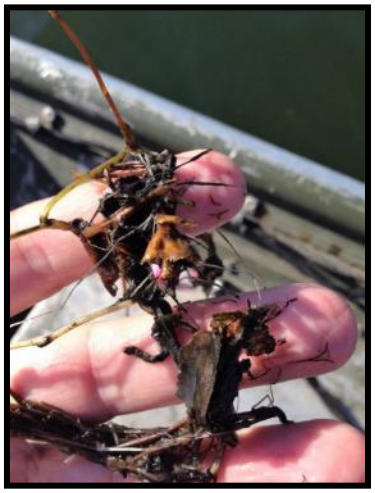
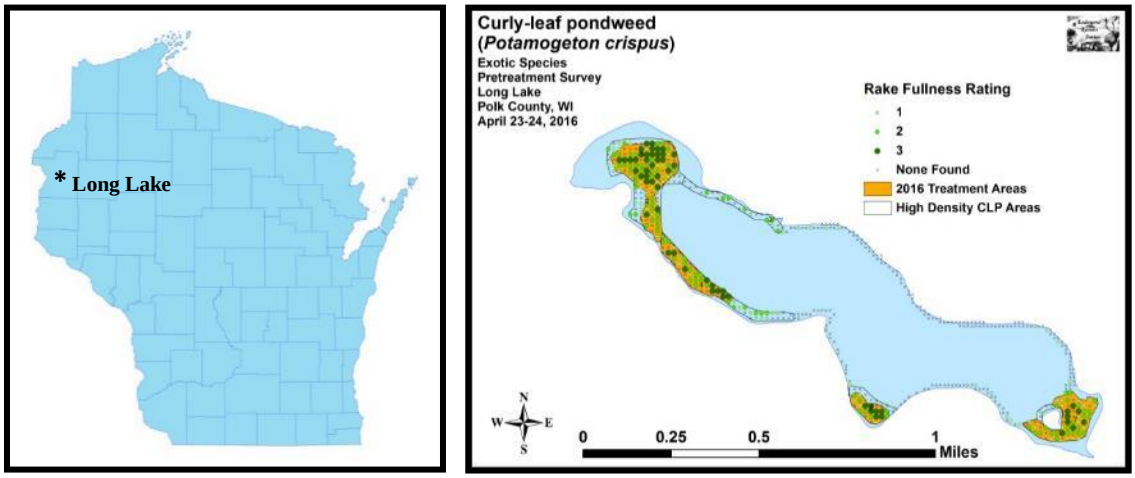
Curly-leaf pondweed (*Potamogeton crispus*)
Pre/Post Herbicide and June Bed Mapping Surveys
Long Lake - WBIC: 2478200
Polk County, Wisconsin

Long Lake Aerial Photo with Final 2016 Treatment Areas



Dead CLP Posttreatment 6/11/16

Project Initiated by:
Long Lake Protection and Rehabilitation District, Harmony Environmental, and the Wisconsin Department of Natural Resources



2016 CLP Pretreatment Density and Distribution

Surveys Conducted by and Report Prepared by:
Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
April 23-24 and June 10-11, 2016

TABLE OF CONTENTS

LIST OF FIGURES AND 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). Long Lake is eutrophic trending toward hypereutrophic, and visibility is generally poor with summer Secchi readings averaging 4.6ft since 1992 (WDNR 2016). 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 substrates.

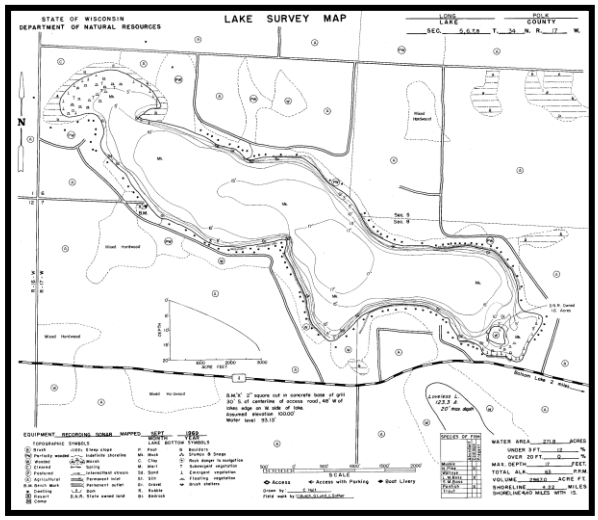


Figure 1: Long Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Long 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 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 Long Lake residents. CLP's late June-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 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, the PCLWCD, and the Wisconsin Department of Natural Resources (WDNR) authorized lakewide herbicide treatments in accordance with the District's WDNR approved Aquatic Plant Management Plan (APMP). Following an initial treatment of over 65 acres of CLP in 2010, the lake treated nearly 57 acres in 2011, 58 acres in 2012, 27 acres in 2013, and 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**.

An unusually early spring in 2015 apparently produced ideal growing conditions for CLP on Long Lake. Unexpectedly, the June 2015 point-intercept monitoring survey found **CLP was present at 45.1% of sample sites within historic CLP areas** (Figure 2). Of these, 139 had moderate to high density CLP suggesting **26.6% of these areas had the potential to impact navigation**. A concurrent bed mapping survey found 13 areas with canopied monotypic CLP of varying densities that covered 43.21 acres or approximately **15.9% of the lake's 272 acres** (Figure 2).

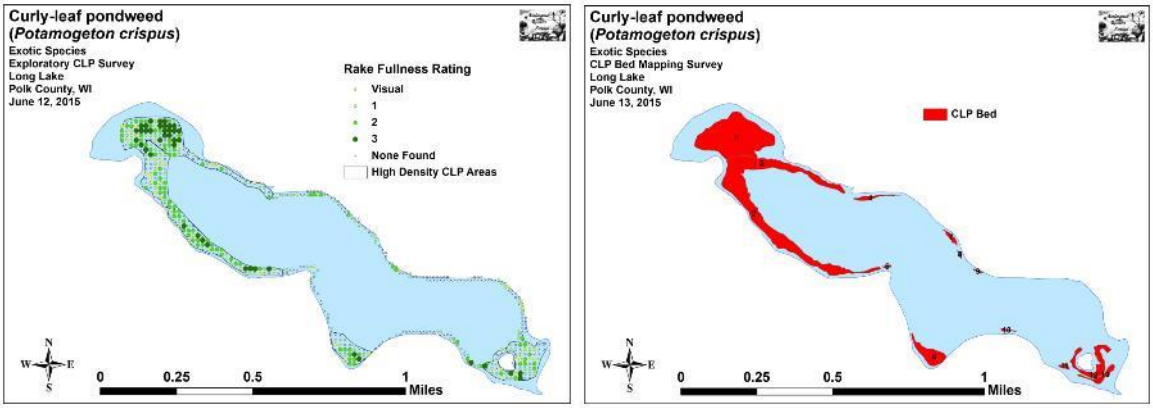


Figure 2: 2015 June CLP Exploratory and Bed Mappings Surveys

At the 2015 fall LLPRD board planning meeting led by president Michael Langer and APMP director Cheryl Clemens (Harmony Environmental), after much discussion among board members and based on the June survey maps as well as the fall CLP turion sediment data that also 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 2016**. Because of this, we conducted a pretreatment survey of the lake on April 23-24th to determine initial CLP levels and finalize treatment areas (Figure 3). Following the May 5th Aquathol K ® application on 34.97 acres of CLP (12.9% of the lake's surface area), a posttreatment survey was conducted on June 10-11th to determine the treatment's effectiveness. A June 11th CLP bed mapping survey was also requested to help determine if and where CLP treatment might be considered in 2017. This report is the summary analysis of these three surveys.

Figure 3: Long Lake with 2016 CLP Treatment Areas

METHODS:

Pre/Post Herbicide 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 for treatment plans. In 2013, we divided the lake into high/low CLP density areas. Within the high density areas (HDA), we used Hawth's Analysis Tools Extension to ArcGIS 9.3.1 to generate pre/post 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 (LDA), 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. Following the expansion of CLP in 2015, all 523 points were used for both the pre and posttreatment surveys in 2016 (Appendix I).

Following the finalization of the survey grid, we uploaded the points to a handheld mapping GPS unit (Garmin 76CSx) and 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 4). We also recorded visual sightings of CLP within six feet of the sample point. However, because visual sightings are not calculated into the pre/post statistical formulas, we only assigned a rake fullness value for non-CLP plants. A cumulative rake fullness value was also recorded at each site.

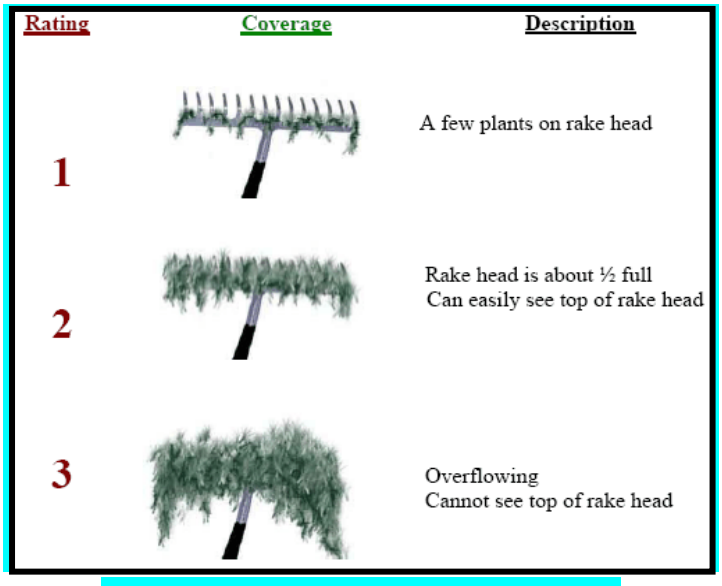


Figure 4: Rake Fullness Ratings

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/post analysis worksheet (UWEX 2010). Pre/post differences were determined to be significant at $p < .05$, moderately significant at $p < .01$ and highly significant at $p < .005$.

CLP Bed Mapping Survey:

Following the posttreatment survey, we conducted a meandering littoral zone search to locate and delineate all significant beds of CLP on the lake. We defined a bed based on the following two criteria: CLP plants made up greater than 50% of all plants in the area, **OR** the CLP had canopied at the surface or was close enough to the surface that it would likely interfere with any normal boat traffic that would try to motor through it.

Upon finding a bed, we circled around the perimeter and used a GPS unit to record waypoints at regular intervals. We then uploaded these points into ArcMap 9.3.1, created bed shapefiles using the WDNR Forestry Tools Extension, and determined the total acreage of the beds to the nearest hundredth of an acre (Table 1). We also estimated the rake density range and mean rake fullness of the bed, the maximum depth of the bed, whether it was canopied, and the impact it was likely to have on navigation (**none** – easily avoidable with a natural channel around or narrow enough to motor through/**minor** – one prop clear to get through or access open water/**moderate** – several prop clears needed to navigate through/**severe** – multiple prop clears and difficult to impossible to row through).

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). Following the pretreatment survey, we eliminated Area 3 and trimmed the rest to encompass the 34.97 acres (12.9% of the lake's surface area) that had the highest CLP densities in 2016 (Figure 5) (Appendix I).

Table 1: Spring CLP Treatment Summary
May 5, 2016 - Long Lake, Polk Co.

High Density CLP Area	Potential Treatment (acres)	Final Treatment (acres)	Difference (+/-)
1	13.34	10.05	-3.29
2	8.46	6.03	-2.43
3	3.84	0.00	-3.84
4	9.51	6.16	-3.35
6	4.88	3.24	-1.64
7	9.85	9.49	-0.36
	49.88	**34.97**	**-14.91**

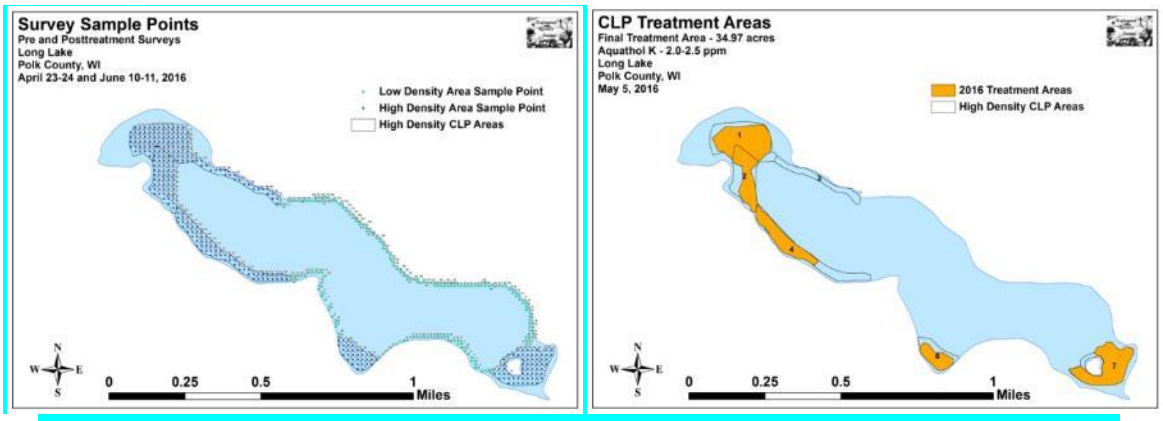


Figure 5: 2016 CLP Survey Points and Final CLP Treatment Areas

Pre/Post Treatment Surveys:

Treatment occurred on May 5th, 2016 with Northern Aquatics (Dresser, WI) applying Aquathol K (Endothall) at a rate of 2.0-2.5 ppm (335 total gallons). The reported water temperatures at the time of treatment were 54.0°F which was well within the WDNR recommended treatment temperature range of 50 - 60°F. Wind speeds were reported to be 0-4mph out of the north.

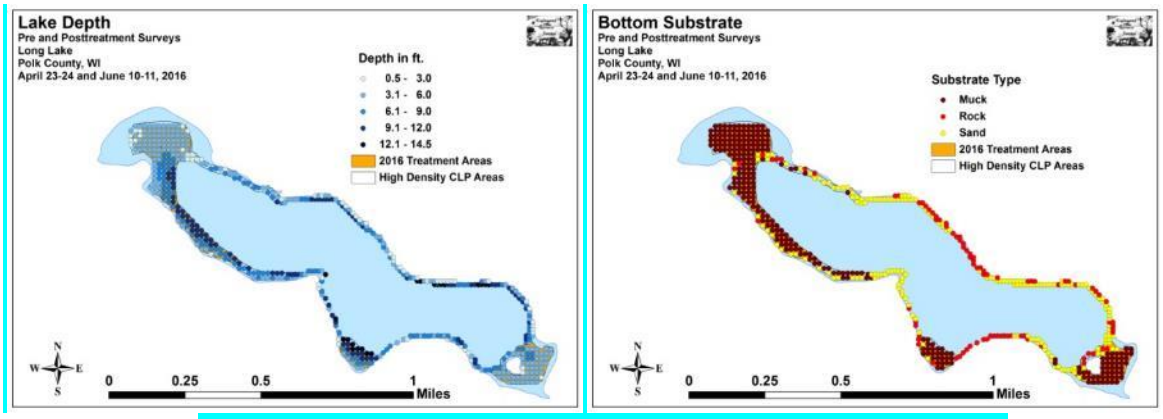


Figure 6: CLP Area Depths and Bottom Substrate

All CLP areas occurred in water between 0.5ft and 14.5ft. During the pretreatment survey, we found the mean and median depth of plant growth in the high density areas to be 6.0ft and 5.5ft respectively. This declined slightly posttreatment to 5.5ft and 5.0ft (Table 2). In the low density areas, the pretreatment mean and median depths were 7.4ft and 7.0ft. Because these areas weren't treated, we were surprised to see both values fall to 6.0ft in June. As in the HDAs, these declines seem to be directly related to the death of CLP plants which dominated the deep water plant community.

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 6) (Appendix III).

Table 2: Pre/Post Survey Summary Statistics
Long Lake, Polk County
April 23-24 and June 10-11, 2016

Summary Statistics:	Pre-High	Post-High	Pre-Low	Post-Low
Total number of points sampled	323	323	200	200
Total number of sites with vegetation	296	223	41	93
Total number of sites shallower than the maximum depth of plants	315	313	195	198
Frequency of occurrence at sites shallower than max. depth of plants	94.0	71.3	21.0	47.0
Simpson Diversity Index	0.62	0.71	0.69	0.83
Mean Coefficient of Conservatism	5.0	5.0	5.0	5.4
Floristic Quality Index	12.2	18.0	12.2	16.3
Average number of all species per site (shallower than max depth)	1.47	1.24	0.29	0.59
Average number of all species per site (veg. sites only)	1.56	1.74	1.39	1.25
Ave. number of native species/site (shallower than max depth)	0.77	1.23	0.21	0.58
Ave. number of native species/site (sites with native plants only)	1.25	1.72	1.38	1.24
Species Richness	7	14	7	10
Maximum depth of plants (ft)	12.0	11.5	12.5	13.5
Mean depth of plants (ft)	6.0	5.5	7.4	6.0
Median depth of plants (ft)	5.0	5.0	7.0	6.0
Mean Rake Fullness	2.00	1.39	1.20	1.10

The pretreatment littoral zone extended to 12.5ft (12.0ft HDA/12.5ft LDA) before expanding slightly to 13.5ft posttreatment (11.5ft HDA/13.5ft LDA) (Figure 7) (Appendix IV). The frequency of plants encountered in high density areas decreased from almost total coverage (94.0%) pretreatment to 71.3% posttreatment. Conversely, in the low density areas where plants were uncommon within the litteral zone prestreatment (21.0% coverage), frequency more than doubled to 47.0% posttreatment. Within the HDAs, species richness doubled brom seven pretreatment to 14 posttreatment while the LDAs increased from seven to ten species. This helped the Simpson's Diversity Index increase in both HDA and LDAs from 0.62/0.71 pretreatment to 0.69/0.83 posttreament. The Floristic Quality Index (another measure of the native plant community health) also increased from 12.2 in all areas prettreatment to 18.0 in HDAs and 16.3 in LDAs posttreatment.

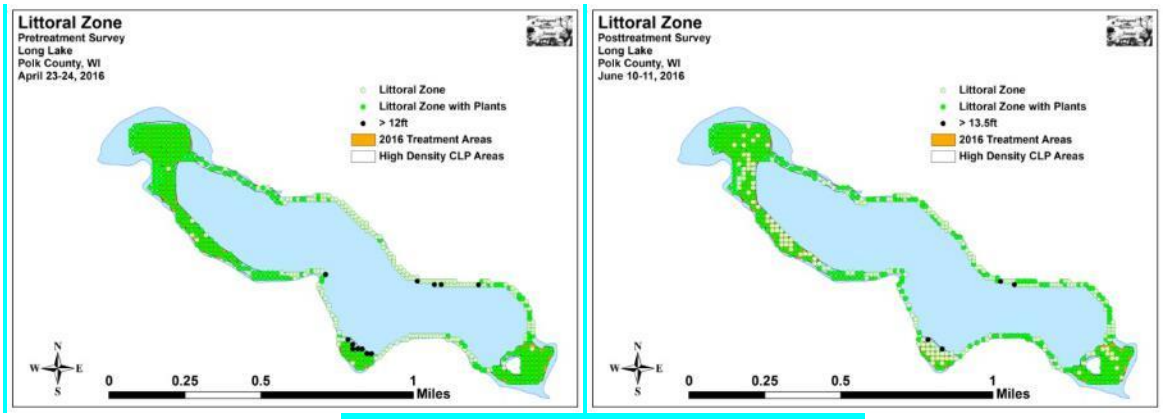


Figure 7: Pre/Post Littoral Zone

We found localized native species richness to be quite low throughout the lake. In the high density areas, richness at survey points with native plants increased from just 1.25 species/site pretreatment to 1.72 species/site posttreatment (Figures 8). However, and somewhat surprisingly, in low density areas, this value fell from 1.38 species/site to a very low 1.24 species/site. Total mean rake fullness in HDAs was a moderate 2.00 pretreatment before falling to a low 1.39 posttreament. In LDAs, where the April mean rake fullness was already an exceptionally low 1.20, we found this level dropped even further to 1.10 posttreatment (Figures 9) (Appendix IV).

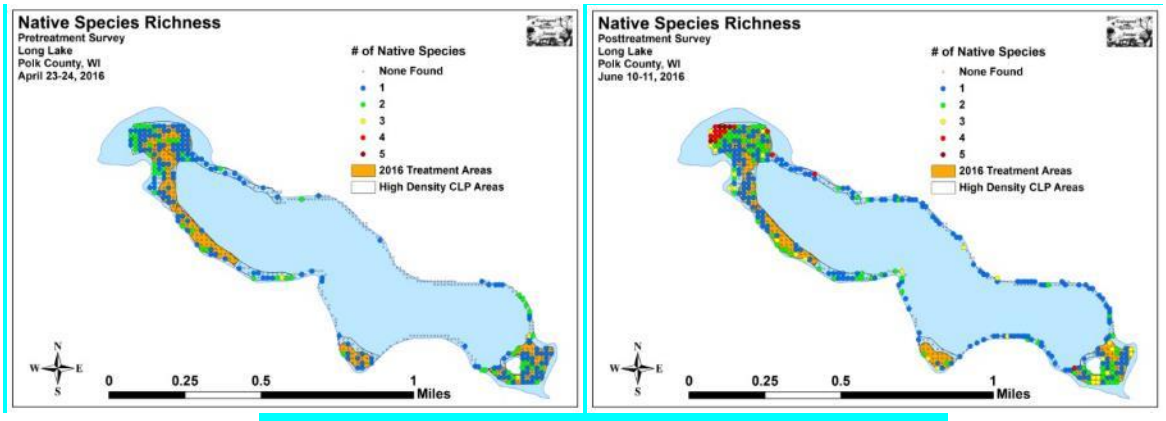


Figure 8: Pre/Post Native Species Richness

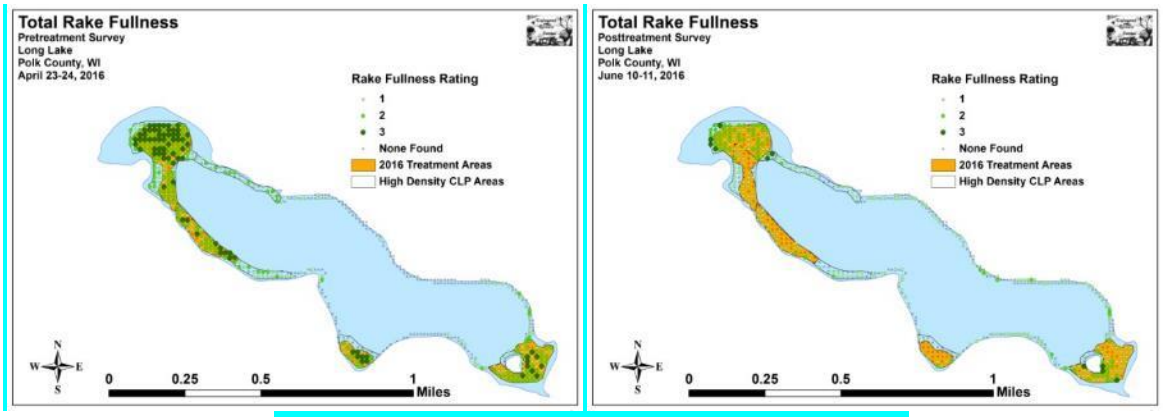


Figure 9: Pre/Post Total Rake Fullness

During the pretreatment survey, we found Curly-leaf pondweed at 237 of 523 total sites (45.3%). Of these, 220 points occurred within the high density area's 323 sites (68.1%) and only 17 occurred within the low density area's 200 points (8.5%) (Figure 10) (Appendix V). The high density areas had 57 points with a rake fullness rating of 3, 94 with a 2, and 69 were a 1. This produced a moderate mean rake fullness of 1.95. The low density areas had no points rating a 3, two that were a 2, and the remaining 15 a 1 for a low mean rake fullness of 1.23.

During the posttreatment survey, we found CLP at just five points (1.0% coverage) all of which rated a 1. Three of these occurred in the the HDAs (0.9%), and just two were in the LDAs (1.0%). **Our findings suggest the treatment produced a highly significant reduction in CLP lakewide** (Figure 11), in the HDAs (Figure 12), AND in the LDAs (Figure 13). This was surprising as only the HDAs were treated, and, even here, only 70% of the acreage was treated. **That CLP was knocked back even in areas that weren't treated suggests that this dosage of Endothall over this acreage effectively resulted in a lakewide treatment.**

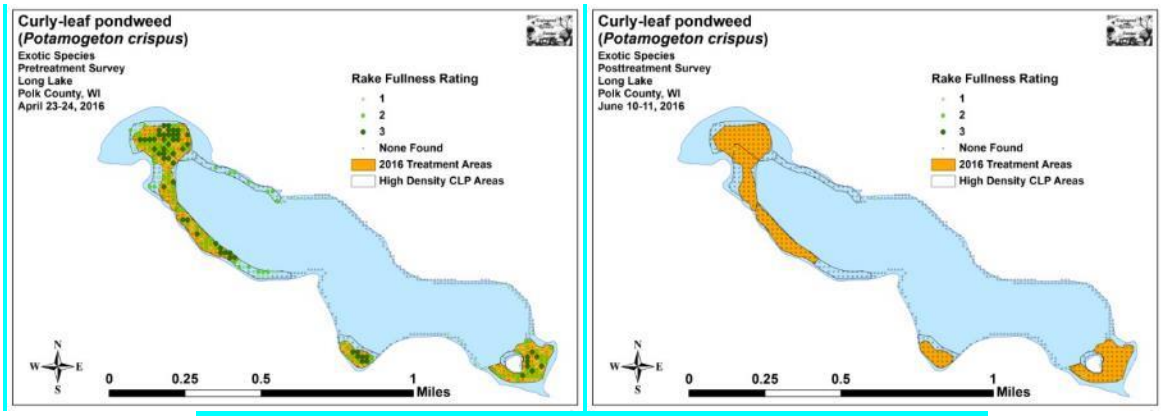
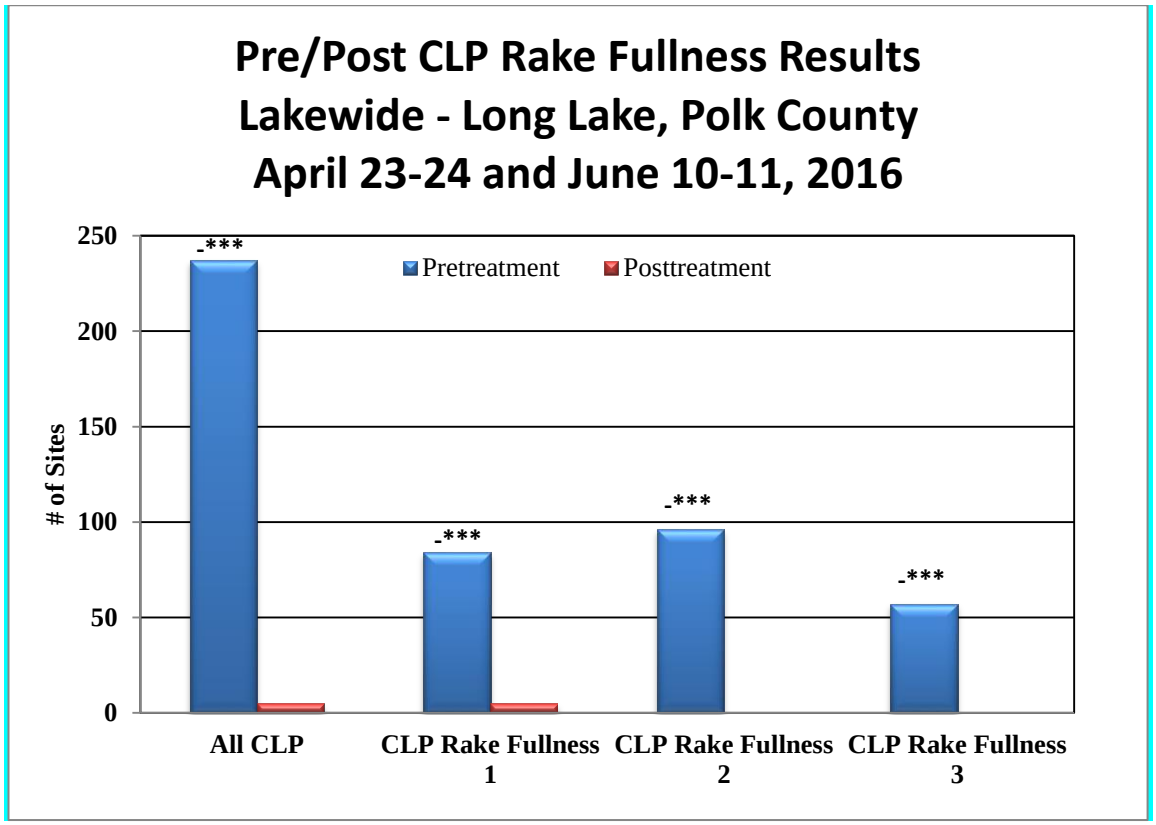
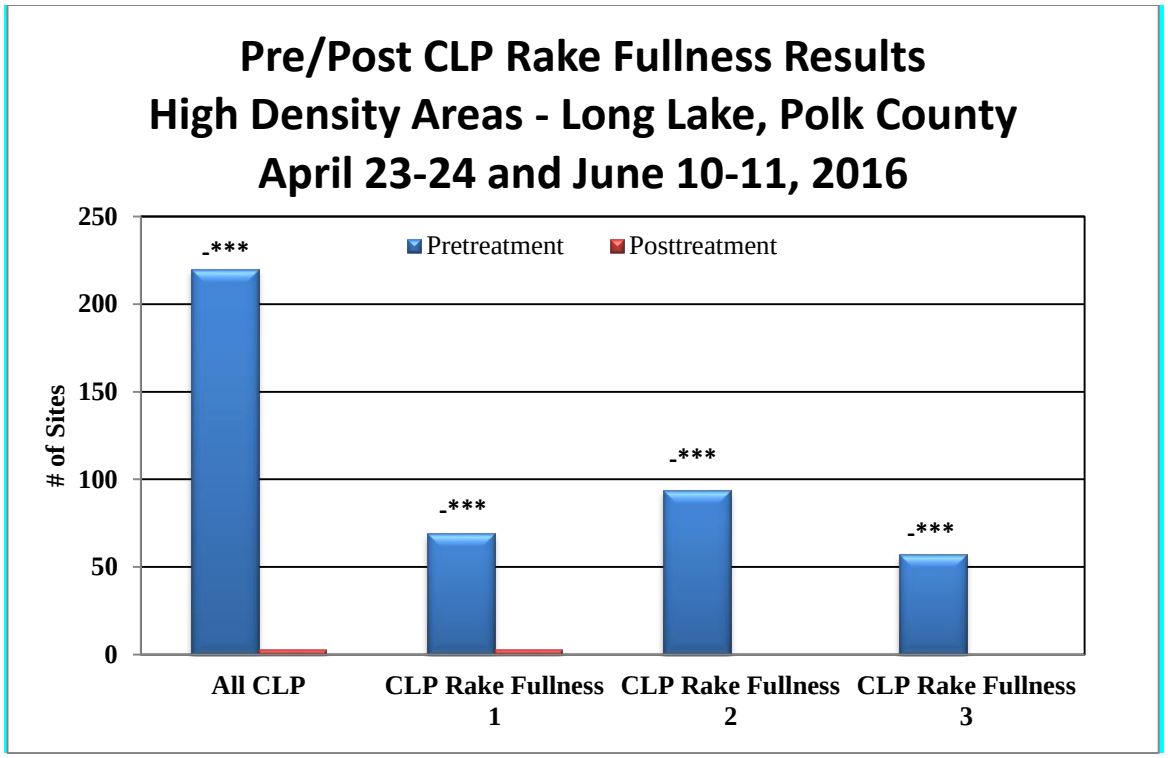


Figure 10: Pre/Post CLP Density and Distribution



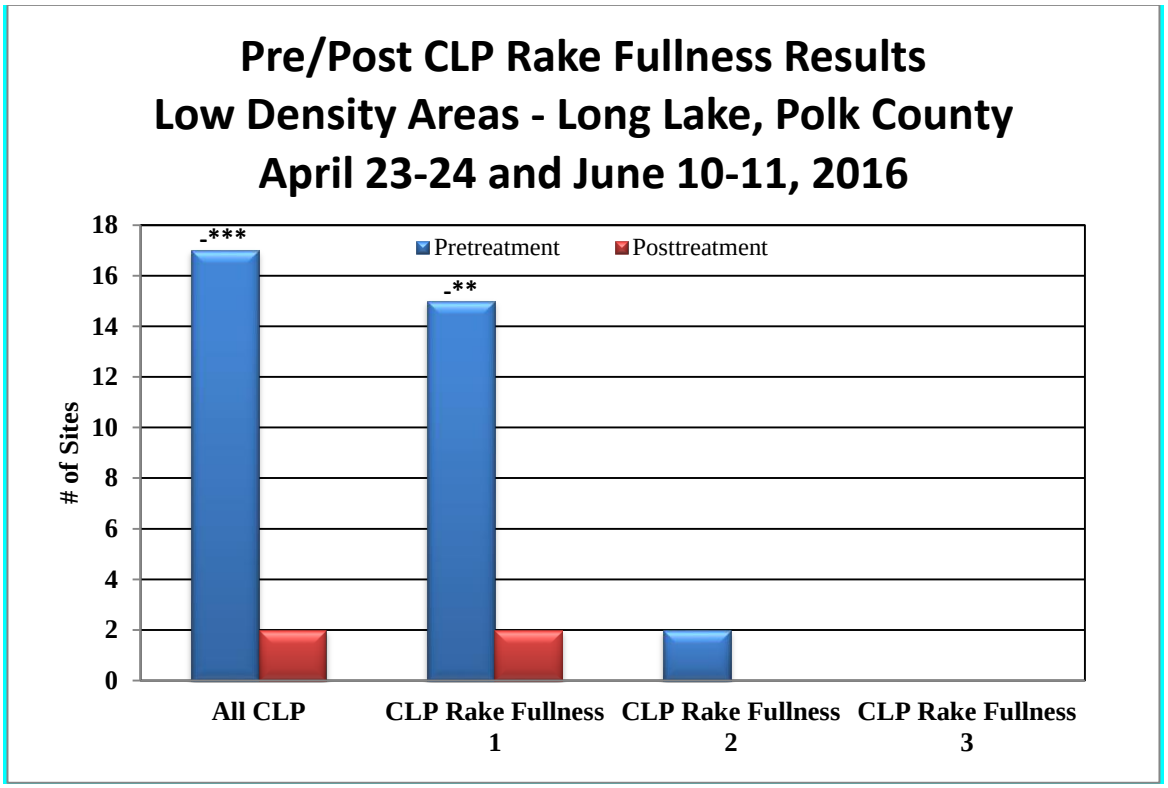
Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 11: Whole Lake Changes in CLP Rake Fullness Ratings



Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 12: High Density Area Changes in CLP Rake Fullness Ratings



Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 13: Low Density Area - Changes in CLP Rake Fullness Ratings

We found Coontail (*Ceratophyllum demersum*) to be the most common native species in during the pre and posttreatment surveys (Figure 14) in both the high and low density CLP areas (Tables 3-6). Lakewide, Common waterweed (*Elodea canadensis*) was the second most common native species during both the pre and posttreatment surveys (Figure 15). Neither these or any other species showed a significant decline posttreatment. However, Filamentous algae demonstrated a highly significant increase (Figure 12). White water lily (*Nymphaea odorata*), a later growing species that was still dormant during the pretreatment survey, also demonstrated a highly significant increase (Maps of all native species from the pre and posttreatment surveys can be found in Appendixes VI and VII).

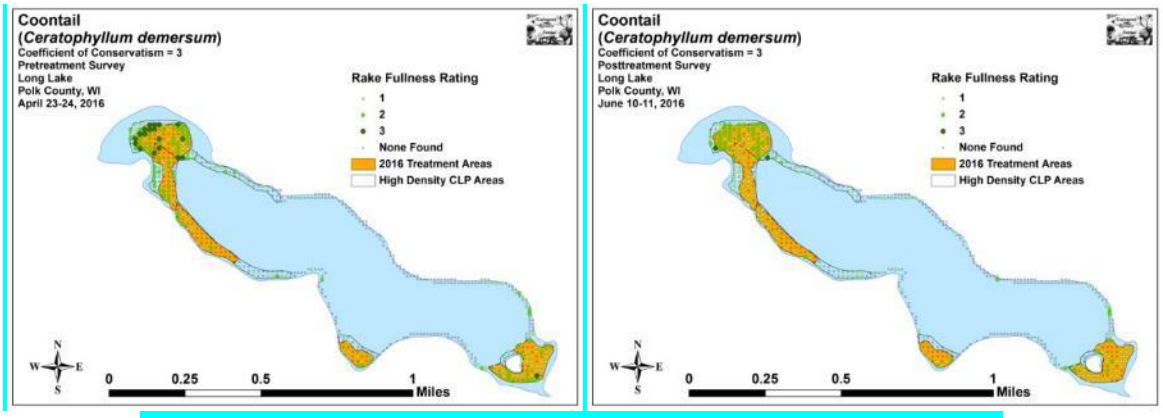


Figure 14: Pre/Post Coontail Density and Distribution

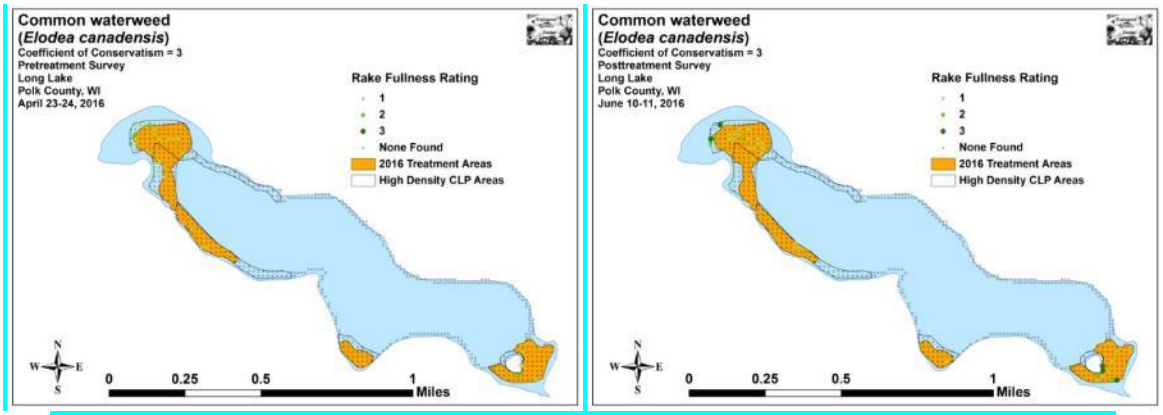


Figure 15: Pre/Post Common Waterweed Density and Distribution

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes Pretreatment Survey – High CLP Density Areas - Long Lake, Polk County April 23-24, 2016

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	220	47.62	74.32	69.84	1.95
Ceratophyllum demersum	Coontail	174	37.66	58.78	55.24	1.61
	Filamentous algae	90	*	30.41	28.57	1.83
Elodea canadensis	Common waterweed	38	8.23	12.84	12.06	1.11
Lemna trisulca	Forked duckweed	14	3.03	4.73	4.44	1.14
Chara sp.	Muskgrass	9	1.95	3.04	2.86	1.33
Myriophyllum sibiricum	Northern water-milfoil	5	1.08	1.69	1.59	1.00
Eleocharis acicularis	Needle spikerush	2	0.43	0.68	0.63	2.00

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes Pretreatment Survey – Low CLP Density Areas - Long Lake, Polk County April 23-24, 2016

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Ceratophyllum demersum	Coontail	26	45.61	63.41	13.33	1.23
Potamogeton crispus	Curly-leaf pondweed	17	29.82	41.46	8.72	1.12
Myriophyllum sibiricum	Northern water-milfoil	6	10.53	14.63	3.08	1.17
Chara sp.	Muskgrass	3	5.26	7.32	1.54	1.00
Elodea canadensis	Common waterweed	2	3.51	4.88	1.03	1.00
Lemna trisulca	Forked duckweed	2	3.51	4.88	1.03	1.00
Eleocharis acicularis	Needle spikerush	1	1.75	2.44	0.51	1.00

* Excluded from relative frequency analysis

Table 5: Frequencies and Mean Rake Sample of Aquatic Macrophytes Posttreatment Survey - High CLP Density Areas - Long Lake, Polk County June 10-11, 2016

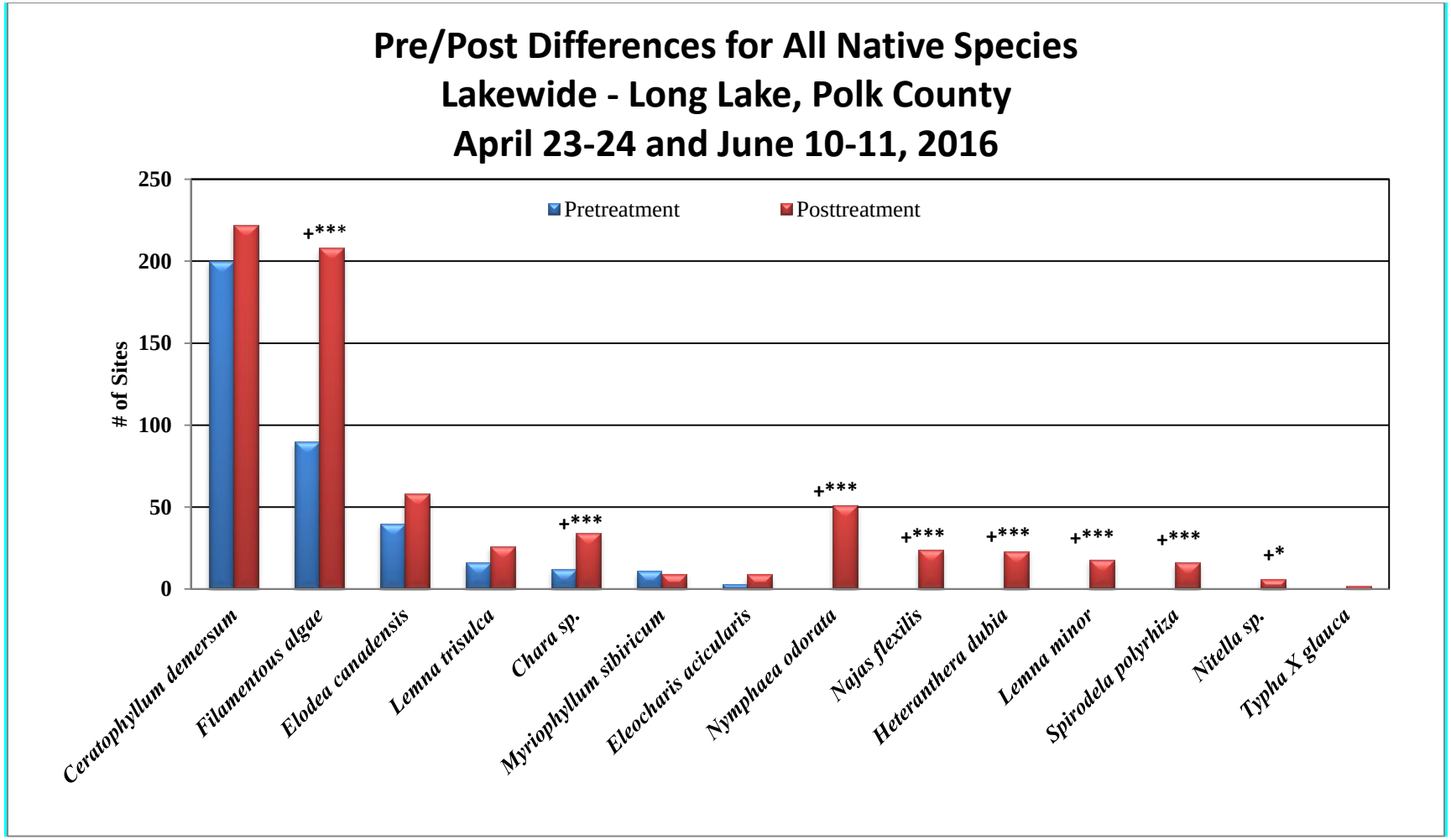
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Ceratophyllum demersum	Coontail	190	49.10	85.20	60.70	1.27
	Filamentous algae	130	*	58.30	41.53	1.62
Elodea canadensis	Common waterweed	54	13.95	24.22	17.25	1.28
Nymphaea odorata	White water lily	51	13.18	22.87	16.29	1.65
Lemna trisulca	Forked duckweed	20	5.17	8.97	6.39	1.10
Lemna minor	Small duckweed	18	4.65	8.07	5.75	1.22
Spirodela polyrhiza	Large duckweed	16	4.13	7.17	5.11	1.13
Chara sp.	Muskgrass	12	3.10	5.38	3.83	1.08
Heteranthera dubia	Water star-grass	6	1.55	2.69	1.92	1.00
Myriophyllum sibiricum	Northern water-milfoil	6	1.55	2.69	1.92	1.00
Eleocharis acicularis	Needle spikerush	4	1.03	1.79	1.28	1.00
Najas flexilis	Slender naiad	4	1.03	1.79	1.28	1.00
Potamogeton crispus	Curly-leaf pondweed	3	0.78	1.35	0.96	1.00
Typha X *glauca*	Hybrid cattail	2	0.52	0.90	0.64	3.00
Nitella sp.	Nitella	1	0.26	0.45	0.32	1.00

* Excluded from relative frequency analysis

Table 6: Frequencies and Mean Rake Sample of Aquatic Macrophytes Posttreatment Survey - Low CLP Density Areas - Long Lake, Polk County June 10-11, 2016

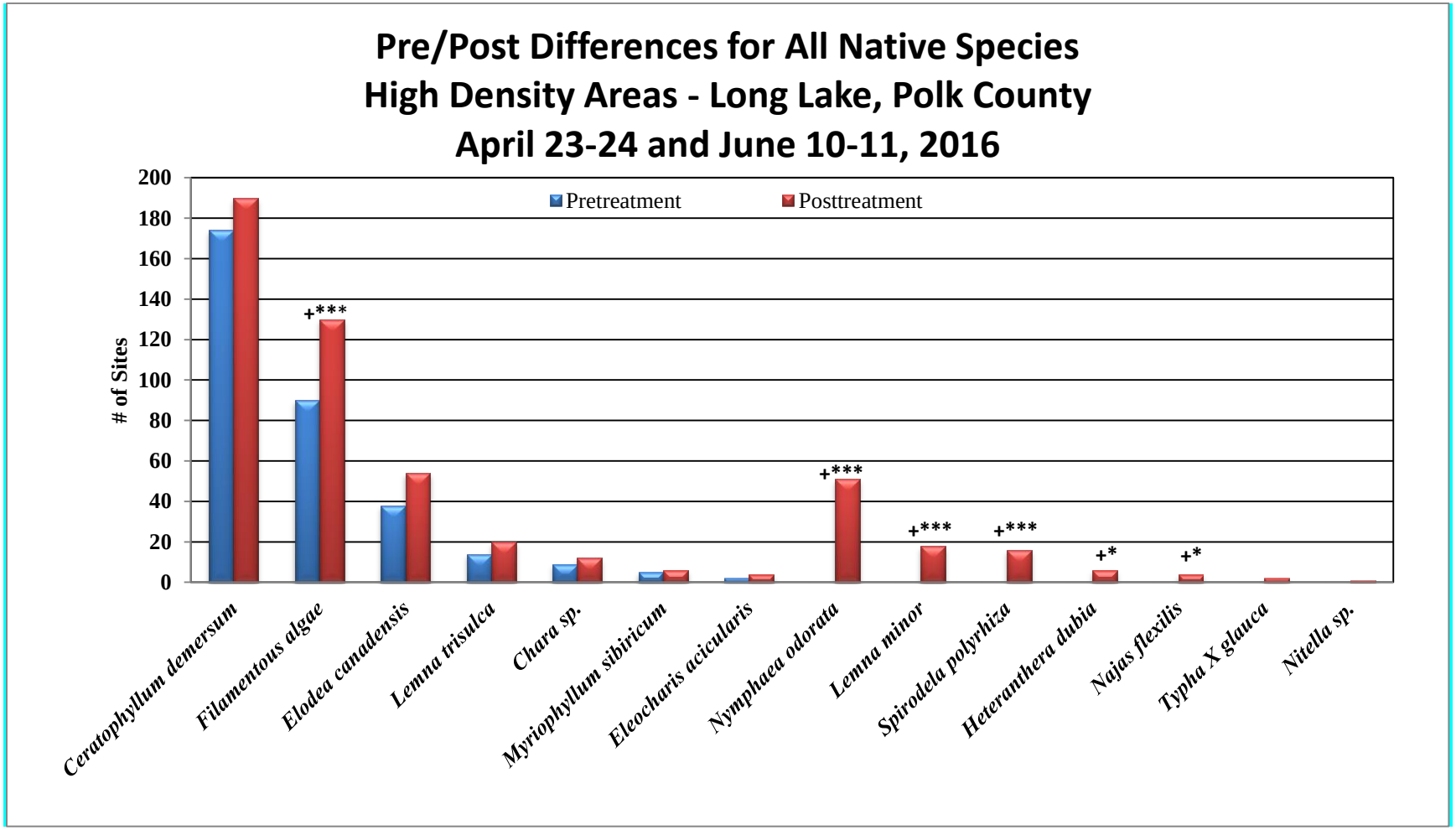
Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
	Filamentous algae	78	*	83.87	39.39	1.14
Ceratophyllum demersum	Coontail	32	27.59	34.41	16.16	1.16
Chara sp.	Muskgrass	22	18.97	23.66	11.11	1.09
Najas flexilis	Slender naiad	20	17.24	21.51	10.10	1.00
Heteranthera dubia	Water star-grass	17	14.66	18.28	8.59	1.06
Lemna trisulca	Forked duckweed	6	5.17	6.45	3.03	1.00
Eleocharis acicularis	Needle spikerush	5	4.31	5.38	2.53	1.20
Nitella sp.	Nitella	5	4.31	5.38	2.53	1.00
Elodea canadensis	Common waterweed	4	3.45	4.30	2.02	1.00
Myriophyllum sibiricum	Northern water-milfoil	3	2.59	3.23	1.52	1.00
Potamogeton crispus	Curly-leaf pondweed	2	1.72	2.15	1.01	1.00

* Excluded from relative frequency analysis



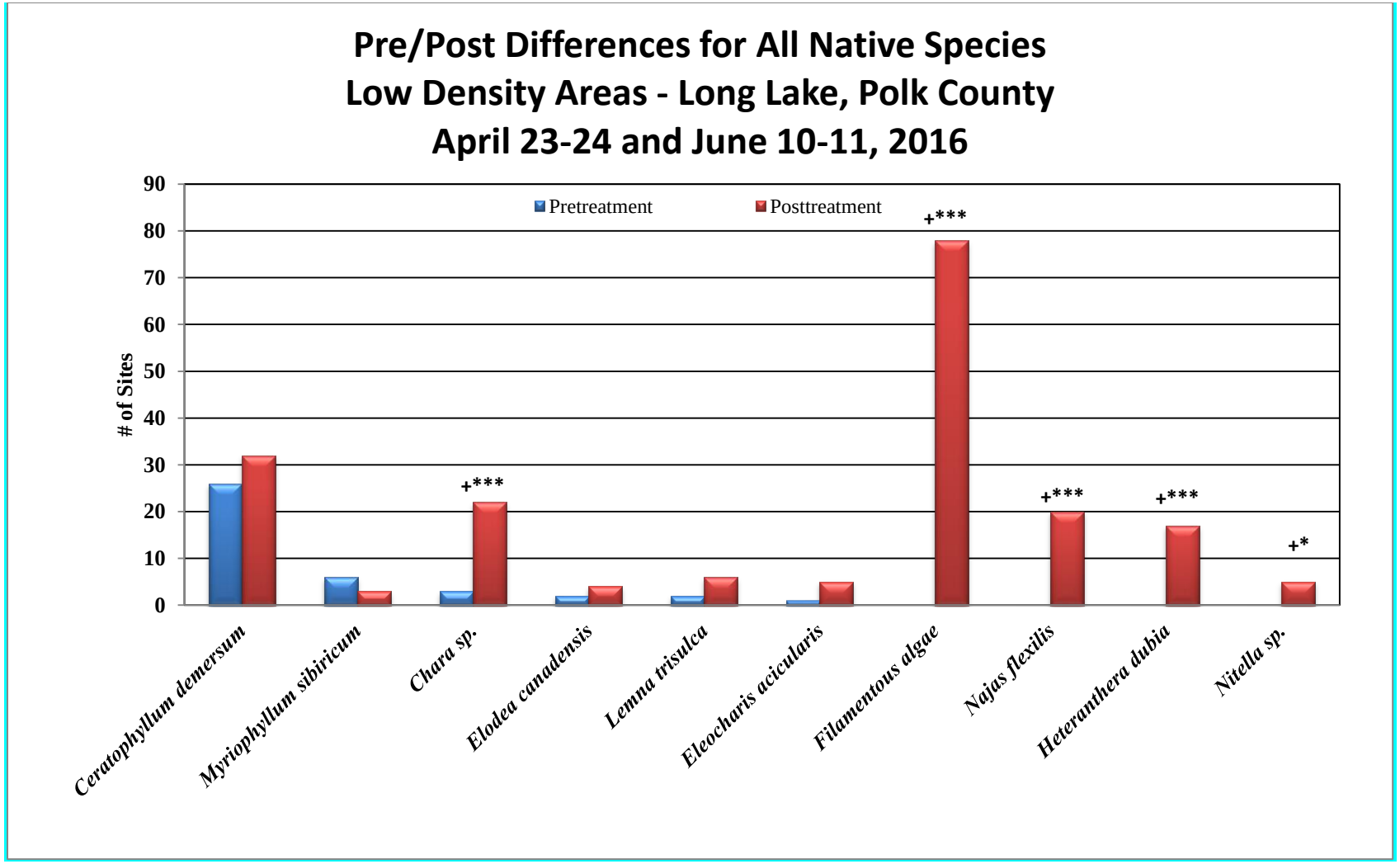
Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 16: Whole Lake Pre/Post Native Species Changes



Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 17: High Density Areas - Pre/Post Native Species Changes



Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

Figure 18: Low Density Areas - Pre/Post Native Species Changes

June CLP Bed Mapping Survey:

Following a spring with out treatment, in 2015 we located and mapped 13 CLP beds totaling 43.21 acres **(15.9% of the lake's 272 acres)** (Figure 19) (Appendix VIII). The biggest was 15.79 acres (Bed 1 in the west bay) and the smallest was just 0.09 acre (Bed 8 on the north shoreline midlake) (Table 7). This was a significant increase as we hadn't found any canopied posttreatment acres in 2013 or 2014, it was still significantly below the original 85.51 acres **(-49.5% reduction)** mapped by Barr Engineering in 2009 prior to the beginning of the expanded treatment program.

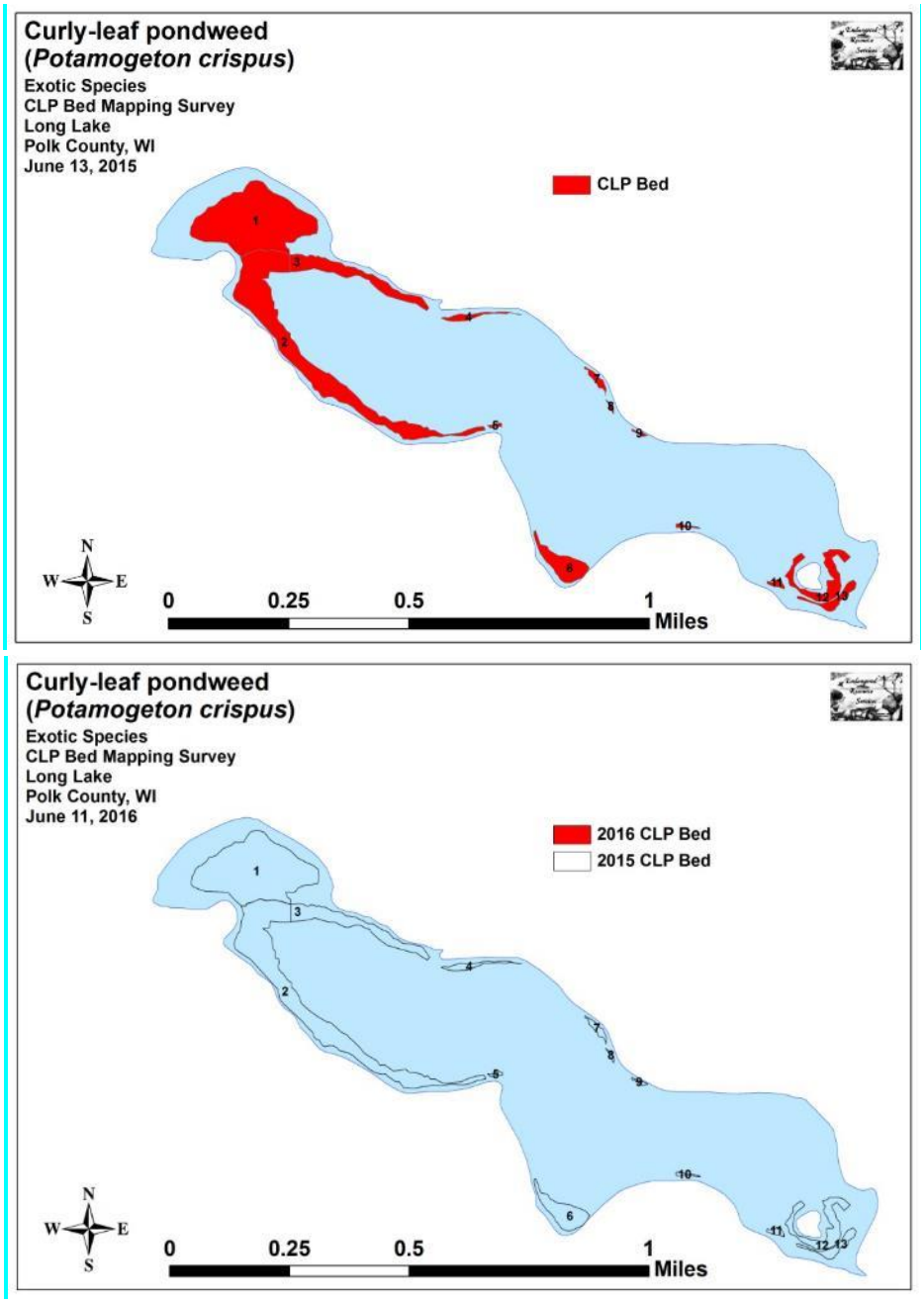


Figure 19: 2015 and 2016 Long Lake June CLP Bed Maps

Table 7: CLP Bed Summary
Long Lake, Polk Co. - June 13, 2015 and June 11, 2016

Bed Number	2016 Acreage	2015 Acreage	2016 Acreage Change	2015 Rake Range	2015 Mean Rake Fullness	2015 Max Depth of CLP	2015 Canopied	2015 Potential Navigation Impairment Level
1	0.00	15.79	-15.79	<1-3	2	5	Yes	Severe
2	0.00	15.13	-15.13	<1-3	2	11	Near	Minor
3	0.00	4.15	-4.15	<1-2	<1	11	Near	None
4	0.00	0.63	-0.63	<<<1-1	<<1	10	Near	None
5	0.00	0.10	-0.10	<<<1-1	<<1	7	Near	None
6	0.00	2.63	-2.63	<1-3	2	11	Near	Moderate
7	0.00	0.41	-0.41	<<1-2	<1	8	Near	None
8	0.00	0.09	-0.09	<<1-2	<1	8	Near	None
9	0.00	0.10	-0.10	<<1-2	<1	8	Near	None
10	0.00	0.14	-0.14	<<<1-2	<<1	8	Near	None
11	0.00	0.24	-0.24	<1-3	2	8	Yes	Minor
12	0.00	2.79	-2.79	<1-3	2	7	Yes	Minor
13	0.00	1.01	-1.01	<1-3	2	4	Yes	Minor
Total Acres	**0.00**	**43.21**	**-43.21**					

LITERATURE CITED

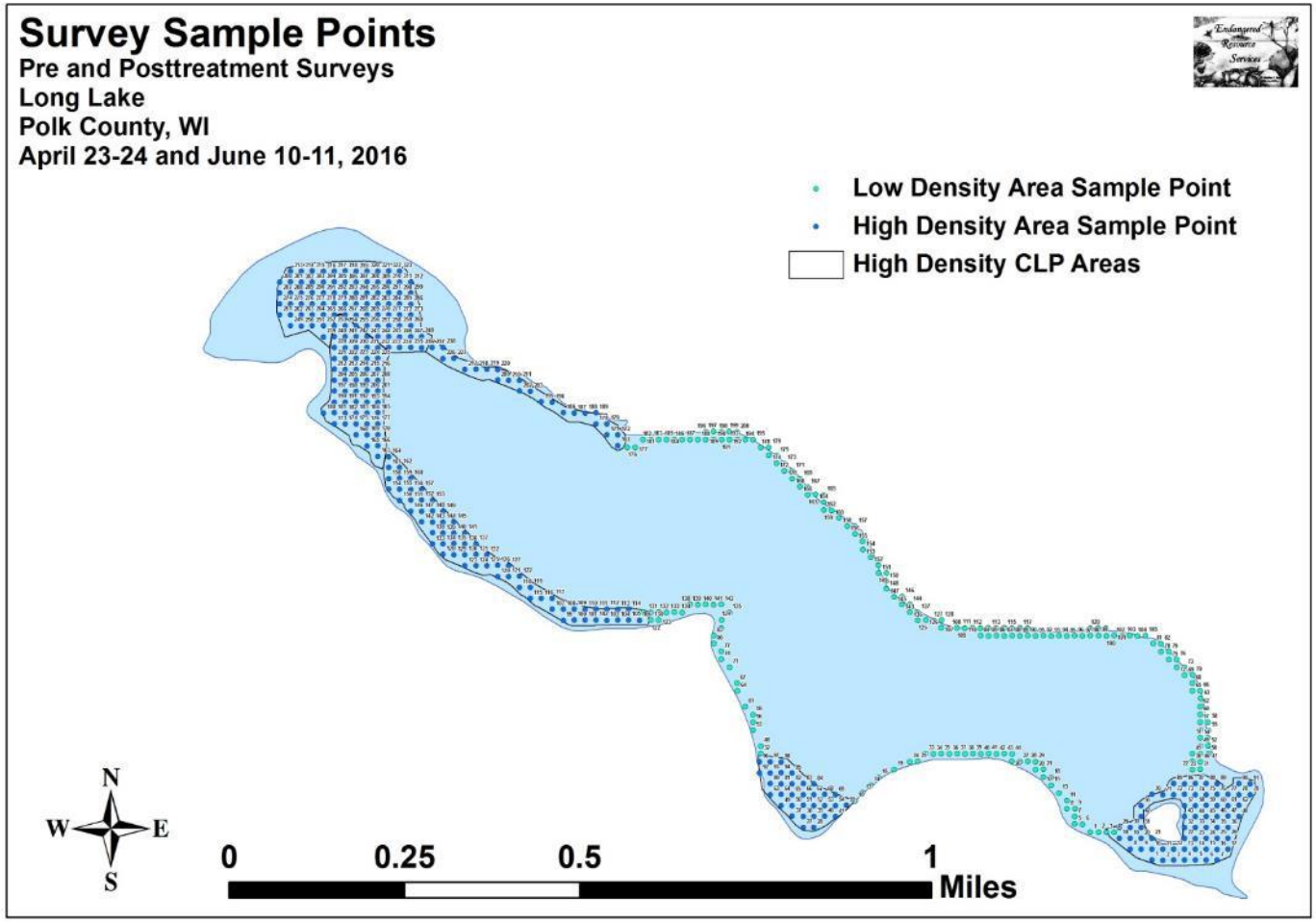
Busch, C., G. Lund, L. Sather, and C. Holt. 1969. Long Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2478200a.pdf (2016, December).

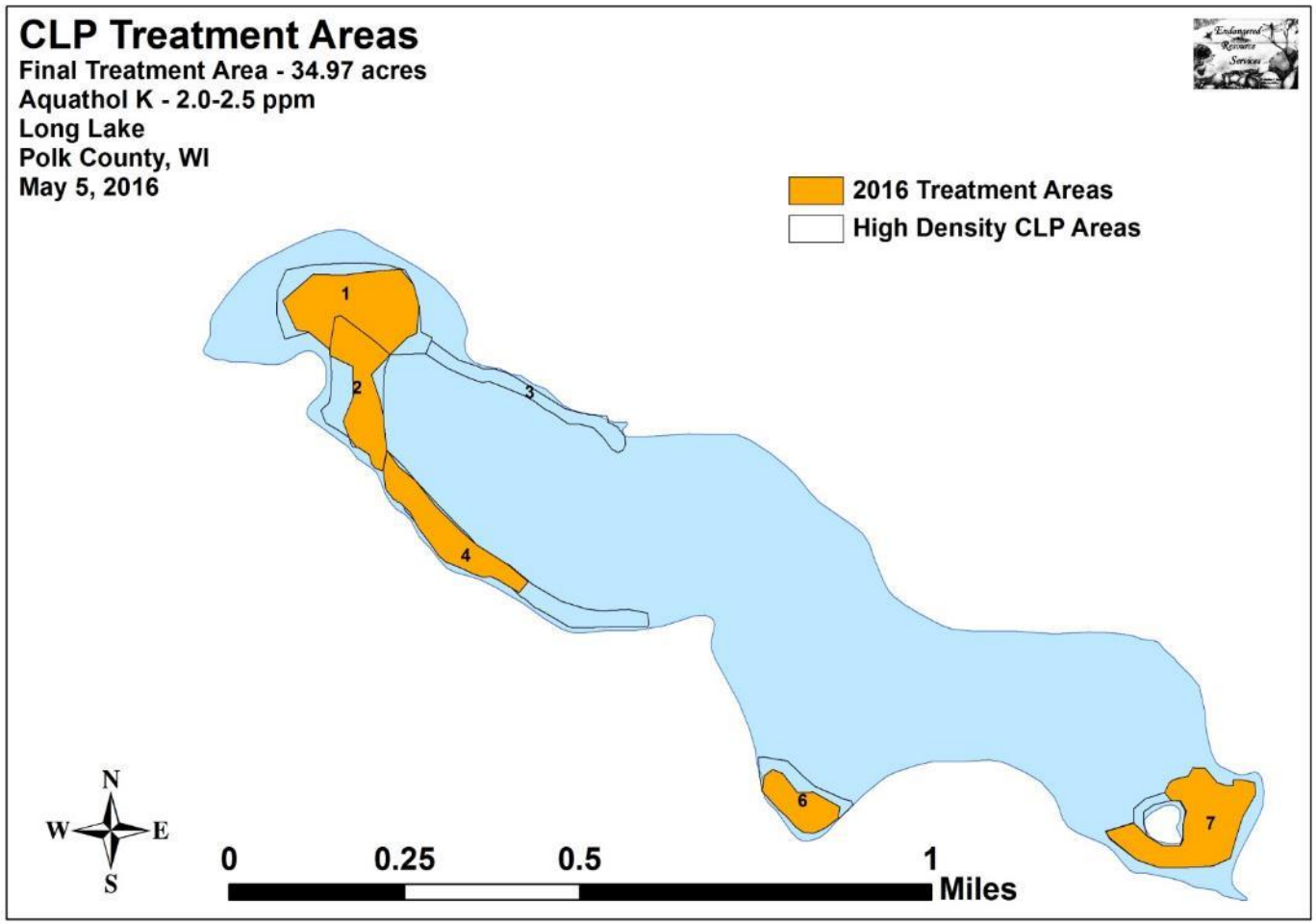
UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2016, November).

UWEX Lakes Program. [online]. 2010. Pre/Post Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2016, November).

WDNR. [online]. 2016. Citizen Lake Monitoring Water Quality Data Report for Long Lake. http://dnr.wi.gov/lakes/waterquality/Station.aspx?id=493102 (2016, December)

Appendix I: CLP Pre/Post Survey Sample Points and Proposed/Final Treatment Areas

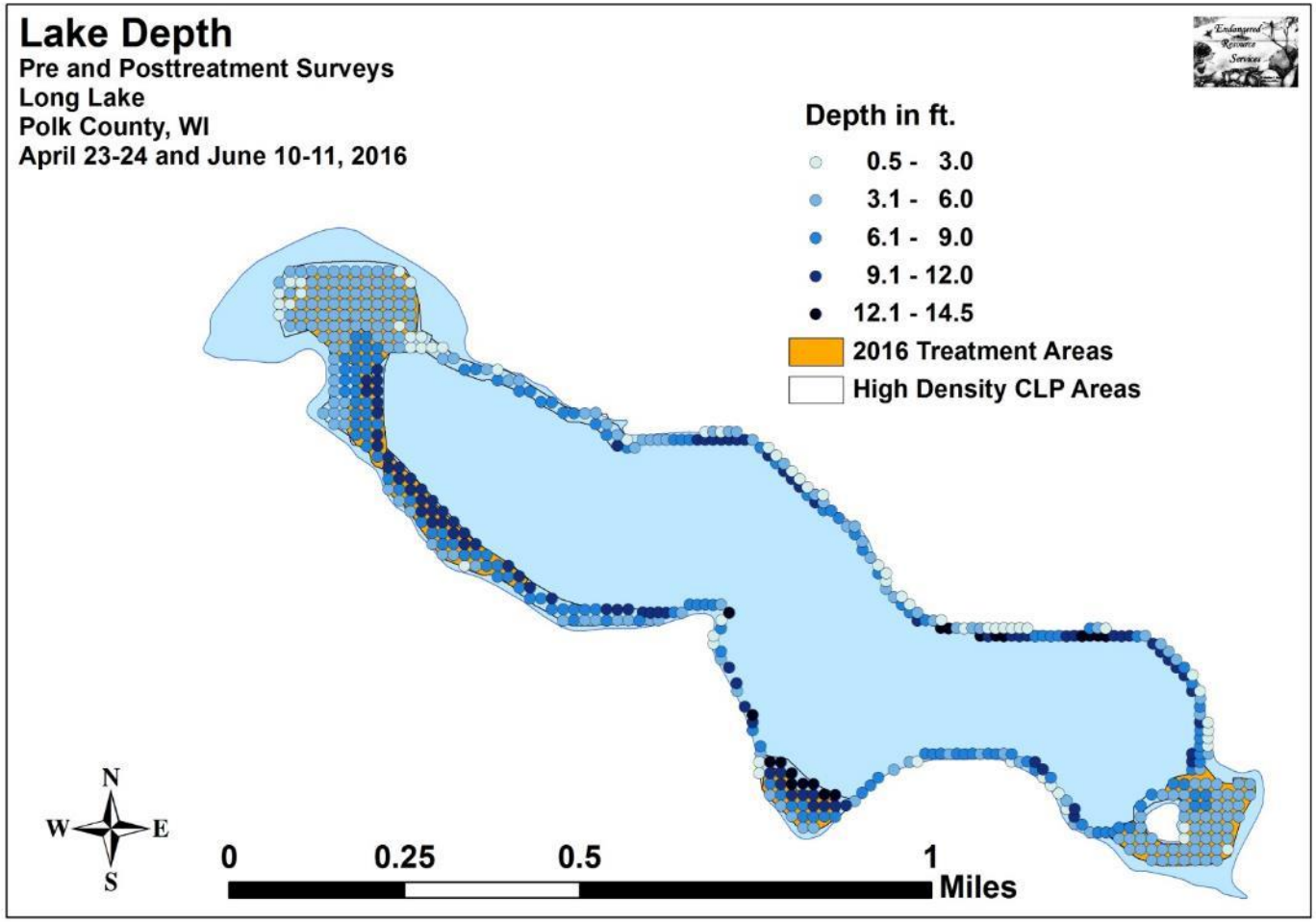

Survey Sample Points
Pre and Posttreatment Surveys
Long Lake
Polk County, WI
April 23-24 and June 10-11, 2016
Low Density Area Sample Point
High Density Area Sample Point
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

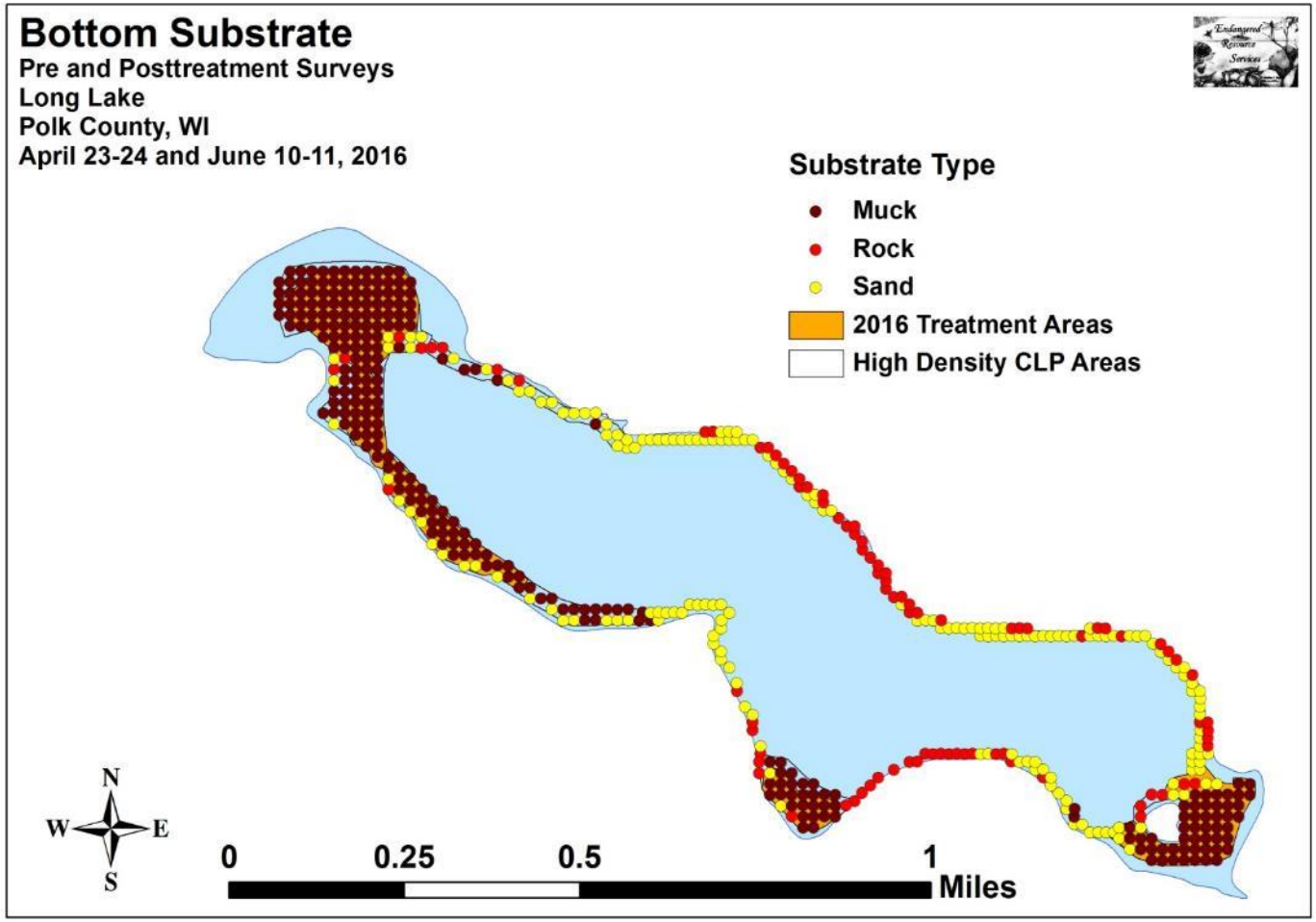

CLP Treatment Areas
Final Treatment Area - 34.97 acres
Aquathol K - 2.0-2.5 ppm
Long Lake
Polk County, WI
May 5, 2016
2016 Treatment Areas
High Density CLP Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles

Appendix II: Vegetative Survey Data Sheet

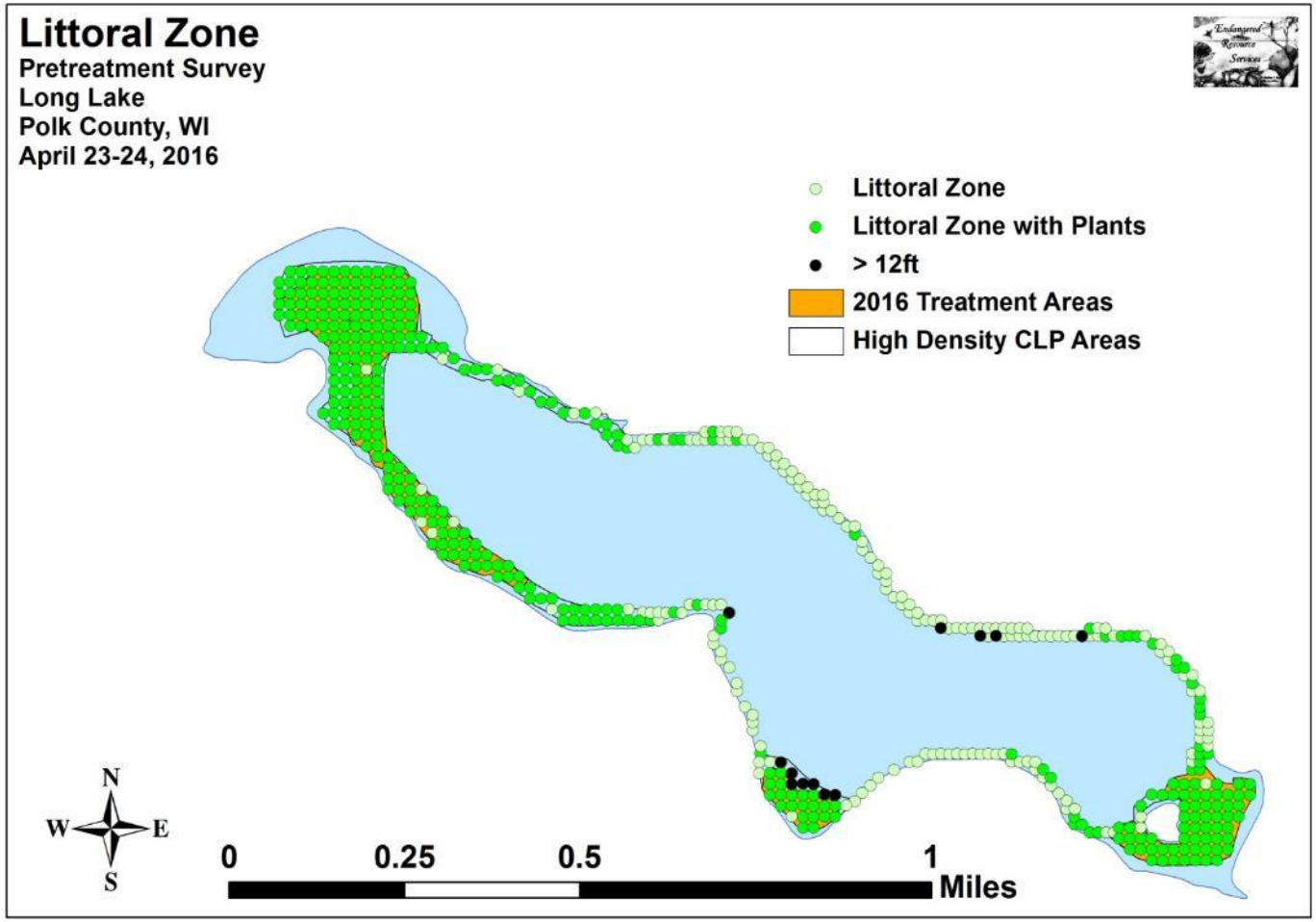
Observers for this lake: names and hours worked by each:																										
Lake:									WBIC									County						Date:	
Site #	Depth (ft)	Muck (M), Sand (S), Rock (R)	Rake pole (P) or rake rope (R)	Total Rake Fullness	CLP	CLP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																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

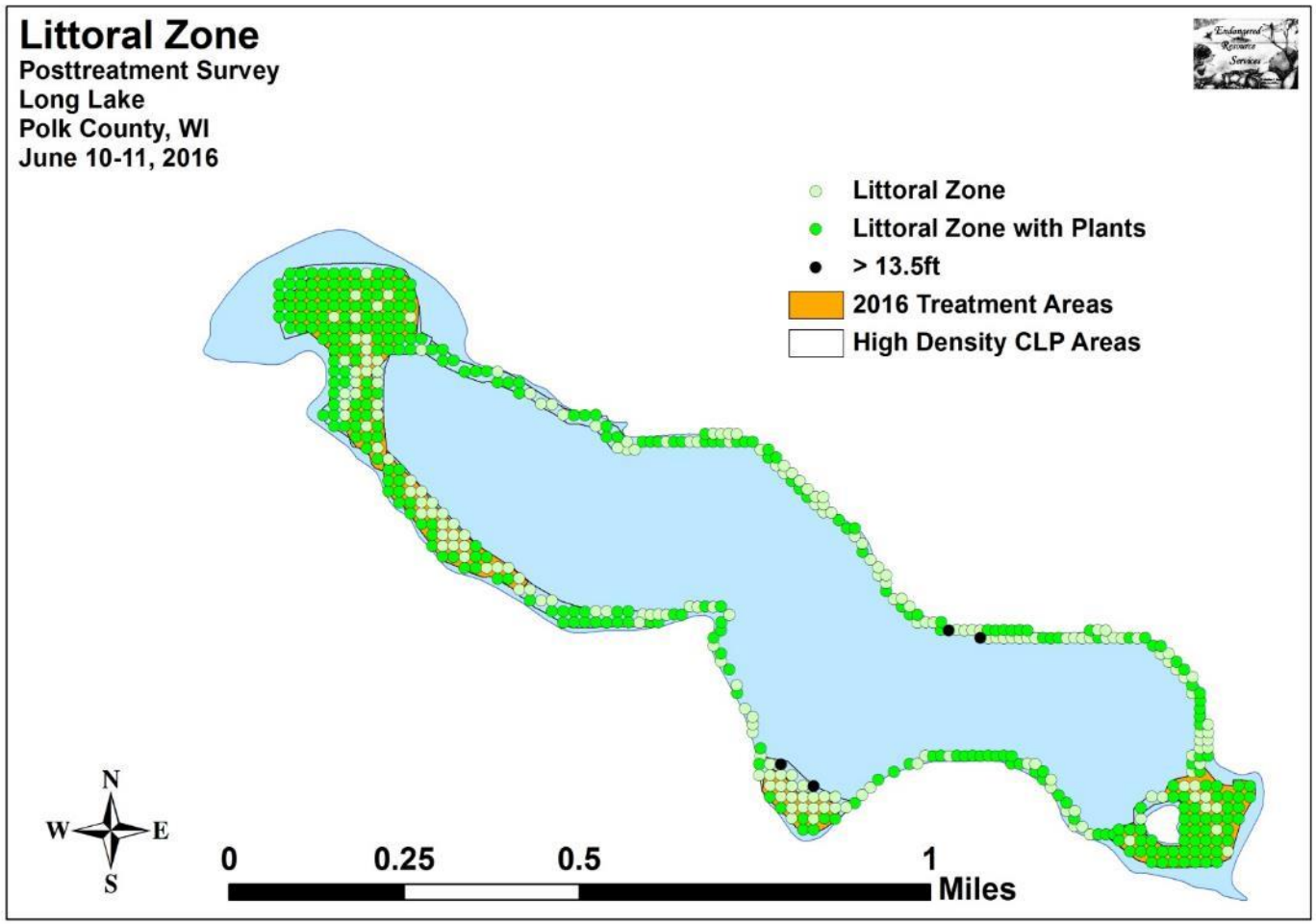
Appendix III: Pre/Post Habitat Variables

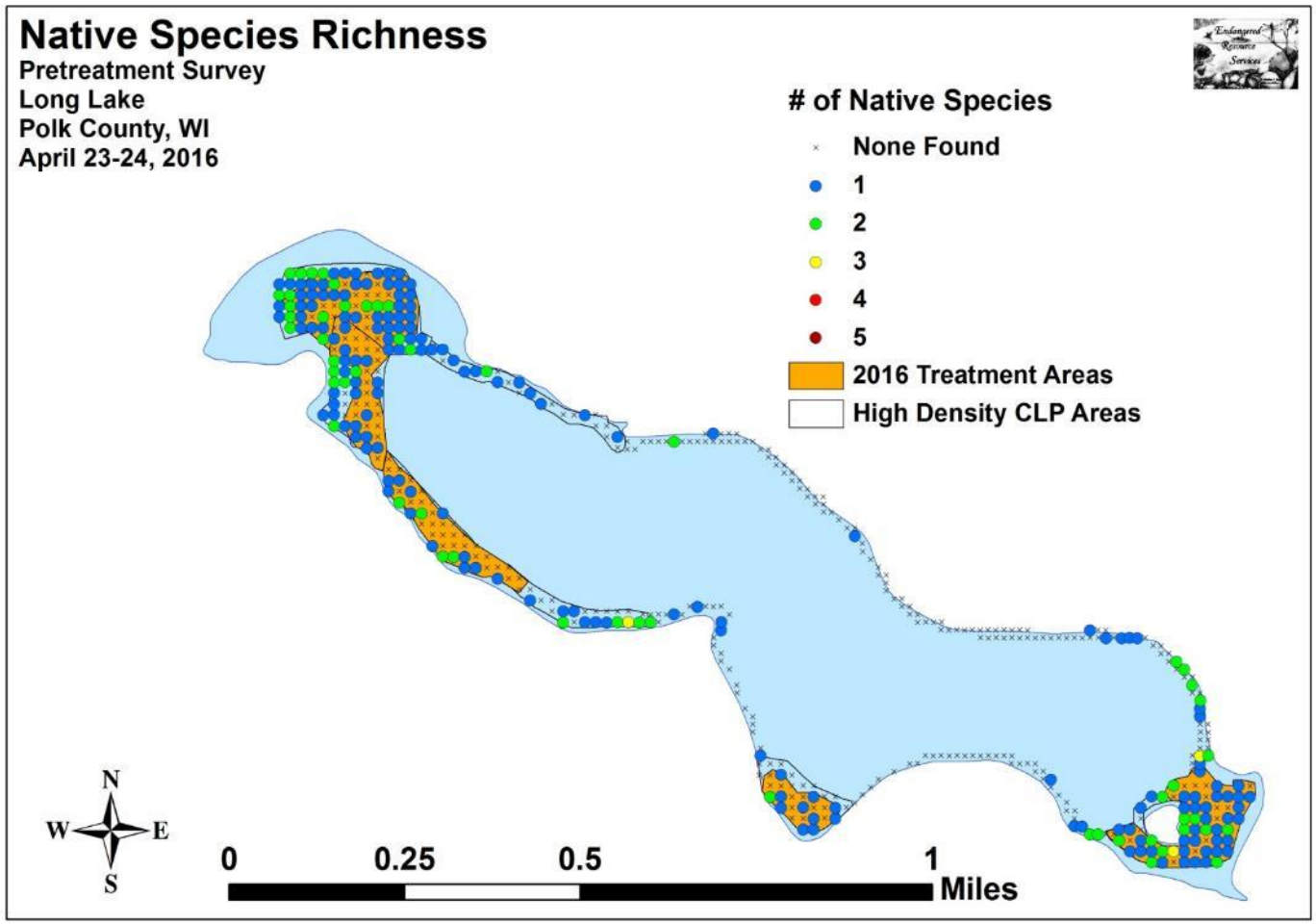

Lake Depth
Pre and Posttreatment Surveys
Long Lake
Polk County, WI
April 23-24 and June 10-11, 2016
Depth in ft.
0.5 - 3.0
3.1 - 6.0
6.1 - 9.0
9.1 - 12.0
12.1 - 14.5
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

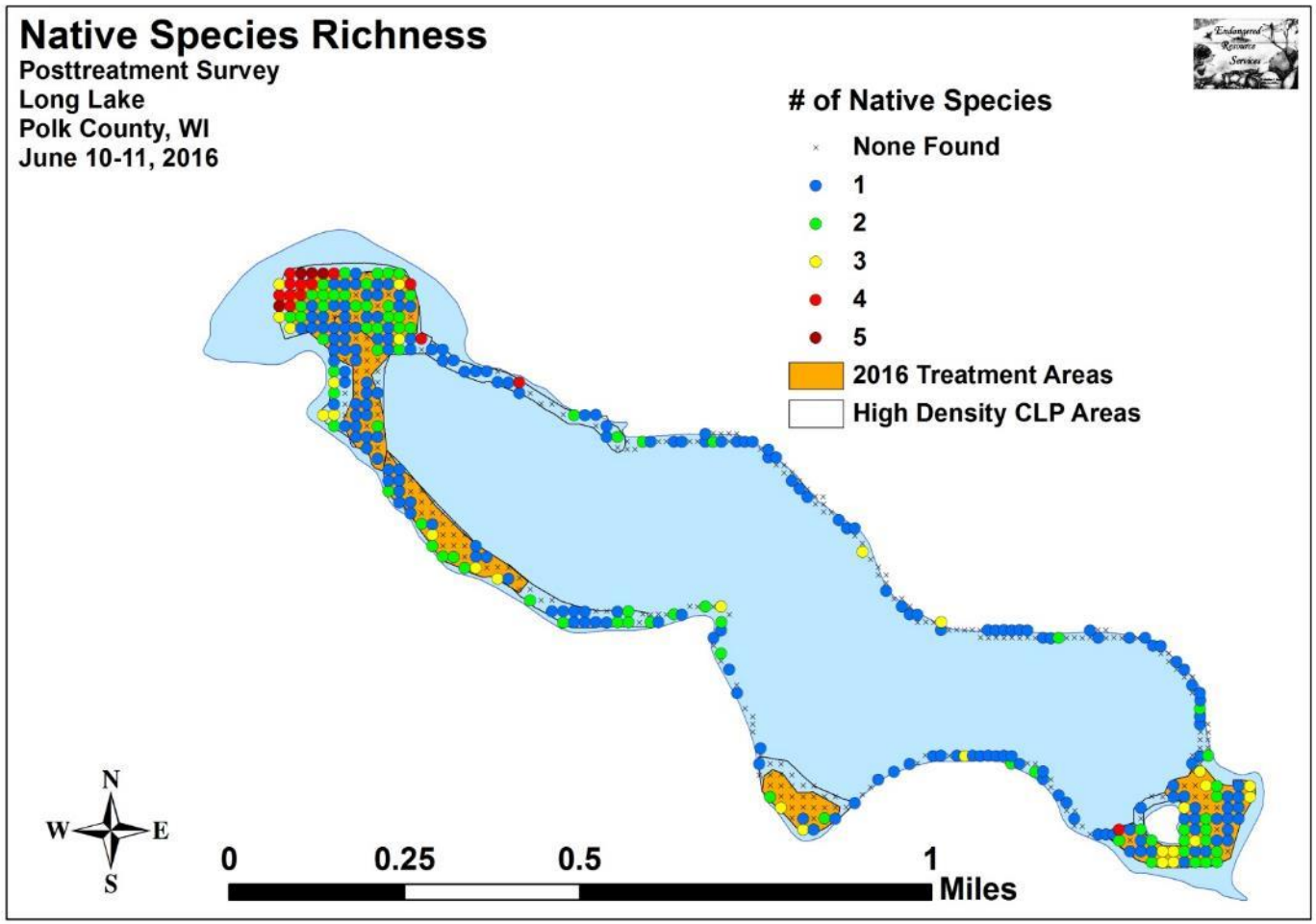

Bottom Substrate
Pre and Posttreatment Surveys
Long Lake
Polk County, WI
April 23-24 and June 10-11, 2016
Substrate Type
Muck
Rock
Sand
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

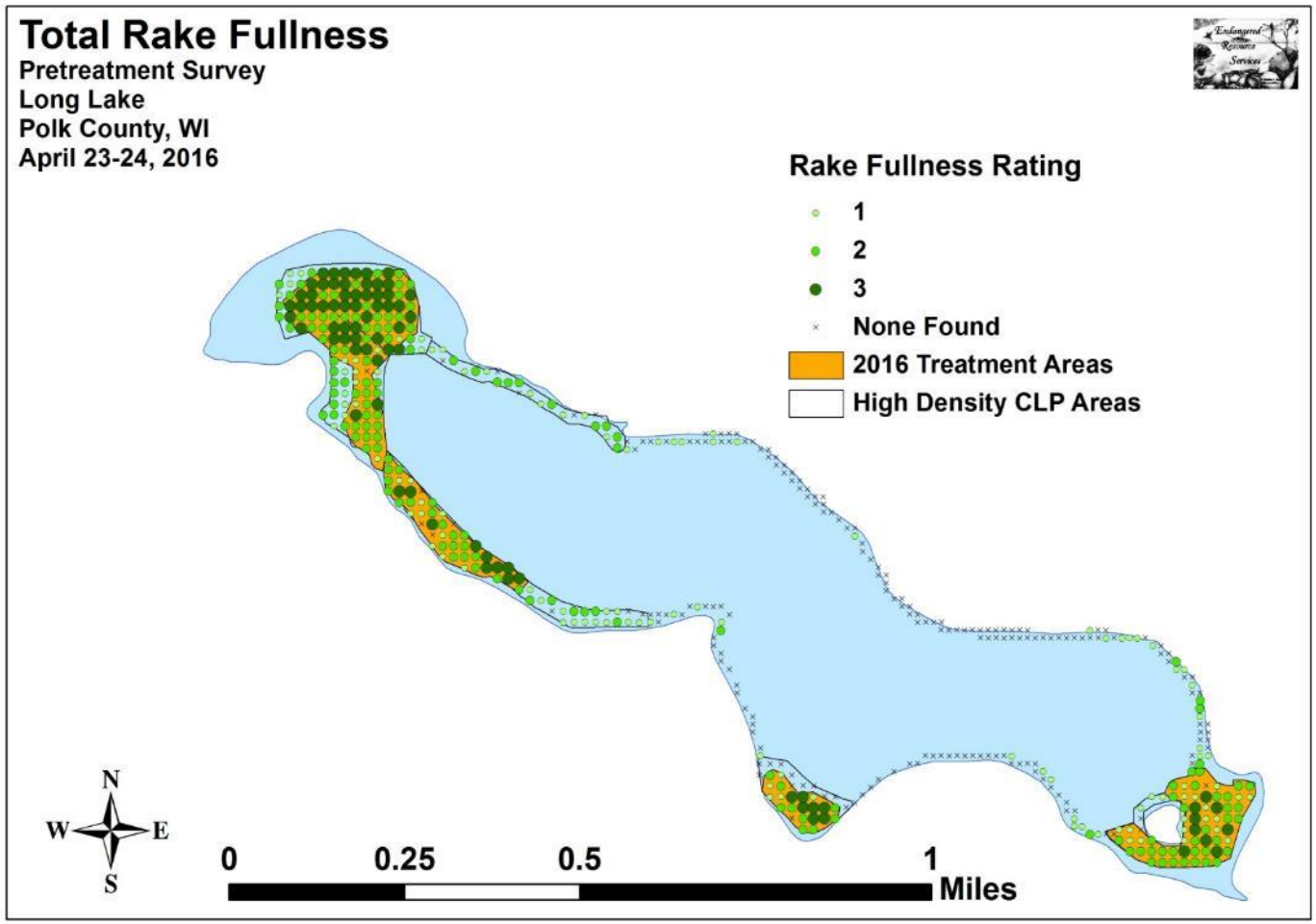
Appendix IV: Pre/Post Littoral Zone, Native Species Richness, and Total Rake Fullness

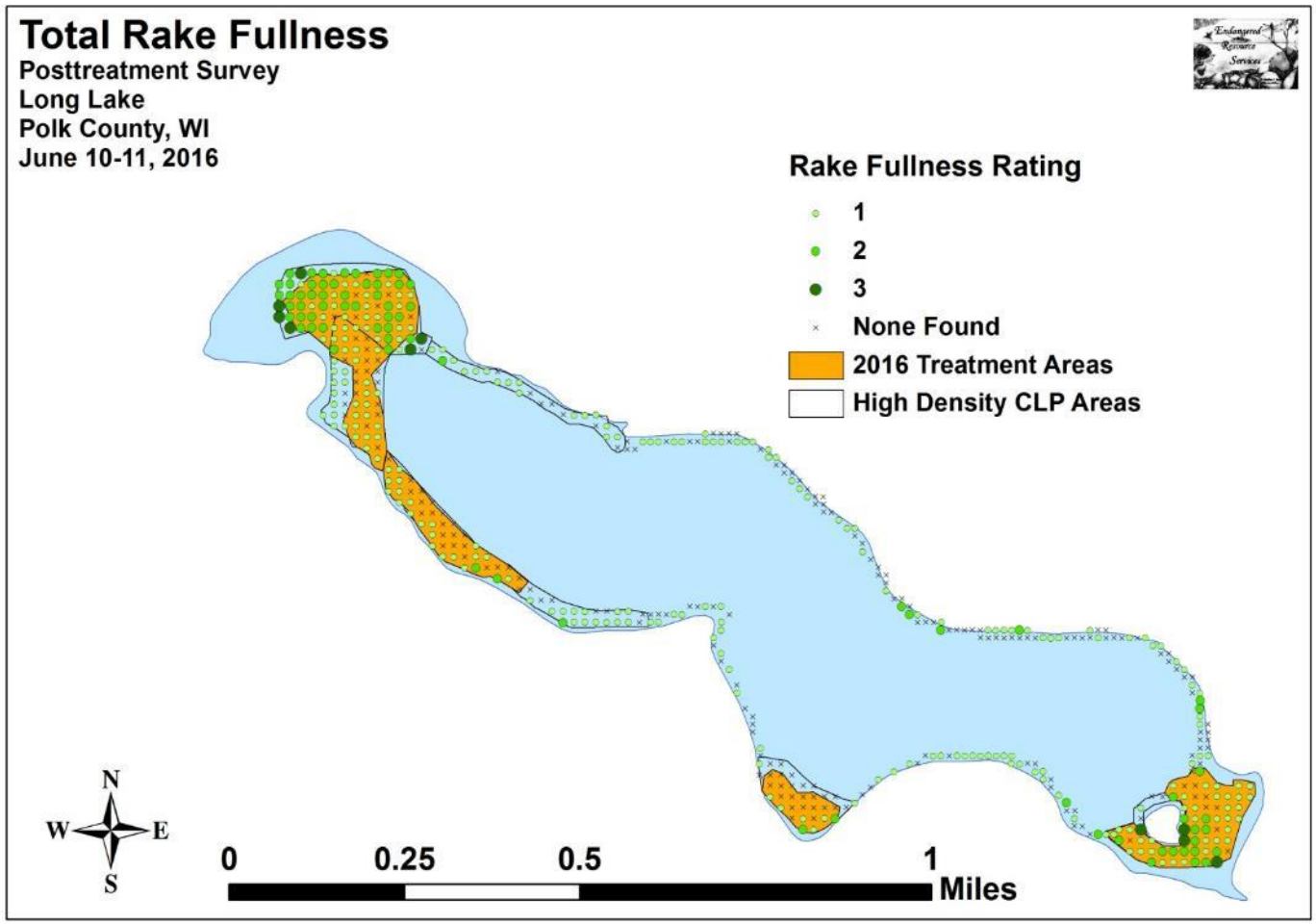

Littoral Zone
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Littoral Zone
Littoral Zone with Plants
> 12ft
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Littoral Zone
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Littoral Zone
Littoral Zone with Plants
> 13.5ft
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

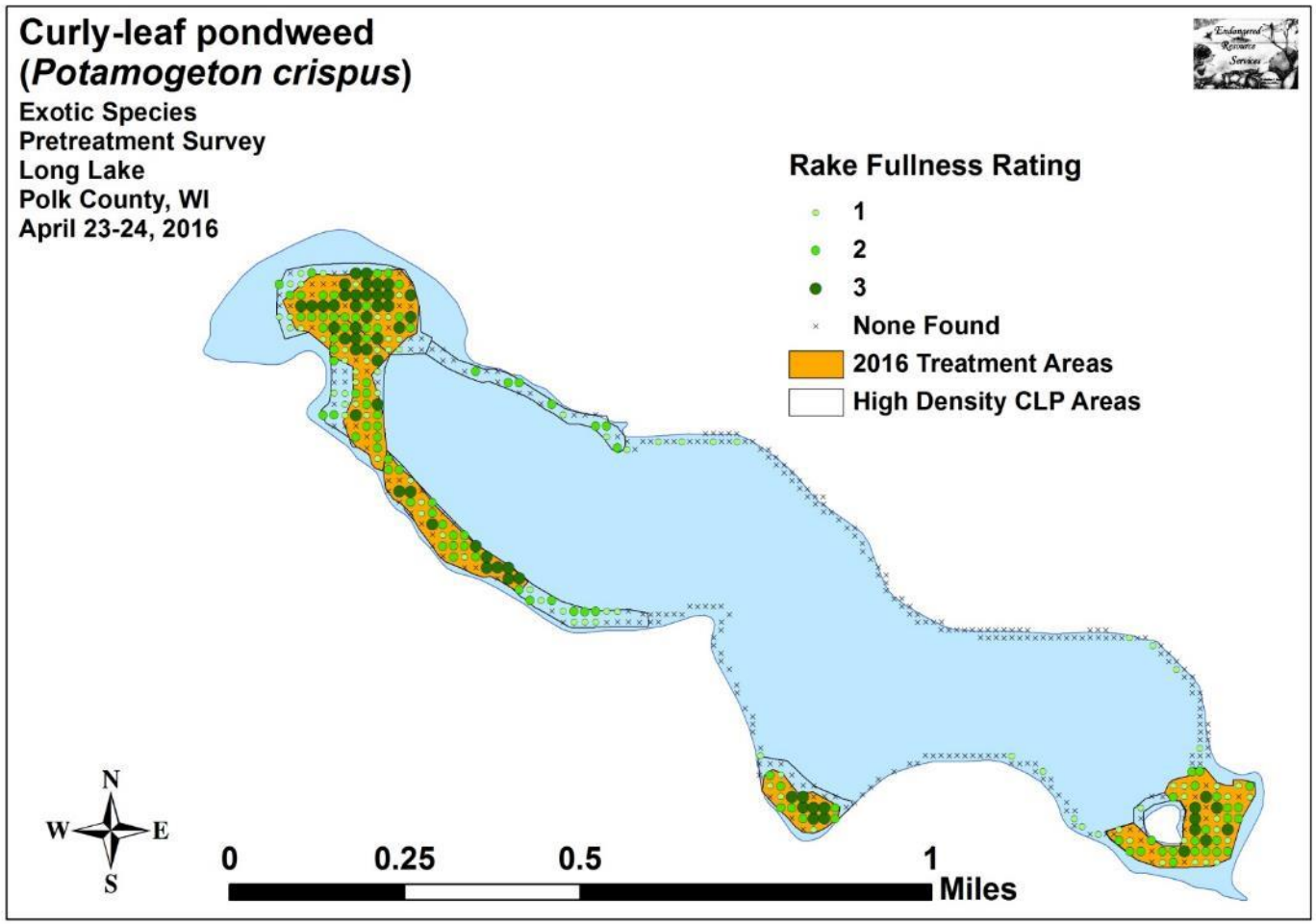

Native Species Richness
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
# of Native Species
None Found
1
2
3
4
5
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

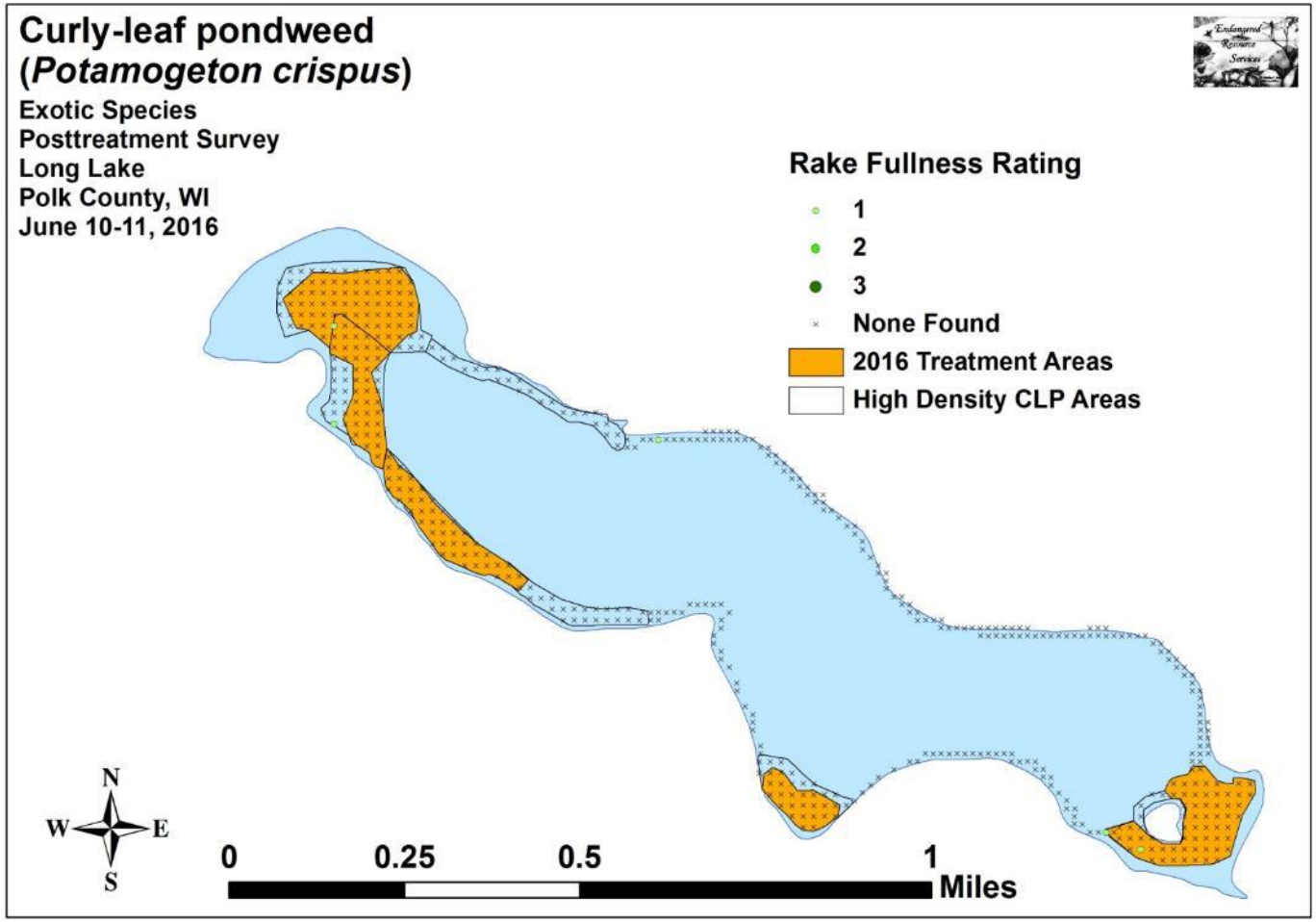

Native Species Richness
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
# of Native Species
None Found
1
2
3
4
5
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Total Rake Fullness
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

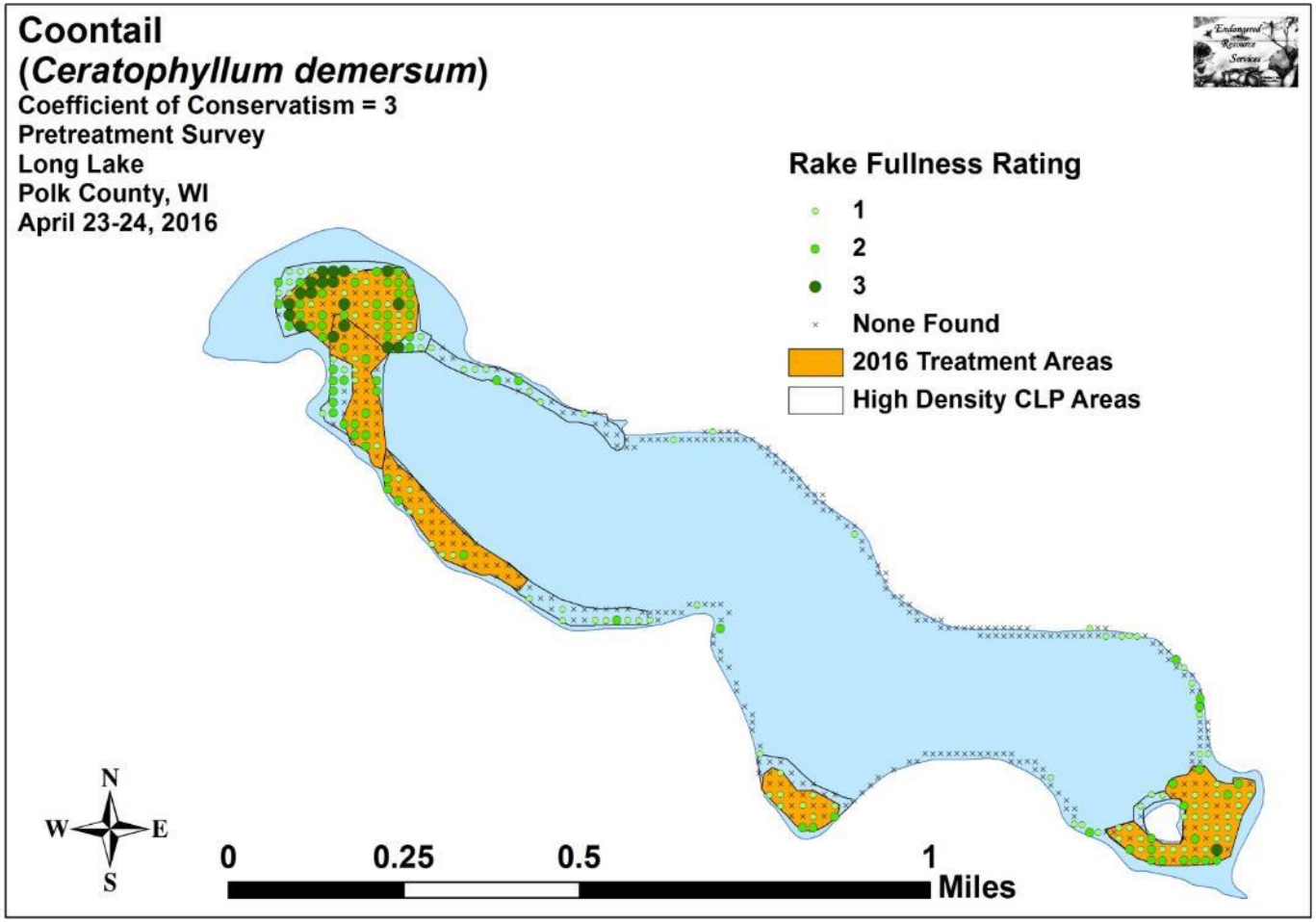

Total Rake Fullness
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

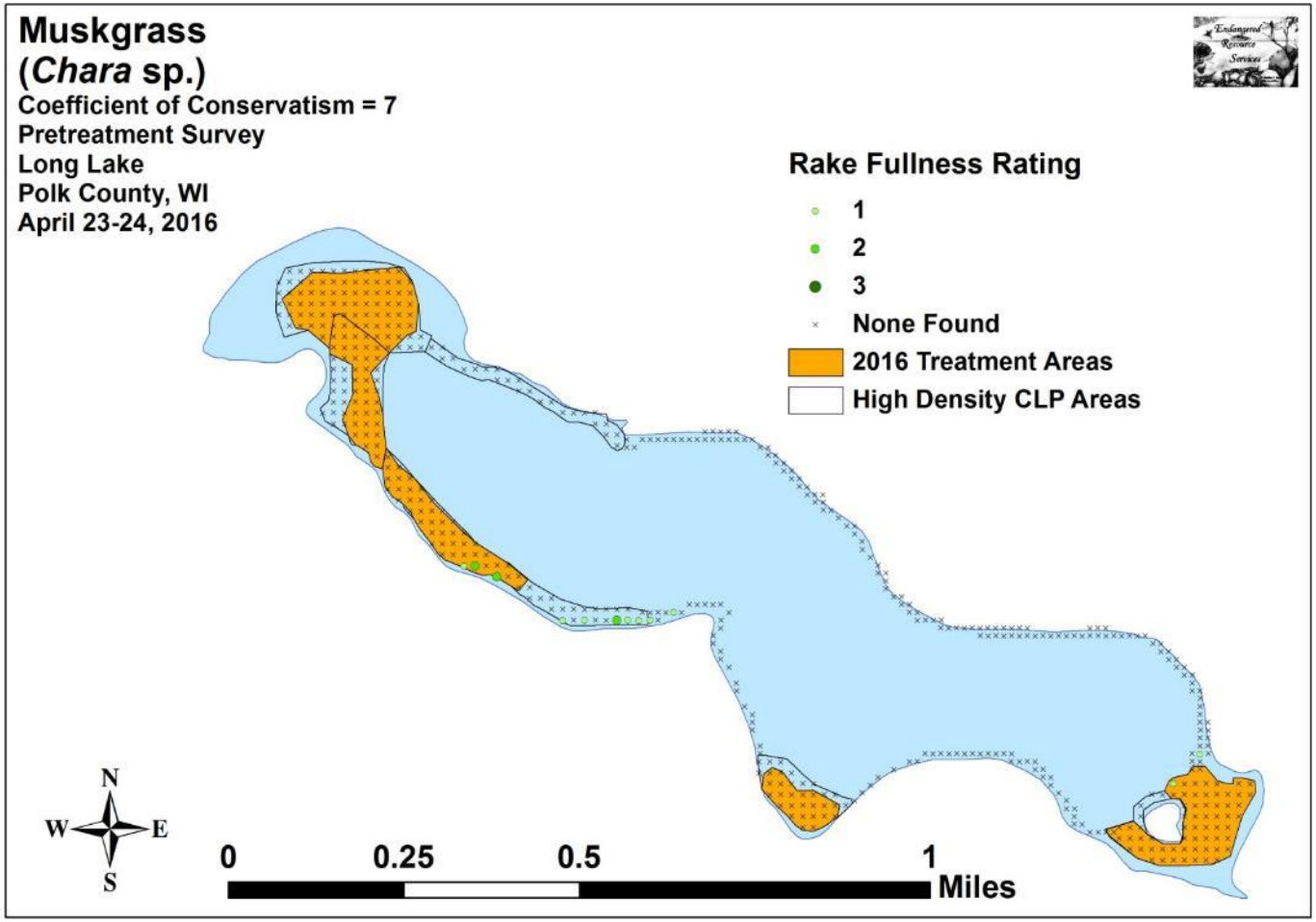
Appendix V: CLP Pre/Posttreatment Distribution

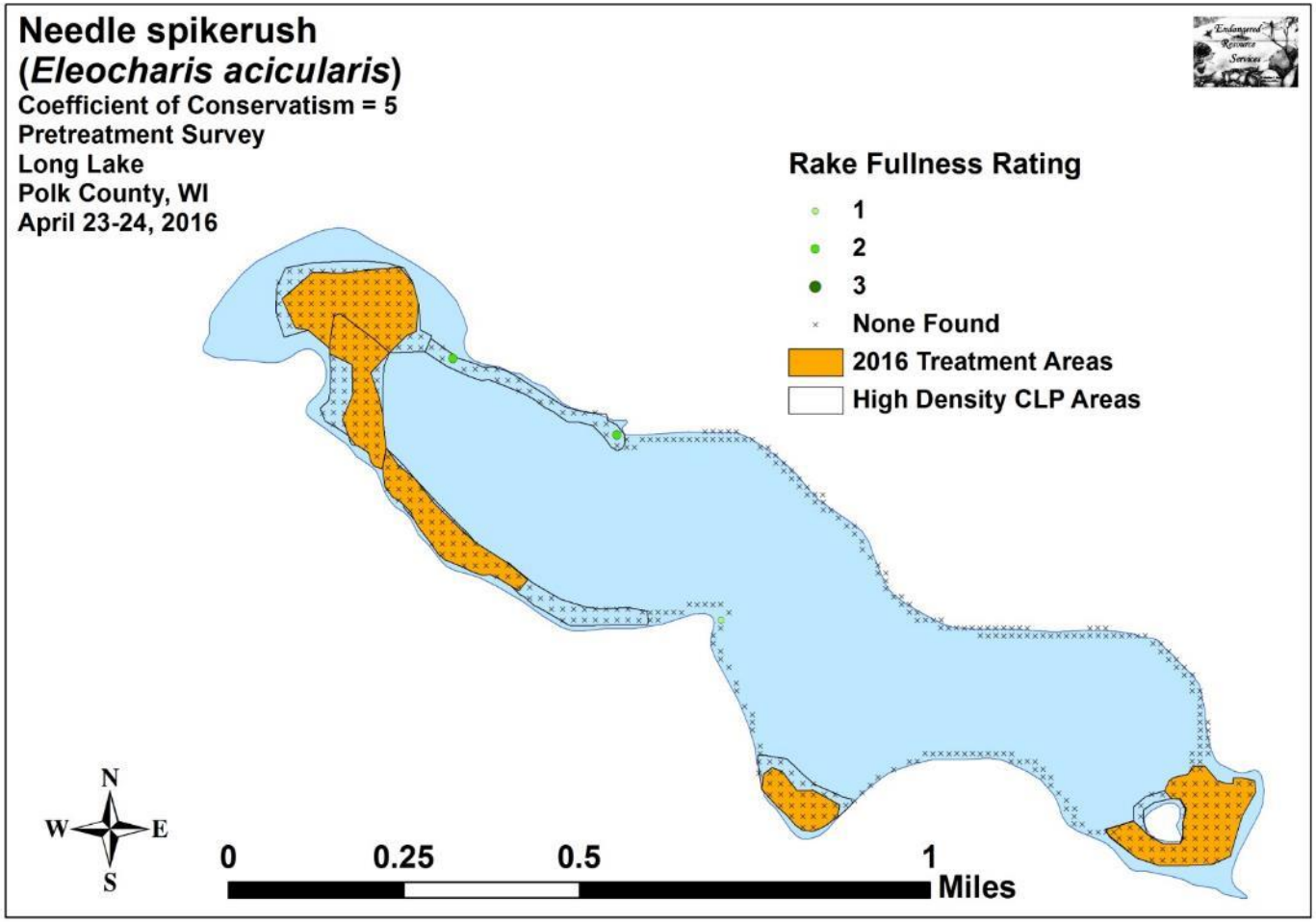

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

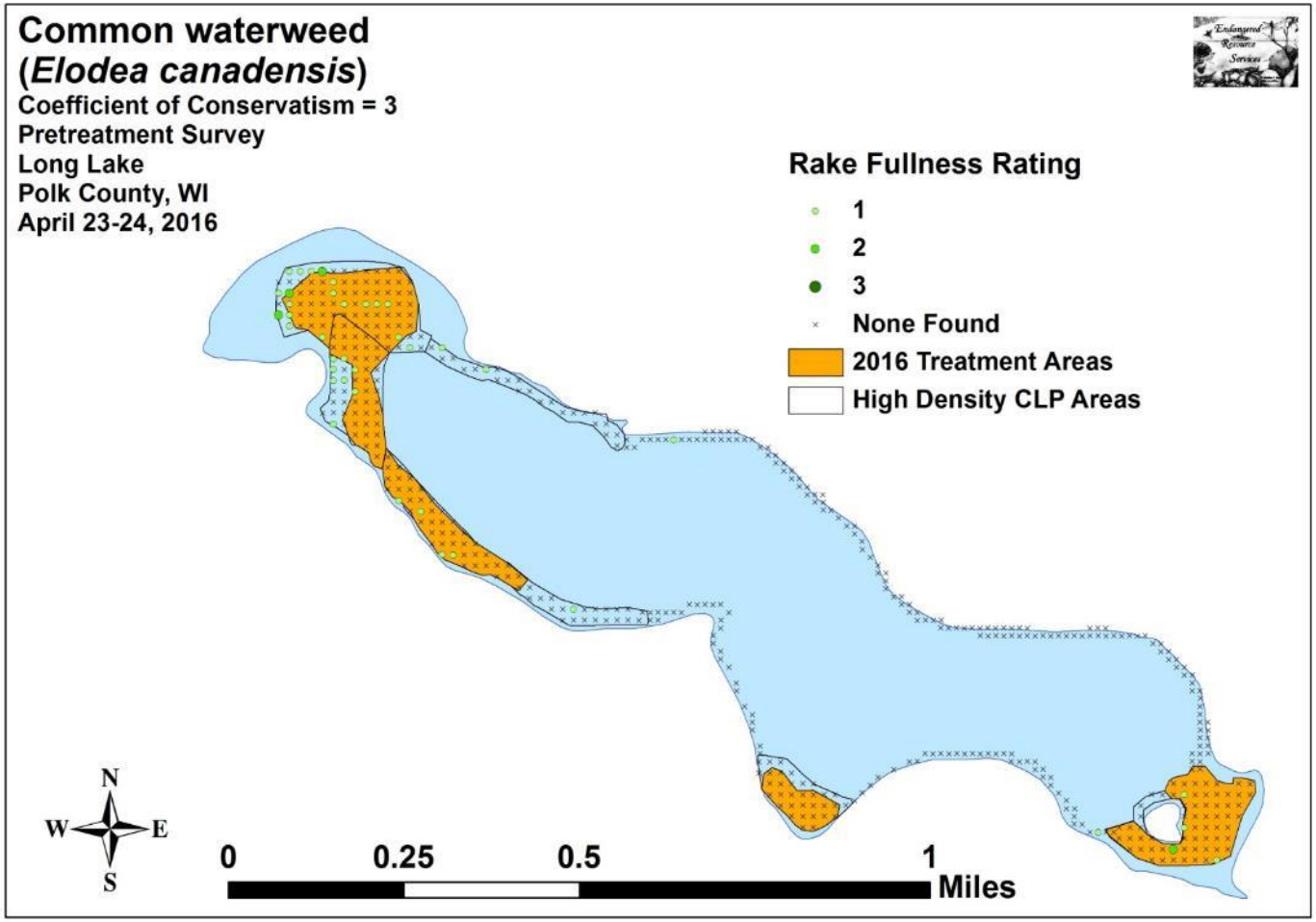

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

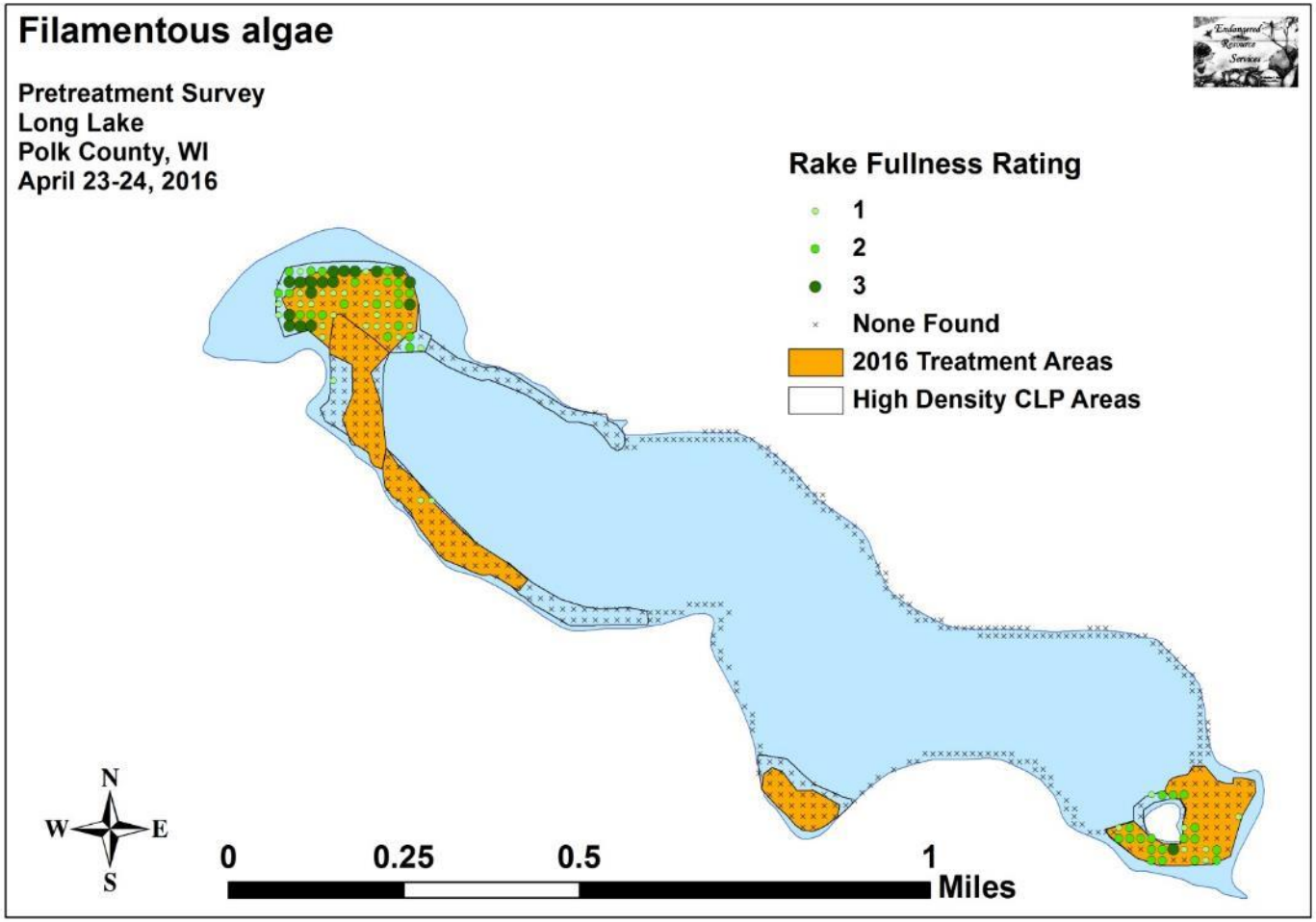
Appendix VI: Pretreatment Native Species Distribution

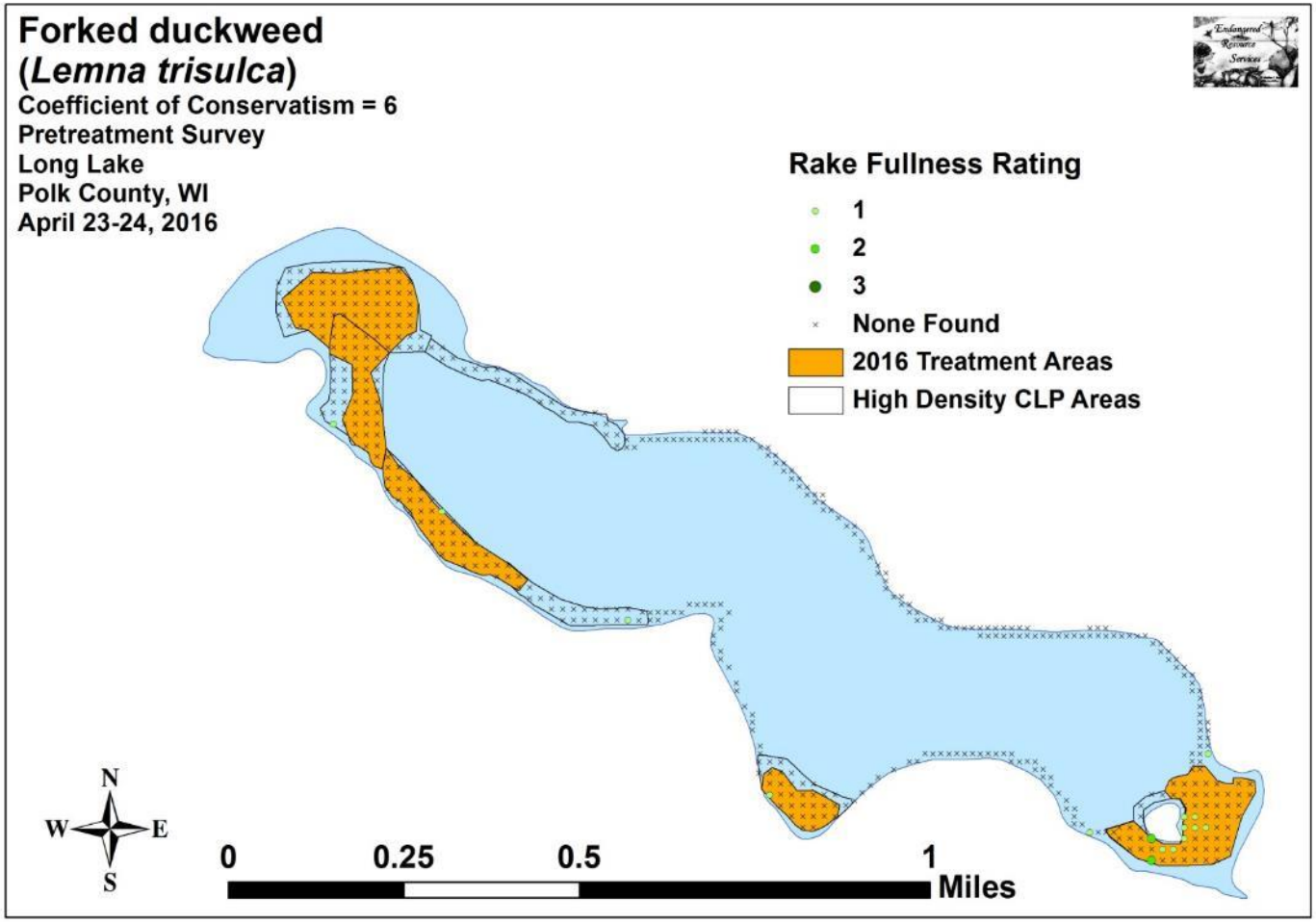

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

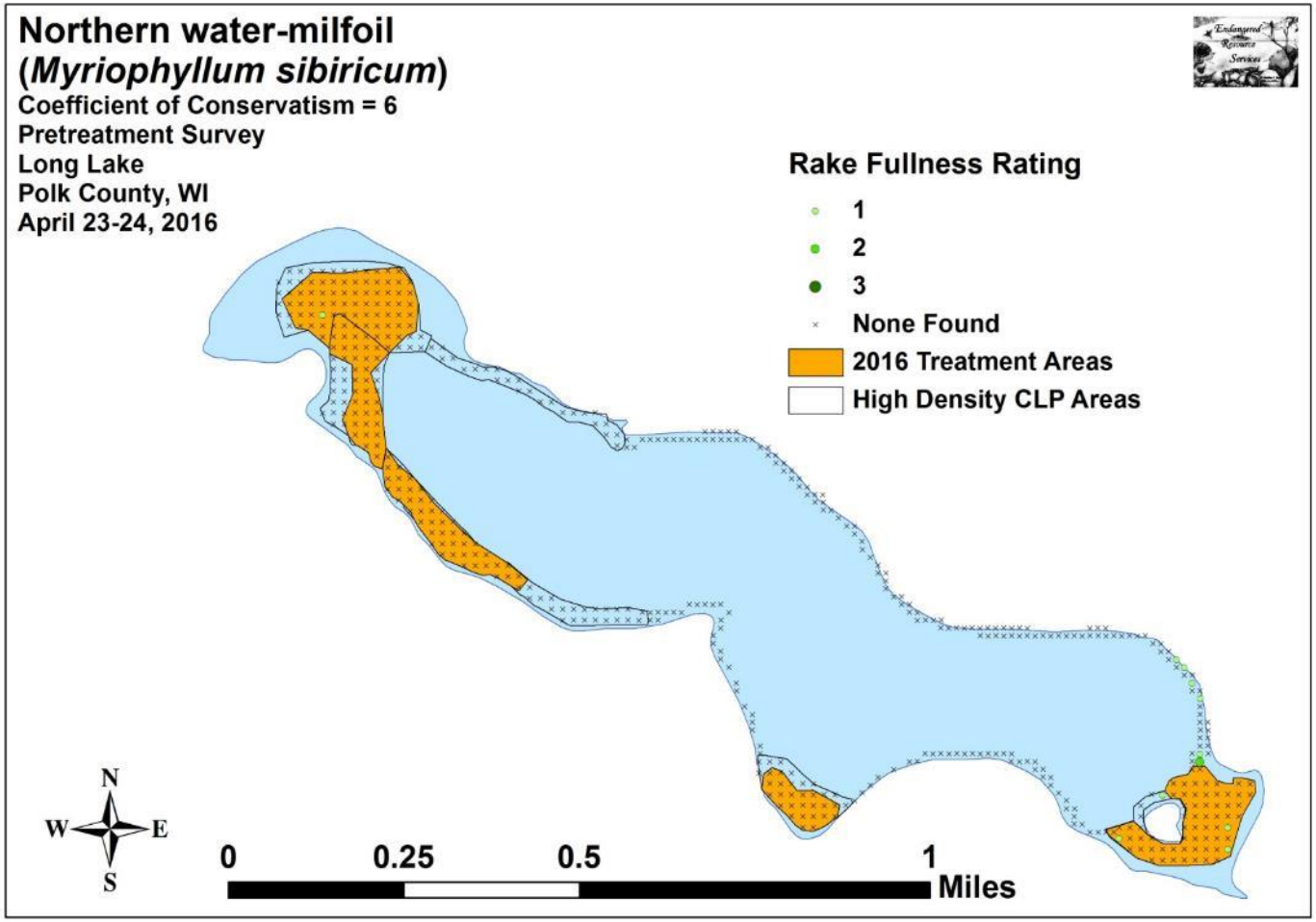

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Needle spikerush
(Eleocharis acicularis)
Coefficient of Conservatism = 5
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

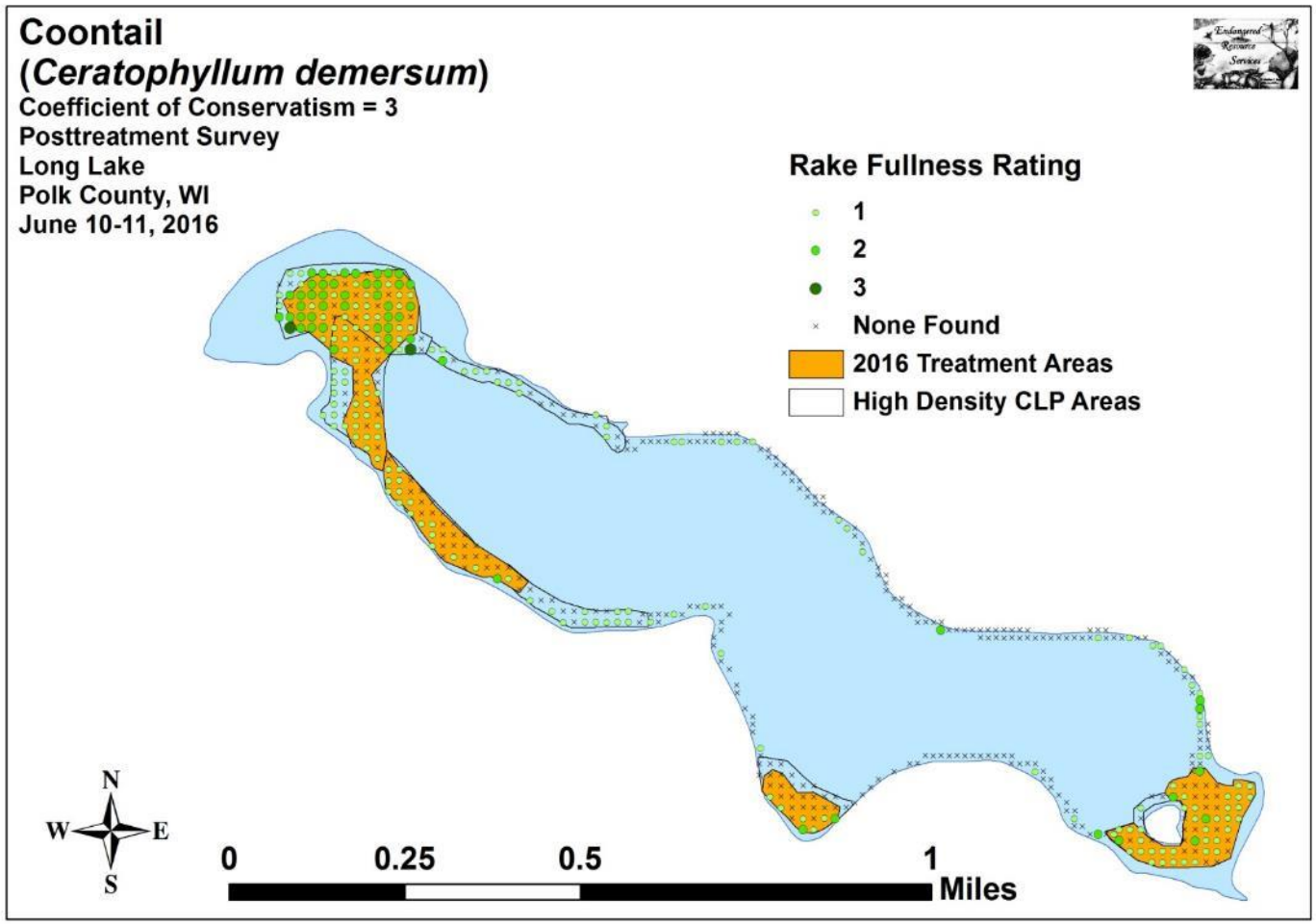

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

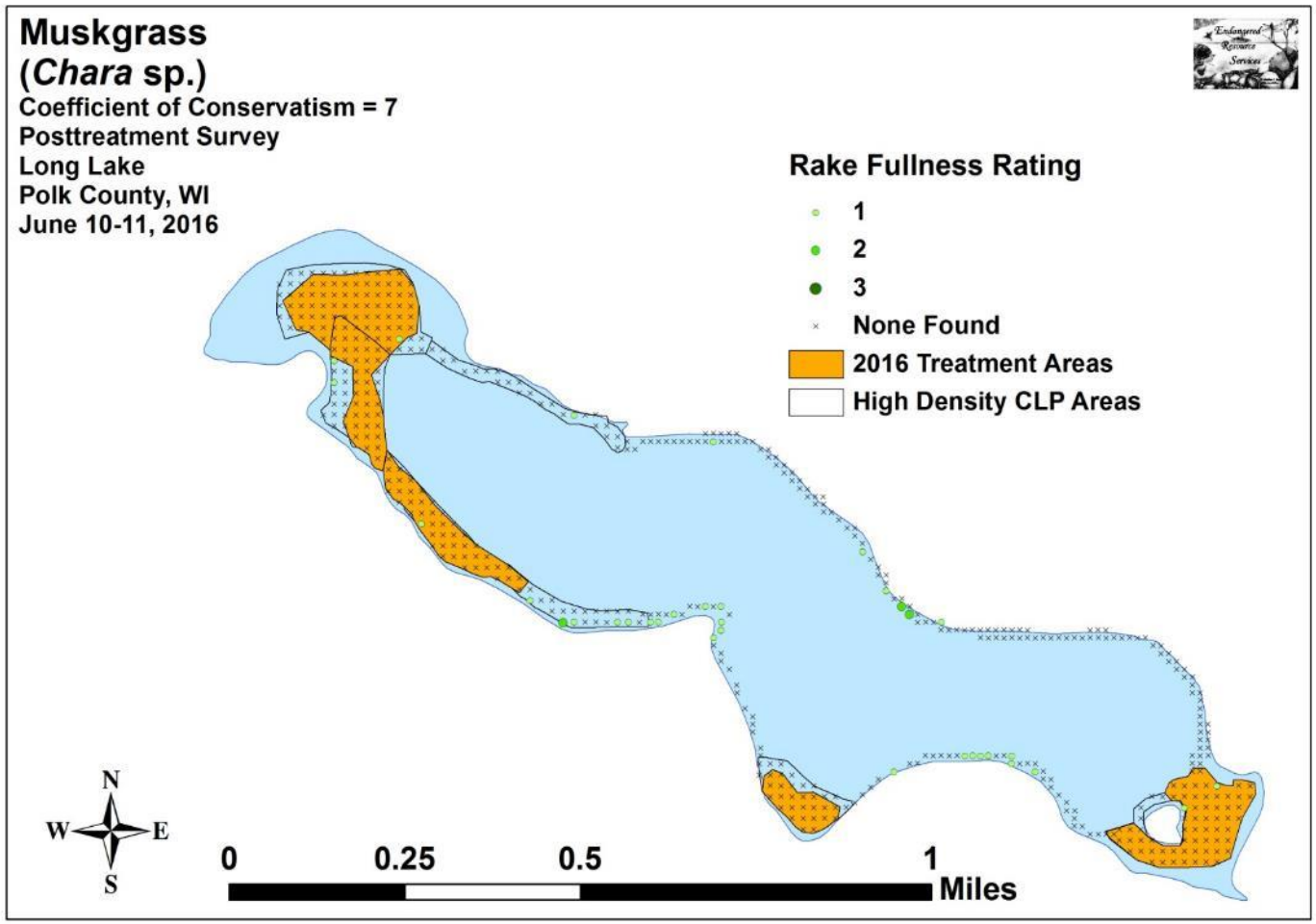

Filamentous algae
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

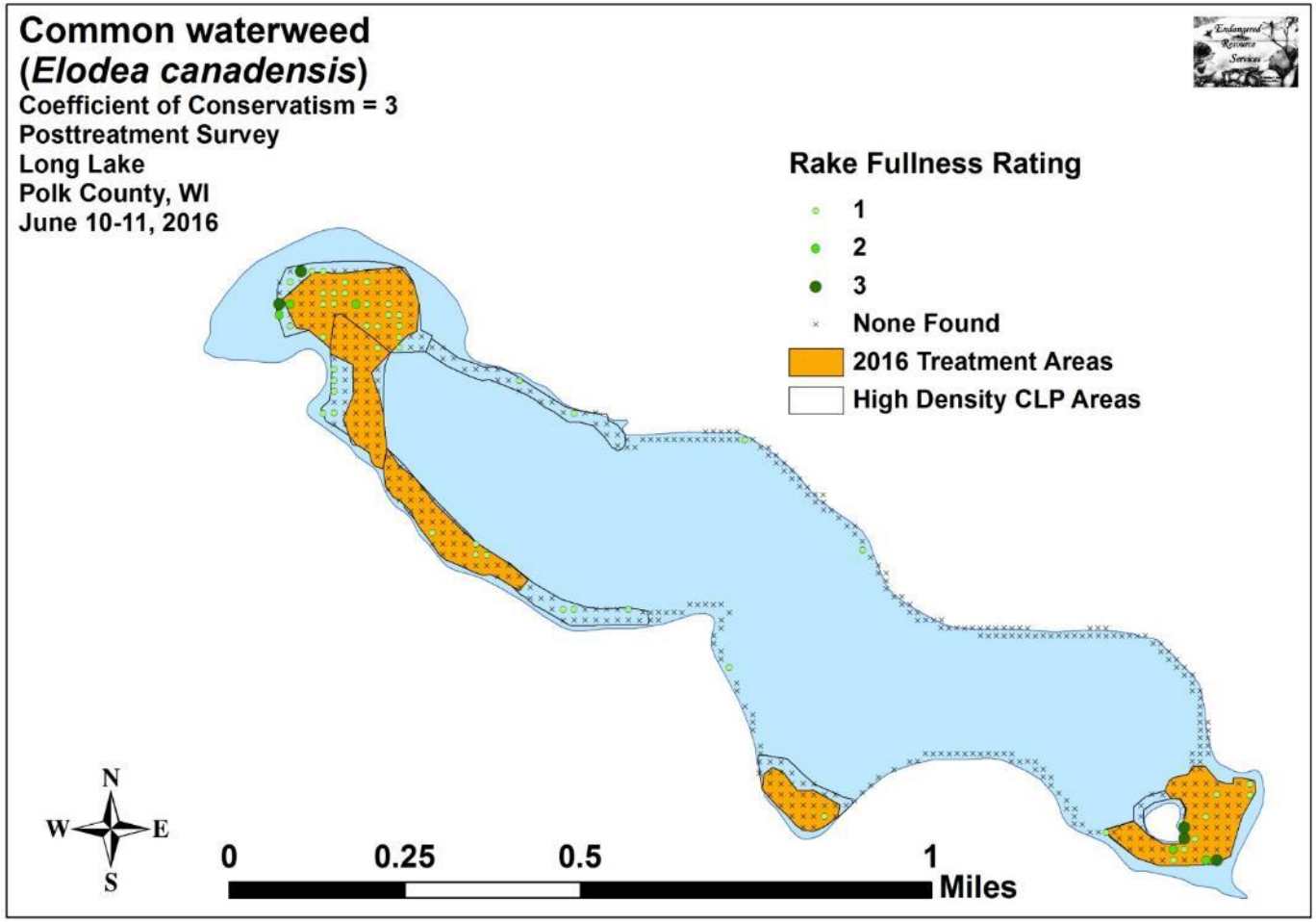

Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

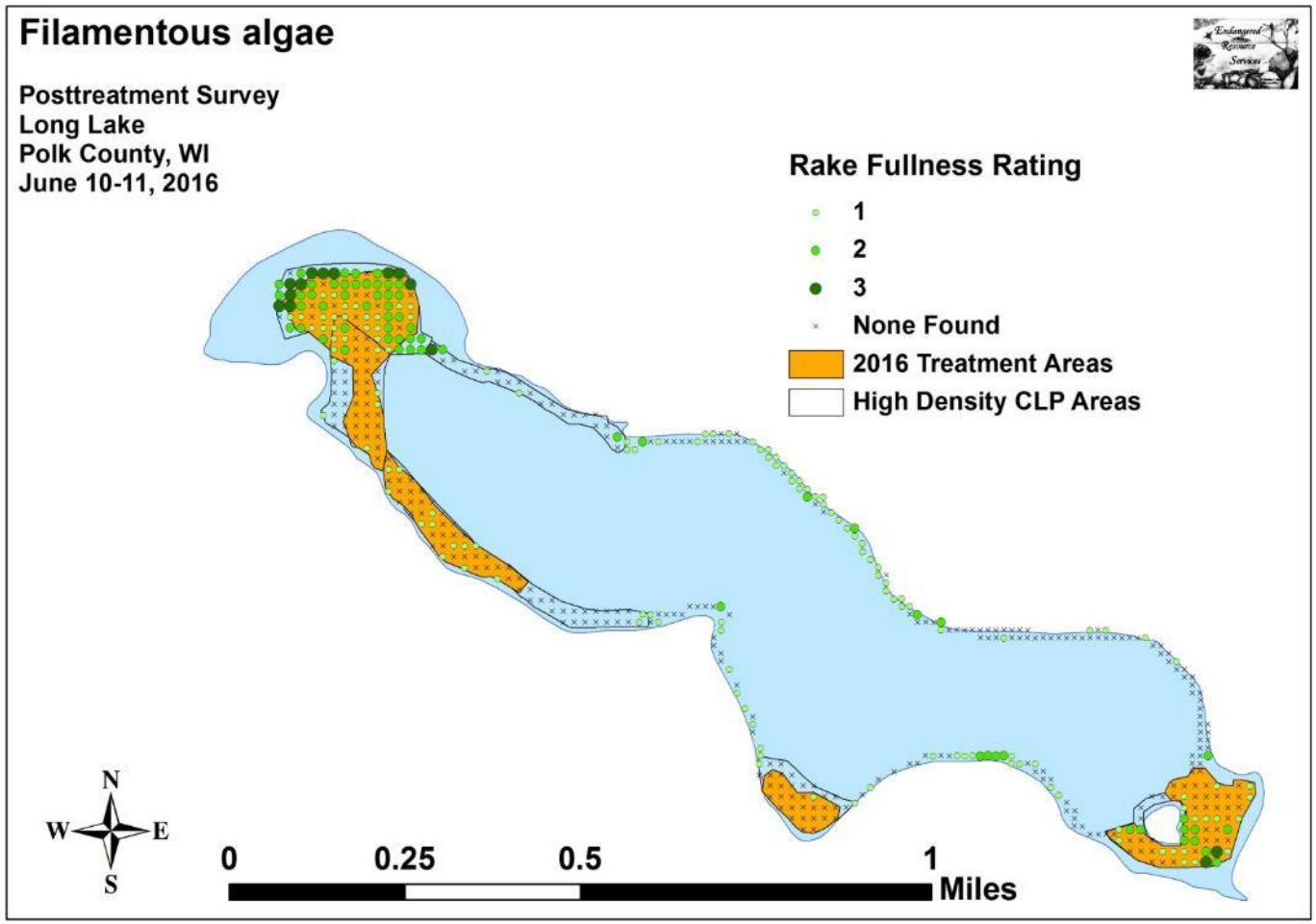

Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Pretreatment Survey
Long Lake
Polk County, WI
April 23-24, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

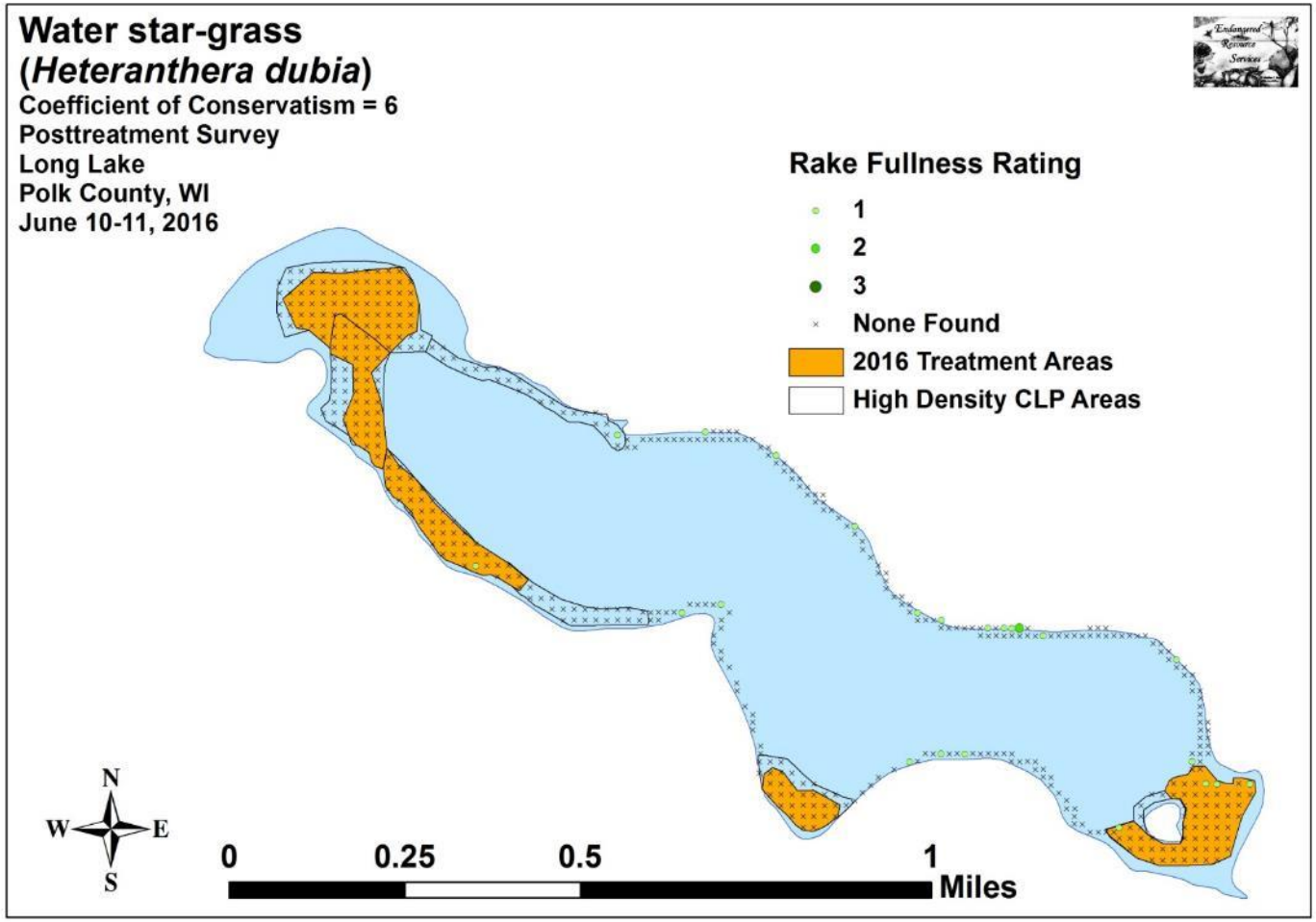
Appendix VII: Posttreatment Native Species Distribution

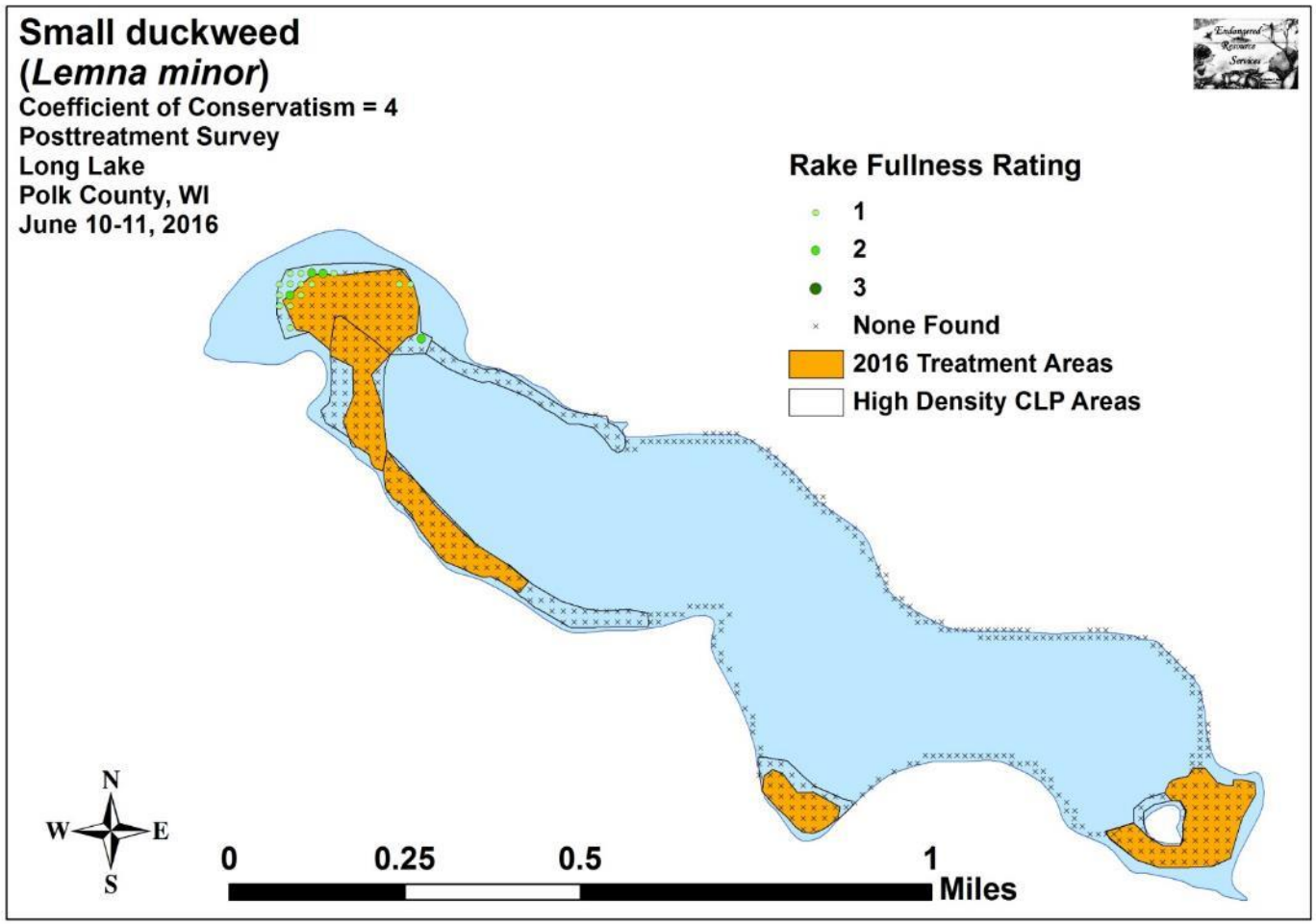

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

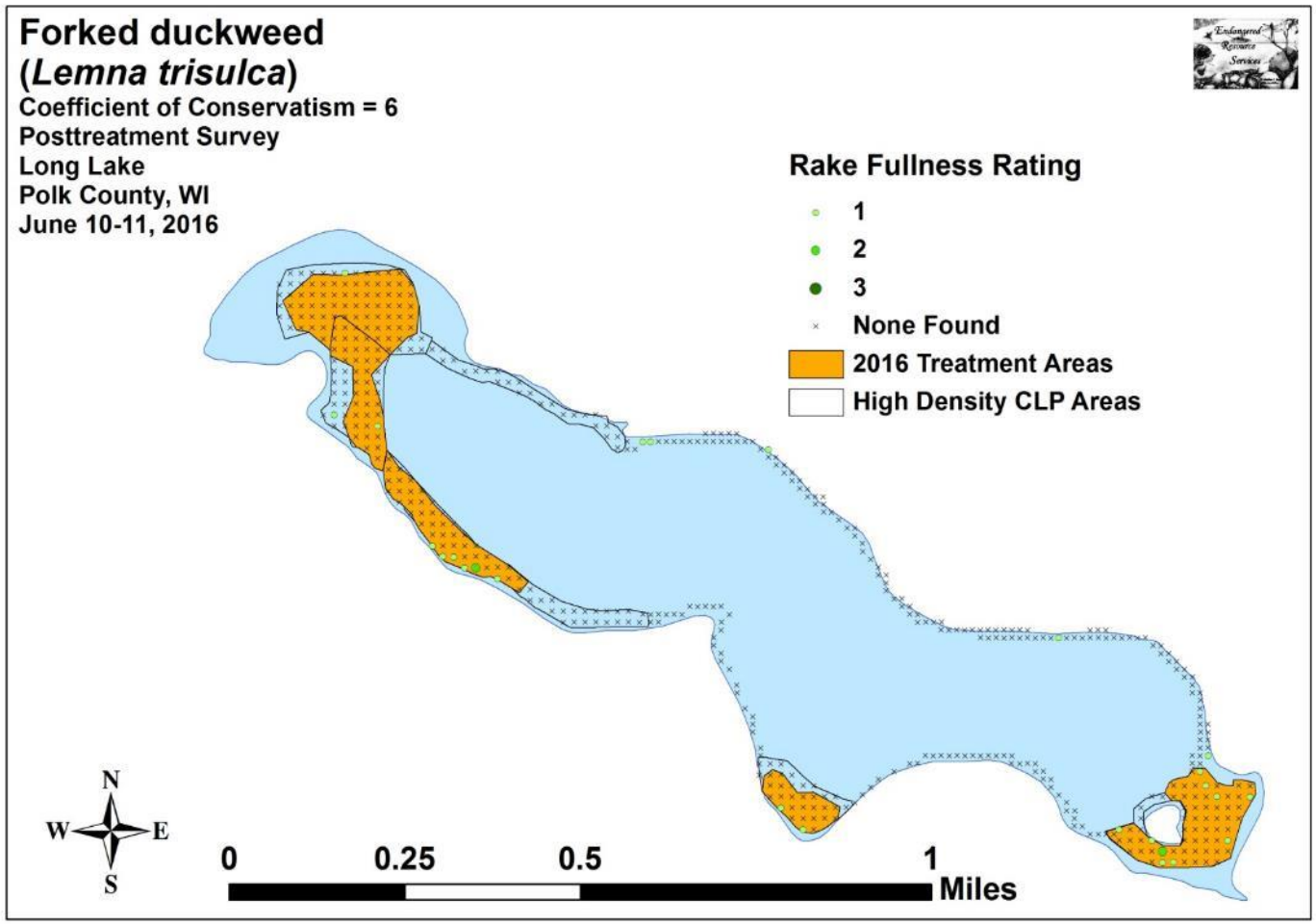

Muskgrass
(Chara sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

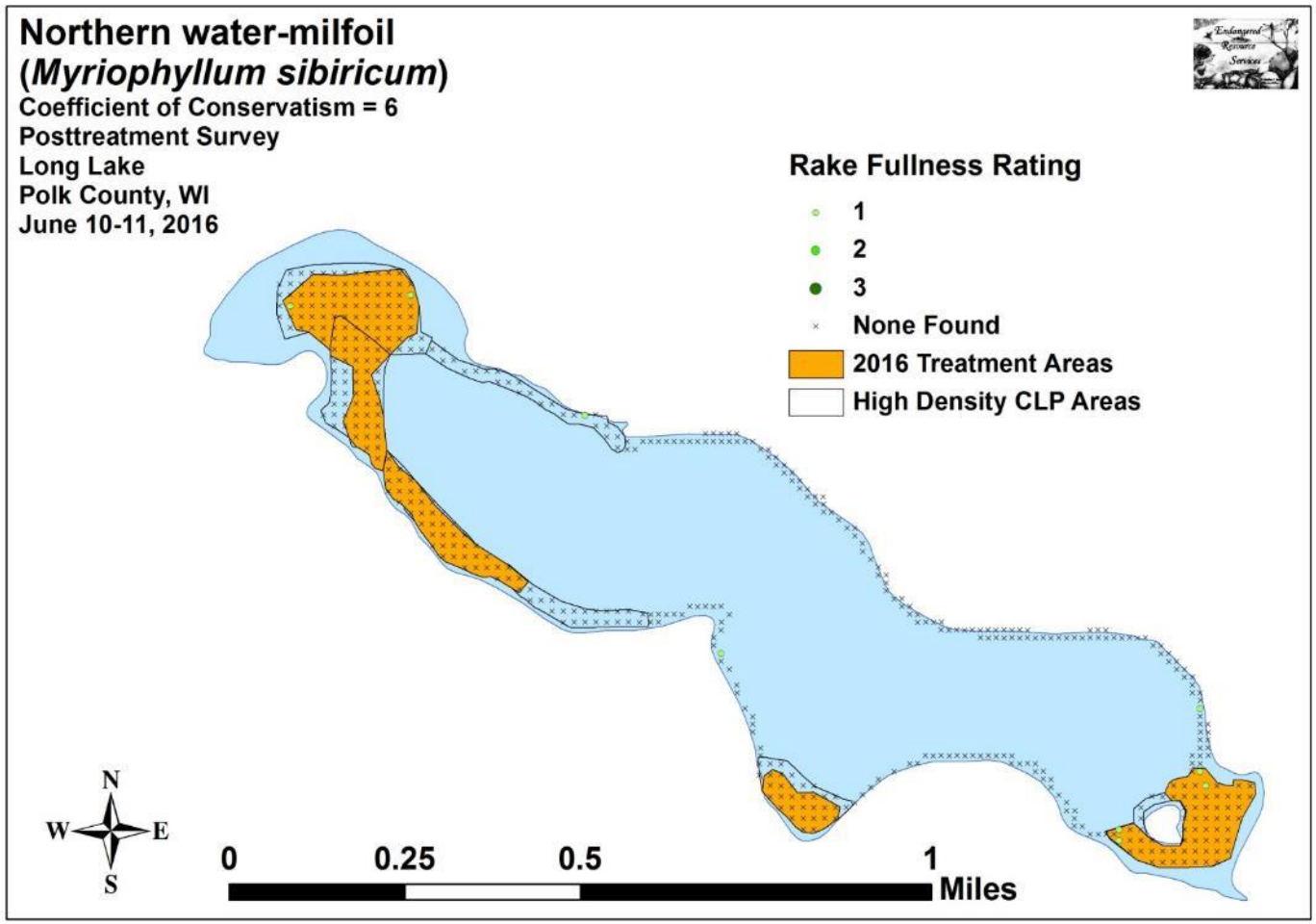

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

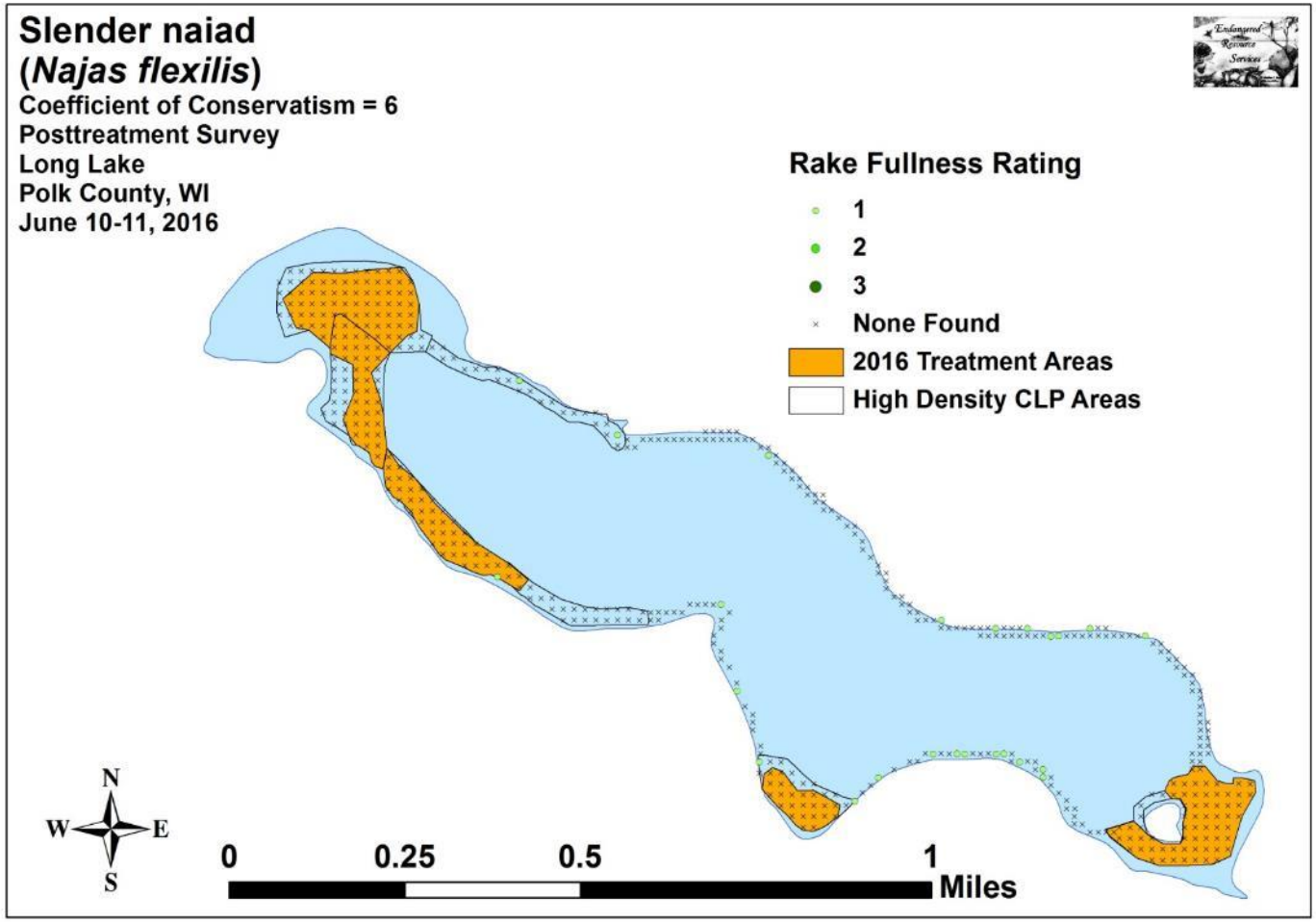

Filamentous algae
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

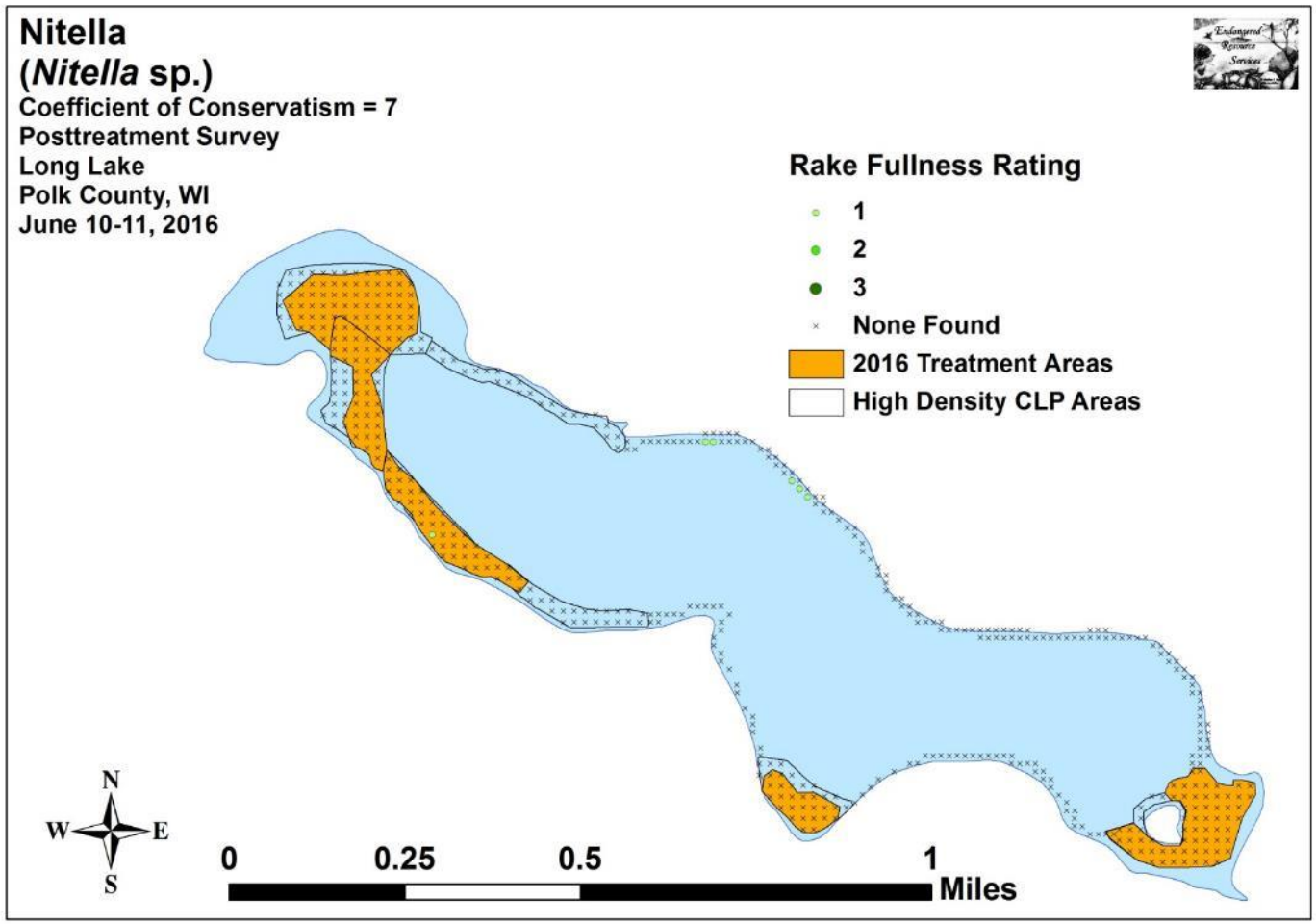

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

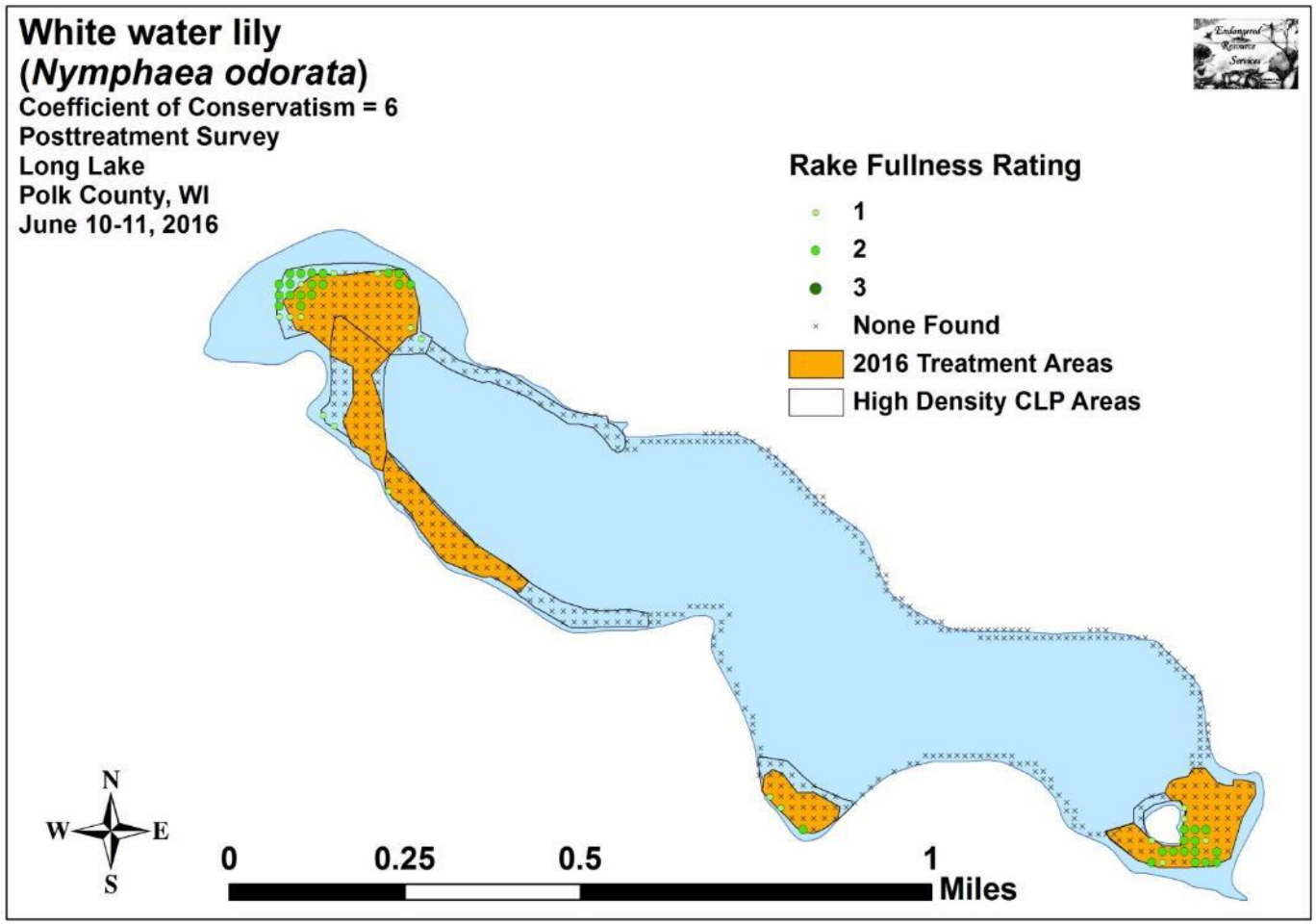

Small duckweed
(Lemna minor)
Coefficient of Conservatism = 4
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

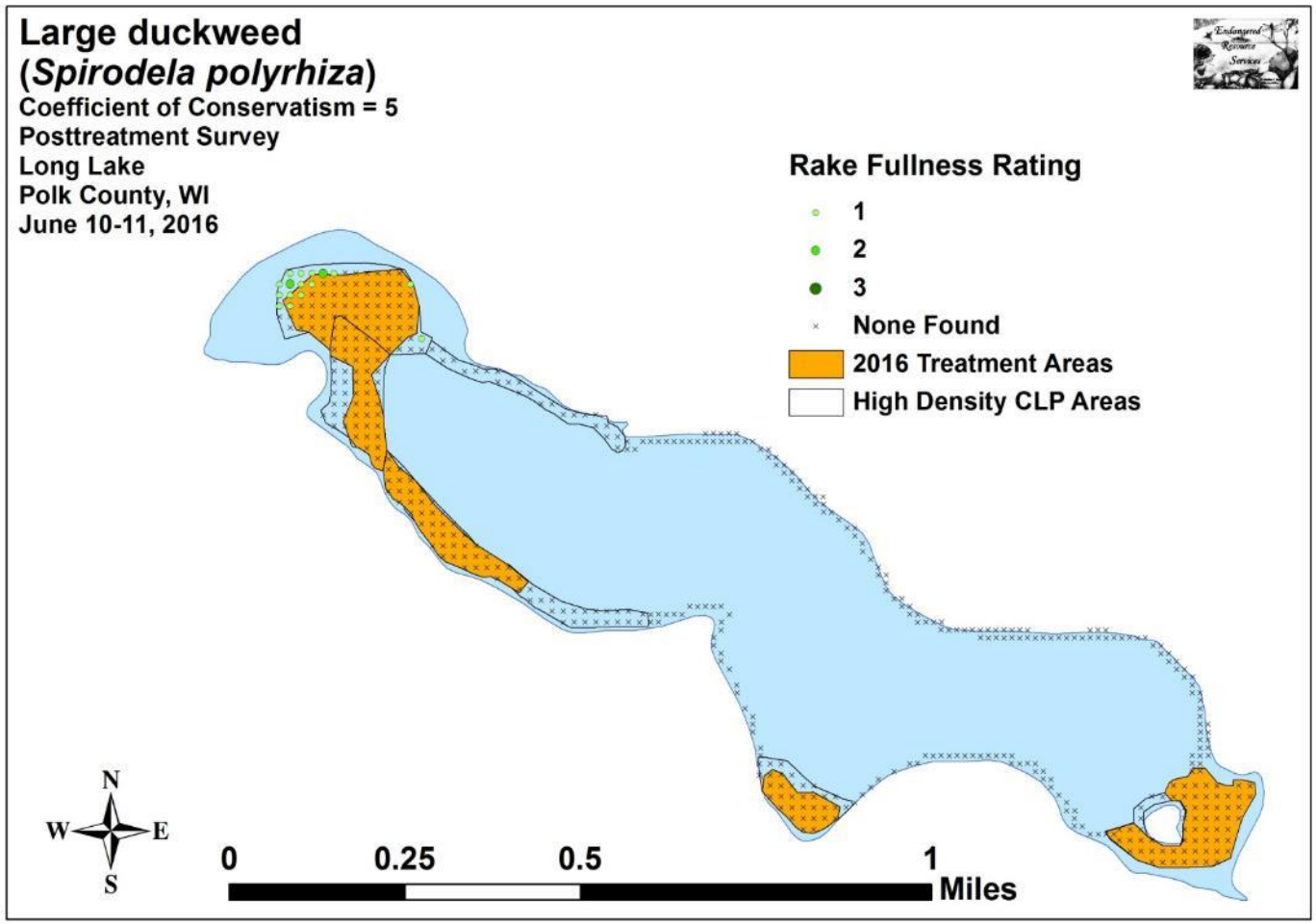

Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

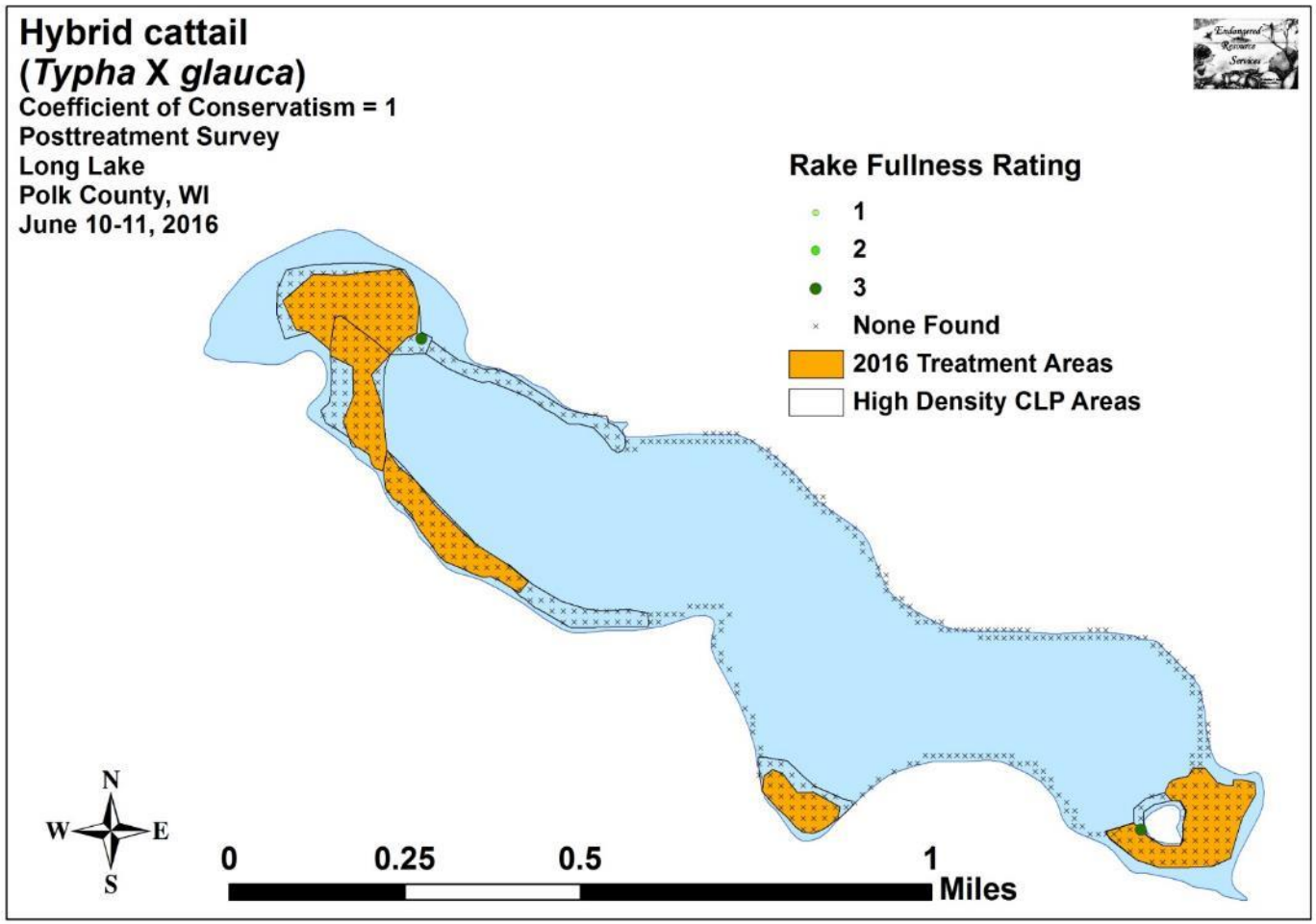

Northern water-milfoil
(Myriophyllum sibiricum)
Coefficient of Conservatism = 6
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

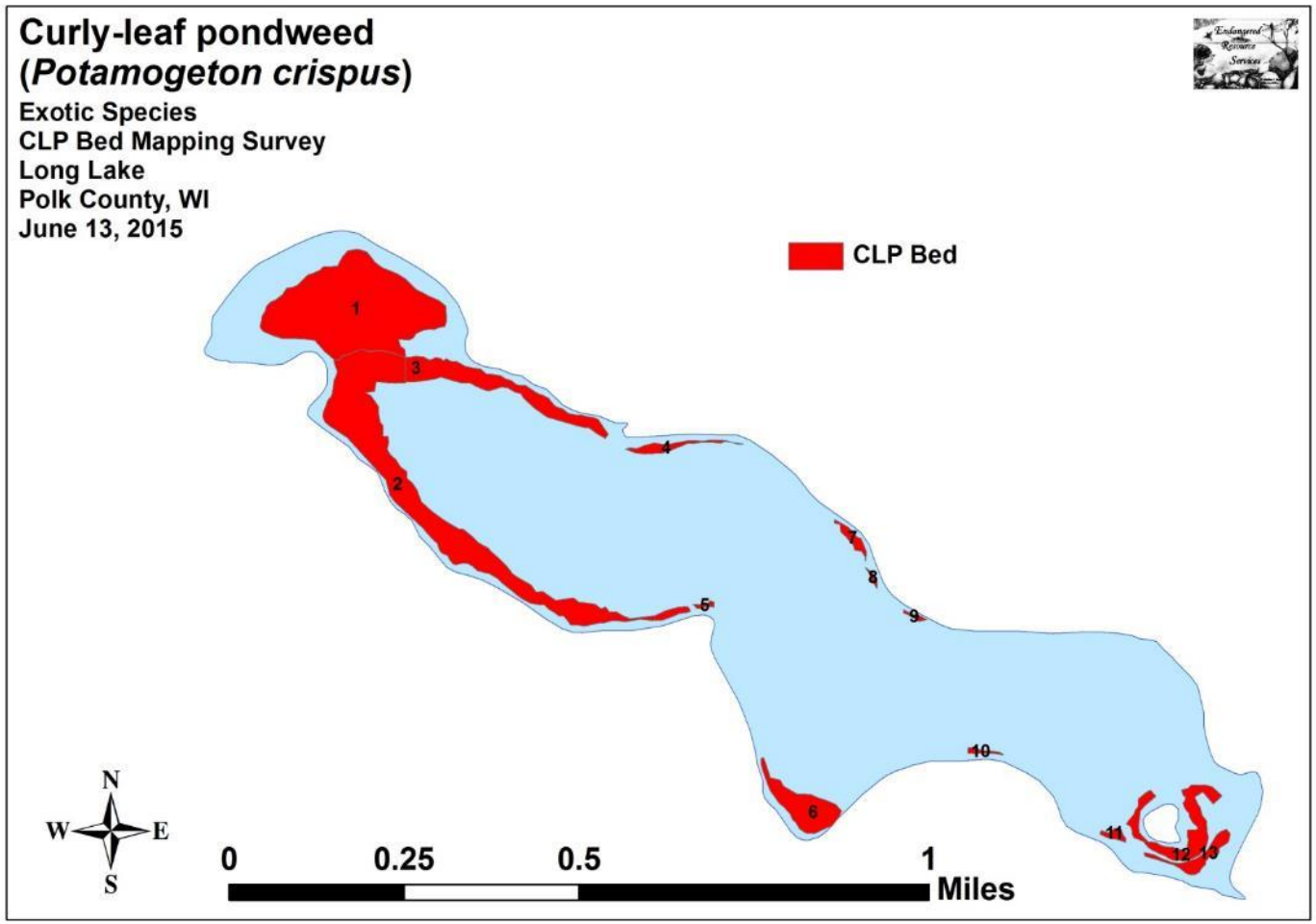

Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

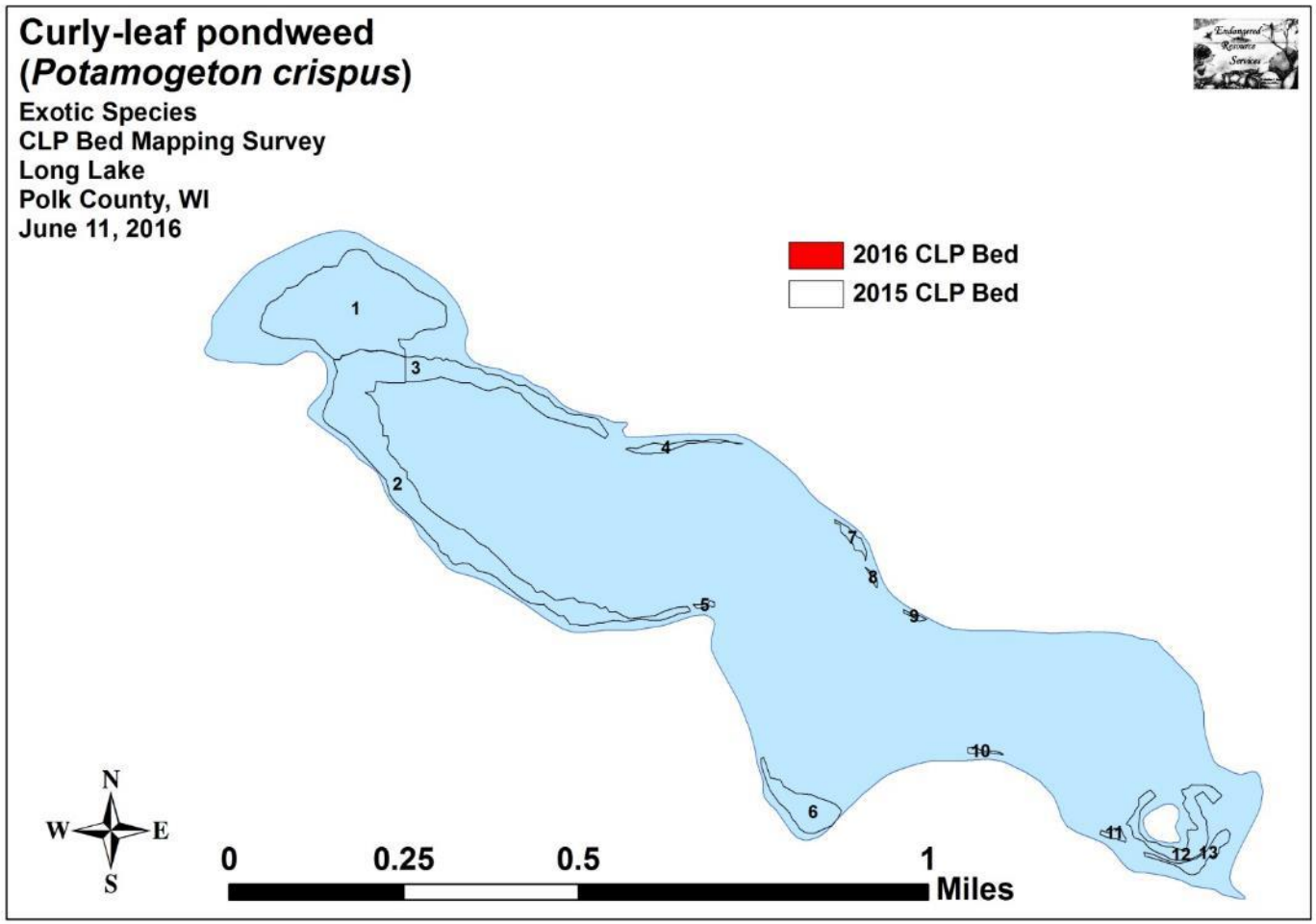

White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Large duckweed
(Spirodela polyrhiza)
Coefficient of Conservatism = 5
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles


Hybrid cattail
(Typha X glauca)
Coefficient of Conservatism = 1
Posttreatment Survey
Long Lake
Polk County, WI
June 10-11, 2016
Rake Fullness Rating
1
2
3
None Found
2016 Treatment Areas
High Density CLP Areas
N
W
E
S
0
0.25
0.5
1
Miles

Appendix VIII: 2015 and 2016 June CLP Bed Maps


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
CLP Bed Mapping Survey
Long Lake
Polk County, WI
June 13, 2015
CLP Bed
1
2
3
4
5
6
7
8
9
10
11
12
13
N
W
E
S
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Exotic Species
CLP Bed Mapping Survey
Long Lake
Polk County, WI
June 11, 2016
2016 CLP Bed
2015 CLP Bed
1
2
3
4
5
6
7
8
9
10
11
12
13
N
W
E
S
0
0.25
0.5
1
Miles