Warm-water Point-intercept Macrophyte Survey
Kirby Lake - WBIC: 1858200
Barron County, Wisconsin

Kirby Lake Aerial Photo (2015)

Open water on Kirby Lake's western shoreline facing south - 7/26/20

Project Initiated by:

The Kirby Lake Management District, Lake Education and Planning Services, LLC, and the Wisconsin Department of Natural Resources (Grant AEPP 60220)

Similar location facing southeast prior to increase in lake levels – 7/29/12

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ABSTRACT

Kirby Lake (WBIC 1858200) is a 98 acre seepage lake located in northwestern Barron County, WI. The lake has abundant native plant growth, and the Kirby Lake Management District (KLMD) has historically used herbicides, manual removal, and mechanical harvesting to improve lake access and create navigation channels for lakeshore owners. Prior to updating the Aquatic Plant Management Plan in 2021, the KLMD, under the direction of Lake Education and Planning Services, LLC (LEAPS – Dave Blumer), and the Wisconsin Department of Natural Resources (WDNR) requested a full point-intercept survey for all aquatic macrophytes on July 26, 2020. The survey's objectives were to compare data from 2012 and 2020 to identify any significant changes in the lake's vegetation over that time, and to determine if any new exotic plant species had invaded the lake. During the July 2020 survey, we found macrophytes growing at 258 sites which approximated to 81.9% of the entire lake bottom and 89.0% of the 13.0ft littoral zone. This was a highly significant increase **(p<0.001)** from 184 sites with plants in 2012 (58.4% of the lake and 73.0% of the then 10.ft littoral zone). Overall diversity was high with a Simpson Index value of 0.86 – down from an exceptionally high 0.90 in 2012. Richness was low with 27 species found in the rake (down from 35 in 2012). This total jumped to 40 when including visuals and plants seen during the boat survey (also down from 49 total species in 2012). This sharp decline in richness was due to the loss of emergent and shallow submergent species that lost their habitat when water levels on the lake increased (up approximately 1.3ft since the 2012 survey). There was an average of 2.90 native species/site with native vegetation – a highly significant decline **(p<0.001)** from 3.87 species/site in 2012. Total rake fullness experienced a significant decline **(p=0.04)** from a very high 2.65 in 2012 to a high 2.52 in 2020. In 2012, after excluding aquatic moss, we found Watershield (*Brasenia schreberi*), Large purple bladderwort (*Utricularia purpurea*), Small pondweed (*Potamogeton pusillus*), and Creeping bladderwort (*Utricularia gibba*) were the most common macrophyte species. Present at 62.50%, 62.50%, 50.54%, and 40.76% of survey points with vegetation, they accounted for 54.90% of the total relative frequency. The 2020 survey found Small pondweed, Watershield, White water lily (*Nymphaea odorata*), and Large purple bladderwort were the most common species (78.68%, 48.45%, 35.27%, and 33.72% of sites with vegetation/combined 67.56% of the total relative frequency). Lakewide, from 2012-2020, fourteen species saw significant changes in distribution: Aquatic moss, Large purple bladderwort, Creeping bladderwort, Flat-leaf bladderwort (*Utricularia intermedia*), Farwell's water-milfoil (*Myriophyllum farwellii*), and Reed canary grass (*Phalaris arundinacea*) suffered highly significant declines; Northern manna grass (*Glyceria borealis*) experienced a moderately significant decline; and Snail-seed pondweed (*Potamogeton bicupulatus*) and Ribbon-leaf pondweed (*Potamogeton epihydrus*) saw significant declines. Conversely, Small pondweed and Large-leaf pondweed (*Potamogeton amplifolius*) experienced highly significant increases; filamentous algae had a moderately significant increase; and Common arrowhead (*Sagittaria latifolia*) and freshwater sponges showed significant increases. The 24 native index species found in the rake during the 2020 survey (down from 31 in 2012) produced a much above average mean Coefficient of Conservatism of 7.5 (down from 7.6 in 2012). The Floristic Quality Index of 36.7 (down from 42.6 in 2012) was also well above the median FQI for this part of the state. Reed canary grass was the only exotic species found. Present in the rake at 16 points with a mean rake fullness of 2.06 in 2012, it was only a visual at a single point in 2020. Future management considerations include preserving the lake's unique, rare, and sensitive plant community which provides important habitat for the lake's fish and other aquatic organisms; providing navigation impairment relief to promote human enjoyment and utilization of the lake, but doing so in a way that minimizes environmental impacts; working to reduce plant and algal growth by limiting nutrient input into the lake from the nearshore area by such things as avoiding mowing down to the lake, bagging grass clippings, disposing of pet waste and fire pit ashes away from the lake, and eliminating fertilizer applications; minimizing soil erosion by restoring shorelines and maintaining native vegetation buffer strips, and avoiding motor start-ups in shallow water; continuing volunteer monitoring for AIS - especially near the boat landing; and continuing the lake's established Clean Boats/Clean Waters landing monitoring program.

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INTRODUCTION:

Kirby Lake (WBIC 1858200) is a 98 acre seepage lake in northwestern Barron County, Wisconsin in the Town of Maple Plain (T36N R14W S14/23). It reaches a maximum depth of 19ft on the west side of the central basin and has an average depth of approximately 8ft (WDNR 2020). The lake is mesotrophic bordering on eutrophic in nature with Secchi readings from 1992-2020 ranging from 4-8ft and averaging 6.3ft (WDNR 2020). Kirby Lake's tannic-stained water produced a littoral zone that extended to 13.0ft during the July 2020 survey. The bottom substrate is predominately muck with scattered sand and rock along the shoreline (Figure 1).

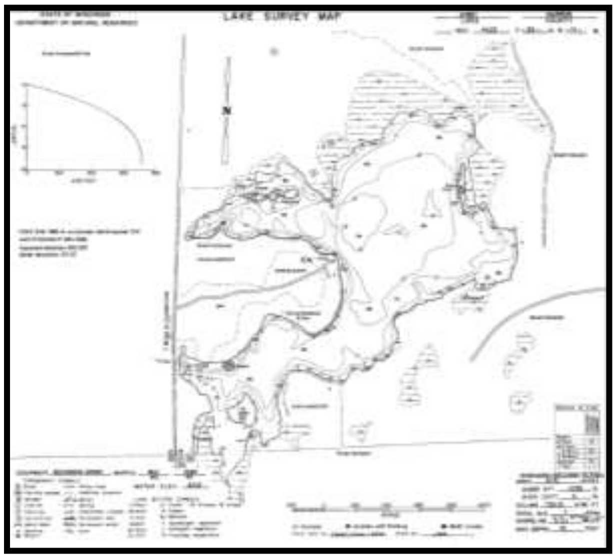


Figure 1: Kirby Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Kirby Lake has abundant native plant growth, and the Kirby Lake Management District (KLMD) has historically used herbicides, and, more recently, manual removal and mechanical harvesting to improve lake access and create navigation channels for lakeshore owners. The district has also conducted regular aquatic plant surveys as a way to quantify the level of vegetation and to look for new exotic invasive species such as Eurasian water-milfoil (*Myriophyllum spicatum*) which is present in several nearby lakes. Past surveys, including an initial point-intercept macrophyte survey by the Wisconsin Department of Natural Resources (WDNR) in 2006 and our survey in 2012, found no exotic species other than Reed canary grass (*Phalaris arundinacea*) which is common along the lake's margins.

Per WDNR expectations, plant surveys on actively managed lakes are normally repeated every five to seven years to remain current (Pamela Toshner/Alex Smith, WDNR – pers. comm.). Because of this, the KLMD, under the direction of Dave Blumer (Lake Education and Planning Services, LLC - LEAPS), requested a late-season macrophyte survey in 2020. The survey's objectives were to compare data from 2012 and 2020 to identify any significant changes in the lake's vegetation over that time, and to determine if any new exotic plant species had invaded the lake prior to updating their Aquatic Plant Management Plan in 2021. This report is the summary analysis of that survey conducted on July 26, 2020.

METHODS:
Warm-water Full Point-intercept Macrophyte Survey:

Prior to beginning the August point-intercept survey, we conducted a general boat survey of the lake to regain familiarity with the species present (Appendix I). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006; Skawinski 2019), and a datasheet was built from the species present.

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth, and total acreage, Jennifer Hauxwell (WDNR) generated the original 315 point sampling grid for Kirby Lake, and this same grid has been used for each whole-lake survey since 2006 (Appendix II). These points were uploaded to a GPS (Garmin 76CSx) and located on the lake. At each site, we recorded a depth reading with a metered pole. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of all plants within six feet of the sample point not found in the rake. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

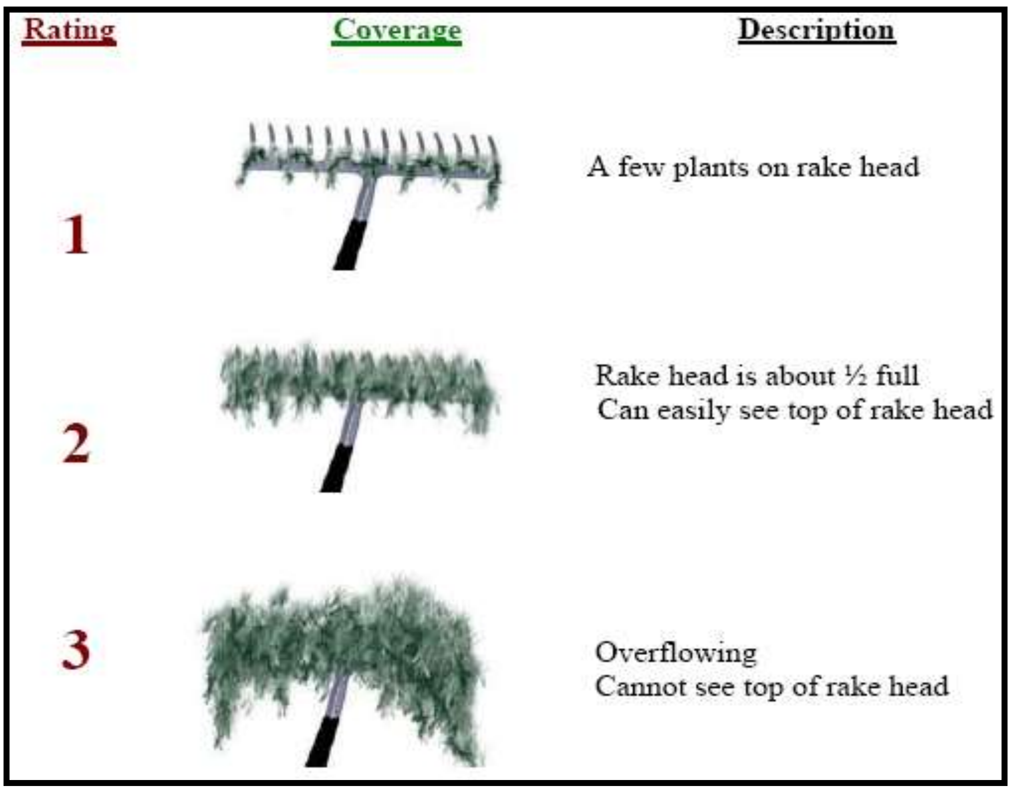


Figure 2: Rake Fullness Ratings (UWEX 2010)

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix I) (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 or kayak.

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

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

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

Frequency of occurrence example:

Plant A is sampled at 70 out of 700 total littoral points = 70/700 = .10 = 10%

This means that Plant A's frequency of occurrence = 10% when considering the entire littoral zone.

Plant A is sampled at 70 out of 350 total points with vegetation = 70/350 = .20 = 20%

This means that Plant A's frequency of occurrence = 20% when only considering the sites in the littoral zone that have vegetation.

From these frequencies, we can estimate how common each species was at depths where plants were able to grow, and at points where plants actually were growing.

Note the second value will be greater as not all the points (in this example, only ½) had plants growing at them.

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

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

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

Number of sites sampled using rope/pole rake: This indicates which rake type was used to take a sample. We use a 20ft pole rake and a 35ft rope rake for sampling.

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

Species richness: This value indicates the number of different plant species found in and directly adjacent to (on the waterline) the lake. Species richness alone only counts those plants found in the rake survey. The other two values include those seen at a sample point during the survey but not found in the rake, and those that were only seen during the initial boat survey or inter-point. **Note: Per WDNR 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).

<u>Relative frequency:</u> This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequencies will add up to 100%. Organizing species from highest to lowest relative frequency value gives us an idea of which species are most important within the macrophyte community (Tables 2-3).

Relative frequency example:

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

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

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

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

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

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey**, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, 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. Kirby Lake is in the North Central Hardwood Forests Ecoregion (Tables 4-5).

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

Comparison to Past Surveys: We compared data from the 2012 and 2020 warm-water point-intercept surveys to see if there were any significant changes in the lake's vegetation (Figure 8) (Tables 2 and 3). For individual plant species as well as count data, we used the Chi-square analysis on the WDNR Pre/Post survey worksheet. For comparing averages (mean species/point and mean rake fullness/point), we used t-tests. Differences were considered significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$ (UWEX 2010). It should be noted that we used the number of littoral points (252 in 2012/290 in 2020) as the basis for "sample points".

RESULTS:

Warm-water Full Point-intercept Macrophyte Survey:

Depth soundings taken at Kirby Lake's 315 survey points revealed a varied underwater topography. The lake's numerous shallow side bays generally dropped off gradually into 5ft+ of water before joining the main basin. The exception to this was the western finger bay which contained two small 12ft+ potholes. The main basin also contained two separate holes that bottomed out at over 15ft. Other notable features included a rocky 10ft saddle that ran from the boat landing due north to the point, and a small rock bar midlake at the pinch point entrance to the southwest bay (Figure 3) (Appendix III). After averaging the depths of all sample points from our two surveys, we determined that lake levels were approximately 1.3ft higher in 2020 than in 2012.

Sand dominated the majority of the nearshore lake bottom; however, this quickly transitioned to sandy or nutrient-rich organic muck at most depths over 5ft. On the lake's exposed points, we also documented scattered gravel and cobble substrates (Figure 3). Collectively, we categorized the bottom substrate as 78.1% muck (246 points), 19.7% sand (62 points), and 2.2% rock (7 points) (Appendix III).

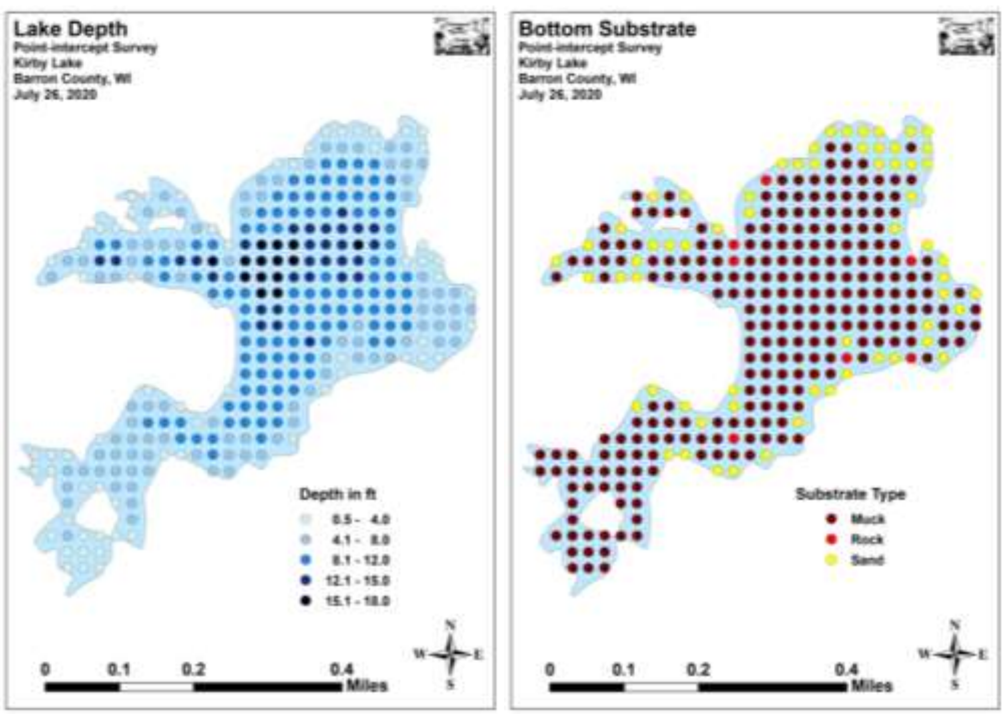


Figure 3: Lake Depth and Bottom Substrate

In 2020, the littoral zone extended to 13.0ft (up from 10.0ft in 2012) (Table 1) (Figure 4). We found plants growing at 258 of 290 littoral points (approximately 81.9% of the entire lake bottom and 89.0% of the littoral zone). This was a highly significant increase **(*p*<0.001)** in both littoral points and littoral points with plants compared to 2012 when we documented macrophytes at 184 of 252 littoral points (58.4% of the bottom and 73.0% of the littoral zone) (Appendix IV).

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics
Kirby Lake, Barron County
July 29, 31, 2012 and July 26, 2020

Summary Statistics:	2012	2020
Total number of points sampled	315	315
Total number of sites with vegetation	184	258
Total number of sites shallower than the maximum depth of plants	252	290
Frequency of occurrence at sites shallower than maximum depth of plants	73.0	89.0
Simpson Diversity Index	0.90	0.86
Maximum depth of plants (ft)	10.0	13.0
Mean depth of plants (ft)	4.2	7.0
Median depth of plants (ft)	4.0	6.8
Average number of all species per site (shallower than max depth)	2.88	2.58
Average number of all species per site (veg. sites only)	3.94	2.90
Average number of native species per site (shallower than max depth)	2.81	2.58
Average number of native species per site (sites with native veg. only)	3.87	2.90
Species richness	35	27
Species richness (including visuals)	38	30
Species richness (including visuals and boat survey)	49	40
Mean rake fullness (veg. sites only)	2.65	2.52

Plant growth in 2020 was slightly skewed to deep water as the mean depth of 7.0ft was more than the median depth of 6.8ft. This was similar to 2012 when we also found plant growth was slightly skewed to deep water (4.2ft mean/4.0ft median). These results were unexpected as rising water levels usually results in a narrowing of the littoral zone. It may be that the sustained increases in clarity documented by Secchi disc volunteers over the past three years allowed greater light penetration which resulted in this deepwater expansion (Figure 5).

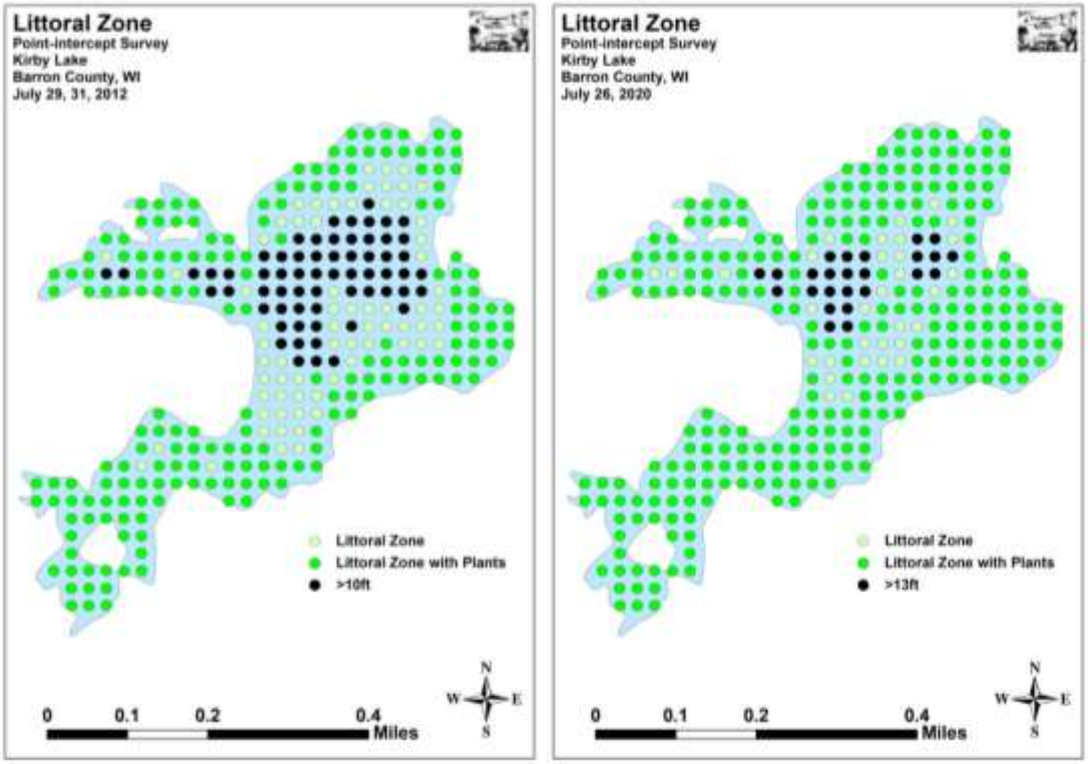


Figure 4: 2012 and 2020 Littoral Zone

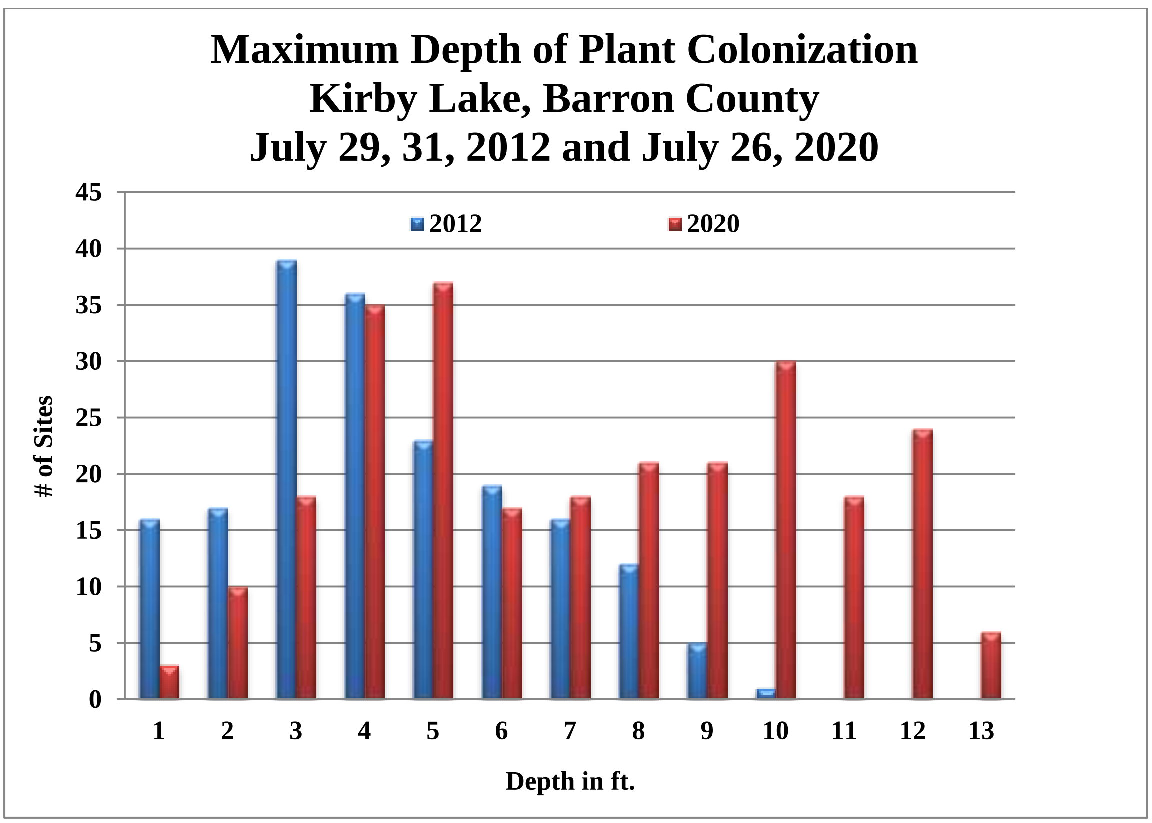


Figure 5: 2012 and 2020 Plant Colonization Depth Chart

Plant diversity was high in 2020 with a Simpson Index value of 0.86 – down from an exceptionally high 0.90 in 2012. However, richness was low with 27 species found in the rake (down from 35 in 2012). This total increased to 40 species when including visuals and plants seen during the boat survey. This number was also down sharply from the 49 total species we documented in 2012. Most of the plants that were present in 2012, but absent in 2020, were shallow-submergent, and emergent shoreline species that apparently lost their habitat when water levels increased.

Along with the overall richness decline, mean native species richness at sites with native vegetation experienced a highly-significant decline **(p<0.001)** from 3.87 species/site in 2012 to 2.90/site in 2020. Visual analysis of the maps suggested there were few areas that had localized gains in richness, but most nearshore areas suffered losses; especially in the emergent community. This, coupled with low richness expansion into deep water, produced the overall decline in the mean (Figure 6).

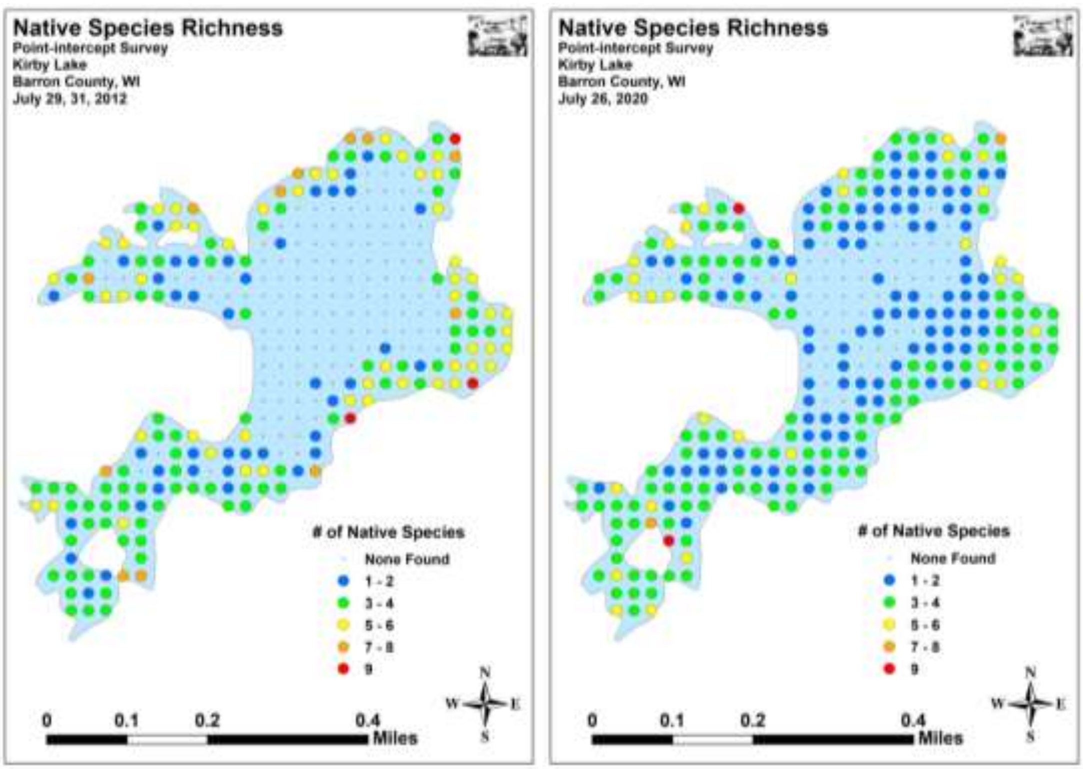


Figure 6: 2012 and 2020 Native Species Richness

Total rake fullness underwent a significant decline **(*p*=0.04)** from a very high 2.65 in 2012 to a high 2.52 in 2020. Rather than a loss of overall biomass, this decline reflected the low density expansion into deep water around the main basin (Figure 7) (Appendix IV).

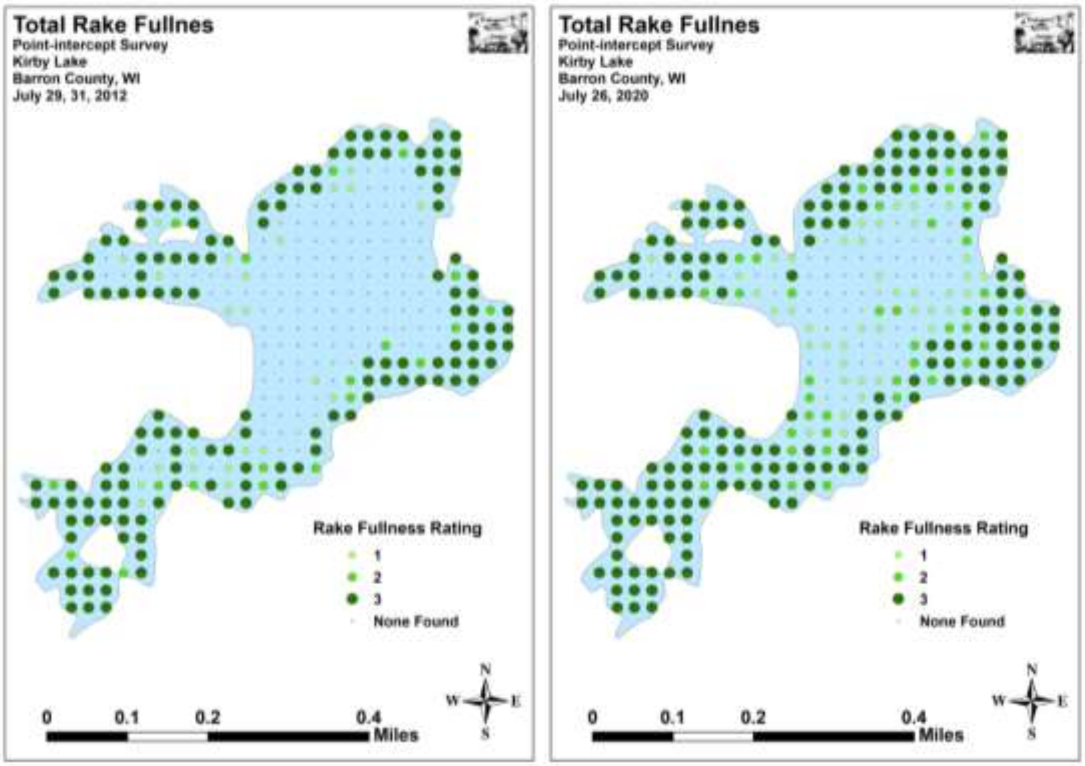


Figure 7: 2012 and 2020 Total Rake Fullness

Kirby Lake Plant Community:

Kirby Lake's abundant plant community is home to many sensitive and rare plants that are characteristic of relatively pristine, 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 habitat for invertebrates like dragonflies and mayflies.

At the immediate shoreline, Reed canary grass dominated the majority of the lake albeit at much lower levels than in 2012. We also found scattered Path rush (*Juncus tenuis*) in disturbed areas like the public boat landing. Primarily on exposed points over firm sand and gravel in water up to 3ft deep, we also documented scattered beds of Creeping spikerush (*Eleocharis palustris*) and Slender bulrush (*Schoenoplectus heterochaetus*).

Reed canary grass (Berg 2020)

Path rush (Barends 2013)

Creeping spikerush (Legler 2016)

Slender bulrush (Chayka 2017)

Over firm sandy muck, especially on the north shoreline, the emergent community was dominated by Common yellow lake sedge (*Carex utriculata*) and Three-way sedge (*Dulichium arundinaceum*) with patches of Torrey's three-square bulrush (*Schoenoplectus torreyi*), and Branched bur-reed (*Sparganium androcladum*) mixed in.

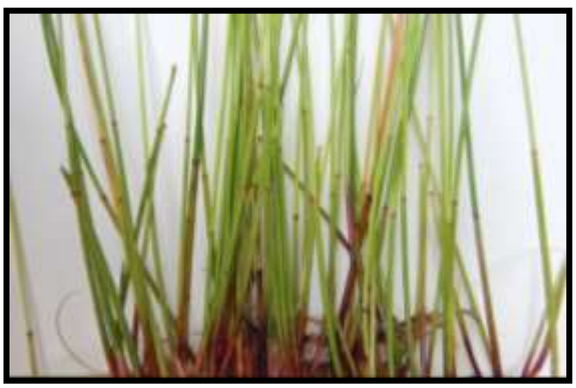
Common yellow lake sedge (Lavin 2011)

Three-way sedge (GMNRI 2016)

Torrey's three-square bulrush (Rothrock 2018)

Branched bur-reed (Sullman 2008)

In bays with more organic muck, these species were replaced by Bald spikerush (*Eleocharis erythropoda*), Water smartweed (*Polygonum amphibium*), Common arrowhead (*Sagittaria latifolia*), Water bulrush (*Schoenoplectus subterminalis*), Woolgrass (*Scirpus cyperinus*), and Broad-leaved cattail (*Typha latifolia*). Primarily on and around the floating bogs in the southwest bay, we also documented a limited amount of Blunt spikerush (*Eleocharis obtusa*) and Robbins' spikerush (*Eleocharis robbinsii*).



Bald spikerush (Schipper 2019)

Water smartweed on the Kirby Lake shoreline (Berg 2012)

Common arrowhead (Young 2006)

Water bulrush (Dziuk 2016)


Woolgrass (Colby 2012)


Broad-leaved cattail (Raymond 2011)


Blunt spikerush (Cameron 2012)


Robbins spikerush (Chayka 2014)

Just beyond the emergents, the lake's shallow sugar-sand areas tended to have the greatest 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. This habitat became rarer with rising water levels, and many of the species found here declined in distribution. Specifically, Waterwort (*Elatine minima*), Needle spikerush (*Eleocharis acicularis*), Golden hedge hyssop (*Gratiola aurea*), Spiny-spored quillwort (*Isoetes echinospora*), Northern naiad (*Najas gracillima*), and Variable pondweed (*Potamogeton gramineus*) were all less common in 2020 than in 2012; and Pipewort (*Eriocaulon aquaticum*), Brown-fruited rush (*Juncus pelocarpus*), Dwarf water-milfoil (*Myriophyllum tenellum*), Creeping spearwort (*Ranunculus flammula*) and Crested arrowhead (*Sagittaria cristata*) disappeared all together.


Waterwort (Fewless 2005)


Needle spikerush (Fewless 2005)


Golden hedge hyssop (Fewless 2005)


Spiny-spored quillwort (Haines 2012)


Northern naiad (Kallor 2016)


Variable pondweed – form with small submergent leaves (Cameron 2019)

When these shallow areas had at least a thin layer of sandy or organic muck, they were dominated by the floating-leaf species Watershield (*Brasenia schreberi*) and White-water lily (*Nymphaea odorata*) with lesser amount of Spatterdock (*Nuphar variegata*) and Water smartweed. The protective canopy cover these species provide is often utilized by panfish and bass.


Watershield (WED 2019)


White water lily (Falkner 2009)

Spatterdock (CBG 2014)

Water smartweed (Someya 2009)

Other pondweed species that occasionally or regularly produce floating leaves in this zone included Large-leaf pondweed (*Potamogeton amplifolius*), Snail-seed pondweed (*Potamogeton bicupulatus*), Ribbon-leaf pondweed (*Potamogeton epihydrus*), Variable pondweed (*Potamogeton gramineus*), Floating-leaf pondweed (*Potamogeton natans*), and Oakes' pondweed (*Potamogeton oakesianus*).

Large-leaf pondweed (Fewless 2010)

Snail-seed pondweed (Haines 2012))

Ribbon-leaf pondweed (Petroglyph 2007)

Variable pondweed with floating leaves (Koshere 2002)

Floating-leaf pondweed (Petroglyph 2007)

Oakes' pondweed (Cameron 2020)

Growing in gaps in the floating-leaf canopy and among the dominant pondweeds, we found scattered patches of Spiny hornwort (*Ceratophyllum echinatum*), Slender waterweed (*Elodea nuttallii*), and Farwell's water-milfoil (*Myriophyllum farwellii*). The roots, shoots, and seeds of all these species are heavily utilized by waterfowl for food, and they also provide important habitat for the lake's fish throughout their lifecycles, as well as a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.

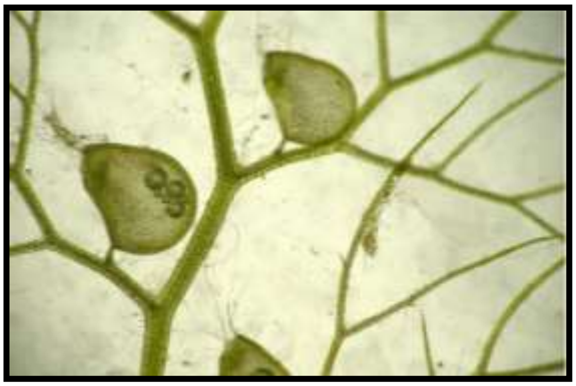
Spiny hornwort (Chayka 2019)

Slender waterweed (Fischer 2011)

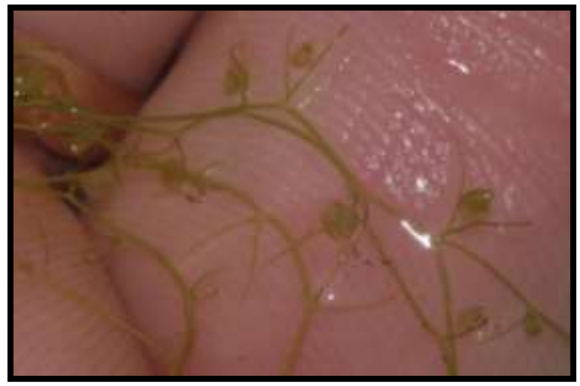
Farwell's water-milfoil (Dziuk 2015)

Farwell's water-milfoil on Kirby Lake's east side (Berg 2012)

Floating amongst the shallow-submergent and floating-leaf species, we also encountered large numbers of carnivorous bladderworts. Rather than drawing nutrients up through roots like other plants, these carnivores trap zooplankton and minute insects in their bladders, digest their prey, and use the nutrients to further their growth. This group included Creeping bladderwort (*Utricularia gibba*), Flat-leaf bladderwort (*Utricularia intermedia*), Small bladderwort (*Utricularia minor*), Large purple bladderwort (*Utricularia purpurea*), and Common bladderwort (*Utricularia vulgaris*).



Bladders for catching plankton and insect larvae (Wontolla 2007)



Creeping bladderwort (Eyewed 2010)

Flat-leaf bladderwort (Woods 2012)

Small bladderwort (Cameron 2019)

Large purple bladderwort among Watershield (Dziuk 2013)

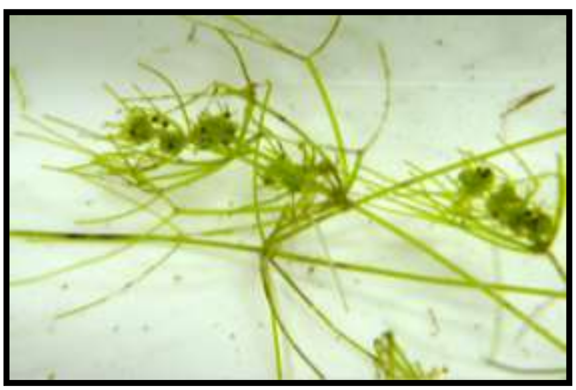
Common bladderwort flowers among lilypads (Hunt 2010)

Floating-leaf and shallow submergent species generally disappeared on Kirby Lake in water over 6-7ft deep. In these deeper submergent areas, Large-leaf pondweed and Small pondweed (*Potamogeton pusillus*) dominated the plant community and often formed dense beds of near canopied vegetation. Predatory fish like the lake's Northern pike are often found along the edges of these deepwater beds waiting in ambush.


Large-leaf pondweed (Dziuk 2018)

Small pondweed (Villa 2011)

Few species were present beyond 10ft, but, along with Small pondweed, we found scattered patches of Nitella (*Nitella* sp. likely *flexilis*) – a type of colonial algae that looks like a higher plant – to 13ft. In areas deeper than this, aquatic moss occurred at very low densities throughout the deepest parts of the lake.



Nitella (USGS 2008)

Aquatic moss leaves magnified 5X (Kleinman 2010)

Comparison of Native Macrophyte Species in 2012 and 2020:

In July 2012, we identified Watershield, Large purple bladderwort, Small pondweed, and Creeping bladderwort as the most common vascular species (Table 2). They were present at 62.50%, 62.50%, 50.54%, and 40.76% of survey points with vegetation respectively, and; collectively, they accounted for 54.90% of the total relative frequency. White water lily (9.93%), Flat-leaf bladderwort (7.45%), Common bladderwort (6.90%), and Farwell's water milfoil (4.41%) also had relative frequencies over 4.00%. Aquatic moss *** was actually the most common macrophyte (present at 66.30% of vegetative sites); however, because it is non-vascular, it was excluded from analysis (Distribution maps for all plants found in 2012 are located in the CD attached to this report).

***WDNR protocol excludes non-vascular plants like aquatic moss from all statistical calculations including species richness, relative frequency, and establishment of the lake's littoral zone.

During our 2020 survey, we found Small pondweed, Watershield, White water lily, and Large purple bladderwort were the most common species. Present at 78.68%, 48.45%, 35.27%, and 33.72% of sites with vegetation (Table 3), they accounted for 67.56% of the total relative frequency. Common bladderwort (10.28%) and Large-leaf pondweed (4.41%) also had relative frequencies over 4% (Species accounts for all plants identified in 2012 and 2020, and distribution maps for all plants found in July 2020 can be found in Appendixes V and VI).

Lakewide, fourteen species showed significant changes in distribution from 2012 to 2020 (Figure 8). Aquatic moss, Large purple bladderwort, Creeping bladderwort, Flat-leaf bladderwort, Farwell's water-milfoil, and Reed canary grass suffered highly significant declines; Northern manna grass (*Glyceria borealis*) experienced a moderately significant decline and was not observed on the lake in 2020; and Snail-seed pondweed and Ribbon-leaf pondweed saw significant declines. Conversely, Small pondweed and Large-leaf pondweed experienced highly significant increases; filamentous algae had a moderately significant increase; and Common arrowhead and freshwater sponges showed significant increases.

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Kirby Lake, Barron County
July 29, 31, 2012

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
	Aquatic moss	122	*	66.30	48.41	1.18	0
Brasenia schreberi	Watershield	115	15.86	62.50	45.63	2.39	12
Utricularia purpurea	Large purple bladderwort	115	15.86	62.50	45.63	1.41	7
Potamogeton pusillus	Small pondweed	93	12.83	50.54	36.90	1.35	5
Utricularia gibba	Creeping bladderwort	75	10.34	40.76	29.76	1.09	5
Nymphaea odorata	White water lily	72	9.93	39.13	28.57	1.97	15
Utricularia intermedia	Flat-leaf bladderwort	54	7.45	29.35	21.43	1.48	1
Utricularia vulgaris	Common bladderwort	50	6.90	27.17	19.84	1.10	6
Myriophyllum farwellii	Farwell's water-milfoil	32	4.41	17.39	12.70	1.25	9
Eleocharis palustris	Creeping spikerush	16	2.21	8.70	6.35	1.94	7
Phalaris arundinacea	Reed canary grass	16	2.21	8.70	6.35	2.06	5
Glyceria borealis	Northern manna grass	8	1.10	4.35	3.17	1.13	6
Utricularia minor	Small bladderwort	8	1.10	4.35	3.17	1.00	1
Dulichium arundinaceum	Three-way sedge	6	0.83	3.26	2.38	1.33	7
Eleocharis robbinsii	Robbins' spikerush	5	0.69	2.72	1.98	1.00	0
Nuphar variegata	Spatterdock	5	0.69	2.72	1.98	1.00	2
Potamogeton amplifolius	Large-leaf pondweed	5	0.69	2.72	1.98	1.00	5
Potamogeton gramineus	Variable pondweed	5	0.69	2.72	1.98	1.20	1
Sparganium androcladum	Branched bur-reed	5	0.69	2.72	1.98	1.00	2
Polygonum amphibium	Water smartweed	4	0.55	2.17	1.59	1.25	4
Potamogeton bicupulatus	Snail-seed pondweed	4	0.55	2.17	1.59	1.75	0
Potamogeton epihydrus	Ribbon-leaf pondweed	4	0.55	2.17	1.59	1.50	3
Potamogeton natans	Floating-leaf pondweed	4	0.55	2.17	1.59	1.00	0
Schoenoplectus subterminalis	Water bulrush	4	0.55	2.17	1.59	1.00	1
Nitella sp.	Nitella	3	0.41	1.63	1.19	1.00	0
Potamogeton oakesianus	Oakes' pondweed	3	0.41	1.63	1.19	1.00	2

* Excluded from relative frequency analysis

Table 2 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Kirby Lake, Barron County
July 29, 31, 2012

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Eleocharis erythropoda	Bald spikerush	2	0.28	1.09	0.79	1.00	0
Elodea nuttallii	Slender waterweed	2	0.28	1.09	0.79	1.00	0
Gratiola aurea	Golden hedge-hyssop	2	0.28	1.09	0.79	1.00	1
Sagittaria cristata	Crested arrowhead	2	0.28	1.09	0.79	1.00	0
Ceratophyllum echinatum	Spiny hornwort	1	0.14	0.54	0.40	1.00	0
Lindernia dubia	False pimpernel	1	0.14	0.54	0.40	1.00	1
Sagittaria latifolia	Common arrowhead	1	0.14	0.54	0.40	1.00	2
Schoenoplectus heterochaetus	Slender bulrush	1	0.14	0.54	0.40	1.00	0
Schoenoplectus purshianus	Pursh's bulrush	1	0.14	0.54	0.40	3.00	1
Sparganium fluctuans	Floating-leaf bur-reed	1	0.14	0.54	0.40	1.00	0
Gallium sp.	Bedstraw	**	**	**	**	**	1
Najas gracillima	Northern naiad	**	**	**	**	**	1
Scirpus cyperinus	Woolgrass	**	**	**	**	**	2
Elatine minima	Waterwort	***	***	***	***	***	***
Eleocharis acicularis	Needle spikerush	***	***	***	***	***	***
Eleocharis obtusa	Blunt spikerush	***	***	***	***	***	***
Eriocaulon aquaticum	Pipewort	***	***	***	***	***	***
Isoetes echinospora	Spiny-spored quillwort	***	***	***	***	***	***
Juncus pelocarpus	Brown-fruited rush	***	***	***	***	***	***
Juncus tenuis	Path rush	***	***	***	***	***	***
Myriophyllum tenellum	Dwarf water milfoil	***	***	***	***	***	***
Potamogeton robbinsii	Fern pondweed	***	***	***	***	***	***
Ranunculus flammula	Creeping spearwort	***	***	***	***	***	***
Typha latifolia	Broad-leaved cattail	***	***	***	***	***	***

** Visual only   *** Boat survey only

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Kirby Lake, Barron County
July 26, 2020

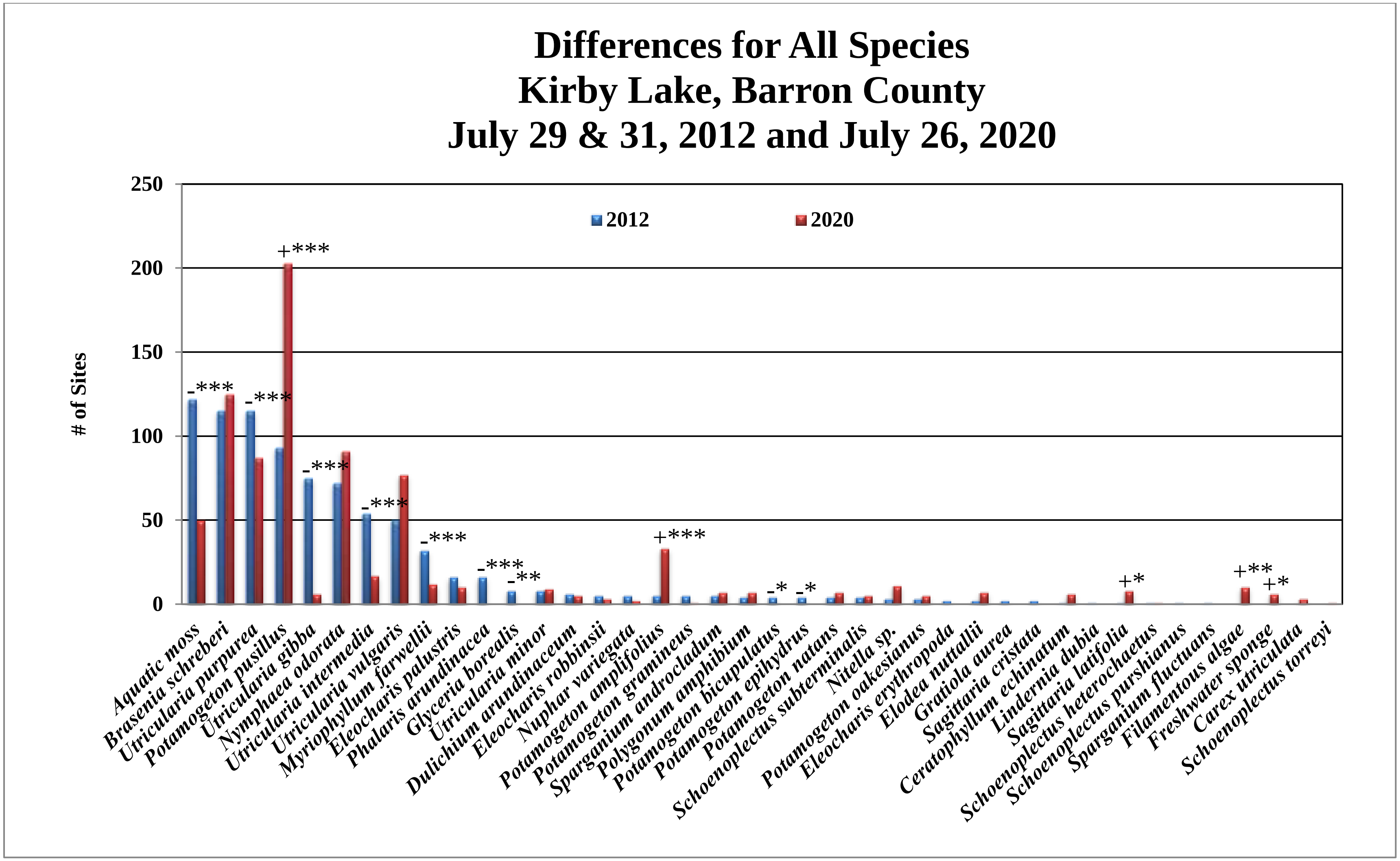
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton pusillus	Small pondweed	203	27.10	78.68	70.00	1.65	0
Brasenia schreberi	Watershield	125	16.69	48.45	43.10	2.42	11
Nymphaea odorata	White water lily	91	12.15	35.27	31.38	1.91	11
Utricularia purpurea	Large purple bladderwort	87	11.62	33.72	30.00	1.41	7
Utricularia vulgaris	Common bladderwort	77	10.28	29.84	26.55	1.30	4
	Aquatic moss	50	*	19.38	17.24	1.00	0
Potamogeton amplifolius	Large-leaf pondweed	33	4.41	12.79	11.38	1.39	8
Utricularia intermedia	Flat-leaf bladderwort	17	2.27	6.59	5.86	1.29	0
Myriophyllum farwellii	Farwell's water-milfoil	12	1.60	4.65	4.14	1.25	7
Nitella sp. likely *flexilis*	Nitella	11	1.47	4.26	3.79	1.00	0
Eleocharis palustris	Creeping spikerush	10	1.34	3.88	3.45	1.20	7
	Filamentous algae	10	*	3.88	3.45	1.20	0
Utricularia minor	Small bladderwort	9	1.20	3.49	3.10	1.11	0
Sagittaria latifolia	Common arrowhead	8	1.07	3.10	2.76	1.25	1
Elodea nuttallii	Slender waterweed	7	0.93	2.71	2.41	1.00	0
Polygonum amphibium	Water smartweed	7	0.93	2.71	2.41	1.14	2
Potamogeton natans	Floating-leaf pondweed	7	0.93	2.71	2.41	1.29	1
Sparganium androcladum	Branched bur-reed	7	0.93	2.71	2.41	1.43	5
Ceratophyllum echinatum	Spiny hornwort	6	0.80	2.33	2.07	1.17	0
	Freshwater sponge	6	*	2.33	2.07	1.00	0
Utricularia gibba	Creeping bladderwort	6	0.80	2.33	2.07	1.00	1
Dulichium arundinaceum	Three-way sedge	5	0.67	1.94	1.72	2.00	1
Potamogeton oakesianus	Oakes' pondweed	5	0.67	1.94	1.72	2.00	9
Schoenoplectus subterminalis	Water bulrush	5	0.67	1.94	1.72	1.40	0

* Excluded from relative frequency analysis

Table 3 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Kirby Lake, Barron County
July 26, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Carex utriculata	Common yellow lake sedge	3	0.40	1.16	1.03	2.33	4
Eleocharis robbinsii	Robbins' spikerush	3	0.40	1.16	1.03	1.00	0
Nuphar variegata	Spatterdock	2	0.27	0.78	0.69	1.00	4
Potamogeton gramineus	Variable pondweed	1	0.13	0.39	0.34	1.00	0
Schoenoplectus heterochaetus	Slender bulrush	1	0.13	0.39	0.34	1.00	0
Schoenoplectus torreyi	Torrey's three-square	1	0.13	0.39	0.34	1.00	4
Potamogeton epihydrus	Ribbon-leaf pondweed	**	**	**	**	**	3
Scirpus cyperinus	Wool grass	**	**	**	**	**	2
Phalaris arundinacea	Reed canary grass	**	**	**	**	**	1
Elatine minima	Waterwort	***	***	***	***	***	***
Eleocharis acicularis	Needle spikerush	***	***	***	***	***	***
Eleocharis erythropoda	Bald spikerush	***	***	***	***	***	***
Eleocharis obtusa	Blunt spikerush	***	***	***	***	***	***
Gratiola aurea	Golden hedge-hyssop	***	***	***	***	***	***
Isoetes echinospora	Spiny spored-quillwort	***	***	***	***	***	***
Juncus tenuis	Path rush	***	***	***	***	***	***
Najas gracillima	Northern naiad	***	***	***	***	***	***
Potamogeton bicupulatus	Snail-seed pondweed	***	***	***	***	***	***
Typha latifolia	Broad-leaved cattail	***	***	***	***	***	***

** Visual only   *** Boat survey only



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

Figure 8: Macrophytes Changes from 2012-2020

Watershield, the most common vascular species in 2012 and the second most common in 2020, was abundant in most areas from 2-6ft deep over sandy muck where it tended to dominate the plant community (Figure 9). Found at 115 sites in 2012, it demonstrated a non-significant increase (p=0.55) in distribution to 125 sites in 2020. Its mean rake fullness increase from 2.39 in 2012 to 2.42 in 2020 was also not significant (p=0.38).

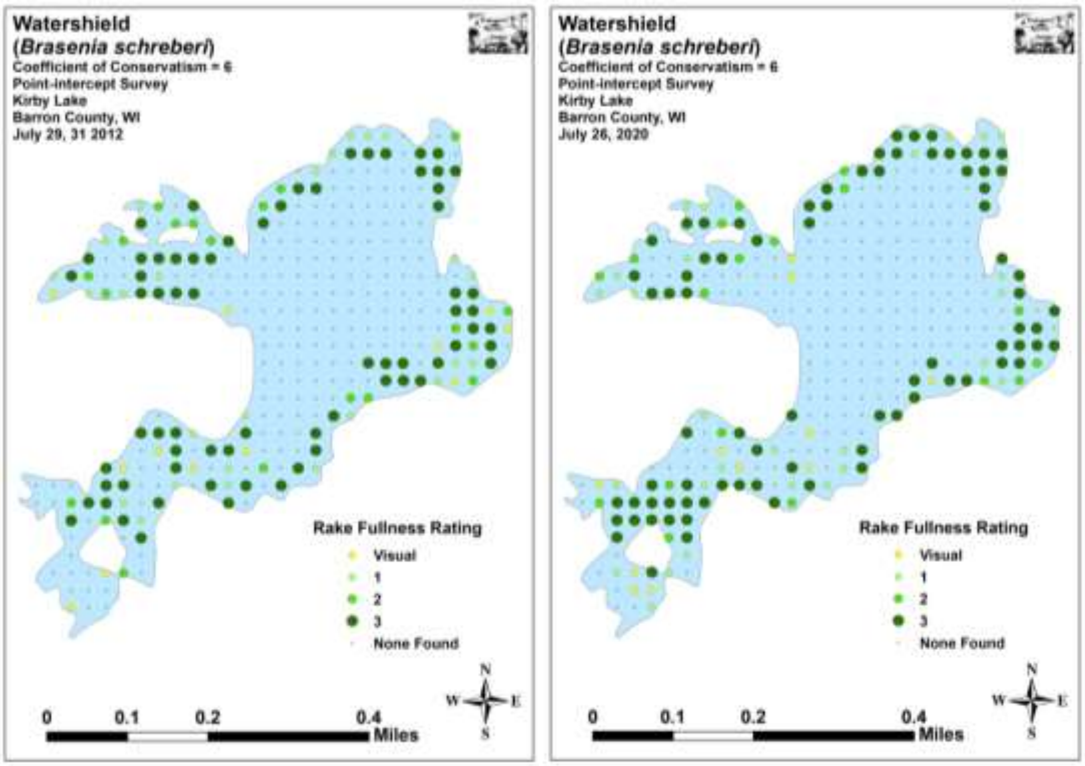


Figure 9: 2012 and 2020 Watershield Density and Distribution

Large purple bladderwort was the second most common vascular species in 2012 and the fourth most common in 2020 (Figure 10). Although it demonstrated a highly significant decline **(p<0.001)** in distribution from 115 sites in 2012 to 87 sites in 2020, its density was unchanged (mean rake fullness of 1.41 each year).

Small pondweed, the third most common vascular species in 2012 and the most common in 2020, experienced a highly-significant increase **(p<0.001)** in both distribution (93 sites in 2012/203 in 2020) and density (mean rake of 1.35 in 2012/1.65 in 2020). Analysis of the maps showed this species seemed to exploit the rising water levels as it came to dominate the expanded 7-13ft zone (Figure 11). Similarly, Large-leaf pondweed jumped from the fourteenth most common species in 2012 (5 sites/mean rake of 1.00) to the sixth most common in 2020 (33 sites/mean rake of 1.39). However, its highly significant increases **(p<0.001)** were more focused in the 7-10ft zone just beyond the Watershield (Figure 12).

Similar to Watershield, White water lily experienced a non-significant increase (p=0.48) in distribution (72 sites in 2012/91 sites in 2020) as its community rank rose from the fifth most common vascular species to the third most common (Figure 13). Most of this expansion was low density as its mean rake fullness declined from 1.97 in 2012 to 1.91 in 2020; however, this was not significant (p=0.33).

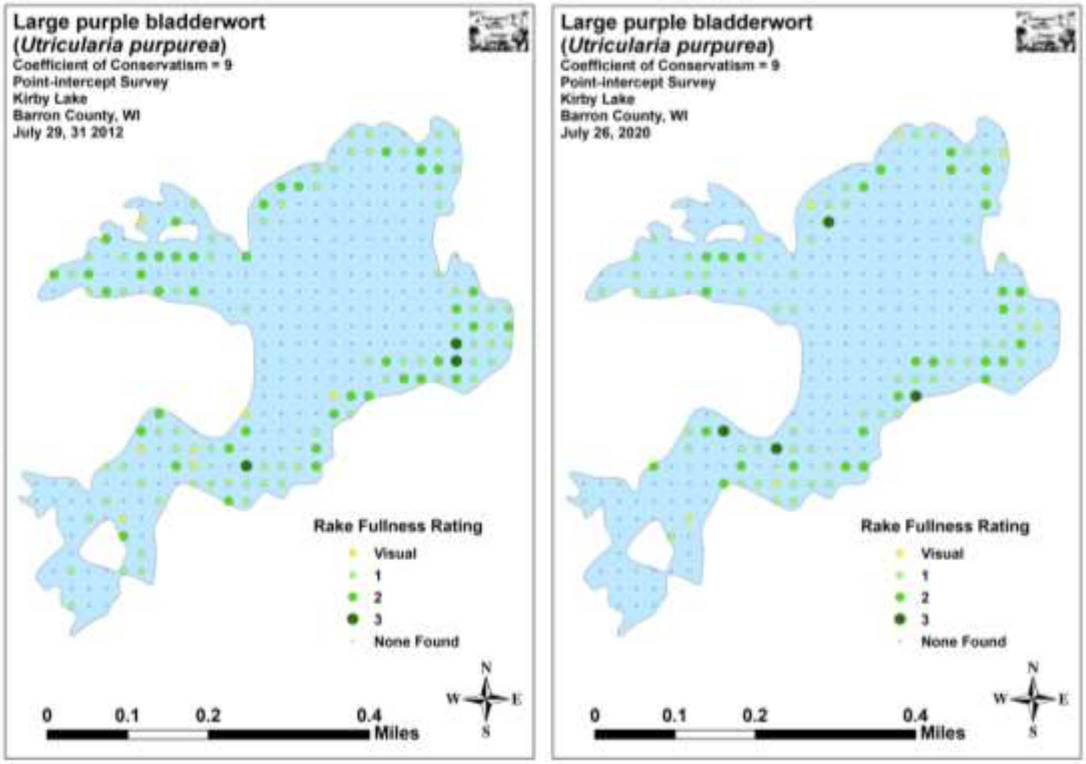


Figure 10: 2012 and 2020 Large Purple Bladderwort Density/Distribution

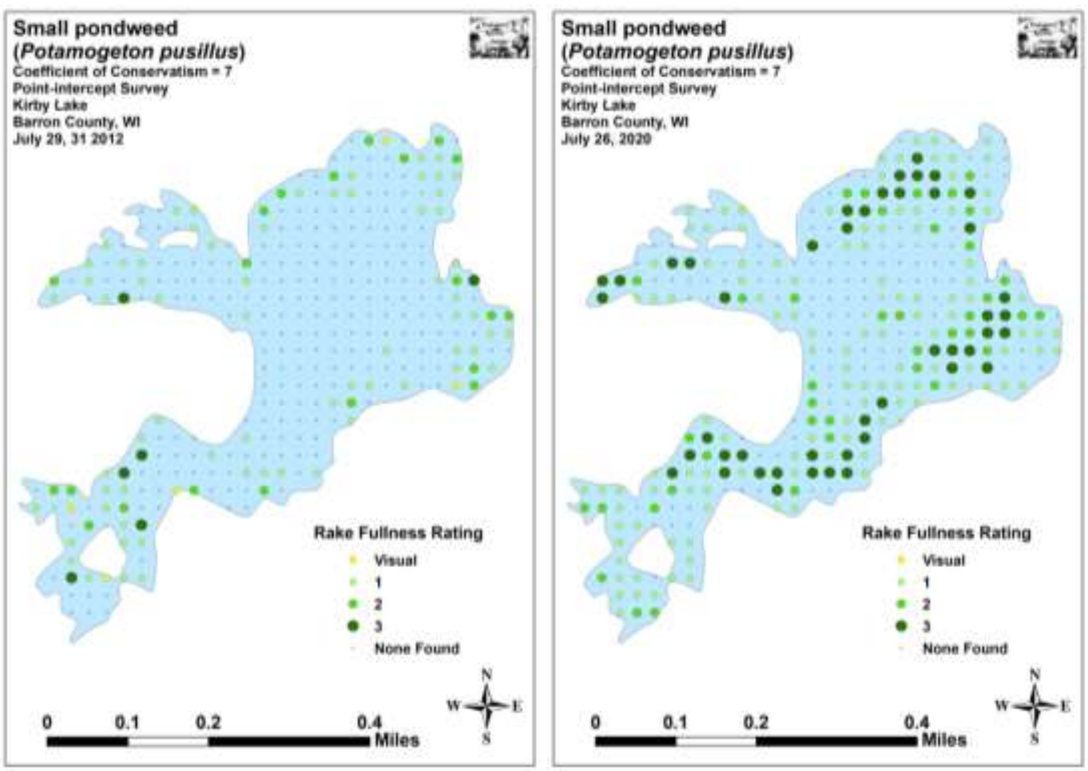
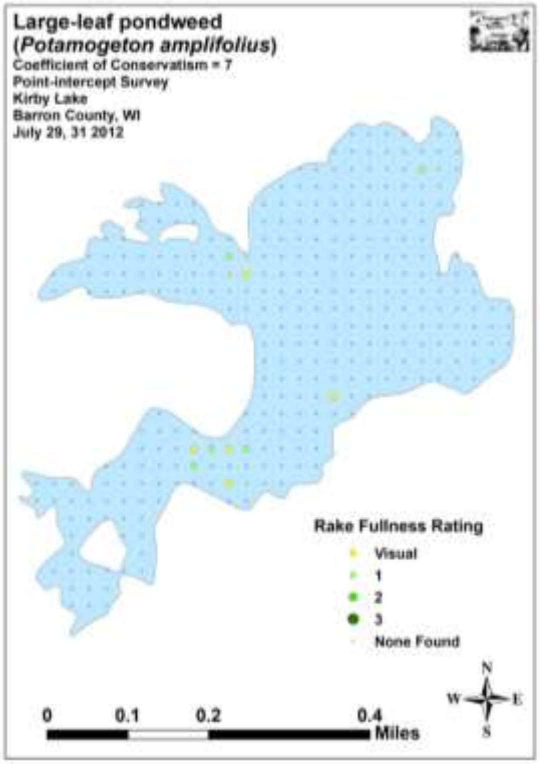


Figure 11: 2012 and 2020 Small Pondweed Density and Distribution



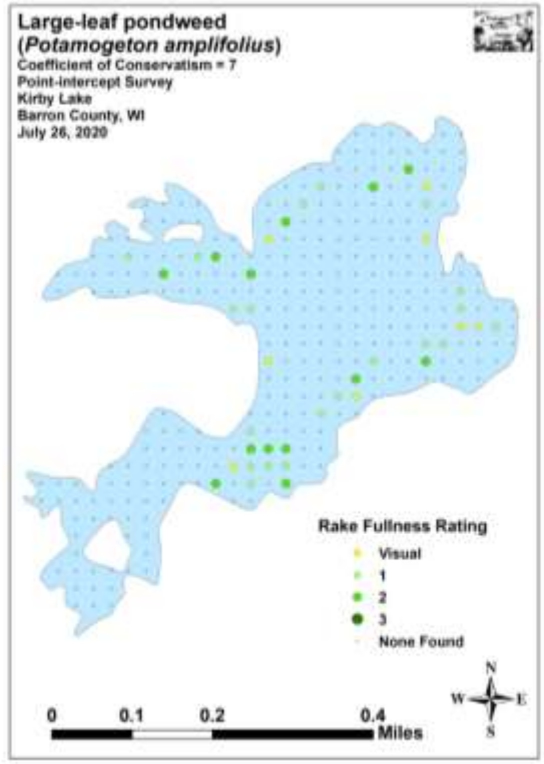


Figure 12: 2012 and 2020 Large-leaf Pondweed Density and Distribution

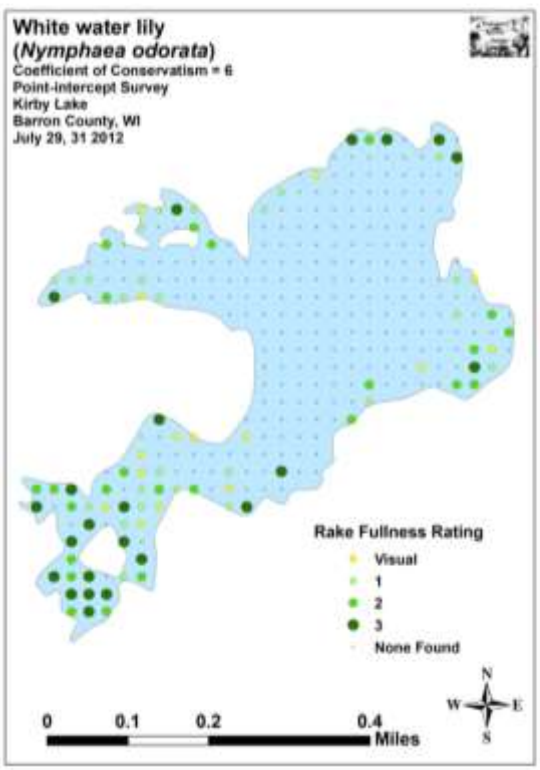


Figure 13: 2012 and 2020 White Water Lily Density and Distribution

Although it is not factored into the community analysis, we felt aquatic moss was worth mentioning as it was the most widely distributed plant on the lake in 2012 when we found it at 122 sites with a mean rake fullness of 1.18. By 2020, following highly significant declines **(p<0.001)** in both distribution (50 sites) and density (mean rake of 1.00), it was only present in the deepest areas of the lake where we never raked up more than a few small individuals in a sample (Figure 14).

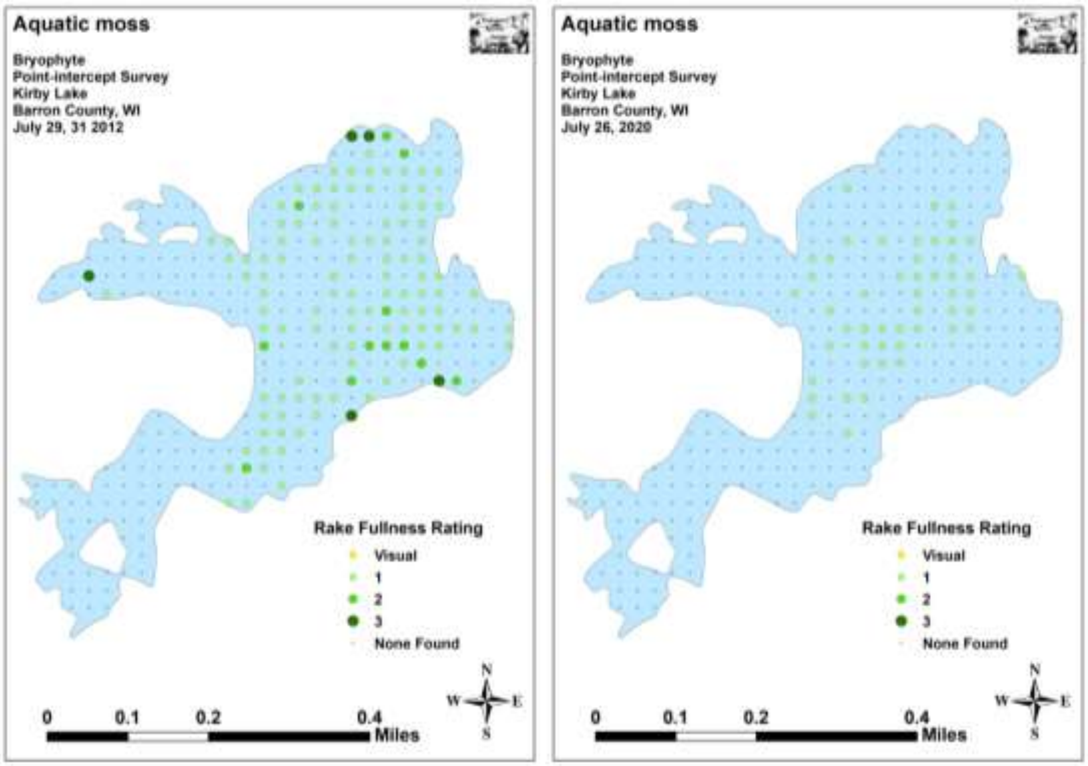


Figure 14: 2012 and 2020 Aquatic Moss Density and Distribution

Comparison of Floristic Quality Indexes in 2012 and 2020:

In 2012, we identified a total of 31 **native index species** in the rake during the point-intercept survey (Table 4). They produced a mean Coefficient of Conservatism of 7.6 and a Floristic Quality Index of 42.6.

Table 4: Floristic Quality Index of Aquatic Macrophytes
Kirby Lake, Barron County
July 29, 31, 2012

Species	Common Name	C
Brasenia schreberi	Watershield	6
Ceratophyllum echinatum	Spiny hornwort	10
Dulichium arundinaceum	Three-way sedge	9
Eleocharis erythropoda	Bald spikerush	3
Eleocharis palustris	Creeping spikerush	6
Elodea nuttallii	Slender waterweed	7
Glyceria borealis	Northern manna grass	8
Gratiola aurea	Golden hedge-hyssop	10
Myriophyllum farwellii	Farwell's water-milfoil	8
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Water smartweed	5
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton bicupulatus	Snail-seed pondweed	9
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton oakesianus	Oakes' pondweed	10
Potamogeton pusillus	Small pondweed	7
Sagittaria cristata	Crested arrowhead	9
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus heterochaetus	Slender bulrush	10
Schoenoplectus subterminalis	Water bulrush	9
Sparganium androcladum	Branched bur-reed	8
Sparganium fluctuans	Floating-leaf bur-reed	10
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia minor	Small bladderwort	10
Utricularia purpurea	Large purple bladderwort	9
Utricularia vulgaris	Common bladderwort	7
N		**31**
Mean C		**7.6**
FQI		**42.6**

In 2020, we found 24 **native index plants** in the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism of 7.5 and a Floristic Quality Index of 36.7 (Table 5). Nichols (1999) reported an average Mean C for the Northern Central Hardwood Forests Region of 5.6 putting Kirby Lake well above average for this part of the state. The FQI was also well above the median FQI of 20.9 for the Northern Central Hardwood Forests Region (Nichols 1999). Exceptionally high value index plants of note included Spiny hornwort (C = 10), Three-way sedge (C = 9), Water bulrush (C = 9), Creeping bladderwort (C = 9), Flat-leaf bladderwort (C = 9), Small bladderwort (C = 10), Large-purple bladderwort (C = 9), and the State Species of Special Concern **Robbins' spikerush (C = 10), Oakes' pondweed (C = 10), and Slender bulrush (C = 10). Four other high value species of note were excluded because they were only seen during the boat survey (Waterwort (C = 9), Golden-hedge hyssop (C = 10) and **Snail-seed pondweed (C = 9)), or they were not an index species (**Torrey's three-square bulrush (C = 9)).

** *"Special Concern"* species like Robbins' spikerush, Snail-seed pondweed and, Oakes' pondweed, Slender bulrush, and Torrey's three-square bulrush are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Table 5: Floristic Quality Index of Aquatic Macrophytes Kirby Lake, Barron County July 26, 2020

Species	Common Name	C
Brasenia schreberi	Watershield	6
Ceratophyllum echinatum	Spiny hornwort	10
Dulichium arundinaceum	Three-way sedge	9
Eleocharis palustris	Creeping spikerush	6
Elodea nuttallii	Slender waterweed	7
Myriophyllum farwellii	Farwell's water-milfoil	8
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Water smartweed	5
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton oakesianus	Oakes' pondweed	10
Potamogeton pusillus	Small pondweed	7
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus heterochaetus	Slender bulrush	10
Schoenoplectus subterminalis	Water bulrush	9
Sparganium androcladum	Branched bur-reed	8
Utricularia gibba	Creeping bladderwort	9
Utricularia intermedia	Flat-leaf bladderwort	9
Utricularia minor	Small bladderwort	10
Utricularia purpurea	Large purple bladderwort	9
Utricularia vulgaris	Common bladderwort	7
N		**24**
Mean C		**7.5**
FQI		**36.7**

Exotic Plant Species:

We did NOT find any evidence of Eurasian water-milfoil, Curly-leaf pondweed, or any other new aquatic or semi-aquatic exotic plant species in Kirby Lake during our 2020 survey. However, Reed canary grass (RCG), a previously described exotic invasive emergent species, continues to be present. In 2012, we found it in the rake at 16 points, noted it as a visual at five additional points, and calculated a mean rake fullness of 2.06. We also found that it had taken over large areas of the lake's shoreline and dominated several surrounding wetlands (Figure 15). Fortunately, rising water levels have resulted in a significant reduction in the available habitat for RCG. In 2020, we only recorded it as a visual at a single point (Figure 16), and we found that native emergents which can tolerate deeper water have reclaimed most areas RCG formerly occupied (For more information on a sampling of aquatic exotic invasive plant species, see Appendix VII).

Figure 15: Kirby Lake Shoreline in the Southwest Bay 7/29/12

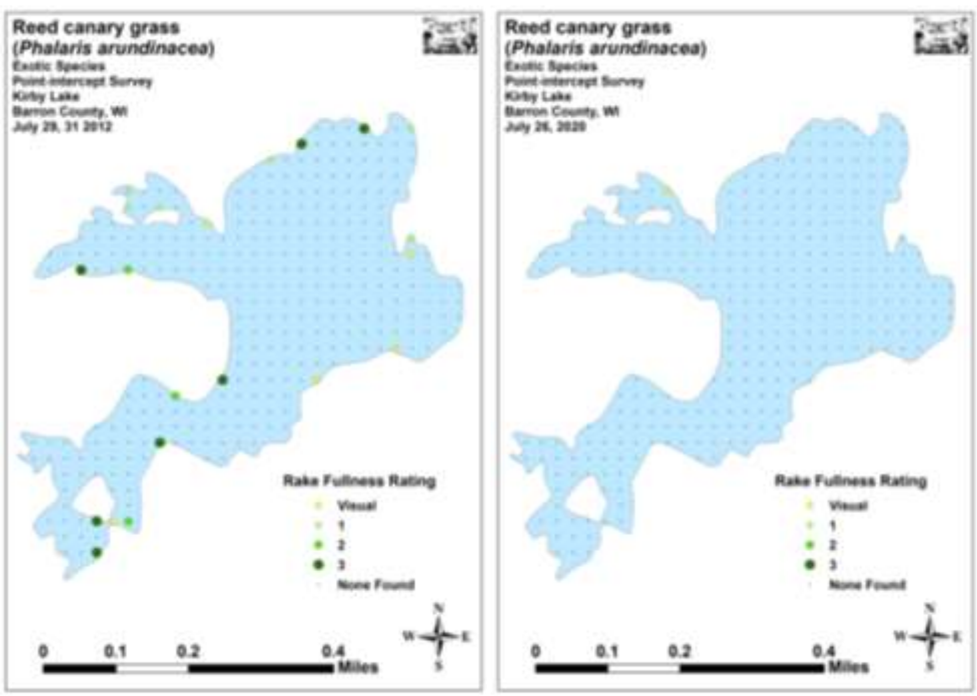


Figure 16: 2012 and 2020 Reed Canary Grass Density and Distribution

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Uniqueness of the Lake's Native Plant Community:

Aquatic plants are the basis of a lake's ecosystem and are as important to the aquatic environment as trees are to a forest. They provide habitat for fish and other aquatic organisms, serve as food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve clarity by absorbing excess nutrients from the water. Because of this, maintaining this community is critical to maintaining a healthy lake.

Out of the 100's of plant surveys we've conducted, Kirby Lake's plant community is one of the "most sensitive" we have ever found. This tiny lake continues to boasts 14 extremely high-value species (C value of 9 or 10). Although this was down from 2012 when we found 18 species in this group, we believe these species simply disappeared due to the loss of their shallow-water habitat and will likely reappear when water levels recede. Regardless, many of these rare species were very limited in both numbers and distribution making them vulnerable to lake-wide extinction. The water clarity and quality they depend on for survival also makes them dependent on continued landowner stewardship to maintain the lake's nearly pristine conditions.

Challenges with the Lake's Plant Community:

Kirby Lake's soft acidic water and shallow depths provide Watershield, Large purple bladderwort, and White water lily with ideal growing conditions. As the lake's bays have grown shallower over time, these species especially have been able to expand their range on the lake to the point where they now dominate most areas in less than five feet of water. Because the majority of owners that live in the lake's bays will likely continue to have significant difficulty getting to and from their docks after June 1st when plants have topped out, some form of plant control will likely be necessary to relieve navigation impairment. As the lake has such a rare and sensitive community, we continue to encourage limited harvesting rather than blanket herbicide treatment as this likely provides the best compromise between maintaining the environment and promoting human enjoyment of the lake.

Figure 17: Nearly Inaccessible Shoreline on Kirby Lake

Nutrient Impacts on the Lake's Plant Community:

Nutrients, especially phosphorus, promote both excess rooted plant and algal growth. Such things as internal loading from sediments, failed septic systems, soil erosion, and lawn and field fertilizer runoff are common causes of excess nutrients in surface water. Currently, Kirby Lake's property owners are to be commended for their generally good shoreline conservation, and the lake has many residences that could serve as a model for how to minimize human impacts on a lakeshore. Educating all lake residents about reducing nutrient input directly along the lake is one of the easiest ways to help limit plant and algal growth, as well as maintain or even improve water clarity and quality. Not mowing down to the lakeshore, bagging grass clippings, disposing of pet waste and fire pit ashes away from the lake, and switching to a phosphorus-free fertilizer or eliminating fertilizer altogether would all be positive steps to this end. Wherever possible, restoring shorelines, building rain gardens, and establishing buffer strips of native vegetation would also enhance water clarity/quality by preventing erosion and runoff.

Away from the immediate shoreline, disturbing nutrient-rich muck bottoms with motor start-ups in shallow water, anchor dragging, and the grounding of personal watercraft can also be a significant contributor to suspended nutrients in the water column. To prevent this, residents are encouraged to use lifts for their watercraft whenever possible, and to try to avoid starting their motors in water less than 5ft in depth.

Finally, distributing a simple self evaluation "lake care" checklist with rational for best practices is a non-confrontational way to help people understand how they may be impacting the lake. Hopefully, a greater understanding of how individual property owners can have lake-wide impacts will result in more people taking appropriate conservation actions to help limit plant growth and promote improved water quality for all.

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water milfoil are an increasing problem in the lakes of northern Wisconsin in general, and several nearby lakes in the Cumberland area in particular. Because of this, we strongly encourage the KLMD to continue its established Clean Boats/Clean Waters program. In addition to the education and reeducation CB/CW workers offer to residents and visitors alike, the physical checking of incoming/outgoing boats provides an important safeguard for the lake. Similarly, regular volunteer monitoring for exotic plant species throughout the growing season, especially near the public landing, increases the odds of early detection if an AIS is introduced into the lake. The sooner an infestation is found, the greater the chances it can be successfully and economically controlled.

LITERATURE CITED

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

Busch, C, C Olson, L. Sather, and J. Roth. [online]. 1968. Kirby Lake Bathymetric Map. http://dnr.wi.gov/lakes/maps/DNR/1858200a.pdf (November, 2020)

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

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

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

Skawinski, Paul. 2019. Aquatic Plants of the Upper Midwest: A photographic field guide to our underwater forests. 4th Edition, Wausau, WI.

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

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2020, November).

UWEX Lakes Program. [online]. 2010. Pre/Post Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2020, November).

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

WDNR. [online]. 2010. Curly-leaf pondweed fact sheet. http://dnr.wi.gov/invasives/fact/curlyleaf_pondweed.htm (2010, August).

WDNR. [online]. 2010. Eurasian Water-milfoil fact sheet. http://dnr.wi.gov/invasives/fact/milfoil.htm (2010, August).

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

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

WDNR. [online]. 2020. Wisconsin Lakes Information. http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=1858200 (2020, December).

WDNR. [online]. 2020. Wisconsin Lake Citizen Monitoring Data for Kirby Lake – Barron County. Available from http://dnr.wi.gov/lakes/waterquality/Station.aspx?id=033160 (2020, December).

Appendix I: Boat and Vegetative Survey Datasheets

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

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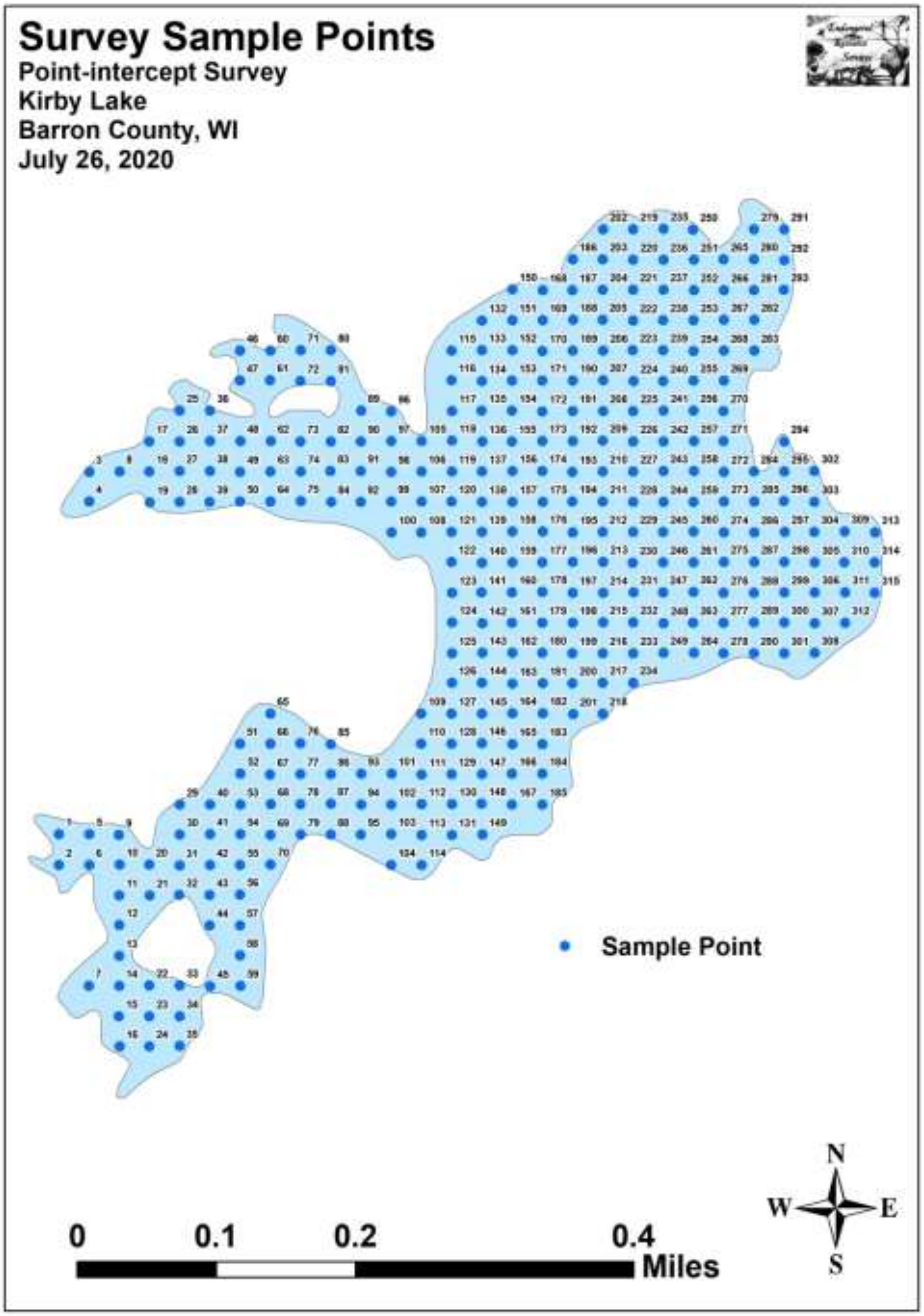
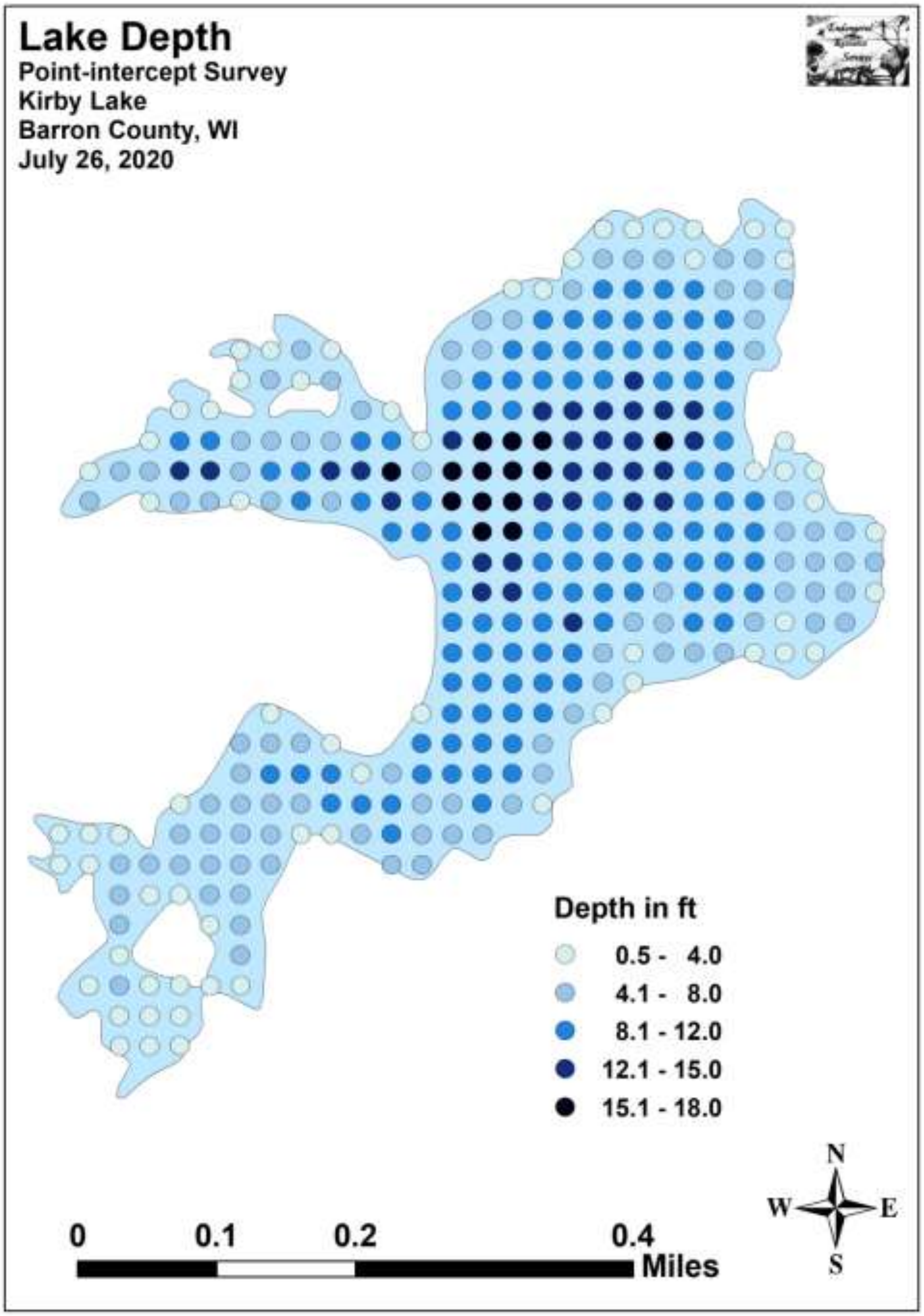
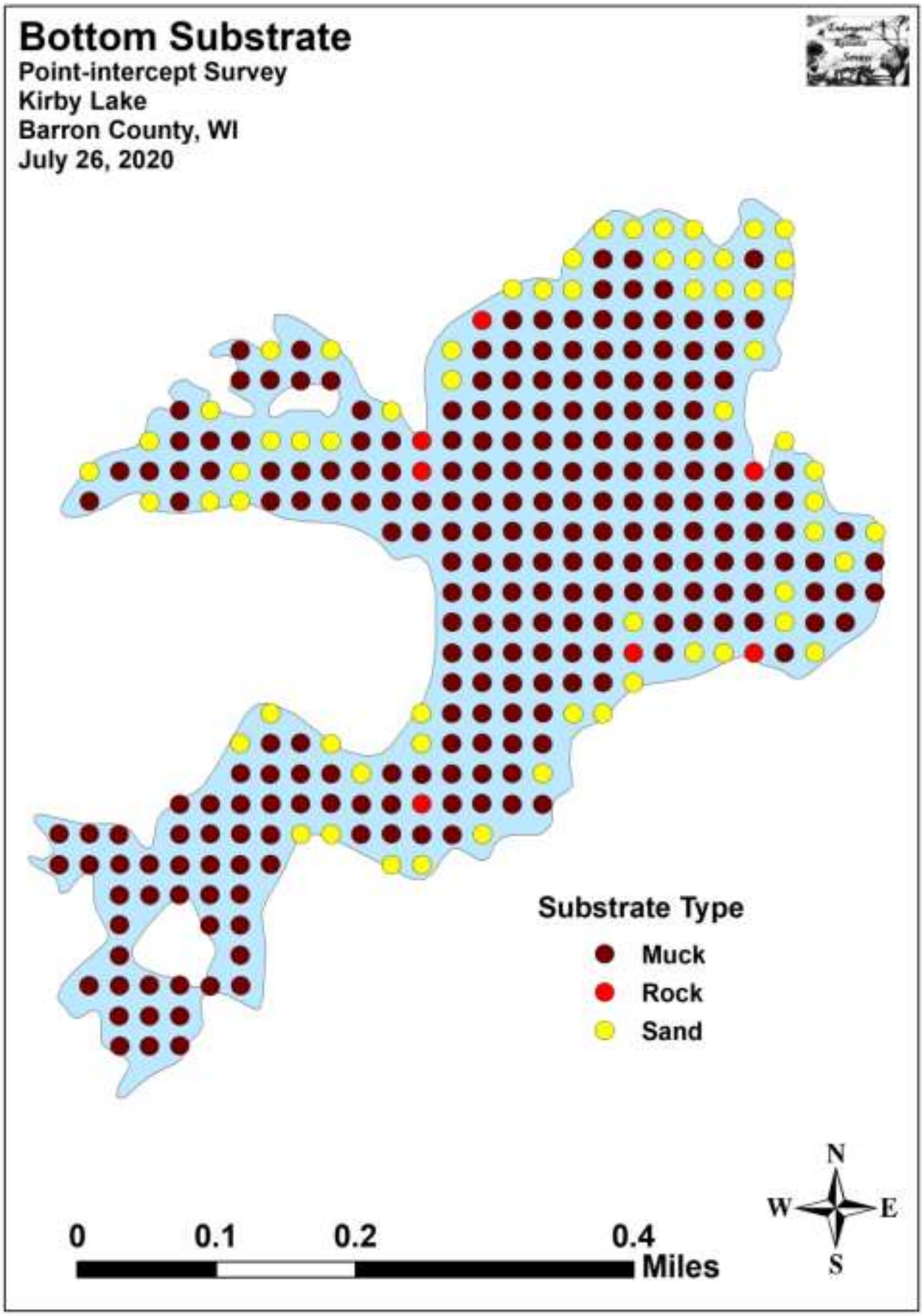
20																									

Appendix II: Survey Sample Points Map


Survey Sample Points
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Sample Point
0
0.1
0.2
0.4
Miles
N
W
E
S

Appendix III: Habitat Variable Maps


Lake Depth
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Depth in ft
0.5 - 4.0
4.1 - 8.0
8.1 - 12.0
12.1 - 15.0
15.1 - 18.0
N
W
E
S
0
0.1
0.2
0.4
Miles

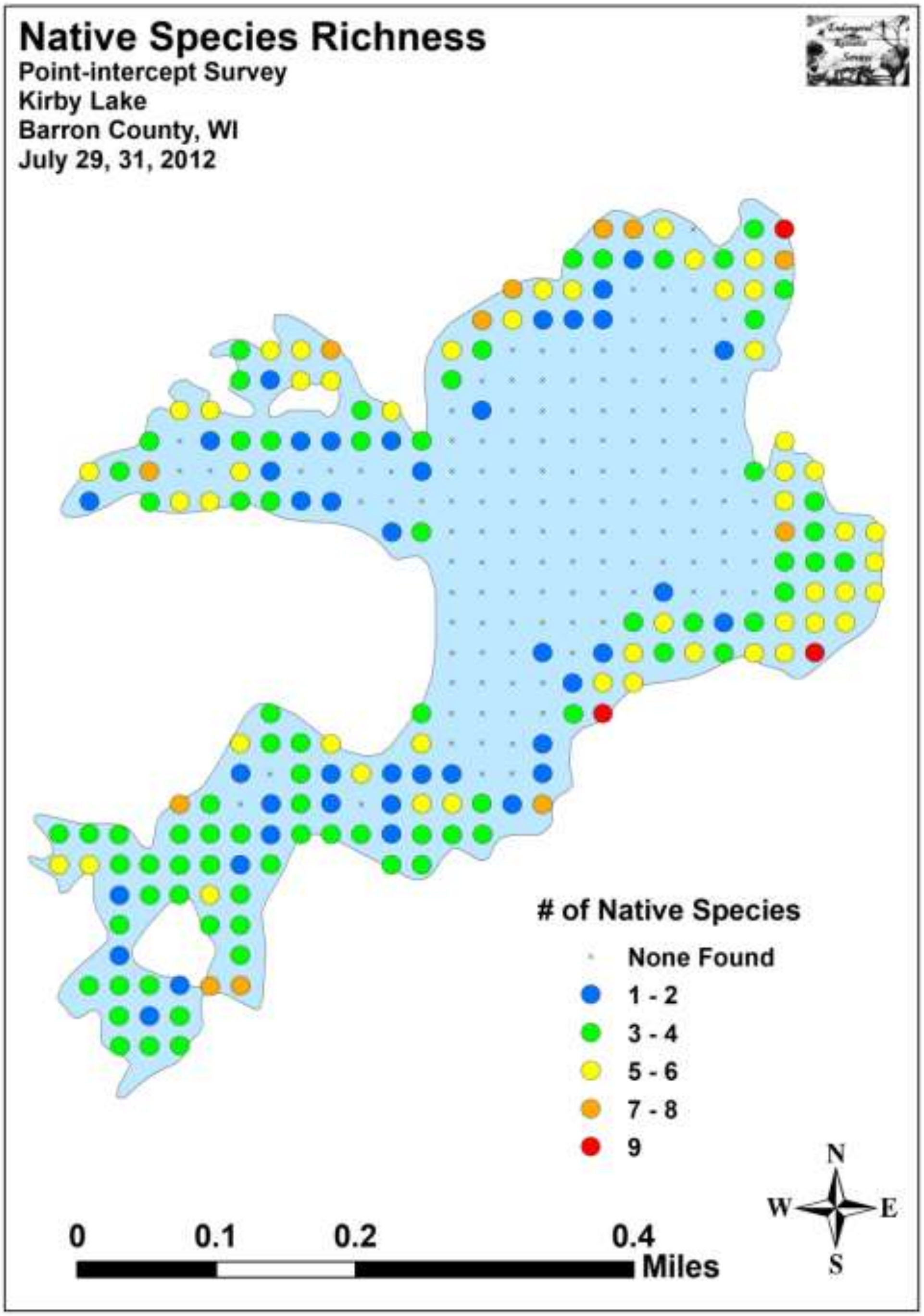


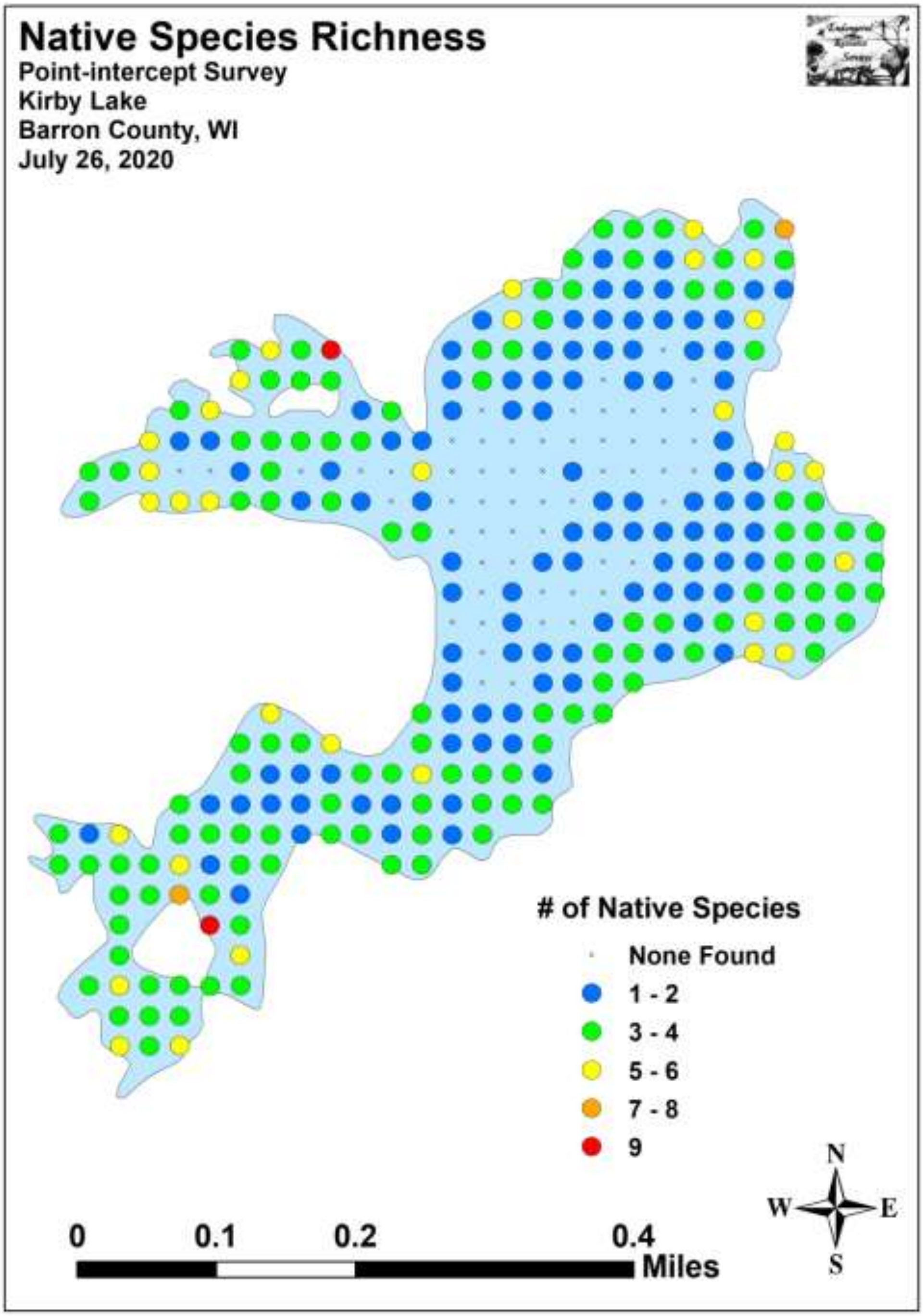
Bottom Substrate
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Substrate Type
Muck
Rock
Sand
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix IV: 2012 and 2020 Littoral Zone, Native Species Richness and Total Rake Fullness Maps


Littoral Zone
Point-intercept Survey
Kirby Lake
Barron County, WI
July 29, 31, 2012
Littoral Zone
Littoral Zone with Plants
>10ft
0
0.1
0.2
0.4
Miles
N
W
E
S


Littoral Zone
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Littoral Zone
Littoral Zone with Plants
>13ft
0
0.1
0.2
0.4
Miles
N
W
E
S


Native Species Richness
Point-intercept Survey
Kirby Lake
Barron County, WI
July 29, 31, 2012
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9
0
0.1
0.2
0.4
Miles
N
W
E
S


Native Species Richness
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9
N
W
E
S
0
0.1
0.2
0.4
Miles


Total Rake Fullnes
Point-intercept Survey
Kirby Lake
Barron County, WI
July 29, 31, 2012
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles

Total Rake Fullnes
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles

Appendix V: Kirby Lake Plant Species Accounts

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: **Aquatic moss**
Specimen Location: Kirby Lake; N45.60093°, W92.06657°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-226
Habitat/Distribution: Muck bottoms in 0-5 meters of water. Common, but seldom abundant, moss was the deepest growing macrophyte in the lake although it occurred at very low densities at depths over 3m.
Common Associates: (*Utricularia gibba*) Creeping bladderwort, (*Potamogeton amplifolius*) Large-leaf pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-227
Habitat/Distribution: Muck and mucky sand bottom in 0.5-1.5 meters. Abundant to the point of restricting boat traffic in many bays of the lake where it formed solid canopies.
Common Associates: (*Utricularia purpurea*) Large purple bladderwort, (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Potamogeton pusillus*) Small pondweed, (*Utricularia intermedia*) Flat-leaf bladderwort

County/State: Barron County, Wisconsin **Date:** 7/26/20
Species: (*Carex utriculata*) **Common yellow lake sedge**
Specimen Location: Kirby Lake; N45.60276°, W92.07023°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2020-200
Habitat/Distribution: Muck and mucky sand bottom in <0.5m of water. Common along margins of the lake.
Common Associates: (*Schoenoplectus torreyi*) Torrey's three-square bulrush, (*Schoenoplectus heterochaetus*) Slender bulrush, (*Sagittaria latifolia*) Common arrowhead, (*Eleocharis palustris*) Creeping spikerush, (*Phalaris arundinacea*) Reed canary grass, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Ceratophyllum echinatum*) **Spiny hornwort**
Specimen Location: Kirby Lake; N45.60067°, W92.06342°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-228
Habitat/Distribution: Muck bottom in 2 meters of water. A single plant was the only specimen found on the entire lake.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Elodea nuttallii*) Slender waterweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Dulichium arundinaceum*) **Three-way sedge**
Specimen Location: Kirby Lake; N45.60410°, W92.06579°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-229
Habitat/Distribution: Located at the edge of the water in mucky and sandy soil. Common in scattered locations throughout.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Schoenoplectus heterochaetus*) Slender bulrush, (*Sagittaria latifolia*) Common arrowhead, (*Eleocharis palustris*) Creeping spikerush, (*Phalaris arundinacea*) Reed canary grass, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Elatine minima*) **Waterwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-230
Habitat/Distribution: Sand/rock bottom in 0-.25m of water. A few individuals were found near the point. Only found at a few other locations on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eleocharis acicularis*) **Needle spikerush**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-231
Habitat/Distribution: Sand/rock bottom in 0-.25m of water. A few individuals were growing in and out of the water near the point. Only found at a few other locations on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eriocaulon aquaticum*) Pipewort, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eleocharis erythropoda*) **Bald spikerush**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-232
Habitat/Distribution: A few dense patches of plants occurred on floating bogs in the small western side bay west/northwest of the island in the southwest bay.
Common Associates: (*Schoenoplectus purshianus*) Pursh's bulrush, (*Typha latifolia*) Broad-leaved cattail, (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eleocharis obtusa*) **Blunt spikerush**
Specimen Location: Kirby Lake; N45.59643°, W92.07135°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-233
Habitat/Distribution: Rare; only plants found were on floating bogs in the lake's far southwest bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Bald spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Phalaris arundinacea*) Reed canary grass

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eleocharis palustris*) **Creeping spikerush**
Specimen Location: Kirby Lake; N45.60410°, W92.06579°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-234
Habitat/Distribution: Located at the edge of the water in sandy soil and on rocky points. Common in scattered locations throughout.
Common Associates: (*Schoenoplectus heterochaetus*) Slender bulrush, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Phalaris arundinacea*) Reed canary grass, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eleocharis robbinsii*) **Robbins' spikerush**
Specimen Location: Kirby Lake; N45.59872°, W92.06694°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-235
Habitat/Distribution: Firm muck and rock bottoms in 1-2 meters of water. Uncommon, but scattered individuals where found throughout the lake – unfortunately, no individuals were in flower/fruit.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Eleocharis palustris*) Creeping spikerush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Elodea nuttallii*) **Slender waterweed**
Specimen Location: Kirby Lake; N45.60067°, W92.06342°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-236
Habitat/Distribution: Muck bottom in 1.5-2 meters of water. A single plant was found at each of two locations.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Ceratophyllum echinatum*) Spiny hornwort

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Eriocaulon aquaticum*) **Pipewort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-237
Habitat/Distribution: Sand/rock bottom in 0-.25m of water. A few individuals were growing in and out of the water near the point. Only found at a few other locations on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Gallium* sp.) **Bedstraw**
Specimen Location: Kirby Lake; N45.60004°, W92.06385°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-238
Habitat/Distribution: Sandy to sandy muck bottoms in 0-0.5m of water. Scattered individuals were found growing along the shoreline near the point. Not found anywhere else.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Glyceria borealis*) Northern manna-grass

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Glyceria borealis*) **Northern manna-grass**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-239
Habitat/Distribution: Sandy to sandy muck bottoms in 0-0.5m of water. Plants were common in shoreline areas throughout where they often mixed with *Phalaris*.
Common Associates: (*Brasenia schreberi*) Watershield, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Phalaris arundinacea*) Reed canary grass, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Grateola aurea*) **Golden hedge-hyssop**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-240
Habitat/Distribution: Sandy to sandy muck bottoms in 0-0.25m of water. A few individuals were growing in and out of the water near the point. Only found at a few other locations on the lake.
Common Associates: (*Eriocaulon aquaticum*) Pipewort, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Isoetes echinospora*) **Spiny-spored quillwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-241
Habitat/Distribution: Sand/rock bottom in 0-.25m of water. A few individuals were growing near the point. Not found anywhere else.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Elatine minima*) Waterwort, (*Sagittaria cristata*) Crested arrowhead, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Juncus pelocarpus*) **Brown-fruited rush**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-242
Habitat/Distribution: Sand/rock bottom in 0-.25m of water. A few individuals were growing in and out of the water near the point. Not found anywhere else.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Elatine minima*) Waterwort, (*Sagittaria cristata*) Crested arrowhead

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Juncus tenuis*) **Path rush**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-243
Habitat/Distribution: Firm muck at the shoreline. A few plants were located at the boat landing.
Common Associates: (*Phalaris arundinacea*) Reed canary grass

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Lindernia dubia*) **False pimpernel**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-244
Habitat/Distribution: Sandy to sandy muck bottoms in 0-0.25m of water. A few individuals were growing in and out of the water near the point. Only found at a few other locations on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Myriophyllum farwellii*) **Farwell's water-milfoil**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-245
Habitat/Distribution: Muck bottom areas in water up to 1.5m. Widespread and common to locally abundant.
Common Associates: (*Nymphaea odorata*) White water lily, (*Utricularia purpurea*) Large purple bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia minor*) Small bladderwort, (*Eleocharis palustris*) Creeping spikerush, (*Potamogeton pusillus*) Small pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Myriophyllum tenellum*) **Dwarf water-milfoil**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-246
Habitat/Distribution: Sandy to sandy muck bottoms in 0-.25m of water. A few individuals were growing at the point. Only found at a few other locations on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Eriocaulon aquaticum*) Pipewort, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Najas gracillima*) **Northern naiad**
Specimen Location: Kirby Lake; N45.60345°, W92.06667°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-247
Habitat/Distribution: Rare; a few plants were found at the point and in the east bay inter-point.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Glyceria borealis*) Northern manna-grass

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Nitella flexilis*) **Nitella**
Specimen Location: Kirby Lake; N45.59904°, W92.06651°
Collected/Identified by: Matthew S. Berg/Paul M. Skawinski Col. #: MSB-2012-248
Habitat/Distribution: Muck bottom in 2 meters. Plants were only found at two points in the entire lake.
Common Associates: Aquatic moss

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: Kirby Lake; N45.59840°, W92.06693°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-249
Habitat/Distribution: Firm muck bottoms in 0-2 meters of water. Much less common than Nymphaea in the lake. Most plants were in sheltered areas of bays and growing off rocky/sandy points.
Common Associates: (*Nymphaea odorata*) White water lily, (*Utricularia purpurea*) Large purple bladderwort, (*Utricularia gibba*) Creeping bladderwort, (*Brasenia schreberi*) Watershield

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Kirby Lake; N45.59840°, W92.06693°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-250
Habitat/Distribution: Muck bottom in 0-2 meters. Plants were abundant and widely distributed throughout.
Common Associates: (*Nuphar variegata*) Spatterdock, (*Utricularia purpurea*) Large purple bladderwort, (*Utricularia gibba*) Creeping bladderwort, (*Sparganium fluctuans*) Floating-leaf bur-reed, (*Brasenia schreberi*) Watershield

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-251
Habitat/Distribution: Prefers thick muck soil in and out of water <0.5 meters. Common to abundant throughout and highly invasive in many shoreline areas.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Polygonum amphibium*) **Water smartweed**
Specimen Location: Kirby Lake; N45.60410°, W92.06579°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-252
Habitat/Distribution: Silt to muck bottom over firm substrate in 0-1 meter of water. Common in both its emergent and floating growth form along undeveloped shorelines throughout the lake.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Nymphaea odorata*) White water lily, (*Sparganium androcladum*) Branched bur-reed, (*Brasenia schreberi*) Watershield, (*Eleocharis palustris*) Creeping spikerush, (*Sagittaria latifolia*) Common arrowhead

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Kirby Lake; N45.60249°, W92.06753°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-253
Habitat/Distribution: Mucky bottom areas in water from 1-3m deep. Widely distributed, but uncommon except in the pinch point/entrance to the southwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed, Aquatic moss

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton bicupulatus*) **Snail-seed pondweed**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-254
Habitat/Distribution: More common than the survey indicated. Plants occupied a fairly narrow habitat niche in water 0.5-1m deep over sand and rock in open canopy areas not dominated by *Brasenia*.
Common Associates: (*Eleocharis palustris*) Creeping spikerush, (*Grateola aurea*) Golden hedge hyssop, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Potamogeton robbinsii*) Fern pondweed, (*Glyceria borealis*) Northern manna grass

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-255
Habitat/Distribution: Found in muck and sand bottom conditions in shallow water 0.5-1.5 meters deep. Uncommon with scattered locations throughout; especially common on the west side of the southwest bay's island.
Common Associates: (*Potamogeton bicupulatus*) Snail-seed pondweed, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton oakesianus*) Oakes' pondweed, (*Potamogeton gramineus*) Variable pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton gramineus*) **Variable pondweed**
Specimen Location: Kirby Lake; N45.60309°, W92.06935°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-256
Habitat/Distribution: Uncommon in 1.0-1.5m of water over organic muck. Stipules/branching thin submerged leaves differentiated this species from the very similar looking *P. oakesianus* that was often found growing nearby.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton natans*) Floating-leaf pondweed, (*Potamogeton oakesianus*) Oakes' pondweed, (*Nuphar variegata*) Spatterdock

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton natans*) **Floating-leaf pondweed**
Specimen Location: Kirby Lake; N45.60280°, W92.06754°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-257
Habitat/Distribution: Most plants were growing over firm sand and sandy muck in 1-1.5 meters of water. Uncommon; most plants were located in the eastern bay, and north of the island northeast of the boat landing.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton oakesianus*) Oakes' pondweed, (*Nuphar variegata*) Spatterdock

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton oakesianus*) **Oakes' pondweed**
Specimen Location: Kirby Lake; N45.60309°, W92.06935°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-258
Habitat/Distribution: Uncommon in 1-1.5 meters of water over organic muck. Bright red spots on the stem and a lack of stipules/branching thin leaves differentiated them from the very similar looking *P. gramineus* morph that was often found growing near this species.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton pusillus pusillus*) **Small pondweed**
Specimen Location: Kirby Lake; N45.60345°, W92.06667°
Collected/Identified by: Matthew S. Berg/Paul Skawinski Col. #: MSB-2012-259
Habitat/Distribution: Most plants were growing over muck in 1-2.5 meters of water. Widely distributed, this species was found in low densities in most submergent beds. Plants had clear to green membranous stipules, and distinct nodal glands. Leaves were <1mm wide, dull/lime green and had little tissue other than the midrib. Stems were dark and thread-like. Nutlets found were immature, but appeared to be on interrupted inflorescences that were terminal.
Common Associates: (*Potamogeton pusillus tenuissimus*) Small pondweed, (*Utricularia gibba*) Creeping bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Potamogeton bicupulatus*) Snail-seed pondweed, Aquatic moss

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton pusillus tenuissimus*) **Small pondweed**
Specimen Location: Kirby Lake; N45.60345°, W92.06667°
Collected/Identified by: Matthew S. Berg/Paul Skawinski Col. #: MSB-2012-260
Habitat/Distribution: Most plants were growing over muck in 1-2.5 meters of water. Widely distributed, this species was often abundant at the edge of the *Brasenia* beds. Plants had clear membranous stipules that had mostly broken off, and small or no nodal glands. Leaves were 2mm wide, bright green and had lacunar bands. Stems were green and up to 1mm wide. Nutlets were in uninterrupted inflorescences and often on peduncles.
Common Associates: (*Potamogeton pusillus pusillus*) Small pondweed, (*Utricularia gibba*) Creeping bladderwort, (*Myriophyllum farwellii*) Farwell's water-milfoil, (*Potamogeton bicupulatus*) Snail-seed pondweed, Aquatic moss

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Potamogeton robbinsii*) **Fern pondweed**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-261
Habitat/Distribution: Firm muck over sand at the shoreline. A single plant was found floating at the boat landing.
Common Associates: (*Potamogeton bicupulatus*) Snail-seed pondweed, Aquatic moss

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Ranunculus flammula*) **Creeping spearwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2012-262
Habitat/Distribution: Sandy to sandy muck bottoms in 0-0.25m of water. A few individuals were growing in and out of the water near the point. Not found anywhere else on the lake.
Common Associates: (*Grateola aurea*) Golden-hedge hyssop, (*Isoetes echinospora*) Spiny-spored quillwort, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Sagittaria cristata*) **Crested arrowhead**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-263
Habitat/Distribution: Uncommon at the shoreline over sand; scattered individuals were found around the main basin.
Common Associates: (*Myriophyllum tenellum*) Dwarf water-milfoil, (*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 latifolia*) **Common arrowhead**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-264
Habitat/Distribution: Relatively common in undeveloped shoreline areas with firm muck bottom in 0-0.25m of water.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Phalaris arundinacea*) Reed canary grass, (*Dulichium arundinaceum*) Three-way sedge, (*Polygonum amphibium*) Water smartweed, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Schoenoplectus heterochaetus*) **Slender bulrush**
Specimen Location: Kirby Lake; N45.60228°, W92.06169°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-265
Habitat/Distribution: Firm muck bottoms in 0.25-1.0 meter of water. Scattered plants occurred around the point in the northeast bay – not found anywhere else on the lake.
Common Associates: (*Scirpus cyperinus*) Woolgrass, (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Schoenoplectus purshianus*) **Pursh's bulrush**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-266
Habitat/Distribution: Firm muck bottoms in 0-0.25 meter of water. A few dense patches of plants occurred on floating bogs in the small side bay west/northwest of the island in the southwest bay.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Eleocharis erythropoda*) Bald spikerush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Schoenoplectus subterminalis*) **Water bulrush**
Specimen Location: Kirby Lake; N45.59935°, W92.06697°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-267
Habitat/Distribution: Firm muck bottoms in 1-2 meters of water. A few widely scattered patches were found throughout the lake.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed

County/State: Barron County, Wisconsin **Date:** 7/26/20
Species: (*Schoenoplectus torreyi*) **Torrey's three-square bulrush**
Specimen Location: Kirby Lake; N45.60276°, W92.07023°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2020-201
Habitat/Distribution: Muck and mucky sand bottom in <0.5m of water. Common along margins of the lake.
Common Associates: (*Carex utriculata*) Common yellow lake sedge, (*Schoenoplectus heterochaetus*) Slender bulrush, (*Sagittaria latifolia*) Common arrowhead, (*Eleocharis palustris*) Creeping spikerush, (*Phalaris arundinacea*) Reed canary grass, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Scirpus cyperinus*) **Woolgrass**
Specimen Location: Kirby Lake; N45.60228°, W92.06169°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-268
Habitat/Distribution: Firm muck bottoms in 0.25-1.0 meter of water. Most plants occurred around the point in the northeast bay, and in the south end of the southwest bay.
Common Associates: (*Schoenoplectus heterochaetus*) Slender bulrush, (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Sparganium androcladum*) **Branched bur-reed**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-269
Habitat/Distribution: Firm muck bottoms at the shoreline to 0.25m of water. Plants were common in emergent beds in undeveloped areas around the lake.
Common Associates: (*Polygonum amphibium*) Water smartweed, (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Scirpus cyperinus*) Woolgrass, (*Eleocharis palustris*) Creeping spikerush

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Sparganium fluctuans*) **Floating-leaf bur-reed**
Specimen Location: Kirby Lake; N45.60345°, W92.06667°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-270
Habitat/Distribution: Soft muck in <1.5m of water. A few small beds were located north and west of the public boat landing.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Potamogeton pusillus*) Small pondweed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Kirby Lake; N45.59831°, W92.07231°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-271
Habitat/Distribution: Thick muck soil in and out of water <0.25 meters. Uncommon in undeveloped shoreline areas. *Phalaris* appears to have excluded it from large areas where it formerly occurred based on the 1968 WDNR lake mapping survey.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge, (*Sparganium androcladum*) Branched bur-reed

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia gibba*) **Creeping bladderwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-272
Habitat/Distribution: Thick organic muck bottom in shallow water <2.5m deep. Plants were common and widely distributed.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia minor*) Small bladderwort, (*Utricularia purpurea*) Large purple bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort, (*Potamogeton pusillus*) Small pondweed

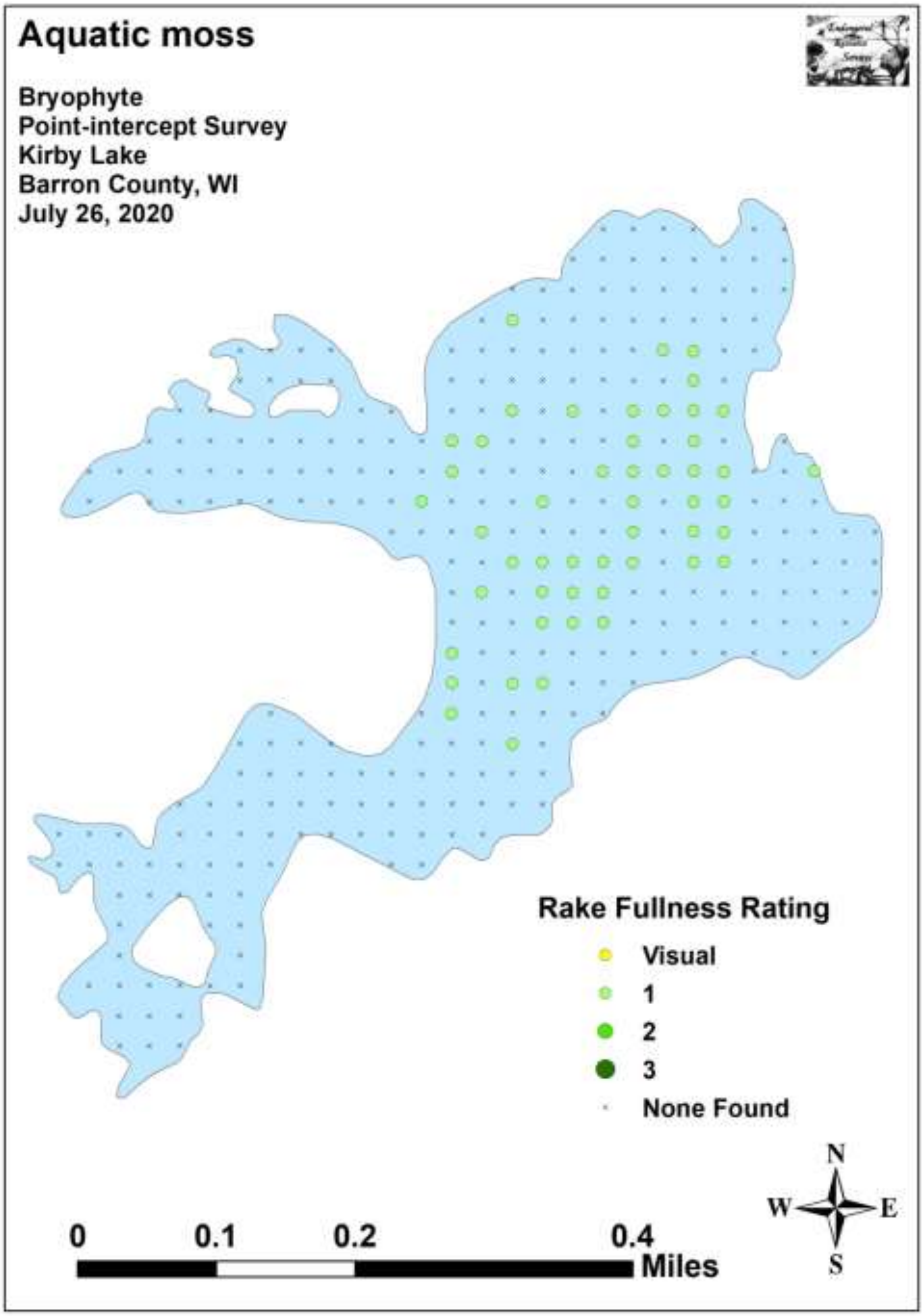
County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia intermedia*) **Flat-leaf bladderwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-273
Habitat/Distribution: Thick organic muck bottom in water <2.0m deep. Plants were common and widely distributed throughout.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia minor*) Small bladderwort, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort

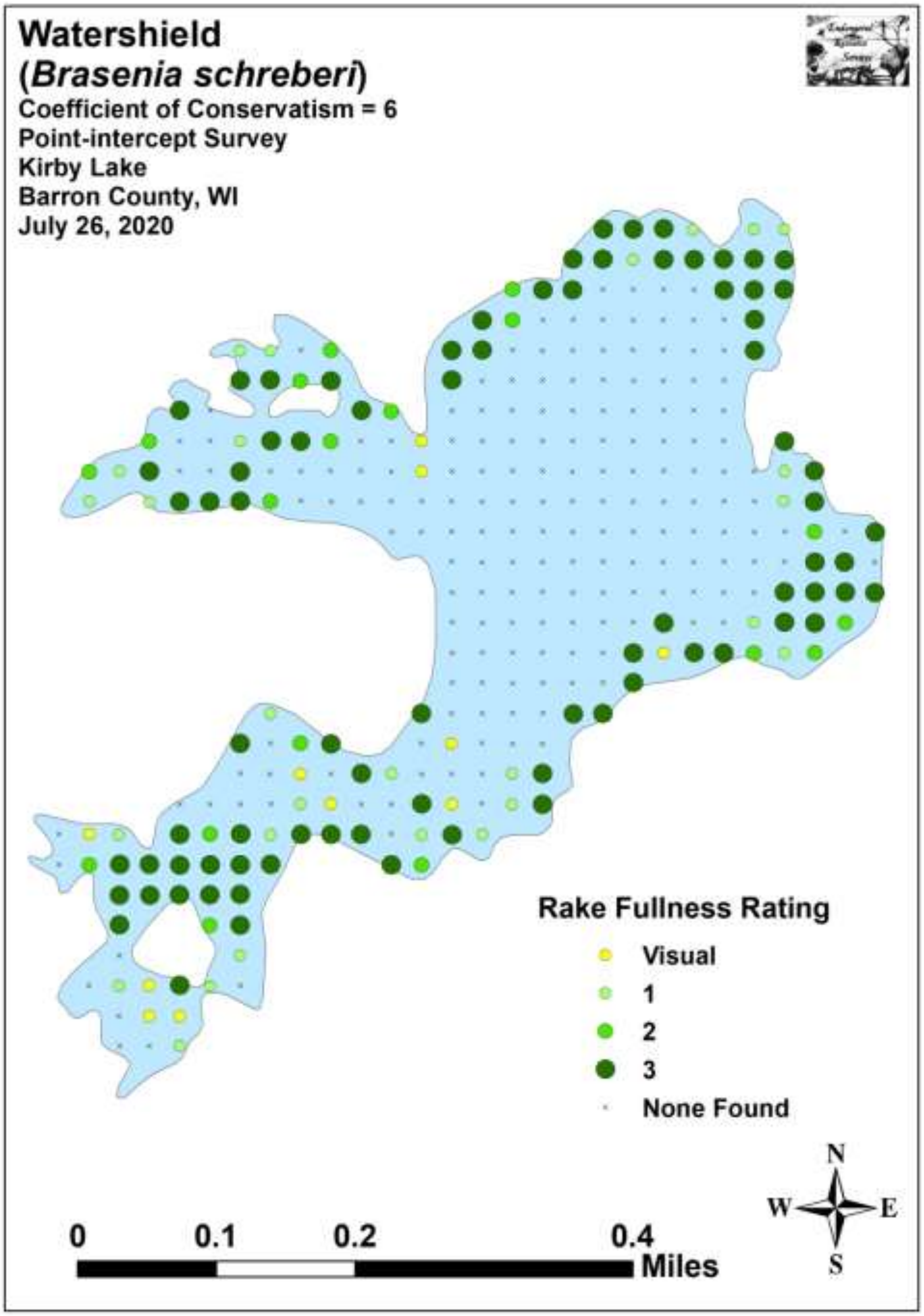
County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia minor*) **Small bladderwort**
Specimen Location: Kirby Lake; N45.59932°, W92.06831°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-274
Habitat/Distribution: Sand and muck bottoms in <2m of water. Much less common than the other bladderworts, *minor* was largely restricted to the far ends of bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia vulgaris*) Common bladderwort

County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia purpurea*) **Large purple bladderwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-275
Habitat/Distribution: Thick organic muck bottom in water <2.5m deep. Plants were abundant and distributed throughout the lake.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia minor*) Small bladderwort, (*Utricularia vulgaris*) Common bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort

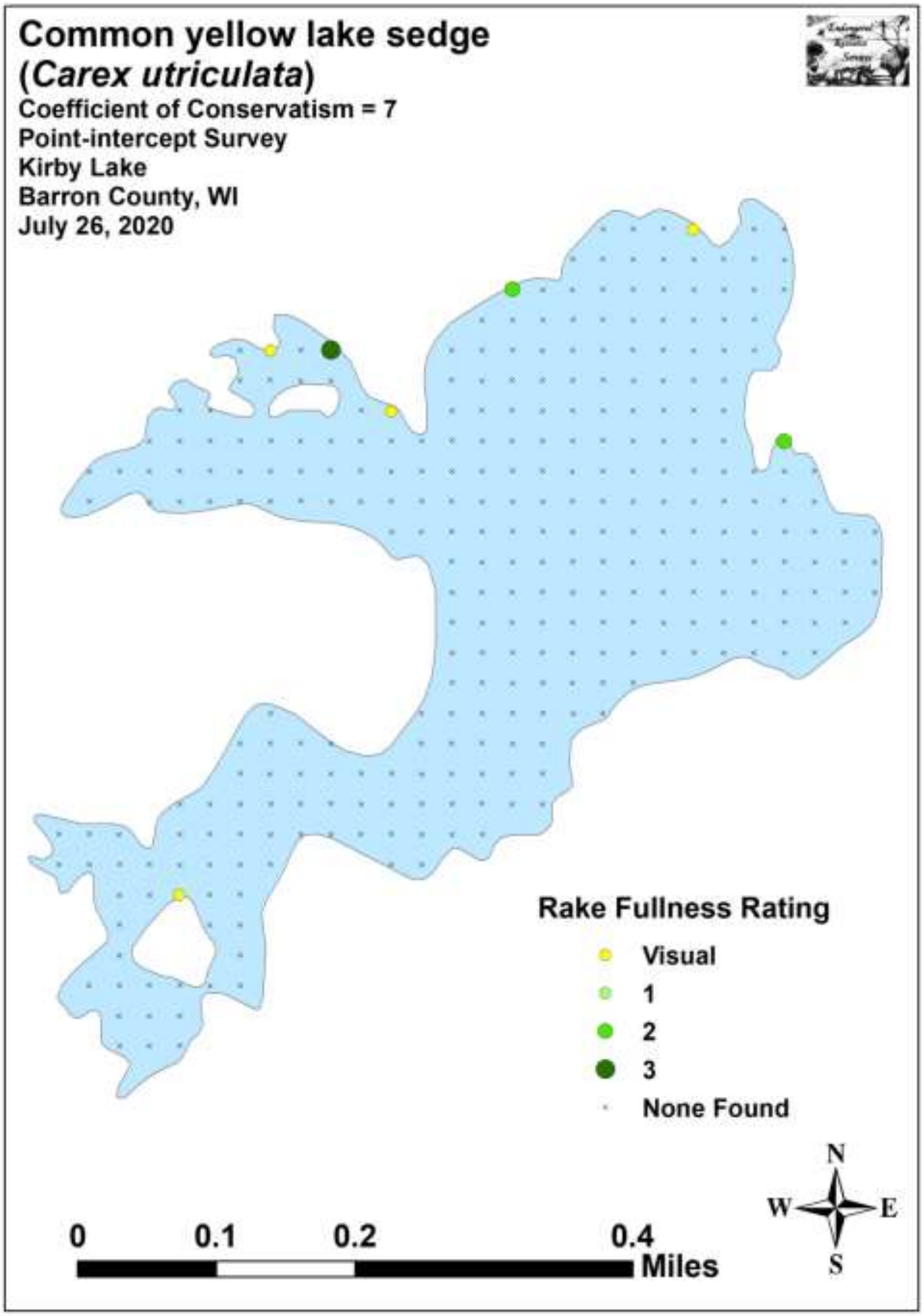
County/State: Barron County, Wisconsin **Date:** 7/29/12
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Kirby Lake; N45.59875°, W92.06515°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2012-276
Habitat/Distribution: Thick organic muck bottom in shallow water <1m deep. Plants were common and widespread throughout.
Common Associates: (*Nymphaea odorata*) White water lily, (*Utricularia purpurea*) Large purple bladderwort, (*Brasenia schreberi*) Watershield, (*Utricularia gibba*) Creeping bladderwort, (*Utricularia minor*) Small bladderwort, (*Utricularia intermedia*) Flat-leaf bladderwort

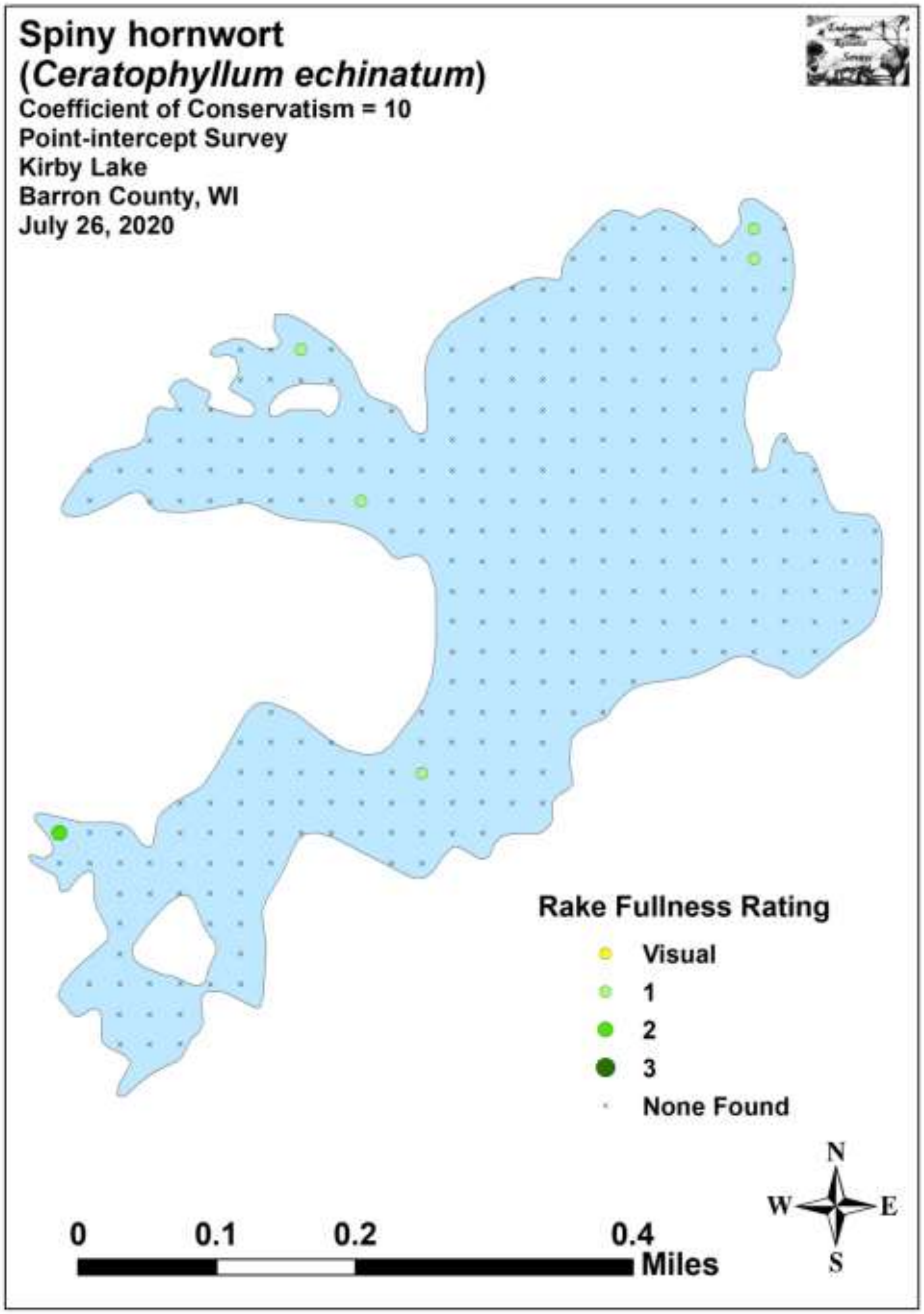
Appendix VI: July 2020 Species Density and Distribution Maps


Aquatic moss
Bryophyte
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles

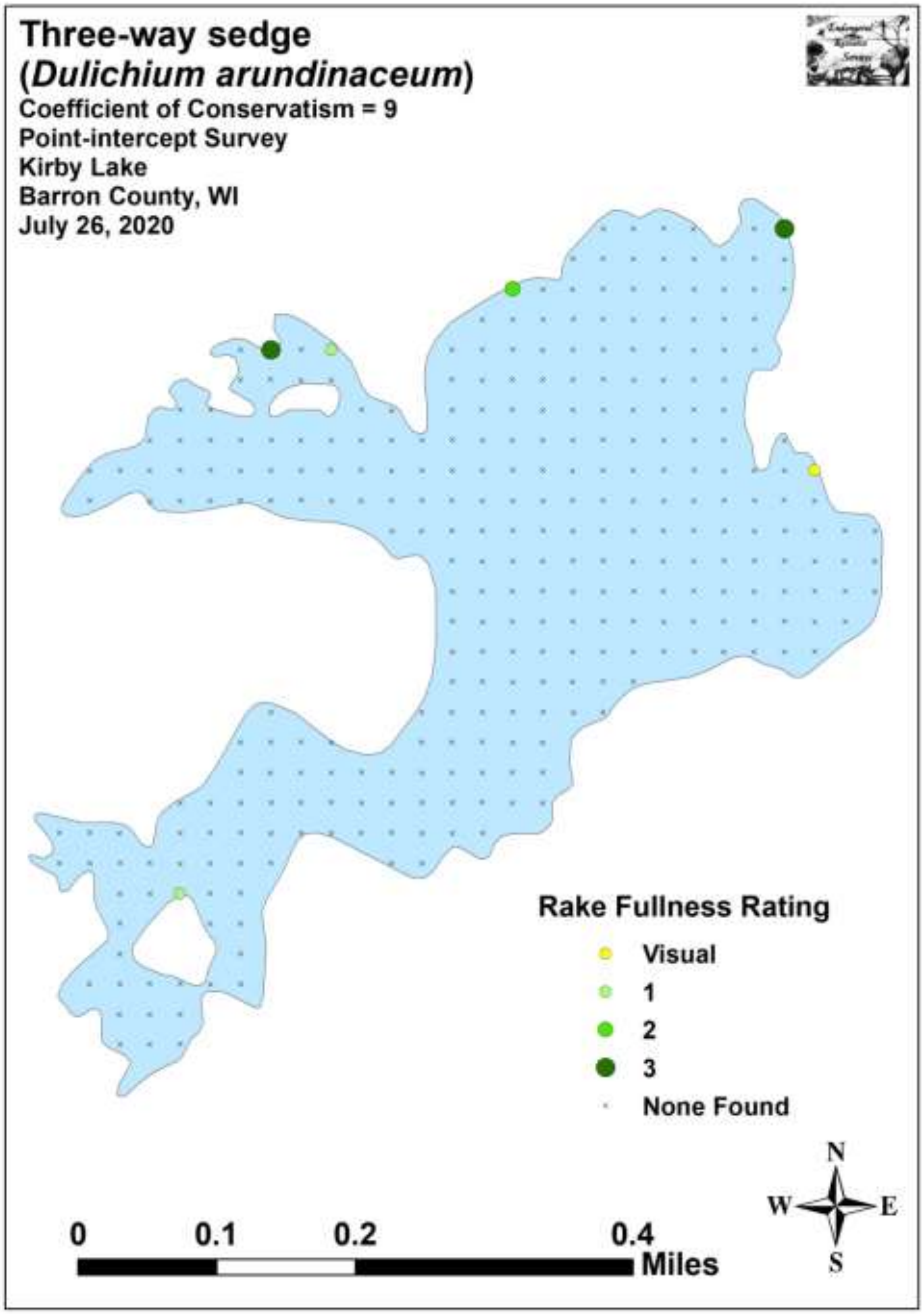


Watershield
(*Brasenia schreberi*)
Coefficient of Conservatism = 6
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles


Common yellow lake sedge
(*Carex utriculata*)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles



Spiny hornwort
(*Ceratophyllum echinatum*)
Coefficient of Conservatism = 10
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles


Three-way sedge
(*Dulichium arundinaceum*)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
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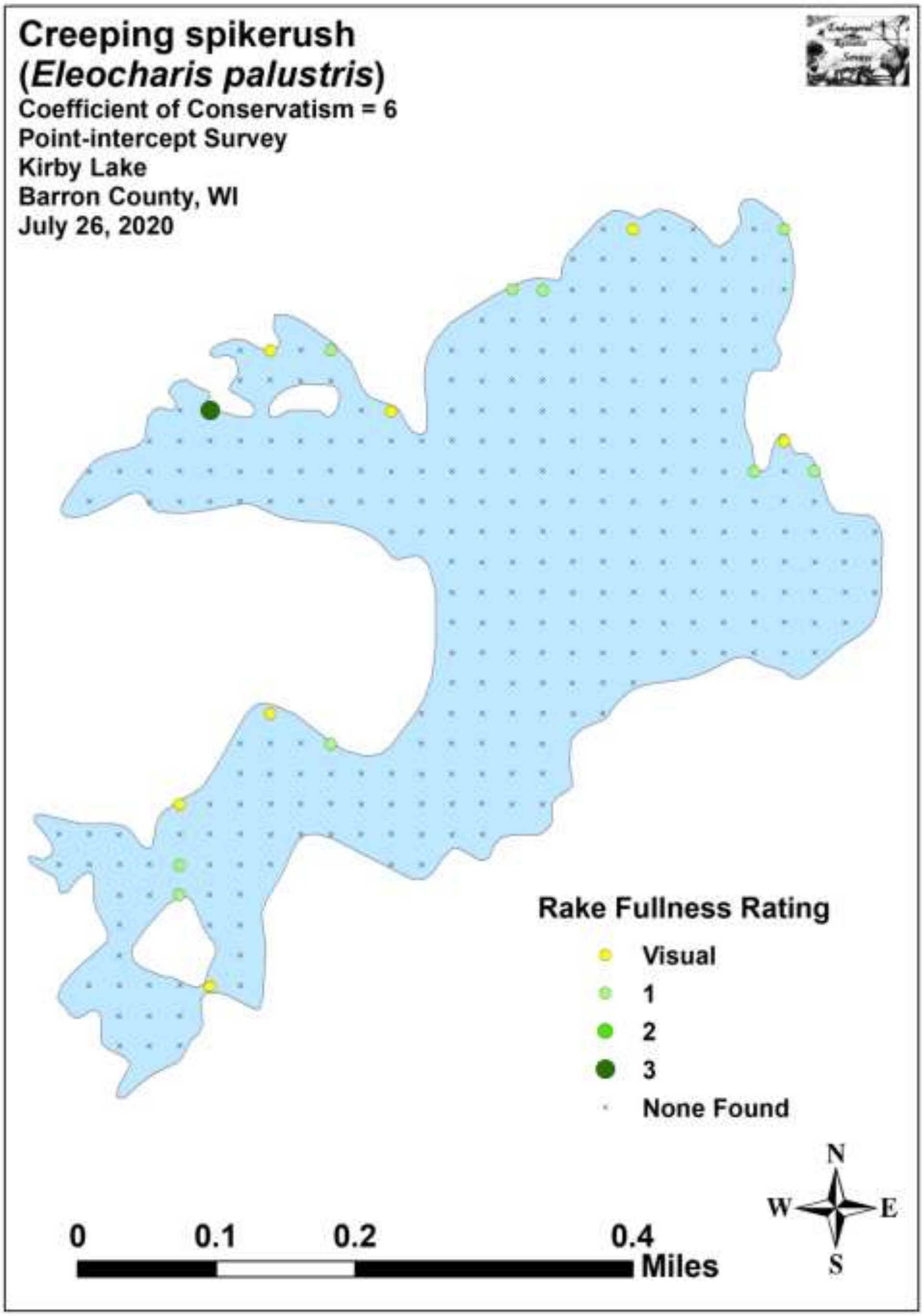
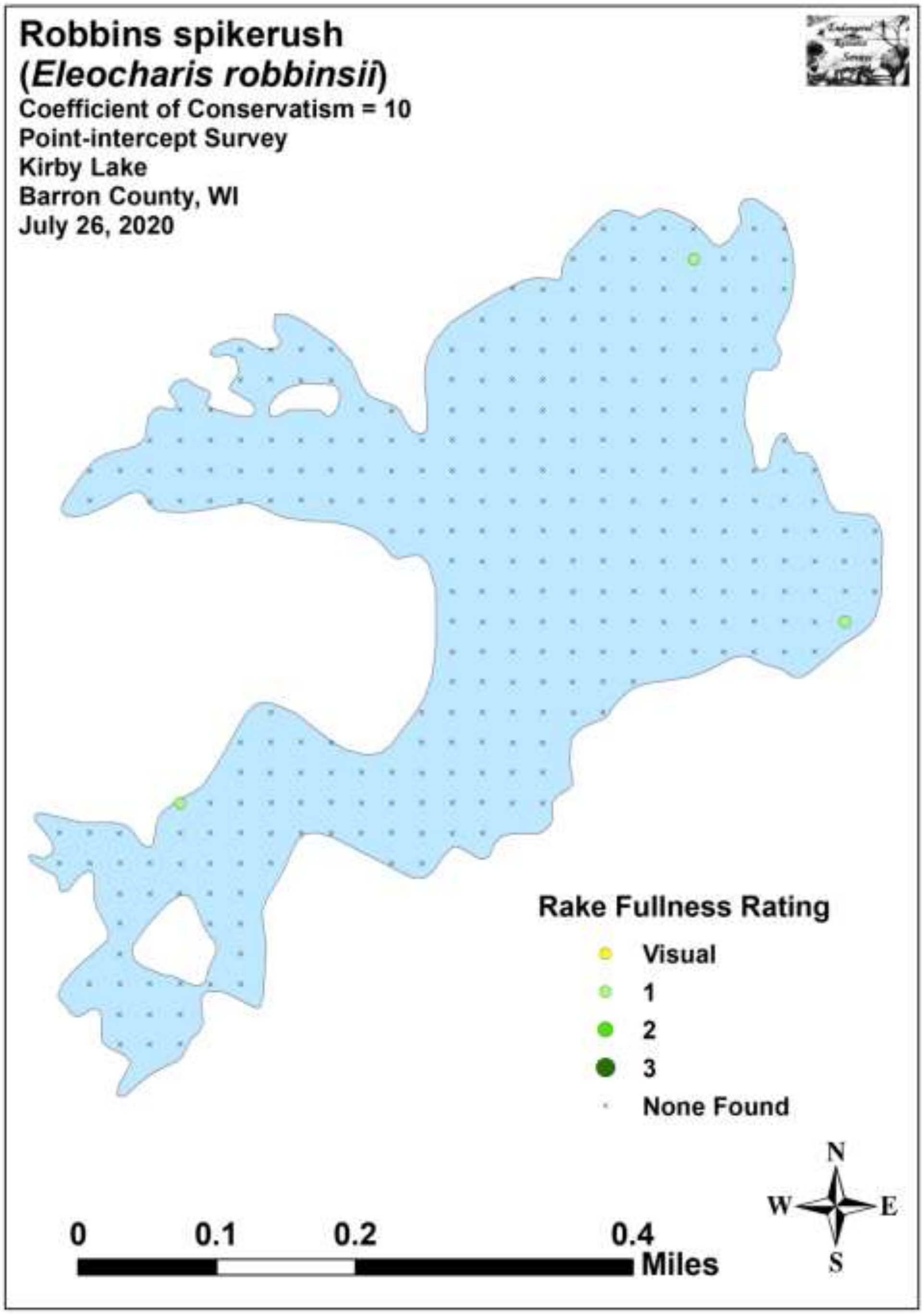
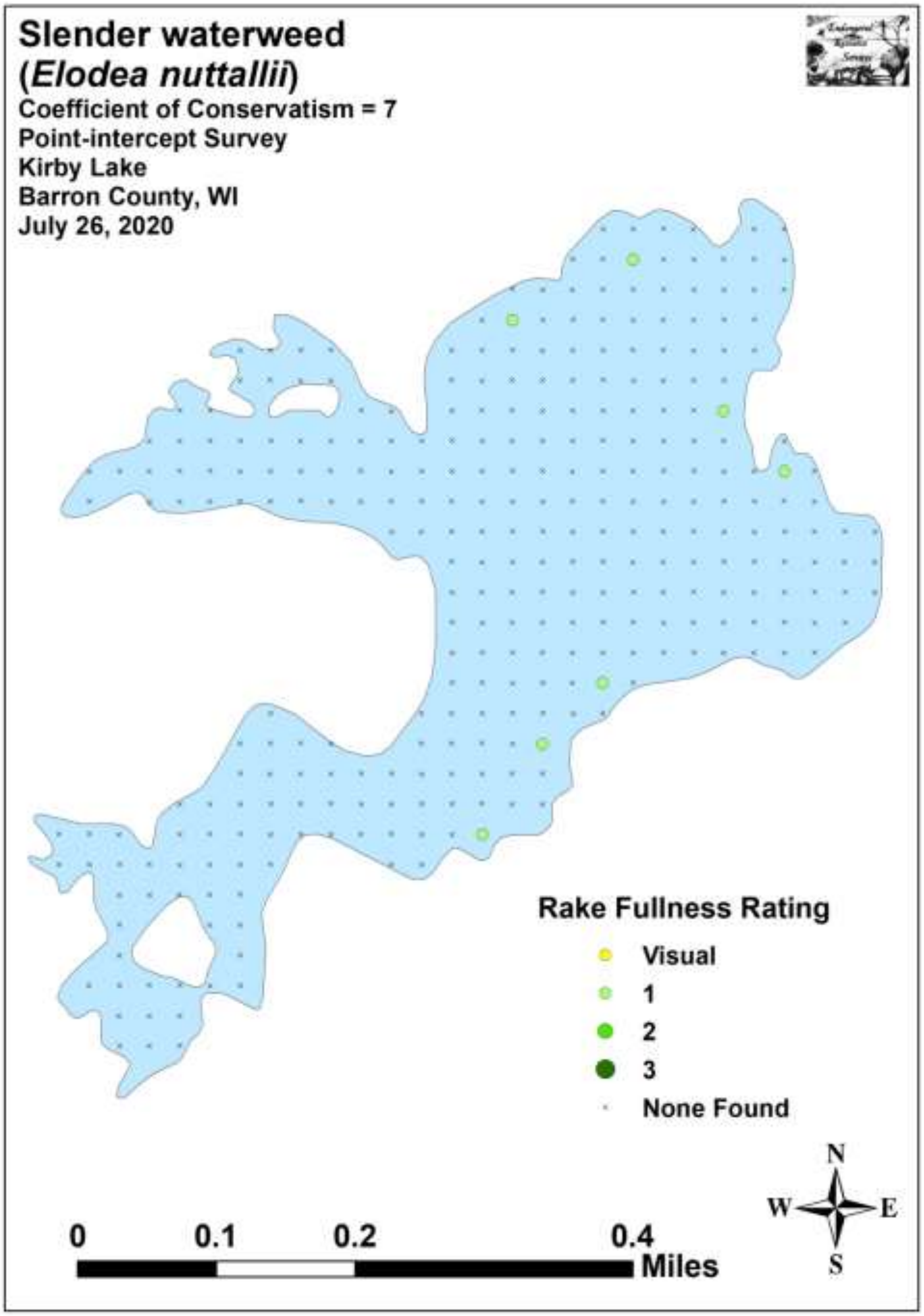
0
0.1
0.2
0.4
Miles

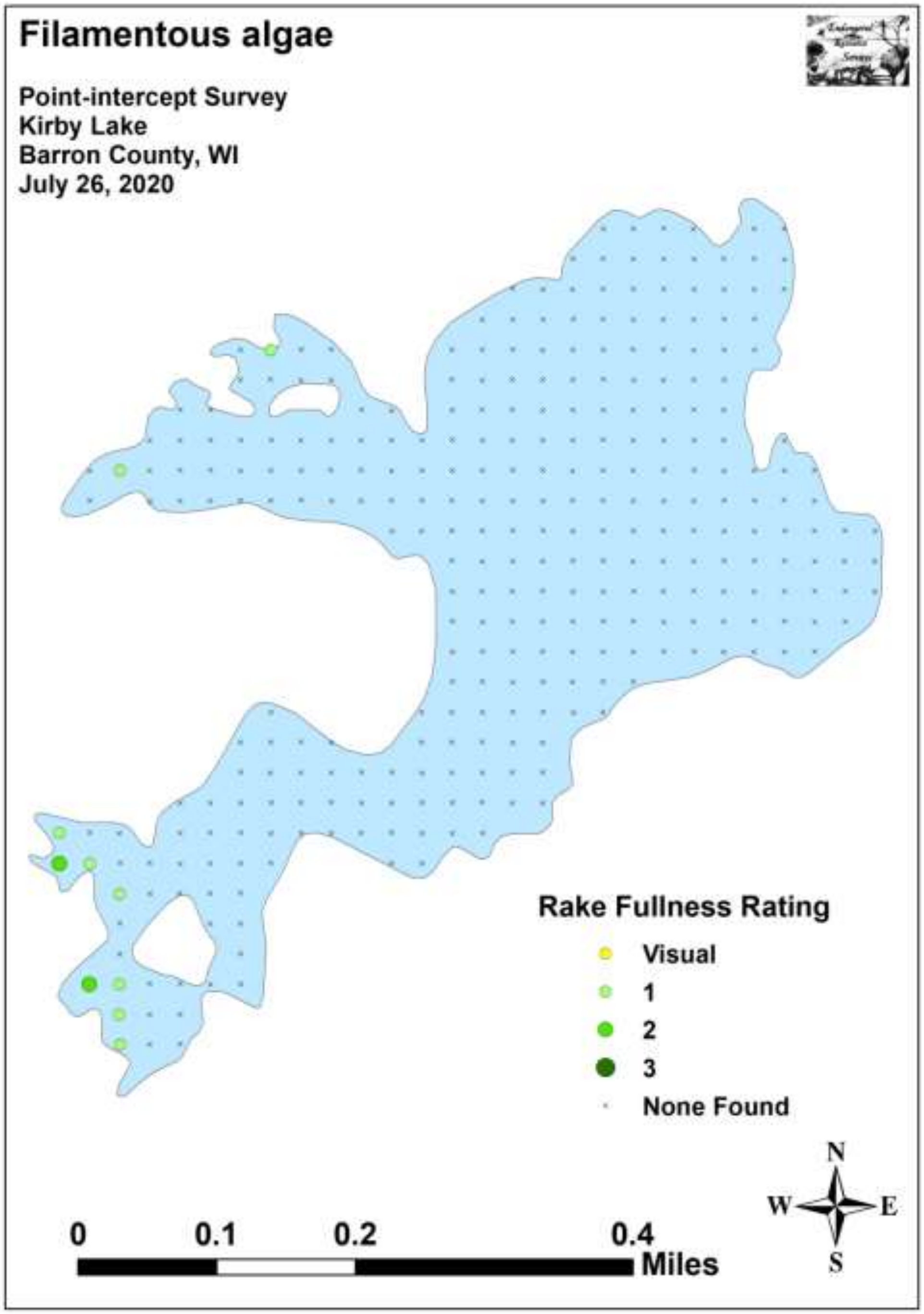


Creeping spikerush
(Eleocharis palustris)
Coefficient of Conservatism = 6
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles

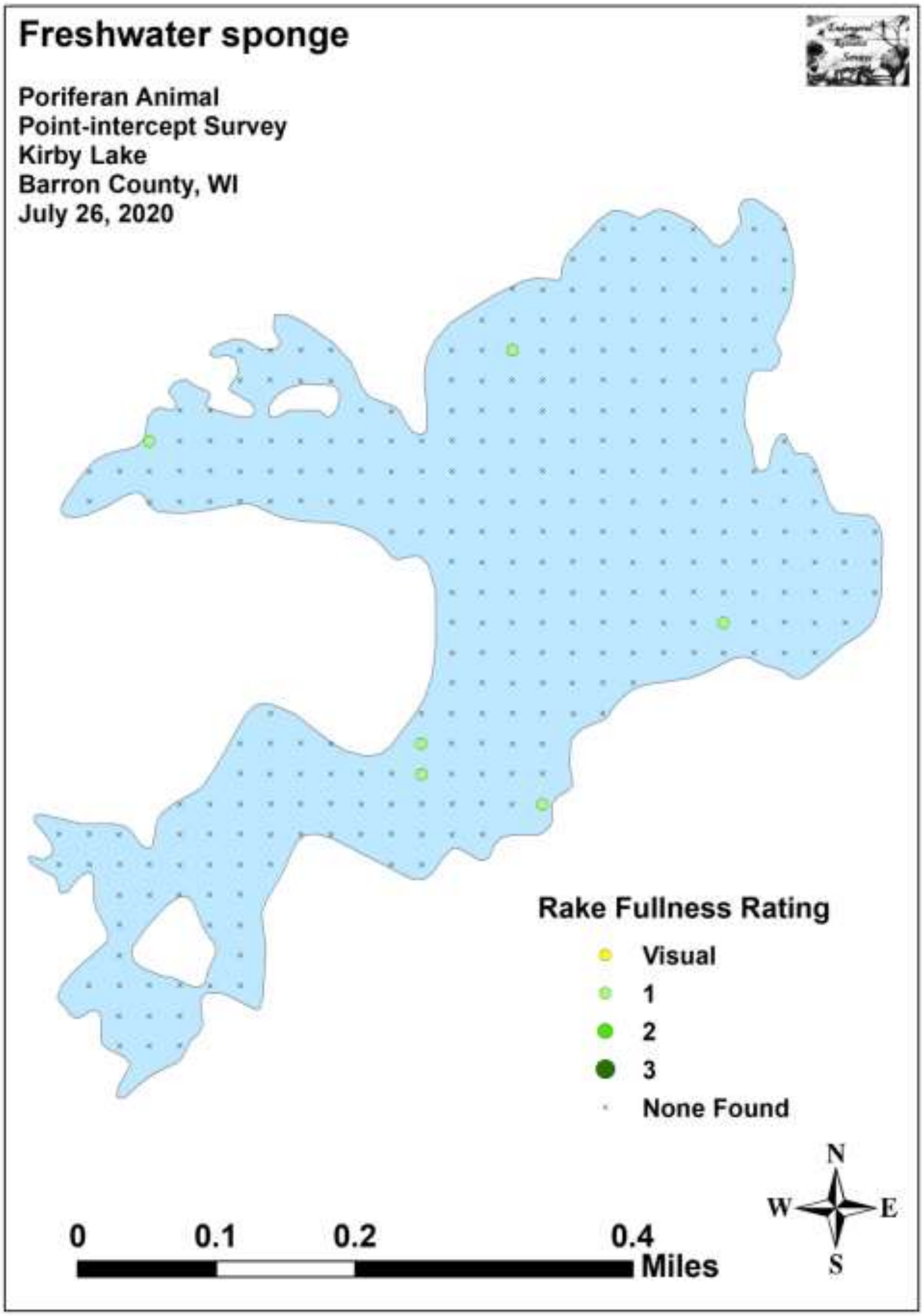


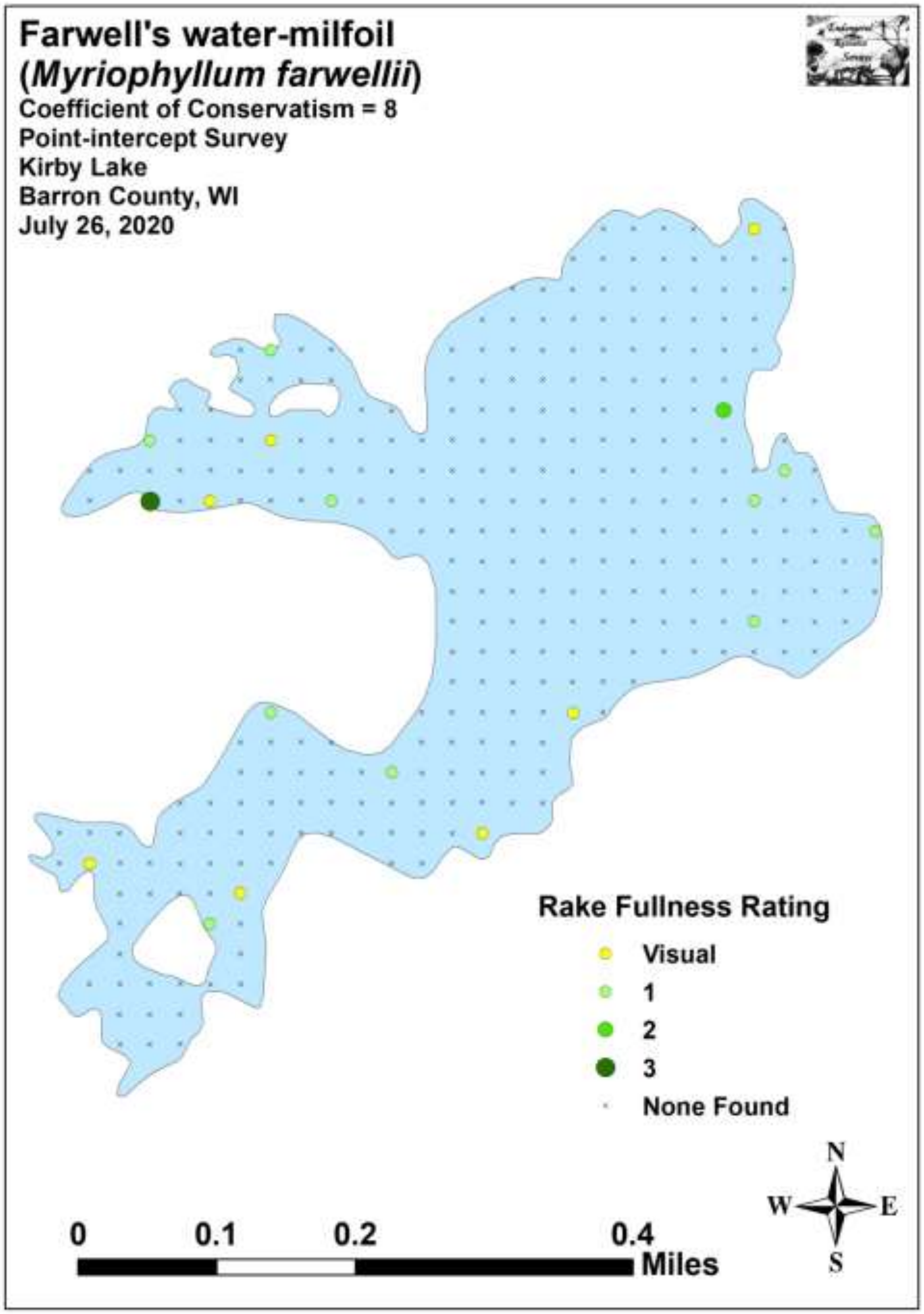
Robbins spikerush
(*Eleocharis robbinsii*)
Coefficient of Conservatism = 10
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles


Slender waterweed
(Elodea nuttallii)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles

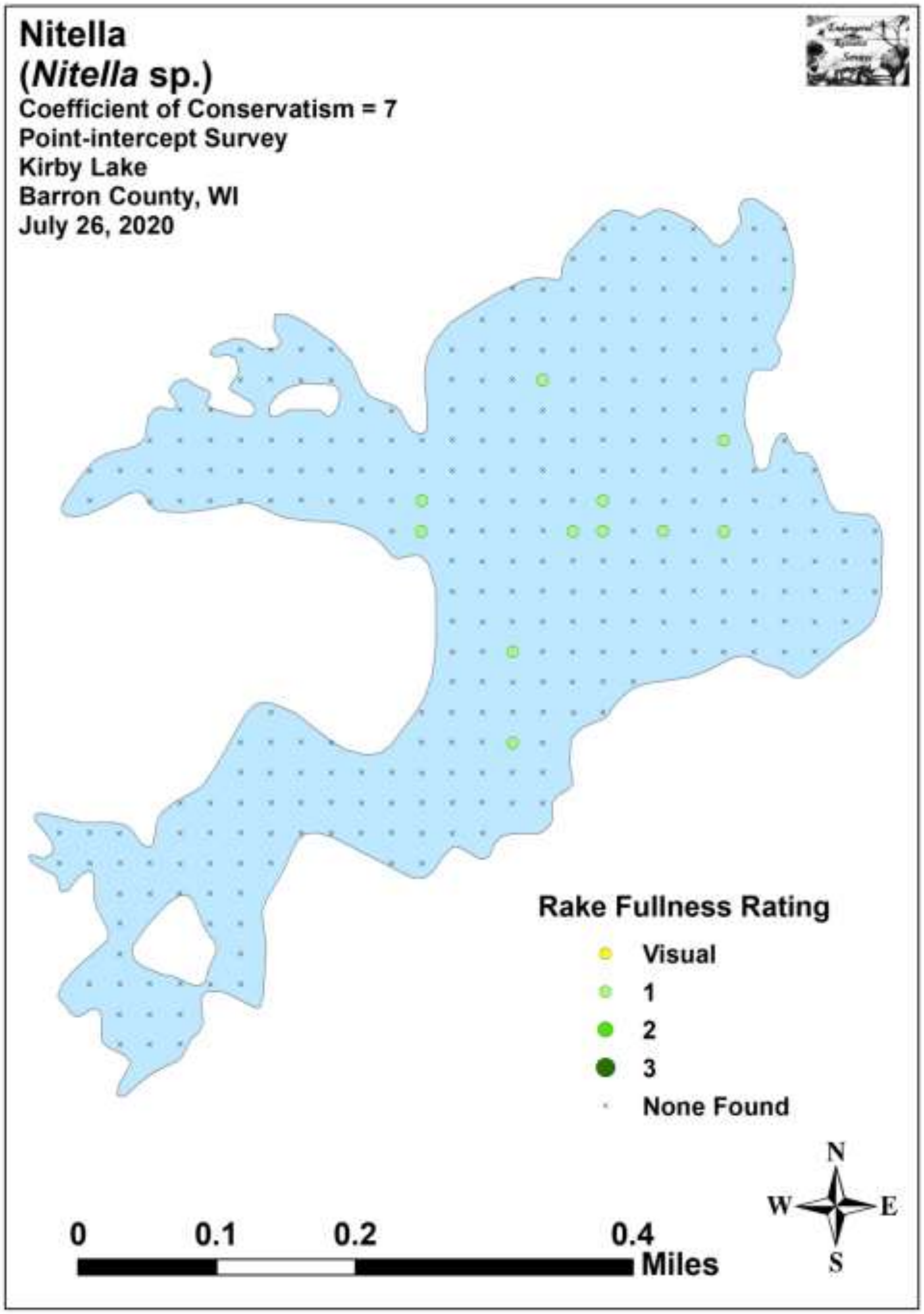


Filamentous algae
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles


Freshwater sponge
Poriferan Animal
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles



Farwell's water-milfoil
(*Myriophyllum farwellii*)
Coefficient of Conservatism = 8
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.1
0.2
0.4
Miles


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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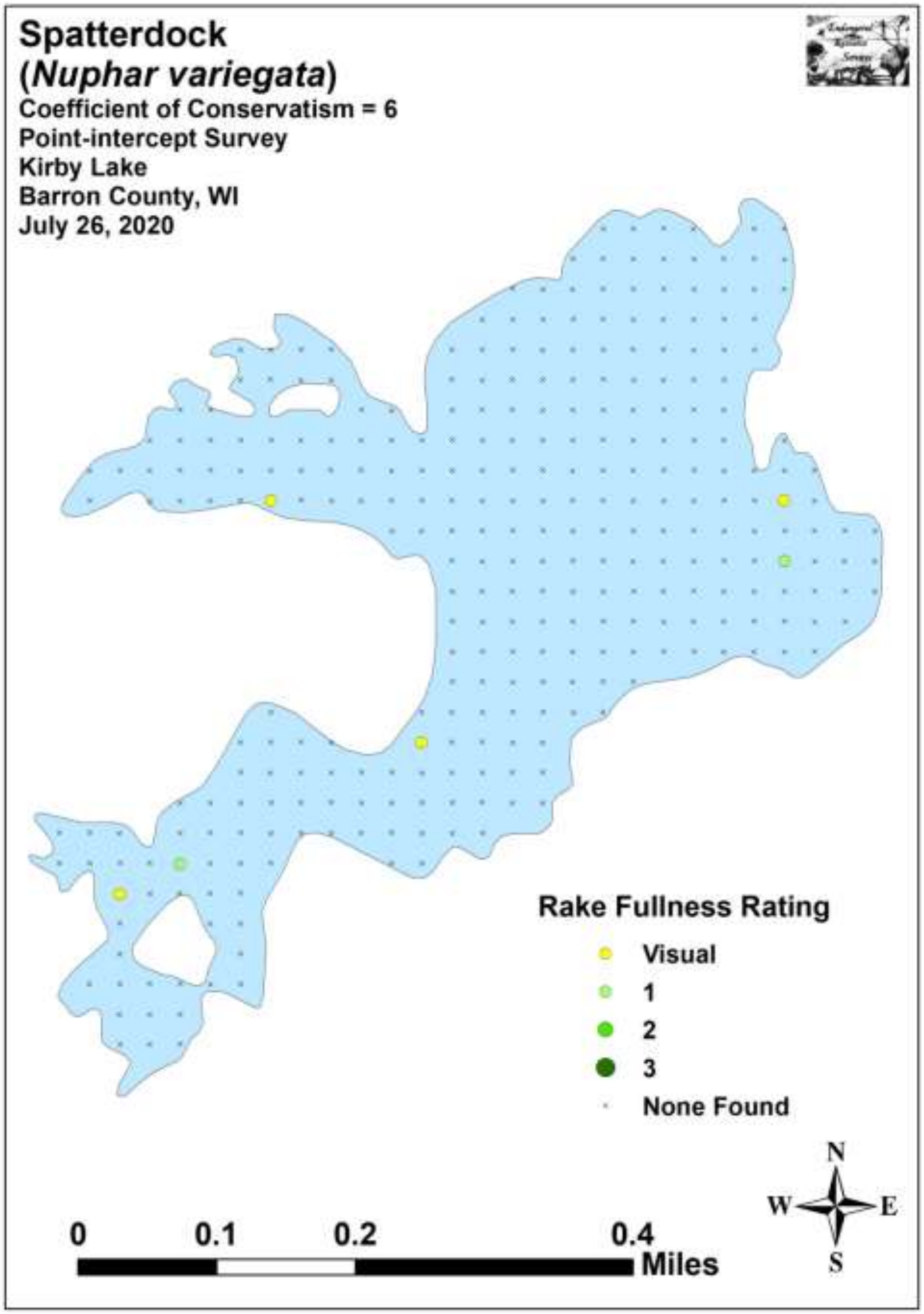
Miles


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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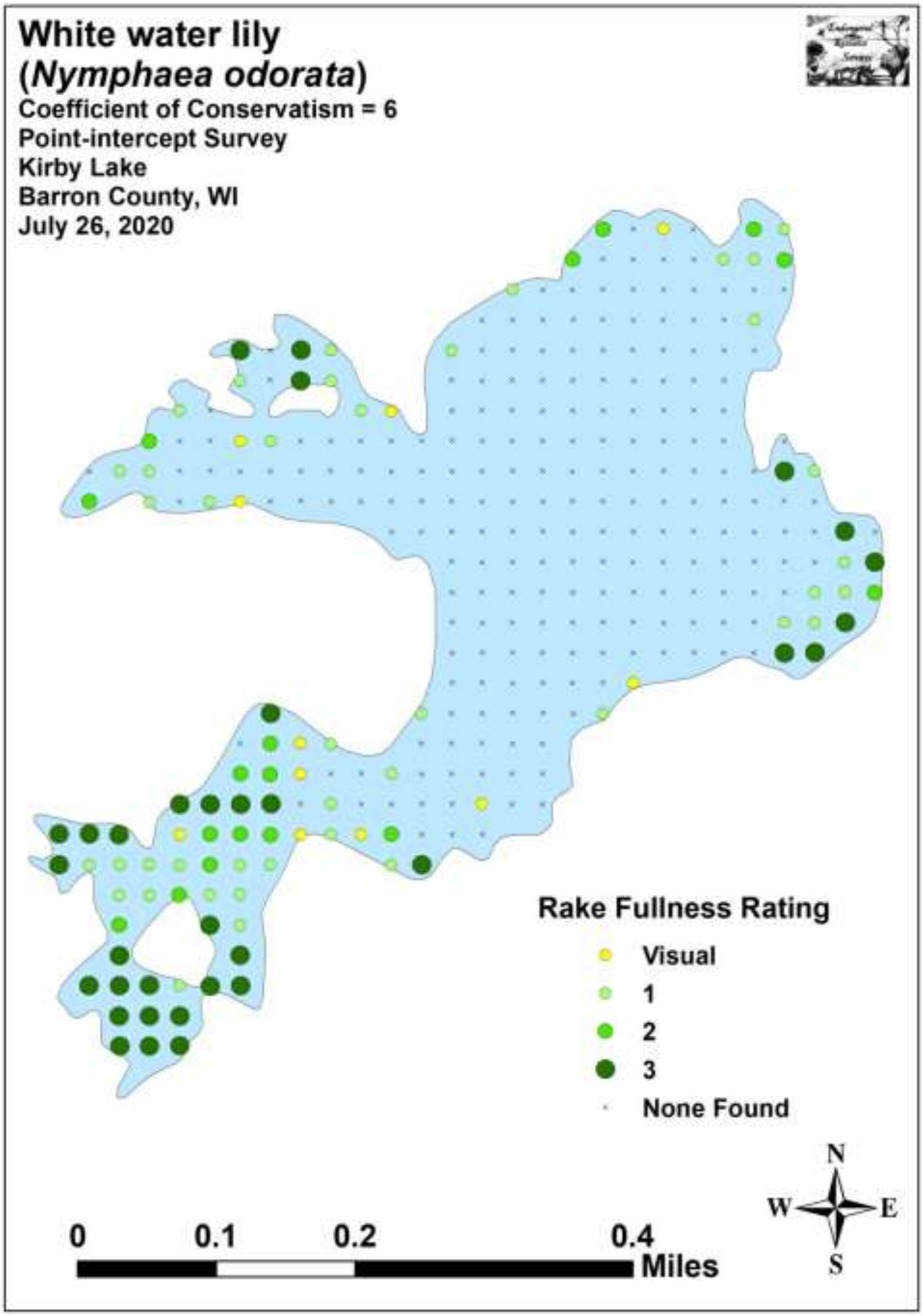
Miles


White water lily
(*Nymphaea odorata*)
Coefficient of Conservatism = 6
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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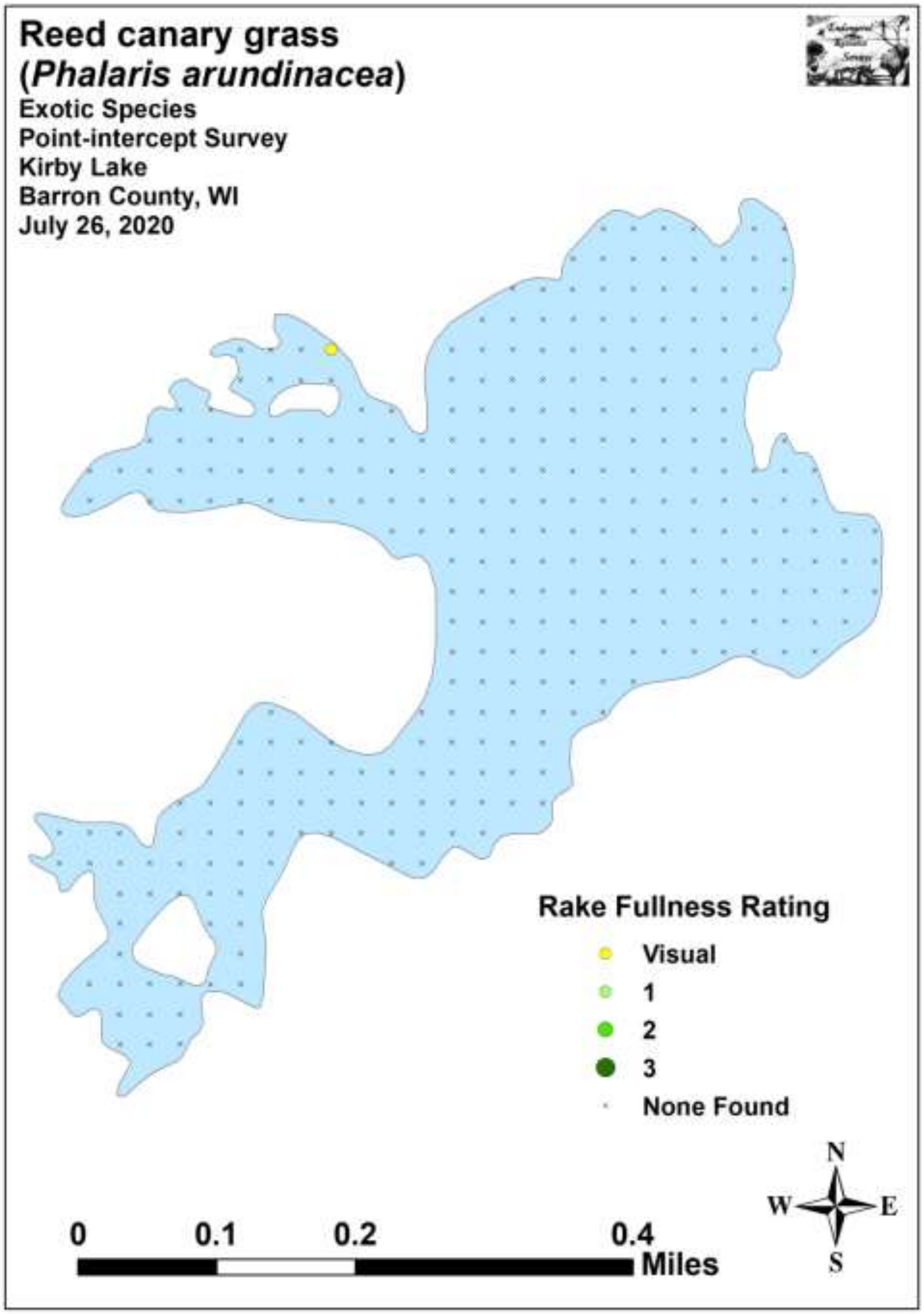
Miles



Reed canary grass
(*Phalaris arundinacea*)
Exotic Species
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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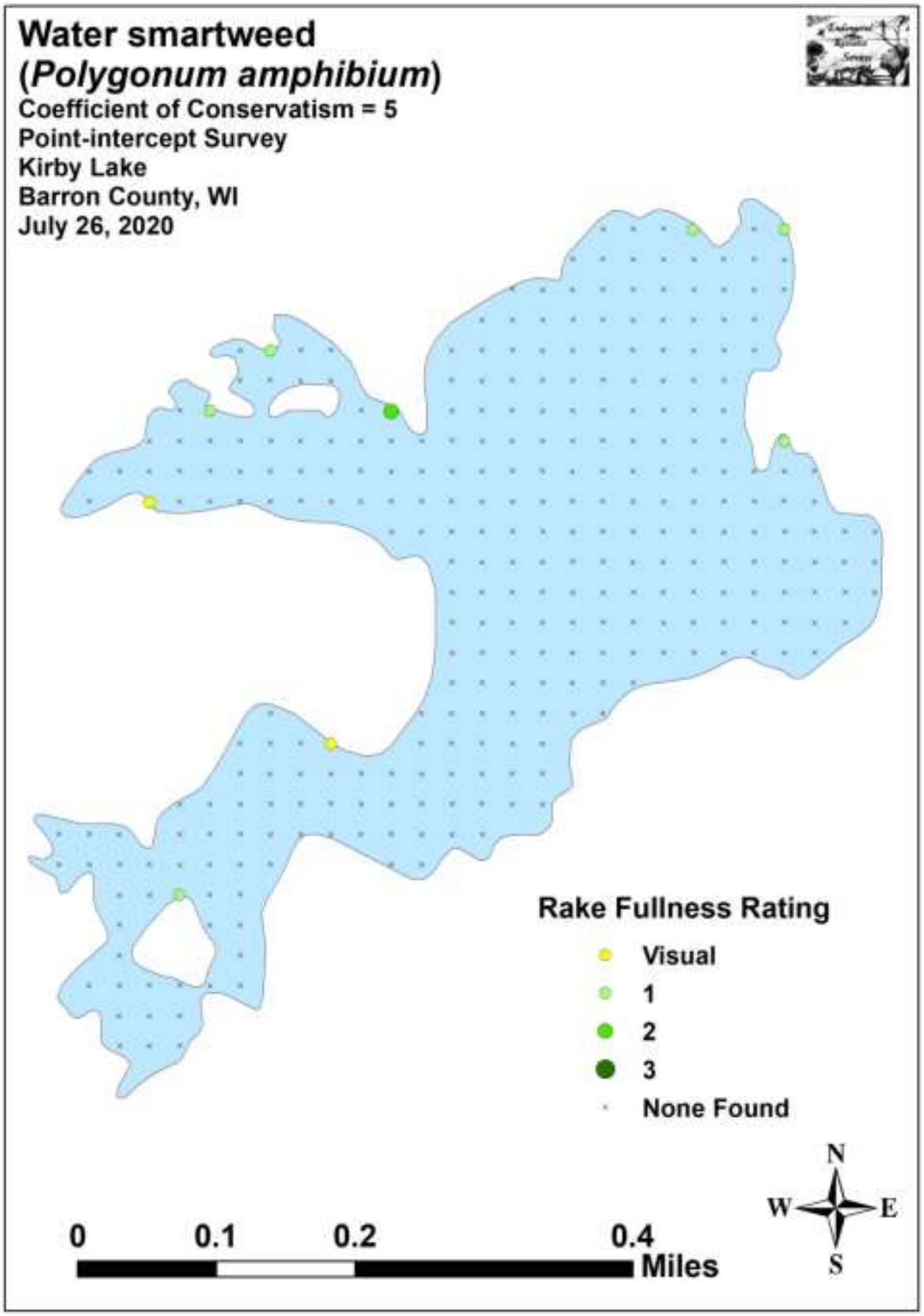
Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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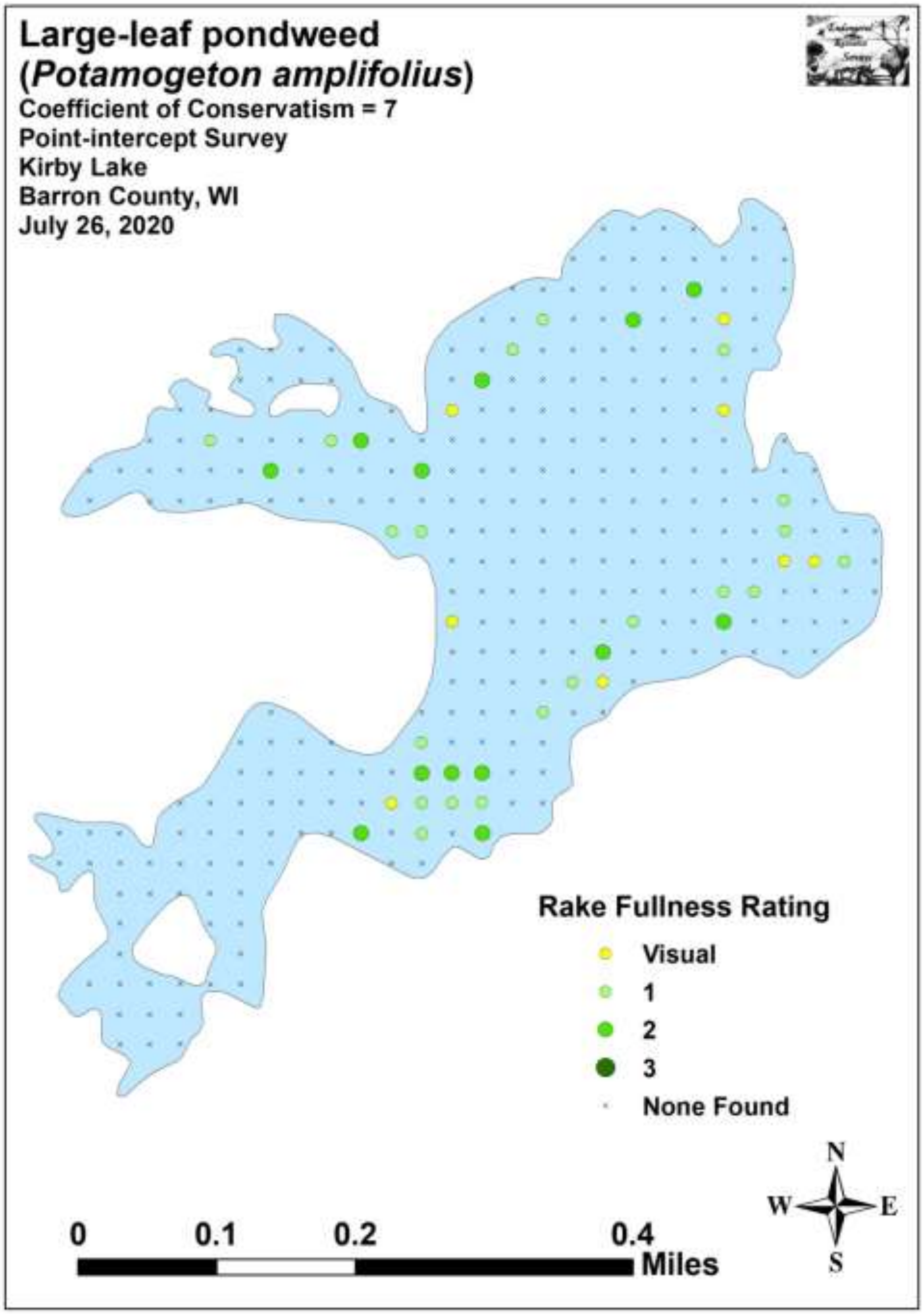
Miles


Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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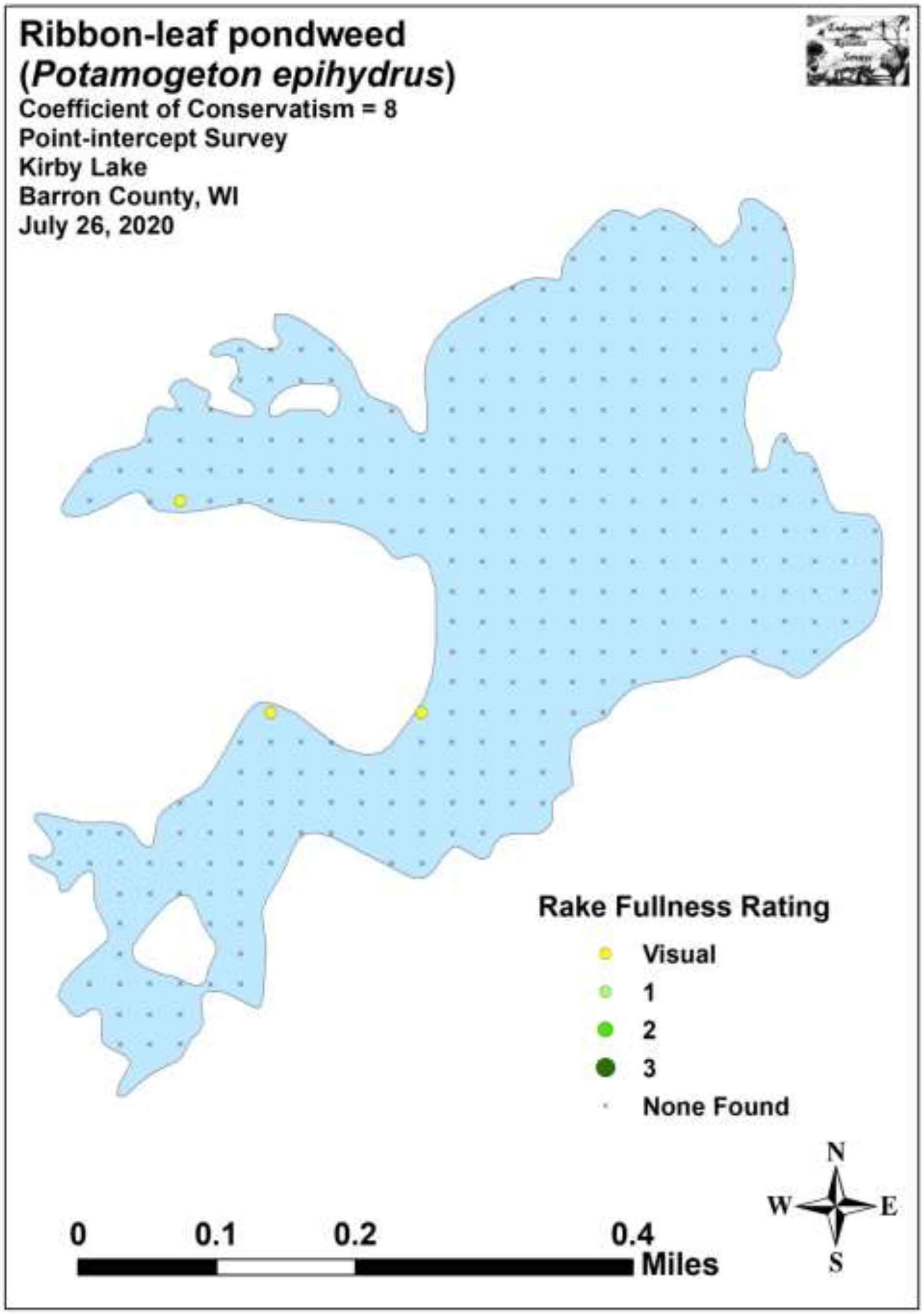
Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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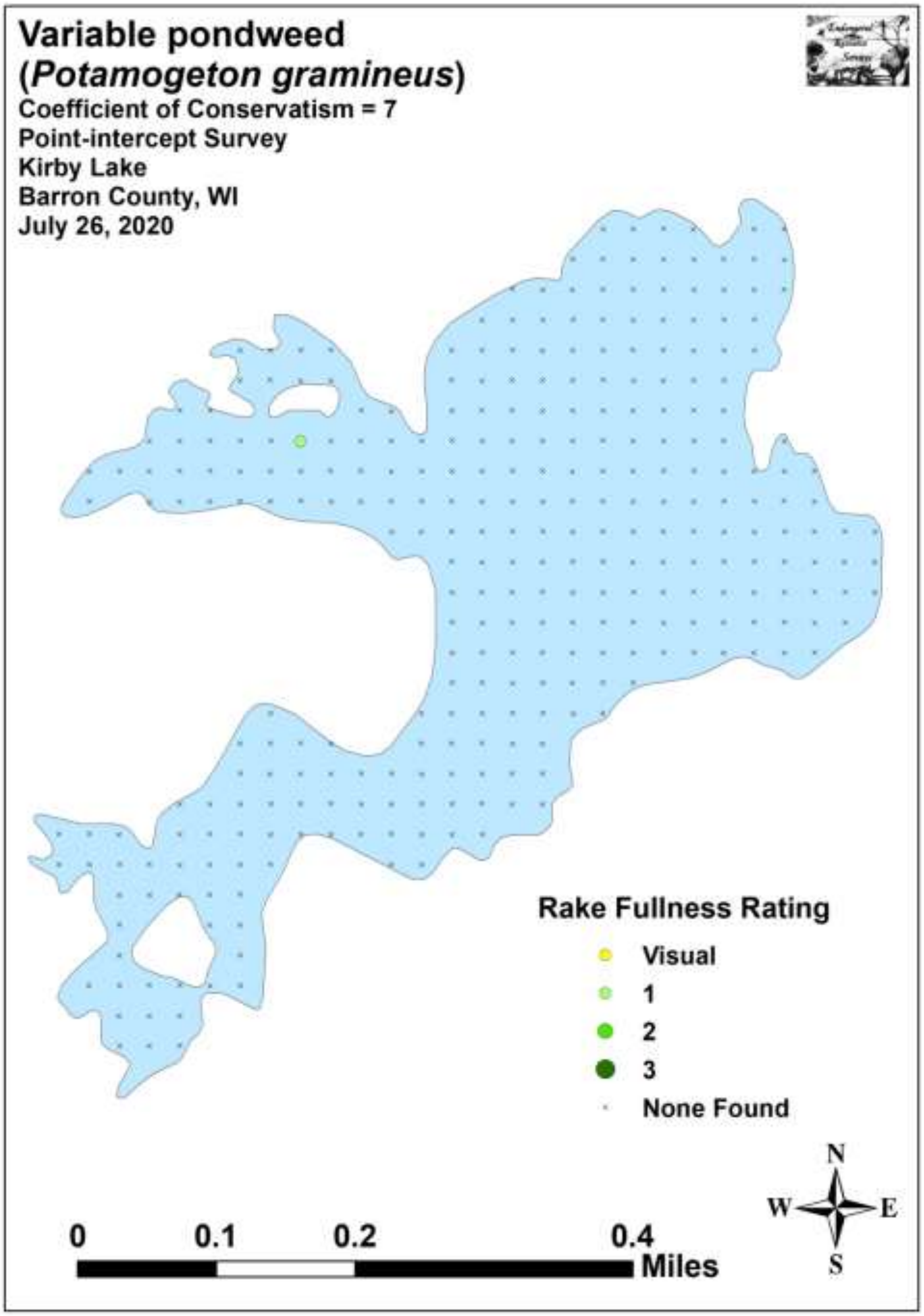
Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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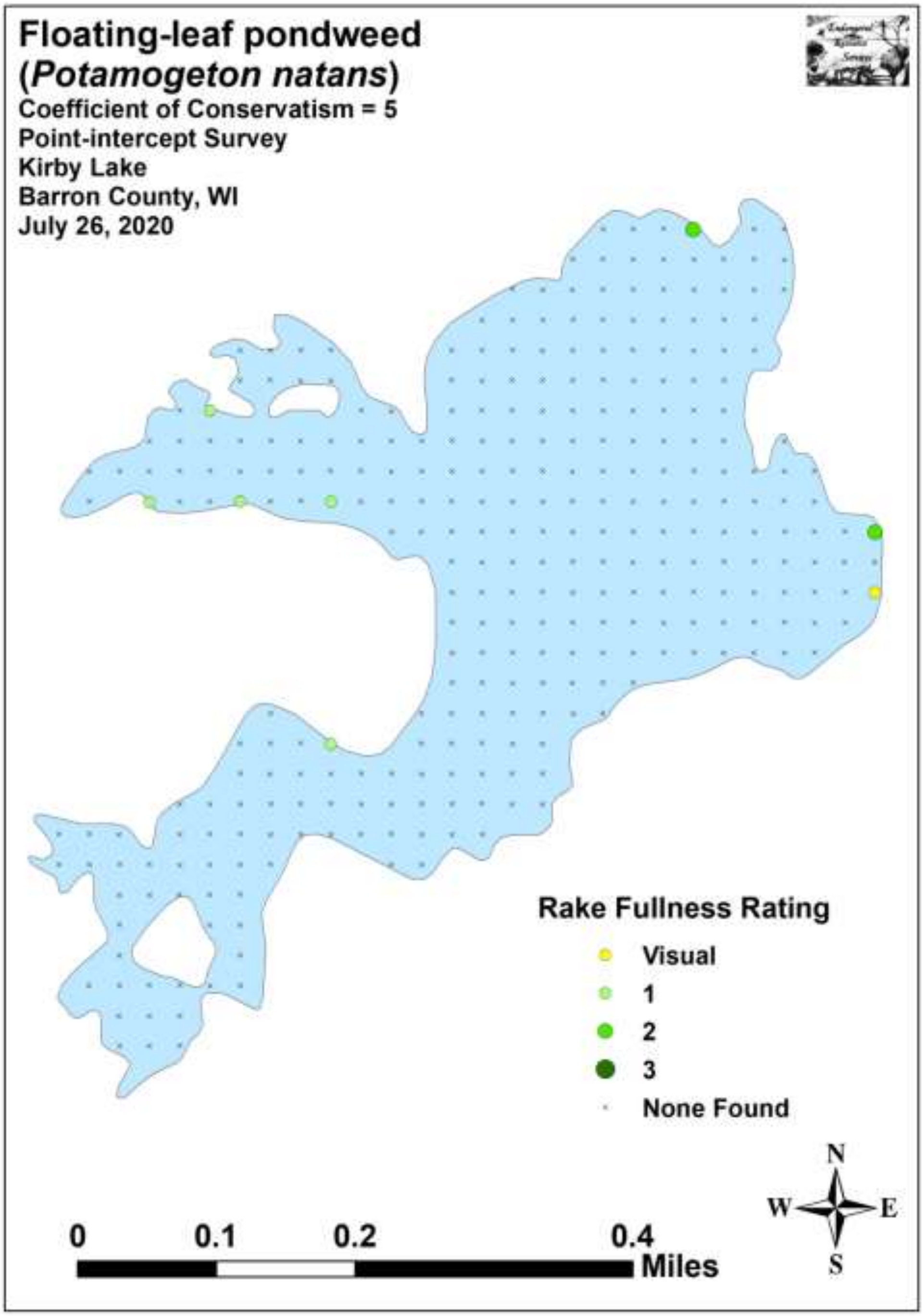

Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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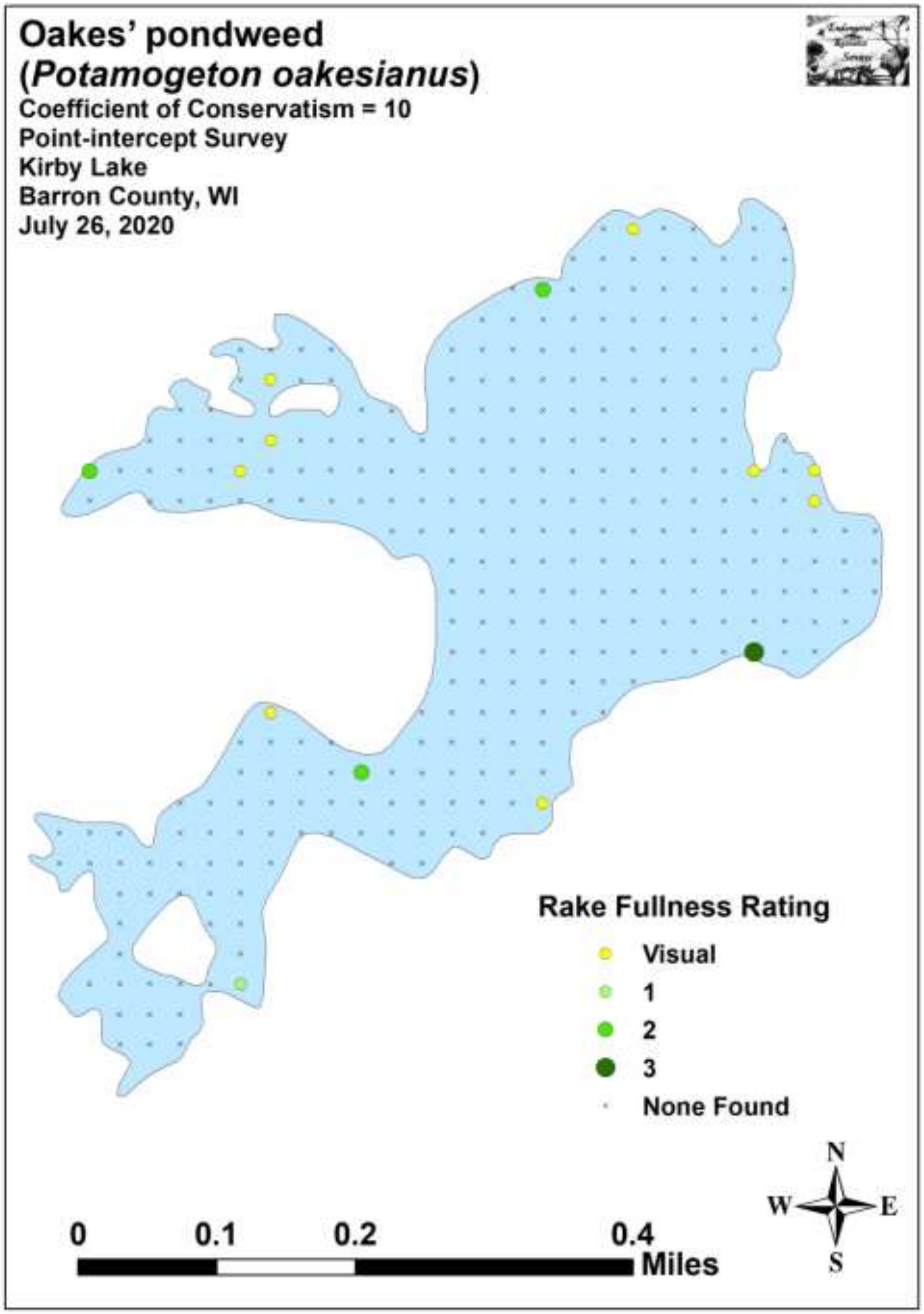
Oakes' pondweed
(*Potamogeton oakesianus*)
Coefficient of Conservatism = 10
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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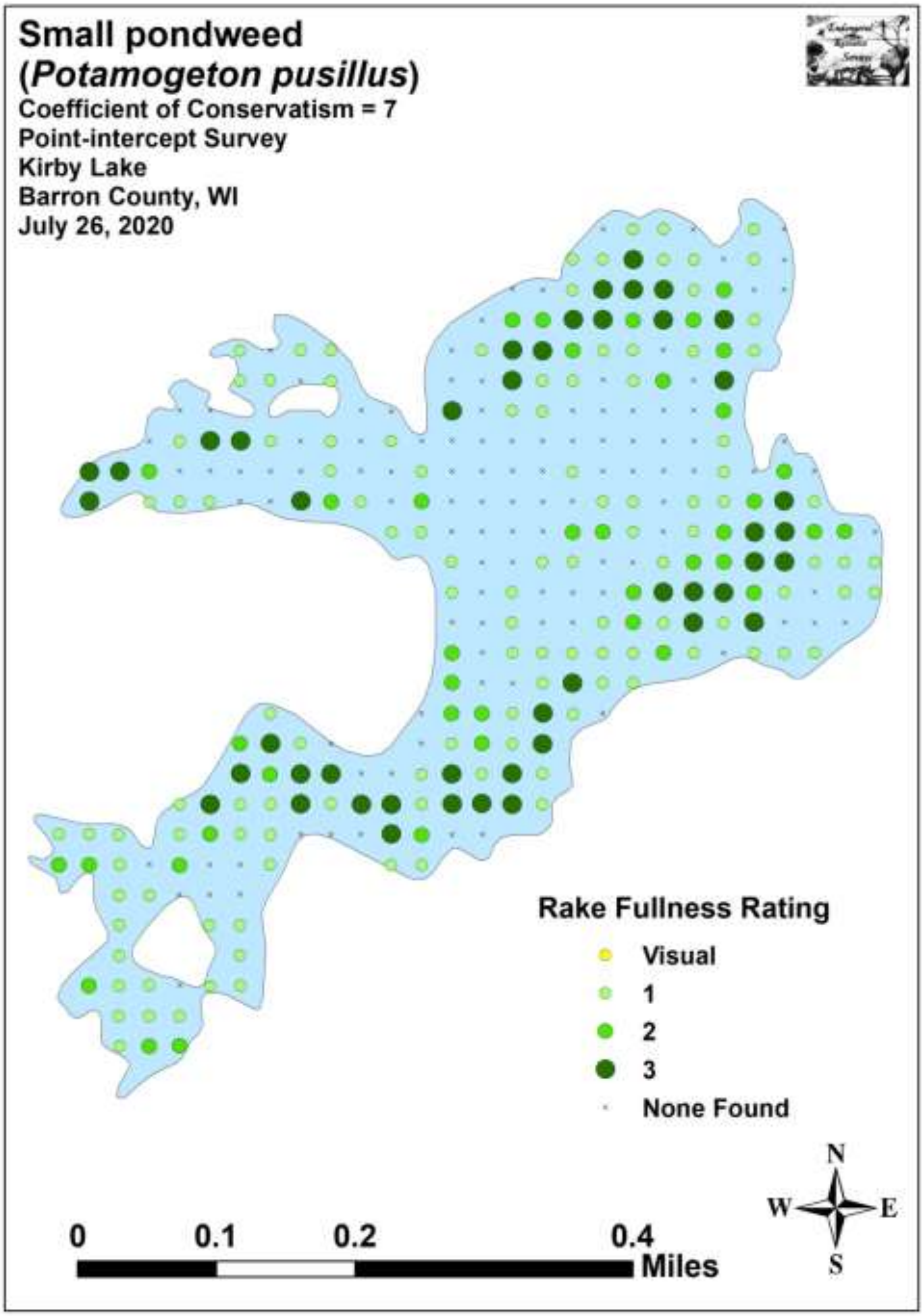
Miles



Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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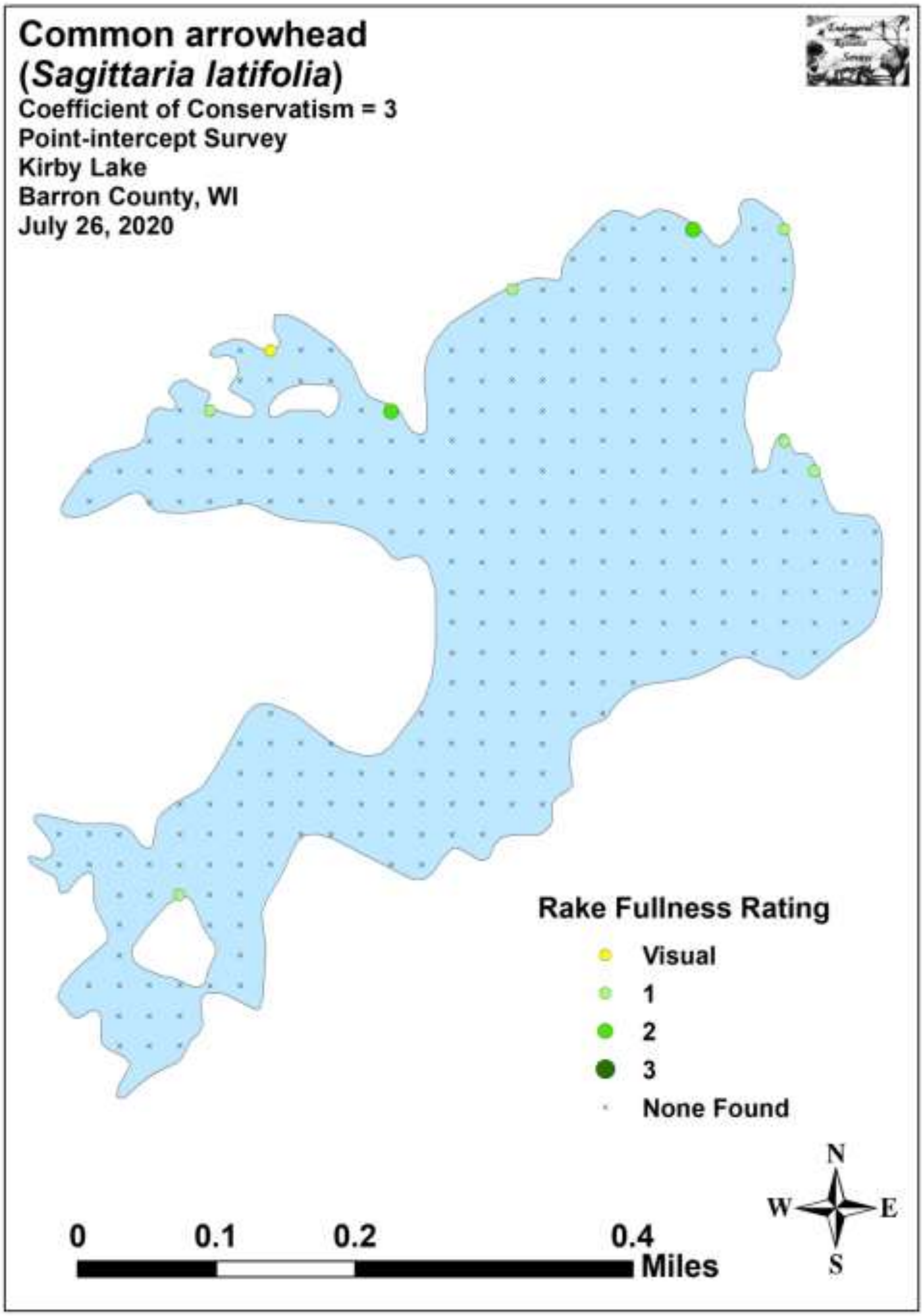
Miles


Common arrowhead
(*Sagittaria latifolia*)
Coefficient of Conservatism = 3
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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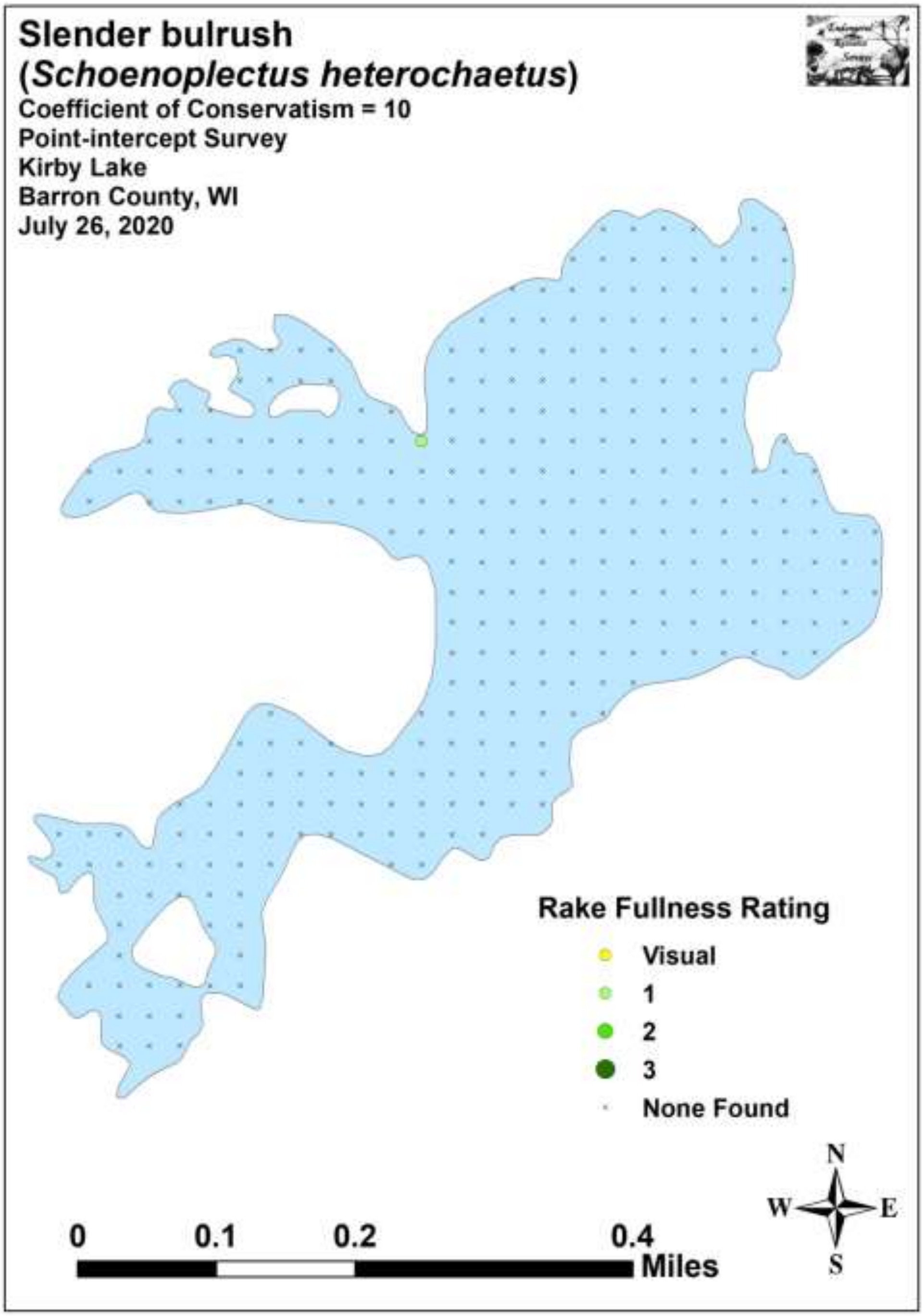

Slender bulrush
(Schoenoplectus heterochaetus)
Coefficient of Conservatism = 10
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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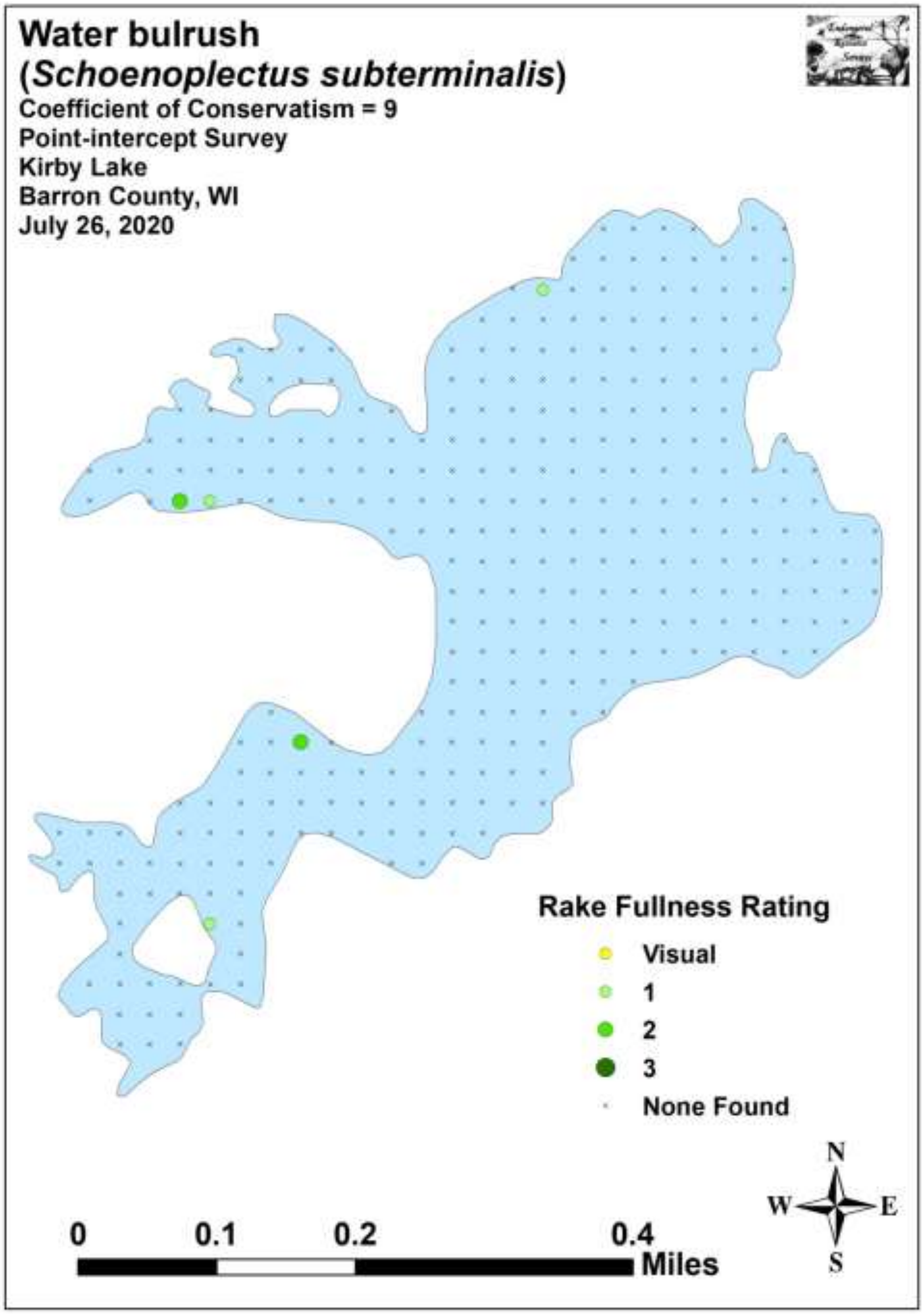

Water bulrush
(*Schoenoplectus subterminalis*)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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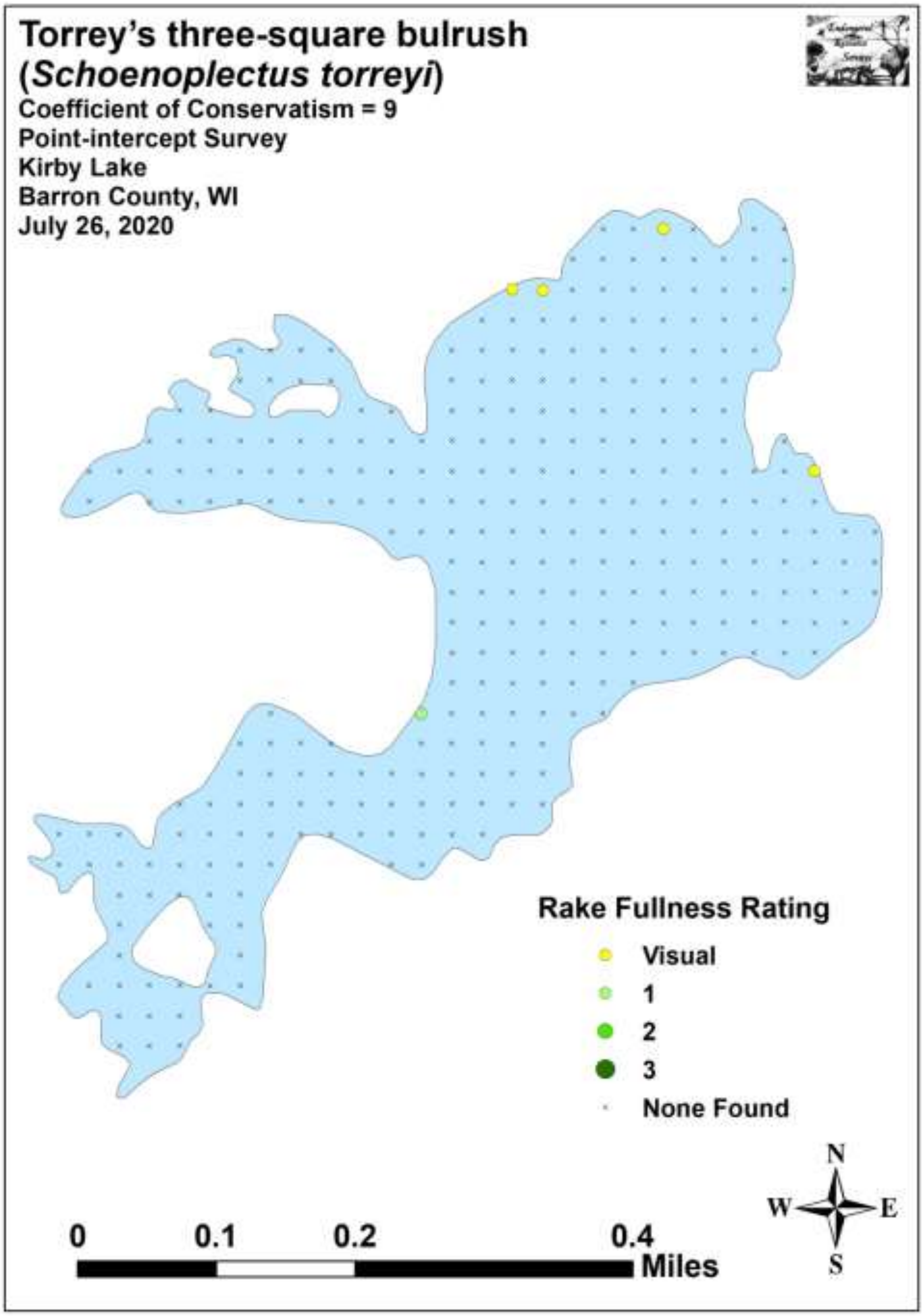
Torrey's three-square bulrush
(Schoenoplectus torreyi)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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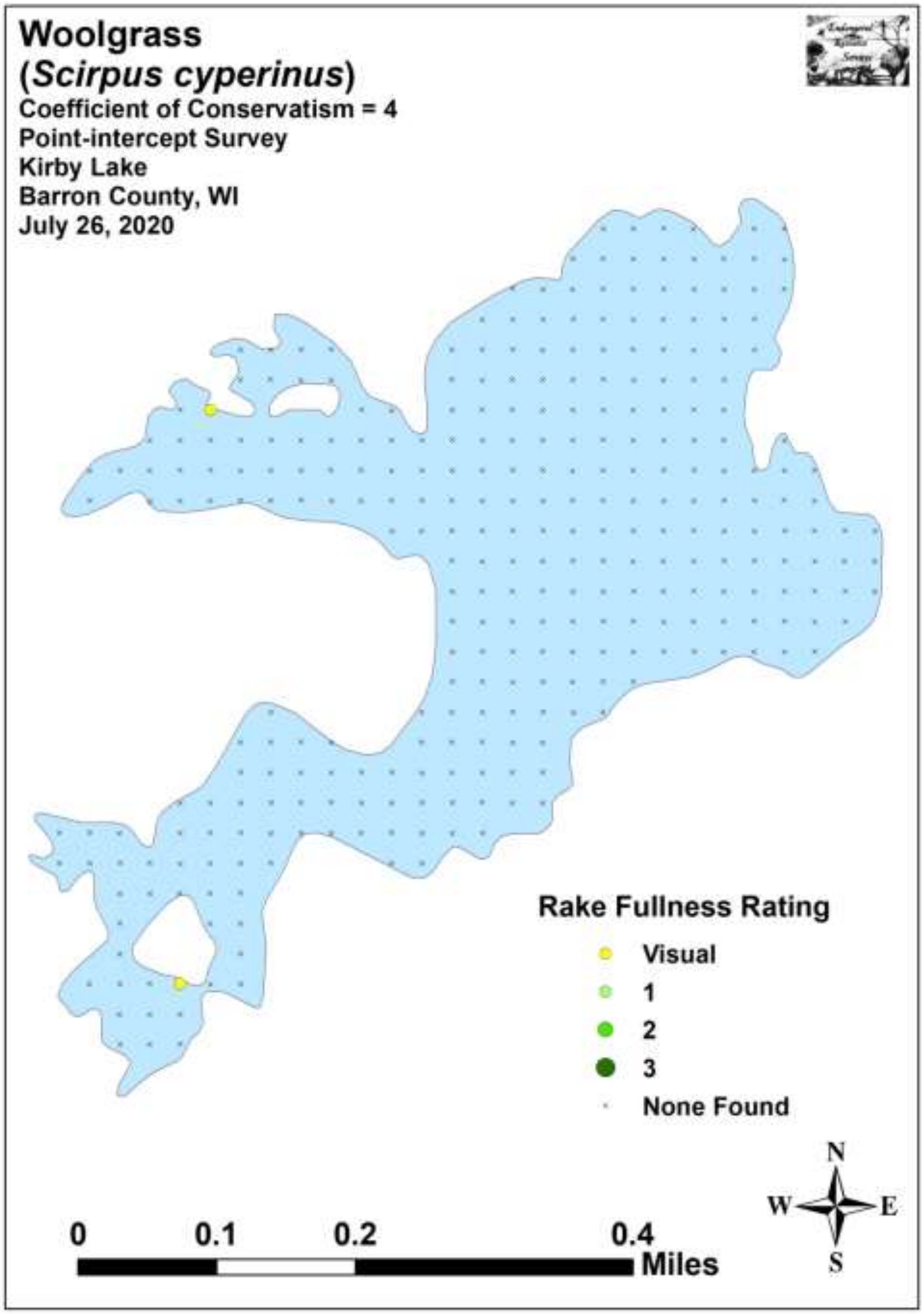
Woolgrass
(Scirpus cyperinus)
Coefficient of Conservatism = 4
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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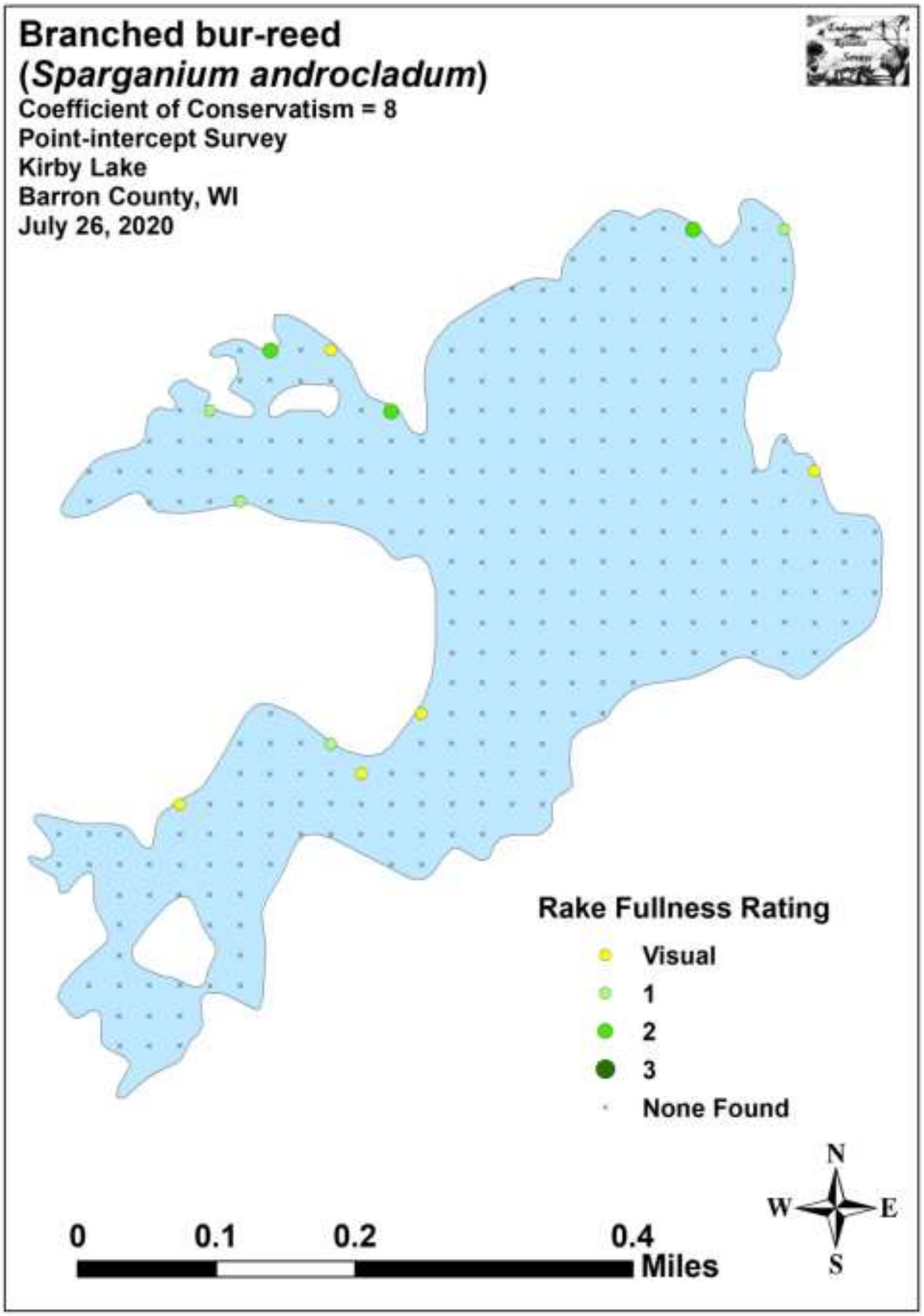

Branched bur-reed
(*Sparganium androcladum*)
Coefficient of Conservatism = 8
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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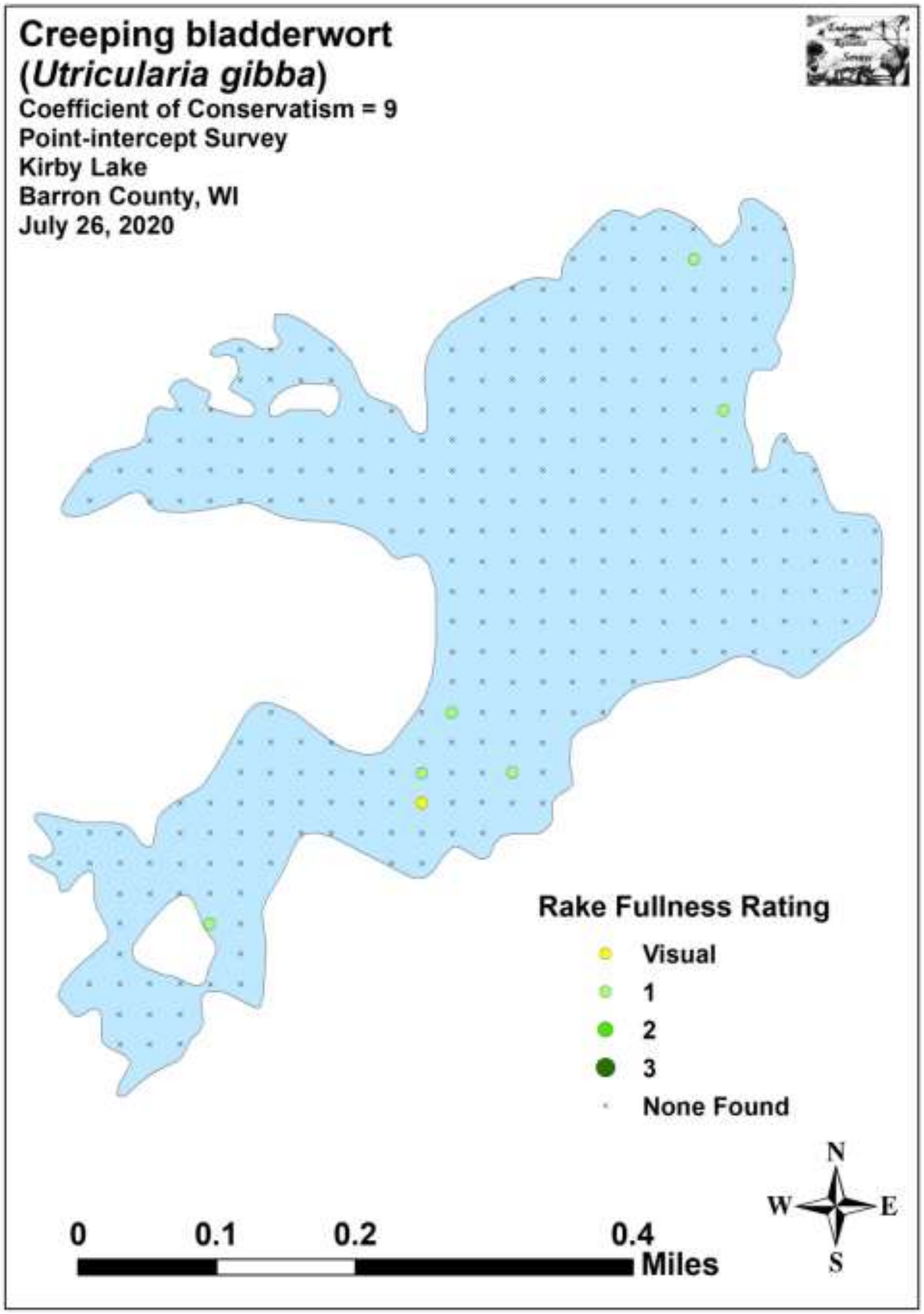
Creeping bladderwort
(Utricularia gibba)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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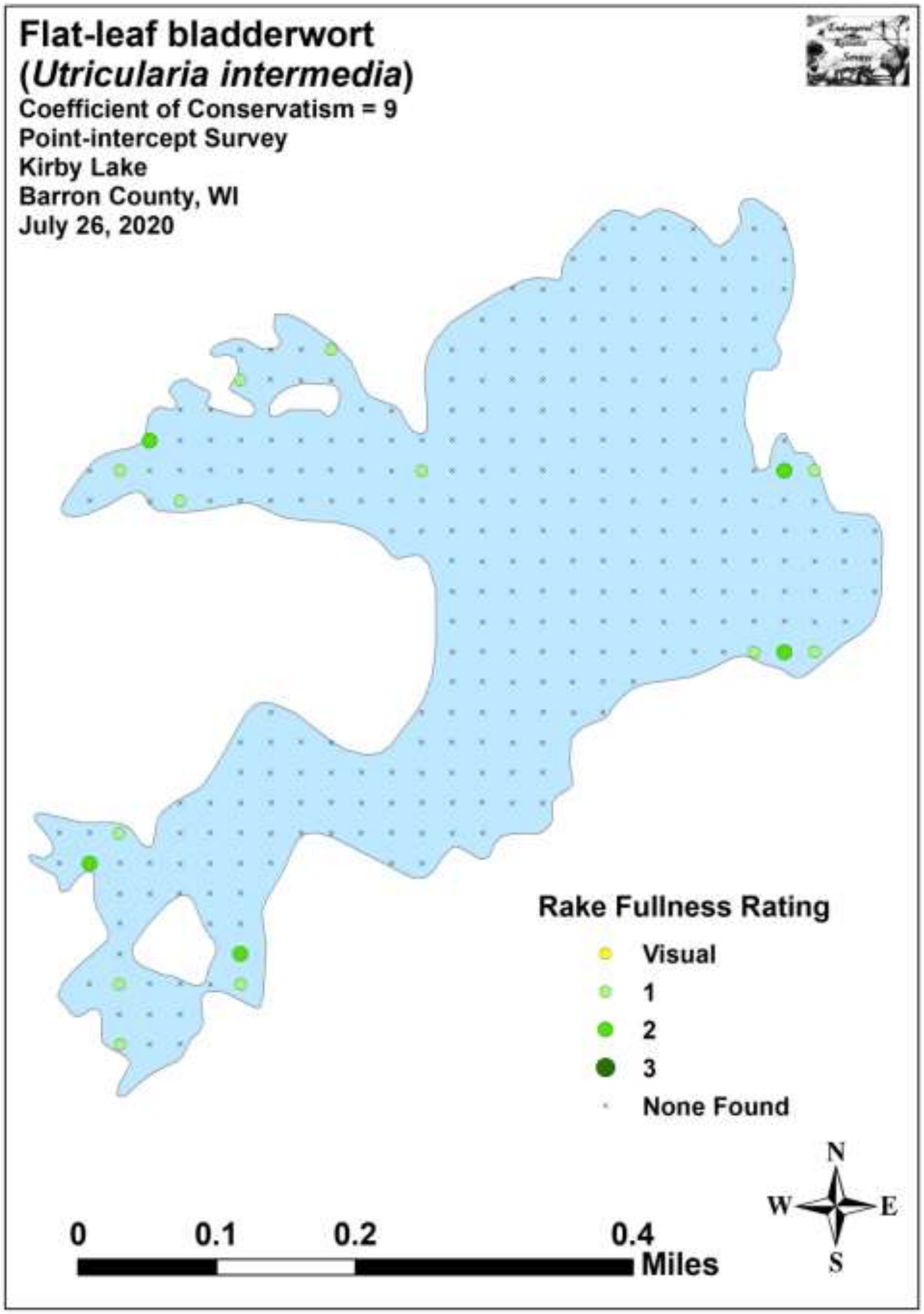
Miles


Flat-leaf bladderwort
(Utricularia intermedia)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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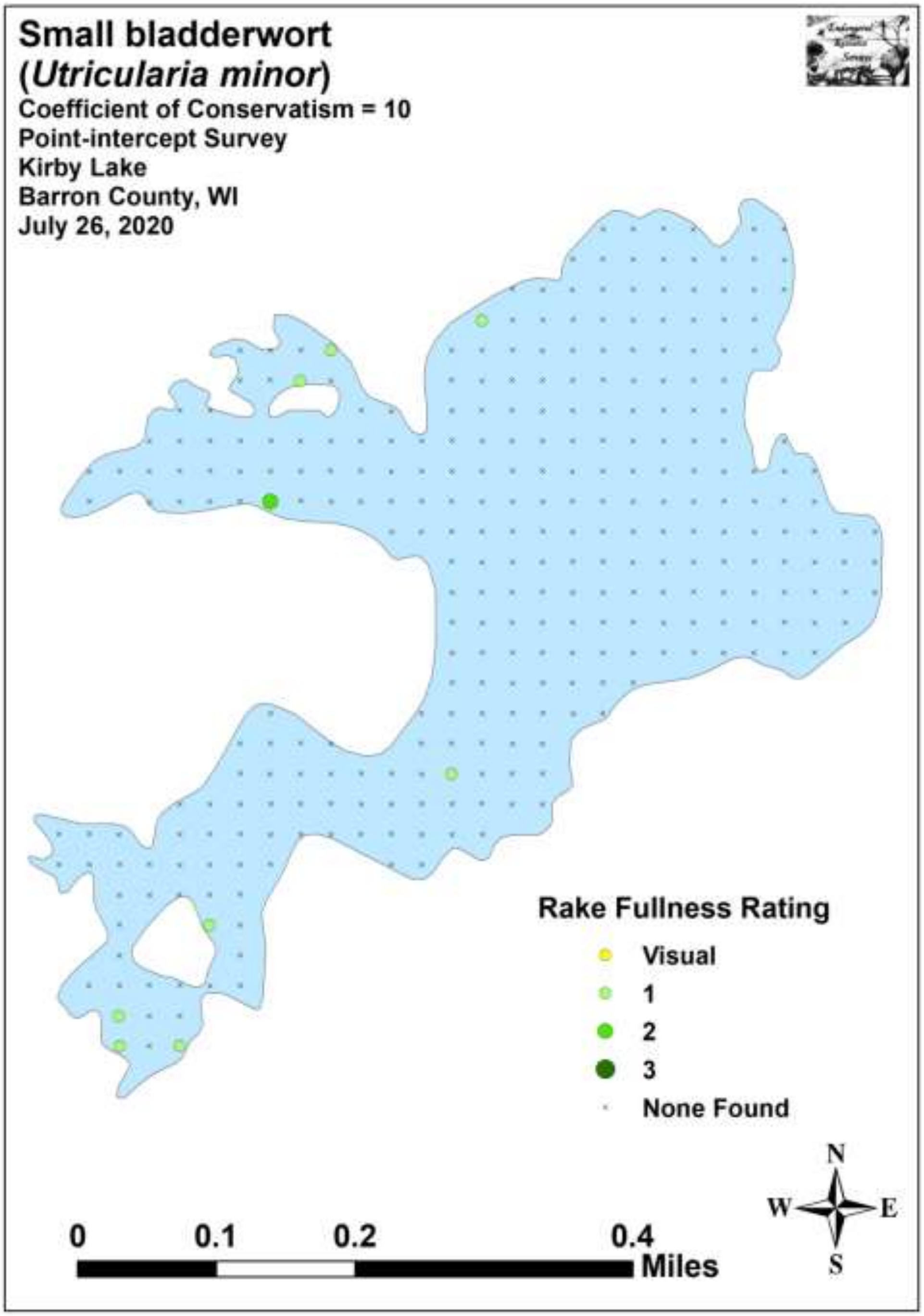

Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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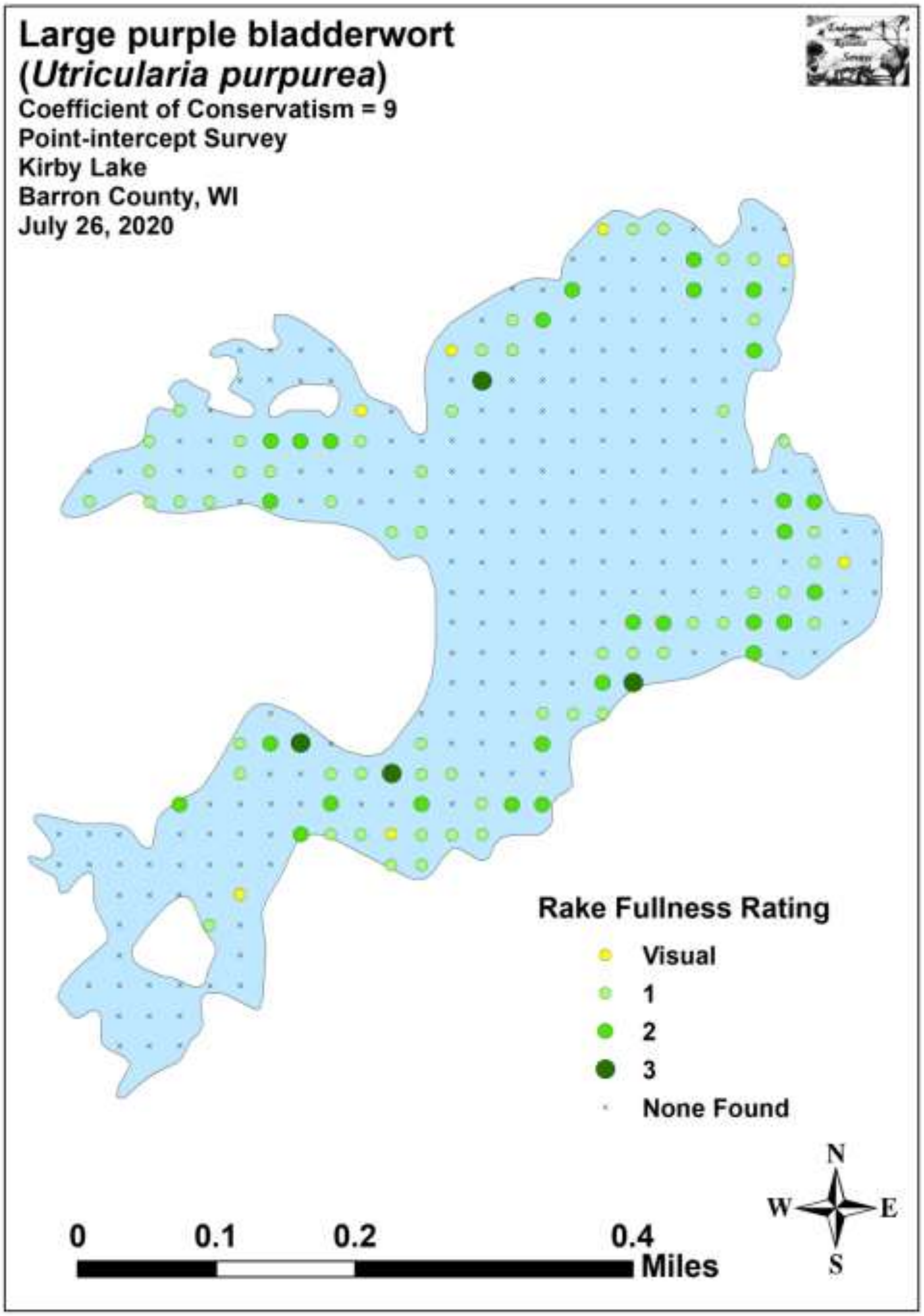
Miles


Large purple bladderwort
(Utricularia purpurea)
Coefficient of Conservatism = 9
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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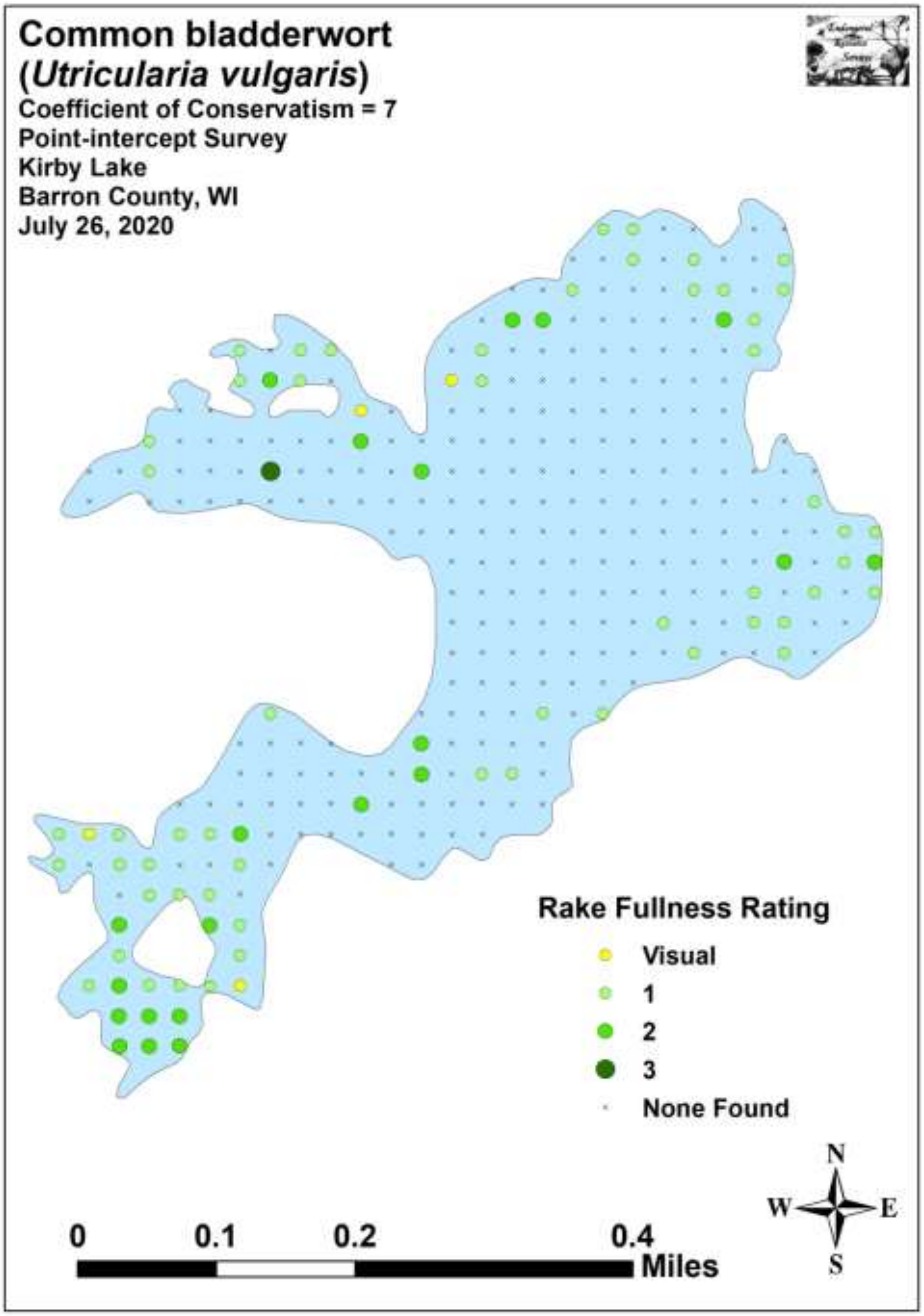
Miles



Common bladderwort
(*Utricularia vulgaris*)
Coefficient of Conservatism = 7
Point-intercept Survey
Kirby Lake
Barron County, WI
July 26, 2020
Rake Fullness Rating
Visual
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None Found
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Appendix VII: Aquatic Exotic Invasive Plant Species Information

Eurasian Water-milfoil

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

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

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

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

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

Dense stands of Eurasian Water-milfoil also inhibit recreational uses like swimming, boating, and fishing. Some stands have been dense enough to obstruct industrial and power generation water intakes. The visual impact that greets the lake user on milfoil-dominated lakes is the flat yellow-green of matted vegetation, often prompting the perception that the lake is "infested" or "dead". Cycling of nutrients from sediments to the water column by Eurasian Water-milfoil may lead to deteriorating water quality and algae blooms of infested lakes. (Taken in its entirety from WDNR, 2010 http://www.dnr.state.wi.us/invasives/fact/milfoil.htm)

Curly-leaf pondweed

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

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

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

It becomes invasive in some areas because of its tolerance for low light and low water temperatures. These tolerances allow it to get a head start on and out compete native plants in the spring. In mid-summer, when most aquatic plants are growing, curly-leaf pondweed plants are dying off. Plant die-offs may result in a critical loss of dissolved oxygen. Furthermore, the decaying plants can increase nutrients which contribute to algal blooms, as well as create unpleasant stinking messes on beaches. Curly-leaf pondweed forms surface mats that interfere with aquatic recreation. (Taken in its entirety from WDNR, 2010 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Reed canary grass

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

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

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

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

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

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

This species prefers disturbed areas, but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites. (Taken in its entirety from WDNR, 2010 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife
(Photo Courtesy Brian M. Collins)

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

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

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

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

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

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

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

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

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

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

Appendix 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: 2020 Raw Data Spreadsheets