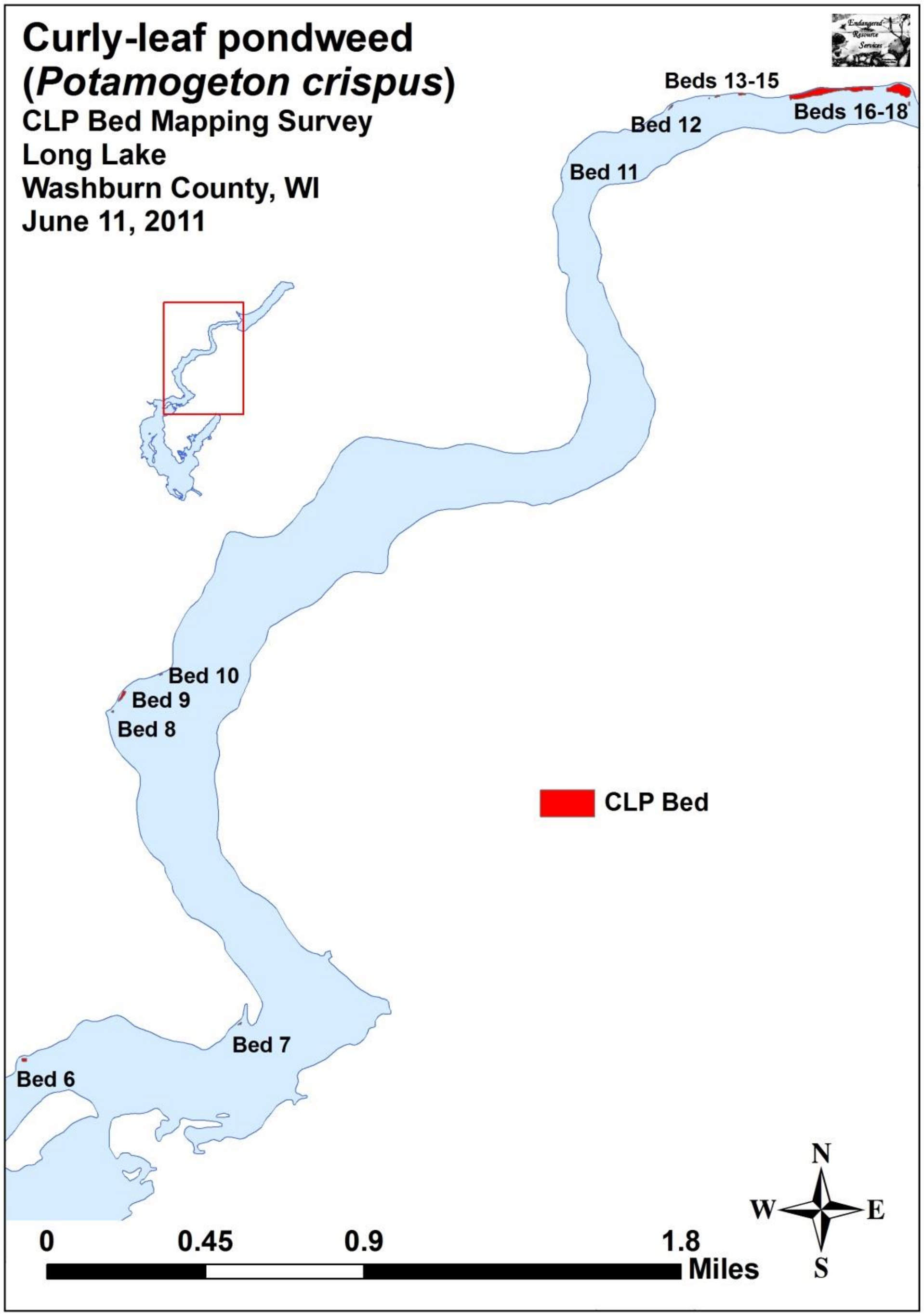
Appendix III: Vegetative Survey Data Sheet

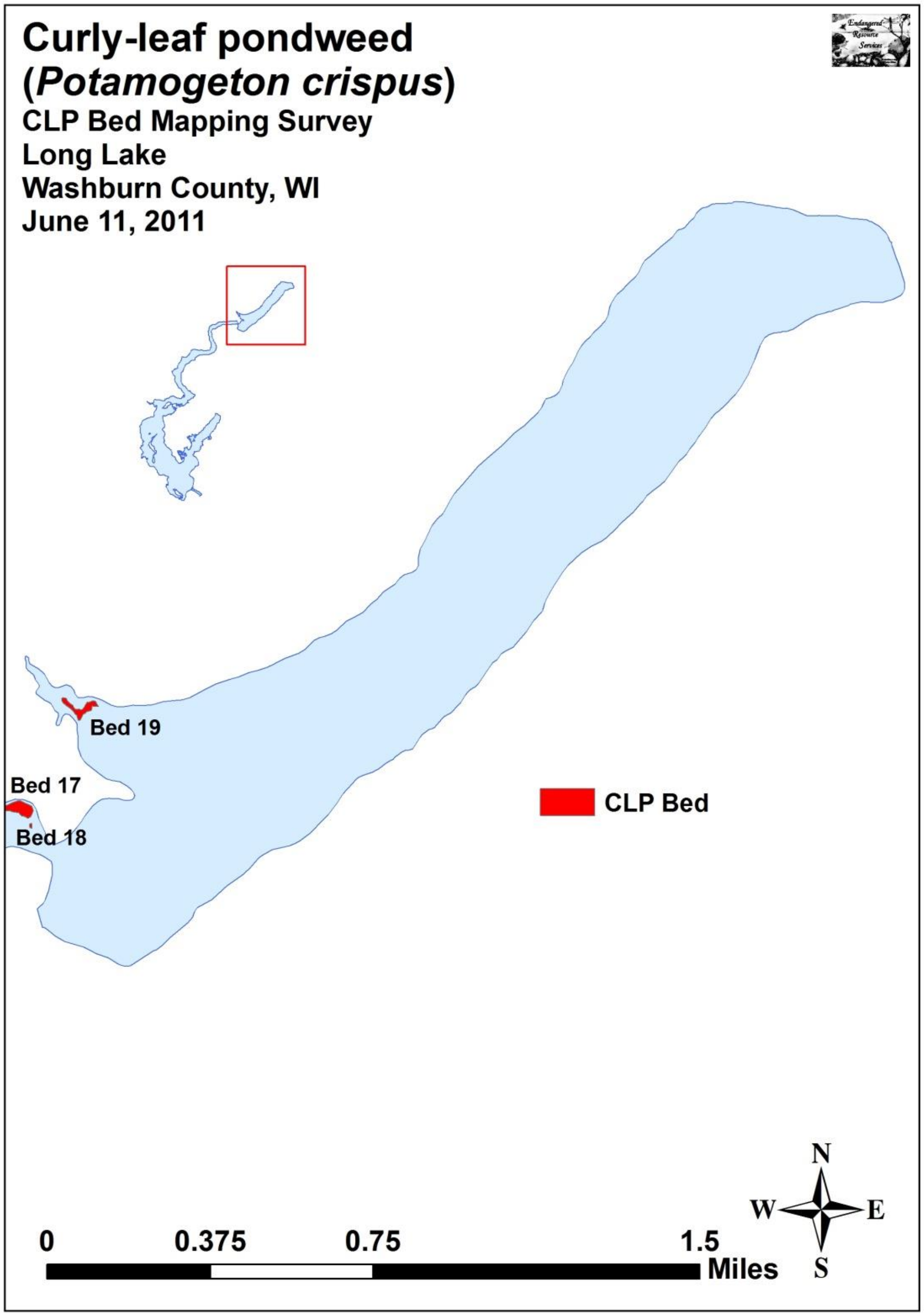
Observers for this lake: names and hours worked by each:																									
Lake:									WBIC									County						Date:	
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	Total Rake Fullness	EWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																	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

Appendix IV: Long Lake May/June CLP Distribution, Density and Bed Maps

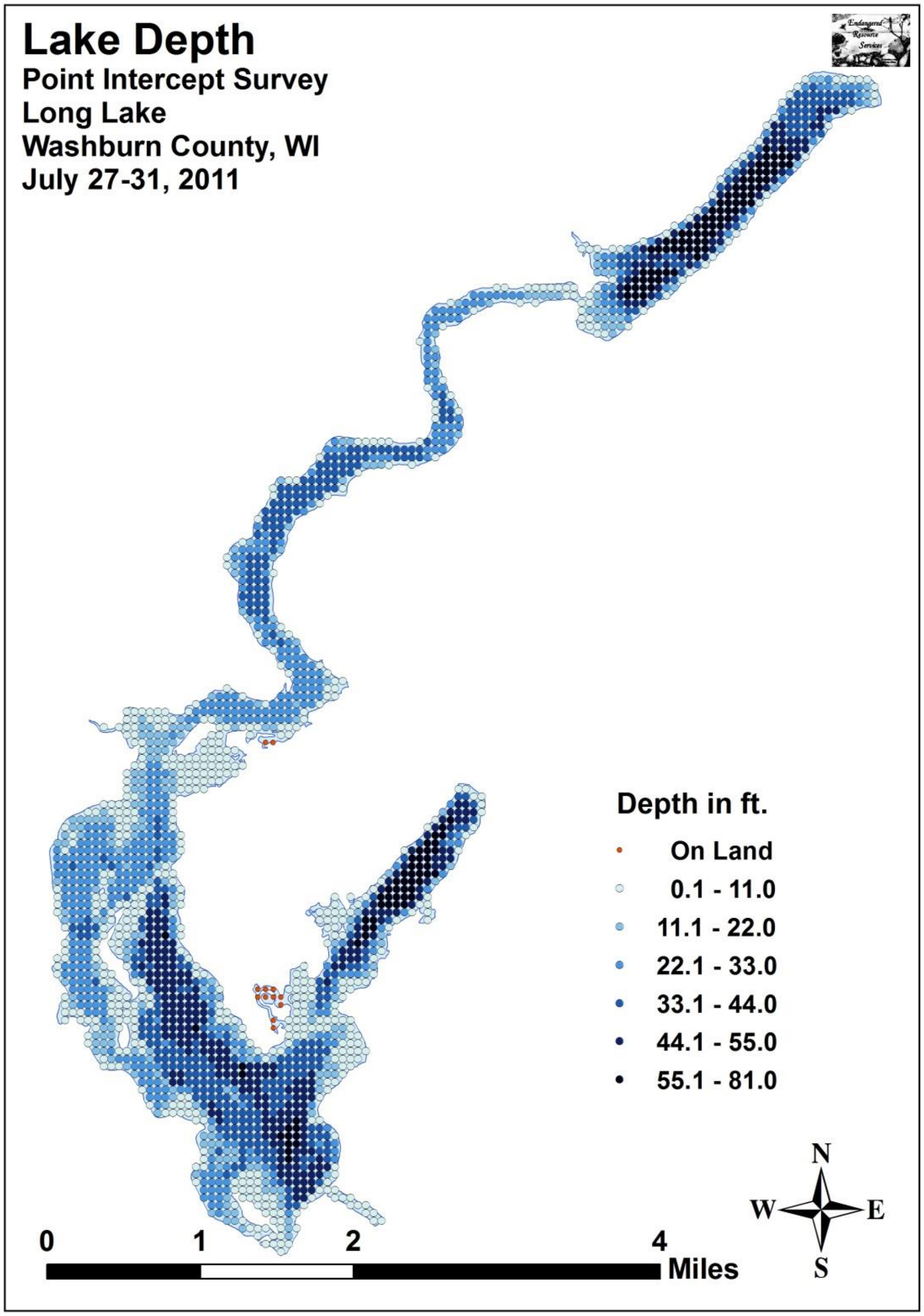

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Early Season CLP Survey
Long Lake
Washburn County, WI
May 30, June 4-5, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

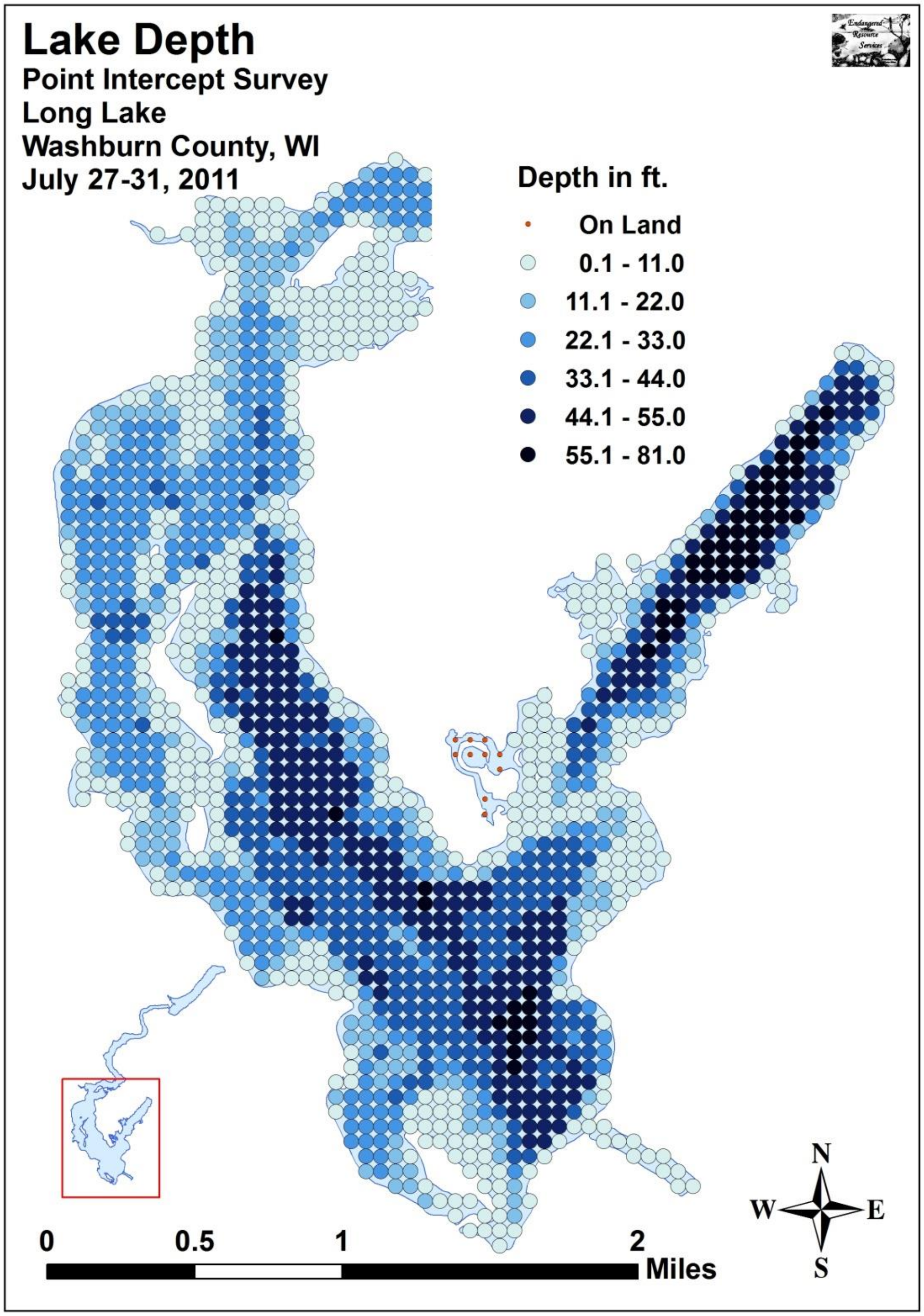

Curly-leaf pondweed
(*Potamogeton crispus*)
CLP Bed Mapping Survey
Long Lake
Washburn County, WI
June 11, 2011
CLP Bed
Bed 6
Bed 1
Bed 5
Bed 4
Beds 2-3
0
0.5
1
2
Miles
N
W
E
S


Curly-leaf pondweed
(*Potamogeton crispus*)
CLP Bed Mapping Survey
Long Lake
Washburn County, WI
June 11, 2011
Beds 13-15
Beds 16-18
Bed 12
Bed 11
Bed 10
Bed 9
Bed 8
Bed 7
Bed 6
CLP Bed
N
W
E
S
0
0.45
0.9
1.8
Miles

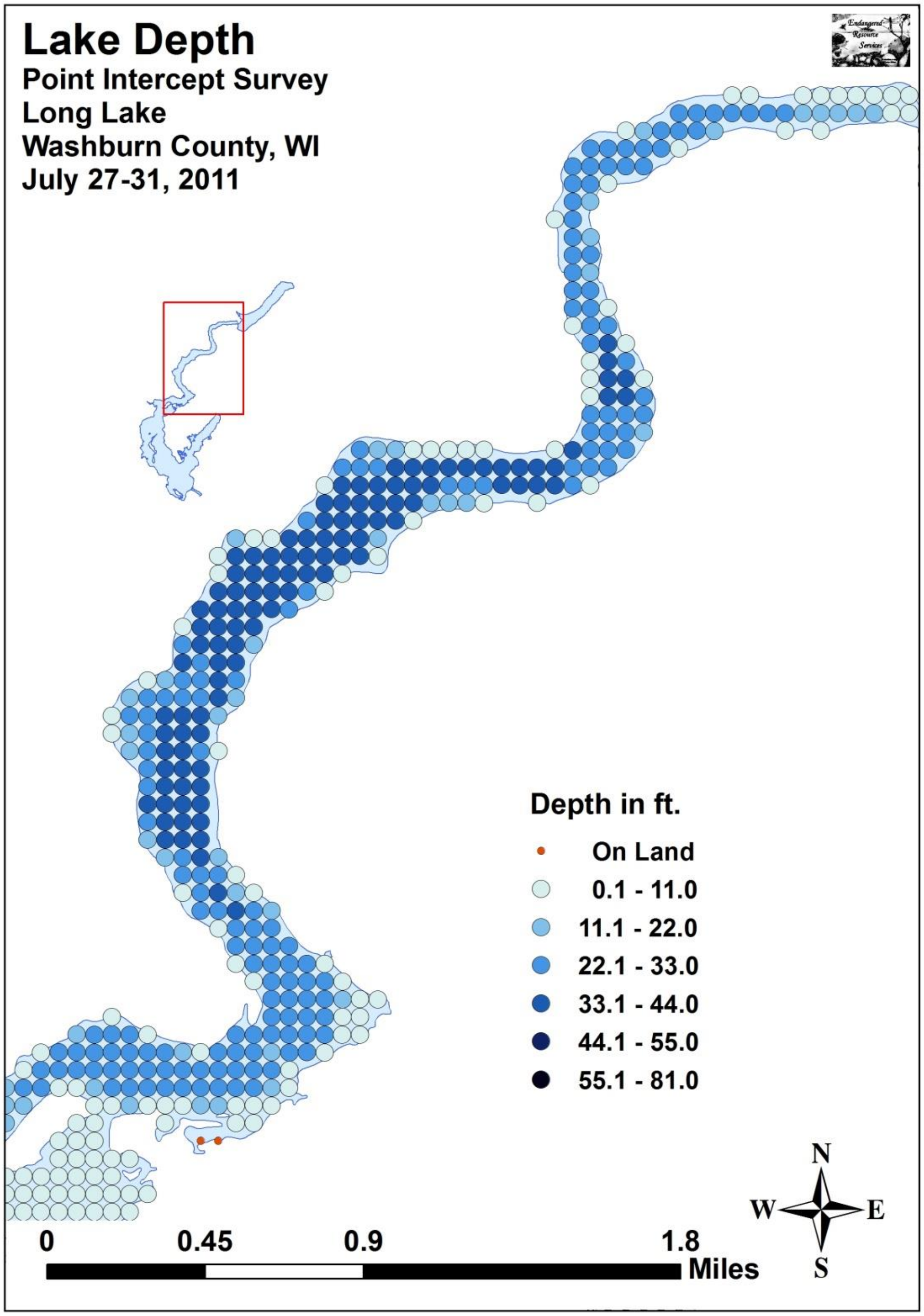

Curly-leaf pondweed
(*Potamogeton crispus*)
CLP Bed Mapping Survey
Long Lake
Washburn County, WI
June 11, 2011
Bed 19
Bed 17
Bed 18
CLP Bed
0
0.375
0.75
1.5
Miles
N
W
E
S

Appendix V: Habitat Variable Maps

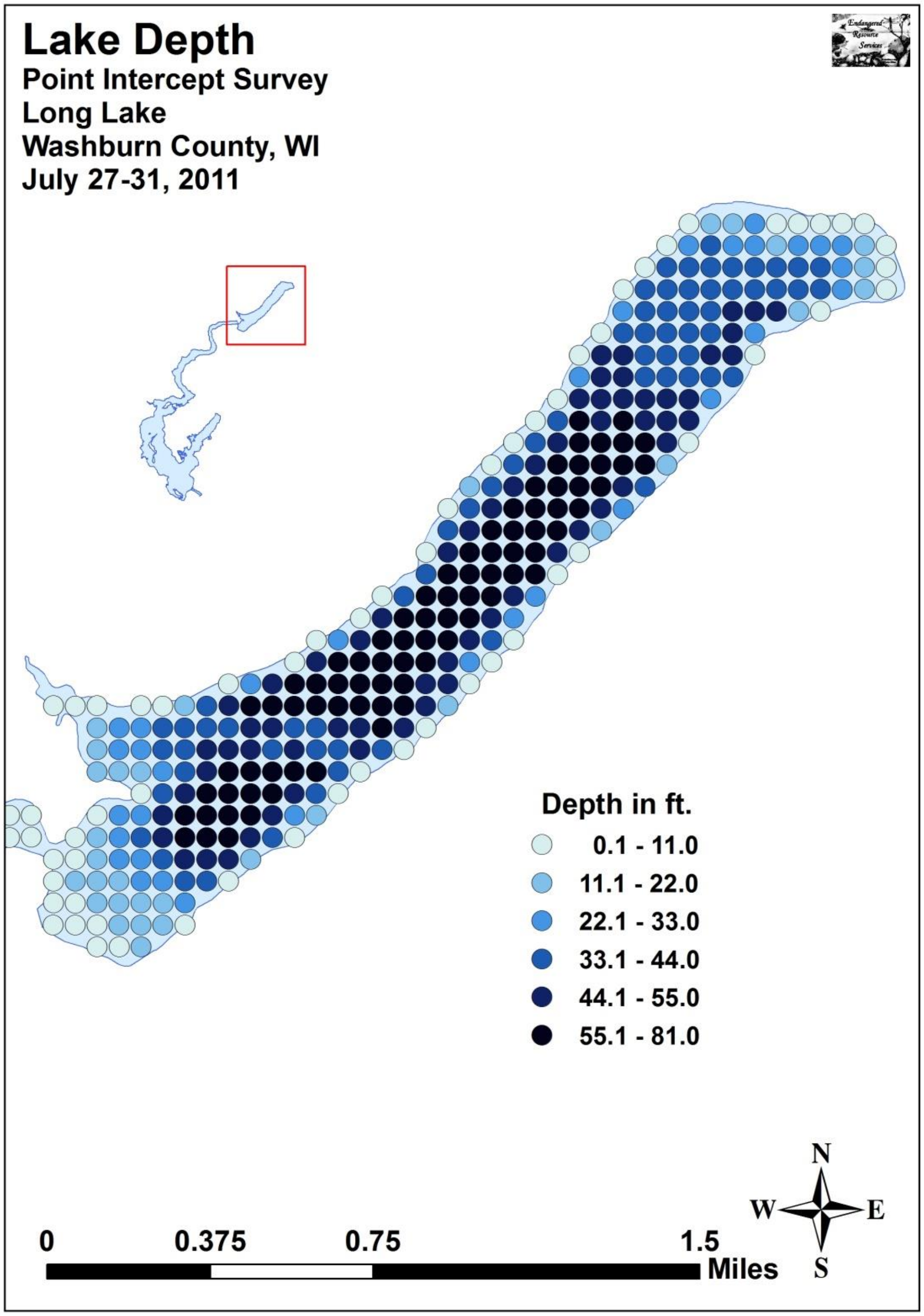

Lake Depth
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Depth in ft.
On Land
0.1 - 11.0
11.1 - 22.0
22.1 - 33.0
33.1 - 44.0
44.1 - 55.0
55.1 - 81.0
N
W
E
S
0
1
2
4
Miles

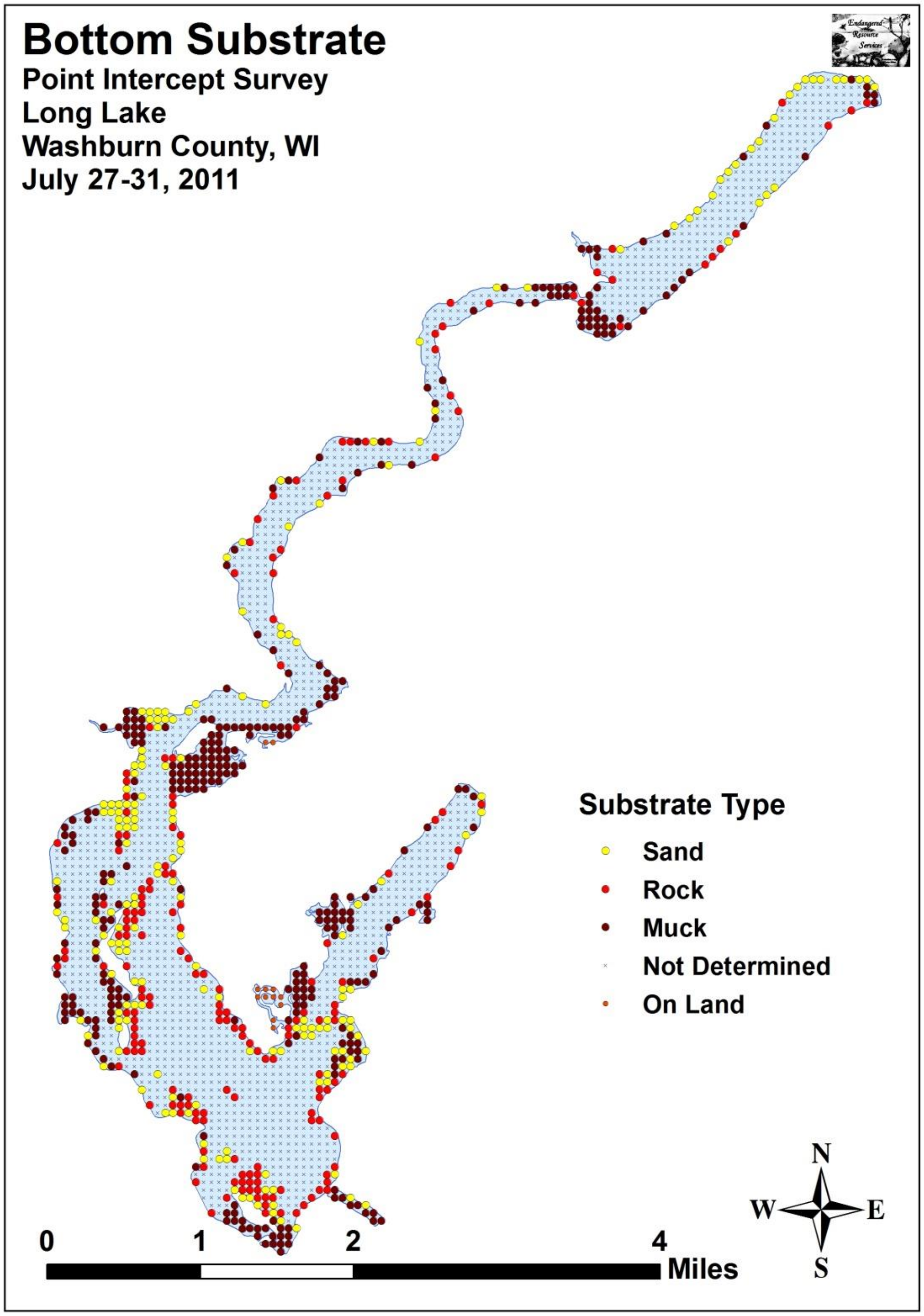


Lake Depth
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Depth in ft.
On Land
0.1 - 11.0
11.1 - 22.0
22.1 - 33.0
33.1 - 44.0
44.1 - 55.0
55.1 - 81.0
0
0.5
1
2
Miles
N
W
E
S

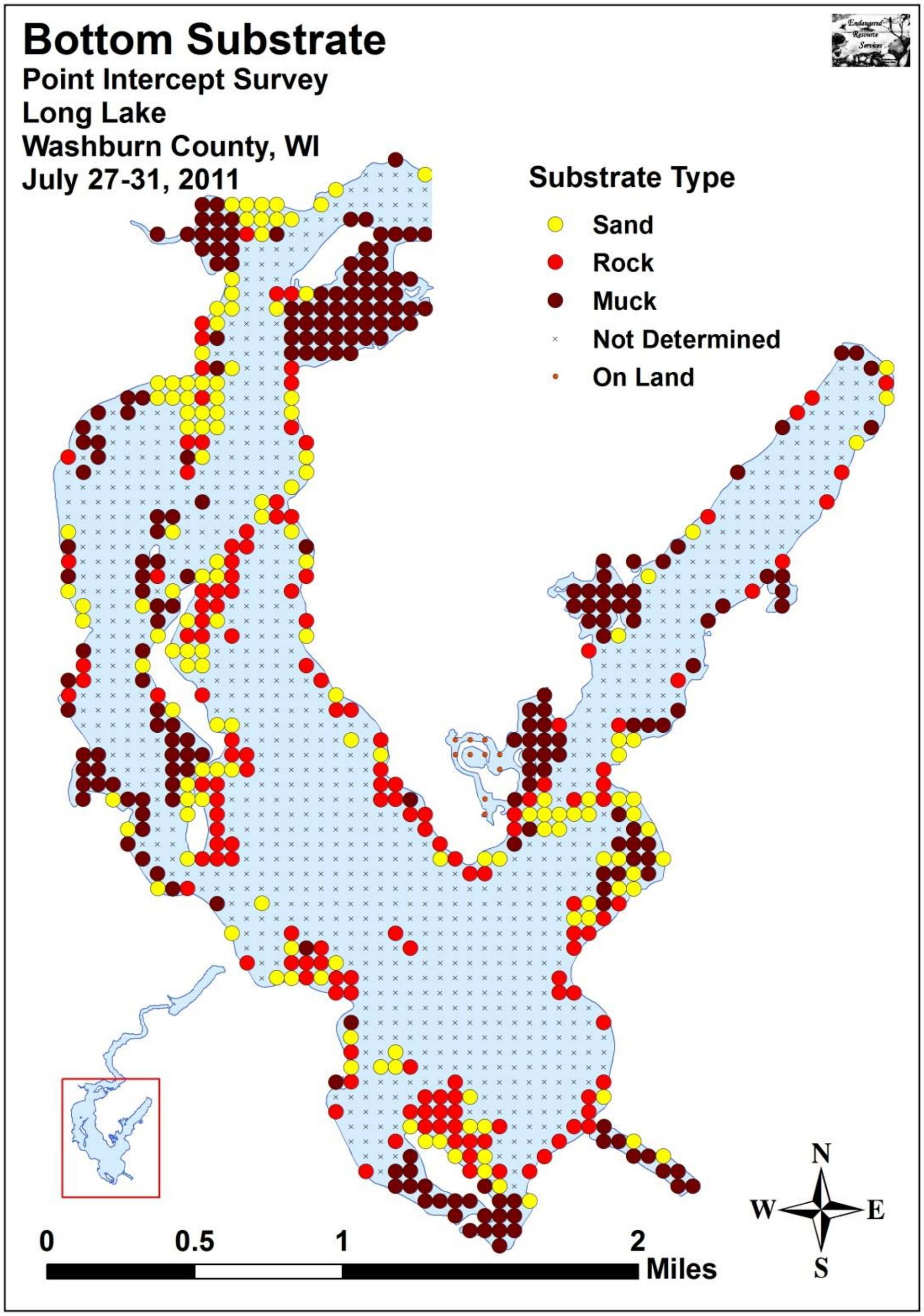


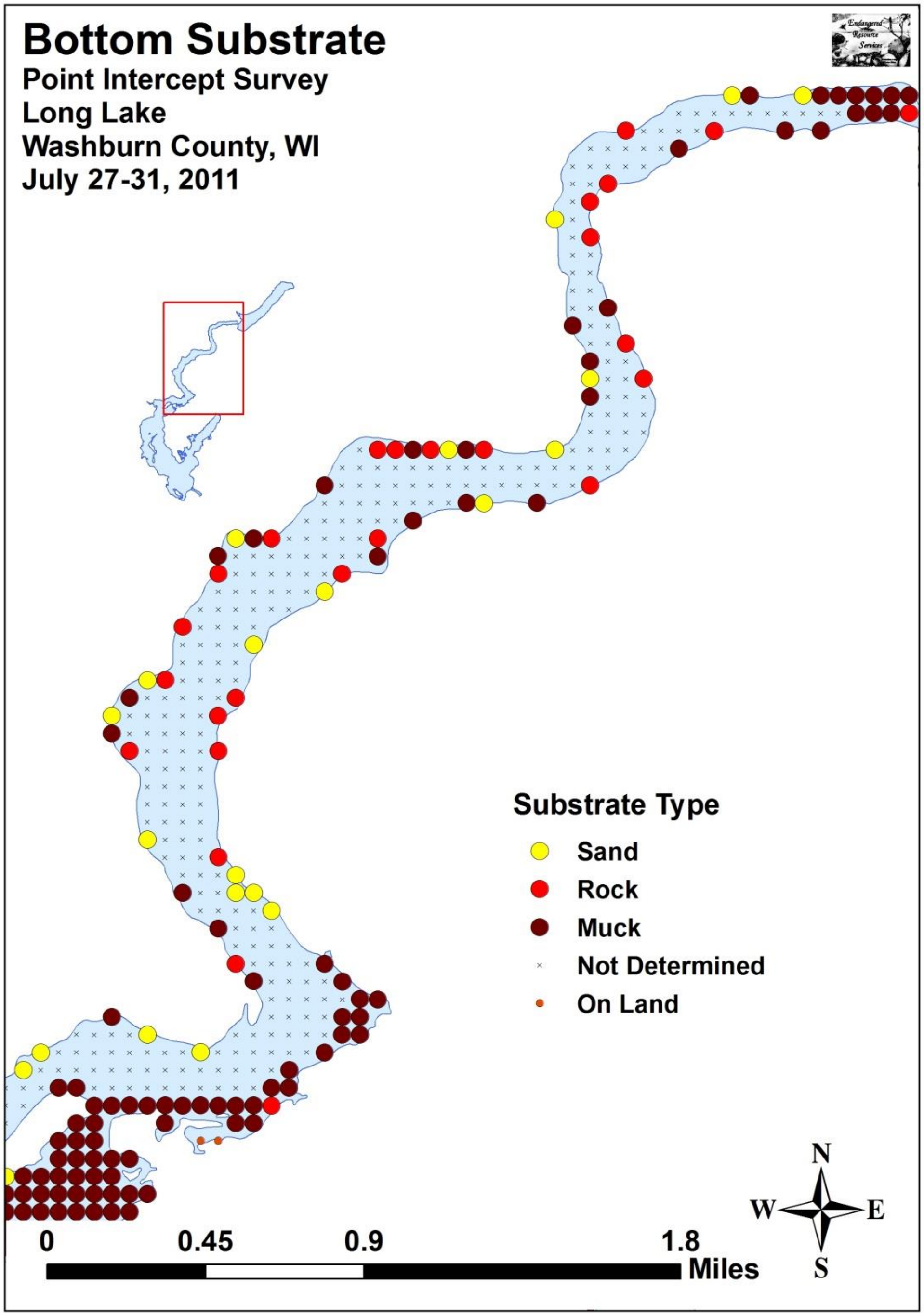
Lake Depth
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Depth in ft.
On Land
0.1 - 11.0
11.1 - 22.0
22.1 - 33.0
33.1 - 44.0
44.1 - 55.0
55.1 - 81.0
N
W
E
S
0
0.45
0.9
1.8
Miles

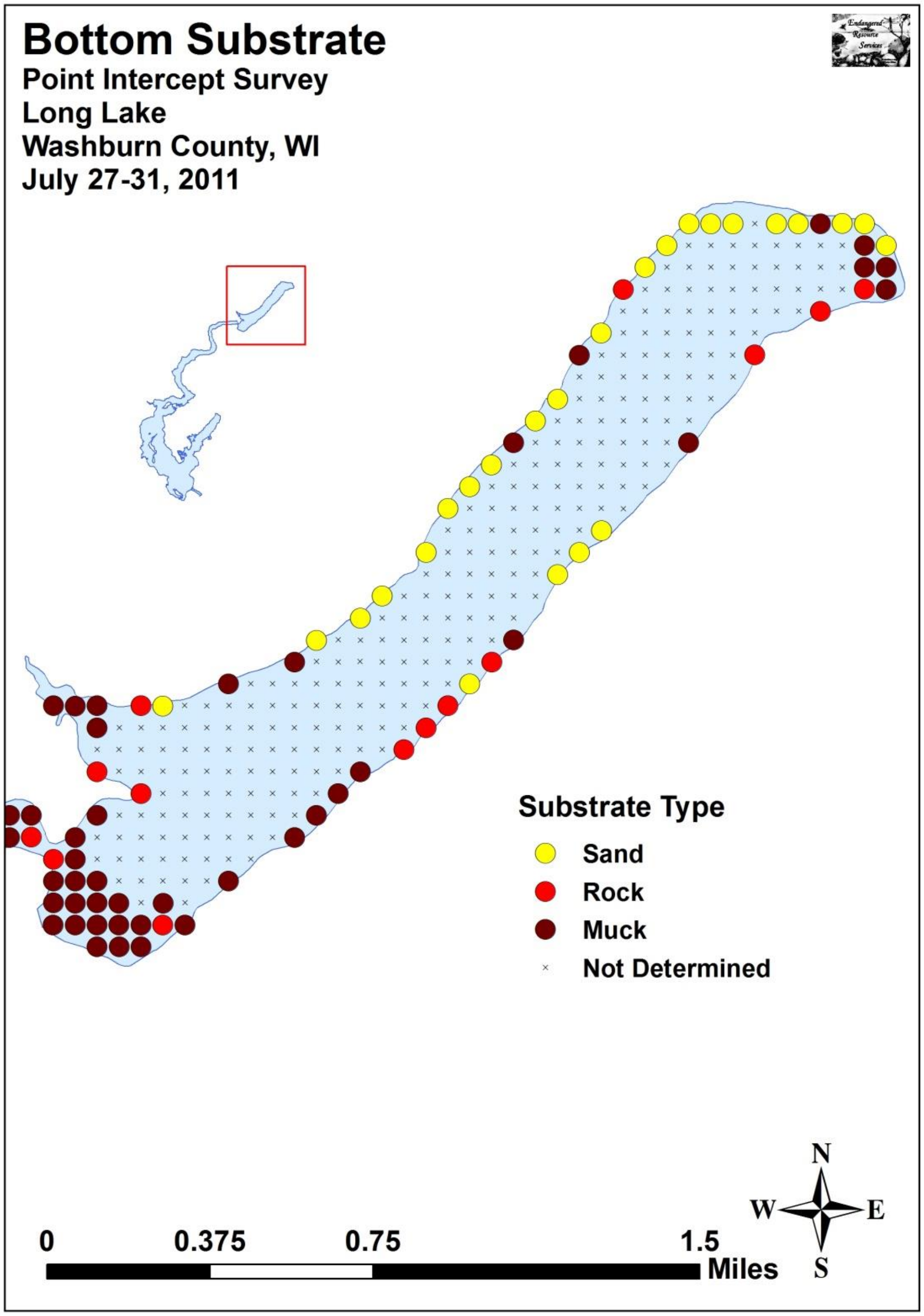

Lake Depth
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Depth in ft.
0.1 - 11.0
11.1 - 22.0
22.1 - 33.0
33.1 - 44.0
44.1 - 55.0
55.1 - 81.0
N
W
E
S
0
0.375
0.75
1.5
Miles

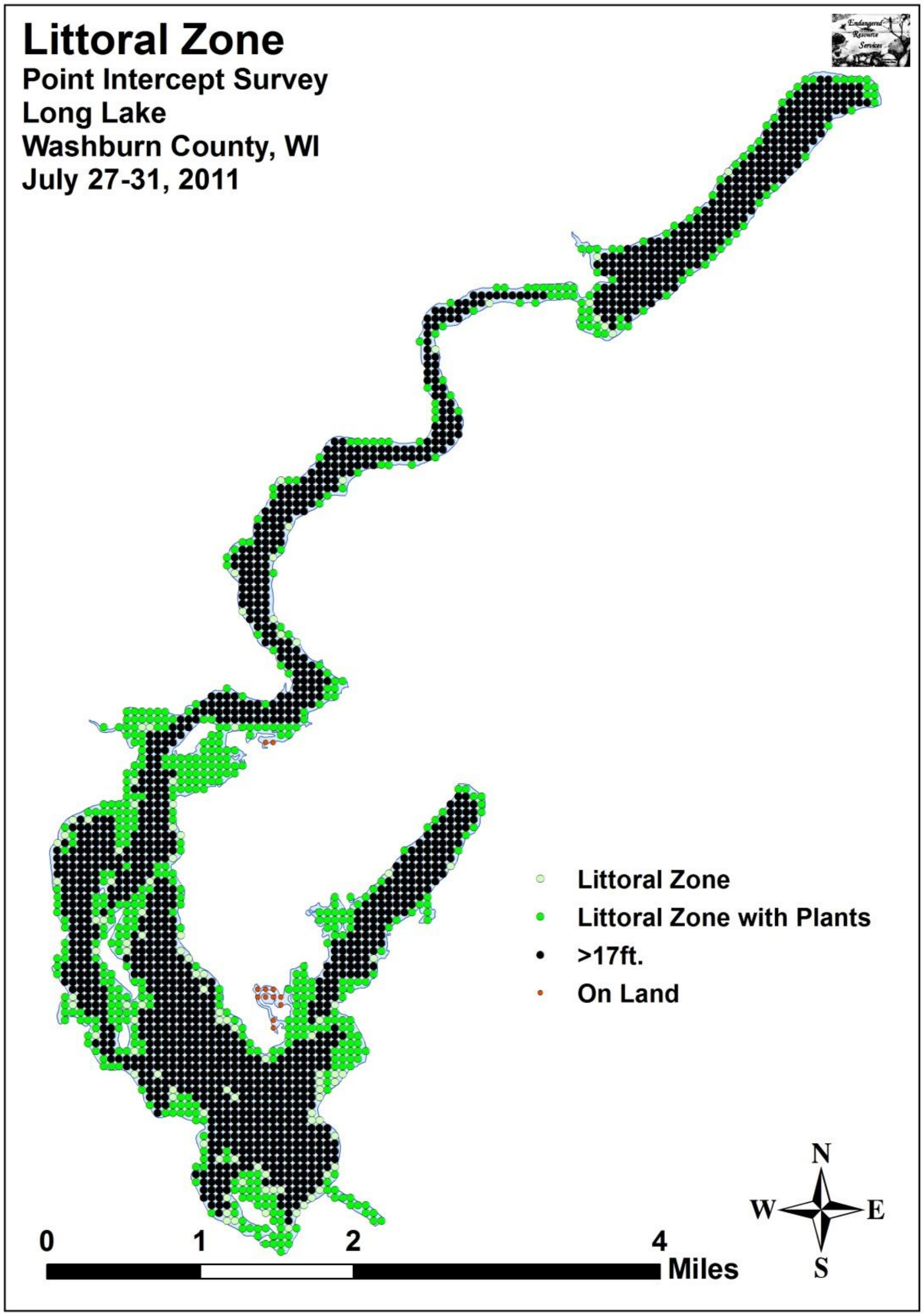


Bottom Substrate
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Substrate Type
Sand
Rock
Muck
Not Determined
On Land
N
W
E
S
0
1
2
4
Miles

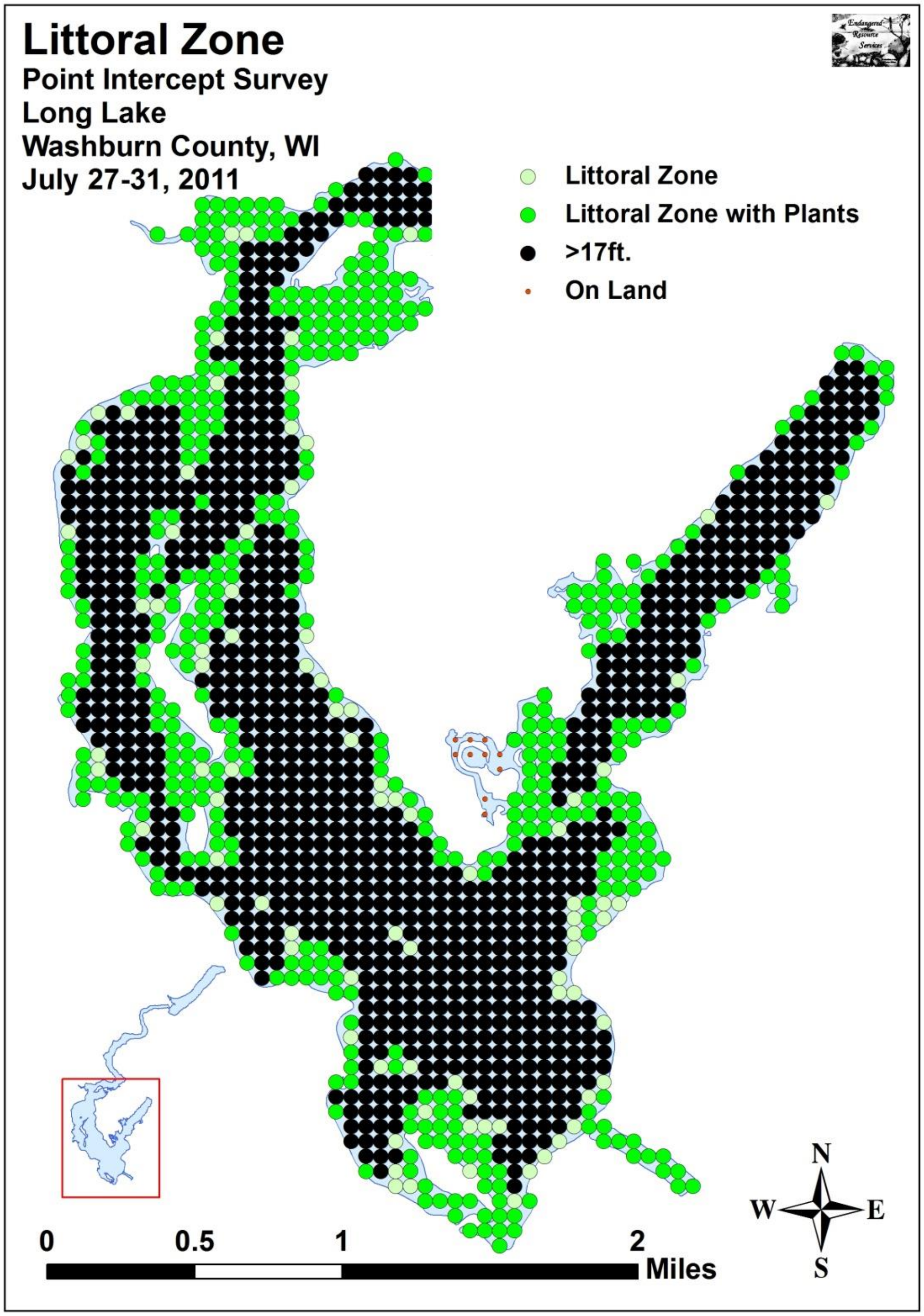

Bottom Substrate
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Substrate Type
Sand
Rock
Muck
Not Determined
On Land
0
0.5
1
2
Miles
N
W
E
S


Bottom Substrate
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Substrate Type
Sand
Rock
Muck
Not Determined
On Land
0
0.45
0.9
1.8
Miles
N
W
E
S

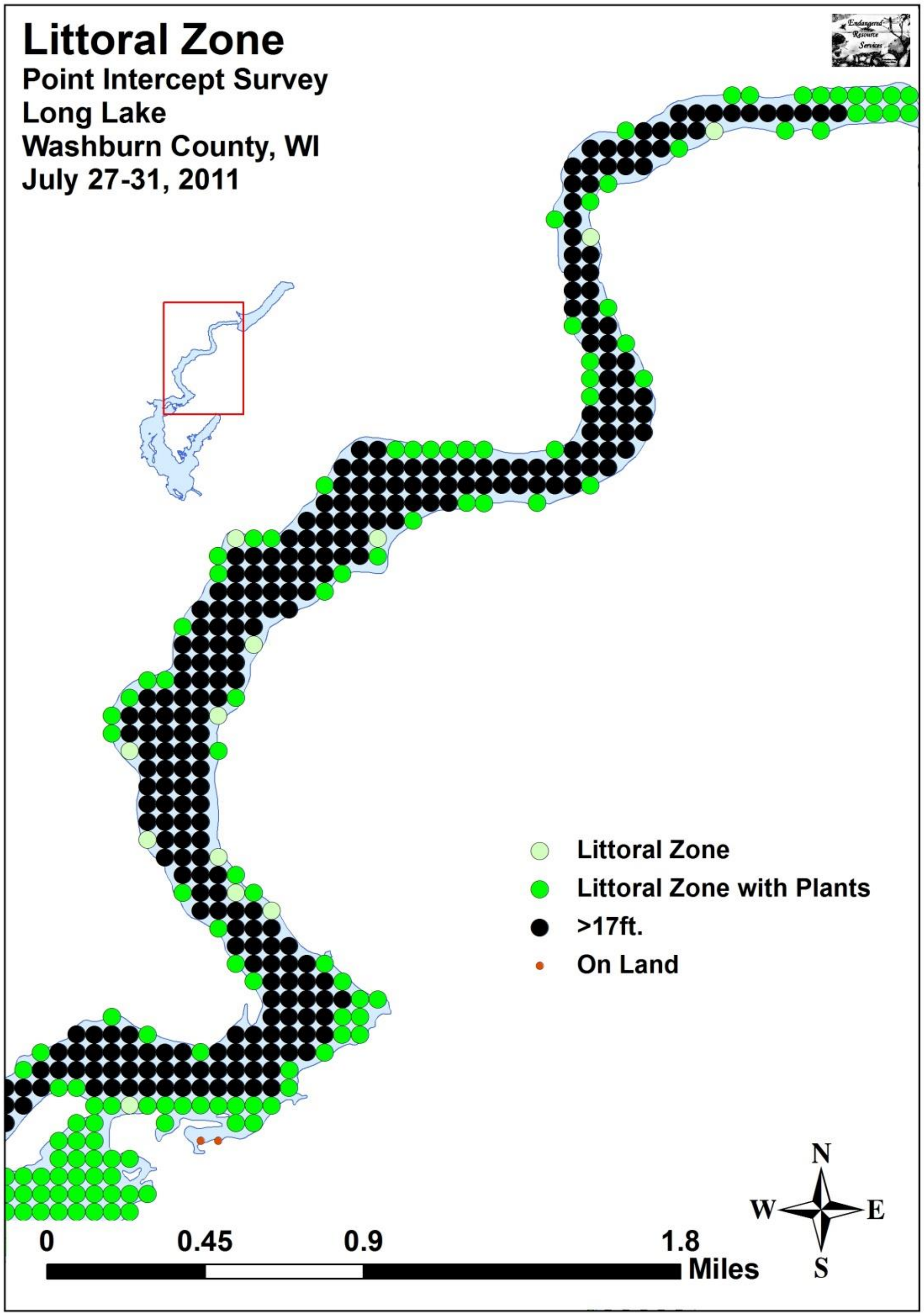

Bottom Substrate
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Substrate Type
Sand
Rock
Muck
Not Determined
N
W
E
S
0
0.375
0.75
1.5
Miles



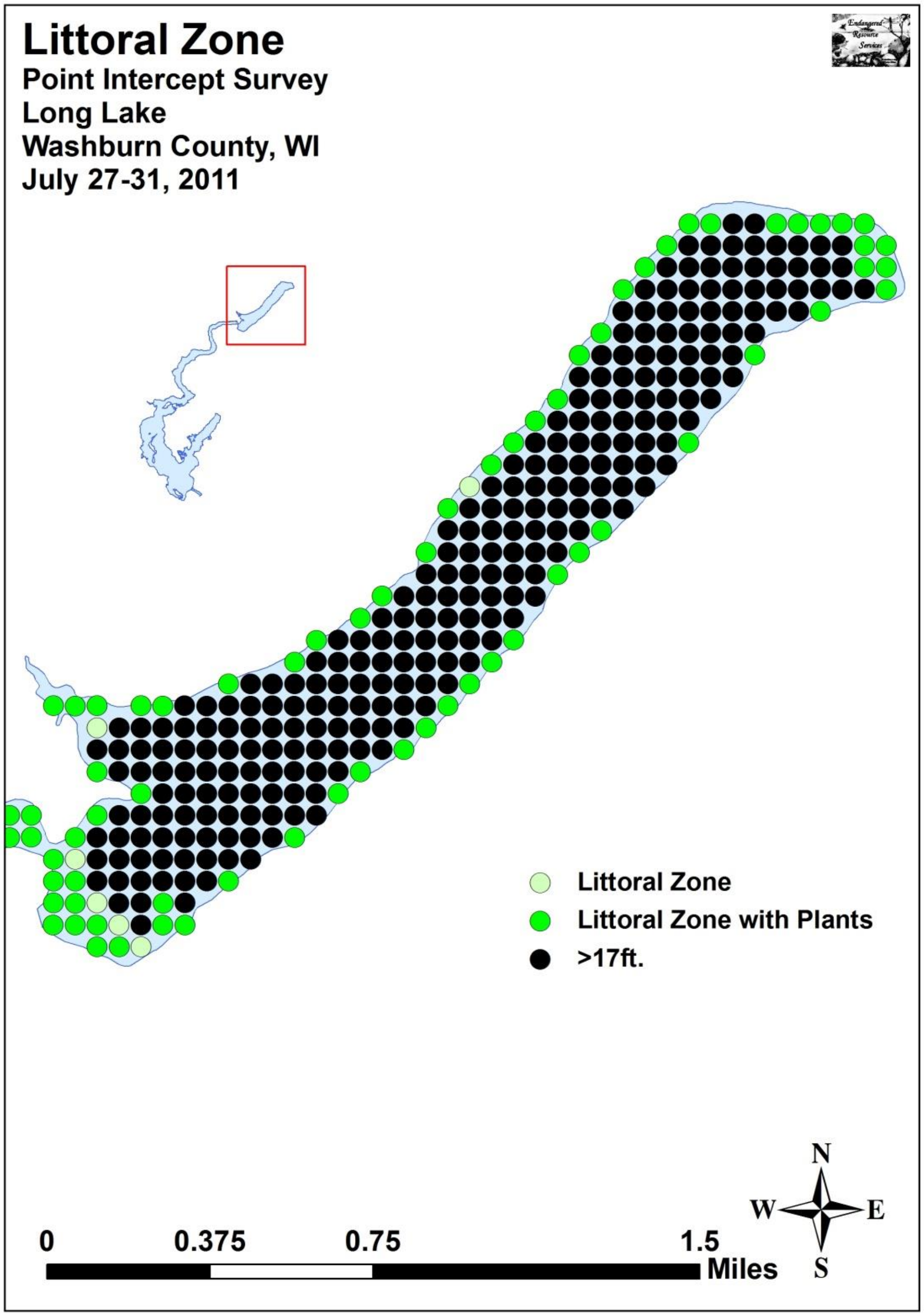
Littoral Zone
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Littoral Zone
Littoral Zone with Plants
>17ft.
On Land
0
1
2
4
Miles
N
W
E
S



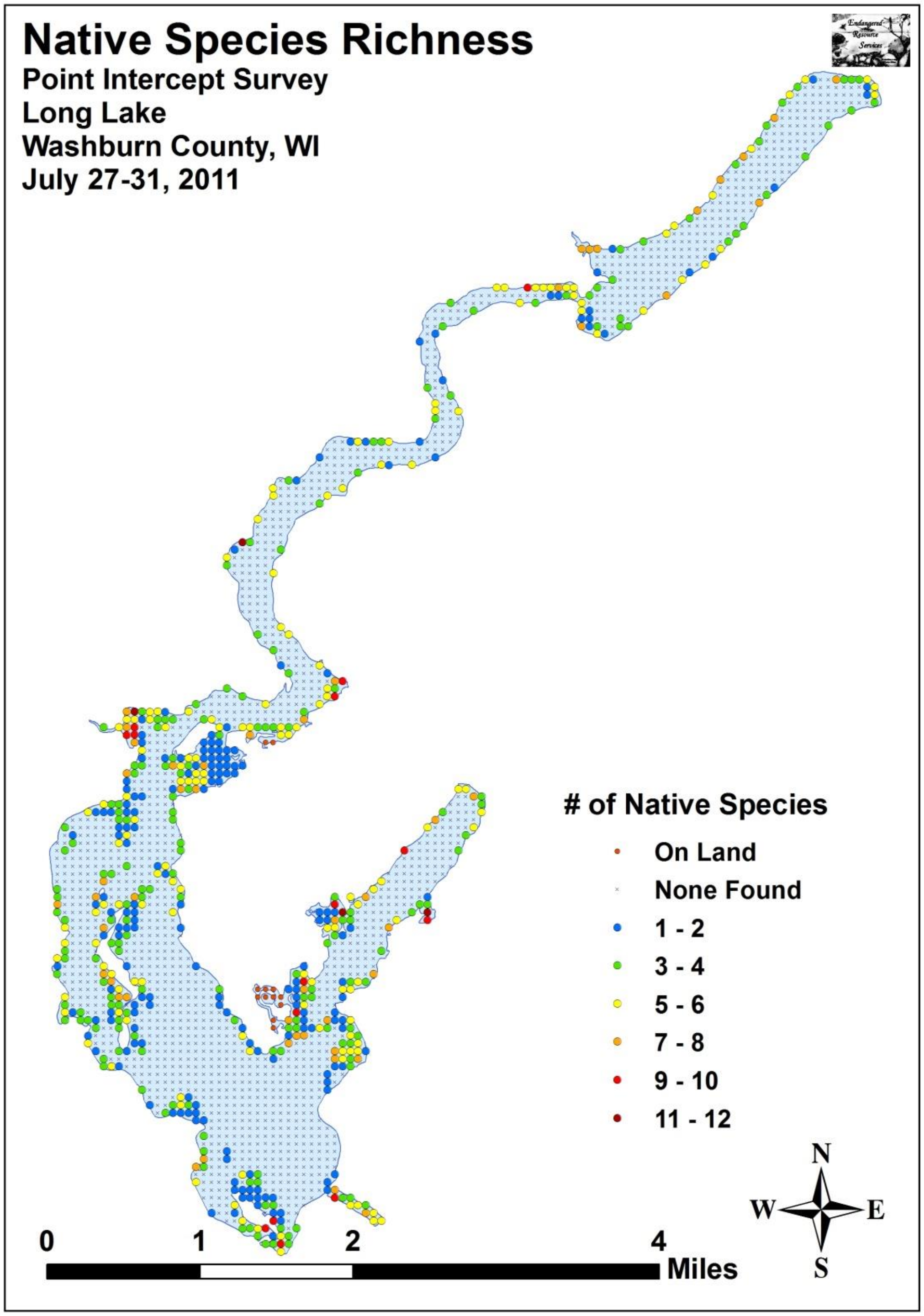
Littoral Zone
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Littoral Zone
Littoral Zone with Plants
>17ft.
On Land
0
0.5
1
2
Miles
N
W
E
S

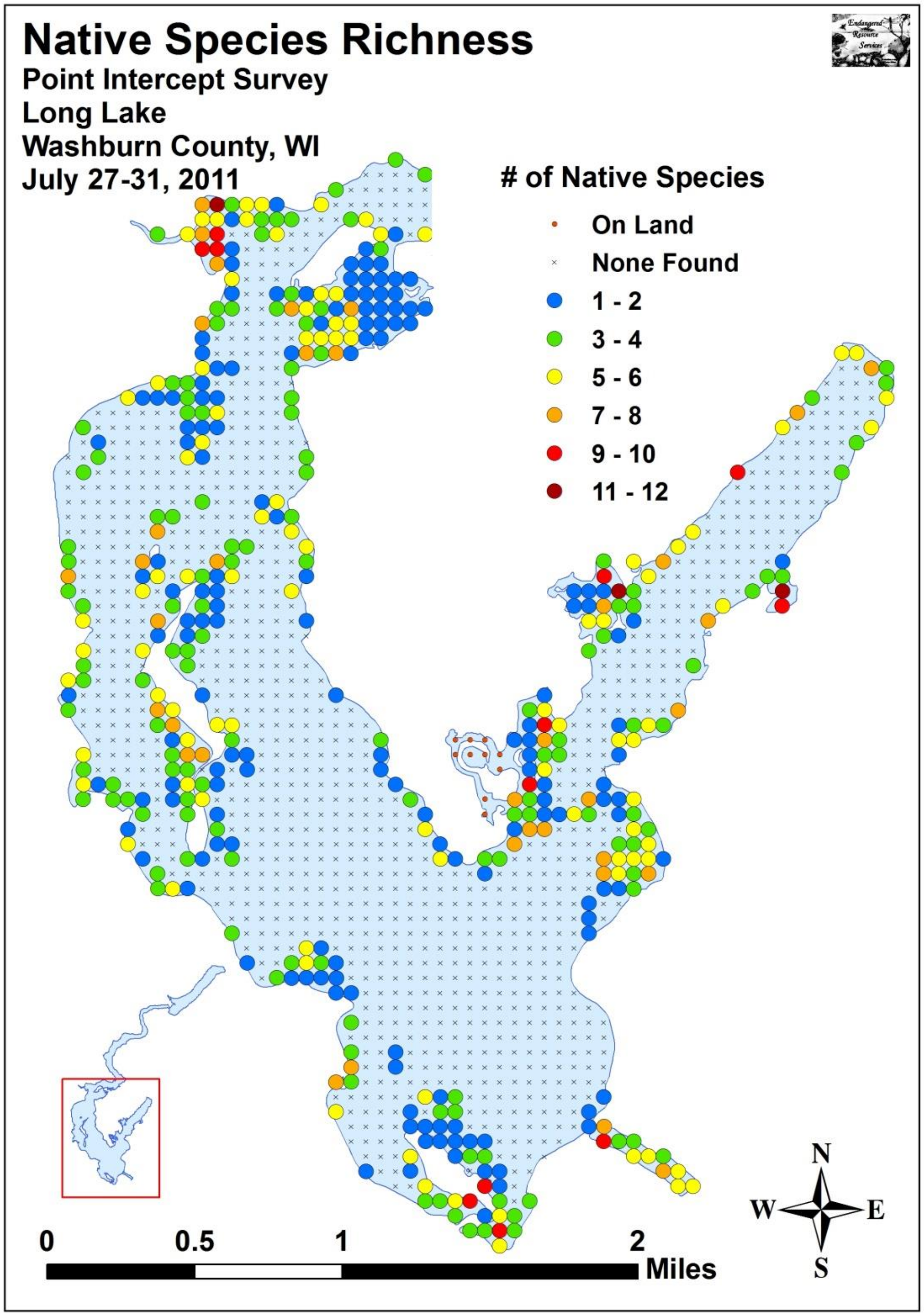


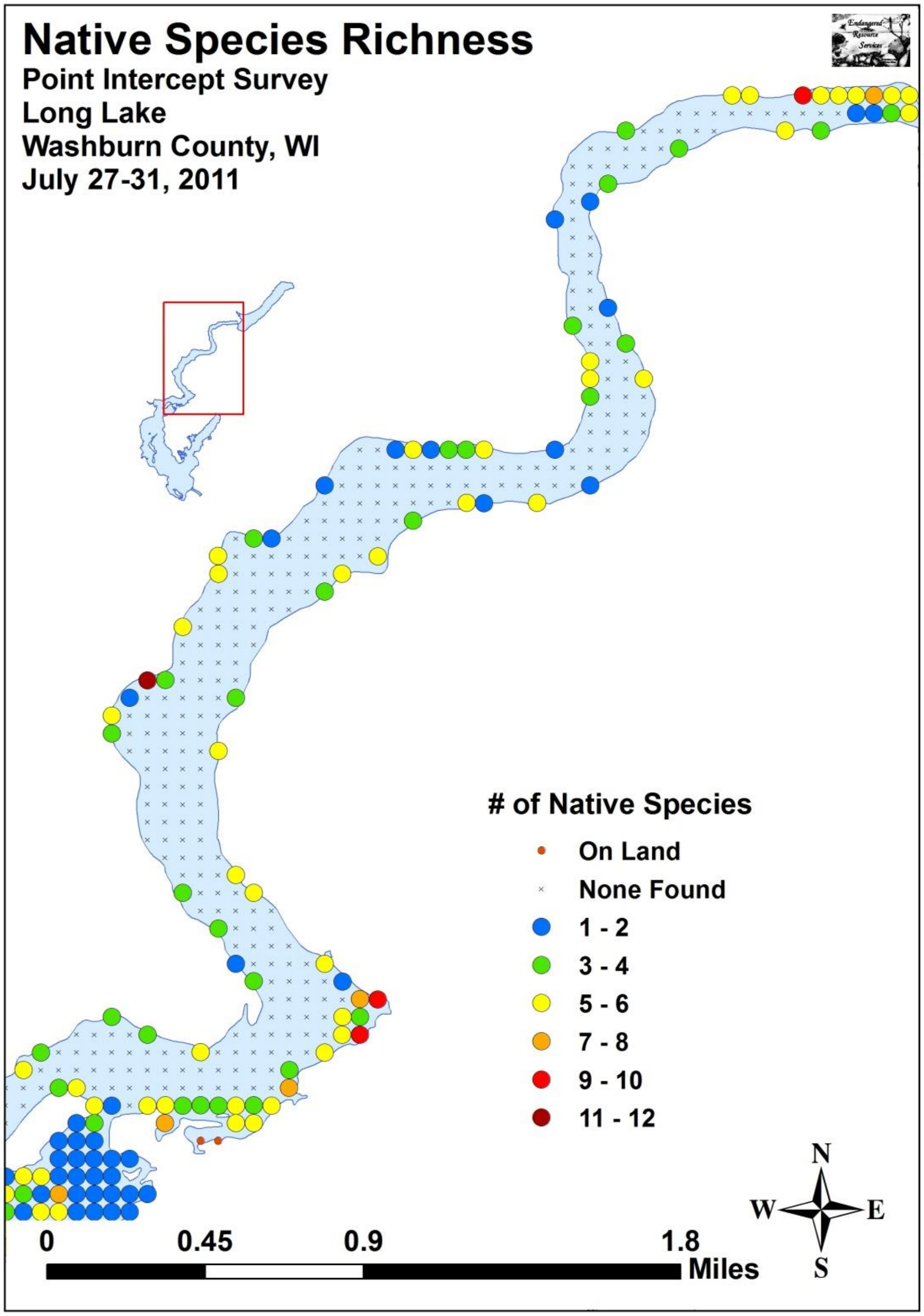
Littoral Zone
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Littoral Zone
Littoral Zone with Plants
>17ft.
On Land
N
W
E
S
0
0.45
0.9
1.8
Miles


Littoral Zone
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Littoral Zone
Littoral Zone with Plants
>17ft.
0
0.375
0.75
1.5
Miles
N
W
E
S

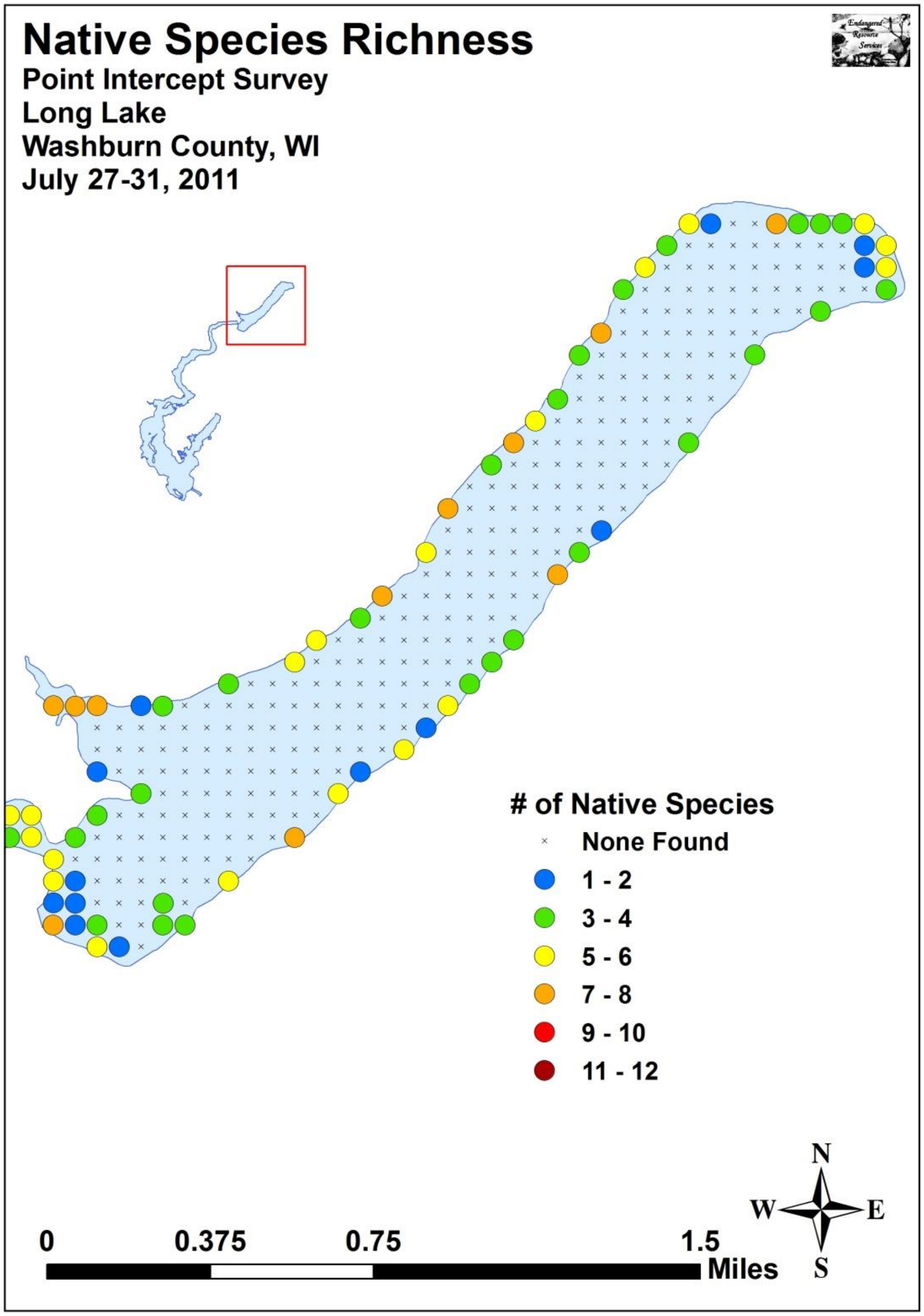
Appendix VI: Native Species Richness and Total Rake Fullness Maps

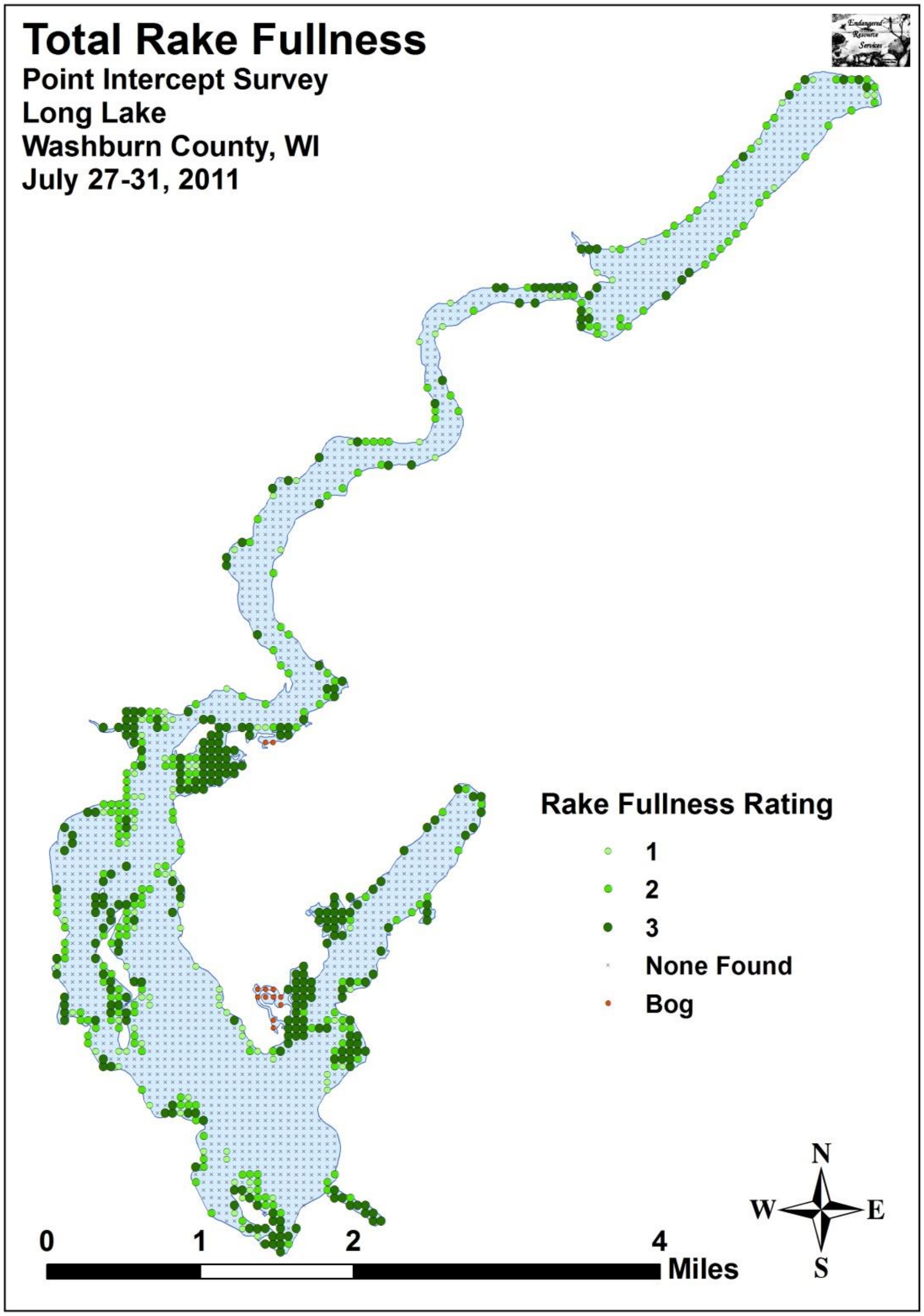

Native Species Richness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
# of Native Species
On Land
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
N
W
E
S
0
1
2
4
Miles

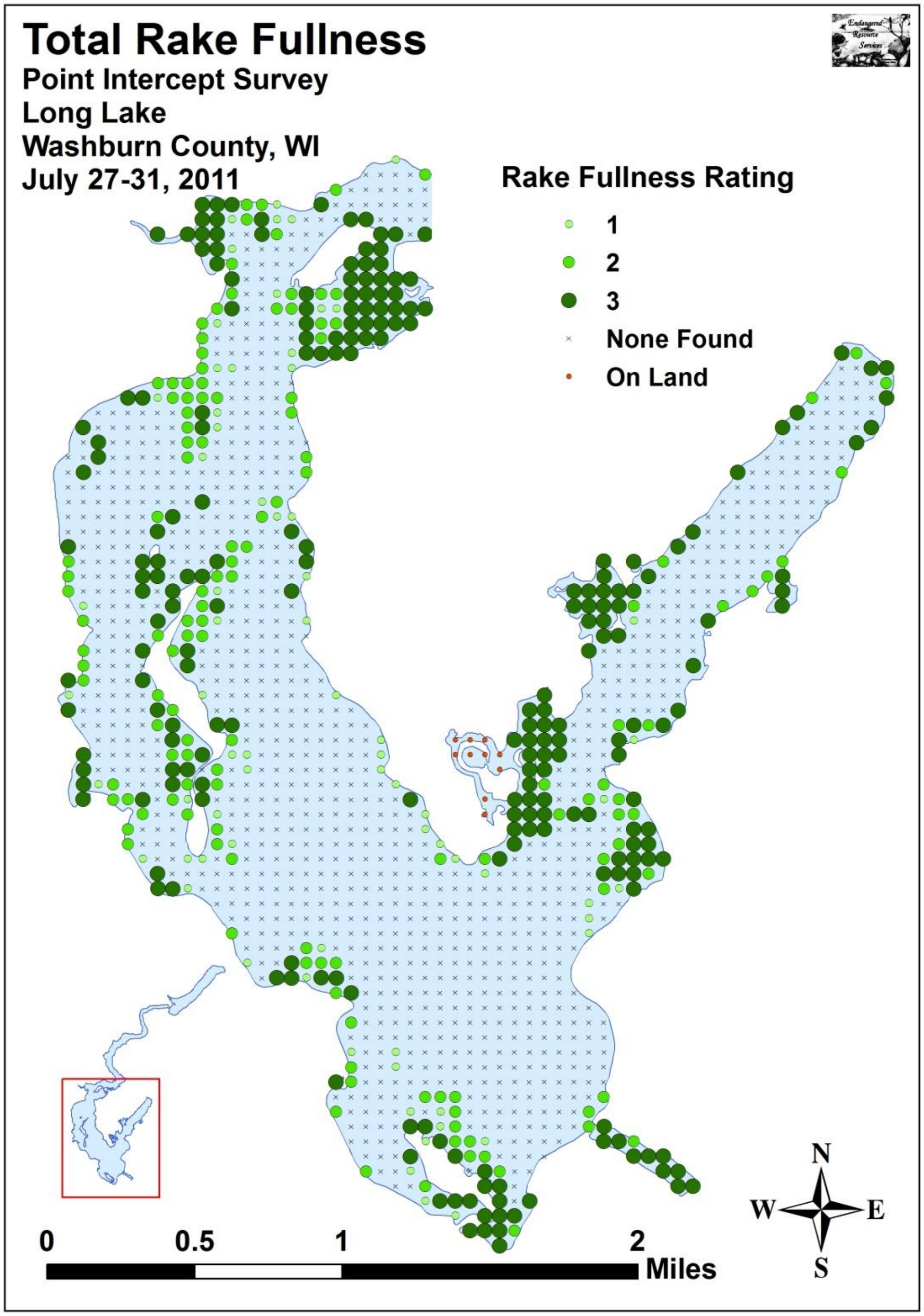

Native Species Richness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
# of Native Species
On Land
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
0
0.5
1
2
Miles
N
W
E
S

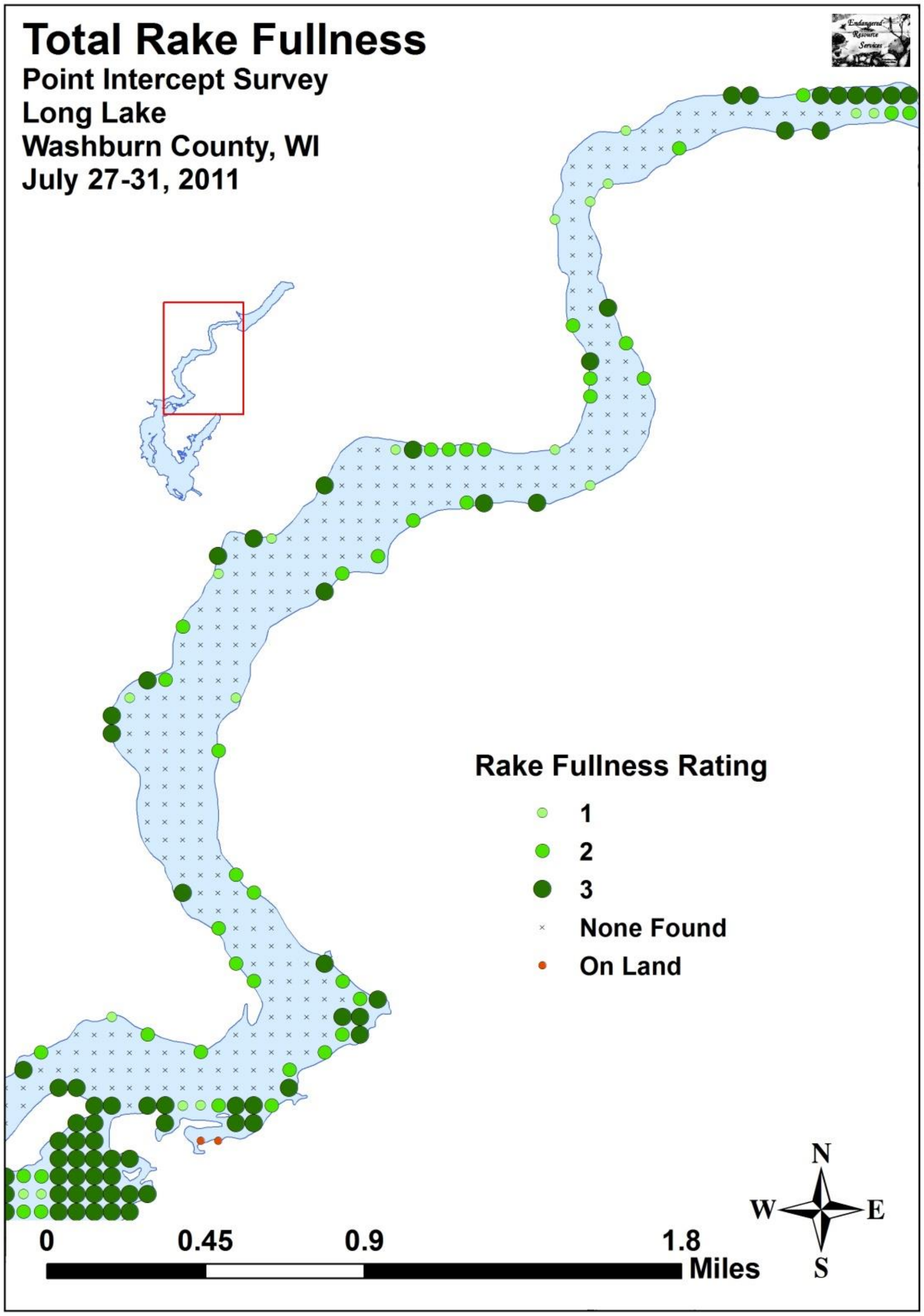


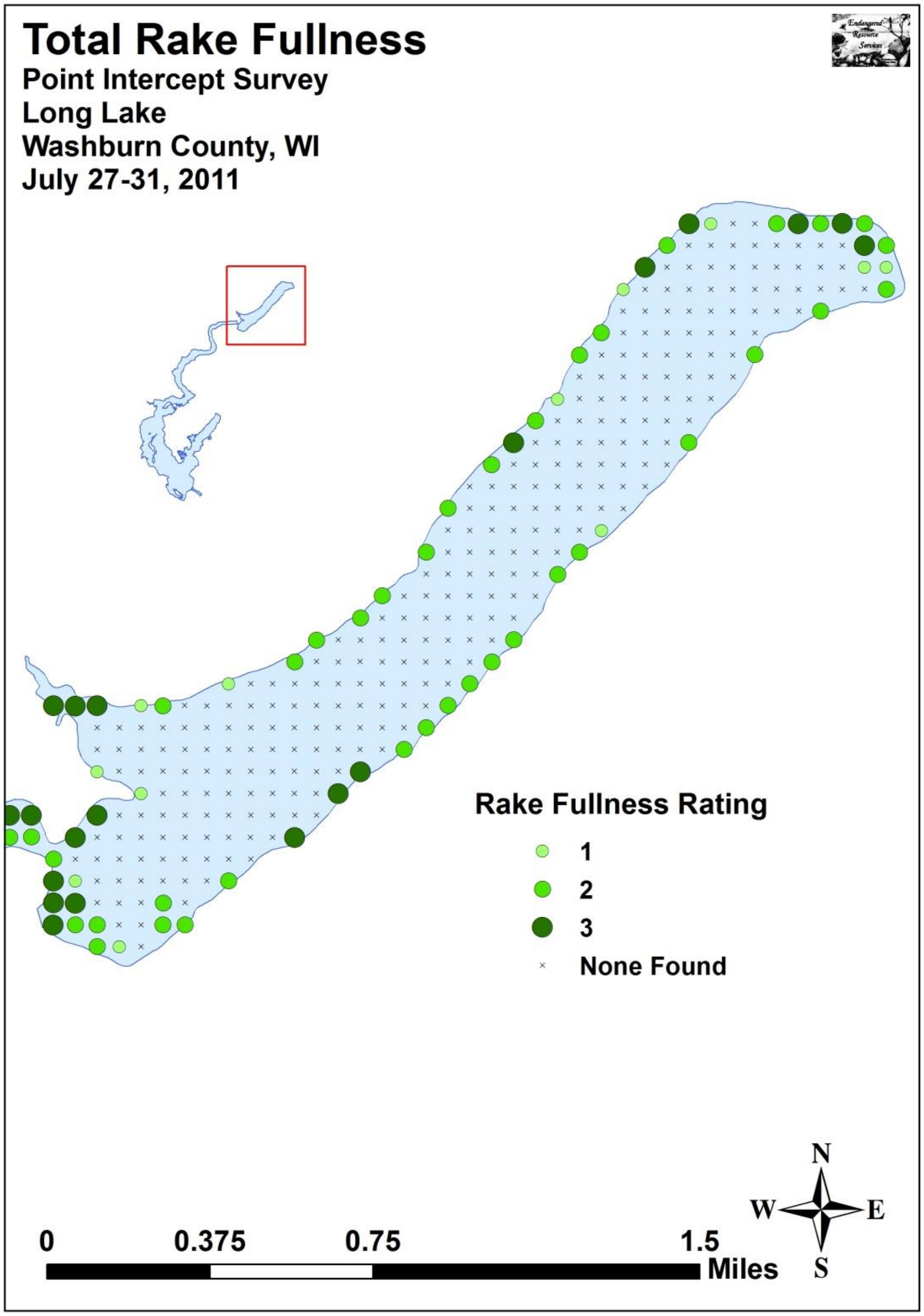
Native Species Richness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
# of Native Species
On Land
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
N
W
E
S
0
0.45
0.9
1.8
Miles


Native Species Richness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
N
W
E
S
0
0.375
0.75
1.5
Miles


Total Rake Fullness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Total Rake Fullness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
1
2
3
None Found
On Land
0
0.5
1
2
Miles
N
W
E
S


Total Rake Fullness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
1
2
3
None Found
On Land
0
0.45
0.9
1.8
Miles
N
W
E
S


Total Rake Fullness
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
1
2
3
None Found
0
0.375
0.75
1.5
Miles
N
W
E
S

Appendix VII: Long and Mud Lakes Plant Species Accounts

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: Aquatic moss
Specimen Location: Long Lake; N45.71767°, W91.68850°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-178
Habitat/Distribution: Mucky bottoms in <1.5 meters. Rare throughout as it was found at only four points. Plants were, however, locally abundant in boggy bays where it carpeted the bottom.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Nymphaea odorata*) White water lily, (*Potamogeton robbinsii*) Fern pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton natans*) Floating-leaf pondweed

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Bidens beckii*) **Water marigold**
Specimen Location: Long Lake; N45.73206°, W91.70142°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-179
Habitat/Distribution: Sand and rock bottom in 1.5-3.0 meters of water. Rare; plants were found at only three widely scattered locations along Long's western shoreline.
Common Associates: (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton friesii*) Fries pondweed**,** (*Elodea canadensis*) Common waterweed, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: Long Lake; N45.71767°, W91.68850°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-180
Habitat/Distribution: Muck and mucky sand bottoms in water <1.5m deep. Uncommon in widely scattered, pristine, high diversity muck bays.
Common Associates: (*Nuphar variegata)* Spatterdock, (*Nymphaea odorata*) White water lily, (*Sparganium emersum*) Short-stemmed bur-reed, (*Potamogeton natans*) Floating-leaf pondweed, (*Pontederia cordata*) Pickerelweed, (*Ceratophyllum demersum*) Coontail

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Bolboschoenus fluviatilis*) **River bulrush**
Specimen Location: Long Lake; N45.68772°, W91.69279°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-181
Habitat/Distribution: Rare; A cluster of plants located at the point were the only ones seen on the lake. Plants were in <1m of water growing over firm muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Polygonum amphibium*) Water smartweed, (*Schoenoplectus acutus*) Hardstem bulrush

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Calla palustris*) **Wild calla**
Specimen Location: Long Lake; N45.71434°, W91.71650°
Also found in Mud Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-182
Habitat/Distribution: Muck bottoms at the shoreline in 0-0.25m of water. Scattered individuals occurred in undeveloped boggy shoreline areas.
Common Associates: (*Eleocharis erythropoda*) Bald spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Typha latifolia*) Broad-leaved cattail, (*Decodon verticillatus*) Swamp Loosestrife

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Carex comosa*) **Bottle brush sedge**
Specimen Location: Mud Lake; N45.74349°, W91.65688°
Also found in Long Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-183
Habitat/Distribution: Muck bottoms at the shoreline in 0-0.25m of water. Scattered individuals occurred in undeveloped boggy shoreline areas.
Common Associates: (*Eleocharis erythropoda*) Bald spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Typha latifolia*) Broad-leaved cattail, (*Decodon verticillatus*) Swamp Loosestrife

State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Carex diandra*) **Panicled bog sedge**
Specimen Location: Mud Lake; N45.74418°, W91.65740°
Collected/Identified by: Matthew S. Berg/Dr. Robert W. Freckmann Col. #: MSB-2011-184
Habitat/Distribution: Muck bottoms at the shoreline in 0-0.25m of water. Plants were common in the channel between Long and Mud Lakes. Clusters were tussock forming at the shoreline.
Common Associates: (*Eleocharis erythropoda*) Bald spikerush, (*Carex comosa*) Bottle brush sedge, (*Decodon verticillatus*) Swamp Loosestrife

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Also found in Mud Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-185
Habitat/Distribution: Muck bottom in 0-5+ meters. Common to abundant in most muck bottom sheltered bays; scattered elsewhere. It was the deepest growing macrophyte in the lakes.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Nymphaea odorata*) White water lily, (*Elodea canadensis*) Common waterweed, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-186
Habitat/Distribution: Common to abundant in sand/silt/rock bottom areas (especially on exposed points) in water from 0 – 5m deep.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery, (*Potamogeton friesii*) Fries' pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Decodon verticillatus*) **Swamp Loosestrife**
Specimen Location: Mud Lake; N45.72935°, W91.66348°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-187
Habitat/Distribution: Muck bottom at the shoreline in 0 – 0.25 meters of water. Plants were abundant in the boggy area on the south side of Mud Lake and where the channel from Long Lake meets the "Lake" portion of Mud Lake.
Common Associates: (*Eleocharis erythropoda*) Bald spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Typha latifolia*) Broad-leaved cattail, (*Carex comosa*) Bottle brush sedge

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Eleocharis acicularis*.) **Needle spikerush**
Specimen Location: Long Lake; N45.74484°, W91.67578°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-188
Habitat/Distribution: Found in shallow water <1.5m deep in sand/rock bottom areas.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Eleocharis erythropoda*) **Bald spikerush**
Specimen Location: Mud Lake; N45.74840°, W91.65703°
Also found in Long Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-189
Habitat/Distribution: Uncommon in firm muck bottoms at the shoreline. Scattered individuals were found in boggy undeveloped areas growing with other emergents. Most common in the channel between Mud and Long.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Carex comosa*) Bottle brush sedge, (*Calla palustris*) Wild calla, (*Sagittaria latifolia*) Common arrowhead

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Eleocharis palustris*) **Creeping spikerush**
Specimen Location: Long Lake; N45.68772°, W91.69279°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-190
Habitat/Distribution: Rare; the scattered plants interspersed with *S. acutus* at the point were the only ones seen on the lake. Plants were in <1m of water growing over firm muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Polygonum amphibium*) Water smartweed, (*Schoenoplectus acutus*) Hardstem bulrush

County/State**:** Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Long Lake; N45.75663°, W91.66676°
Also found in Mud Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-191
Habitat/Distribution: Muck bottom in 0-5 meters of water.
Common to abundant in the main basin on the southern end of Long and the channel between Mud and Long; just scattered elsewhere.
Common Associates: (*Potamogeton friesii*) Fries' pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Myriophyllum sibiricum*) Northern water milfoil, (*Potamogeton amplifolius*) Large-leaf pondweed

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Equisetum fluviatile*) **Water horsetail**
Specimen Location: Long Lake; N45.68624°, W91.69379°
Also found in Mud Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-192
Habitat/Distribution: Sandy bottoms in 0-1.5m of water. Only seen at the point in Long and at a single point in the southwest corner of Mud.
Common Associates: (*Sparganium eurycarpum*) Common bur-reed, (*Schoenoplectus acutus*) Hardstem bulrush, (*Potamogeton friesii*) Fries pondweed, (*Vallisneria americana*) Wild celery, (*Chara* sp.) Muskgrass

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Long Lake; N45.71155°, W91.70809°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-193
Habitat/Distribution: Found in a variety of bottom types in water up to 2 meters deep. Widespread but never common or abundant in either Long or Mud Lake.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery, (*Potamogeton friesii*) Fries' pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Juncus effusus*) **Common rush**
Specimen Location: Long Lake; N45.67294°, W91.70587°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-194
Habitat/Distribution: Only plants found were near the point in muck along the shore of a tiny stagnant inlet.
Common Associates: (*Leersia oryzoides*) Rice cut-grass, (*Sagittaria rigida*) Sessile-fruited arrowhead

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Leersia oryzoides*) **Rice cut-grass**
Specimen Location: Long Lake; N45.67294°, W91.70587°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-195
Habitat/Distribution: Only plants found were near the point in muck along the shore of a tiny stagnant inlet.
Common Associates: (*Juncus effusus*) Common rush, (*Sagittaria rigida*) Sessile-fruited arrowhead

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Mud Lake; N45.74699°, W91.65749°
Also found in Long Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-196
Habitat/Distribution: Located floating at or just under the surface. Common to abundant in most sheltered areas interspersed between the lilypads and wild rice.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Zizania palustris*) Northern wild rice, (*Lemna trisulca*) Forked duckweed

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Lemna trisulca*) **Forked duckweed**
Specimen Location: Mud Lake; N45.74699°, W91.65749°
Also found in Long Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-197
Habitat/Distribution: Located along the bottom or tangled in other plants. Common to abundant in Mud, but only scattered in Long with the exception of the Narrows and in the far northeast corner.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Zizania palustris*) Northern wild rice, (*Lemna minor*) Small duckweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Myriophyllum sibiricum*) **Northern water milfoil**
Specimen Location: Long Lake; N45.77695°, W91.62256°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-198
Habitat/Distribution: Found in muck and sandy muck bottoms in water up to 5 meters. Common and widely distributed throughout Long, but only a handful of plants were seen in Mud.
Common Associates: (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Vallisneria americana*) Wild celery

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Myriophyllum verticillatum)* **Whorled water milfoil**
Specimen Location: Long Lake; N45.71380°, W91.70399°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-199
Habitat/Distribution: Muck bottom in water <1 meter deep. Plants were dominant at the edge of cattails in the bays east of Rice Island. They were also scattered in boggy side bays in the finger bay that projects to the northeast out of the main basin towards Little Mud Lake.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Sparganium emersum*) Short-stemmed bur-reed, (*Zizania palustris*) Northern wild rice, (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum*) Coontail

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Najas flexilis*) **Slender naiad**
Specimen Location: Long Lake; N45.77695°, W91.62256°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-200
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 0.5-.5 meters of water. Common and widely distributed throughout Long but restricted to the channel in Mud.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Nitella* sp.) **Nitella**
Specimen Location: Long Lake; N45.70939°, W91.70594°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-201
Habitat/Distribution: Variable substrate in water up 4.5m deep. Uncommon but widely distributed.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Sagittaria cristata*) Crested arrowhead, (*Vallisneria americana*) Wild celery, (*Myriophyllum sibiricum*) Northern water milfoil, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Nuphar variegata)* **Spatterdock**
Specimen Location: Long Lake; N45.71767°, W91.68850°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-202
Habitat/Distribution: Muck bottom in 0-2m of water in bays and sheltered shoreline areas. It generally preferred a firmer bottom and was less common than *Nymphaea.*
Common Associates: (*Nymphaea odorata*) White water lily,
(*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Long Lake; N45.71767°, W91.68850°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-203
Habitat/Distribution: Muck bottom in 0-2 meters where it formed dense canopies with other floating leaf species. Common to abundant in calm water bays throughout both lakes.
Common Associates: (*Nuphar variegata)* Spatterdock, (*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail, (*Sparganium emersum*) Short-stemmed bur-reed, (*Zizania palustris*) Northern wild rice, (*Myriophyllum sibiricum*) Northern water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Polygonum amphibium*) **Water smartweed**
Specimen Location: Long Lake; N45.68772°, W91.69279°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-204
Habitat/Distribution: Rare; a cluster of plants located at the point were the only ones seen on the lake. Plants were in <1m of water growing over firm muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Pontederia cordata*) Pickerelweed, (*Bolboschoenus fluviatilis*) River bulrush, (*Schoenoplectus acutus*) Hardstem bulrush

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Pontederia cordata*) **Pickerelweed**
Specimen Location: Long Lake; N45.71507°, W91.71652°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-205
Habitat/Distribution: Uncommon in firm silt to muck bottoms in water generally <0-1m deep. Most plants occurred in sheltered bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Schoenoplectus acutus*) Hardstem bulrush

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Long Lake; N45.73057°, W91.70346°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-206
Habitat/Distribution: Found in firm muck bottom areas in water from 1-3m deep. Relatively common and widely distributed throughout Long.
Common Associates: (*Myriophyllum sibiricum*) Northern water milfoil, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Potamogeton crispus*) **Curly-leaf pondweed**
Specimen Location: Long Lake; N45.76044°, W91.65541°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-207
Habitat/Distribution: Widely distributed, but not common. Most beds were extremely small and appeared to be established in places of disturbance along developed shorelines. Plants were completely absent from the shorelines of the Tomahawk Scout Reservation property.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed, (*Stuckenia pectinata*), Sago pondweed

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Potamogeton foliosus*) **Leafy pondweed**
Specimen Location: Long Lake; N45.69876°, W91.68584°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-208
Habitat/Distribution: Muck bottoms in 0-1 meters of water. Found at a single point in a small western side bay of the finger bay that projects to the northeast from the south basin towards Little Mud Lake.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton friesii*) **Fries' pondweed**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-209
Habitat/Distribution: Abundant and widespread throughout both lakes. Plants were most common over sandy muck in water <4m deep.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Myriophyllum sibiricum*) Northern water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton gramineus*) **Variable pondweed**
Specimen Location: Long Lake; N45.74183°, W91.68193°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-210
Habitat/Distribution: Sand and rock bottom areas generally in water <3m deep. Plants were common and widely distributed throughout Long Lake.
Common Associates: (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Chara* sp.) Muskgrass, (*Eleocharis acicularis*) Needle spikerush

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton illinoensis*) **Illinois pondweed**
Specimen Location: Long Lake; N45.75607°, W91.65528°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-211
Habitat/Distribution: Plants were found in variable substrate in water <4m deep. Most plants were located in the south basin of Long. It was especially common in the Christiana Point area.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed, (*Chara* sp.) Muskgrass

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Potamogeton natans*) **Floating-leaf pondweed**
Specimen Location: Long Lake; N45.71767°, W91.68850°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-212
Habitat/Distribution: Firm muck and sand bottoms in <1.5meters of water. Plants were locally common in a few widely scattered beds.
Common Associates: (*Schoenoplectus acutus*) Hardstem bulrush, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Pontederia cordata*) Pickerelweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Elodea canadensis*) Common waterweed

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Potamogeton obtusifolius*) **Blunt-leaf pondweed**
Specimen Location: Long Lake; N45.69138°, W91.69187°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-213
Habitat/Distribution: Thick organic muck bottoms in <1.5meters of water. Uncommon; a few patches were found scattered boggy bays. Plants formed a continuum with *P. pusillus*, and they may be hybrids. The voucher is the widest leaved example we found. None were in fruit, but the huge membranous stipule, lacunar bands, and the slight rusty color at pressing lead to this determination.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Nymphaea odorata*) White water lily, (*Zizania palustris*) Northern wild rice, (*Myriophyllum verticillatum*) Whorled water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Potamogeton praelongus*) **White-stem pondweed**
Specimen Location: Long Lake; N45.75607°, W91.65528°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-214
Habitat/Distribution: Variable substrate in 1-4 meters of water. Plants were widely distributed in both lakes, but seldom abundant.
Common Associates: (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Myriophyllum sibiricum*) Northern water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Long Lake; N45.76044°, W91.65541°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-215
Habitat/Distribution: Plants were found in almost any bottom condition but were most common in muck and sandy muck in 1-4.5 meters of water. Common and widespread throughout both lakes.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Elodea canadensis*) Common waterweed, (*Najas flexilis*) Slender naiad, (*Vallisneria americana*) Wild celery

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Long Lake; N45.75663°, W91.66676°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-216
Habitat/Distribution: Most plants were found in sandy/muck bottom conditions in water 1-4 meters deep. Common and widespread in Long; rare in Mud.
Common Associates: (*Vallisneria americana*) Wild celery, (*Stuckenia pectinata*) Sago pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton robbinsii*) **Fern pondweed**
Specimen Location: Long Lake; N45.75663°, W91.66676°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-217
Habitat/Distribution: Uncommon, but widely distributed over thick organic muck in 1-2.5 meters of water. In the sheltered bays where it was found, it often completely dominated the bottom.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Potamogeton strictifolius*) **Stiff pondweed**
Specimen Location: Long Lake; N45.69745°, W91.67540°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-218
Habitat/Distribution: Found in sandy and sandy mucky bottom conditions in shallow water 0.5-3.5 meters deep. Uncommon; a few individuals were found scattered throughout Long.
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Heteranthera dubia*) Water stargrass, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-219
Habitat/Distribution: Abundant and widely distributed throughout both lakes over thick muck in 1-5m of water.
Common Associates: (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Myriophyllum sibiricum*) Northern water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Ranunculus aquatilis*) **White water crowfoot**
Specimen Location: Long Lake; N45.70997°, W91.71636°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-220
Habitat/Distribution: Rare, but widely distributed over sandy muck substrate in 0-1.5 meters of water.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Myriophyllum sibiricum*) Northern water milfoil, (*Najas flexilis*) Slender naiad, (*Chara* sp.) Muskgrass

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Riccia fluitans*) **Slender riccia**
Specimen Location: Long Lake; N45.69745°, W91.67540°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-221
Habitat/Distribution: Located floating at or just under the surface and tangled in other plants. Only plants found were in the muck bottomed bay surrounding the point over water <1m deep.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Sparganium emersum*) Short-stemmed bur-reed, (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Myriophyllum verticillatum*) Whorled water milfoil, (*Utricularia gibba*) Creeping bladderwort

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Sagittaria cristata*) **Crested arrowhead**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-222
Habitat/Distribution: Widely distributed in Long, but seldom abundant. Most plants were growing in water <1.5m deep over rock/sand bottoms.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Stuckenia pectinata*) Sago pondweed, (*Eleocharis acicularis*) Needle spikerush

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: Long Lake; N45.69876°, W91.68584°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-223
Habitat/Distribution: Found in undeveloped shoreline areas with firm muck bottom in 0-0.25m of water. Plants were more common than the survey indicated as most were located away from the lakeshore in marshy lowlands.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Bald spikerush, (*Calla palustris*) Wild calla

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Sagittaria rigida*) **Sessile-fruited arrowhead**
Specimen Location: Long Lake; N45.67294°, W91.70587°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-224
Habitat/Distribution: Rare; being found at only two point in 0-0.5 meters of water over firm muck in stagnant bays along the shoreline.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock

County/State: Washburn County, Wisconsin **Date:** 7/29/11
Species: (*Schoenoplectus acutus*) **Hardstem bulrush**
Specimen Location: Long Lake; N45.71386°, W91.69983°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-225
Habitat/Distribution: Rocky and sandy bottoms in 0-1 meter of water. Common in scattered reed beds along exposed rocky points and islands in Long Lake.
Common Associates: (*Potamogeton illinoensis*) Illinois pondweed, (*Chara* sp.) Muskgrass, (*Potamogeton natans*) Floating-leaf pondweed, (*Pontederia cordata*) Pickerelweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-226
Habitat/Distribution: Firm muck and sand bottoms in 0-0.5 meter of water. Scattered beds occurred throughout the lake along the shoreline.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Chara* sp.) Muskgrass

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Sparganium emersum*) **Short-stemmed bur-reed**
Specimen Location: Long Lake; N45.71507°, W91.71652°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-227
Habitat/Distribution: Uncommon; scattered plants occurred in water <1m deep over thick organic muck in boggy bays in Long Lake.
Common Associates: (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum)* Coontail, (*Pontederia cordata*) Pickerelweed, (*Myriophyllum verticillatum*) Whorled water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Sparganium eurycarpum*) **Common bur-reed**
Specimen Location: Mud Lake; N45.73252°, W91.66257°
Also found in Long Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-228
Habitat/Distribution: Rare in Long, but common in Mud were if formed dense, nearly monotypic beds in shallow water <0.5m over rock/sand.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Potamogeton richardsonii)* Clasping-leaf pondweed, (*Stuckenia pectinata*) Sago pondweed, (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad

County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Spirodela polyrhiza*) **Large duckweed**
Specimen Location: Mud Lake; N45.74699°, W91.65749°
Also found in Long Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-229
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Common to abundant in most sheltered areas interspersed between the lilypads and wild rice.
Common Associates: (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Leman minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail, (*Zizania palustris*) Northern wild rice, (*Lemna trisulca*) Forked duckweed

County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Stuckenia pectinata*) **Sago pondweed**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-230
Habitat/Distribution: Common and widely distributed in both Long and Mud Lakes. Plants were located in sand and sandy muck in <3meters of water.
Common Associates: (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Chara* sp.) Muskgrass, (*Najas flexilis*) Slender naiad, (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Typha angustifolia*) **Narrow-leaved cattail**
Specimen Location: Long Lake; N45.70939°, W91.70594°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-231
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. A few individuals were found mixed in with the other cattails that dominated the bay south of Rice Island.
Common Associates: (*Typha glauca*) Hybrid cattail, (*Typha latifolia*) Broad-leaved cattail

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Typha glauca*) **Hybrid cattail**
Specimen Location: Long Lake; N45.70939°, W91.70594°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-232
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Seems to tolerate "wet feet" better than *T. latifolia*. Hybrids dominated the bay south of Rice Island and several side bays off of the finger bay that projects to the northeast out of the main basin towards Little Mud Lake.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Nymphaea odorata*) White water lily

County/State: Washburn County, Wisconsin **Date:** 7/30/11
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Long Lake; N45.70939°, W91.70594°
Also found in Mud Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-233
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Found in undeveloped shoreline areas. Seems to be increasingly excluded by *T. glauca*.
Common Associates: (*Typha glauca*) Hybrid cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Eleocharis erythropoda*) Red-footed spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Calla palustris*) Wild calla

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Utricularia gibba*) **Creeping bladderwort**
Specimen Location: Long Lake; N45.69745°, W91.67540°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-234
Habitat/Distribution: Muck bottom in shallow water 0-1.5 meters deep in calm bays floating among lilypads or entangled in other plants. Rare; only a handful of individuals were found.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Riccia fluitans*) Slender riccia, (*Myriophyllum verticillatum*) Whorled water milfoil

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Utricularia intermedia*) **Flat-leaved bladderwort**
Specimen Location: Long Lake; N45.70939°, W91.70594°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-235
Habitat/Distribution: Muck bottom in shallow water <1m deep. Rare; restricted to the side bay surrounding the point.
Common Associates: (*Utricularia vulgaris*) Common bladderwort, (*Utricularia minor*) Small bladderwort, (*Nymphaea odorata*) White water lily, (*Zizania palustris*) Northern wild rice, (*Sparganium emersum*) Short-stemmed bur-reed

County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Utricularia minor*) **Small bladderwort**
Specimen Location: Long Lake; N45.70865°, W91.70696°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-236
Habitat/Distribution: Muck bottom in shallow water <1m deep. Rare; restricted to two side bay off the finger bay projecting from the south basin towards Little Mud Lake.
Common Associates: (*Utricularia intermedia*) Flat-leaved bladderwort, (*Myriophyllum verticillatum*) Whorled water milfoil, (*Nymphaea odorata*) White water lily, (*Zizania palustris*) Northern wild rice, (*Sparganium emersum*) Short-stemmed bur-reed

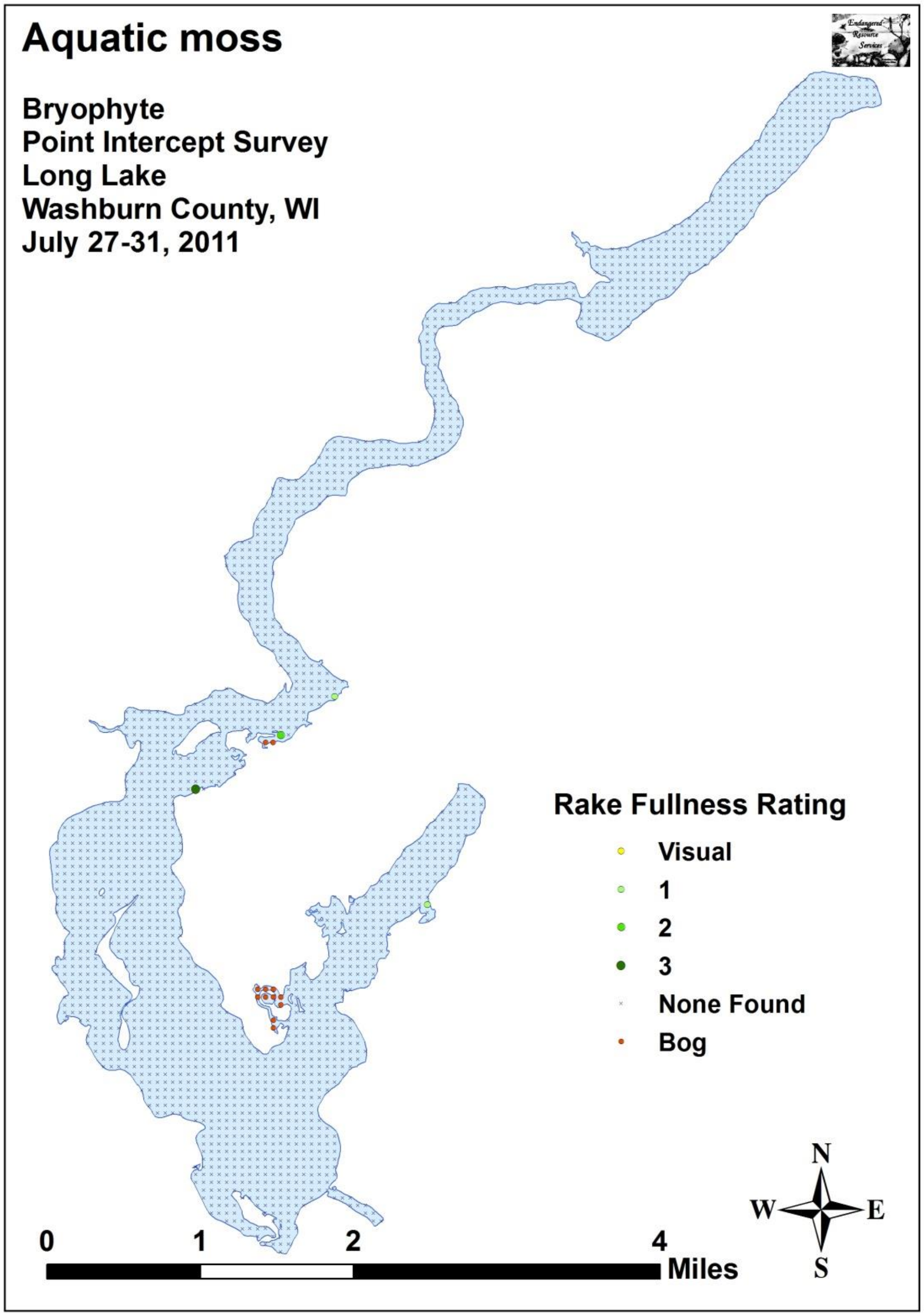
County/State**:** Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Mud Lake; N45.72969°, W91.66399°
Also found in Long Lake.
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-237
Habitat/Distribution: Thick muck bottom in shallow water <1.5m. Uncommon but locally abundant in boggy bays of Long; restricted to a single point in Mud.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum*) Coontail, (*Potamogeton natans*) Floating-leaf pondweed, (*Sparganium emersum*) Short-stemmed bur-reed

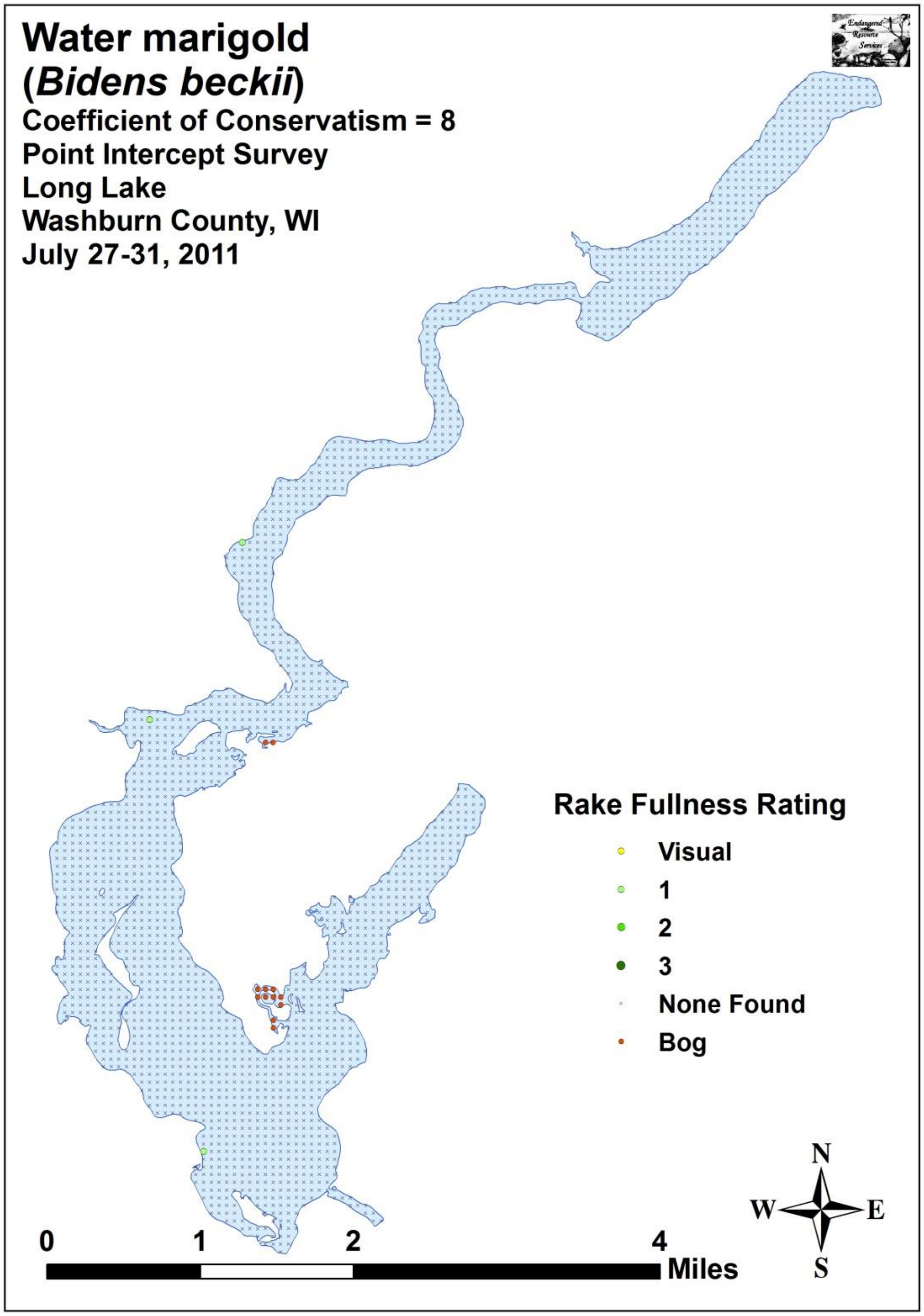
County/State: Washburn County, Wisconsin **Date:** 7/28/11
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Long Lake; N45.75662°, W91.66780°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-238
Habitat/Distribution: Found in almost any bottom conditions, but grows best in sandy to sand/muck bottoms in 0.5-5 meters of water. Common and widely distributed throughout Long.
Common Associates: (*Najas flexilis*) Slender naiad, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Chara* sp.) Muskgrass, (*Stuckenia pectinata*) Sago pondweed

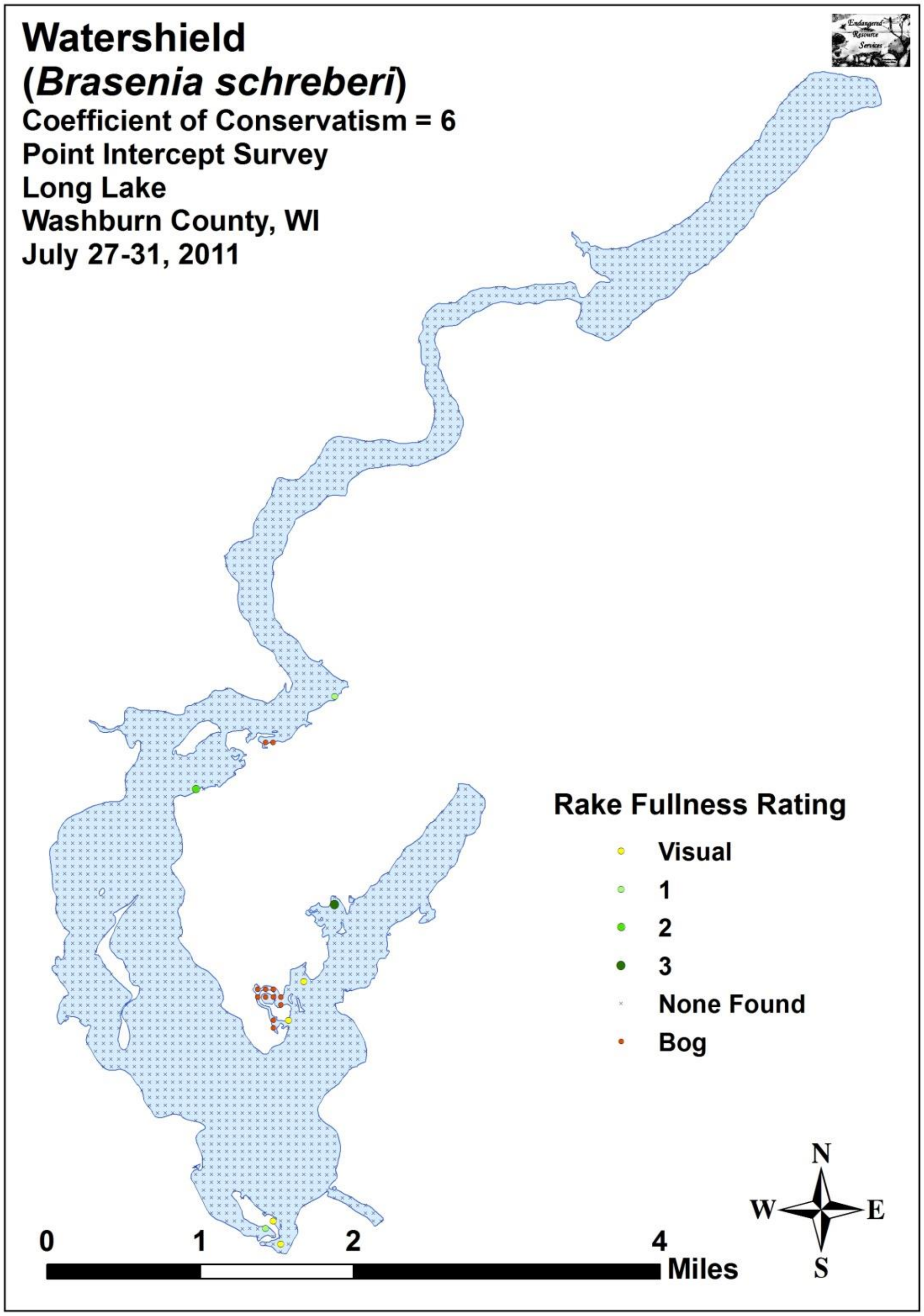
County/State: Washburn County, Wisconsin **Date:** 7/27/11
Species: (*Wolffia columbiana*) **Common watermeal**
Specimen Location: Mud Lake; N45.74699°, W91.65749°
Also found in Long Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-239
Habitat/Distribution: Located floating at or just under the surface. Common to abundant in most sheltered areas interspersed between the lilypads and wild rice.
Common Associates: (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza)* Large duckweed, (*Leman minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail, (*Zizania palustris*) Northern wild rice, (*Lemna trisulca*) Forked duckweed

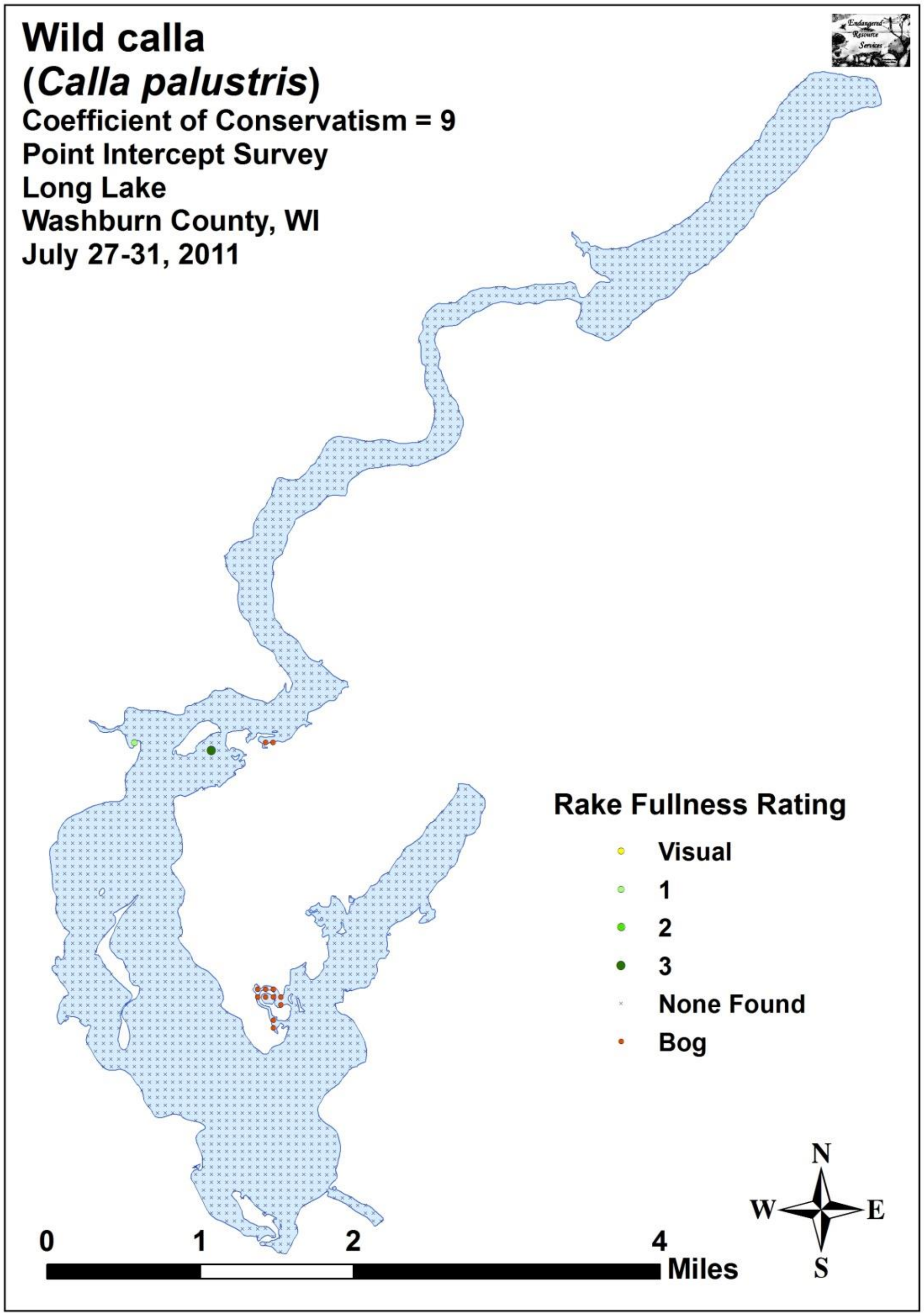
County/State: Washburn County, Wisconsin **Date:** 7/31/11
Species: (*Zizania palustris*) **Northern wild rice**
Specimen Location: Long Lake; N45.71394°, W91.69463°
Also found in Mud Lake.
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-240
Habitat/Distribution: Locally common and widespread in undeveloped pristine areas over muck in water <1.5m; especially where there was slight water flow. Most plants were in the channel between Mud and Long, but scattered patches occurred at most small stream inlets.
Common Associates: (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza)* Large duckweed, (*Leman minor*) Small duckweed, (*Ceratophyllum demersum*) Coontail, (*Wolffia columbiana*) Common watermeal, (*Lemna trisulca*) Forked duckweed

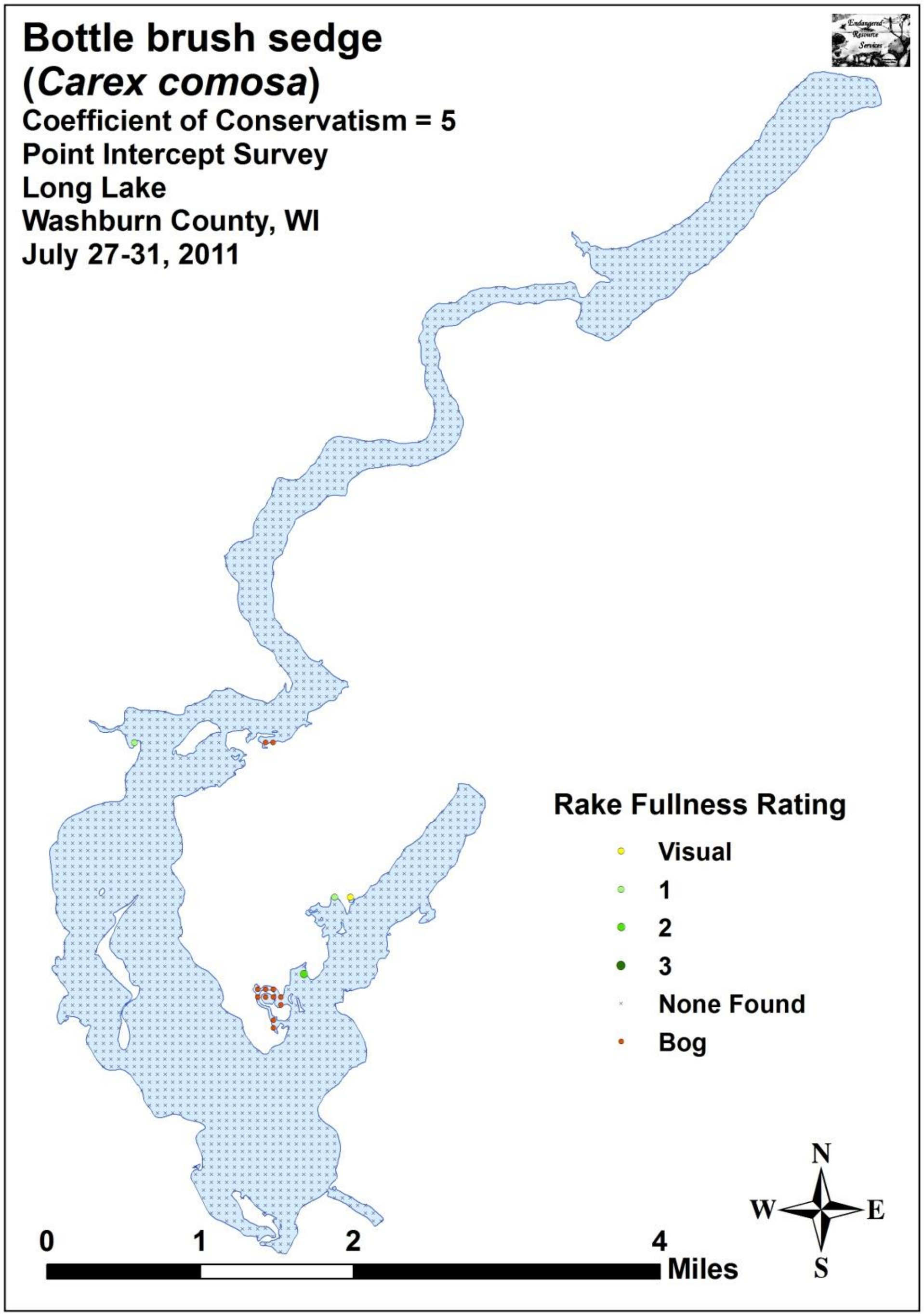
Appendix VIII: Long Lake P/I Density and Distribution Maps

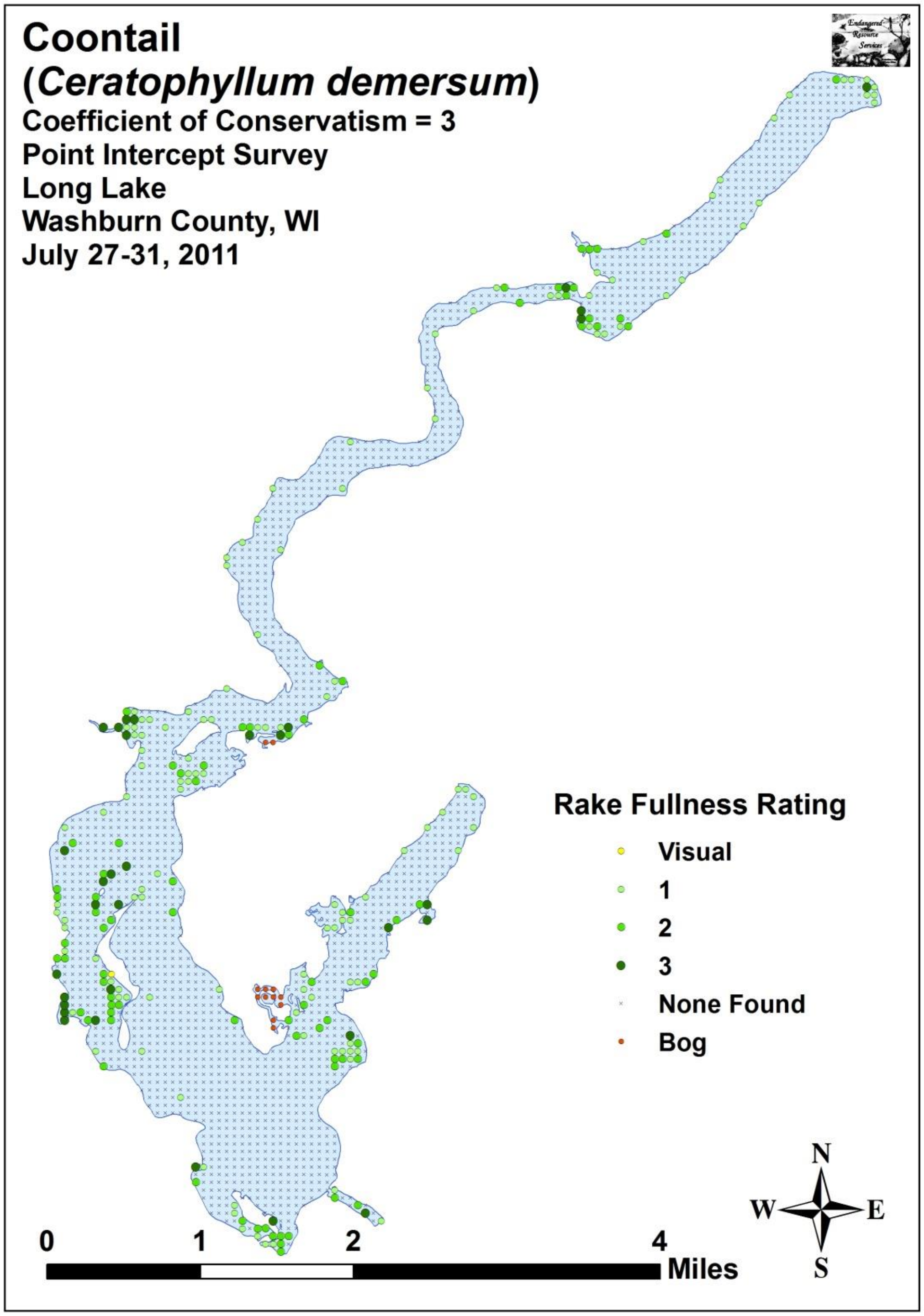

Aquatic moss
Bryophyte
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

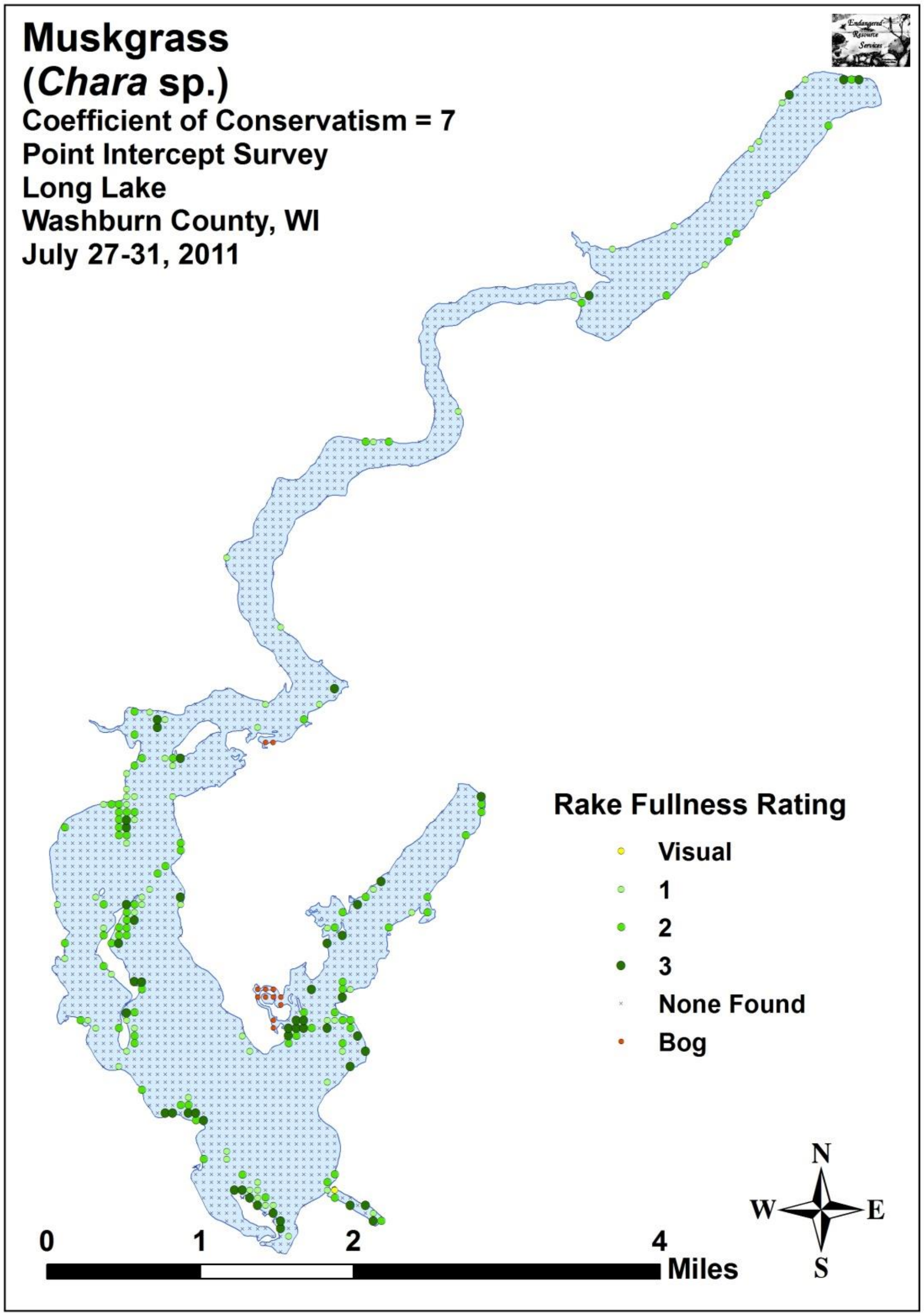

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

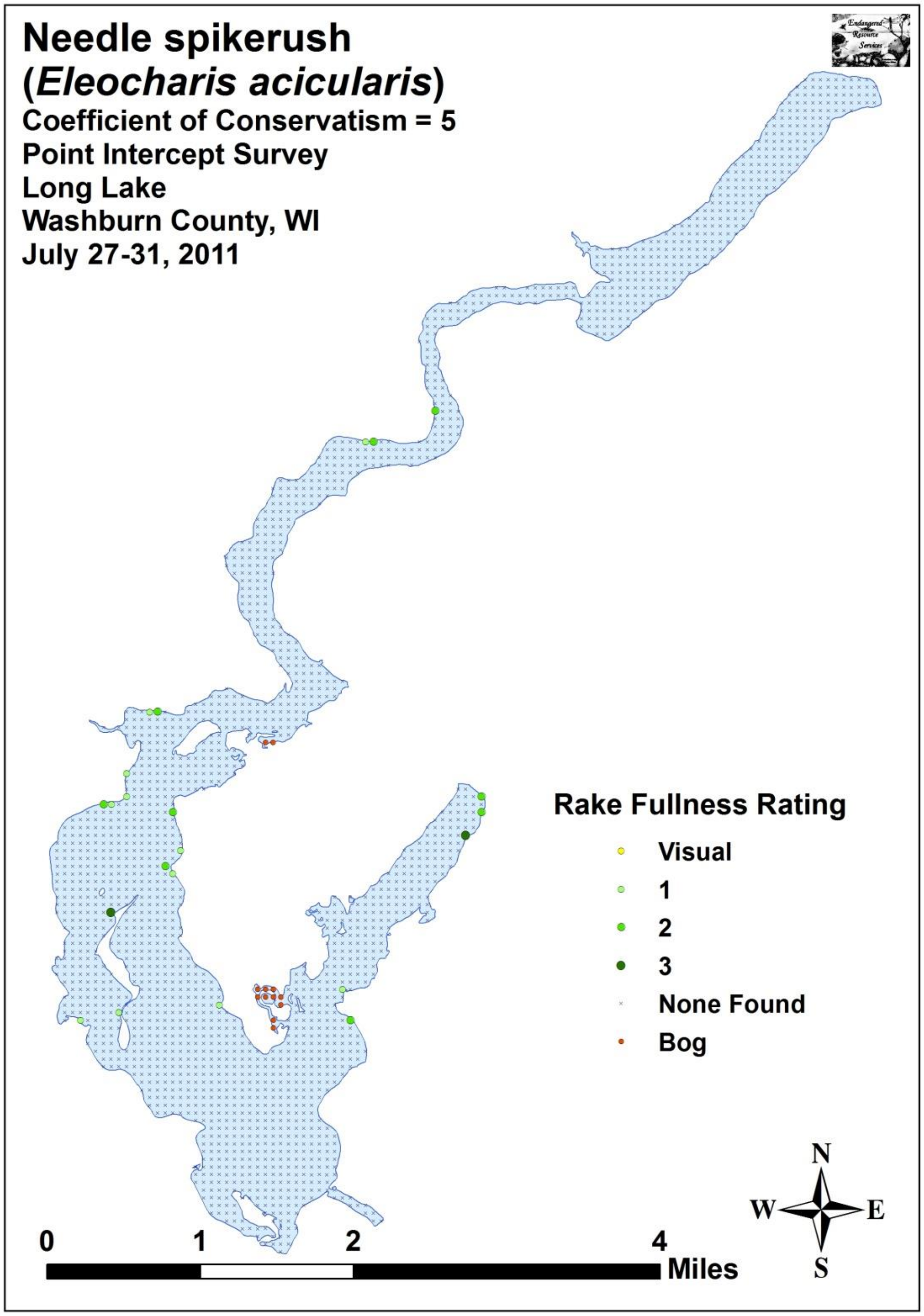

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

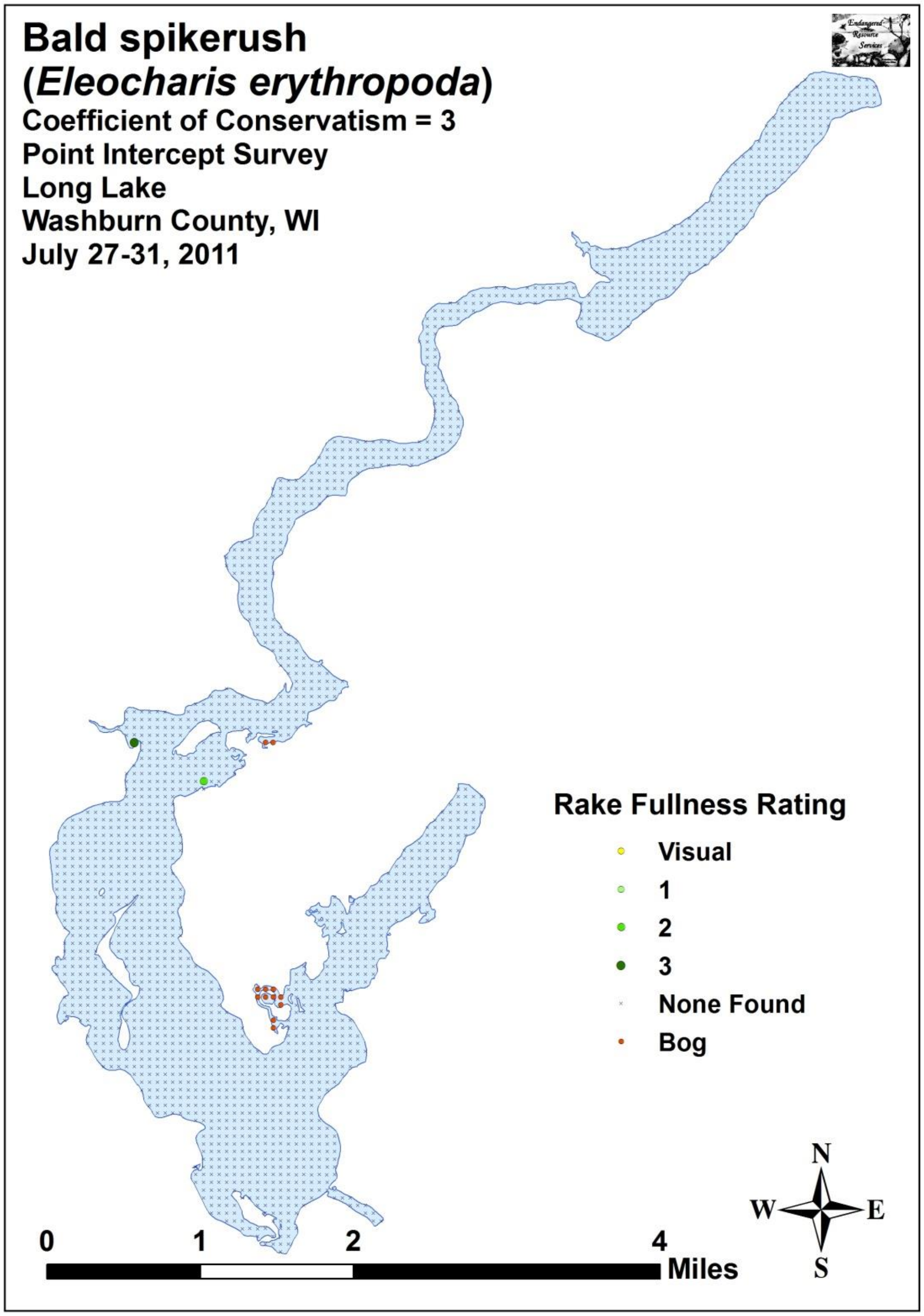

Wild calla
(Calla palustris)
Coefficient of Conservatism = 9
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

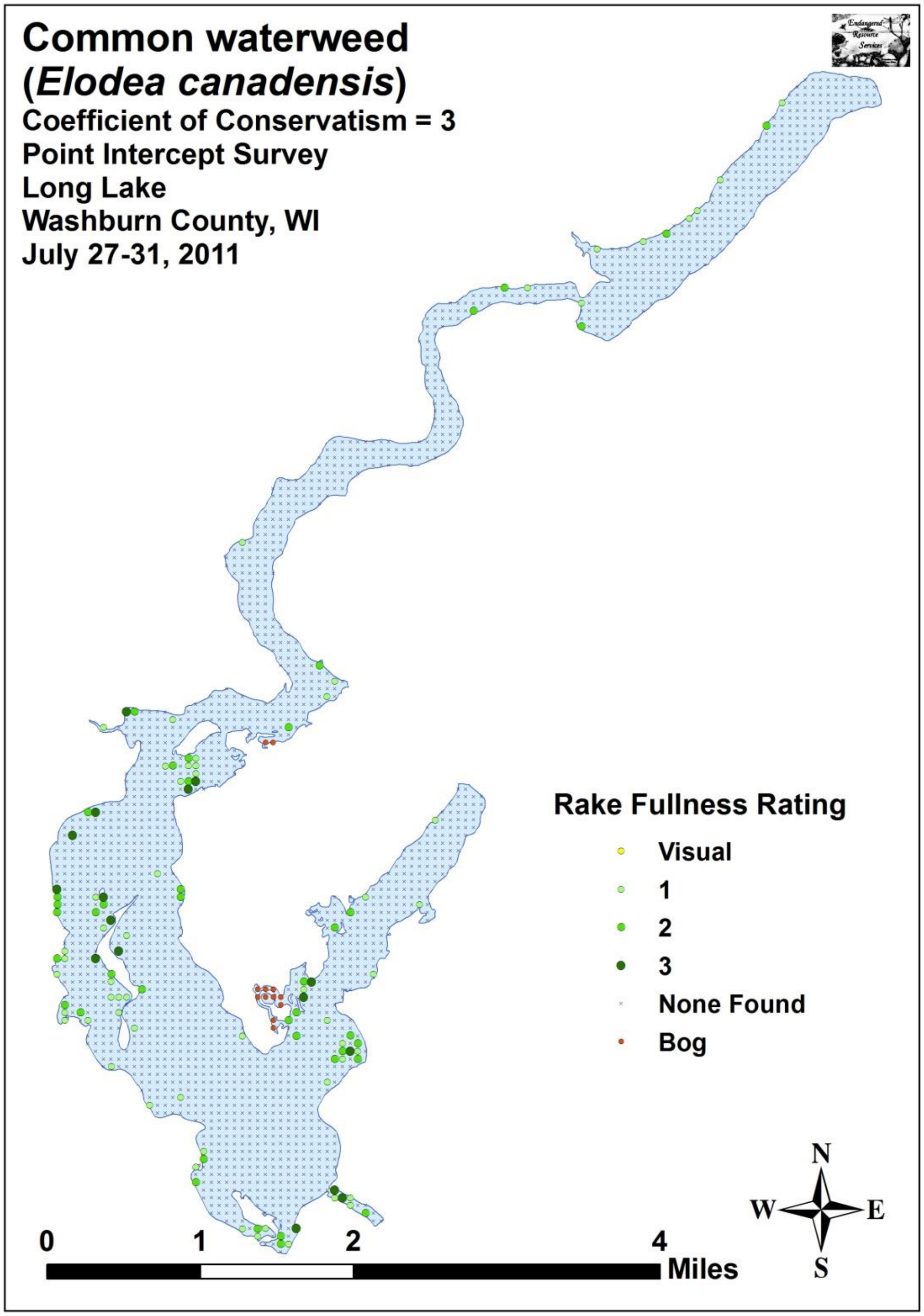

Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

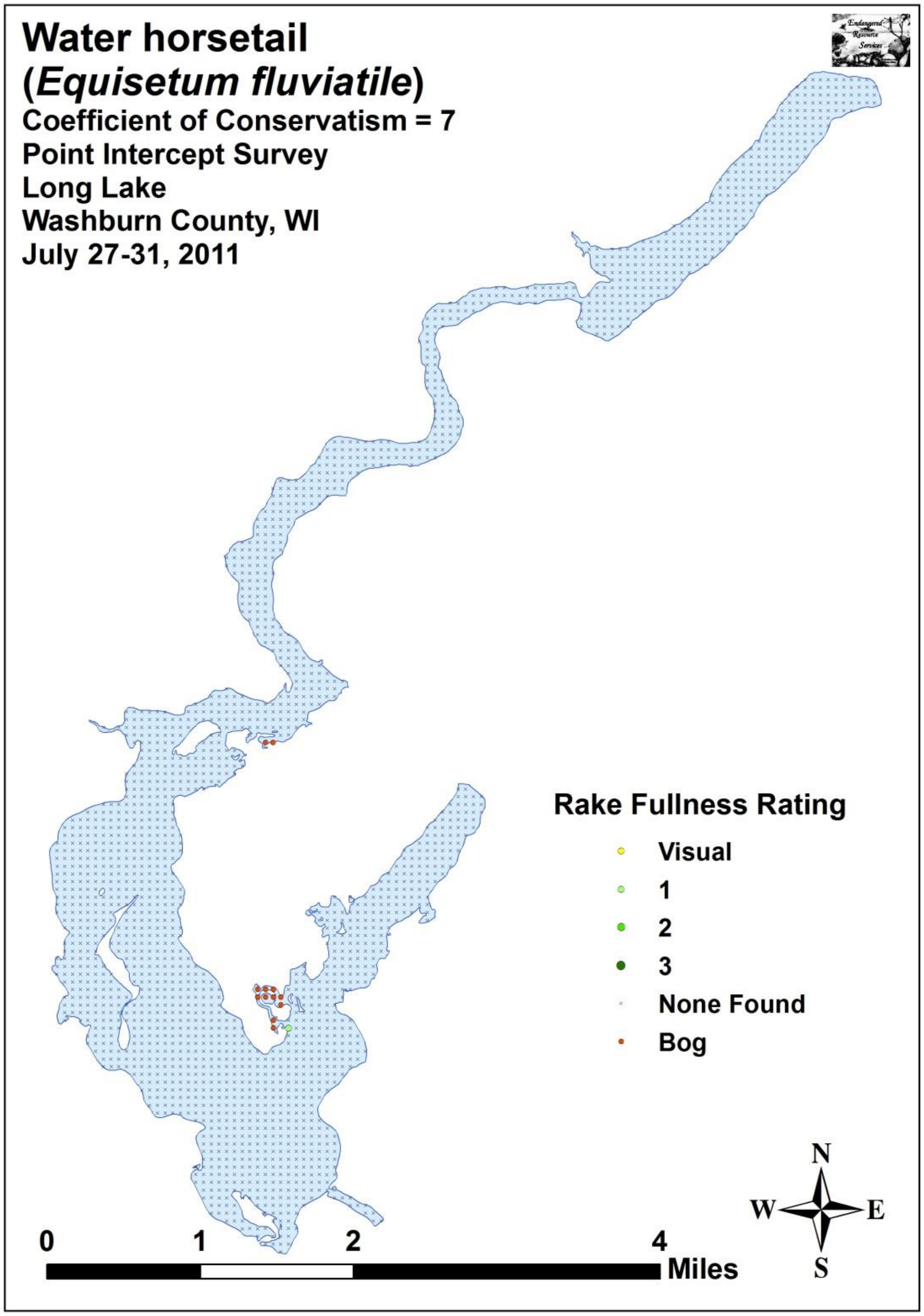

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles


Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

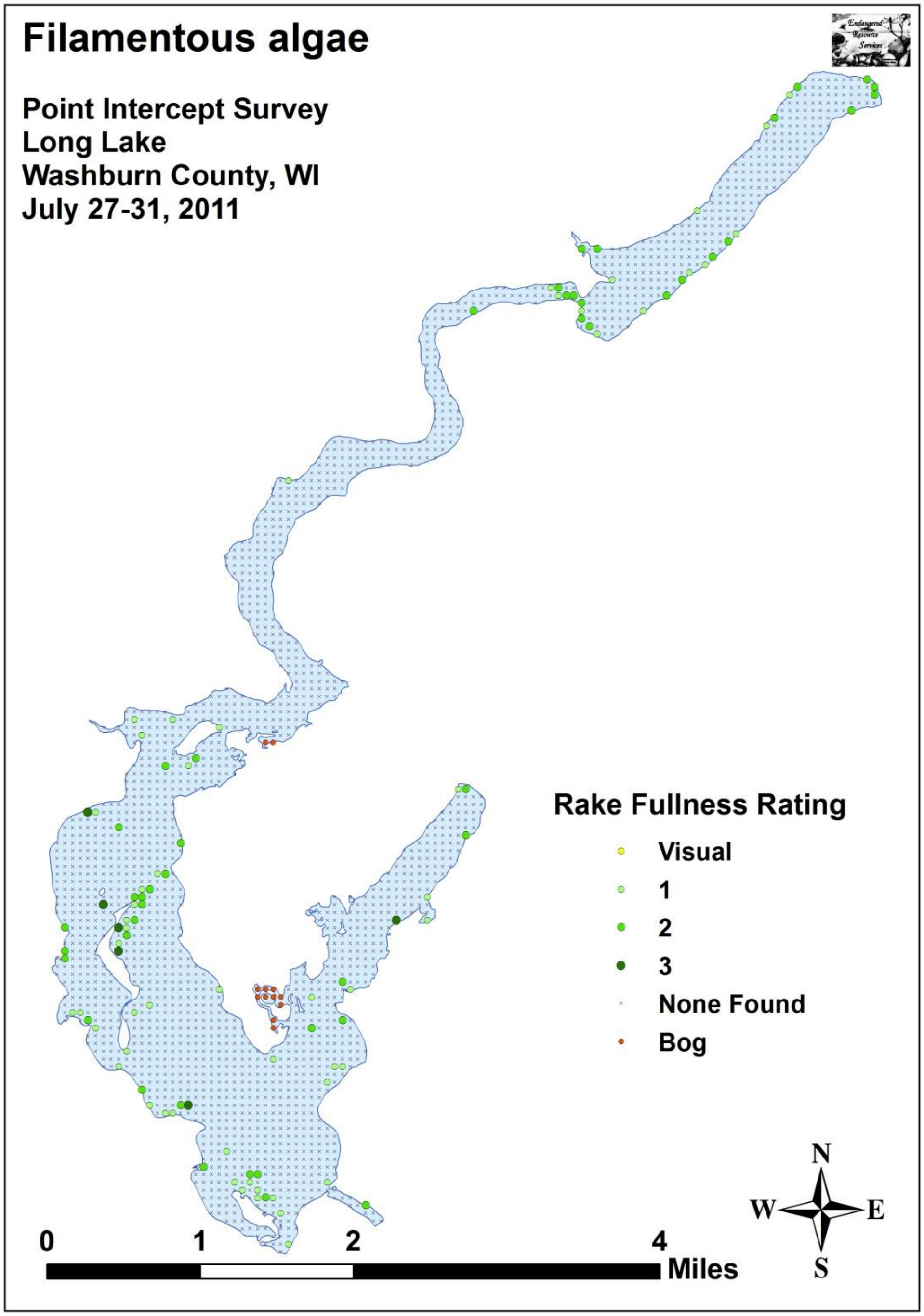

Needle spikerush
(*Eleocharis acicularis*)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

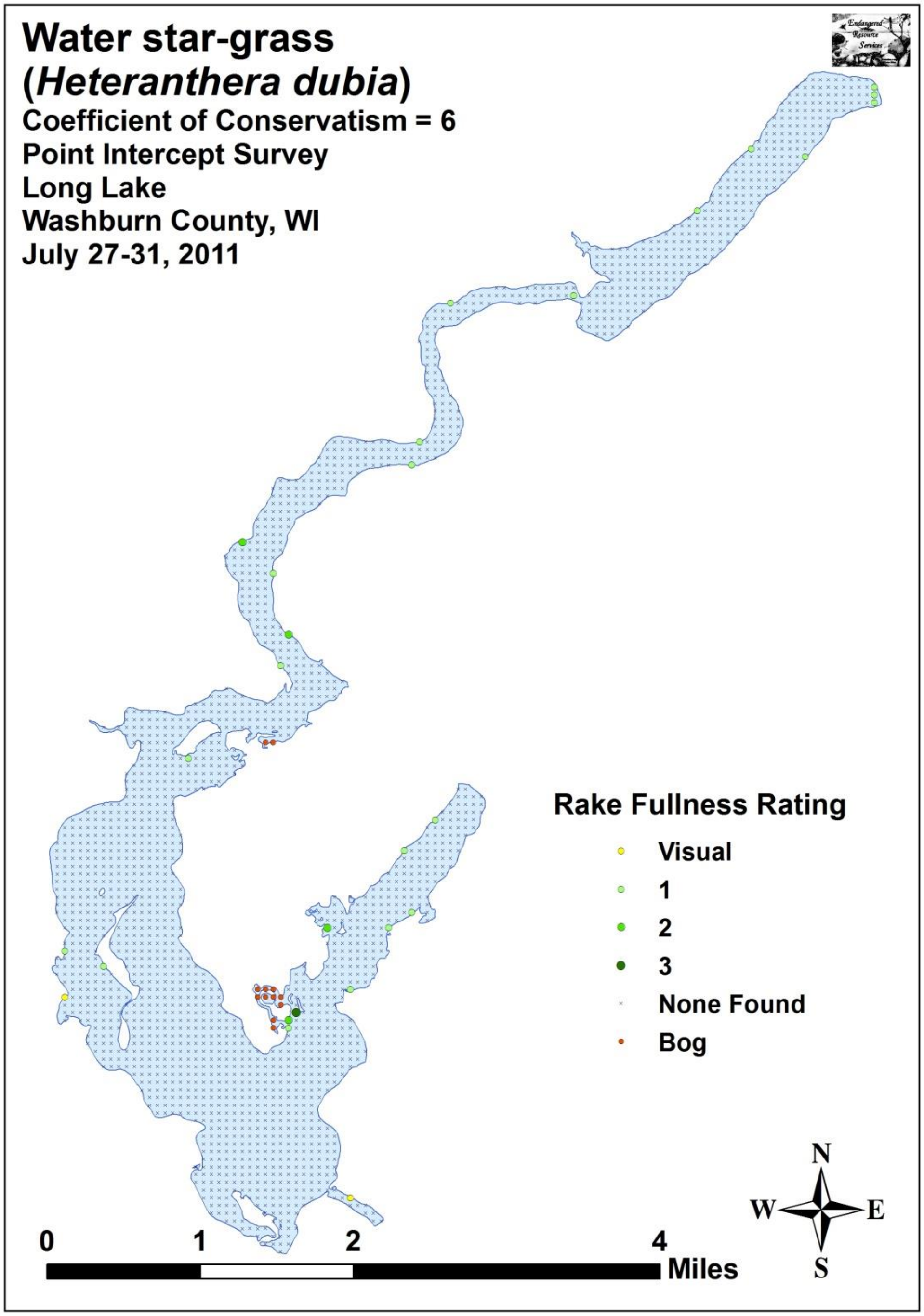

Bald spikerush
(Eleocharis erythropoda)
Coefficient of Conservatism = 3
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles


Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

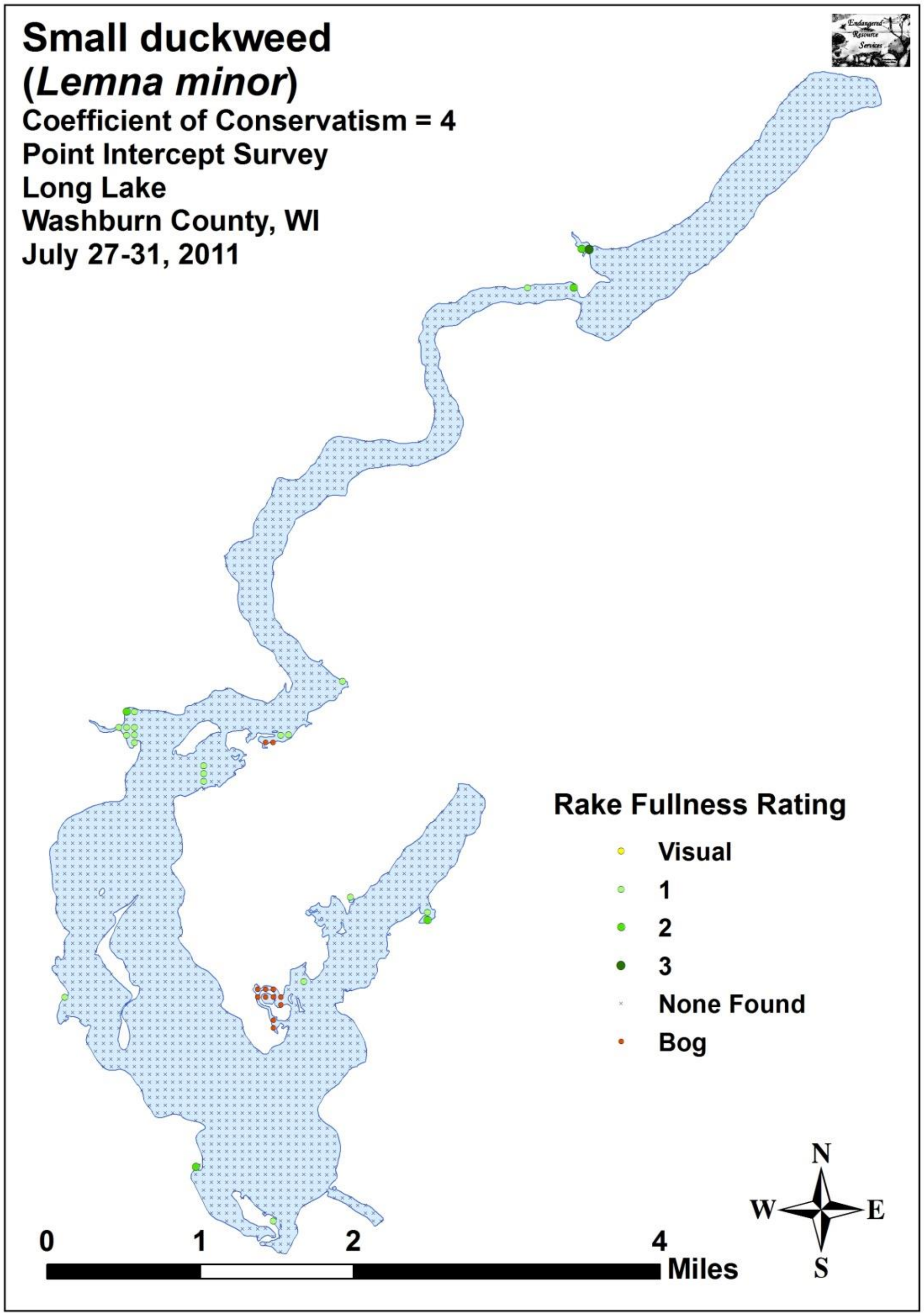


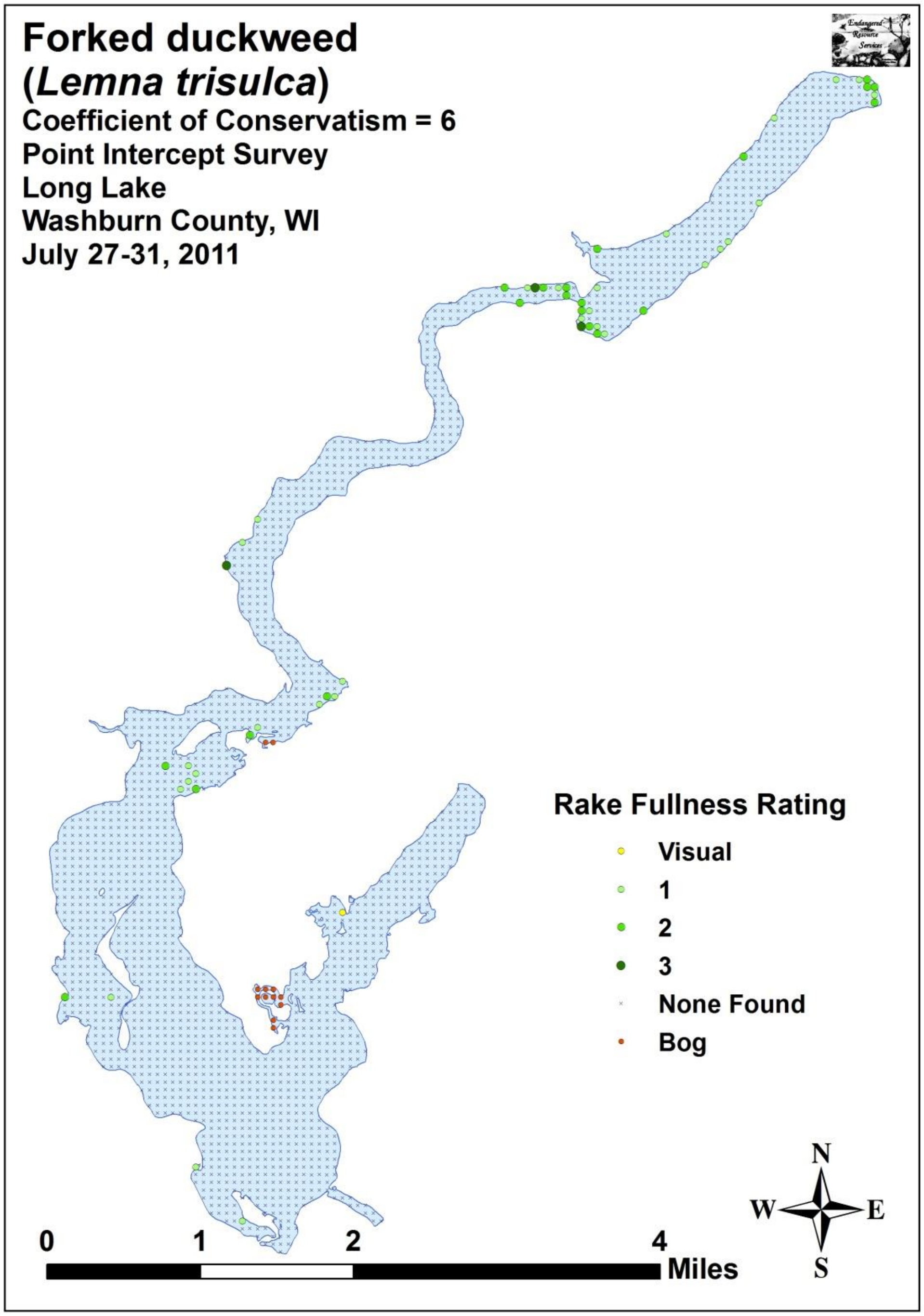
Water horsetail
(*Equisetum fluviatile*)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

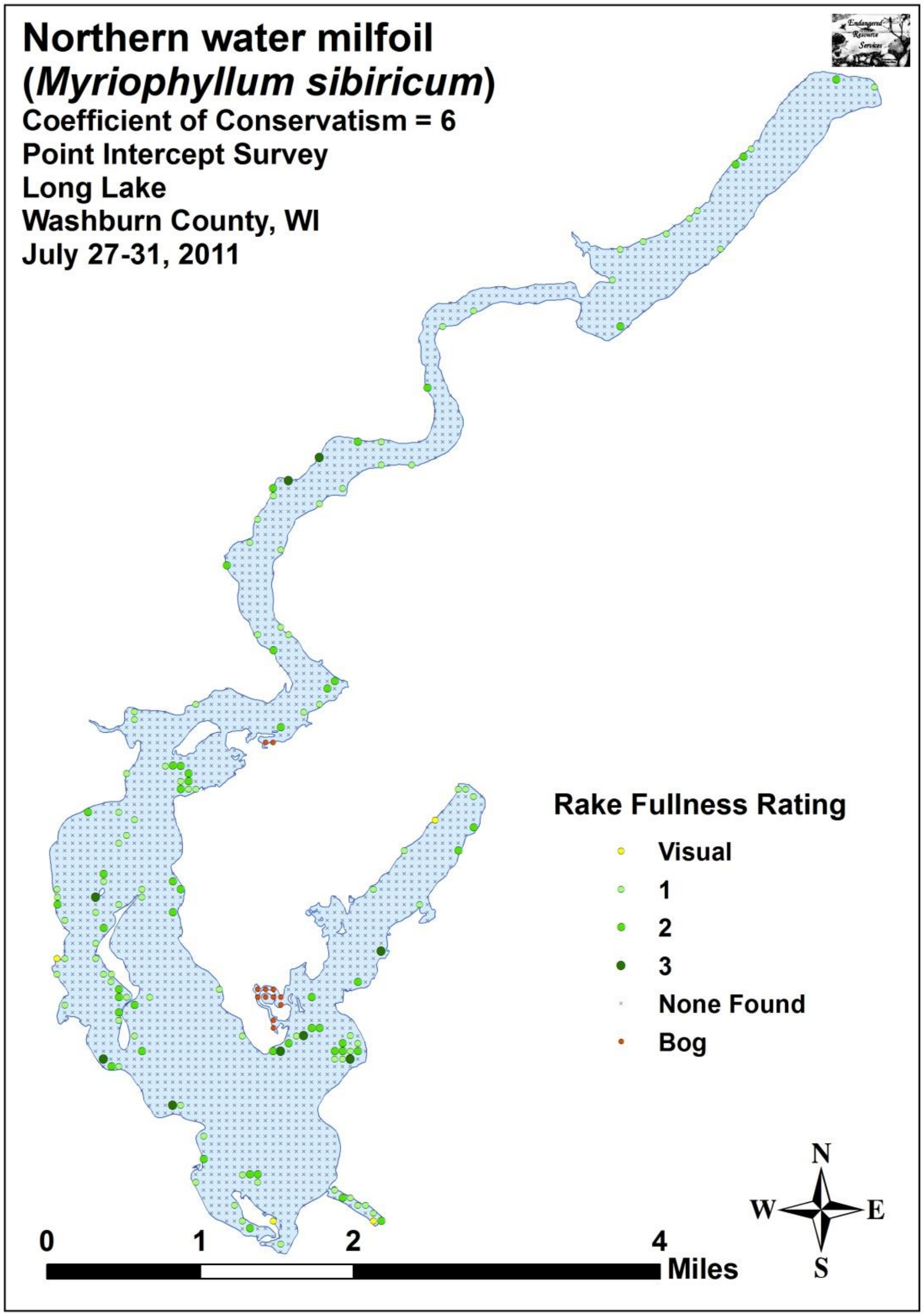

Filamentous algae
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

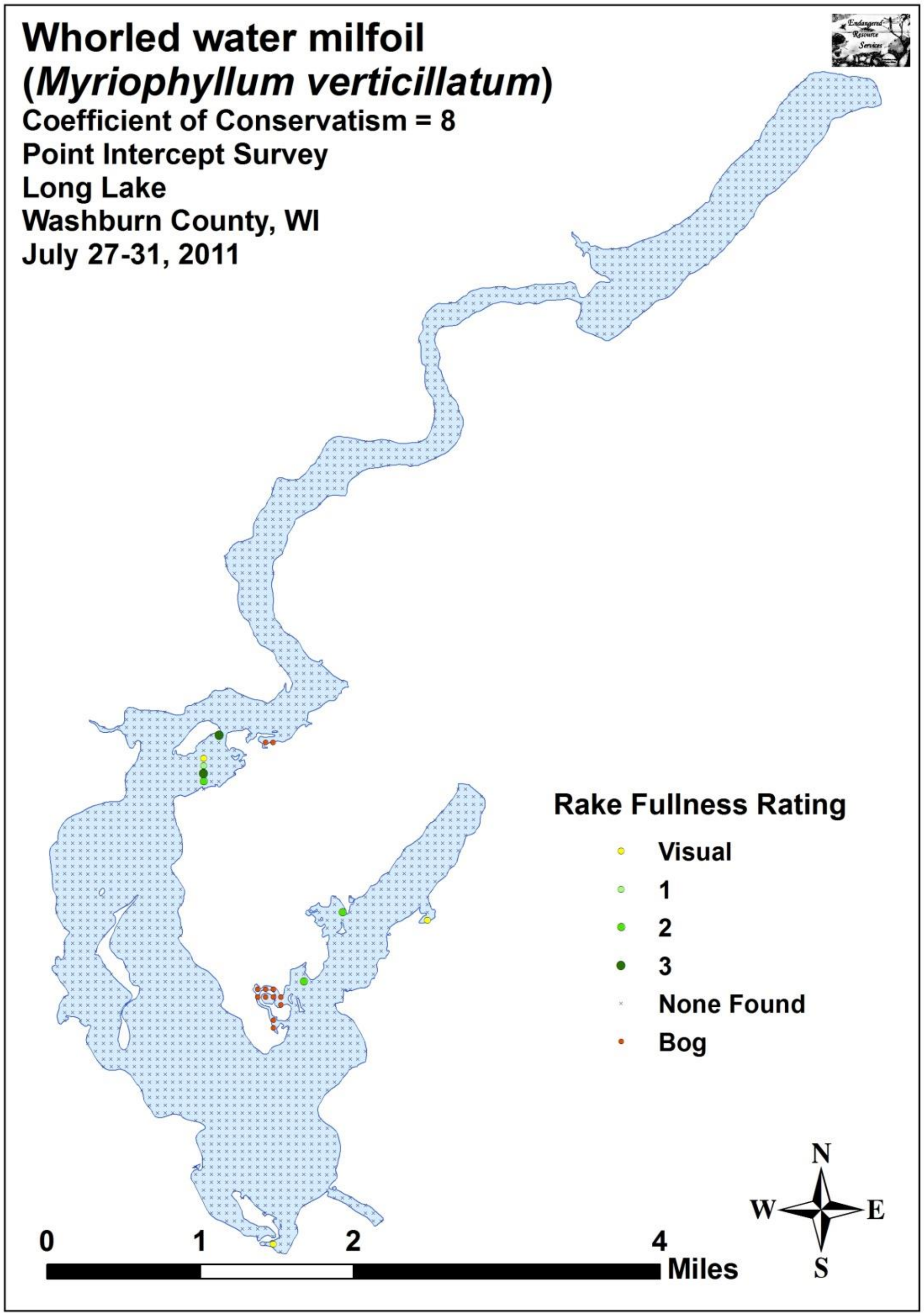


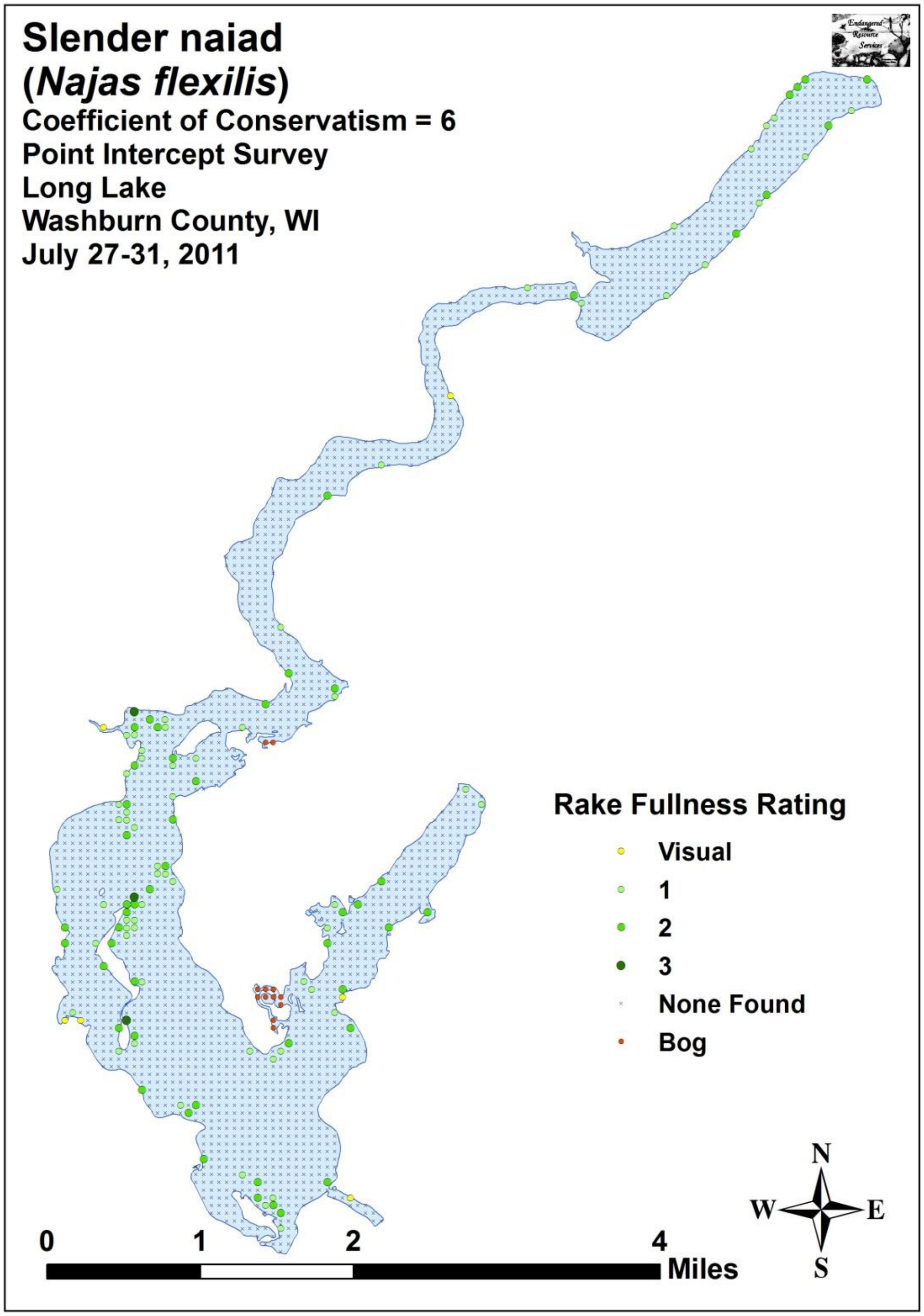
Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

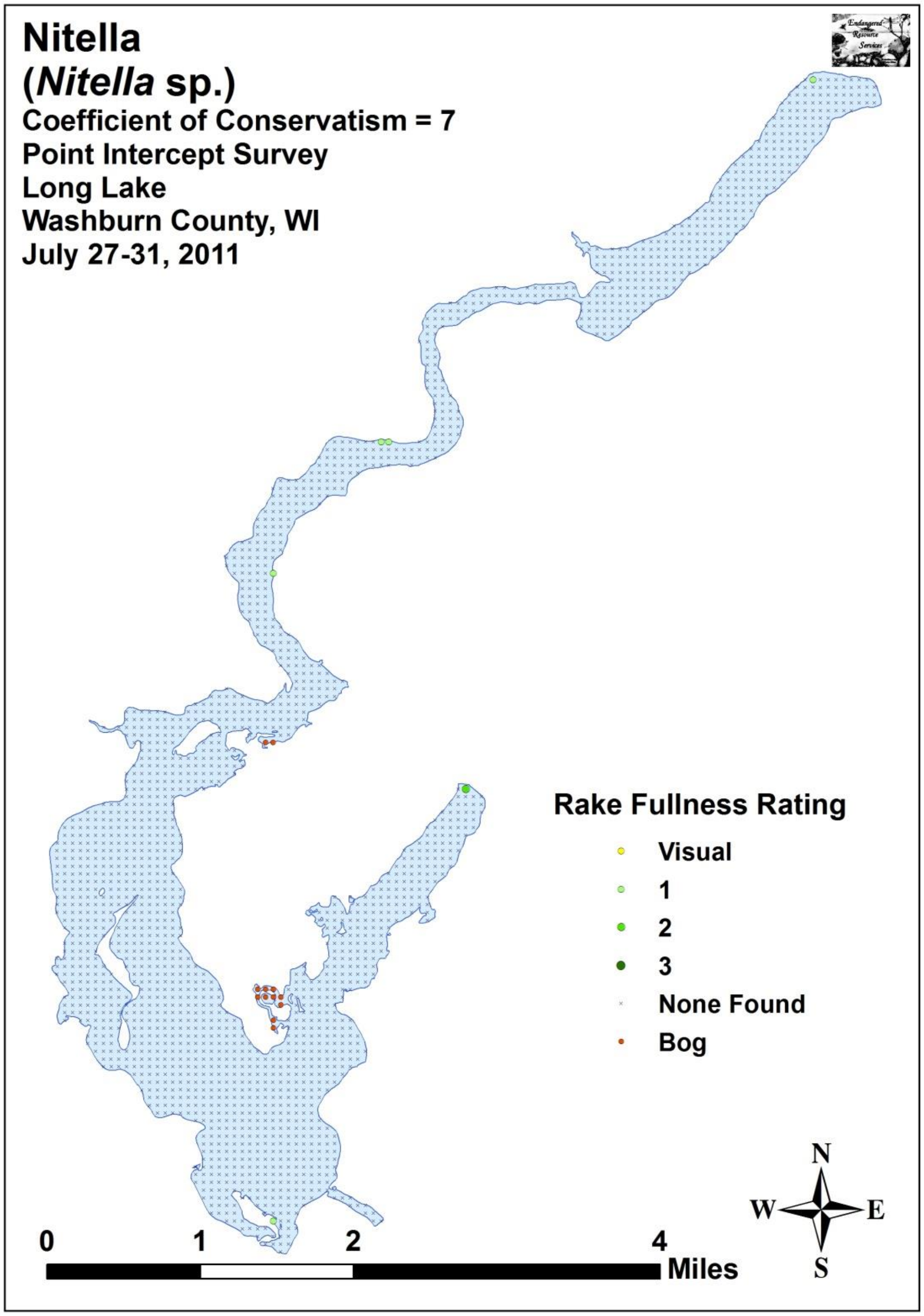

Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

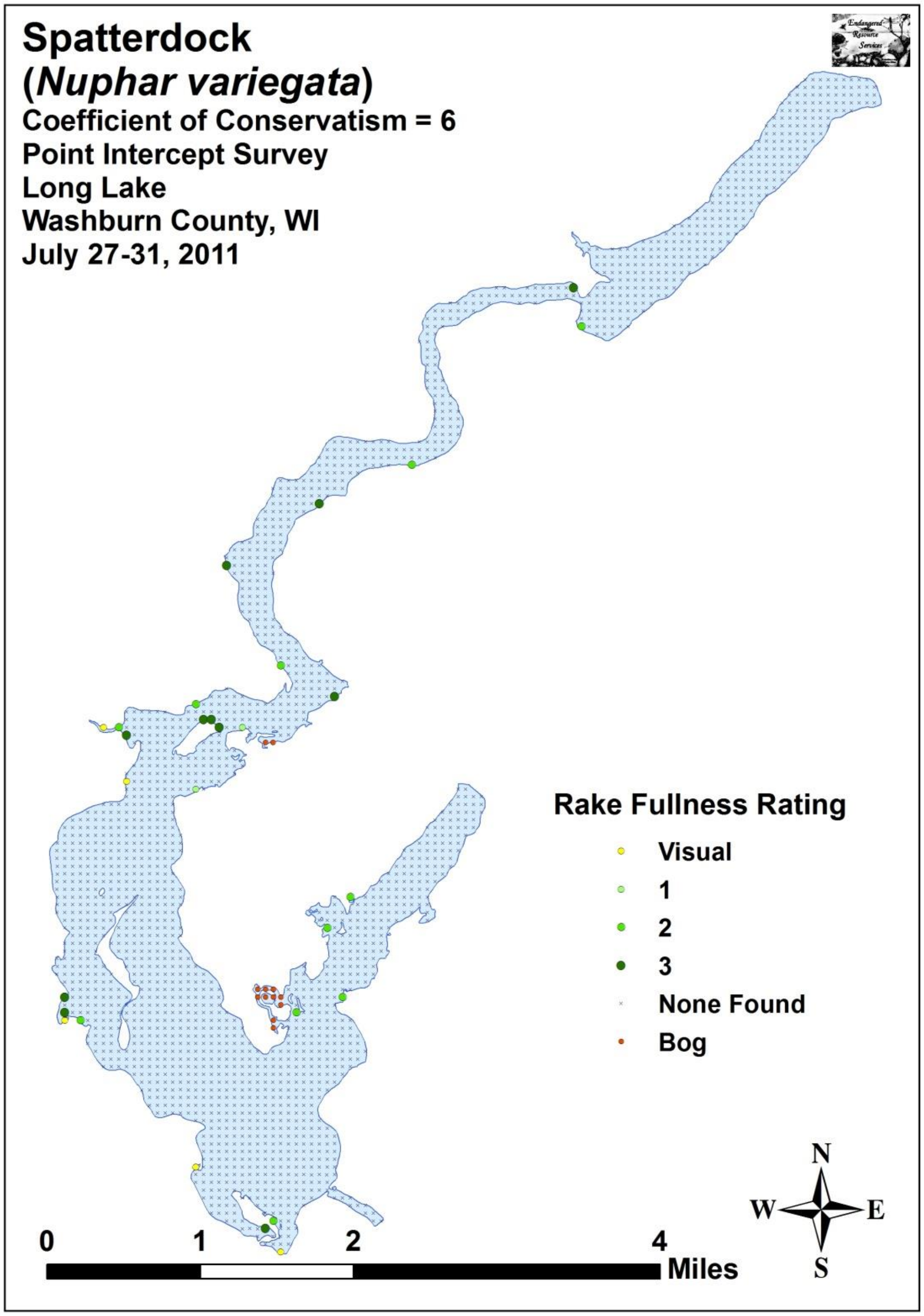

Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

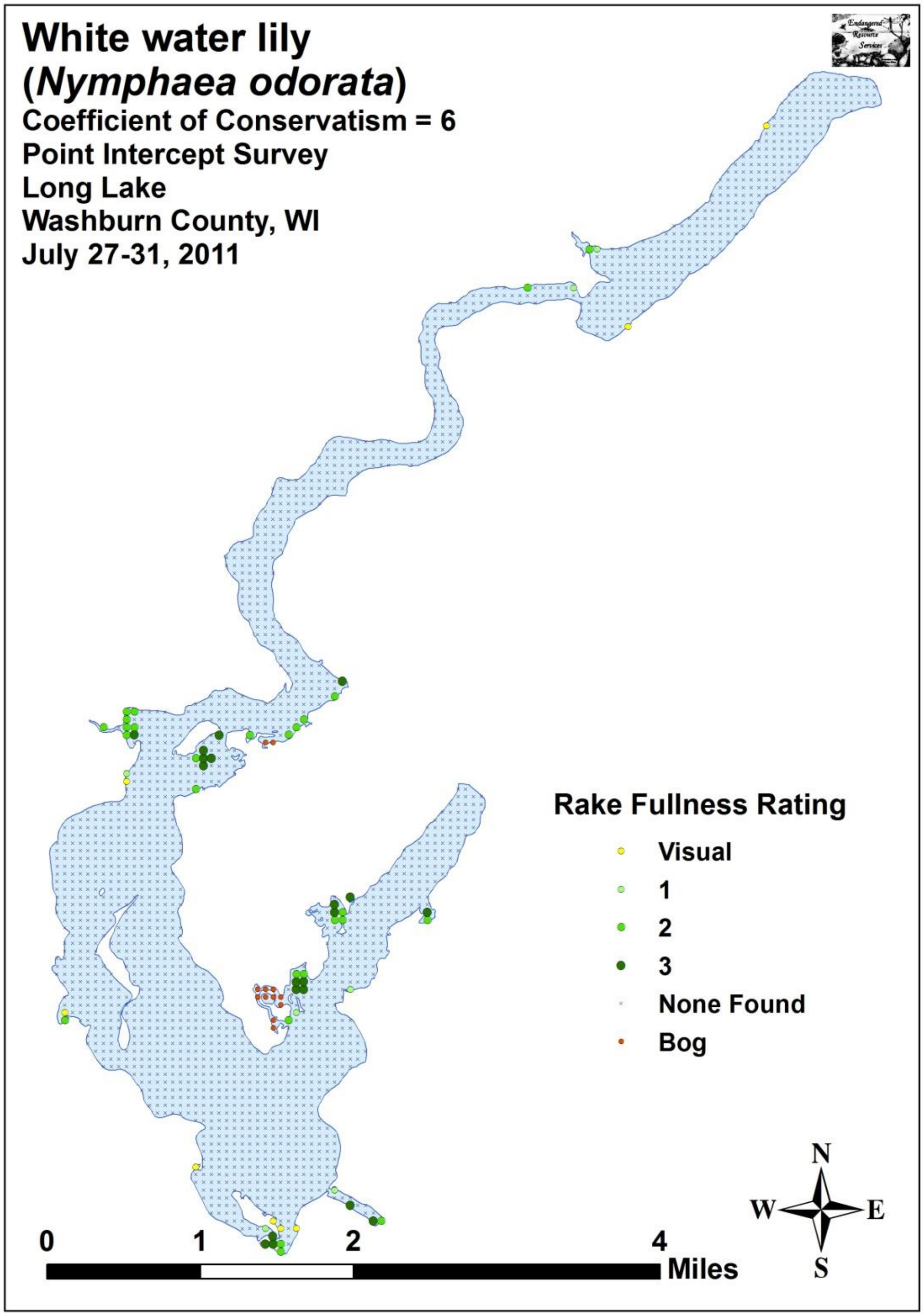

Northern water milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

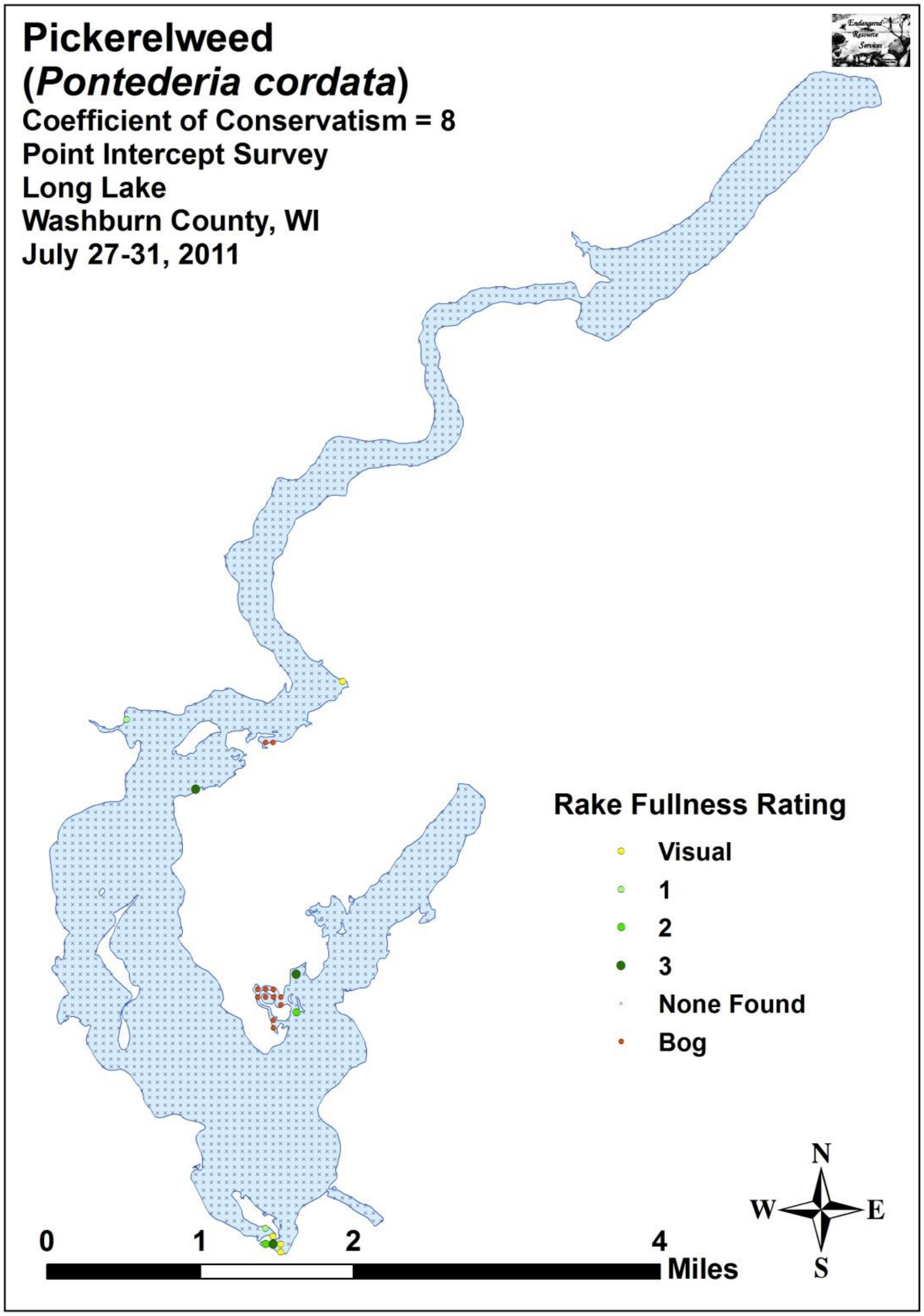

Whorled water milfoil
(*Myriophyllum verticillatum*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

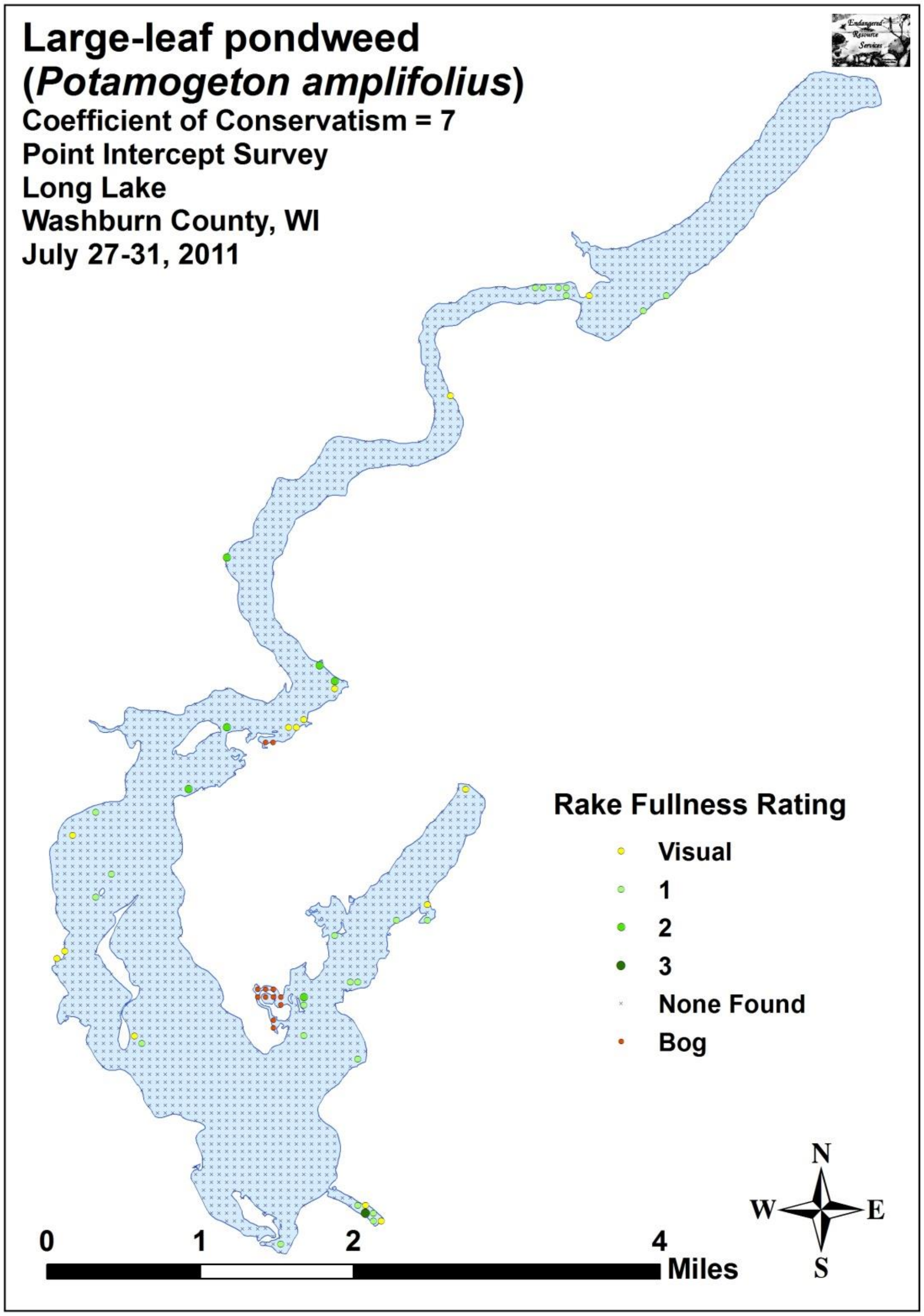

Slender naiad
(*Najas flexilis*)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

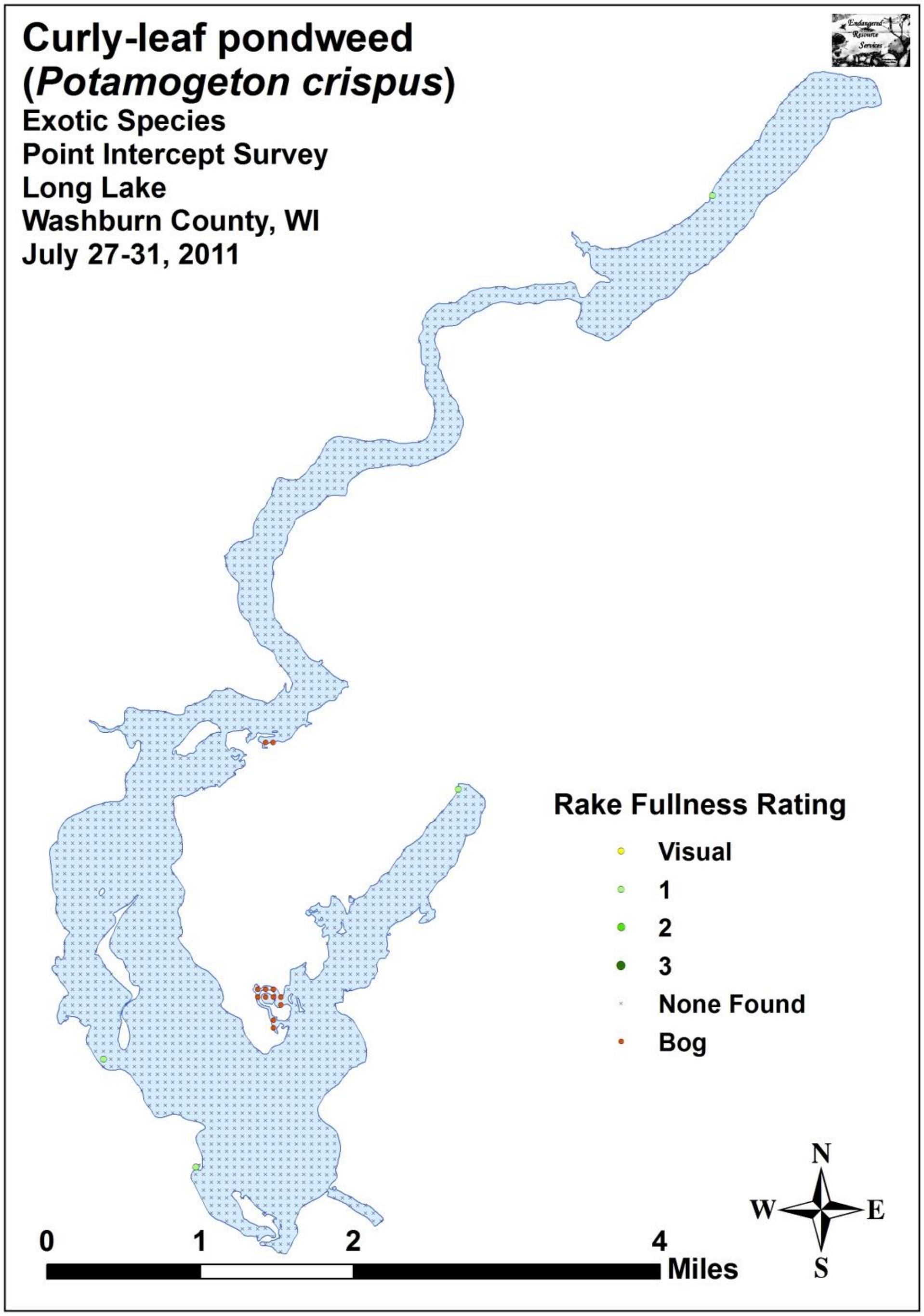

Spatterdock
(*Nuphar variegata*)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

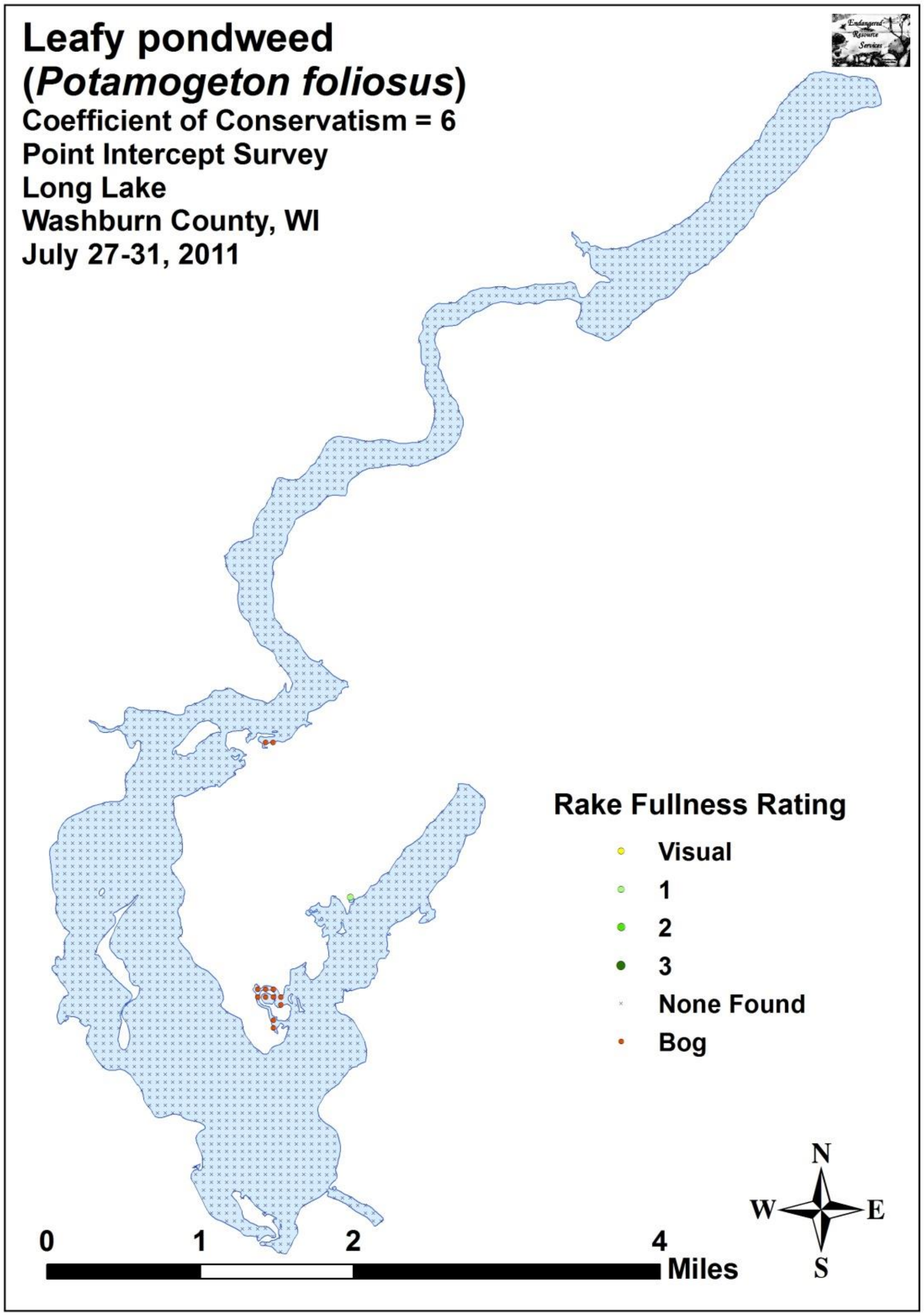

White water lily
(*Nymphaea odorata*)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

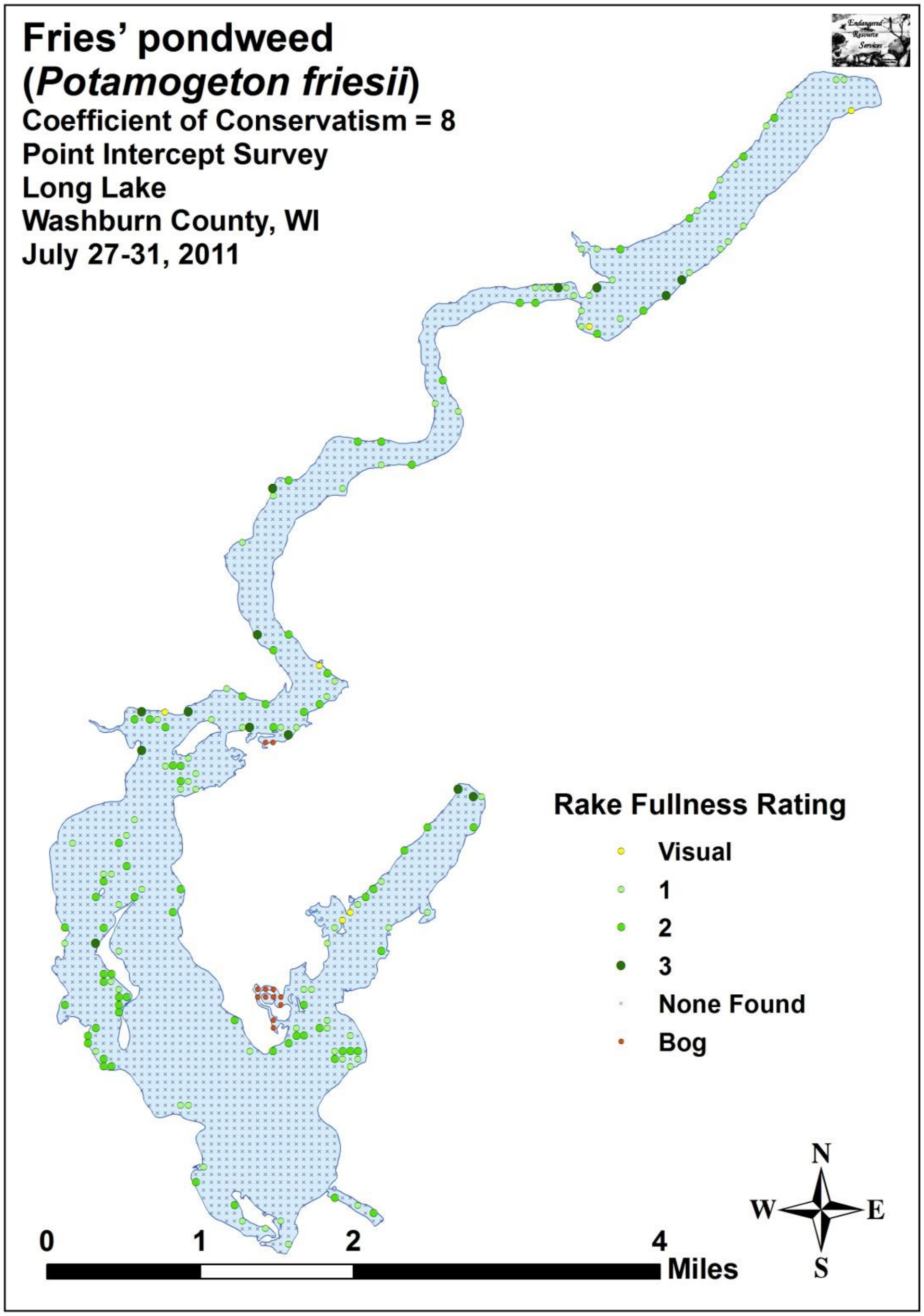

Pickerelweed
(*Pontederia cordata*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

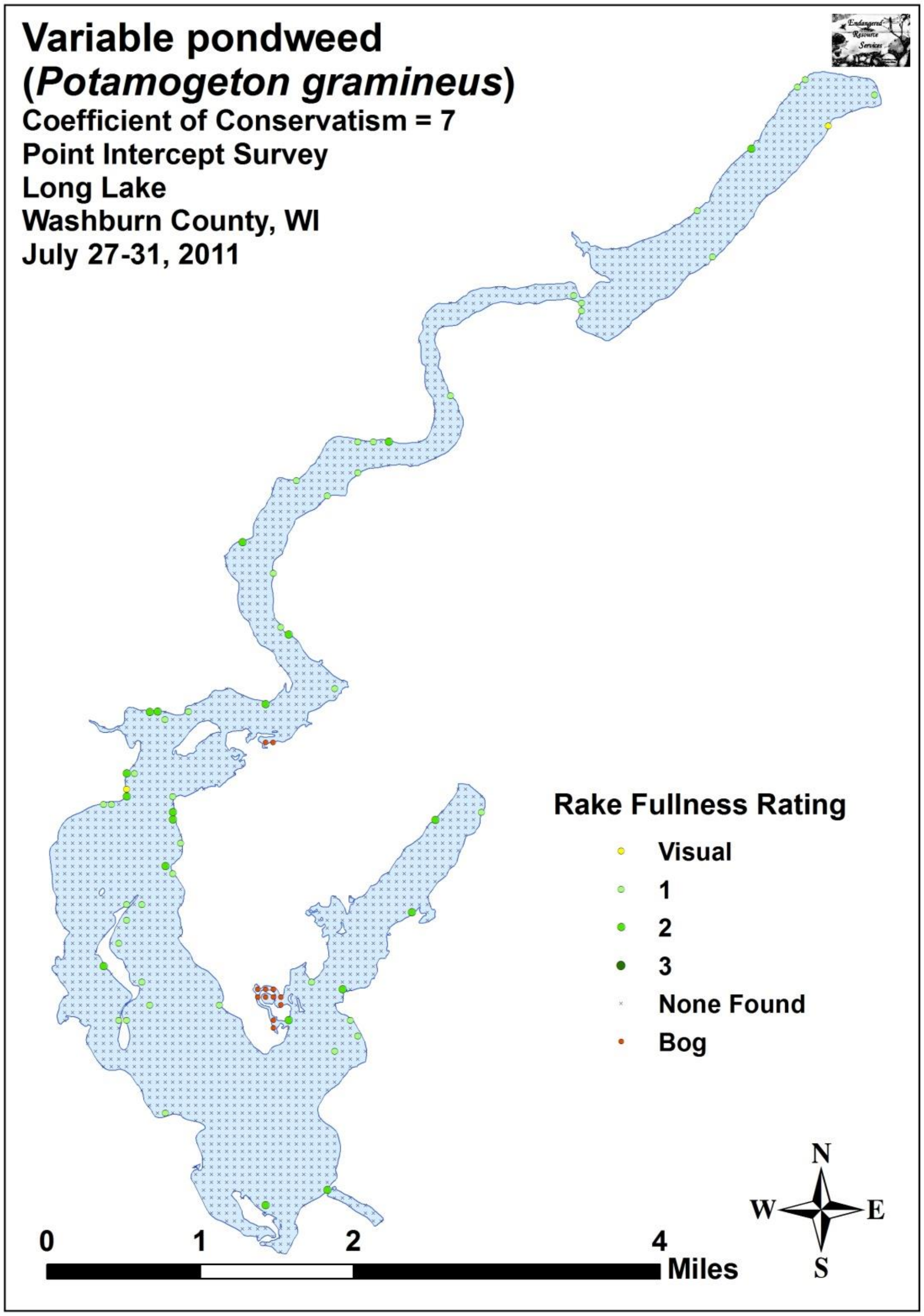


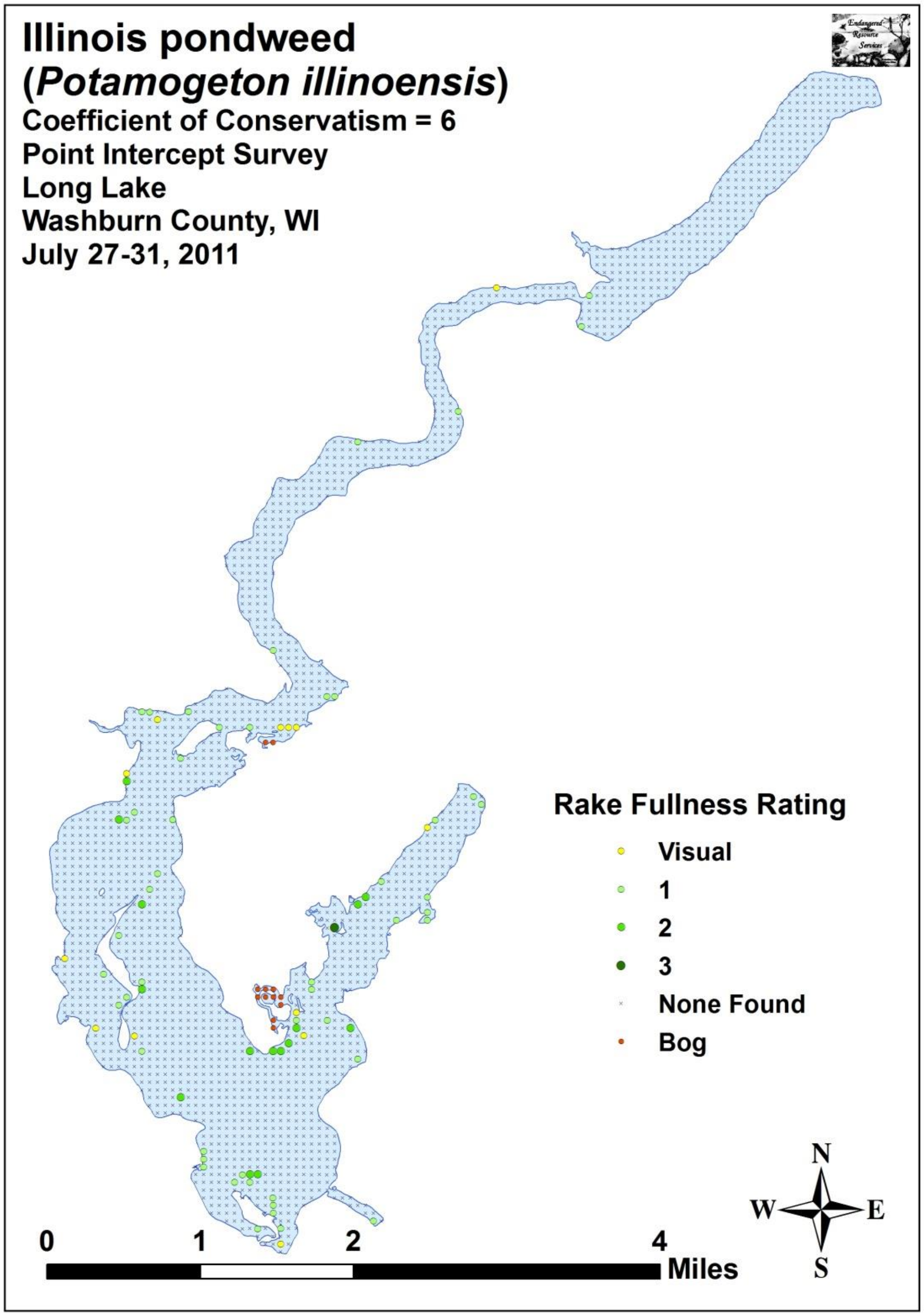
Large-leaf pondweed
(*Potamogeton amplifolius*)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

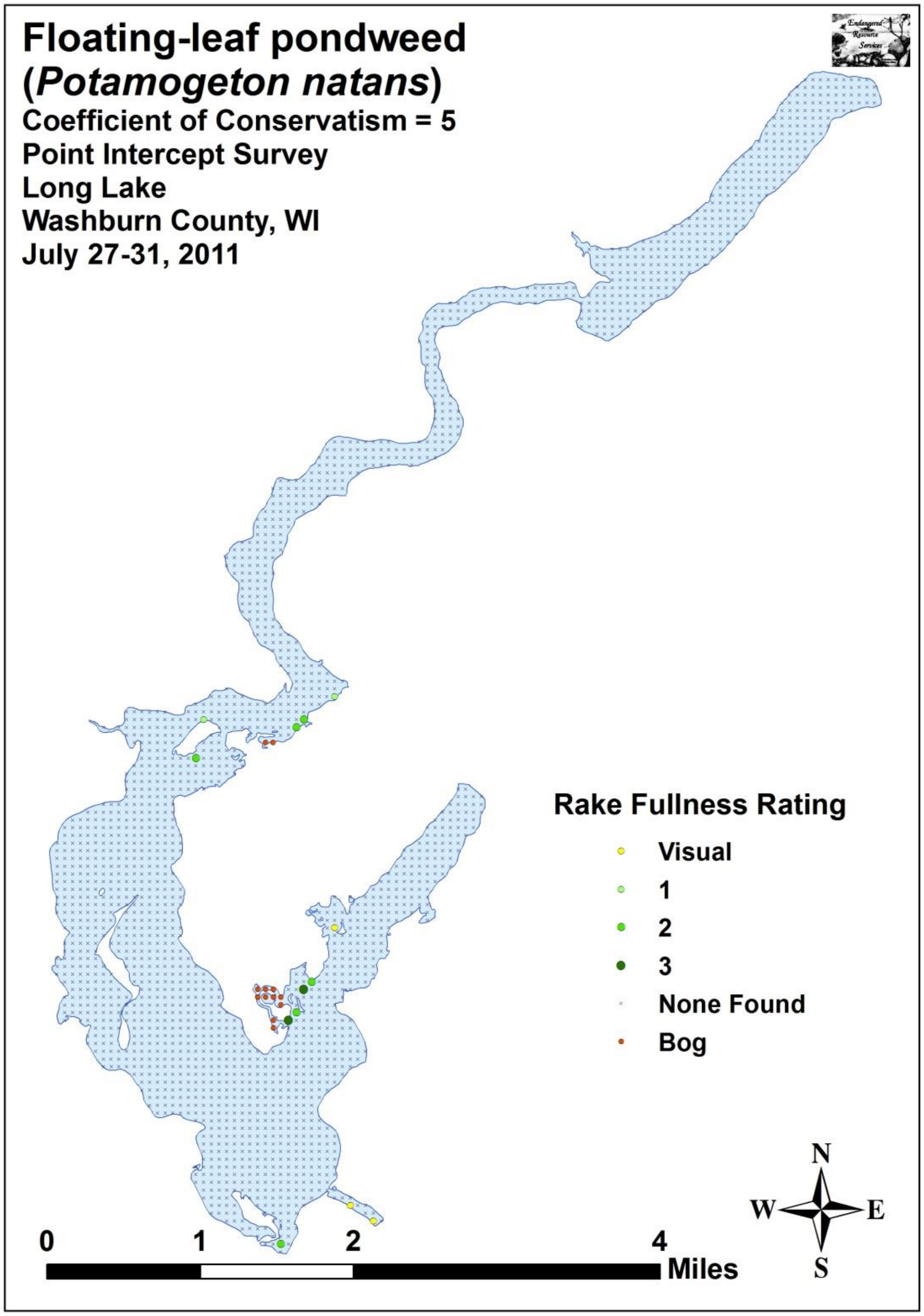

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

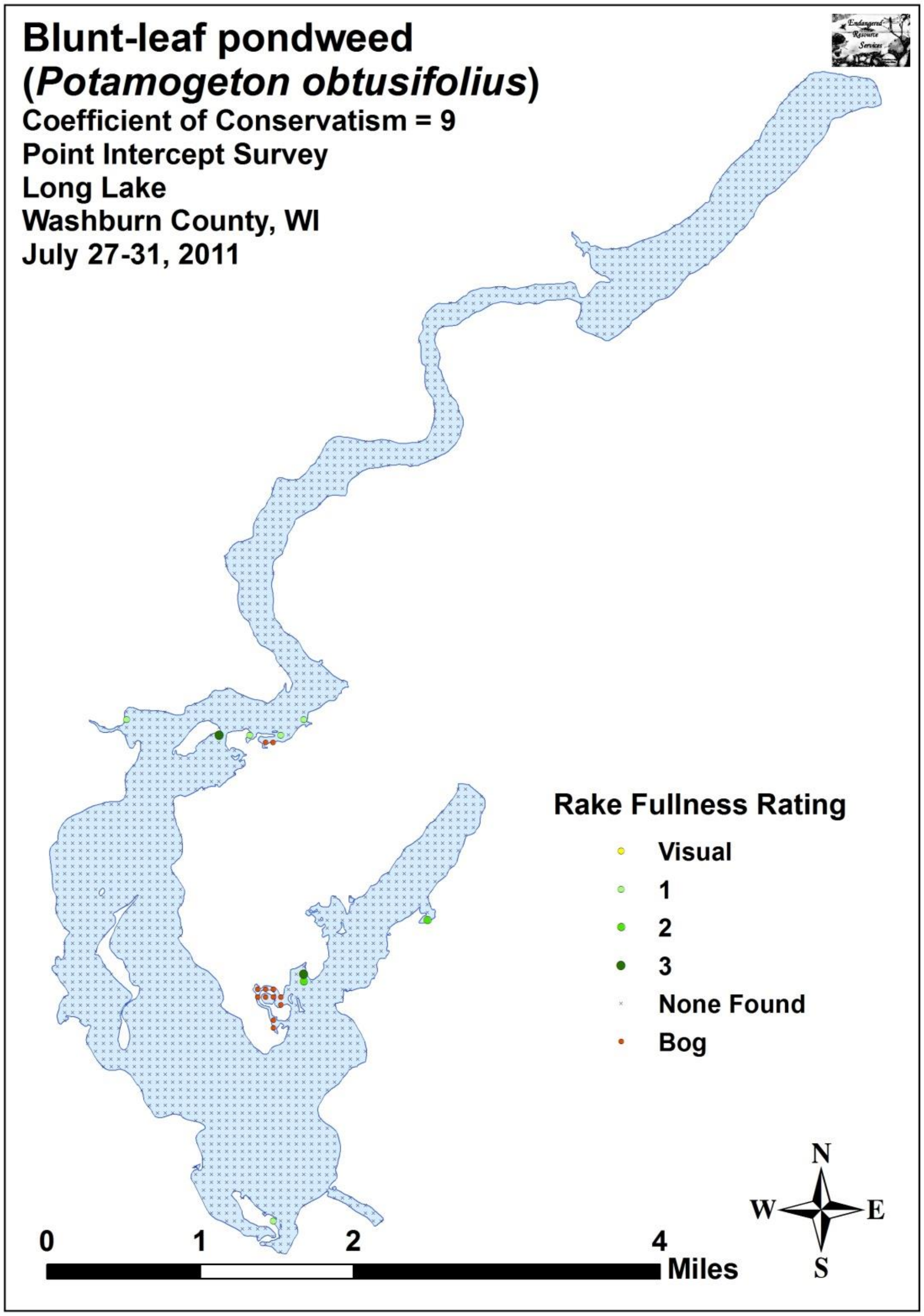

Leafy pondweed
(Potamogeton foliosus)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

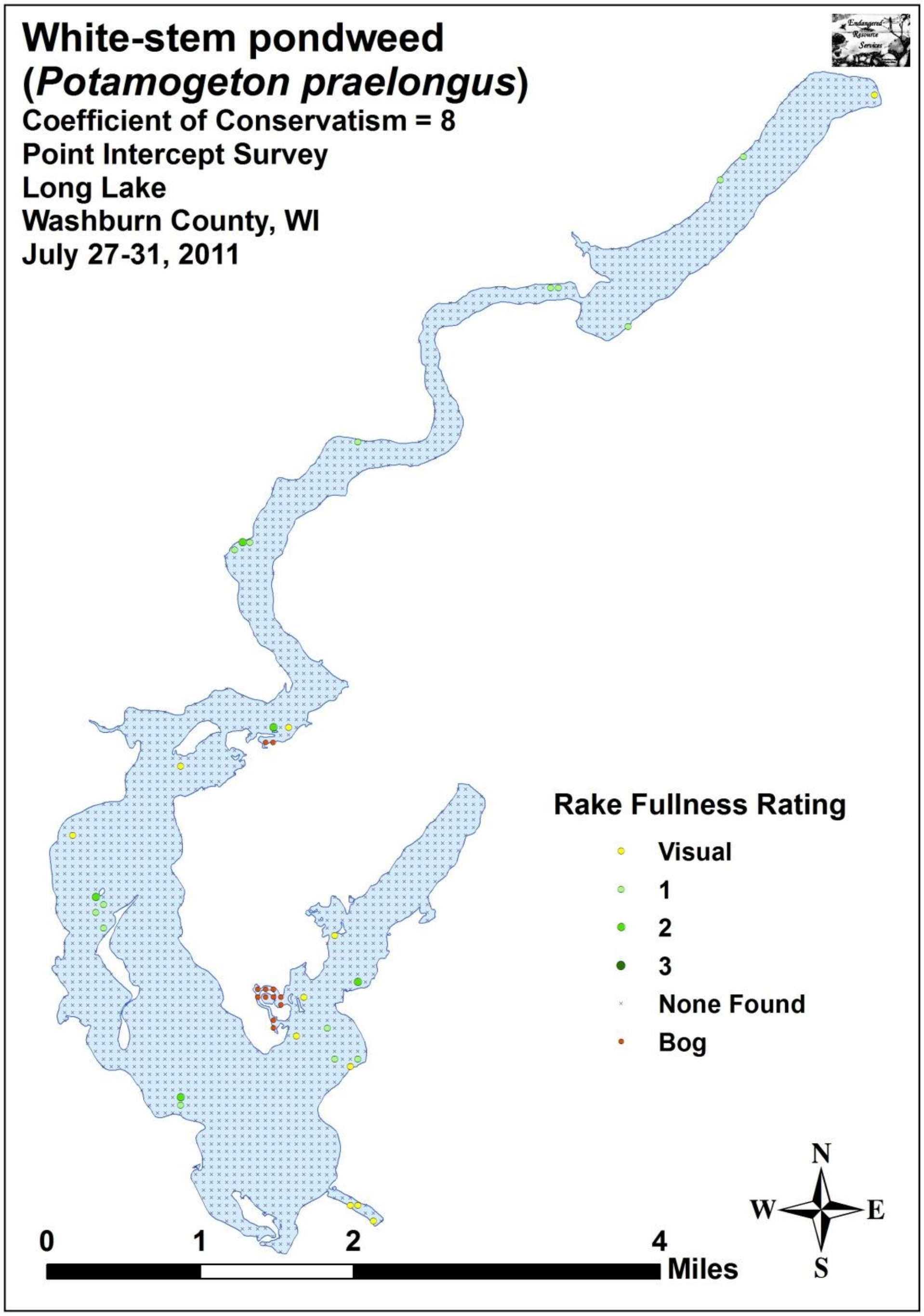

Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

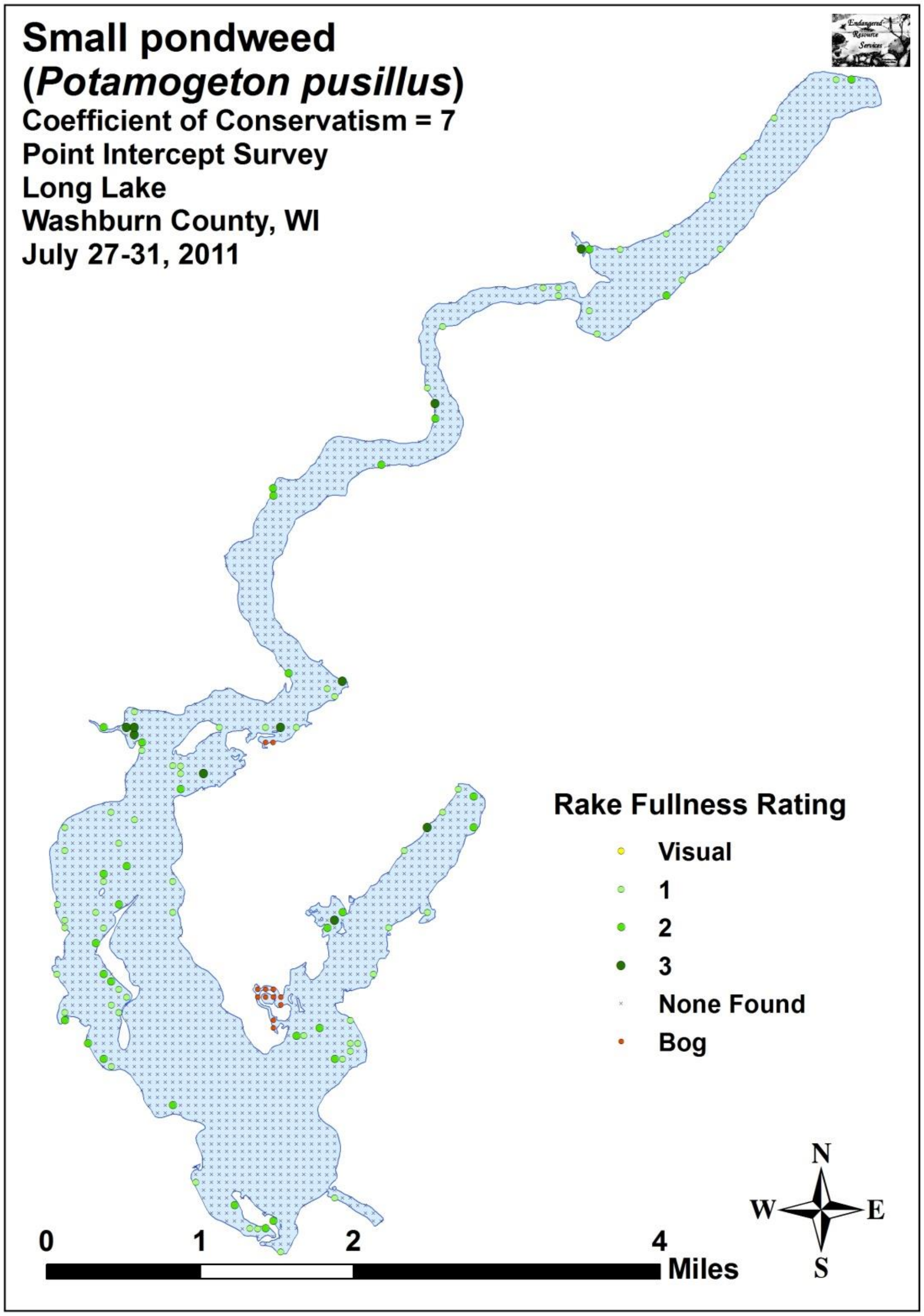

Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles


Illinois pondweed
(*Potamogeton illinoensis*)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

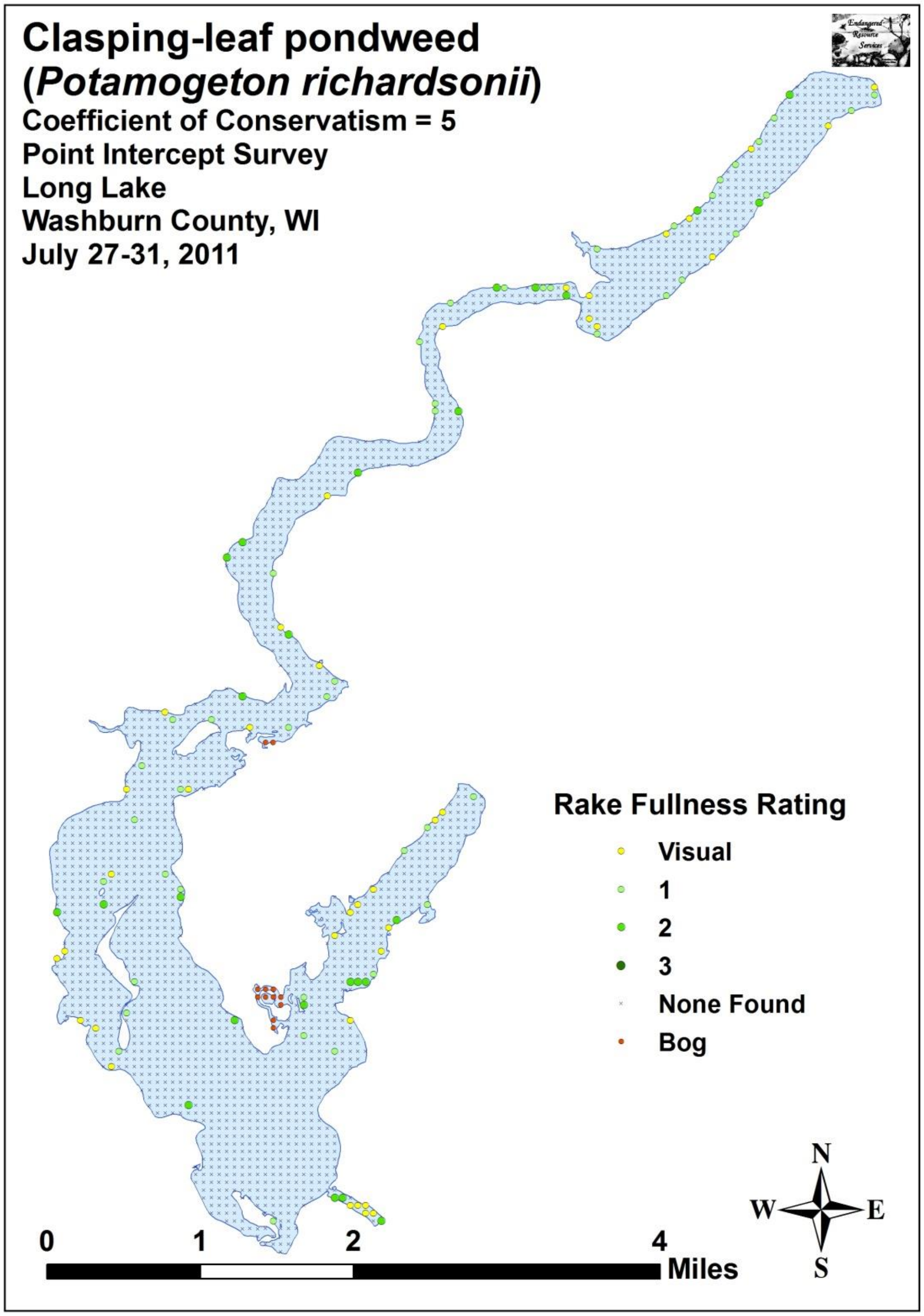

Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

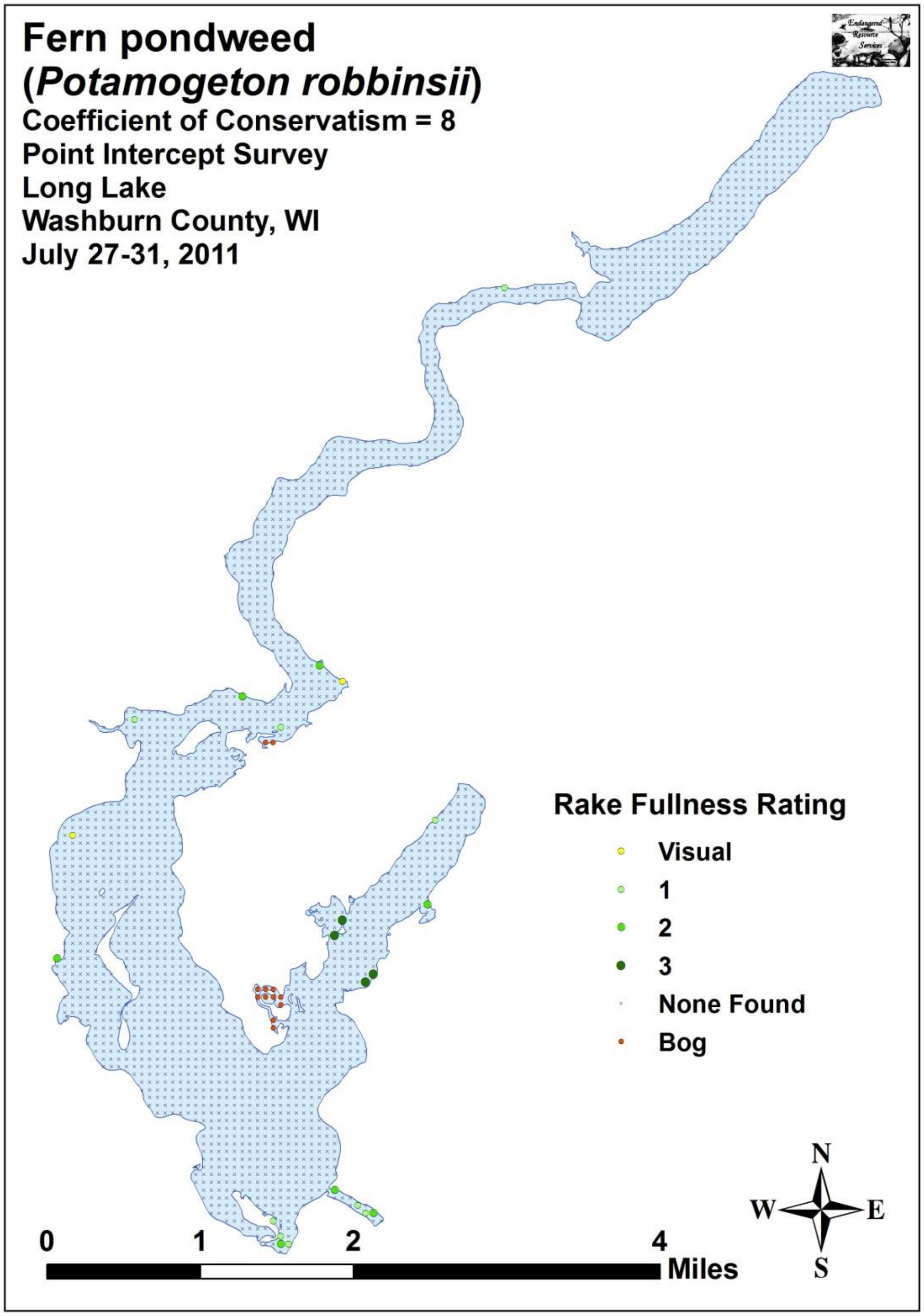

Blunt-leaf pondweed
(Potamogeton obtusifolius)
Coefficient of Conservatism = 9
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

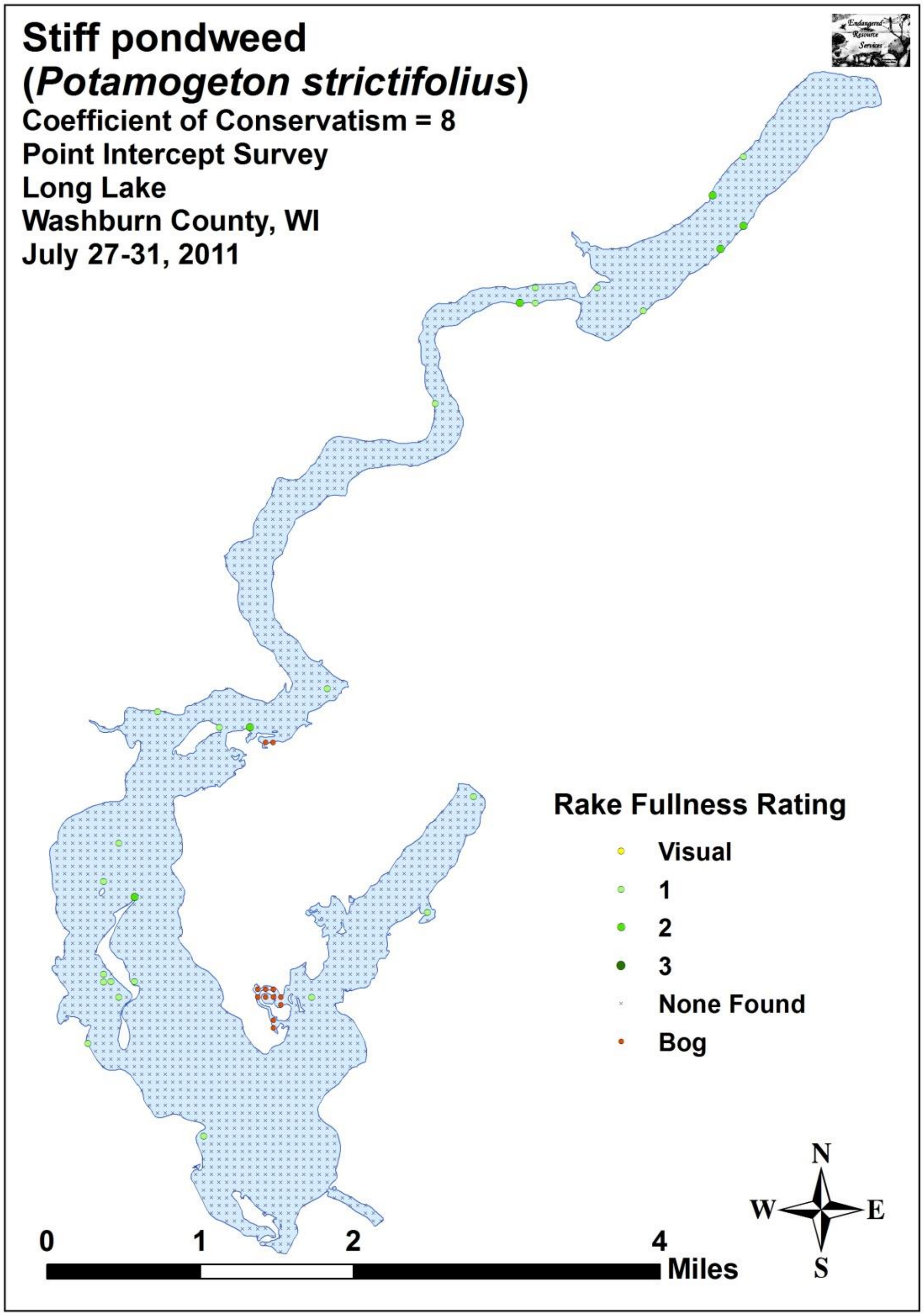

White-stem pondweed
(*Potamogeton praelongus*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

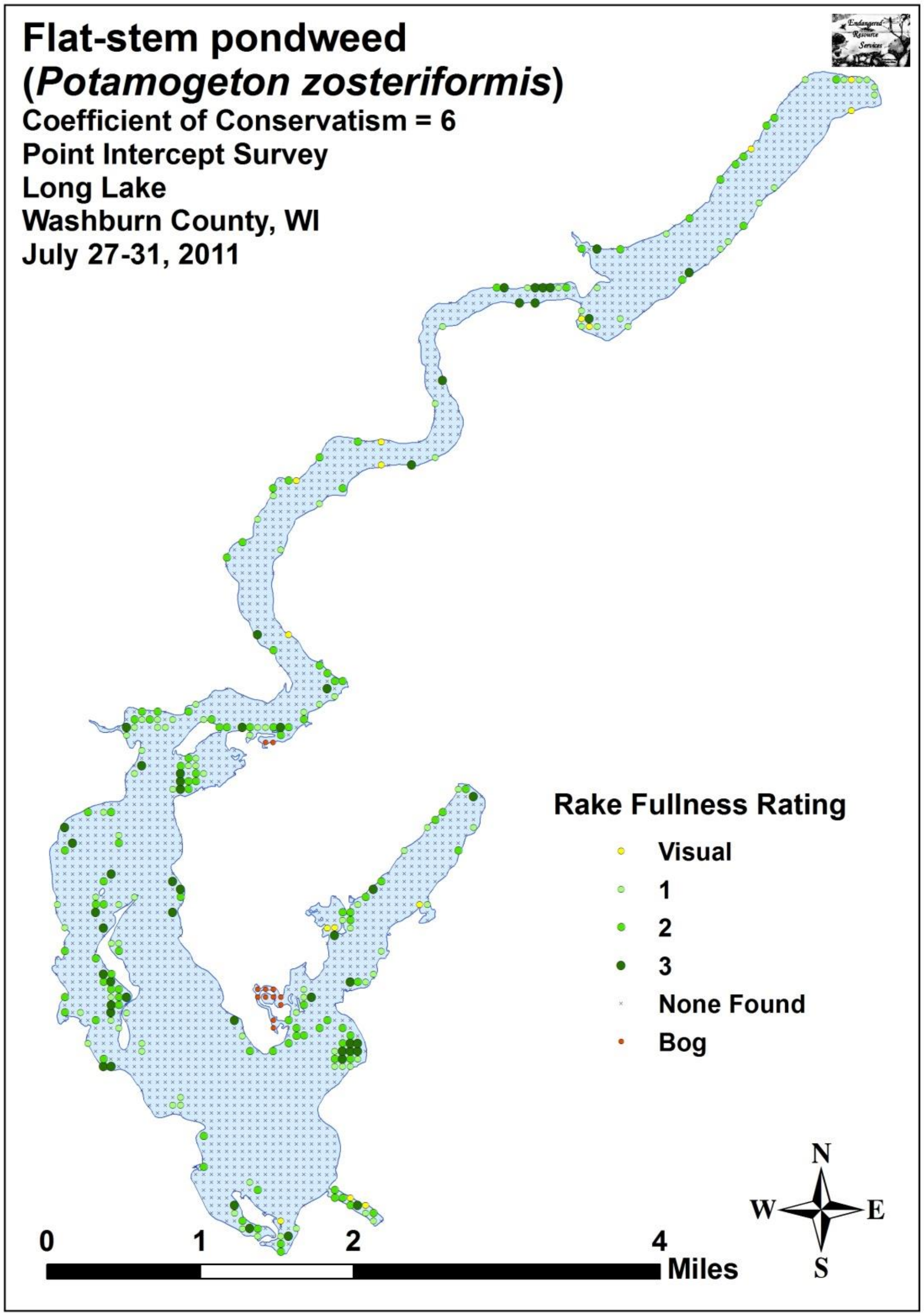


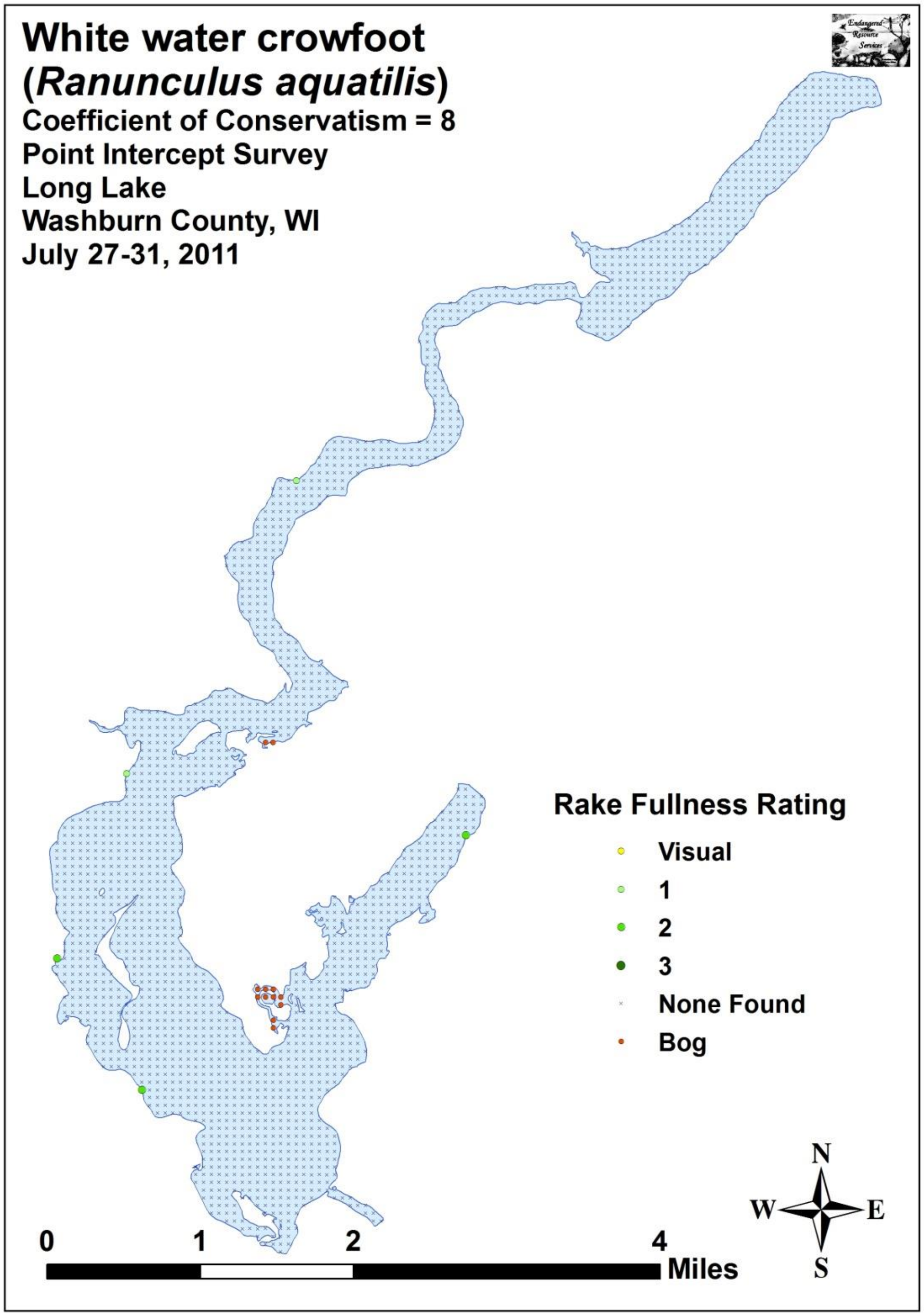
Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

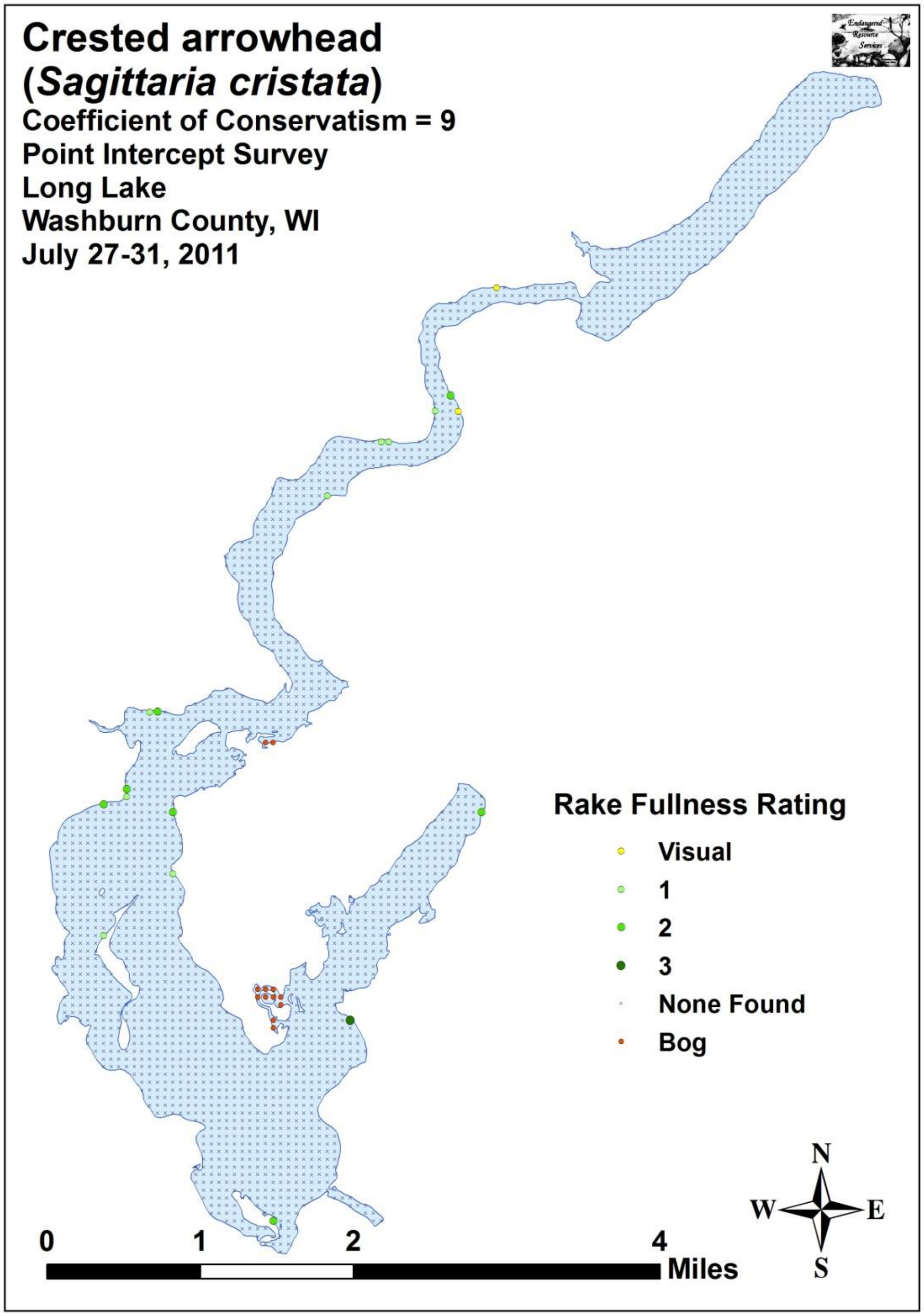

Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

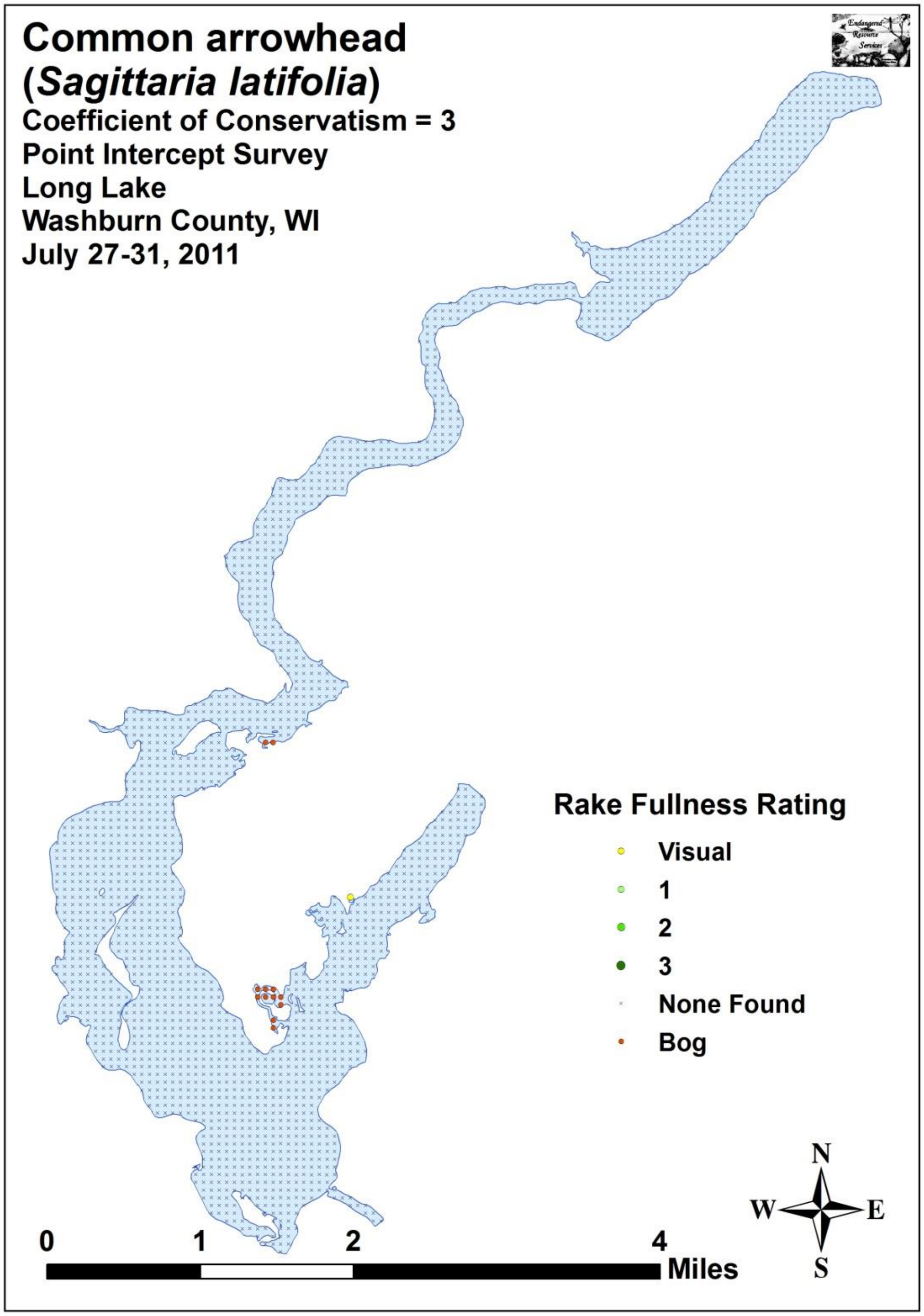

Fern pondweed
(*Potamogeton robbinsii*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

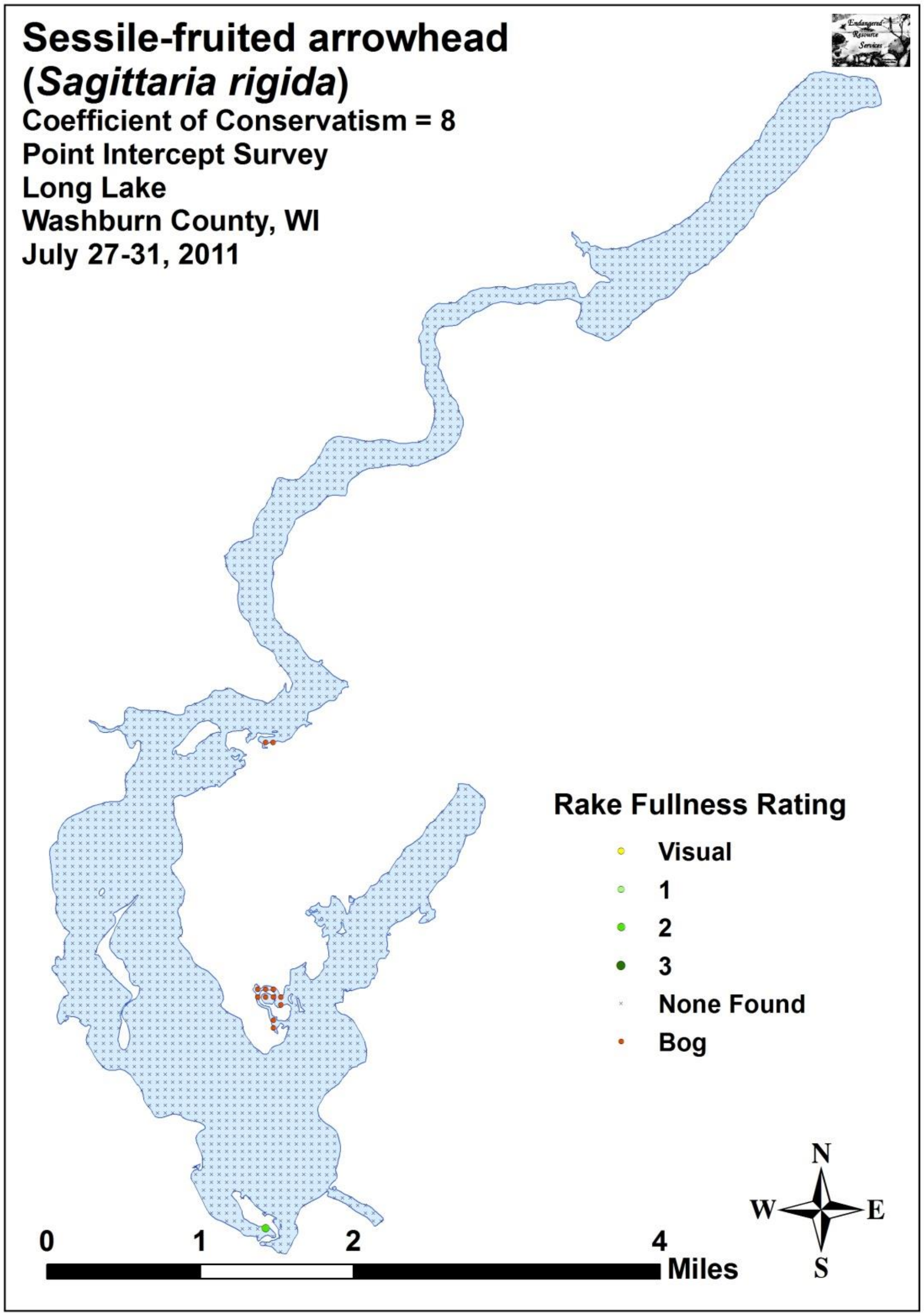

Stiff pondweed
(Potamogeton strictifolius)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Flat-stem pondweed
(*Potamogeton zosteriformis*)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

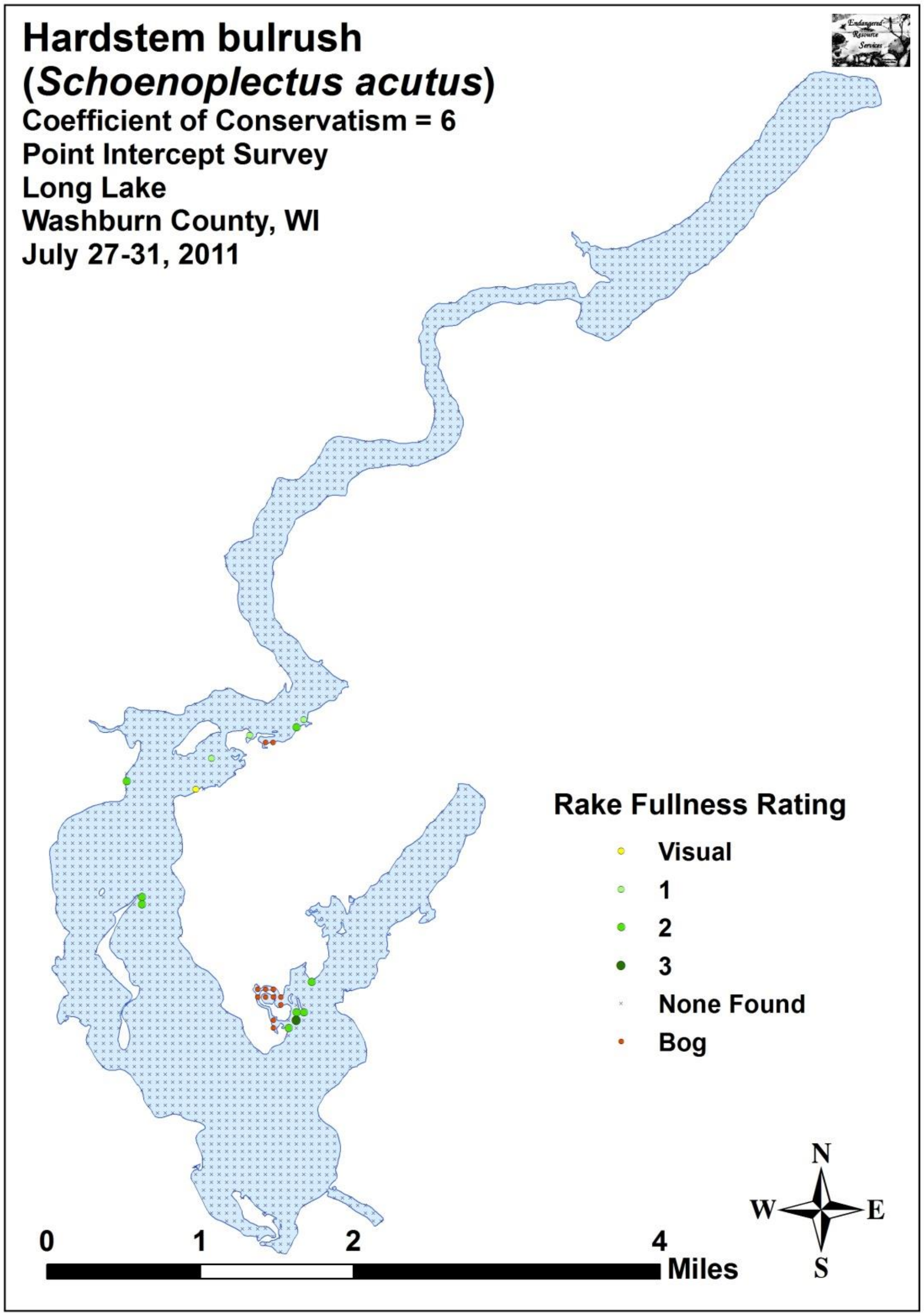

White water crowfoot
(*Ranunculus aquatilis*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

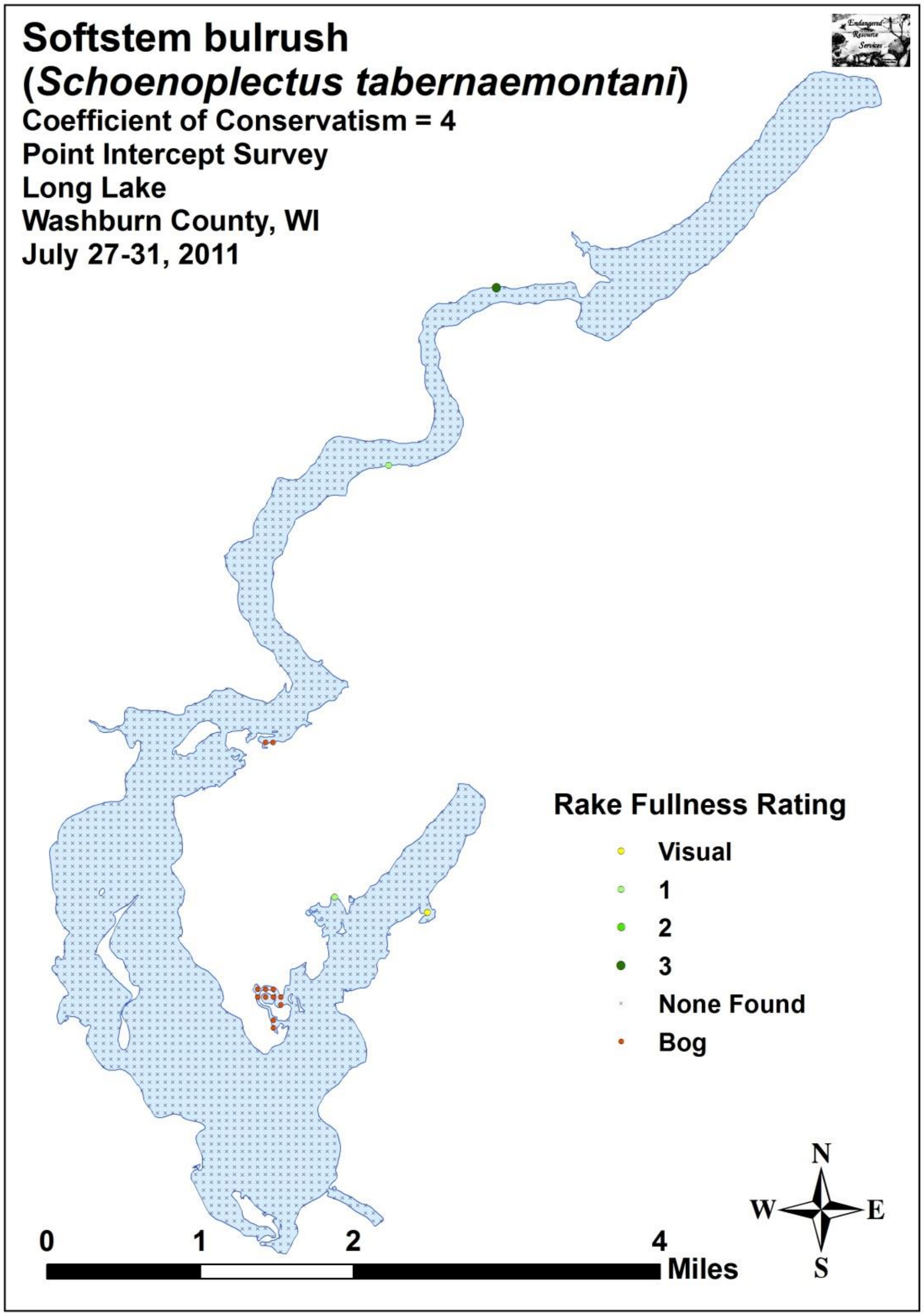

Crested arrowhead
(*Sagittaria cristata*)
Coefficient of Conservatism = 9
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

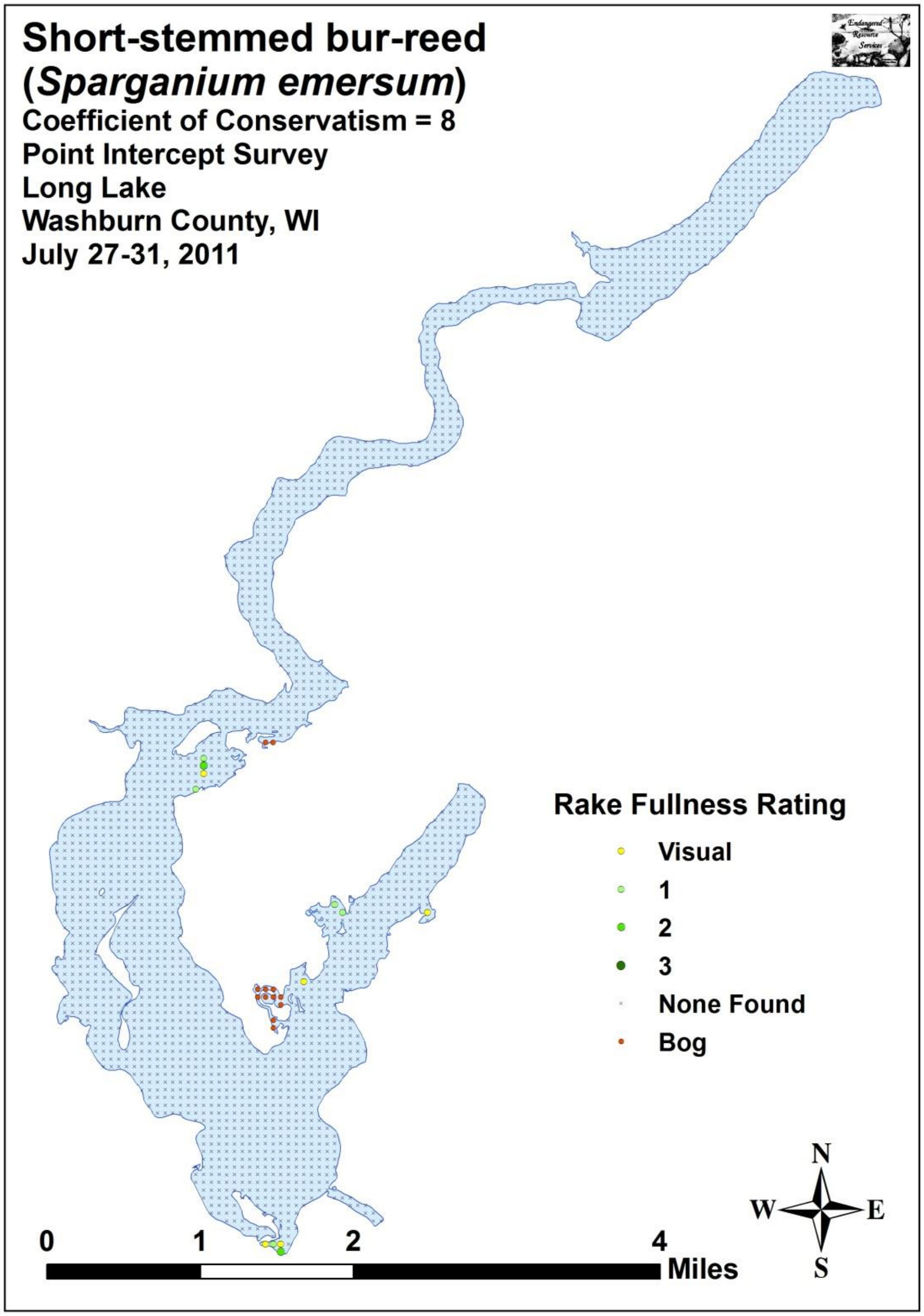

Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

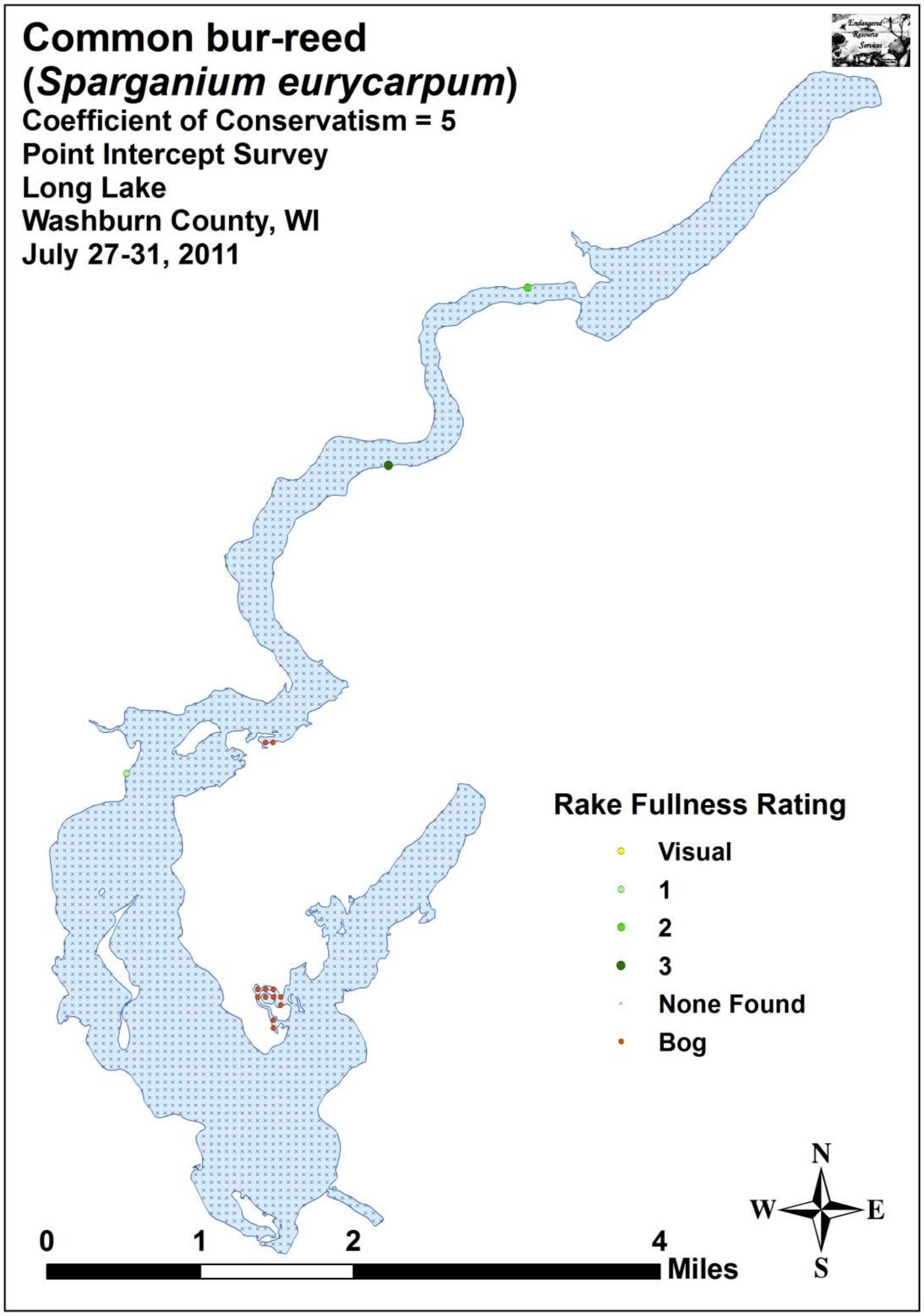


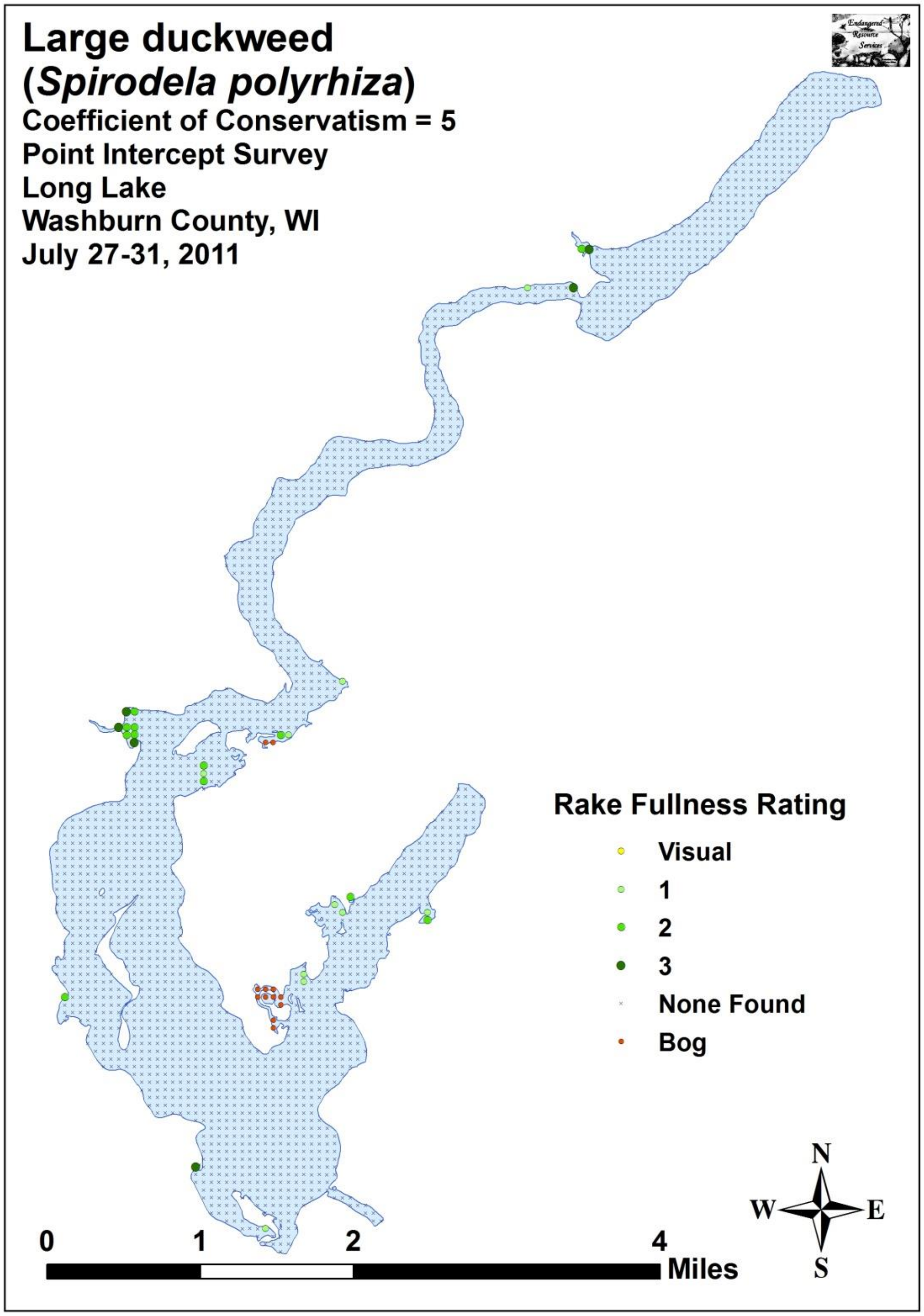
Sessile-fruited arrowhead
(*Sagittaria rigida*)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

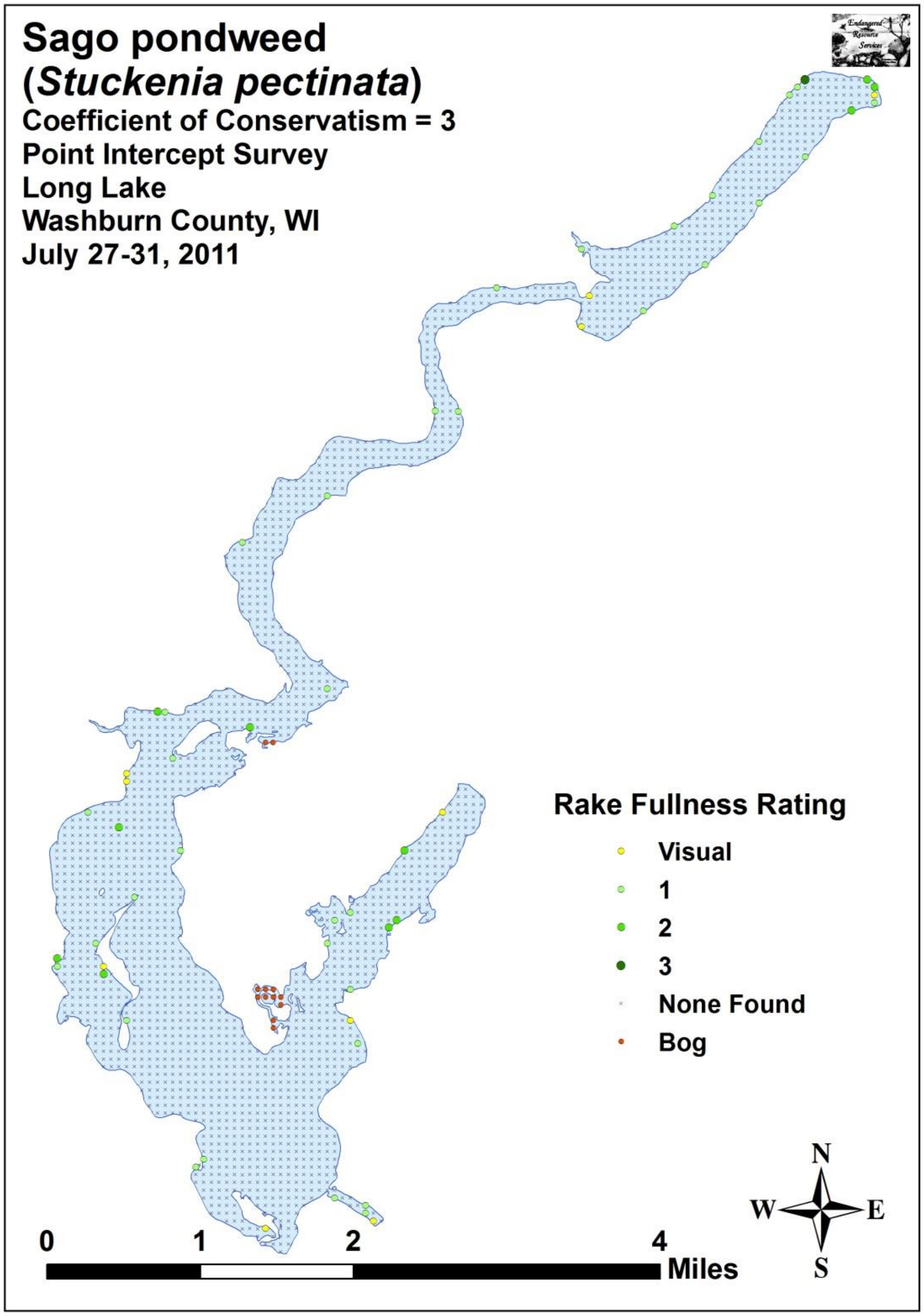

Hardstem bulrush
(Schoenoplectus acutus)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

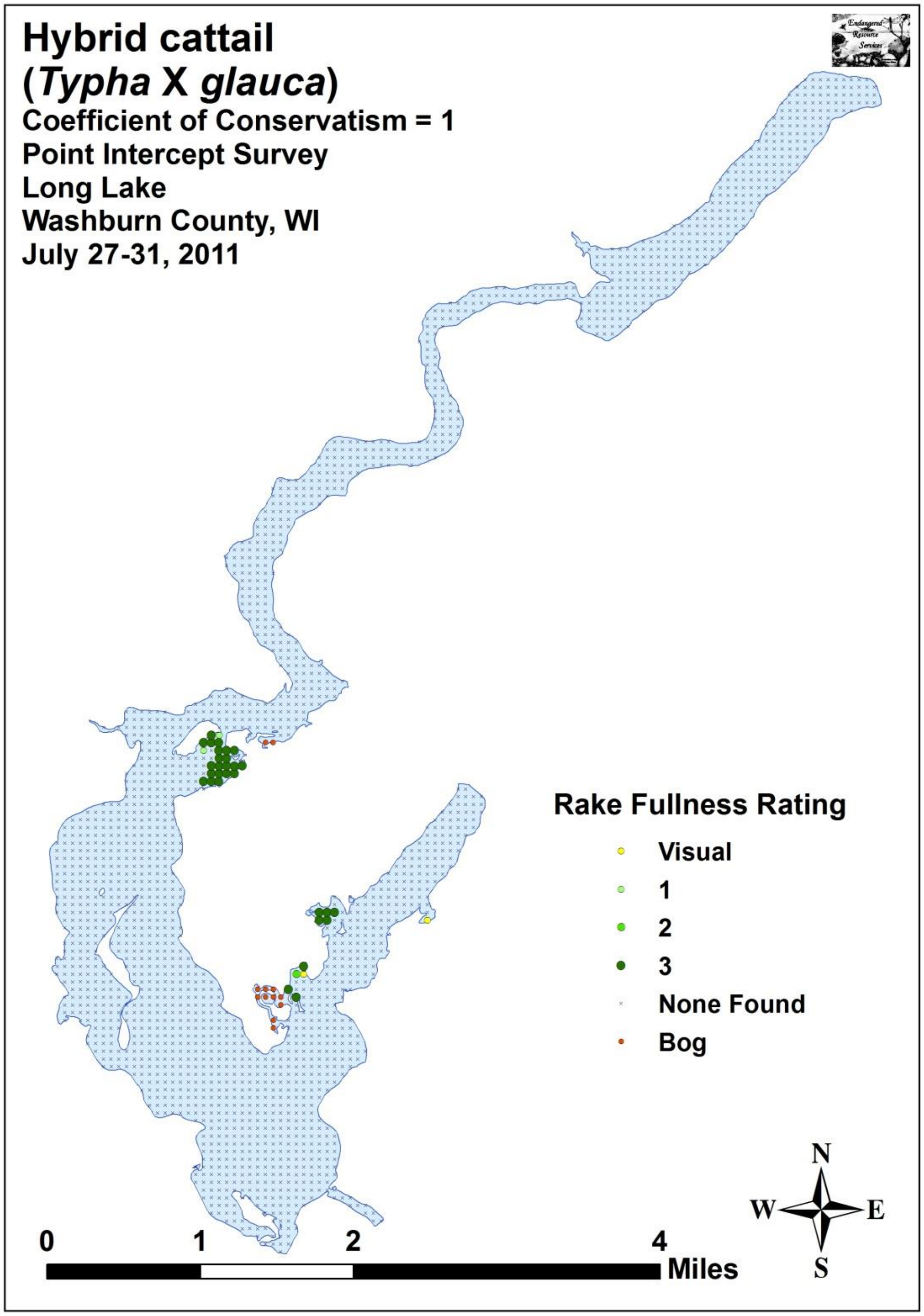

Softstem bulrush
(*Schoenoplectus tabernaemontani*)
Coefficient of Conservatism = 4
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

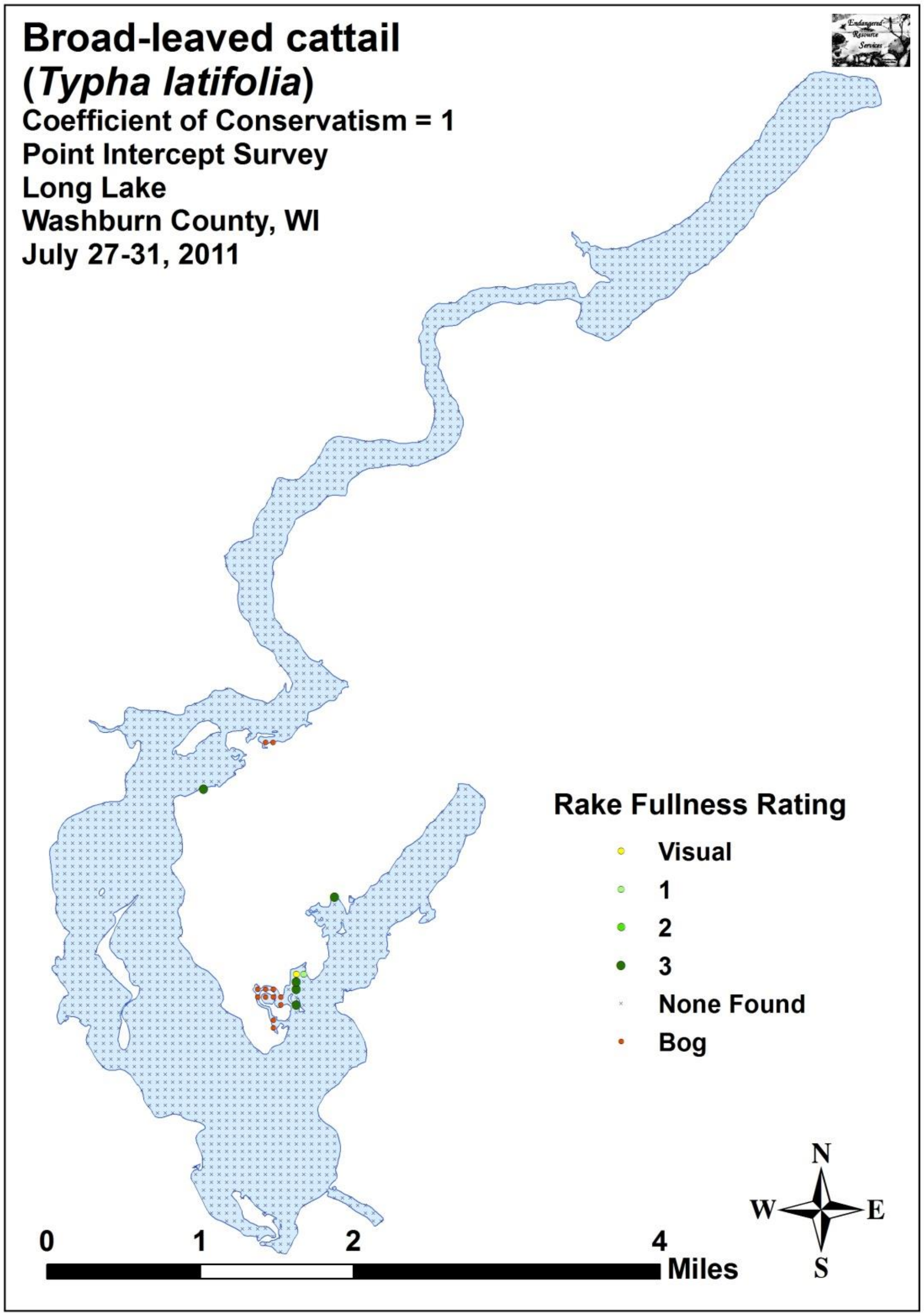

Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

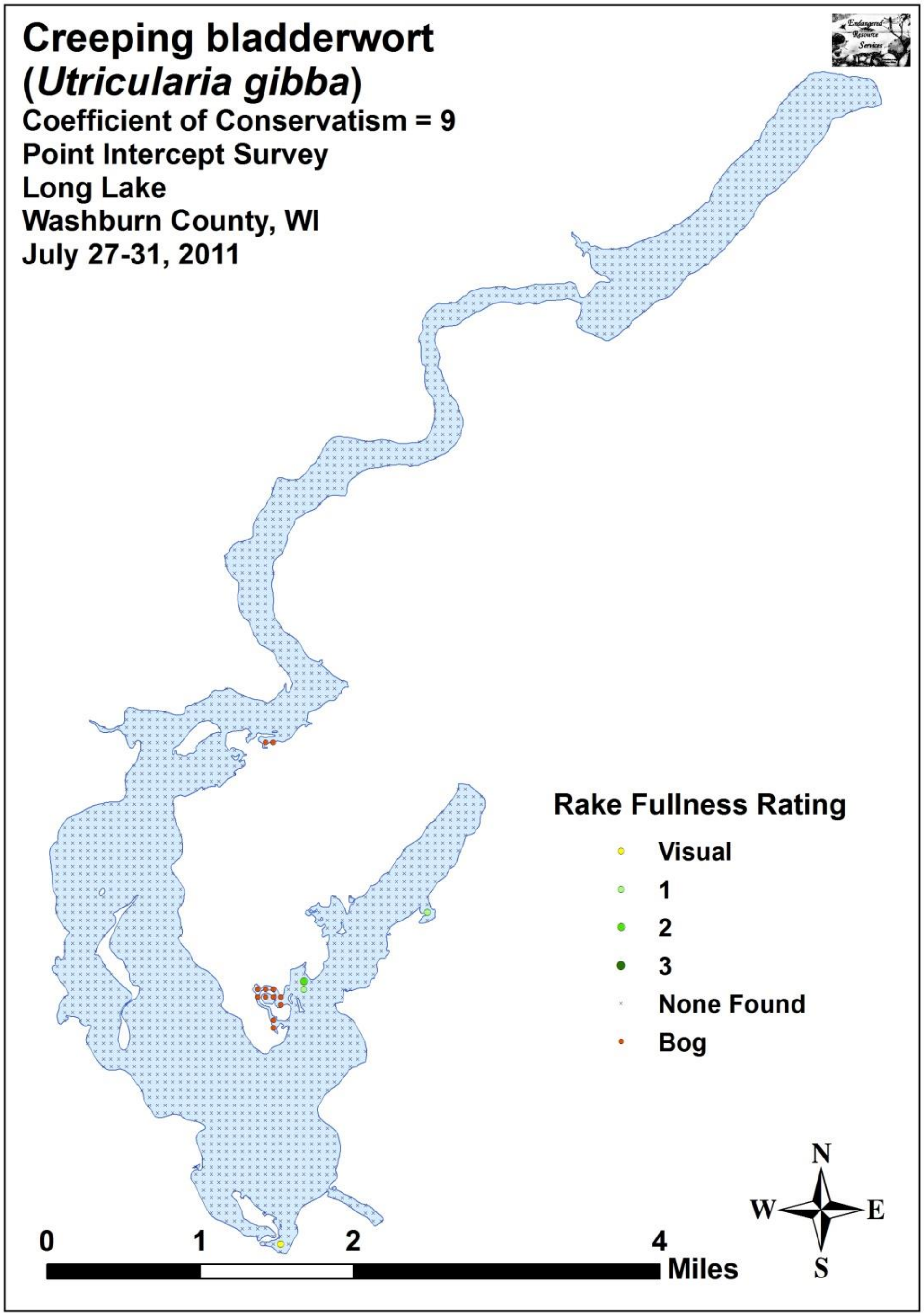

Common bur-reed
(Sparganium eurycarpum)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

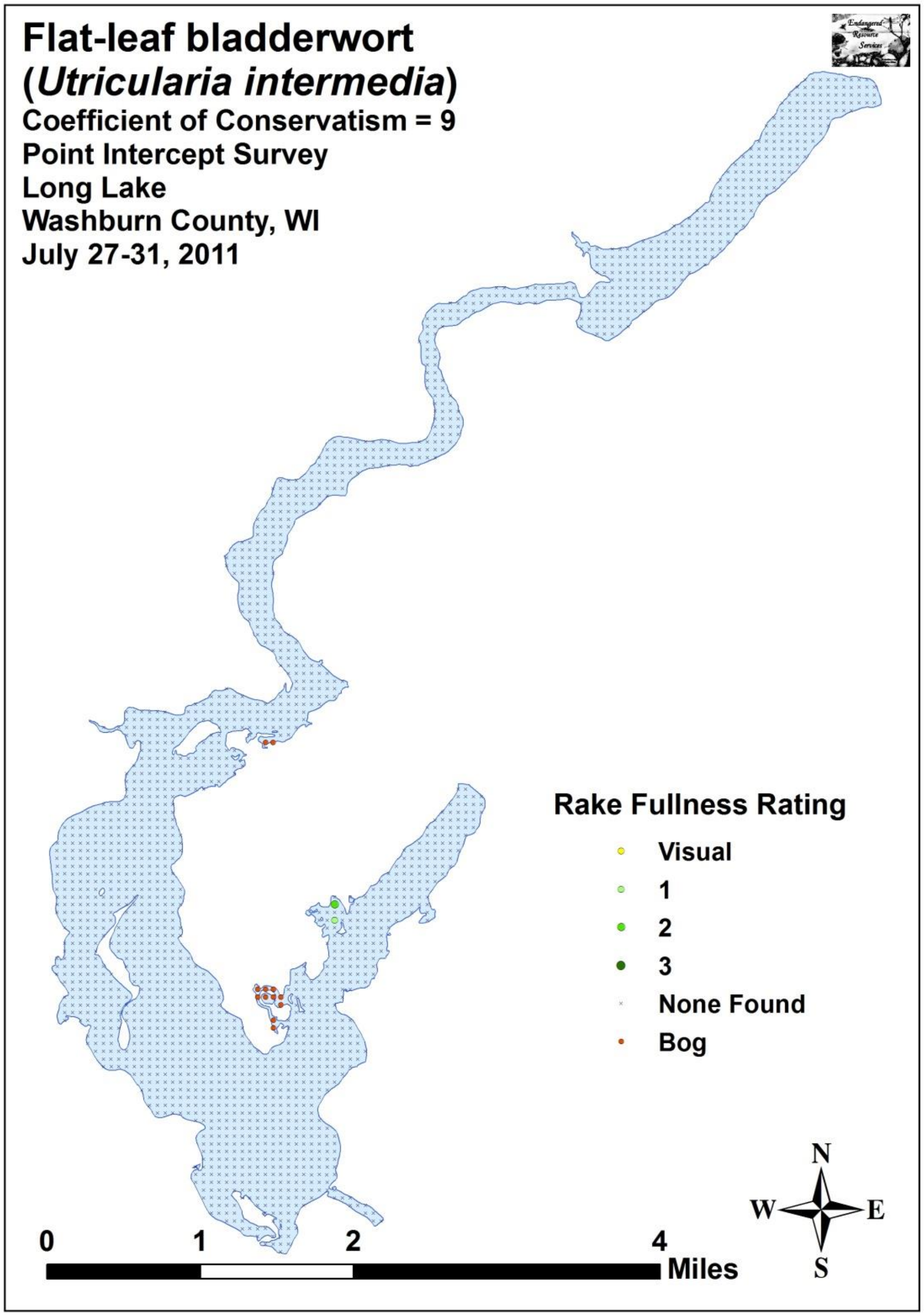

Large duckweed
(*Spirodela polyrhiza*)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

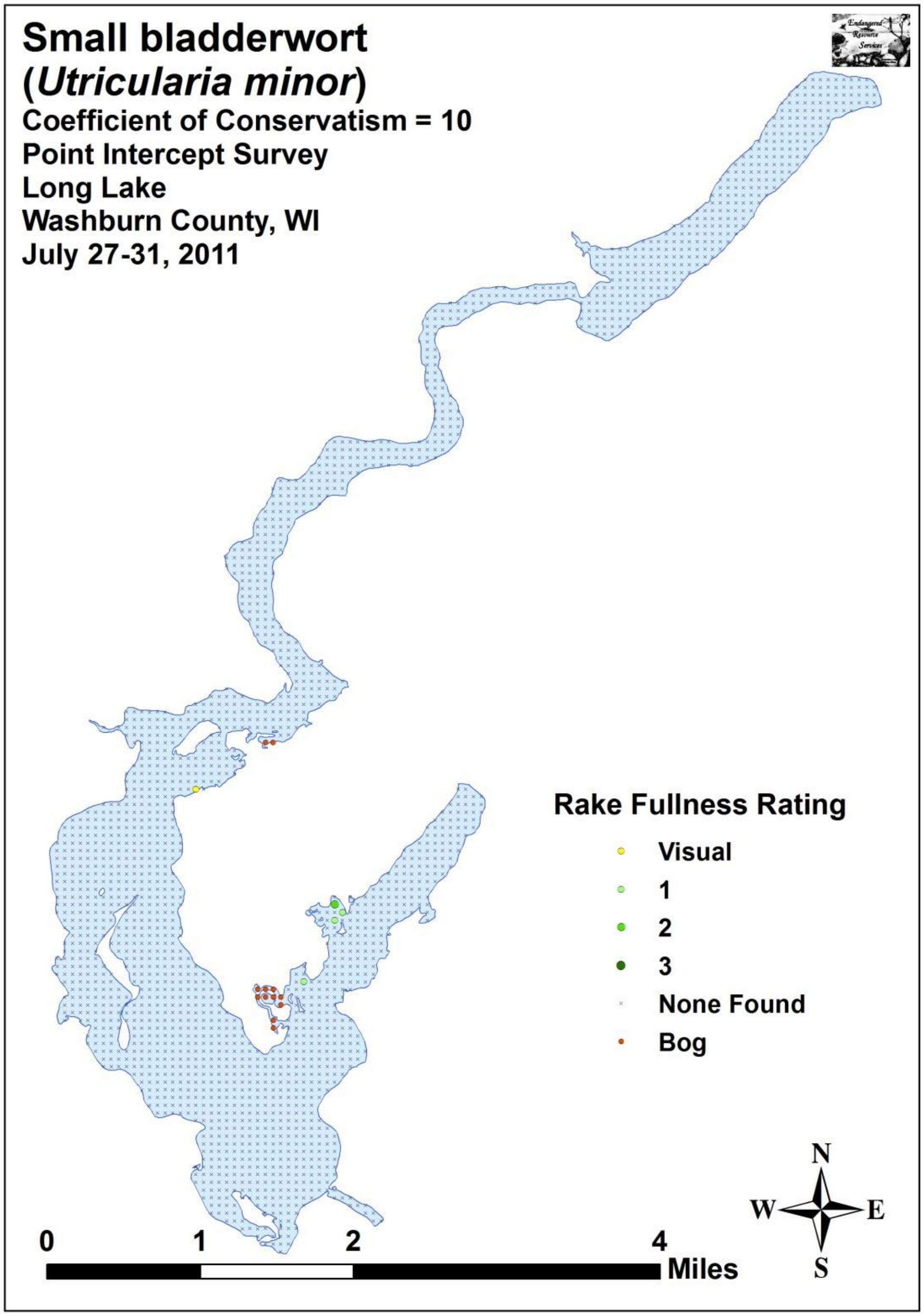

Sago pondweed
(Stuckenia pectinata)
Coefficient of Conservatism = 3
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

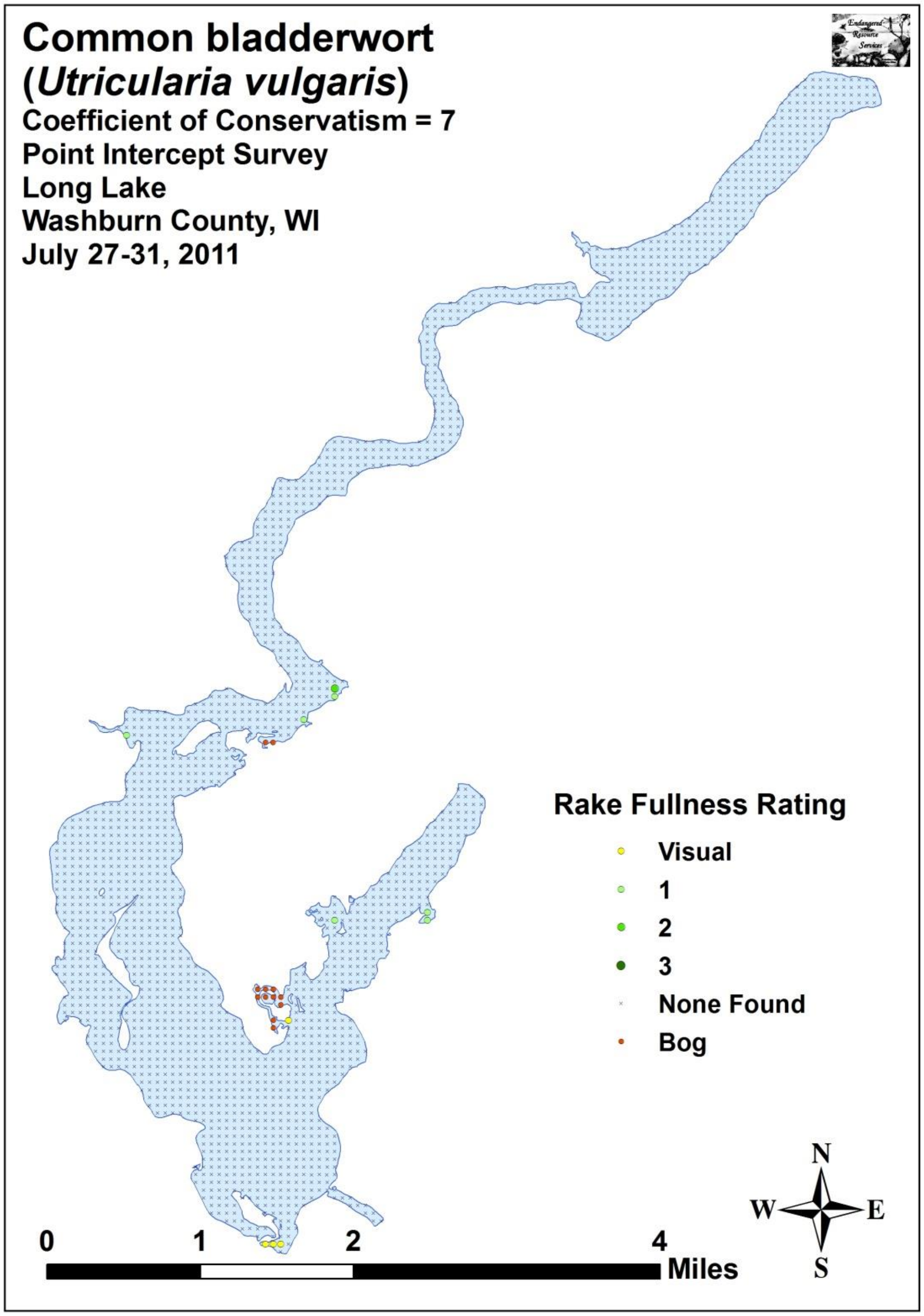

Hybrid cattail
(*Typha* X *glauca*)
Coefficient of Conservatism = 1
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

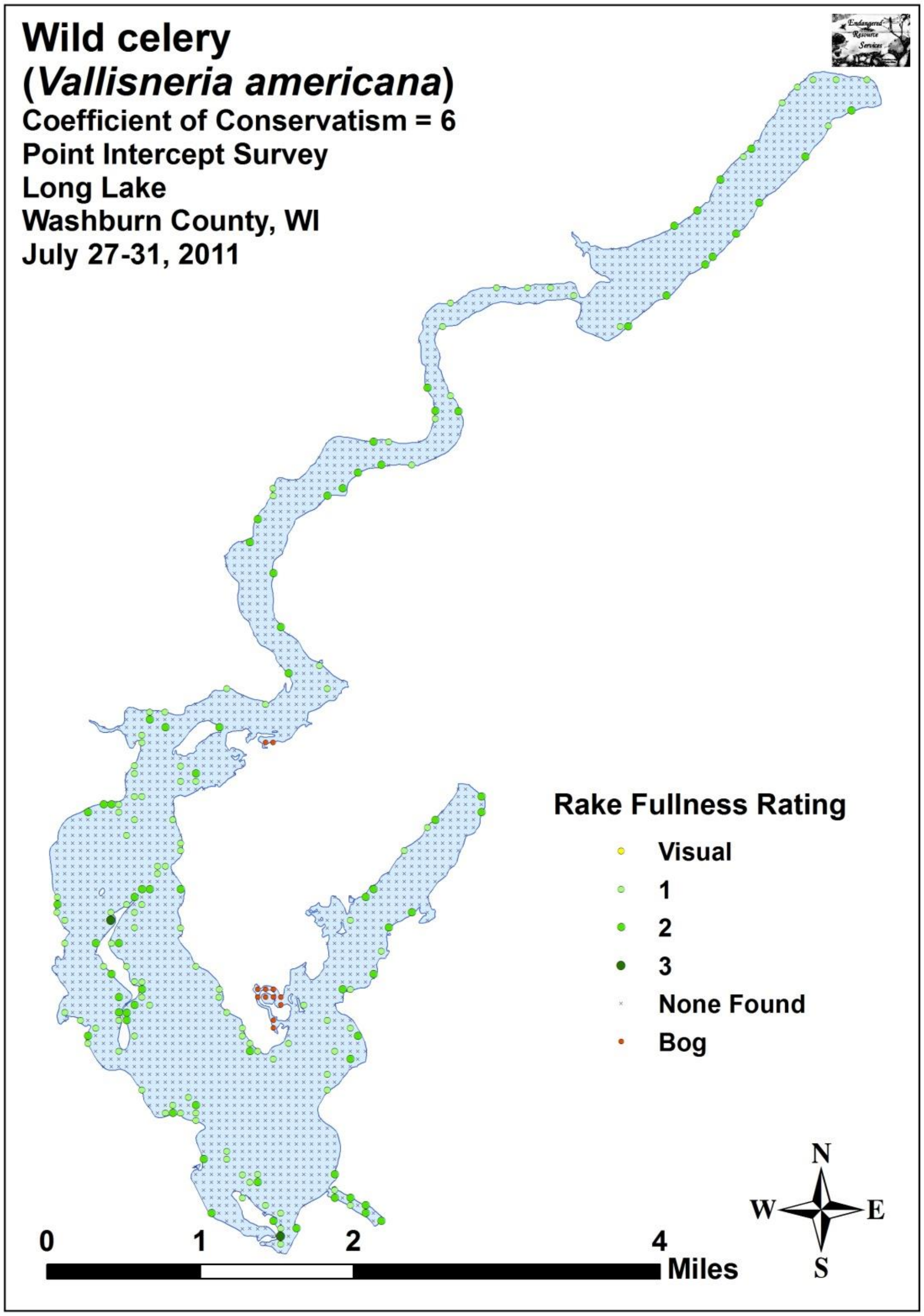

Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles

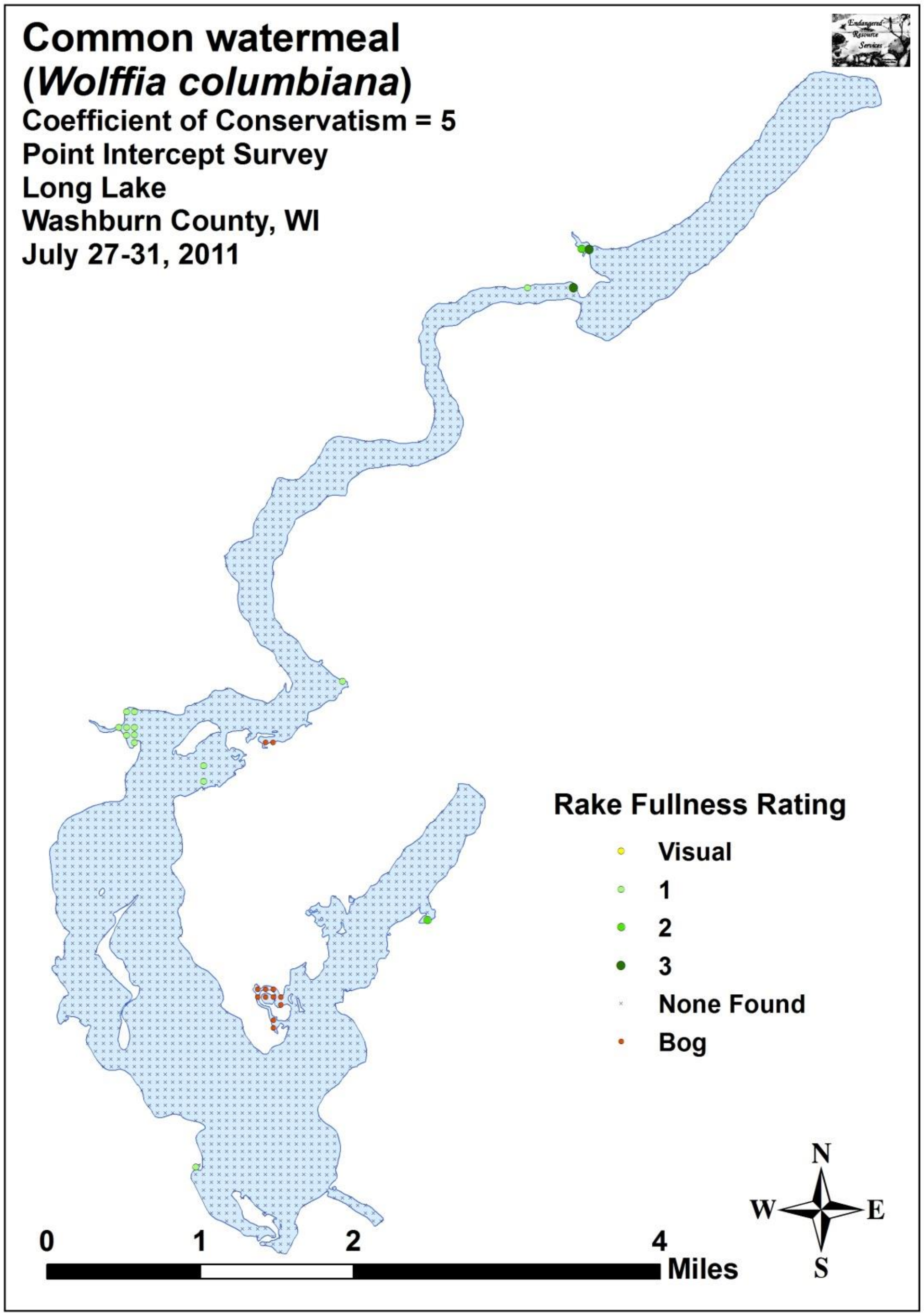

Creeping bladderwort
(Utricularia gibba)
Coefficient of Conservatism = 9
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

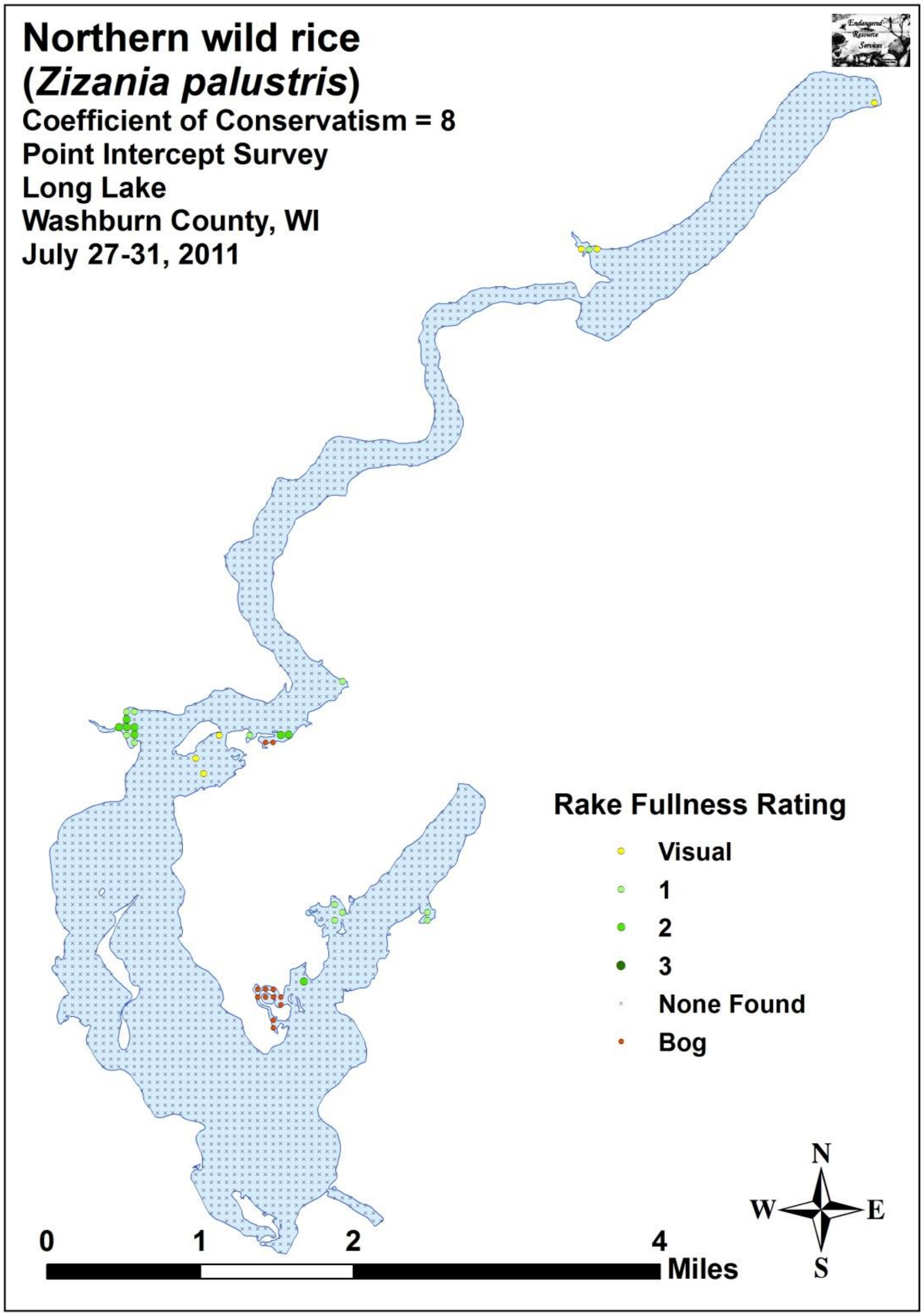

Flat-leaf bladderwort
(Utricularia intermedia)
Coefficient of Conservatism = 9
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
N
W
E
S
0
1
2
4
Miles


Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Common watermeal
(Wolffia columbiana)
Coefficient of Conservatism = 5
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S


Northern wild rice
(Zizania palustris)
Coefficient of Conservatism = 8
Point Intercept Survey
Long Lake
Washburn County, WI
July 27-31, 2011
Rake Fullness Rating
Visual
1
2
3
None Found
Bog
0
1
2
4
Miles
N
W
E
S

Appendix IX: Aquatic Exotic Invasive Plant Species Information

Curly-leaf pondweed

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

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

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

It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out compete native plants in the spring. In mid-summer, when most aquatic plants are growing, curly-leaf pondweed plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. Curly-leaf pondweed forms surface mats that interfere with aquatic recreation. (Taken in its entirety from WDNR, 2011 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Eurasian water milfoil

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

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

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

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

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

Dense stands of Eurasian water milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian water milfoil may lead to deteriorating water quality and algae blooms of infested lakes. (Taken in its entirety from WDNR, 2011 http://www.dnr.state.wi.us/invasives/fact/milfoil.htm)

Reed canary grass

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

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

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

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

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

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

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites. (Taken in its entirety from WDNR, 2011 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife
(Photo Courtesy Brian M. Collins)

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

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

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

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

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

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

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

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

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways. (Taken in its entirety from WDNR, 2011 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)

Appendix X: Glossary of Biological Terms (Adapted from UWEX 2011)

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: Raw Data Spreadsheets