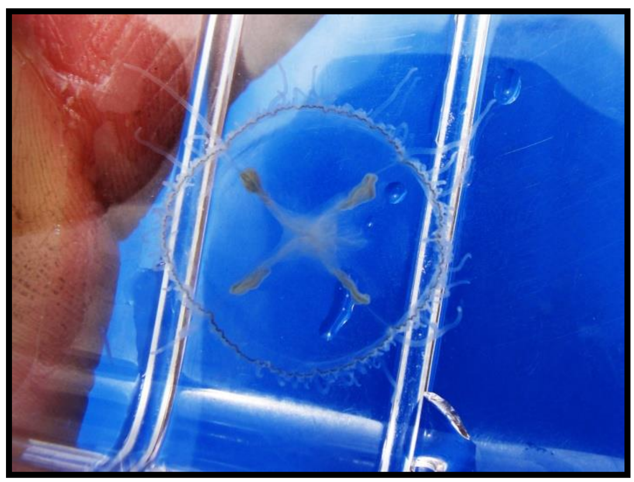
August Warm Water Point Intercept Survey and Eurasian water milfoil (*Myriophyllum spicatum*) Dive Removal George Lake (WBIC: 2465700) Bayfield County, Wisconsin

Eurasian water milfoil (Berg 2007)

George Lake Aerial Photo (2010)

Project Initiated by: The Town of Barnes
and the Wisconsin Department of Natural Resources



Freshwater jellyfish found during the survey (Honz 2011)

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August 4-5, 2011

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ABSTRACT

George Lake (WBIC 2465700) is a 50-acre, oligotrophic seepage lake located in west-central Bayfield County, Wisconsin. The lake's average depth is 16ft, and the bottom substrate is predominantly sand and sandy/muck. Water clarity is good to very good with Secchi values averaging 12.6ft over the past 12 years. In July 2011, Eurasian water milfoil (*Myriophyllum spicatum*) was discovered in the lake. Because of this, the Town of Barnes and the WDNR commissioned an August full point intercept macrophyte survey, and a follow-up EWM dive removal in preparation for developing an Aquatic Plant Management Plan for the lake. The August survey found macrophytes at 109 of the 224 total survey points. The 45 species found growing in and immediately adjacent to the lake produced a Simpson Index Value of 0.93. Plant growth was moderate with a mean total rake fullness value at vegetative sites of 1.80. Slender naiad (*Najas flexilis*), Nitella (*Nitella* sp.), Small pondweed (*Potamogeton pusillus*), and White water lily (*Nymphaea odorata*) were the most common species being found at 31.19%, 21.10%, 20.18% and 16.51% of survey points with vegetation respectively. A total of 26 native index species produced a slightly below average mean Coefficient of Conservatism of 6.4 and an above average Floristic Quality Index of 32.8. During the initial boat survey, three small beds and two other rooted plants were found in the south basin confirming the plants have spread out of the north bay where they were originally discovered. The point intercept survey quantified EWM at three points and it was recorded as a visual at six additional points. Narrow-leaved cattail (*Typha angustifolia*), was the only other exotic species found on the lake. The August 5th follow-up dive removed approximately 70 plants from the south basin. This total included all plants found the previous day. Future management considerations include preserving the lake's rich, diverse, and unique native plant community, training volunteers to recognize EWM, and conducting at least monthly shoreline surveys to quickly identify and economically control new EWM beds. Lakeshore owners can help prevent the spread of EWM and improve water clarity and quality by refraining from removing native plants from the lake, working to reduce nutrient input into the lake, and restoring shorelines with buffer strips of native vegetation to prevent erosion and runoff. Finally, completing an Aquatic Plant Management Plan will help guide the management of EWM and the lake's native plants moving forward.

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INTRODUCTION:

George Lake (WBIC 2465700) is a 50 acre seepage lake on the west-central edge of Bayfield County, Wisconsin in the Town of Barnes (T45N R9W S18 SE SW). It reaches a maximum depth of 50ft at the southwest end of the southern basin and has an average depth of approximately 16ft (WDNR 2009). The lake is oligotrophic bordering on mesotrophic in nature with Secchi readings from 2000 to 2011 averaging 12.6ft (WDNR 2011). This good to very good water clarity produced a littoral zone that extended to 24ft in August of 2011. The bottom substrate is predominately sand along the shoreline, but this gradually transitions to sandy and organic muck at most depths over 6ft (Figure 1) (Sather et al. 1971).

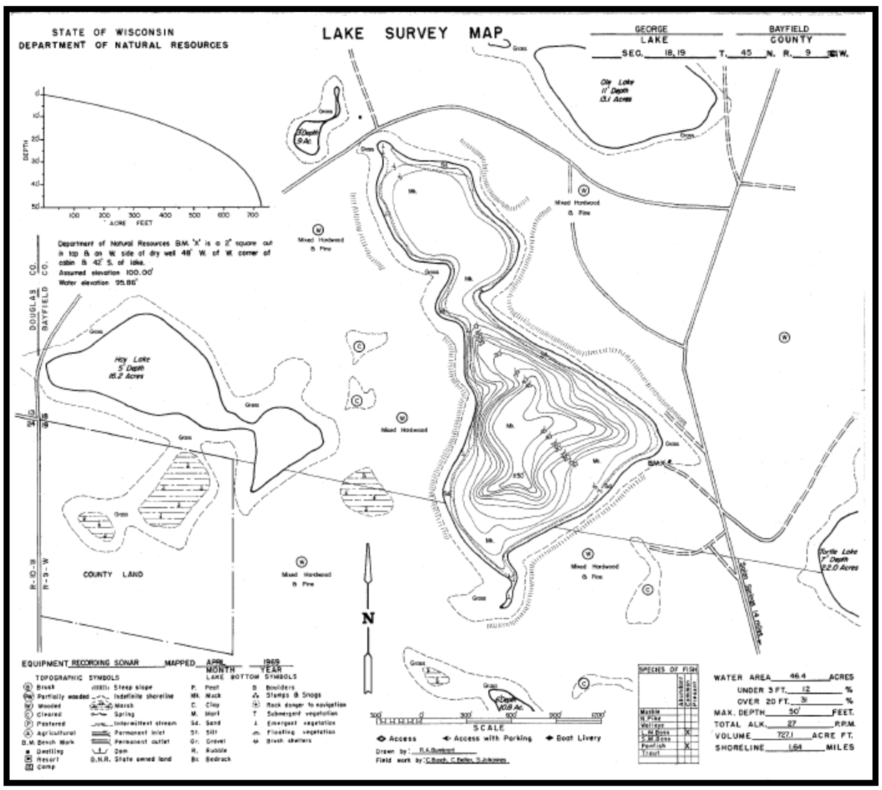


Figure 1: George Lake Bathymetric Map

Eurasian water milfoil (*Myriophyllum spicatum*) (EWM) is an exotic invasive plant species that is a growing problem in the lakes and rivers of northwestern Wisconsin. Present in nearby Tomahawk and Sandbar Lakes since 2004, EWM was first found in George Lake in July, 2011. Because of this discovery, the Town of Barnes (TOB) and the Wisconsin Department of Natural Resources (WDNR) authorized a lakewide systematic point intercept macrophyte survey on August 4th, 2011. The standardized methods of this survey ensure that all sampling in the state will be conducted in the same manner, thus allowing data to be compared across time and space. Following the survey, an August 5th SCUBA dive removal of EWM was carried out in the southern basin. The primary goals of the project were to determine the level of the EWM infestation, establish baseline data on native plant density and distribution, and suggest ideas for the TOB to consider as they work to control EWM and manage their resource moving forward.

PLANT SURVEY METHODS:

August Warm Water Full Point/Intercept Survey:

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, and total lake acres, Michelle Nault (WDNR) generated a 224 point sampling grid for George Lake (Appendix I). Prior to beginning the point intercept survey on August 4th, we conducted a rapid boat survey of the lake to gain familiarity with the species present (Appendix II). All plants found were identified, and a set of vouchers was pressed and mounted to be sent to the state herbarium in Stevens Point for identification confirmation. During the point intercept survey, we located each littoral survey point using a handheld mapping GPS unit (Garmin 76CSX) and recorded a depth reading with a metered pole rake or hand held sonar (Vexlar LPS-1). At each of these points, we used the rake to sample an approximately 2.5ft section of the bottom. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of plants within six feet of the sample point. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate type (lake bottom) was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

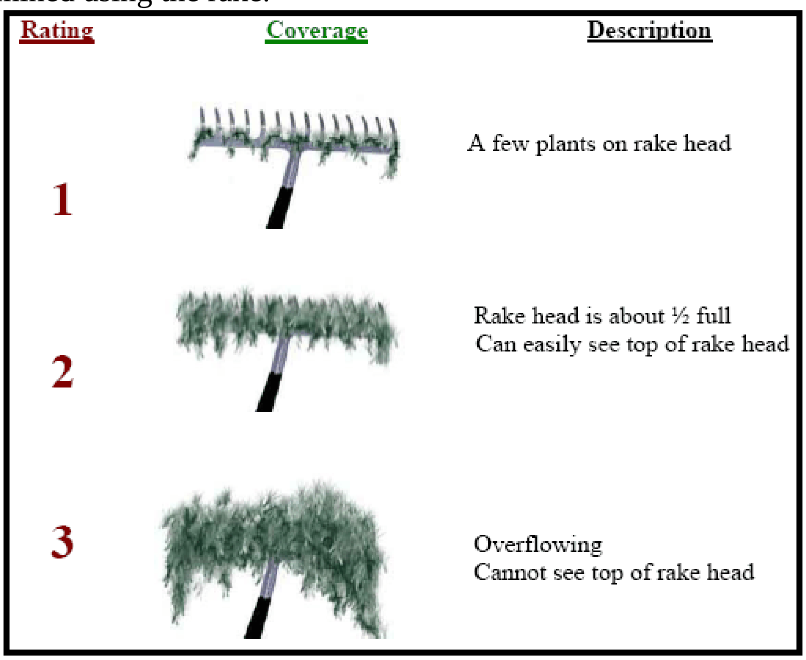


Figure 2: Rake Fullness Ratings (UWEX, 2011)

EWM Dive Removal:

We used SCUBA to locate and remove EWM plants along the southeastern shoreline of the south basin. Working in teams of five, divers spaced out at arm's length and swam transects parallel to shore throughout the littoral zone. All EWM plants found were dug up by the roots, placed in mesh bags while underwater, and immediately removed and disposed of away from the water. While the divers were underwater, volunteers in the boat took GPS coordinates of their position and gathered any EWM fragments that floated up.

DATA ANALYSIS:

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

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

Total number of sites with vegetation: These included all sites where vegetation was found 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, this value is used 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.

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

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

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

Average number of species per site: This value is reported using four different considerations. 1) **shallower than the 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 the maximum depth of plants** and 4) **native species at vegetative sites only** excludes exotic species from consideration.

Species richness: This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include additional visual species seen at a point but not found in the rake, and additional species found during the initial boat survey or between points.

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

Mean and median depth of plants: The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value (Table 1).

<u>Relative frequency:</u> This value shows species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value gives us an idea of which species are most important within the macrophyte community (Table 2).

Relative frequency example:

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

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

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

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

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

Floristic Quality Index (FQI): This index measures the impact of human development on an area'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. George Lake is in the Northern Lakes and Forests Ecoregion (Table 3).

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

RESULTS:

August Warm Water Full Point/Intercept Survey:

The George Lake survey grid contained 224 points (Figure 3). The north bay was a very shallow flat that, due to years of prolonged drought, had a maximum depth of 3.5ft. Conversely, the southern basin was a deep bowl that dropped off rapidly from shore. The lake's deepest hole on the southwest side of the bowl reached 46.5ft at the time of the survey (Figure 3) (Appendix III).

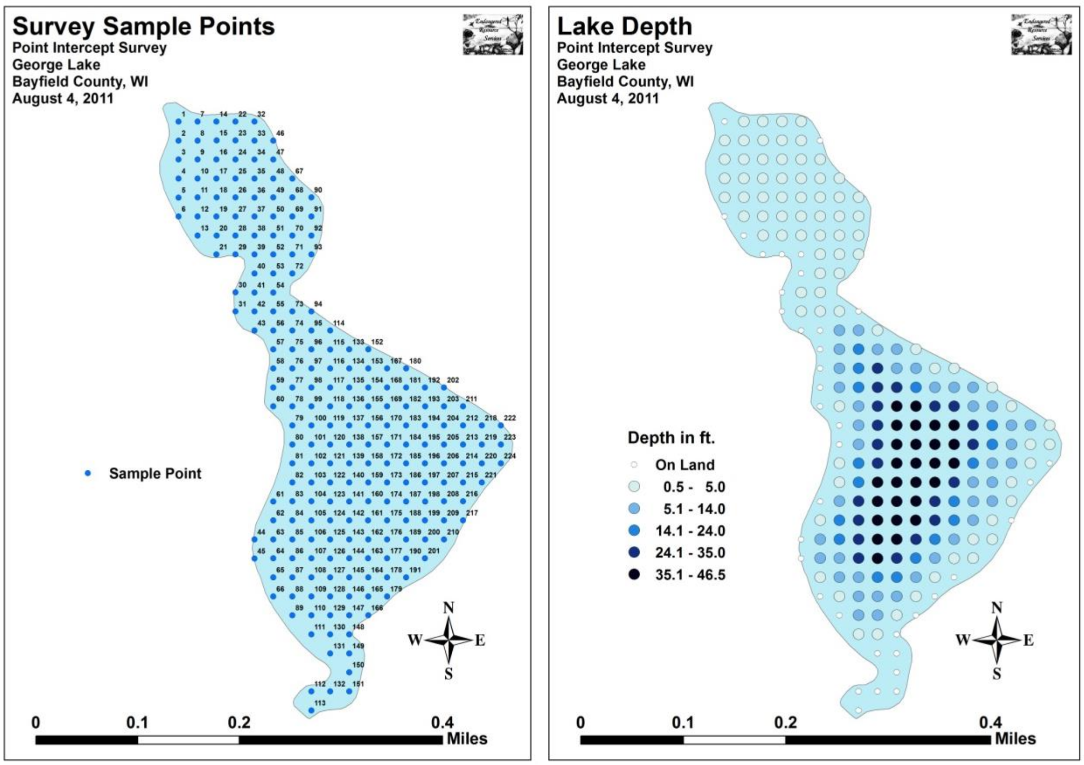
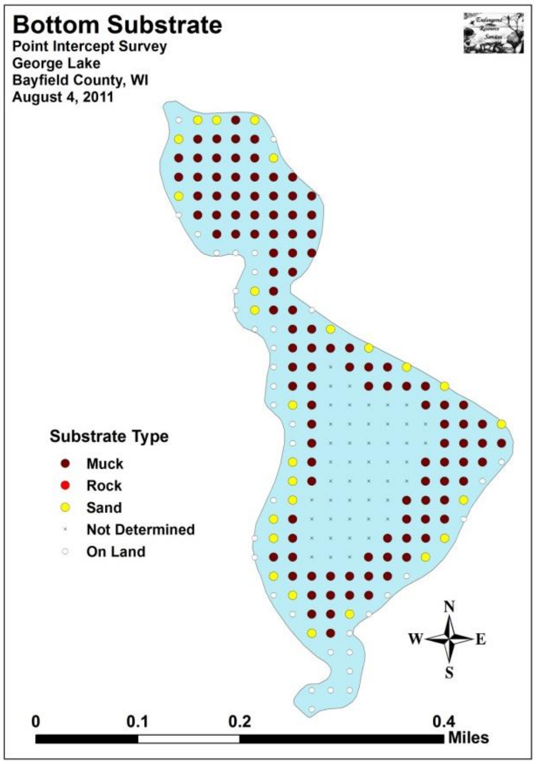


Figure 3: Survey Points and Lake Depth

Sugar sand lined the margins of the majority of the lake. This quickly transitioned to sandy muck at most depths beyond 6ft. The only dark organic muck occurred in parts of the north bay, and in the east and south bays of the south basin. Of the 139 points where we could determine the bottom substrate, 81.3% were covered in muck and sandy muck, and 18.7% were pure sand (Figure 4). The lake's good to very good water clarity produced a littoral zone that extended to 24ft before ending abruptly. Unusually, plant growth was strongly skewed to deep water with a mean depth of 6.5ft and a median depth of only 3.5ft. Plants were somewhat patchy in distribution with just over 78% of the lake's available substrate being colonized (Table 1). Surprisingly, many of the shallow organic muck bottom areas, a habitat that usually supports the densest growth in a lake, were nearly devoid of plants (Appendix III). Overall diversity was very high with a Simpson Diversity Index value of 0.93. Species richness was also relatively high for such a small lake with 45 total species found growing in and immediately adjacent to the lake; however, the average number of native species per site was low with only 2.03 species/vegetative site.



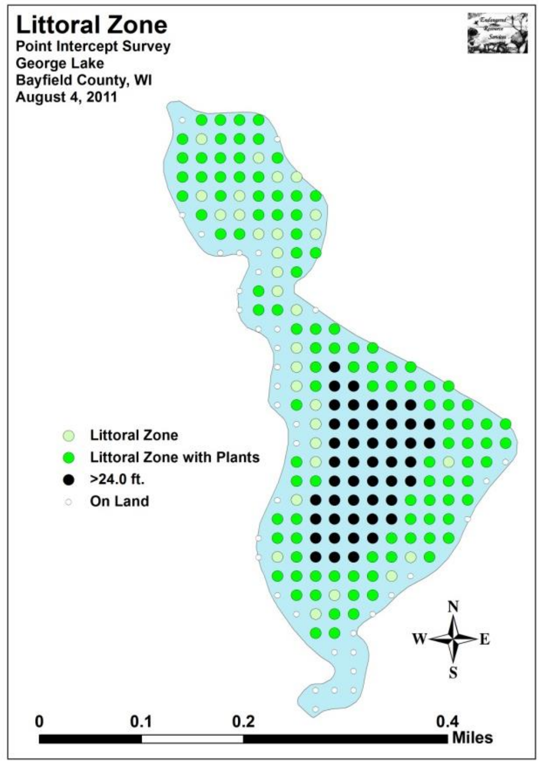


Figure 4: Bottom Substrate and Littoral Zone

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics George Lake, Bayfield County August 4, 2011

Summary Statistics:

Total number of points sampled	186
Total number of sites with vegetation	109
Total number of sites shallower than the maximum depth of plants	139
Frequency of occurrence at sites shallower than maximum depth of plants	78.42
Simpson Diversity Index	0.93
Maximum depth of plants (ft)	24.0
Mean depth of plants (ft)	6.5
Median depth of plants (ft)	3.5
Number of sites sampled using rope rake (R)	13
Number of sites sampled using pole rake (P)	126
Average number of all species per site (shallower than max depth)	1.61
Average number of all species per site (veg. sites only)	2.06
Average number of native species per site (shallower than max depth)	1.55
Average number of native species per site (veg. sites only)	2.03
Species richness	36
Species richness (including visuals)	40
Species richness (including visuals and boat survey)	45
Mean total rake fullness (veg. sites only)	1.81

Lakewide, only 8 of the 109 sites with vegetation had more than 4 species present in the rake. Overall plant density was moderate with a mean rake fullness of 1.8 at sites with vegetation (Figure 5) (Appendix IV).

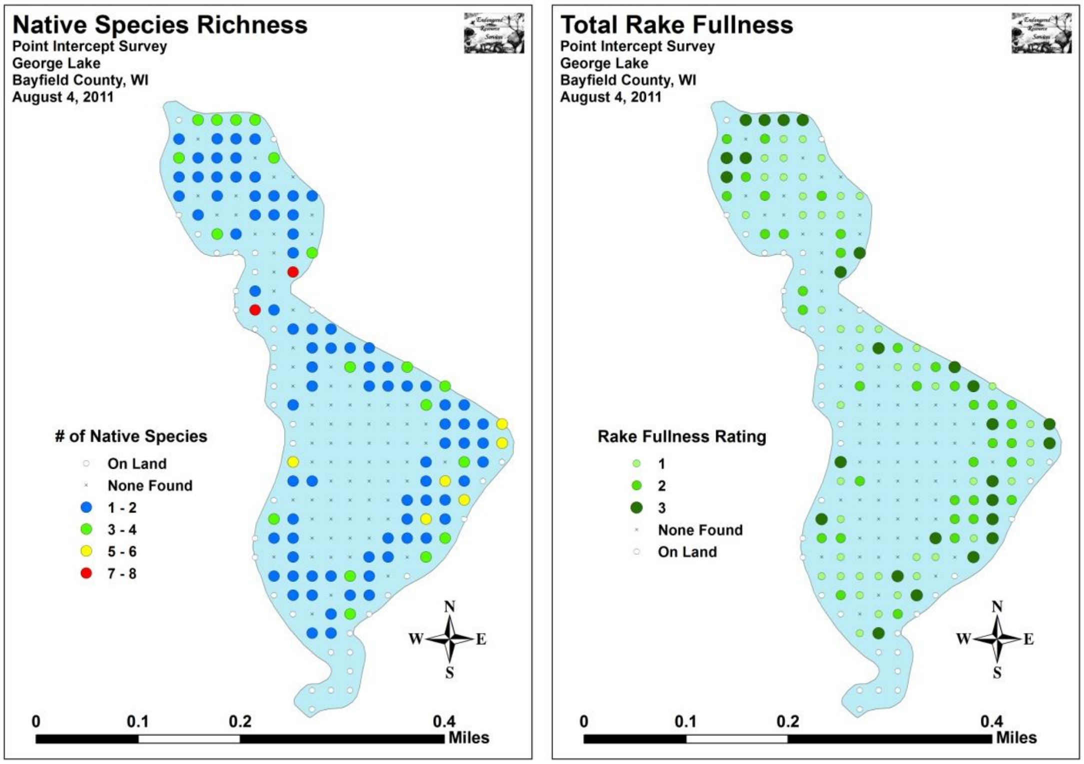


Figure 5: Native Species Richness and Total Rake Fullness Rating

The George Lake plant community can be broken into five distinct zones each of which has its own characteristic species and functions in the lake ecosystem. Around the shoreline, emergent species such as Hardstem bulrush (*Schoenoplectus acutus*), Softstem bulrush (*Schoenoplectus tabernaemontani*), Creeping spikerush (*Eleocharis palustris*), and a variety of sedges (*Carex* spp.), rushes (*Juncus* spp.), and cattails (*Typha* spp.) stabilize the lakeshore, 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.

Sedges in the north bay looking towards the boat landing

Softstem and Hardstem bulrushes in the north bay.

Shallow sugar sand areas tended to have low total biomass. These nutrient poor substrates provided habitat most suited to fine leaved "isoetid" species like Needle spikerush (*Eleocharis acicularis*) and Brown-fruited rush (*Juncus pelocarpus*). Narrow-leaved pondweed species like Spiral-fruited pondweed (*Potamogeton spirillus*) and Leafy pondweed (*Potamogeton foliosus*) were also found growing in these areas. All of these species are typical of low nutrient, sand bottom lakes like George and, along with the emergents, work to stabilize the bottom and prevent wave action erosion.


Spiral-fruited pondweed (Koshere, 2002)


Brown-fruited rush (Koshere, 2002)

Just beyond the emergents in shallow organic muck areas, floating leaf species like White-water lily (*Nymphaea odorata*), Spatterdock (*Nuphar variegata*), Watershield (*Brasenia schreberi*), and the Illinois X Variable pondweed hybrid (*Potamogeton spathuliformis*) dominated the plant community. The protective canopy cover they provide is often utilized by panfish and bass.


Floating-leaf species at the edge of bulrushes in the north bay

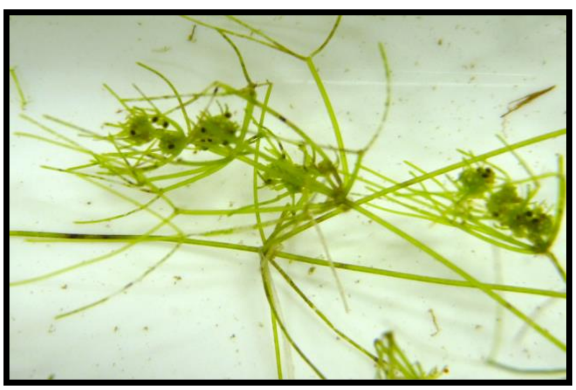

Watershield (Gmelin, 2009)

In slightly deeper water that had low nutrient sandy muck, Slender naiad (*Najas flexilis*), Northern naiad (*Najas gracillima*), Muskgrass (*Chara* sp.), and Variable pondweed (*Potamogeton gramineus*) were common. These species are heavily utilized by waterfowl for food and larval insects for habitat.

Slender naiad (Koshere, 2002)

Variable pondweed (Koshere, 2002)

Deeper areas over thicker muck were dominated by Nitella (*Nitella* sp.) and Small pondweed (*Potamogeton pusillus*). Scattered patches of Coontail (*Ceratophyllum demersum*), Fern pondweed (*Potamogeton robbinsii*), Large-leaf pondweed (*Potamogeton amplifolius*), and Slender waterweed (*Elodea nuttallii*) also occurred in this habitat. All of these species offer prime habitat for mature gamefish.



Nitella

Fern pondweed (Apipp, 2011)

When considering the lake as a whole, Slender naiad, Nitella, Small pondweed, and White water lily were the most common species (Table 2). They were found at 31.19%, 21.10%, 20.18% and 16.51% of survey points with vegetation respectively. Collectively, they accounted for 43.30% of the total relative frequency (Figure 6). Although many other species were widely distributed, only Muskgrass (5.36), Needle spikerush (4.46), and Fern pondweed (4.02) had relative frequencies over 4% (Species accounts and distribution maps for all plants found are located in Appendices V and VI).

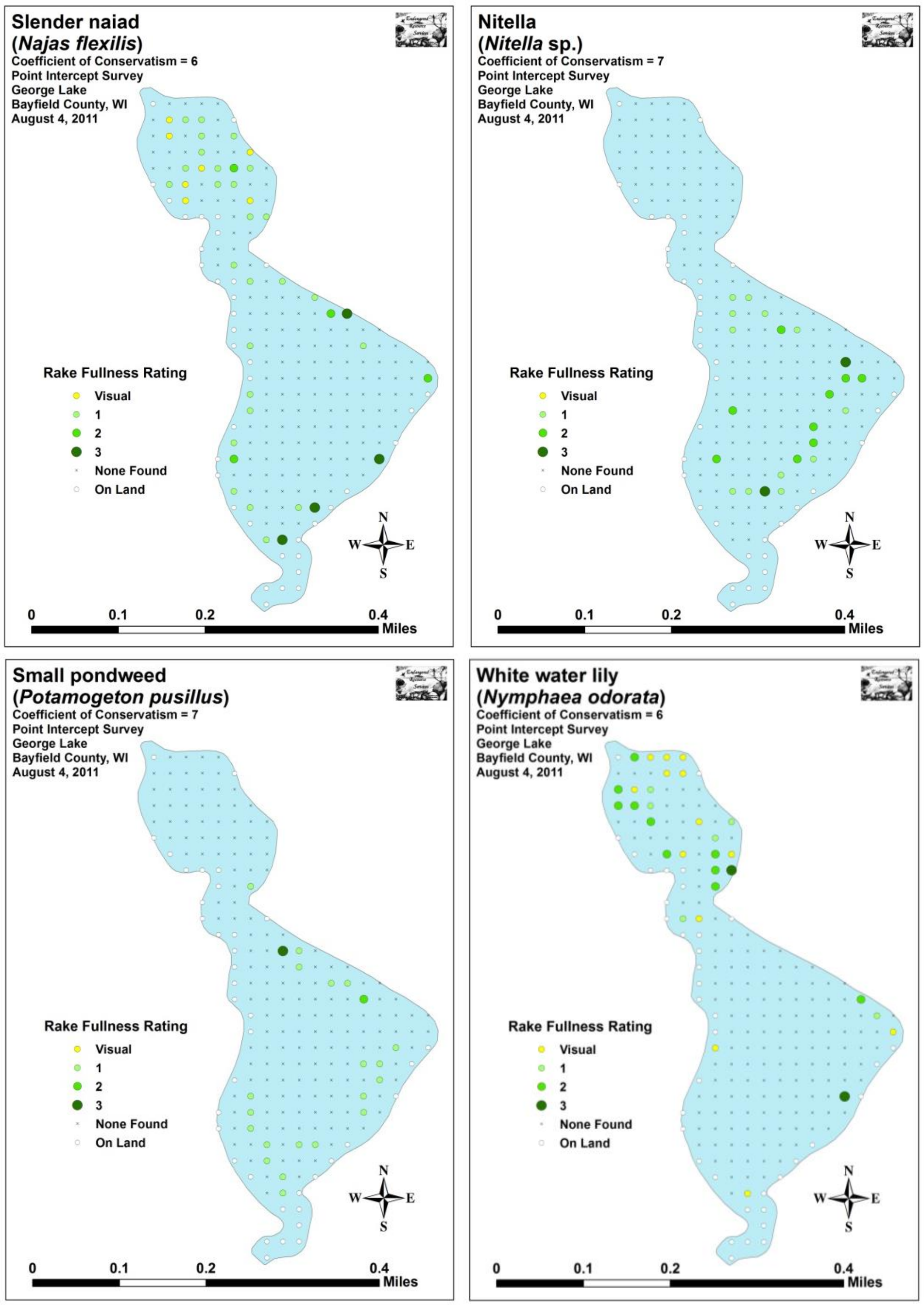


Figure 6: George Lake's Most Common Species

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
George Lake, Bayfield County
August 4, 2011

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Najas flexilis	Slender naiad	34	15.18	31.19	24.46	1.35	7
Nitella sp.	Nitella	23	10.27	21.10	16.55	1.57	0
Potamogeton pusillus	Small pondweed	22	9.82	20.18	15.83	1.14	0
Nymphaea odorata	White water lily	18	8.04	16.51	12.95	1.78	13
Chara sp.	Muskgrass	12	5.36	11.01	8.63	1.33	0
Eleocharis acicularis	Needle spikerush	10	4.46	9.17	7.19	1.00	0
Potamogeton robbinsii	Fern pondweed	9	4.02	8.26	6.47	1.67	0
Eleocharis palustris	Creeping spikerush	8	3.57	7.34	5.76	1.38	3
Potamogeton X *spathuliformis*	Illinois pondweed hybrid	8	3.57	7.34	5.76	1.38	1
Juncus canadensis	Canada rush	7	3.13	6.42	5.04	1.71	3
Schoenoplectus tabernaemontani	Softstem bulrush	7	3.13	6.42	5.04	1.86	9
Brasenia schreberi	Watershield	5	2.23	4.59	3.60	1.80	3
Ceratophyllum demersum	Coontail	5	2.23	4.59	3.60	1.80	0
Leersia oryzoides	Rice cut-grass	5	2.23	4.59	3.60	1.40	6
Najas gracillima	Northern naiad	5	2.23	4.59	3.60	1.20	0
Potamogeton spirillus	Spiral-fruited pondweed	5	2.23	4.59	3.60	1.60	0
Carex scoparia	Broom sedge	4	1.79	3.67	2.88	1.25	0
Carex utriculata	Common yellow lake sedge	4	1.79	3.67	2.88	2.50	1
Elodea nuttallii	Slender waterweed	4	1.79	3.67	2.88	1.00	0
Potamogeton gramineus	Variable pondweed	4	1.79	3.67	2.88	1.50	1
Juncus effusus	Common rush	3	1.34	2.75	2.16	2.00	0
Juncus pelocarpus	Brown-fruited rush	3	1.34	2.75	2.16	1.00	1
Myriophyllum spicatum	Eurasian water milfoil	3	1.34	2.75	2.16	1.67	6
Carex cryptolepis	Small yellow sedge	2	0.89	1.83	1.44	2.00	2
Potamogeton amplifolius	Large-leaf pondweed	2	0.89	1.83	1.44	1.00	2

Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
George Lake, Bayfield County
August 4, 2011

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Schoenoplectus acutus	Hardstem bulrush	2	0.89	1.83	1.44	2.50	4
Bidens beckii	Water marigold	1	0.45	0.92	0.72	1.00	0
Carex lurida	Shallow sedge	1	0.45	0.92	0.72	2.00	0
Dulichium arundinaceum	Three-way sedge	1	0.45	0.92	0.72	1.00	0
Juncus brevicaudatus	Narrow-pancaled rush	1	0.45	0.92	0.72	1.00	0
Nuphar variegata	Spatterdock	1	0.45	0.92	0.72	2.00	1
Polygonum amphibium	Water smartweed	1	0.45	0.92	0.72	1.00	1
Potamogeton foliosus	Leafy pondweed	1	0.45	0.92	0.72	2.00	1
Sagittaria latifolia	Common arrowhead	1	0.45	0.92	0.72	2.00	0
Scirpus cyperinus	Woolgrass	1	0.45	0.92	0.72	1.00	2
Sparganium angustifolium	Narrow-leaved bur-reed	1	0.45	0.92	0.72	1.00	3
	Filamentous algae	1	*	0.92	0.72	1.00	0
Drosera rotundifolia	Round-leaved sundew	**	**	**	**	**	1
Eleocharis ovata	Oval spikerush	**	**	**	**	**	1
Potamogeton epihydrus	Ribbon-leaf pondweed	**	**	**	**	**	1
Typha latifolia	Broad-leaved cattail	**	**	**	**	**	2
Carex viridula	Green yellow sedge	***	***	***	***	***	***
Juncus arcticus var. balticus	Arctic rush	***	***	***	***	***	***
Lipocarpha micrantha	Small-flowered hemicarpha	***	***	***	***	***	***
Myriophyllum sibiricum	Northern water milfoil	***	***	***	***	***	***
Typha angustifolia	Narrow-leaved cattail	***	***	***	***	***	***

* Algae are excluded from the Relative Frequency Calculation ** Visual Only *** Boat Survey Only

Table 3: Floristic Quality Index of Aquatic Macrophytes
George Lake, Bayfield County
August 4, 2011

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Dulichium arundinaceum	Three-way sedge	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea nuttallii	Slender waterweed	7
Juncus pelocarpus	Brown-fruited rush	8
Najas flexilis	Slender naiad	6
Najas gracillima	Northern naiad	7
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Water smartweed	5
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton foliosus	Leafy pondweed	6
Potamogeton gramineus	Variable pondweed	7
Potamogeton X *spathuliformis*	Illinois pondweed hybrid	6
Potamogeton pusillus	Small pondweed	7
Potamogeton robbinsii	Fern pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus acutus	Hardstem bulrush	6
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium angustifolium	Narrow-leaved bur-reed	9
N		26
Mean C		6.4
FQI		32.8

We identified a total of 26 **native index species** in the rake during the point intercept survey. They produced a mean Coefficient of Conservatism of 6.4 and a Floristic Quality Index of 32.8 (Table 3). Nichols (1999) reported an Average mean C for the Northern Lakes and Forest Region of 6.7 putting George Lake slightly below average for this part of the state. The FQI was, however, well above the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). Six high value species of note included Water marigold (*Bidens beckii*) (C = 8), Three-way sedge (*Dulichium arundinaceum*) (C = 9), Brown-fruited rush (C = 8), Fern pondweed (C = 8), Spiral-fruited pondweed (C = 8), and Narrow-leaved bur-reed (*Sparganium angustifolium*) (C = 9).

During the initial boat survey, we found Eurasian water milfoil scattered throughout the north bay. Plants were generally in small clusters of 5-10 stems each, and, for the most part, they had not started joining up to form beds. Floating fragments were common, and we found many of them were taking root in very shallow water (<0.25m) among the bulrushes and sedges. In the south basin, we found two additional individual rooted plants as well as three small beds, the biggest of which was $2m^2$ with 10's of plants.

The point intercept survey quantified EWM at only three points, but it was a visual at six additional points (Figure 7) (Appendix VII). The only other exotic species we found growing in the lake was Narrow-leaved cattail (*Typha angustifolia*) – a species native to southern Wisconsin, but not northern Wisconsin. It is potentially invasive and is excluding the native Broad-leaved cattail in many places where the two are found together in this part of the state. Because of this, there is the potential that it will continue to spread beyond the small patch currently growing in the east bay of the south basin (For more information on aquatic exotic invasive plant species, see Appendix VIII).

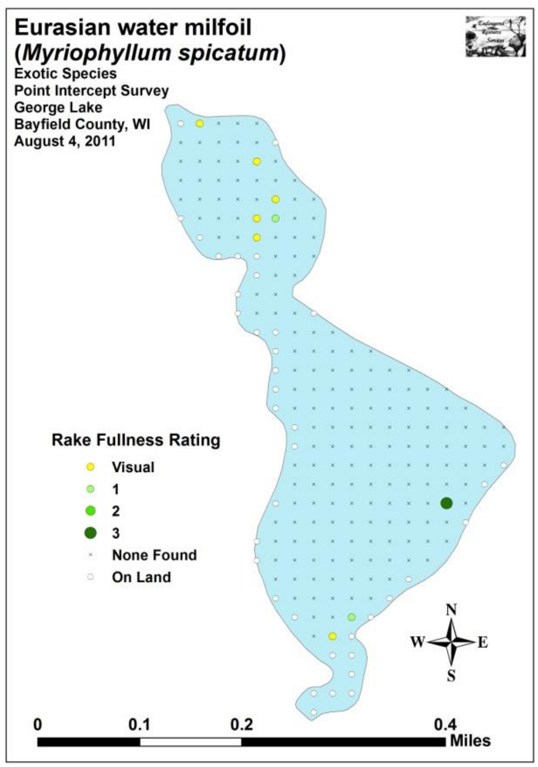


Figure 7: EWM Density and Distribution 8 4, 2011

Dive Removal:

On August 5th, we, along with several volunteer helpers, gathered on the southeastern shoreline of the lake adjacent to where the three beds had been located the previous day. The divers quickly relocated the beds and removed all visible plants from the area (approximately 70 individual stems). A few other single plants were removed along this shoreline, but no plants were found outside this area.

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:
Eurasian water milfoil Management:

George Lake has a rich and diverse plant community that is unique to sand bottomed, seepage lakes with good water clarity and quality. Unfortunately, the introduction of Eurasian water-milfoil will pose a continued threat to that diversity and the resource as a whole moving forward as it is unlikely that EWM will ever be totally eliminated from the lake. With this reality in mind, working to minimize the spread of EWM within the lake, and quickly identifying and eliminating new beds that appear will likely be high priority management goals moving forward.

The majority of EWM plants were located in the north bay and many of these were growing among the emergent plant beds. This will make locating and removing them by hand, except in areas deep enough that emergents can't grow, extremely difficult. Fortunately, because the bay is so shallow, a bay-wide herbicide treatment may be both cost effective and justified. If this strategy is acted upon, using a curtain to seal off the narrow channel leading out to deeper water could prevent dilution and limit any herbicide damage to native plants outside the bay. Treating early in the growing season when EWM is active, but many other species have not yet germinated or begun active growth could also minimize damage to native vegetation.

Outside the bay, there are many control and prevention strategies to consider. A snorkel, SCUBA, swim, or boat over of the dive removal area should be carried out as early as plant growth is observed in the spring to determine if any EWM plants are growing back in these areas. If EWM plants have returned, a decision on how to proceed with control (i.e. divers or herbicide) will have to be made.

In areas where EWM has not been found, lakeshore owners should minimize the removal of native plants from the lake unless absolutely necessary as these patches of barren substrate can provide an easy place for EWM fragments to take root and become established. Training volunteers to recognize EWM is another low cost management strategy that we strongly encourage. At least monthly volunteer meandering shoreline surveys of the whole lake would likely result in early detection of new beds. The sooner these beds can be found, the greater the chances the infestation can continue to be economically maintained at its current low level.

Although the very similar native species Northern water milfoil (*Myriophyllum sibiricum*) does occur in the lake, it is extremely rare (Figure 8). Because of this, any suspicious looking plants that are found in the future should be immediately investigated to determine species. If any volunteer, lake resident or boater discovers a plant they even suspect may be EWM, they are invited to contact Matthew Berg, ERS, LLC Research Biologist at (715) 338-7502 mberg@grantsburg.k12.wi.us and/or Pamela Toshner/Alex Smith, Regional Lakes Management Coordinators in the Spooner DNR office at 715-635-4073 for identification confirmation. If possible, a specimen, a jpg, and the accompanying GPS coordinates of the location it was found at should be included.

Figure 8: Eurasian and Northern Water Milfoil Identification

Native Aquatic Macrophytes, Algae and Water Clarity:

George Lake's somewhat limited plant community is characterized by sensitive, fine-leaved species typical of low nutrient systems and dependent on water clarity, quality, chemistry, and generally positive shoreline practices. Residents should be mindful that these plants are the basis of the ecosystem, and they are as important to the aquatic environment as trees are to a forest. Because of this, preserving them is critical to maintaining a healthy lake. As the basis of the food pyramid, they provide habitat for other aquatic organisms, are important food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve water clarity by absorbing excess nutrients from the water.

During our time on the lake, we immediately noticed that most residents were currently practicing good shoreline conservation (Figure 9). We also noticed that there were few filamentous or floating algae in the lake. This is likely not a coincidence. These algae proliferate in the presence of excessive nutrients in the water. Because the lake's plant community is so limited, even a small percentage decline in macrophyte plants or a small increase in nutrient input could tip the lake's current balance allowing algae to proliferate and leading to a decline in both water clarity and quality. Conversely, working to limit nutrient input could result in fewer algal blooms and better clarity throughout the summer. It could also inhibit EWM growth as it favors higher nutrient waters.

Such things as internal loading from sediments, failed septic systems, and lawn and field fertilizer runoff are common causes of excess nutrients in surface water. Educating all lake residents about reducing nutrient input directly along the lake is one of the easiest ways to limit algal growth and maintain or even improve water clarity and quality. Not mowing down to the lakeshore, bagging grass clippings, and switching to a phosphorus-free fertilizer or eliminating fertilizer altogether would all be positive steps to this end. Wherever possible, restoring shorelines, building rain gardens, and establishing buffer strips of native vegetation would also enhance water clarity/quality by preventing erosion and runoff.

Figure 9: Model Natural Shoreline on a Nearby Lake

Finally, completing an Aquatic Plant Management Plan (APMP) will help the lake clarify a management strategy for dealing with EWM moving forward. A team approach that uses all available data from this report and the lake usership survey that would accompany the development of the plan coupled with open and frank communication between the TOB, WDNR, interested citizens and the plan manager will be critical in formulating the best APMP possible for the lake.

MANAGEMENT CONSIDERATIONS SUMMARY:

- Preserve the lake's rich, diverse, and unique native plant community by continuing to maintain/reduce Eurasian water milfoil at/from its current low rates.
- Train volunteers to recognize EWM, and conduct at least monthly shoreline surveys so new beds can be quickly and economically controlled before they spread.
- Whenever possible, refrain from unnecessary removal of native plants from the lake as this provides a place for exotic species like EWM to more easily establish and colonize.
- Reduce and, wherever possible, eliminate fertilizer applications, soil erosion, and grass clipping and leaf runoff as these nutrient inputs encourage algal growth.
- Encourage shoreline restoration that establishes native vegetation buffer strips along the lakeshore to help prevent runoff and erosion.
- Complete an Aquatic Plant Management Plan (APMP) to guide the management of EWM and the lake's native plants moving forward.

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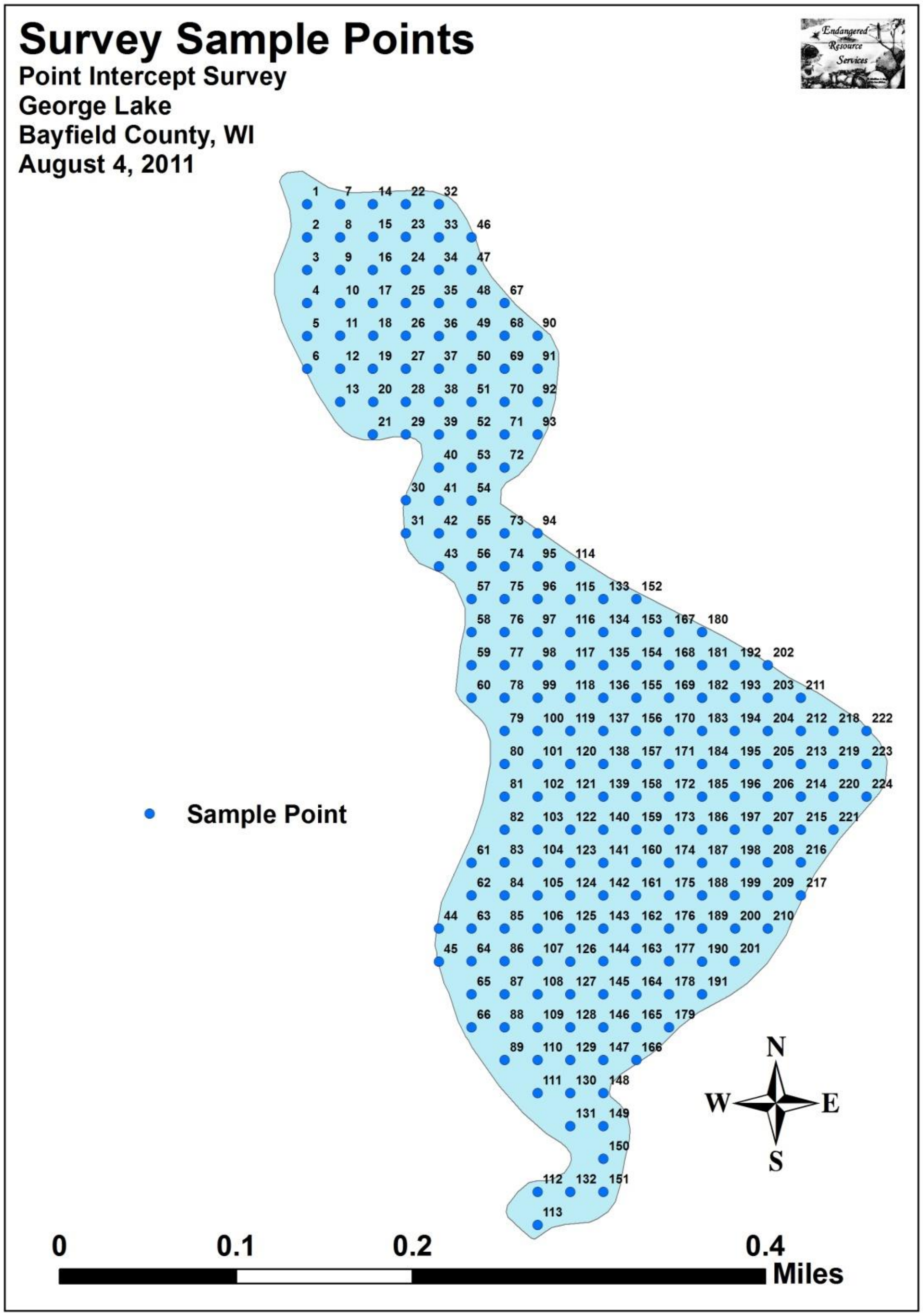
Appendix I: George Lake Survey Sample Points


Survey Sample Points
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Sample Point
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix II: Boat and Vegetative Survey Data Sheets

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

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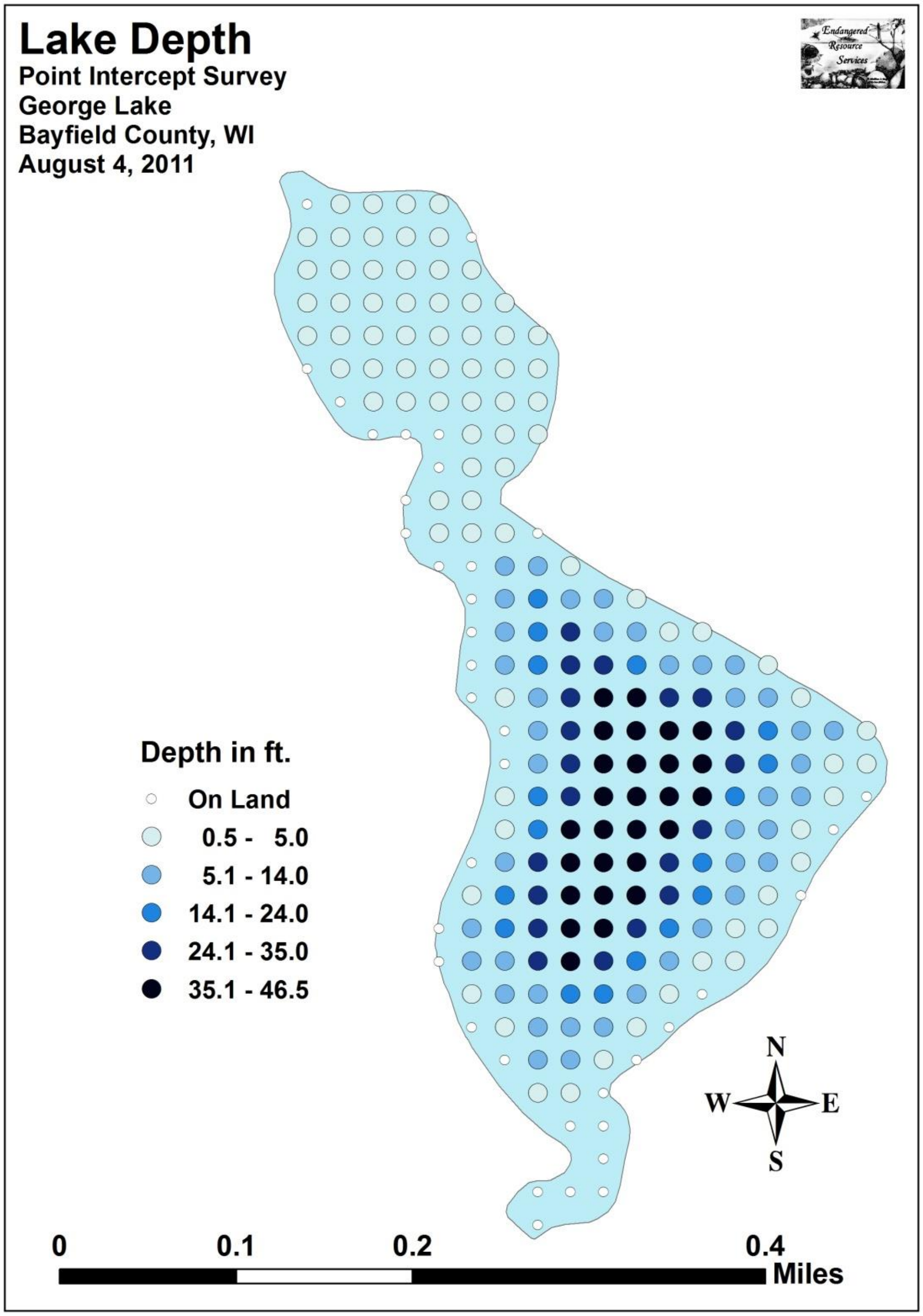
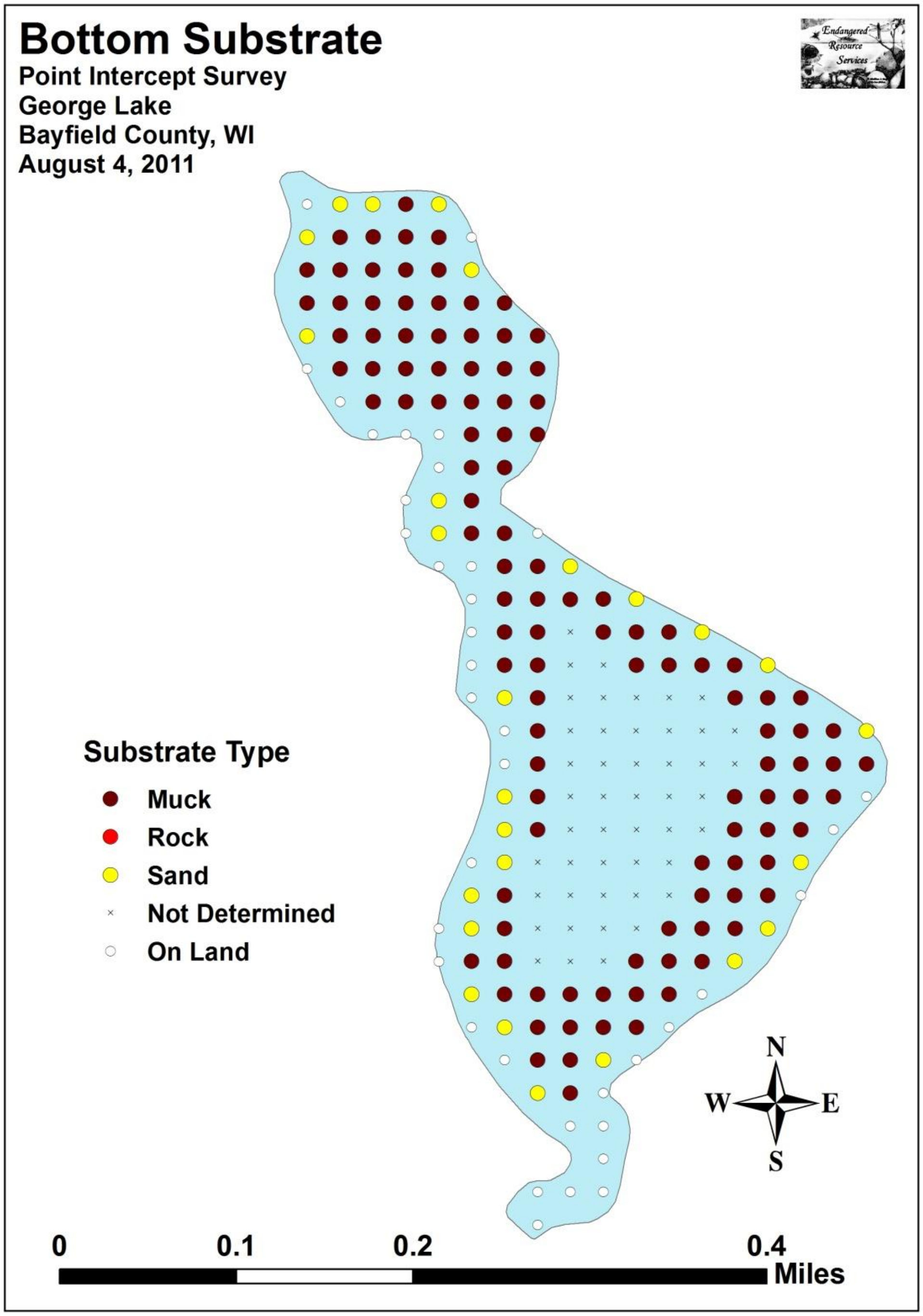
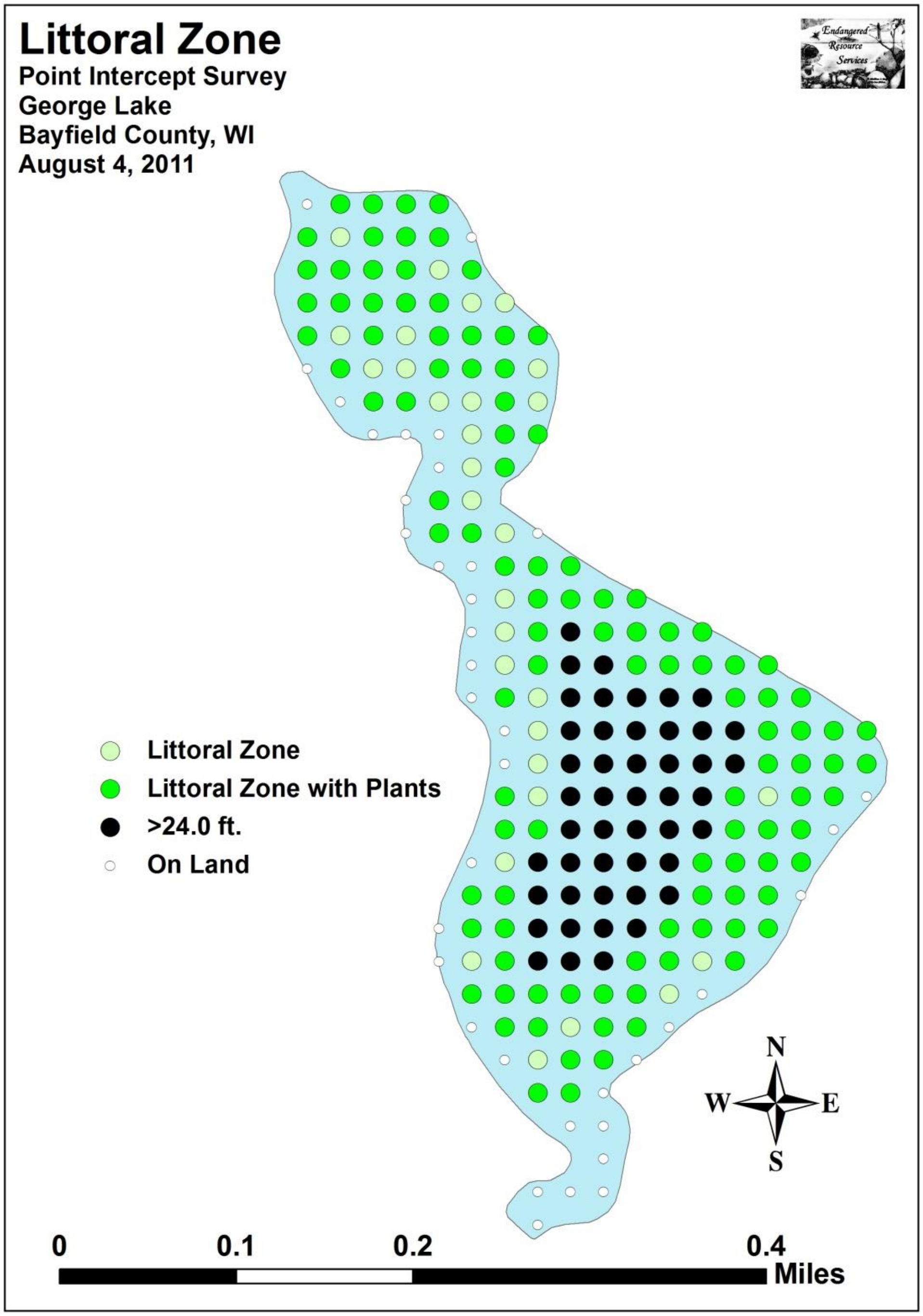
20																									

Appendix III: Habitat Variable Maps

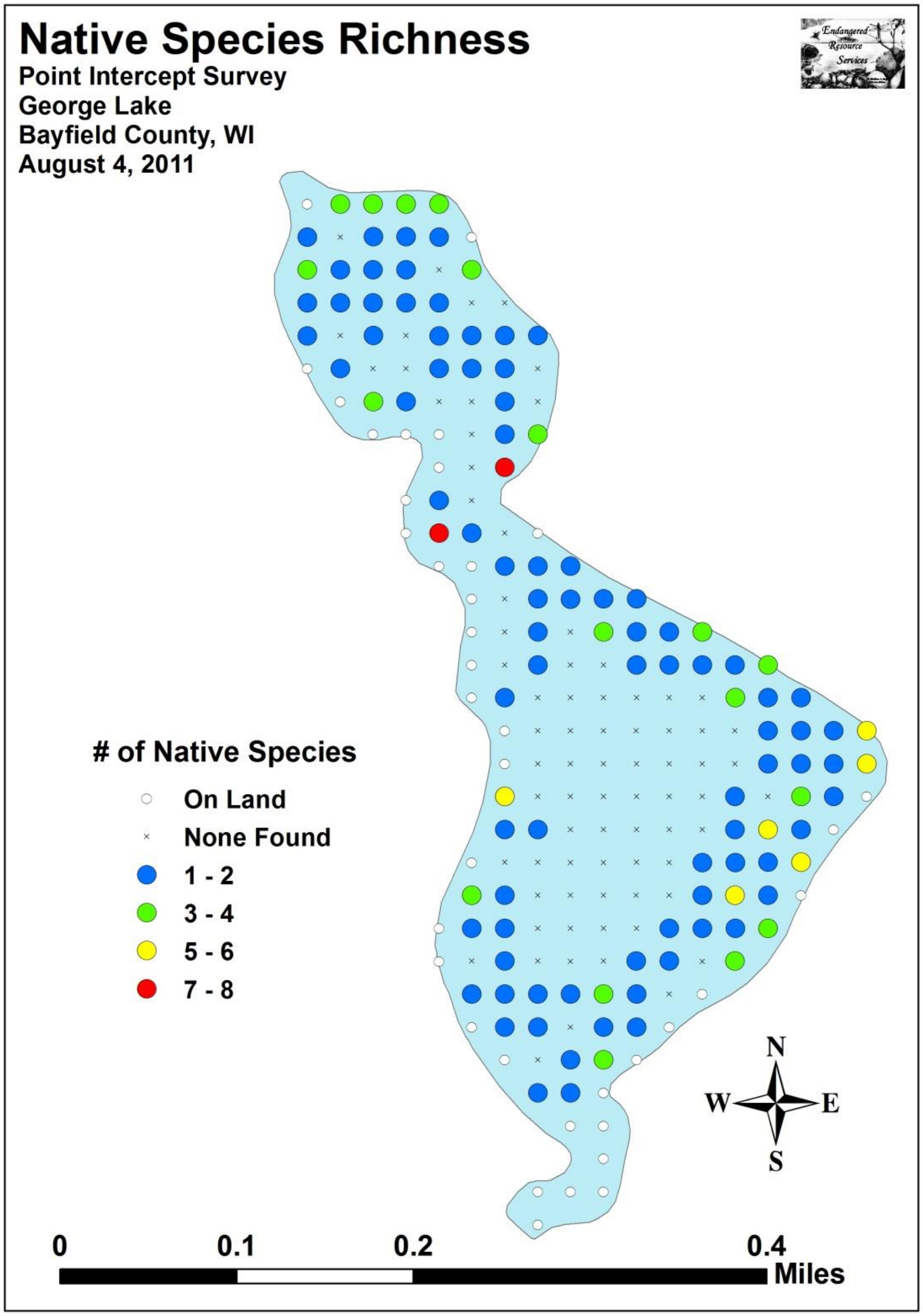

Lake Depth
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Depth in ft.
On Land
0.5 - 5.0
5.1 - 14.0
14.1 - 24.0
24.1 - 35.0
35.1 - 46.5
N
W
E
S
0
0.1
0.2
0.4
Miles


Bottom Substrate
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Substrate Type
Muck
Rock
Sand
Not Determined
On Land
N
W
E
S
0
0.1
0.2
0.4
Miles

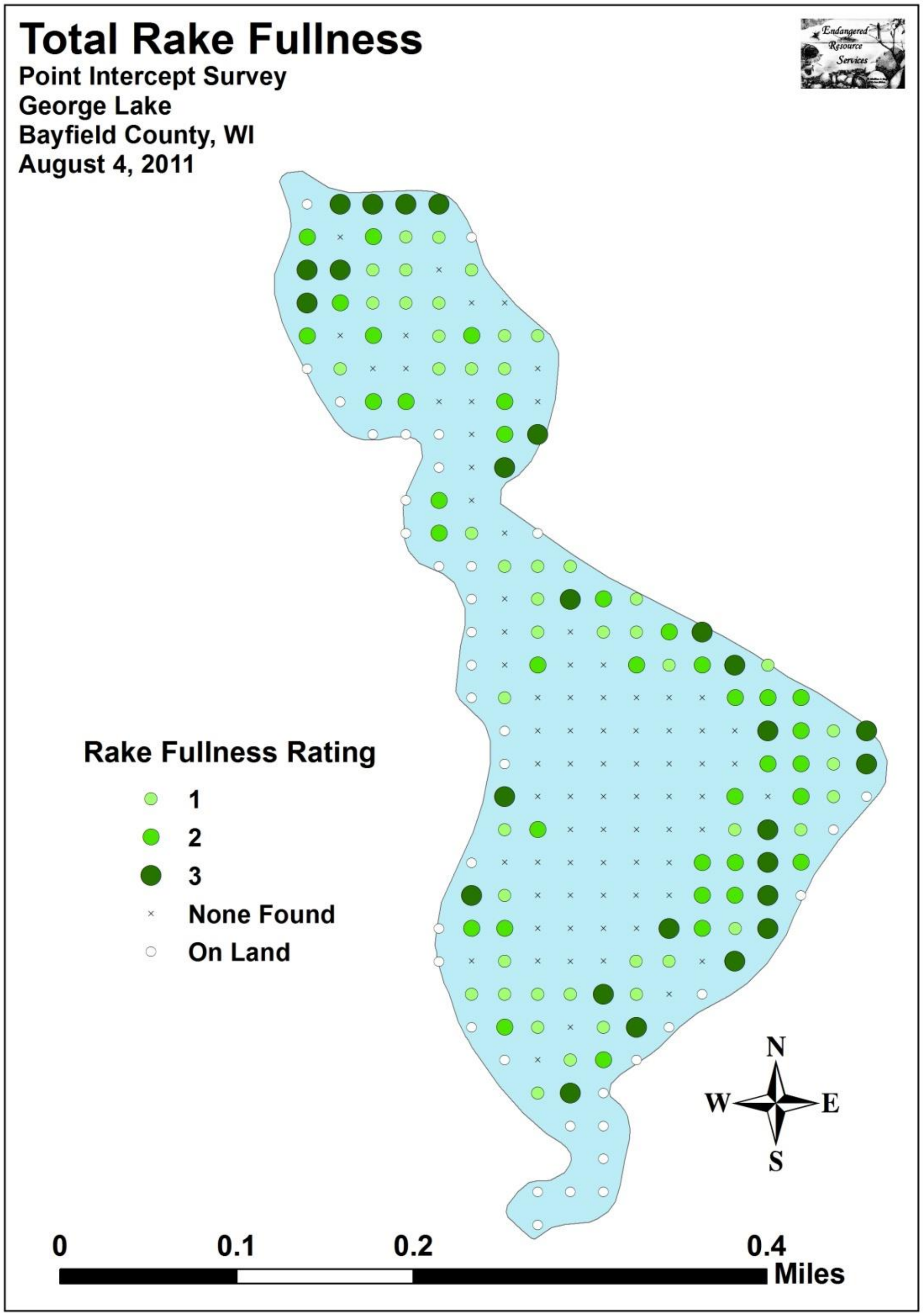


Littoral Zone
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Littoral Zone
Littoral Zone with Plants
>24.0 ft.
On Land
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix IV: Native Species Richness and Total Rake Fullness Maps



Native Species Richness
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
# of Native Species
On Land
None Found
1 - 2
3 - 4
5 - 6
7 - 8
N
W
E
S
0
0.1
0.2
0.4
Miles


Total Rake Fullness
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
On Land
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix V: Plant Species Accounts

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Bidens beckii*) **Water marigold**
Specimen Location: George Lake; N46.37791°, W91.54054°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-241
Habitat/Distribution: Muck bottom in 3-5m. A single plant was found in the rake at the point, and it was seen inter-point at two other locations.
Common Associates: (*Nitella* sp.) Nitella, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton pusillus*) Small pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-242
Habitat/Distribution: Muck and mucky sand bottoms in 1-1.5m. Relatively common. Most plants were in the north bay; it was widely scattered in the south basin.
Common Associates: (*Nymphaea odorata*) White water lily, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Najas flexilis*) Slender naiad, (*Potamogeton X spathuliformis*) Illinois X Variable pondweed hybrid

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Carex cryptolepis*) **Small yellow sedge**
Specimen Location: George Lake; N46.37977°, W91.54332°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-243
Habitat/Distribution: Wet sand to sandy muck along the shoreline. Scattered individuals occurred throughout the north bay. Peryginium were inflated and strongly curved with the achene only filling the lower ½ of them.
Common Associates: (*Juncus canadensis*) Canada rush, (*Carex utriculata*) Common yellow lake sedge, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Carex lurida*) **Shallow sedge**
Specimen Location: George Lake; N46.37817°, W91.54171°
Collected/Identified by: **Matthew S. Berg/Dr. Robert W. Freckmann**
Col. #: MSB-2011-244
Habitat/Distribution: Sandy muck soils near the shoreline in water <0.25m deep. Found growing among other sedges. Perhaps more common than the survey indicated; only a few individuals were in fruit to confirm identification. The scabrous, awned pistilate scales were distinctive.
Common Associates: (*Carex utriculata*) Common yellow lake sedge, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Carex scoparia*) **Broom sedge**
Specimen Location: George Lake; N46.37498°, W91.53772°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-245
Habitat/Distribution: Wet sand at the shoreline. Widely scattered individuals occurred on the west and south shorelines of the south basin.
Common Associates: (*Leersia oryzoides*) Rice cut-grass, (*Juncus brevicaudatus*) Narrow-panicle rush, (*Eleocharis palustris*) Creeping spikerush, (*Drosera rotundifolia*) Round-leaved sundew

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Carex utriculata*) **Common yellow lake sedge**
Specimen Location: George Lake; N46.38085°, W91.54296°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-246
Habitat/Distribution: Wet sand and sandy muck at the shoreline. A single individual was in fruit, but this was the dominant species in the north bay. Plants dominated the area by public boat landing in and out of the water.
Common Associates: (*Juncus canadensis*) Canada rush, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Carex viridula*) **Little green sedge**
Specimen Location: George Lake; N46.37977°, W91.54332°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-247
Habitat/Distribution: Sand and sandy muck at the shoreline. A single individual was collected with *C. cryptolepis* specimens. Pistilate scales were persistent and the achene filled the entire peryginium which was also much less inflated than the *C. cryptolepis* specimens.
Common Associates: (*Carex cryptolepis*) Small yellow sedge, (*Juncus canadensis*) Canada rush, (*Carex utriculata*) Common yellow lake sedge, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: George Lake; N46.37714°, W91.53817°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-248
Habitat/Distribution: Muck bottom in 1.5-4.5 meters. Plants were widely scattered throughout the east bay of the south basin where the muck bottom was more organic rich than elsewhere in the lake.
Common Associates: (*Nitella* sp.) Nitella, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Myriophyllum spicatum*) Eurasian water milfoil, (*Nymphaea odorata*) White water lily, (*Elodea nuttallii*) Slender waterweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: George Lake; N46.37575°, W91.54048°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-249
Habitat/Distribution: Plants were scattered throughout the south basin over sandy muck and sand in water from 2.5-4.5m deep.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Nitella* sp.) Nitella

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Drosera rotundifolia*) **Round-leaved sundew**
Specimen Location: George Lake; N46.37498°, W91.53772°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-250
Habitat/Distribution: Wet sand at the shoreline. A few plants were scattered along the southeast shoreline of the south basin near the point.
Common Associates: (*Leersia oryzoides*) Rice cut-grass, (*Juncus brevicaudatus*) Narrow-panicle rush, (*Eleocharis palustris*) Creeping spikerush, (*Carex scoparia*) Broom sedge

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Dulichium arundinaceum*) **Three-way sedge**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-251
Habitat/Distribution: Muck bottoms at the shoreline. Only plants found were at the point on the east side of the entrance to the north bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Eleocharis acicularis*) **Needle spikerush**
Specimen Location: George Lake; N46.38033°, W91.54139°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-252
Habitat/Distribution: Sand and sandy muck from 0-2m. Plants at deeper depths grew progressively taller (up to 10cm). Widely distributed, but never abundant or common.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Eleocharis palustris*) Creeping spikerush, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Eleocharis ovata*) **Oval spikerush**
Specimen Location: George Lake; N46.37580°, W91.53697°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-253
Habitat/Distribution: A few plants occurred mixed in with other emergents in muck soils at the shoreline in the southeast corner of the south basin.
Common Associates: (*Leersia oryzoides*) Rice cut-grass, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Scirpus cyperinus*) Woolgrass, (*Sagittaria latifolia*) Common arrowhead

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Eleocharis palustris*) **Creeping spikerush**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-254
Habitat/Distribution: Firm sand bottoms in 0-0.5 meters of water. Common to abundant; especially along the margins of the south basin where it was a dominant emergent.
Common Associates: (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Juncus canadensis*) Canada rush, (*Juncus effusus*) Common rush, (*Najas flexilis*) Slender naiad, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Elodea nuttallii*) **Slender waterweed**
Specimen Location: George Lake; N46.37579°, W91.53814°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-255
Habitat/Distribution: Muck bottom in 2-4 meters of water.
Uncommon; a few scattered plants were found in the east bay of the south basin. No leaves had widths of more than 1.2mm while most lengths were in the 8-10mm range.
Common Associates: (*Potamogeton robbinsii*) Fern pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton pusillus*) Small pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Juncus arcticus var. balticus*) **Arctic rush**
Specimen Location: George Lake; N46.37843°, W91.54211°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-256
Habitat/Distribution: Sandy soils from the lake shore inland to the former margins of the lake (extended period of drought had lowered the lake nearly 2m). Plants were common to abundant; especially on the western shore of the south basin.
Common Associates: (*Juncus canadensis*) Canada rush, (*Juncus pelocarpus*) Brown-fruited rush, (*Carex utriculata*) Common yellow lake sedge, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Juncus brevicaudatus*) **Narrow-panicle rush**
Specimen Location: George Lake; N46.37412°, W91.54121°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-257
Habitat/Distribution: Sugar sand at the lake shore in areas that were recently underwater. A few individuals were found scattered among other emergents on the east and south side of the south basin. All plants found had insect galls. We used analysis of the tailed seeds to confirm identification on the few flowers that reached maturity. The seed capsules were also noticeably longer than the tepals/petals.
Common Associates: (*Juncus canadensis*) Canada rush, (*Juncus pelocarpus*) Brown-fruited rush, (*Drosera rotundifolia*) Round-leaved sundew

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Juncus canadensis*) **Canada rush**
Specimen Location: George Lake; N46.37412°, W91.54121°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-258
Habitat/Distribution: Sandy soils from the lake shore inland to the former margins of the lake (extended period of drought had lowered the lake nearly 2m). Plants were common to abundant; especially on the western shore of the south basin.
Common Associates: (*Juncus arcticus*) Arctic rush, (*Juncus pelocarpus*) Brown-fruited rush, (*Carex utriculata*) Common yellow lake sedge, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Juncus effusus*) **Common rush**
Specimen Location: George Lake; N46.37412°, W91.54121°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-259
Habitat/Distribution: Firm sand and sandy muck bottoms in 0-1.0 meter of water at the shoreline. Relatively common in scattered locations throughout.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Juncus canadensis*) Canada rush, (*Eleocharis palustris*) Creeping spikerush, (*Leersia oryzoides*) Rice cut-grass

County/State: Bayfield County, Wisconsin **Date:** 8/4/1
Species: (*Juncus pelocarpus*) **Brown-fruited rush**
Specimen Location: George Lake; N46.37412°, W91.54121°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-260
Habitat/Distribution: Sandy bottoms on shore to depths of 1m. Uncommon but widely scattered throughout the south basin.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Juncus canadensis*) Canada rush, (*Eleocharis palustris*) Creeping spikerush, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Leersia oryzoides*) **Rice cut-grass**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-261
Habitat/Distribution: Abundant in wet sand and sandy muck shoreline areas near the water line. Plants were mixed in with sedges and other emergents.
Common Associates: (*Juncus canadensis*) Canada rush, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex utriculata*) Common yellow lake sedge, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Lipocarpha micrantha*) **Small-flowered hemicarpha**
Specimen Location: George Lake; N46.37493°, W91.54123°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-262
Habitat/Distribution: Scattered individuals were found in wet sand at the shoreline.
Common Associates: (*Juncus arcticus*) Arctic rush, (*Juncus pelocarpus*) Brown-fruited rush, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Myriophyllum sibiricum*) **Northern water milfoil**
Specimen Location: George Lake; N46.37360°, W91.54042°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-263
Habitat/Distribution: Muck to sand bottom in water up to 3 meters. Extremely rare on the south end of the lake. A single plant was seen during the boat survey, and a few others were encountered while SCUBA diving on 8/5/11 to remove EWM plants.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton epihydrus*) Ribbon-leaf, (*Myriophyllum spicatum*) Eurasian water milfoil

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Myriophyllum spicatum*) **Eurasian water milfoil**
Specimen Location: George Lake; N46.37979°, W91.54137°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-264
Habitat/Distribution: Muck to sand bottom in water up to 2.5 m. Small clusters of plants were scattered throughout the north bay, but we also found and removed approximately 70 plants with SCUBA in the south basin on 8/5/11.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Ceratophyllum demersum*) Coontail, (*Najas flexilis*) Slender naiad, (*Nymphaea odorata*) White water lily

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Najas flexilis*) **Slender naiad**
Specimen Location: George Lake; N46.37979°, W91.54137°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-265
Habitat/Distribution: Sand and sandy muck bottoms in 0.5-3.5 meters of water. Common to abundant and widely distributed throughout.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Nymphaea odorata*) White water lily, (*Najas gracillima*) Northern naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Najas gracillima*) **Northern naiad**
Specimen Location: George Lake; N46.37412°, W91.54121°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-266
Habitat/Distribution: Found in muck and sandy bottom areas in water from 2.5-3.5m deep. Plants were scattered throughout the south basin.
Common Associates: (*Chara* sp.) Muskgrass, (*Najas flexilis*) Slender naiad, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton robbinsii*) Fern pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Nitella* sp.) **Nitella**
Specimen Location: George Lake; N46.37660°, W91.53777°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-267
Habitat/Distribution: Plants ringed the south basin over sandy muck. Scattered plants were found in water as shallow as 2m; became abundant in water from 4-6m and then disappeared abruptly. SCUBA dives on 8/5/11 confirmed this.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton pusillus*) Small pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: George Lake; N46.38059°, W91.54256°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-268
Habitat/Distribution: Firm muck bottom in <1m. Rare; a few small beds were found scattered throughout the lake.
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton pusillus*) Small pondweed, (*Najas flexilis*) Slender naiad, (*Myriophyllum spicatum*) Eurasian water milfoil

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-269
Habitat/Distribution: Thick organic muck bottoms in 0-2m. Common to abundant in the north bay, but only scattered in the south basin.
Common Associates: (*Nuphar variegata*) Spatterdock, (*Najas flexilis*) Slender naiad, (*Potamogeton X spathuliformis*) Illinois X Variable pondweed hybrid, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Polygonum amphibium*) **Water smartweed**
Specimen Location: George Lake; N46.38085°, W91.54296°
Collected/Identified by: **Matthew S. Berg Col. #:** MSB-2011-270
Habitat/Distribution: A few handfuls of plants were found on the north shore of the north bay growing on sand in <1m of water.
Common Associates: (*Nymphaea odorata*) White water lily, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Potamogeton X spathuliformis*) Illinois X Variable pondweed hybrid, (*Carex utriculata*) Common yellow lake sedge

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: George Lake; N46.37525°, W91.53812°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-271
Habitat/Distribution: Found in organic mucky bottom edges of the south basin's east bay in a very narrow range of water from 2.5-3m deep. Uncommon with only a few small beds seen.
Common Associates: (*Chara* sp.) Muskgrass, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Ceratophyllum demersum*) Coontail, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: George Lake; N46.37360°, W91.54042°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-272
Habitat/Distribution: Found in mucky bottom conditions in shallow water 1-2 meters deep. A very few plants were located in the southwest bay of the south basin.
Common Associates: (*Myriophyllum sibiricum*) Northern water milfoil, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton foliosus*) **Leafy pondweed**
Specimen Location: George Lake; N46.37635°, W91.53659°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-273
Habitat/Distribution: Sand and sandy muck in $<$1m. Rare; found at only two points in the east bay of the south basin and not seen anywhere interpoint. The strongly keeled fruit of the plants was distinctive.
Common Associates: (*Najas flexilis*) Slender naiad, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton gramineus*) **Variable pondweed**
Specimen Location: George Lake; N46.37765°, W91.53975°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-274
Habitat/Distribution: Most common in sandy/muck bottom conditions in water from 0.5-3 meters deep. Leaves had 5-9 veins, and were only weakly awned. Stem growth was rangy and branching, and the numerous stipules were small and weakly keeled. It's possible these are all hybrids as well, but we felt confident separating them based on these morphological characters while on the water, and both forms were distinct even when found in the same area/habitat.
Common Associates: (*Chara* sp.) Muskgrass, (*Najas flexilis*) Slender naiad, (*Schoenoplectus acutus*) Hardstem bulrush, (*Eleocharis acicularis*) Needle spikerush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton X spathuliformis*) **Illinois X Variable pondweed hybrid**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-275
Habitat/Distribution: Muck and sand bottom in <1m of water. Plants were common in the north bay, but only scattered in the south basin. Many grew right up to the shore line. Submersed leaves were strongly awned, had 7-13 veins (intermediate between the two species), exhibited generally linear growth, and had keeled stipules more similar in morphologically to normal *P. illinoensis*.
Common Associates: (*Nymphaea odorata*) White water lily, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: George Lake; N46.37765°, W91.54014°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-276
Habitat/Distribution: Found in muck and sandy muck in 1-5 meters of water. Plants were scattered around the south basin as well as occurring on the east side of the entrance to the north bay.
Common Associates: (*Potamogeton robbinsii*) Fern pondweed, (*Nitella* sp.) Nitella, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Ceratophyllum demersum*) Coontail, (*Elodea nuttallii*) Slender waterweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton robbinsii*) **Fern pondweed**
Specimen Location: George Lake; N46.37791°, W91.54054°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-277
Habitat/Distribution: Found in organic muck bottom areas. Most plants were in the east bay in a very narrow range of water from 2.5-3m deep. Relatively common with scattered plants located throughout.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton pusillus*) Small pondweed, (*Chara* sp.) Muskgrass, (*Ceratophyllum demersum*) Coontail, (*Elodea nuttallii*) Slender waterweed

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Potamogeton spirillus*) **Spiral-fruited pondweed**
Specimen Location: George Lake; N46.37520°, W91.54124°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2011-278
Habitat/Distribution: Found in sand and sandy muck bottoms in 0-1.5 meters of water. Locally common in sandy stretches on the western shoreline of the south basin; more widely scattered on the east.
Common Associates: (*Potamogeton foliosus*) Leafy pondweed, (*Eleocharis palustris*) Creeping spikerush, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: George Lake; N46.37635°, W91.53659°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-279
Habitat/Distribution: Uncommon in scattered mucky shoreline locations. Almost all plants were found in the far east corner of the east bay in the south basin.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Eleocharis ovata*) Oval spikerush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Schoenoplectus acutus*) **Hardstem bulrush**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-280
Habitat/Distribution: *S. acutus* was much less common than *S. tabernaemontani*, but both were found throughout the lake. Small clusters occurred over firm sand from the lakeshore into shallow water <0.5m deep.
Common Associates: (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Eleocharis palustris*) Creeping spikerush, (*Najas flexilis*) Slender naiad

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-281
Habitat/Distribution: Firm muck bottoms in 0-1 meter of water. A ring of dense bulrushes, sedges, and rushes circled the north bay in shallow water. Plants were also scattered throughout the south basin.
Common Associates: (*Nymphaea odorata*) White water lily, (*Eleocharis palustris*) Creeping spikerush, (*Najas flexilis*) Slender naiad, (*Potamogeton X spathuliformis*) Illinois X Variable pondweed hybrid, (*Juncus effusus*) Common rush

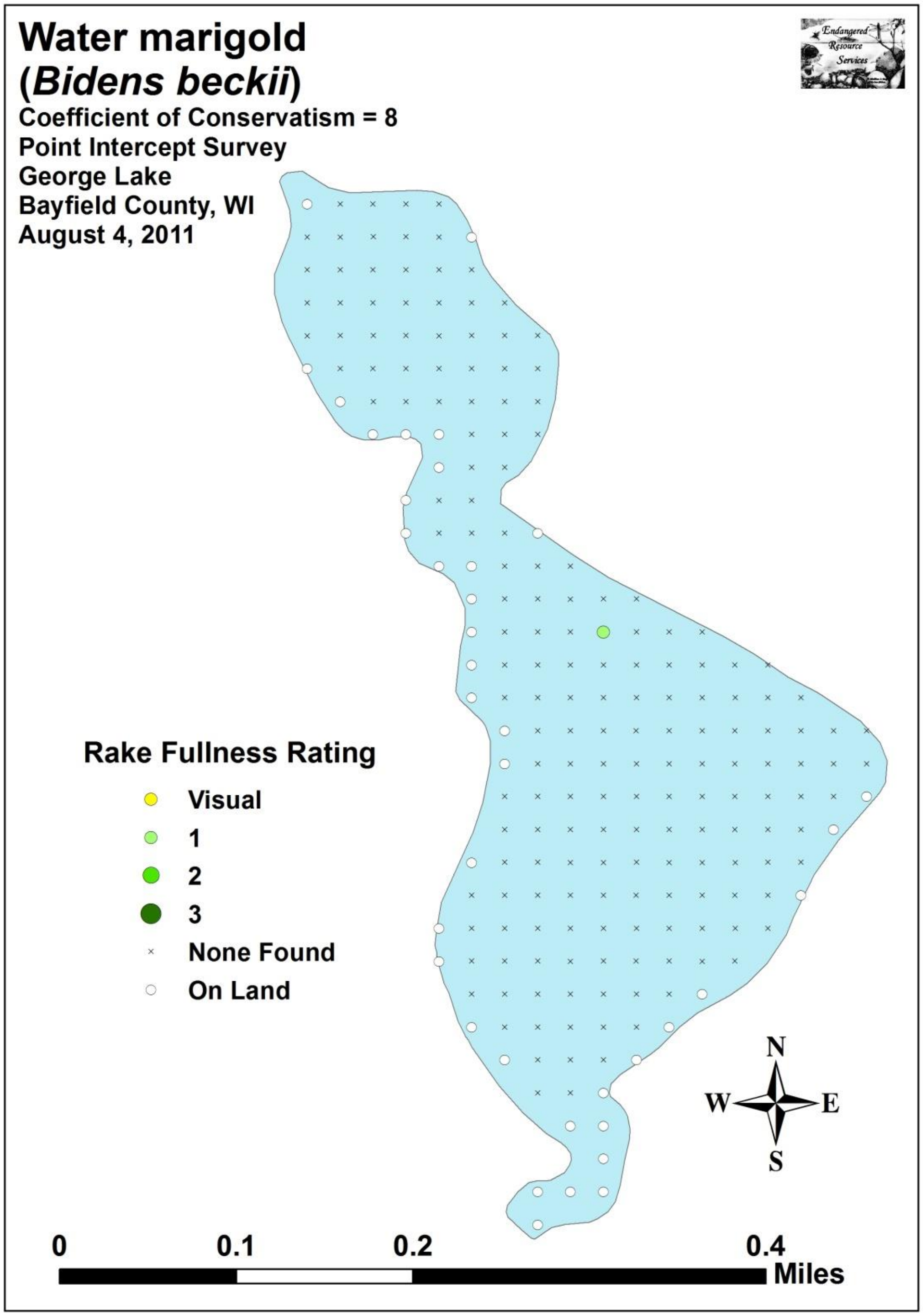
County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Scirpus cyperinus*) **Woolgrass**
Specimen Location: George Lake; N46.37634°, W91.53659°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-282
Habitat/Distribution: Firm muck/sandy muck at the shoreline. Plants were found at widely scattered locations along the southeast shoreline in the south basin.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Sparganium angustifolium*) **Narrow-leaved bur-reed**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-283
Habitat/Distribution: Many scattered small beds occurred over organic muck in the north bay in <1m of water. A very few additional small beds were located in the south basin.
Common Associates: (*Nymphaea odorata*) White water lily, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Potamogeton X spathuliformis*) Illinois X Variable pondweed hybrid

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Typha angustifolia*) **Narrow-leaved cattail**
Specimen Location: George Lake; N46.37651°, W91.53657°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-284
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Restricted to locations in the east bay of the south basin.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass, (*Eleocharis palustris*) Creeping spikerush, (*Juncus effusus*) Common rush

County/State: Bayfield County, Wisconsin **Date:** 8/4/11
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: George Lake; N46.37872°, W91.54095°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2011-285
Habitat/Distribution: Firm muck soil in and out of water <0.25 meters. Plants were scattered along the shoreline – mostly on the east side of the lake.
Common Associates: (*Typha angustifolia*) Narrow-leaved cattail, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass, (*Juncus effusus*) Common rush

Appendix VI: Native Plant Species Density and Distribution Maps


Water marigold
(*Bidens beckii*)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
On Land
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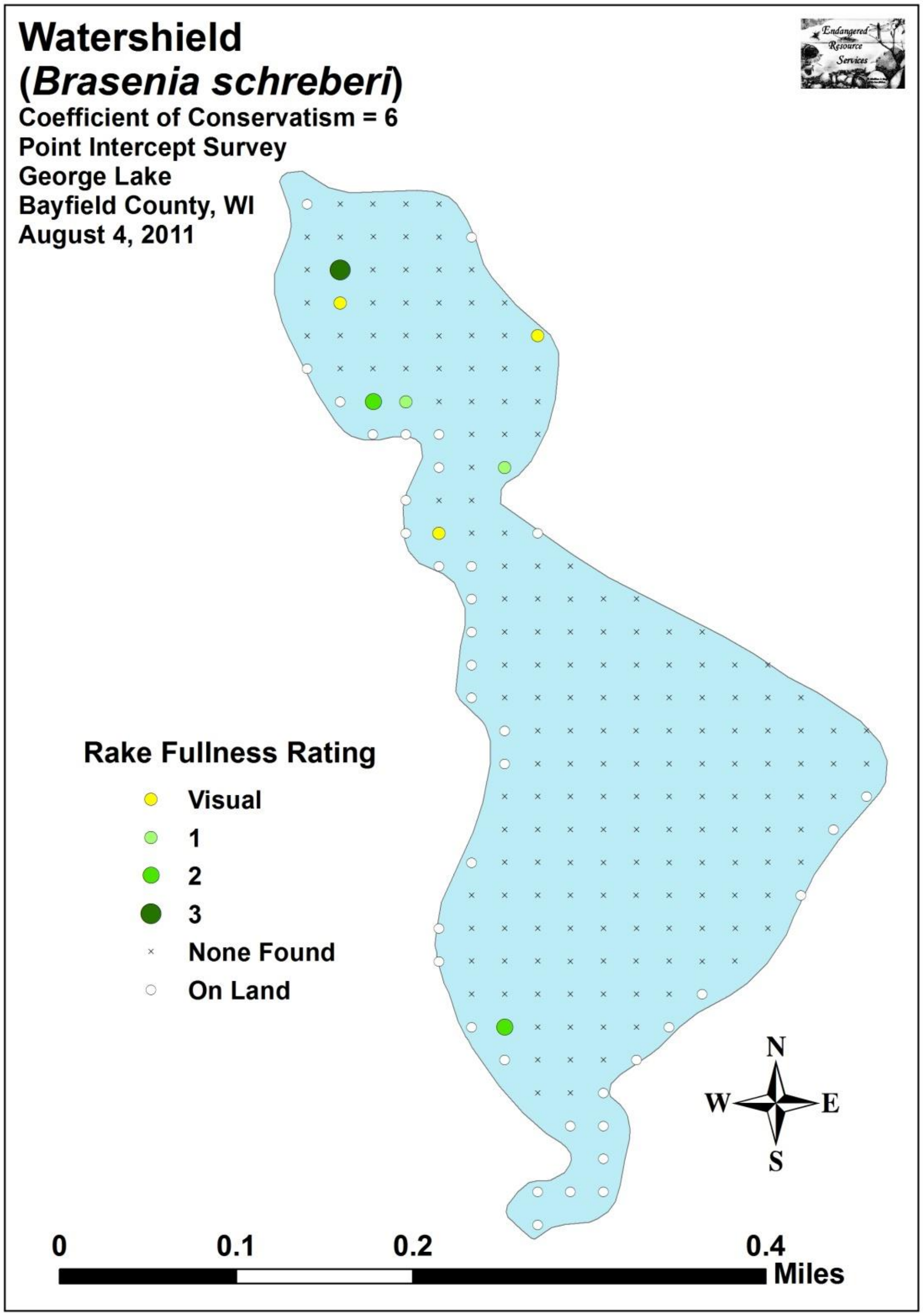
Miles


Watershield
(*Brasenia schreberi*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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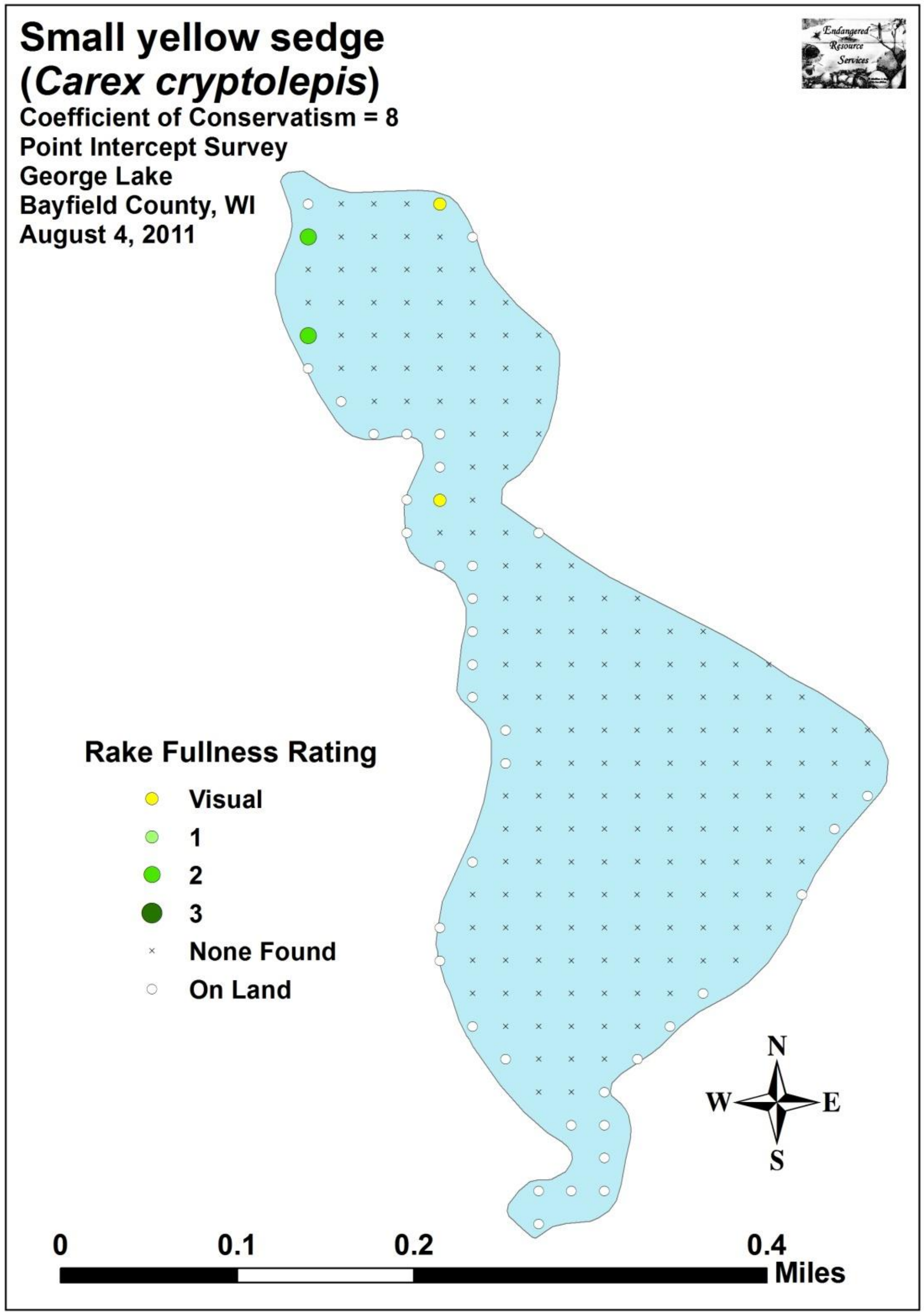
Miles


Small yellow sedge
(Carex cryptolepis)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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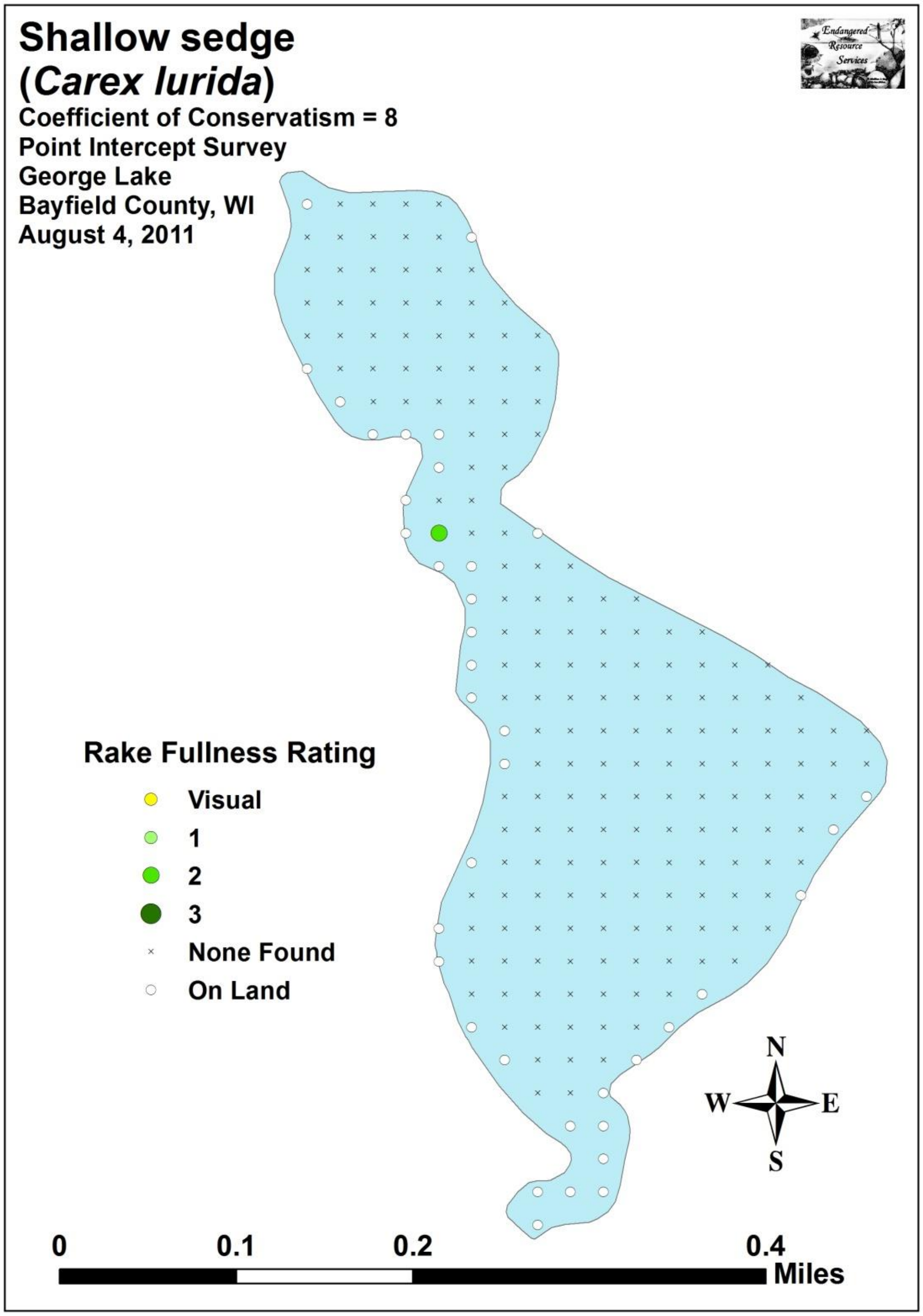
Shallow sedge
(*Carex lurida*)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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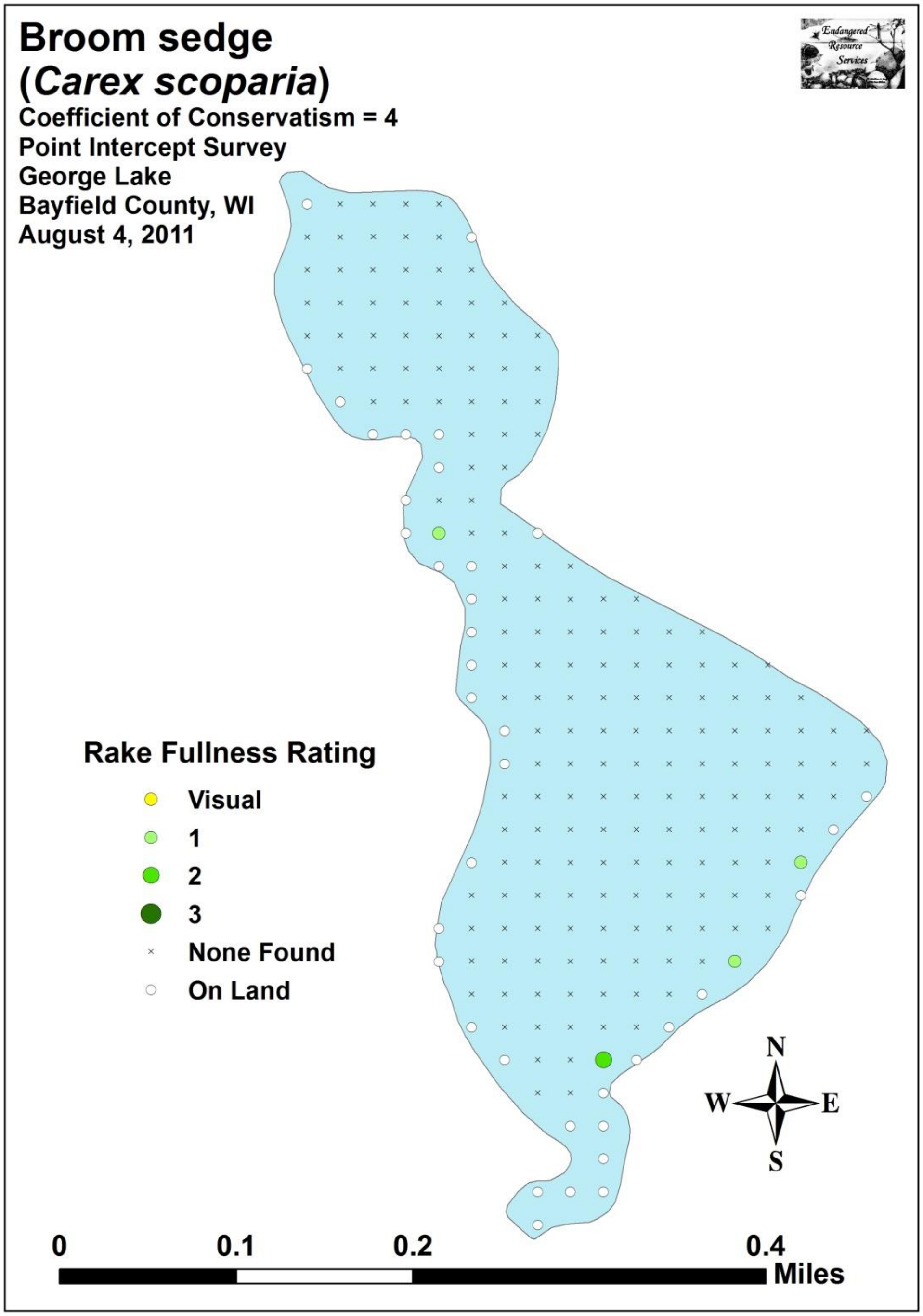
Miles


Broom sedge
(*Carex scoparia*)
Coefficient of Conservatism = 4
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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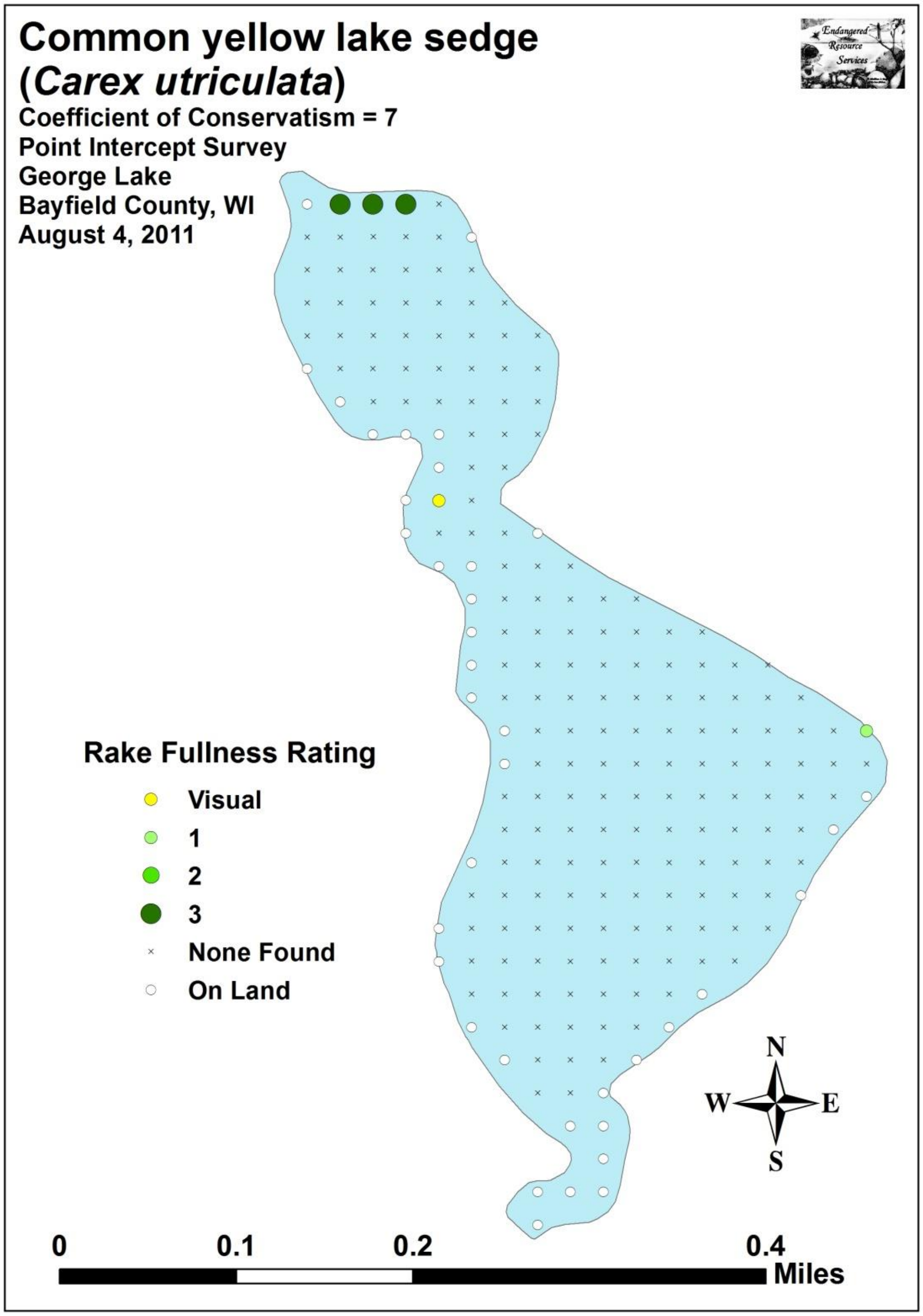
Miles


Common yellow lake sedge
(*Carex utriculata*)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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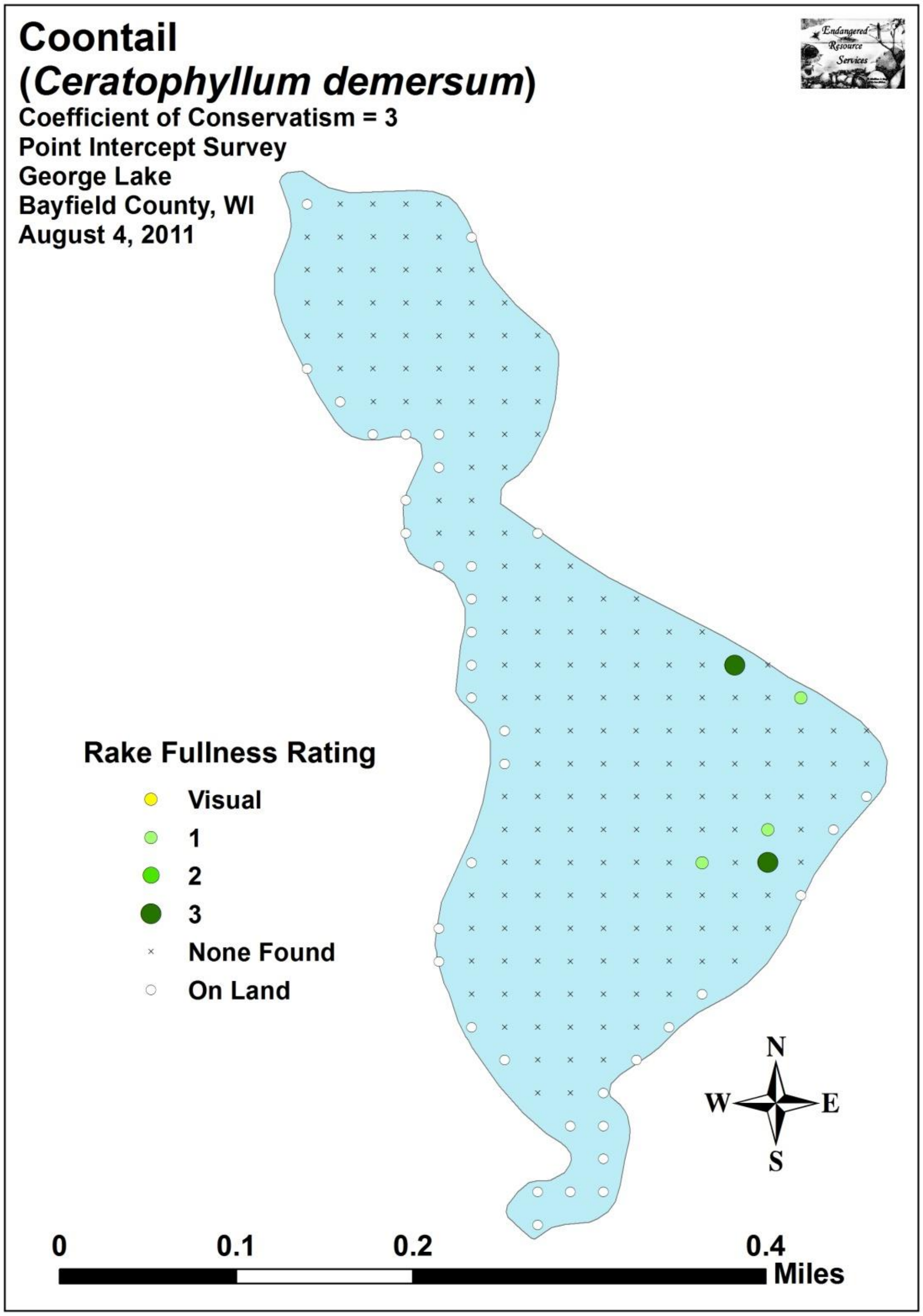
Miles



Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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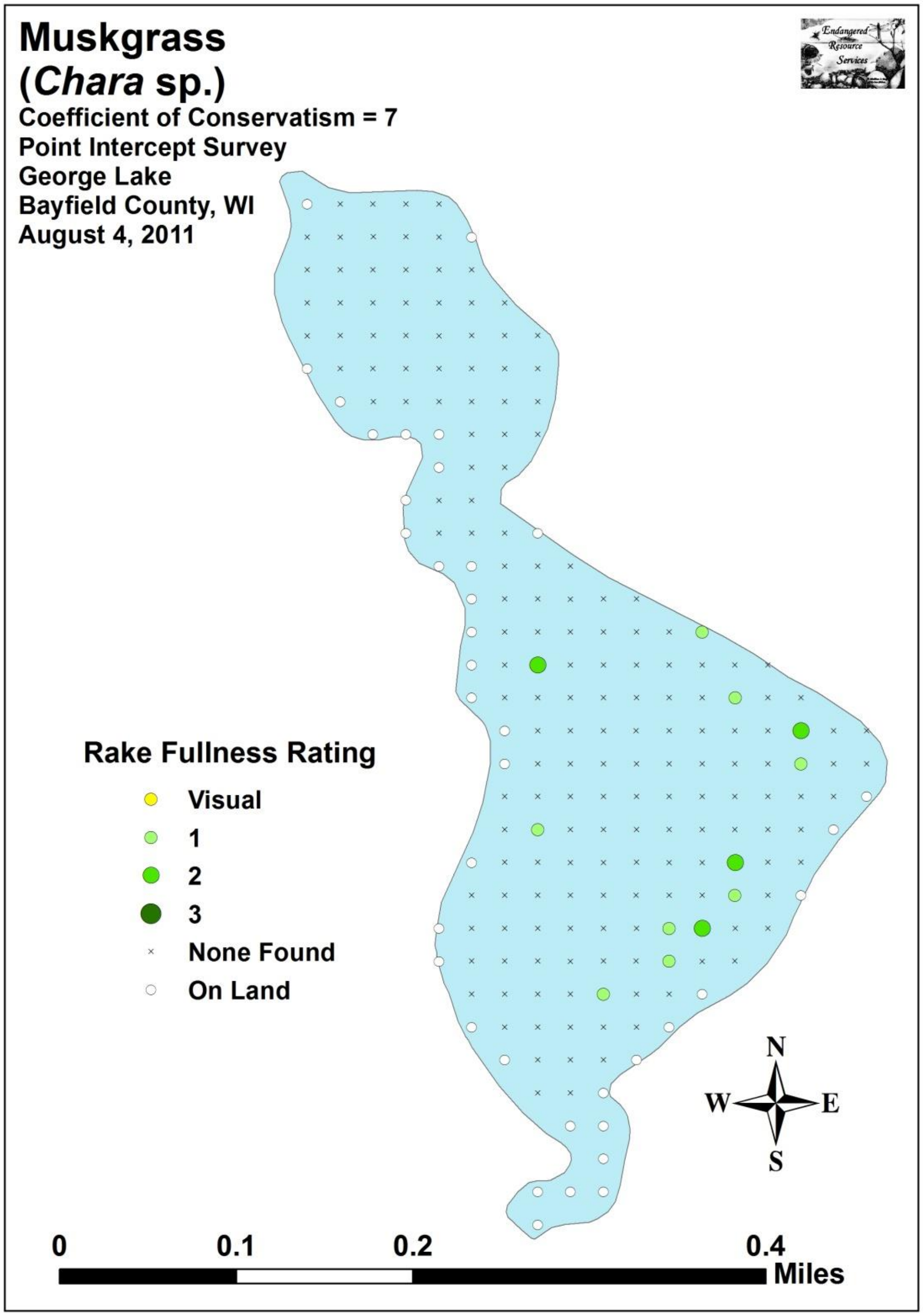
Miles


Muskgrass
(*Chara* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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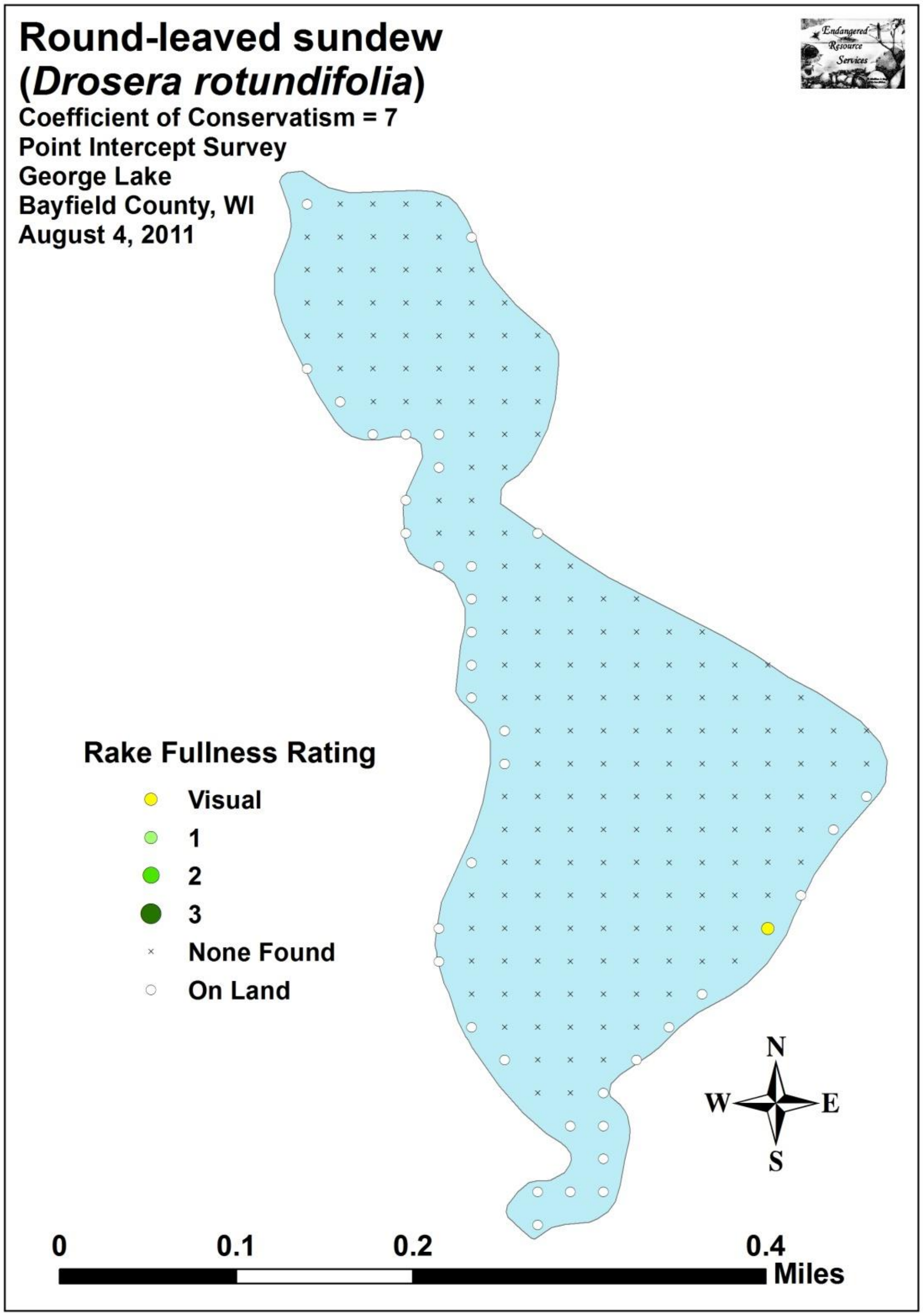
Miles


Round-leaved sundew
(Drosera rotundifolia)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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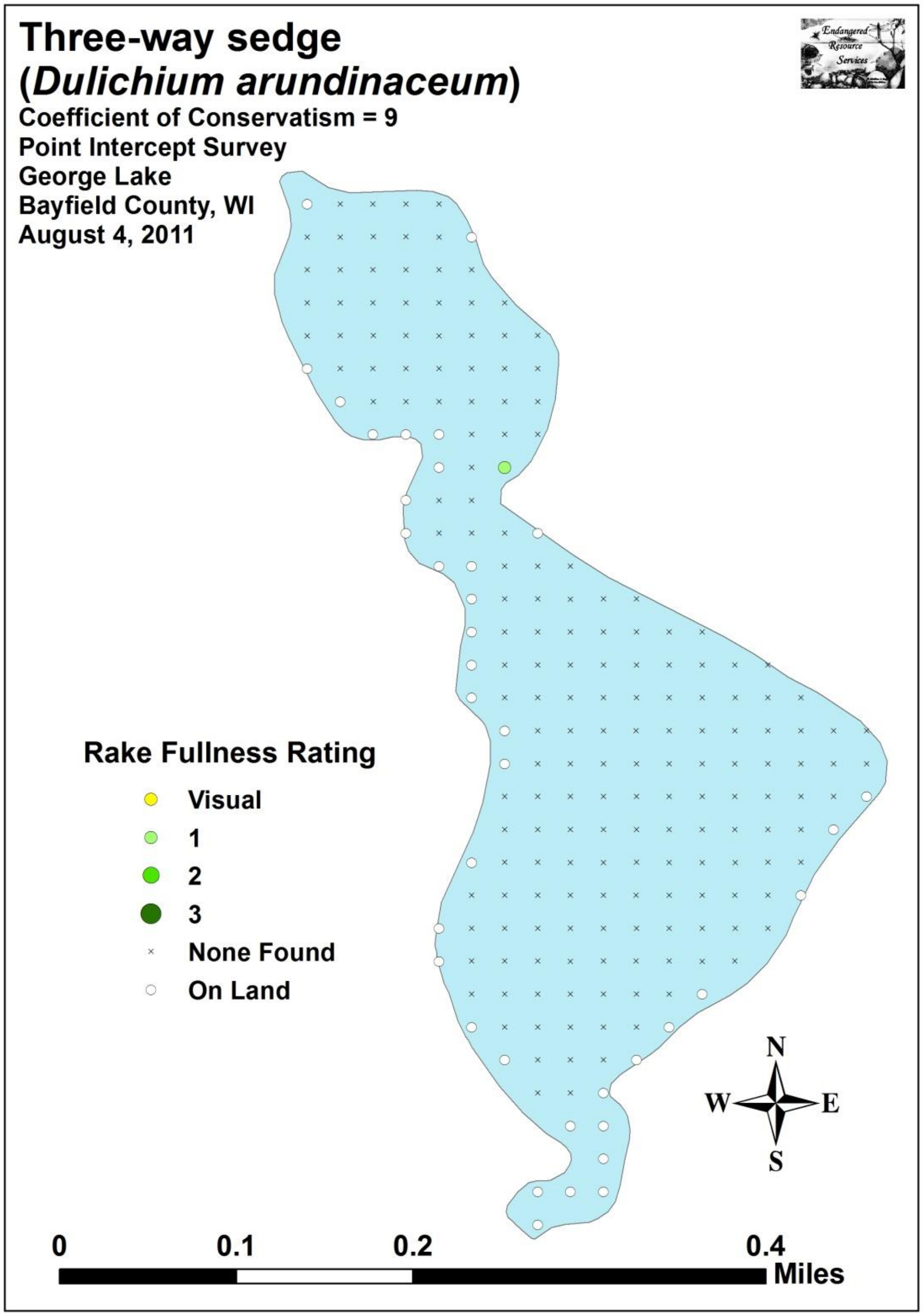
Miles


Three-way sedge
(*Dulichium arundinaceum*)
Coefficient of Conservatism = 9
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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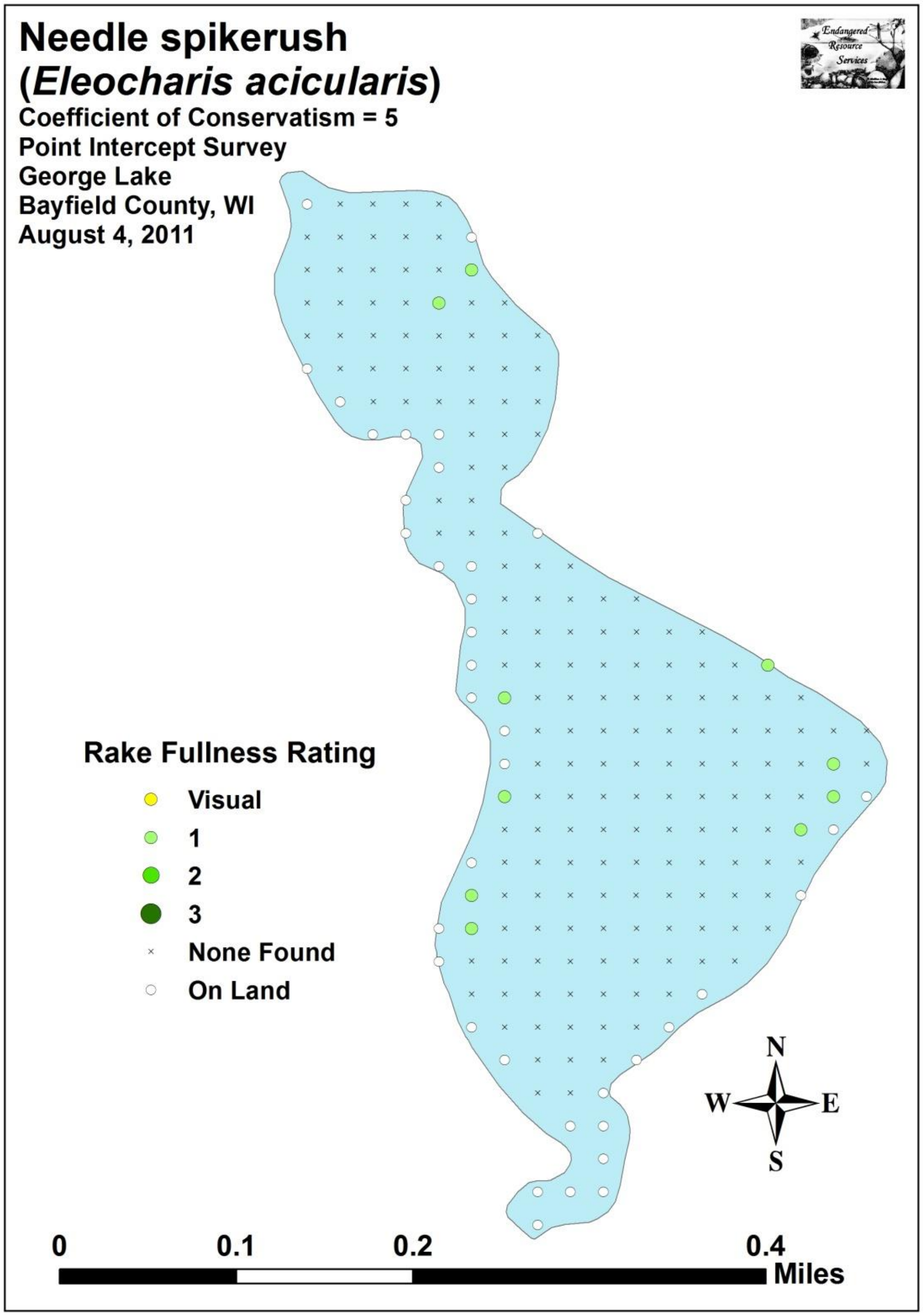
Miles


Needle spikerush
(*Eleocharis acicularis*)
Coefficient of Conservatism = 5
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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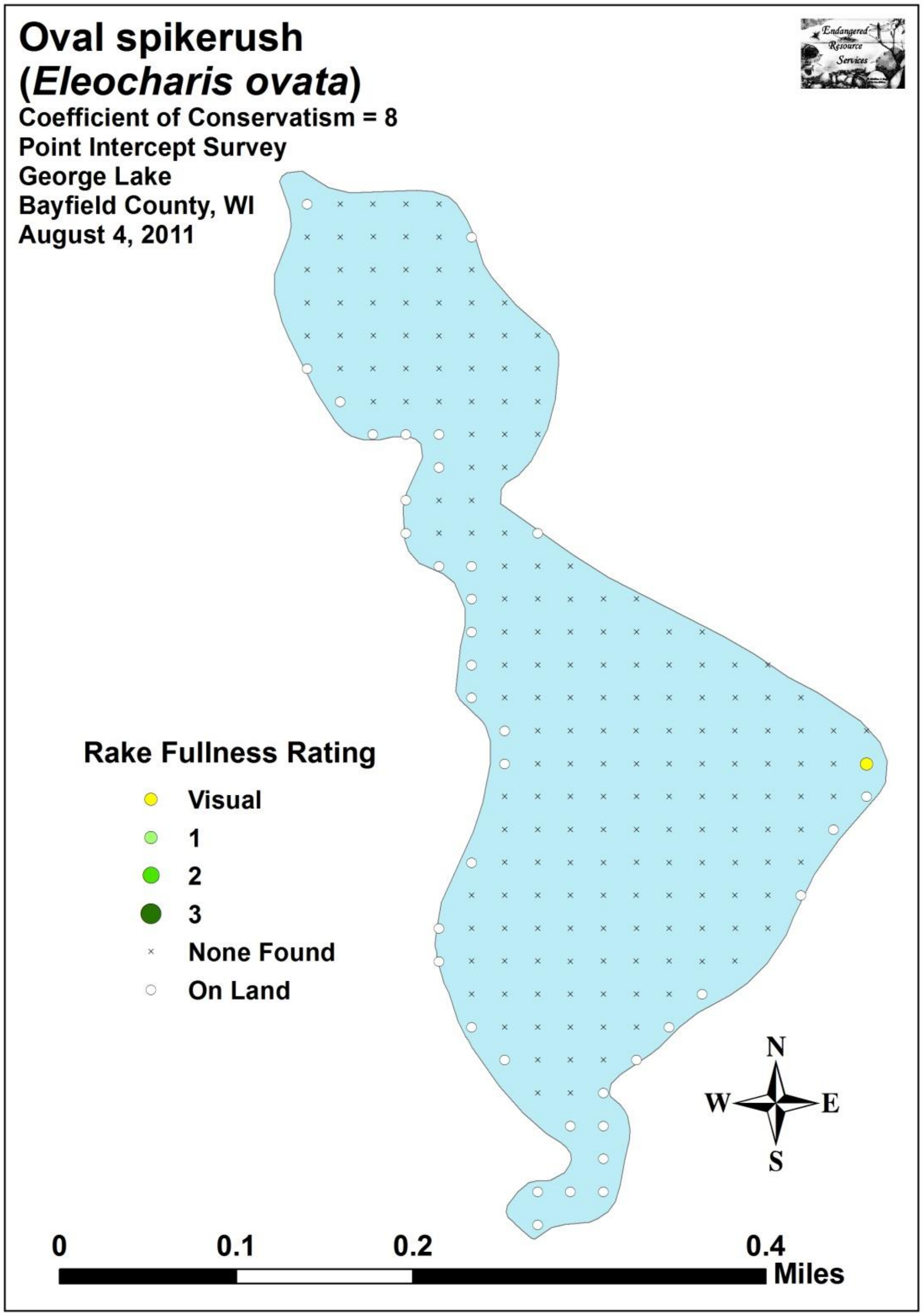
0.4
Miles


Oval spikerush
(*Eleocharis ovata*)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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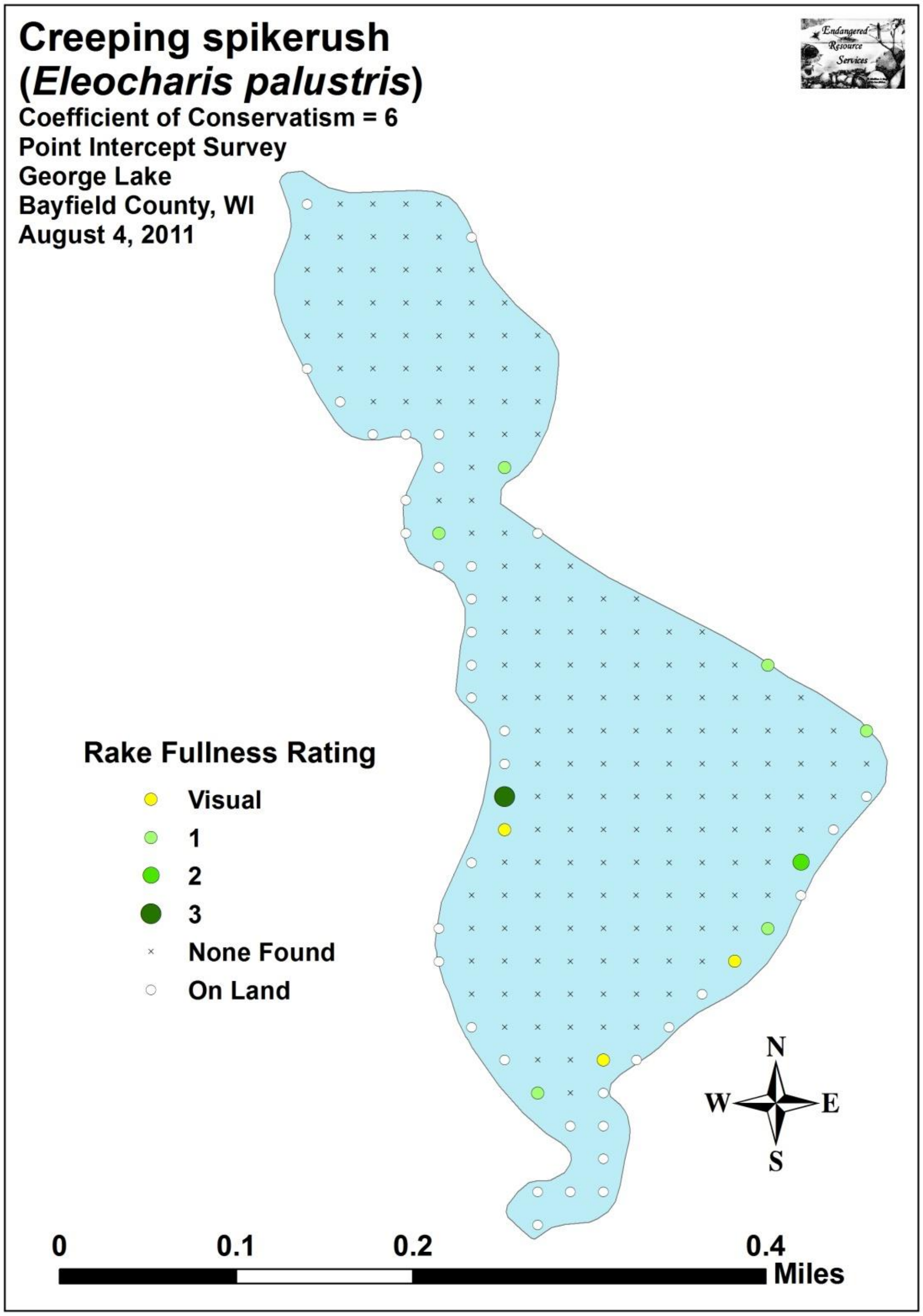
Miles


Creeping spikerush
(*Eleocharis palustris*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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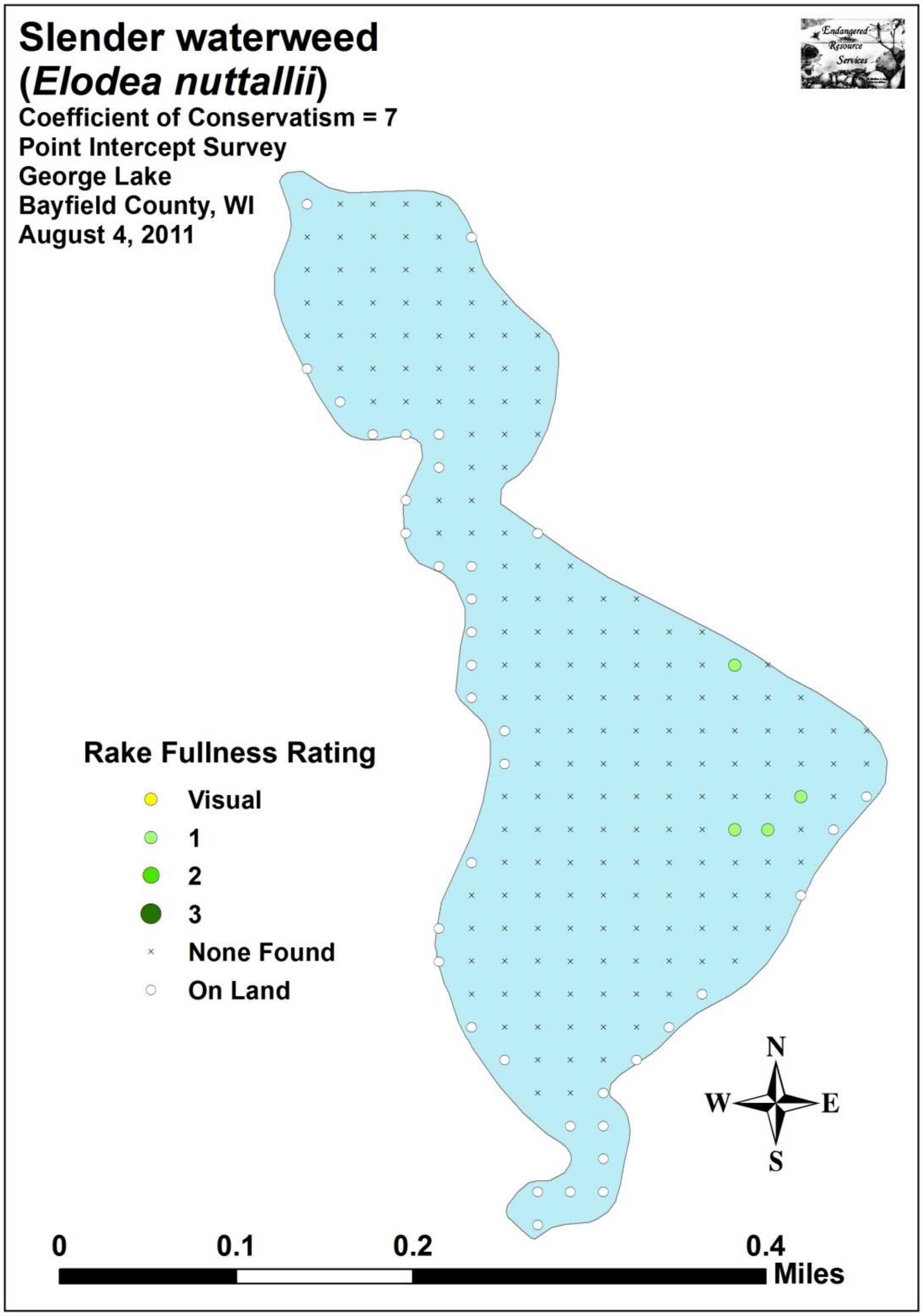
Miles


Slender waterweed
(Elodea nuttallii)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
On Land
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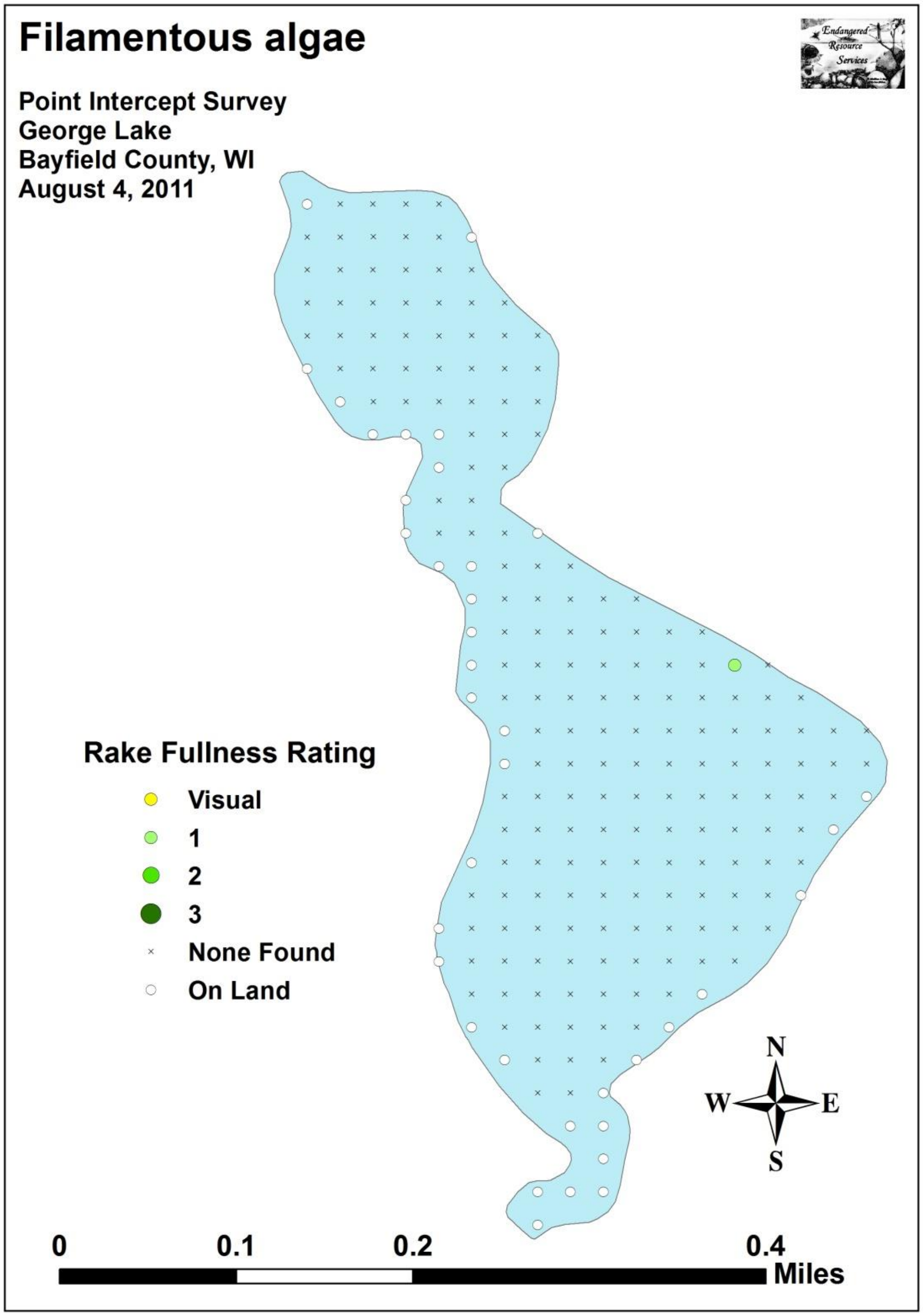
Miles



Filamentous algae
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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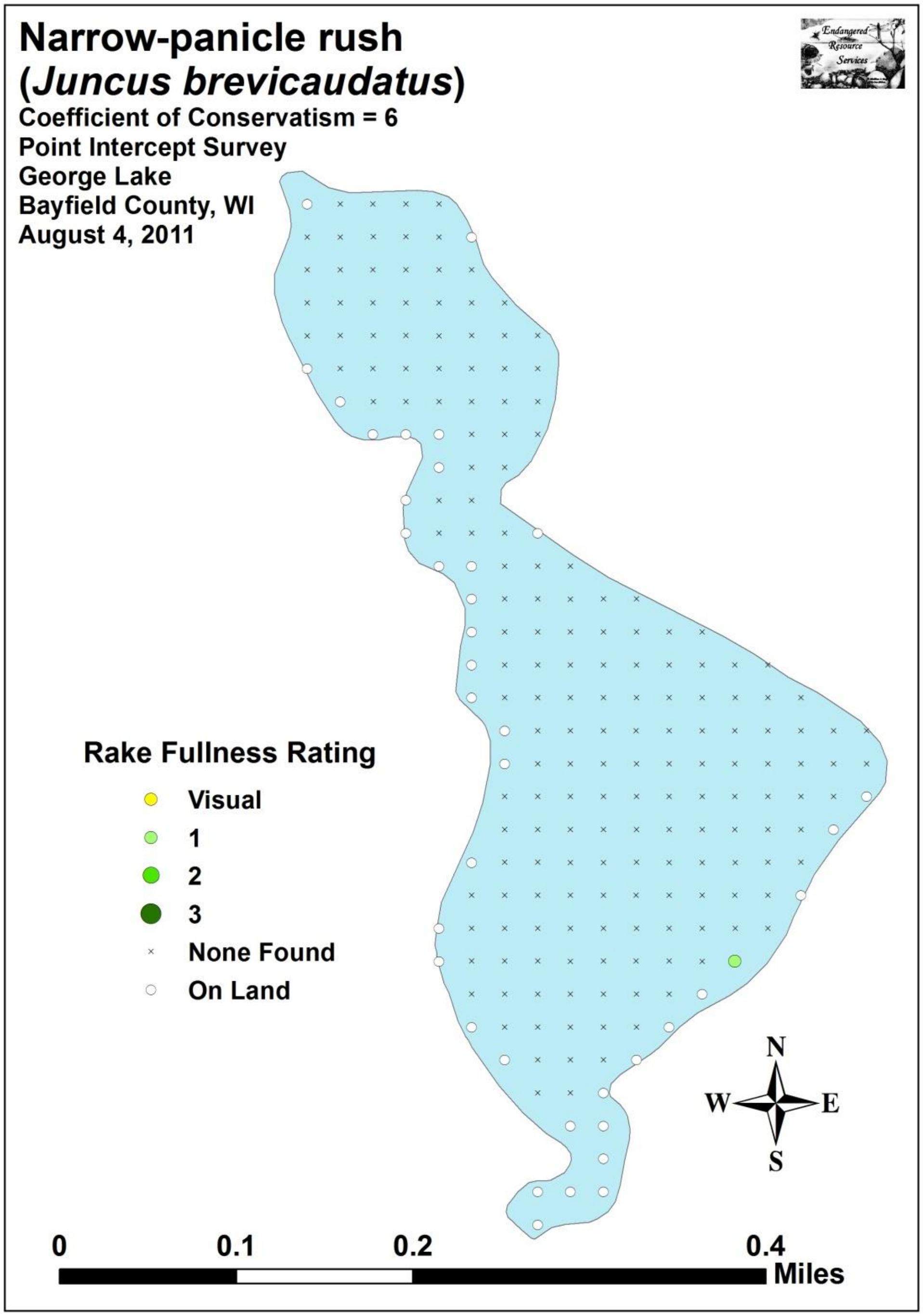
Miles



Narrow-panicle rush
(*Juncus brevicaudatus*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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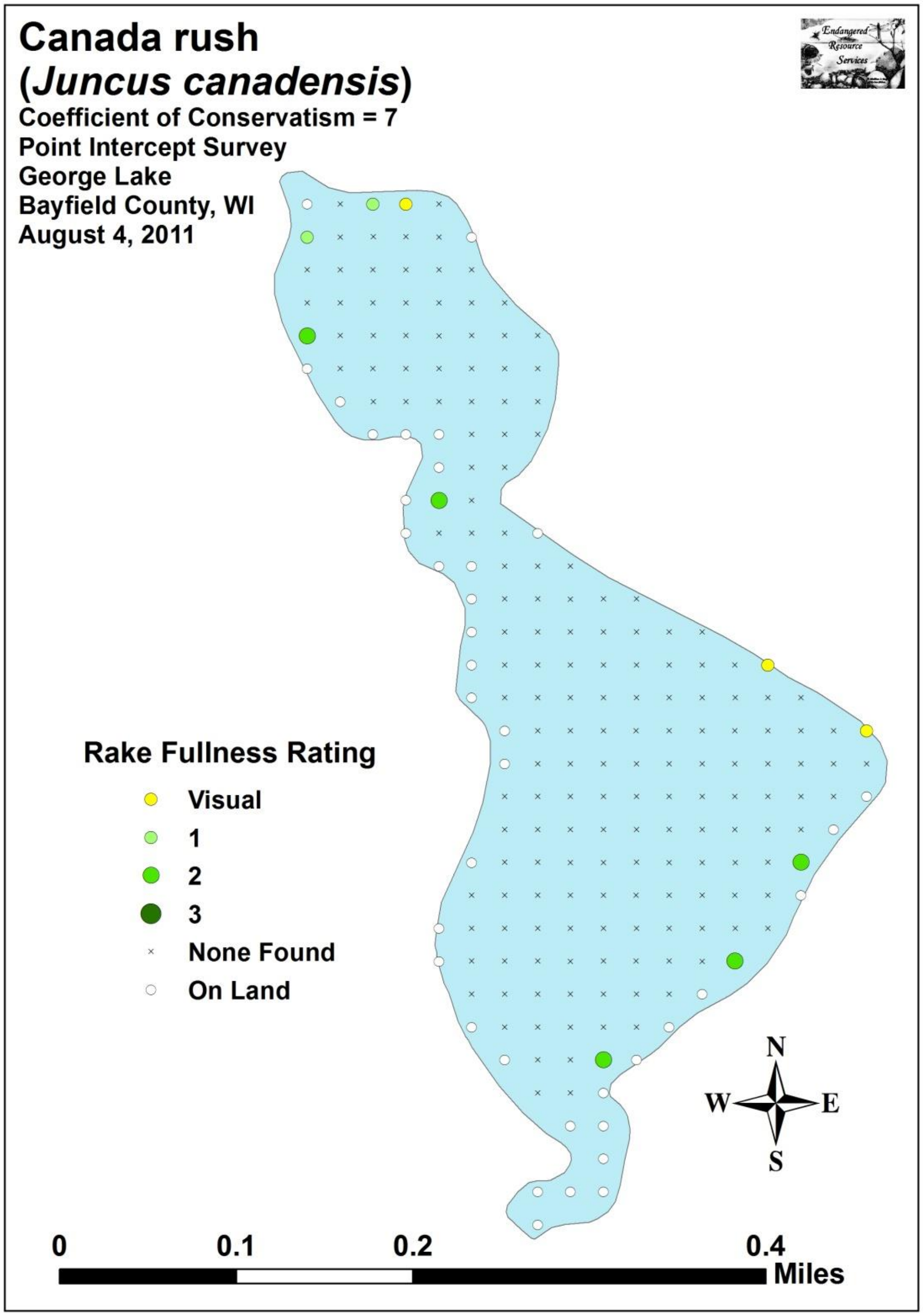
Miles


Canada rush
(*Juncus canadensis*)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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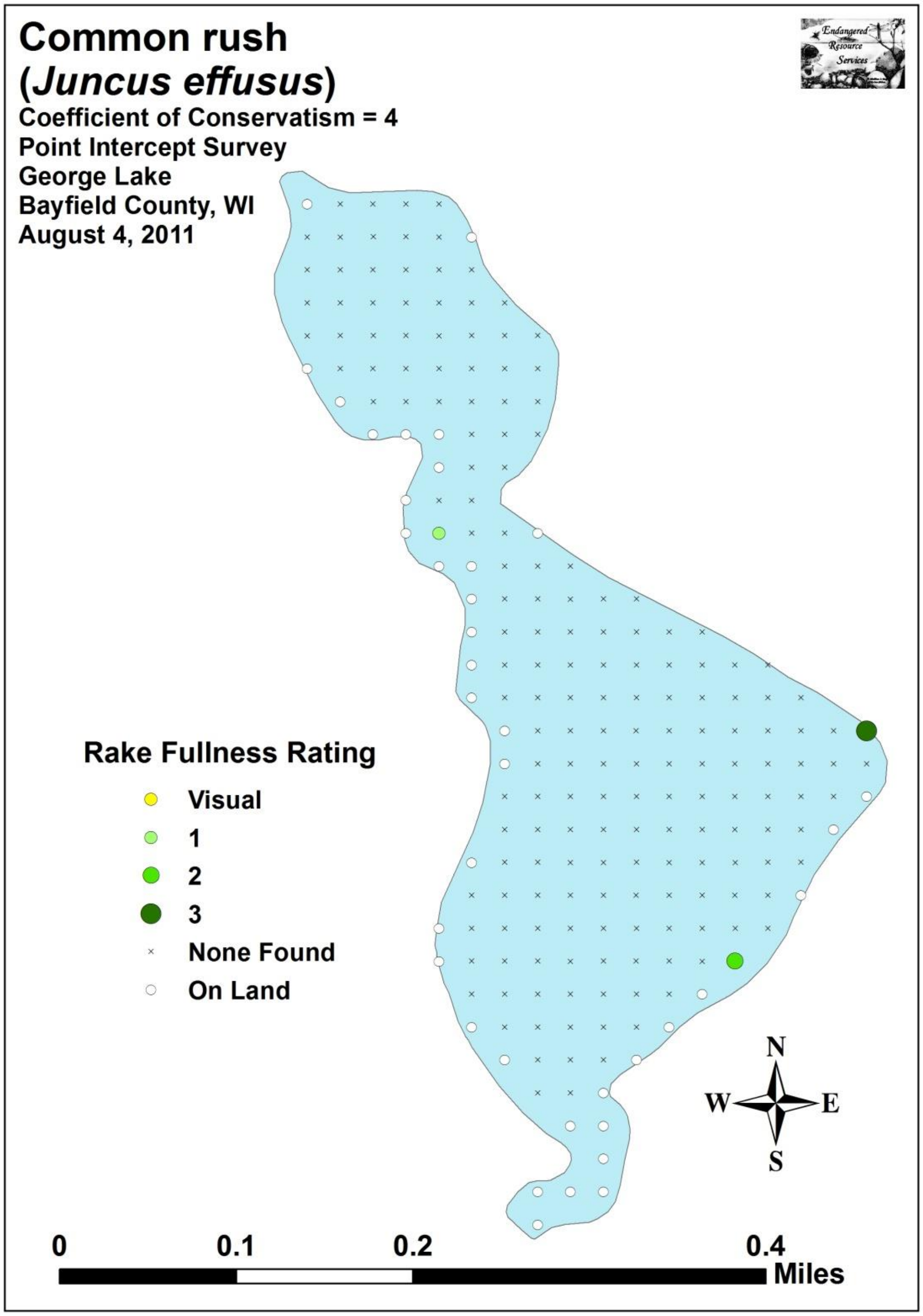
Miles


Common rush
(*Juncus effusus*)
Coefficient of Conservatism = 4
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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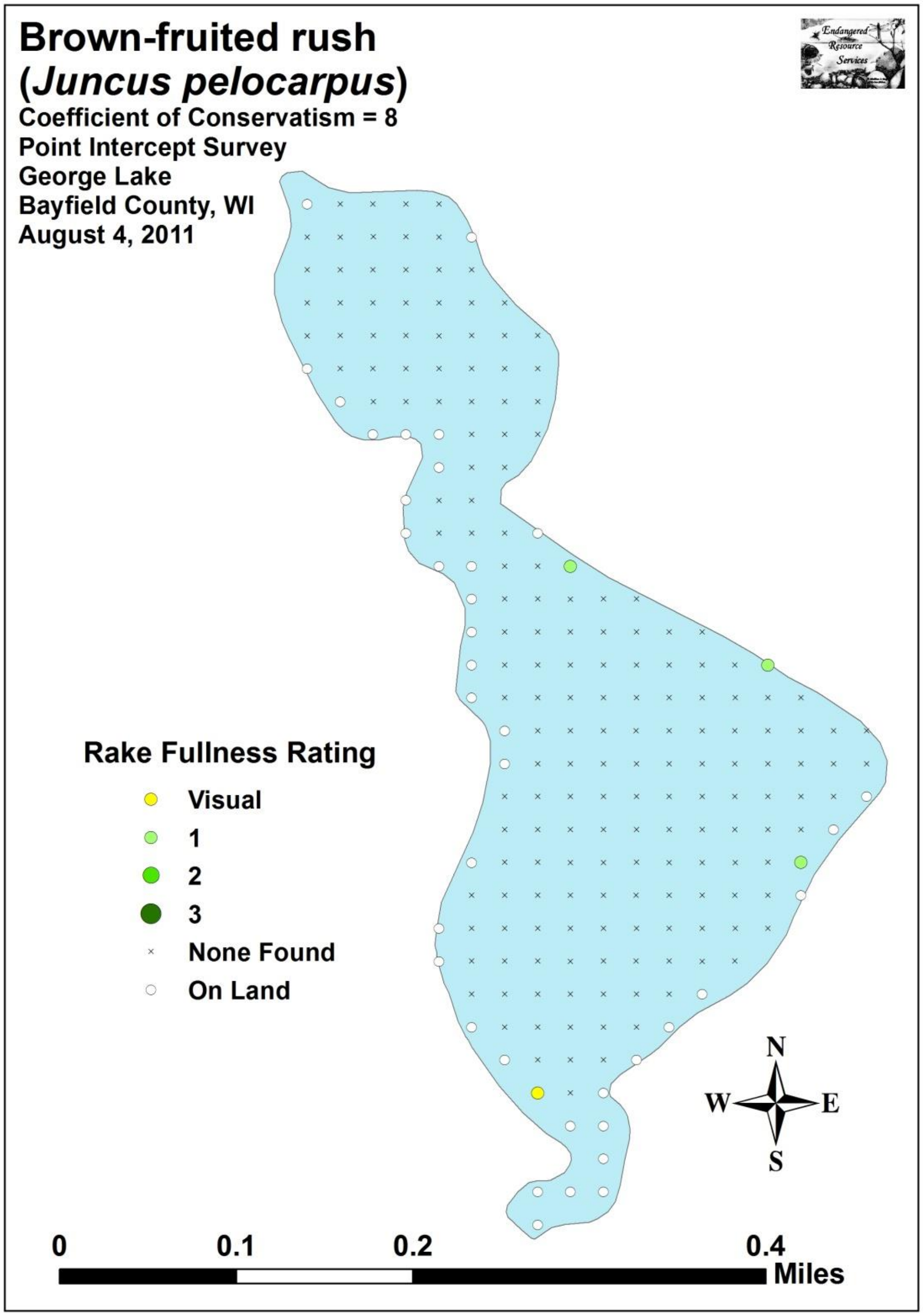
Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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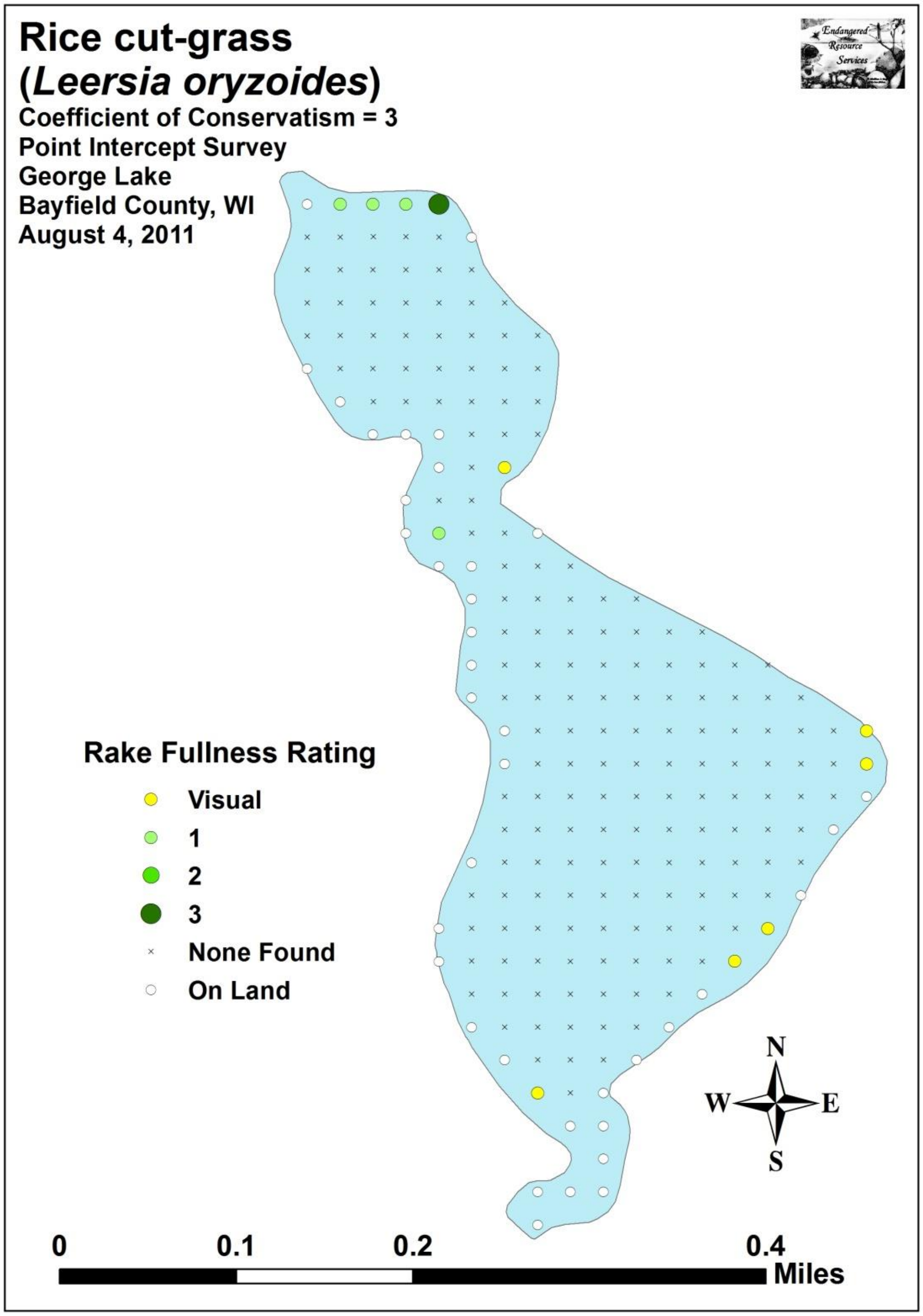
Rice cut-grass
(*Leersia oryzoides*)
Coefficient of Conservatism = 3
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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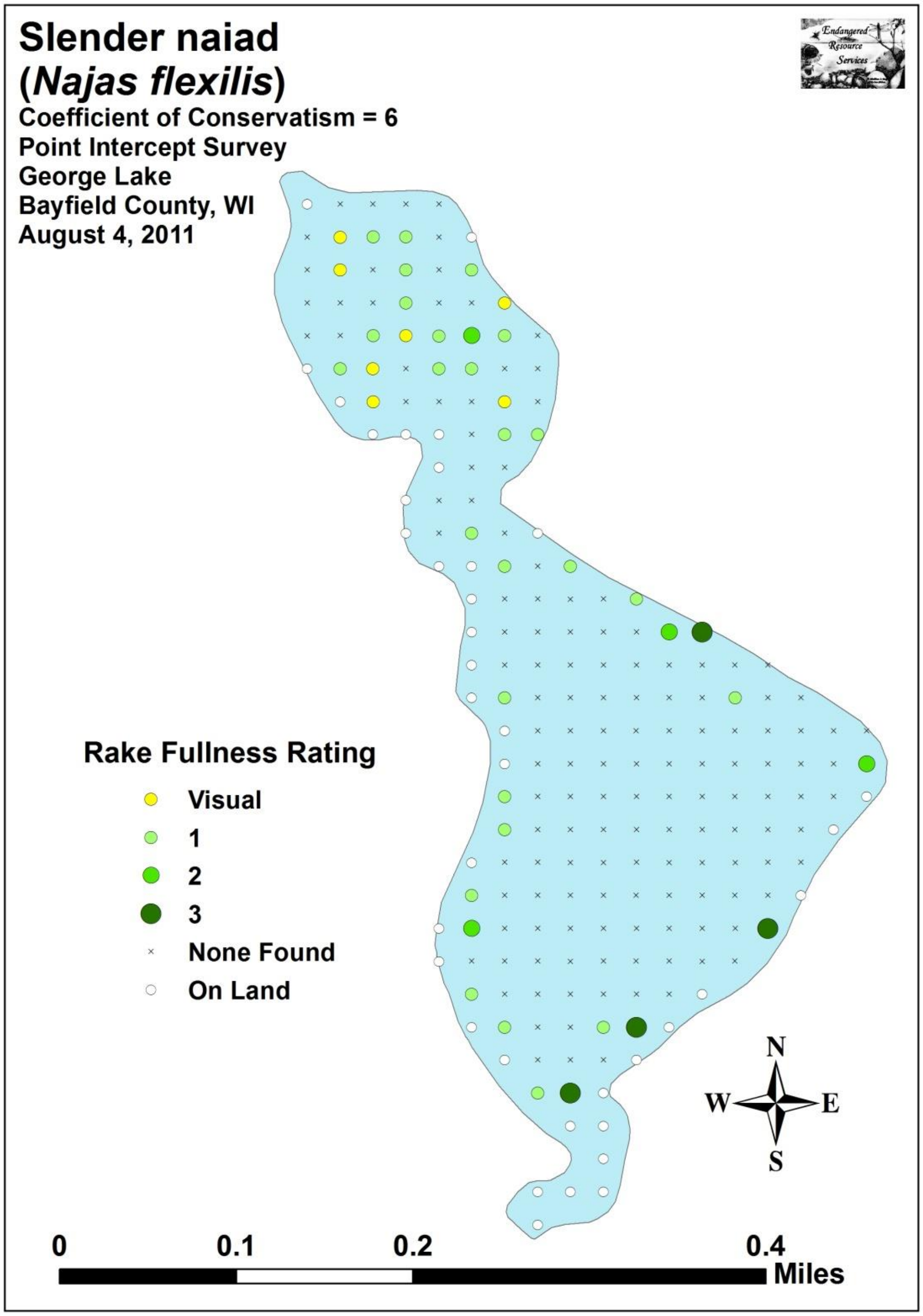
Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Rake Fullness Rating
Visual
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None Found
On Land
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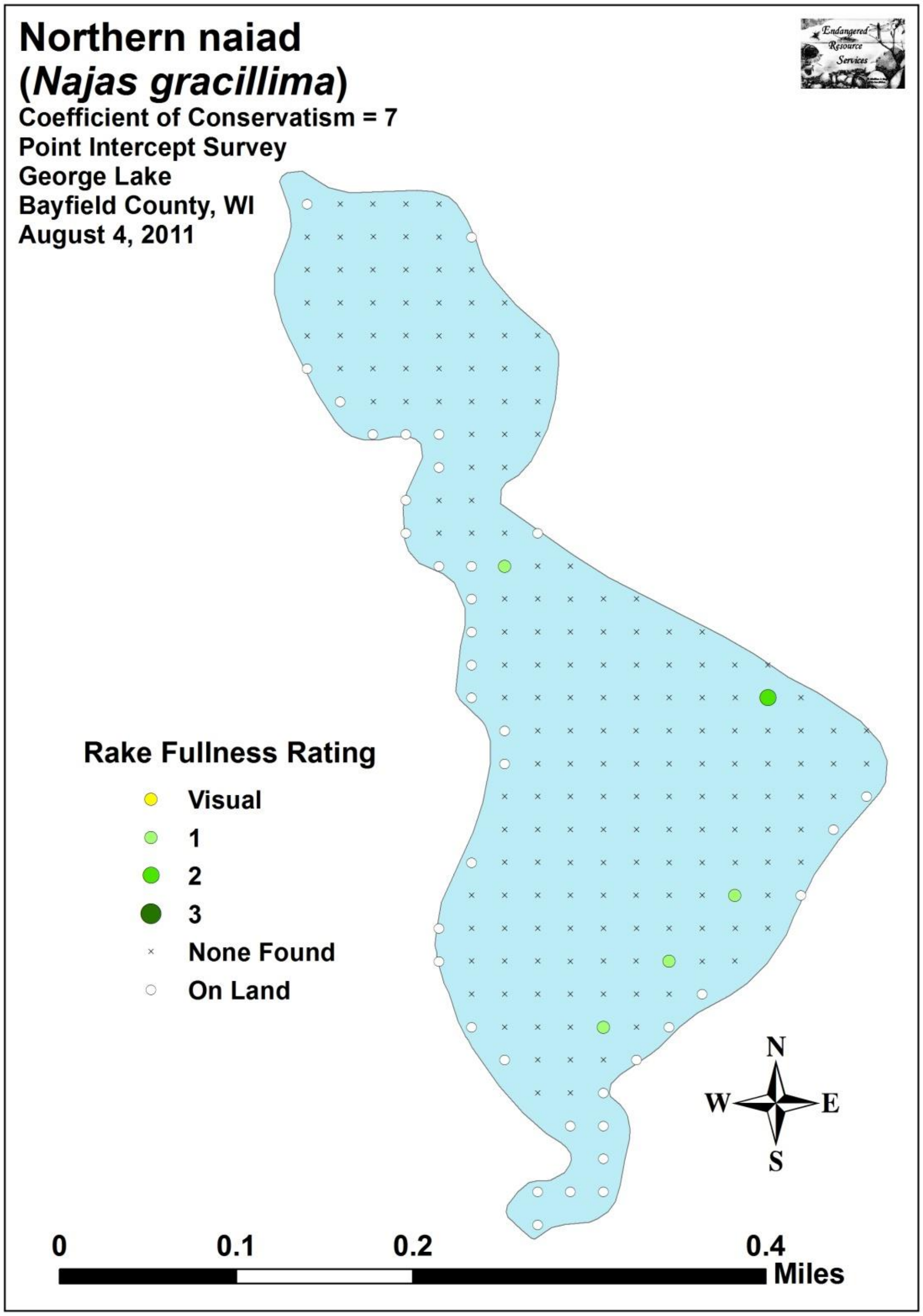
Miles


Northern naiad
(Najas gracillima)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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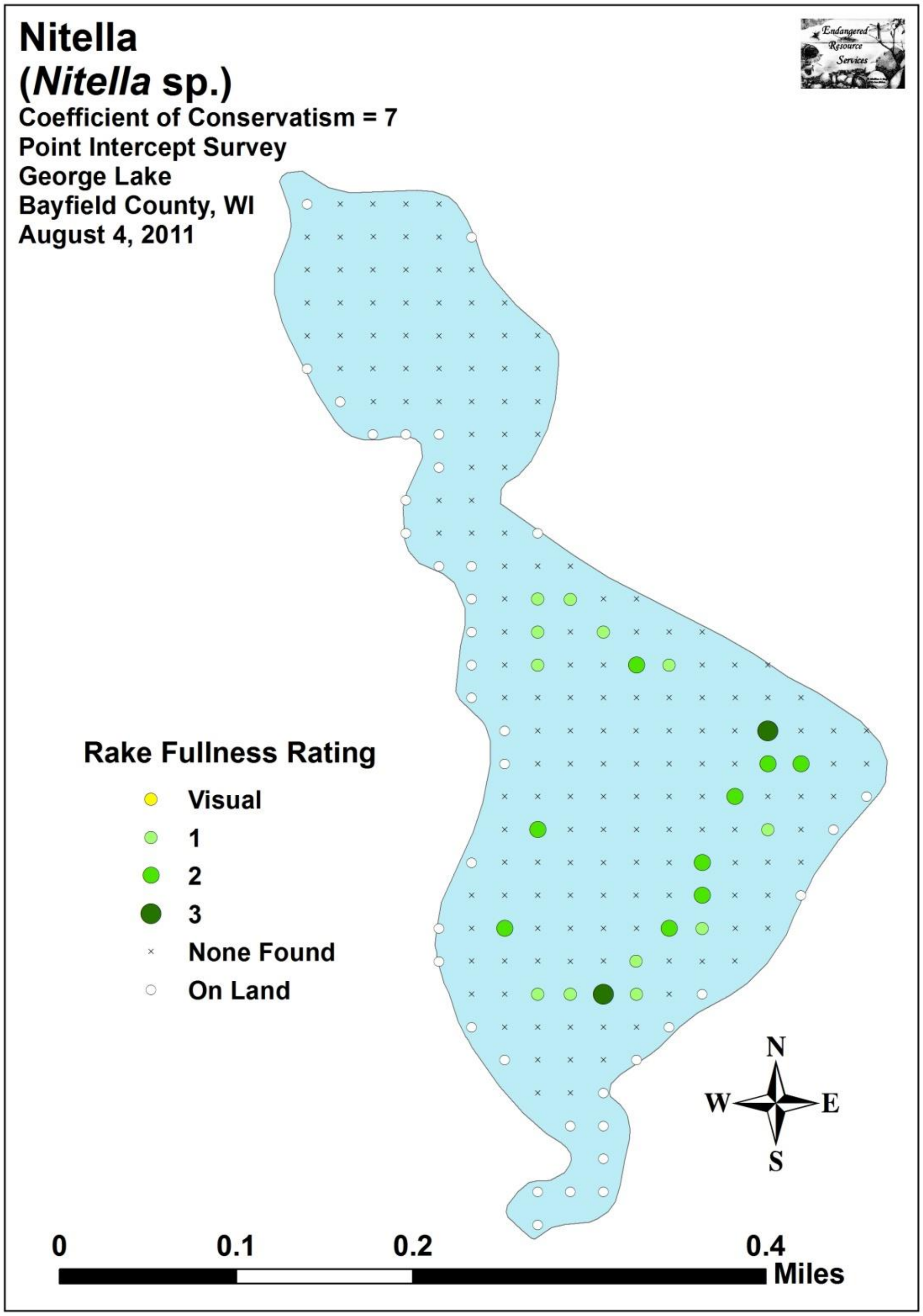
Miles


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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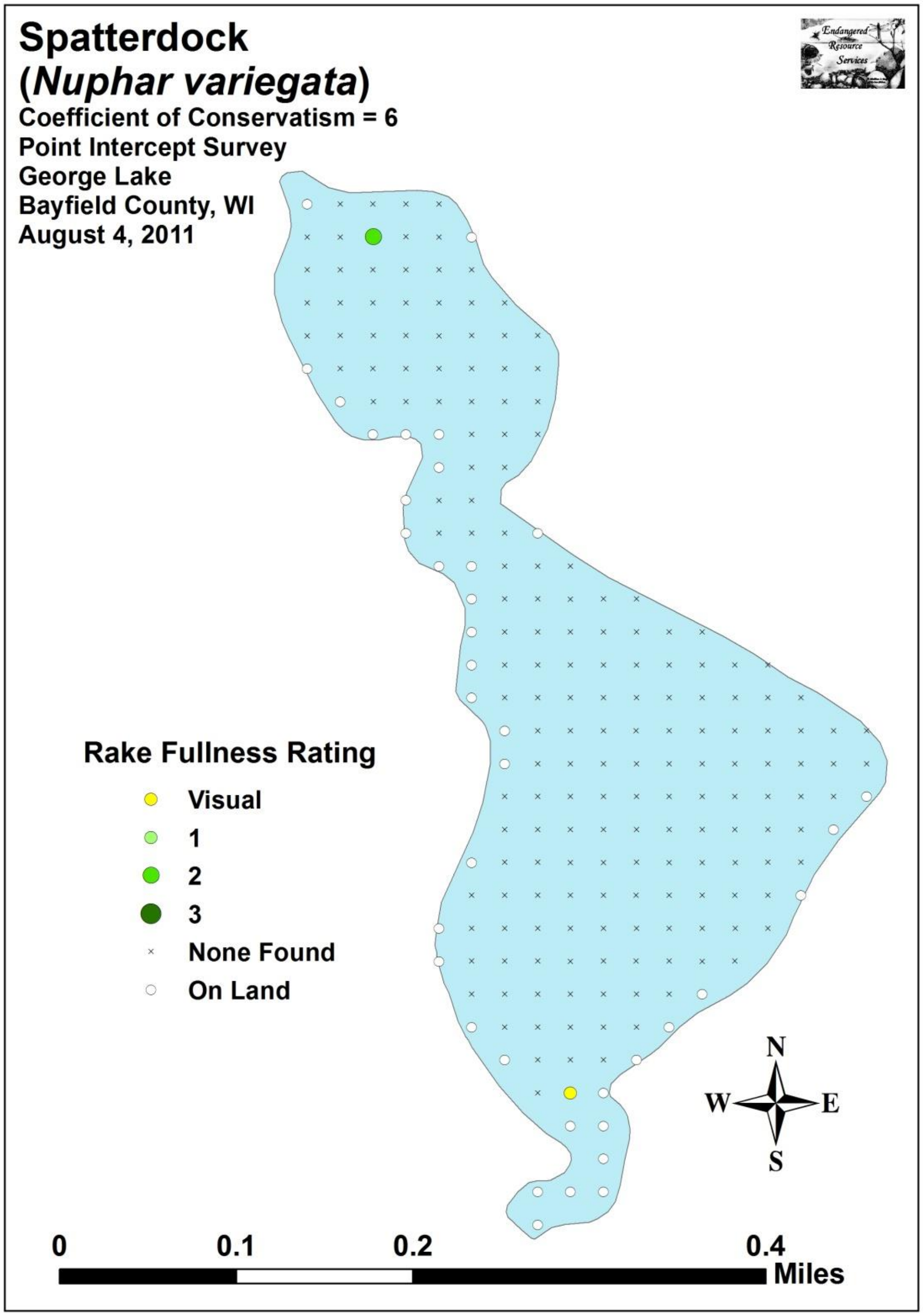
Miles



Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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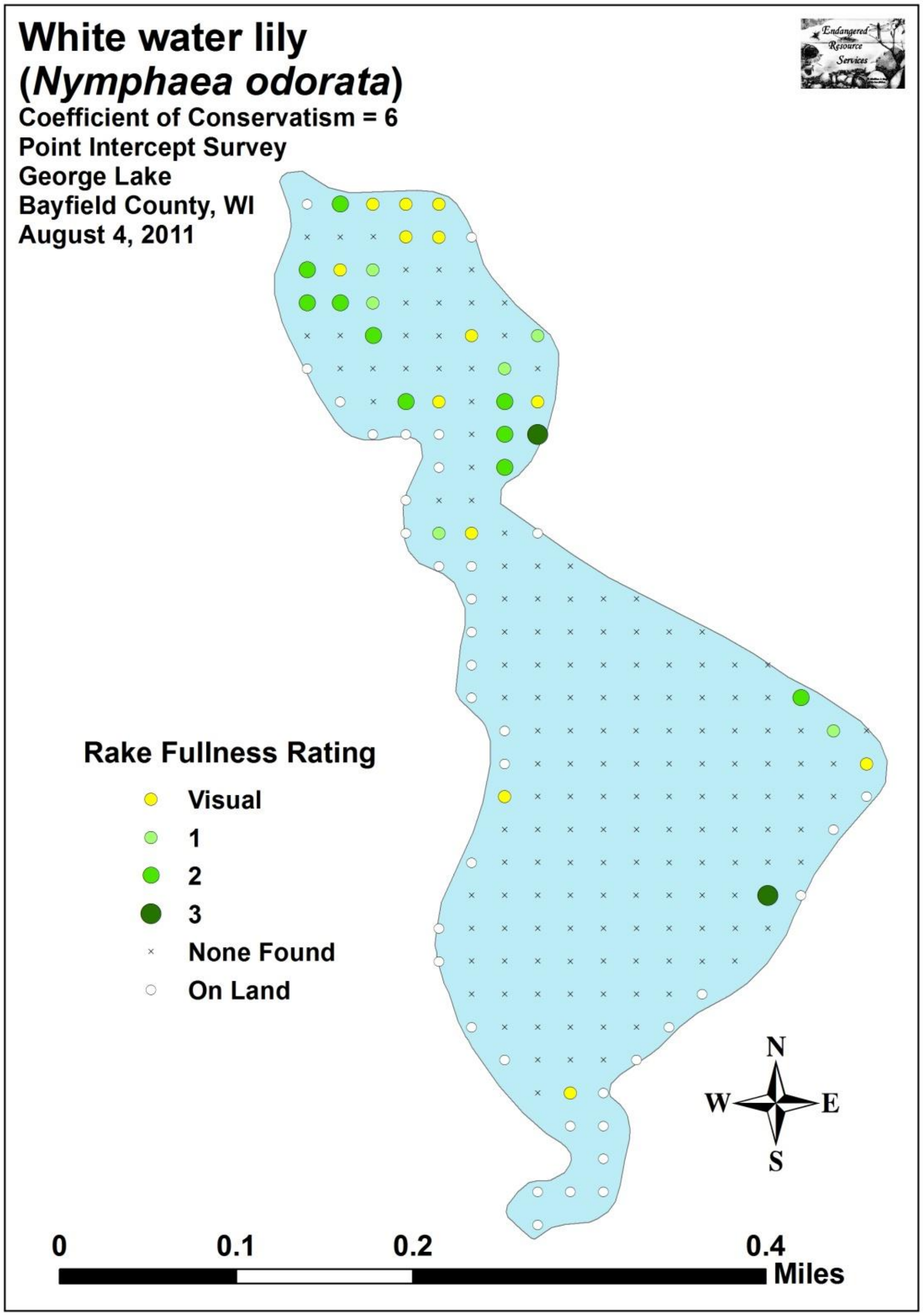
White water lily
(*Nymphaea odorata*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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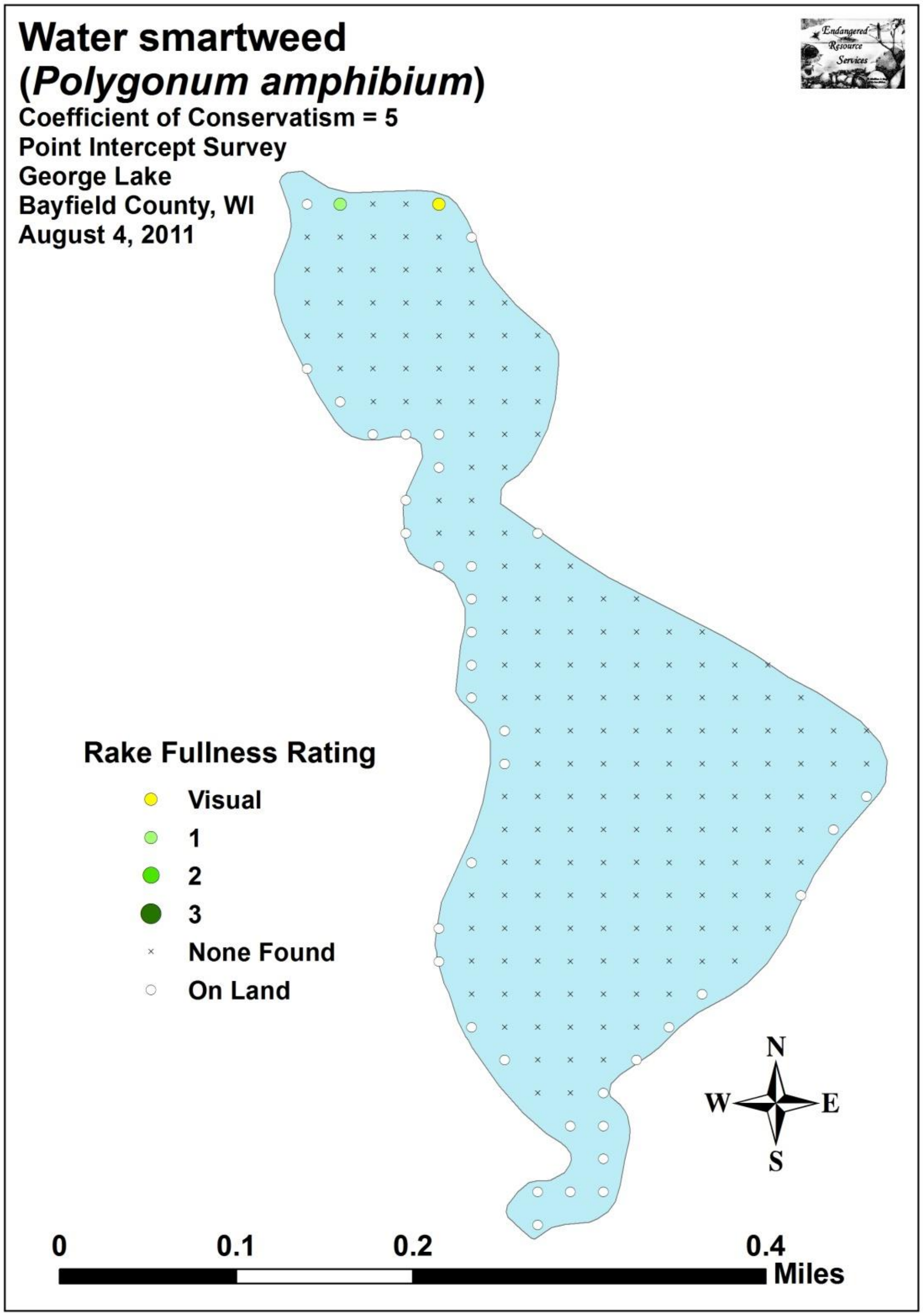
Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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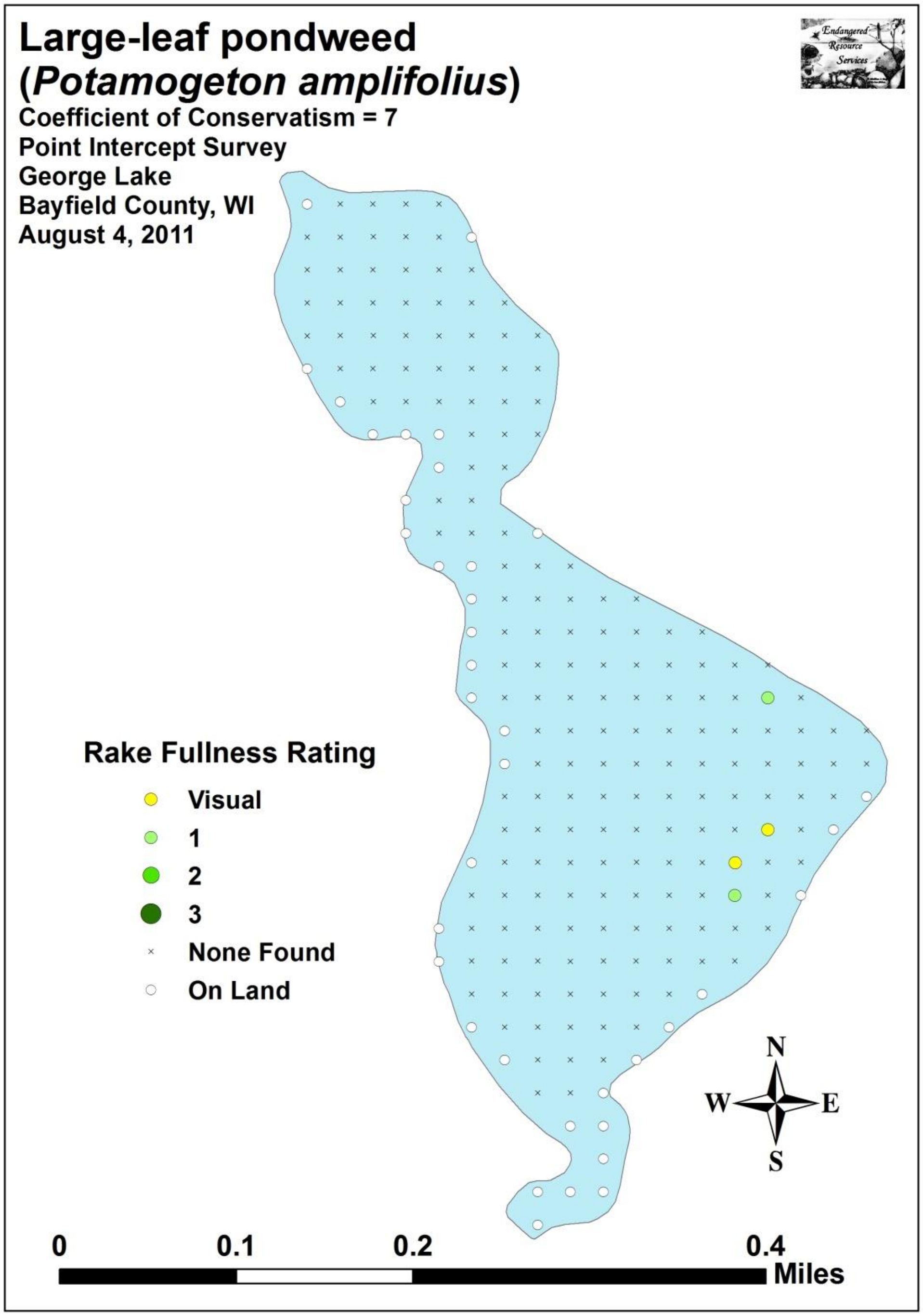
Miles


Large-leaf pondweed
(*Potamogeton amplifolius*)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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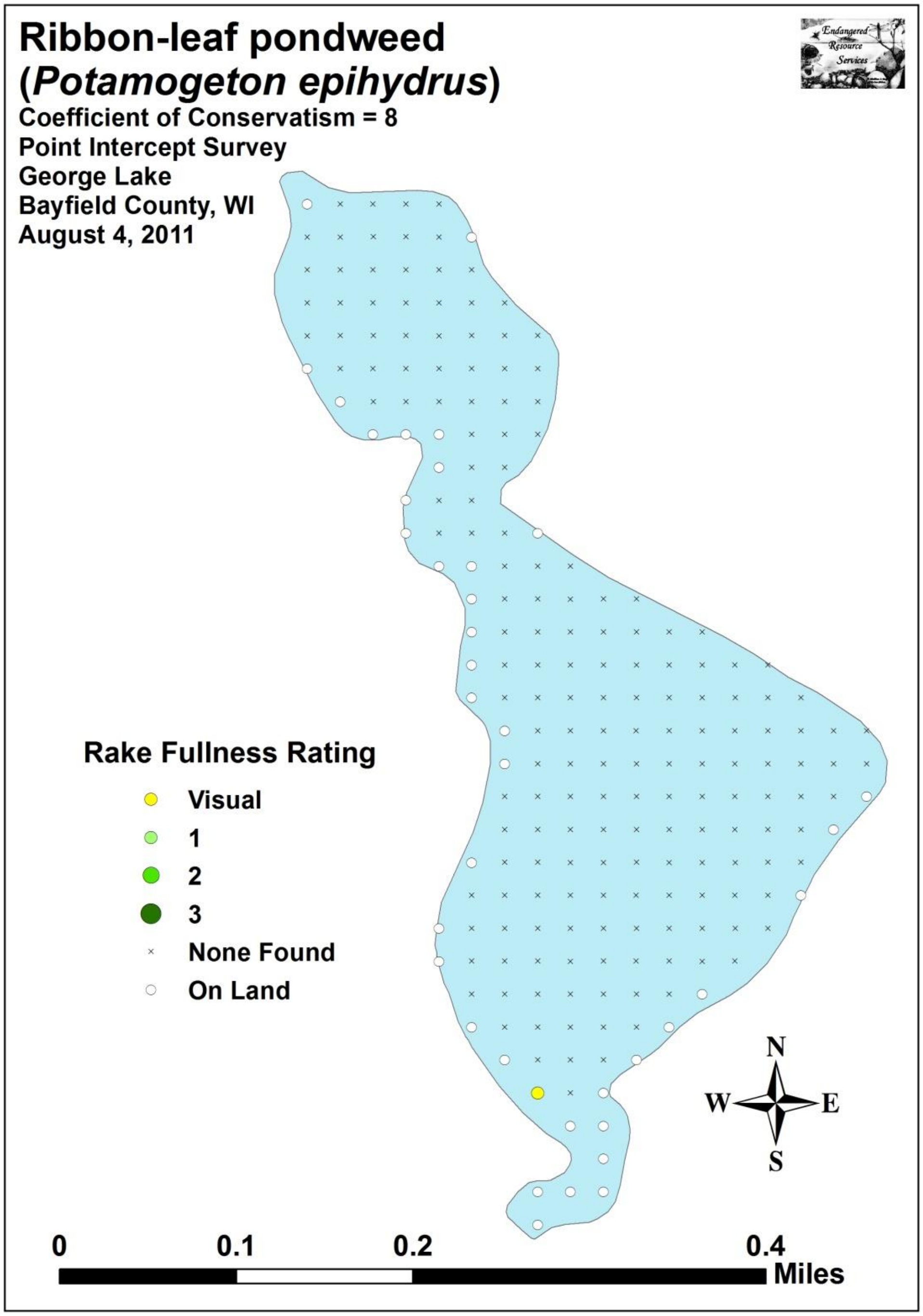
Miles


Ribbon-leaf pondweed
(*Potamogeton epihydrus*)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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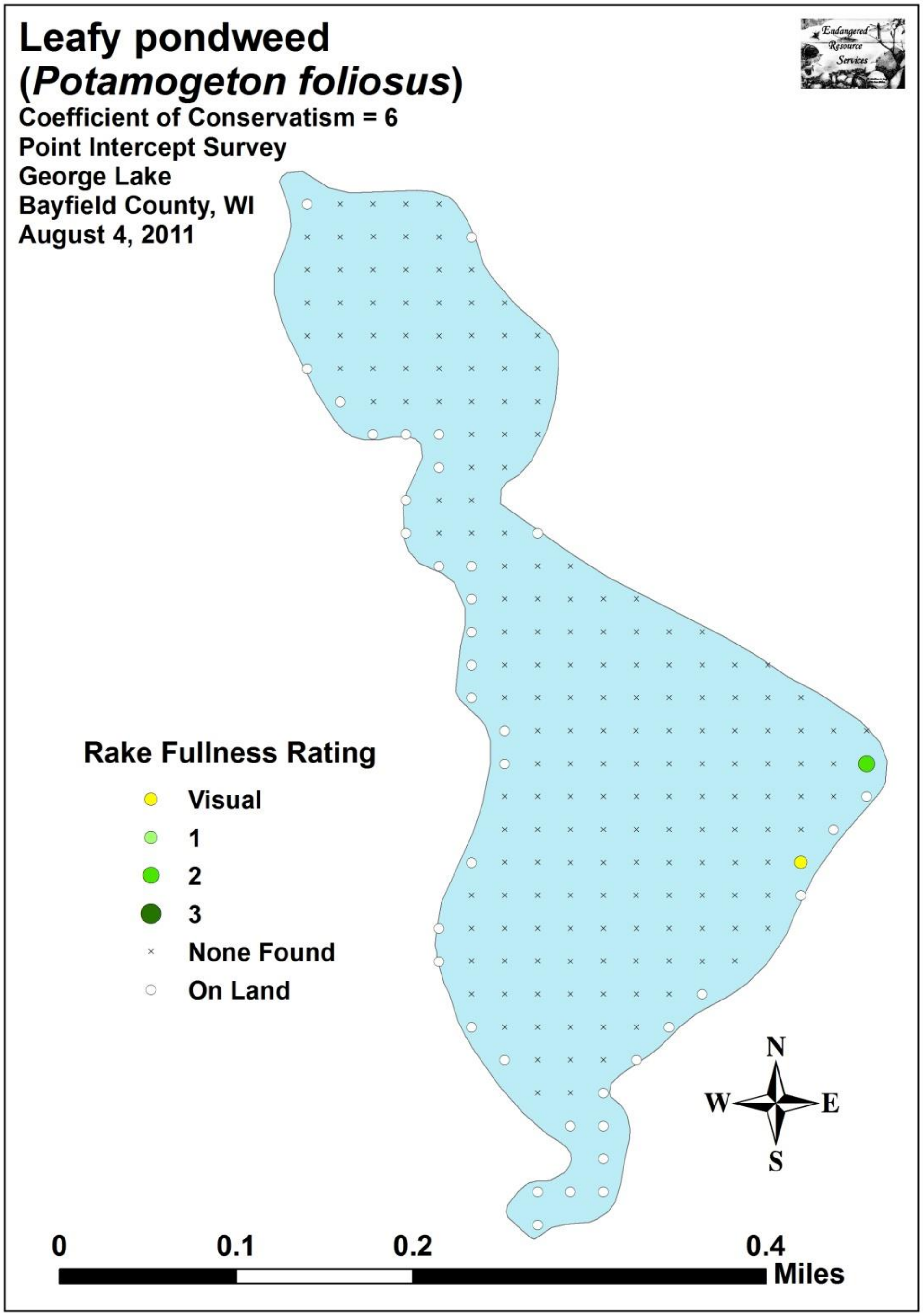
Miles


Leafy pondweed
(*Potamogeton foliosus*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
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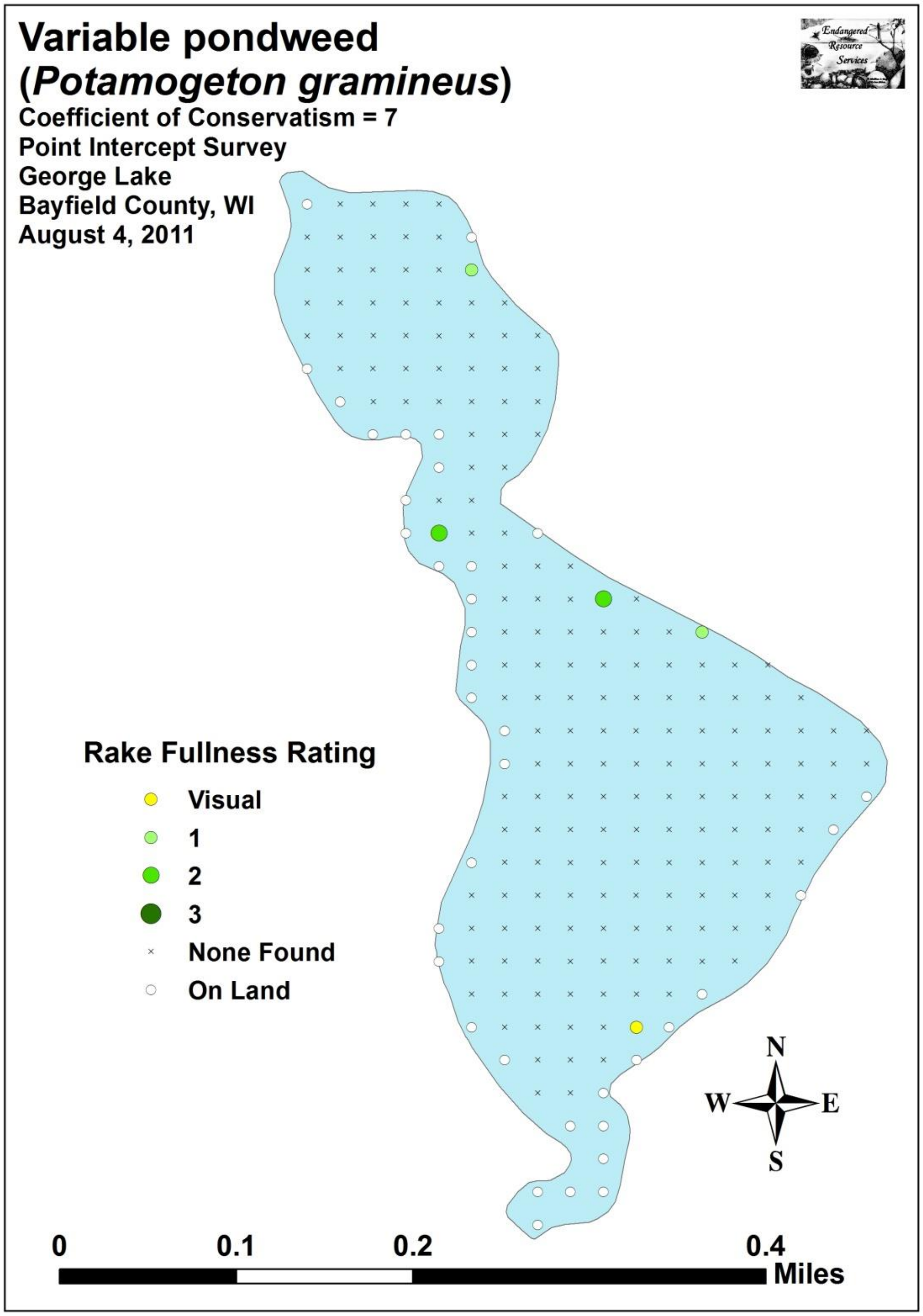
Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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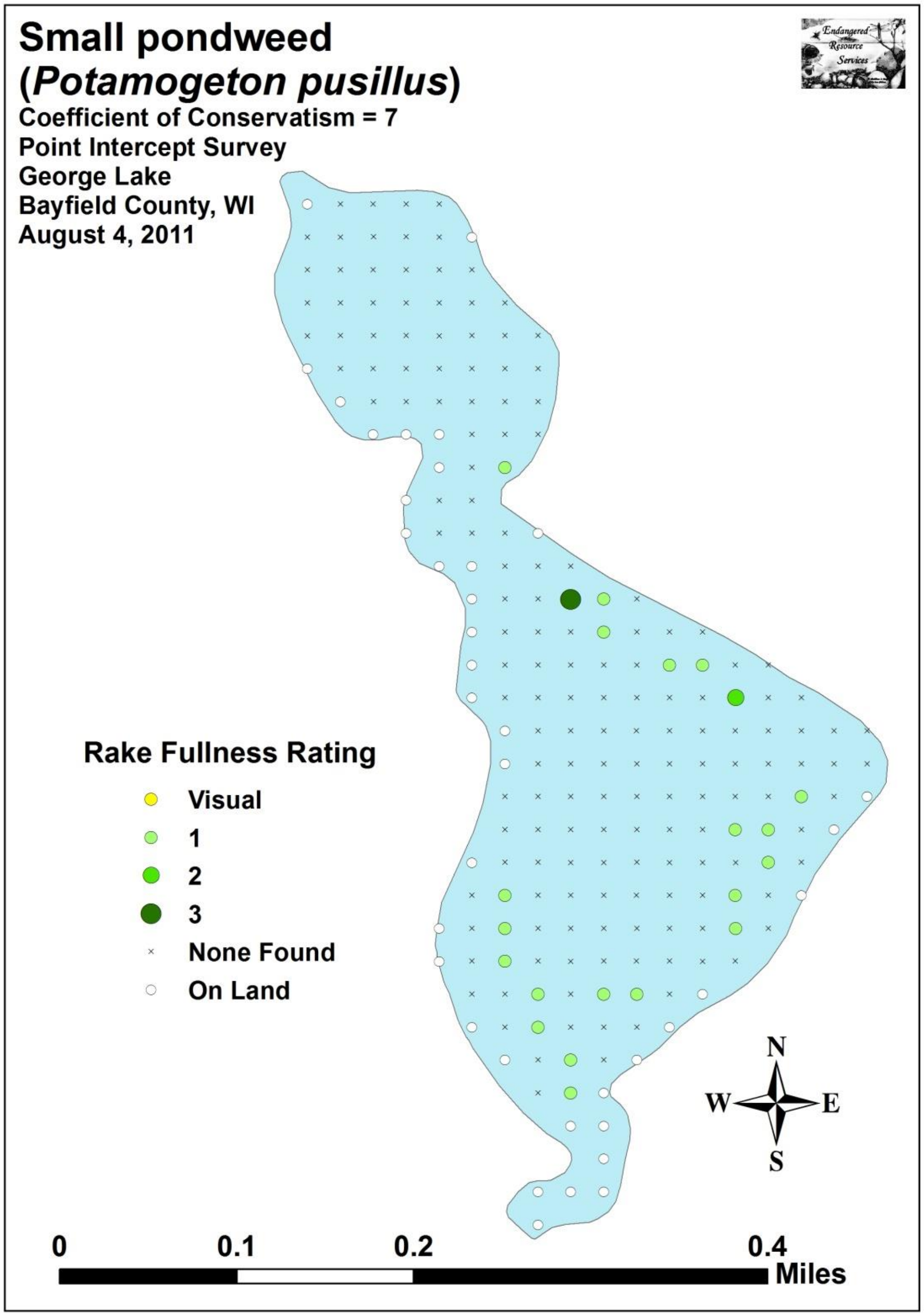
Miles



Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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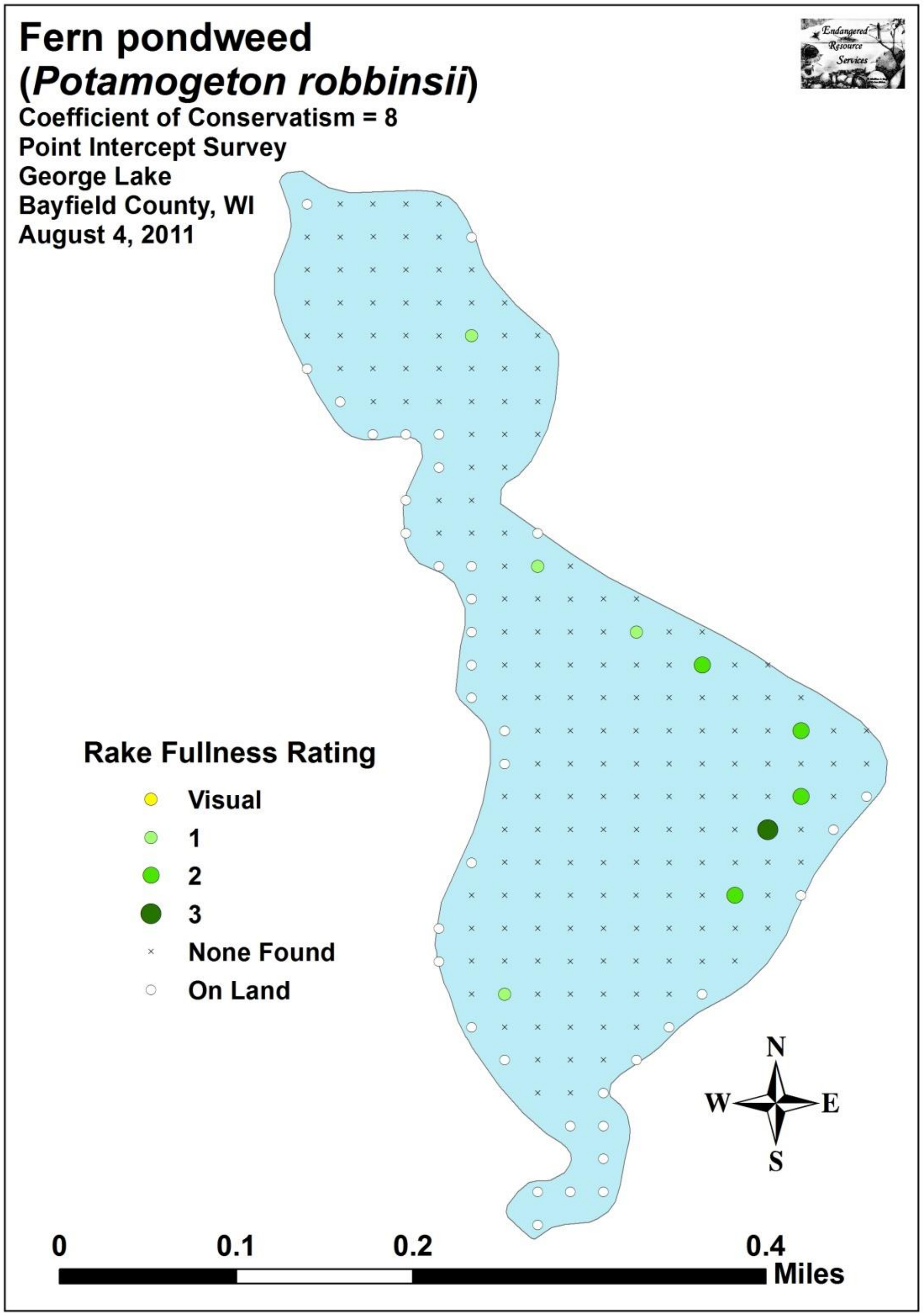
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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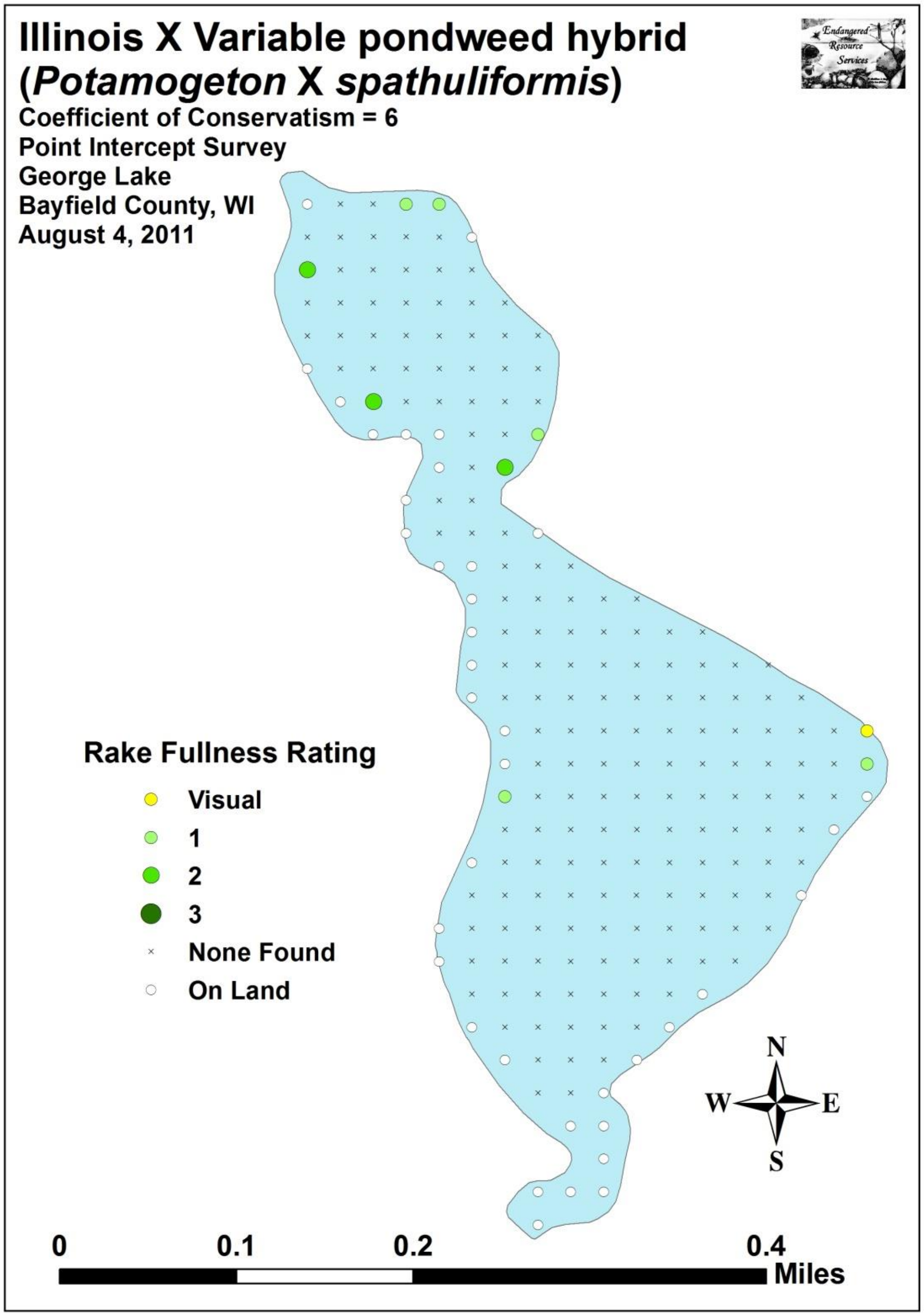
Miles


Illinois X Variable pondweed hybrid
(*Potamogeton* X *spathuliformis*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
On Land
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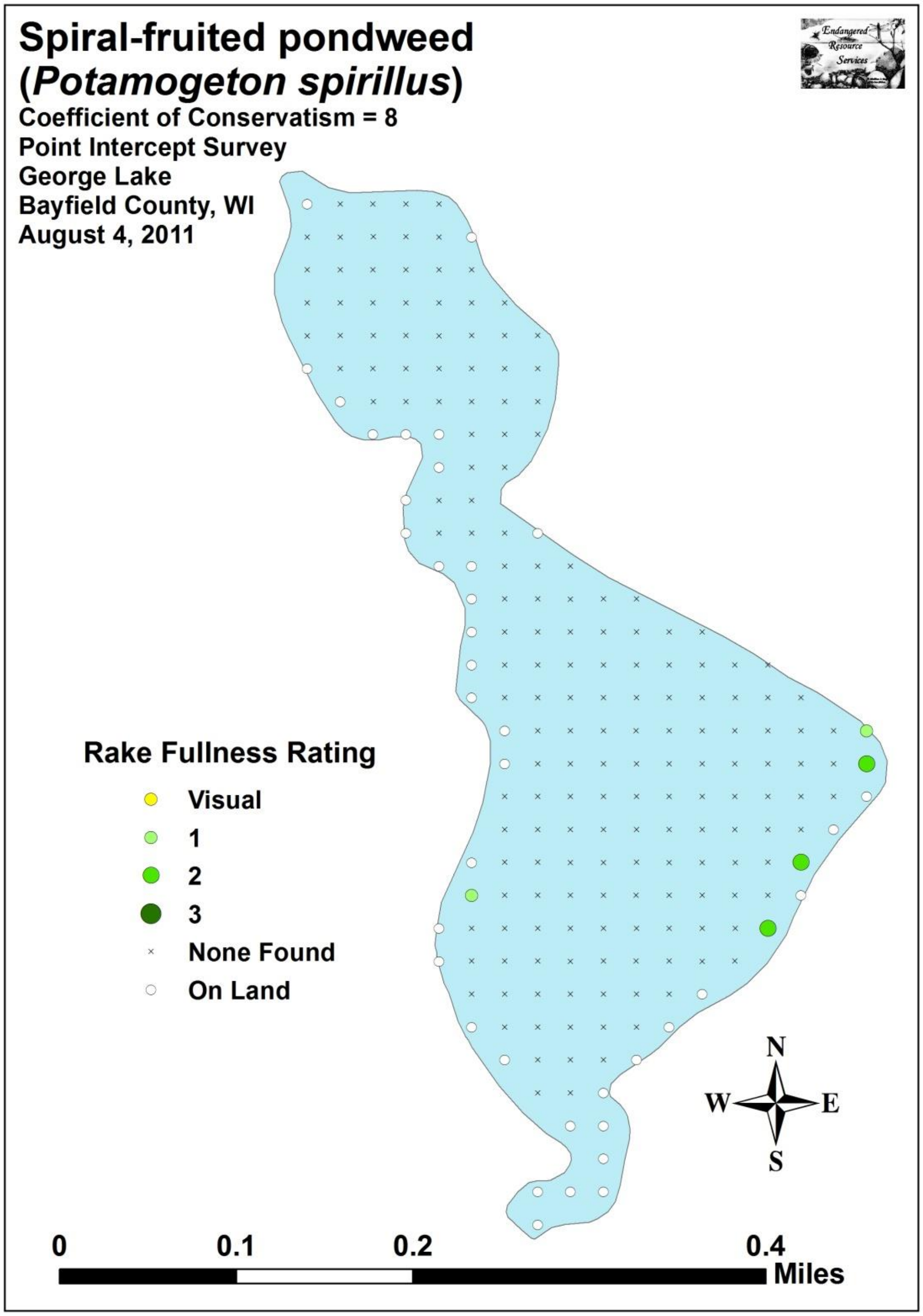
Miles


Spiral-fruited pondweed
(Potamogeton spirillus)
Coefficient of Conservatism = 8
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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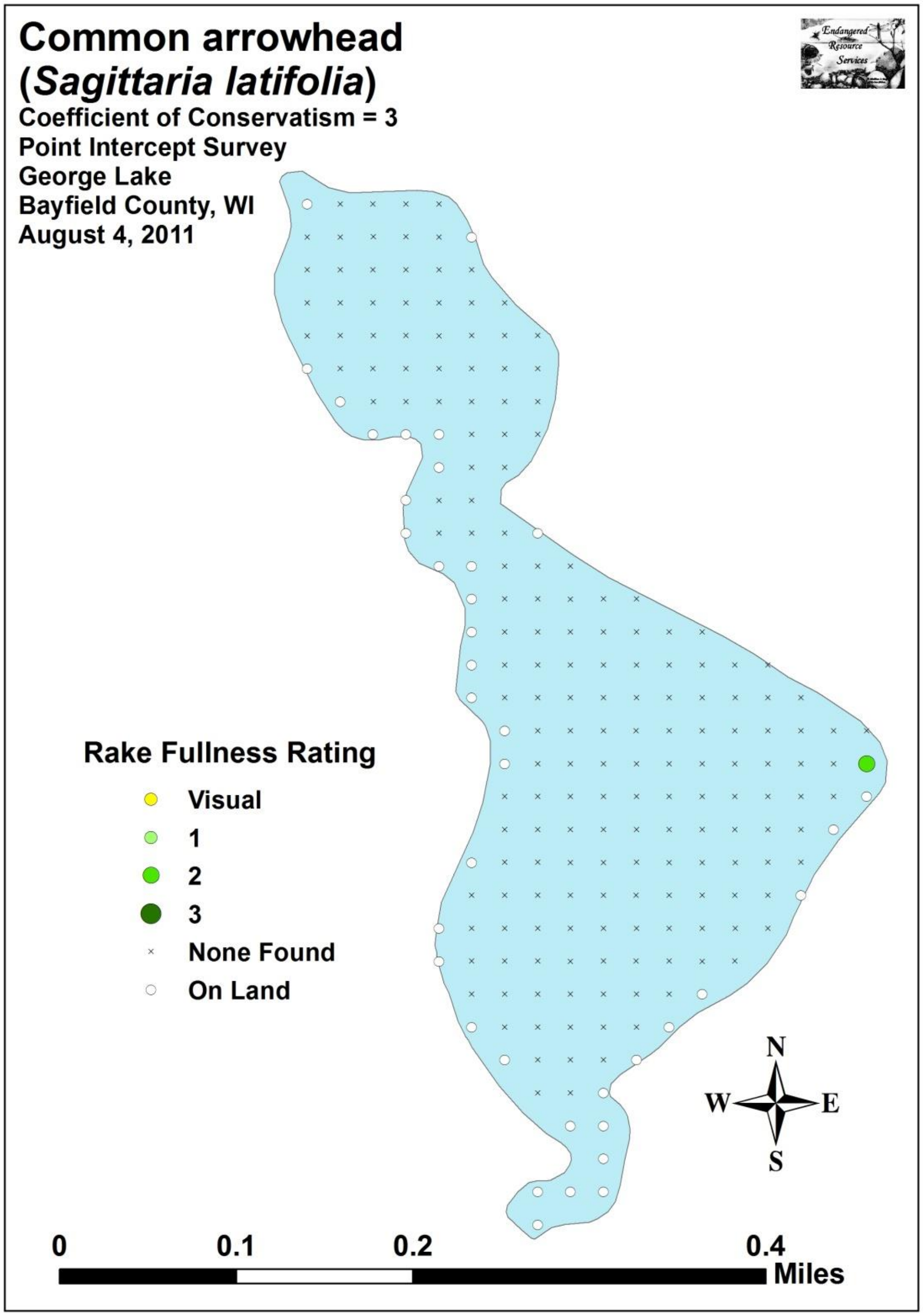
Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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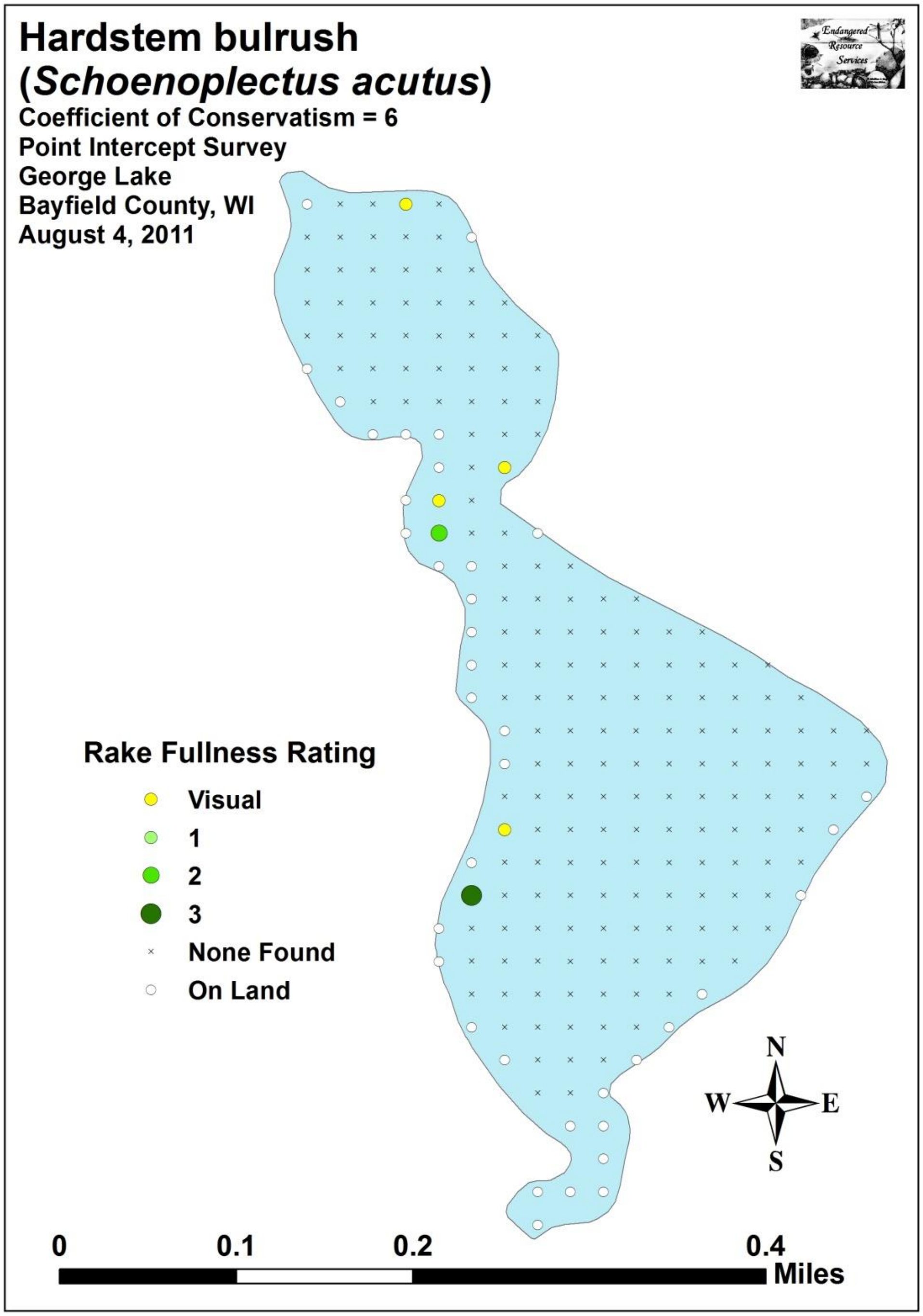
Miles


Hardstem bulrush
(*Schoenoplectus acutus*)
Coefficient of Conservatism = 6
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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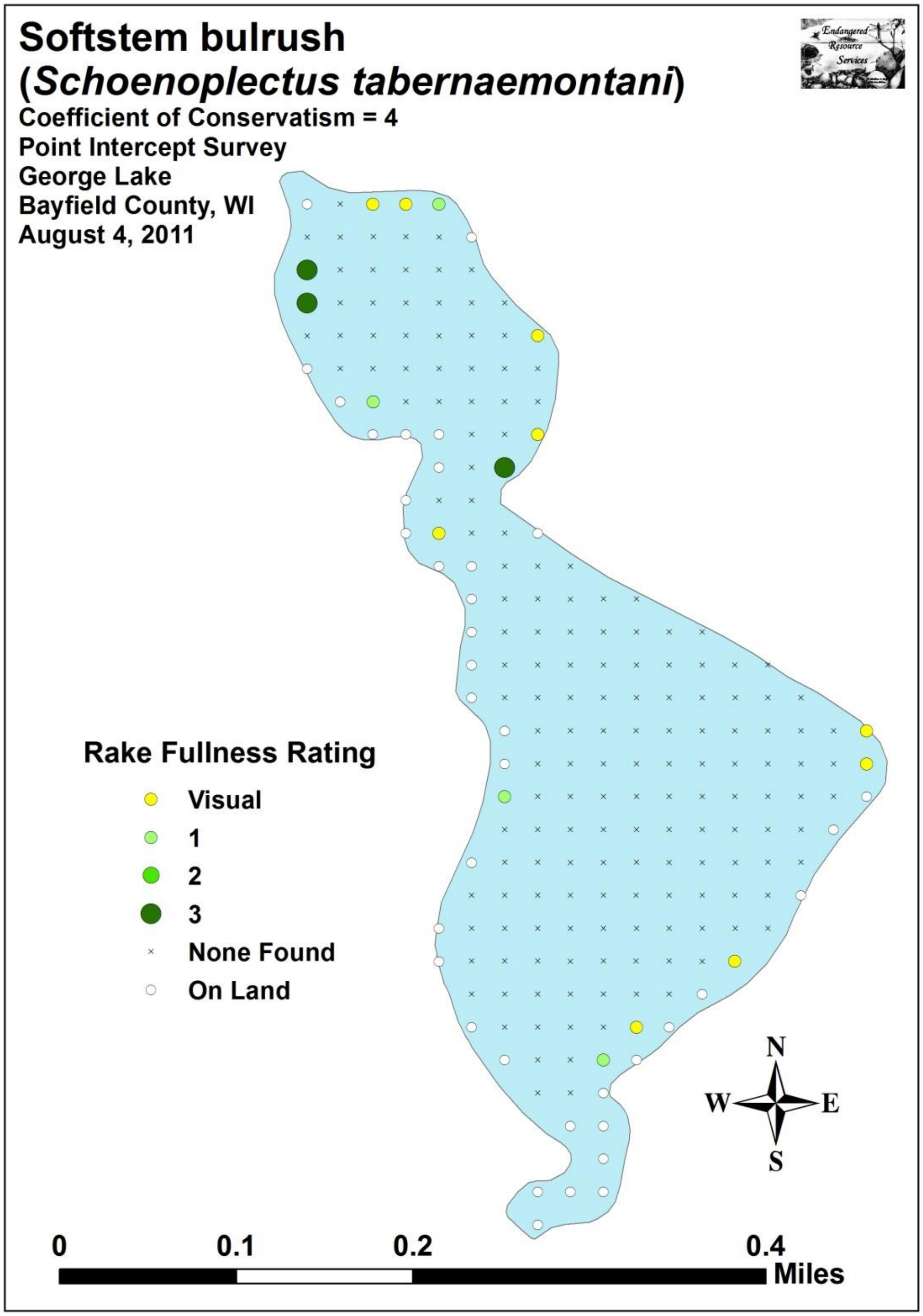
Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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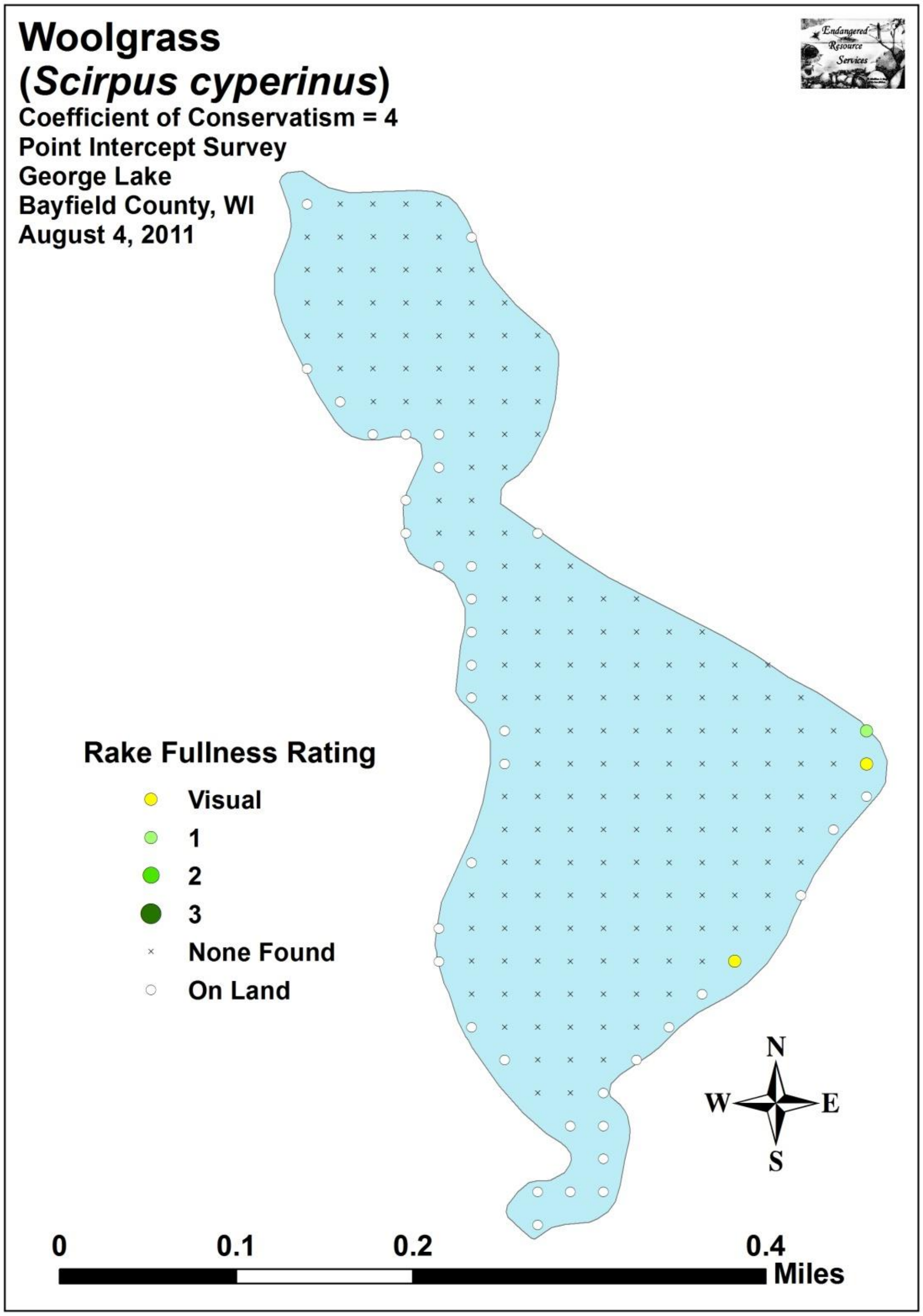
Miles



Woolgrass
(Scirpus cyperinus)
Coefficient of Conservatism = 4
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
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None Found
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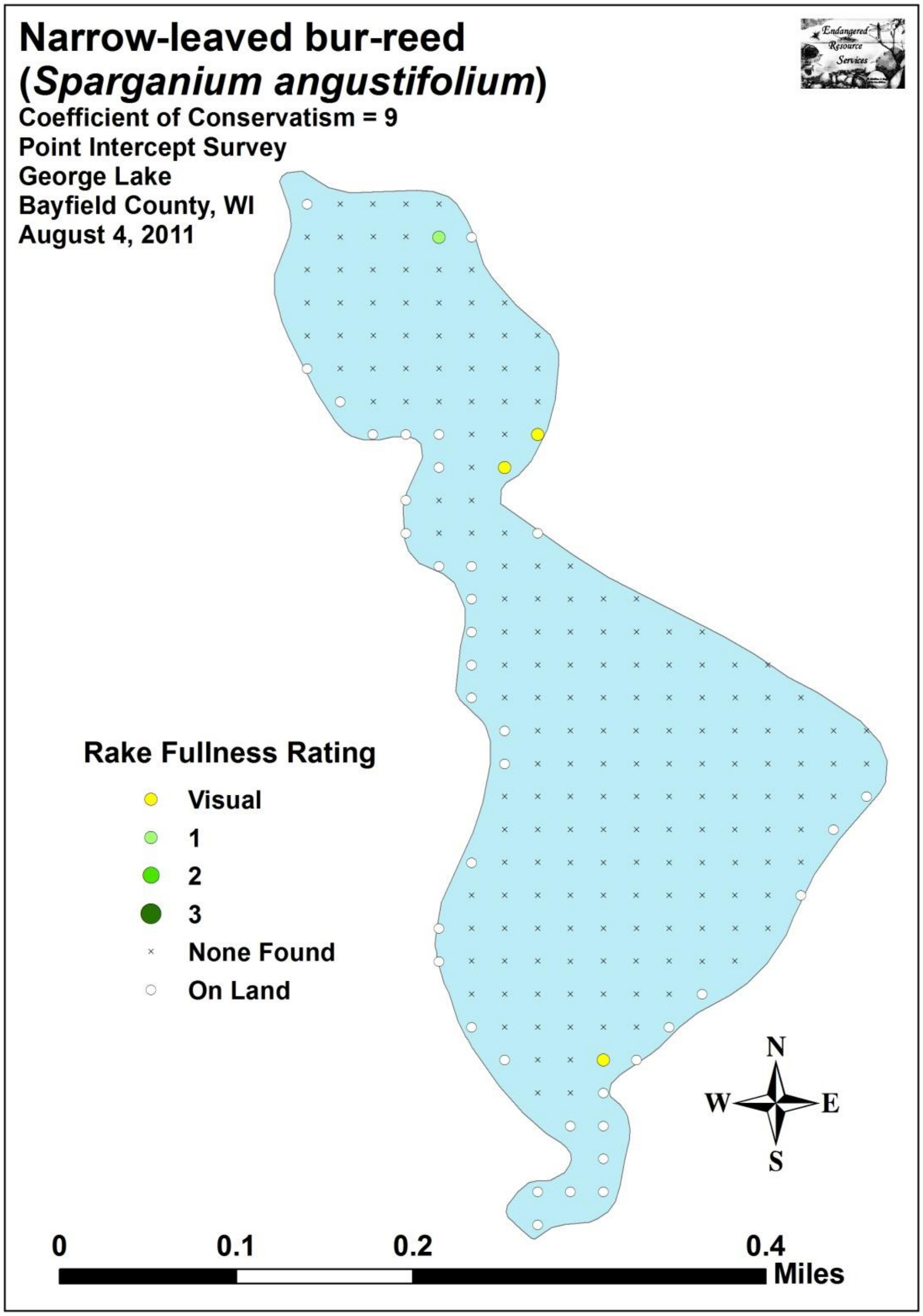
Narrow-leaved bur-reed
(Sparganium angustifolium)
Coefficient of Conservatism = 9
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Rake Fullness Rating
Visual
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None Found
On Land
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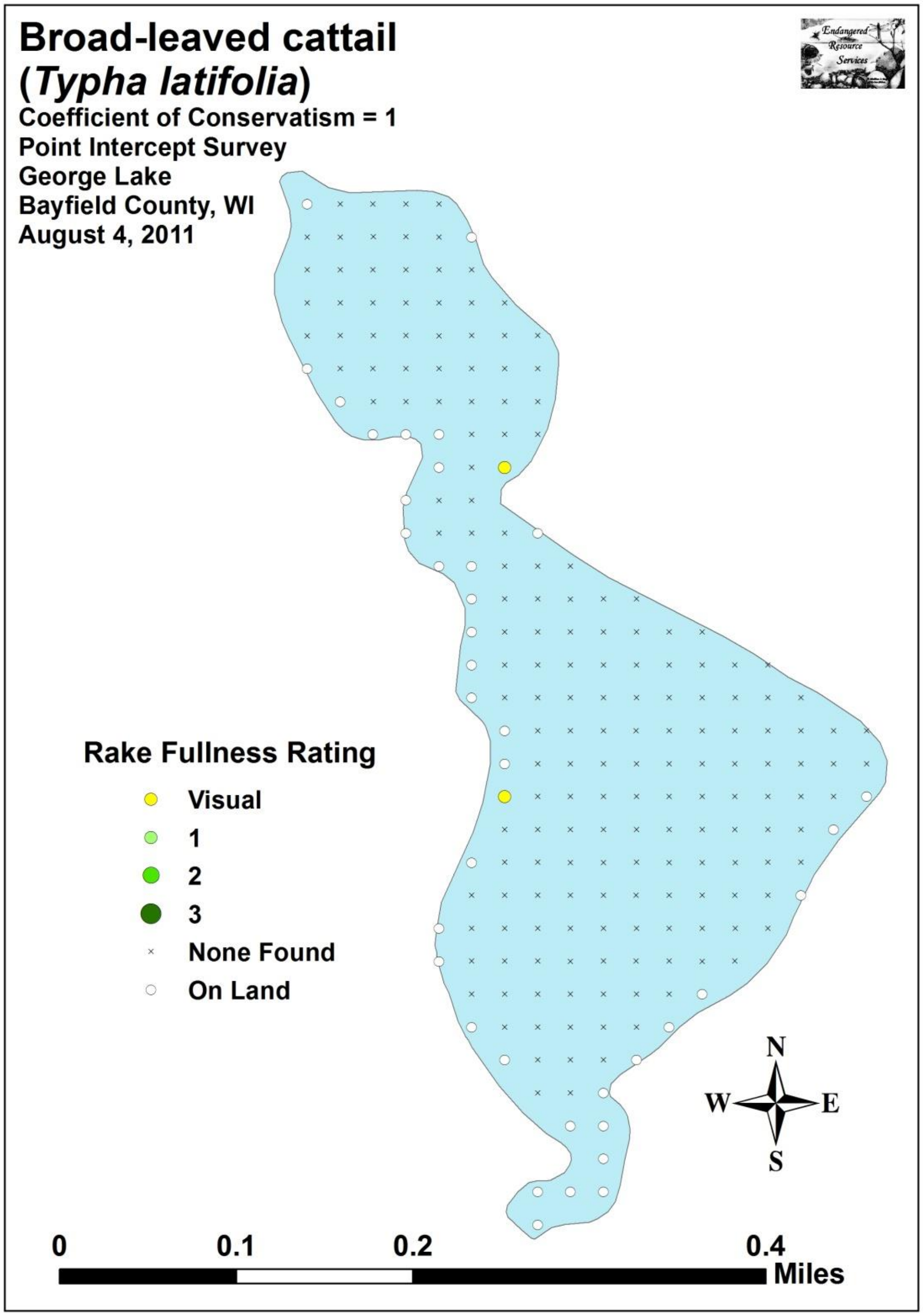
Miles



Broad-leaved cattail
(*Typha latifolia*)
Coefficient of Conservatism = 1
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
On Land
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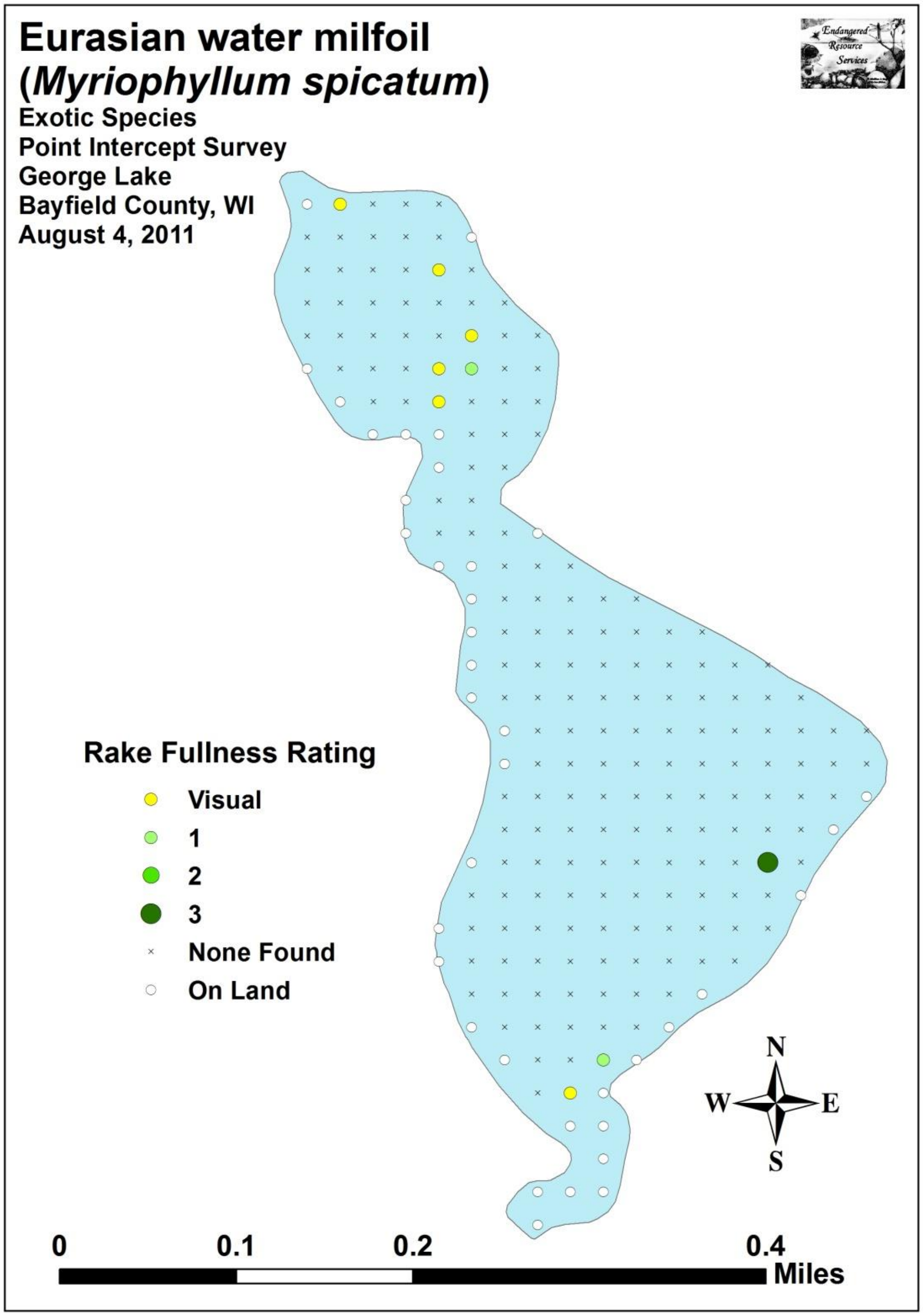
Miles

Appendix VII: EWM Density and Distribution Map


Eurasian water milfoil
(*Myriophyllum spicatum*)
Exotic Species
Point Intercept Survey
George Lake
Bayfield County, WI
August 4, 2011
Rake Fullness Rating
Visual
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None Found
On Land
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Miles

Appendix VIII: Aquatic Exotic Invasive Plant Species Information

Eurasian water milfoil

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

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

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

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

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

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

Curly-leaf pondweed

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

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)

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

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

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

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

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

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

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

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

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

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

Appendix IX: 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 X: Raw Data Spreadsheets