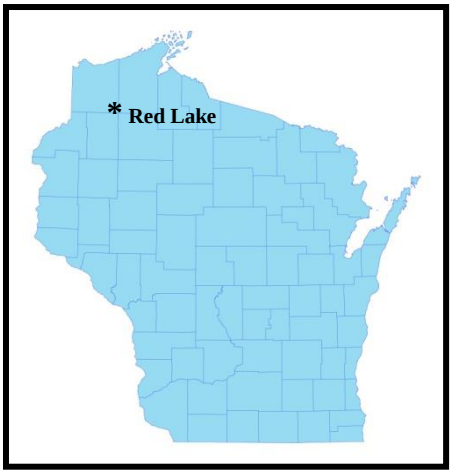
# Warm-water Point-intercept Macrophyte and Fall Eurasian Water-milfoil Bed Mapping Surveys
# Red Lake - WBIC: 2492100
# Douglas County, Wisconsin


Red Lake Eurasian water-milfoil regrowing from chemically burned root crowns 7/30/17


EWM Bed on Red Lake 9/30/17

## Project Initiated by:
The Red Lake Association and the
Wisconsin Department of Natural Resources





Calm search conditions 9/30/17

## Surveys Conducted by and Report Prepared by:
Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
July 30 and September 30, 2017

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# ABSTRACT

Red Lake (WBIC 2492100) is a 253 acre stratified seepage lake located in south-central/southeastern Douglas County, WI. Our original point-intercept survey on July 25, 2013 found no evidence of Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM) in Red Lake. Unfortunately, EWM was discovered in the summer of 2016, and, after our fall bed mapping survey located ten small beds totaling 1.18 acres, the Red Lake Association (RLA) treated two areas totaling 4.0 acres with Diquat in May 2017. As a prerequisite to developing an Aquatic Plant Management Plan, the RLA and the Wisconsin Department of Natural Resources (WDNR) requested a follow-up full point-intercept survey for all aquatic macrophytes on July 30, 2017; and a fall bed mapping survey on September 30, 2017. During the July 2017 survey, we found macrophytes growing at 406 sites which approximated to 75.3% of the entire lake bottom and 83.9% of the 22.5ft littoral zone. This was a non-significant decline ($p$=0.22) from 423 sites with plants in 2013 (78.5% of the lake bottom and 93.4% of the then 22.5ft littoral zone). Overall diversity was exceptionally high with a Simpson Index value of 0.92 – down from 0.93 in 2013. Richness was also exceptionally high with 64 species found growing in and immediately adjacent to the water (down from 67 species in 2013). There was an average of 2.32 native species/site with native vegetation – a highly significant decline **($p$<0.001)** from 2.70 species/site in 2013. Total rake fullness experienced a non-significant decline ($p$=0.23) from a moderate 2.05 in 2013 to a moderate 2.01 in 2017. Fern pondweed (*Potamogeton robbinsii*), Muskgrass (*Chara* sp.), Nitella (*Nitella* sp.), and Small pondweed (*Potamogeton pusillus*) were the most common macrophyte species in 2017. They were present at 40.89%, 28.57%, 23.89%, and 14.29% of sites with vegetation, and accounted for 46.34% of the total relative frequency. In 2013, Fern pondweed, Common waterweed (*Elodea canadensis*), Muskgrass, and Nitella were the most common species (36.88%, 32.86%, 28.37%, and 22.22% of survey points with vegetation), and they collectively accounted for 44.61% of the total relative frequency. Lakewide, from 2013-2017, five species saw significant changes in distribution: Common waterweed, Flat-stem pondweed (*Potamogeton zosteriformis*), and Variable pondweed (*Potamogeton gramineus*) suffered highly significant declines; and White-stem pondweed (*Potamogeton praelongus*) experienced a moderately significant decline. Conversely, filamentous algae experienced a highly significant increase. The 50 native index species found in the rake during the July 2017 survey (down from 52 in 2013) produced an above average mean Coefficient of Conservatism of 6.9 (up from 6.7 in 2013). The Floristic Quality Index of 48.5 (up from 48.4 in 2013) was almost double the median FQI for this part of the state. During the July survey, we didn't find any exotic species in the rake at any point; and, other than a patch of surviving EWM at the core of the northwest treatment area, we saw no evidence of any exotic plants. The September 30, 2017 EWM bed mapping survey found a single surviving bed totaling 0.09 acre in the same area at the core of Bed 5. Continuing to aggressively manage EWM to limit its spread while simultaneously working to minimize its impact on Red Lake's native plants and keeping economic costs low; and proactively working to limit nutrient inputs around the lake which can fuel both algal as well as milfoil growth are management priorities for the RLA to consider as they develop their initial management plan.

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## INTRODUCTION:

Red Lake (WBIC 2492100) is a 253 acre stratified seepage lake located in the Town of Wascott in south-central/southeastern Douglas County (T43N R11W S21, 28, 29, 32). The lake reaches a maximum depth of 37ft in the deep hole on the south end of the central basin and has an average depth of 11ft (WDNR 2009). Red Lake is mesotrophic in nature and water clarity is good with Secchi readings averaging 11.0ft from 1993-2017 and 13.0ft in 2017 (WDNR 2017). This produced a littoral zone that extended to 22.5ft in 2017. The shoreline is dominated by sand with most areas transitioning to sandy muck at depths beyond 10ft. The lake's only nutrient-rich organic muck occurs in areas adjacent to the tamarack bogs near the small bay in the far southeast corner and on the north and south ends of the northeast bay (Holt et al. 1973) (Figure 1).

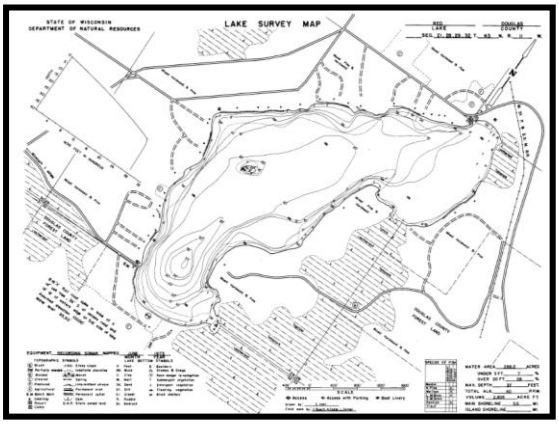



**Figure 1: Red Lake Bathymetric Map**

## BACKGROUND AND STUDY RATIONALE:

On July 25, 2013, at the request of the Red Lake Association (RLA) and the Wisconsin Department of Natural Resources (WDNR), we conducted the original warm-water point-intercept survey of all aquatic plants in Red Lake. This extensive study established base-line data on the richness, diversity, abundance, and distribution of the lake's aquatic plant populations. At that time, we found no evidence of Eurasian water-milfoil (*Myriophyllum spicatum*) (EWM), an invasive exotic aquatic plant, anywhere in the lake.

Unfortunately, in July 2016, biologists from the Great Lakes Indian Fish & Wildlife Commission (GLIFWC) found a few EWM plants near the public boat landing on the lake's southwest side and near the Red Lake Resort in the northeast bay. A follow-up survey by the WDNR also found plants in these areas, and our lakewide EWM bed mapping survey on October 2, 2016 found ten beds totaling 1.18 acres.

In 2017, the WDNR authorized the treatment of two areas that encompassed four of the five largest beds and totaled 4.0 acres (1.58% of the lake's surface area). Because of the small size of the treatment area and in an effort to save money, it was decided NOT to perform pre and posttreatment surveys. However, because an updated full point-intercept macrophyte survey was needed to develop an Aquatic Plant Management Plan, we were asked to survey the lake on July 30$^{th}$. We were also asked to complete a September 30$^{th}$ EWM bed mapping survey to help determine where active management might be considered in 2018. This report is the summary analysis of these two field surveys.

## METHODS:

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

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, and total lake acres, Michelle Nault (WDNR) generated the 539 point sampling grid for Red Lake that was used in both 2013 and 2017 (Appendix I). Prior to beginning the July point-intercept survey, we conducted a general boat survey of the lake to regain familiarity with the species present (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2013; Skawinski 2014), and a data sheet was built from the species present. For species not seen in 2013, we retained d two specimens and mounted them on high grade herbarium paper. One voucher was given to the RLA, and the second was deposited at the University of Wisconsin – Stevens Point's Freckmann Herbarium.

During the survey, we located each point with a GPS (Garmin 76CSx), recorded a depth reading with a metered pole or hand held sonar (Vexilar LPS-1), 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.

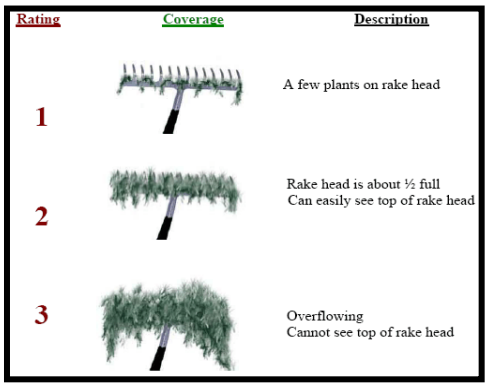



**Figure 2: Rake Fullness Ratings (UWEX 2010)**

### Fall Eurasian Water-milfoil Bed Mapping Survey:

We searched the visible littoral zone of the lake in overlapping visual transects and mapped all known beds of EWM. A "bed" was determined to be any place where we visually estimated that EWM made up >50% of the area's plants and was generally continuous with clearly defined borders. After we located a bed, we motored around the perimeter of the area; took GPS coordinates at regular intervals; estimated the rake range and mean rake fullness rating of EWM within the bed (Figure 2); recorded the depth range and mean depth EWM was growing at; and noted whether it was canopied or not. Using the WDNR's Forestry Tool's Extension to ArcGIS 9.3.1, we then generated bed shapefiles with these coordinates and determined the acreage to the nearest hundredth of an acre. As this was a new infestation, we also marked and attempted to rake remove any individual plants found outside the beds as they were generally few in number.

## DATA ANALYSIS:

We entered all data collected into the standard 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.

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

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

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

Frequency of occurrence example:

Plant A is sampled at 70 out of 700 total littoral points = 70/700 = .10 = 10%
This means that Plant A's frequency of occurrence = 10% when considering the entire littoral zone.

Plant A is sampled at 70 out of 350 total points with vegetation = 70/350 = .20 = 20%
This means that Plant A's frequency of occurrence = 20% when only considering the sites in the littoral zone that have vegetation.

From these frequencies, we can estimate how common each species was at depths where plants were able to grow, and at points where plants actually were growing. Note the second value will be greater as not all the points (in this example, only ½) had plants growing at them.

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

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

**Mean and median depth of plants:** The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value.
**Number of sites sampled using rope/pole rake:** This indicates which rake type was used to take a sample. We use a 20ft pole rake and a 35ft rope rake for sampling.

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

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

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

**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 5 species of plants with the following results:

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

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

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

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

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

**Comparison to Past Surveys:** We compared data from our 2013 and 2017 surveys (Figure 8) (Tables 2 and 3) to see if there were any significant changes in the lake's vegetation. 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 $p < .05$, moderately significant at $p < .01$ and highly significant at $p < .001$ (UWEX 2010). It should be noted that we used the number points with vegetation (423 in 2013/406 in 2017) as the basis for "sample points".

# RESULTS:

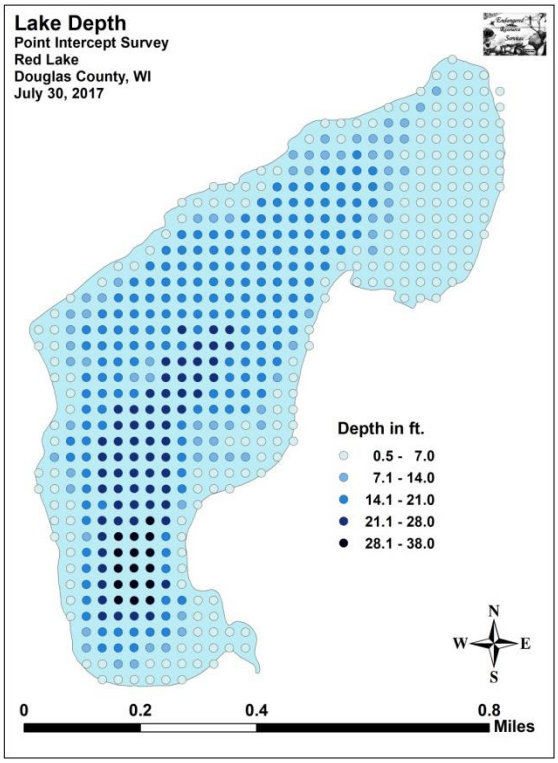
## Warm-water Full Point-intercept Macrophyte Survey:

Depth soundings taken at Red Lake's 539 survey sample points revealed the lake is a crescent-shaped trench that grows gradually deeper as it curves from the northeast bay to the 37ft deep hole on the south end of the central basin. This crescent is pinched by two gently sloping flats midlake. Other notable features include a sunken island that tops out at 7ft on the north end of the western midlake flat, and a sandy point on the south end of the shallow flat that dominates the northeast bay (Figure 3) (Appendix III).

Of the 494 points where we could reliably determine the substrate, sandy areas dominated the shoreline and accounted for 194 (39.3%) of the survey sites. Away from the shore, we found these firm sand substrates transitioned to a nutrient-poor sandy muck at most depths over 10ft. The broad northeast bay was dominated by a sterile marly silt, while the small southeast bay and the northern and southern ends of the northeast bay that were adjacent to Tamarack (*Larix laricina*) and Leatherleaf (*Chamaedaphne calyculata*) bogs had the lake's only nutrient-rich organic muck. Collectively, these mucky areas covered 60.1% of the lake's bottom (297 points). We also found three small gravel areas along the north shoreline and on the eastern flat, but they totaled just 0.6% of the lake bottom (Figure 3) (Appendix III).

In 2017, we found plants growing to 22.5ft (identical to 2013) (Table 1). The 406 points with vegetation (approximately 75.3% of the entire lake bottom and 83.9% of the littoral zone) was a non-significant decline ($p$=0.22) from 2013 when we found plants growing at 423 points (78.5% of the bottom and 93.4% of the littoral zone) (Figure 4) (Appendix IV).

Growth in 2017 was slightly skewed to deep water as the mean depth of 9.9ft was higher than the median of 8.0ft. Both of these values were similar to the 2013 survey when we found the mean/median to be 10.1ft and 8.5ft respectively. Interestingly, these values are actually deceptive because, unlike most lakes where plant coverage declines with increasing depth and graphs demonstrate a more or less normal distribution with skew to deep water, Red Lake's plants exhibited a bimodal (twin peak) distribution (Figure 5). This unusual growth depth chart captured both the tendency to drop off rapidly from the shallower shoreline areas as well as the nearly universal coverage of Charophytes (valuable habitat producing colonial algae that look like higher plants) from 12ft to the edge of the littoral zone.



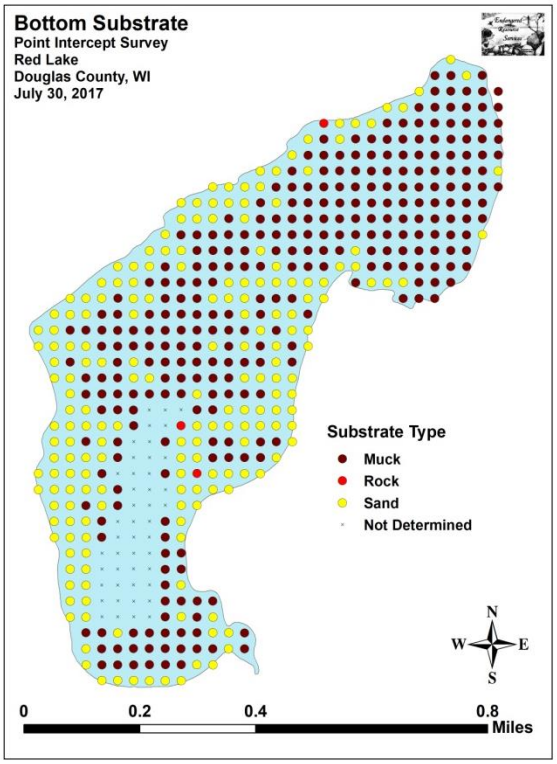
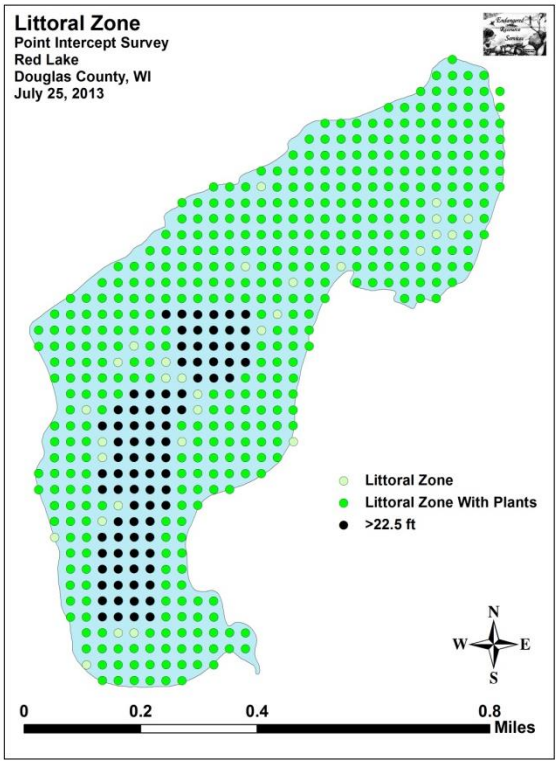




**Figure 3: Lake Depth and Bottom Substrate**



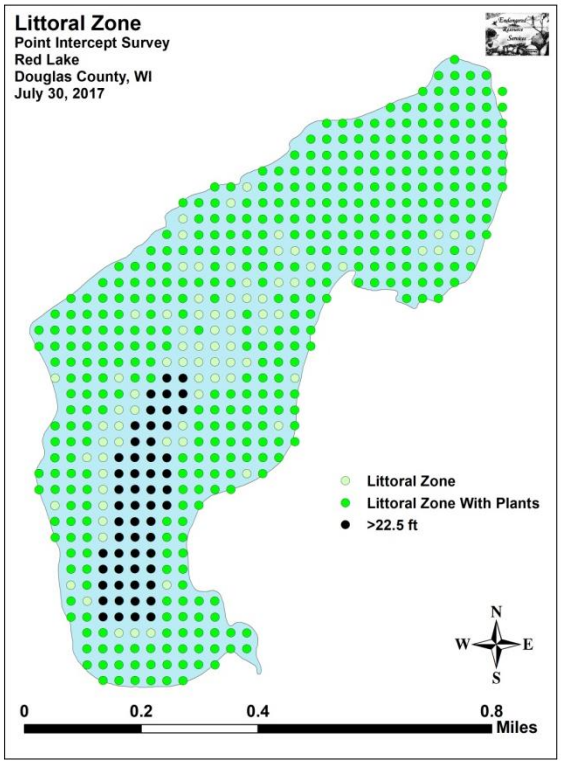




**Figure 4: 2013 and 2017 Littoral Zone**

**Table 1: Aquatic Macrophyte P/I Survey Summary Statistics**
**Red Lake, Douglas County**
**July 25, 2013 and July 30, 2017**

| Summary Statistics: | 2013 | 2017 |
|---|---|---|
| Total number of points sampled | 539 | 539 |
| Total number of sites with vegetation | 423 | 406 |
| Total number of sites shallower than the maximum depth of plants | 453 | 484 |
| Frequency of occurrence at sites shallower than maximum depth of plants | 93.38 | 83.88 |
| Simpson Diversity Index | 0.93 | 0.92 |
| Maximum depth of plants (ft) | 22.5 | 22.5 |
| Mean depth of plants (ft) | 10.1 | 9.9 |
| Median depth of plants (ft) | 8.5 | 8.0 |
| Average number of all species per site (shallower than max depth) | 2.52 | 1.95 |
| Average number of all species per site (veg. sites only) | 2.70 | 2.32 |
| Average number of native species per site (shallower than max depth) | 2.52 | 1.95 |
| Average number of native species per site (sites with native veg. only) | 2.70 | 2.32 |
| Species richness | 57 | 53 |
| Species richness (including visuals) | 58 | 56 |
| Species richness (including visuals and boat survey) | 67 | 64 |
| Mean rake fullness (veg. sites only) | 2.05 | 2.01 |

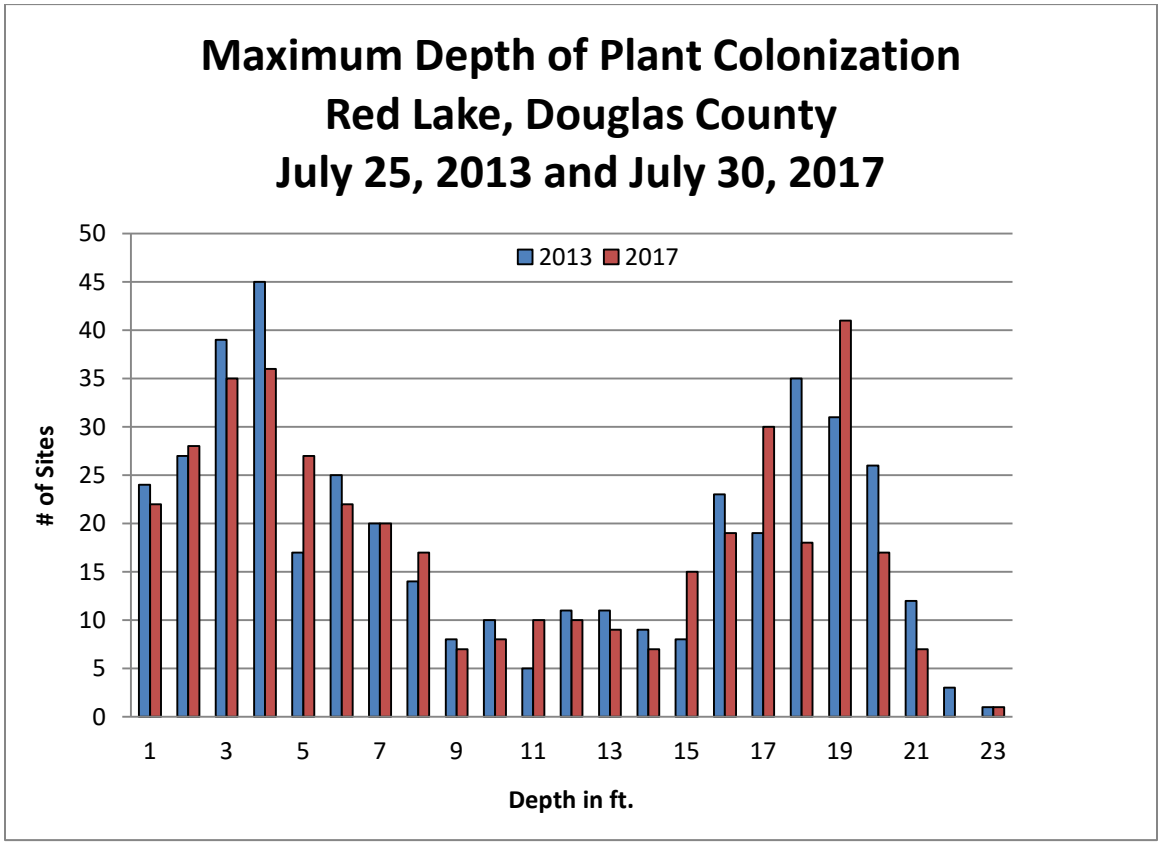



**Figure 5: 2013 and 2017 Plant Colonization Depth Chart**

Plant diversity was exceptionally high in 2017 with a Simpson Index value of 0.92 – down from 0.93 in 2013. Species richness was also exceptionally high with 53 species found in the rake (down from 57 in 2013). This total increased to 64 species when including visuals and plants seen during the boat survey. This number was also down slightly from the 67 total species we documented in 2013. Most of the plants that were present in 2013, but absent in 2017, were emergent and shoreline species found along the north shoreline that apparently lost their habitat when water levels increased.

Along with the decline in overall richness, mean native species richness at sites with vegetation experienced a highly-significant loss **($p<0.001$)** from 2.70 species/site in 2013 to 2.32/site in 2017. Visual analysis of the maps suggested much of this loss occurred in the eastern bays away from areas that were treated with herbicide (Figure 6). Total rake fullness experienced a non-significant decline ($p=0.23$) from a moderate 2.05 in 2013 to a moderate 2.01 in 2017 (Figure 7) (Appendix IV).

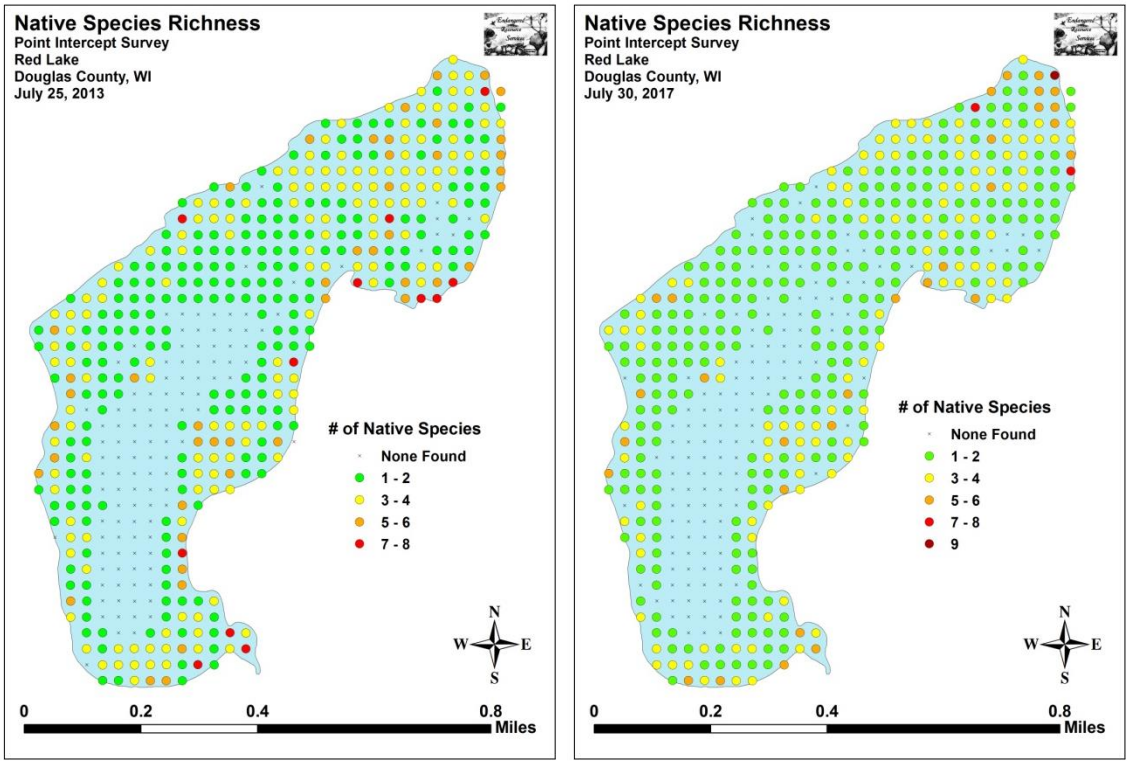



**Figure 6: 2013 and 2017 Native Species Richness**

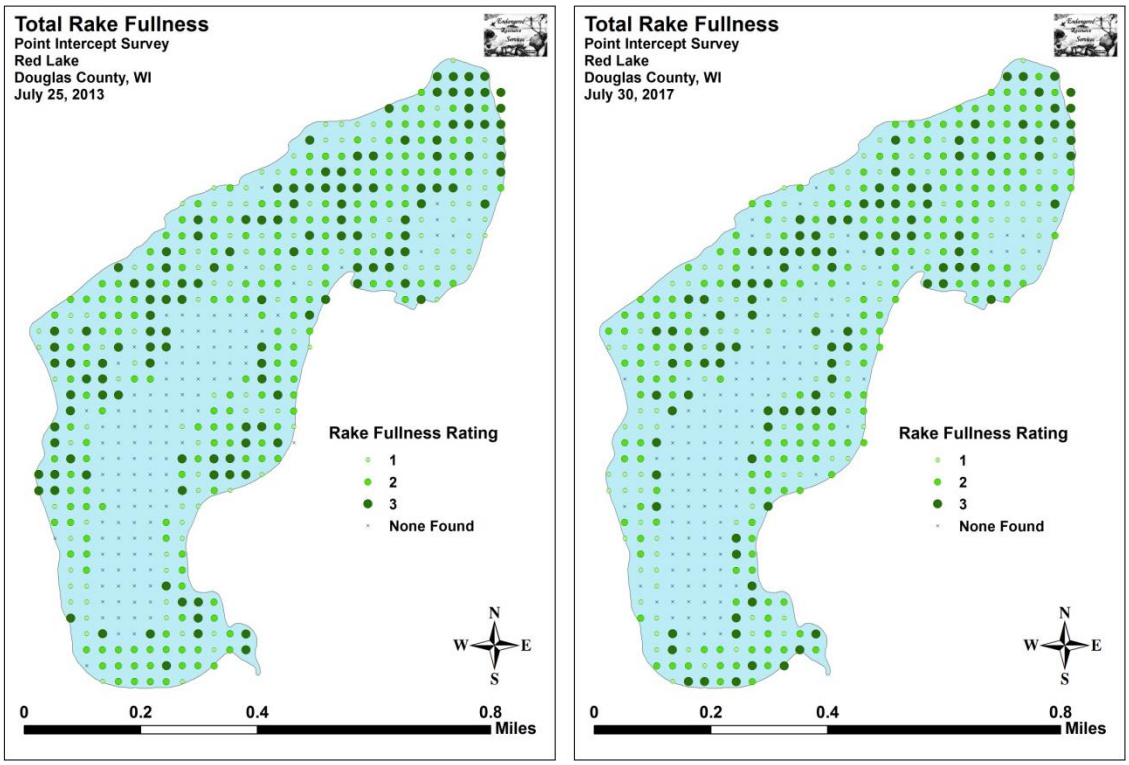



**Figure 7: 2013 and 2017 Total Rake Fullness**

## Red Lake Plant Community:

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

Along sandy shorelines, the lake's emergent plant beds were dominated by Hardstem bulrush (*Schoenoplectus acutus*), Creeping spikerush (*Eleocharis palustris*), and Smooth saw-grass (*Cladium mariscoides*). We also found small numbers of Lake sedge (*Carex lacustris*), Rice cut-grass (*Leersia oryzoides*), and Softstem bulrush (*Schoenoplectus tabernaemontani*). Some species that were present along the lake's north shore in 2013 like, Bebb's sedge (*Carex bebbii*) and Common yellow lake sedge (*Carex utriculata*) were not seen in 2017. This may be because water levels were up and their habitat was eliminated, or it may have simply been that they were overlooked due to their rarity.

Hardstem bulrush (Per 2002)

Smooth saw-grass (Perlman 2011)

Common yellow lake sedge (Lavin 2011)

Softstem bulrush (Schwarz 2011)

In sandy and organic muck-bottomed areas, these species were replaced by Pickerelweed (*Pontederia cordata*), Bald spikerush (*Eleocharis erythropoda*), Wild calla (*Calla palustris*), Marsh cinquefoil (*Comarum palustre*), Three-way sedge (*Dulichium arundinaceum*), Robbins' spikerush (*Eleocharis robbinsii*), Common arrowhead (*Sagittaria latifolia*), Short-stemmed bur-reed (*Sparganium emersum*), and Broad-leaved cattail (*Typha latifolia*). Interestingly, despite extensive searching, we were unable to find Water bulrush (*Schoenoplectus subterminalis*) in 2017. This high-value species was fairly common in undeveloped shoreline areas of the eastern bays in 2013. Collectively, all these emergents work to stabilize the lakeshore, provide a nursery for baitfish and juvenile gamefish, offer shelter for amphibians, and give waterfowl and predatory wading birds like herons a place to hunt.

Pickerelweed (Texas A&M 2012)

Robbins' spikerush on Red Lake's northeast shore (Berg 2013)

Just beyond the emergents, in water up to 5ft deep, shallow sugar sand areas tended to have high species richness. They also tended to have low total biomass as these nutrient-poor substrates provide habitat most suited to fine-leaved "isoetid" turf-forming species like Muskgrass (*Chara* sp.), Waterwort, (*Elatine minima*), Needle spikerush (*Eleocharis acicularis*), Pipewort (*Eriocaulon aquaticum*), Brown-fruited rush (*Juncus pelocarpus*), Water lobelia (*Lobelia dortmanna*), Dwarf water-milfoil (*Myriophyllum tenellum*), Creeping spearwort (*Ranunculus flammula*), and Small purple bladderwort (*Utricularia resupinata*). We also found Narrow-leaved bur-reed (*Sparganium angustifolium*) with its ribbon-like floating leaves growing in these areas. These species are typical of low-nutrient sand-bottomed seepage lakes where they, along with the emergents, work to stabilize the bottom and prevent wave action erosion.

Needle spikerush (Fewless 2005)

Brown-fruited rush (Koshere 2002)

Water lobelia in bloom (Penskar 2011)

Dwarf water-milfoil (Koshere 2002)

Small purple bladderwort (Zerr 2008)

Narrow-leaved bur-reed (Schouh 2006)

Shallow organic muck-bottomed areas were the rarest habitat in the lake. Because of this, floating-leaf species like White-water lily (*Nymphaea odorata*), Spatterdock (*Nuphar variegata*), Watershield (*Brasenia schreberi*), Water smartweed (*Polygonum amphibium*), and Ribbon-leaf pondweed (*Potamogeton epihydrus*) that require this type of substrate were also relatively uncommon. The protective canopy cover this group provides is often utilized by panfish and bass, and mature gamefish like Northern Pike are often found prowling around the edges of these beds.

Spatterdock and White water lily (Falkner, 2009)

Ribbon-leaf pondweed (Petroglyph 2007)

Watershield (Gmelin, 2009)

Water smartweed (Someya 2009)

Growing amongst these floating-leaf species, we also noted the submergent species Coontail (*Ceratophyllum demersum*), Alpine pondweed (*Potamogeton alpinus*), Leafy pondweed (*Potamogeton foliosus*), and Water marigold (*Bidens beckii*). In addition to these rooted plants, a limited number of "duckweeds" and carnivorous bladderworts (*Utricularia* spp.) were observed floating among the lilypads. 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.

Keeled nutlets of Leafy pondweed (Kleinman 2009)

Large duckweed (Thomas 2013)

Common bladderwort flowers among lilypads (Hunt 2010)

Bladders for catching plankton and insect larvae (Wontolla 2007)

Sandy-muck areas in water from 5-15ft supported a rich collection of generally large-leaved species including Slender naiad (*Najas flexilis*), Eurasian and Northern water-milfoils (*Myriophyllum sibiricum*), Variable pondweed (*Potamogeton gramineus*), Illinois pondweed (*Potamogeton illinoensis*), White-stem pondweed (*Potamogeton praelongus*), Small pondweed (*Potamogeton pusillus*), Clasping-leaf pondweed (*Potamogeton richardsonii*), Stiff pondweed (*Potamogeton strictifolius*), Crested arrowhead (*Sagittaria cristata*), and Wild celery (*Vallisneria americana*). In this habitat, we also found a small bed of Alternate-flowered water-milfoil (*Myriophyllum alterniflorum*) – a rare native milfoil not seen in 2013. The seeds, shoots, roots, and tubers this group supplies are heavily utilized by resident and migratory waterfowl. They also provide important habitat for baitfish and juvenile game fish as well as insects like dragonflies and mayflies during the aquatic nymph stages of their lifecycles.

Slender naiad (Cameron 2013)

Northern water-milfoil (Berg 2006)

Large-leaf pondweed (Martin 2002)

Variable pondweed (Koshere 2002)

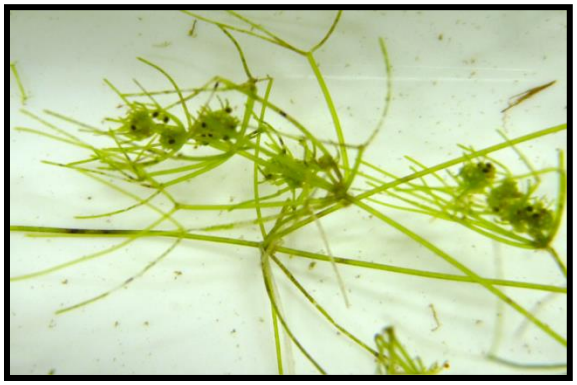
White-stem pondweed (Fewless 2005)

Wild celery (Dalvi 2009)

Areas over 15ft were dominated by just five species: Common waterweed (*Elodea canadensis*), Flat-stem pondweed (*Potamogeton zosteriformis*), Fern pondweed (*Potamogeton robbinsii*), Muskgrass (*Chara* sp.) and, growing deeper and at higher densities than any other species, Nitella (*Nitella* sp.). All of these species provide important deep-water habitat for mature gamefish.

Common waterweed (Pinkka 2013)

Fern pondweed (Apipp 2011)



Nitella

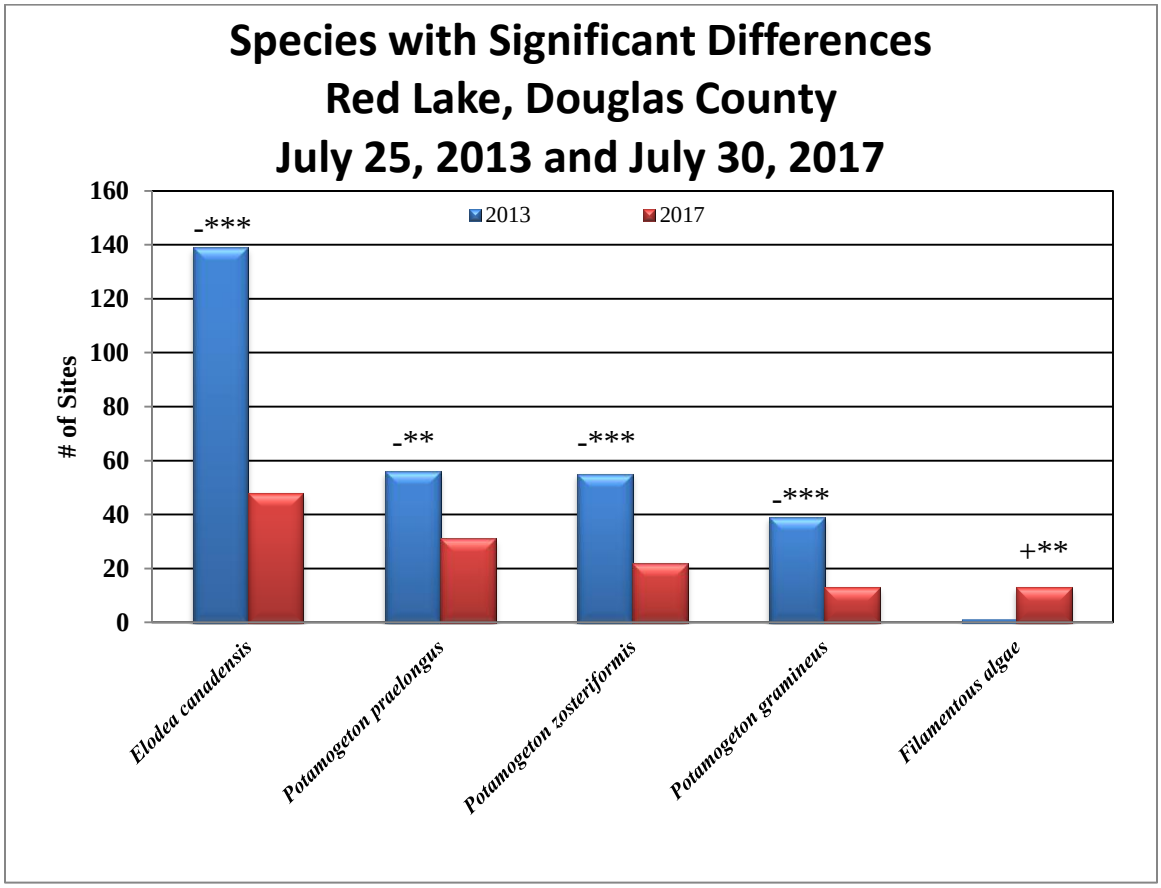
Rake of Nitella in 20ft. of water off Red Lake's north shore (Berg 2013)

## Comparison of Native Macrophyte Species in 2013 and 2017:

In July 2013, when considering the lake as a whole, Fern pondweed, Common waterweed, Muskgrass, and Nitella were the most widely distributed species (Table 2). They were present at 36.88%, 32.86%, 28.37%, and 22.22% of survey points with vegetation respectively, and, collectively, they accounted for 44.61% of the total relative frequency. White-stem pondweed (4.91), Small pondweed (4.91), Flat-stem pondweed (4.82), and Slender naiad (4.38) were the only other species that had relative frequencies over 4% (Species distribution maps for all plants found in 2013 are located in Appendix V).

During our 2017 survey, we found Fern pondweed, Muskgrass, Nitella, and Small pondweed were the most common species. Present at 40.89%, 28.57%, 23.89%, and 14.29% of sites with vegetation (Table 3), they accounted for 46.34% of the total relative frequency. Common waterweed (5.09), Slender naiad (4.98), and Large-leaf pondweed (4.24) also had relative frequencies over 4% (Species accounts for all species found in 2013 and 2017, and maps for all plants found in 2017 can be found in Appendixes VI and VII).

Lakewide, five species showed significant changes in distribution from 2013 to 2017. Common waterweed, Flat-stem pondweed, and Variable pondweed suffered highly significant declines; and White-stem pondweed experienced a moderately significant decline. Conversely, filamentous algae saw a highly significant increase (Figure 8).




**Significant differences = * $p < .05$, ** $p < .01$, *** $p < .001$**

**Figure 8: Significant Macrophyte Changes from 2013-2017**

## Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
## Red Lake, Douglas County
## July 25, 2013

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Potamogeton robbinsii* | Fern pondweed | 156 | 13.67 | 36.88 | 34.44 | 1.79 | 1 |
| *Elodea canadensis* | Common waterweed | 139 | 12.18 | 32.86 | 30.68 | 1.19 | 0 |
| *Chara* sp. | Muskgrass | 120 | 10.52 | 28.37 | 26.49 | 1.87 | 0 |
| *Nitella* sp. | Nitella | 94 | 8.24 | 22.22 | 20.75 | 1.96 | 0 |
| *Potamogeton praelongus* | White-stem pondweed | 56 | 4.91 | 13.24 | 12.36 | 1.29 | 4 |
| *Potamogeton pusillus* | Small pondweed | 56 | 4.91 | 13.24 | 12.36 | 1.29 | 0 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 55 | 4.82 | 13.00 | 12.14 | 1.00 | 0 |
| *Najas flexilis* | Slender naiad | 50 | 4.38 | 11.82 | 11.04 | 1.14 | 1 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 44 | 3.86 | 10.40 | 9.71 | 1.23 | 5 |
| *Potamogeton gramineus* | Variable pondweed | 39 | 3.42 | 9.22 | 8.61 | 1.08 | 6 |
| *Myriophyllum tenellum* | Dwarf water-milfoil | 29 | 2.54 | 6.86 | 6.40 | 1.41 | 0 |
| *Vallisneria americana* | Wild celery | 29 | 2.54 | 6.86 | 6.40 | 1.10 | 1 |
| *Potamogeton illinoensis* | Illinois pondweed | 27 | 2.37 | 6.38 | 5.96 | 1.04 | 31 |
| *Utricularia resupinata* | Small purple bladderwort | 26 | 2.28 | 6.15 | 5.74 | 1.54 | 0 |
| *Eleocharis acicularis* | Needle spikerush | 25 | 2.19 | 5.91 | 5.52 | 1.00 | 0 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 19 | 1.67 | 4.49 | 4.19 | 1.05 | 0 |
| *Nymphaea odorata* | White water lily | 19 | 1.67 | 4.49 | 4.19 | 1.63 | 5 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 16 | 1.40 | 3.78 | 3.53 | 1.00 | 0 |
| *Brasenia schreberi* | Watershield | 14 | 1.23 | 3.31 | 3.09 | 1.36 | 2 |
| *Lobelia dortmanna* | Water lobelia | 14 | 1.23 | 3.31 | 3.09 | 1.50 | 12 |
| *Sagittaria cristata* | Crested arrowhead | 13 | 1.14 | 3.07 | 2.87 | 1.00 | 1 |
| *Eriocaulon aquaticum* | Pipewort | 9 | 0.79 | 2.13 | 1.99 | 1.33 | 3 |
| *Bidens beckii* | Water marigold | 8 | 0.70 | 1.89 | 1.77 | 1.00 | 0 |
| *Pontederia cordata* | Pickerelweed | 8 | 0.70 | 1.89 | 1.77 | 2.13 | 6 |
| *Heteranthera dubia* | Water star-grass | 5 | 0.44 | 1.18 | 1.10 | 1.60 | 0 |

**Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes**
**Red Lake, Douglas County**
**July 25, 2013**

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Sparganium angustifolium* | Narrow-leaved bur-reed | 5 | 0.44 | 1.18 | 1.10 | 1.00 | 1 |
| *Utricularia vulgaris* | Common bladderwort | 5 | 0.44 | 1.18 | 1.10 | 1.00 | 0 |
| *Eleocharis robbinsii* | Robbins' spikerush | 4 | 0.35 | 0.95 | 0.88 | 2.25 | 0 |
| *Potamogeton friesii* | Fries' pondweed | 4 | 0.35 | 0.95 | 0.88 | 1.50 | 2 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 4 | 0.35 | 0.95 | 0.88 | 1.00 | 0 |
| *Schoenoplectus acutus* | Hardstem bulrush | 4 | 0.35 | 0.95 | 0.88 | 2.25 | 5 |
| *Ceratophyllum demersum* | Coontail | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 0 |
| *Dulichium arundinaceum* | Three-way sedge | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 0 |
| *Nuphar variegata* | Spatterdock | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 1 |
| *Potamogeton strictifolius* | Stiff pondweed | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 0 |
| *Schoenoplectus subterminalis* | Water bulrush | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 1 |
| *Utricularia minor* | Small bladderwort | 3 | 0.26 | 0.71 | 0.66 | 1.00 | 0 |
| *Eleocharis erythropoda* | Bald spikerush | 2 | 0.18 | 0.47 | 0.44 | 3.00 | 0 |
| *Eleocharis palustris* | Creeping spikerush | 2 | 0.18 | 0.47 | 0.44 | 1.00 | 1 |
| *Lemna minor* | Small duckweed | 2 | 0.18 | 0.47 | 0.44 | 1.50 | 0 |
| *Potamogeton alpinus* | Alpine pondweed | 2 | 0.18 | 0.47 | 0.44 | 1.50 | 0 |
| *Potamogeton foliosus* | Leafy pondweed | 2 | 0.18 | 0.47 | 0.44 | 2.00 | 0 |
| *Stuckenia pectinata* | Sago pondweed | 2 | 0.18 | 0.47 | 0.44 | 1.00 | 0 |
| *Typha latifolia* | Broad-leaved cattail | 2 | 0.18 | 0.47 | 0.44 | 1.50 | 1 |
| *Calla palustris* | Wild calla | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| *Carex comosa* | Bottle brush sedge | 1 | 0.09 | 0.24 | 0.22 | 3.00 | 0 |
| *Carex utriculata* | Common yellow lake sedge | 1 | 0.09 | 0.24 | 0.22 | 3.00 | 0 |
| *Comarum palustre* | Marsh cinquefoil | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| *Eleocharis ovata* | Blunt spikerush | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| *Isoetes echinospora* | Spiny spored-quillwort | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |

## Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
## Red Lake, Douglas County
## July 25, 2013

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Myrica gale* | Sweet gale | 1 | 0.09 | 0.24 | 0.22 | 3.00 | 0 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| *Ranunculus flammula* | Creeping spearwort | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| *Sagittaria latifolia* | Common arrowhead | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 1 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 1 | 0.09 | 0.24 | 0.22 | 2.00 | 0 |
| *Sparganium emersum* | Short-stemmed bur-reed | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 1 |
| *Spirodela polyrhiza* | Large duckweed | 1 | 0.09 | 0.24 | 0.22 | 1.00 | 0 |
| | Filamentous algae | 1 | * | 0.24 | 0.22 | 1.00 | 0 |
| *Ranunculus aquatilis* | White water crowfoot | ** | ** | ** | ** | ** | 1 |
| *Calamagrostis canadensis* | Bluejoint | *** | *** | *** | *** | *** | *** |
| *Carex lacustris* | Lake sedge | *** | *** | *** | *** | *** | *** |
| *Carex bebbii* | Bebb's sedge | *** | *** | *** | *** | *** | *** |
| *Cladium mariscoides* | Smooth sawgrass | *** | *** | *** | *** | *** | *** |
| *Gallium* sp. | Bedstraw | *** | *** | *** | *** | *** | *** |
| *Leersia oryzoides* | Rice cut-grass | *** | *** | *** | *** | *** | *** |
| *Polygonum amphibium* | Water smartweed | *** | *** | *** | *** | *** | *** |
| *Scirpus atrovirens* | Black bulrush | *** | *** | *** | *** | *** | *** |
| *Typha angustifolia* | Narrow-leaved cattail | *** | *** | *** | *** | *** | *** |

* Excluded from relative frequency analysis ** Visual Only *** Boat Survey Only

## Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
## Red Lake, Douglas County
## July 30, 2017

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Potamogeton robbinsii* | Fern pondweed | 166 | 17.60 | 40.89 | 34.30 | 1.60 | 3 |
| *Chara* sp. | Muskgrass | 116 | 12.30 | 28.57 | 23.97 | 1.91 | 0 |
| *Nitella* sp. | Nitella | 97 | 10.29 | 23.89 | 20.04 | 2.01 | 0 |
| *Potamogeton pusillus* | Small pondweed | 58 | 6.15 | 14.29 | 11.98 | 1.36 | 0 |
| *Elodea canadensis* | Common waterweed | 48 | 5.09 | 11.82 | 9.92 | 1.10 | 1 |
| *Najas flexilis* | Slender naiad | 47 | 4.98 | 11.58 | 9.71 | 1.17 | 6 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 40 | 4.24 | 9.85 | 8.26 | 1.20 | 16 |
| *Vallisneria americana* | Wild celery | 32 | 3.39 | 7.88 | 6.61 | 1.22 | 4 |
| *Potamogeton praelongus* | White-stem pondweed | 31 | 3.29 | 7.64 | 6.40 | 1.13 | 13 |
| *Myriophyllum tenellum* | Dwarf water-milfoil | 30 | 3.18 | 7.39 | 6.20 | 1.57 | 2 |
| *Nymphaea odorata* | White water lily | 24 | 2.55 | 5.91 | 4.96 | 1.83 | 2 |
| *Eleocharis acicularis* | Needle spikerush | 23 | 2.44 | 5.67 | 4.75 | 1.09 | 0 |
| *Potamogeton zosteriformis* | Flat-stem pondweed | 22 | 2.33 | 5.42 | 4.55 | 1.09 | 3 |
| *Utricularia resupinata* | Small purple bladderwort | 19 | 2.01 | 4.68 | 3.93 | 1.58 | 0 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 18 | 1.91 | 4.43 | 3.72 | 1.33 | 1 |
| *Lobelia dortmanna* | Water lobelia | 18 | 1.91 | 4.43 | 3.72 | 1.39 | 7 |
| *Brasenia schreberi* | Watershield | 16 | 1.70 | 3.94 | 3.31 | 1.44 | 1 |
| *Potamogeton illinoensis* | Illinois pondweed | 15 | 1.59 | 3.69 | 3.10 | 1.00 | 11 |
| *Bidens beckii* | Water marigold | 14 | 1.48 | 3.45 | 2.89 | 1.00 | 1 |
| *Potamogeton gramineus* | Variable pondweed | 13 | 1.38 | 3.20 | 2.69 | 1.08 | 3 |
| | Filamentous algae | 13 | * | 3.20 | 2.69 | 1.15 | 0 |
| *Eriocaulon aquaticum* | Pipewort | 12 | 1.27 | 2.96 | 2.48 | 1.33 | 4 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 11 | 1.17 | 2.71 | 2.27 | 1.09 | 2 |
| *Pontederia cordata* | Pickerelweed | 9 | 0.95 | 2.22 | 1.86 | 1.56 | 5 |
| *Sagittaria cristata* | Crested arrowhead | 7 | 0.74 | 1.72 | 1.45 | 1.14 | 3 |

* Excluded from relative frequency analysis

**Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes**
**Red Lake, Douglas County**
**July 30, 2017**

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Eleocharis robbinsii* | Robbins' spikerush | 5 | 0.53 | 1.23 | 1.03 | 1.60 | 0 |
| *Eleocharis palustris* | Creeping spikerush | 4 | 0.42 | 0.99 | 0.83 | 1.25 | 0 |
| *Potamogeton strictifolius* | Stiff pondweed | 4 | 0.42 | 0.99 | 0.83 | 1.25 | 0 |
| *Heteranthera dubia* | Water star-grass | 3 | 0.32 | 0.74 | 0.62 | 1.00 | 2 |
| *Nuphar variegata* | Spatterdock | 3 | 0.32 | 0.74 | 0.62 | 1.67 | 1 |
| *Potamogeton richardsonii* | Clasping-leaf pondweed | 3 | 0.32 | 0.74 | 0.62 | 1.00 | 0 |
| *Schoenoplectus acutus* | Hardstem bulrush | 3 | 0.32 | 0.74 | 0.62 | 2.00 | 4 |
| *Sparganium emersum* | Short-stemmed bur-reed | 3 | 0.32 | 0.74 | 0.62 | 1.00 | 2 |
| *Ceratophyllum demersum* | Coontail | 2 | 0.21 | 0.49 | 0.41 | 1.00 | 0 |
| *Dulichium arundinaceum* | Three-way sedge | 2 | 0.21 | 0.49 | 0.41 | 2.00 | 0 |
| *Elatine minima* | Waterwort | 2 | 0.21 | 0.49 | 0.41 | 1.00 | 0 |
| *Myrica gale* | Sweet gale | 2 | 0.21 | 0.49 | 0.41 | 2.50 | 0 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 2 | 0.21 | 0.49 | 0.41 | 1.00 | 2 |
| *Sparganium angustifolium* | Narrow-leaved bur-reed | 2 | 0.21 | 0.49 | 0.41 | 1.00 | 1 |
| *Typha latifolia* | Broad-leaved cattail | 2 | 0.21 | 0.49 | 0.41 | 2.50 | 1 |
| *Utricularia minor* | Small bladderwort | 2 | 0.21 | 0.49 | 0.41 | 1.50 | 1 |
| *Carex comosa* | Bottle brush sedge | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |
| *Eleocharis erythropoda* | Bald spikerush | 1 | 0.11 | 0.25 | 0.21 | 2.00 | 1 |
| *Leersia oryzoides* | Rice cut grass | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |
| *Lemna minor* | Small duckweed | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |
| *Myriophyllum alterniflorum* | Alternate-flowered water-milfoil | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 1 |
| *Potamogeton alpinus* | Alpine pondweed | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 1 |
| *Potamogeton foliosus* | Leafy pondweed | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |
| *Potamogeton friesii* | Fries' pondweed | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 1 |
| *Ranunculus aquatilis* | White water crowfoot | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |

## Table 3 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
## Red Lake, Douglas County
## July 30, 2017

| Species | Common Name | Total Sites | Relative Freq. | Freq. in Veg. | Freq. in Lit. | Mean Rake | Visual Sight. |
|---|---|---|---|---|---|---|---|
| *Ranunculus flammula* | Creeping spearwort | 1 | 0.11 | 0.25 | 0.21 | 2.00 | 0 |
| *Sagittaria latifolia* | Common arrowhead | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 0 |
| *Spirodela polyrhiza* | Large duckweed | 1 | 0.11 | 0.25 | 0.21 | 2.00 | 0 |
| *Utricularia vulgaris* | Common bladderwort | 1 | 0.11 | 0.25 | 0.21 | 1.00 | 1 |
| *Carex lacustris* | Lake sedge | ** | ** | ** | ** | ** | 1 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | ** | ** | ** | ** | ** | 1 |
| *Stuckenia pectinata* | Sago pondweed | ** | ** | ** | ** | ** | 1 |
| *Calamagrostis canadensis* | Bluejoint | *** | *** | *** | *** | *** | *** |
| *Calla palustris* | Wild calla | *** | *** | *** | *** | *** | *** |
| *Cladium mariscoides* | Smooth saw grass | *** | *** | *** | *** | *** | *** |
| *Comarum palustre* | Marsh cinquefoil | *** | *** | *** | *** | *** | *** |
| *Eleocharis ovata* | Blunt spikerush | *** | *** | *** | *** | *** | *** |
| *Myriophyllum spicatum* | Eurasian water-milfoil | *** | *** | *** | *** | *** | *** |
| *Polygonum amphibium* | Water smartweed | *** | *** | *** | *** | *** | *** |
| *Scirpus atrovirens* | Black bulrush | *** | *** | *** | *** | *** | *** |

** Visual Only *** Boat Survey Only

Fern pondweed, the most widely distributed species in both 2013 and 2017, was common to abundant in most areas from 2-16ft deep over most muck substrates (Figure 9). Found at 156 sites in 2013, it demonstrated a non-significant increase ($p$=0.24) in distribution to 166 sites in 2017. However, its mean rake fullness value experienced a moderately significant decline **($p$=0.008)** from 1.79 in 2013 to 1.60 in 2017.

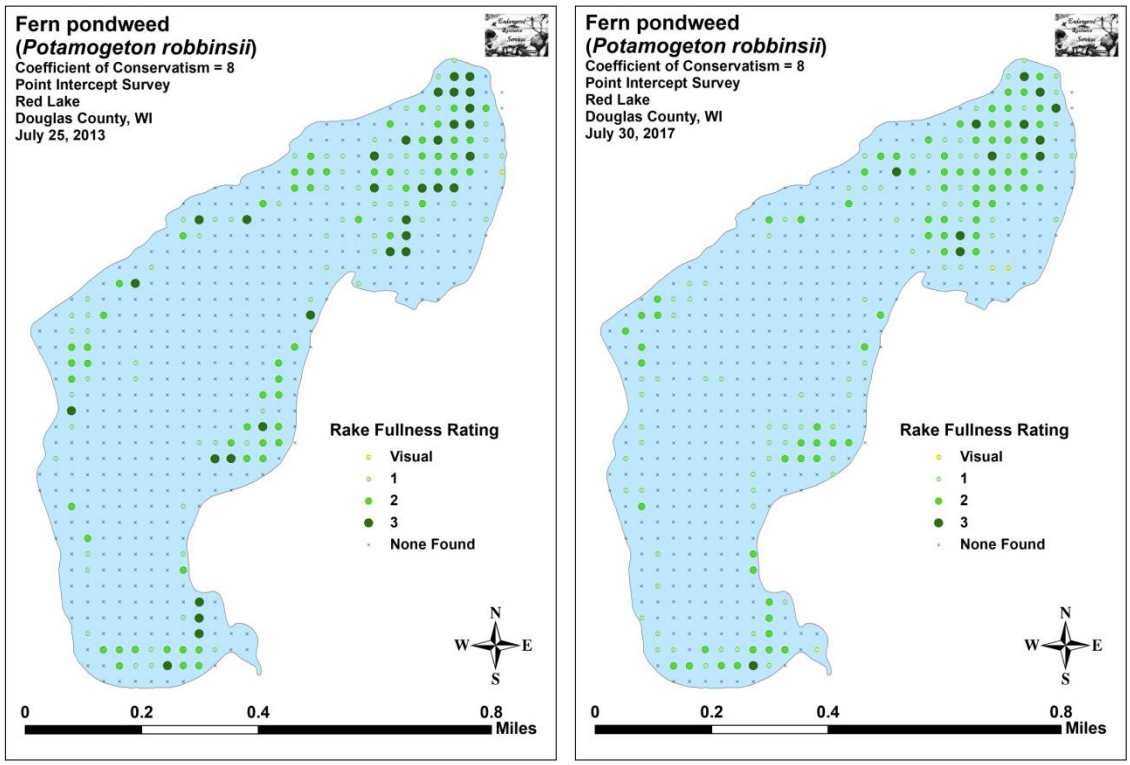



**Figure 9: 2013 and 2017 Fern Pondweed Density/Distribution**

Common water weed was the second most common species in 2013, but only the fifth most common in 2017. Although it had a highly significant decline **($p$<0.001)** in distribution from 139 sites in 2013 to 48 sites in 2017, the accompanying decline in density (mean rake fullness of 1.19 in 2013/1.10 in 2017) was only nearly significant ($p$=0.07) (Figure 10).

Both Muskgrass, the third most common species in 2013 (120 sites – mean rake 1.87) and the second most common in 2017 (115 sites - mean rake 1.91), and Nitella, the fourth most common species in 2013 (94 sites – mean rake 1.96) and the third most common in 2017 (97 sites – mean rake 2.01) were little changed in either density or distribution. Each species were primarily found on the outer edges of the littoral zone where they provided important deep water habitat (Figures 11 and 12).

Most important habitat-producing broad-leaved pondweed species such as Flat-stem, Large-leaf, Variable, and Illinois pondweeds experienced significant or nearly significant declines in distribution. However, White-stem pondweed, which suffered a moderately significant decline **($p$=0.008)** in distribution from the fifth most common species in 2013 (56 sites) to the ninth most common in 2017 (31 sites), was the only species that also suffered a significant decline in density **($p$=0.04)** (mean rake of 1.29 in 2013/1.13 in 2017) (Figure 13).

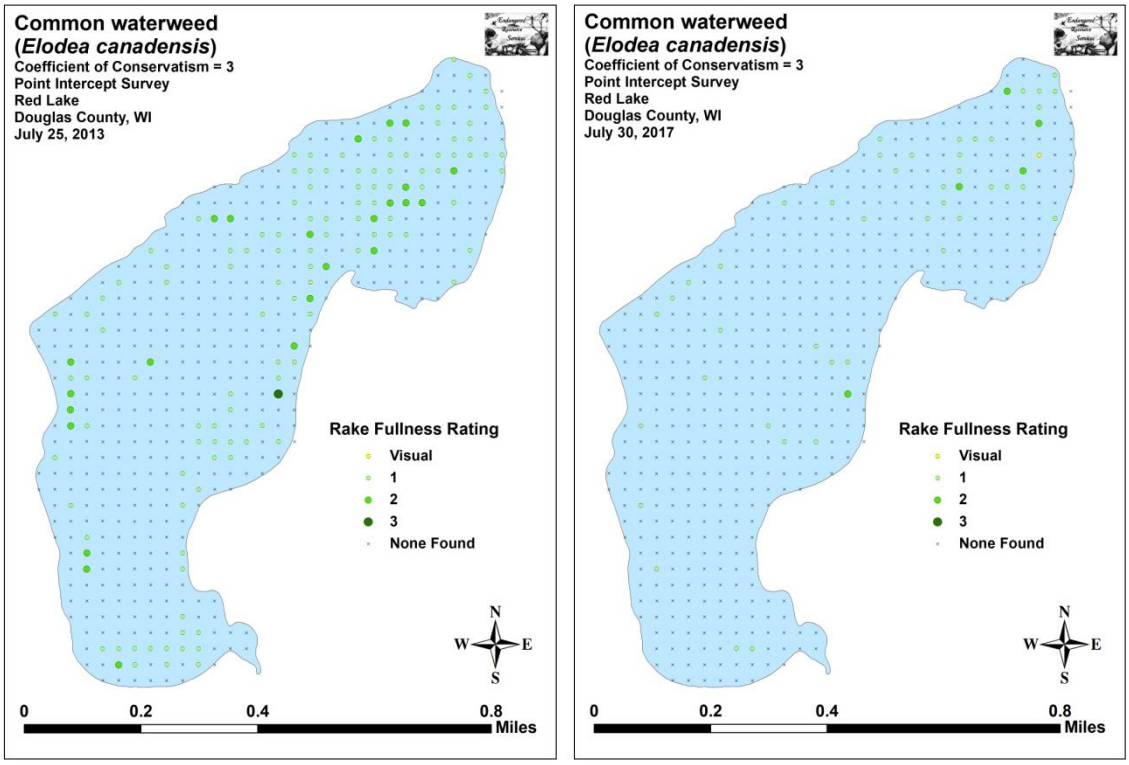



**Figure 10: 2013 and 2017 Common Waterweed Density and Distribution**

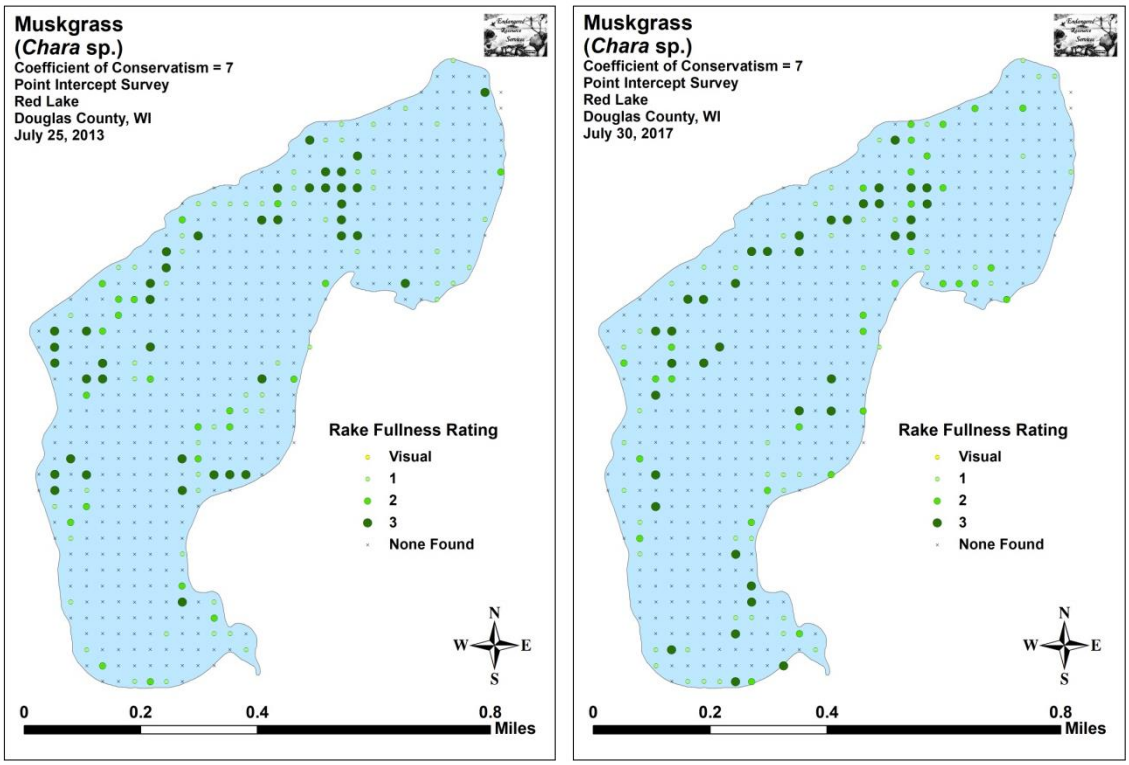



**Figure 11: 2013 and 2017 Muskgrass Density and Distribution**

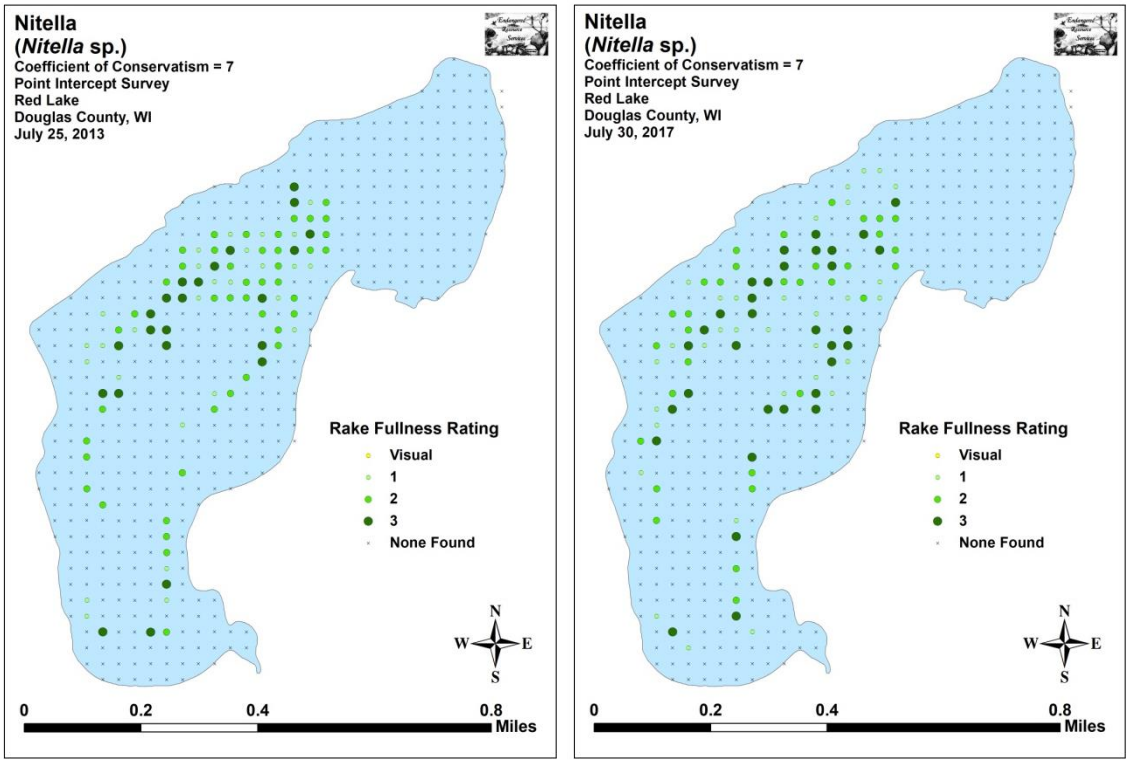



**Figure 12: 2013 and 2017 Nitella Density and Distribution**

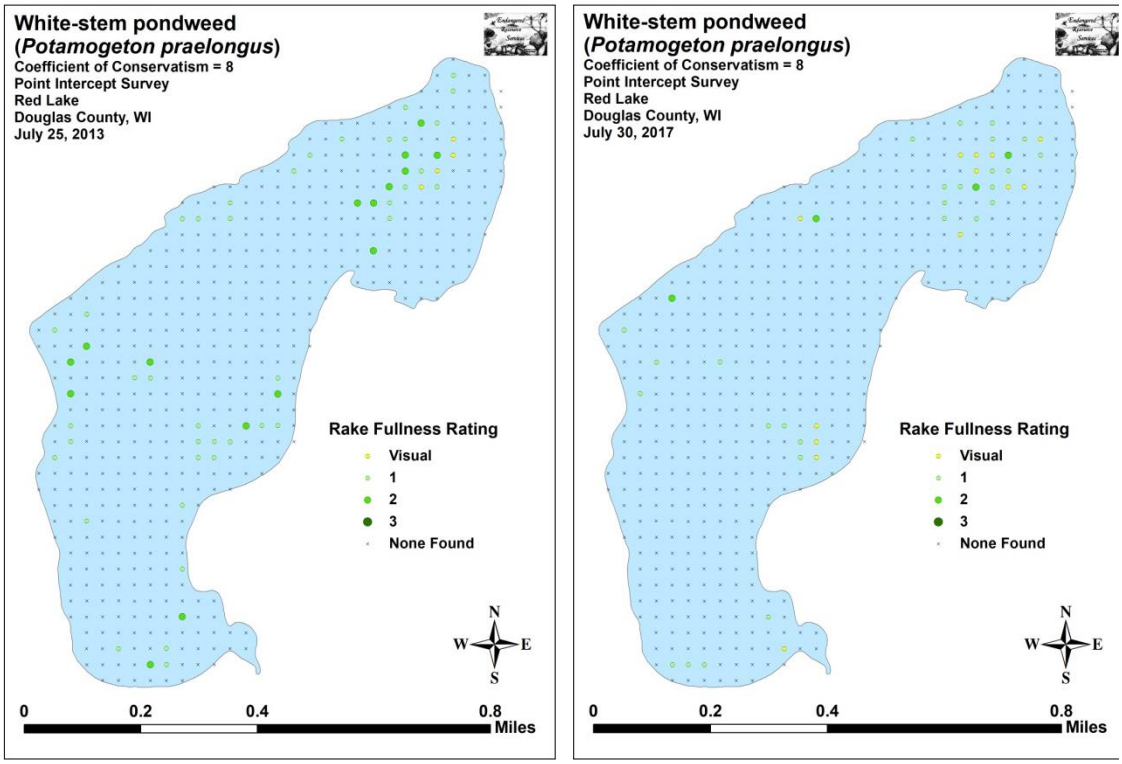



**Figure 13: 2013 and 2017 White-stem pondweed Density and Distribution**

## Comparison of Floristic Quality Indexes in 2013 and 2017:

In 2013, we identified a total of 52 **native index species** in the rake during the point-intercept survey (Table 4). They produced a mean Coefficient of Conservatism of 6.7 and a Floristic Quality Index of 48.4.

### Table 4: Floristic Quality Index of Aquatic Macrophytes
### Red Lake, Douglas County
### July 25, 2013

| Species | Common Name | C |
|---|---|---|
| *Bidens beckii* | Water marigold | 8 |
| *Brasenia schreberi* | Watershield | 6 |
| *Calla palustris* | Wild calla | 9 |
| *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 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |
| *Eriocaulon aquaticum* | Pipewort | 9 |
| *Heteranthera dubia* | Water star-grass | 6 |
| *Isoetes echinospora* | Spiny-spored quillwort | 8 |
| *Juncus pelocarpus* | Brown-fruited rush | 8 |
| *Lemna minor* | Small duckweed | 4 |
| *Lobelia dortmanna* | Water lobelia | 10 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 6 |
| *Myriophyllum tenellum* | Dwarf water-milfoil | 10 |
| *Najas flexilis* | Slender naiad | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Pontederia cordata* | Pickerelweed | 8 |
| *Potamogeton alpinus* | Alpine pondweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 8 |
| *Potamogeton foliosus* | Leafy pondweed | 6 |
| *Potamogeton friesii* | Fries' pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton illinoensis* | Illinois pondweed | 6 |
| *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 zosteriformis* | Flat-stem pondweed | 6 |
| *Ranunculus flammula* | Creeping spearwort | 9 |

## Table 4 (cont'): Floristic Quality Index of Aquatic Macrophytes
## Red Lake, Douglas County
## July 25, 2013

| Species | Common Name | C |
|---|---|---|
| *Sagittaria cristata* | Crested arrowhead | 9 |
| *Sagittaria latifolia* | Common arrowhead | 3 |
| *Schoenoplectus acutus* | Hardstem bulrush | 6 |
| *Schoenoplectus subterminalis* | Water bulrush | 9 |
| *Schoenoplectus tabernaemontani* | Softstem bulrush | 4 |
| *Sparganium angustifolium* | Narrow-leaved bur-reed | 9 |
| *Sparganium emersum* | Short-stemmed bur-reed | 8 |
| *Spirodela polyrhiza* | Large duckweed | 5 |
| *Stuckenia pectinata* | Sago pondweed | 3 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia minor* | Small bladderwort | 10 |
| *Utricularia resupinata* | Small purple bladderwort | 9 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| | | |
| **N** | | **52** |
| **Mean C** | | **6.7** |
| **FQI** | | **48.4** |

In 2017, we identified a total of 50 **native index plants** in the rake during the point-intercept survey. They produced a mean Coefficient of Conservatism of 6.9 and a Floristic Quality Index of 48.5 (Table 5). Nichols (1999) reported an average mean C for the Northern Lakes and Forest Region of 6.7 putting Red Lake above average for this part of the state. The exceptional FQI value was almost double the median FQI of 24.3 for the Northern Lakes and Forest Region (Nichols 1999). These high values are likely the result of the many pristine shoreline areas on the lake and the conservation measures residents have afforded over the years. Specifically, the 12 high value index plants Three-way sedge (C = 9), Waterwort (C = 9), Pipewort (C = 9), Water lobelia (C = 10), Alternate-flowered water-milfoil (C = 10), Dwarf water-milfoil (C = 10), Alpine pondweed (C = 9), Creeping spearwort (C = 9), Crested arrowhead (C = 9), Narrow-leaved bur-reed (C = 9), Small bladderwort (*Utricularia minor*) (C = 10), and the State Species of Special Concern ** Small purple bladderwort (*Utricularia resupinata*) (C = 9) would not be present if Red Lake had not enjoyed a history of apparent good water clarity and quality.

** "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
## Red Lake, Douglas County
## July 30, 2017

| 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 |
| *Elatine minima* | Waterwort | 9 |
| *Eleocharis acicularis* | Needle spikerush | 5 |
| *Eleocharis erythropoda* | Bald spikerush | 3 |
| *Eleocharis palustris* | Creeping spikerush | 6 |
| *Elodea canadensis* | Common waterweed | 3 |
| *Eriocaulon aquaticum* | Pipewort | 9 |
| *Heteranthera dubia* | Water star-grass | 6 |
| *Juncus pelocarpus f. submersus* | Brown-fruited rush | 8 |
| *Lemna minor* | Small duckweed | 4 |
| *Lobelia dortmanna* | Water lobelia | 10 |
| *Myriophyllum alterniflorum* | Alternate-flowered water-milfoil | 10 |
| *Myriophyllum sibiricum* | Northern water-milfoil | 6 |
| *Myriophyllum tenellum* | Dwarf water-milfoil | 10 |
| *Najas flexilis* | Slender naiad | 6 |
| *Nitella* sp. | Nitella | 7 |
| *Nuphar variegata* | Spatterdock | 6 |
| *Nymphaea odorata* | White water lily | 6 |
| *Pontederia cordata* | Pickerelweed | 8 |
| *Potamogeton alpinus* | Alpine pondweed | 9 |
| *Potamogeton amplifolius* | Large-leaf pondweed | 7 |
| *Potamogeton epihydrus* | Ribbon-leaf pondweed | 8 |
| *Potamogeton foliosus* | Leafy pondweed | 6 |
| *Potamogeton friesii* | Fries' pondweed | 8 |
| *Potamogeton gramineus* | Variable pondweed | 7 |
| *Potamogeton illinoensis* | Illinois pondweed | 6 |
| *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 zosteriformis* | Flat-stem pondweed | 6 |
| *Ranunculus aquatilis* | White water crowfoot | 8 |
| *Ranunculus flammula* | Creeping spearwort | 9 |
| *Sagittaria cristata* | Crested arrowhead | 9 |
| *Sagittaria latifolia* | Common arrowhead | 3 |
| *Schoenoplectus acutus* | Hardstem bulrush | 6 |
| *Sparganium angustifolium* | Narrow-leaved bur-reed | 9 |

**Table 5 (cont'): Floristic Quality Index of Aquatic Macrophytes**
**Red Lake, Douglas County**
**July 30, 2017**

| Species | Common Name | C |
|---|---|---|
| *Sparganium emersum* | Short-stemmed bur-reed | 8 |
| *Spirodela polyrhiza* | Large duckweed | 5 |
| *Typha latifolia* | Broad-leaved cattail | 1 |
| *Utricularia minor* | Small bladderwort | 10 |
| *Utricularia resupinata* | Small purple bladderwort | 9 |
| *Utricularia vulgaris* | Common bladderwort | 7 |
| *Vallisneria americana* | Wild celery | 6 |
| | | |
| **N** | | **50** |
| **Mean C** | | **6.9** |
| **FQI** | | **48.5** |

## Comparison of Filamentous Algae in 2013 an 2017:

Filamentous algae, normally associated with excessive nutrients in the water column, were located at a single survey point with a rake fullness of 1 in 2013. In addition to the highly significant increase in distribution **($p<0.001$)** to 13 points in 2017, it also increased in density to a mean rake fullness of 1.15. Most sites were located in the northeast bay, and we found several thick mats near the docks of the Red Lake Lodge (Figure 14).

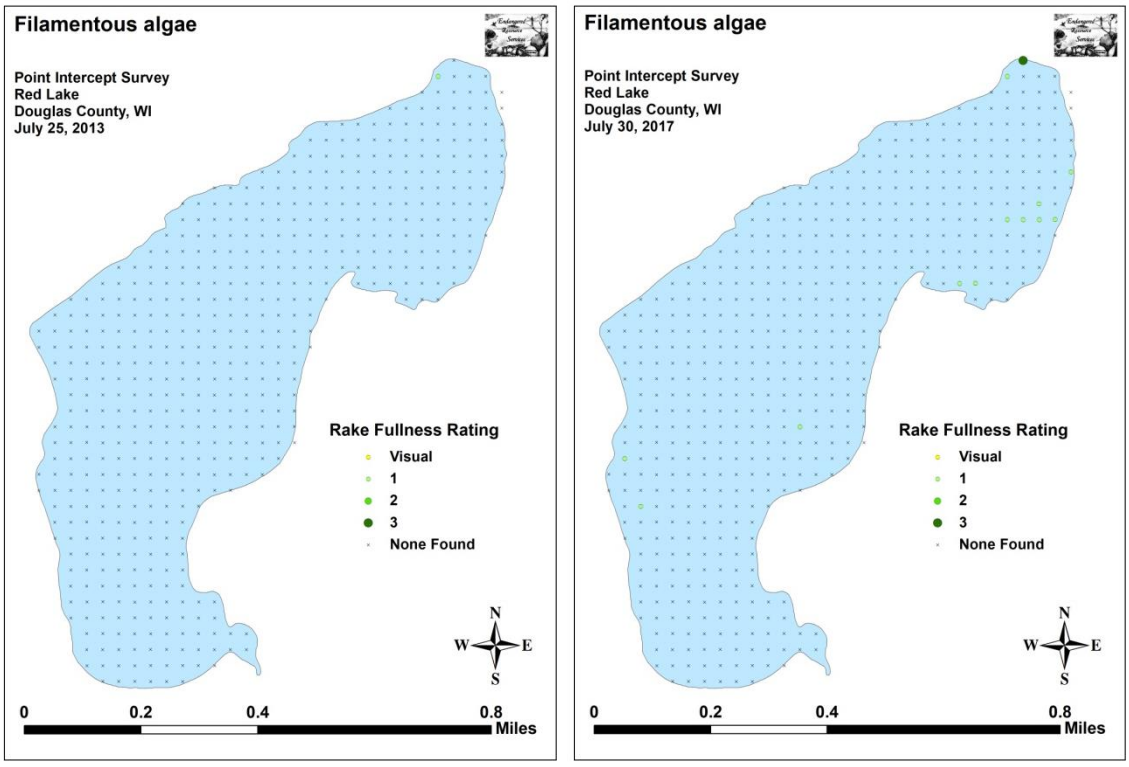



**Figure 14: 2013and 2017 Filamentous Algae Density and Distribution**

## July Eurasian Water-milfoil Distribution:

We did **NOT** find any evidence of Eurasian water-milfoil at or near any survey point during the July survey. We also didn't see any evidence of floating fragments. In fact, had we not gone back to check each of the beds located in fall 2016, we wouldn't have know EWM was present in the lake. The only evidence of EWM we saw was a small area between survey points 295, 296, 311, and 312 at the core of the treatment area in what had been Bed 5. Even here, most EWM plants were raked up were dead. However, a few of the largest plants had survived and were regrowing from severely burned root crowns (Figure 15) (Appendix VIII).

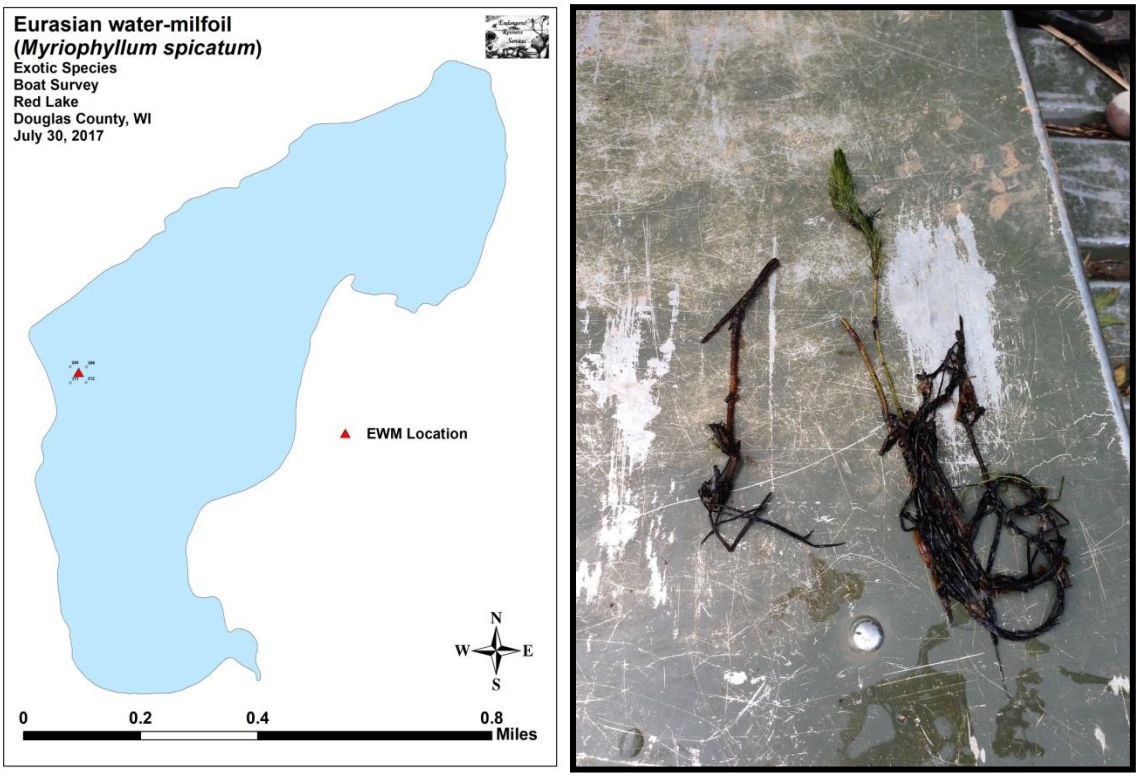



**Figure 15: 2017 July Eurasian Water-milfoil Bed – EWM Regrowing from Root Crown**

## Other Exotic Plant Species:

Other than EWM, we saw no evidence of Curly-leaf pondweed (*Potamogeton crispus*), Purple loosestrife (*Lythrum salicaria*), Reed canary grass (*Phalaris arundinacea*), or any other exotic plant species on Red Lake. The small stand of Narrow-leaved cattail (*Typha angustifolia*) we found in the northwest corner bay on the western shoreline during the original 2013 survey was not present in 2017. Native to southern but not northern Wisconsin, this species is potentially invasive in that it often excludes the native Broad-leaved cattail from places where the two are found together. 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 16). As the lake offers little of the organic muck shoreline habitat that cattails prefer, it seems unlikely that either species will become invasive on Red Lake. However, if residents find cattails growing along their shoreline and determine them to be exotic, they may want to consider removing them (For more information on a sampling of aquatic exotic invasive plant species, see Appendix VIII).

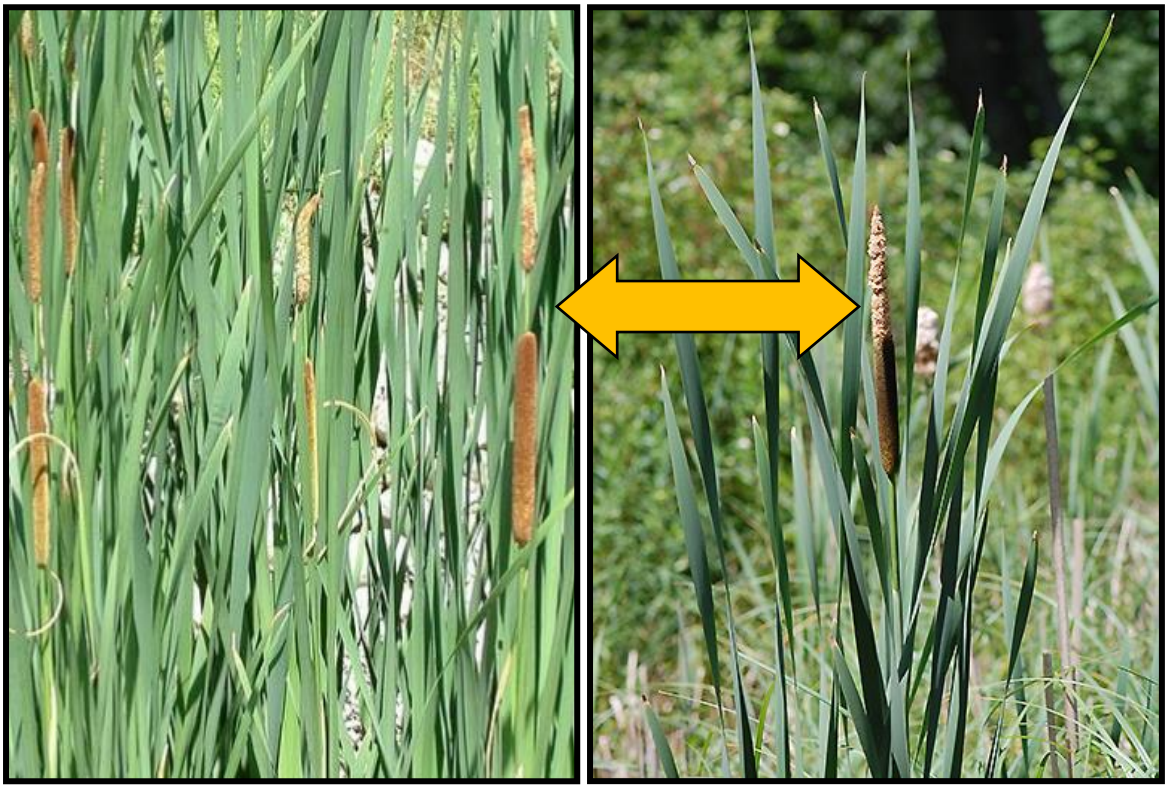


**Figure 16: Exotic Hybrid and Native Broad-leaved Cattail Identification**

## Fall Eurasian Water-milfoil Bed Mapping Survey:

During the fall survey, we had bright overhead sun, and winds were calm or nearly calm making for good to excellent survey condition. Overall clarity, however, was only fair as the water was somewhat "milky", and we could only see the bottom clearly in 5-7ft meaning short EWM plants in deep water may have gone unnoticed. In total, we searched over 21km (13.1 miles) of transects within Red Lake's visible littoral zone (Figure 17). Because almost all Eurasian water-milfoil found in 2016 was growing in 8-11ft over sandy muck on the outer edge of the rooted littoral zone, we spent extra time searching in this ecological niche where EWM seems to have a significant competitive advantage and was having the easiest time establishing.

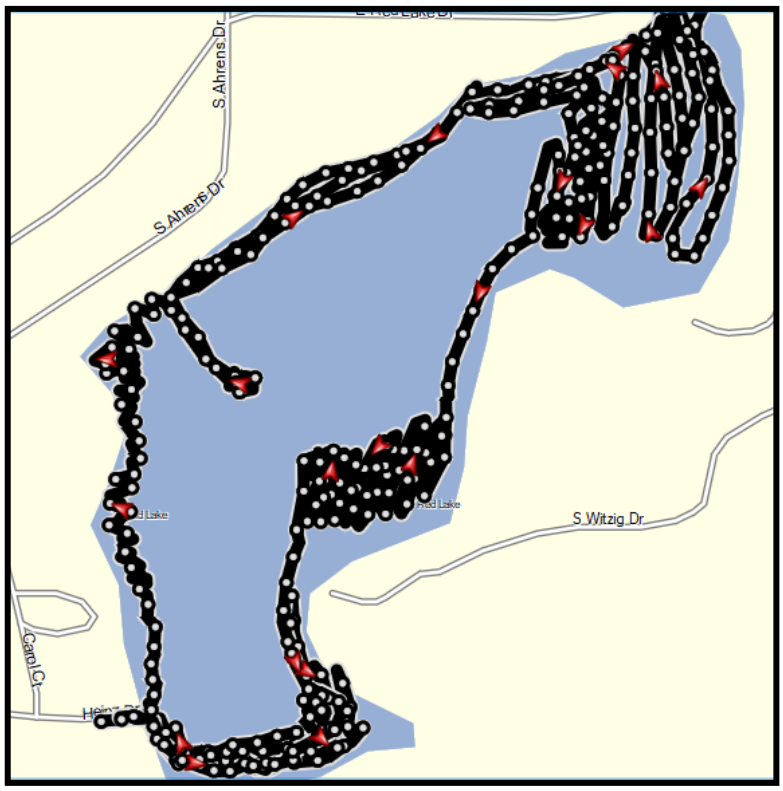



**Figure 17: 2017 Fall EWM Bed Mapping Survey Transects**

As in July, the only bed found was at the core of the area formerly covered by Bed 5 (Figure 18) (Appendix IX). Covering 0.09 acre or approximately 0.003% of the lake's surface area, it represented a 94.4% decline from the 1.18 acres mapped in the fall of 2016 (Table 6). Outside of this bed, we found and removed six individual plants – three in the south bay, and three in the northeast bay near the Red Lake Lodge's docks.

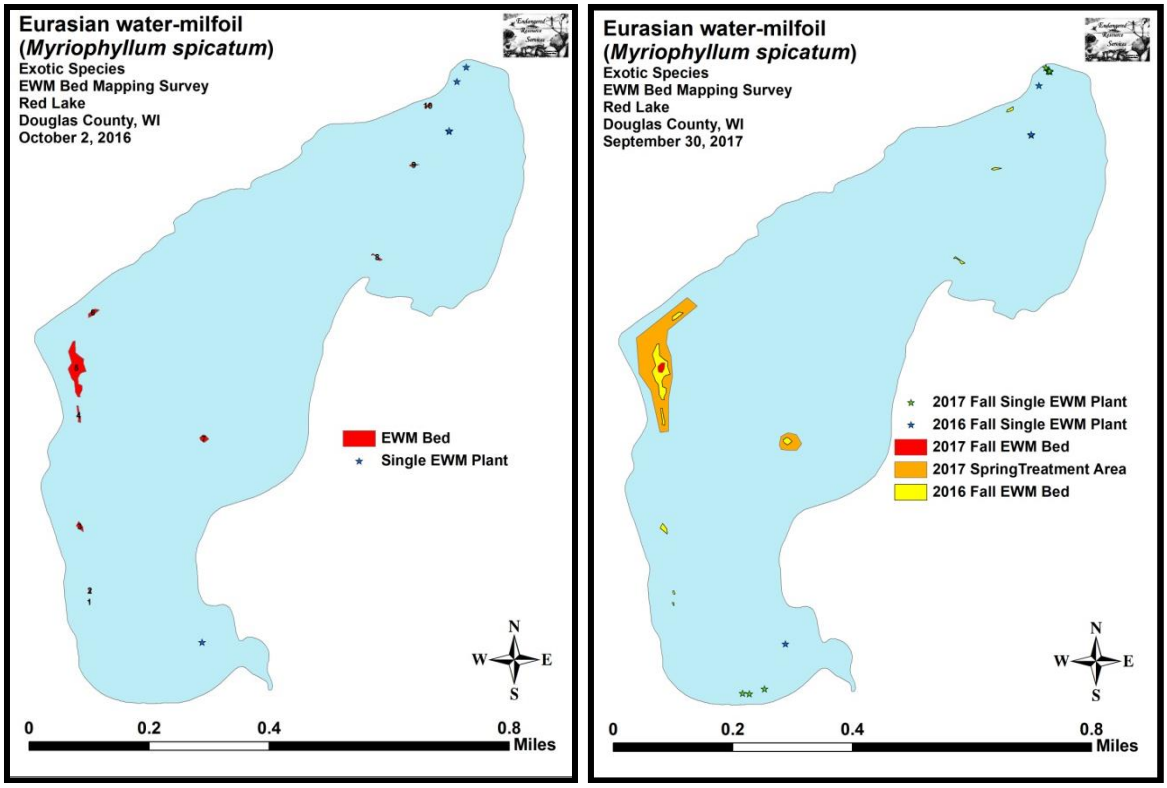



**Figure 18: 2016 and 2017 Fall EWM Bed Maps**

## Descriptions of Past and Present EWM Beds:

South Bay – We found three large multi-stemmed towers in 5-8ft of water along the visible littoral edge mixed in with beds dominated by Northern water-milfoil. Each plant was near canopy and had rooted fragments that fell off the stems when we raked the plants out. Because of this and the fact that the root crowns were intertwined with other plants, we believe it is unlikely that EWM was completely eliminated from this area. Scheduling a revisit to this flat should be a priority in 2018.

Beds 1, 2 and 3 – Despite extensive searching in the 8-11ft bathy ring, we were unable to relocate these three narrow microbeds that we found growing along the western shoreline in 2016. Common loons (*Gavia immer*), which originally tipped us off to the presence of these beds, were again seen foraging along this shoreline. Unfortunately, following the birds didn't turn up any beds in 2017. Although it's possible the plants died over the winter, we expect that that is NOT the case and that the reason we didn't relocate them was the poor water clarity we experienced during the fall 2017 survey.

Beds 4, 5, and 6 – The areas that were chemically treated with Diquat continued to be EWM free with the exception of the core area where we found surviving plants in July. Plants that ranged from 1-4ft over the summer (Figure 19) were nearing canopy in 8-10ft of water by fall. Although we didn't find any floating fragments, satellite plants were radiating out from the core in all directions as they recolonized areas left barren by the herbicide treatment.

**Figure 19: Significant EWM Regrowth from Chemically Burned Roots**

Bed 7 – We found no evidence of EWM in or around the treatment area on the broad eastern flat of the lake.

Beds 8, 9 and 10 – After we rake removed plants from these areas in fall 2016, we found no evidence of surviving plants in 2017.

Northeast Bay – The three EWM plants growing near the Red Lake Lodge's docks were canopied in 3-4ft of water. Each was multi-stemmed and actively fragmenting, but we believe we were successful in removing each of the plants. A shallow area where motor start-ups continually scour the bottom, this will continue to be a likely area of establishment for floating fragments of EWM carried by the prevailing summer winds.

**Table 6: Fall Eurasian Water-milfoil Bed Mapping Summary**
**Red Lake, Douglas County**
**September 30, 2017**

| Bed Number | 2017 Area in Acres | 2016 Area in Acres | Change in Acreage | Rake Range and Mean Rake Fullness | Field Notes |
|---|---|---|---|---|---|
| 1 | 0 | <0.01 | -<0.01 | 0 | No EWM seen. |
| 2 | 0 | <0.01 | -<0.01 | 0 | No EWM seen. |
| 3 | 0 | 0.06 | -0.06 | 0 | No EWM seen. |
| 4 | 0 | 0.06 | -0.06 | 0 | No EWM seen. |
| 5 | 0.09 | 0.83 | -0.74 | <1-3; 2 | EWM rapidly reestablishing |
| 6 | 0 | 0.07 | -0.07 | 0 | No EWM seen. |
| 7 | 0 | 0.07 | -0.07 | 0 | No EWM seen. |
| 8 | 0 | 0.03 | -0.03 | 0 | No EWM seen. |
| 9 | 0 | 0.03 | -0.03 | 0 | No EWM seen. |
| 10 | 0 | 0.03 | -0.03 | 0 | No EWM seen. |
| **Total** | **0.09** | **1.18** | **-1.09** | | |

## DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

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

Red Lake continues to have a healthy native plant community that is dominated by high value species that tend to be both sensitive and rare. Like trees in a forest, these plants are the basis of the aquatic ecosystem. They capture the sun's energy and turn it into usable food, "clean" the water of excess nutrients, and provide habitat for other organisms like aquatic invertebrates and the lake's fish populations. Because of this, preserving them is critical to maintaining the lake's overall health.

The majority of property owners on the lake are practicing sound shoreline conservation, but 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 initial 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 improve water clarity and quality, but also to benefit the lake's native plant species.

### Eurasian Water-milfoil Management:

Eurasian water-milfoil currently occupies only a small percentage of the lake's surface area, but it is widely-established making eradication an unrealistic expectation. With this in mind, controlling its spread in the most cost effective manner possible while simultaneously minimizing its impact on the lake's aquatic ecosystem will likely be another important goal for the lake association moving forward.

The initial treatment in 2017 appears to have been highly successful at knocking back, but not eliminating EWM within the northwest treatment area. The surviving bed is likely too large for manual removal by SCUBA divers to be an effective control strategy; however, this doesn't mean dive removal shouldn't be considered in other areas of the lake. Although our 2017 fall survey didn't find plants in the narrow littoral areas on the western shoreline where small EWM beds were present in 2016, we believe it is likely there are some surviving plants in these areas. Due to the difficulty in treating small beds adjacent to deep water, we believe these beds, if EWM plants are still present, would make excellent candidates for manual removal; especially if volunteers that are SCUBA certified already exist on the lake.

Red Lake has a significant amount of the very similar looking Northern water-milfoil – a valuable native plant that provides important fish habitat and is likely to be heavily impacted by any future chemical treatments. NWM is widely distributed throughout the lake's rooted littoral zone, but does best over sandy and organic muck. Despite its superficial resemblance to EWM, Northern water-milfoil can be told apart by its leaflets numbering <24 that are usually held rigidly at 90 degree angles off the stem when out of water. Conversely, EWM normally has >26 leaflets that fall limp against the stem when out of water (Figure 20). EWM also tends to have a bright red growth tip on the top of the plant whereas NWM has a bright lime green growth tip. NWM on Red Lake is often mixed with other plants, is seldom bed-forming, and rarely canopies on the surface; whereas EWM was often found in nearly monotypic beds that excluded most native species and canopied even in deep water. In the fall, NWM also forms winter buds on the tips of shoots whereas EWM has none. These buds were readily visible during the fall survey (Figure 21).

**Eurasian water-milfoil** **Northern water-milfoil**

**Figure 20: EWM and Northern Water-milfoil Identification (Berg 2007)**

**Figure 21: Limp Nature of EWM Leaflets along Stem – Stiff Nature of NWM Leaflets along Stem and Overwintering Turions**

Because there is so much available habitat for Eurasian water-milfoil on the lake, we encourage all residents on to be on the lookout for new beds and promptly contact us (saintcroixdfly@gmail.com and/or 715-338-7502) with a picture, specimen, description of, and/or preferably GPS coordinates of anything they find that looks suspicious. These locations could then be added to the existing map for management consideration. To help with this effort, presenting all residents on the lake with "WANTED" posters that show the differences between our native Northern water-milfoil and exotic Eurasian water-milfoil along with our contact information is another idea for the RLA to consider.

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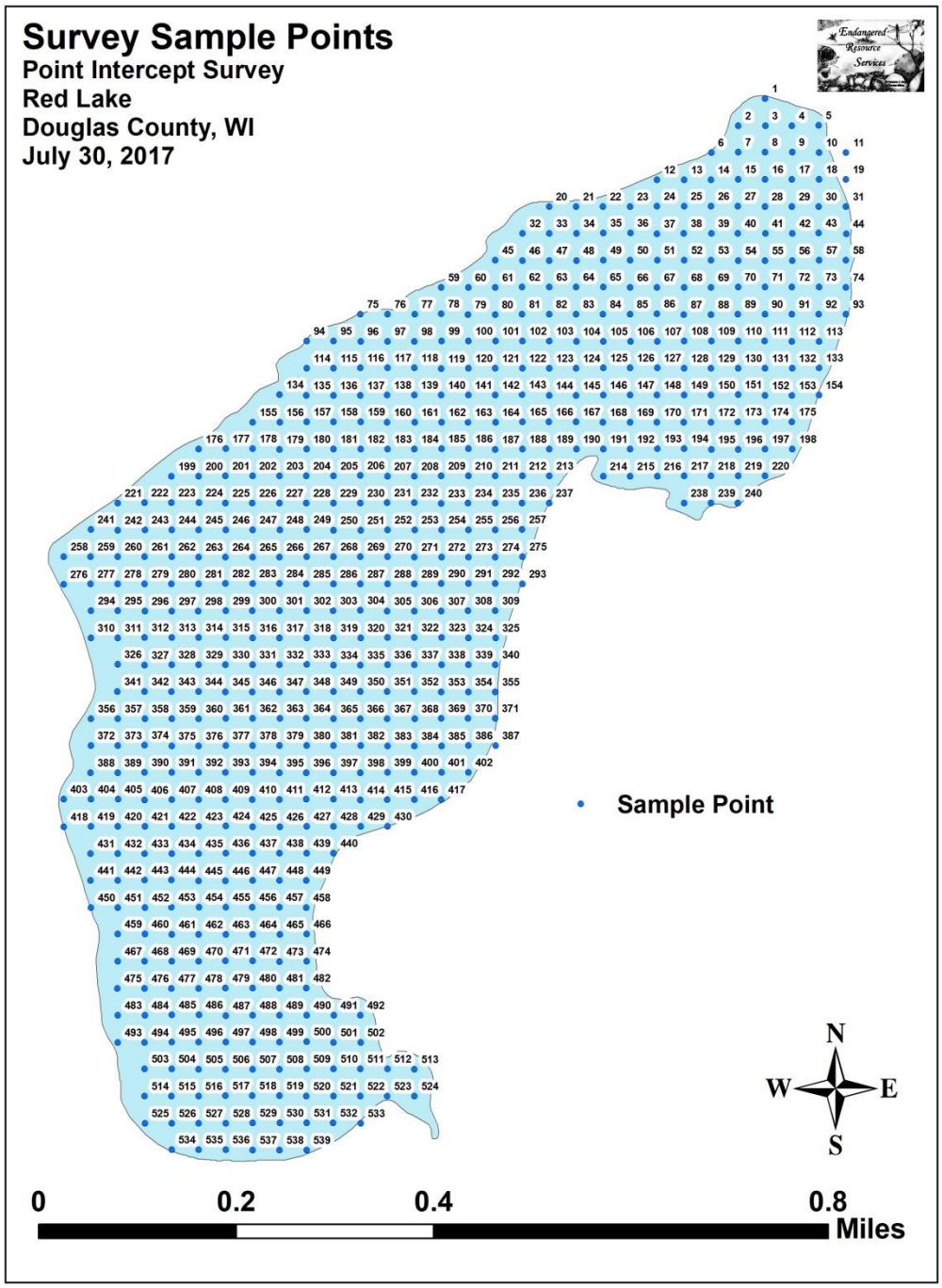
## Appendix I:  Survey Sample Points Map


Survey Sample Points
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Sample Point
N
W
E
S
0
0.2
0.4
0.8
Miles

# Appendix II:  Boat and Vegetative Survey Data Sheets

| **Boat Survey** | |
|---|---|
| **Lake Name** | |
| **County** | |
| **WBIC** | |
| **Date of Survey** | |
| **(mm/dd/yy)** | |
| **workers** | |
| | |
| **Nearest Point** | **Species seen, habitat information** |
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| Observers for this lake: names and hours worked by each: | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake: | | | | | | | | | WBIC | | | | | | | | | County | | | | | | Date: | |
| Site # | Depth (ft) | Muck (M), Sand (S), Rock (R) | Rake pole (P) or rake rope (R) | Total Rake Fullness | EWM | CLP | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | |
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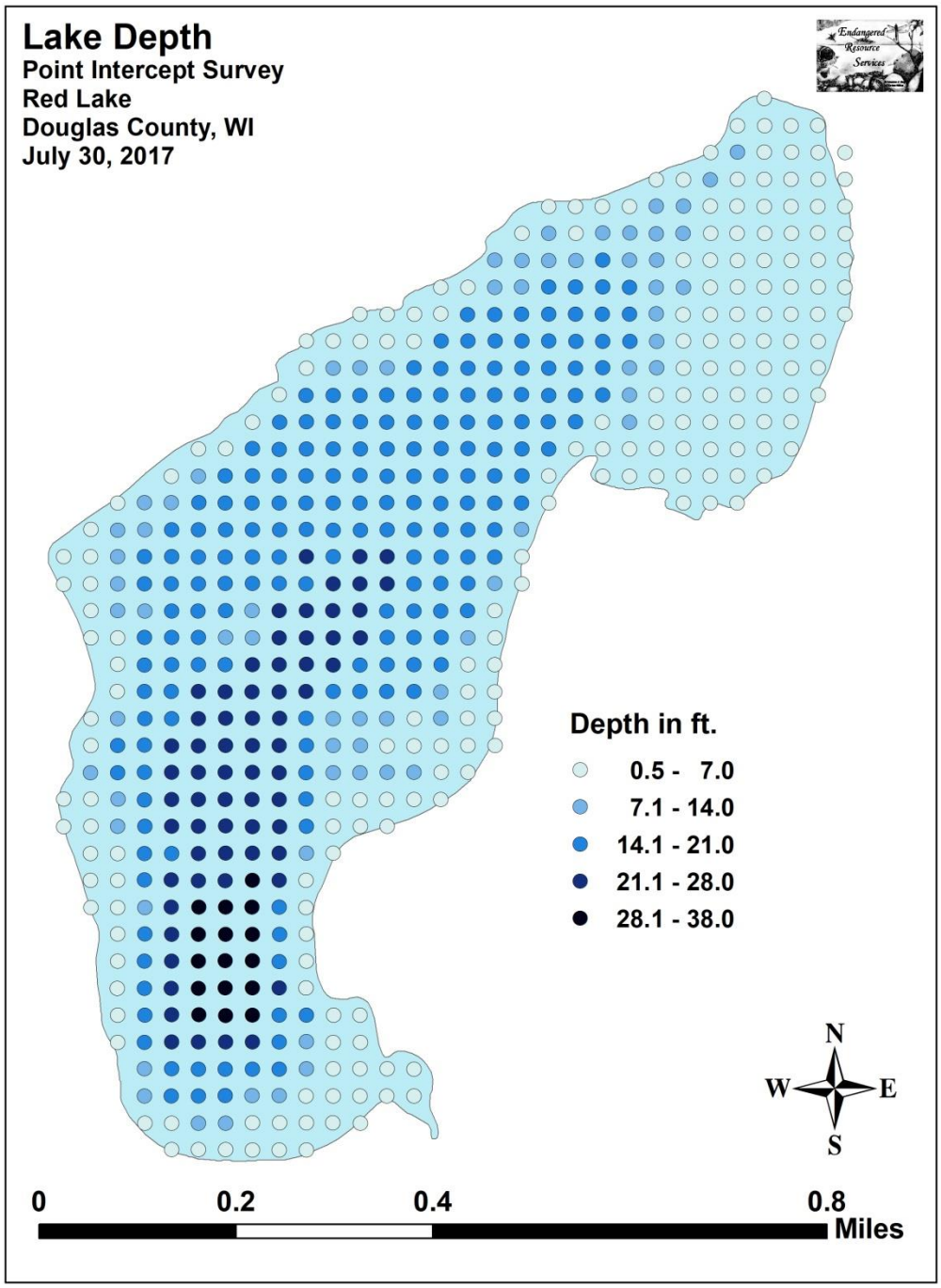
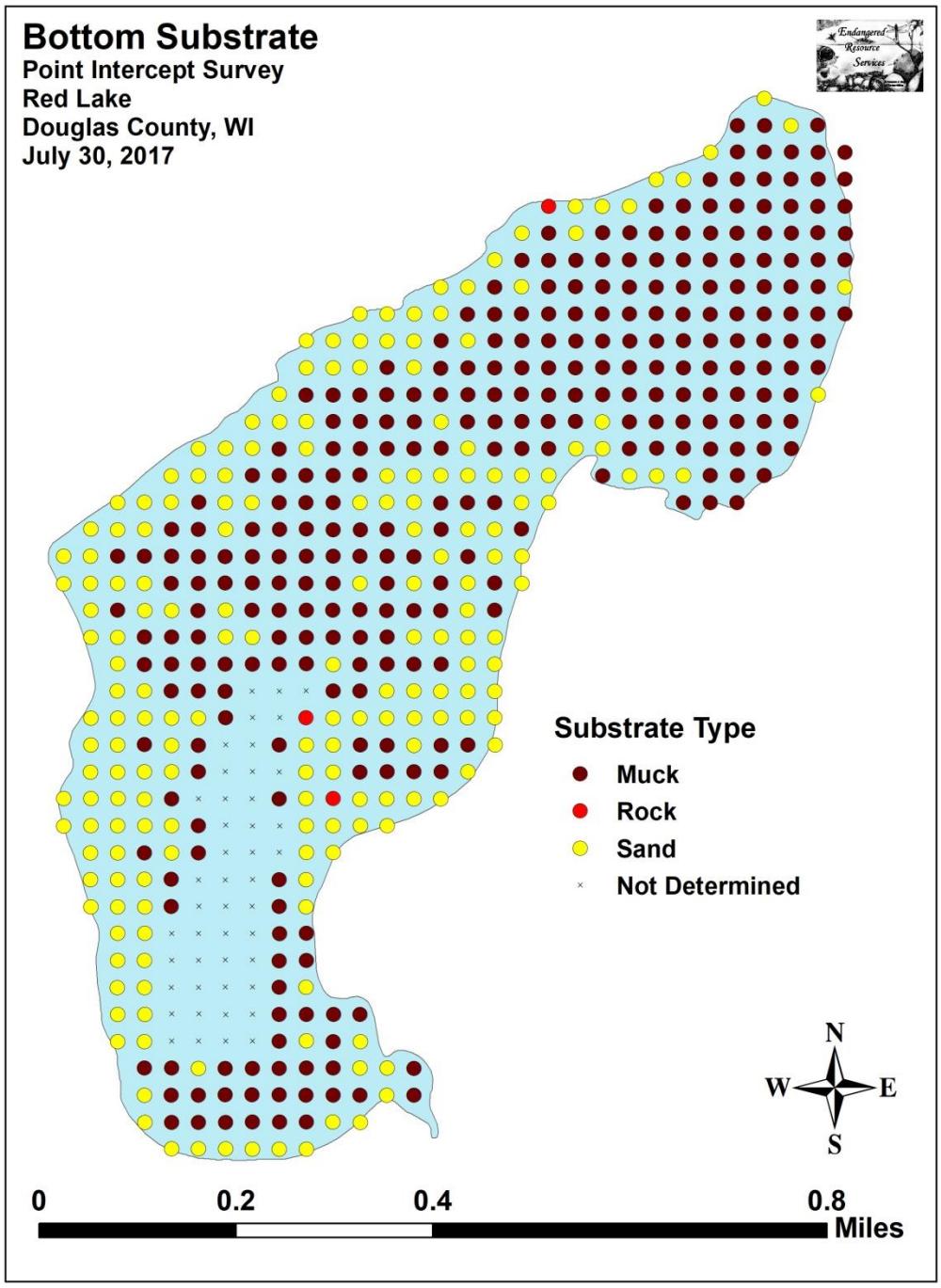
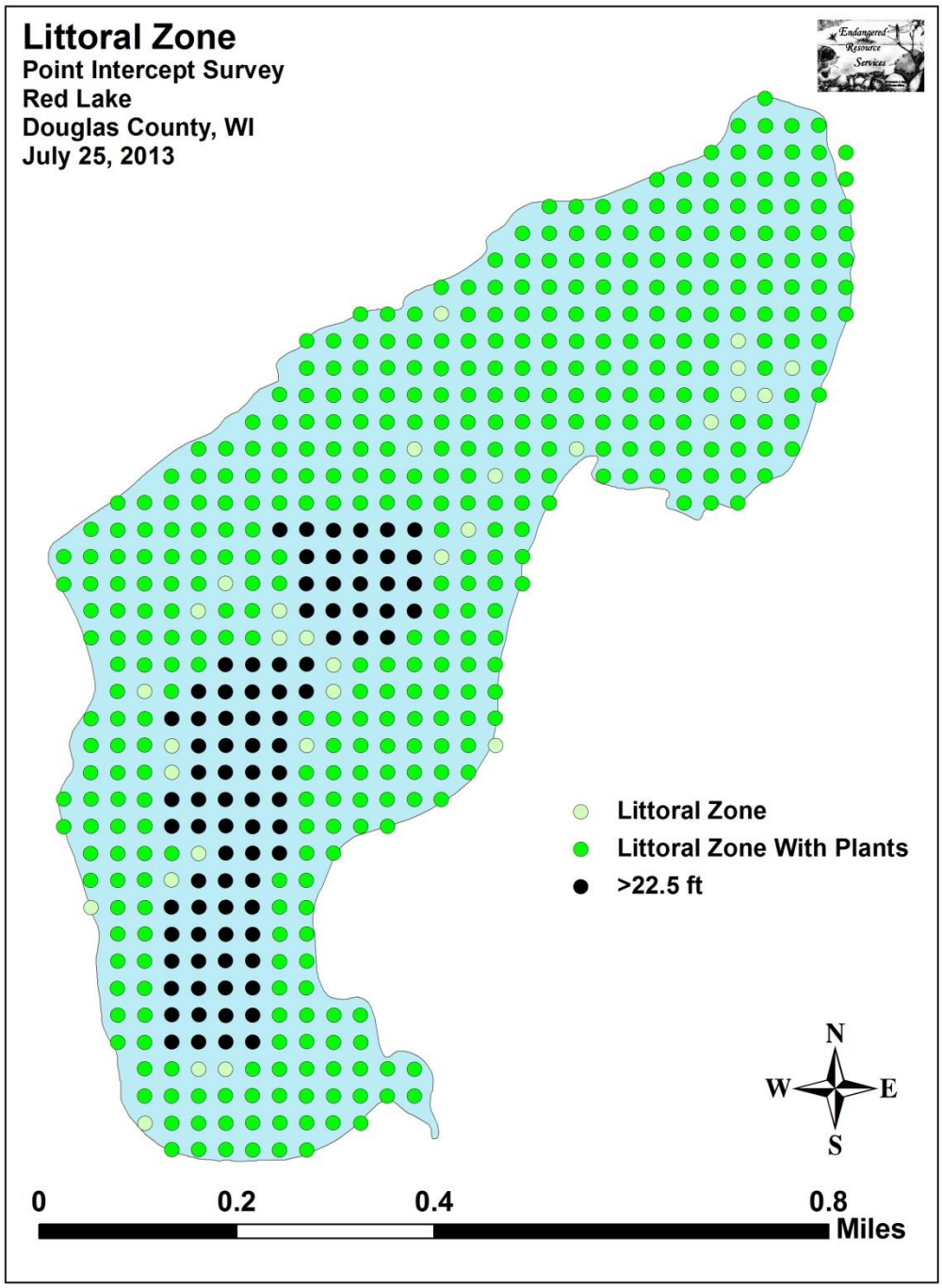
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | |

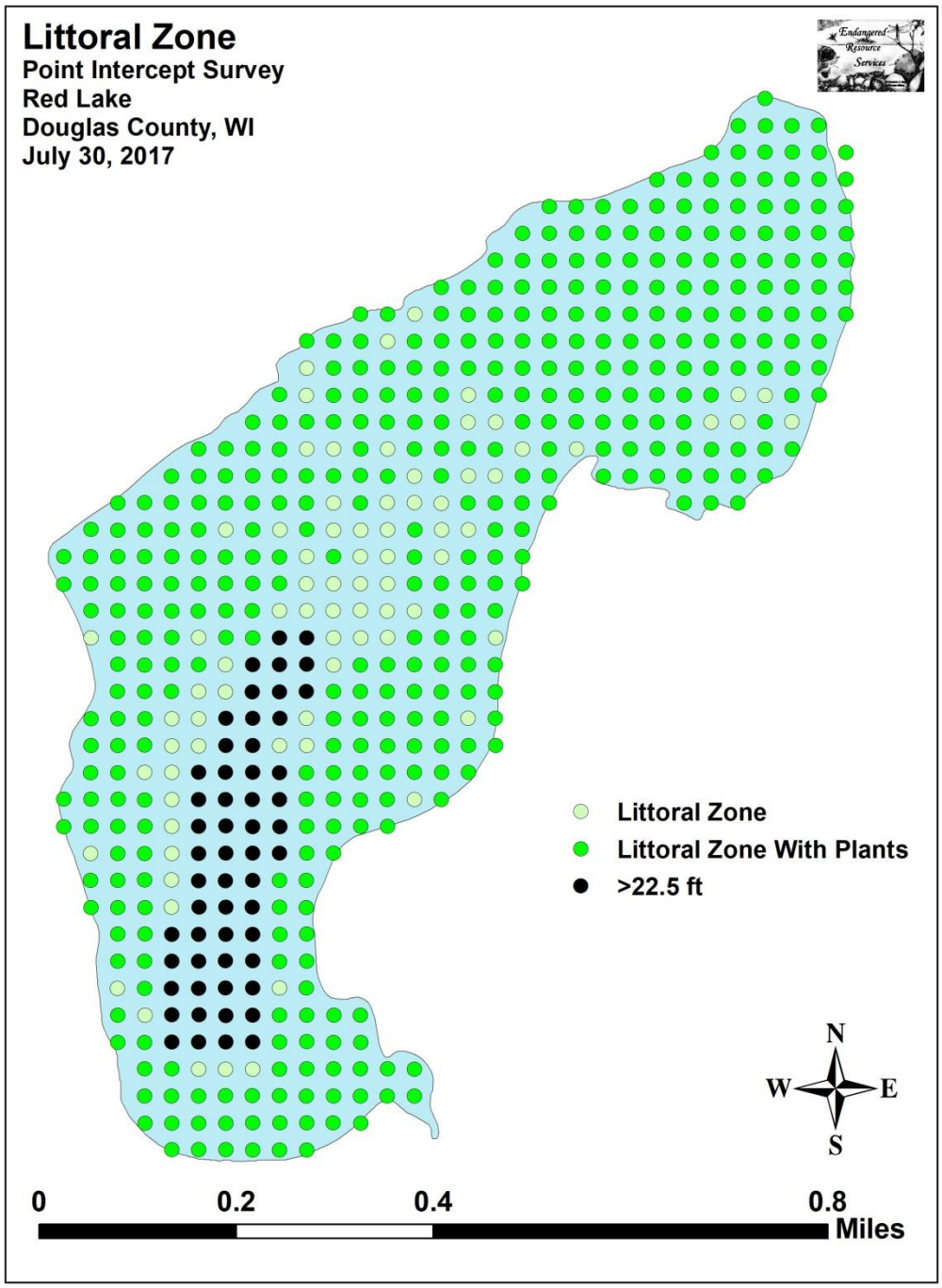
# Appendix III:  Habitat Variable Maps

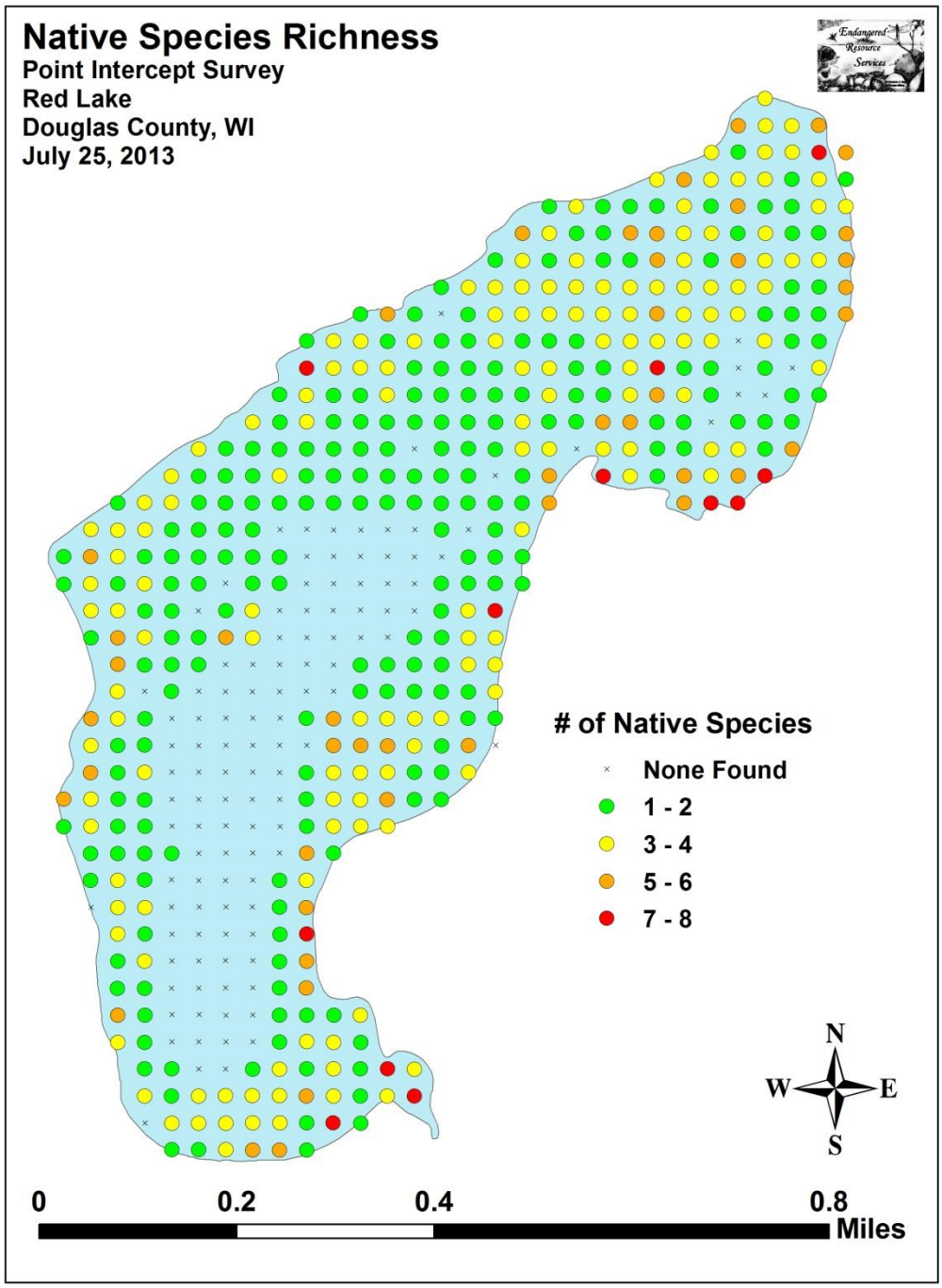

Lake Depth
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Depth in ft.
0.5 - 7.0
7.1 - 14.0
14.1 - 21.0
21.1 - 28.0
28.1 - 38.0
N
W
E
S
0
0.2
0.4
0.8
Miles

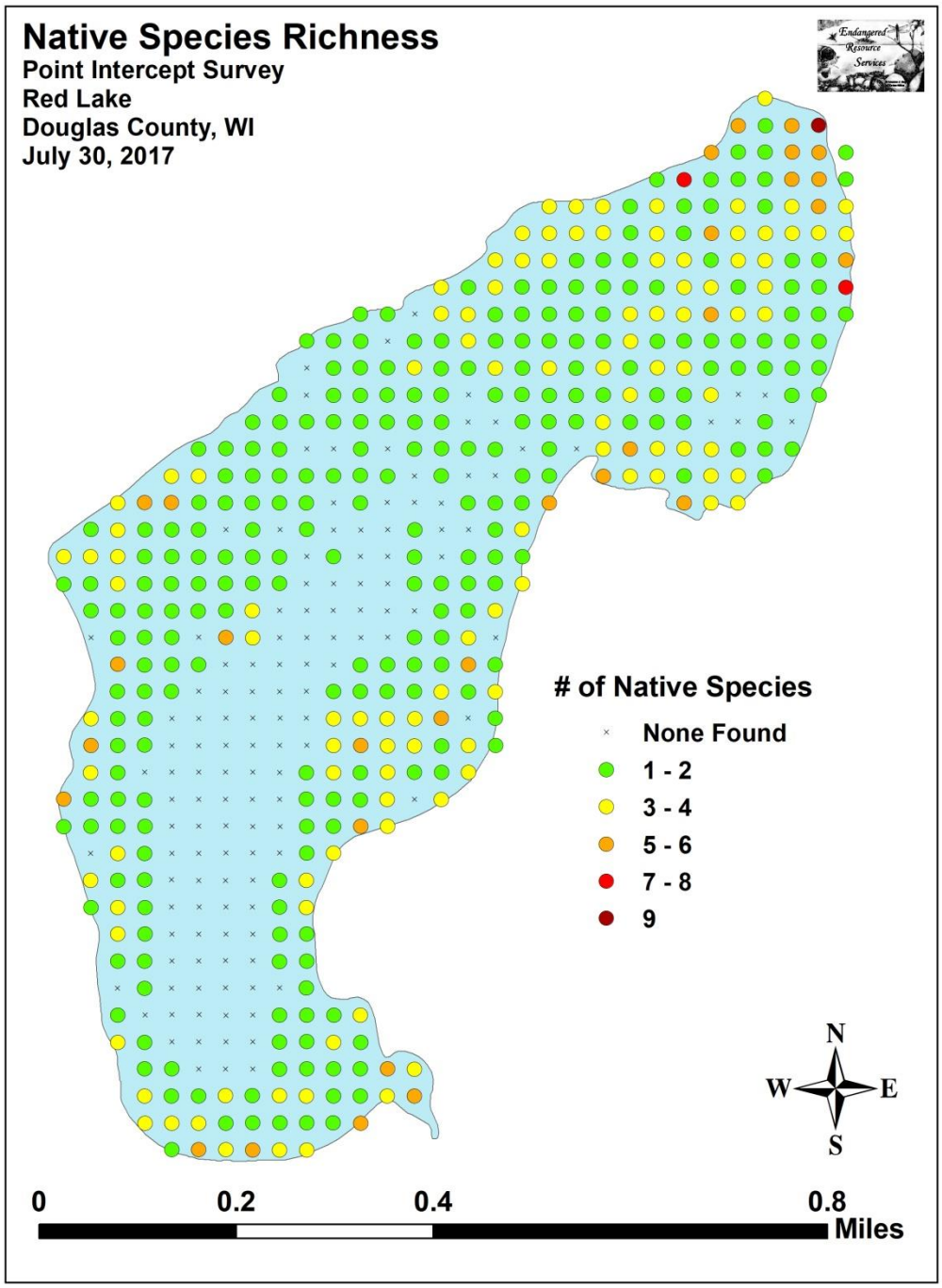

Bottom Substrate
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Substrate Type
Muck
Rock
Sand
Not Determined
N
W
E
S
0
0.2
0.4
0.8
Miles

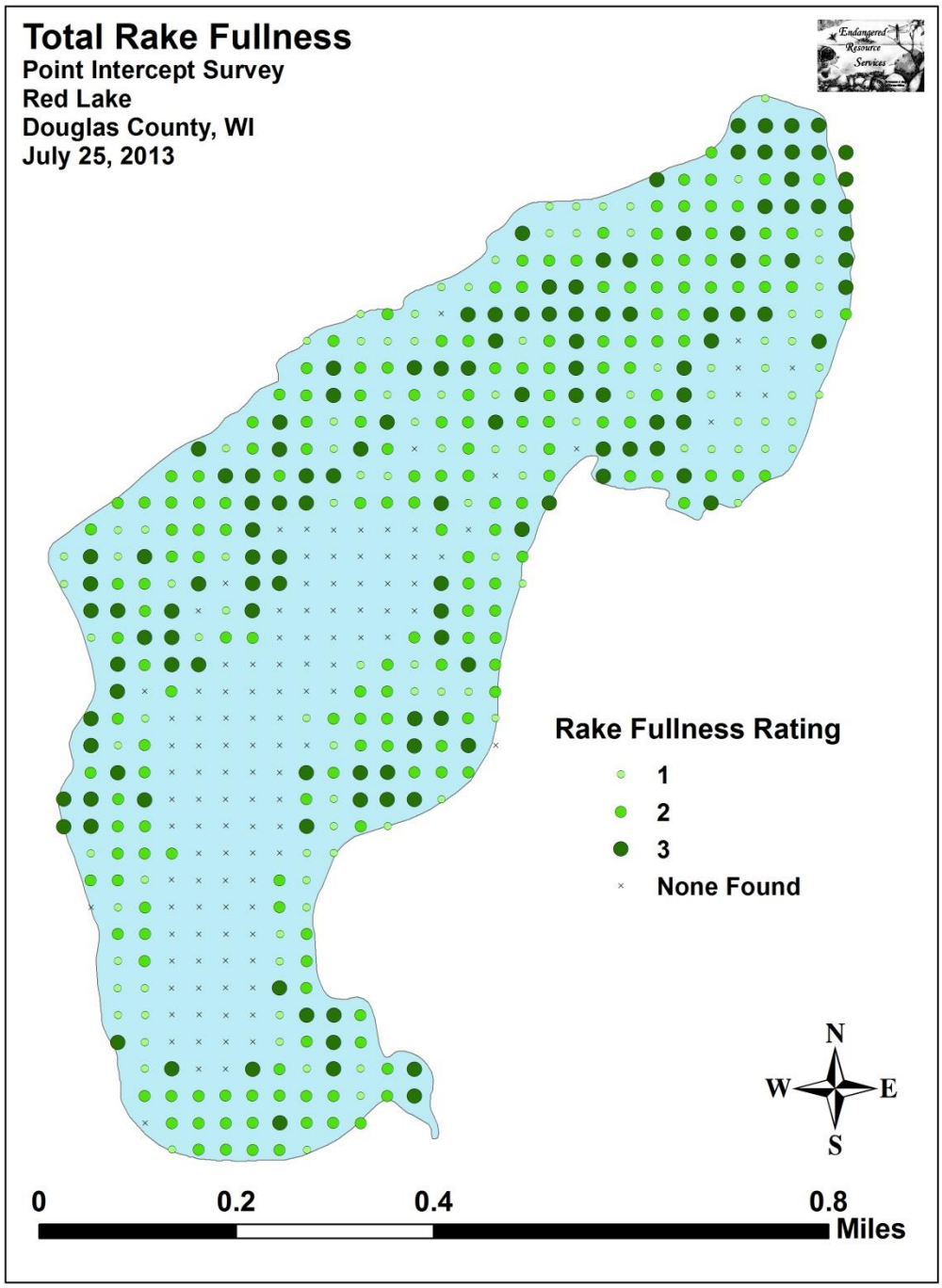
## Appendix IV: 2013 and 2017 Littoral Zone, Native Species Richness and Total Rake Fullness Maps

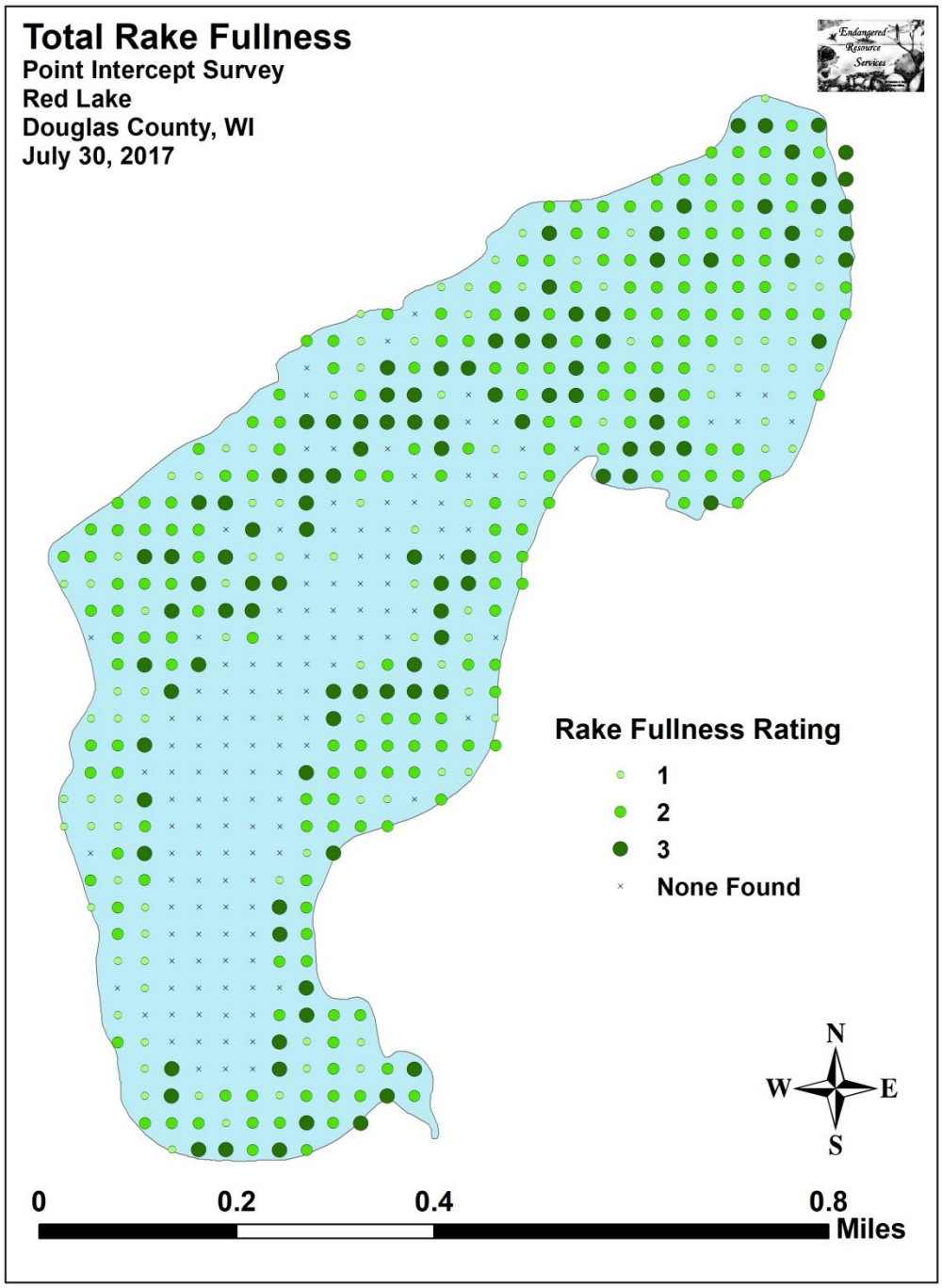

Littoral Zone
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Littoral Zone
Littoral Zone With Plants
>22.5 ft
N
W
E
S
0
0.2
0.4
0.8
Miles


Littoral Zone
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Littoral Zone
Littoral Zone With Plants
>22.5 ft
N
W
E
S
0
0.2
0.4
0.8
Miles

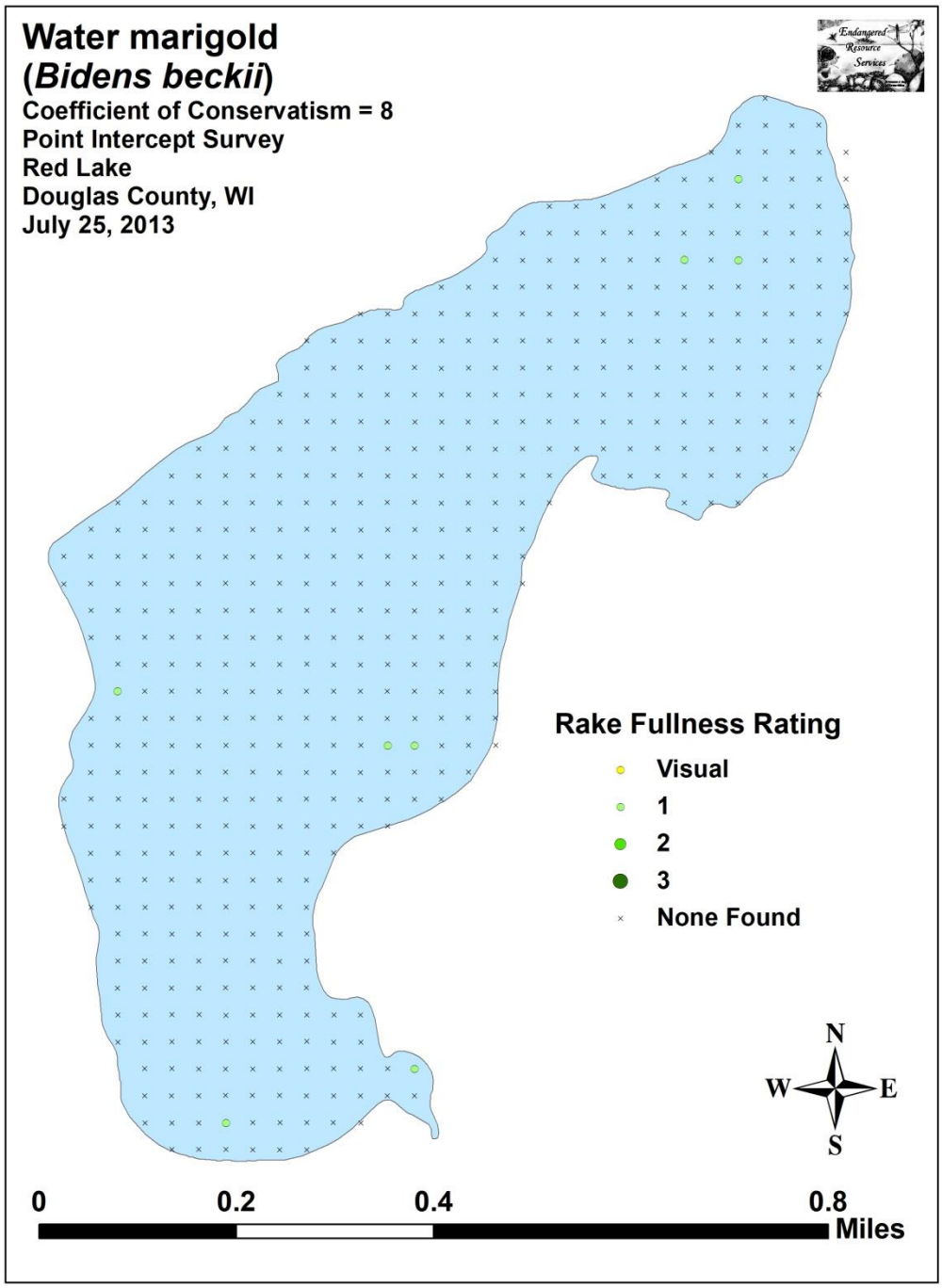

Native Species Richness
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
N
W
E
S
0
0.2
0.4
0.8
Miles

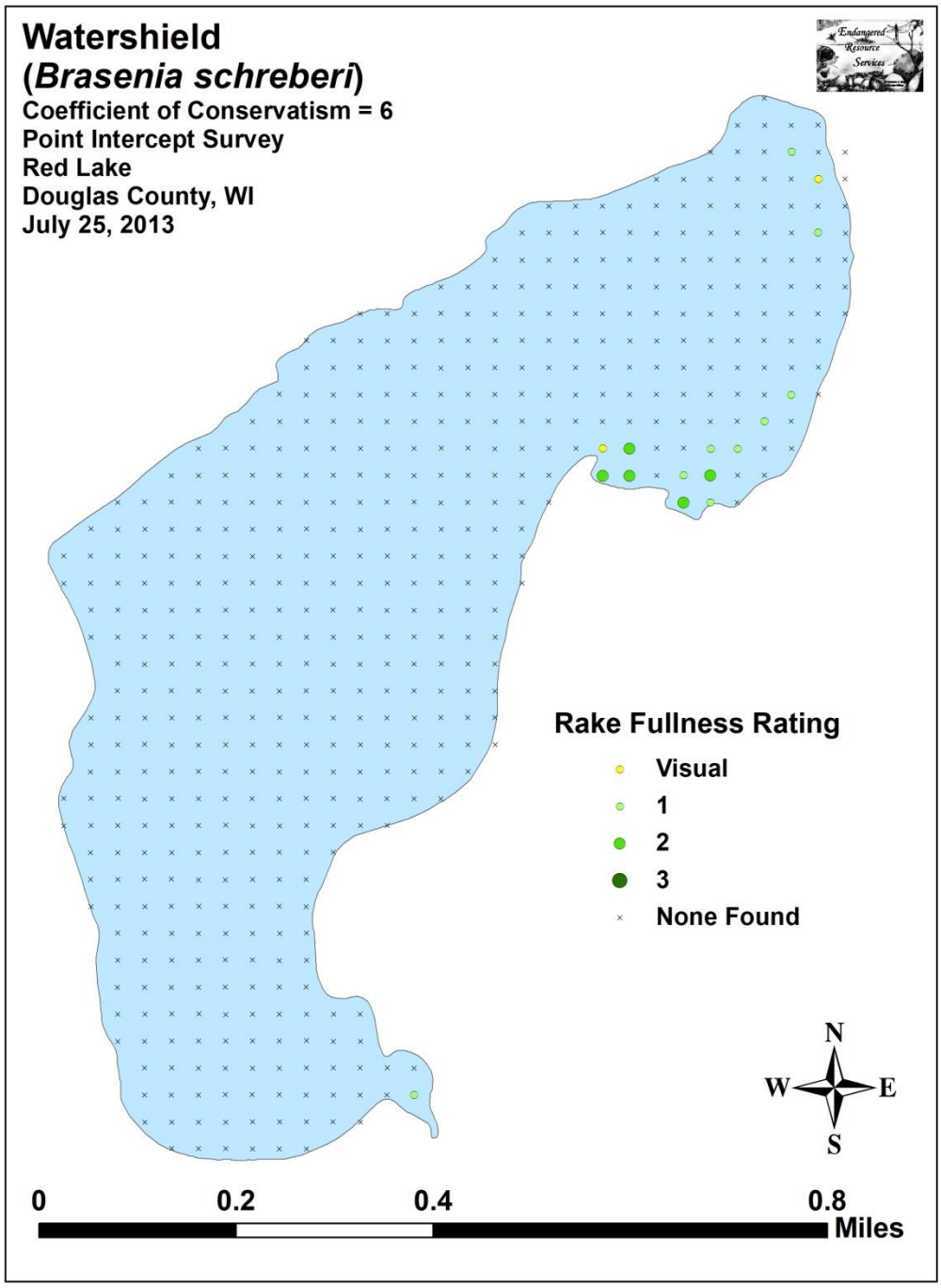

Native Species Richness
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
# of Native Species
None Found
1 - 2
3 - 4
5 - 6
7 - 8
9
N
W
E
S
0
0.2
0.4
0.8
Miles

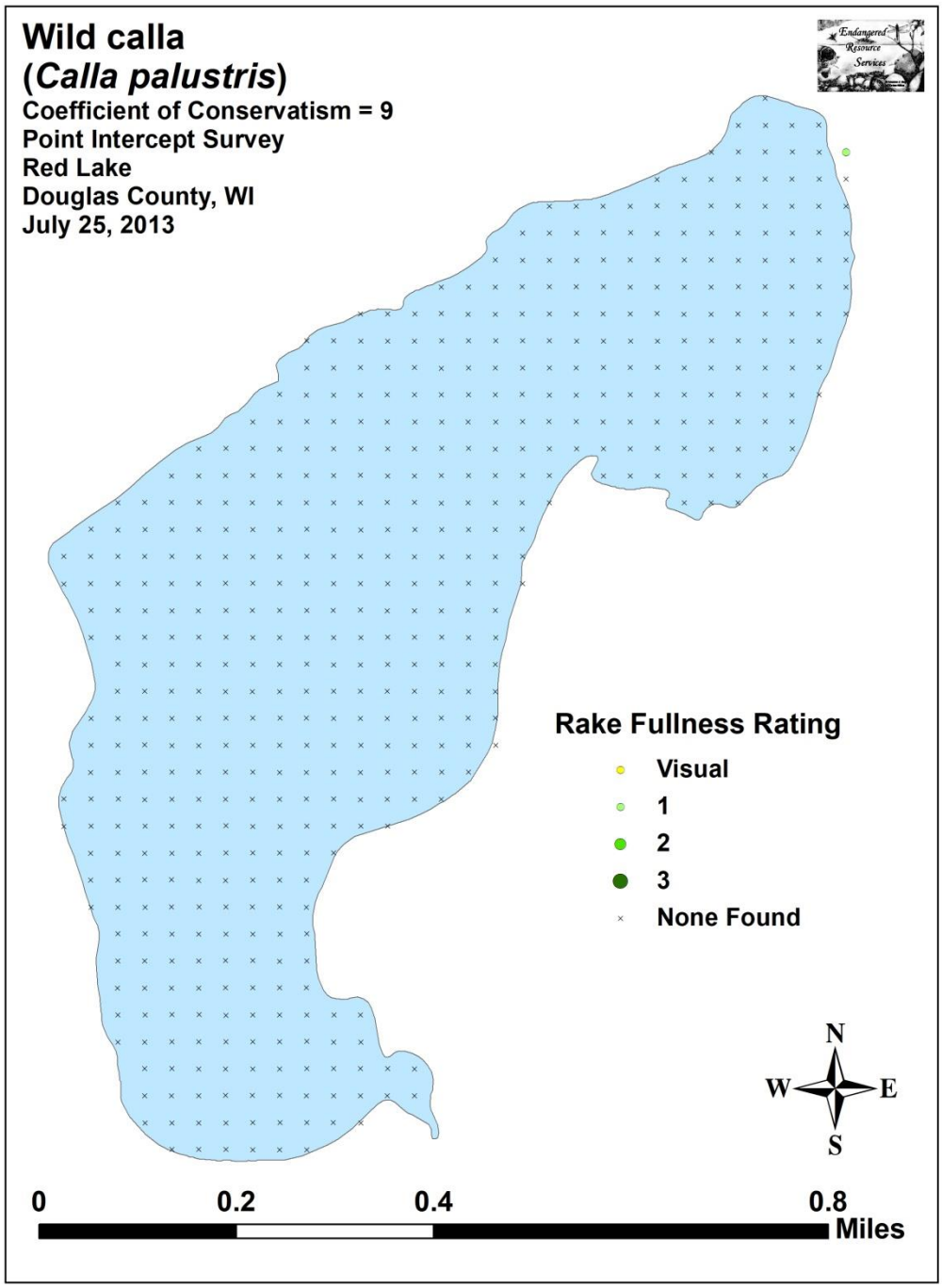

Total Rake Fullness
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

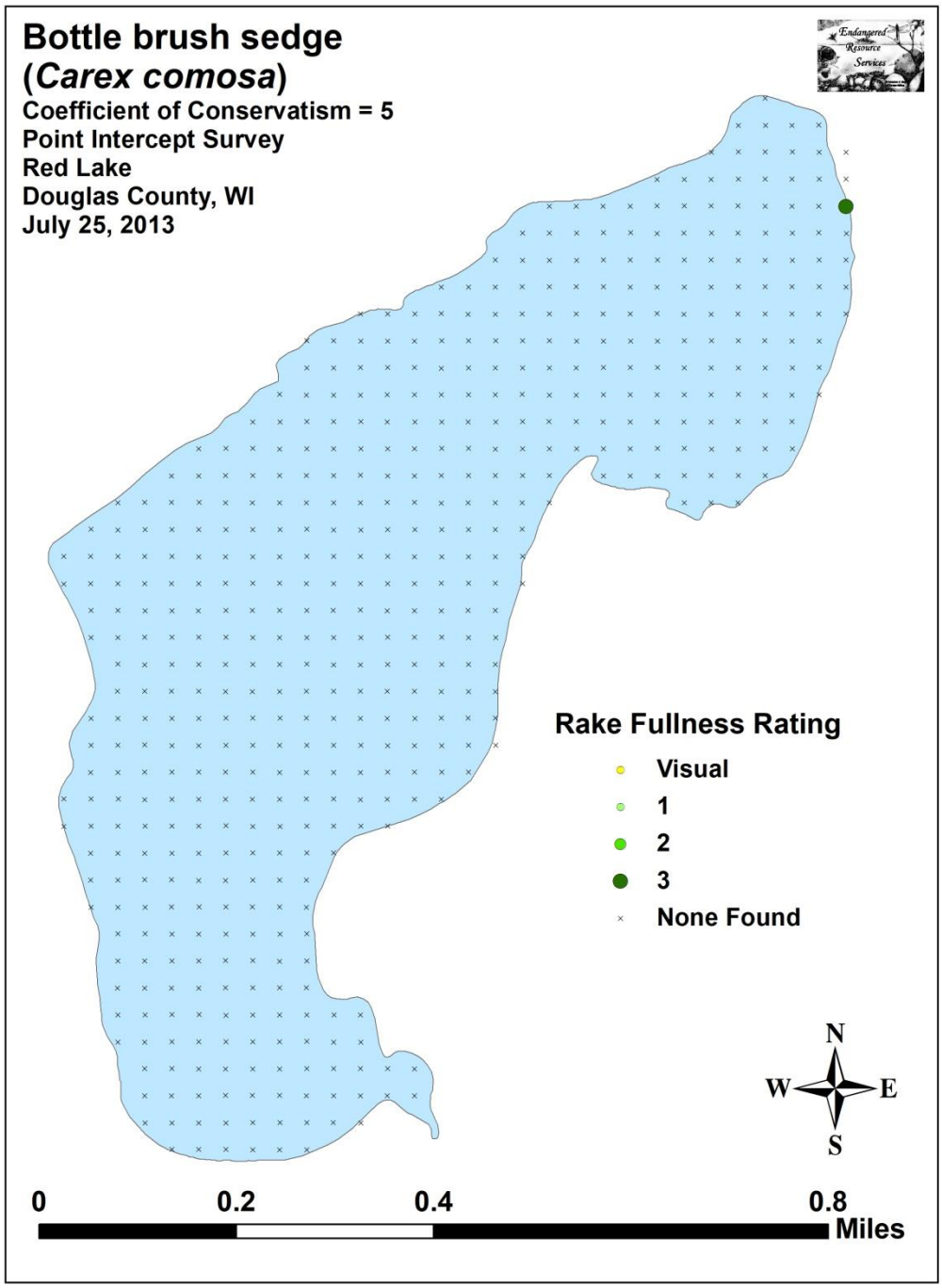

Total Rake Fullness
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

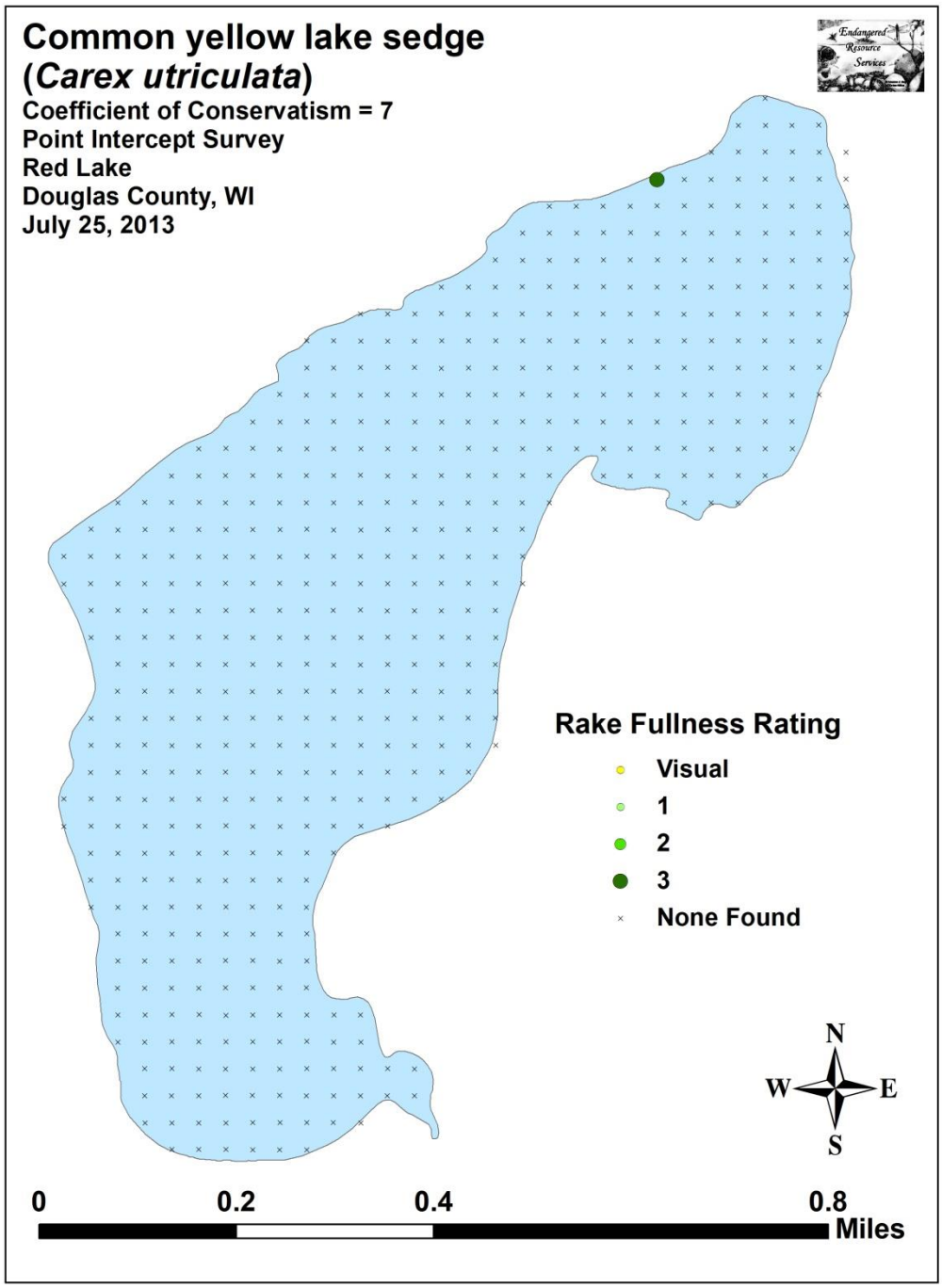
## Appendix V:  July 2013 Species Density and Distribution Maps

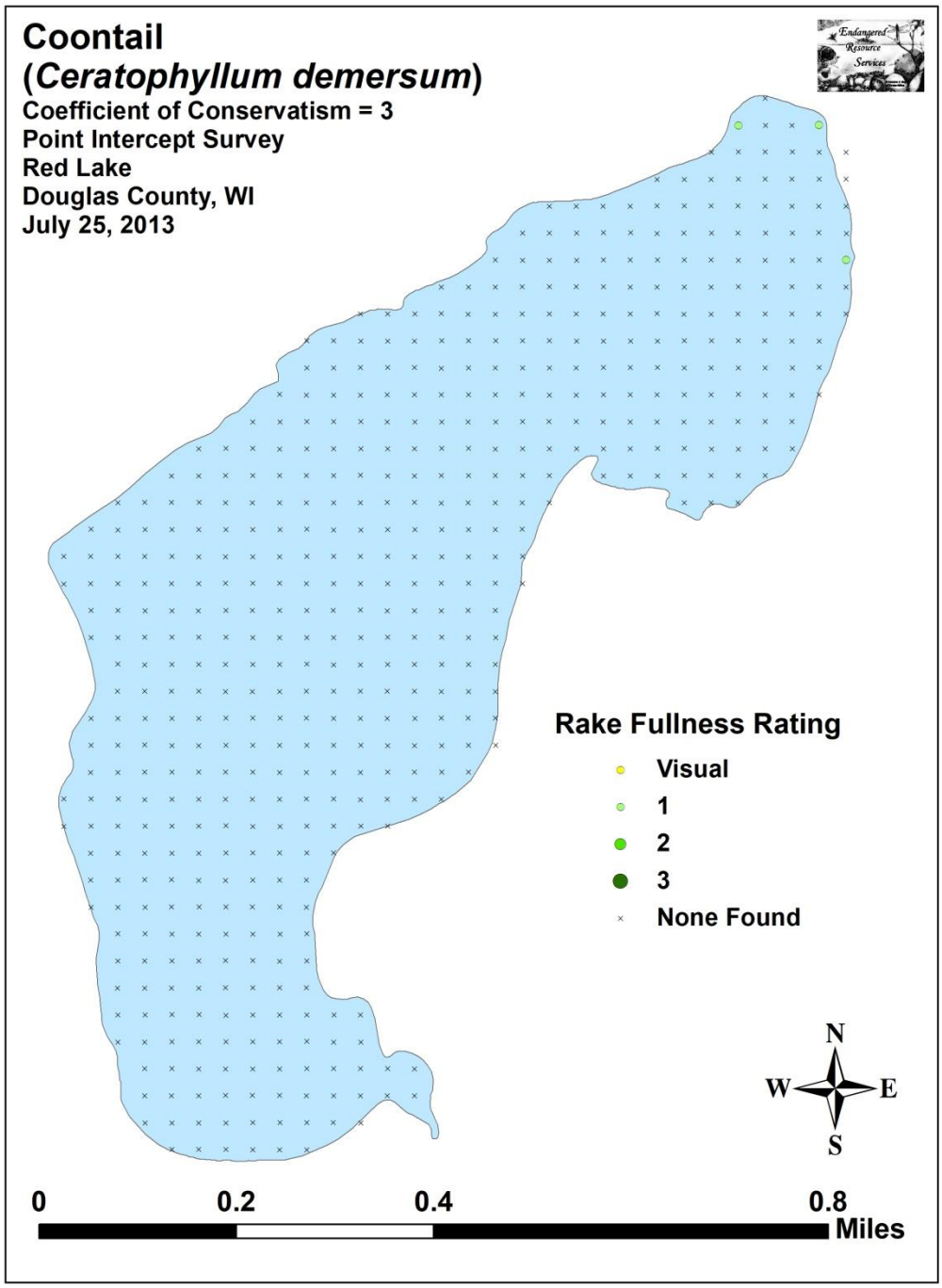

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

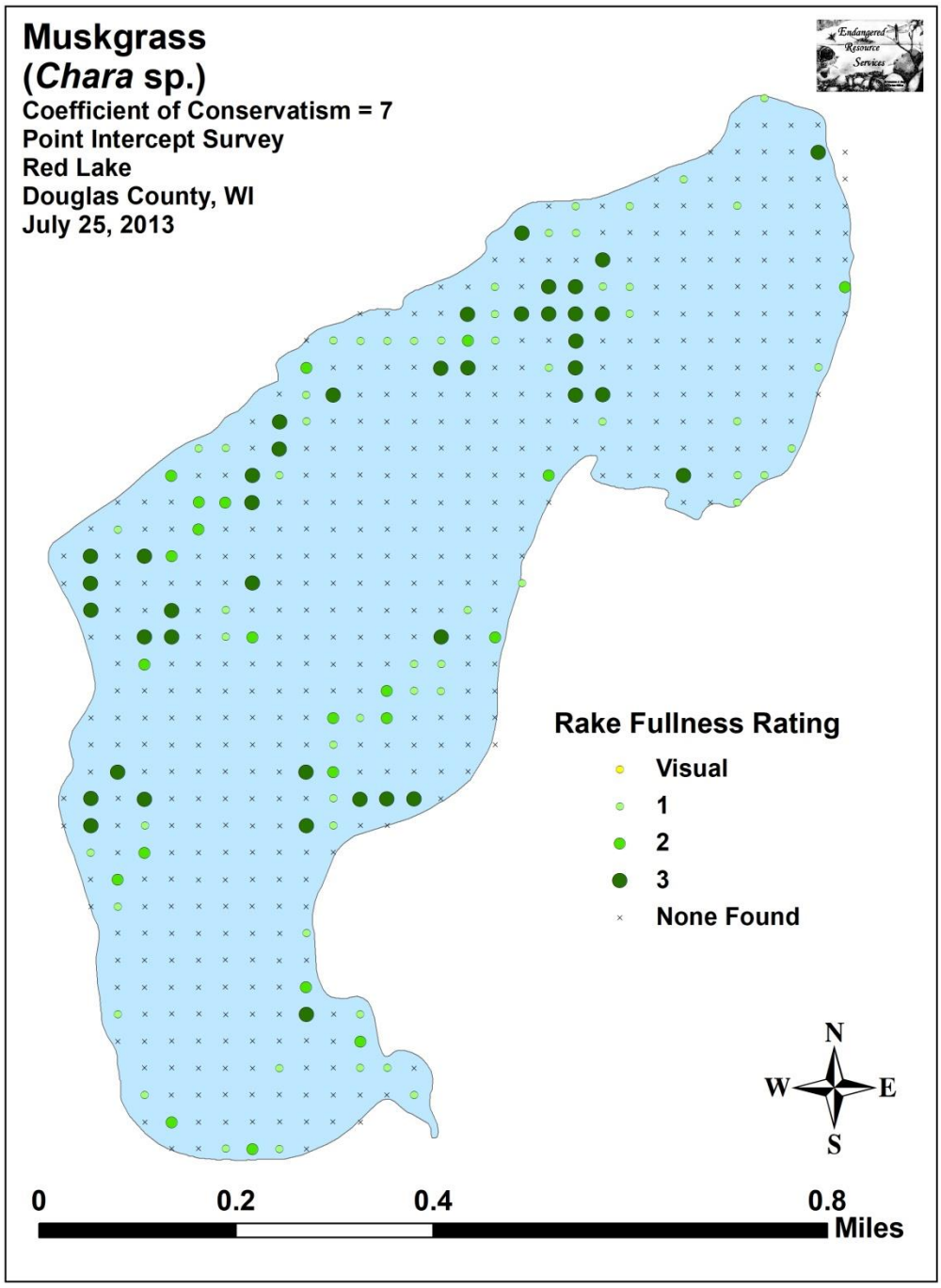

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

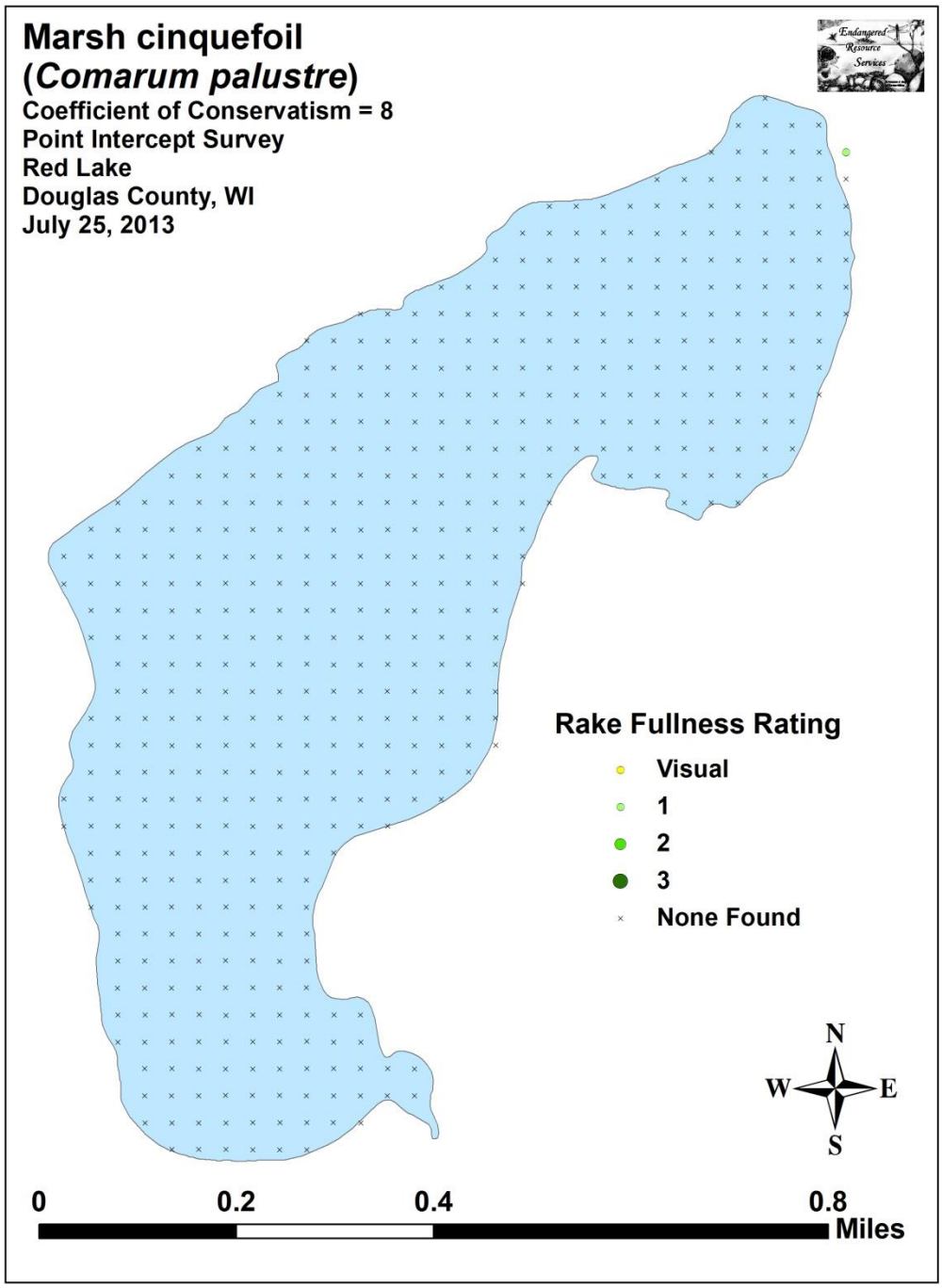

Wild calla
(Calla palustris)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

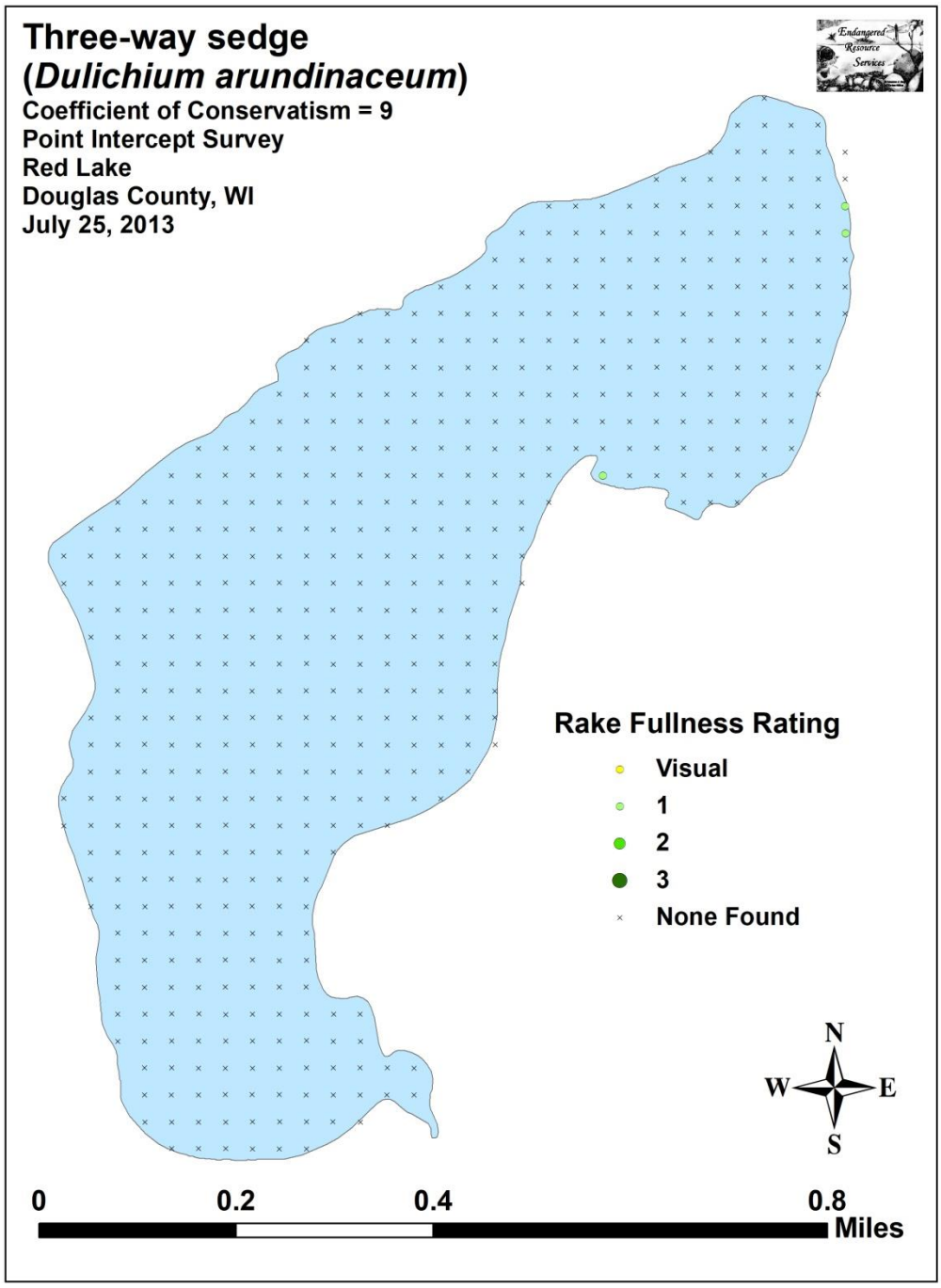

Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

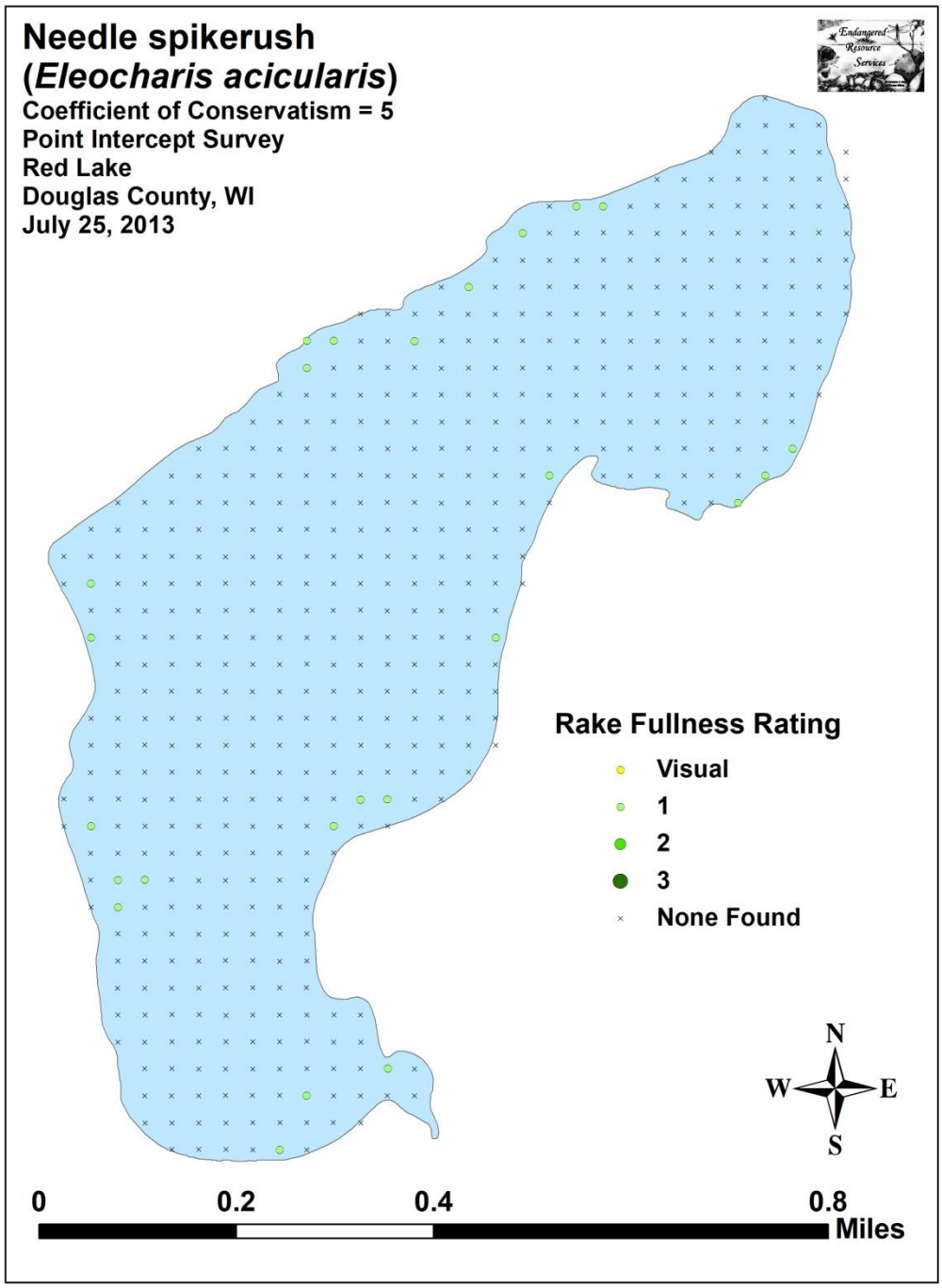

Common yellow lake sedge
(Carex utriculata)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

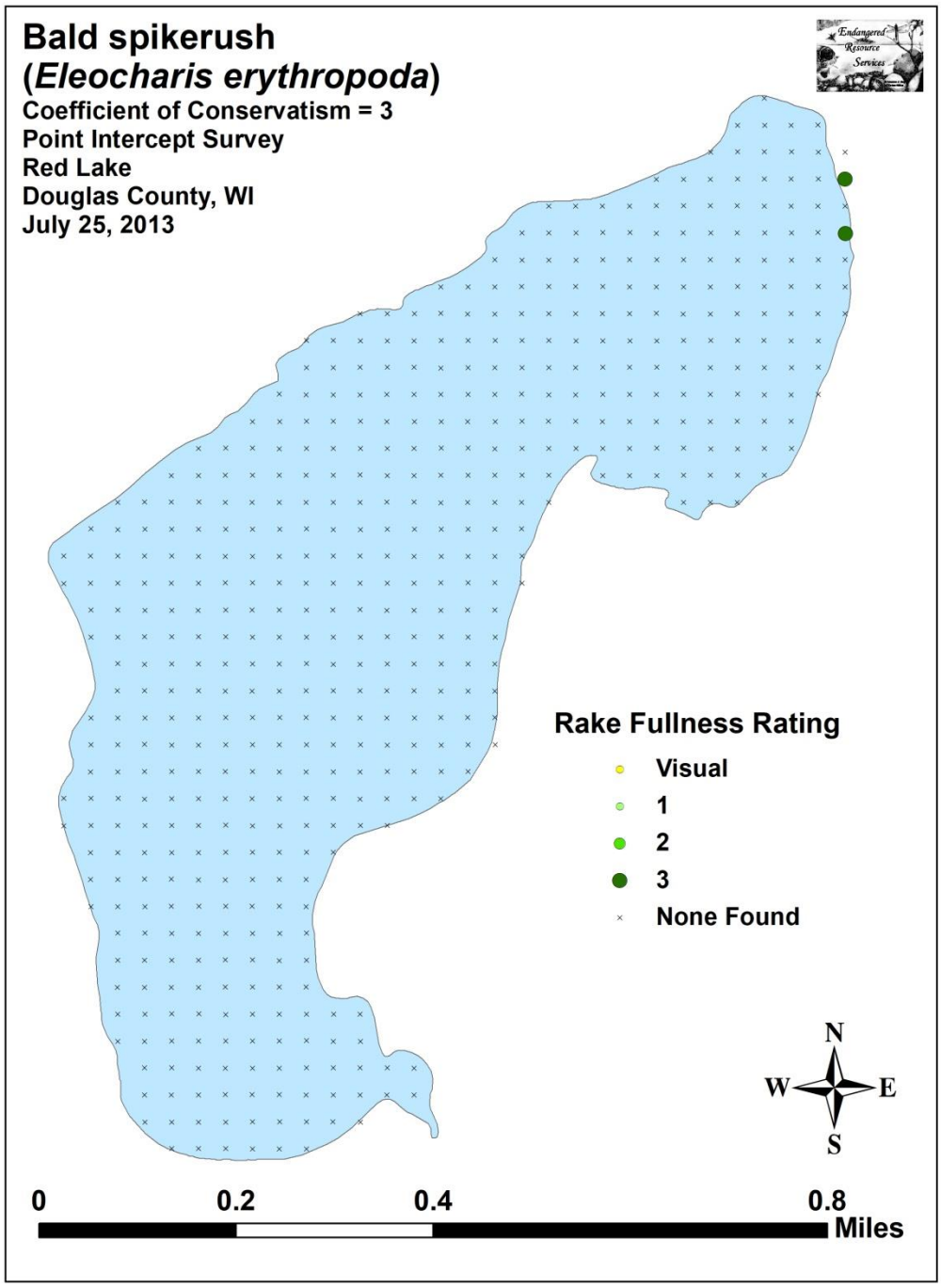

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

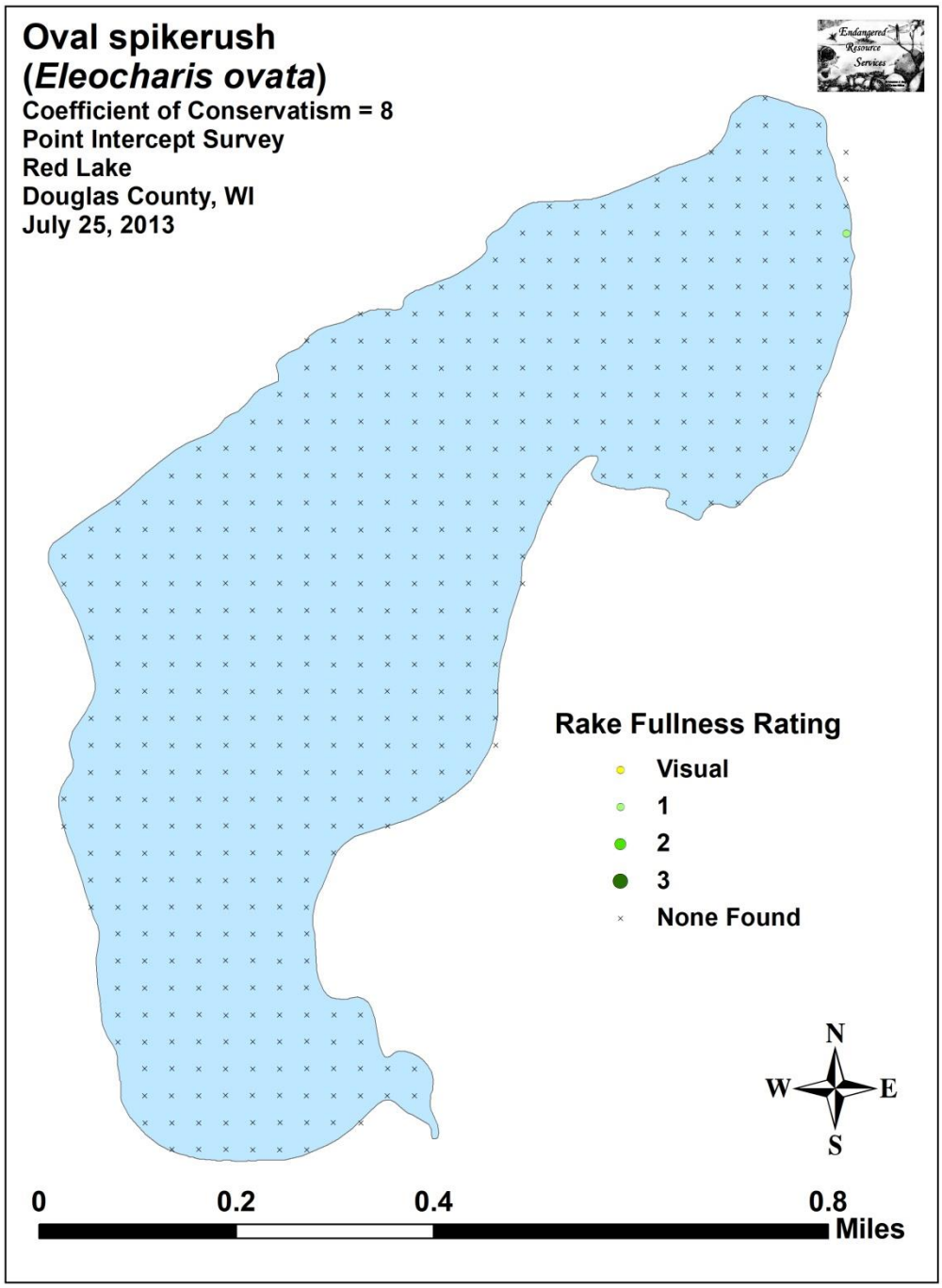

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

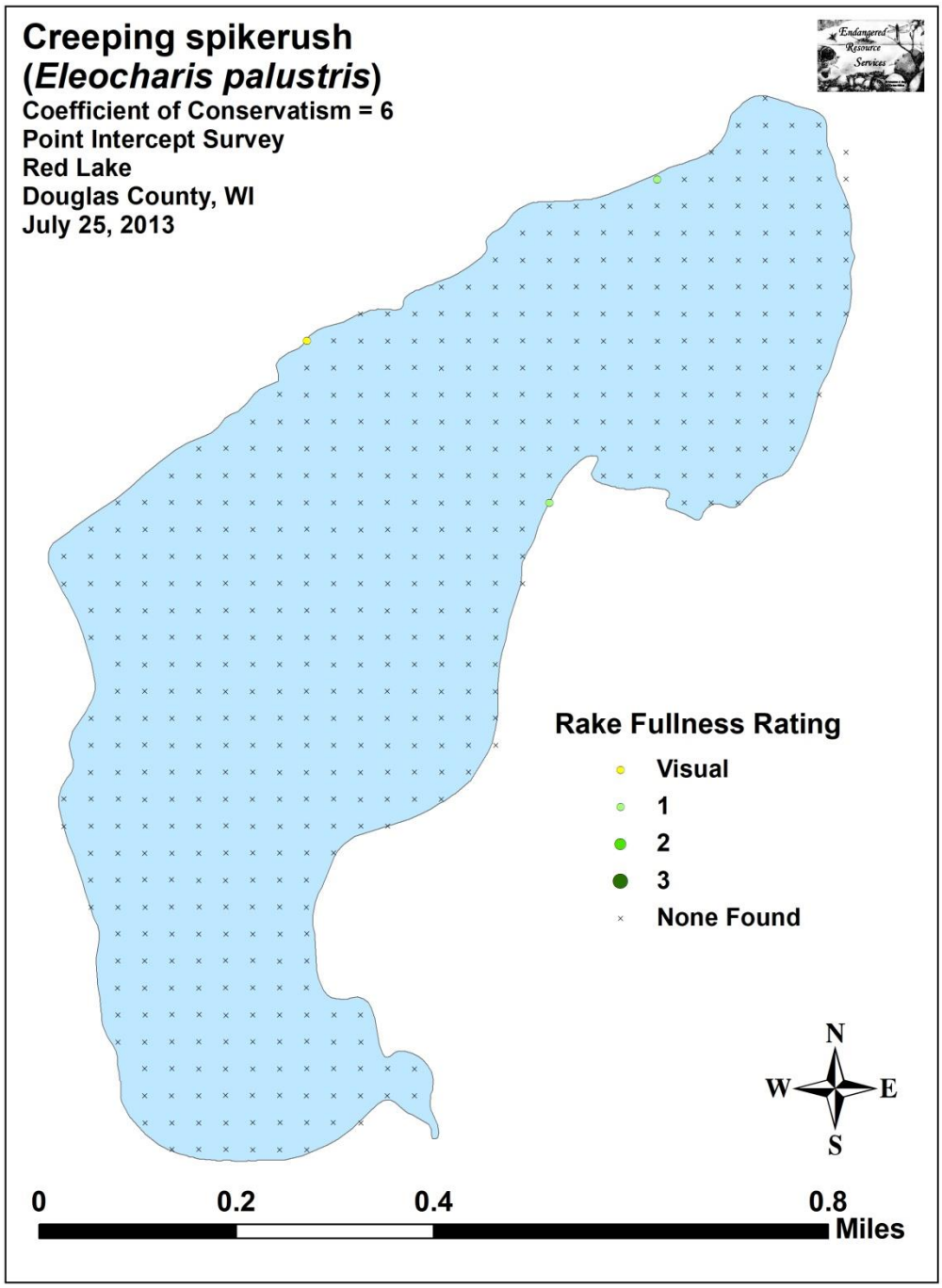

Marsh cinquefoil
(Comarum palustre)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

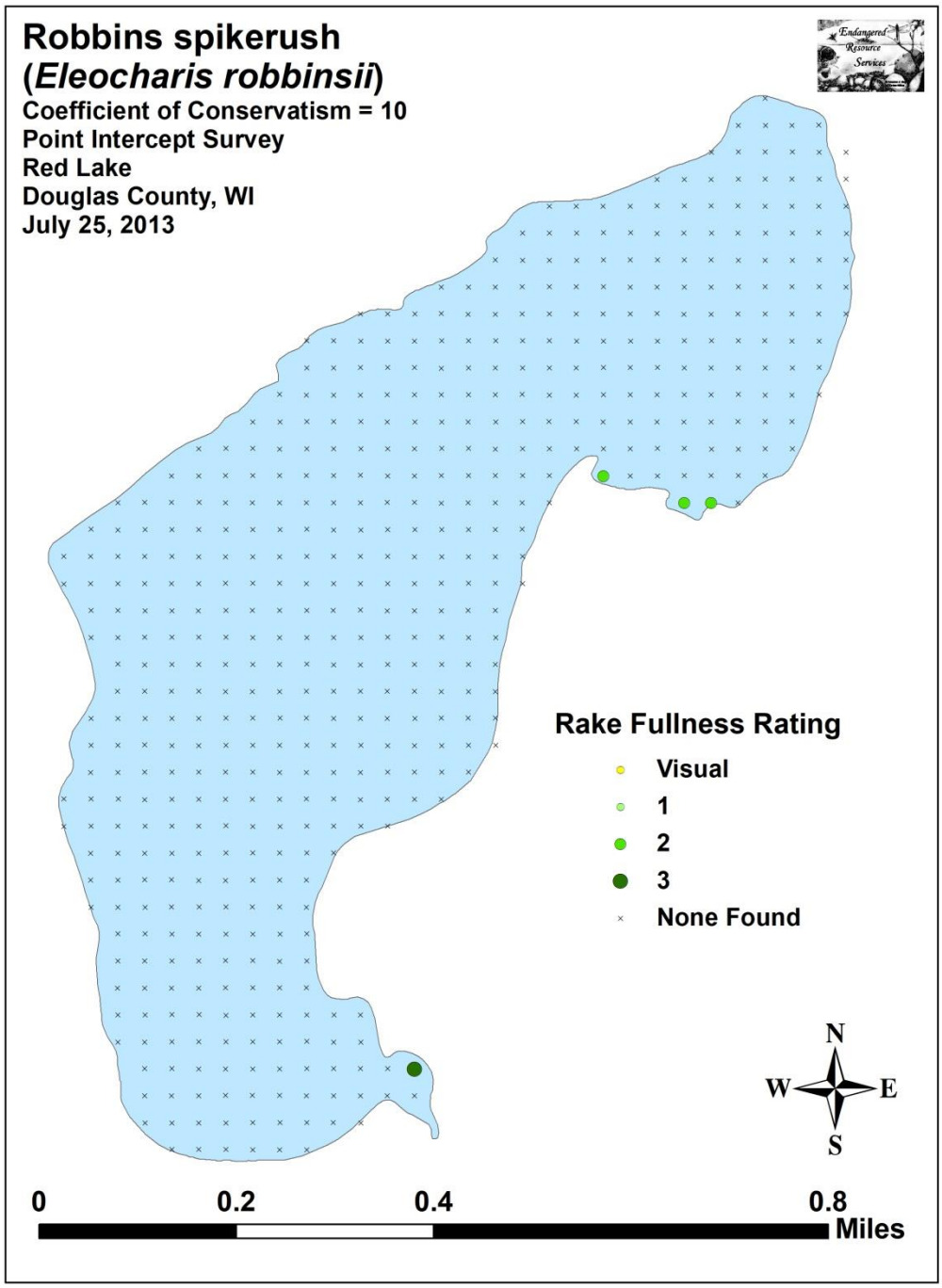

Three-way sedge
(Dulichium arundinaceum)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

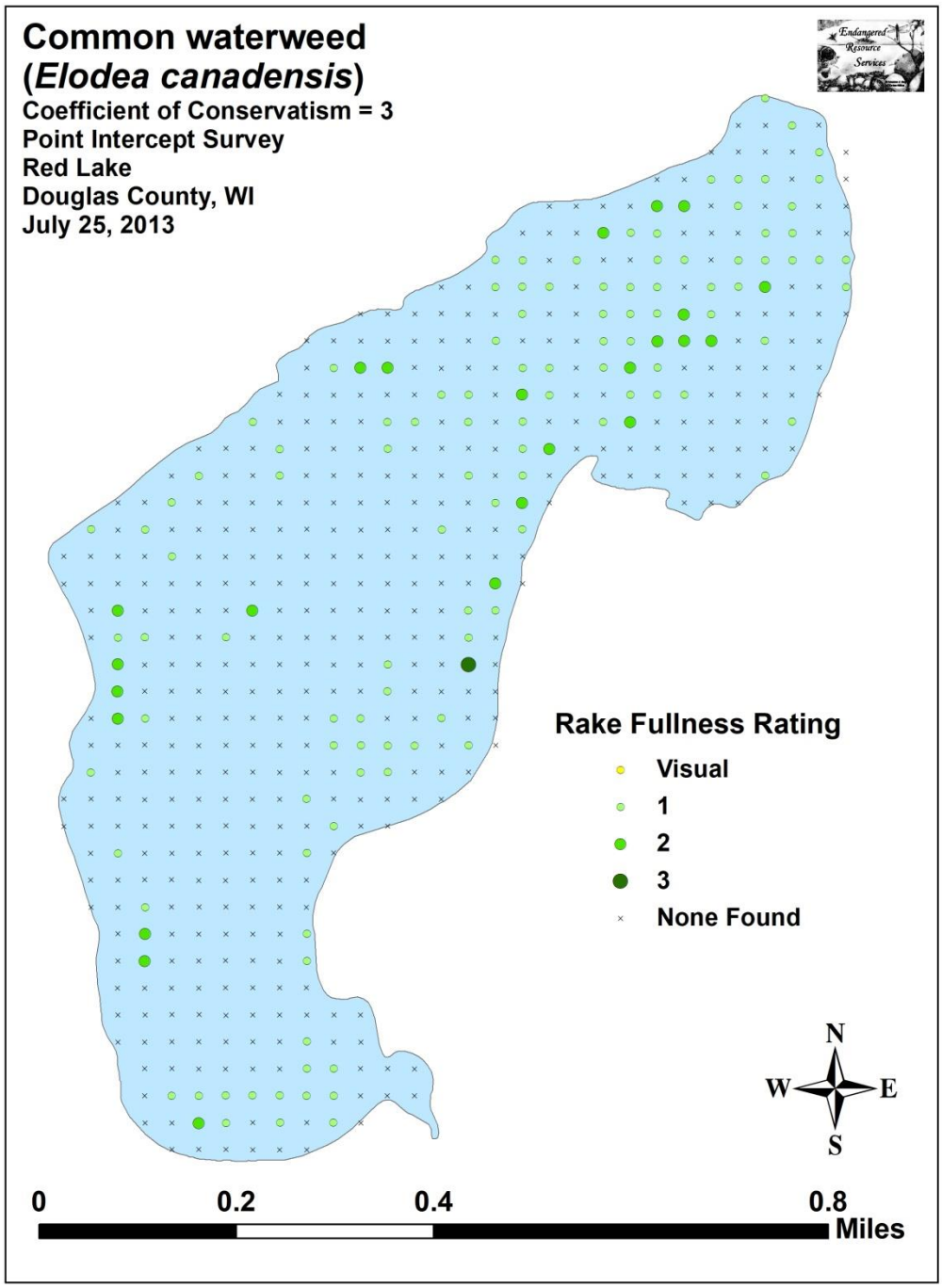

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

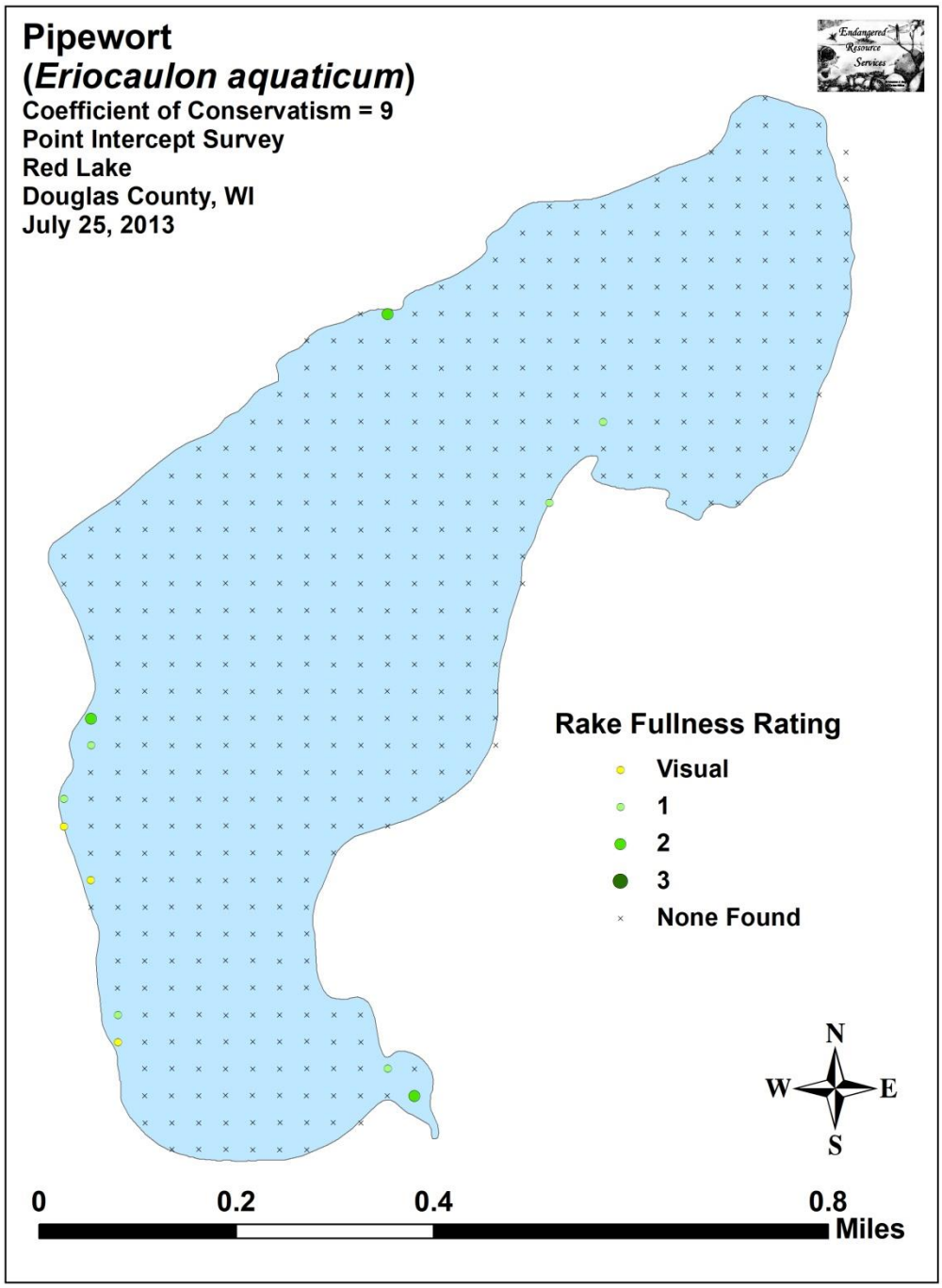

Bald spikerush
(Eleocharis erythropoda)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

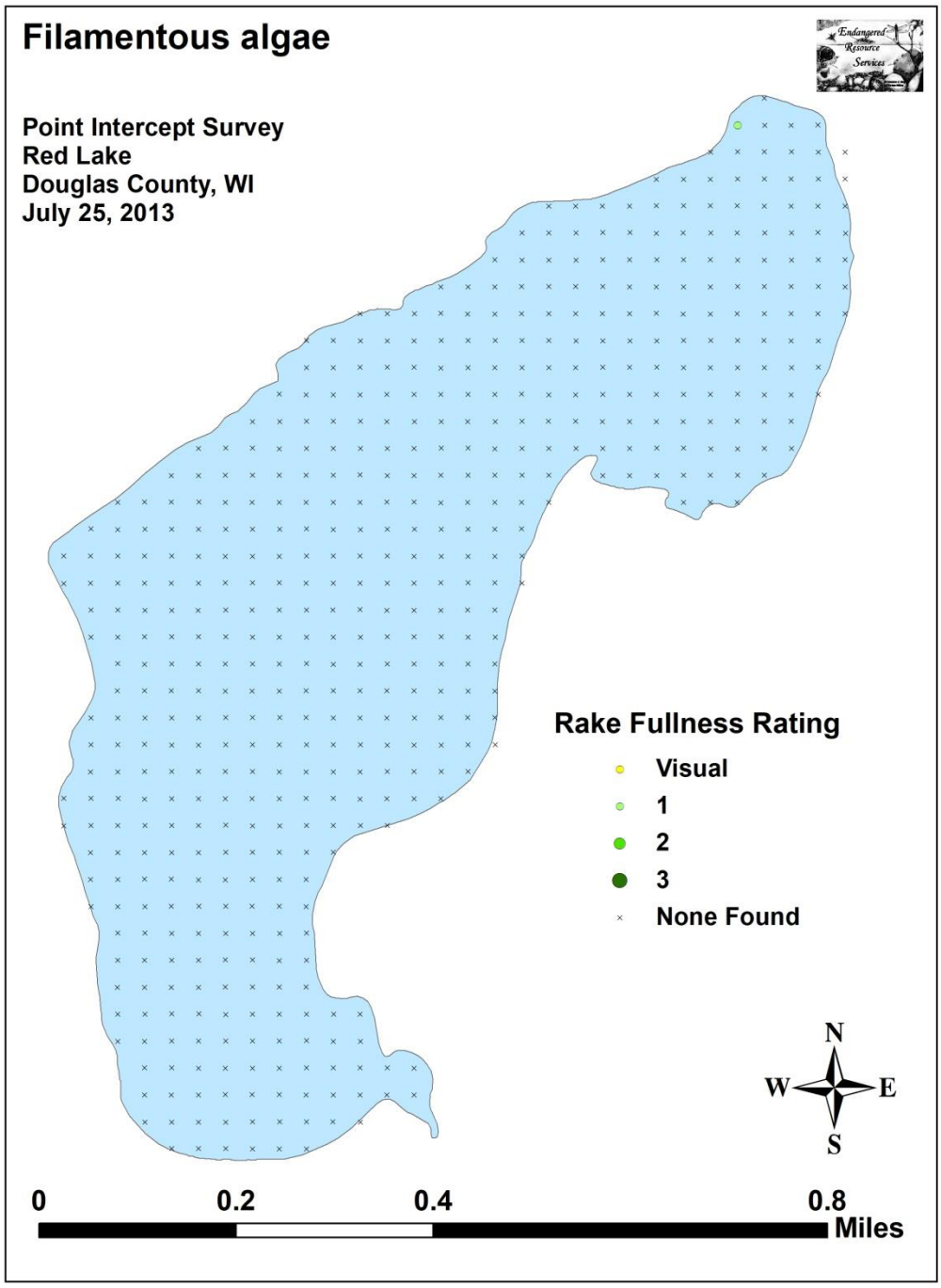

Oval spikerush
(Eleocharis ovata)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

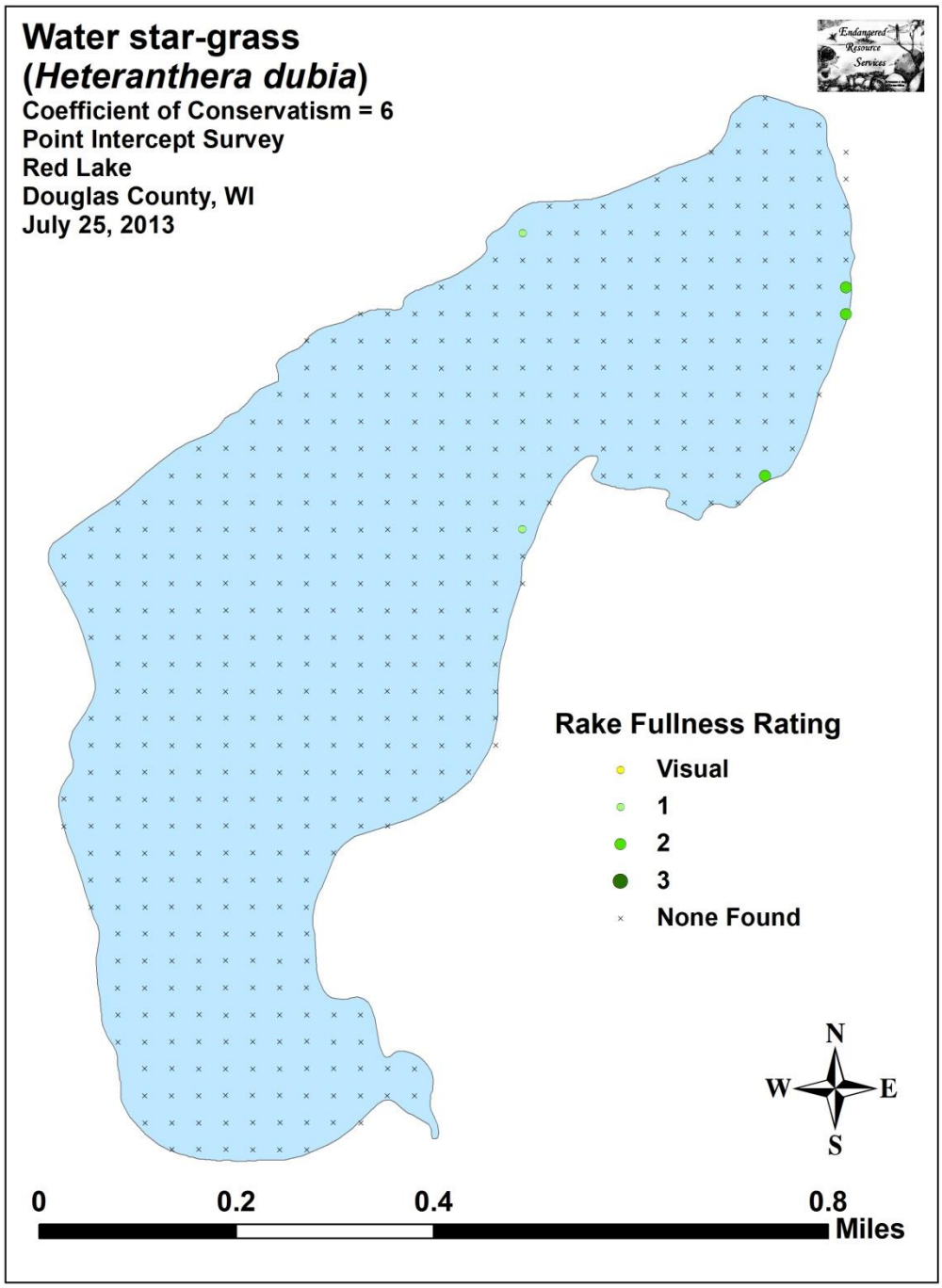

Creeping spikerush
(Eleocharis palustris)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

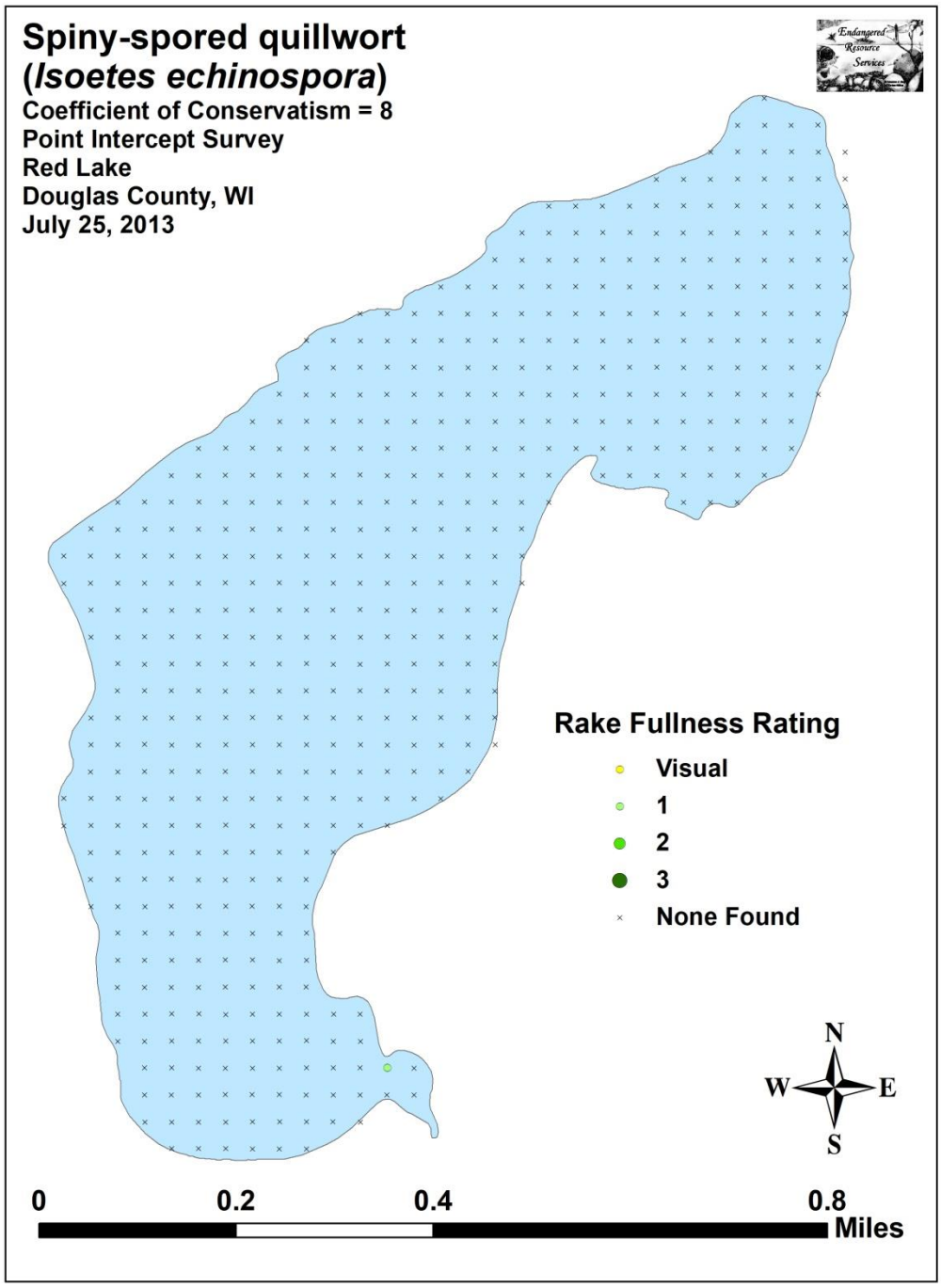

Robbins spikerush
(Eleocharis robbinsii)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

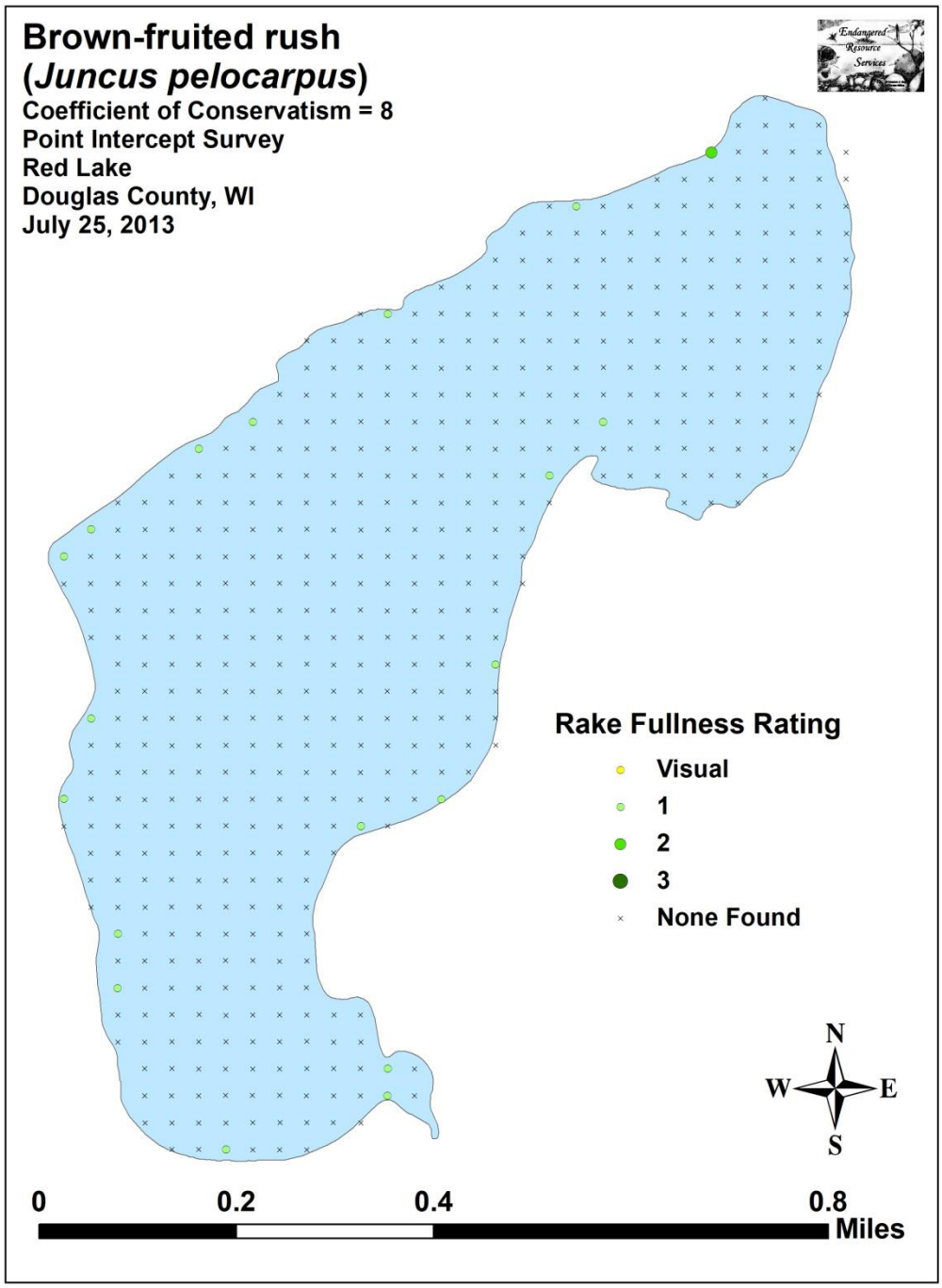

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

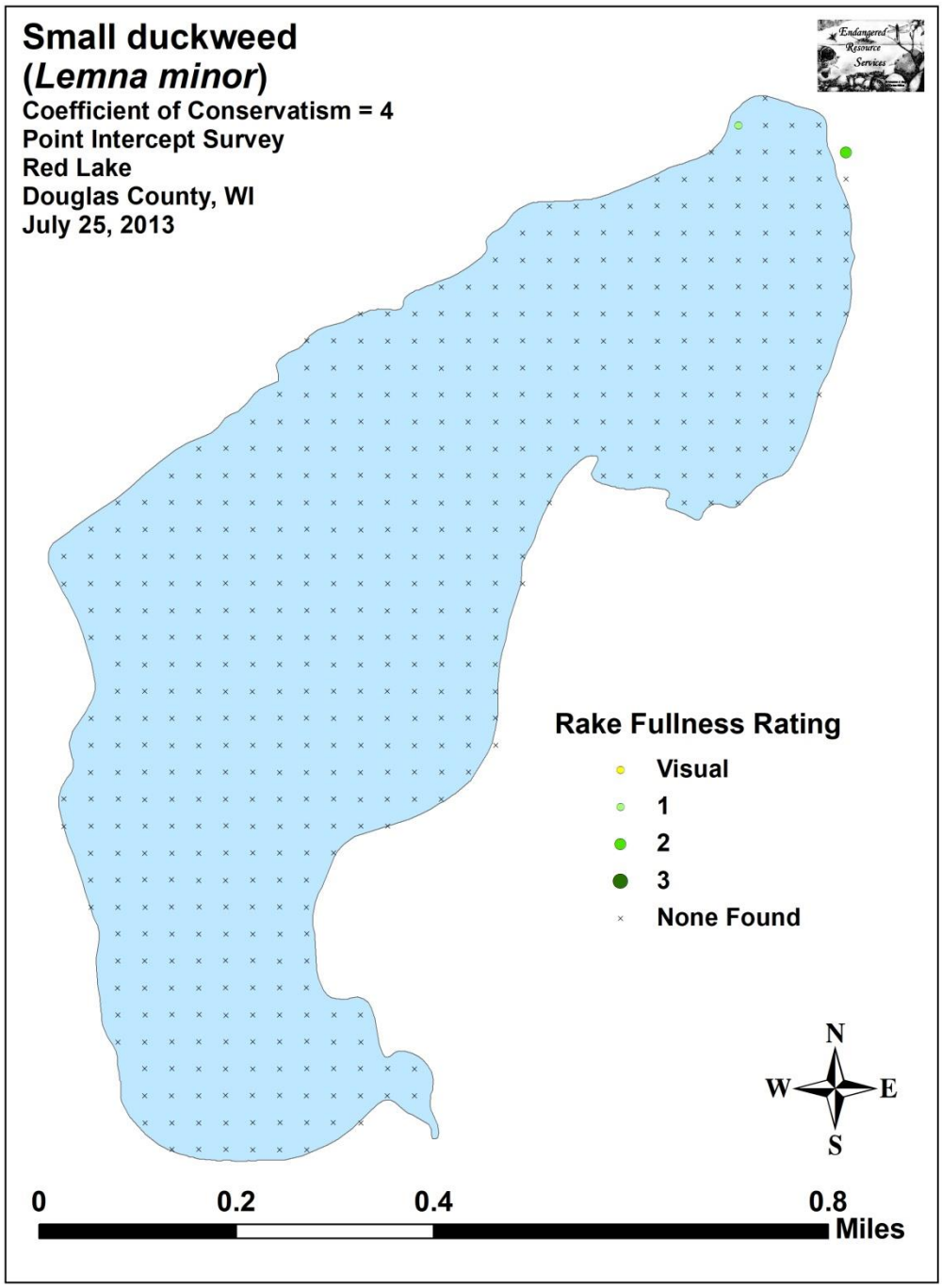

Pipewort
(Eriocaulon aquaticum)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

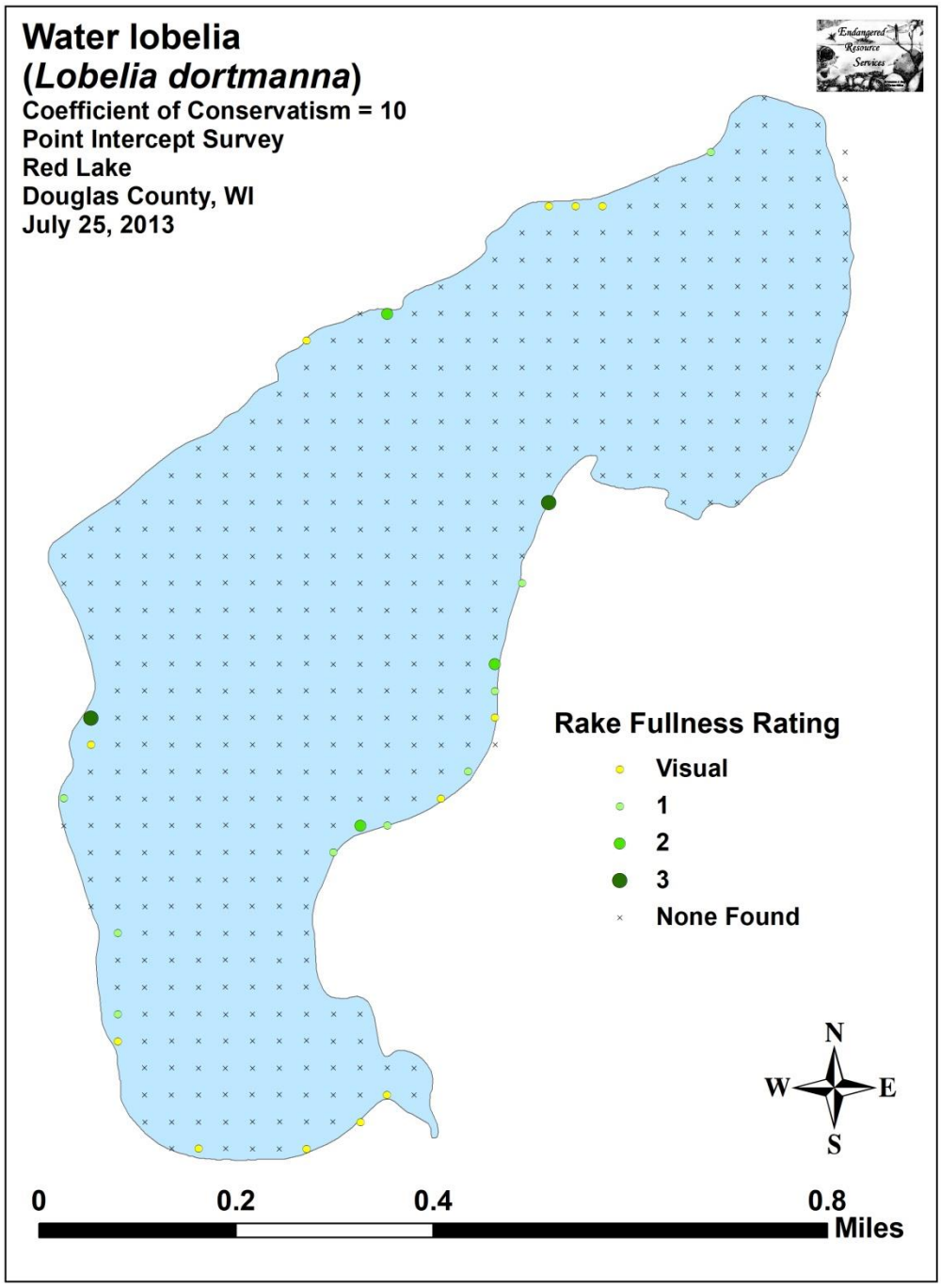

Filamentous algae
Endangered Resource Services
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

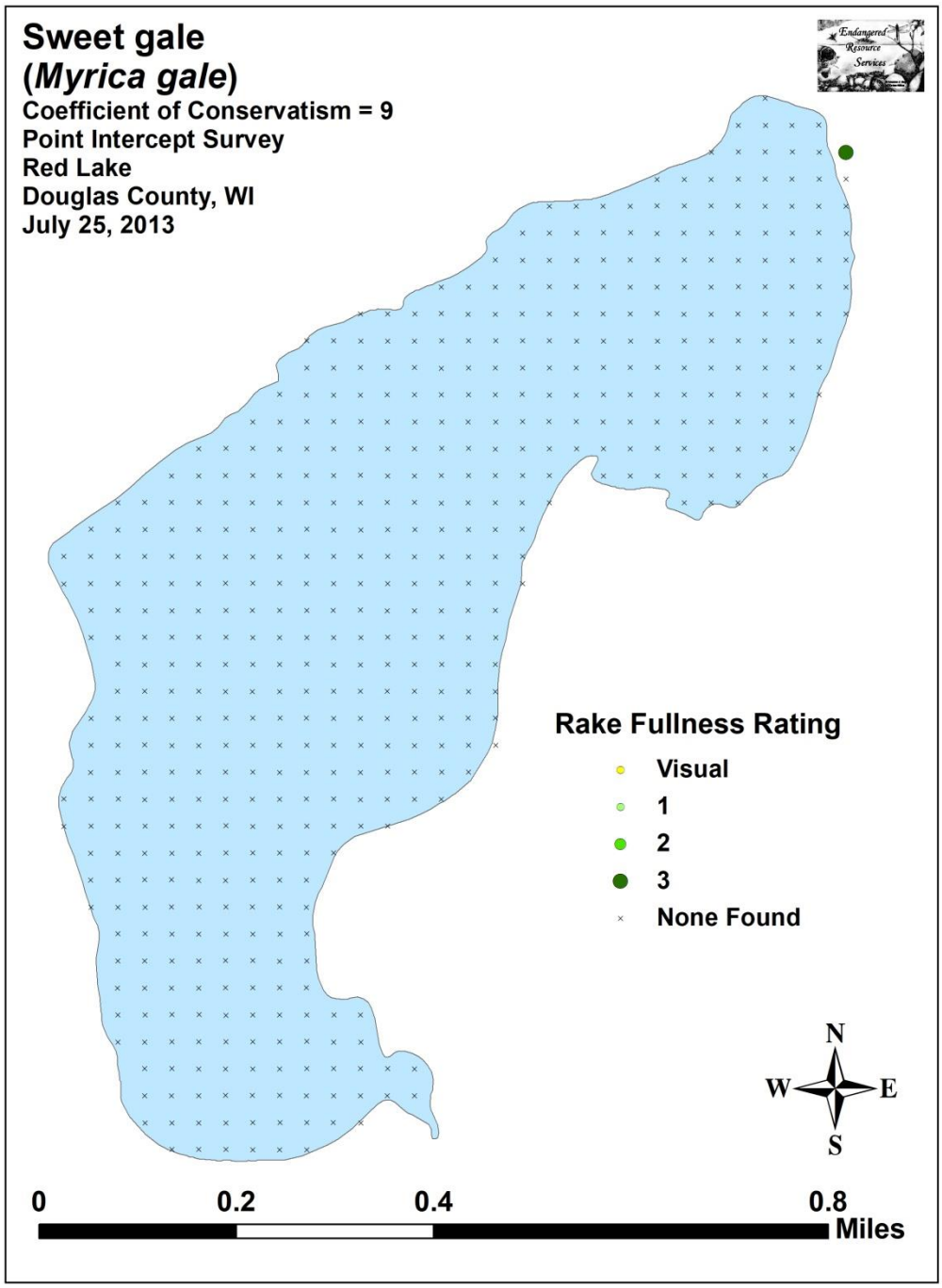

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

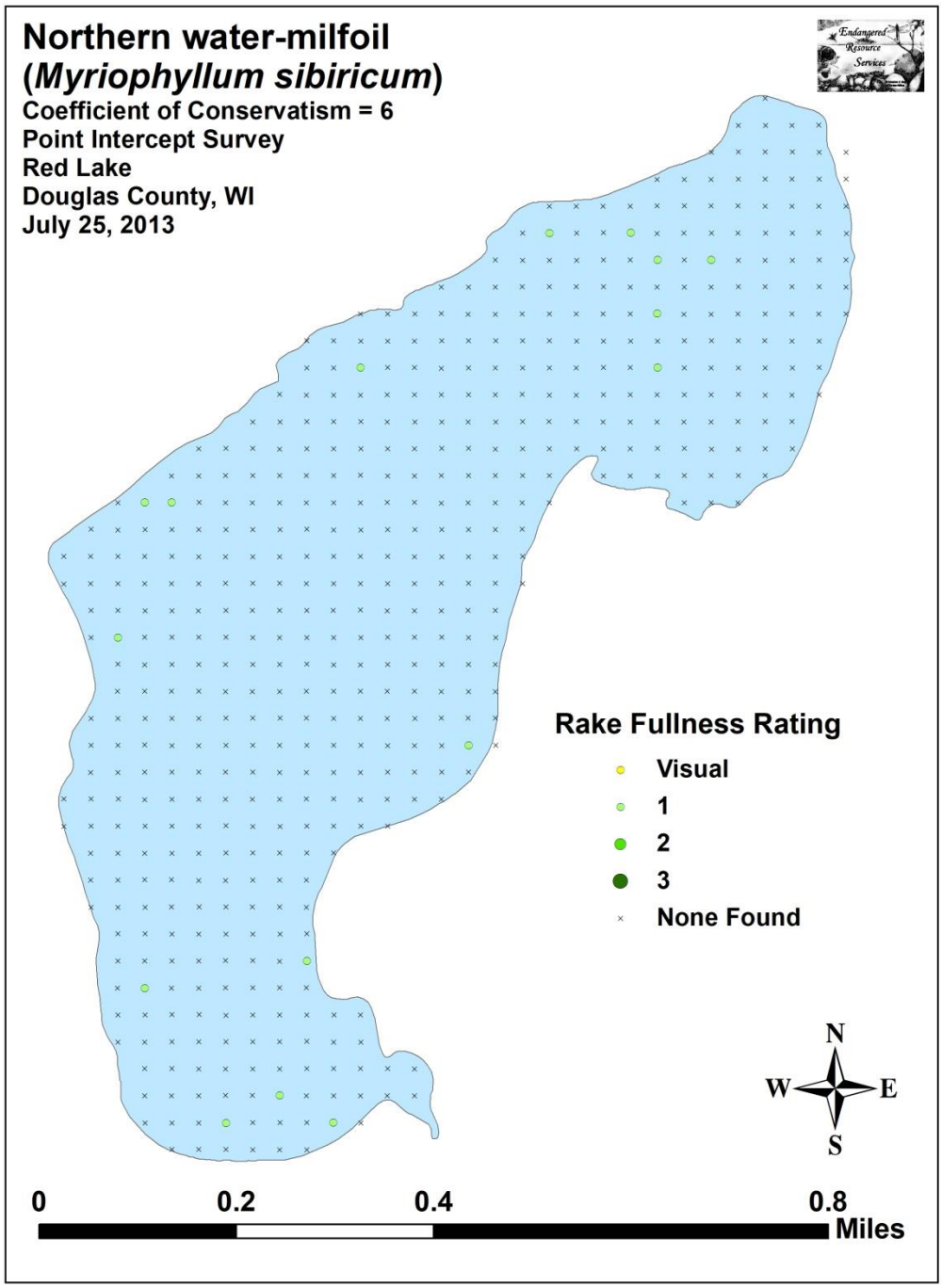

Spiny-spored quillwort
(Isoetes echinospora)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

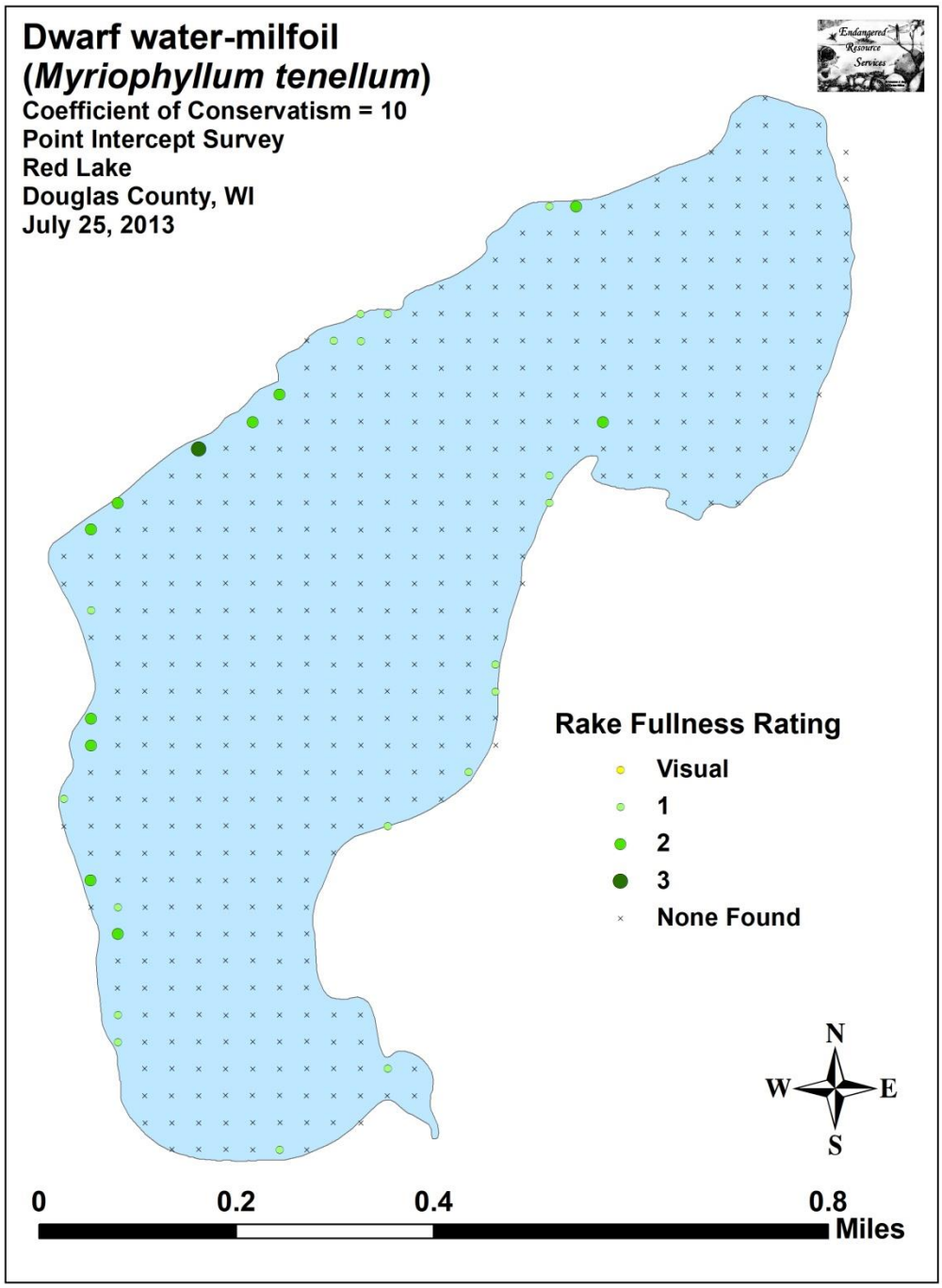

Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

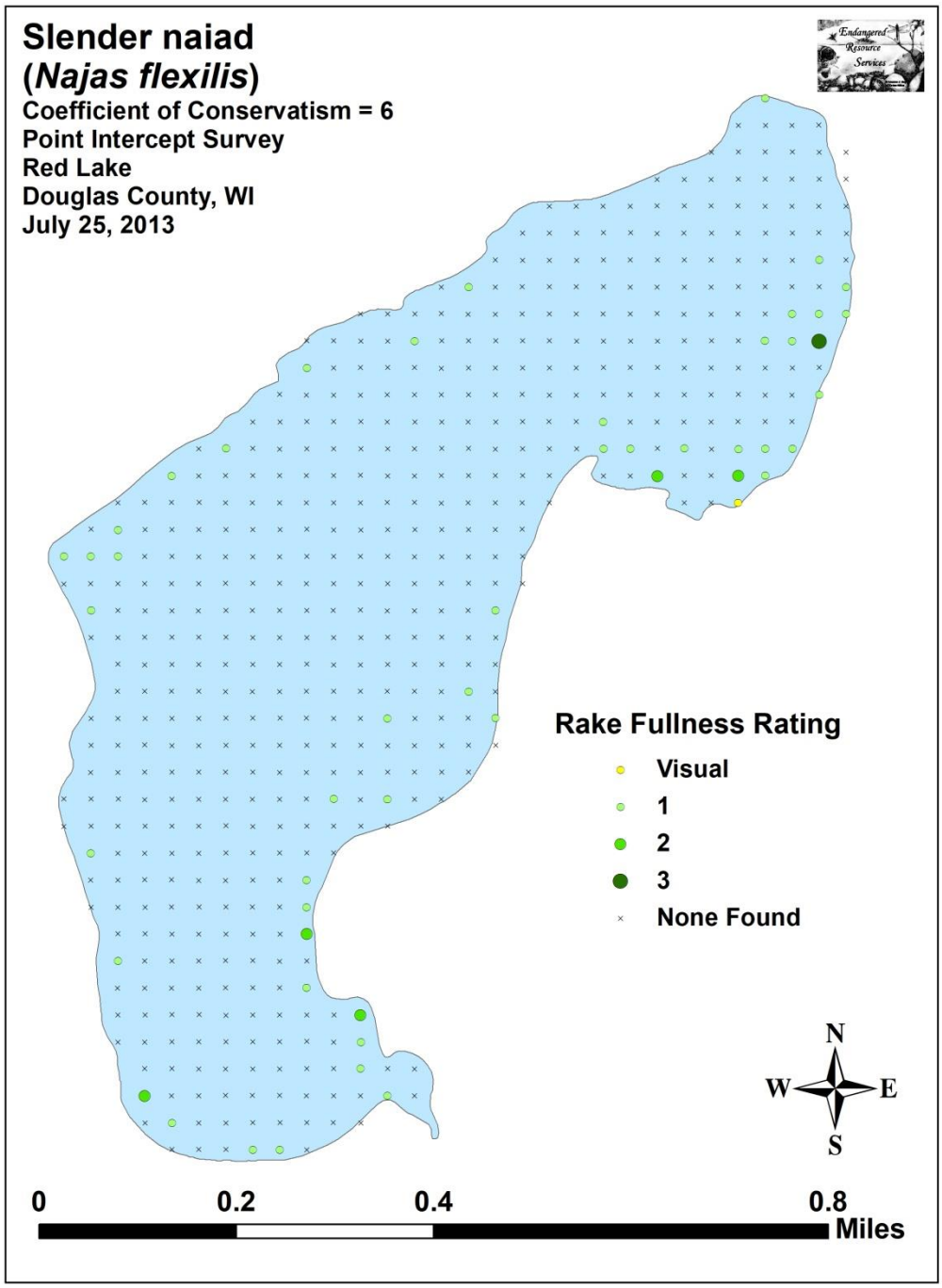

Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

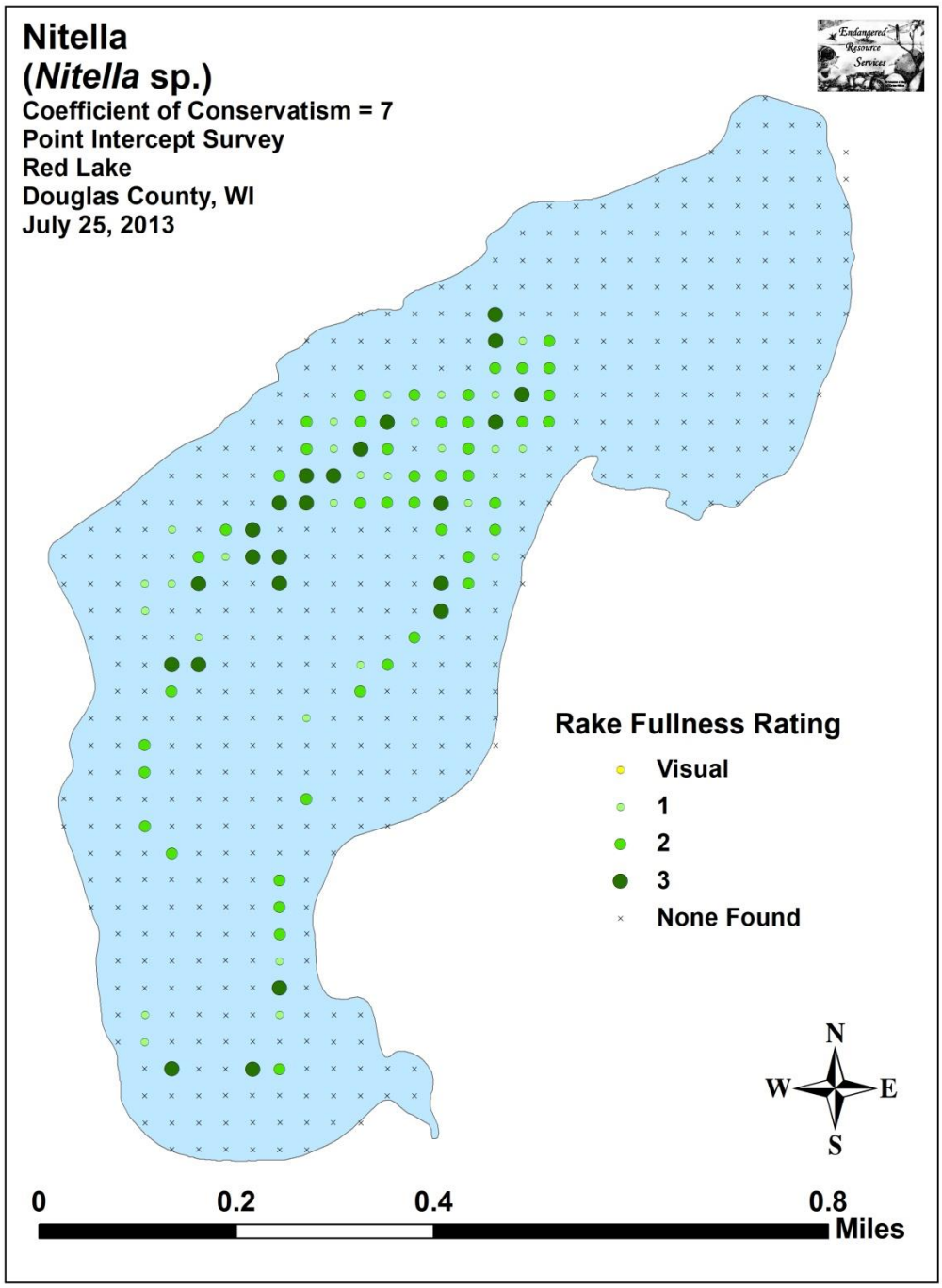

Water lobelia
(Lobelia dortmanna)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Sweet gale
(Myrica gale)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Dwarf water-milfoil
(Myriophyllum tenellum)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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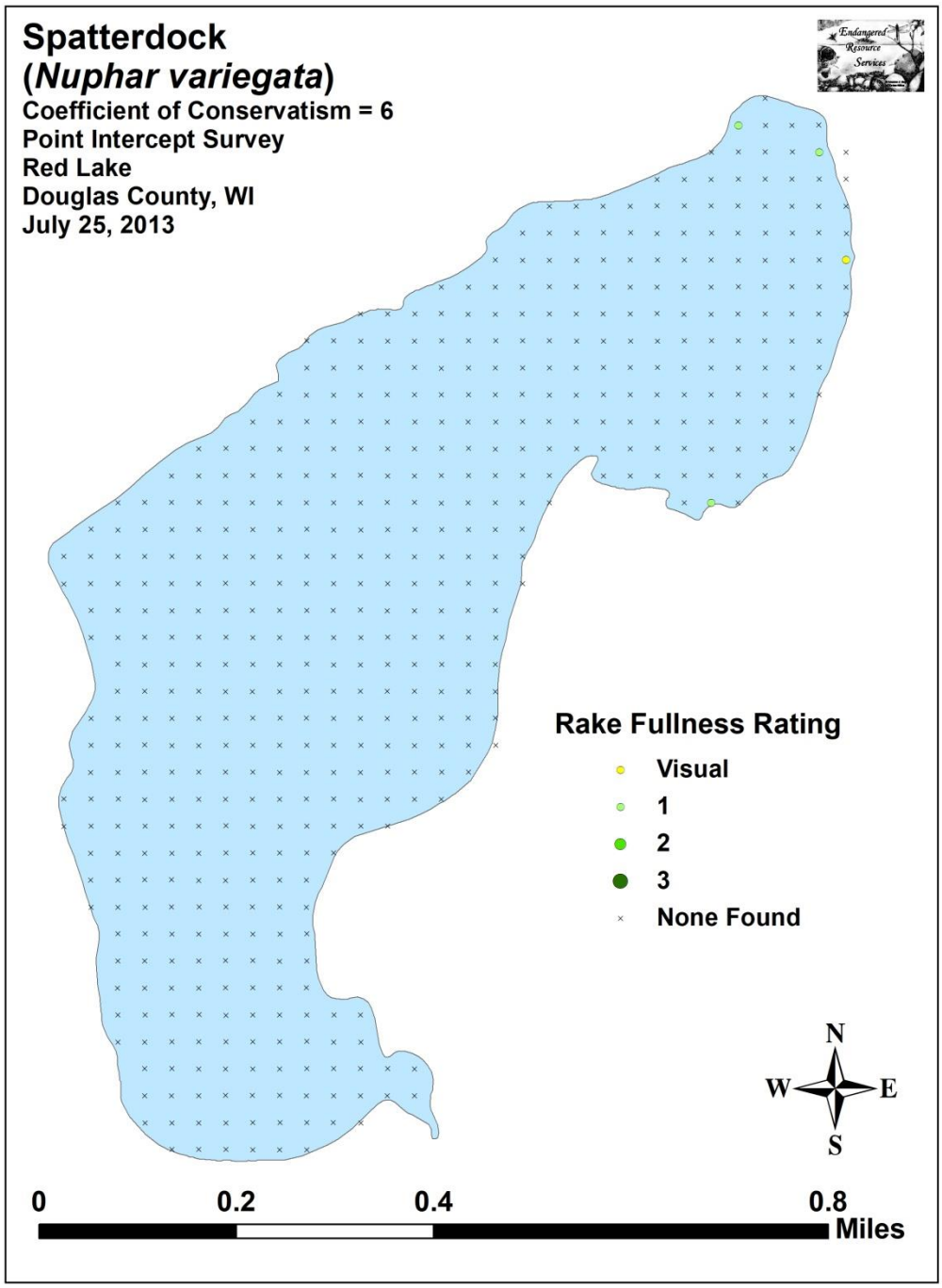
Miles


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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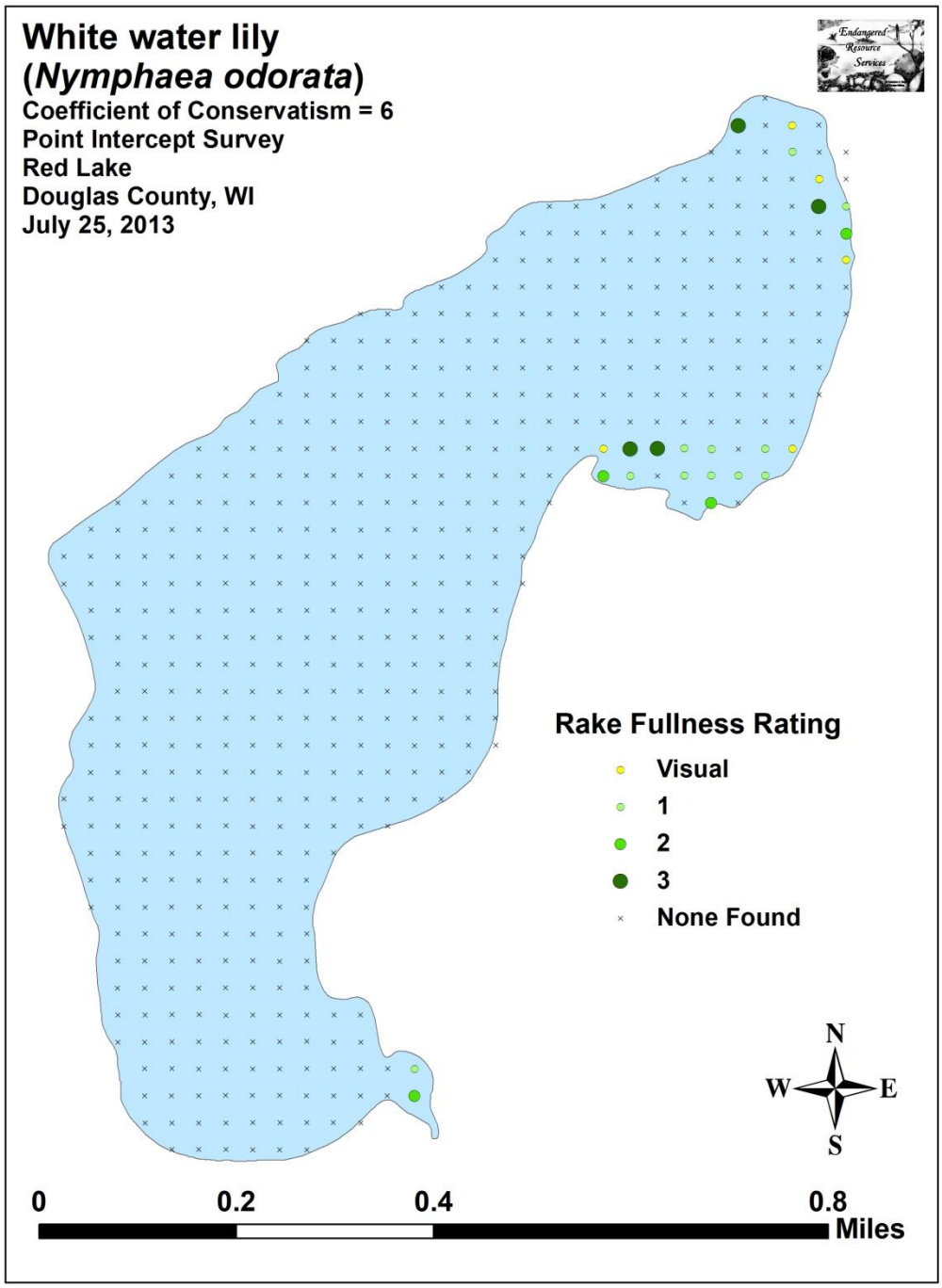
Miles


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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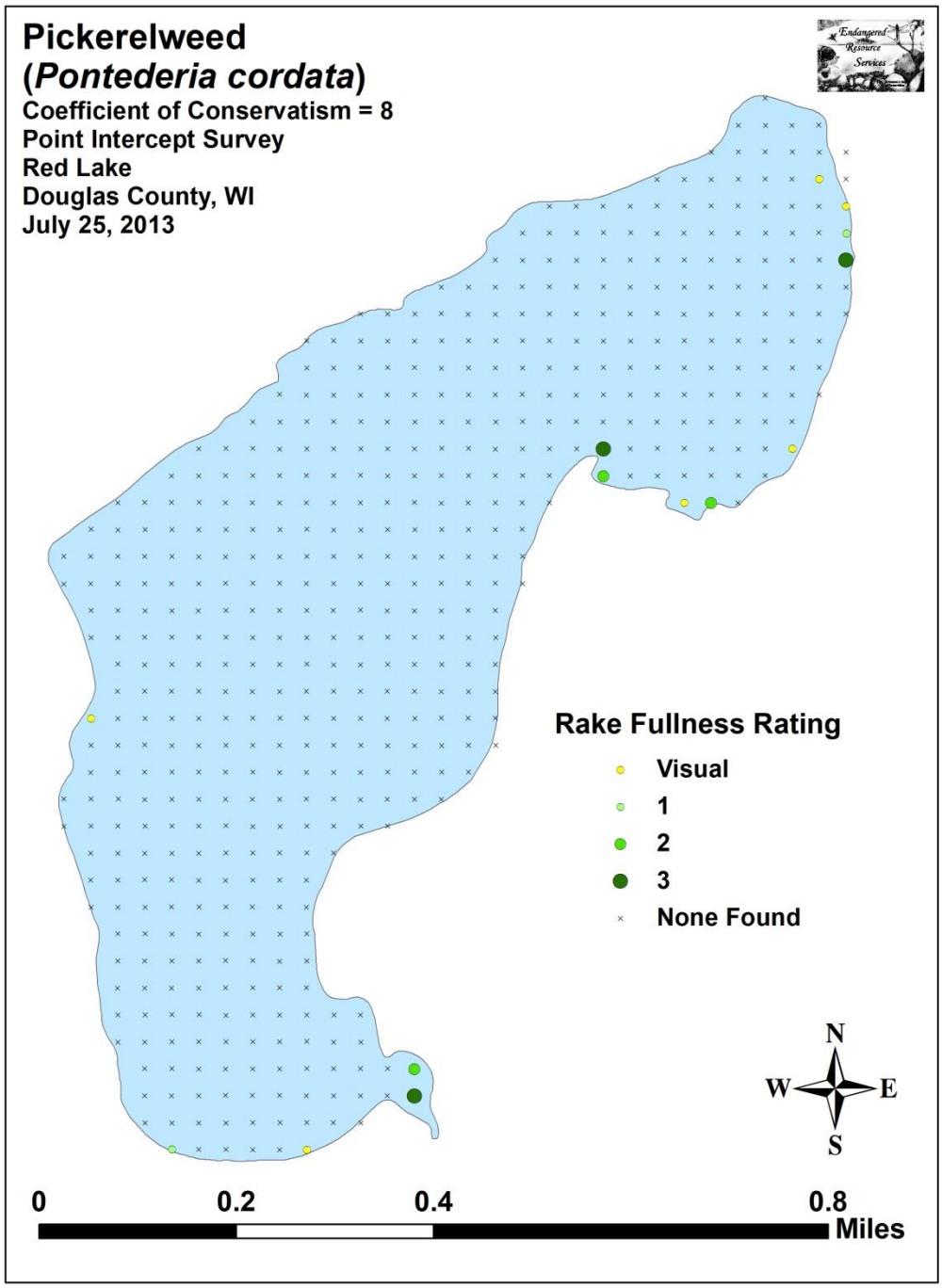
Miles


Pickerelweed
(Pontederia cordata)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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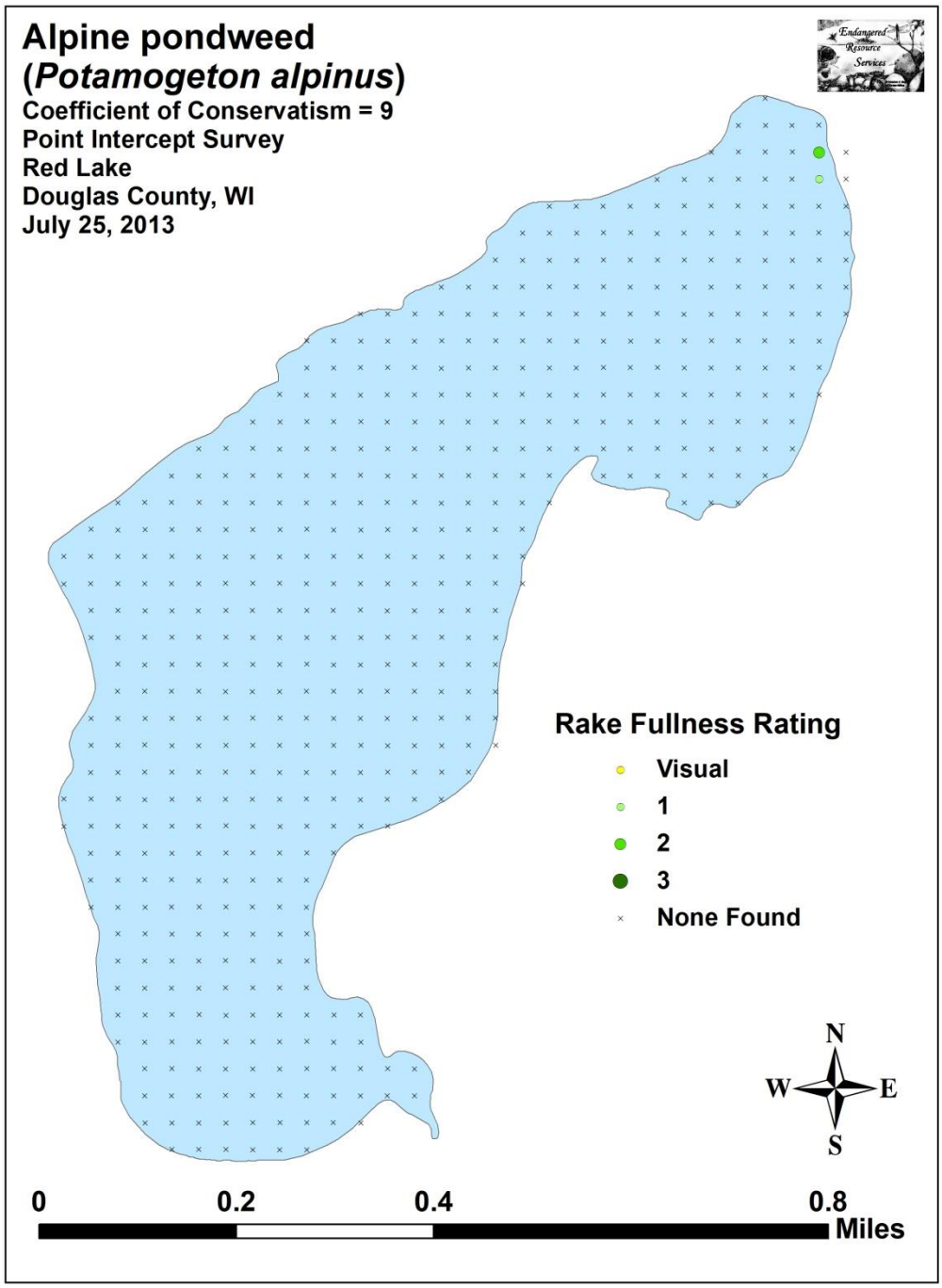
Miles


Alpine pondweed
(Potamogeton alpinus)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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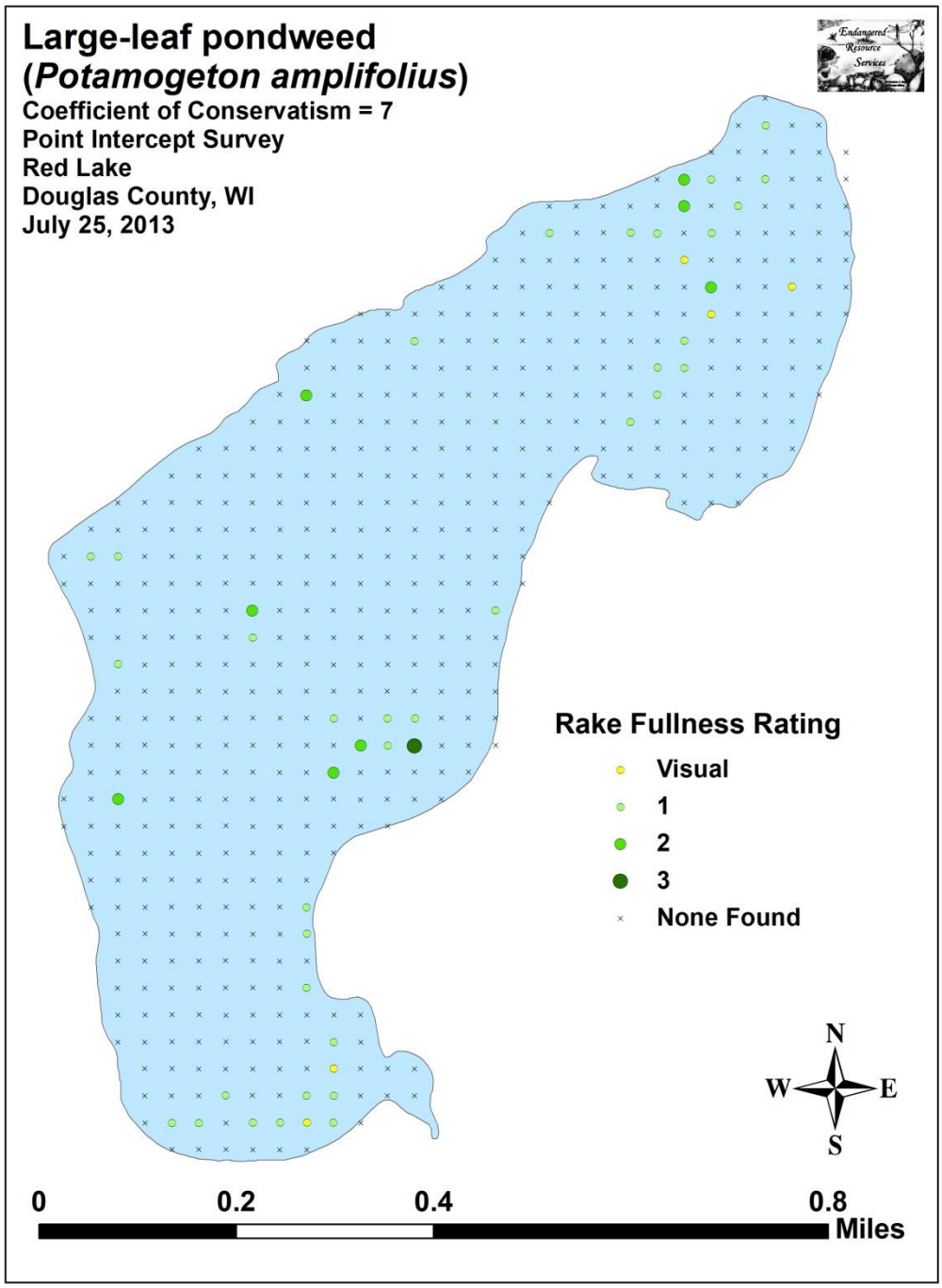
Miles


Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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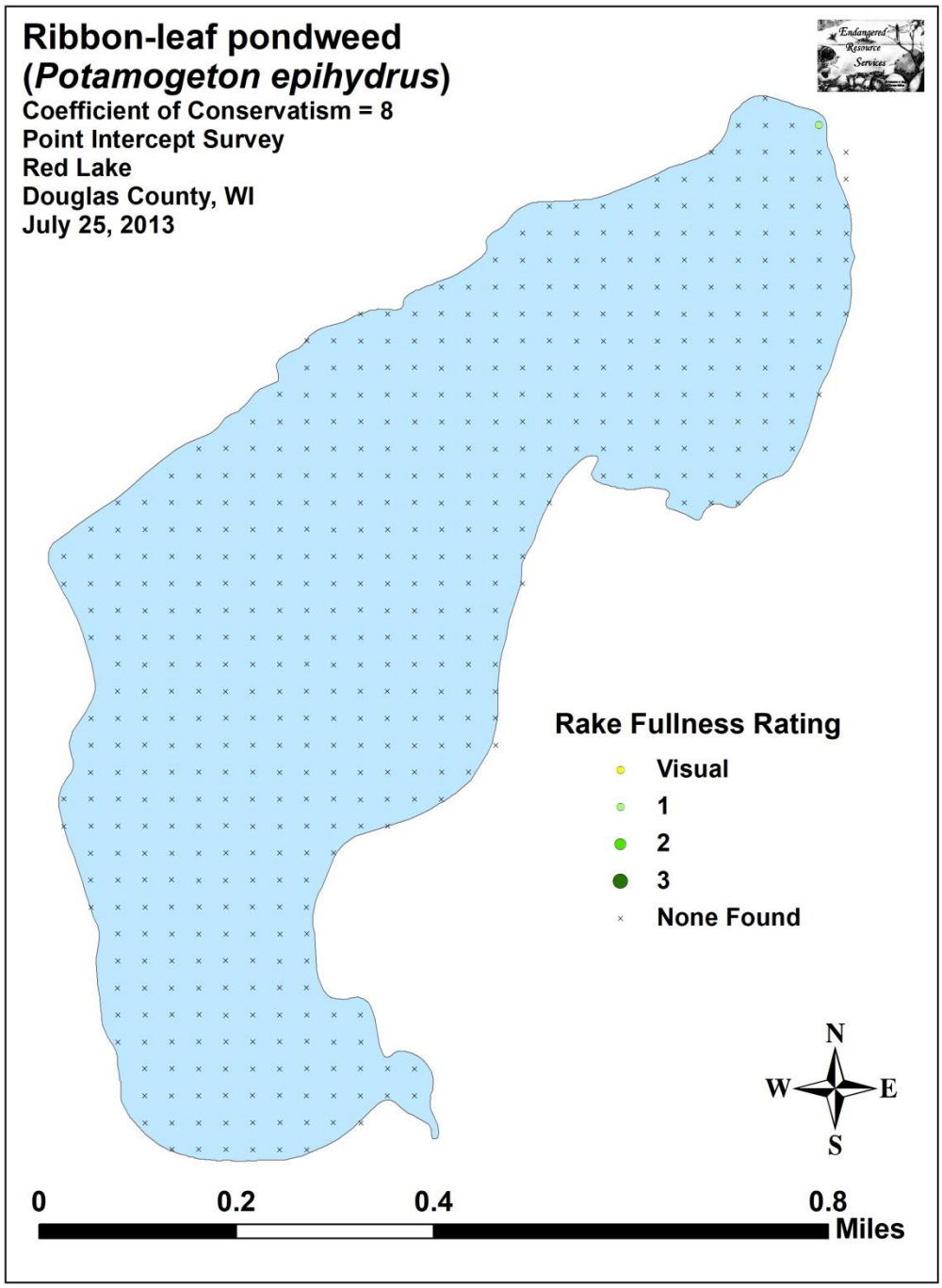
Miles


Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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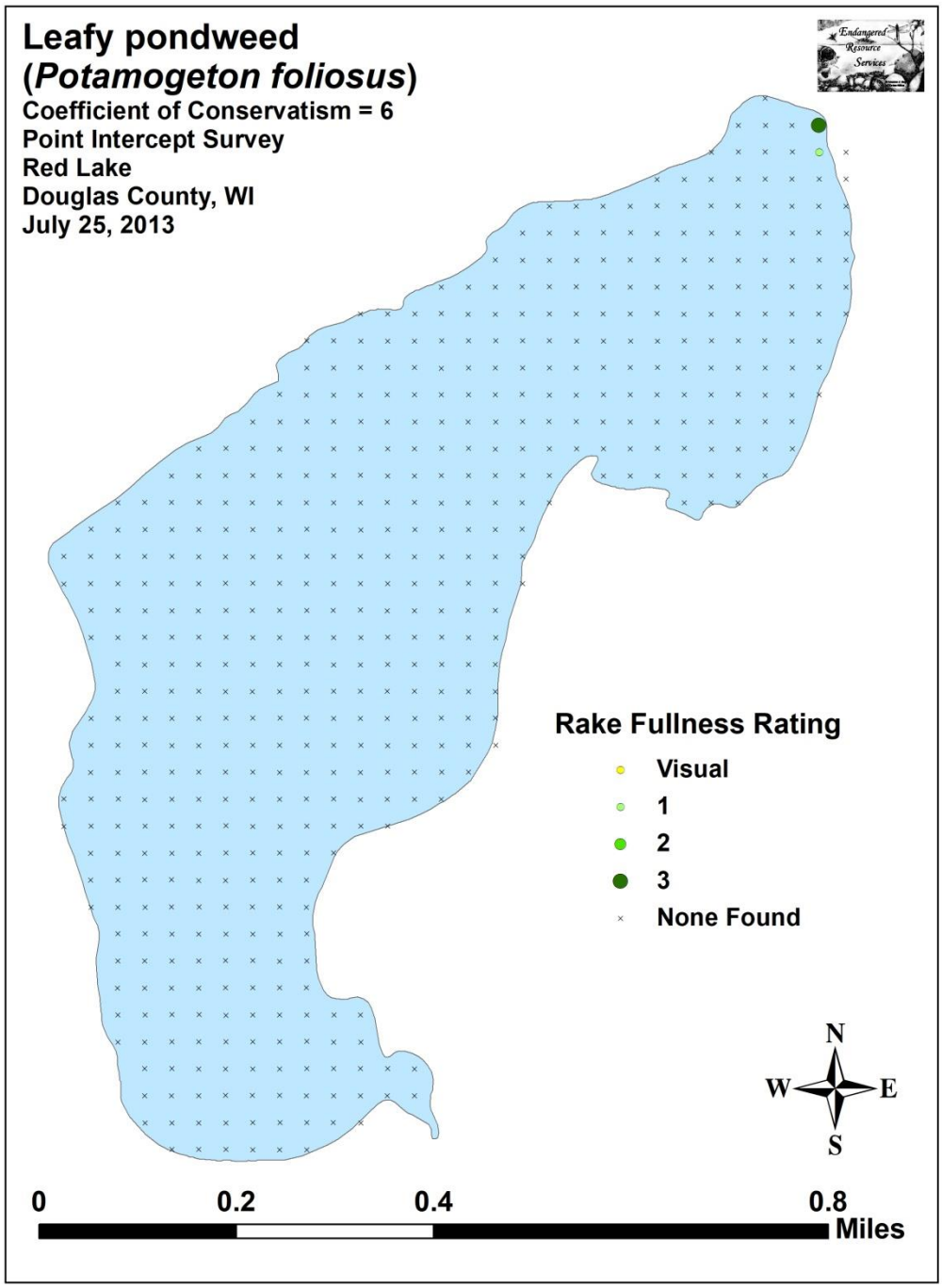
Miles


Leafy pondweed
(Potamogeton foliosus)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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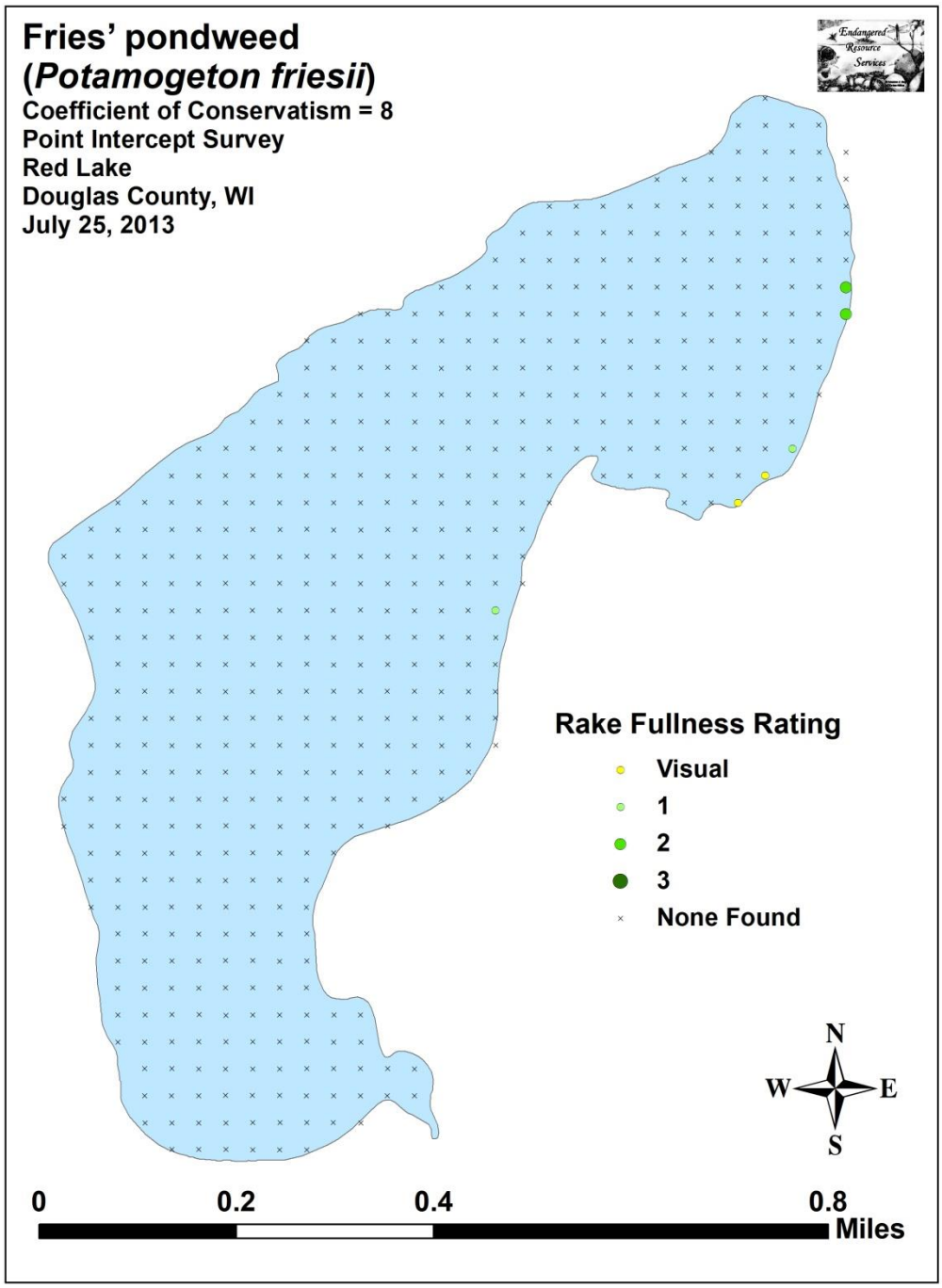
Miles


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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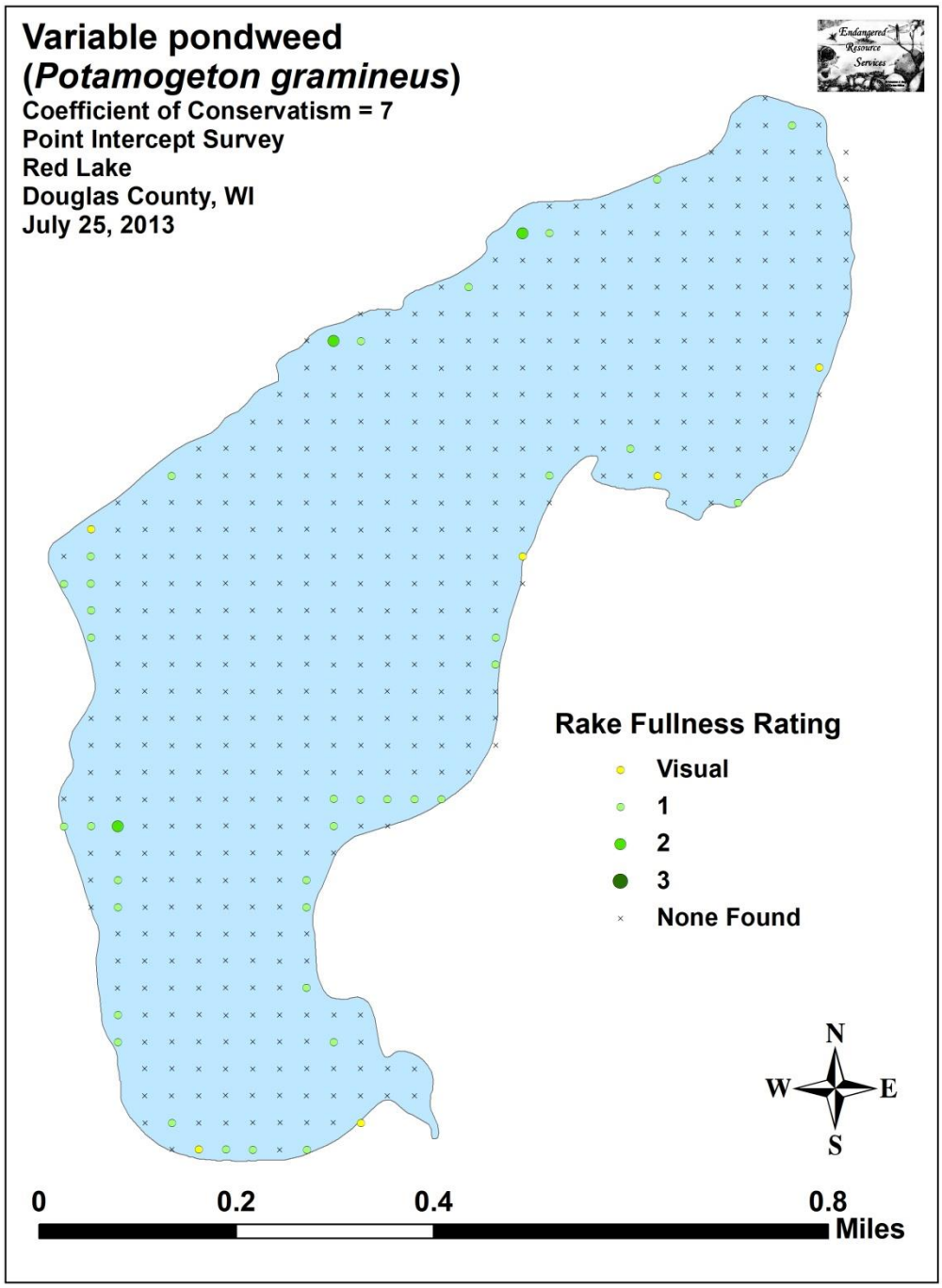
Miles


Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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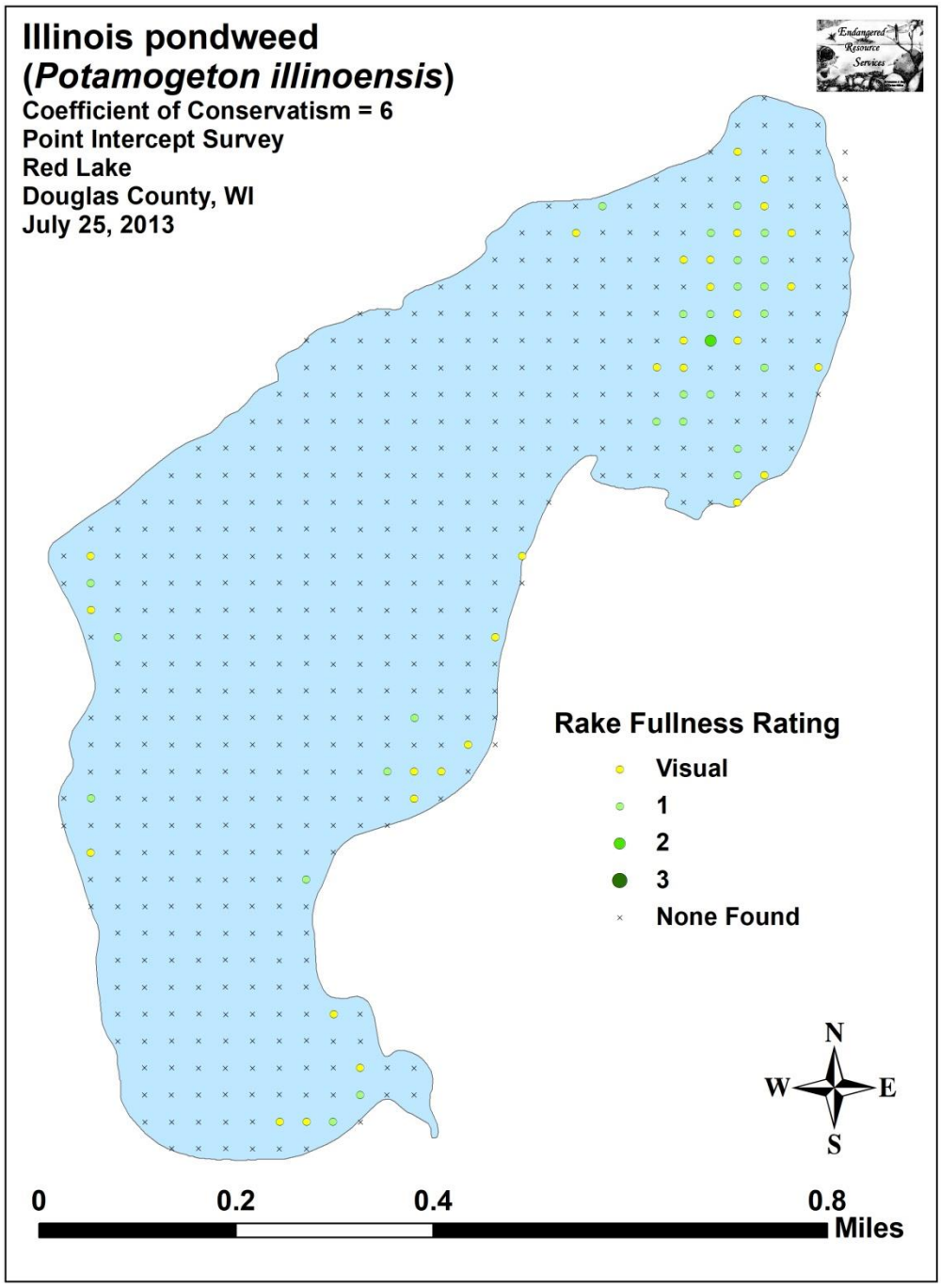
Miles


Illinois pondweed
(Potamogeton illinoensis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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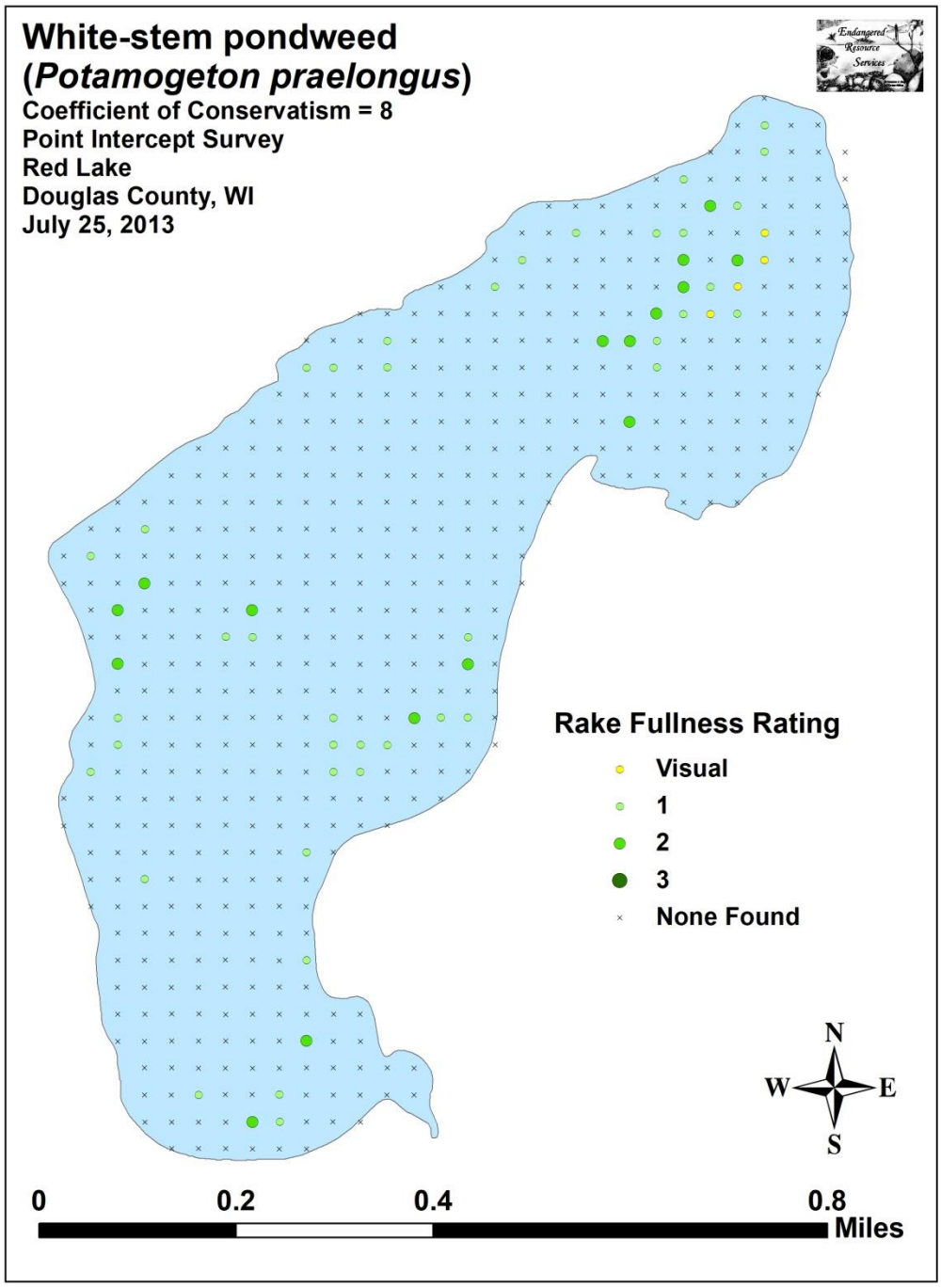
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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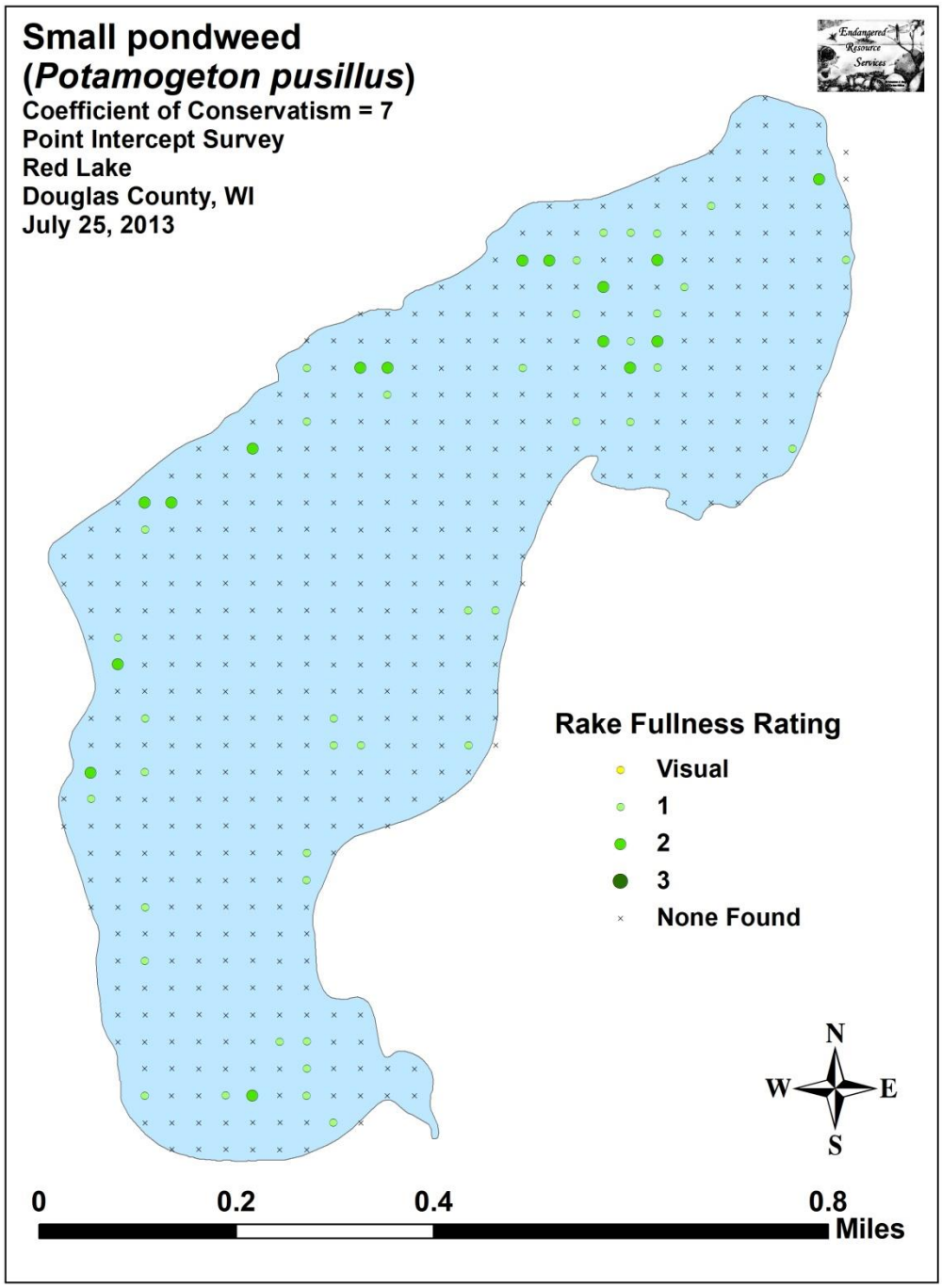
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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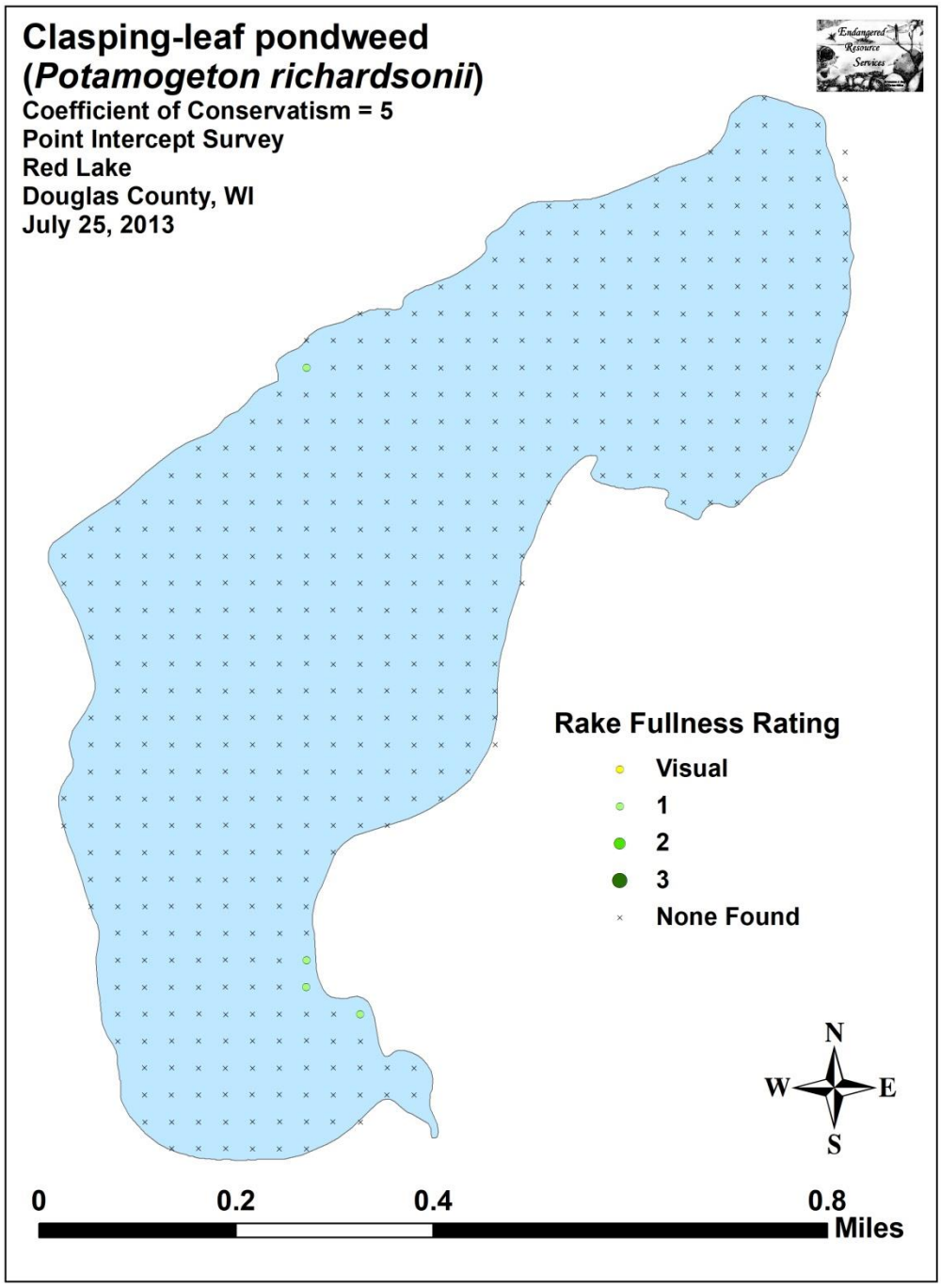
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
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None Found
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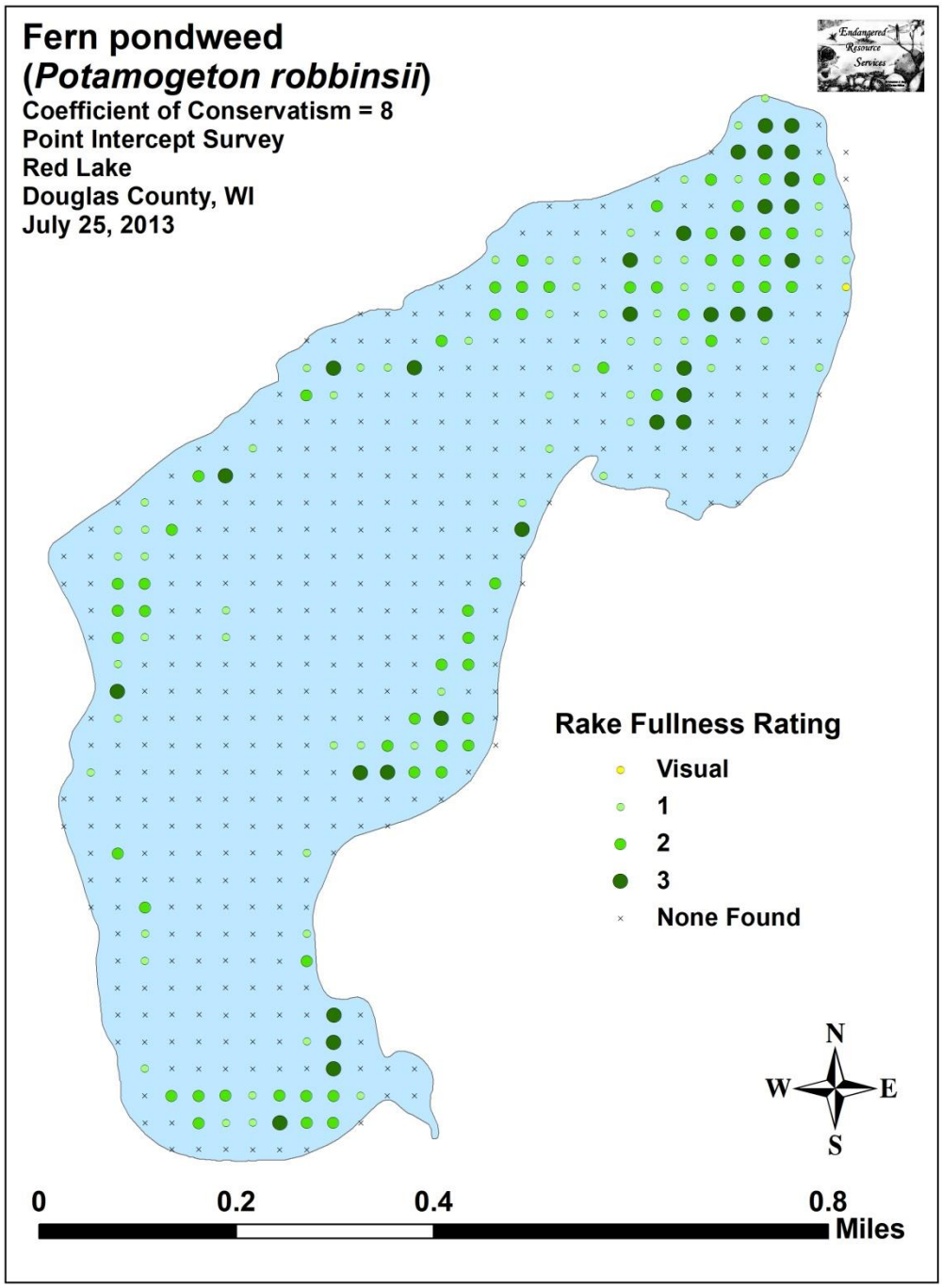
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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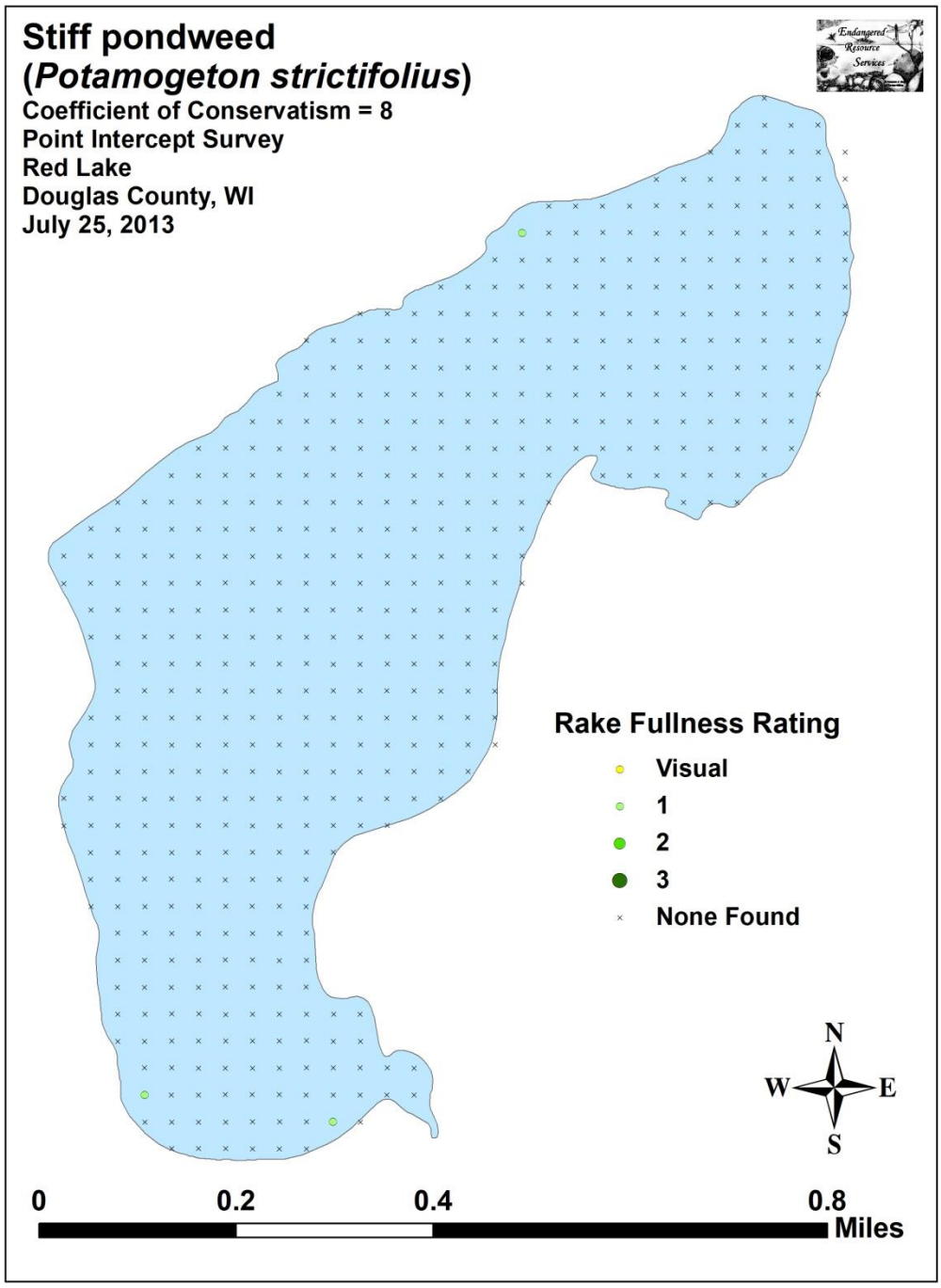
Miles


Stiff pondweed
(Potamogeton strictifolius)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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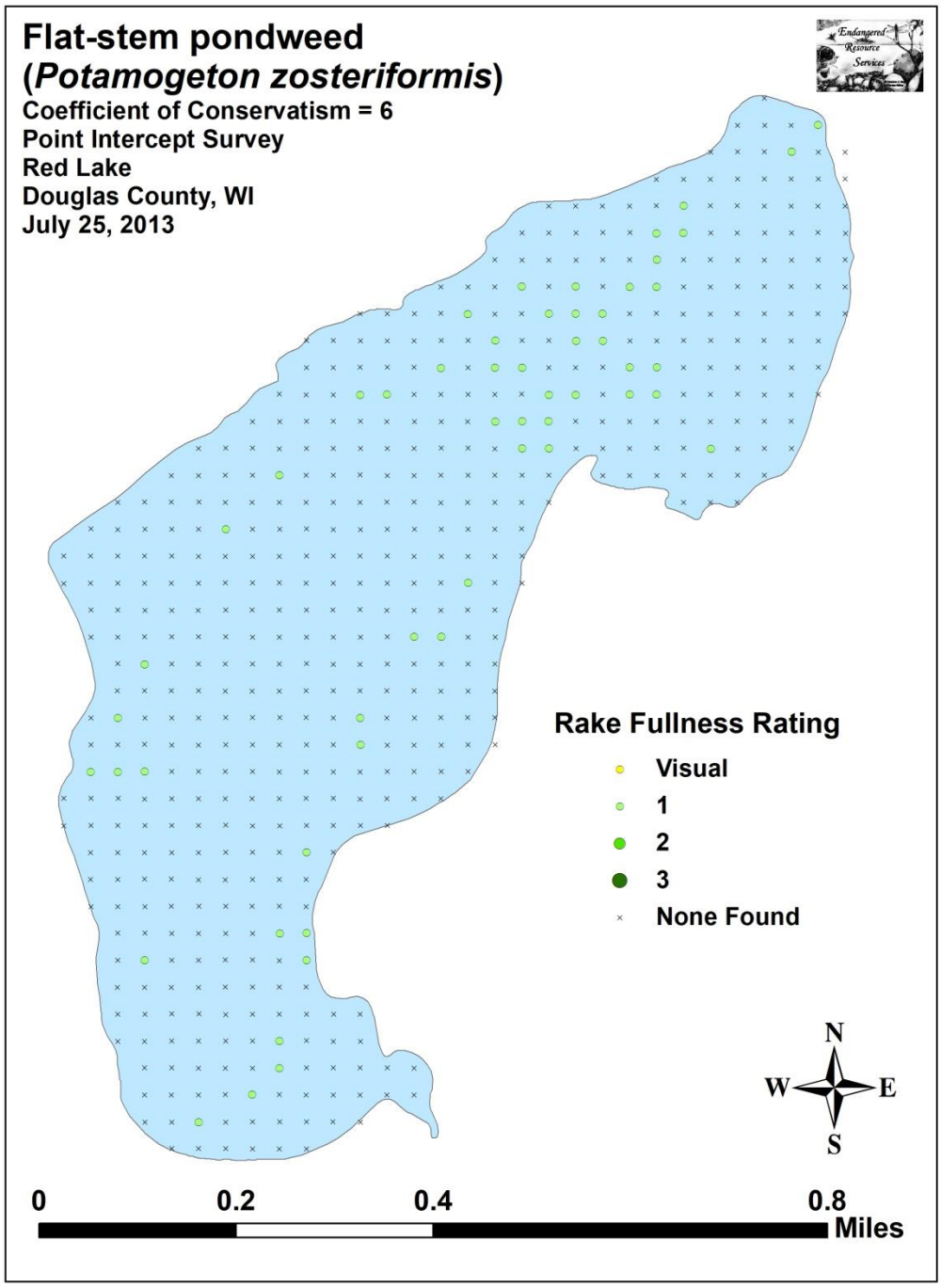
Miles


Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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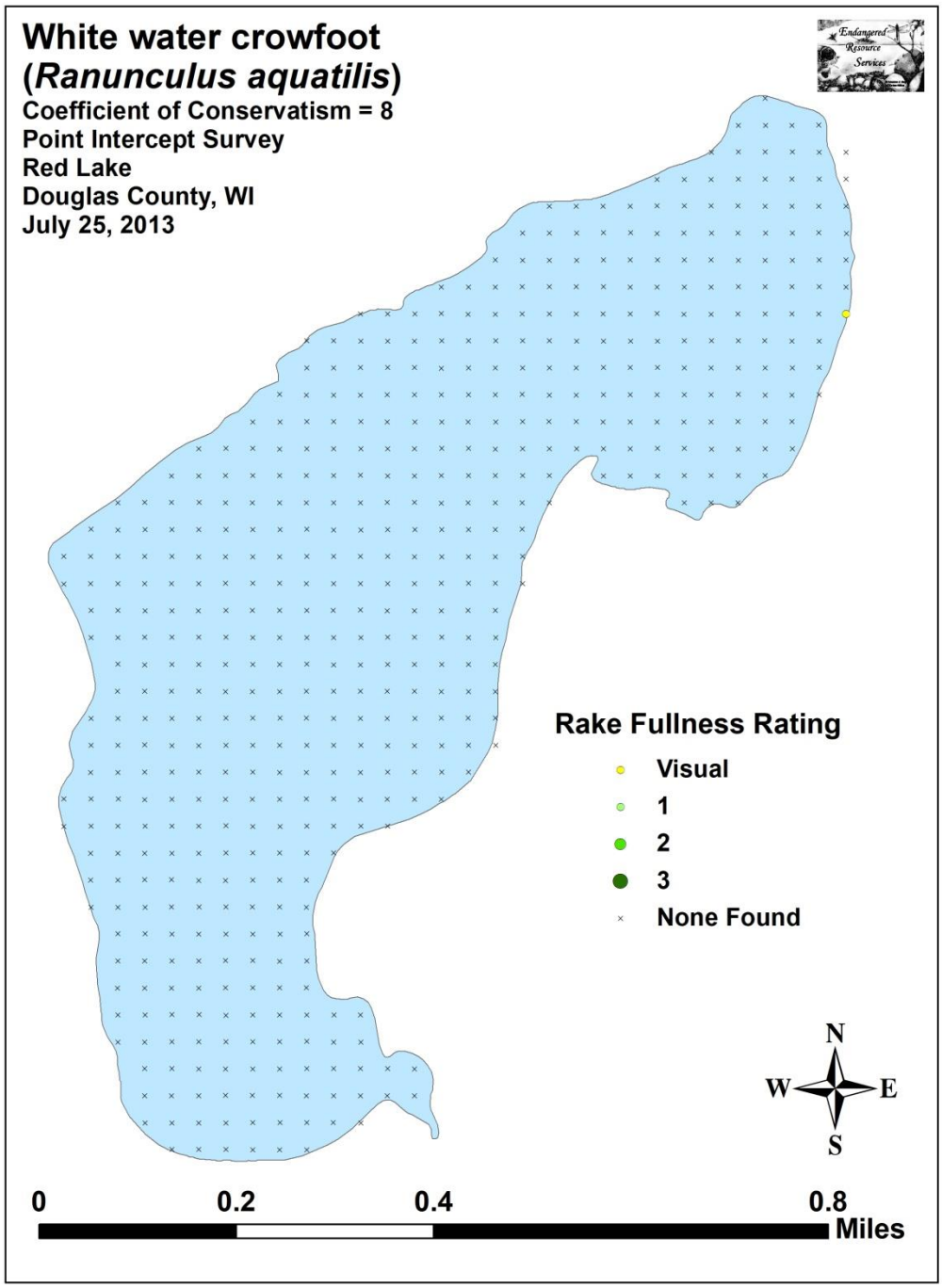
Miles


White water crowfoot
(Ranunculus aquatilis)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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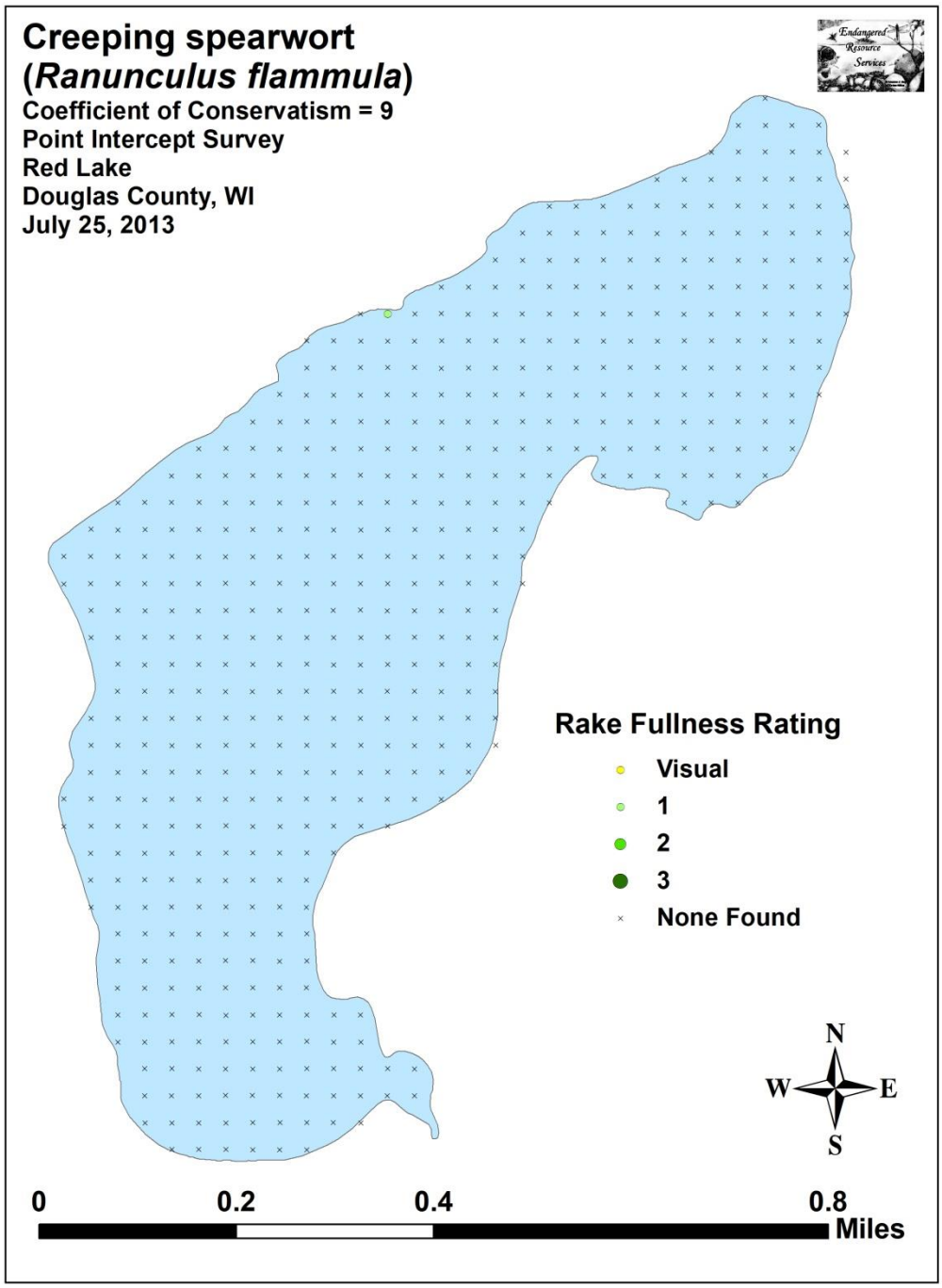
Miles


Creeping spearwort
(Ranunculus flammula)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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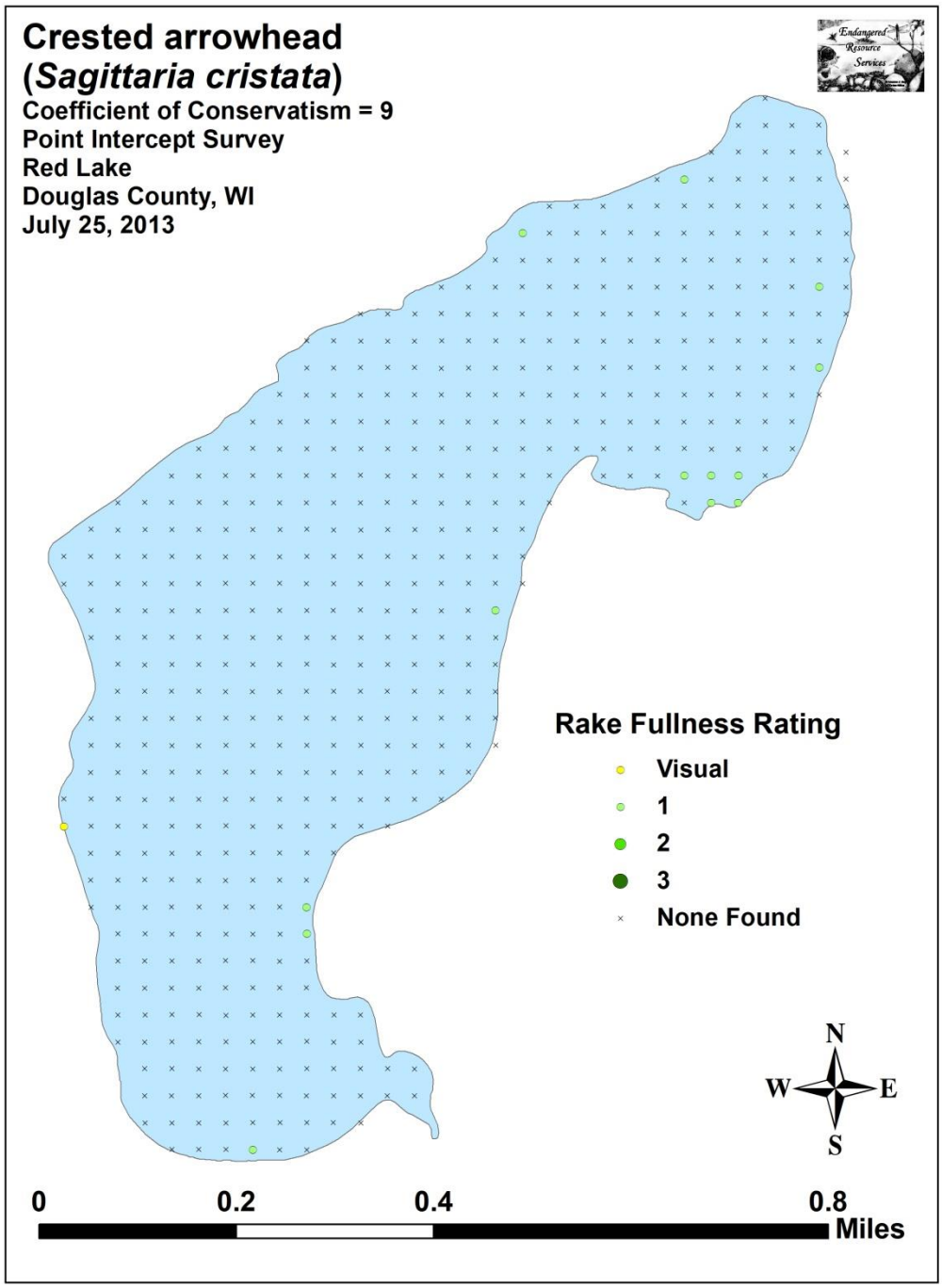
Miles


Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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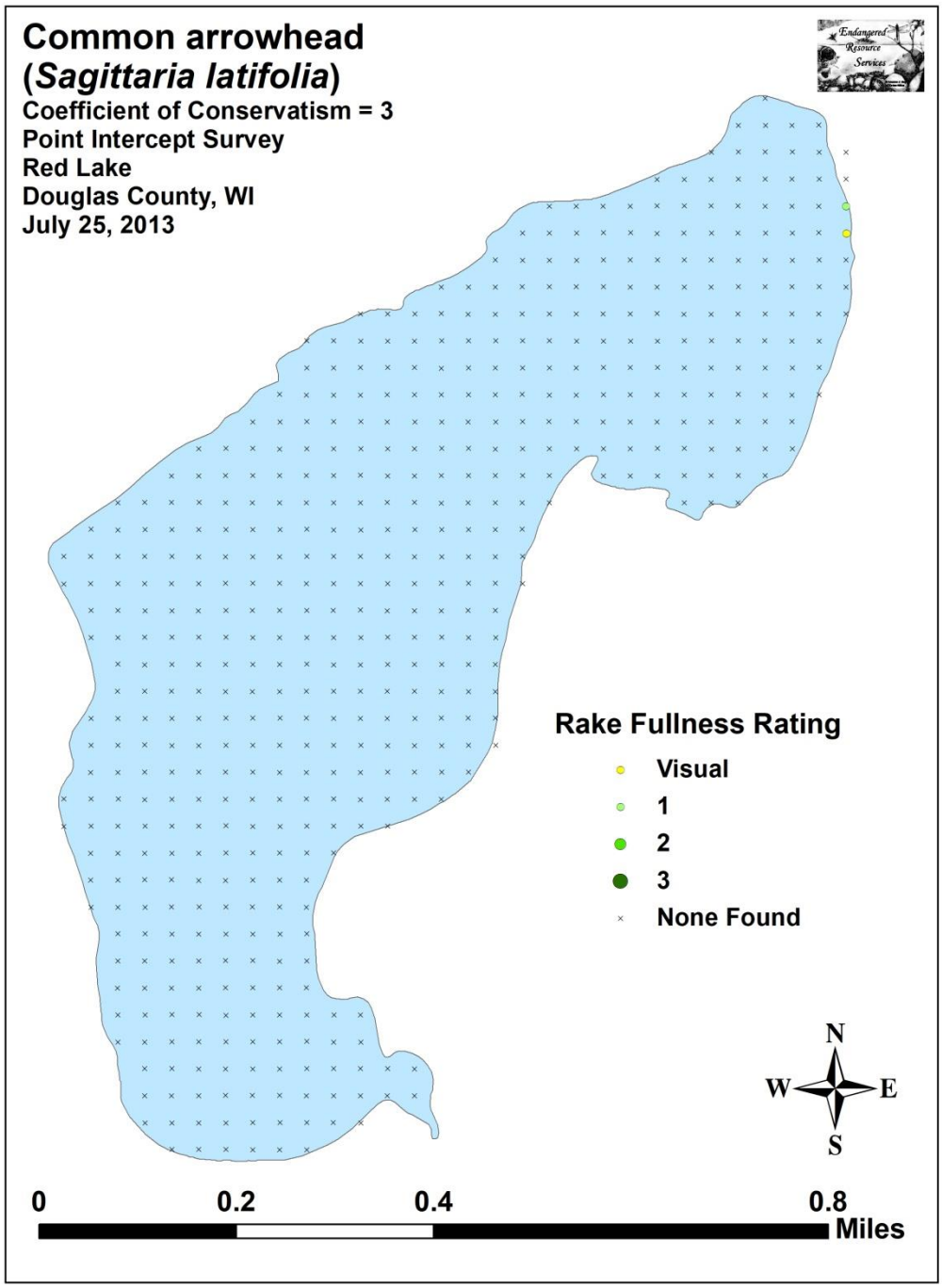
Miles


Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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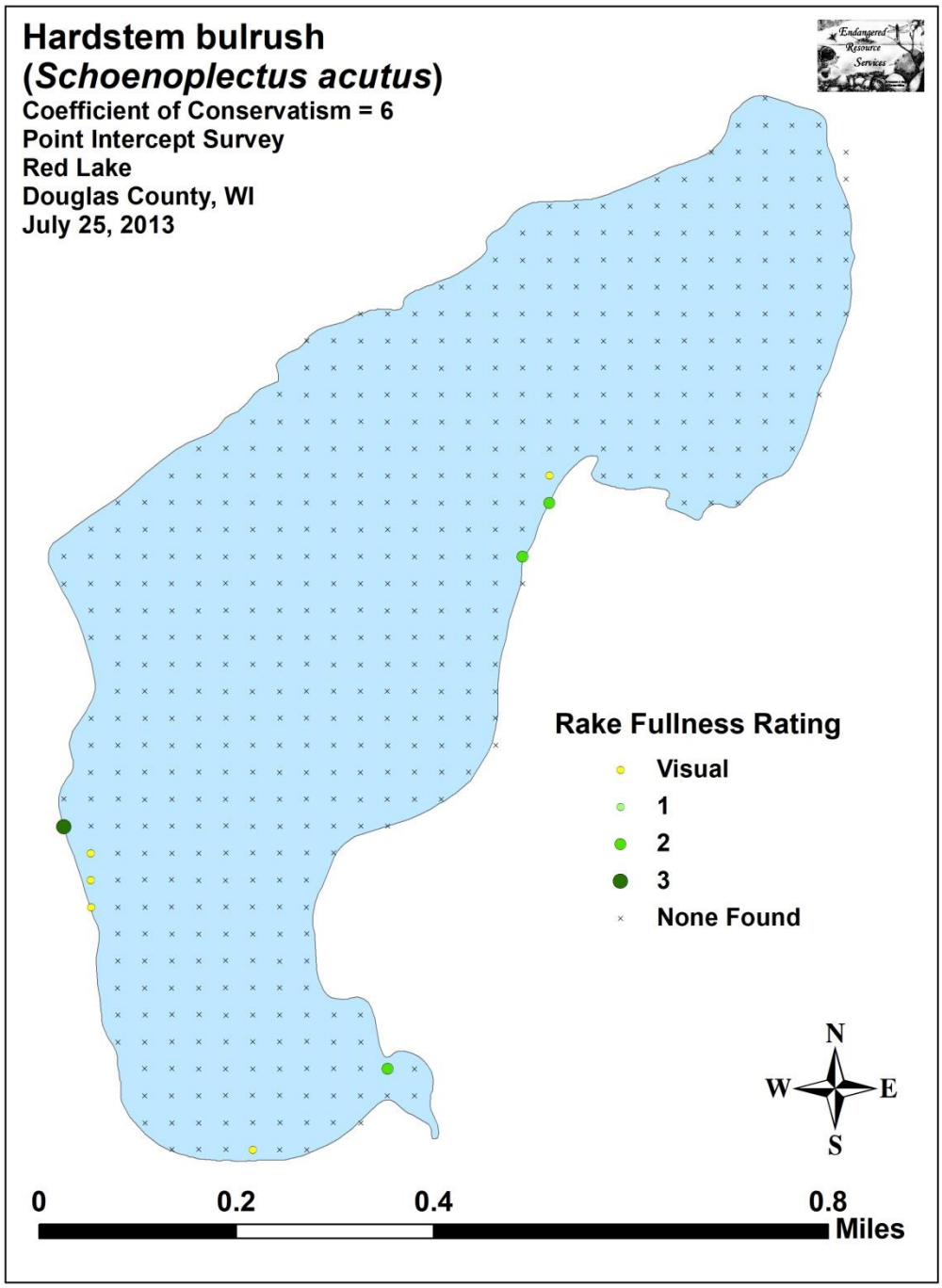
Miles


Hardstem bulrush
(Schoenoplectus acutus)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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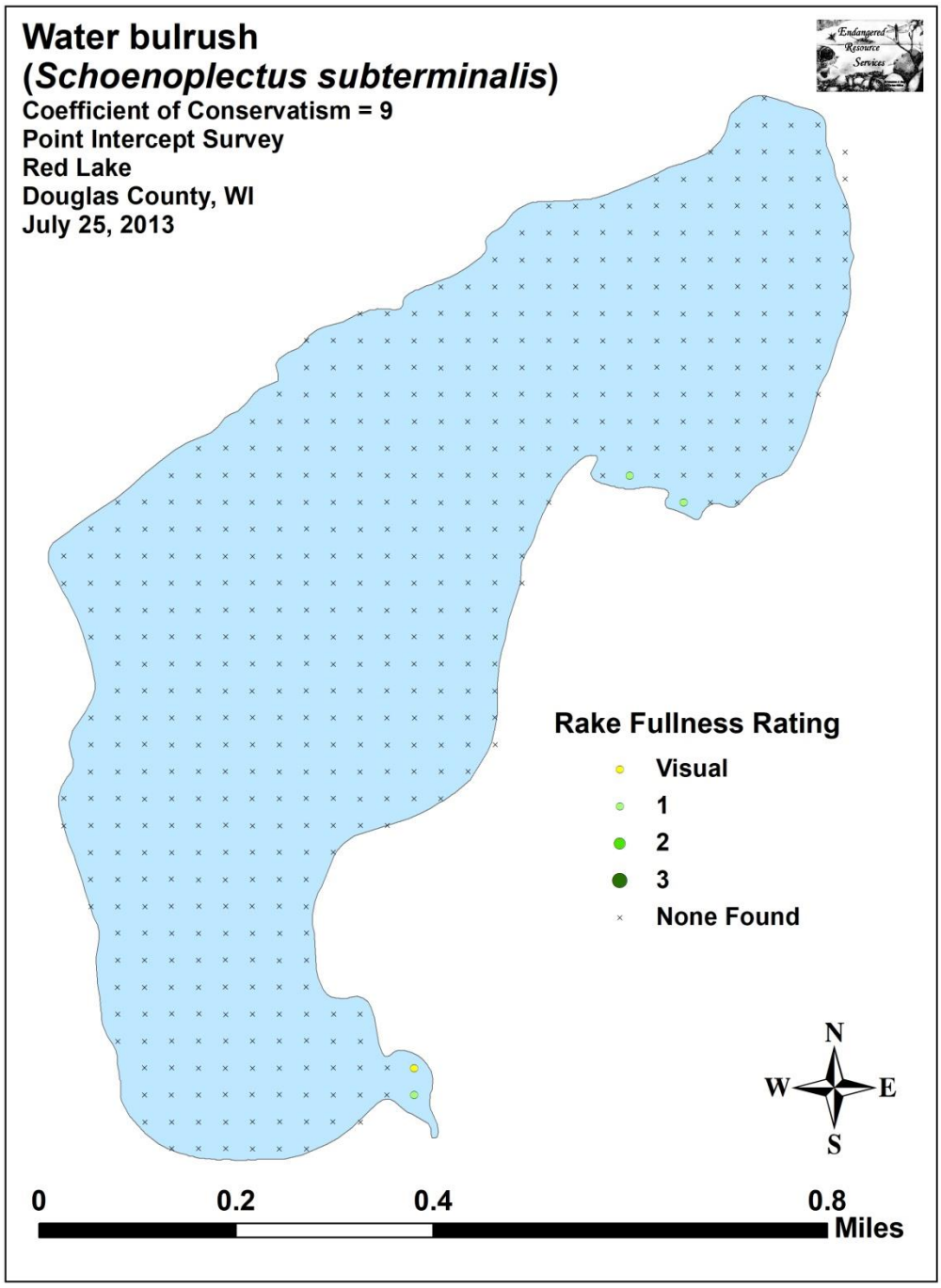
Miles


Water bulrush
(Schoenoplectus subterminalis)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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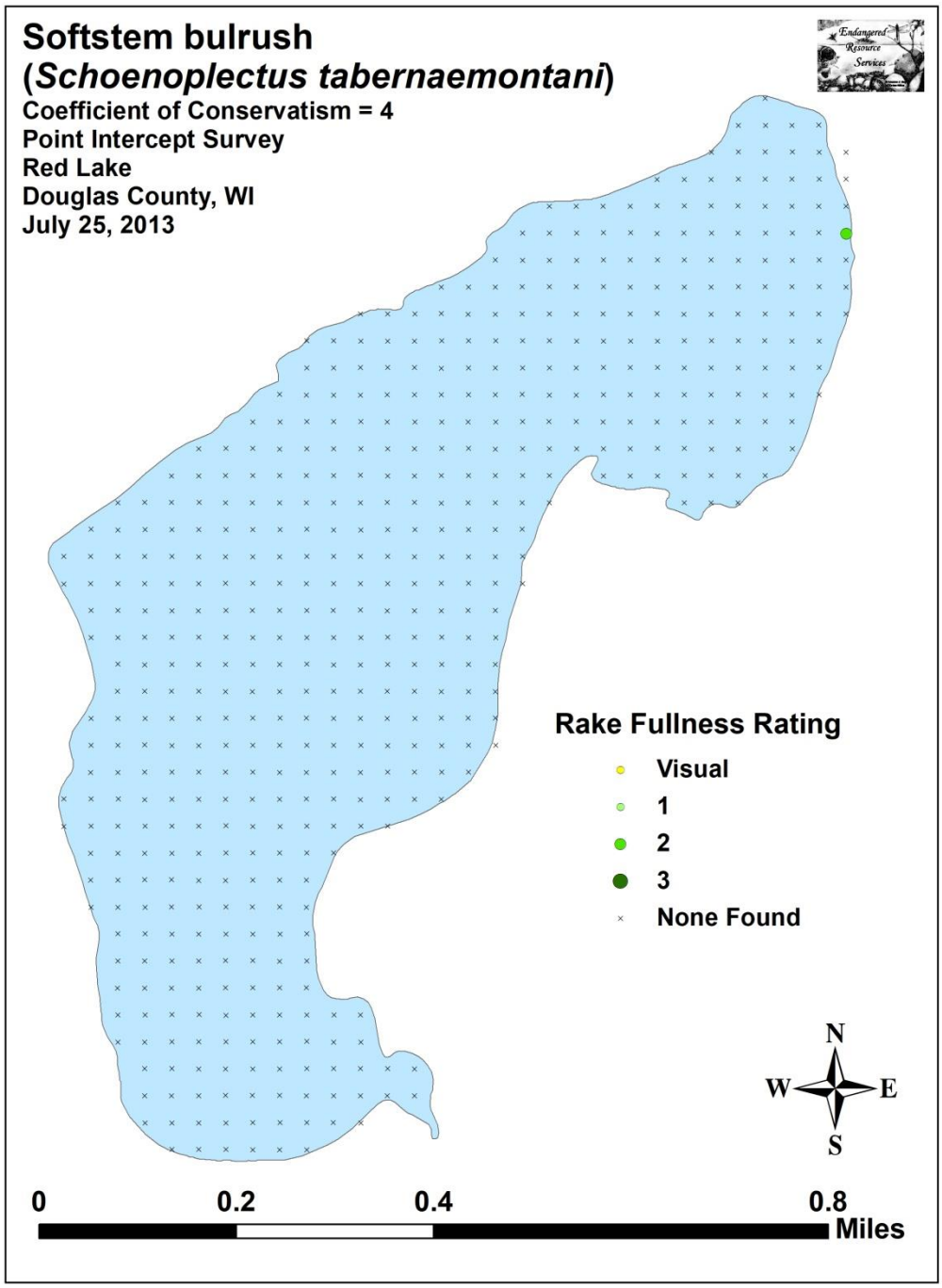
Miles


Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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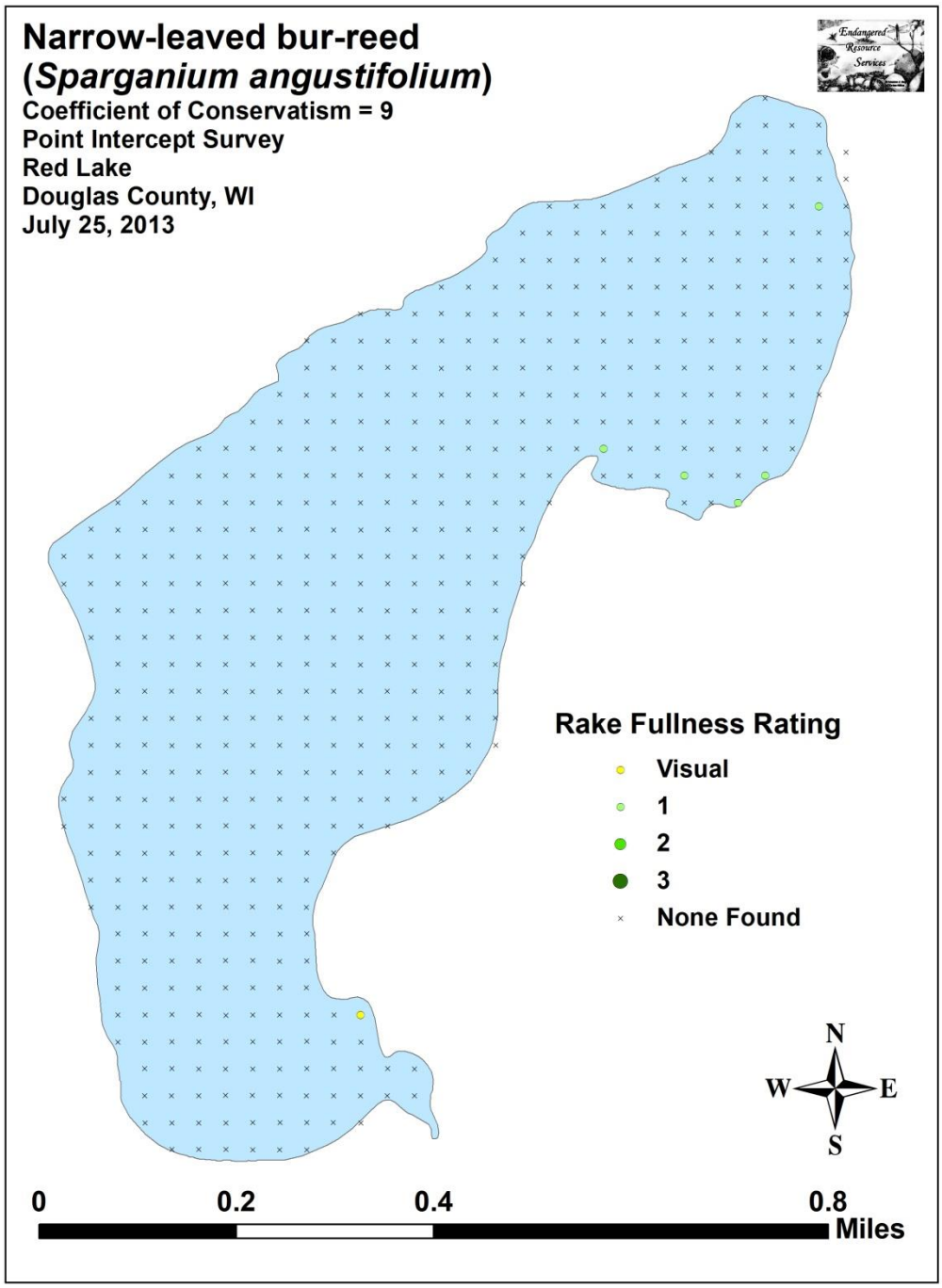
Miles


Narrow-leaved bur-reed
(Sparganium angustifolium)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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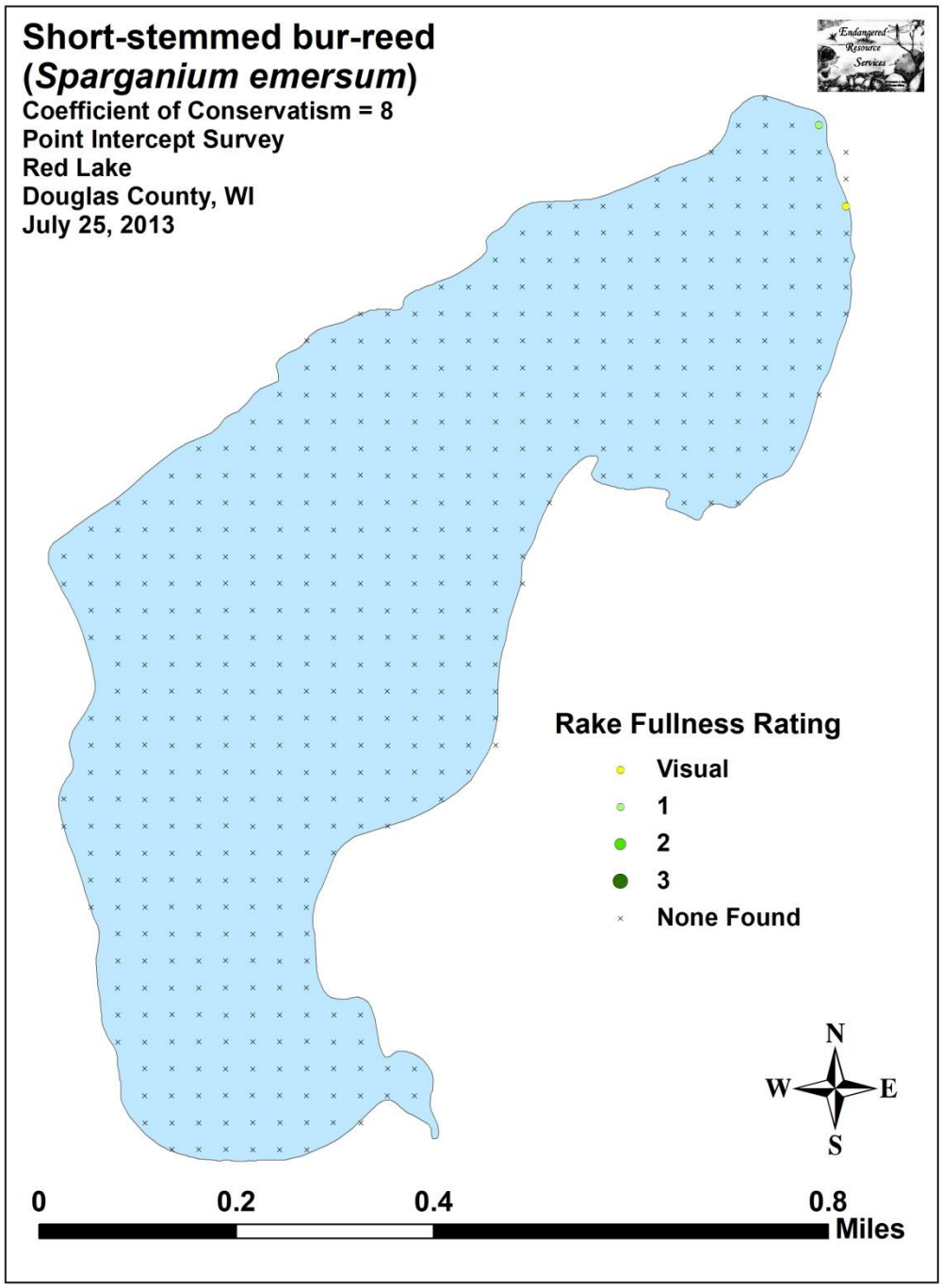
Miles


Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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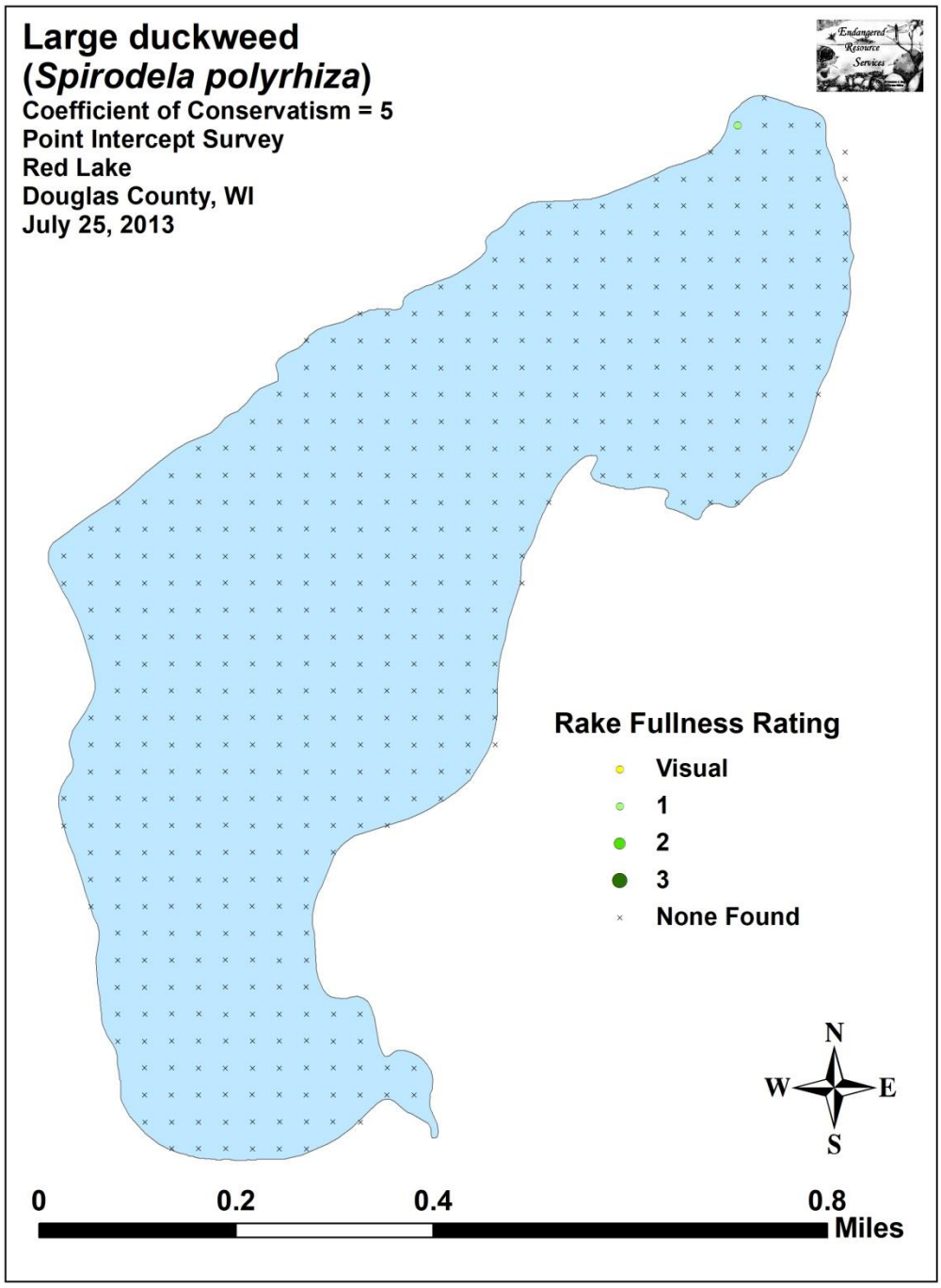
Miles


Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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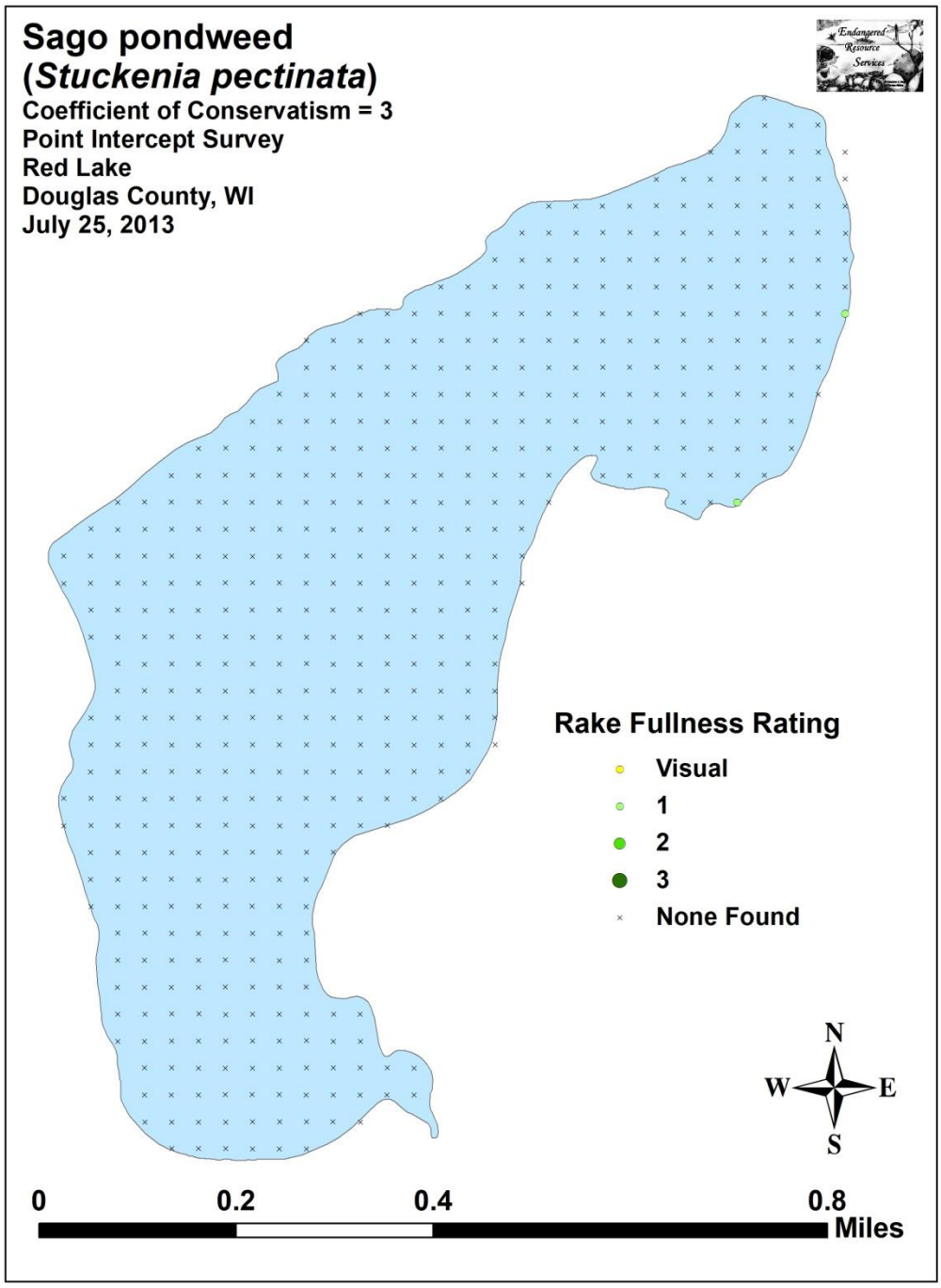
Miles


Sago pondweed
(Stuckenia pectinata)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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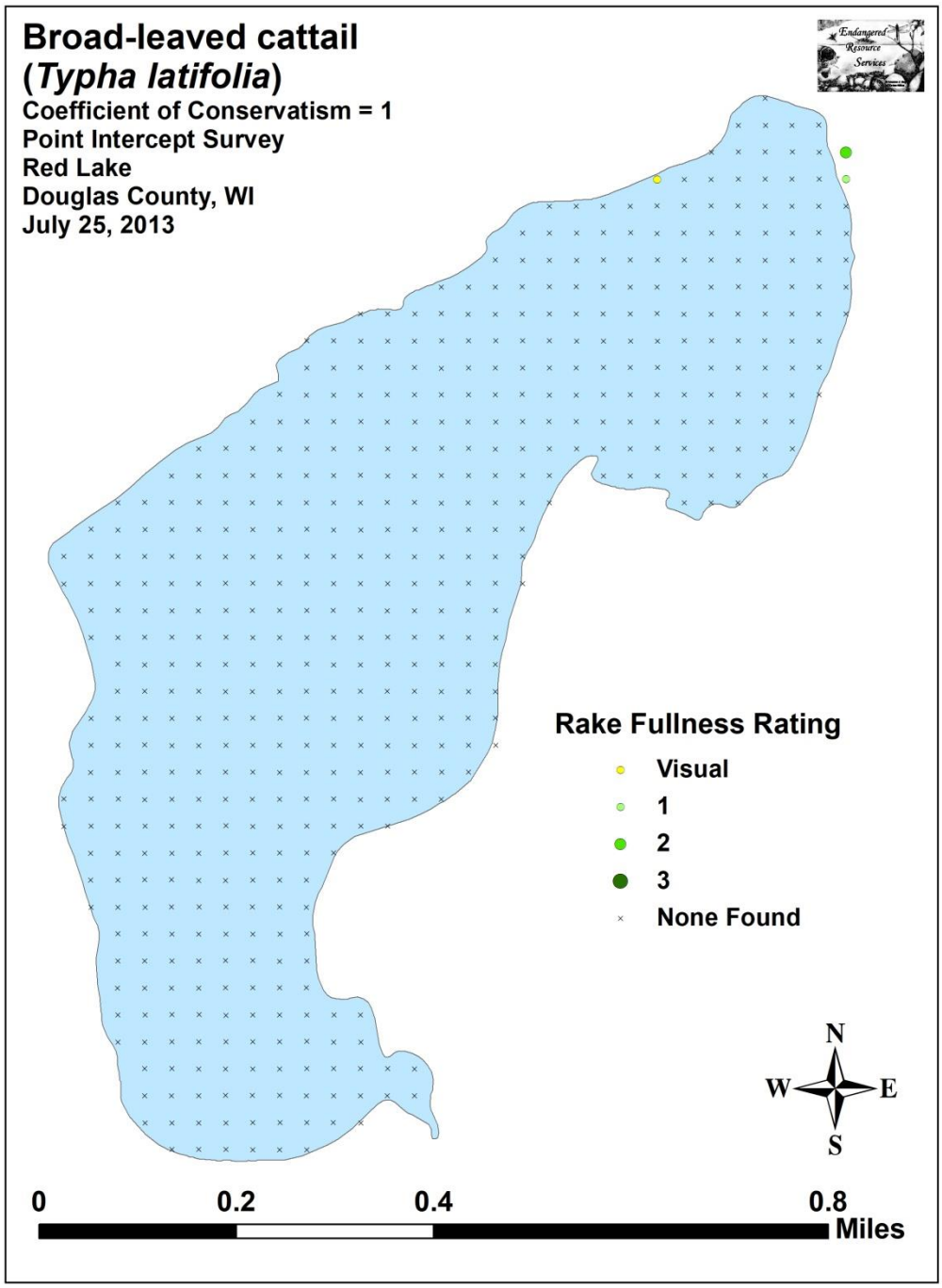
Miles


Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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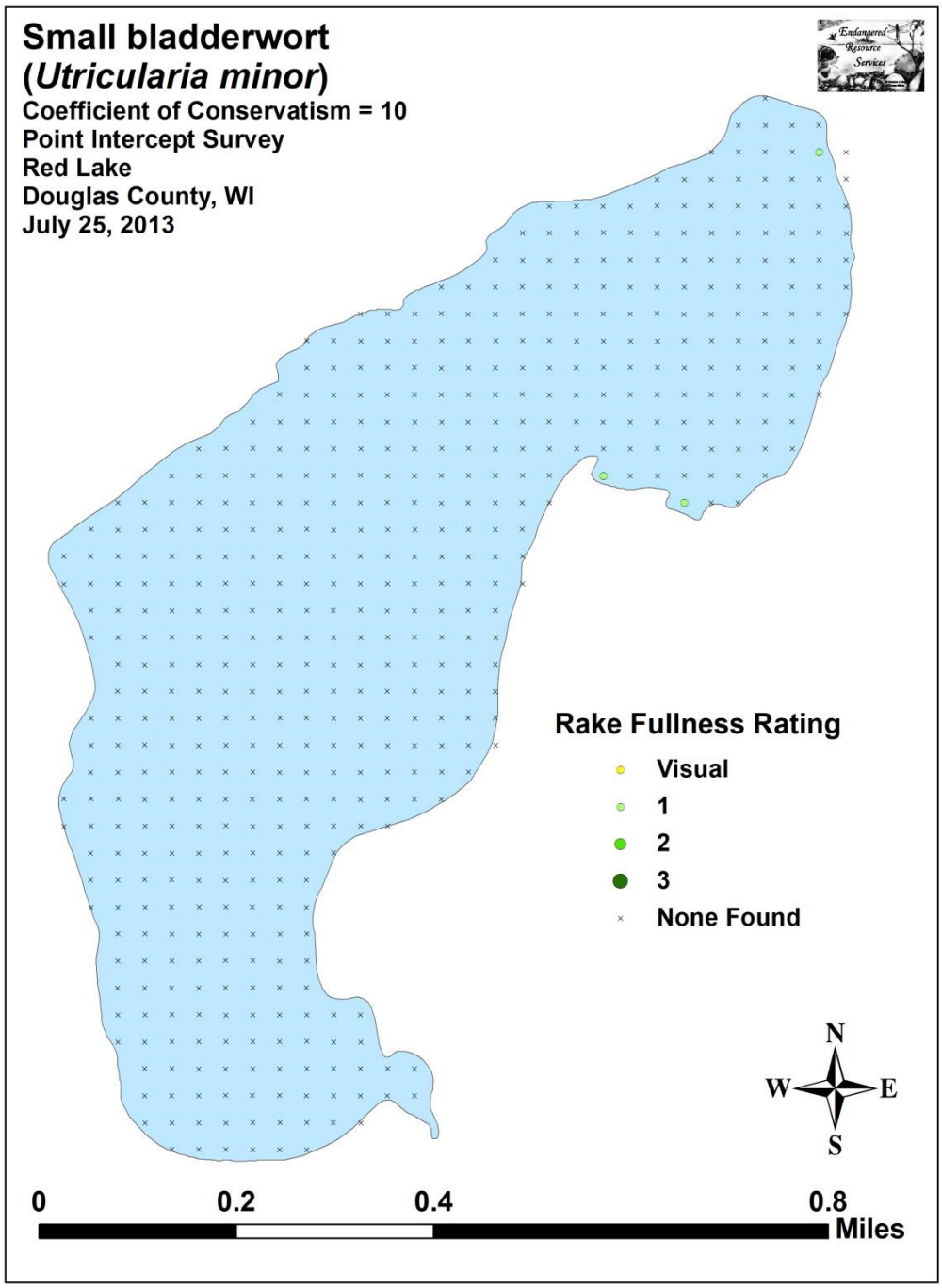
Miles


Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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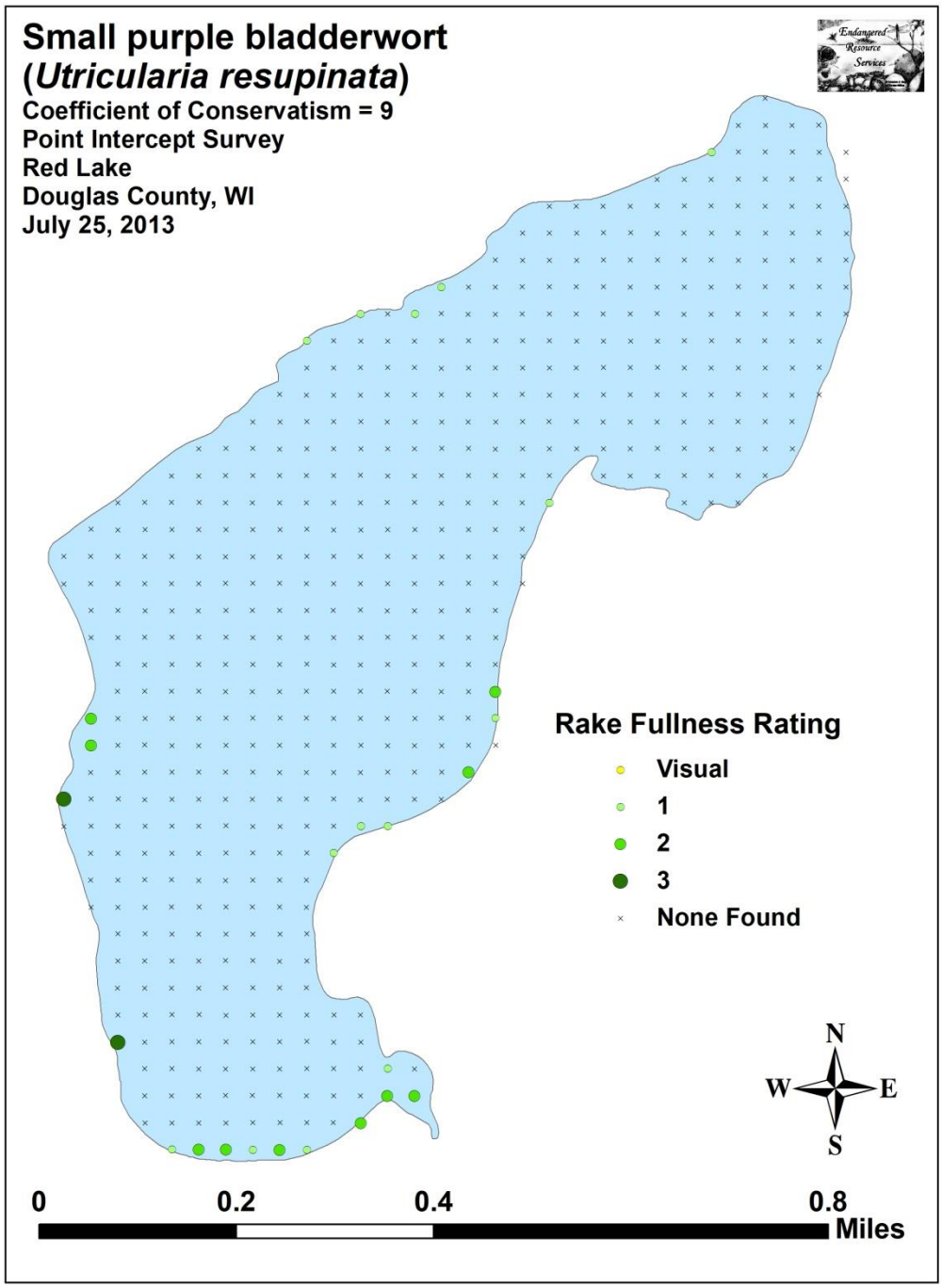
Miles


Small purple bladderwort
(Utricularia resupinata)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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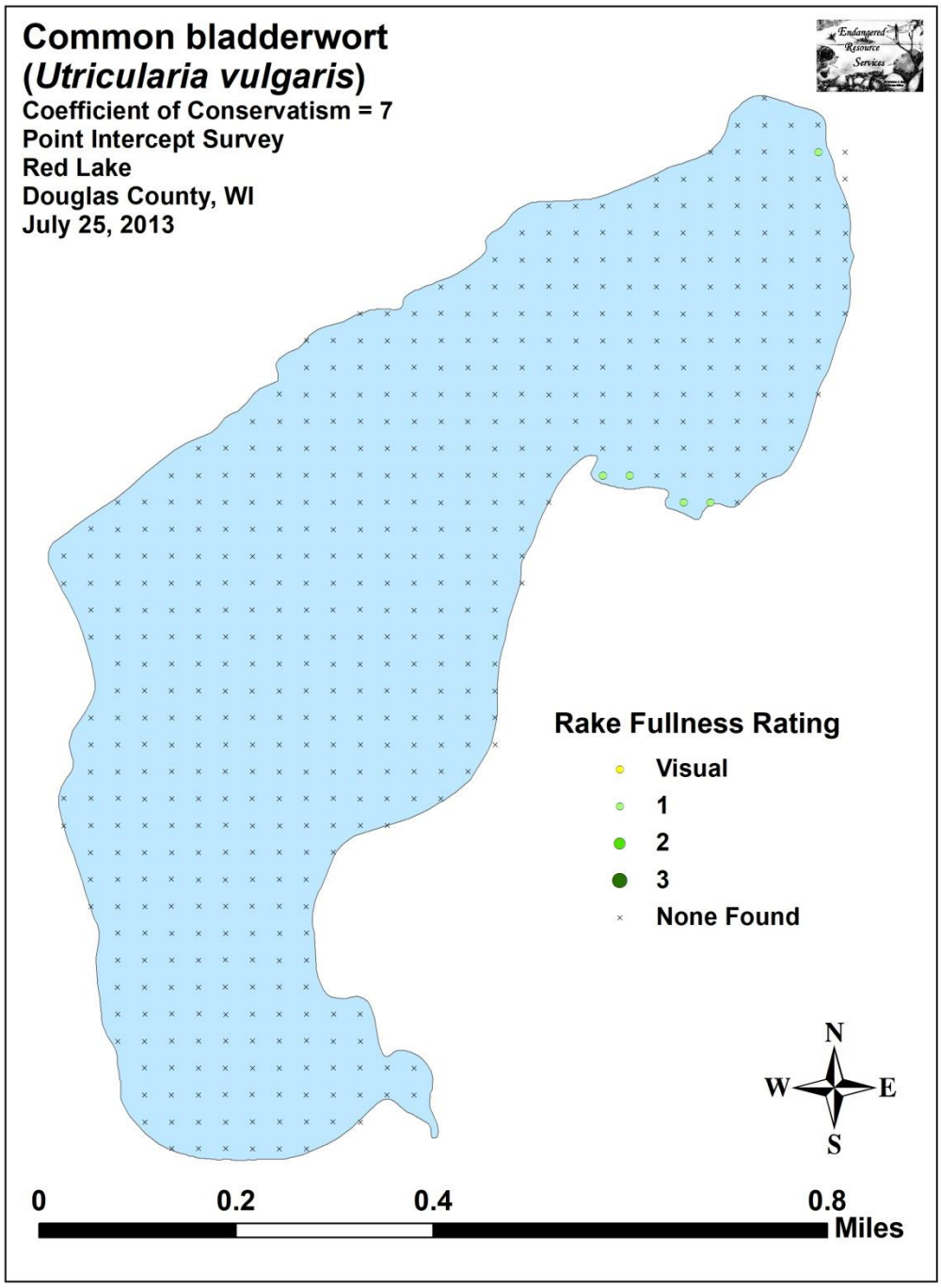
Miles


Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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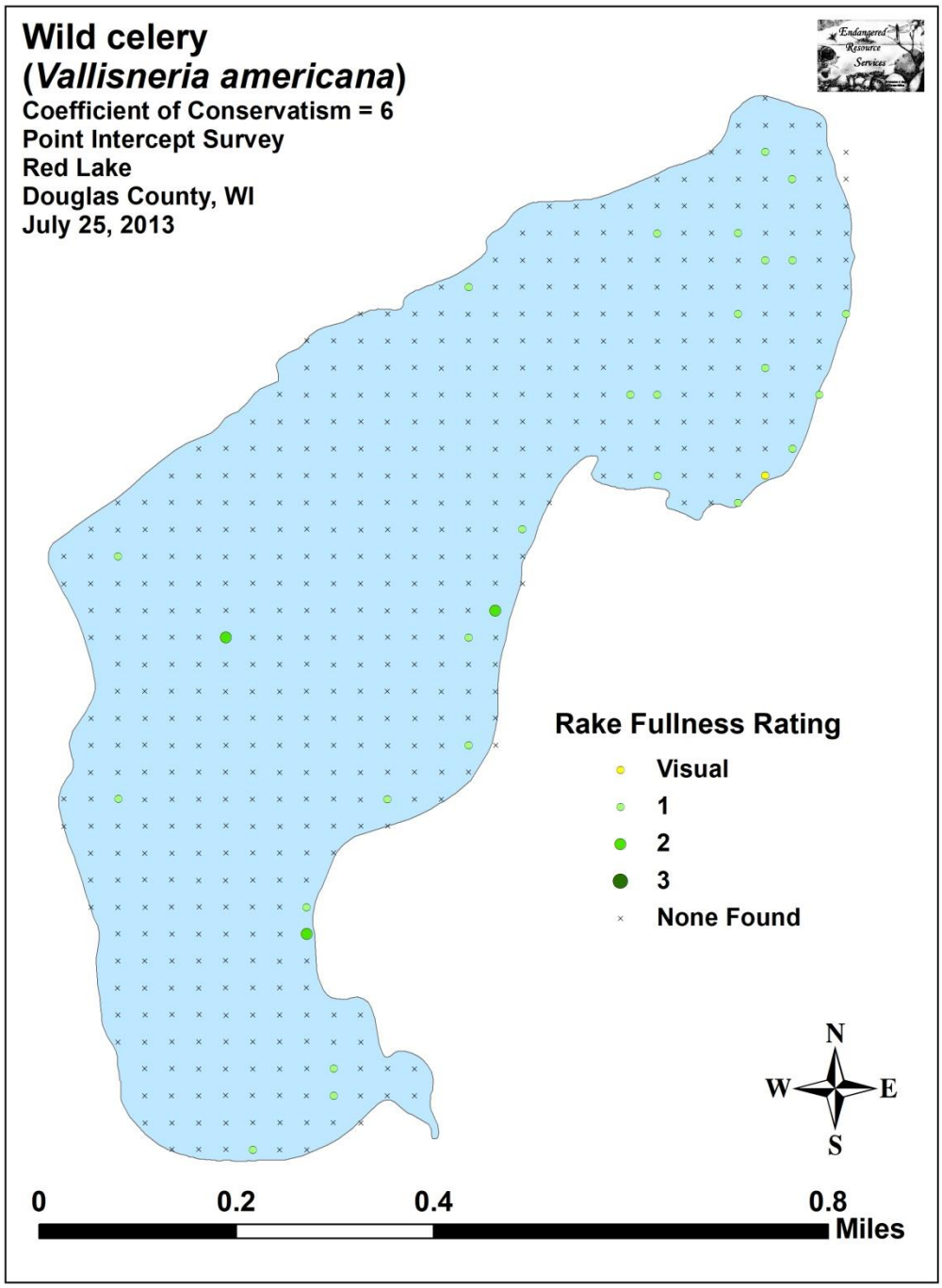
Miles


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 25, 2013
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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Miles

# Appendix VI:  Red Lake Plant Species Accounts

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Bidens beckii*) **Water marigold**
**Specimen Location:** Red Lake; N46.17245°, W91.76390°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-039
**Habitat/Distribution:** Muck bottom in 0-2.5 meters of water. Uncommon, but scattered throughout.
**Common Associates:** (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Brasenia schreberi*) **Watershield**
**Specimen Location:** Red Lake; N46.17245°, W91.76390°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-040
**Habitat/Distribution:** Muck and mucky sand bottom in 0.5-1.5 meters. Common to abundant in boggy bays and scattered sheltered shoreline areas.
**Common Associates:** (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Eleocharis robbinsii*) Robbins' spikerush, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus subterminalis*) Water bulrush, (*Utricularia vulgaris*) Common bladderwort

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Calla palustris*) **Wild calla**
**Specimen Location:** Red Lake; N46.18605°, W91.75521°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-041
**Habitat/Distribution:** Muck bottom in 0-0.25 meters. Relatively common in boggy areas of the northeast bays.
**Common Associates:** (*Myrica gale*) Sweet gale, (*Nymphaea odorata*) White water lily, (*Comarum palustre*) Marsh cinquefoil, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge

**State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Calamagrostis canadensis*) **Blue-joint**
**Specimen Location:** Red Lake; N46.17238°, W91.77005°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-042
**Habitat/Distribution:** Firm muck soil at the shoreline. Scattered individuals were located at the public boat landing.
**Common Associates:** (*Scirpus atrovirens*) Black bulrush

**State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Carex bebbii*) **Bebb's sedge**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-043
**Habitat/Distribution:** Firm sandy muck at the shoreline. Plants were scattered around the point and mixed with other sedges on the northeast shoreline just west of the Red Lake Resort Bay. Perigynium 3.0-3.2mm X 1.2-1.3 for an approx 2.5 to 1 ratio suggesting *bebbii* and not *scoparia* or *crawfordii*.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Carex utriculata*) Common yellow lake sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass

**State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Carex comosa*) **Bottle brush sedge**
**Specimen Location:** Red Lake; N46.18526°, W91.75519°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-044
**Habitat/Distribution:** Muck bottom in 0-0.25 meters. Relatively common in boggy areas of the northeast bays.
**Common Associates:** (*Myrica gale*) Sweet gale, (*Nymphaea odorata*) White water lily, (*Comarum palustre*) Marsh cinquefoil, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Dulichium arundinaceum*) Three-way sedge

**State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Carex lacustris*) L**ake sedge**
**Specimen Location:** Red Lake; N46.17997°, W91.77180°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-045
**Habitat/Distribution:** Sandy muck bottom along the shoreline. Rare; only plants found were in one bed near the point in the northwest bay at the shoreline.
**Common Associates:** (*Typha angustifolia*) Narrow-leaved cattail

**State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Carex utriculata*) **Common yellow lake sedge**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-046
**Habitat/Distribution:** Firm sandy muck at the shoreline. Plants were scattered around the point and mixed with other sedges on the northeast shoreline just west of the Red Lake Resort Bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Carex bebbii*) Bebb's sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Leersia oryzoides*) Rice cut-grass

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Ceratophyllum demersum*) **Coontail**
**Specimen Location:** Red Lake; N46.18641°, W91.75750°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-047
**Habitat/Distribution:** Organic muck bottom in <1m of water. Rare and local; only plants found were in the northeast bay.
**Common Associates:** (*Lemna minor*) Small duckweed, (*Potamogeton robbinsii*) Fern pondweed, (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton alpinus*) Alpine pondweed, (*Spirodela polyrhiza*) Large duckweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Chara* sp. likely *vulgaris*) **Muskgrass**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-048
**Habitat/Distribution:** Sand bottom areas in water from 0 – 2 meters deep. Common and widely distributed along all sandy lakeshores.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Utricularia resupinata*) Small purple bladderwort, (*Eriocaulon aquaticum*) Pipewort, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Lobelia dortmanna*) Water lobelia

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Chara* sp.) **Muskgrass**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-049
**Habitat/Distribution:** Sandy muck in water 4-6.5m. Common, but occurring in much deeper water than the preceding – there was a distinct 2m gap between their distribution, and we suspect it is another species.
**Common Associates:** (*Nitella* sp.) Nitella, (*Potamogeton robbinsii*) Fern pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Cladium mariscoides*) **Smooth sawgrass**
**Specimen Location:** Red Lake; N46.17749°, W91.77090°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-050
**Habitat/Distribution:** Firm sand bottoms along the shoreline. Scattered clusters of plants occurred on the southern half of the lake along undeveloped shoreline areas.
**Common Associates:** (*Eleocharis palustris*) Creeping spikerush, (*Juncus pelocarpus*) Brown-fruited rush, (*Schoenoplectus acutus*) Hardstem bulrush

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Comarum palustre*) **Marsh cinquefoil**
**Specimen Location:** Red Lake; N46.18605°, W91.75521°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-a50
**Habitat/Distribution:** Muck bottom at the shoreline in 0 – 0.25 meters of water. Scattered in boggy areas in the northeast bay.
**Common Associates:** (*Calla palustris*) Wild calla, (*Myrica gale*) Sweet gale, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Dulichium arundinaceum*) **Three-way sedge**
**Specimen Location:** Red Lake; N46.18566°, W91.75520°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-a51
**Habitat/Distribution:** Mucky to firm bottoms in 0-0.25 meters of water. Clusters occurred on floating bog mats scattered along the eastern shoreline of the northeast bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Comarum palustre*) Marsh cinquefoil, (*Calla palustris*) Wild calla, (*Carex comosa*) Bottle brush sedge, (*Sagittaria latifolia*) Common arrowhead, (*Eleocharis erythropoda*) Bald spikerush

**County/State:** Douglas County, Wisconsin **Date:** 7/30/17
**Species:** (*Elatine minima*) **Waterwort**
**Specimen Location:** Red Lake; N46.18601°, W91.75806°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2017-005
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1 meter deep. Common and widely distributed along most sandy lakeshores.
**Common Associates:** (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Ranunculus flammula*) Creeping spearwort, (*Najas flexilis*) Slender naiad, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Eleocharis erythropoda*) **Bald spikerush**
**Specimen Location:** Red Lake; N46.18566°, W91.75520°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-052
**Habitat/Distribution:** Mucky to firm bottoms in 0-0.25 meters of water. Dense clusters of plants occurred on floating bog mats scattered along the eastern shoreline of the northeast bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Comarum palustre*) Marsh cinquefoil, (*Dulichium arundinaceum*) Three-way sedge, (*Carex comosa*) Bottle brush sedge, (*Sagittaria latifolia*) Common arrowhead

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Eleocharis ovata*) **Oval spikerush**
**Specimen Location:** Red Lake; N46.18605°, W91.75521°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-053
**Habitat/Distribution:** Scattered clusters of plants were found growing on floating muck bogs along the eastern shoreline in the lake's northeast bay.
**Common Associates:** (*Dulichium arundinaceum*) Three-way sedge, (*Carex comosa*) Bottle brush sedge,

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Eleocharis palustris*) **Creeping spikerush**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-054
**Habitat/Distribution:** Firm sandy bottoms in 0-0.5 meters of water. Uncommon, a few scattered individuals were found growing in Hard and Softstem bulrush beds or in monotypic stands.
**Common Associates:** (*Schoenoplectus acutus*) Hardstem bulrush, (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Utricularia resupinata*) Small purple bladderwort

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Eleocharis robbinsii*) **Robbins' spikerush**
**Specimen Location:** Red Lake; N46.17245°, W91.76390°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-055
**Habitat/Distribution:** Organic and silty muck in 0.5-1.0 meter of water. Locally common in a few boggy bays on the northeast and southeast corners of the lake.
**Common Associates:** (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Brasenia schreberi*) Watershield, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus subterminalis*) Water bulrush, (*Utricularia vulgaris*) Common bladderwort

County/State**:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Elodea canadensis*) **Common waterweed**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-056
**Habitat/Distribution:** Muck bottom in 0-6.5 meters of water.
Rarely abundant, but found almost everywhere within the littoral zone except over pure sand.
**Common Associates:** (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton illinoensis*) Illinois pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Eriocaulon aquaticum*) **Pipewort**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-057
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1 meter deep. Common and widely distributed along most sandy lakeshores.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Utricularia resupinata*) Small purple bladderwort, (*Ranunculus flammula*) Creeping spearwort, (*Lobelia dortmanna*) Water lobelia

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Gallium* sp.) **Bedstraw**
**Specimen Location:** Red Lake; N46.18122°, W91.76019°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-058
**Habitat/Distribution:** Soft muck bottoms in water <1 meter deep. Only plants found were in the southwest corner of the northeast bay.
**Common Associates:** (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Pontederia cordata*) Pickerelweed, (*Brasenia schreberi*) Watershield, (*Utricularia minor*) Small bladderwort

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Heteranthera dubia*) **Water star-grass**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-059
**Habitat/Distribution:** Silty and sandy muck in 0.5-2.5m of water. Almost all plants were located along the eastern shore of the northeast bay.
**Common Associates:** (*Stuckenia pectinata*) Sago pondweed, (*Najas flexilis*) Slender naiad, (*Pontederia cordata*) Pickerelweed, (*Potamogeton friesii*) Fries' pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Isoetes echinospora*) **Spiny-spored quillwort**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-060
**Habitat/Distribution:** Sand in 1meter of water. A single individual was found at the point – not seen anywhere else in the lake.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Eriocaulon aquaticum*) Pipewort, (*Utricularia resupinata*) Small purple bladderwort, (*Juncus pelocarpus*) Brown-fruited rush, (*Schoenoplectus acutus*) Hardstem bulrush

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Juncus pelocarpus*) **Brown-fruited rush**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-061
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1 meter deep. Common and widely distributed along all sandy shorelines.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Eriocaulon aquaticum*) Pipewort, (*Utricularia resupinata*) Small purple bladderwort, (*Ranunculus flammula*) Creeping spearwort, (*Lobelia dortmanna*) Water lobelia

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Leersia oryzoides*) **Rice cut-grass**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-062
**Habitat/Distribution:** Firm sandy muck at the shoreline. Plants were scattered around the point and mixed with sedges on the northeast shoreline just west of the Red Lake Resort Bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Carex utriculata*) Common yellow lake sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex bebbii*) Bebb's sedge

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Lemna minor*) **Small duckweed**
**Specimen Location:** Red Lake; N46.18641°, W91.75750°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-063
**Habitat/Distribution:** Located floating at or just under the surface in sheltered areas over nutrient rich organic muck. Rare; a few scattered individuals were found in the northeast bays.
**Common Associates:** (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Spirodela polyrhiza*) Large duckweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Lobelia dortmanna*) **Water lobelia**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-064
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1 meter deep. Common and widely distributed along all sandy lakeshores.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Utricularia resupinata*) Small purple bladderwort, (*Ranunculus flammula*) Creeping spearwort, (*Eriocaulon aquaticum*) Pipewort

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Myrica gale*) **Sweet gale**
**Specimen Location:** Red Lake; N46.18605°, W91.75521°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-065
**Habitat/Distribution:** Muck bottom at the shoreline. The dominant brush species adjacent to the bay.
**Common Associates:** (*Calla palustris*) Wild calla, (*Comarum palustre*) Marsh cinquefoil, (*Pontederia cordata*) Pickerelweed, (*Typha latifolia*) Broad-leaved cattail

**County/State:** Douglas County, Wisconsin **Date:** 7/30/17
**Species:** (*Myriophyllum alterniflorum*) **Alternate-flowered water-milfoil**
**Specimen Location:** Red Lake; N46.18248°, W91.75567°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2017-006
**Habitat/Distribution:** Found over sandy muck bottoms in water <1m deep. Rare; a few dozen plants were seen at the point.
**Common Associates:** (*Vallisneria americana*) Wild celery, (*Najas flexilis*) Slender naiad, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Chara* sp.) Muskgrass

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Myriophyllum sibiricum*) **Northern water-milfoil**
**Specimen Location:** Red Lake; N46.17830°, W91.77036°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-066
**Habitat/Distribution:** Found over sandy muck bottoms in water 1-6m deep. Relatively common but seldom abundant. Widespread around the central basin and in the broad flat in the northeast bay.
**Common Associates:** (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/30/17
**Species:** (*Myriophyllum spicatum*) **Eurasian water-milfoil**
**Specimen Location:** Red Lake; N46.17909°, W91.76981°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2017-007
**Habitat/Distribution:** Found over sandy muck bottoms in water 1-5m deep. Following the herbicide treatment, found only near the point.
**Common Associates:** (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Myriophyllum tenellum*) **Dwarf water-milfoil**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-067
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1.5 meters deep. Common and widely distributed along most sandy lakeshores.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Eriocaulon aquaticum*) Pipewort, (*Juncus pelocarpus*) Brown-fruited rush, (*Utricularia resupinata*) Small purple bladderwort, (*Ranunculus flammula*) Creeping spearwort, (*Lobelia dortmanna*) Water lobelia

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Najas flexilis*) **Slender naiad**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-068
**Habitat/Distribution:** Sand, sandy muck, and marly muck in 0.5-3 meters of water. Relatively common and widely distributed throughout.
**Common Associates:** (*Chara* sp.) Muskgrass, (*Potamogeton gramineus*) Variable pondweed, (*Vallisneria americana*) Wild celery, (*Eleocharis acicularis*) Needle spikerush, (*Potamogeton amplifolius*) Large-leaf pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Nitella* sp. likely *flexilis*) **Nitella**
**Specimen Location:** Red Lake; N46.17951°, W91.76869°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-069
**Habitat/Distribution:** Sandy muck bottom areas in water generally over 3 meters deep and up to 7 meters. Common to abundant in the 4.5-5.5m bathymetric ring around the southern basin.
**Common Associates:** (*Elodea canadensis*) Common waterweed, (*Potamogeton pusillus*) Small pondweed, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Nuphar variegata*) **Spatterdock**
**Specimen Location:** Red Lake; N46.18641°, W91.75750°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-070
**Habitat/Distribution:** Muck bottom in <1m of water. Uncommon, a few small patches occurred in the north and south ends of the northeast bay.
**Common Associates:** (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort, (*Pontederia cordata*) Pickerelweed, (*Brasenia schreberi*) Watershield

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Nymphaea odorata*) **White water lily**
**Specimen Location:** Red Lake; N46.18641°, W91.75750°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-071
**Habitat/Distribution:** Muck bottom in 0-1.5 meters. Restricted to the northeast and southeast bays where it was the dominant floating-leaf species.
**Common Associates:** (*Nuphar variegata*) Spatterdock, (*Brasenia schreberi*) Watershield, (*Potamogeton robbinsii*) Fern pondweed, (*Utricularia vulgaris*) Common bladderwort, (*Schoenoplectus subterminalis*) Water bulrush, (*Eleocharis robbinsii*) Robbins' spikerush

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Polygonum amphibium*) **Water smartweed**
**Specimen Location:** Red Lake; N46.18644°, W91.75580°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-072
**Habitat/Distribution:** Found in sandy muck bottom conditions in shallow water 0.5-1 meter deep. Rare; a few 10's of plants were growing just east of the docks at Red Lake Resort in the lake's northeast bay.
**Common Associates:** (*Ceratophyllum demersum*) Coontail, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Pontederia cordata*) **Pickerelweed**
**Specimen Location:** Red Lake; N46.17245°, W91.76390°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-073
**Habitat/Distribution:** Silt to muck bottom over firm substrate in 0-1 meter of water. Common in emergent beds in sheltered areas of the northeast and southeast bays – much more scattered over sand on the western shoreline.
**Common Associates:** (*Schoenoplectus acutus*) Hardstem bulrush, (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Brasenia schreberi*) Watershield, (*Schoenoplectus subterminalis*) Water bulrush, (*Utricularia vulgaris*) Common bladderwort, (*Eleocharis robbinsii*) Robbins' spikerush

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Potamogeton alpinus*) **Alpine pondweed**
**Specimen Location:** Red Lake; N46.18604°, W91.75578°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-074
**Habitat/Distribution:** Found in mucky bottom conditions in shallow water 0.5-1 meter deep. Rare; a few scattered locations occurred just east of the Red Lake Resort in the lake's northeast bay.
**Common Associates:** (*Utricularia minor*) Small bladderwort, (*Ceratophyllum demersum*) Coontail, (*Sparganium emersum*) Short-stemmed bur-reed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton foliosus*) Leafy pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton amplifolius*) **Large-leaf pondweed**
**Specimen Location:** Red Lake; N46.17197°, W91.76959°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-075
**Habitat/Distribution:** Sandy muck in .water 1-5m deep. Common and widespread, but seldom abundant. Scattered around the central basin, and in the broad flat in the northeast bay.
**Common Associates:** (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton pusillus*) Small pondweed, (*Chara* sp.) Muskgrass, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
**Specimen Location:** Red Lake; N46.18644°, W91.75580°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-076
**Habitat/Distribution:** Found in mucky bottom conditions in shallow water 0.5-1 meter deep. Rare; a few 10's of plants were found just east of the Red Lake Resort in the lake's northeast bay.
**Common Associates:** (*Potamogeton foliosus*) Leafy pondweed, (*Ceratophyllum demersum*) Coontail, (*Sparganium emersum*) Short-stemmed bur-reed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton alpinus*) Alpine pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Potamogeton foliosus*) **Leafy pondweed**
**Specimen Location:** Red Lake; N46.18604°, W91.75578°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-077
**Habitat/Distribution:** Found in mucky bottom conditions in shallow water 0.5-1 meter deep. Rare; a few scattered locations occurred just east of the Red Lake Resort in the lake's northeast bay.
**Common Associates:** (*Utricularia minor*) Small bladderwort, (*Ceratophyllum demersum*) Coontail, (*Sparganium emersum*) Short-stemmed bur-reed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton alpinus*) Alpine pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton friesii*) **Fries' pondweed**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-078
**Habitat/Distribution:** Silty muck in <1m of water. Located along the eastern shoreline of the northeast bay – not seen anywhere else.
**Common Associates:** (*Stuckenia pectinata*) Sago pondweed, (*Heteranthera dubia*) Water star-grass, (*Pontederia cordata*) Pickerelweed, (*Ranunculus aquatilis*) White water crowfoot, (*Najas flexilis*) Slender naiad

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton gramineus*) **Variable pondweed**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-079
**Habitat/Distribution:** Compact morph only form found on the lake. They were most common in sandy/muck bottom conditions in water 0.5-4 meters deep. Common and widespread.
**Common Associates:** (*Najas flexilis*) Slender naiad, (*Chara* sp.) Muskgrass, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Sagittaria cristata*) Crested arrowhead, (*Eleocharis acicularis*) Needle spikerush, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton illinoensis*) **Illinois pondweed**
**Specimen Location:** Red Lake; N46.17197°, W91.76959°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-080
**Habitat/Distribution:** Sandy muck in water 1-2.5m deep. Relatively common in a bathymetric ring at this depth around the central basin and in the broad flat in the northeast bay.
**Common Associates:** (*Potamogeton amplifolius*) Large-leaf pondweed, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton pusillus*) Small pondweed, (*Chara* sp.) Muskgrass, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton praelongus*) **White-stem pondweed**
**Specimen Location:** Red Lake; N46.17830°, W91.77036°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-081
**Habitat/Distribution:** Sandy muck bottom conditions in water 1.5-5m deep. Common and widespread around the central basin, and in the broad flat in the northeast bay.
**Common Associates:** (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Nitella* sp.) Nitella, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton pusillus pusillus*) **Small pondweed**
**Specimen Location:** Red Lake; N46.18437°, W91.76143°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-082
**Habitat/Distribution:** Common and widespread over sandy and organic muck in water from 0.5-7 meters deep. Most individuals were in fruit - nutlets with offset beak confirmed ID.
**Common Associates:** (*Potamogeton robbinsii*) Fern pondweed, (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Nitella* sp.) Nitella, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-083
**Habitat/Distribution:** Found in sandy muck bottom conditions in shallow water 1-2 meters deep. Rare, but widespread throughout the lake.
**Common Associates:** (*Potamogeton praelongus*) White-stem pondweed, (*Potamogeton gramineus*) Variable pondweed, (*Najas flexilis*) Slender naiad, (*Chara* sp.) Muskgrass, (*Potamogeton robbinsii*) Fern pondweed, (*Heteranthera dubia*) Water star-grass, (*Potamogeton friesii*) Fries' pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton robbinsii*) **Fern pondweed**
**Specimen Location:** Red Lake; N46.17830°, W91.77036°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-084
**Habitat/Distribution:** Found over sandy and organic muck bottom s in water 0.25m deep. Common and widespread around the central basin and in the broad flat in the northeast bay.
**Common Associates:** (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Nitella* sp.) Nitella, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton strictifolius*) **Stiff pondweed**
**Specimen Location:** Red Lake; N46.17197°, W91.76959°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-085
**Habitat/Distribution:** Rare over sandy marl in water from 1-2m deep. A few small patches occurred in the south bay with a single individual found along the north shore.
**Common Associates:** (*Potamogeton pusillus*) Small pondweed, (*Chara* sp.) Muskgrass, (*Elodea canadensis*) Common waterweed, (*Potamogeton robbinsii*) Fern pondweed, (*Potamogeton gramineus*) Variable pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Potamogeton zosteriformis*) **Flat-stem pondweed**
**Specimen Location:** Red Lake; N46.17830°, W91.77036°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-086
**Habitat/Distribution:** Found over sandy and organic muck bottoms in water 0.25m deep. Common and widespread, but seldom abundant around the central basin and in the broad flat in the northeast bay.
**Common Associates:** (*Myriophyllum sibiricum*) Northern water-milfoil, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Nitella* sp.) Nitella, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton robbinsii*) Fern pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Ranunculus aquatilis*) **White water crowfoot**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-087
**Habitat/Distribution:** Silty muck in <1m of water. A small bed occurred around the point; not seen anywhere else on the lake.
**Common Associates:** (*Stuckenia pectinata*) Sago pondweed, (*Heteranthera dubia*) Water star-grass, (*Pontederia cordata*) Pickerelweed, (*Potamogeton friesii*) Fries' pondweed, (*Najas flexilis*) Slender naiad

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Ranunculus flammula*) **Creeping spearwort**
**Specimen Location:** Red Lake; N46.18353°, W91.76482°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-088
**Habitat/Distribution:** Sand bottom in water <1m deep. Rare; only plants found were in the rake at the point.
**Common Associates:** (*Eleocharis acicularis*) Needle spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Utricularia resupinata*) Small purple bladderwort, (*Eriocaulon aquaticum*) Pipewort

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Sagittaria cristata*) **Crested arrowhead**
**Specimen Location:** Red Lake; N46.18126°, W91.75791°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-089
**Habitat/Distribution:** Submergent form was uncommon over sand and silt bottoms. A few individuals were emergent, but none were in bloom. Relatively common in the silt flats of the northeast bay.
**Common Associates:** (*Najas flexilis*) Slender naiad, (*Chara* sp.) Muskgrass, (*Vallisneria americana*) Wild celery, (*Potamogeton amplifolius*) Large-leaf pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Sagittaria latifolia*) **Common arrowhead**
**Specimen Location:** Red Lake; N46.18526°, W91.75519°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-090
**Habitat/Distribution:** Muck bottom in 0-0.25m of water. Relatively common in undeveloped shoreline areas of the northeast bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Bald spikerush, (*Dulichium arundinaceum*) Three-way sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Schoenoplectus acutus*) **Hardstem bulrush**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-091
**Habitat/Distribution:** Firm sand bottoms in 0-1 meter of water. The dominant reed on the lake, beds were common along most undisturbed sandy shorelines.
**Common Associates:** (*Eleocharis palustris*) Creeping spikerush, (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Eriocaulon aquaticum*) Pipewort, (*Utricularia resupinata*) Small purple bladderwort

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Schoenoplectus subterminalis*) **Water bulrush**
**Specimen Location:** Red Lake; N46.17245°, W91.76390°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-092
**Habitat/Distribution:** Organic muck bottoms in 0-0.5 meter of water. Scattered locations in the bays on the lake's east side – especially adjacent to the bog in the tiny southeast bay.
**Common Associates:** (*Brasenia schreberi*) Watershield, (*Eleocharis robbinsii*) Robbins' spikerush, (*Pontederia cordata*) Pickerelweed, (*Nymphaea odorata*) White water lily, (*Utricularia vulgaris*) Common bladderwort

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-093
**Habitat/Distribution:** Firm sandy muck to organic muck bottoms in 0-0.25 meter of water. A single large bed was found surrounding the point on the northeast shoreline just west of the Red Lake Resort Bay. Scattered clusters occurred at a few points elsewhere along the eastern shore in the northeast bay.
**Common Associates:** (*Typha latifolia*) Broad-leaved cattail, (*Carex utriculata*) Common yellow lake sedge, (*Sagittaria latifolia*) Common arrowhead, (*Carex bebbii*) Bebb's sedge

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Scirpus atrovirens*) **Black bulrush**
**Specimen Location:** Red Lake; N46.17238°, W91.77005°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-094
**Habitat/Distribution:** Firm muck soil at the shoreline. Scattered individuals were located at the public boat landing.
**Common Associates:** (*Calamagrostis canadensis*) Blue-joint

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Sparganium angustifolium*) **Narrow-leaved bur-reed**
**Specimen Location:** Red Lake; N46.17221°, W91.77003°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-095
**Habitat/Distribution:** Located over sandy muck in 0.5-1m of water. More common than the survey indicated - small patches of plants were scattered in a narrow band around the shore of much of the lake.
**Common Associates:** (*Nymphaea odorata*) White water lily, (*Najas flexilis*) Slender naiad, (*Sagittaria cristata*) Crested arrowhead, (*Vallisneria americana*) Wild celery, (*Potamogeton gramineus*) Variable pondweed, (*Chara* sp.) Muskgrass

**County/State:** Douglas County, Wisconsin **Date:** 7/25/13
**Species:** (*Sparganium emersum*) **Short-stemmed bur-reed**
**Specimen Location:** Red Lake; N46.18644°, W91.75580°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-096
**Habitat/Distribution:** Only plants found were near the point in the northeast bay over thick organic muck in water <1m deep.
**Common Associates:** (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Nuphar variegata*) Spatterdock, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Potamogeton foliosus*) Leafy pondweed, (*Brasenia schreberi*) Watershield, (*Nymphaea odorata*) White water lily, (*Ceratophyllum demersum*) Coontail

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Spirodela polyrhiza*) **Large duckweed**
**Specimen Location:** Red Lake; N46.18641°, W91.75750°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-097
**Habitat/Distribution:** Located floating at or just under the surface in sheltered areas. Rare; a few scattered individuals occurred interspersed between the lilypads in the northeast bay near the Red Lake Resort.
**Common Associates:** (*Nymphaea odorata*) White water lily, (*Nuphar variegata*) Spatterdock, (*Lemna minor*) Small duckweed, (*Potamogeton friesii*) Fries' pondweed

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Stuckenia pectinata*) **Sago pondweed**
**Specimen Location:** Red Lake; N46.18368°, W91.75514°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-098
**Habitat/Distribution:** Silty muck in <1m of water. Rare; seen at only two locations in the northeast bay.
**Common Associates:** (*Ranunculus aquatilis*) White water crowfoot, (*Heteranthera dubia*) Water star-grass, (*Pontederia cordata*) Pickerelweed, (*Potamogeton friesii*) Fries' pondweed, (*Najas flexilis*) Slender naiad

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Typha angustifolia*) **Narrow-leaved cattail**
**Specimen Location:** Red Lake; N46.17997°, W91.77180°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-099
**Habitat/Distribution:** Firm sand/sandy muck bottoms in 0-0.5 meter of water. A single small bed was found on the northwest shoreline in a small muck pocket.
**Common Associates:** (*Carex lacustris*) Lake sedge

**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Typha latifolia*) **Broad-leaved cattail**
**Specimen Location:** Red Lake; N46.18559°, W91.75919°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-100
**Habitat/Distribution:** Firm sand and muck bottoms in 0-0.5 meter of water. Scattered patches were found primarily along the northeast shoreline adjacent to bog areas.
**Common Associates:** (*Carex utriculata*) Common yellow lake sedge, (*Sagittaria latifolia*) Common arrowhead, (*Carex bebbii*) Bebb's sedge, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Eleocharis erythropoda*) Bald spikerush

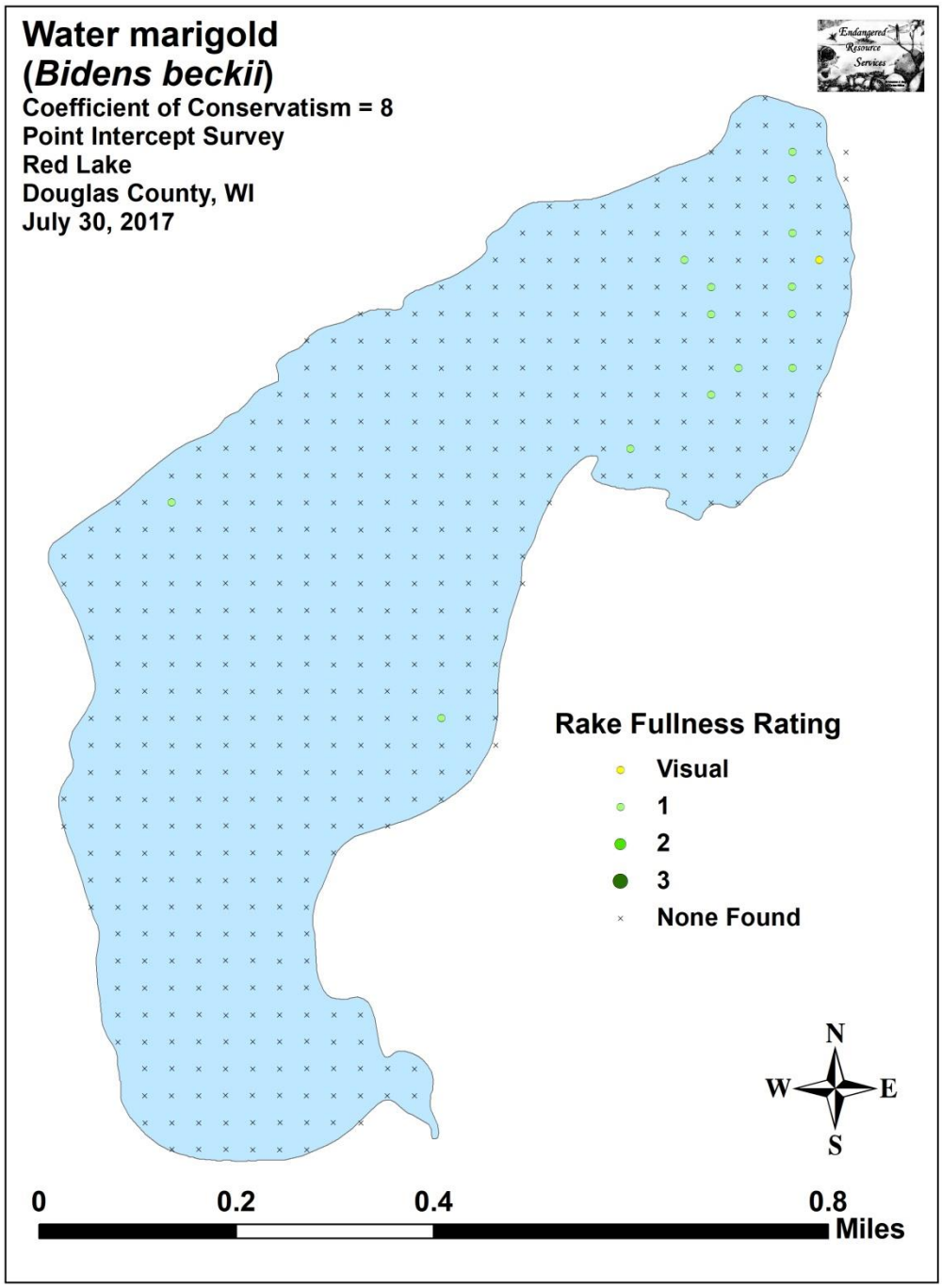
**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Utricularia minor*) **Small bladderwort**
**Specimen Location:** Red Lake; N46.18604°, W91.75578°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-101
**Habitat/Distribution:** Muck bottom in shallow water <1 meter deep. Rare; scattered locations in mucky areas of the northeast bays.
**Common Associates:** (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Brasenia schreberi*) Watershield, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus subterminalis*) Water bulrush, (*Utricularia vulgaris*) Common bladderwort, (*Eleocharis robbinsii*) Robbins' spikerush

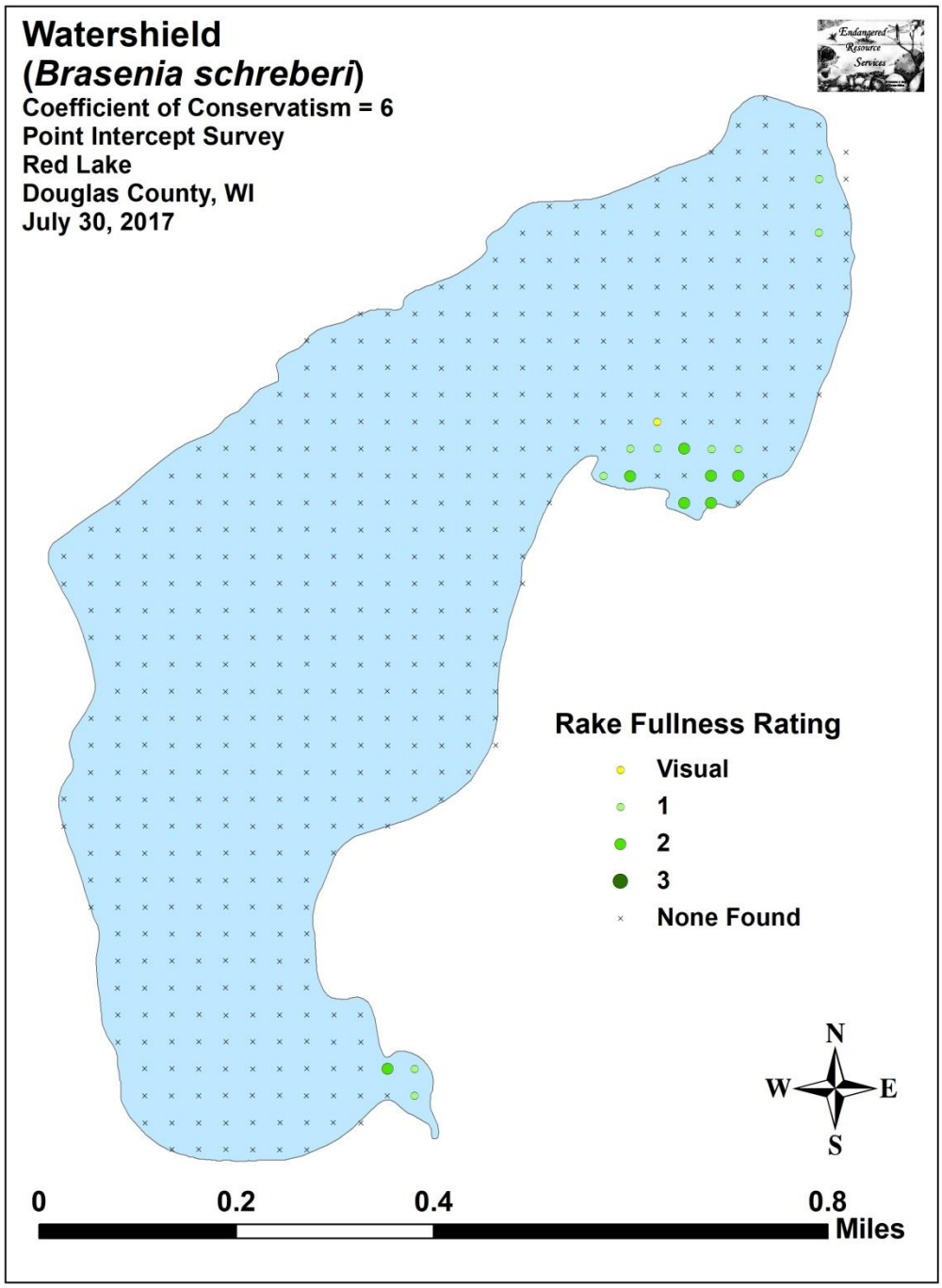
County/State**:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Utricularia resupinata*) **Small purple bladderwort**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-102
**Habitat/Distribution:** Sand bottom areas in water from 0 – 1 meter deep. Common and widely distributed along all sandy lakeshores.
**Common Associates:** (*Chara* sp.) Muskgrass, (*Myriophyllum tenellum*) Dwarf water-milfoil, (*Juncus pelocarpus*) Brown-fruited rush, (*Eriocaulon aquaticum*) Pipewort, (*Ranunculus flammula*) Creeping spearwort, (*Lobelia dortmanna*) Water lobelia

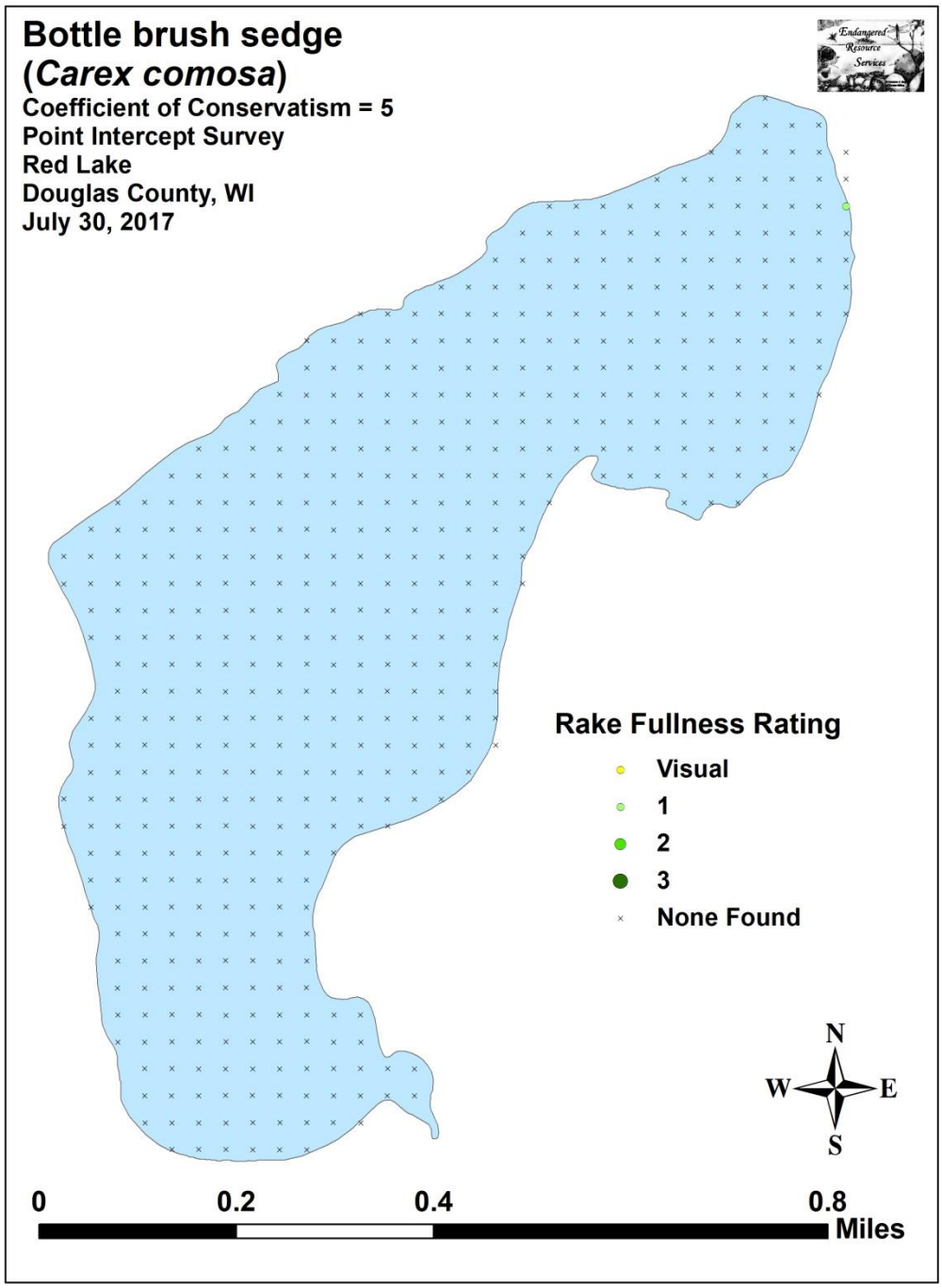
County/State**:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Utricularia vulgaris*) **Common bladderwort**
**Specimen Location:** Red Lake; N46.18604°, W91.75578°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-103
**Habitat/Distribution:** Muck bottom in shallow water <1meter deep. Rare; scattered locations in mucky areas of the northeast bays.
**Common Associates:** (*Nuphar variegata*) Spatterdock, (*Nymphaea odorata*) White water lily, (*Brasenia schreberi*) Watershield, (*Pontederia cordata*) Pickerelweed, (*Schoenoplectus subterminalis*) Water bulrush, (*Utricularia minor*) Small bladderwort, (*Eleocharis robbinsii*) Robbins' spikerush

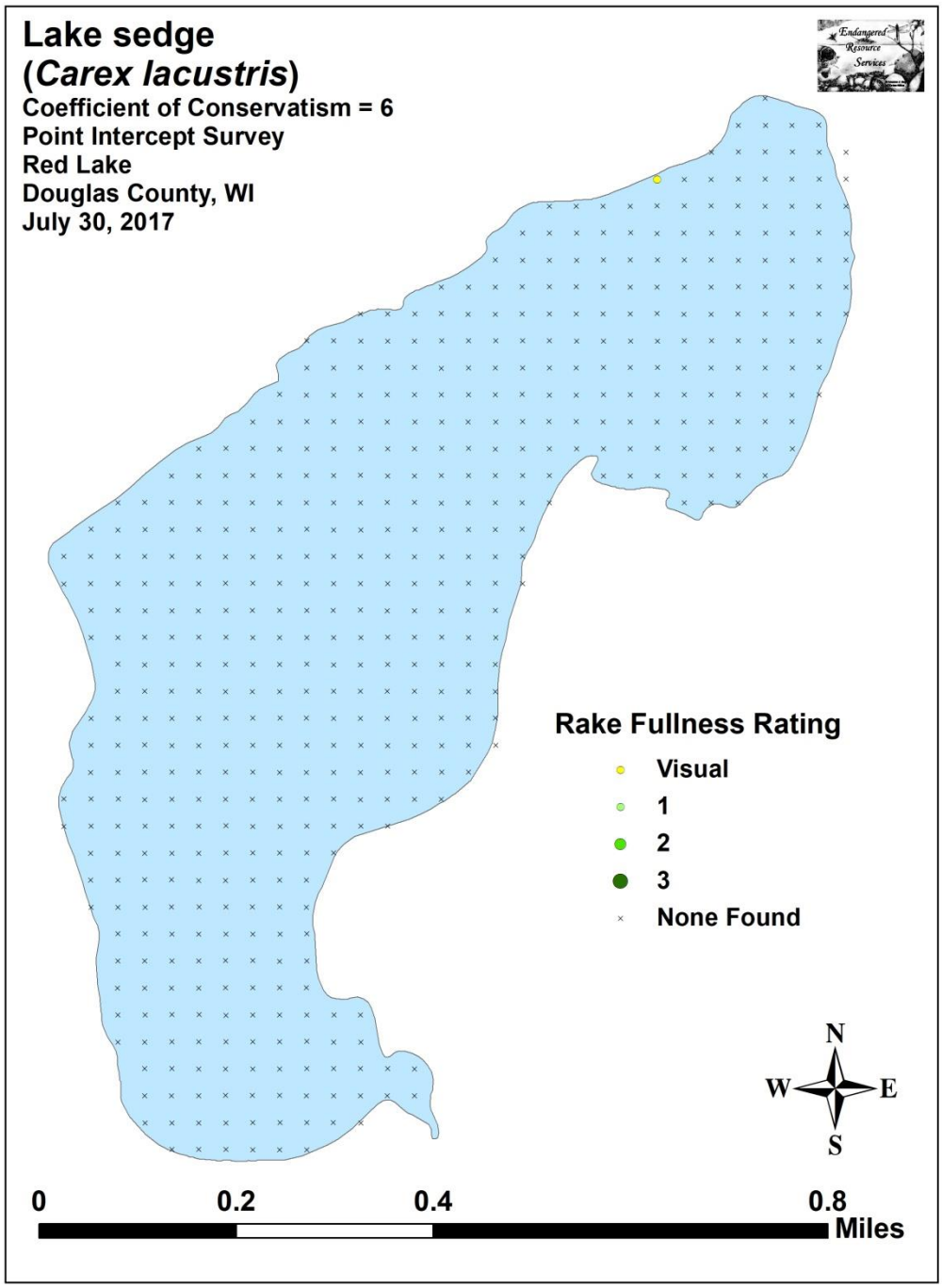
**County/State:** Douglas County, Wisconsin **Date:** 7/15/13
**Species:** (*Vallisneria americana*) **Wild celery**
**Specimen Location:** Red Lake; N46.17245°, W91.76447°
**Collected/Identified by: Matthew S. Berg Col. #:** MSB-2013-104
**Habitat/Distribution:** Found over sandy and organic muck bottoms in water 0.5-4m deep. Common and widespread, but seldom abundant around the central basin and in the broad flat in the northeast bay.
**Common Associates:** (*Najas flexilis*) Slender naiad, (*Potamogeton gramineus*) Variable pondweed, (*Potamogeton amplifolius*) Large-leaf pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton illinoensis*) Illinois pondweed, (*Potamogeton robbinsii*) Fern pondweed

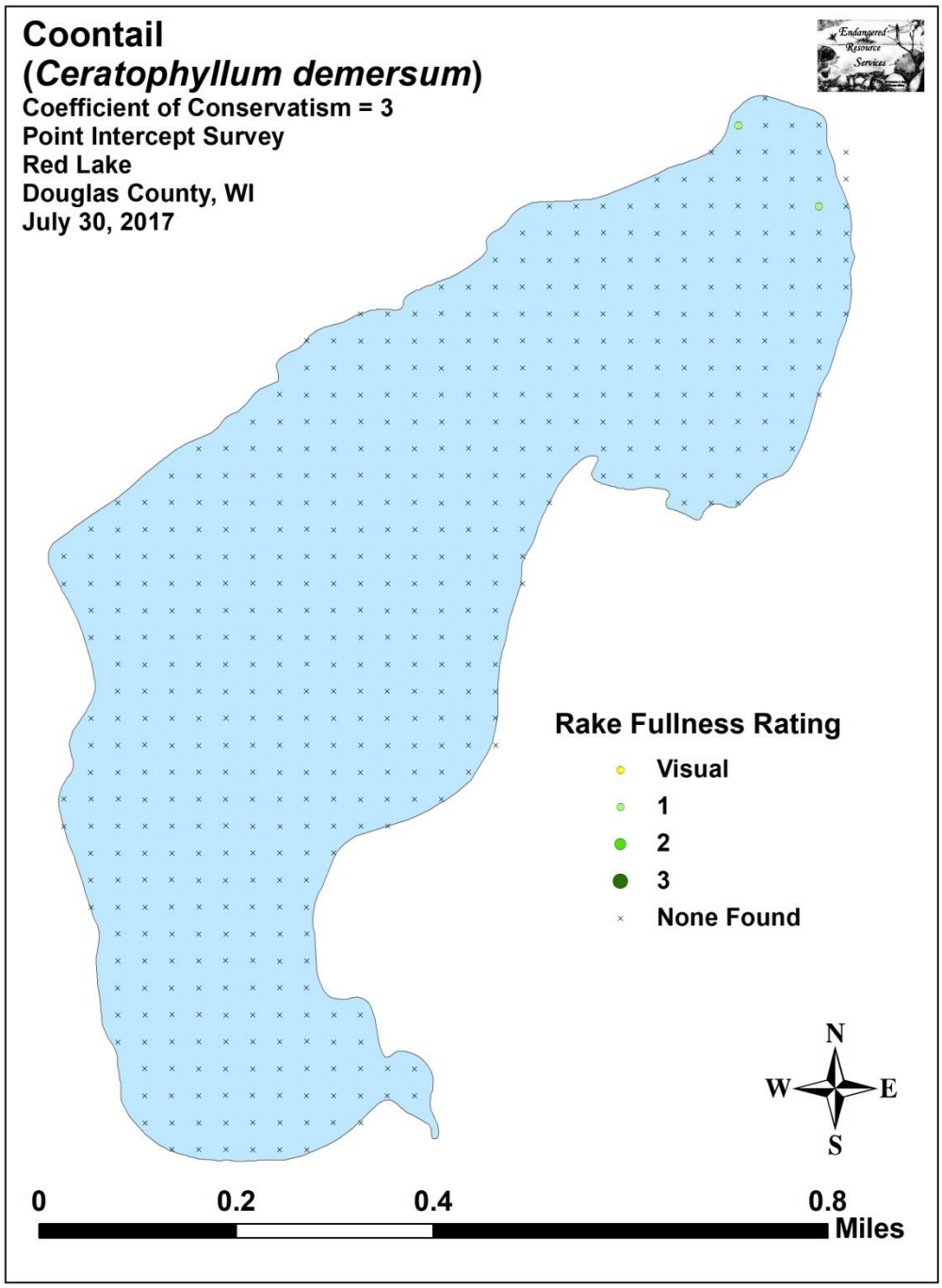
# Appendix VII:  July 2017 Species Density and Distribution Maps

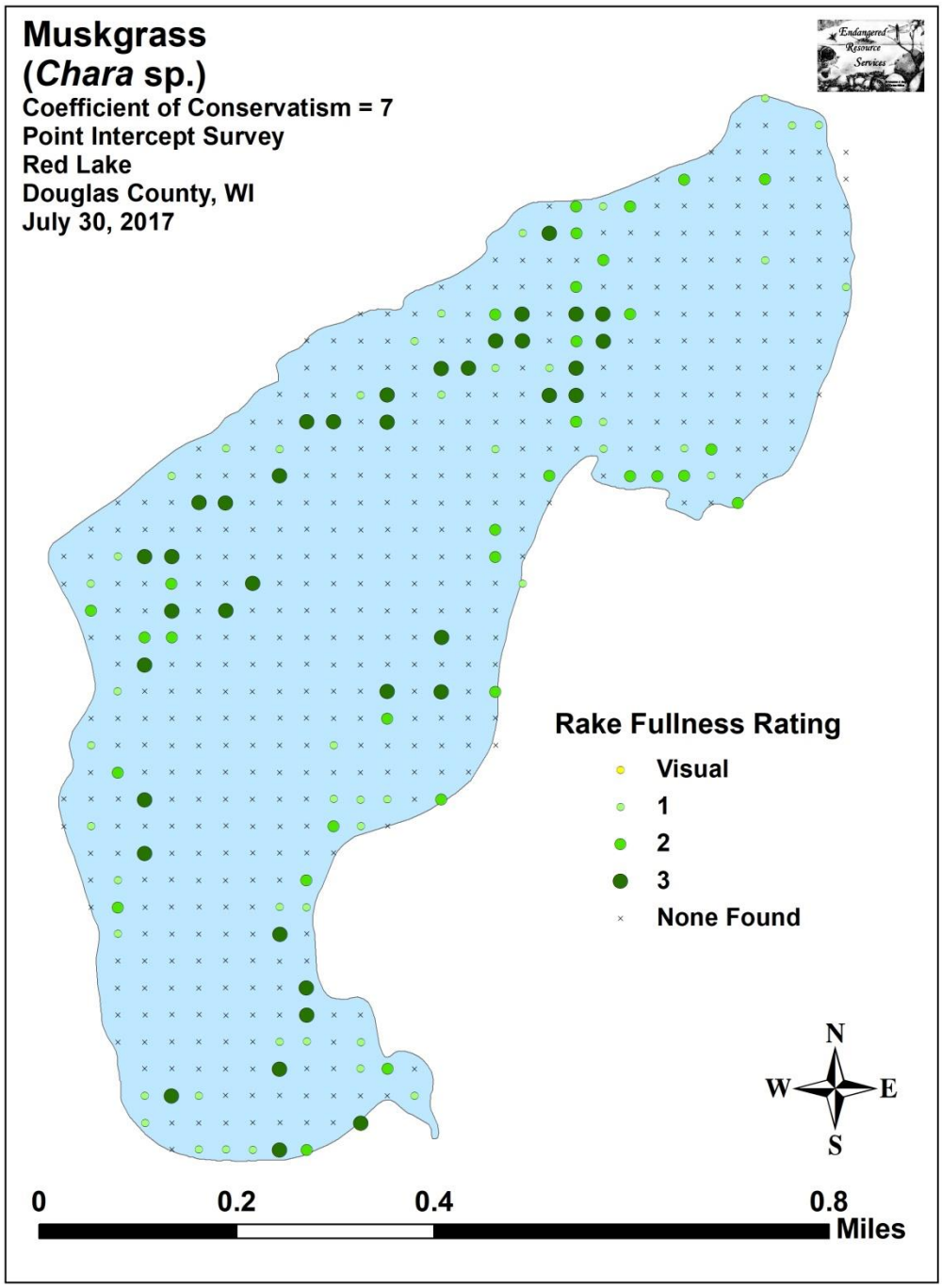

Water marigold
(Bidens beckii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

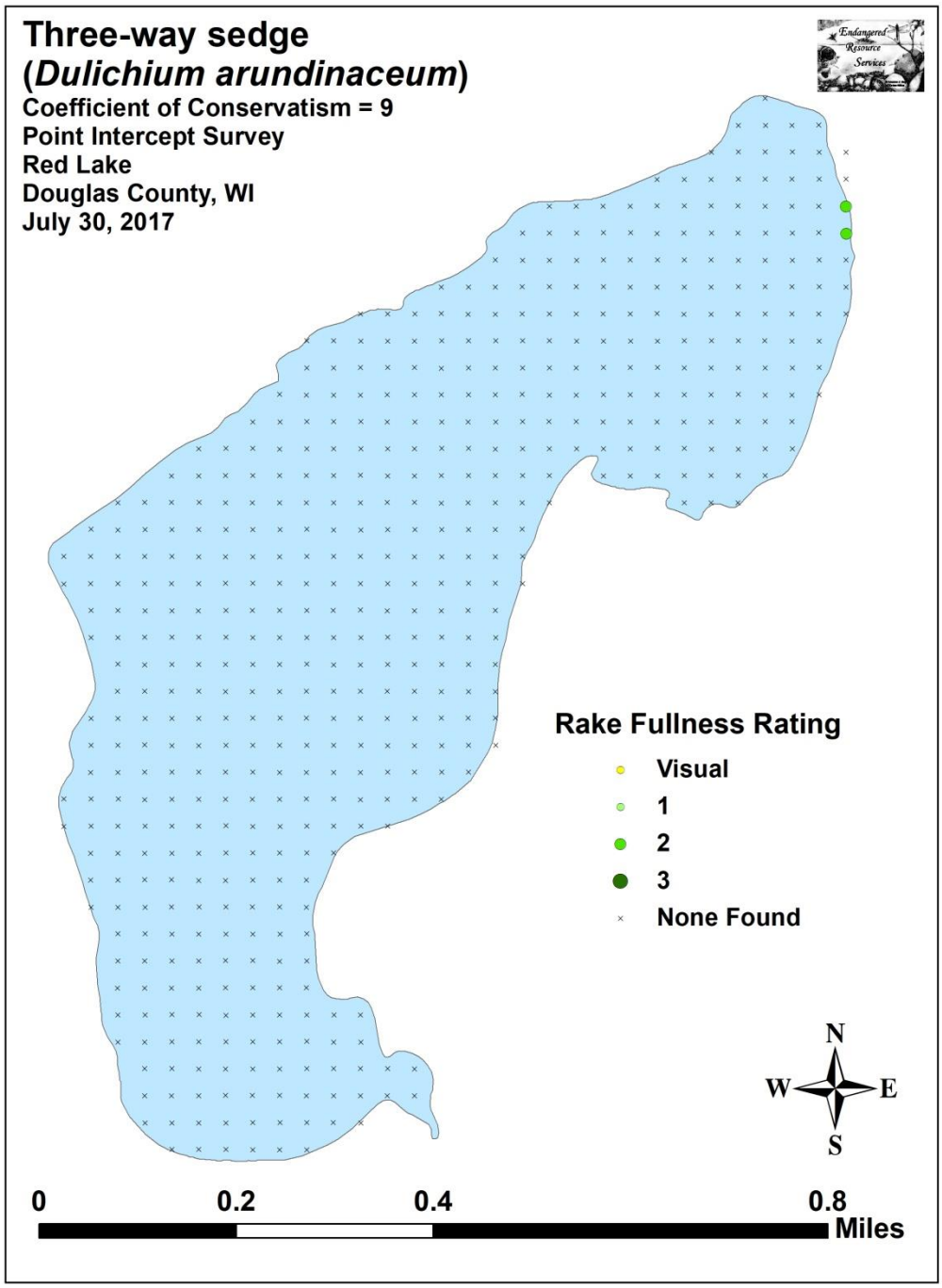

Watershield
(Brasenia schreberi)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

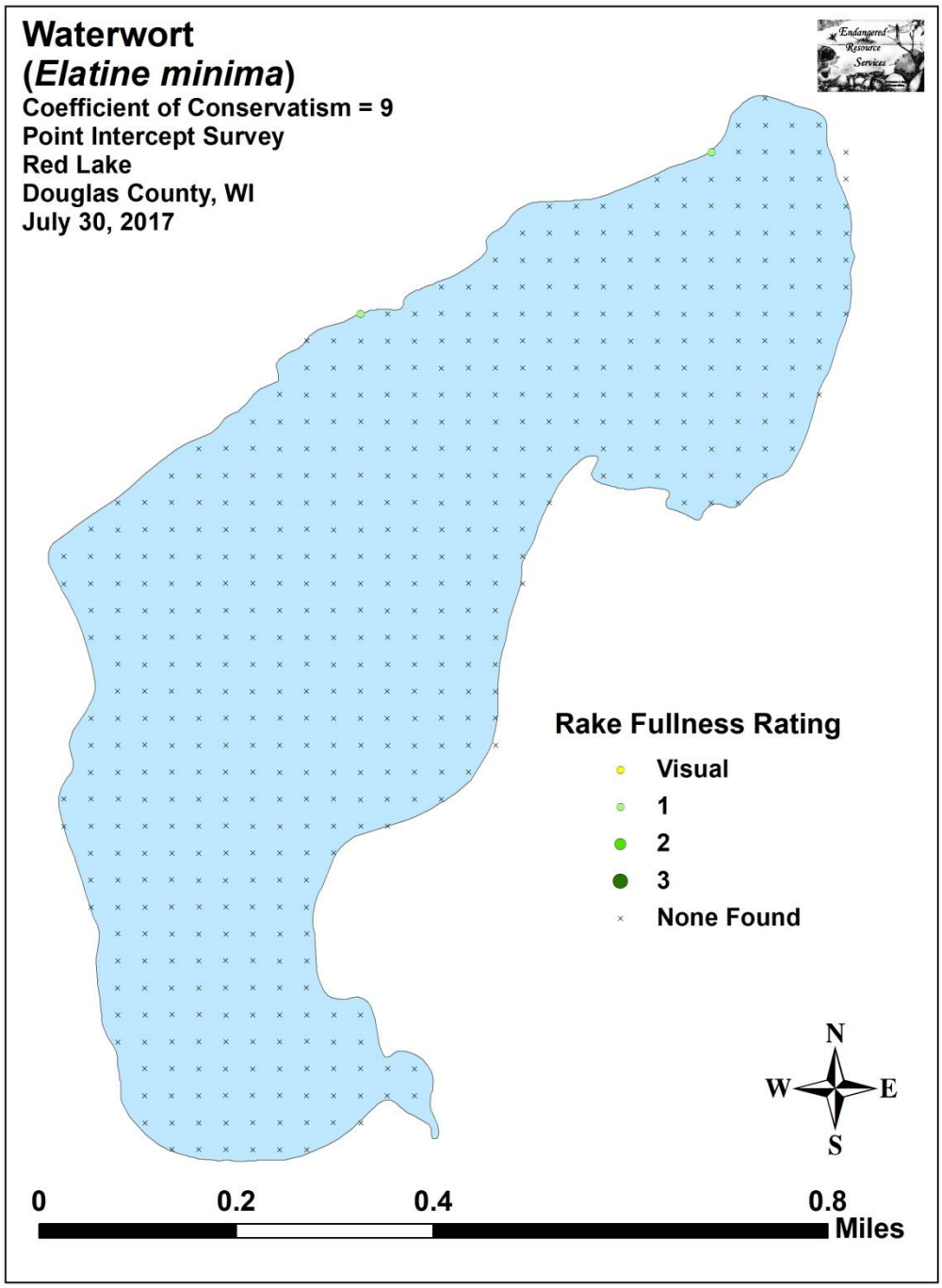

Bottle brush sedge
(Carex comosa)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles

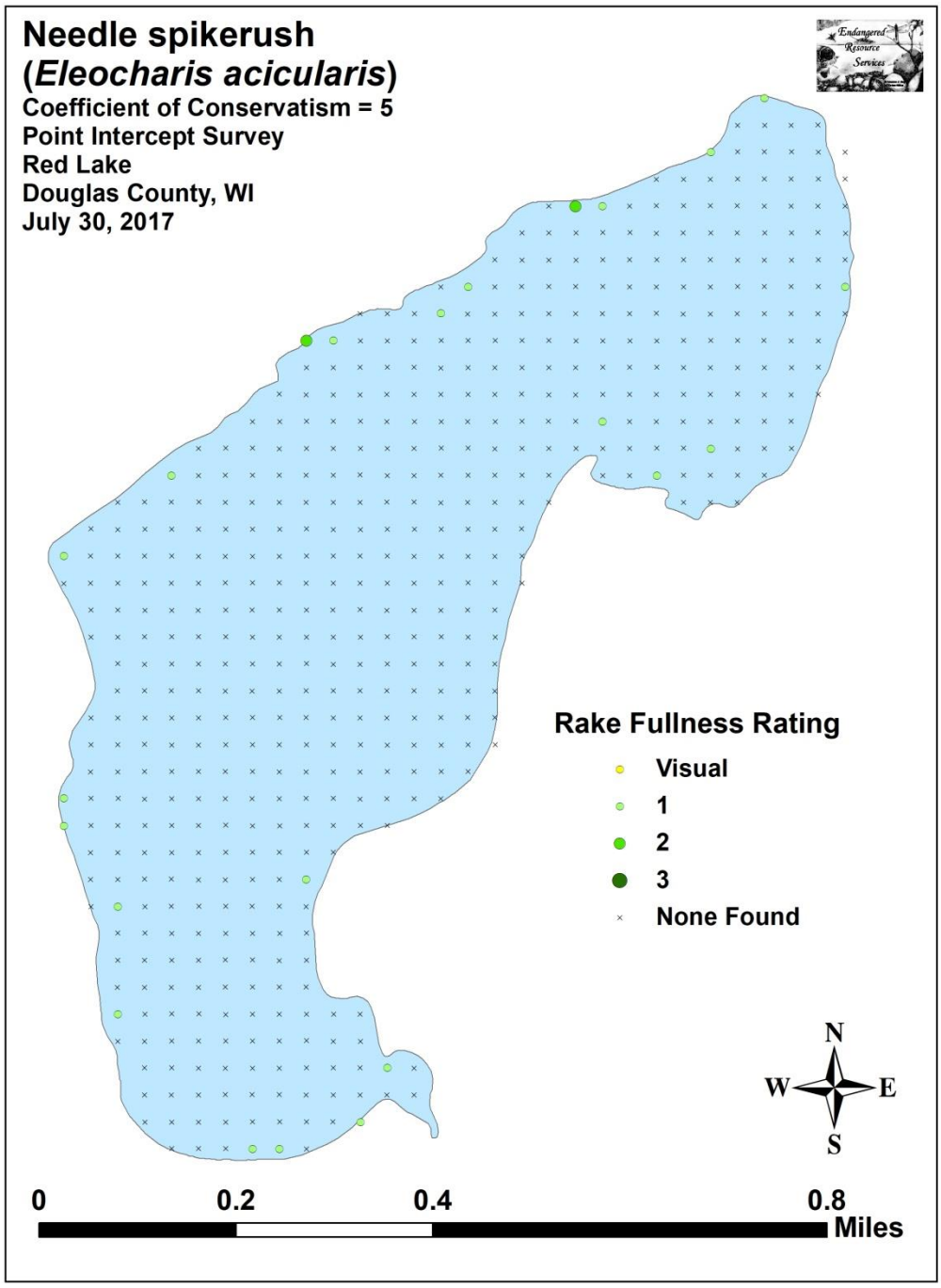

Lake sedge
(Carex lacustris)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Three-way sedge
(Dulichium arundinaceum)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Waterwort
(Elatine minima)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.2
0.4
0.8
Miles


Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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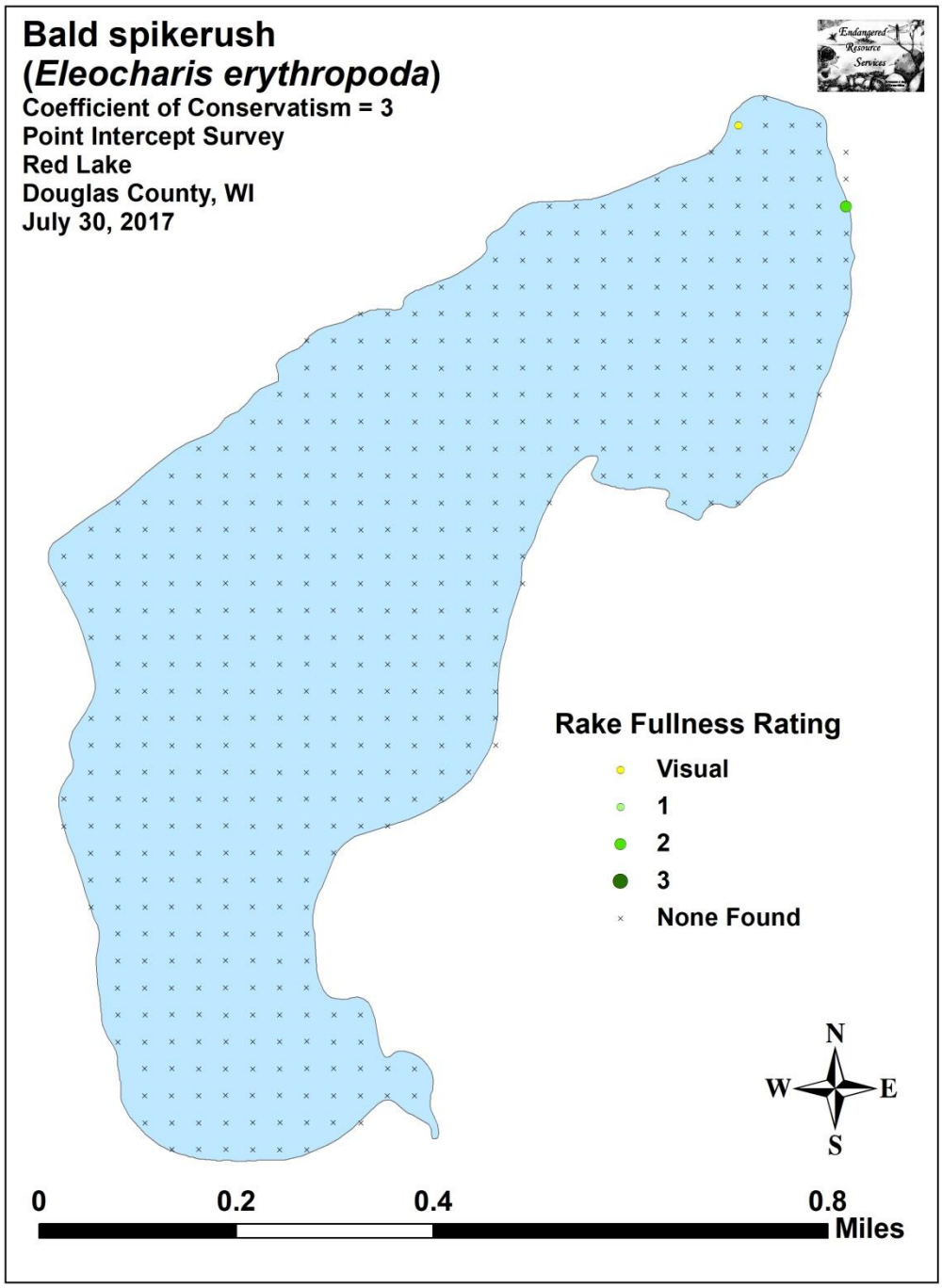
Miles


Bald spikerush
(Eleocharis erythropoda)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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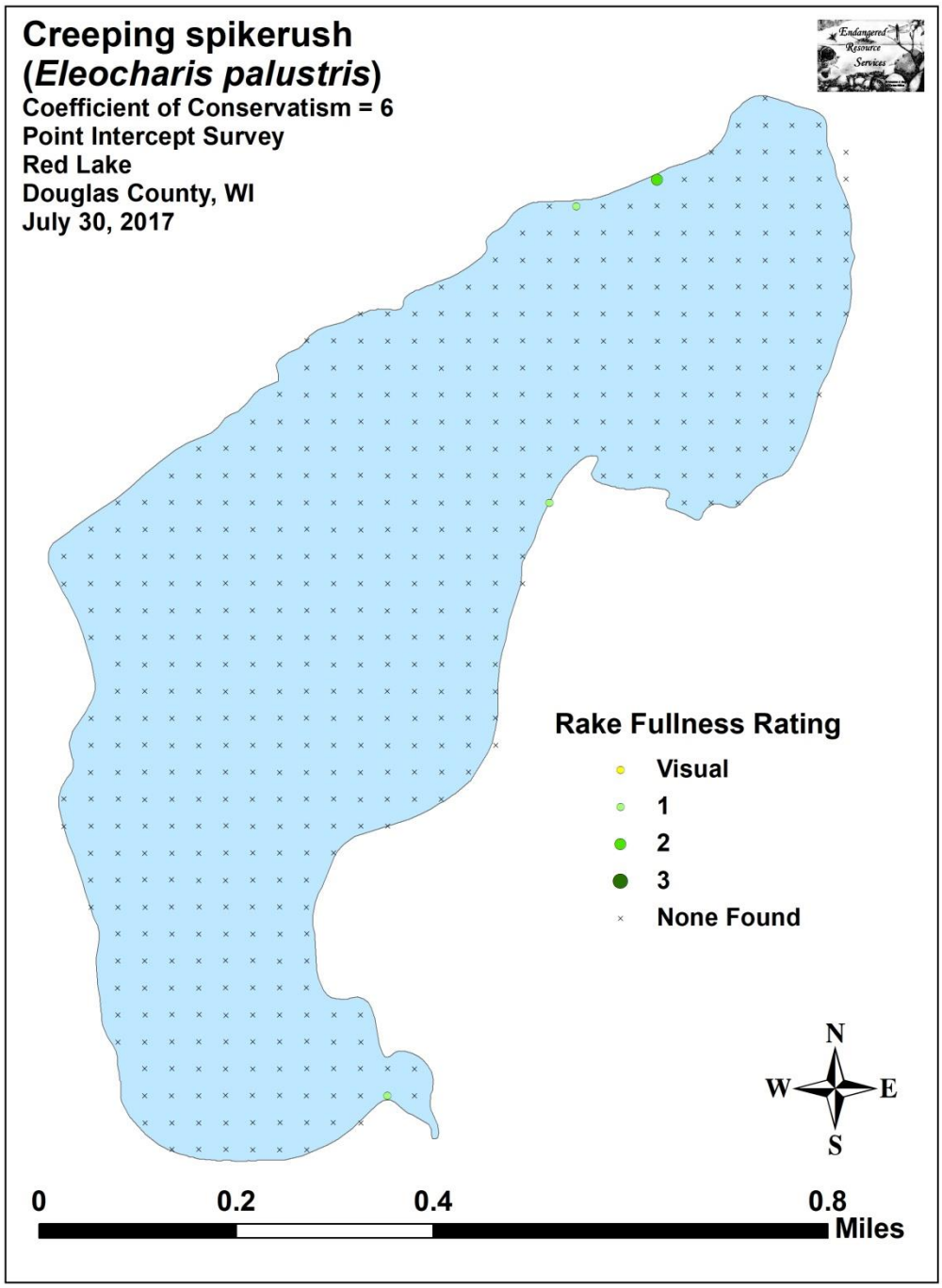
Miles


Creeping spikerush
(Eleocharis palustris)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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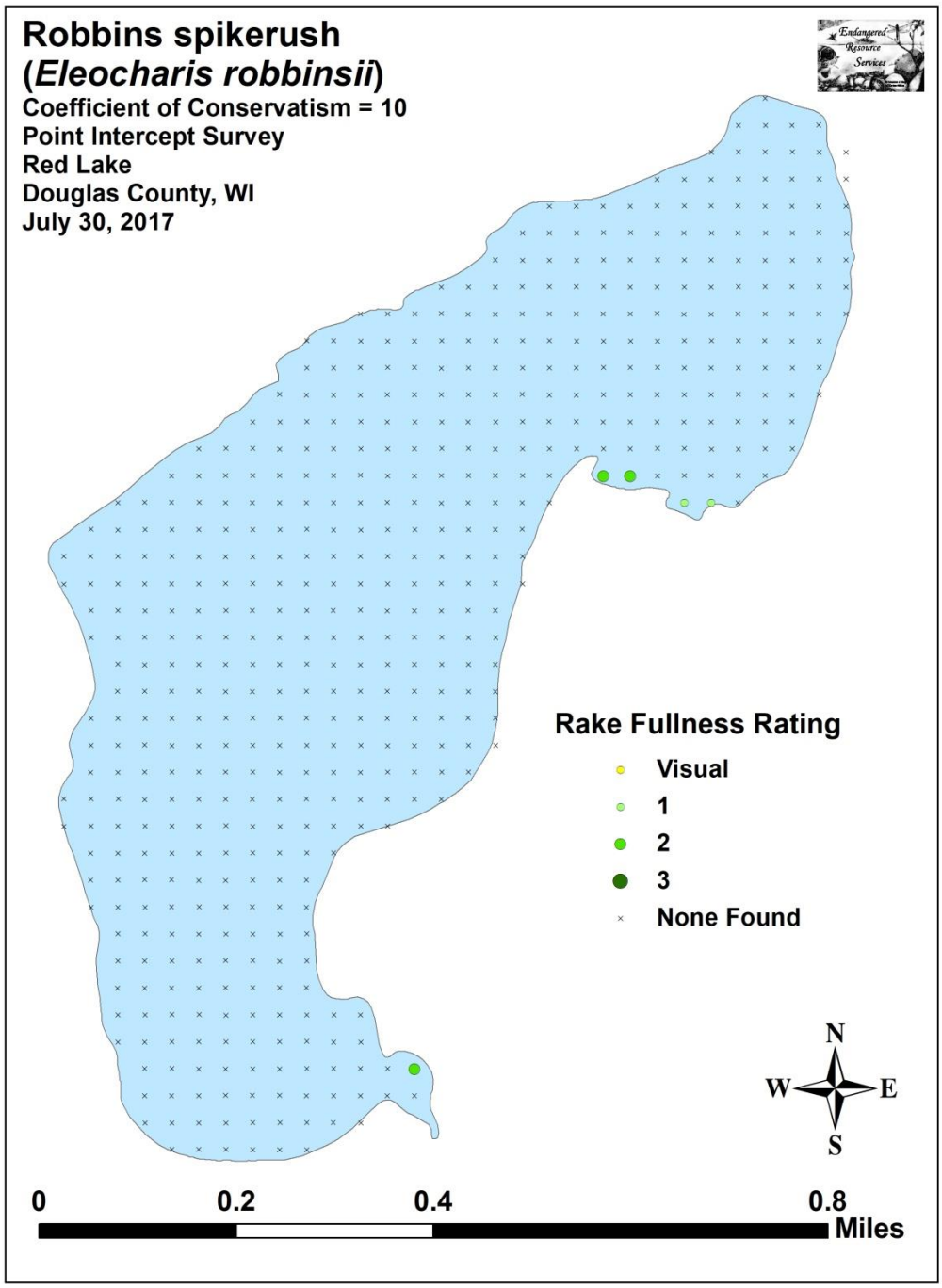
Miles


Robbins spikerush
(Eleocharis robbinsii)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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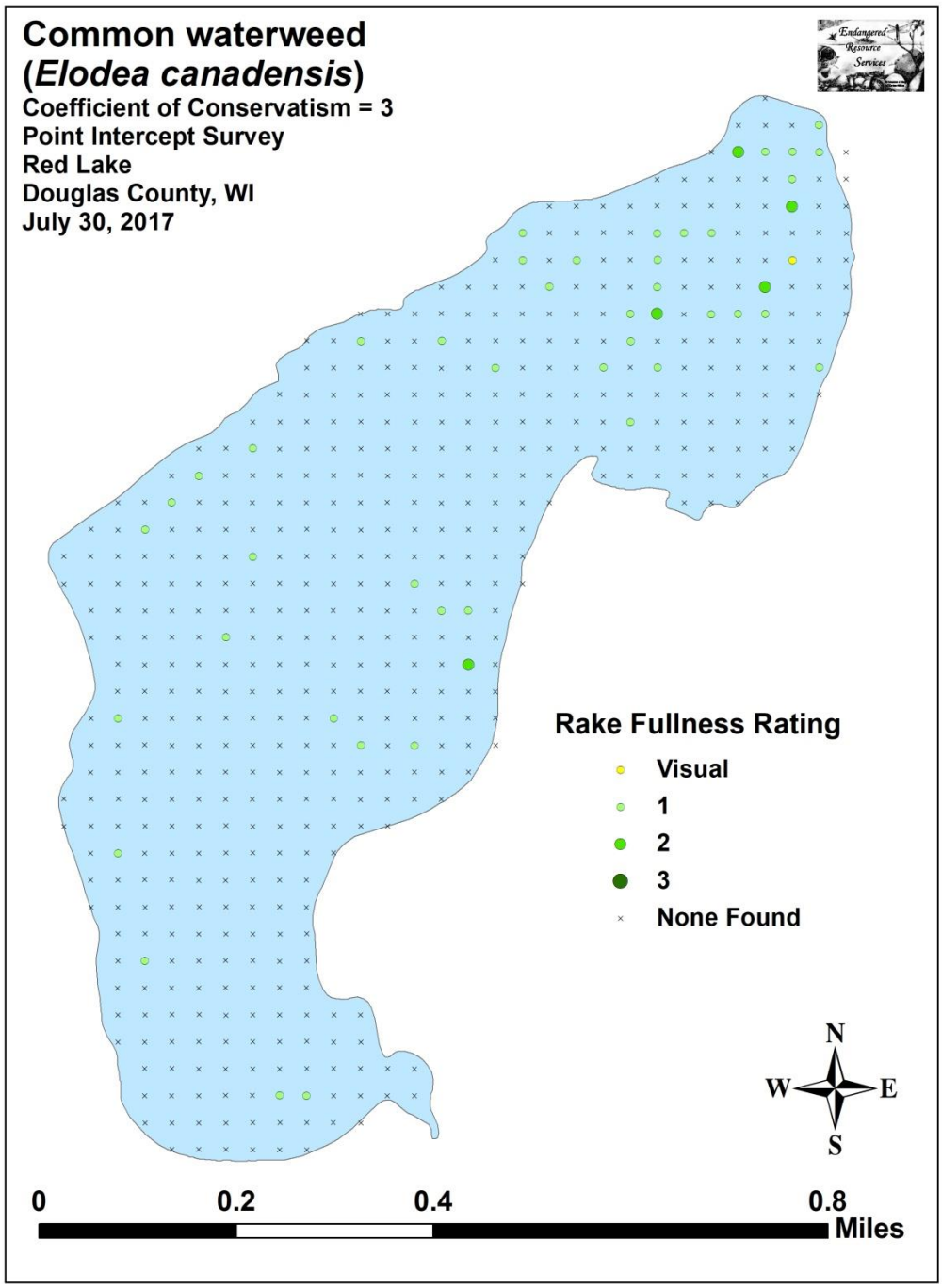
Miles


Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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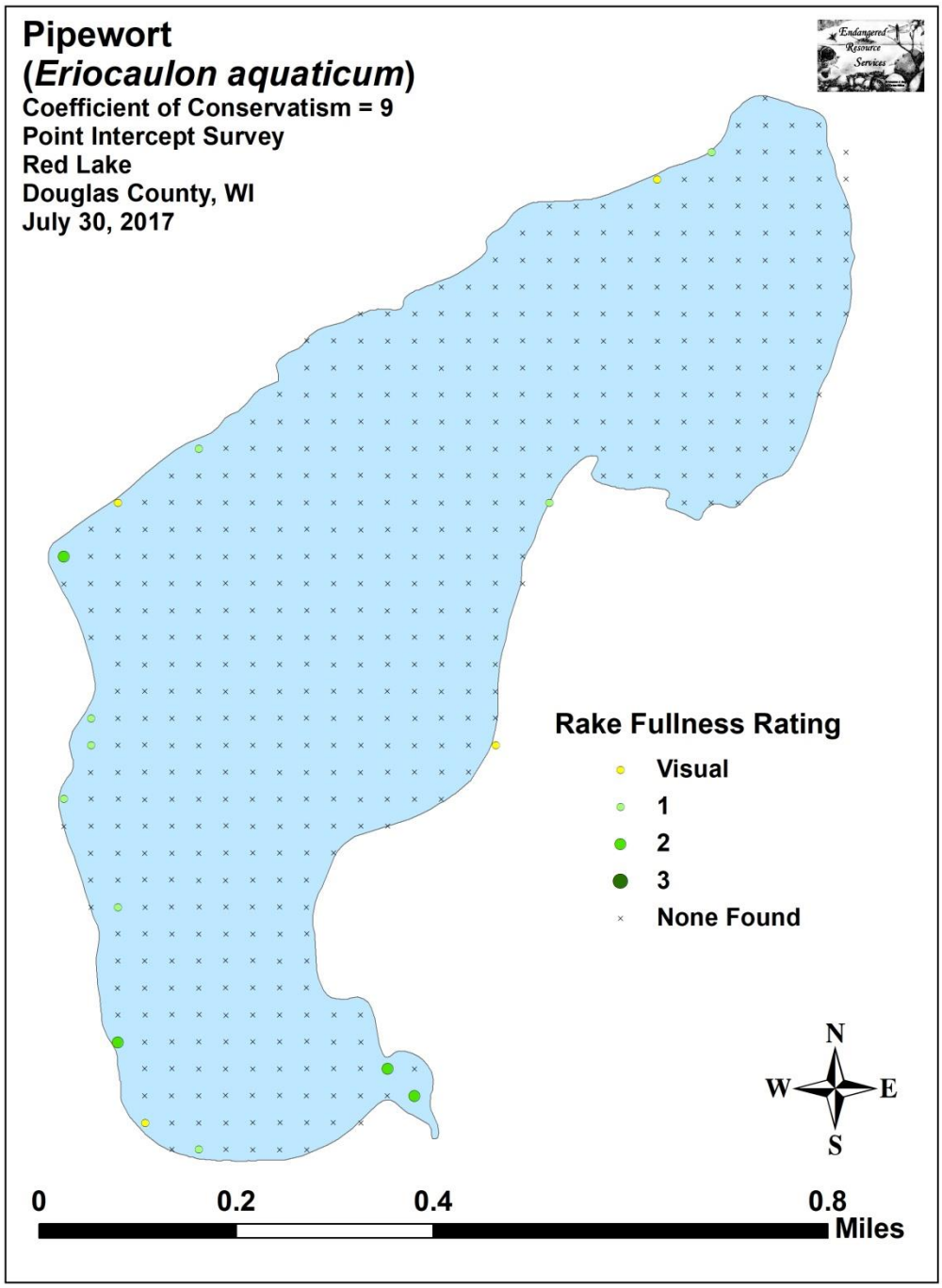
Miles


Pipewort
(Eriocaulon aquaticum)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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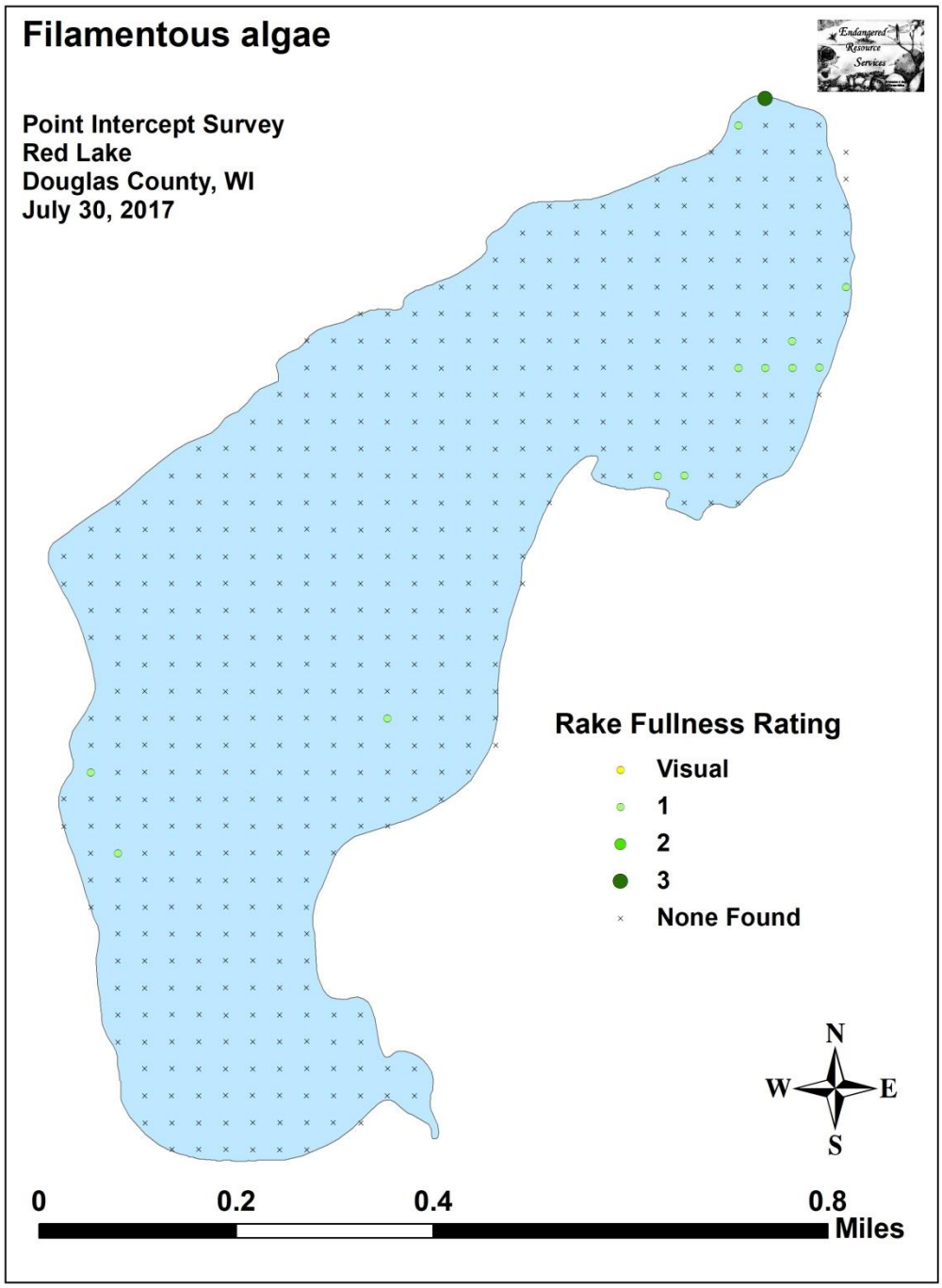
Miles


Filamentous algae
Endangered Resource Services
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Rake Fullness Rating
Visual
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None Found
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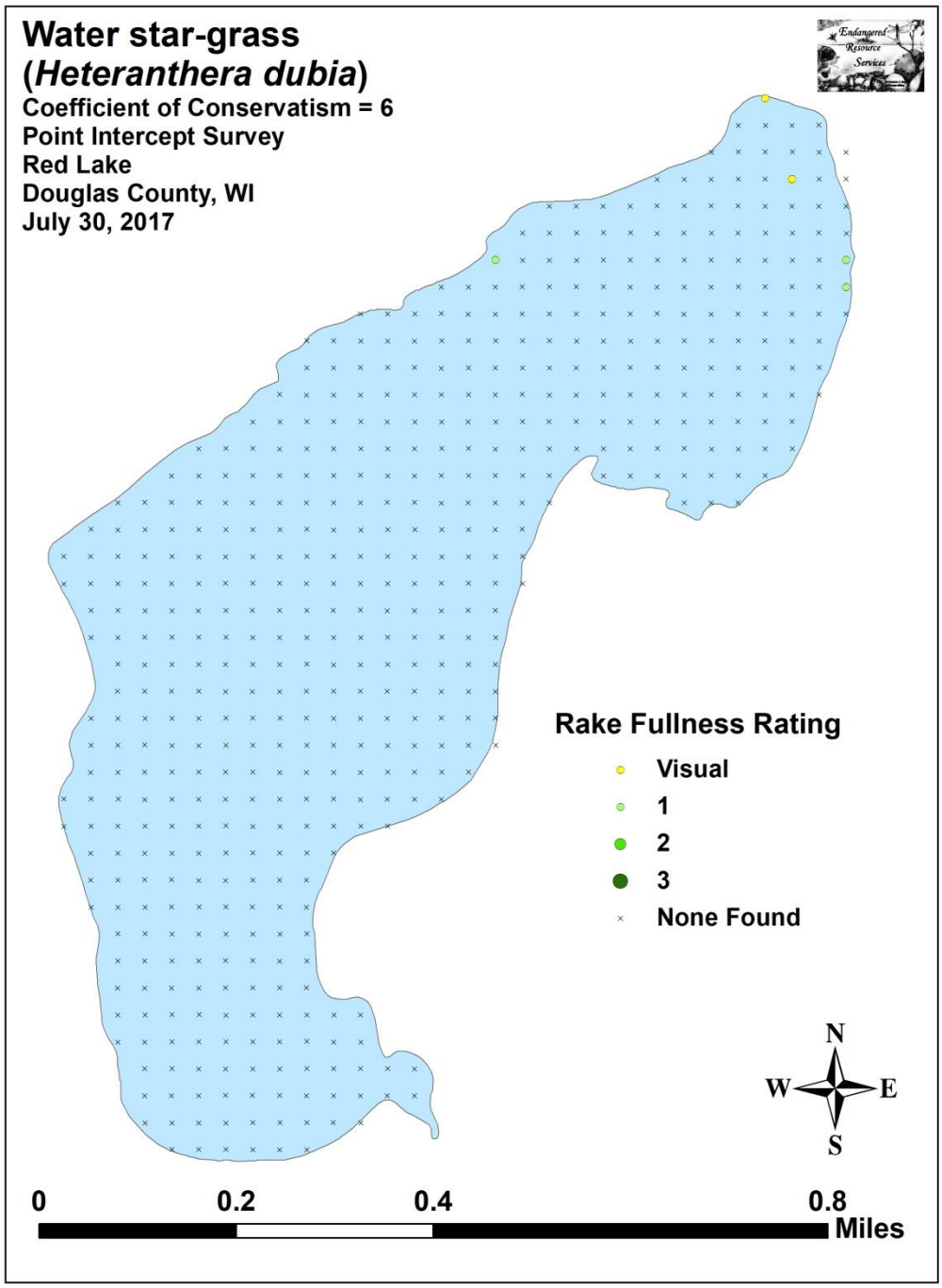
Miles


Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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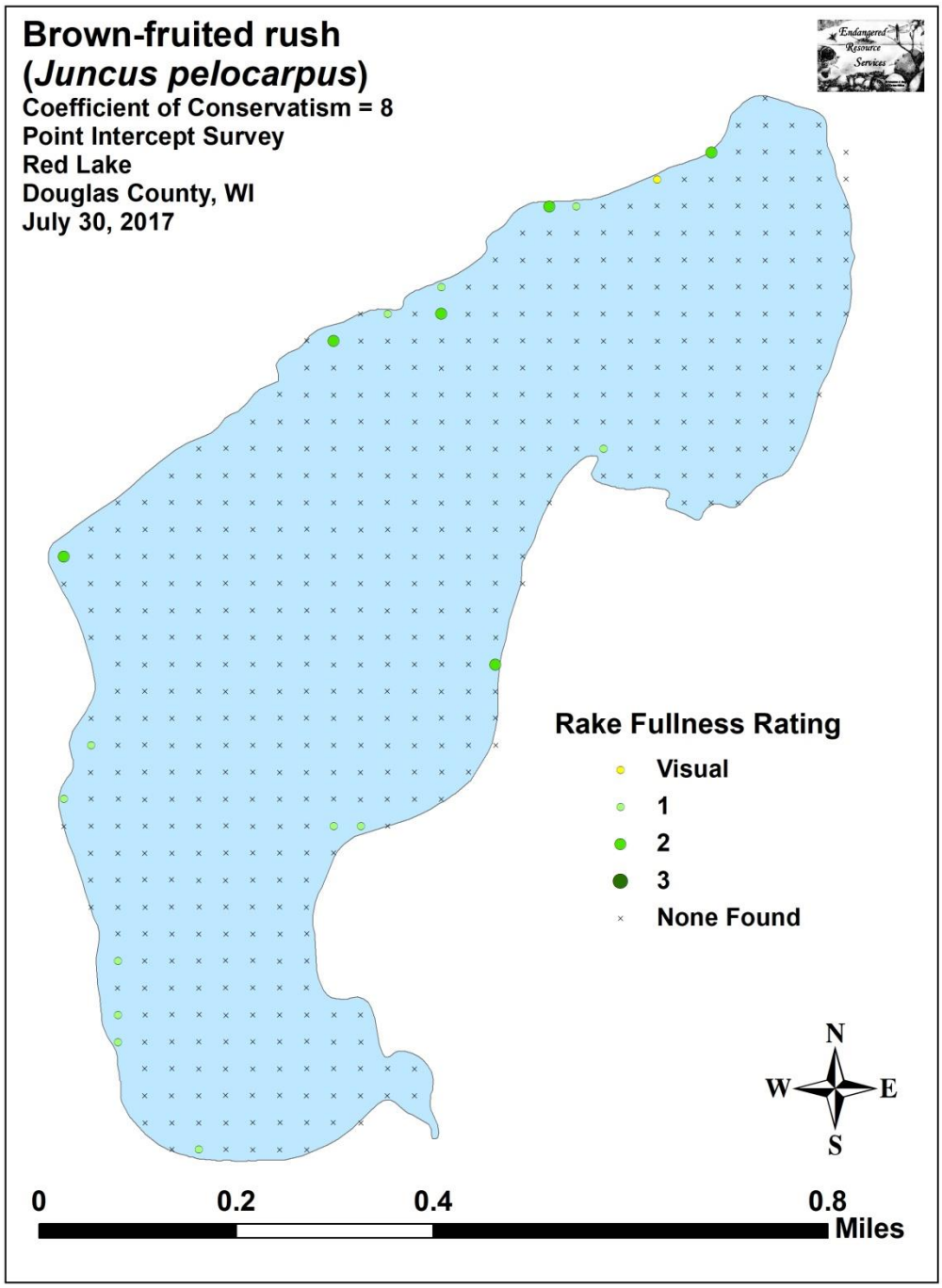
Miles


Brown-fruited rush
(Juncus pelocarpus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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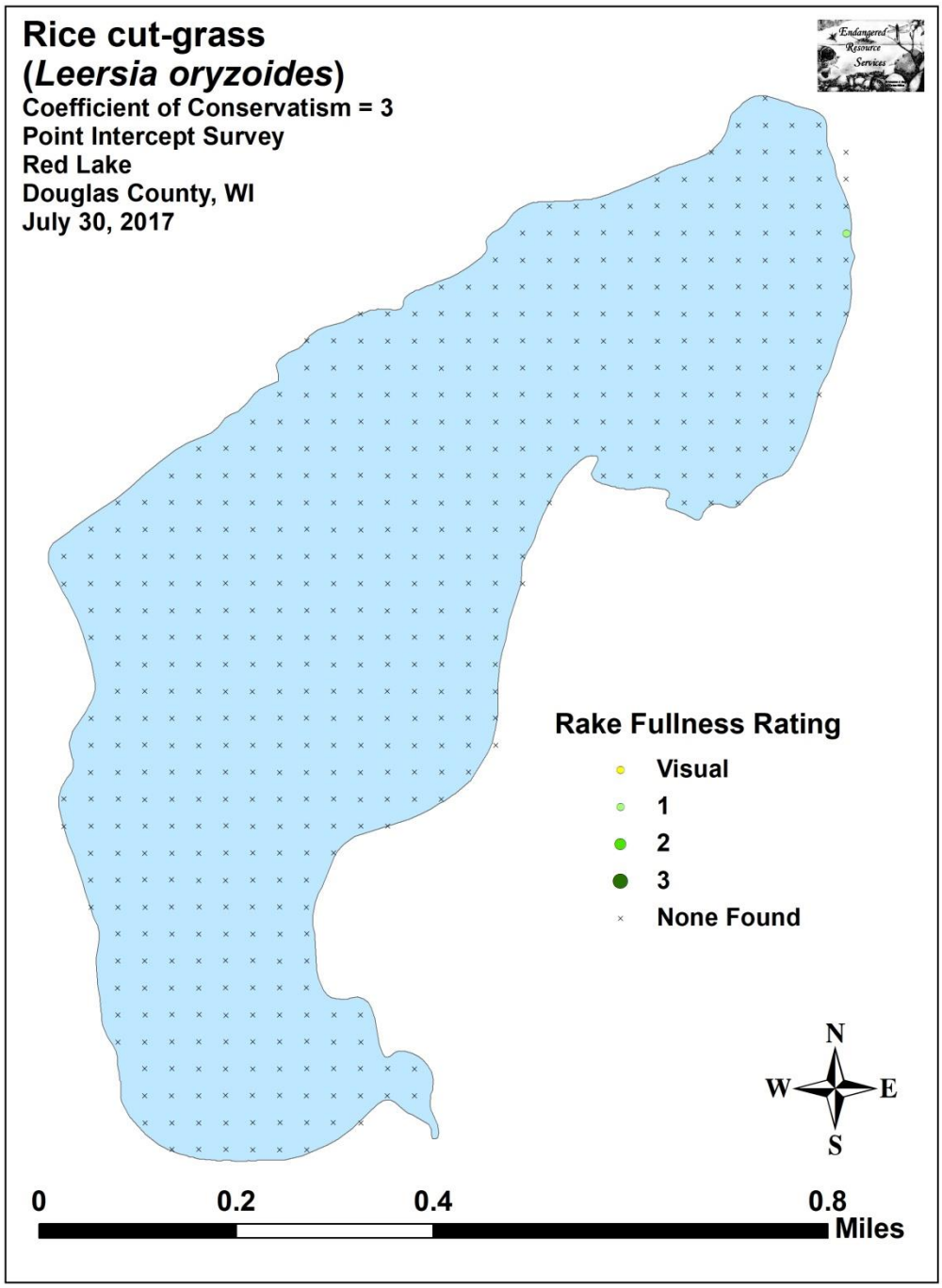
Miles


Rice cut-grass
(Leersia oryzoides)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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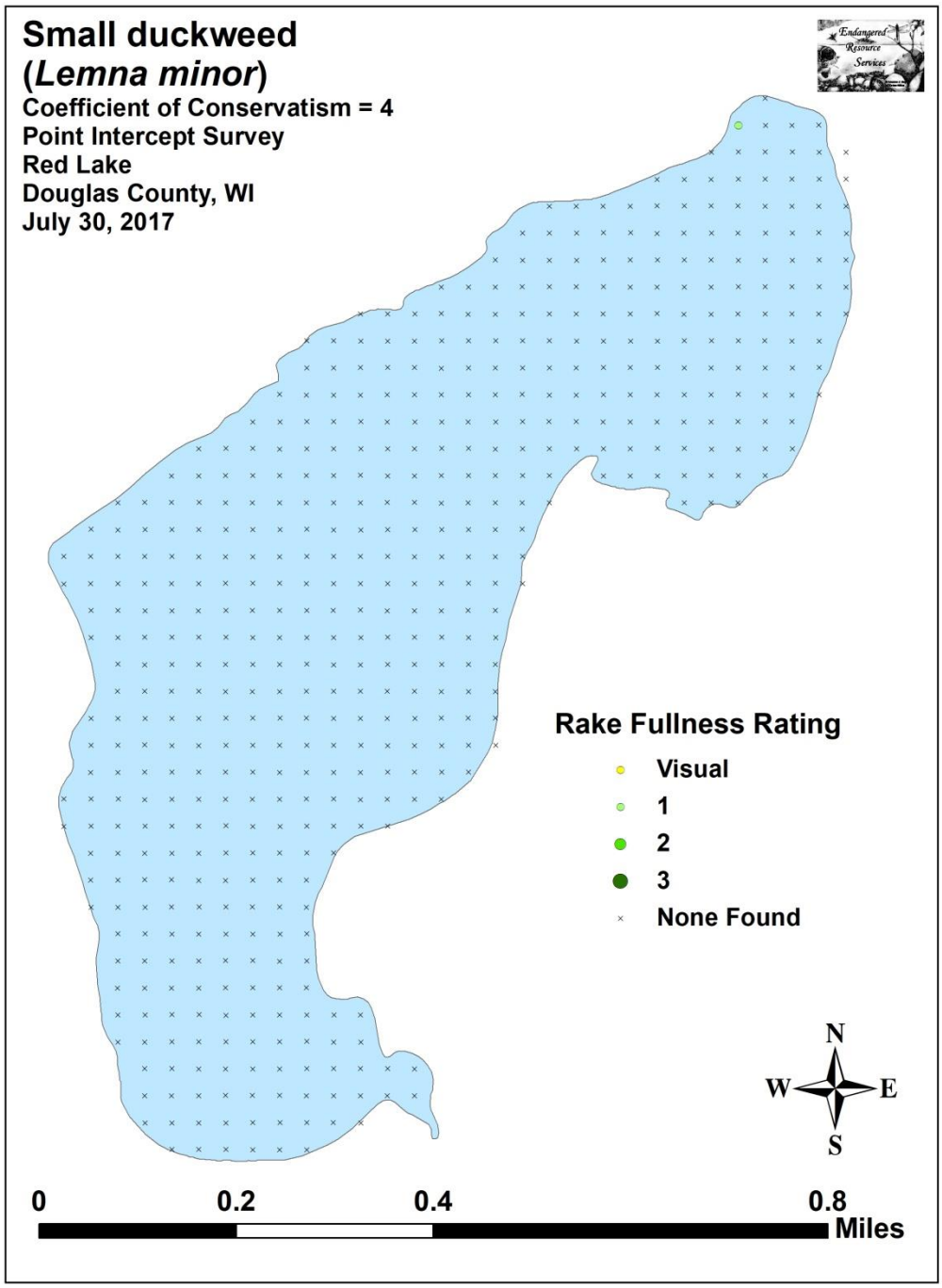
Miles


Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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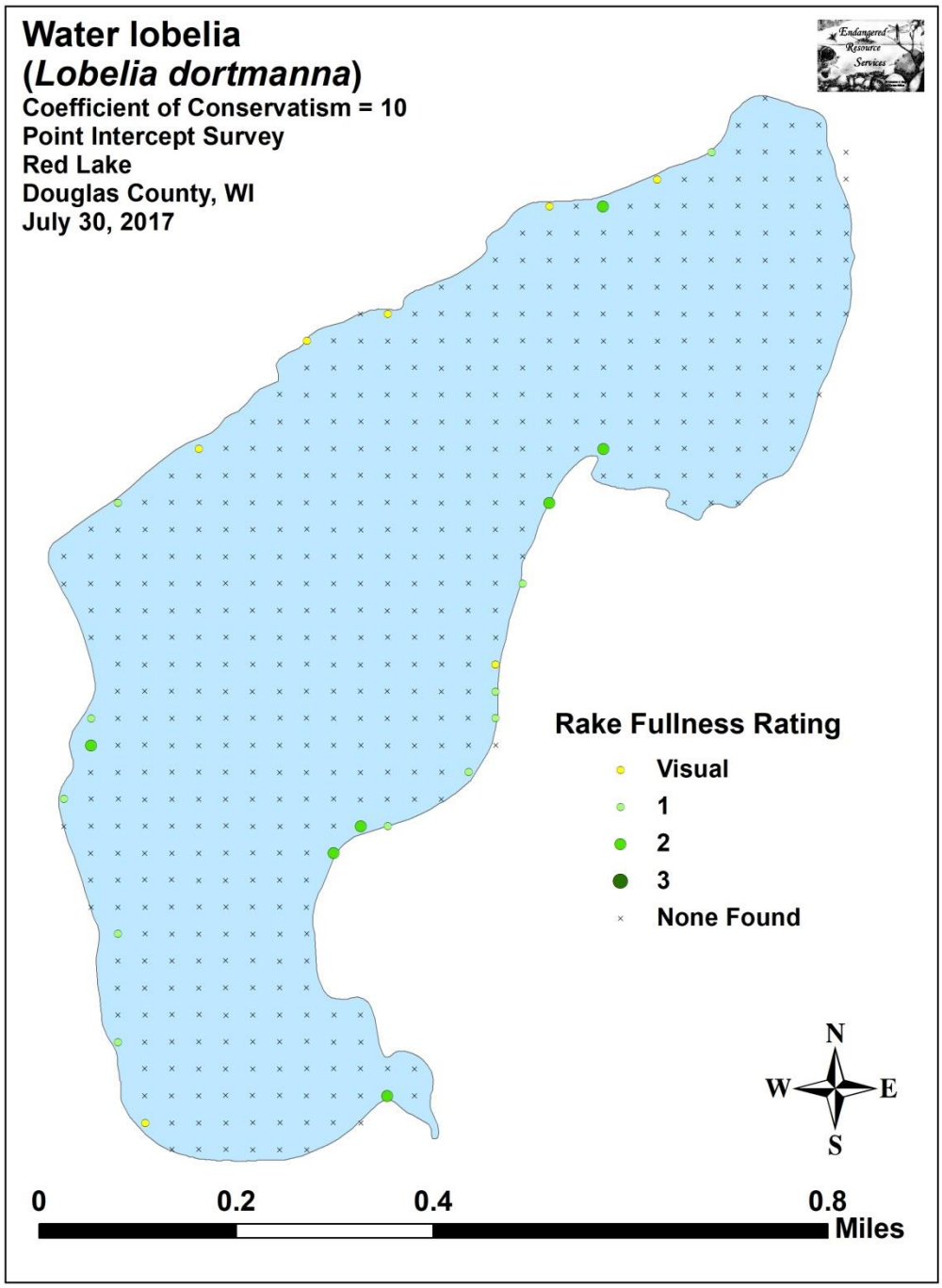
Miles


Water lobelia
(Lobelia dortmanna)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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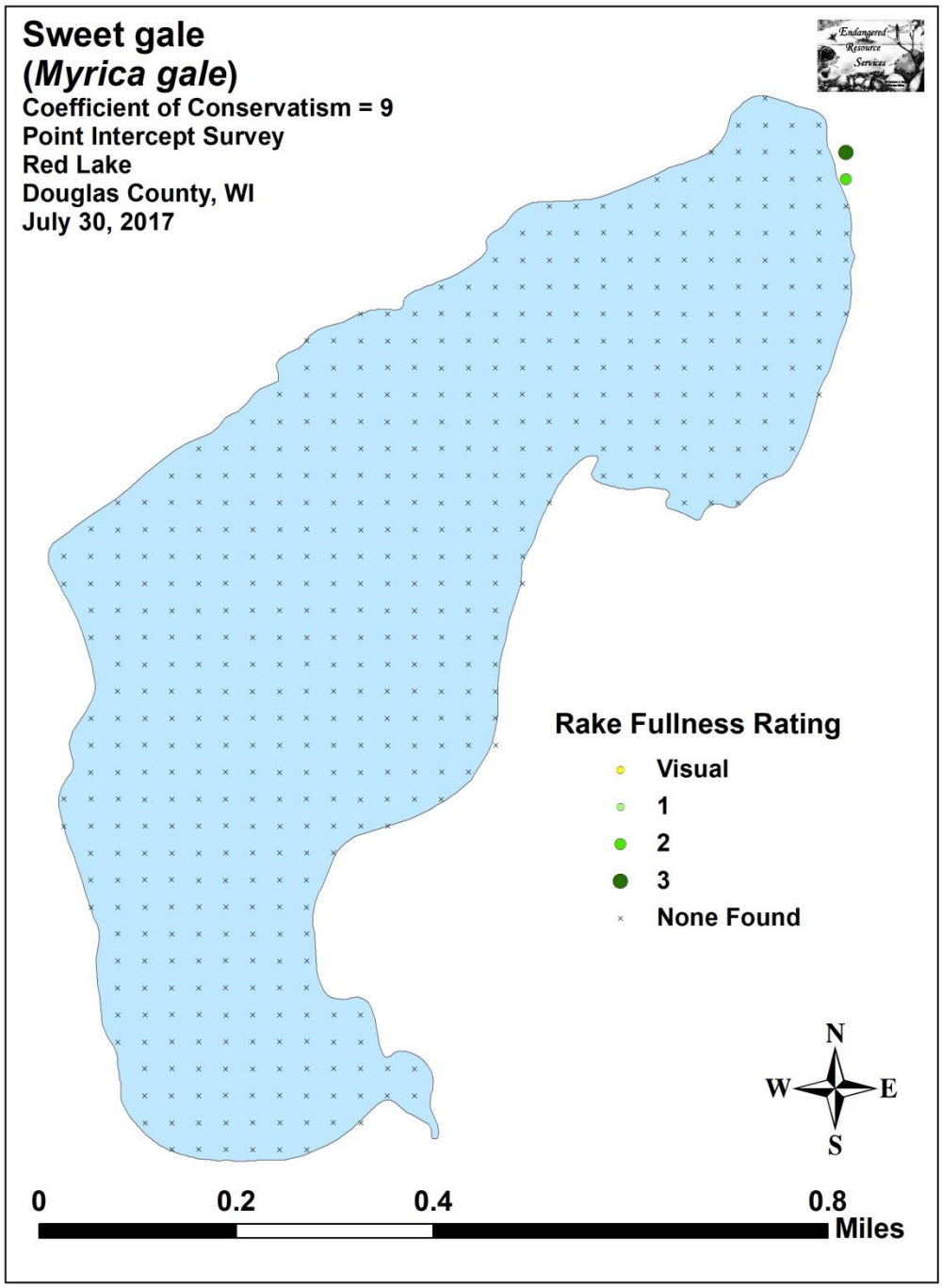
Miles


Sweet gale
(Myrica gale)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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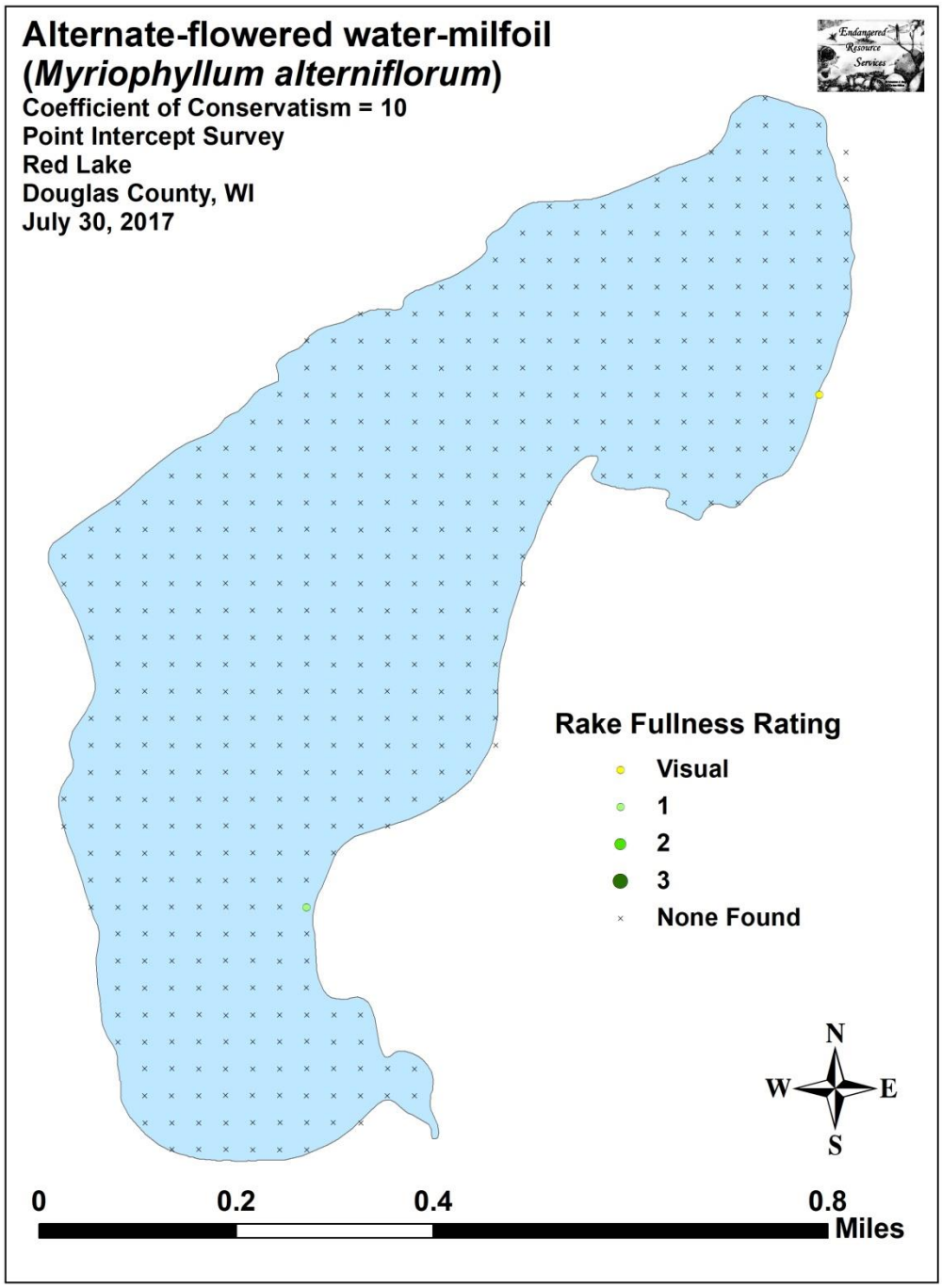
Miles


Alternate-flowered water-milfoil
(Myriophyllum alterniflorum)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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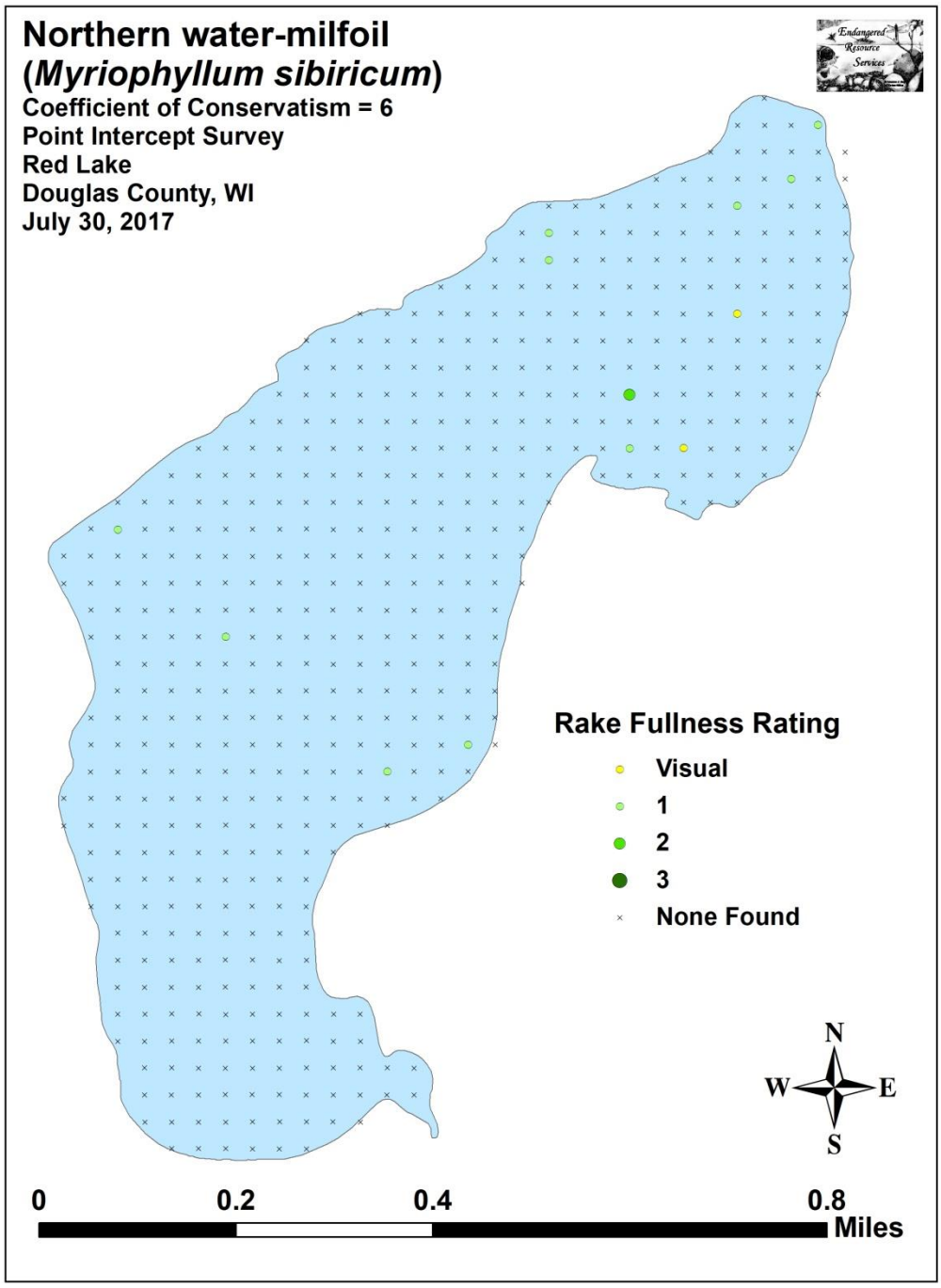
Miles


Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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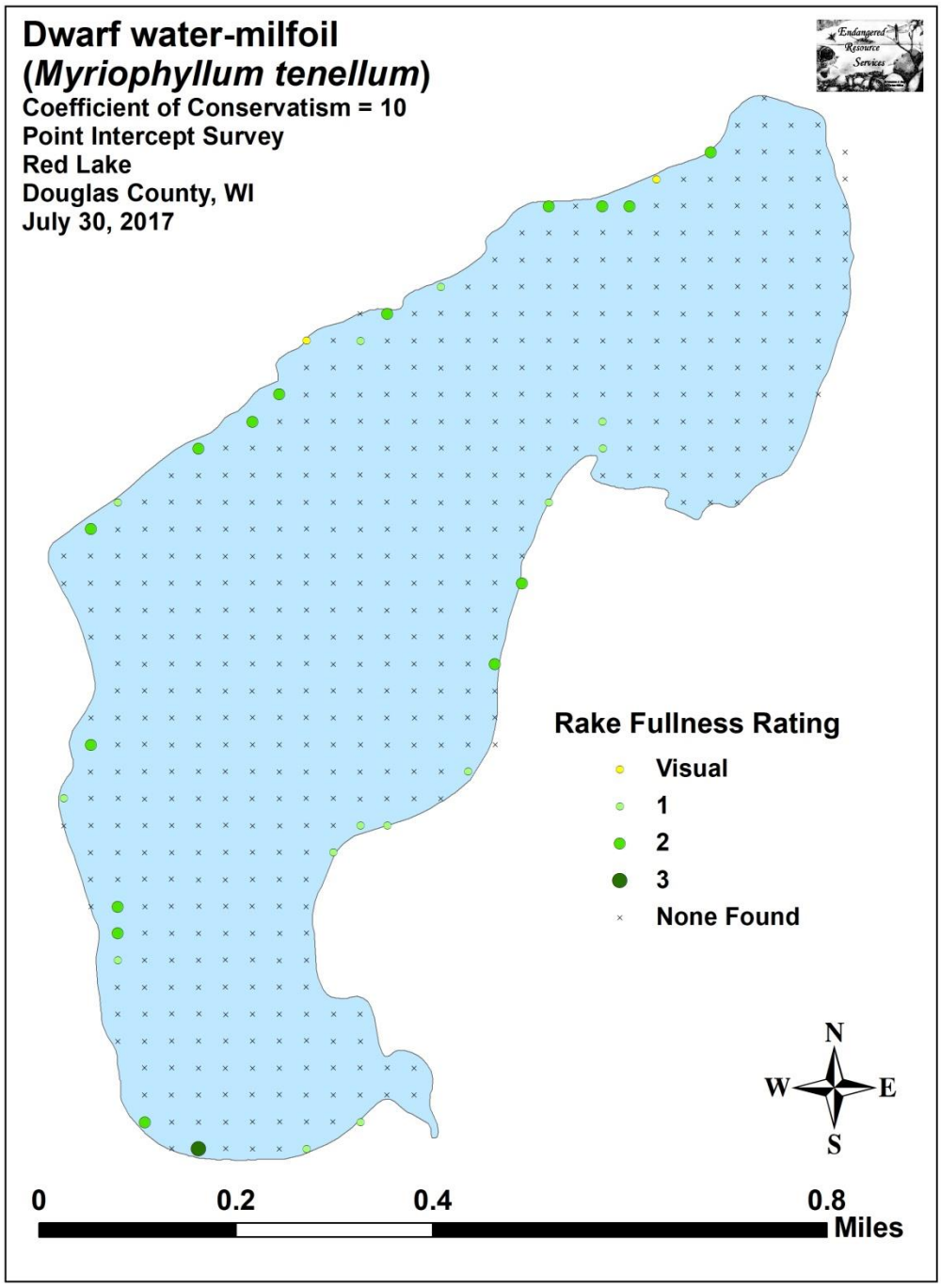
Miles


Dwarf water-milfoil
(Myriophyllum tenellum)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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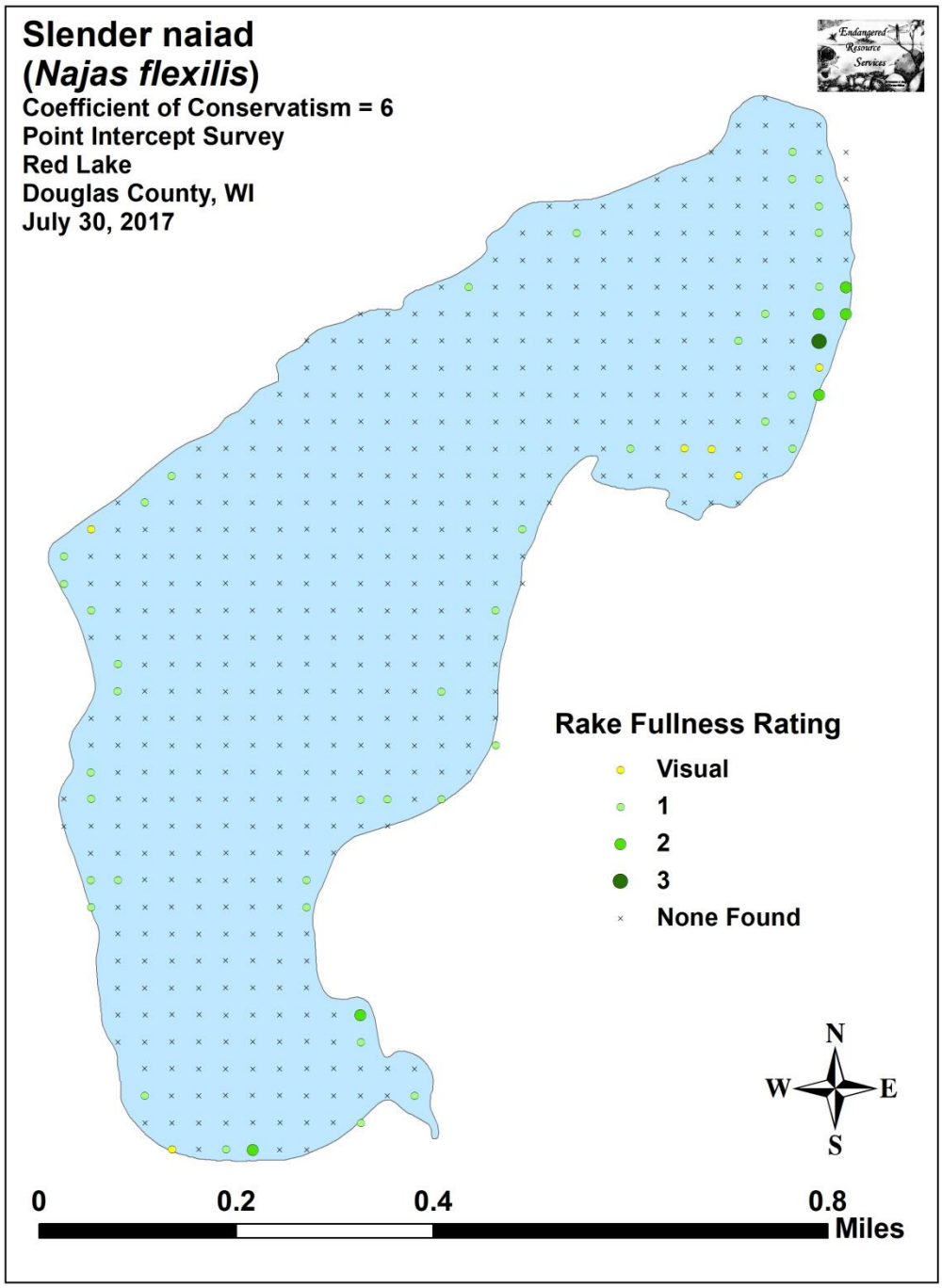
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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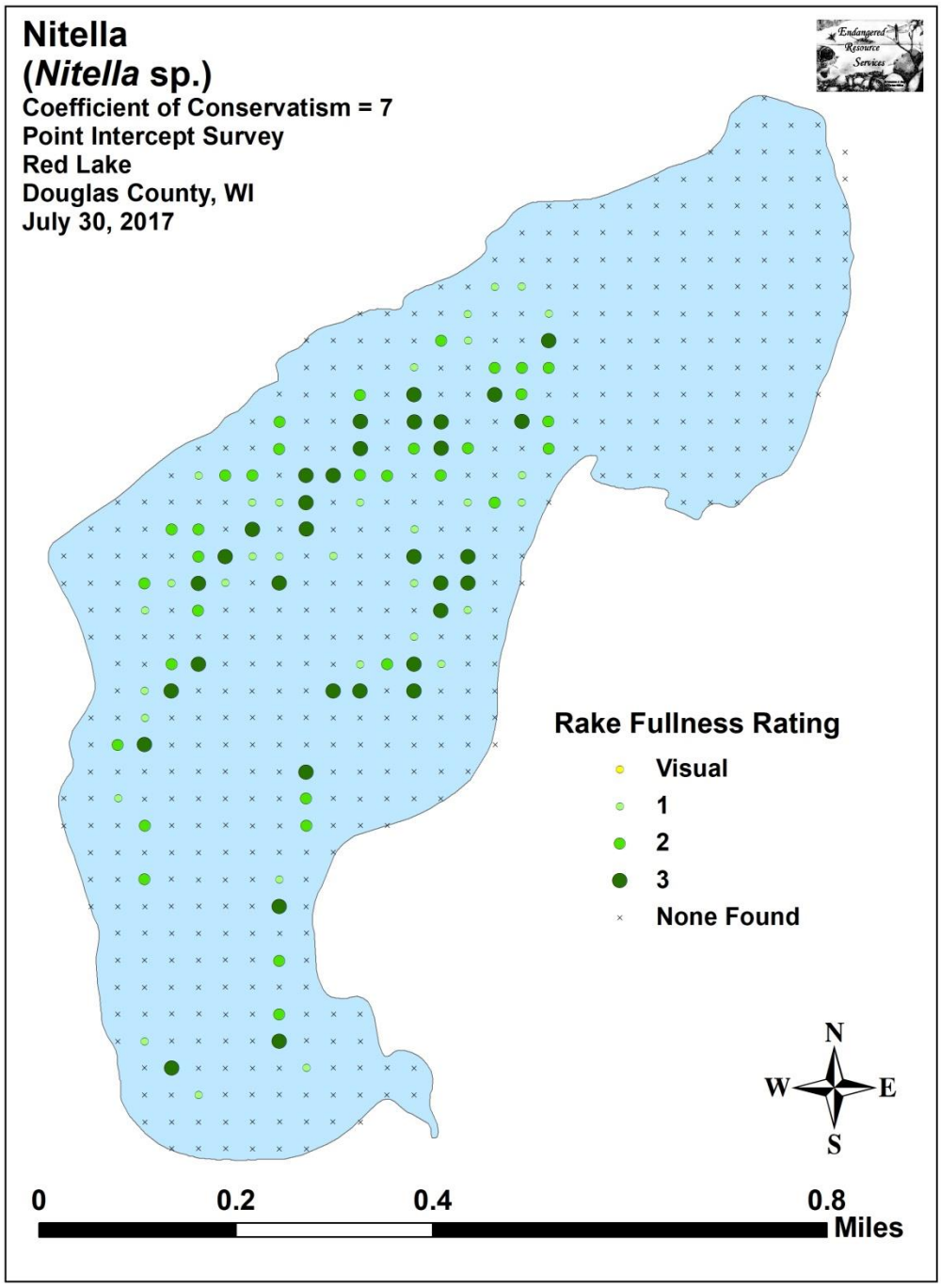
Miles


Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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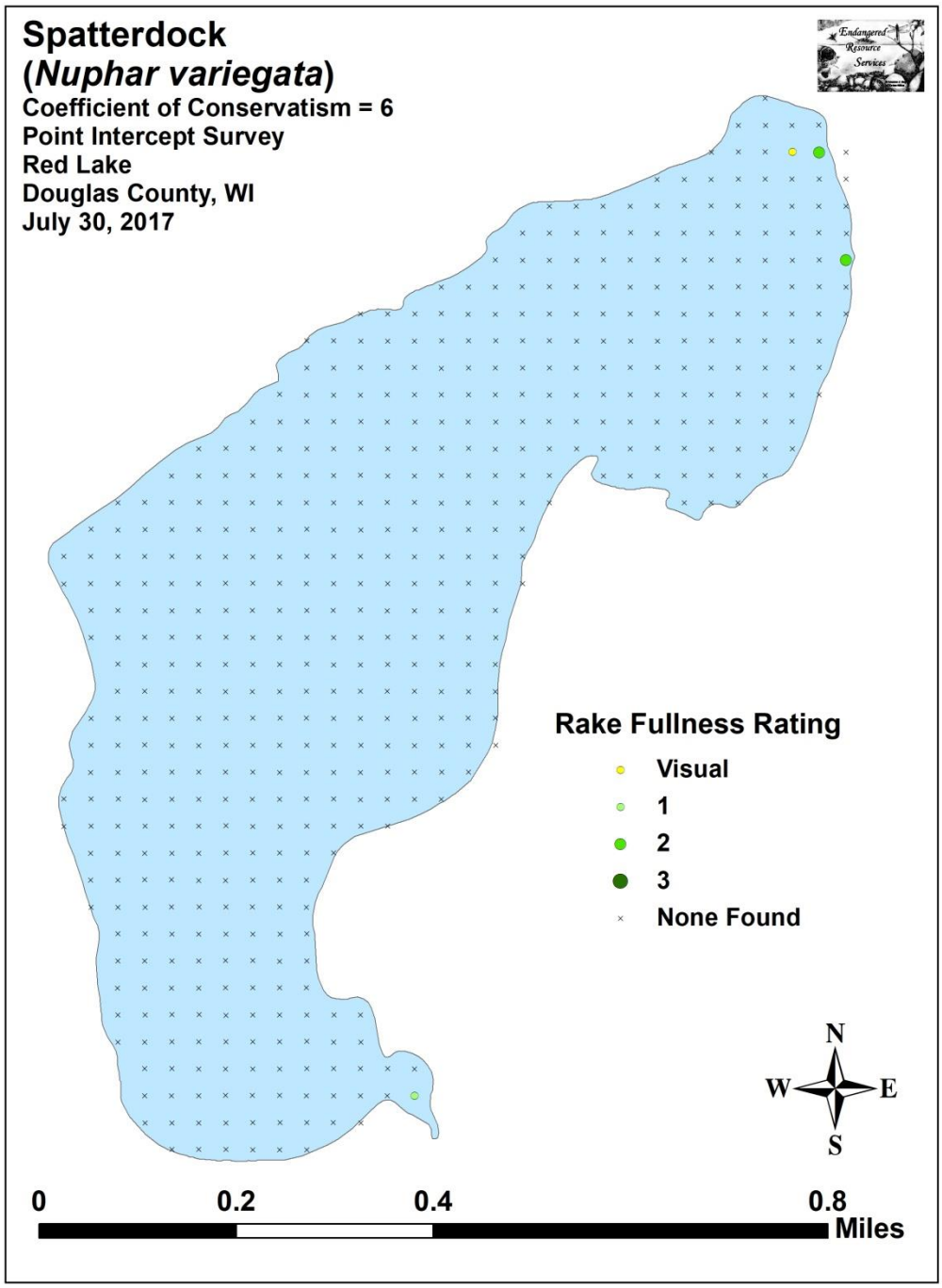
Miles


Spatterdock
(Nuphar variegata)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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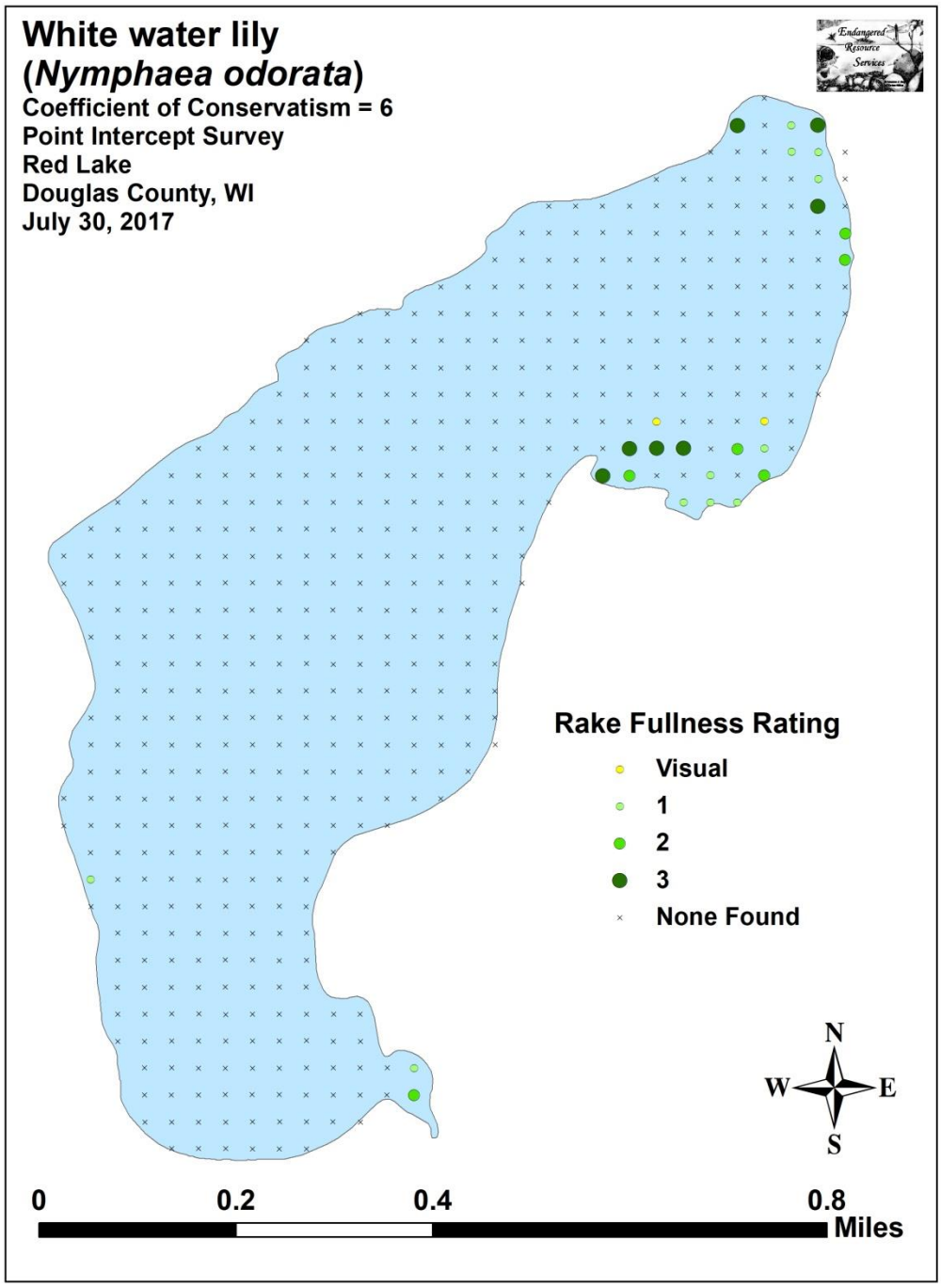
Miles


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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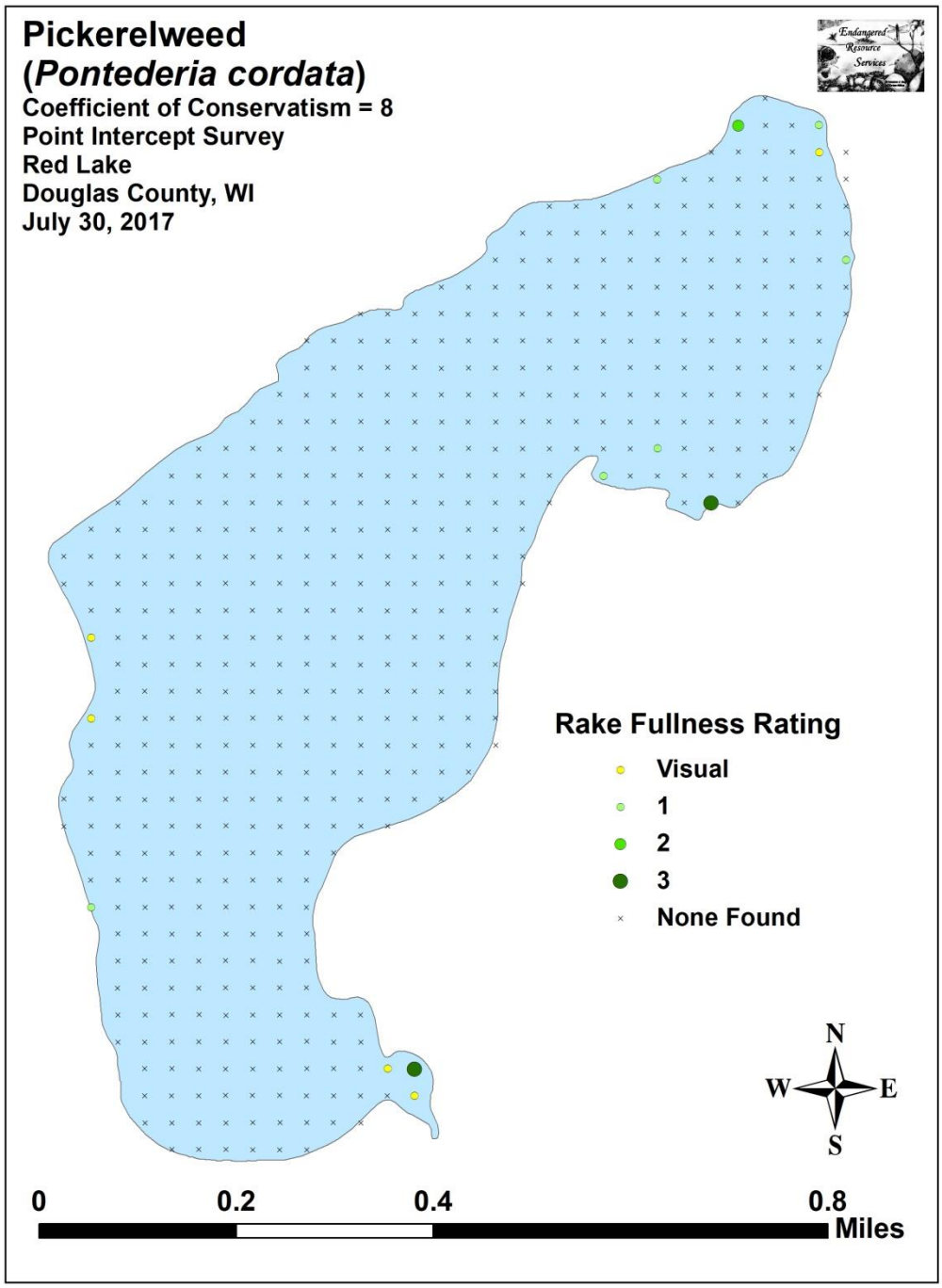
Miles


Pickerelweed
(Pontederia cordata)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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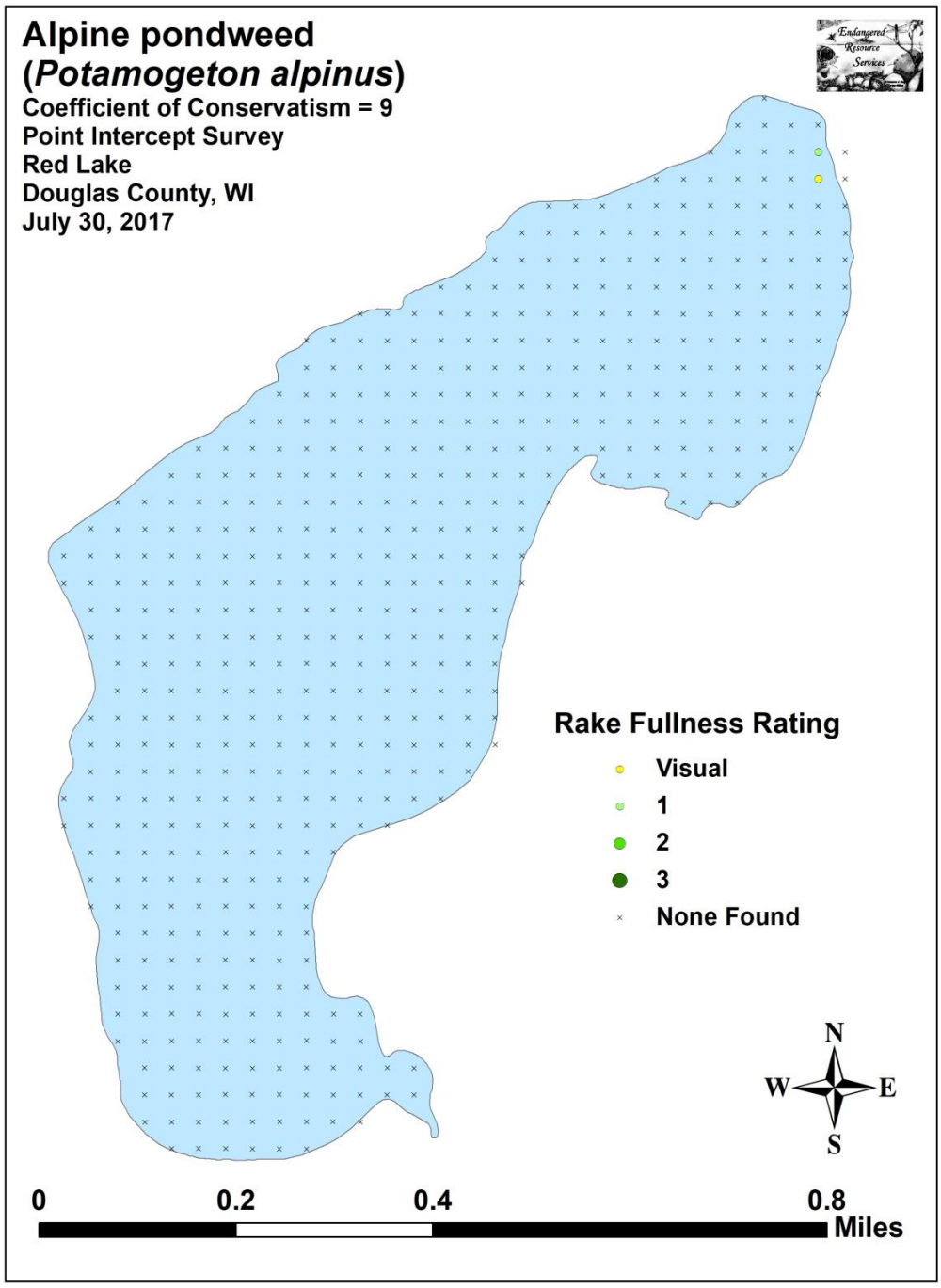
Miles


Alpine pondweed
(Potamogeton alpinus)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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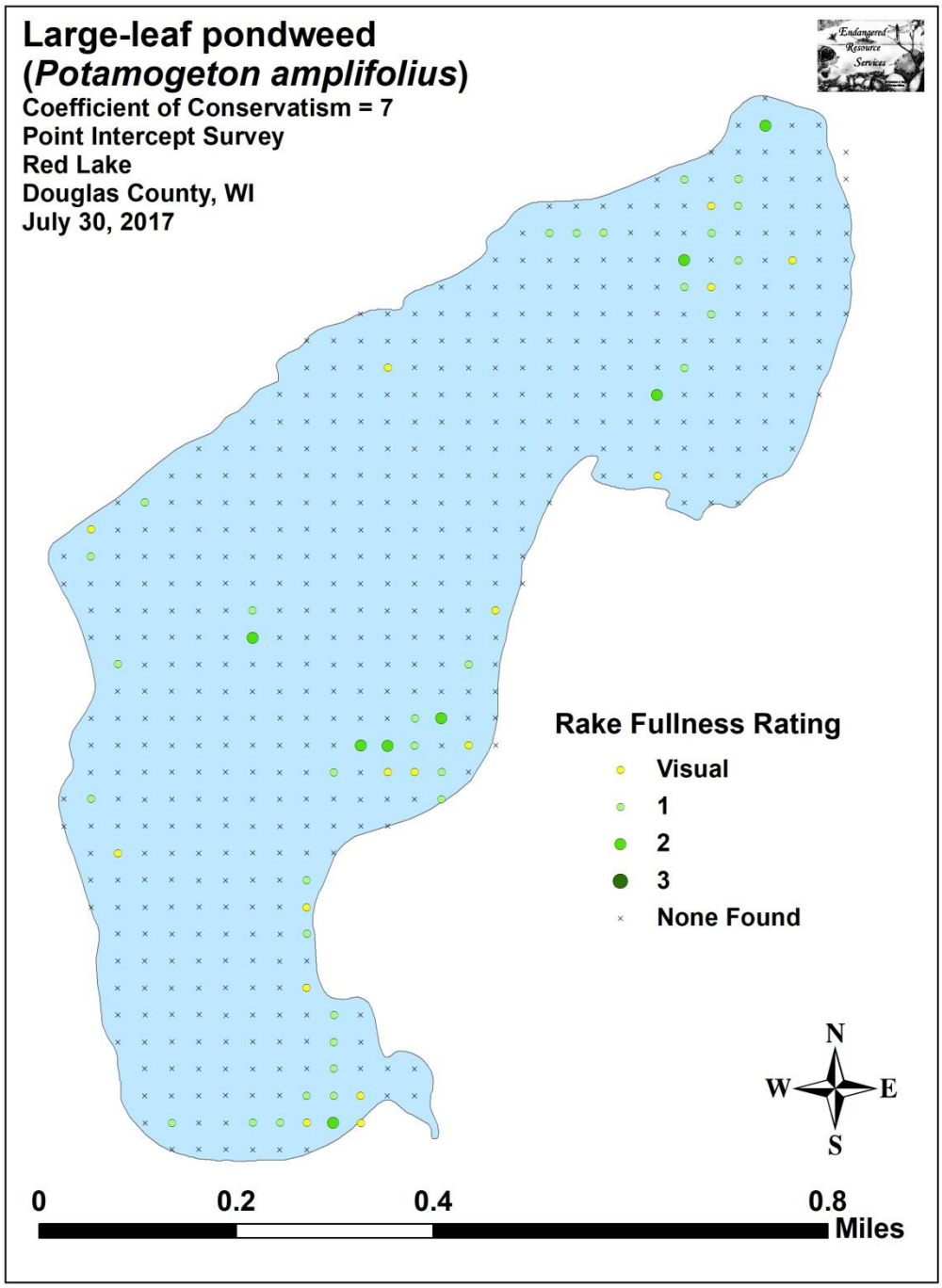
Miles


Large-leaf pondweed
(Potamogeton amplifolius)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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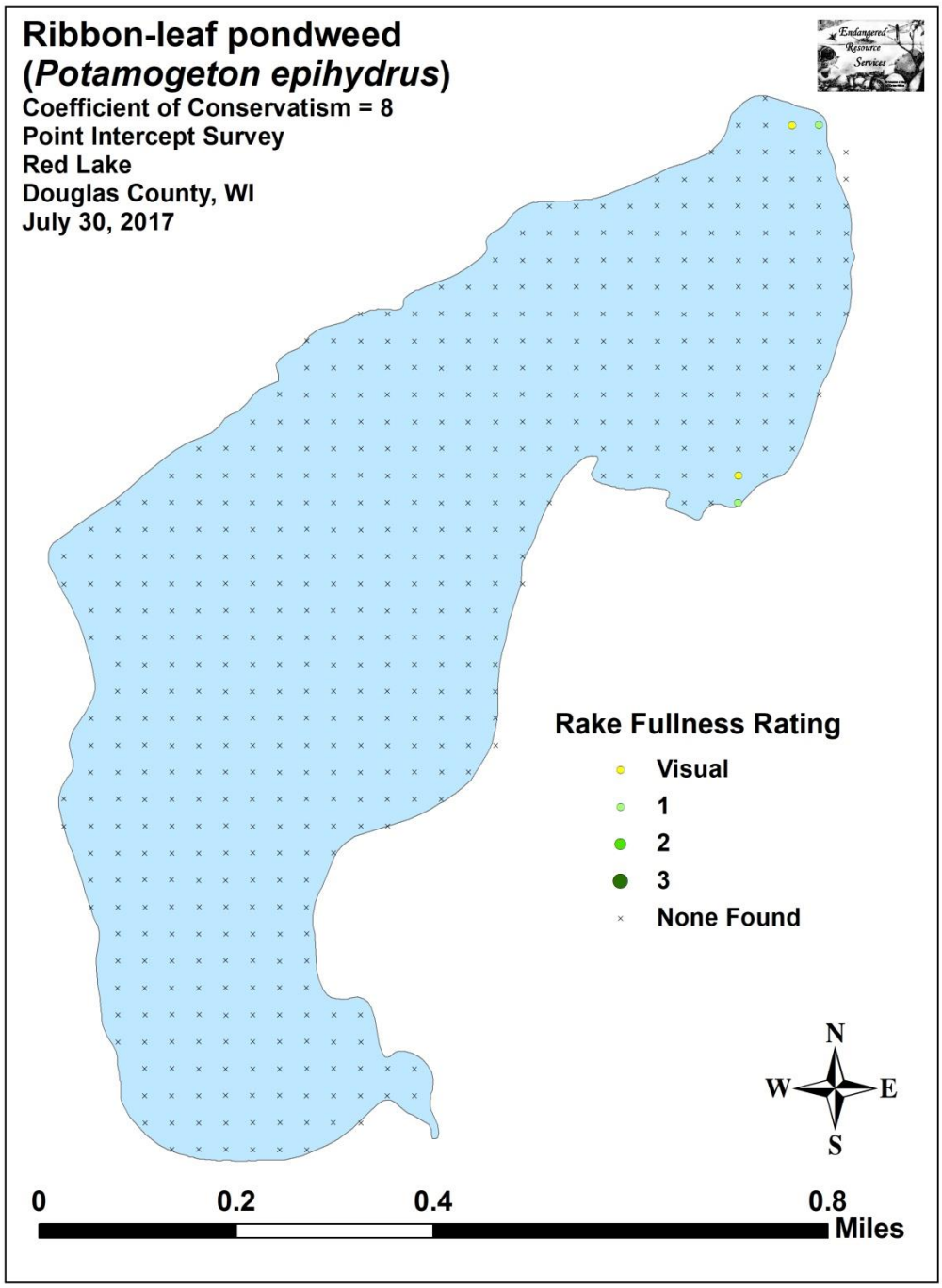
Miles


Ribbon-leaf pondweed
(Potamogeton epihydrus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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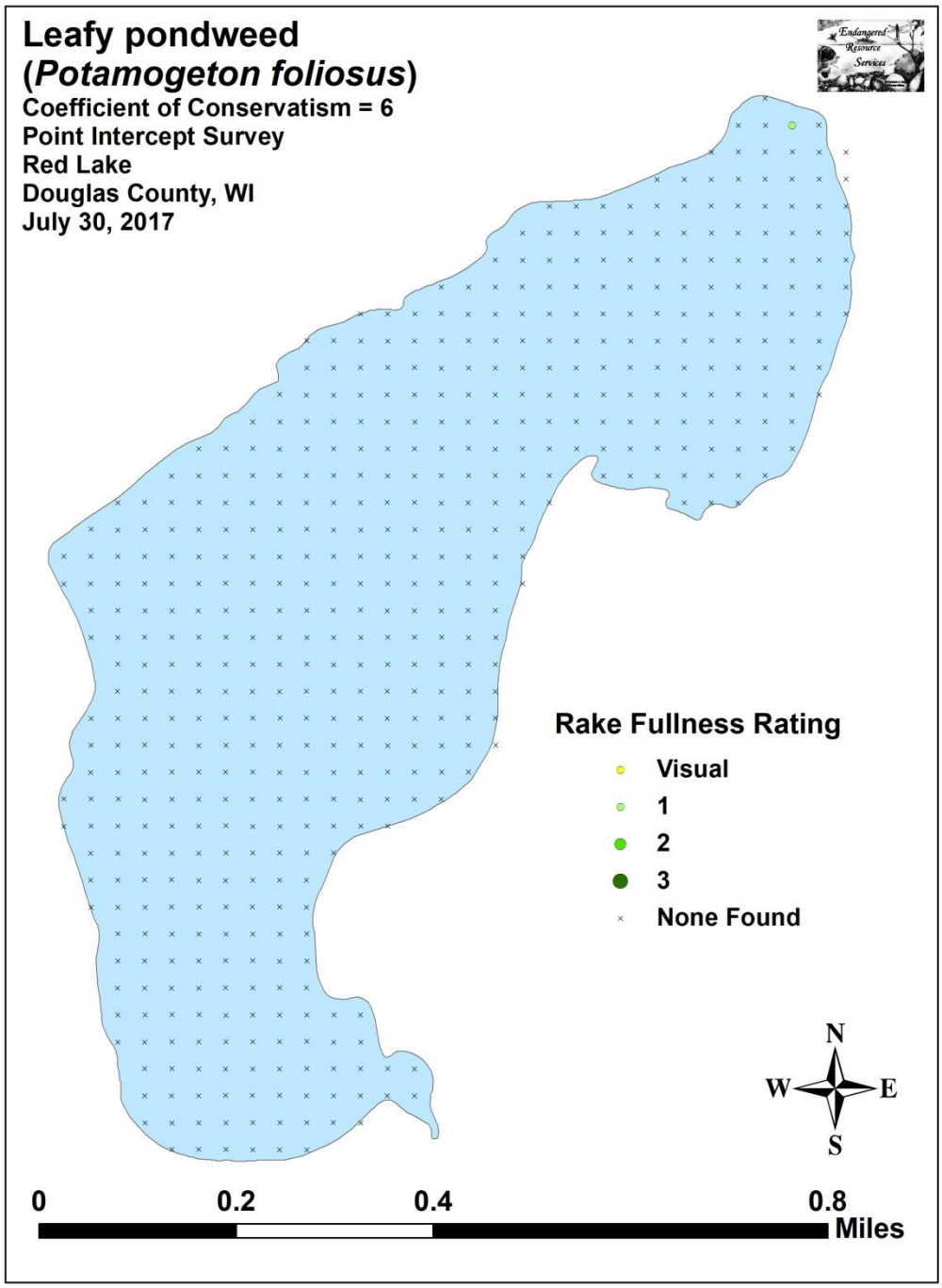
Miles


Leafy pondweed
(Potamogeton foliosus)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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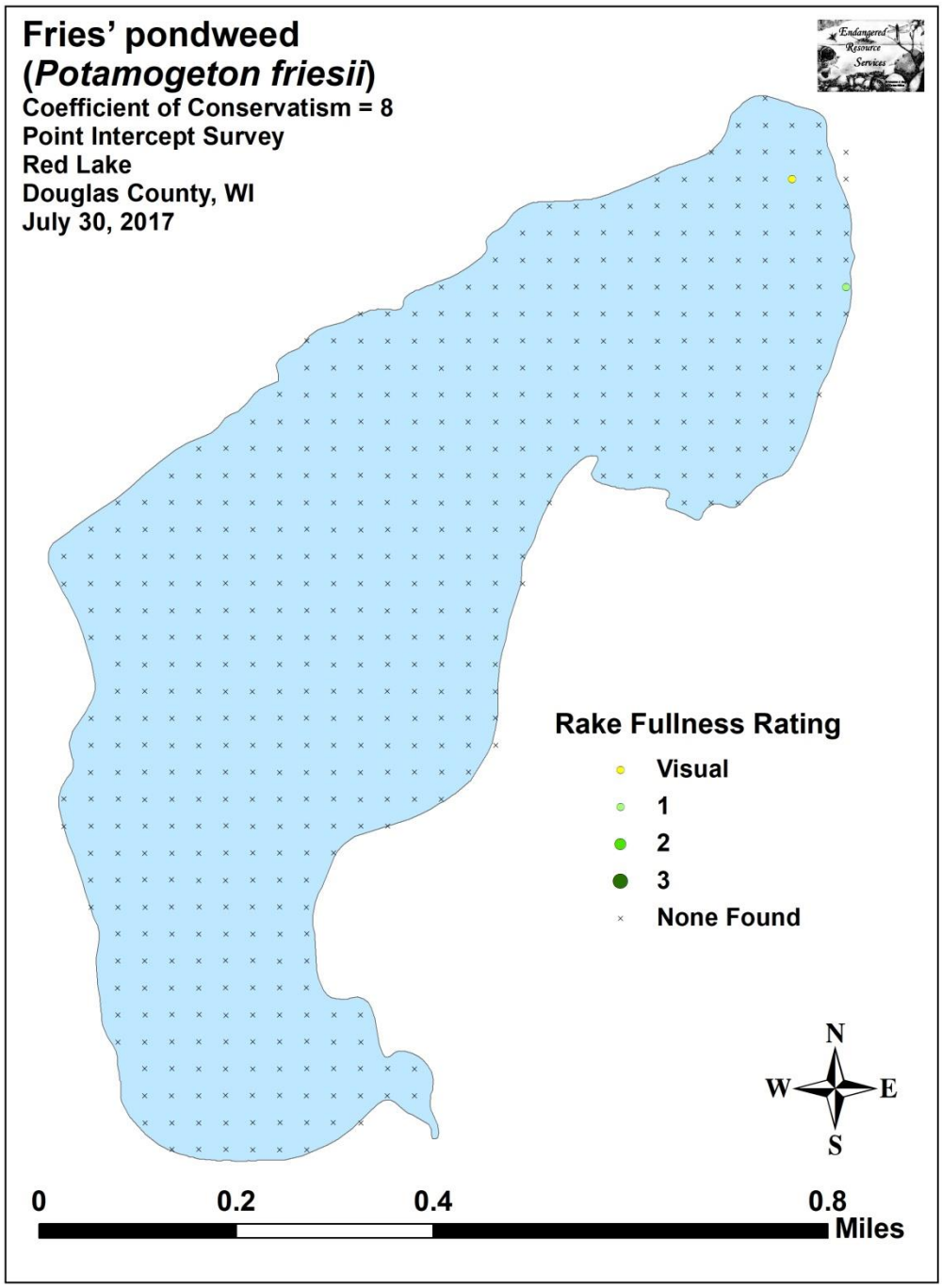
Miles


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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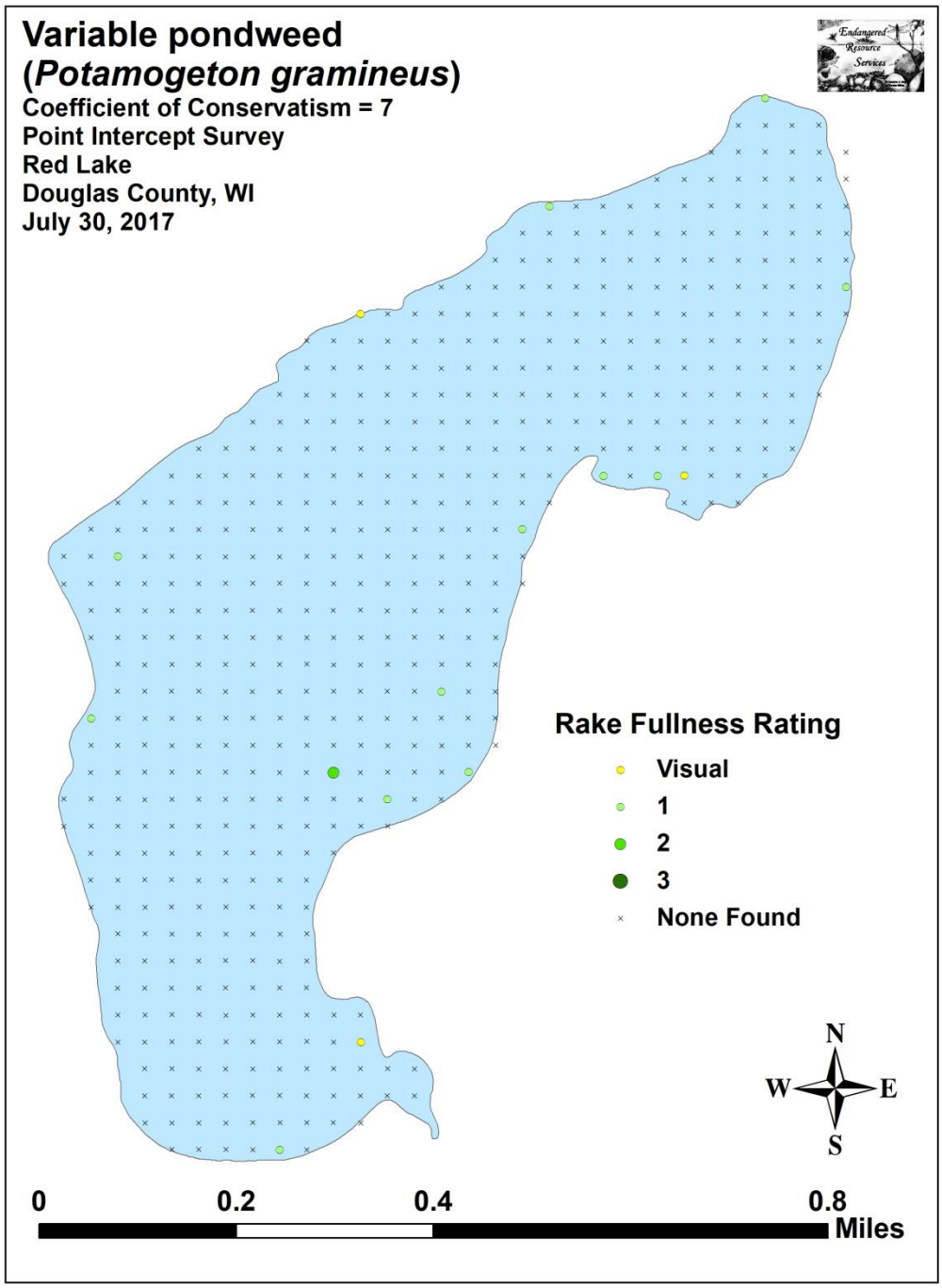
Miles


Variable pondweed
(Potamogeton gramineus)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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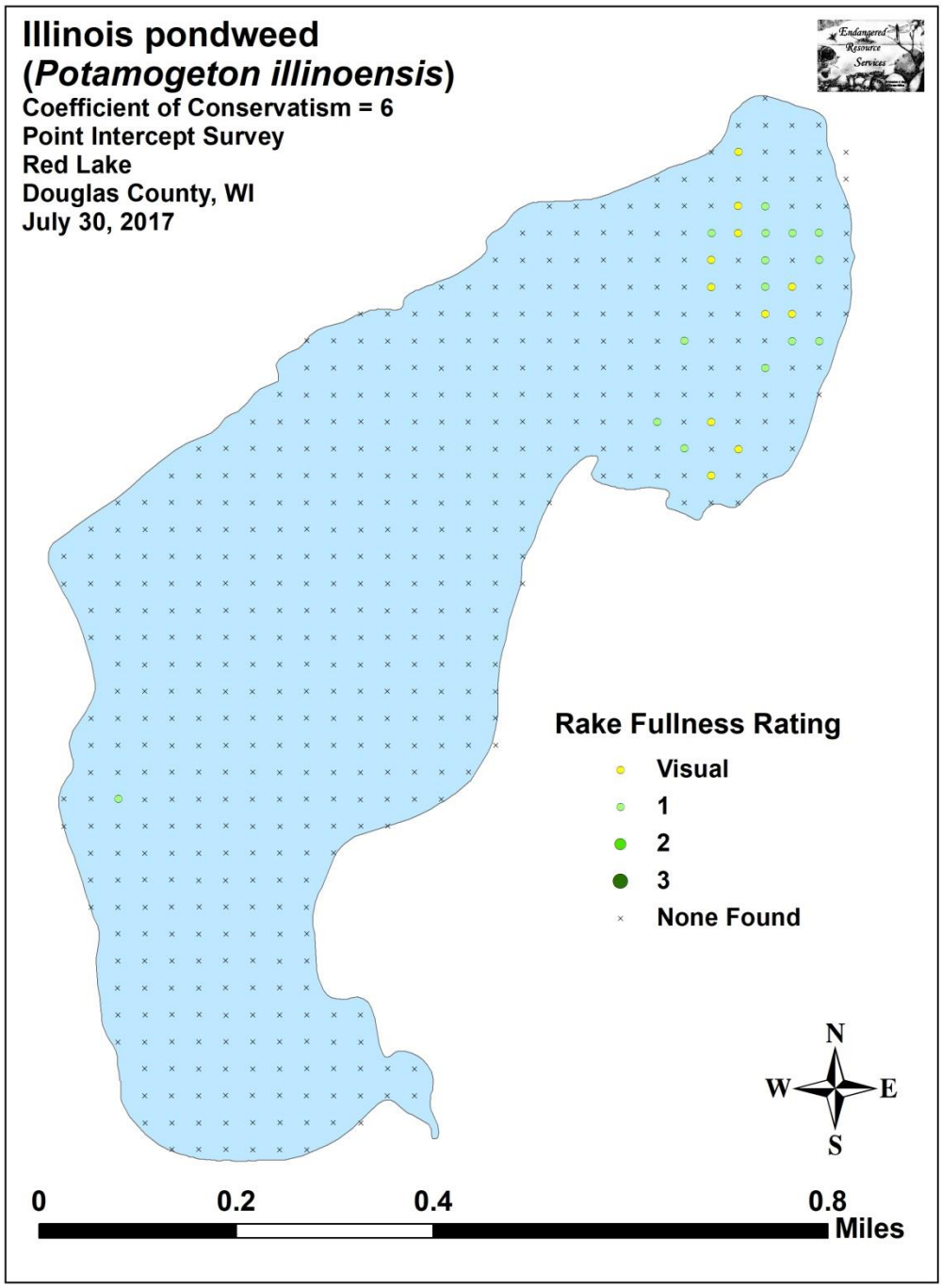
Miles


Illinois pondweed
(Potamogeton illinoensis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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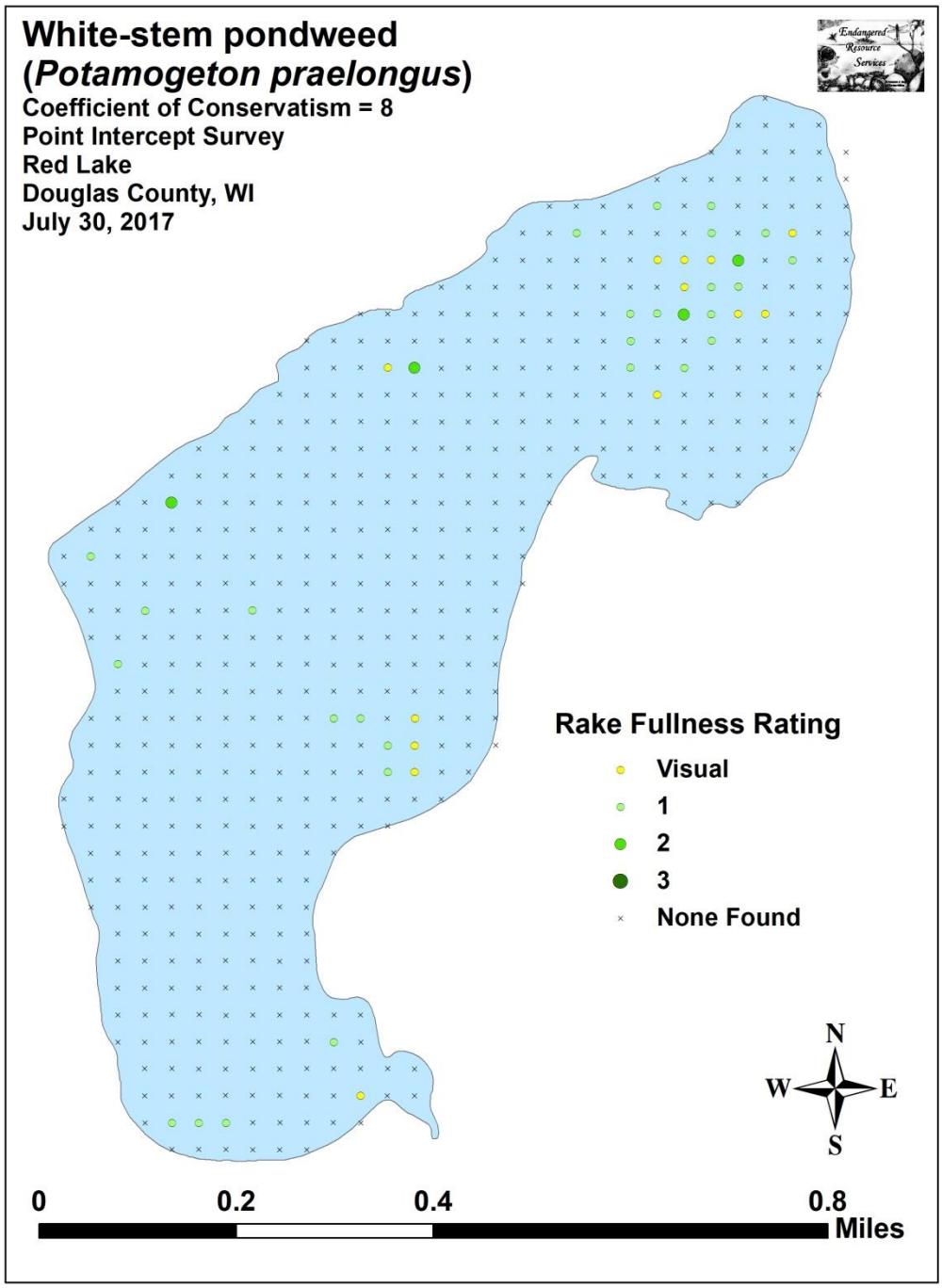
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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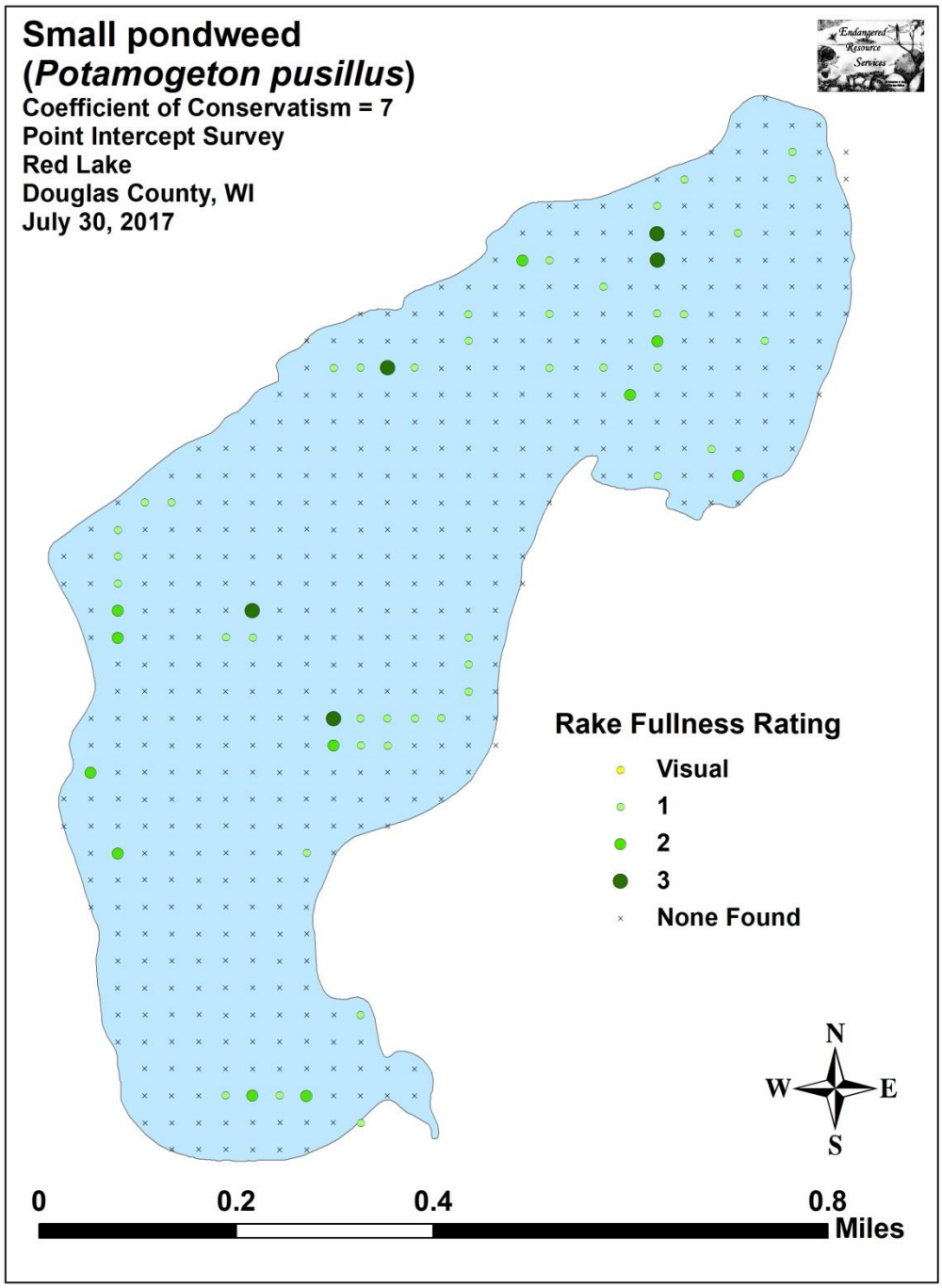
Miles


Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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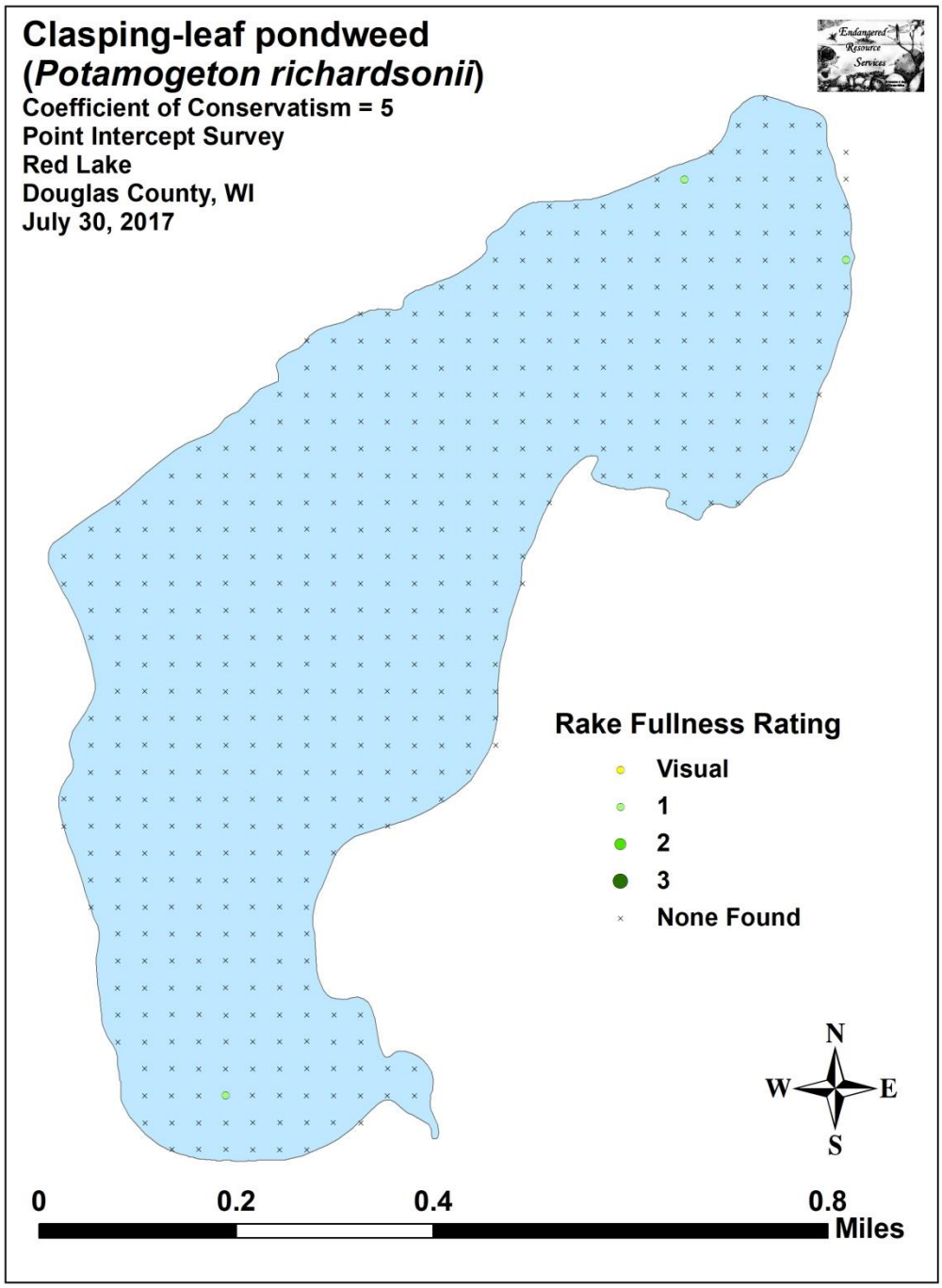
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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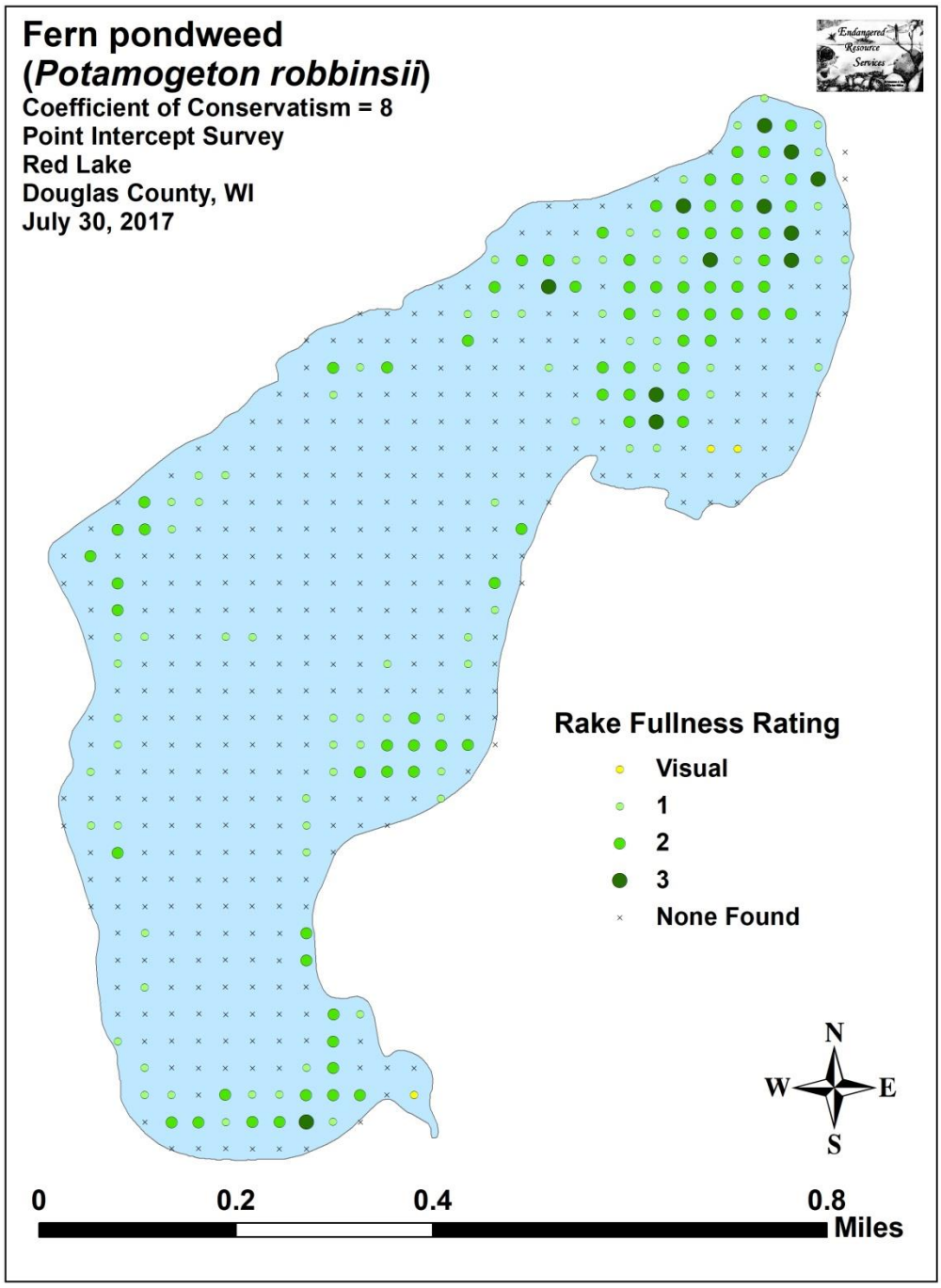
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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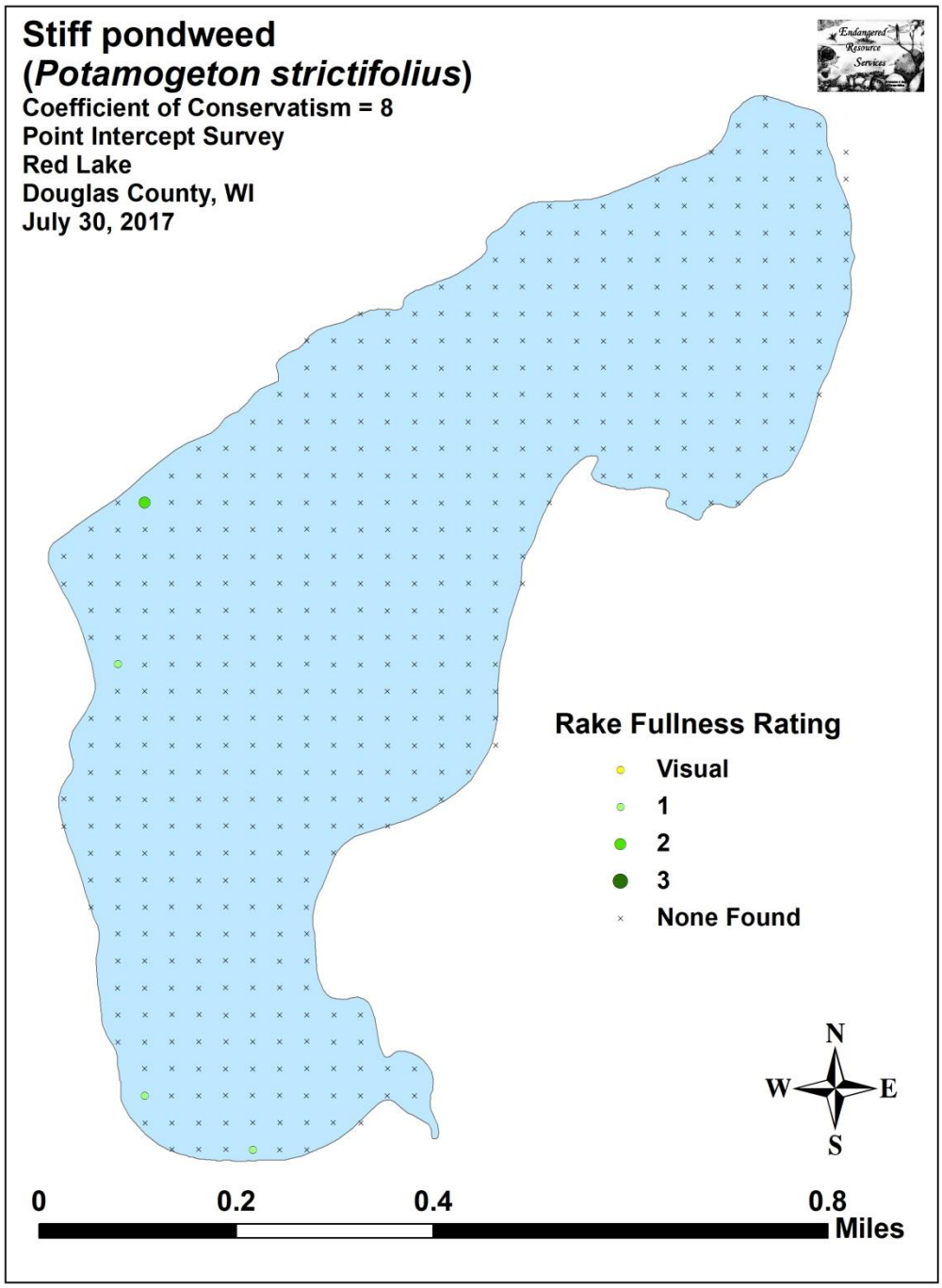
Miles


Stiff pondweed
(Potamogeton strictifolius)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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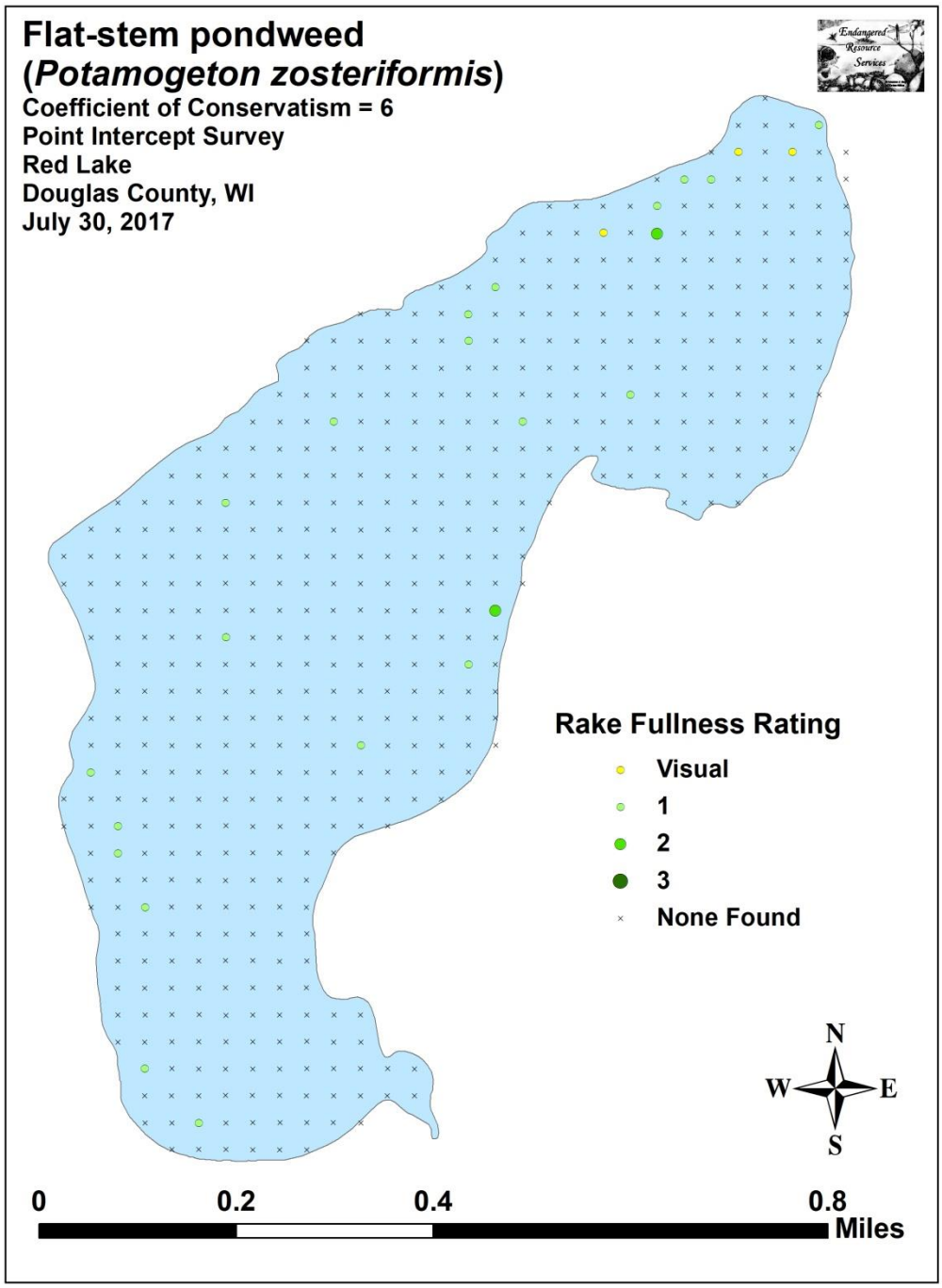
Miles


Flat-stem pondweed
(Potamogeton zosteriformis)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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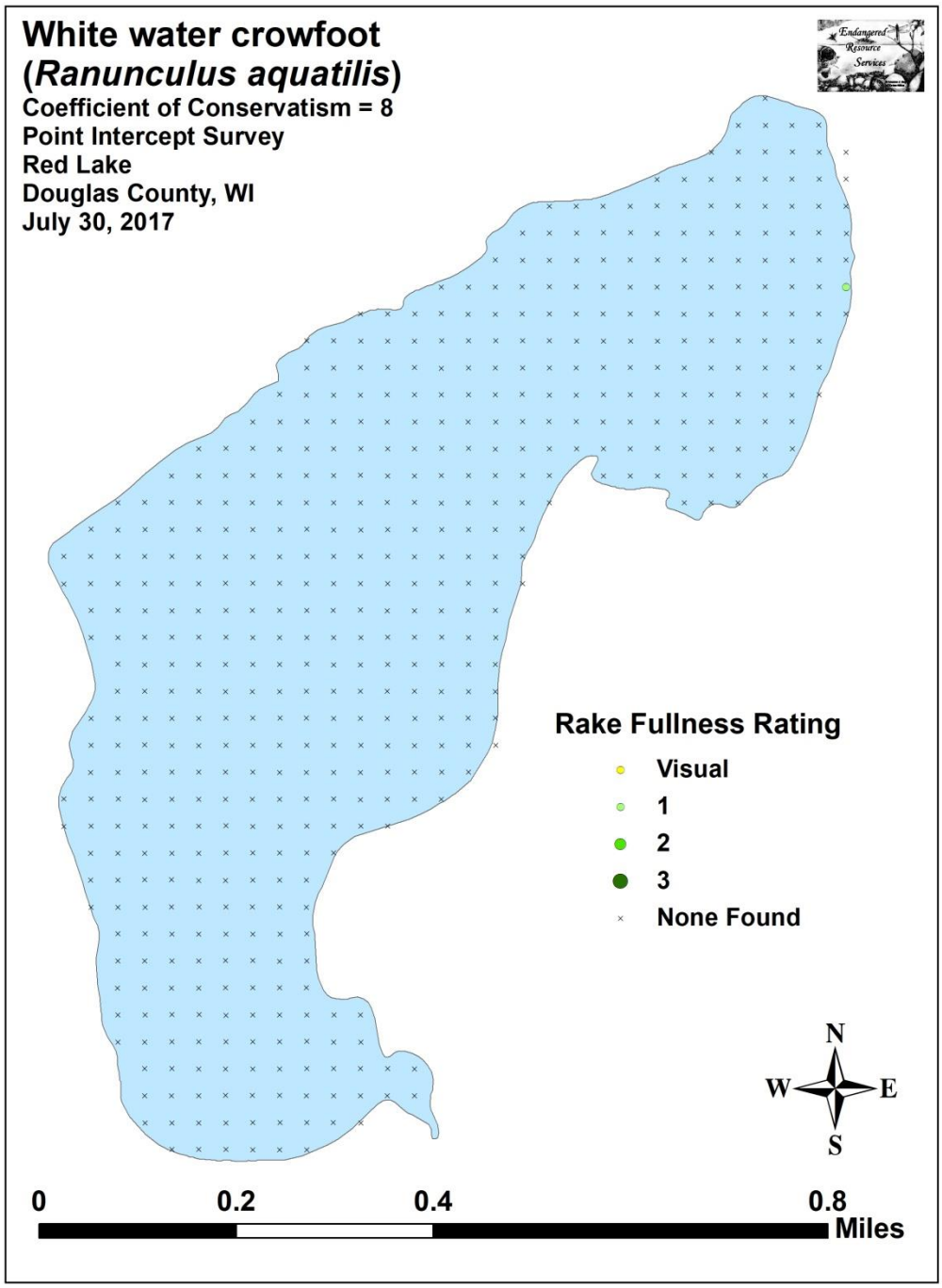
Miles


White water crowfoot
(Ranunculus aquatilis)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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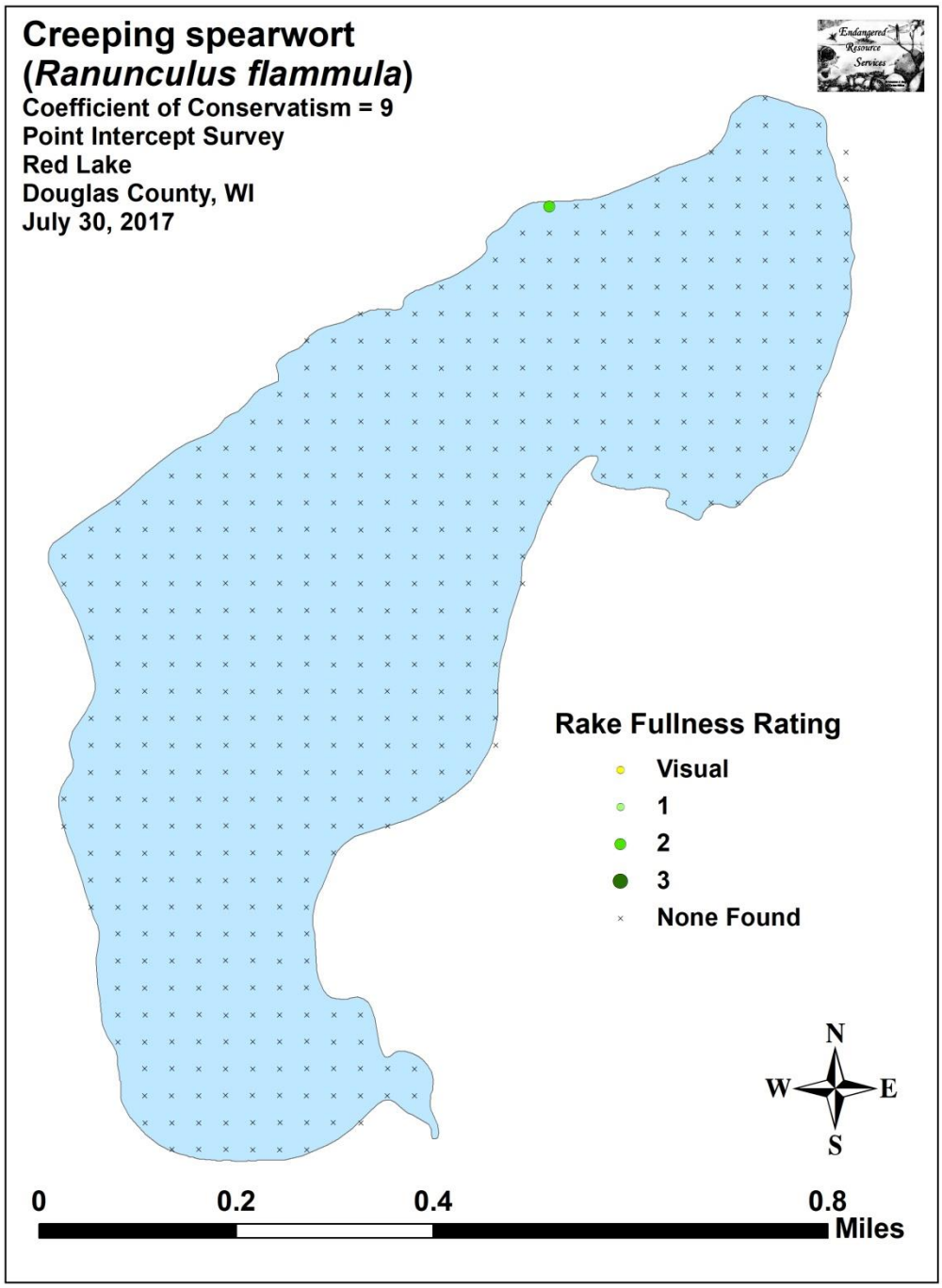
0.2
0.4
0.8
Miles


Creeping spearwort
(Ranunculus flammula)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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0.2
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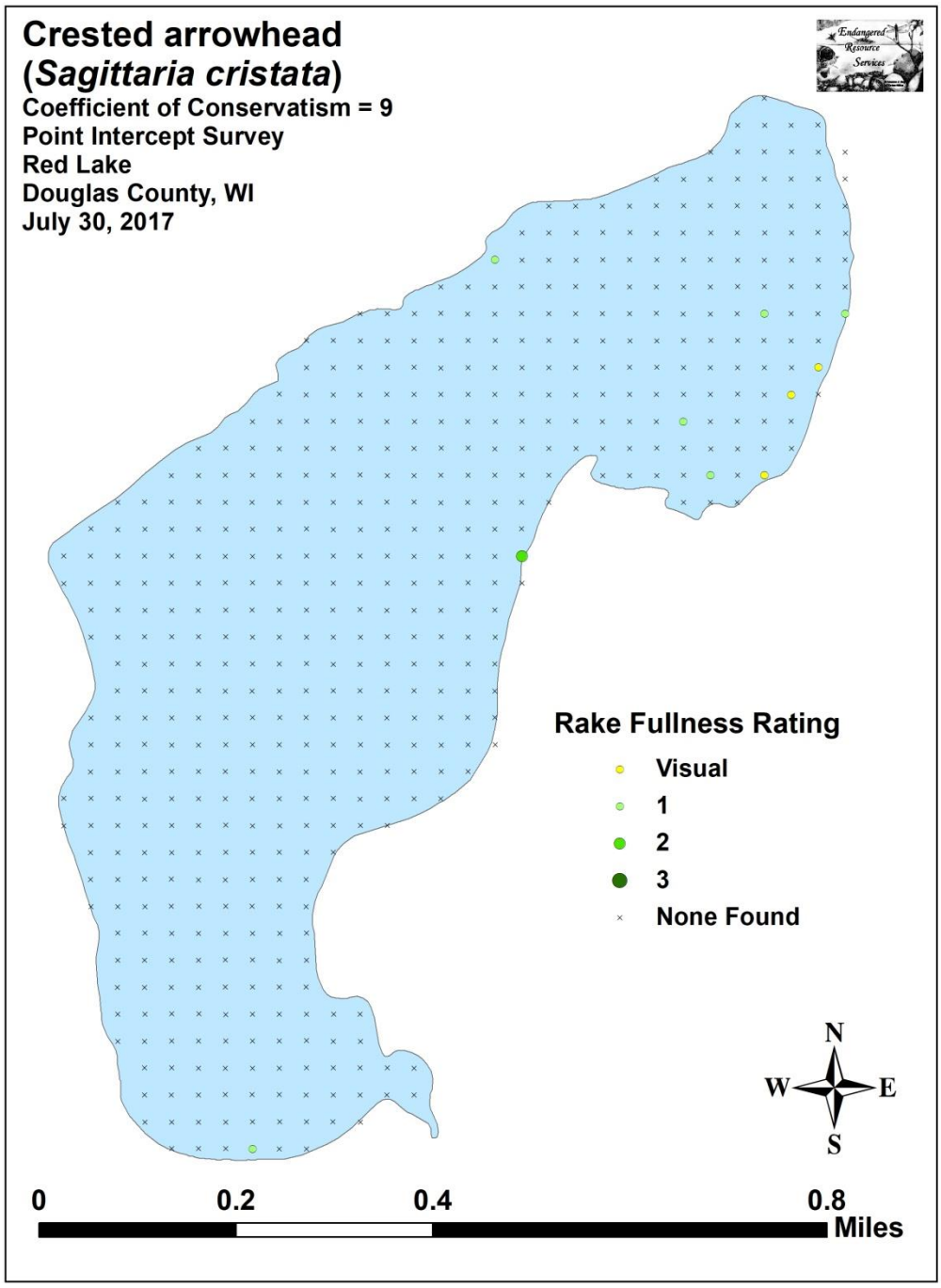
0.8
Miles


Crested arrowhead
(Sagittaria cristata)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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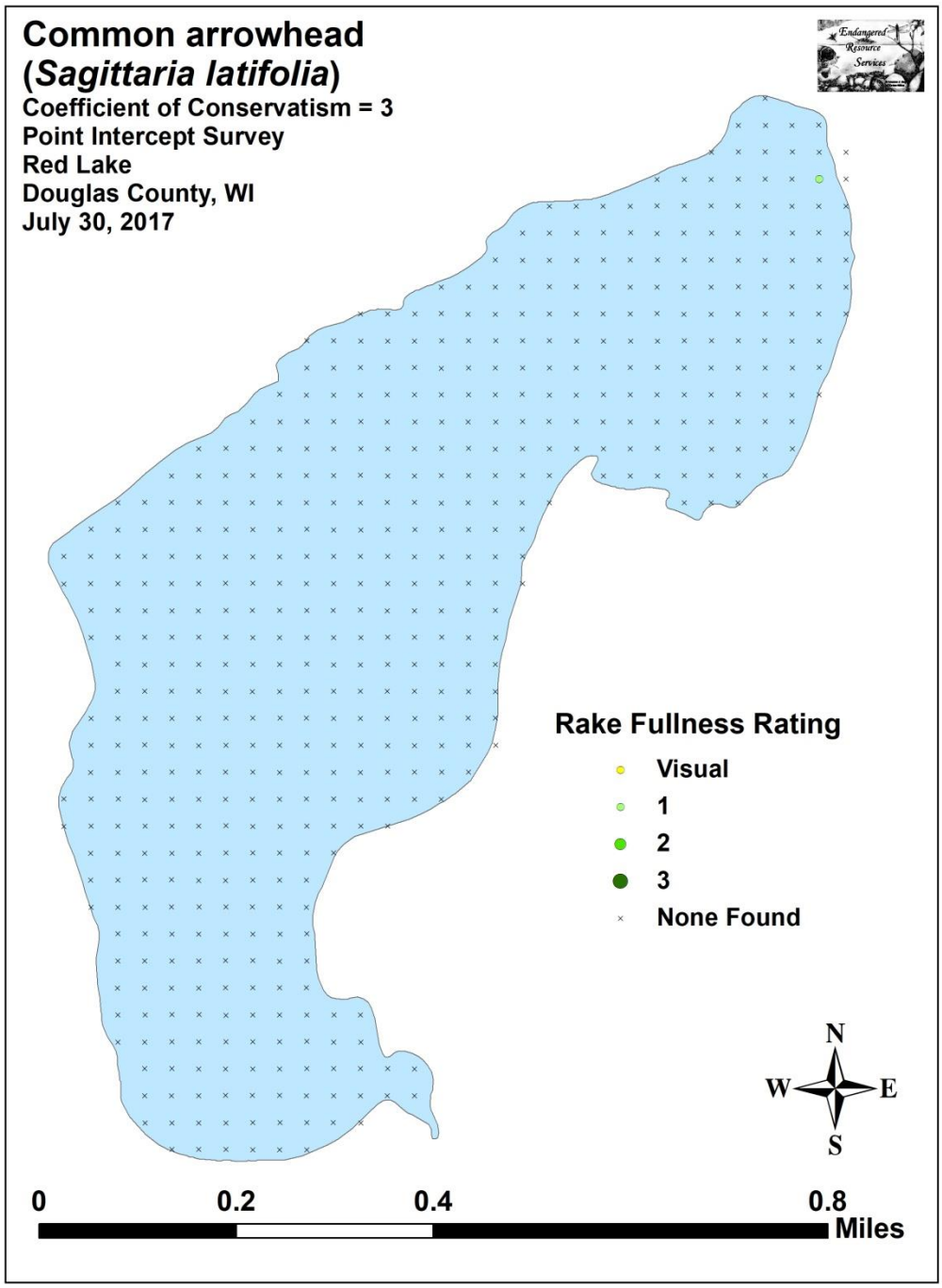
0.4
0.8
Miles


Common arrowhead
(Sagittaria latifolia)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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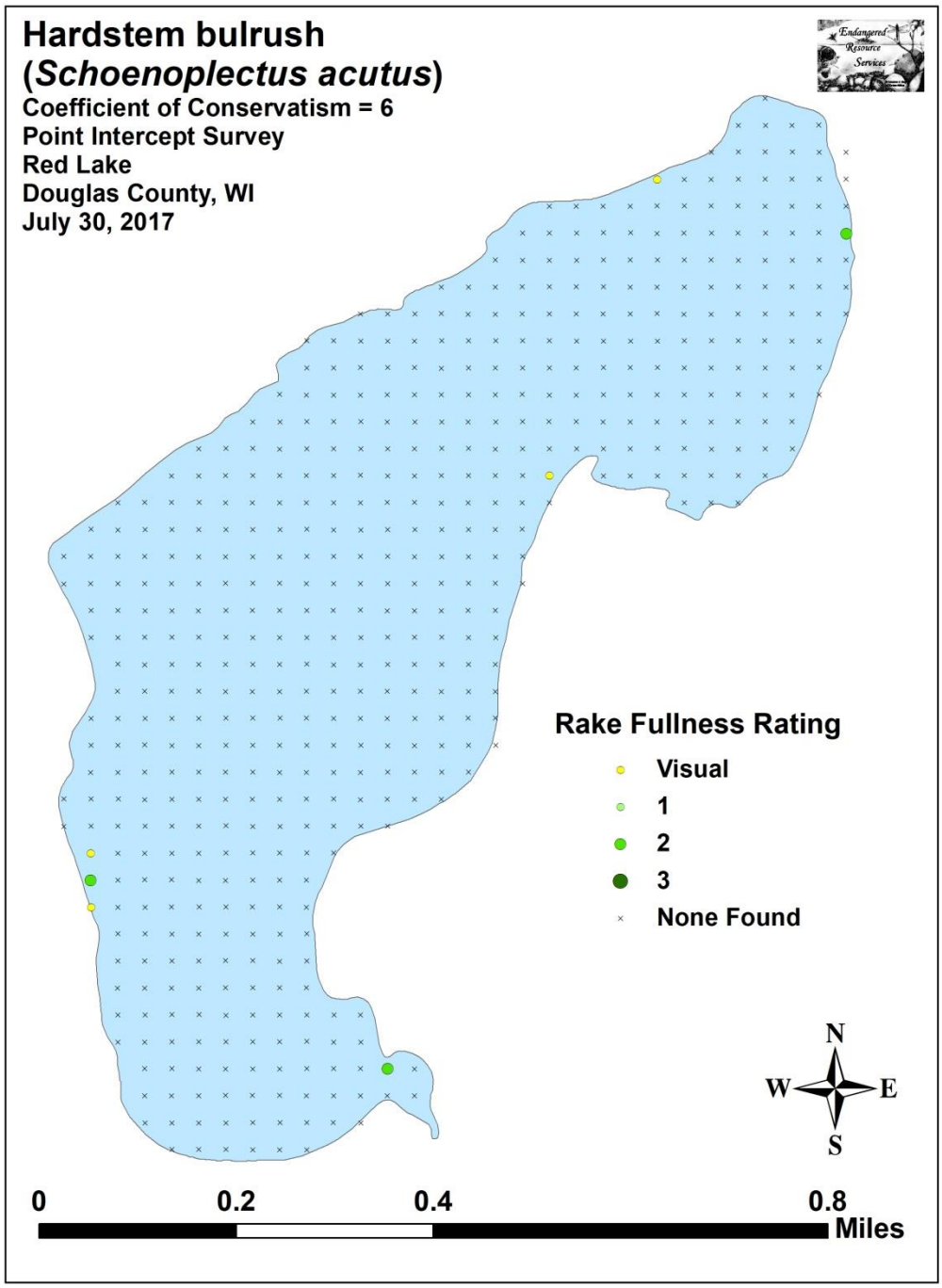
Miles


Hardstem bulrush
(Schoenoplectus acutus)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
N
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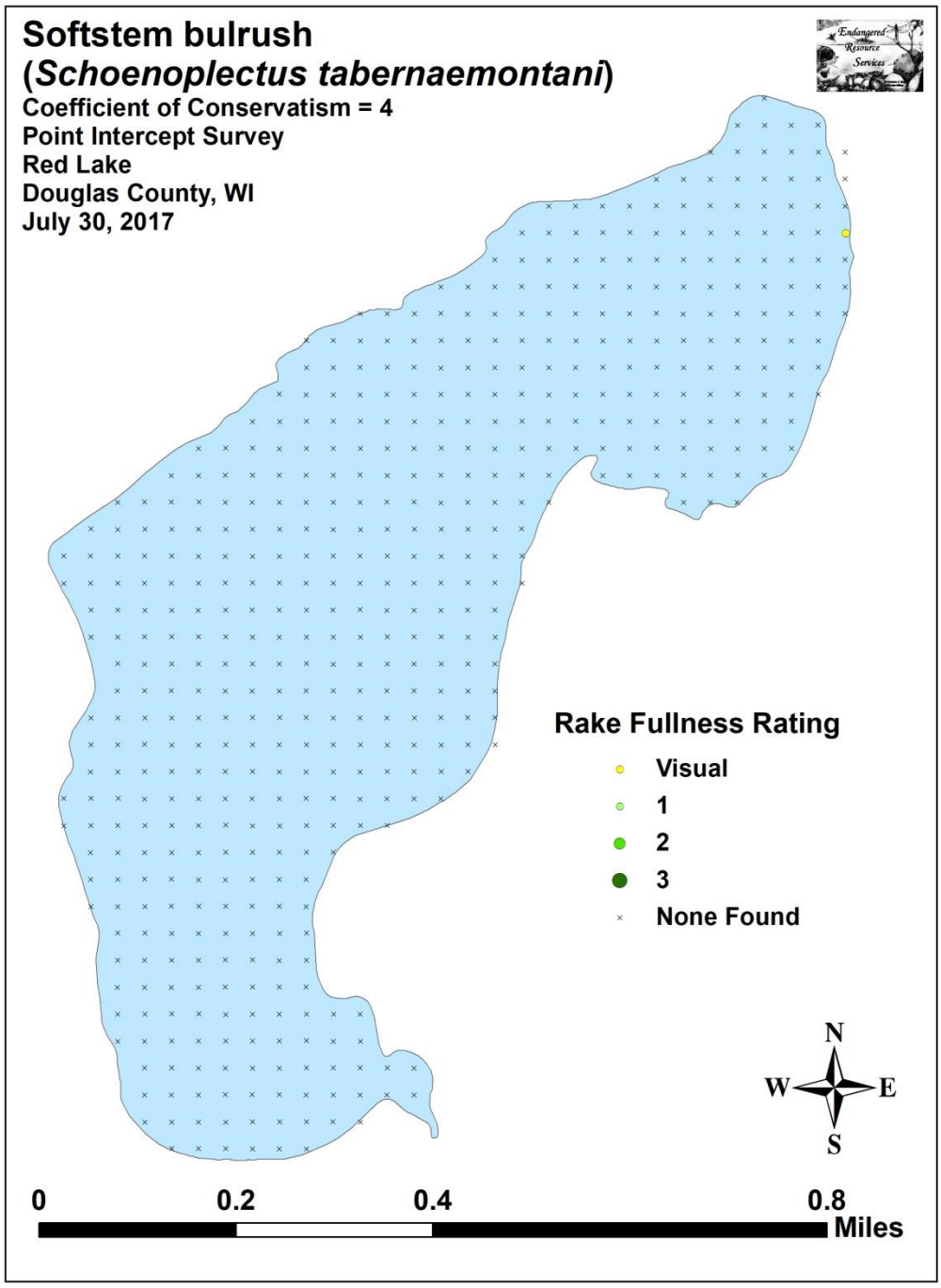
Miles


Softstem bulrush
(Schoenoplectus tabernaemontani)
Coefficient of Conservatism = 4
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
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3
None Found
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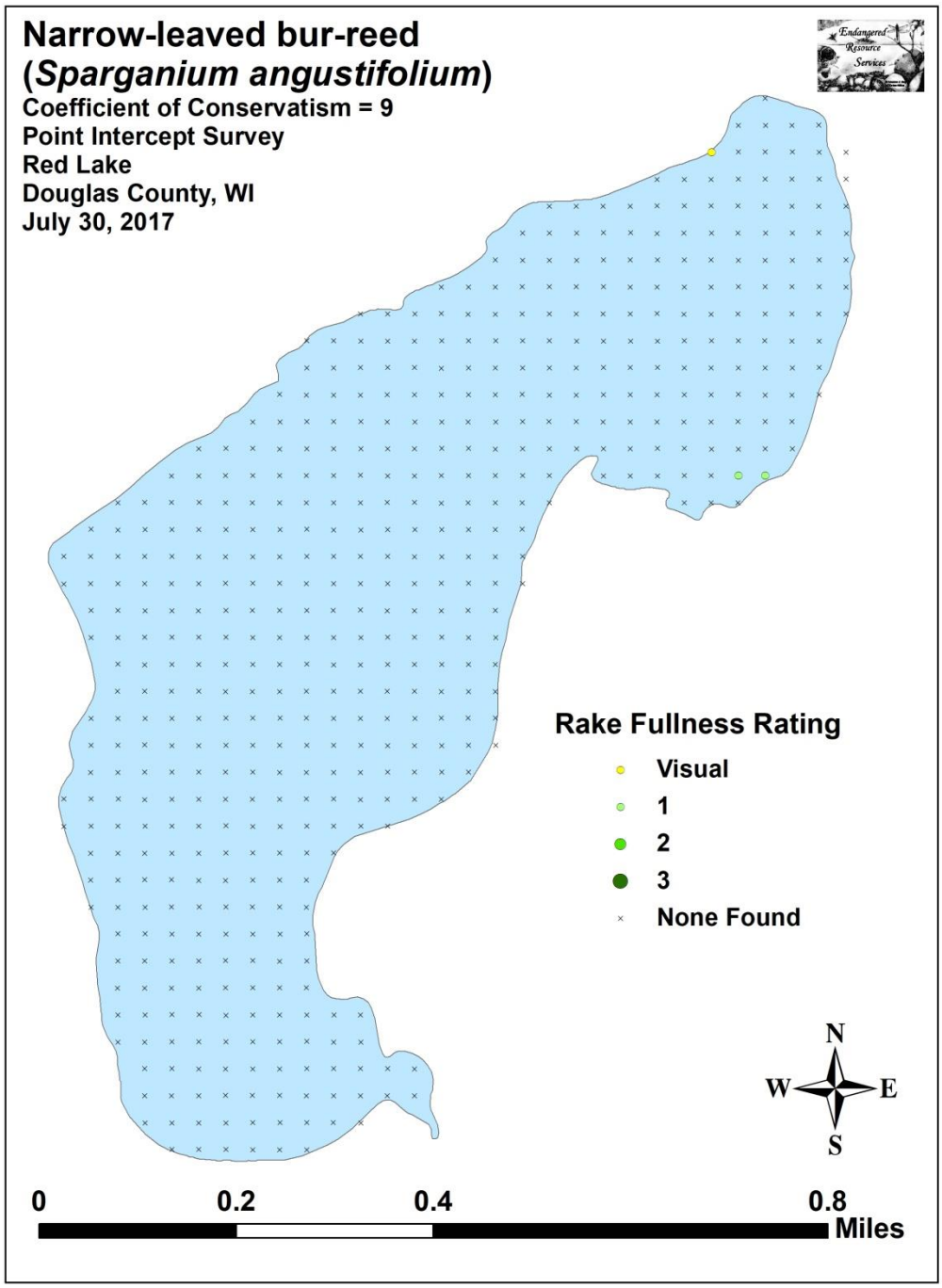
Miles


Narrow-leaved bur-reed
(Sparganium angustifolium)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
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None Found
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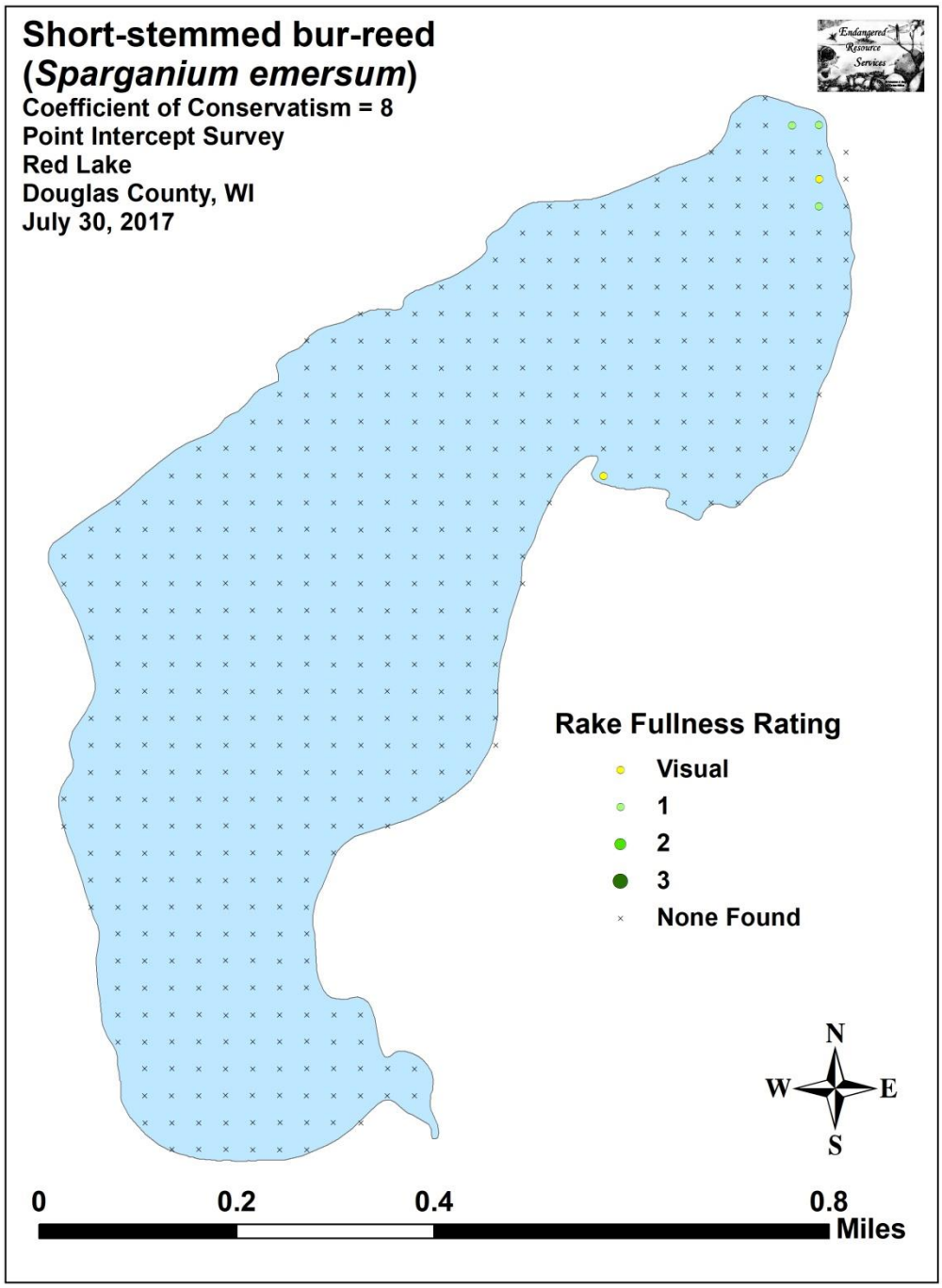
Miles


Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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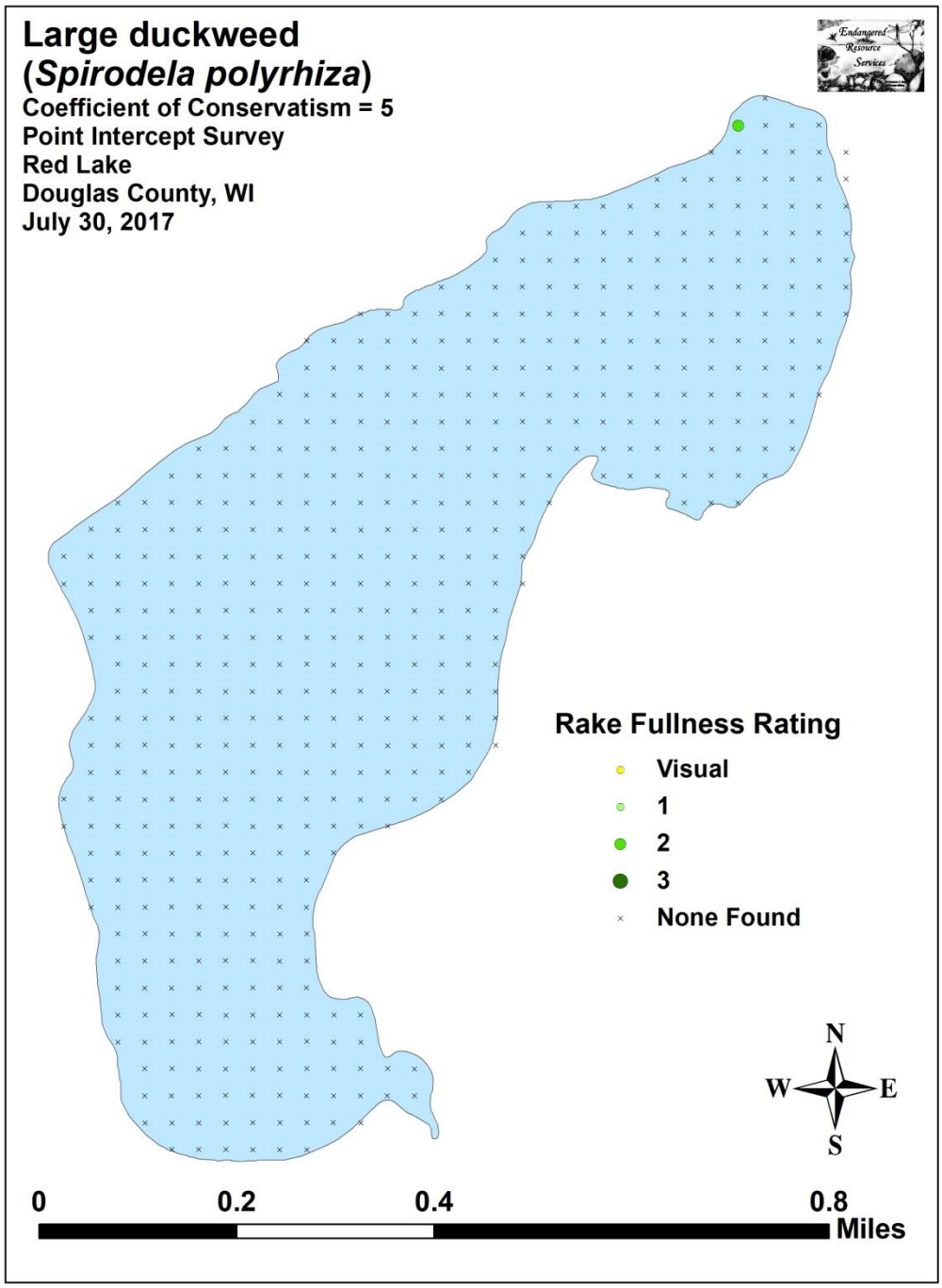
Miles


Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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3
None Found
N
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0.2
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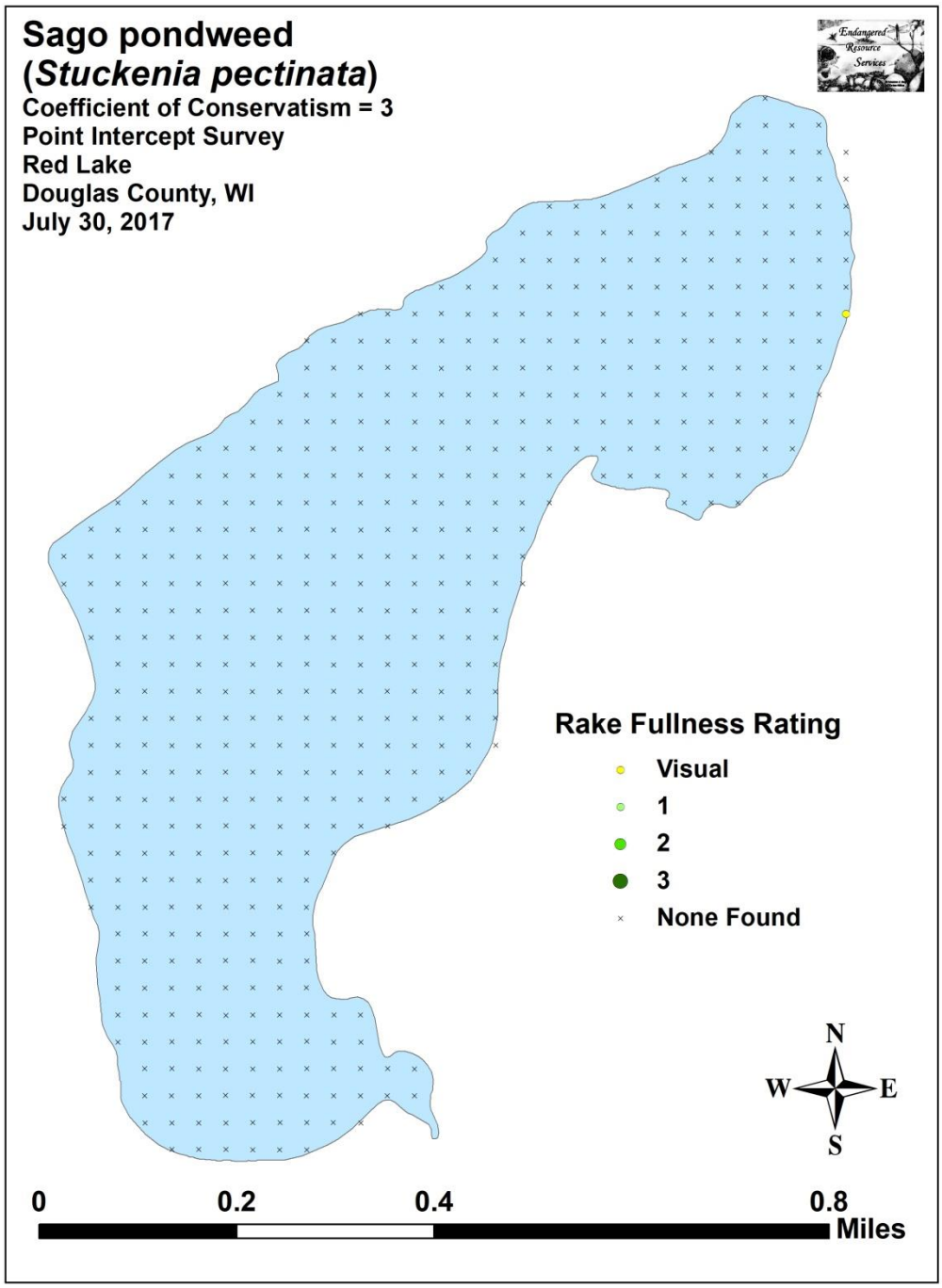
0.8
Miles


Sago pondweed
(Stuckenia pectinata)
Coefficient of Conservatism = 3
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
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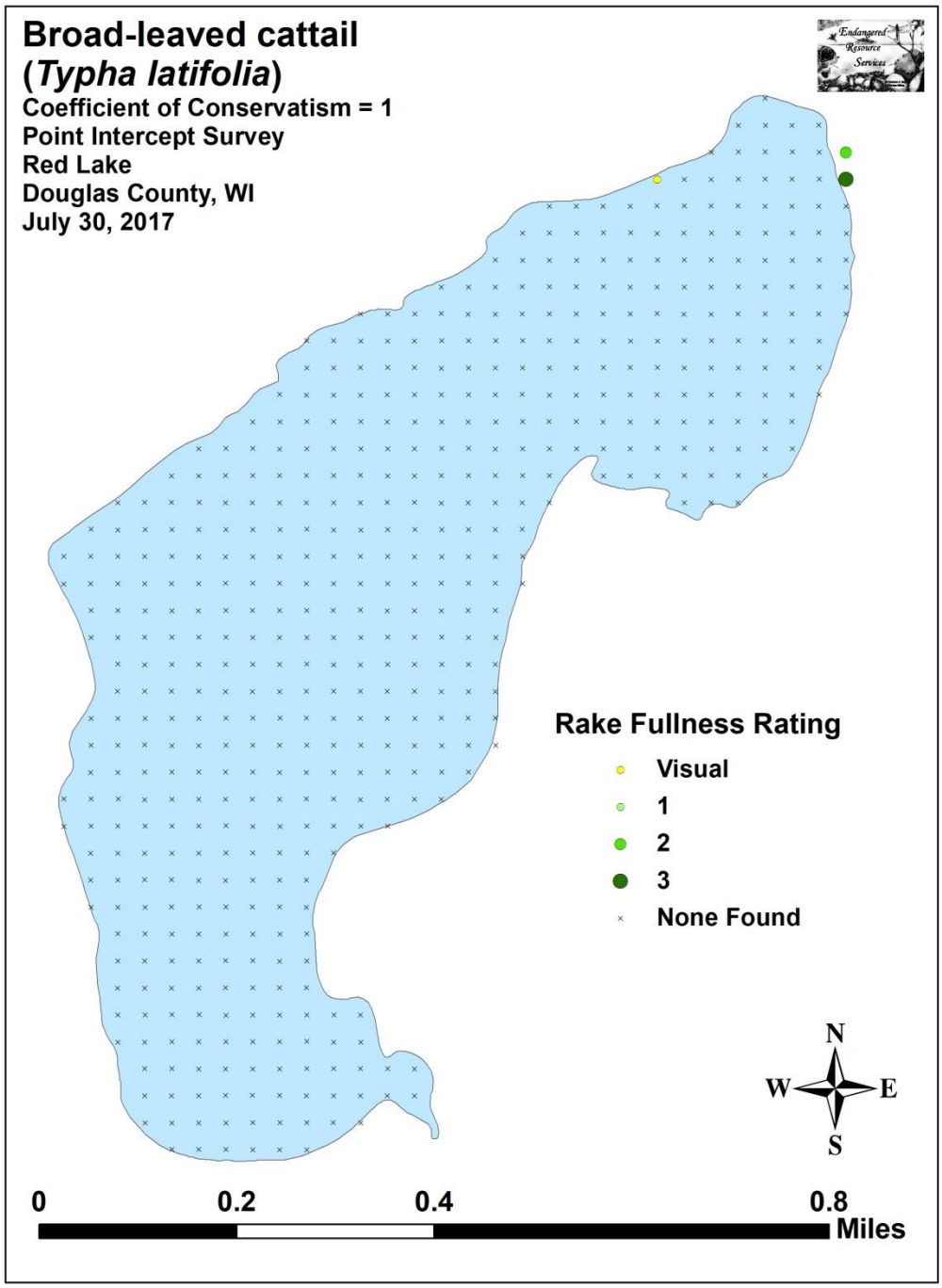
S
0
0.2
0.4
0.8
Miles


Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
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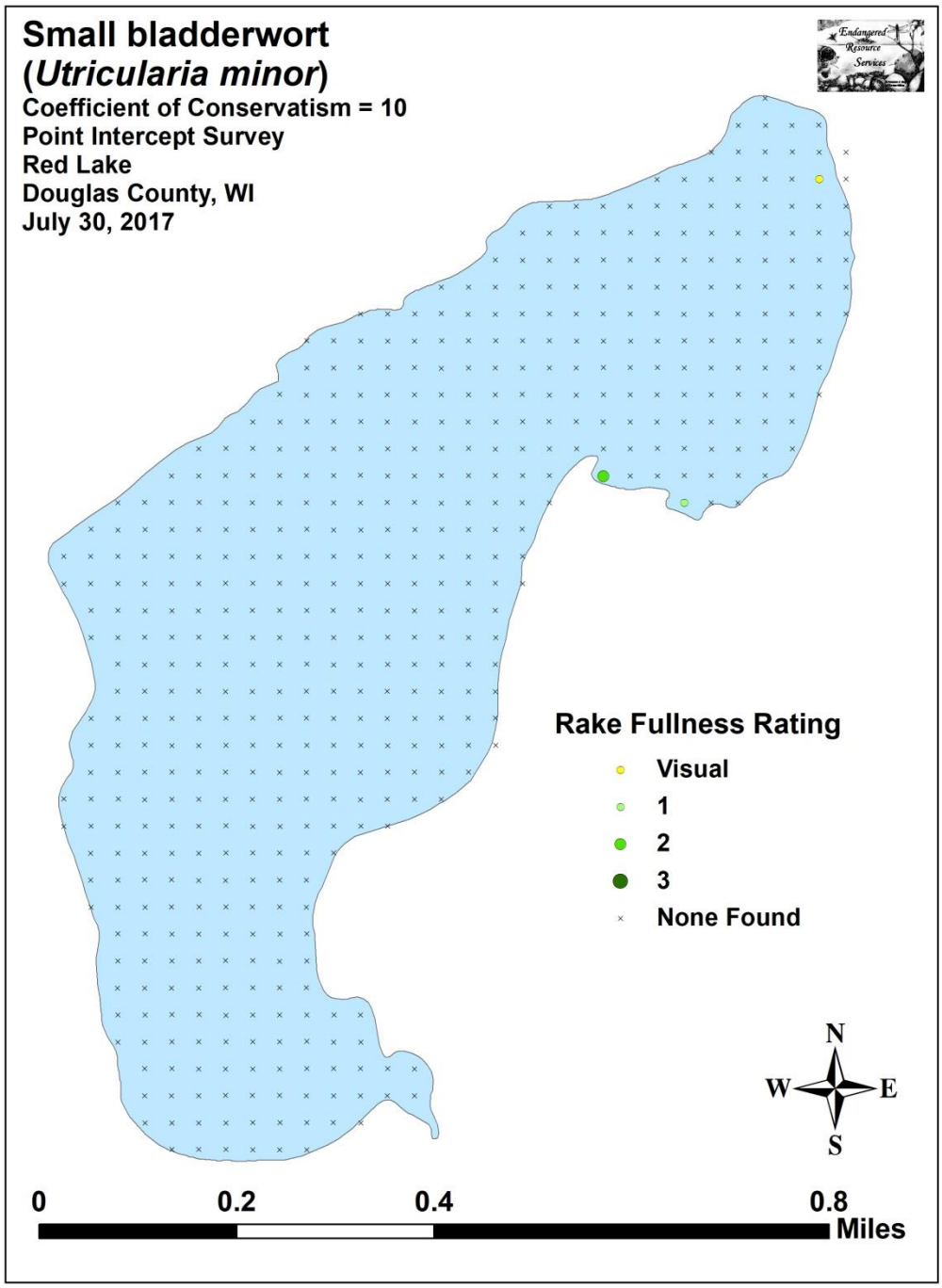
Miles


Small bladderwort
(Utricularia minor)
Coefficient of Conservatism = 10
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
N
W
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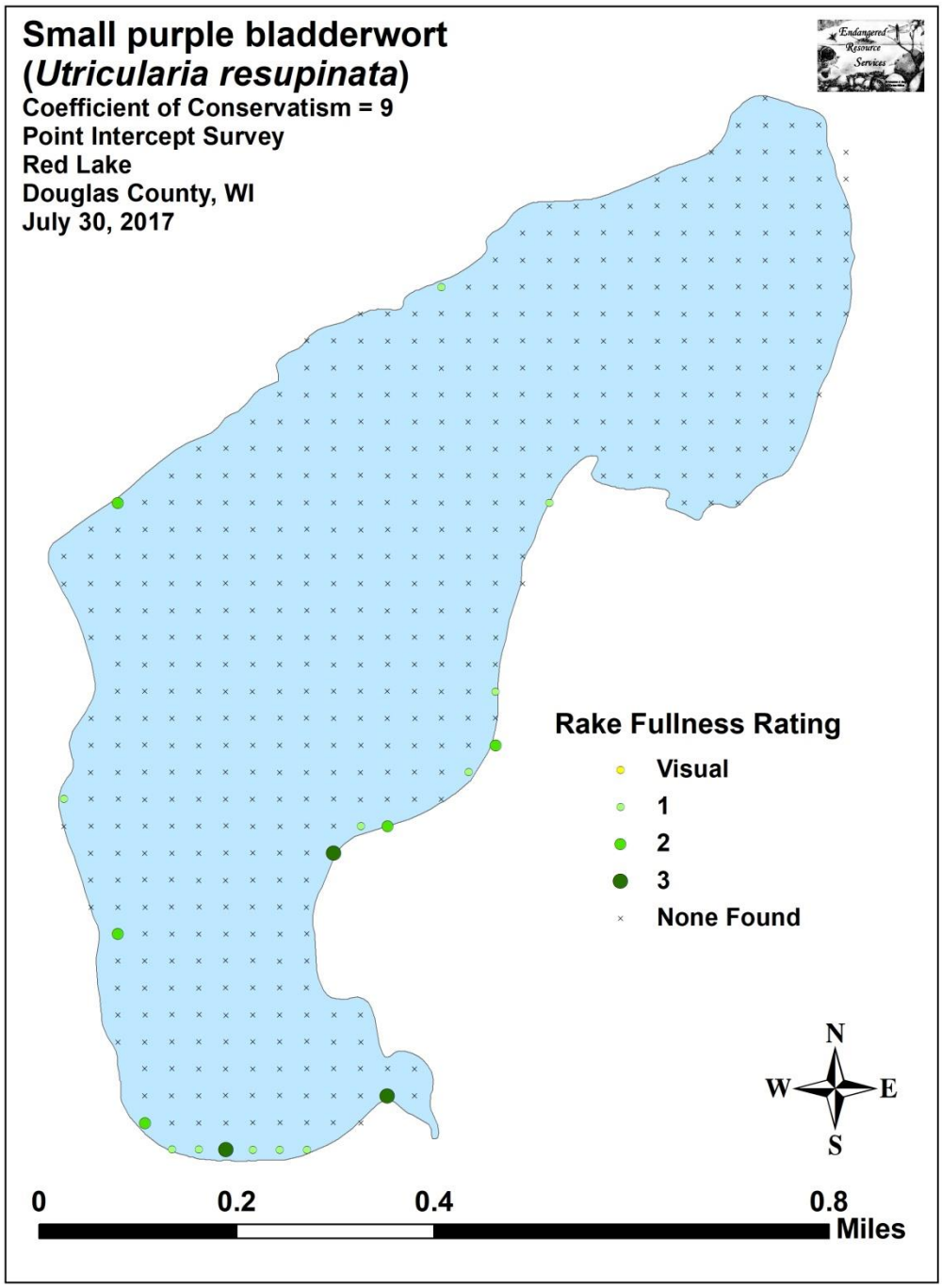
Miles


Small purple bladderwort
(Utricularia resupinata)
Coefficient of Conservatism = 9
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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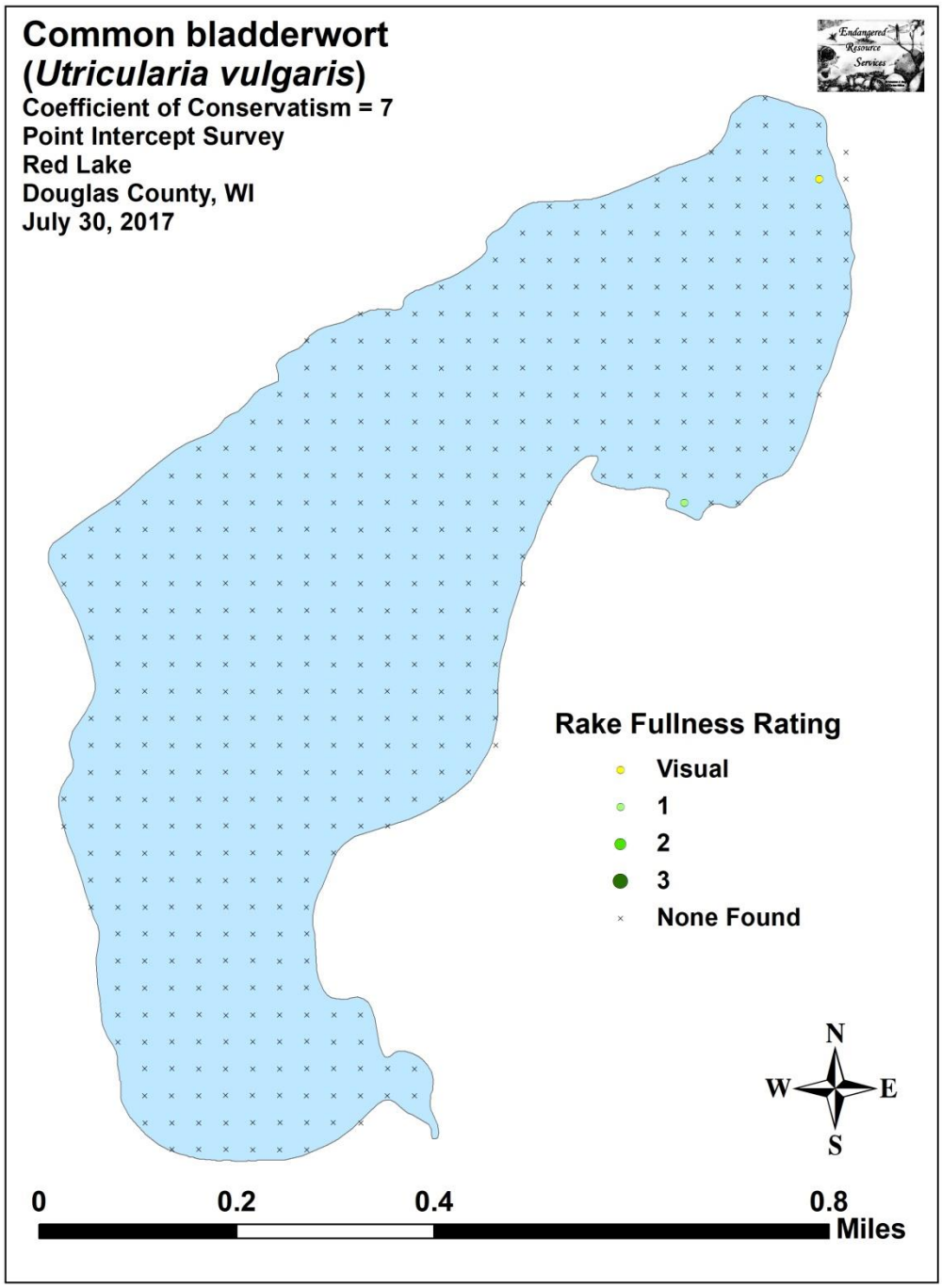
Miles


Common bladderwort
(Utricularia vulgaris)
Coefficient of Conservatism = 7
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
N
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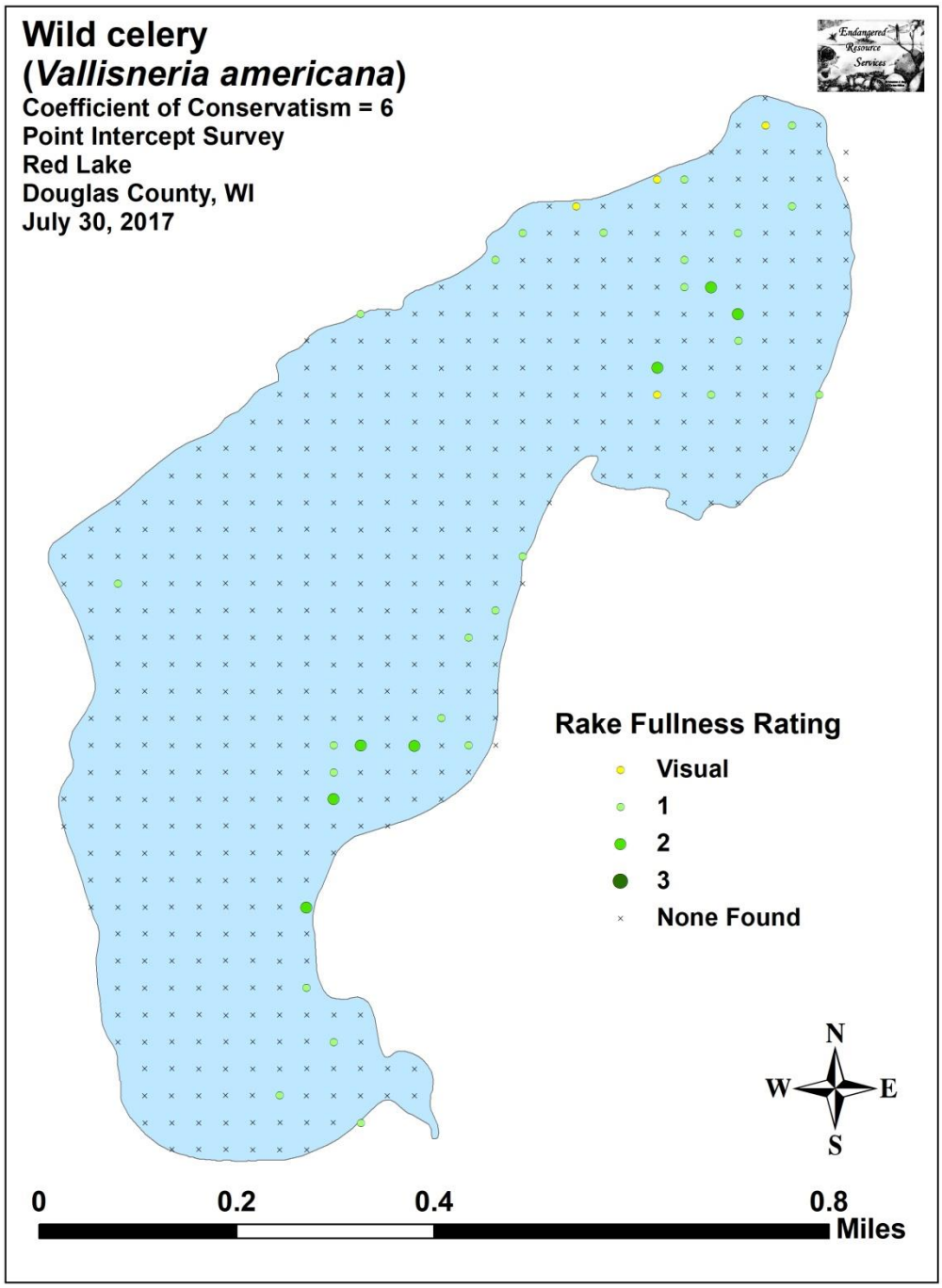
Miles


Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Point Intercept Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
Rake Fullness Rating
Visual
1
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3
None Found
N
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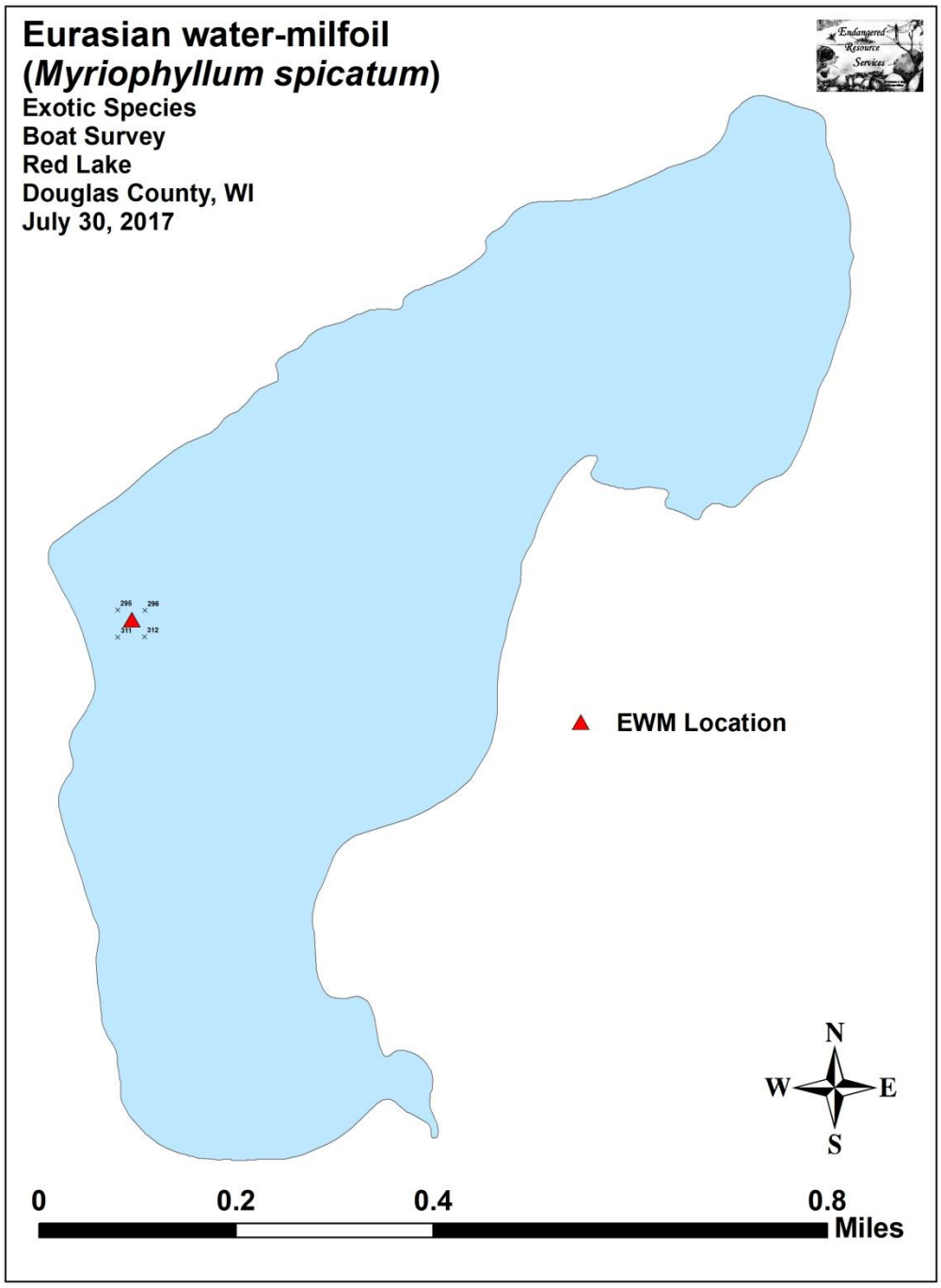
Miles

## Appendix VIII: July Eurasian Water-milfoil Boat Survey Map and Aquatic Exotic Invasive Plant Species Information


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
Boat Survey
Red Lake
Douglas County, WI
July 30, 2017
Endangered Resource Services
295
296
311
312
EWM Location
N
W
E
S
0
0.2
0.4
0.8
Miles

**Eurasian Water-milfoil**

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

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

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

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

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

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

**Curly-leaf pondweed**

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

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

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

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


## Reed canary grass

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

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

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

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

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

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

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

**Purple loosestrife**
(Photo Courtesy Brian M. Collins)

**DESCRIPTION:** Purple loosestrife is a perennial herb 3-7 feet tall with a dense bushy growth of 1-50 stems. The stems, which range from green to purple, die back each year. Showy flowers vary from purple to magenta, possess 25 petals aggregated into numerous long spikes, and bloom from July to September. Leaves are opposite, nearly linear, and attached to four-sided stems without stalks. It has a large, woody taproot with fibrous rhizomes that form a dense mat.

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

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

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

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

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

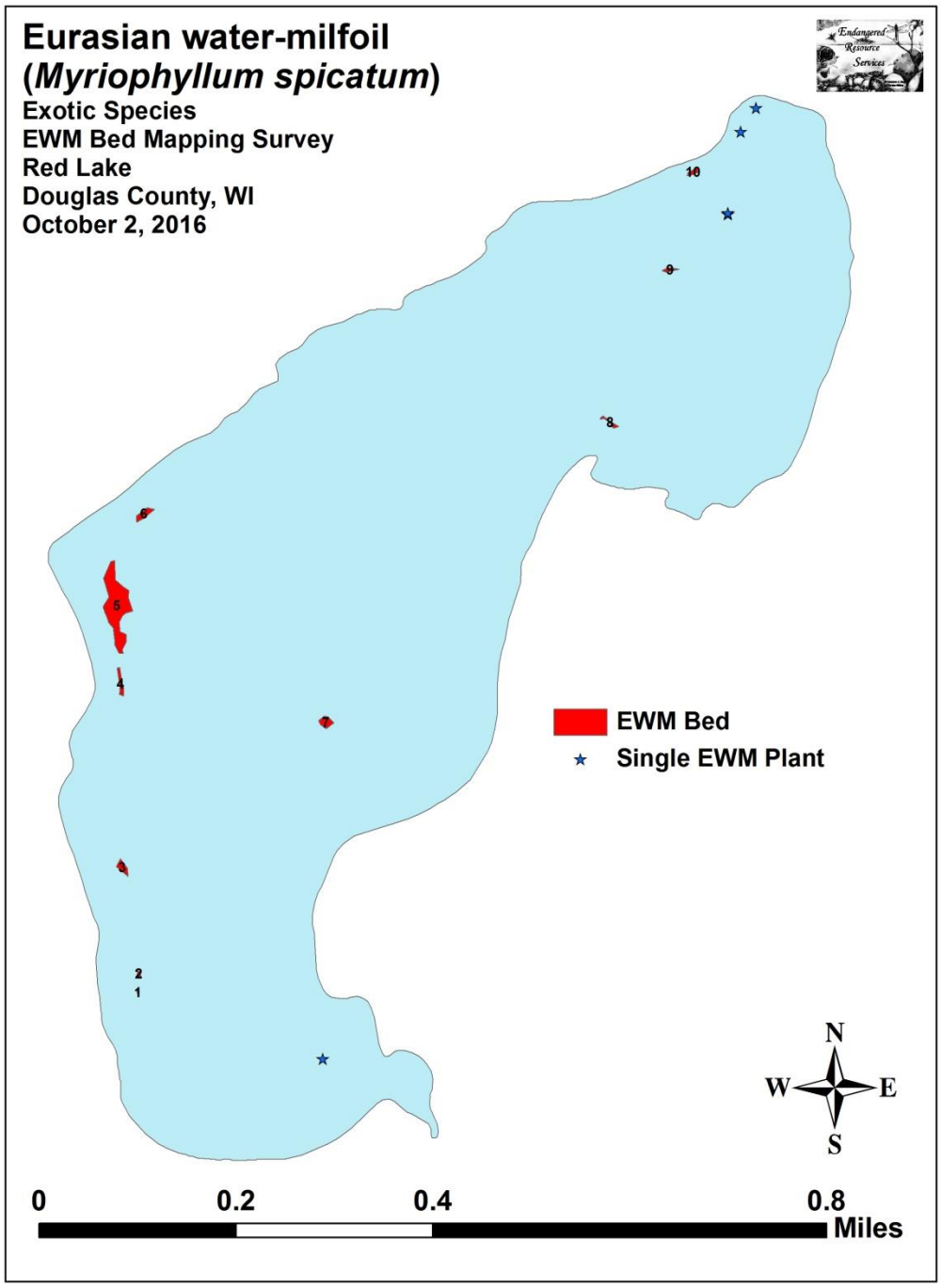
**Life History and Effects of Invasion:** Purple loosestrife can germinate successfully on substrates with a wide range of pH. Optimum substrates for growth are moist soils of neutral to slightly acidic pH, but it can exist in a wide range of soil types. Most seedling establishment occurs in late spring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

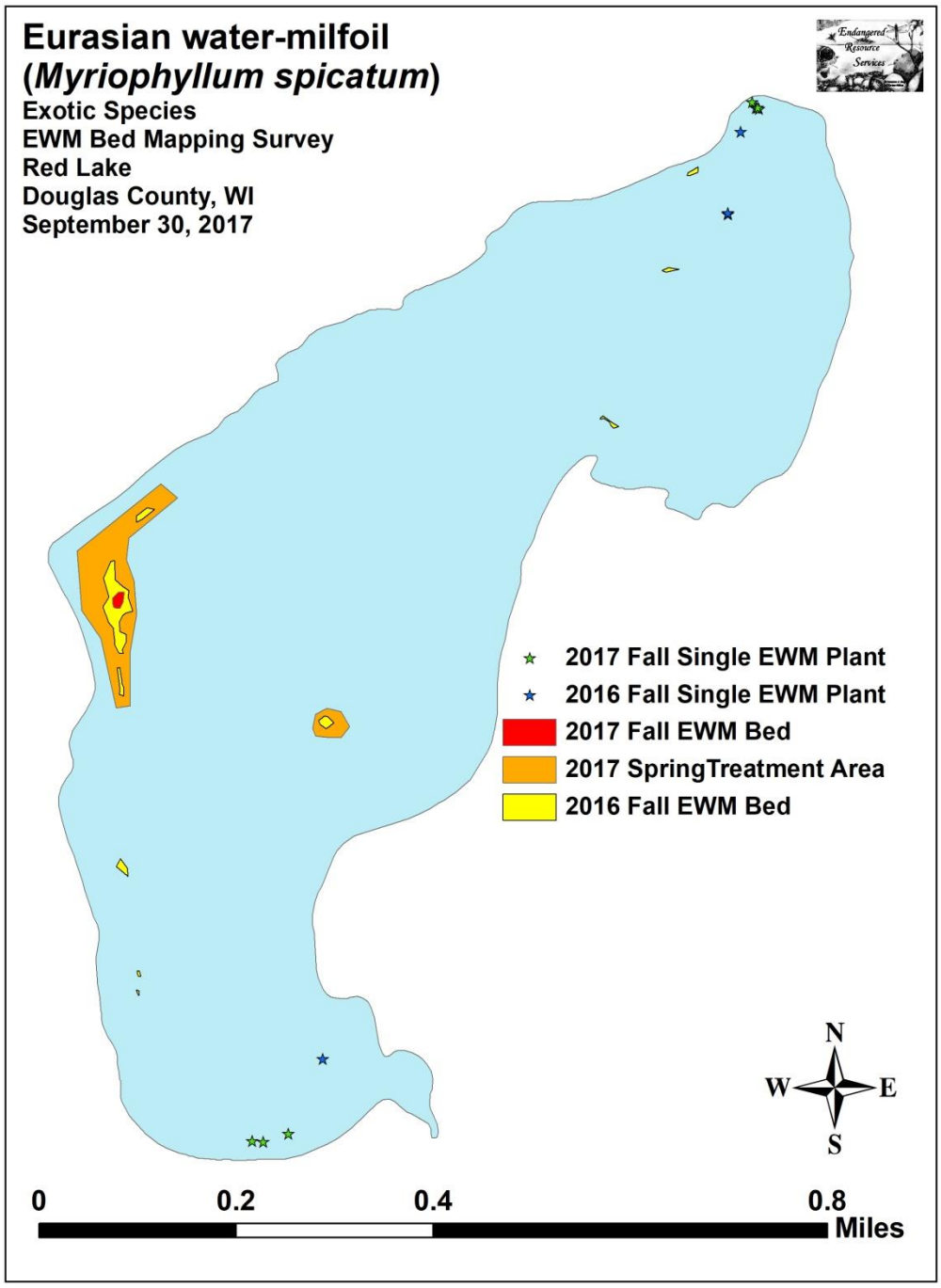
Purple loosestrife spreads mainly by seed, but it can also spread vegetatively from root or stem segments. A single stalk can produce from 100,000 to 300,000 seeds per year. Seed survival is up to 60-70%, resulting in an extensive seed bank. Mature plants with up to 50 shoots grow over 2 meters high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

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

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

# Appendix IX:  Fall 2016 and 2017 Eurasian Water-milfoil Bed Maps


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
EWM Bed Mapping Survey
Red Lake
Douglas County, WI
October 2, 2016
Endangered Resource Services
10
9
8
6
5
4
3
2
1
EWM Bed
Single EWM Plant
N
W
E
S
0
0.2
0.4
0.8
Miles


Eurasian water-milfoil
(Myriophyllum spicatum)
Exotic Species
EWM Bed Mapping Survey
Red Lake
Douglas County, WI
September 30, 2017
Endangered Resource Services
2017 Fall Single EWM Plant
2016 Fall Single EWM Plant
2017 Fall EWM Bed
2017 SpringTreatment Area
2016 Fall EWM Bed
N
W
E
S
0
0.2
0.4
0.8
Miles

# Appendix X: 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 XI: 2017 Raw Data Spreadsheets