Warm-water Point-intercept Macrophyte Survey
Diamond Lake - WBIC: 2897100
Bayfield County, Wisconsin

Alternate-flowered water-milfoil (Cameron 2019)

Diamond Lake aerial photo (2015)

Project Initiated by:

Diamond Lakers, Inc. and the
Wisconsin Department of Natural Resources

Shoreline facing west from the public landing (8/18/21)

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ABSTRACT

Diamond Lake (WBIC 2897100) is a 322-acre stratified drainage lake in south-central Bayfield County, WI. The lake is mesotrophic in nature with Secchi readings averaging 12.7ft from 1992-2021. A desire to determine if exotic species such as Eurasian water-milfoil (*Myriophyllum spicatum*) or Curly-leaf pondweed (*Potamogeton crispus*) had invaded the lake; and to establish baseline data on the richness, diversity, abundance, and distribution of other native aquatic plant populations prompted members of the Diamond Lakers (DL) and the Wisconsin Department of Natural Resources (WDNR) to authorize a full lake point-intercept macrophyte survey on August 17-18, 2021. The survey found macrophytes growing at 277 of 887 survey points which extrapolated to 31.3% of the entire lake bottom and 85.2% of the 17.0ft littoral zone. Overall diversity was exceptionally high with a Simpson Index value of 0.94. Richness was also moderately high with 43 species found in the rake. This total increased to 60 species when including visuals and plants found during the boat survey. Several of these additional species were uncommon to rare; highly localized along undeveloped shorelines; and known to be sensitive to habitat modification making them potentially vulnerable to lakewide extinction. Localized richness was also moderately high as we calculated a mean native species at sites with native vegetation of 3.27 species/site. We documented a moderate mean total rake fullness of 1.97. Wild celery (*Vallisneria americana*), Nitella (*Nitella* sp.), Variable pondweed (*Potamogeton gramineus*), and Water star-grass (*Heteranthera dubia*) were the most common macrophyte species. They occurred at 47.29%, 26.71%, 26.71%, and 20.22% of sites with vegetation, and accounted for 37.02% of the total relative frequency. The 44 native index species found in the rake during the survey produced a mean Coefficient of Conservatism of 7.3 and resulted in a Floristic Quality Index of 48.7. When compared to other lakes in the Northern Lakes and Forest Ecoregion, both of these values were higher than the average mean C of 6.7 and the median FQI of 24.3. Filamentous algae were present at 40 points with a mean rake fullness of 1.15. Common forget-me-not (*Myosotis scorpioides*) and Reed canary grass (*Phalaris arundinacea*) were the only non-native species we found, and both were restricted to small patches in a disturbed area near the seep at the public boat landing. A cluster of Yellow iris (*Iris pseudacorus*) was found and removed by DL volunteers in spring 2021. Future management considerations include preserving the lake's high quality and sensitive native plant communities; working to maintain water clarity and limit nutrient inputs along the lakeshore by such things as establishing buffer strips of native vegetation, eliminating fertilizer applications, bagging grass clippings, removing pet waste, disposing of fire pit ash away from the lake, maintaining septic systems, and avoiding motor startups in shallow water; considering starting a Clean Boats/Clean Waters program and adding a secondary sign at the landing to warn about Aquatic Invasive Species (AIS); conducting monthly monitoring at the public boat landing and at least annual lake-wide meandering littoral zone surveys to look for AIS; and developing an Aquatic Plant Management Plan that clarifies a response if a new AIS is introduced into the lake.

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INTRODUCTION:

Diamond Lake (WBIC 2897100) is a 322-acre stratified drainage lake in south-central Bayfield County, Wisconsin in the Town of Grandview (T44N R6W S20, 29, and 32). It reaches a maximum depth of 83ft in the central basin and has an average depth of approximately 33ft (WDNR 2021). The lake is mesotrophic in nature with summer Secchi readings averaging 12.7ft from 1992-2021 (WDNR 2021). This good clarity produced a littoral zone that extended to 17.0ft in August of 2021. The bottom is dominated by sand and gravel along the shoreline, but this gradually transitions to sandy muck at greater depths (Burnkrant et al. 1968) (Figure 1).

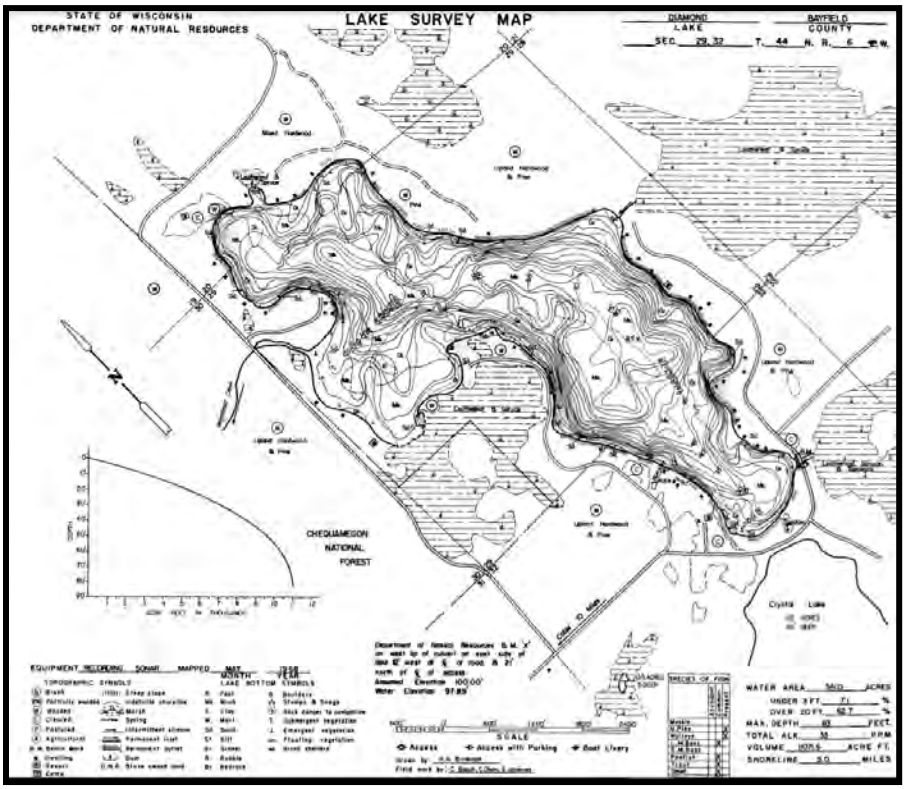


Figure 1: Diamond Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

The Diamond Lakers, Inc. (DL) and the Wisconsin Department of Natural Resources (WDNR) authorized a warm-water point-intercept survey of all aquatic plants in the lake on August 17-18, 2021. This survey used the WDNR's statewide guidelines for conducting systematic point-intercept macrophyte sampling. These methods ensure that all sampling in the state will be conducted in the same manner thus allowing data to be compared across time and space. The immediate goals of the survey were to determine if any exotic species such as Curly-leaf pondweed (*Potamogeton crispus*) (CLP) or Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) had invaded the lake; and to establish data on the richness, diversity, abundance, distribution, and density of native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's macrophyte community as well as a way to measure any impacts on the lake's plants if an exotic species is introduced or active management occurs in the future.

METHODS:

Warm-water Full Point-intercept Macrophyte Survey:

Prior to beginning the August point-intercept survey, we conducted a general boat survey to gain familiarity with the lake's macrophytes. All plants found were identified (Voss 1996, Boreman et al. 1997; Crow and Hellquist 2006; Chadde 2012; Skawinski 2019), a datasheet was built from the species present, and two vouchers were collected to be pressed and mounted for herbarium specimens – one to be retained by the lake association, and one to be sent to the state herbarium in Stevens Point for identification confirmation (Appendix I).

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, and total acreage, Michelle Nault (WDNR) generated an 887-point sampling grid for Diamond Lake (Appendix II). Using this grid, we completed a density survey where we sampled for plants at each point in and adjacent to the lake's littoral zone. We located each survey point using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. 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, and a depth reading was taken using a metered pole or handheld sonar.

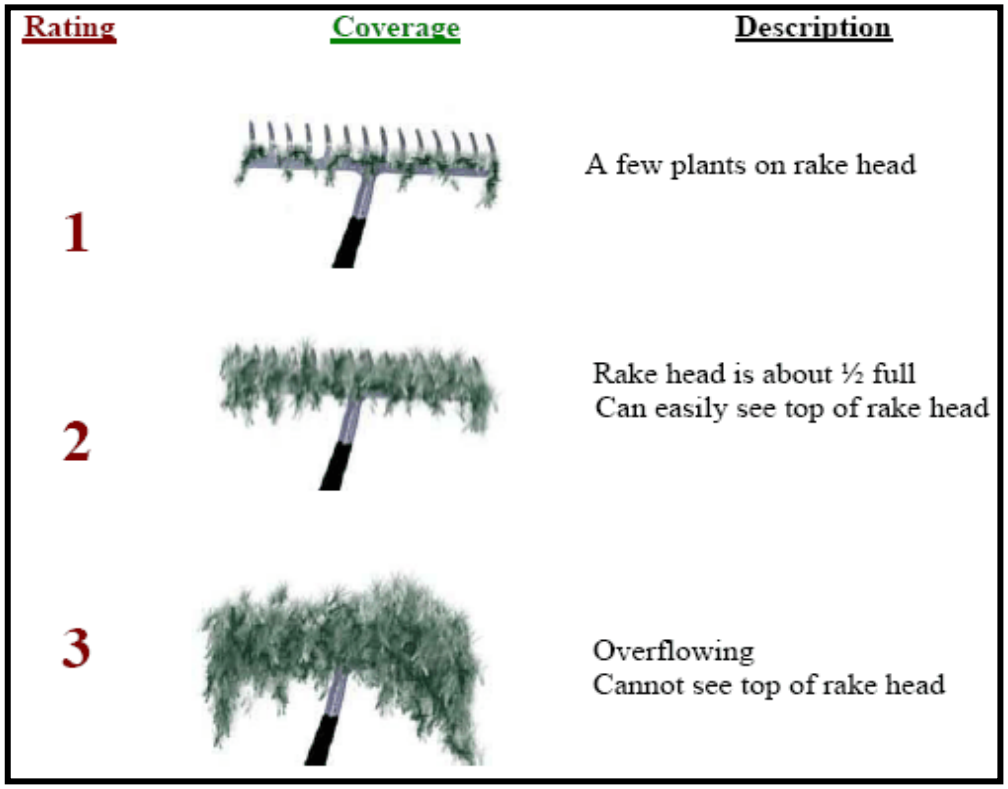


Figure 2: Rake Fullness Ratings (UWEX 2010)

DATA ANALYSIS:

We entered all data collected into the standard WDNR Aquatic Plant Management 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.

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. Although 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).

Relative frequency: This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative 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 (Table 2).

Relative frequency example:

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

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

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

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

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

Floristic Quality Index (FQI): This index measures the impact of human development on a lake's aquatic plants. The 124 species in the index are assigned a Coefficient of Conservatism (C) which ranges from 1-10. The higher the value assigned, the more likely the plant is to be negatively impacted by human activities relating to water quality or habitat modifications. Plants with low values are tolerant of human habitat modifications, and they often exploit these changes to the point where they may crowd out other species. The FQI is calculated by averaging the conservatism value for each native index species found in the lake during the point-intercept survey**, and multiplying it by the square root of the total number of plant species (N) in the lake ($FQI=(\Sigma(c1+c2+c3+\ldots cn)/N)*\sqrt{N}$). Statistically speaking, the higher the index value, the healthier the lake's macrophyte community is assumed to be. Nichols (1999) identified four eco-regions in Wisconsin: Northern Lakes and Forests, North Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. He recommended making comparisons of lakes within ecoregions to determine the target lake's relative diversity and health. Diamond Lake is in the Northern Lakes and Forests Ecoregion (Table 3).

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

RESULTS:

Warm-water Full Point-intercept Macrophyte Survey:

Depth readings taken at Diamond Lake's 887 survey points revealed a varied underwater topography (Figure 3). In the southern half of the lake, with the exception of the broad flat just north of the public landing, we found most shoreline areas had a narrow rim that extended out into 10-15ft of water before plunging into the deep trench that dominated the center of the lake. Conversely, most side bays in the northern half of the lake sloped gradually into 20ft+ before joining the central basin. Specifically, a broad shallow flat dominated the majority of the northwest bay, and the north bay contained a variety of shallow flats and rock humps including several small areas that were not shown on the WDNR bathymetric map (Appendix III).

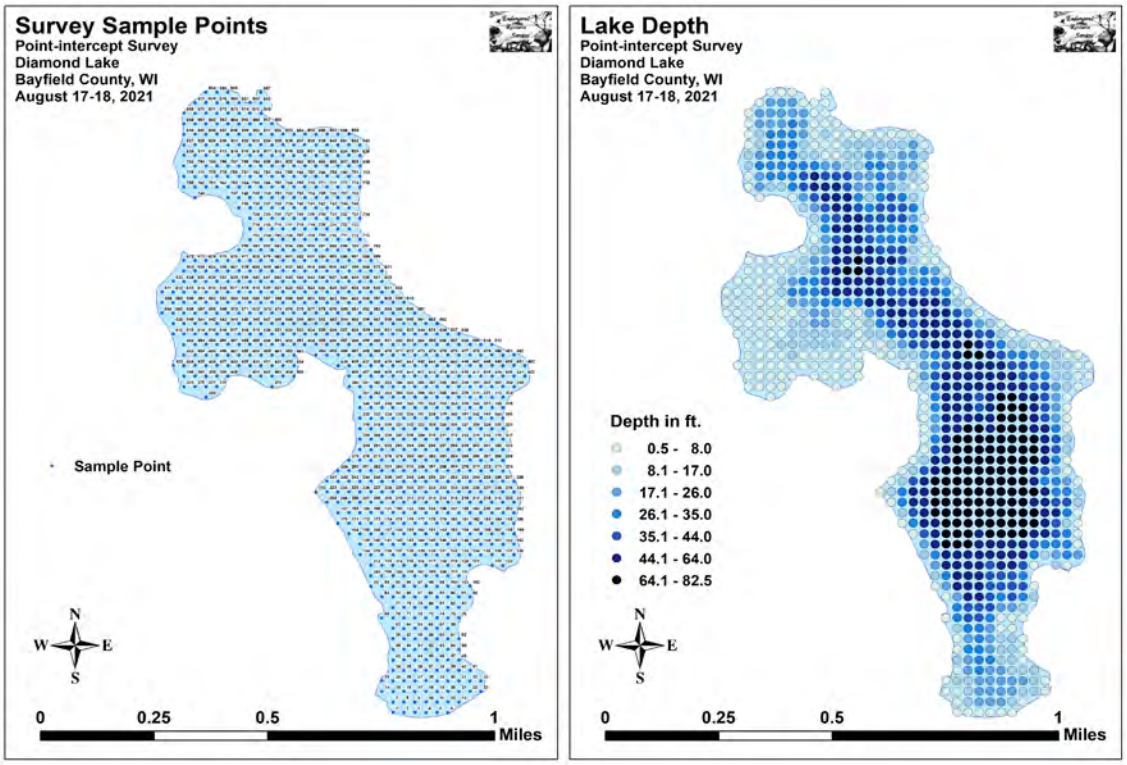


Figure 3: Survey Sample Points and Lake Depth

Of the 339 points where we could determine the bottom substrate, we categorized 72.9% as pure sand (247 points), 15.3% as rock (52 points), and 11.8% as sandy or organic muck (40 points) (Figure 4) (Appendix III). The majority of areas along the immediate shoreline were pure sand or a mix of sand and gravel. With increasing depths, most areas tended to have a very thin layer of soft sandy muck over a pure sand base; however, we didn't classify these points as muck unless it was obviously more than a few inches thick. The only areas with nutrient-rich organic muck occurred adjacent to the Tamarack (*Larix laricina*), Black spruce (*Picea mariana*), and Leatherleaf (*Chamaedaphne calyculata*) bogs on the southern end of the northwestern side bay and in the small "nook" bay on the lake's north side.

We found plants growing at 277 points (Table 1). This extrapolated to 31.3% of the total lake bottom and 85.2% of the 17.0ft littoral zone (Figure 4) (Appendix IV). Overall plant colonization was strongly skewed to deep water as the mean depth of 6.1ft was much higher than the median depth of 5.0ft (Figure 5).

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Summary Statistics:

Total number of points sampled	887
Total number of sites with vegetation	277
Total number of sites shallower than the maximum depth of plants	325
Frequency of occurrence at sites shallower than maximum depth of plants	85.2
Simpson Diversity Index	0.94
Number of sites sampled using rake on Rope (R)	0
Number of sites sampled using rake on Pole (P)	339
Maximum depth of plants (ft)	17.0
Mean depth of plants (ft)	6.1
Median depth of plants (ft)	5.0
Average number of all species per site (shallower than max depth)	2.78
Average number of all species per site (veg. sites only)	3.27
Average number of native species per site (shallower than max depth)	2.78
Average number of native species per site (sites with native veg. only)	3.27
Species richness	43
Species richness (including visuals)	43
Species richness (including visuals and boat survey)	60
Mean total rake fullness (veg. sites only)	1.97

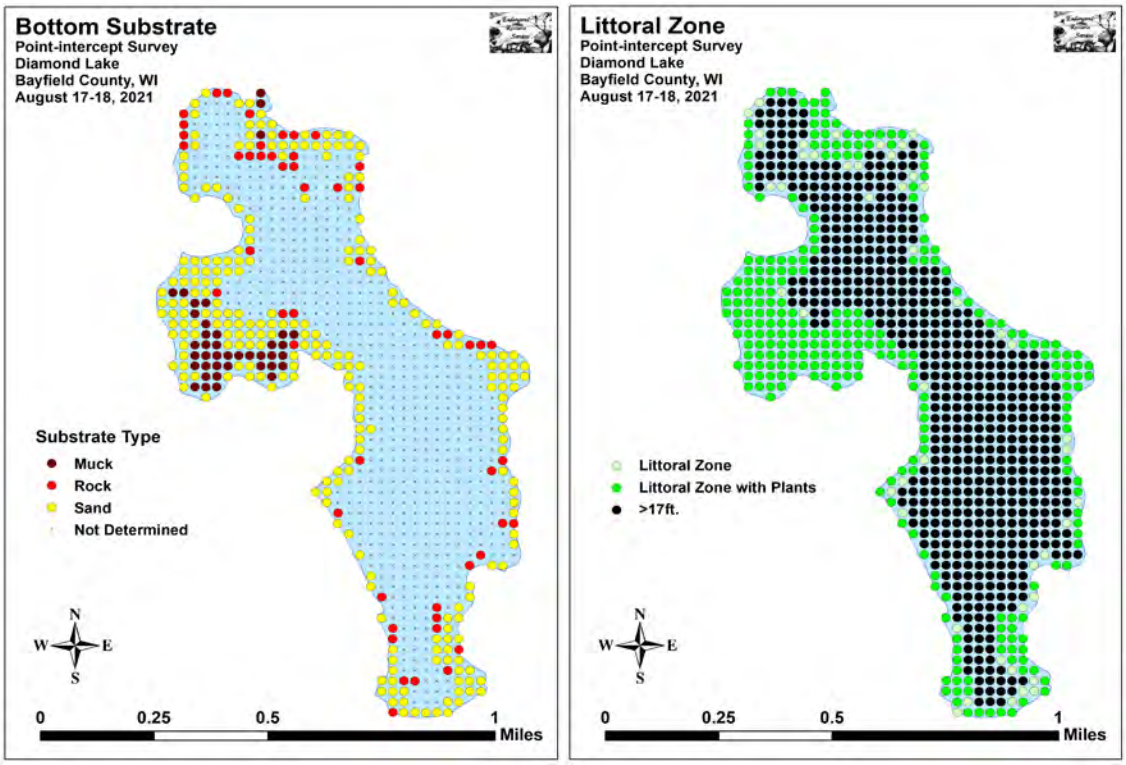


Figure 4: Bottom Substrate and Littoral Zone

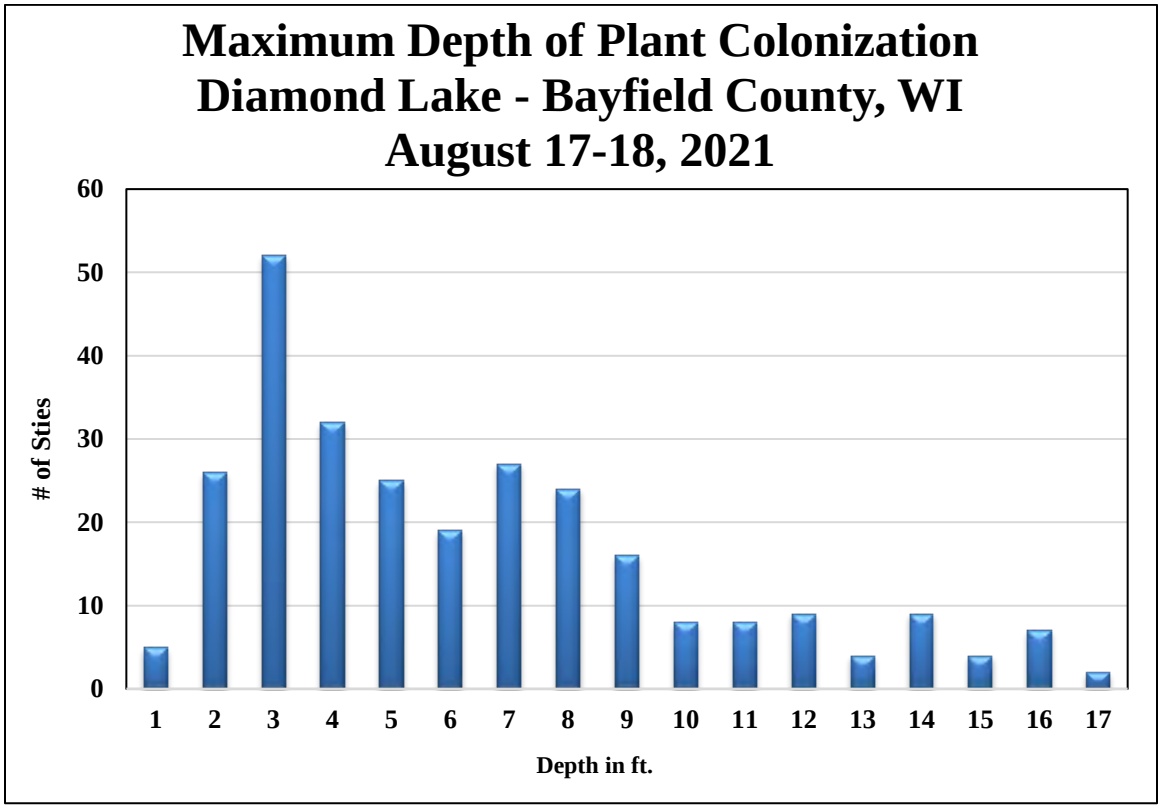


Figure 5: Plant Colonization Depth Chart

Plant diversity was exceptionally high with a Simpson Index value of 0.94. Richness was also moderately high with 43 species found in the rake. This total increased to 60 species (63 when separating Muskgrass/Nitella by species) when including visuals and plants seen during the boat survey. We noted that several of these additional species were uncommon to rare, highly localized along undeveloped shorelines, and known to be sensitive to habitat modification. Because of this, they are potentially vulnerable to lakewide extinction.

Localized richness was moderately high, and we calculated a mean native species at sites with native vegetation of 3.27 species/site. Most high richness areas were found along the immediate shoreline, and few deepwater areas had more than four species present (Figure 6) (Appendix IV).

We documented a moderate mean total rake fullness of 1.97. Visual analysis of the map showed that most of the areas with dense vegetation occurred in the north and northwest bays over nutrient-rich organic muck. In the southern half of the lake, most high-density points were located along the immediate shoreline where carpets of low-growing turf-forming species occasionally covered the bottom (Figure 6) (Appendix IV).

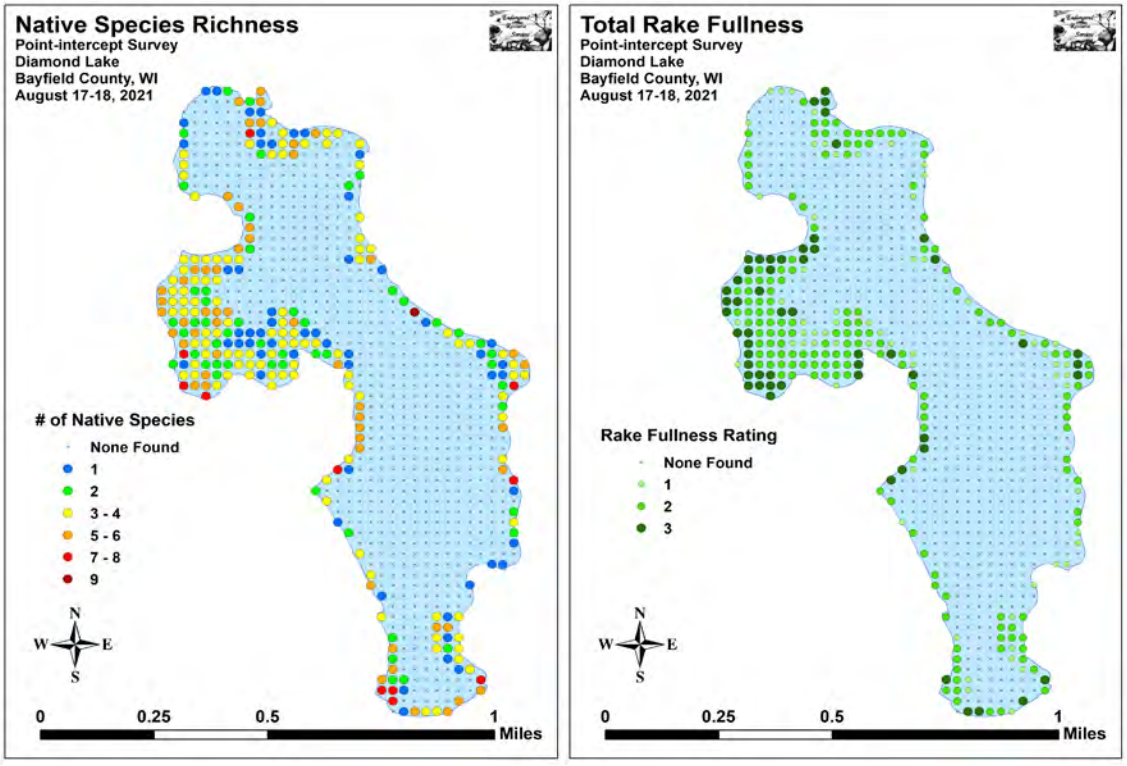


Figure 6: Native Species Richness and Total Rake Fullness

Diamond Lake Plant Community:

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

In shallow areas, beds of emergent plants prevent erosion by stabilizing the shoreline, 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.

In pure sand areas at and just inland from the immediate shoreline, Blue-joint (*Calamagrostis canadensis*) was common around forested edges of the lake. In adjacent bog edges, this species was replaced by a rich community that included False bottle brush sedge (*Carex pseudocyperus*), Crawford's sedge (*Carex crawfordii*), Common rush (*Juncus effusus*), Rice cut-grass (*Leersia oryzoides*), Black bulrush (*Scirpus atrovirens*), and Woolgrass (*Scirpus cyperinus*). In disturbed areas along the seep inlet at the public boat landing, we also found the exotic species Common forget-me-not (*Myosotis scorpioides*) and Reed canary grass (*Phalaris arundinacea*).

Bluejoint (Routledge 2013)

False bottle brush sedge (Husveth 2016) & Crawford's sedge (Chaka 2017)

Common rush (Eggers 2008)

Rice cut-grass (Wallis 2019)

Black bulrush (Dziuk 2014)

Woolgrass (Colby 2012)

Over sandy and rocky flats and shorelines, the emergent community was dominated by Creeping spikerush (*Eleocharis palustris*) and Hardstem bulrush (*Schoenoplectus acutus*) with only scattered beds of Crested arrowhead (*Sagittaria cristata*), American bur-reed (*Sparganium americanum*), and Broad-leaved cattail (*Typha latifolia*).

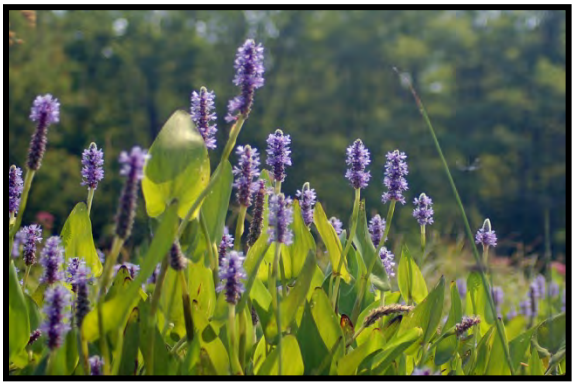
Creeping spikerush (Legler 2016)

Hardstem bulrush (Elliot 2007)

American bur-reed (Hubick 2018)

Broad-leaved cattail (Raymond 2011)

In the lake's shoreline areas where there was a thin layer of muck over firm sand, we found small but often dense beds of Pickerelweed (*Pontederia cordata*). On the south end of the northwest bay where we noted the muck had more organic matter, we also documented a very limited number of Water horsetail (*Equisetum fluviatile*), Water bulrush (*Schoenoplectus subterminalis*), and Short-stemmed bur-reed (*Sparganium emersum*). Immediately adjacent to several of the seep inlets, this habitat supported limited numbers of Wild calla (*Calla palustris*) and Marsh cinquefoil (*Comarum palustre*).



Pickerelweed (Texas A&M 2012)

Water horsetail (Elliot 2007)

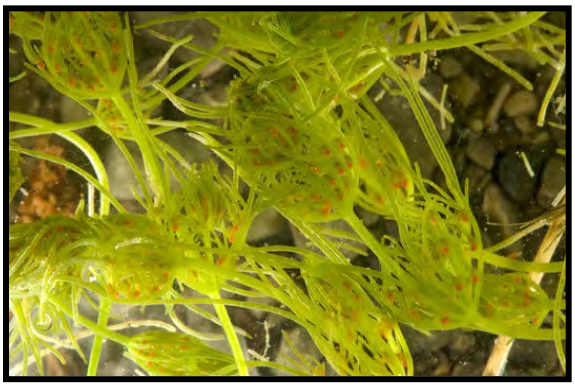
Water bulrush (Dziuk 2016)

Short-stemmed bur-reed (Cameron 2016)

Wild calla (Pierce 2001)

Marsh cinquefoil (Myrhatt 2012)

Firm sand and gravel dominated the majority of the lake's nearshore (<6ft deep) environment. These areas naturally tend to have low total biomass as the nutrient-poor substrate provides habitat most suited to fine-leaved "isoetid" species. Immediately adjacent to the shore in this environment, we found Rough stonewort (*Chara aspera*) - a species of Muskgrass, Needle spikerush (*Eleocharis acicularis*), Spiny-spored quillwort (*Isoetes echinospora*), Brown-fruited rush (*Juncus pelocarpus*), Dwarf stonewort (*Nitella tennuissima*) - a species of Nitella, and Crested arrowhead (*Sagittaria cristata*).



Rough Stonewort – a Muskgrass (Gibbons 2012)

Needle spikerush (Fewless 2005)

Spiny-spored quillwort (Haines 2012)

Brown-fruited rush (Koshere 2002)

Dwarf stonewort – a Nitella (Oyadomari 2010)

Crested arrowhead (Fewless 2004)

Just beyond the immediate shoreline, Lake quillwort (*Isoetes lacustris*), Dwarf water-milfoil (*Myriophyllum tenellum*), Slender naiad (*Najas flexilis*), and Variable pondweed (*Potamogeton gramineus*) added to this low-density community.

Dwarf water-milfoil (Koshere 2002)

Slender naiad (Cameron 2013)

Variable pondweed – with and without floating leaves (Koshere 2002)

Low density "Isoetid" carpet community (Bertrin 2017)

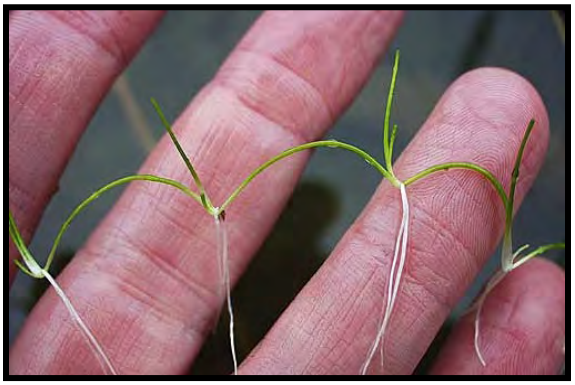
In the most pristine shoreline areas on the lake, these shallow sandy habitats also supported an often limited number of species that are regionally uncommon to rare. These plants, which are extremely sensitive to human disturbance, included Waterwort (*Elatine minima*), Pipewort (*Eriocaulon aquaticum*), Water lobelia (*Lobelia dortmanna*), Alternate-flowered water-milfoil (*Myriophyllum alterniflorum*), Creeping spearwort (*Ranunculus flammula*), and Small purple bladderwort (*Utricularia resupinata*). All of these "turf" species, along with the emergents, stabilize the bottom and prevent wave action erosion.

Waterwort (Fewless 2005)

Pipewort (Fewless 2005)

Water lobelia in bloom (Penskar 2011)

Alternate-flowered water-milfoil (Barrents 2013)



Creeping spearwort with arching “stolons” (Fewless 2005)

Small purple bladderwort (Cameron 2019)

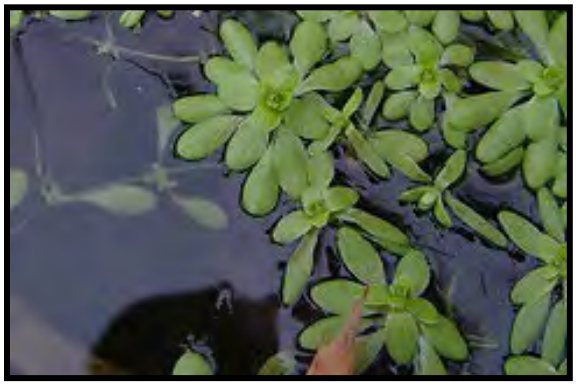
These nearshore nutrient-poor substrates seldom provided habitat for floating-leaf species. In this environment, we found Spiral-fruited pondweed (*Potamogeton spirillus*) and, with its flowing ribbon-like leaves, Narrow-leaved bur-reed (*Sparganium angustifolium*). Other species that occasionally produce floating-leaves like Large-leaf pondweed (*Potamogeton amplifolius*) and Variable pondweed seldom had them unless they were growing near shore over substrate with at least a thin layer of muck.

Spiral-fruited pondweed (Cameron 2019)

Narrow-leaved bur-reed (Schouh 2006)

Especially near the bogs and seep inlets, these species were joined by clusters of Common water star-grass (*Callitriche palustris*), Ribbon-leaf pondweed (*Potamogeton epihydrus*) Floating-leaf pondweed (*Potamogeton natans*), Floating-leaf bur-reed (*Sparganium fluctuans*), and Arum-leaved arrowhead (*Sagittaria cuneata*).

Large-leaf pondweed (Dziuk 2018)



Common water-starwort (Cameron 2014)

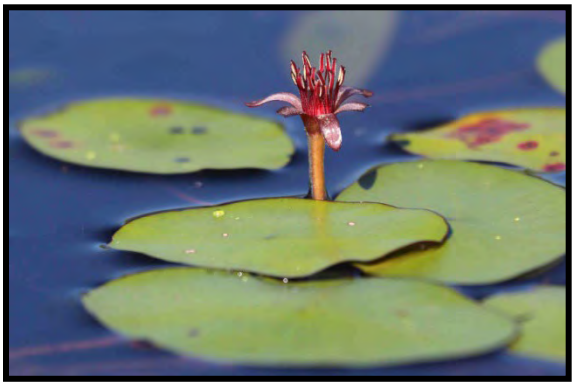
Ribbon-leaf pondweed (Petroglyph 2007)

Floating-leaf pondweed (Petroglyph 2007)

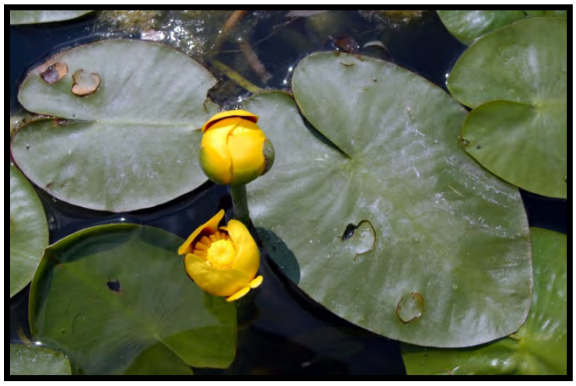
Floating-leaf bur-reed pondweed (Dziuk 2017)

Arum-leaved arrowhead (Cameron 2018)

In the most nutrient-rich organic substrates, Watershield (*Brasenia schreberi*), Spatterdock (*Nuphar variegata*), White water lily (*Nymphaea odorata*), and Water smartweed (*Polygonum amphibium*) were the most common floating-leaf species. The protective canopy cover this entire group provides is often utilized by panfish and bass.



Watershield (WED 2019)



Spatterdock (CBG 2014)

White water lily (Falkner 2009)

Water smartweed (Someya 2009)

Floating between these larger floating-leaf species, we documented a very limited number of Small duckweed (*Lemna minor*) and the aquatic liverwort Slender riccia (*Riccia fluitans*). We also saw scattered Water marigold (*Bidens beckii*), Spiny hornwort (*Ceratophyllum echinatum*), Common waterweed (*Elodea canadensis*), and aquatic moss.

Small duckweed (Kramer 2013)

Slender riccia (Barth 2018)

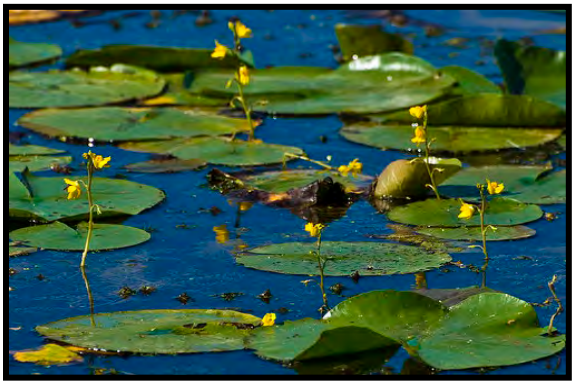
Water marigold (Dziuk 2012)

Spiny hornwort (Chayka 2019)

Common waterweed (Pinkka 2013)

Aquatic moss (Coring 2010)

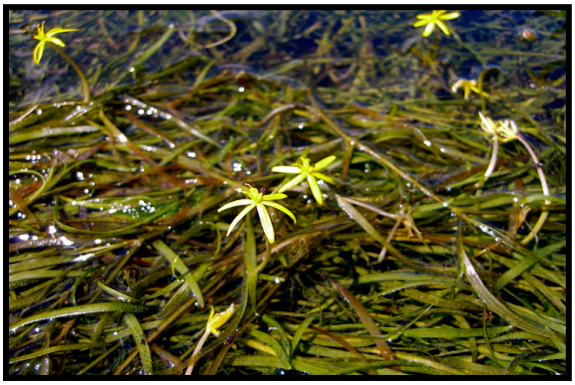
Common bladderwort (*Utricularia vulgaris*) was also found in this environment. Rather than drawing nutrients up through roots like other plants, the carnivorous bladderworts trap zooplankton and minute insects in their bladders, digest their prey, and use the nutrients to further their growth.



Common bladderwort flowers among lilypads (Hunt 2010)

Bladders for catching plankton and insect larvae (Wontolla 2007)

Sandy areas in water from 6-10ft deep supported low to moderate density stands with generally narrow-leaved species like Water star-grass (*Heteranthera dubia*), Northern water-milfoil (*Myriophyllum sibiricum*), Slender naiad, Variable pondweed, Clasping-leaf pondweed (*Potamogeton richardsonii*), and Wild celery (*Vallisneria americana*). The roots, shoots, and seeds of all these submergent species are heavily utilized by both resident and migratory waterfowl for food. They also provide important habitat for the lake's fish throughout their lifecycles; as well as support a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.



Water star-grass (Muller 2010)

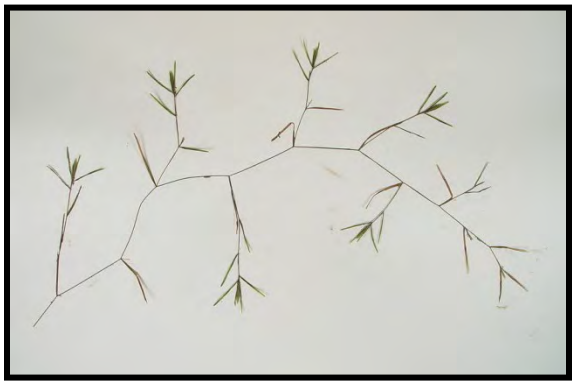
Northern water-milfoil (Berg 2007)

Clasping-leaf pondweed (Cameron 2014)

Wild celery (Dalvi 2009)

In areas with more nutrient-rich muck, this zone was dominated by generally broader-leaved pondweed species (*Potamogeton* spp.) such as Large-leaf pondweed, White-stem pondweed (*Potamogeton praelongus*), Small pondweed (*Potamogeton pusillus*), Fern pondweed (*Potamogeton robbinsii*), and Flat-stem pondweed (*Potamogeton zosteriformis*). Predatory fish like the lake's Northern pike (*Esox lucius*) are often found along the edges of these beds waiting in ambush.

White-stem pondweed (Fewless 2005)



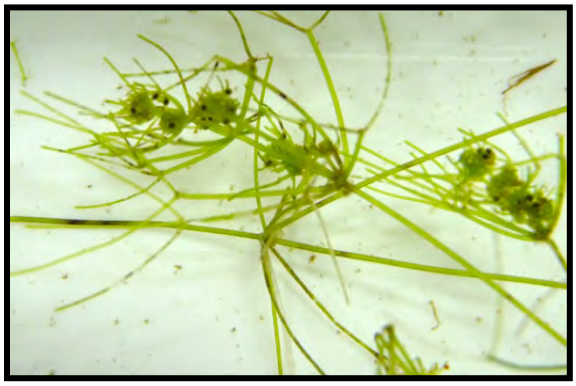
Small pondweed (Cameron 2013)

Fern pondweed (Apipp 2011)

Flat-stem pondweed (Dziuk 2019)

Plant distribution became increasingly patchy at depths over 10ft, and both richness and diversity fell rapidly as depths approached the 17.0ft littoral limit. These deep-water areas were dominated by the colonial macroalgae Muskgrass and Nitella. Although they aren't higher plants, dense mats of these Charophytes provide important deepwater habitat.

Muskgrass (Fischer 2014)



Nitella (USGS 2013)

Plant Community Dominance:

When considering the lake as a whole, Wild celery, Nitella, Variable pondweed, and Water star-grass were the most widely-distributed macrophyte species. Present at 47.29%, 26.71%, 26.71%, and 20.22% of survey points with vegetation respectively, they collectively accounted for 37.02% of the total relative frequency (Table 2) (Figure 7). Muskgrass (5.08%), Creeping spearwort (4.75%), Dwarf water-milfoil (4.64%), Fern pondweed (4.64%), and Slender naiad (4.09%) were the only other species with relative frequencies over 4.00% (Maps and species accounts for all plants are located in Appendixes V and VI).

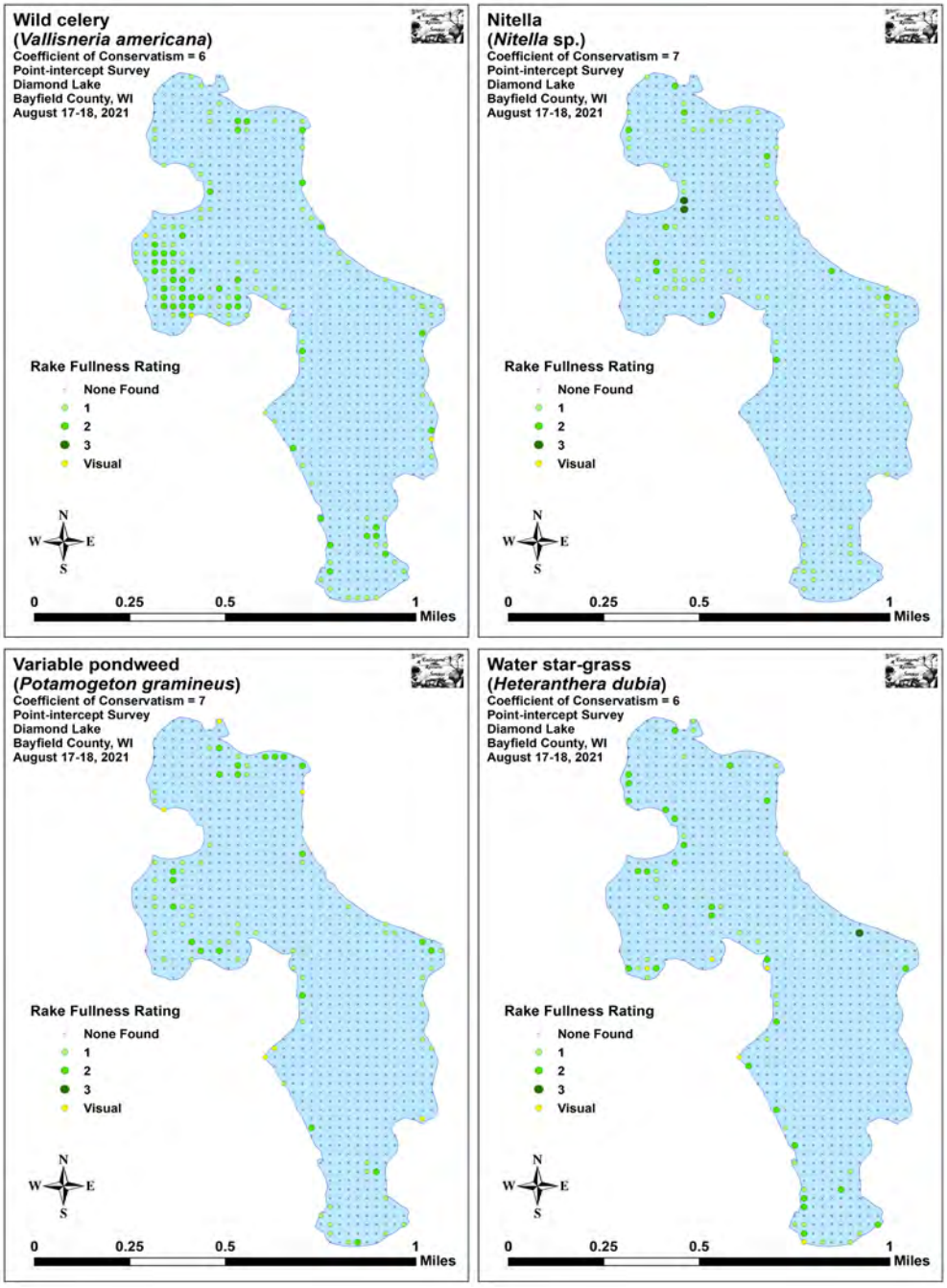


Figure 7: Diamond Lake's Most Common Species

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Vallisneria americana	Wild celery	131	14.48	47.29	40.31	1.35	3
Nitella sp.	Nitella	74	8.18	26.71	22.77	1.20	0
Potamogeton gramineus	Variable pondweed	74	8.18	26.71	22.77	1.28	6
Heteranthera dubia	Water star-grass	56	6.19	20.22	17.23	1.54	5
Chara sp.	Muskgrass	46	5.08	16.61	14.15	1.24	0
Ranunculus flammula	Creeping spearwort	43	4.75	15.52	13.23	2.00	1
Myriophyllum tenellum	Dwarf water-milfoil	42	4.64	15.16	12.92	1.69	1
Potamogeton robbinsii	Fern pondweed	42	4.64	15.16	12.92	1.62	0
	Filamentous algae	40	*	14.44	12.31	1.15	0
Najas flexilis	Slender naiad	37	4.09	13.36	11.38	1.30	1
Elodea canadensis	Common waterweed	34	3.76	12.27	10.46	1.44	1
Myriophyllum sibiricum	Northern water-milfoil	32	3.54	11.55	9.85	1.38	10
Potamogeton richardsonii	Clasping-leaf pondweed	31	3.43	11.19	9.54	1.13	7
Utricularia resupinata	Small purple bladderwort	30	3.31	10.83	9.23	2.00	0
Potamogeton amplifolius	Large-leaf pondweed	26	2.87	9.39	8.00	1.50	6
Myriophyllum alterniflorum	Alternate-flowered water-milfoil	24	2.65	8.66	7.38	1.58	2
Eleocharis acicularis	Needle spikerush	20	2.21	7.22	6.15	1.25	1
Juncus pelocarpus f. submersus	Brown-fruited rush	20	2.21	7.22	6.15	1.55	0
Potamogeton pusillus	Small pondweed	20	2.21	7.22	6.15	1.30	0
Brasenia schreberi	Watershield	17	1.88	6.14	5.23	1.41	5
Lobelia dortmanna	Water lobelia	17	1.88	6.14	5.23	1.29	5
Potamogeton spirillus	Spiral-fruited pondweed	14	1.55	5.05	4.31	1.21	2
Nymphaea odorata	White water lily	12	1.33	4.33	3.69	1.92	1

*Excluded from relative frequency analysis

Table 2 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Isoetes lacustris	Lake quillwort	9	0.99	3.25	2.77	1.11	0
Bidens beckii	Water marigold	8	0.88	2.89	2.46	1.00	0
Nuphar variegata	Spatterdock	6	0.66	2.17	1.85	1.33	1
Eriocaulon aquaticum	Pipewort	5	0.55	1.81	1.54	1.20	1
Ceratophyllum echinatum	Spiny hornwort	4	0.44	1.44	1.23	1.25	0
Eleocharis palustris	Creeping spikerush	4	0.44	1.44	1.23	1.50	1
Elatine minima	Waterwort	3	0.33	1.08	0.92	1.33	0
Pontederia cordata	Pickerelweed	3	0.33	1.08	0.92	2.33	0
Potamogeton epihydrus	Ribbon-leaf pondweed	3	0.33	1.08	0.92	1.00	0
Sparganium fluctuans	Floating-leaf bur-reed	3	0.33	1.08	0.92	2.33	1
Utricularia vulgaris	Common bladderwort	3	0.33	1.08	0.92	1.00	0
Potamogeton praelongus	White-stem pondweed	2	0.22	0.72	0.62	1.50	0
Potamogeton zosteriformis	Flat-stem pondweed	2	0.22	0.72	0.62	1.00	1
Riccia fluitans	Slender riccia	2	*	0.72	0.62	1.00	0
Polygonum amphibium	Water smartweed	1	0.11	0.36	0.31	1.00	0
Potamogeton natans	Floating-leaf pondweed	1	0.11	0.36	0.31	1.00	3
Sagittaria cristata	Crested arrowhead	1	0.11	0.36	0.31	1.00	0
Sagittaria cuneata	Arum-leaved arrowhead	1	0.11	0.36	0.31	1.00	0
Schoenoplectus acutus	Hardstem bulrush	1	0.11	0.36	0.31	2.00	2
Sparganium americanum	American bur-reed	1	0.11	0.36	0.31	1.00	2
Sparganium angustifolium	Narrow-leaved bur-reed	1	0.11	0.36	0.31	2.00	0
Sparganium emersum	Short-stemmed bur-reed	1	0.11	0.36	0.31	1.00	1

*Excluded from relative frequency analysis

Table 2 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
	Aquatic moss	***	***	***	***	***	***
Calamagrostis canadensis	Blue-joint	***	***	***	***	***	***
Calla palustris	Wild calla	***	***	***	***	***	***
Callitriche palustris	Common water star-wort	***	***	***	***	***	***
Carex pseudocyperus	False bottle brush sedge	***	***	***	***	***	***
Carex crawfordii	Crawford's sedge	***	***	***	***	***	***
Comarum palustre	March cinquefoil	***	***	***	***	***	***
Equisetum fluviatile	Water horsetail	***	***	***	***	***	***
Isoetes echinospora	Spiny-spored quillwort	***	***	***	***	***	***
Juncus effusus	Common rush	***	***	***	***	***	***
Leersia oryzoides	Rice cut-grass	***	***	***	***	***	***
Lemna minor	Small duckweed	***	***	***	***	***	***
Myosotis scorpioides	**Common forget-me-not**	***	***	***	***	***	***
Phalaris arundinacea	**Reed canary grass**	***	***	***	***	***	***
Schoenoplectus subterminalis	Water bulrush	***	***	***	***	***	***
Scirpus atrovirens	Black bulrush	***	***	***	***	***	***
Typha latifolia	Broad-leaved cattail	***	***	***	***	***	***
Iris pseudacorus	**Yellow iris**	****	****	****	****	****	****

Visual only * Boat survey only **** Reported by lake association **Exotic Species in Bold**

Floristic Quality Index:

We identified a total of 44 **native index plants** in the rake during the survey. They produced a mean Coefficient of Conservatism of 7.3 and a Floristic Quality Index of 48.7 (Table 3). Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Diamond Lake above average for this part of the state. The FQI was also well above the region's median FQI of 31.8 (Nichols 1999). Eleven highly sensitive index plants of note included Spiny hornwort (C = 10), Waterwort (C = 9), (Pipewort (C = 9), Water lobelia (C = 10), Alternate-flower water-milfoil (C = 10), Dwarf water-milfoil (C = 10), Creeping spearwort (C = 9), Crested arrowhead (C = 9), Narrow-leaved bur-reed (C = 9), Floating-leaf bur-reed (C = 10), and Small purple bladderwort (C = 9).

Table 3: Floristic Quality Index of Aquatic Macrophytes
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Ceratophyllum echinatum	**Spiny hornwort**	**10**
Chara sp.	Muskgrass	7
Elatine minima	**Waterwort**	**9**
Eleocharis acicularis	Needle spikerush	5
Eleocharis palustris	Creeping spikerush	6
Elodea canadensis	Common waterweed	3
Eriocaulon aquaticum	**Pipewort**	**9**
Heteranthera dubia	Water star-grass	6
Isoetes lacustris	Lake quillwort	8
Juncus pelocarpus	Brown-fruited rush	8
Lobelia dortmanna	**Water lobelia**	**10**
Myriophyllum alterniflorum	**Alternate-flowered water-milfoil**	**10**
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum tenellum	**Dwarf water-milfoil**	**10**
Najas flexilis	Slender naiad	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Polygonum amphibium	Water smartweed	5
Pontederia cordata	Pickerelweed	8
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton spirillus	Spiral-fruited pondweed	8
Potamogeton zosteriformis	Flat-stem pondweed	6

Table 3 (continued): Floristic Quality Index of Aquatic Macrophytes
Diamond Lake – Bayfield County, Wisconsin
August 17-18, 2021

Species	Common Name	C
Ranunculus flammula	**Creeping spearwort**	**9**
Riccia fluitans	Slender riccia	7
Sagittaria cristata	**Crested arrowhead**	**9**
Sagittaria cuneata	Arum-leaved arrowhead	7
Schoenoplectus acutus	Hardstem bulrush	6
Sparganium americanum	American bur-reed	8
Sparganium angustifolium	**Narrow-leaved bur-reed**	**9**
Sparganium emersum	Short-stemmed bur-reed	8
Sparganium fluctuans	**Floating-leaf bur-reed**	**10**
Utricularia resupinata	**Small purple bladderwort**	**9**
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Ranunculus flammula	**Creeping spearwort**	**9**
Riccia fluitans	Slender riccia	7
Sagittaria cristata	**Crested arrowhead**	**9**
Sagittaria cuneata	Arum-leaved arrowhead	7
Schoenoplectus acutus	Hardstem bulrush	6
Sparganium americanum	American bur-reed	8
Sparganium angustifolium	**Narrow-leaved bur-reed**	**9**
Sparganium emersum	Short-stemmed bur-reed	8
Sparganium fluctuans	**Floating-leaf bur-reed**	**10**
Utricularia resupinata	**Small purple bladderwort**	**9**
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
N		**44**
Mean C		**7.3**
FQI		**48.7**

Filamentous Algae:

Filamentous algae are normally associated with excessive nutrients in the water column from such things as runoff, internal nutrient recycling, and failed septic systems. We found these algae at 40 points with a mean rake fullness of 1.15. Although present throughout the lake, most moderate density areas were scattered around the south bay and the east-central bay (Figure 8).

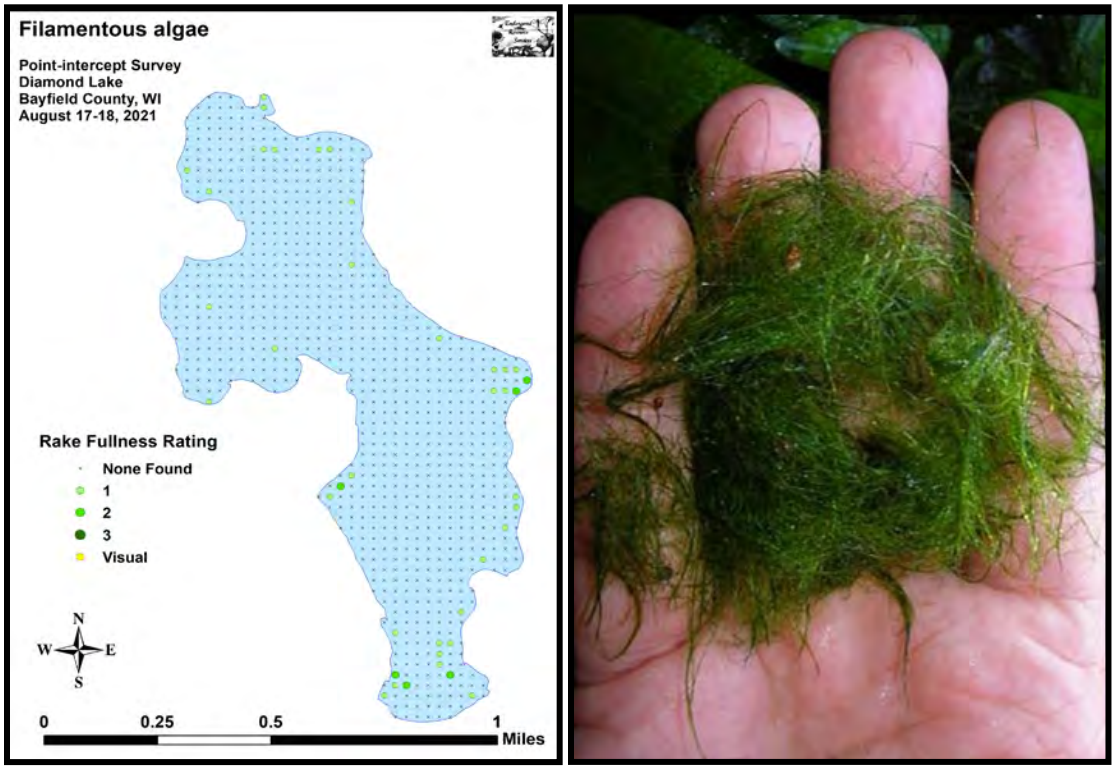


Figure 8: Filamentous Algae Density and Distribution

Exotic Plant Species:

We did NOT find any evidence of Eurasian water-milfoil, Curly-leaf pondweed, or any other fully aquatic exotic plant in Diamond Lake. The only non-native species seen anywhere were Common forget-me-not and Reed canary grass (Figure 9). Each was growing in a small patch immediately adjacent to the seep entrance at the public boat landing on the lake's south side.

Yellow iris (*Iris pseudacorus*), a potentially aggressive invader that is spreading in nearby Lake Namekagon and along the Namekagon River, was reported by members of the lake association while doing a spring shoreline survey (Figure 10). A property owner planted these individuals, but all were dug back out and disposed of (R. Jacobel – pers. comm.). For more information on a selection of exotic invasive plant species, see Appendix VII.

Figure 9: Common Forget-me-not and Reed Canary Grass

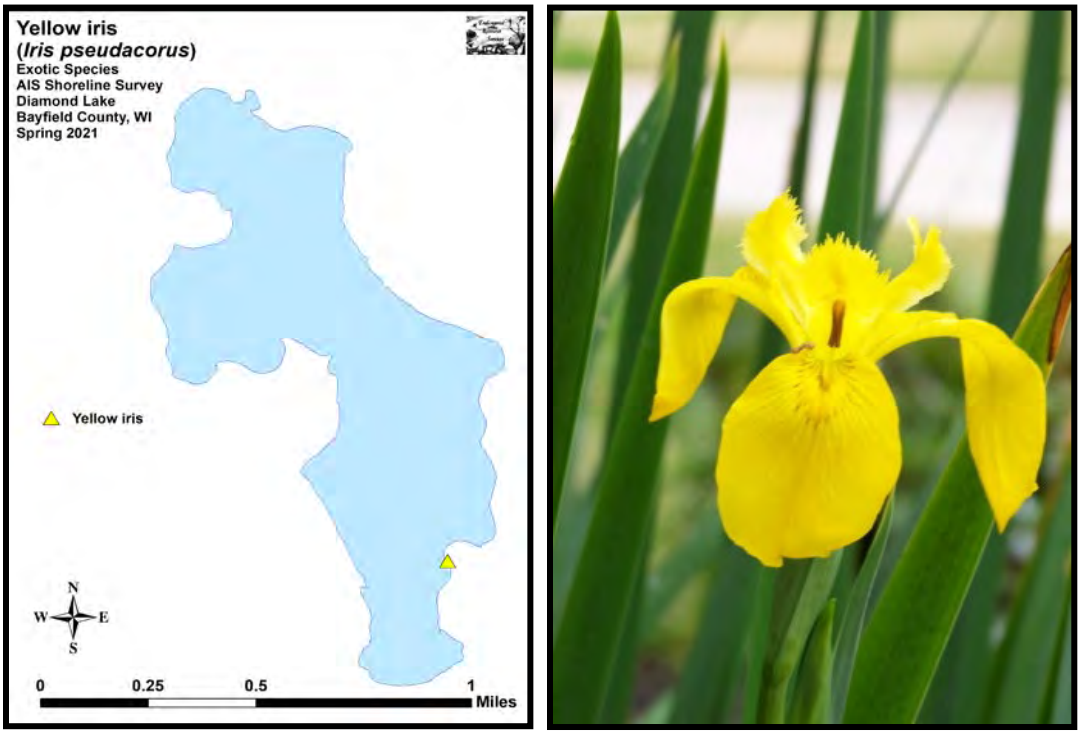


Figure 10: Yellow Iris Location – Spring 2021

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:
Water Clarity, Nutrient Inputs, and the Role of Native Macrophytes:

Diamond Lake has a truly exceptional native plant community that is dominated by high-value species that are both sensitive to human impacts and regionally uncommon. Like trees in a forest, a lake's plants are the basis of the aquatic ecosystem. They capture the sun's energy and turn it into usable food, "clean" the water of excess nutrients, and provide habitat for other organisms like aquatic invertebrates and the lake's fish populations. Because of this, preserving them is critical to maintaining the lake's overall health.

When phosphorus and nitrogen in a lake's water column increase to levels beyond what macrophytes can absorb, filamentous and floating algae tend to proliferate leading to declines in both water clarity and quality. Over the past 20 years, water quality data collected by Diamond Lake volunteers shows a history of consistently good clarity. This is probably not a coincidence. Rather, it is likely at least partially tied to the work done by conservation-minded people. Their native vegetation buffers along the majority of the lake's shorelines help cut down on soil erosion and nutrient runoff into the lake which would otherwise promote algae growth and decrease clarity. Despite this positive news, the lake's small size and relatively low littoral percentage means there is no room for complacency as even a small increase in nutrient inputs could negatively impact clarity. Because of this, residents should continually evaluate how their shoreline practices may be impacting the lake. Simple things like establishing a buffer strip of native vegetation along the lakeshore if one isn't already present (Figure 11), bagging grass clippings, eliminating fertilizer near the lake, collecting pet waste, disposing of ash from fire pits away from the lakeshore, maintaining septic systems, and avoiding stirring up sediments with motor start-ups in shallow water can all significantly reduce the amount of nutrients entering the lake's water column. Hopefully, a greater understanding of how individual property owners can have lake-wide impacts will result in even more people taking appropriate conservation actions and thus ensure continued water clarity and quality for all.

Figure 11: Model Natural Shoreline on a Nearby Northwest Wisconsin Lake

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water-milfoil, Curly-leaf pondweed, Purple loosestrife (*Lythrum salicaria*), and Yellow iris are an increasing problem in and along the lakes of northern Wisconsin in general, and several nearby lakes in Bayfield County in particular. Working to prevent their introduction into Diamond Lake with proactive measures is strongly encouraged. With this in mind, the Diamond Lakers might consider applying for a Clean Boats/Clean Waters grant to hire landing monitors at the public boat landing; especially during high in/out traffic times like weekends and holidays. These monitors offer a layer of protection against AIS by checking incoming watercraft, and they provide education, reeducation, and reminders of the potential negative impacts of AIS to lake property owners and visitors alike.

A small standard WDNR AIS sign and a motion-activated landing monitor with a recorded message are currently serving as the "guardians of the lake". Adding a secondary sign that is located at the waterline is another potential actionable item for the DL to consider. Hopefully, a simple bright sign will increase the chances that visitors will remember to check their boat carefully before launching (Figure 12).

Figure 12: Potential Secondary Sign to be Placed Near the Water's Edge

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

Management Considerations Summary:

- Preserve the many high-value and sensitive native plants on Diamond Lake and the critical habitat they provide for the whole lake ecosystem.
- Work to maintain water clarity and suppress algal growth by limiting nutrient inputs.
- Specifically, avoid mowing down to the lakeshore and reduce or, if possible, eliminate grass clipping runoff, fertilizer applications, and other sources of nutrients like pet waste and fire pit ashes near the lakeshore.
- Maintain septic systems and avoid motor startups in shallow water.
- Encourage shoreline restoration and the establishment of native vegetation buffer strips along the lakeshore to further prevent runoff and erosion.
- Consider applying for a Clean Boats/Clean Waters program grant to monitor incoming boat traffic; especially during peak visit times.
- Consider adding a second small bright sign at the water line to remind people to clean their boats prior to launching.
- Consider carrying out monthly landing inspections and at least one annual meandering shoreline survey of the lake's entire visible littoral zone to look for new AIS like Yellow iris.
- Complete an Aquatic Plant Management Plan that clarifies a potential response to a new AIS, such as Eurasian water-milfoil, if one becomes established in the lake.

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Appendix I: 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																									
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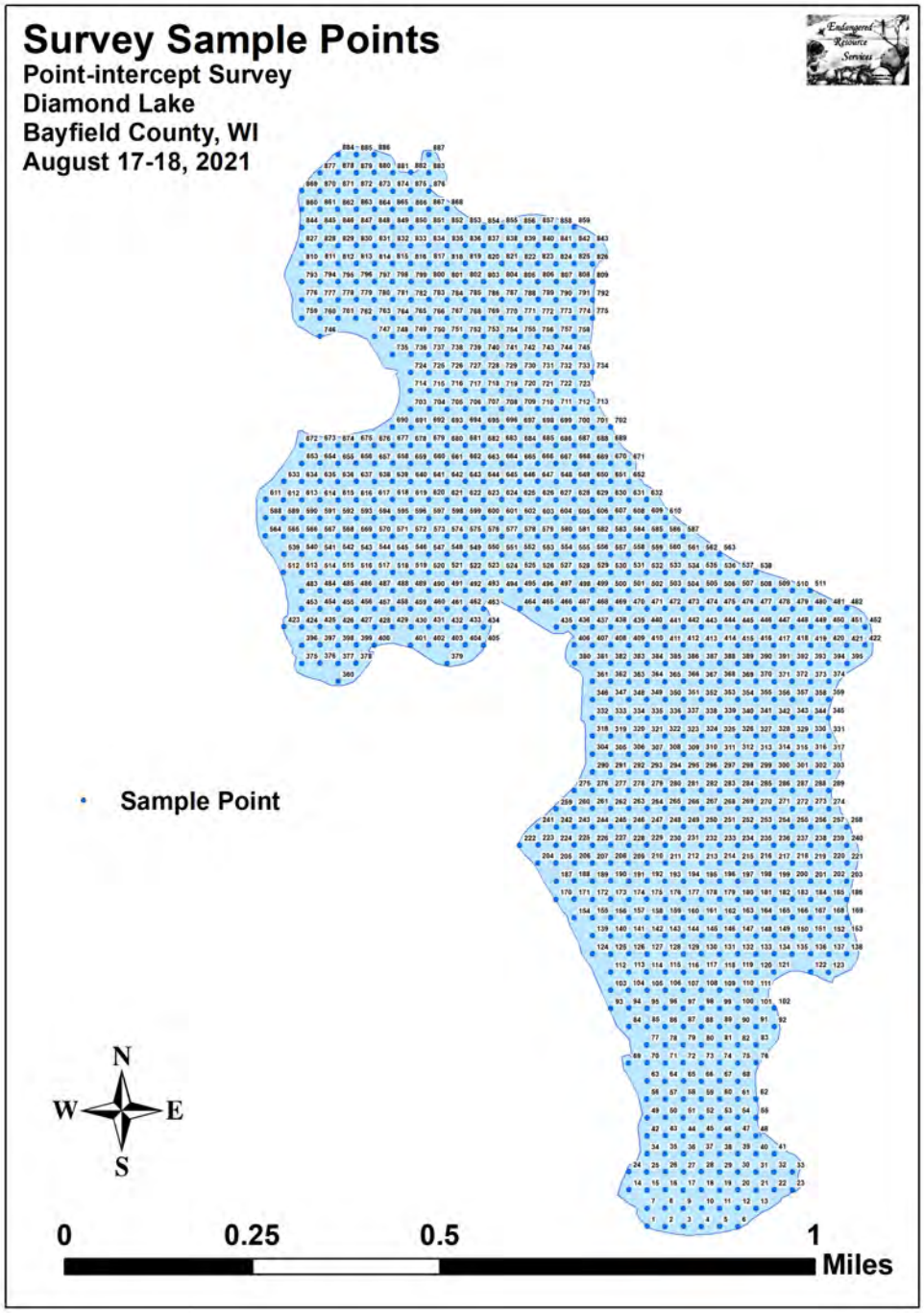
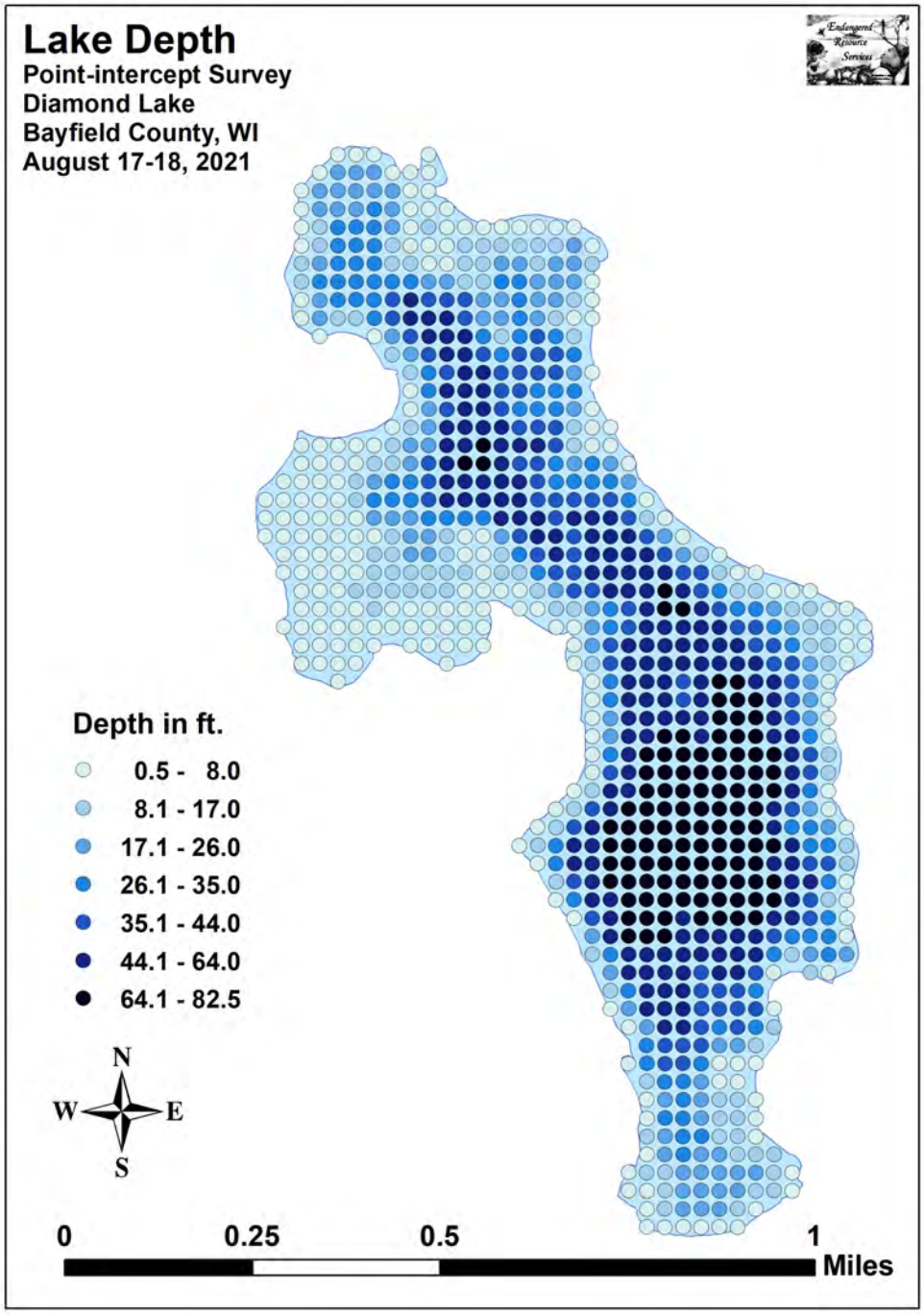
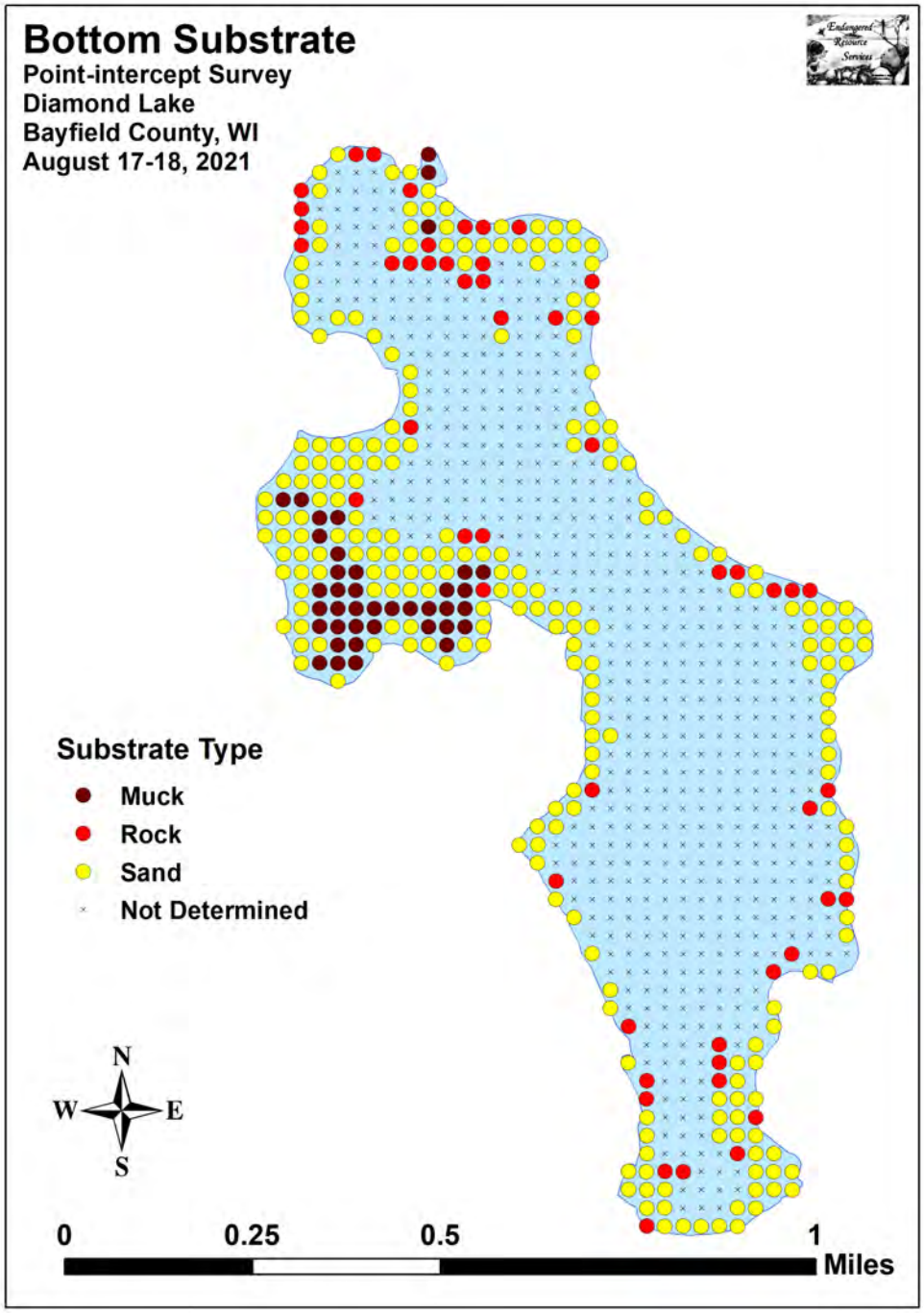
Appendix II: Point-intercept Survey Sample Points Map

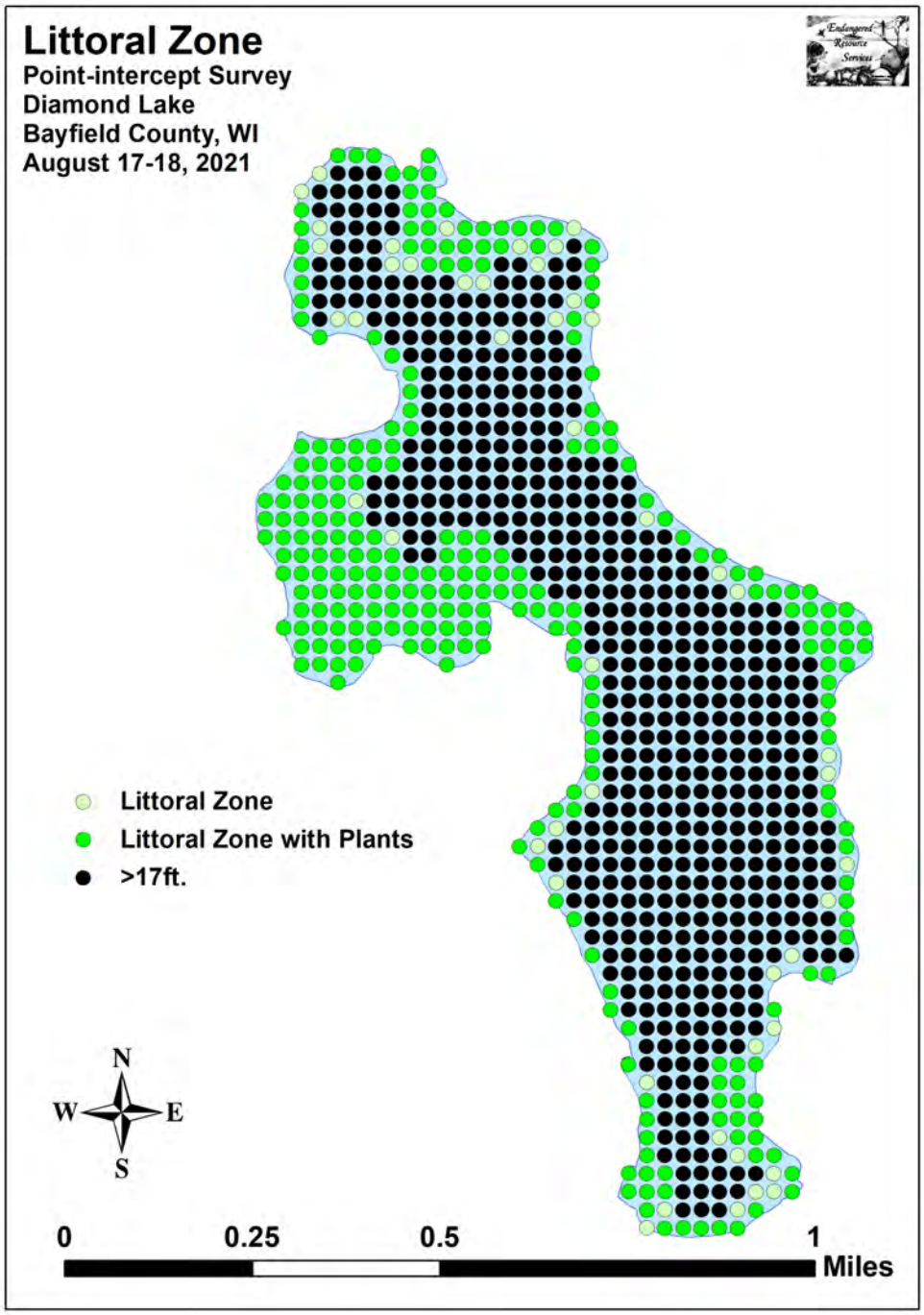

Survey Sample Points
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Sample Point
N
W
E
S
0
0.25
0.5
1
Miles

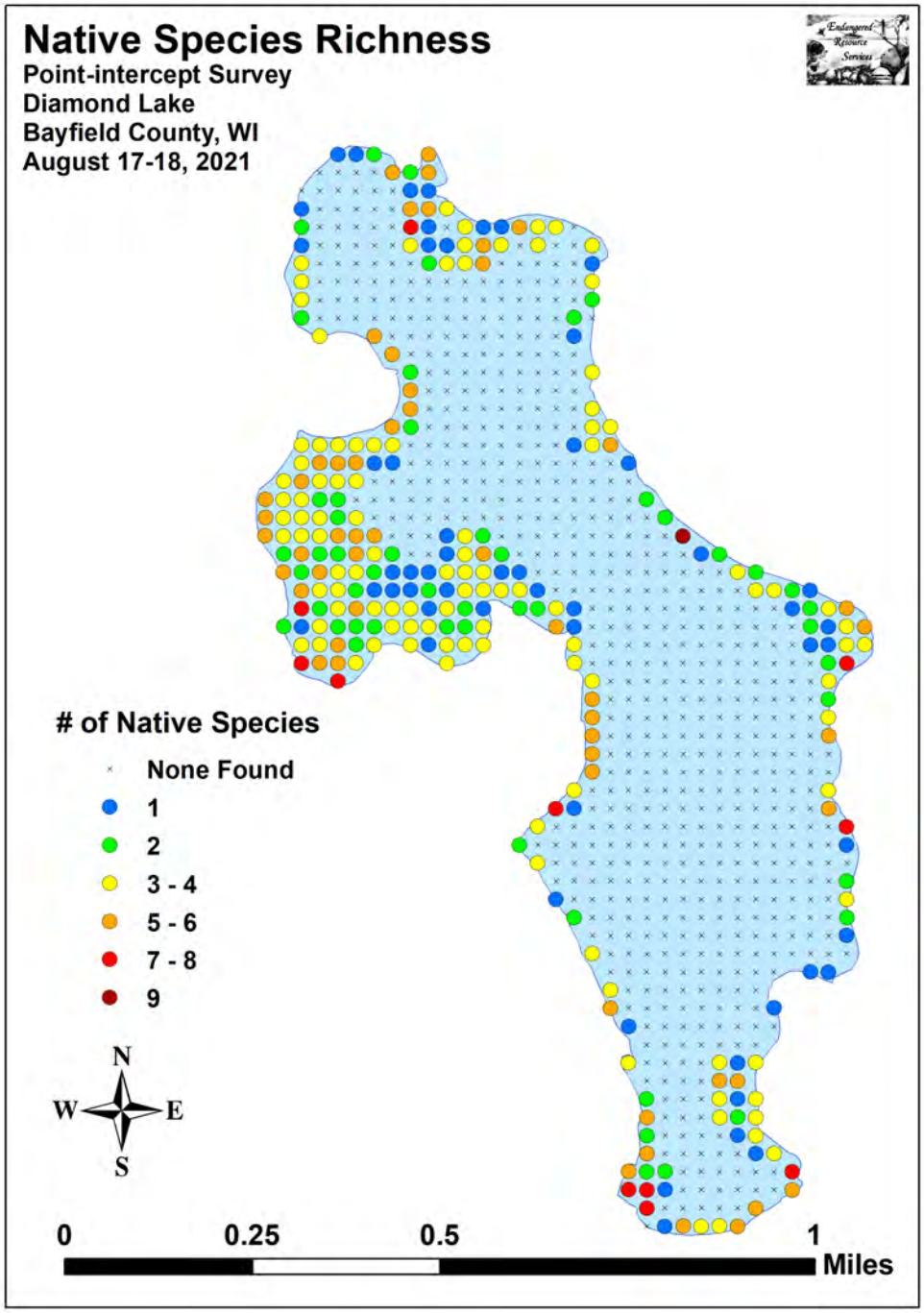
Appendix III: Habitat Variable Maps

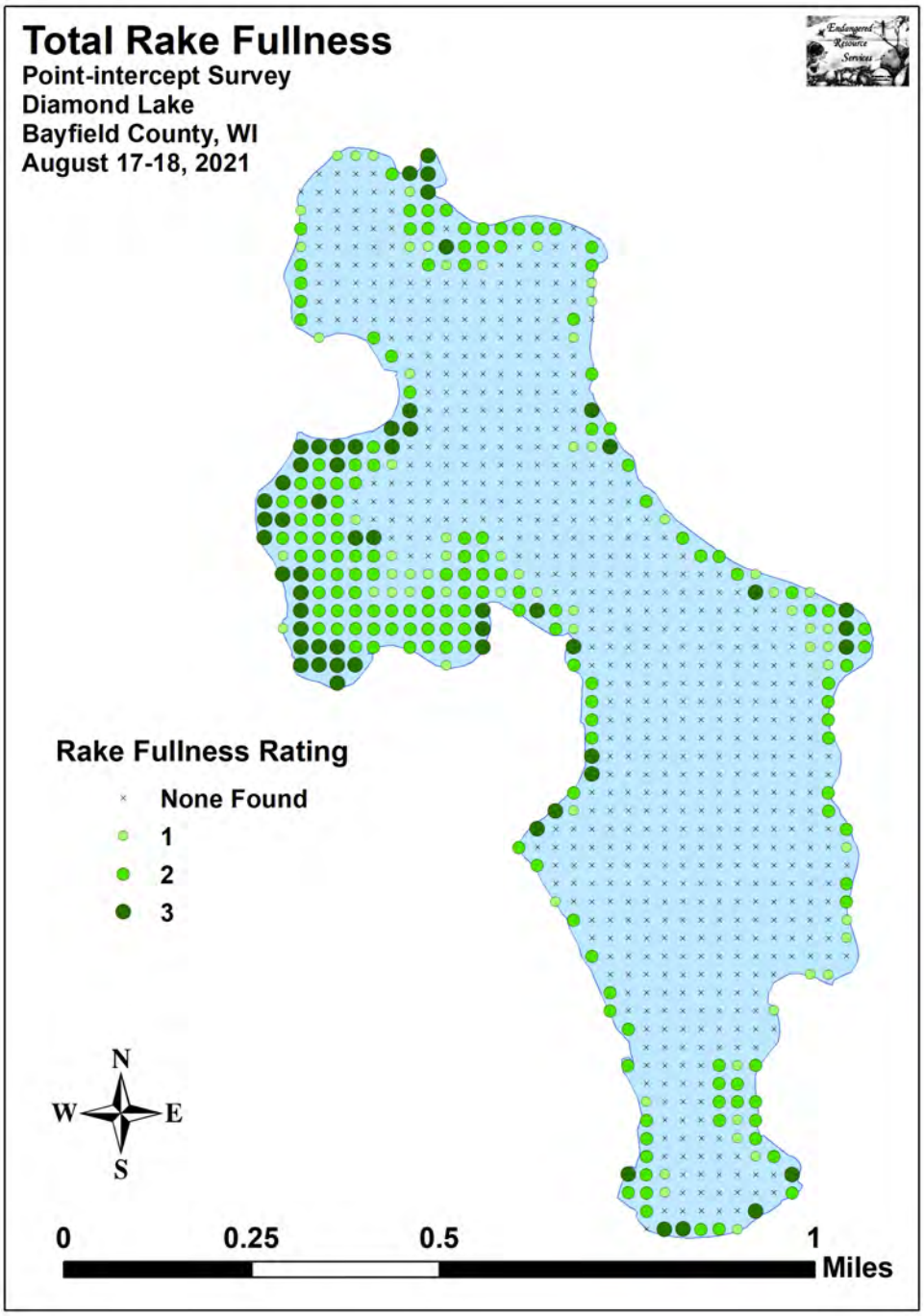

Lake Depth
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Depth in ft.
0.5 - 8.0
8.1 - 17.0
17.1 - 26.0
26.1 - 35.0
35.1 - 44.0
44.1 - 64.0
64.1 - 82.5
N
W
E
S
0
0.25
0.5
1
Miles


Bottom Substrate
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Substrate Type
Muck
Rock
Sand
Not Determined
N
W
E
S
0
0.25
0.5
1
Miles

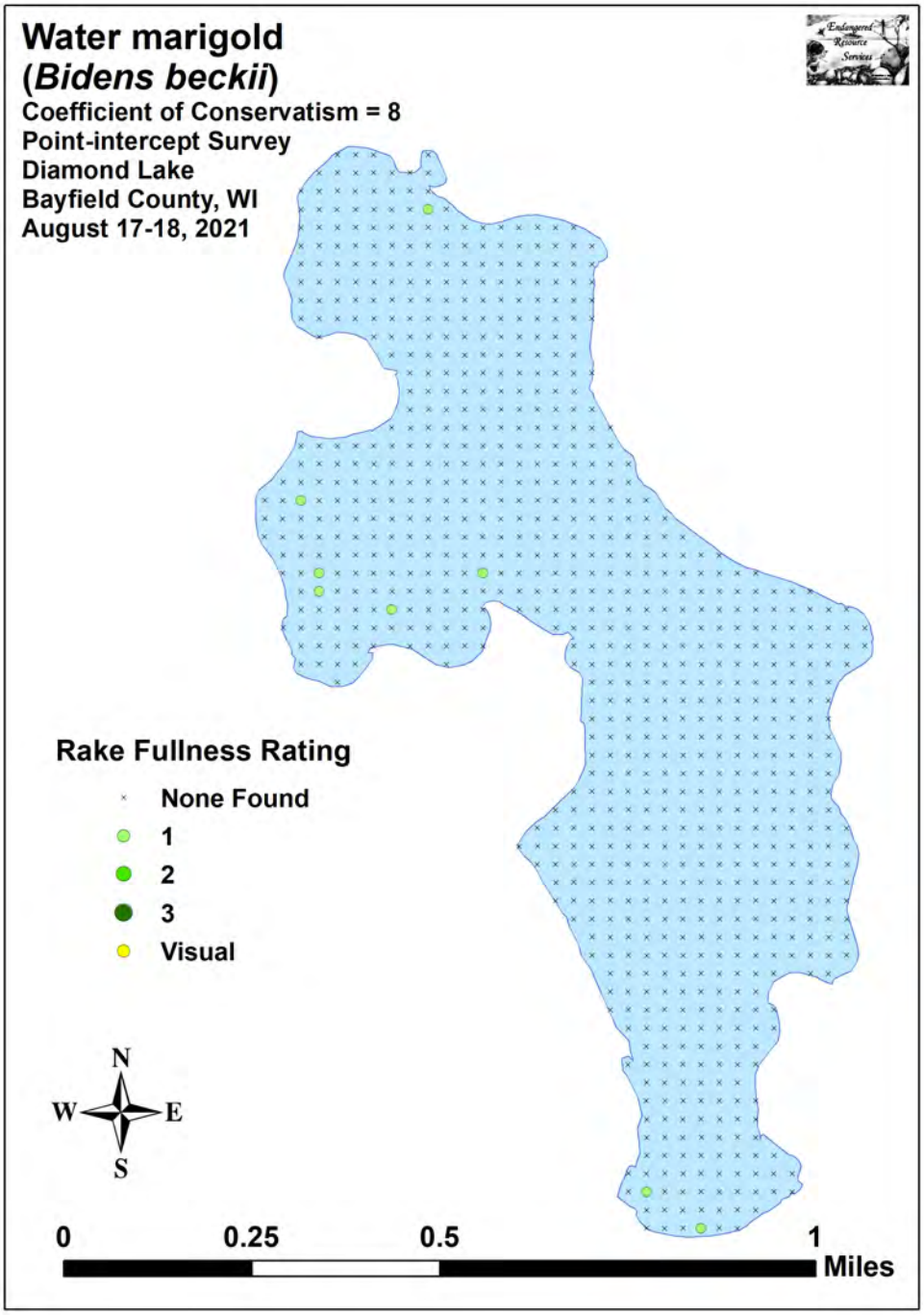
Appendix IV: Littoral Zone, Native Species Richness, and Total Rake Fullness Maps

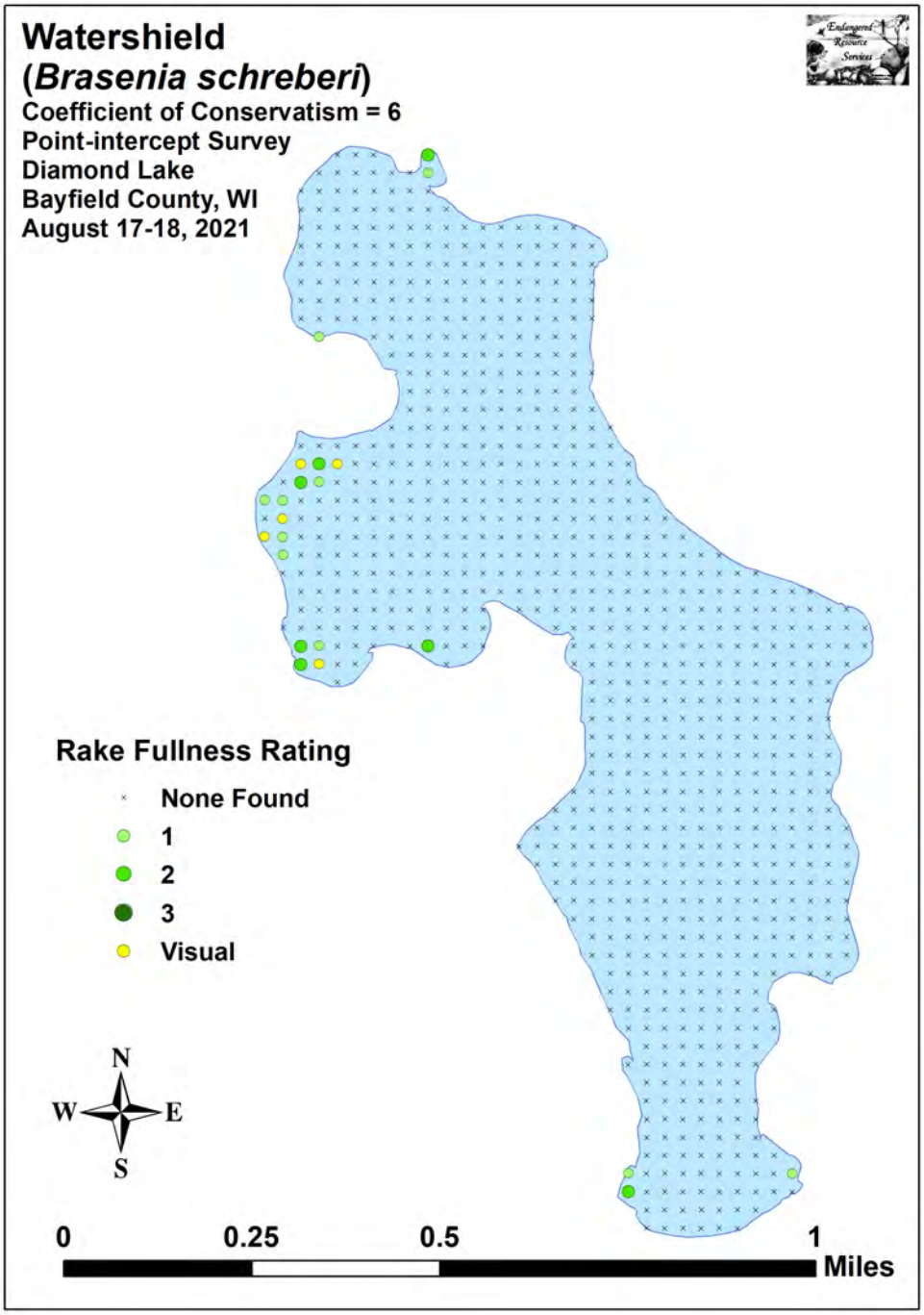

Littoral Zone
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Littoral Zone
Littoral Zone with Plants
>17ft.
N
W
E
S
0
0.25
0.5
1
Miles

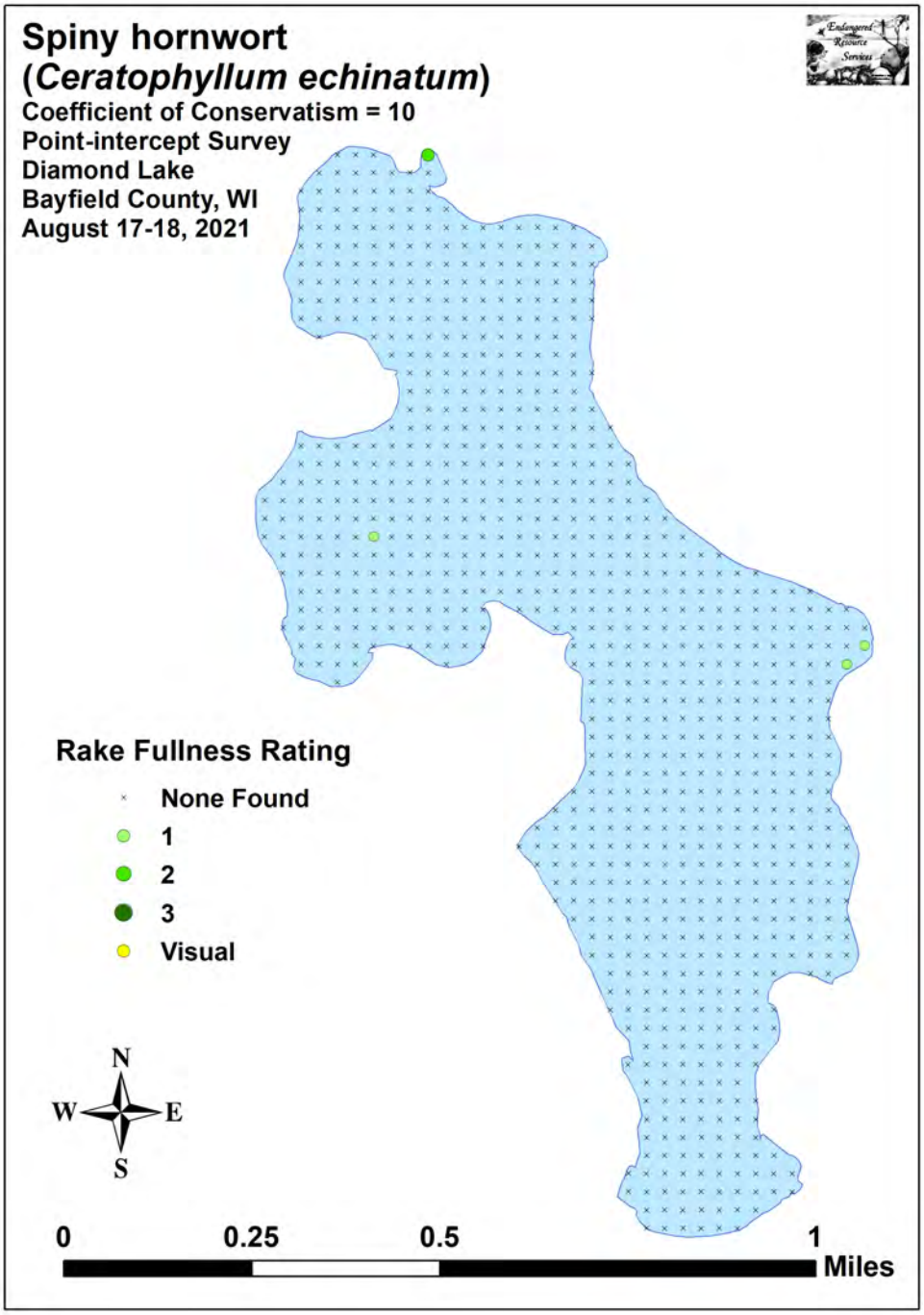

Native Species Richness
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
# of Native Species
None Found
1
2
3 - 4
5 - 6
7 - 8
9
N
W
E
S
0
0.25
0.5
1
Miles

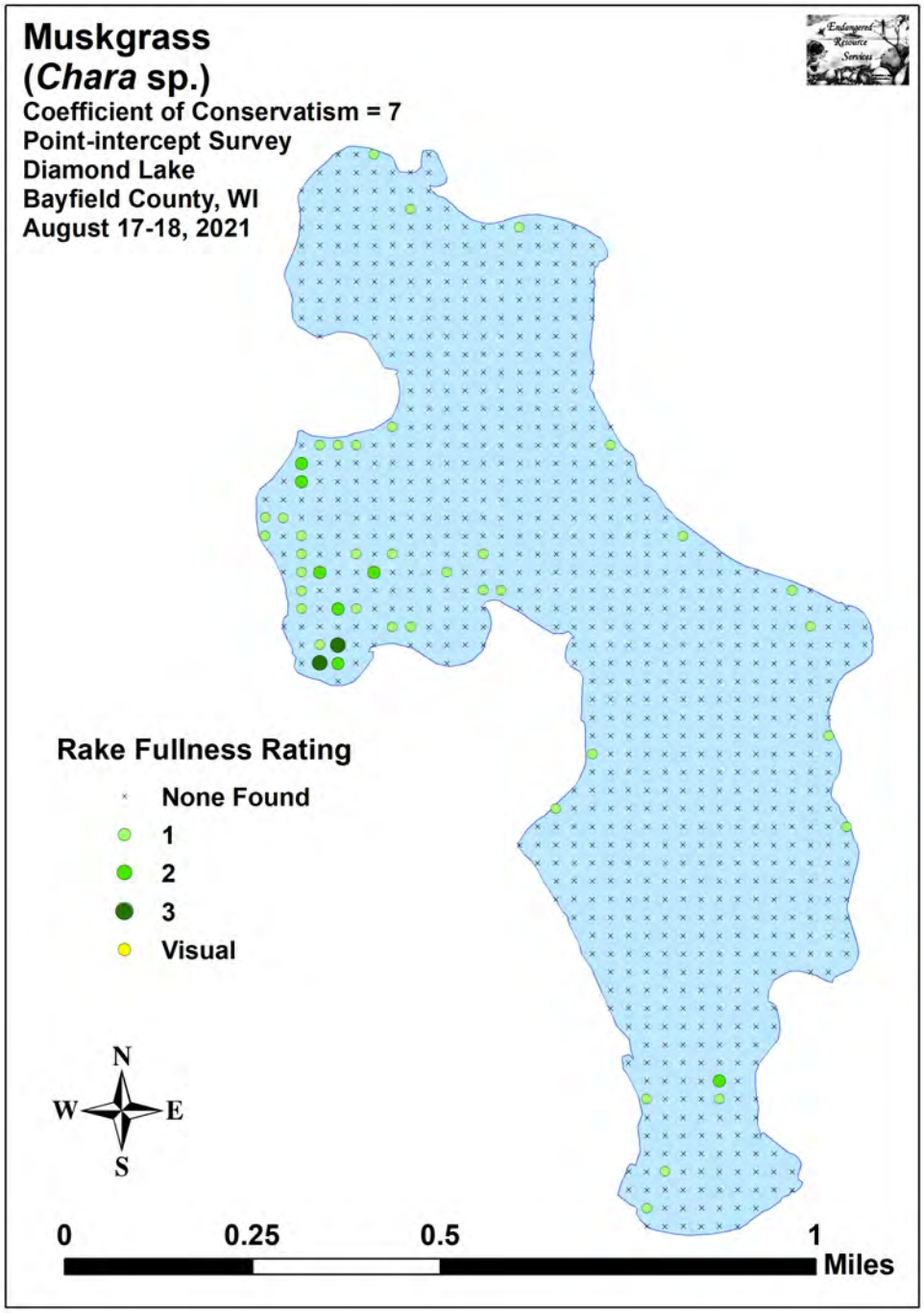

Total Rake Fullness
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
N
W
E
S
0
0.25
0.5
1
Miles

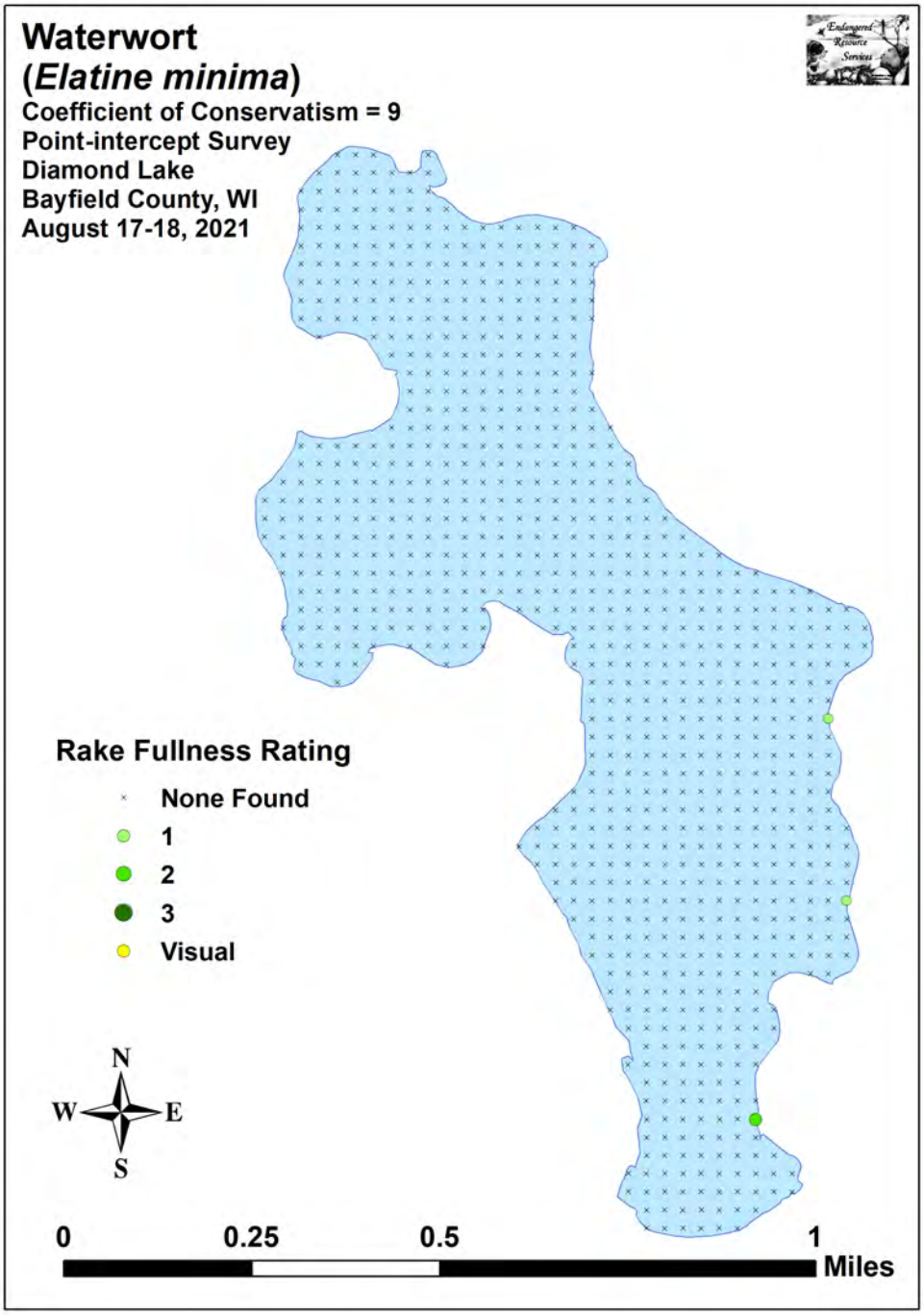
Appendix V: August 2021 Species Density and Distribution Maps

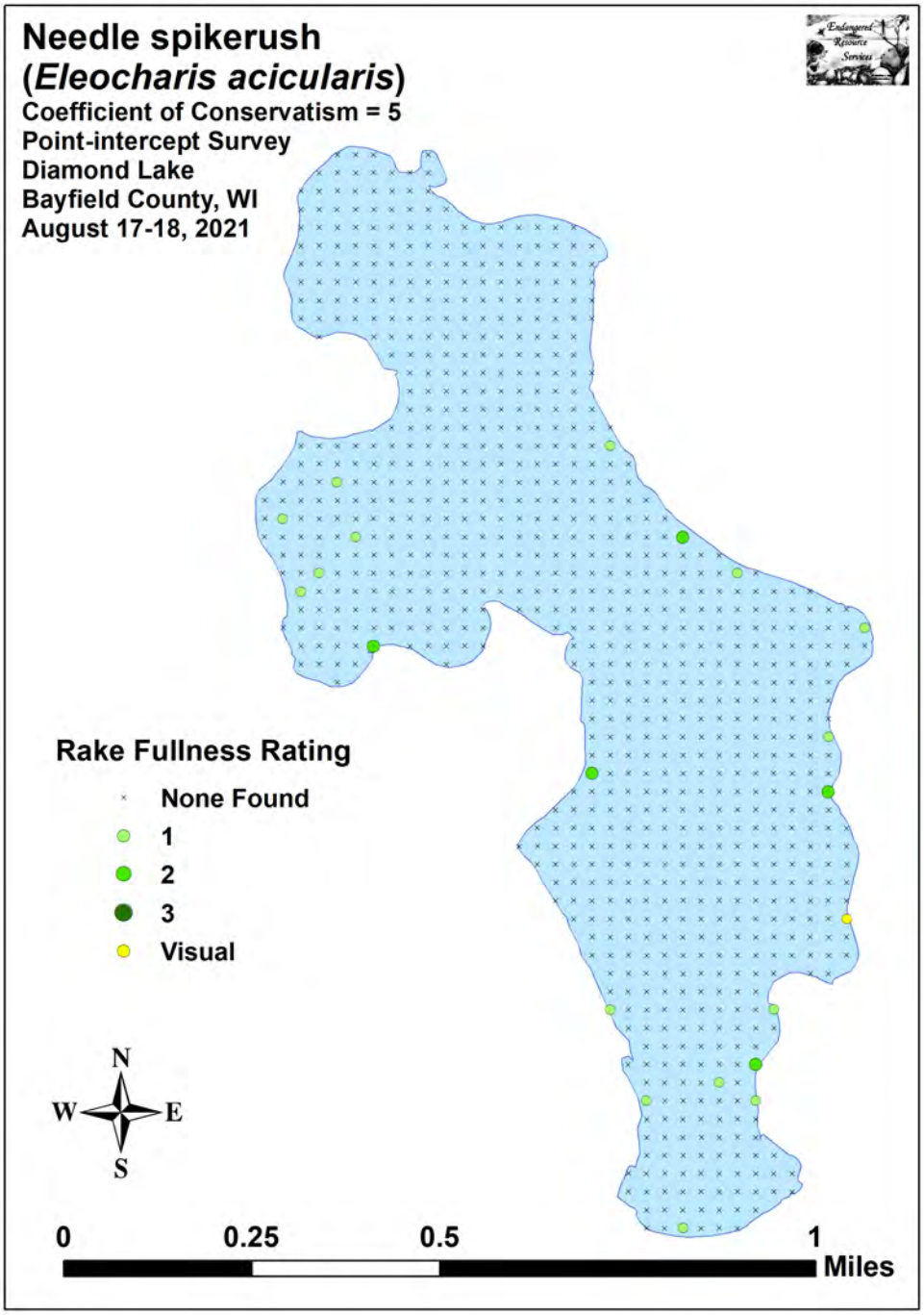

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

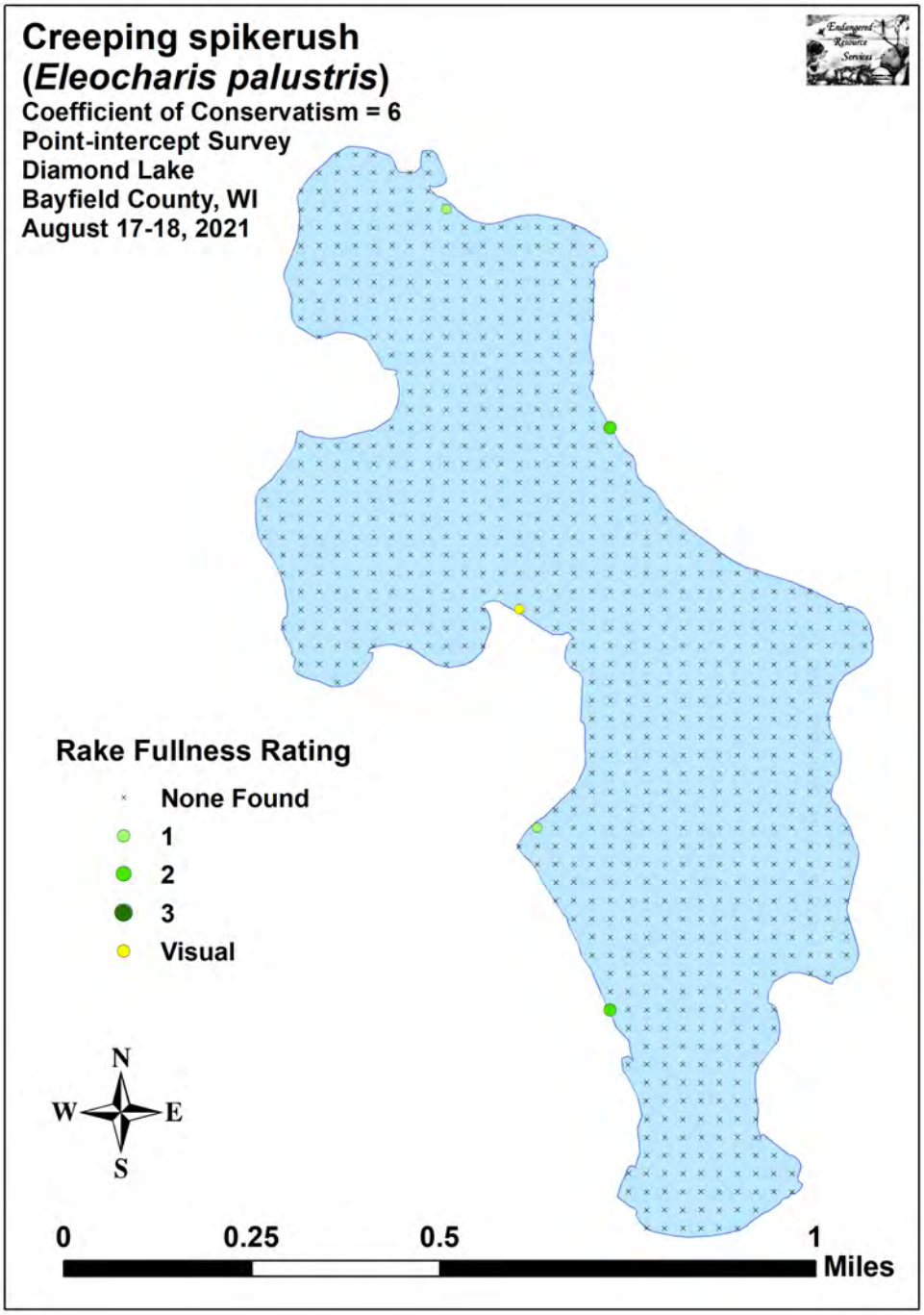

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

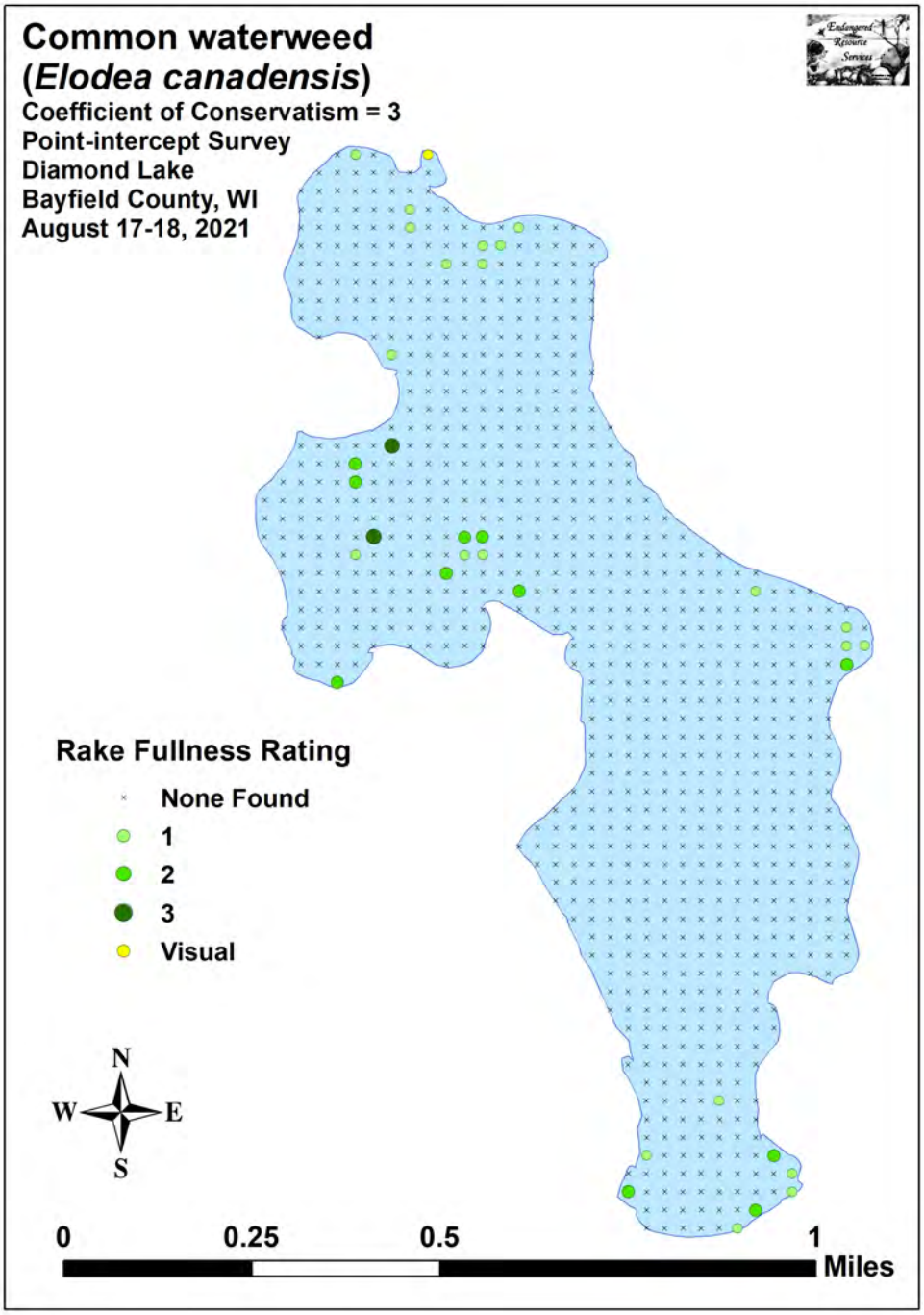

Spiny hornwort
(Ceratophyllum echinatum)
Coefficient of Conservatism = 10
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

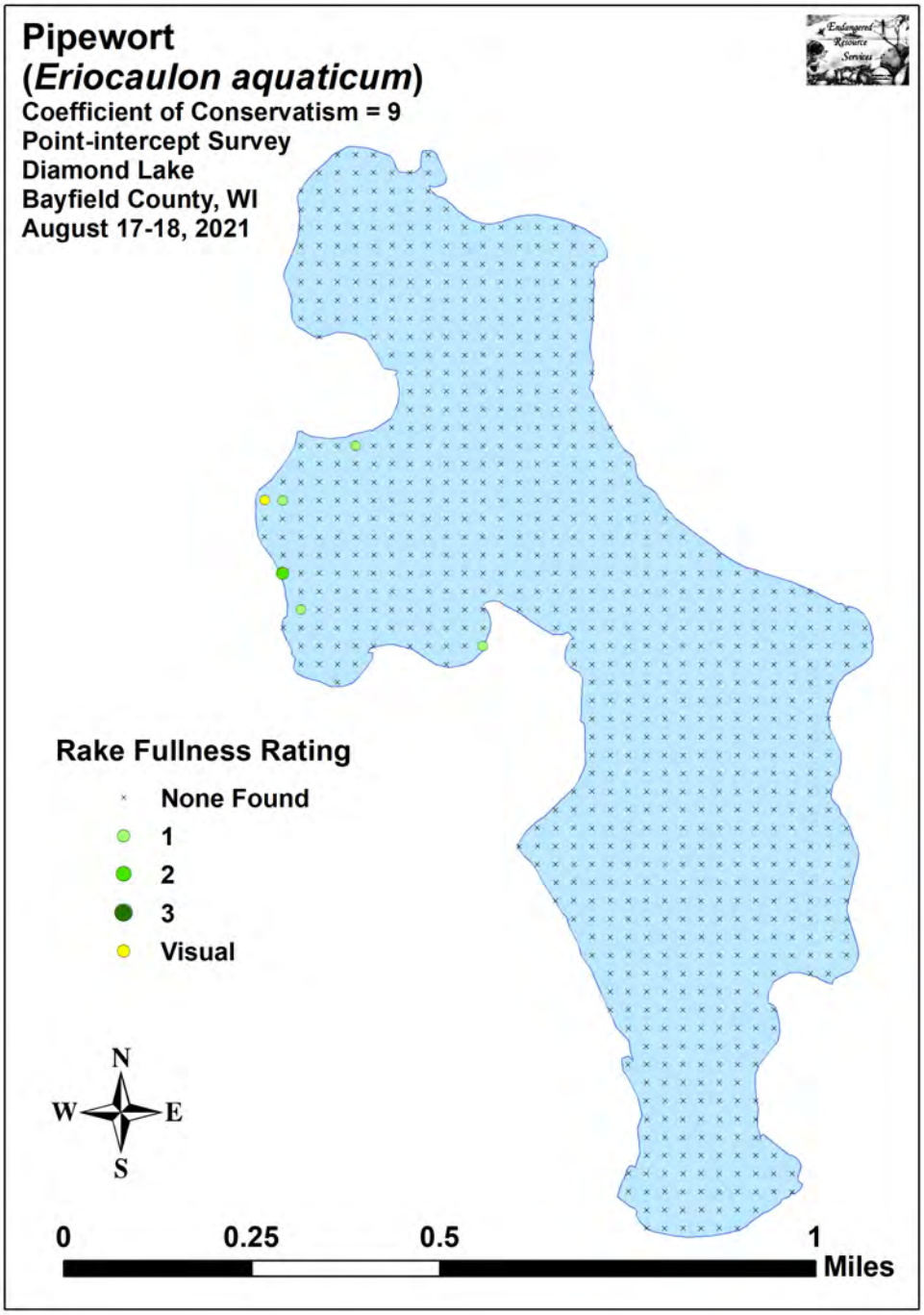

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

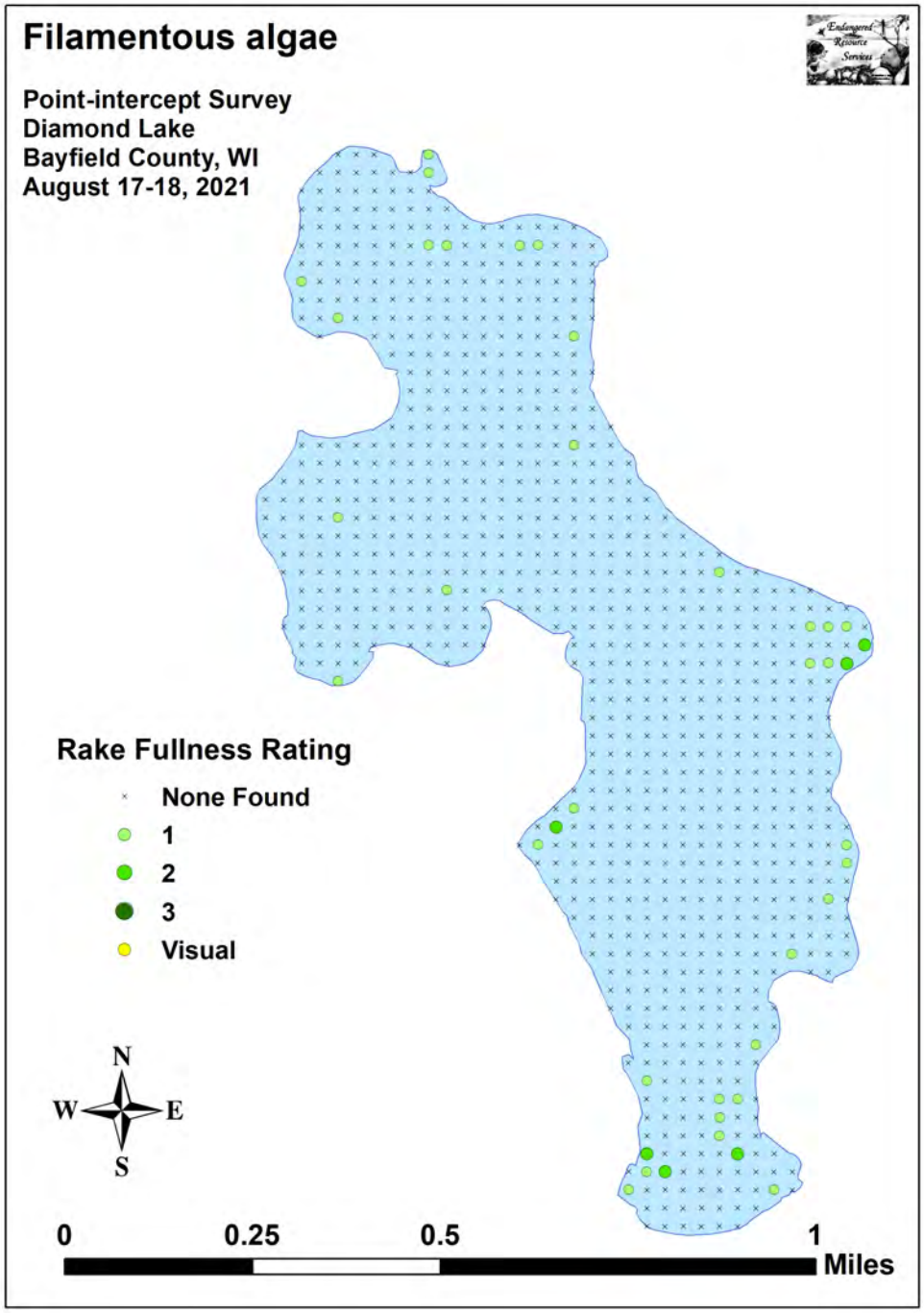

Waterwort
(Elatine minima)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

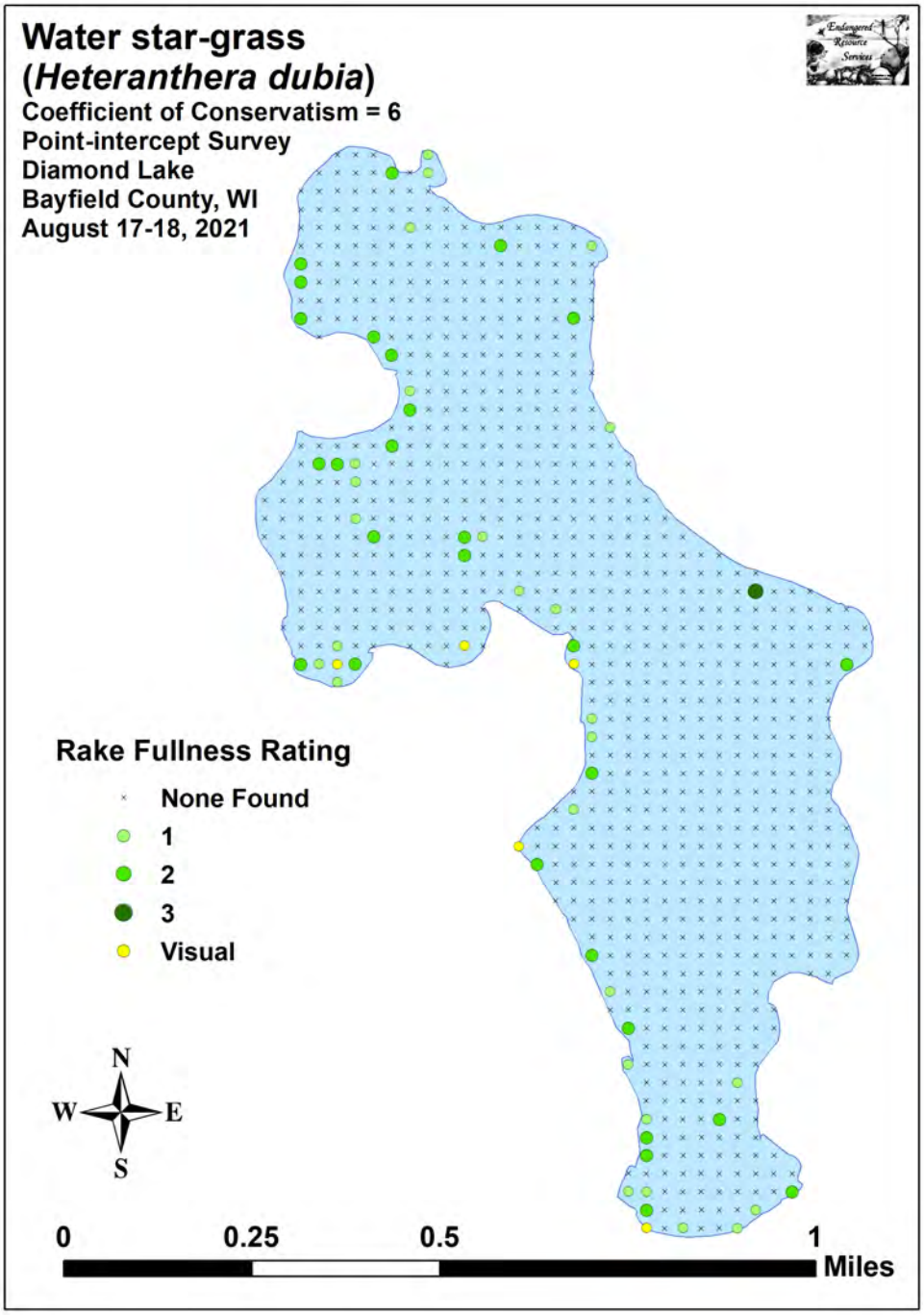

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

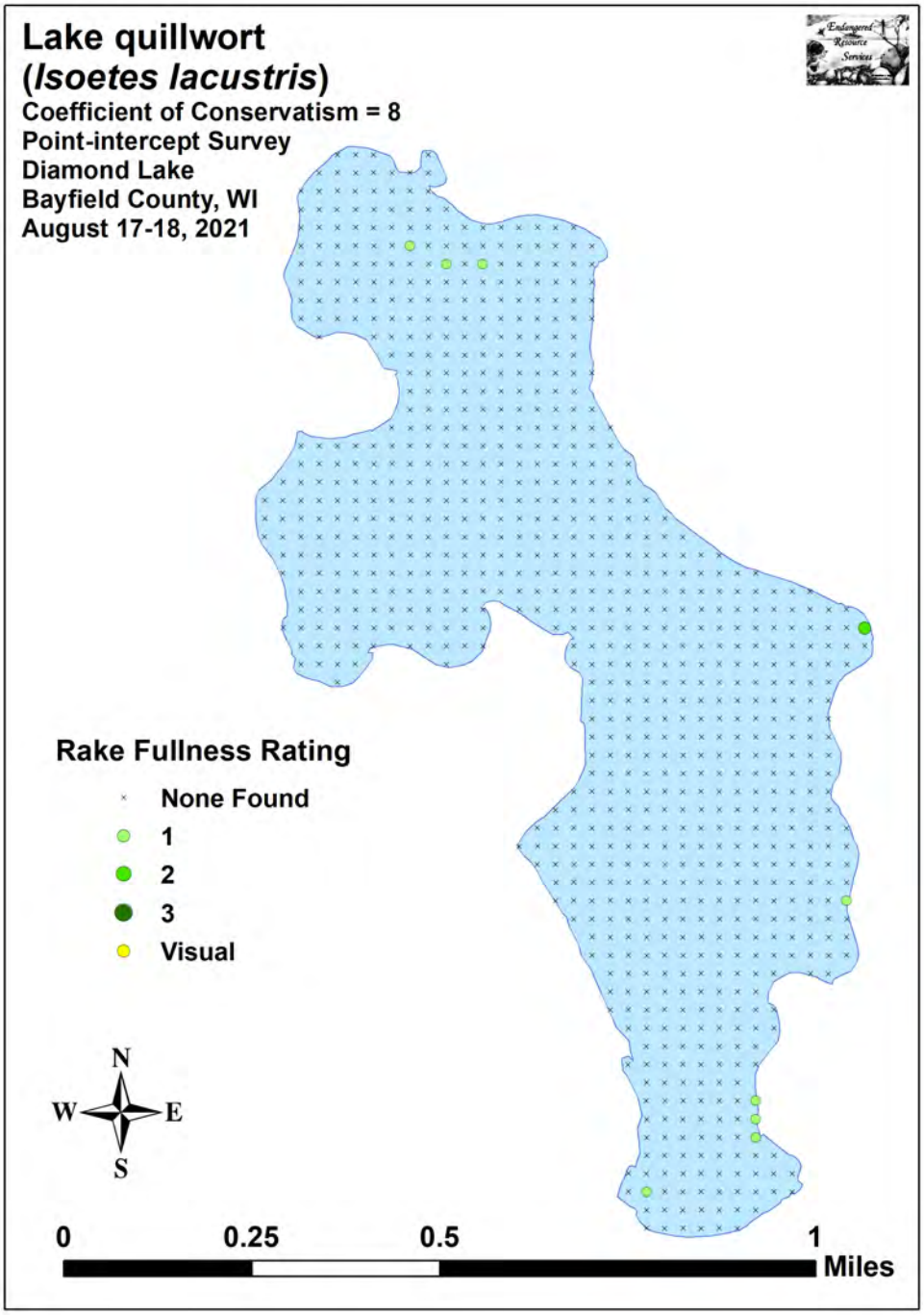

Creeping spikerush
(Eleocharis palustris)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

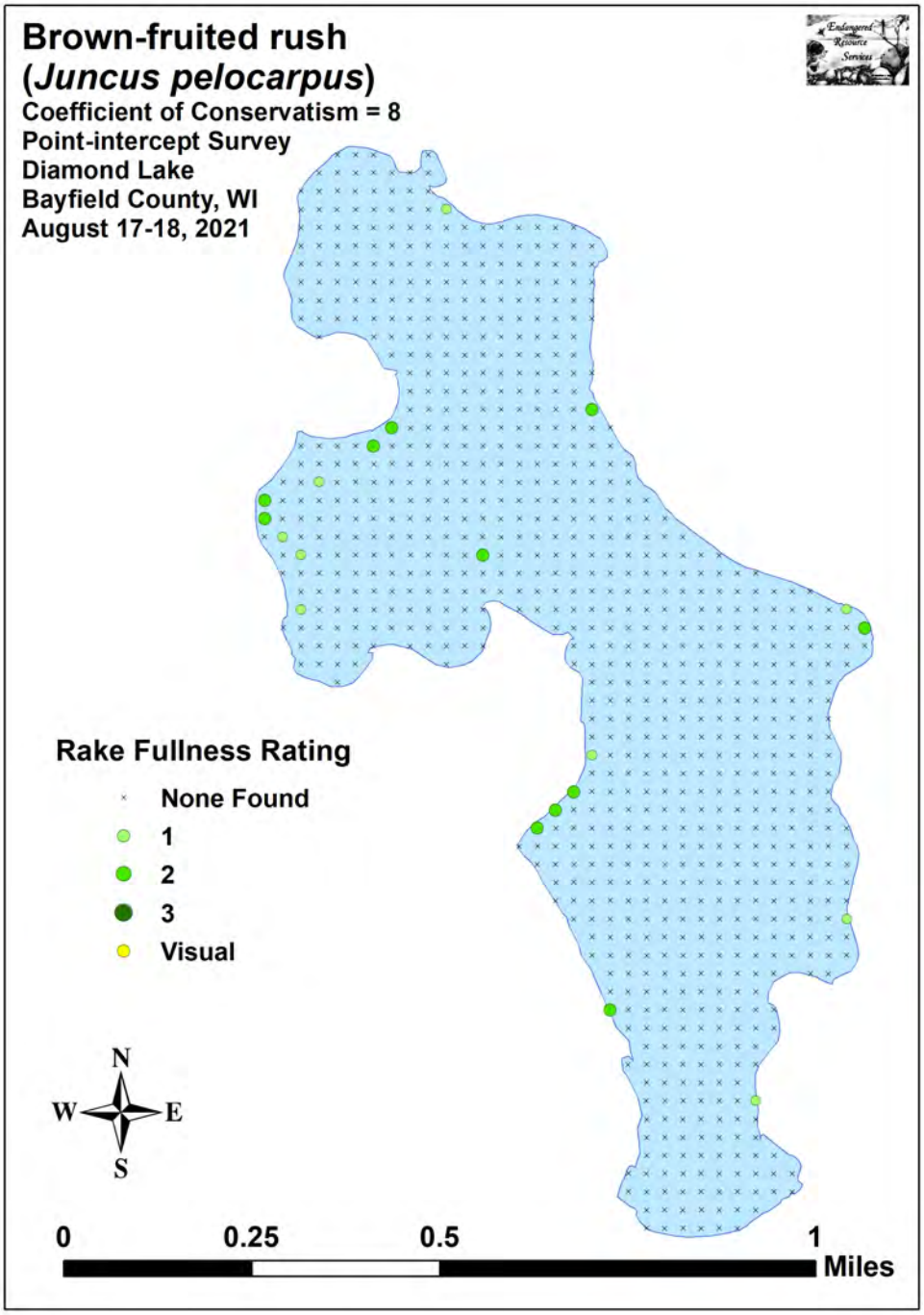

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

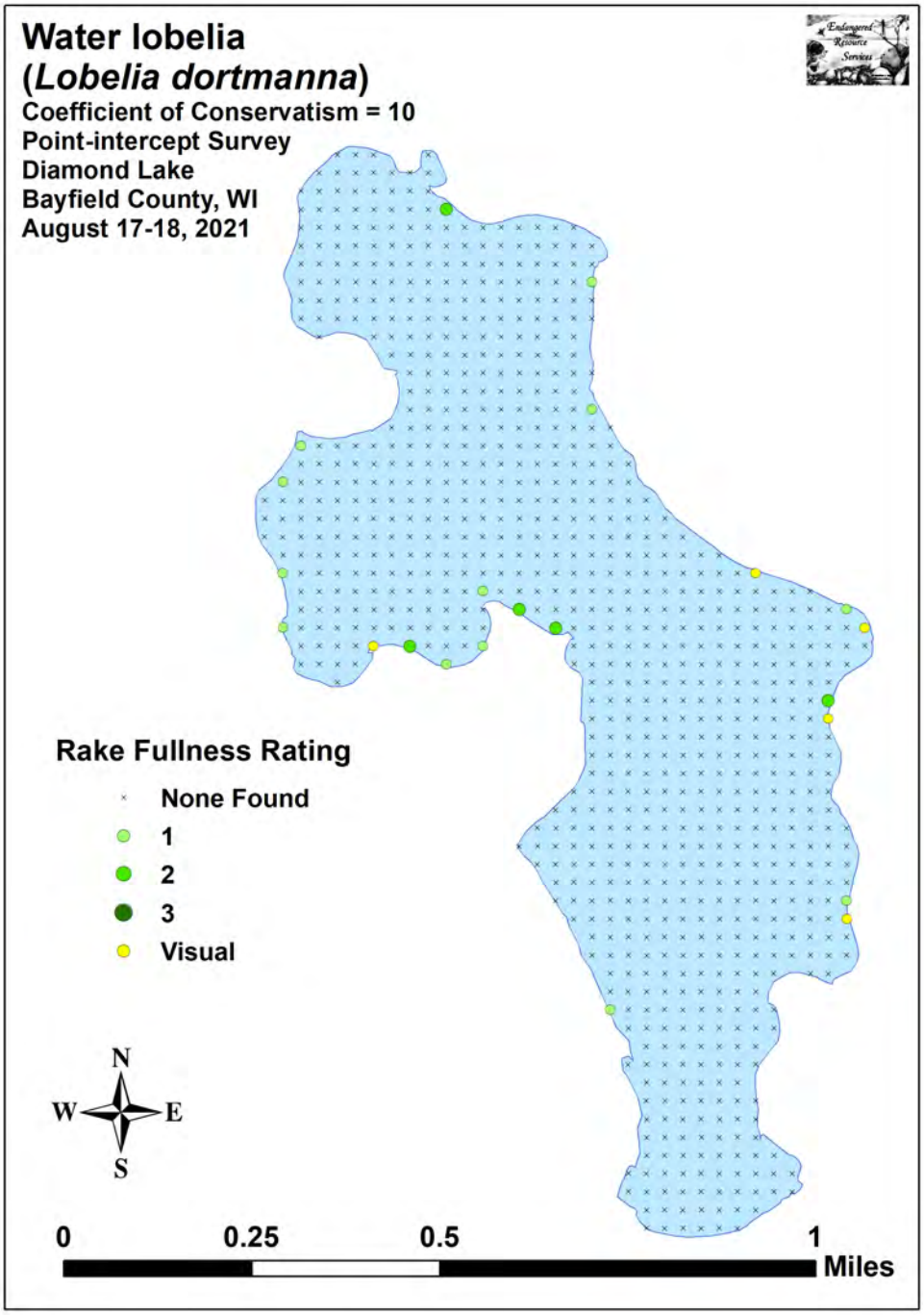

Pipewort
(Eriocaulon aquaticum)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

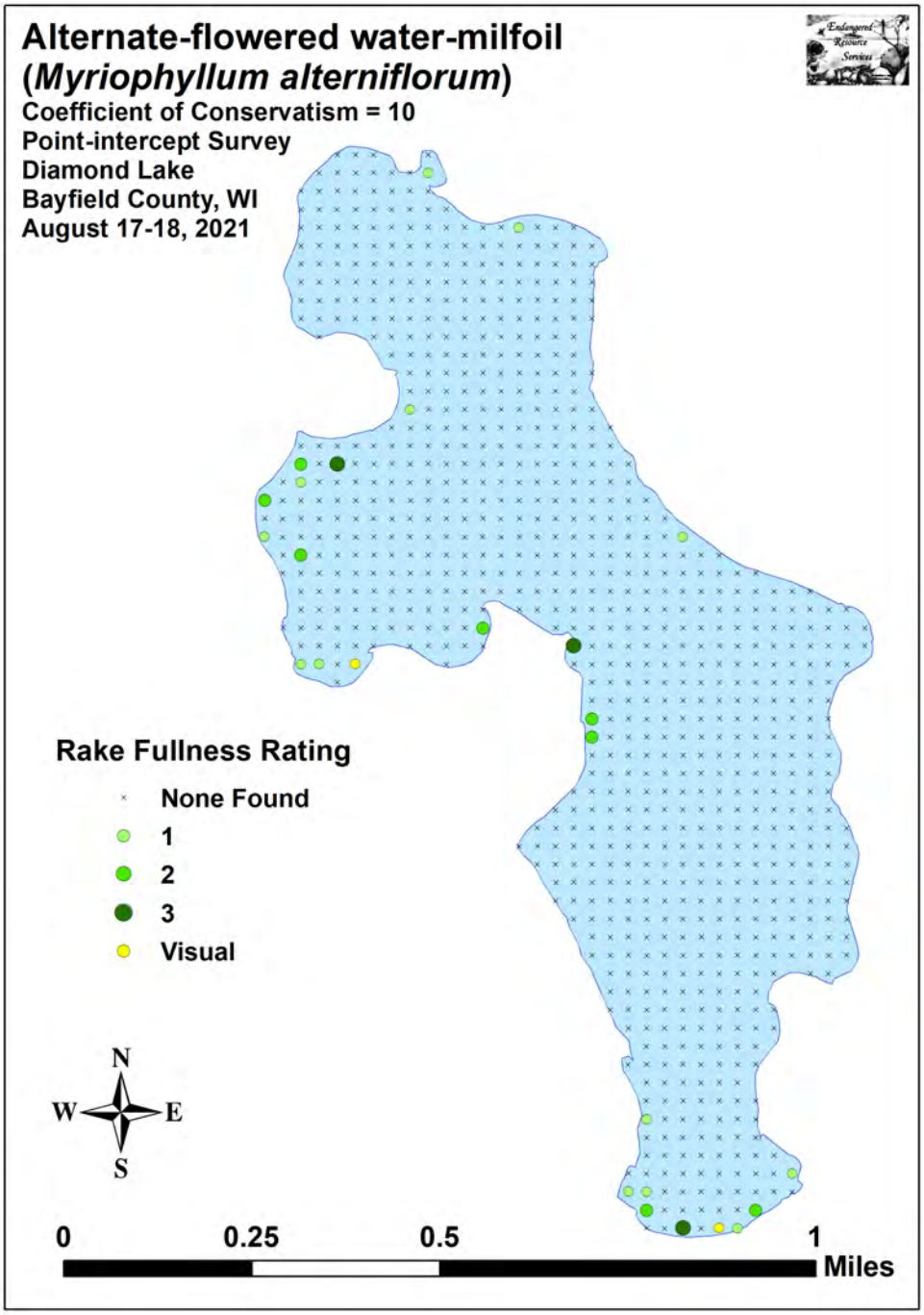

Filamentous algae
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

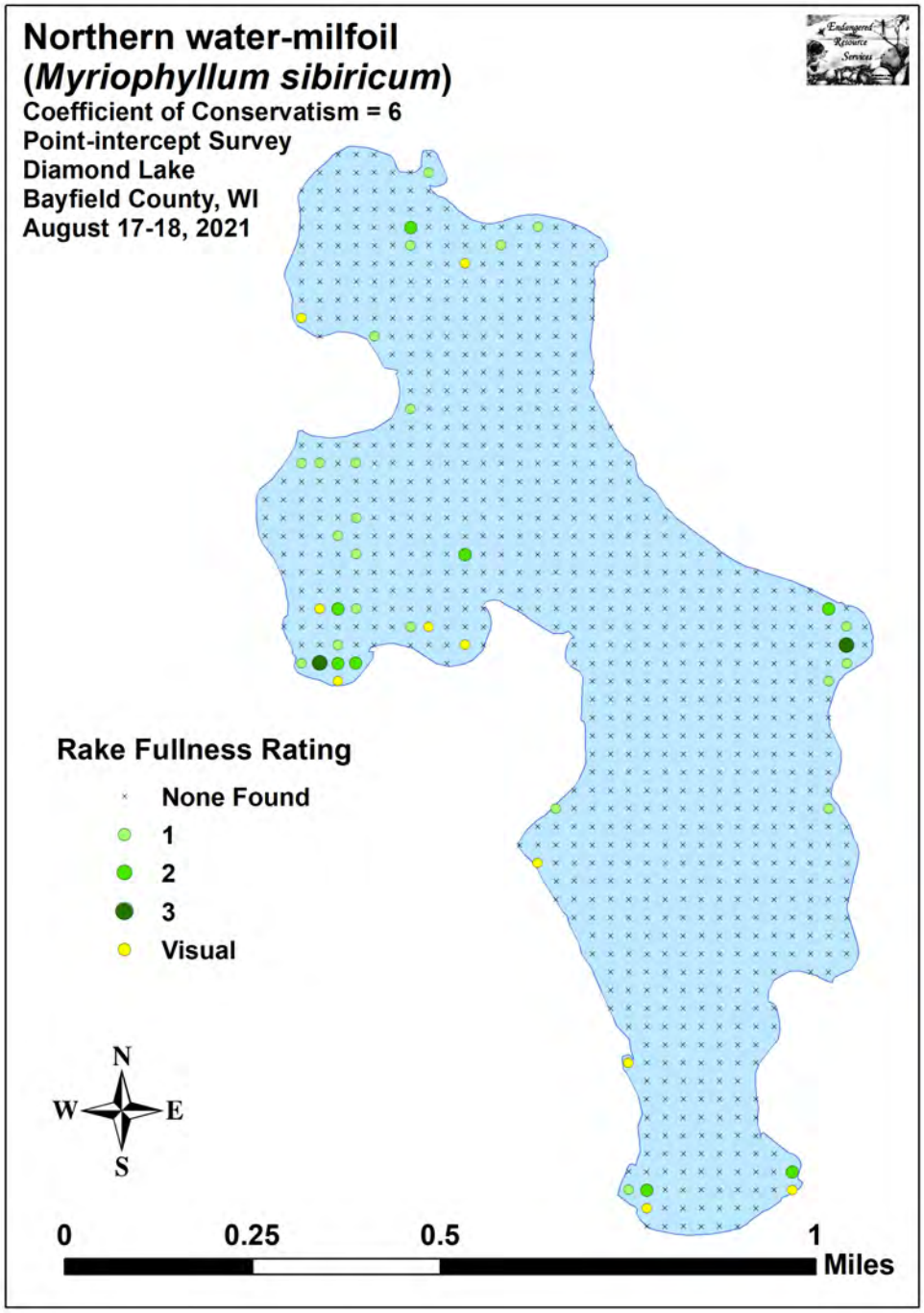

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

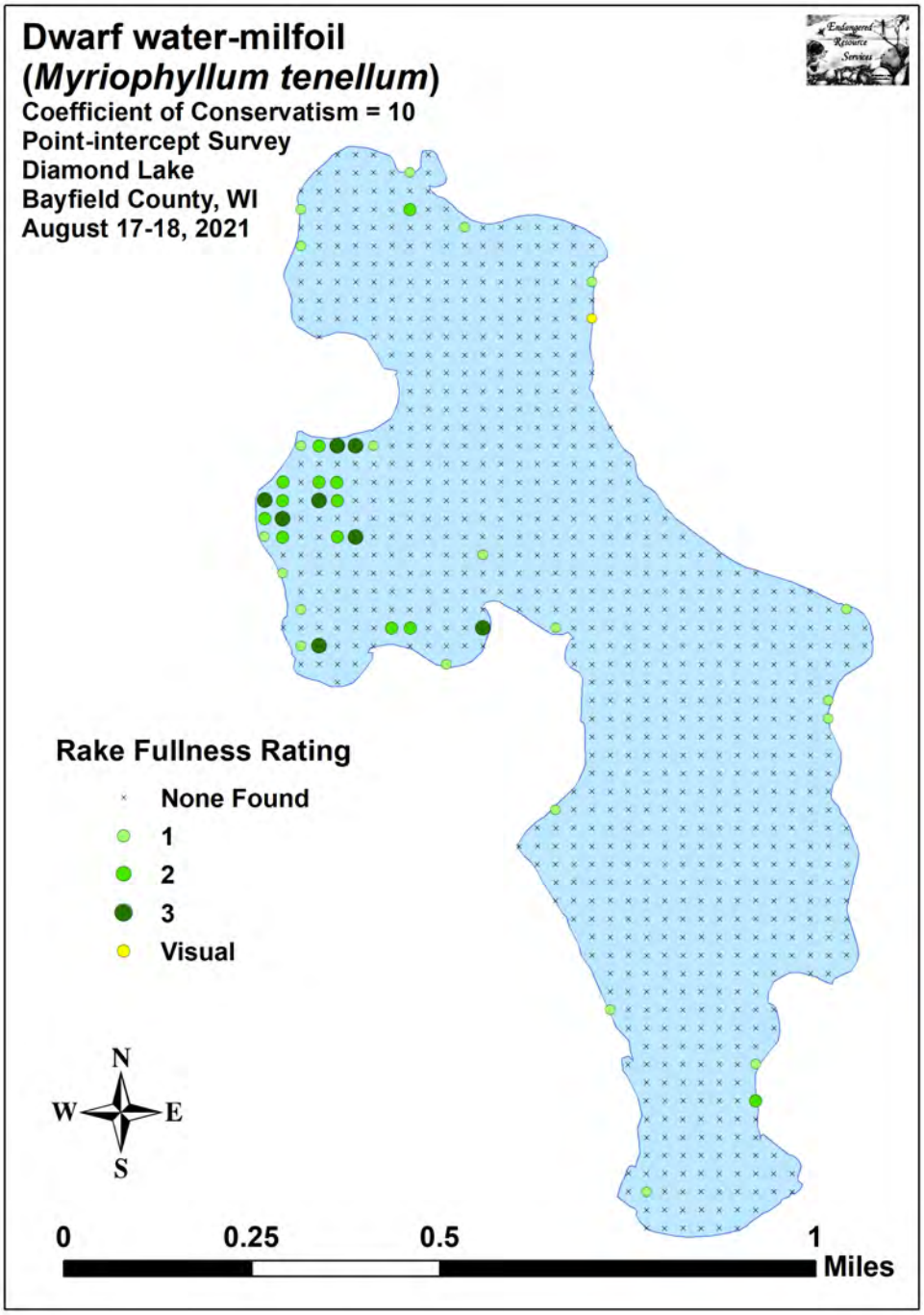

Lake quillwort
(Isoetes lacustris)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

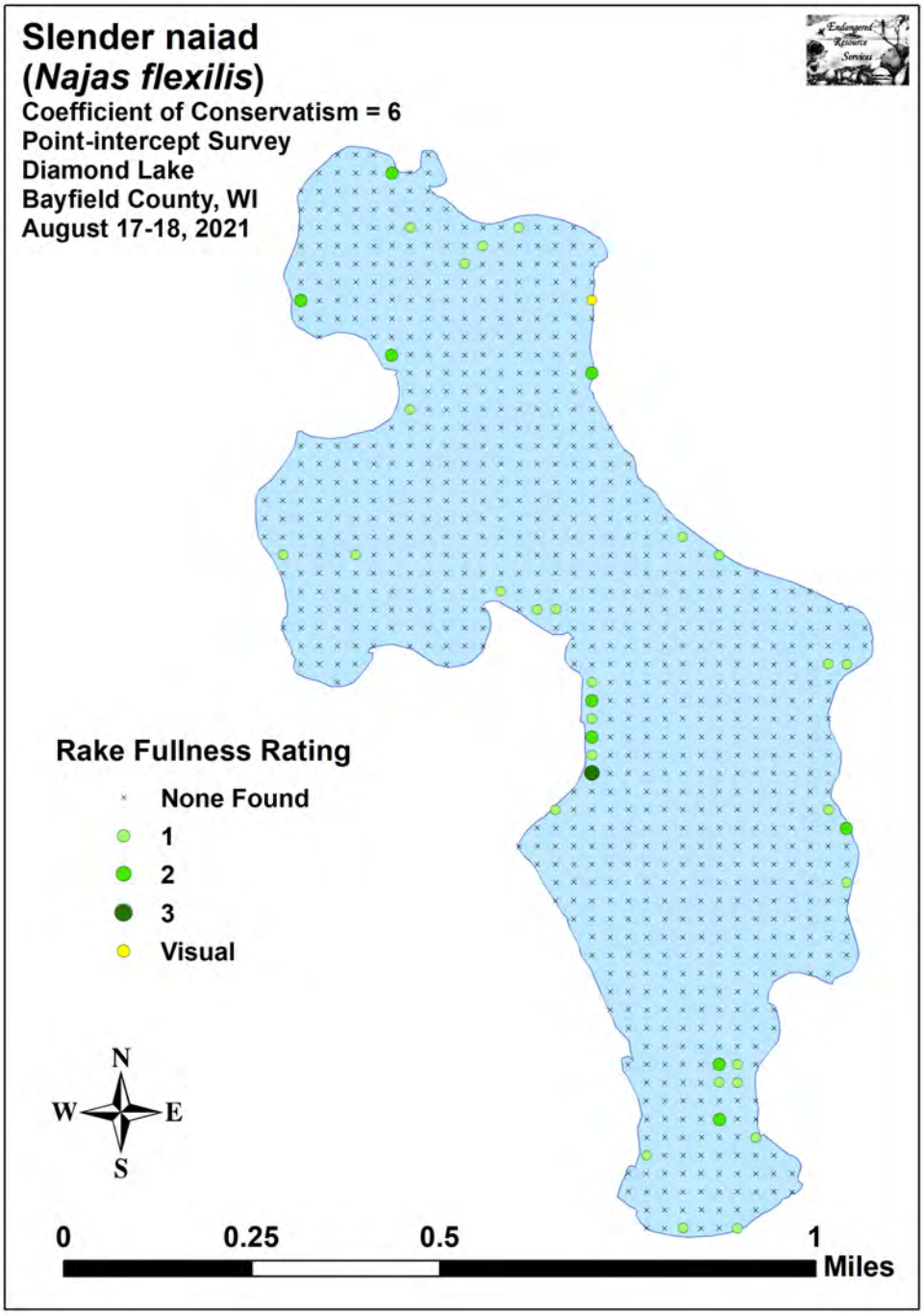

Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

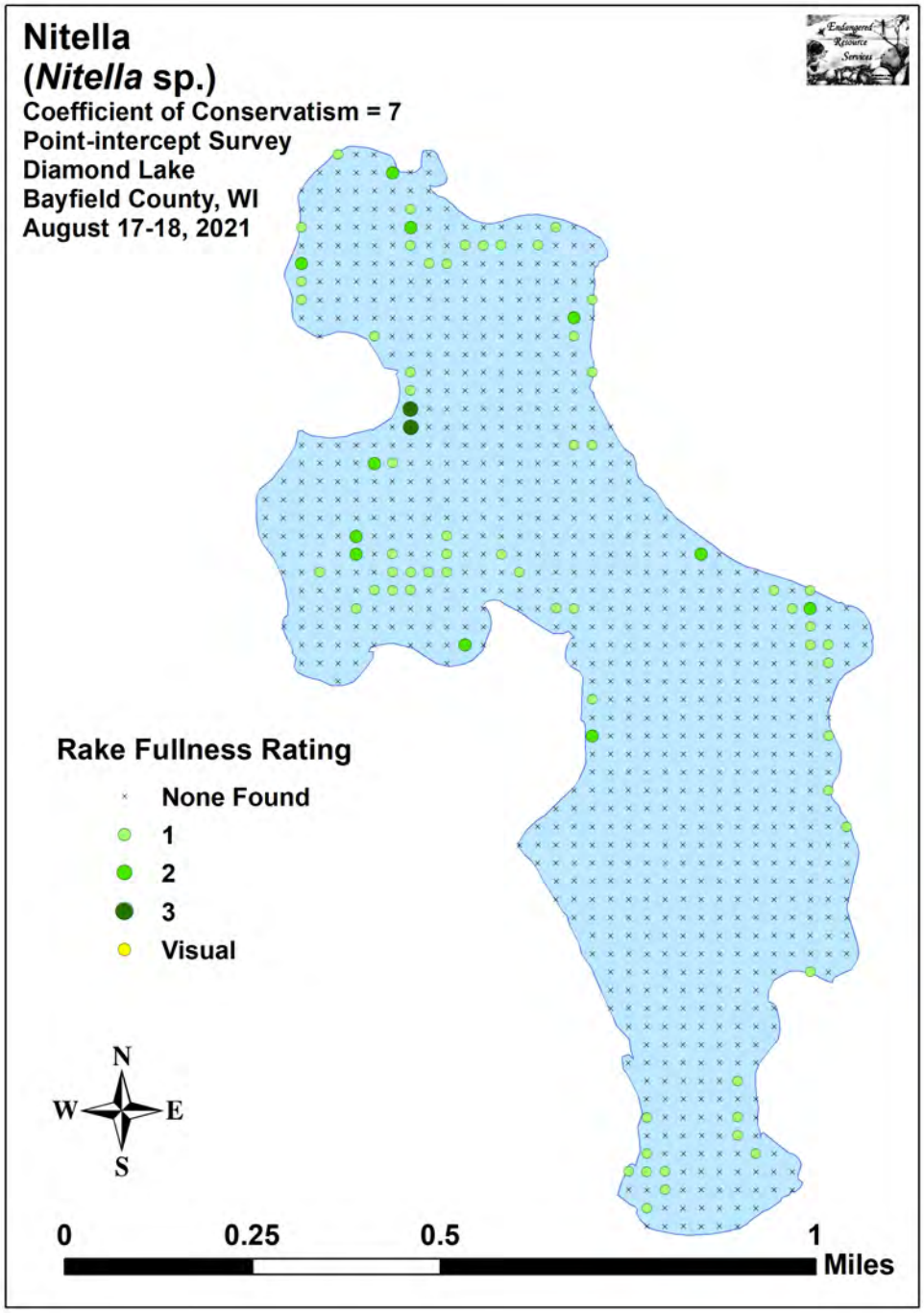

Water lobelia
(Lobelia dortmanna)
Coefficient of Conservatism = 10
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

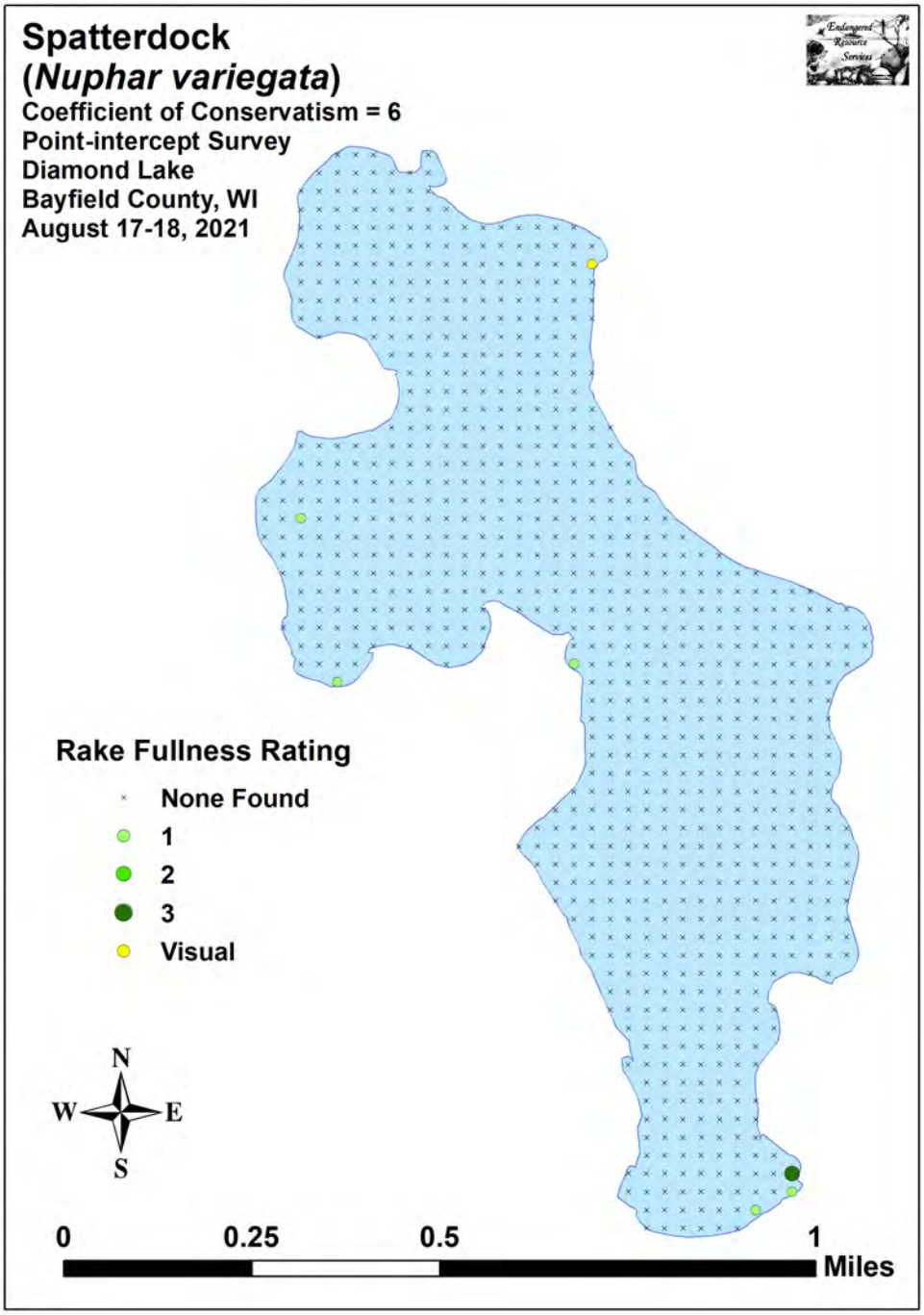

Alternate-flowered water-milfoil
(Myriophyllum alterniflorum)
Coefficient of Conservatism = 10
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

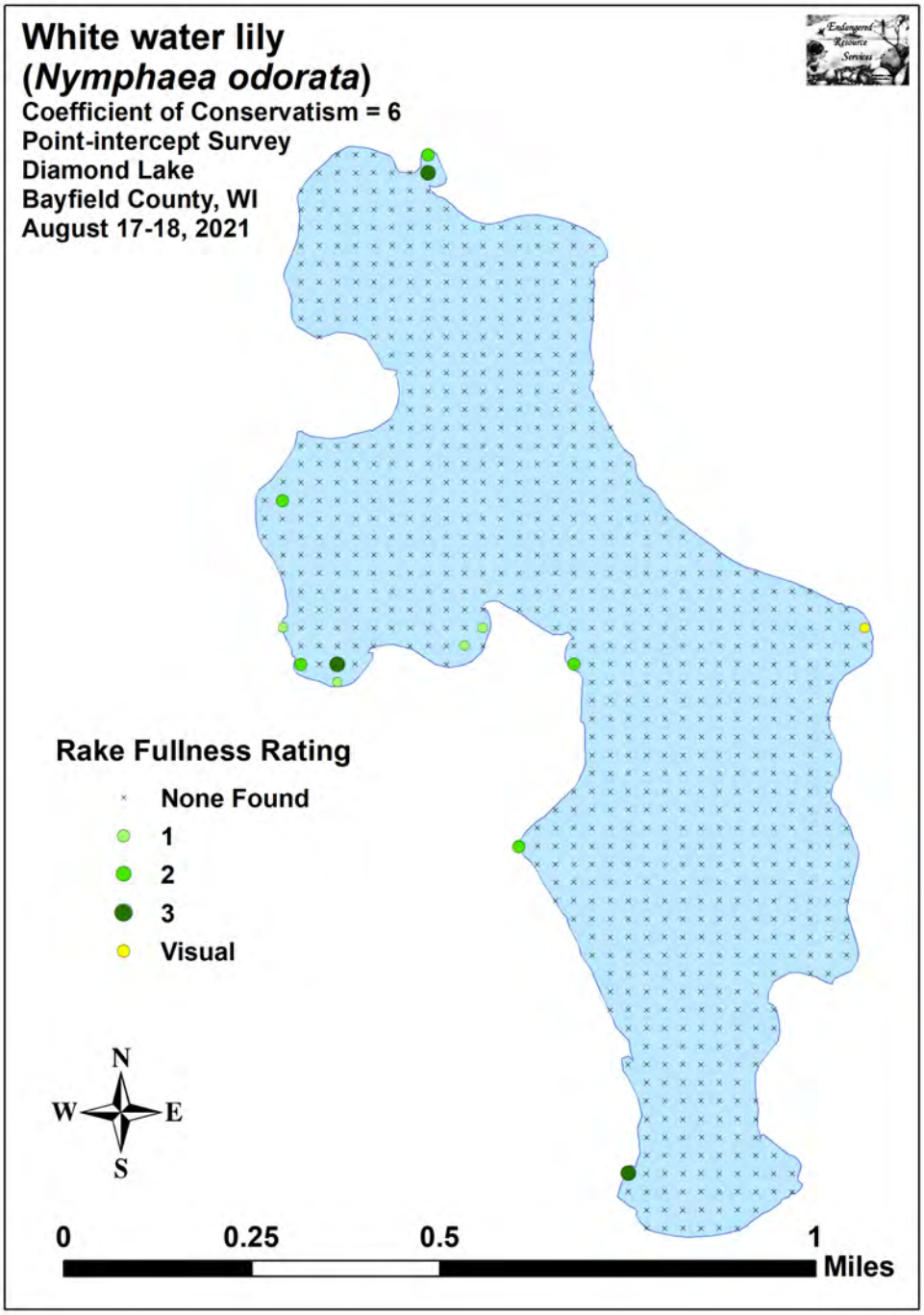

Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

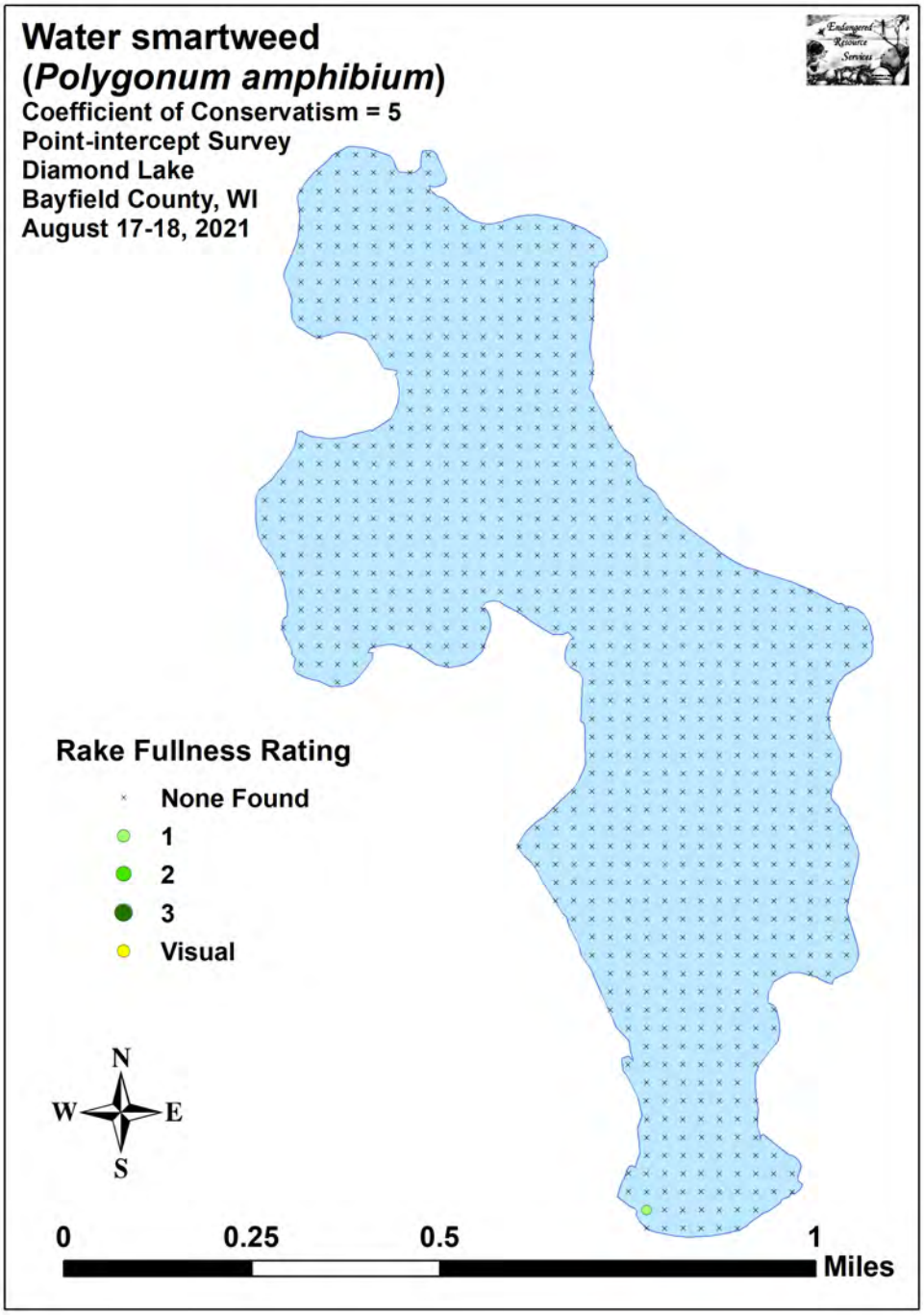

Dwarf water-milfoil
(Myriophyllum tenellum)
Coefficient of Conservatism = 10
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

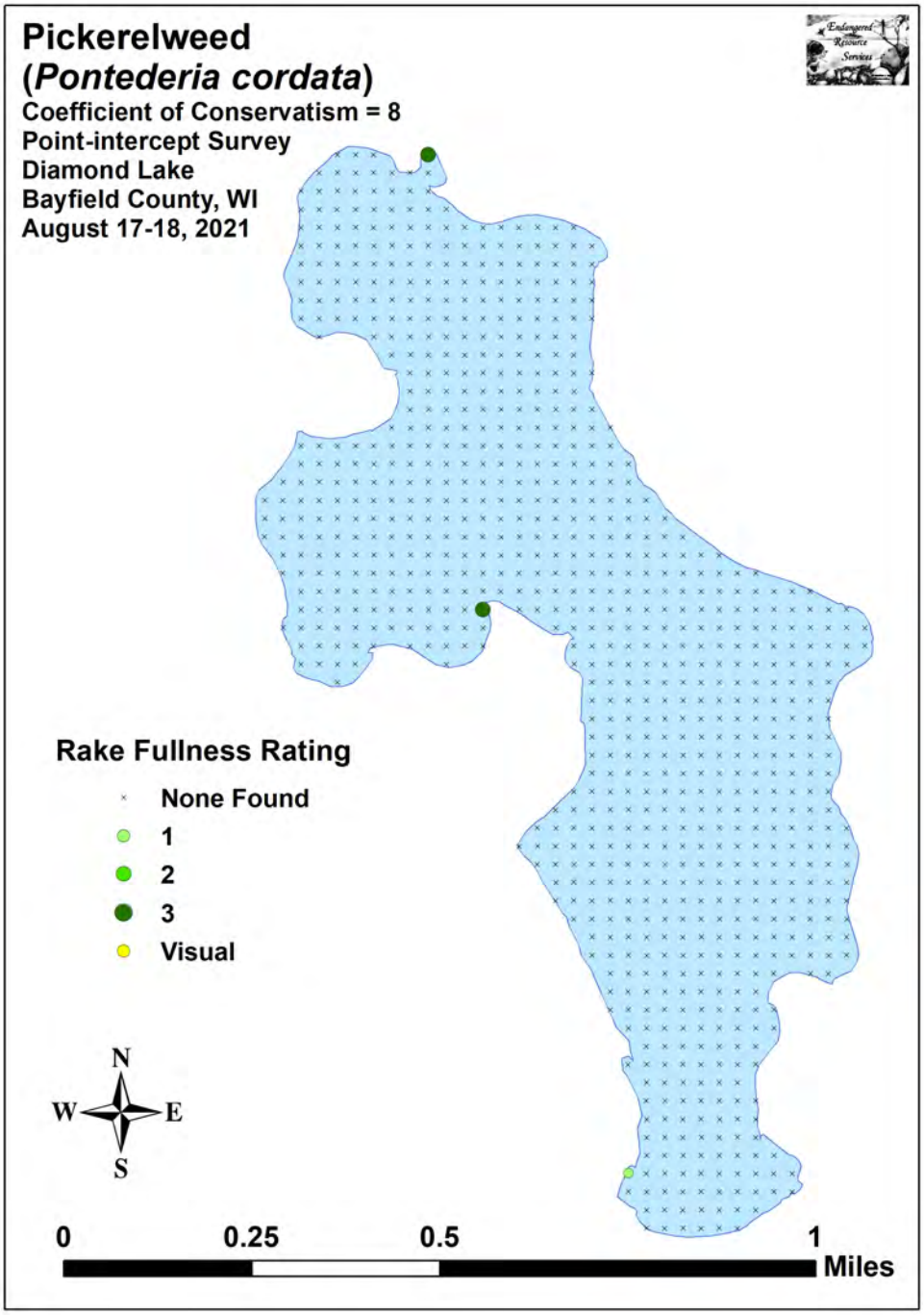

Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

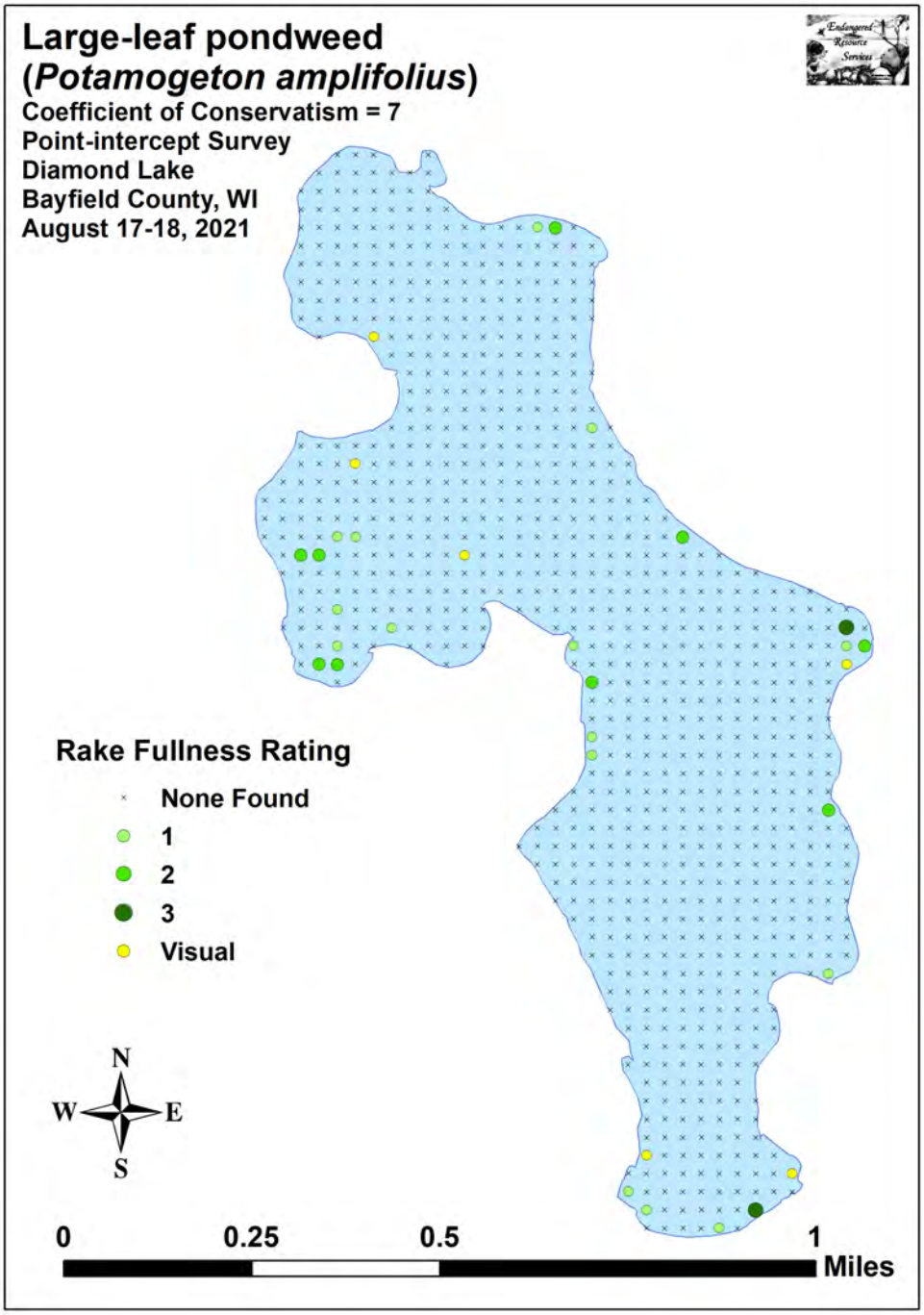

Nitella
(Nitella sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

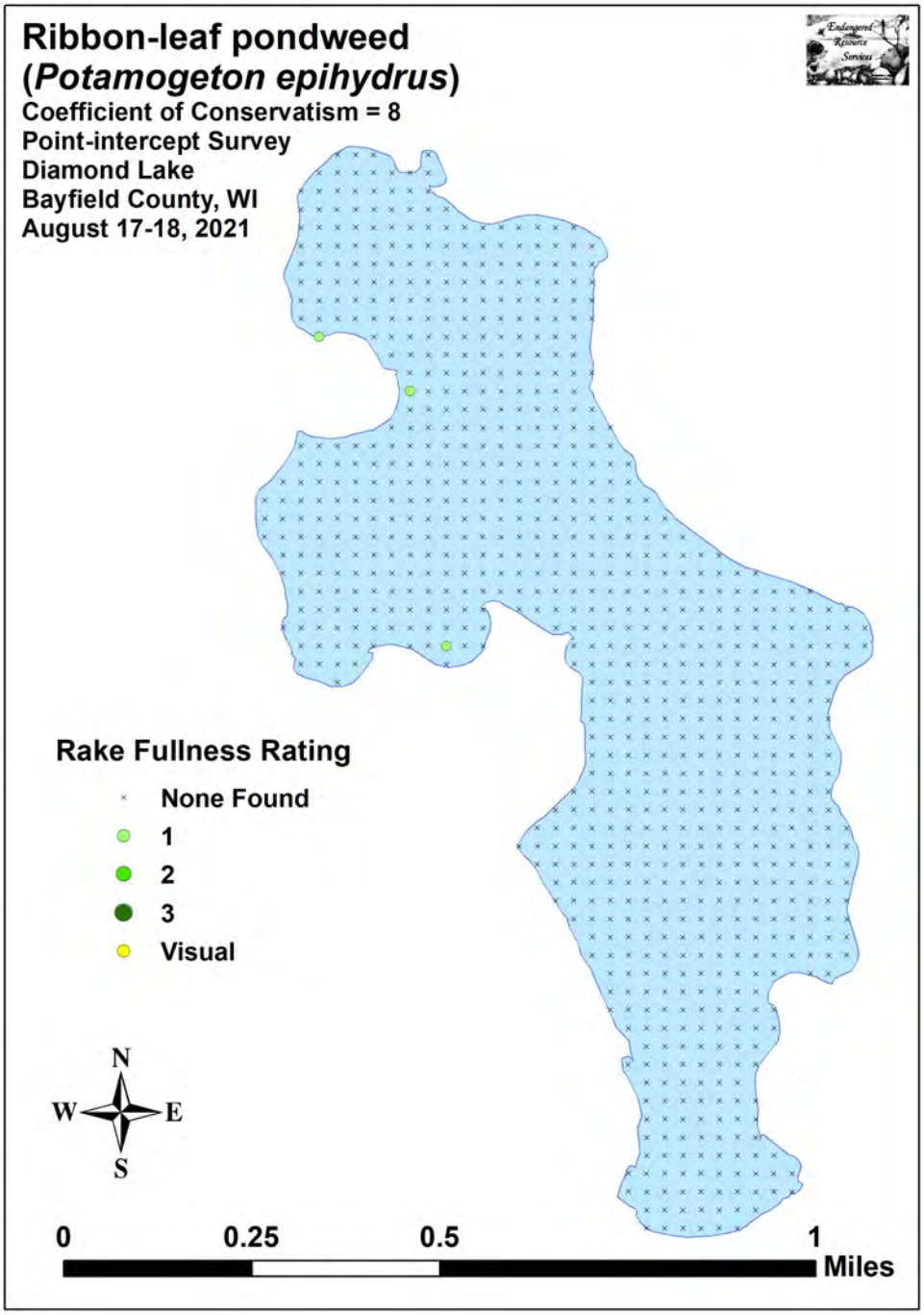

Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

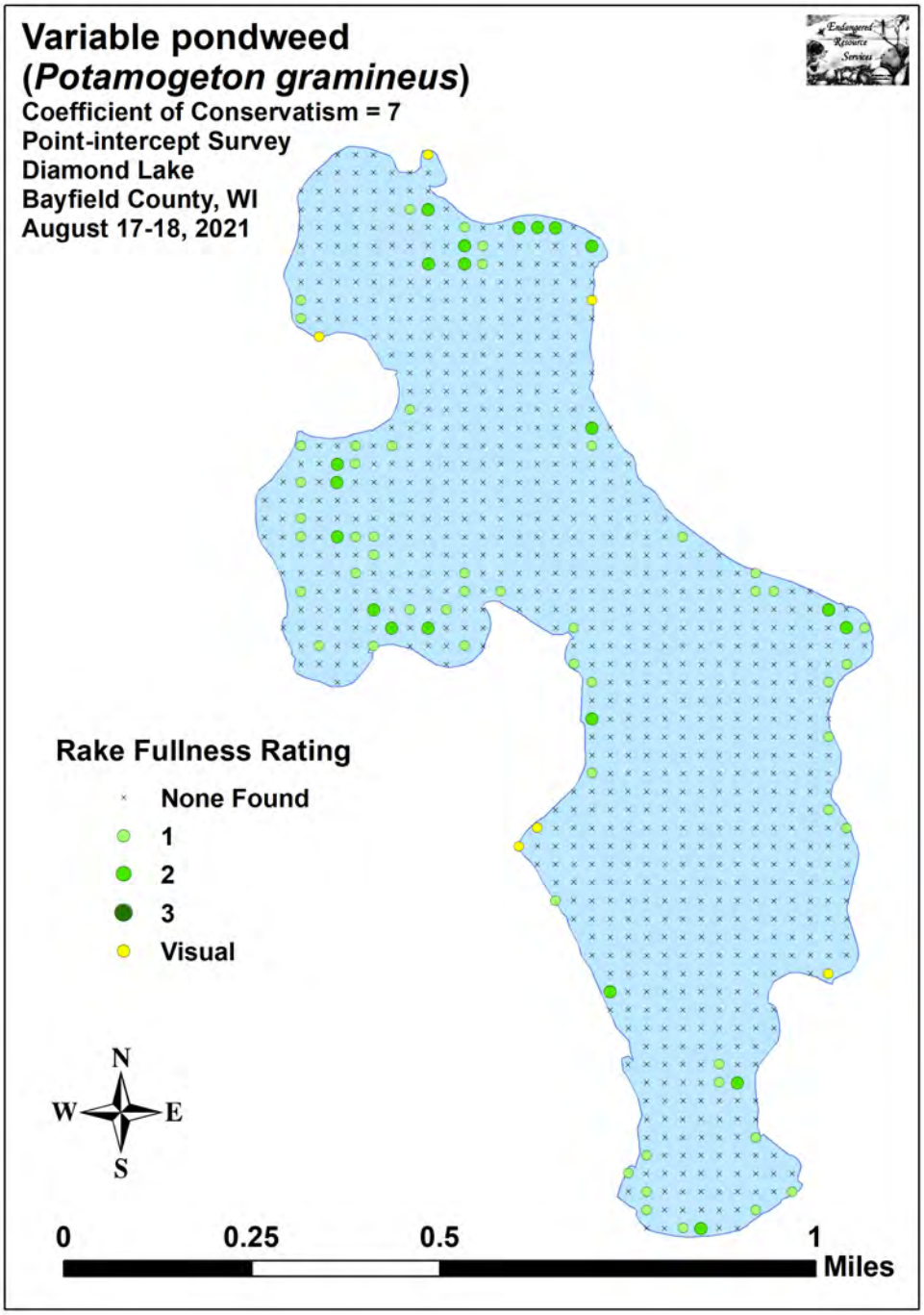

White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

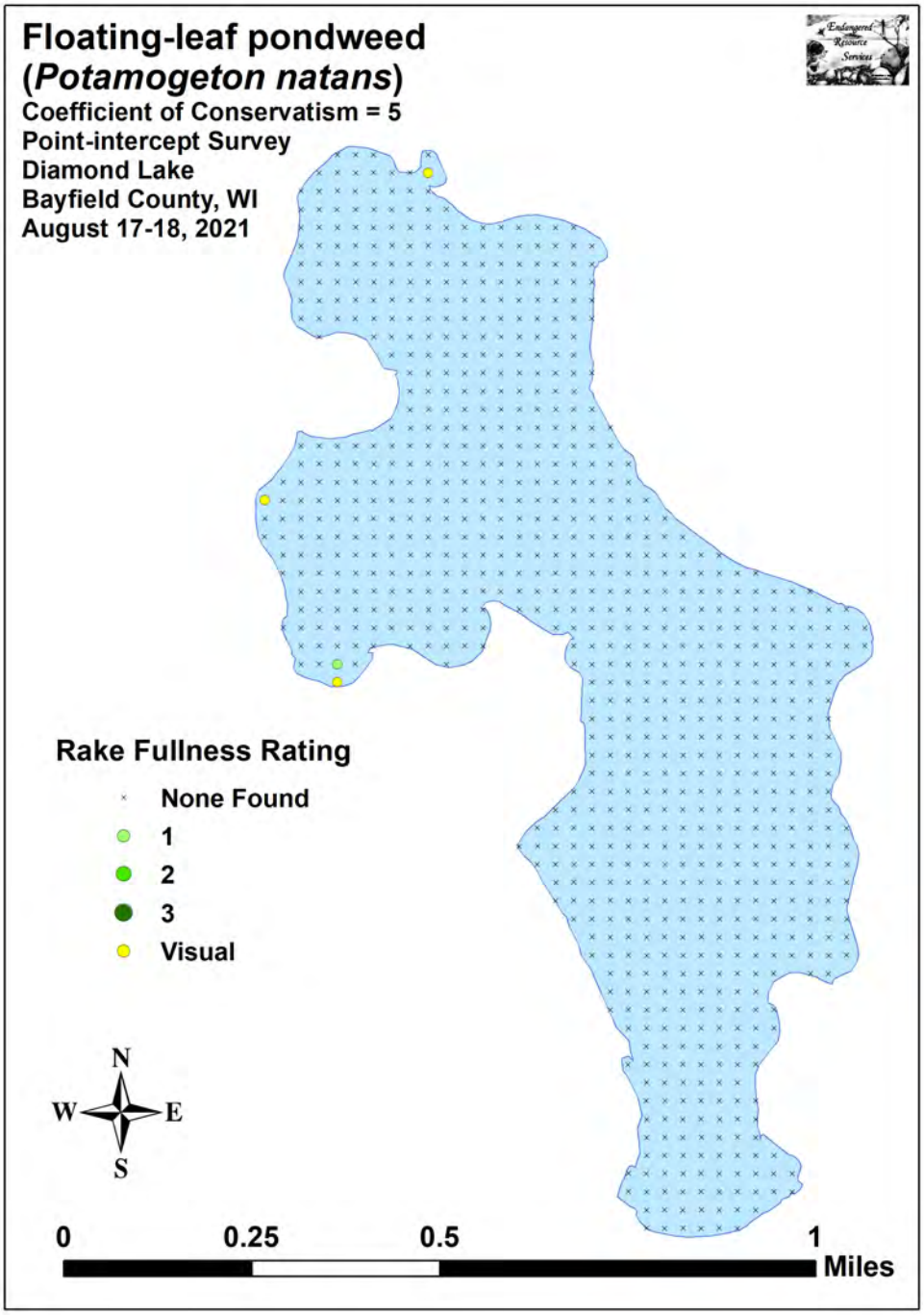

Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

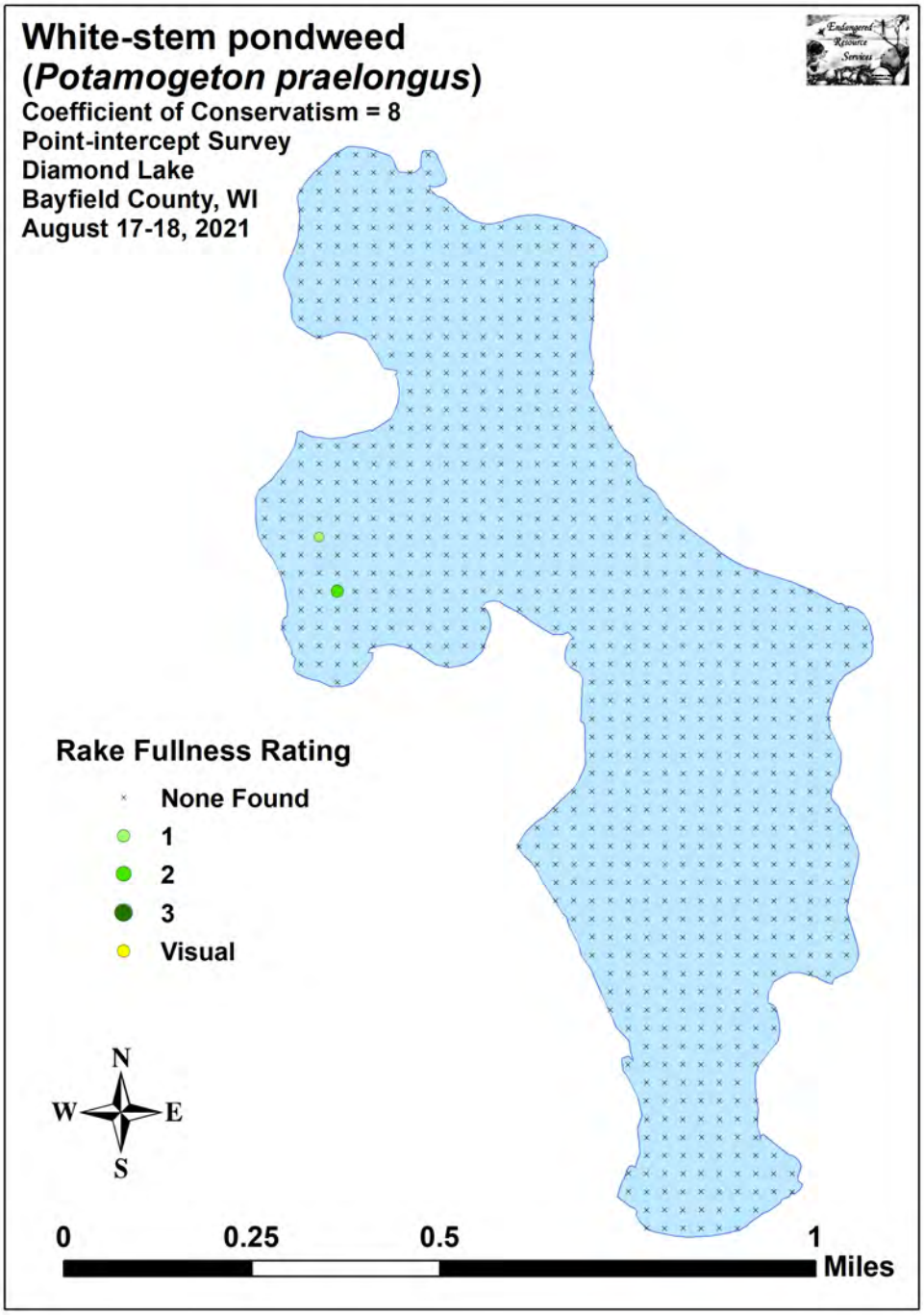

Pickerelweed
(Pontederia cordata)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

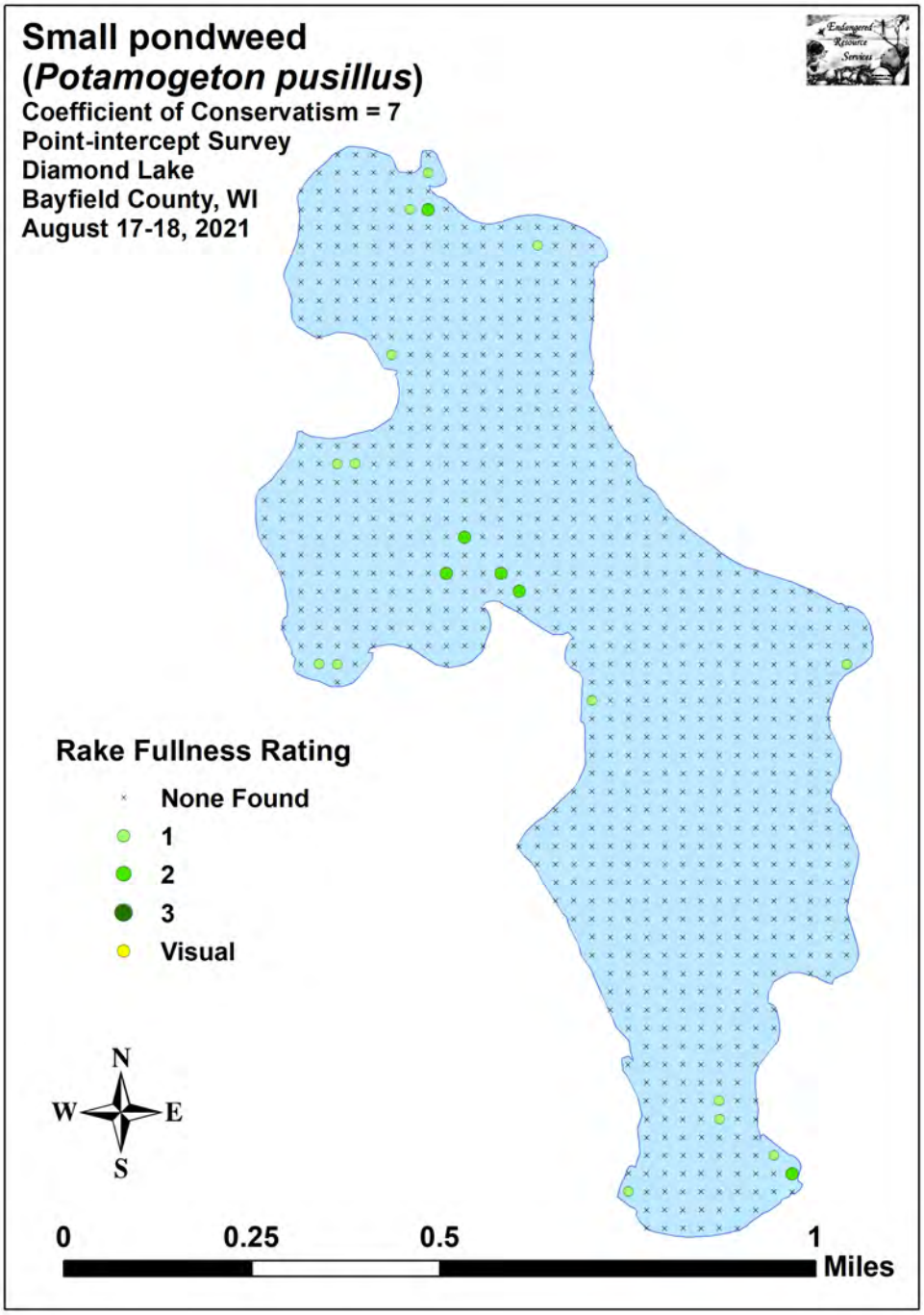

Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles

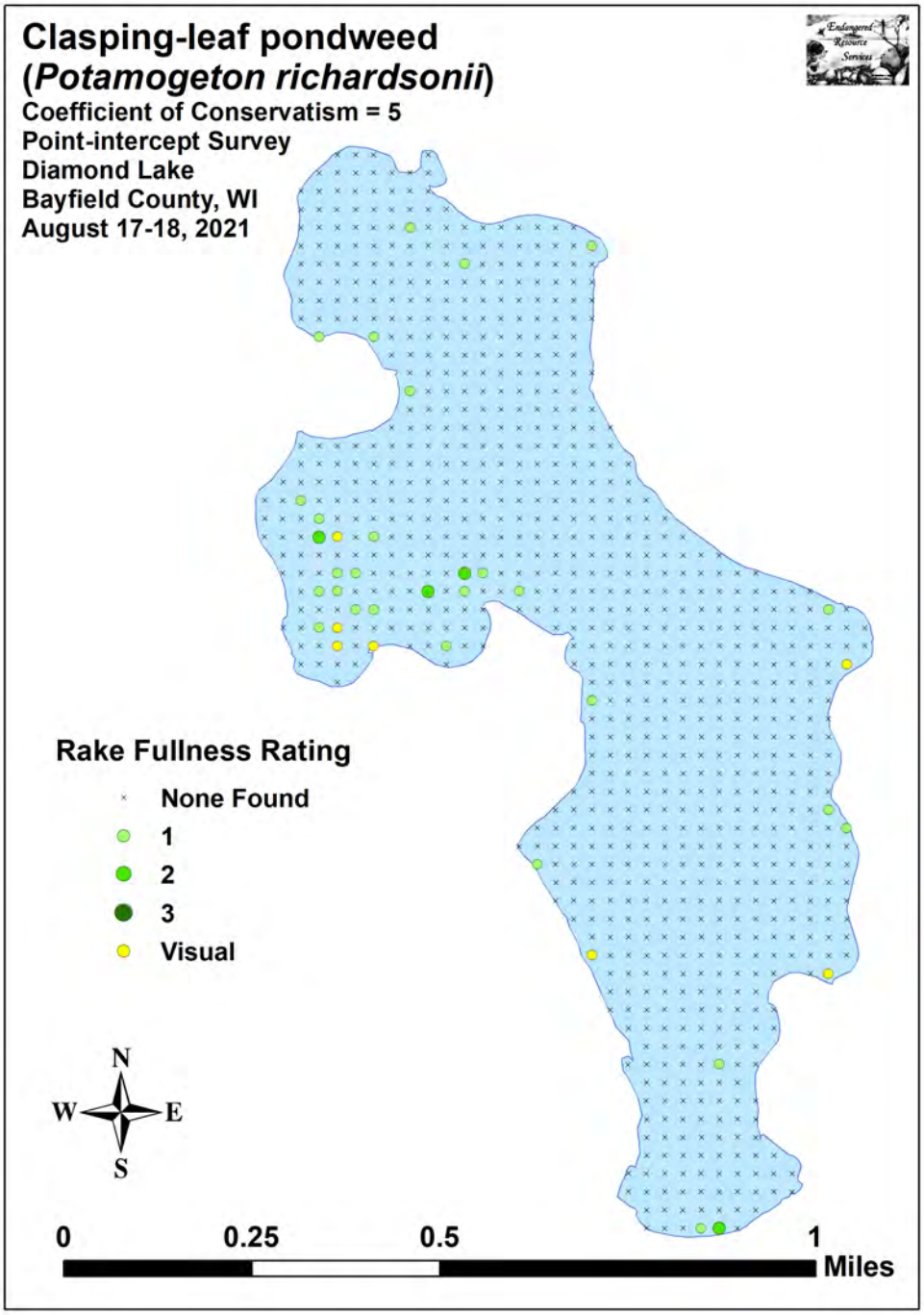

Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles


Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles


Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
1
2
3
Visual
N
W
E
S
0
0.25
0.5
1
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
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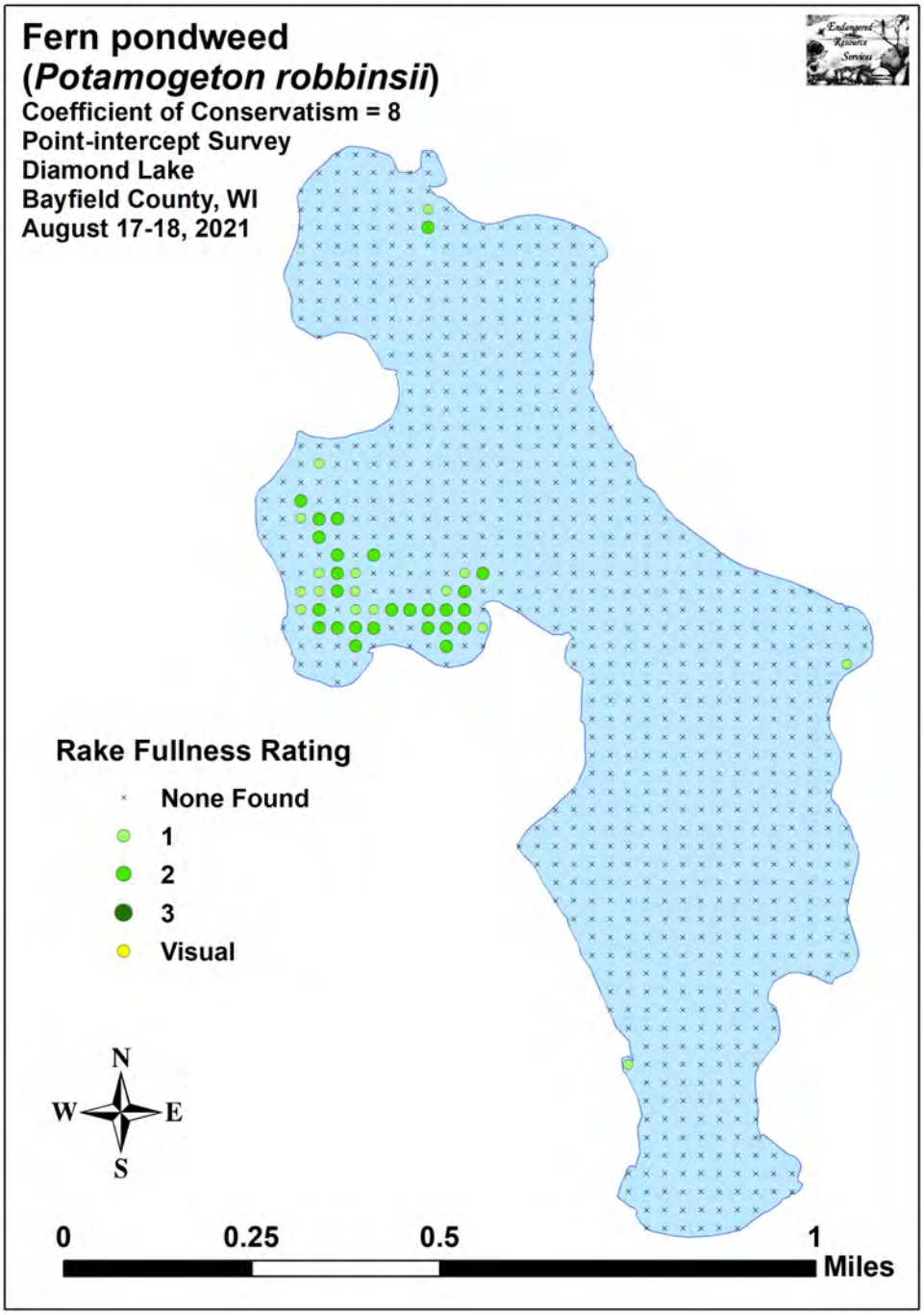
Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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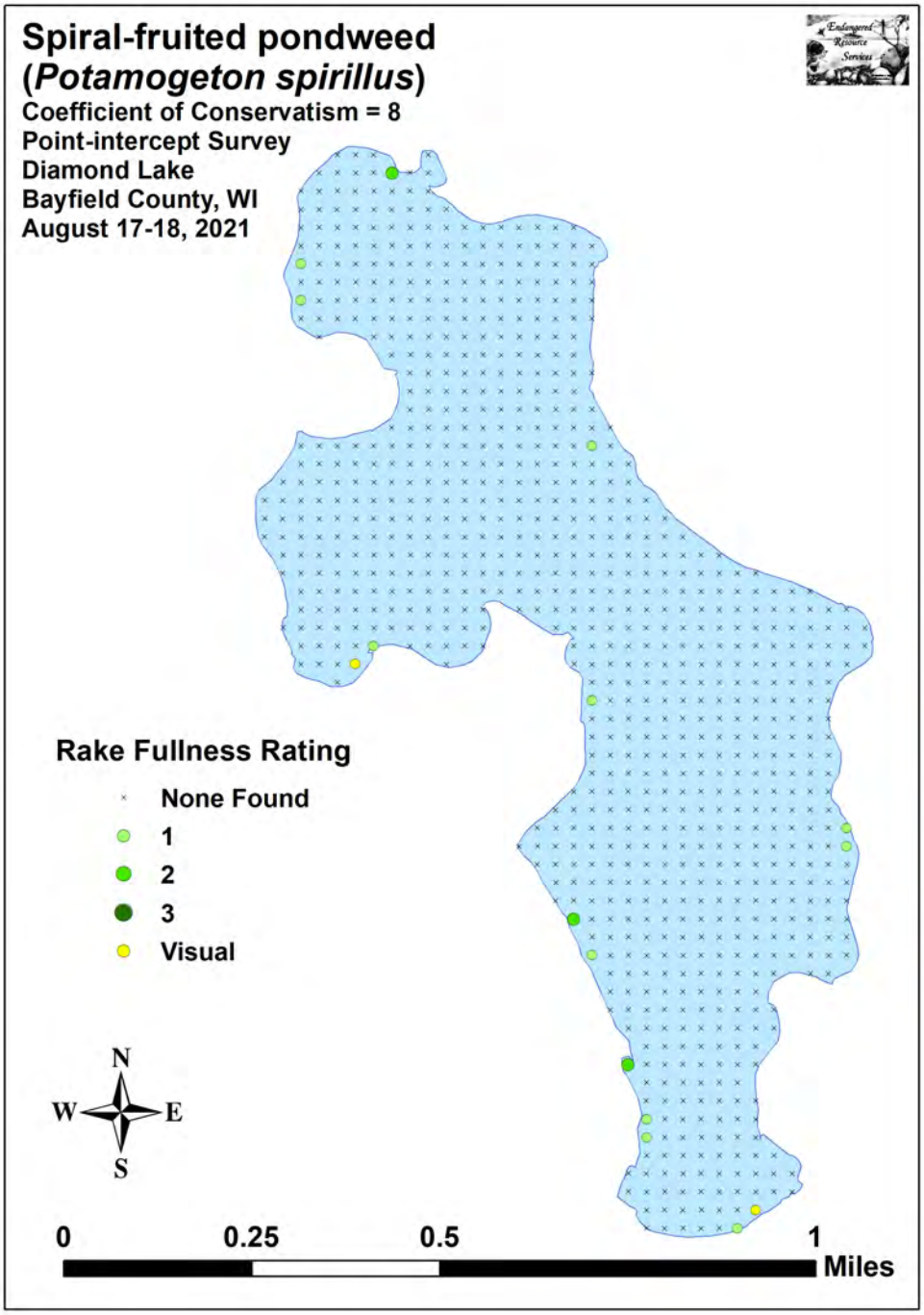
Spiral-fruited pondweed
(Potamogeton spirillus)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
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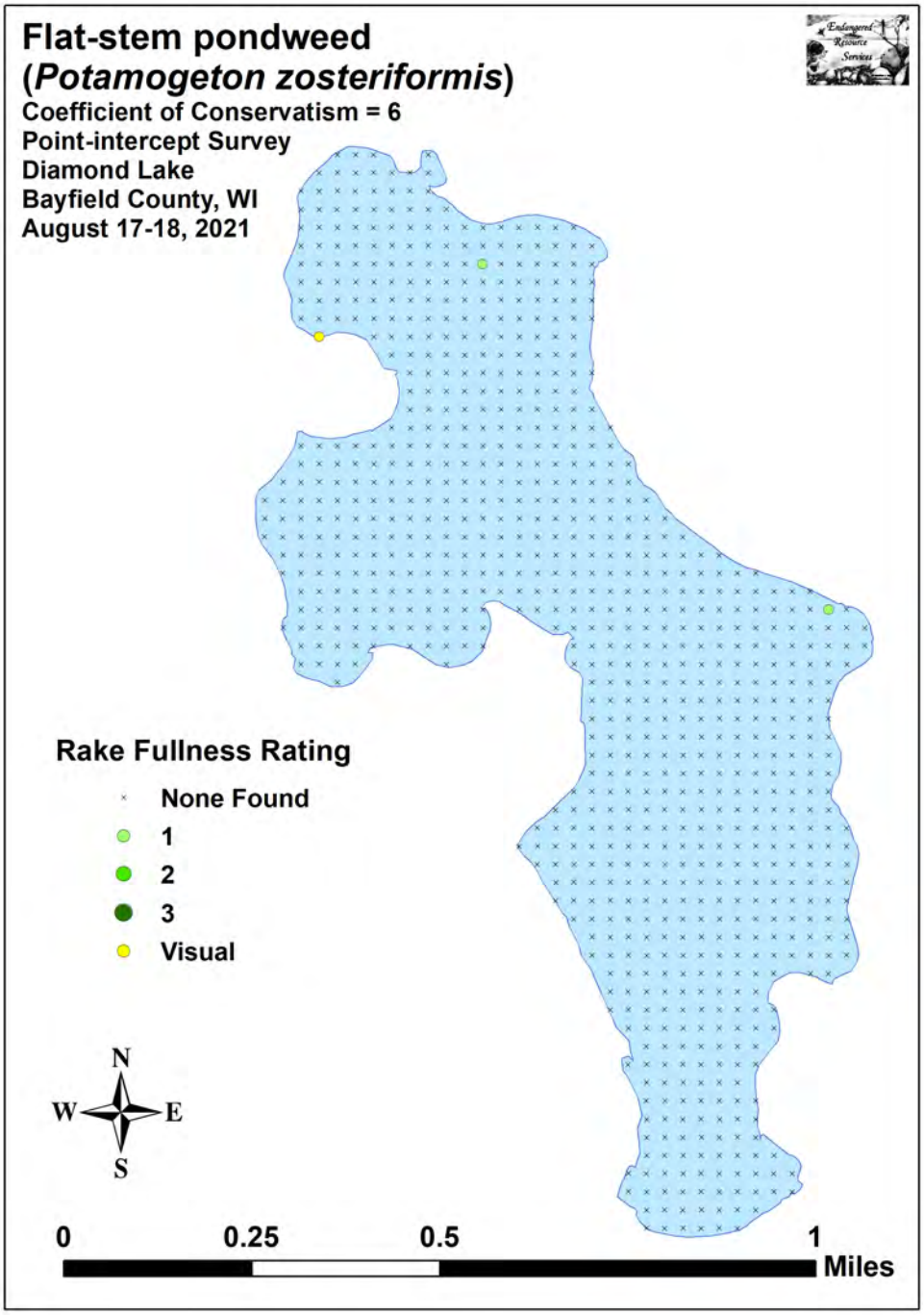
Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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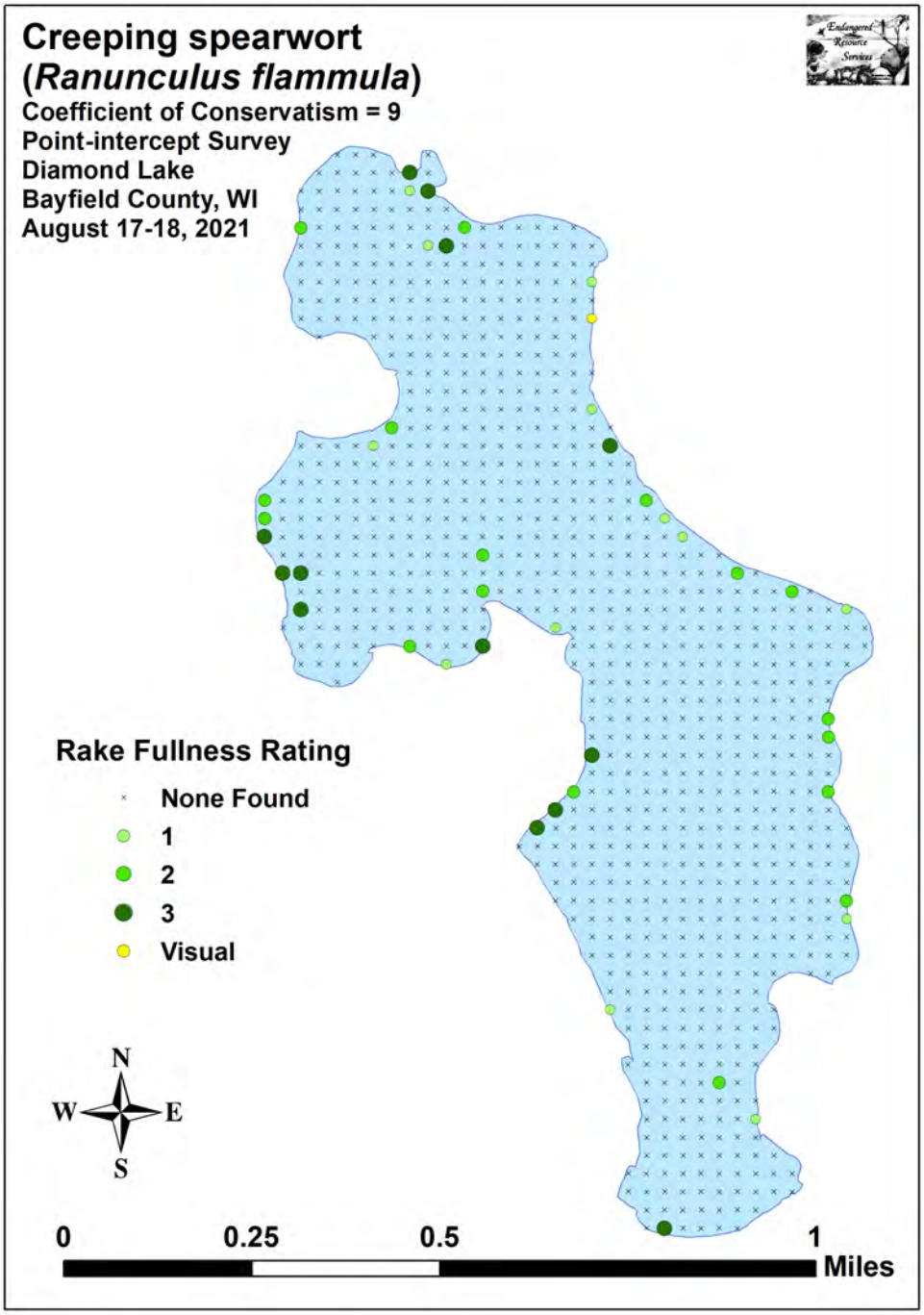
Creeping spearwort
(Ranunculus flammula)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
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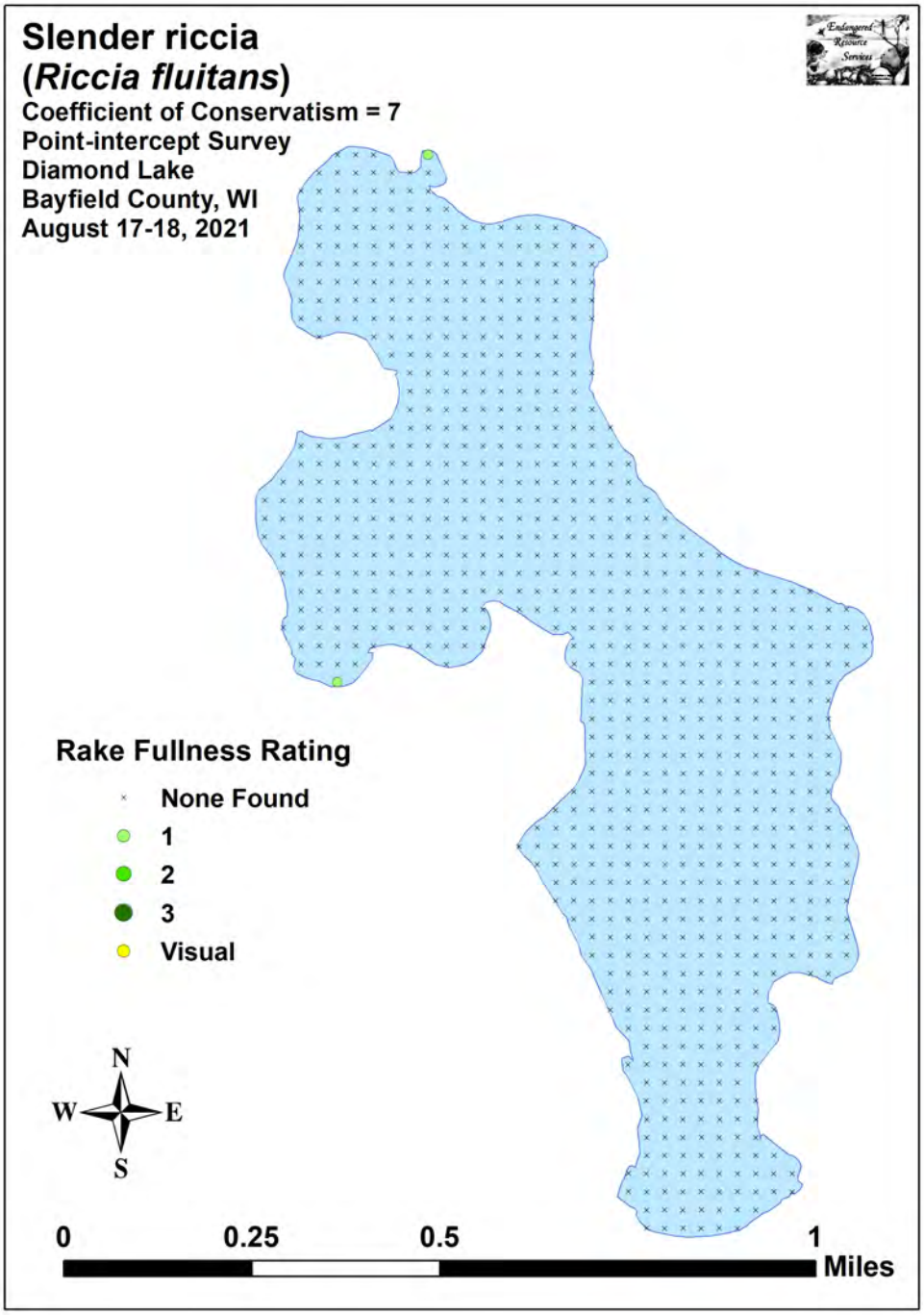
Slender riccia
(Riccia fluitans)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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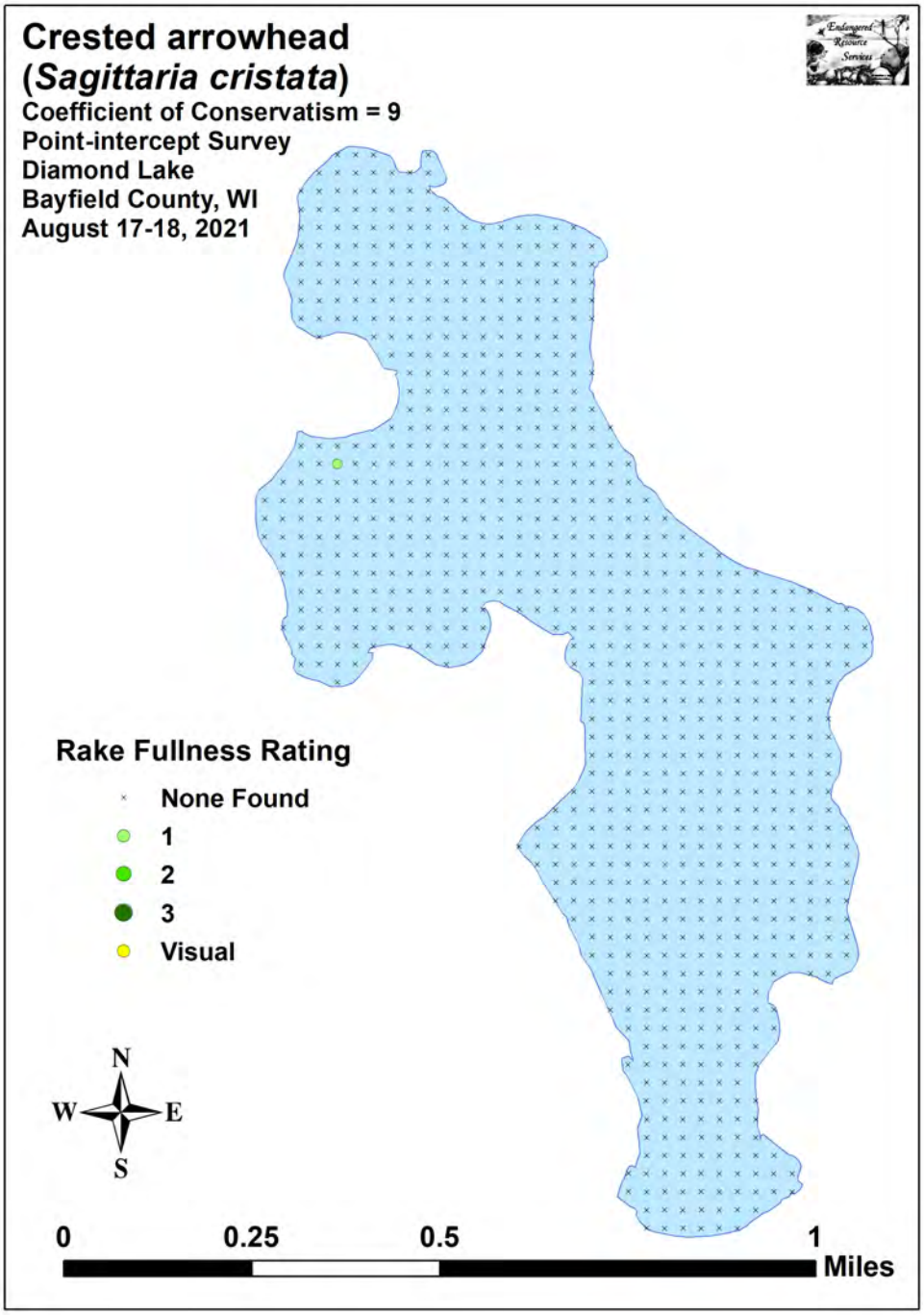
Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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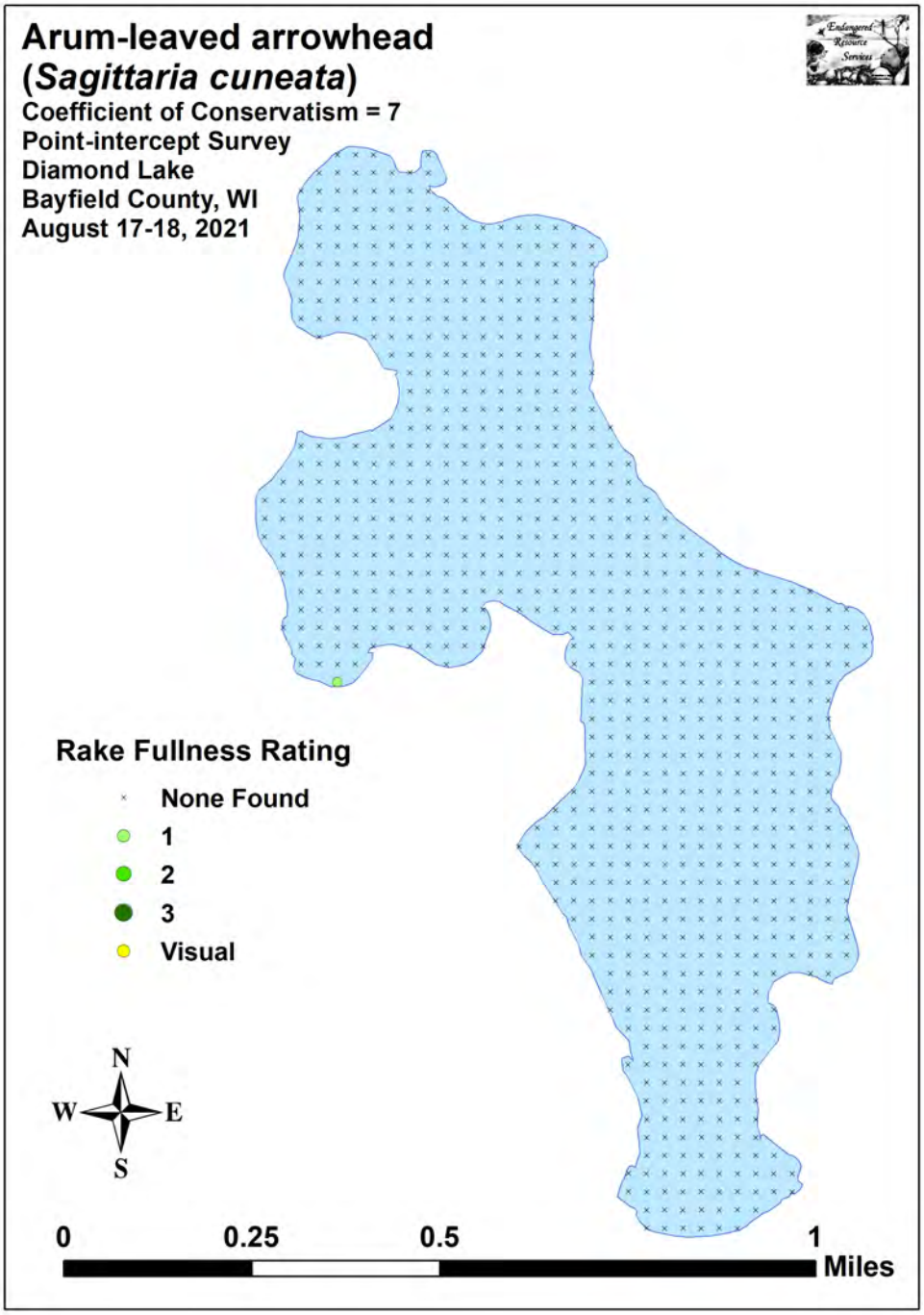
Arum-leaved arrowhead
(Sagittaria cuneata)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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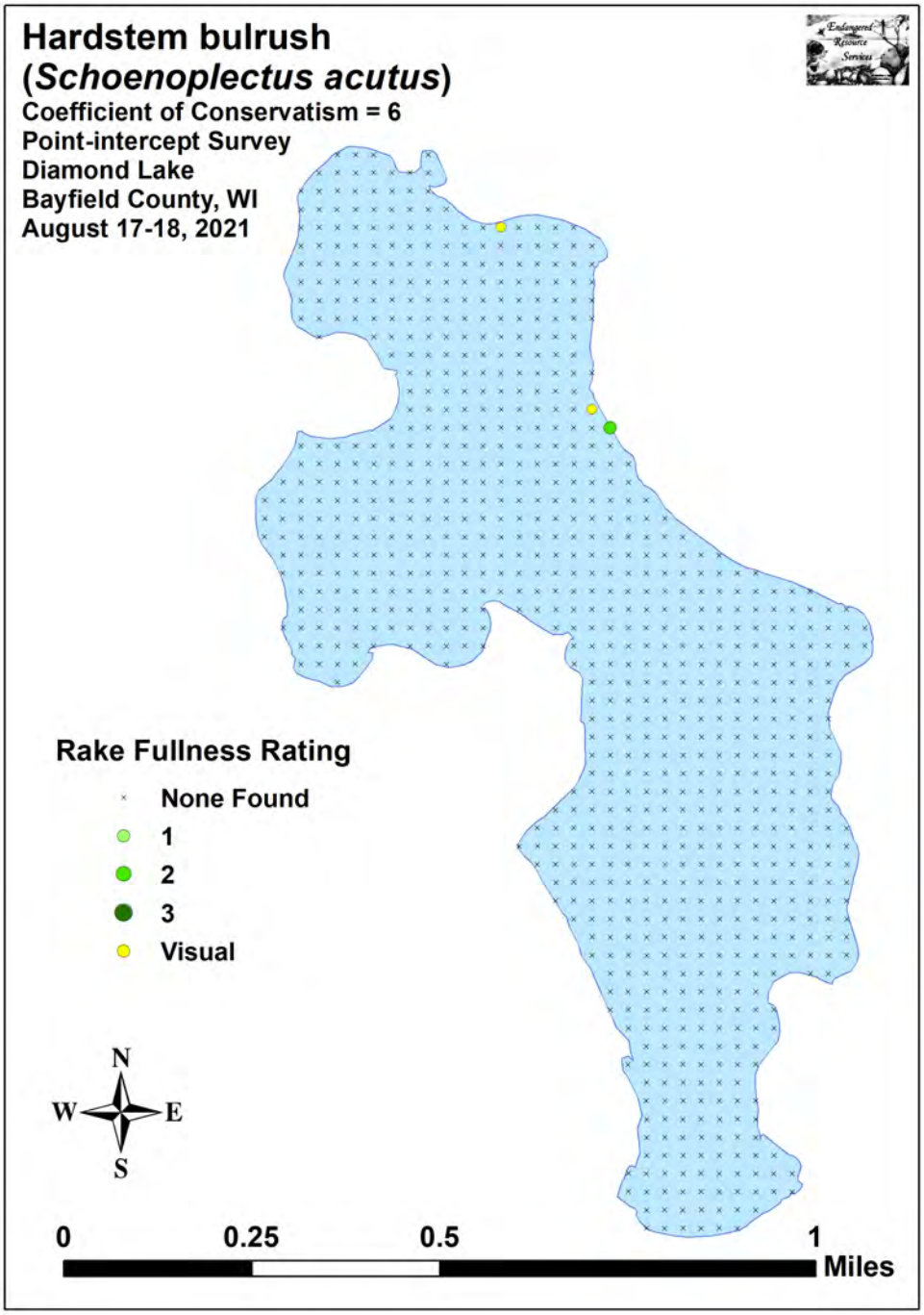
Hardstem bulrush
(Schoenoplectus acutus)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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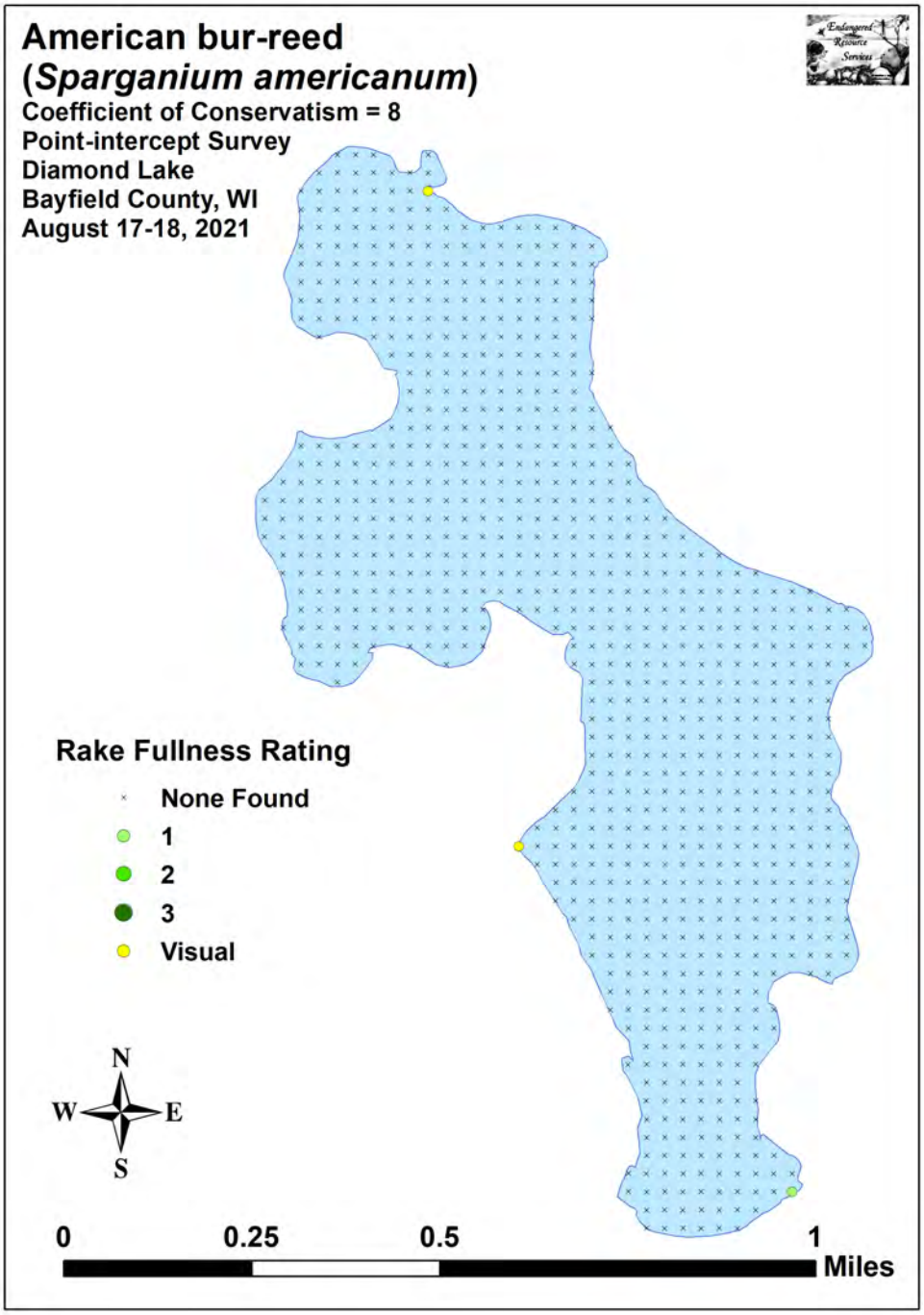
American bur-reed
(Sparganium americanum)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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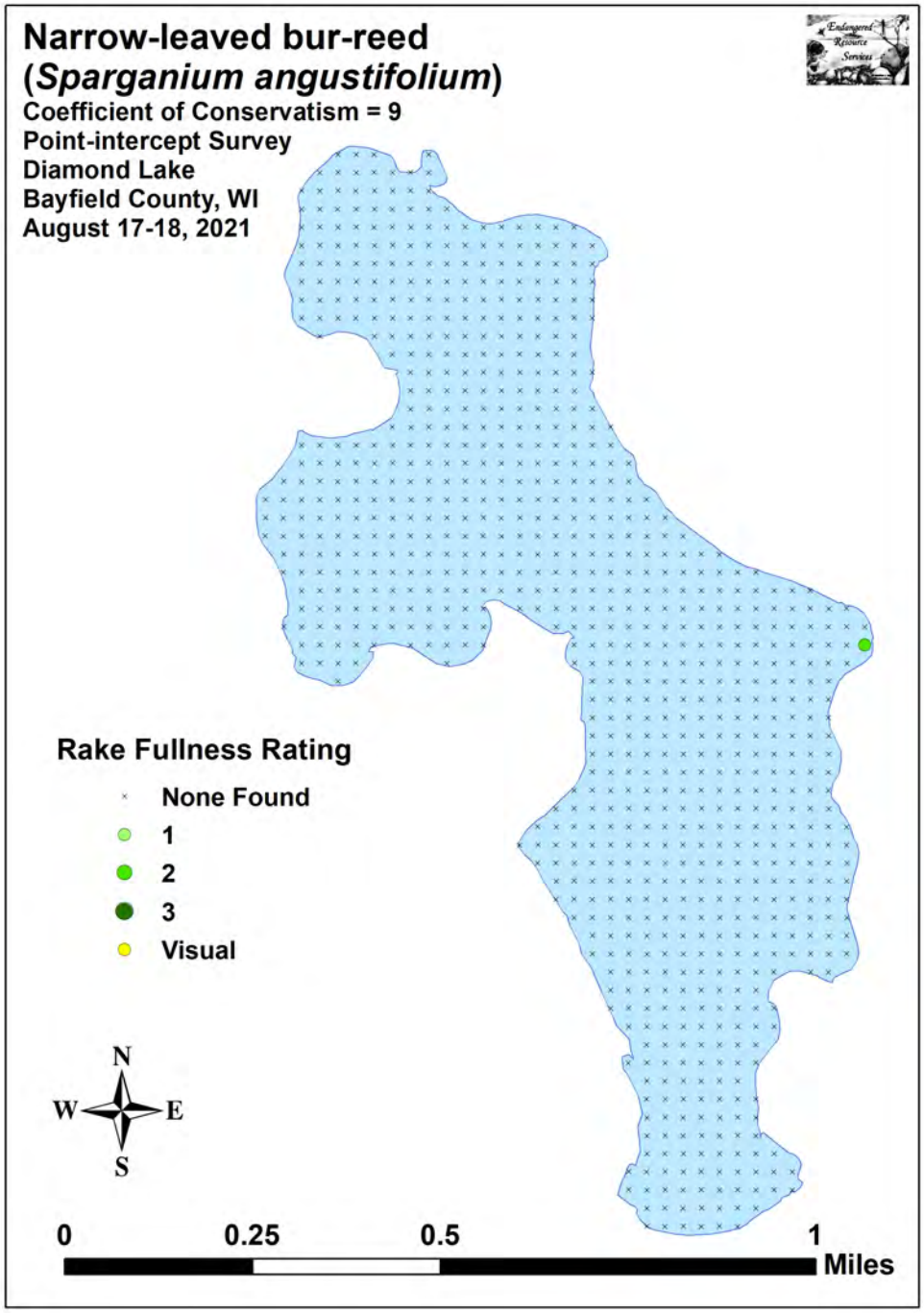
Narrow-leaved bur-reed
(Sparganium angustifolium)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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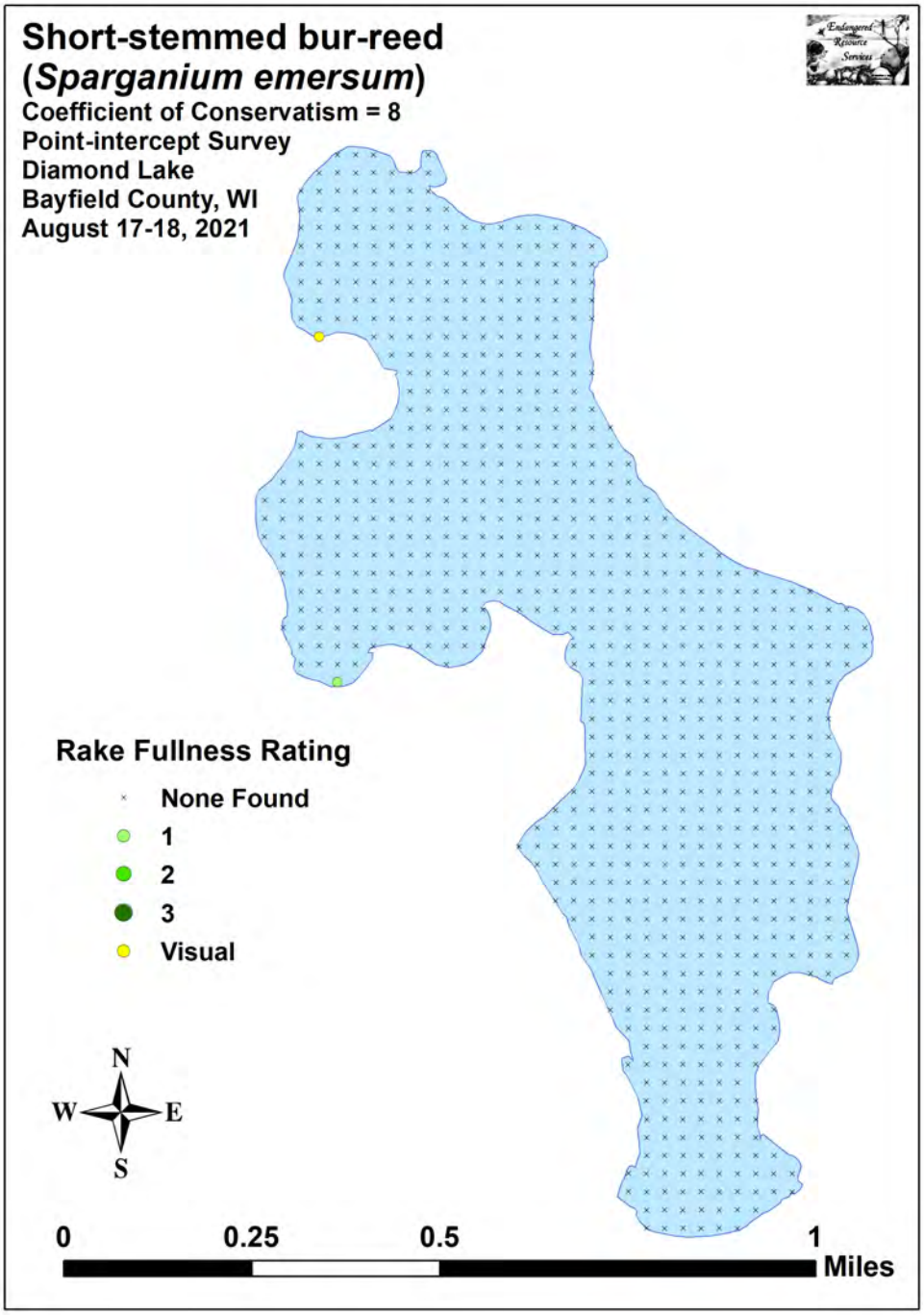
Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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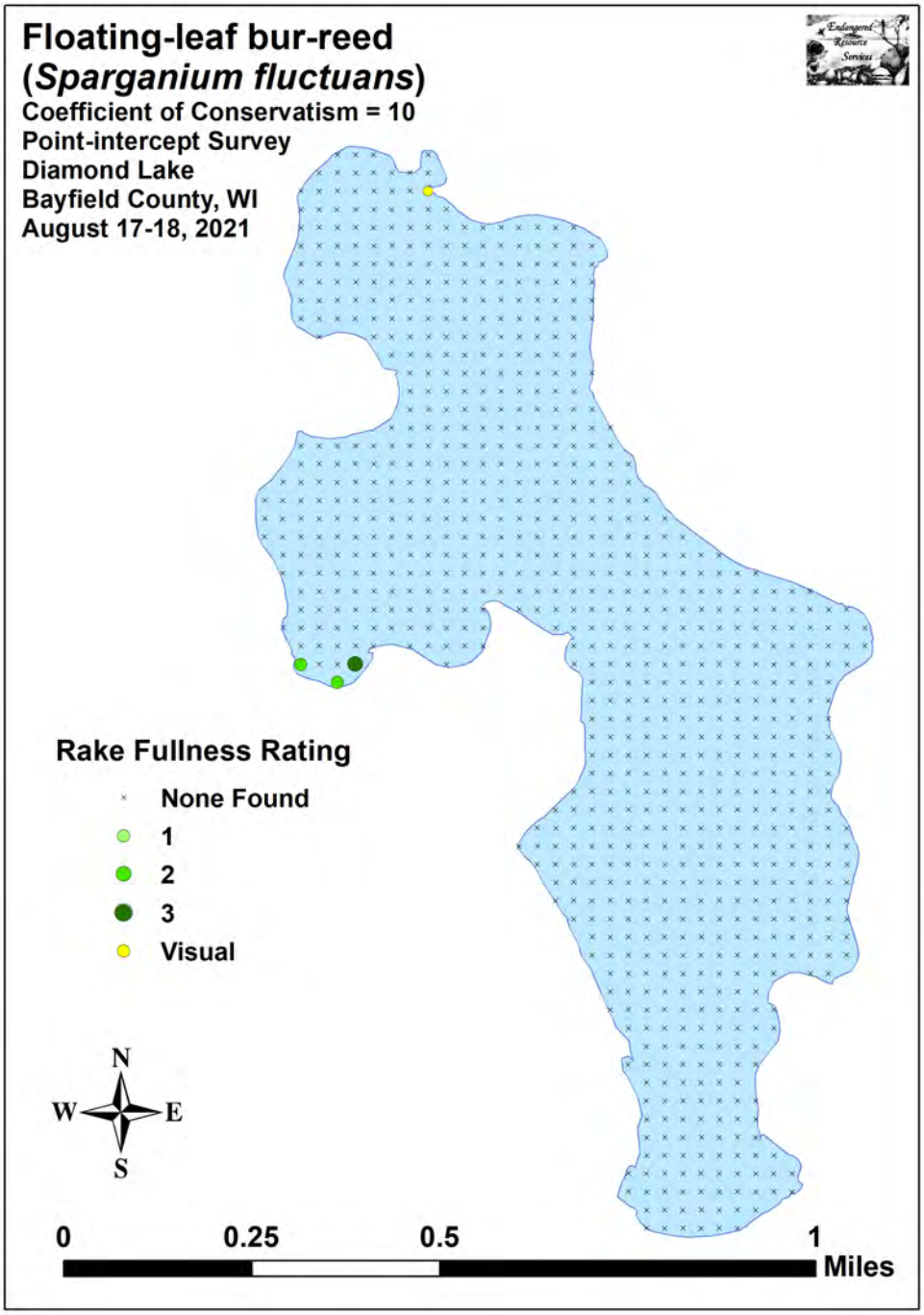
Floating-leaf bur-reed
(Sparganium fluctuans)
Coefficient of Conservatism = 10
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
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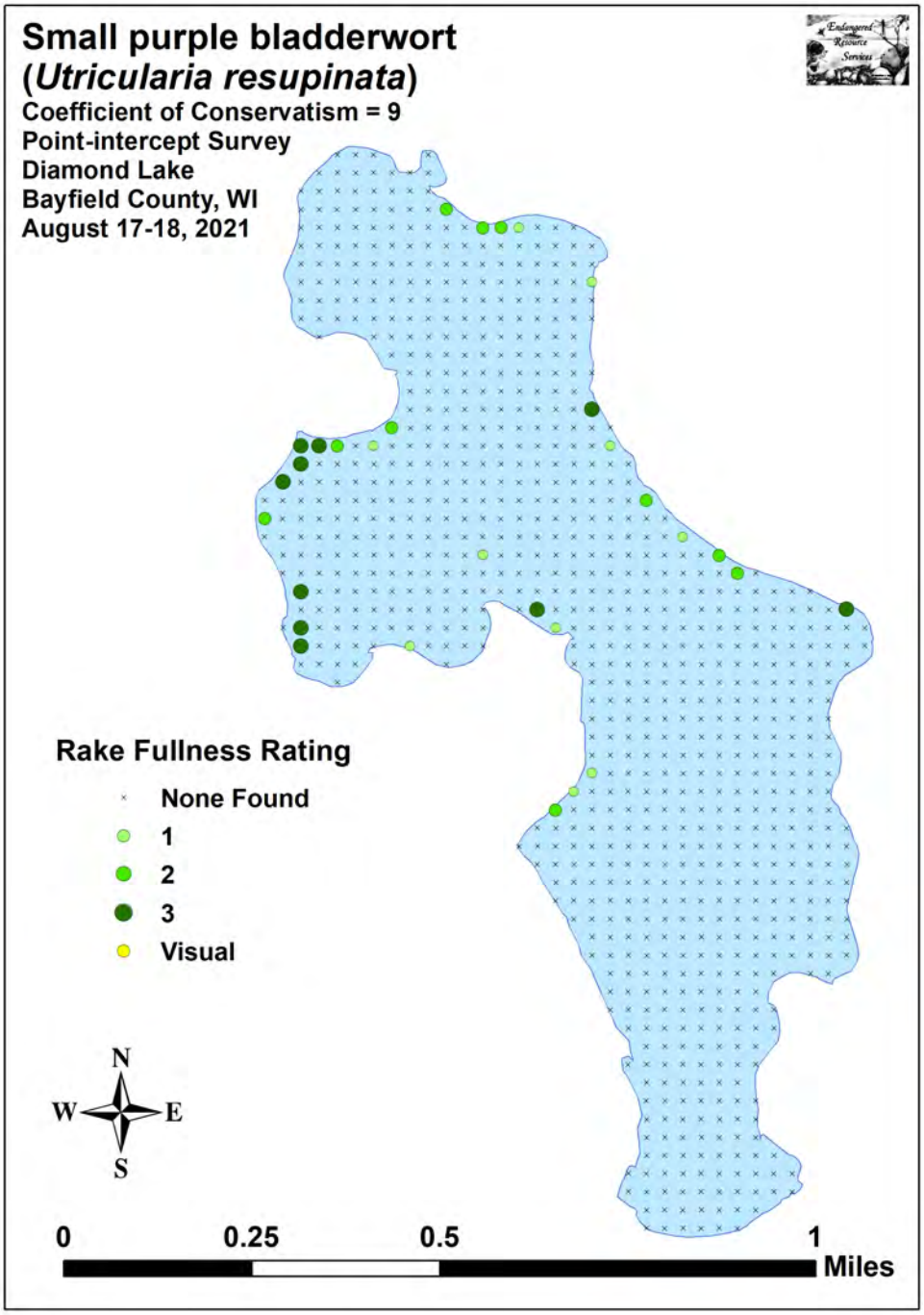
Small purple bladderwort
(Utricularia resupinata)
Coefficient of Conservatism = 9
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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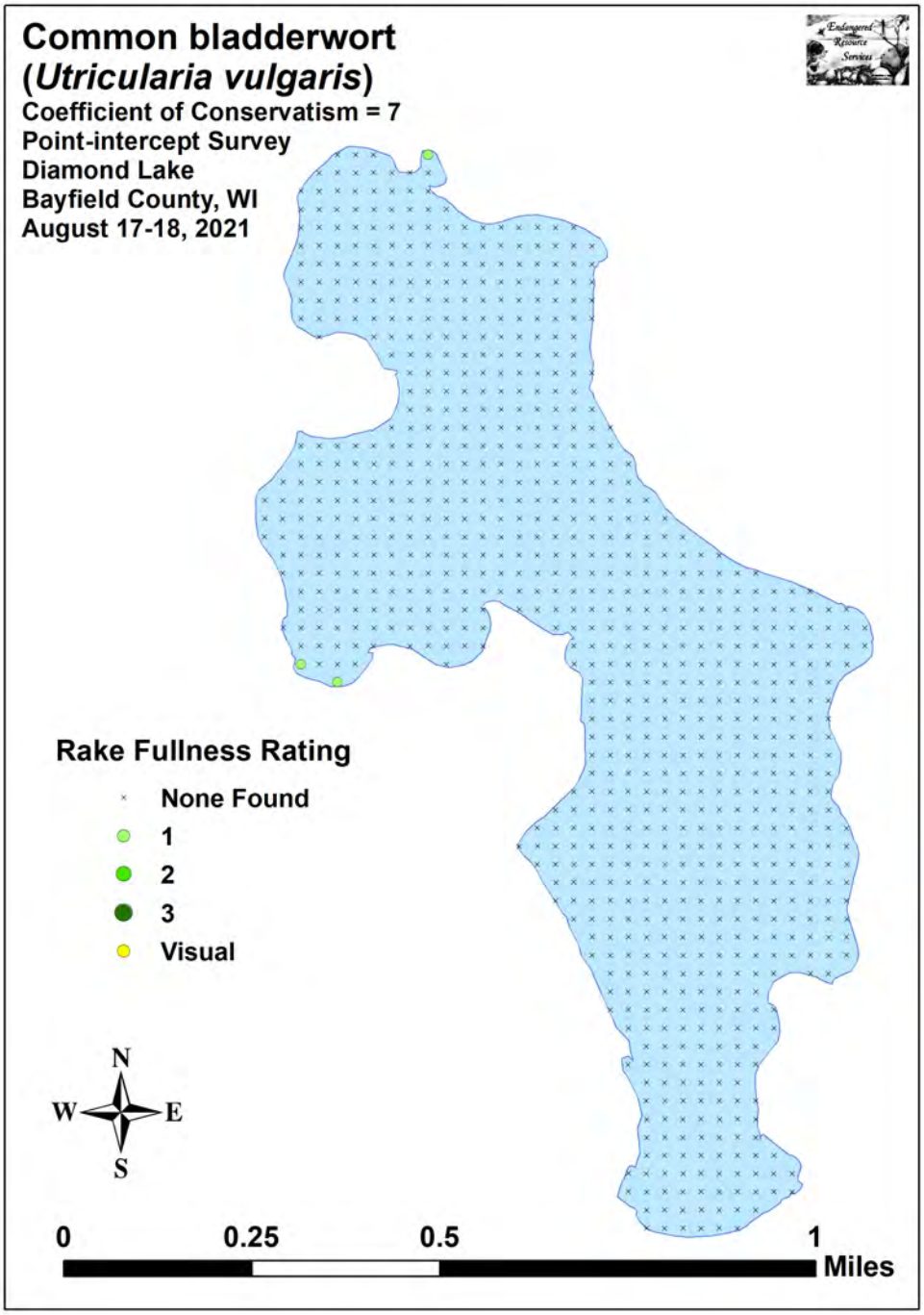
Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Rake Fullness Rating
None Found
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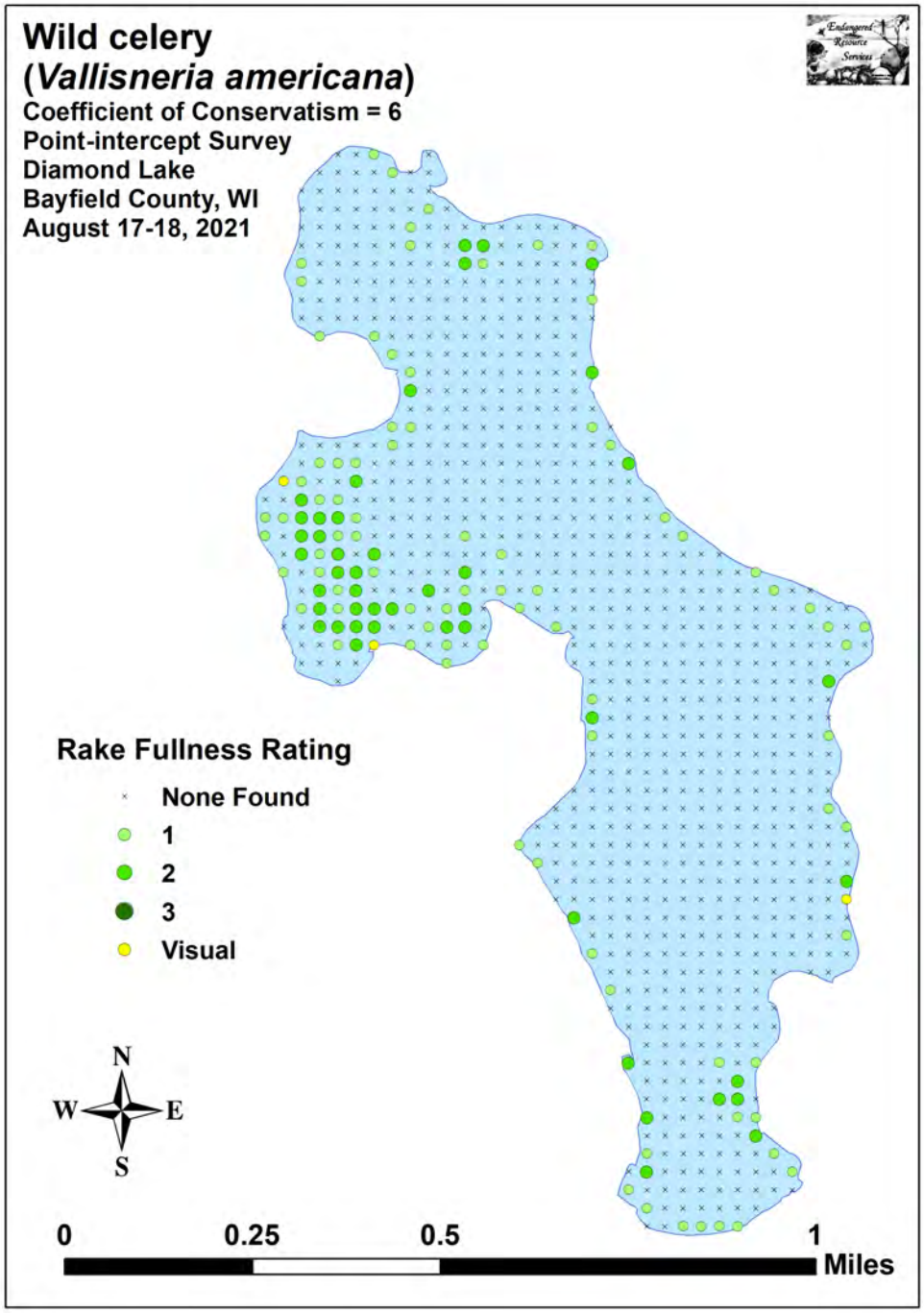
Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point-intercept Survey
Diamond Lake
Bayfield County, WI
August 17-18, 2021
Endangered Resource Services
Rake Fullness Rating
None Found
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Appendix VI: Plant Species Accounts

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: Aquatic moss
Specimen Location: Diamond Lake; N46.26172°, W91.13948°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-002
Habitat/Distribution: Found in <1 meter of water over organic and sandy muck. Uncommon, but widely-scattered in sheltered side bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Schoenoplectus subterminalis*) Water bulrush, (*Sparganium emersum*) Short-stemmed bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Bidens beckii*) **Water marigold**
Specimen Location: Diamond Lake; N46.26229°, W91.15214°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-003
Habitat/Distribution: Found in water from 1.5-2.5 meters deep over sandy muck. Uncommon, but widely-scattered throughout.
Common Associates: (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Brasenia schreberi*) **Watershield**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-004
Habitat/Distribution: Found in water <1 meter deep over generally sandy substrates. Common – especially in the northwest bay.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum alterniflorum*) Alternate-flowered water-milfoil, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Pontederia cordata*) Pickerelweed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Calamagrostis canadensis*) **Blue-joint**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-005
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Common in sunny shoreline areas around much of the lake.
Common Associates: (*Carex pseudocyperus*) False bottle brush sedge, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush, (*Scirpus cyperinus*) Woolgrass

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Calla palustris*) **Wild calla**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-006
Habitat/Distribution: Found in water <0.5 meter deep over organic and sandy muck. Uncommon in scattered locations adjacent to bogs.
Common Associates: (*Brasenia schreberi*) Watershield, (*Comarum palustre*) Marsh cinquefoil, (*Pontederia cordata*) Pickerelweed

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Callitriche palustris*) **Common water-starwort**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-007
Habitat/Distribution: Found in water <1 meter deep over sand and sandy muck. Rare – only plants seen occurred in the seep inlet at the public boat landing.
Common Associates: (*Ceratophyllum echinatum*) Spiny hornwort, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Sparganium americanum*) American bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Carex pseudocyperus*) **False bottle brush sedge**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-008
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush, (*Scirpus cyperinus*) Woolgrass

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Carex crawfordii*) **Crawford's sedge**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-009
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Carex pseudocyperus*) False bottle brush sedge, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush, (*Scirpus cyperinus*) Woolgrass

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Ceratophyllum echinatum*) **Spiny hornwort**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-010
Habitat/Distribution: Found in water <2 meters deep over sandy and organic muck. Uncommon – most plants seen occurred near the public boat landing in the seep inlet and in the "thumb" bay on the far north end of the lake.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Sparganium americanum*) American bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Chara aspera*) **Rough stonewort**
Specimen Location: Diamond Lake; N46.25469°, W91.14034°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-011
Habitat/Distribution: Found in water <1 meter deep over rocky and pure sand substrate. Scattered throughout in nearshore areas.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water milfoil, (*Potamogeton gramineus*) Variable pondweed, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Chara* sp. Likely *globularis*) **Muskgrass**
Specimen Location: Diamond Lake; N46.26229°, W91.15214°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-012
Habitat/Distribution: Found in water 0.5-4.5 meters deep over generally sandy substrates. Common to abundant and widespread throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Comarum palustre*) **Marsh cinquefoil**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-013
Habitat/Distribution: Found in water <0.5 meter deep over organic and sandy muck. Uncommon in scattered locations next to bogs.
Common Associates: (*Brasenia schreberi*) Watershield, (*Calla palustris*) Wild calla, (*Pontederia cordata*) Pickerelweed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Elatine minima*) **Waterwort**
Specimen Location: Diamond Lake; N46.25469°, W91.14034°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-014
Habitat/Distribution: Found in water <0.5 meter deep over mostly rocky substrate. Uncommon in pristine shoreline areas.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Isoetes echinospora*) Spiny-spored quillwort, (*Lobelia dortmanna*) Water lobelia, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Eleocharis acicularis*) **Needle spikerush**
Specimen Location: Diamond Lake; N46.25469°, W91.14034°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-015
Habitat/Distribution: Found in water <1.5 meters deep over sand and rock substrates. Common and widespread throughout.
Common Associates: (*Chara sp*.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Potamogeton gramineus*) Variable pondweed, (*Ranunculus flammula*) Creeping spearwort, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Eleocharis palustris*) **Creeping spikerush**
Specimen Location: Diamond Lake; N46.27008°, W91.14522°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-016
Habitat/Distribution: Found in water <1 meter deep over sand and rock substrates. Scattered beds occurred along shorelines throughout.
Common Associates: (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia, (*Ranunculus flammula*) Creeping spearwort, (*Schoenoplectus acutus*) Hardstem bulrush

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Diamond Lake; N46.26229°, W91.15214°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-017
Habitat/Distribution: Found in water from 0.5-3.5 meters deep over firm substrates. Common and widespread throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton pusillus*) Small pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Eriocaulon aquaticum*) **Pipewort**
Specimen Location: Diamond Lake; N46.26508°, W91.15422°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-018
Habitat/Distribution: Found in water <1.5 meters deep over sandy substrate. Almost exclusively found in the northwest bay where it was locally common.
Common Associates: (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Ranunculus flammula*) Creeping spearwort, (*Sagittaria cristata*) Crested arrowhead, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Equisetum fluviatile*) **Water horsetail**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-019
Habitat/Distribution: Muck and sandy muck in <0.5 meter of water. A small bed occurred at the point in the northwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Diamond Lake; N46.26271°, W91.14557°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-020
Habitat/Distribution: Found in water 0.5-3 meters deep over mostly sandy substrate. Common and widespread throughout.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Myriophyllum alterniflorum*) Alternate-flowered water-milfoil, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Isoetes echinospora*) **Spiny-spored quillwort**
Specimen Location: Diamond Lake; N46.25469°, W91.14034°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-021
Habitat/Distribution: Found in water <1 meter deep over firm substrates. Rare – a few individuals were found at the point – not seen anywhere else.
Common Associates: (*Elatine minima*) Waterwort, (*Eleocharis acicularis*) Needle spikerush, (*Lobelia dortmanna*) Water lobelia, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Isoetes lacustris*) **Lake quillwort**
Specimen Location: Diamond Lake; N46.25220°, W91.14333°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-022
Habitat/Distribution: Found in water 0.5-3 meters deep over firm substrates. Uncommon, but widely-distributed throughout.
Common Associates: (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Juncus effusus*) **Common rush**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-023
Habitat/Distribution: Found in water <0.5 meter deep over organic and sandy muck. Uncommon in scattered locations next to bogs.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Carex pseudocyperus*) False bottle brush sedge, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Juncus pelocarpus*) **Brown-fruited rush**
Specimen Location: Diamond Lake; N46.26305°, W91.14608°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-024
Habitat/Distribution: Found in water <1.5 meters deep over sandy substrate. Common and widespread throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Leersia oryzoides*) **Rice cut-grass**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-025
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Carex pseudocyperus*) False bottle brush sedge, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-026
Habitat/Distribution: Found in water <1 meter deep over sandy and organic muck. Rare – most plants seen occurred near the public boat landing in the seep inlet and in the "thumb" bay on the far north end of the lake.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Pontederia cordata*) Pickerelweed, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Sparganium americanum*) American bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Lobelia dortmanna*) **Water lobelia**
Specimen Location: Diamond Lake; N46.26305°, W91.14608°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-027
Habitat/Distribution: Found in water <1 meter deep over mostly sandy substrate. Common and widespread throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Juncus pelocarpus*) Brown-fruited rush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Myosotis scorpioides*) **Common forget-me-not**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-028
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Carex pseudocyperus*) False bottle brush sedge, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Myriophyllum alterniflorum*)
Alternate-flowered water-milfoil
Specimen Location: Diamond Lake; N46.26271°, W91.14557°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-029
Habitat/Distribution: Found in water 0.5-2 meters deep over mostly sandy substrate. Common and widespread throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Myriophyllum sibiricum*) **Northern water-milfoil**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-030
Habitat/Distribution: Found in water from 0.5-2.5 meters deep over sandy muck. Common and widespread throughout.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Myriophyllum tenellum*) **Dwarf water-milfoil**
Specimen Location: Diamond Lake; N46.26305°, W91.14608°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-031
Habitat/Distribution: Found in water 0.5-2 meters deep over mostly sandy substrate. Common in shoreline areas throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Najas flexilis*) **Slender naiad**
Specimen Location: Diamond Lake; N46.26827°, W91.15075°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-032
Habitat/Distribution: Found in water from 0.5-3.5 meters deep over sandy substrate. Common and widespread throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Nitella flexilis*) **Slender nitella**
Specimen Location: Diamond Lake; N46.26277°, W91.13899°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-033
Habitat/Distribution: Found in water up to 5 meters deep over sandy and sandy muck substrates. Common throughout; especially on the outer edges of the littoral zone.
Common Associates: (*Chara* sp.) Muskgrass, (*Heteranthera dubia*) Water star-grass, (*Najas flexilis*) Slender naiad, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Nitella* sp. likely *mucronata*) **Nitella**
Specimen Location: Diamond Lake; N46.26277°, W91.13899°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-034
Habitat/Distribution: Found in water from 3.5-5 meters deep over firm sandy substrate. Rare; only seen near the point.
Common Associates: (*Chara* sp.) Muskgrass, (*Heteranthera dubia*) Water star-grass, (*Najas flexilis*) Slender naiad, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Nitella tenuissima*) **Small nitella**
Specimen Location: Diamond Lake; N46.25469°, W91.14034°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-035
Habitat/Distribution: Found in water <1 meter deep over firm substrates. Uncommon in scattered pristine shoreline areas.
Common Associates: (*Elatine minima*) Waterwort, (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia, (*Ranunculus flammula*) Creeping spearwort, (*Utricularia resupinata*) Small purple bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Nuphar variegata*) **Spatterdock**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-036
Habitat/Distribution: Found in water from 0.5-2 meters deep over sandy and sandy muck substrates. Scattered throughout.
Common Associates: (*Brasenia schreberi*) Watershield, (*Elodea canadensis*) Common waterweed, (*Nymphaea odorata*) White water lily, (*Potamogeton gramineus*) Variable pondweed, (*Sparganium fluctuans*) Floating-leaf bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-037
Habitat/Distribution: Found in water from 0.5-1.5 meters over sandy and organic muck.
Common Associates: (*Brasenia schreberi*) Watershield, (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Potamogeton gramineus*) Variable pondweed, (*Sparganium fluctuans*) Floating-leaf bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-038
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Carex pseudocyperus*) False bottle brush sedge, (*Leersia oryzoides*) Rice cut-grass, (*Scirpus atrovirens*) Black bulrush

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Polygonum amphibium*) **Water smartweed**
Specimen Location: Diamond Lake; N46.25185°, W91.14332°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-039
Habitat/Distribution: Found in water <1.5 meters deep over firm sand. Uncommon – beds primarily along the southwest shoreline.
Common Associates: (*Chara* sp.) Muskgrass, (*Heteranthera dubia*) Water star-grass, (*Myriophyllum alterniflorum*) Alternate-flowered water-milfoil, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Pontederia cordata*) **Pickerelweed**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-040
Habitat/Distribution: Found in <1 meter of water over sandy muck. Scattered locations; especially common in the northwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Sparganium fluctuans*) Floating-leaf bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton amplifolius*) **Large-leaf pondweed**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-041
Habitat/Distribution: Found in water from 0.5-2.5 meters deep over sand and sandy muck. Common and widespread throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, *Potamogeton praelongus*) White-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: Diamond Lake; N46.26860°, W91.15278°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-042
Habitat/Distribution: Found in water from 0.5-2.5 meters deep over sandy muck. Uncommon, but widely-scattered in sheltered bays throughout.
Common Associates: (*Ceratophyllum echinatum*) Spiny hornwort, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton spirillus*) Spiral-fruited pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton gramineus*) **Variable pondweed**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-043
Habitat/Distribution: Found in water from 0.5-3 meters deep over firm substrate. Comon and widely-distributed throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Eleocharis acicularis*) Needle spikerush, (*Heteranthera dubia*) Water star-grass, (*Najas flexilis*) Slender naiad, (*Nitella* sp.) Nitella, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton natans*) **Floating-leaf pondweed**
Specimen Location: Diamond Lake; N46.26229°, W91.15214°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-044
Habitat/Distribution: Found in water 1-1.5 meters deep over mucky substrate. Rare – scattered individuals occurred in sheltered bays throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nymphaea odorata*) White water lily, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton pusillus*) Small pondweed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton praelongus*) **White-stem pondweed**
Specimen Location: Diamond Lake; N46.26228°, W91.15315°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-045
Habitat/Distribution: Found in water 2 meters deep over mucky substrate. Uncommon in the northwest bay.
Common Associates: (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Potamogeton pusillus - berchtoldii*) **Small pondweed**
Specimen Location: Diamond Lake; N46.26409°, W91.14762°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-046
Habitat/Distribution: Found in water 0.5-4 meters deep over sandy muck. Common and widespread throughout. Many individuals were in fruit (axillary with no keel) which made for easy identification.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Diamond Lake; N46.26271°, W91.14557°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-047
Habitat/Distribution: Found in water from 0.5-3 meters deep over sandy muck. Common and widespread throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Potamogeton robbinsii*) **Fern pondweed**
Specimen Location: Diamond Lake; N46.26299°, W91.15216°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-048
Habitat/Distribution: Found in water from 1-3 meters deep over muck. Abundant in the northwest bay, but only scattered elsewhere.
Common Associates: (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Potamogeton spirillus*) **Spiral-fruited pondweed**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-049
Habitat/Distribution: Found in water from 0.5-3.5 meters deep over sand substrate. Relatively common and widespread.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Najas flexilis*) Slender naiad, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Diamond Lake; N46.26348°, W91.13850°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-050
Habitat/Distribution: Found in water 2-3 meters deep over rock and sand. Rare – present at just two widely-scattered locations.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Isoetes lacustris*) Lake quillwort, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Ranunculus flammula*) **Creeping spearwort**
Specimen Location: Diamond Lake; N46.26305°, W91.14608°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-051
Habitat/Distribution: Found in water <1 meter deep over rocky and sandy substrates. Common to abundant in most shoreline areas.
Common Associates: (*Chara* sp.) Muskgrass, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Utricularia resupinata*) Small purple bladderwort, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Riccia fluitans*) **Slender riccia**
Specimen Location: Diamond Lake; N46.27214°, W91.14982°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-052
Habitat/Distribution: Found in water <1 meter deep over organic muck. Rare – a few individuals occurred in sheltered areas of the north and northwest bays.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Lemna minor*) Small duckweed, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Sagittaria cristata*) **Crested arrowhead**
Specimen Location: Diamond Lake; N46.26508°, W91.15422°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-053
Habitat/Distribution: Found in water <1.5 meters deep over firm sand. Scattered beds occurred in shoreline areas throughout.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum alterniflorum*) Alternate-flowered water-milfoil, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton pusillus*) Small pondweed, (*Vallisneria americana*) Wild celery

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Sagittaria cuneata*) **Arum-leaved arrowhead**
Specimen Location: Diamond Lake; N46.26860°, W91.15278°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-054
Habitat/Distribution: Found in water 1 meter deep over sand. Rare – only plants seen were at the point near the seep inlet.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Heteranthera dubia*) Water star-grass, (*Nuphar variegate*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Sparganium emersum*) Short-stemmed bur-reed, (*Sparganium fluctuans*) Floating-leaf bur-reed, (*Utricularia vulgaris*) Common bladderwort

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Schoenoplectus acutus*) **Hardstem bulrush**
Specimen Location: Diamond Lake; N46.27008°, W91.14522°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-055
Habitat/Distribution: Found in water <0.5 meter deep over sand and rock substrates. Scattered locations primarily in the northern half of the lake.
Common Associates: (*Eleocharis palustris*) Creeping spikerush, (*Heteranthera dubia*) Water star-grass, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia, (*Myriophyllum tenellum*) Dwarf water-milfoil

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Schoenoplectus subterminalis*) **Water bulrush**
Specimen Location: Diamond Lake; N46.26172°, W91.13948°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-056
Habitat/Distribution: Found in <1.5 meters of water over sandy muck. Scattered beds occurred along the south shoreline of the northwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Potamogeton natans*) Floating-leaf pondweed, (*Sparganium fluctuans*) Floating-leaf bur-reed, (*Utricularia vulgaris*) Common bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Scirpus atrovirens*) **Black bulrush**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-057
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus cyperinus*) Woolgrass

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Scirpus cyperinus*) **Woolgrass**
Specimen Location: Diamond Lake; N46.25235°, W91.13912°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-058
Habitat/Distribution: Moist sand and sandy muck at the immediate shoreline. Rare – only plants seen occurred next to the public boat landing.
Common Associates: (*Calamagrostis canadensis*) Blue-joint, (*Leersia oryzoides*) Rice cut-grass, (*Phalaris arundinacea*) Reed canary grass, (*Scirpus atrovirens*) Black bulrush

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Sparganium americanum*) **American bur-reed**
Specimen Location: Diamond Lake; N46.27008°, W91.14522°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-059
Habitat/Distribution: Firm sandy and sandy muck in water <0.5 meter deep. Dense clone beds occurred in scattered locations around the lake.
Common Associates: (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus acutus*) Hardstem bulrush, (*Typha latifolia*) Broad-leaved cattail

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Sparganium angustifolium*) **Narrow-leaved bur-reed**
Specimen Location: Diamond Lake; N46.26508°, W91.15422°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-060
Habitat/Distribution: Found in water <1 meter deep over firm sand. Uncommon but widely-distributed in sheltered shoreline areas.
Common Associates: (*Eriocaulon aquaticum*) Pipewort, (*Pontederia cordata*) Pickerelweed, (*Sagittaria cristata*) Crested arrowhead

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Sparganium emersum*) **Short-stemmed bur-reed**
Specimen Location: Diamond Lake; N46.26172°, W91.13948°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-061
Habitat/Distribution: Found in water <1 meter deep over sandy muck. Rare – scattered individuals occurred in the north and northwest bay.
Common Associates: (*Brasenia schreberi*) Watershield, (*Heteranthera dubia*) Water star-grass, (*Nuphar variegate*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Sagittaria cuneate*) Arum-leaved arrowhead, (*Sparganium fluctuans*) Floating-leaf bur-reed, (*Utricularia vulgaris*) Common bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Sparganium fluctuans*) **Floating-leaf bur-reed**
Specimen Location: Diamond Lake; N46.26172°, W91.13948°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-062
Habitat/Distribution: Found in water <1 meter deep over sandy muck. Uncommon – a few small beds occurred in the northwest and north bays.
Common Associates: (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton natans*) Floating-leaf pondweed, (*Utricularia vulgaris*) Common bladderwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Diamond Lake; N46.27008°, W91.14522°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-063
Habitat/Distribution: Firm sandy muck in and out of water <0.5 meter deep. Rare – only plants seen occurred at the point.
Common Associates: (*Eleocharis palustris*) Creeping spikerush, (*Schoenoplectus acutus*) Hardstem bulrush, (*Sparganium americanum*) American bur-reed

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Utricularia resupinata*) **Small purple bladderwort**
Specimen Location: Diamond Lake; N46.26305°, W91.14608°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-064
Habitat/Distribution: Found in water <1.5 meters deep over sandy substrate. Relatively common and widespread.
Common Associates: (*Chara* sp.) Muskgrass, (*Eleocharis acicularis*) Needle spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Ranunculus flammula*) Creeping spearwort

County/State: Bayfield County, Wisconsin **Date:** 8/18/21
Species: (*Utricularia vulgaris*) **Common bladderwort**
Specimen Location: Diamond Lake; N46.27214°, W91.14982°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-065
Habitat/Distribution: Found in water <1 meter deep over sandy and organic muck. Uncommon – plants were scattered in sheltered areas of the north and northwest bays.
Common Associates: (*Brasenia schreberi*) Watershield, (*Heteranthera dubia*) Water star-grass, (*Nymphaea odorata*) White water lily, (*Sparganium fluctuans*) Floating-leaf bur-reed, (*Potamogeton natans*) Floating-leaf pondweed

County/State: Bayfield County, Wisconsin **Date:** 9/27/21
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Diamond Lake; N46.26862°, W91.15126°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2021-066
Habitat/Distribution: Found in water 0.5-4 meters deep over firm substrate. Common and widespread throughout.
Common Associates: (*Chara* sp.) Muskgrass, (*Heteranthera dubia*) Water star-grass, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Nitella* sp.) Nitella, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton robbinsii*) Fern pondweed

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

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

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

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

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: 2021 Raw Data Spreadsheets

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