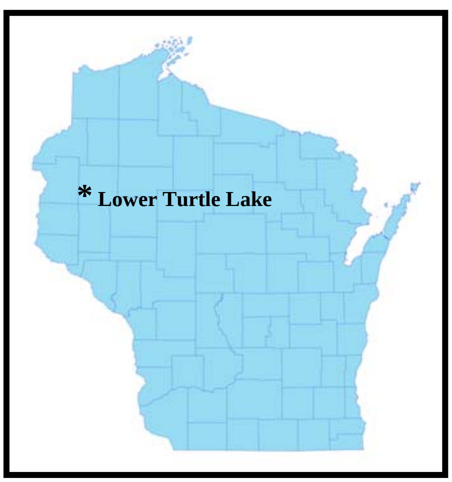
Aquatic Macrophyte Survey for Lower Turtle Lake Barron County, Wisconsin WBIC: 2692900


White Water Lily

Project Sponsored by:
The Lower Turtle Lake Management District




Wild Celery in Bloom

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Summer 2008

TABLE OF CONTENTS

ABSTRACT

Lower Turtle Lake (WBIC 2692900) is a 276-acre drainage water body in west-central Barron County. It is eutrophic in nature with maximum summer Secchi readings ranging from 2-4ft, and a littoral zone that extends to 8ft. A desire to determine the level of Curly-leaf pondweed (*Potamogeton crispus*) infestation and decide what, if any, management of CLP would be appropriate, prompted members of the Lower Turtle Management District to authorize two surveys of aquatic macrophytes in 2008. The early season survey found CLP at 51 points throughout the lake or approximately 10.6% of the lake's surface. Of these locations, 29 points rated a 2 or a 3 meaning that 6.1% of the lake's surface had a sizable infestation. The full point intercept survey found macrophytes at 112 of the 479 survey points (23.4%) of Lower Turtle Lake. We identified a total of 24 plants to species in and immediately adjacent to the lake that produced a below average mean Coefficient of Conservatism of 5.0 and a slightly above average Floristic Quality Index value of 24.5. Flat-stem pondweed (*Potamogeton zosteriformis*), Wild celery (*Vallisneria americana*), Coontail (*Ceratophyllum demersum*) and Fries' pondweed (*Potamogeton friesii*) were the most common species in the lake being found at 69.64%, 50.89%, 46.43% and 38.39% of survey points with vegetation respectively. Future management goals should include maintaining the lake's plant community and working to improve water clarity and quality by reducing algal blooms. Completing an Aquatic Plant Management Plan, identifying nutrient sources and working to reduce the nutrient load coming into the lake, restoring shorelines, adding buffer strips of native vegetation, continuing to educate boaters and residents about the threat of Aquatic Invasive Species, and monitoring for Eurasian water milfoil (*Myriophyllum spicatum*) in transects parallel to the shore at the east boat launch at least once a month during the summer are management ideas for the Lake District to consider moving forward.

ACKNOWLEDMENTS

We wish to thank the Lower Turtle Management District for funding this project; Jennifer Hauxwell, WDNR for technical assistance, and Whitney Johnson, Jessica Ilgen and Mitchel and Noah Berg for assistance in conducting this survey.

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION:

Lower Turtle Lake (WBIC 2692900) is a 276 acre, drainage lake in west-central Barron County, Wisconsin in the Town of Almena (T33N R14W S02 NW NW). It achieves a maximum depth of 24ft in the central basin, and has an average depth of approximately 15ft. Lower Turtle Lake is eutrophic (nutrient rich) with very poor water clarity. Normal summer Secchi readings range from 2-4ft (WDNR 2008), and the littoral zone extends to 8ft. The bottom substrate is predominately sand, and sandy muck, with organic muck in the north and south bays, and scattered gravel bars throughout.

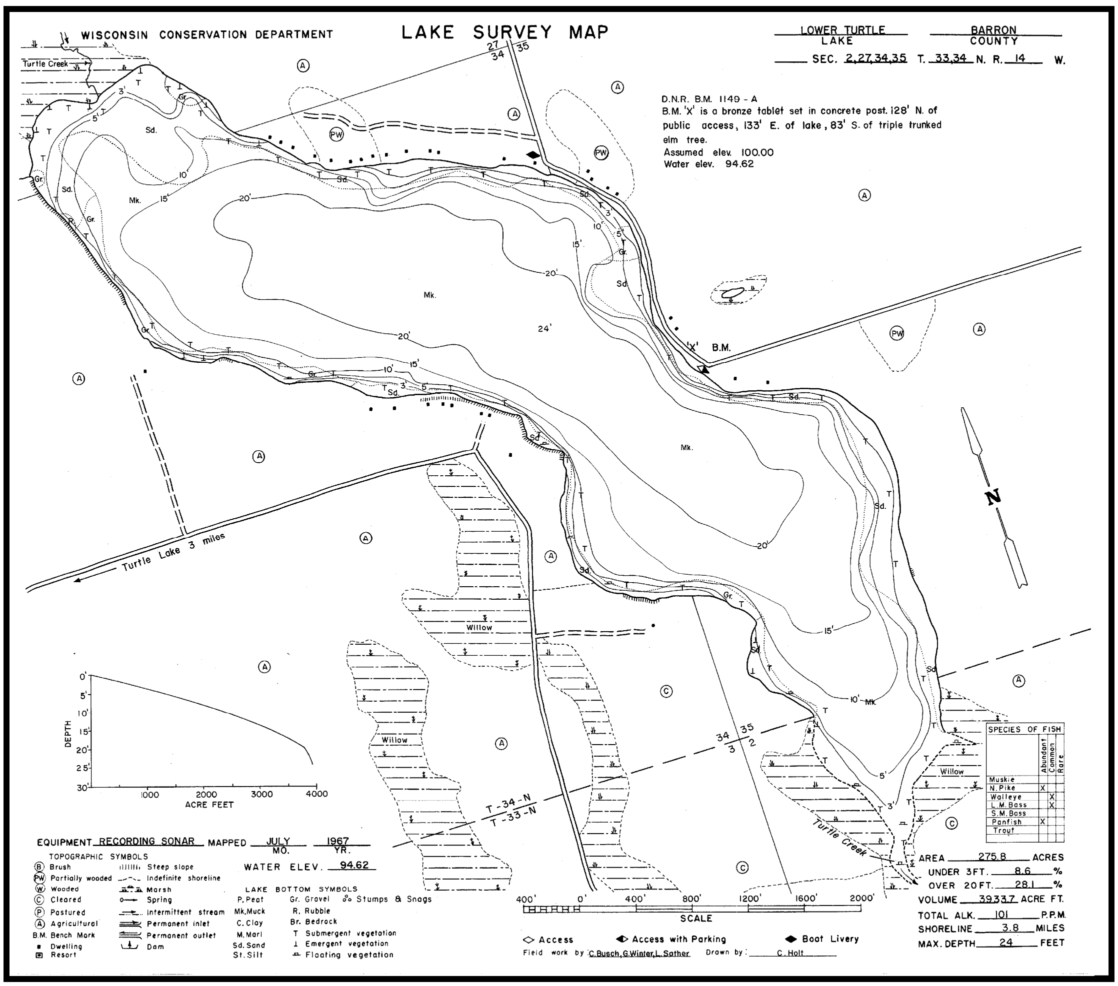

Figure 1: Lower Turtle Lake Map (Busch, C., et al. 1967).

A desire to determine the level of Curly-leaf pondweed (*Potamogeton crispus*) (CLP) infestation, and decide what, if any, management of CLP would be appropriate, prompted members of the Lower Turtle Management District to authorize a survey of aquatic macrophytes using the Wisconsin Department of Natural Resources (WDNR) statewide guidelines for conducting systematic point intercept macrophyte sampling. The guidelines ensure that all sampling in the state will be conducted in the same manner, thus allowing data to be compared across time and space. This report represents the summary analysis of the data collected during two surveys of Lower Turtle Lake in June and July of 2008. The immediate goals of the project were to map the abundance and distribution of CLP, determine if Eurasian water milfoil (*Myriophyllum spicatum*) had invaded the lake and to establish baseline data on the diversity, abundance and distribution of native aquatic plant populations. These data provide a baseline for long-term monitoring of the lake's macrophyte community.

PLANT SURVEY METHODS:

June Cold Water Curly-leaf pondweed Survey:

Using a standard formula that takes into account the shoreline shape and distance, islands, water clarity, depth and total lake acres, Jennifer Hauxwell (WDNR) generated a sampling grid for the lake (Appendix I). In June, we conducted a Curly-leaf pondweed survey to determine the distribution and density of this invasive species. This survey randomly selects 100 points that are likely to have Curly-leaf pondweed growing near them if it is present. If the target species is found, additional points are added to the survey so that a positive point ultimately is completely boxed in with negative survey points before moving on to the next random point. This rapid survey should result in both detection and approximate mapping of the infestation.

July Warm Water Full Point/Intercept Survey:

On July 18th, prior to beginning the point intercept survey, we conducted a general boat survey of Lower Turtle Lake to gain familiarity with the species present (Appendix II). All plants found were identified (Voss 1996; Boreman et al. 1997; Chadde 2002; Crow and Hellquist 2006), and two vouchers were pressed and retained for herbarium specimens – one to be retained by the Lower Turtle Management District, and one to be sent to the state for identification confirmation. During the point intercept survey, we located each survey point using a handheld mapping GPS unit (Garmin 76Cx). At each point, we recorded a depth reading with a Polar Vision hand held sonar unit. Following the establishment of the littoral zone at 8ft., we sampled for plants within the depth range of plant growth. At each of these points, we used a rake on a pole to sample an approximately 2.5ft. section of the bottom. All plants on the rake, as well as any that were dislodged by the rake were identified, and assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of plants within six feet of the sample point. Substrate (lake bottom) type was assigned at each site where the bottom was visible or it could be reliably determined using the rake.

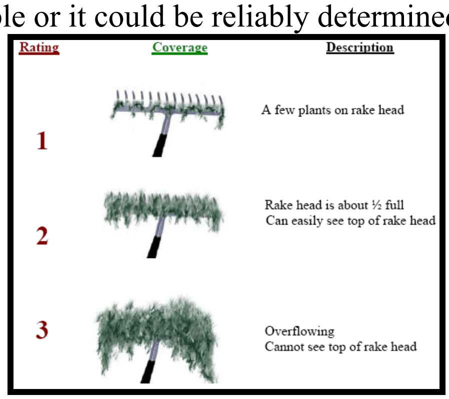

Figure 2: Rake Fullness Ratings (UWEX, 2008)

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix III) (UWEX, 2008). From this, we calculated the following:

Total number of points sampled: This included the total number of points on the lake coverage (Appendix I). Although depth measurements are taken at all points, only those points that were within the littoral zone (0-maximum depth where plants are found) were sampled for plants. Once we established this maximum depth, most points beyond this depth were not rake sampled.

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 lake's littoral zone has plants.

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

Frequency of occurrence example:

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

This means that Plant A's frequency of occurrence = 10% considering the entire lake sample.

Plant A is sampled at 70 out of 350 total points in the littoral zone = 70/350 = .20 = 20%

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

From these frequencies, we can estimate how common each species was throughout the lake, and how common the species was at depths where plants were able to grow. Note the second value will be greater as not all the points (in this example, only ½) occur at depths shallow enough for plant growth.

<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 individuals (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>Number of sites sampled using rope/pole rake:</u> This indicates which rake type was used to take a sample. Protocol suggests a 15ft pole rake, and a 25ft rope rake for sampling (Wagoner personal communication).

<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** indicates 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 during the point intercept survey and the initial boat survey.

<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.

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 frequency will add up to 100%. Organizing species from highest to lowest relative frequency value (Tables 3 and 4) gives us an idea of which species are most important within the macrophyte community.

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. 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 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 species found in the lake during the point intercept and boat surveys, and multiplying the Mean C 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. Lower Turtle Lake is in the North Central Hardwood Forests Ecoregion.

RESULTS:

June Cold Water Curly-leaf pondweed Survey:

We located Curly-leaf pondweed at 51 points throughout the lake. This approximated to slightly more than 10.6% of the lake's surface (Figure 3) (Appendix VIII). Of these locations, 29 points rated a 2 or a 3 meaning that 6.1% of the lake's surface had a sizable infestation. These points were almost exclusively located in the north and south bays surrounding the Turtle Creek inlet and outlet over CLP's preferred habitat of thick organic muck. We also noticed there were few cabins along the lake directly adjacent to these beds. Although CLP was also widely distributed in the shallow sand flats along the highly developed eastern shoreline, this habitat did not support dense growth. By July, most of the plants had senesced, and we only documented 18 points with CLP of which none rated a 2 or 3.

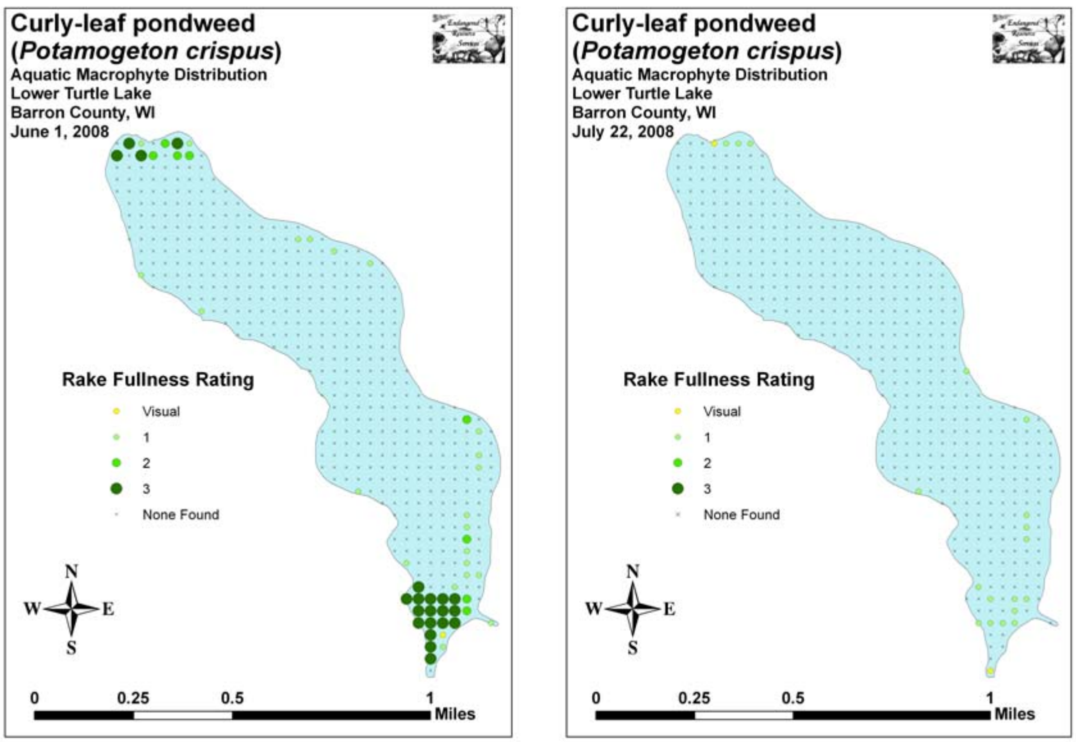

Figure 3: CLP June and July Distribution

July Warm Water Full Point/Intercept Survey:

We surveyed 479 points for depth (Figure 4). The lake forms an elongated bowl with gently sloping north/south bays and rapid east/west drop-offs into a 20+ft. muck bottom flat that extends most of the length of the lake. Of the 142 points where we measured bottom substrate in or immediately adjacent to the littoral zone, 50.0% were organic muck, 44.4% were sand, and 5.6% were rock (Figure 5) (Appendix IV). This topography resulted in expansive plant beds in the north and south bays around the Turtle Creek inlet and outlet where shallow water and thick organic muck promoted both plant density and species richness. The sandy/rocky bottom and relatively narrow littoral zone along most of the east and west sides supported relatively fewer species in lower densities.

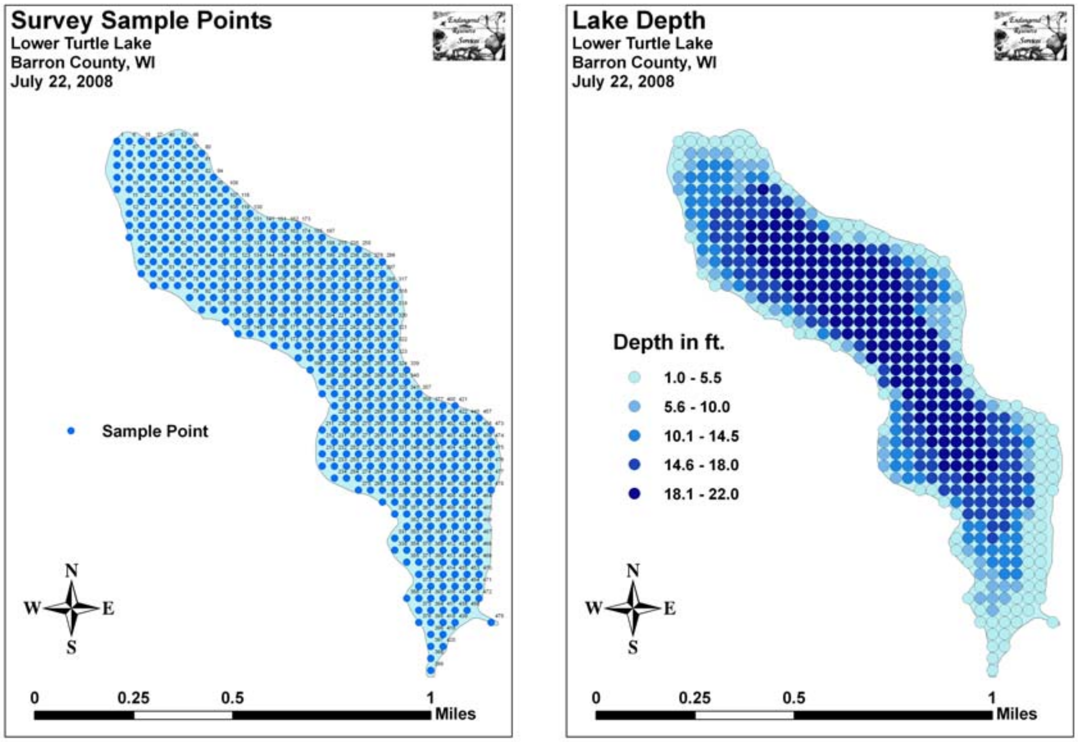

Figure 4: Survey Sample Points and Lake Depth

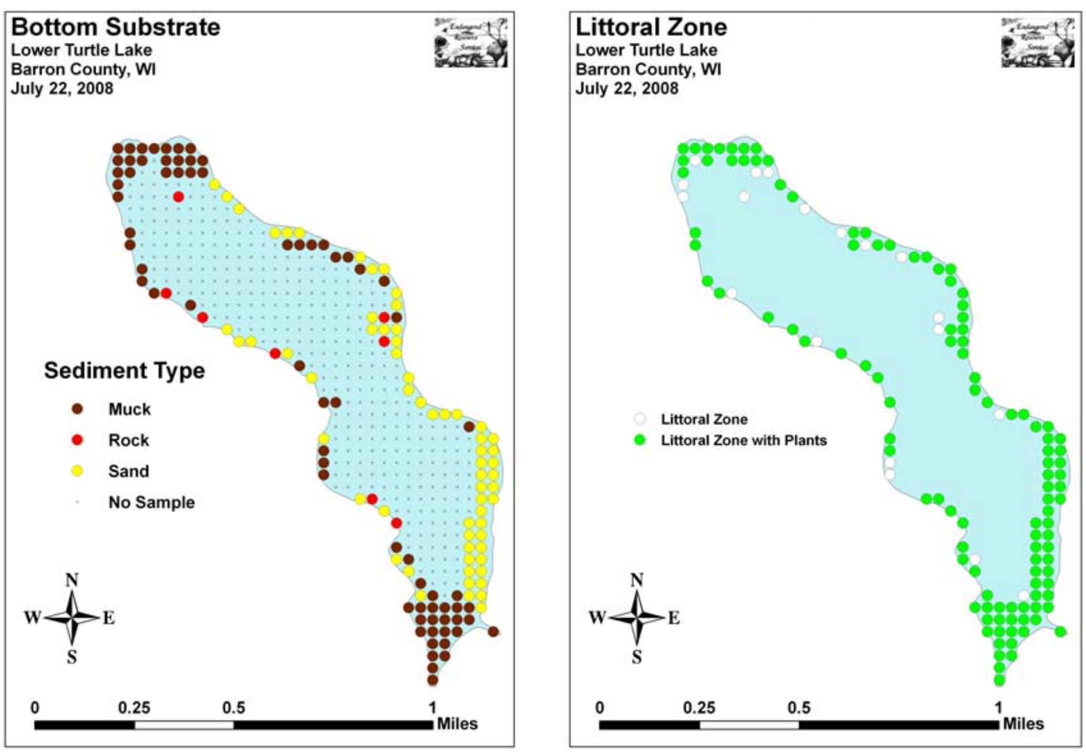

Figure 5: Lake Bottom Substrate and Littoral Zone

We found plants growing on approximately 23.4% of the entire lake bottom, and in 85.5% of the littoral zone (Table 1). Diversity was high with a Simpson Diversity Index value of 0.88. Species richness was average with 27 total species found growing in and immediately adjacent to the lake (Appendix V and VI). The majority of aquatic macrophytes were found growing in shallow water with a mean depth of 3.8ft, and a median depth 3.5ft.

Table 1: Aquatic Macrophytes Survey Summary Statistics Lower Turtle Lake, Barron County July 2008

Summary Statistics:

Total number of points sampled	479
Total number of sites with vegetation	112
Total number of sites shallower than the maximum depth of plants	131
Frequency of occurrence at sites shallower than maximum depth of plants	85.50
Simpson Diversity Index	0.88
Maximum depth of plants (ft)	8.00
Number of sites sampled using rope rake (R)	0
Number of sites sampled using pole rake (P)	142
Average number of all species per site (shallower than max depth)	2.95
Average number of all species per site (veg. sites only)	3.46
Average number of native species per site (shallower than max depth)	2.82
Average number of native species per site (veg. sites only)	3.29
Species Richness	18
Species Richness (including visuals)	19
Species Richness (including visuals and boat survey)	27
Mean depth of plants (ft)	3.8
Median depth of plants (ft)	3.5

Flat-stem pondweed (*Potamogeton zosteriformis*), Wild celery (*Vallisneria americana*), Coontail (*Ceratophyllum demersum*) and Fries' pondweed (*Potamogeton friesii*) were the most common species in the lake being found at 69.64%, 50.89%, 46.43% and 38.39% of survey points with vegetation respectively (Figure 6) (Table 2). Together, they combined for over 59% of the total relative frequency.

In general, we found bottom substrate to be the best predictor of the plant community at any given location in Lower Turtle Lake. Flat-stem pondweed and Small pondweed (*Potamogeton pusillus*) were true habitat generalists being found throughout the lake regardless of bottom type. Coontail, Curly-leaf pondweed, White water lily (*Nymphaea odorata*), Spatterdock (*Nuphar variegata*), Small duckweed (*Lemna minor*), Large duckweed (*Spirodela polyrhiza*) and Northern water milfoil (*Myriophyllum sibiricum*) dominated over organic muck areas. In sandy areas, we found Wild celery, Fries' pondweed, Clasping-leaf pondweed (*Potamogeton richardsonii*), Sago pondweed (*Stuckenia pectinata*), and Bushy pondweed (*Najas flexilis*) to be the dominant species. Each of these communities provided unique habitats and food sources for mammals, birds, fish, aquatic insects and other invertebrates.

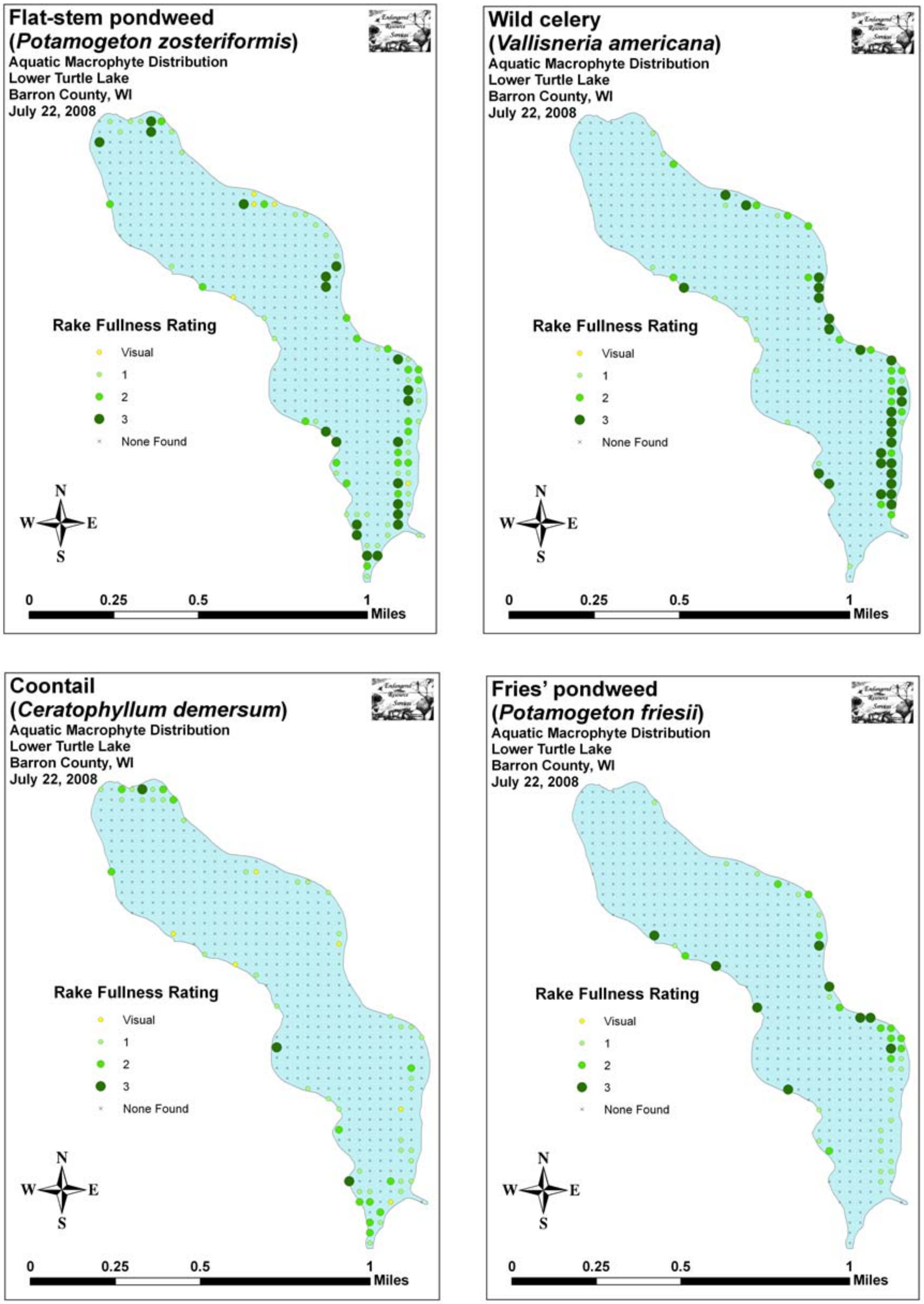

Figure 6: Lower Turtle Lake Dominant Species

Table 2: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Lower Turtle Lake, Barron County, July 2008

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton zosteriformis	Flat-stem pondweed	78	20.16	69.64	59.54	1.79
Vallisneria americana	Wild celery	57	14.73	50.89	43.51	2.21
Ceratophyllum demersum	Coontail	52	13.44	46.43	39.69	1.35
Potamogeton friesii	Fries' pondweed	43	11.11	38.39	32.82	1.70
Potamogeton pusillus	Small pondweed	35	9.04	31.25	26.72	1.57
	Filamentous algae	31	8.01	27.68	23.66	2.42
Potamogeton richardsonii	Clasping-leaf pondweed	23	5.94	20.54	17.56	1.43
Potamogeton crispus	Curly-leaf pondweed	18	4.65	16.07	13.74	1.00
Stuckenia pectinata	Sago pondweed	16	4.13	14.29	12.21	1.88
Lemna minor	Small duckweed	8	2.07	7.14	6.11	1.63
Nymphaea odorata	White water lily	8	2.07	7.14	6.11	1.63
Spirodela polyrhiza	Large duckweed	6	1.55	5.36	4.58	2.00
Myriophyllum sibiricum	Northern water milfoil	4	1.03	3.57	3.05	1.00
Najas flexilis	Bushy pondweed	4	1.03	3.57	3.05	1.25
Chara sp.	Muskgrass	1	0.26	0.89	0.76	1.00
Heteranthera dubia	Water star-grass	1	0.26	0.89	0.76	1.00
Sparganium eurycarpum	Common bur-reed	1	0.26	0.89	0.76	3.00
Wolffia columbiana	Common watermeal	1	0.26	0.89	0.76	1.00
Nuphar variegata	Spatterdock	**	**	**	**	**
Carex comosa	Bottle-brush sedge	***	***	***	***	***
Eleocharis erythropoda	Red-footed spikerush	***	***	***	***	***
Elodea canadensis	Common waterweed	***	***	***	***	***
Phalaris arundinacea	Reed canary grass	***	***	***	***	***
Sagittaria latifolia	Common arrowhead	***	***	***	***	***

Table 2 (cont'): Frequencies and Mean Rake Sample of Aquatic Macrophytes
Lower Turtle Lake, Barron County, July 2008

Schoenoplectus fluviatilis	River bulrush	***	***	***	***	***
Schoenoplectus tabernaemontani	Softstem bulrush	***	***	***	***	***
Typha latifolia	Broad-leaved cattail	***	***	***	***	***

** Visual Only
*** Boat Survey Only

Table 3: Floristic Quality Index of Aquatic Macrophytes
Lower Turtle Lake, Barron County
July 2008

Species	Common Name	C
Carex comosa	Bottle brush sedge	5
Ceratophyllum demersum	Coontail	3
Chara sp.	Muskgrass	7
Eleocharis erythropoda	Red-footed spikerush	3
Elodea canadensis	Common waterweed	3
Heteranthera dubia	Water star-grass	6
Lemna minor	Small duckweed	5
Myriophyllum sibiricum	Northern water milfoil	7
Najas flexilis	Bushy pondweed	6
Nuphar variegata	Spatterdock	6
Nymphaea odorata	White water lily	6
Potamogeton friesii	Fries' pondweed	8
Potamogeton pusillus	Small pondweed	7
Potamogeton richardsonii	Clasping-leaf pondweed	5
Potamogeton zosteriformis	Flat-stem pondweed	6
Sagittaria latifolia	Common arrowhead	3
Schoenoplectus fluviatilis	River bulrush	5
Schoenoplectus tabernaemontani	Softstem bulrush	4
Sparganium eurycarpum	Common bur-reed	5
Spirodela polyrhiza	Large duckweed	5
Stuckenia pectinata	Sago pondweed	3
Typha latifolia	Broad-leaved cattail	1
Vallisneria americana	Wild celery	6
Wolffia columbiana	Common watermeal	5
N		24
mean C		5.0
FQI		24.5

We identified a total of 24 native plants to species in and immediately adjacent to Lower Turtle Lake (Table 3). They produced a mean Coefficient of Conservatism of 5.0 and a Floristic Index of 24.5. Nichols (1999) reported Average Mean C for the North Central Hardwood Forests Region of 5.6 putting Lower Turtle Lake below average for this part of the state. The FQI was, however, slightly above the mean FQI of 20.9 for the North Central Hardwood Forests Region (Nichols 1999). These numbers indicate the lake had few species that can tolerate disturbance or pollution, but a slightly higher than average number of species overall.

Besides Curly-leaf pondweed, Reed canary grass (*Phalaris arundinacea*) was the only other exotic species we found. It was common in the marsh areas around the north and south bays, and in undeveloped shoreline areas. We did **not** locate any Eurasian water milfoil, Purple Loosestrife or any other new exotic species during either the June or July surveys. For more information on exotic species, see Appendix VIII.

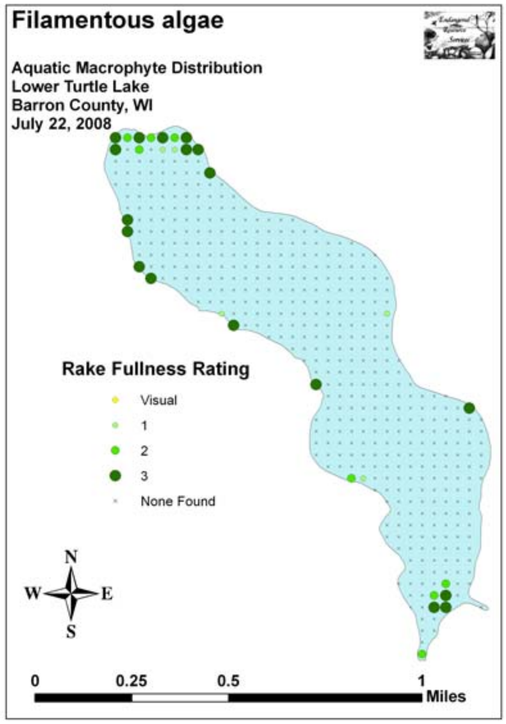

Figure 7: Filamentous algae in Lower Turtle Lake, July 2008

Figure 8: Filamentous algae over Muck in Shallow Areas

We noted significant amounts of filamentous algae (relative frequency of 8.01) and other floating algae throughout Lower Turtle Lake (Figures 7 and 8). We found it to be especially common in the north and south bays over organic muck, in front of "managed" lawns where fertilizer application was evident, along shoreline areas where agricultural fields were immediately across the street, and in areas where property owners cut the native vegetation down to the lakeshore (Figure 9).

Figure 9: Elimination of Native Shoreline Vegetation

DISCUSSION AND CONSIDERATIONS FOR MANAGEMENT:

Lower Turtle Lake's aquatic plants are critical to the overall health of the lake. As the base of the aquatic food pyramid, they provide food and shelter for insects and other aquatic invertebrates. These animals then provide food for baitfish which are then eaten by gamefish. The leaves, shoots and roots of aquatic plants are also important food for waterfowl and other wildlife. Aquatic plants also prevent erosion by stabilizing the shoreline, and work to improve water clarity by absorbing excess nutrients from the water.

Based on our June Curly-leaf pondweed (CLP) survey, July point intercept survey, and general boat survey observations, we feel there are two main threats to the current and future health of Lower Turtle Lake's plant community and the lake's overall water clarity and quality. The first and most immediate threat is the high levels of filamentous and floating algae in the lake. The presence of these algae is strong anecdotal evidence that there are excessive nutrients in the water from such things as dead plant breakdown, failed septic systems, and lawn and field fertilizer runoff.

The breakdown of CLP in June may have contributed to the algal blooms we observed in July. Analysis of the data suggests there is a strong correlation between areas of high CLP densities in June and high filamentous algae blooms in July. The elimination of shoreline vegetation can also increase the lake's nutrient load. The dense areas of filamentous algae that occurred in front of some residences where there is no obvious visual reason for it may indicate septic systems are leaching nutrients into the lake. In other instances, obviously fertilized lawns or nearby agricultural fields seemed to be the most likely explanation for these high levels of localized algae growth.

Educating lake residents about reducing nutrient input directly along the lake is the least expensive way to decrease algal growth and improve water clarity. Not mowing down to the lakeshore, switching to a phosphorus-free fertilizer or eliminating fertilizer altogether would all be positive steps to this end. Where possible, especially along the east and west shores of Lower Turtle Lake, shoreline restoration and buffer strips of native vegetation would enhance water quality by preventing erosion and runoff as well as improve the aesthetic value of these highly developed shorelines.

Lake wide septic system analysis would be expensive, but could pay significant dividends towards improving water clarity and quality. Perhaps the most ambitious potential solution both from a time and cost perspective, but the one that promises the greatest potential benefit is a comprehensive watershed analysis plan. By testing surface water input, ground water, wells and septic systems, a more complete picture of nutrient loading throughout the system would provide strong direction on how to best reduce these nutrients. A project of this scale would ideally involve Upper Turtle Lake as ultimately, their water quality becomes Lower Turtle Lake's water quality.

The second biggest threat to Lower Turtle Lake's native plant community is the future introduction of Eurasian water milfoil (EWM) into the lake. Preventing aquatic invasive species (AIS) introduction or detecting them immediately upon introduction when there is a chance to eliminate them should be one of the Management District's top priorities. Many area lakes have established "Clean Boats/Clean Water" programs, landing cameras, and noticeable signage about AIS. Improving the current signage would be a positive step as it provides education, reeducation, and continual reminders of the dangers/impacts of AIS. One of the simplest ways to reduce the likelihood of introduction is for lake shore owners to refrain from removing plants from the lake. When they clear native plants from the lake bottom, the patches of barren substrate provide an easy place for invasive plants to take root and become established. Conducting monthly or bimonthly EWM surveys in transects parallel to the shore at the public boat launches would also improve the odds of detecting a EWM infestation early on before it has a chance to spread.

Finally, although we did not locate any Purple loosestrife on or directly adjacent to the lake, it is present in Barron County, and as close as Horseshoe Lake. Because of this, it is possible that it will show up at Lower Turtle Lake at some point in the future. As Purple loosestrife prefers organic muck soil, the most likely point for this invasion would be the cattail marsh areas surrounding the north and south bays. Spotting a new infestation would be easiest when the plant blooms in mid-late August. Catching it early on would allow removal before the plants could spread and take over the marsh.

Regardless of which if any of these recommendations the Lake District decides to consider, any active management of the lake's plants will require the development and completion of an Aquatic Plant Management Plan (APMP) as outlined by the WDNR. Because of this, completing an APMP will be the next step in managing the lake and its aquatic plants.

Prioritized Management Considerations Summary:

- Preserve and maintain Lower Turtle Lake's native plant community.
- Complete an Aquatic Plant Management Plan
- Reduce and, wherever possible, eliminate fertilizer applications near the lakeshore.
- Encourage owners to refrain from removing native plants from the lake as these areas provide Aquatic Invasive Species an ideal place to become established.
- Consider transect monitoring for invasive species at the lake's boat landing.
- Establish native vegetation buffer strips along the lakeshore.
- Encourage shoreline restoration
- Consider establishing a Clean Boats/Clean Water campaign.
- Consider joining with Upper Turtle Lake to complete a watershed wide analysis of water quality to determine where nutrients are entering the system.

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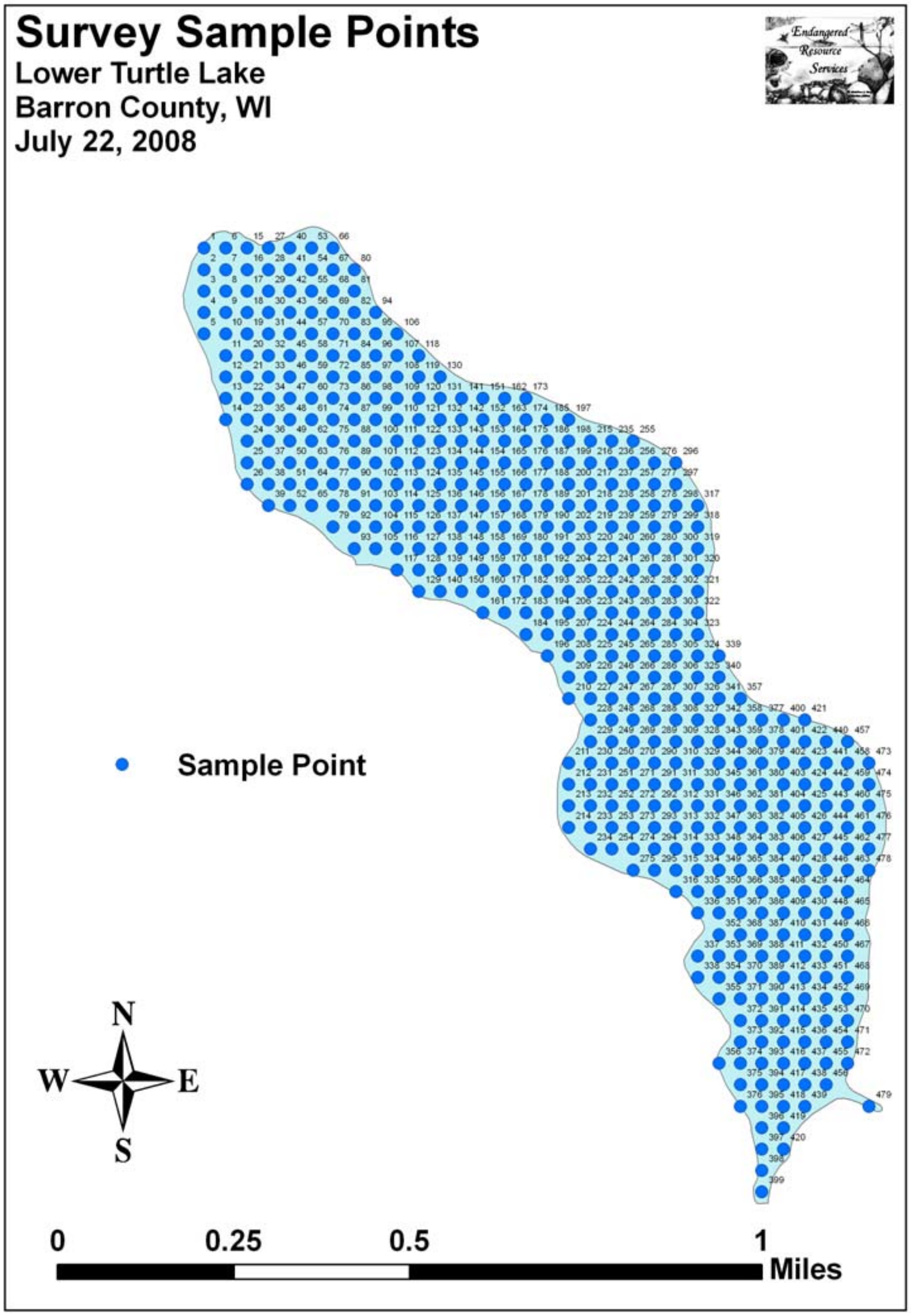
WDNR. [online]. 2008. Reed canary grass. http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm (2008, September).

Appendix I: Lower Turtle Lake Map with Survey Sample Points


Survey Sample Points
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Sample Point
N
W
E
S
0
0.25
0.5
1
Miles

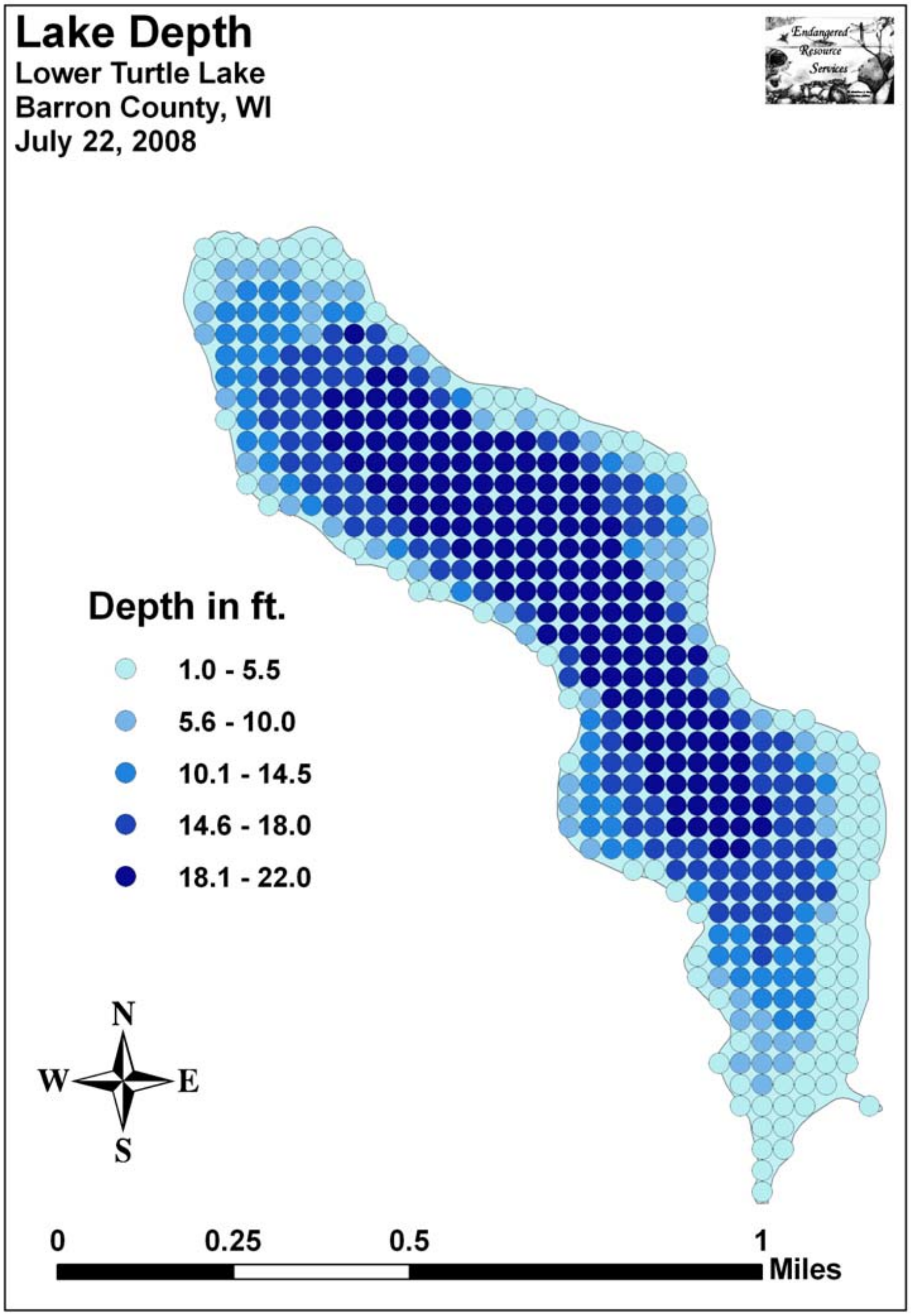
Appendix II: Boat Survey Data Sheet

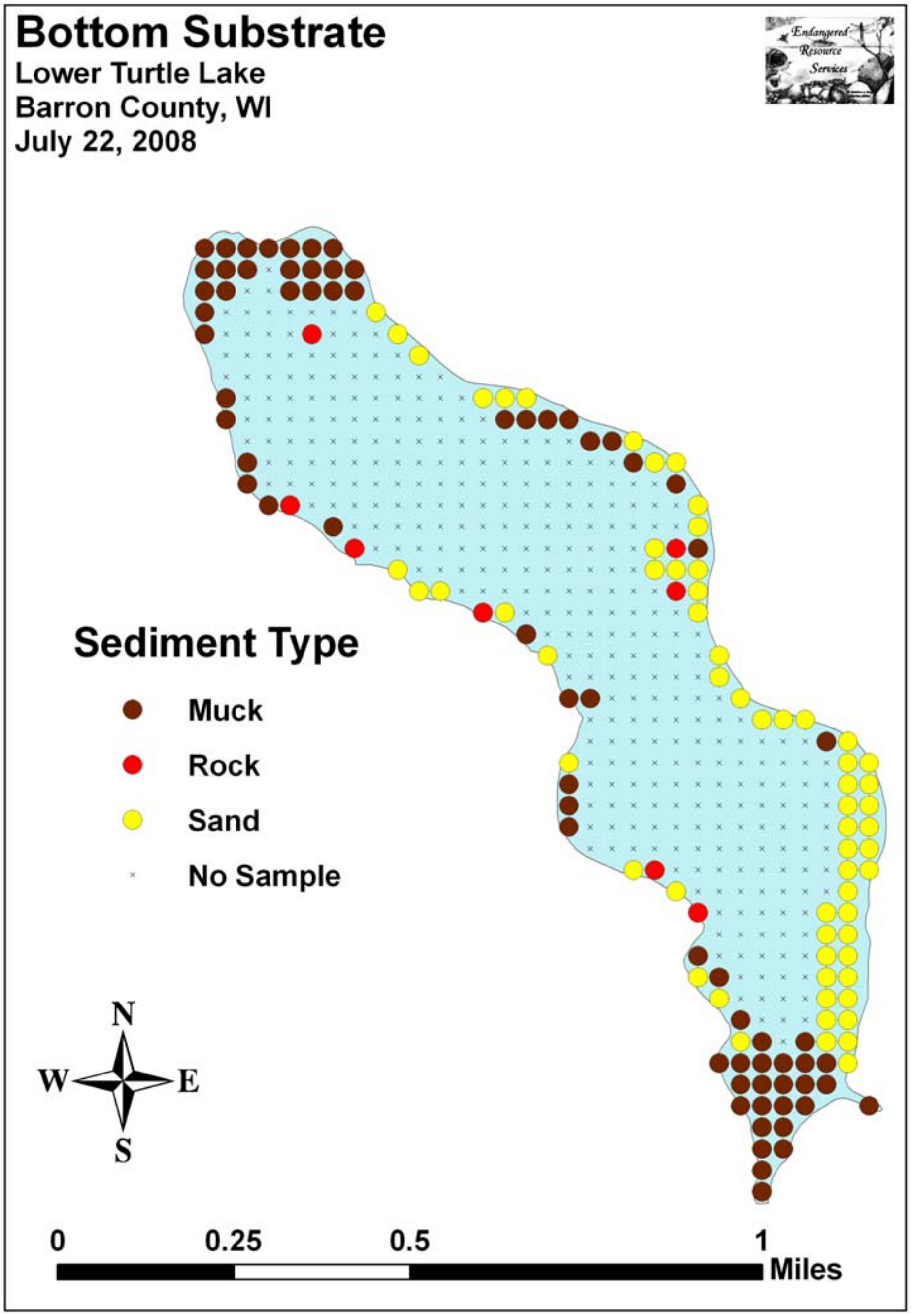
Boat Survey	
Lake Name	
County	
WBIC	
Date of Survey	
(mm/dd/yy)	
workers	
Nearest Point	**Species seen, habitat information**

Appendix III: Vegetative Survey Data Sheet

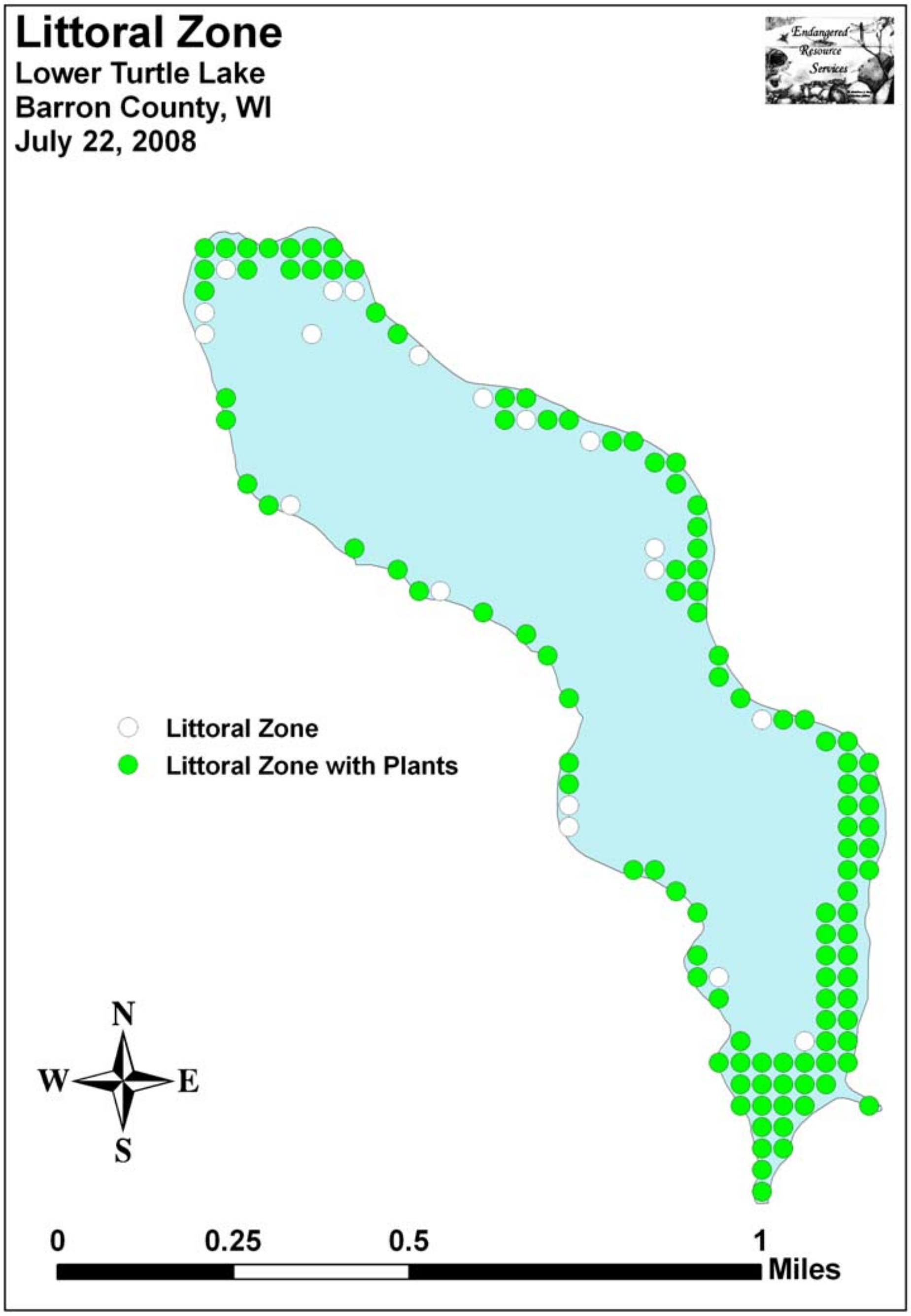
Observers for this lake: names and hours worked by each:																									
Lake:									WBIC									County						Date:	
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	EWM	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																									
2							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

Appendix IV: Habitat Variable Maps


Lake Depth
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Depth in ft.
1.0 - 5.5
5.6 - 10.0
10.1 - 14.5
14.6 - 18.0
18.1 - 22.0
N
W
E
S
0
0.25
0.5
1
Miles



Bottom Substrate
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Sediment Type
Muck
Rock
Sand
No Sample
N
W
E
S
0
0.25
0.5
1
Miles


Littoral Zone
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Littoral Zone
Littoral Zone with Plants
N
W
E
S
0
0.25
0.5
1
Miles

Appendix V: Plant Specimen Labels

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Carex comosa*) **Bottle-brush sedge**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-001
Habitat/Distribution: Muck bottom along the shoreline. A very few individuals were scattered near the Turtle Creek outlet.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Red-footed spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Schoenoplectus fluviatilis*) River bulrush

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Ceratophyllum demersum*) **Coontail**
Specimen Location: Lower Turtle Lake; N45.39655°, W92.08740°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-002
Habitat/Distribution: Found in almost any bottom type, but preferred thick organic muck in 0-2.5 meters. Abundant in the north and south bays where it and CLP formed dense beds. Along with Small and Flat-stem pondweeds, it was the deepest growing plant.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton crispus*) Curly-leaf pondweed**,** (*Nuphar variegata)* Spatterdock, (*Nymphaea odorata*) White water lily, (*Potamogeton pusillus*) Small pondweed, Filamentous algae

County/State: Barron County, Wisconsin **Date:** 7/22/08
Species: (*Chara* sp.) **Muskgrass**
Specimen Location: Lower Turtle Lake; N45.39364°, W92.07790°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-003
Habitat/Distribution: A single individual was found in a sand bottom area in water between 0.5 – 1 meter deep.
Common Associates: (*Vallisneria americana*) Wild celery, (*Stuckenia pectinata*) Sago pondweed, (*Najas flexilis*) Bushy pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Eleocharis erythropoda*) **Red-footed spikerush**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-004
Habitat/Distribution: Muck bottom along the shoreline. A very few individuals were scattered among cattails and arrowheads near the Turtle Creek outlet.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Schoenoplectus fluviatilis*) River bulrush, (*Carex comosa*) Bottle-brush sedge

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Elodea canadensis*) **Common waterweed**
Specimen Location: Lower Turtle Lake; N45.39694, W92.08400°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-005
Habitat/Distribution: Muck bottom in 0.5-1.5 meters of water. Rare; No specimens were found at survey points, but a few individuals were located in the northeast corner of the north bay.
Common Associates: (*Potamogeton crispus*) Curly-leaf pondweed**,** (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed, Filamentous algae

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Heteranthera dubia*) **Water star-grass**
Specimen Location: Lower Turtle Lake; N45.38921°, W92.07899°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-006
Habitat/Distribution: Firm muck bottoms usually in water < 1 meter deep. Although we found star-grass at only one survey point, we observed a few individuals at several other locations in the lake.
Common Associates: (*Vallisneria americana*) Wild celery, (*Stuckenia pectinata*) Sago pondweed, (*Potamogeton friesii*) Fries' pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Ceratophyllum demersum*) Coontail

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Lemna minor*) **Small duckweed**
Specimen Location: Lower Turtle Lake; N45.39655°, W92.08740°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-007
Habitat/Distribution: Located floating at or just under the surface in sheltered areas in the north and south bays. Scattered individuals found interspersed between the lilypads, and Coontail beds.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Nymphaea odorata*) White water lily, Filamentous algae, (*Spirodela polyrhiza*) Large duckweed, (*Potamogeton crispus*) Curly-leaf pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Myriophyllum sibiricum*) **Northern water milfoil**
Specimen Location: Lower Turtle Lake; N45.38008°, W92.07177°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-008
Habitat/Distribution: Muck to sand bottom in water up to 2 meters. Uncommon in the south bay and along the southeast shore.
Common Associates: (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Najas flexilis*) **Bushy pondweed**
Specimen Location: Lower Turtle Lake; N45.38932°, W92.07274°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-009
Habitat/Distribution: Found in sand bottom areas in 0.5-1.5 meters of water. Uncommon being found at only a few scattered locations on the east and west shorelines.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Nuphar variegata)* **Spatterdock**
Specimen Location: Lower Turtle Lake; N45.37879°, W92.06985°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-010
Habitat/Distribution: Muck bottom in 0-1.5 meters of water where it often forms dense canopies with White water lily. Uncommon in muck bays and sheltered shoreline areas of the lake. Most plants were restricted to the southwest and southern end of the lake. It normally preferred a firmer bottom than *Nymphaea*.
Common Associates: (*Nymphaea odorata*) White water lily, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Ceratophyllum demersum*) Coontail, (*Potamogeton pusillus*) Small pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Nymphaea odorata*) **White water lily**
Specimen Location: Lower Turtle Lake; N45.37879°, W92.06985°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-011
Habitat/Distribution: Muck bottom in 0-2 meters where it forms dense canopies with other floating leaf species. Relatively common in its preferred habitat; especially in the south and southwest bays.
Common Associates: (*Nuphar variegata)* Spatterdock, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, Filamentous algae

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Phalaris arundinacea*) **Reed canary grass**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-012
Habitat/Distribution: Common in undeveloped low areas - especially at the edge of cattail marshes on the north and south end of the lake. Prefers thick muck soil in and out of water <0.5 meters.
Common Associates: (*Typha latifolia*) Broad-leaved cattail**,** (*Sparganium* eurycarpum) Common bur-reed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Potamogeton crispus*) **Curly-leaf pondweed**
Specimen Location: Lower Turtle Lake; N45.39655°, W92.08740°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-013
Habitat/Distribution: Found in all bottoms types, but only abundant over thick muck in 0-2m of water. Common in the north and south bays near the Turtle Creek inlet and outlet.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, Filamentous algae

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Potamogeton friesii*) **Fries' pondweed**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-014
Habitat/Distribution: Sand and gravel in .5-1.5 meters of water. Widespread and abundant; especially on the east shoreline.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Potamogeton pusillus*) **Small pondweed**
Specimen Location: Lower Turtle Lake; N45.39620°, W92.08301°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-015
Habitat/Distribution: Found in almost any bottom conditions, but grows best in rock/ sand bottoms in 1-2 meters of water. Common and widely distributed throughout.
Common Associates: (*Potamogeton crispus*) Curly-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Potamogeton richardsonii*) **Clasping-leaf pondweed**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-016
Habitat/Distribution: Found in sand and sandy/muck bottom areas in shallow water 0.5-1.5 meter deep. Common and widespread in the southern 2/3rds of the lake; especially on the east shore.
Common Associates: (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed, (*Stuckenia pectinata*) Sago pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Potamogeton zosteriformis*) **Flat-stem pondweed**
Specimen Location: Lower Turtle Lake; N45.39620°, W92.08301
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-017
Habitat/Distribution: Thick organic muck to sandy muck. Widely distributed and common to abundant throughout the lake where it grows in 0-2.5 meters of water.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Vallisneria americana*) Wild celery, (*Potamogeton friesii*) Fries' pondweed, (*Stuckenia pectinata*) Sago pondweed, (*Potamogeton pusillus*) Small pondweed, (*Potamogeton crispus*) Curly-leaf pondweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Sagittaria latifolia*) **Common arrowhead**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-018
Habitat/Distribution: Muck bottom along the shoreline. Relatively common scattered among cattails; especially near the Turtle Creek outlet.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Red-footed spikerush, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Schoenoplectus fluviatilis*) River bulrush, (*Carex comosa*) Bottle-brush sedge

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Schoenoplectus fluviatilis*) **River bulrush**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-019
Habitat/Distribution: Firm muck bottom along the shoreline. A very few individuals were scattered at the point near the Turtle Creek outlet.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Red-footed spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Carex comosa*) Bottle-brush sedge

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Schoenoplectus tabernaemontani*) **Softstem bulrush**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-020
Habitat/Distribution: Muck bottom along the shoreline to water <.5 meters deep. Normally occurs in scattered small patches; especially common on the southeast shore in the bay immediately north and west of the Turtle Creek outlet.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Eleocharis erythropoda*) Red-footed spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus fluviatilis*) River bulrush, (*Carex comosa*) Bottle-brush sedge

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Sparganium* eurycarpum) **Common bur-reed**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-021
Habitat/Distribution: Rare over firm sand/muck; a single large patch occurred in the southeast corner of the lake in and out of water <.5m deep.
Common Associates: (*Typha latifolia*) Broad-leaved cattail, (*Phalaris arundinacea*) Reed canary grass

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Spirodela polyrhiza*) **Large duckweed**
Specimen Location: Lower Turtle Lake; N45.37928°, W92.06736°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-022
Habitat/Distribution: Located floating at or just under the surface in stagnant bays. Rare; scattered individuals occur interspersed between the lilypads at a few sites in the north and south bays.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Nymphaea odorata*) White water lily, (*Nuphar variegata)* Spatterdock, (*Wolffia columbiana*) Common watermeal, (*Lemna minor*) Small duckweed

County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Stuckenia pectinata*) **Sago pondweed**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-023
Habitat/Distribution: Found in sand and sandy/muck bottom areas in shallow water 0.5-1.5 meter deep. Relatively common throughout; especially on the eastern shore.
Common Associates: (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Vallisneria americana*) Wild celery, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton friesii*) Fries' pondweed

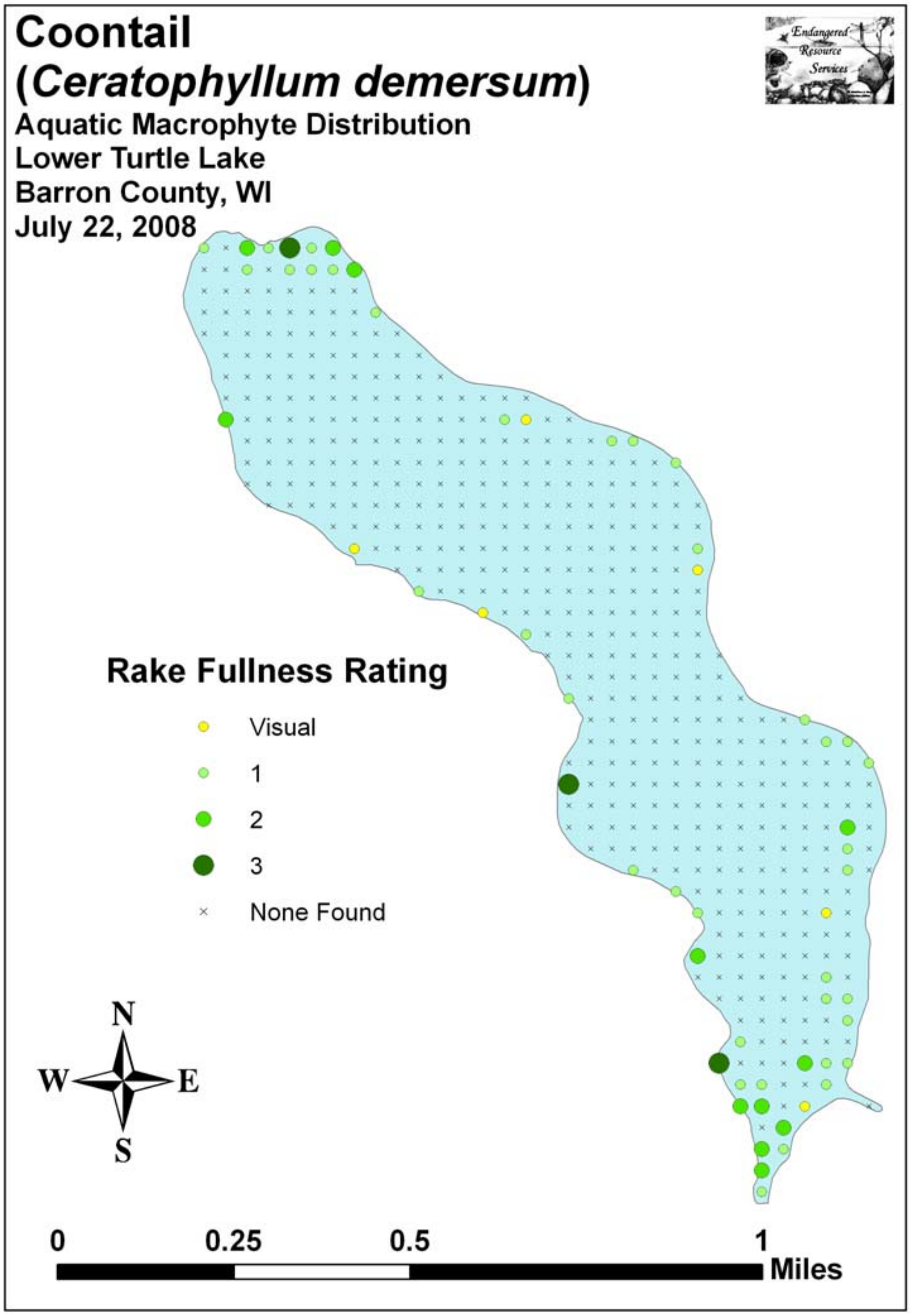
County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Typha latifolia*) **Broad-leaved cattail**
Specimen Location: Lower Turtle Lake; N45.37891°, W92.06926°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-024
Habitat/Distribution: Muck bottom areas along undeveloped shoreline. Scattered individuals were located throughout, but the biggest patches were in the marshy bays along the Turtle Creek inlet and outlet.
Common Associates: (*Eleocharis erythropoda*) Red-footed spikerush, (*Sagittaria latifolia*) Common arrowhead, (*Schoenoplectus tabernaemontani*) Softstem bulrush, (*Schoenoplectus fluviatilis*) River bulrush, (*Carex comosa*) Bottle-brush sedge

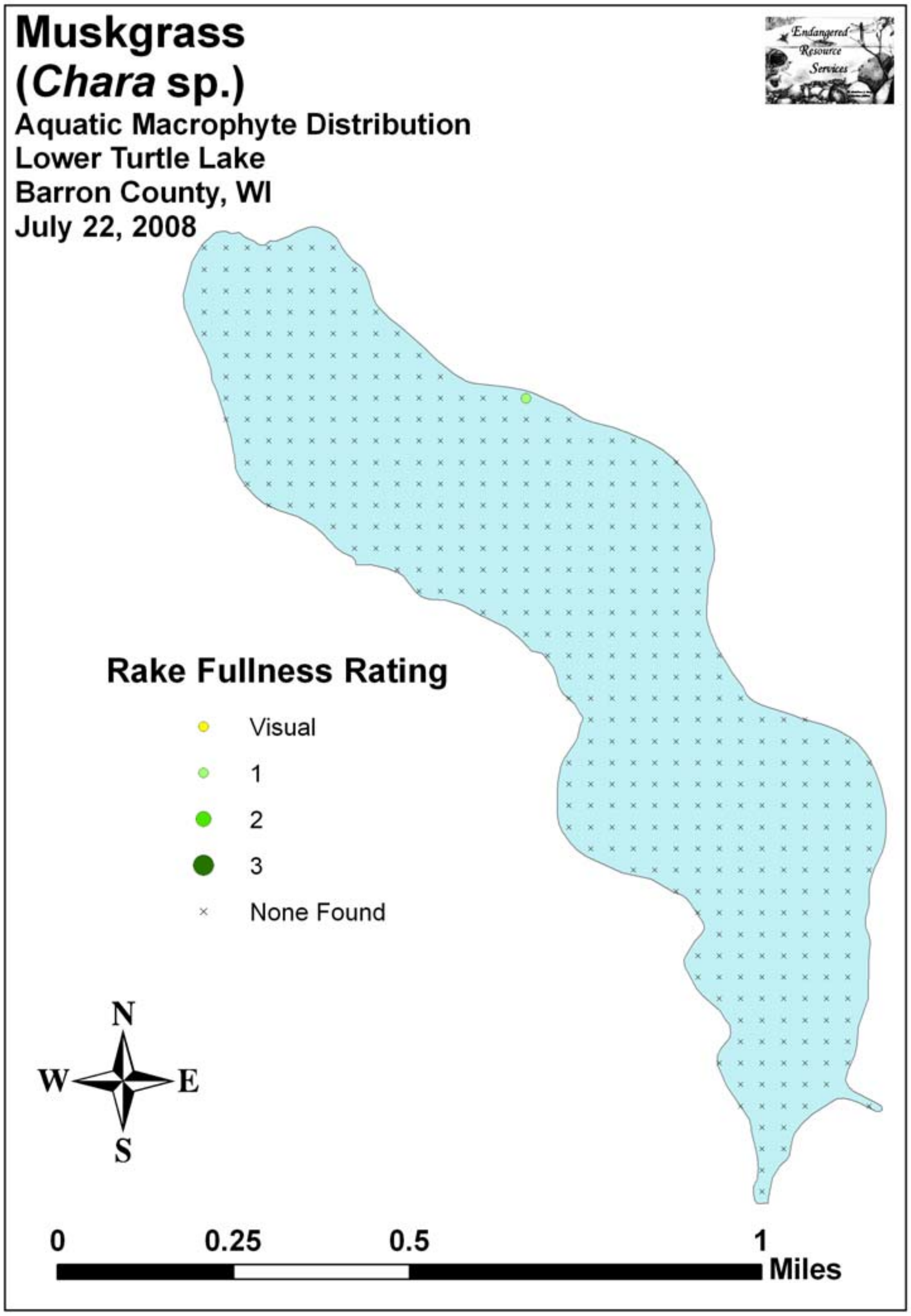
County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Vallisneria americana*) **Wild celery**
Specimen Location: Lower Turtle Lake; N45.38015°, W92.06802°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-025
Habitat/Distribution: Found in almost any bottom conditions, but grows best in sandy to sand/muck bottoms in 0.5-1.5 meters of water. Abundant and widely distributed throughout the lake. It forms especially dense beds along the east shoreline.
Common Associates: (*Potamogeton pusillus*) Small pondweed, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton richardsonii*) Clasping-leaf pondweed, (*Stuckenia pectinata*) Sago pondweed, (*Potamogeton friesii*) Fries's pondweed

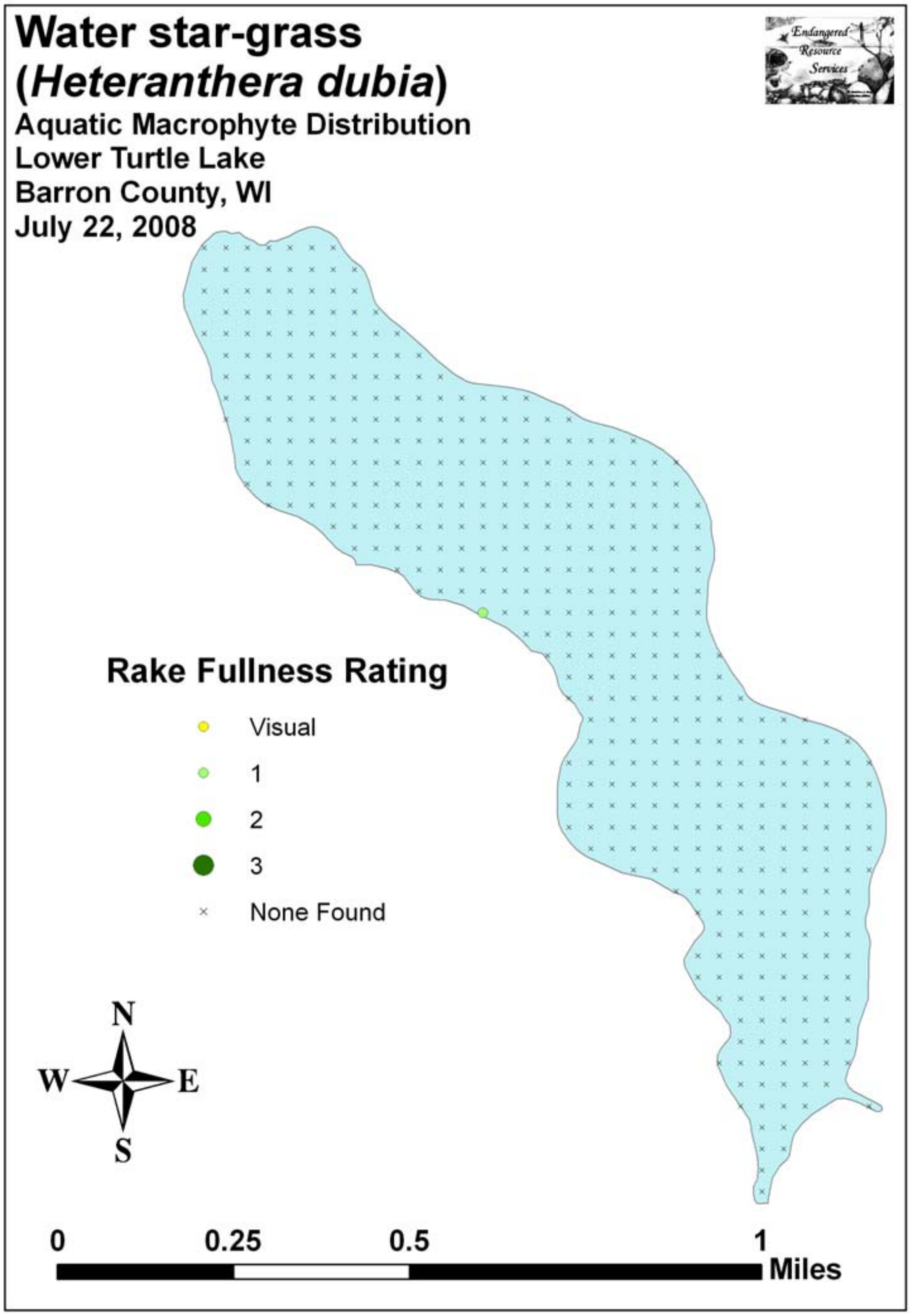
County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: (*Wolffia columbiana*) **Common watermeal**
Specimen Location: Lower Turtle Lake; N45.37928°, W92.06736°
Collected/Identified by: Matthew S. Berg **Col. #:** MSB-2008-026
Habitat/Distribution: Located floating at or just under the surface in sheltered areas. Only specimens were found in a stagnant bay in the far southeast corner of the lake interspersed between the lilypads and along shore.
Common Associates: (*Nymphaea odorata*) White water lily, (*Spirodela polyrhiza*) Large duckweed, (*Potamogeton zosteriformis*) Flat-stem pondweed

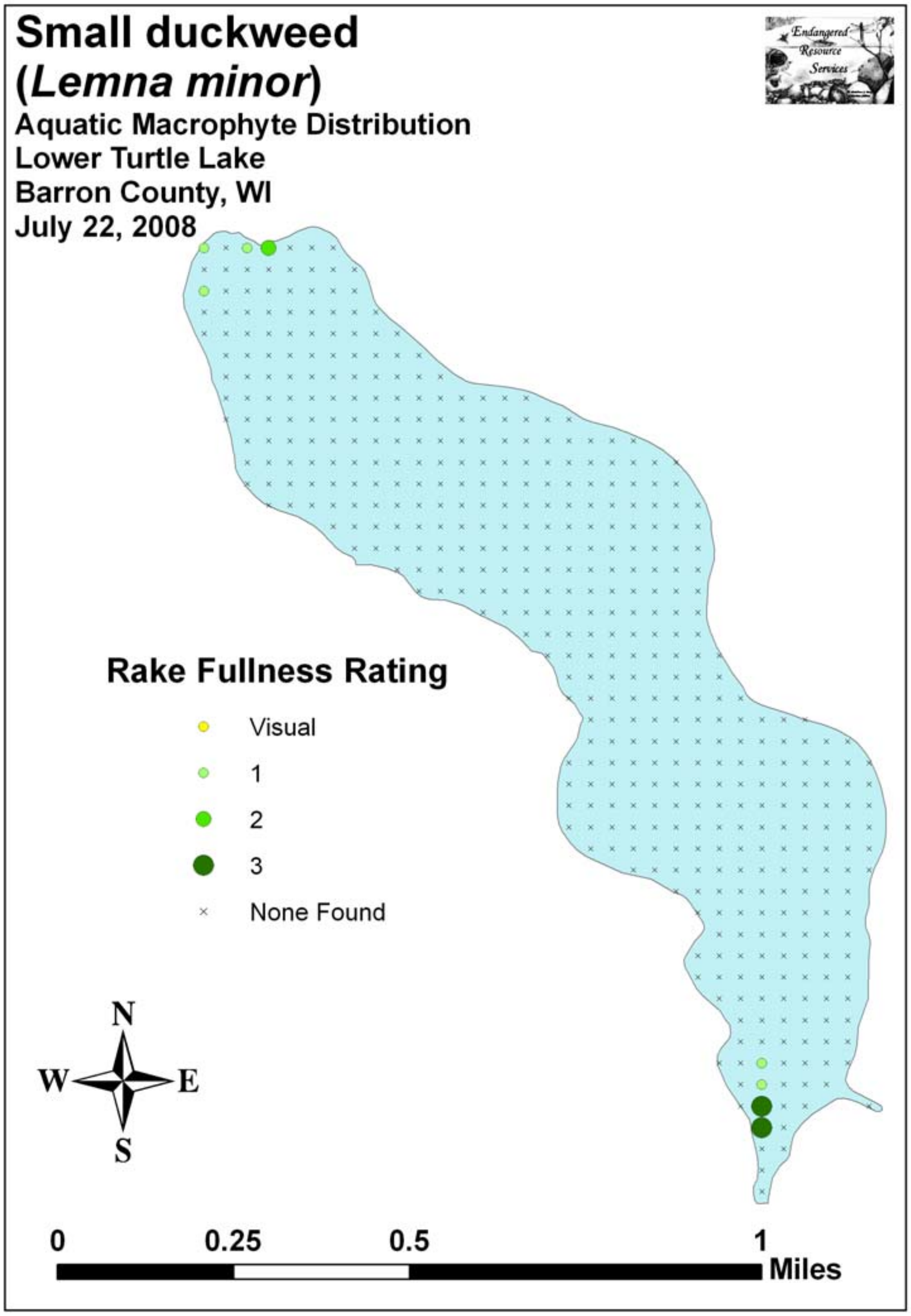
County/State: Barron County, Wisconsin **Date:** 7/18/08
Species: Filamentous algae
Habitat/Distribution: Most common in stagnant areas in the north and south bays in areas that had high densities of Curly-leaf pondweed in June, and in front of properties with "managed lawns" where fertilizer runoff encouraged growth. High levels throughout the lake are likely due to these factors coupled with agricultural runoff from the many surrounding farm fields immediately adjacent to the lake.
Common Associates: (*Ceratophyllum demersum*) Coontail, (*Potamogeton zosteriformis*) Flat-stem pondweed, (*Potamogeton crispus*) Curly-leaf pondweed

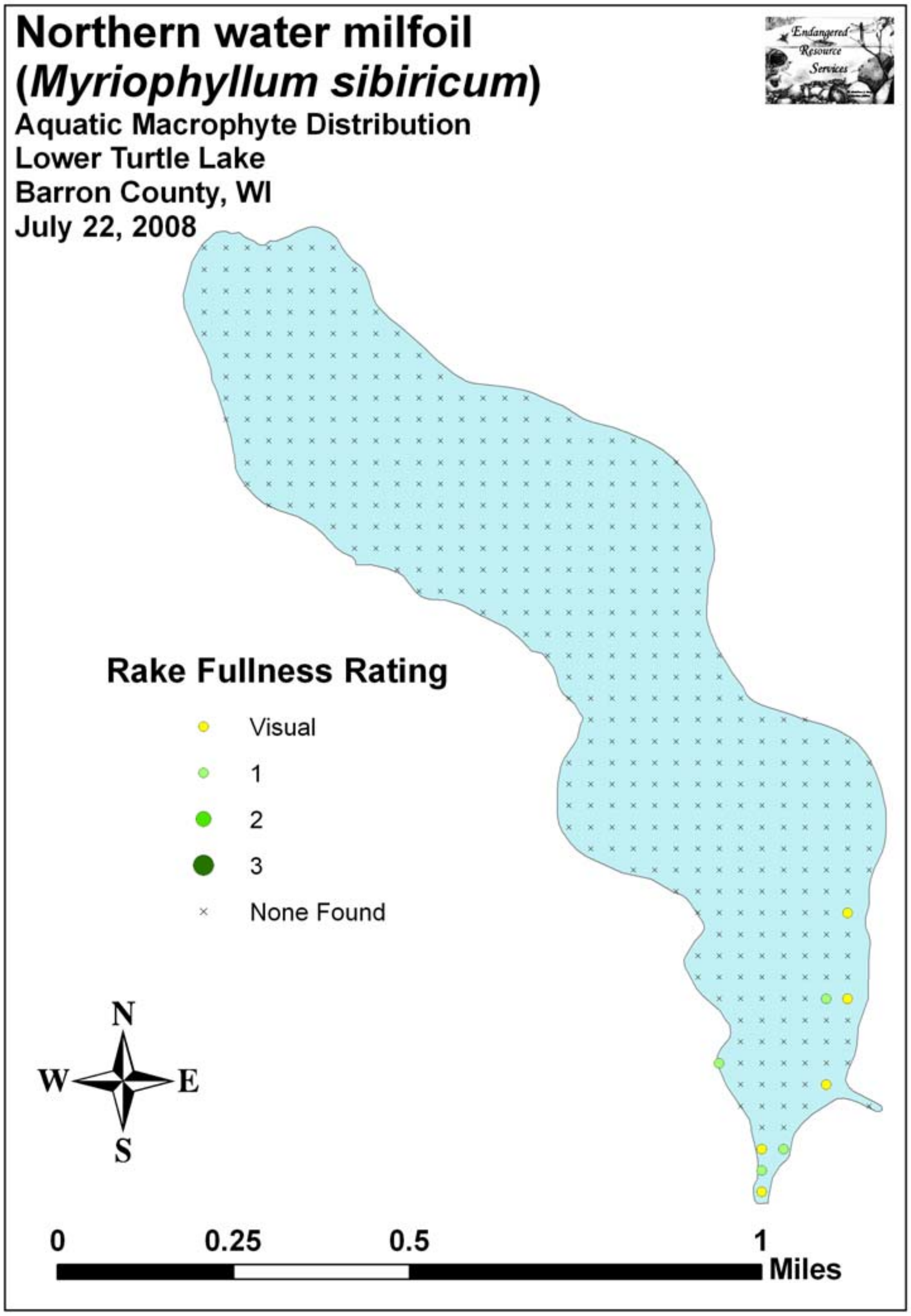
Appendix VI: Plant Species Distribution Maps

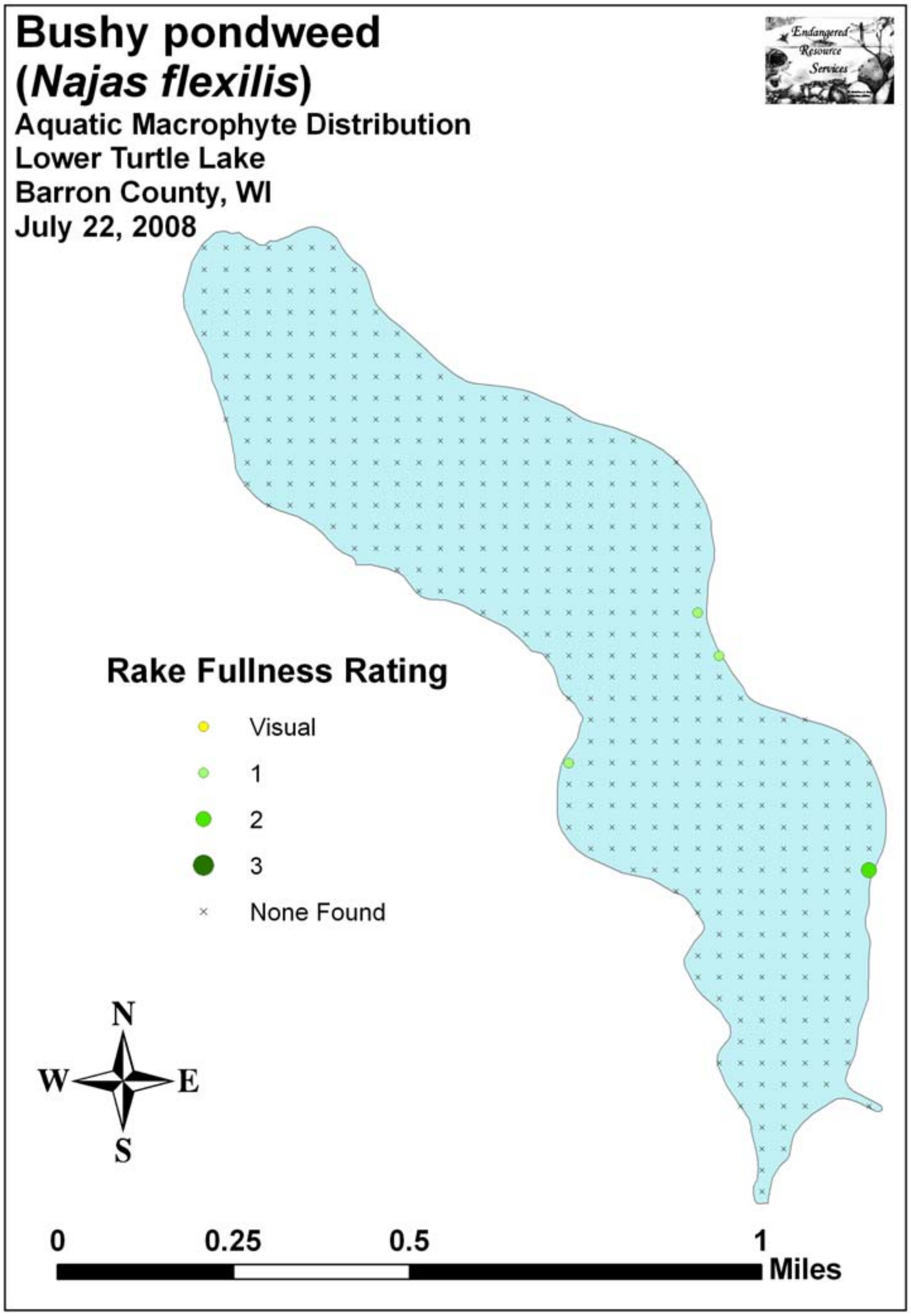

Coontail
(Ceratophyllum demersum)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Muskgrass
(*Chara* sp.)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Water star-grass
(Heteranthera dubia)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Small duckweed
(Lemna minor)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Northern water milfoil
(Myriophyllum sibiricum)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles



Bushy pondweed
(*Najas flexilis*)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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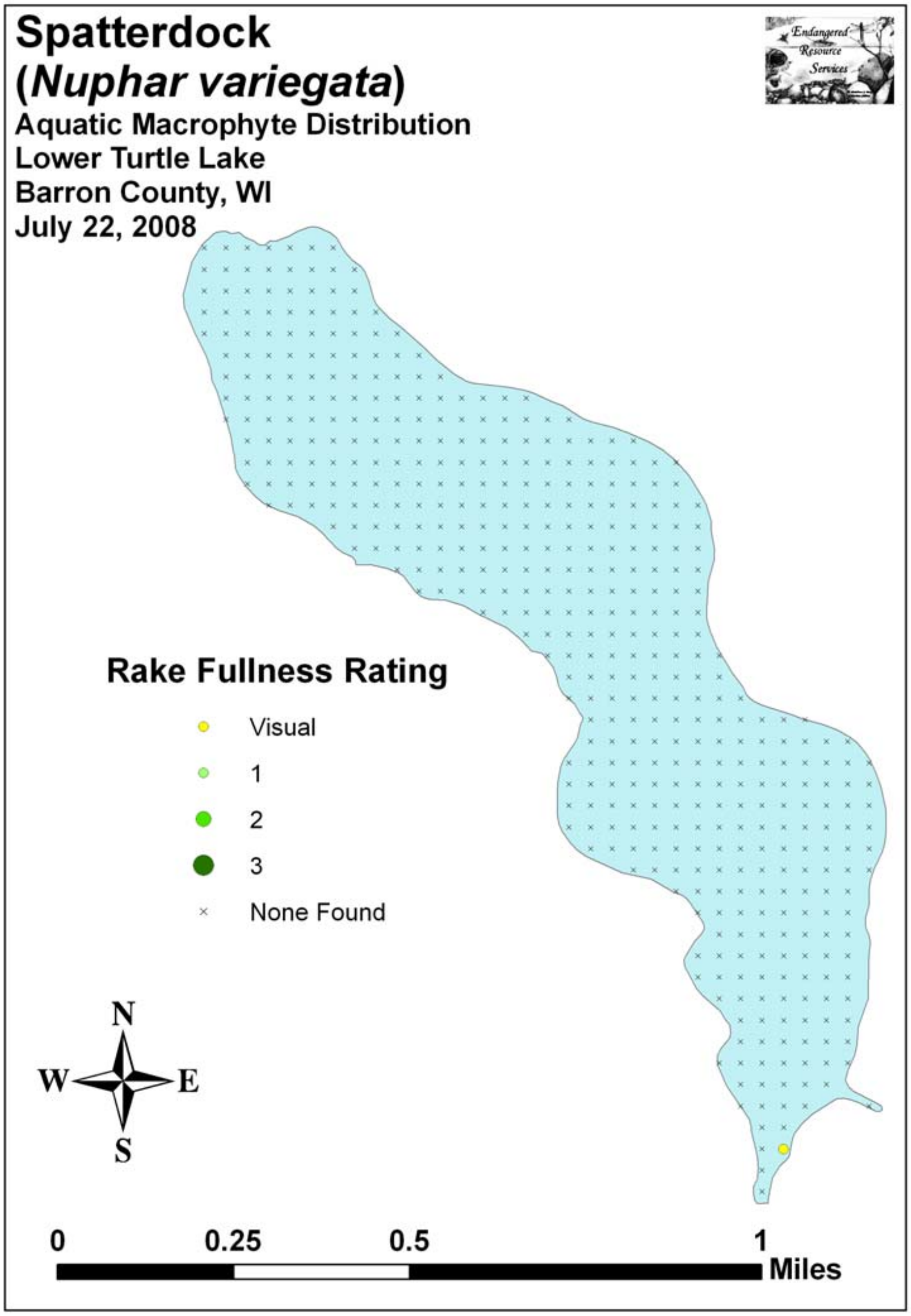
Spatterdock
(Nuphar variegata)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
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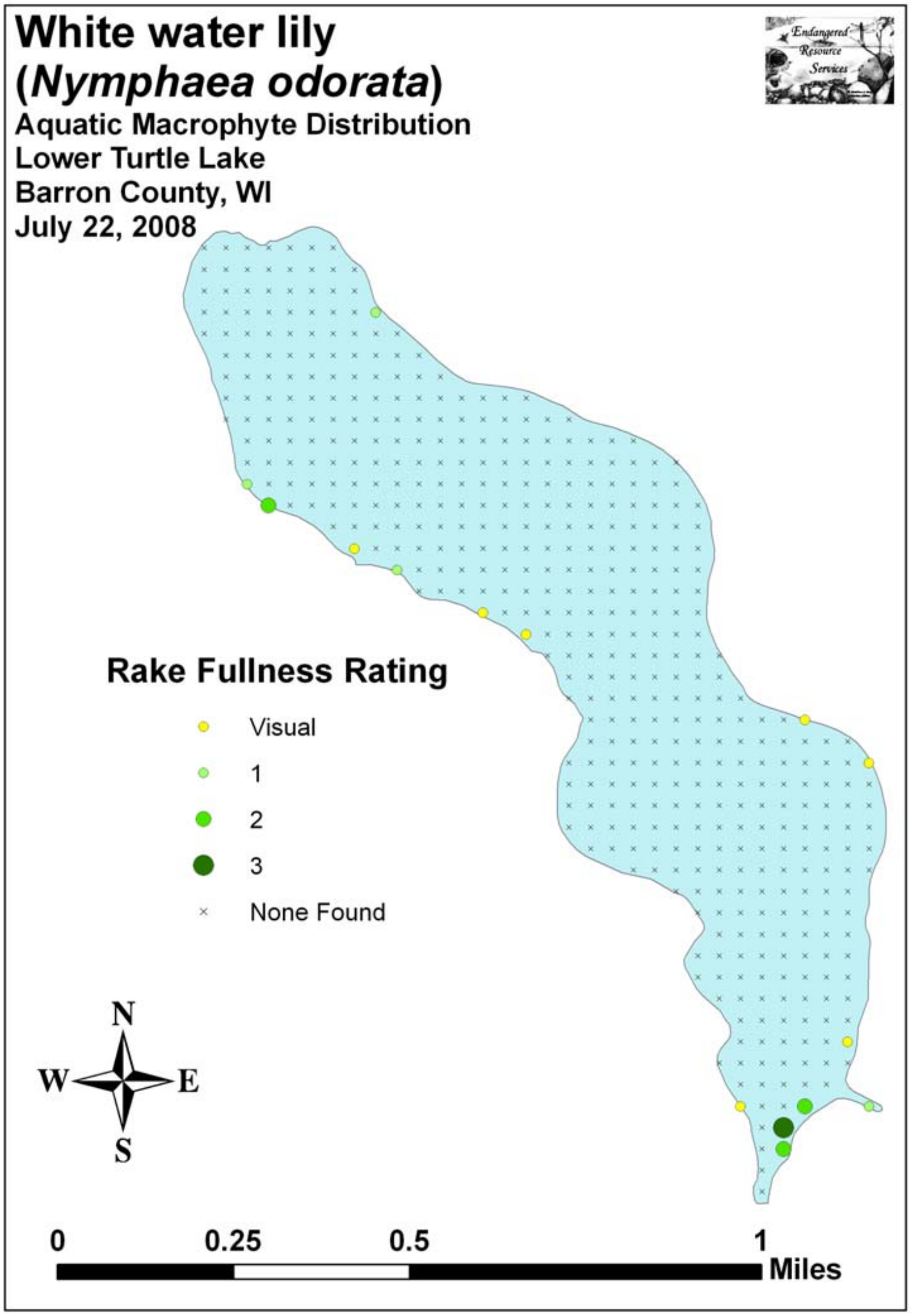
White water lily
(Nymphaea odorata)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
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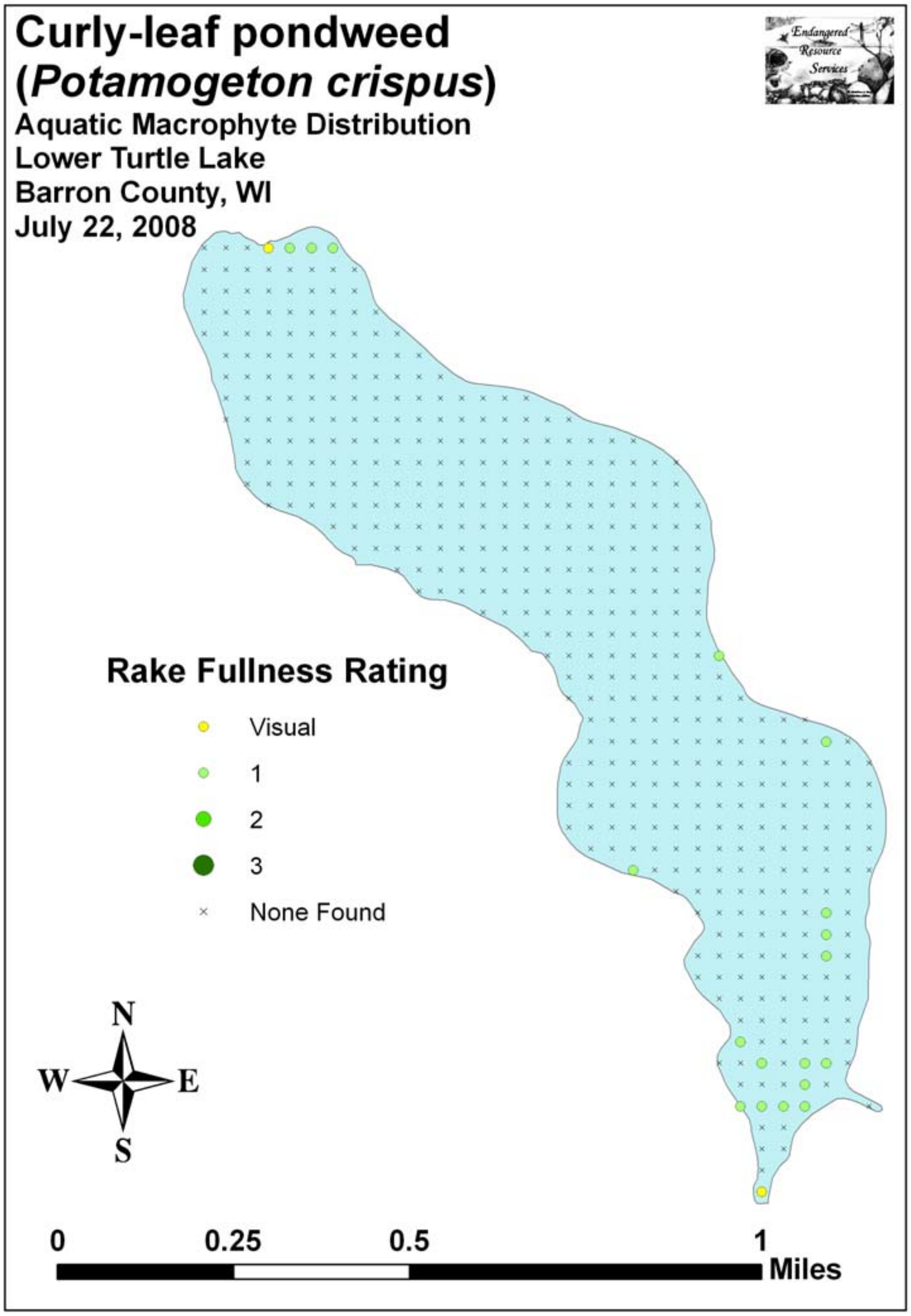
Curly-leaf pondweed
(Potamogeton crispus)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
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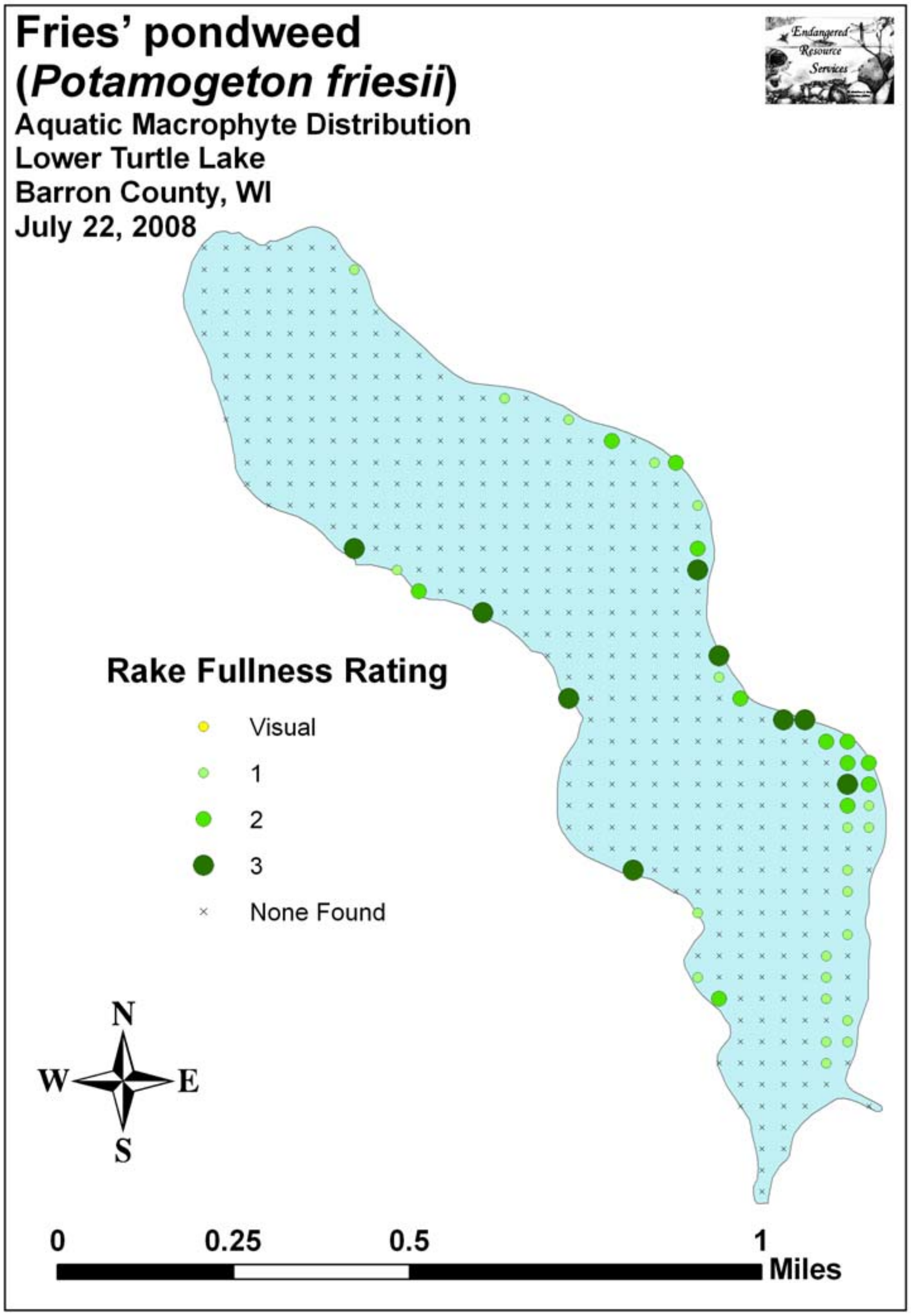
Fries' pondweed
(Potamogeton friesii)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
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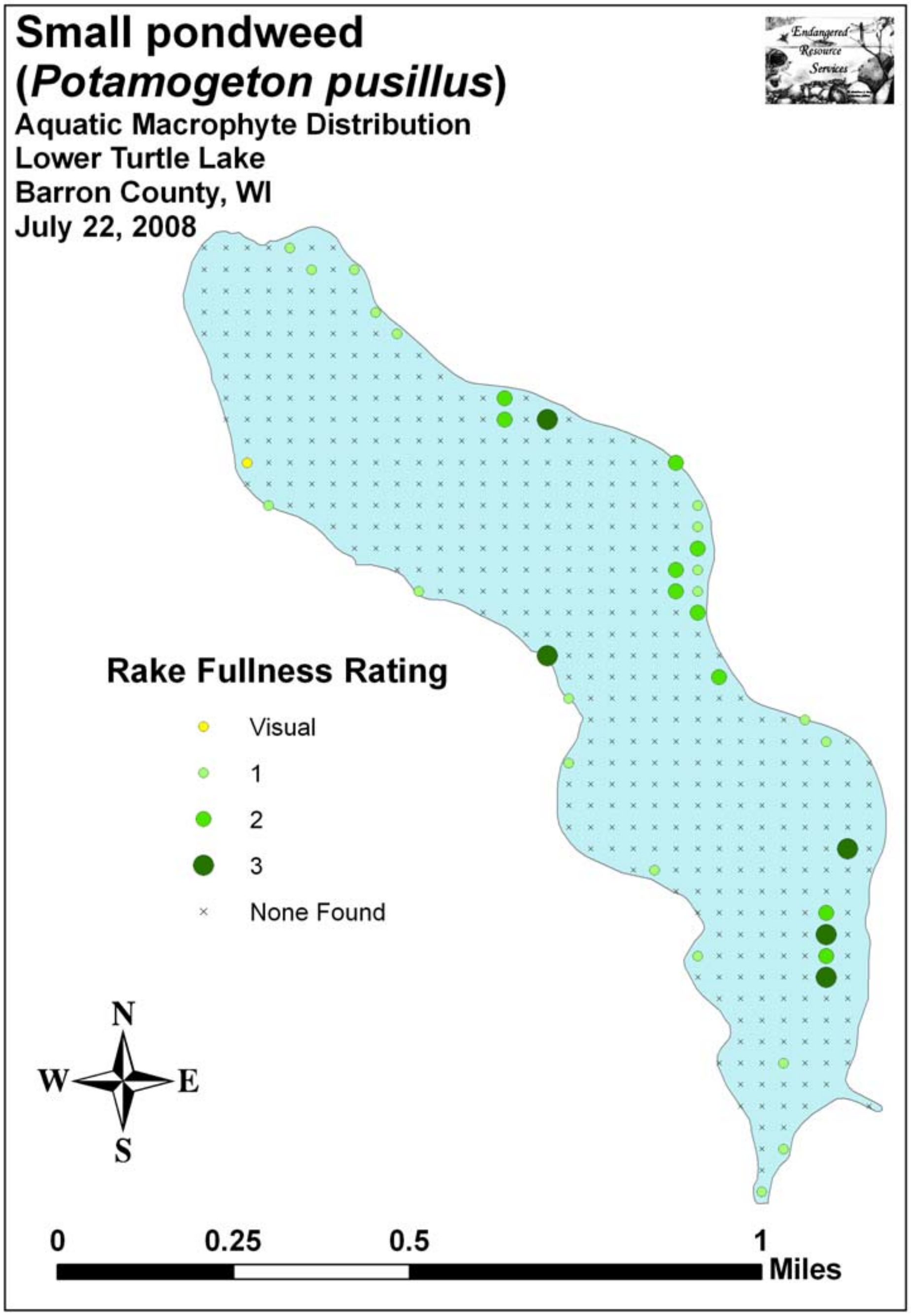

Small pondweed
(Potamogeton pusillus)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
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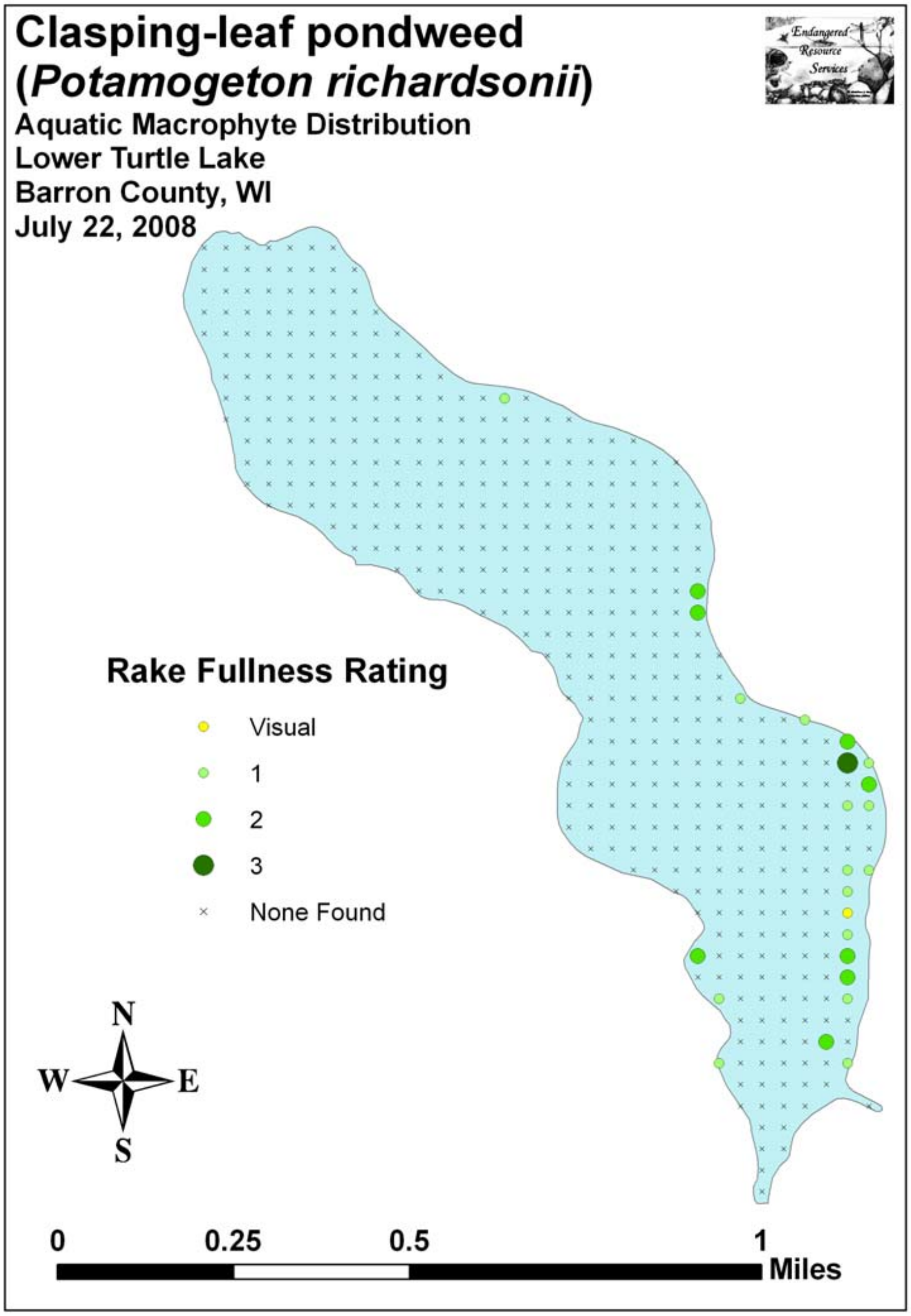
Clasping-leaf pondweed
(*Potamogeton richardsonii*)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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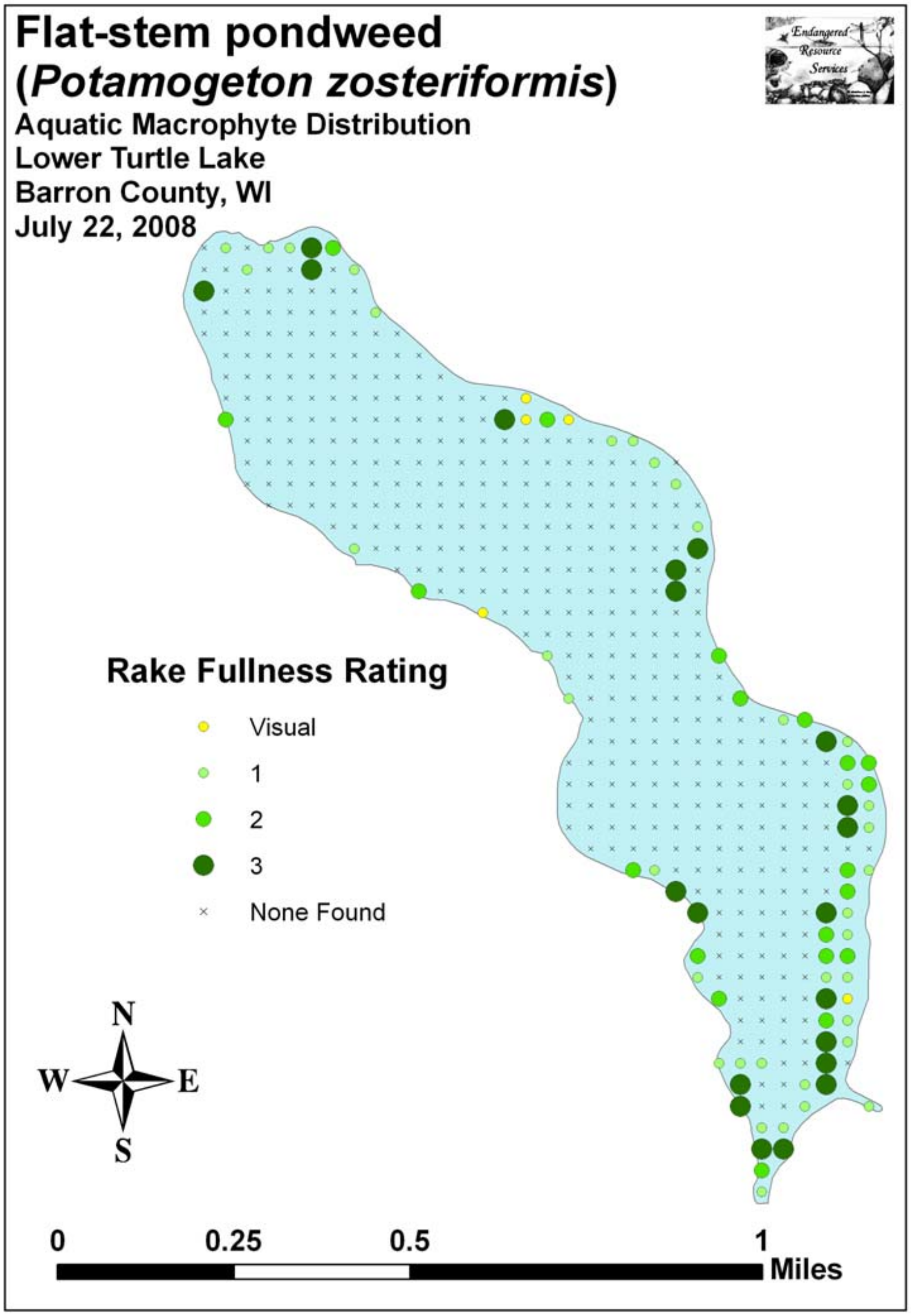
Flat-stem pondweed
(Potamogeton zosteriformis)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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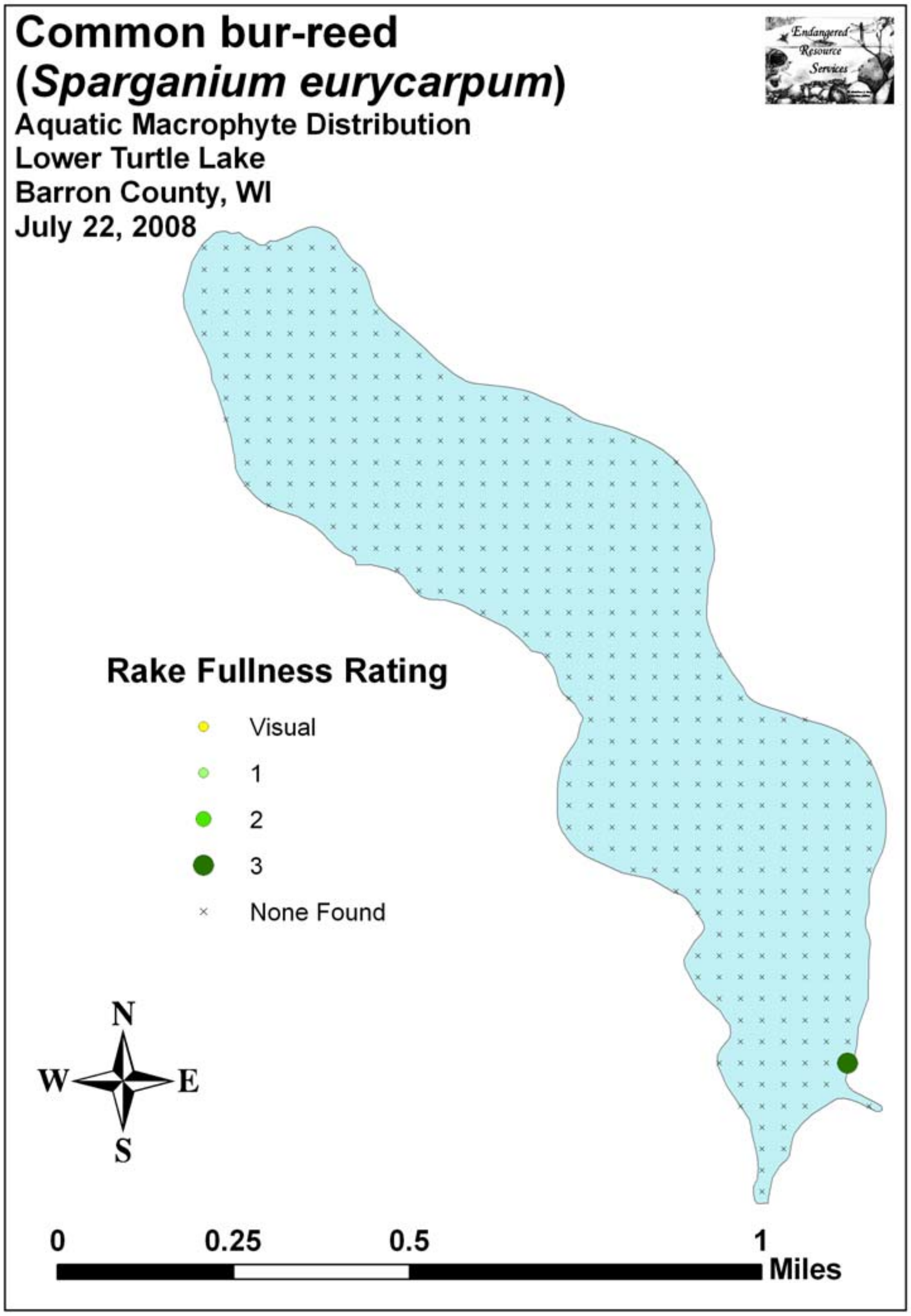
Common bur-reed
(Sparganium eurycarpum)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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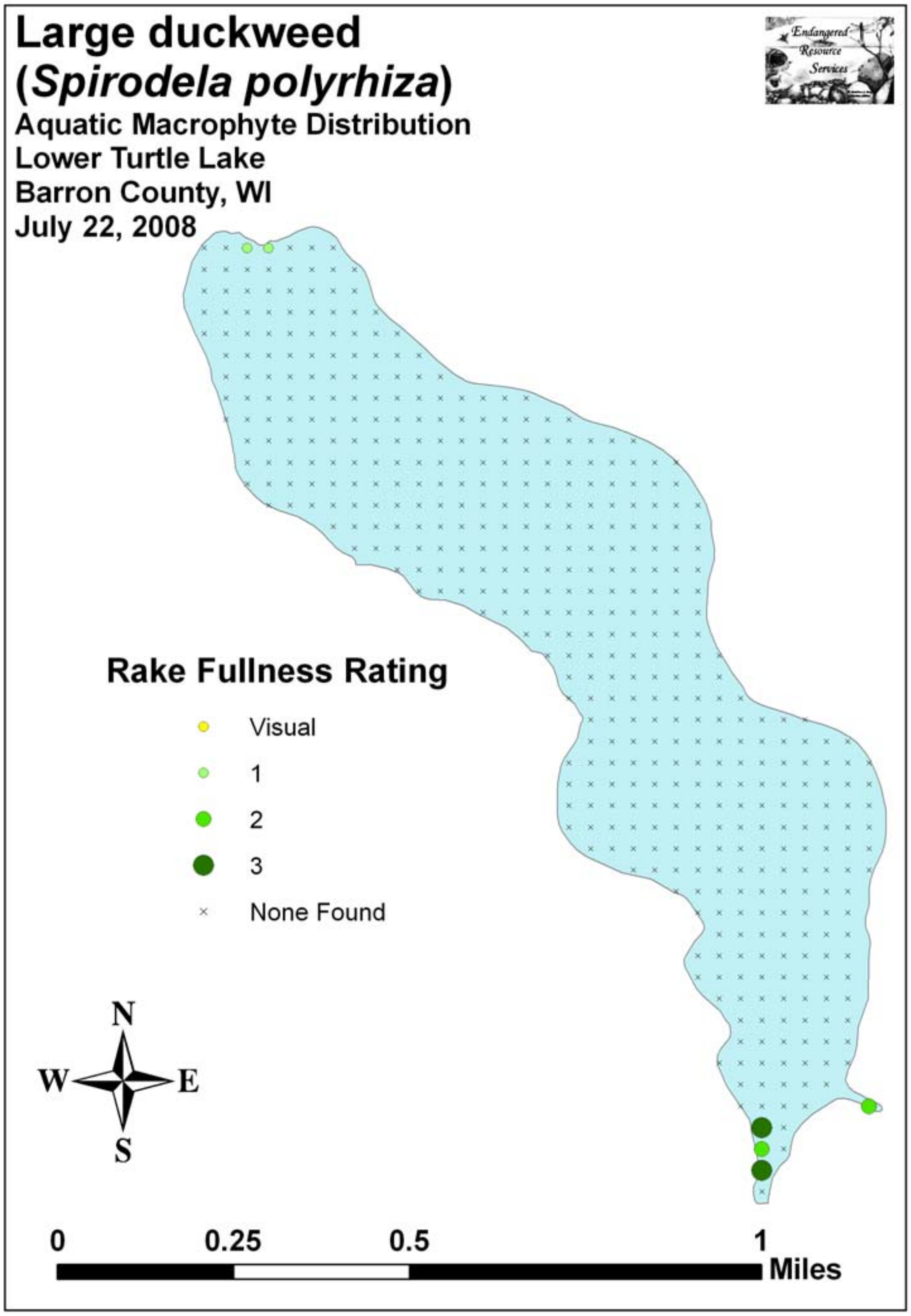
Large duckweed
(Spirodela polyrhiza)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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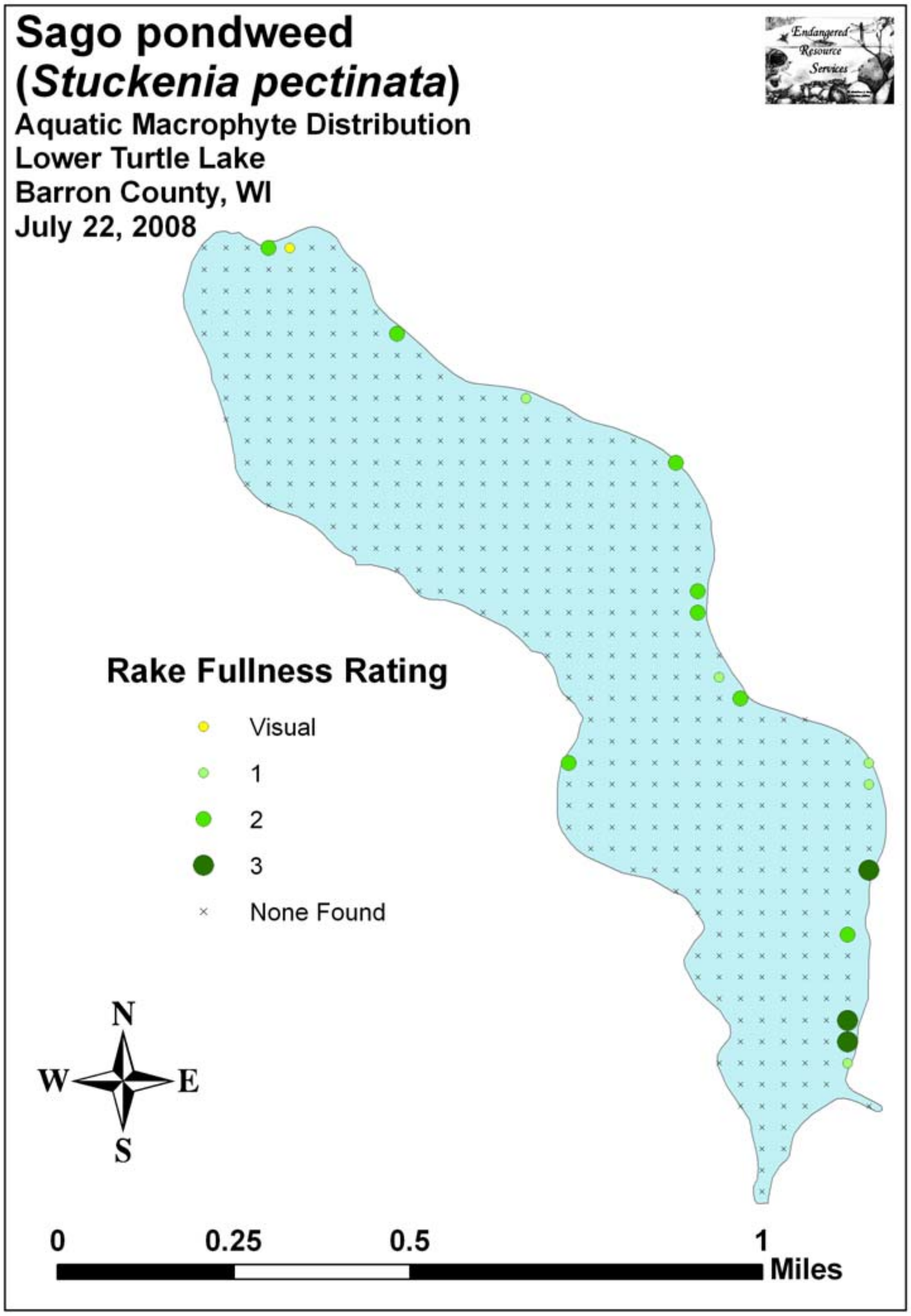
Sago pondweed
(Stuckenia pectinata)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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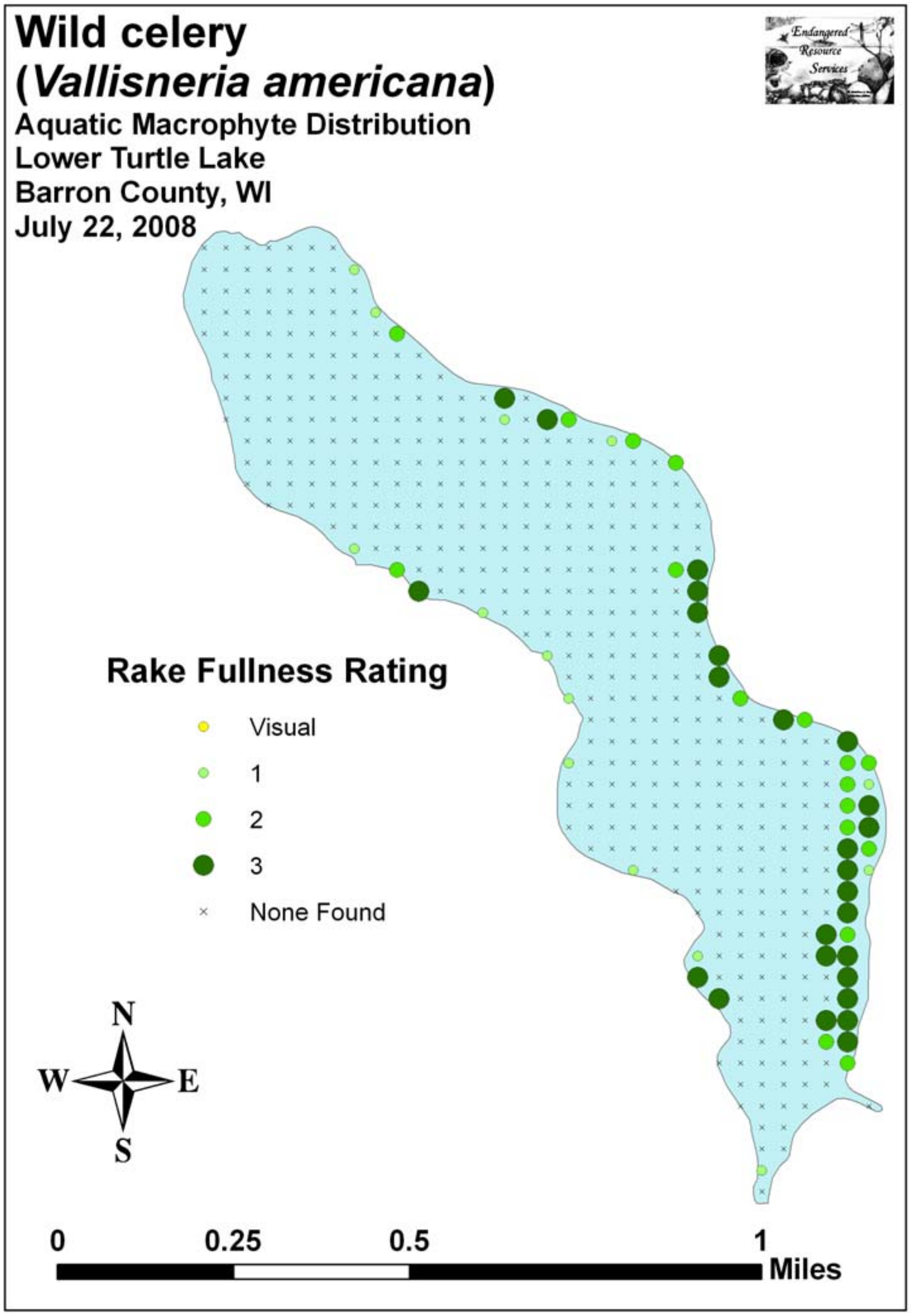
Miles


Wild celery
(*Vallisneria americana*)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
N
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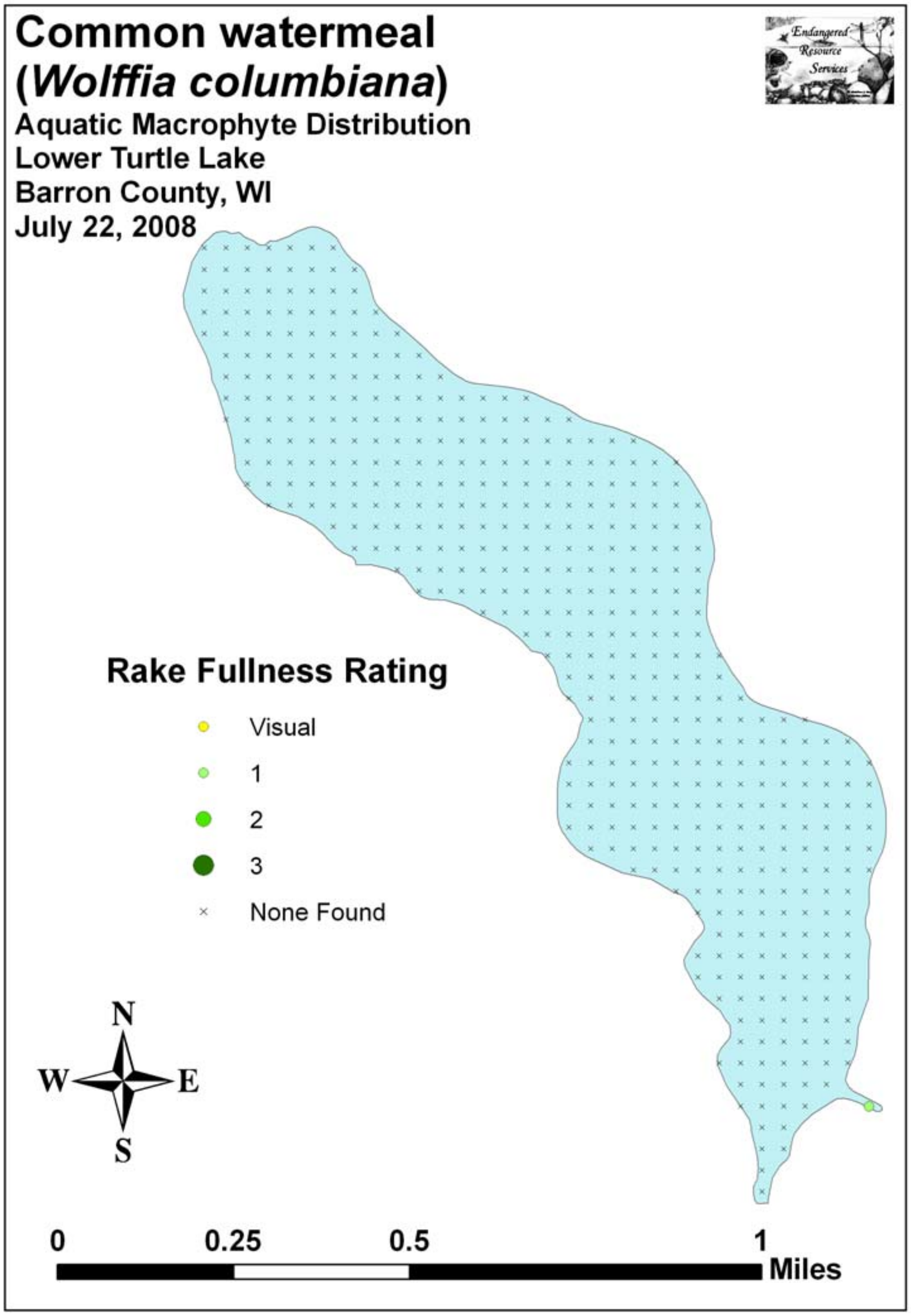
Miles


Common watermeal
(*Wolffia columbiana*)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
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None Found
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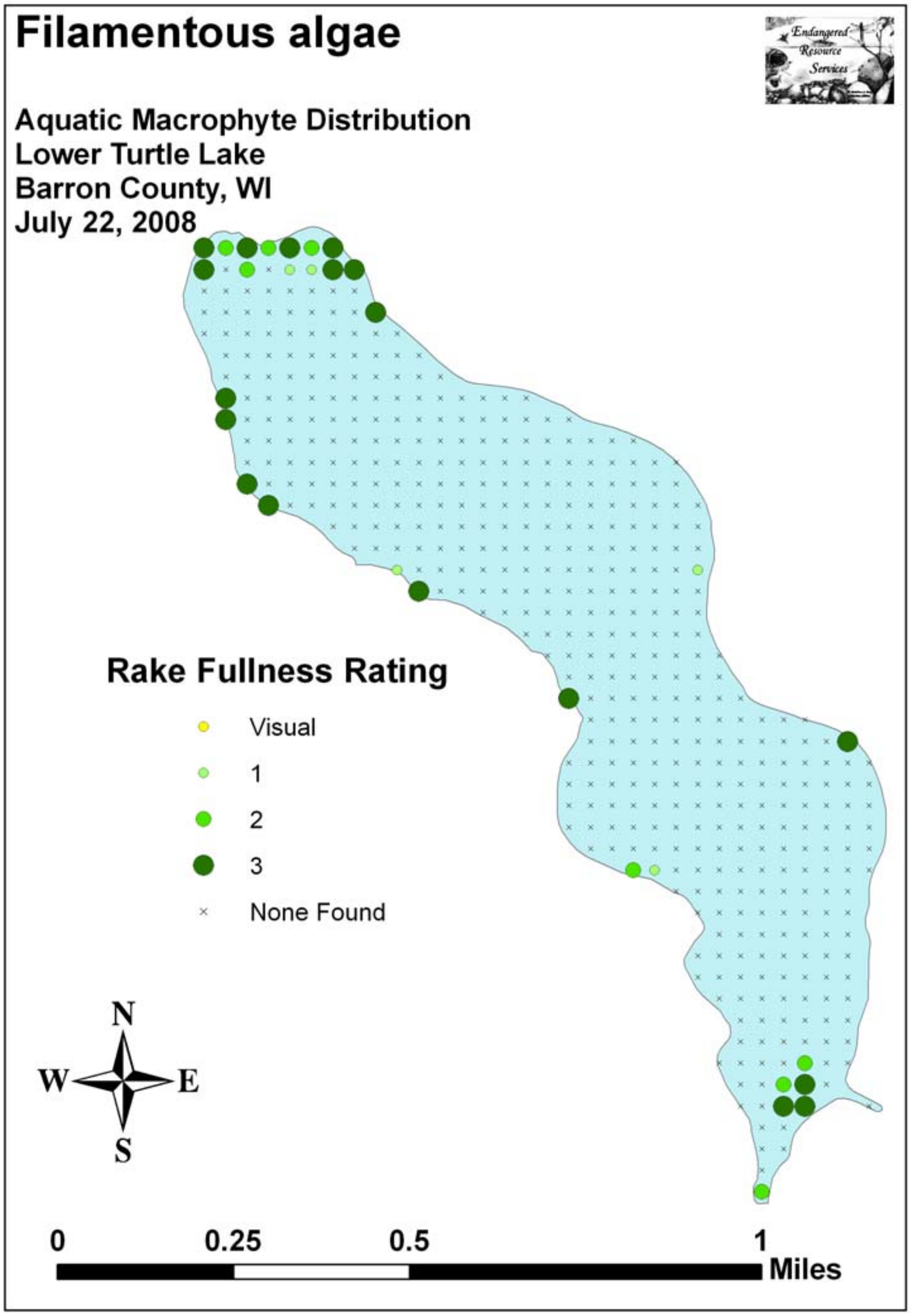
Miles


Filamentous algae
Endangered Resource Services
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
July 22, 2008
Rake Fullness Rating
Visual
1
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None Found
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0.25
0.5
1
Miles

Appendix VII: Glossary of Biological Terms
(Adapted from UWEX 2008)

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 drainage 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.

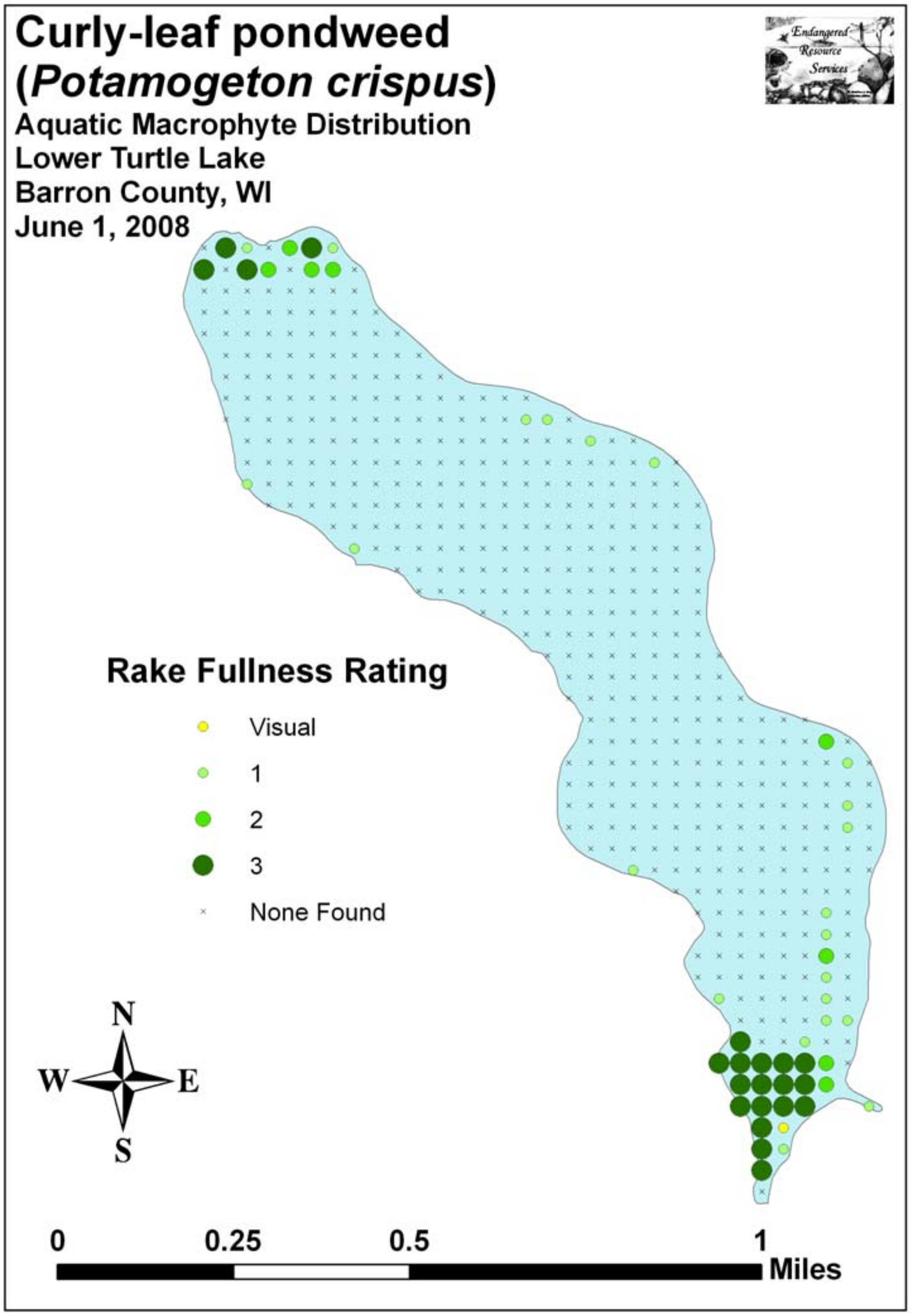
Drainage lakes:
Lakes without a significant inlet or outlet, fed by rainfall and groundwater. Drainage lakes lose water through evaporation and groundwater moving on a down gradient. Lakes with little groundwater inflow tend to be naturally acidic and most susceptible to the effects of acid rain. Drainage 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 VIII: June CLP Survey Map and Additional Exotic Species Information


Curly-leaf pondweed
(Potamogeton crispus)
Aquatic Macrophyte Distribution
Lower Turtle Lake
Barron County, WI
June 1, 2008
Endangered Resource Services
Rake Fullness Rating
Visual
1
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None Found
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1
Miles

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, 2008 http://www.dnr.state.wi.us/invasives/fact/curlyleaf_pondweed.htm)

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, 2008 http://www.dnr.state.wi.us/invasives/fact/milfoil.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, 2008 http://www.dnr.state.wi.us/invasives/fact/reed_canary.htm)

Purple loosestrife

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

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

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

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

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

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

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

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

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

Purple loosestrife displaces native wetland vegetation and degrades wildlife habitat. As native vegetation is displaced, rare plants are often the first species to disappear. Eventually, purple loosestrife can overrun wetlands thousands of acres in size, and almost entirely eliminate the open water habitat. The plant can also be detrimental to recreation by choking waterways. (Taken in its entirety from WDNR, 2008 http://www.dnr.state.wi.us/invasives/fact/loosestrife.htm)

Appendix IX: Raw Data Spreadsheets