Curly-leaf pondweed (*Potamogeton crispus*)

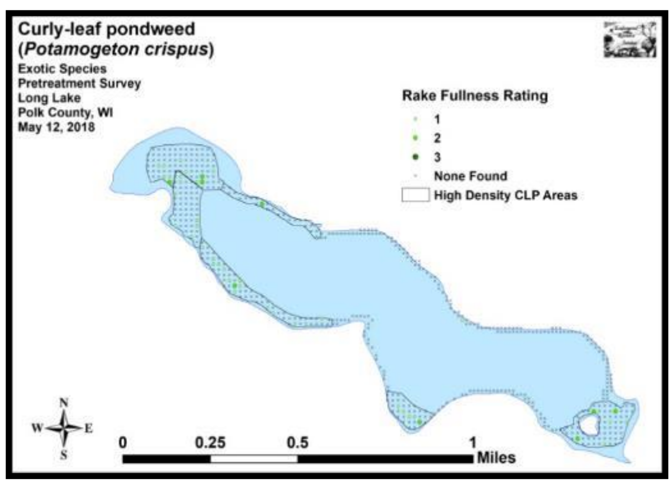
Pretreatment and Follow-up Surveys
Long Lake - WBIC: 2478200
Polk County, Wisconsin

Alum Treatment on Long Lake 6/11/18

Rake with CLP in NW Bay 6/11/18

Project Initiated by:

Long Lake Protection and Rehabilitation District, Harmony Environmental, and the Wisconsin Department of Natural Resources



2018 CLP Pretreatment Density and Distribution

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May 12 and June 11, 2018

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION:

Long Lake (WBIC 2478200) is a 272 acre seepage lake in central Polk County, Wisconsin in the Town of Balsam Lake (T34N R17W S07 NE NE). It reaches a maximum depth of just over 17ft in the central basin and has an average depth of approximately 11ft (Busch et al. 1969) (Figure 1). The lake is eutrophic trending toward hypereutrophic, and visibility is generally poor with summer Secchi readings averaging 4.7ft since 1992; however, the mean reading in 2018 was 5.9ft which was the highest in 10 years (WDNR 2018). The bottom substrate in the lake's bays and central basin is predominately thick organic muck, while exposed points and most north/south shorelines are dominated by gravel and sand.

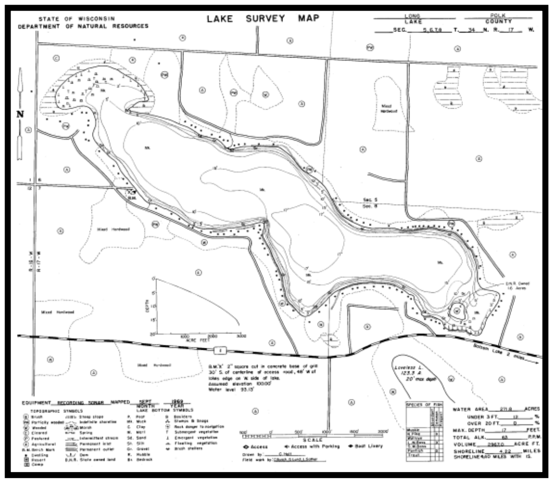


Figure 1: Long Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Long Lake and the Long Lake Protection and Rehabilitation District (LLPRD) have an extended history of battling Curly-leaf pondweed (*Potamogeton crispus*) (CLP) - an exotic invasive plant species that thrives in the nutrient-rich sediments found in many parts of the lake. In the past, CLP often grew so densely in the spring and early summer that it made lake access and boating difficult for residents. CLP's late-June to early-July senescence was also cited in past studies by Barr Engineering and the Polk County Land and Water Conservation Department (PCLWCD) as a significant contributor to the lake's overall phosphorus load, and it was at least partially responsible for the lake's frequent late-summer toxic blue-green algae blooms.

In 2010, after years of study, the LLPRD and the Wisconsin Department of Natural Resources (WDNR) authorized an initial lakewide herbicide treatment of over 65 acres of CLP. The LLPRD treated nearly 57 acres again in 2011, and 58 acres in 2012. After updating the District's WDNR approved Aquatic Plant Management Plan (APMP) in 2012, it was decided to treat just 27 acres in 2013, and only 20 acres in 2014. Although **the 2010-2013 treatments resulted in highly significant reductions** in both CLP coverage and density on the lake, **the 2014 treatment showed no significant change from pretreatment levels**. A follow-up survey of CLP turions in the lake's sediment also suggested 2015 CLP levels would likely be very low in most parts of the lake. Based on these data, and following a discussion with the lake's executive board and APMP director Cheryl Clemens (Harmony Environmental) in the fall of 2014, it was decided **not to treat CLP in 2015**.

Because both the 2015 June CLP point-intercept monitoring survey and the fall CLP turion sediment data suggested CLP had made a significant rebound throughout much of the lake, **it was decided that herbicide treatments (not to exceed 35 acres) would resume in the future**. Ultimately, the LLPRD decided to treat 34.97 acres in 2016 and 33.65 acres in 2017.

Prior to the planned 2018 herbicide application, we conducted a pretreatment survey of the lake on May 12th to determine initial CLP levels and finalize treatment areas. Because this survey found little CLP, **it was decided to cancel the 2018 treatment**. However, in order to see how CLP and native plant populations responded to skipping treatment, it was requested that we do a follow-up survey on June 11th. This report is the summary analysis of these two surveys.

METHODS:

Pre/Follow-up Treatment Surveys:

Following three years (2010-12) of doing extensive plant surveys as was required for the lakewide herbicide treatments, it was established that most midlake sandy/rocky shorelines that had narrow littoral areas supported extremely low densities of CLP. Because of this, these areas were annually greatly reduced or eliminated from treatment plans. In 2013, we divided the lake into high/low CLP density areas. Within the high density areas (HDAs), we used Hawth's Analysis Tools Extension to ArcGIS 9.3.1 to generate Pre/Follow-up survey points at 25m resolution within that year's 50 acres of proposed treatment areas. The resulting sampling grid contained 323 points which approximated to 6.5 points/acre. In the historically low density areas (LDAs), we constructed an alternative 200 point grid at 18m resolution where we conducted exploratory CLP point-intercept surveys to monitor for any potential resurgence in CLP. Because of the expansion of CLP in 2015, all 523 points were used for both the pre and posttreatment (follow-up) surveys in 2016, 2017, and 2018 (Appendix I).

Prior to each survey, we uploaded the points to a handheld mapping GPS unit (Garmin 76CSx) and then located them on the lake. At each point, we used a rake to sample an approximately 2.5ft section of the bottom and recorded the depth and bottom substrate. CLP was assigned a rake fullness value of 1-3 as an estimation of abundance (Figure 2). We also recorded visual sightings of CLP within six feet of the sample point. However, because visual sightings are not calculated into the Pre/Posttreatment statistical formulas, we only assigned a rake fullness value for non-CLP plants. A cumulative rake fullness value was also noted at each site.

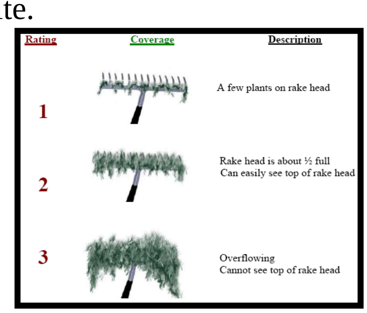


Figure 2: Rake Fullness Ratings

We entered all data collected into the standard APM spreadsheet (Appendix II) (UWEX 2010). Data was analyzed using the linked statistical summary sheet and the WDNR Pre/Posttreatment analysis worksheet (UWEX 2010). Pre/Post differences were determined to be significant at $p<0.05$, moderately significant at $p<0.01$ and highly significant at $p<0.001$.

RESULTS AND DISCUSSION:

Finalization of Treatment Areas:

Of the seven areas identified by Barr Engineering as having CLP in 2009, we have consistently found high density CLP in only six of them in an area covering 49.88 acres (Table 1). In 2018, northwest Wisconsin experienced near record late ice-out in late April/early May followed by a rapid warming of the water to over 60°F by the time of the pretreatment survey. These conditions appeared to negatively impact CLP growth as many area lakes also had unusually low overall CLP plant density and total biomass. In general, we observed the majority of CLP plants grew just a few feet and then topped off before they started to form turions. Following analysis of the pretreatment survey, we found there were just 21.29 acres that had ANY CLP (Figure 3). After considering the cost/benefit, the LLPRD decided to **cancel treatment in all areas in 2018** (Appendix I).

Table 1: 2018 Spring CLP Treatment Summary - Long Lake, Polk Co.

High Density CLP Area	Potential Treatment (acres)	Proposed Treatment (acres)	Final Treatment (acres)	Difference (+/-)
1	13.34	9.85	0.00	9.85
2	8.46	1.41	0.00	1.41
3	3.84	0.00	0.00	0.00
4	9.51	3.25	0.00	3.25
6	4.88	2.28	0.00	2.28
7	9.85	4.50	0.00	4.50
	49.88	**21.29**	**0.00**	**-21.29**

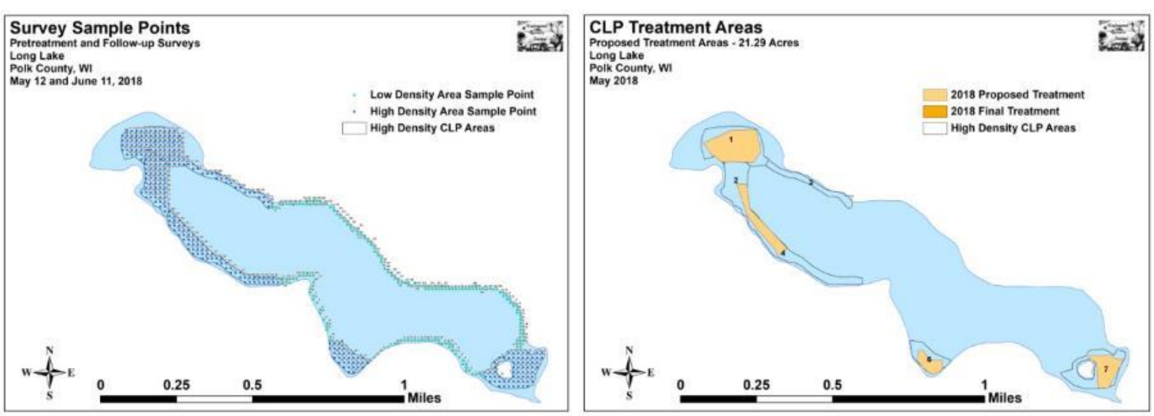


Figure 3: 2018 Pretreatment/Follow-up Survey Sample Points and Final CLP Treatment Areas

Pretreatment/Follow-up Surveys:

All Curly-leaf pondweed areas occurred in water between 0.5ft and 15.0ft deep (Figure 4). During the pretreatment survey, we found the mean and median depth of plant growth in the high density areas to be 5.9ft and 5.5ft respectively. These both increased 0.5ft in June to 6.4ft and 6.0ft with this increase likely related to the expansion of CLP plants which dominated the lake's deep-water plant community (Table 2). In the low density areas, the pretreatment mean and median depths were each 7.8ft. before declining sharply to 6.0ft and 5.5ft in June. This lowering of the mean is presumably due to the expansion of native vegetation in shallow water. Most CLP within the HDAs occurred over organic muck, although the western edge of Bed 7 near the island was established over sandy/rocky substrates. LDAs were dominated by sand and rock (Figure 4) (Appendix III).

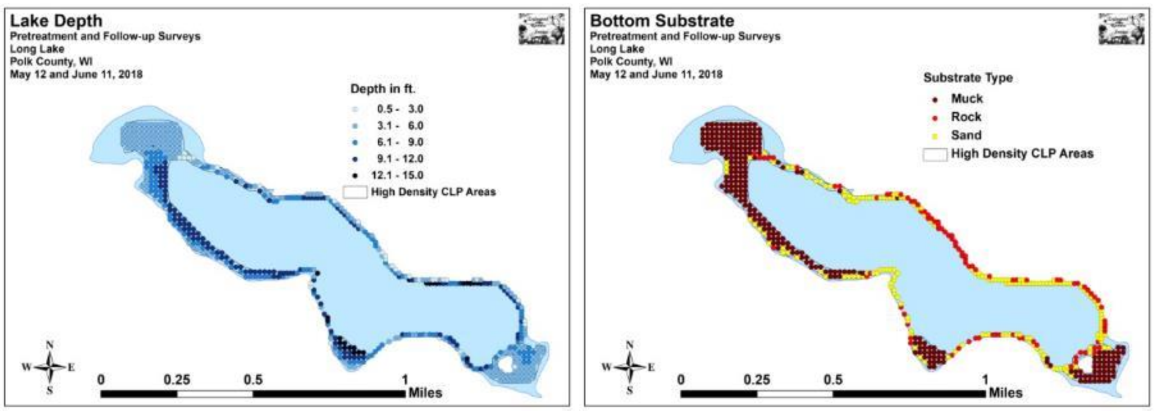


Figure 4: CLP Area Depths and Bottom Substrate

Table 2: Pretreatment/Follow-up Surveys Summary Statistics
Long Lake, Polk County
May 12 and June 11, 2018

Summary Statistics:	Pre-High	June-High	Pre-Low	June-Low
Total number of points sampled	323	323	200	200
Total number of sites with vegetation	217	254	40	83
Total number of sites shallower than the maximum depth of plants	314	314	200	198
Frequency of occurrence at sites shallower than max. depth of plants	69.1	80.9	20.0	41.9
Simpson Diversity Index	0.73	0.84	0.73	0.86
Mean Coefficient of Conservatism	5.9	5.2	5.6	5.6
Floristic Quality Index	19.6	21.3	14.7	17.7
Average number of all species per site (shallower than max depth)	1.11	1.71	0.22	0.61
Average number of all species per site (veg. sites only)	1.60	2.12	1.08	1.45
Ave. number of native species/site (shallower than max depth)	0.96	1.32	0.21	0.57
Ave. number of native species/site (sites with native plants only)	1.60	2.19	1.08	1.43
Species Richness	12	18	8	11
Maximum depth of plants (ft)	12.0	12.0	15.0	14.0
Mean depth of plants (ft)	5.9	6.4	7.8	6.0
Median depth of plants (ft)	5.5	6.0	7.8	5.5
Mean Rake Fullness (veg. sites only)	1.41	1.65	1.17	1.08

In May, the littoral zone extended to 15.0ft (12.0ft HDAs/15.0ft LDAs) before contracting slightly in June (12.0ft HDAs/14.0ft LDAs) (Figure 5) (Appendix IV). Within this zone, the frequency of plants encountered in the HDAs increased from 69.1% pretreatment to 80.9% during the follow-up. In the LDAs, where plants were uncommon in May (20.0% coverage), the frequency more than doubled to 41.9% in June. Within the HDAs, richness rose from 12 species in May to 18 in June, while the LDAs increased only slightly from eight to 11 species (Both areas increased over 2017 posttreatment totals - 10 species HDAs/8 LDAs). This also helped the Simpson's Diversity Index increase in the HDAs (0.73 May/0.84 June) and the LDAs (0.73 May/0.86 June). The Floristic Quality Index (another measure of the native plant community health) in the HDAs increased from 19.6 in May to 21.3 in June (up sharply from 2017 values of 11.2 pretreatment to 16.3 posttreatment). In the LDAs, the FQI increased from 14.7 to 17.7 (also up from 12.7 pre and 15.2 post in 2017).

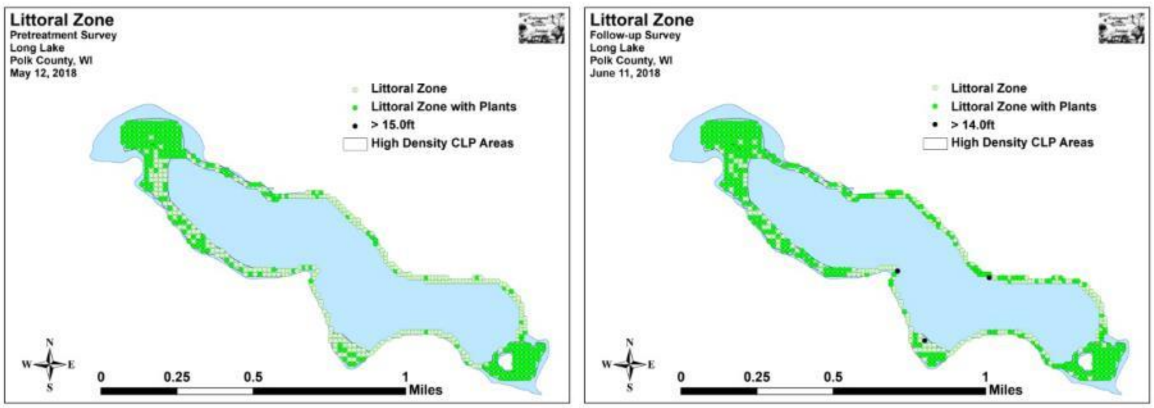


Figure 5: Pretreatment/Follow-up Littoral Zone

We found localized native species richness to be quite low throughout the lake. In the high density areas, mean richness at points with native plants increased from 1.60 species/site in May to 2.19 species/site in June (up from 2017's 1.47 species/site posttreatment). In low density areas, this value grew from 1.08 species/site in May to 1.45 species/site in June (up from 1.30 in June 2017) (Figures 6) (Appendix IV).

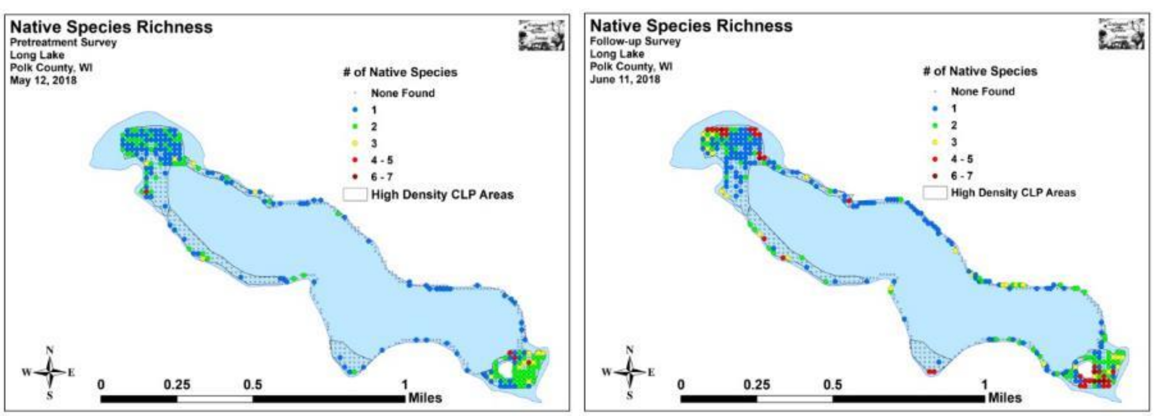


Figure 6: Pretreatment/Follow-up Native Species Richness

Total mean rake fullness in the HDAs was a low 1.41 in May before increasing slightly to a low/moderate 1.65 in June (up from 1.43 in June 2017). In LDAs, where the May mean rake fullness was already an exceptionally low 1.17, we found this level dropped further to 1.08 in June (similar to 2017's drop from 1.29 to 1.04) (Figures 7) (Appendix IV).

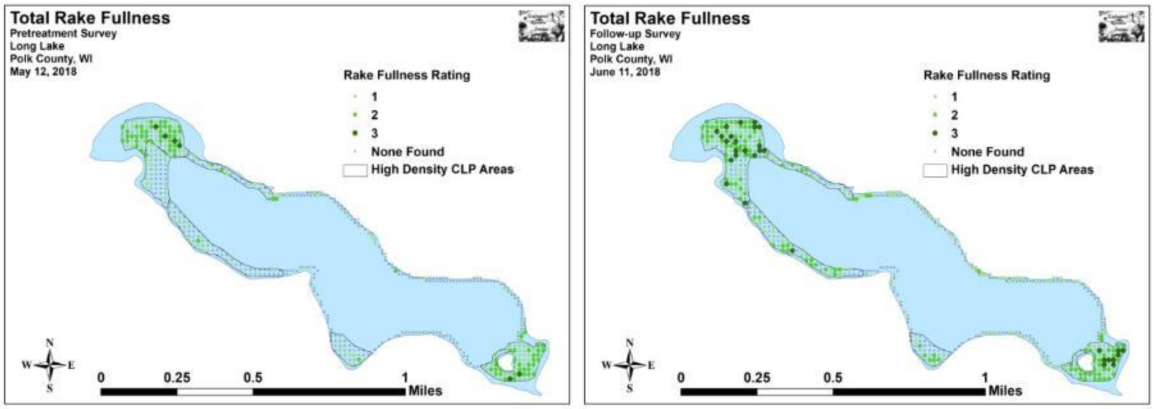


Figure 7: Pretreatment/Follow-up Total Rake Fullness

During the pretreatment survey, we found Curly-leaf pondweed at 46 of 523 total sites (8.8% coverage – down from 209 points/40.0% coverage in 2017). Of these, 45 occurred within the high density area's 323 points (13.9% coverage), and one occurred within the low density area's 200 points (0.5% coverage) (Figure 8) (Appendix V). The HDAs had no points with a rake fullness rating of 3, nine points that rated a 2, and 36 that were a 1. This produced a mean rake fullness of 1.20 (down from 1.71 in 2017). The single point in the LDA's had a rake fullness of 1.

As expected without treatment and with such a low starting point, total CLP levels experienced a highly significant increase from May to June. During the follow-up survey, we found CLP at 132 points (25.2% coverage) with seven additional visual sightings. Of these, eight rated a three, 42 a 2, and the remaining 82 were a 1 for a mean rake fullness of a low/moderate 1.44 (Figure 9). All but seven of these points occurred in the high density areas (38.7% coverage) where 50 points (15.5% coverage) had a significant infestation (rake fullness of 2 or 3) (Figure 10). In the LDAs, the seven points with CLP (3.5% coverage) represented a significant overall increase in both total CLP and rake fullness 1 (Figure 11).

Despite these increases, the untreated totals in 2018 were still significantly less than the pretreatment totals from 2017. Analysis of the follow-up survey map showed that CLP distribution remained patchy with no clear areas that "should have been treated" under the current Aquatic Plant Management Plan minimum treatment acreage guidelines. We also noted that no CLP ever canopied in water over 5ft, and many plants at depths greater than this were already starting to fall over and die with no turions visible.

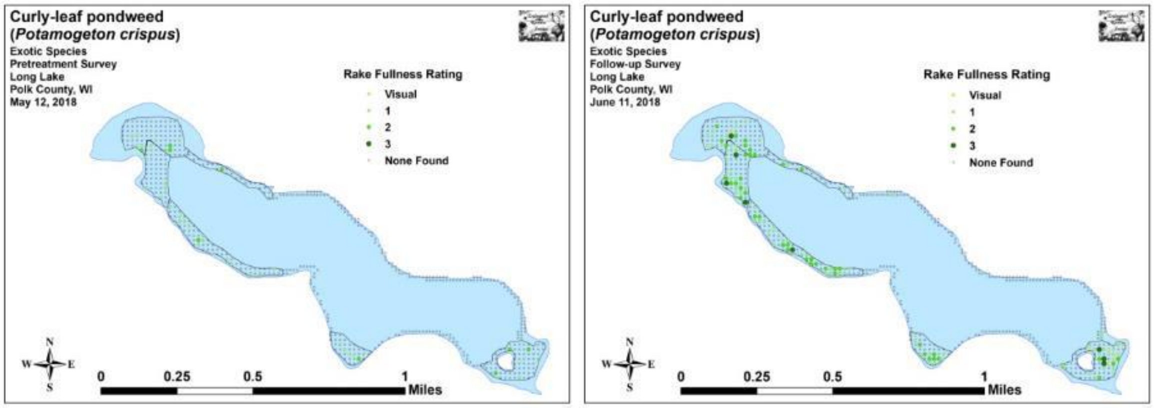
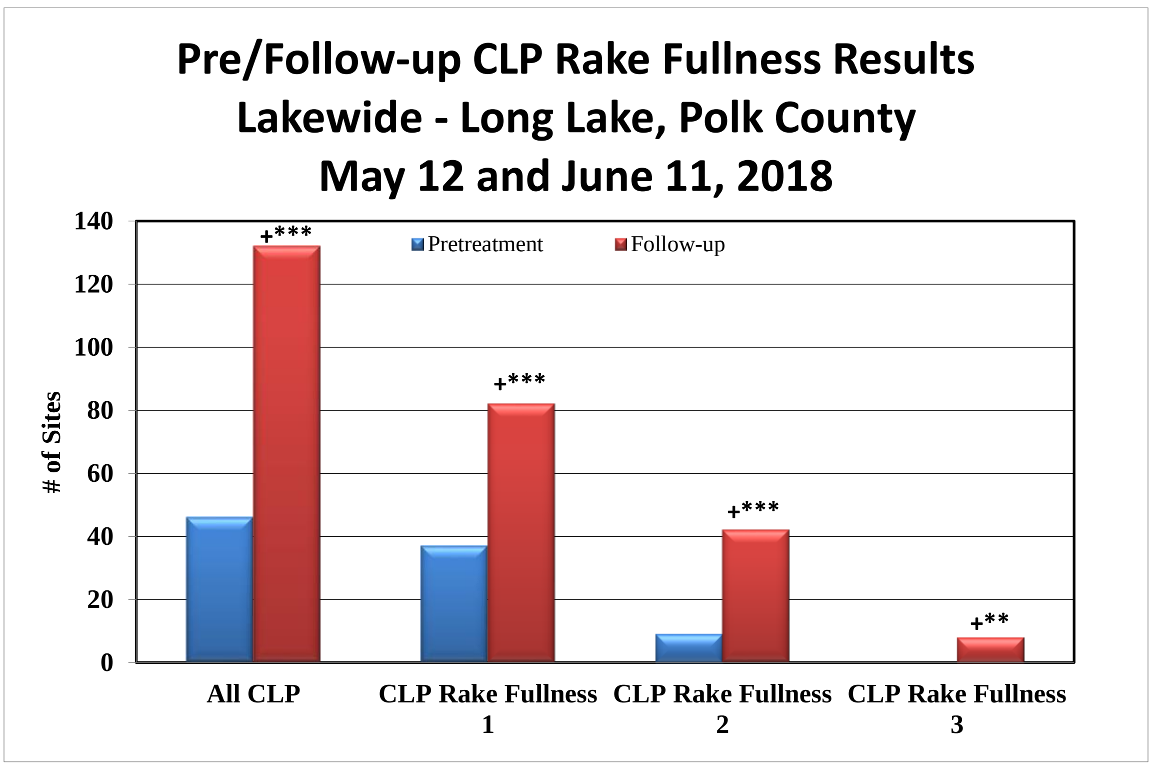
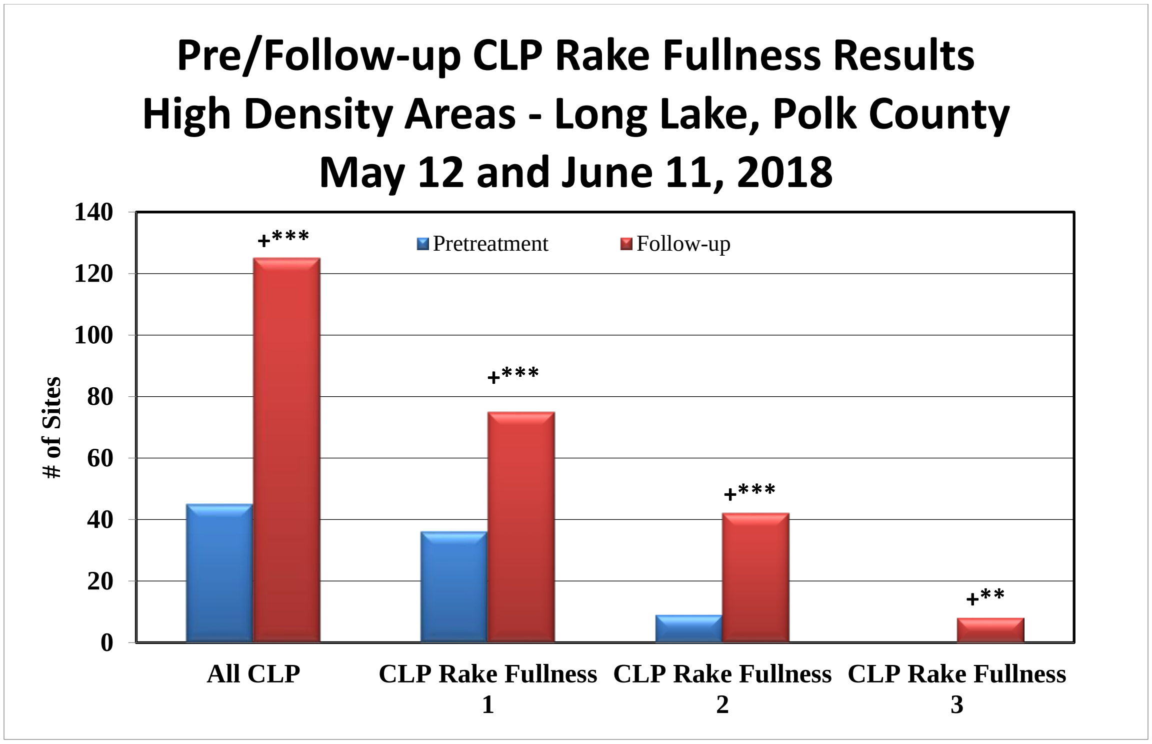


Figure 8: Pretreatment/Follow-up CLP Density and Distribution



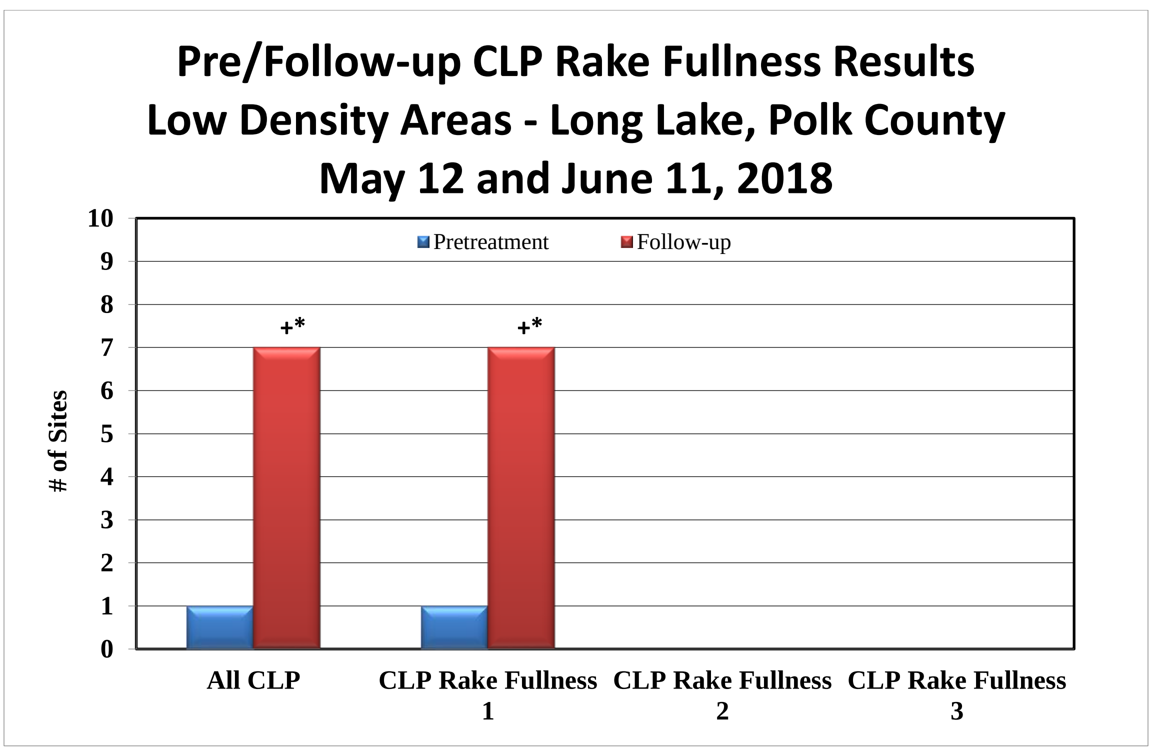
Significant differences = * p<0.05, ** p<0 .01, *** p<0.001

Figure 9: Whole Lake – Changes in CLP Rake Fullness Ratings



Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 10: High Density Areas - Changes in CLP Rake Fullness Ratings



Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 11: Low Density Areas - Changes in CLP Rake Fullness Ratings

Lakewide, we found Coontail (*Ceratophyllum demersum*) and Common waterweed (*Elodea canadensis*) were the most common and second most common native species during both the pretreatment and follow-up surveys (Figures 12 and 13) (Tables 3-6). Interestingly, both declined in total distribution although neither change was significant.

As is typical, many later growing native species that were largely dormant during the pretreatment survey showed significant lakewide increases (Figure 14). Specifically, filamentous algae, White water lily (*Nymphaea odorata*), Slender naiad (*Najas flexilis*), Small duckweed (*Lemna minor*), Large duckweed (*Spirodela polyrhiza*), and Common watermeal (*Wolffia columbiana*) demonstrated highly significant increases; and Water star-grass (*Heteranthera dubia*), Northern water-milfoil (*Myriophyllum sibiricum*), and Small pondweed (*Potamogeton pusillus*) experienced significant increases (Maps of all native species from the pretreatment and follow-up surveys are located in Appendixes VI and VII).

Breaking the 2018 data out between high density areas (Figure 15) and low density areas (Figure 16) provided little additional information. However, comparing the 2017 posttreatment and 2018 June surveys (Figure 17) showed significant recoveries in native species that are sensitive to Endothall including Coontail, Northern water-milfoil, and Small pondweed. We also found Clasping-leaf pondweed (*Potamogeton richardsonii*), a beneficial habitat producing native plant, for the first time ever. Although the expected increase in CLP is disappointing, these increases in native populations during a "rest" year are a positive.

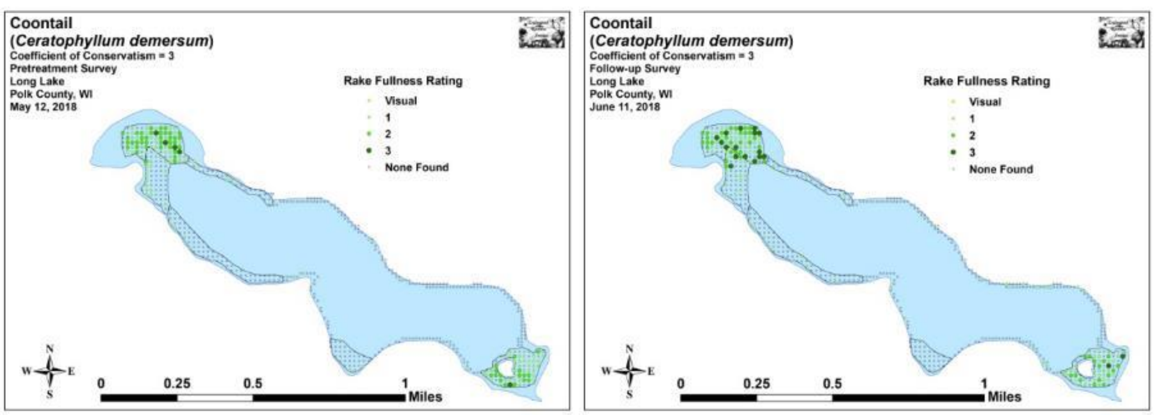


Figure 12: Pre/Follow-up Coontail Density and Distribution

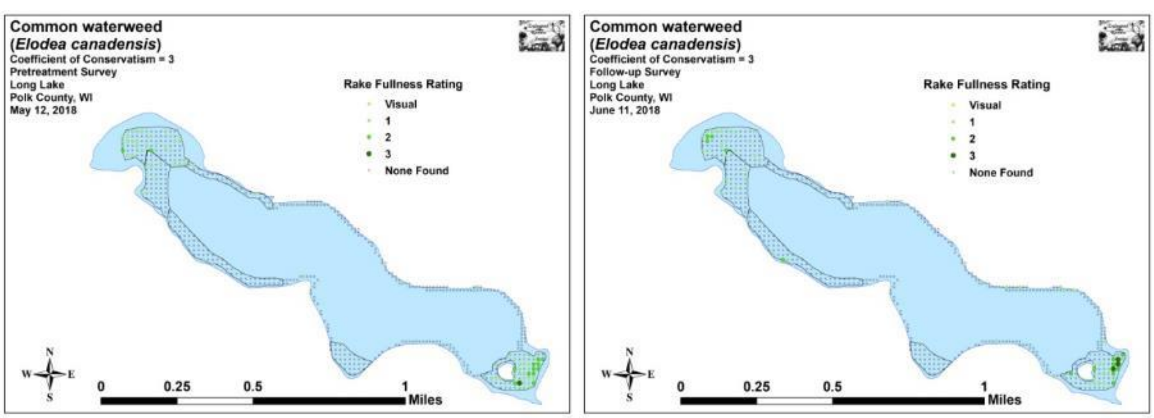


Figure 13: Pre/Follow-up Common Waterweed Density and Distribution

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes Pretreatment Survey – High CLP Density Areas - Long Lake, Polk County May 12, 2018

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Ceratophyllum demersum	Coontail	152	43.80	70.05	48.41	1.41
	Filamentous algae	124	*	57.14	39.49	1.14
Elodea canadensis	Common waterweed	81	23.34	37.33	25.80	1.19
Potamogeton crispus	Curly-leaf pondweed	45	12.97	20.74	14.33	1.20
Chara sp.	Muskgrass	26	7.49	11.98	8.28	1.04
Lemna trisulca	Forked duckweed	21	6.05	9.68	6.69	1.05
Nitella sp.	Nitella	6	1.73	2.76	1.91	1.00
Eleocharis acicularis	Needle spikerush	5	1.44	2.30	1.59	1.20
Myriophyllum sibiricum	Northern water-milfoil	4	1.15	1.84	1.27	1.00
Heteranthera dubia	Water star-grass	3	0.86	1.38	0.96	1.00
Nymphaea odorata	White water lily	2	0.58	0.92	0.64	1.00
Potamogeton pusillus	Small pondweed	1	0.29	0.46	0.32	1.00
Sagittaria graminea	Grass-leaved arrowhead	1	0.29	0.46	0.32	1.00

* Excluded from relative frequency analysis

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Pretreatment Survey – Low CLP Density Areas - Long Lake, Polk County
May 12, 2018

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Chara sp.	Muskgrass	20	46.51	50.00	10.00	1.05
	Filamentous algae	8	*	20.00	4.00	1.25
Heteranthera dubia	Water star-grass	6	13.95	15.00	3.00	1.00
Ceratophyllum demersum	Coontail	5	11.63	12.50	2.50	1.00
Eleocharis acicularis	Needle spikerush	4	9.30	10.00	2.00	1.00
Lemna trisulca	Forked duckweed	4	9.30	10.00	2.00	1.00
Elodea canadensis	Common waterweed	2	4.65	5.00	1.00	1.00
Potamogeton crispus	Curly-leaf pondweed	1	2.33	2.50	0.50	1.00
Sagittaria graminea	Grass-leaved arrowhead	1	2.33	2.50	0.50	1.00

* Excluded from relative frequency analysis

Table 5: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Follow-up Survey - High CLP Density Areas - Long Lake, Polk County
June 11, 2018

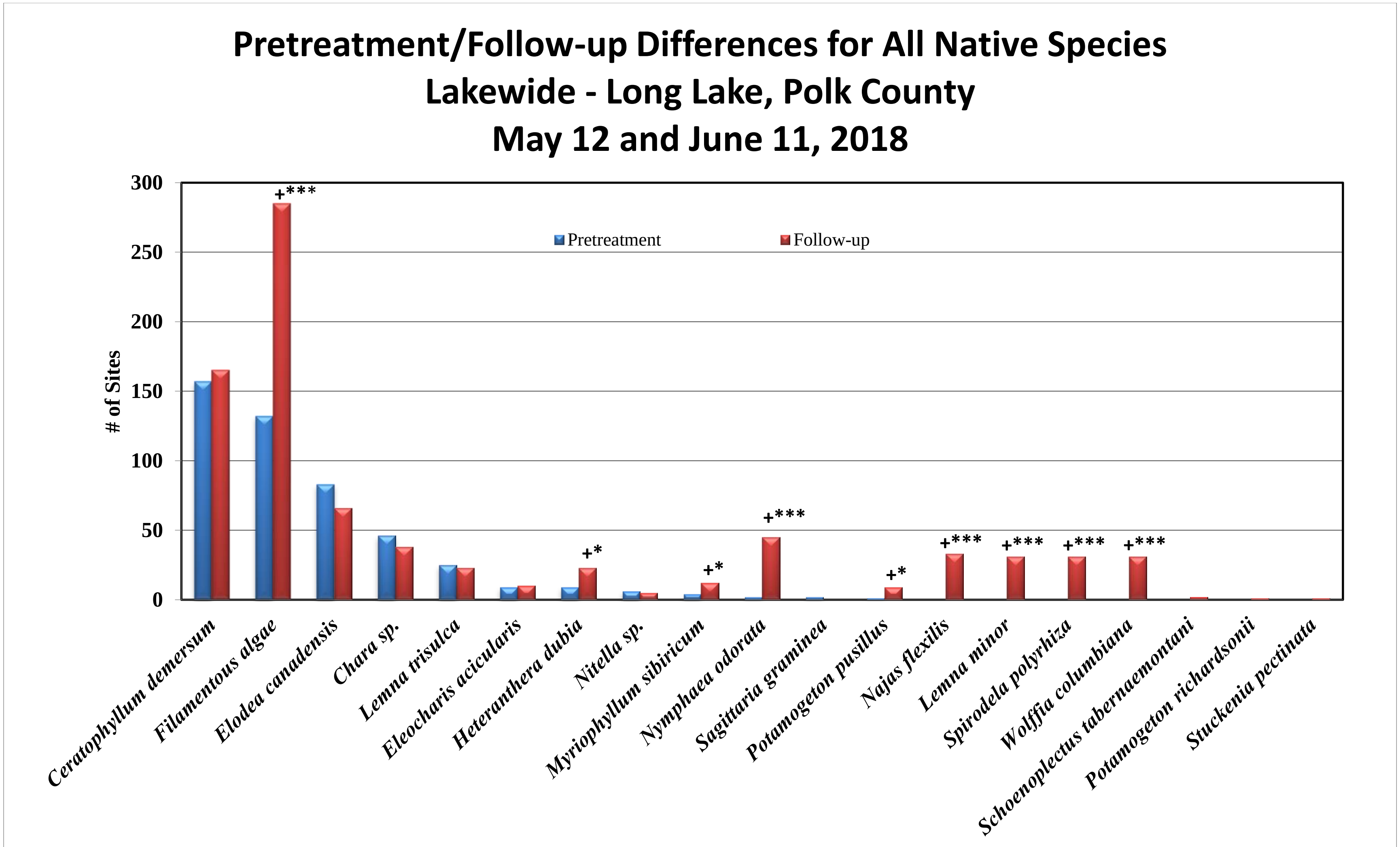
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
	Filamentous algae	170	*	66.93	54.14	1.26
Ceratophyllum demersum	Coontail	149	27.70	58.66	47.45	1.53
Potamogeton crispus	Curly-leaf pondweed	125	23.23	49.21	39.81	1.46
Elodea canadensis	Common waterweed	56	10.41	22.05	17.83	1.34
Nymphaea odorata	White water lily	45	8.36	17.72	14.33	1.51
Lemna minor	Small duckweed	31	5.76	12.20	9.87	1.48
Spirodela polyrhiza	Large duckweed	31	5.76	12.20	9.87	1.42
Wolffia columbiana	Common watermeal	31	5.76	12.20	9.87	1.16
Chara sp.	Muskgrass	22	4.09	8.66	7.01	1.18
Lemna trisulca	Forked duckweed	12	2.23	4.72	3.82	1.00
Myriophyllum sibiricum	Northern water-milfoil	11	2.04	4.33	3.50	1.09
Heteranthera dubia	Water star-grass	9	1.67	3.54	2.87	1.00
Eleocharis acicularis	Needle spikerush	5	0.93	1.97	1.59	1.20
Potamogeton pusillus	Small pondweed	4	0.74	1.57	1.27	1.00
Nitella sp.	Nitella	2	0.37	0.79	0.64	1.00
Schoenoplectus tabernaemontani	Softstem bulrush	2	0.37	0.79	0.64	1.00
Najas flexilis	Slender naiad	1	0.19	0.39	0.32	1.00
Potamogeton richardsonii	Clasping-leaf pondweed	1	0.19	0.39	0.32	1.00
Stuckenia pectinata	Sago pondweed	1	0.19	0.39	0.32	1.00

* Excluded from relative frequency analysis

Table 6: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Follow-up Survey - Low CLP Density Areas - Long Lake, Polk County
June 11, 2018

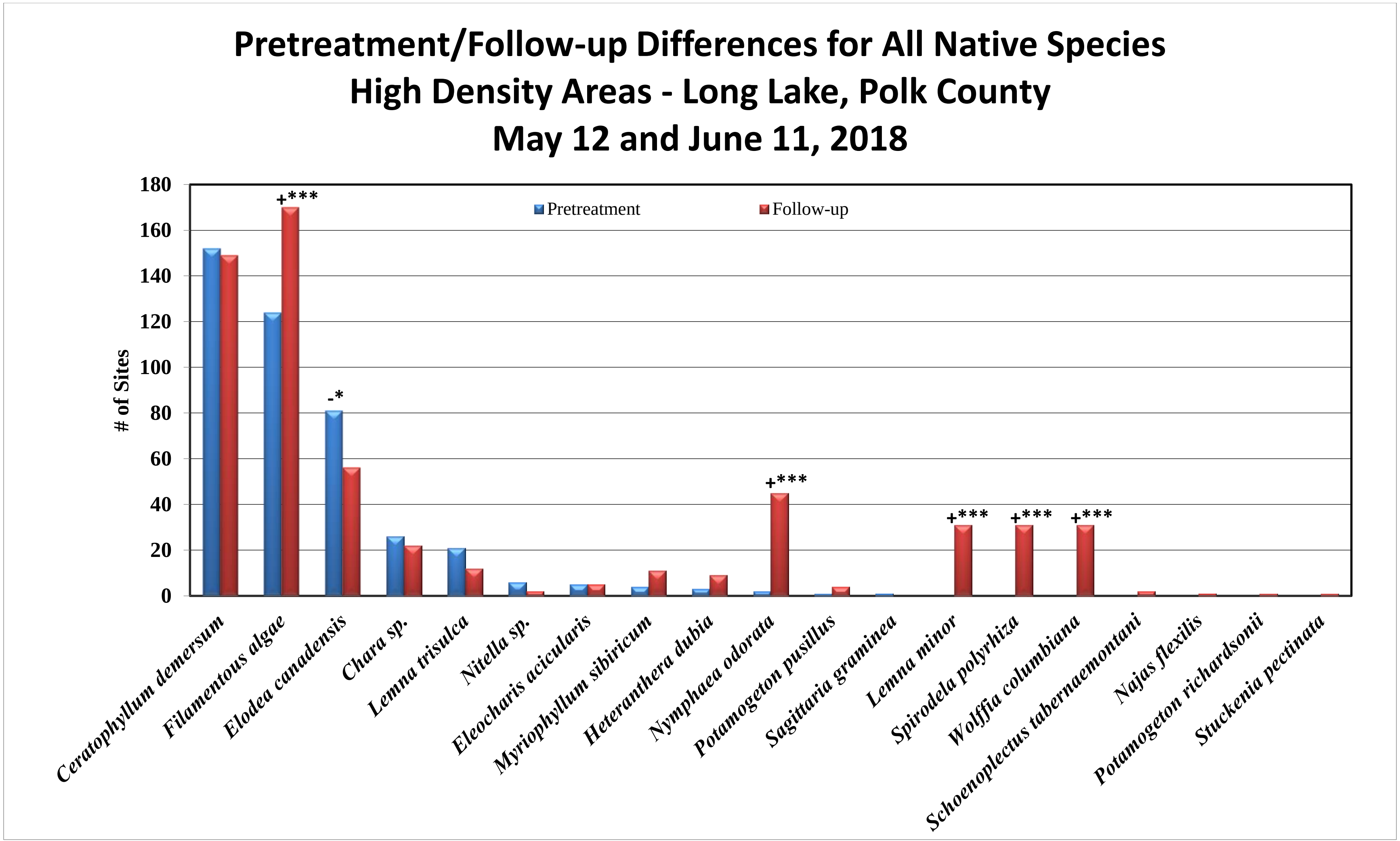
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
	Filamentous algae	115	*	138.55	58.08	1.17
Najas flexilis	Slender naiad	32	26.67	38.55	16.16	1.03
Ceratophyllum demersum	Coontail	16	13.33	19.28	8.08	1.00
Chara sp.	Muskgrass	16	13.33	19.28	8.08	1.38
Heteranthera dubia	Water star-grass	14	11.67	16.87	7.07	1.00
Lemna trisulca	Forked duckweed	11	9.17	13.25	5.56	1.00
Elodea canadensis	Common waterweed	10	8.33	12.05	5.05	1.00
Potamogeton crispus	Curly-leaf pondweed	7	5.83	8.43	3.54	1.00
Eleocharis acicularis	Needle spikerush	5	4.17	6.02	2.53	1.00
Potamogeton pusillus	Small pondweed	5	4.17	6.02	2.53	1.00
Nitella sp.	Nitella	3	2.50	3.61	1.52	1.00
Myriophyllum sibiricum	Northern water-milfoil	1	0.83	1.20	0.51	1.00

* Excluded from relative frequency analysis



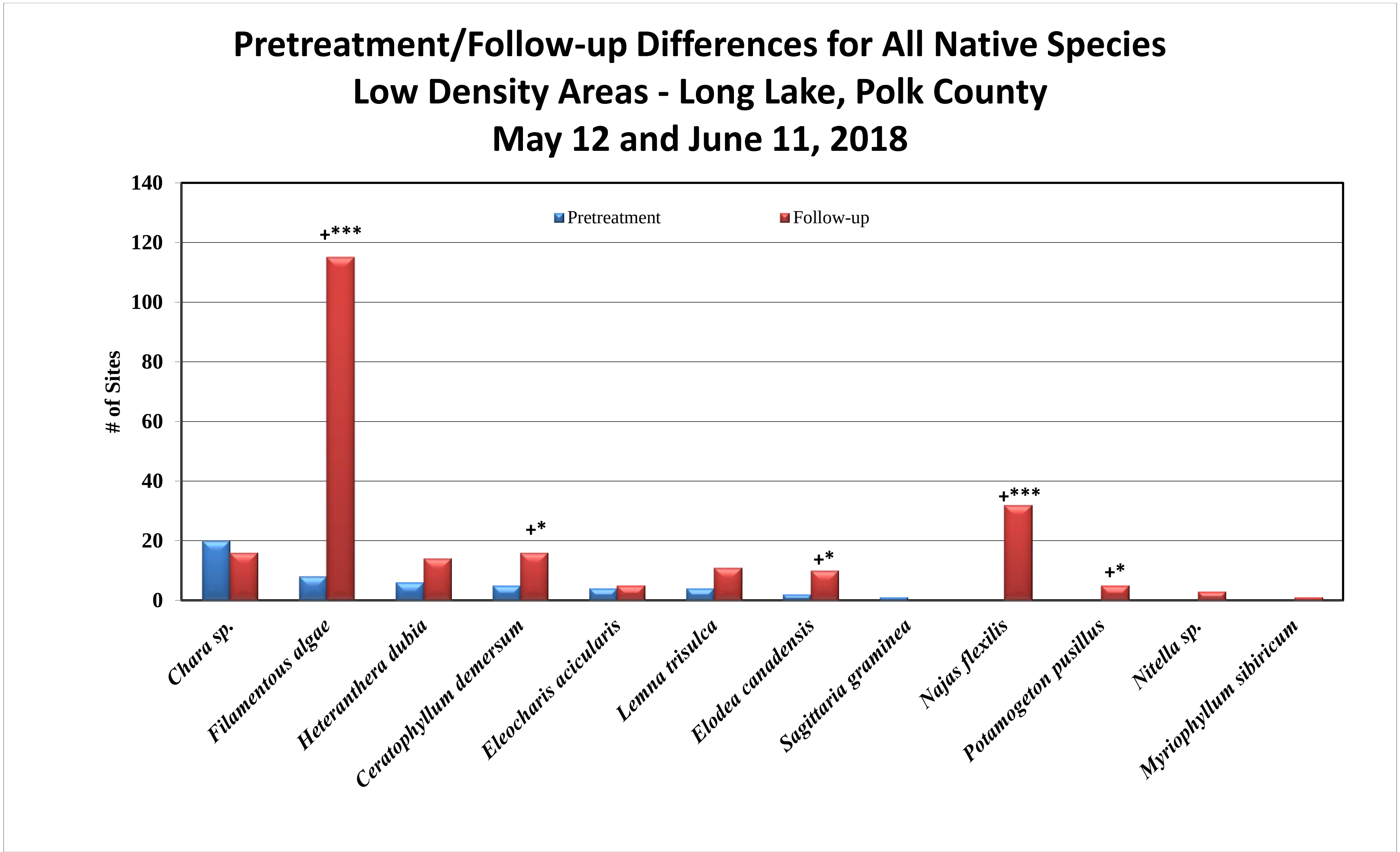
Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 14: Whole Lake Pretreatment/Follow-up Native Species Changes



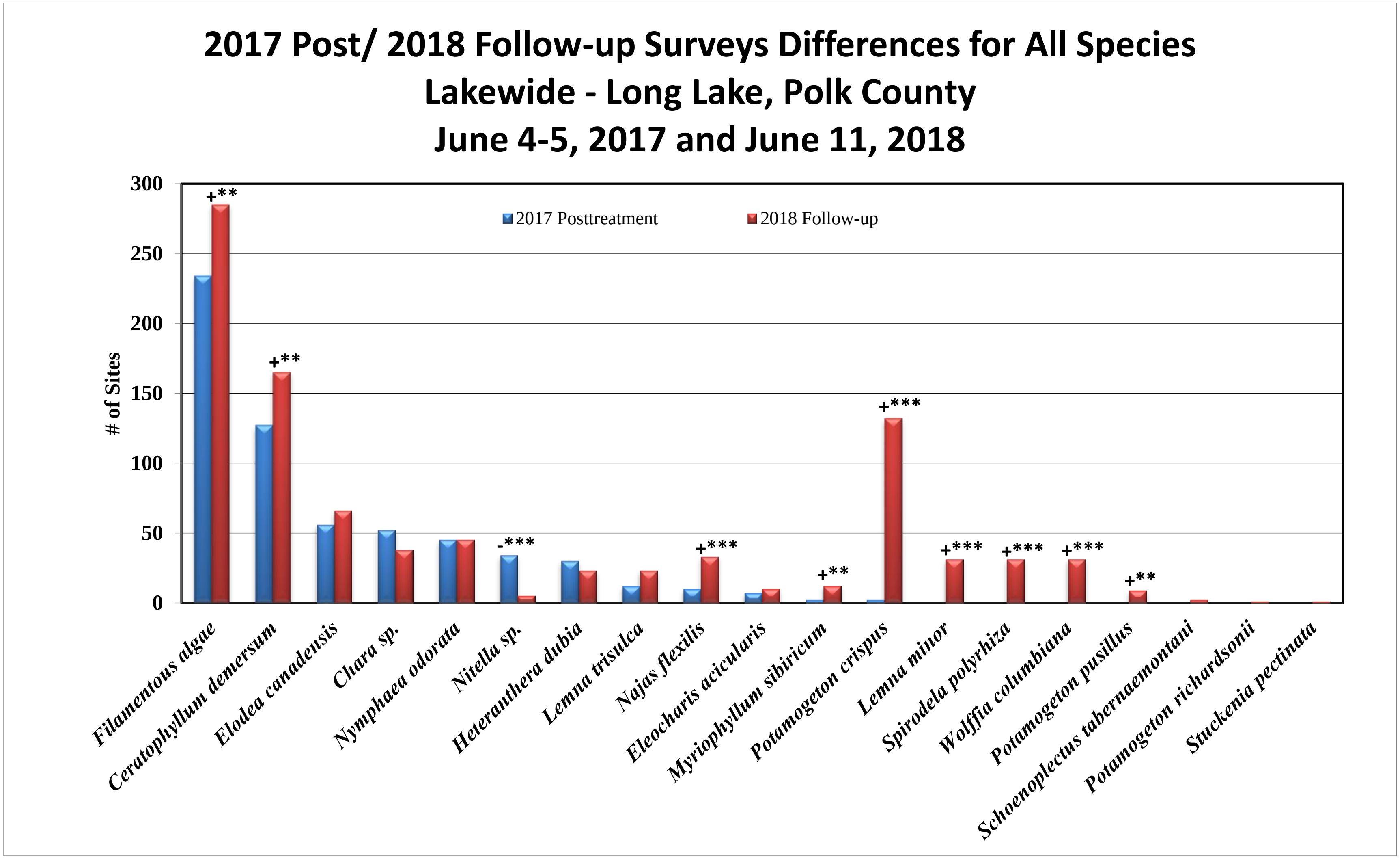
Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 15: High Density Areas - Pretreatment/Follow-up Native Species Changes



Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 16: Low Density Areas - Pretreatment/Follow-up Native Species Change



Significant differences = * *p*<0.05, ** *p*<0 .01, * *p*<0.001**

Figure 17: 2017 Posttreatment/2018 Follow-up All Species Change

LITERATURE CITED

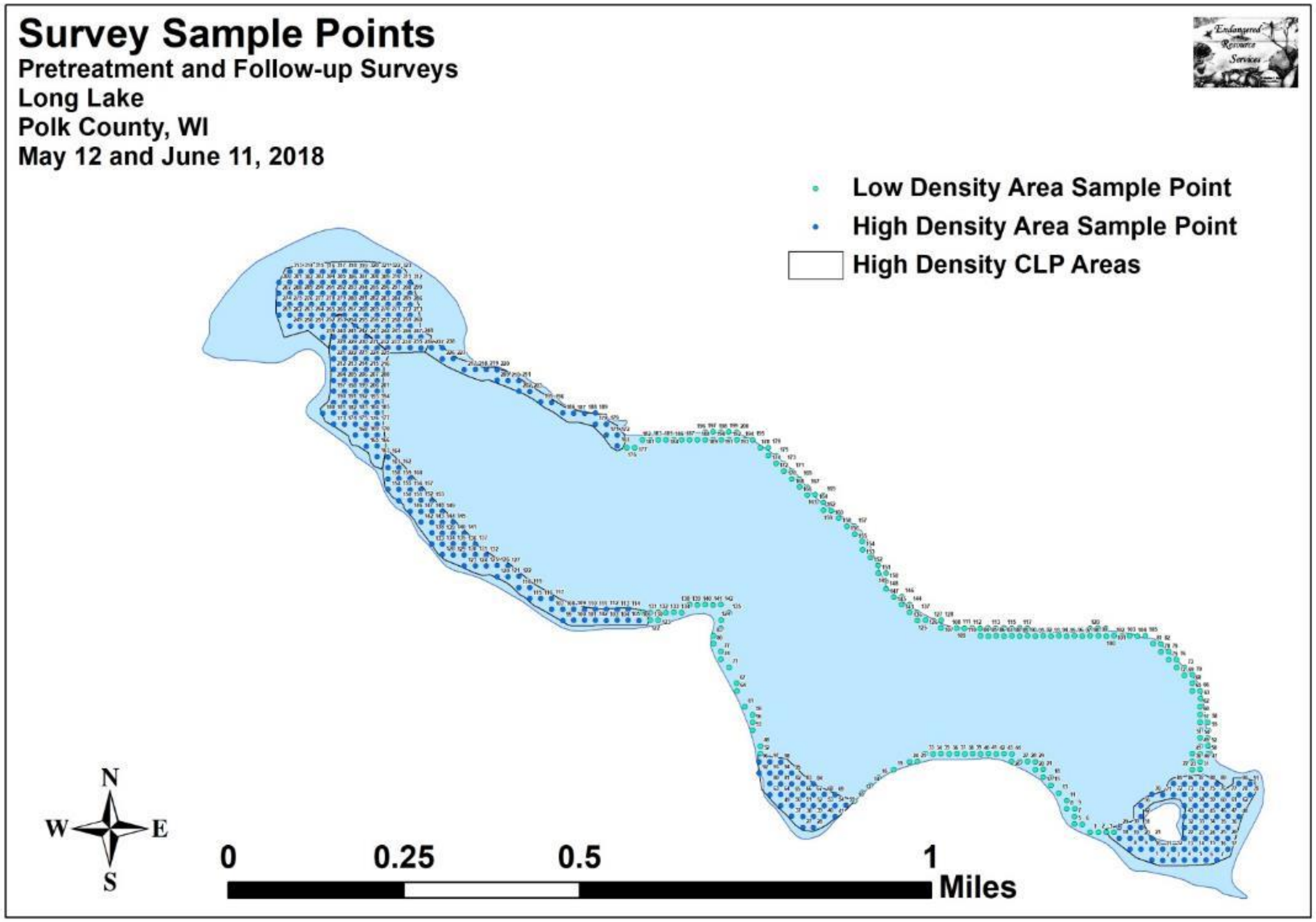
Busch, C., G. Lund, L. Sather, and C. Holt. 1969. Long Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2478200a.pdf (2018, November)

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2018, November).

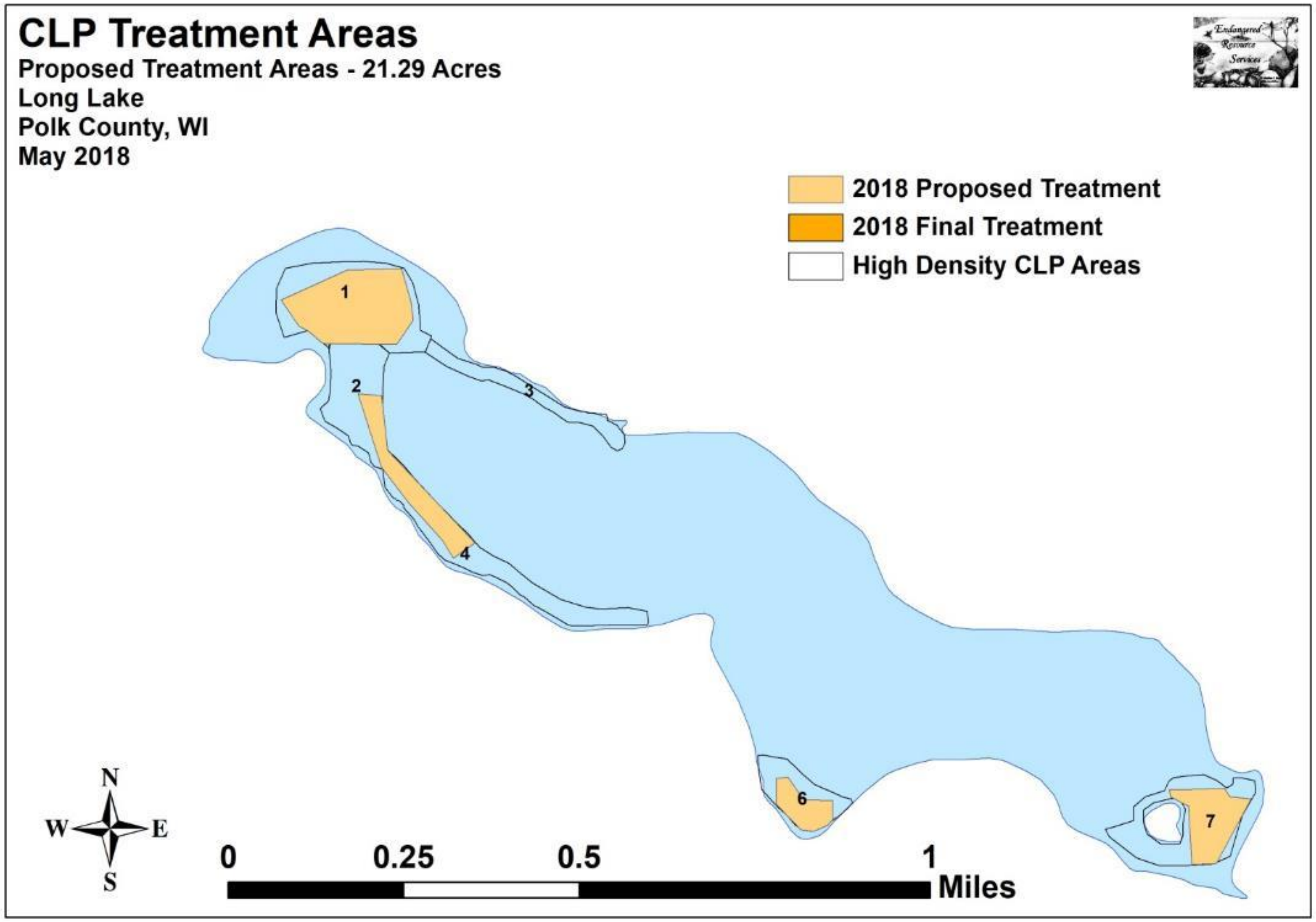
UWEX Lakes Program. [online]. 2010. Pre/Follow-up Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2018, November).

WDNR. [online]. 2018. Citizen Lake Monitoring Water Quality Data Report for Long Lake. http://dnr.wi.gov/lakes/waterquality/Station.aspx?id=493102 (2018, November)

Appendix I: CLP Pretreatment/Follow-up Survey Sample Points and Final Treatment Areas



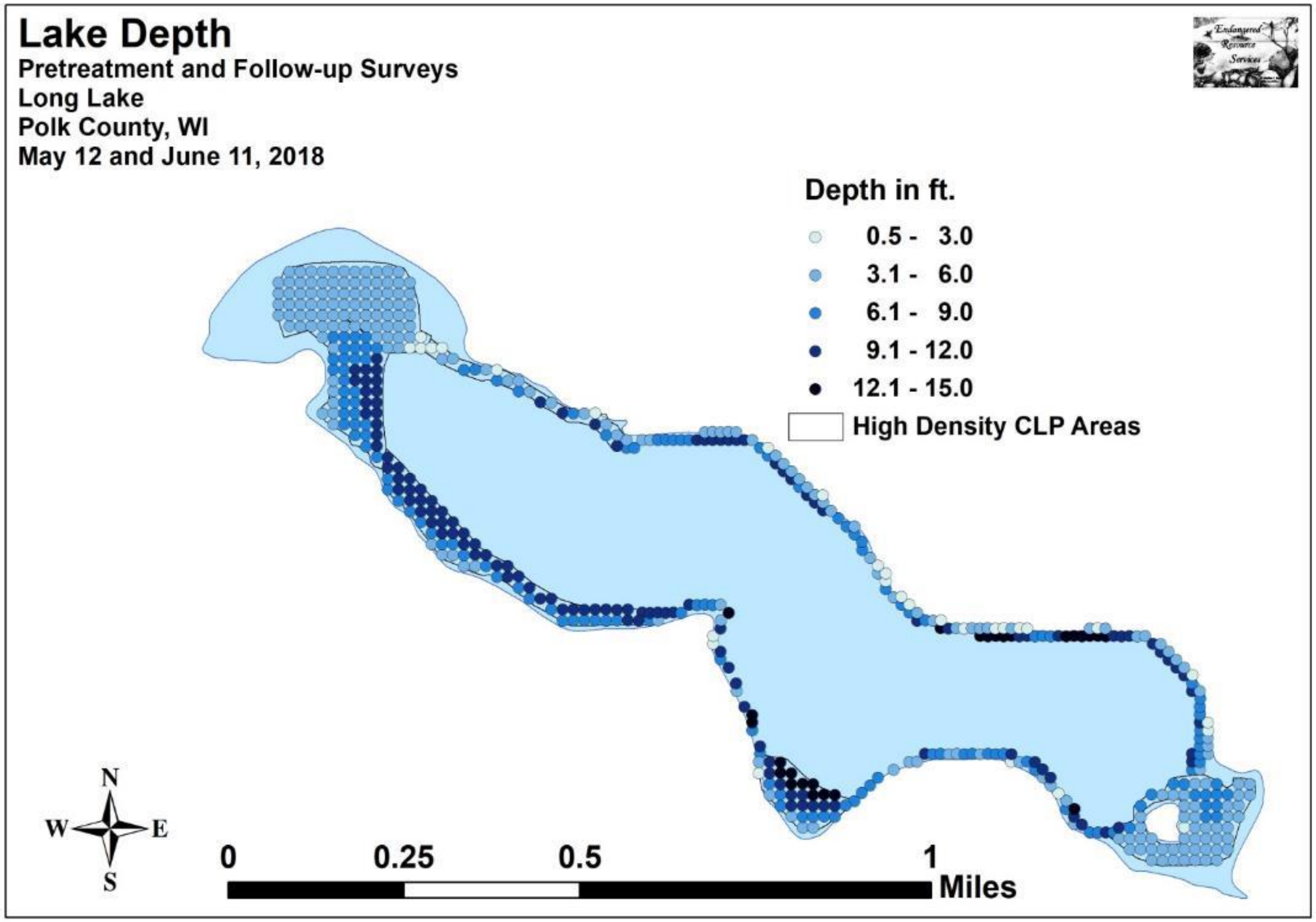
Survey Sample Points
Pretreatment and Follow-up Surveys
Long Lake
Polk County, WI
May 12 and June 11, 2018
Low Density Area Sample Point
High Density Area Sample Point
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


CLP Treatment Areas
Proposed Treatment Areas - 21.29 Acres
Long Lake
Polk County, WI
May 2018
2018 Proposed Treatment
2018 Final Treatment
High Density CLP Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles

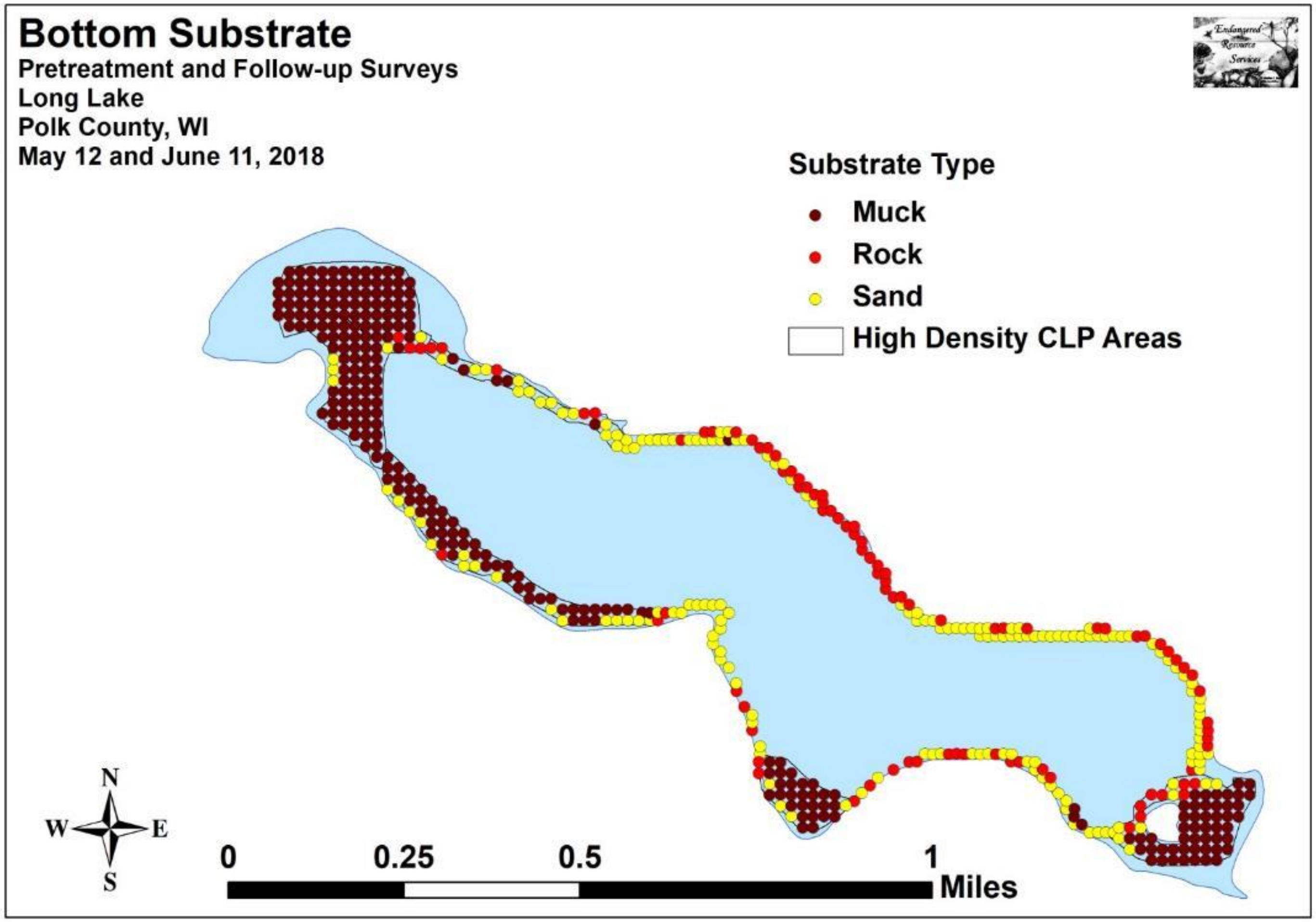
Appendix II: Vegetative Survey Data Sheet

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)	Total Rake Fullness	CLP	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																									

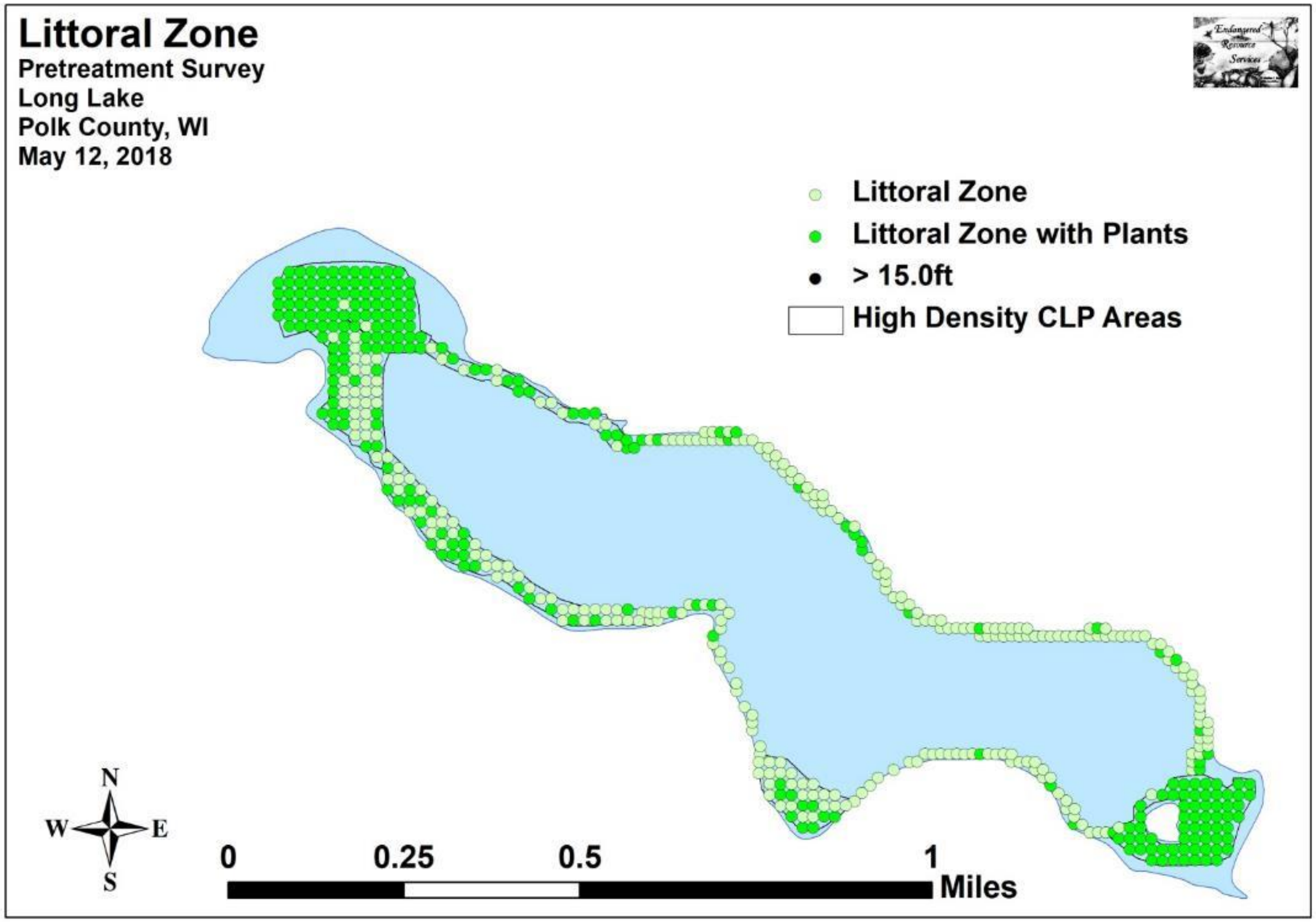
Appendix III: Pretreatment/Follow-up Habitat Variables



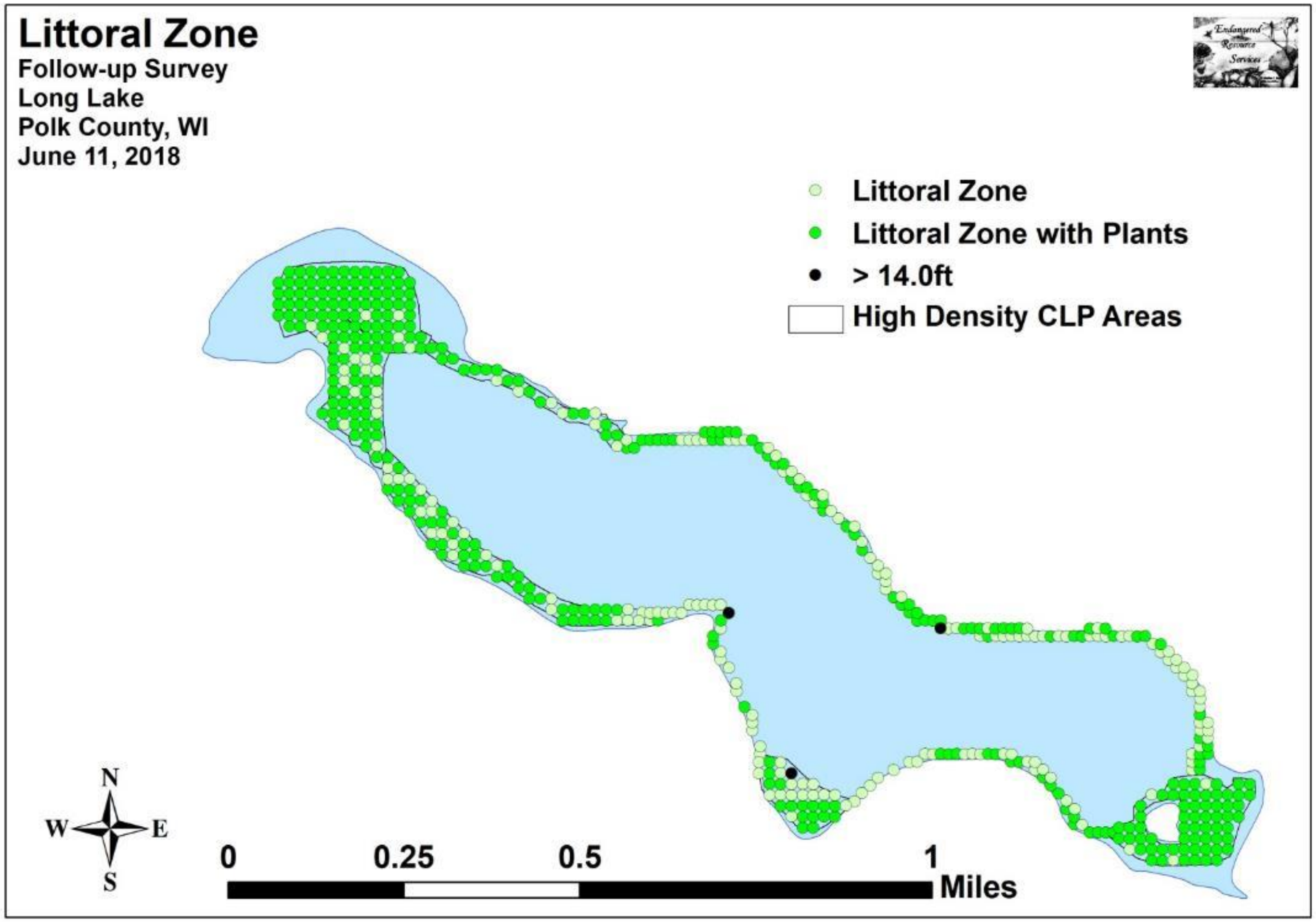
Lake Depth
Pretreatment and Follow-up Surveys
Long Lake
Polk County, WI
May 12 and June 11, 2018
Depth in ft.
0.5 - 3.0
3.1 - 6.0
6.1 - 9.0
9.1 - 12.0
12.1 - 15.0
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

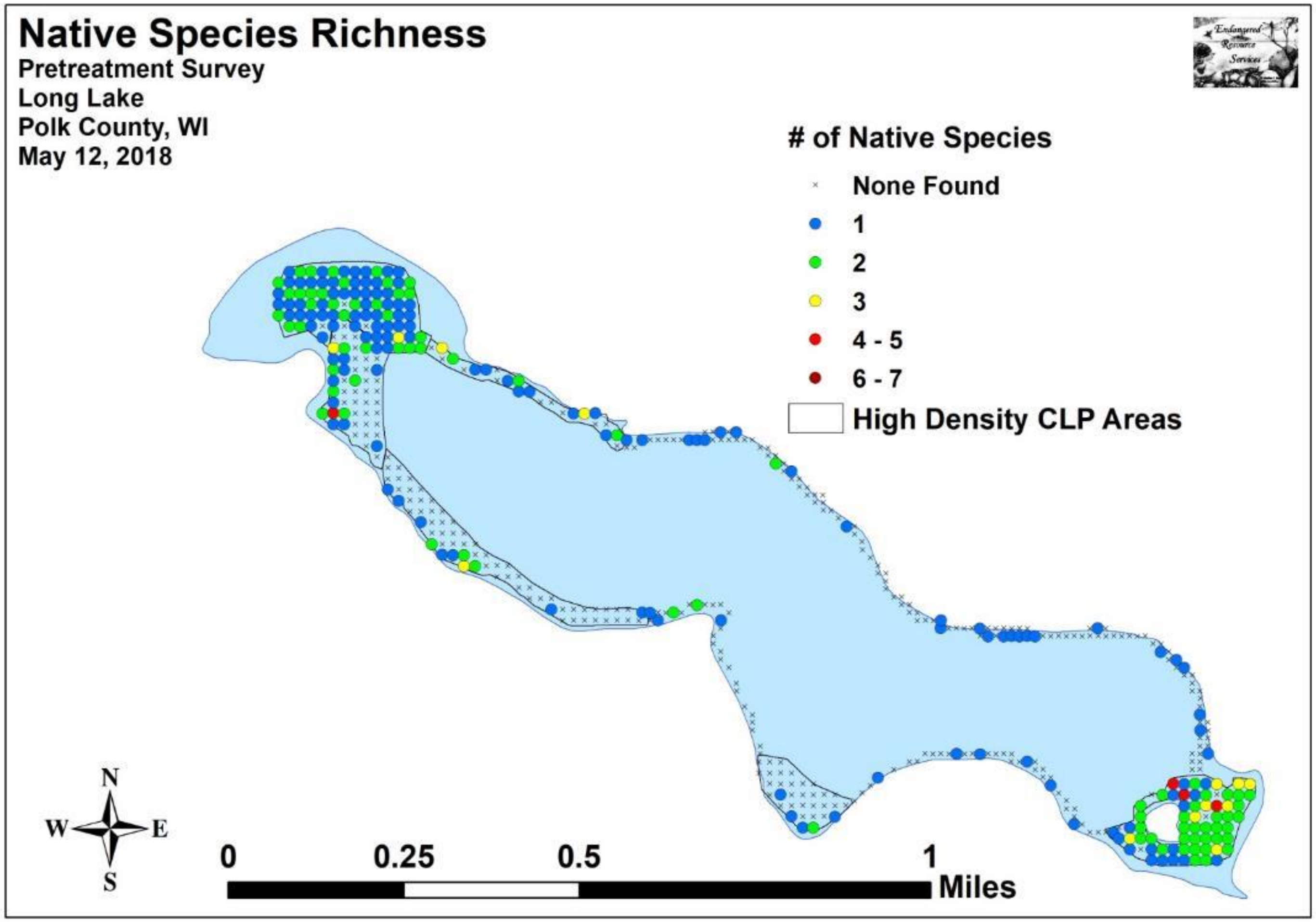

Bottom Substrate
Pretreatment and Follow-up Surveys
Long Lake
Polk County, WI
May 12 and June 11, 2018
Substrate Type
Muck
Rock
Sand
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

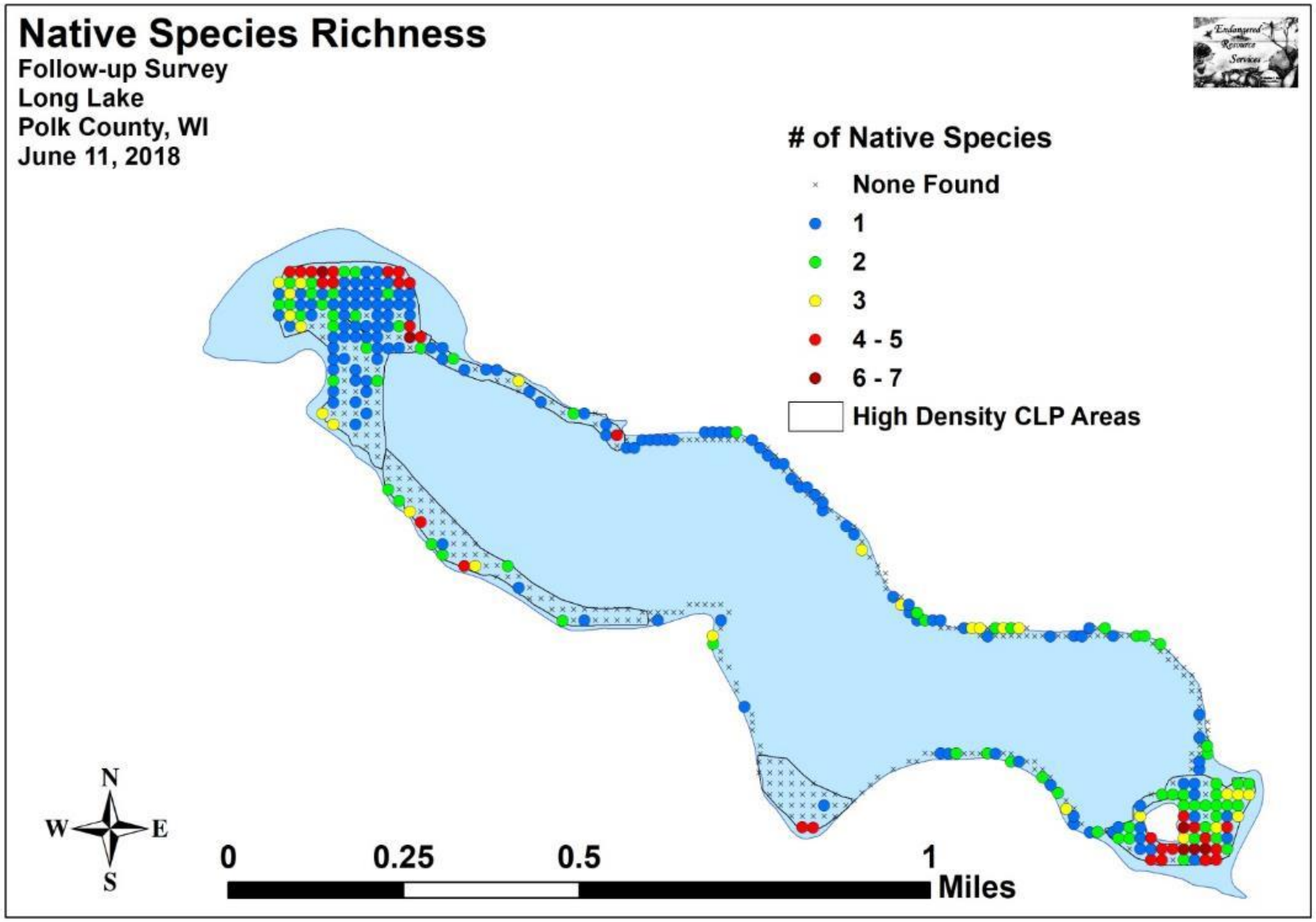
Appendix IV: Pretreatment/Follow-up Littoral Zone, Native Species Richness, and Total Rake Fullness

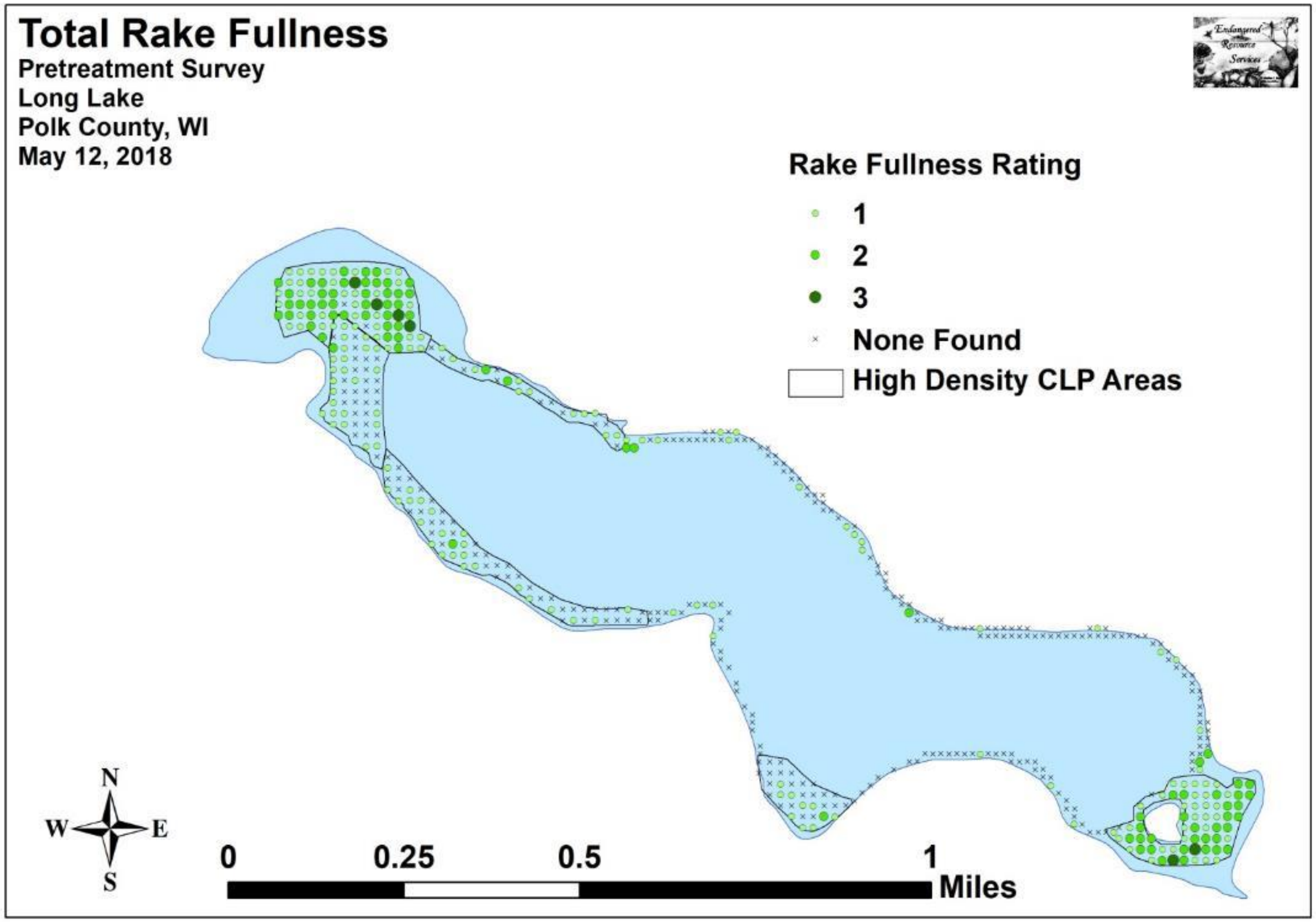


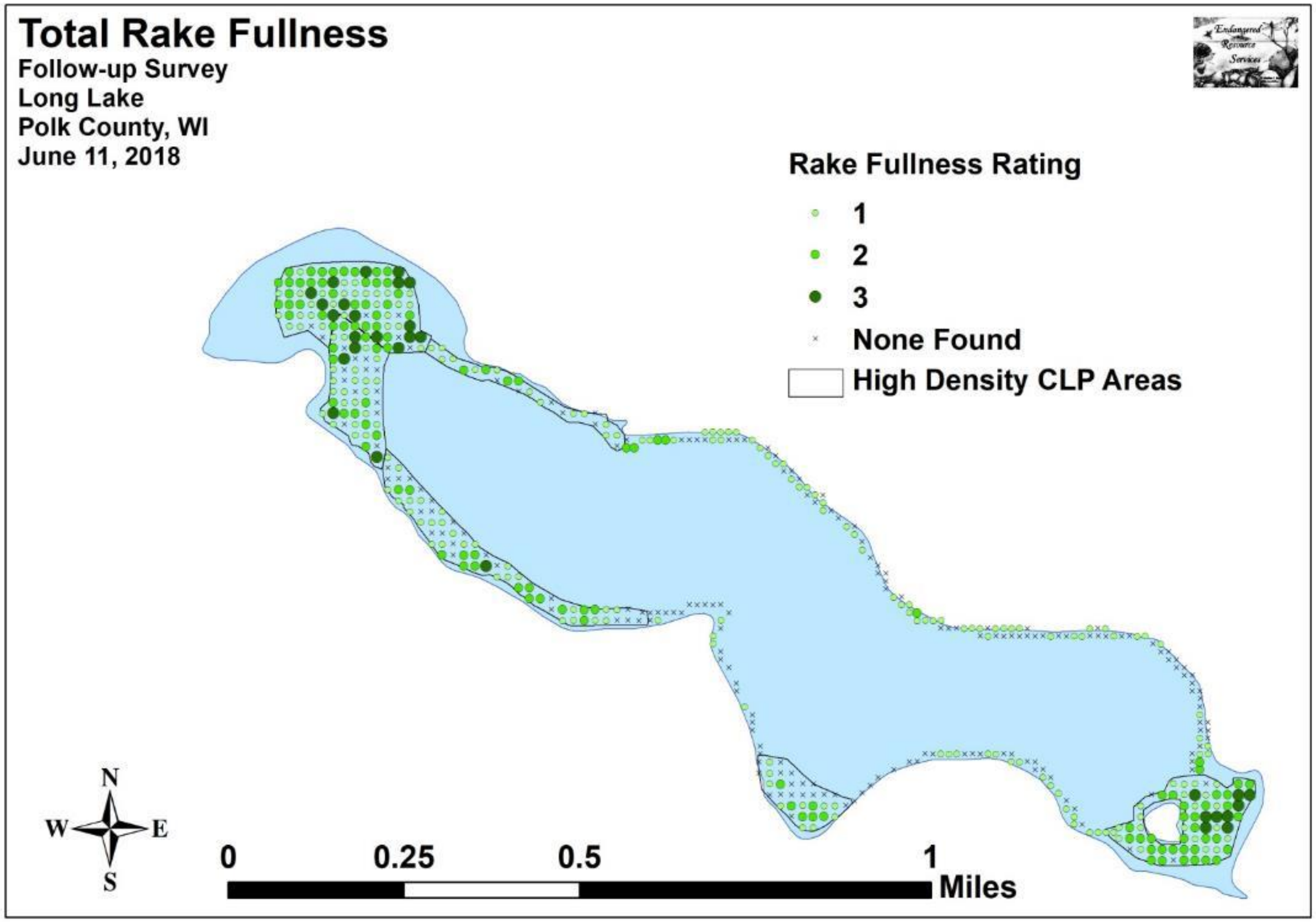
Littoral Zone
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Littoral Zone
Littoral Zone with Plants
> 15.0ft
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Littoral Zone
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Littoral Zone
Littoral Zone with Plants
> 14.0ft
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

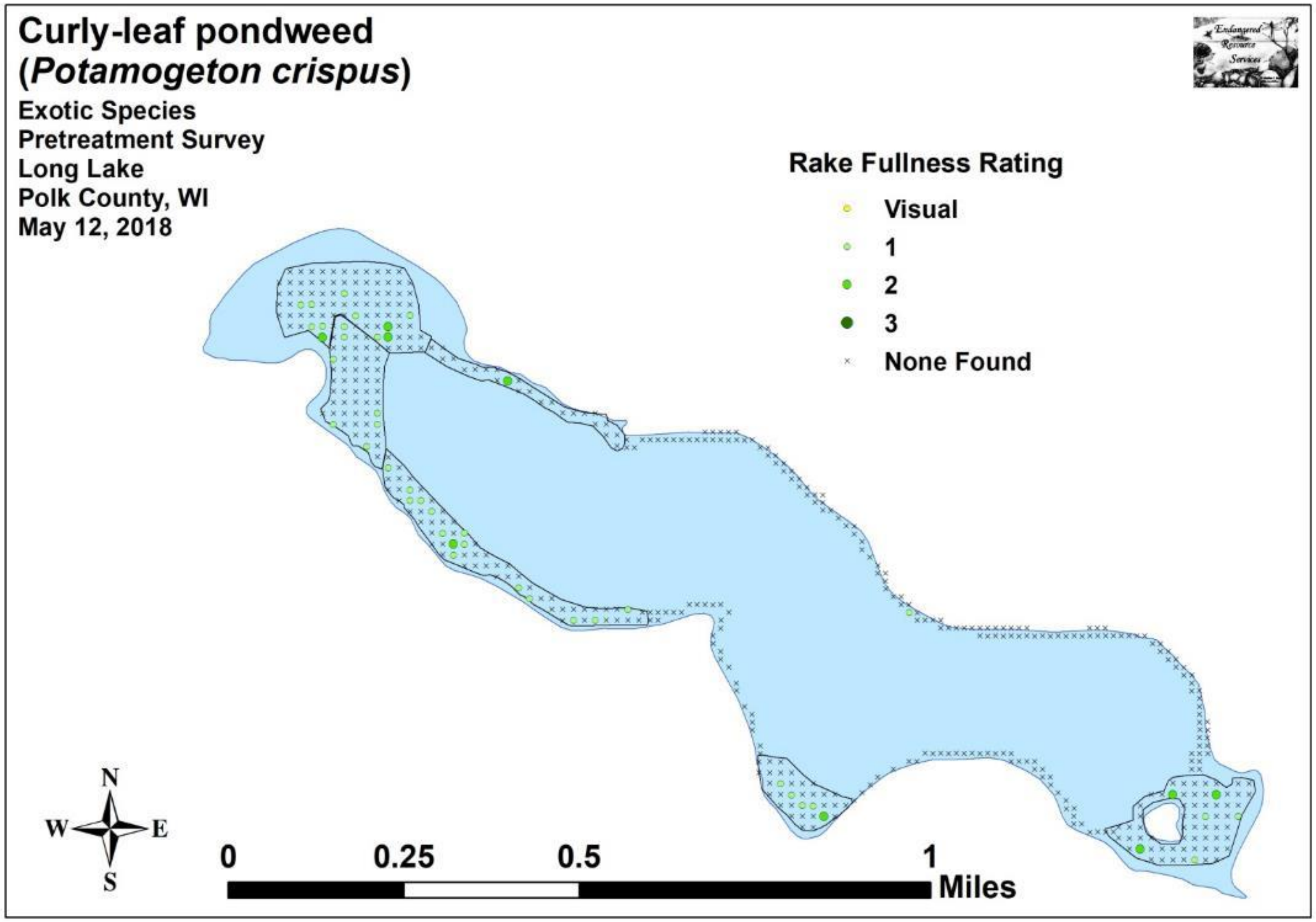

Native Species Richness
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
# of Native Species
None Found
1
2
3
4 - 5
6 - 7
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

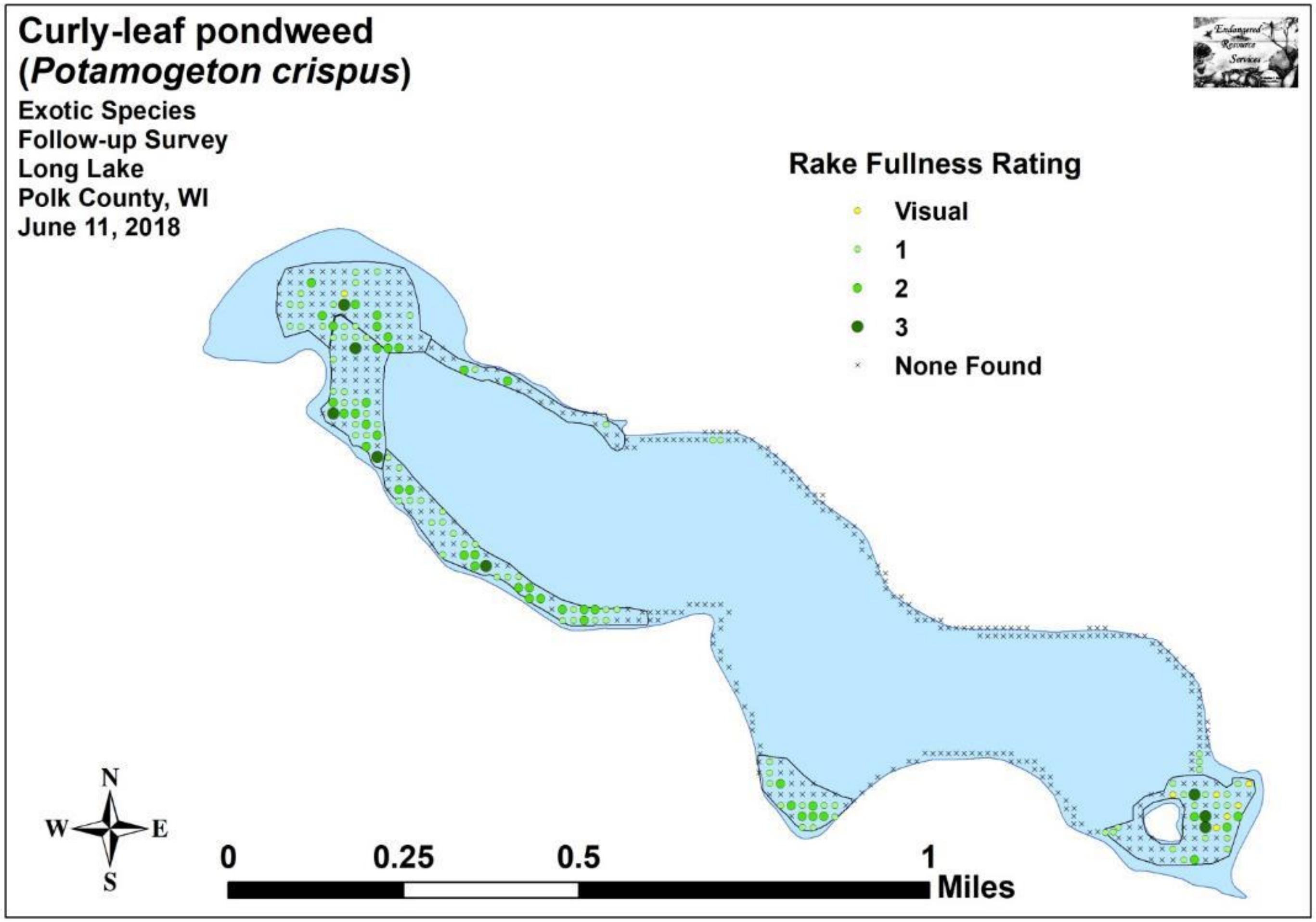

Native Species Richness
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
# of Native Species
None Found
1
2
3
4 - 5
6 - 7
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Total Rake Fullness
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
1
2
3
None Found
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

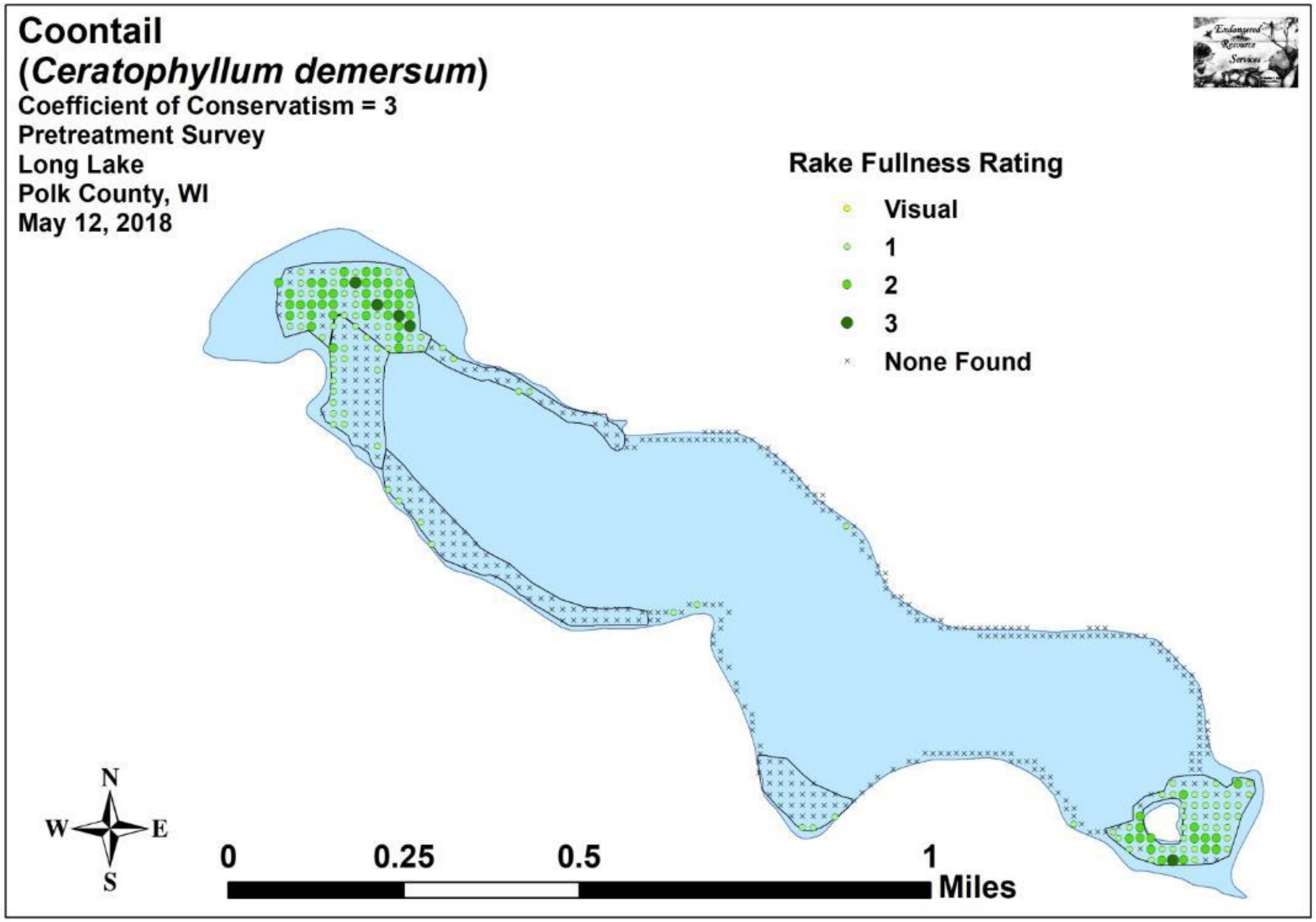

Total Rake Fullness
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
1
2
3
None Found
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

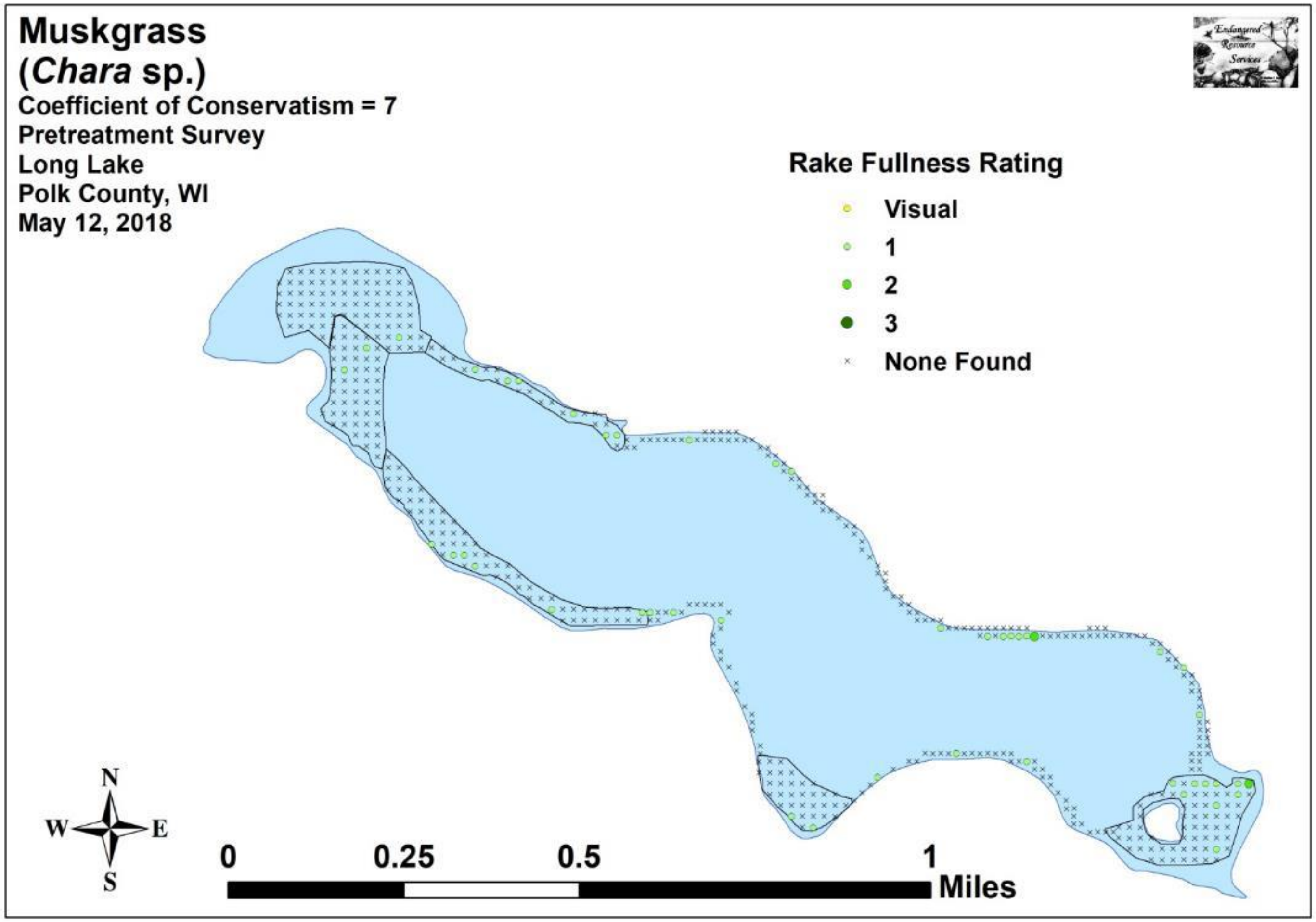
Appendix V: CLP Pretreatment/Follow-up Density and Distribution

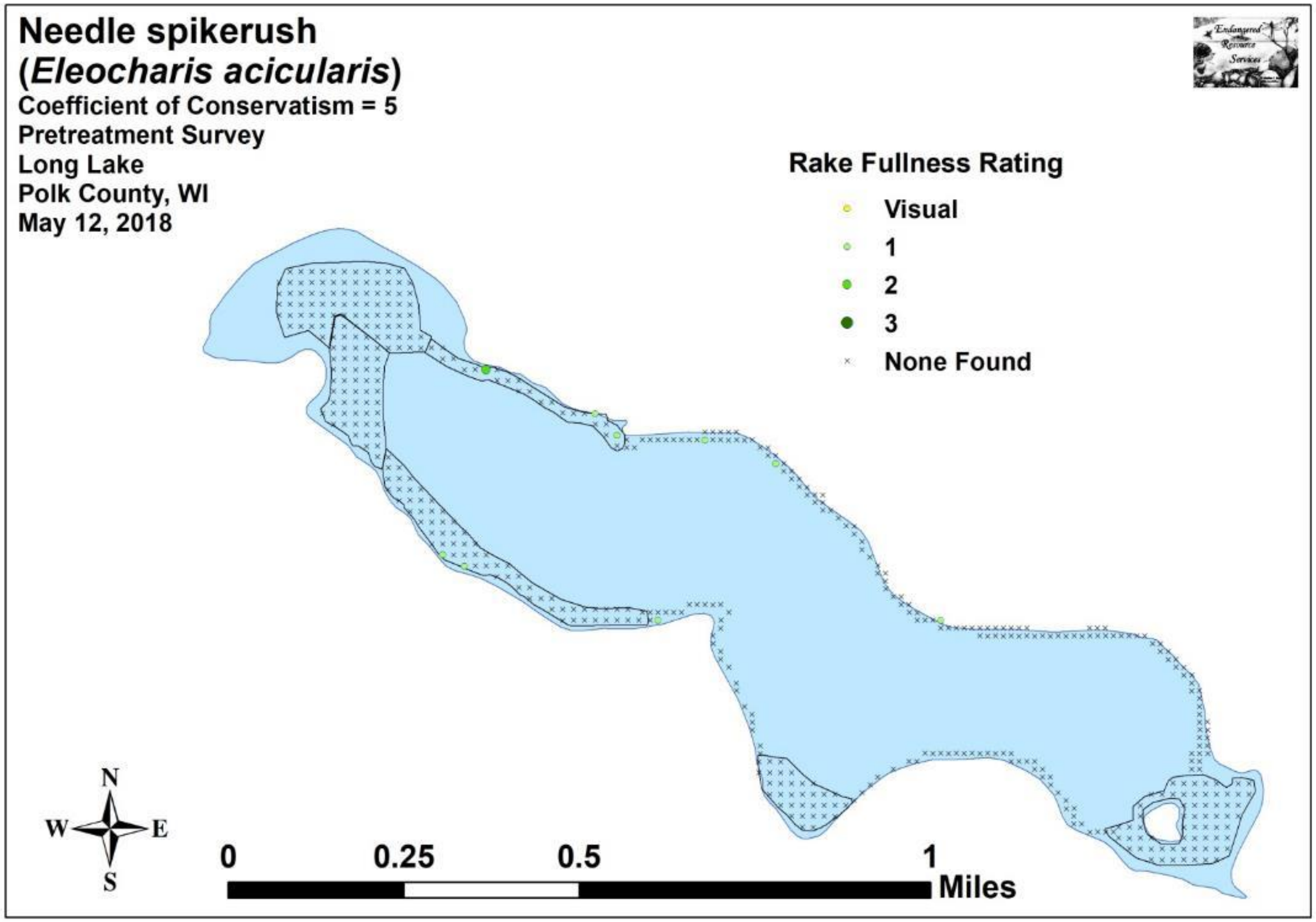

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

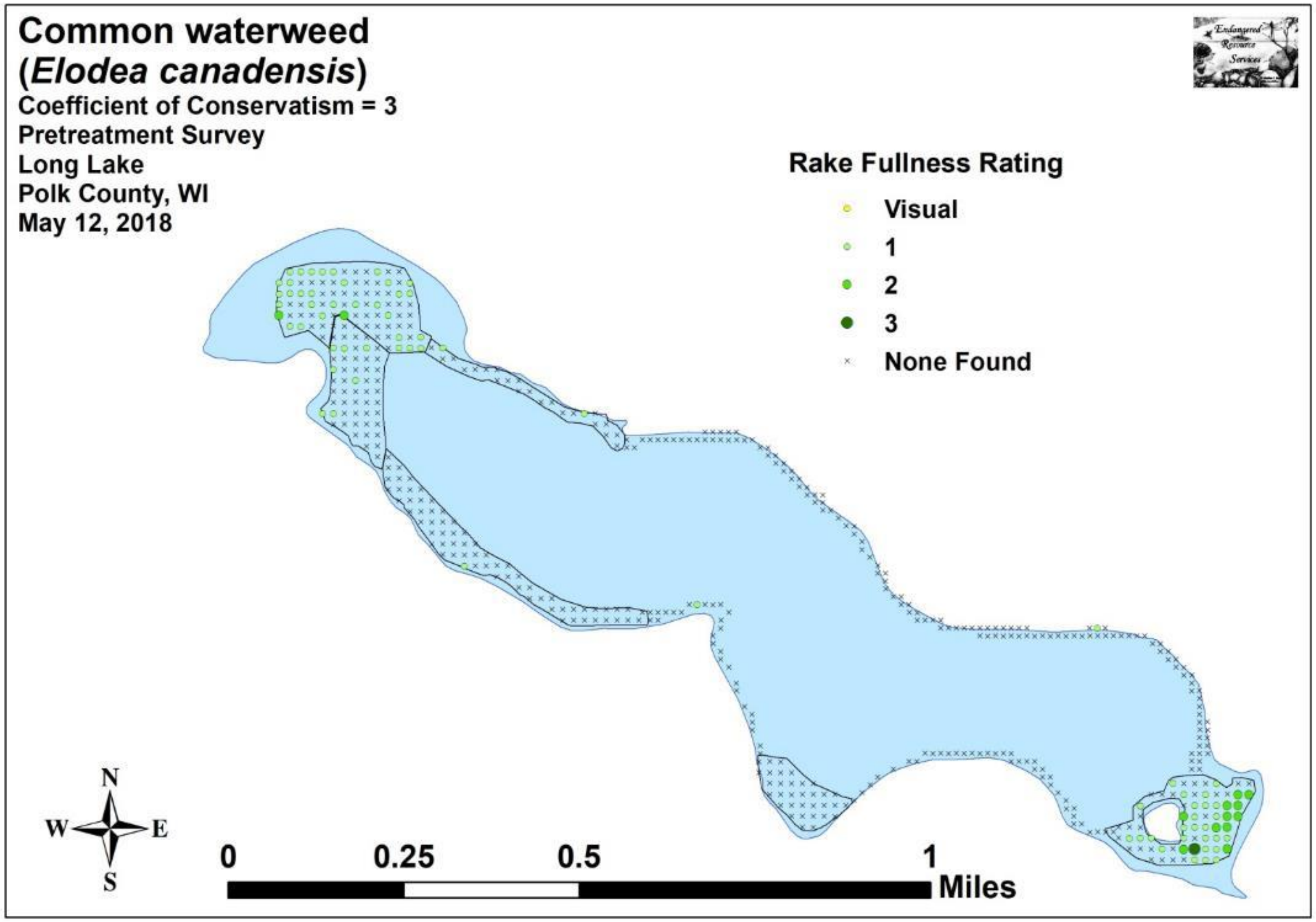

Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

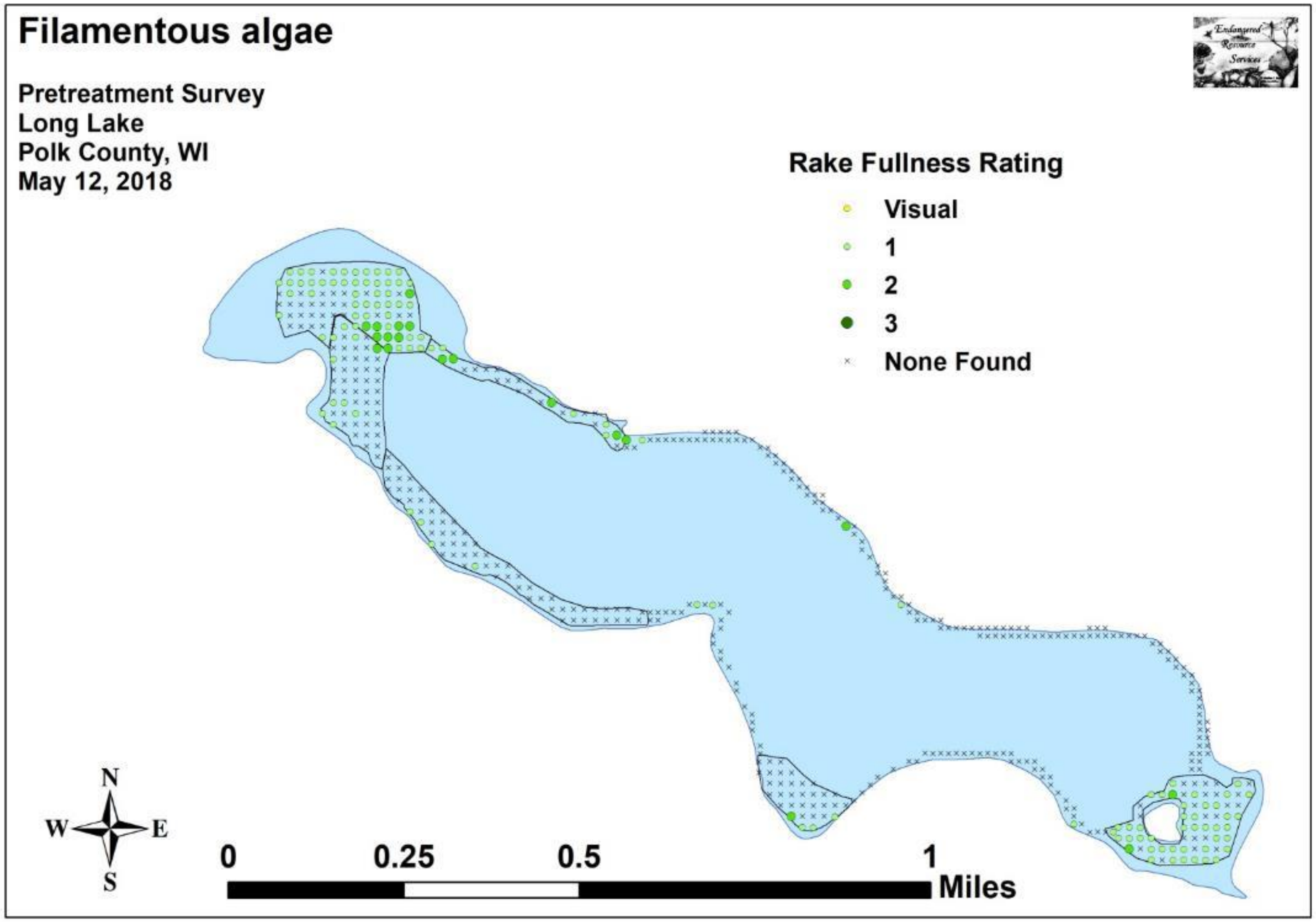
Appendix VI: Pretreatment Native Species Density and Distribution

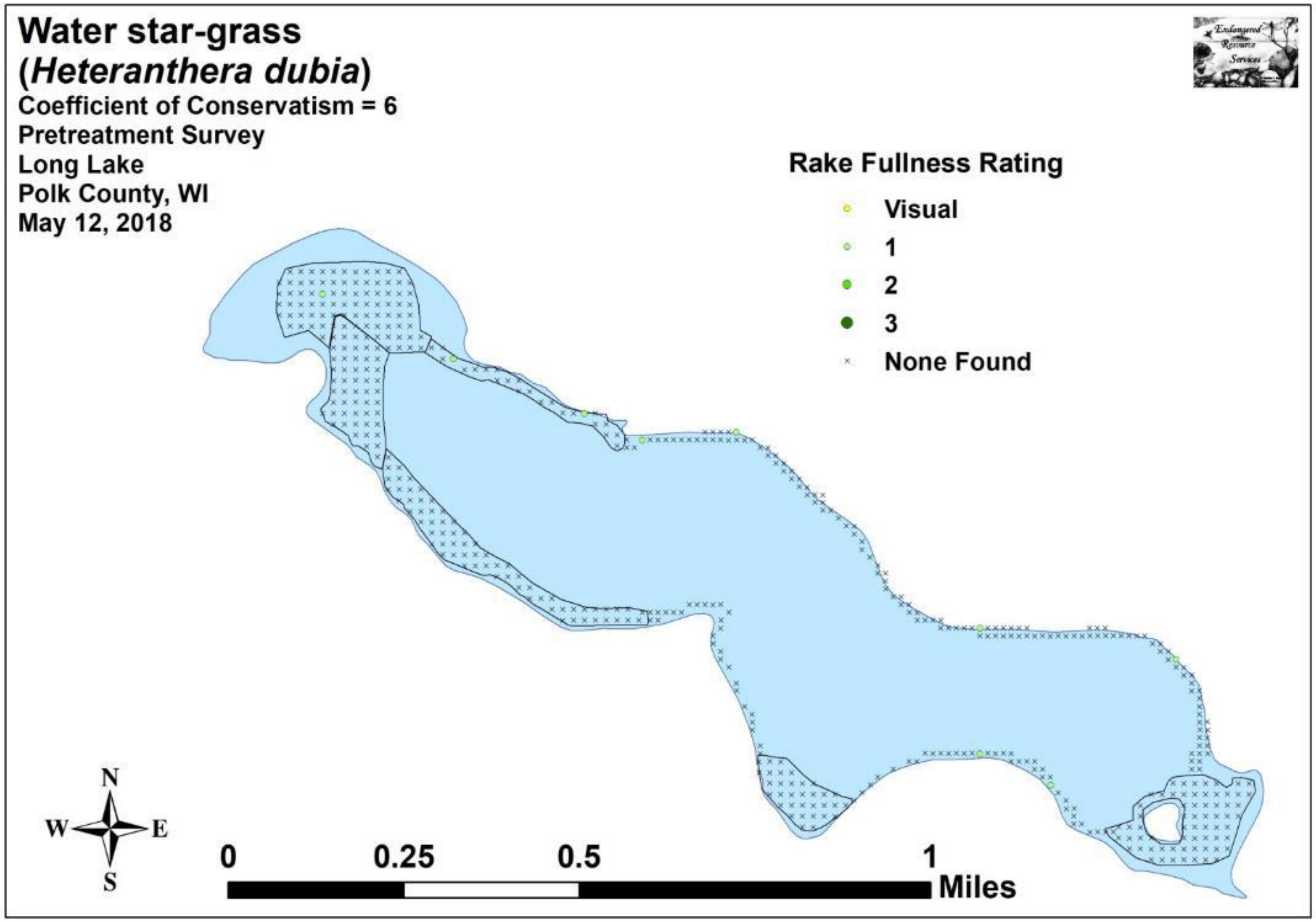

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

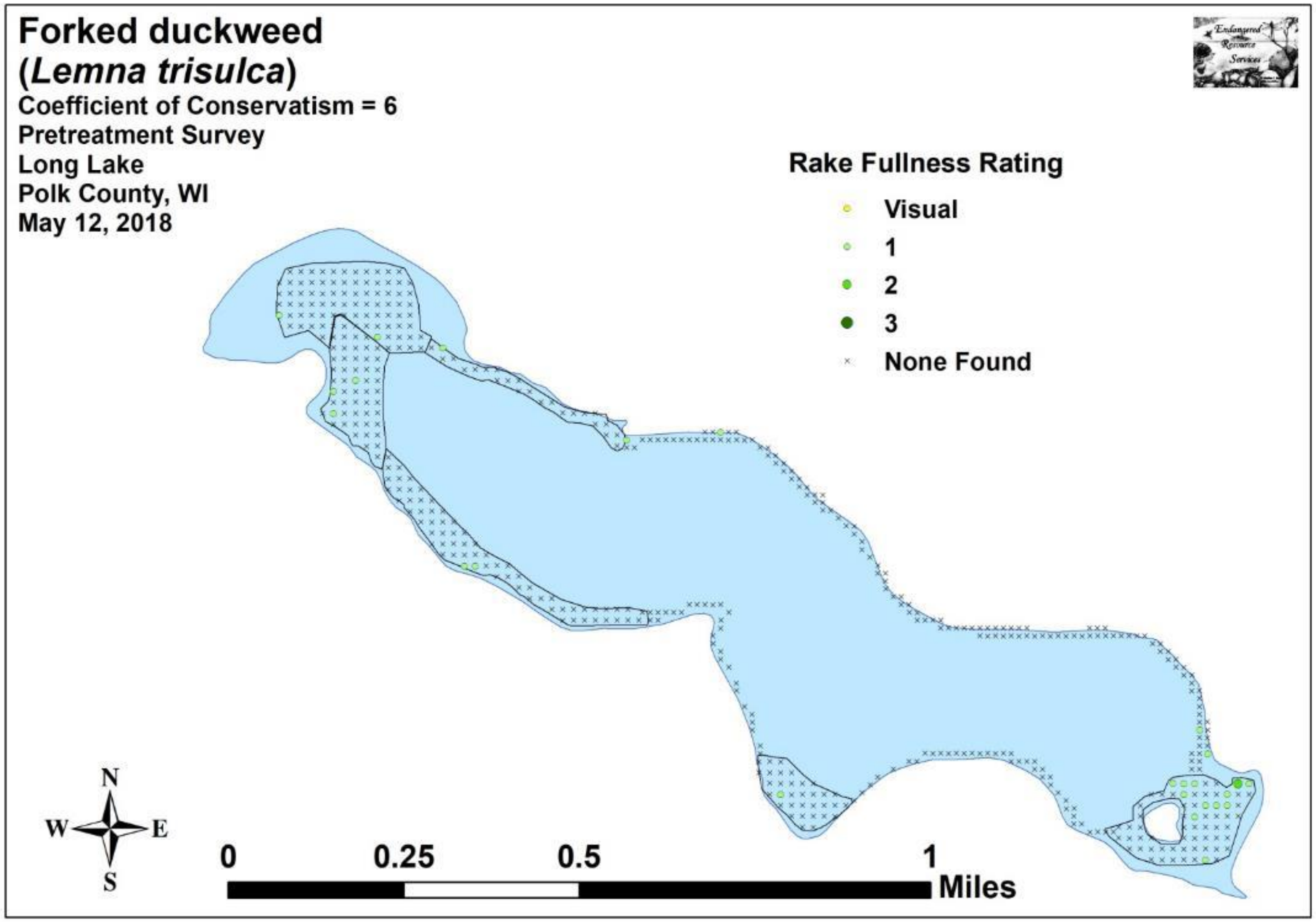

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

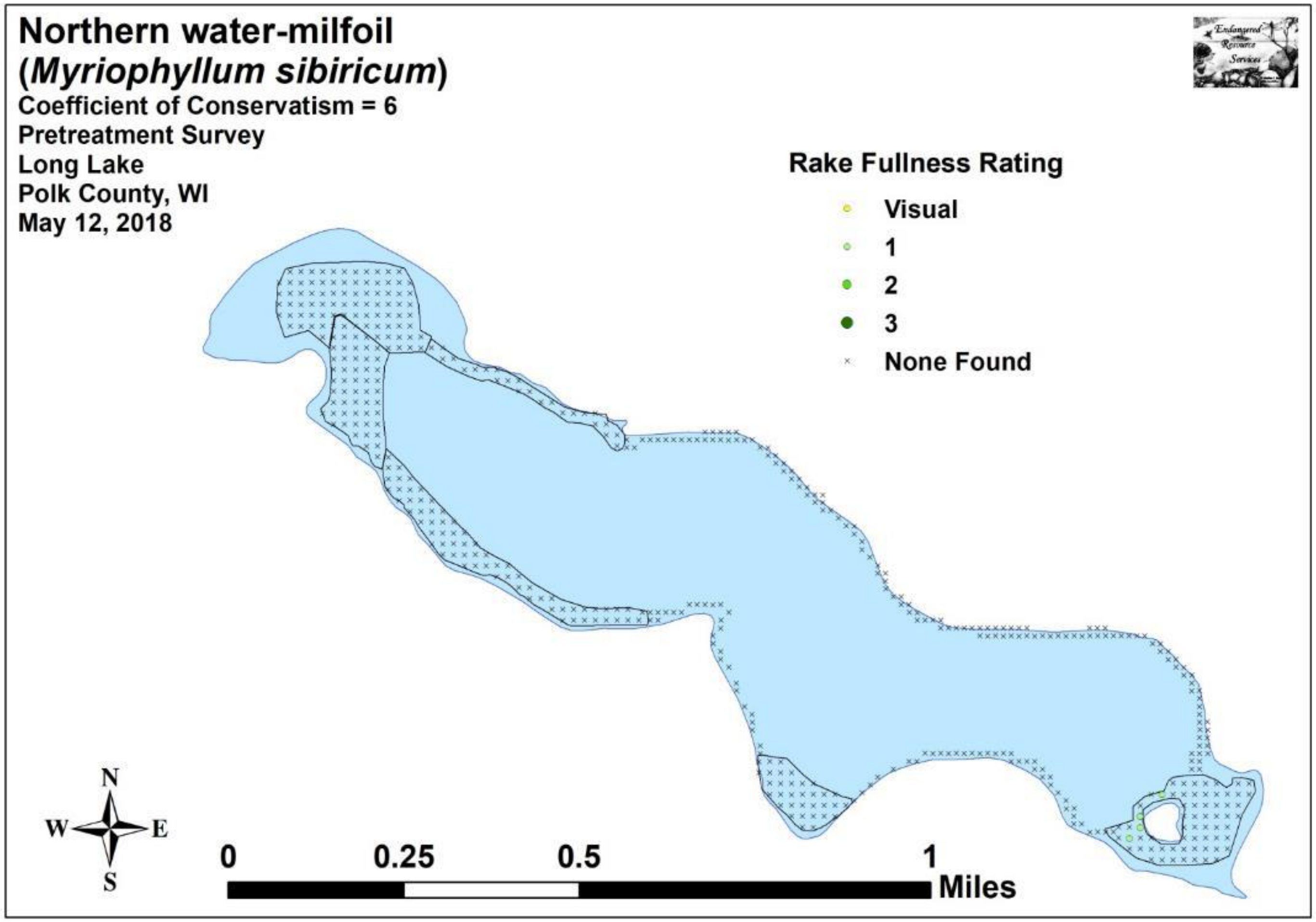

Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

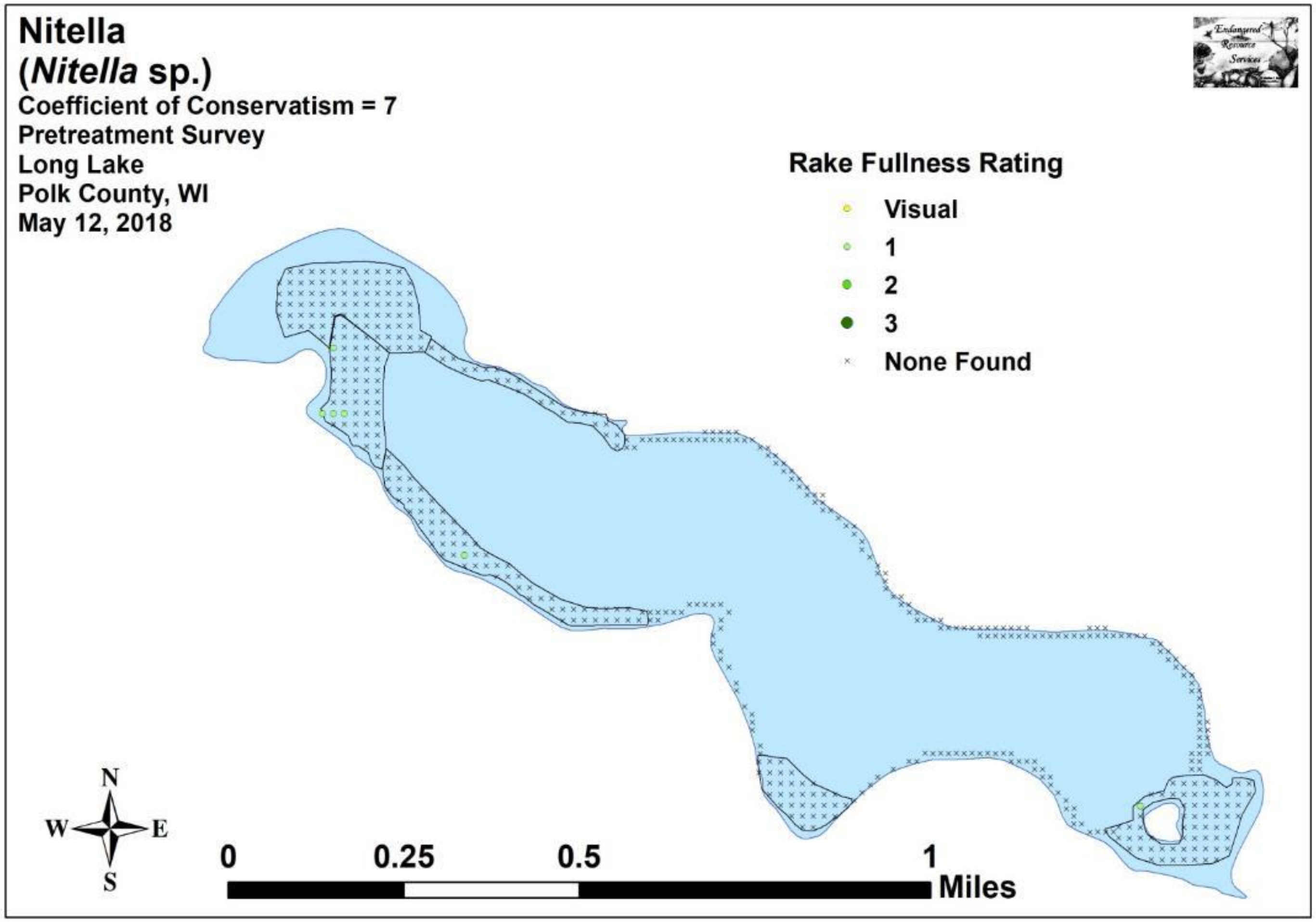

Common waterweed
(*Elodea canadensis*)
Coefficient of Conservatism = 3
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

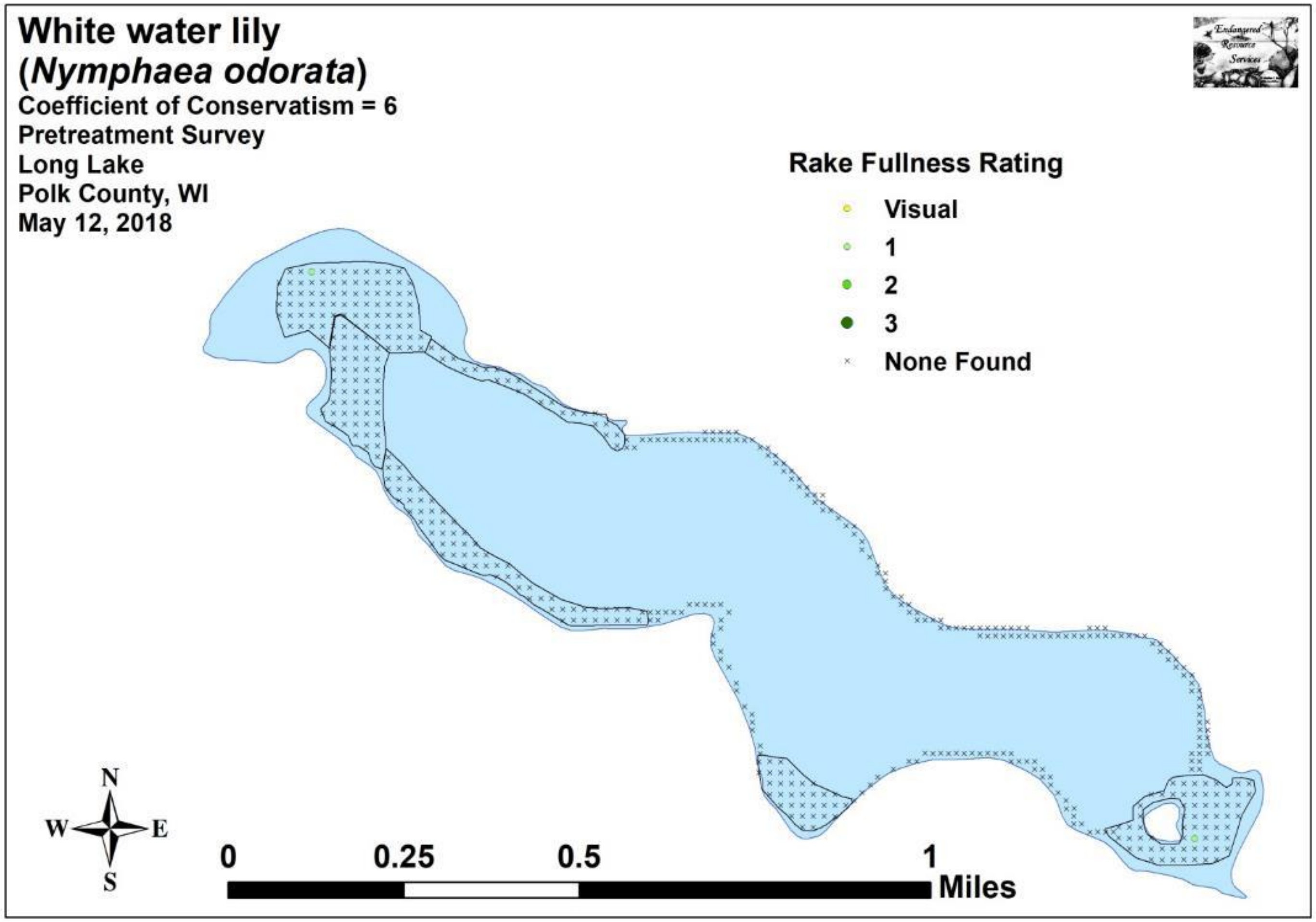

Filamentous algae
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

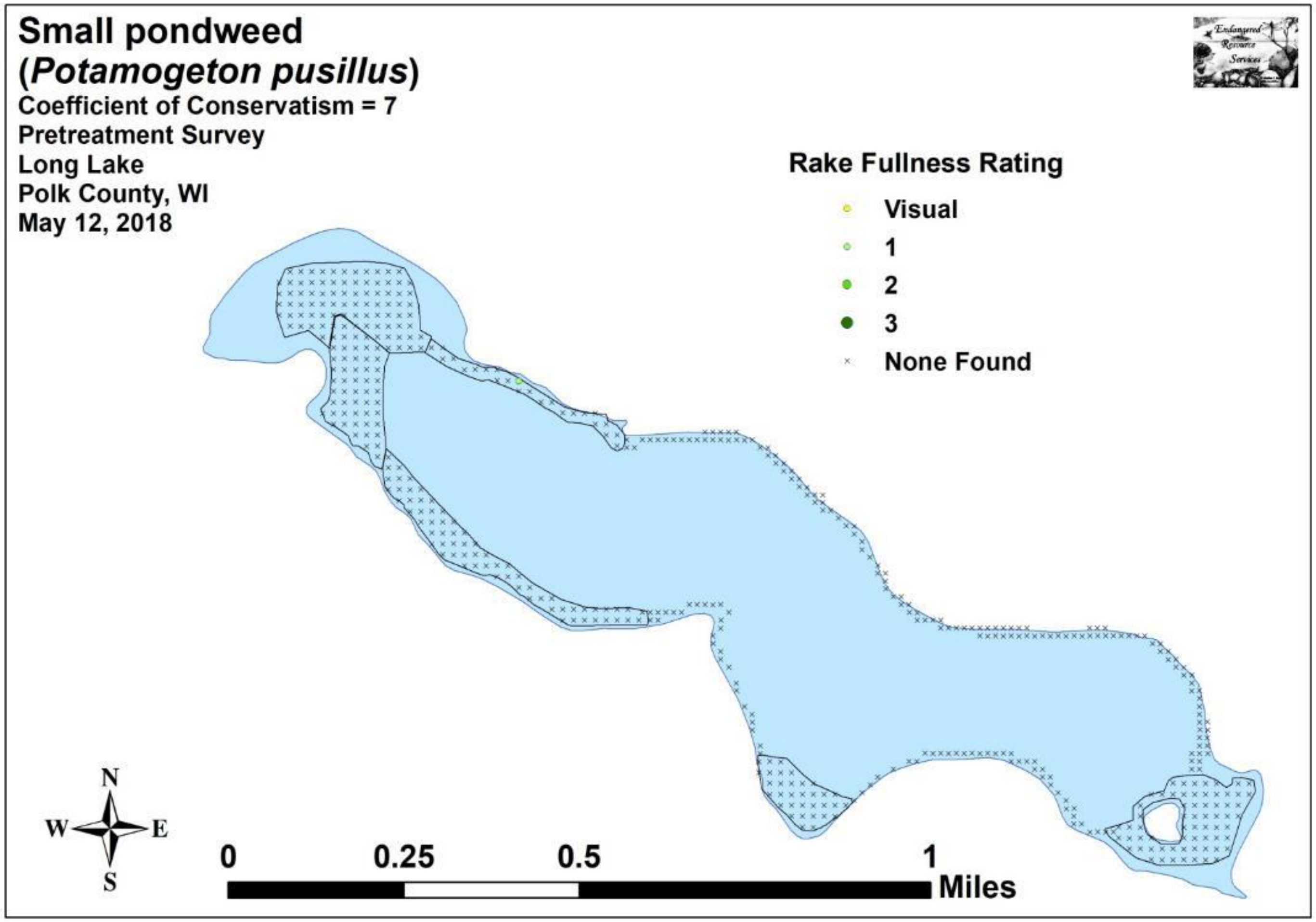

Water star-grass
(*Heteranthera dubia*)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

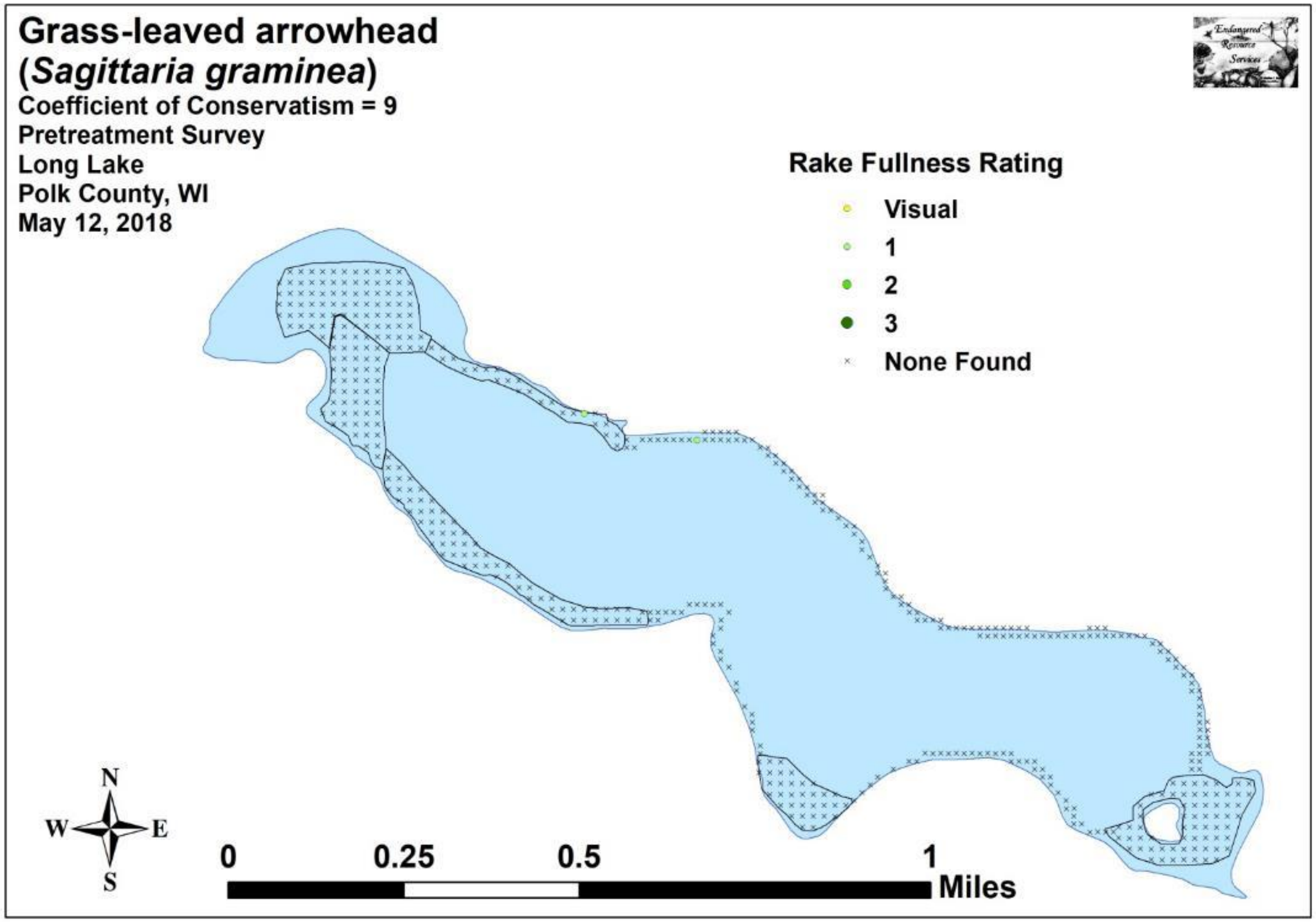

Forked duckweed
(*Lemna trisulca*)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Northern water-milfoil
(*Myriophyllum sibiricum*)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

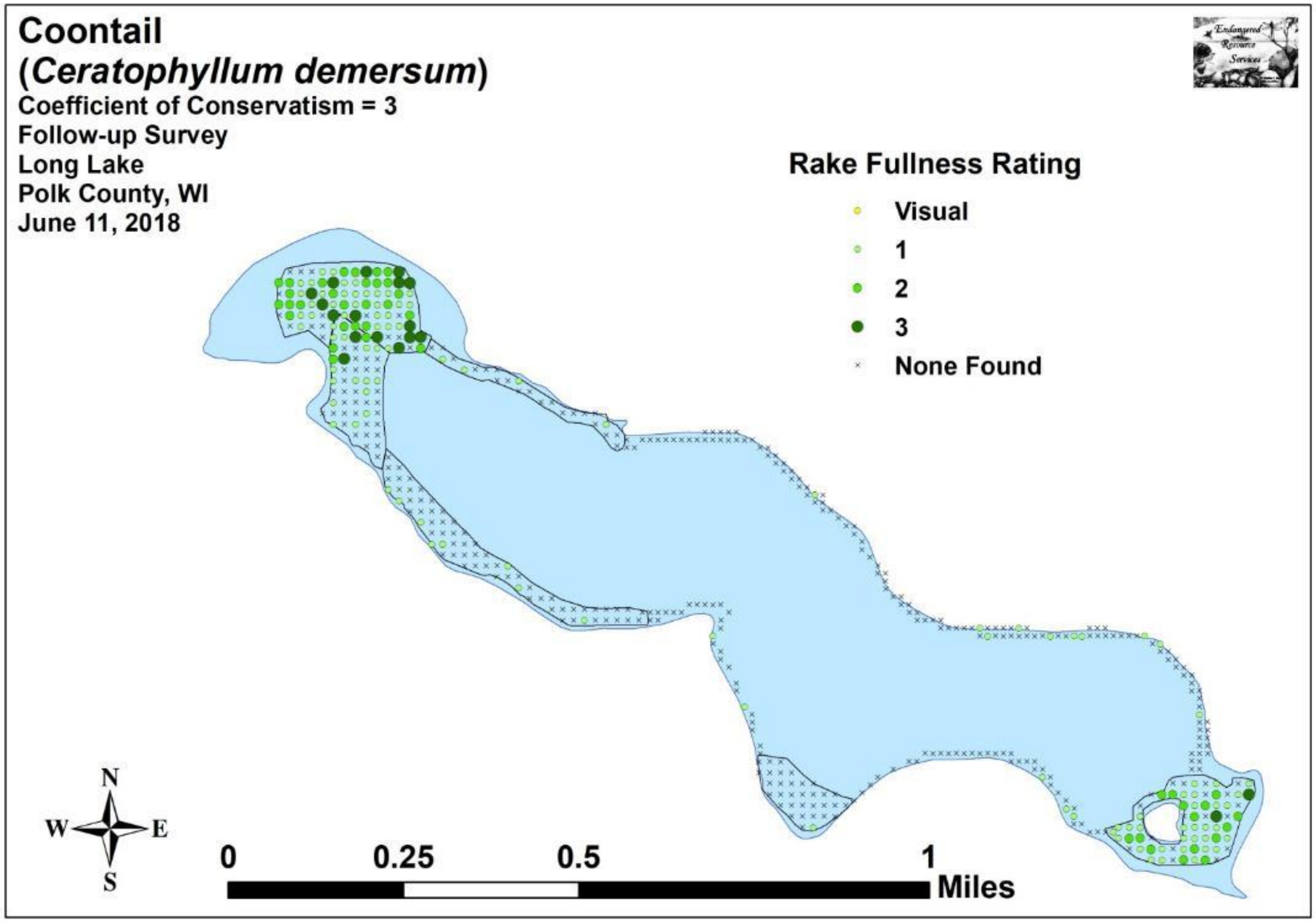

Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

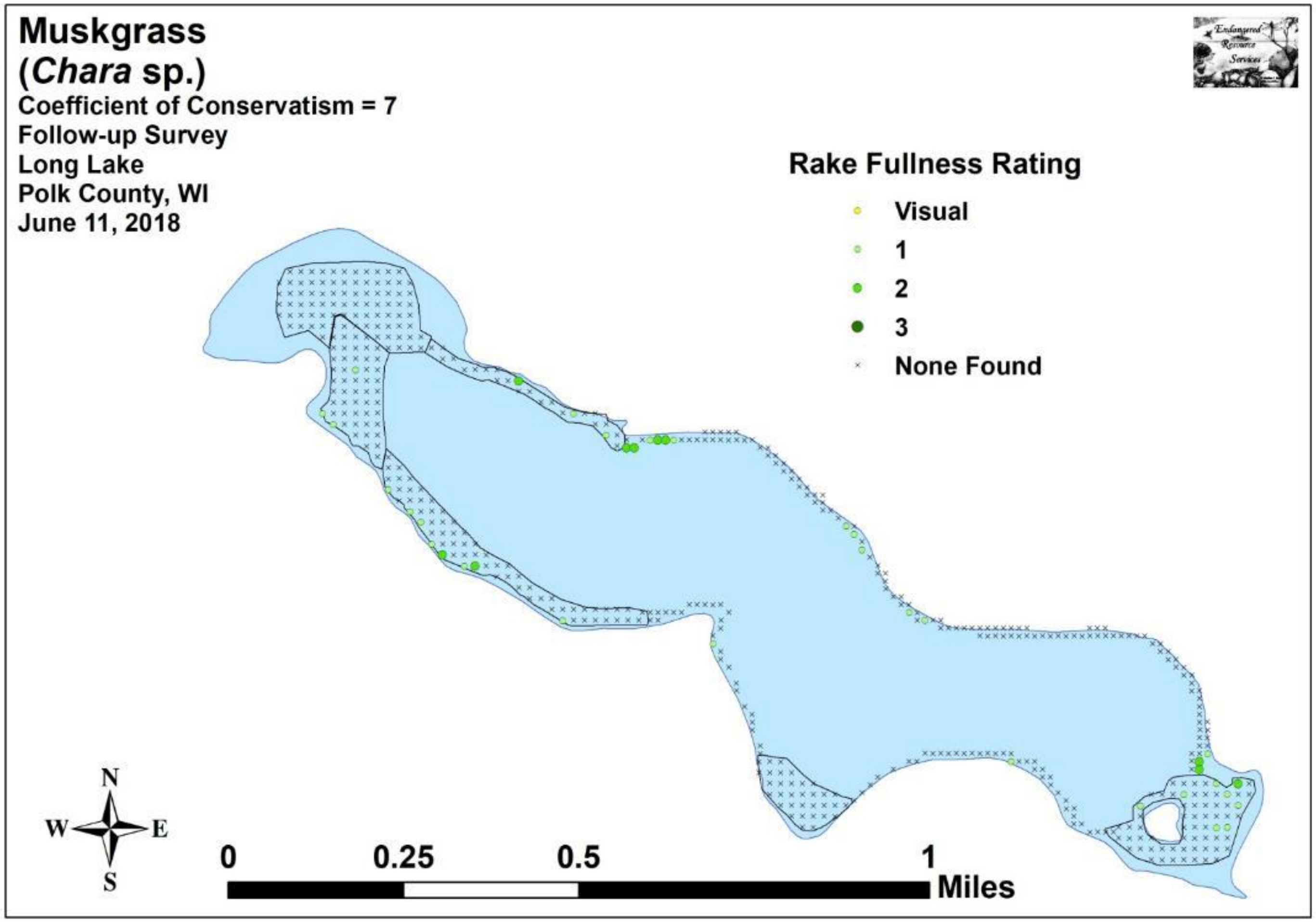

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

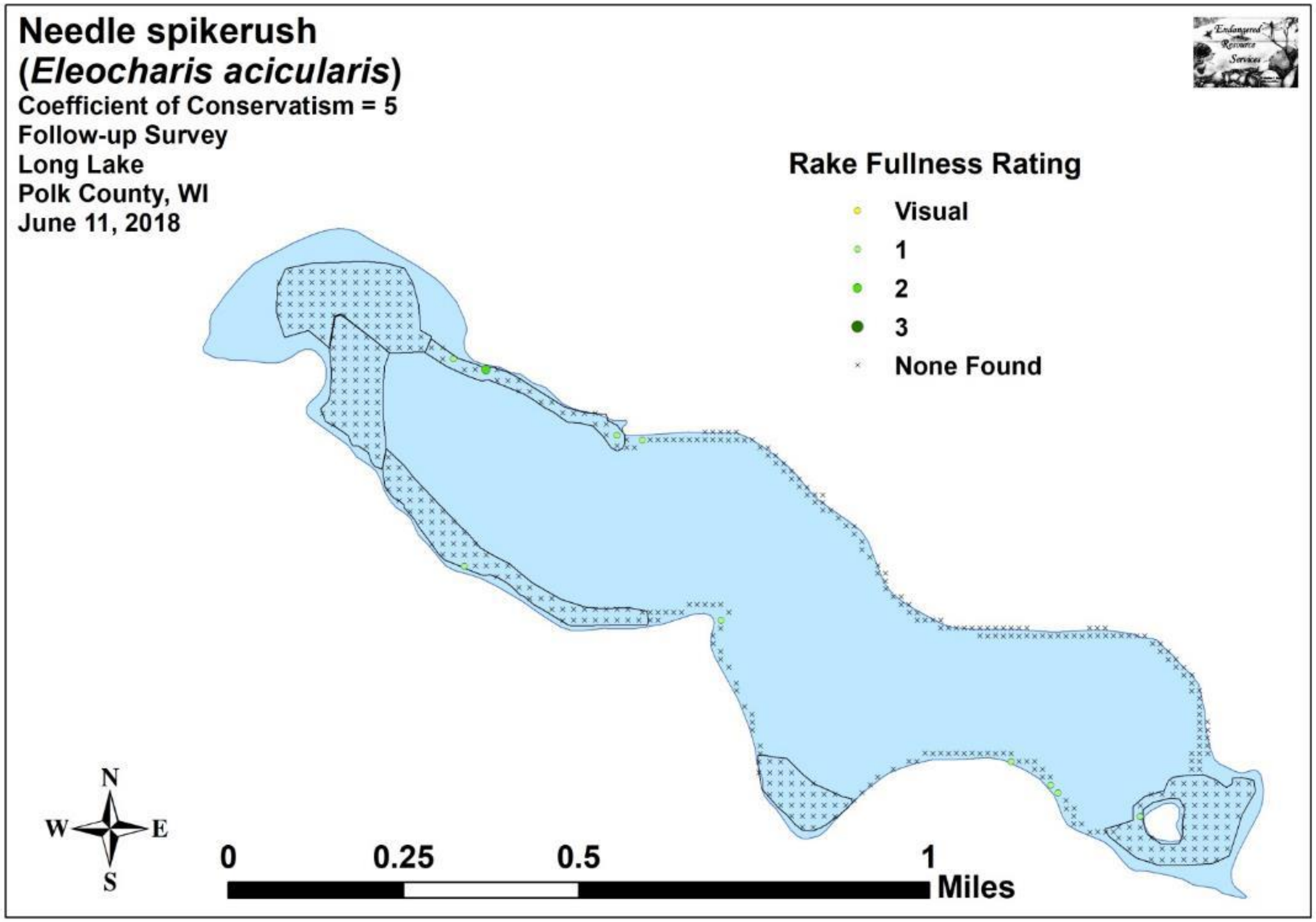

Grass-leaved arrowhead
(*Sagittaria graminea*)
Coefficient of Conservatism = 9
Pretreatment Survey
Long Lake
Polk County, WI
May 12, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

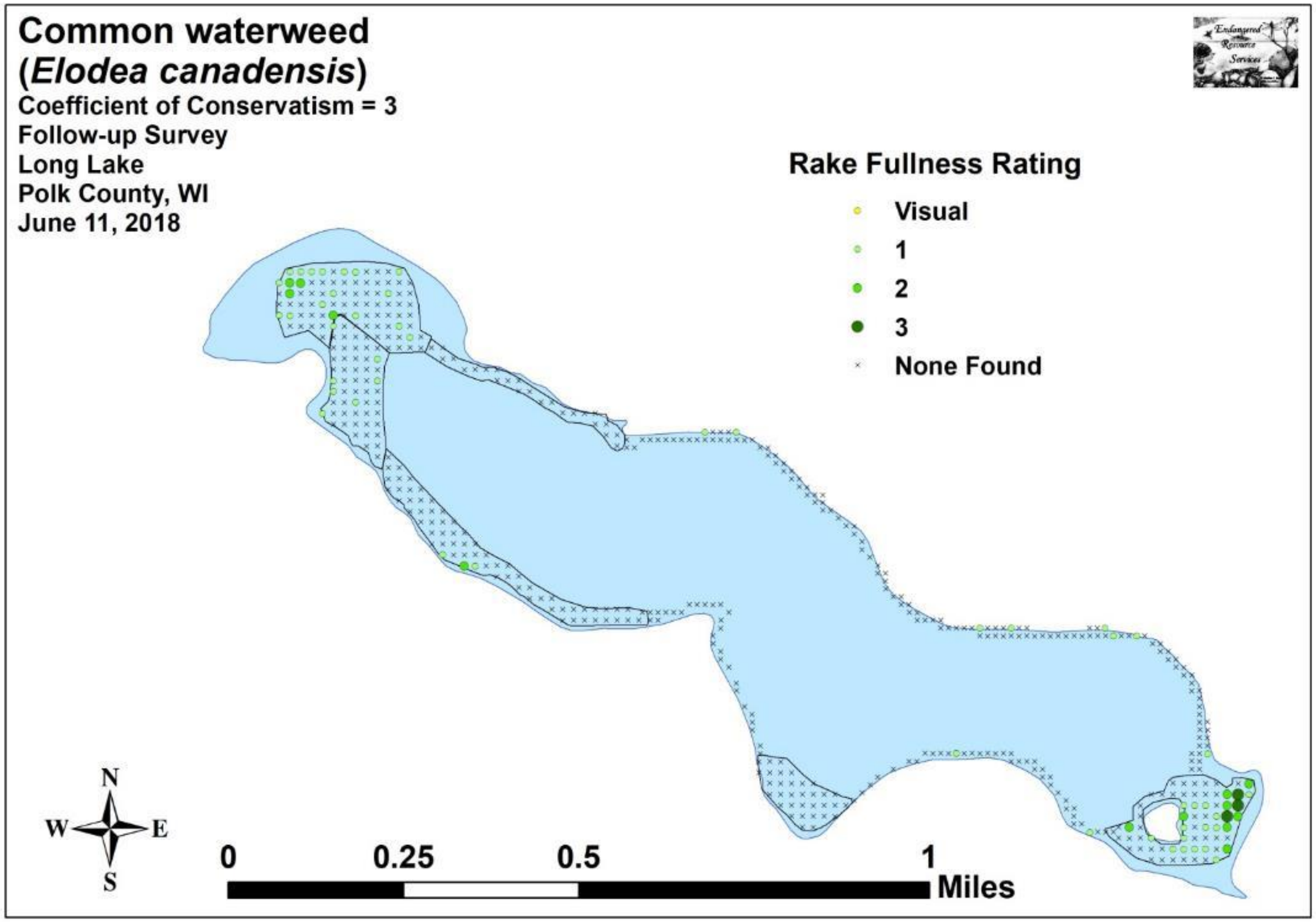
Appendix VII: Follow-up Native Species Density and Distribution

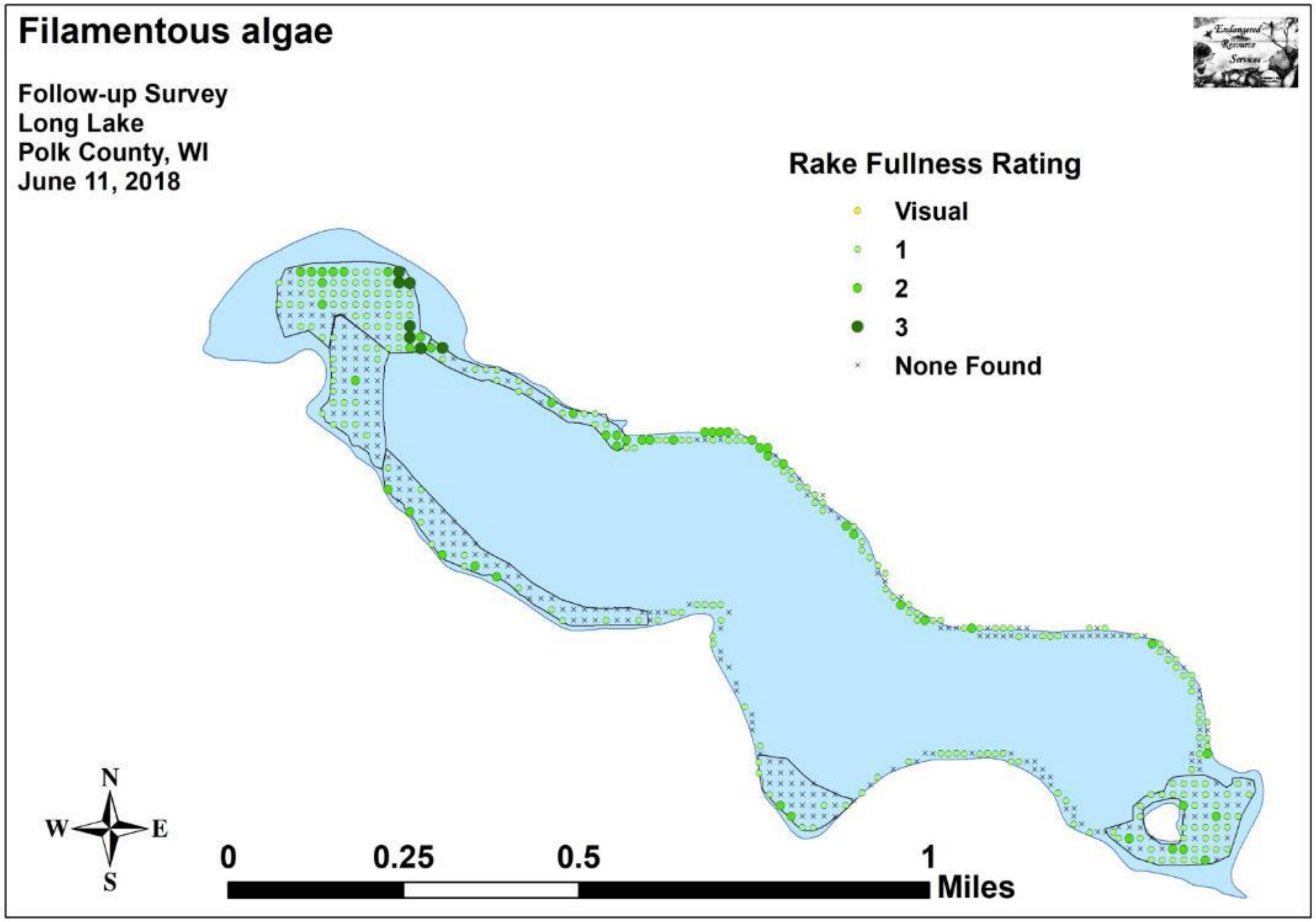


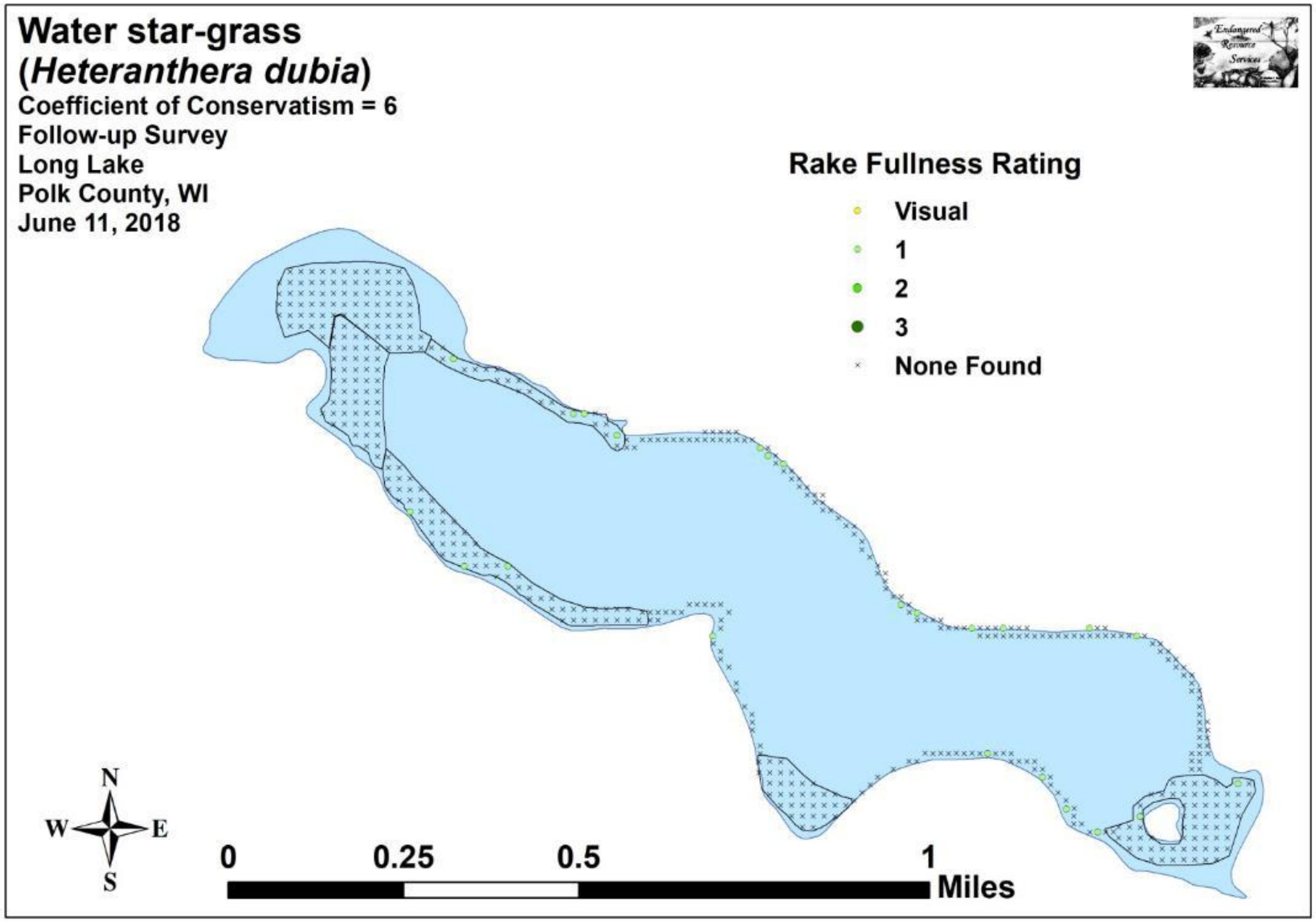
Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

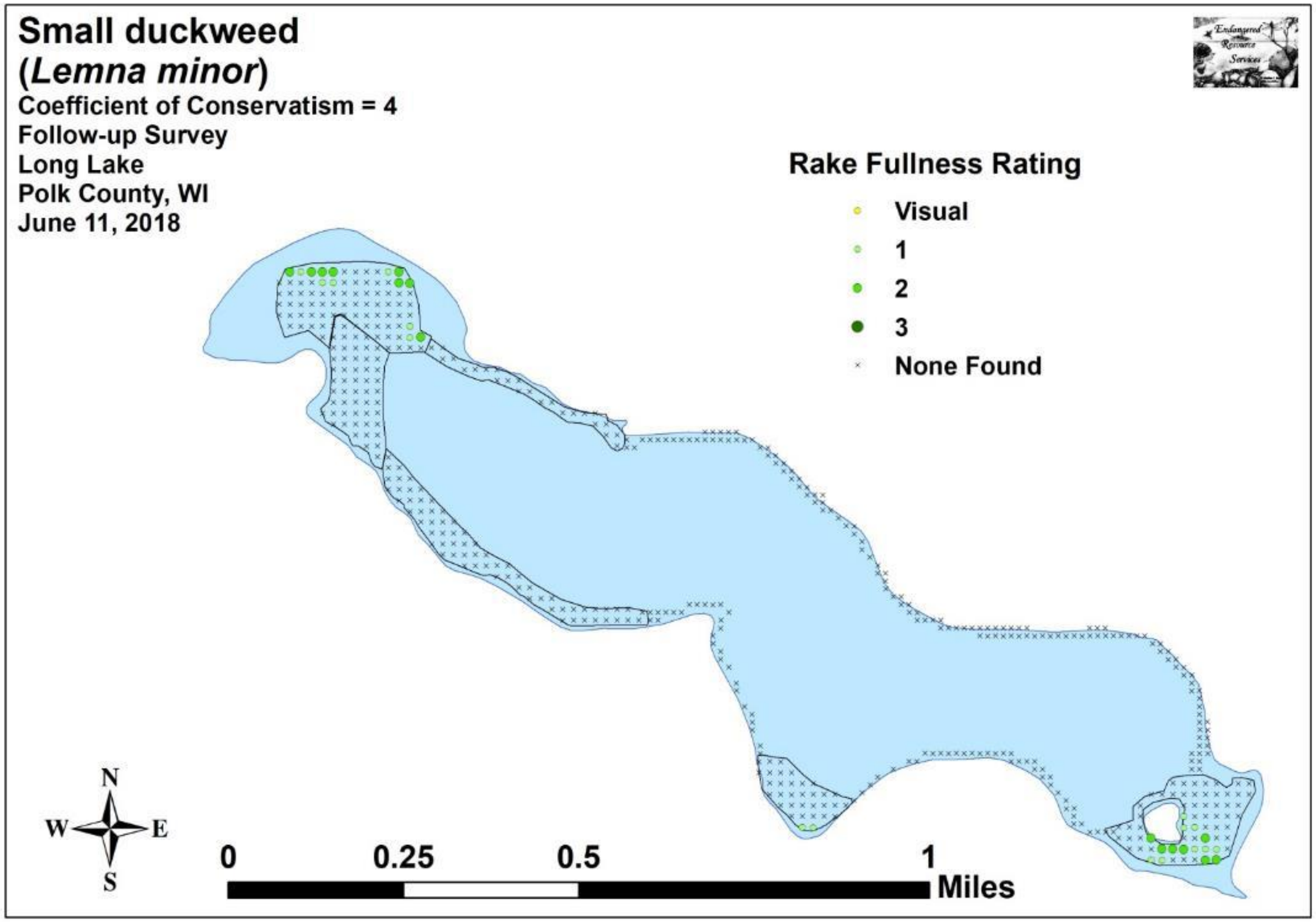

Muskgrass
(*Chara* sp.)
Coefficient of Conservatism = 7
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

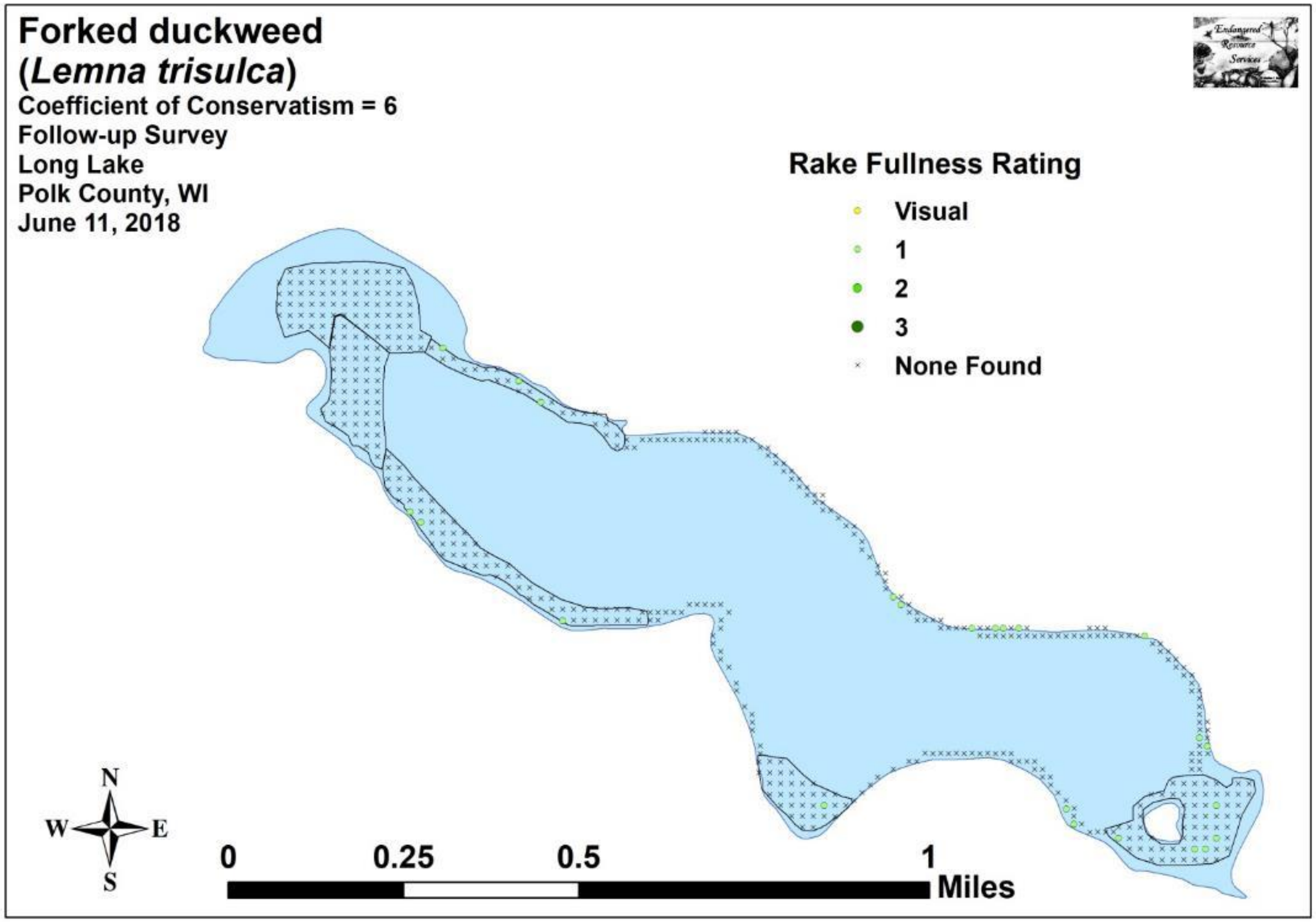

Needle spikerush
(*Eleocharis acicularis*)
Coefficient of Conservatism = 5
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

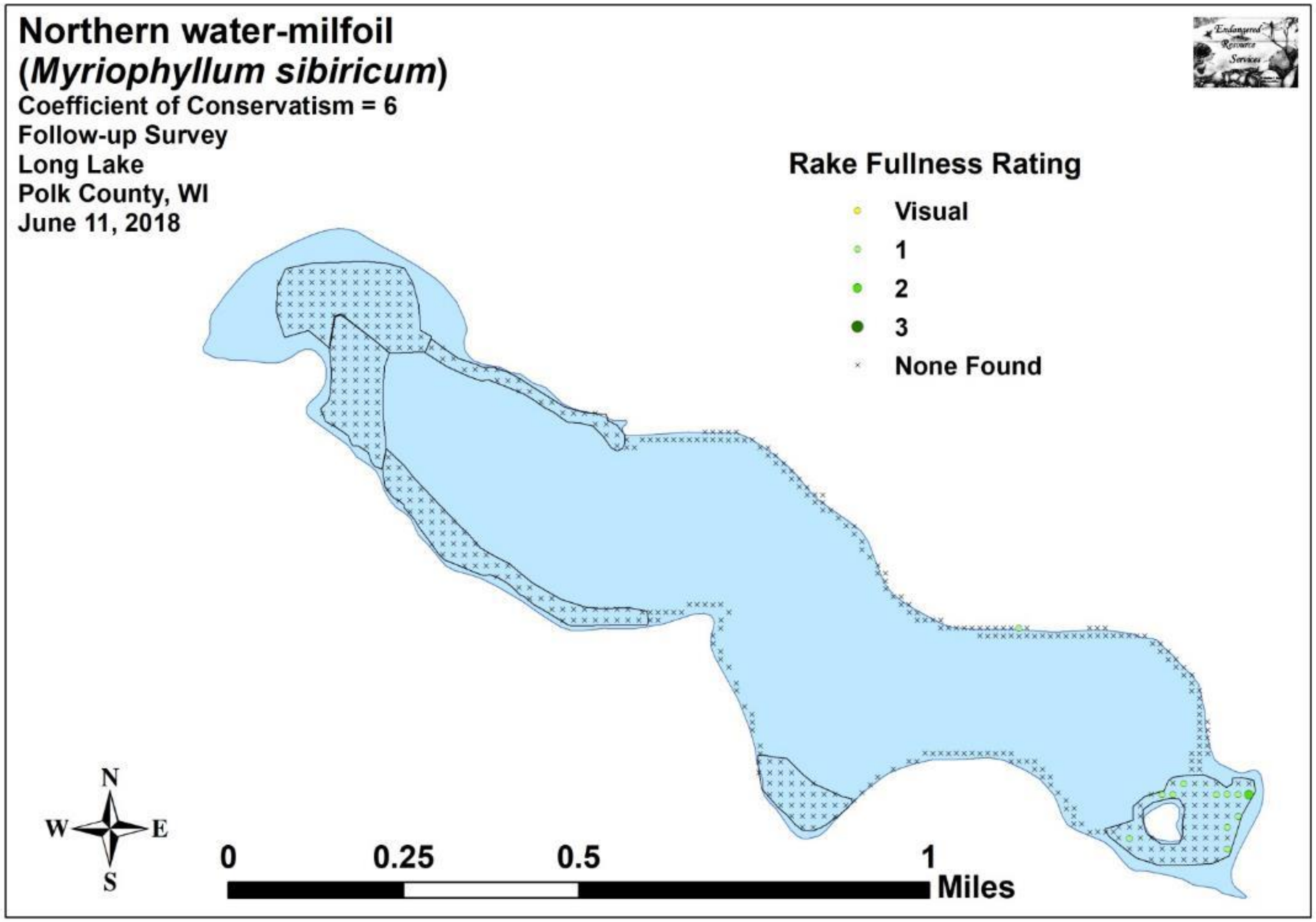

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

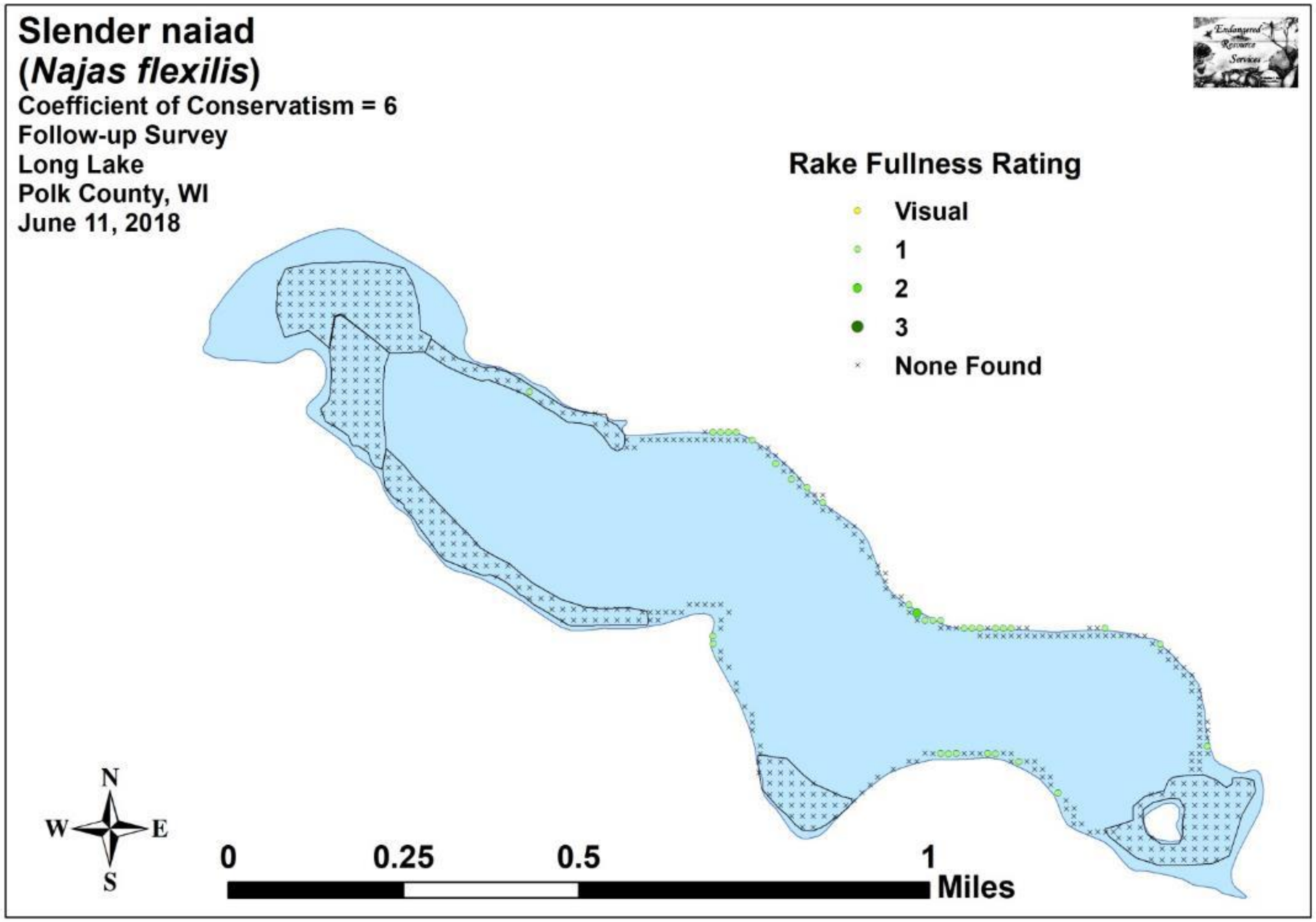

Filamentous algae
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Water star-grass
(*Heteranthera dubia*)
Coefficient of Conservatism = 6
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

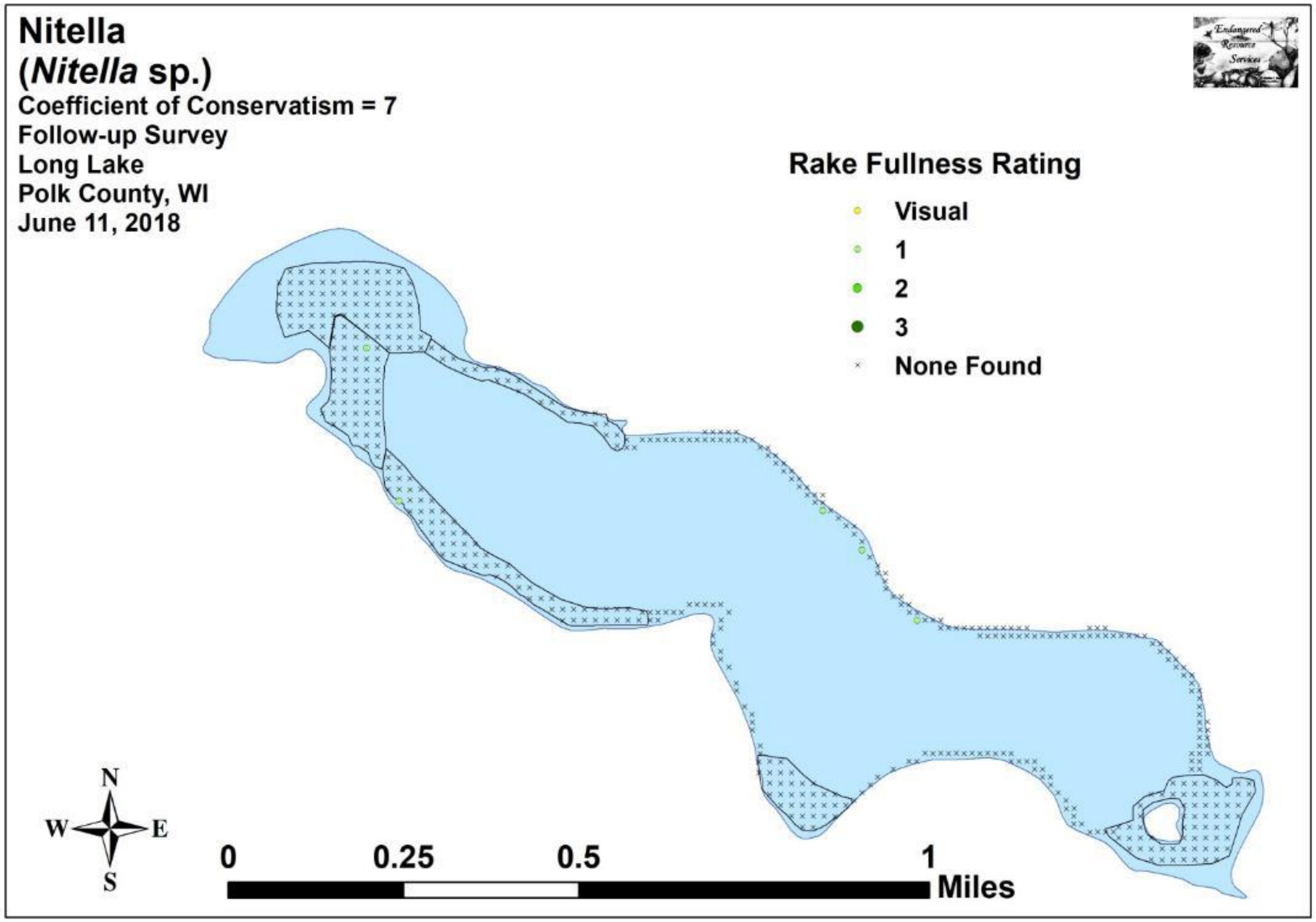

Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

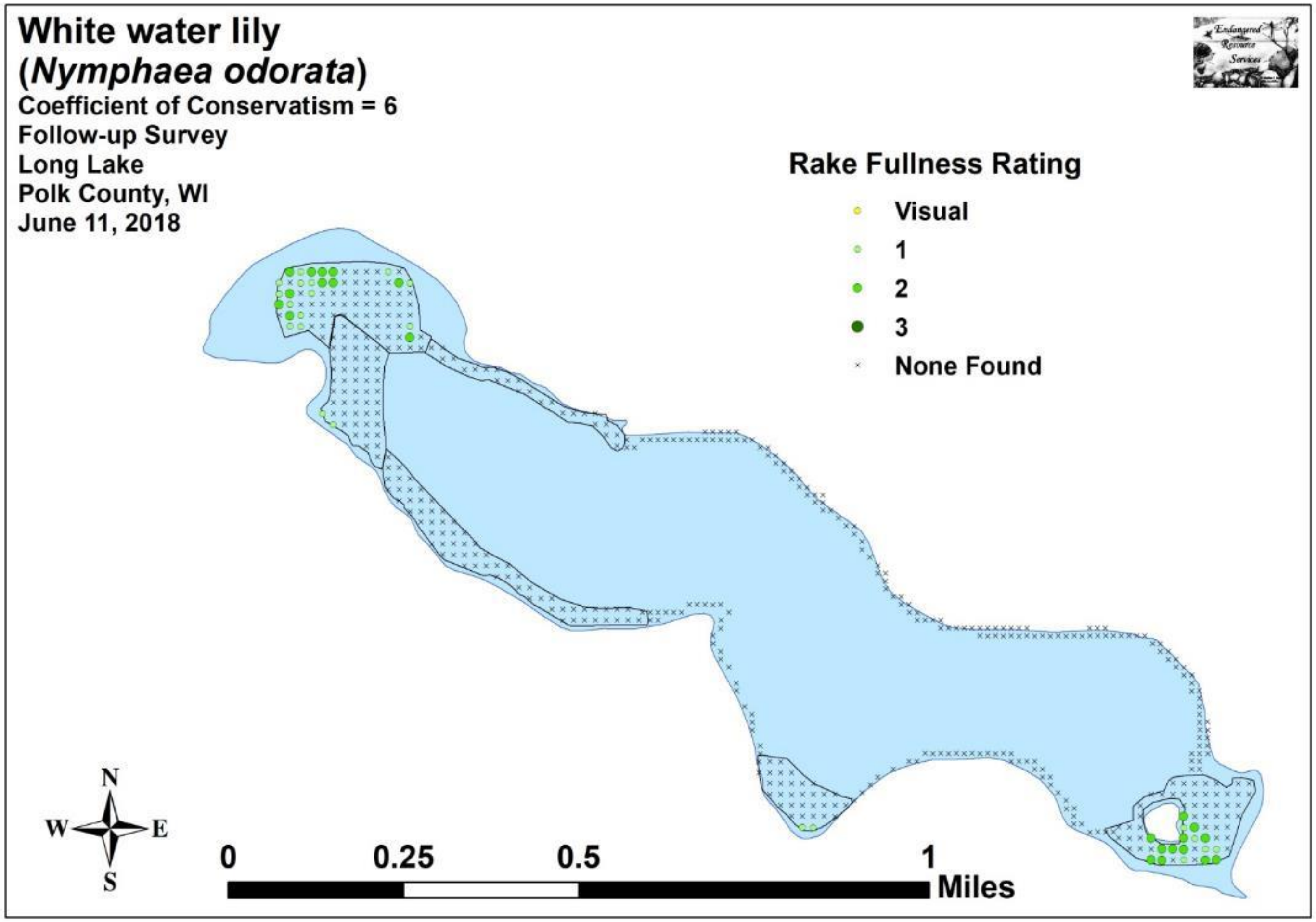

Forked duckweed
(*Lemna trisulca*)
Coefficient of Conservatism = 6
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Northern water-milfoil
(*Myriophyllum sibiricum*)
Coefficient of Conservatism = 6
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

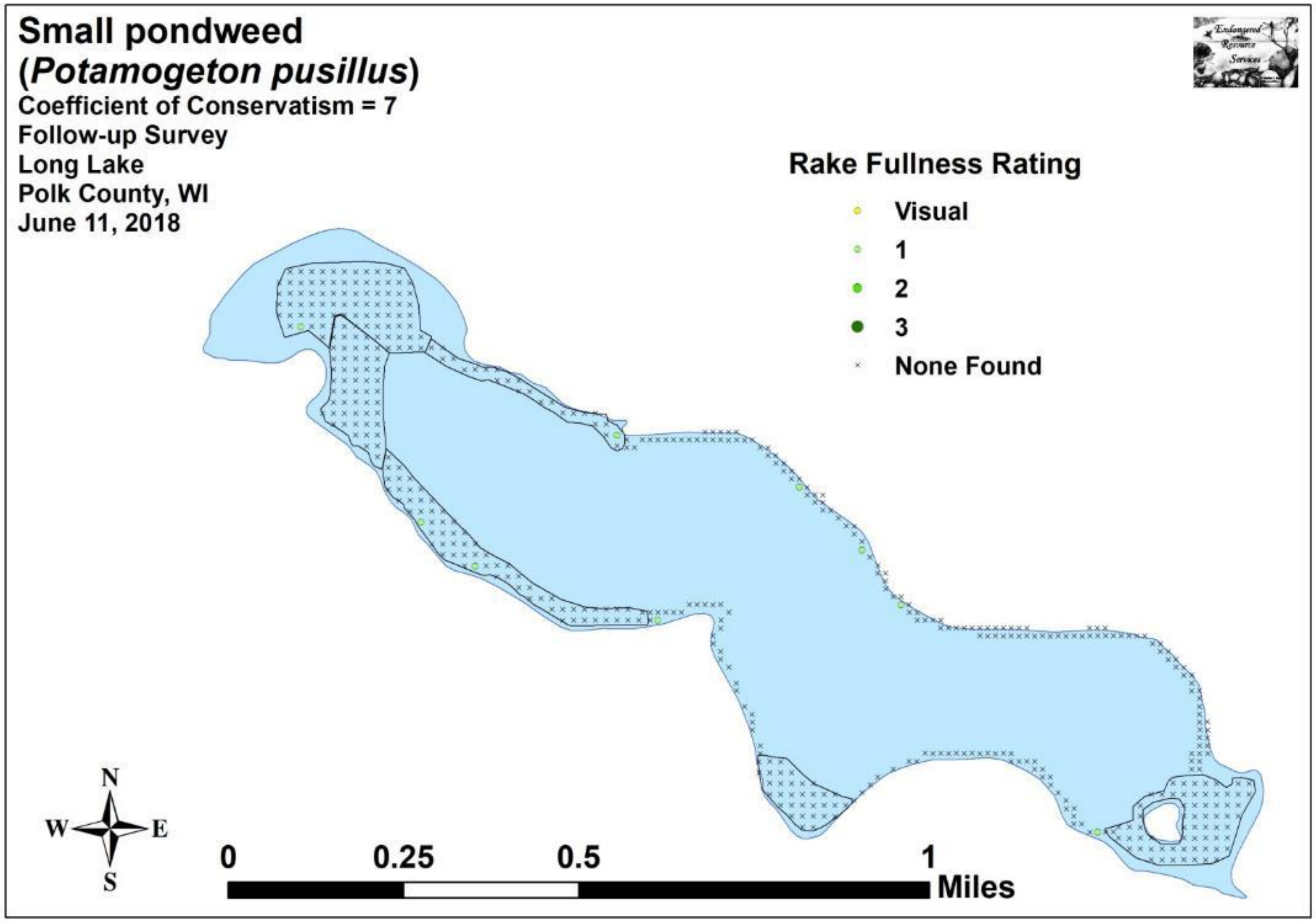


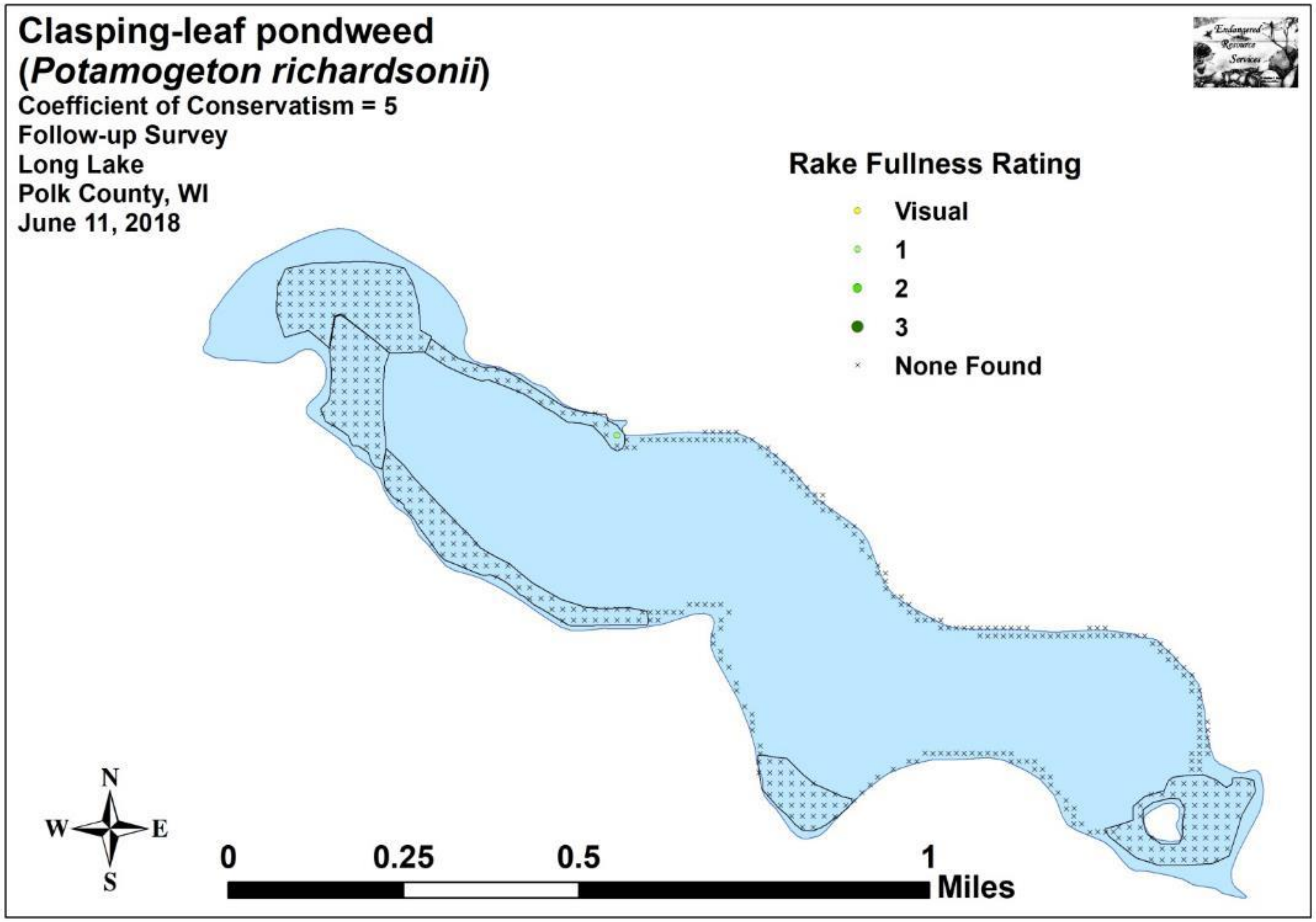
Slender naiad
(*Najas flexilis*)
Coefficient of Conservatism = 6
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

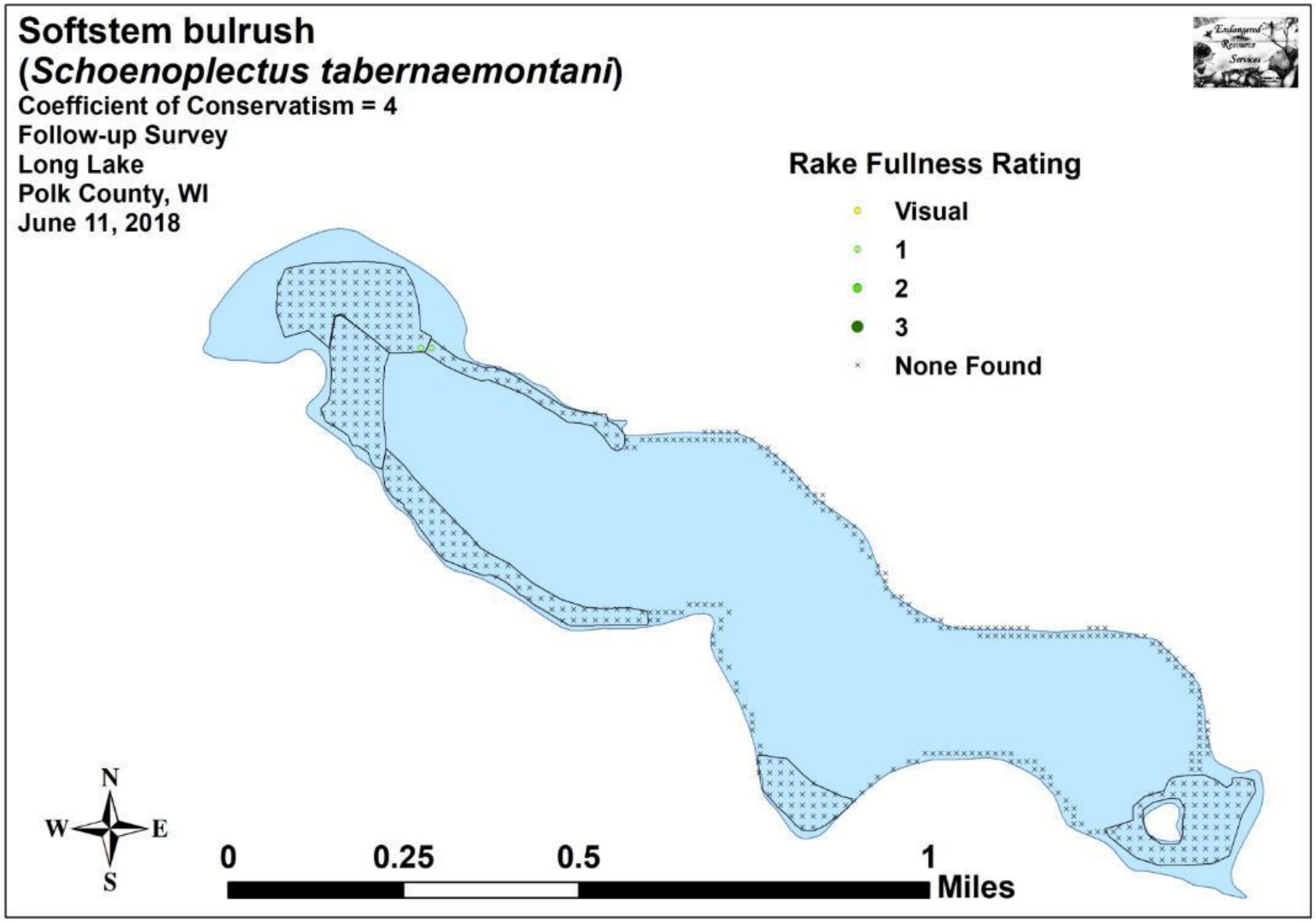

Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

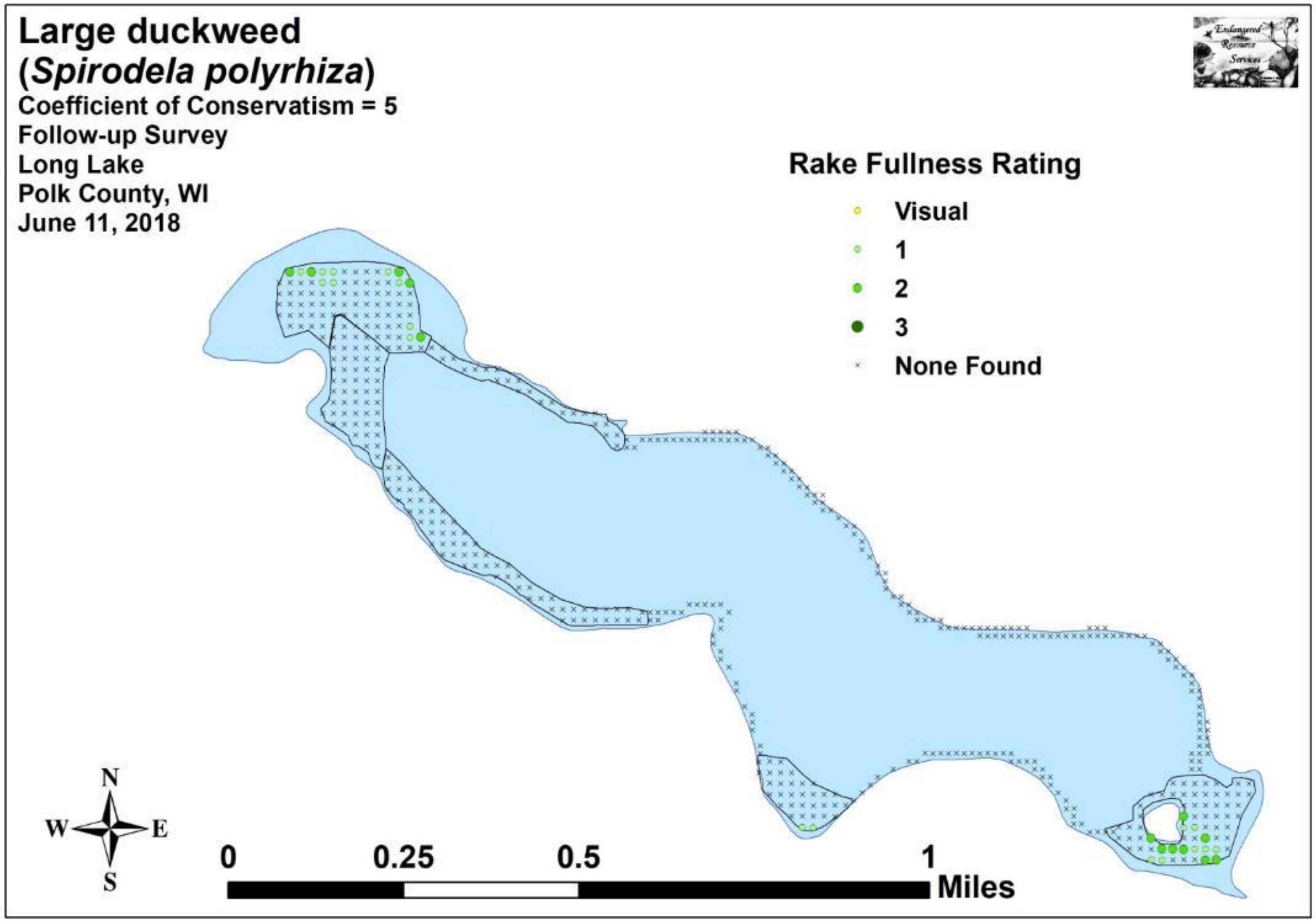


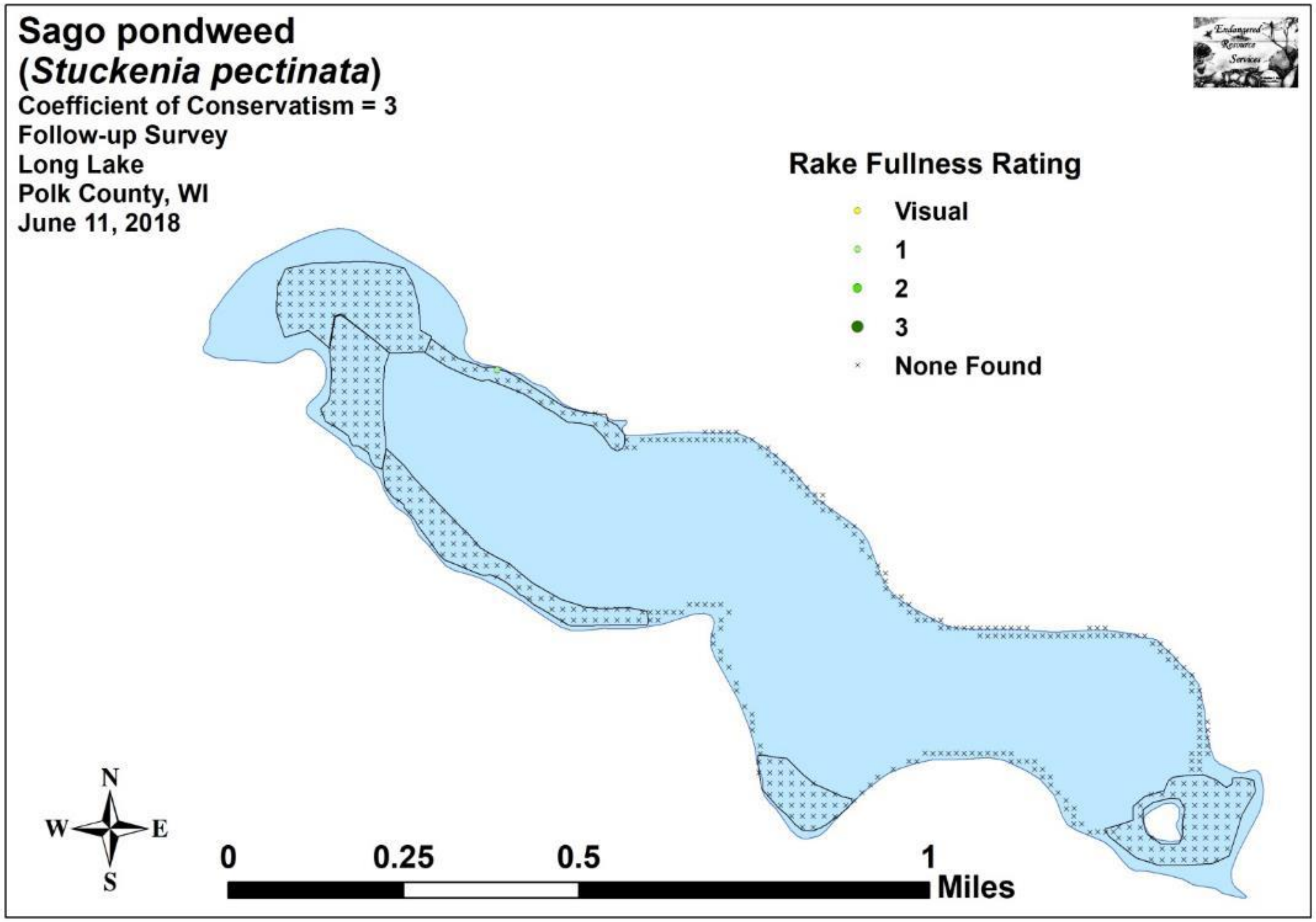
White water lily
(*Nymphaea odorata*)
Coefficient of Conservatism = 6
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles

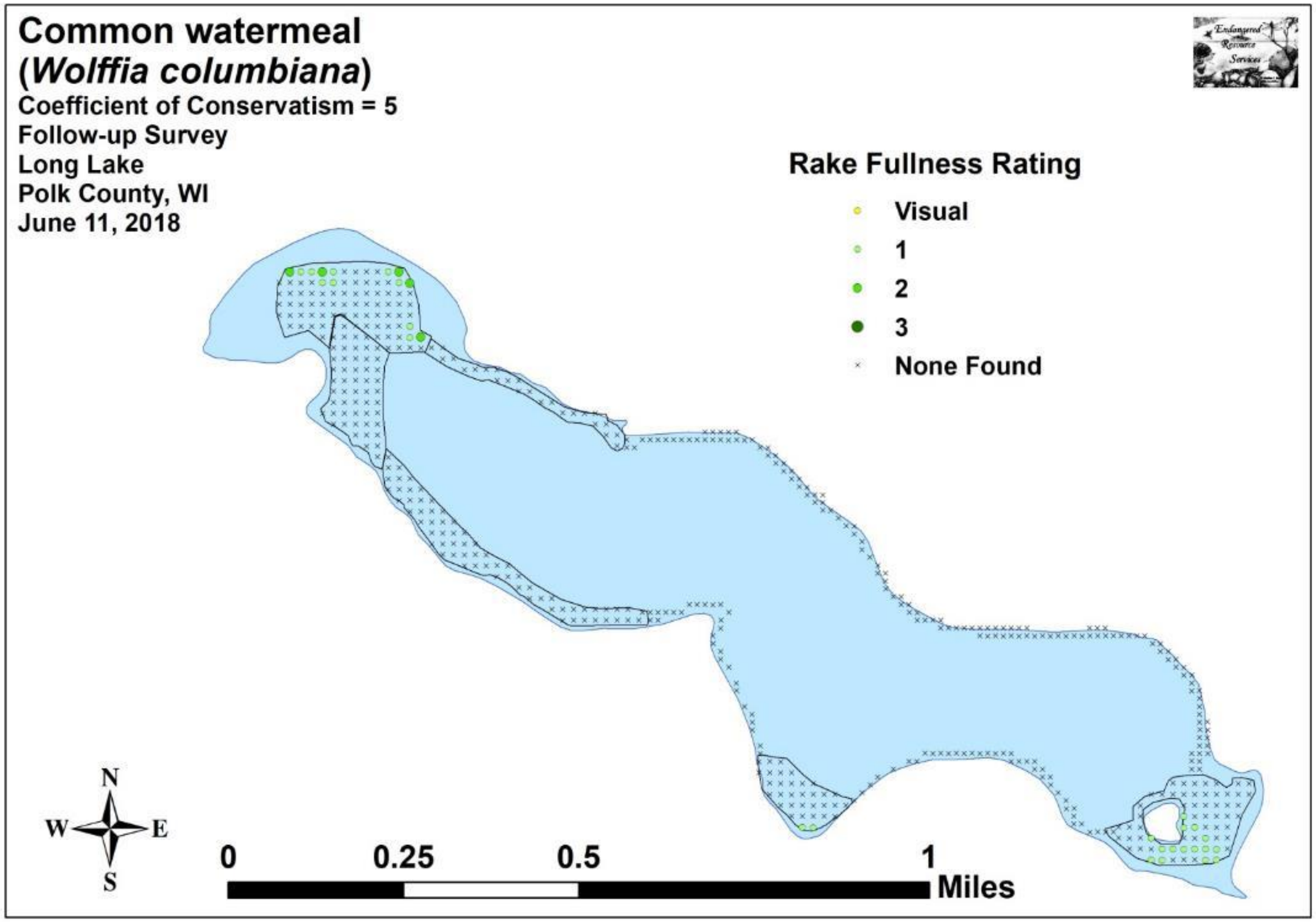

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Softstem bulrush
(*Schoenoplectus tabernaemontani*)
Coefficient of Conservatism = 4
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Sago pondweed
(*Stuckenia pectinata*)
Coefficient of Conservatism = 3
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles


Common watermeal
(*Wolffia columbiana*)
Coefficient of Conservatism = 5
Follow-up Survey
Long Lake
Polk County, WI
June 11, 2018
Rake Fullness Rating
Visual
1
2
3
None Found
N
W
E
S
0
0.25
0.5
1
Miles