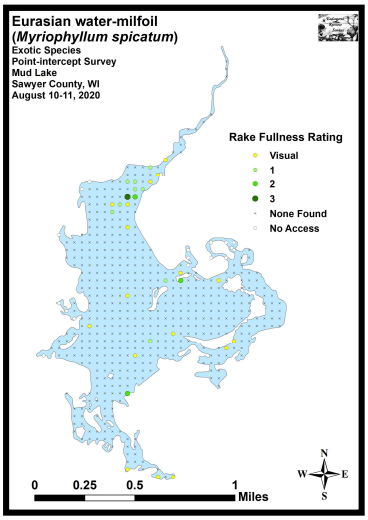
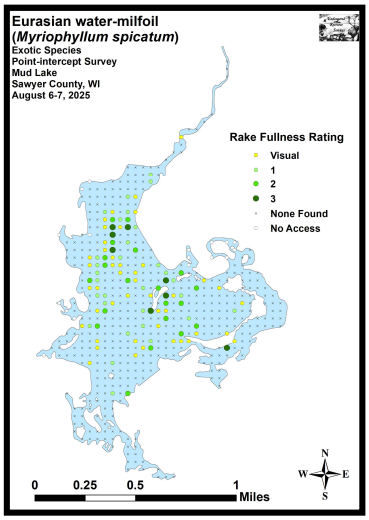
Warm-water Point-intercept Macrophyte Survey
Mud Lake (WBIC: 2434800)
Sawyer County, Wisconsin



2020 EWM Density and Distribution

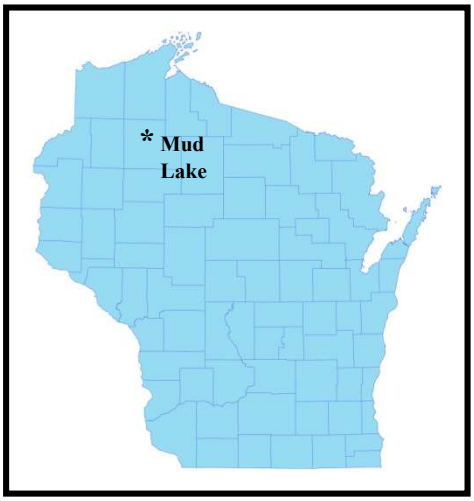


2025 EWM Density and Distribution

Typical mat of EWM in north bay – 8/7/25

Project Initiated by:

The Callahan and Mud Lakes Protective Association,
Lake Education and Planning Services, LLC, and the
Wisconsin Department of Natural Resources (Grant ACEI35725)



One of a very few wild rice plants in the far northwest bay – 8/7/25

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
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Saint Croix Falls, Wisconsin
August 6-7, 2025

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ABSTRACT

Mud Lake (WBIC 2434800) is a 464-acre drainage lake located in north-central Sawyer County, WI. Following the discovery of Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) in 2005, Jeremy Williamson (JW) conducted the lake's original point-intercept survey in 2008, and Ayres Associates developed the lake's original Wisconsin Department of Natural Resources (WDNR) approved Aquatic Plant Management Plan (APMP) which outlined herbicide applications to control the infestation. Using data from our point-intercept survey in 2021, Lake Education and Planning Services, LLC (LEAPS – Dave Blumer) updated and expanded the plan to include manual removal with diver assisted suction harvesting (DASH). As a prerequisite to reupdating their plan in 2026, the CMLPA – again under the direction of LEAPS – and the WDNR requested a warm-water point-intercept survey of all aquatic macrophytes on August 6-7, 2025. During the 2025 survey, we found plants growing at 494 sites which approximated to 99.0% of the entire lake bottom. This was a moderately significant increase **($p<0.01$)** compared to 2020 when 484 points with plants covered 96.6% of the lake. Plant diversity was exceptionally high with a Simpson Index value of 0.94 – up a tick from 0.93 in 2020. Total species richness was also very high with 54 species found in the rake (identical to 2020). This total jumped to 65 species when including visuals and plants found during the boat survey (also identical to 2020). There was an average of 3.91 native species/site with native vegetation – a non-significant decline (p=0.37) from 3.95 species/site in 2020. Total biomass was a high mean total rake fullness of 2.56 - a highly significant increase **($p<0.001$)** from a moderately high mean total rake fullness of 2.40 in 2020. In 2020, Fern pondweed (*Potamogeton robbinsii*), Coontail (*Ceratophyllum demersum*), Common waterweed (*Elodea canadensis*), and Flat-stem pondweed (*Potamogeton zosteriformis*) were the most common macrophyte species. Present at 55.58%, 43.60%, 37.40%, and 34.50% of sites with vegetation, they accounted for 43.06% of the total relative frequency. The 2025 survey found Fern pondweed, Flat-stem pondweed, Large-leaf pondweed (*Potamogeton amplifolius*), and Wild celery (*Vallisneria americana*) were the most widely-distributed species (53.24%, 47.98%, 38.26%, and 28.74% of survey points with vegetation/41.80% of the total relative frequency). Lakewide, from 2020-2025, 16 species showed significant changes in distribution. Coontail and Common waterweed both suffered highly significant declines **($p<0.001$)**; Common bladderwort (*Utricularia vulgaris*) **($p=0.003$)** and White-stem pondweed (*Potamogeton praelongus*) **($p=0.009$)** underwent moderately significant declines; and Short-stemmed bur-reed (*Sparganium emersum*) **($p=0.03$)** saw a significant decline. Conversely, Flat-stem pondweed, Northern water-milfoil (*Myriophyllum sibiricum*), Eurasian water-milfoil, and Various-leaved water-milfoil (*Myriophyllum heterophyllum*) enjoyed highly significant increases **($p<0.001$)**; Slender naiad (*Najas flexilis*) **($p=0.003$)**, Water marigold (*Bidens beckii*) **($p=0.003$)**, and Small bladderwort (*Utricularia minor*) **($p=0.003$)** experienced moderately significant increases; and Large-leaf pondweed **($p<0.05$)**, Watershield (*Brasenia schreberi*) **($p=0.03$)**, Clasping-leaf pondweed (*Potamogeton richardsonii*) **($p=0.03$)**, and Stiff pondweed (*Potamogeton strictifolius*) **($p=0.01$)** saw significant increases. The 49 native index species found in the rake during the August 2025 survey

(down from 50 in 2025) produced a just below average mean Coefficient of Conservatism of 6.6 (identical to 2020). The Floristic Quality Index of 45.9 (down from 46.7 in 2020) was, however, nearly double the median FQI for this part of the state. A single Northern wild rice (*Zizania palustris*) plant was present in the rake at a single point in the northwest bay (identical to 2020), and we also noted rice as a visual at two other points. We estimated there were not more than a few 100 total rice plants in the entire area, and there was no place that would support human harvest. Filamentous algae were present at two points both with a rake fullness of 1 – similar to 2020 when we found these algae at five points with a mean rake fullness of 1.00. In 2008, JW reported EWM at 31 points (7.8% of surveyed points) with 69 additional visual sightings. One of these points had a rake fullness of 3, eight were a 2 (2.3% of surveyed points had a significant infestation), and 22 were a 1 (mean rake fullness of 1.32). In 2020, we found EWM in the rake at 13 points (2.6% of surveyed points) with 17 additional visual sightings. We rated one point a rake fullness of 3, three were a 2 (0.8% of surveyed points had a significant infestation), and nine were a 1 for a mean rake fullness of 1.38. Our 2025 survey found EWM in the rake at 58 points (11.6% of surveyed points) with 44 additional visual records. Eight points rated a rake of 3, 20 points were a 2 (5.6% of surveyed points had a significant infestation), and the remaining 30 points were a 1 resulting in a mean rake fullness of 1.62. When compared to our 2020 survey, this suggested that EWM had undergone a highly significant increase **($p<0.001$)** in distribution that amounted to a **+346.2% increase in coverage**. Although the mean density also increased, this was not significant ($p=0.13$). When broken out by density class, rake fullness 2, rake fullness 1, and visual sightings all saw highly significant increases **($p<0.001$)**; and rake fullness 3 had a significant increase **($p=0.02$)**. Other than EWM, Hybrid cattail (*Typha* X *glauca*) was the only other exotic plant found. It was present at 15 points with a mean rake fullness of 3.00 (up from 12 points with a mean rake fullness of 2.83 in 2020), had one additional visual sighting, and formed dense and often nearly monotypic stands primarily along the lake's northwest shoreline. Continuing to manage EWM in a way that minimizes its impact on Mud Lake's native plants; and proactively working to limit nutrient inputs around the lake which can fuel algal as well as milfoil growth are likely management priorities for the CMLPA as they move forward in updating their APMP.

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INTRODUCTION:

Mud Lake (WBIC 2434800) is a 464-acre drainage lake created by an 8ft dam on the north fork of the Chief River in north-central Sawyer County, Wisconsin in the Town of Round Lake (T41N R7W S27/28 and 33/34). It has a maximum depth of 15ft and an average depth of 6ft. The lake is mesotrophic in nature, and water clarity is good with summer Secchi readings averaging 9.1ft in 2021 – the last year data was available (WDNR 2025). The lake's bottom substrate is primarily sand along the shoreline before transitioning to a sandy muck at most depths over 7ft (Bush et al. 1968) (Figure 1).

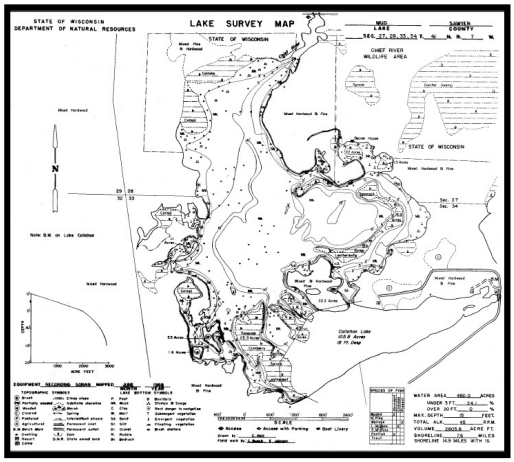


Figure 1: Mud Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) is an exotic invasive plant species that was first identified in Mud Lake in the fall of 2005. Following an initial whole lake point-intercept survey in 2008 (J. Williamson), the Callahan and Mud Lakes Protective Association (CMLPA) and the Sawyer County Land and Water Conservation Department (SCLWC - K. Maki) used a 2009 Wisconsin Department of Natural Resources (WDNR) rapid response grant to hire Ayres Associates to write the lakes' original Aquatic Plant Management Plan (APMP) that called for herbicide applications to control the infestation (Kleczewski 2009). Using data gathered from our 2020 and 2021 late-summer EWM bed mapping surveys and our 2021 whole lake point-intercept surveys, Dave Blumer (Lake Education and Planning Services, LLC - LEAPS) updated this plan in 2022. In addition to continued small-scale herbicide treatments, the new APMP outlined manual removal efforts that included diver assisted suction harvesting (DASH).

Per WDNR expectations (Pamela Toshner/Alex Smith, WDNR – pers. comm.), whole-lake plant surveys on actively managed lakes are normally repeated every five to seven years to remain current. In anticipation of updating their plan in 2026, the CMLPA – again under the direction of LEAPS – applied for and received a WDNR grant (ACEI35725) to help cover the cost of surveys and the APMP review. In order to quantify the current levels of both EWM and the lake's native macrophyte community and to compare those results to our 2020 survey to determine if any changes had occurred over that time, the CMLPA, LEAPS, and the WDNR authorized a warm-water full point-intercept survey. This report is the summary analysis of that survey conducted on August 6-7, 2025.

METHODS:

Warm-water Full Point-intercept Macrophyte Survey:

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, islands, and total lake acres, the WDNR generated the 517-point sampling grid for Mud Lake that was used for the original 2008 survey and our 2020 and 2025 surveys (Appendix I). Prior to beginning the August point-intercept survey, we conducted a general boat survey of the entire system to gain familiarity with the lakes' macrophytes (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006; Skawinski 2019), and a datasheet was built from the species present.

During the survey, we located each point with a GPS (Garmin 76CSx), recorded a depth reading with a metered pole, and took a rake sample. All plants on the rake, as well as any that were dislodged by the rake, were identified and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of all plants within six feet of the sample point not found in the rake. In addition to a rake rating for each species, a total rake fullness rating was also noted. Substrate (bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

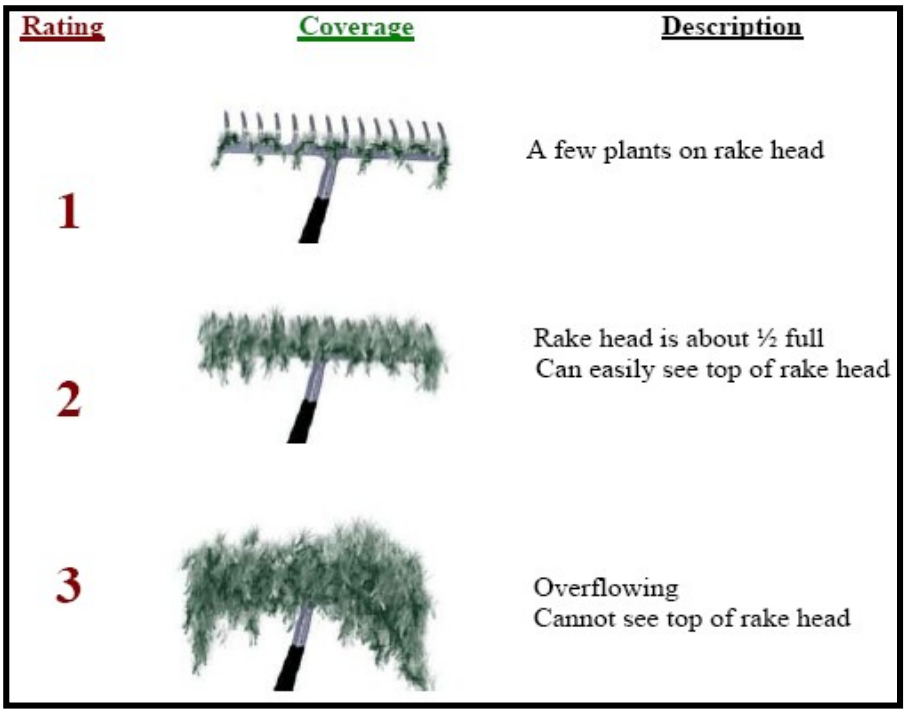


Figure 2: Rake Fullness Ratings (UWEX 2010)

DATA ANALYSIS:

In an effort to visualize the changes on the lake since our first point-intercept survey in 2020, we included summary statistics and maps in the 2025 report. During the 2025 survey, we entered all data collected into the standard WDNR aquatic plant management spreadsheet (Appendix II) (UWEX 2010). From this, we calculated the following:

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

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

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

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

Frequency of occurrence example:

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

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

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

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

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

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

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

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

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

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

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

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

Average rake fullness: This value is the average of the total rake fullness of all species found in the rake at each point. 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 (Tables 2 and 3).

Relative frequency example:

Suppose that we sample 100 points and found four 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 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. Mud Lake is in the Northern Lakes and Forests Ecoregion (Tables 4 and 5).

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

Comparisons to the Past Survey: We compared data from our 2020 and 2025 surveys to see if there were any significant changes in the lake's vegetation (Tables 2 and 3) (Figures 8 and 20). For individual plant species as well as count data, we used the Chi-square analysis on the WDNR Pre/Post survey worksheet. For comparing averages (mean species/point and mean rake fullness/point), we used t-tests. Differences were considered significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$ (UWEX 2010). It should be noted that we used the number of littoral points surveyed (501 in 2020/499 in 2025) as the basis for "sample points" in the comparison.

RESULTS:

Warm-water Full Point-intercept Macrophyte Survey:

The Mud Lake sampling grid contains 517 points (Appendix I). However, we found that 18 of them were not accessible by boat or kayak AND were out of sight so we could not visually estimate the density and species at the location using a compass, range finder, and binoculars (we did this when it was a dense stand of exotic cattails or when it was a sedge meadow and we could confidently identify the dominant species present). Because of this, we only surveyed 499 points (down from 501 in 2020 when water levels were approximately 0.5ft higher). Depth readings taken at these points revealed most of the shorelines drop off gently into 6-8 feet of water. The only areas deeper than this occurred in the central river channel and in the 9-14ft deep bowl on the lake's eastern side. Floating and partially emergent mud islands in the center of the lake also produced unexpectedly shallow areas (Figure 3) (Appendix III).

Sandy and organic muck areas dominated the lake bottom and accounted for 97.6% (488 points) of the survey sites. Most of the pure sand areas (2.4% - 12 points) occurred along the immediate shoreline and in the river channel (Figure 3) (Appendix III).

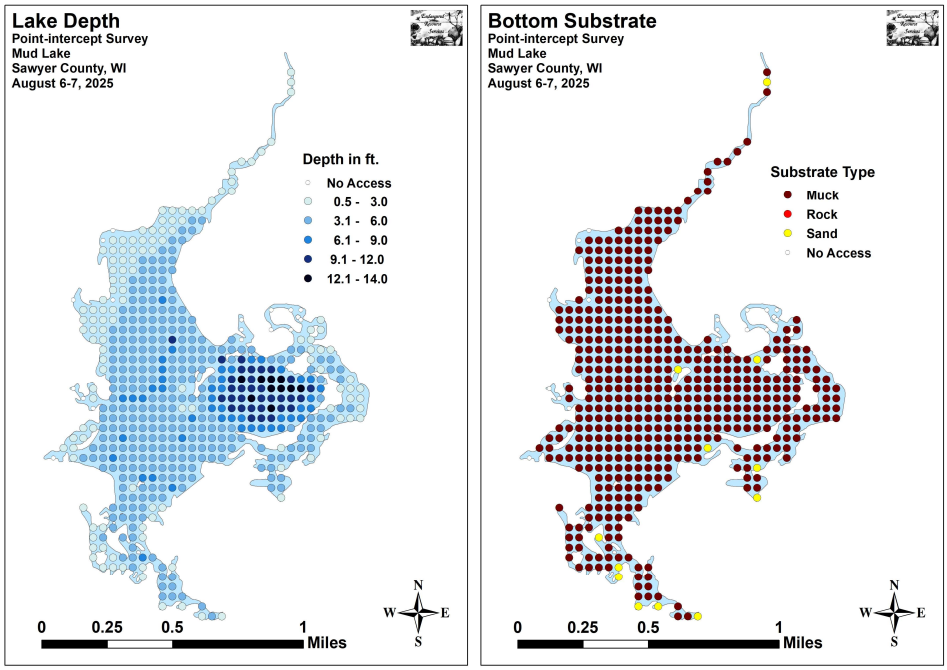


Figure 3: Lake Depth and Bottom Substrate

In 2025, we found plants growing to 13.0ft (down from 14.0ft in 2020) and the entire lake fell within the littoral zone (Table 1). The 494 points with macrophytes extrapolated to 99.0% vegetative coverage. This was a moderately significant increase **($p<0.01$)** compared to 2020 when 484 points with plants covered 96.6% of the lake (Figure 4) (Appendix IV).

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020 and August 6-7, 2025

Summary Statistics:	2020	2025
Total number of points sampled	501	499
Total number of sites with vegetation	484	494
Total number of sites shallower than the max. depth of plants	501	499
Freq. of occur. at sites shallower than max. depth of plants	96.6	99.0
Simpson Diversity Index	0.93	0.94
Maximum depth of plants (ft)	14.0	13.0
Mean depth of plants (ft)	5.3	4.7
Median depth of plants (ft)	5.5	5.0
Number of sites sampled using rake on Rope (R)	0	0
Number of sites sampled using rake on Pole (P)	485	484
Ave. number of all species per site (shallower than max depth)	3.84	3.98
Ave. number of all species per site (veg. sites only)	3.97	4.02
Ave. number of native species per site (shallower than max depth)	3.81	3.87
Ave. number of native species per site (sites with native veg. only)	3.95	3.91
Species richness	54	54
Species richness (including visuals)	56	58
Species richness (including visuals and boat survey)	65	65
Mean rake fullness (veg. sites only)	2.40	2.56

Growth in 2025 was slightly skewed to shallow water as the mean depth of 4.7ft was lower than the median of 5.0ft. This was similar to 2020 when we calculated a mean of 5.3ft and a median of 5.5ft – changes that reflect the approximate decline in water levels (Figure 5).

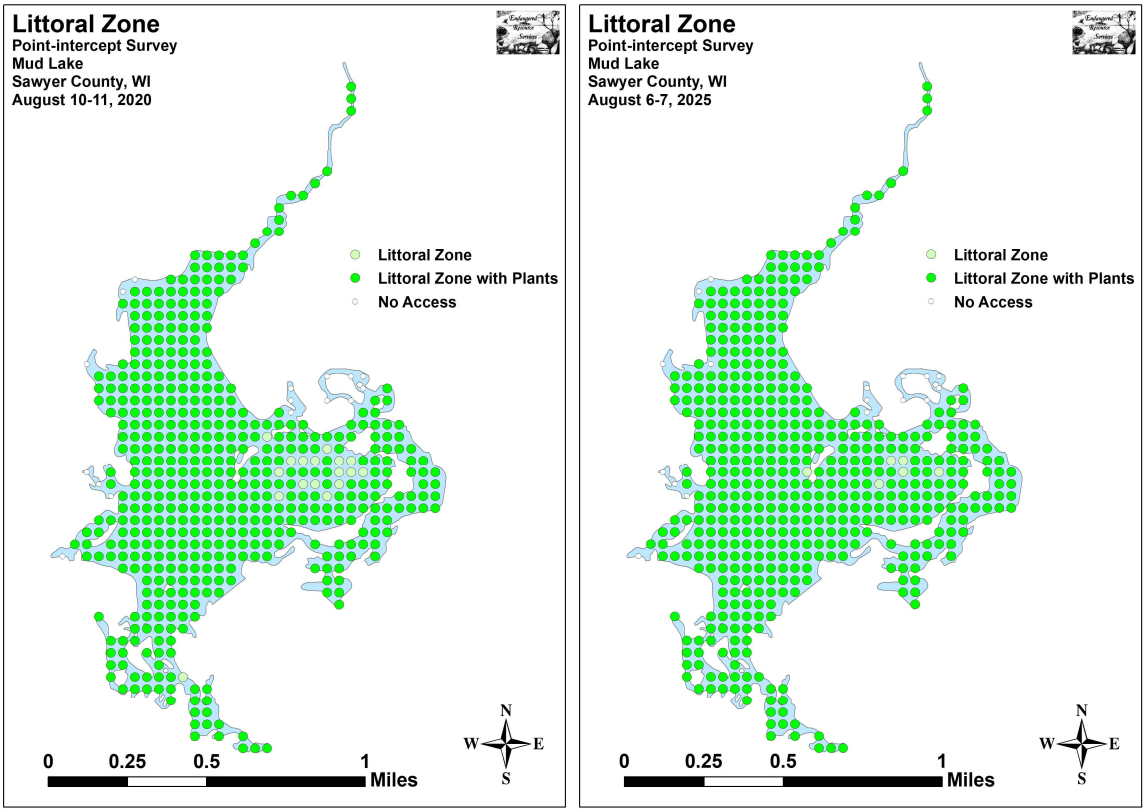


Figure 4: 2020 and 2025 Littoral Zone

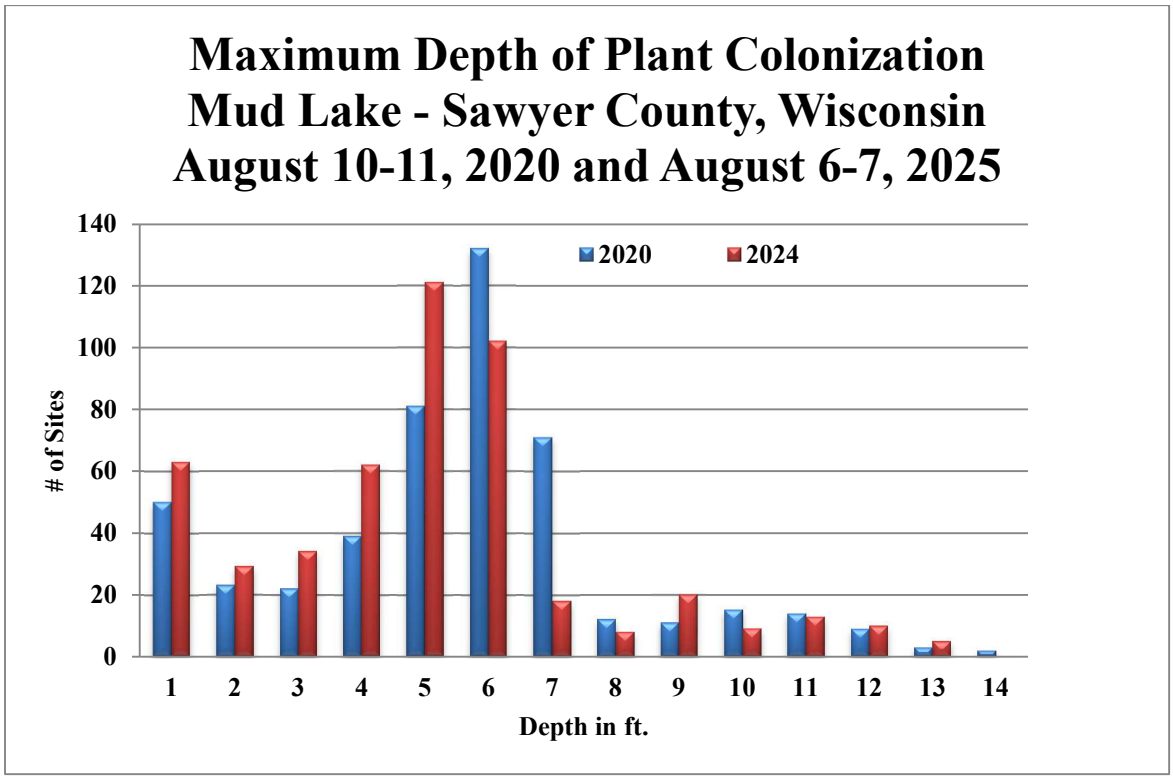


Figure 5: 2020 and 2025 Plant Colonization Depth Chart

Plant diversity was exceptionally high in 2025 with a Simpson Index value of 0.94 – up a tick from 0.93 in 2020. Total richness was also very high with 54 species found in the rake – identical to 2020. This total jumped to 65 species when including visuals and plants found during the boat survey – also identical to 2020.

Mean native species richness at sites with native vegetation experienced a non-significant decline (p=0.37) from 3.95 species/site in 2020 to 3.91 species/site in 2025. Visual analysis of the maps suggested widespread declines in the central flat were offset by increases around the deep hole in the eastern bay (Figure 6) (Appendix IV).

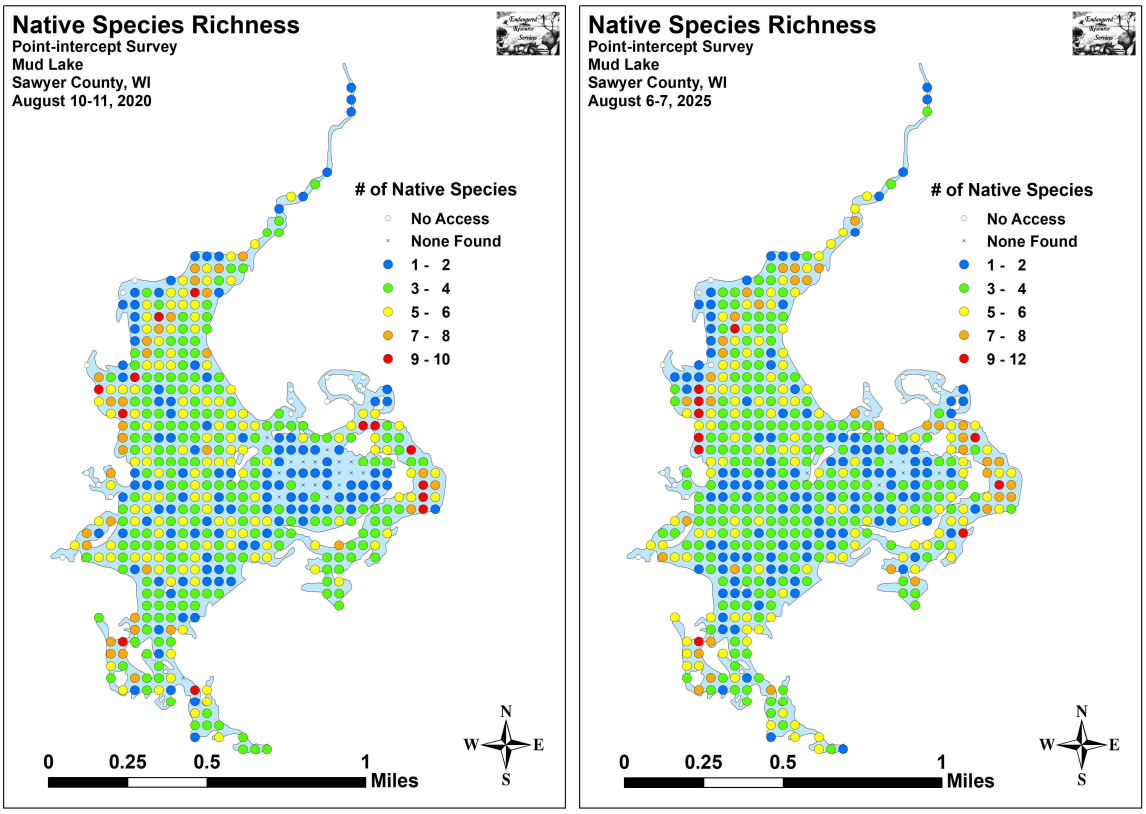


Figure 6: 2020 and 2025 Native Species Richness

Total biomass underwent a highly significant increase **(p<0.001)** from a moderately high mean total rake fullness of 2.40 in 2020 to a high mean of 2.56 in 2025. Visual analysis of the maps suggested most of these increases occurred on the north end of the central flat in areas that were dominated by canopied mats of Eurasian water-milfoil (Figure 7) (Appendix IV).

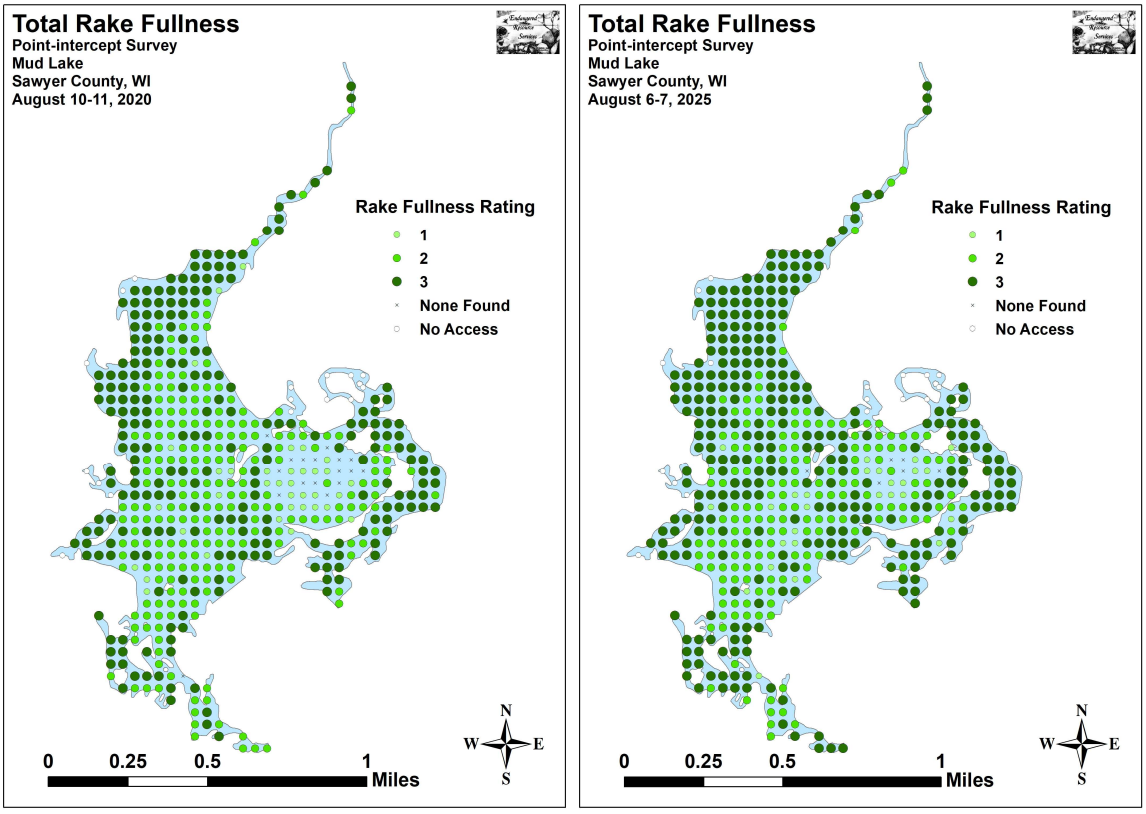


Figure 7: 2020 and 2025 Total Rake Fullness

Mud Lake Plant Community:

The Mud Lake ecosystem is home to an exceptionally diverse and rich plant community that is typical of mesotrophic lakes in northern Wisconsin that have tannic-stained water. This community can be subdivided into four distinct zones (emergent, shallow submergent, floating-leaf, and deep submergent) with each zone having its own characteristic functions in the lake ecosystem. Depending on the local bottom type (sand, rock, sandy muck, or nutrient-rich organic muck), these zones often had somewhat different species present.

In shallow areas, beds of emergent plants prevent erosion by stabilizing the 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, Bluejoint (*Calamagrostis canadensis*) was common around forested edges of the lake. In adjacent wetlands and on the bog edges and islands, this species was replaced by a rich sedge community that was dominated by Narrow-leaved woolly sedge (*Carex lasiocarpa*) but also included Gray bog sedge (*Carex canescens*), Bottle brush sedge (*Carex comosa*), Star sedge (*Carex echinata*), and Three-way sedge (*Dulichium arundinaceum*).

Bluejoint (Routledge 2013)

Narrow-leaved woolly sedge (Navratil 2016)

Gray bog sedge (Berkley 2020)

Bottle-brush sedge (Penta 2009)

Star sedge (Pokorny 2013)

Three-way sedge (GMNRI 2016)

Scattered among the sedges, we also found aquatic moss, Wild calla (*Calla palustris*), Marsh cinquefoil (*Comarum palustre*), Bald spikerush (*Eleocharis erythropoda*), Slender cotton-grass (*Eriophorum gracile*), Northern St. John's-wort (*Hypericum boreale*), Northern blue flag (*Iris versicolor*), Softstem bulrush (*Schoenoplectus tabernaemontani*), and Broad-leaved cattail (*Typha latifolia*).

Aquatic moss (Skawinski 2010)

Wild calla (Pierce 2001)

Marsh cinquefoil (Myrhatt 2012)

Bald spikerush (Schipper 2019)

Slender cotton-grass (Cameron 2020)

Northern St. John's-wort (Crow 2018)

Northern blue flag (Tracey 2007)

Common rush (Eggers 2008)

Softstem bulrush (Schwarz 2011)

Woolgrass (Colby 2012)

Shallow areas over firm sand supported few emergents other than a handful of Hardstem bulrush (*Schoenoplectus acutus*). In areas where there tended to be a layer of nutrient-poor muck over firm sand, we occasionally found dense beds of Water horsetail (*Equisetum fluviatile*), Pickerelweed (*Pontederia cordata*), Common arrowhead (*Sagittaria latifolia*), American bur-reed (*Sparganium americanum*), and Hybrid cattail (*Typha* X *glauca*).

Hardstem bulrush stand (Dziuk 2015)

Hardstem bulrush flowers (Elliot 2007)

Water horsetail (Elliot 2007)

Pickerelweed (Berg 2024)

Common arrowhead (Young 2006)

American bur-reed (Hubick 2018)

Areas among the floating bogs on the lake's northwest side that had thicker soft muck supported open, often low-density beds of Water bulrush (*Schoenoplectus subterminalis*), Short-stemmed bur-reed (*Sparganium emersum*), Small bur-reed (*Sparganium natans*), and Northern wild-rice (*Zizania palustris*).

Water bulrush (Dziuk 2016)

Short-stemmed bur-reed (Cameron 2016)

Small bur-reed (Taylor 2004)

Northern wild rice flower (Haines 2018)

A narrow ring of firm sand occurred in scattered nearshore (<6ft deep) areas. These environments naturally tend to have low total biomass as the nutrient-poor substrate provides habitat most suited to relatively fine-leaved submergent species such as Muskgrasses (*Chara* sp.), Slender naiad (*Najas flexilis*), and Stiff pondweed (*Potamogeton strictifolius*).

Muskgrass (Ivanov 2006)

Muskgrass (Fischer 2018)

Slender naiad (Cameron 2013)

Stiff pondweed (Cameron 2019)

If these shallow sandy areas had even a small amount of muck, we also tended to find Water star-grass (*Heteranthera dubia*), Variable pondweed (*Potamogeton gramineus*), Clasping-leaf pondweed (*Potamogeton richardsonii*), and Wild celery (*Vallisneria americana*). These species, along with the emergents, work to stabilize the bottom and prevent wave action erosion.

Water star-grass (Mueller 2010)

Variable pondweed (Koshere 2002)

Clasping-leaf pondweed (Cameron 2013)

Wild celery (Dalvi 2009)

Nearshore nutrient-poor substrates rarely provided habitat for floating-leaf species. In this environment, we found a few widely-scattered individuals of species that only occasionally produce floating-leaves like Large-leaf pondweed (*Potamogeton amplifolius*) and Variable pondweed. In areas with sandy muck, especially near the floating muck bogs, these species were joined by scattered beds of Alpine pondweed (*Potamogeton alpinus*), Ribbon-leaf pondweed (*Potamogeton epihydrus*), Floating-leaf pondweed (*Potamogeton natans*), and, in the river inlet, Long-leaf pondweed (*Potamogeton nodosus*) and Arun-leaved arrowhead (*Sagittaria cuneata*).

Large-leaf pondweed (Dziuk 2018)

Alpine pondweed (Holm 2016)

Ribbon-leaf pondweed (Petroglyph 2007)

Floating-leaf pondweed (Petroglyph 2007)

Floating-leaf pondweed (Petroglyph 2007)

Arum-leaved arrowhead in the river inlet – 8/7/25)

In the most nutrient-rich substrates, we found often dense beds containing Watershield (*Brasenia schreberi*), Spatterdock (*Nuphar variegata*), White water lily (*Nymphaea odorata*), and Water smartweed (*Polygonum amphibium*). We also found a few scattered Vasey's pondweed (*Potamogeton vaseyi*) and Floating-leaf bur-reed (*Sparganium fluctuans*). 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)

Vasey's pondweed (Cameron 2016)

Floating-leaf bur-reed pondweed (Dziuk 2017)

Growing among these floating-leaf species, we also found Water marigold (*Bidens beckii*), Various-leaved water-milfoil (*Myriophyllum heterophyllum*), Whorled water-milfoil (*Myriophyllum verticillatum*), and, in the river inlet, Blunt-leaf pondweed (*Potamogeton obtusifolius*). Along with these rooted plants, we noted a very limited numbers of "duckweeds" including Small duckweed (*Lemna minor*) and Large duckweed (*Spirodela polyrhiza*).

Water marigold (Dziuk 2012)

Various-leaved water-milfoil in bloom in the north bay – 8/7/25

Whorled water-milfoil (Cameron 2018)

Blunt-leaf pondweed (Dziuk 2017)

Small duckweed (Kramer 2013)

Large duckweed (Thomas 2014)

This environment also supported a variety of carnivorous bladderworts including Creeping bladderwort (*Utricularia gibba*), Flat-leaf bladderwort (*Utricularia intermedia*), Small bladderwort (*Utricularia minor*), and Common bladderwort (*Utricularia vulgaris*). Rather than drawing nutrients up through roots like other plants, bladderworts trap zooplankton and minute insects in their bladders, digest their prey, and use the nutrients to further their growth.

Creeping bladderwort showing bladders for catching prey (Eyewed 2010)

Flat-leaf bladderwort (Woods 2012)

Small bladderwort (Cameron 2019)

Common bladderwort flowers among lilypads (Hunt 2010)

Sandy muck areas in water over 6ft deep supported diverse stands of Water marigold, Northern water-milfoil (*Myriophyllum sibiricum*), Eurasian water-milfoil, Slender naiad, Large-leaf pondweed, White-stem pondweed (*Potamogeton praelongus*), and Wild celery. 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.

Northern water milfoil (Berg 2007)

Eurasian water milfoil (Berg 2007)

Large-leaf pondweed (Dziuk 2018)

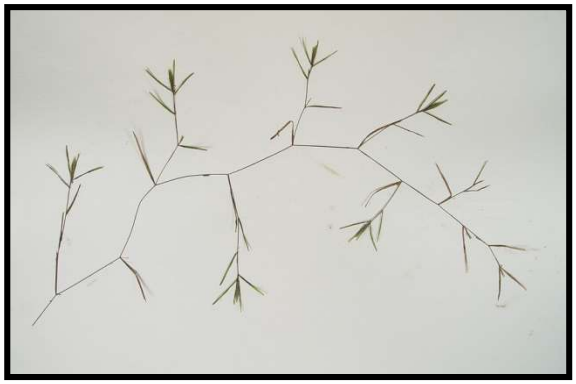
White-stem pondweed (Fewless 2005)

Especially on the outer edges of the littoral zone, this habitat also supported often dense stands of Coontail (*Ceratophyllum demersum*), Common waterweed (*Elodea canadensis*), Leafy pondweed (*Potamogeton foliosus*), Small pondweed (*Potamogeton pusillus*), Fern pondweed (*Potamogeton robbinsii*), and Flat-stem pondweed (*Potamogeton zosteriformis*). Predatory fish like the lake's Musky are often found along the edges of these deepwater beds waiting in ambush.

Coontail (Hassler 2011)

Common waterweed (Pinkka 2013)

Leafy pondweed (Skowinski 2009)



Small pondweed (Cameron 2021)

Fern pondweed (Apipp 2011)

Flat-stem pondweed (Dziuk 2019)

The very outer edges of the littoral zone also supported scattered patches of aquatic moss and Nitella (*Nitella flexilis*) - a type of colonial algae that looks like a higher plant. Although individuals of both are small, in their preferred zone of growth, these species occasionally formed dense "underwater haystacks" that provide excellent habitat for invertebrates as well as fish.

Aquatic moss leaves magnified 5X (Kleinman 2010)

Nitella (Schou 2003)

Comparison of Native Macrophyte Species in 2020 and 2025:

During our 2020 survey, we identified Fern pondweed, Coontail, Common waterweed, and Flat-stem pondweed as the most widely-distributed species (Table 2). They were present at 55.58%, 43.60%, 37.40%, and 34.50% of survey points with vegetation respectively; and, collectively, they accounted for 43.06% of the total relative frequency. Large-leaf pondweed (8.32%), Wild celery (7.28%), and White water lily (4.68%) also had relative frequencies over 4.00% (Density and distribution maps for all native plants identified in 2020 are located in Appendix V).

During our 2025 survey, we found Fern pondweed, Flat-stem pondweed, Large-leaf pondweed, and Wild celery were the most common species (Table 3). Present at 53.24%, 47.98%, 38.26%, and 28.74% of sites with vegetation, they accounted for 41.80% of the total relative frequency. Coontail (6.29%), Common waterweed (5.58%), White water lily (5.03%), and Slender naiad (4.48%) also had relative frequencies over 4.00% (Density and distribution maps for all plants found in 2025 are located in Appendix VI).

Lakewide, 16 species showed significant changes in distribution from 2020 to 2025. Coontail and Common waterweed both suffered highly significant declines **($p<0.001$)**; Common bladderwort **($p=0.003$)** and White-stem pondweed **($p=0.009$)** underwent moderately significant declines; and Short-stemmed bur-reed **($p=0.03$)** saw a significant decline. Conversely, Flat-stem pondweed, Northern water-milfoil, Eurasian water-milfoil, and Various-leaved water-milfoil enjoyed highly significant increases **($p<0.001$)**; Slender naiad **($p=0.003$)**, Water marigold **($p=0.003$)**, and Small bladderwort **($p=0.003$)** experienced moderately significant increases; and Large-leaf pondweed **($p<0.05$)**, Watershield **($p=0.03$)**, Clasping-leaf pondweed **($p=0.03$)**, and Stiff pondweed **($p=0.01$)** saw significant increases (Figure 8).

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton robbinsii	Fern pondweed	269	13.99	55.58	53.69	1.72	2
Ceratophyllum demersum	Coontail	211	10.97	43.60	42.12	1.34	2
Elodea canadensis	Common waterweed	181	9.41	37.40	36.13	1.32	0
Potamogeton zosteriformis	Flat-stem pondweed	167	8.68	34.50	33.33	1.37	16
Potamogeton amplifolius	Large-leaf pondweed	160	8.32	33.06	31.94	1.62	35
Vallisneria americana	Wild celery	140	7.28	28.93	27.94	1.64	4
Nymphaea odorata	White water lily	90	4.68	18.60	17.96	1.90	18
Myriophyllum verticillatum	Whorled water-milfoil	57	2.96	11.78	11.38	1.56	12
Najas flexilis	Slender naiad	56	2.91	11.57	11.18	1.30	2
Utricularia vulgaris	Common bladderwort	54	2.81	11.16	10.78	1.19	4
Potamogeton praelongus	White-stem pondweed	49	2.55	10.12	9.78	1.37	39
Nuphar variegata	Spatterdock	46	2.39	9.50	9.18	1.76	30
Potamogeton pusillus	Small pondweed	45	2.34	9.30	8.98	1.16	1
Pontederia cordata	Pickerelweed	39	2.03	8.06	7.78	1.74	11
Brasenia schreberi	Watershield	37	1.92	7.64	7.39	1.54	10
Potamogeton natans	Floating-leaf pondweed	28	1.46	5.79	5.59	1.61	7
Utricularia gibba	Creeping bladderwort	25	1.30	5.17	4.99	1.08	2
Bidens beckii	Water marigold	19	0.99	3.93	3.79	1.26	2
Chara sp.	Muskgrass	19	0.99	3.93	3.79	1.21	0
Dulichium arundinaceum	Three-way sedge	19	0.99	3.93	3.79	1.32	6
Potamogeton gramineus	Variable pondweed	18	0.94	3.72	3.59	1.33	8
Schoenoplectus subterminalis	Water bulrush	18	0.94	3.72	3.59	2.00	4
Eleocharis erythropoda	Bald spikerush	16	0.83	3.31	3.19	2.31	7
Carex lasiocarpa	Narrow-leaved woolly sedge	15	0.78	3.10	2.99	2.47	2
Spirodela polyrhiza	Large duckweed	14	0.73	2.89	2.79	1.14	0

Table 2 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Myriophyllum spicatum	**Eurasian water-milfoil**	**13**	**0.68**	**2.69**	**2.59**	**1.38**	**17**
Utricularia intermedia	Flat-leaf bladderwort	13	0.68	2.69	2.59	1.38	0
Typha* X *glauca	**Hybrid cattail**	**12**	**0.62**	**2.48**	**2.40**	**2.83**	**0**
Sparganium emersum	Short-stemmed bur-reed	11	0.57	2.27	2.20	1.27	7
Myriophyllum sibiricum	Northern water-milfoil	9	0.47	1.86	1.80	1.11	14
Heteranthera dubia	Water star-grass	7	0.36	1.45	1.40	1.29	1
Utricularia minor	Small bladderwort	7	0.36	1.45	1.40	1.29	1
Potamogeton richardsonii	Clasping-leaf pondweed	6	0.31	1.24	1.20	1.33	8
Lemna minor	Small duckweed	5	0.26	1.03	1.00	1.00	0
Schoenoplectus tabernaemontani	Softstem bulrush	5	0.26	1.03	1.00	1.00	0
Sparganium natans	Small bur-reed	5	0.26	1.03	1.00	1.40	3
	Filamentous algae	5	*	1.03	1.00	1.00	0
Potamogeton epihydrus	Ribbon-leaf pondweed	4	0.21	0.83	0.80	2.00	1
Sparganium americanum	American bur-reed	4	0.21	0.83	0.80	2.00	3
Typha latifolia	Broad-leaved cattail	4	0.21	0.83	0.80	1.25	1
	Freshwater sponge	4	*	0.83	0.80	1.25	0
Comarum palustre	Marsh cinquefoil	3	0.16	0.62	0.60	1.00	3
Myriophyllum heterophyllum	Various-leaved water-milfoil	3	0.16	0.62	0.60	1.67	2
Nitella sp.	Nitella	3	0.16	0.62	0.60	1.00	0
Potamogeton vaseyi	Vasey's pondweed	3	0.16	0.62	0.60	1.33	0
Sagittaria latifolia	Common arrowhead	3	0.16	0.62	0.60	1.33	1
Sagittaria graminea	Grass-leaved arrowhead	2	0.10	0.41	0.40	1.50	0
	Aquatic moss	2	*	0.41	0.40	1.50	0

* Excluded from relative frequency analysis **Exotic species in bold**

Table 2 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Calamagrostis canadensis	Bluejoint	1	0.05	0.21	0.20	3.00	0
Carex comosa	Bottle brush sedge	1	0.05	0.21	0.20	1.00	3
Eleocharis acicularis	Needle spikerush	1	0.05	0.21	0.20	1.00	0
Lemna trisulca	Forked duckweed	1	0.05	0.21	0.20	1.00	0
Potamogeton alpinus	Alpine pondweed	1	0.05	0.21	0.20	2.00	0
Potamogeton nodosus	Long-leaf pondweed	1	0.05	0.21	0.20	3.00	0
Potamogeton strictifolius	Stiff pondweed	1	0.05	0.21	0.20	1.00	1
Sparganium fluctuans	Floating-leaf bur-reed	1	0.05	0.21	0.20	3.00	0
Zizania palustris	Northern wild rice	1	0.05	0.21	0.20	1.00	2
Polygonum amphibium	Water smartweed	**	**	**	**	**	1
Potamogeton illinoensis	Illinois pondweed	**	**	**	**	**	2
Carex canescens	Gray bog sedge	***	***	***	***	***	***
Carex echinata	Star sedge	***	***	***	***	***	***
Equisetum fluviatile	Water horsetail	***	***	***	***	***	***
Eriophorum gracile	Slender cotton-grass	***	***	***	***	***	***
Hypericum boreale	Northern St. John's-wort	***	***	***	***	***	***
Iris versicolor	Northern blue flag	***	***	***	***	***	***
Potamogeton obtusifolius	Blunt-leaf pondweed	***	***	***	***	***	***
Riccia fluitans	Slender riccia	***	***	***	***	***	***
Schoenoplectus acutus	Hardstem bulrush	***	***	***	***	***	***

** Visual only *** Boat survey only

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 6-7, 2025

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton robbinsii	Fern pondweed	263	13.23	53.24	52.71	1.78	2
Potamogeton zosteriformis	Flat-stem pondweed	237	11.92	47.98	47.49	1.37	15
Potamogeton amplifolius	Large-leaf pondweed	189	9.51	38.26	37.88	1.46	42
Vallisneria americana	Wild celery	142	7.14	28.74	28.46	1.35	4
Ceratophyllum demersum	Coontail	125	6.29	25.30	25.05	1.25	7
Elodea canadensis	Common waterweed	111	5.58	22.47	22.24	1.32	1
Nymphaea odorata	White water lily	100	5.03	20.24	20.04	1.87	13
Najas flexilis	Slender naiad	89	4.48	18.02	17.84	1.47	3
Myriophyllum spicatum	**Eurasian water-milfoil**	**58**	**2.92**	**11.74**	**11.62**	**1.62**	**44**
Brasenia schreberi	Watershield	57	2.87	11.54	11.42	1.54	12
Myriophyllum verticillatum	Whorled water-milfoil	51	2.57	10.32	10.22	1.63	7
Nuphar variegata	Spatterdock	51	2.57	10.32	10.22	1.61	20
Bidens beckii	Water marigold	41	2.06	8.30	8.22	1.15	4
Myriophyllum heterophyllum	Various-leaved water-milfoil	39	1.96	7.89	7.82	1.92	9
Pontederia cordata	Pickerelweed	35	1.76	7.09	7.01	1.46	22
Myriophyllum sibiricum	Northern water-milfoil	33	1.66	6.68	6.61	1.52	26
Potamogeton pusillus	Small pondweed	33	1.66	6.68	6.61	1.03	6
Utricularia vulgaris	Common bladderwort	28	1.41	5.67	5.61	1.14	4
Potamogeton praelongus	White-stem pondweed	27	1.36	5.47	5.41	1.11	25
Utricularia minor	Small bladderwort	23	1.16	4.66	4.61	1.35	0
Eleocharis erythropoda	Bald spikerush	20	1.01	4.05	4.01	2.25	1
Potamogeton natans	Floating-leaf pondweed	20	1.01	4.05	4.01	1.25	6
Utricularia gibba	Creeping bladderwort	19	0.96	3.85	3.81	1.00	2
Potamogeton gramineus	Variable pondweed	17	0.86	3.44	3.41	1.18	5
Schoenoplectus subterminalis	Water bulrush	17	0.86	3.44	3.41	1.59	6

Exotic species in bold

Table 3 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 6-7, 2025

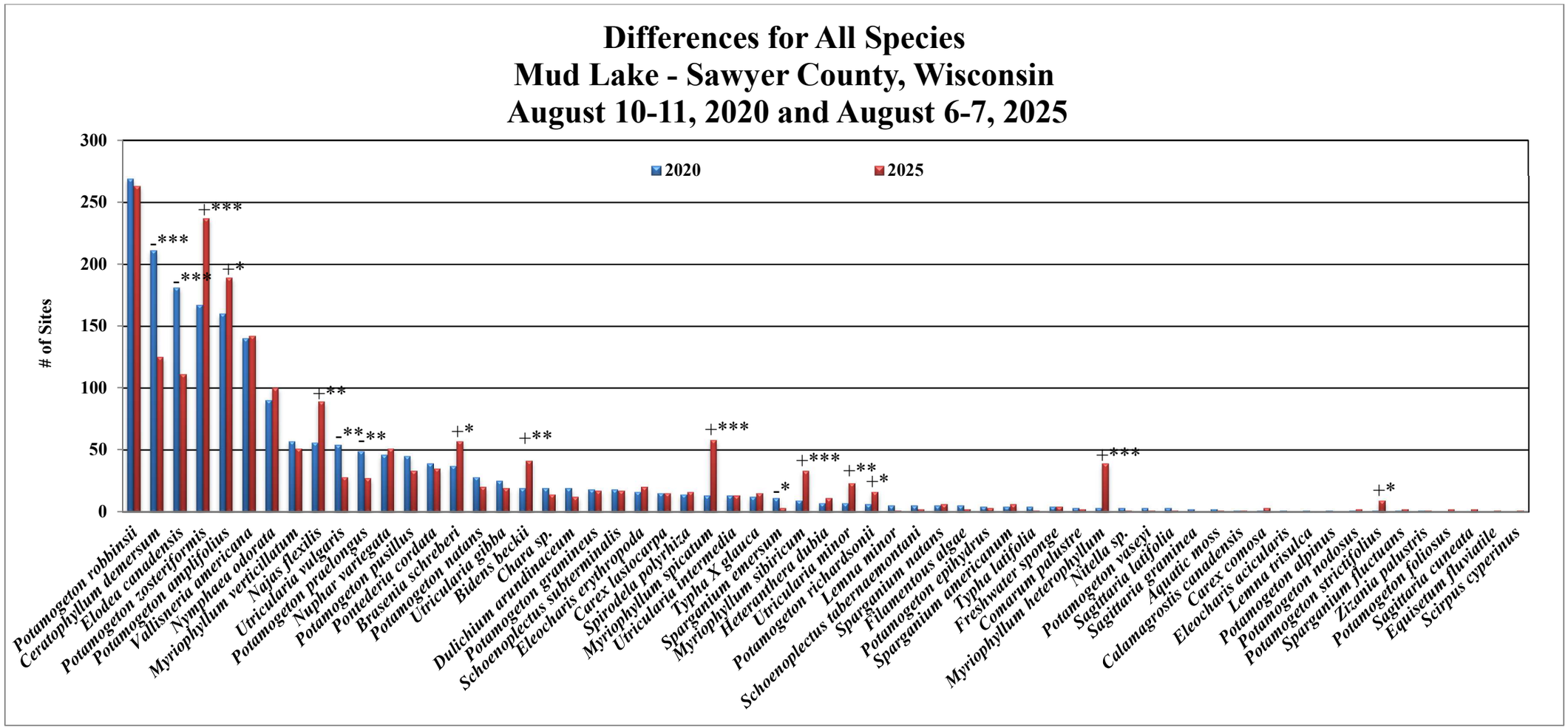
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Potamogeton richardsonii	Clasping-leaf pondweed	16	0.80	3.24	3.21	1.25	6
Spirodela polyrhiza	Large duckweed	16	0.80	3.24	3.21	1.19	1
Carex lasiocarpa	Narrow-leaved woolly sedge	15	0.75	3.04	3.01	2.47	3
Typha* X *glauca	**Hybrid cattail**	**15**	**0.75**	**3.04**	**3.01**	**3.00**	**1**
Chara sp.	Muskgrass	14	0.70	2.83	2.81	1.21	0
Utricularia intermedia	Flat-leaf bladderwort	13	0.65	2.63	2.61	1.62	2
Dulichium arundinaceum	Three-way sedge	12	0.60	2.43	2.40	1.33	5
Heteranthera dubia	Water star-grass	11	0.55	2.23	2.20	1.45	1
Potamogeton strictifolius	Stiff pondweed	9	0.45	1.82	1.80	1.11	0
Sparganium americanum	American bur-reed	6	0.30	1.21	1.20	2.50	3
Sparganium natans	Small bur-reed	6	0.30	1.21	1.20	1.50	1
	Freshwater sponge	4	*	0.81	0.80	1.00	0
Carex comosa	Bottle brush sedge	3	0.15	0.61	0.60	1.00	1
Potamogeton epihydrus	Ribbon-leaf pondweed	3	0.15	0.61	0.60	2.00	0
Sparganium emersum	Short-stemmed bur-reed	3	0.15	0.61	0.60	1.67	3
Comarum palustre	Marsh cinquefoil	2	0.10	0.40	0.40	1.00	2
Potamogeton foliosus	Leafy pondweed	2	0.10	0.40	0.40	1.00	0
Potamogeton nodosus	Long-leaf pondweed	2	0.10	0.40	0.40	3.00	1
Sagittaria cuneata	Arum-leaved arrowhead	2	0.10	0.40	0.40	1.00	2
Schoenoplectus tabernaemontani	Softstem bulrush	2	0.10	0.40	0.40	1.00	0
Sparganium fluctuans	Floating-leaf bur-reed	2	0.10	0.40	0.40	1.00	0
	Filamentous algae	2	*	0.40	0.40	1.00	0

* Excluded from relative frequency analysis **Exotic species in bold**

Table 3 (continued): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 6-7, 2025

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Calamagrostis canadensis	Bluejoint	1	0.05	0.20	0.20	3.00	0
Equisetum fluviatile	Water horsetail	1	0.05	0.20	0.20	1.00	0
Lemna minor	Small duckweed	1	0.05	0.20	0.20	1.00	0
Nitella sp.	Nitella	1	0.05	0.20	0.20	1.00	0
Potamogeton vaseyi	Vasey's pondweed	1	0.05	0.20	0.20	1.00	0
Sagittaria latifolia	Common arrowhead	1	0.05	0.20	0.20	1.00	0
Scirpus cyperinus	Woolgrass	1	0.05	0.20	0.20	1.00	0
Typha latifolia	Broad-leaved cattail	1	0.05	0.20	0.20	1.00	4
Zizania palustris	Northern wild rice	1	0.05	0.20	0.20	1.00	1
	Aquatic moss	1	*	0.20	0.20	2.00	0
Calla palustris	Wild calla	**	**	**	**	**	1
Hypericum boreale	Northern St. John's-wort	**	**	**	**	**	1
Iris versicolor	Northern blue flag	**	**	**	**	**	3
Juncus effusus	Common rush	**	**	**	**	**	1
Carex canescens	Gray bog sedge	***	***	***	***	***	***
Carex echinata	Star sedge	***	***	***	***	***	***
Eriophorum gracile	Slender cotton-grass	***	***	***	***	***	***
Polygonum amphibium	Water smartweed	***	***	***	***	***	***
Potamogeton alpinus	Alpine pondweed	***	***	***	***	***	***
Potamogeton obtusifolius	Blunt-leaf pondweed	***	***	***	***	***	***
Schoenoplectus acutus	Hardstem bulrush	***	***	***	***	***	***

* Excluded from relative frequency analysis ** Visual only *** Boat survey only



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

Figure 8: 2020 – 2025 Macrophyte Differences for All Species

Fern pondweed, the most widely-distributed macrophyte during each of our surveys, was common throughout the lake (Figure 9). Found at 269 sites in 2020, it underwent a non-significant decline (p=0.75) in distribution to 263 sites in 2025. Conversely, its average biomass underwent an increase from a mean rake fullness of 1.72 in 2020 to 1.78 in 2025; however, this wasn't significant either (p=0.14).

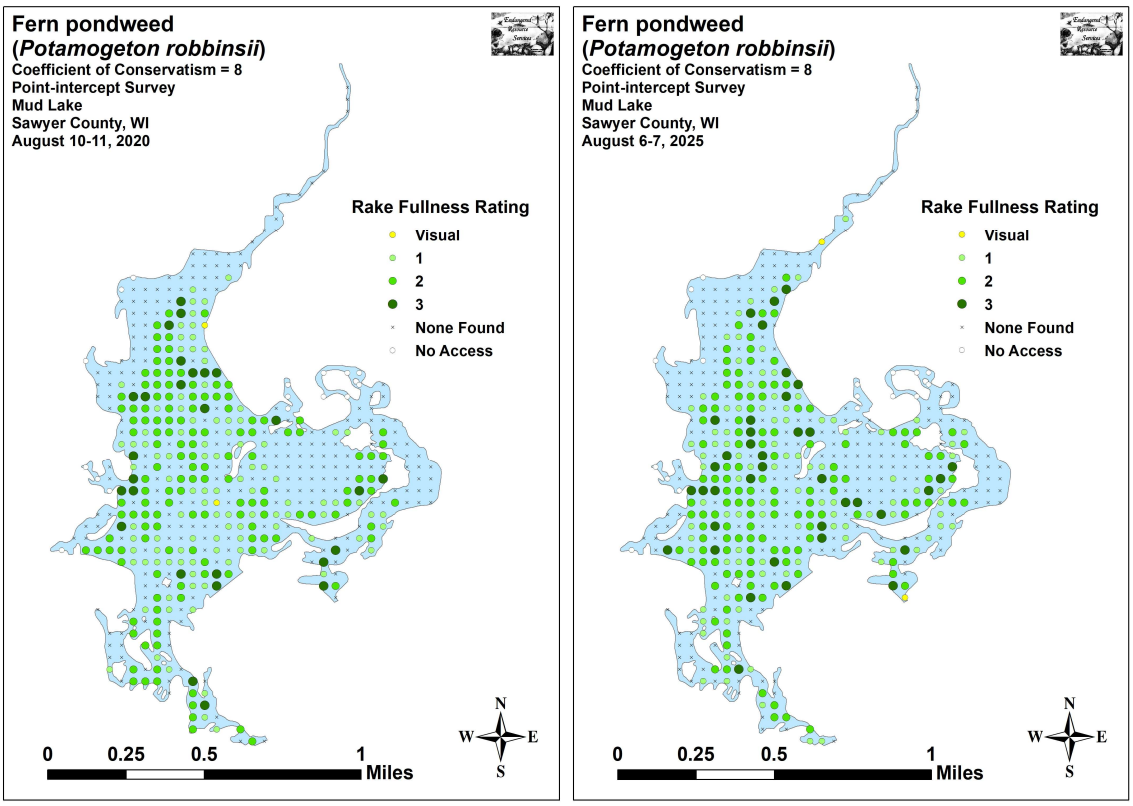


Figure 9: 2020 and 2025 Fern Pondweed Density and Distribution

In 2020, Coontail was the second most common species (211 sites/mean rake fullness of 1.34). By 2025, it had undergone a highly significant decline **(p<0.001)** in distribution (125 sites), and a nearly significant decline (p=0.08) in density (mean rake fullness of 1.25) as it fell to the fifth most common species in the overall community. These losses were especially noticeable in the west-central flats (Figure 10).

Common waterweed was the third most common species in 2020 when it was present at 181 sites with a mean rake fullness of 1.32. Similar to Coontail, the 2025 survey documented a highly significant decline **(p<0.001)** in distribution (111 sites) as it fell to the sixth-ranked species in the plant community. Also like Coontail, these declines were most noticeable in the west-central flats (Figure 11). Despite this loss in coverage, it again had a mean rake fullness of 1.32.

In 2020, we found Flat-stem pondweed at 167 points with a mean rake fullness of 1.37. The 2025 survey documented a highly significant increase **(p<0.001)** in distribution (237 sites) as it rose in community rank from the fourth most widely-distributed to the most common species (Figure 12). Its mean rake fullness was, however, unchanged at 1.37.

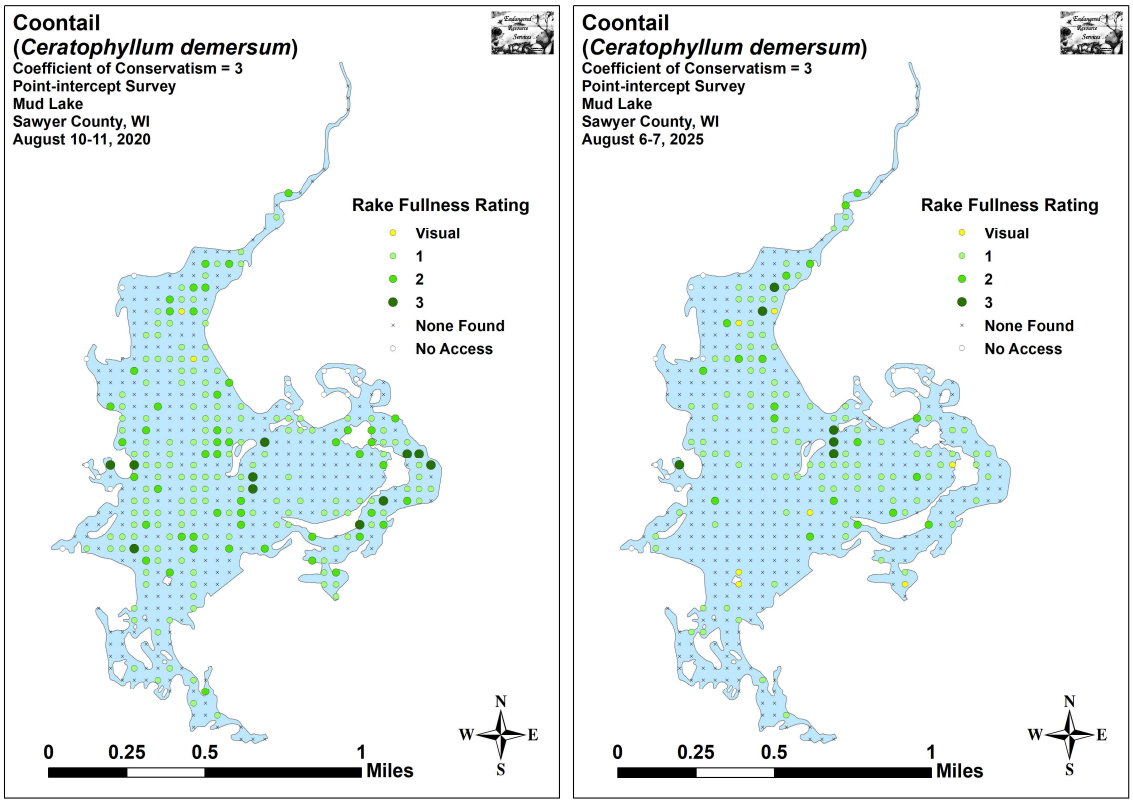


Figure 10: 2020 and 2025 Coontail Density and Distribution

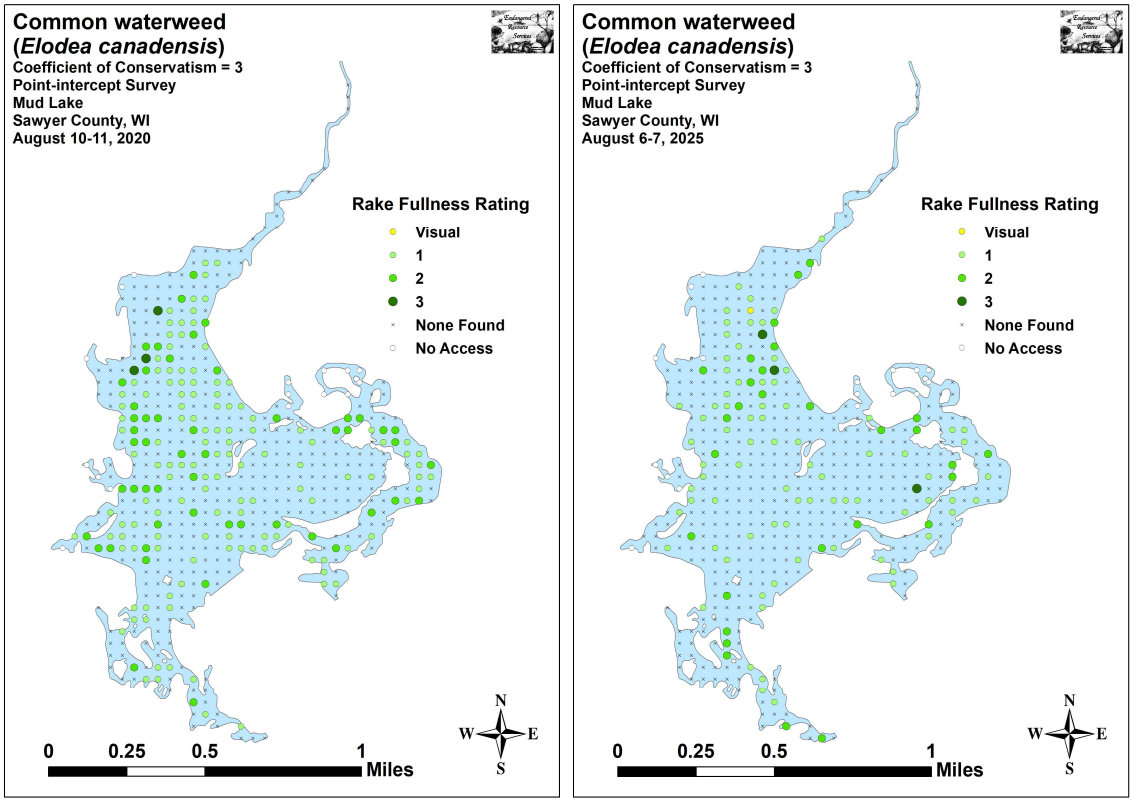


Figure 11: 2020 and 2025 Common Waterweed Density and Distribution

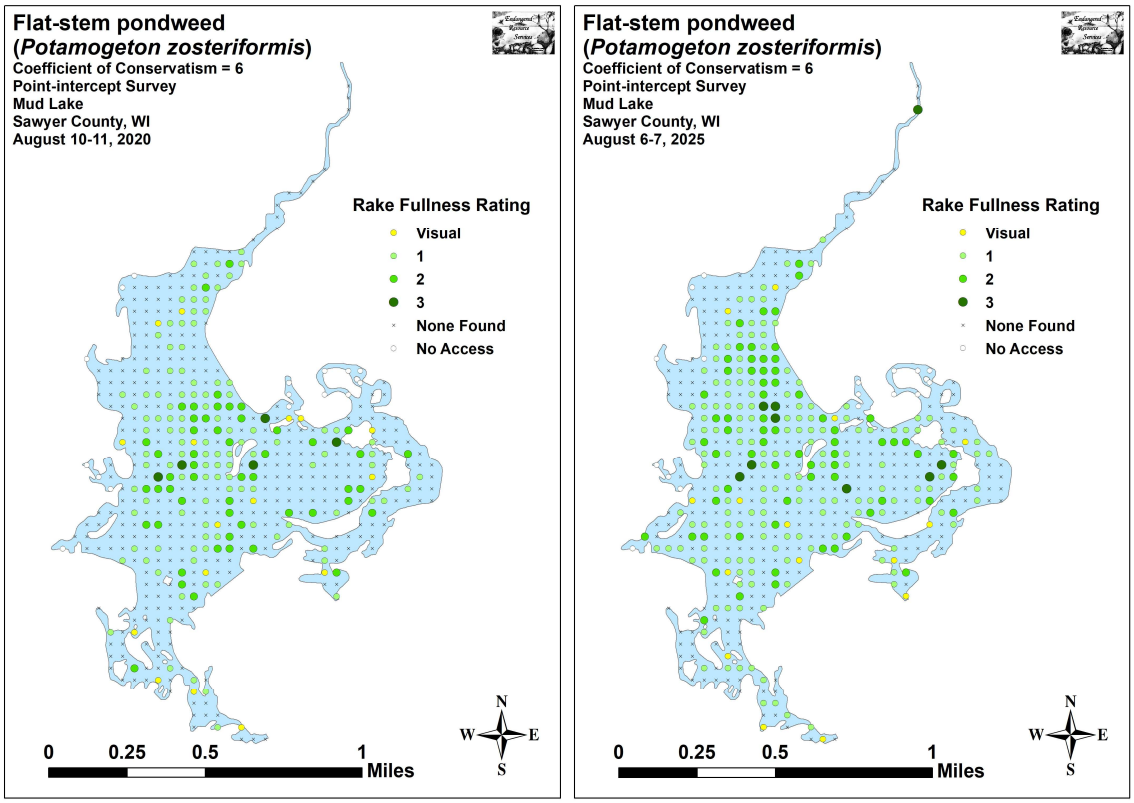


Figure 12: 2020 and 2025 Flat-stem Pondweed Density and Distribution

Large-leaf pondweed is an important habitat-producing species often known as "cabbage" or "musky weed". It jumped from the fifth most common species in 2020 (160 sites – mean rake 1.62) to the third most common in 2025 (189 sites – mean rake 1.46) – a significant increase **($p<0.05$)** in distribution, but a moderately significant decline **($p=0.008$)** in mean distribution (Figure 13).

In 2020, Wild celery was the sixth most common species when it was present at 140 sites with a mean rake fullness of 1.64 (Figure 14). In 2025, it rose to the fourth-ranked species but was almost unchanged in distribution (142 sites). It did, however, suffer a highly significant decline **($p<0.001$)** in density to a mean rake fullness of 1.35.

White water lily, the seventh-ranked species in both 2020 and 2025, saw a non-significant increase (p=0.40) in distribution (90 sites in 2020/100 sites in 2025) and a non-significant decline (p=0.40) in density (mean rake of 1.90 in 2020/mean rake of 1.87 in 2025). Analysis of the maps also suggested it was little changed (Figure 15).

Northern water-milfoil's highly significant increase **($p<0.001$)** in distribution from nine sites in 2020 to 33 sites in 2025, and its significant increase **($p=0.01$)** in density from a mean rake fullness of 1.11 in 2020 to 1.52 in 2025 were potentially at least partially tied to the lack of recent chemical management in the lake. A species known to go through dramatic natural boom/bust population cycles, its expansion in areas that were never treated may indicated there was more than a single reason for its growth over this time (Figure 16).

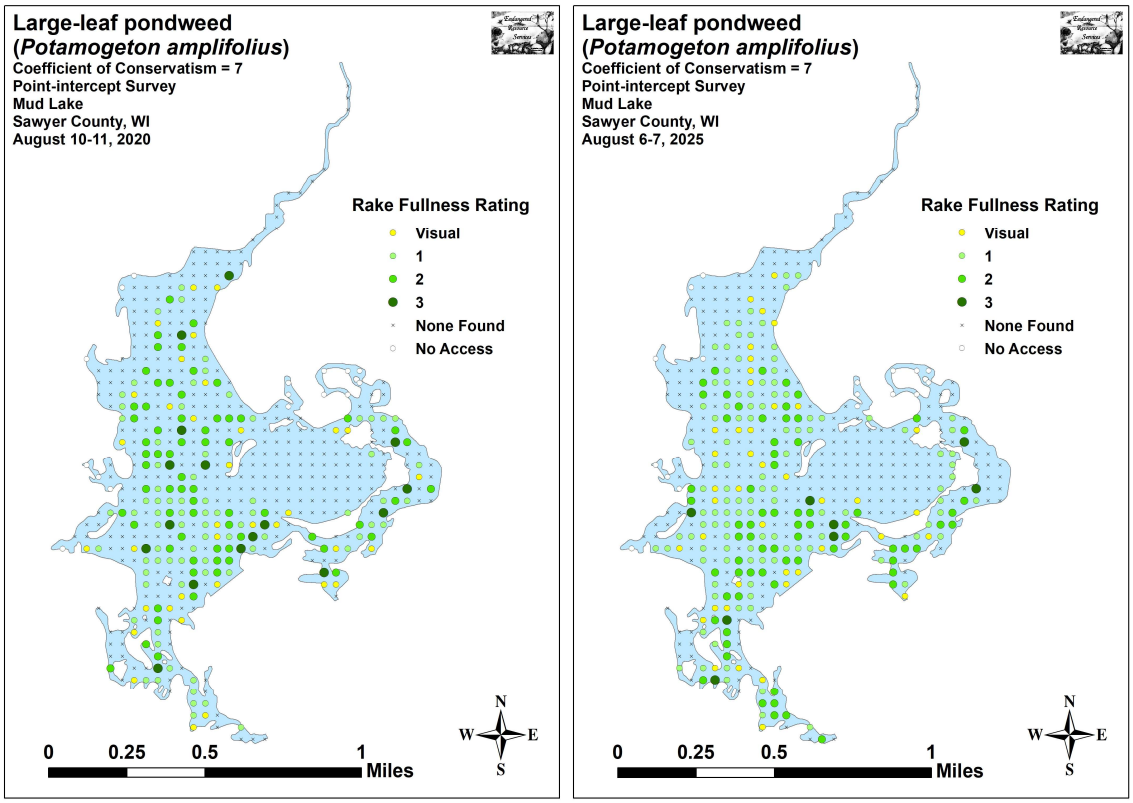


Figure 13: 2020 and 2025 Large-leaf Pondweed Density and Distribution

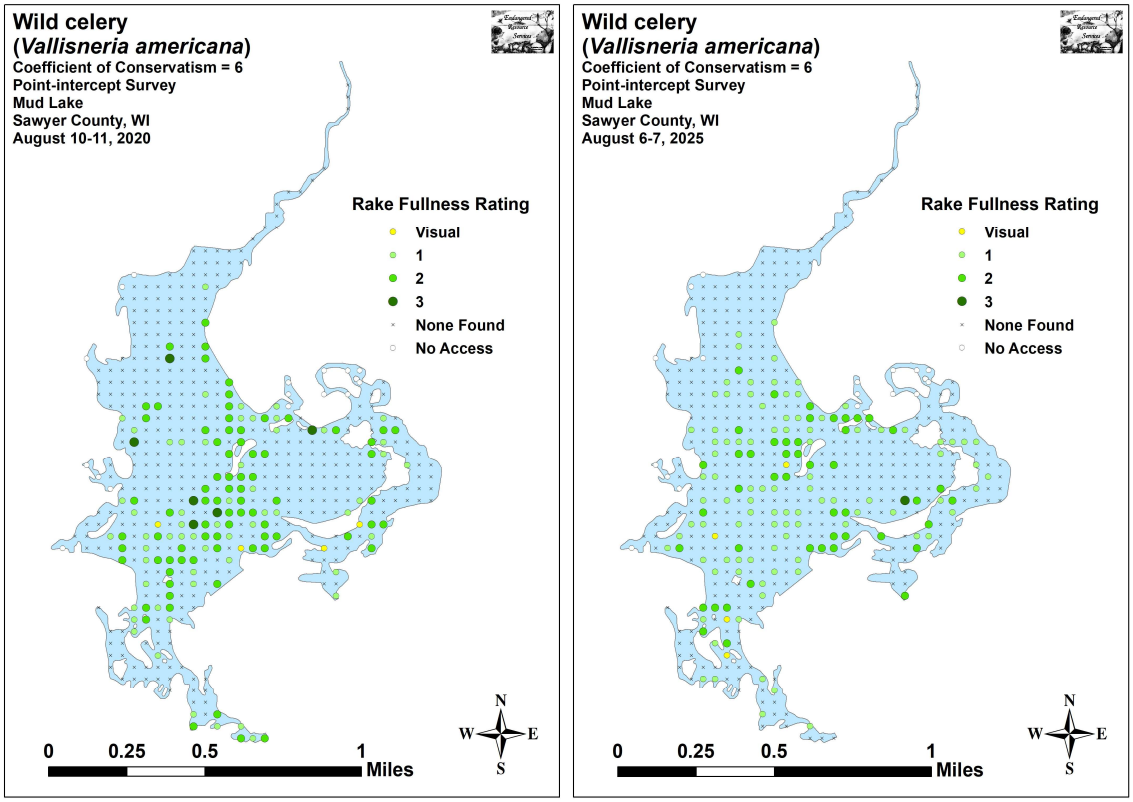


Figure 14: 2020 and 2025 Wild Celery Density and Distribution

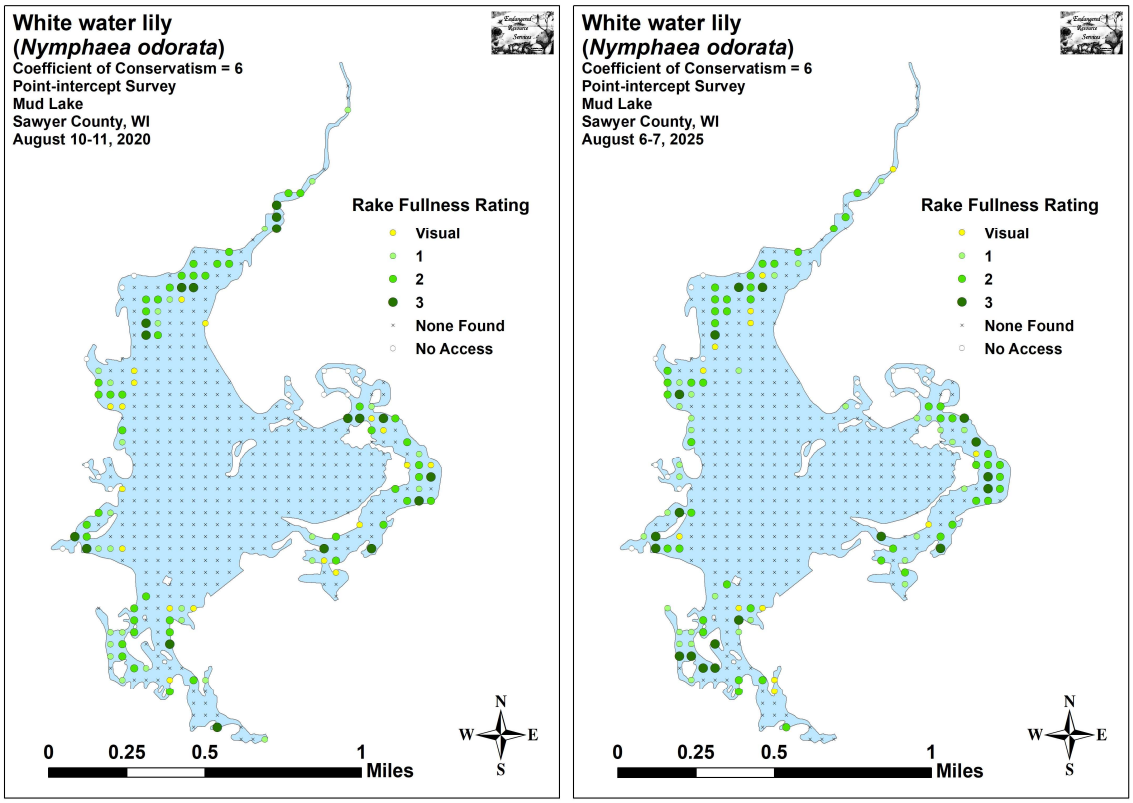


Figure 15: 2020 and 2025 White Water Lily Density and Distribution

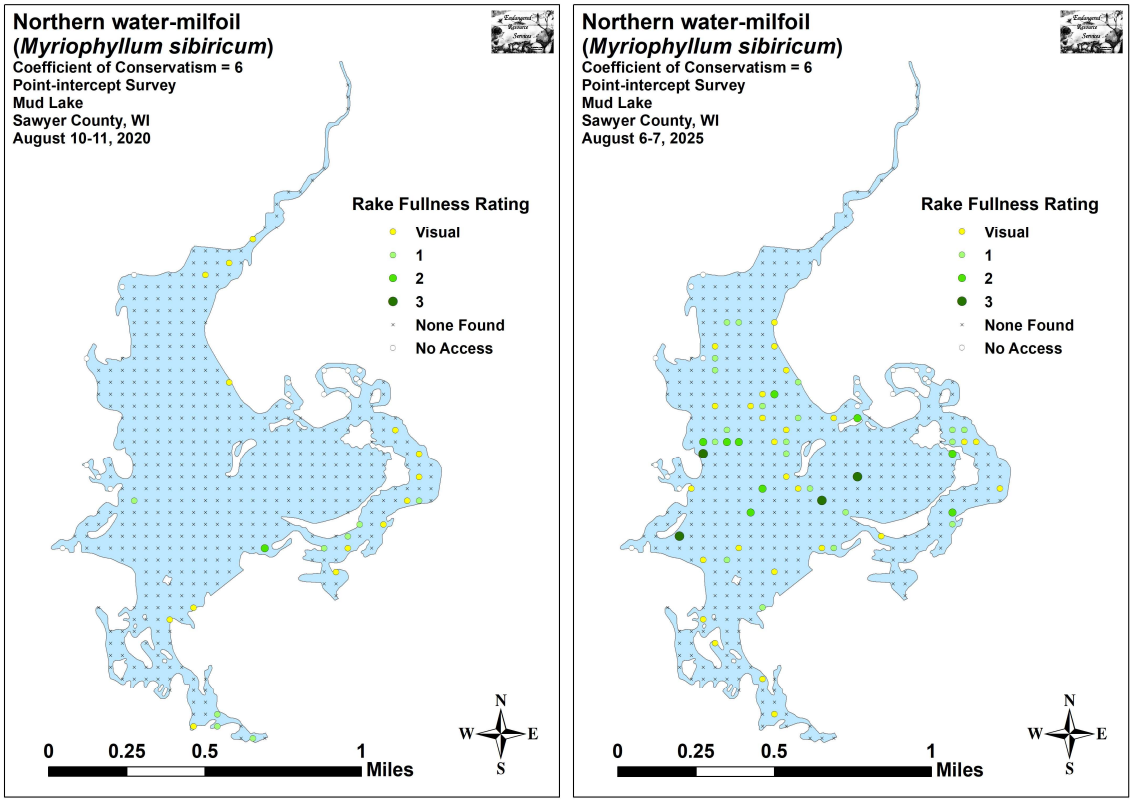


Figure 16: 2020 and 2025 Northern Water-milfoil Density and Distribution

Comparison of Floristic Quality Indexes in 2020 and 2025:

Our 2020 survey documented a total of 50 **native index species** in the rake during the point-intercept survey (Table 4). They produced a mean Coefficient of Conservatism of 6.6 and a Floristic Quality Index of 46.7.

Table 4: Floristic Quality Index of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Dulichium arundinaceum	**Three-way sedge**	**9**
Eleocharis acicularis	Needle spikerush	5
Eleocharis erythropoda	Bald spikerush	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Lemna trisulca	Forked duckweed	6
Myriophyllum heterophyllum	Various-leaved water-milfoil	7
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum verticillatum	Whorled water-milfoil	8
Najas flexilis	Slender naiad	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	8
Potamogeton alpinus	**Alpine pondweed**	**9**
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton nodosus	Long-leaf pondweed	7
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton vaseyi	**Vasey's pondweed**	**10**
Potamogeton zosteriformis	Flat-stem pondweed	6
Sagittaria graminea	**Grass-leaved arrowhead**	**9**
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus subterminalis	**Water bulrush**	**9**
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium americanum	American bur-reed	8

Table 4 (continued): Floristic Quality Index of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 10-11, 2020

Species	Common Name	C
Sparganium emersum	Short-stemmed bur-reed	8
Sparganium fluctuans	**Floating-leaf bur-reed**	**10**
Sparganium natans	**Small bur-reed**	**9**
Spirodela polyrhiza	Large duckweed	5
Typha latifolia	Broad-leaved cattail	1
Typha X *glauca*	Hybrid cattail	1
Utricularia gibba	**Creeping bladderwort**	**9**
Utricularia intermedia	**Flat-leaf bladderwort**	**9**
Utricularia minor	**Small bladderwort**	**10**
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Zizania palustris	Northern wild rice	8
N		**50**
Mean C		**6.6**
FQI		**46.7**

In 2025, we found a total of 49 **native index plants** in the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism of 6.6 and a Floristic Quality Index of 45.9 (Table 5). Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Mud Lake just below average for this part of the state. The FQI value was, however, nearly double the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). Eight extremely sensitive high value index plants of note included Three-way sedge (C = 9), Water bulrush (C = 9), Floating-leaf bur-reed (C = 10), Small bur-reed (C = 9), Creeping bladderwort (C = 9), Flat-leaf bladderwort (C = 9), Small bladderwort (C = 10), and the state Species of Special Concern*** Vasey's pondweed (C = 10). Other high value species were either only recorded as visuals (Wild calla (C = 10)), during the boat survey (Alpine pondweed (C = 9) and Blunt-leaf pondweed (C = 9)), or they are not included in the index (Narrow-leaved woolly sedge (C = 9) and Slender cotton-grass (C = 10)).

*** *"Special Concern"* species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Table 5: Floristic Quality Index of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 6-7, 2025

Species	Common Name	C
Bidens beckii	Water marigold	8
Brasenia schreberi	Watershield	6
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Dulichium arundinaceum	**Three-way sedge**	**9**
Eleocharis erythropoda	Bald spikerush	3
Elodea canadensis	Common waterweed	3
Equisetum fluviatile	Water horsetail	7
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	4
Myriophyllum heterophyllum	Various-leaved water-milfoil	7
Myriophyllum sibiricum	Northern water-milfoil	6
Myriophyllum verticillatum	Whorled water-milfoil	8
Najas flexilis	Slender naiad	6
Nitella sp.	Nitella	7
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Pontederia cordata	Pickerelweed	8
Potamogeton amplifolius	Large-leaf pondweed	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton foliosus	Leafy pondweed	6
Potamogeton gramineus	Variable pondweed	7
Potamogeton natans	Floating-leaf pondweed	5
Potamogeton nodosus	Long-leaf pondweed	7

Table 5 (continued): Floristic Quality Index of Aquatic Macrophytes
Mud Lake - Sawyer County, Wisconsin
August 6-7, 2025

Species	Common Name	C
Potamogeton praelongus	White-stem pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton robbinsii	Fern pondweed	8
Potamogeton strictifolius	Stiff pondweed	8
Potamogeton vaseyi	**Vasey's pondweed**	**10**
Potamogeton zosteriformis	Flat-stem pondweed	6
Sagittaria cuneata	Arum-leaved arrowhead	7
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus subterminalis	Water bulrush	9
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium americanum	American bur-reed	8
Sparganium emersum	Short-stemmed bur-reed	8
Sparganium fluctuans	**Floating-leaf bur-reed**	**10**
Sparganium natans	**Small bur-reed**	**9**
Spirodela polyrhiza	Large duckweed	5
Typha latifolia	Broad-leaved cattail	1
Typha X *glauca*	Hybrid cattail	1
Utricularia gibba	**Creeping bladderwort**	**9**
Utricularia intermedia	**Flat-leaf bladderwort**	**9**
Utricularia minor	**Small bladderwort**	**10**
Utricularia vulgaris	Common bladderwort	7
Vallisneria americana	Wild celery	6
Zizania palustris	Northern wild rice	8
N		**49**
mean C		**6.6**
FQI		**45.9**

Comparison of Northern Wild Rice in 2020 and 2025:

Wild rice, a plant of significant wildlife and cultural value, occurred along the northwest shoreline near the river inlet. During the 2025 survey, we found a single rice plant in the rake at a single point and also recorded it as a visual at one other site. This was similar to 2020 when we also found a single plant in the rake at a single point and noted rice as a visual at two others. During each survey, we noted rice plants were extremely sparse, and it didn't appear there were more than a few 100 total individuals in the system; consequently, there were no areas that would support human harvesting (Figure 17).

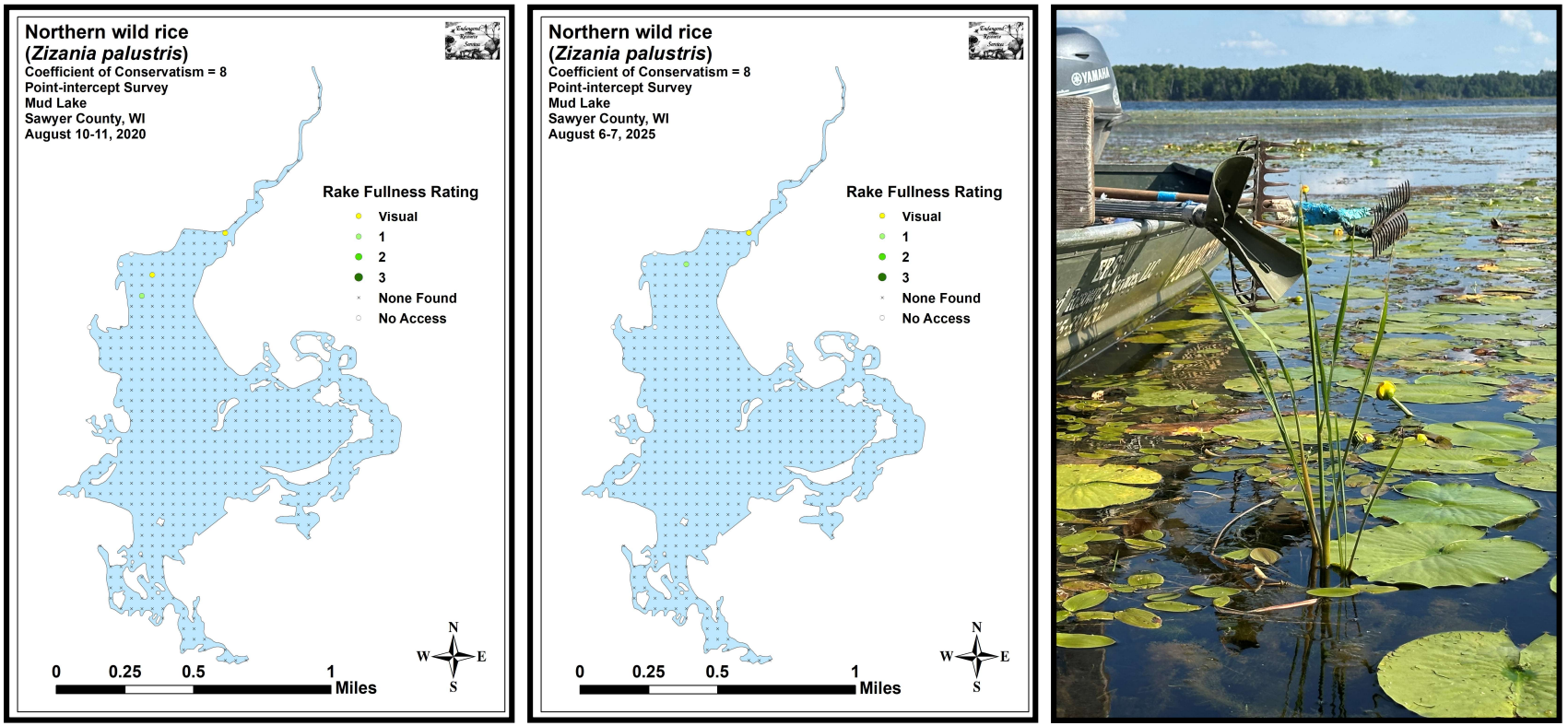


Figure 17: 2020 and 2025 Northern Wild Rice Density and Distribution and Typical Rice Density Found in the Northwest Bay – 8/7/25

Comparison of Filamentous Algae in 2020 and 2025:

Filamentous algae are normally associated with excessive nutrients in the water column. In 2025, we found these algae at two points each of which had a rake fullness of 1. This was similar to 2020 when five points with algae also all had a rake fullness of 1 (Figure 18).

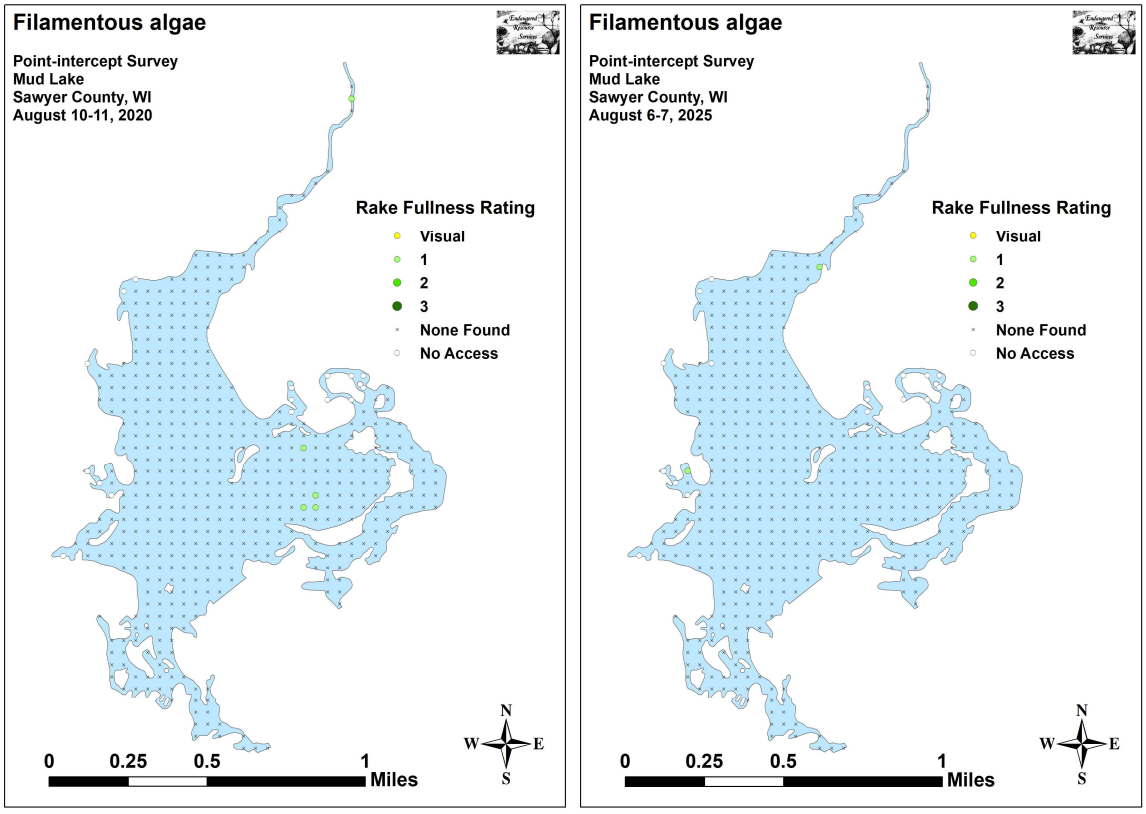


Figure 18: 2020 and 2025 Filamentous Algae Density and Distribution

Comparison of Eurasian Water-milfoil in 2008, 2020, and 2025:

The original 2008 survey reported Eurasian water-milfoil at 31 points (7.8% of surveyed points) with 69 additional visual sightings. One of these points had a rake fullness of 3, eight were a 2 (2.3% of surveyed points had a significant infestation), and 22 were a 1 (mean rake fullness of 1.32) (Figure 19) (Appendix VII).

In 2020, we found EWM in the rake at 13 points (2.6% of surveyed points) with 17 additional visual sightings (Figure 19) (Appendix VII). We rated one point a rake fullness of 3, three were a 2 (0.8% of surveyed points had a significant infestation), and nine were a 1 for a mean rake fullness of 1.38. Compared to the 2008 survey, this suggested EWM had undergone a highly significant decline in total distribution and visual sightings **($p<0.001$)**; a moderately significant decline in rake fullness 1 **($p=0.002$)**; and a nearly significant decline in rake fullness 2 ($p=0.05$) (Figure 20). Although the mean density actually increased, this change was not significant ($p=0.38$).

Our 2025 survey found EWM in the rake at 58 points (11.6% of surveyed points) with 44 additional visual records (Figure 19) (Appendix VII). Eight points rated a rake of 3, 20 points were a 2 (5.6% of surveyed points had a significant infestation), and the remaining 30 points were a 1 resulting in a mean rake fullness of 1.62. When compared to our 2020 survey, this suggested that EWM had undergone a highly significant increase **($p<0.001$)** in distribution that amounted to a **+346.2% increase in coverage**. Although the mean density also increased, this was not significant ($p=0.13$). When broken out by density class, rake fullness 2, rake fullness 1, and visual sightings all saw highly significant increases **($p<0.001$)**; and rake fullness 3 had a significant increase **($p=0.02$)** (Figure 20).

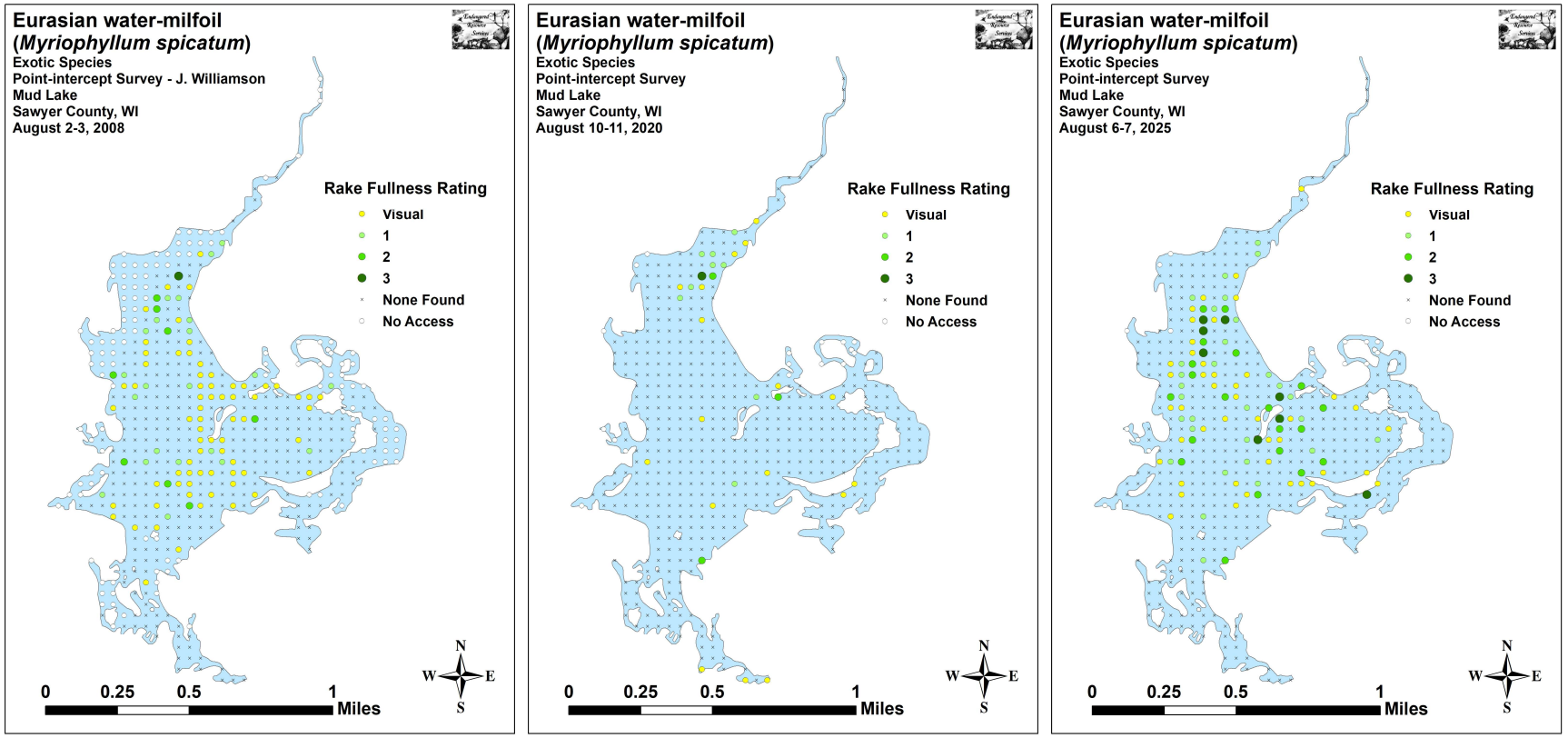


Figure 19: 2008, 2020, and 2025 Eurasian Water-milfoil Density and Distribution

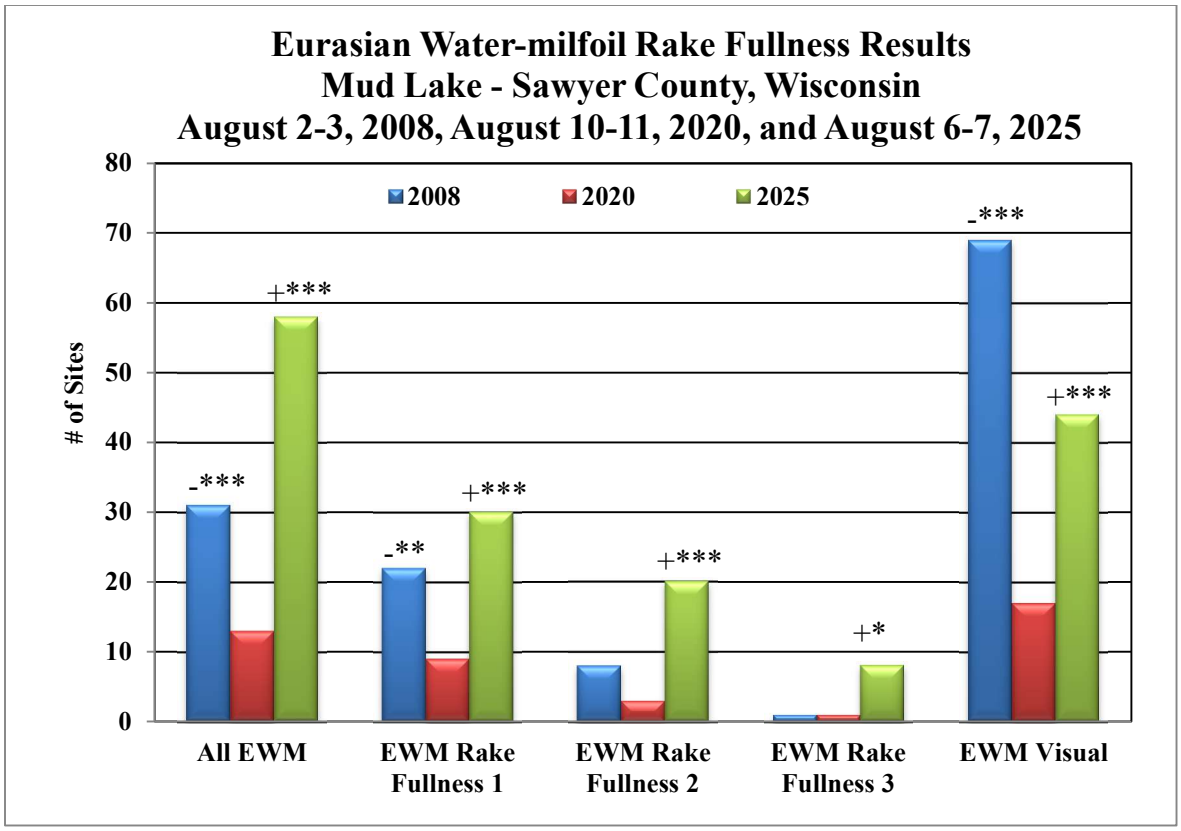


Figure 20: 2008 – 2025 Changes in Eurasian Water-milfoil Rake Fullness

Other Exotic Plant Species:

Native to southern but not northern Wisconsin, Narrow-leaved cattail and its hybrids with Broad-leaved cattail are becoming increasingly common in Sawyer County where they also tend to be invasive. On Mud Lake, this was the only exotic species we found other than Eurasian water-milfoil. In 2020, these cattails were present at 12 points with a mean rake fullness of 2.83. Our 2025 survey found them at 15 points with a mean rake fullness of 3.00 and a single additional visual sighting. Most cattail stands were established along the lake's northwest shoreline where they formed dense and often nearly monotypic stands (Figure 21) (Appendix VII).

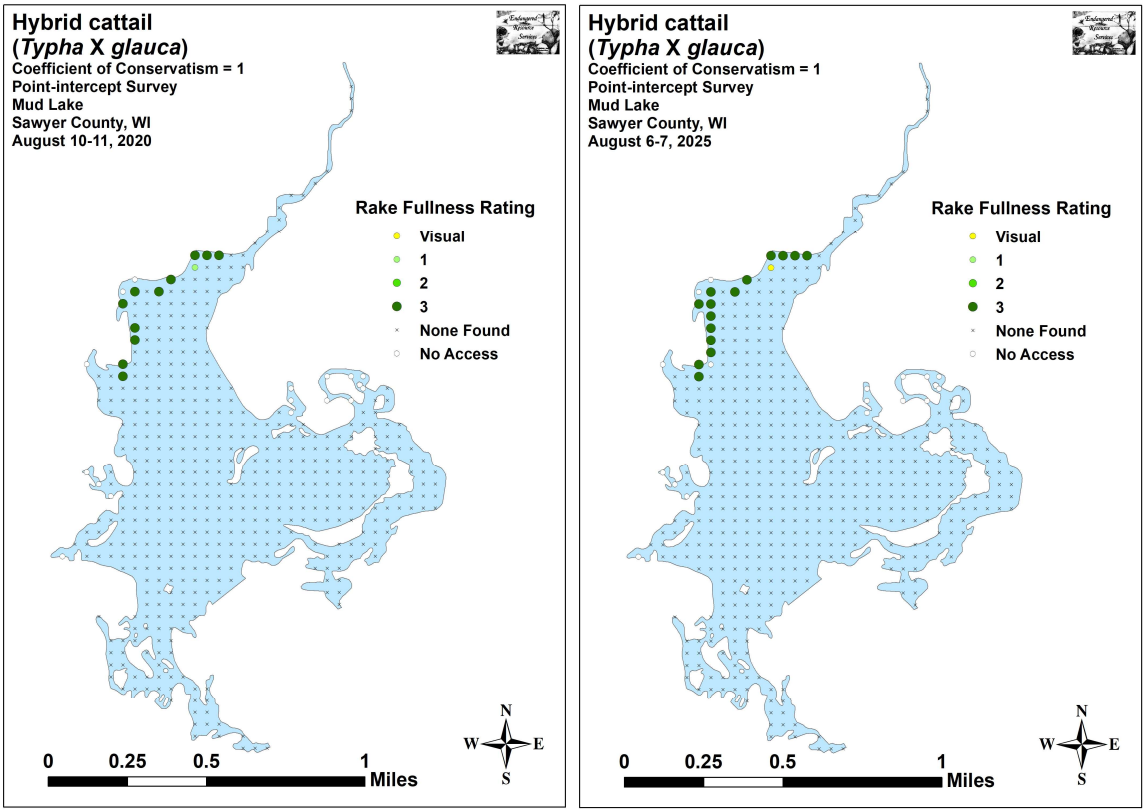


Figure 21: 2020 and 2025 Hybrid Cattail Density and Distribution

Besides having narrower leaves, the exotics can be told from our native cattails by having a relatively narrower and longer "hotdog-shaped" tan female cattail flower, whereas our native species tends to produce a fatter and shorter "bratwurst-shaped" dark chocolate colored female flower. Narrow-leaved cattail and its hybrids also have a male flower that is separated from the female flower by a thin green stem while the native Broad-leaved cattail has its male and female flowers connected (Figure 22) (For more information on a sampling of aquatic exotic invasive plant species, see Appendix VIII).

Figure 22: Exotic Hybrid and Native Broad-leaved Cattail Identification

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Water Clarity, Nutrient Inputs, and the Role of Native Macrophytes:

Like trees in a forest, a lake's native plants support the entire aquatic ecosystem. Because of this, preserving them is critical to maintaining a healthy environment moving forward. As the basis of the food pyramid, they provide habitat for other aquatic organisms, are important food sources for waterfowl and other wildlife, stabilize the shoreline, and work to improve water clarity by absorbing excess nutrients from the water. In lakes without a healthy population of these rooted plants or when nutrients in the water column increase to levels beyond what macrophytes can absorb, filamentous and floating algae tend to proliferate leading to declines in both water clarity and quality.

Soil erosion and runoff can be significant contributors to a lake's overall nutrient load. Although the majority of property owners on the lake are practicing sound shoreline conservation, there is always room for improvement. By consciously working to limit runoff, residents can proactively cut the amount of phosphorus and nitrogen entering the system. This is an important management goal because, when levels of these nutrients increase in the water column, they tend to promote excessive plant growth (like milfoil) and algae blooms that negatively impact sensitive plant species as well as general lake esthetics.

Simple things like establishing or maintaining a buffer strip of native vegetation along the lakeshore to prevent erosion, building rain gardens, bagging grass clippings, switching to a phosphorus-free fertilizer or preferably eliminating fertilizer near the lake altogether, collecting pet waste, and disposing of the ash from fire pits away from the lakeshore can all significantly reduce the amount of nutrients entering the lake. Hopefully, a greater understanding of how all property owners can have lake-wide impacts will result in more people taking appropriate conservation actions to not only help maintain water clarity and quality, but also to benefit the lake's many rare and sensitive native plant species which depend on these pristine conditions.

Eurasian Water-milfoil Management:

Eurasian water-milfoil is widespread in the Mud/Callahan system making eradication an unrealistic expectation. Although EWM is still found throughout Mud Lake, past active management has dramatically reduced it from an estimated 109 acres covering 23.49% of the lake's surface area in 2008 (Kleczewski 2009). However, without recent management, levels of EWM are again climbing.

Past management of Eurasian water-milfoil in Mud Lake has come at a high economic cost, and, as herbicides are non-selective, has also likely had significant impacts on the aquatic plant community. With this in mind, working to control its spread in the most cost-effective manner possible, while simultaneously minimizing its impact on the lake's aquatic ecosystem, will likely continue to be important goals for the CMLPA as they update their management plan. Ultimately, the amount of EWM growth the CMLPA and WDNR are comfortable with will determine how much, if any, active management occurs in Mud Lake in 2026. Likewise, what if any future monitoring will occur on the lake is a conversation that needs to occur.

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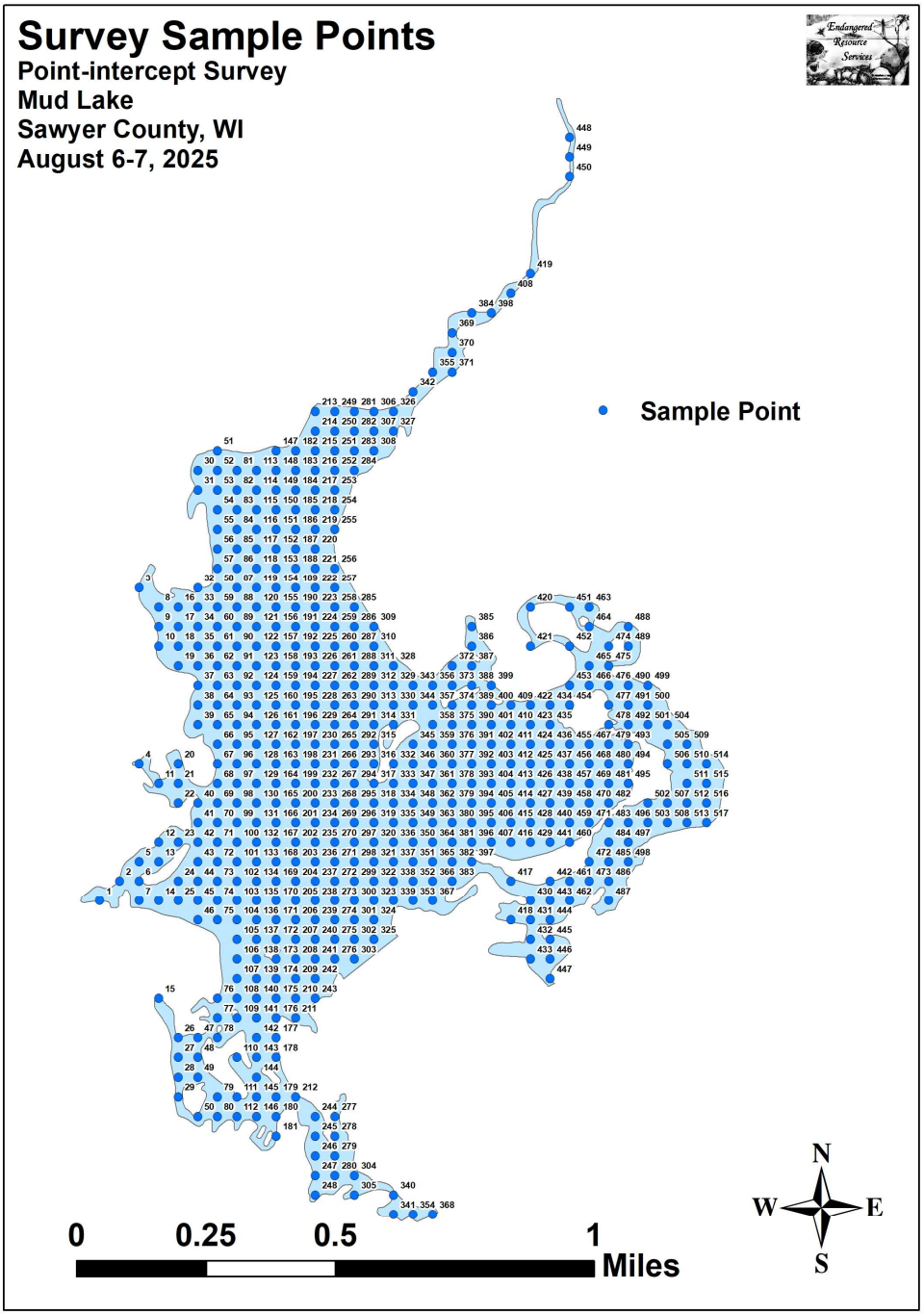
Appendix I: Survey Sample Points Map


Survey Sample Points
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Sample Point
0
0.25
0.5
1
Miles
N
W
E
S

Appendix II: Boat and Vegetative Survey Datasheets

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

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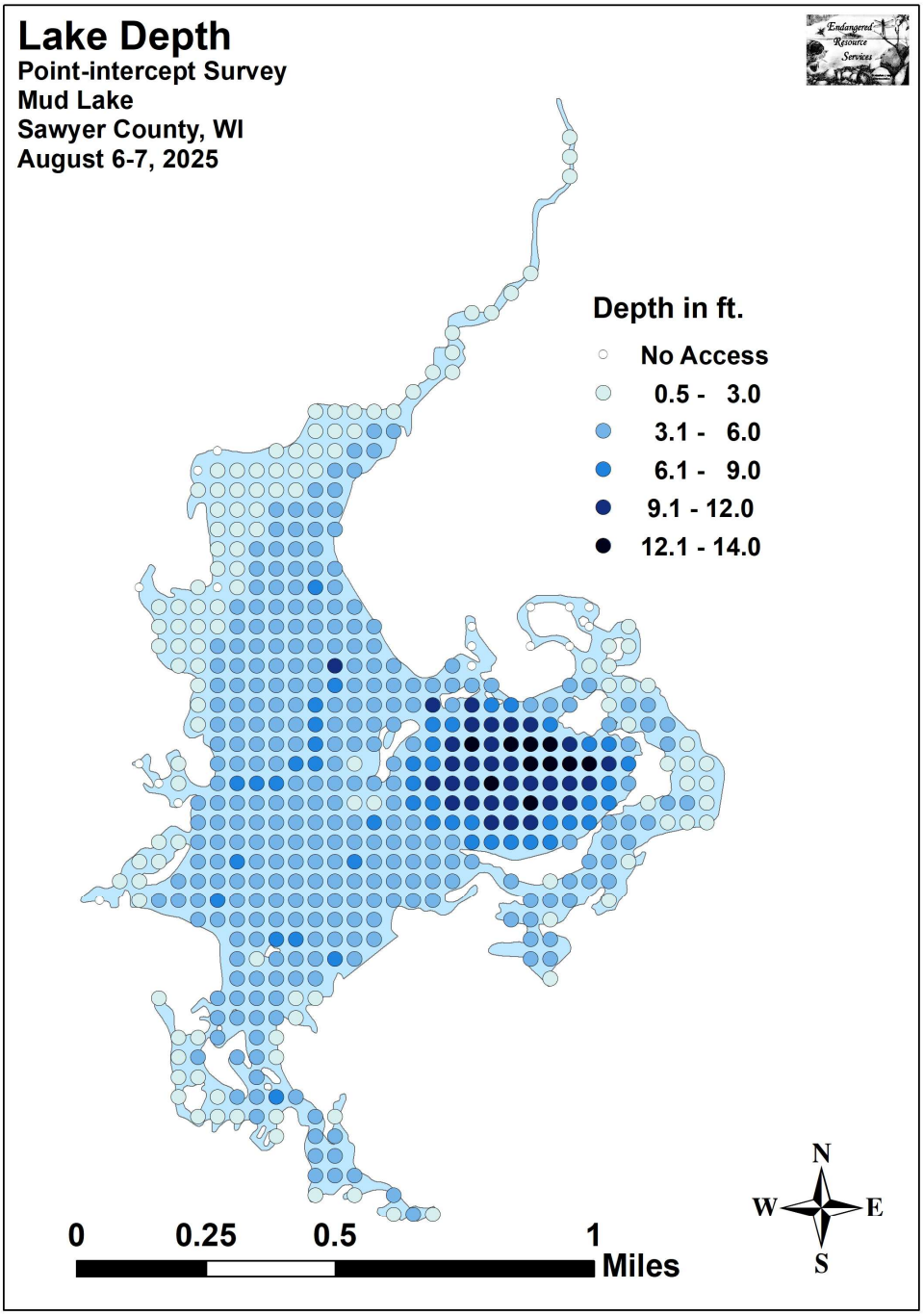
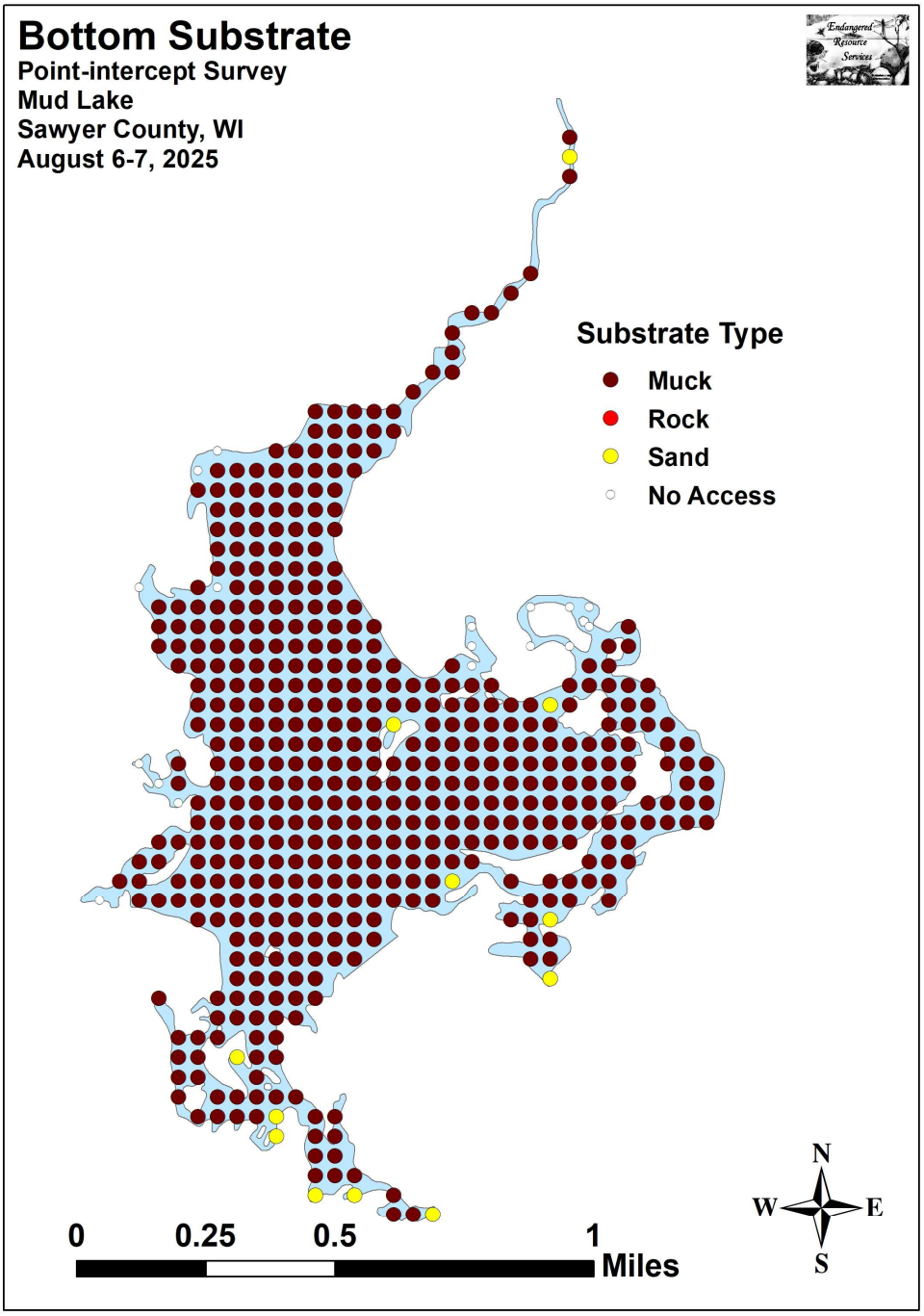
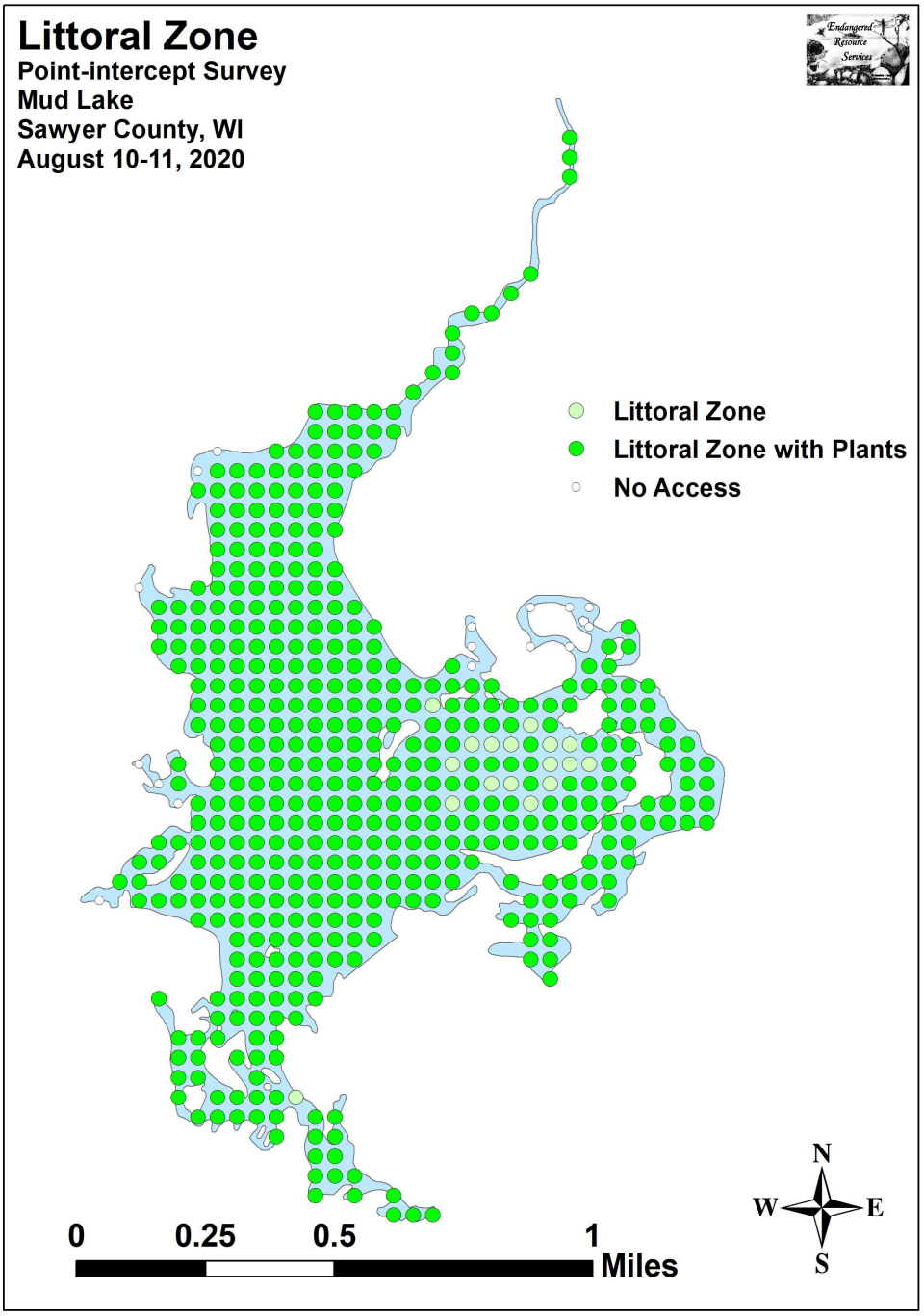
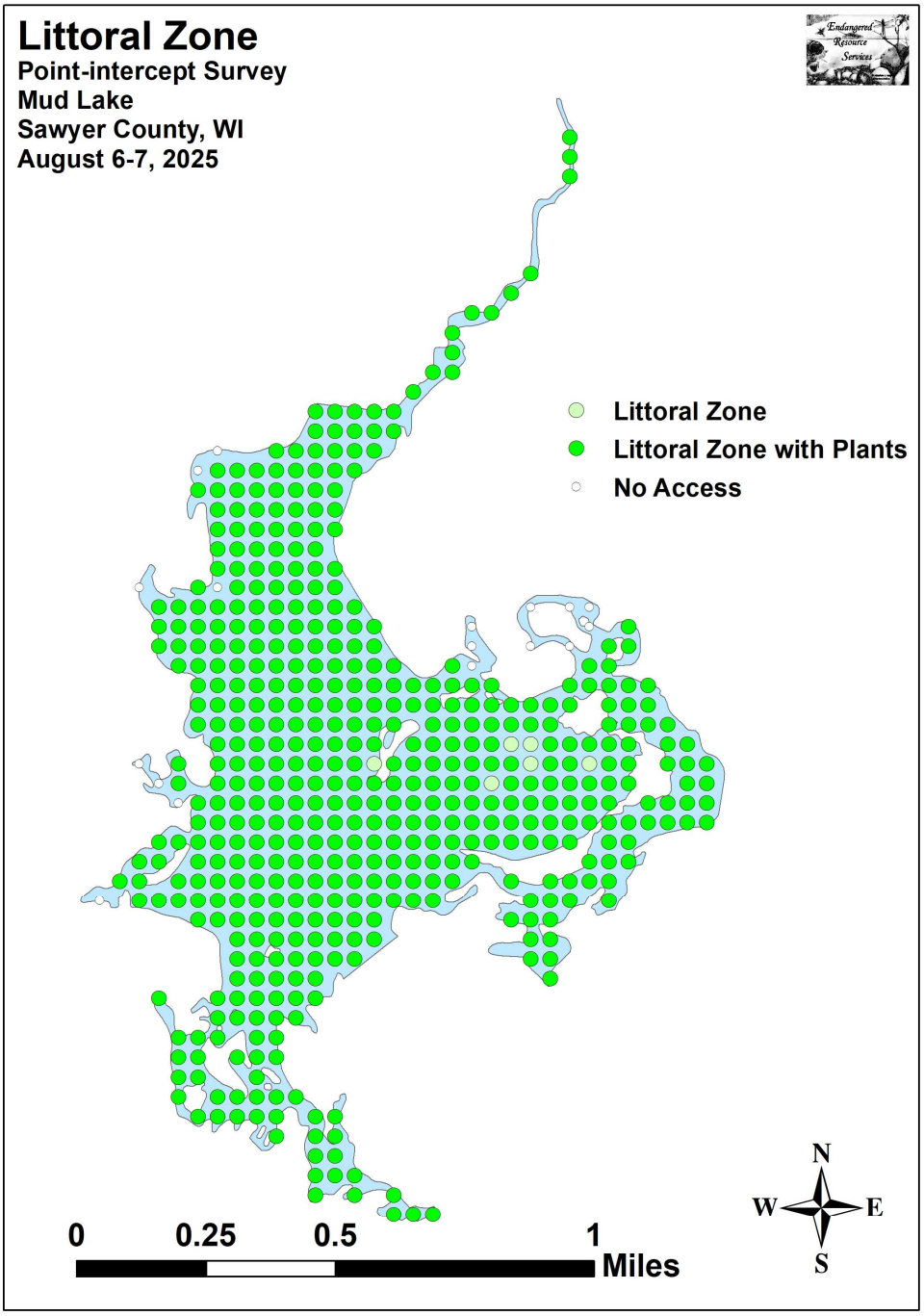
Appendix III: Habitat Variable Maps

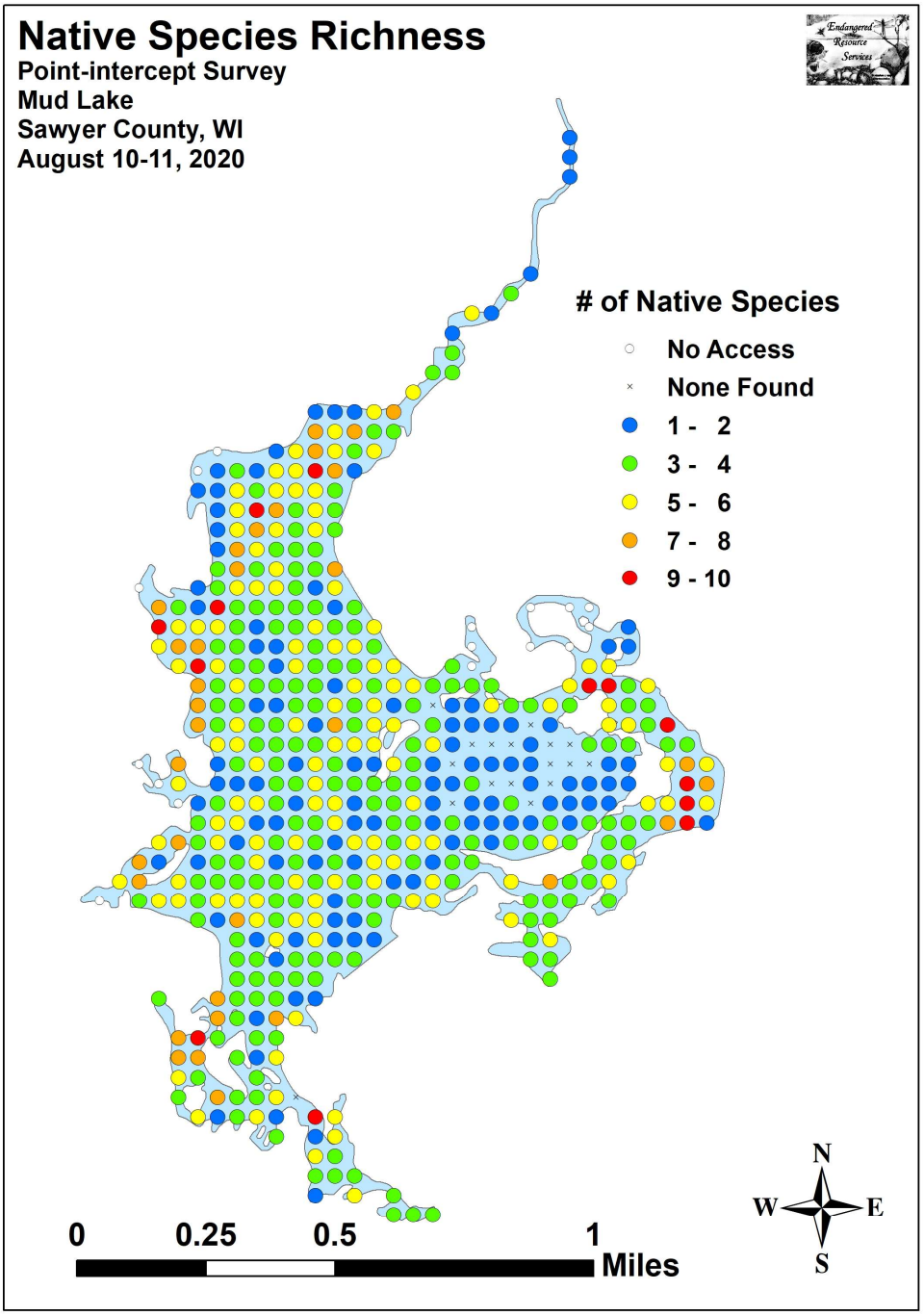

Lake Depth
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Depth in ft.
No Access
0.5 - 3.0
3.1 - 6.0
6.1 - 9.0
9.1 - 12.0
12.1 - 14.0
0
0.25
0.5
1
Miles
N
W
E
S

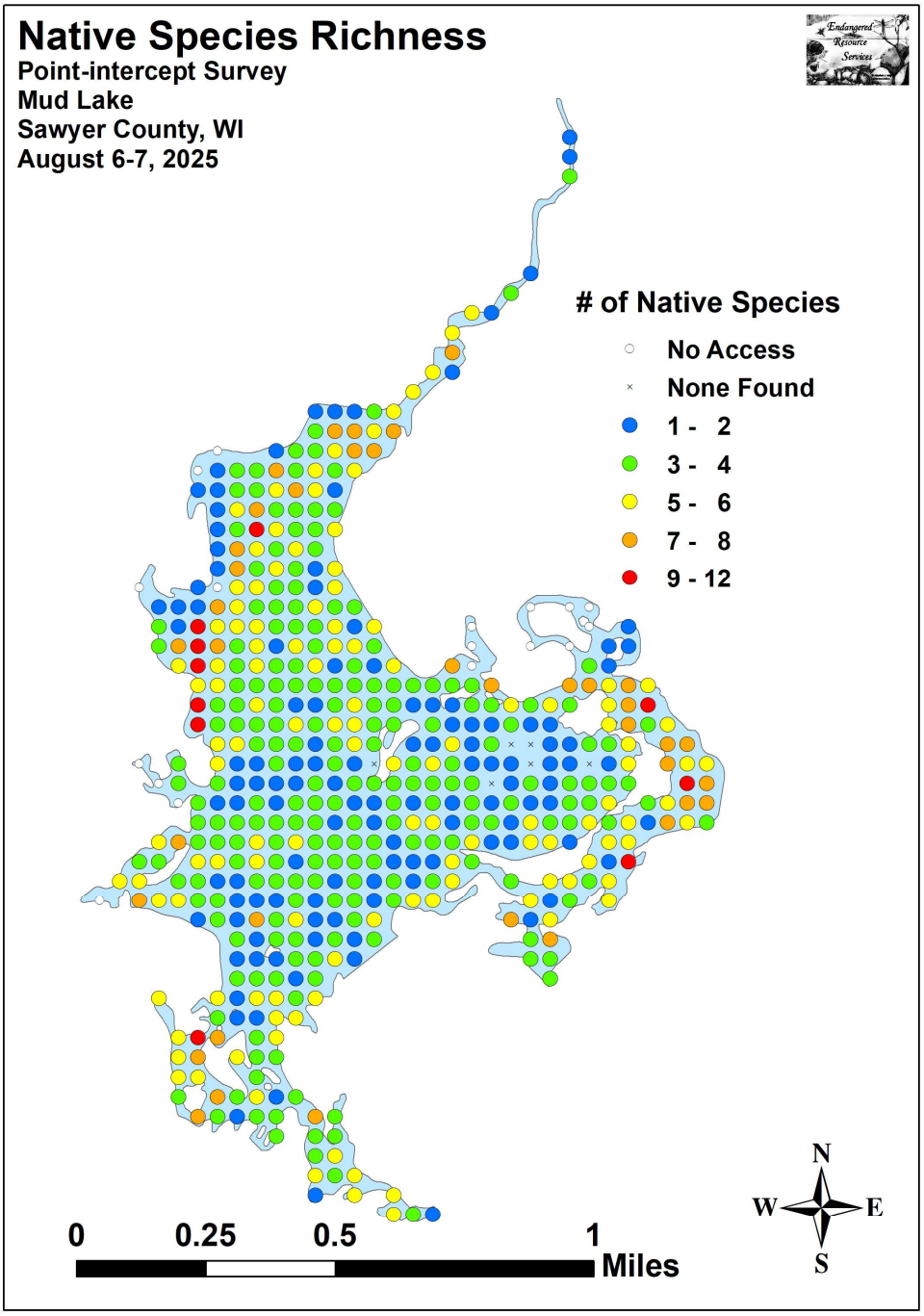

Bottom Substrate
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Substrate Type
Muck
Rock
Sand
No Access
0
0.25
0.5
1
Miles
N
W
E
S

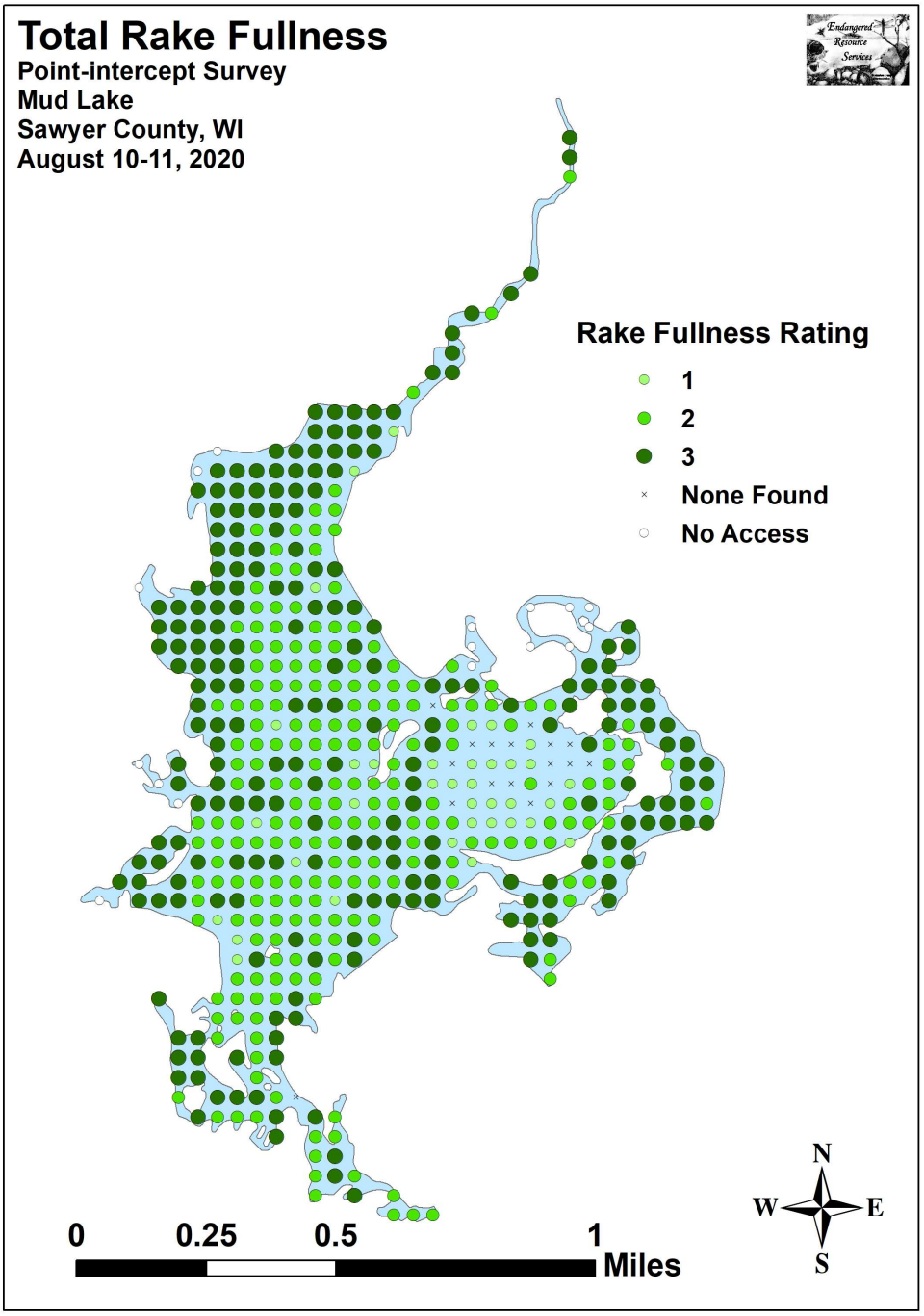
Appendix IV: 2020 and 2025 Littoral Zone, Native Species Richness, and Total Rake Fullness Maps

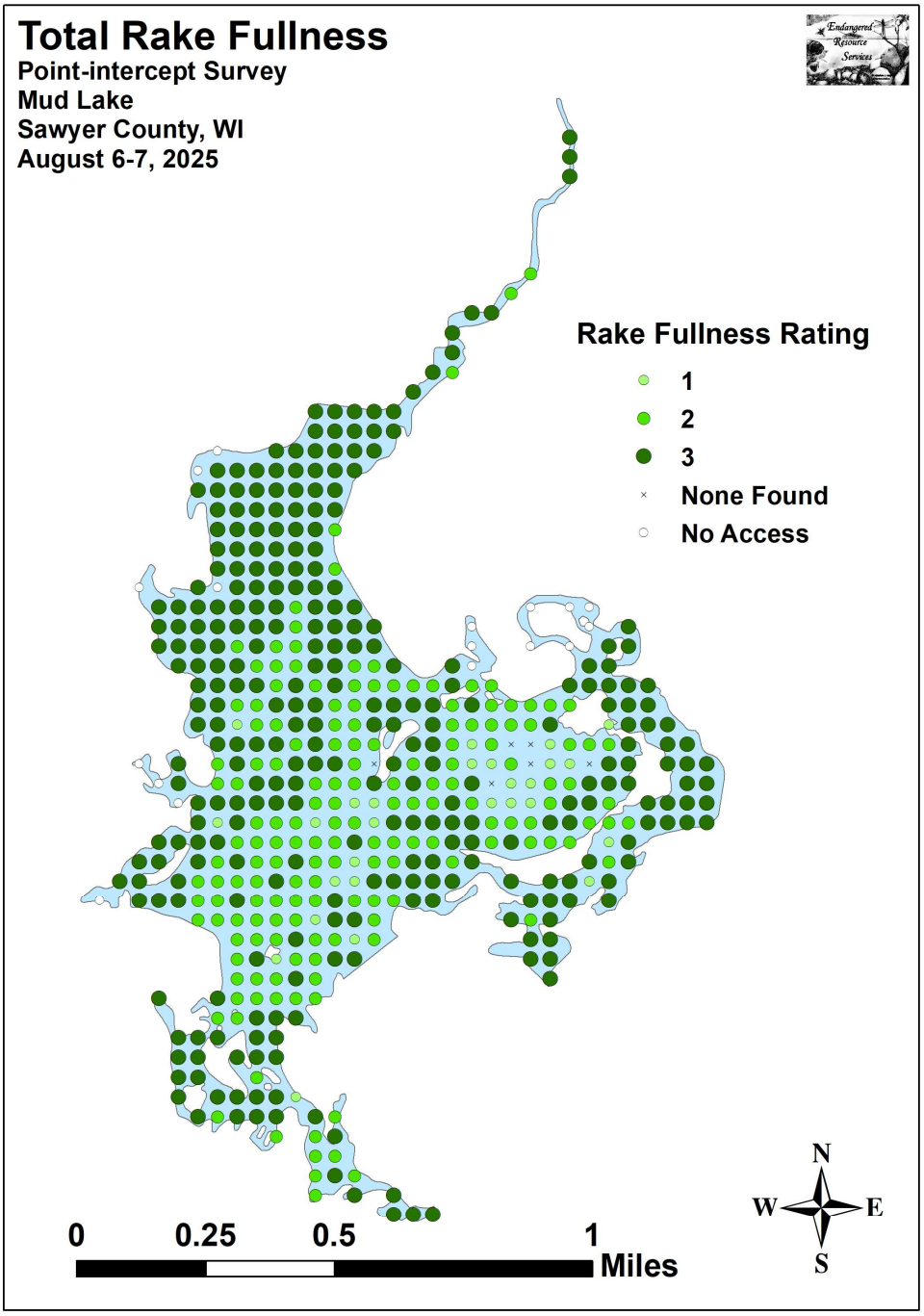

Littoral Zone
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Littoral Zone
Littoral Zone with Plants
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Littoral Zone
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Littoral Zone
Littoral Zone with Plants
No Access
0
0.25
0.5
1
Miles
N
W
E
S

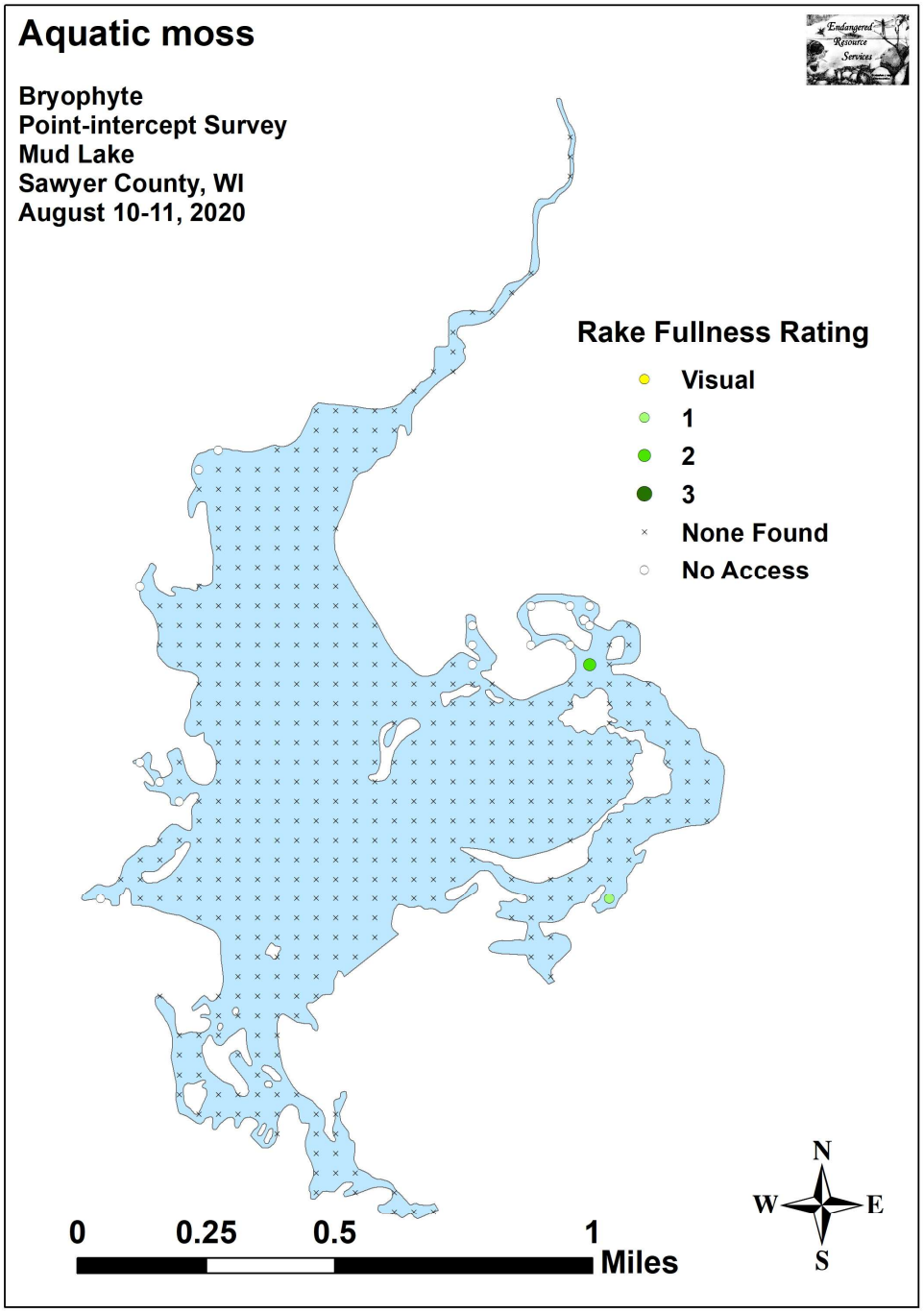

Native Species Richness
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
# of Native Species
No Access
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 10
0
0.25
0.5
1
Miles
N
W
E
S

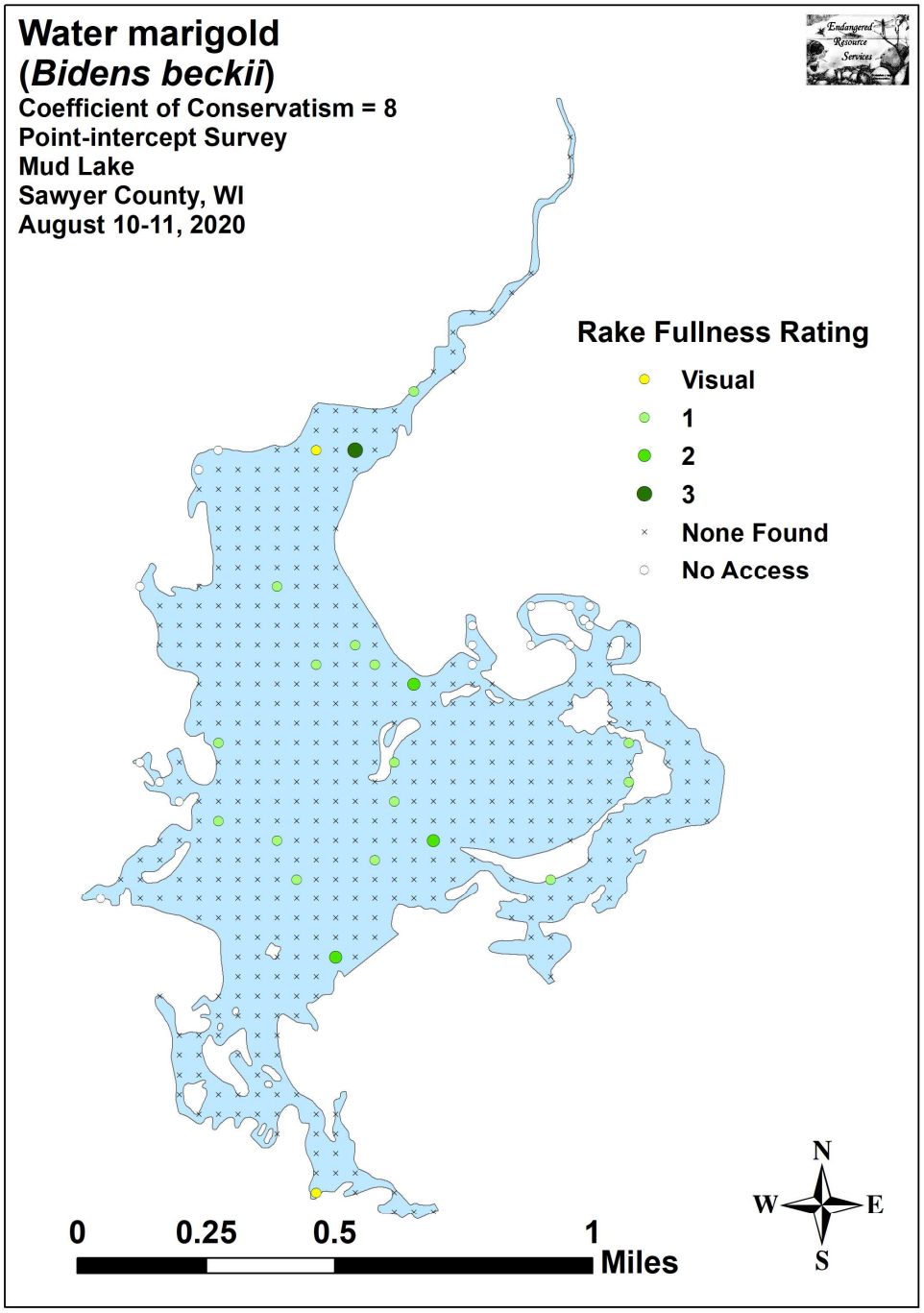

Native Species Richness
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
# of Native Species
No Access
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9 - 12
0
0.25
0.5
1
Miles
N
W
E
S

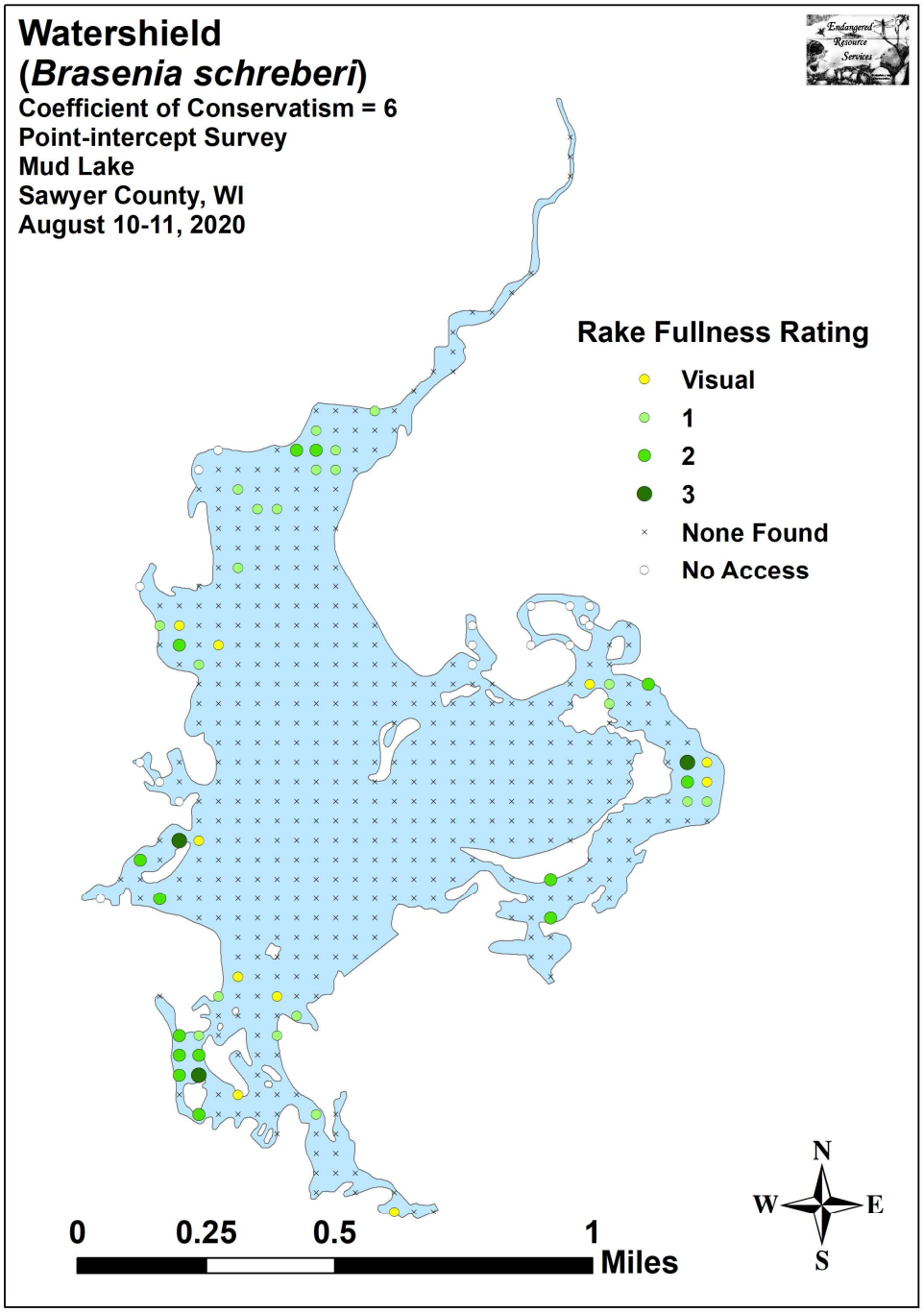

Total Rake Fullness
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S

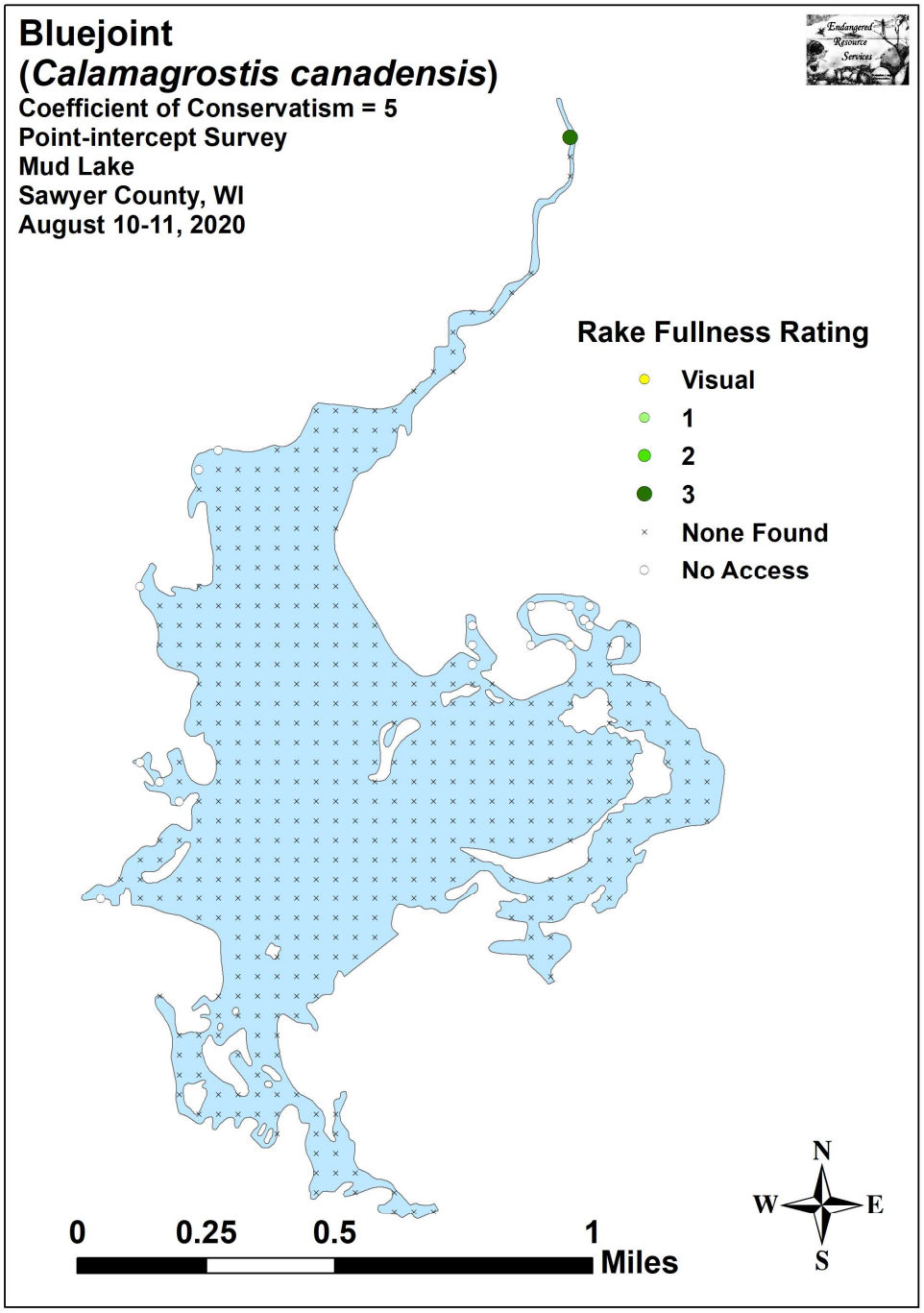

Total Rake Fullness
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S

Appendix V: August 2020 Native Species Density and Distribution Maps


Aquatic moss
Bryophyte
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Bluejoint
(Calamagrostis canadensis)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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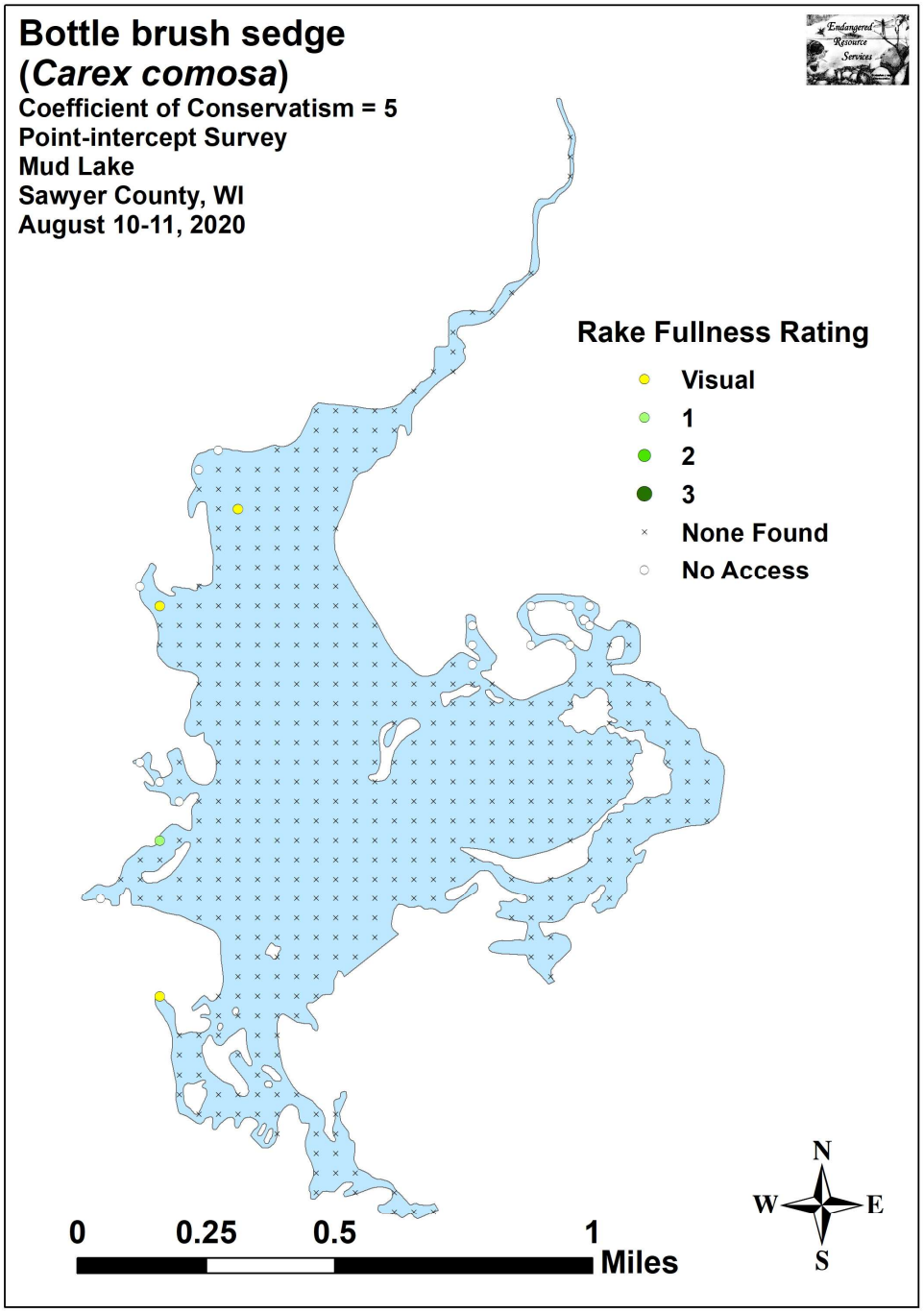
W
E
S


Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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W
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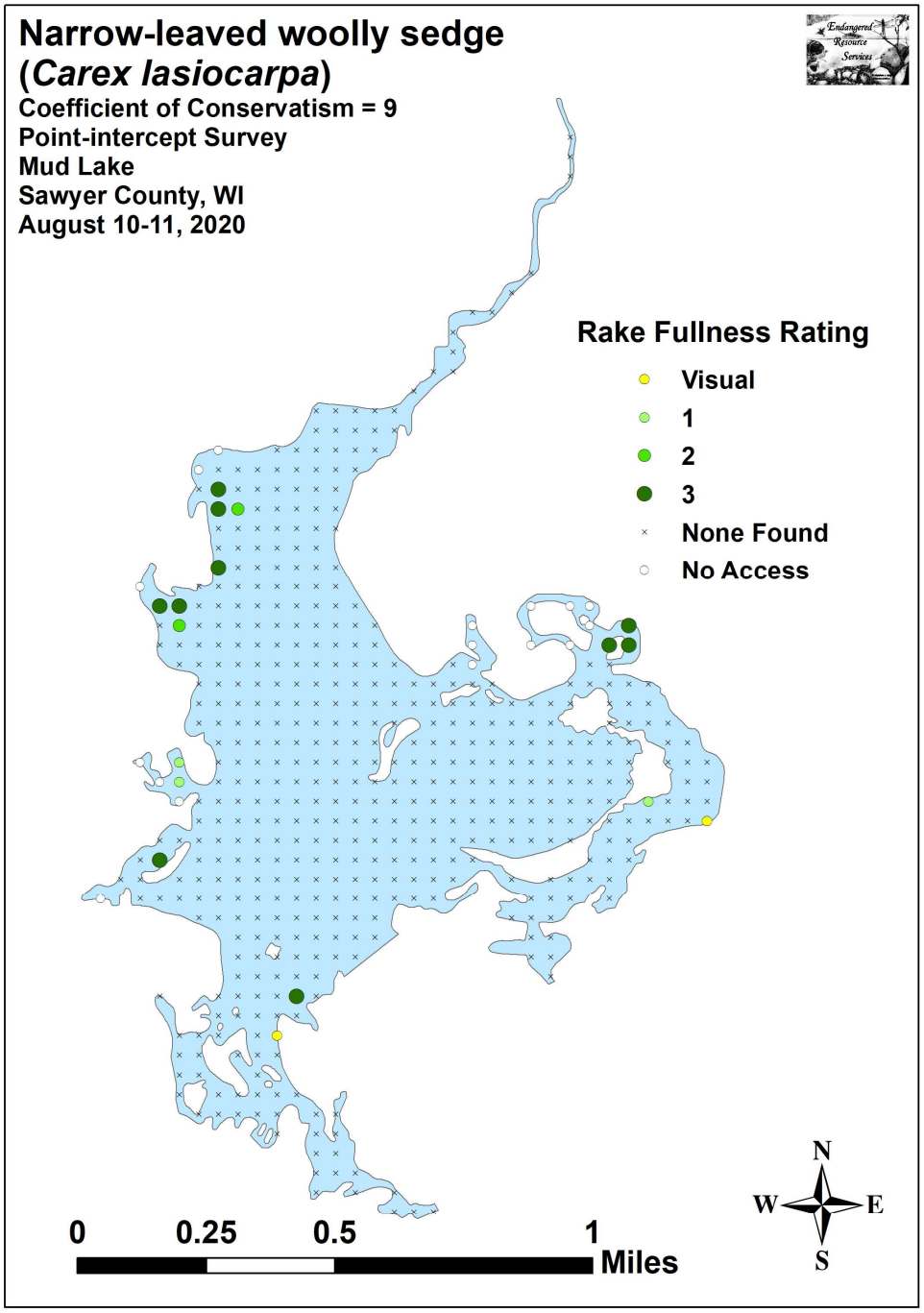
Narrow-leaved woolly sedge
(Carex lasiocarpa)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
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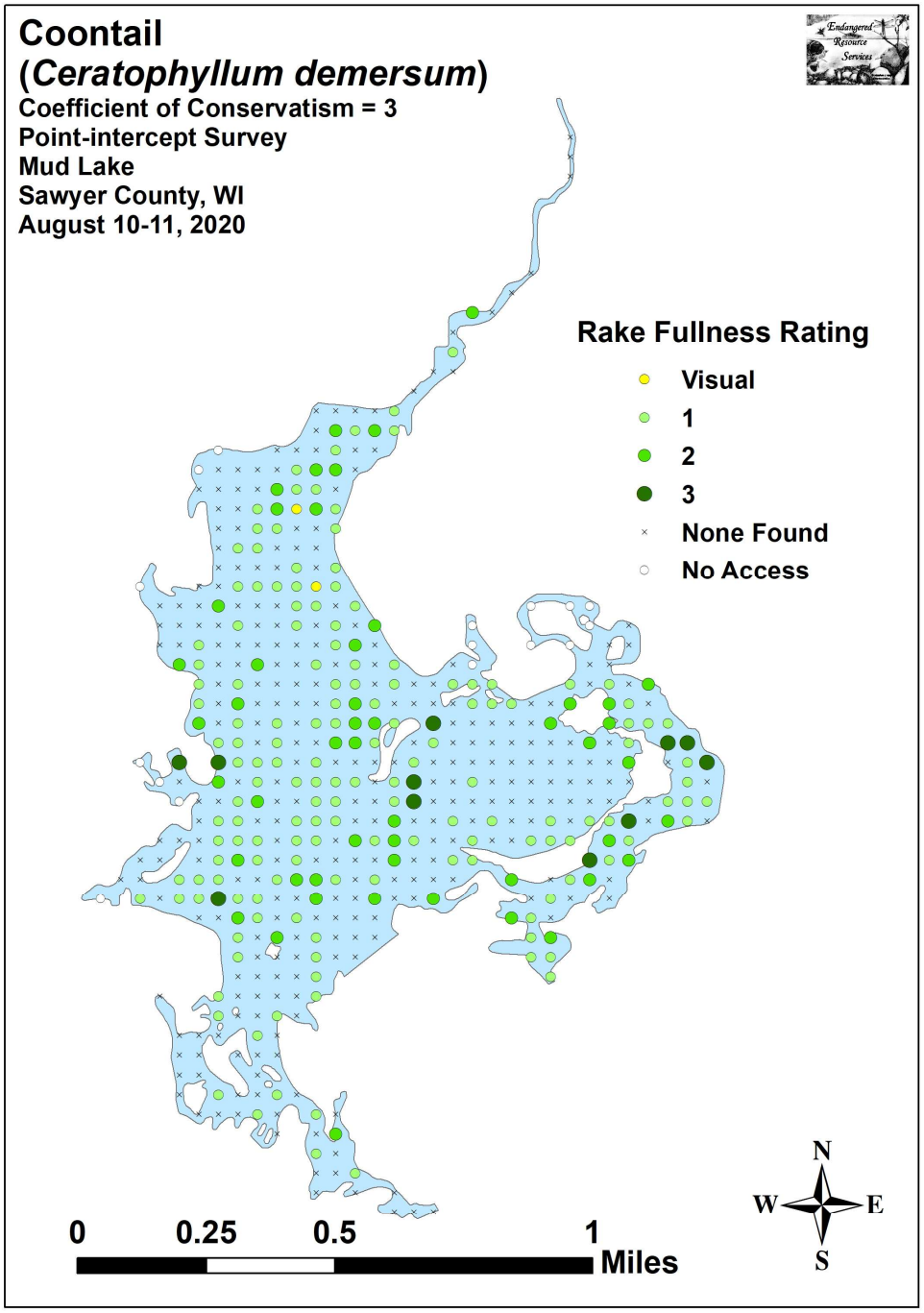
Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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W
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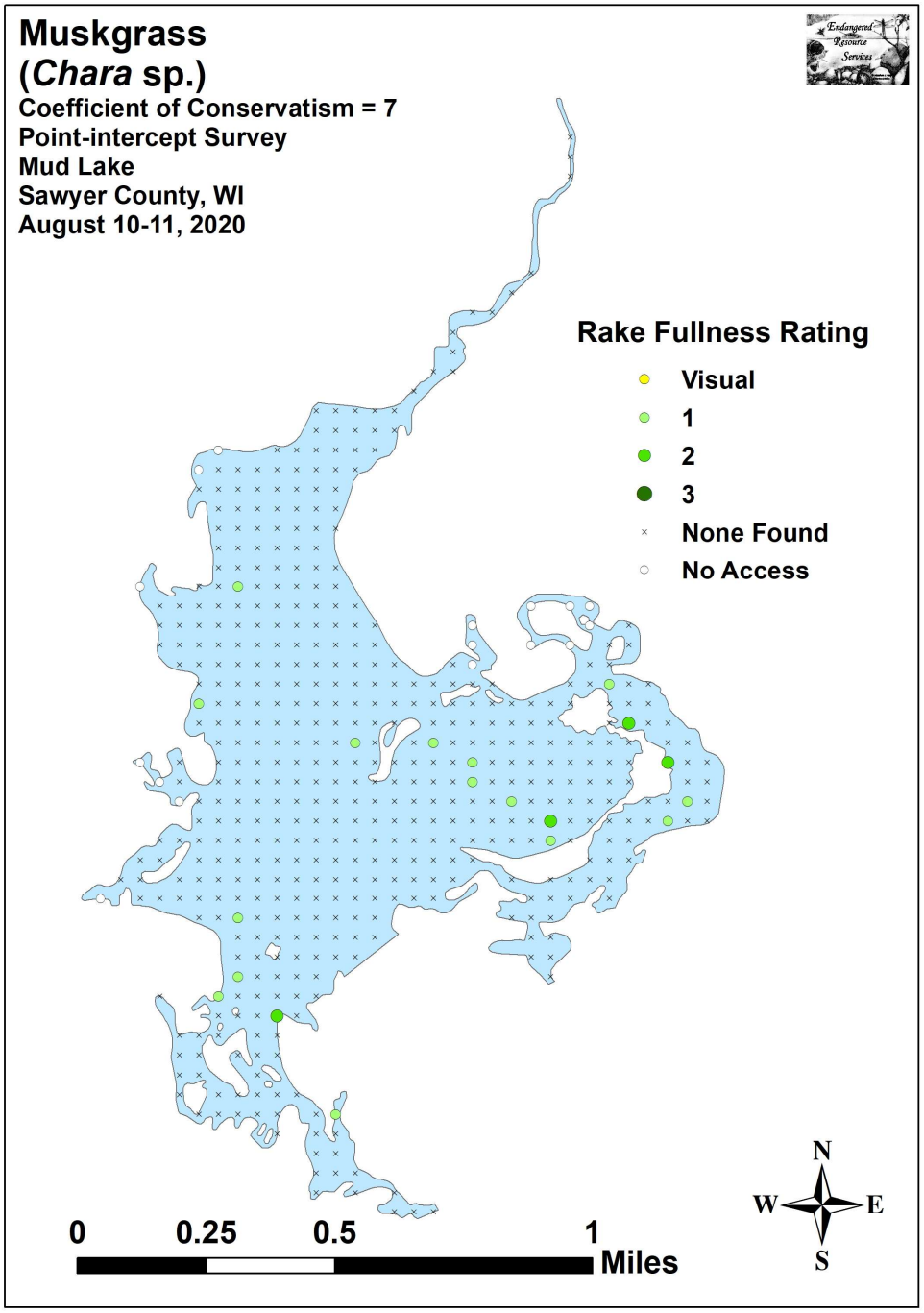
Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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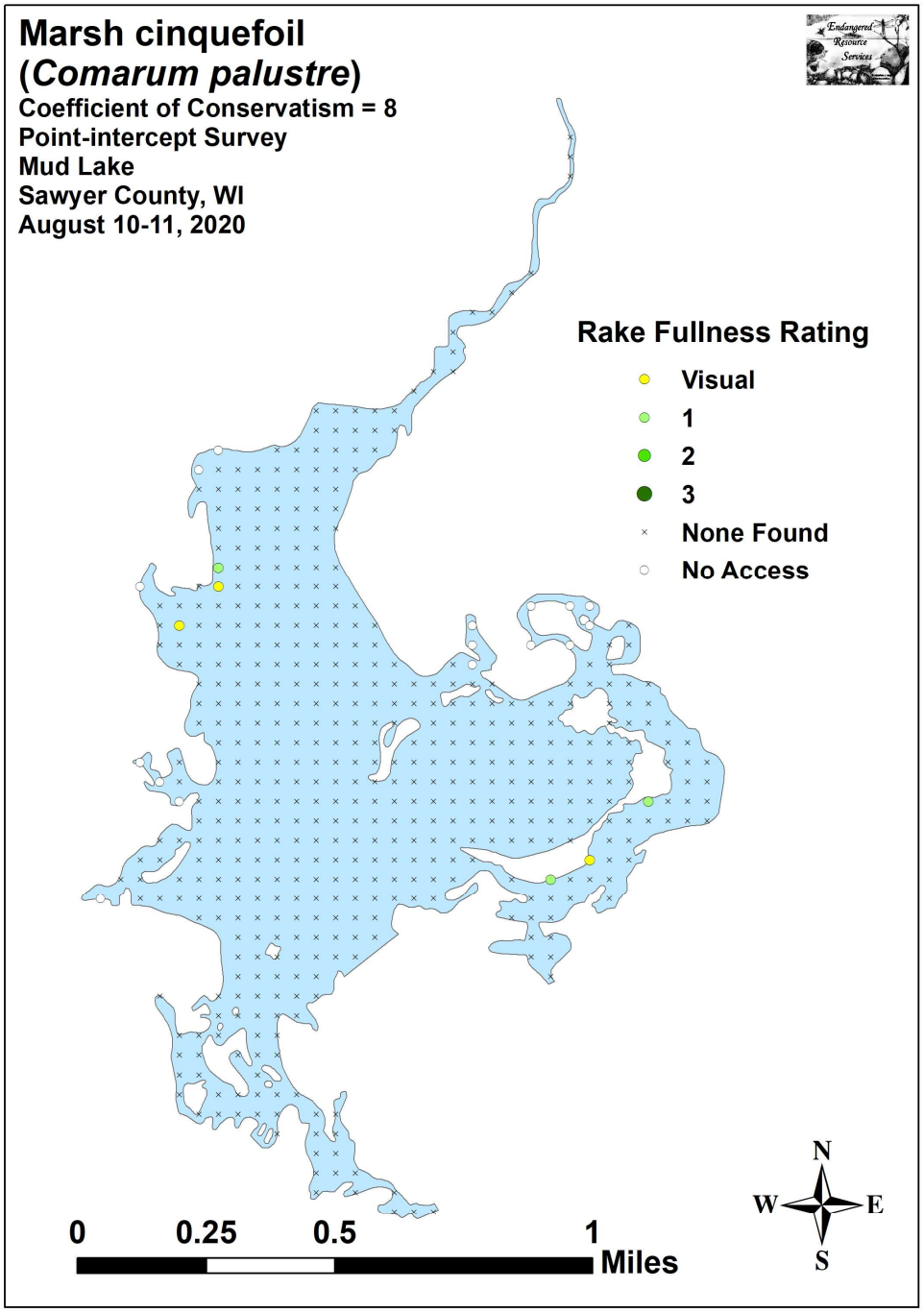
Marsh cinquefoil
(Comarum palustre)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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W
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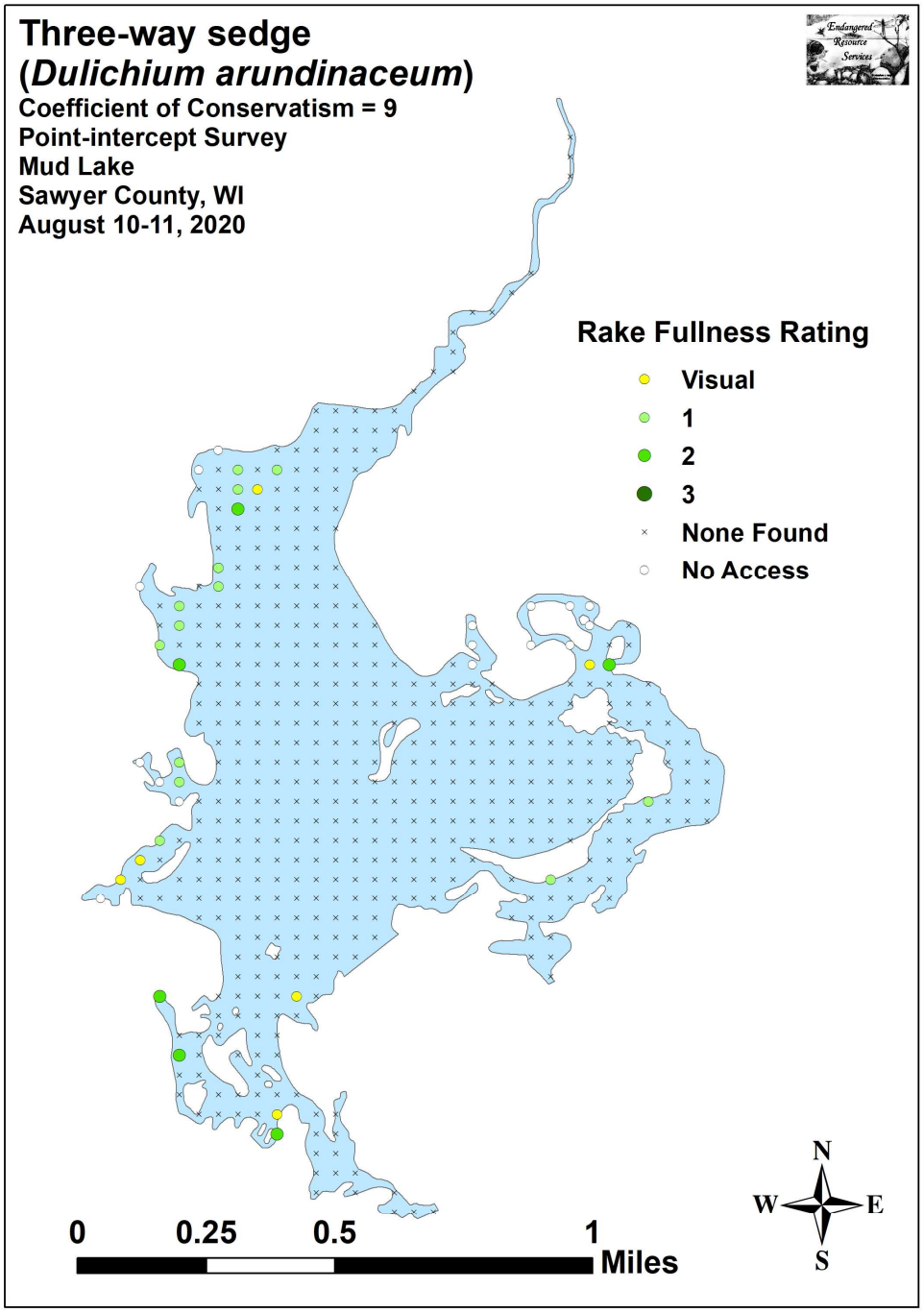
S


Three-way sedge
(Dulichium arundinaceum)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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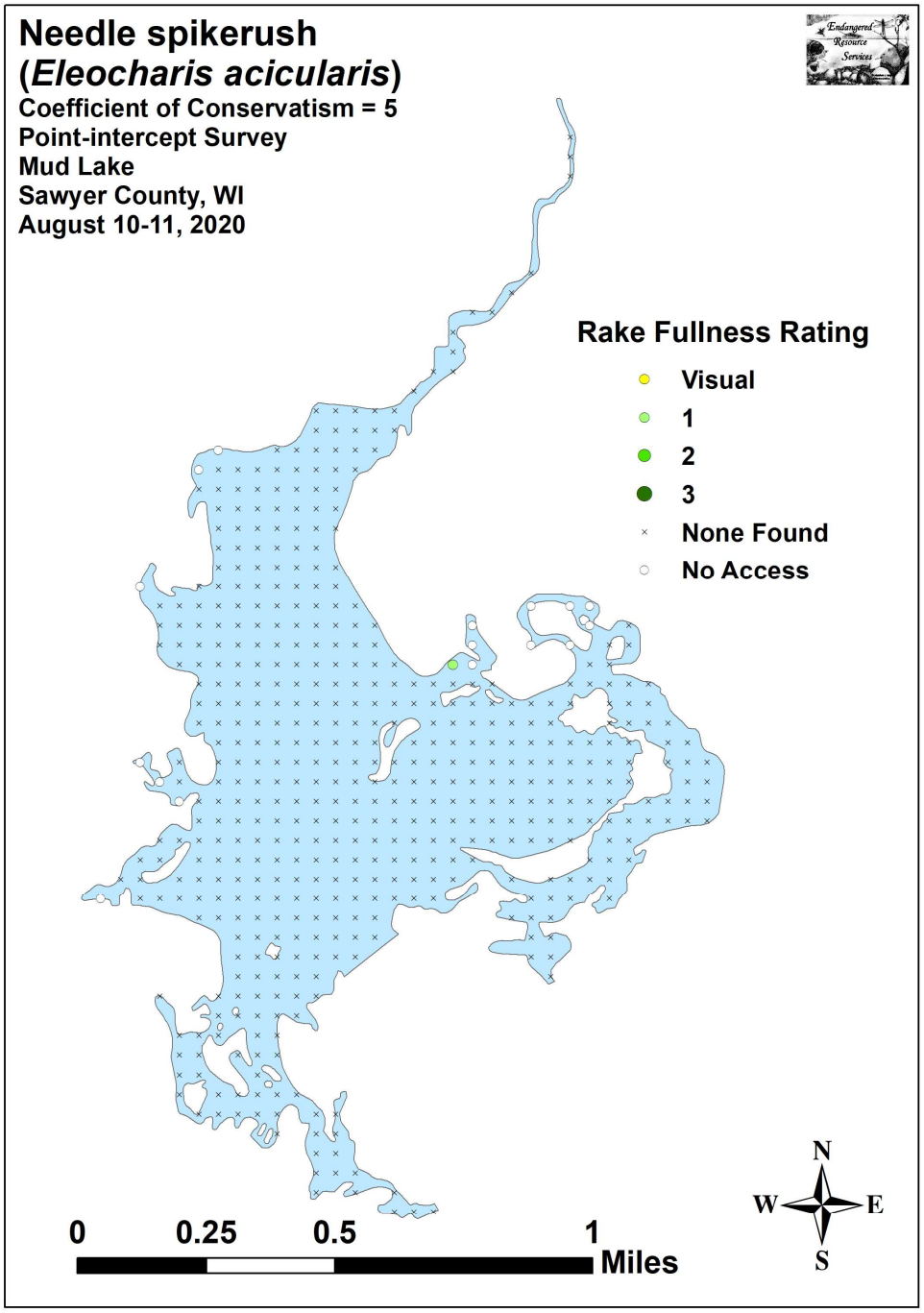
S


Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
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0.25
0.5
1
Miles
N
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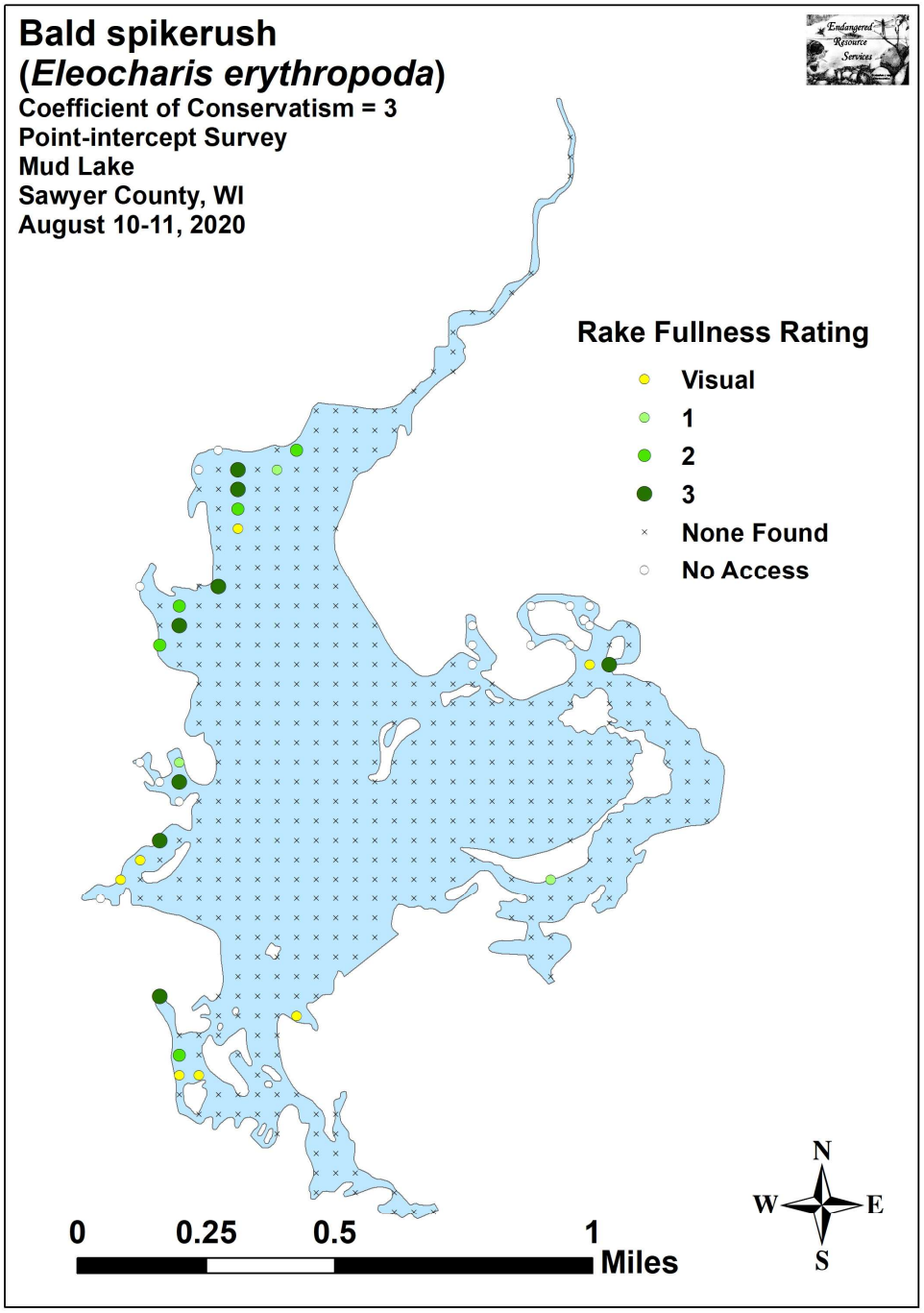
S


Bald spikerush
(Eleocharis erythropoda)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
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3
None Found
No Access
0
0.25
0.5
1
Miles
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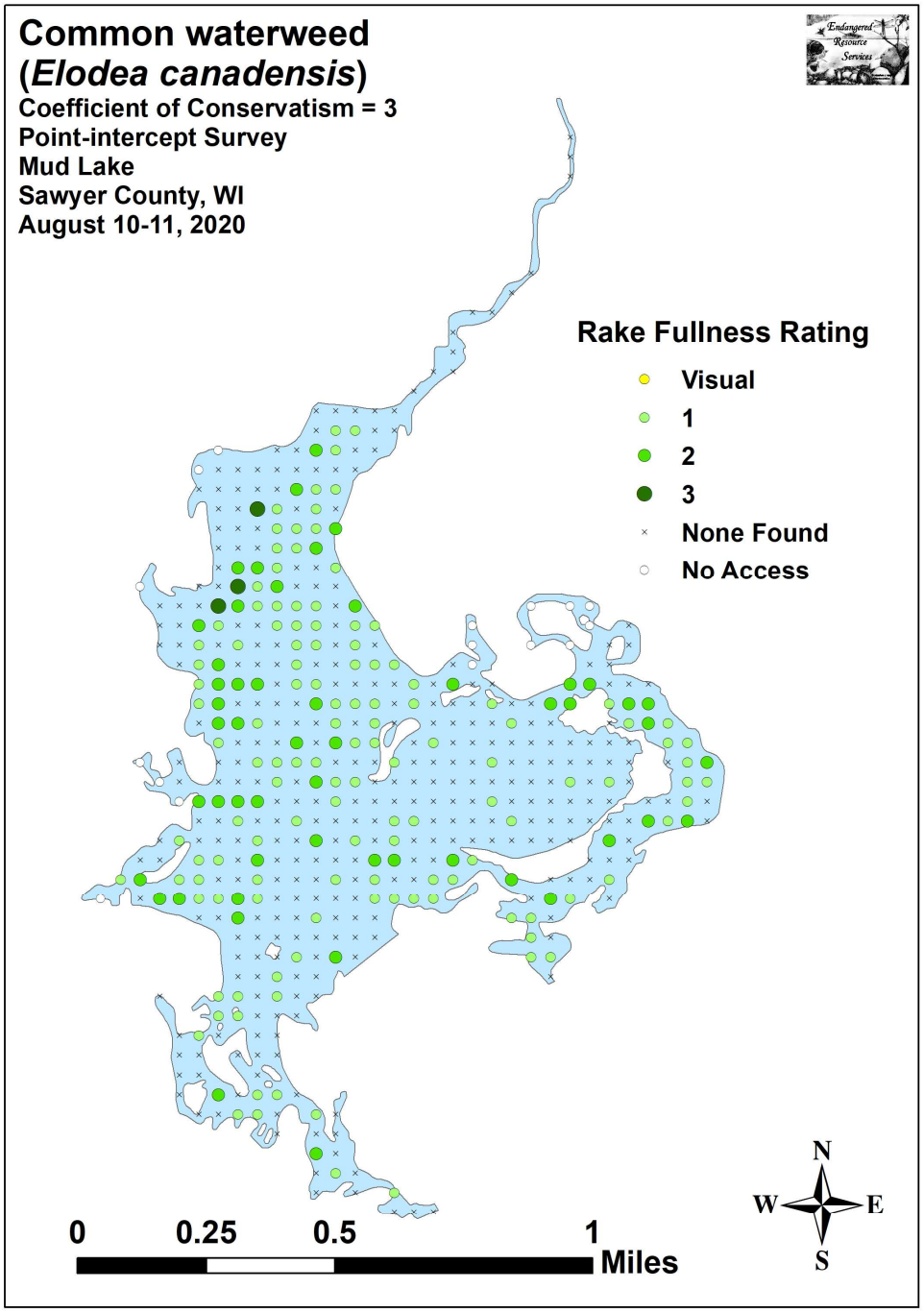
S


Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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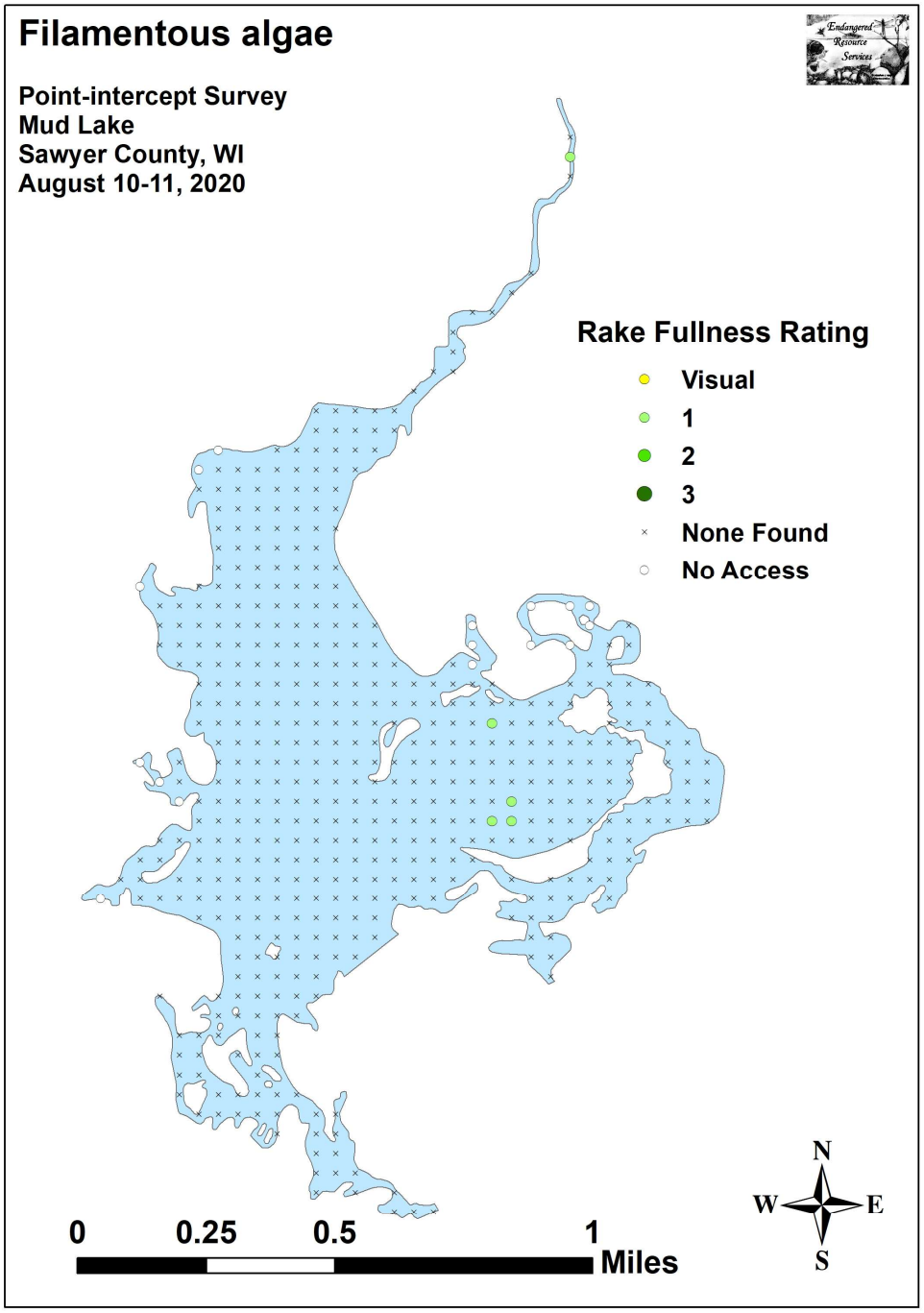
Filamentous algae
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
No Access
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0.25
0.5
1
Miles
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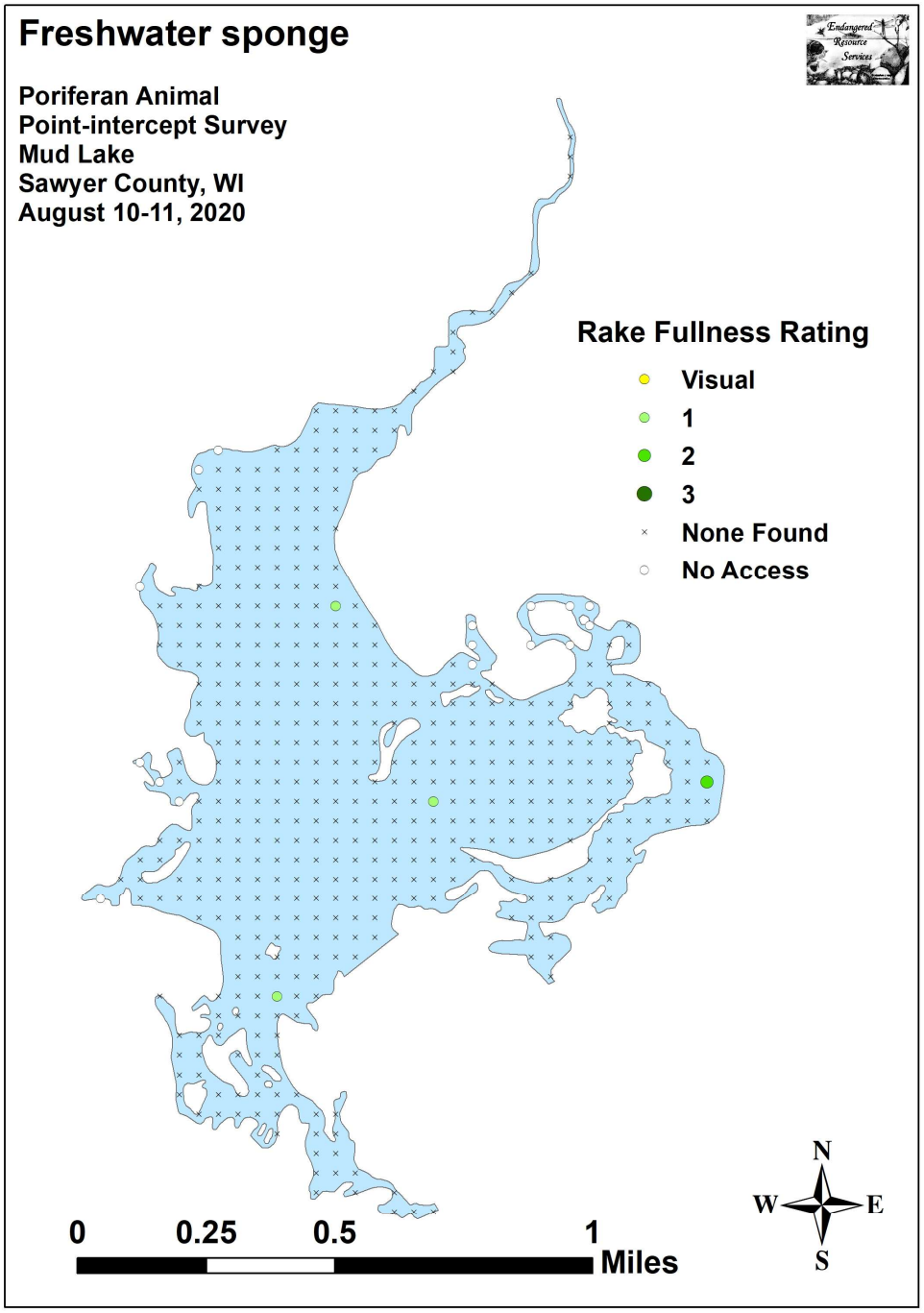
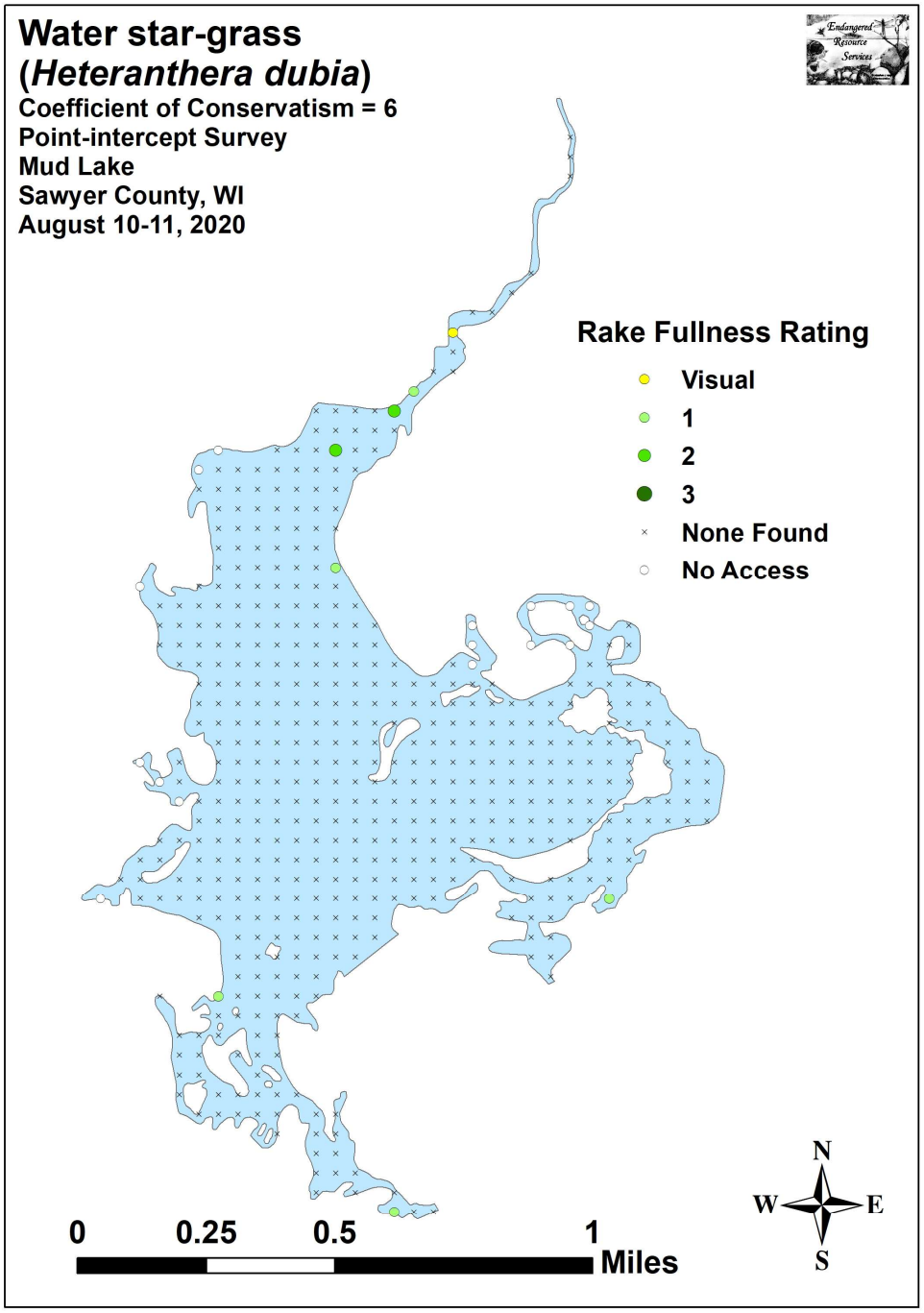
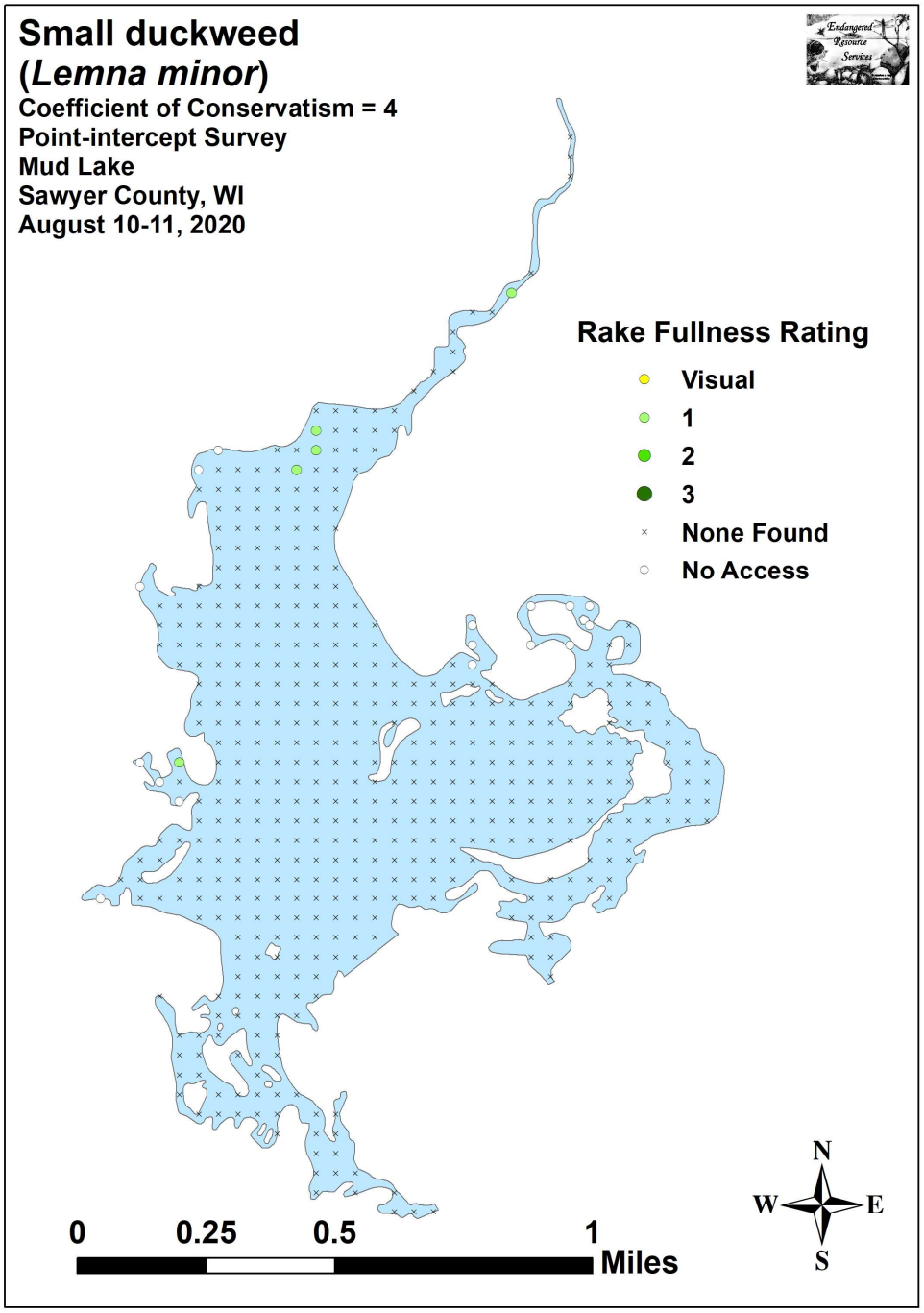

Freshwater sponge
Poriferan Animal
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
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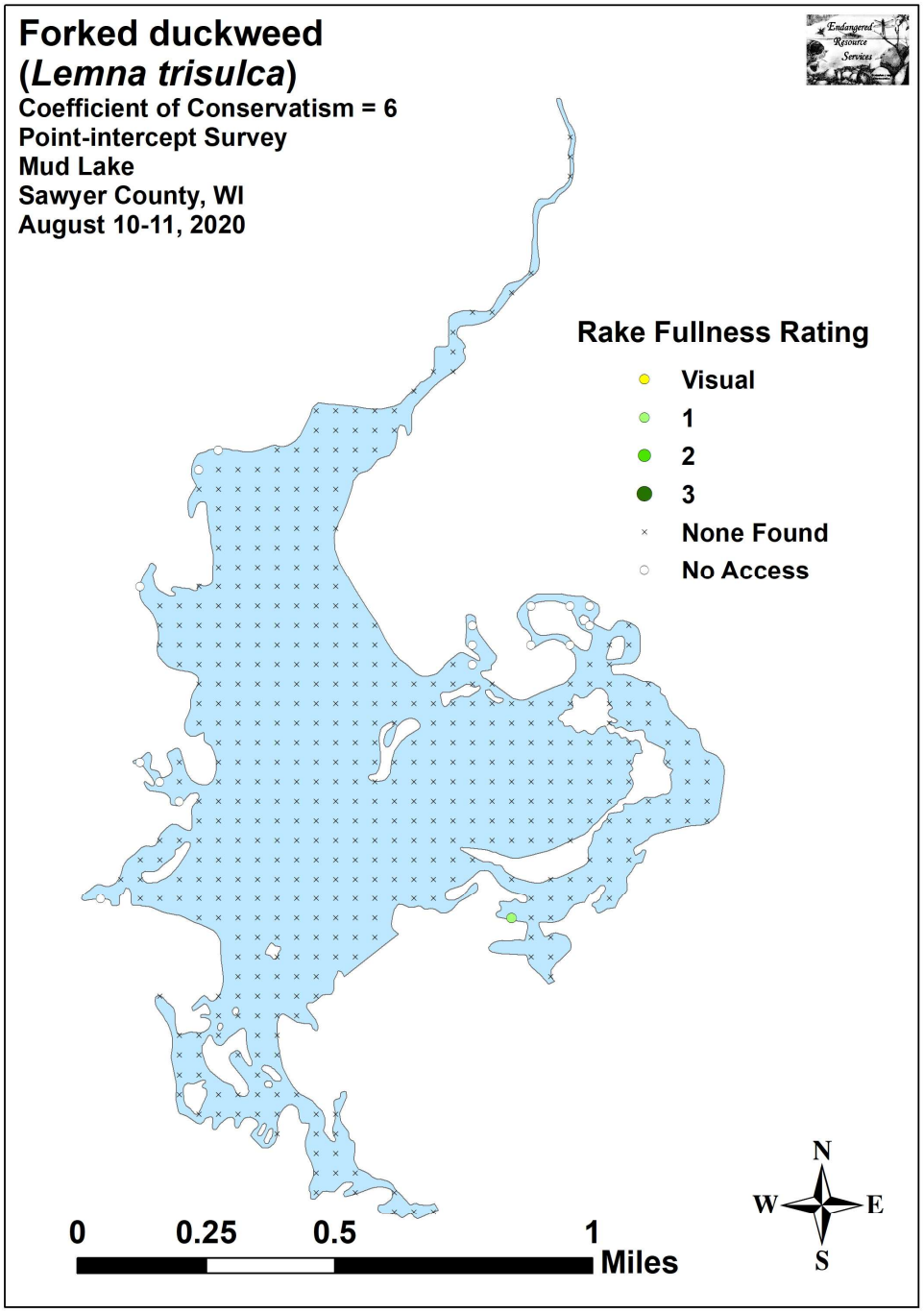
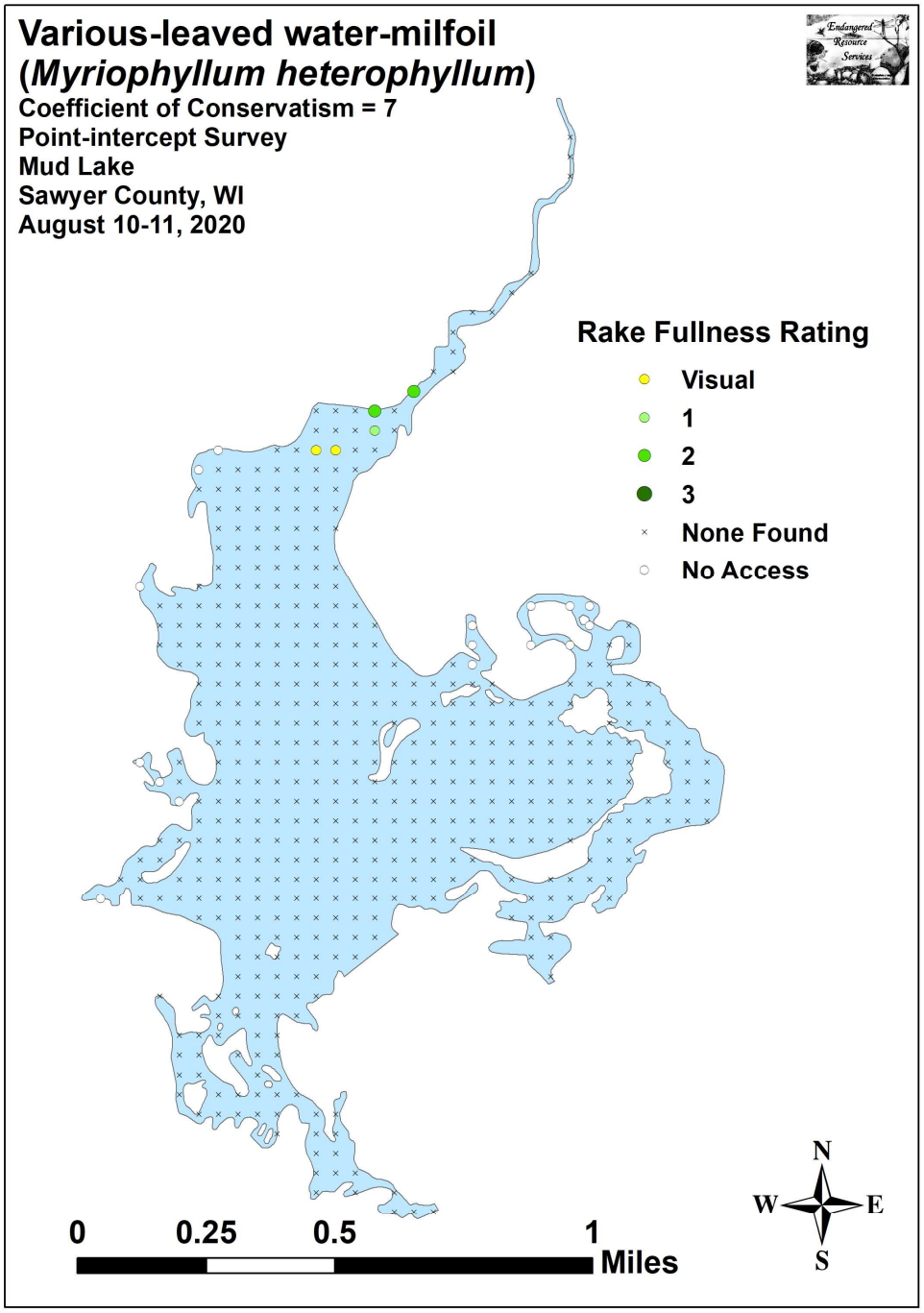
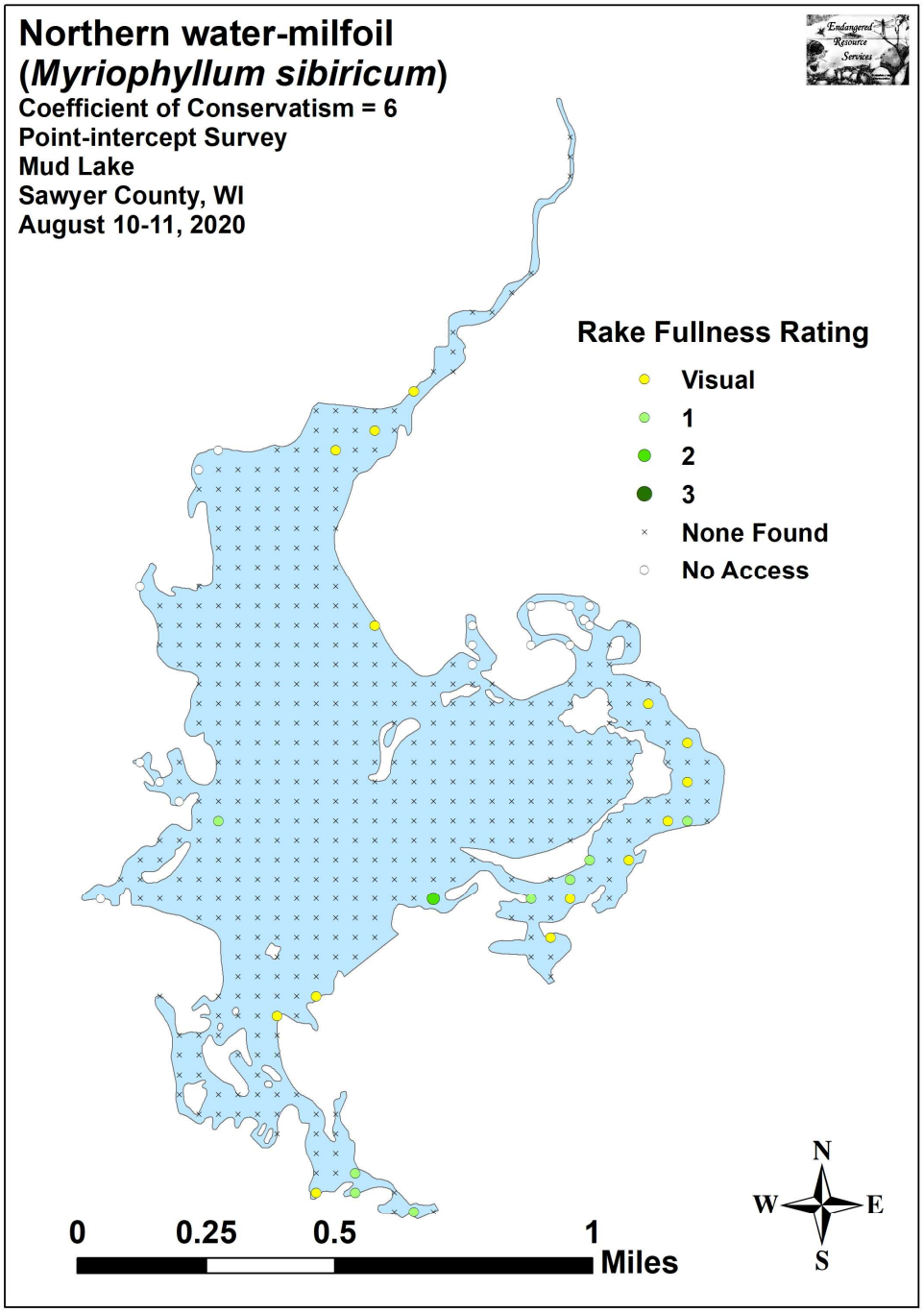
S


Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Various-leaved water-milfoil
(Myriophyllum heterophyllum)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
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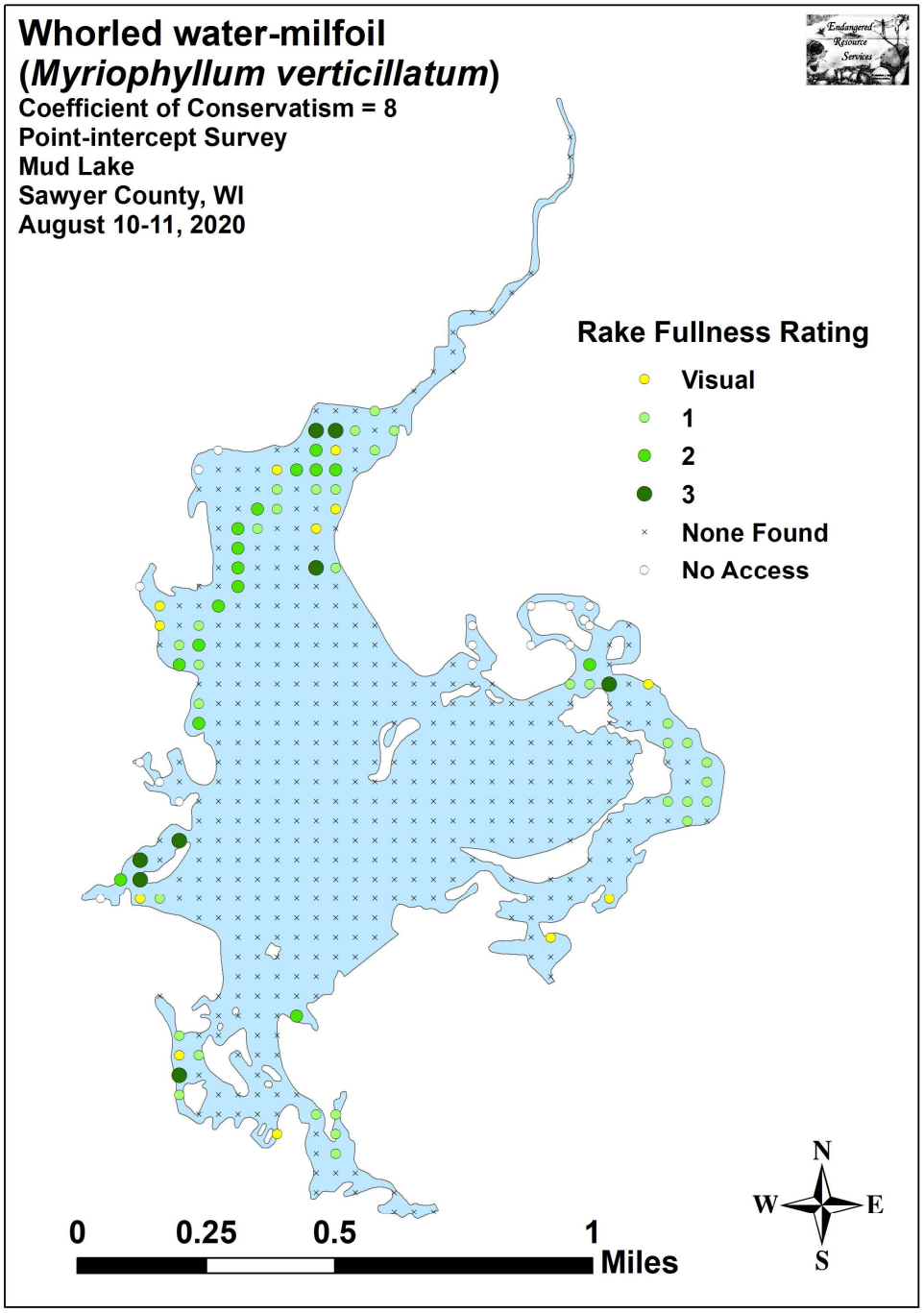
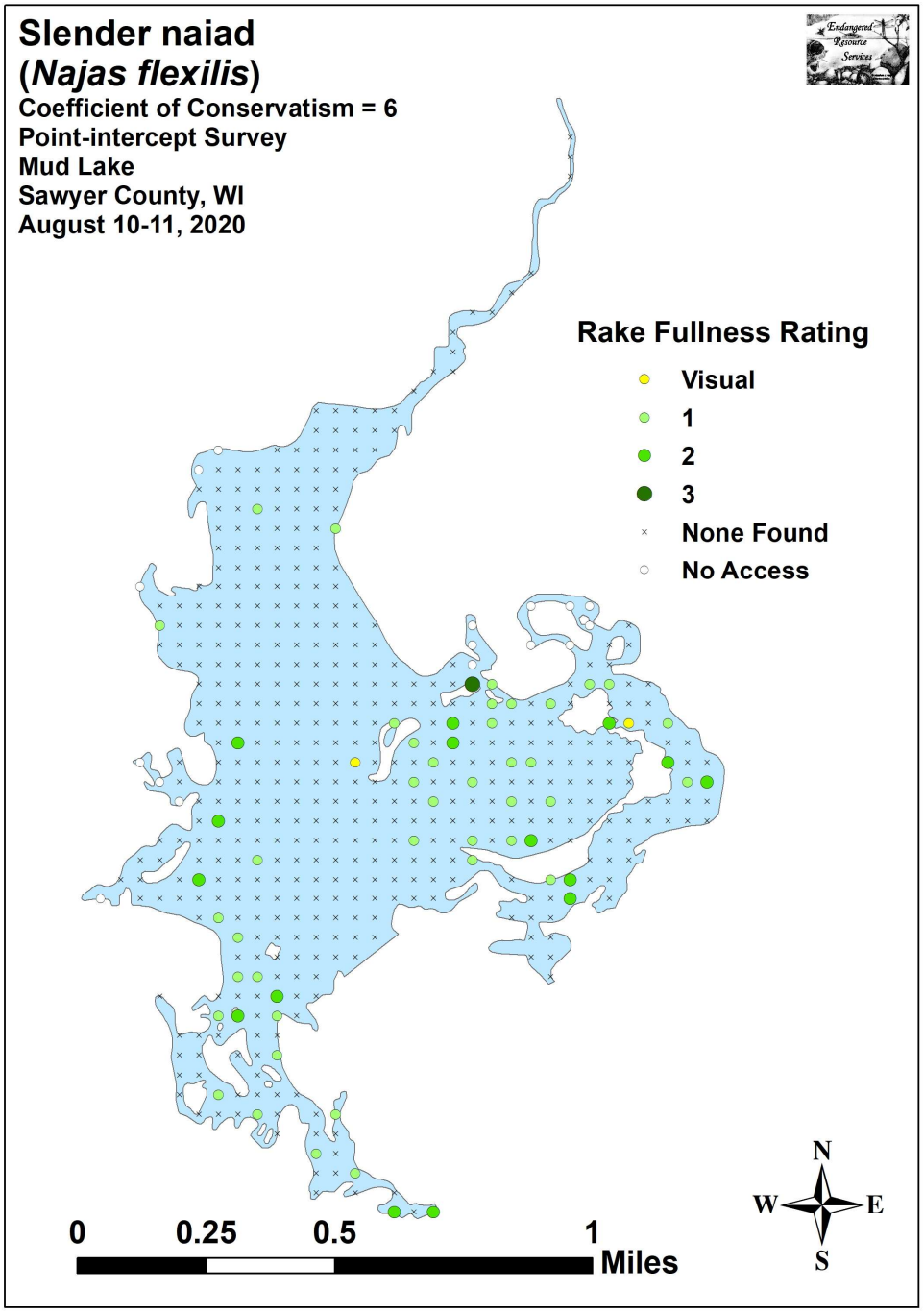
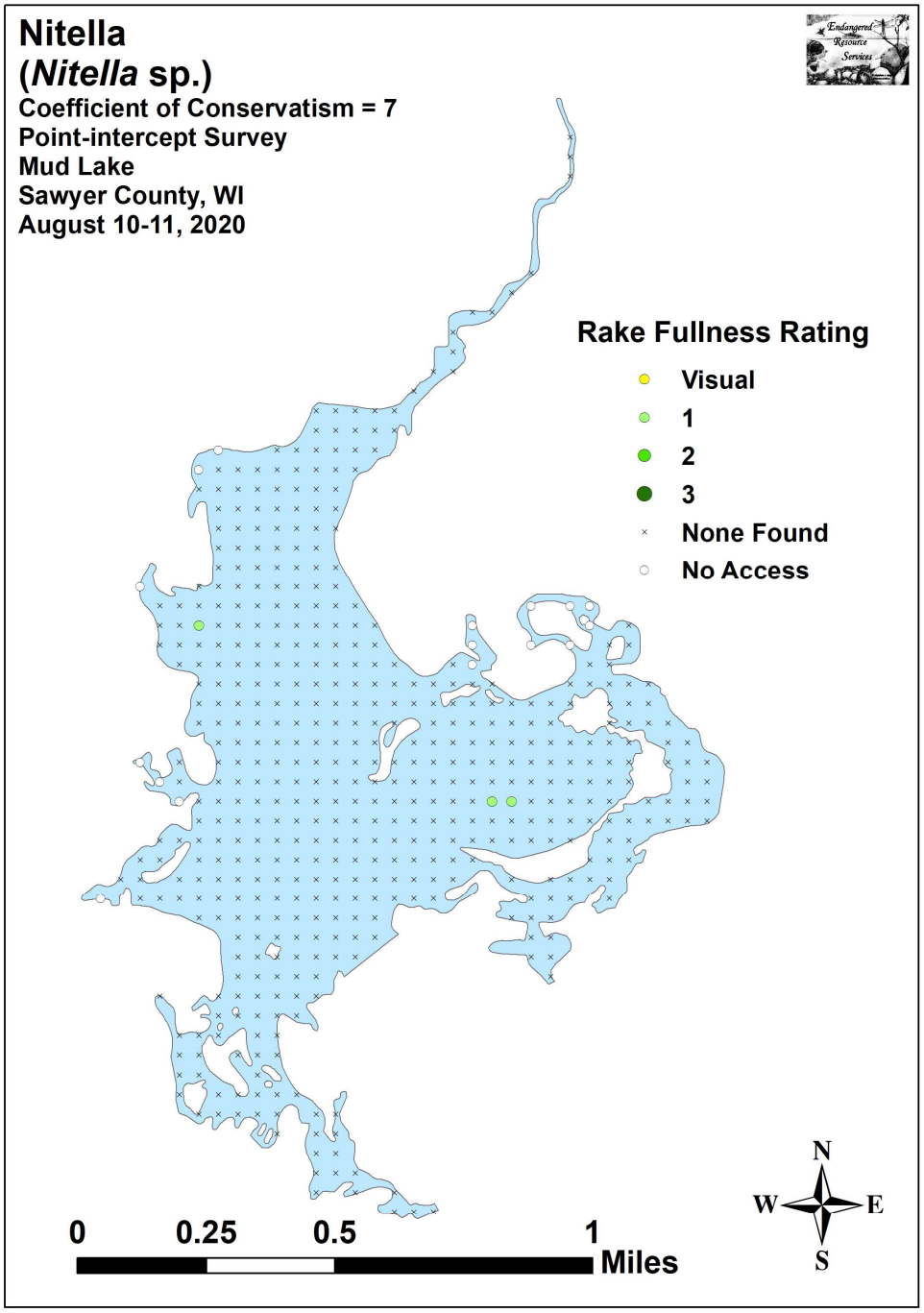
S


Whorled water-milfoil
(Myriophyllum verticillatum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
E
S


Nitella
(Nitella sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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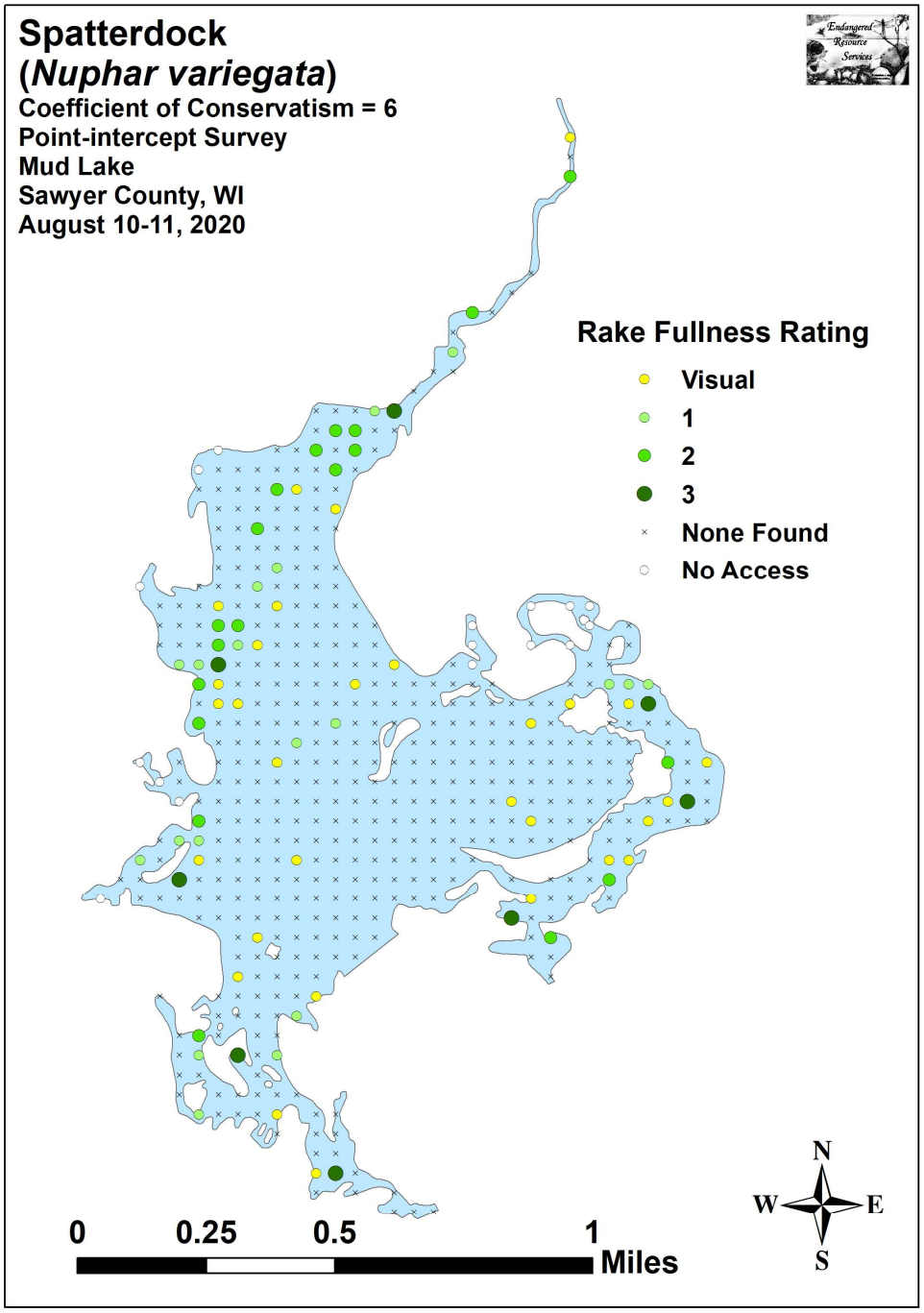
E
S


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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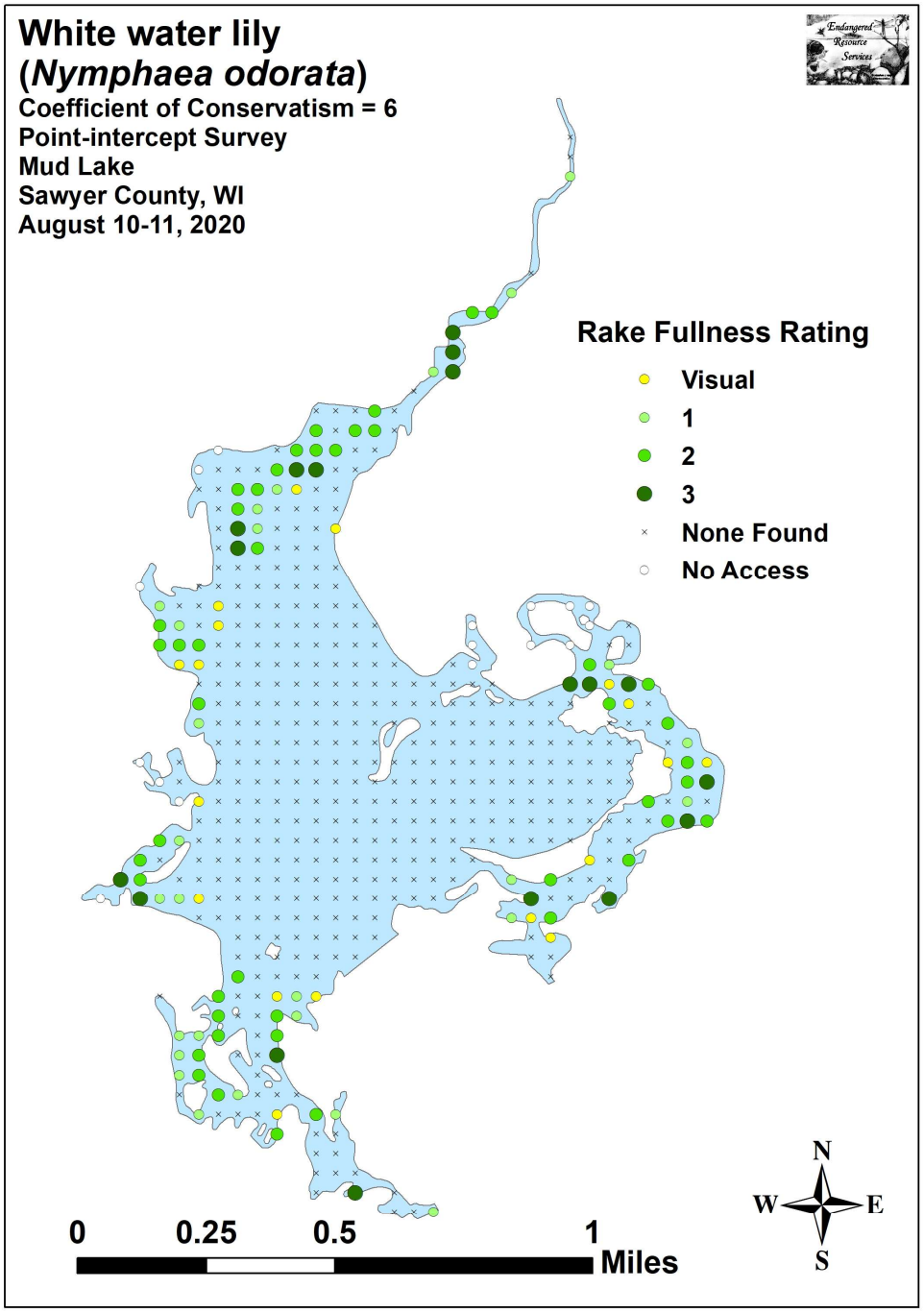
S


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
N
W
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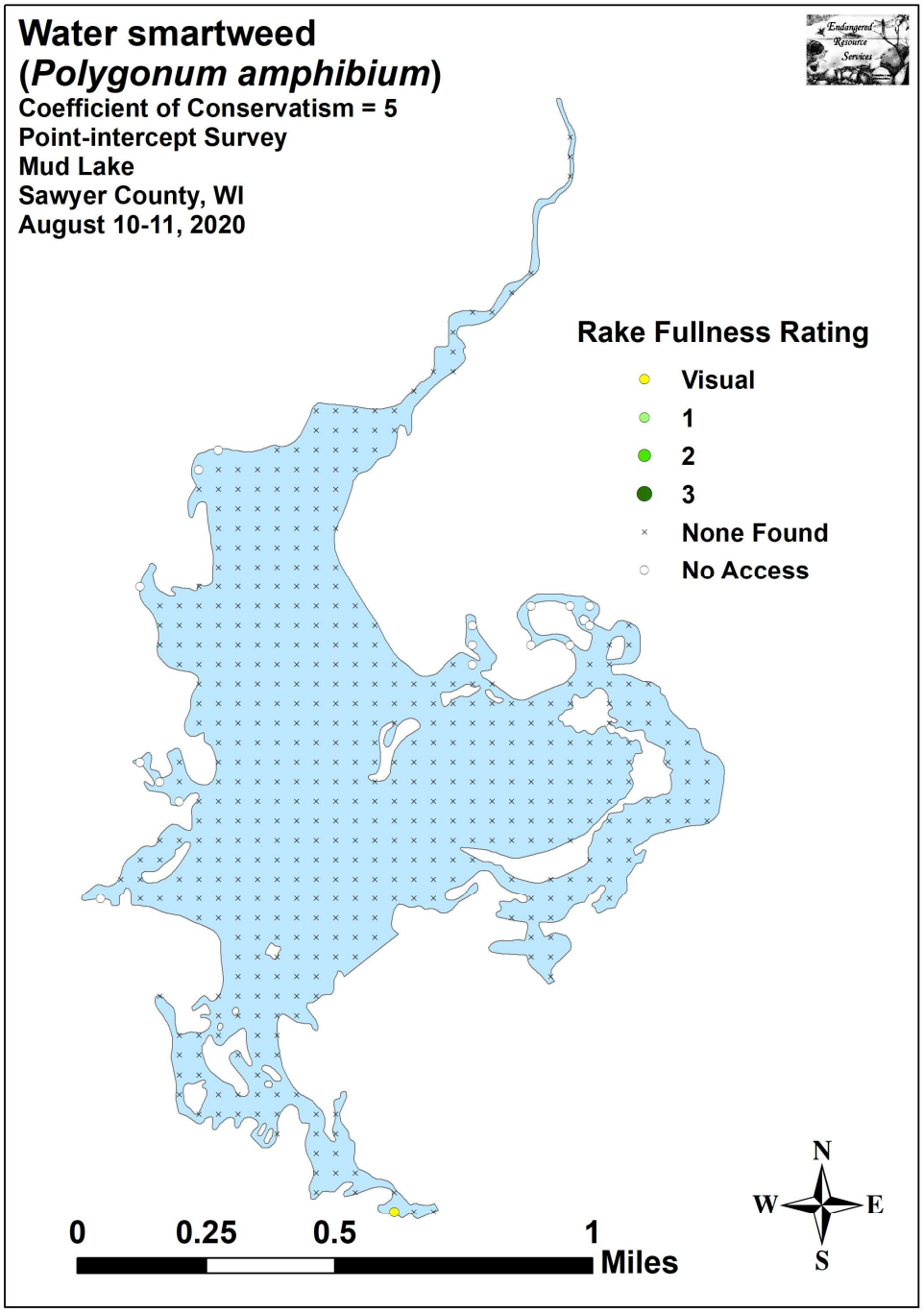
S


Water smartweed
(Polygonum amphibium)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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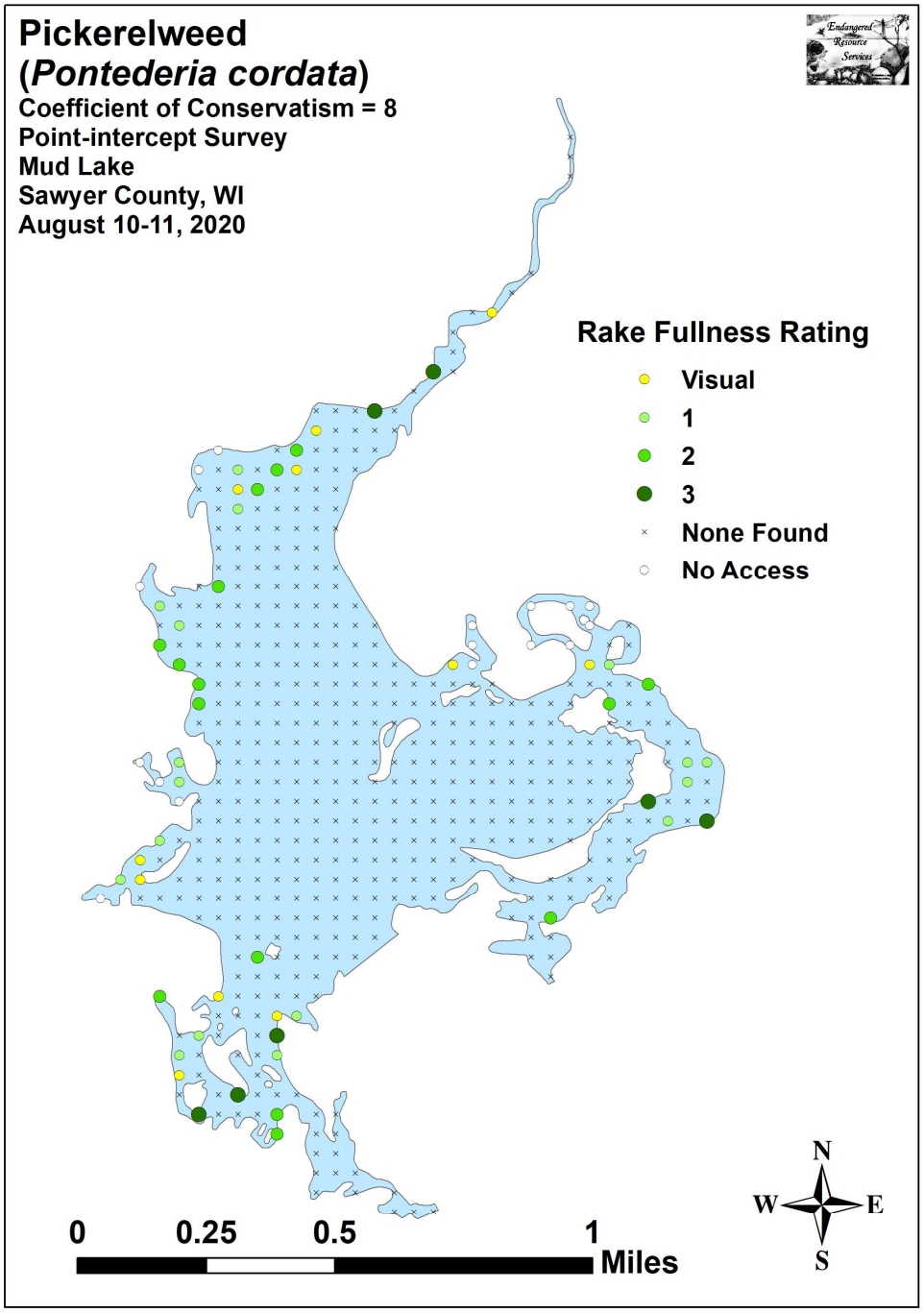
Pickerelweed
(Pontederia cordata)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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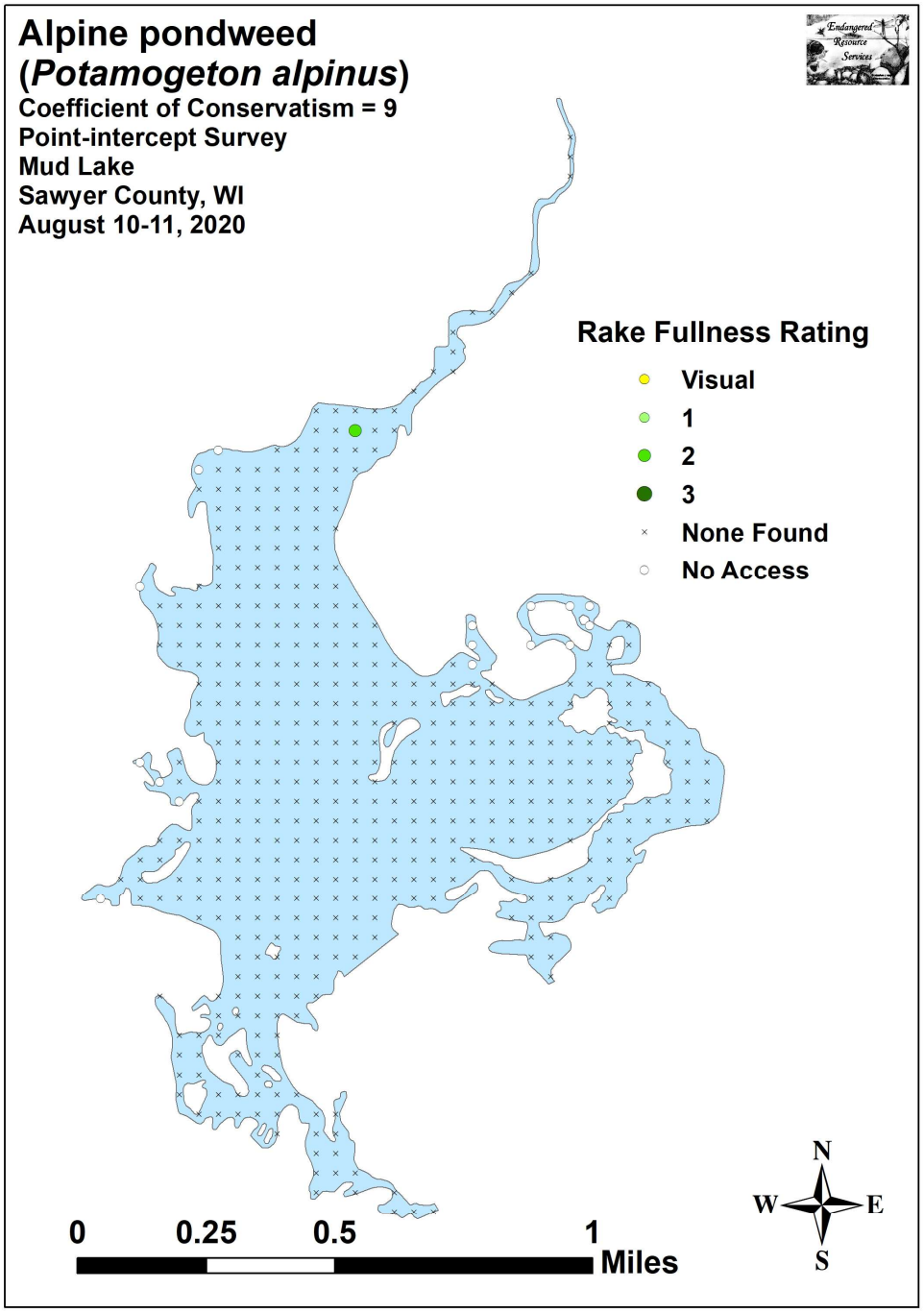
Alpine pondweed
(Potamogeton alpinus)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
1
2
3
None Found
No Access
0
0.25
0.5
1
Miles
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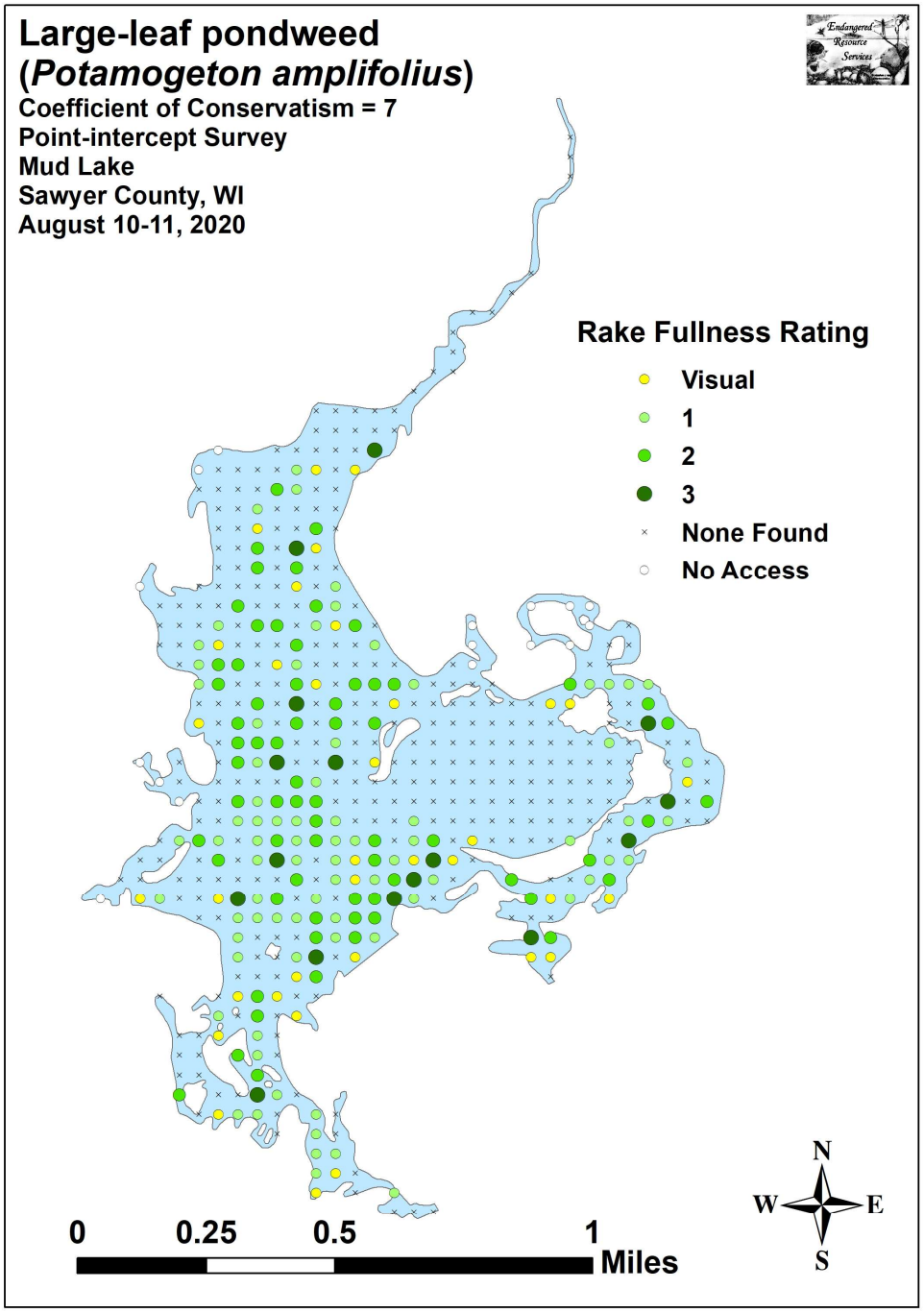
Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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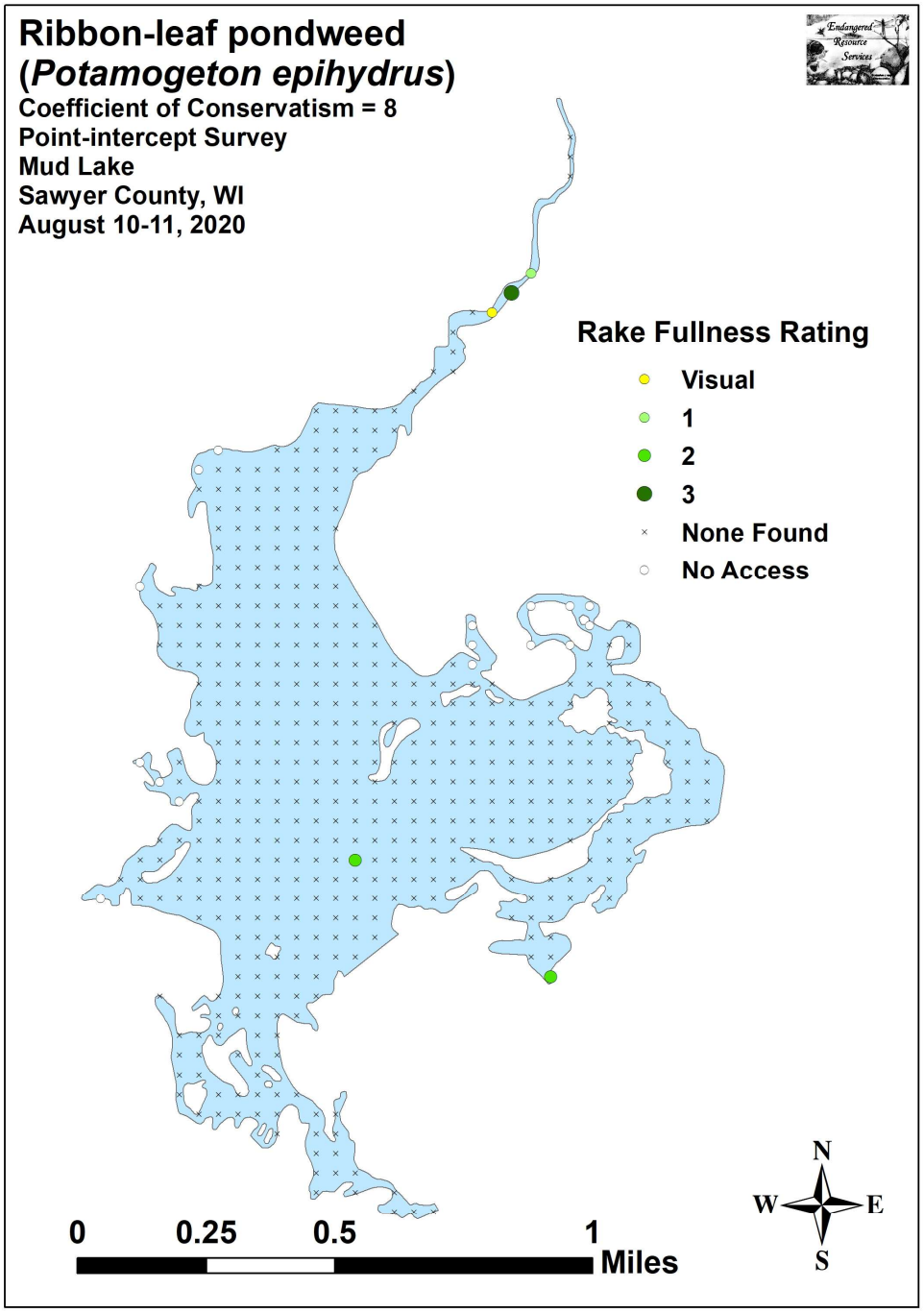
Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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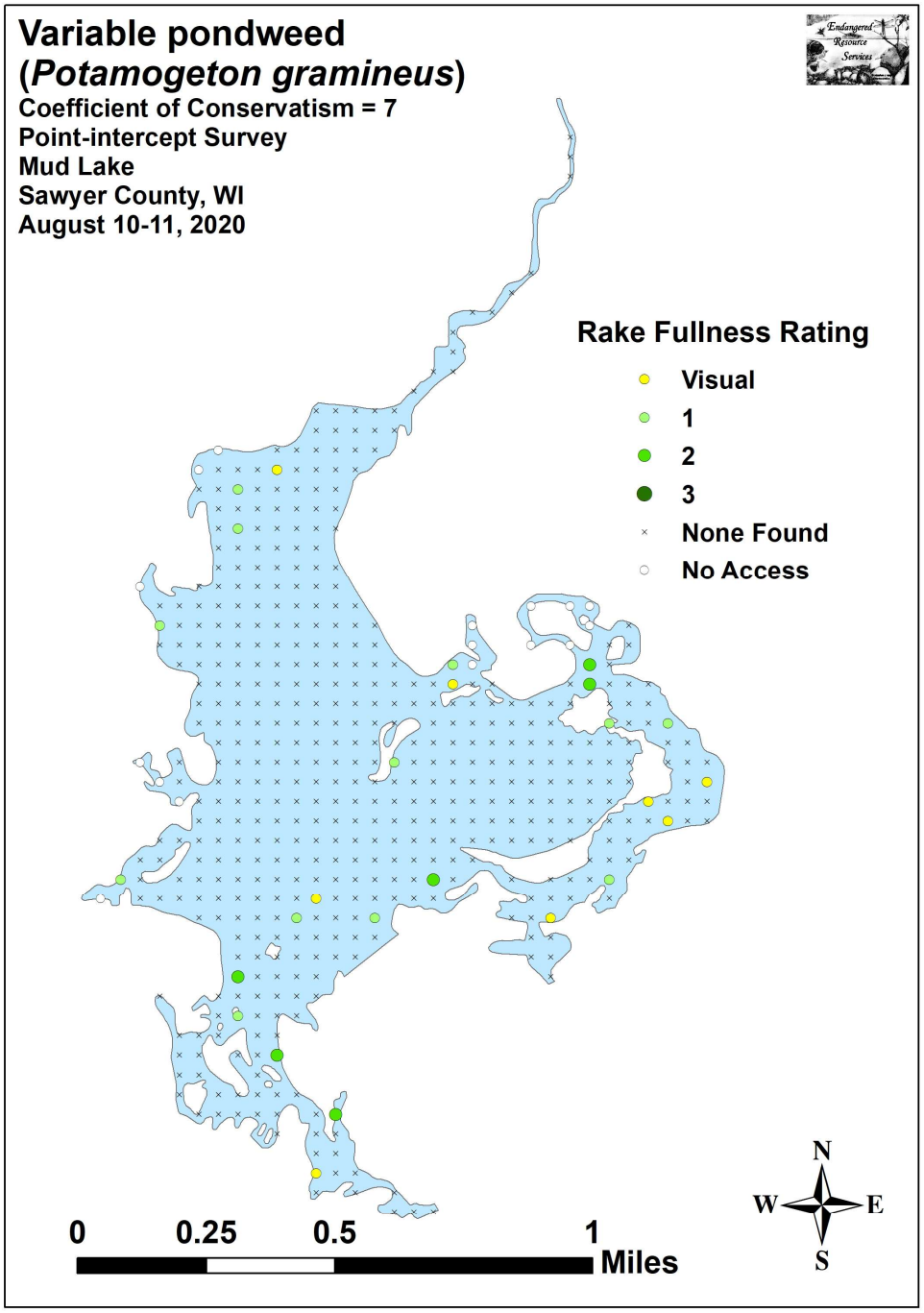
Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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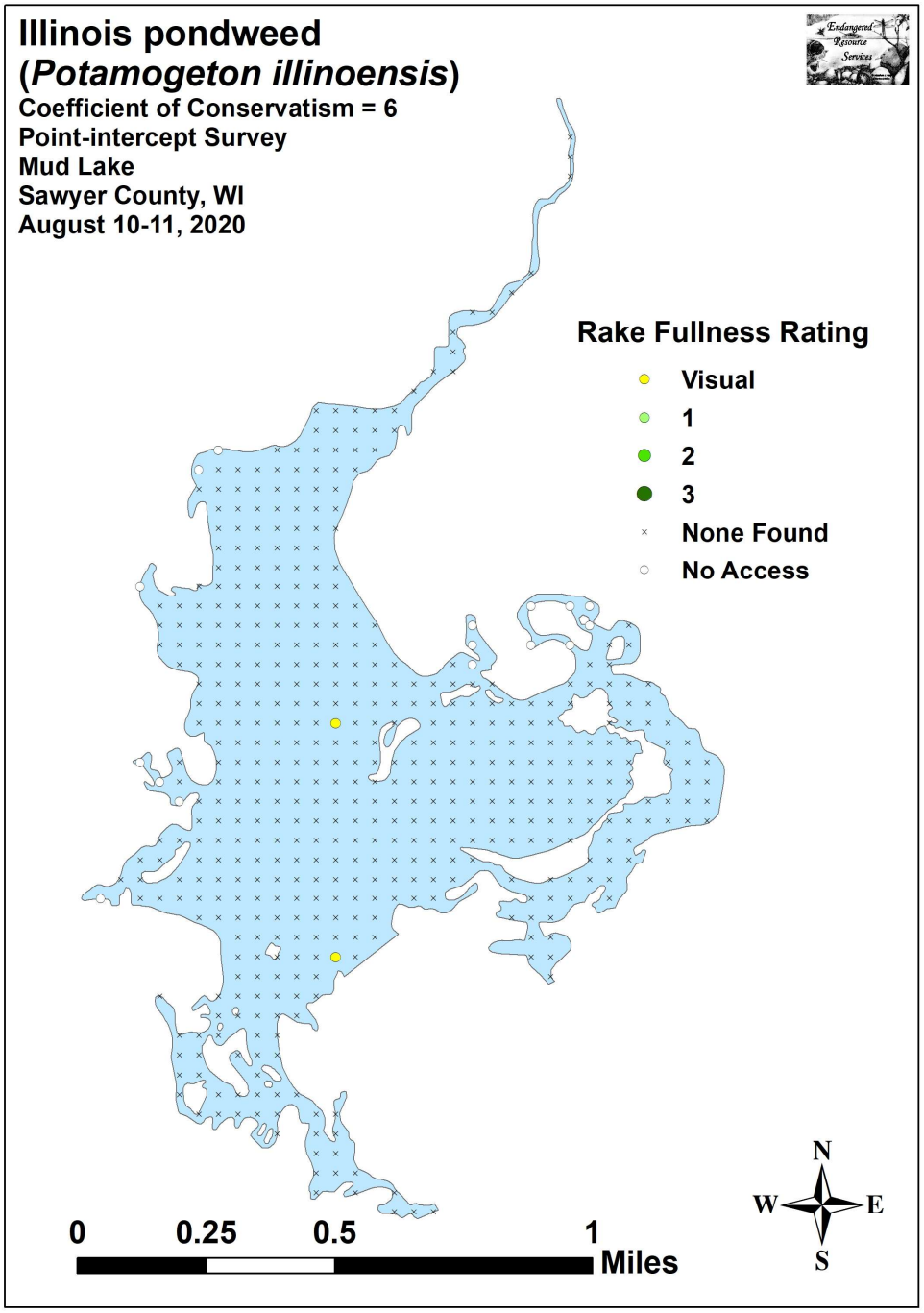
Illinois pondweed
(Potamogeton illinoensis)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
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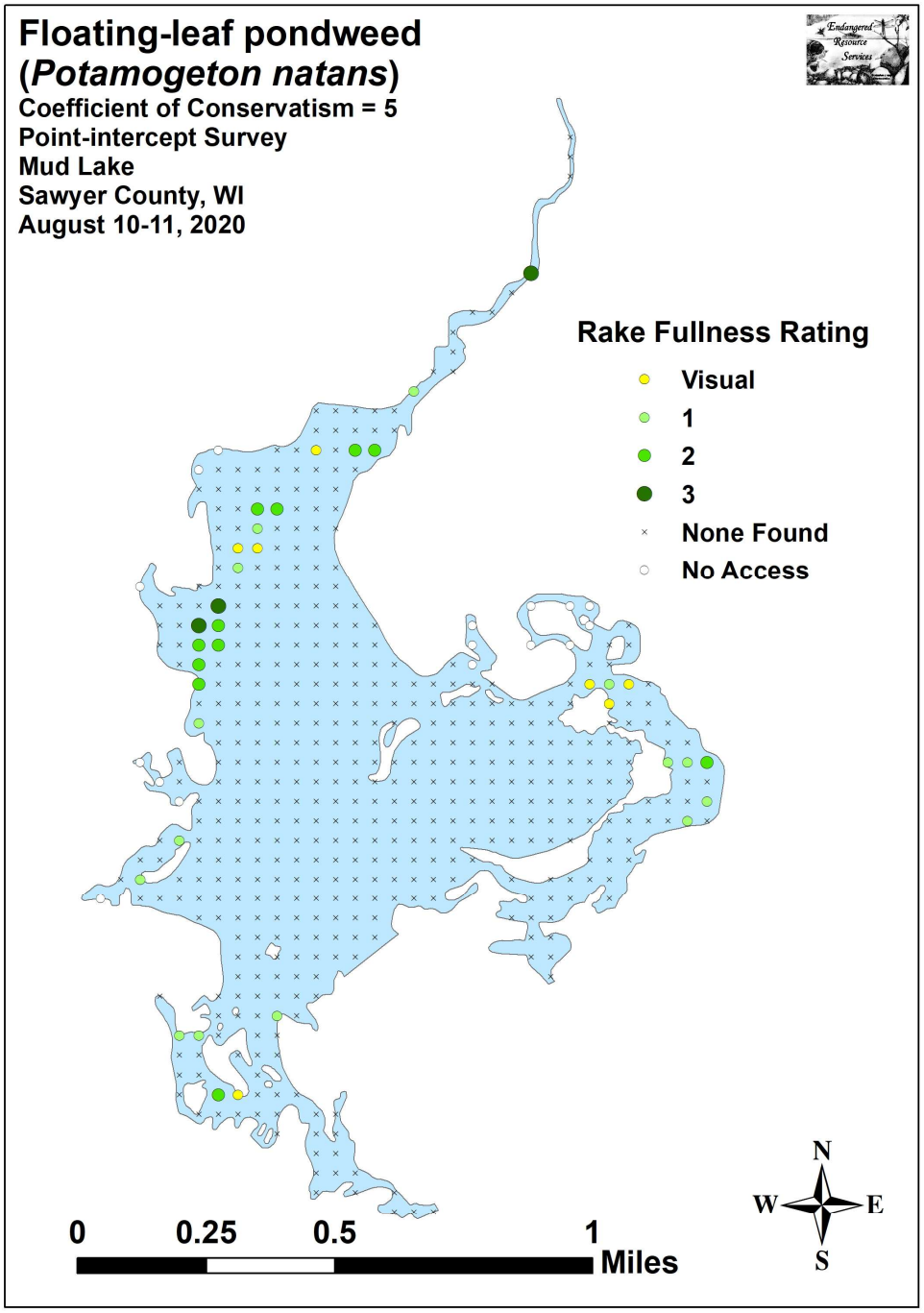
Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
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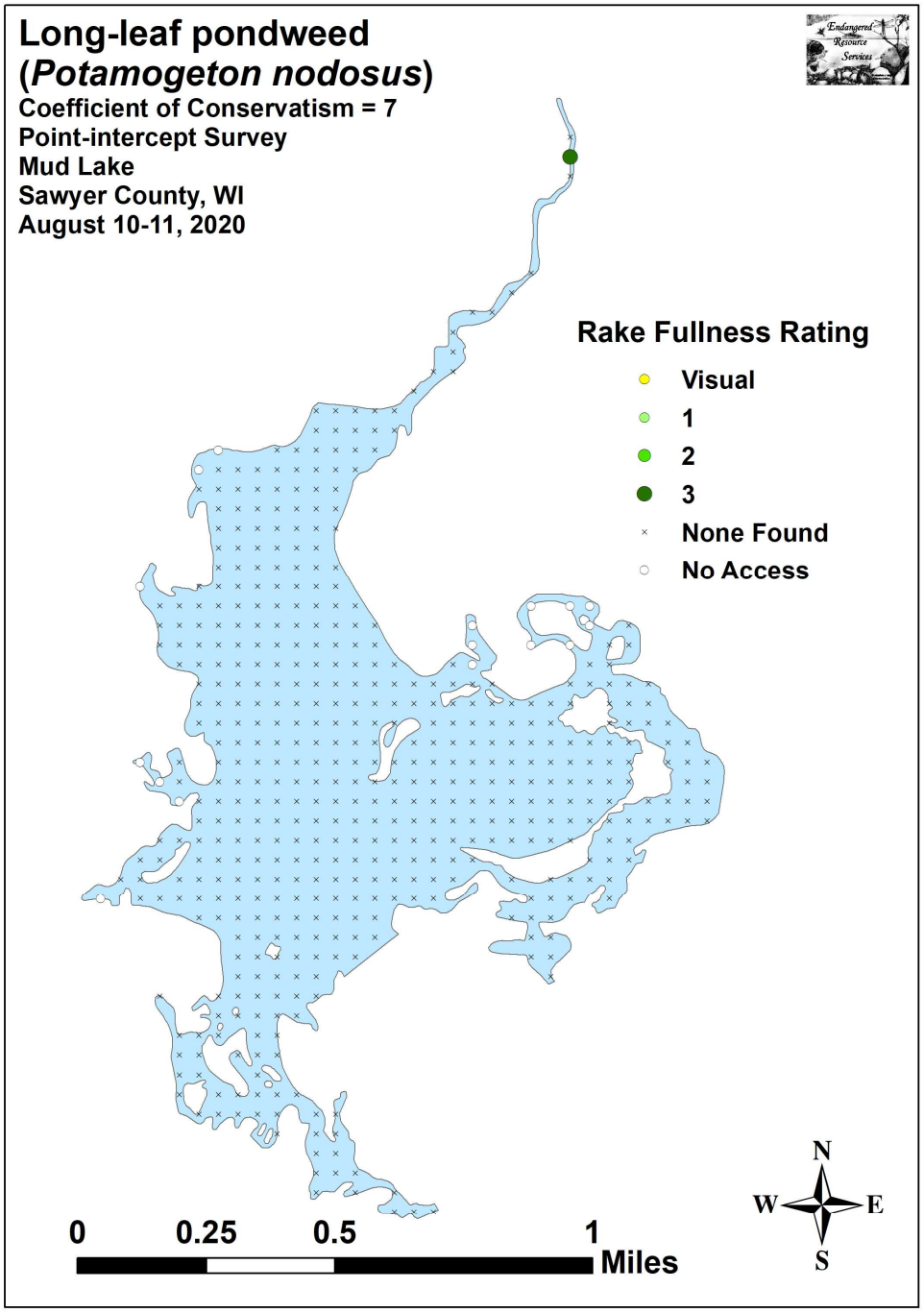
Long-leaf pondweed
(Potamogeton nodosus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
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None Found
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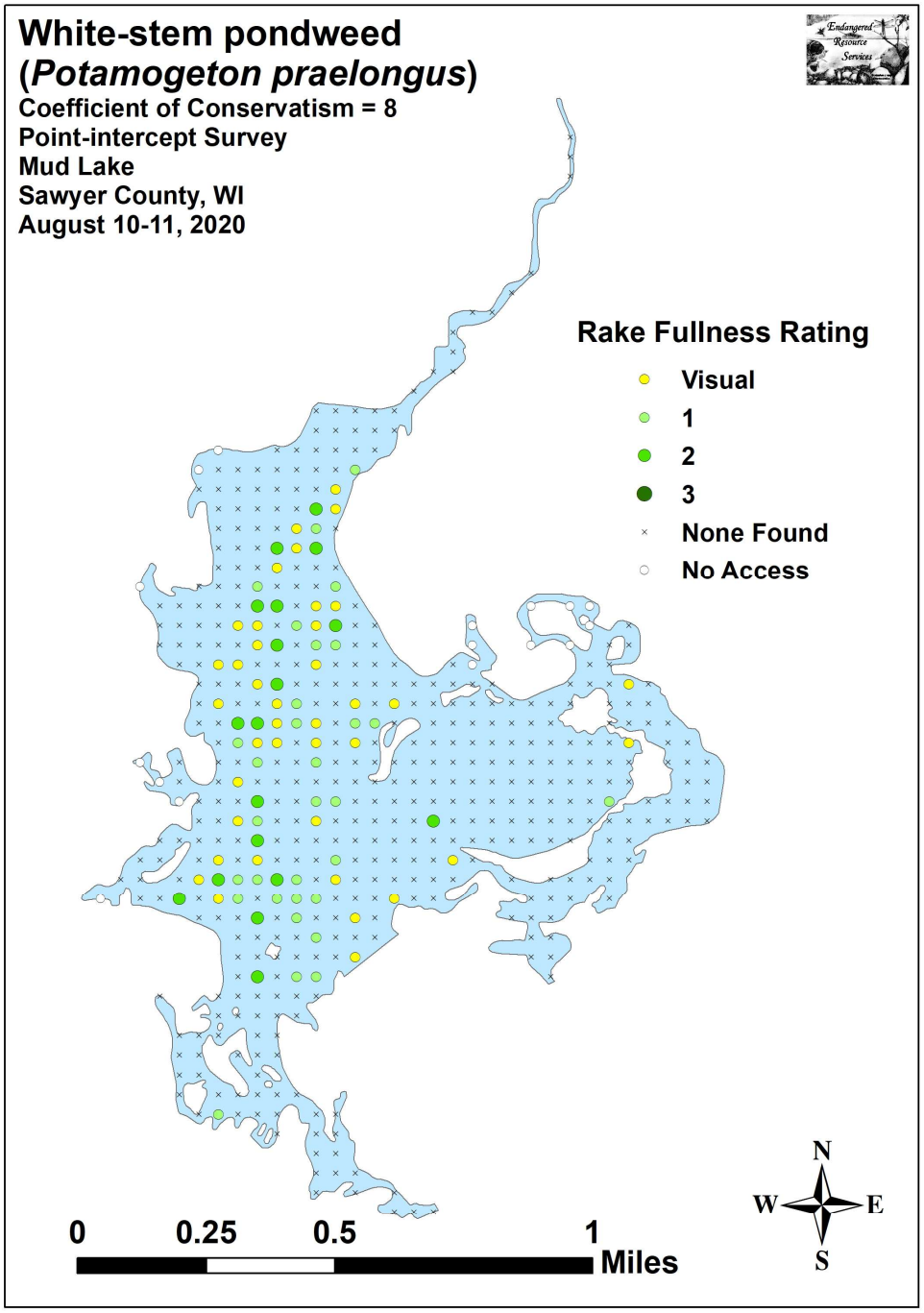
White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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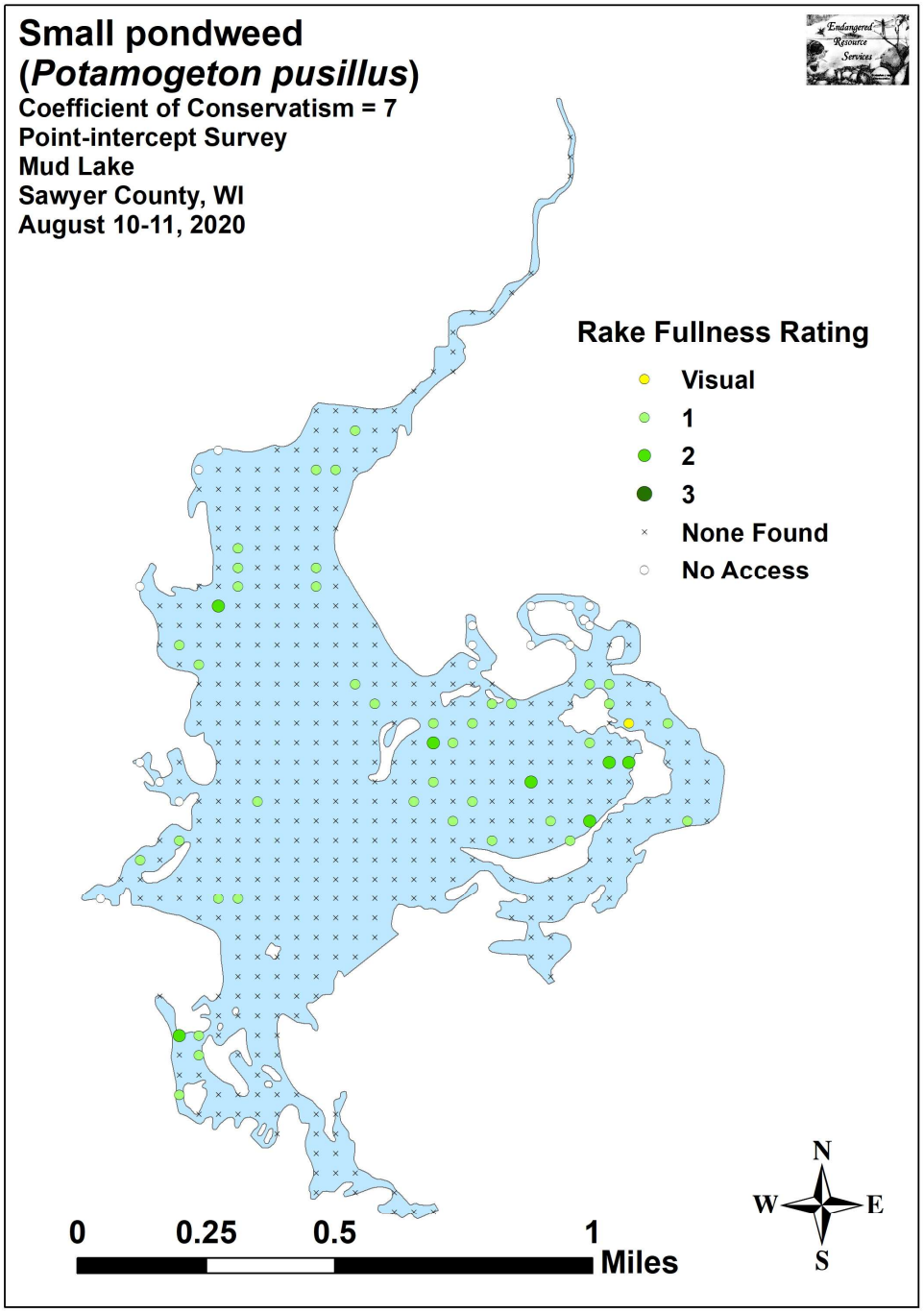
Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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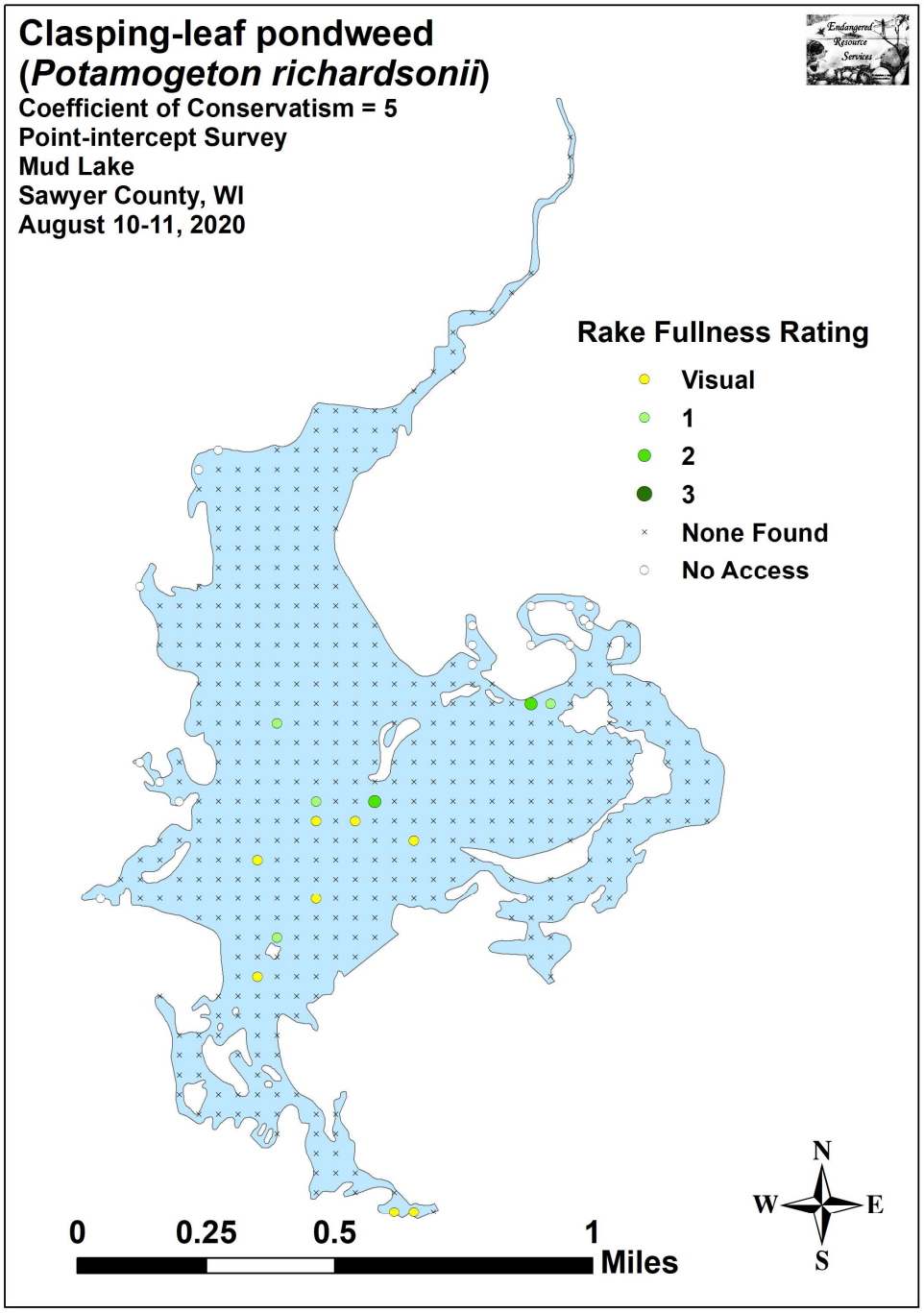
Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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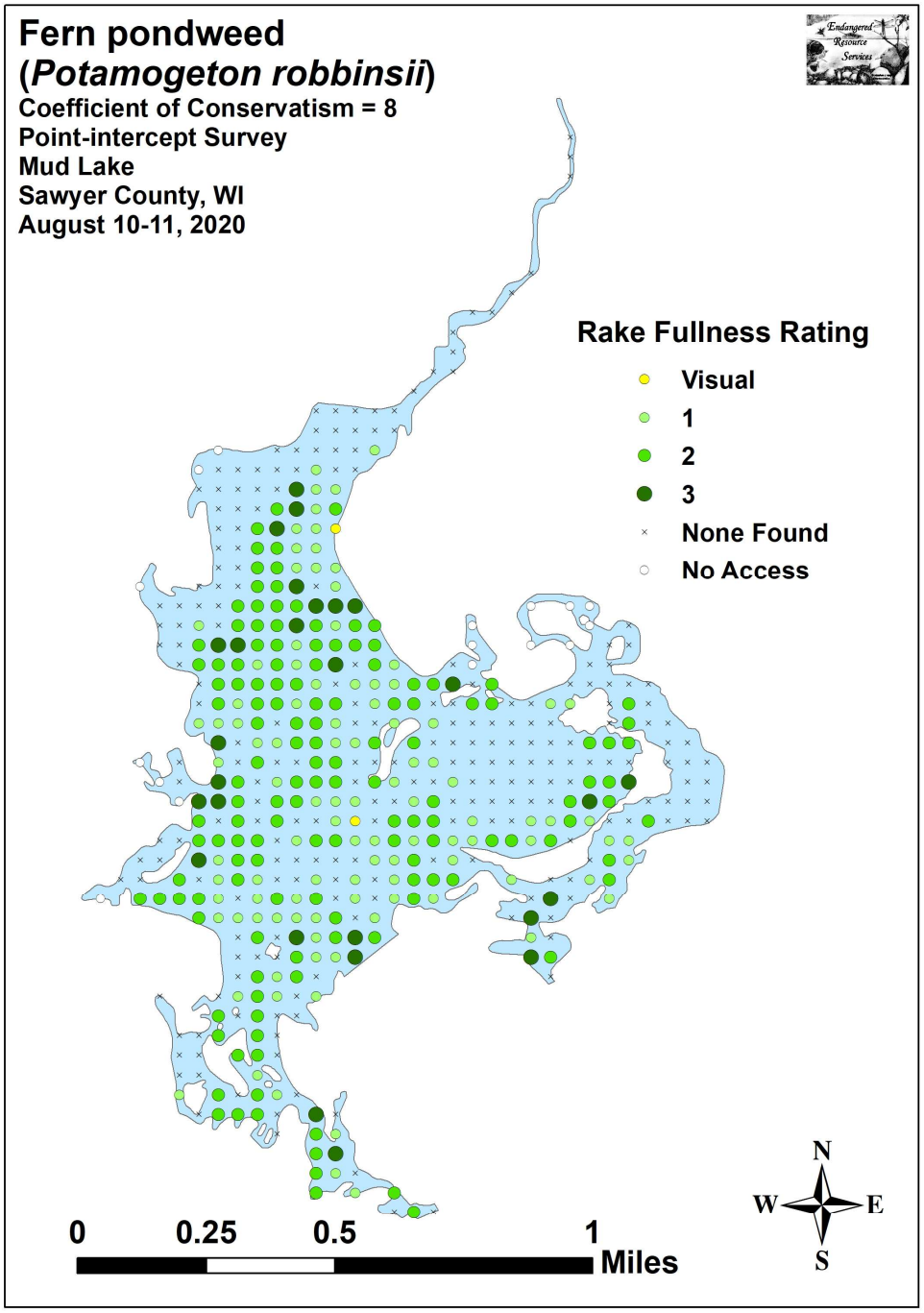
Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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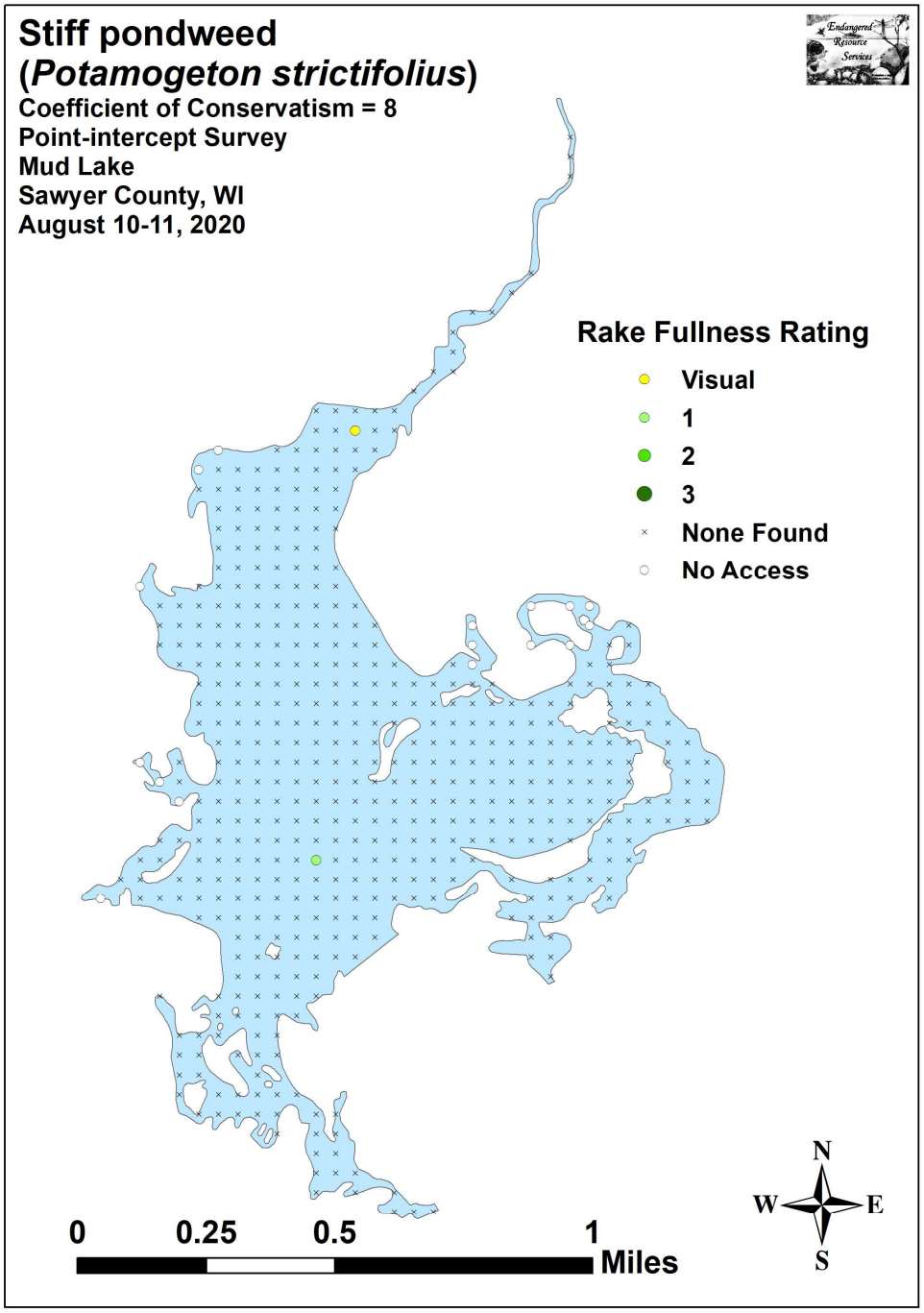
Stiff pondweed
(Potamogeton strictifolius)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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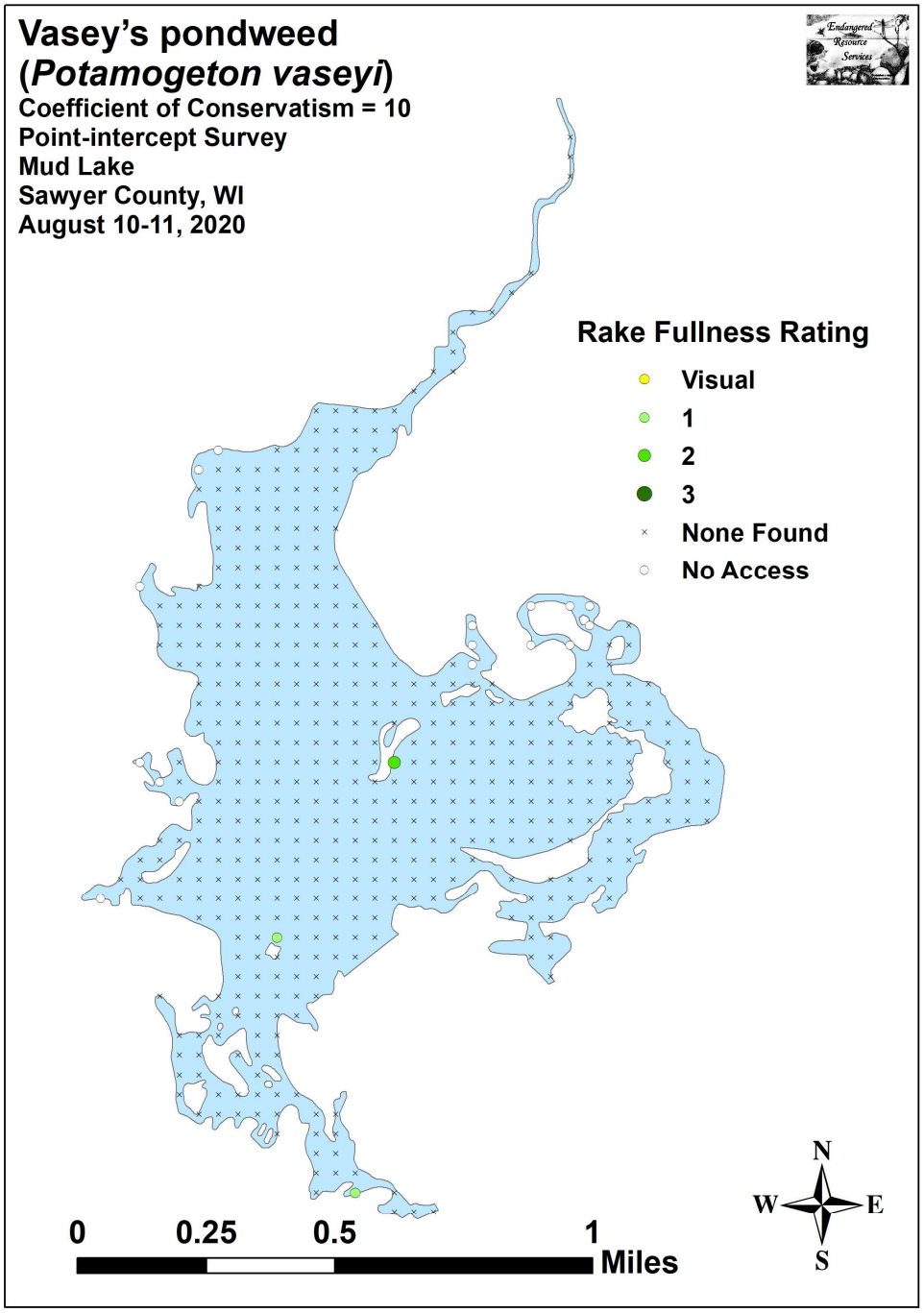
Vasey's pondweed
(Potamogeton vaseyi)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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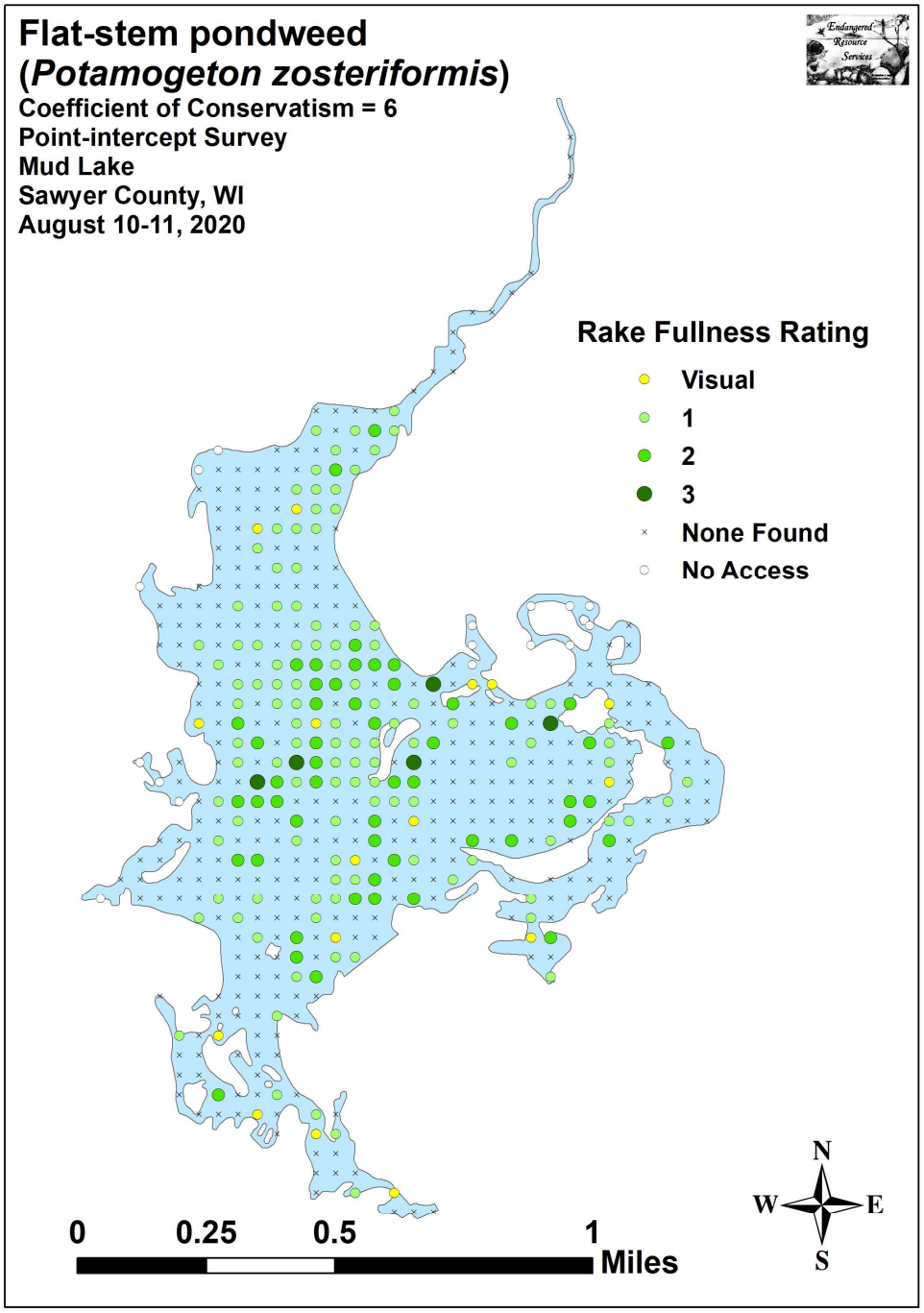
Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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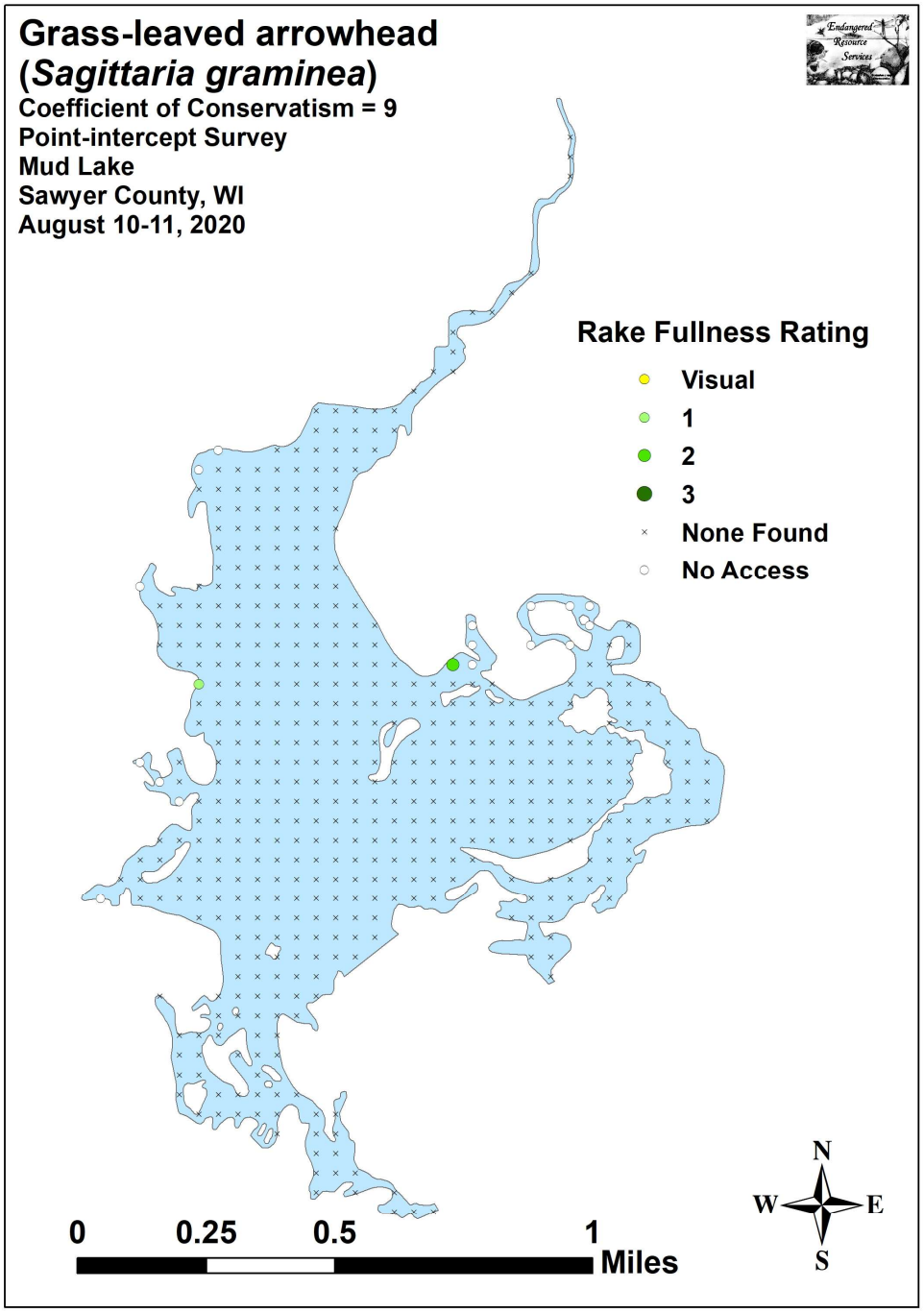
Grass-leaved arrowhead
(Sagittaria graminea)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
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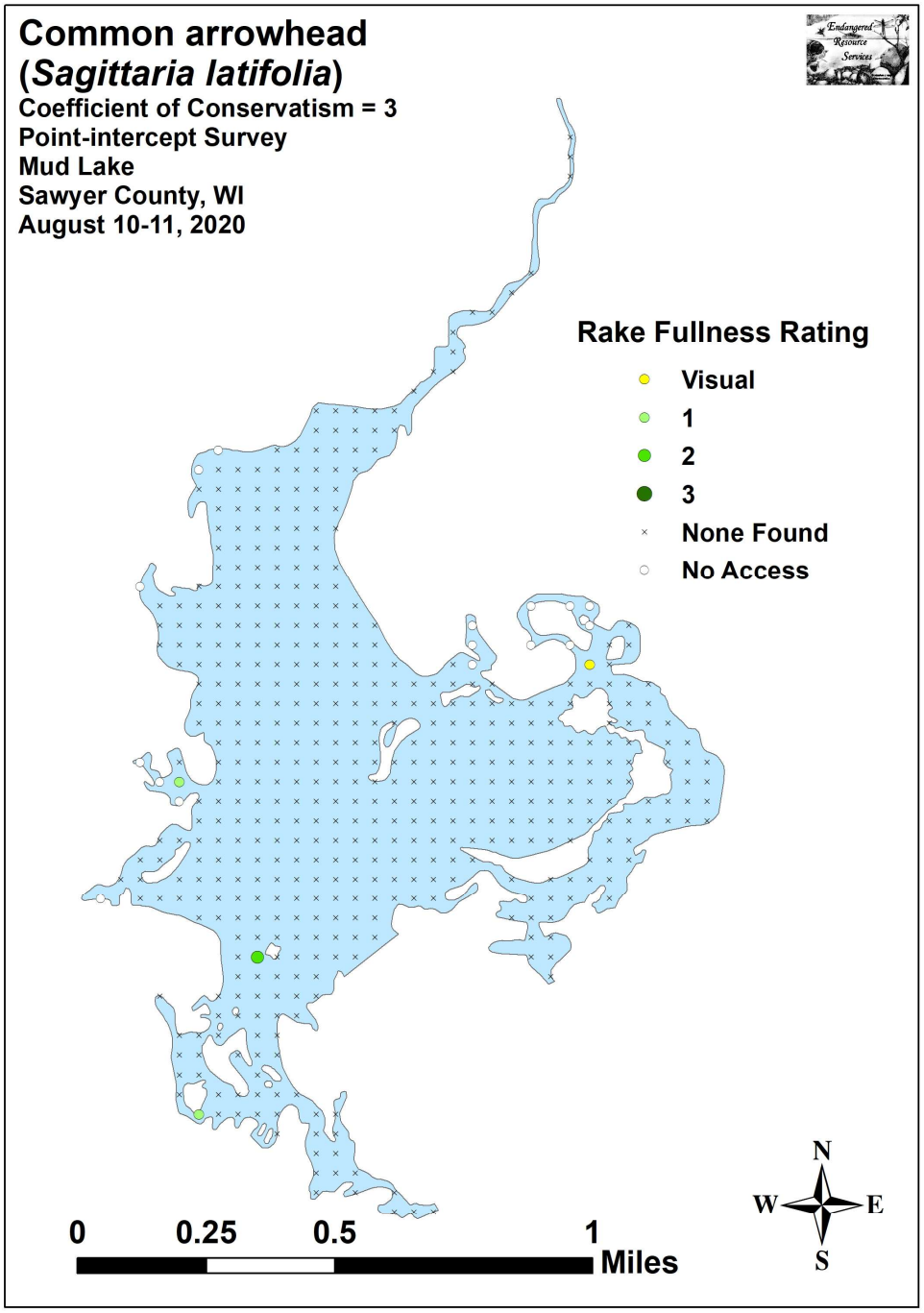
Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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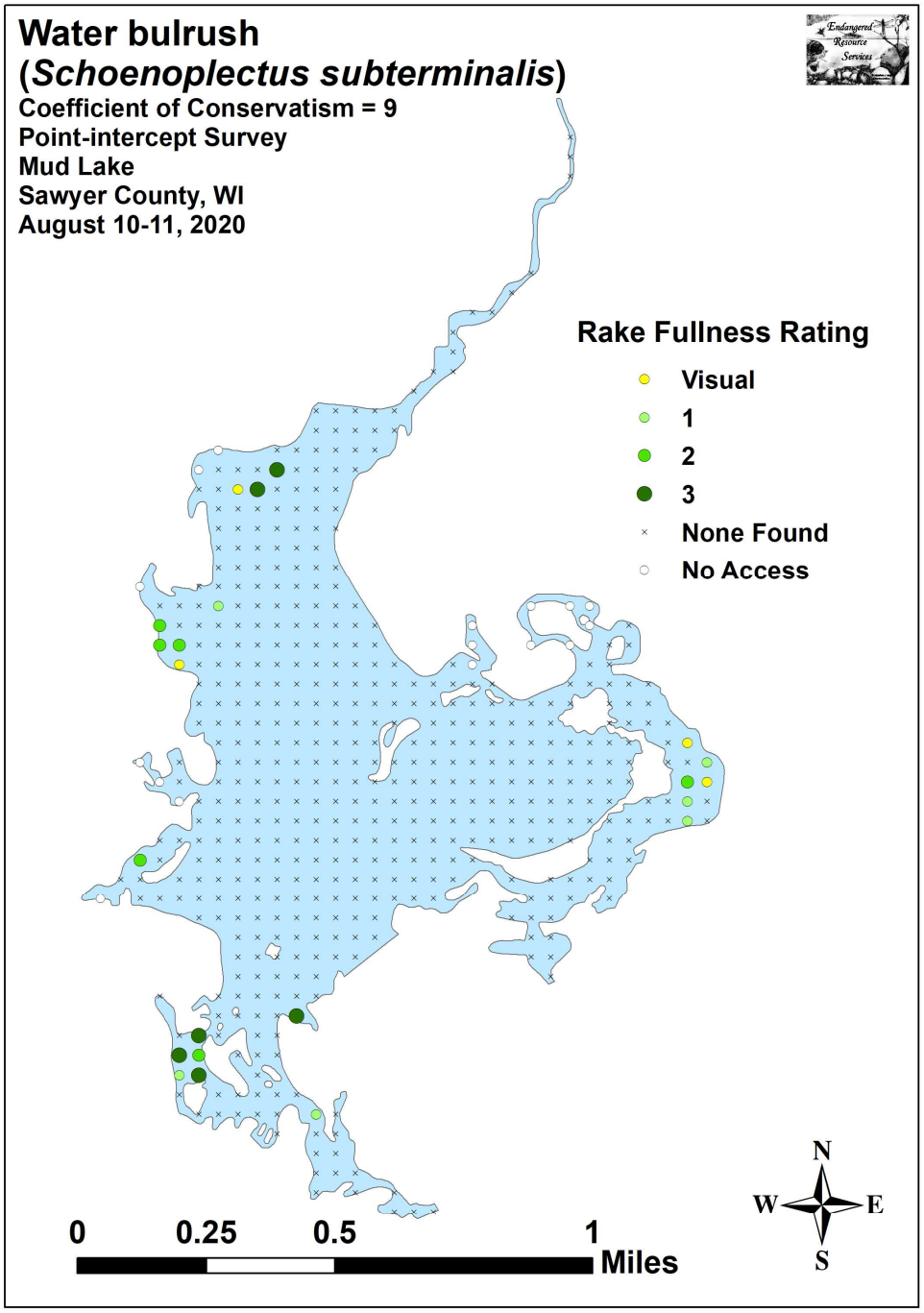
Water bulrush
(Schoenoplectus subterminalis)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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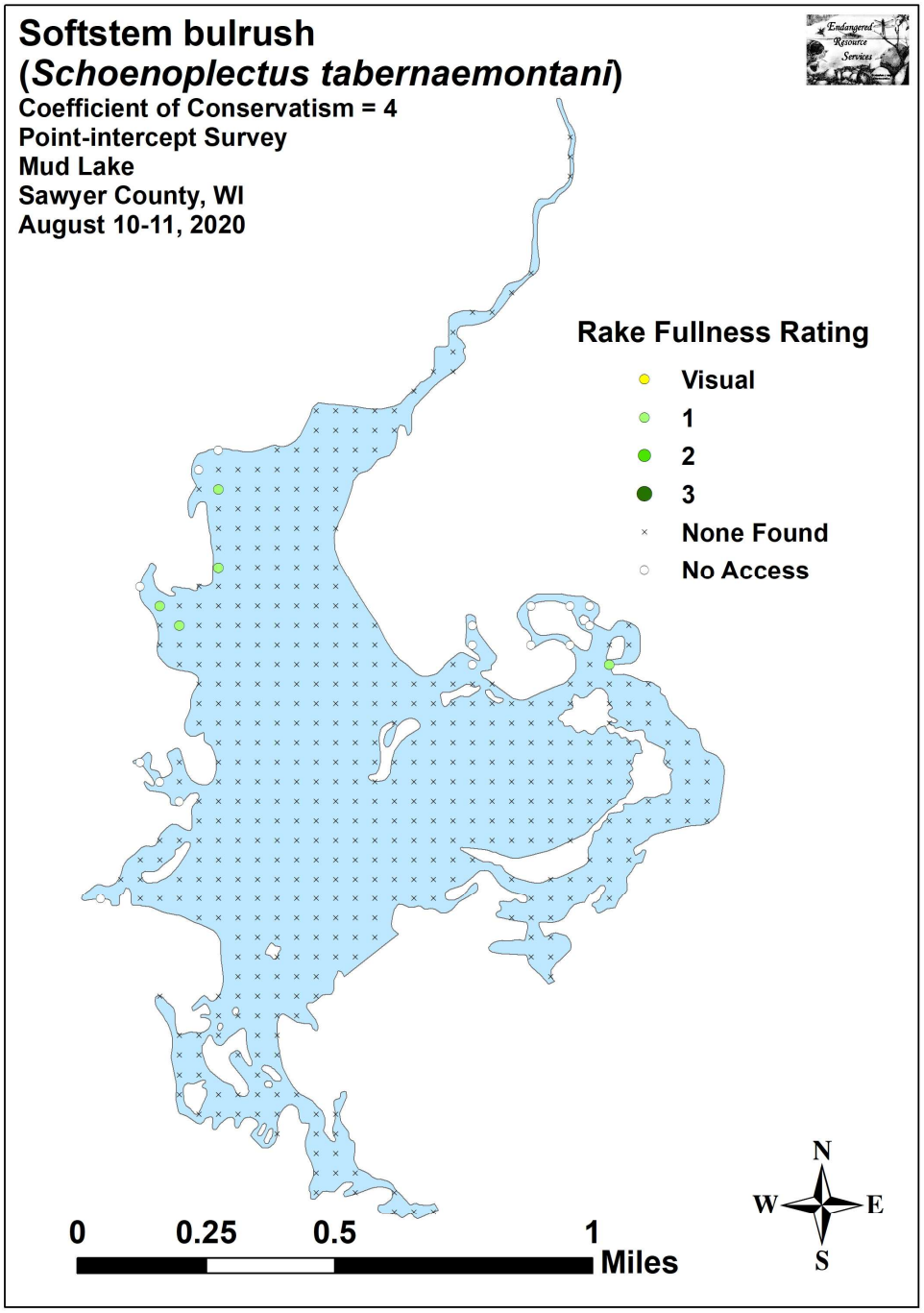
Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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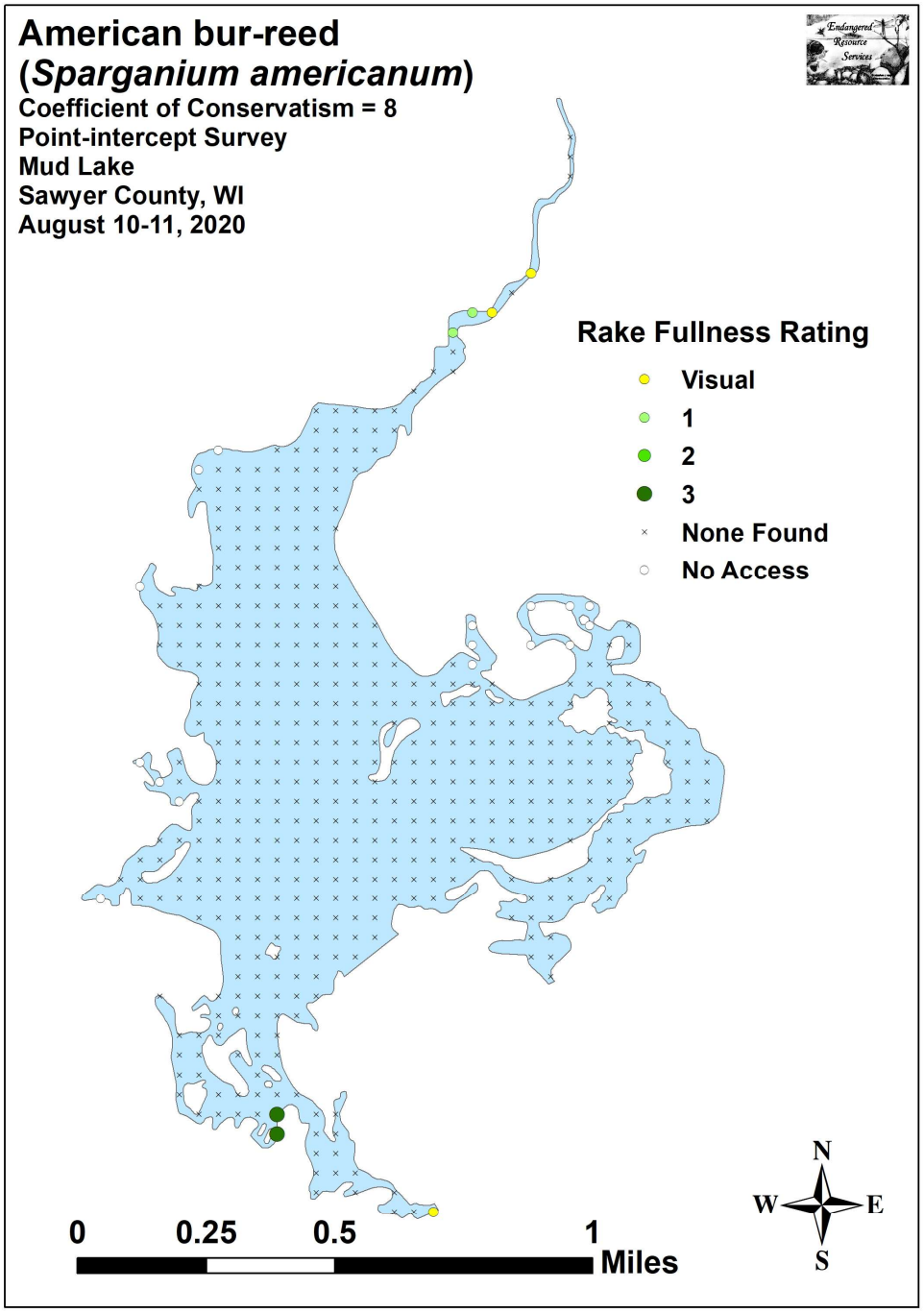
American bur-reed
(Sparganium americanum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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None Found
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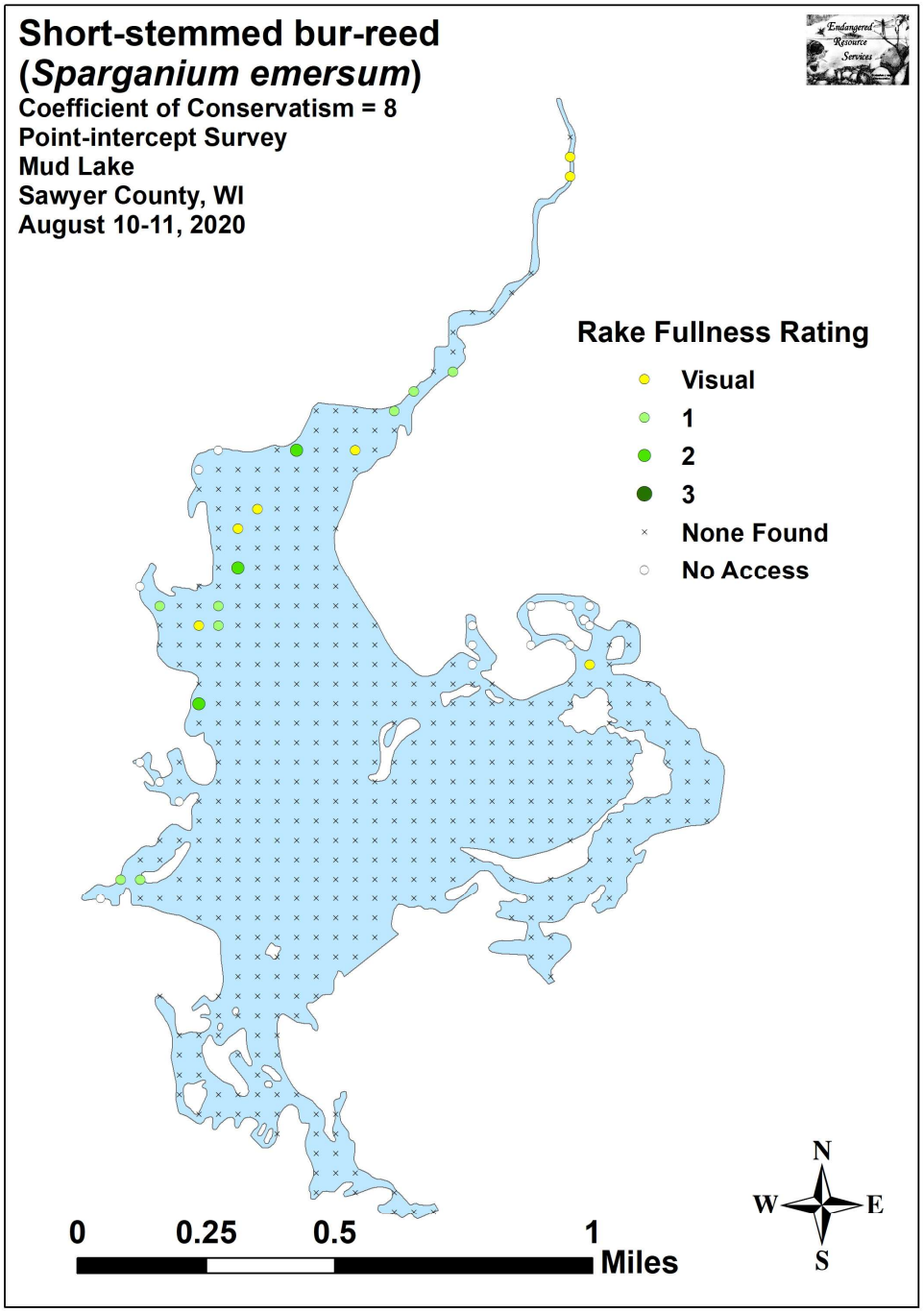
Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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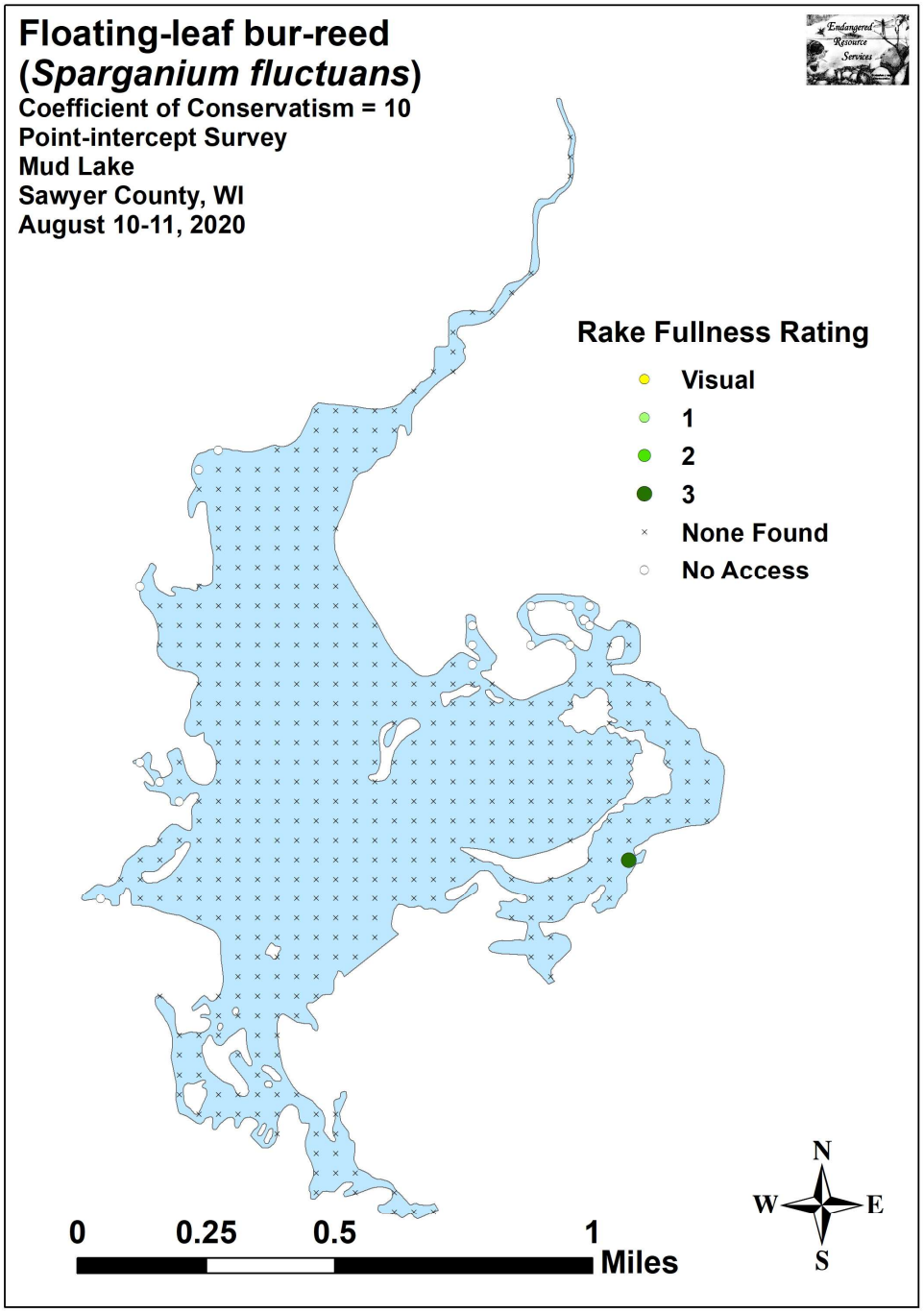
Floating-leaf bur-reed
(Sparganium fluctuans)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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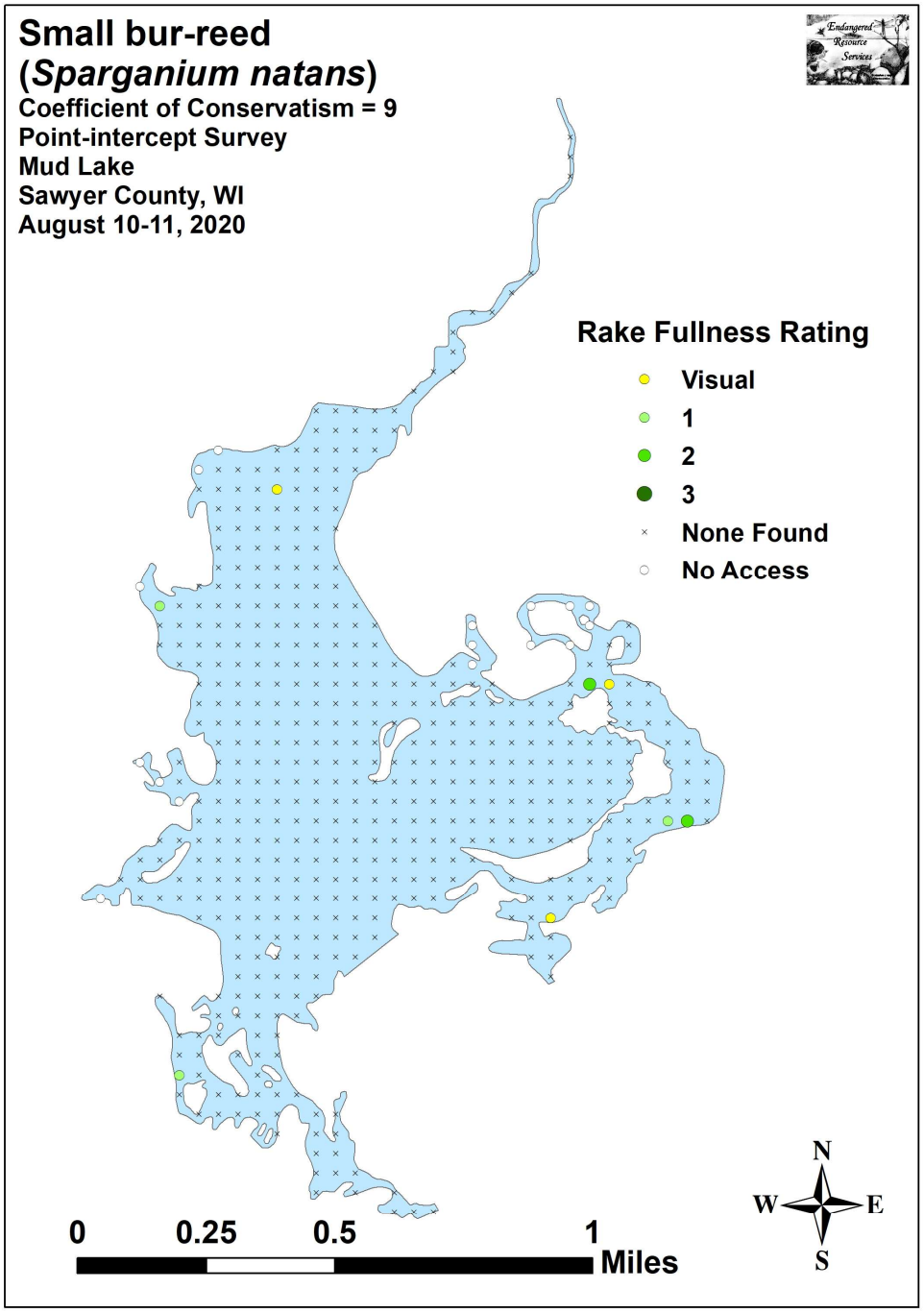
Small bur-reed
(Sparganium natans)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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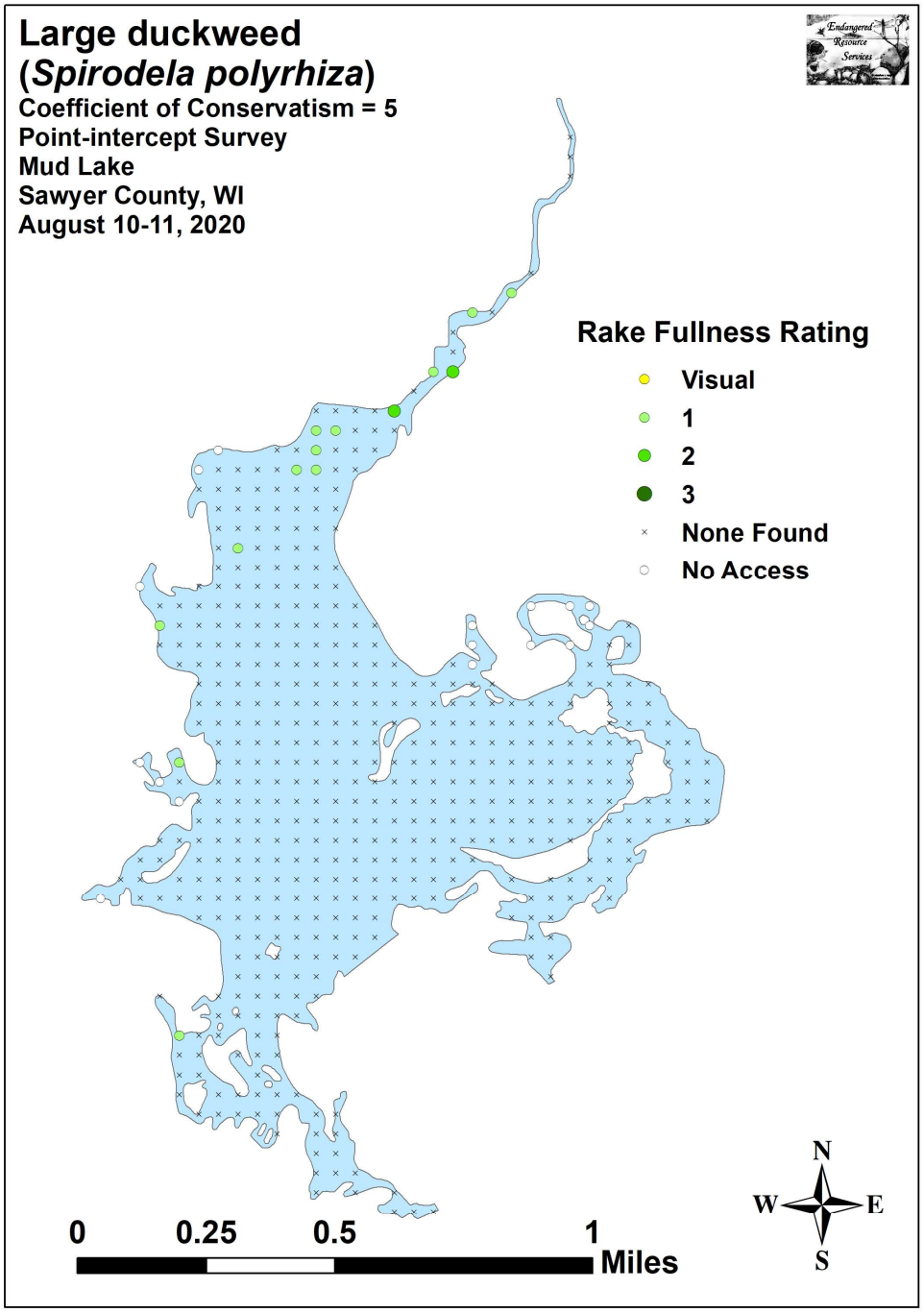
Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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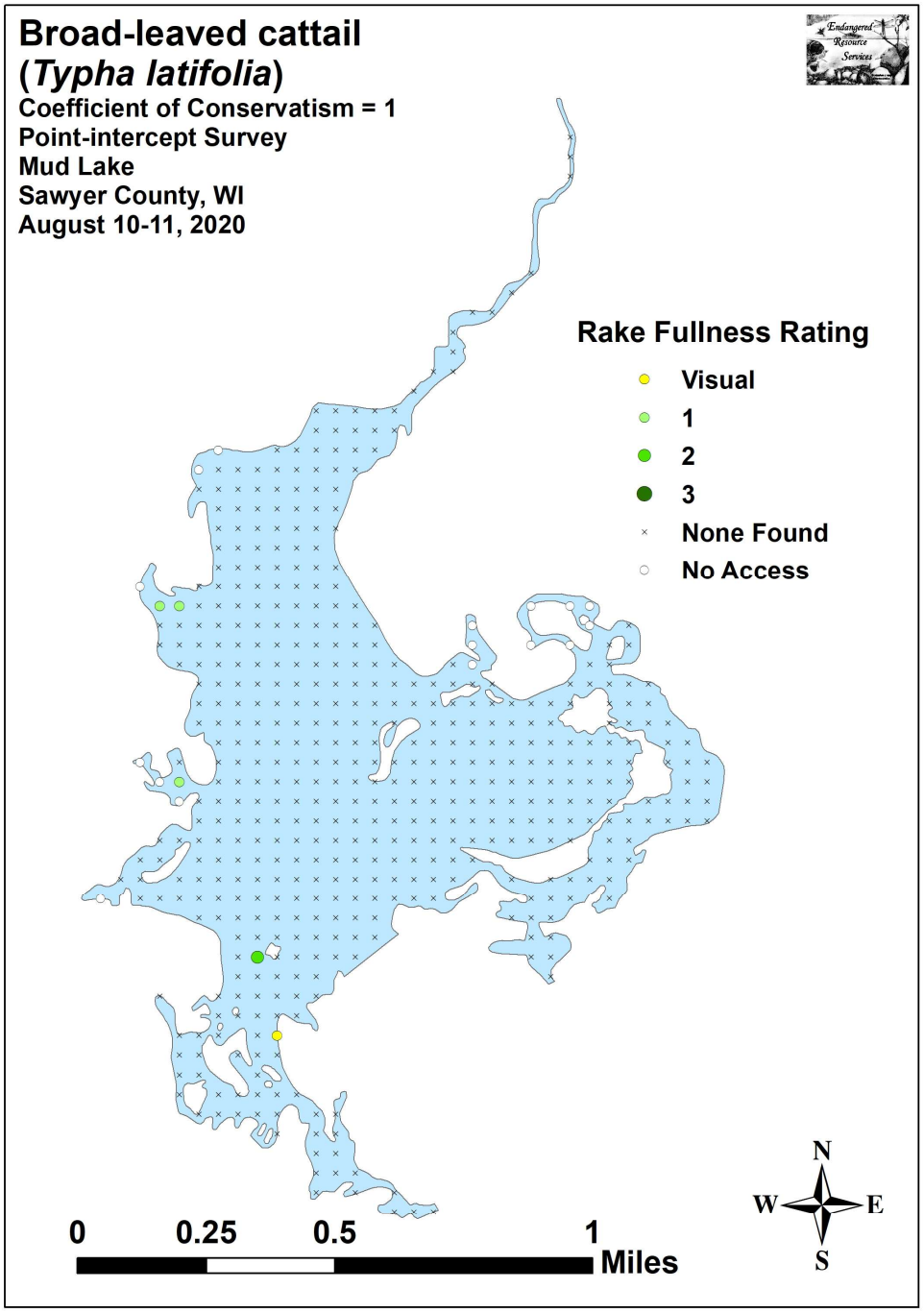
Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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None Found
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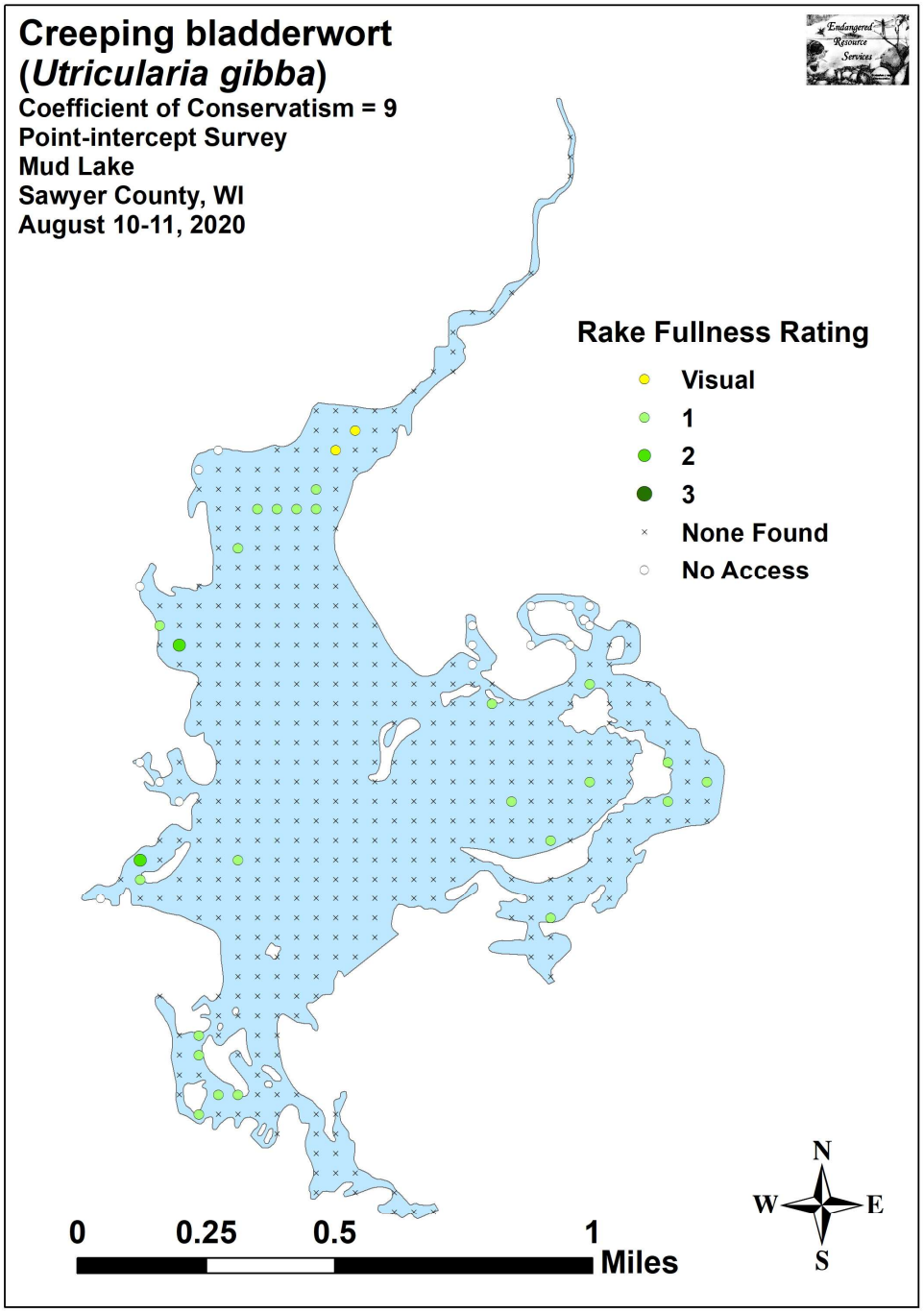
Creeping bladderwort
(Utricularia gibba)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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None Found
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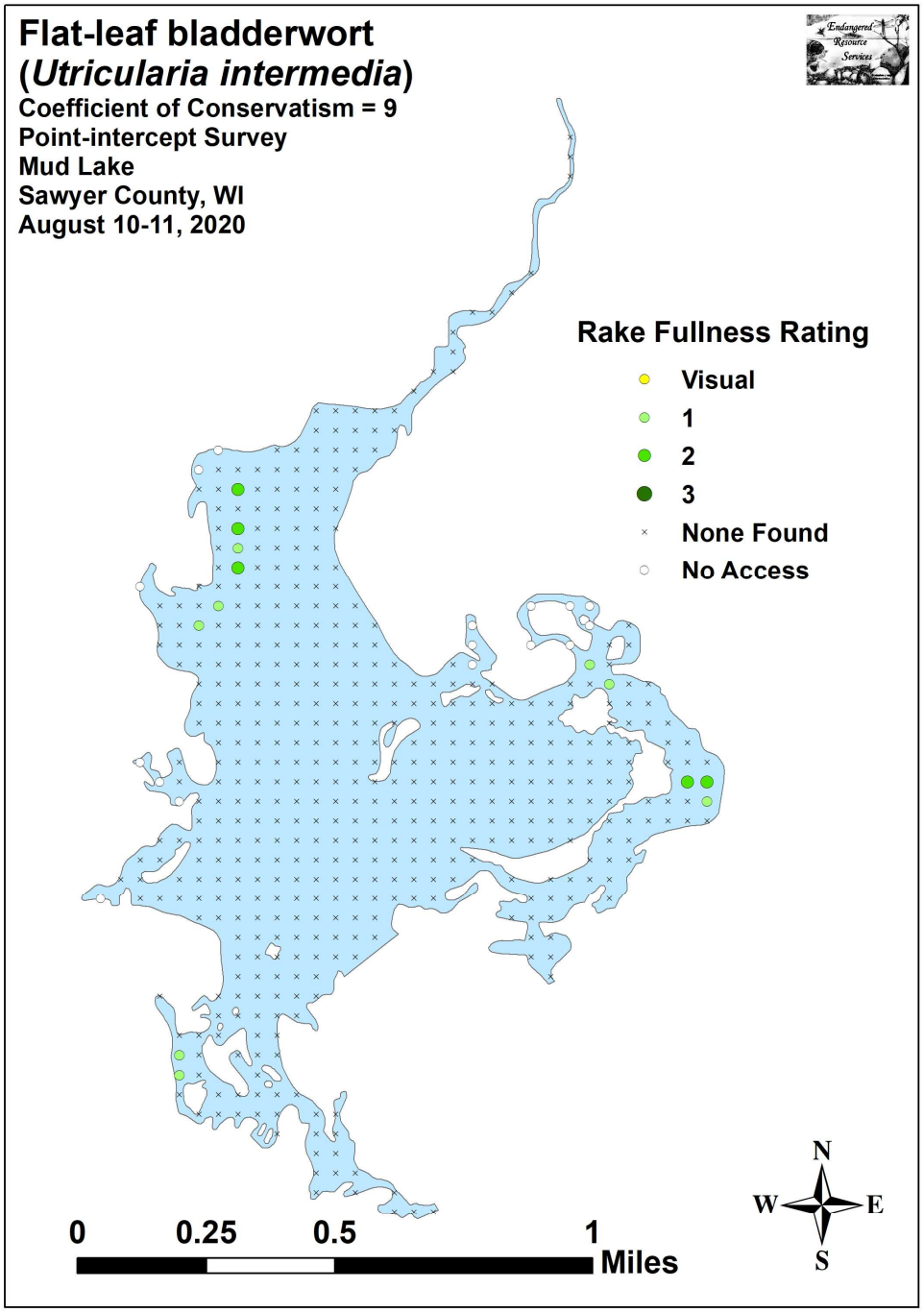
Flat-leaf bladderwort
(Utricularia intermedia)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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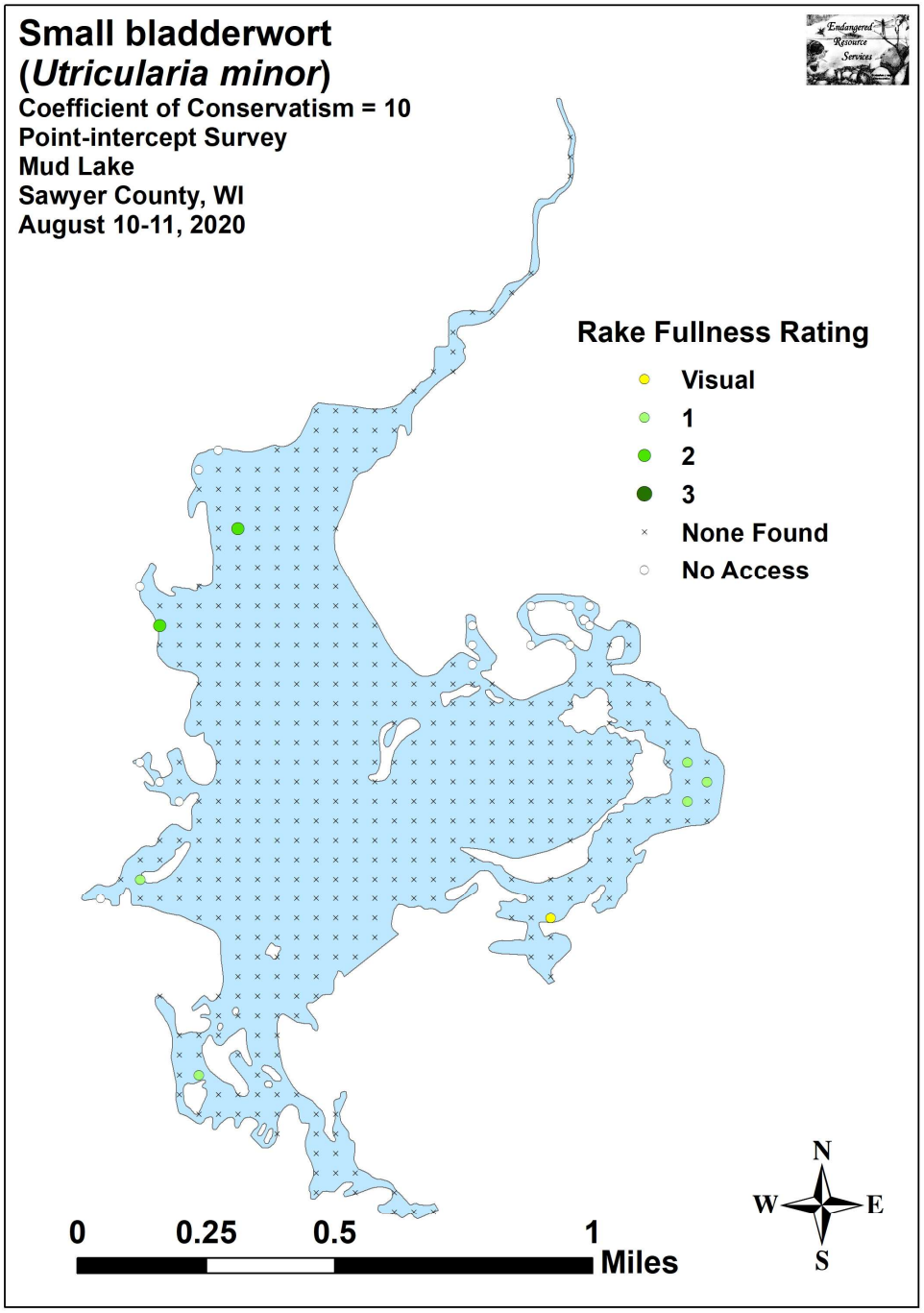
Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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None Found
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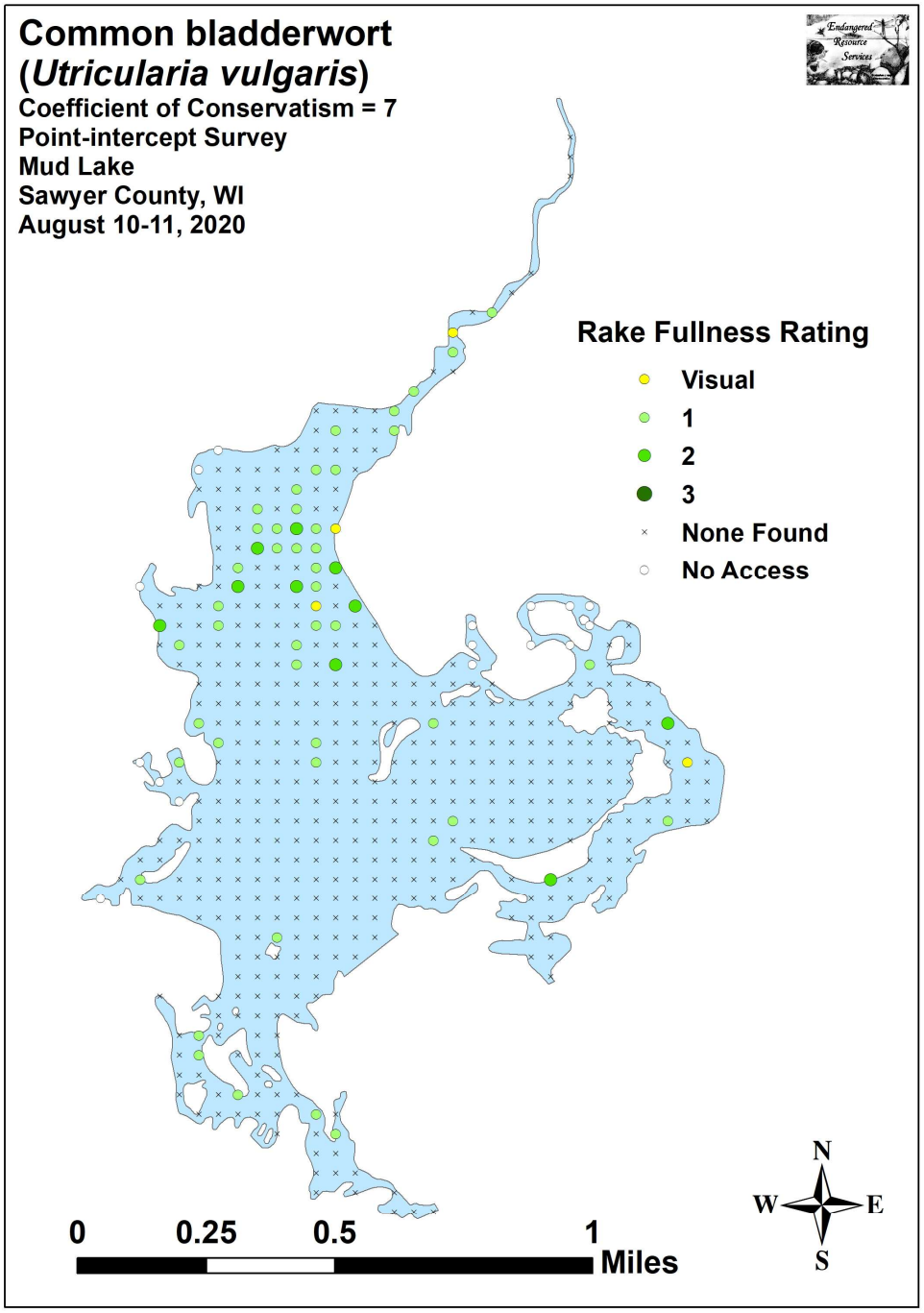
Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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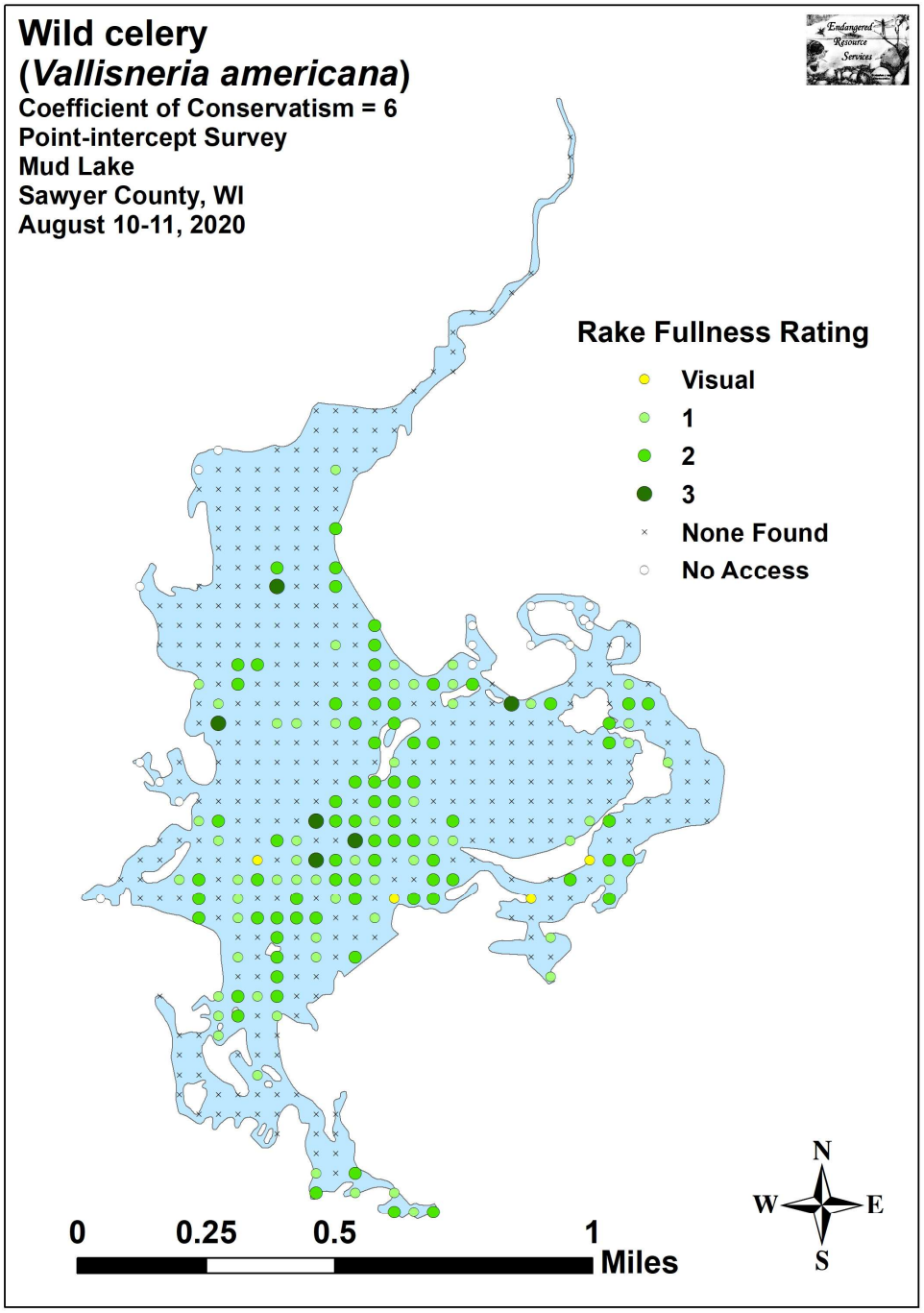
Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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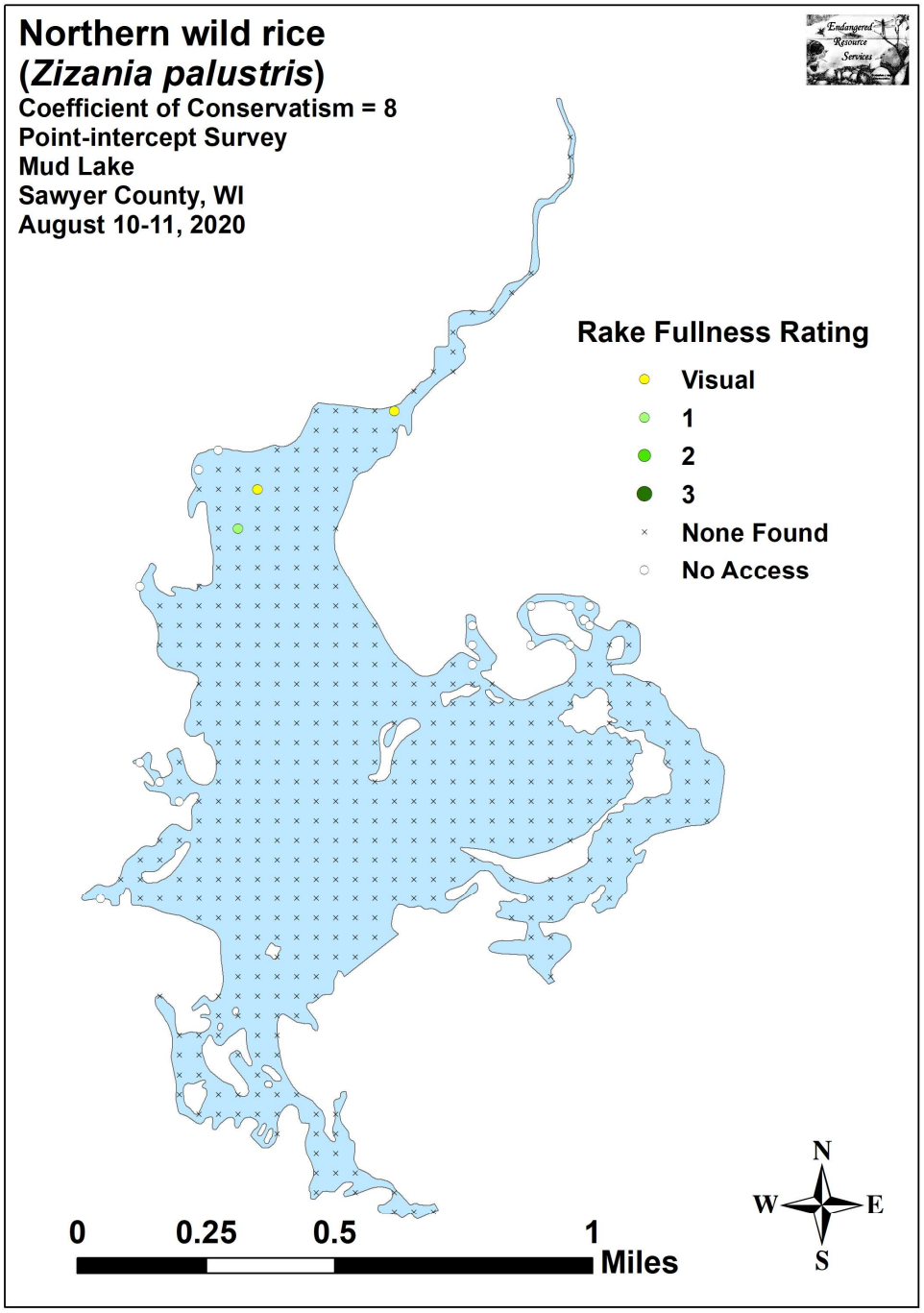
Northern wild rice
(Zizania palustris)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Rake Fullness Rating
Visual
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None Found
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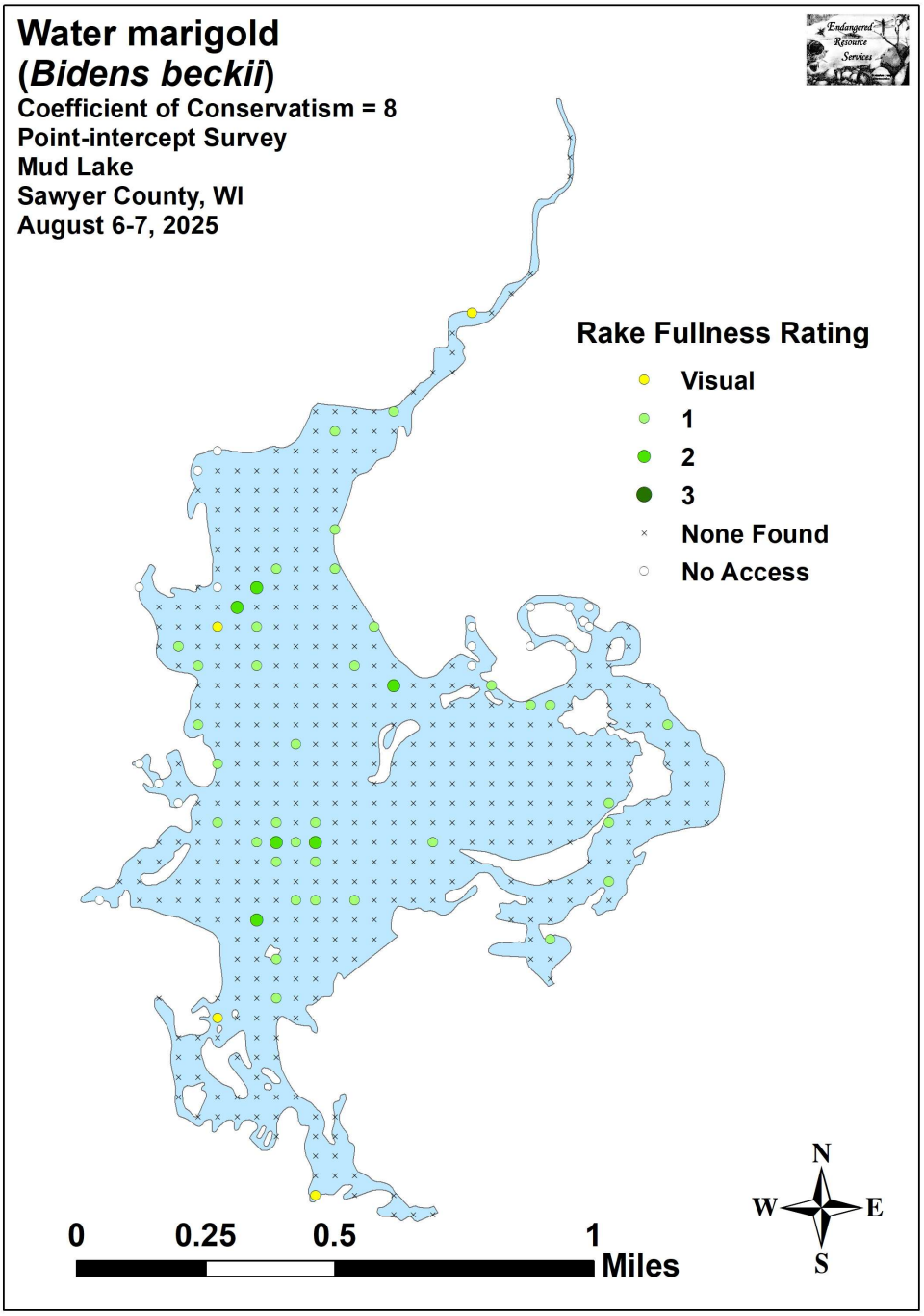
Appendix VI: August 2025 Native Species Density and Distribution Maps


Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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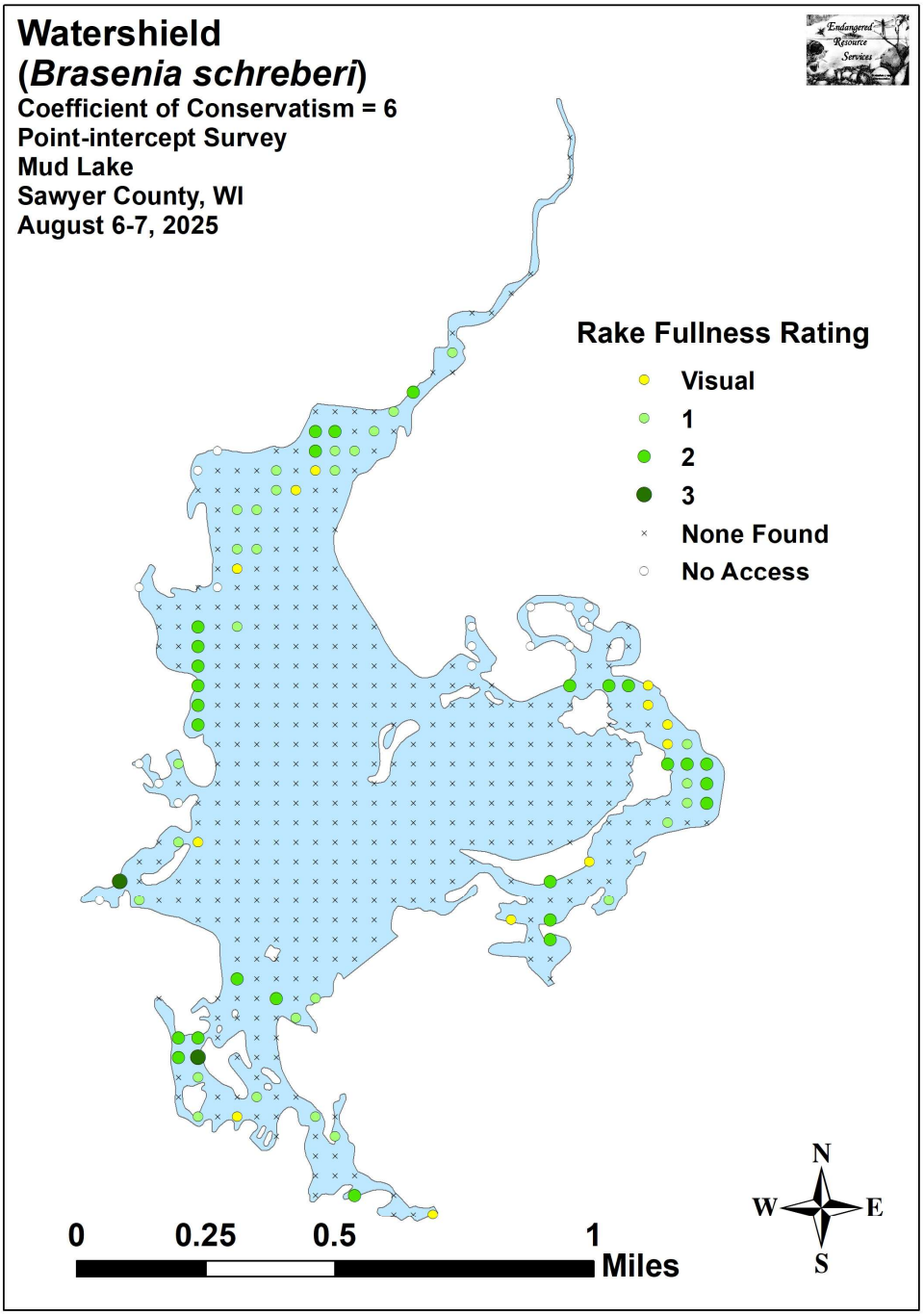
Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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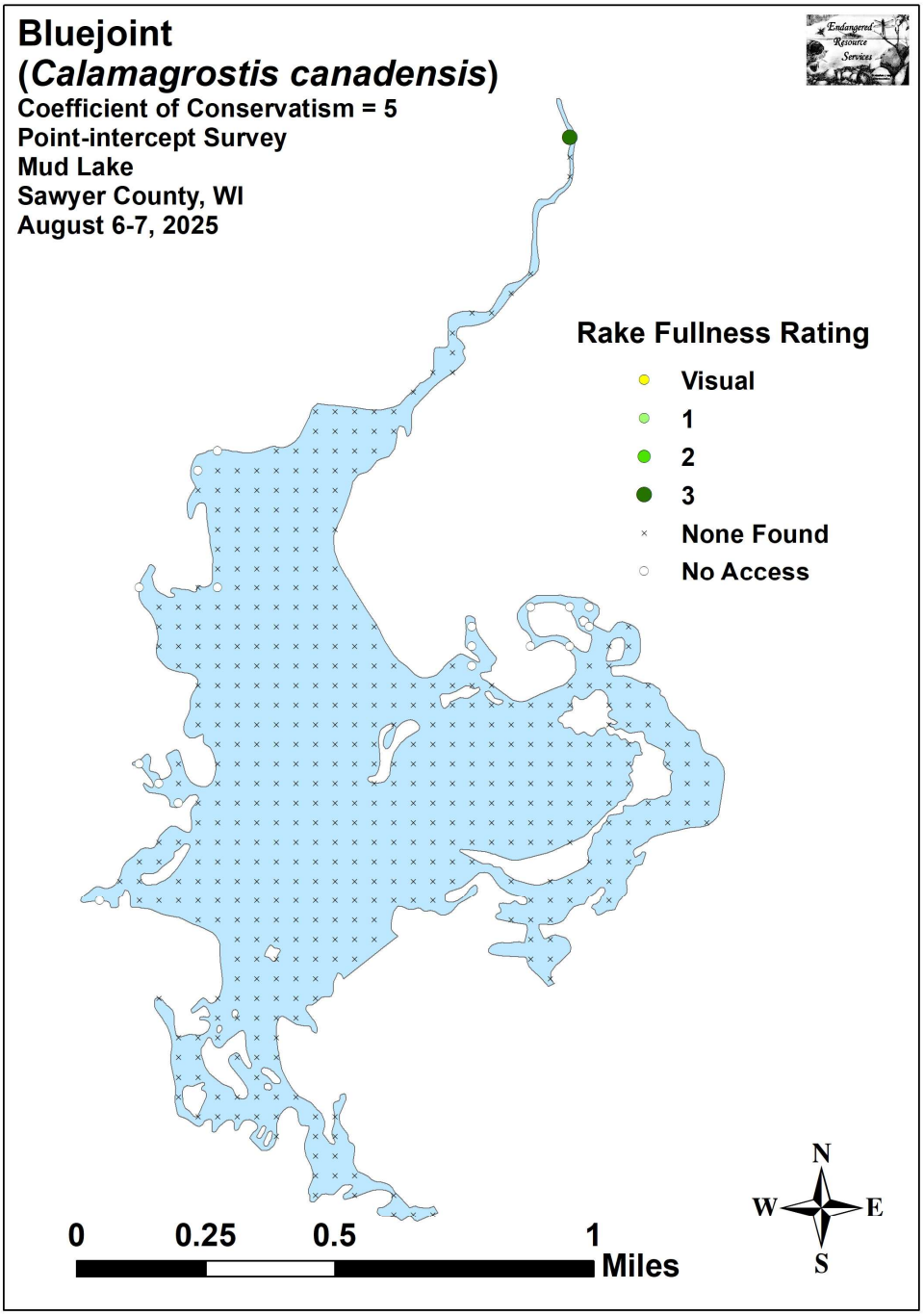
Bluejoint
(Calamagrostis canadensis)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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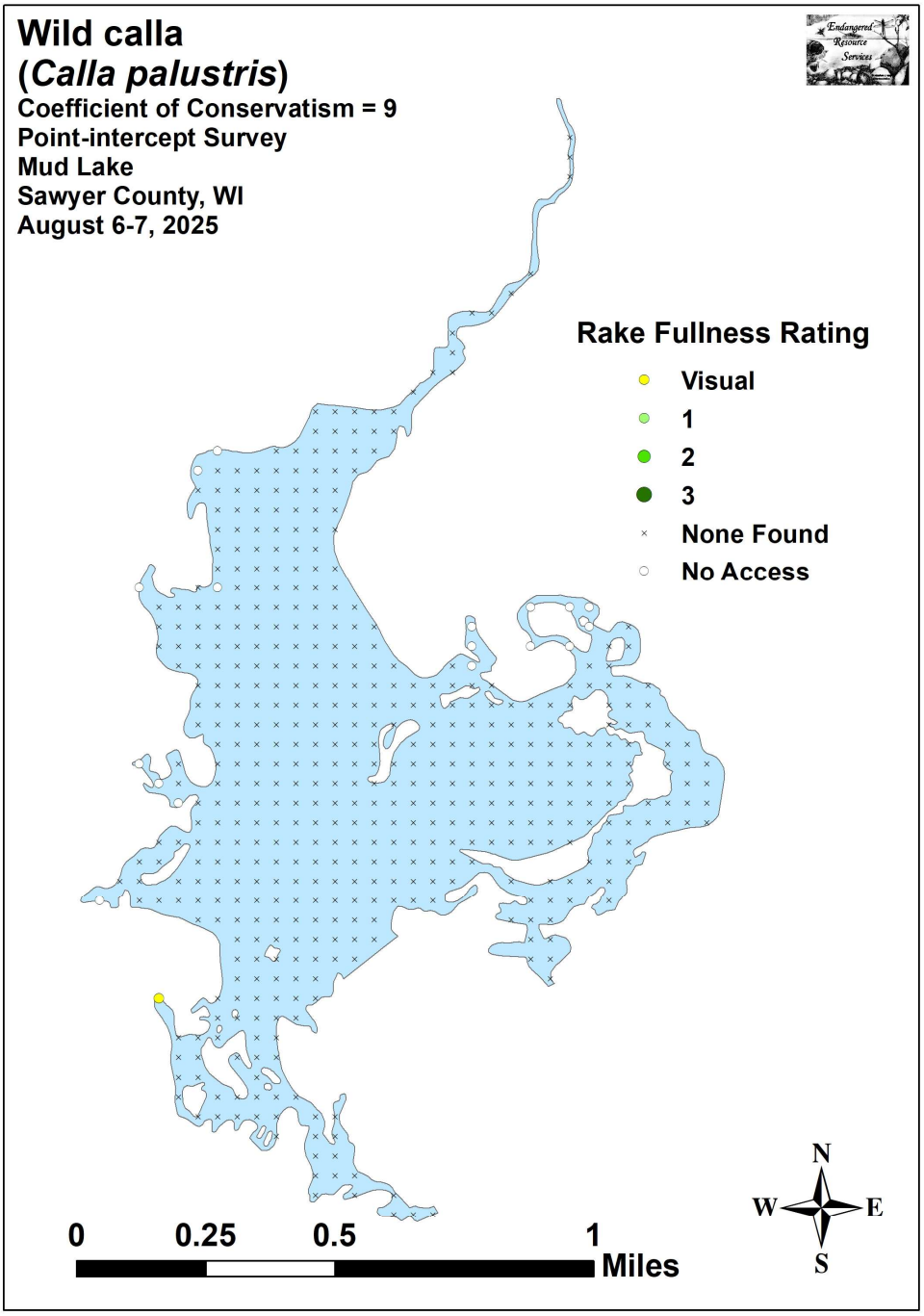
Wild calla
(Calla palustris)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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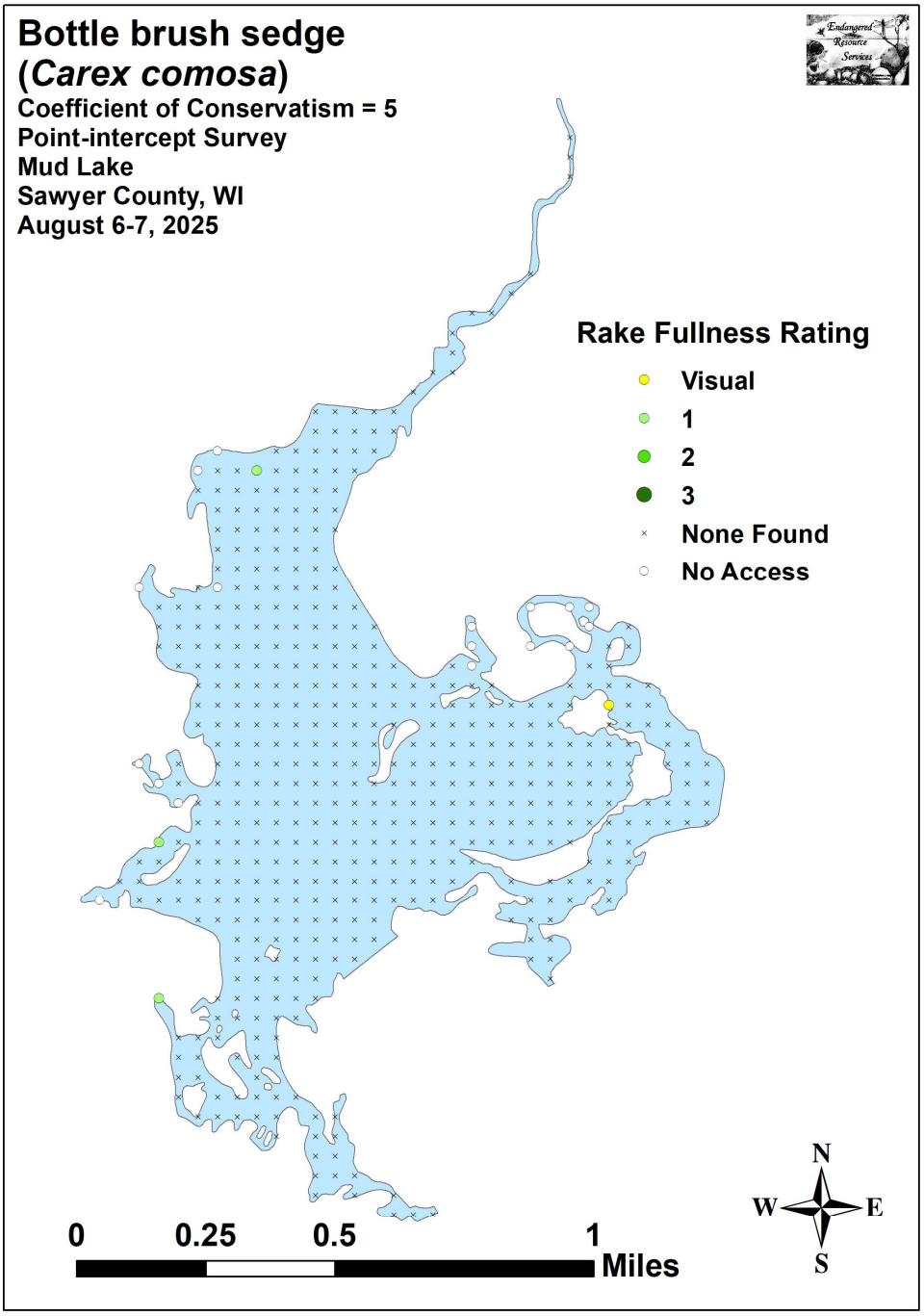
Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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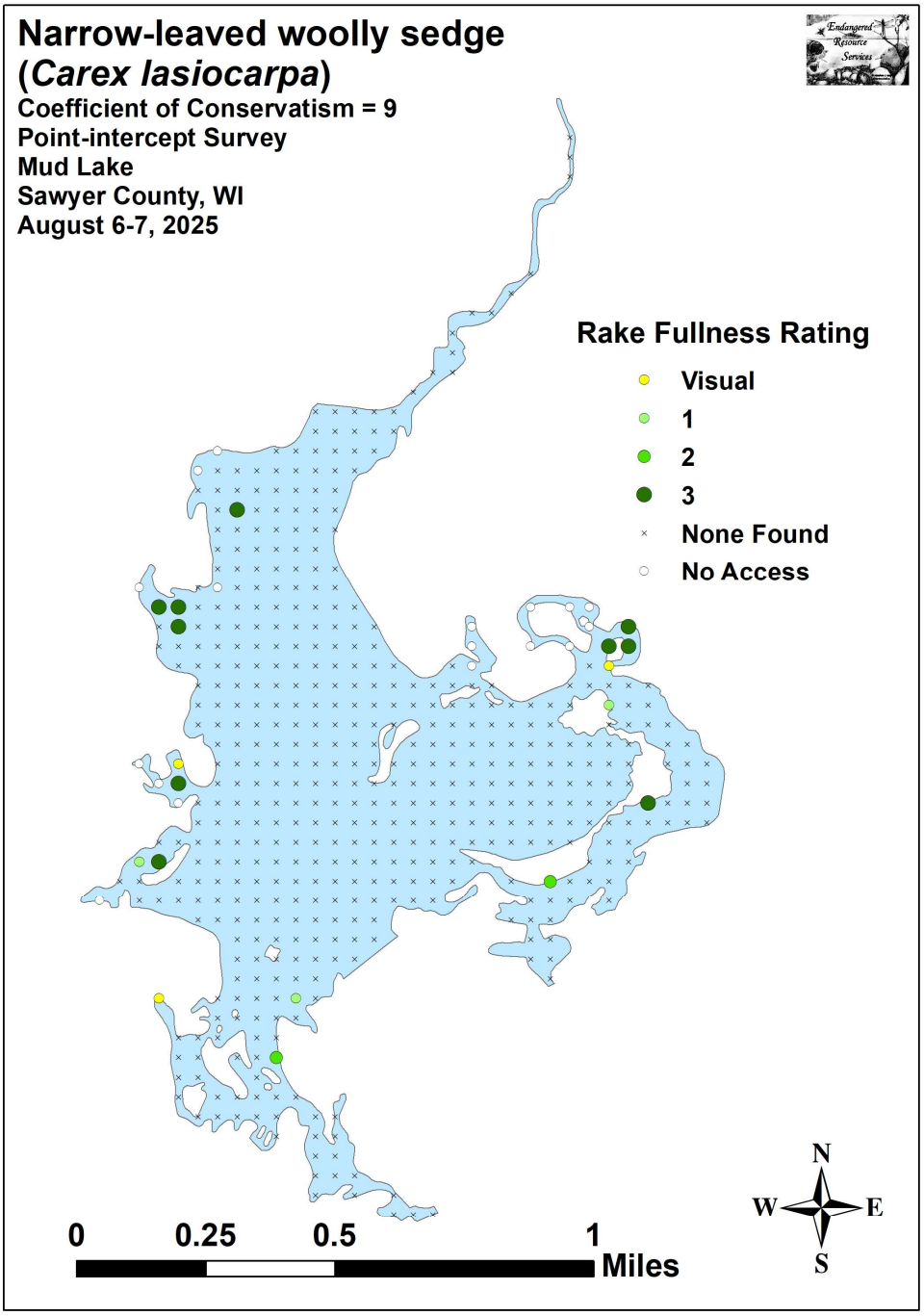
Narrow-leaved woolly sedge
(Carex lasiocarpa)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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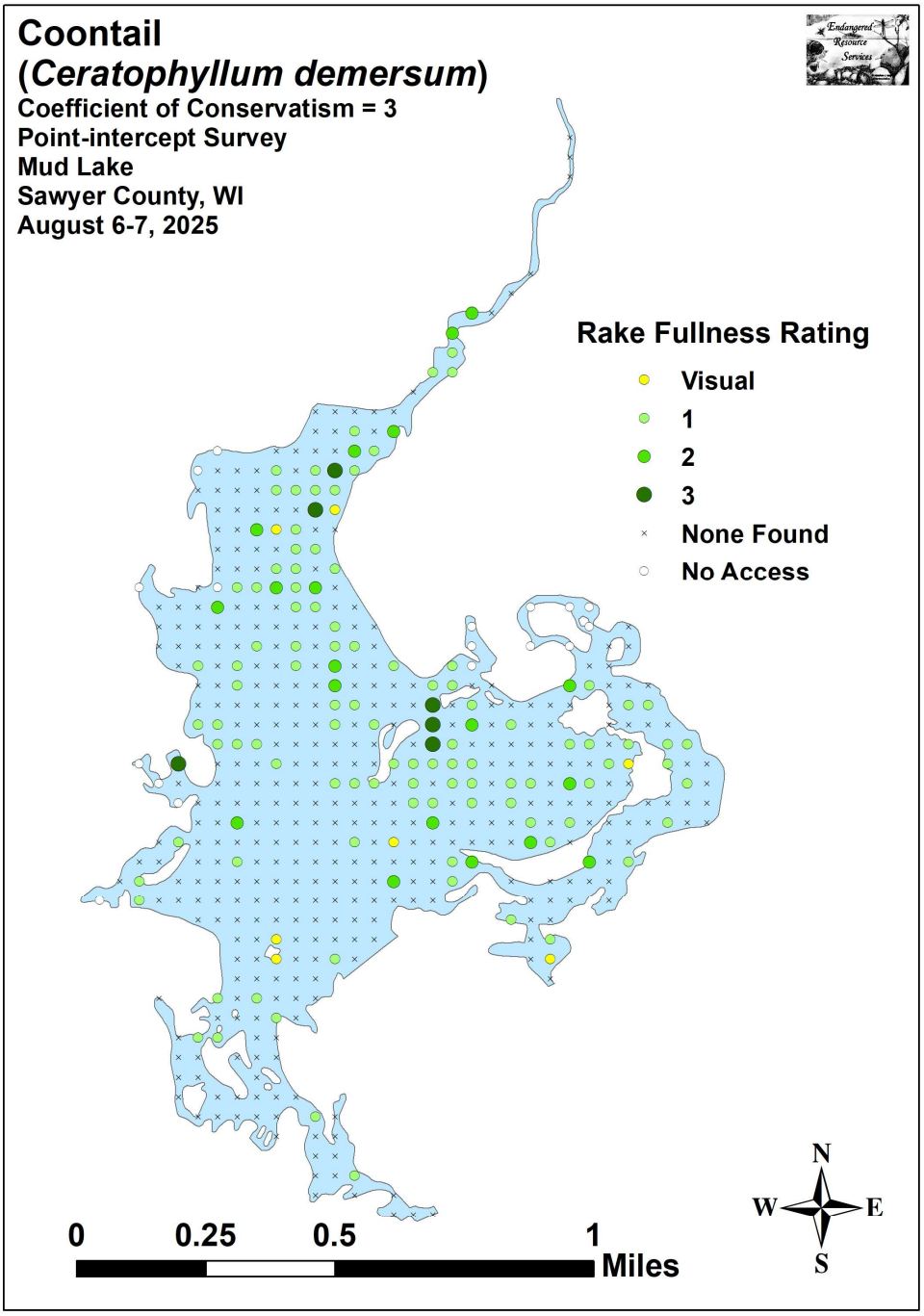
Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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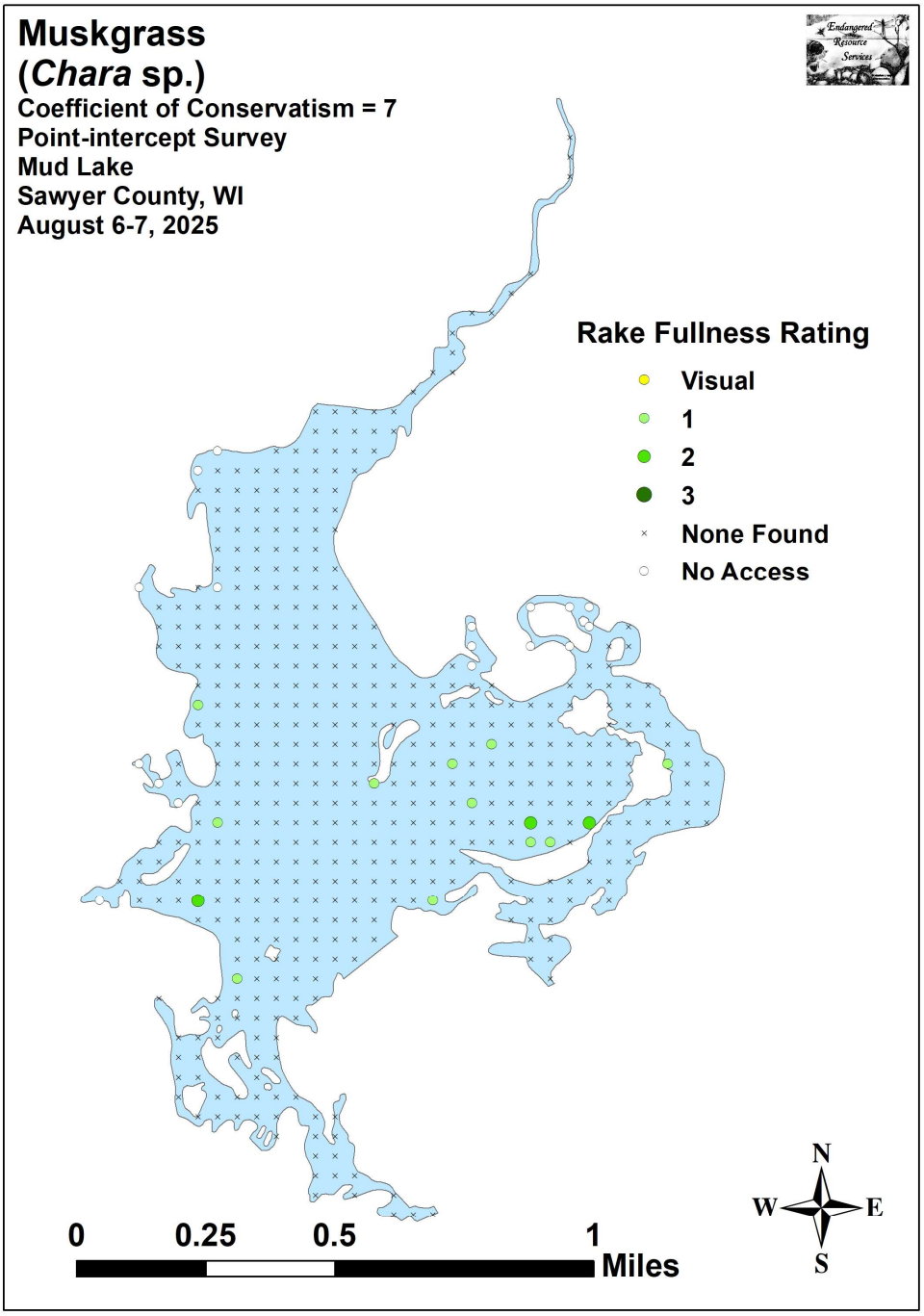
Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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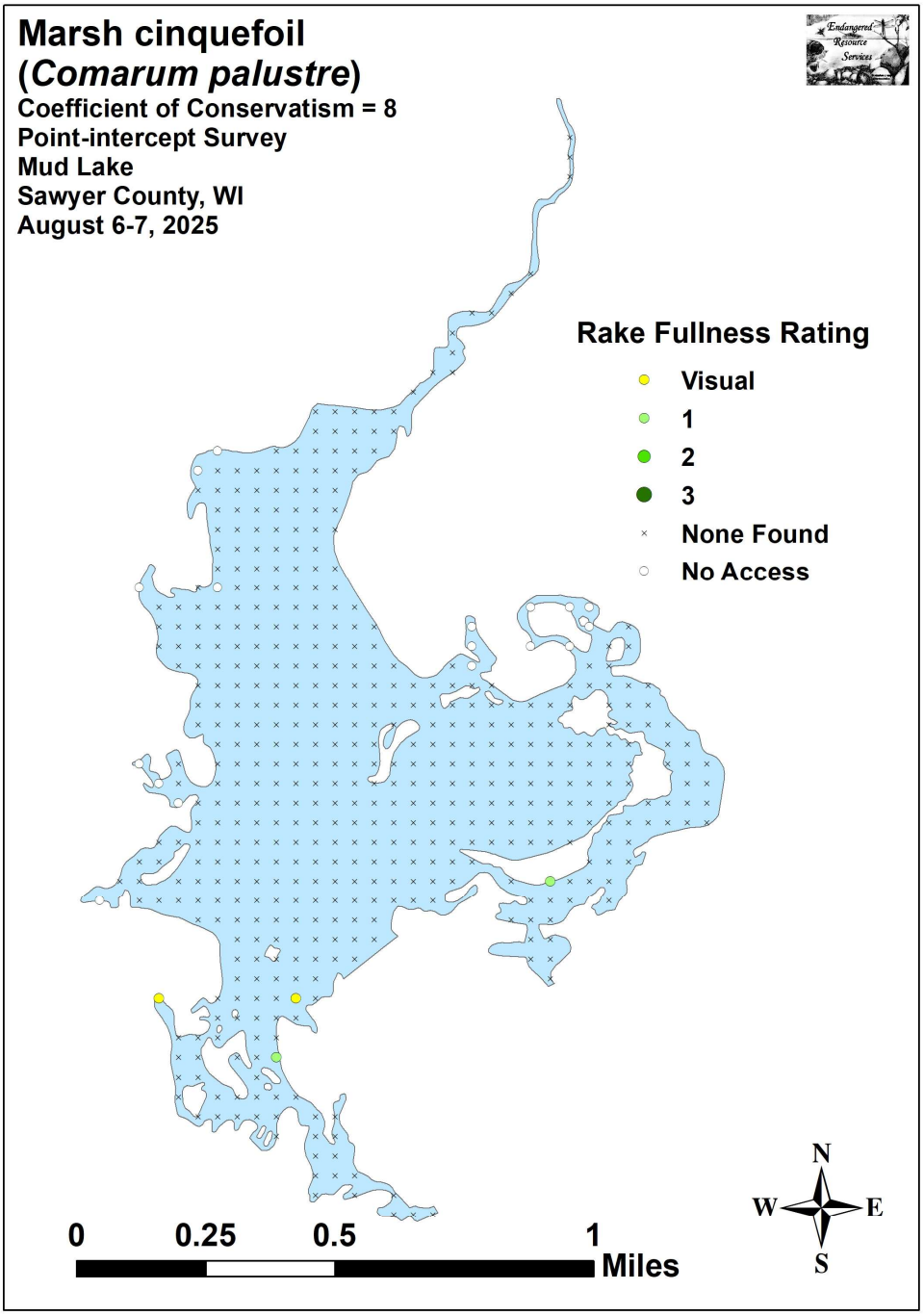
Marsh cinquefoil
(Comarum palustre)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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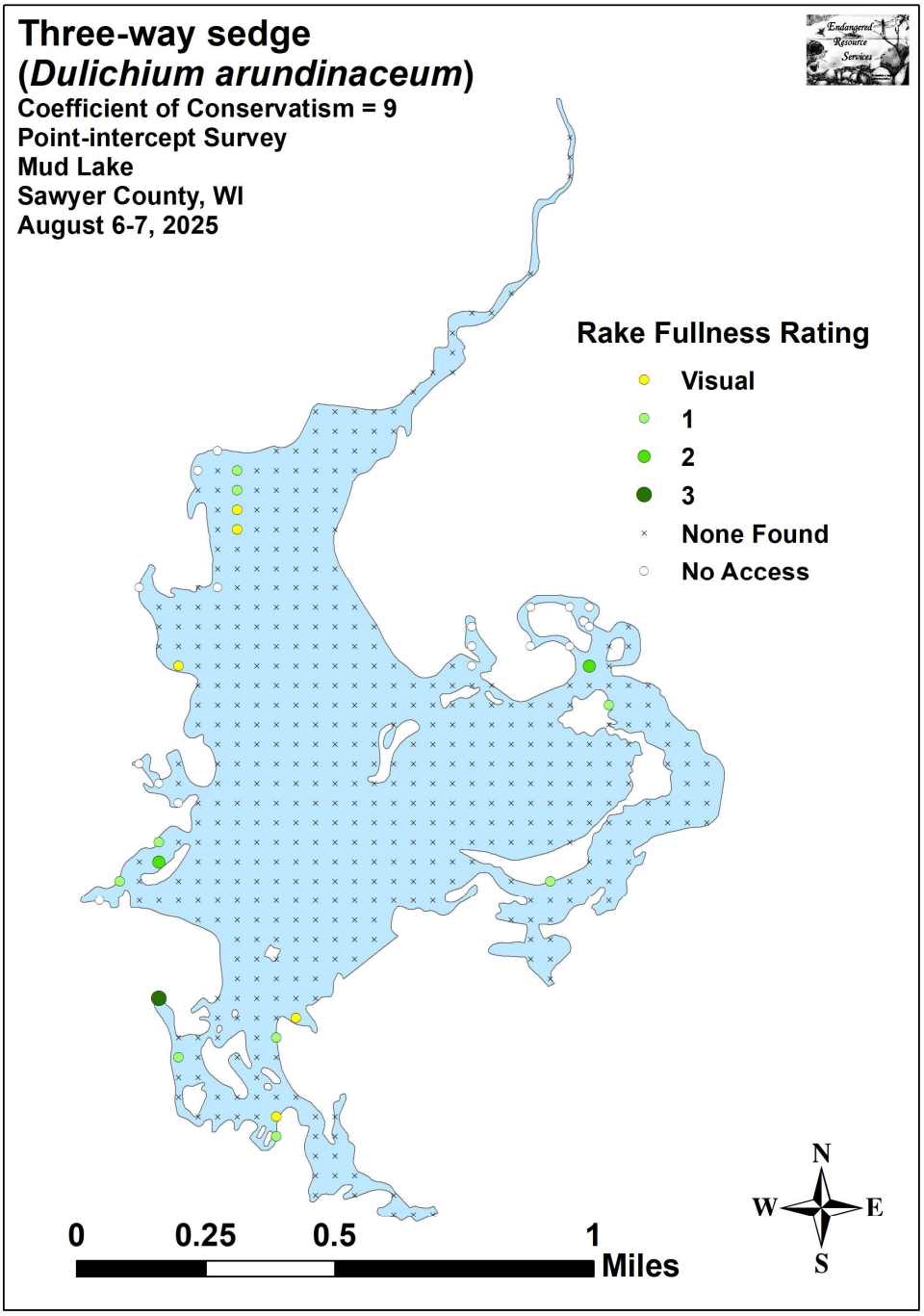
Three-way sedge
(Dulichium arundinaceum)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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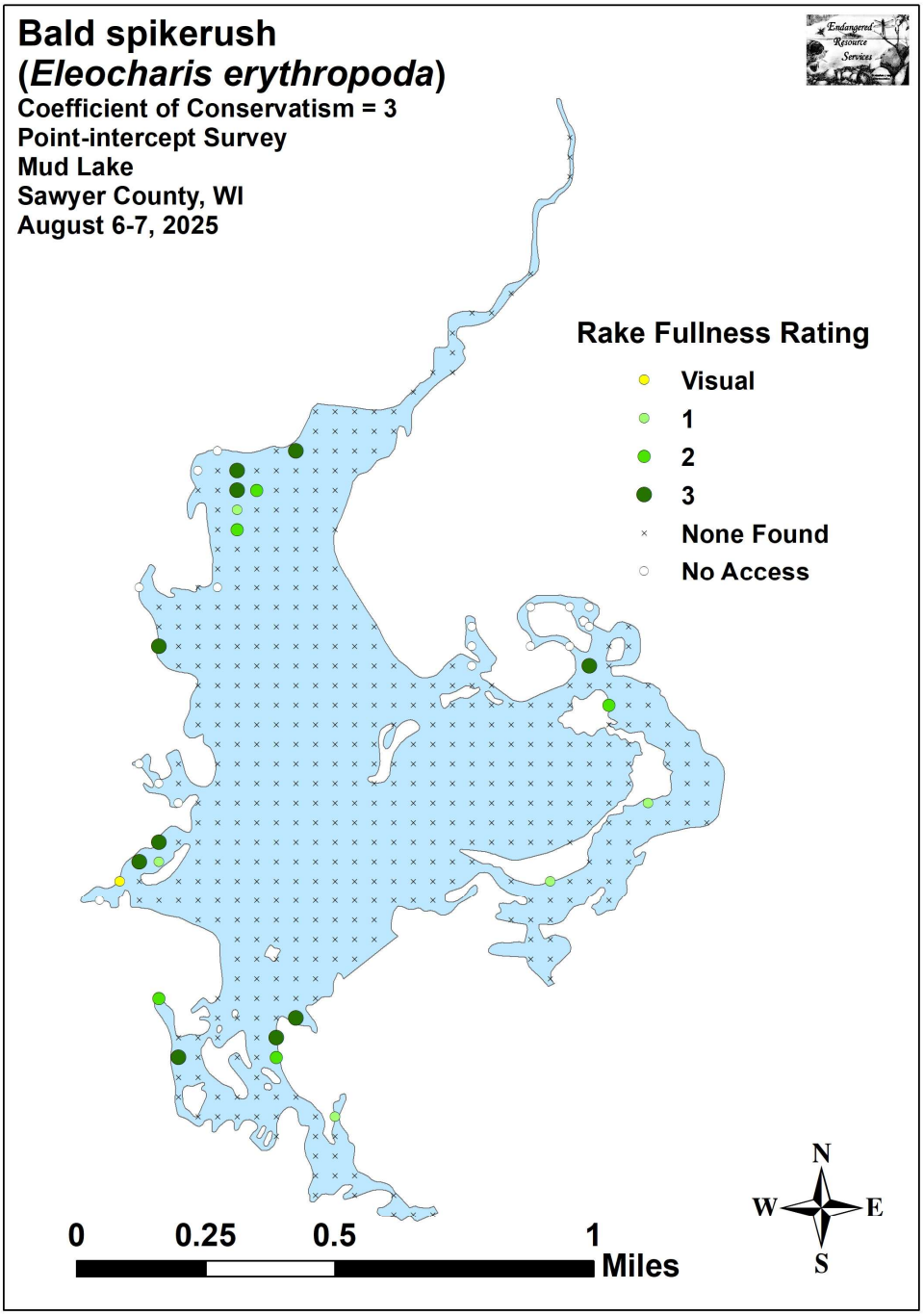
Bald spikerush
(Eleocharis erythropoda)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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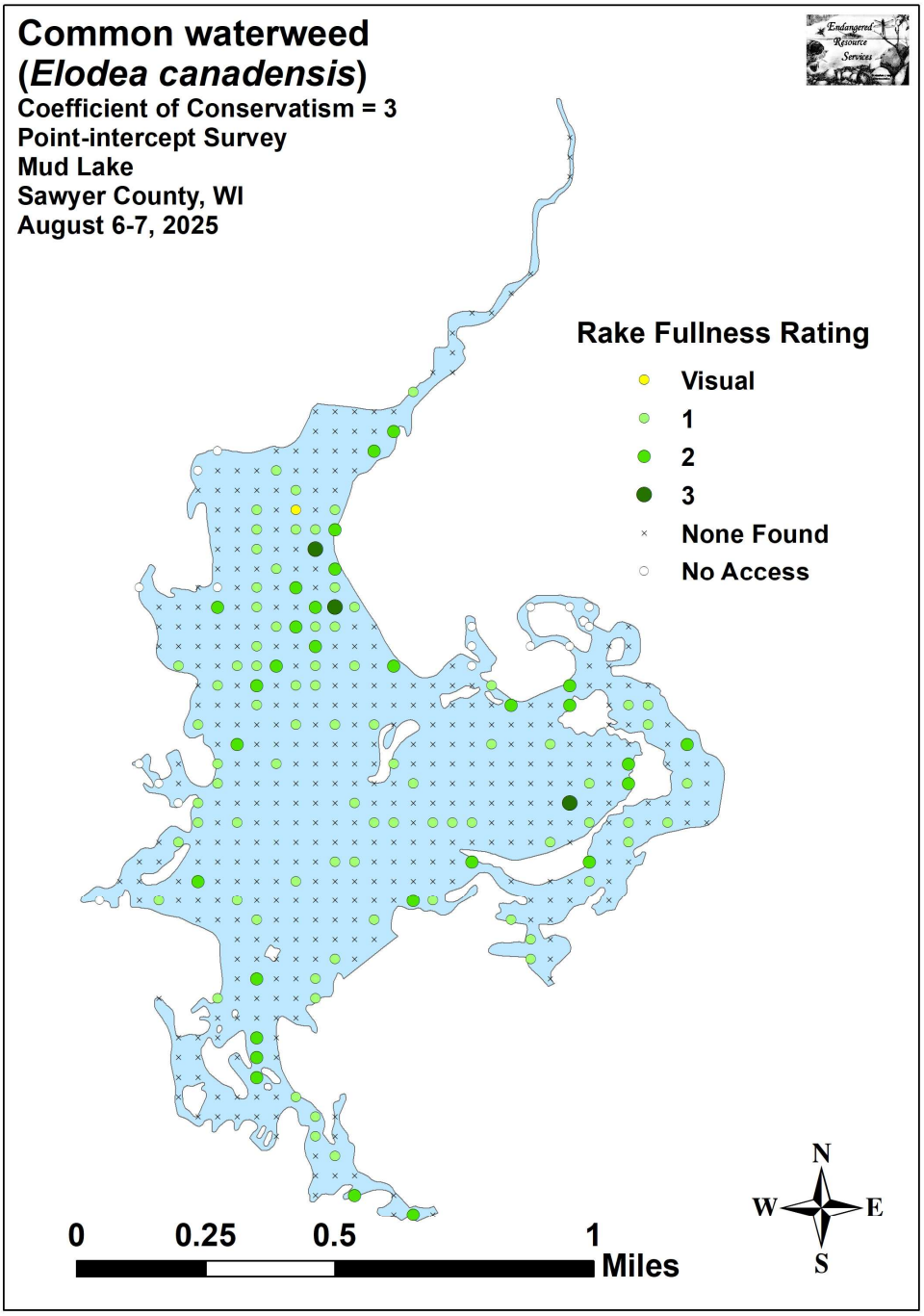
Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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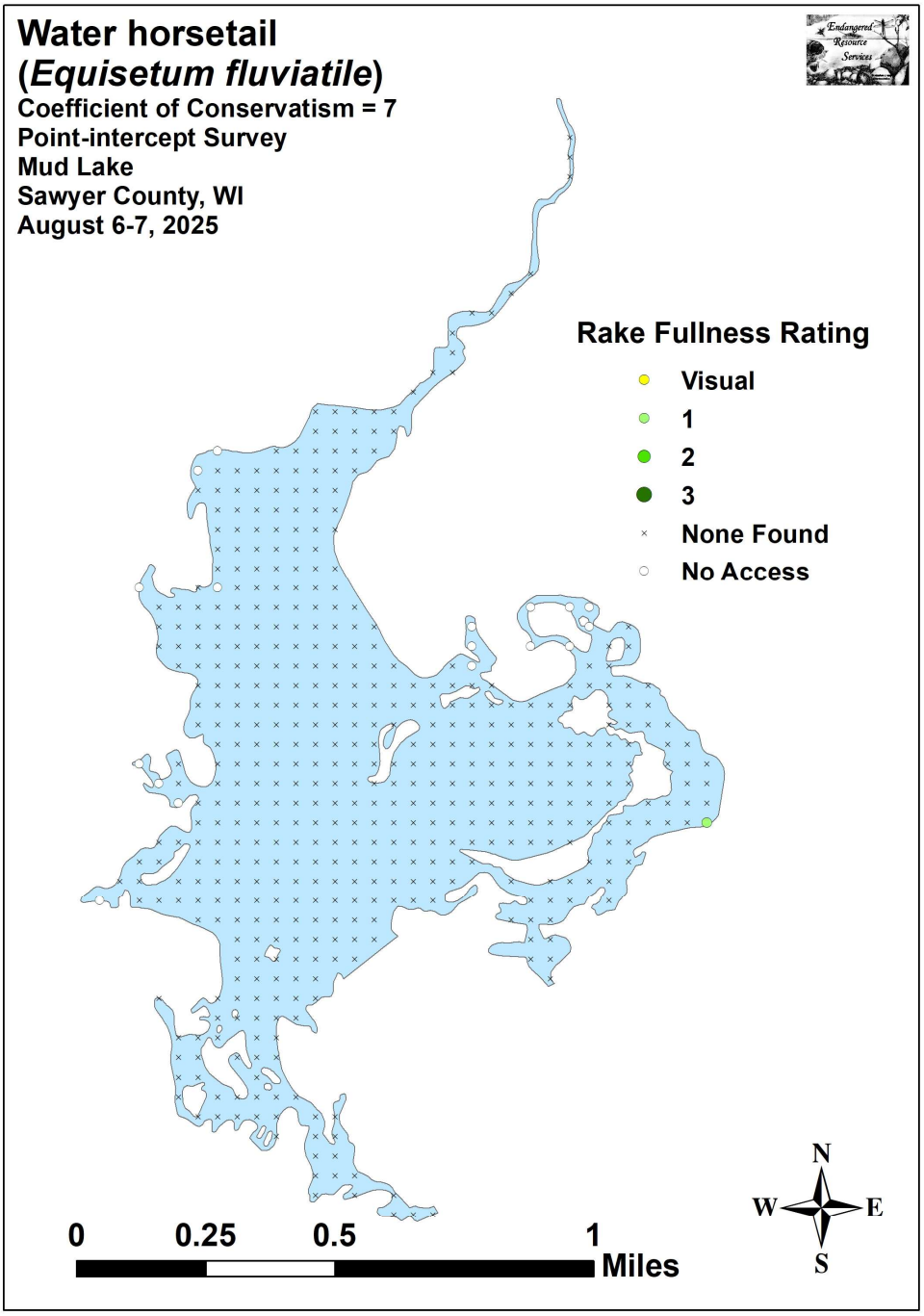
Water horsetail
(Equisetum fluviatile)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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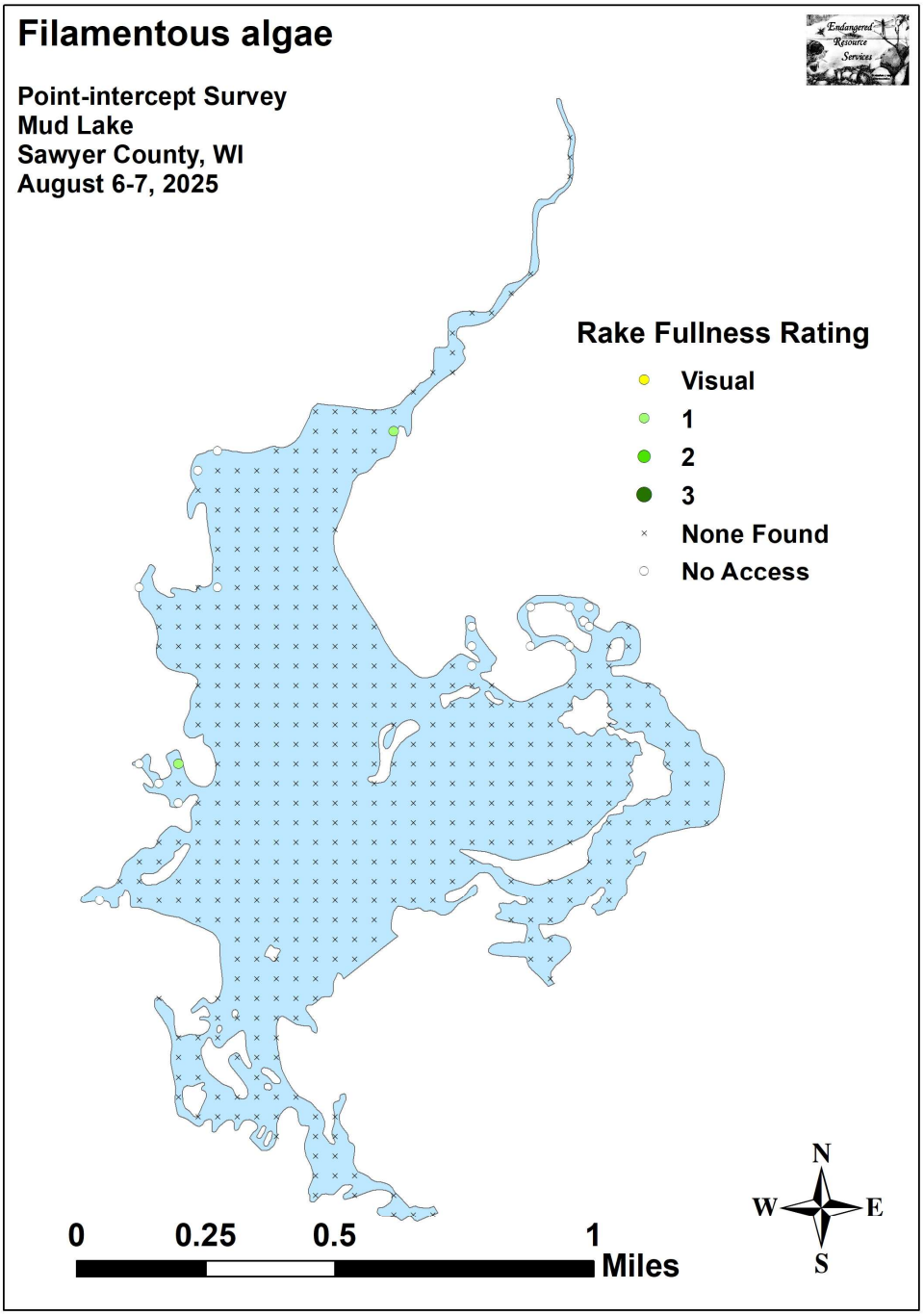
Filamentous algae
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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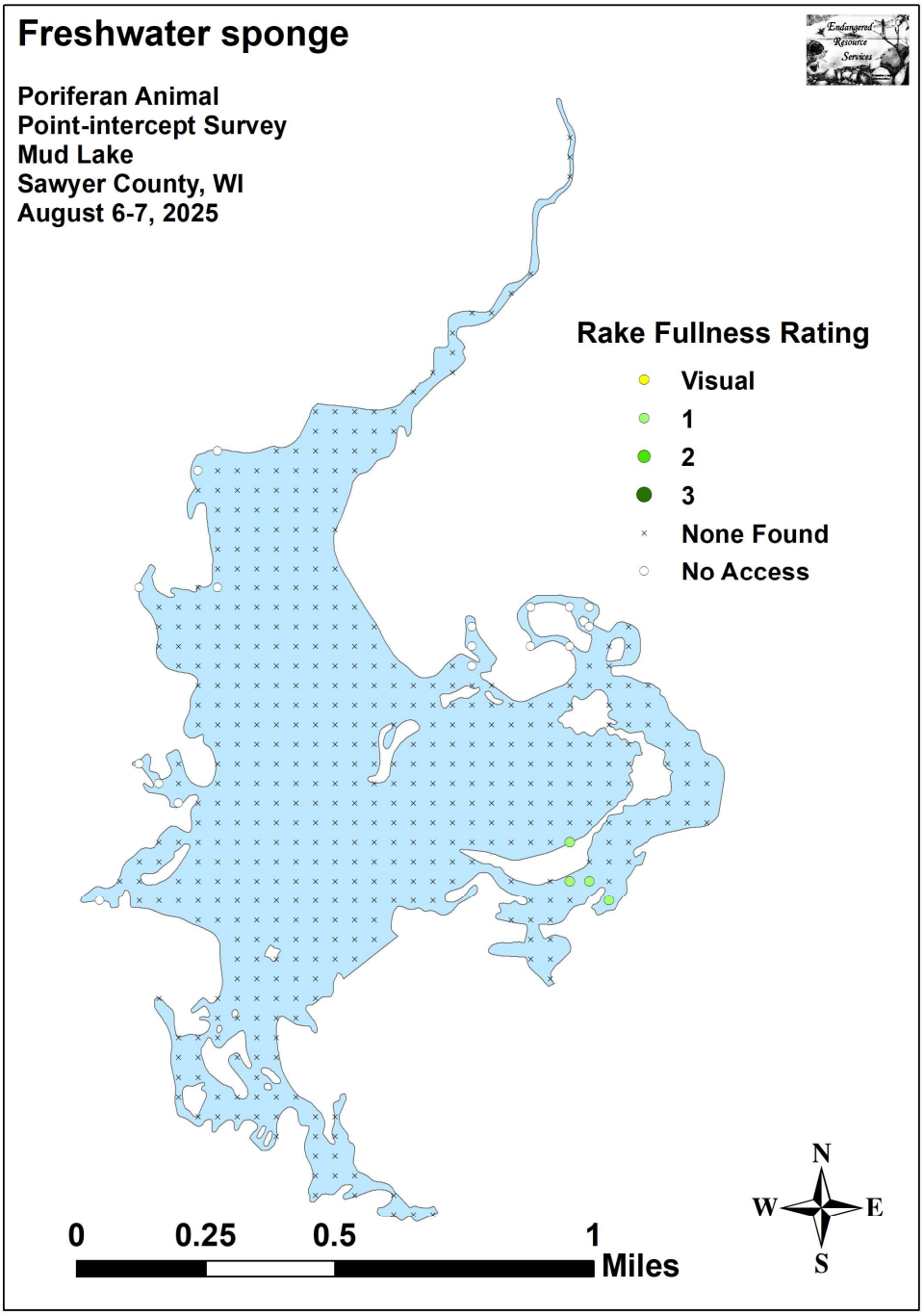
Freshwater sponge
Poriferan Animal
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Rake Fullness Rating
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None Found
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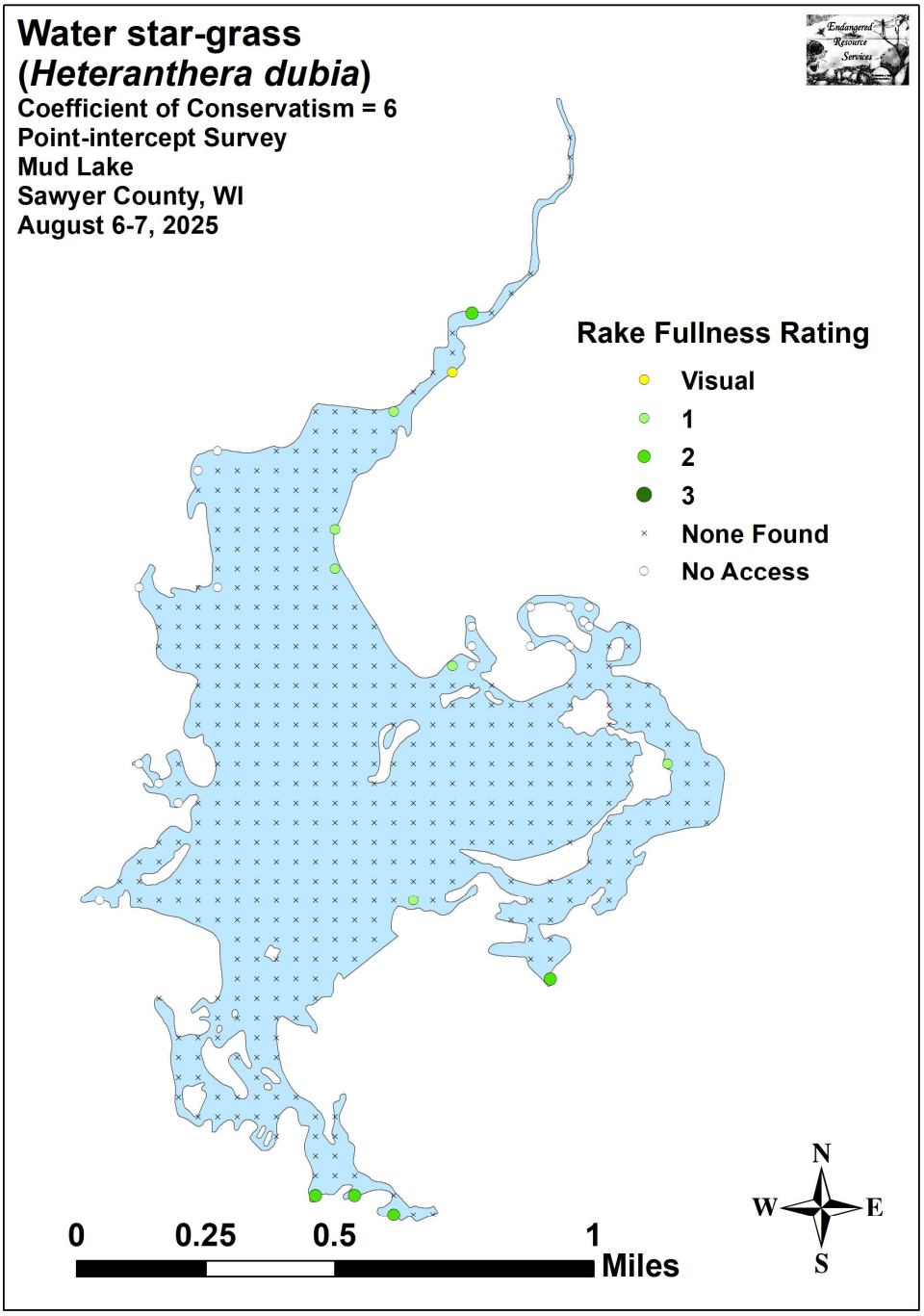
Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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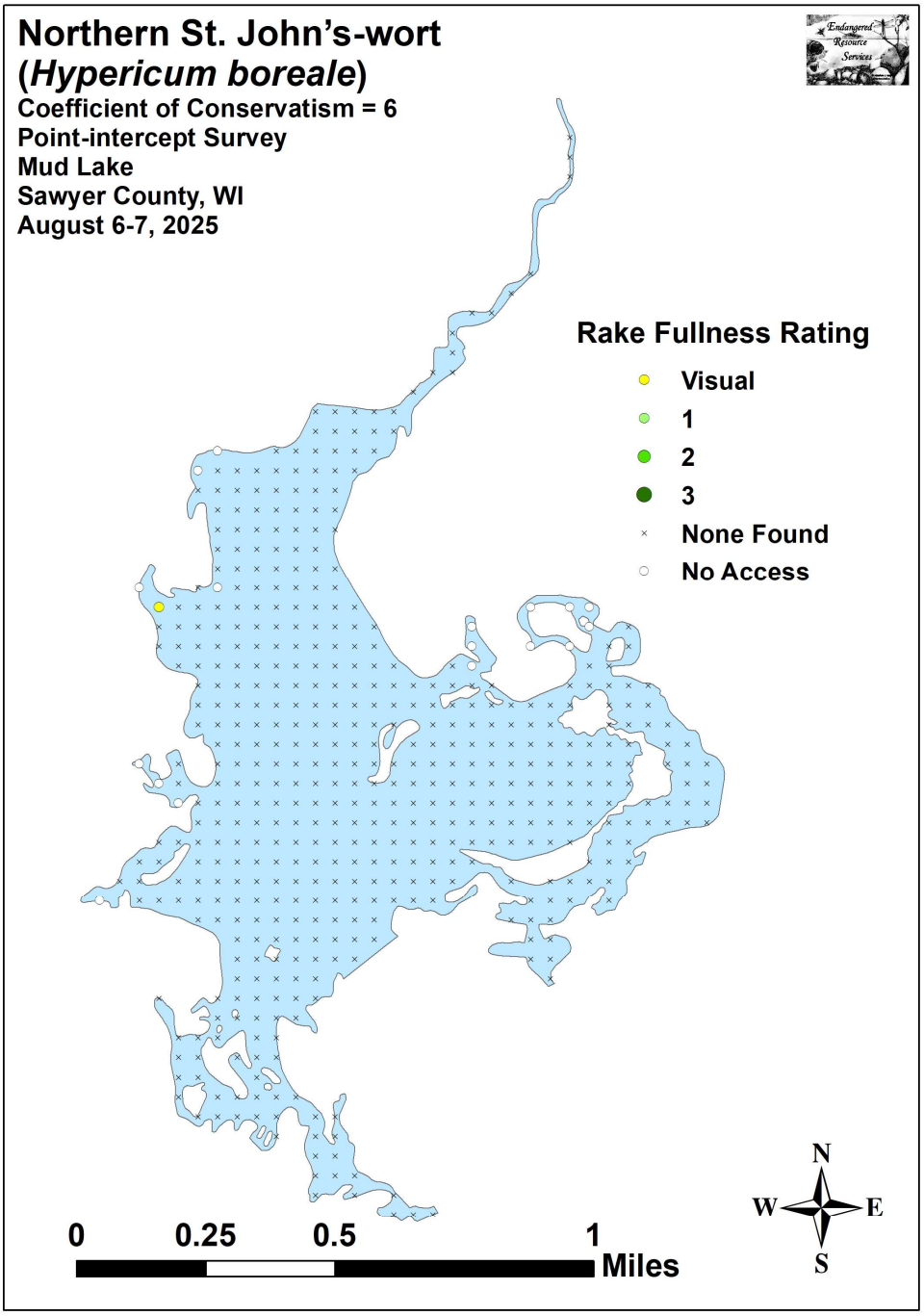
Northern St. John's-wort
(Hypericum boreale)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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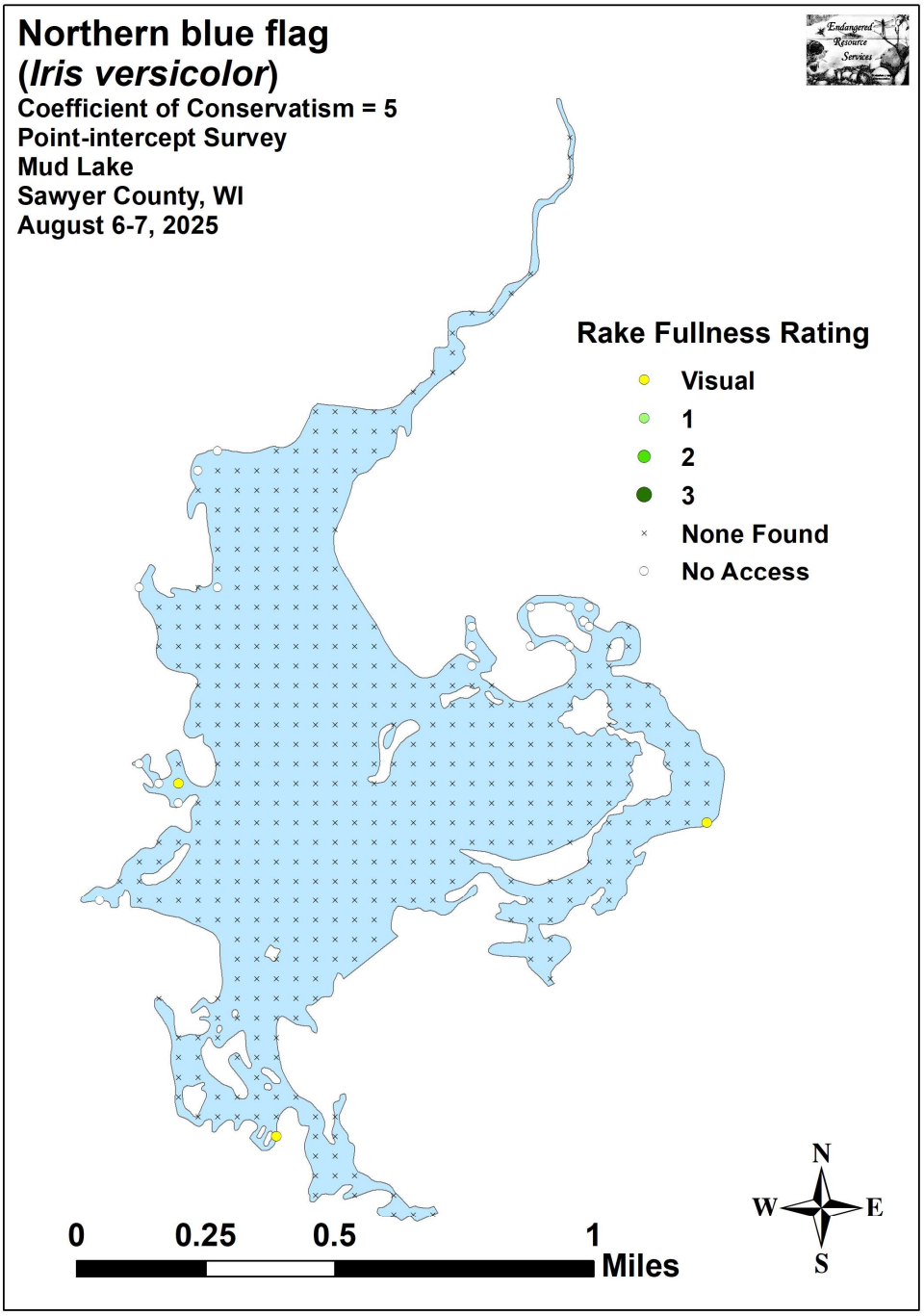
Northern blue flag
(Iris versicolor)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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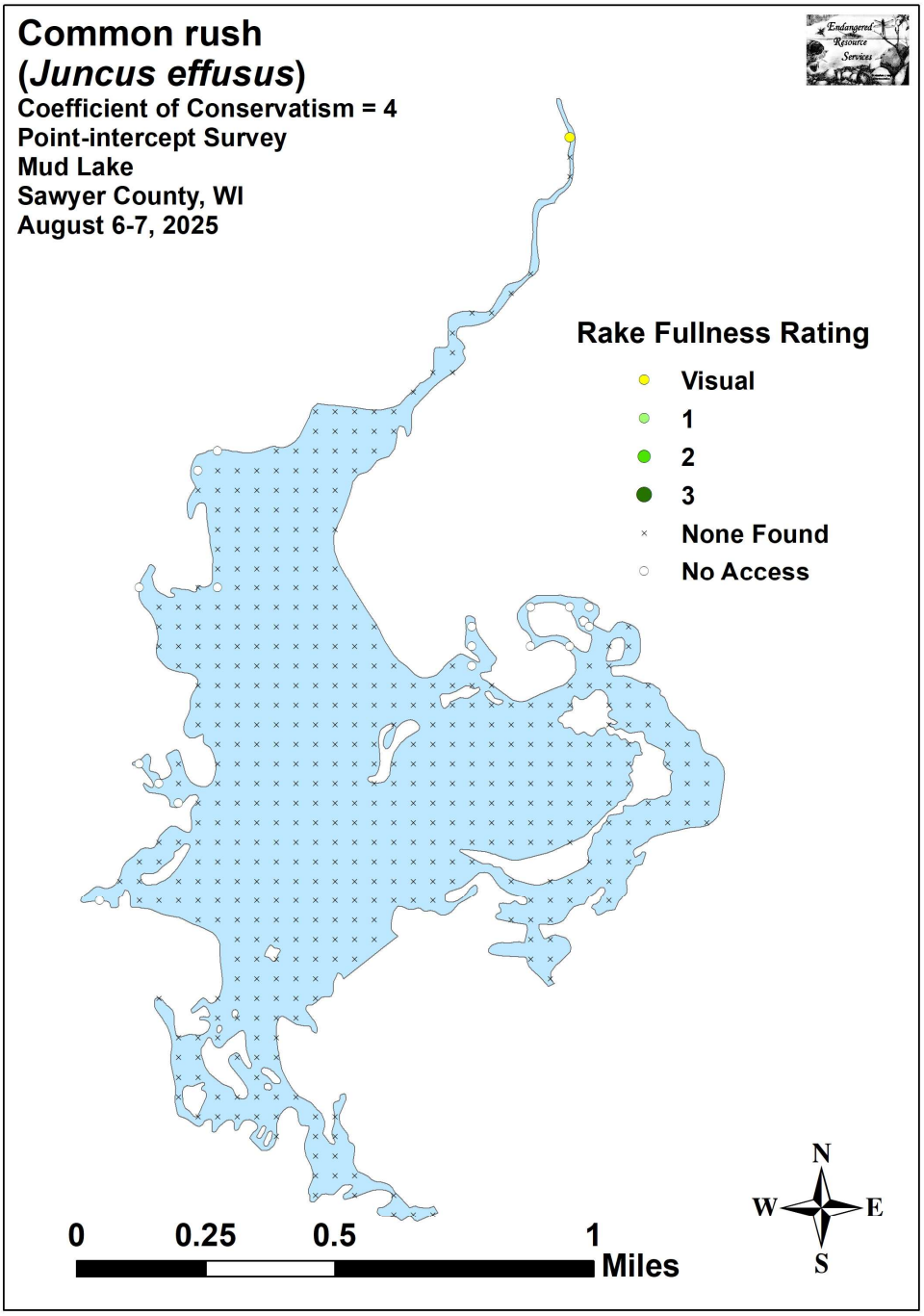
Common rush
(Juncus effusus)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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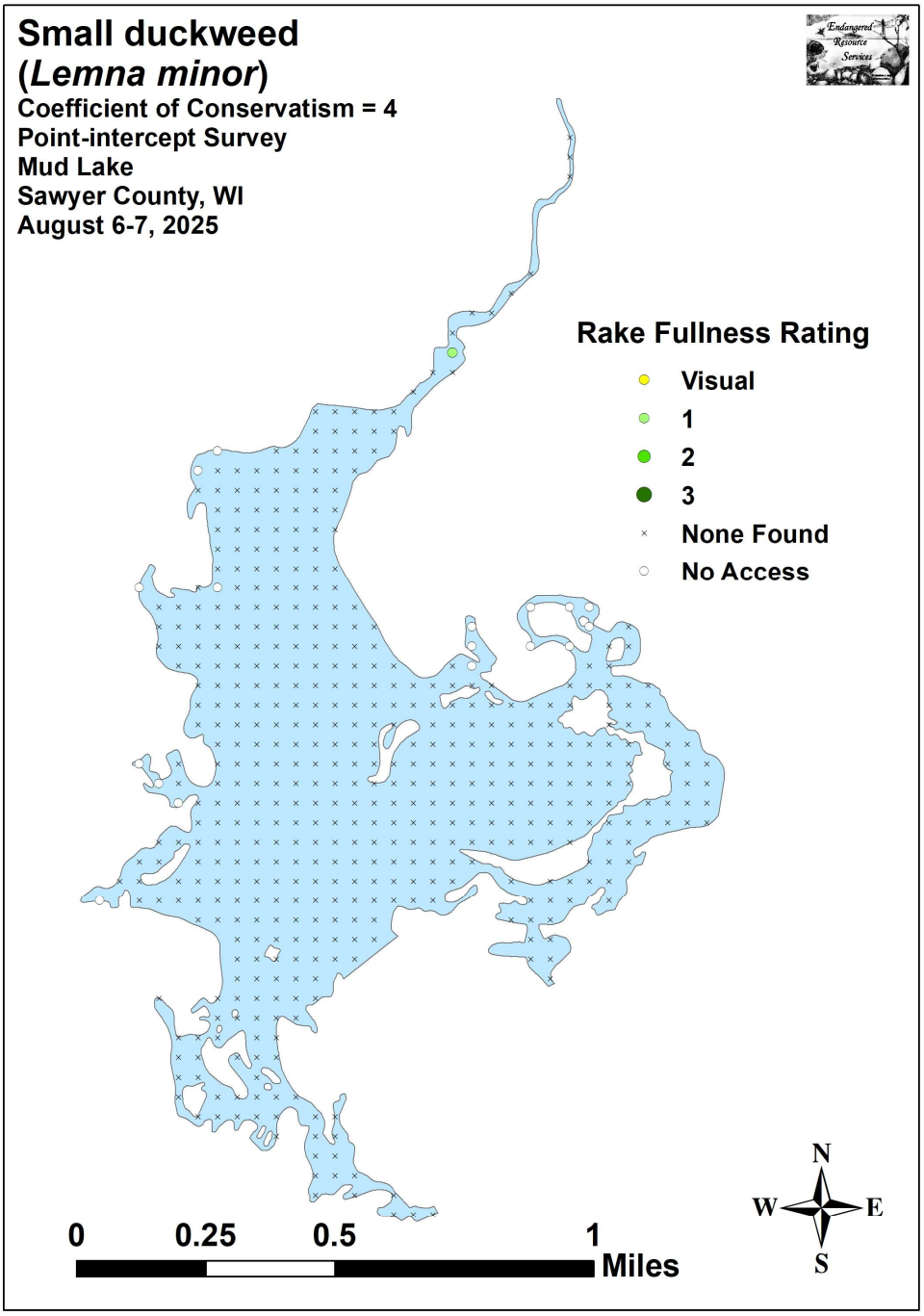
Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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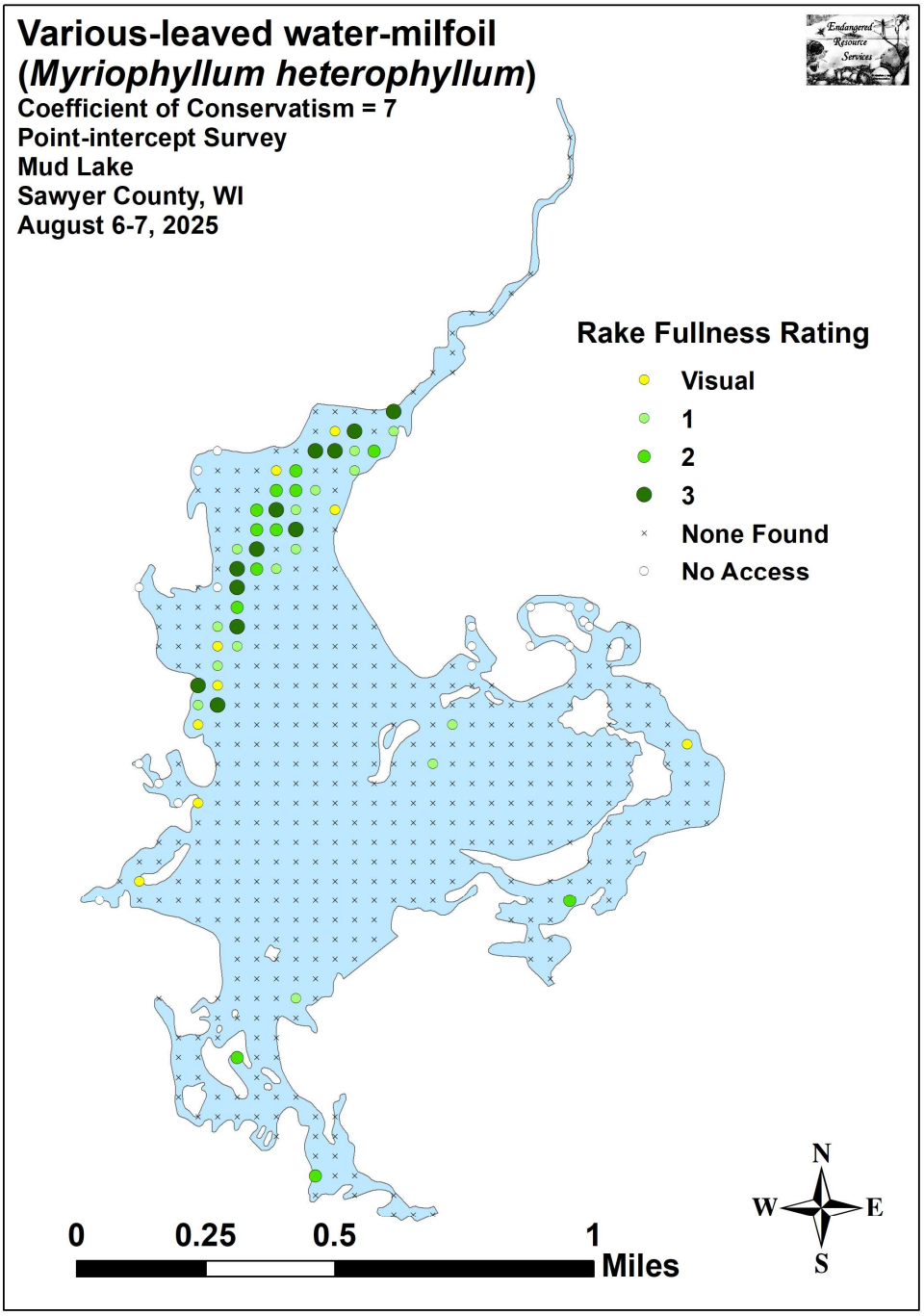
Various-leaved water-milfoil
(Myriophyllum heterophyllum)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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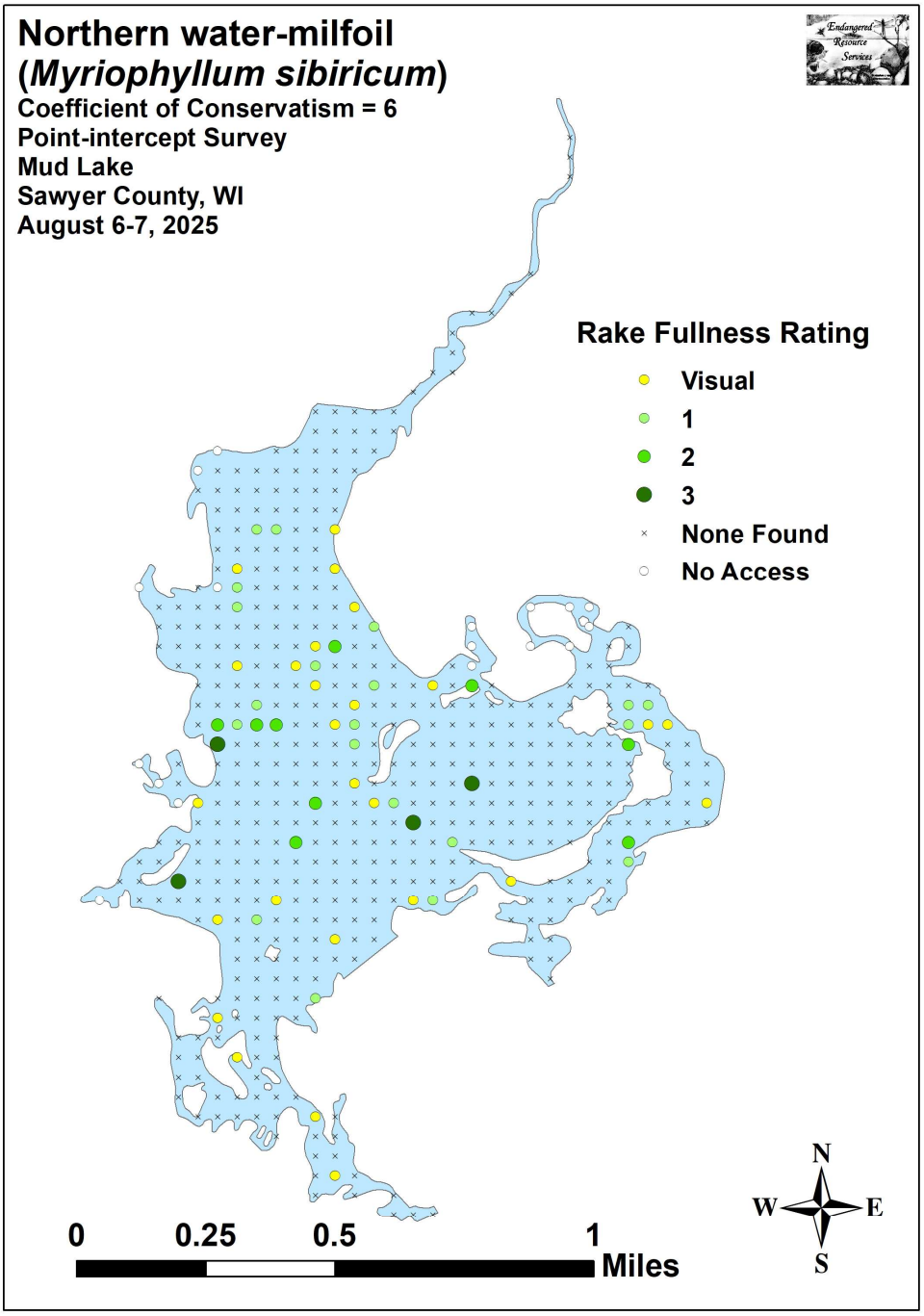
Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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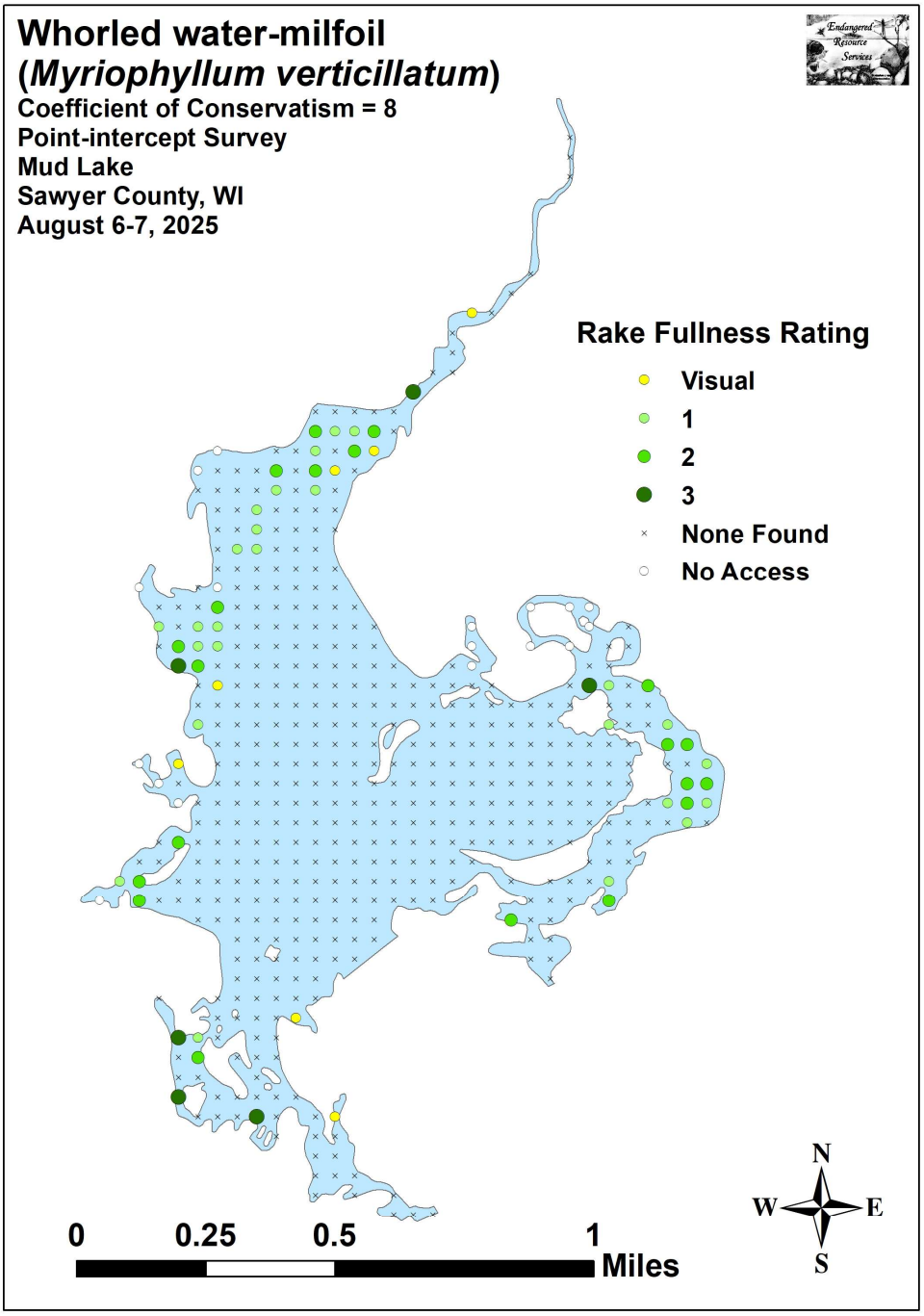
Whorled water-milfoil
(Myriophyllum verticillatum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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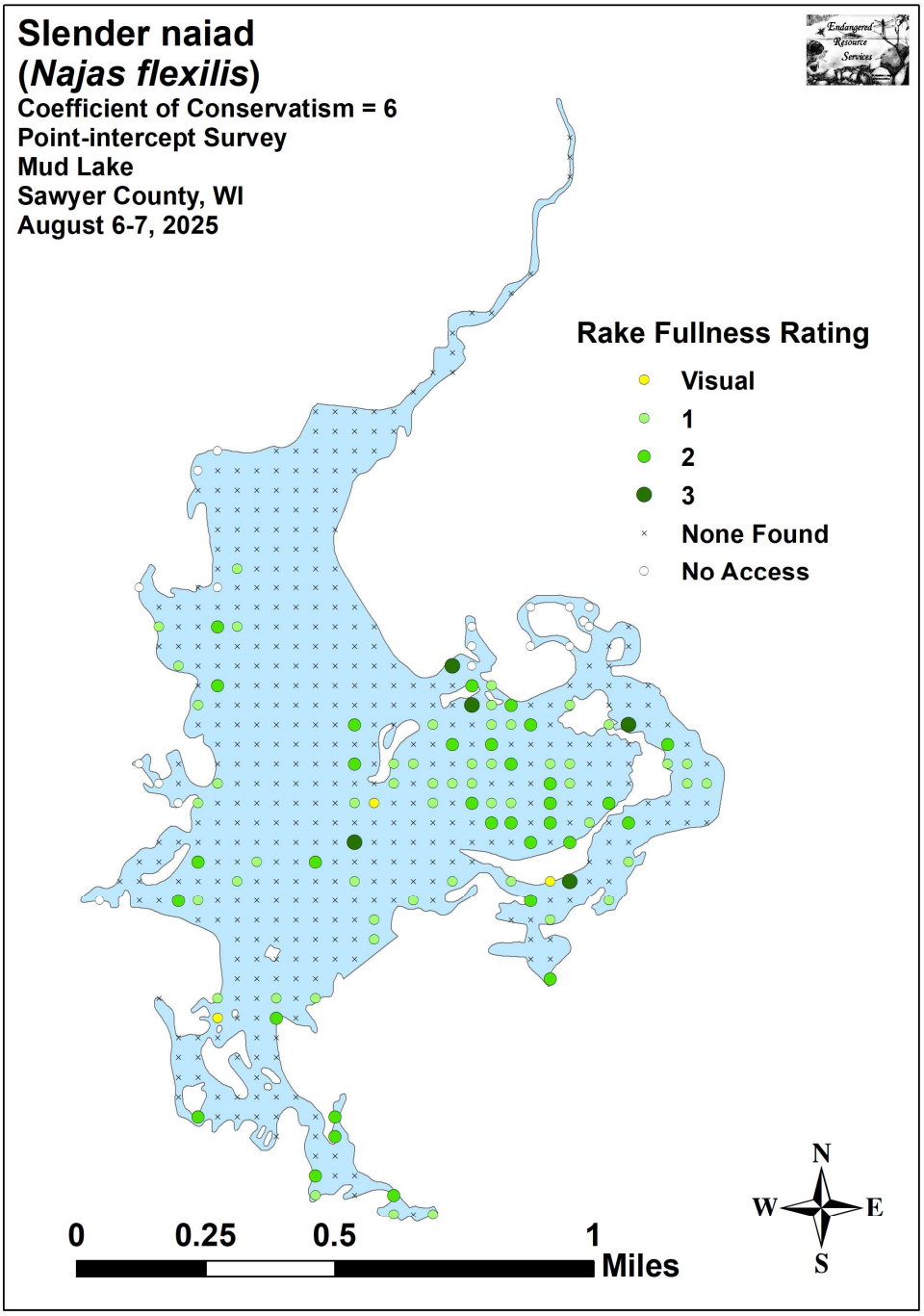
Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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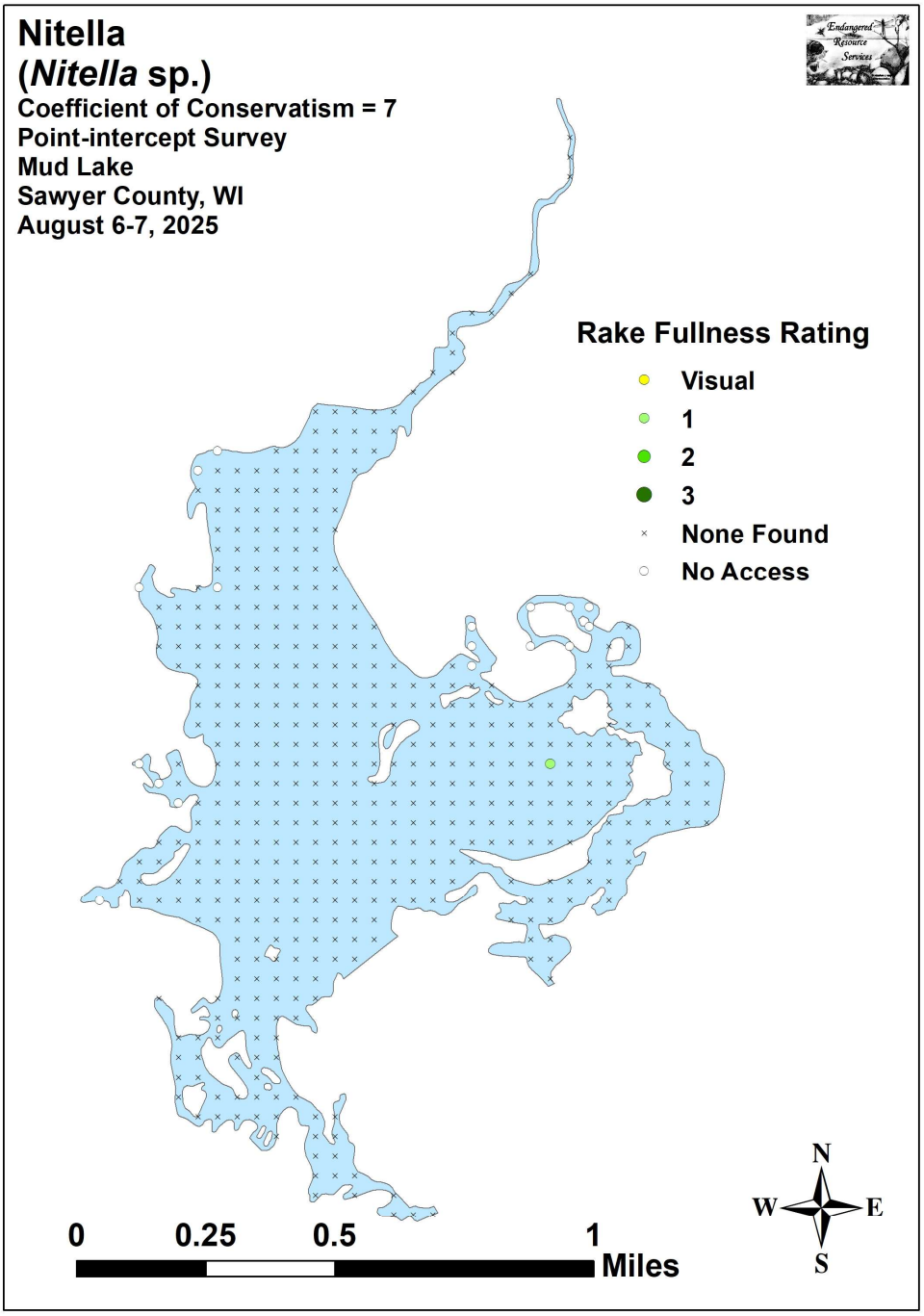
Nitella
(Nitella sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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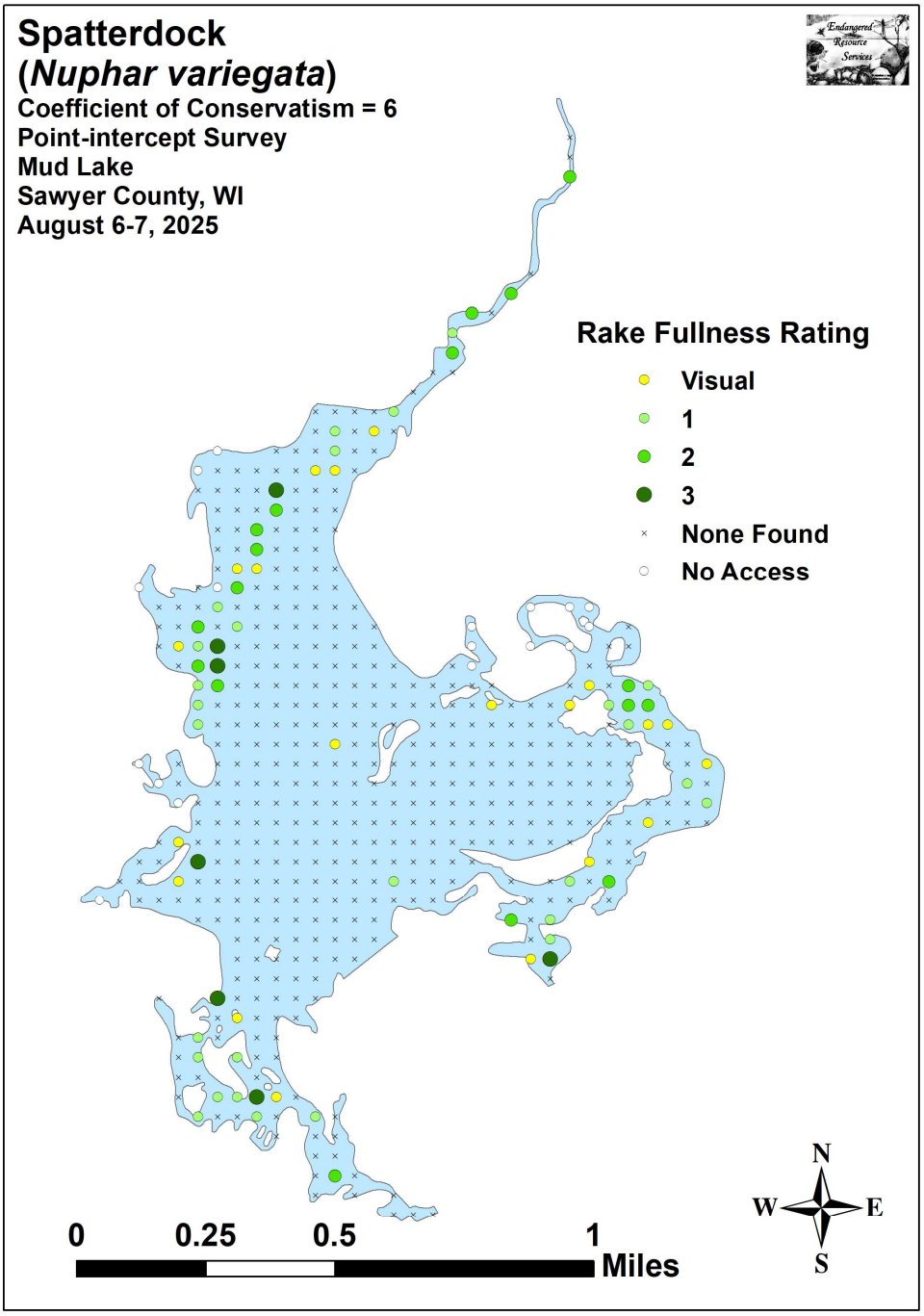
Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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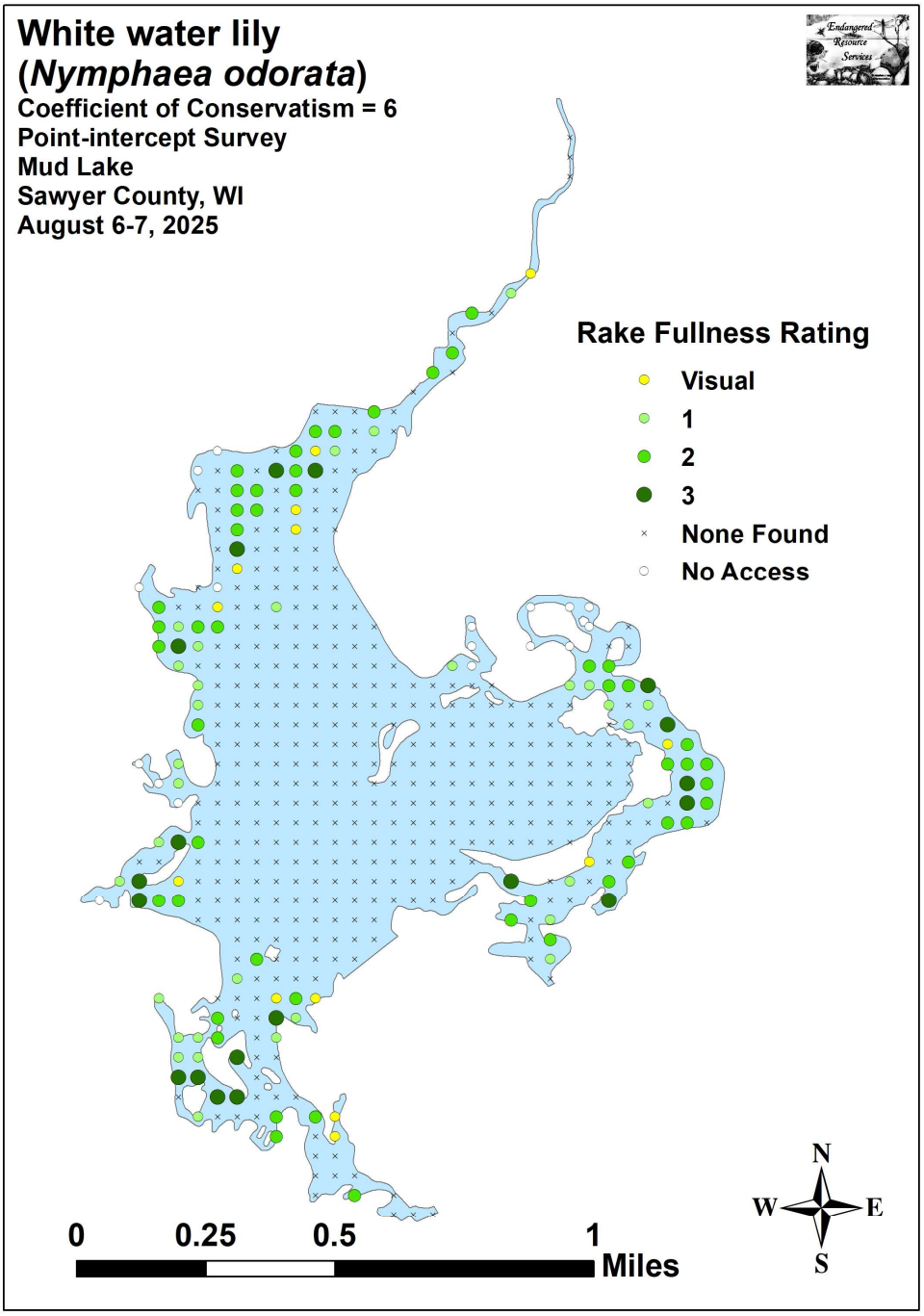
White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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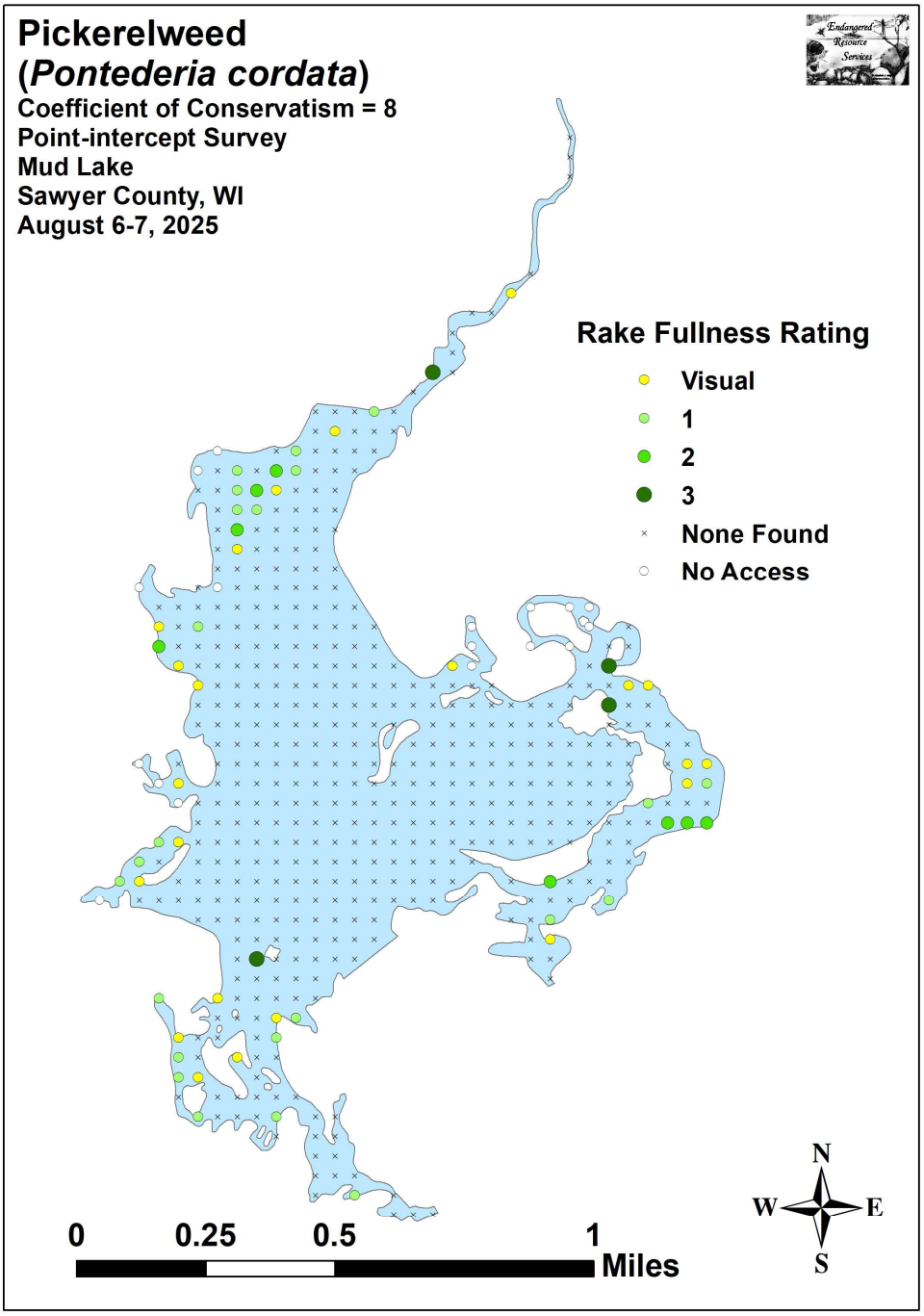
Pickerelweed
(*Pontederia cordata*)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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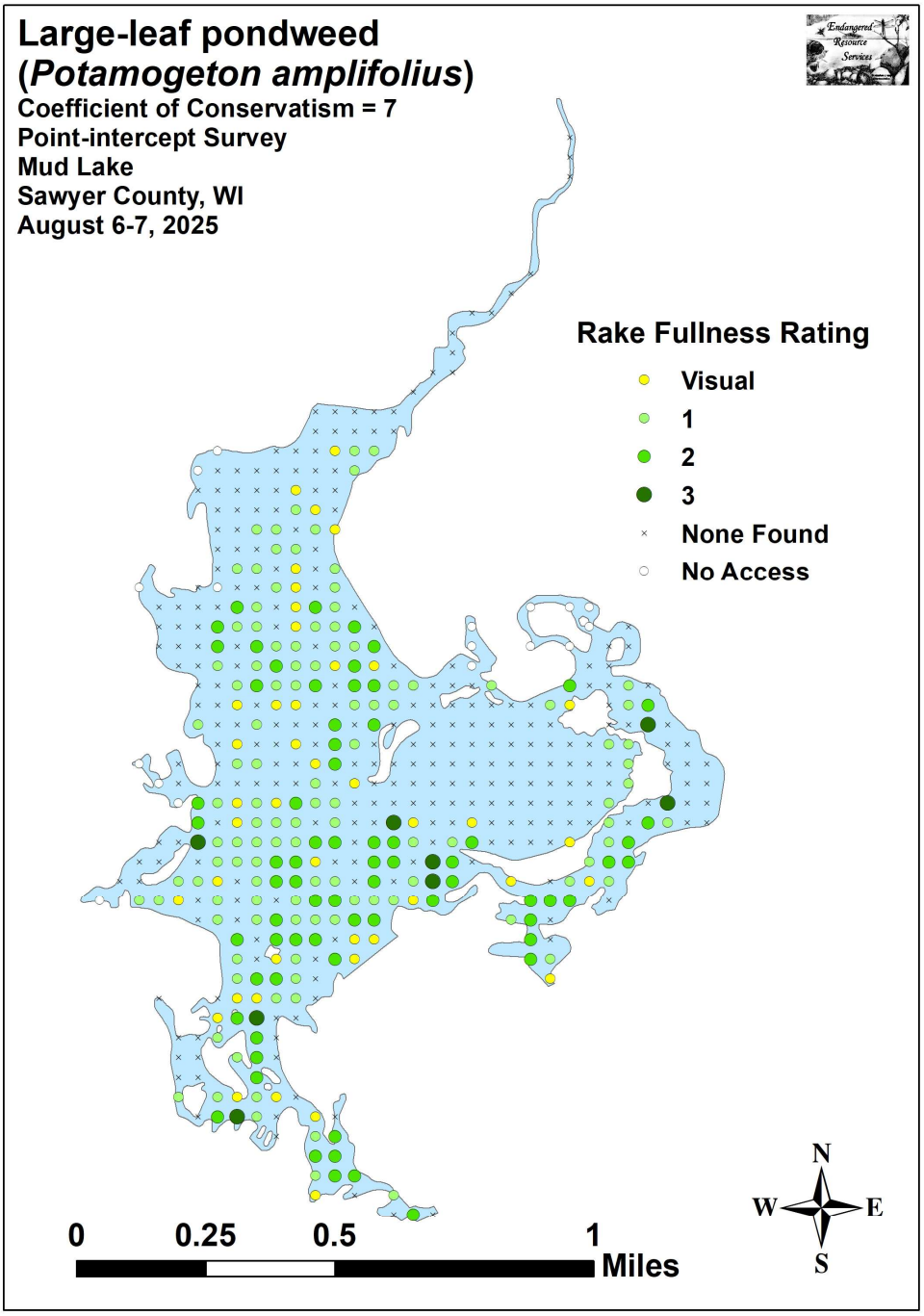
Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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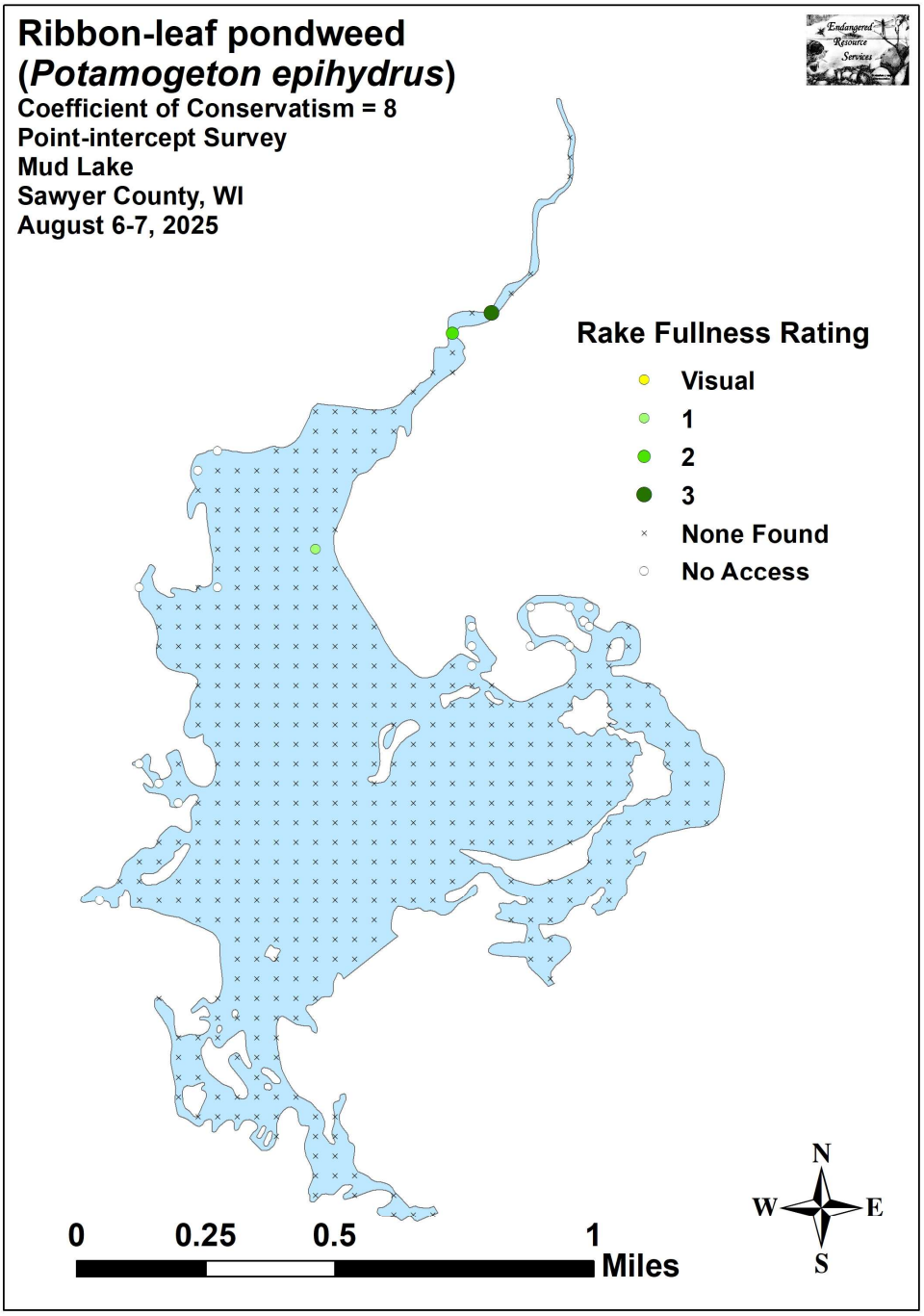
Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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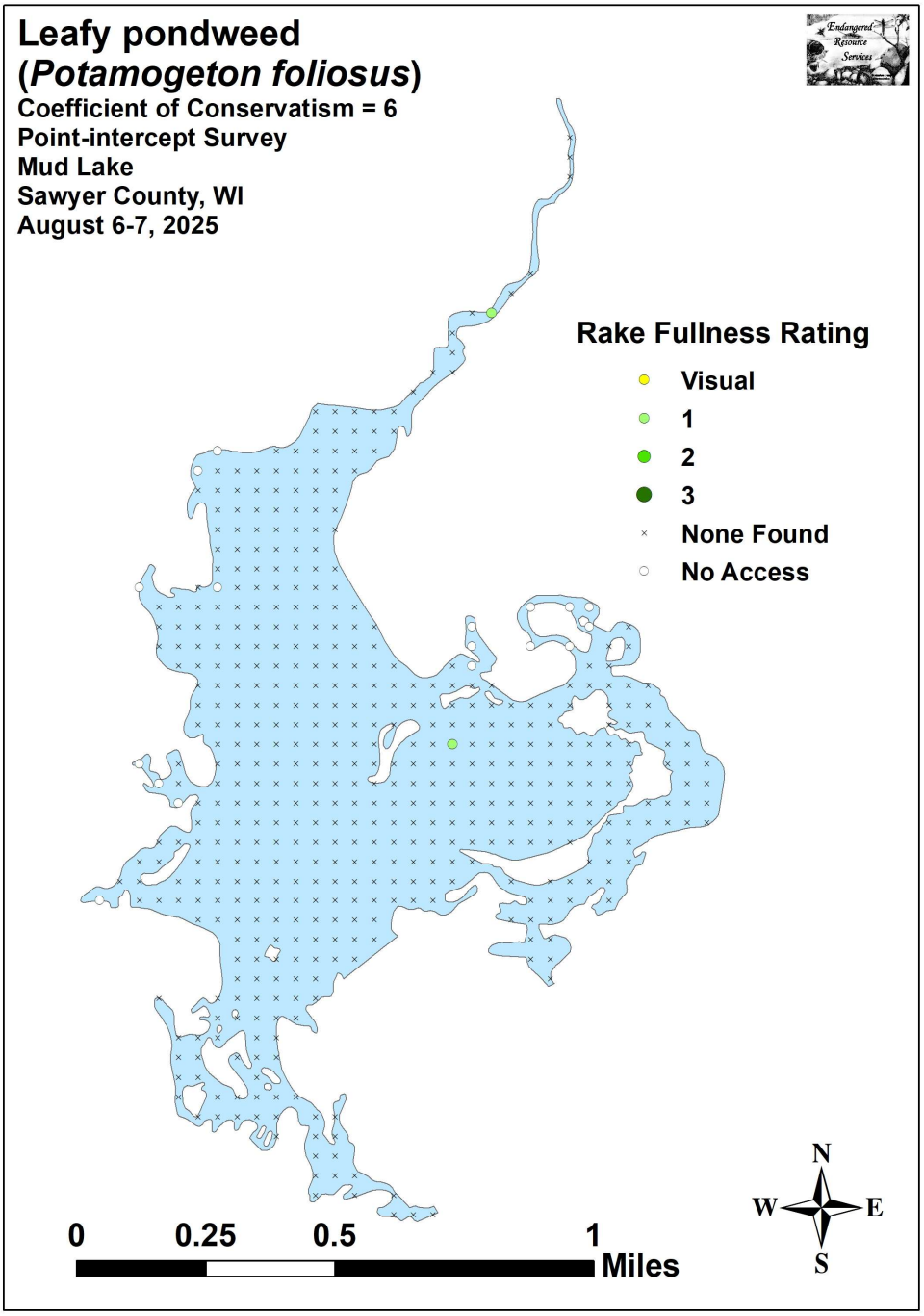
Leafy pondweed
(Potamogeton foliosus)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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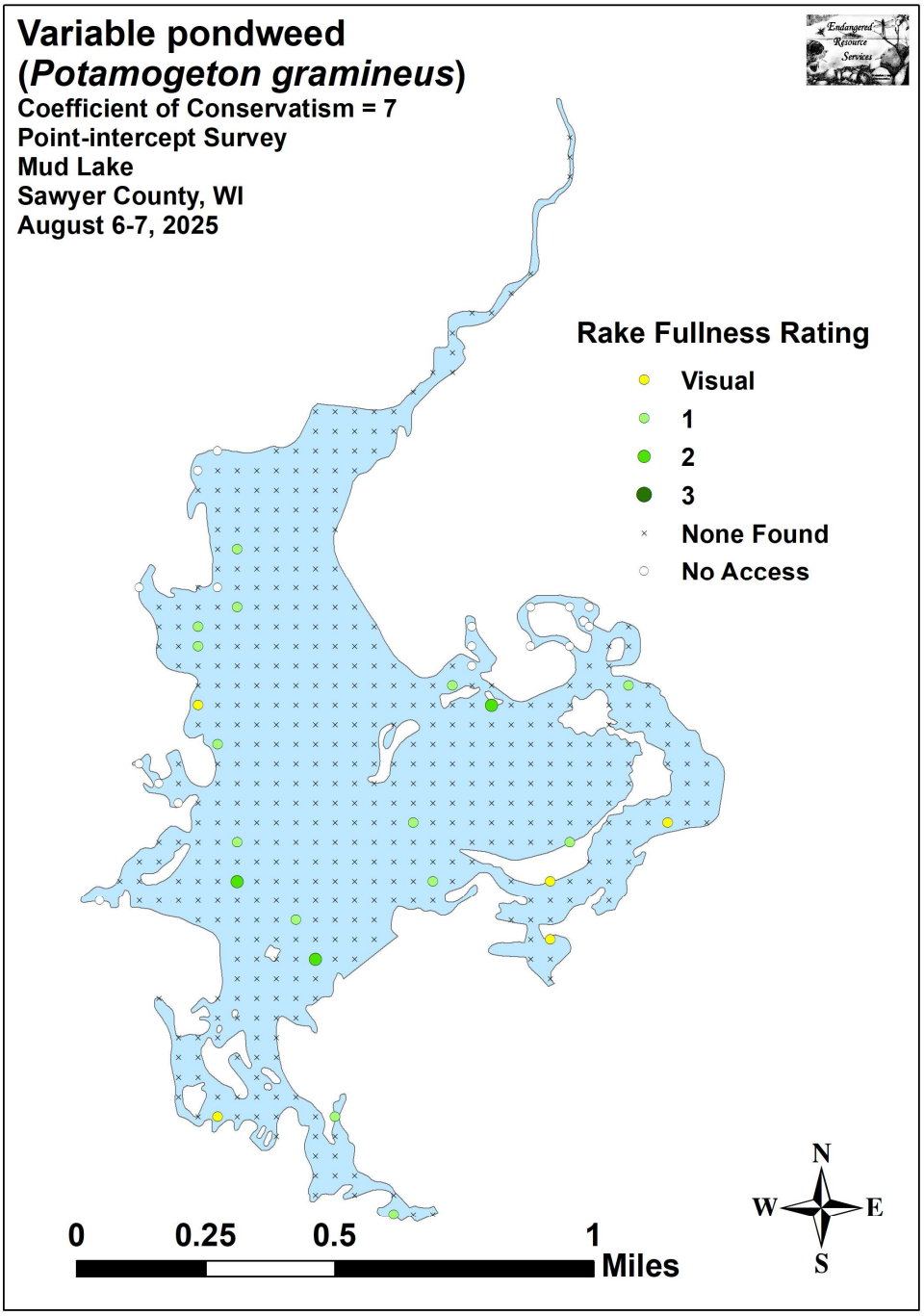
Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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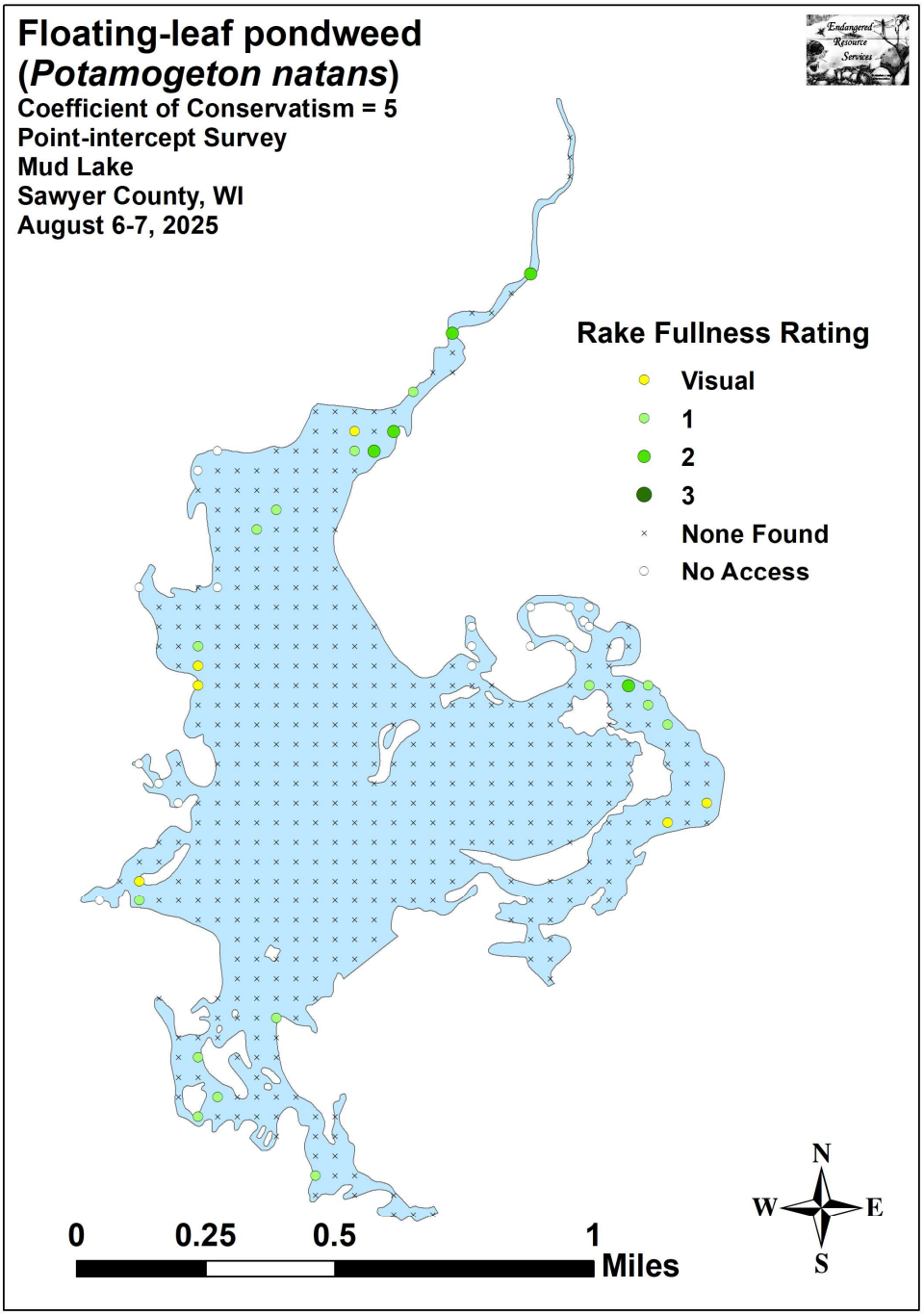
Floating-leaf pondweed
(Potamogeton natans)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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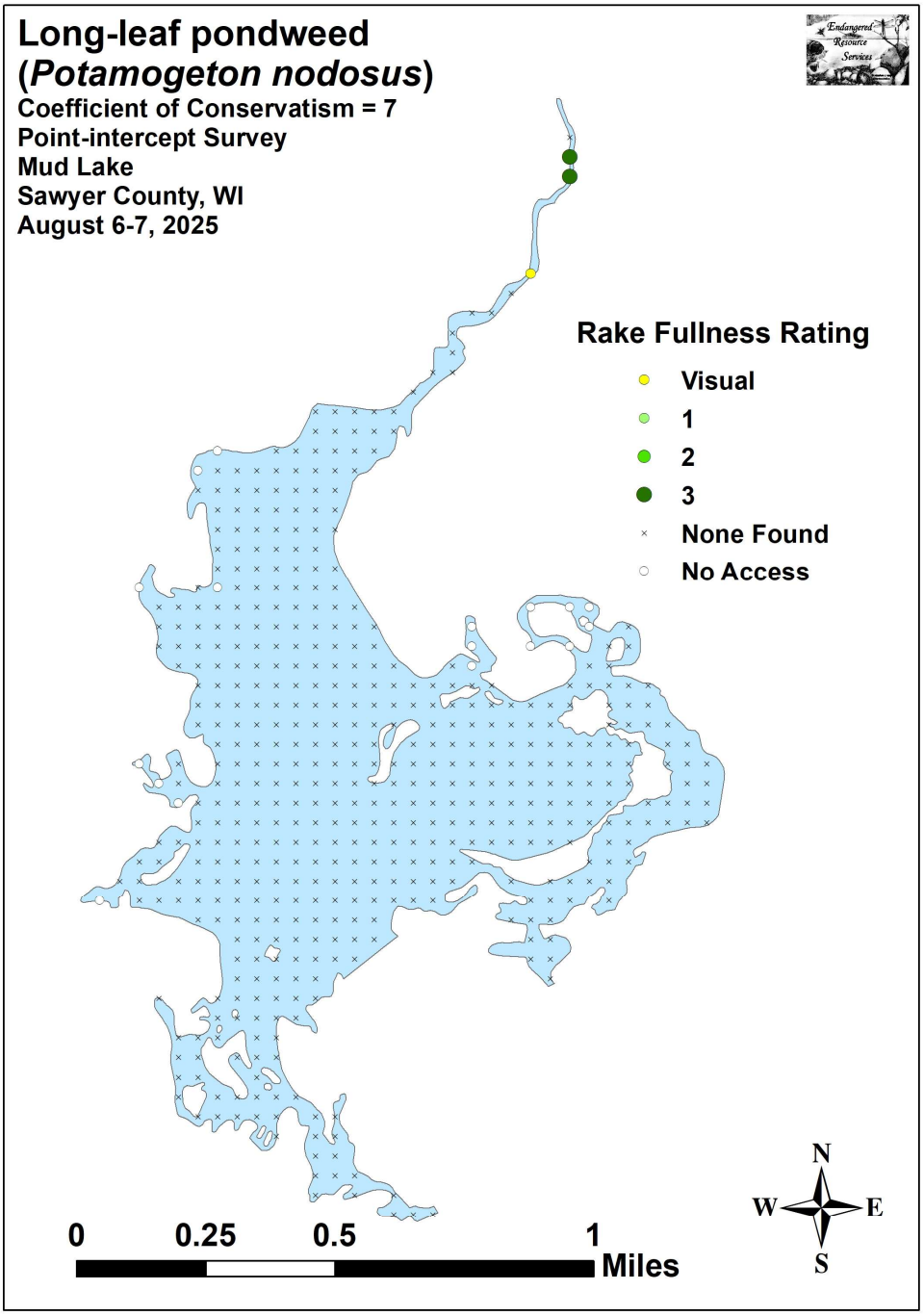
Long-leaf pondweed
(Potamogeton nodosus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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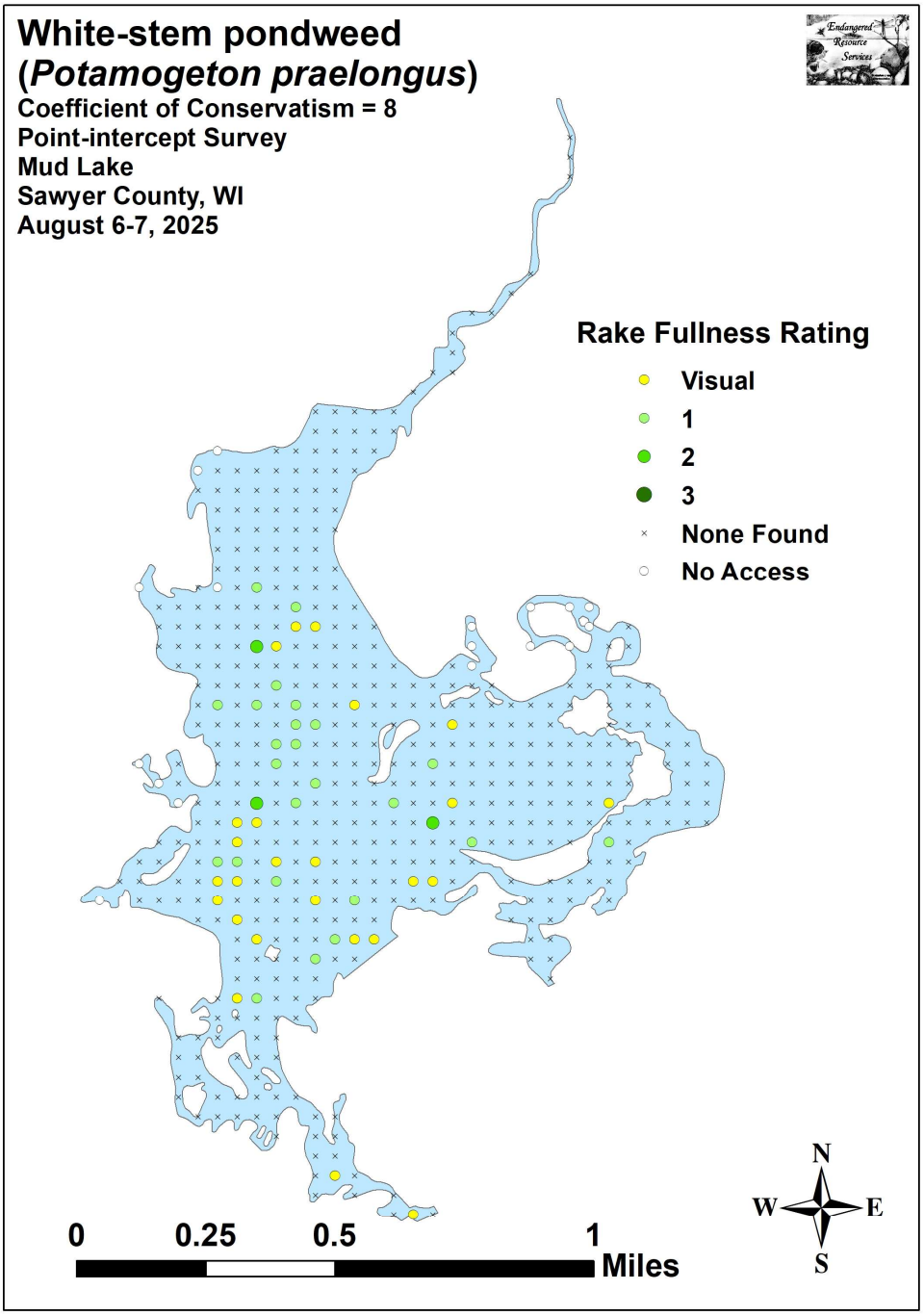
White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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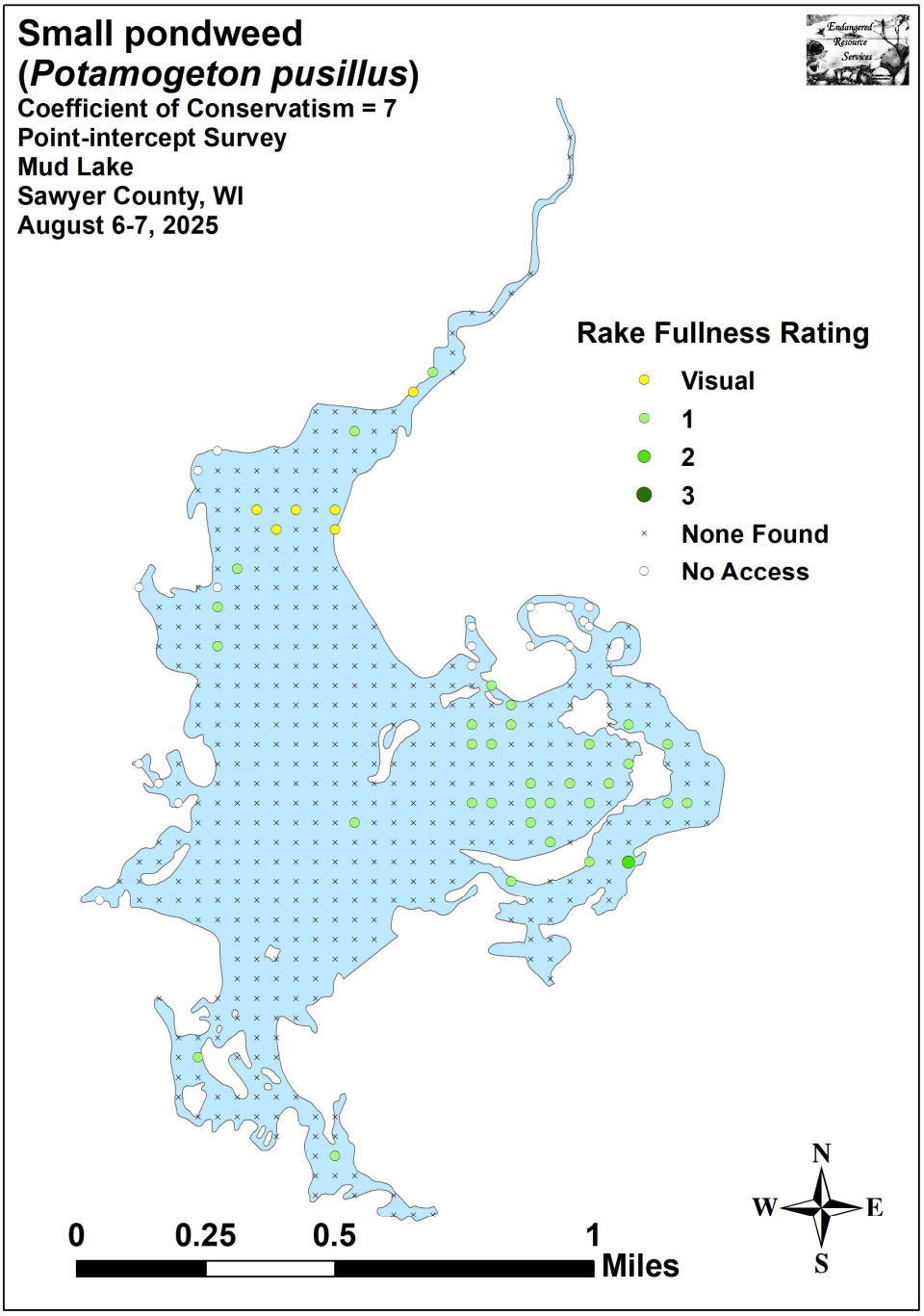
Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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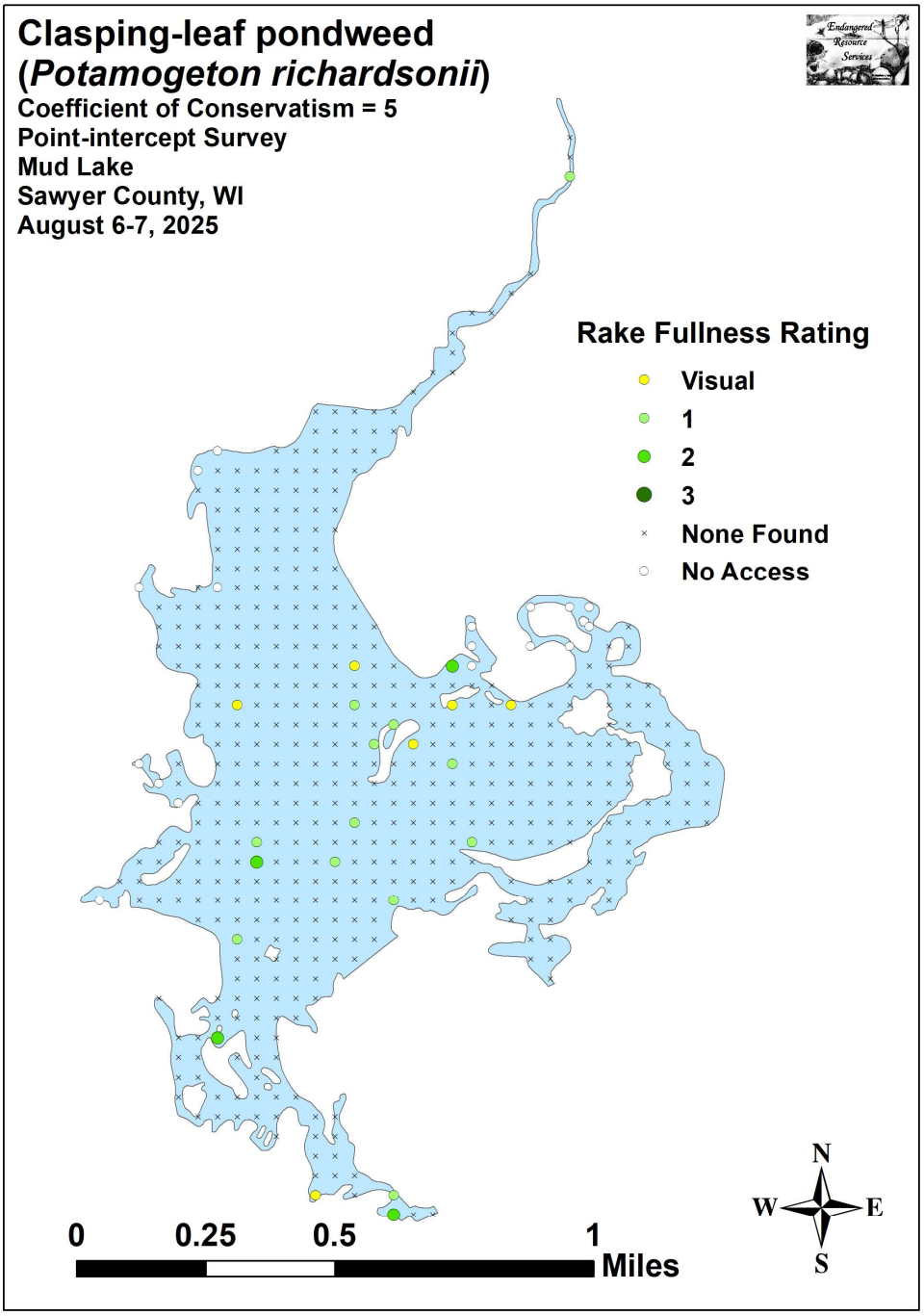
Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
No Access
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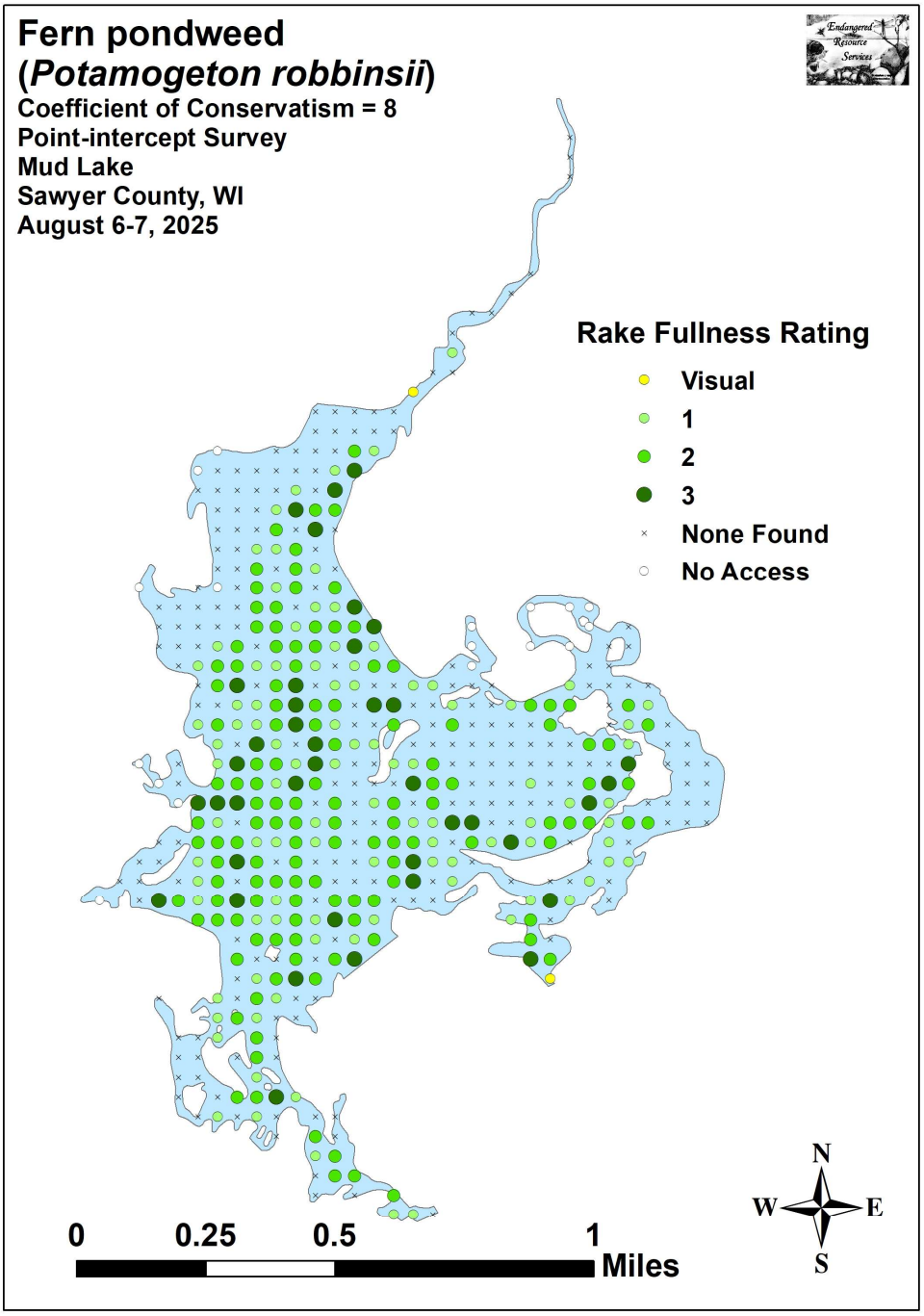
Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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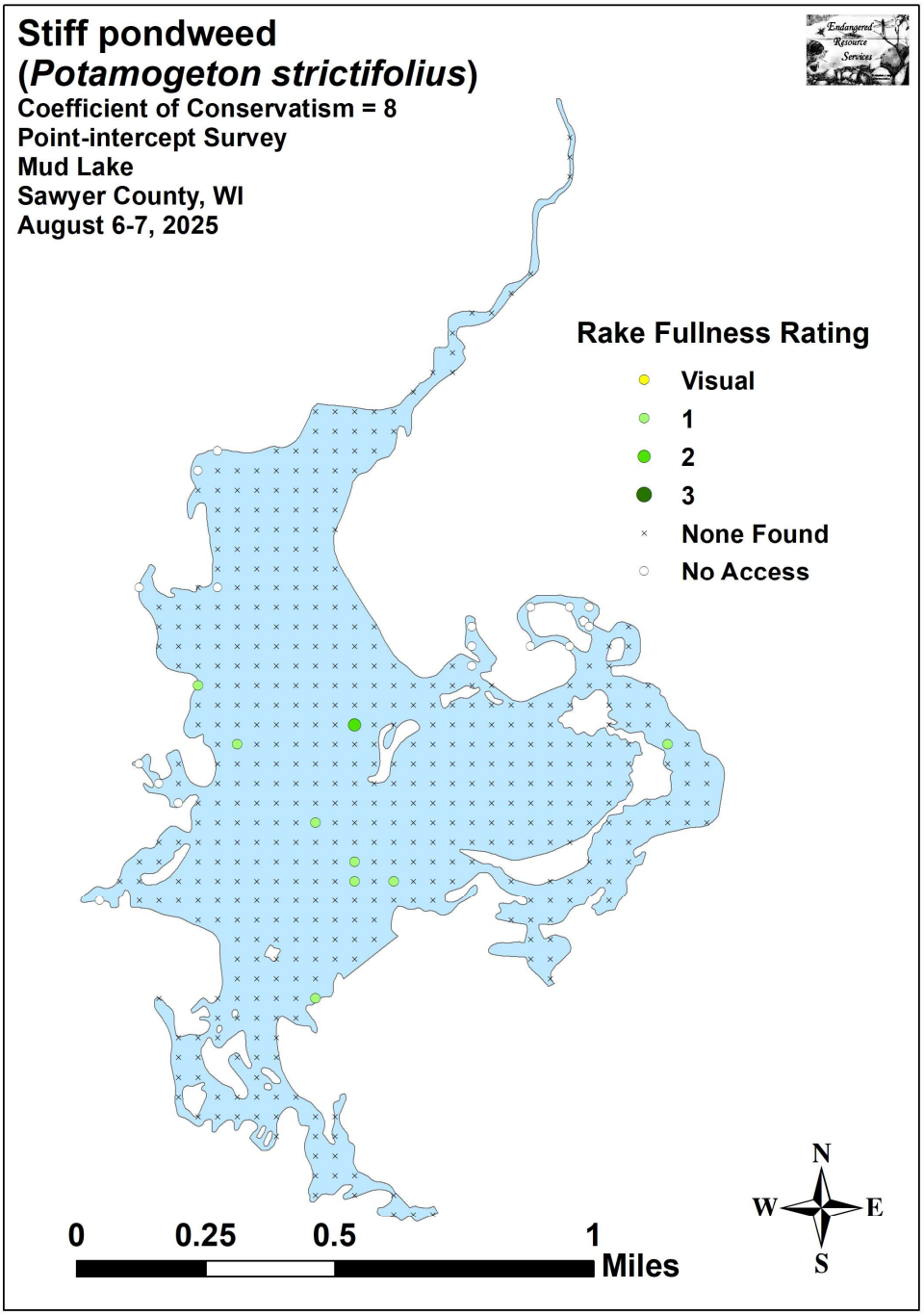
Stiff pondweed
(Potamogeton strictifolius)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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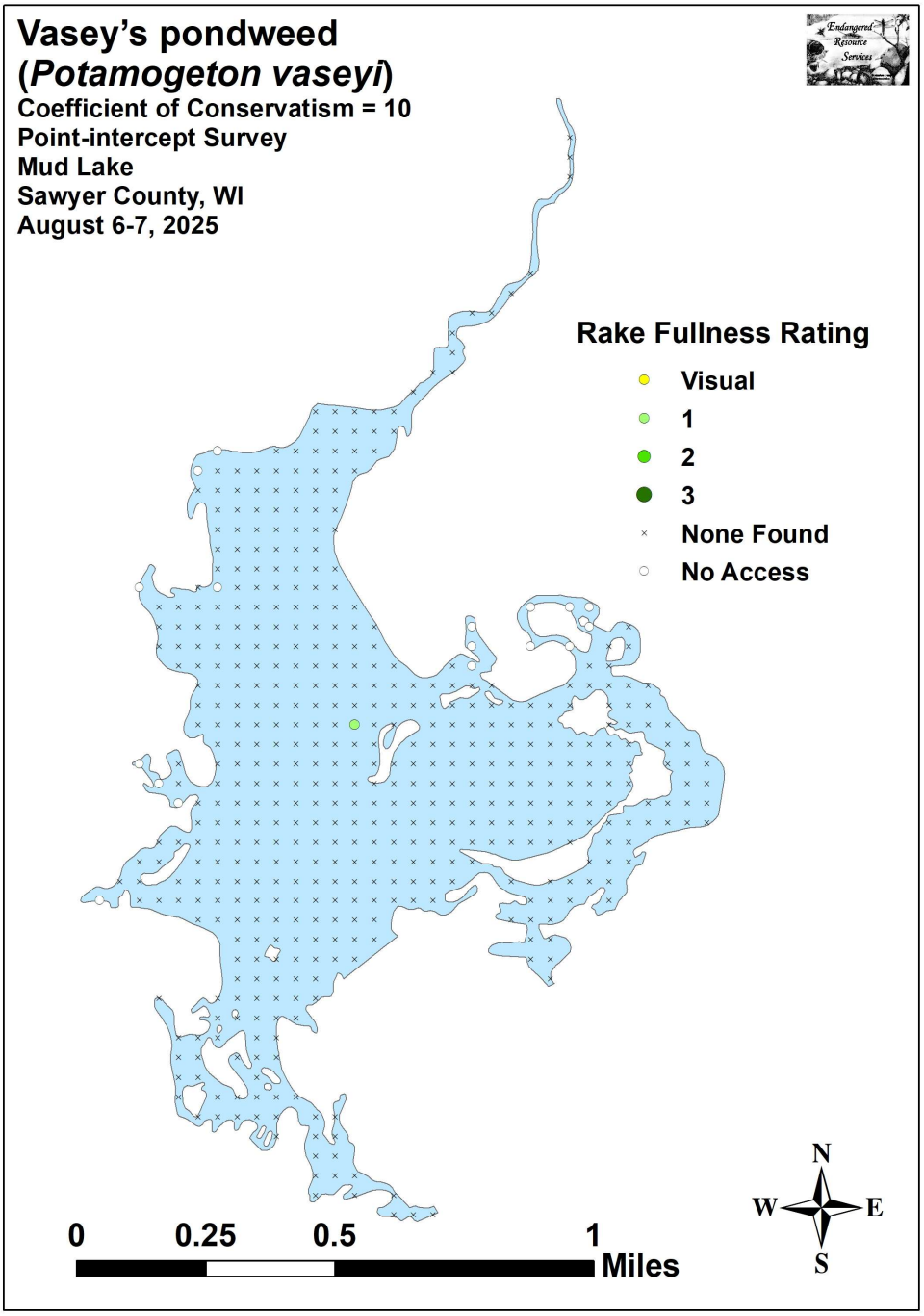
Vasey's pondweed
(Potamogeton vaseyi)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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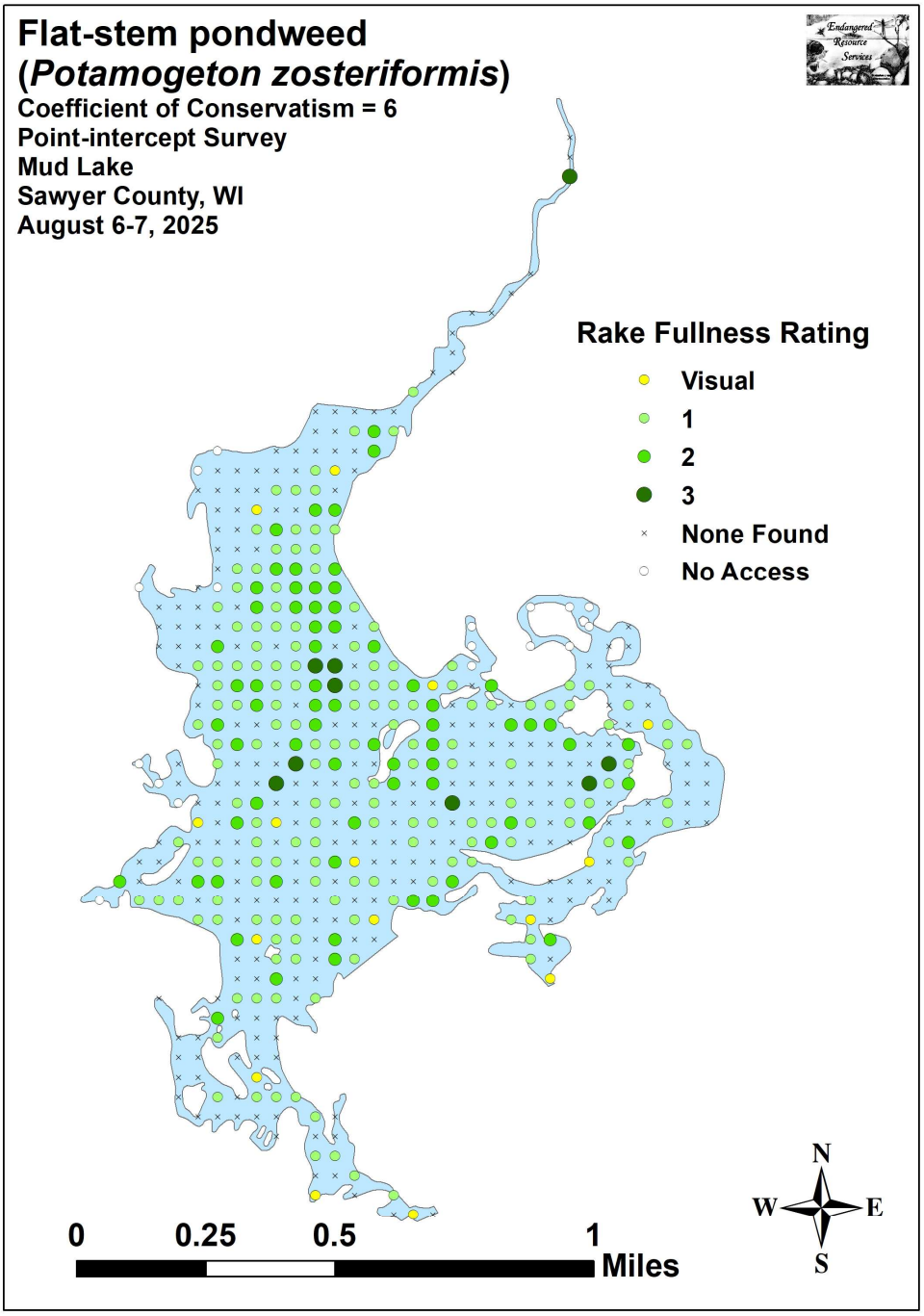
Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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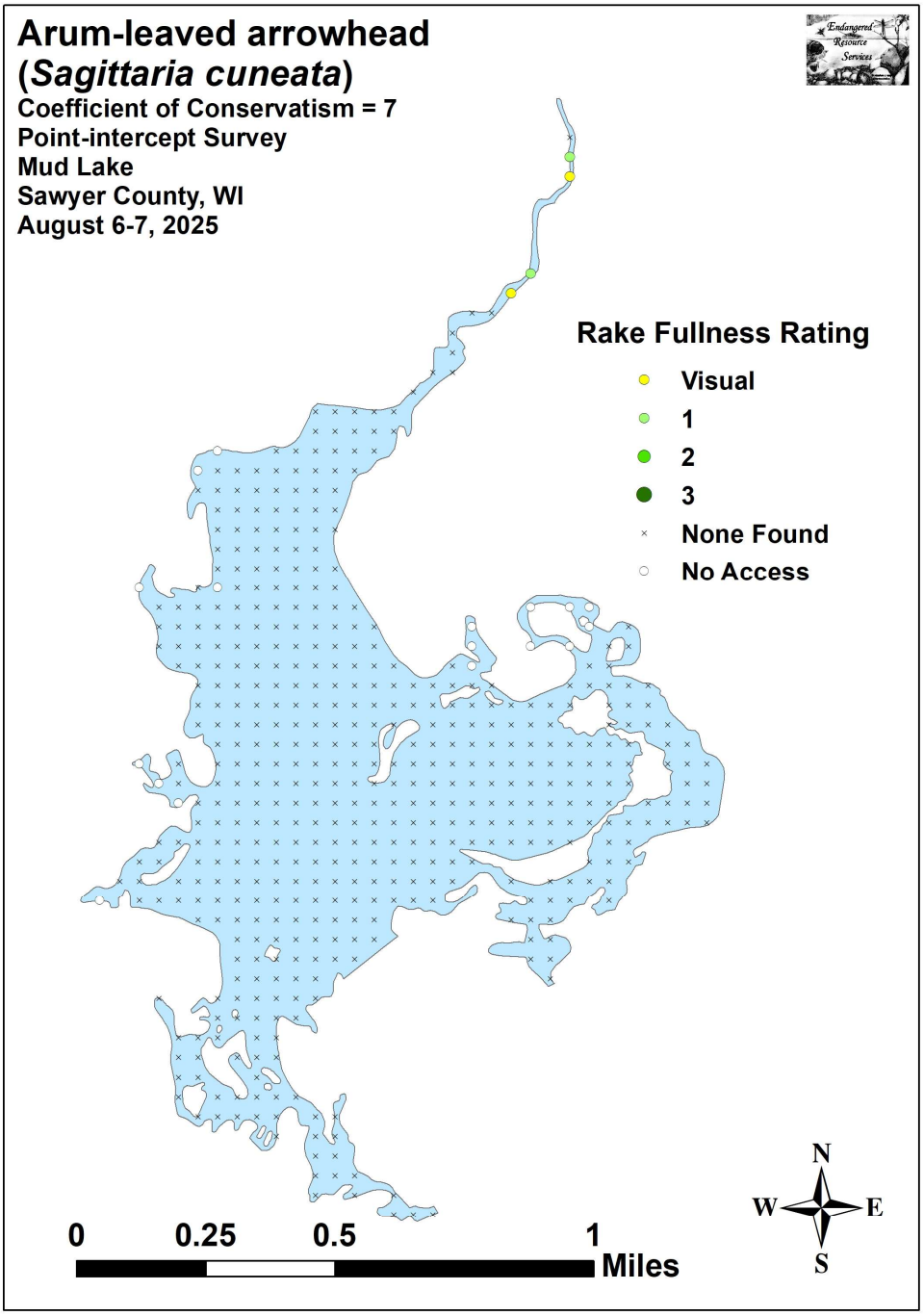
Arum-leaved arrowhead
(Sagittaria cuneata)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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No Access
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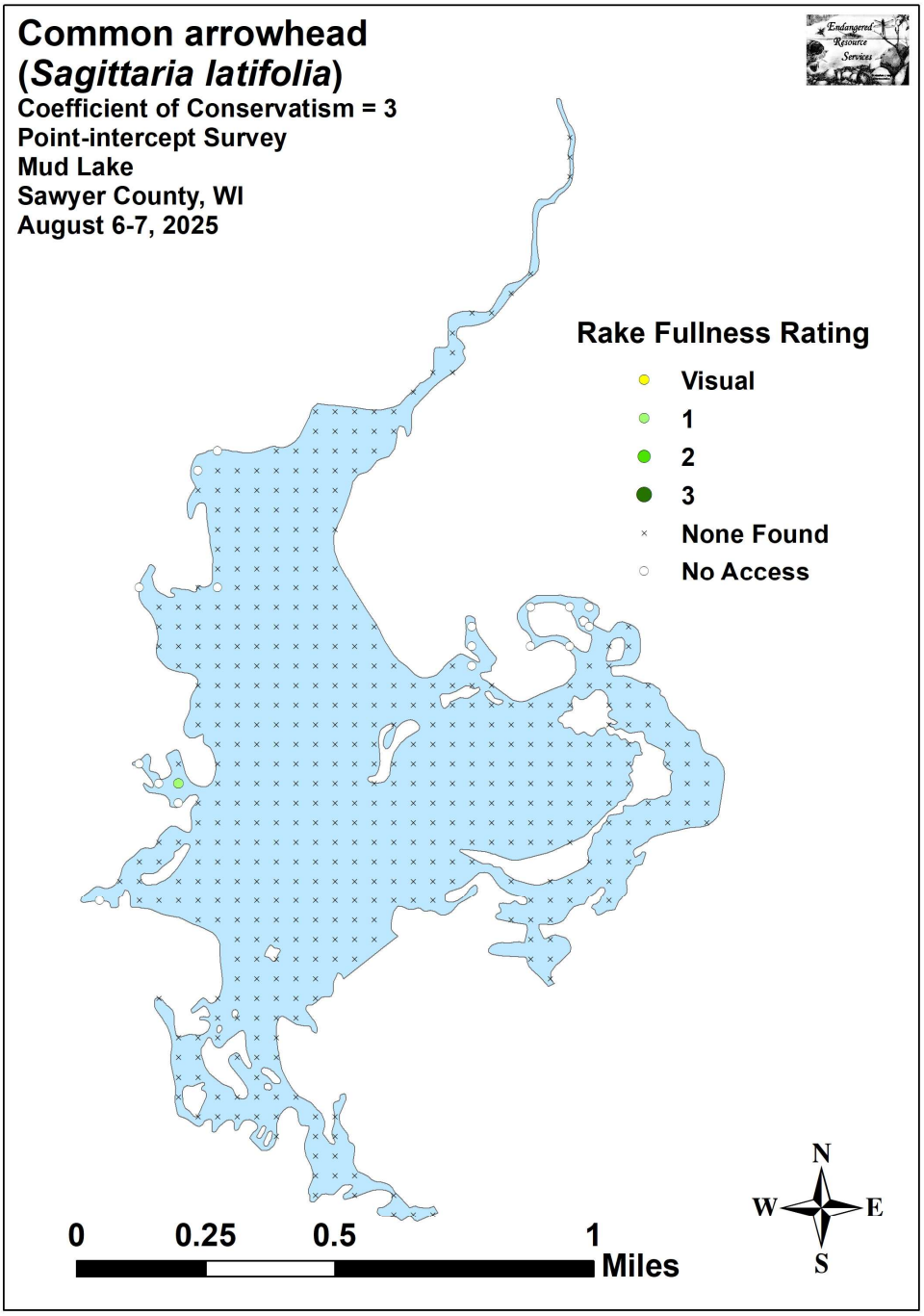
Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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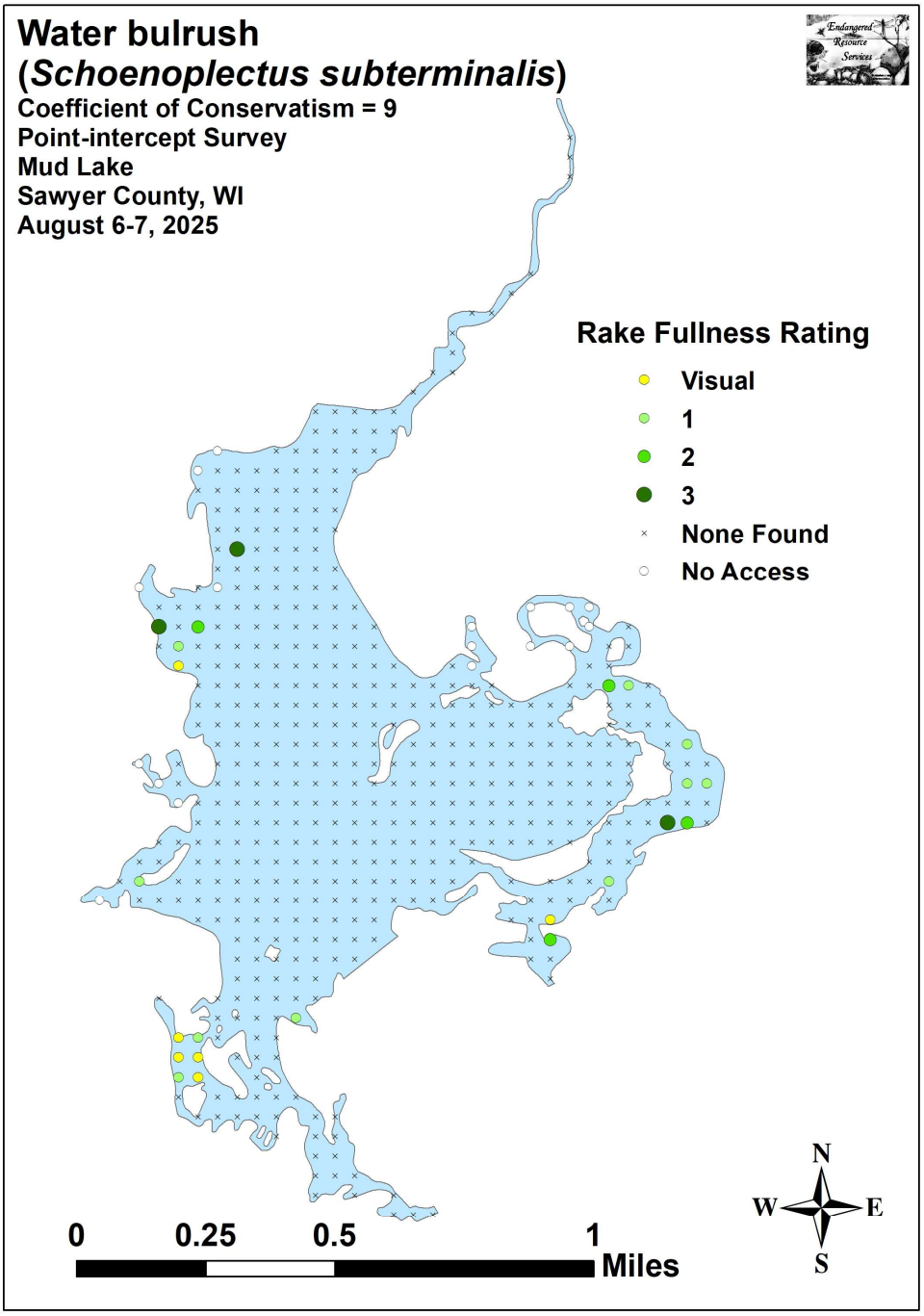
Water bulrush
(Schoenoplectus subterminalis)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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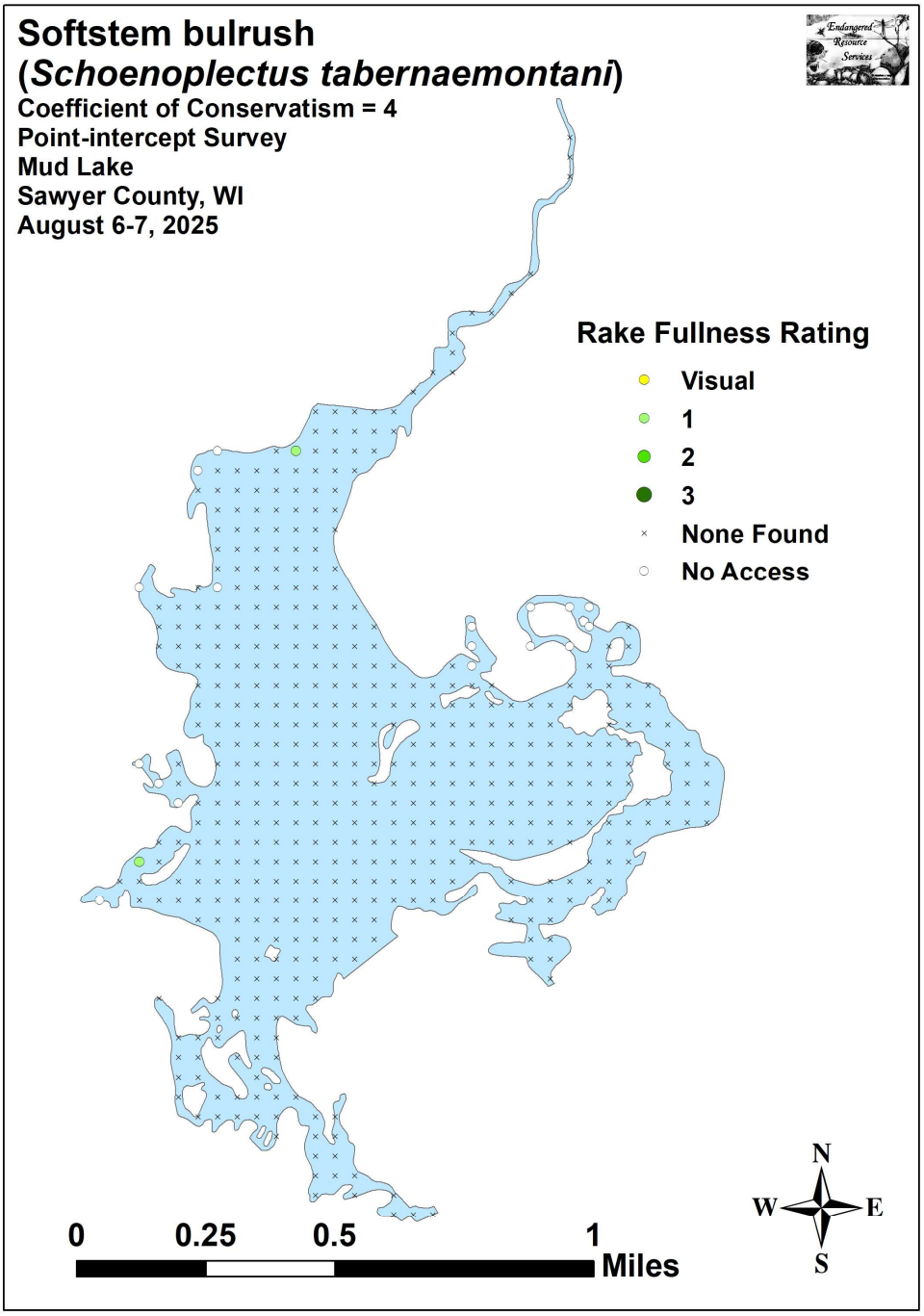
Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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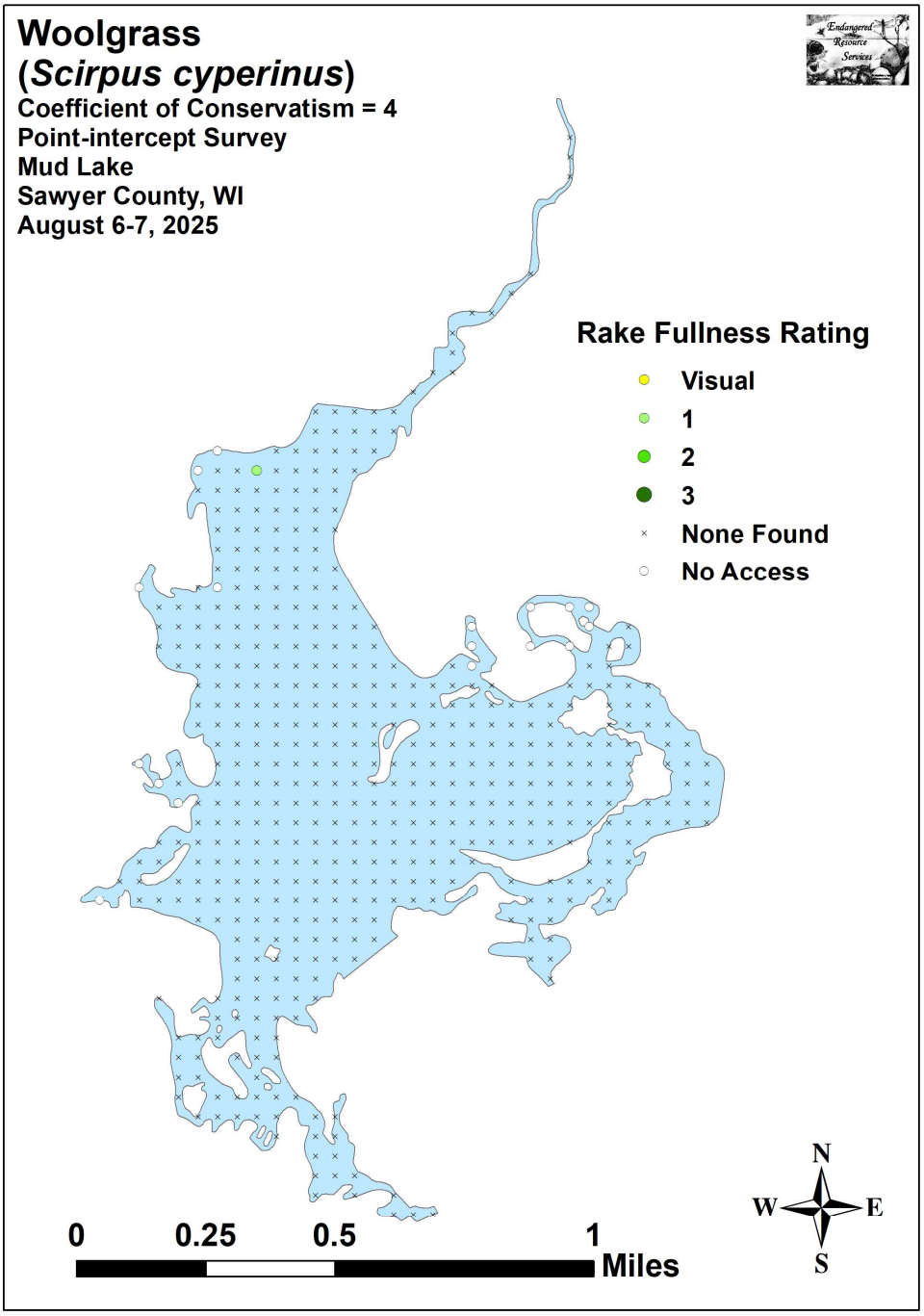
Woolgrass
(Scirpus cyperinus)
Coefficient of Conservatism = 4
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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No Access
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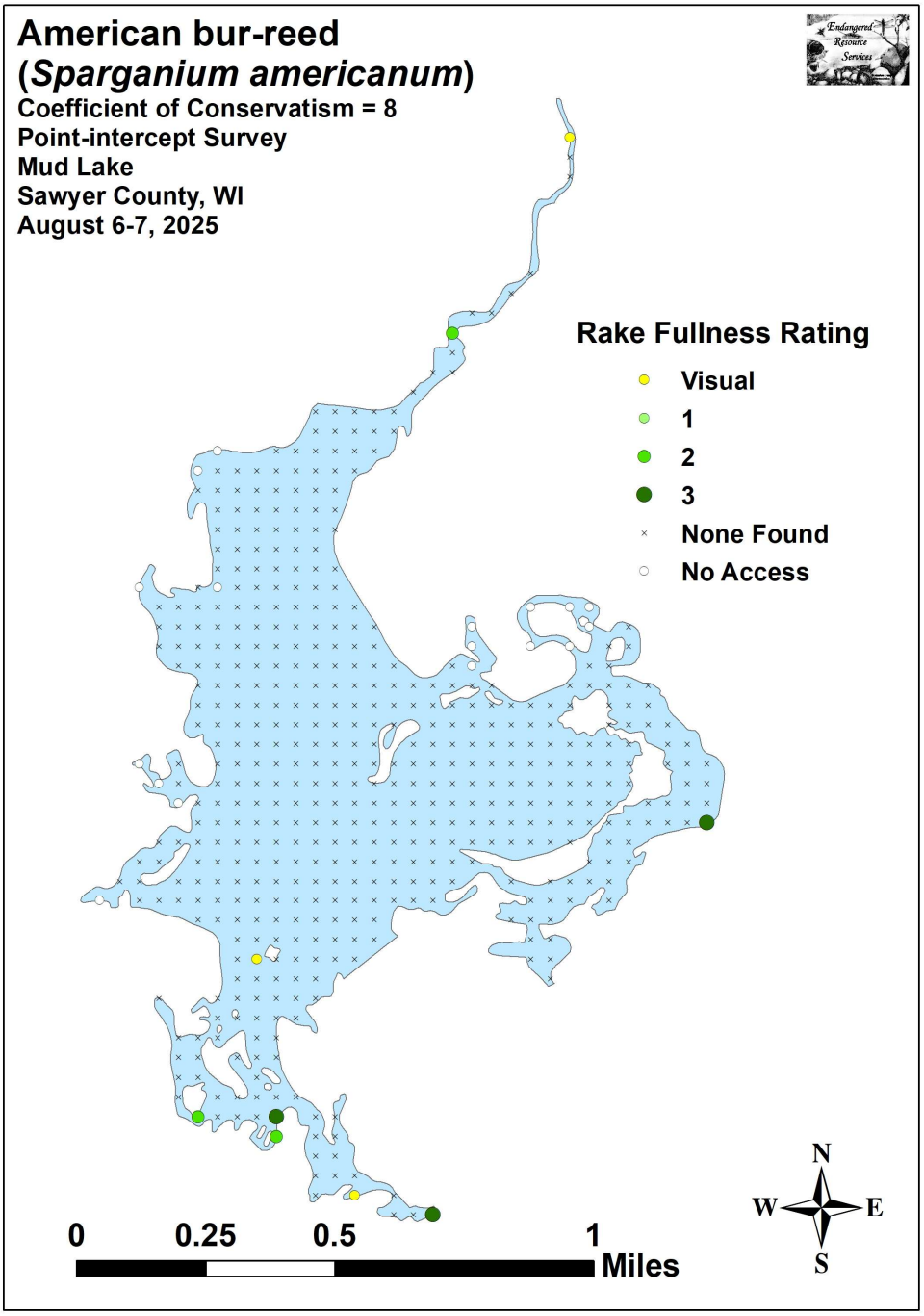
American bur-reed
(Sparganium americanum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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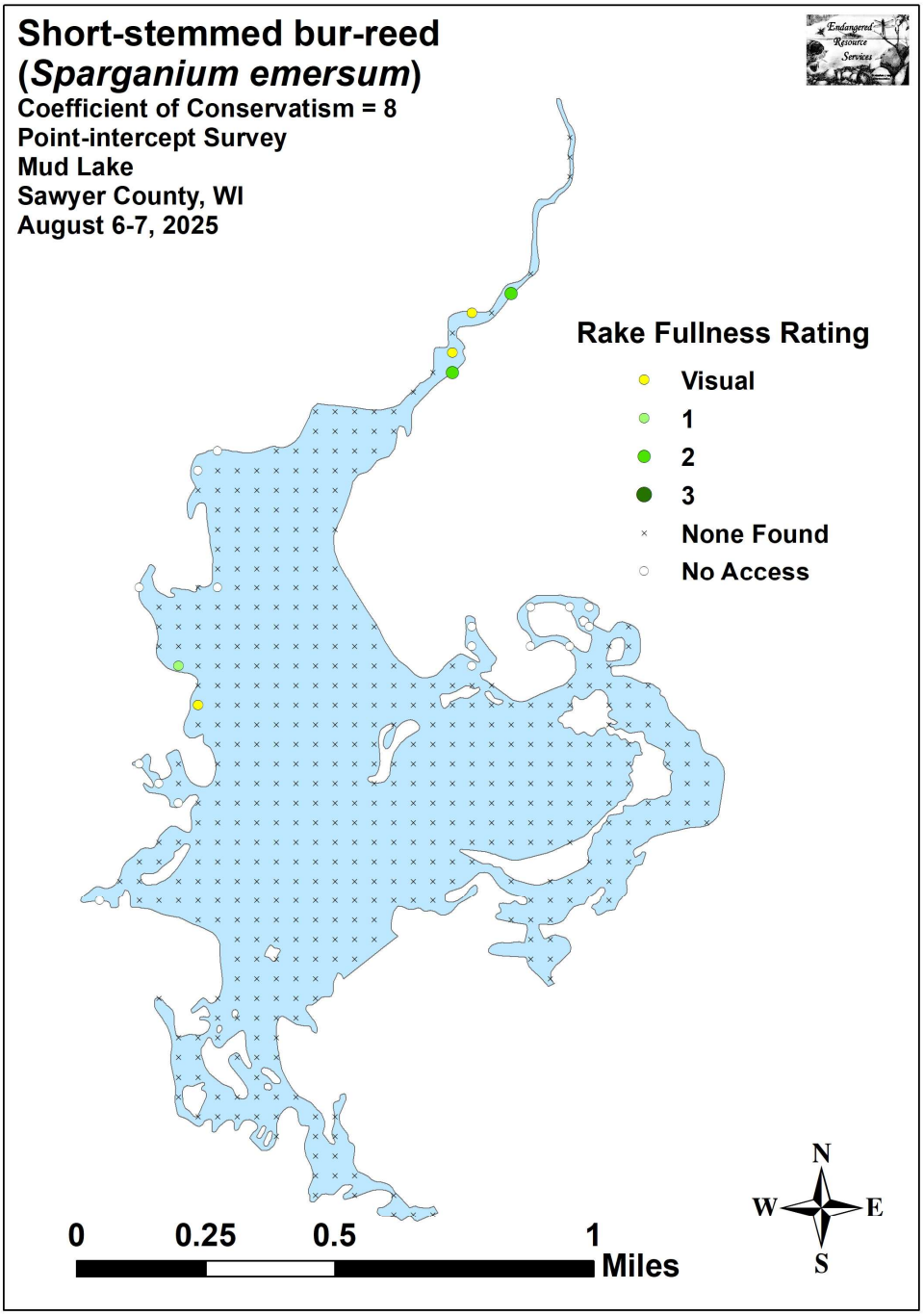
Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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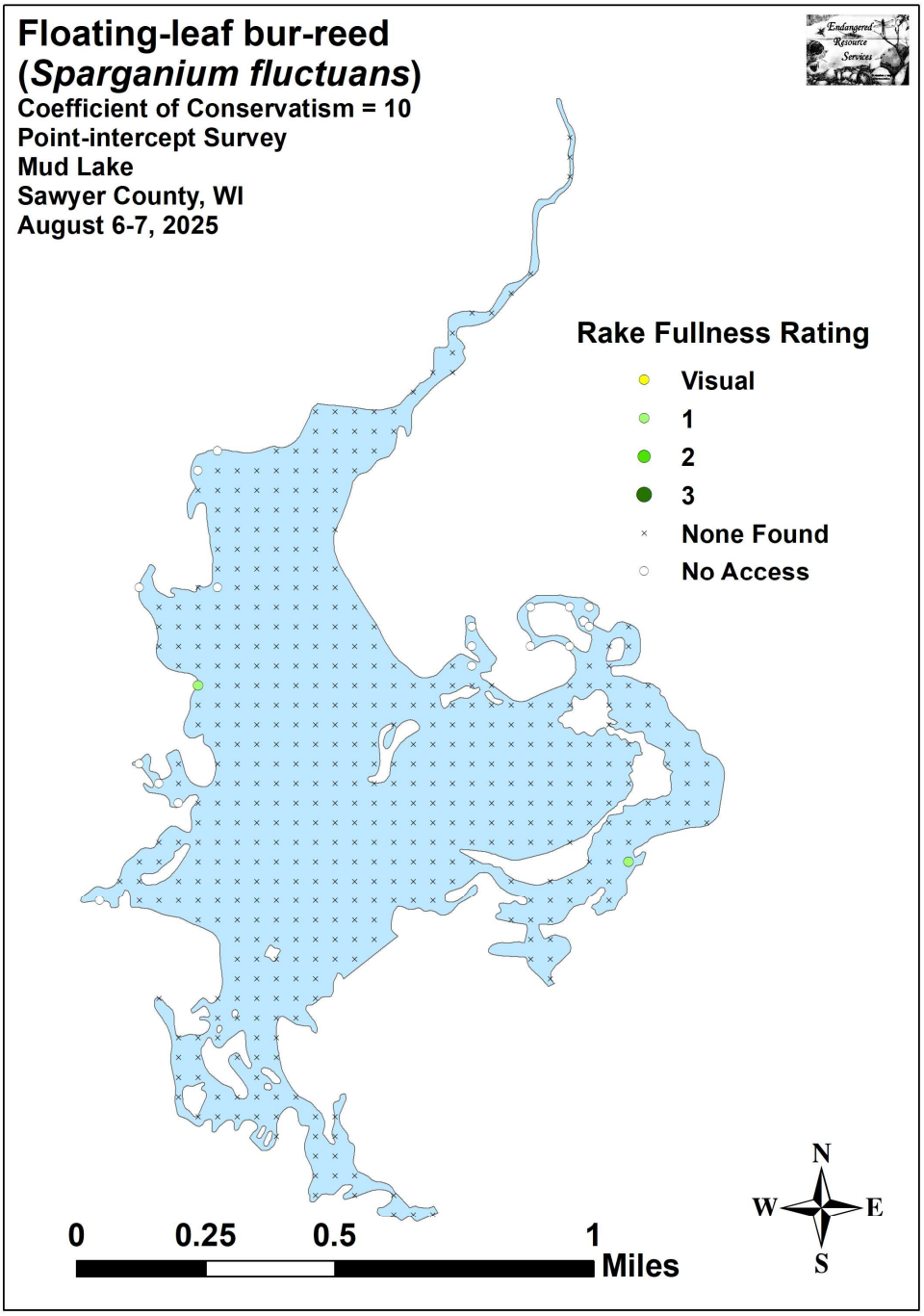
Floating-leaf bur-reed
(Sparganium fluctuans)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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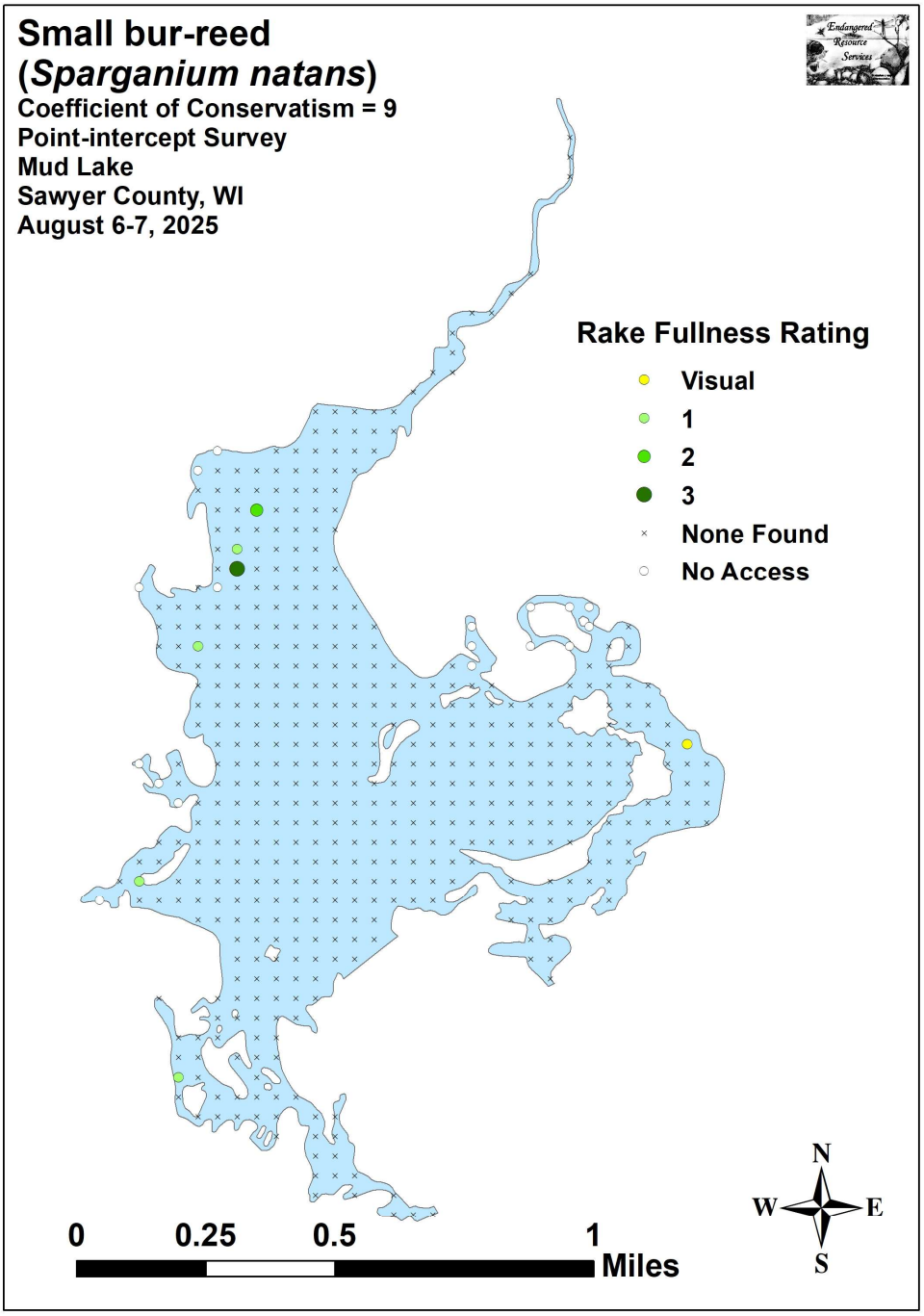
Small bur-reed
(Sparganium natans)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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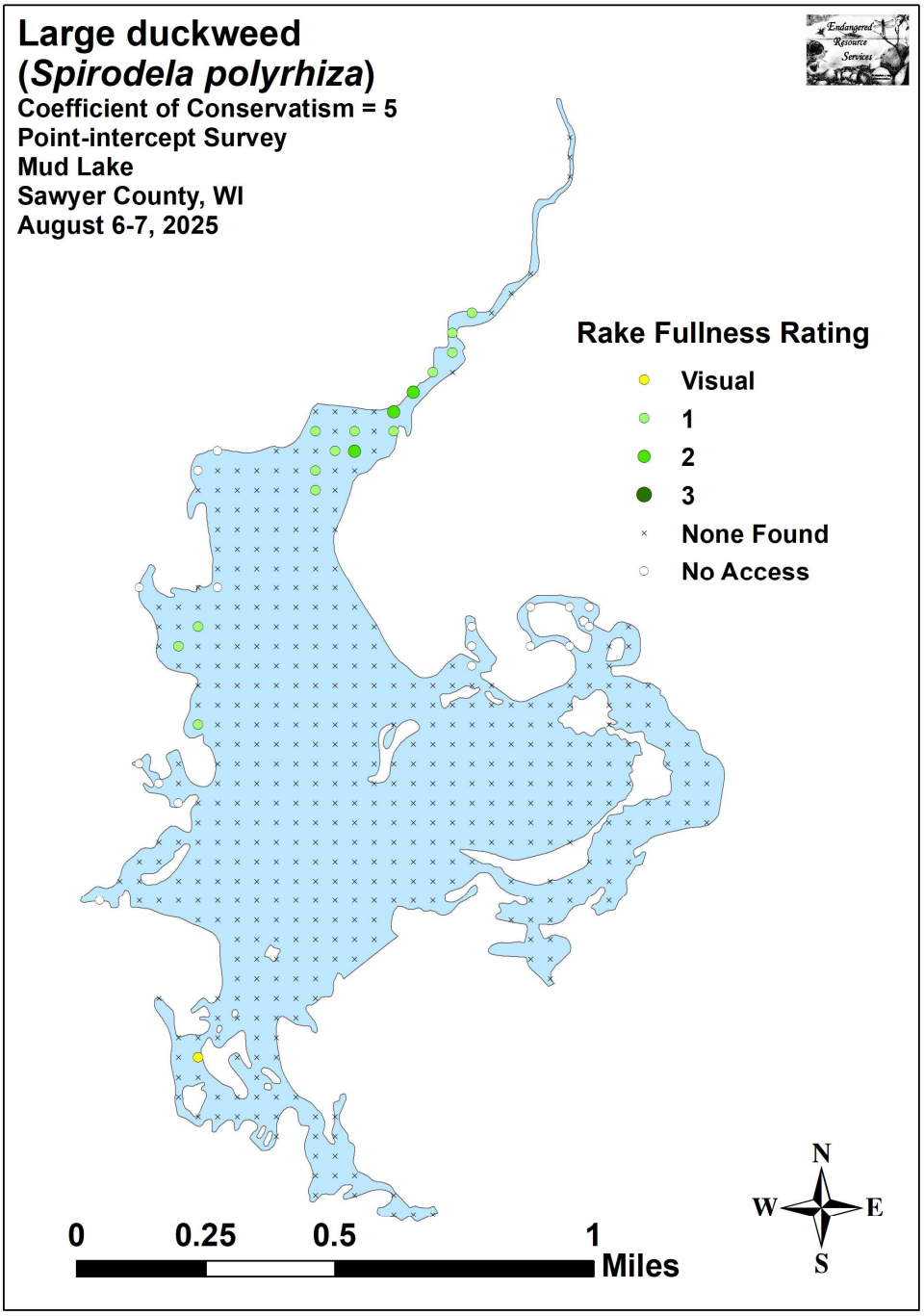
Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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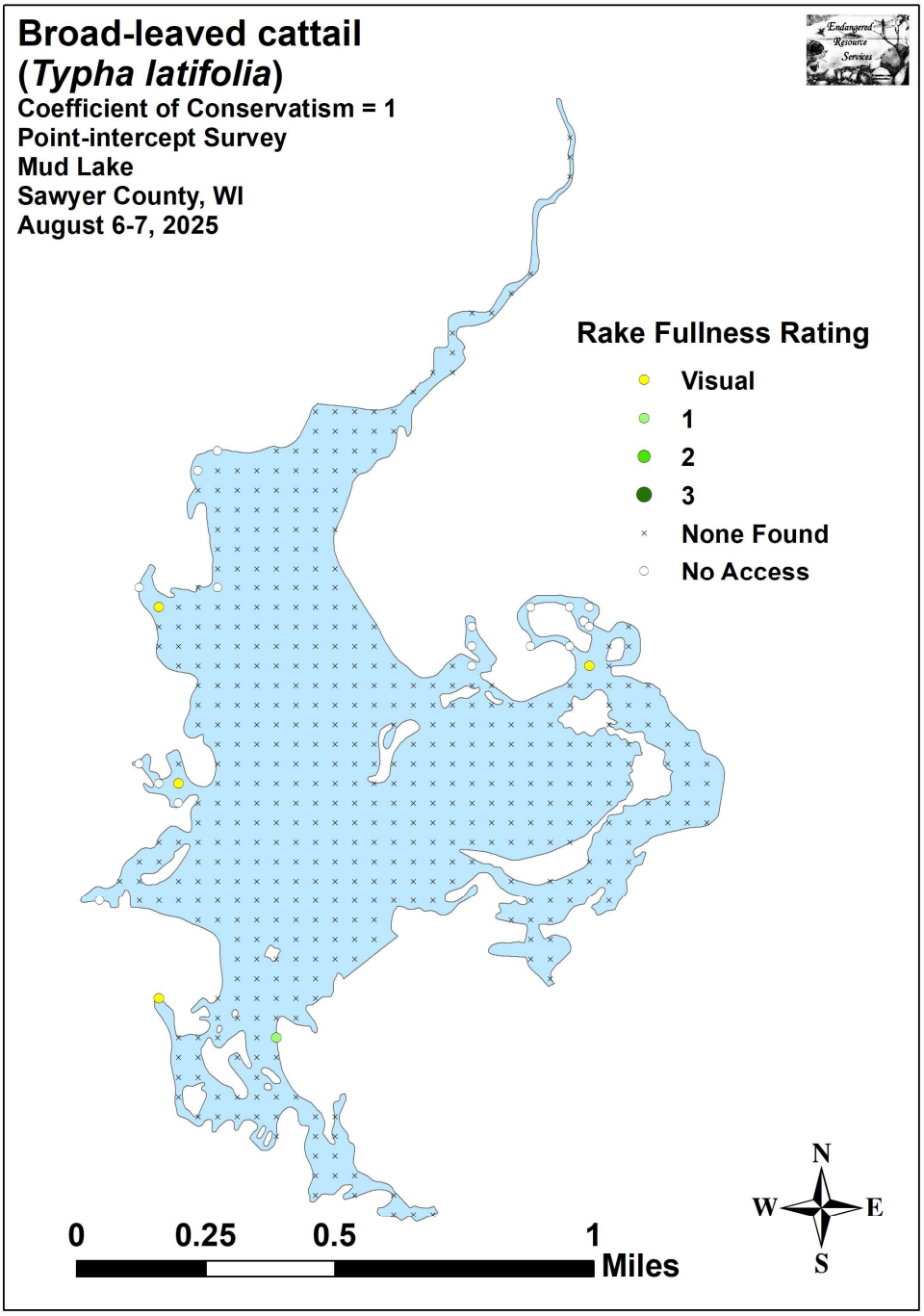
Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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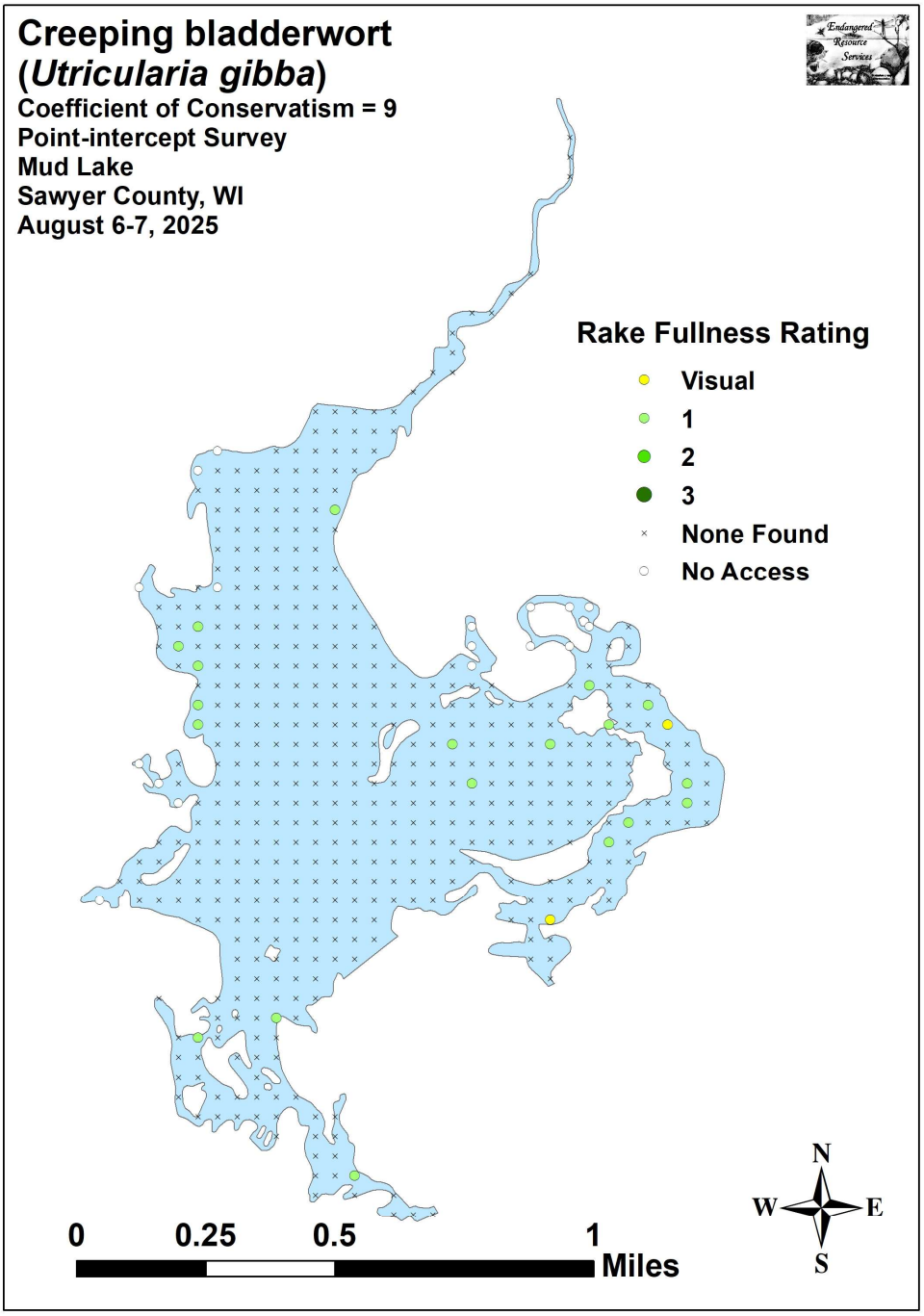
Creeping bladderwort
(Utricularia gibba)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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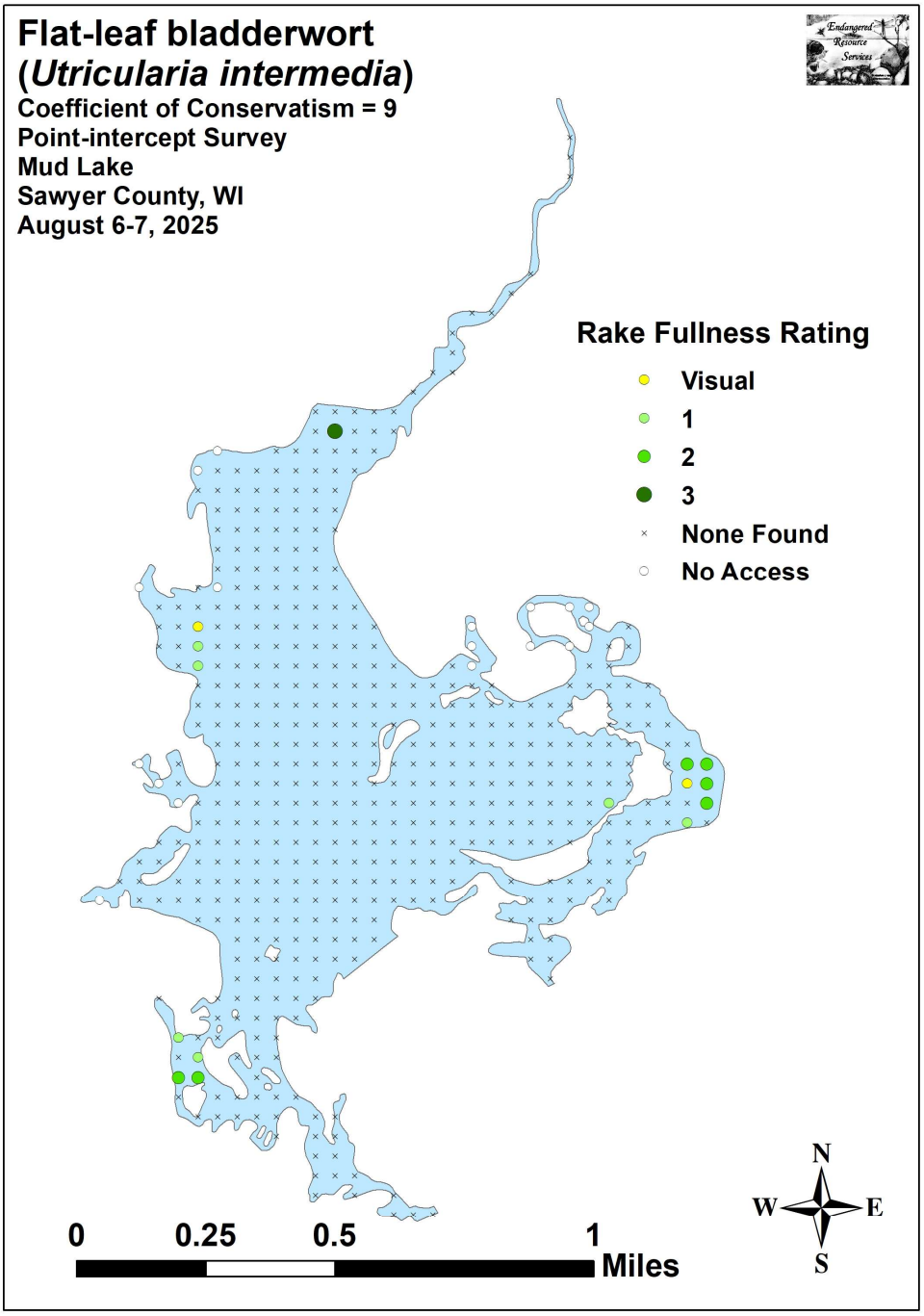
Flat-leaf bladderwort
(Utricularia intermedia)
Coefficient of Conservatism = 9
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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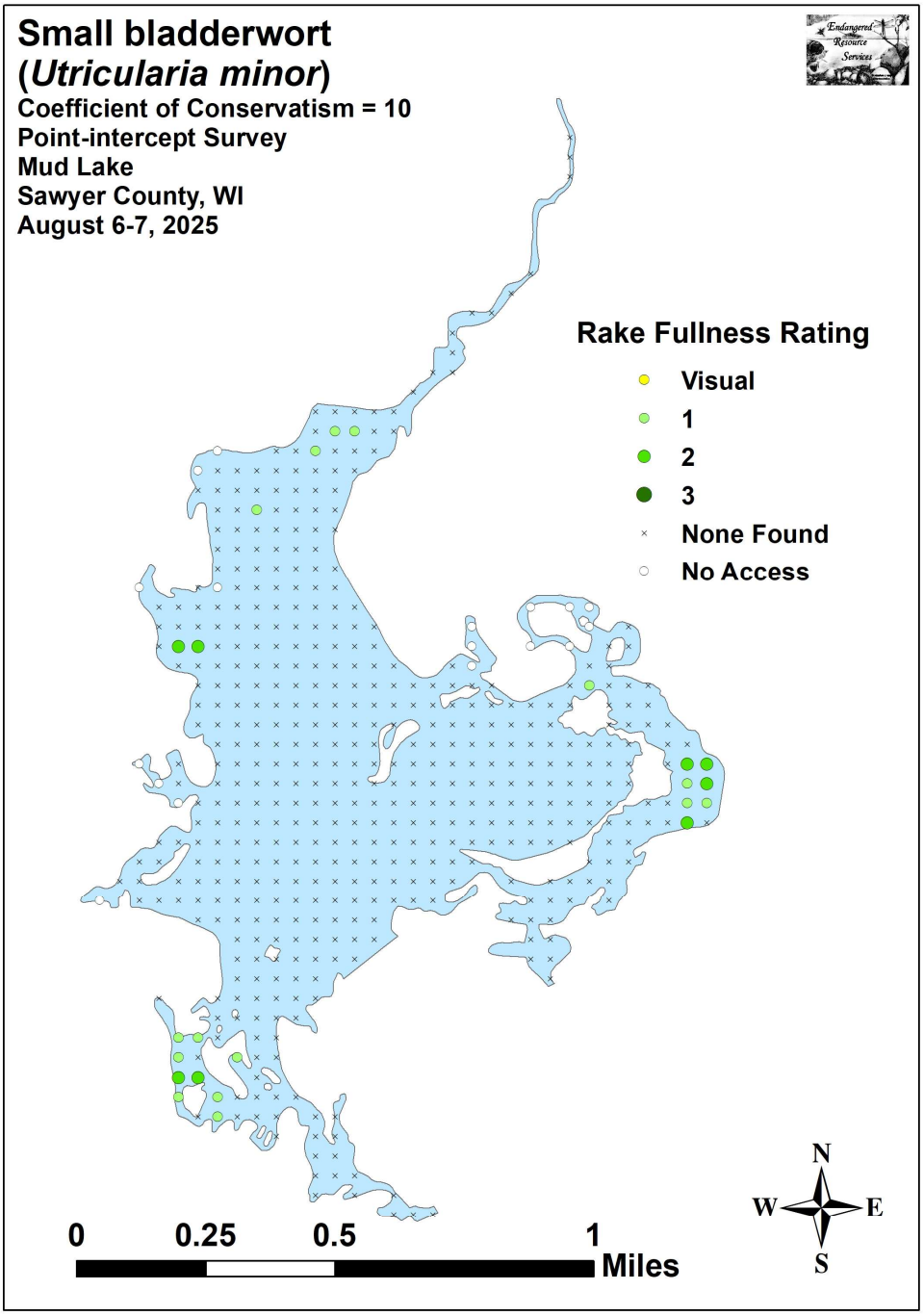
Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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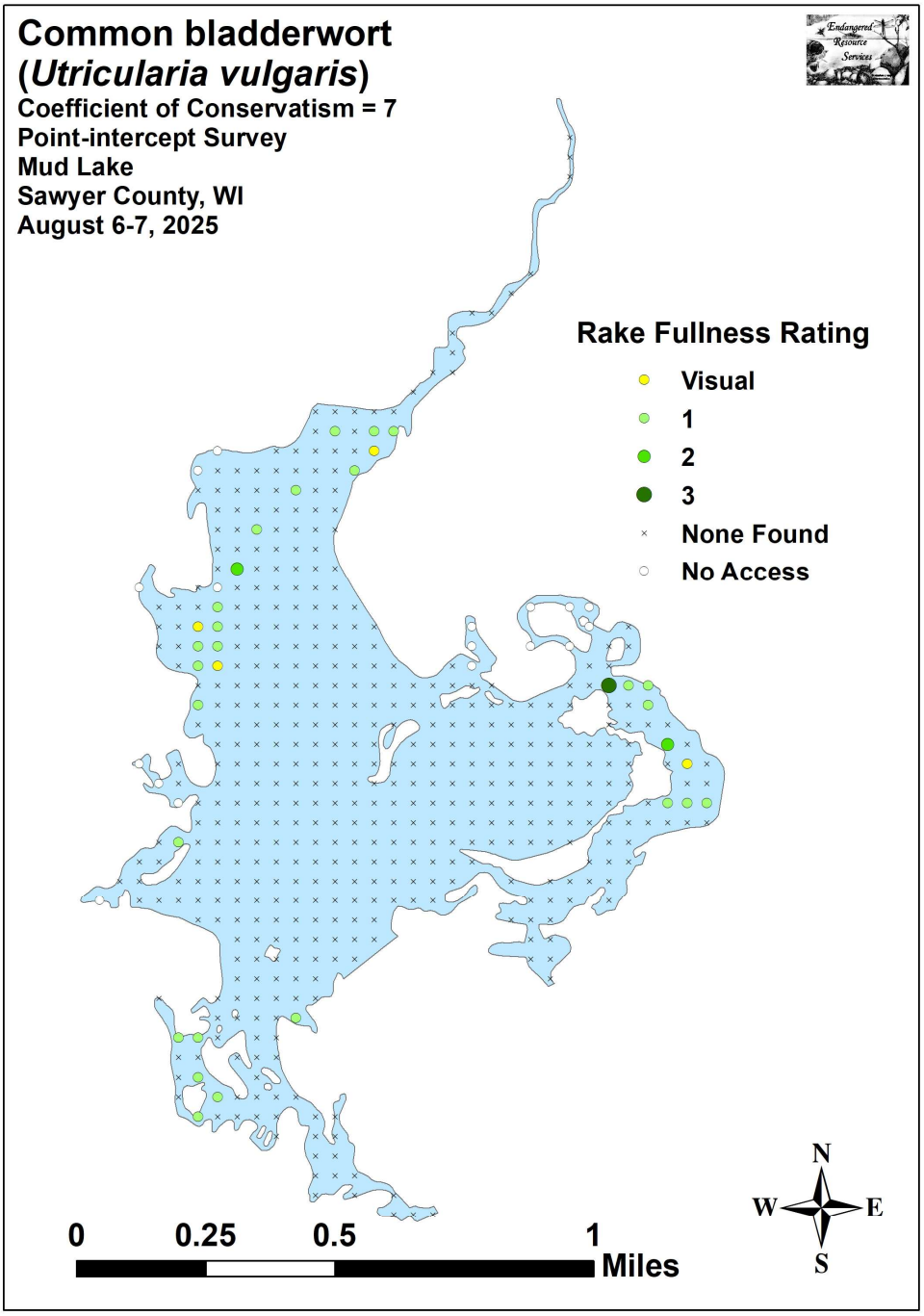
Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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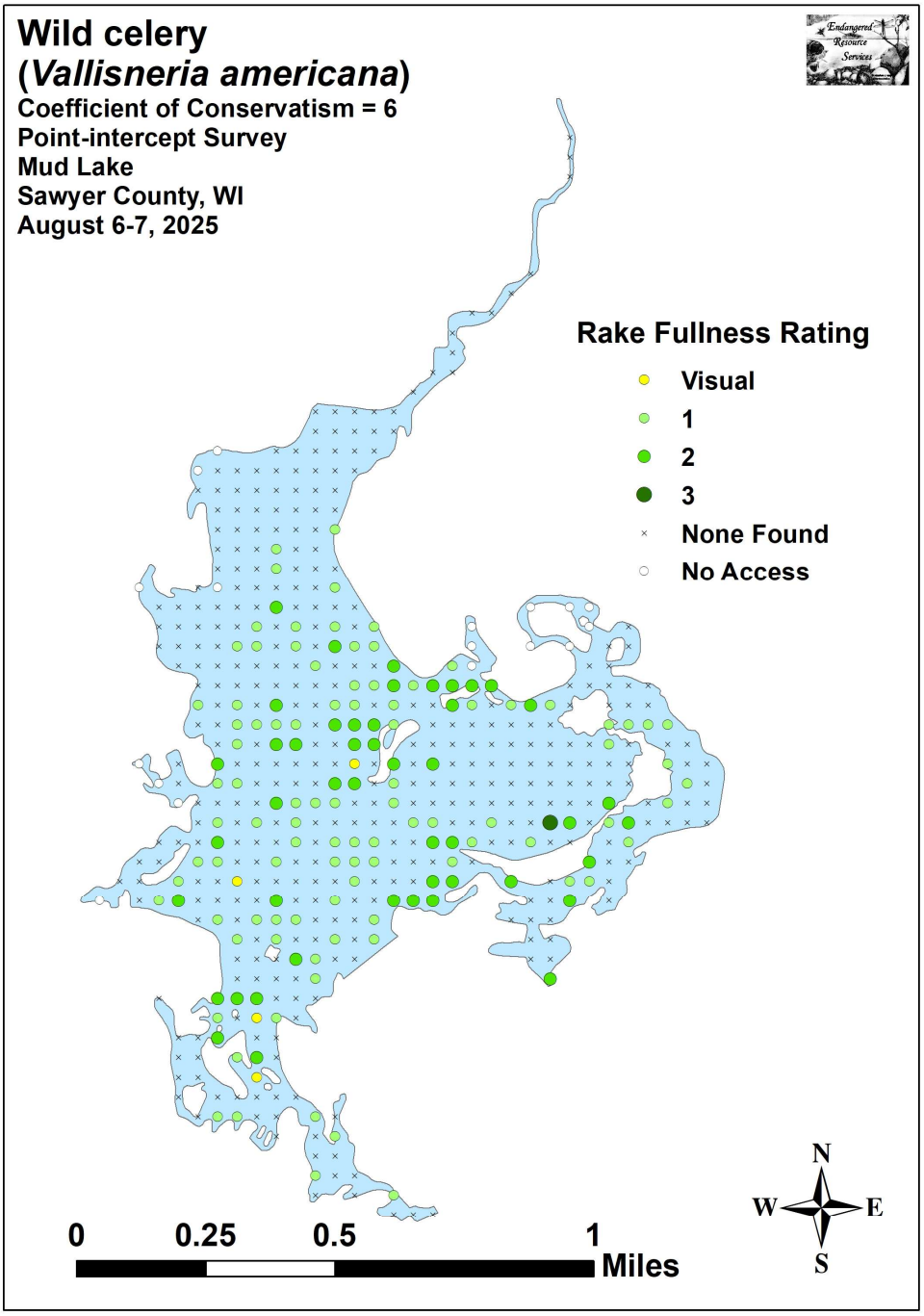
Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
No Access
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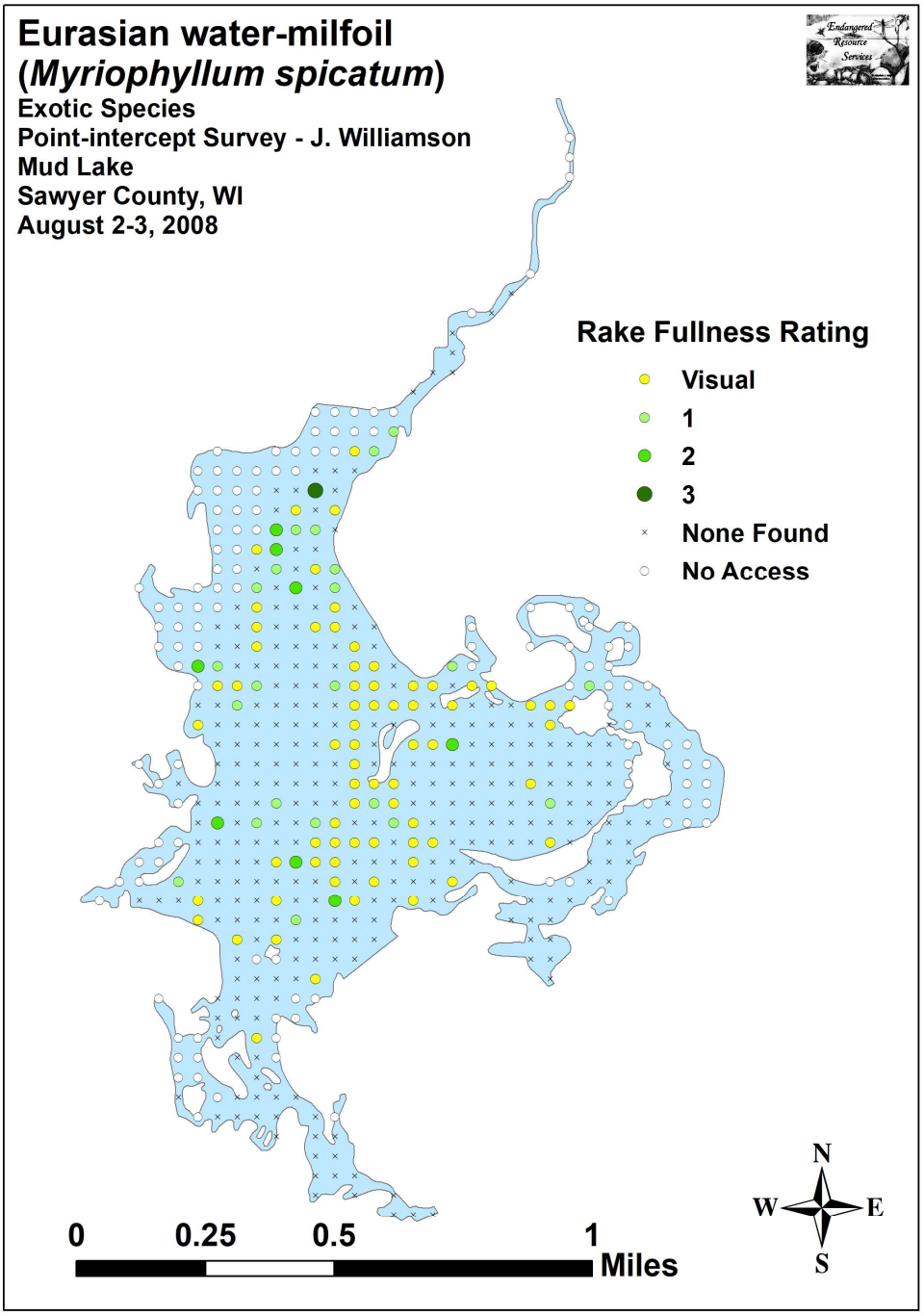
Appendix VII: August 2008, 2020 and 2025 Eurasian Water-milfoil and 2020 and 2025 Other Exotic Species Density and Distribution Maps


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Point-intercept Survey - J. Williamson
Mud Lake
Sawyer County, WI
August 2-3, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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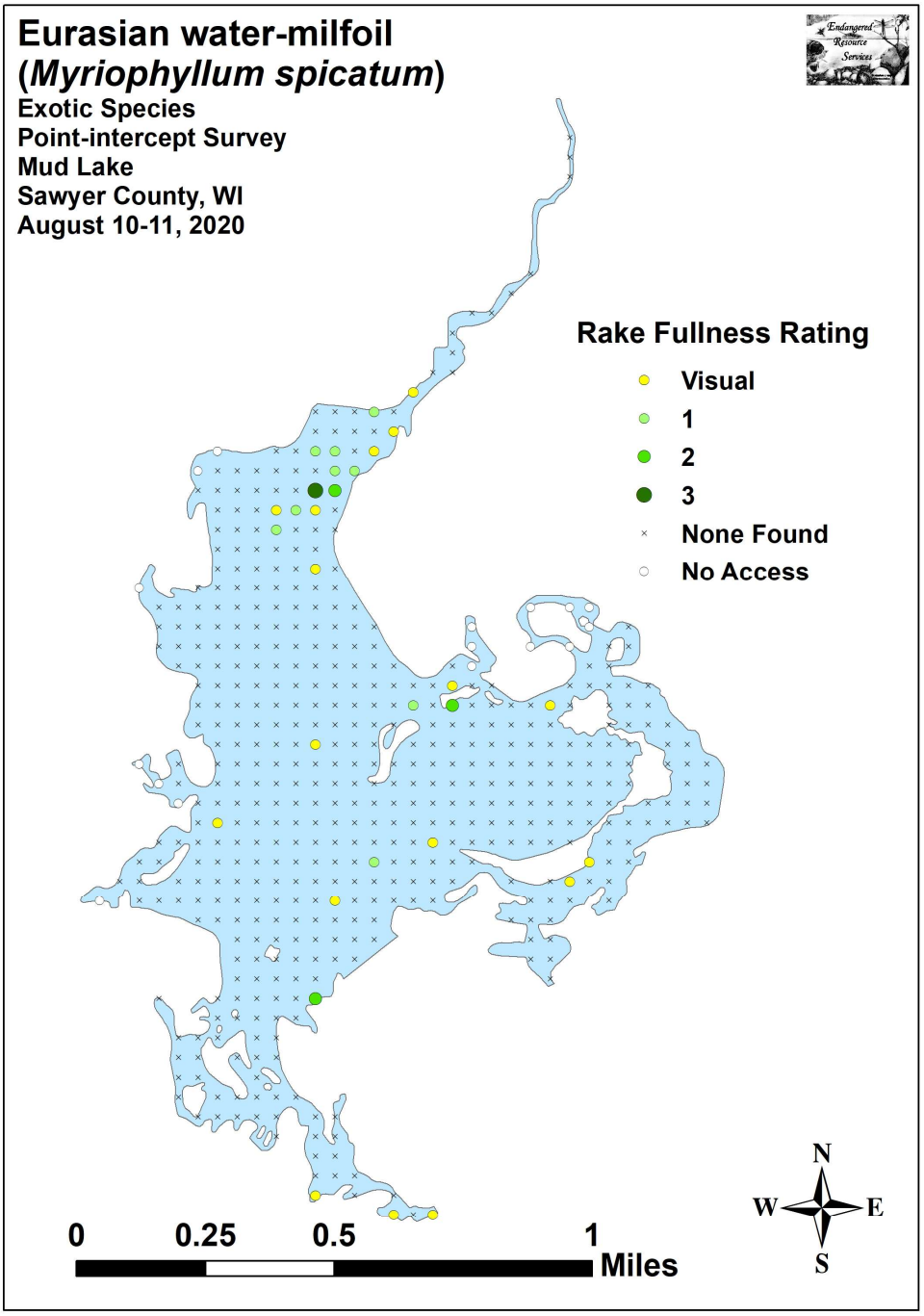
Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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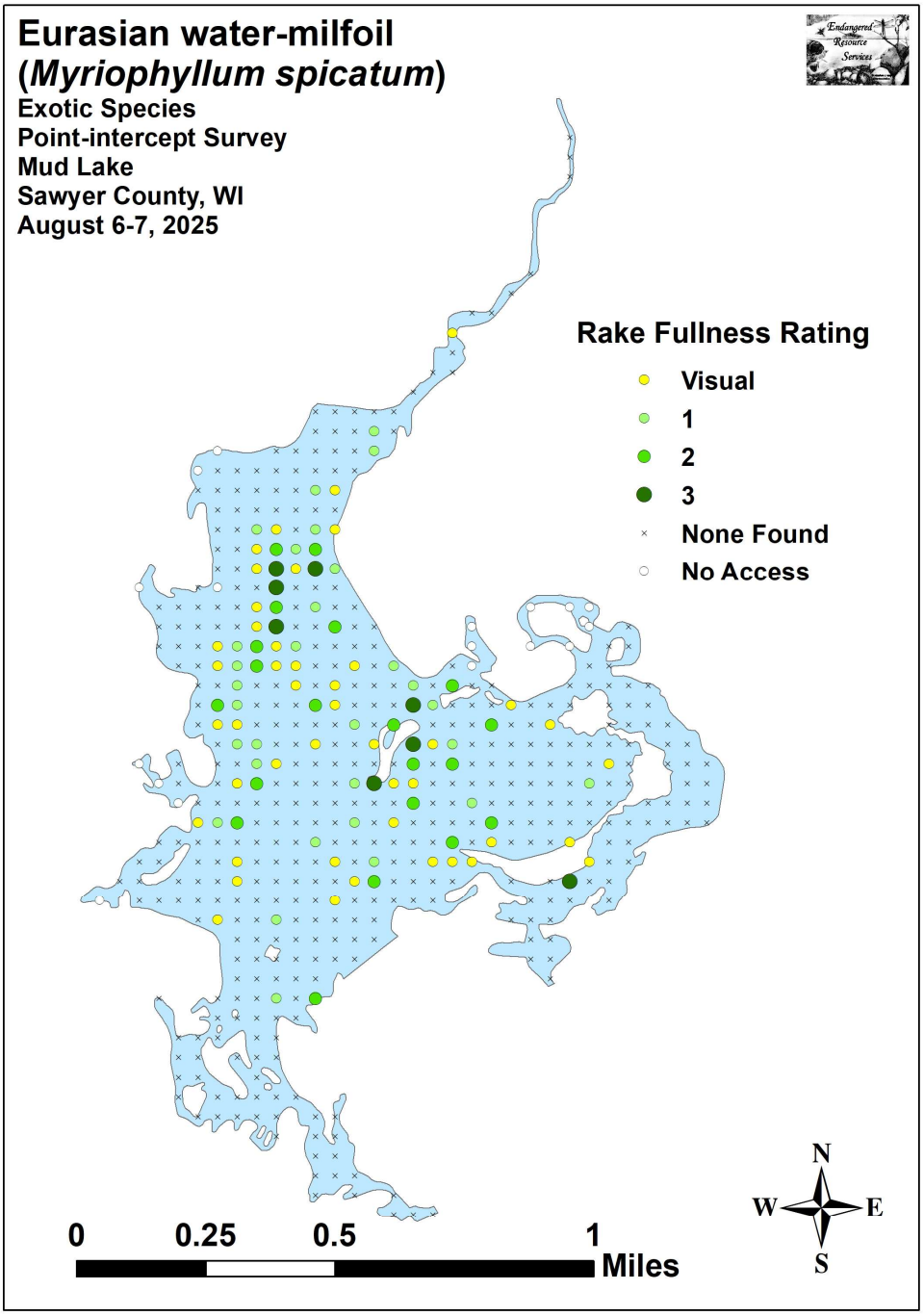
Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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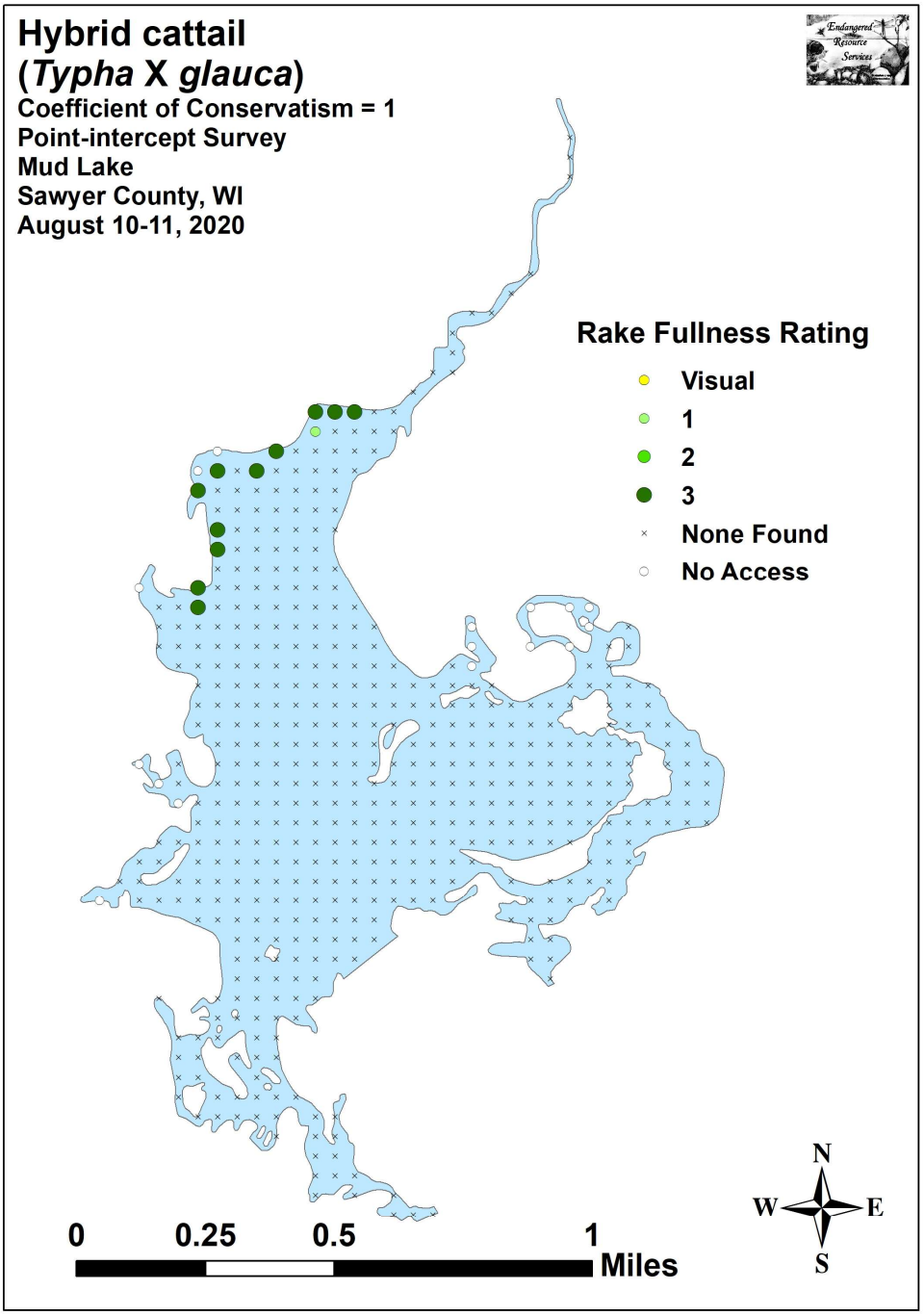
Hybrid cattail
(Typha X glauca)
Coefficient of Conservatism = 1
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 10-11, 2020
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
No Access
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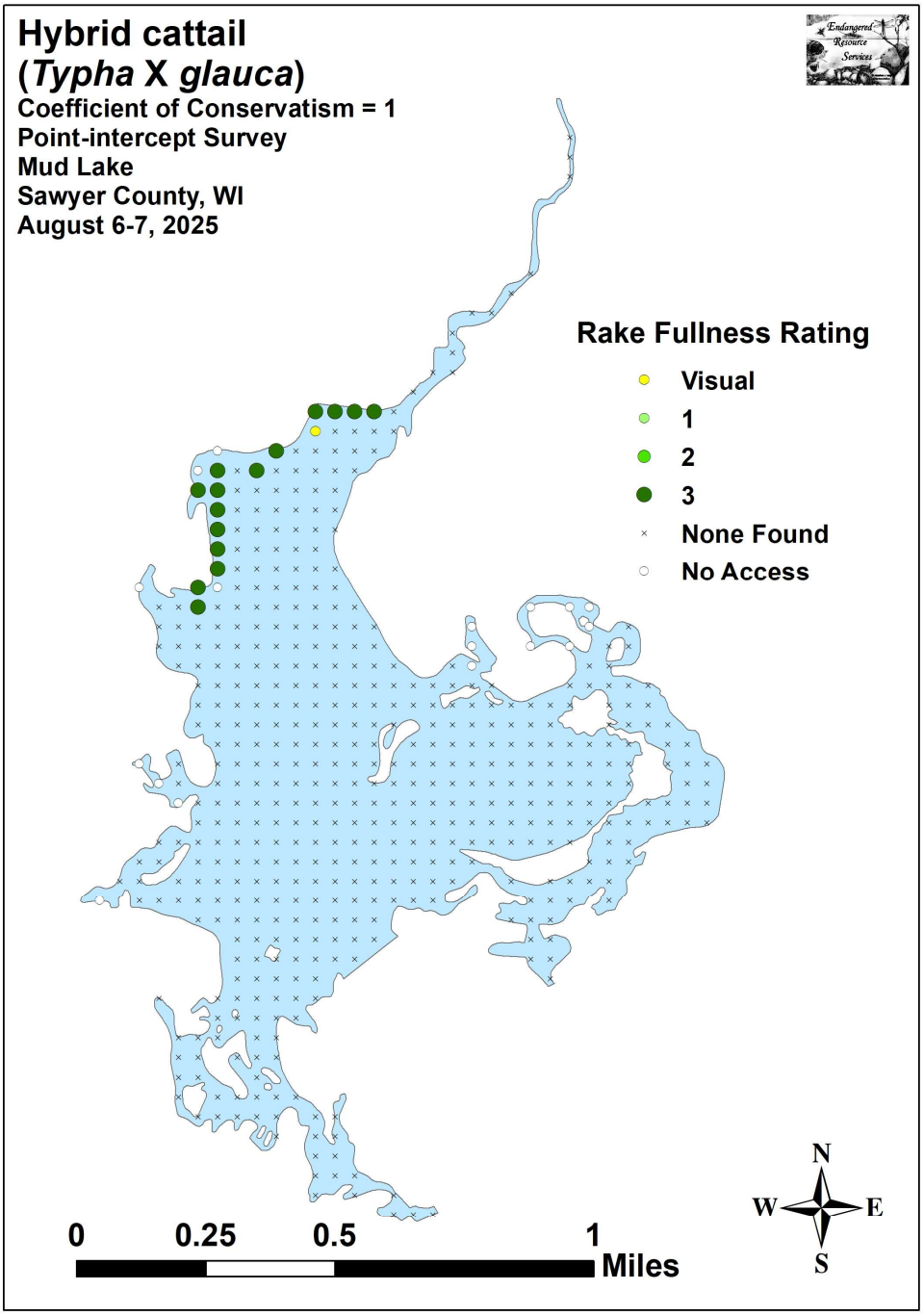
Hybrid cattail
(Typha X glauca)
Coefficient of Conservatism = 1
Point-intercept Survey
Mud Lake
Sawyer County, WI
August 6-7, 2025
Endangered Resource Services
Rake Fullness Rating
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Appendix VIII: Aquatic Exotic Invasive Plant Species Information

Eurasian Water-milfoil

DESCRIPTION: Eurasian water-milfoil is a submersed aquatic plant native to Europe, Asia, and northern Africa. It is the only non-native milfoil in Wisconsin. Like the native milfoils, the Eurasian variety has slender stems whorled by submersed feathery leaves and tiny flowers produced above the water surface. The flowers are located in the axils of the floral bracts and are either four-petaled or without petals. The leaves are threadlike, typically uniform in diameter, and aggregated into a submersed terminal spike. The stem thickens below the inflorescence and doubles its width further down, often curving to lie parallel with the water surface. The fruits are four-jointed nut-like bodies. Without flowers or fruits, Eurasian water-milfoil is nearly impossible to distinguish from Northern water-milfoil. Eurasian water-milfoil has 9-21 pairs of leaflets per leaf, while Northern water-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 water-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 lakebed). 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, 2009 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, 2009 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

Reed canary grass

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

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

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

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

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

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

This species prefers disturbed areas but can easily move into native wetlands. Reed canary grass can invade a disturbed wetland in less than twelve years. Invasion is associated with disturbances including ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, and intentional planting. The difficulty of selective control makes reed canary grass invasion of particular concern. Over time, it forms large, monotypic stands that harbor few other plant species and are subsequently of little use to wildlife. Once established, reed canary grass dominates an area by building up a tremendous seed bank that can eventually erupt, germinate, and recolonize treated sites. (Taken in its entirety from WDNR, 2009 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 IX: 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 X: 2020 and 2025 Raw Data Spreadsheets

MudLakeSawyerCoWBIC2434800PISurvey810-112020MBergERSLLC.xlsx

MudLakeSawyerWBIC2434800PISurvey86-72025MBergERSLLC.xlsx