Warm Water Point/Intercept Macrophyte Survey
Silver Lake (WBIC: 1881100)
Barron County, Wisconsin


Watershield along Silver Lake's Receding Shoreline (Berg 2012)


Aerial Photo of Silver Lake (2010)

Project Initiated by:
The Silver Lake Association, Harmony Environmental, and the
Wisconsin Department of Natural Resources


Snail-seed pondweed in Silver Lake's northwest bay (Berg 2012)

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July 9-10, 2012

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ABSTRACT

Silver Lake (WBIC 1881100) is a 331-acre stratified seepage lake located in north-central Barron County. The lake is mesotrophic in nature with Secchi readings averaging 13.4ft from 1987-2011. A desire to determine if exotic species such as Curly-leaf pondweed (*Potamogeton crispus*) or Eurasian water milfoil (*Myriophyllum spicatum*) had invaded the lake, and to establish baseline data on the richness, diversity, abundance and distribution of other native aquatic plant populations prompted members of the Silver Lake Association, Harmony Environmental, and the Wisconsin Department of Natural Resources to authorize a full lake point intercept survey on July 9-10, 2012. The survey found macrophytes at 383 of the 951 aquatic survey points (40.3%) and in 77.2% of the 28.5ft littoral zone. Overall plant density was low to moderate with an average rake fullness value of 1.67 at sites with vegetation. Species richness at individual points averaged a relatively low 2.11species/site, but we identified a total of 41 plants to species growing in and immediately adjacent to the lake. Diversity was moderately high with a Simpson Index value of 0.86. Nitella (*Nitella* sp.), Needle spikerush (*Eleocharis acicularis*), Northern naiad (*Najas gracillima*), and Slender waterweed (*Elodea nuttallii*) were the most common macrophyte species being found at 61.10%, 38.38%, 19.06%, and 18.54% of survey points with vegetation. The 28 native index species found in the rake produced a mean Coefficient of Conservatism of 7.2 and resulted in a Floristic Quality Index of 38.1. Both of these values were much above the average mean C of 5.6 and the median FQI of 20.9 for the North Central Hardwoods Ecoregion. Scattered patches of Reed canary grass (*Phalaris arundinacea*) along the shoreline were the only exotic plants found. Future management considerations include maintaining the lake's native plant communities; working to maintain water clarity and reducing nutrient inputs along the lakeshore by such things as establishing buffer strips of native vegetation, eliminating fertilizer applications, bagging grass clippings, removing pet waste, disposing of fire pit ash away from the lake, and avoiding motor startups in shallow water; continuing the lake's Clean Boats/Clean Waters program; conducting monthly monitoring at the boat landing and at least annual lake-wide meandering littoral zone surveys to look for Aquatic Invasive Species; and developing an Aquatic Plant Management Plan that clarifies a response if a new AIS is introduced into the lake.

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INTRODUCTION:

Silver Lake (WBIC 1881100) is a 331-acre, stratified, seepage lake located in the Town of Lakeland in north-central Barron County (T36N R13W S23, 24, 25). The lake reaches a maximum depth of 91ft in the central basin and has an average depth of 38ft (WDNR 2009). Silver Lake is mesotrophic in nature and water clarity is good to very good with Secchi readings averaging 13.4ft from 1987-2011 (WDNR 2012). This produced a littoral zone that extended to 28.5ft in 2012. The lake shoreline is dominated by sand, gravel and rock with scattered patches of sandy muck; especially at depths beyond 10ft. The lake's only nutrient rich organic muck occurs in the northwest bay (Bush et al. 1967) (Figure 1).

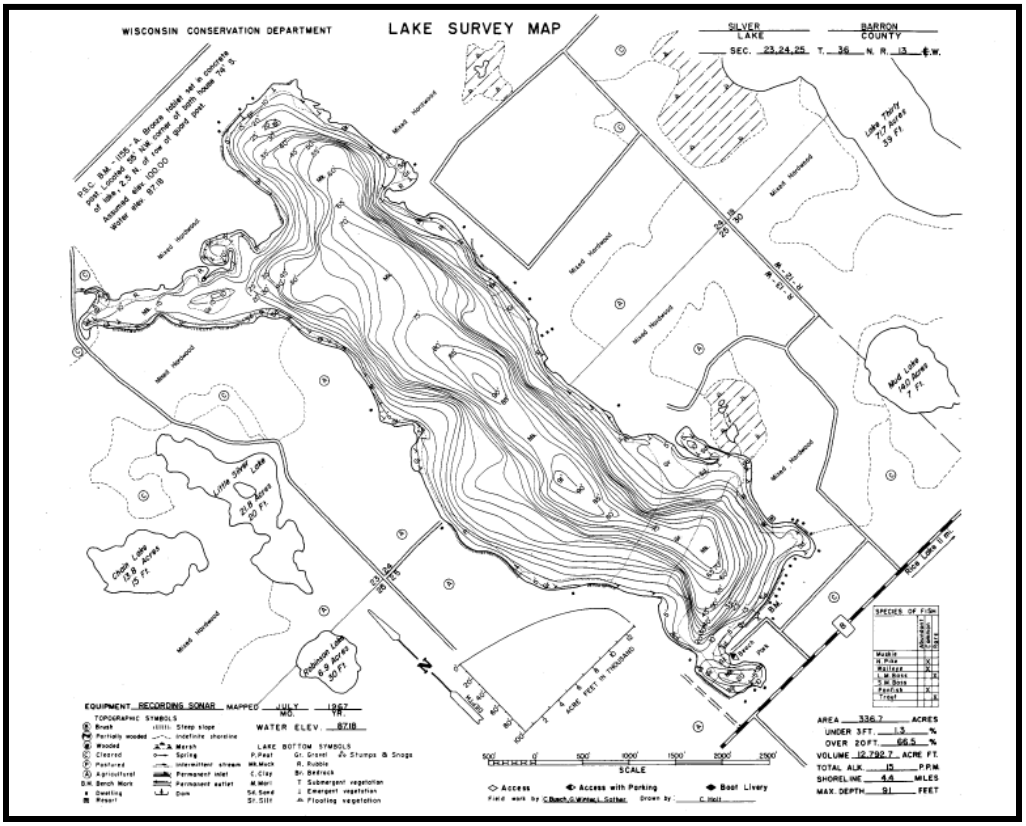


Figure 1: Silver Lake Bathymetric Map

The Silver Lake Association (SLA), Harmony Environmental, and the Wisconsin Department of Natural Resources (WDNR) authorized a warm water point intercept survey of all aquatic plants on the lake on July 9-10, 2012. This survey used the WDNR's statewide guidelines for conducting systematic point intercept macrophyte sampling. These methods ensure that all sampling in the state will be conducted in the same manner, thus allowing data to be compared across time and space. The immediate goals of the surveys were to determine if any exotic species such as Curly-leaf pondweed (*Potamogeton crispus*) (CLP) or Eurasian water milfoil (*Myriophyllum spicatum*) (EWM) had invaded the lake, and to establish data on the richness, diversity, abundance and distribution of native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's macrophyte community as well as a way to measure any impacts on the lake's plants if active management occurs in the future.

METHODS:

July 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 acreage, Michelle Nault (WDNR) generated a 977 point sampling grid for Silver Lake (Appendix I). Prior to beginning the July point intercept survey, we conducted a general boat survey of the lake to gain familiarity with the species present (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006, Skawinski 2011), and two vouchers were pressed and mounted for herbarium specimens – one to be retained by the SLA, and one to be sent to the state herbarium in Stevens Point for identification confirmation. During the survey, we located each point in and just beyond the littoral zone using a handheld mapping GPS unit (Garmin 76CSx), recorded a depth reading with a Vexlar handheld sonar unit, and used a rake to sample an approximately 2.5ft section of the bottom. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of plants within six feet of the sample point not found in the rake. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

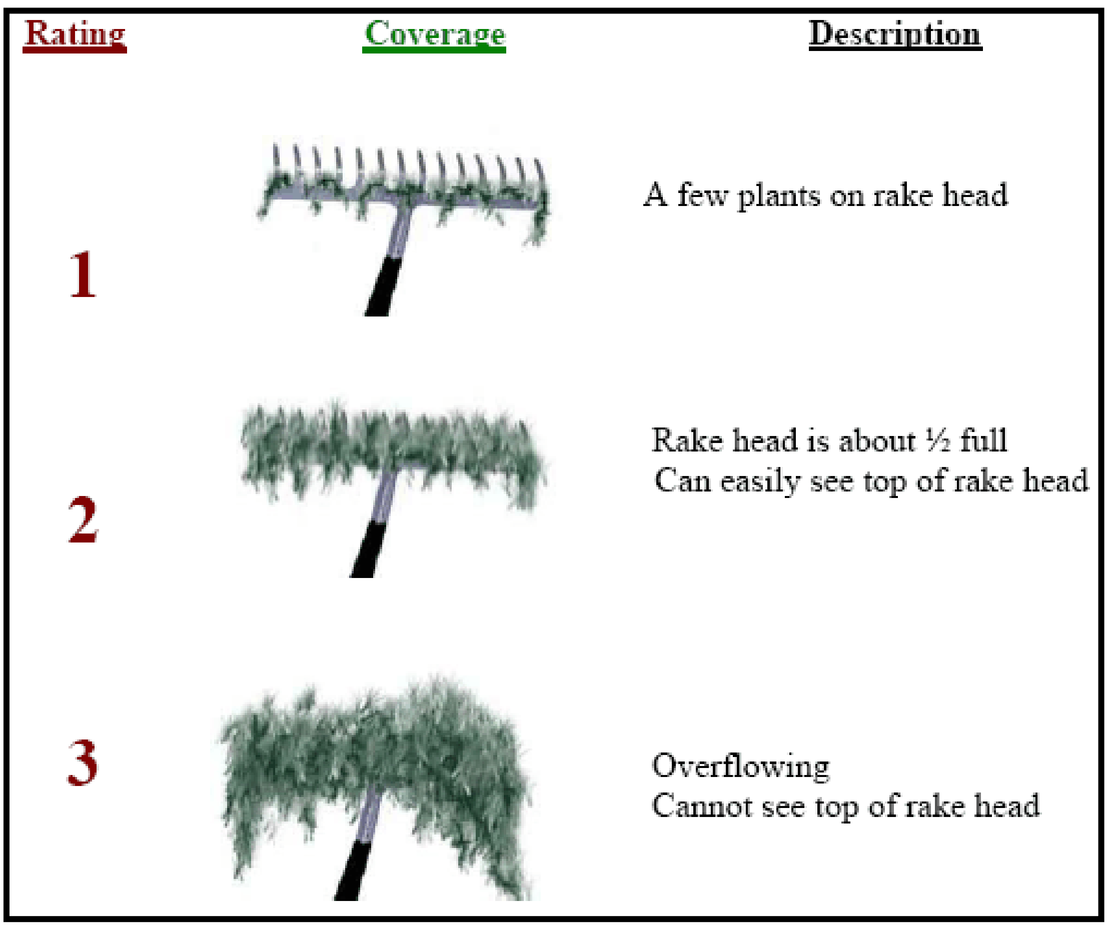


Figure 2: Rake Fullness Ratings (UWEX, 2010)

DATA ANALYSIS:

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

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

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

Total number of sites shallower than the maximum depth of plants: This is the number of sites that are in the littoral zone. Because not all sites that are within the littoral zone actually have vegetation, we use this value to estimate how prevalent vegetation is throughout the littoral zone. For example, if 60% of the sites shallower than the maximum depth of plants have vegetation, then we estimate that 60% of the 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 individual plants (randomly selected) will be different species. The index values range from 0 -1 where 0 indicates that all the plants sampled are the same species to 1 where none of the plants sampled are the same species. The greater the index value, the higher the diversity in a given location. Although many natural variables like lake size, depth, dissolved minerals, water clarity, mean temperature, etc. can affect diversity, in general, a more diverse lake indicates a healthier ecosystem. Perhaps most importantly, plant communities with high diversity also tend to be **more resistant** to invasion by exotic species.

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

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

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

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

Species richness: This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include those seen at a sample point during the survey but not found in the rake, and those that were only seen during the initial boat survey or inter-point. **Note: Per DNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.**

Average rake fullness: This value is the average rake fullness of all species in the rake. It only takes into account those sites with vegetation (Table 1).

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

Relative frequency example:

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

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

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

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

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

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

July Warm Water Full Point/Intercept Survey:

The Silver Lake grid contained 977 points, but, due to prolonged drought, 26 of them were on land. Depth soundings taken at the 648 points in and adjacent to the littoral zone revealed the lake is a fairly uniform, steep-sided trench running north/south. In the northwest corner of the lake, a shallow finger bay sloped gradually from a few feet in the northwest end to 14ft in the southeast where it joined the main lake. Elsewhere, four other small side bays extended off the main lake on the east and south sides. Other notable features included a midlake sand/rock bar on the lake's west side and a broad shallow sand flat on the southeast end (Figure 3) (Appendix III).

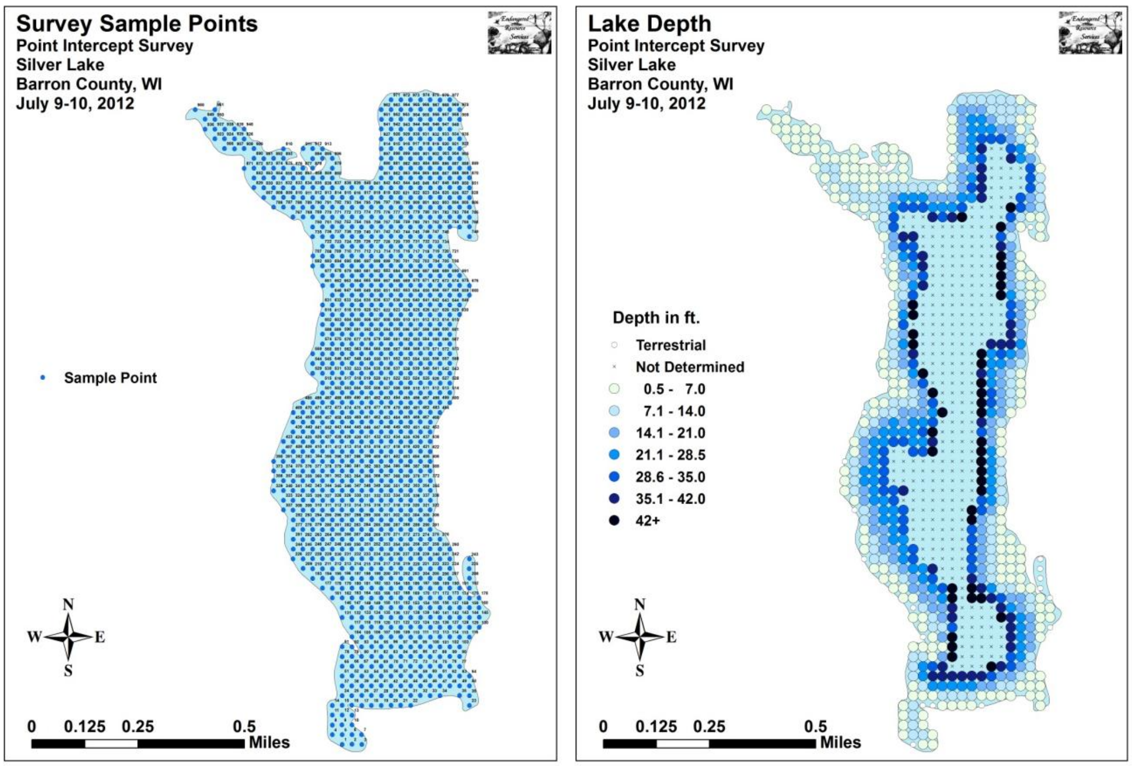
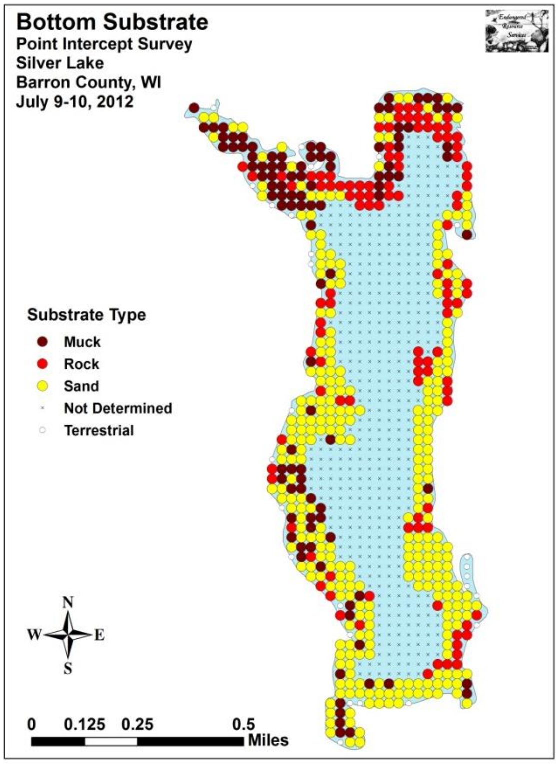


Figure 3: Silver Lake Survey Points and Lake Depth

Of the 498 points where we could reliably determine the substrate, sand dominated the lake bottom at 57.4% of survey sites. Away from the shoreline, we found scattered patches of nutrient poor sandy muck and, in the lake's sheltered bays, small amount of more nutrient rich organic muck. These areas made up 21.1% of points with the remaining 21.5% being characterized as rock. These cobble and gravel areas were especially common around the northern 1/3rd of the lake and bordering the large sand flat on the southeast side (Figure 4).

The survey located plants growing at 383 sites or approximately 40.3% of the lake's 951 aquatic points and in 77.2% of the 28.5ft littoral zone. Plants were found at almost all points below 15ft, exhibited patchy coverage between 15 and 22ft, and became relatively uncommon with very low numbers of individuals as we approached the 28.5ft upper littoral limit (Figure 4) (Table 1) (Appendix III).



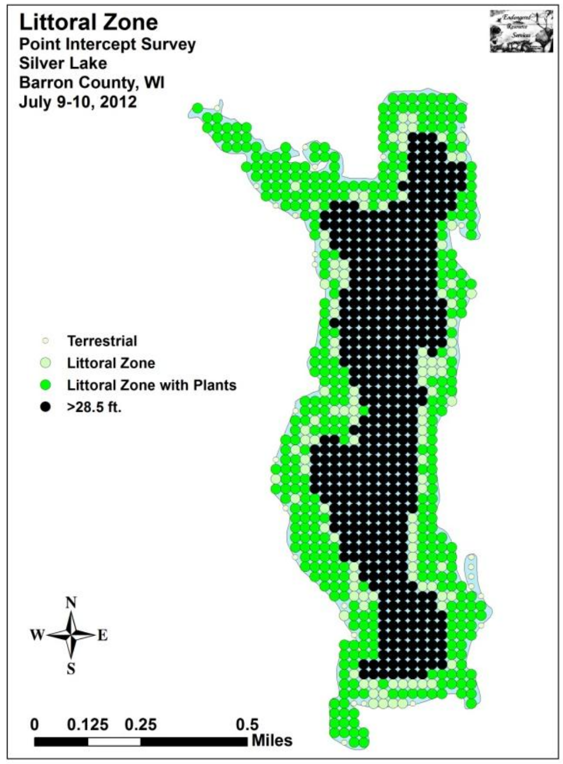


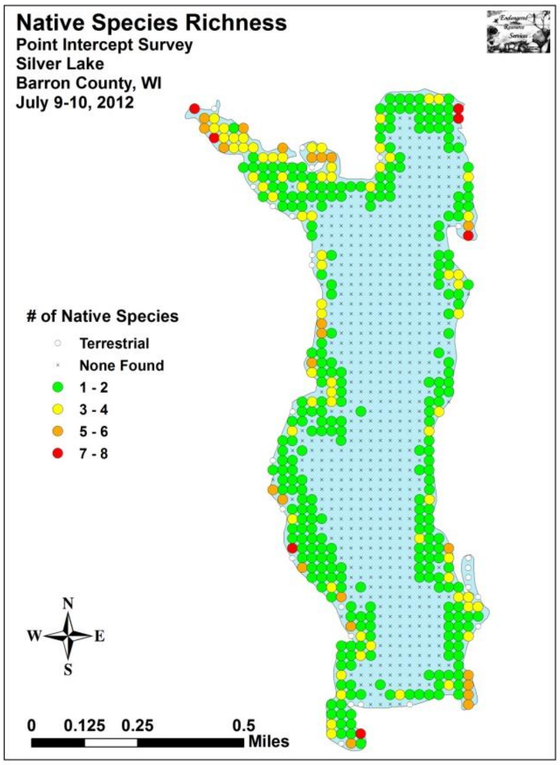
Figure 4: Bottom Substrate and Littoral Zone

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics Silver Lake, Barron County July 9-10, 2012

Summary Statistics:

Total number of points sampled	648
Total number of sites with vegetation	383
Total number of sites shallower than the maximum depth of plants	496
Frequency of occurrence at sites shallower than maximum depth of plants	77.22
Simpson Diversity Index	0.86
Maximum depth of plants (ft)	28.5
Mean depth of plants (ft)	10.0
Median depth of plants (ft)	8.5
Number of sites sampled using rope rake (R)	186
Number of sites sampled using pole rake (P)	312
Average number of all species per site (shallower than max depth)	1.63
Average number of all species per site (veg. sites only)	2.11
Average number of native species per site (shallower than max depth)	1.63
Average number of native species per site (veg. sites only)	2.11
Species richness	29
Species richness (including visuals)	32
Species richness (including visuals and boat survey)	41
Average rake fullness (veg. sites only)	1.67

Overall diversity was moderately high with a Simpson Diversity Index value of 0.86. Species richness was also moderately high with 41 total species found growing in and immediately adjacent to the water. However, local richness was a relatively low average of 2.33 native species/vegetative site. Plant growth was skewed to deep water with a mean depth of 10.0ft, but a median depth of only 8.5ft. Total mean rake fullness was low to moderate averaging 1.67 at sites with vegetation. In general, species richness, diversity and total rake biomass declined rapidly at depths beyond 10ft (Figure 5) (Appendix IV).



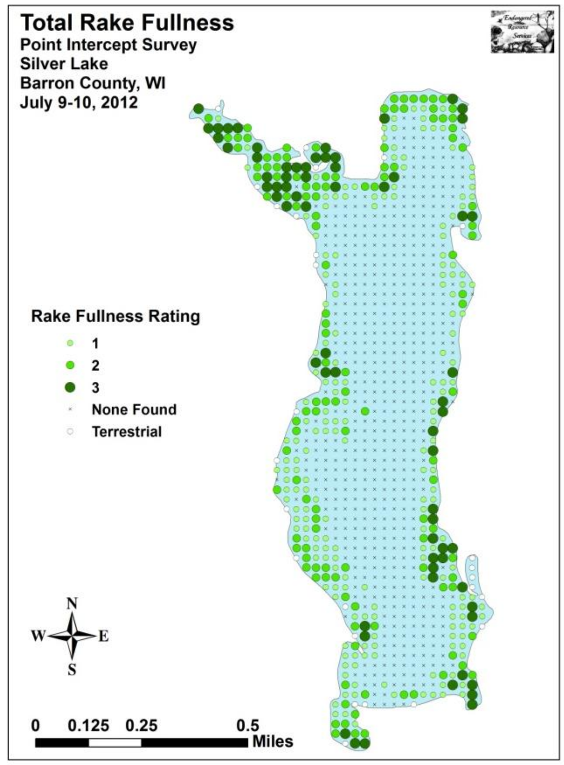


Figure 5: Native Species Richness and Total Rake Fullness

The Silver Lake ecosystem is home to a sensitive and rare plant community that is characteristic of pristine, low nutrient, soft water, seepage lakes. This community can be subdivided into four distinct zones (emergent, shallow submergent, floating-leaf, and deep submergent) with each zone having its own characteristic functions in the lake ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient rich organic muck), these zones often had somewhat different species present.

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

At the time of the survey, most of these emergent plants were actually out of the water due to the prolonged drought. Over sand and rock exposed by the receding shoreline, Common rush (*Juncus effusus*), Arctic rush (*Juncus arcticus var. balticus*), False nut sedge (*Cyperus strigosus*), Rough bent grass (*Agrostis scabra*), Woolgrass (*Scirpus cyperinus*), Reed canary grass (*Phalaris arundinacea*), and a variety of sedges (*Carex* spp.) dominated the lakeshore. In sandy muck areas scattered throughout the lake in water up to 1ft deep, we found a small numbers of Bald spikerush (*Eleocharis erythropoda*), Sessile-fruited arrowhead (*Sagittaria rigida*), and Softstem bulrush (*Schoenoplectus tabernaemontani*). We also documented a few patches of Broad-leaved cattail (*Typha latifolia*), False pimpernel (*Lindernia dubia*), and Short-stemmed bur-reed (*Sparganium emersum*) in organic muck shoreline areas of the northwest bay.

Typical Silver Lake shoreline emergent community (Berg 2012)

Common rush (Ranger 2011)

Woolgrass (Colby 2012)

Short-stemmed bur-reed (Texas A&M 2012)

Softstem bulrush (Schwarz 2011)

Broad-leaved cattail (Raymond 2011)

Just beyond the emergents, the lake's shallow sugar sand areas tended to have moderate to high species richness. They also tended to have low total biomass as the nutrient poor substrates provided habitat most suited to fine leaved "isoetid" turf forming species like Quillworts (*Isoetes* spp.), Waterwort (*Elatine minima*), Needle spikerush (*Eleocharis acicularis*), Brown-fruited rush (*Juncus pelocarpus*), Creeping spearwort (*Ranunculus flammula*), Pipewort (*Eriocaulon aquaticum*), and Dwarf water milfoil (*Myriophyllum tenellum*). These shallow submergent species are typical of low nutrient, sand bottom lakes like Silver Lake and, along with the emergents, work to stabilize the bottom and prevent wave action erosion.

Spiny-spored quillwort (Haines 2012)

Waterwort (Fewless 2005)

Needle spikerush (Fewless 2005)

Brown-fruited rush (Koshere 2002)

Dwarf water milfoil (Koshere 2002)

Pipewort/Needle spikerush "turf" in the lake's northeast corner (Berg 2012)

In shallow water generally <6ft deep, nutrient poor sandy muck provided habitat for slightly larger leaved species like Wild celery (*Vallisneria americana*), Crested arrowhead (*Sagittaria cristata*), Greater waterwort (*Elatine triandra*), and species with very small to medium sized floating leaves like Snail-seed pondweed (*Potamogeton bicupulatus*), Spiral-fruited pondweed (*Potamogeton spirillus*), Ribbon-leaf pondweed (*Potamogeton epihydrus*), and Watershield (*Brasenia schreberi*). The seeds, shoots, roots, and tubers this group provides are prized by both resident and migrant waterfowl. They also provide important habitat for baitfish and juvenile game fish as well as insects like dragonflies and mayflies during their aquatic nymph stages.

Wild celery (Dalvi 2009)

Crested arrowhead (Fewless 2004)

Snail-seed pondweed (Haines 2012)

Spiral-fruited pondweed (Cameron 2007)

Dragonfly emerging from exoskeleton on a Silver Lake dock (Brown 2012)

Ribbon-leaf pondweed (Petroglyph 2007)

Watershield (Gmelin 2009)

Watershield and Snail-seed pondweed fish "nursery" habitat (Berg 2012)

Shallow areas with more nutrient rich organic muck were the rarest habitat in the lake. Because of this, species with large floating leaves like White-water lily (*Nymphaea odorata*), Spatterdock (*Nuphar variegata*), and Large-leaf pondweed (*Potamogeton amplifolius*) that require this type of substrate were also uncommon. The protective canopy cover they provide is often utilized by panfish and bass, and mature gamefish like Northern Pike are often found prowling around the edges of these beds.

Spatterdock and White water lily (Falkner 2009)

Large-leaf pondweed (Fewless 2010)

Floating among these species, we also encountered a very few Small duckweed (*Lemna minor*), scattered Spiny hornwort (*Ceratophyllum echinatum*), and, in the northwest bay, the carnivorous Common bladderwort (*Utricularia vulgaris*). Rather than drawing nutrients up through roots like other plants, bladderworts trap zooplankton and minute insects in their bladders, digest their prey, and use the nutrients to further their growth.

Small duckweed (Lenes 2006)

Spiny hornwort (Skawinski 2010)

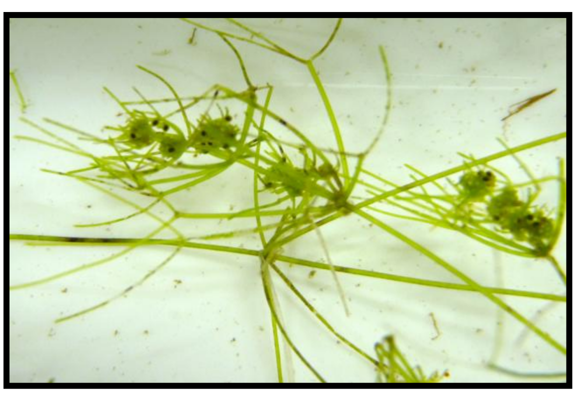

Common bladderwort flowers among lilypads (Hunt, 2010)


Common bladderwort bladders for catching plankton (Wontolla, 2007)

Areas over 5ft were dominated by three species: From 5-15ft, Northern naiad (*Najas gracillima*), and Slender waterweed (*Elodea nuttallii*) were common. Beyond 15ft, the colonial algae Nitella (*Nitella* sp.) dominated the lake bottom. All of these species provide important deep water habitat for mature gamefish.


Northern naiad (Show 2010)


Slender waterweed (Jonsson 2009)


Nitella


Rake full of Nitella (Berg 2012)

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Silver Lake, Barron County
July 9-10, 2012

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Nitella sp.	Nitella	234	28.89	61.10	47.37	1.41	0
Eleocharis acicularis	Needle spikerush	147	18.15	38.38	29.76	1.73	1
Najas gracillima	Northern naiad	73	9.01	19.06	14.78	1.21	6
Elodea nuttallii	Slender waterweed	71	8.77	18.54	14.37	1.18	0
Elatine minima	Waterwort	46	5.68	12.01	9.31	1.20	4
Isoetes echinospora	Spiny spored-quillwort	45	5.56	11.75	9.11	1.22	1
Potamogeton spirillus	Spiral-fruited pondweed	39	4.81	10.18	7.89	1.18	9
	Filamentous algae	31	*	8.09	6.28	1.10	0
Isoetes lacustris	Lake quillwort	29	3.58	7.57	5.87	1.59	0
Brasenia schreberi	Watershield	23	2.84	6.01	4.66	1.91	7
Potamogeton bicupulatus	Snail-seed pondweed	22	2.72	5.74	4.45	1.50	8
Sagittaria cristata	Crested arrowhead	14	1.73	3.66	2.83	1.64	5
Ceratophyllum echinatum	Spiny hornwort	12	1.48	3.13	2.43	1.25	1
Potamogeton epihydrus	Ribbon-leaf pondweed	9	1.11	2.35	1.82	1.33	4
Myriophyllum tenellum	Dwarf water-milfoil	8	0.99	2.09	1.62	1.50	0
Sagittaria rigida	Sessile-fruited arrowhead	6	0.74	1.57	1.21	1.50	1
Nymphaea odorata	White water lily	4	0.49	1.04	0.81	1.50	8
Elatine triandra	Greater waterwort	3	0.37	0.78	0.61	1.33	0
Juncus pelocarpus	Brown-fruited rush	3	0.37	0.78	0.61	1.00	1
Lemna minor	Small duckweed	3	0.37	0.78	0.61	1.00	0
Potamogeton amplifolius	Large-leaf pondweed	3	0.37	0.78	0.61	1.00	3
Ranunculus flammula	Creeping spearwort	3	0.37	0.78	0.61	1.67	1
Vallisneria americana	Wild celery	3	0.37	0.78	0.61	1.00	3

* Excluded from Relative Freq.

Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Silver Lake, Barron County
July 9-10, 2012

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sightings
Eleocharis erythropoda	Bald spikerush	2	0.25	0.52	0.40	1.00	0
Eriocaulon aquaticum	Pipewort	2	0.25	0.52	0.40	2.50	1
Utricularia vulgaris	Common bladderwort	2	0.25	0.52	0.40	1.00	1
Chara sp.	Muskgrass	1	0.12	0.26	0.20	1.00	0
Lindernia dubia	False pimpernel	1	0.12	0.26	0.20	1.00	0
Potamogeton pusillus	Small pondweed	1	0.12	0.26	0.20	1.00	0
Typha latifolia	Broad-leaved cattail	1	0.12	0.26	0.20	2.00	0
Juncus effusus	Common rush	**	**	**	**	**	2
Nuphar variegata	Spatterdock	**	**	**	**	**	1
Schoenoplectus tabernaemontani	Softstem bulrush	**	**	**	**	**	1
Agrostis scabra	Rough bent grass	***	***	***	***	***	***
Carex pellita	Broad-leaved woolly sedge	***	***	***	***	***	***
Carex scoparia	Broom sedge	***	***	***	***	***	***
Carex vulpinoidea	Fox sedge	***	***	***	***	***	***
Cyperus strigosus	False nut sedge	***	***	***	***	***	***
Juncus arcticus var. balticus	Arctic rush	***	***	***	***	***	***
Phalaris arundinacea	Reed canary grass	***	***	***	***	***	***
Scirpus cyperinus	Woolgrass	***	***	***	***	***	***
Sparganium emersum	Short-stemmed bur-reed	***	***	***	***	***	***

** Visual only *** Boat Survey Only

Nitella, Needle spikerush, Northern naiad, and Slender waterweed were the most common macrophyte species being found at 61.10%, 38.38%, 19.06%, and 18.54% of survey points with vegetation respectively (Table 2) (Figure 6). Together, they accounted for 64.81% of the total relative frequency. Waterwort (5.68), Spiny-spored quillwort (5.56), and Spiral-fruited pondweed (4.81) were the only other species with a relative frequency over 4.00 (for maps and information on all species, see Appendixes V and VI).

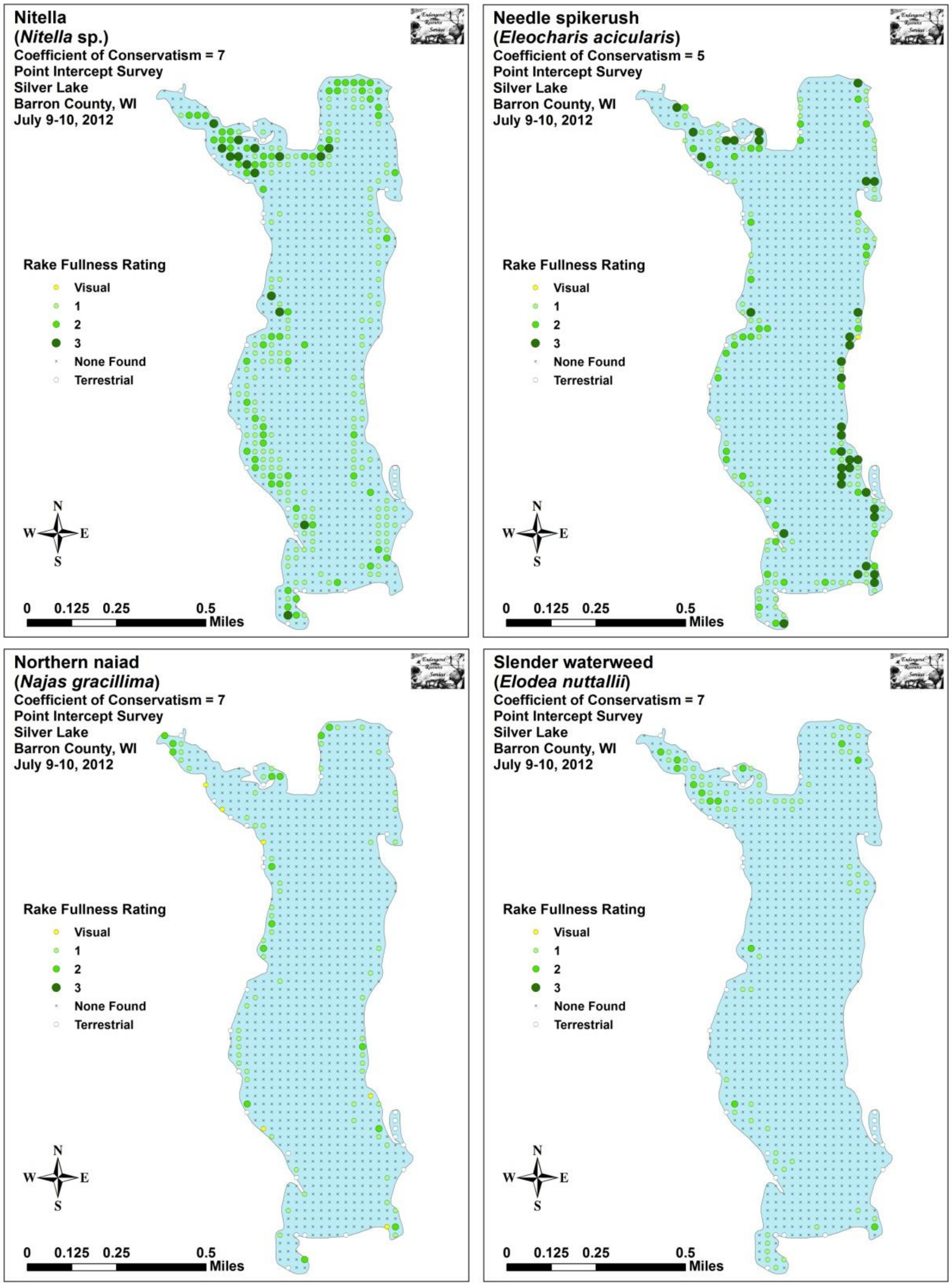


Figure 6: Silver Lake's Most Common Macrophyte Species

Table 3: Floristic Quality Index of Aquatic Macrophytes
Silver Lake, Barron County
July 9-10, 2012

Species	Common Name	C
Brasenia schreberi	Watershield	6
Ceratophyllum echinatum	Spiny hornwort	10
Chara sp.	Muskgrass	7
Elatine minima	Waterwort	9
Elatine triandra	Greater waterwort	9
Eleocharis acicularis	Needle spikerush	5
Eleocharis erythropoda	Bald spikerush	3
Elodea nuttallii	Slender waterweed	7
Eriocaulon aquaticum	Pipewort	9
Isoetes echinospora	Spiny-spored quillwort	8
Isoetes lacustris	Lake quillwort	8
Juncus pelocarpus	Brown-fruited rush	8
Lemna minor	Small duckweed	4
Myriophyllum tenellum	Dwarf water-milfoil	10
Najas gracillima	Northern naiad	7
Nitella sp.	Nitella	7
Nymphaea odorata	White water lily	6
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton bicupulatus	Snail-seed pondweed	9
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton spirillus	Spiral-fruited pondweed	8
Ranunculus flammula	Creeping spearwort	9
Sagittaria cristata	Crested arrowhead	9
Sagittaria rigida	Sessile-fruited arrowhead	8
Typha latifolia	Broad-leaved cattail	1
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
N		**28**
Mean C		**7.2**
FQI		**38.1**

We identified a total of 28 native **index** plants to species on the rake during the point intercept survey. They produced a mean Coefficient of Conservatism of 7.2 and Floristic Quality Index of 38.1 (Table 3). Nichols (1999) reported an average Mean C for the North Central Hardwood Forests Ecoregion of 5.6 putting Silver Lake well above average for this part of the state. The FQI was also nearly double the median FQI of 20.9 for the North Central Hardwood Forests Ecoregion (Nichols 1999). Exceptionally high value species of note included Spiny hornwort (C=10), Waterwort (C=9), Pipewort (C=9), Dwarf water milfoil (C = 10), Crested arrowhead (C=9), Creeping spearwort (C=9), and the two state special concern species ** Greater waterwort (C=9), and Snail-seed pondweed (C=9).

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

Exotic Species:

We did **NOT** find any evidence of Curly-leaf pondweed, Eurasian water milfoil or Purple loosestrife (*Lythrum salicaria*) on Silver Lake. Reed canary grass (*Phalaris arundinacea*), a ubiquitous exotic grass species, was present in scattered patches along the eastern and western shorelines and near the public boat landing (Figure 7). (For more information on exotic invasive species, see Appendix VII).

Figure 7: Reed Canary Grass on the Silver Lake Shoreline

Filamentous Algae:

Filamentous algae, normally associated with excessive nutrients in the water column, was located at 31 survey points (Figure 8). Most points occurred in front of residences or over organic muck in the bays. In these locations, the algae often coated native plants.

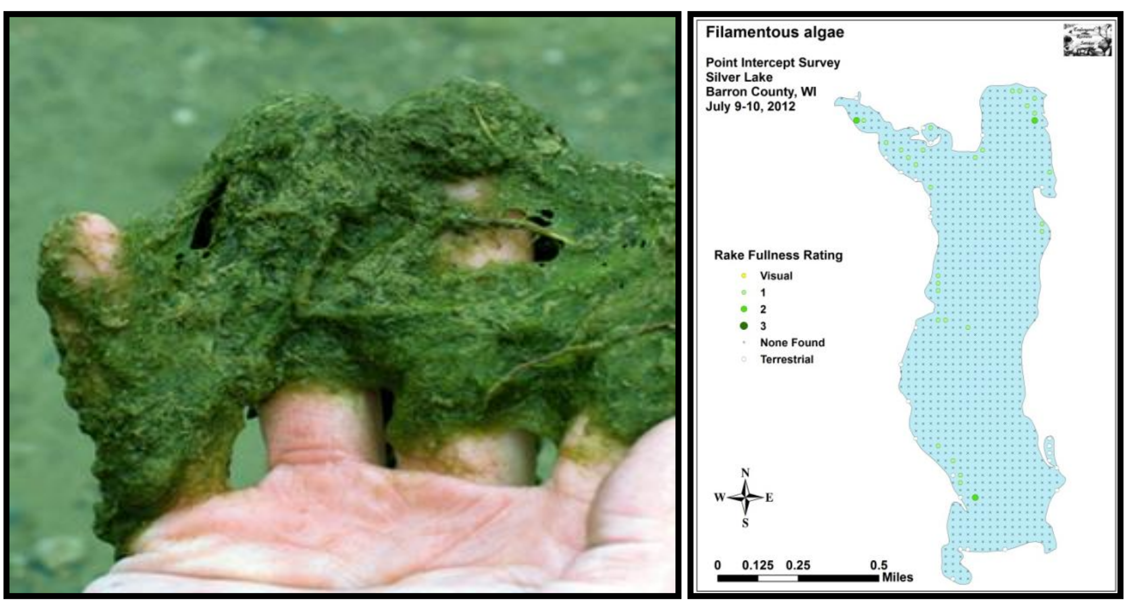


Figure 8: Filamentous Algae Distribution and Density

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Native Aquatic Macrophytes and Algae:

The Silver Lake aquatic ecosystem, based on the many species of rare and sensitive plants present, appears to be in excellent condition. The lake has healthy, rich, and diverse plant communities that appear to be positively affected by water clarity, quality, and chemistry. The presence of so many high index species suggests a history of conservation, and the biggest current challenge in management may simply be to maintain the status quo.

A lake's plants are the basis of the aquatic ecosystem, and preserving them is critical to maintaining a healthy lake. As the basis of the lake's 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. However, when nutrients in the water column increase to levels beyond what macrophytes can absorb, filamentous and floating algae tend to proliferate leading to declines in both water clarity and quality.

Because soil erosion and nutrient runoff promote algae growth, residents should evaluate how their shoreline practices may be impacting the lake. Simple things like establishing a buffer strip of native vegetation along the lake shore, bagging grass clippings, eliminating fertilizer near the lake, collecting pet waste, disposing of ash from fire pits away from the lakeshore, and avoiding stirring up sediments with motor start-ups in shallow water can all significantly reduce the amount of nutrients entering the lake's water column. We consistently noticed that residents who maintained their shorelines tended to have higher numbers of sensitive species in front of their residences and were much less likely to have filamentous algae coating the bottom and smothering these native plants. In general, Silver Lake's residents are to be commended for their shoreline conservation – especially in light of the current low water levels which are making it difficult to prevent erosion. In fact, many residences could serve as models for how to minimize human impacts along a lake (Figure 9). Hopefully, a greater understanding of how individual property owners can have lake-wide impacts will result in more people taking appropriate conservation actions to ensure continued water clarity and quality for all.

Figure 9: Model Natural Shoreline on Silver Lake's West Side

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water milfoil are an increasing problem in the lakes of northern Wisconsin in general, and several nearby lakes in Barron County in particular. Working to prevent their introduction into Silver Lake with proactive measures is strongly encouraged. Currently, the lake's establish Clean Boats/Clean Waters program and the noticeable signs at the lake's boat landing offer a layer of protection against AIS by providing education, reeducation, and reminders of the potential negative impacts of AIS to lake property owners and visitors alike (Figure 10).

Figure 10: Bright Signage at Silver Lake's Public Boat Landing

In the future, conducting monthly visual inspections around the public boat landing throughout the growing season and at least one annual meandering shoreline survey of the lake's entire visible littoral zone are further suggestions to consider as these surveys can result in early detection if an AIS is introduced into the lake. The sooner an infestation is detected, the greater the chances it can be successfully and economically controlled. Finally, developing an Aquatic Plant Management Plan prior to an infestation would help streamline an appropriate response if/when an infestation of EWM or some other AIS occurs.

Management Considerations Summary:

- Preserve the rare and sensitive native plants on Silver Lake and the critical habitat they provide for the whole lake ecosystem.
- Work to maintain water clarity and reduce algal growth by limiting nutrient inputs.
- Specifically, avoid mowing down to the lakeshore and reduce or, if possible, eliminate grass clippings runoff, fertilizer applications, and other sources of nutrients like pet waste and fire pit ashes near the lakeshore.
- Encourage shoreline restoration and the establishment of native vegetation buffer strips along the lakeshore to further prevent runoff and erosion.
- Avoiding stirring up sediments with motor start-ups in shallow water as this also promotes algal growth.
- Continue the Lake's Established Clean Boats/Clean Waters program.
- Maintain the signage at the public boat landing to remind people to clean their boats prior to launching.
- Consider carrying out monthly landing inspections and at least one annual meandering shoreline surveys of the lake's entire visible littoral zone to look for new AIS.
- Complete an Aquatic Plant Management Plan that clarifies a potential response to a new AIS, such as Eurasian water milfoil, if one becomes established in the lake.

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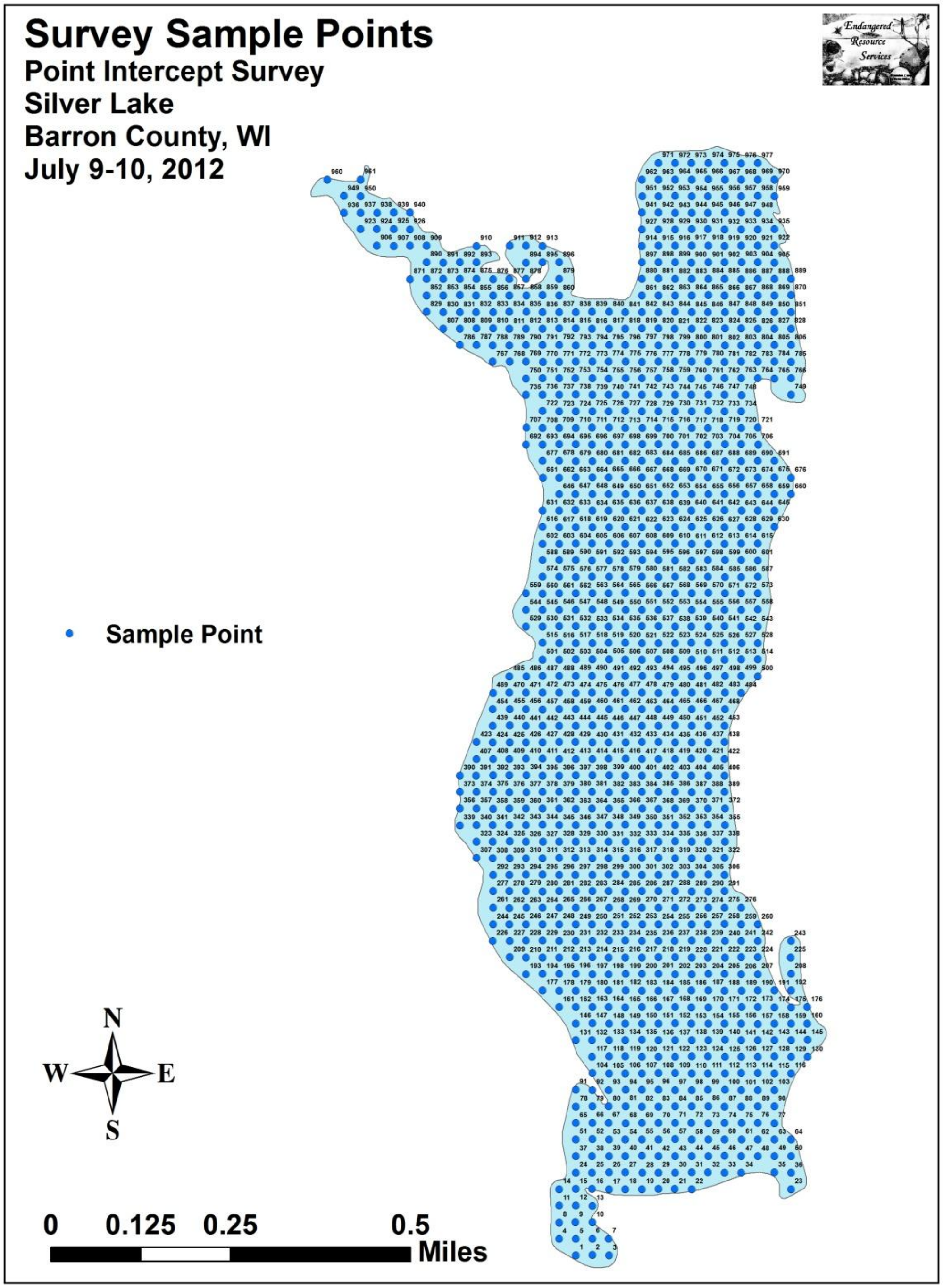
Appendix I: Silver Lake Survey Sample Points


Survey Sample Points
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Sample Point
N
W
E
S
0
0.125
0.25
0.5
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																									
9																									
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11																									
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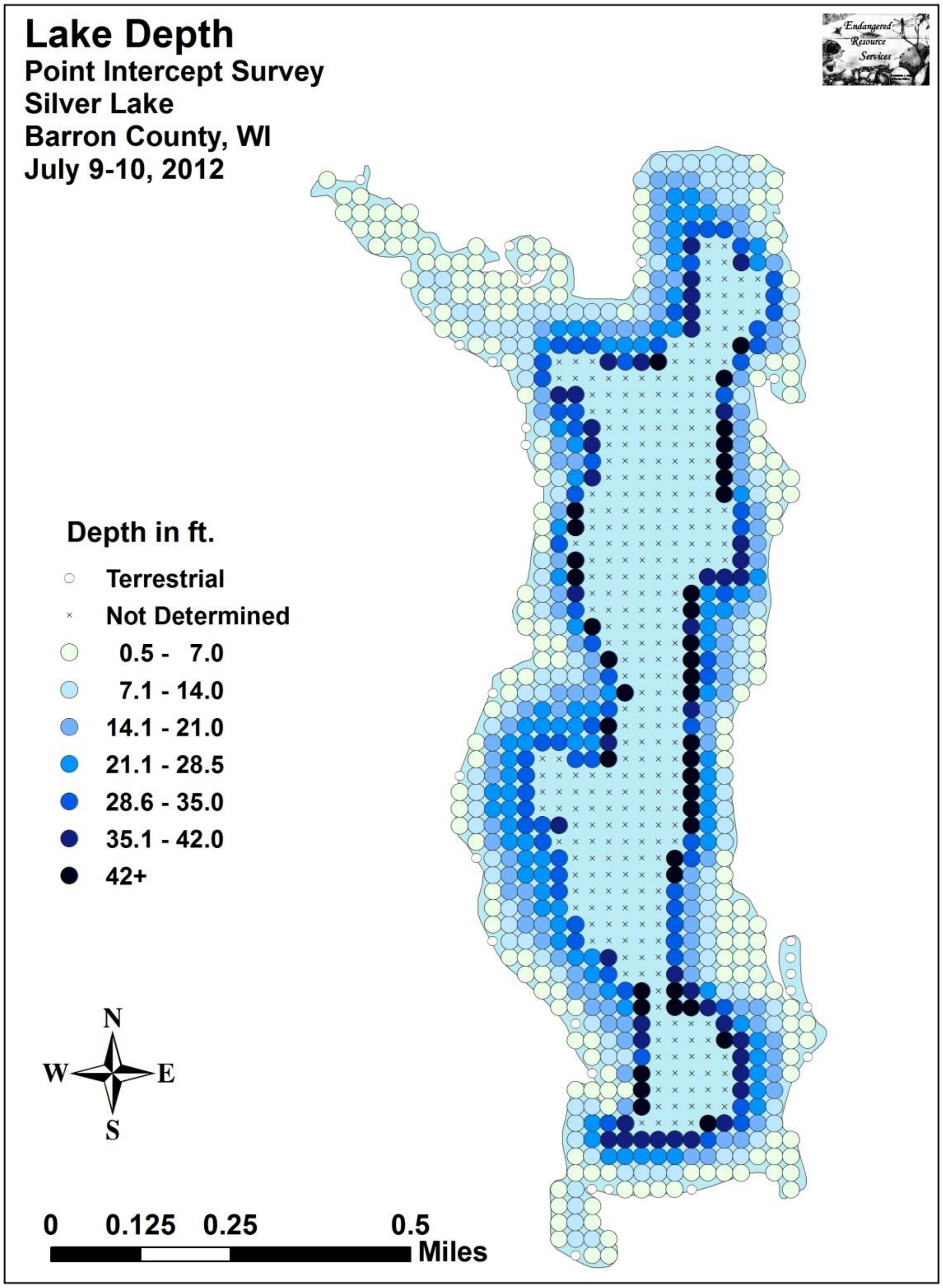
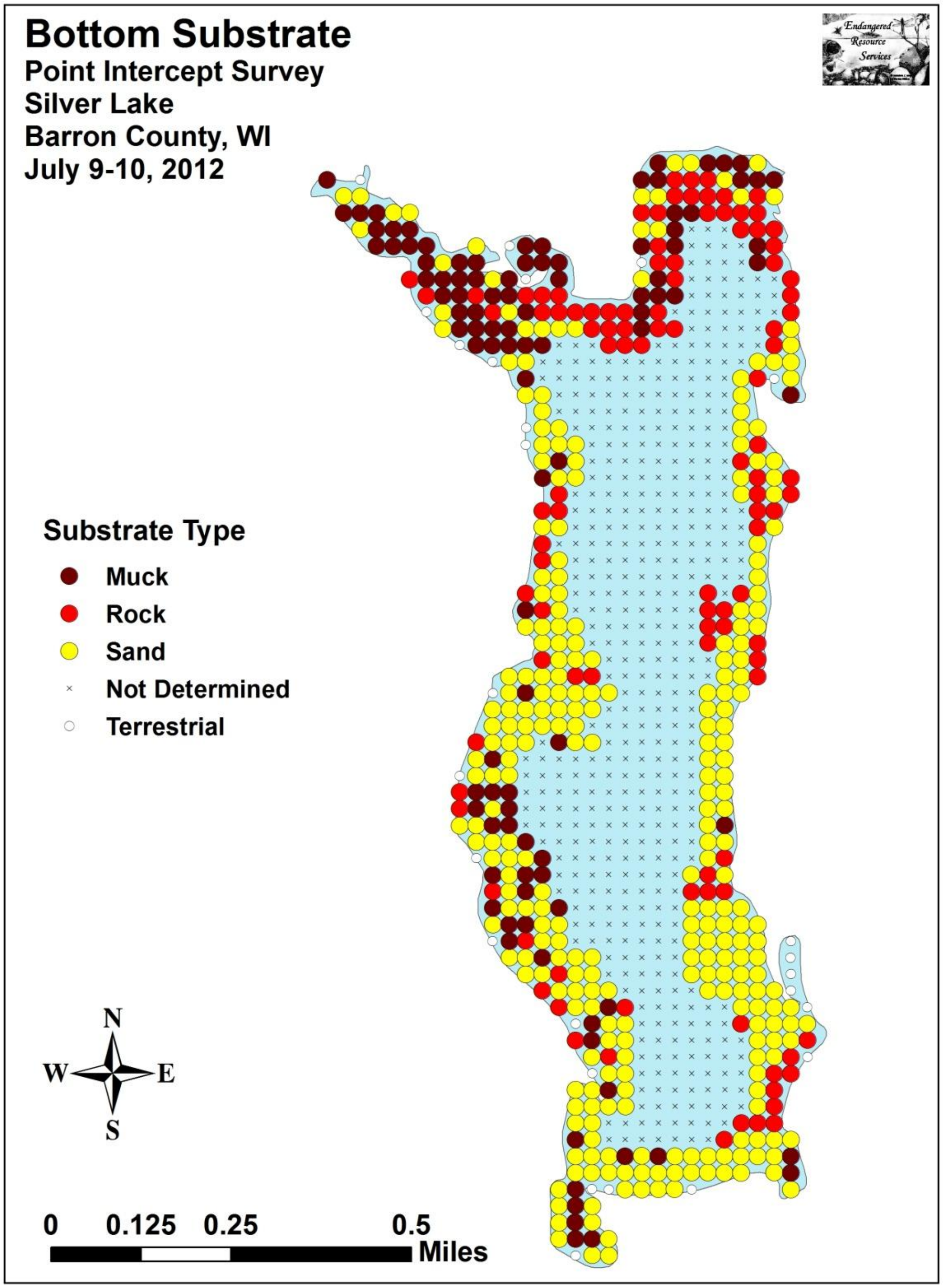
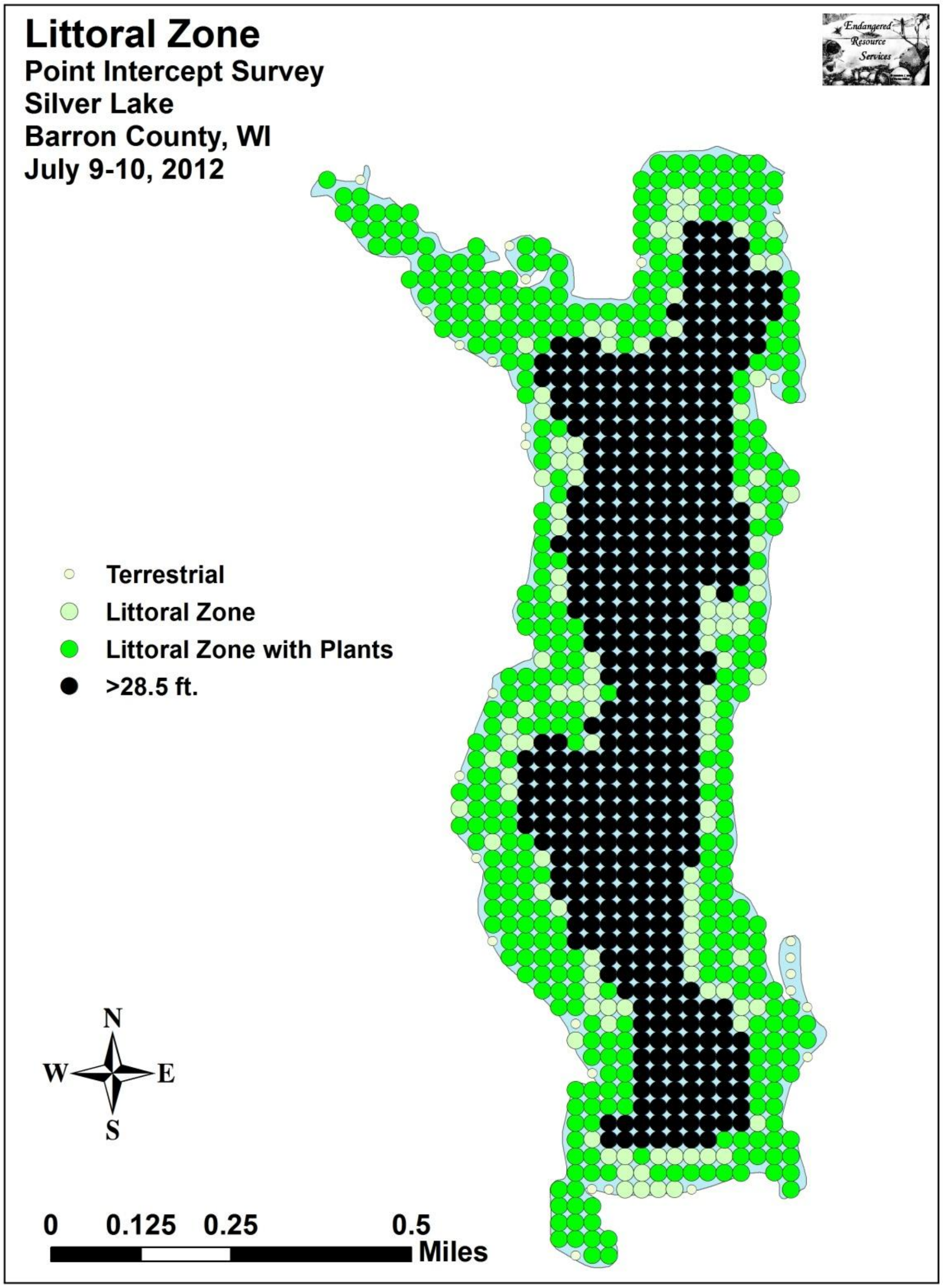
19																									
20																									

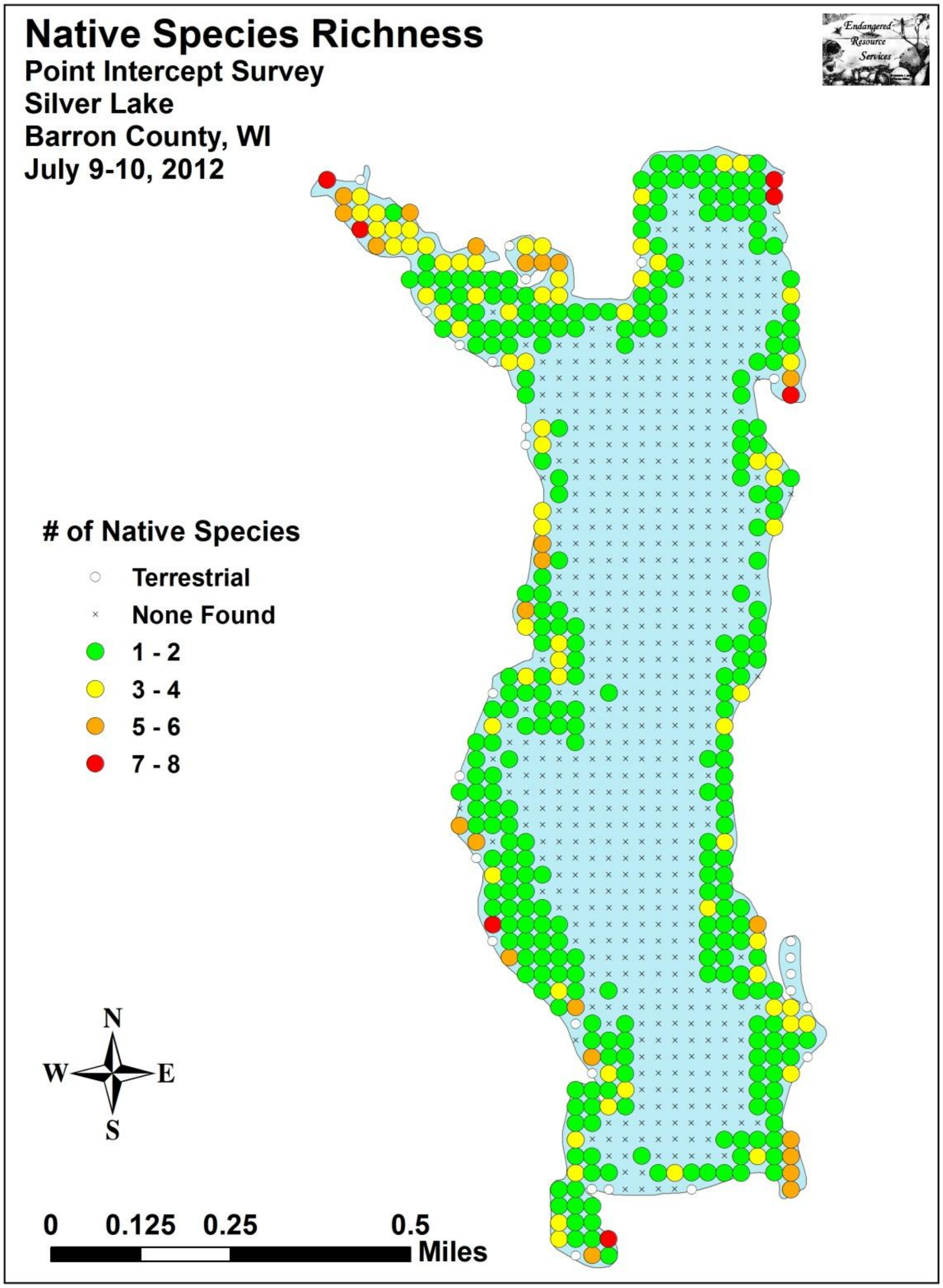
Appendix III: Habitat Variable Maps

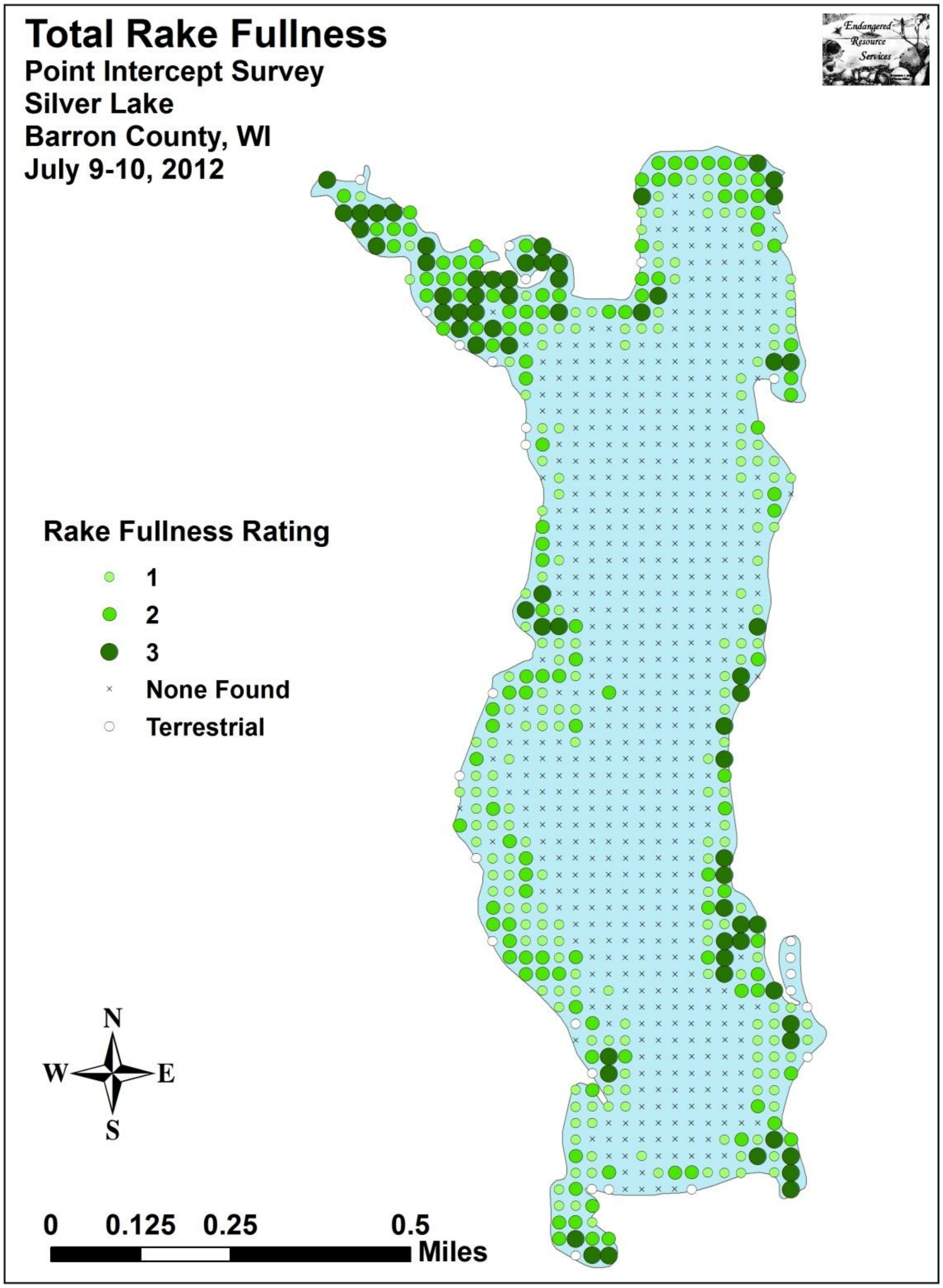

Lake Depth
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Depth in ft.
Terrestrial
Not Determined
0.5 - 7.0
7.1 - 14.0
14.1 - 21.0
21.1 - 28.5
28.6 - 35.0
35.1 - 42.0
42+
N
W
E
S
0
0.125
0.25
0.5
Miles


Bottom Substrate
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Substrate Type
Muck
Rock
Sand
Not Determined
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles


Littoral Zone
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Terrestrial
Littoral Zone
Littoral Zone with Plants
>28.5 ft.
N
W
E
S
0
0.125
0.25
0.5
Miles

Appendix IV: Native Species Richness and Total Rake Fullness Maps


Native Species Richness
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
# of Native Species
Terrestrial
None Found
1 - 2
3 - 4
5 - 6
7 - 8
N
W
E
S
0
0.125
0.25
0.5
Miles


Total Rake Fullness
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles

Appendix V: Silver Lake Plant Species Accounts

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Agrostis scabra*) **Rough bent grass**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-131
Habitat/Distribution: Sugar sand soils from the lake shore inland to the former margins of the lake (extended period of drought had lowered the lake several meters). Plants were common to abundant around the park/public boat landing and scattered elsewhere.
Common Associates: (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Cyperus strigosus*) False nut sedge, (*Carex pellita*) Broad-leaved woolly sedge, (*Juncus arcticus var. balticus*) Arctic rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-132
Habitat/Distribution: Muck and mucky sand bottoms in water 0.5-1.5m deep. Relatively common in bays and scattered shoreline locations.
Common Associates: (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Carex pellita*) **Broad-leaved woolly sedge**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-133
Habitat/Distribution: Sandy shoreline areas created by receding lake levels. Only plants seen were near the public boat landing.
Common Associates: (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Juncus arcticus var. balticus*) Arctic rush, (*Cyperus strigosus*) False nut sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Carex scoparia*) **Broom sedge**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-134
Habitat/Distribution: Sand bottom areas at the shoreline. Uncommon; a few individuals were scattered among the rushes in areas that were exposed by receding lake levels.
Common Associates: (*Juncus effusus*) Common rush, (*Juncus arcticus var. balticus*) Arctic rush, (*Carex pellita*) Broad-leaved woolly sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Carex vupinoidea*) **Fox sedge**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-135
Habitat/Distribution: Sand bottom areas at the shoreline. Uncommon; a few individuals were scattered among the rushes in areas that were exposed by receding lake levels.
Common Associates: (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Juncus arcticus*) Arctic rush, (*Cyperus strigosus*) False nut sedge, (*Carex pellita*) Broad-leaved woolly sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Ceratophyllum echinatum*) **Spiny hornwort**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-136
Habitat/Distribution: Muck bottom in 0-1.5 meters of water. Uncommon; plants were restricted to the northwest bay.
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Brasenia schreberi*) Watershield, (*Nuphar variegata*) Spatterdock

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: Silver Lake; N45.58781°, W91.91738°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-137
Habitat/Distribution: Sandy bottoms in 2 meters of water. A single individual was the only plant found. Told from the similar looking Nitella by its strong "skunk-like" smell.
Common Associates: (*Elodea nuttallii*) Slender waterweed, (*Nitella* sp.) Nitella

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Cyperus strigosus*) **False nut sedge**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-138
Habitat/Distribution: Widely distributed in sandy shoreline areas created by receding lake levels.
Common Associates: (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Juncus arcticus var. balticus*) Arctic rush, (*Carex pellita*) Broad-leaved woolly sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Elatine minima*) **Waterwort**
Specimen Location: Silver Lake; N45.57868°, W91.92513°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-139
Habitat/Distribution: Rocky to sandy bottoms in <1 meter of water. Common throughout.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine triandra*) Greater waterwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Isoetes echinospora*) Spiny-spored quillwort

County/State: Barron County, Wisconsin **Date:** 9/29/12
Species: (*Elatine triandra*) **Greater waterwort**
Specimen Location: Silver Lake; N45.59215°, W91.92699°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-140
Habitat/Distribution: Soft sandy muck in <1m of water. Plants were abundant in the Northwest bay and scattered elsewhere. We returned to the lake in September to find individuals in fruit to confirm identification. At this time, we found many more plants than in July.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Elatine minima*) Waterwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Isoetes echinospora*) Spiny-spored quillwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Eleocharis acicularis*) **Needle spikerush**
Specimen Location: Silver Lake; N45.57868°, W91.92513°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-141
Habitat/Distribution: Abundant throughout in sand/silt/rock bottom areas in water from 0 – 1 meter deep. Occasionally growing as an emergent at the shoreline.
Common Associates: (*Isoetes echinospora*) Spiny-spored quillwort, (*Ranunculus flammula*) Creeping spearwort, (*Juncus pelocarpus*) Brown-fruited rush, (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Eleocharis erythropoda*) **Bald spikerush**
Specimen Location: Silver Lake; N45.58935°, W91.92455°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-142
Habitat/Distribution: Rare at the shoreline. Specimens were somewhat ambiguous in size between *E. erythropoda*/*E. palustris*. We identified as erythropoda based on the "tooth" present on most individuals and the distal leaves being persistent and not shredding.
Common Associates: (*Juncus pelocarpus*) Brown-fruited rush, (*Juncus effusus*) Common rush

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Elodea nuttallii*) **Slender waterweed**
Specimen Location: Silver Lake; N45.59235°, W91.92465°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-143
Habitat/Distribution: Soft sandy muck in water from 1-4m deep. Deeper water specimens had longer leaves (9-12mm) while shallow water individuals were more often shorter (7-9mm). Width varied from 0.7-1.5mm. It's possible some individuals were depauperate *E. canadensis*, but, as the majority of plants fell in the 1:10 width/length leaf ratio of *E. nuttallii*, we opted to put all specimens in this group.
Common Associates: (*Najas gracillima*) Northern naiad, (*Nitella* sp.) Nitella, (*Isoetes lacustris*) Lake quillwort, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Eriocaulon aquaticum*) **Pipewort**
Specimen Location: Silver Lake; N45.59380°, W91.91758°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-144
Habitat/Distribution: Sand and sandy muck bottoms in water <1m deep. Locally abundant, but restricted to the far northeast bay where it carpeted the lake bottom.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Ranunculus flammula*) Creeping spearwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Isoetes echinospora*) Spiny-spored quillwort, (*Elatine minima*) Waterwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Isoetes echinospora*) **Spiny-spored quillwort**
Specimen Location: Silver Lake; N45.57868°, W91.92513°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-145
Habitat/Distribution: Sand and sandy muck in water <1.5m deep. Widespread and common.
Common Associates: (*Juncus pelocarpus*) Brown-fruited rush, (*Ranunculus flammula*) Creeping spearwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Isoetes lacustris*) **Lake quillwort**
Specimen Location: Silver Lake; N45.59106°, W91.92176°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-146
Habitat/Distribution: Sand, sandy muck and rock bottoms in water usually >1m deep. Widespread and common.
Common Associates: (*Elodea nuttallii*) Slender waterweed, (*Najas gracillima*) Northern naiad, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Nitella* sp.) Nitella

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Juncus effusus*) **Common rush**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-147
Habitat/Distribution: Common in firm sand bottom areas at the shoreline and in areas that were exposed by receding lake levels.
Common Associates: (*Juncus arcticus var. balticus*) Arctic rush, (*Juncus pelocarpus*) Brown-fruited rush, (*Scirpus cyperinus*) Woolgrass, (*Cyperus strigosus*) False nut sedge, (*Carex pellita*) Broad-leaved woolly sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Juncus arcticus var. balticus*) **Arctic rush**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-148
Habitat/Distribution: Sugar sand soils from the lake shore inland to the former margins of the lake (extended period of drought had lowered the lake several meters). Plants were common to abundant around the park/public boat landing and scattered elsewhere.
Common Associates: (*Juncus effusus*) Common rush, (*Scirpus cyperinus*) Woolgrass, (*Cyperus strigosus*) False nut sedge, (*Carex pellita*) Broad-leaved woolly sedge

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Juncus pelocarpus*) **Brown-fruited rush**
Specimen Location: Silver Lake; N45.59380°, W91.91758°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-149
Habitat/Distribution: Uncommon but widely distributed in sand/silt/rock bottom areas in water from 0 – 1 meter deep. Occasionally growing as an emergent at the shoreline.
Common Associates: (*Isoetes echinospora*) Spiny-spored quillwort, (*Ranunculus flammula*) Creeping spearwort, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-150
Habitat/Distribution: Floating over organic muck; only plants found were in the northwest corner of the northwest bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Utricularia vulgaris*) Common bladderwort, (*Sagittaria rigida*) Sessile-fruited arrowhead, (*Nymphaea odorata*) White water lily

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Lindernia dubia*) **False pimpernel**
Specimen Location: Silver Lake; N45.59326 °, W91.92942°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-151
Habitat/Distribution: Sandy muck in <0.5m of water and on shore. Rare; only submersed individuals were found at the point. Emergent plants were scattered in mucky shoreline areas of the northwest bay.
Common Associates: (*Sparganium emersum*) Short-stemmed bur-reed, (*Elatine minima*) Waterwort, (*Juncus pelocarpus*) Brown-fruited rush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Elatine triandra*) Greater waterwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Myriophyllum tenellum*) **Dwarf water milfoil**
Specimen Location: Silver Lake; N45.57868°, W91.92513°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-152
Habitat/Distribution: Variable substrate in 0-2 meters of water. Plants were widely distributed, but uncommon.
Common Associates: (*Isoetes echinospora*) Spiny-spored quillwort, (*Ranunculus flammula*) Creeping spearwort, (*Juncus pelocarpus*) Brown-fruited rush, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Najas gracillima*) **Northern naiad**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-153
Habitat/Distribution: Sandy to sandy muck bottom in water from 1-3m deep. Widespread and common throughout.
Common Associates: (*Elodea nuttallii*) Slender waterweed, (*Nitella* sp.) Nitella, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton bicupulatus*) Snail-seed pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Nitella* sp.) **Nitella**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-154
Habitat/Distribution: Sandy to sandy muck bottom in water from 1-9m deep; especially in water >4m. Widespread and abundant throughout.
Common Associates: (*Elodea nuttallii*) Slender waterweed, (*Najas gracillima*) Northern naiad, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Isoetes lacustris*) Lake quillwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: Silver Lake; N45.59235°, W91.92465°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-155
Habitat/Distribution: Muck bottom in 0-1.5 meters of water. Rare; almost all plants were restricted to the northwest bay.
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Brasenia schreberi*) Watershield, (*Ceratophyllum echinatum*) Spiny hornwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Silver Lake; N45.59235°, W91.92465°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-156
Habitat/Distribution: Muck and mucky sand bottoms in water 0.5-2m deep. Relatively common in muck and sandy muck bottom bays and scattered shoreline locations.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Brasenia schreberi*) Watershield, (*Nuphar variegata*) Spatterdock, (*Ceratophyllum echinatum*) Spiny hornwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-157
Habitat/Distribution: Common, but not abundant. Plants were scattered at the "normal" waterline with most plants being found on the lake's south ½; especially near the boat landing.
Common Associates: (*Juncus arcticus var. balticus*) Arctic rush, (*Carex pellita*) Broad-leaved woolly sedge, (*Juncus effusus*) Common rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-158
Habitat/Distribution: Uncommon, but widely distributed. Most plants were found in the northwest bay over organic muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Ceratophyllum echinatum*) Spiny hornwort, (*Potamogeton spirillus*) Spiral-fruited pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton bicupulatus*) **Snail-seed pondweed**
Specimen Location: Silver Lake; N45.59346°, W91.91757°
Collected/Identified by: Matthew S. Berg/Paul Skawinski Col. #: MSB-2012-159
Habitat/Distribution: Common and widely distributed in sheltered muck bottom bays and shorelines. Plants were especially abundant in the northwest bay and on the western shoreline with lesser numbers on the east side. An unusual morph in that it had lacunar bands (this species should not), wide leaves (0.3-0.5mm wide), and minimal spines on the nutlet (no beak/ it is definitely not *P. diversifolius*). All characters graded into *P. spirillus* of which it occurred side by side throughout. Skawinski felt confident it was this species based on stipules being attached for <1/2 of leaf.
Common Associates: (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Eleocharis acicularis*) Needle spikerush, (*Najas gracillima*) Northern naiad, (*Brasenia schreberi*) Watershield

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-160
Habitat/Distribution: Most plants were found in sandy muck bottom conditions in shallow water 0.5-1.5 meters deep. For this species, they had very thin leaves, and seemed to be in generally poor health suggesting the lake provides marginal habitat at best.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Potamogeton bicupulatus*) Snail-seed pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Silver Lake; N45.59208°, W91.92084°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-161
Habitat/Distribution: Rare over organic muck bottoms in shallow water 0.5-1.5 meters deep. With one exception, all plants found were in the north side bay at the entrance of the northwest bay interpoint.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Potamogeton bicupulatus*) Snail-seed pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton spirillus*) **Spiral-fruited pondweed**
Specimen Location: Silver Lake; N45.57803°, W91.92463°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-162
Habitat/Distribution: Found in sandy to sandy muck bottom conditions in water from 0.5-3.0 meters deep. Plants were very common throughout. Nutlets and leaves (0.4-0.6mm) on nutrient poor sediments graded into *P. bicupulatus* making i.d. challenging although bicup usually had a single poorly formed ventral spine on the nutlet that spirillus did not.
Common Associates: (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Brasenia schreberi*) Watershield, (*Eleocharis acicularis*) White water lily, (*Najas gracillima*) Northern naiad

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Ranunculus flammula*) **Creeping spearwort**
Specimen Location: Silver Lake; N45.59380°, W91.91758°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-163
Habitat/Distribution: Firm sandy muck bottoms in 0-0.5 meter of water. Uncommon in shoreline areas along the northern 1/3rd of the lake.
Common Associates: (*Isoetes echinospora*) Spiny-spored quillwort, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Juncus pelocarpus*) Brown-fruited rush, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Sagittaria cristata*) **Crested arrowhead**
Specimen Location: Silver Lake; N45.59380°, W91.91758°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-164
Habitat/Distribution: Firm sandy muck bottoms in <1m of water. Common and widely distributed throughout.
Common Associates: (*Isoetes echinospora*) Spiny-spored quillwort, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Juncus pelocarpus*) Brown-fruited rush, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Eriocaulon aquaticum*) Pipewort

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Sagittaria rigida*) **Sessile-fruited arrowhead**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-165
Habitat/Distribution: Firm sand to sandy muck at the shoreline. Scattered patches of plants were found throughout. It was especially common on the western shoreline.
Common Associates: (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Elatine triandra*) Greater waterwort, (*Eleocharis acicularis*) Needle spikerush, (*Elatine minima*) Waterwort, (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Isoetes echinospora*) Spiny-spored quillwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Silver Lake; N45.57770°, W91.92415°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-166
Habitat/Distribution: Firm sandy muck bottoms at the shoreline. Only plants seen on the entire lake were at the point.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Sagittaria rigida*) Sessile-fruited arrowhead, (*Scirpus cyperinus*) Woolgrass, (*Juncus effusus*) Common rush

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Scirpus cyperinus*) **Woolgrass**
Specimen Location: Silver Lake; N45.57274°, W91.92208°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-167
Habitat/Distribution: Firm sand bottom at the shoreline. Plants were scattered in areas that were exposed by receding lake levels.
Common Associates: (*Juncus effusus*) Common rush, (*Juncus arcticus var. balticus*) Arctic rush, (*Cyperus strigosus*) False nut sedge, (*Carex pellita*) Broad-leaved woolly sedge

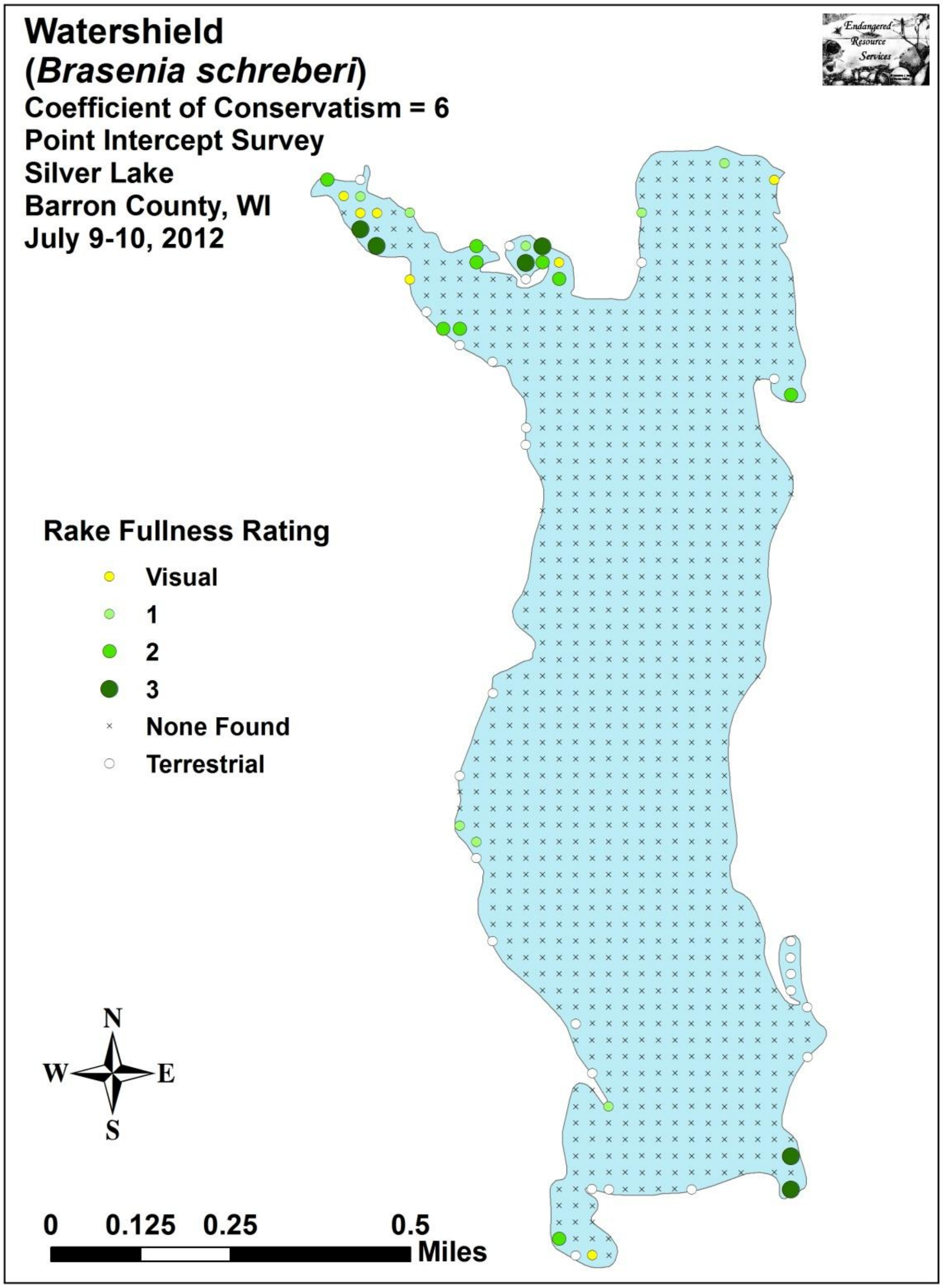
County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Sparganium emersum*) **Short-stemmed bur-reed**
Specimen Location: Silver Lake; N45.59326 °, W91.92942°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-168
Habitat/Distribution: Sandy muck in <0.25m of water and on shore. Rare; only individuals were found at the point in the northwest corner of the northwest bay.
Common Associates: (*Lindernia dubia*) False pimpernel, (*Elatine minima*) Waterwort, (*Juncus pelocarpus*) Brown-fruited rush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Elatine triandra*) Greater waterwort

County/State: Barron County, Wisconsin **Date:** 7/9/12
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-169
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Rare; a few 10's of plants were found in the lake's northwest bay.
Common Associates: (*Sagittaria rigida*) Sessile-fruited arrowhead, (*Utricularia vulgaris*) Common bladderwort, (*Lemna minor*) Small duckweed, (*Sparganium emersum*) Short-stemmed bur-reed

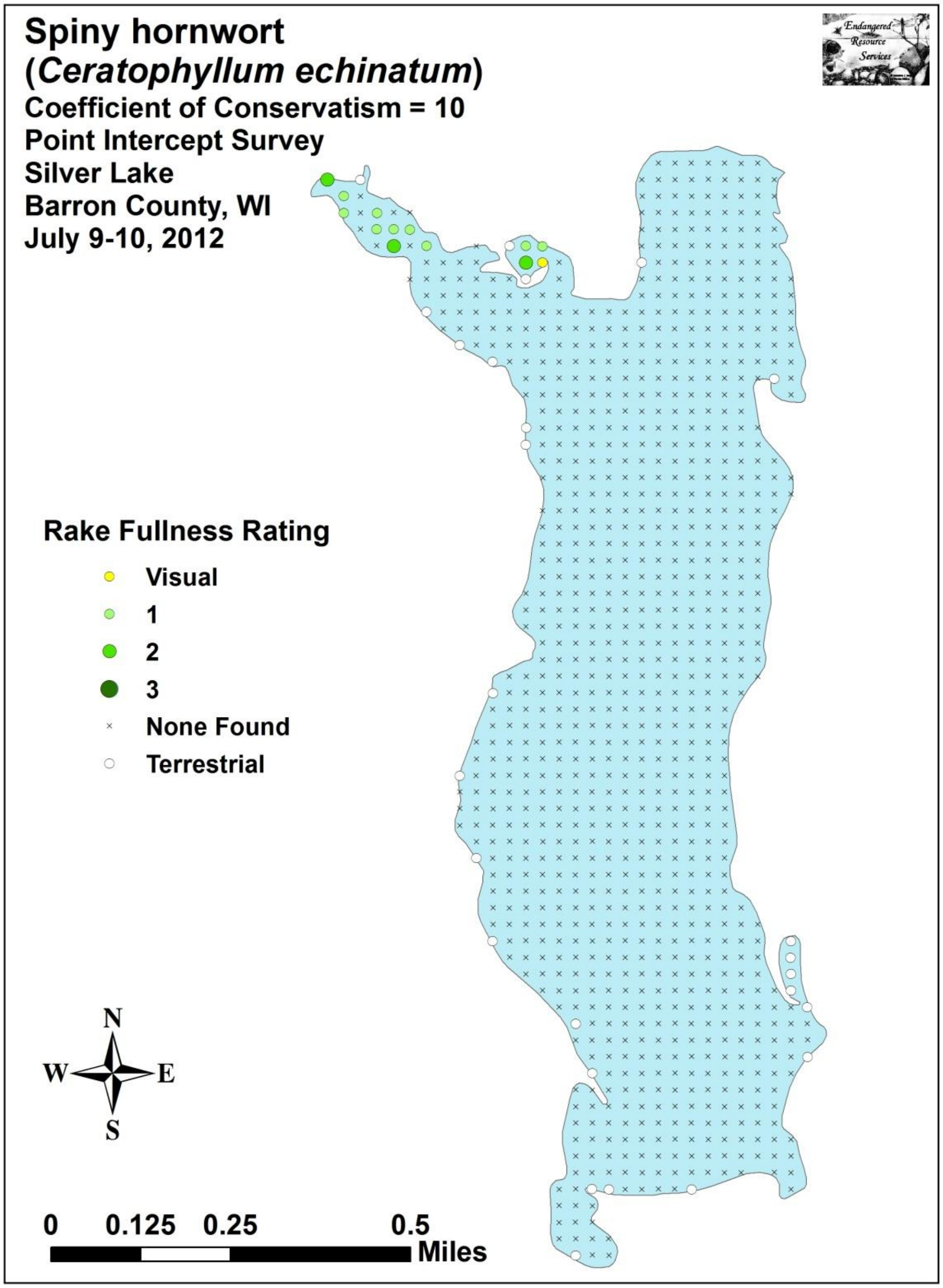
County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Silver Lake; N45.59292°, W91.92989°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-170
Habitat/Distribution: Muck bottom in water 0-1 meters deep. Rare; restricted to the far northwest corner of the northwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Typha latifolia*) Broad-leaved cattail, (*Lemna minor*) Small duckweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Silver Lake; N45.58703°, W91.92399°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-171
Habitat/Distribution: Uncommon in <1.5m of water over sandy muck. Plants were widely scattered along the shoreline of the northern 1/3rd of the lake; especially in the northwest bay.
Common Associates: (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Eriocaulon aquaticum*) Pipewort

Appendix VI: Silver Lake P/I Density and Distribution Maps



Watershield
(*Brasenia schreberi*)
Coefficient of Conservatism = 6
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles



Spiny hornwort
(*Ceratophyllum echinatum*)
Coefficient of Conservatism = 10
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
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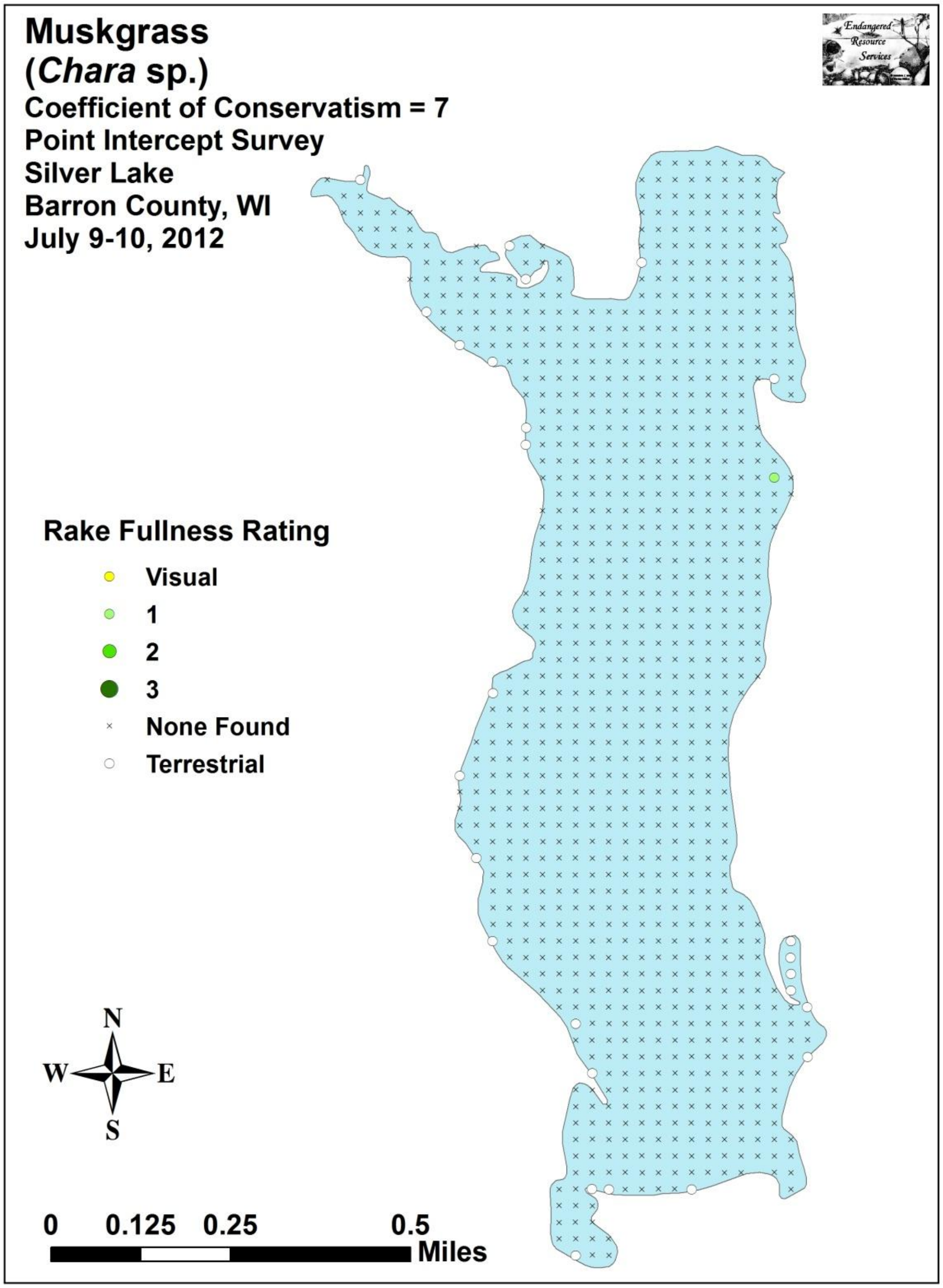
0
0.125
0.25
0.5
Miles


Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
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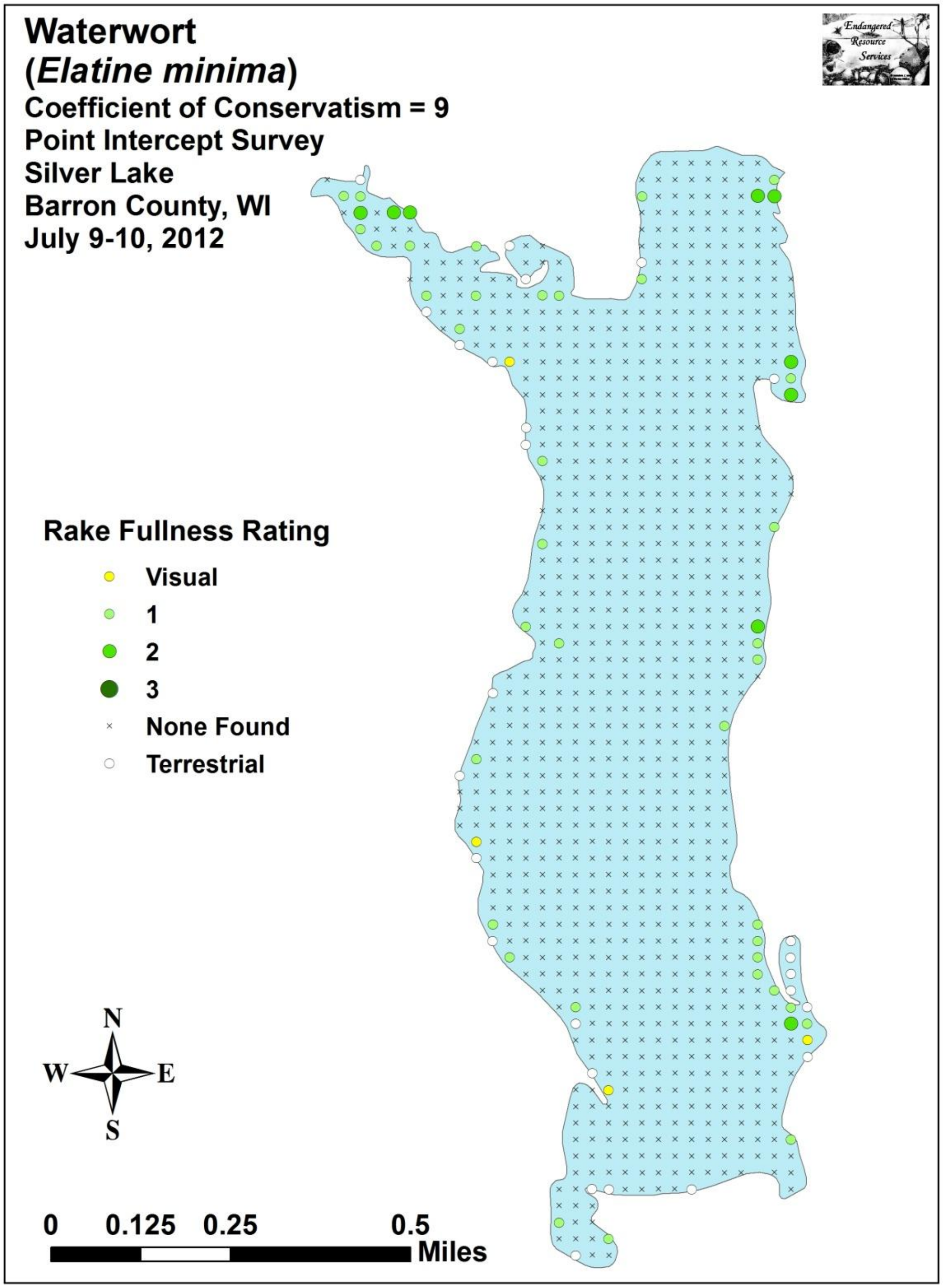
0
0.125
0.25
0.5
Miles


Waterwort
(*Elatine minima*)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
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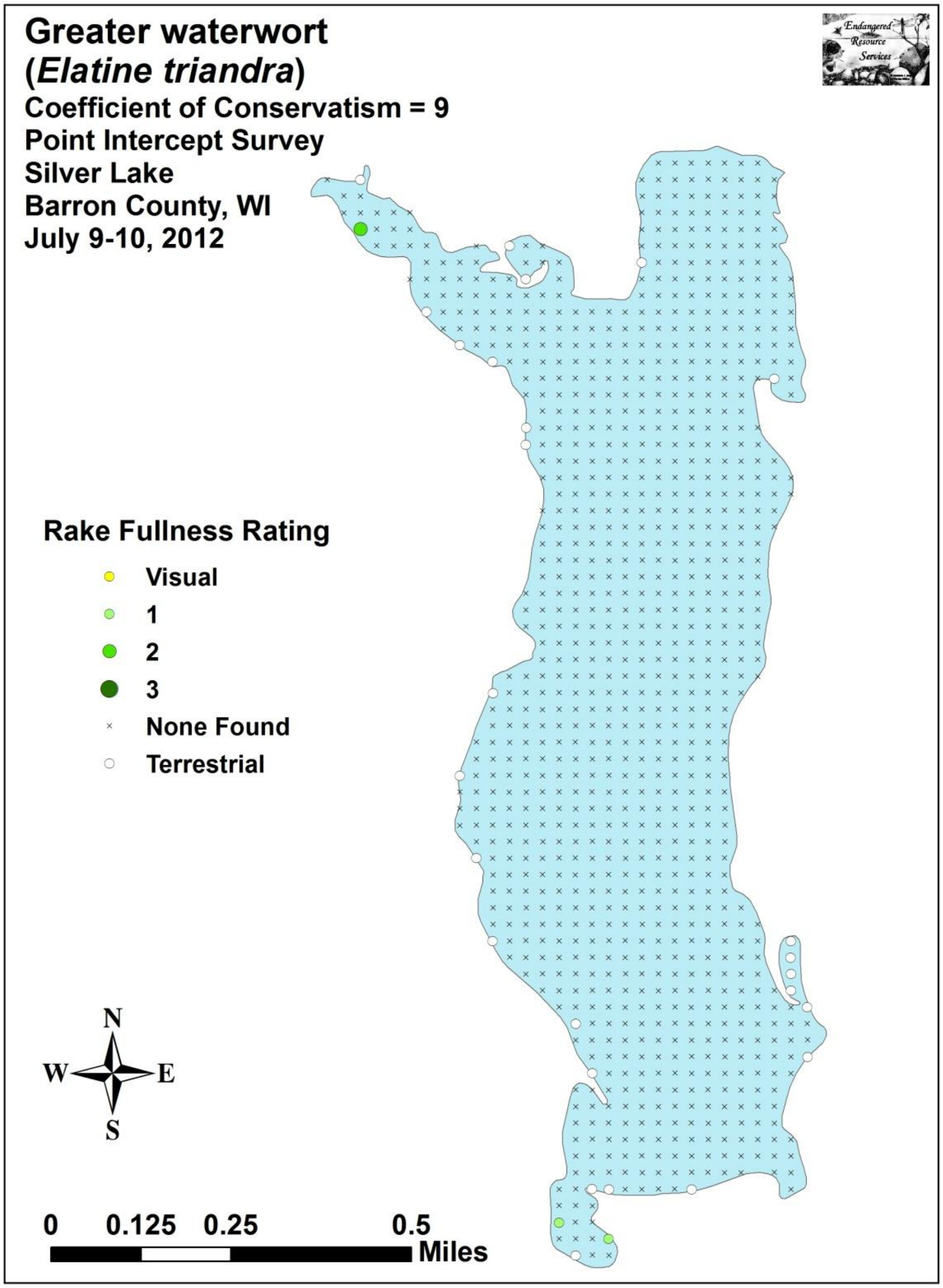
Miles


Greater waterwort
(*Elatine triandra*)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
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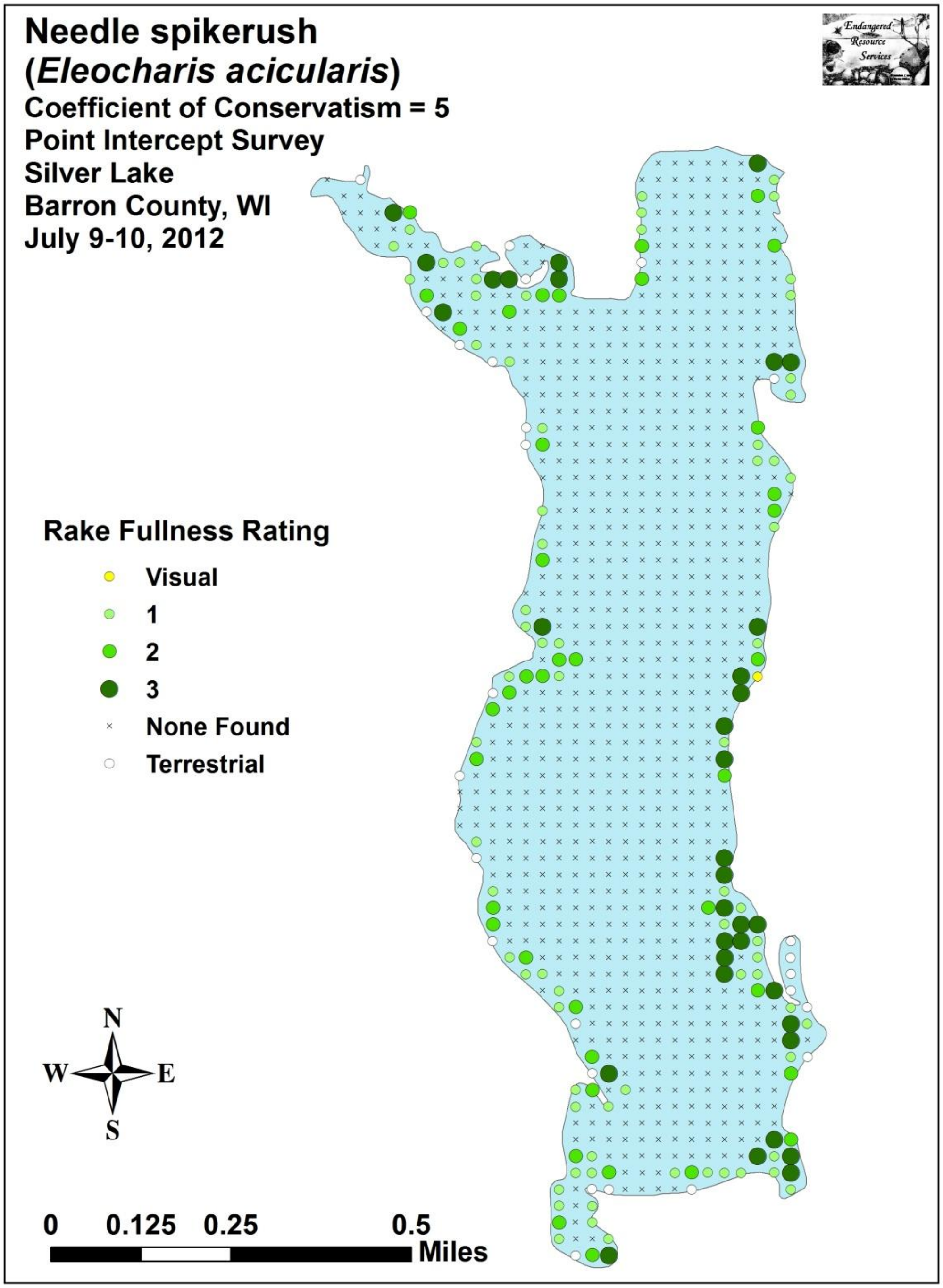
0
0.125
0.25
0.5
Miles


Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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2
3
None Found
Terrestrial
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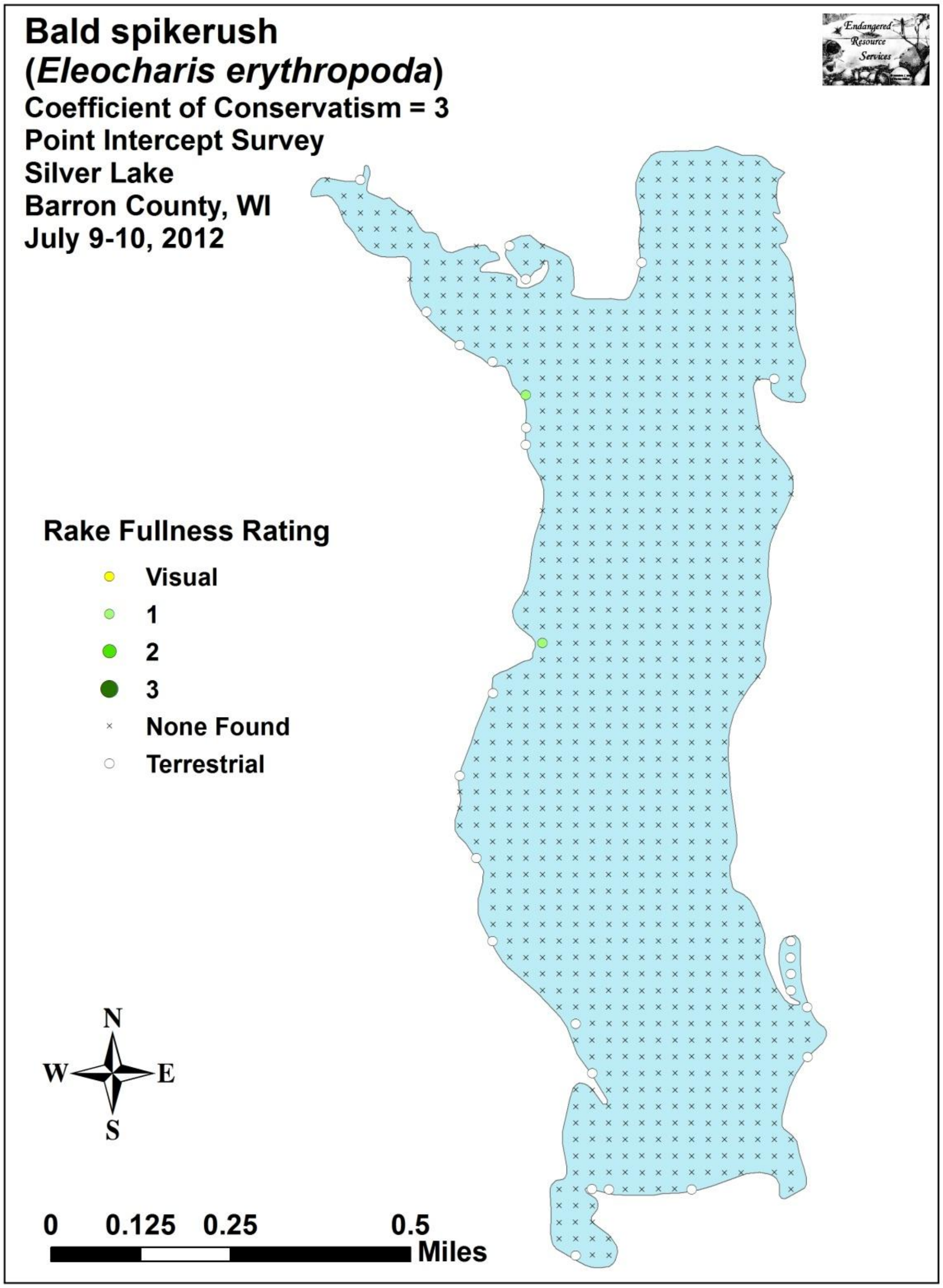
0.125
0.25
0.5
Miles


Bald spikerush
(*Eleocharis erythropoda*)
Coefficient of Conservatism = 3
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
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W
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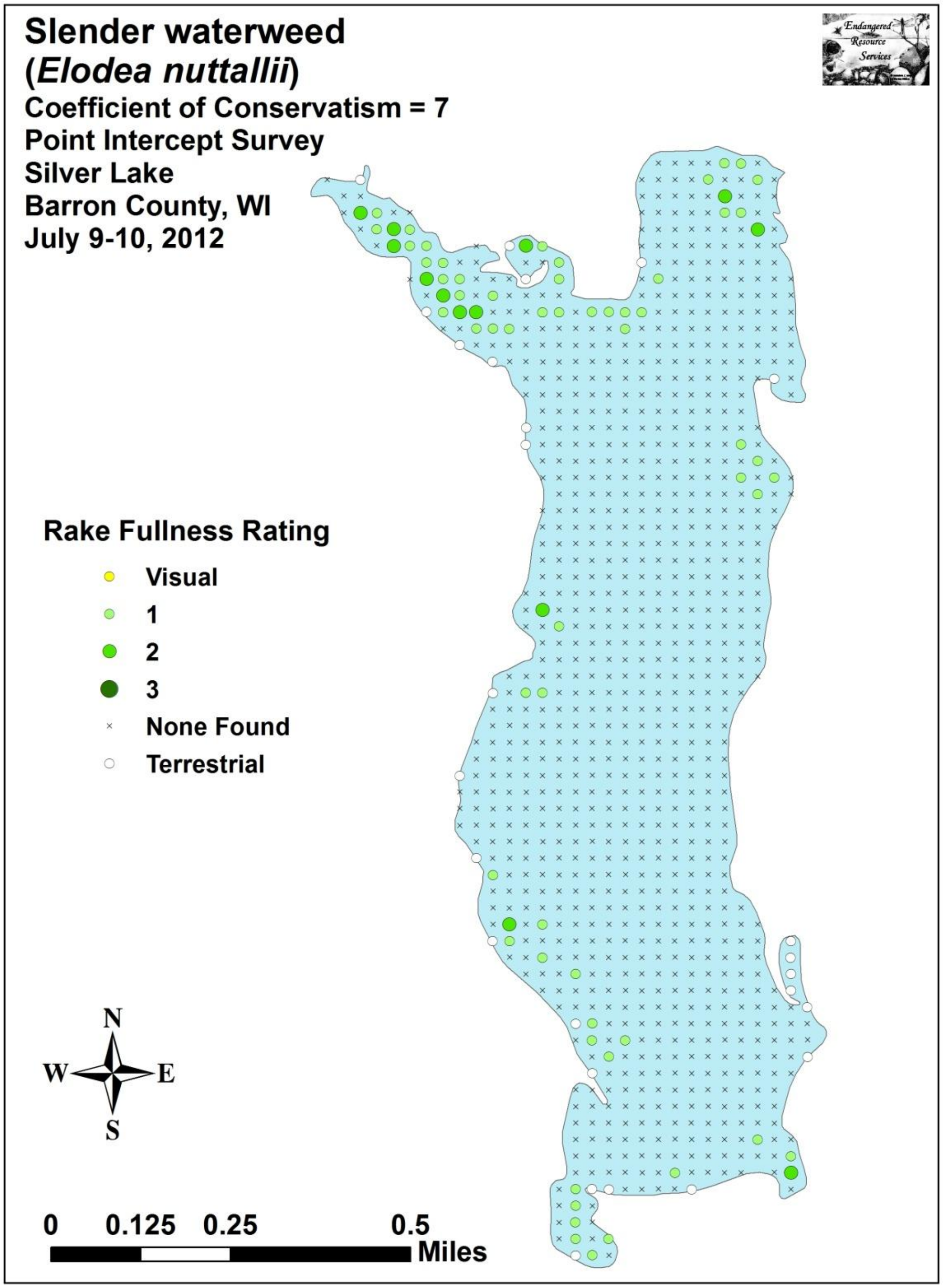
0
0.125
0.25
0.5
Miles


Slender waterweed
(Elodea nuttallii)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
Terrestrial
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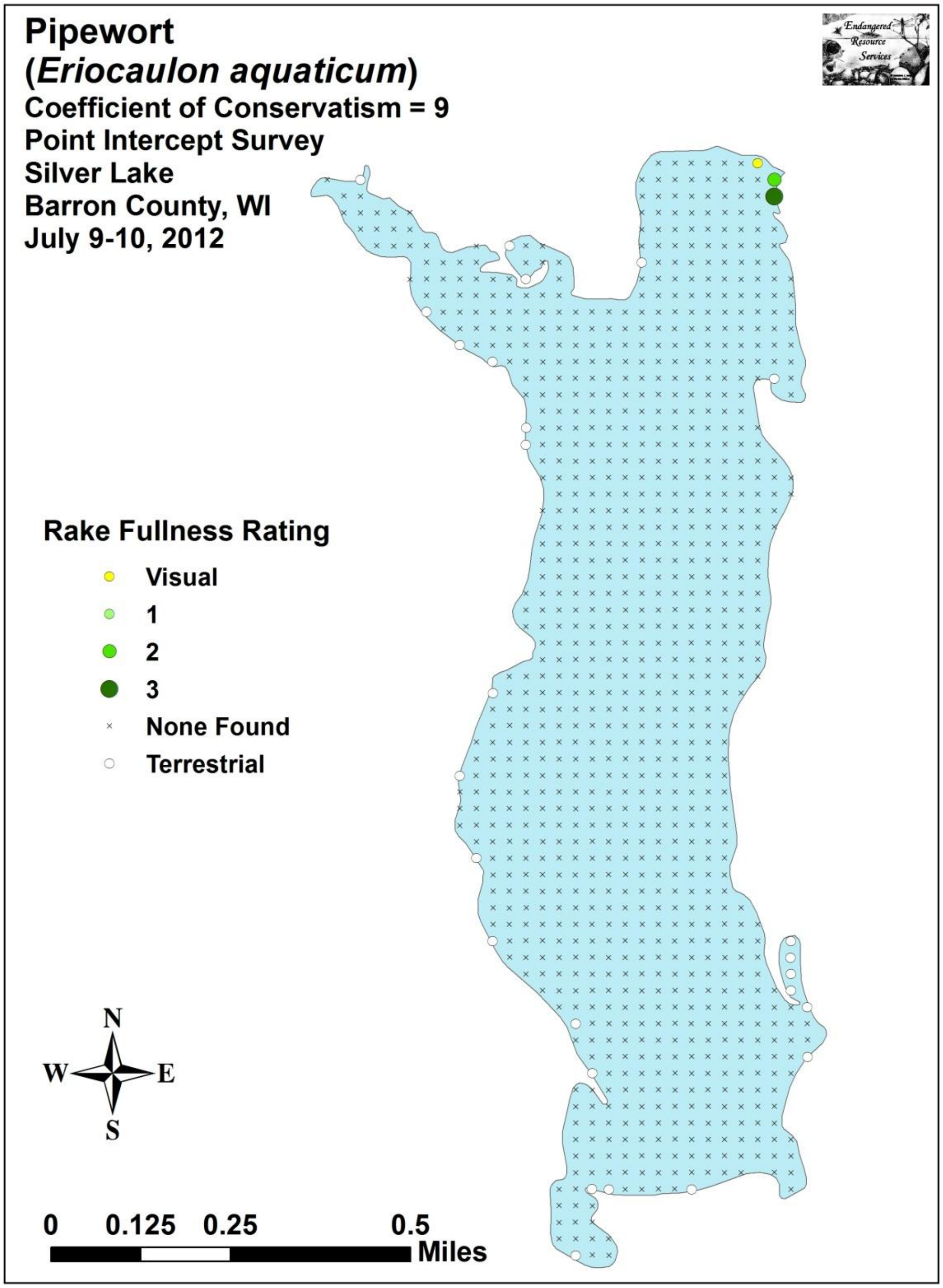
0.125
0.25
0.5
Miles


Pipewort
(*Eriocaulon aquaticum*)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
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W
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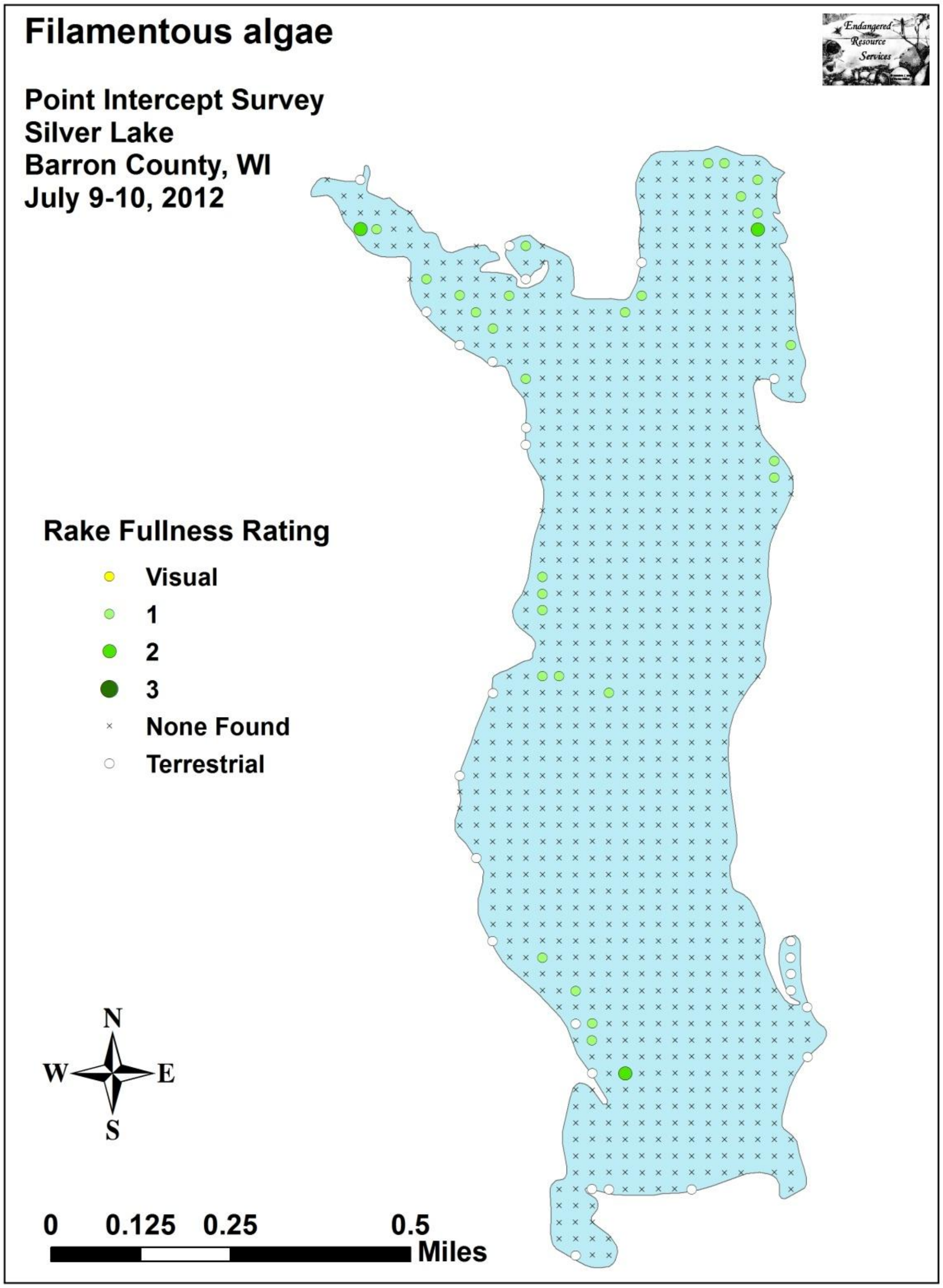
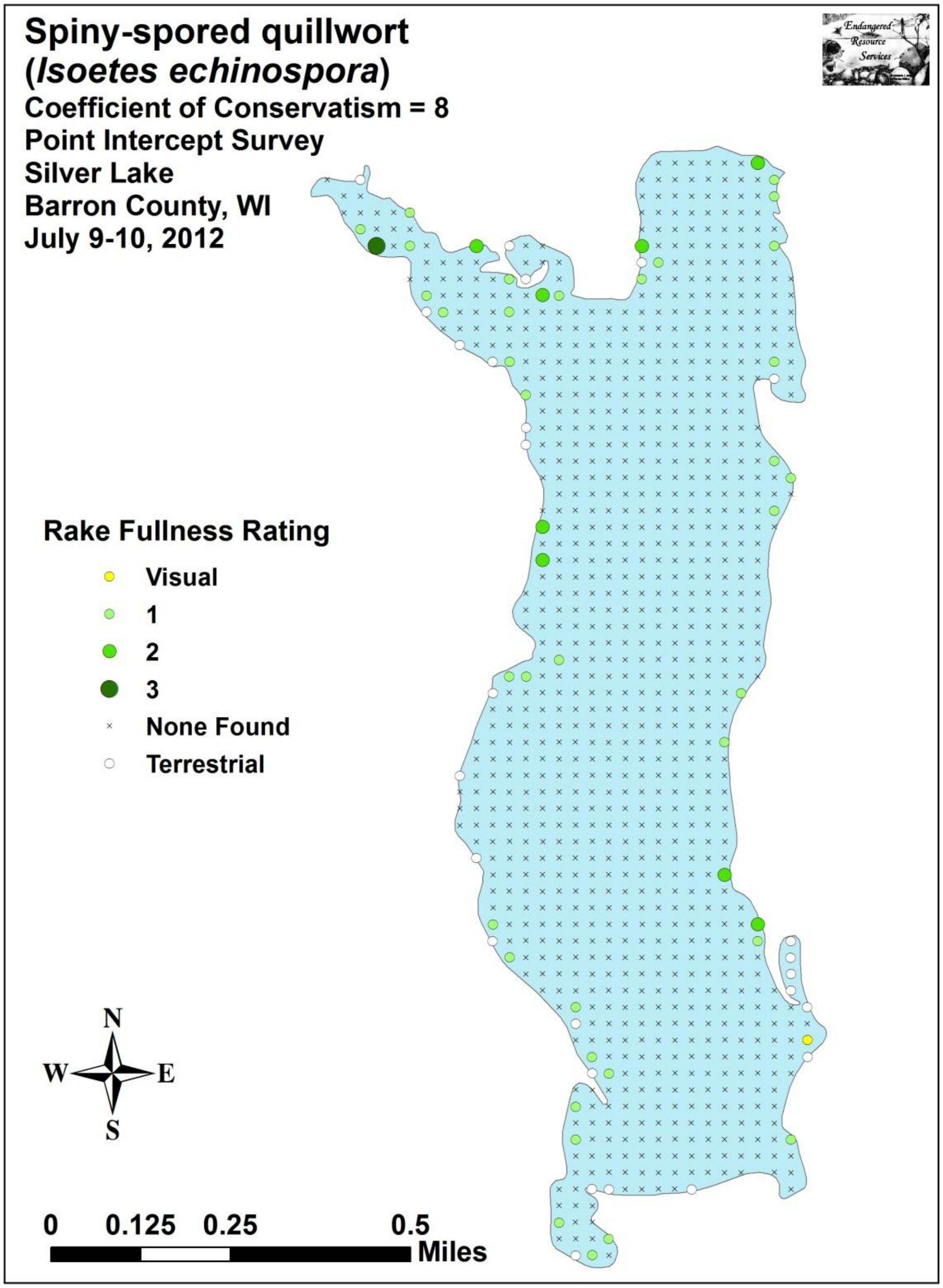
0
0.125
0.25
0.5
Miles



Filamentous algae
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles


Spiny-spored quillwort
(*Isoetes echinospora*)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
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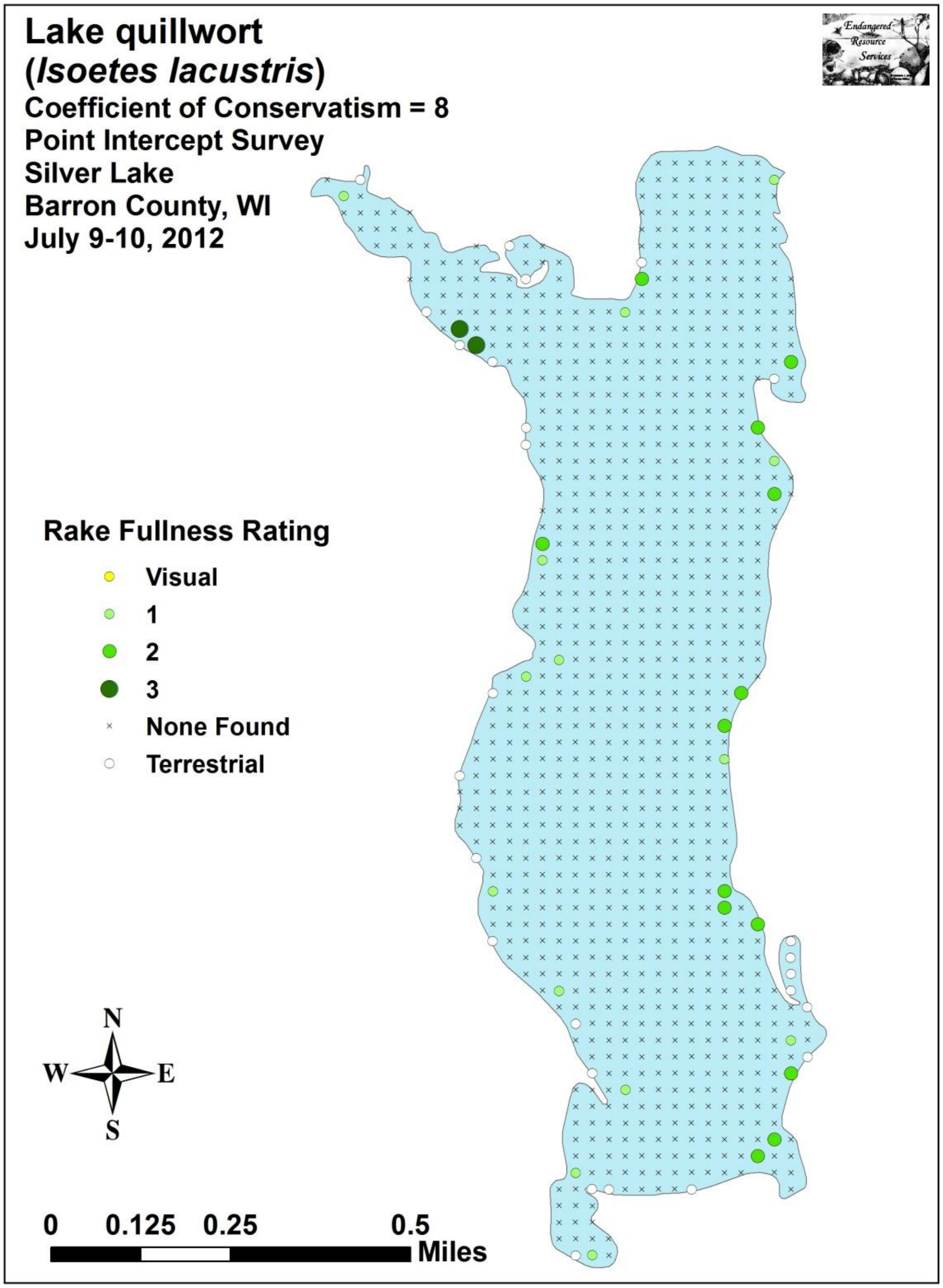
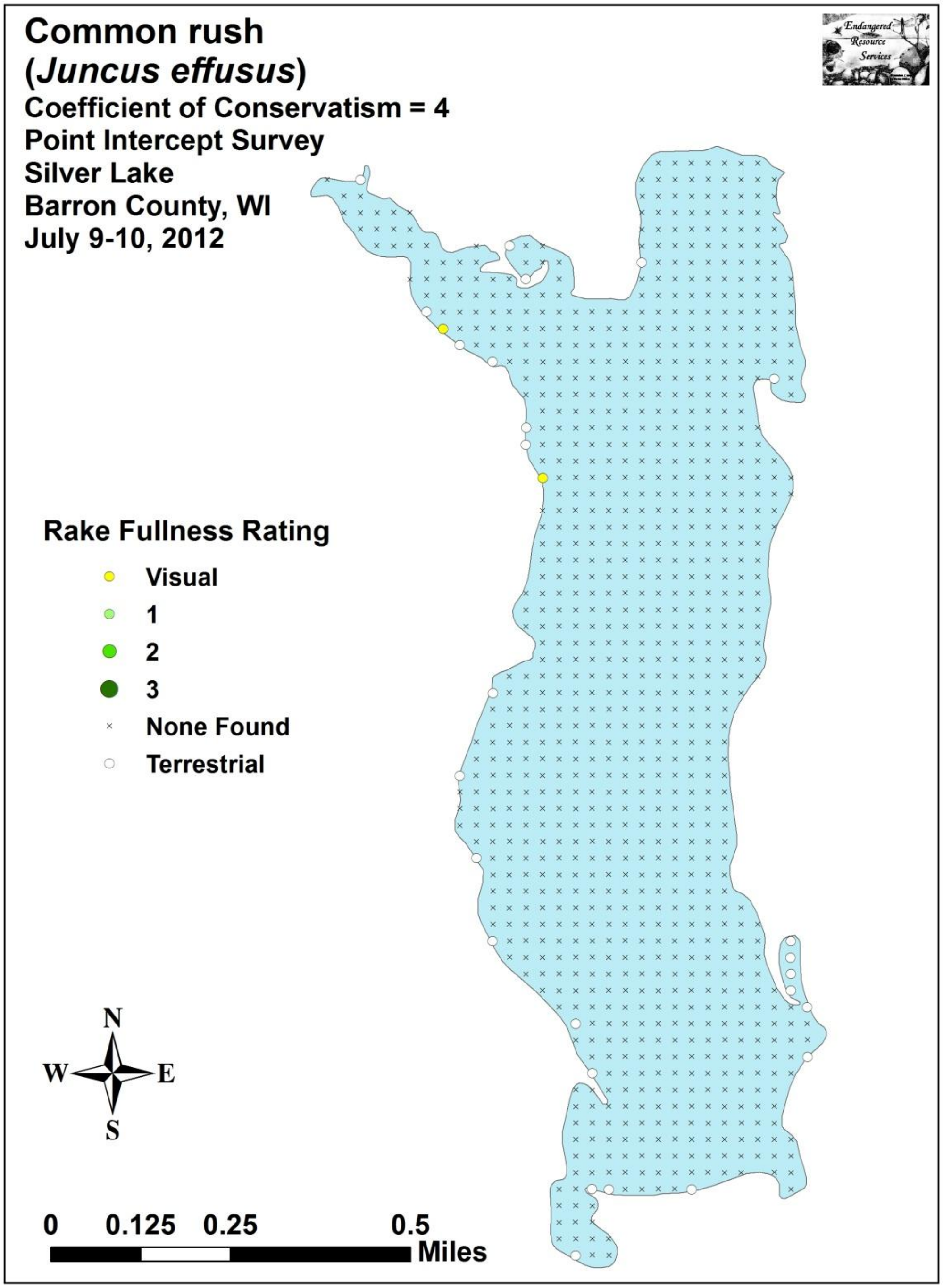
0
0.125
0.25
0.5
Miles


Lake quillwort
(*Isoetes lacustris*)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles


Common rush
(Juncus effusus)
Coefficient of Conservatism = 4
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
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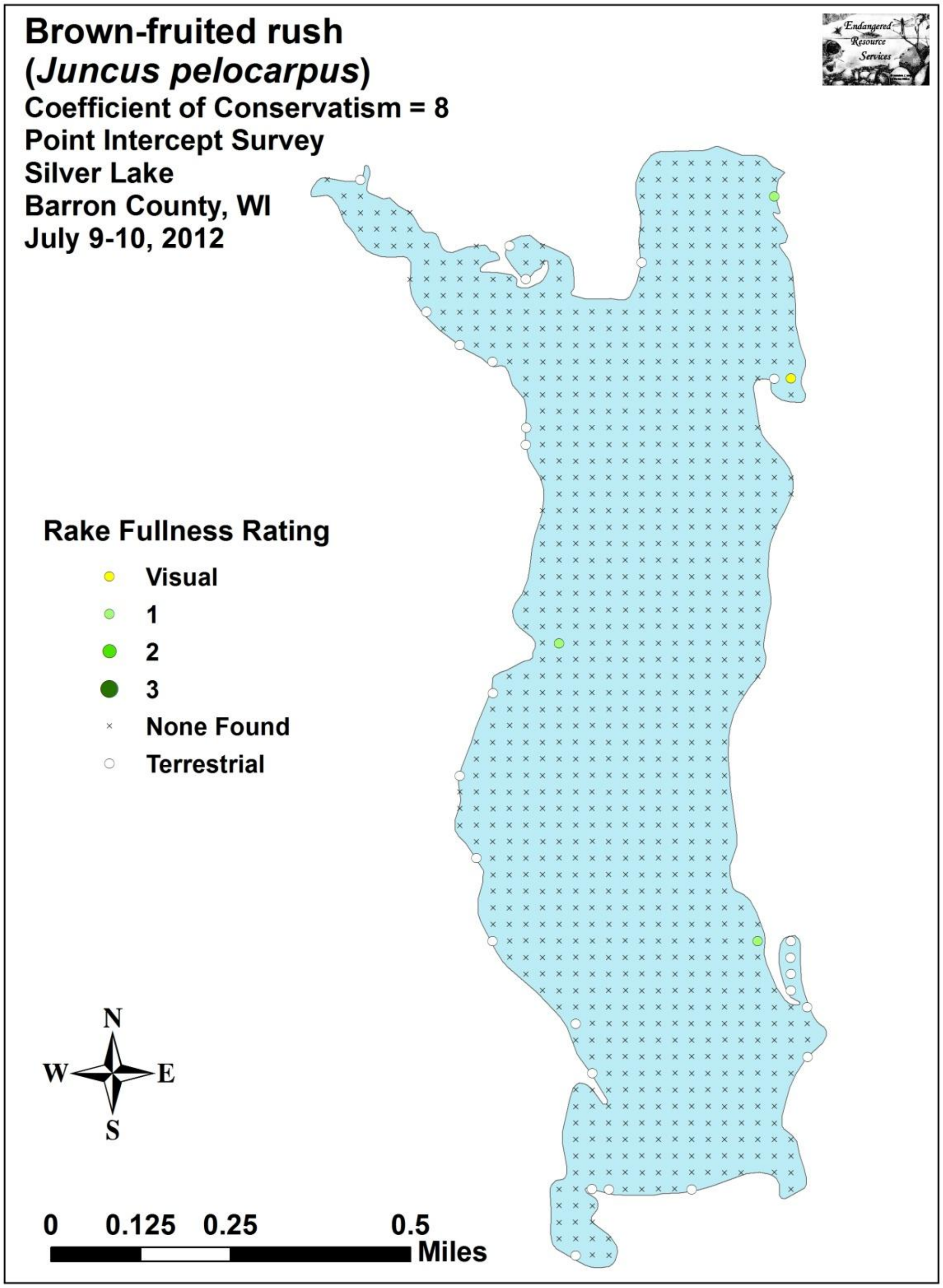
0.125
0.25
0.5
Miles



Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
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W
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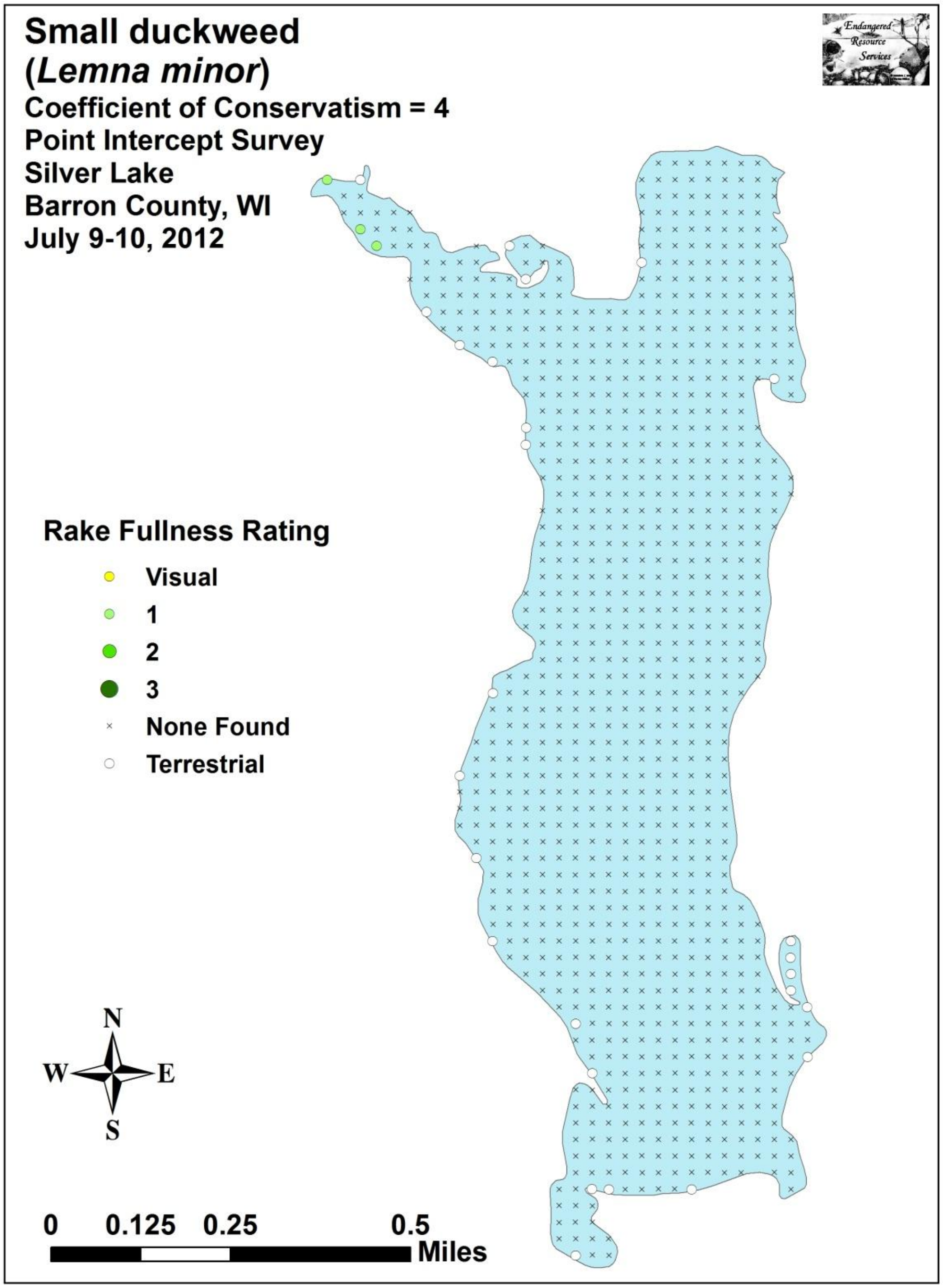
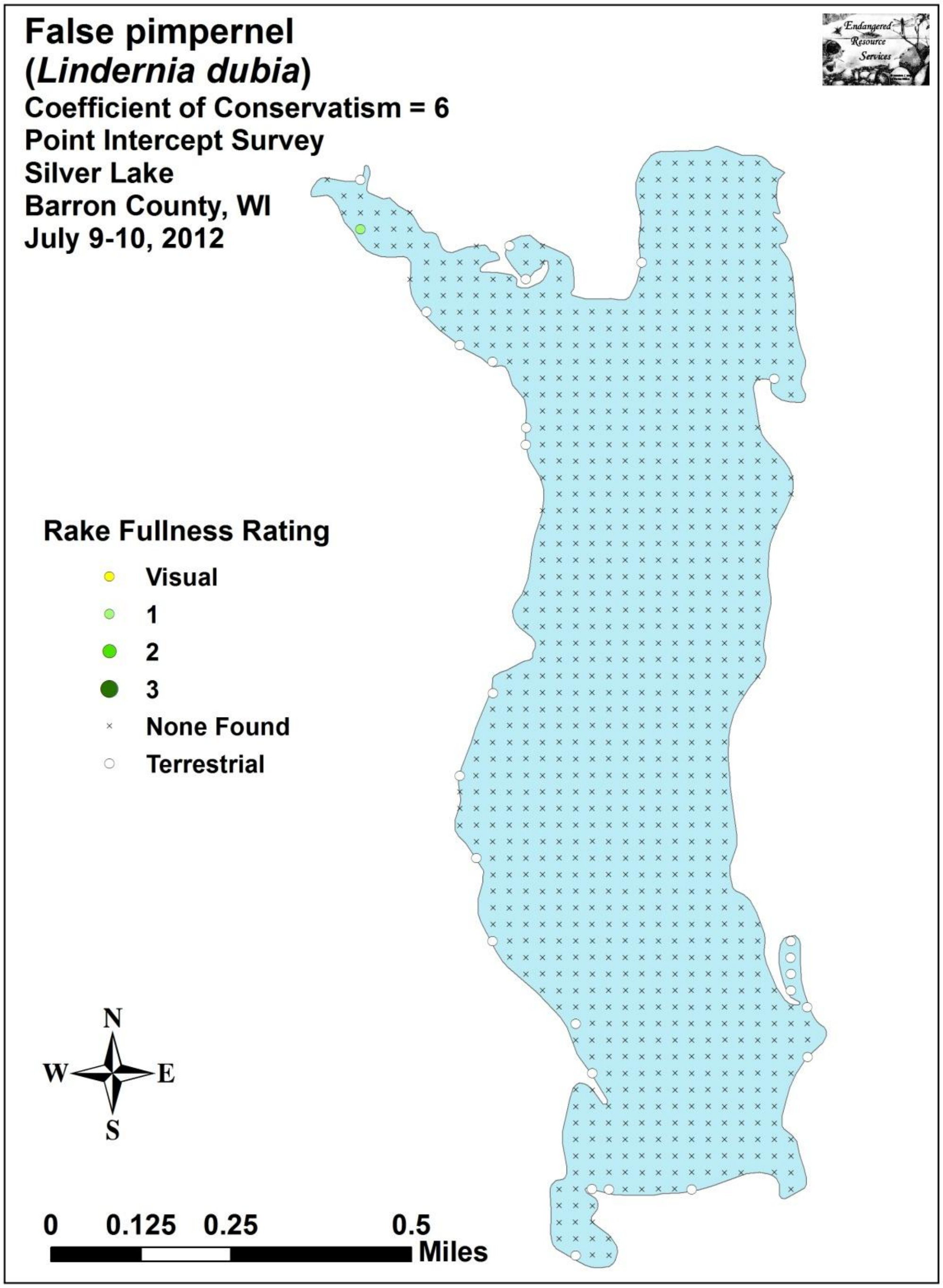
0
0.125
0.25
0.5
Miles



Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.125
0.25
0.5
Miles


False pimpernel
(*Lindernia dubia*)
Coefficient of Conservatism = 6
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
Terrestrial
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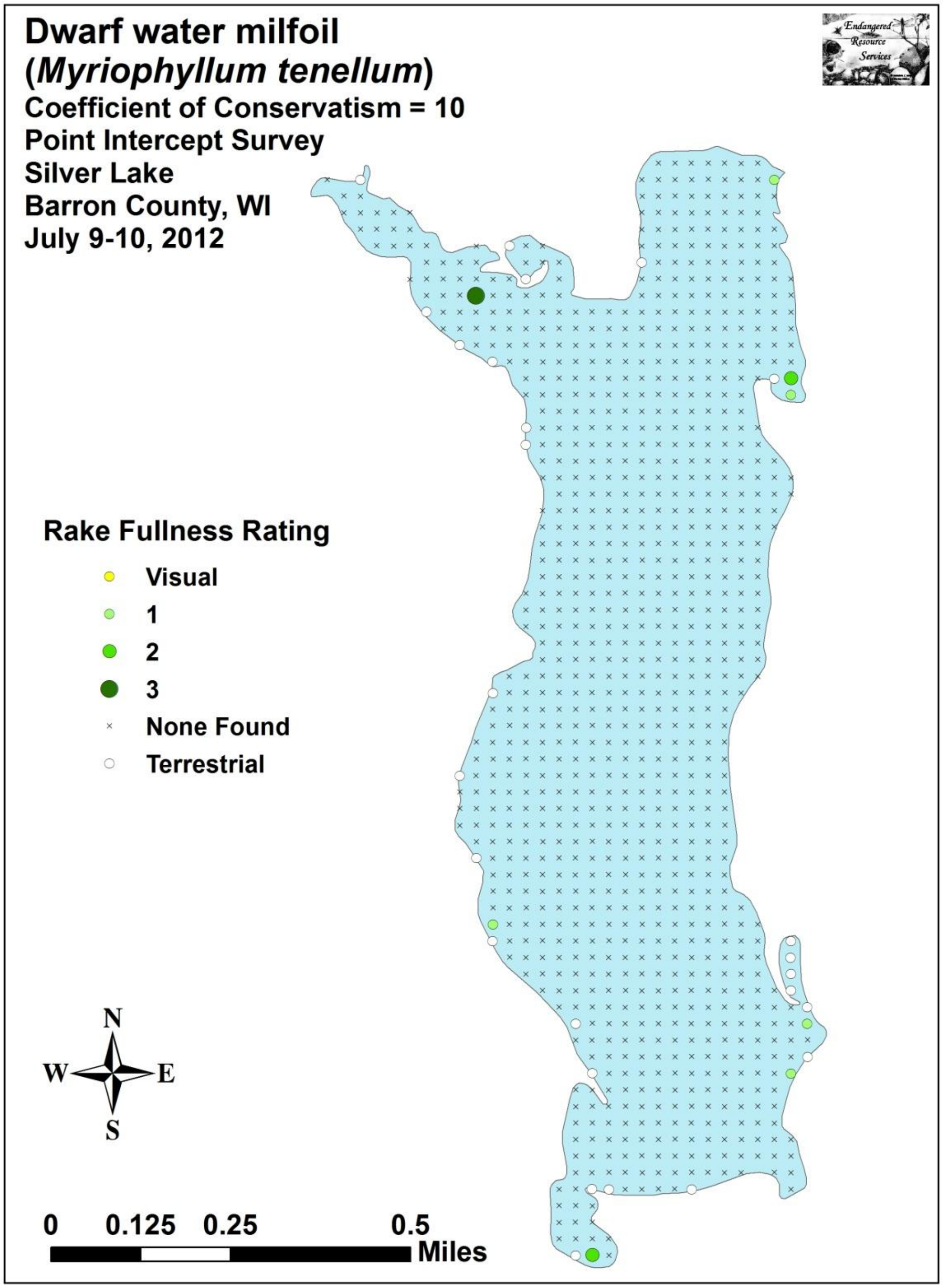
Miles


Dwarf water milfoil
(*Myriophyllum tenellum*)
Coefficient of Conservatism = 10
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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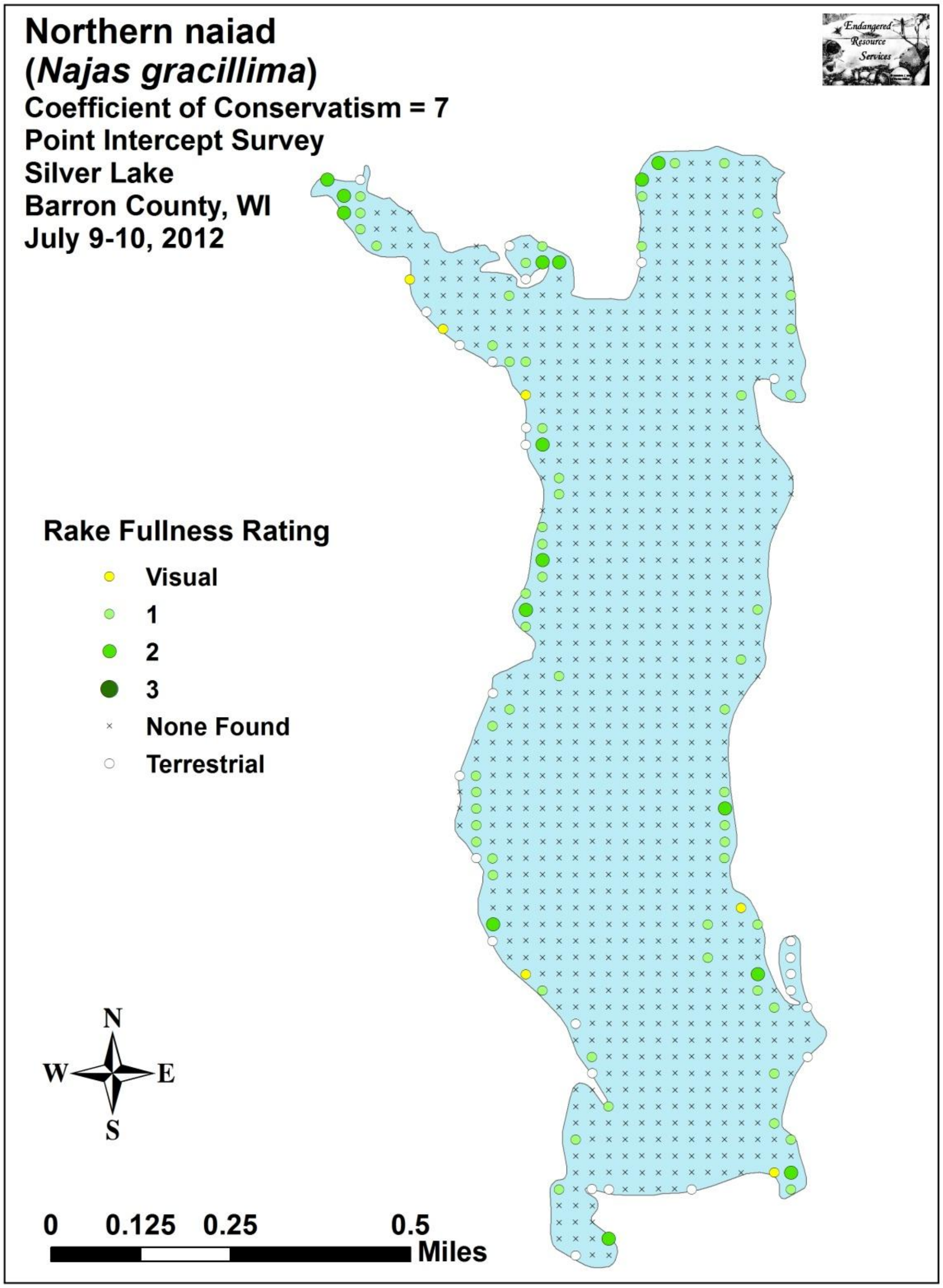
Miles


Northern naiad
(Najas gracillima)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Rake Fullness Rating
Visual
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None Found
Terrestrial
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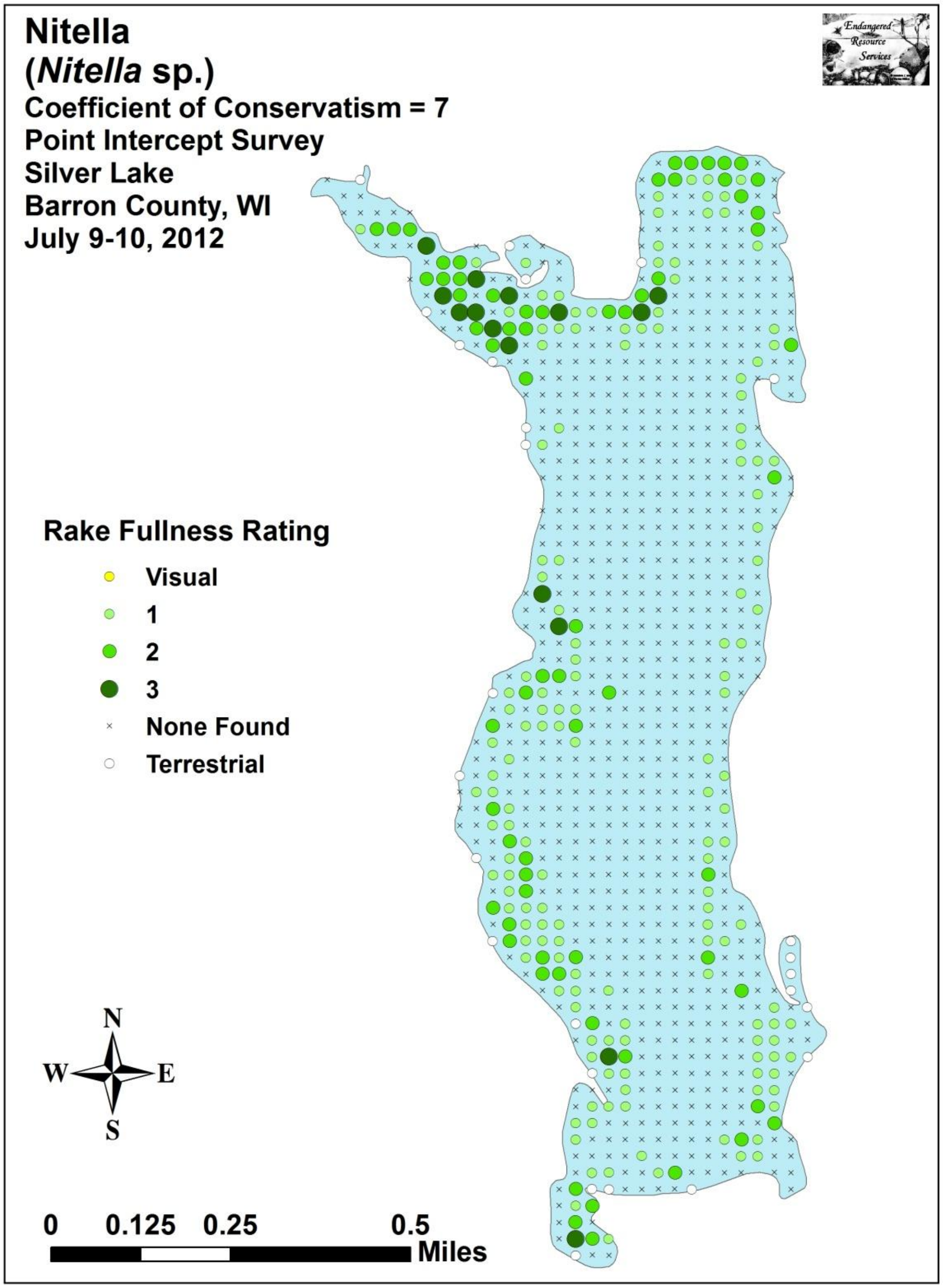
Miles


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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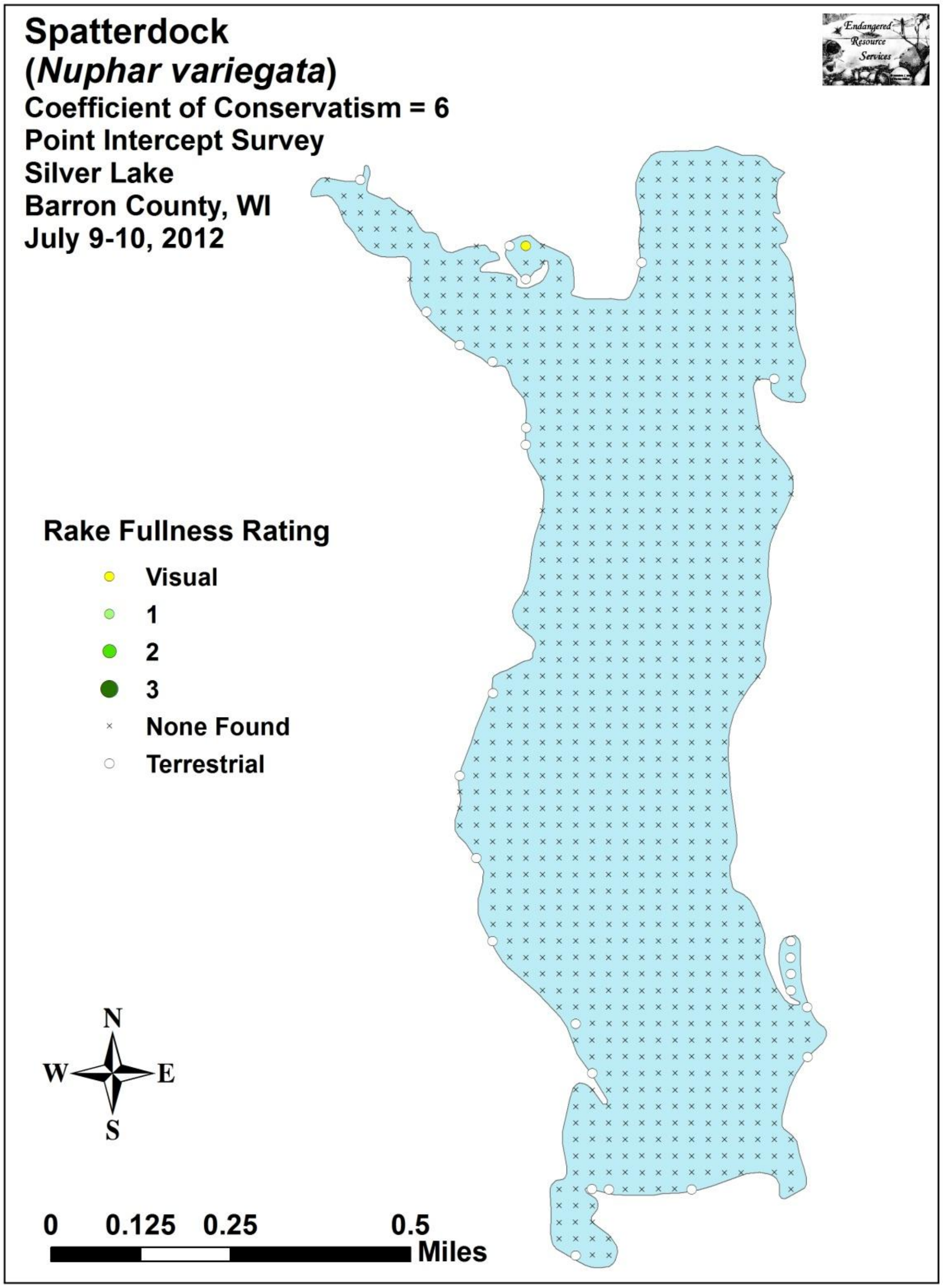
Miles



Spatterdock
(*Nuphar variegata*)
Coefficient of Conservatism = 6
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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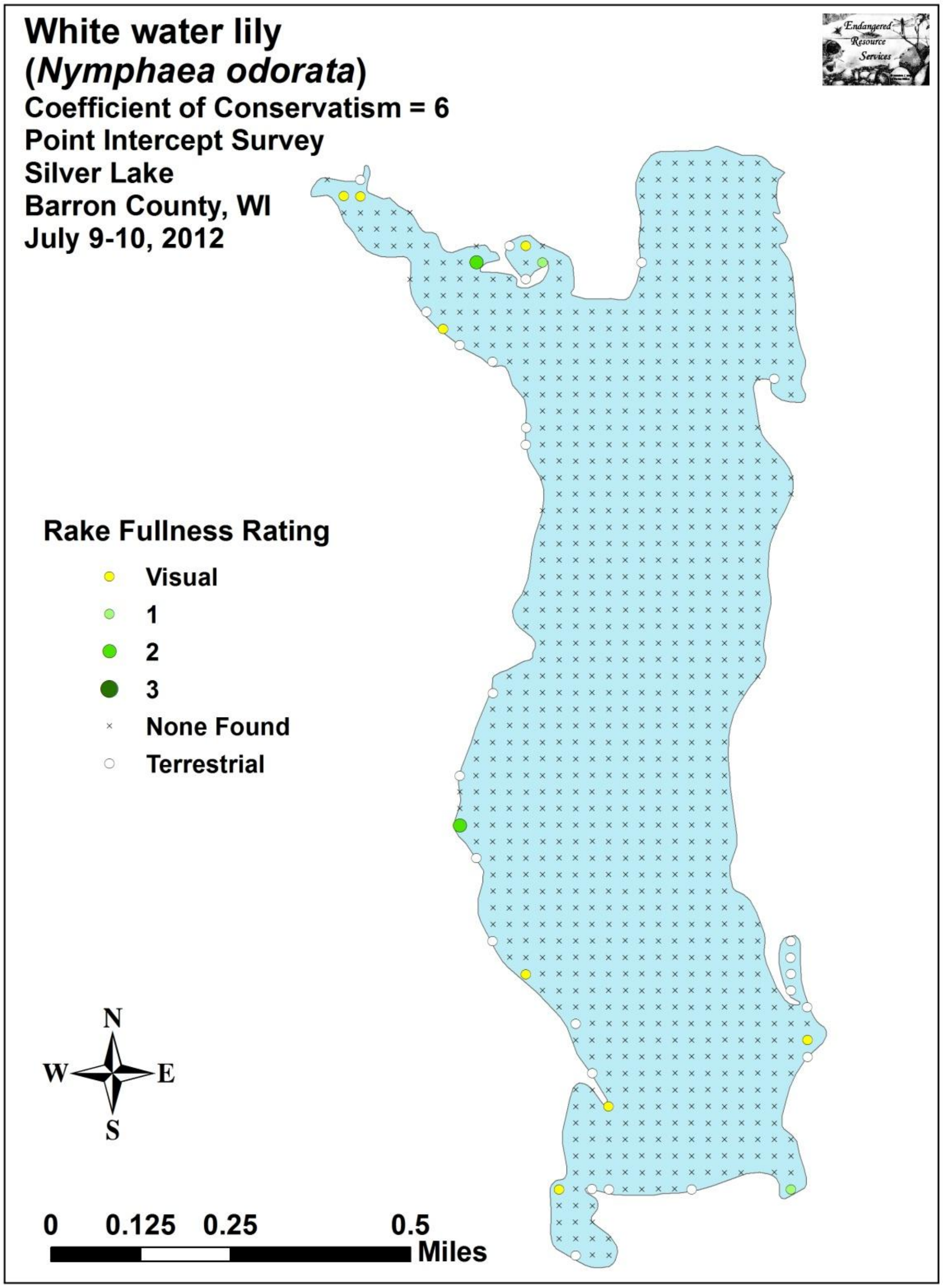
Miles


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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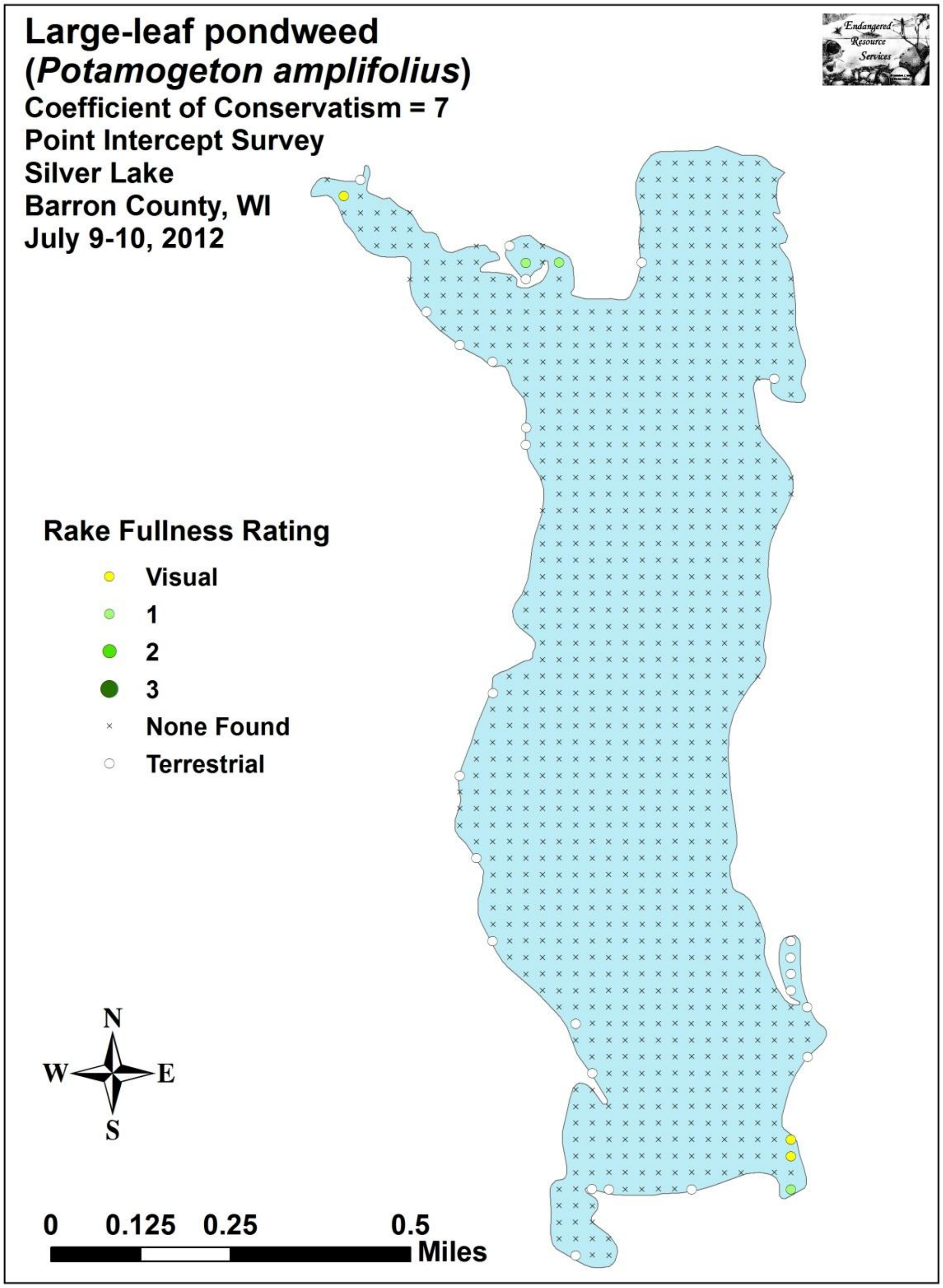
Miles


Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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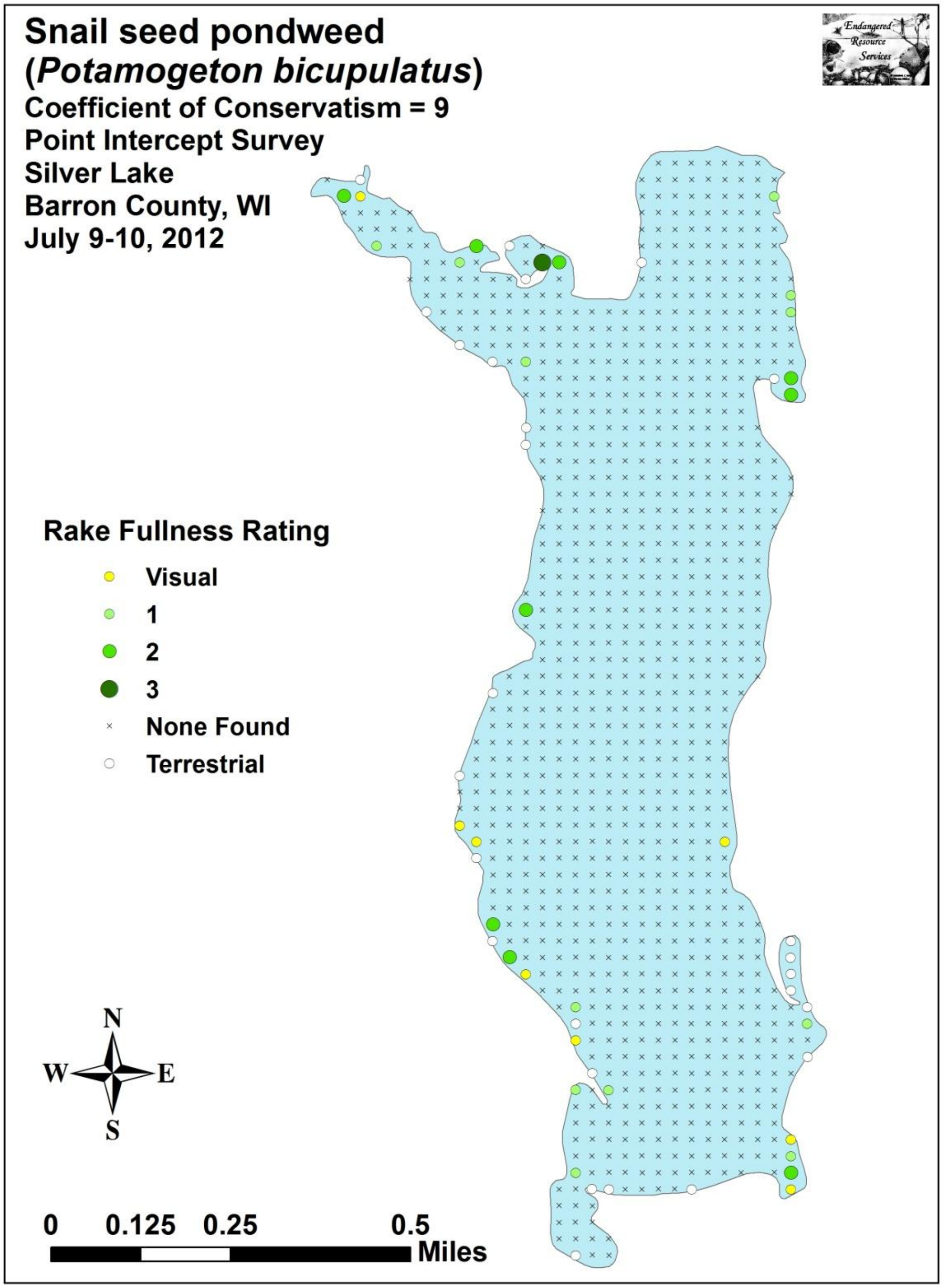
Miles


Snail seed pondweed
(*Potamogeton bicupulatus*)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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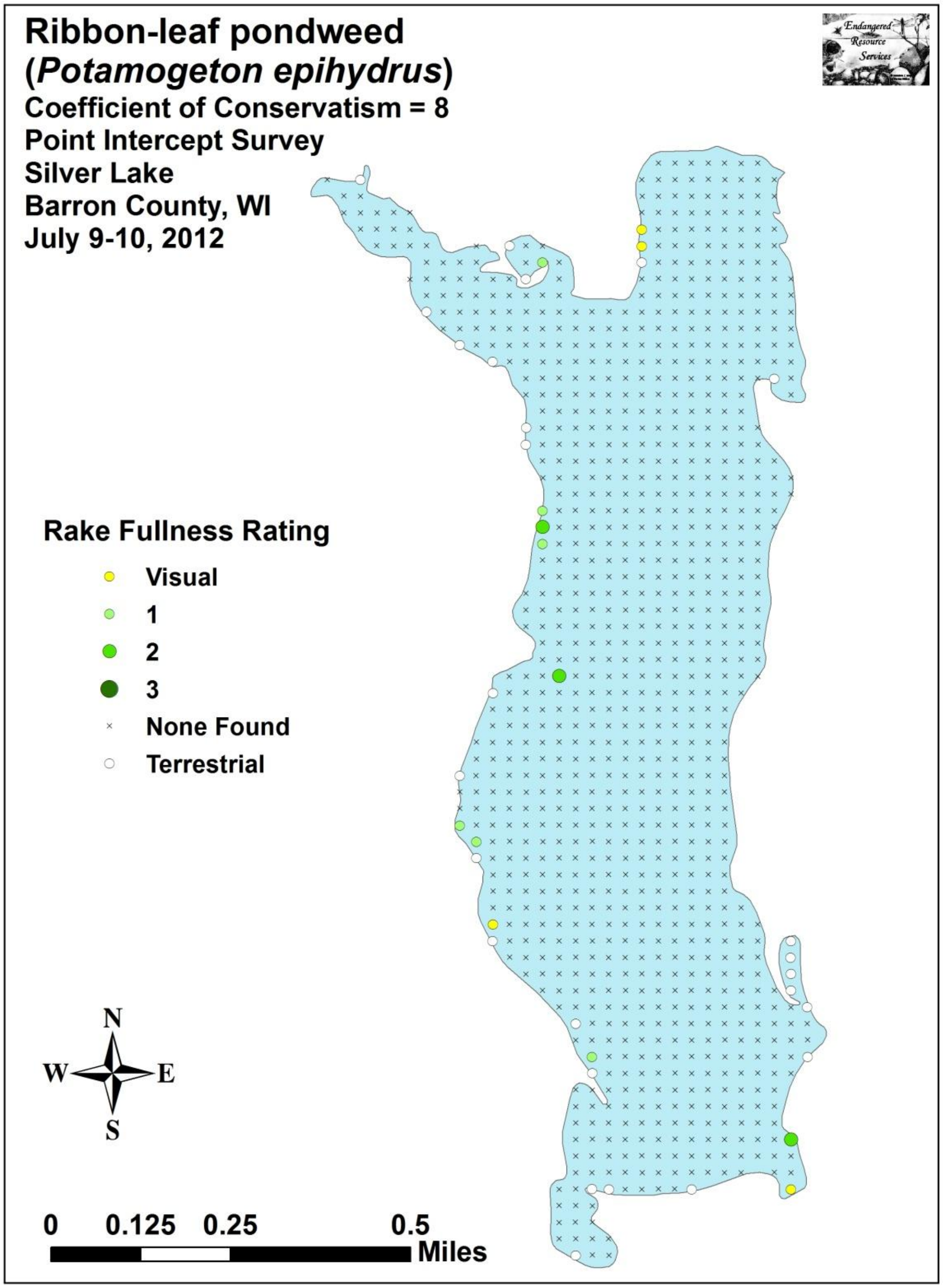
Miles


Ribbon-leaf pondweed
(*Potamogeton epihydrus*)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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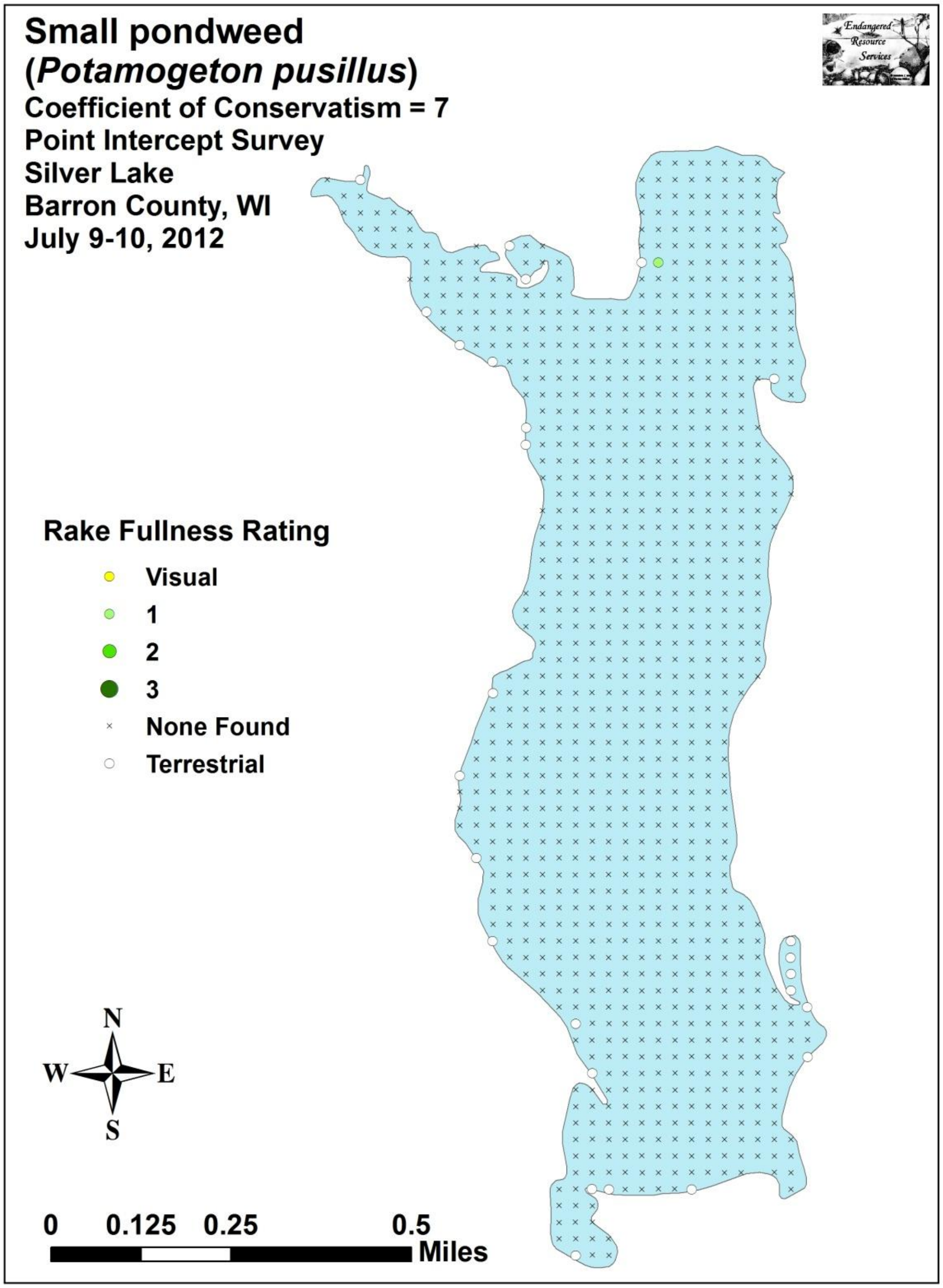
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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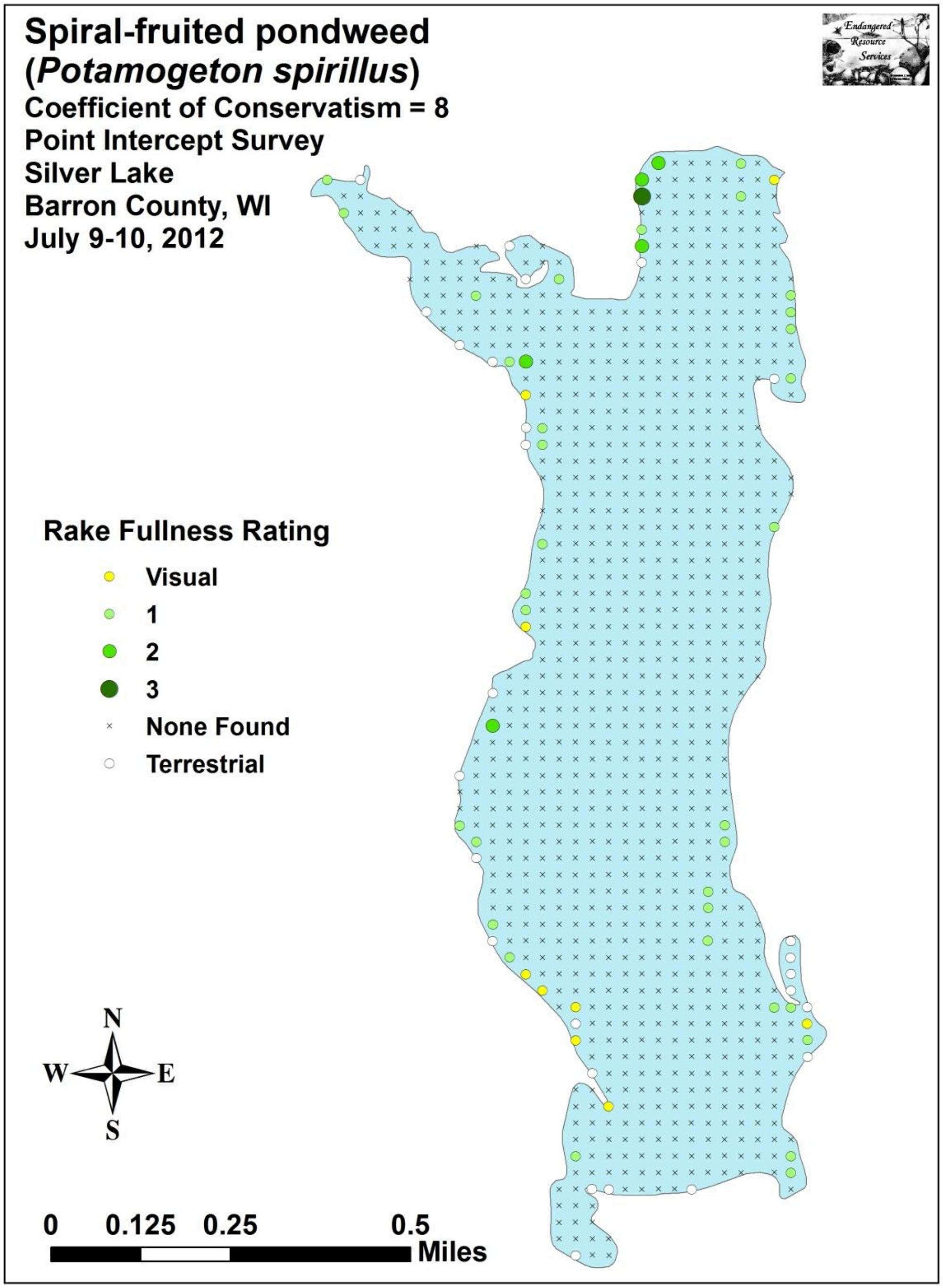
Miles


Spiral-fruited pondweed
(*Potamogeton spirillus*)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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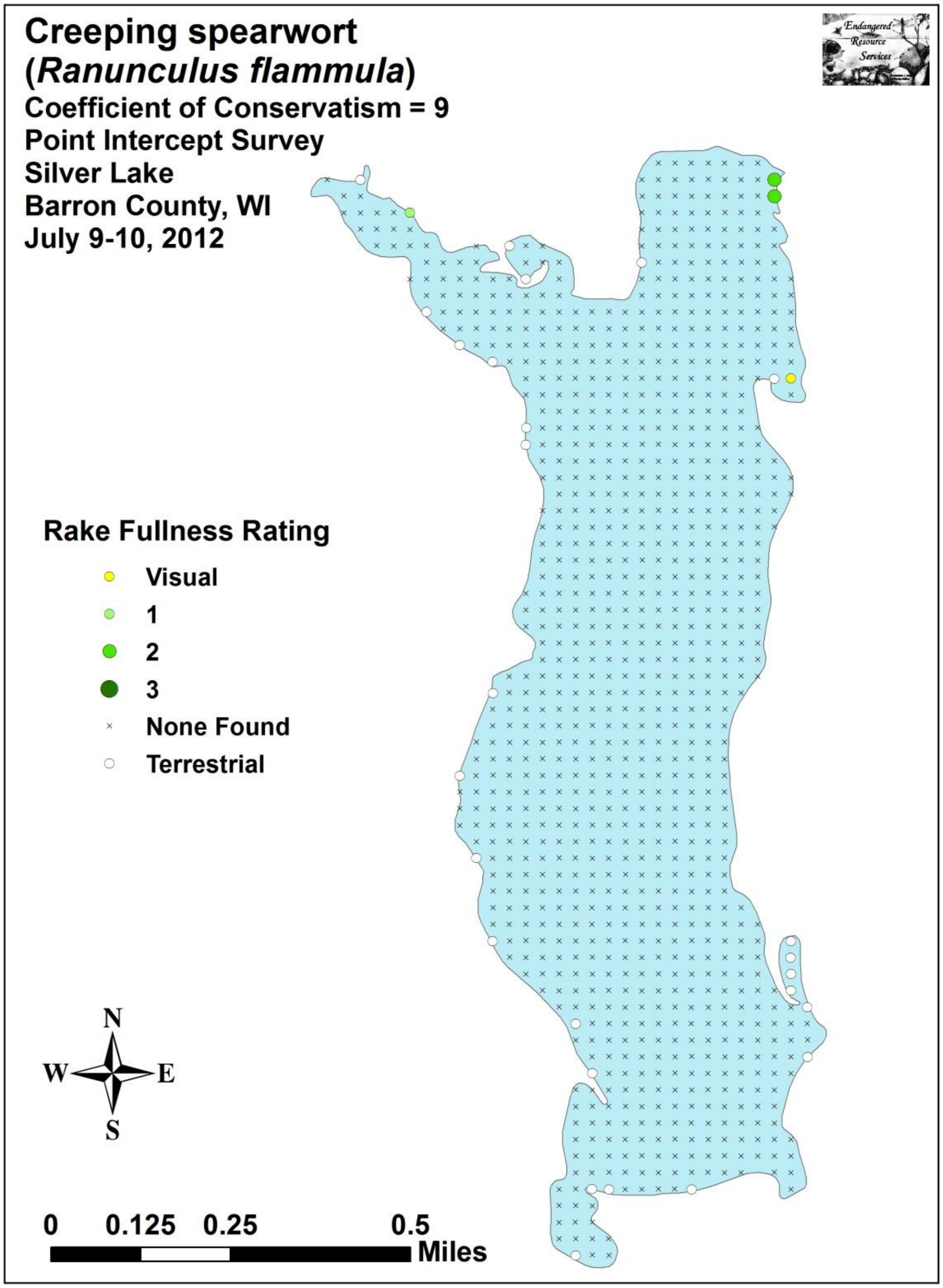
Miles


Creeping spearwort
(Ranunculus flammula)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Rake Fullness Rating
Visual
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None Found
Terrestrial
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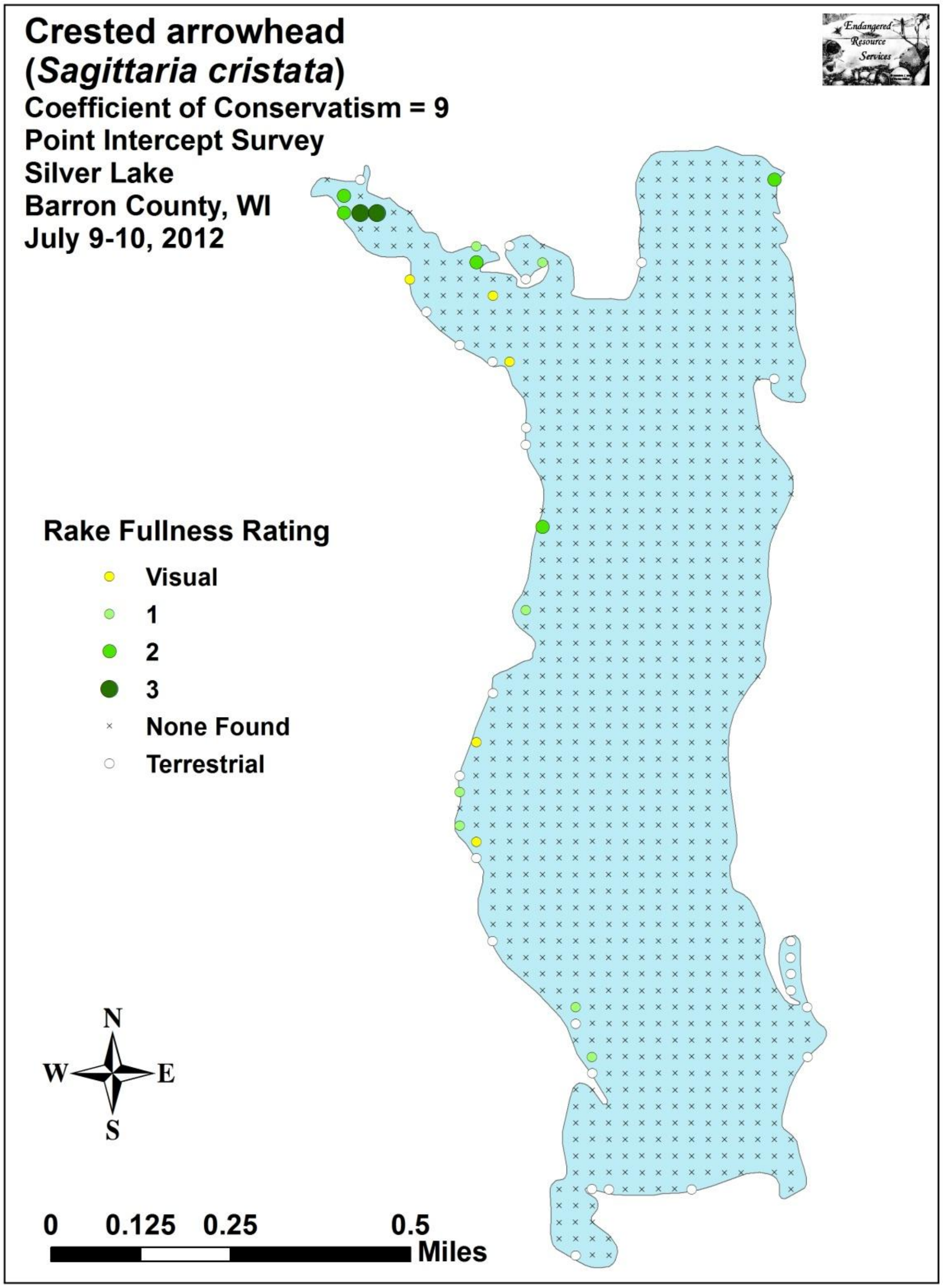
Miles



Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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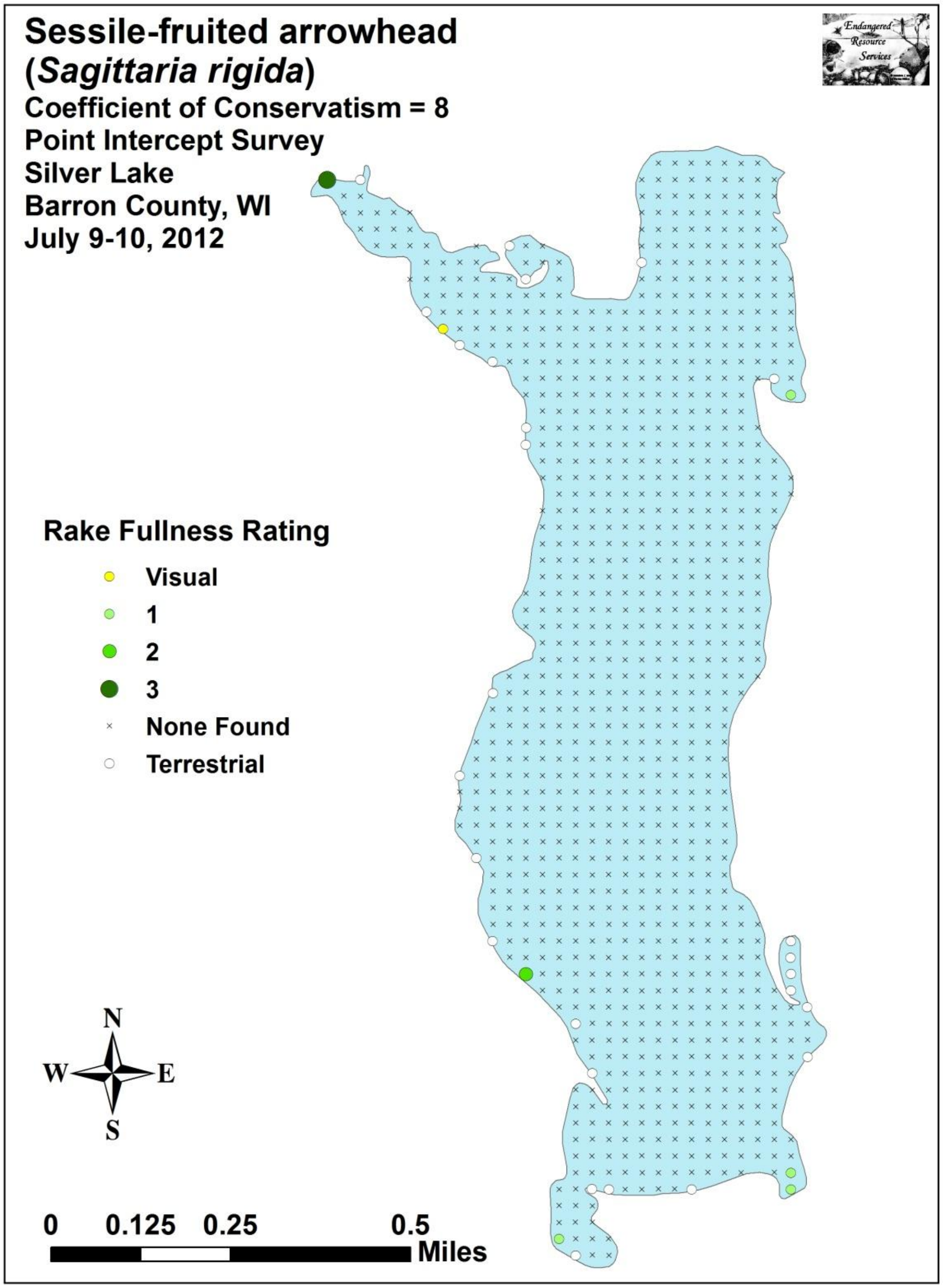
Miles


Sessile-fruited arrowhead
(*Sagittaria rigida*)
Coefficient of Conservatism = 8
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Rake Fullness Rating
Visual
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None Found
Terrestrial
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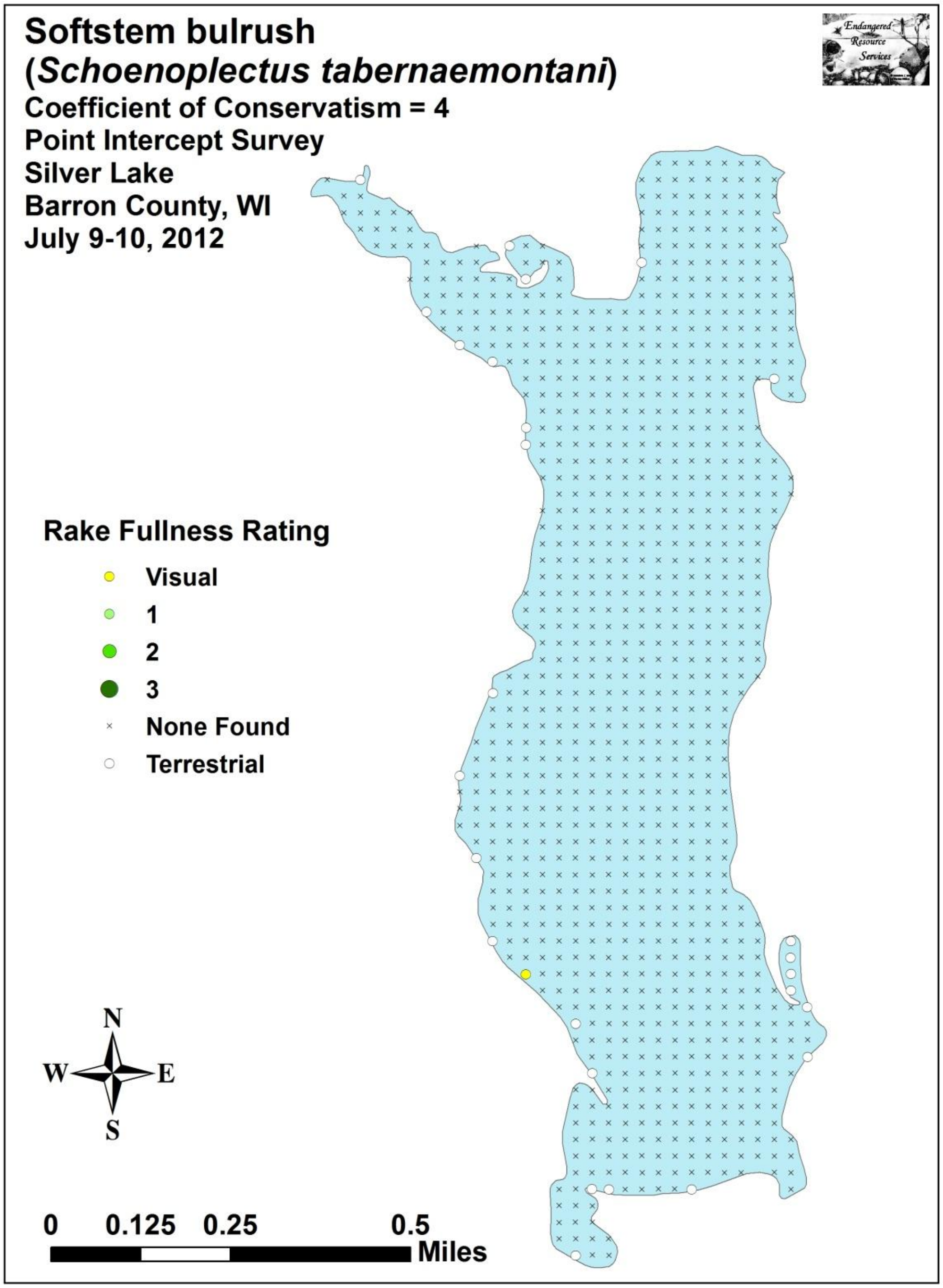
Miles



Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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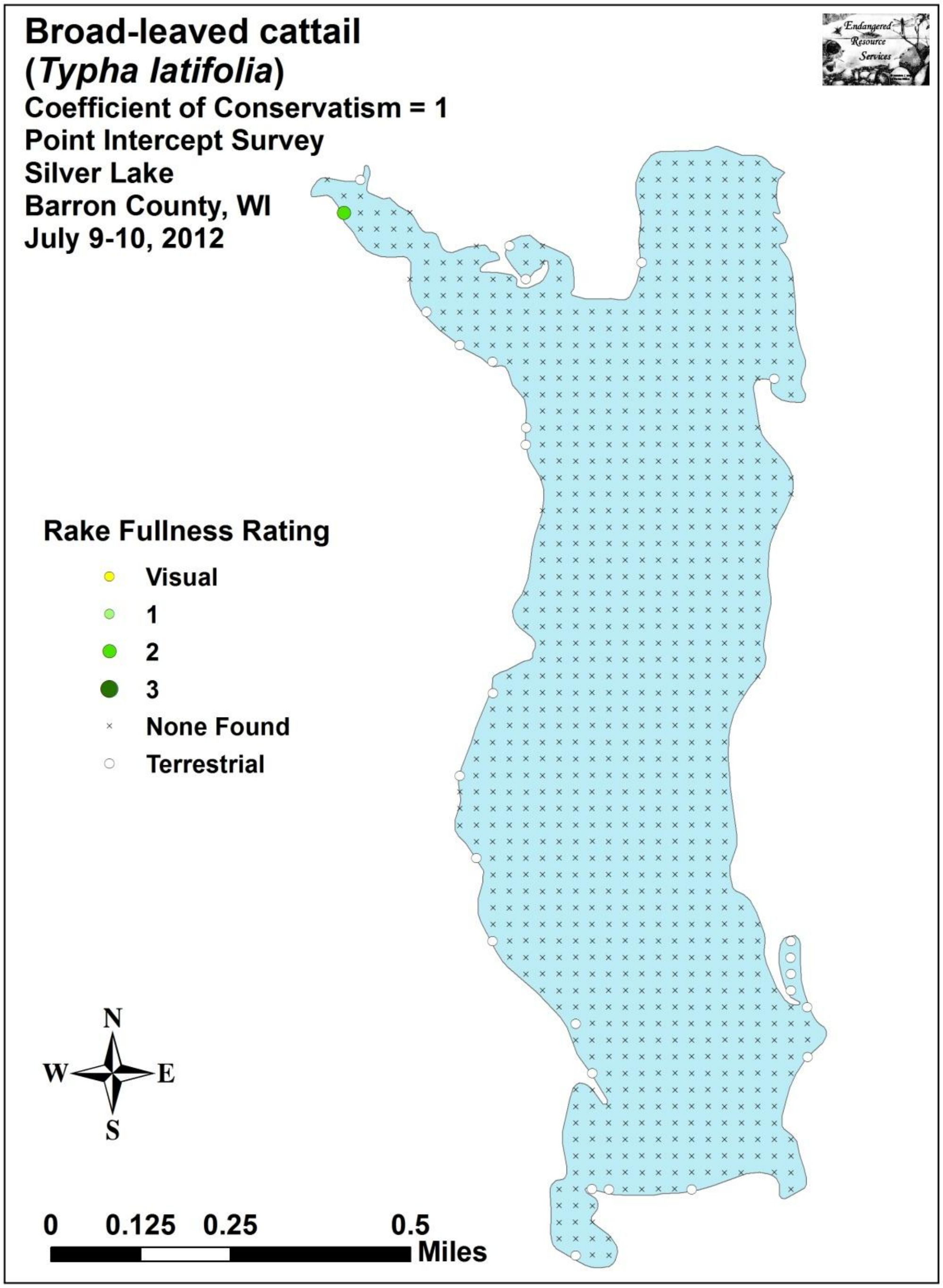
Miles


Broad-leaved cattail
(*Typha latifolia*)
Coefficient of Conservatism = 1
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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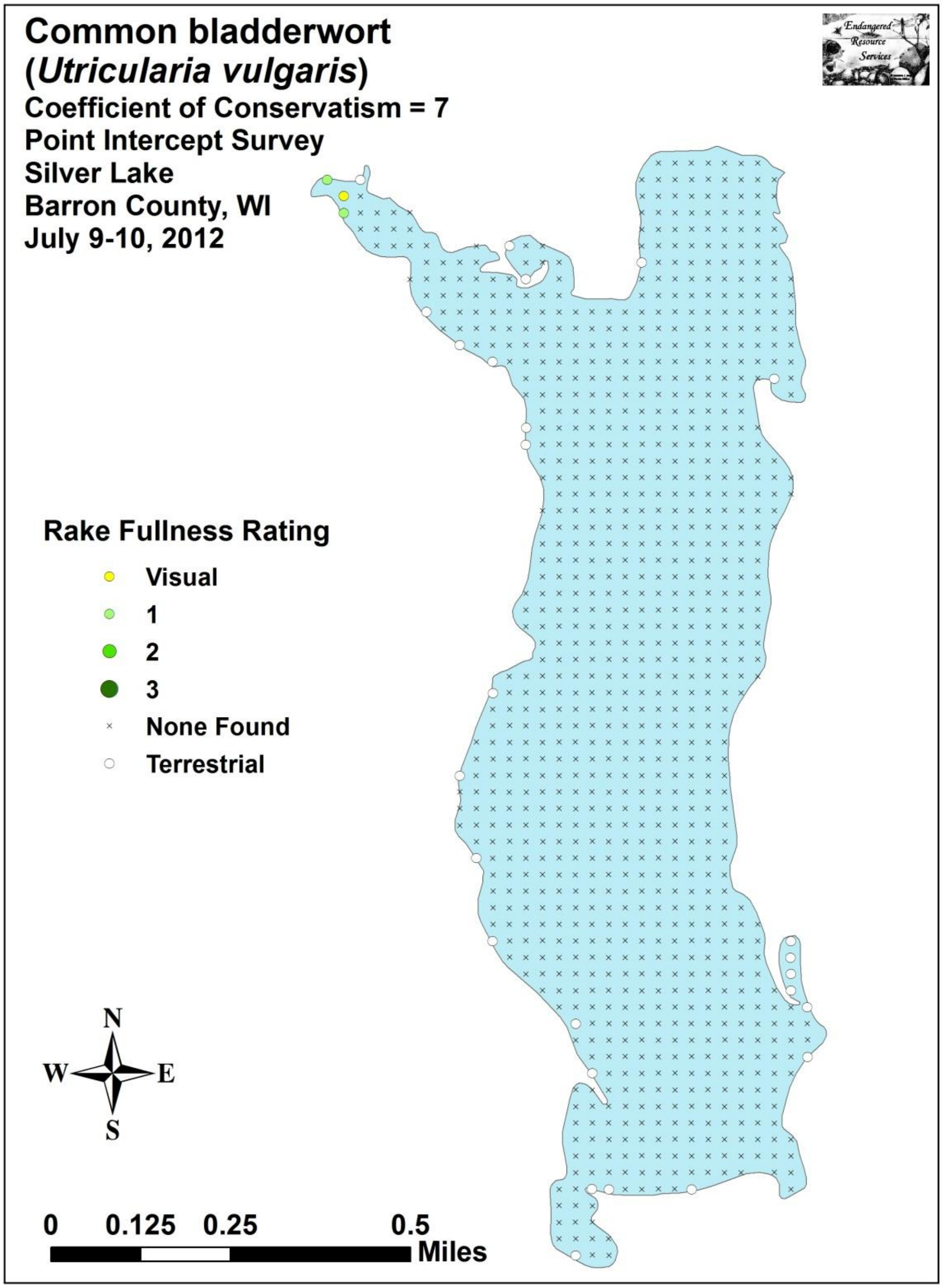
Miles



Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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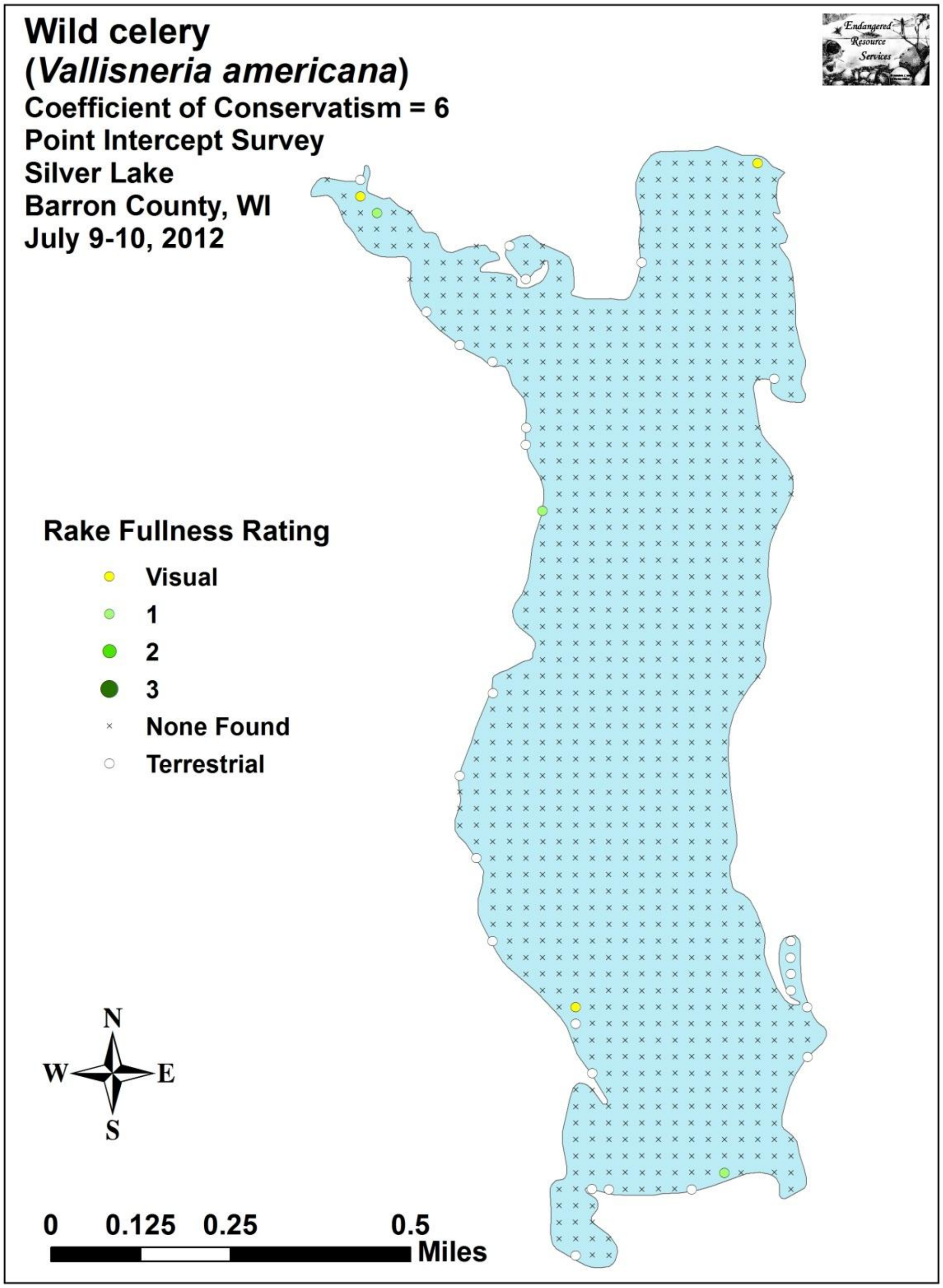
Miles


Wild celery
(*Vallisneria americana*)
Coefficient of Conservatism = 6
Point Intercept Survey
Silver Lake
Barron County, WI
July 9-10, 2012
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
Terrestrial
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Miles

Appendix VII: Aquatic Exotic Invasive Plant Species Information

Curly-leaf pondweed

DESCRIPTION: Curly-leaf pondweed is an invasive aquatic perennial that is native to Eurasia, Africa, and Australia. It was accidentally introduced to United States waters in the mid-1880s by hobbyists who used it as an aquarium plant. The leaves are reddish-green, oblong, and about 3 inches long, with distinct wavy edges that are finely toothed. The stem of the plant is flat, reddish-brown and grows from 1 to 3 feet long. The plant usually drops to the lake bottom by early 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, 2012 http://dnr.wi.gov/topic/Invasives/fact/CurlyLeafPondweed.html)

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, 2012 http://dnr.wi.gov/topic/Invasives/fact/EurasianWatermilfoil.html)

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, 2012 http://dnr.wi.gov/topic/Invasives/fact/ReedCanaryGrass.html)

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, 2012 http://dnr.wi.gov/topic/Invasives/fact/PurpleLoosestrife.html)

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

Aquatic:
: organisms that live in or frequent water.

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

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

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

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

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

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

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

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

Limnology:
: the study of inland lakes and waters.

Littoral:

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

Macrophytes:

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

Nutrients:

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

Organic Matter:

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

Photosynthesis:

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

Phytoplankton:

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

Plankton:

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

ppm:

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

Richness:
number of species in a particular community or habitat.

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

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

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

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

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

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

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

Appendix IX: Raw Data Spreadsheets