Curly-leaf pondweed (*Potamogeton crispus*) Point-intercept and Bed Mapping Surveys, and Warm-water Macrophyte Point-intercept Survey Lake Como - WBIC: 2152100 Chippewa County, Wisconsin

Duckweeds and filamentous algae in the Como Creek Inlet (7/15/18)

CLP in the Duncan Creek Inlet (5/28/18)

Project Initiated by:

Bloomer Community Lake Association, Lake Education and Planning Services, LLC, and the Wisconsin Department of Natural Resources

Canopied Common waterweed near the city beach (7/15/18)

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ABSTRACT

Lake Como (WBIC 2152100) is a 98 acre drainage impoundment located in northwest Chippewa County, WI. In 2018, concerns about increasing levels of aquatic plants prompted the Bloomer Community Lake Association to inquire about developing an initial Wisconsin Department of Natural Resources (WDNR) approved Aquatic Plant Management Plan. As a prerequisite to developing this plan in 2019, the BCLA, (BCLA), under the direction of Lake Education and Planning Services, LLC (LEAPS – Dave Blumer) and the WDNR, authorized a Curly-leaf pondweed (*Potamogeton crispus*) (CLP) point-intercept survey on May 28th, a CLP bed mapping survey on June 14th, and a full point-intercept survey for all aquatic macrophytes on July 14-15, 2018. During the early-season survey, we found CLP at seven points (2.0% coverage) with a mean rake fullness of 1.14. The single point with a rake fullness of 2 meant just 0.3% of the lake having a significant CLP infestation (rake fullness 2 or 3). In June, we didn't find any true CLP beds; however, a 1.64 acres (1.7% of the lake) area near the Duncan Creek Inlet had enough CLP to be called a High Density Area. In July, we found macrophytes growing at 268 of 352 survey sites which approximated to 76.1% of the entire lake bottom and 77.5% of the 9.5ft littoral zone. Overall diversity was moderate with a Simpson Index value of 0.76. Species richness was very low with only 12 species found in the rake. This total increased to just 18 when including visuals and plants found during the boat survey. There was an average of 2.82 native species/site with native plants although much of this was attributed to "duckweeds" which occurred at most points with vegetation. Mean total rake fullness was a moderate 1.93, although most areas <6ft deep had thick vegetation. We found Common waterweed (*Elodea canadensis*), Small duckweed (*Lemna minor*), Common watermeal (*Wolffia columbiana*), and Coontail (*Ceratophyllum demersum*) were the most common macrophyte species. They occurred at 93.28%, 66.42%, 64.93%, and 45.90% of sites with vegetation, and accounted for an exceptionally high 95.02% of the total relative frequency. The 10 native index species found in the rake during the July survey produced a below average mean Coefficient of Conservatism of 5.3. The Floristic Quality Index of 16.8 was also below the median FQI for this part of the state. Filamentous algae were present at 185 points with a mean rake fullness of 1.75. In addition to CLP, we found four other exotic plant species growing in and adjacent to Lake Como: Yellow iris (*Iris pseudacorus*), Common forget-me-not (*Myosotis scorpioides*), Reed canary grass (*Phalaris arundinacea*), and Narrow-leaved cattail (*Typha angustifolia*). If future active management to control Common waterweed and Coontail is decided on, it will be important to develop a strategy that balances recreational and economic considerations while simultaneously working to limit ecological impacts; especially on non-invasive native species. Regardless of any potential future management, all residents are encouraged to limit nutrient inputs around the lake which can fuel both algal as well as excessive plant growth. We also strongly encourage the BCLA to contact the land owner with the Yellow iris plants near the Duncan Creek Inlet to make sure they are immediately removed, and to inform all residents they should look for and eliminate any new plants in the future. Improving signage at the public boat landings to warn people of the dangers of Aquatic Invasive Species and to remind them to clean/drain their boats and trailers before and after launching is another idea for the BCLA and the City of Bloomer to consider as they move forward in the management of their resource.

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INTRODUCTION:

Lake Como (WBIC 2152100) is a 98 acre impoundment of Duncan Creek located in northwest Chippewa County, Wisconsin in the Towns of Bloomer and Woodmohr as well as the City of Bloomer (T30N R09W S5,6, and 8) (Figure 1). Created by a dam near Oak Street in Bloomer, the lake reaches a maximum depth of 11ft and has an average depth of approximately 6ft (WDNR, 2018). Although historic water quality data is extremely limited, samples taken in 2018 suggest the lake is eutrophic bordering on hypereutrophic. Water clarity is also very poor with summer 2018 Secchi readings averaging 3.7ft (WDNR 2018).

Figure 1: Lake Como Aerial Photo

BACKGROUND AND STUDY RATIONALE:

In the 1990's, it was determined that the Lake Como dam was structurally unsound and needed to be removed or repaired. In an effort to address this and other community concerns about the lake including sedimentation, poor water quality, excessive plant and algal growth, and declining fisheries, the Bloomer Community Lake Association (BCLA) and the City of Bloomer (COB) applied for and received a series of Wisconsin Department of Natural Resources (WDNR) grants to develop a comprehensive management plan for Lake Como (Dearlove 2002). After conducting numerous studies, it was ultimately decided to repair the dam and dredge a significant portion of the lake bottom in 2003-2004.

In 2018, concerns about increasing levels of aquatic plants in Lake Como prompted the BCLA to initiate steps to develop a WDNR approved Aquatic Plant Management Plan (APMP) that will outline strategies to control the floating mats of vegetation that dominate the lake's spring and summer littoral zone. In anticipation of writing their plan in 2019, the BCLA, under the direction of Lake Education and Planning Services, LLC – D. Blumer (LEAPS), authorized three lakewide surveys on Lake Como in 2018. On May 28th, we conducted an early-season Curly-leaf pondweed (*Potamogeton crispus*) (CLP) point-intercept survey. This was followed by a CLP bed mapping survey on June 14th, and a warm-water point-intercept survey of all macrophytes on July 14-15th. The surveys' objectives were to document the density and distribution of CLP, gather baseline data on the richness and diversity of all other species in the summer, and determine the overall density of plant growth. This report is the summary analysis of these three field surveys.

METHODS:

Curly-leaf Pondweed Point Intercept Survey:

Using a standard formula that takes into account the shoreline shape and distance, water clarity, depth, and total acreage, WDNR biologists generated a 353 point sampling grid for Lake Como (Appendix I). Using this grid, we completed a density survey where we sampled for Curly-leaf pondweed at each point in the lake. We located the points using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. When found, CLP was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also noted visual sightings of CLP within six feet of the sample point.

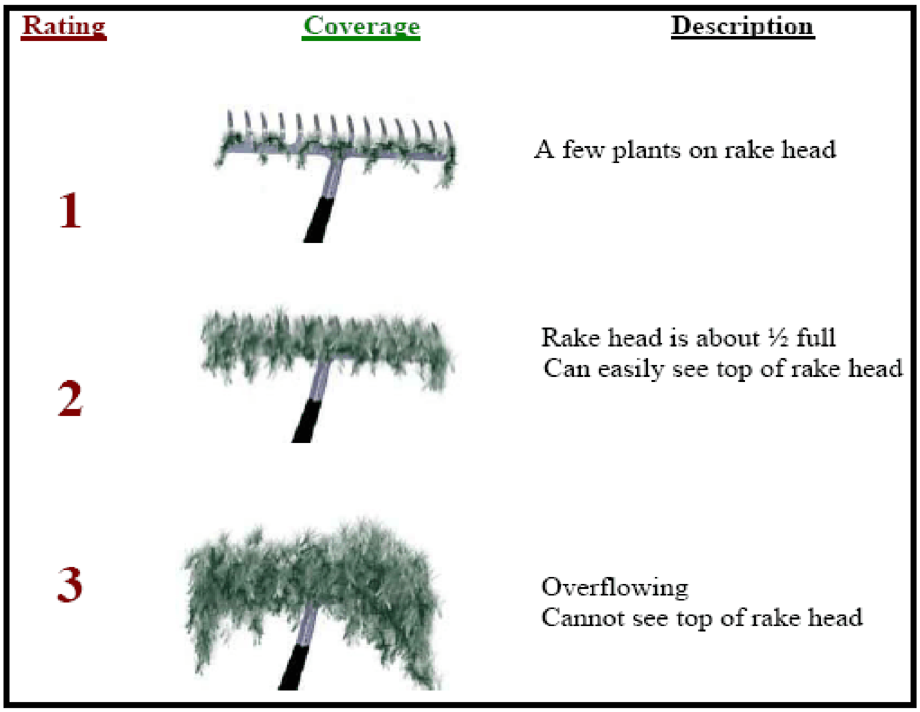


Figure 2: Rake Fullness Ratings (UWEX 2010)

Curly-leaf Pondweed Bed Mapping Survey:

During the bed mapping survey, we searched the lake's entire visible littoral zone. By definition, a "bed" was determined to be any area where we visually estimated that CLP made up >50% of the area's plants, was generally continuous with clearly defined borders, and was canopied or close enough to being canopied that it would likely interfere with boat traffic. After we located a bed, we motored around the perimeter taking GPS coordinates at regular intervals. We also estimated the rake density range and mean rake fullness of the bed (Figure 2), the range and mean depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none** – easily avoidable with a natural channel around or narrow enough to motor through/**minor** – one prop clear to get through or access open water/**moderate** – several prop clears needed to navigate through/**severe** – multiple prop clears and difficult to impossible to row through). These data were then mapped using ArcMap 9.3.1, and we used the WDNR's Forestry Tools Extension to determine the acreage of each bed to the nearest hundredth of an acre.

Warm-water Full Point-intercept Macrophyte Survey:

Prior to beginning the July point-intercept survey, we conducted a general boat survey to become familiar with the lake's macrophytes (Appendix II). All plants found were identified (Voss 1996, Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2012; Skawinski 2014), a datasheet was built from the species present, and two vouchers were collected to be pressed and mounted for herbarium specimens – one to be retained by the BCLA, and one to be sent to the state herbarium in Stevens Point for identification confirmation. We again located each survey point with a GPS, recorded a depth reading with a metered pole rake, 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.

DATA ANALYSIS:

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

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

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

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

<u>Simpson's Diversity Index:</u> 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.

<u>Maximum depth of plants:</u> 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.

<u>Mean and median depth of plants:</u> 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.

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

<u>Average number of species per site:</u> 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.

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

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

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

Relative frequency example:

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

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

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

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

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

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

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

RESULTS:

Curly-leaf Pondweed Point-intercept and Bed Mapping Surveys:

During the early season point-intercept survey, we found Curly-leaf pondweed growing over sand and muck in water from 2.5-7.0ft deep with a mean depth of 4.7ft. CLP was present in the rake sample at seven points with nine additional visual sightings. Of these, no points had a rake fullness rating of 3, one rated a 2, and the remaining six were a 1 for a mean rake fullness of 1.14. This extrapolated to 2.0% of the entire lake having CLP, and just 0.3% having a significant infestation (rake fullness 2 and 3). Interestingly, we found that CLP was almost entirely restricted to the Como Creek Inlet upstream from the HWY Q bridge, and the Duncan Creek Inlet upstream from the North City Park. Most CLP in these areas occurred in water from 2-5ft deep in the outwash near the channel where the bottom was disturbed and had at least some organic muck (Figure 3) (Appendix III).

On June 14th, we found very little additional Curly-leaf pondweed. Despite searching the entire lake, the only significant CLP occurred in a single 1.64 acres high density area near the Duncan Creek Inlet (Figure 3) (Appendix III). Although CLP was canopied, it wasn't a true bed as the area was dominated by Common waterweed (*Elodea canadensis*) and Coontail (*Ceratophyllum demersum*) with the CLP occurring as scattered patches that never had a rake fullness of more than 2. Fortunately, there were few residences in the area, and flowing water created a natural navigation channel that likely meant this particular area was only a minor navigational impairment at worst. A bigger issue was the thick mats of filamentous algae that covered all the other plants and tended to clog the water intakes on the motor (Figure 4).

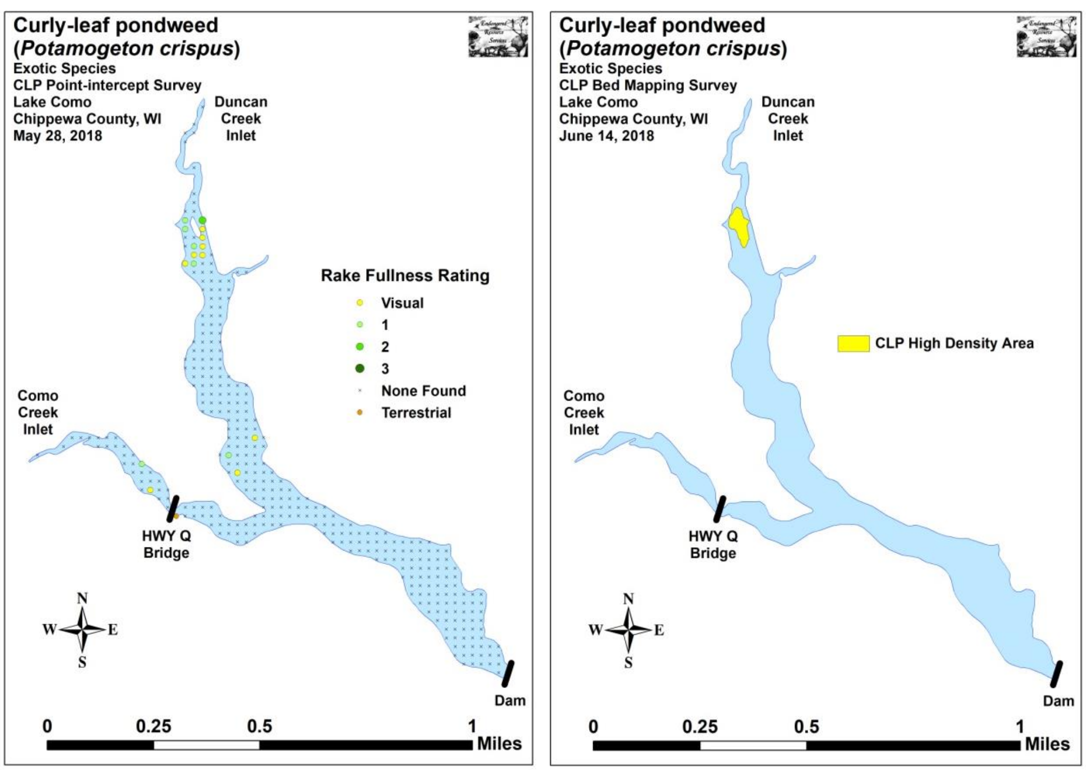


Figure 3: Early-season CLP Density and Distribution/High Density Area

Figure 4: Canopied CLP Covered in Filamentous Algae Near the Duncan Creek Inlet 6/14/18

Warm-water Full Point-intercept Macrophyte Survey:

Depth readings taken at Lake Como's 352 survey points (one point near the HWY Q bridge was on land) revealed the majority of the shoreline dropped off sharply into >6ft of water. In the southern basin, the flat surrounding the city beach was the only significant area under 5ft. Upstream of the HWY Q bridge, the Como Creek Inlet was never more than 4ft deep. Downstream from the bridge, depths slowly increased from 3ft to 6ft before dropping into the main basin. In the northern lobe, depth increased rapidly from 4ft at the Duncan Creek Inlet to >6ft just south of the North City Park (Figure 5) (Appendix IV).

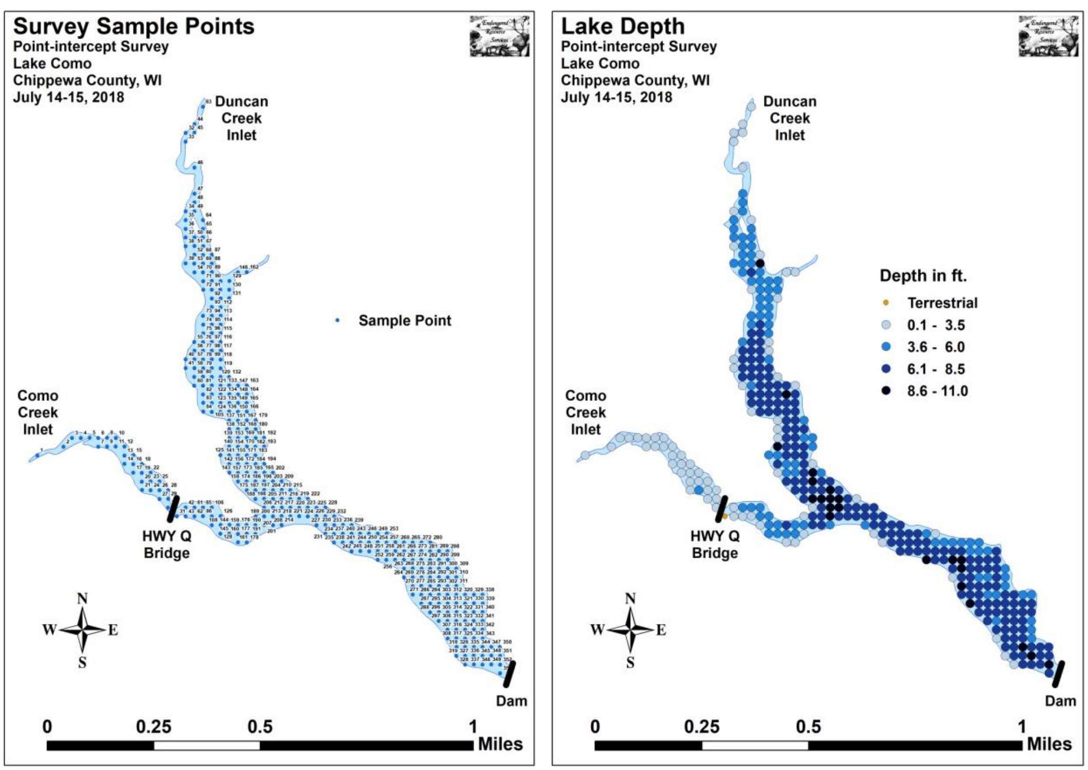


Figure 5: Survey Sample Points and Lake Depth

We categorized the lake's bottom as 48.6% pure sand (171 points), 45.7% organic and sandy muck (161 points), and the remaining 5.7% rock (20 points). Most of the main basin was sand and sandy muck, while areas with more nutrient-rich organic muck were largely confined to a few side bays and the Como Creek Inlet. We also noted that almost all rocky and gravel areas occurred along the main channel or on exposed points around the main basin (Figure 6) (Appendix IV).

We found plants growing to 9.5ft (Table 1) (Figure 6). Because only six points were deeper than this, almost the entire lake fell within the littoral zone. Despite this, only 268 points had vegetation (approximately 76.1% of the entire lake bottom and 77.5% of the littoral zone), and we noted that most areas over 7ft had little total biomass even if plants were present (Appendix V). Collectively, overall plant colonization was slightly skewed to shallow water as the mean depth of 5.2ft was lower than the median depth of 5.5ft (Figure 7).

Table 1: Aquatic Macrophyte P/I Survey Summary Statistics
Lake Como, Chippewa County
July 14-15, 2018

Summary Statistics:

Total number of points sampled	352
Total number of sites with vegetation	268
Total number of sites shallower than the maximum depth of plants	346
Frequency of occurrence at sites shallower than maximum depth of plants	77.46
Simpson Diversity Index	0.76
Maximum depth of plants (ft)	9.5
Mean depth of plants (ft)	5.2
Median depth of plants (ft)	5.5
Average number of all species per site (shallower than max depth)	2.21
Average number of all species per site (veg. sites only)	2.85
Average number of native species per site (shallower than max depth)	2.19
Average number of native species per site (sites with native veg. only)	2.82
Species richness	12
Species richness (including visuals)	12
Species richness (including visuals and boat survey)	18
Mean total rake fullness (veg. sites only)	1.93

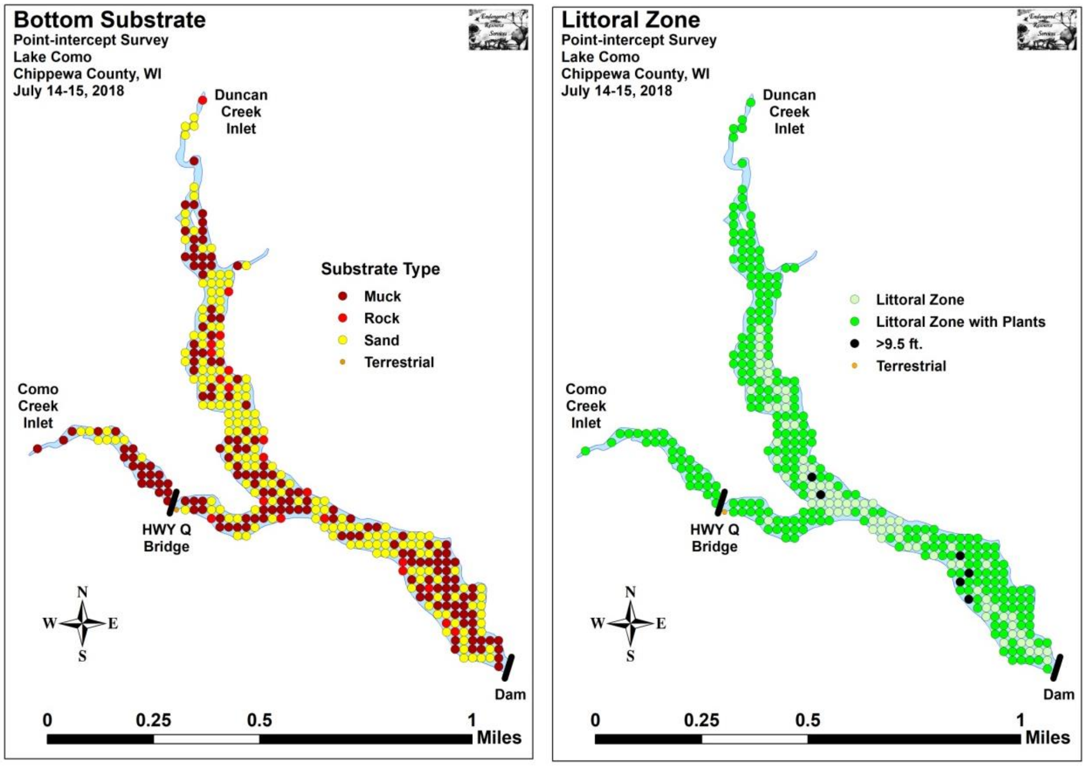


Figure 6: Bottom Substrate and Littoral Zone

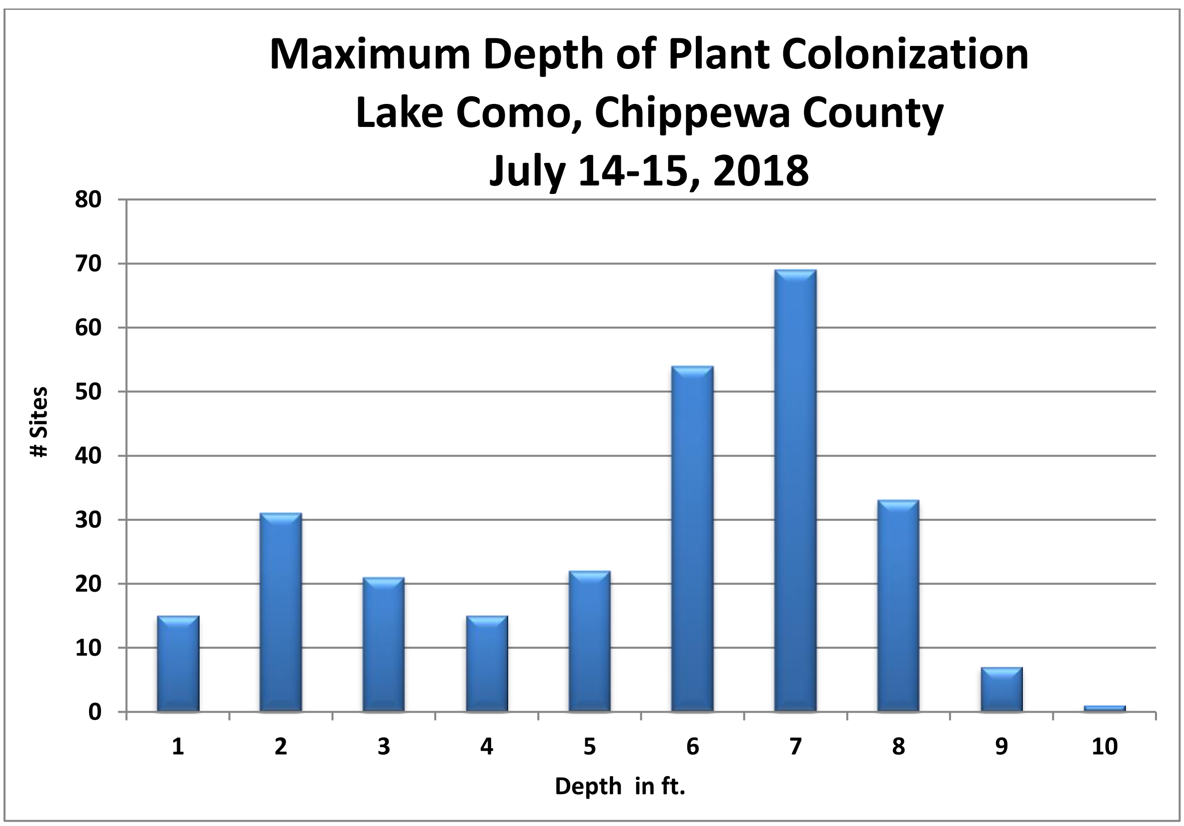


Figure 7: Plant Colonization Depth Chart

Plant diversity was moderate with a Simpson Index value of 0.76. Richness was, however, very low with only 12 species found in the rake. This total increased to just 18 species when including visuals and plants seen during the boat survey. Despite this low overall richness, mean native species at sites with native vegetation was a moderate 2.82/site although much of this total could be attributed to “duckweeds” which were nearly ubiquitous (Figure 8) (Appendix V).

Mean total rake fullness was a moderate 1.93. Visual analysis of the map showed that almost all areas <6ft had thick vegetation, but density generally declined rapidly with increased depth (Figure 8) (Appendix V).

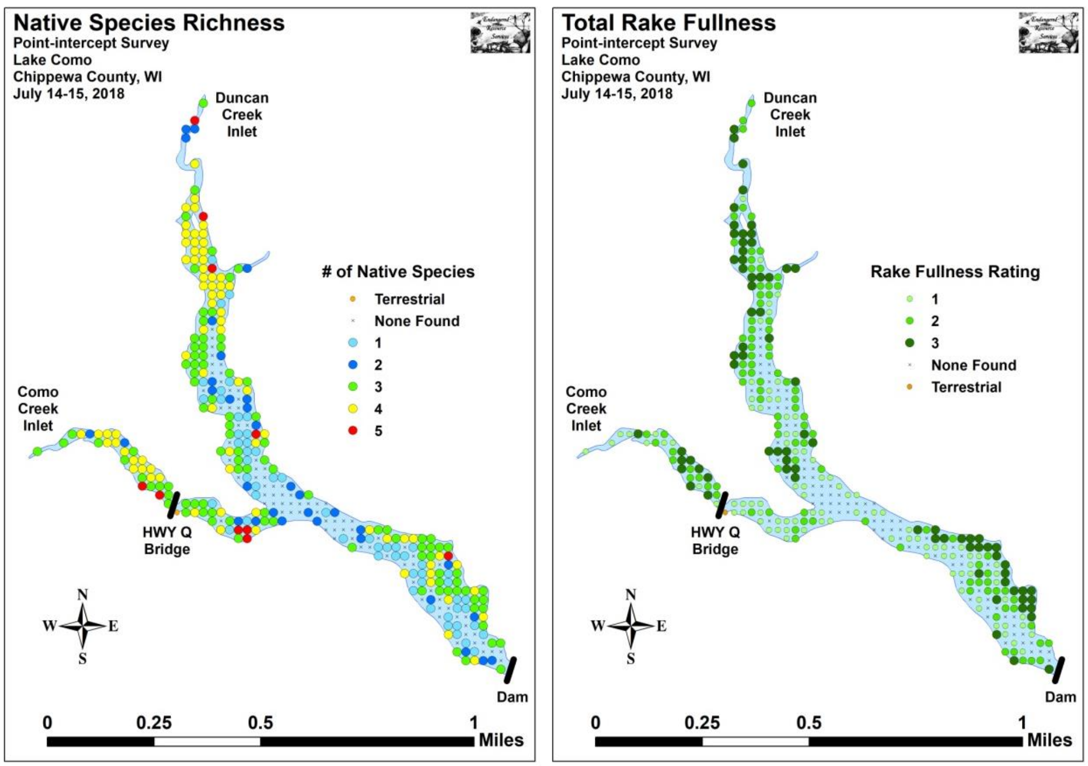


Figure 8: Native Species Richness and Total Rake Fullness

Lake Como Plant Community:

The Lake Como ecosystem is home to a plant community that is typical of high-nutrient lakes with fair to poor water quality and disturbed shoreline habitats. This community can be subdivided into three distinct zones (emergent, floating-leaf, and submergent) with each zone having its own characteristic functions in the aquatic ecosystem. Depending on the local bottom type (sand, rock, sandy muck or nutrient-rich organic muck), these zones often had somewhat different species present.

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

On Lake Como, exposed sandy and rocky shorelines had few emergents other than Reed canary grass (*Phalaris arundinacea*) which dominated most of the lakeshore. This habitat also supported widely scattered clusters of Common forget-me-not (*Myosotis scorpioides*) and Cattails (*Typha* spp.). In sandy-muck areas near the Duncan Creek Inlet, we also found and a few small beds of Yellow iris (*Iris pseudacorus*), Softstem bulrush (*Schoenoplectus tabernaemontani*), and Short-stemmed bur-reed (*Sparganium emersum*).

Softstem bulrush (Schwarz 2011)

Short-stemmed bur-reed (Gmelin, 2009)

The only floating-leaf species found on Lake Como were a few scattered patches of Ribbon-leaf pondweed (*Potamogeton epihydrus*) in the Duncan Creek Inlet, and Long-leaf pondweed (*Potamogeton nodosus*) which mostly occurred near the Como Creek Inlet. The canopy cover these species provides is often utilized by panfish and bass for protection.

Ribbon-leaf pondweed (Petroglyph 2007)

Long-leaf pondweed (Curtis 2010)

The vast majority of individual plants in the main lake were the submergent species Common waterweed and Coontail – both of which tended to form dense stands that often filled the water column. Growing in the gaps between these "haystacks" of vegetation, we occasionally found patches of Curly-leaf pondweed, Small pondweed (*Potamogeton pusillus*), and the colonial macroalgae Nitella (*Nitella* sp. – likely *flexilis*). We also documented large numbers of "duckweeds" including Small duckweed (*Lemna minor*), and Common watermeal (*Wolffia columbiana*) floating among the canopied vegetation and emergents.

Coontail (Hassler 2011)

Common waterweed (Pinkka 2013)

Curly-leaf pondweed (Peroti 2012)

Small pondweed (Villa 2011)

Nitella (Green 2002)

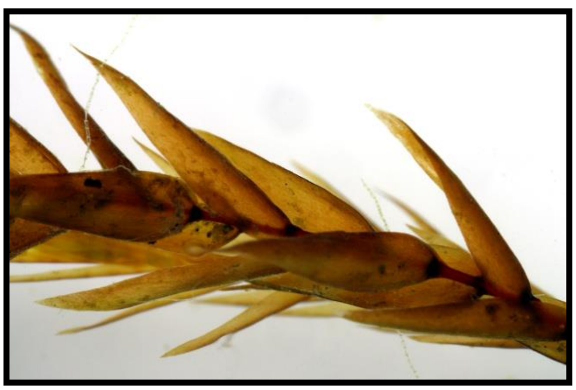
Small duckweed and Common watermeal (Kieron 2010)

Shallow rocky areas around the main lake were almost entirely devoid of plants other than filamentous algae. However, in the far upstream areas of the Duncan Creek Inlet, we documented Common water starwort (*Callitriche palustris*), Nitella, and very limited numbers of White water crowfoot (*Ranunculus aquatilis*), aquatic moss, and freshwater sponges which, although technically animals with algae cells living inside them, the WDNR keeps track of as their presence indicates generally good water quality.

Collectively, the roots, shoots, and seeds of all these submergent species are heavily utilized by both resident and migratory waterfowl for food. They also provide important habitat for the lake's fish throughout their lifecycles, as well as a myriad of invertebrates like scuds, dragonfly and mayfly nymphs, and snails.

Common water-starwort (Cameron 2014)

White water crowfoot (Wasser 2014)



Aquatic moss (Collins 2017)

Green freshwater sponges with symbiotic algae (Collins 2017)

Plant Community Dominance:

Common waterweed, Small duckweed, Common watermeal, and Coontail were the most widely distributed species (Figure 9). We found them at 93.28%, 66.42%, 64.93%, and 45.90% of sites with vegetation (Table 2), and they accounted for an exceptionally high 95.02% of the total relative frequency. This suggests there was little room in the plant community for any other species. In fact, Small pondweed (2.49) was the only other plant with a relative frequency over 1.0 (Maps and species accounts for all plants found in July are located in Appendixes VI and VII).

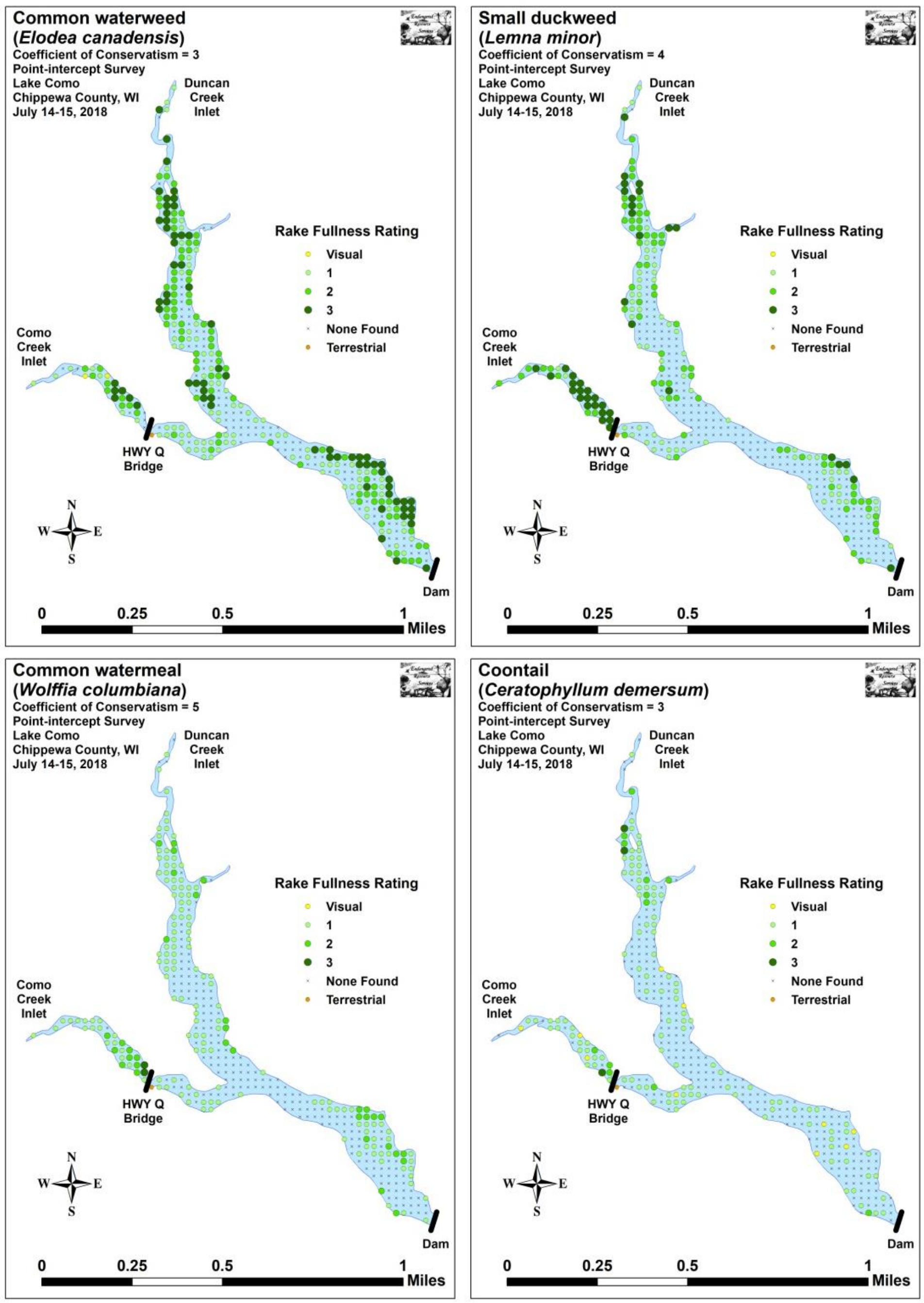


Figure 9: Lake Como's Most Widely Distributed Species

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Lake Como, Chippewa County
July 14-15, 2018

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake	Visual Sight.
Elodea canadensis	Common waterweed	250	32.77	93.28	72.25	1.90	2
	Filamentous algae	185	*	69.03	53.47	1.75	0
Lemna minor	Small duckweed	178	23.33	66.42	51.45	1.85	0
Wolffia columbiana	Common watermeal	174	22.80	64.93	50.29	1.21	0
Ceratophyllum demersum	Coontail	123	16.12	45.90	35.55	1.15	10
Potamogeton pusillus	Small pondweed	19	2.49	7.09	5.49	1.05	4
Nitella sp. likely *flexilis*	Nitella	5	0.66	1.87	1.45	1.00	0
Phalaris arundinacea	**Reed canary grass**	3	0.39	1.12	0.87	2.33	4
Potamogeton crispus	**Curly-leaf pondweed**	3	0.39	1.12	0.87	1.00	0
Sparganium emersum	Short-stemmed bur-reed	3	0.39	1.12	0.87	1.67	0
Potamogeton nodosus	Long-leaf pondweed	2	0.26	0.75	0.58	1.50	6
Typha latifolia	Broad-leaved cattail	2	0.26	0.75	0.58	3.00	0
	Aquatic moss	2	*	0.75	0.58	1.50	0
Potamogeton epihydrus	Ribbon-leaf pondweed	1	0.13	0.37	0.29	2.00	2
	Freshwater sponge	1	*	0.37	0.29	1.00	0
Callitriche palustris	Common water starwort	***	***	***	***	***	***
Iris pseudacorus	**Yellow iris**	***	***	***	***	***	***
Myosotis scorpioides	**Common forget-me-not**	***	***	***	***	***	***
Ranunculus aquatilis	White water crowfoot	***	***	***	***	***	***
Schoenoplectus tabernaemontani	Softstem bulrush	***	***	***	***	***	***
Typha angustifolia	**Narrow-leaved cattail**	***	***	***	***	***	***

*Excluded from Relative Frequency Analysis   *** Boat Survey Only   **Exotic Species in Bold**

Floristic Quality Index:

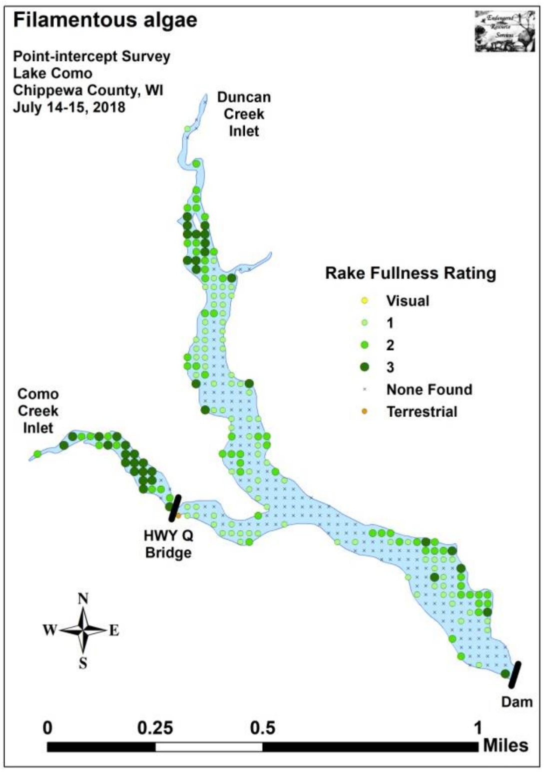
We identified a total of 10 **native index plants** in the rake during the July point-intercept survey. They produced a mean Coefficient of Conservatism of 5.3 and a Floristic Quality Index of 16.8 (Table 3). Nichols (1999) reported an average mean C for the North Central Hardwood Forests Region of 5.6 putting Lake Como below average for this part of the state. The FQI was also below the median FQI of 20.9 for the North Central Hardwood Forests (Nichols 1999).

Table 3: Floristic Quality Index of Aquatic Macrophytes
Lake Como, Chippewa County
July 14-15, 2018

Species	Common Name	C
Ceratophyllum demersum	Coontail	3
Elodea canadensis	Common waterweed	3
Lemna minor	Small duckweed	4
Nitella sp.	Nitella	7
Potamogeton epihydrus	Ribbon-leaf pondweed	8
Potamogeton nodosus	Long-leaf pondweed	7
Potamogeton pusillus	Small pondweed	7
Sparganium emersum	Short-stemmed bur-reed	8
Typha latifolia	Broad-leaved cattail	1
Wolffia columbiana	Common watermeal	5
N		**10**
Mean C		**5.3**
FQI		**16.8**

Filamentous Algae:

Filamentous algae are normally associated with excessive nutrients in the water column. These algae aren't factored into the relative frequency equation, but they were the second most widely distributed plant on the lake (present at 185 survey sites) and had a moderate mean rake fullness of 1.75 (Figure 10). We noted they were especially abundant in the creek inlets where they often formed thick mats along the surface and tended to cover all other vegetation (Figure 11).



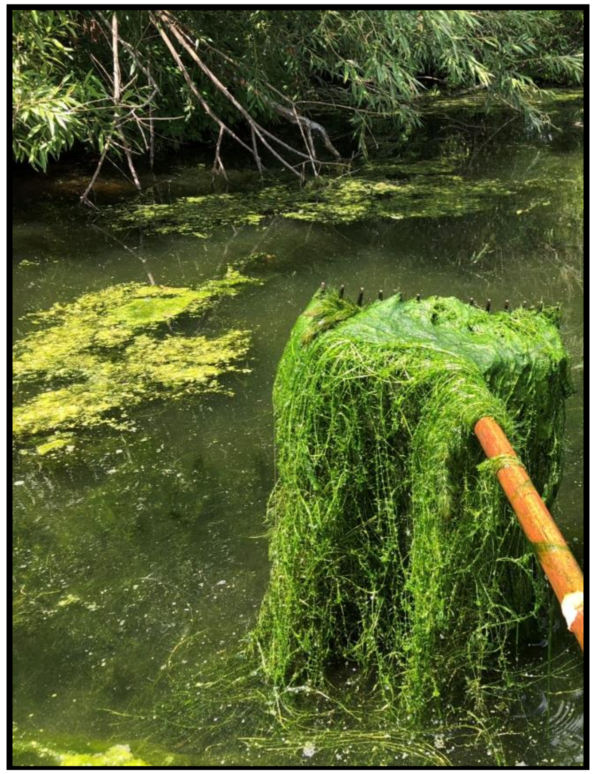
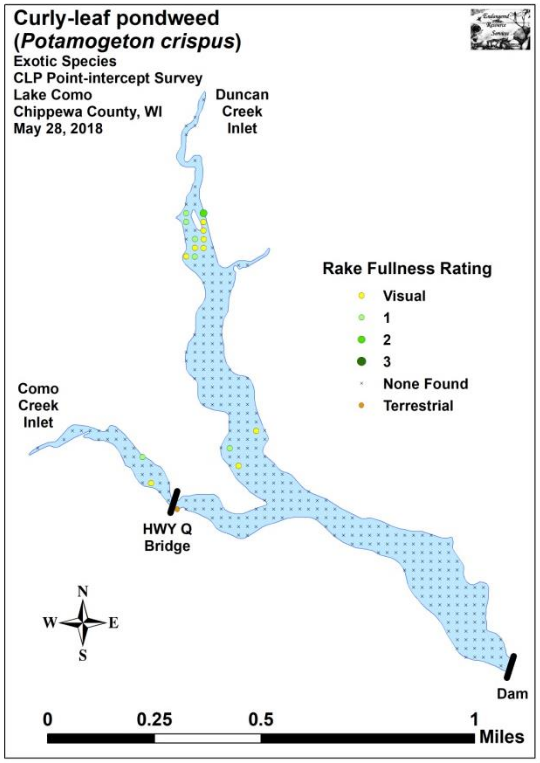


Figure 10: Filamentous Algae Density and Distribution/ Common Waterweed Covered in Filamentous Algae near the City Beach

Figure 11: Thick Mats of Filamentous Algae and Duckweeds in the Como Creek Inlet (left) and Duncan Creek Inlet (right)

Exotic Plant Species:

We did NOT find any evidence of Eurasian water milfoil in Lake Como during any of our surveys. By July, the limited amount of Curly-leaf pondweed we had documented in May and June had almost entirely senesced as we found a single CLP plant at each of only three points (Figure 12).



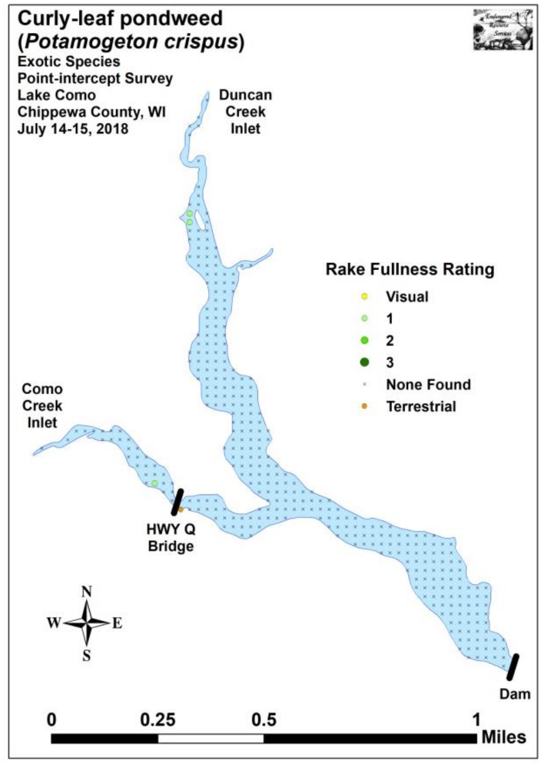


Figure 12: May and July Curly-leaf Pondweed Density and Distribution

In addition to Curly-leaf pondweed, we found four other exotic plant species growing in and adjacent to Lake Como: Yellow iris, Common forget-me-not, Reed canary grass, and Narrow-leaved cattail. Yellow iris was restricted to a few large clusters along the western shoreline just downstream from the Duncan Creek Inlet. Plants were growing on either side of a dock, and there were several smaller satellite clusters nearby (Figure 13).

Common forget-me-nots were similarly few in number with a few 10's of plants noted in a couple of disturbed areas south and east of the main public boat landing ramp on the western shoreline (Figure 14). A plant that prefers cold-water seeps and streams, there doesn't appear to be much additional habitat for this species on the lake.

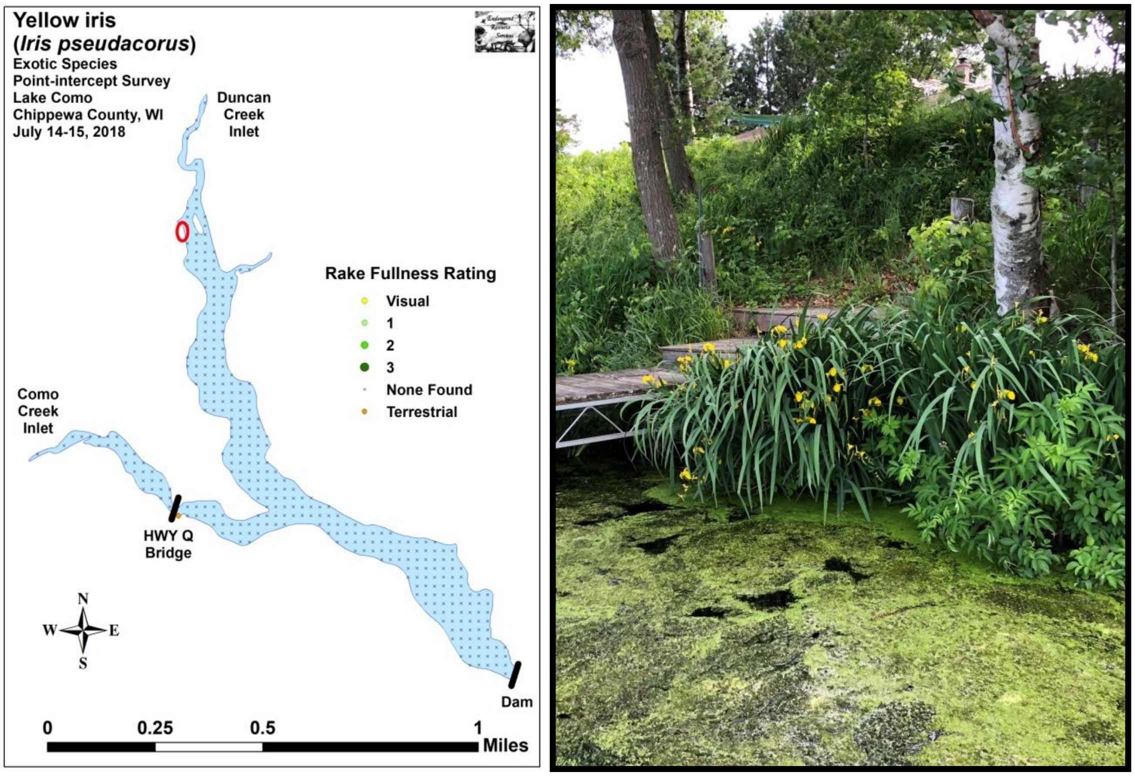


Figure 13: Yellow Iris Distribution/Clusters near the Duncan Creek Inlet

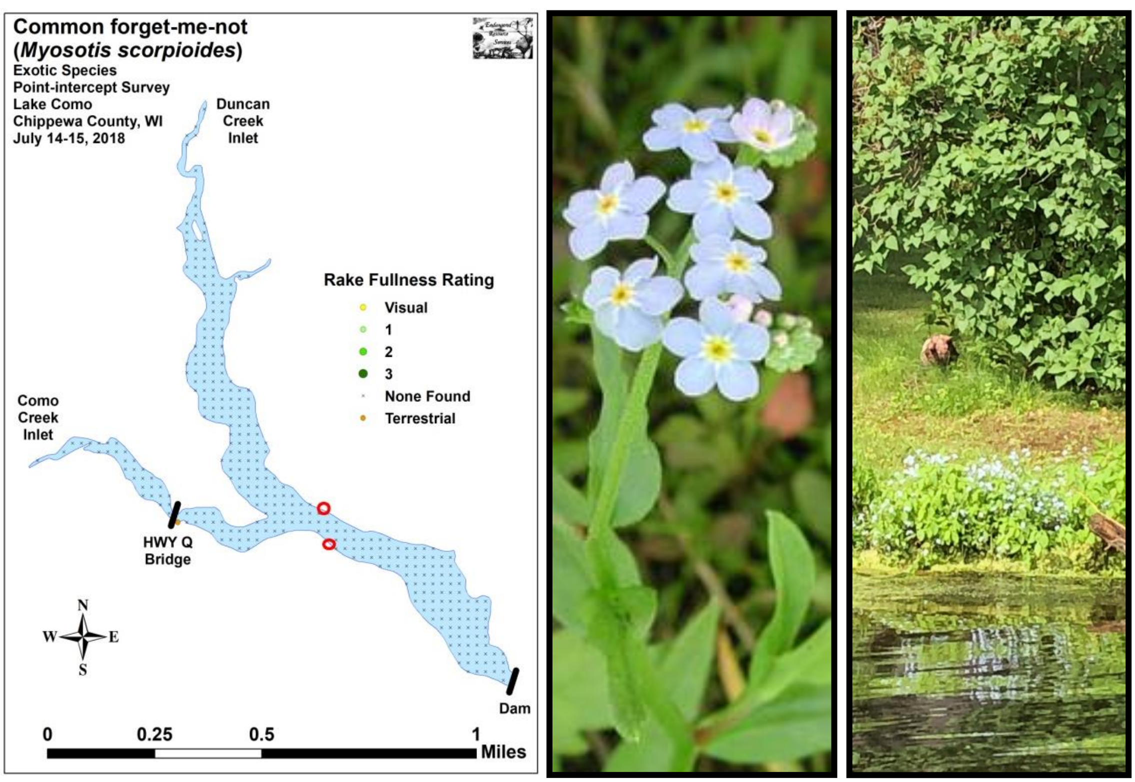
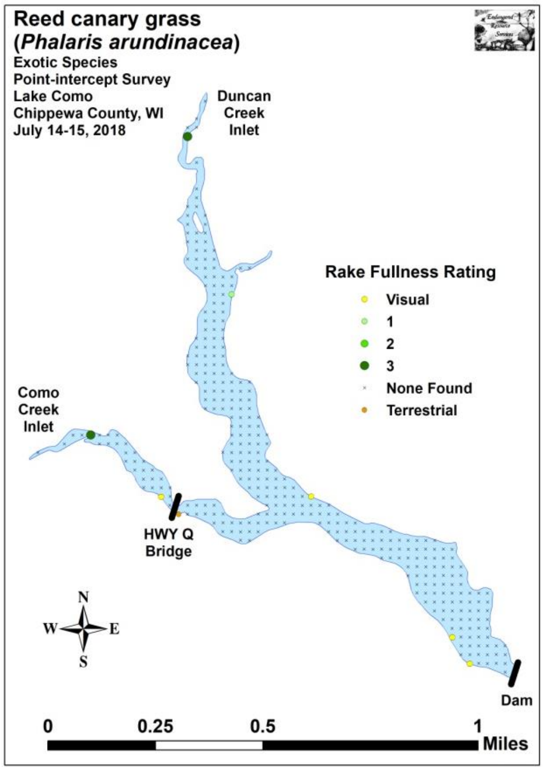


Figure 14: Common Forget-me-not Distribution/Cluster on the Shoreline

Despite only being found in the rake at three points and occurring as a visual at four others, Reed canary grass was often a dominant plant just beyond the lakeshore (Figure 15). We noticed this species often dominated adjacent wetlands, and it was common along mowed and otherwise disturbed shorelines around most of the lake. As this plant has already spread throughout the entire state, there's likely little that can be done about it.



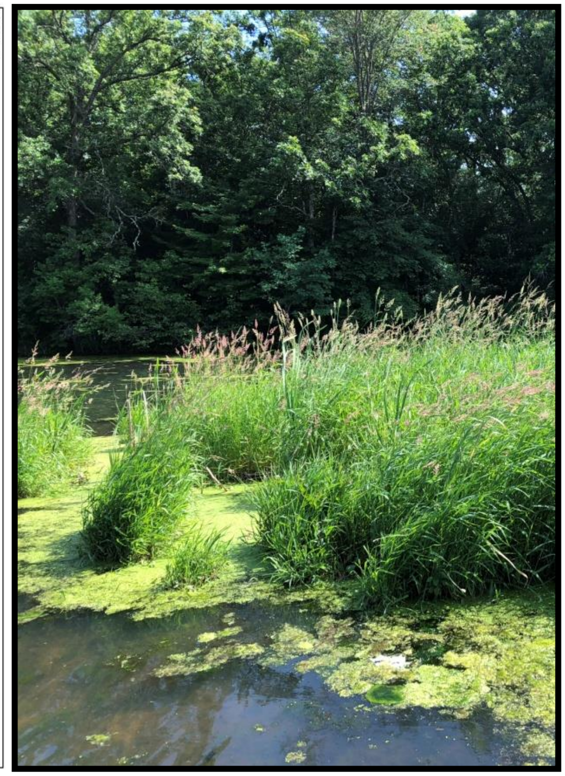


Figure 15: Reed Canary Grass Density and Distribution/ Bed of Reed Canary in the Como Creek Inlet

Native to southern but not northern Wisconsin, Narrow-leaved cattail (*Typha angustifolia*) and its hybrids with Broad-leaved cattail are becoming increasingly common in northern Wisconsin where they also tend to be invasive. We found a single small patch of these exotic cattails immediately north of the dock at the main boat landing on the lake's west side.

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) (For more information on select exotic invasive plant species, see Appendix VIII).

Figure 16: Exotic Narrow-leaved and Native Broad-leaved Cattail Identification

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

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

Lake Como has an abundant native plant community that is dominated by just a few lower conservatism value species which can tolerate the lake's poor to very poor water clarity and high nutrient load. These plants are currently so abundant that they are significantly impacting both lake access and recreational activities. Because of this, some type of active management is likely in the future. Regardless of what, if any, management occurs, it is important to remember that these plants are supremely important to the lake as they 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, **maintaining some level of plants** in the lake is critical to maintaining the lake's overall health.

Soil erosion and runoff are often important sources of the phosphorus and nitrogen that enter aquatic systems. When levels of these nutrients increase in the water column, they tend to promote excessive plant growth (like Common waterweed, Coontail, and Curly-leaf pondweed) and algae blooms. In addition to negatively impacting general lake esthetics, this overgrowth and loss of clarity tends to diminish other beneficial and less invasive native plant species.

Although many of these nutrients are likely washing in from upstream, all residents have the ability to help mitigate shoreline runoff. Simple things like establishing or maintaining a buffer strip of 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 help improve water clarity and quality.

Common waterweed and Coontail Management:

Common waterweed and Coontail do not have roots and can rapidly reproduce vegetatively in nutrient-rich waters. Because of this ability, these native species can act like exotics and quickly become invasive. This seems to be the case in Lake Como where dense "haystacks" of vegetation dominated by these species and filamentous algae fill the entire water column in most areas on the lake that are less than 6ft deep. Although the band of canopied plants that borders the shoreline can be quite narrow where the lake drops off rapidly, in many areas, like on the east side of the south basin (Figure 17), it is so wide that plants are severely restricting both lake access and general navigation. Several lake residents and BCLA board members mentioned they would like to consider herbicide applications to relieve this impairment; however, the ability of these species to rapidly proliferate under current conditions may allow their populations to recover from a herbicide treatment within a very short period of time. Because of this, mechanical harvesting, although it has a significant initial cost, may give better results in the long run. Ultimately, the BCLA, COB, LEAPS, and the WDNR will have to decide which type of active management, if any, makes the most sense when balancing recreation, economic, and ecological considerations.

Figure 17: Dense Canopied Common Waterweed/Coontail along the Eastern Shoreline Facing the City Beach/Dam 7/15/18

Curly-leaf Pondweed Management:

Curly-leaf pondweed is so uncommon and makes up such a small amount of the lake's total biomass that managing specifically for this species is likely unnecessary at this time. If active management of Common waterweed or Coontail occurs in the future, it's likely that any CLP in the management area will also be eliminated.

Yellow Iris Management:

The presence of Yellow iris on Lake Como is troubling as this species can rapidly take over both shoreline and adjacent wetland areas. Because of this, we **STRONGLY** encourage the lake association to make contract with the resident in the Duncan Creek Inlet and work to **IMMEDIATELY** remove these plants. An informational bulletin should also go out to other lake residents warning them to look for and eliminate plants on their property before a minor problem becomes a significant one. Iris plants and pods should be bagged to prevent seed dispersal, and they should then be disposed of well away from the lake or any other wetland. June is the best month to look for this species as the bright yellow fleur-de-lis are most common at this time of year (Figure 18). When not in bloom, its leaves could be confused with Northern blue flag (*Iris versicolor*) – a native and non-invasive iris species.

Figure 18: Yellow Iris Flower/Iris Cluster with Mature Seed Pods Hanging in the Water

Exotic Cattails:

All of Wisconsin's cattails have wildlife value as many bird species nest in them, and muskrats and a variety of insects use them as food. Because Narrow-leaved cattail and its hybrids can be invasive along the shoreline to the point that they interfere with lake access, property owners may want to remove pioneering individuals before they become a bed. However, unless they are interfering with access or other human activity, removing previously established stands is probably unnecessary and unlikely to be ecologically beneficial. Because cattail seeds are transported by the wind, the continued expansion of this species in northern Wisconsin is likely inevitable.

Aquatic Invasive Species Prevention:

Aquatic Invasive Species (AIS) such as Eurasian water-milfoil and Zebra mussels are an increasing problem in Wisconsin lakes. Currently, there is only a small sign at the main landing warning boaters to clean their trailers/watercraft prior to launching. As the BCLA doesn't have a landing monitoring program, that sign is the only "guardian" the lake has to encourage people to think twice before they put their boat in the water. Improving the signage to something that is bigger, brighter, and generally harder to ignore is another idea worth considering.

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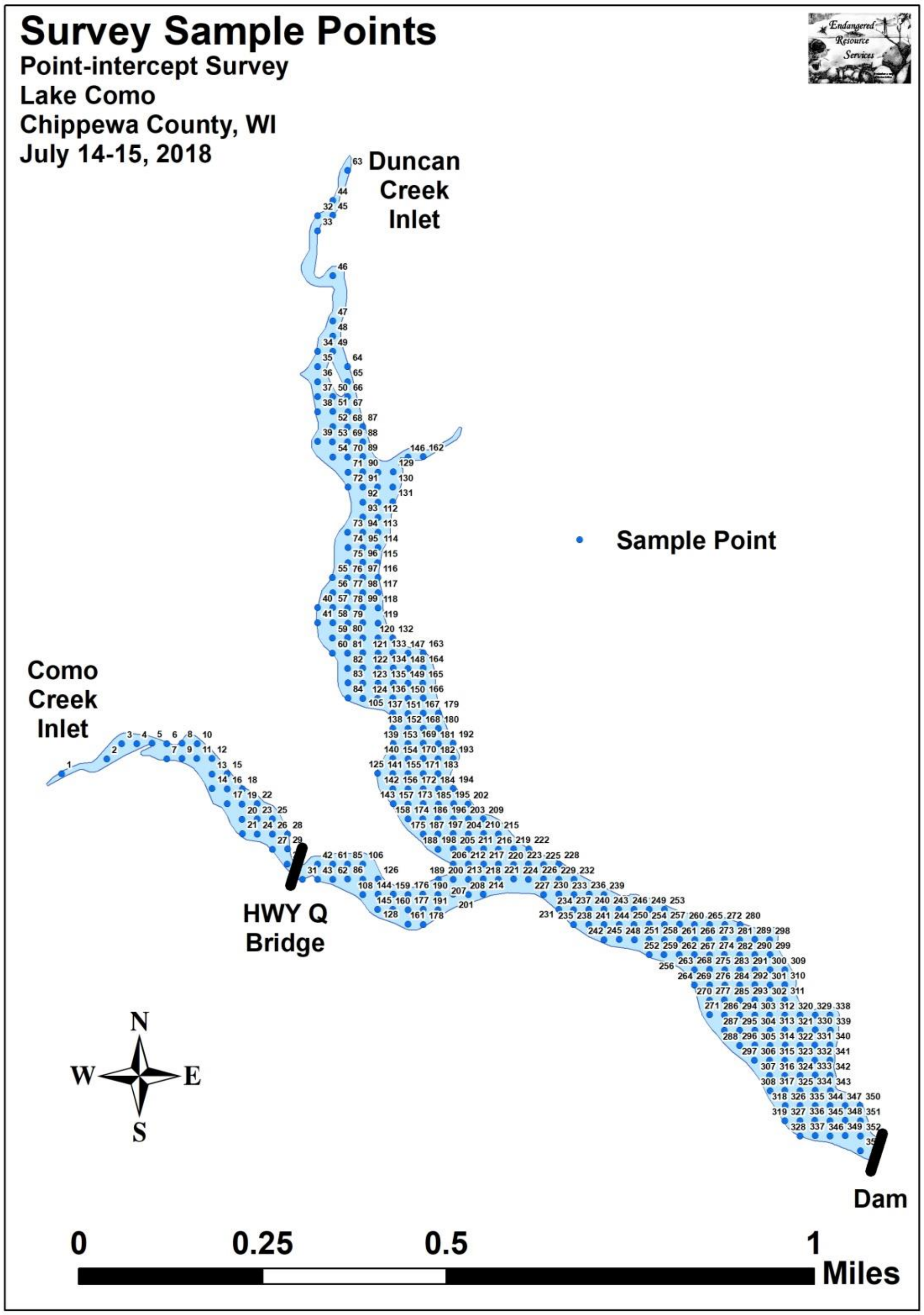
WDNR. [online]. 2010. Reed canary grass fact sheet. http://dnr.wi.gov/invasives/fact/reed_canary.htm (2010, August).

Appendix I: Survey Sample Points Map

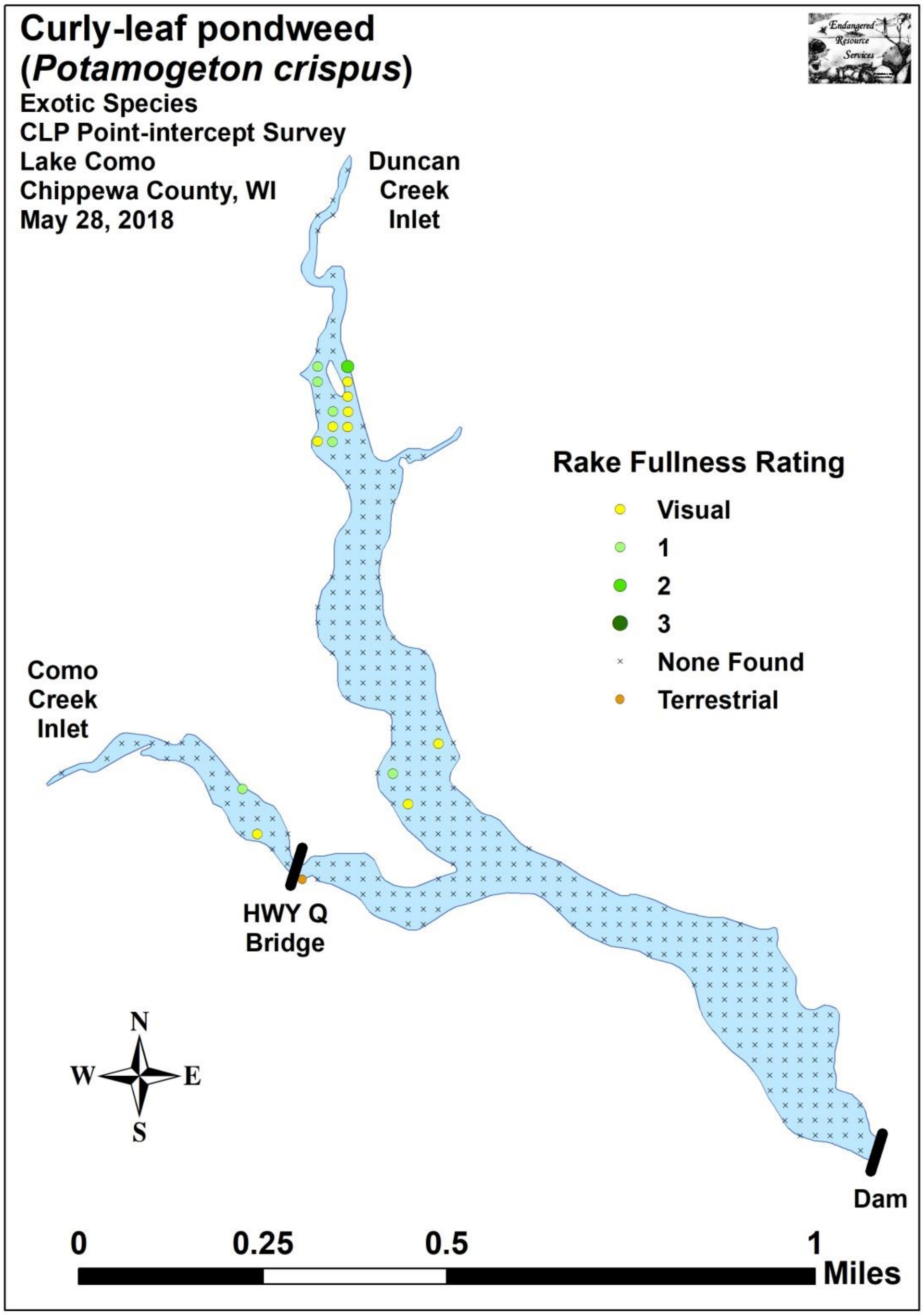

Survey Sample Points
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Como Creek Inlet
Sample Point
HWY Q Bridge
Dam
N
W
E
S
0
0.25
0.5
1
Miles

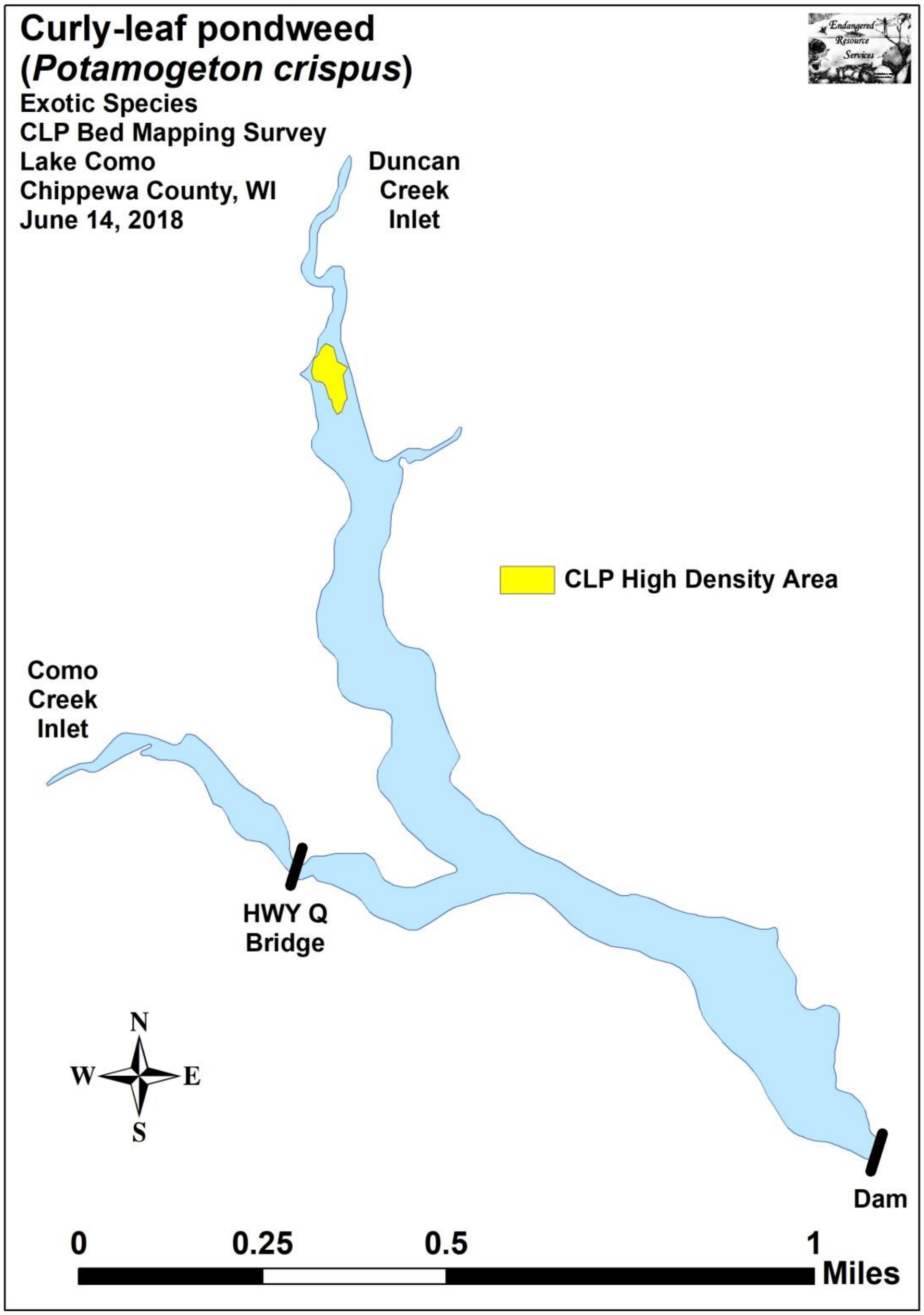
Appendix II: Boat and Vegetative Survey Data Sheets

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

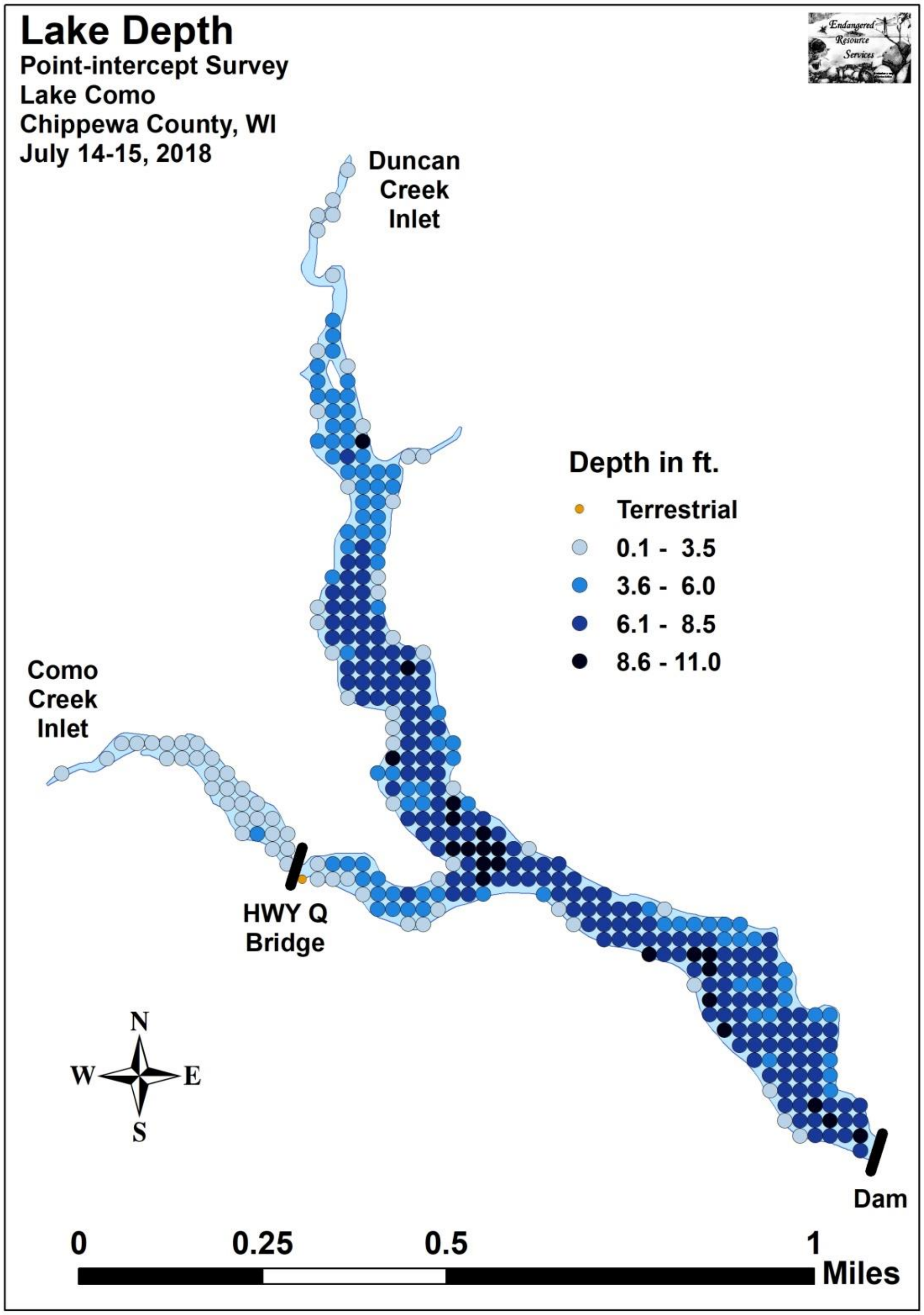
Observers for this lake: names and hours worked by each:																									
Lake:									**WBIC**									**County**						**Date:**	
Site #	**Depth (ft)**	**Muck (M), Sand (S), Rock (R)**	**Rake pole (P) or rake rope (R)**	**Total Rake Fullness**	**EWM**	**CLP**	**1**	**2**	**3**	**4**	**5**	**6**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

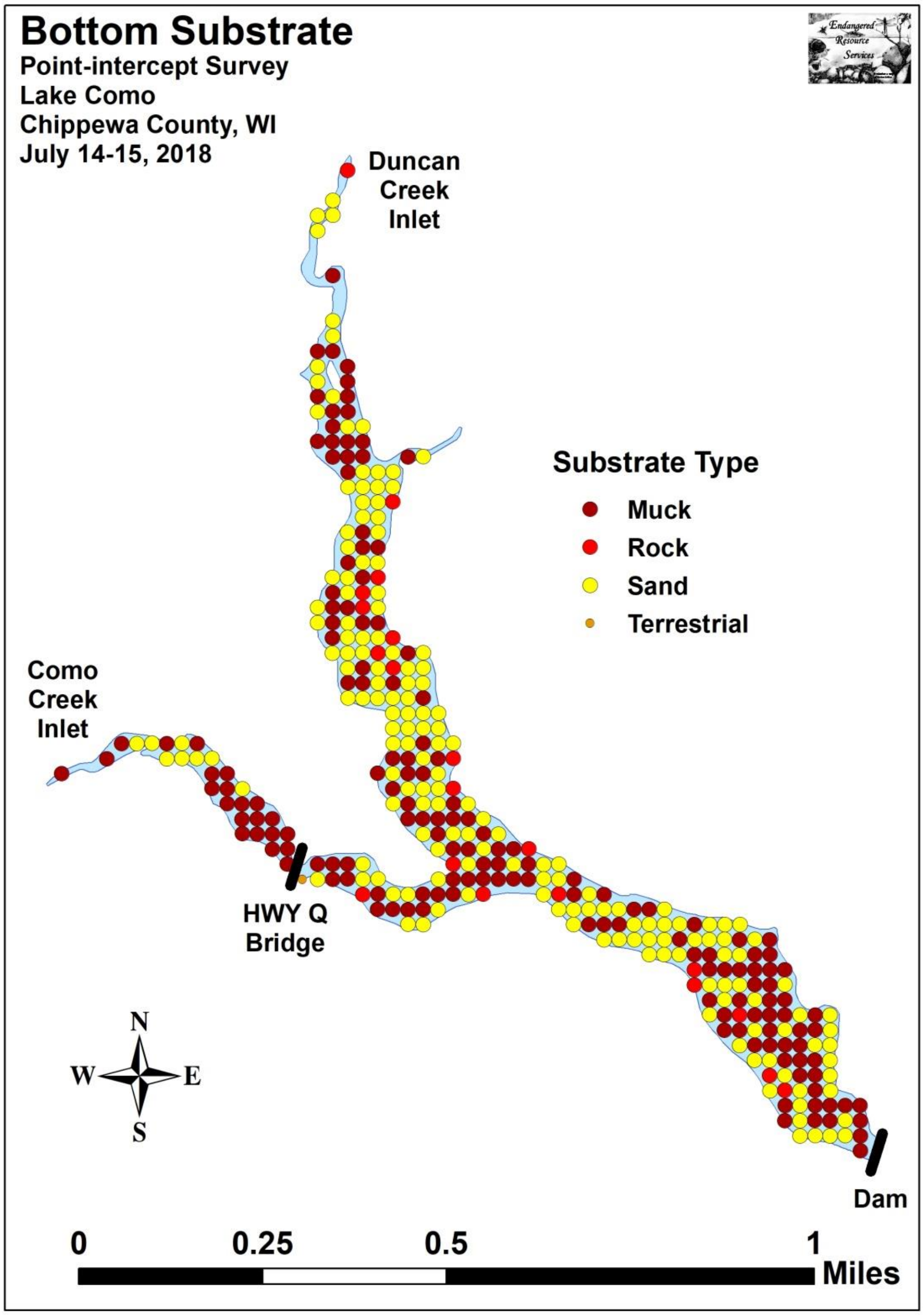
Appendix III: Early-season CLP Density and Distribution and High Density Area Maps


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
CLP Point-intercept Survey
Lake Como
Chippewa County, WI
May 28, 2018
Endangered Resource Services
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
CLP Bed Mapping Survey
Lake Como
Chippewa County, WI
June 14, 2018
Duncan
Creek
Inlet
CLP High Density Area
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

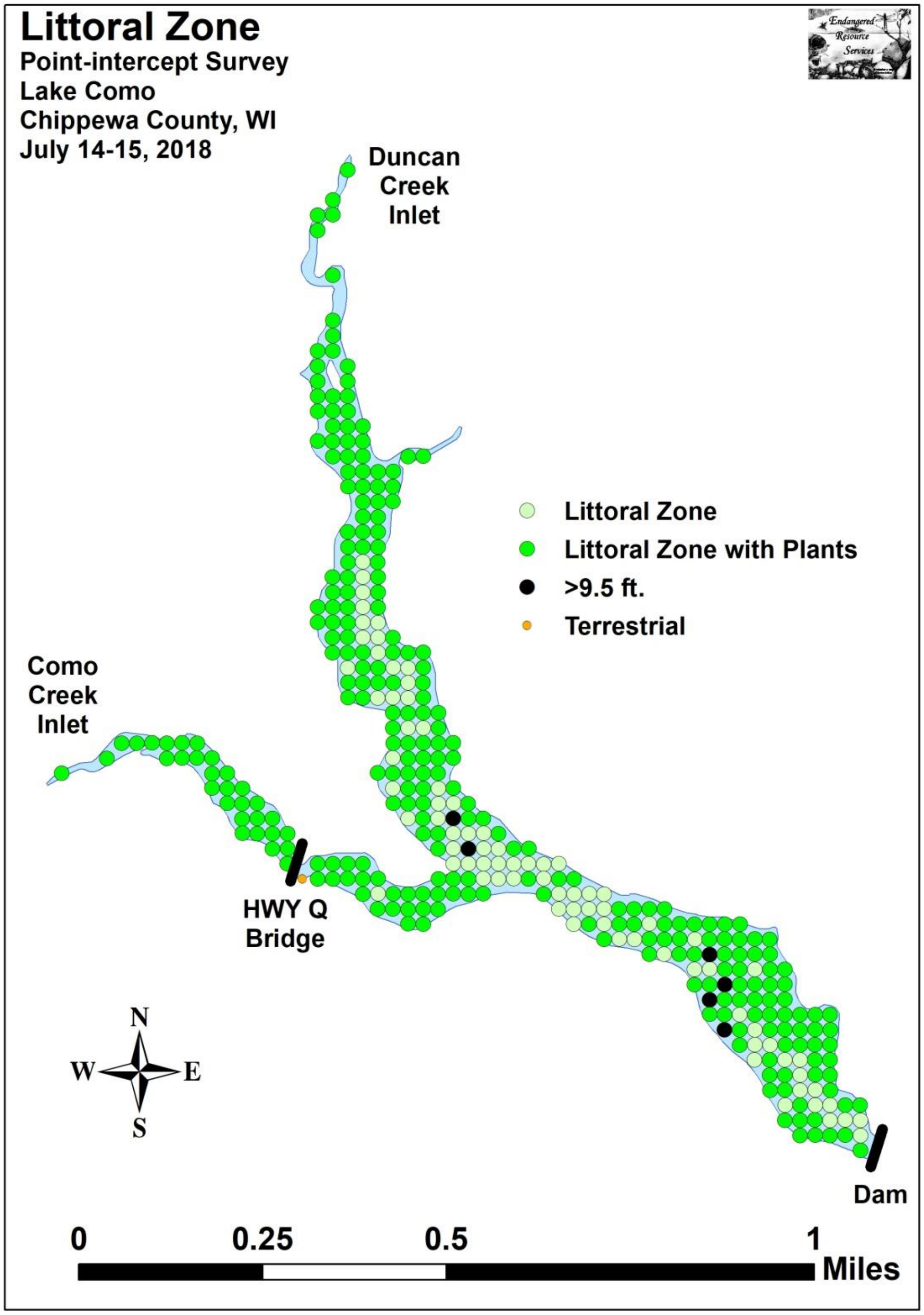
Appendix IV: Habitat Variable Maps

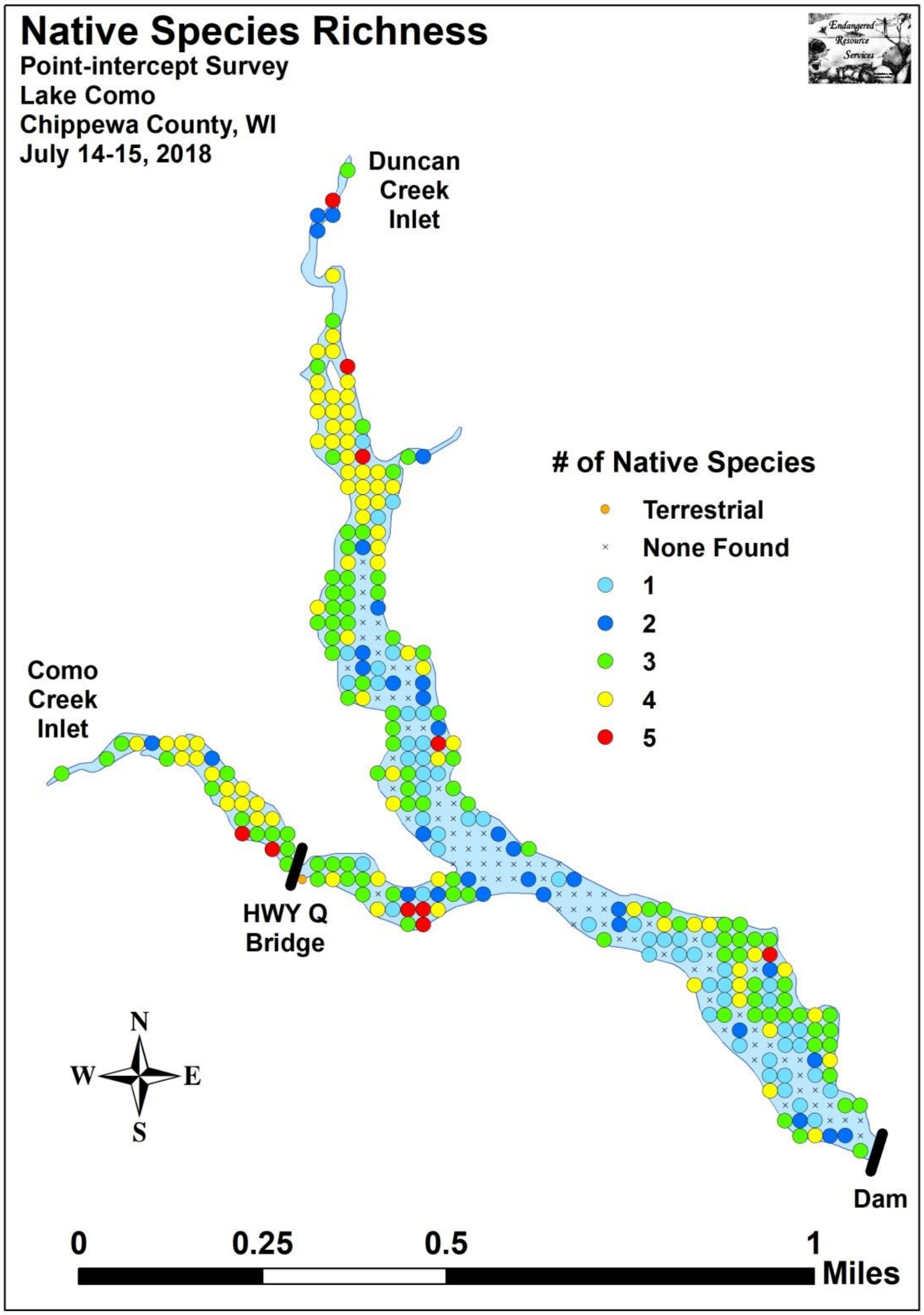

Lake Depth
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Depth in ft.
Terrestrial
0.1 - 3.5
3.6 - 6.0
6.1 - 8.5
8.6 - 11.0
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

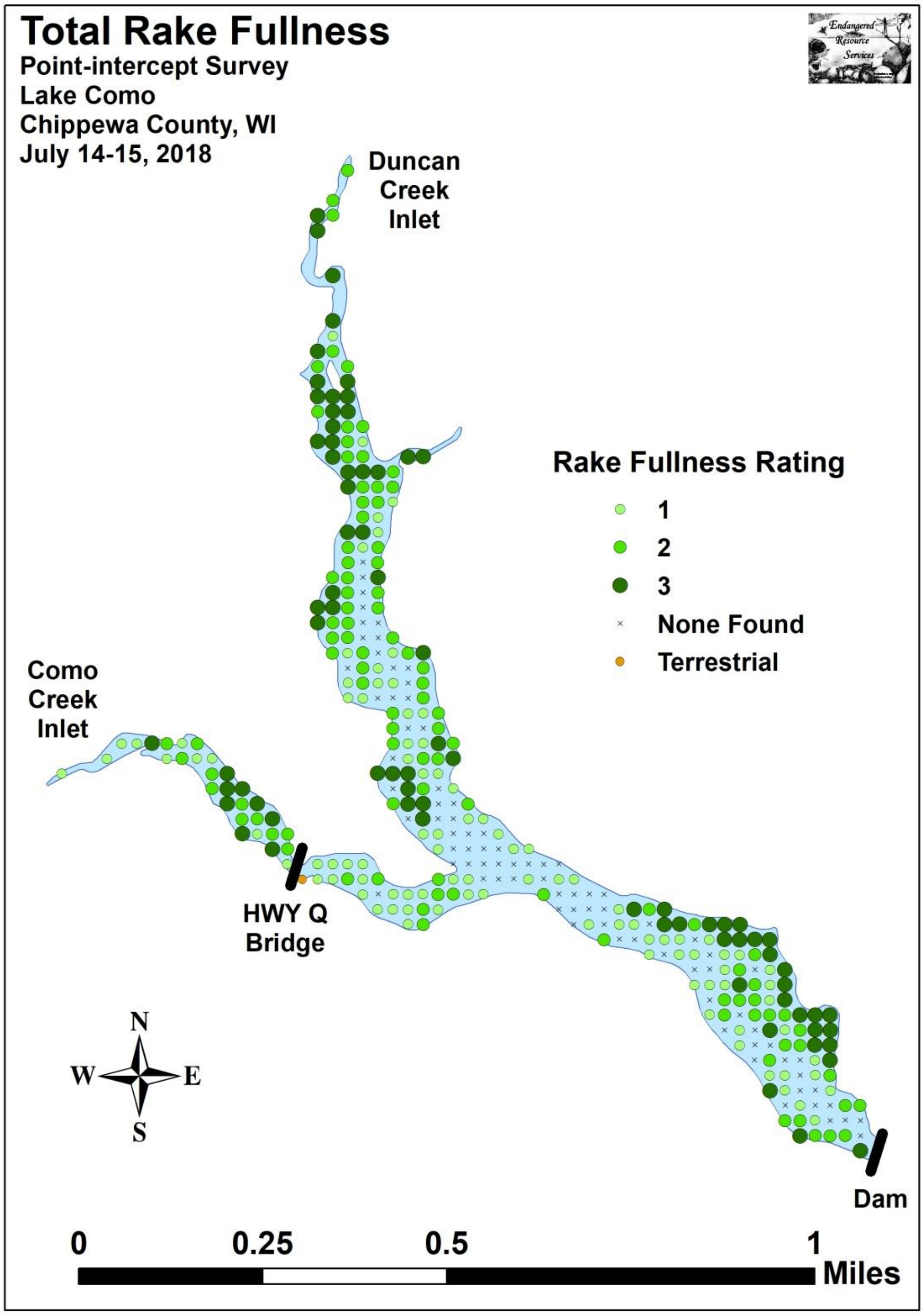


Bottom Substrate
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Substrate Type
Muck
Rock
Sand
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

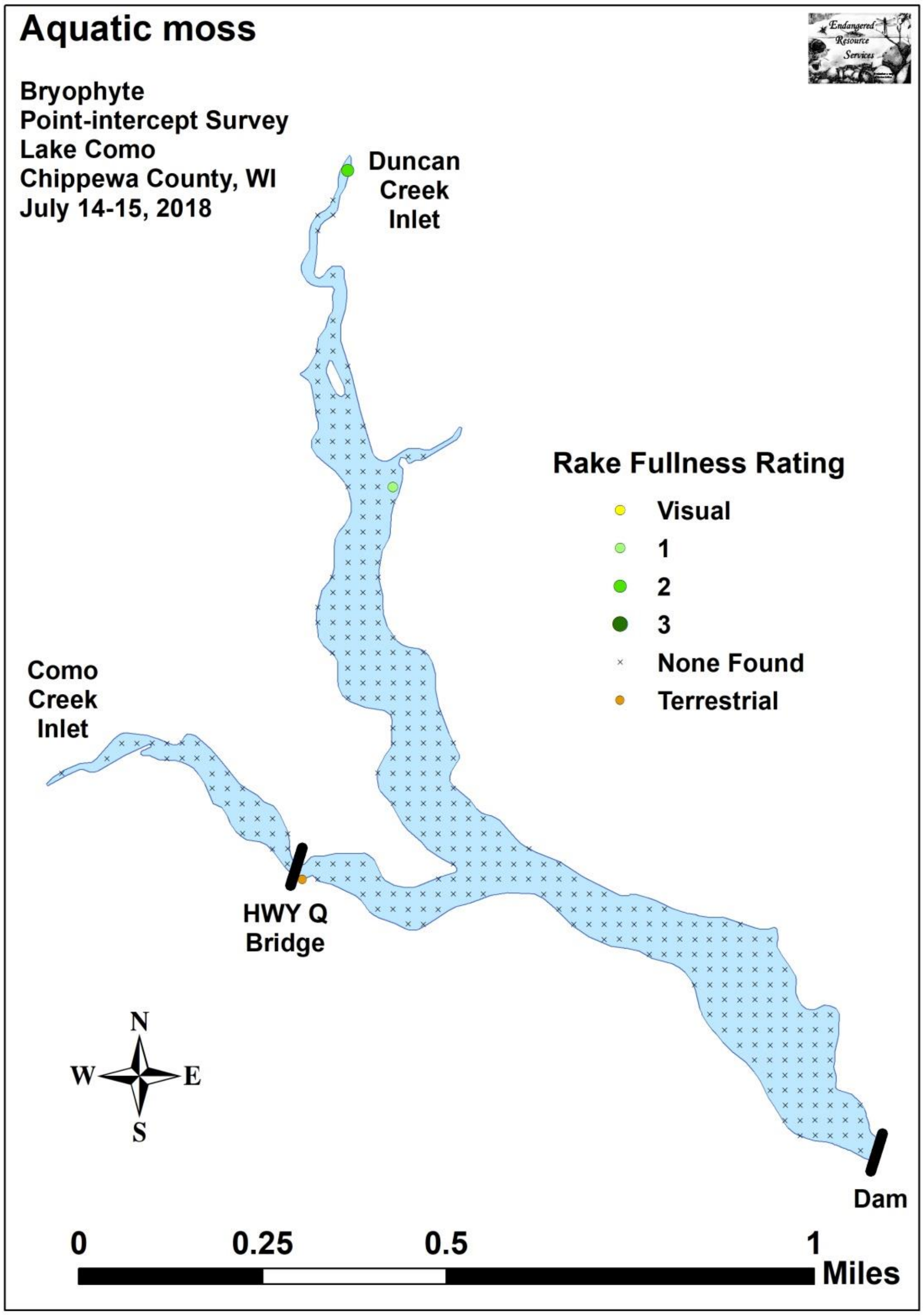
Appendix V: Littoral Zone, Native Species Richness, and Total Rake Fullness Maps

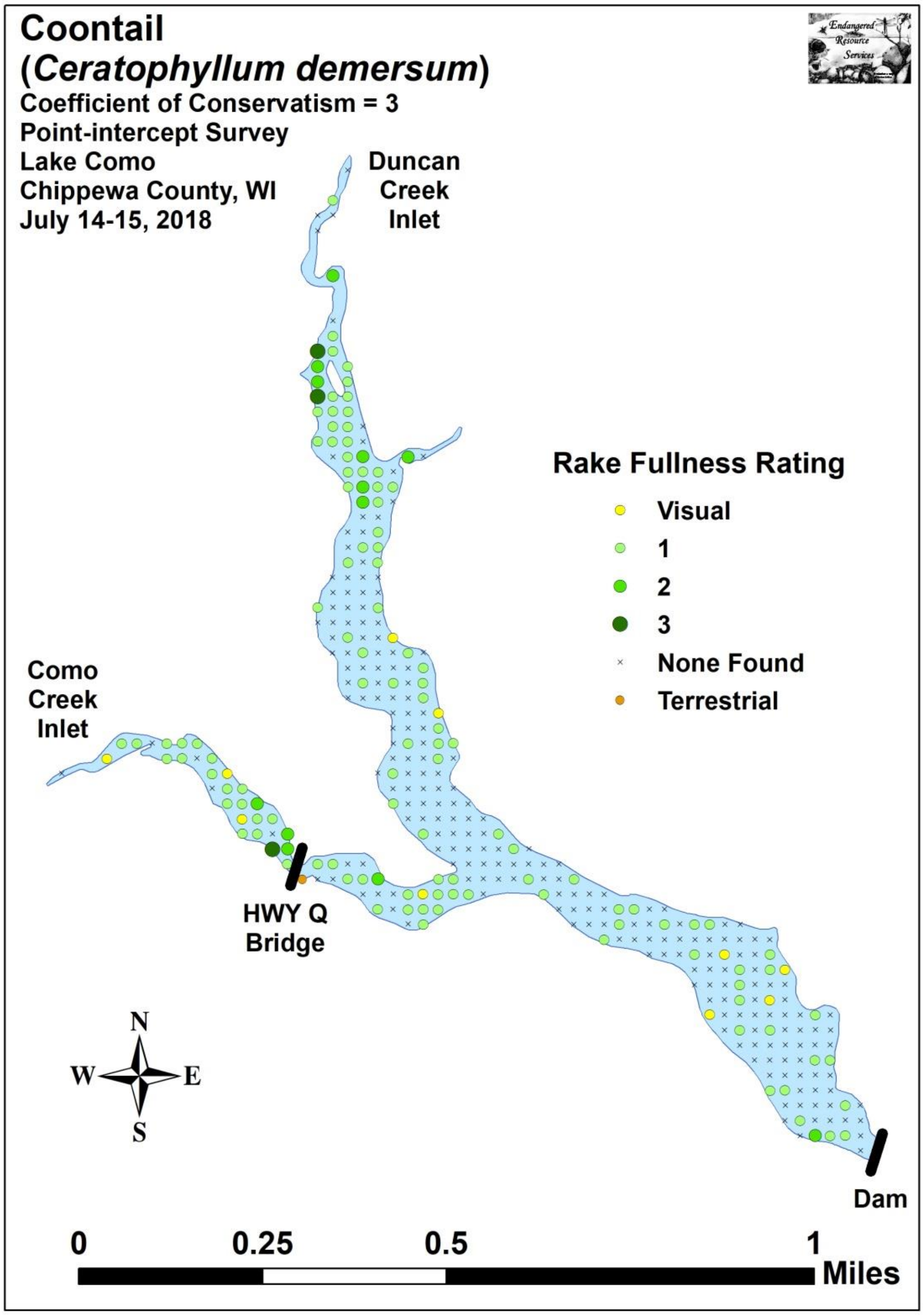

Littoral Zone
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Como Creek Inlet
HWY Q Bridge
Dam
Littoral Zone
Littoral Zone with Plants
>9.5 ft.
Terrestrial
N
W
E
S
0
0.25
0.5
1
Miles

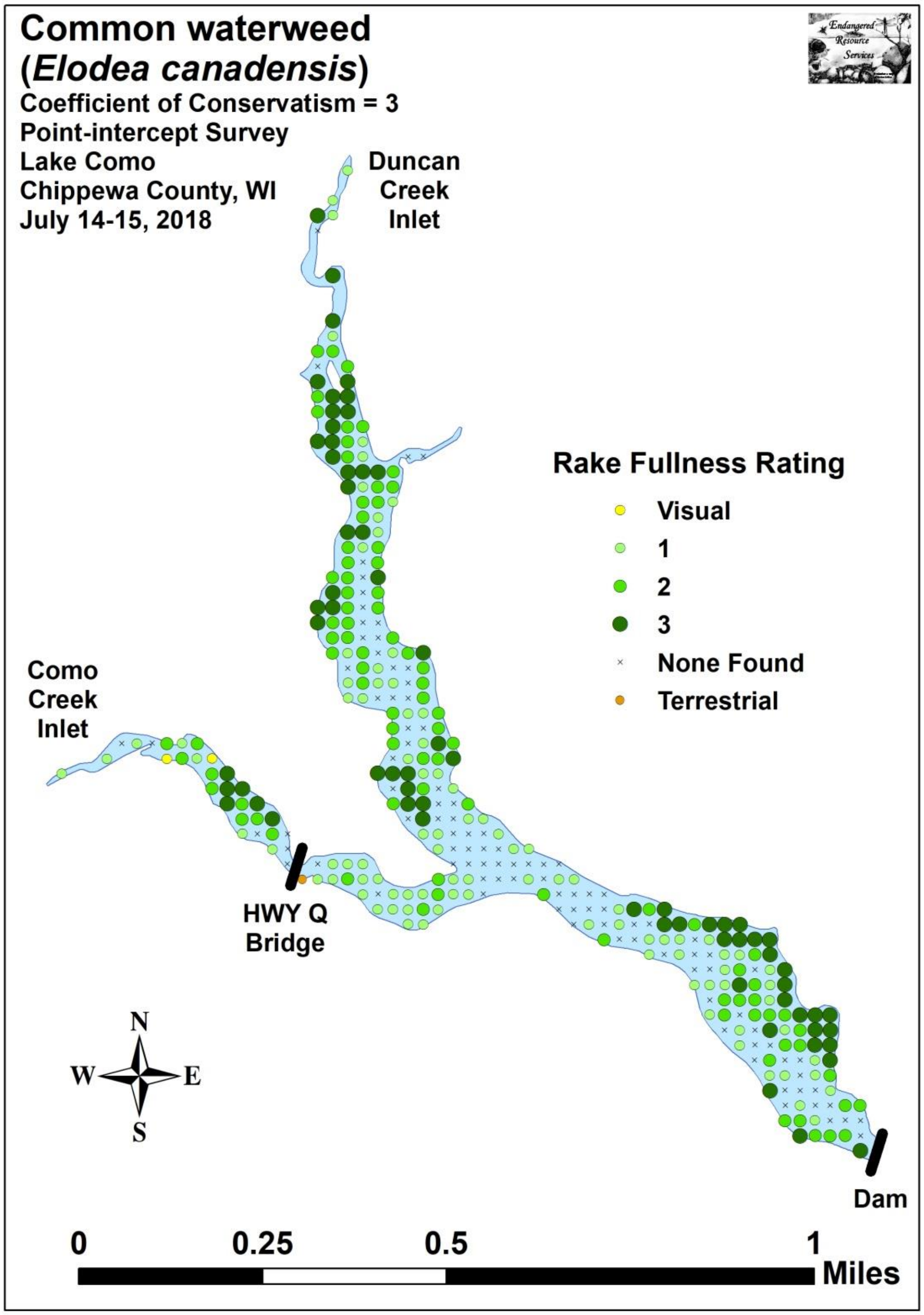

Native Species Richness
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Como Creek Inlet
# of Native Species
Terrestrial
None Found
1
2
3
4
5
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

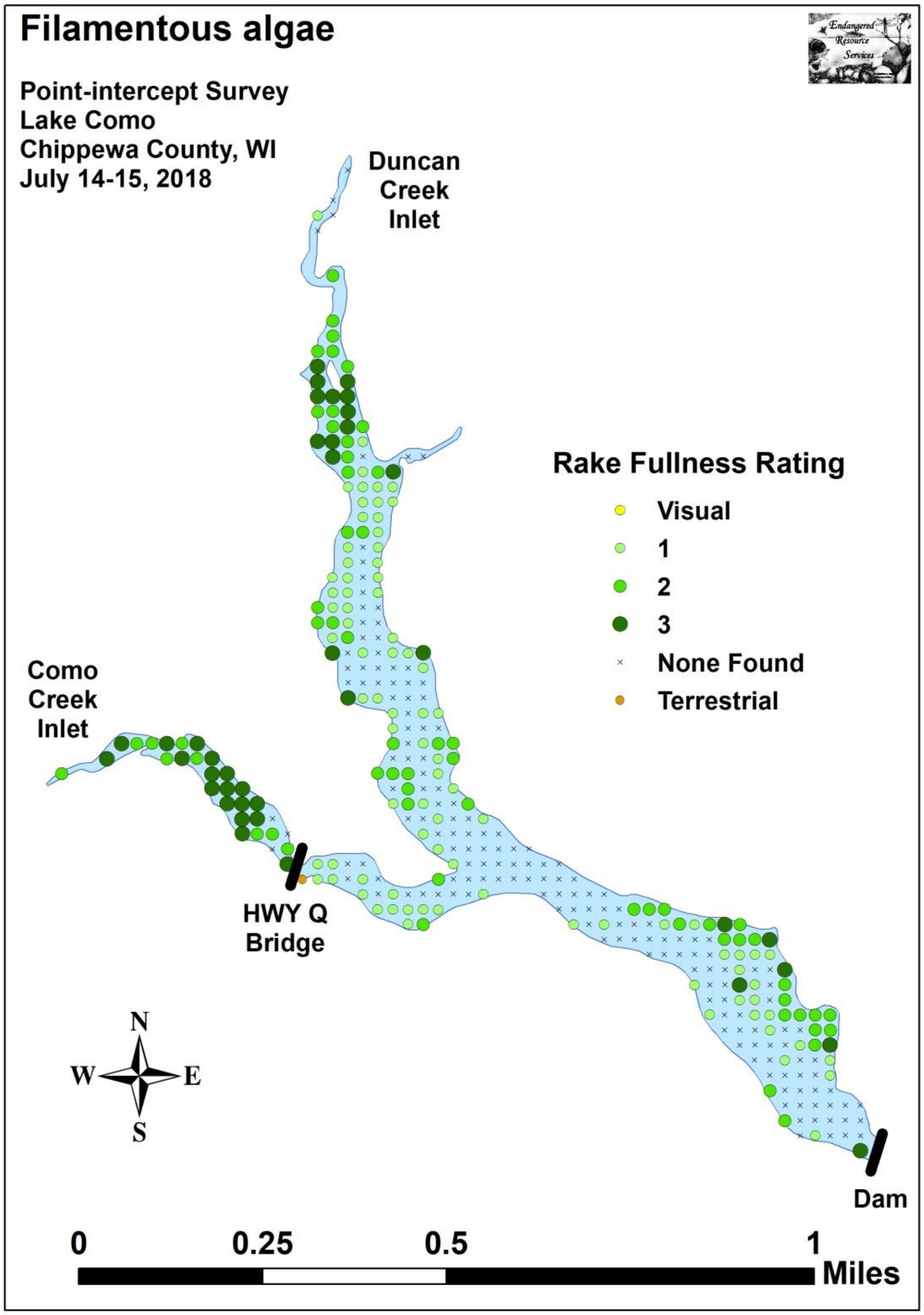

Total Rake Fullness
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Endangered Resource Services
Duncan Creek Inlet
Como Creek Inlet
HWY Q Bridge
Dam
Rake Fullness Rating
1
2
3
None Found
Terrestrial
N
W
E
S
0
0.25
0.5
1
Miles

Appendix VI: July 2018 Species Density and Distribution Maps

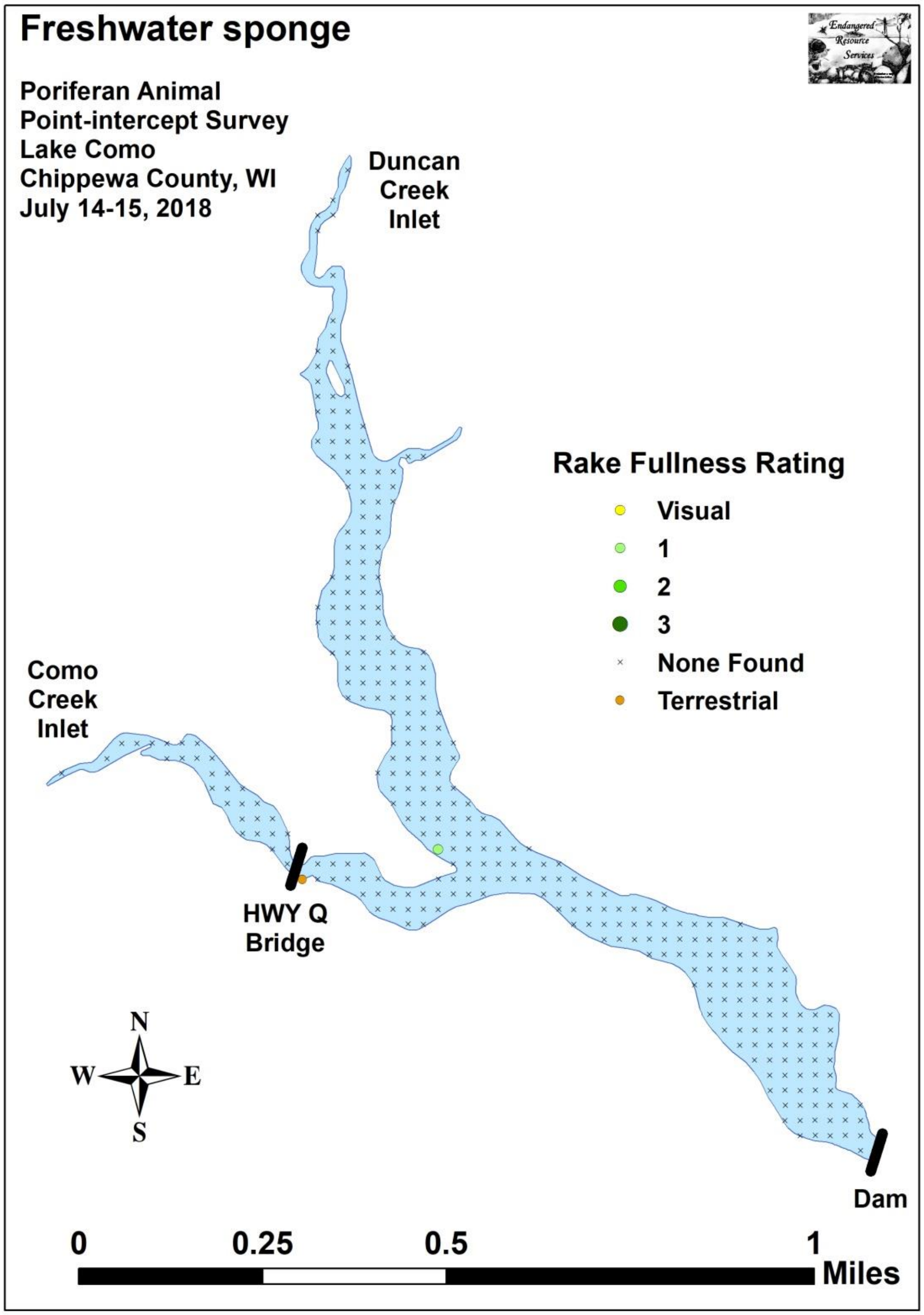

Aquatic moss
Bryophyte
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Como Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
HWY Q Bridge
Dam
N
W
E
S
0
0.25
0.5
1
Miles

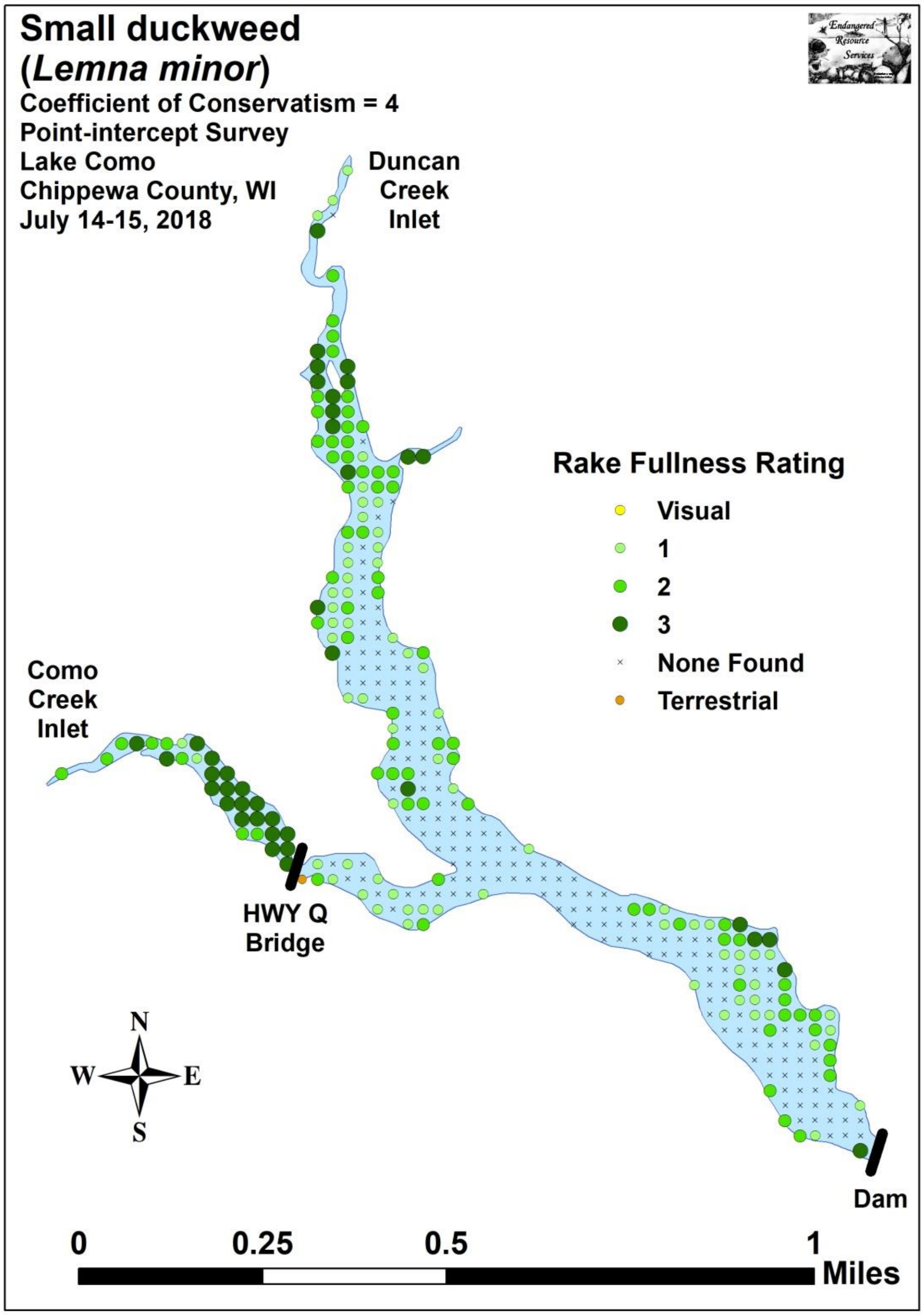

Common waterweed
(*Elodea canadensis*)
Coefficient of Conservatism = 3
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

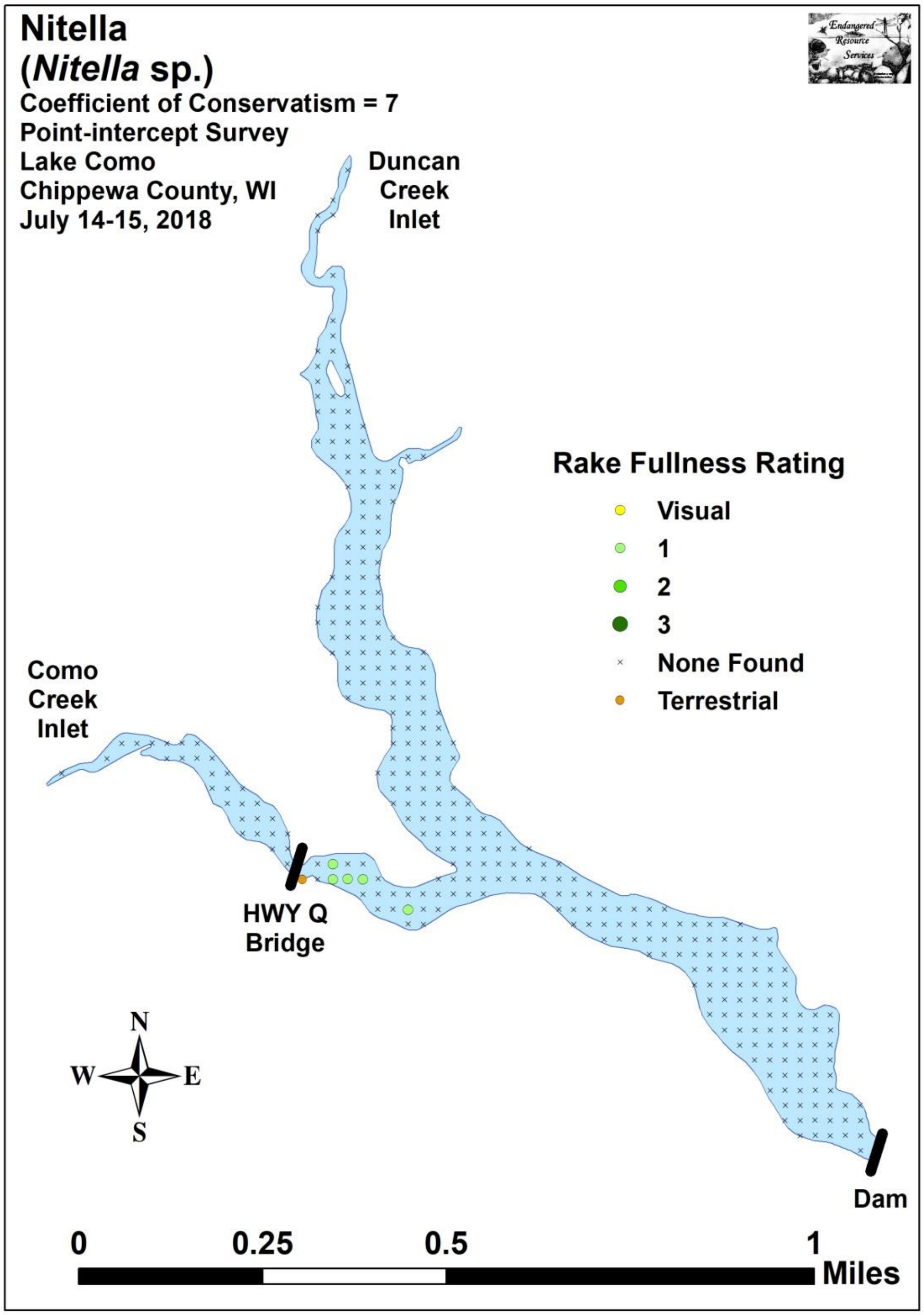


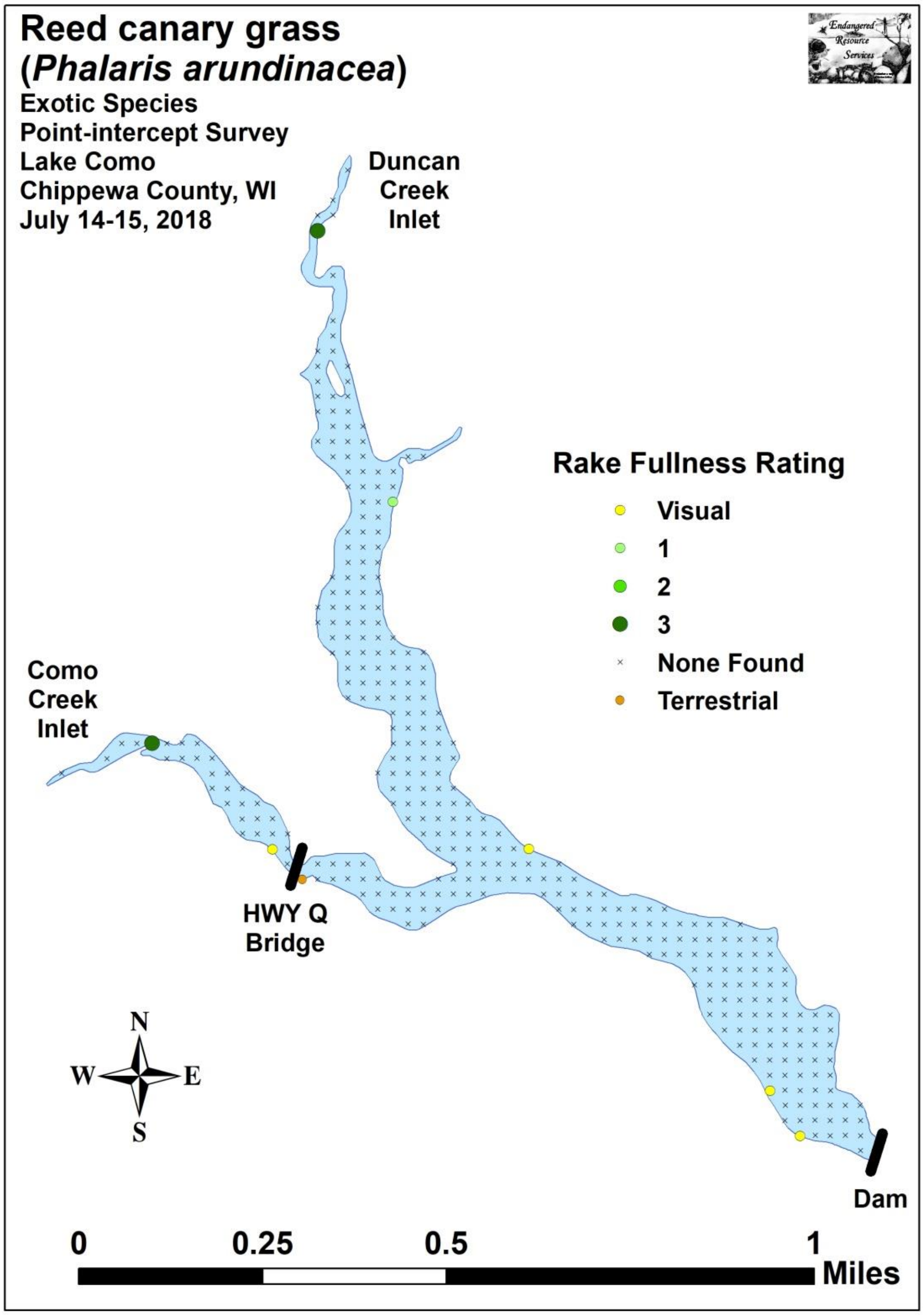
Filamentous algae
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles



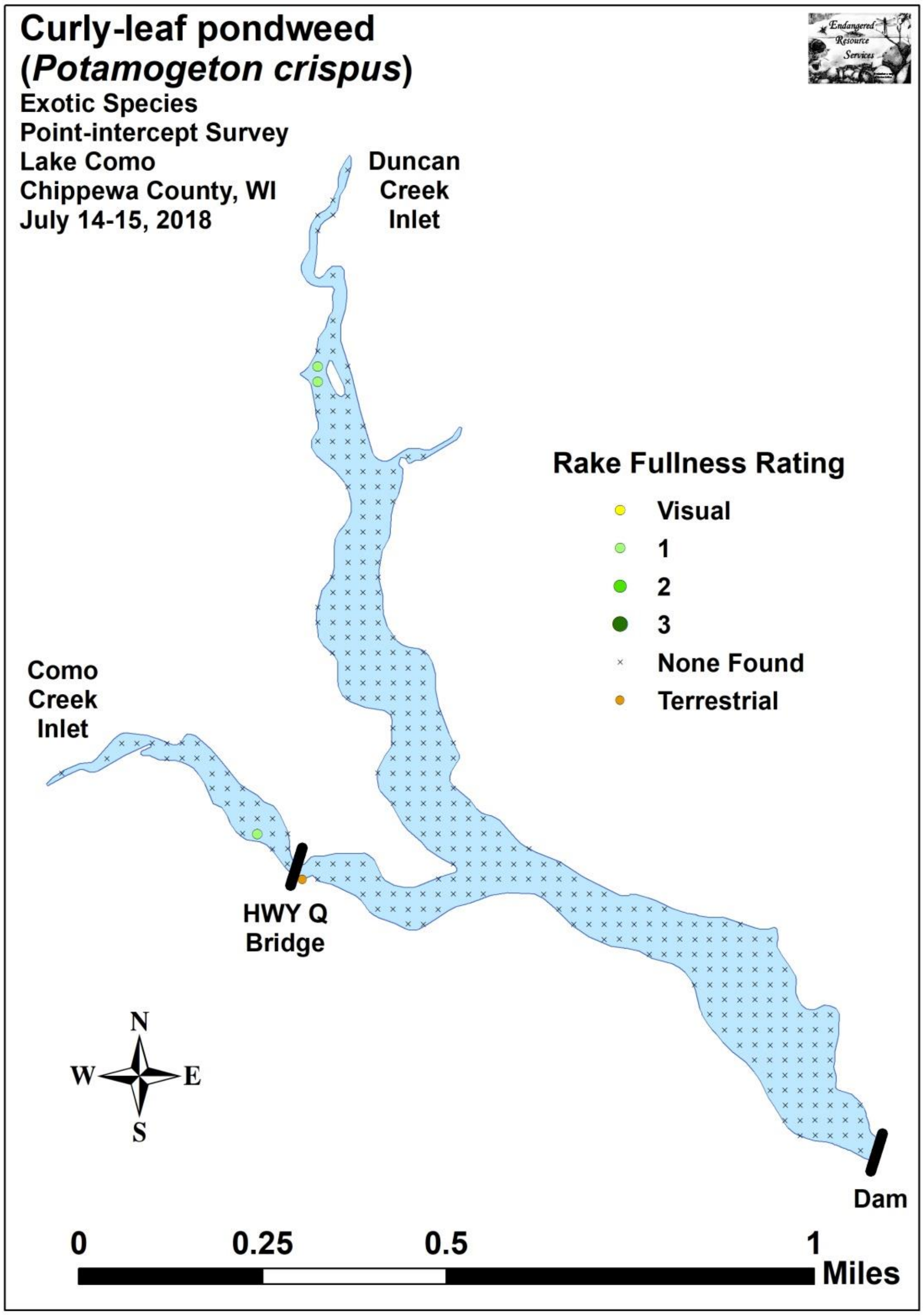
Freshwater sponge
Poriferan Animal
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

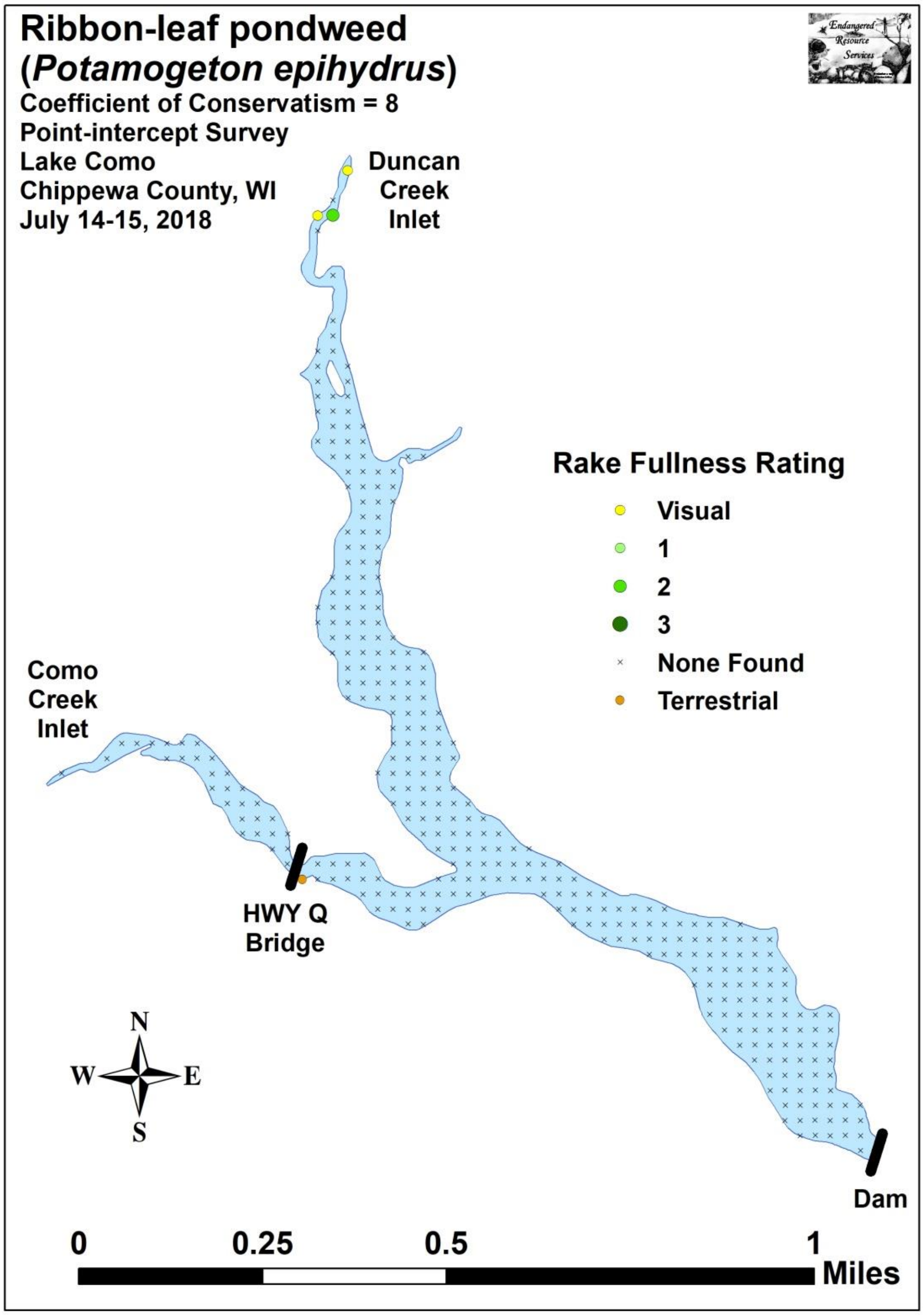

Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Endangered Resource Services
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
Dam
N
W
E
S
0
0.25
0.5
1
Miles

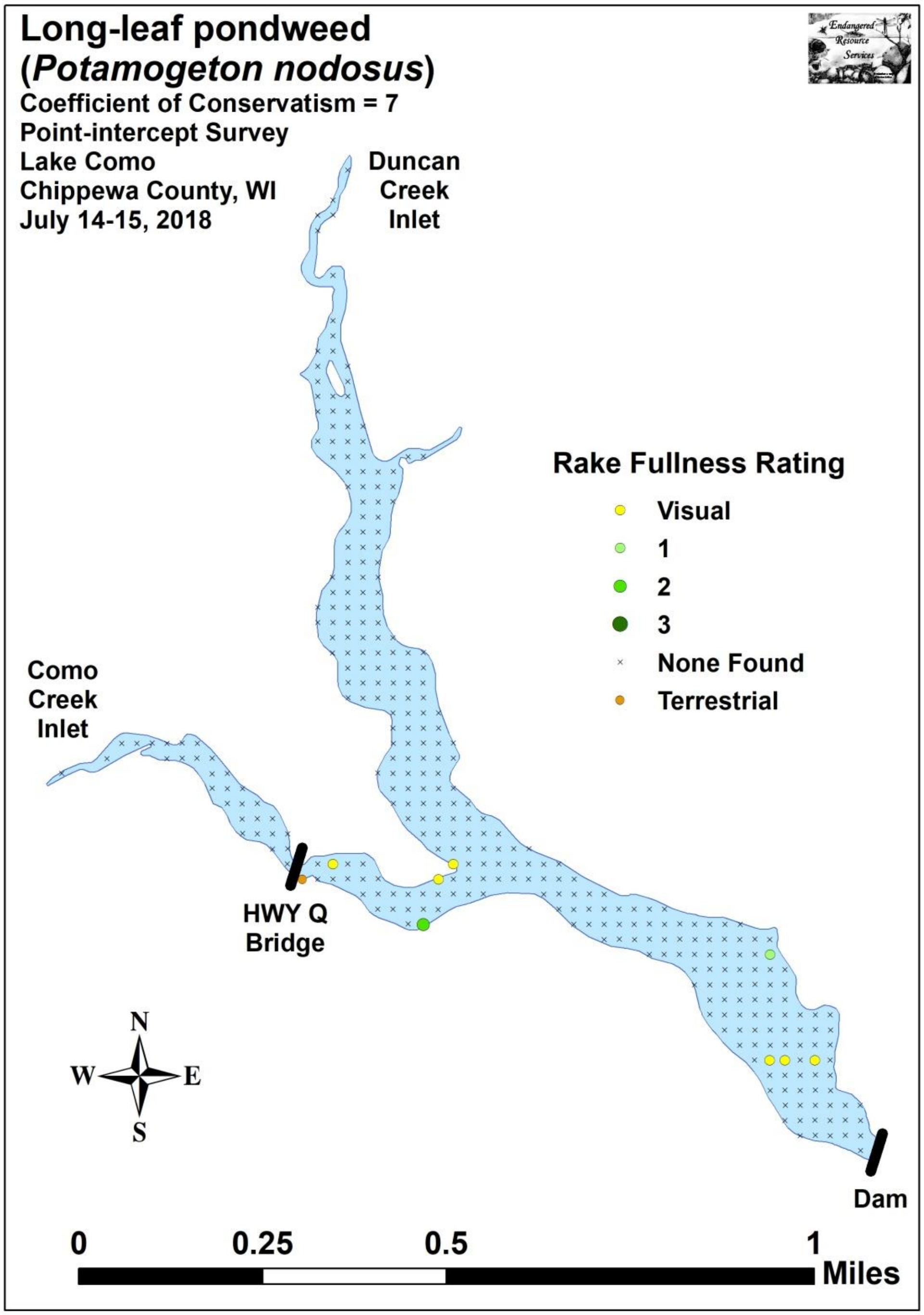

Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Como Creek Inlet
HWY Q Bridge
Dam
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
N
S
E
W
0
0.25
0.5
1
Miles



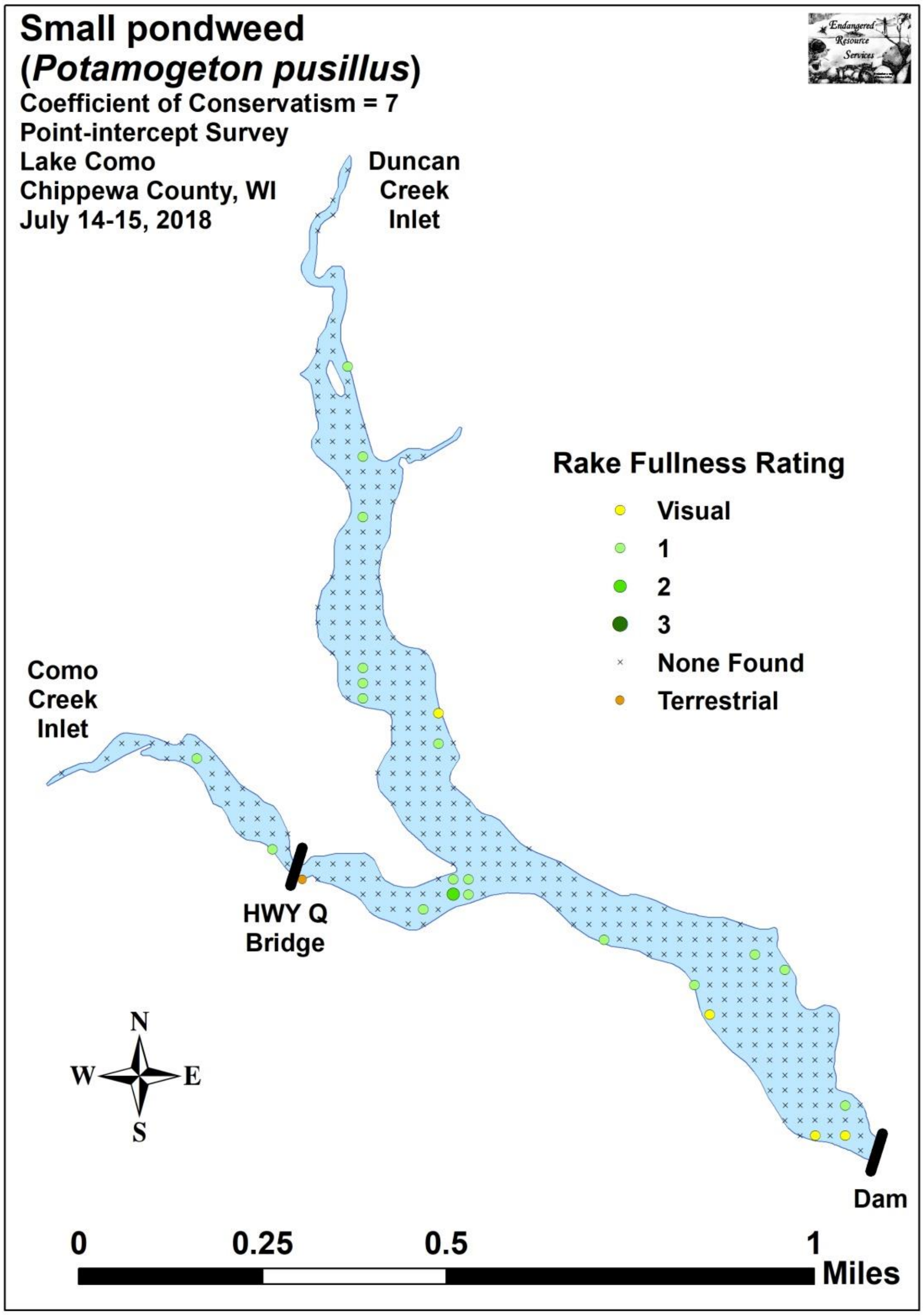
Reed canary grass
(Phalaris arundinacea)
Exotic Species
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Endangered Resource Services
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

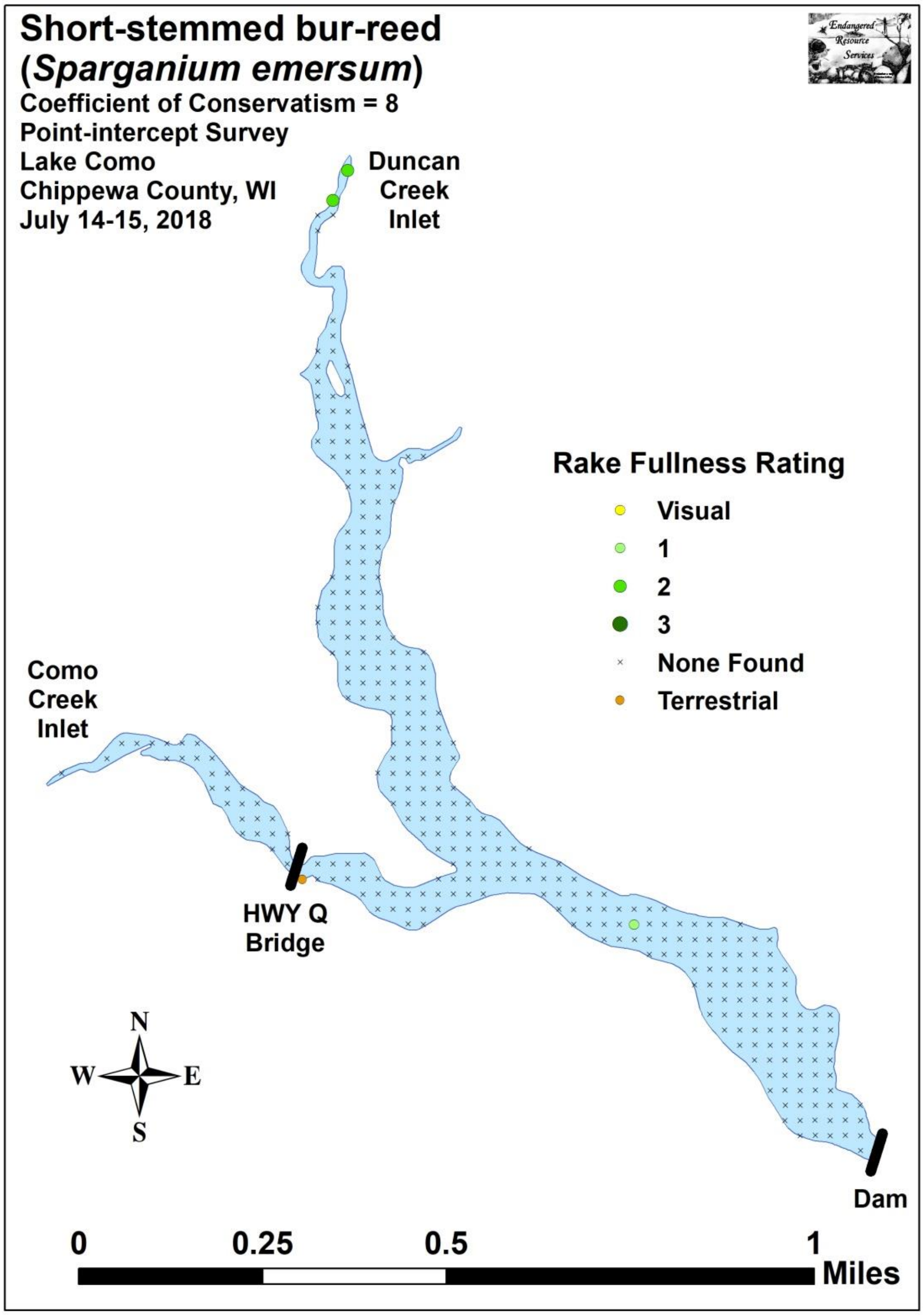

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

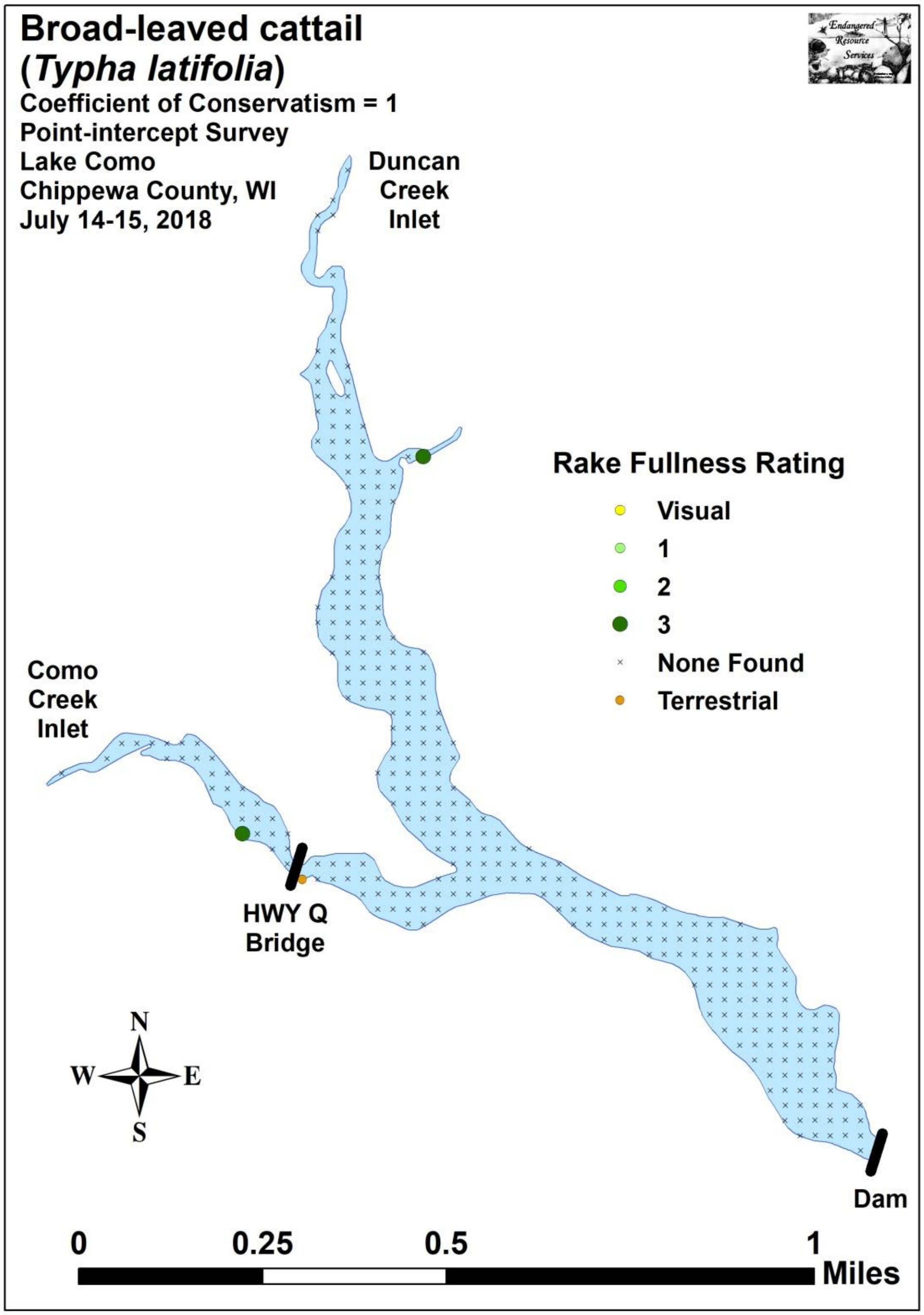

Ribbon-leaf pondweed
(*Potamogeton epihydrus*)
Coefficient of Conservatism = 8
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles

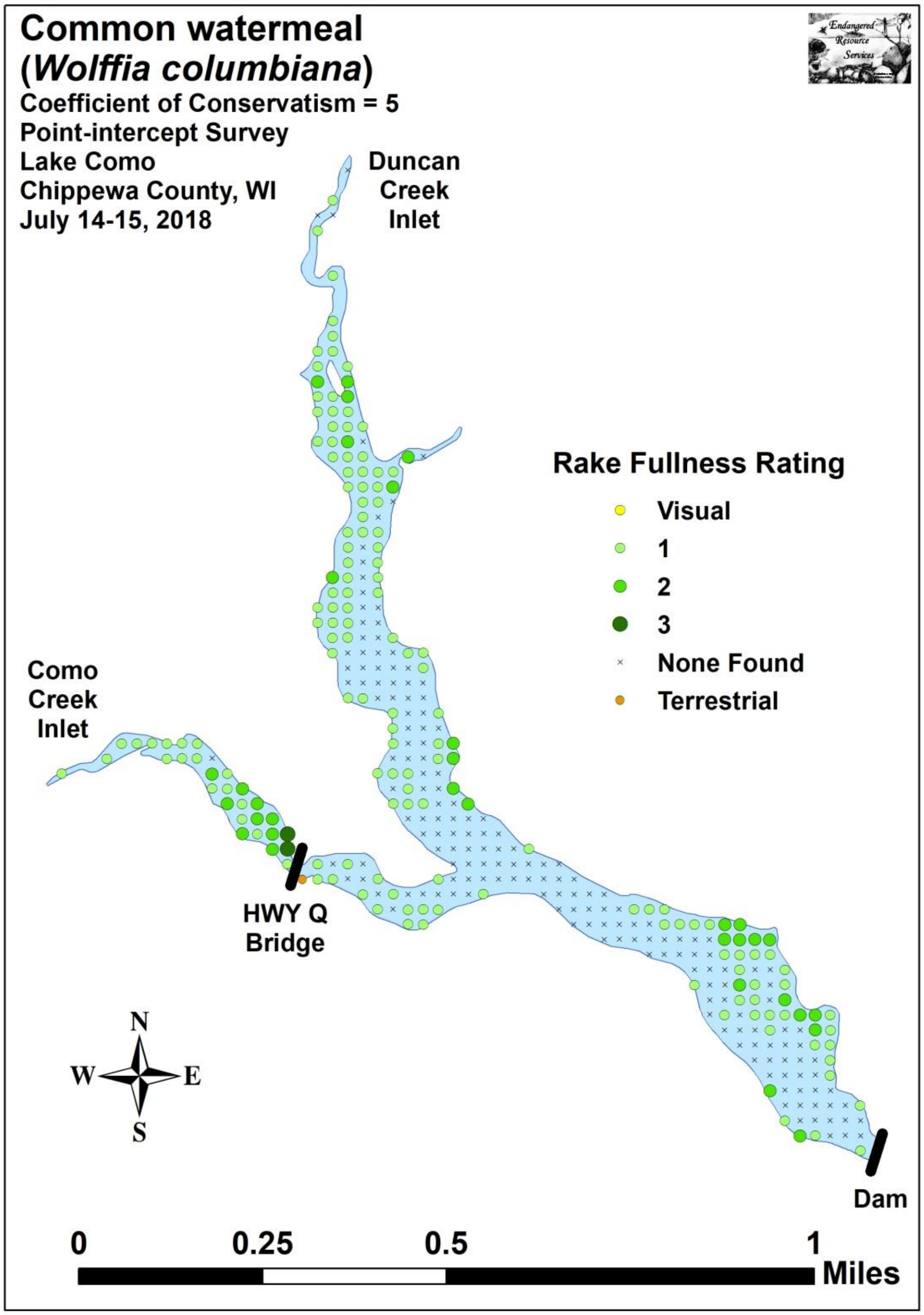


Long-leaf pondweed
(*Potamogeton nodosus*)
Coefficient of Conservatism = 7
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Small pondweed
(*Potamogeton pusillus*)
Coefficient of Conservatism = 7
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan
Creek
Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como
Creek
Inlet
HWY Q
Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Short-stemmed bur-reed
(Sparganium emersum)
Coefficient of Conservatism = 8
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Endangered Resource Services
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Broad-leaved cattail
(Typha latifolia)
Coefficient of Conservatism = 1
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
N
W
E
S
Dam
0
0.25
0.5
1
Miles


Common watermeal
(*Wolffia columbiana*)
Coefficient of Conservatism = 5
Point-intercept Survey
Lake Como
Chippewa County, WI
July 14-15, 2018
Endangered Resource Services
Duncan Creek Inlet
Rake Fullness Rating
Visual
1
2
3
None Found
Terrestrial
Como Creek Inlet
HWY Q Bridge
Dam
N
W
E
S
0
0.25
0.5
1
Miles

Appendix VII: Plant Species Accounts

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: **Aquatic moss**
Specimen Location: Lake Como; N45.11474°, W91.50694°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-001
Habitat/Distribution: Several small patches occurred in the Duncan Creek inlet in <0.5 meter of water over sand/gravel. Scattered individuals were also found along the North City Park shoreline.
Common Associates: (*Callitriche palustris*) Common water starwort, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Ranunculus aquatilis*) White water crowfoot, (*Sparganium emersum*) Short-stemmed bur-reed, (*Nitella* sp.) Nitella

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Callitriche palustris*) **Common water starwort**
Specimen Location: Lake Como; N45.12007°, W91.50875°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-002
Habitat/Distribution: Rare; only plants found were in the Duncan Creek Inlet in water <0.5m deep over sand/gravel substrate.
Common Associates: (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Ranunculus aquatilis*) White water crowfoot, (*Sparganium emersum*) Short-stemmed bur-reed, (*Nitella* sp.) Nitella, Aquatic moss

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Lake Como; N45.10730°, W91.50842°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-003
Habitat/Distribution: Common throughout over muck and sandy muck in <3m of water. The highest densities occurred in the Como and Duncan Creek Inlets.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Lemna minor*) Small duckweed, (*Potamogeton crispus*) Curly-leaf pondweed, (*Potamogeton nodosus*) Long-leaf pondweed, (*Potamogeton pusillus*) Small pondweed, (*Wolffia columbiana*) Common watermeal

County/State**:** Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Lake Como; N45.10730°, W91.50842°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-004
Habitat/Distribution: Common to abundant throughout the lake over all types of bottoms in <3.0m of water. Dense "haystacks" often filled the entire water column in <2.0m of water.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal, (*Potamogeton crispus*) Curly-leaf pondweed, (*Potamogeton pusillus*) Small pondweed

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Iris pseudacorus*) **Yellow iris**
Specimen Location: Lake Como; N45.11672°, W91.50929°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-005
Habitat/Distribution: Only plants seen were at the point where several giant clusters were producing satellite plants along the shoreline.

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Lake Como; N45.11534°, W91.50653°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-006
Habitat/Distribution: Located floating at or just under the surface. Common and widespread in sheltered areas over muck or trapped among floating mats of vegetation.
Common Associates: (*Elodea canadensis*) Common waterweed, (*Ceratophyllum demersum*) Coontail, (*Wolffia columbiana*) Common watermeal, (*Potamogeton crispus*) Curly-leaf pondweed

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Nitella* sp. likely *flexilis*) **Nitella**
Specimen Location: Lake Como; N45.10643°, W91.50630°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-007
Habitat/Distribution: Uncommon, but widely distributed. Most plants were in the Como Creek Inlet downstream from the CTH Q bridge and in the far upstream end of the Duncan Creek Inlet.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed, (*Elodea canadensis*) Common waterweed, (*Potamogeton nodosus*) Long-leaf pondweed

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Myosotis scorpioides*) **Common forget-me-not**
Specimen Location: Lake Como; N45.10636°, W91.50197°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-008
Habitat/Distribution: Muck bottom at the shoreline. A few scattered patches were located in the south basin downstream from the main west side boat landing.
Common Associates: (*Phalaris arundinacea*) Reed canary grass

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Lake Como; N45.10960°, W91.51393°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-009
Habitat/Distribution: Scattered throughout in adjacent wetlands, and in disturbed habitats at the immediate shoreline in water <0.25m deep.
Common Associates: (*Typha latifolia*) Broad-leaved cattail

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Potamogeton crispus*) **Curly-leaf pondweed**
Specimen Location: Lake Como; N45.11976°, W91.50917°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-010
Habitat/Distribution: Uncommon over muck in <1.5m. Most plants were located in the north lobe near the Duncan Creek Inlet or scattered around the Como Creek Inlet upstream from the CTH Q Bridge.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Potamogeton epihydrus*) **Ribbon-leaf pondweed**
Specimen Location: Lake Como; N45.12007°, W91.50875°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-011
Habitat/Distribution: Rare; only plants found were in the Duncan Creek Inlet in water <1m deep over sand/gravel substrate.
Common Associates: (*Callitriche palustris*) Common water starwort, (*Ranunculus aquatilis*) White water crowfoot, (*Sparganium emersum*) Short-stemmed bur-reed, (*Nitella* sp.) Nitella, Aquatic moss

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Potamogeton nodosus*) **Long-leaf pondweed**
Specimen Location: Lake Como; N45.10730°, W91.50842°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-012
Habitat/Distribution: Scattered clusters were regularly encountered in shallow areas <1.5m deep with flowing water; especially near the Como Creek Inlet downstream from the CTH Q Bridge.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed, (*Elodea canadensis*) Common waterweed, (*Nitella* sp.) Nitella

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Potamogeton pusillus pusillus*) **Small pondweed**
Specimen Location: Lake Como; N45.10705°, W91.50464°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-013
Habitat/Distribution: Uncommon, but widely distributed along the north half of the lake over sand and muck in water <2.5m deep.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Lemna minor*) Small duckweed, (*Wolffia columbiana*) Common watermeal, (*Potamogeton nodosus*) Long-leaf pondweed, (*Nitella* sp.) Nitella

County/State: Chippewa County, Wisconsin **Date:** 9/29/18
Species: (*Ranunculus aquatilis*) **White water crowfoot**
Specimen Location: Lake Como; N45.12007°, W91.50875°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-014
Habitat/Distribution: Rare; only plants found were in the Duncan Creek Inlet in water <.5m deep over sand/gravel substrate.
Common Associates: (*Callitriche palustris*) Common water starwort, (*Potamogeton epihydrus*) Ribbon-leaf pondweed, (*Sparganium emersum*) Short-stemmed bur-reed, Aquatic moss

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Lake Como; N45.11888°, W91.50872°
Collected/Identified by: **Matthew S. Berg** **Col. #:** MSB-2018-015
Habitat/Distribution: Found in <0.25m over firm muck and sand. Only plants seen were in the Duncan Creek Inlet at the point.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Typha latifolia*) Broad-leaved cattail

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Sparganium emersum*) **Short-stemmed bur-reed (likely)**
Specimen Location: Lake Como; N45.12007°, W91.50875°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2018-016
Habitat/Distribution: Found in <1m over firm muck and sand. All plants were in the Duncan Creek Inlet. Unfortunately, none were in fruit in July or when we checked back in August/September. All plants had keeled floating leaves/none were truly emergent.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Typha latifolia*) Broad-leaved cattail, (*Callitriche palustris*) Common water starwort, (*Potamogeton epihydrus*) Ribbon-leaf pondweed

County/State: Chippewa County, Wisconsin **Date:** 9/29/18
Species: (*Typha angustifolia*) **Narrow-leaved cattail**
Specimen Location: Lake Como; N45.10695°, W91.50283°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2018-017
Habitat/Distribution: A single patch occurred immediately north of the main public boat landing on the lake's west side. Plants were at the shoreline in and out of water <0.25 m deep.
Common Associates: (*Phalaris arundinacea*) Reed canary grass

County/State: Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Lake Como; N45.11534°, W91.50653°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2018-018
Habitat/Distribution: Scattered along undeveloped shorelines in thick muck soil in and out of water <0.25m deep.
Common Associates: (*Phalaris arundinacea*) Reed canary grass, (*Schoenoplectus tabernaemontani*) Softstem bulrush

County/State**:** Chippewa County, Wisconsin **Date:** 7/15/18
Species: (*Wolffia columbiana*) **Common watermeal**
Specimen Location: Lake Como; N45.11534°, W91.50653°
Collected/Identified by: Matthew S. Berg Col. #: MSB-2018-019
Habitat/Distribution: Located floating at or just under the surface. Common and widespread in sheltered areas over muck or trapped among floating mats of vegetation.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Elodea canadensis*) Common waterweed, (*Lemna minor*) Small duckweed, (*Potamogeton crispus*) Curly-leaf pondweed

Appendix VIII: Aquatic Exotic Invasive Plant Species Information

Eurasian Water-milfoil

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

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

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

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

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

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

Curly-leaf pondweed

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

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

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

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

Reed canary grass

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

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

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

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

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

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

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

Purple loosestrife
(Photo Courtesy Brian M. Collins)

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

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

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

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

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

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

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

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

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

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

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

Aquatic:

organisms that live in or frequent water.

Cultural Eutrophication:

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

Dissolved Oxygen (DO):

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

Diversity:

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

Drainage lakes:

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

Ecosystem:

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

Eutrophication:

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

Exotic:

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

Habitat:

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

Limnology:

the study of inland lakes and waters.

Littoral:

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

Macrophytes:

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

Nutrients:

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

Organic Matter:

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

Photosynthesis:

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

Phytoplankton:

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

Plankton:

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

ppm:

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

Richness:

number of species in a particular community or habitat.

Rooted Aquatic Plants:

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

Runoff:

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

Secchi Disc:

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

Seepage lakes:

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

Turbidity:

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

Watershed:

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

Zooplankton:

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

Appendix X: July 2018 Raw Data Spreadsheets