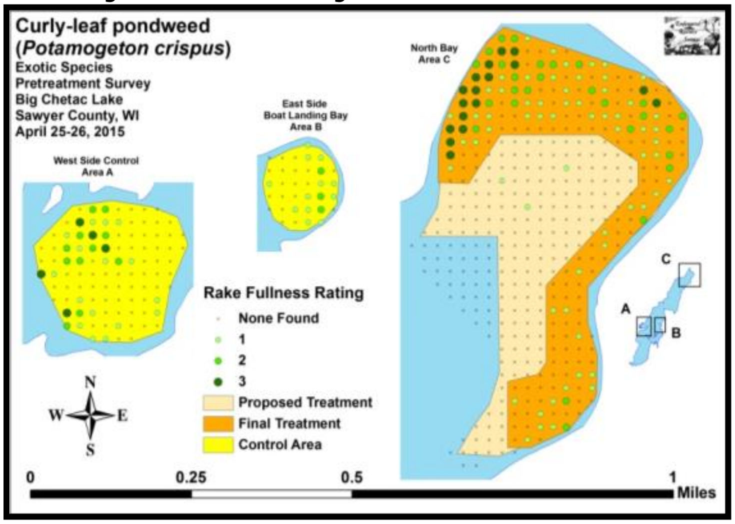
Curly-leaf pondweed (*Potamogeton crispus*)
Pre/Post Herbicide Treatment Surveys
Big Chetac Lake – WBIC: 2113300
Sawyer County, Wisconsin



2015 Final CLP Treatment Area

Project Funded by:

Grant ACEI-133-13 - Big Chetac Chain Lake Association, and the Wisconsin Department of Natural Resources

Severely Burned CLP Posttreatment in the North Bay (Berg 2015)

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April 25-26 and May 30-31, 2015

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ABSTRACT

Big Chetac Lake (WBIC 2113300) is a 1,920-acre stratified drainage lake in southwestern Sawyer Co., WI. The lake is eutrophic with a littoral zone that reached 12.5ft in the spring of 2015. In 2013 and 2014, following the acceptance of a three year Wisconsin Department of Natural Resources exotic species control grant to actively manage Curly-leaf pondweed (*Potamogeton crispus*), the Big Chetac Chain Lake Association chemically treated a 90.8 acre bed in the lake's north bay where CLP nearly completely dominated the plant community. Prior to conducting a treatment in 2015, so as to compare the same areas year-over-year, we again surveyed the original 550 point grid used in 2013/2014: 416 points in the north bay treatment area, 34 control points in the boat landing bay, and an additional 100 control points in a bay on the lake's west side. During the April 25-26th, 2015 pretreatment survey in the north bay treatment area, we found CLP at **107 of 416 total points with a mean rake fullness of 1.57 (25.7% coverage - down from 60.1% in 2014 and 81.7% in 2013**). In the boat landing control area, it was present at 15 of 34 points with a mean rake fullness of 1.20 (44.15% coverage – down from 55.9% in 2014 and 70.6% in 2013). The western control bay had CLP present at 32 of 100 points with a mean rake fullness of 1.66 (32% coverage - down from 45% in 2014 and 70% in 2013). Using these data, it was determined that the north bay treatment area would be reduced from the proposed 90.8 acres to 55.2 acres – a decline of 35.6% from the originally proposed acreage and the total area treated in 2013and 2014. Following the May 4th application of Aquathol K at a concentration of 1.0ppm, we returned to the lake on May 30-31, 2015 to assess the effectiveness of the treatment. **We found CLP at 16 of 416 points (3.8%) with a mean rake fullness of 1.19. This was a decline in distribution of over 85% from the 107 points in the pretreatment survey. Statistically speaking, our findings demonstrated a highly significant reduction of total CLP, as well as rake fullness 3, 2, and 1. The only CLP plants remaining in the treatment area were either small sprouts (<12inches) that appeared to have germinated from turions after the treatment or were severely burned and their long term survival was questionable.** In the boat landing control bay, CLP experienced a non-significant declined to 14 points, but the mean rake fullness increased to 1.36. In the western control bay, we documented a non-significant increase in both distribution (44 sites) and density (1.77). Other than CLP, no other species experienced a significant decline in the north bay treatment area. However, Forked duckweed (*Lemna trisulca*), Common water weed (*Elodea canadensis*), and Nitella (*Nitella* sp.) demonstrated significant increases, and filamentous algae experienced a highly significant increase. No species demonstrated significant changes in the boat landing control bay, but Coontail (*Ceratophyllum demersum*), the most common native plant in the western control bay, suffered a significant decline – presumably as other species expanded.

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INTRODUCTION:

Big Chetac Lake (WBIC 2113300) is a 1,920-acre stratified drainage lake in southwestern Sawyer County, Wisconsin in the Town of Edgewater (T37N R09W S19 NE NE). It reaches a maximum depth of 28ft in the narrows between the islands in the south basin and has an average depth of approximately 14ft (Busch et al. 1967). The lake is eutrophic (nutrient rich) in nature with summer Secchi readings averaging 3.3ft over the past 17 years (WDNR 2015). This poor to very poor water clarity produced a littoral zone that extended to approximately 12.5ft in the spring of 2015. The bottom substrate is predominately muck in the lake's side bays and throughout the north and south ends, and a mixture of sand and rock along exposed shorelines, the mid-lake narrows, and around the islands (Busch et al. 1967).

Figure 1: Proposed 2015 Spring CLP Treatment Area

Curly-leaf pondweed (*Potamogeton crispus*) (CLP), an exotic invasive species, is abundant in Big Chetac Lake. The 2008 spring point-intercept survey found CLP dominated approximately 30% of the lake's surface area, and, especially in the lake's muck bottom bays, almost always formed a solid canopy in up to 10ft of water, excluded most native plants, and often made boating difficult. Additionally, CLP's natural annual senescence in late June/early July contributes significantly to phosphorus loading (James et al. 2002) making it a factor in the lake's summer algae blooms that negatively impact water clarity and quality.

In 2013, after years of study and discussion among board members, residents, local businesses, and the WDNR, the Big Chetac Chain Lake Association applied for and received a 3 year WDNR exotic species control grant to begin actively managing CLP chemically and manually. After evaluating the 2008 maps, it was decided to treat 90 acres in the north bay in both 2013 and 2014. Following the posttreatment and fall CLP turion surveys in 2014, it was proposed to treat the same area in 2015 (Figure 1).

On April 25-26th, we conducted a pretreatment survey to gather baseline data from the scheduled treatment area and to finalize treatment plans. Following the May 4th herbicide application, we conducted a May 30-31th posttreatment survey to evaluate the effectiveness of the treatment. This report is the summary analysis of these field surveys.

METHODS:

We used the identical 550 point grid generated in 2013 so as to be able to make year-over-year comparisons in the treatment and control areas. The points were based on the size and shape of the initially proposed treatment areas and were just over the 4pts/acre threshold required by WDNR protocol for pre/post treatment sampling (Appendix I).

During the surveys, we located each point using a handheld mapping GPS unit (Garmin 76CSx) and used a rake to sample an approximately 2.5ft section of the bottom. All plants on the rake were assigned a rake fullness value of 1-3 as an estimation of abundance, and a total rake fullness for all species was also recorded (Figure 2). In addition to plant data, we recorded the lake depth using a handheld sonar (Vexilar LPS-1) or the metered survey rake. We also noted the substrate type (bottom) when we could see it or reliably determine it with the rake.

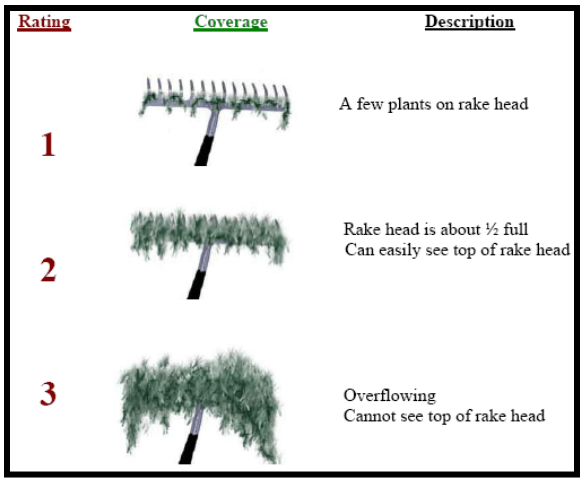


Figure 2: Rake Fullness Ratings

DATA ANALYSIS:

We entered all data collected into the standard APM spreadsheet (Appendix II). These data were then analyzed using the linked statistical summary sheet and the WDNR pre/post analysis worksheet (UWEX 2010). From this, we calculated the following:

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

Total number of sites with vegetation: These included all sites where we found vegetation after doing a rake sample. For example, if 20% of all sample sites have vegetation, it suggests that 20% of the study area 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 site's littoral zone has plants.

Frequency of occurrence: The frequency of all plants (or individual species) is generally reported as a percentage of occurrences at all sample points. It can also be reported as a percentage of occurrences 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% when 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.

Simpson's diversity index: A diversity index allows the entire plant community at one location to be compared to the entire plant community at another location. It also allows the plant community at a single location to be compared over time thus allowing a measure of community degradation or restoration at that site. With Simpson's diversity index, the index value represents the probability that two 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.

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

Mean and median depth of plants: The mean depth of plants indicates the average depth in the water column where plants were sampled. Because a few samples in deep water can skew this data, median depth is also calculated. This tells us that half of the plants sampled were in water shallower than this value, and half were in water deeper than this value

Number of sites sampled using rope/pole rake: This indicates which rake type was used to take a sample. As is standard protocol, we used a 15ft pole rake and a 25ft rope rake for sampling.

<u>Average number of species per site:</u> This value is reported using four different considerations. 1) **shallower than maximum depth of plants** indicates the average number of plant species at all sites in the littoral zone. 2) **vegetative sites only** indicate the average number of plants at all sites where plants were found. 3) **native species shallower than maximum depth of plants** and 4) **native species at vegetative sites only** considers sites with native species and 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 survey site. Species richness alone only counts those plants found in the rake survey. **Note: Per WDNR protocol, filamentous algae, freshwater sponges, aquatic moss and the aquatic liverworts *Riccia fluitans* and *Ricciocarpus natans* are excluded from these totals.**

<u>Mean rake fullness:</u> This value is the average rake fullness of all species at all sites with vegetation. It excludes filamentous algae, and the other species not included in the species richness calculation as stated above (Table 2).

<u>Relative frequency:</u> This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequencies will add up to 100%. Organizing species from highest to lowest gives us an idea of which species are most important within the macrophyte community (Tables 3-8).

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.

<u>Pre/Post Treatment and April/May Significance:</u>
Data from the two surveys was compared using the linked statistical summary sheet and the WDNR pre/post analysis worksheet (UWEX 2010). Pre/posttreatment and April/May differences in the untreated areas were determined to be significant at $p < .05$, moderately significant at $p < .01$, and highly significant at $p < .005$ (Figures 9-11, 14-16).

RESULTS AND DISCUSSION:

Finalization of Treatment Areas:

Following analysis of the 2014 posttreatment survey and the fall 2014 turion survey, it was proposed to retreat the same 90.8 acre bed in the north bay that was treated in 2014. After resurveying all 550 points during the 2015 pretreatment survey, it was decided to trim the treatment area inward to 55.2 acres (Figure 3) as there was little evidence of CLP on the outer edge of the proposed treatment area. This represented a nearly 40% reduction over initial expectations. As in previous years, the east side boat landing bay and the western bay were left as control areas (Table 1) (Appendix I).

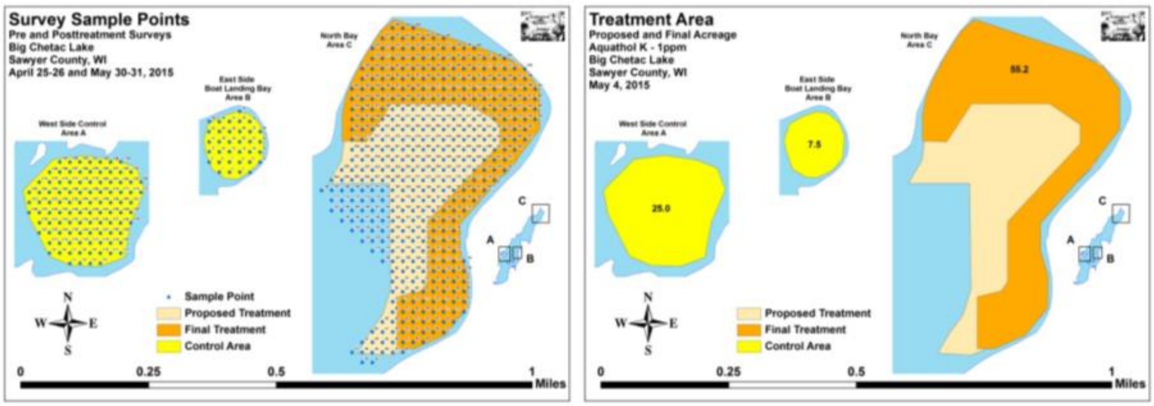


Figure 3: 2015 Survey Sample Points and Final Treatment Area

On May 4th, Midwest Aqua Care, Inc., under WDNR supervision, applied 234 gallons of Aquathol K to the north bay with a target concentration of 1.0ppm (Table 1). The reported water temperature at the time of treatment was 58°F which was within the recommended CLP treatment temperature range of 50 - 60°F. Wind speeds were reported to be 4.9mph out of the northwest.

Table 1: Spring CLP Treatment Summary
Big Chetac Lake – May 4, 2015

CLP Bed Name	2015 Proposed Acreage	Final Acreage	Difference +/-
North Bay	90.8	55.2	-35.6
Boat Landing Bay	0.0	0.0	0.0
Control Bay	0.0	0.0	0.0
Total Acres	**90.8**	**55.2**	**-35.6**

CLP Pre/Post Herbicide Survey:

Depths in the survey areas ranged from 2.5-14.5ft with most of the Curly-leaf pondweed established in 5-10.5ft of water and canopied or near canopy throughout this range. Although present in some sandy and rocky areas at low densities, most CLP was growing over thick organic muck (Figure 4) (Appendix III).

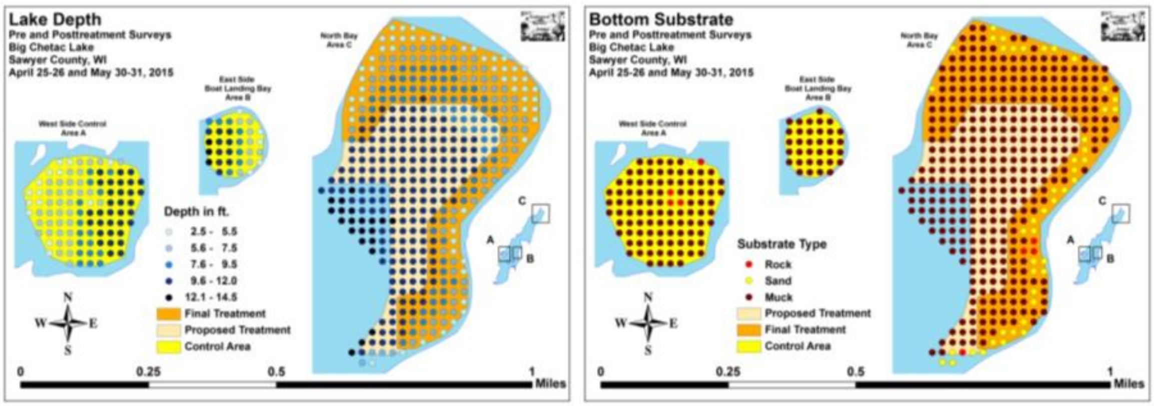


Figure 4: Treatment Area Depths and Bottom Substrate

The littoral zone for all three areas maxed out at 12.5ft during the April survey and 12.0ft during the May survey (Figure 5) (Appendix IV). In the north bay, mean and median depths for all plants shrunk from 6.6ft and 6.5ft during the pretreatment survey to 6.2 and 6.0ft respectively in the posttreatment survey. In the boat landing and western control bays, both values shrunk by 0.5ft each (7.3ft and 7.0ft to 6.8ft and 6.5ft in the boat landing bay – 6.5ft and 6.0ft to 6.0ft and 5.5ft in the western bay) (Table 2).

The narrowing of the littoral zone in the north bay was much less significant than in either 2013 or 2014 when these values shrunk by over 1ft posttreatment. This is likely because, based on both the 2014 turion survey and the 2015 pretreatment survey, there were simply many fewer CLP plants in deep water to start with.

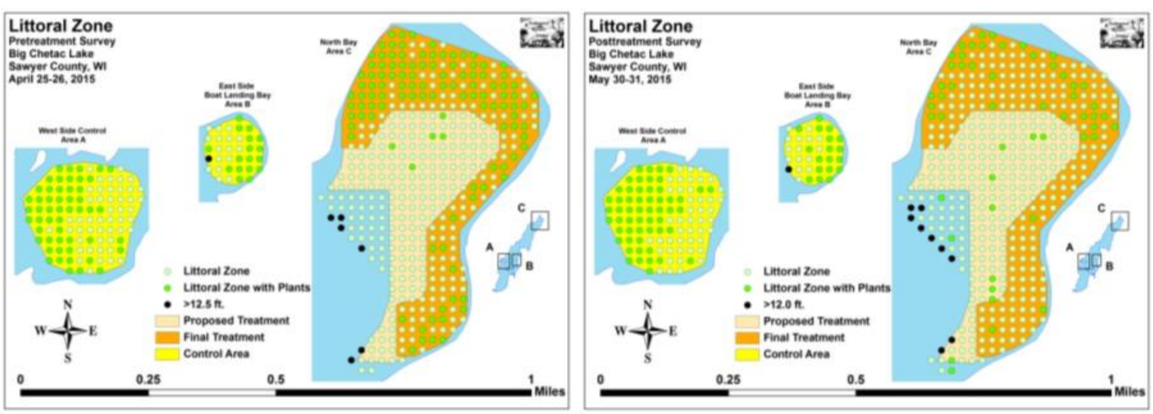


Figure 5: Pre/Post Littoral Zone

Initial diversity within the north bay was extremely low with a Simpson Diversity Index value of 0.39. This value increased significantly to 0.78 posttreatment. The boat landing bay also had a low index value of 0.43 in April that rose slightly to 0.53 in May. The western control bay had the highest starting value at 0.63, and it was essentially unchanged at 0.62 in May (Table 2).

Mean native species richness was also low in all three areas. The north bay treatment area averaged 0.09 native species at littoral points pretreatment and 0.12 posttreatment. Even at sites that had natives present, only the western control bay (1.29) averaged more than 1.20 species/site, and no point in any area had more than three native species in any rake during either the pre or posttreatment surveys (Figure 6) (Appendix IV).

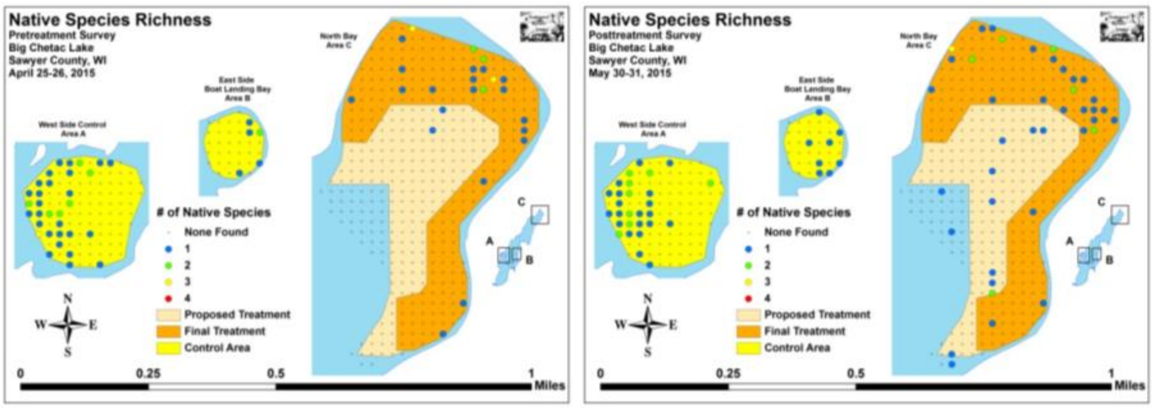


Figure 6: Pre/Post Native Species Richness

Total species richness was very low in all three areas with just three to six species being found in each area in April/pretreatment. During the May/posttreatment survey, we found four species in the boat landing bay and six in the western control bay. However, the treatment area had jumped to nine – similar to posttreatment in 2014.

Following treatment, the mean total rake fullness declined significantly in the north bay from 1.54 to 1.06. In the boat landing bay, this value increased slightly from 1.29 to1.33, and, in the western control bay, mean rake fullness values also increased from 1.56 to 1.65 (Figure 7) (Table 2) (Appendix IV).

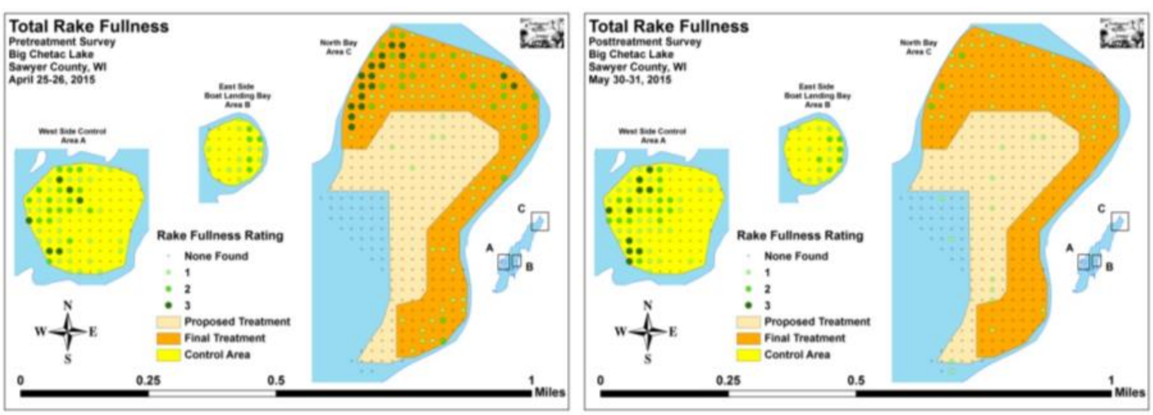
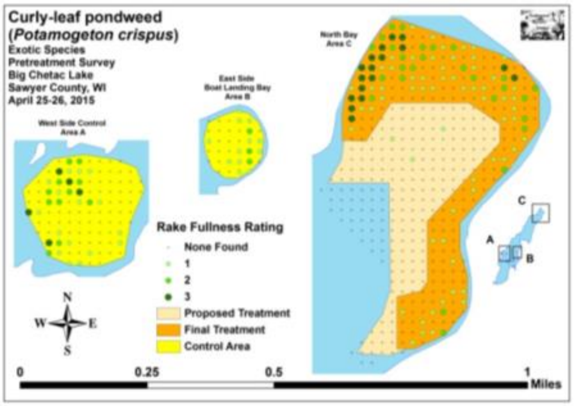


Figure 7: Pre/Post Total Rake Fullness

Table 2: Pre/Posttreatment and April/May Survey Summary Statistics
North Bay – Boat Landing Bay – Western Control Bay
Big Chetac Lake, Sawyer County
April 25-26 and May 30-31, 2015

Summary Statistics:	North Bay Treatment Area			Boat Landing Bay			Western Control Bay		
	Pre 2013	Pre 2015	Post 2015	May 2013	April 2015	May 2015	May 2013	April 2015	May 2015
Total number of points sampled	416	416	416	34	34	34	100	100	100
Total number of sites with vegetation	354	113	53	26	17	18	97	52	55
Total number of sites shallower than the maximum depth of plants	414	338	407	31	33	27	100	90	97
Frequency of occurrence at sites shallower than maximum depth of plants	85.5	33.43	13.0	83.9	51.5	66.7	97.0	57.8	56.7
Simpson Diversity Index	0.41	0.39	0.78	0.51	0.43	0.53	0.73	0.63	0.62
Maximum depth of plants (ft)	13.0	11.0	12.0	11.5	12.5	10.0	12.0	10.5	11.0
Mean depth of plants (ft)	8.6	6.6	6.2	7.7	7.3	6.8	8.0	6.5	6.0
Median depth of plants (ft)	9.0	6.5	6.0	7.8	7.0	6.5	8.0	6.0	5.5
Number of sites sampled using pole rake (P)	416	416	416	34	34	34	100	100	100
Average number of all species per site (shallower than max depth)	1.09	0.41	0.16	1.26	0.64	0.81	1.70	0.80	0.82
Average number of all species per site (veg. sites only)	1.27	1.22	1.21	1.50	1.24	1.22	1.75	1.38	1.45
Average number of native species per site (shallower than max depth)	0.27	0.09	0.12	0.48	0.18	0.30	1.00	0.44	0.37
Average number of native species per site (veg. sites with natives only)	1.24	1.29	1.20	1.07	1.20	1.00	1.54	1.25	1.29
Species richness	8	6	9	4	3	4	5	5	6
Mean rake fullness (veg. sites only)	1.81	1.54	1.06	1.42	1.29	1.33	1.72	1.56	1.65
Mean Coefficient of Conservatism	5.9	6.0	5.5	6.0	7.5	7.0	6.0	6.5	6.4
Floristic Quality Index	15.5	13.4	15.6	10.4	10.6	12.1	12.0	13.0	14.3

During the pretreatment survey of the north bay, we found CLP at 107 of 416 total points (25.7% - **down from 60.1% in 2014 and 81.7% in 2013**) (Figures 8) (Appendix V). Of these, 17 had a rake fullness rating of 3, 27 rated a 2, and 63 rated a 1 for a mean rake fullness of 1.57. During the posttreatment survey, we found CLP at just 16 sites (3.8%). None rated a 3, three rated a 2, and the remaining 13 were a one for a mean rake of 1.19. Most CLP plants were either small sprouts (<12inches) that appeared to have germinated from turions after the treatment or were severely burned making their long term survival questionable. Our findings demonstrated a highly significant reduction of total CLP, as well as rake fullness 3, 2, and 1 (Figure 9) (Tables 3 and 4).



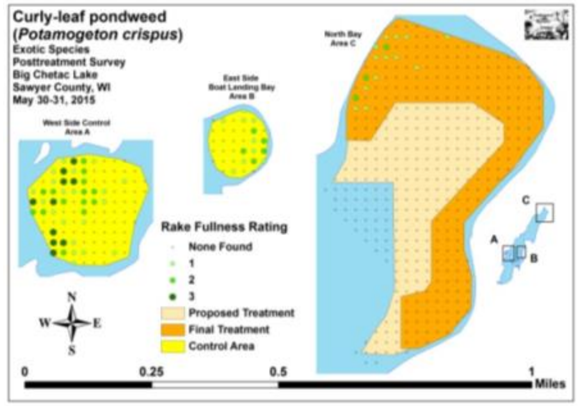
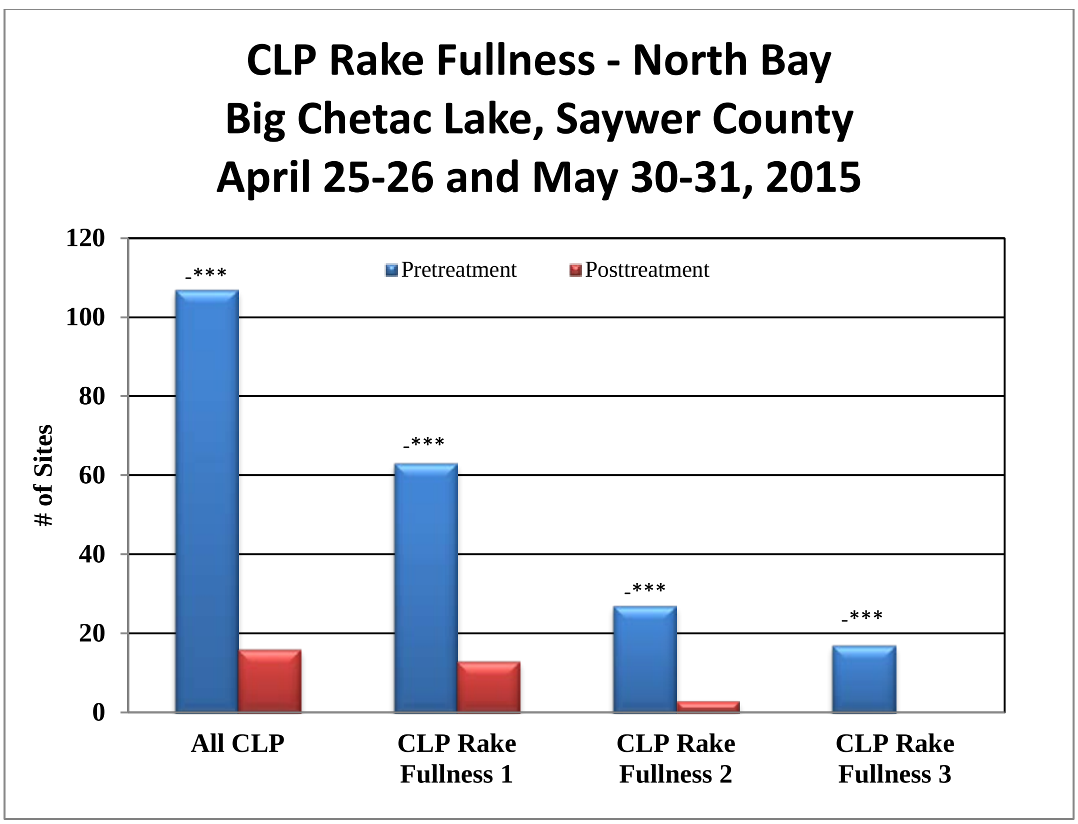


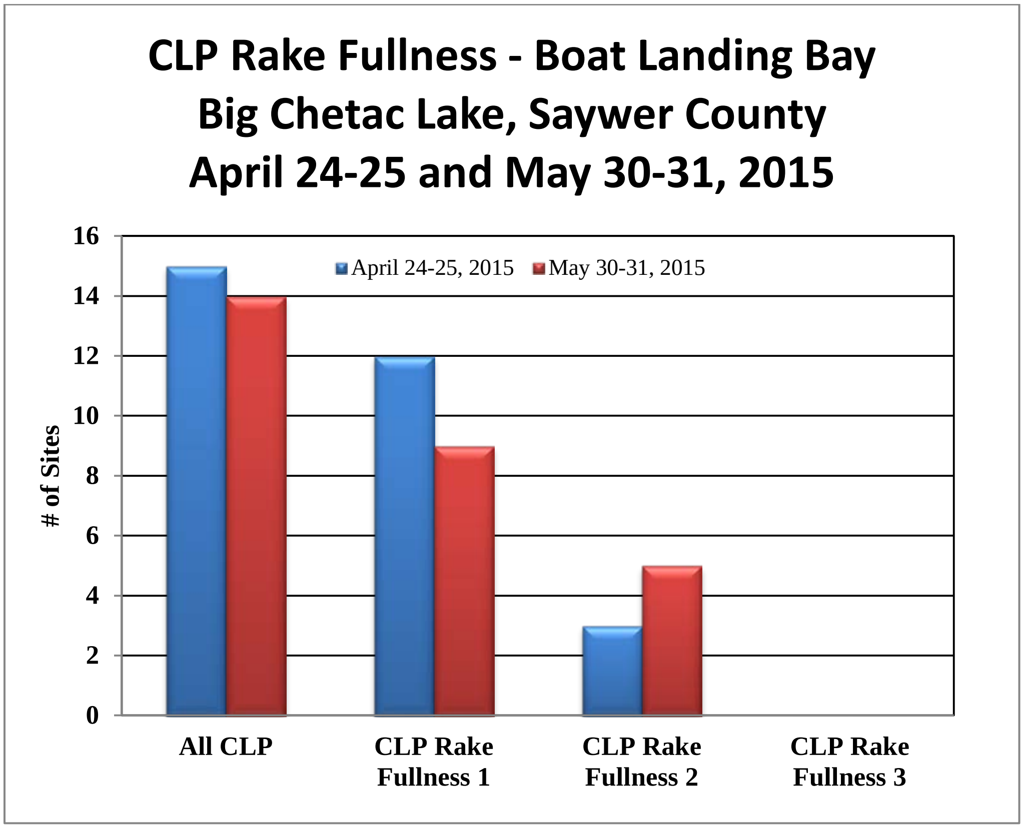
Figure 8: Pre/Post CLP Density and Distribution



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

Figure 9: Pre/Post Changes in CLP Rake Fullness – North Bay

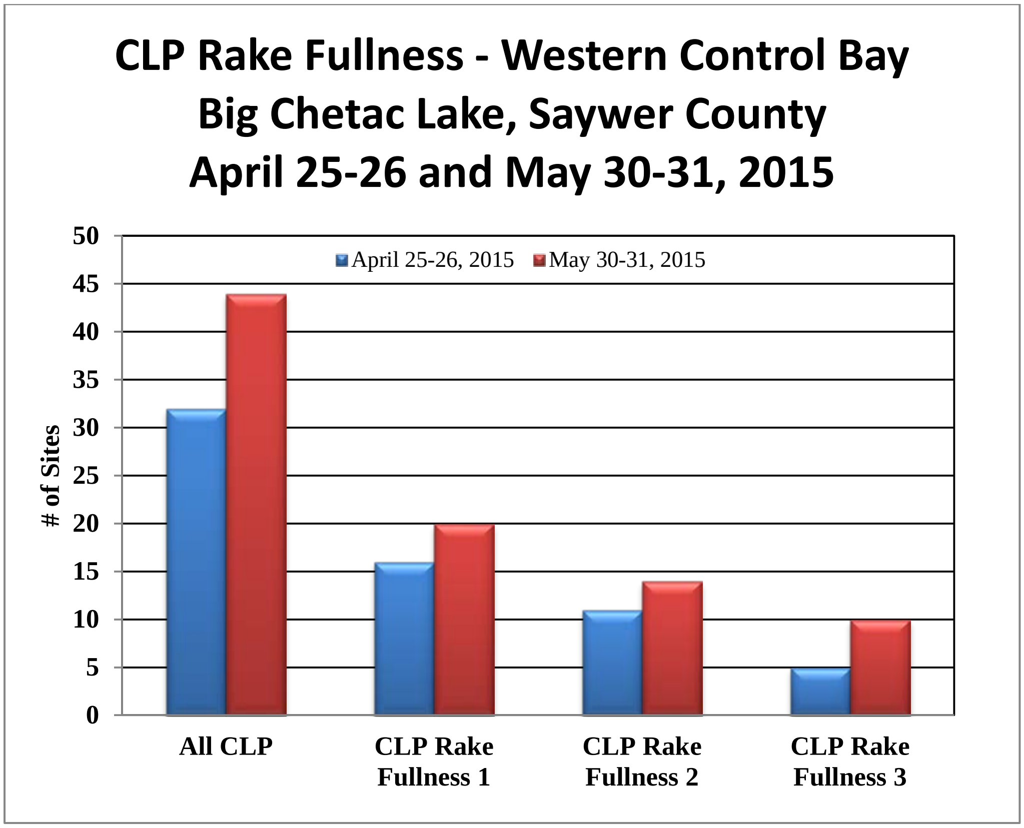
In the boat landing bay, the April survey found CLP at 15 of 34 points (44.1%). This was down from 19 points (55.9%) in 2014 and 24 points (70.6%) in 2013. Of these, none had a rake fullness rating of 3, three rated a 2, and 12 were a 1 for a mean rake fullness of 1.20. In May, CLP was present at 14 spots (41.2%) with none rating a 3, nine rating a 2, and the remaining five rating a 1 for a mean rake of 1.36. Our findings demonstrated no significant change in CLP growth in 2015, although this total was down from 19 points (55.9%) in June 2014, and 29 points (85.3%) in May of 2013 (Figure 10) (Tables 5 and 6).



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

Figure 10: April/May Changes in CLP Rake Fullness – Boat Landing Bay

We documented CLP at 32 of 100 points (32.0%) in the western control bay during the April survey (Figure 8). This represented a highly significant reduction from the 70 points we found CLP at during the 2013 pretreatment survey and a further reduction from the 45 points it was found at in 2014. In 2015, five of the pretreatment points rated a 3, 11 were a 2, and 16 were a 1 producing a mean rake fullness value of 1.66. By May, CLP had increased to 44 sites (44.0%) with ten sites rating a 3, 14 a 2, and the remaining 20 a 1 for a mean rake fullness of 1.77. Despite increasing in all categories, none of these changes were statistically significant (Figure 11) (Tables 7 and 8).



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

Figure 11: April/May Changes in CLP Rake Fullness – Western Control Bay

When combining data from all three study areas, Coontail (*Ceratophyllum demersum*) and Forked duckweed (*Lemna trisulca*) were the most common native species during both surveys (Tables 3-8) (Figures 12 and 13). Posttreatment in the north bay, Coontail was essentially unchanged, while filamentous algae demonstrated a highly significant increase, and Forked duckweed, Common waterweed (*Elodea canadensis*), and Nitella (*Nitella* sp.) experienced significant increases (Figure 14).

Outside the treatment area, plants were little changed from April to May. In the boat landing bay, there were no significant changes (Figure 15), while in the western control area, the only significant change was a decline in Coontail that was presumably due to the expansion of other species as the growing season progressed (Figure 16) (Maps for all native species pre and posttreatment are available in Appendixes VI and VII.)

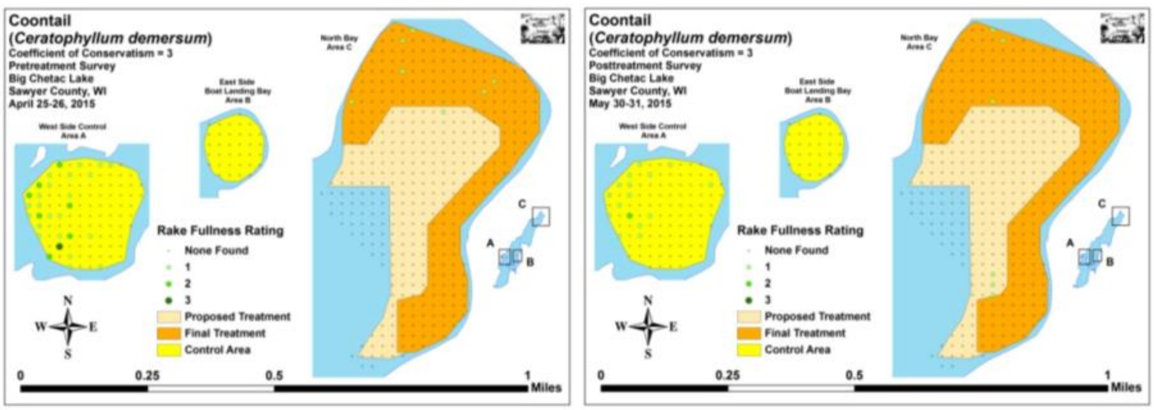


Figure 12: Pre/Post Coontail Density and Distribution

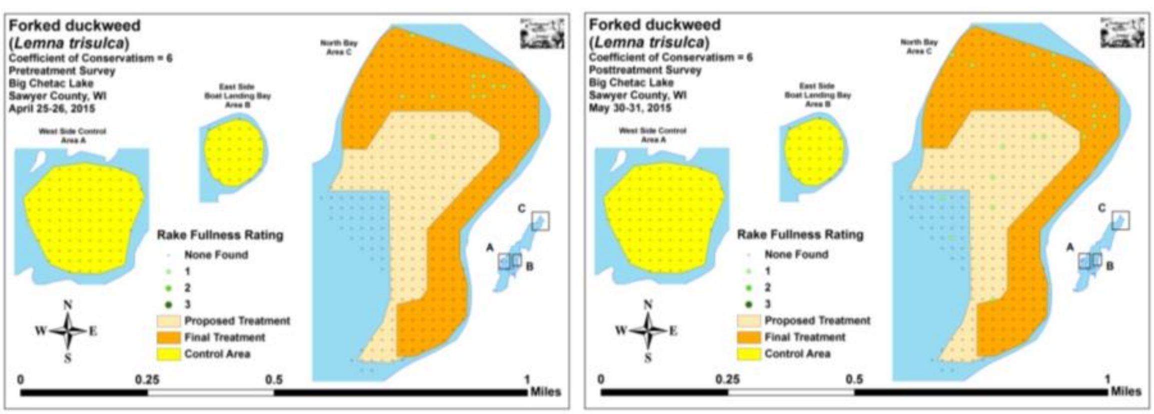
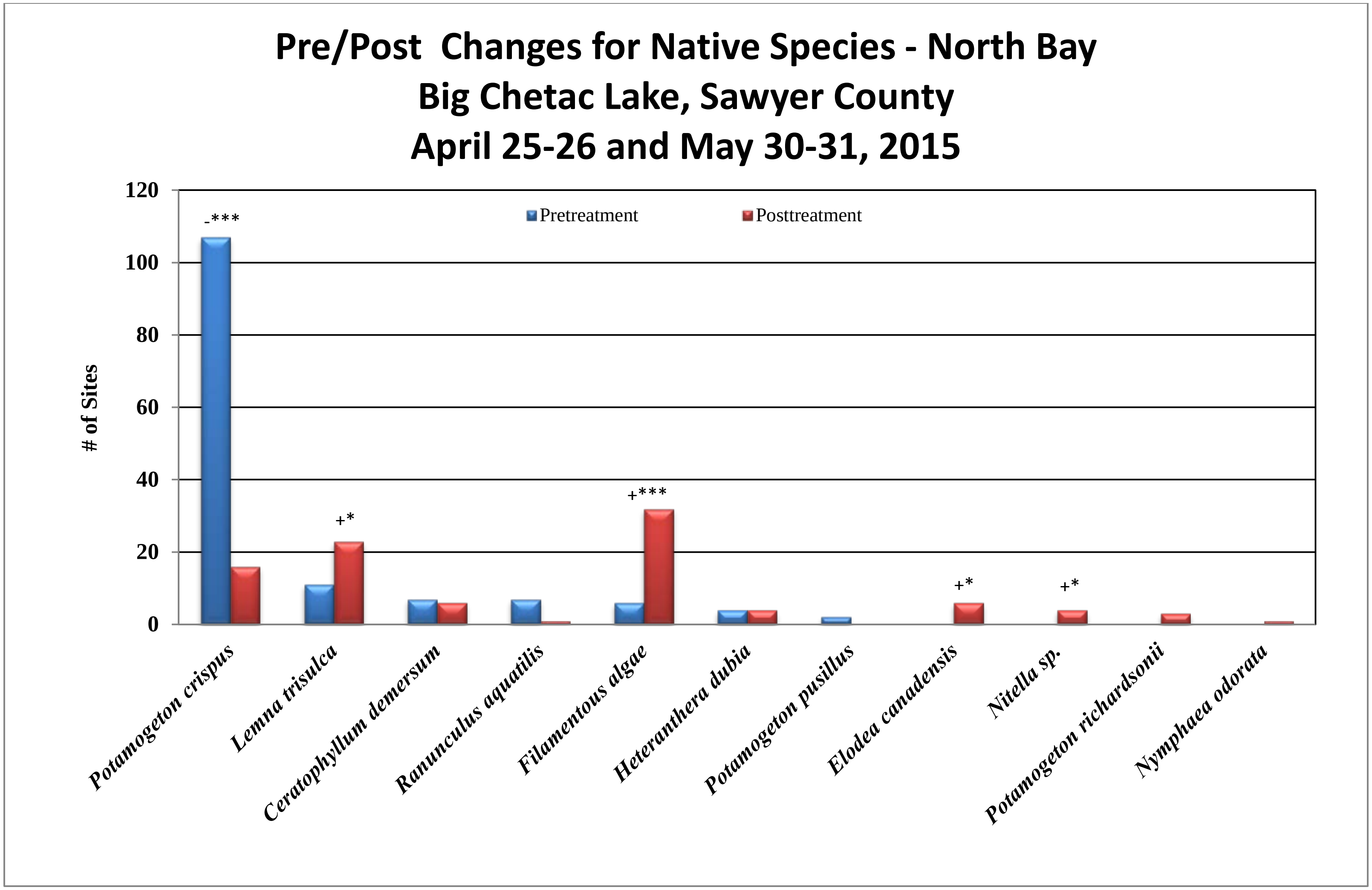
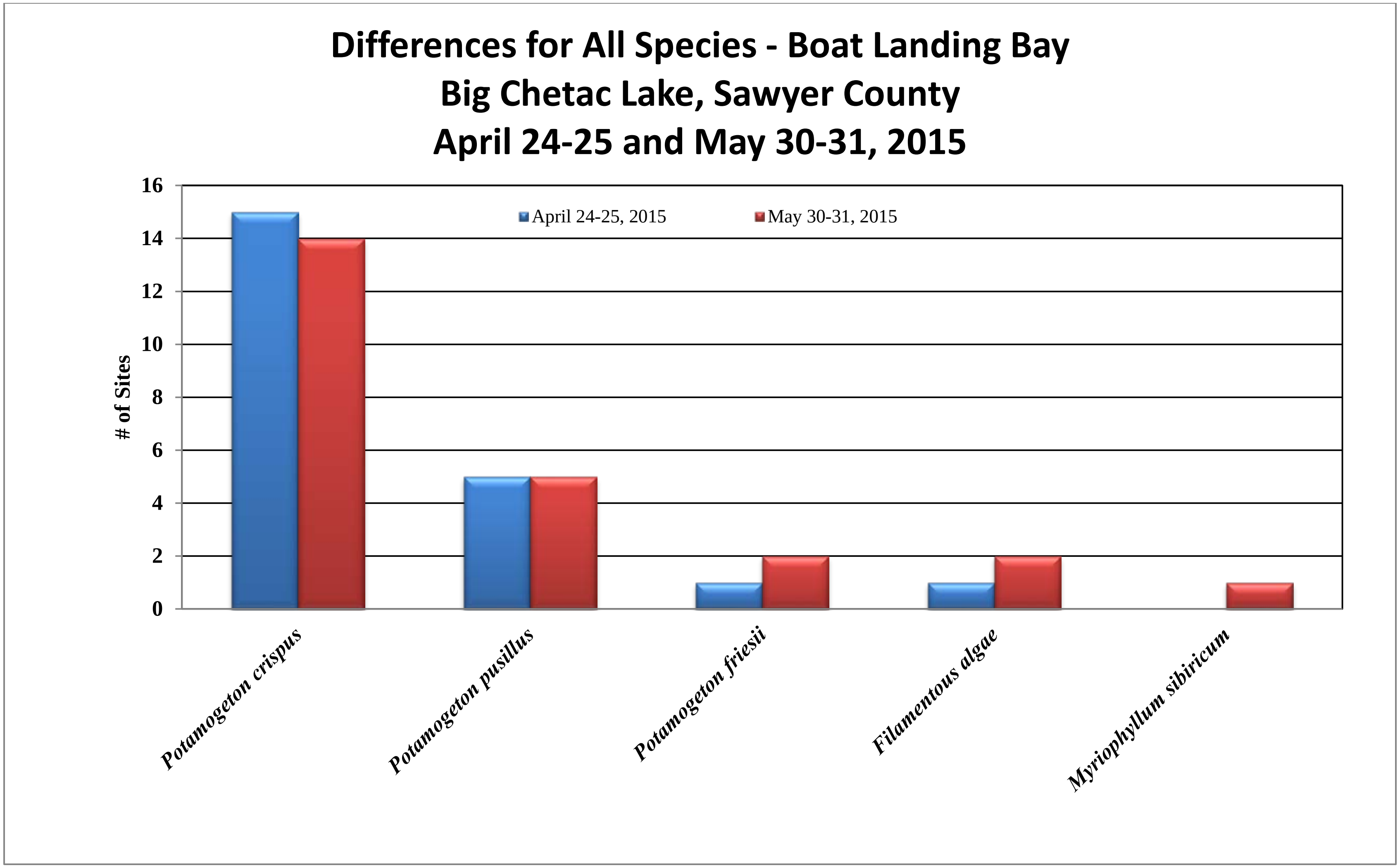


Figure 13: Pre/Post Forked Duckweed Density and Distribution



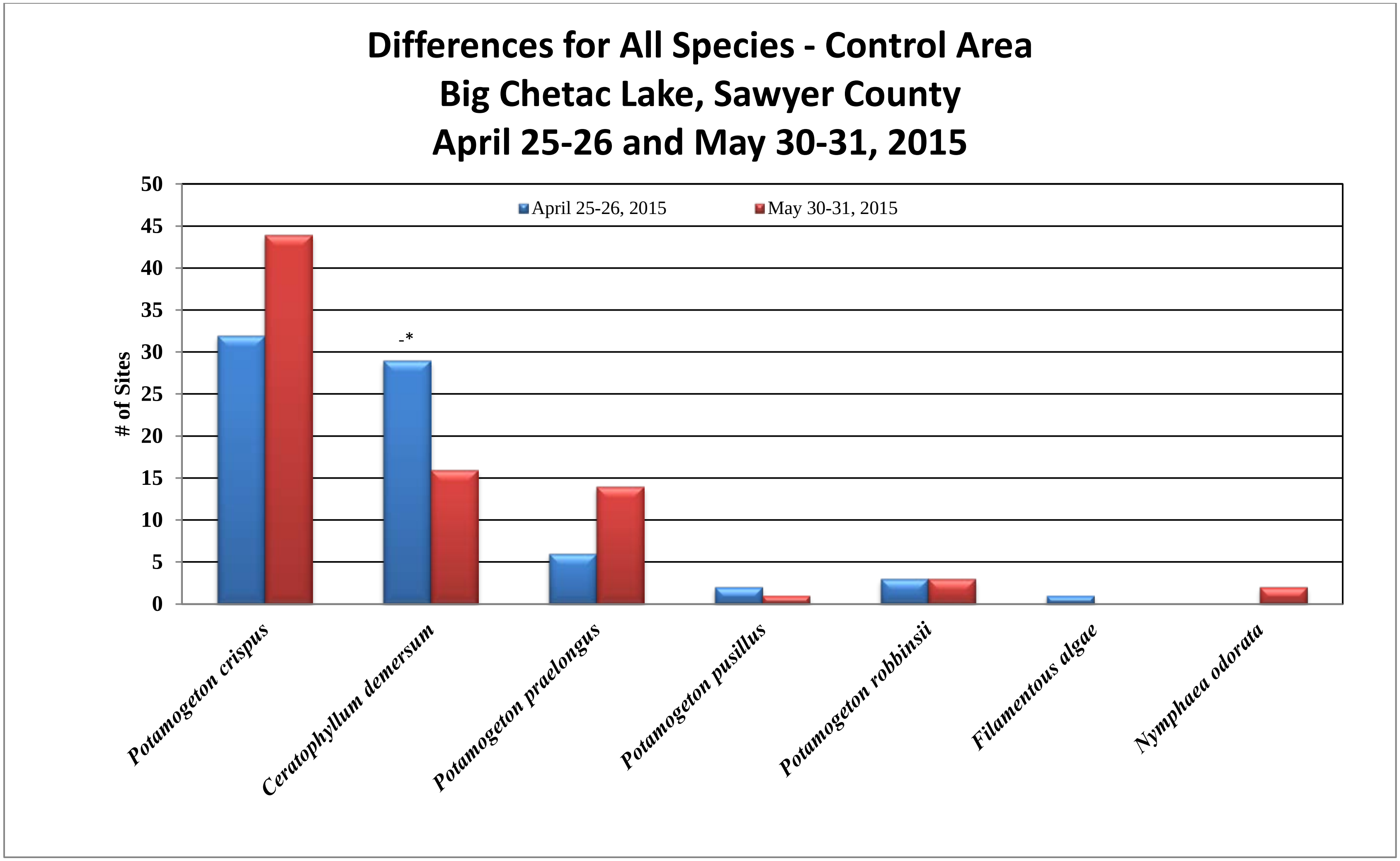
Significant differences = * *p* < .05, ** *p* < .01, * *p* < .005**

Figure 14: Pre/Post Native Macrophyte Changes – North Bay Treatment Area



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

Figure 15: April/May Macrophyte Changes – Boat Landing Bay



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

Figure 16: April/May Macrophyte Changes – Western Control Bay

**Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Pretreatment Survey – North Bay - Big Chetac Lake, Sawyer County
April 25-26, 2015**

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	107	77.54	94.69	31.66	1.57
Lemna trisulca	Forked duckweed	11	7.97	9.73	3.25	1.00
Ceratophyllum demersum	Coontail	7	5.07	6.19	2.07	1.00
Ranunculus aquatilis	White water crowfoot	7	5.07	6.19	2.07	1.00
	Filamentous algae	6	*	5.31	1.78	1.00
Heteranthera dubia	Water star-grass	4	2.90	3.54	1.18	1.00
Potamogeton pusillus	Small pondweed	2	1.45	1.77	0.59	1.00

**Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey – North Bay - Big Chetac Lake, Sawyer County
May 30-31, 2015**

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
	Filamentous algae	32	*	60.3774	7.86	1.22
Lemna trisulca	Forked duckweed	23	35.94	43.40	5.65	1.00
Potamogeton crispus	Curly-leaf pondweed	16	25.00	30.19	3.93	1.19
Ceratophyllum demersum	Coontail	6	9.38	11.32	1.47	1.00
Elodea canadensis	Common waterweed	6	9.38	11.32	1.47	1.00
Heteranthera dubia	Water star-grass	4	6.25	7.55	0.98	1.00
Nitella sp.	Nitella	4	6.25	7.55	0.98	1.00
Potamogeton richardsonii	Clasping-leaf pondweed	3	4.69	5.66	0.74	1.00
Nymphaea odorata	White water lily	1	1.56	1.89	0.25	1.00
Ranunculus aquatilis	White water crowfoot	1	1.56	1.89	0.25	1.00

* Excluded from Relative Frequency Analysis

Table 5: Frequencies and Mean Rake Sample of Aquatic Macrophytes
April Survey – Boat Landing Bay - Big Chetac Lake, Sawyer County
April 25-26, 2015

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	15	71.43	88.24	45.45	1.20
Potamogeton pusillus	Small pondweed	5	23.81	29.41	15.15	1.40
Potamogeton friesii	Fries' pondweed	1	4.76	5.882	3.03	1.00
	Filamentous algae	1	*	5.88	3.03	1.00

Table 6: Frequencies and Mean Rake Sample of Aquatic Macrophytes
May Survey – Boat Landing Bay - Big Chetac Lake, Sawyer County
May 30-31, 2015

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	14	63.64	77.78	51.85	1.36
Potamogeton pusillus	Small pondweed	5	22.73	27.78	18.52	1.00
Potamogeton friesii	Fries' pondweed	2	9.09	11.11	7.41	1.50
	Filamentous algae	2	*	11.11	7.41	1.00
Myriophyllum sibiricum	Northern water-milfoil	1	4.55	5.56	3.70	1.00

* Excluded from Relative Frequency Analysis

Table 7: Frequencies and Mean Rake Sample of Aquatic Macrophytes
April Survey – Western Control Bay - Big Chetac Lake, Sawyer County
April 25-26, 2015

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	32	44.44	61.54	35.56	1.66
Ceratophyllum demersum	Coontail	29	40.28	55.77	32.22	1.31
Potamogeton praelongus	White-stem pondweed	6	8.33	11.54	6.67	1.17
Potamogeton pusillus	Small pondweed	2	2.78	3.85	2.22	1.00
Potamogeton robbinsii	Fern pondweed	3	4.17	5.77	3.33	1.00
	Filamentous algae	1	*	1.92	1.11	2.00

Table 8: Frequencies and Mean Rake Sample of Aquatic Macrophytes
May Survey – Western Control Bay - Big Chetac Lake, Sawyer County
May 30-31, 2015

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	44	55.00	80.00	45.36	1.77
Ceratophyllum demersum	Coontail	16	20.00	29.09	16.49	1.06
Potamogeton praelongus	White-stem pondweed	14	17.50	25.45	14.43	1.07
Potamogeton robbinsii	Fern pondweed	3	3.75	5.45	3.09	1.00
Nymphaea odorata	White water lily	2	2.50	3.64	2.06	1.00
Potamogeton pusillus	Small pondweed	1	1.25	1.82	1.03	1.00

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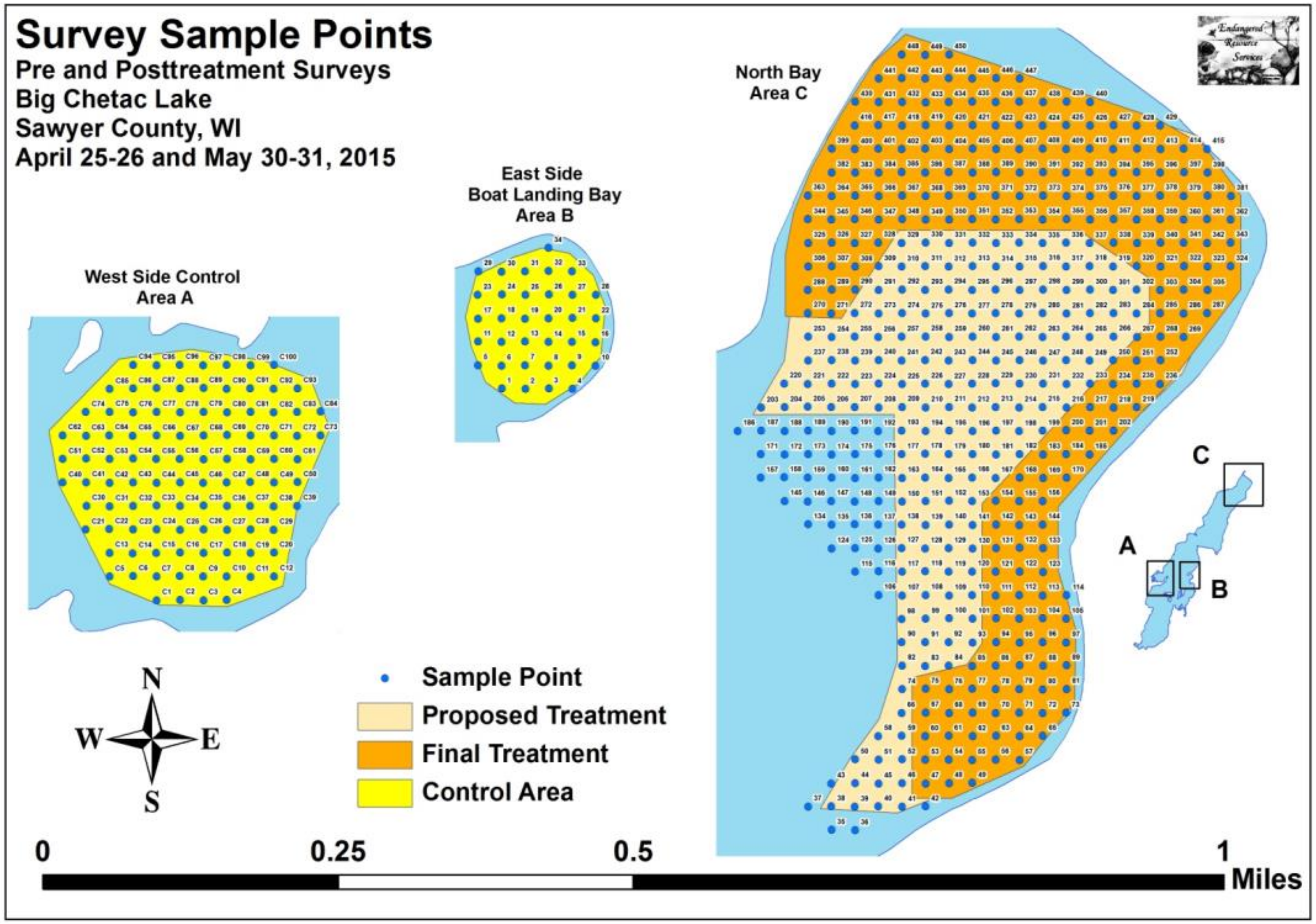
Busch, C., E. Eaton, N. Pokorny, and C. Holt. [online]. 1967. Big Chetac Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2113300a.pdf (2013, July).

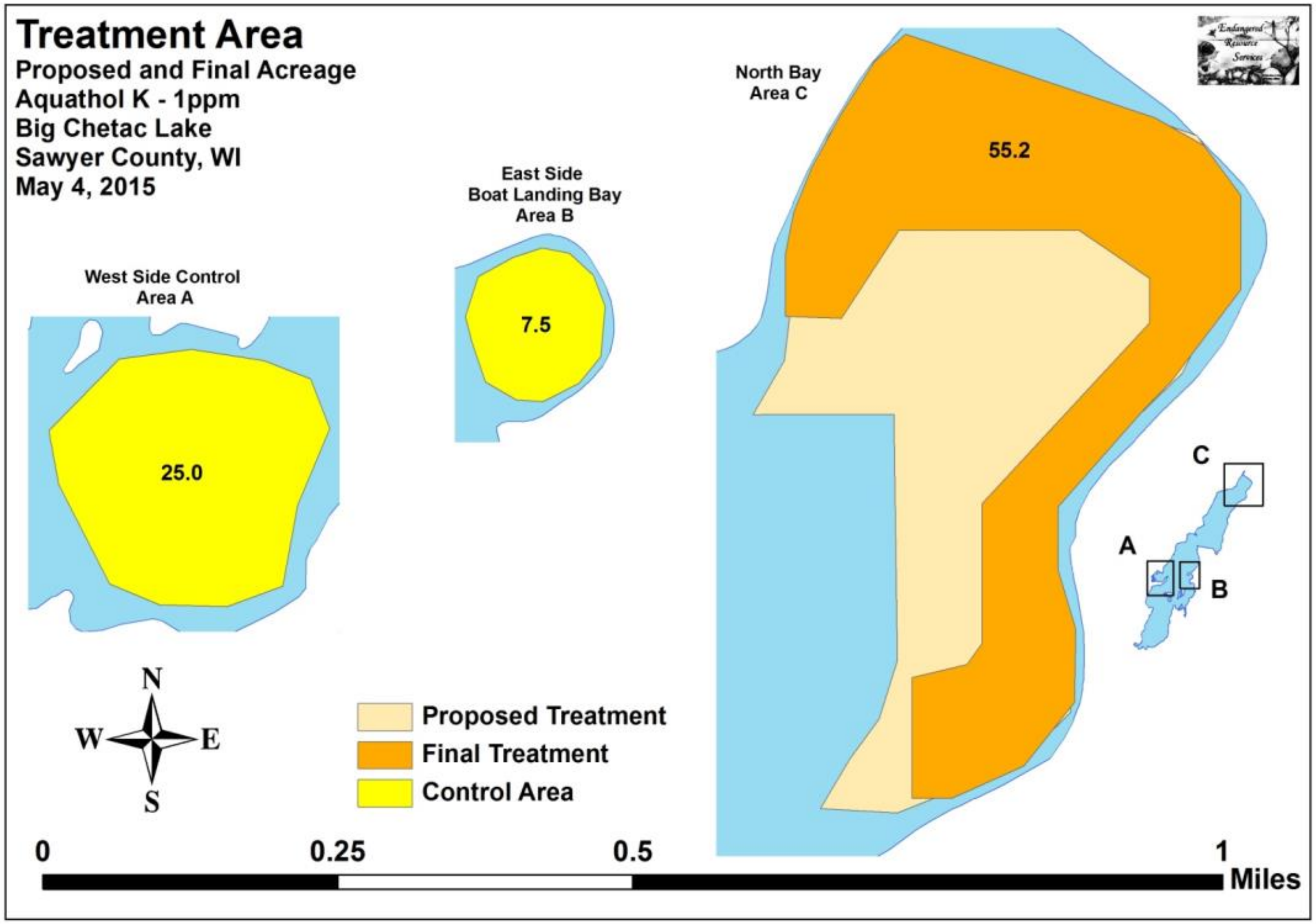
James, W.F., J.W. Barko, H.L. Eakin, and P.W. Sorge. 2002. Phosphorus budget and management strategies for an urban Wisconsin lake. Lake and Reserv. Manage. 18(2): 149-163

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp (2010, July).

WDNR. [online]. 2015. Big Chetac Lake - Citizen Lake Water Quality Monitoring Database. Available from http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2113300&page=waterquality 2015, August).

Appendix I: Survey Sample Points and CLP Treatment Area

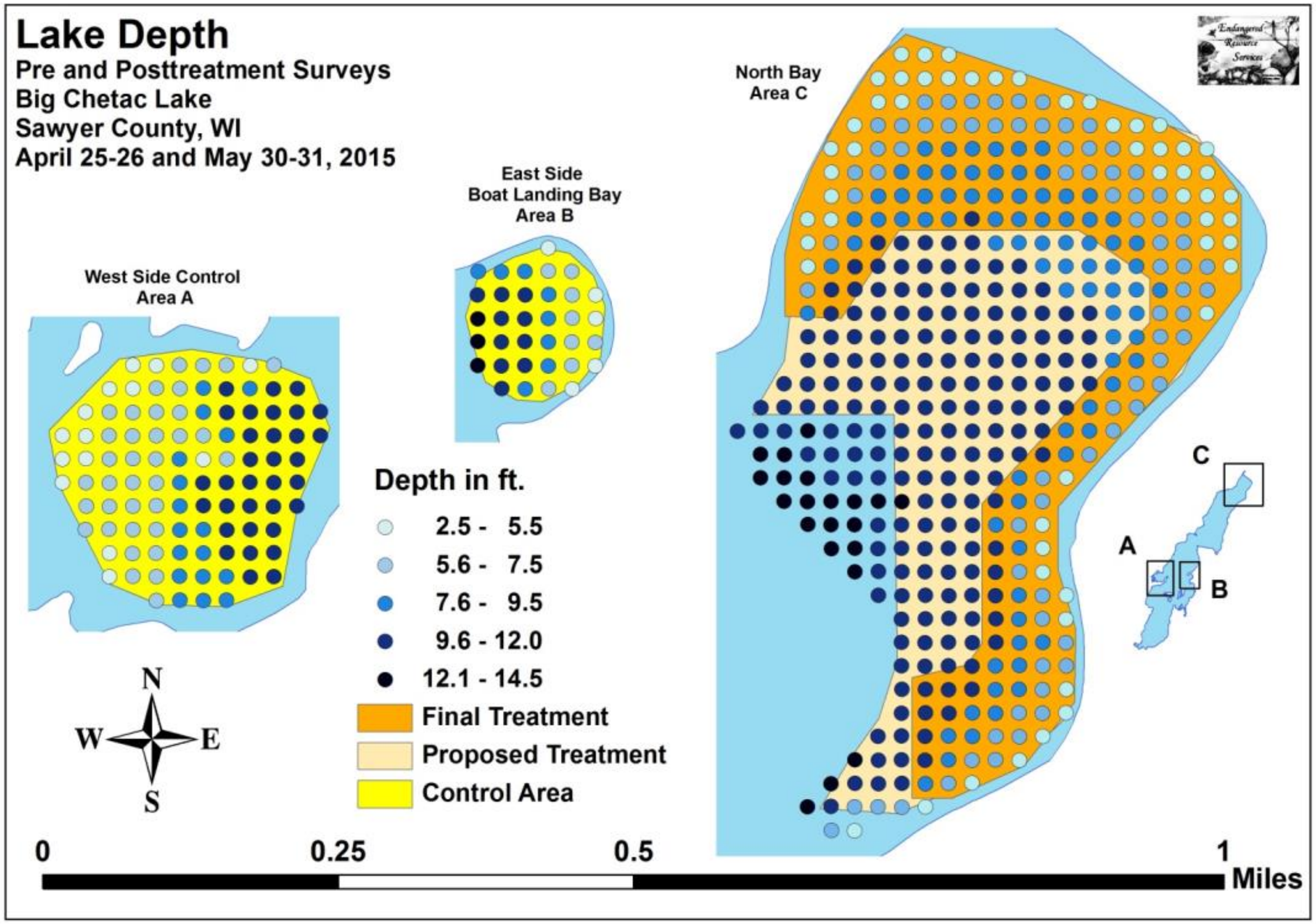

Survey Sample Points
Pre and Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
April 25-26 and May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
A
B
C
N
W
E
S
Sample Point
Proposed Treatment
Final Treatment
Control Area
0
0.25
0.5
1
Miles

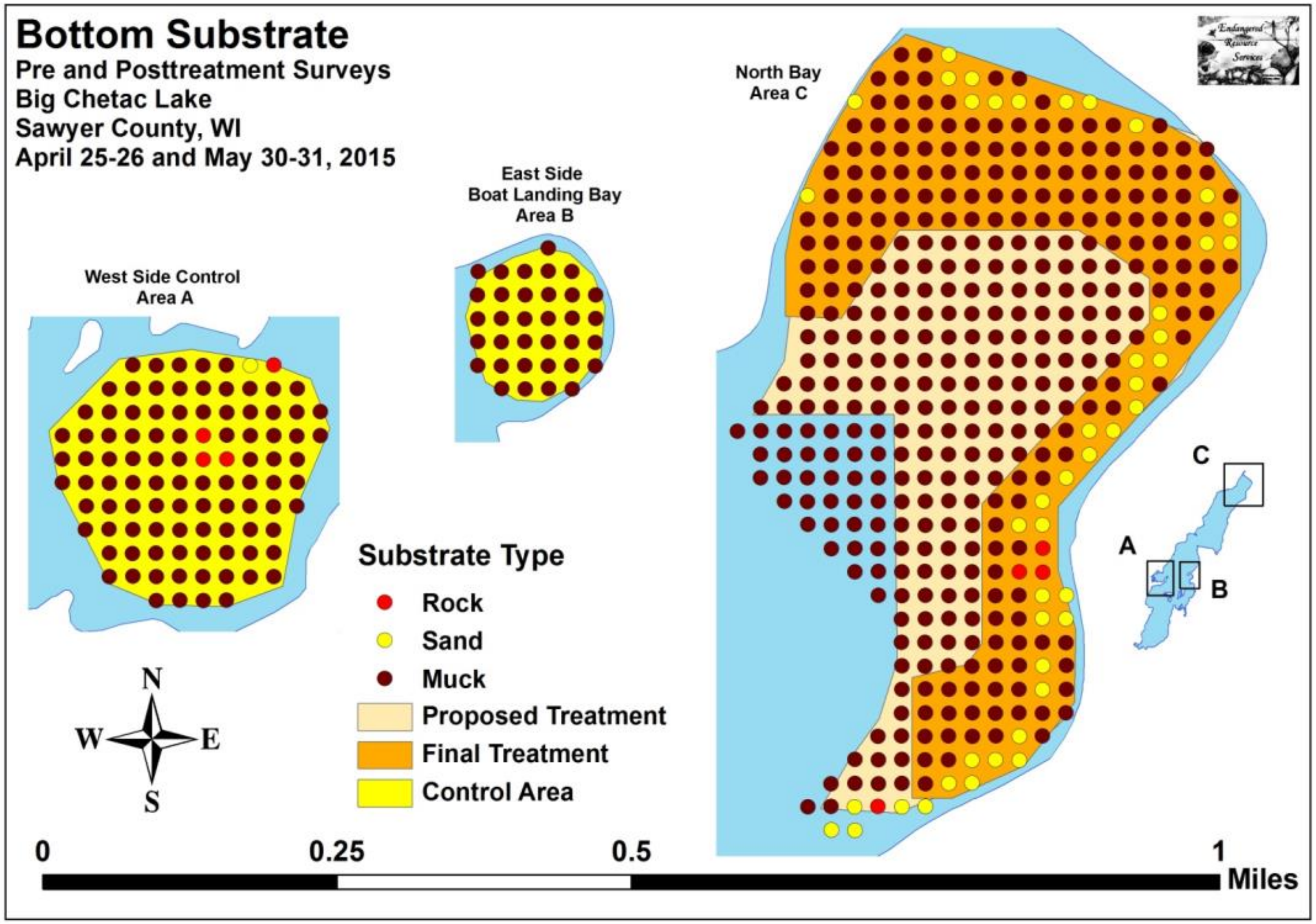

Treatment Area
Proposed and Final Acreage
Aquathol K - 1ppm
Big Chetac Lake
Sawyer County, WI
May 4, 2015
West Side Control
Area A
25.0
East Side
Boat Landing Bay
Area B
7.5
North Bay
Area C
55.2
C
A
B
N
W
E
S
Proposed Treatment
Final Treatment
Control Area
0
0.25
0.5
1
Miles

Appendix II: Vegetative Survey Data Sheet

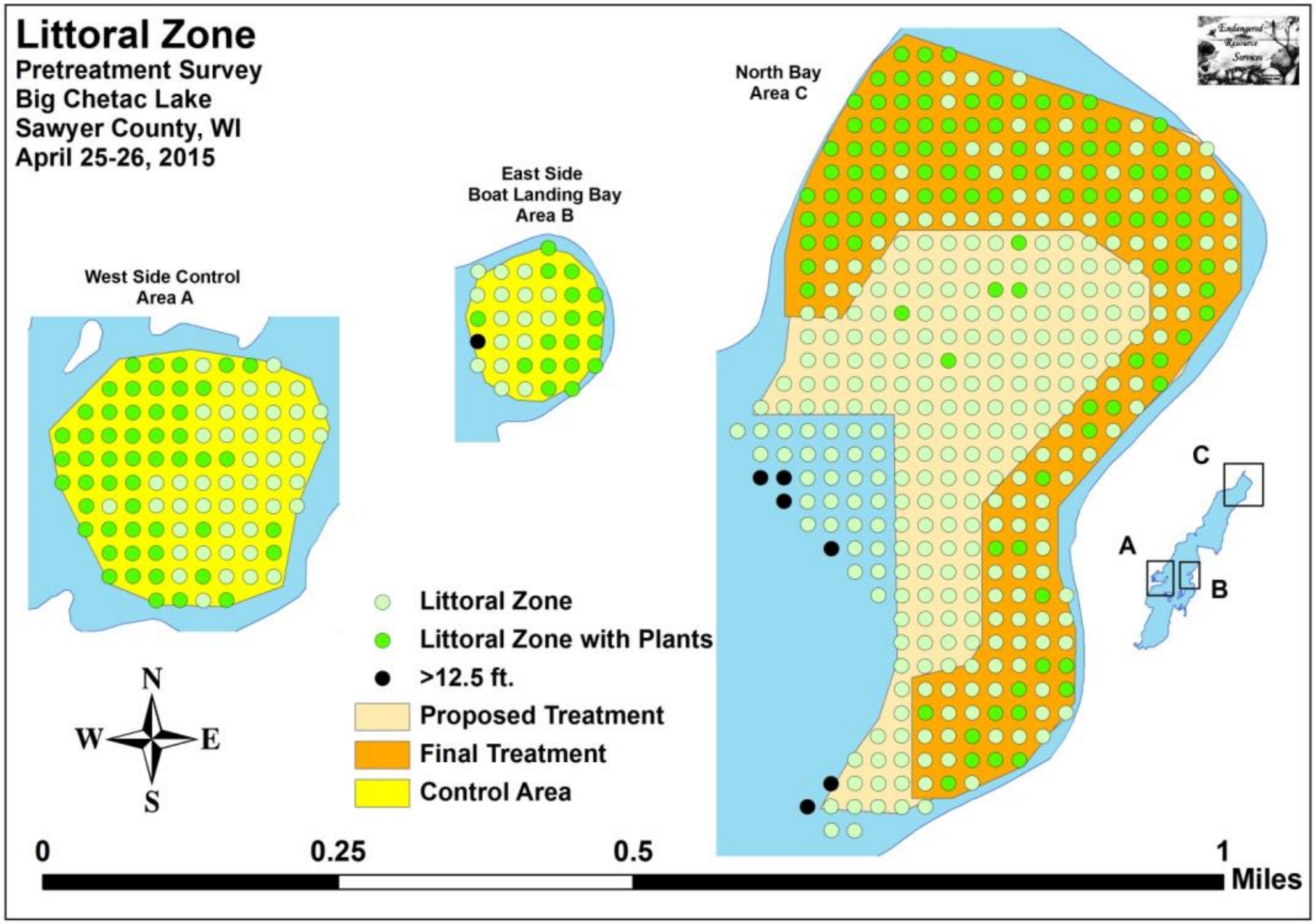
Lake:								WBIC									County						Date:	
Site #	**Depth (ft)**	**Muck (M), Sand (S), Rock (R)**	**Rake pole (P) or rake rope (R)**	**Total Rake Fullness**	**CLP**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1								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

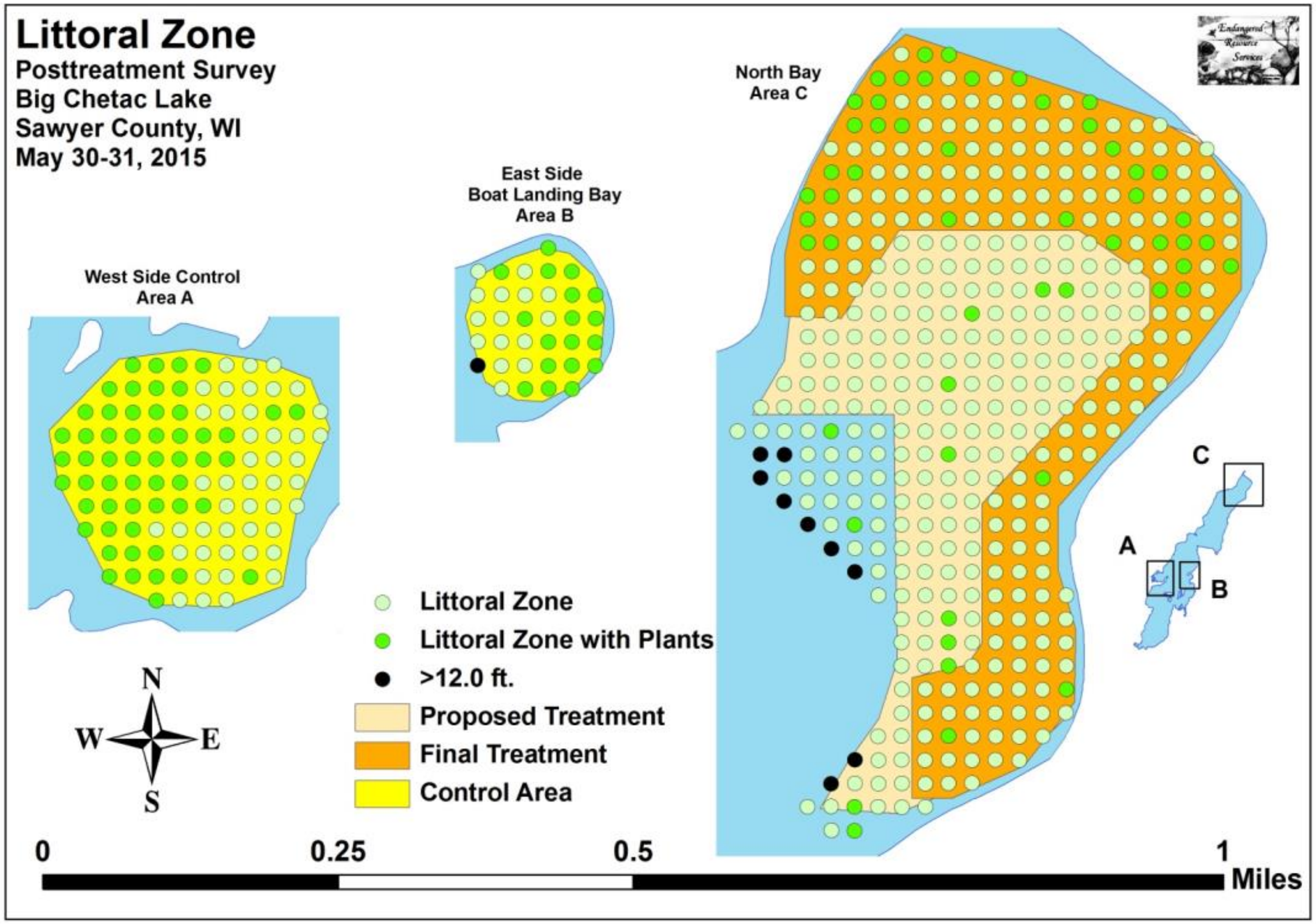
Appendix III: Pre/Post Habitat Variable Maps

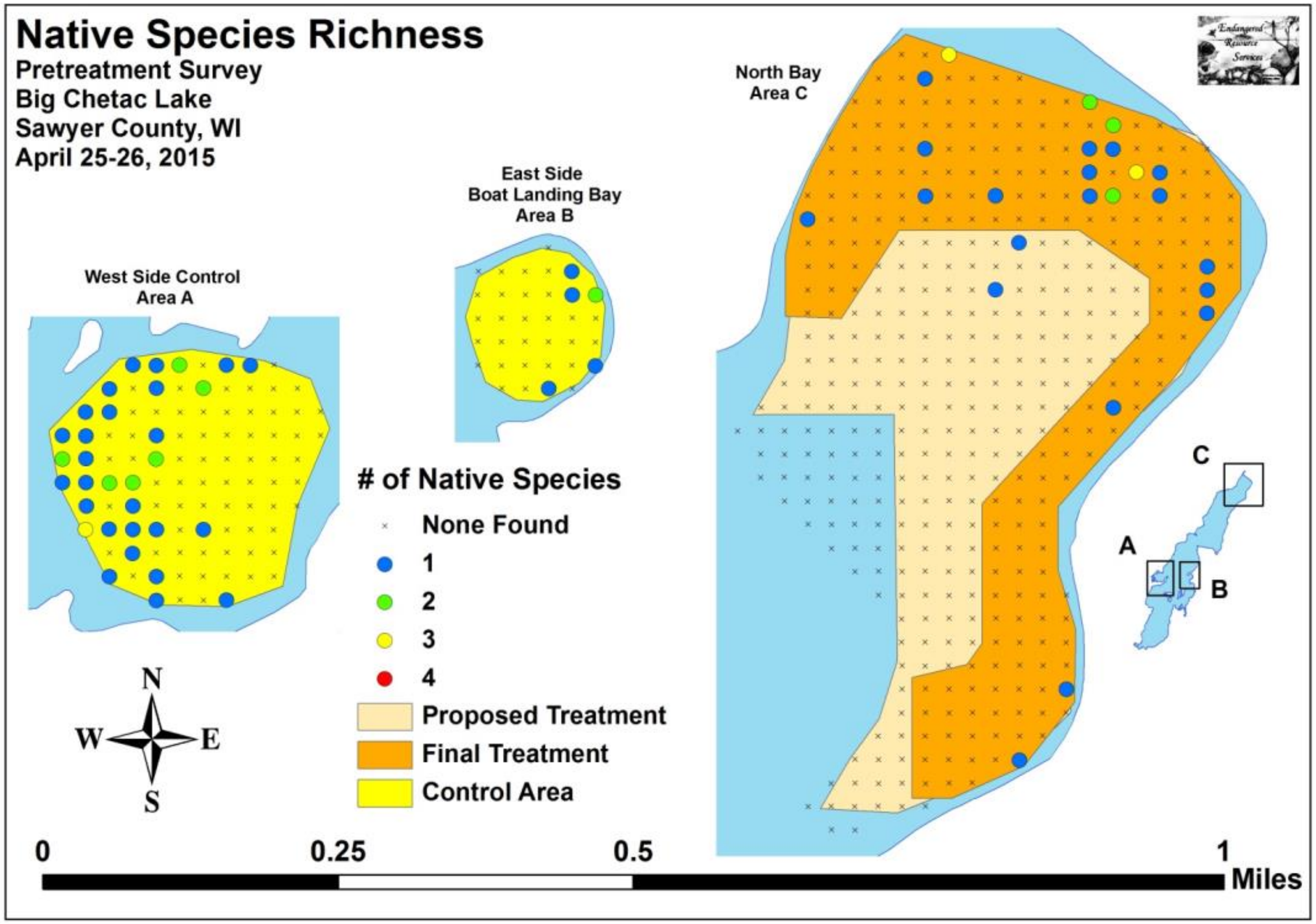

Lake Depth
Pre and Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
April 25-26 and May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Depth in ft.
2.5 - 5.5
5.6 - 7.5
7.6 - 9.5
9.6 - 12.0
12.1 - 14.5
Final Treatment
Proposed Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

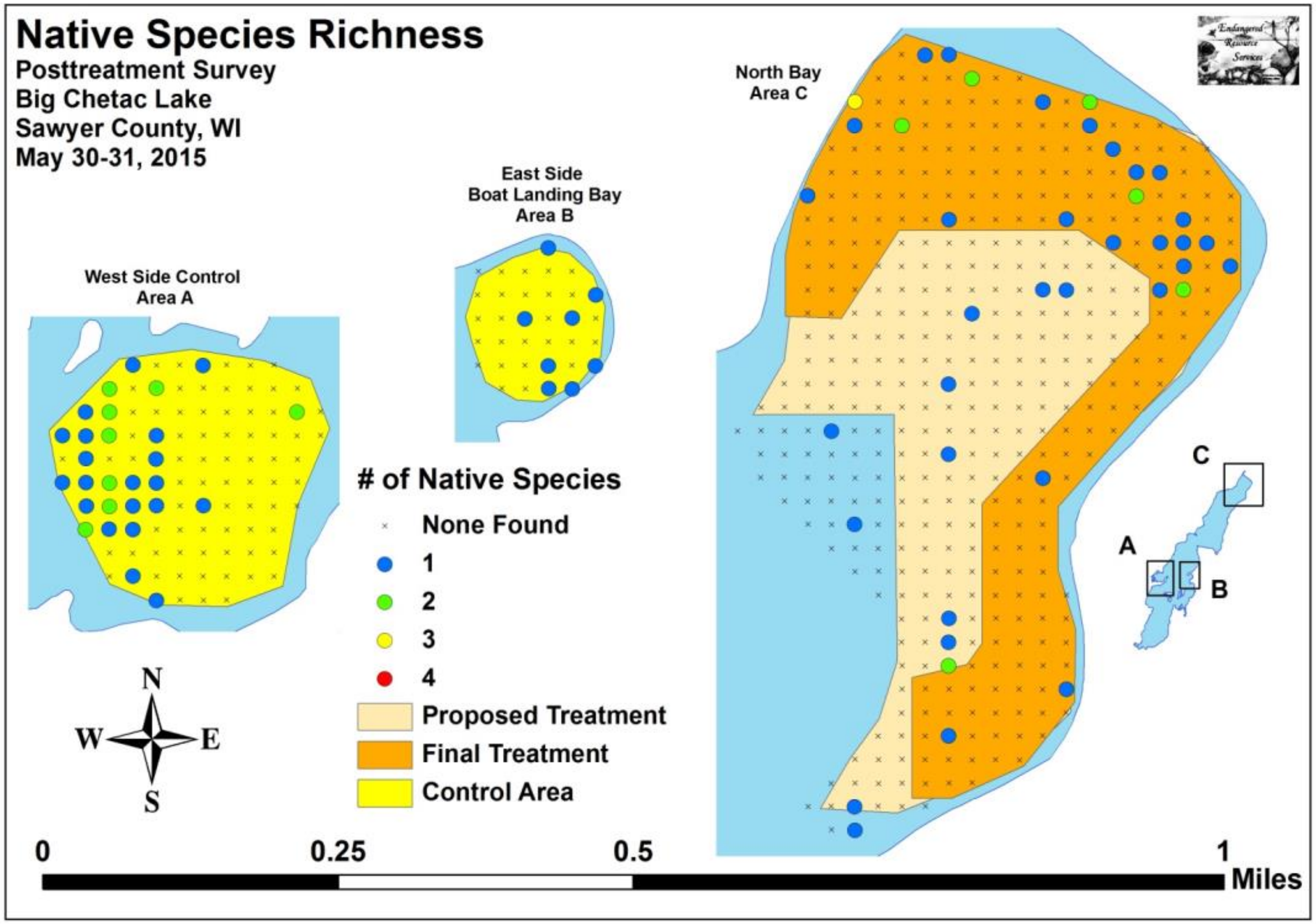

Bottom Substrate
Pre and Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
April 25-26 and May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Substrate Type
Rock
Sand
Muck
Proposed Treatment
Final Treatment
Control Area
N
S
W
E
A
B
C
0
0.25
0.5
1
Miles

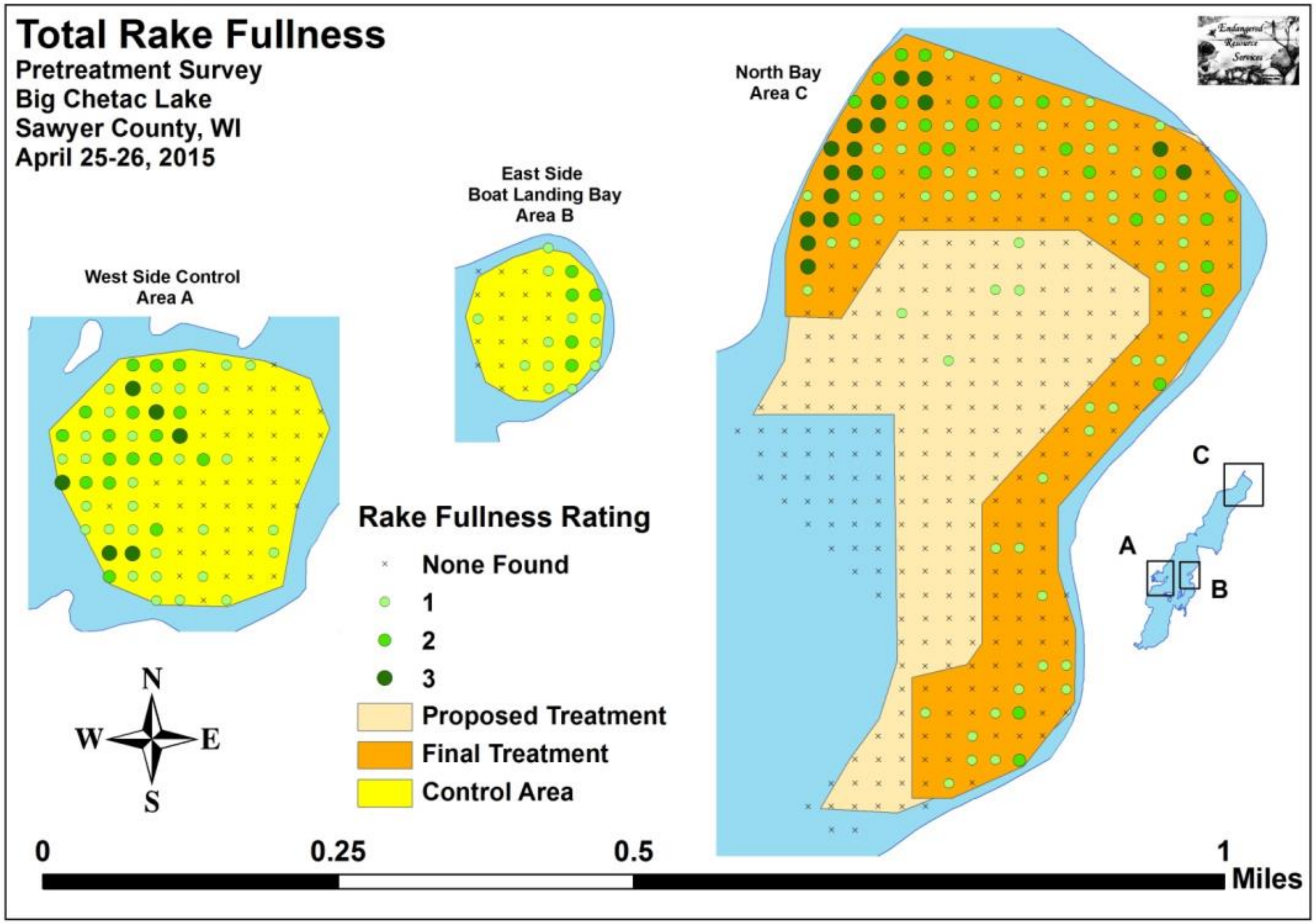
Appendix IV: Pre/Post Littoral Zone, Native Species Richness, and Total Rake Fullness


Littoral Zone
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Littoral Zone
Littoral Zone with Plants
>12.5 ft.
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

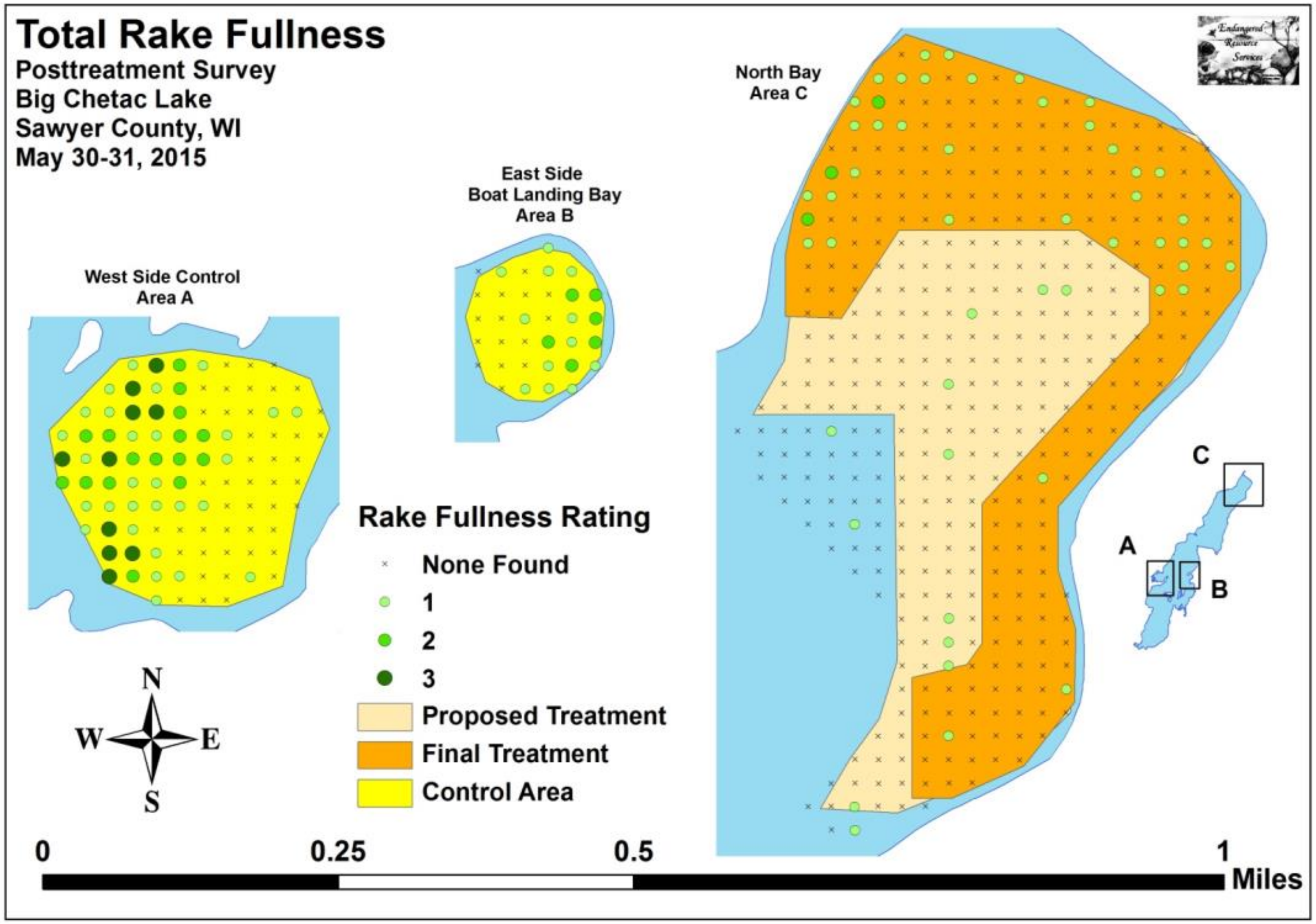

Littoral Zone
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Littoral Zone
Littoral Zone with Plants
>12.0 ft.
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Native Species Richness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
# of Native Species
None Found
1
2
3
4
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

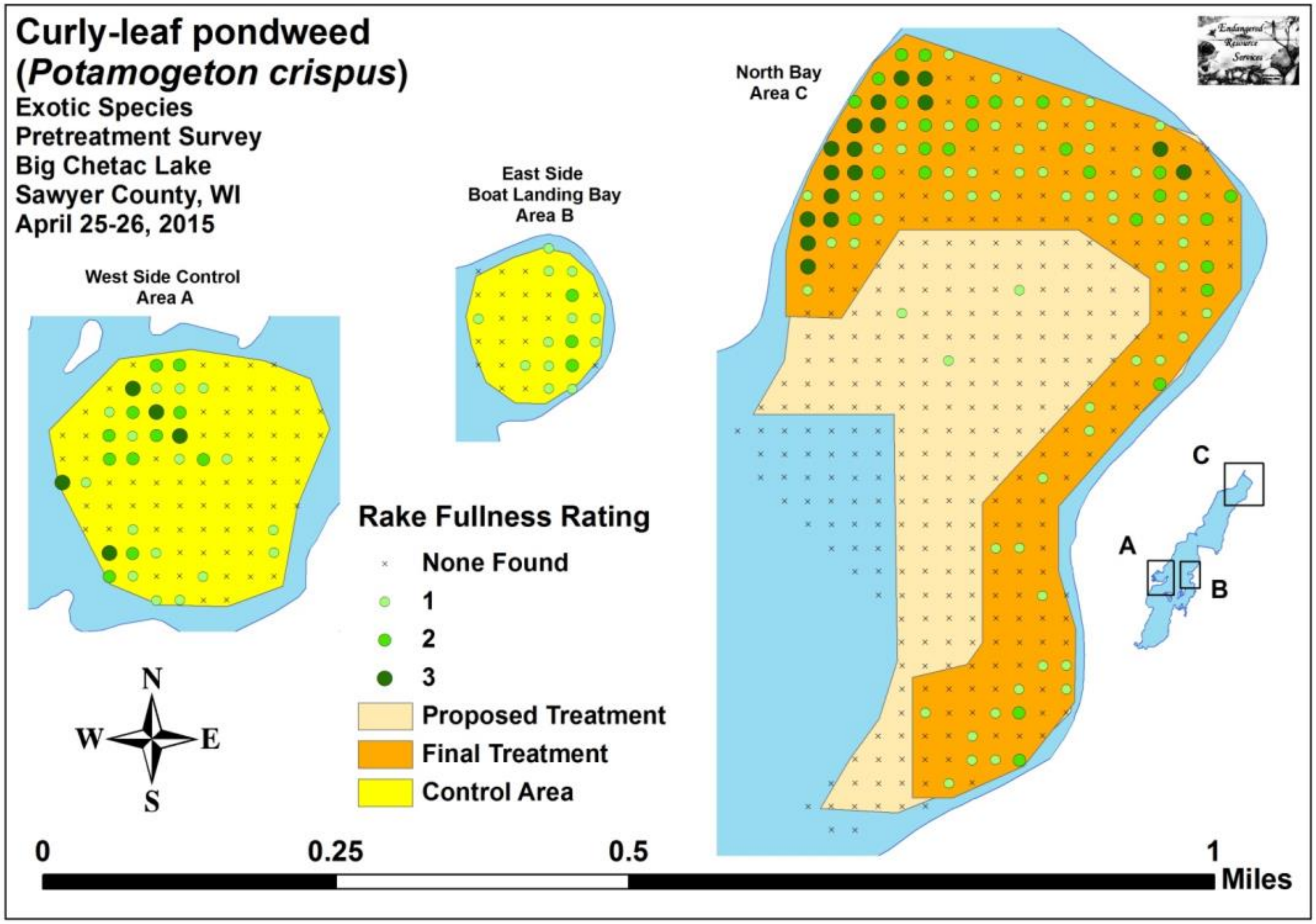

Native Species Richness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
# of Native Species
None Found
1
2
3
4
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

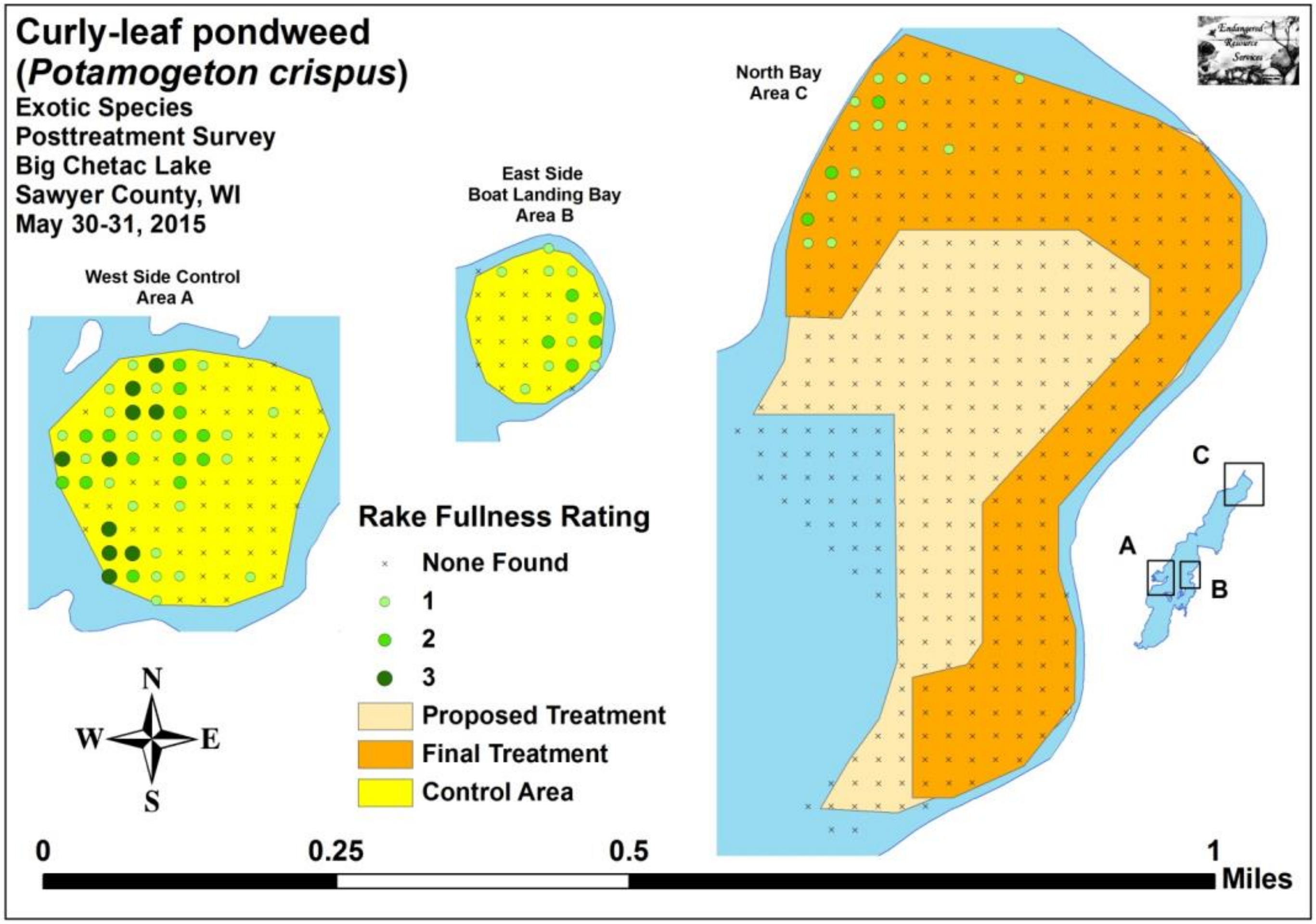


Total Rake Fullness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

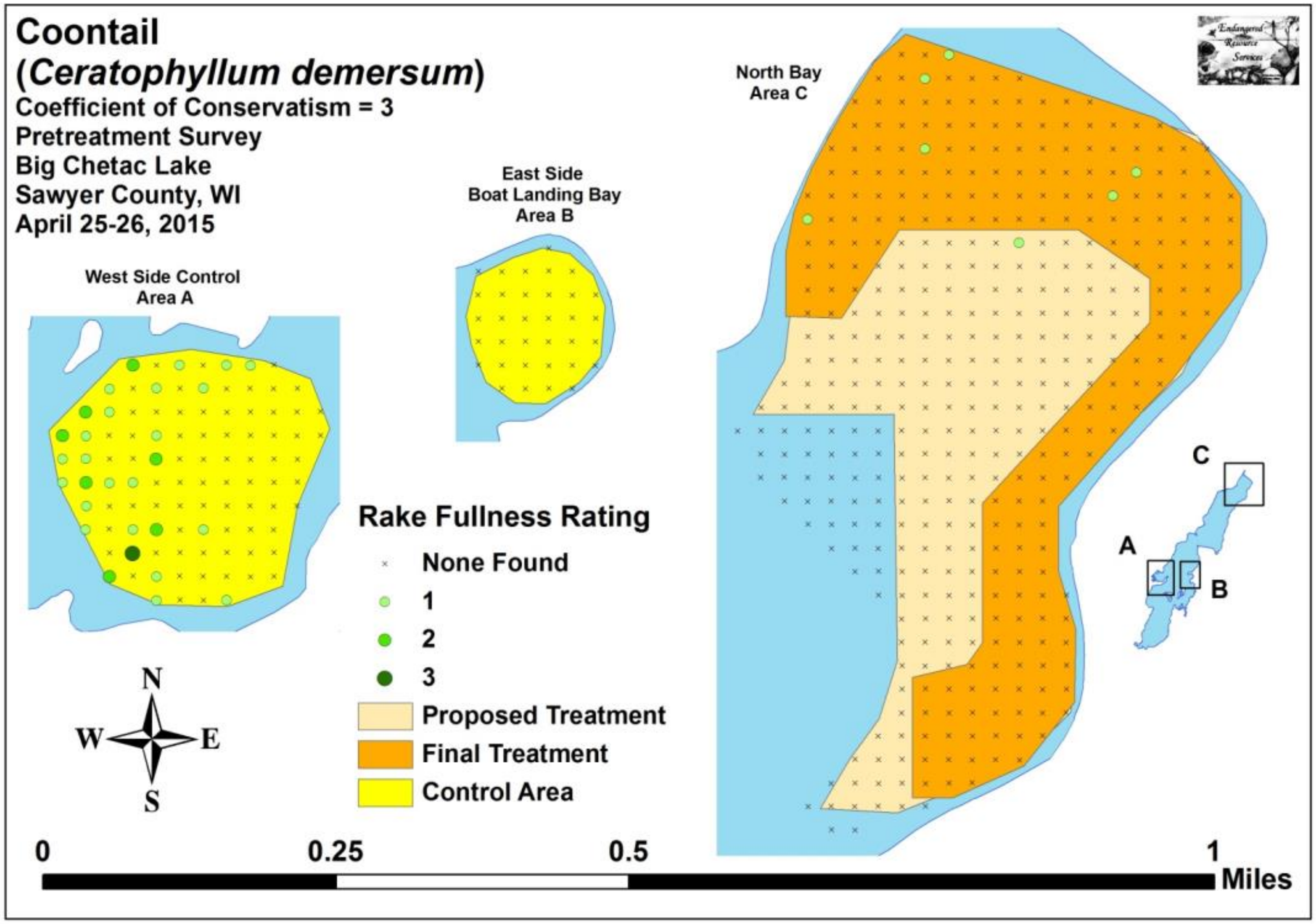

Total Rake Fullness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
North Bay
Area C
East Side
Boat Landing Bay
Area B
West Side Control
Area A
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
C
A
B
0
0.25
0.5
1
Miles

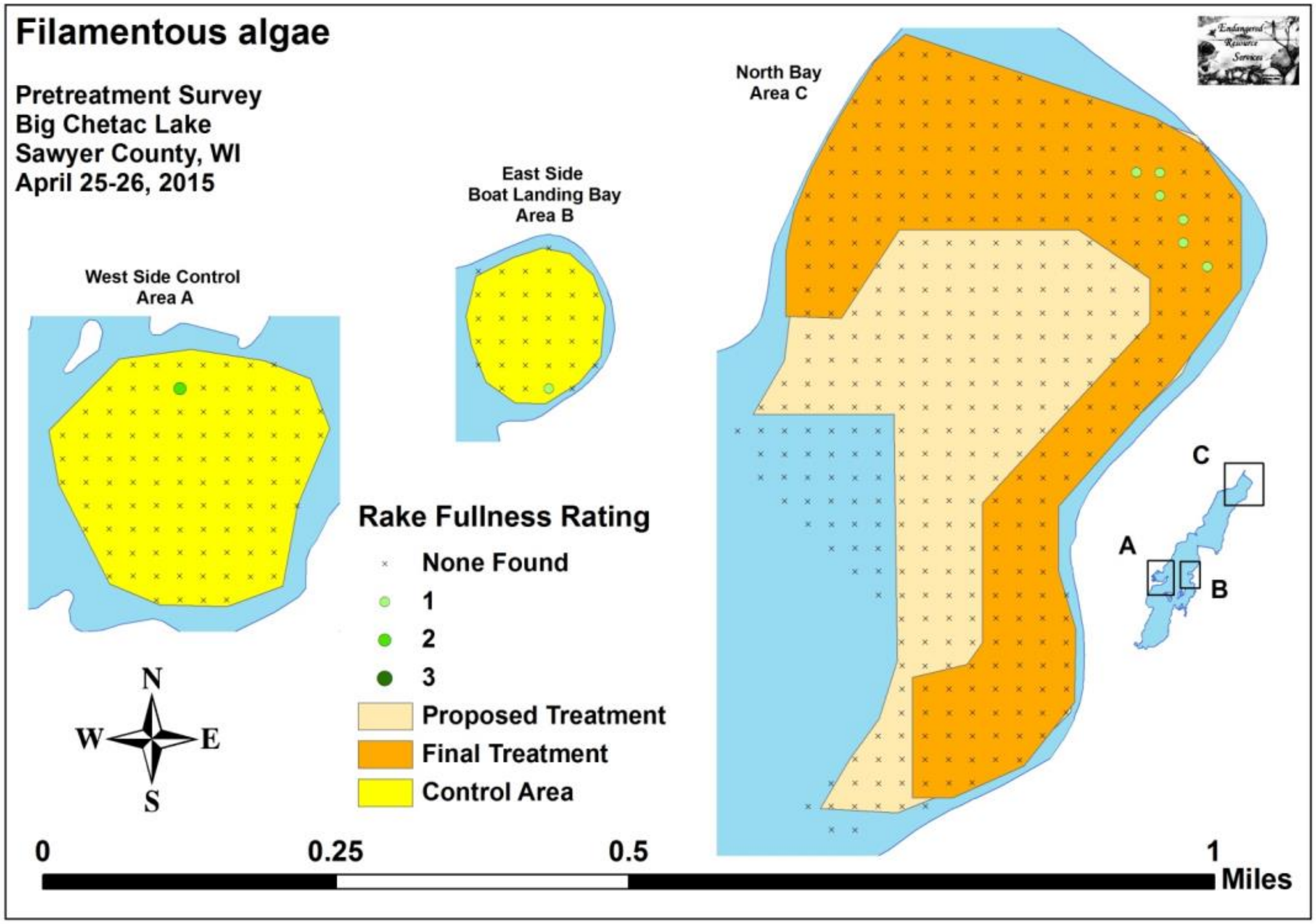
Appendix V: CLP Pre/Post Density and Distribution

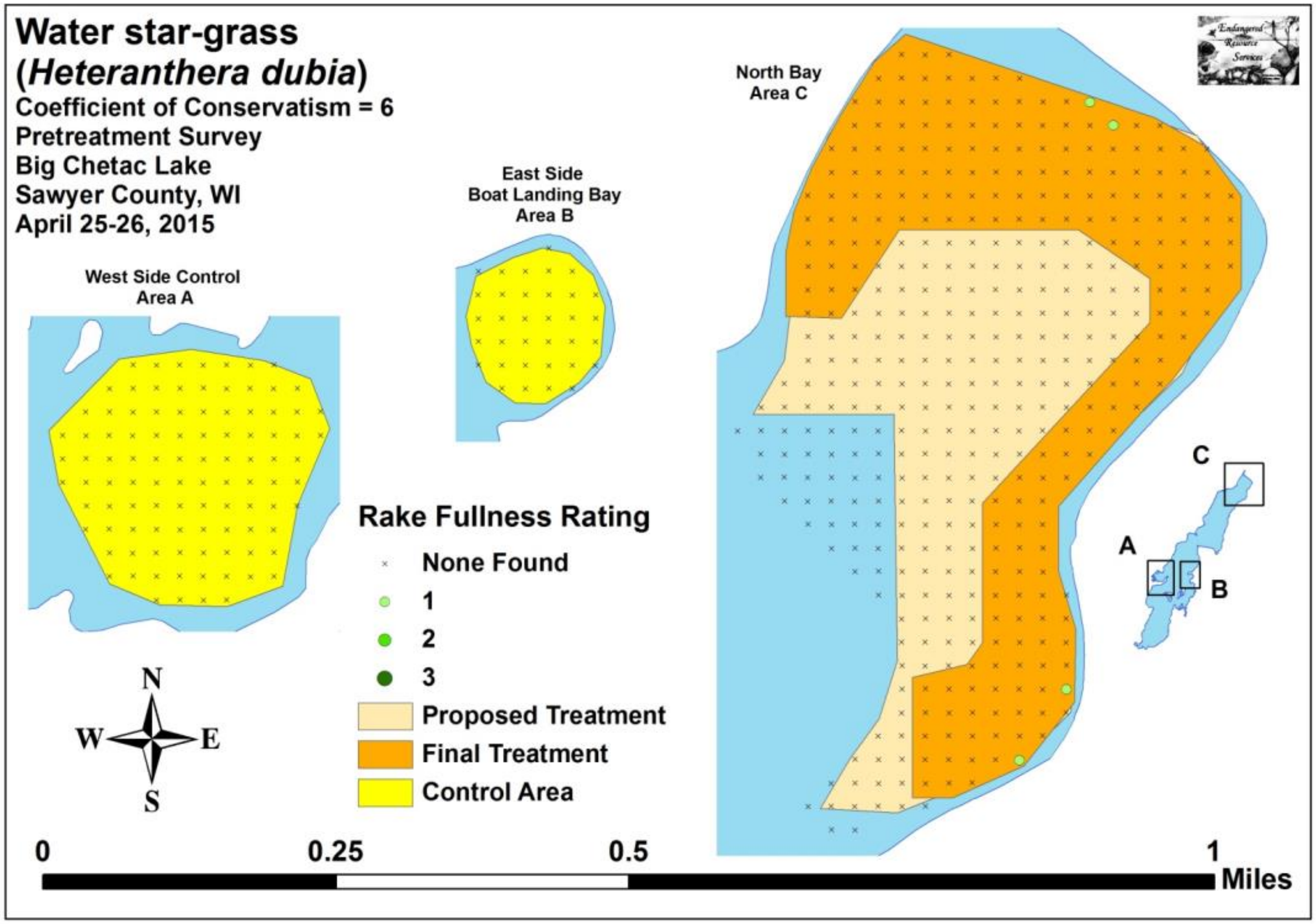

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
0
0.25
0.5
1
Miles
A
B
C

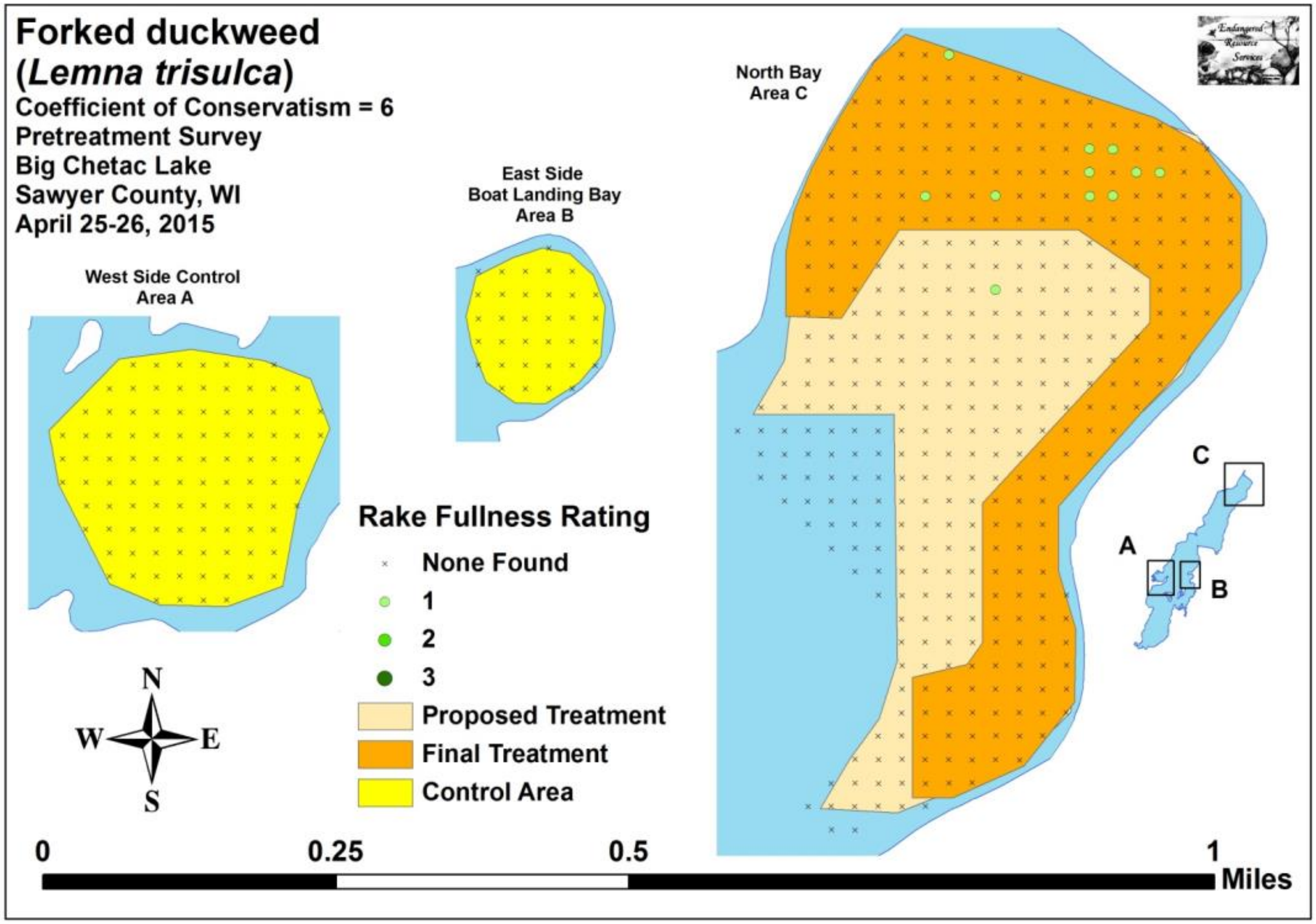

Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

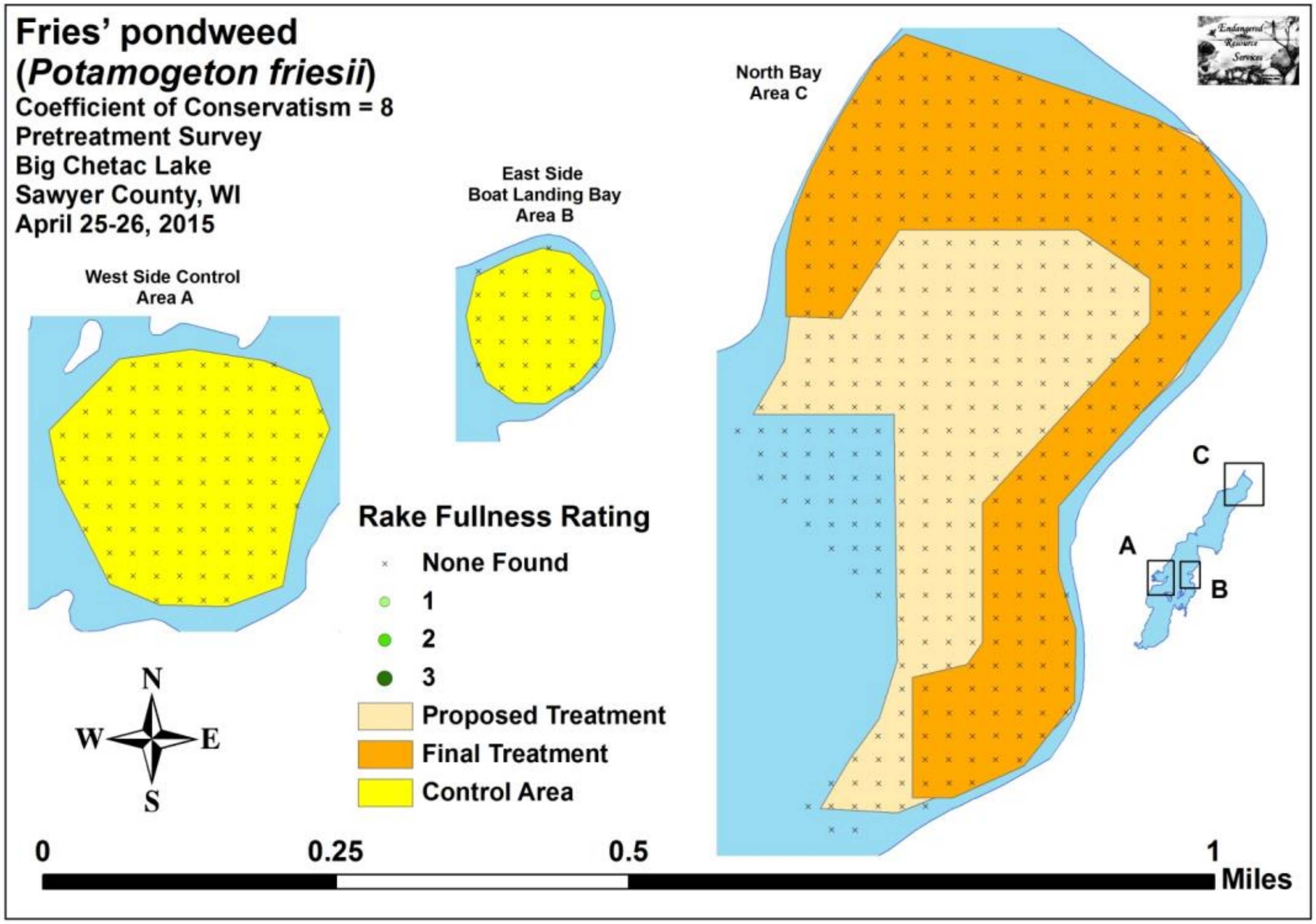
Appendix VI: Pretreatment Native Species Density and Distribution

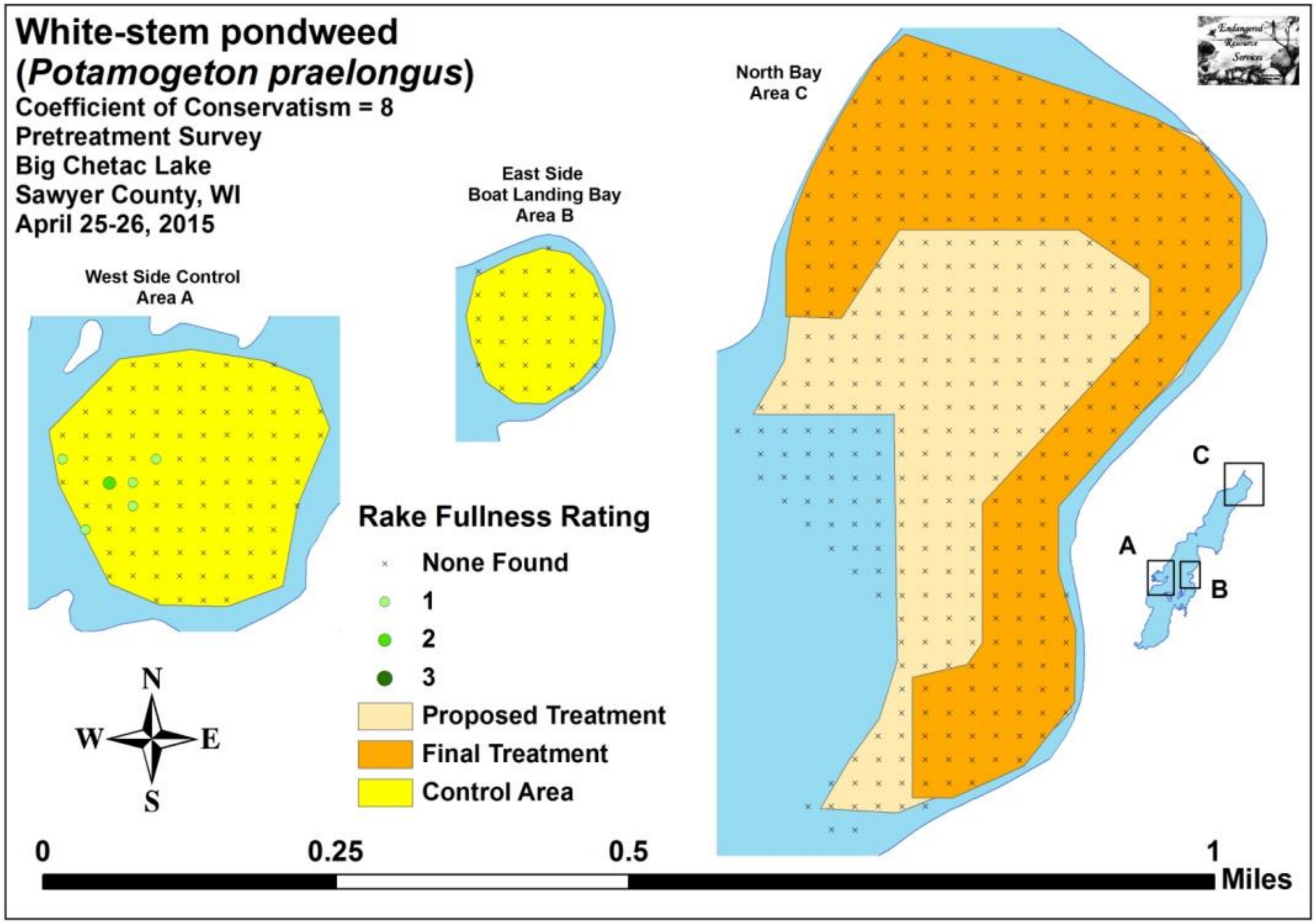

Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

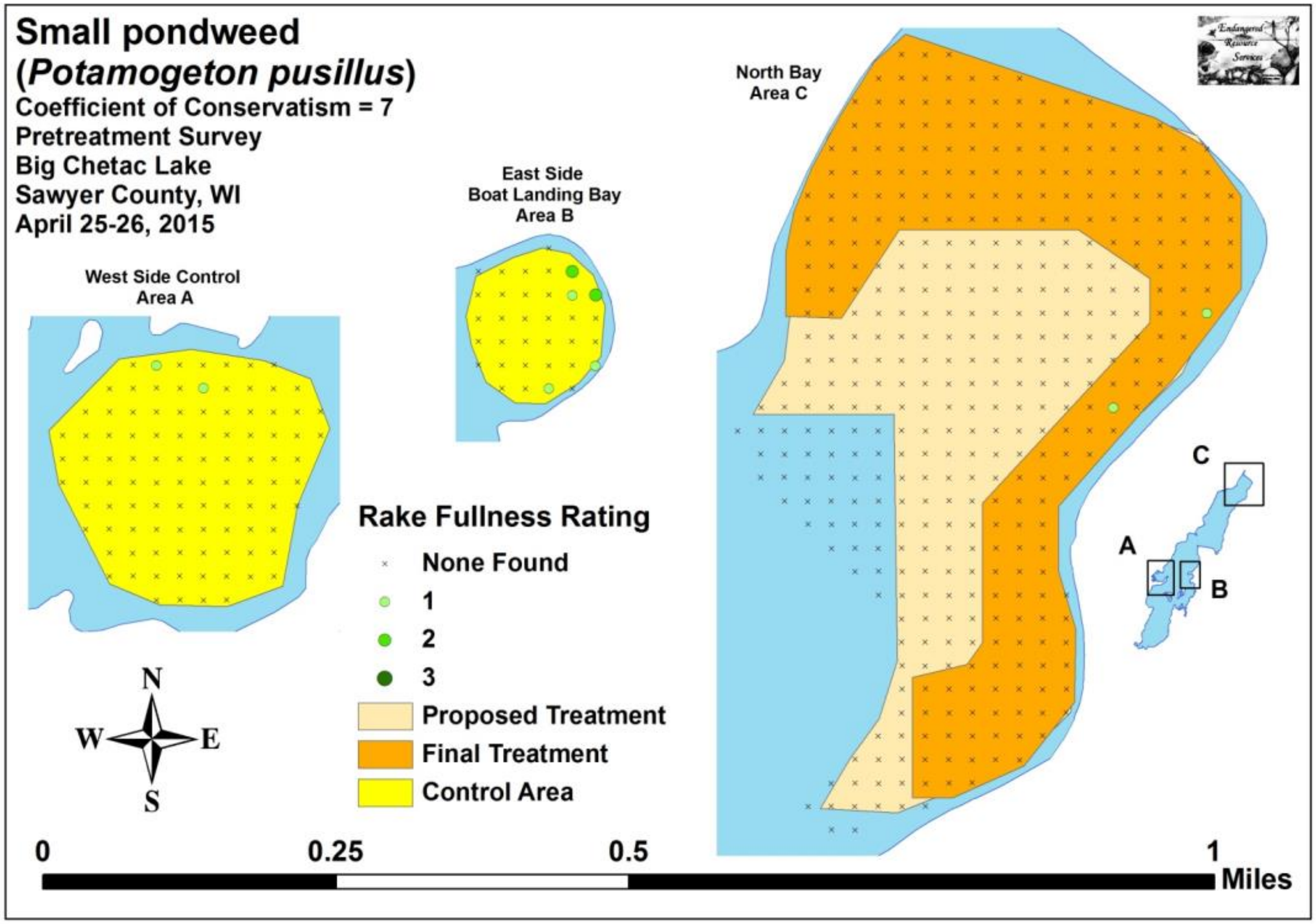

Filamentous algae
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

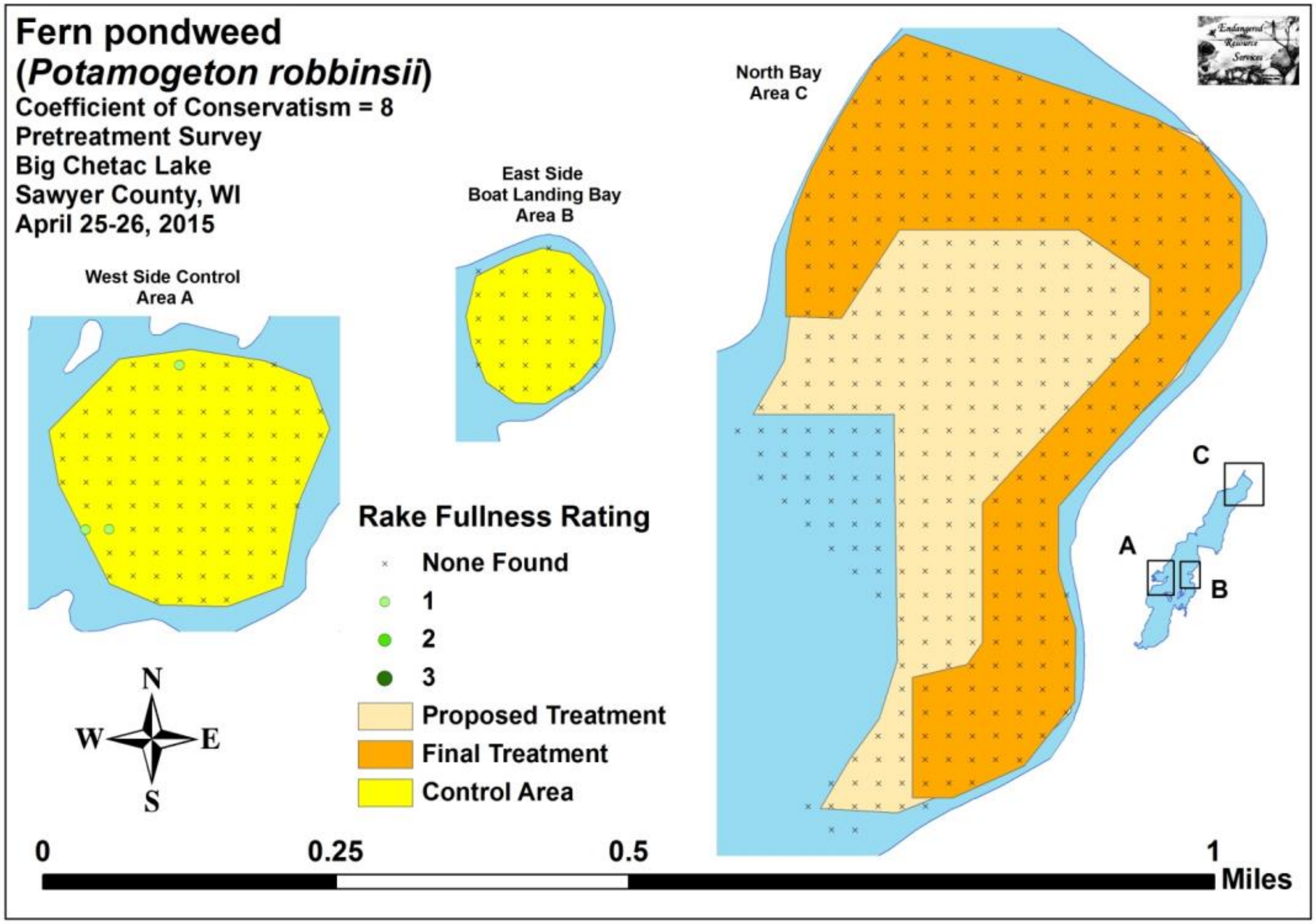

Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles
Endangered Resource Services


Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

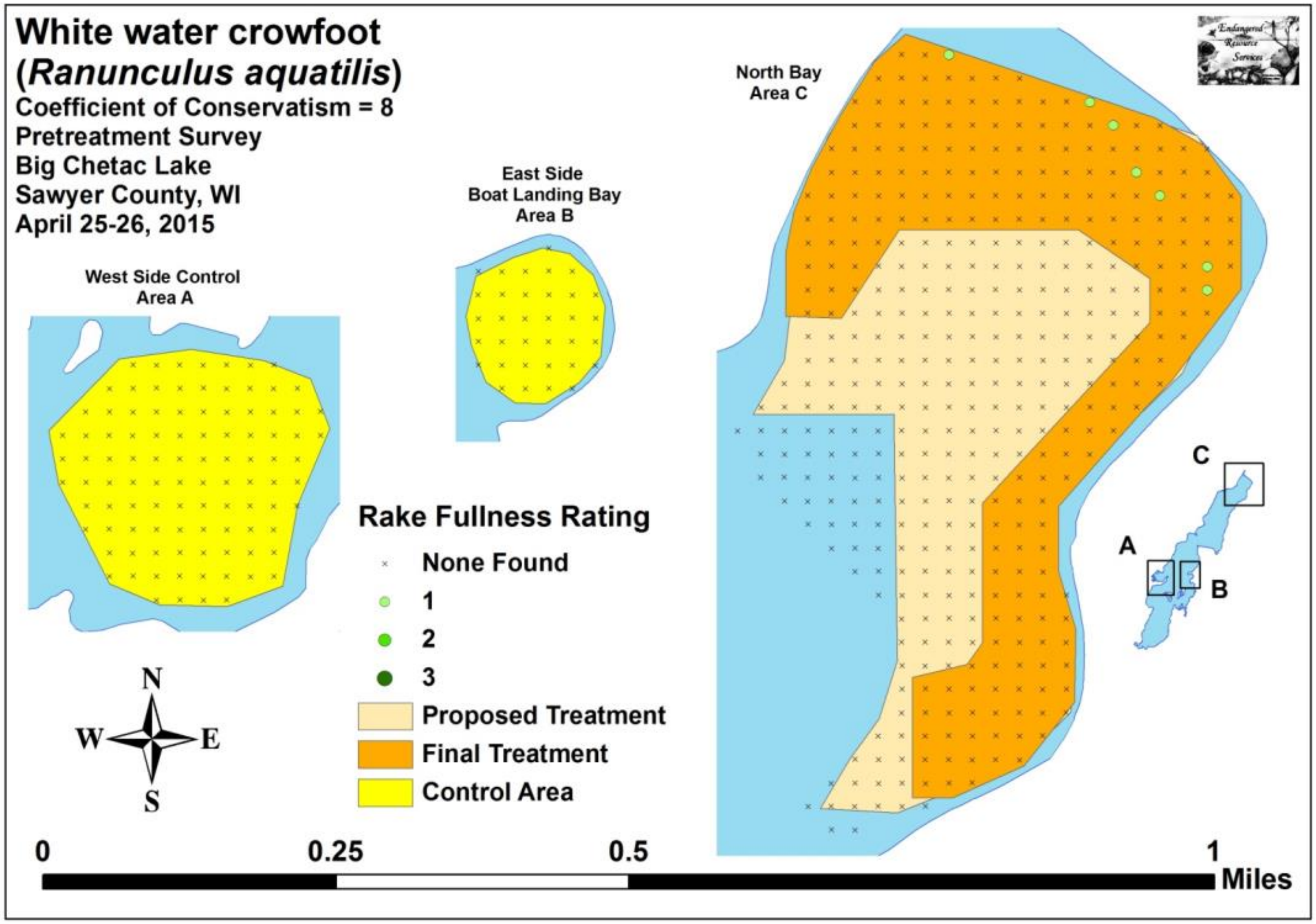

Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

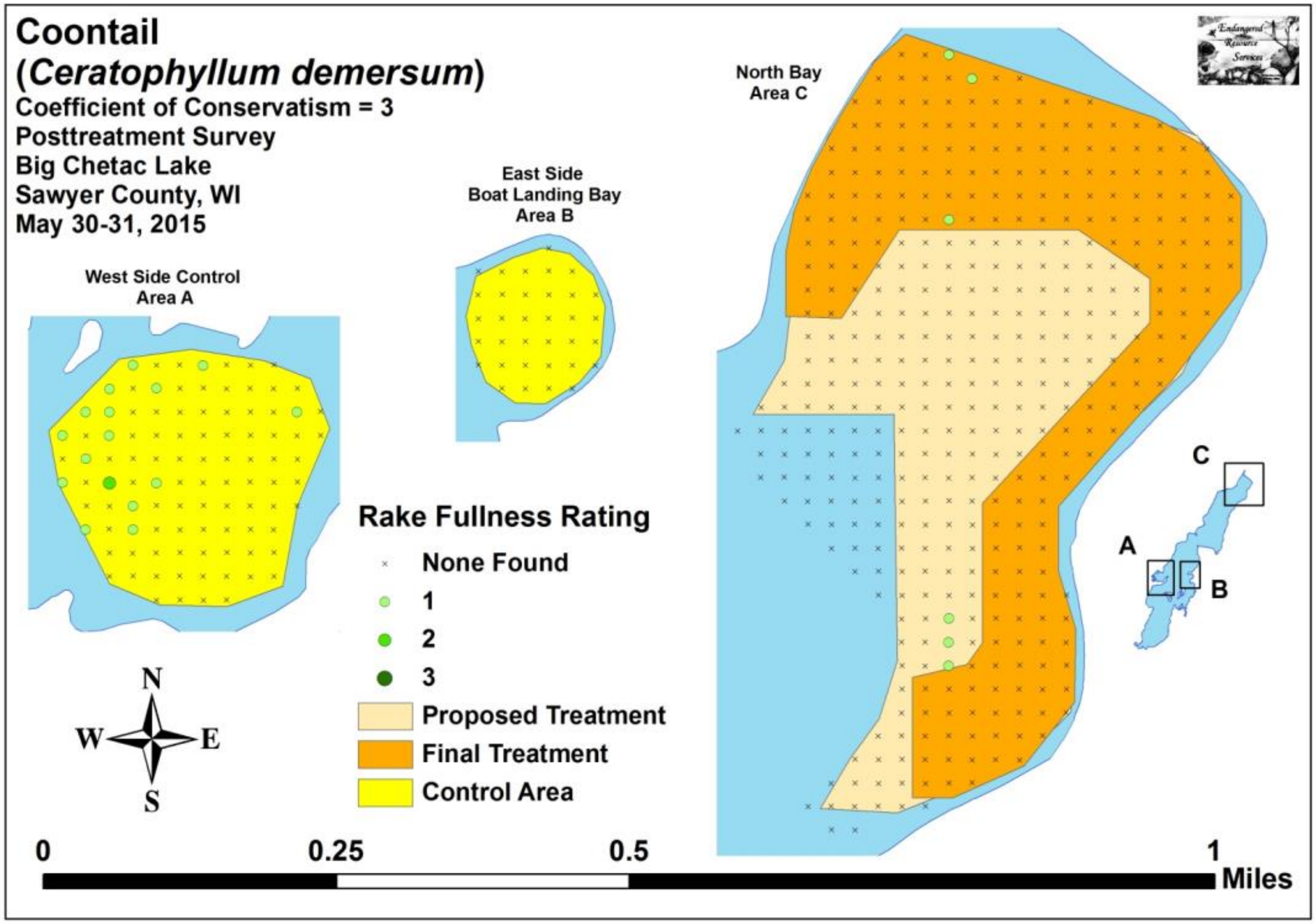

Small pondweed
(*Potamogeton pusillus*)
Coefficient of Conservatism = 7
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

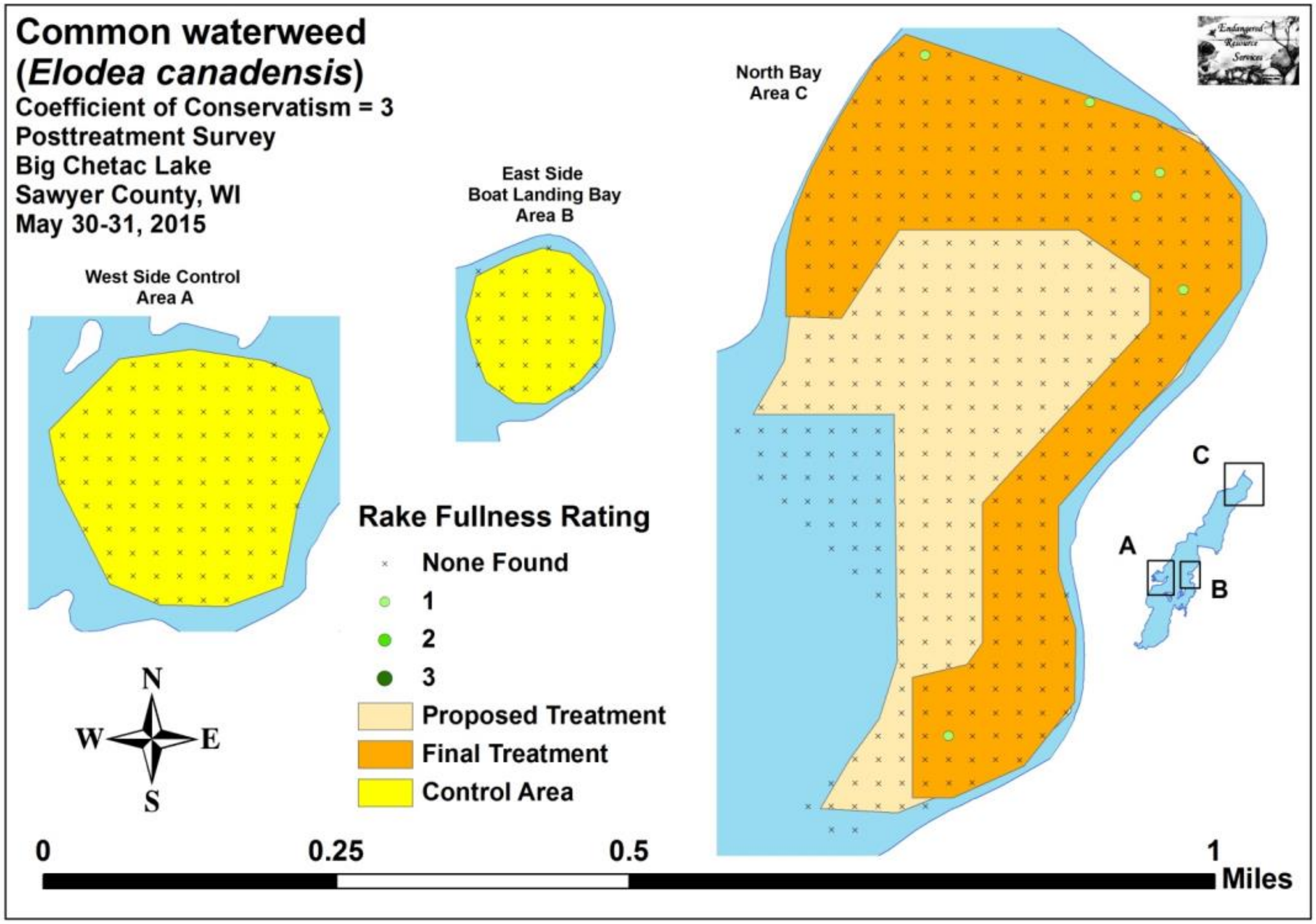


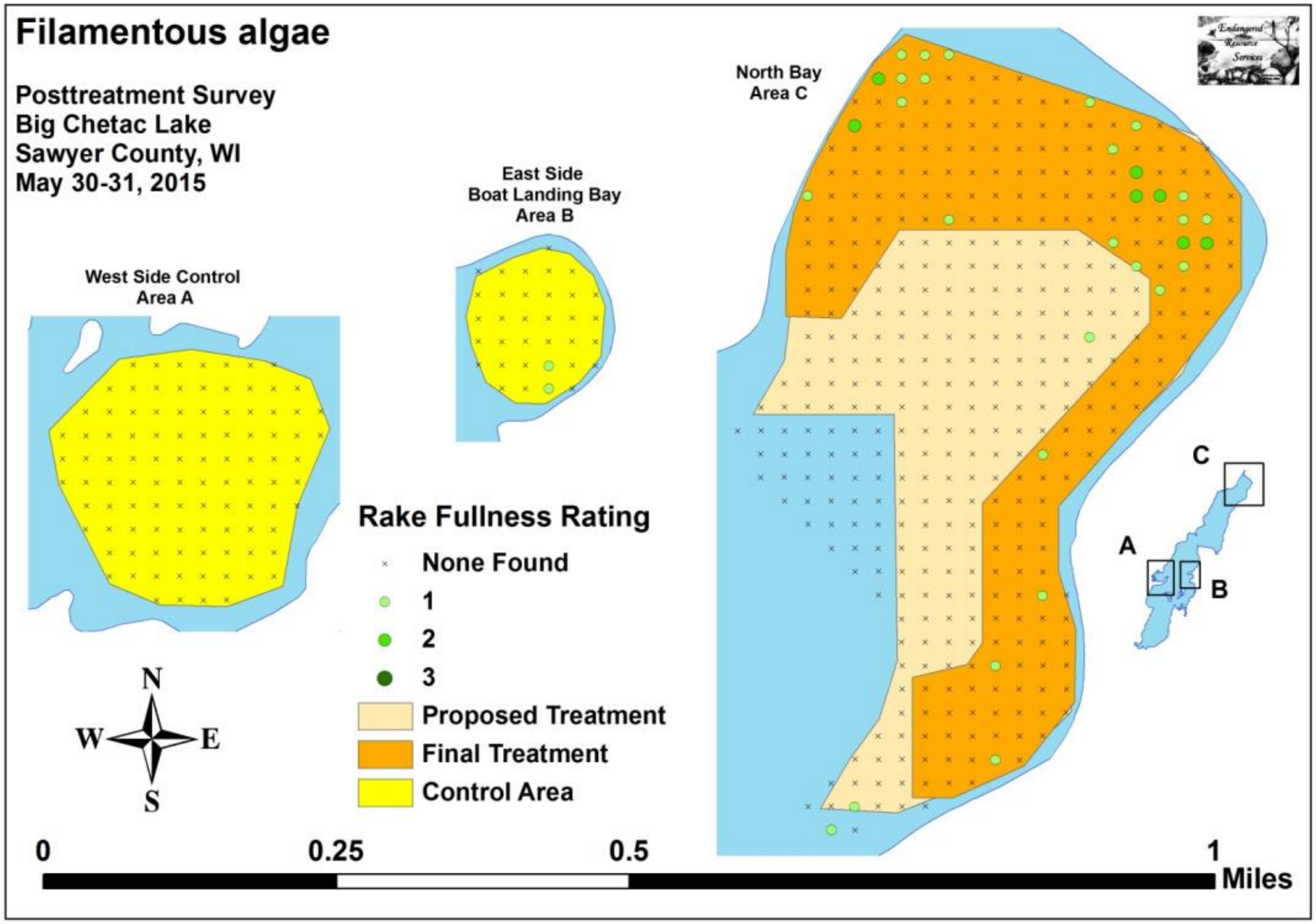
Fern pondweed
(*Potamogeton robbinsii*)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


White water crowfoot
(Ranunculus aquatilis)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
April 25-26, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

Appendix VII: Posttreatment Native Species Density and Distribution


Coontail
(Ceratophyllum demersum)
Coefficient of Conservatism = 3
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Filamentous algae
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
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Proposed Treatment
Final Treatment
Control Area
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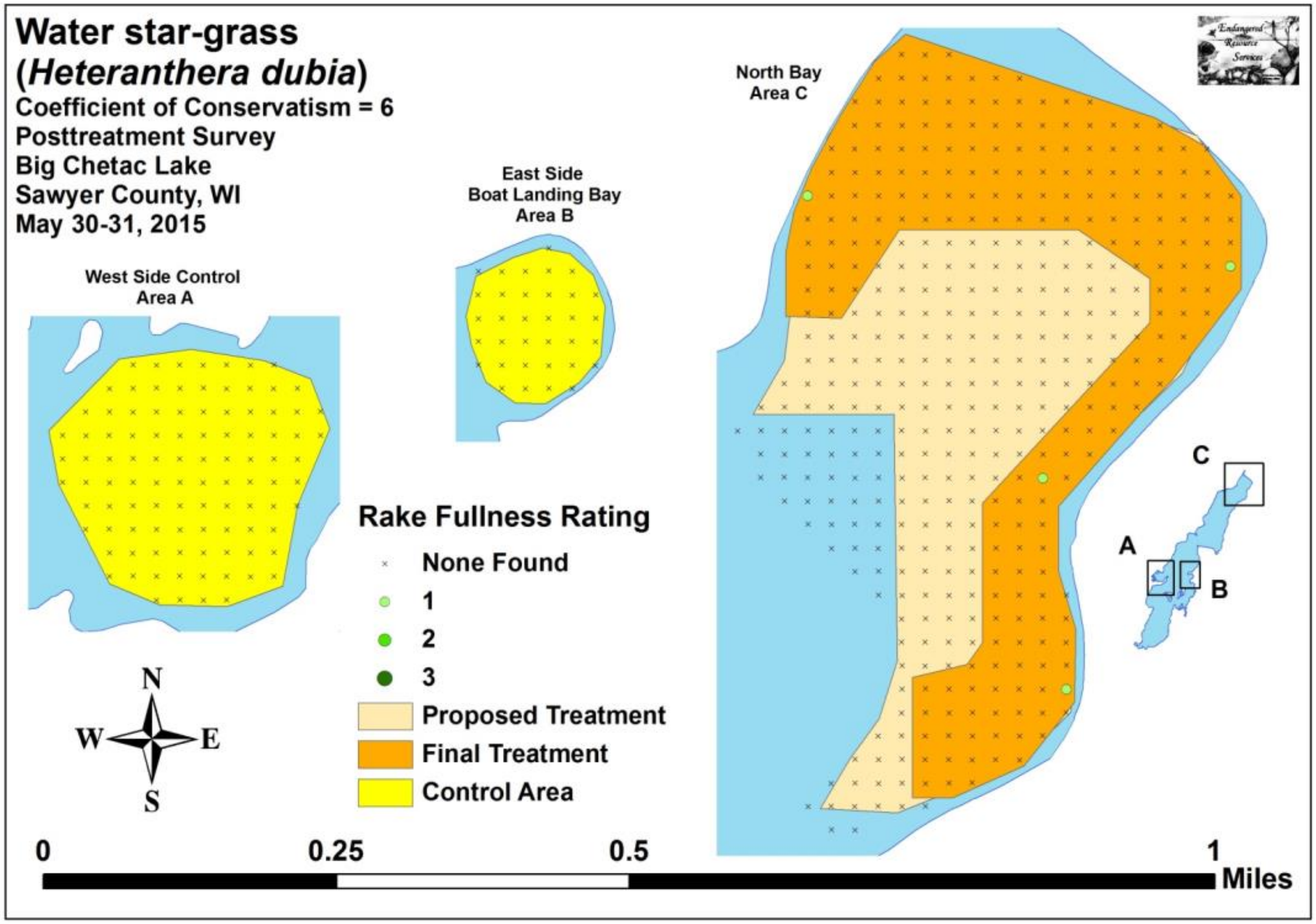
Water star-grass
(*Heteranthera dubia*)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
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Area B
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Area C
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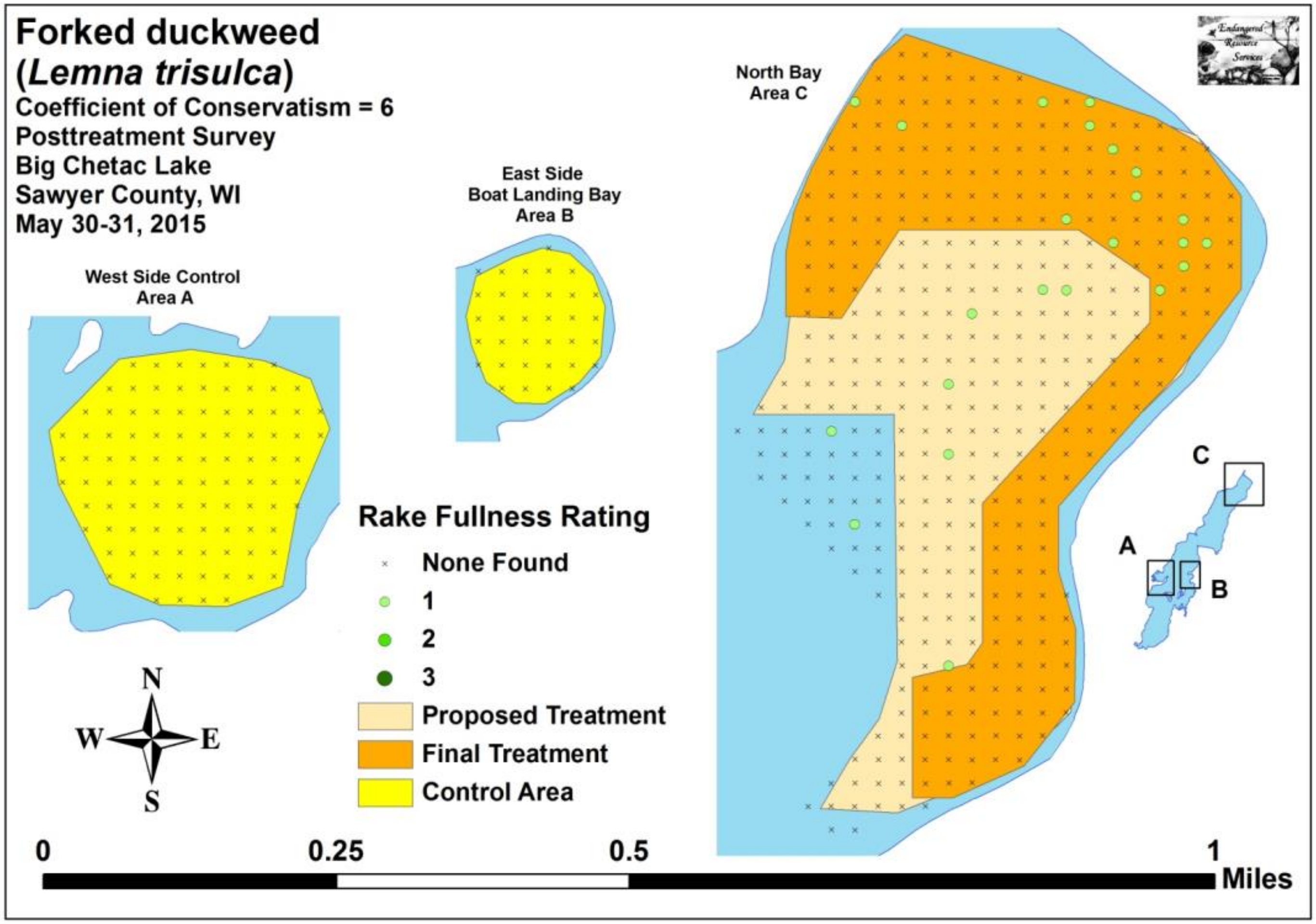
Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
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Miles
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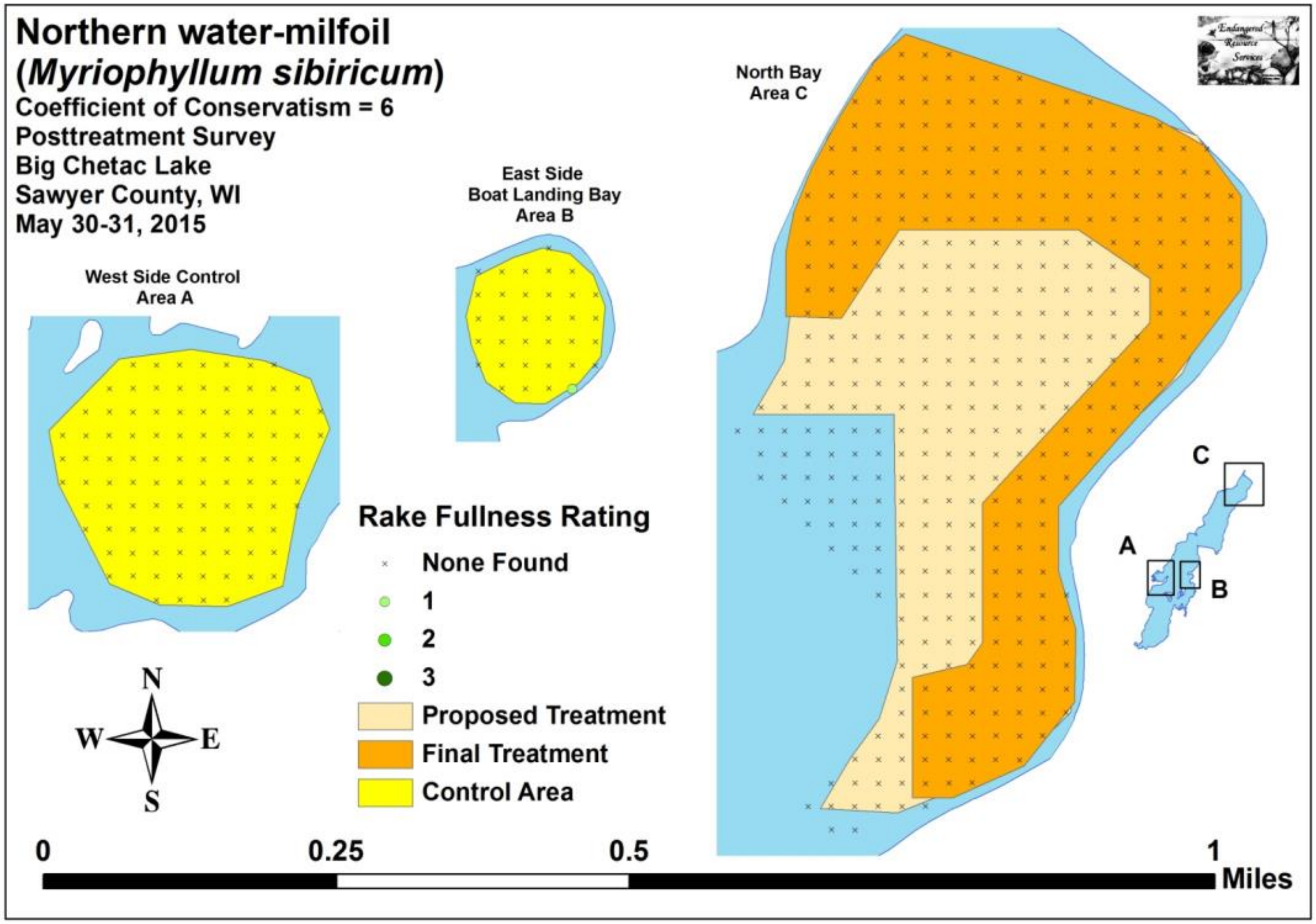
Northern water-milfoil
(*Myriophyllum sibiricum*)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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Miles
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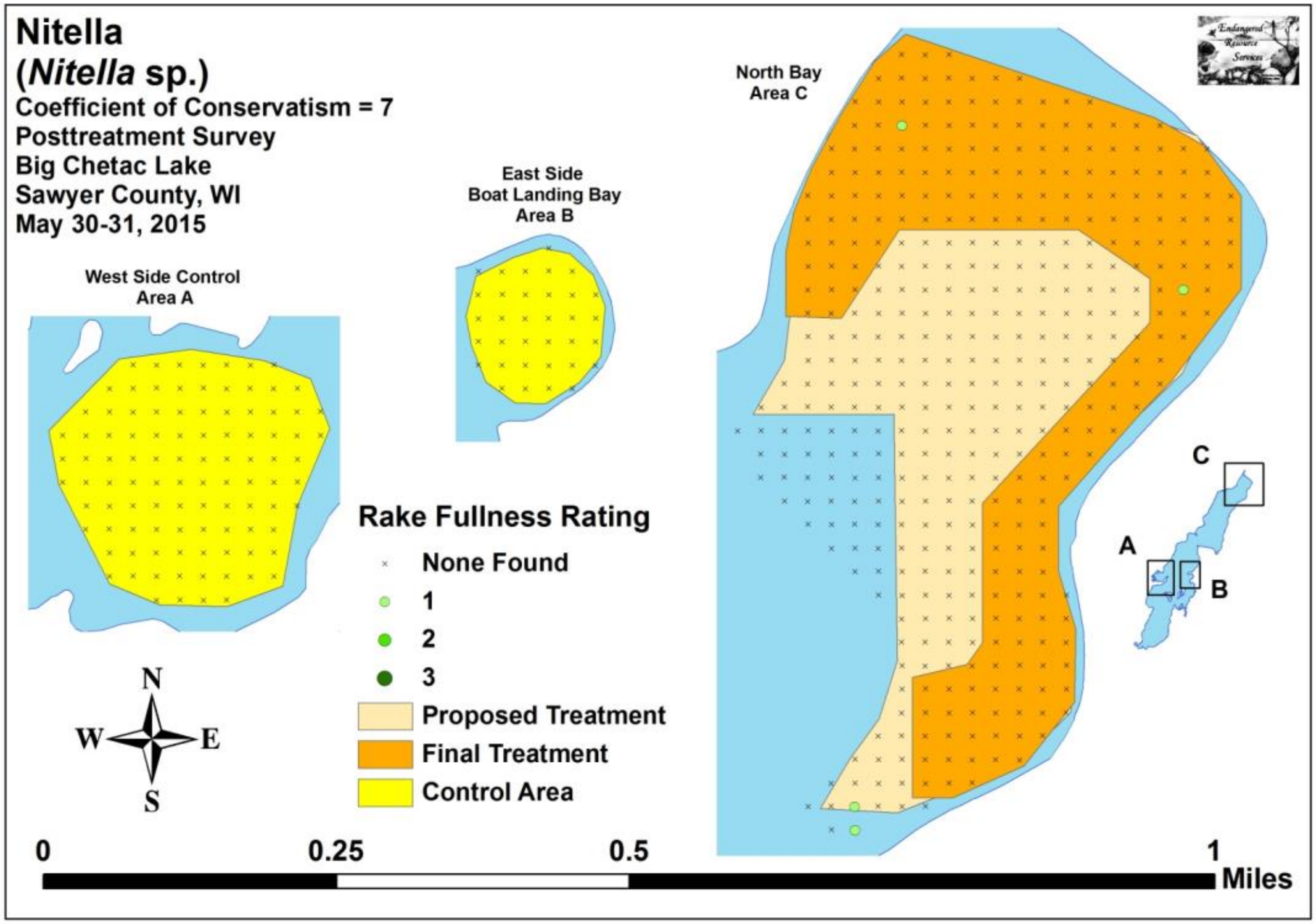
Nitella
(*Nitella* sp.)
Coefficient of Conservatism = 7
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
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Final Treatment
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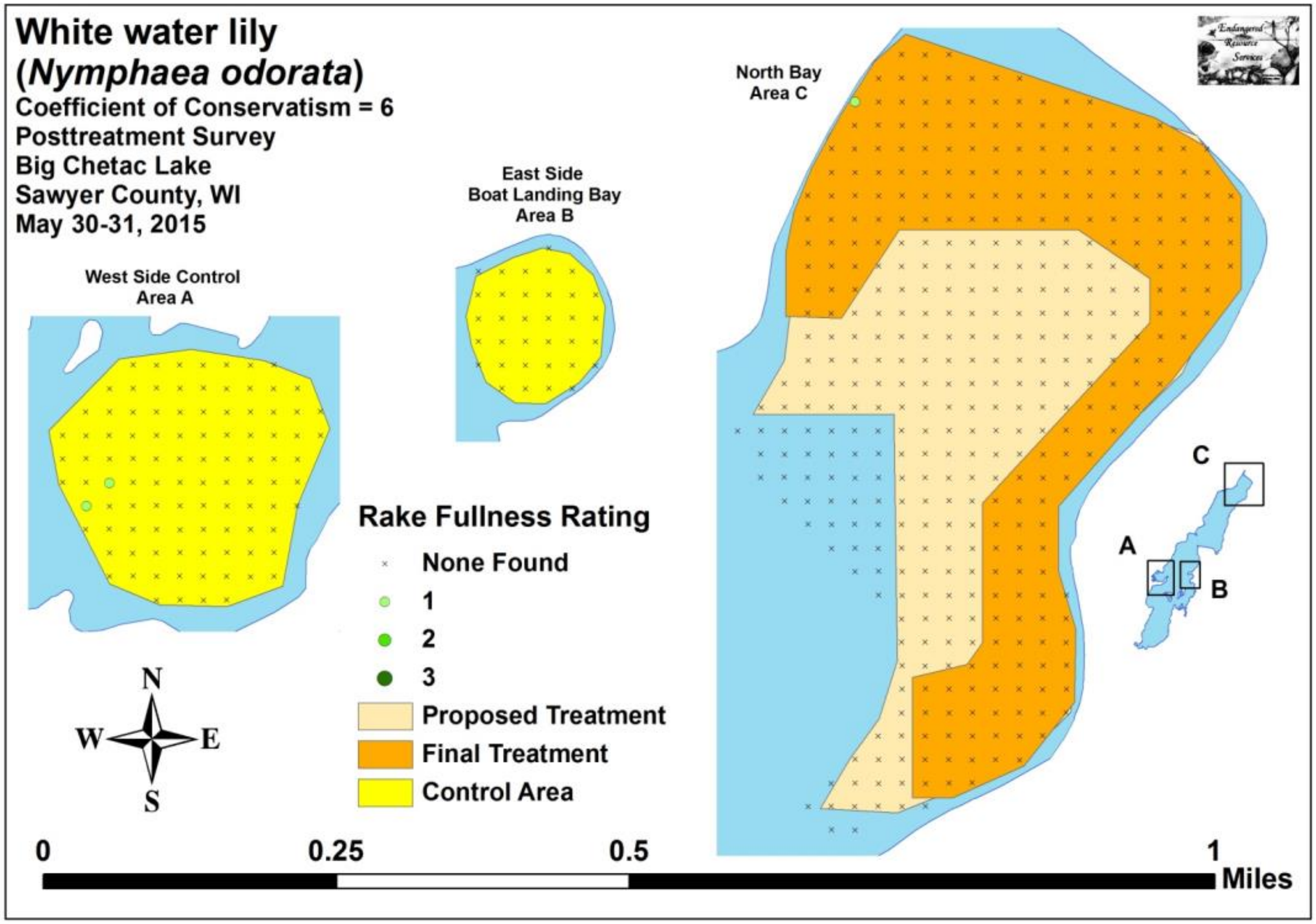
White water lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
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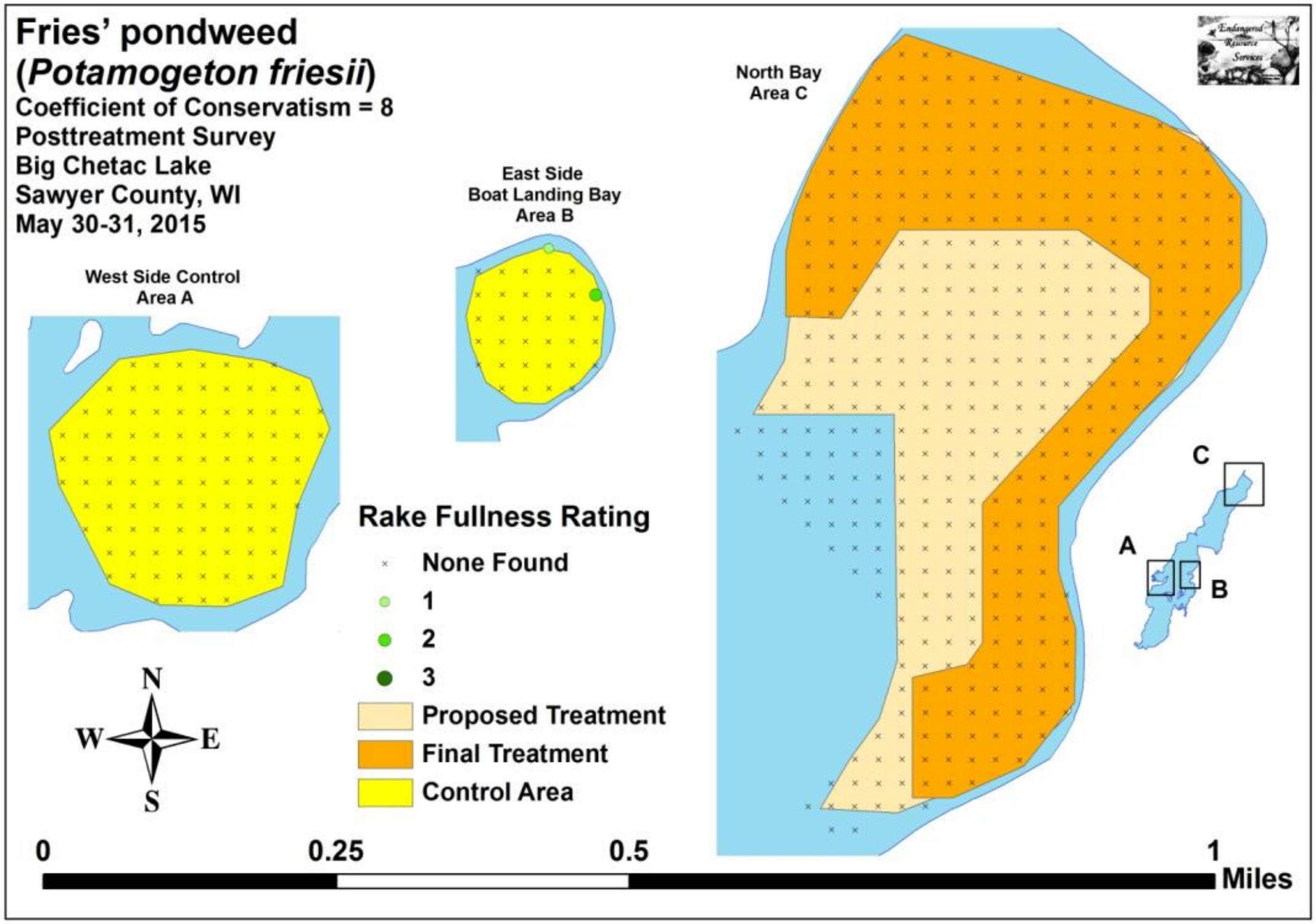
Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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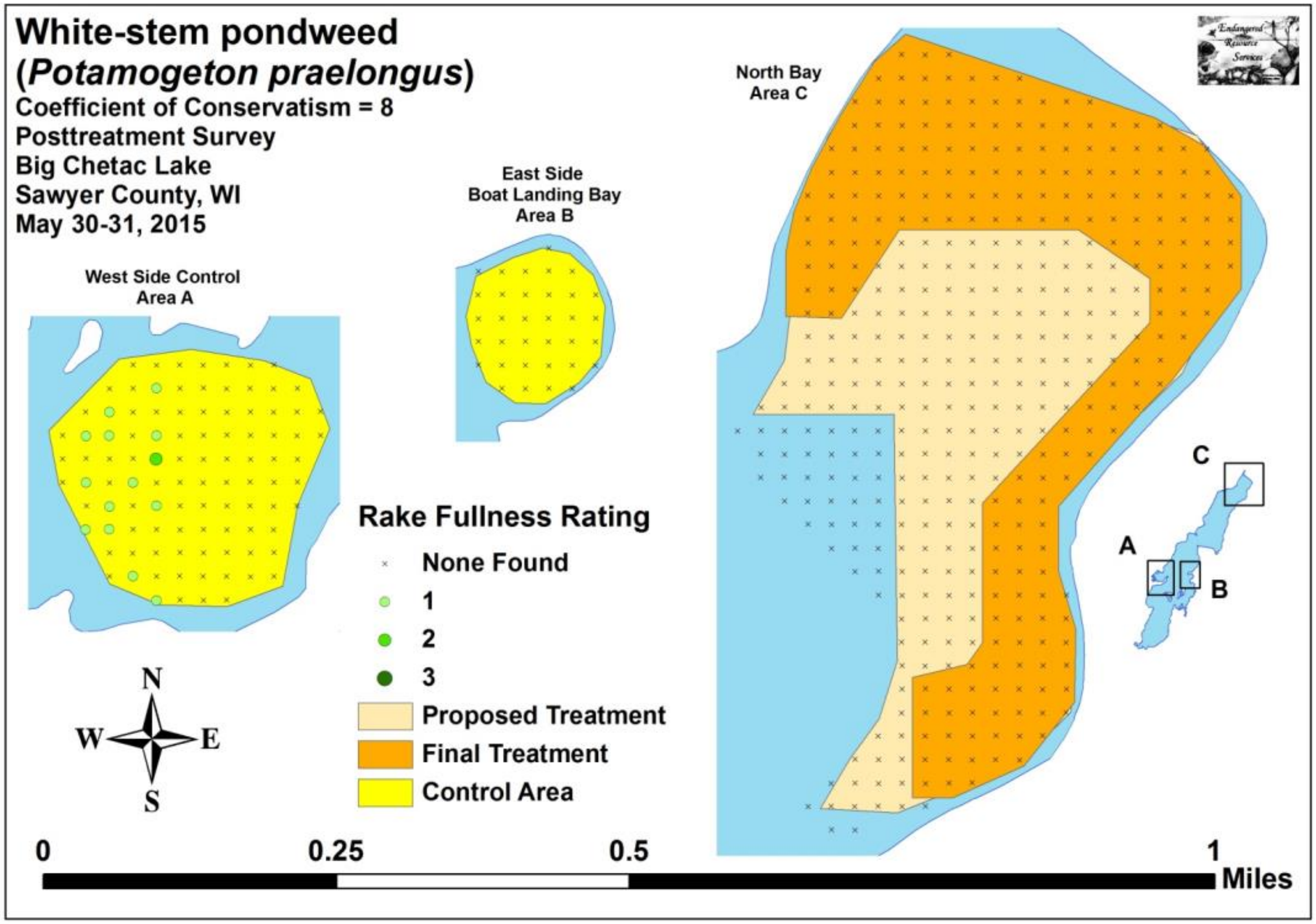

White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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Area B
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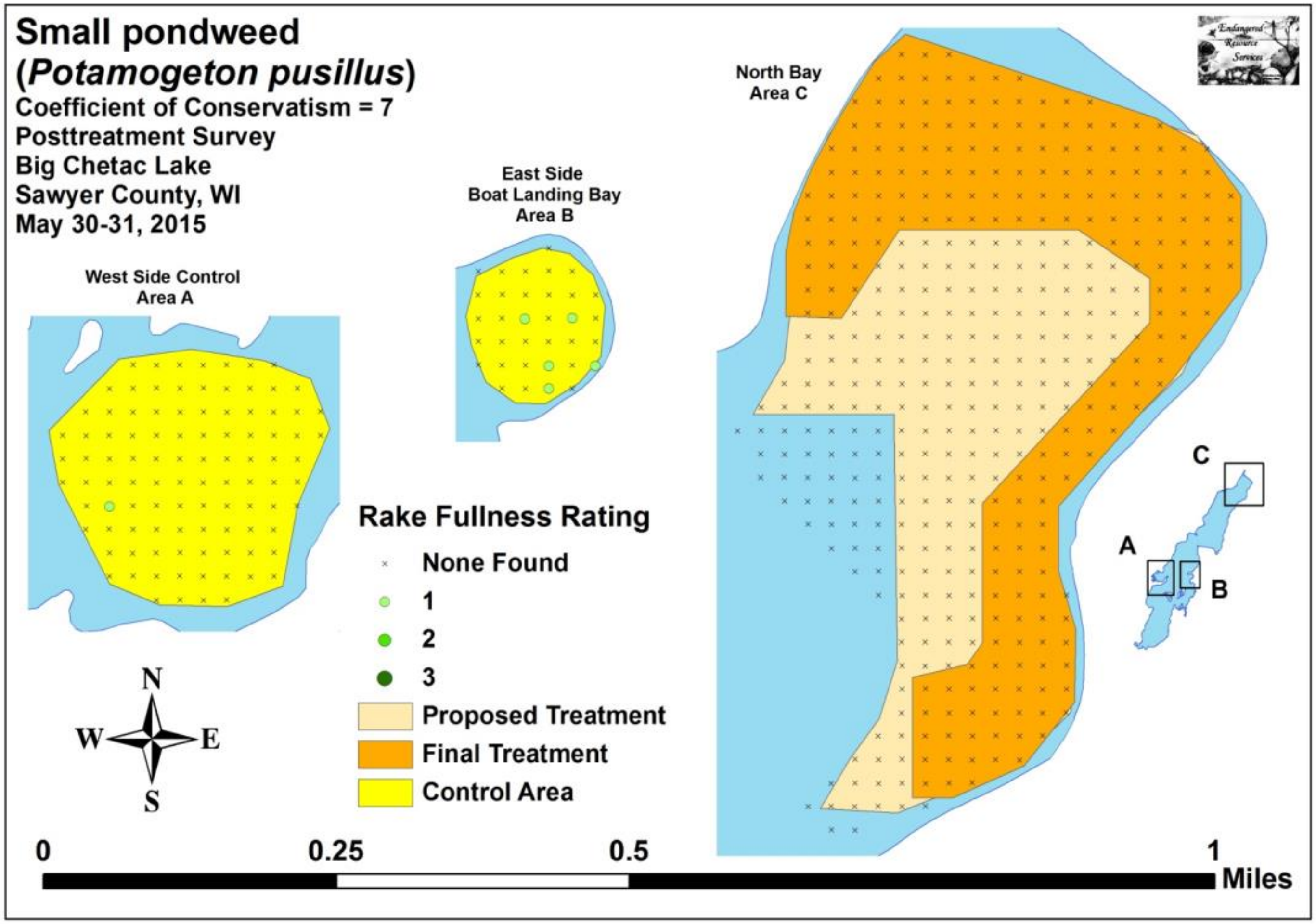
Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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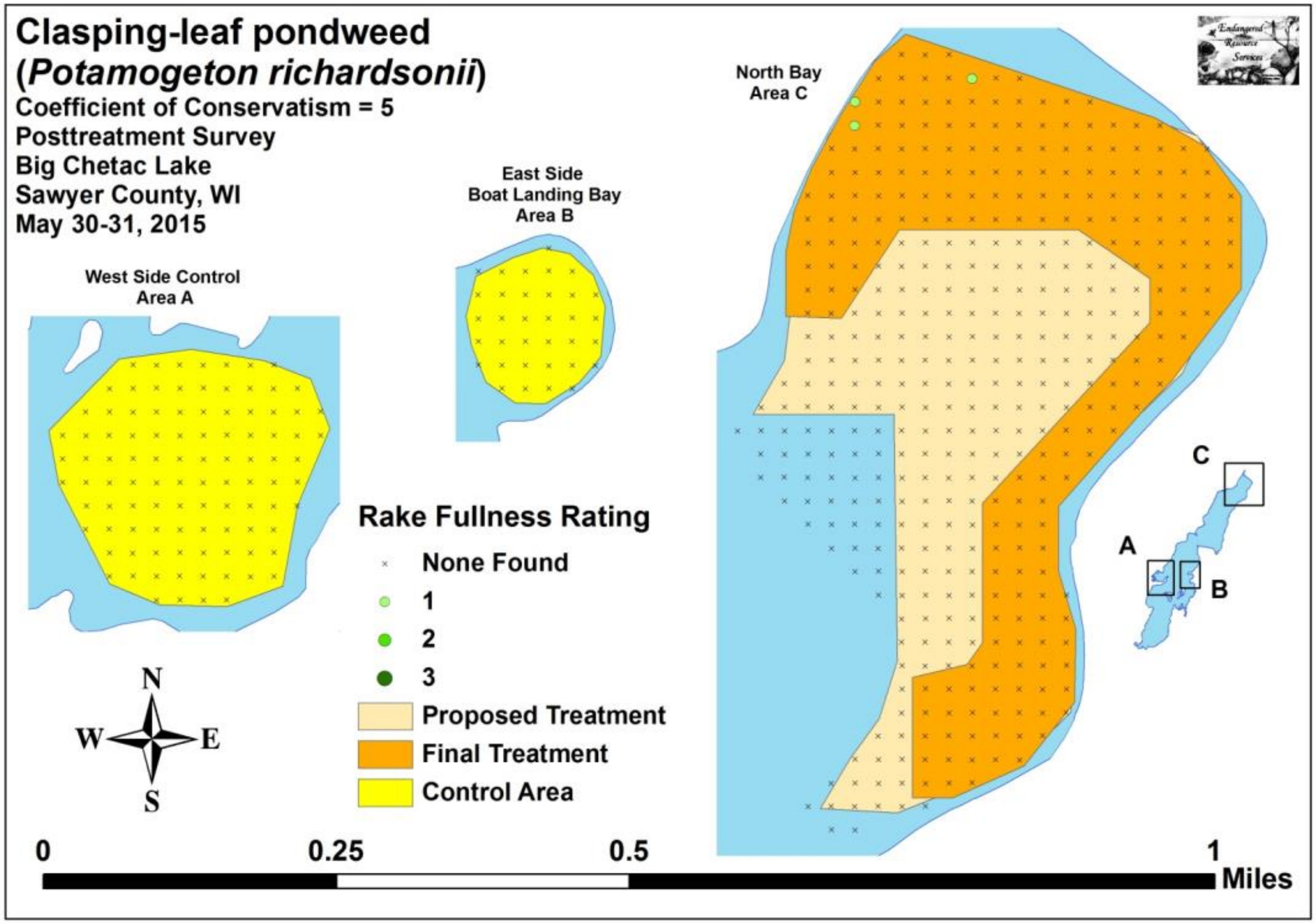
Clasping-leaf pondweed
(*Potamogeton richardsonii*)
Coefficient of Conservatism = 5
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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East Side
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Area B
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Area C
Rake Fullness Rating
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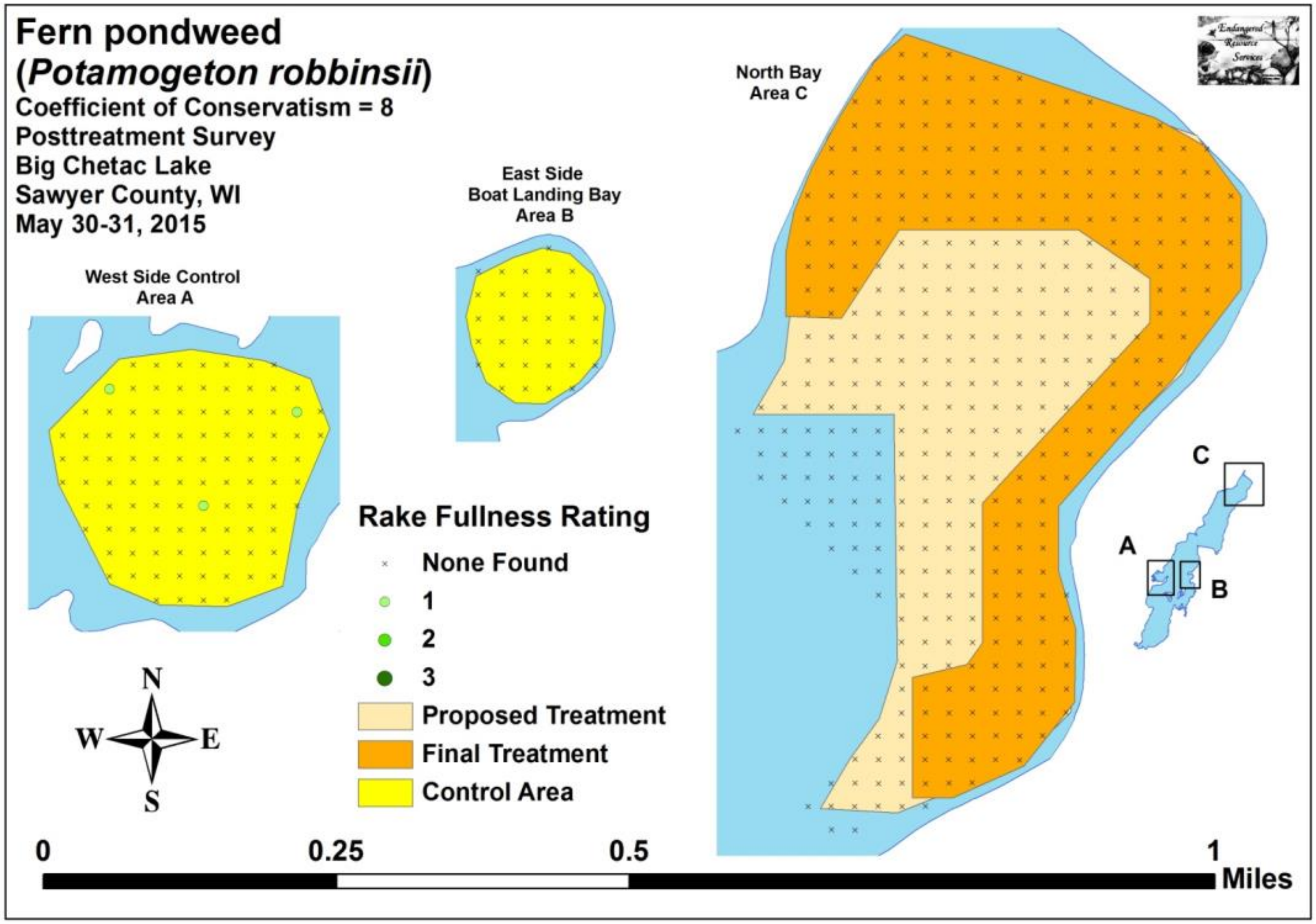
Fern pondweed
(*Potamogeton robbinsii*)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
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East Side
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Area C
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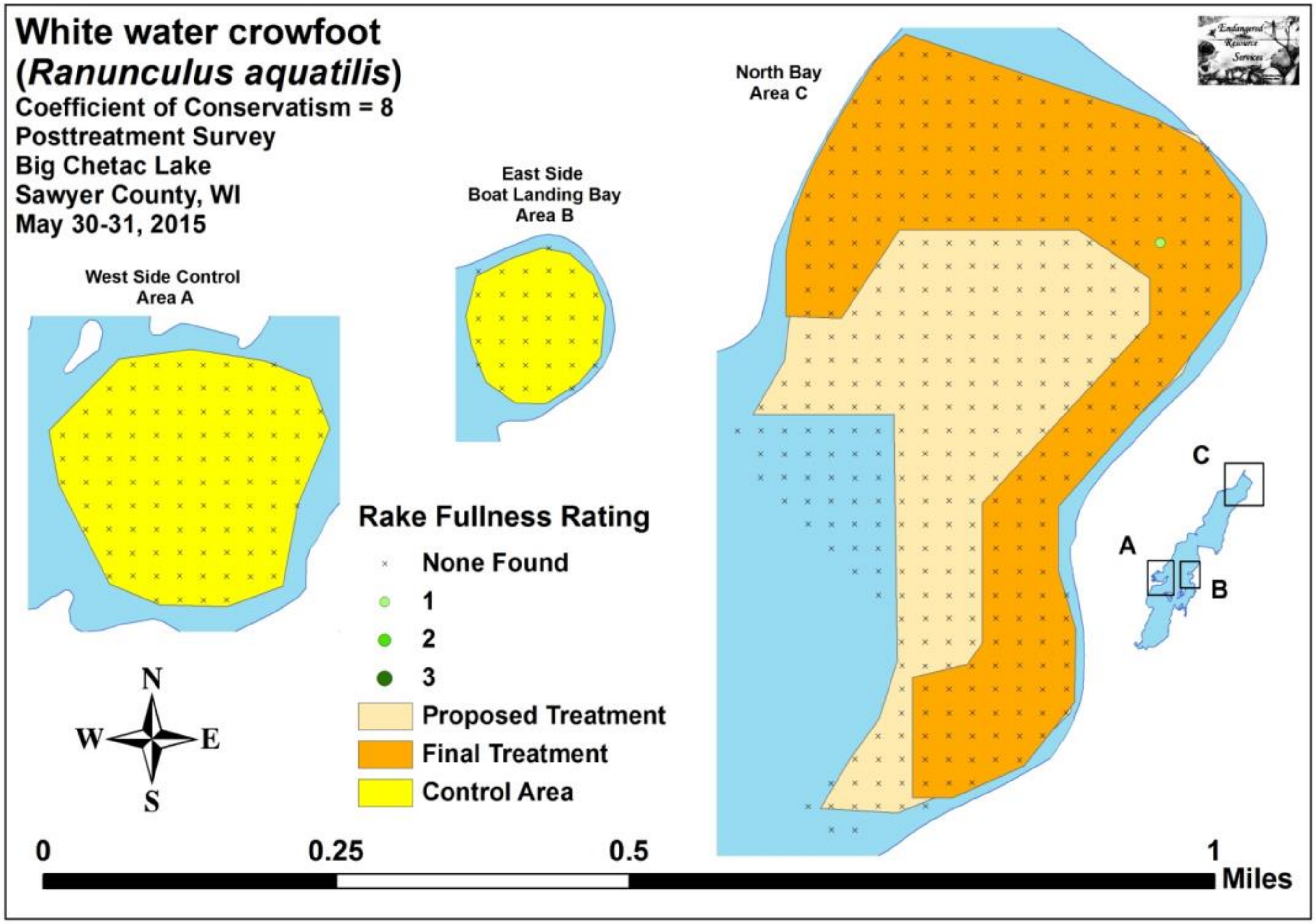

White water crowfoot
(Ranunculus aquatilis)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
May 30-31, 2015
West Side Control
Area A
East Side
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Area B
North Bay
Area C
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Proposed Treatment
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Miles

Appendix VIII: Glossary of Biological Terms (UWEX 2010)

Aquatic:
: organisms that live in or frequent water.

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

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

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

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

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

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

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

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

Limnology:
: the study of inland lakes and waters.

Littoral:

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

Macrophytes:

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

Nutrients:

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

Organic Matter:

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

Photosynthesis:

the process by which green plants convert carbon dioxide (CO_2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

Phytoplankton:

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

Plankton:

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

ppm:

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

Richness:

number of species in a particular community or habitat.

Rooted Aquatic Plants:

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

Runoff:

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

Secchi Disc:

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

Seepage lakes:

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

Turbidity:

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

Watershed:

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

Zooplankton:

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