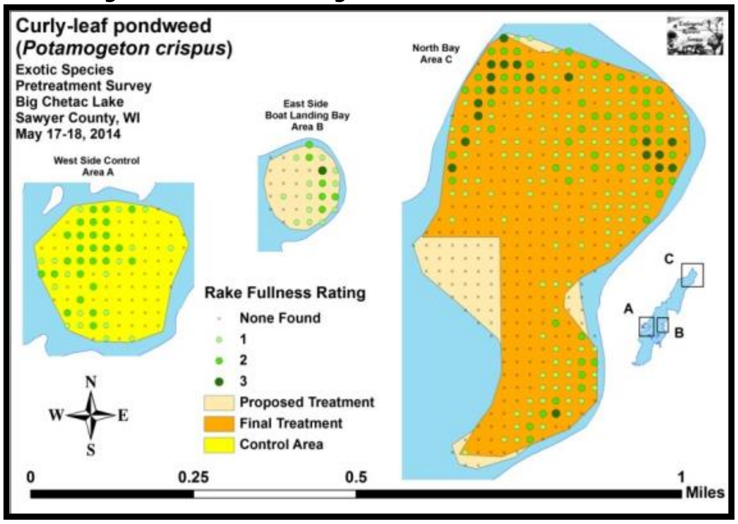
Curly-leaf pondweed (*Potamogeton crispus*) Pre/Post Herbicide Treatment Surveys Big Chetac Lake – WBIC: 2113300 Sawyer County, Wisconsin



2014 Final CLP Treatment Area

Project Funded by:

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

Canopied Curly-leaf Pondweed Mat in the Boat Landing Bay (Berg 2014)

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May 17-18 and June 14-15, 2014

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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 13ft in the spring of 2014. In 2013, 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 acre bed in the lake's north bay where CLP nearly completely dominated the plant community. Prior to conducting a treatment in 2014, so as to compare the same areas year-over-year, we again surveyed the original 550 point grid used in 2013: 416 points in the north bay, 34 in the boat landing bay, and an additional 100 control points in a bay on the lake's west side. During the May17-18, 2014 pretreatment survey, we found CLP at 205 of 416 sample points in the north bay (60.1% - down from 340 points - 81.7% in 2013), at 19 of 34 points in the boat landing bay (55.9% - down from 24 points - 70.6% in 2013), and at 45 of 100 points in the western control bay (45% - down from 70 points -70.0% in 2013). Using these data, it was determined that the north bay treatment area would be the same 90 acres treated in 2013. It was also decided that, out of concern for the Northern wild rice (*Zizania palustris*) located in the "Bull Pen" bay immediately south of the boat landing area, treatment of the entire 7.5 acres in this area would again be cancelled. Following the May 21st application of Aquathol K at a concentration of 1.0ppm (down from 1.5ppm in 2013), we returned to the lake on June 14-15, 2014 to assess the effectiveness of the treatment. **We found CLP at 37 of 416 points (8.9%) – a decline of nearly 82% from the 205 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 widely scattered and small (<12inches tall)**. During the posttreatment survey, we also noted evidence of residual control of CLP throughout the north basin at a distance of up to two miles downstream of the treatment area. In both the untreated areas (control bay and the east boat landing bay), CLP showed a significant increase in rake fullness rating of 3 as plants continued to thicken and canopy as the growing season progressed. In the untreated boat landing bay, overall CLP abundance was unchanged (present at 19 points pre and post). However, in the control bay, overall CLP demonstrated a significant decline (45 points pre/28 post). Forked duckweed (*Lemna trisulca*) and Coontail (*Ceratophyllum demersum*) were the most common native plants in the north bay prior to treatment. Forked duckweed demonstrated a significant decline posttreatment while Coontail remained unchanged. Conversely, filamentous algae showed a highly significant increase and Wild celery (*Vallisneria americana*) showed a significant increase. Native plants in the control area and boat landing bay were nearly unchanged. As the project moves into its third year, all data from 2014 posttreatment survey, 2014 CLP bed mapping and full lake point intercept surveys, the fall 2014 CLP turion survey, and the 2015 pretreatment survey will be used to finalize 2015 treatment areas as shareholders continue to work towards the Aquatic Plant Management Plan's restoration goals.

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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 2014). This poor to very poor water clarity produced a littoral zone that extended to approximately 12ft in the spring of 2014. 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: 2014 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 2013. Following posttreatment and fall CLP turion surveys in 2013, it was proposed to treat the same area in 2014 (Figure 1).

On May 17-18th, we conducted a pretreatment survey to gather baseline data from the scheduled treatment area and to finalize treatment plans. Following the May 21st herbicide application, we conducted a June 14-15th 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. These grids 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.

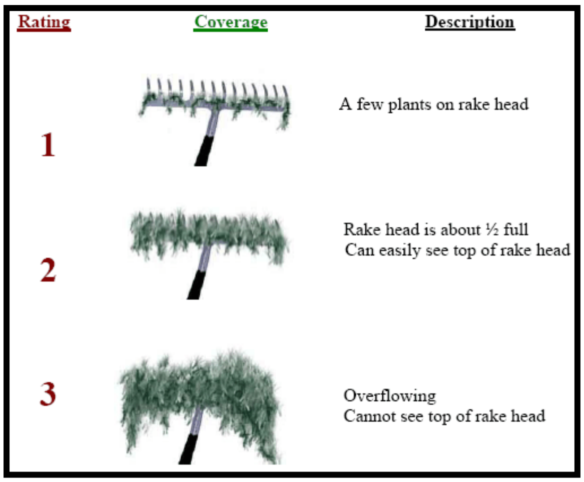


Figure 2: Rake Fullness Ratings

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 May/June 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 May/June 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 2013 posttreatment survey and the fall 2013 turion survey, it was proposed to retreat the same 90 acre bed in the north bay that was ultimately treated in 2013. After resurveying all 550 points during the 2014 pretreatment survey, it was decided to again ignore some deep water edges in the north bay that were initially proposed for treatment in 2013 and continue with the core 90 acre bed as planned (Figure 3) (Appendix I). It was also decided that, out of concern for the Northern wild rice (*Zizania palustris*) located in the "Bull Pen" bay immediately south of the boat landing area, that treatment of the entire 7.5 acres in this area would again be cancelled.

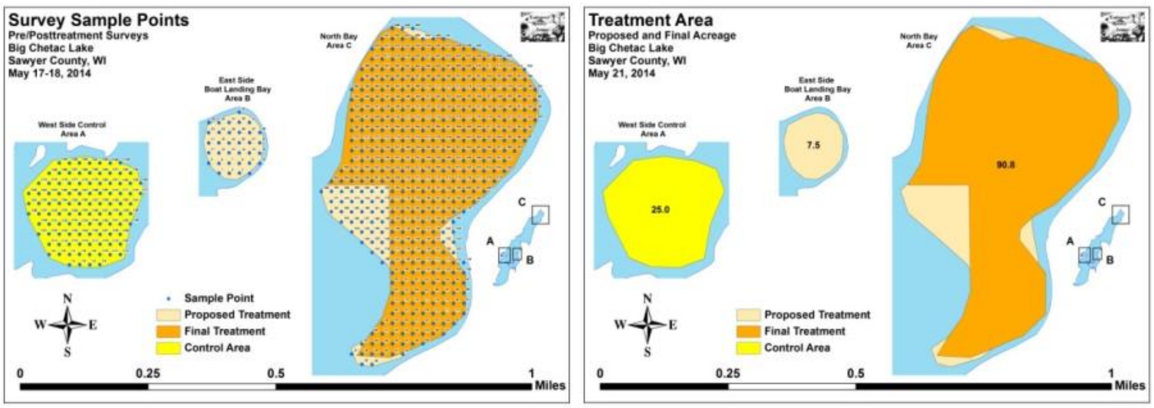


Figure 3: 2014 Survey Sample Points and Final Treatment Area

On May 21st, Midwest Aqua Care, Inc., under WDNR supervision, applied 460 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 57.4°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 southwest.

Table 1: Spring CLP Treatment Summary
Big Chetac Lake – May 21, 2014

CLP Bed Name	2014 Proposed Acreage	Final Acreage	Difference +/-
North Bay	90	90	0.0
Boat Landing Bay	0.0	0.0	0.0
Control Bay	0.0	0.0	0.0
Total Acres	**90**	**90**	**0.00**

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 5-10ft 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).

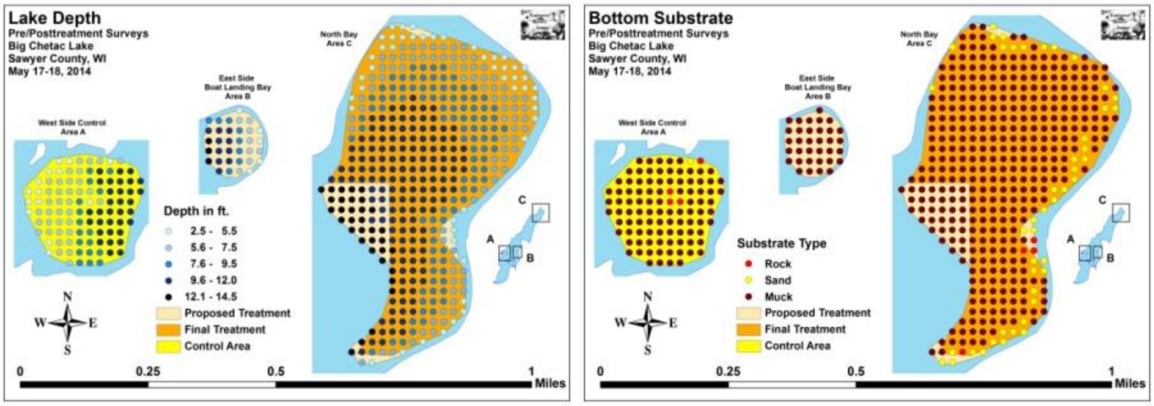


Figure 4: Treatment Area Depths and Bottom Substrate

The littoral zone for all three areas maxed out at 12ft during both the May and June surveys (Figure 5) (Appendix IV). In the north bay, mean and median depths for all plants shrunk significantly from 8.0ft each during the pretreatment survey to 6.8 and 6.5ft respectively in the posttreatment survey. In the boat landing bay, these values were unchanged at 7.3ft and 7.5ft. The control bay was also nearly unchanged at approximately 6.9ft and 6.5ft (Table 2).

This narrowing of the littoral zone in the north bay was expected as CLP was again the dominant rooted plant in deep water. Once the treatment eliminated it, the majority of plants left in the bay were native plants in shallow water. As the growing season progressed into July, the lake's plant community became dominated by algae. Due to poor water clarity, there was again little evidence of native plants on the outer edge of the littoral zone once CLP senesced – this was similar to what we observed in 2008 and 2013. However, in shallow areas along the north bay shoreline and near the Benson Creek Inlet, we noted further expansion of late-growing species like Wild celery (*Vallisneria americana*) and Clasping-leaf pondweed (*Potamogeton richardsonii*).

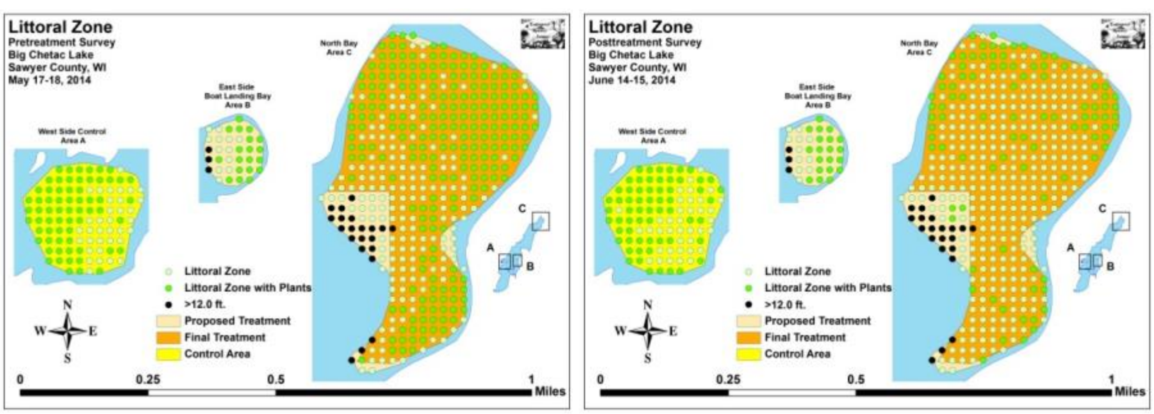


Figure 5: Pre/Post Littoral Zone

Initial diversity within the north bay was extremely low with a Simpson Diversity Index value of 0.44. This value increased significantly to 0.65 posttreatment. The boat landing bay also had an exceptionally low index value of 0.36 in May that rose to 0.46 in June. The control area had the highest starting value at 0.60, but it increased only slightly to 0.64 in June (Table 2).

Mean native species richness was extremely low in all three areas. The north bay treatment area averaged 0.23 native species at littoral points pretreatment and only 0.19 posttreatment. Even at sites that had natives present, only the boat landing bay (1.60) averaged more than 1.20 species/site, and no point had more than three native species in any rake during either the pre or posttreatment surveys (Figure 6) (Appendix IV).

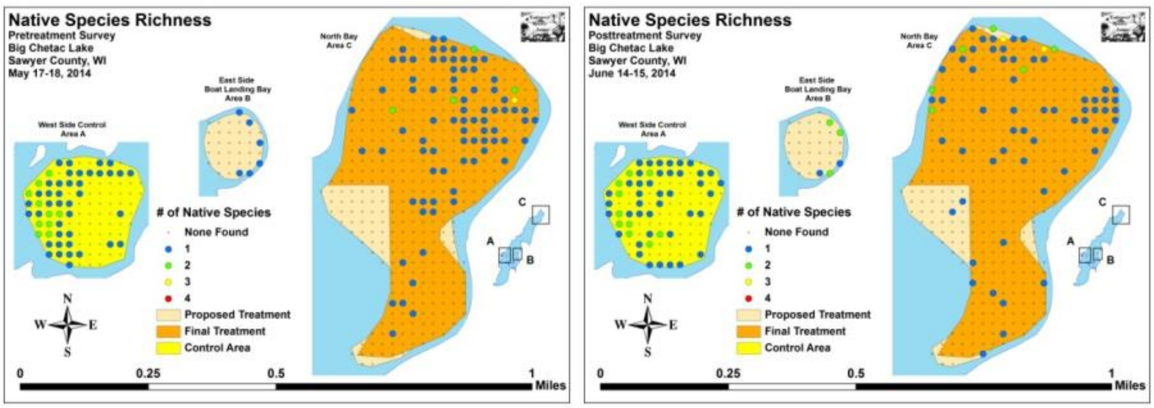


Figure 6: Pre/Post Native Species Richness

Total species richness was very low in all three areas with just two to four species being found in each area pretreatment. During the posttreatment survey, we found only four species in the boat landing bay and three in the western control bay. However, the treatment area had jumped to nine – the most ever found there. Following treatment, the mean total rake fullness declined significantly in the north bay from 1.44 to 1.06. In the boat landing bay, this value increased sharply from 1.47 to 2.30 as CLP continued to fill in the area; however, in the control bay, mean rake fullness values decrease slightly from 1.65 to 1.52 (Figure 7) (Table 2) (Appendix IV).

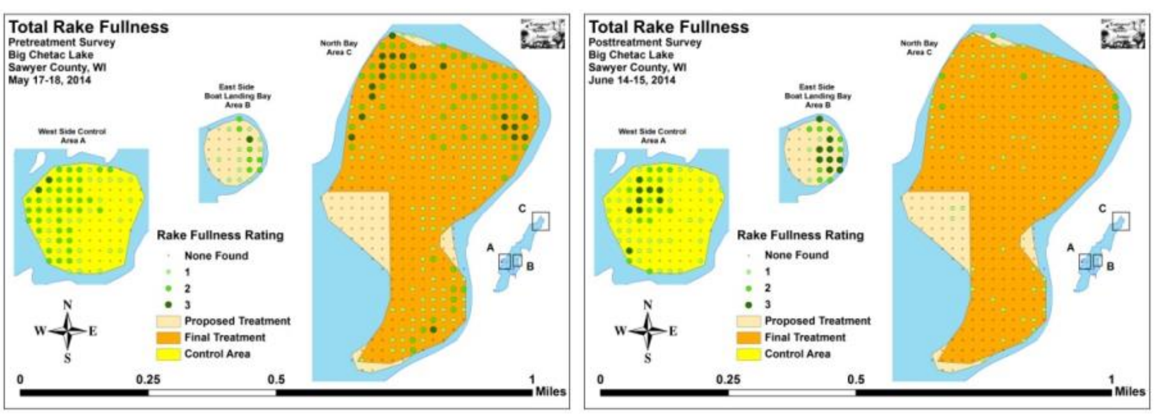


Figure 7: Pre/Post Total Rake Fullness

Table 2: Pre/Posttreatment and May/June Survey Summary Statistics
North Bay – Boat Landing Bay – Western Control Bay
Big Chetac Lake, Sawyer County
May 17-18 and June 14-15, 2014

Summary Statistics:	North Bay Treatment Area			Boat Landing Bay			Western Control Bay		
	Pre 2013	Pre 2014	Post 2014	May 2013	May 2014	June 2014	May 2013	May 2014	June 2014
Total number of points sampled	416	416	416	34	34	34	100	100	100
Total number of sites with vegetation	354	227	93	26	19	20	97	65	62
Total number of sites shallower than the maximum depth of plants	414	395	395	31	31	27	100	100	100
Frequency of occurrence at sites shallower than maximum depth of plants	85.5	57.47	23.5	83.9	61.3	74.1	97.0	65.0	62.0
Simpson Diversity Index	0.41	0.44	0.65	0.51	0.36	0.46	0.73	0.60	0.64
Maximum depth of plants (ft)	13.0	12.0	12.0	11.5	11.5	10.5	12.0	11.50	11.5
Mean depth of plants (ft)	8.6	8.0	6.8	7.7	7.3	7.3	8.0	6.9	7.0
Median depth of plants (ft)	9.0	8.0	6.5	7.8	7.5	7.5	8.0	6.5	6.5
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	0.74	0.29	1.26	0.81	1.00	1.70	1.05	0.89
Average number of all species per site (veg. sites only)	1.27	1.30	1.23	1.50	1.32	1.35	1.75	1.62	1.44
Average number of native species per site (shallower than max depth)	0.27	0.23	0.19	0.48	0.19	0.30	1.00	0.60	0.61
Average number of native species per site (veg. sites with natives only)	1.24	1.07	1.15	1.07	1.00	1.60	1.54	1.20	1.20
Species richness	8	6	9	4	2	4	5	4	3
Mean rake fullness (veg. sites only)	1.81	1.44	1.06	1.42	1.47	2.30	1.72	1.65	1.52
Mean Coefficient of Conservatism	5.9	5.2	5.3	6.0	7.0	6.0	6.0	6.3	6.3
Floristic Quality Index	15.5	11.6	14.8	10.4	7.0	10.4	12.0	11.0	11.0

During the pretreatment survey of the north bay, we found CLP at 205 of 416 total points (60.1% - down from an initial percentage of 81.7% in 2013) (Figures 8) (Appendix V). Of these, 19 had a rake fullness rating of 3, 62 rated a 2, and 124 rated a 1 for a mean rake fullness of 1.49. During the posttreatment survey, we found CLP at 37 sites (8.9%). None rated a 3, one rated a 2, and the remaining 36 were a one for a mean rake of 1.03. Most CLP plants were small sprouts (<12inches) that appeared to have germinated from turions after the treatment. 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).

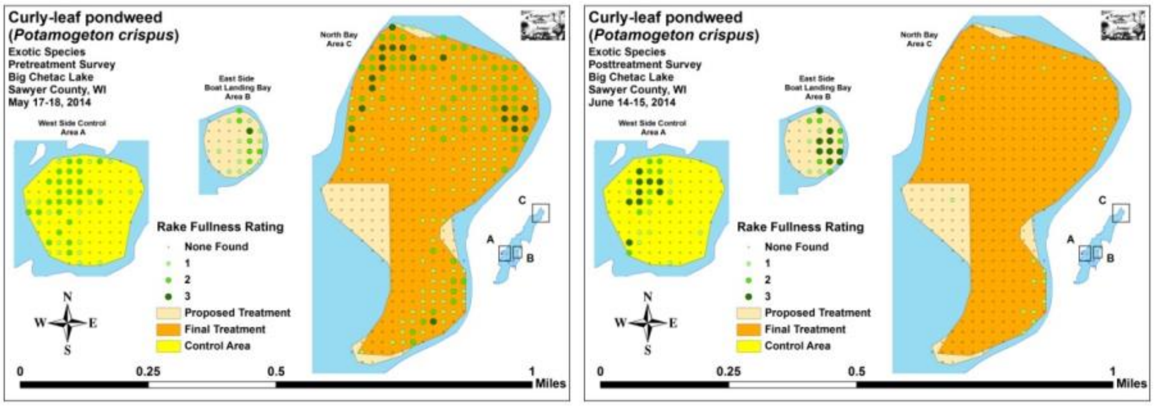
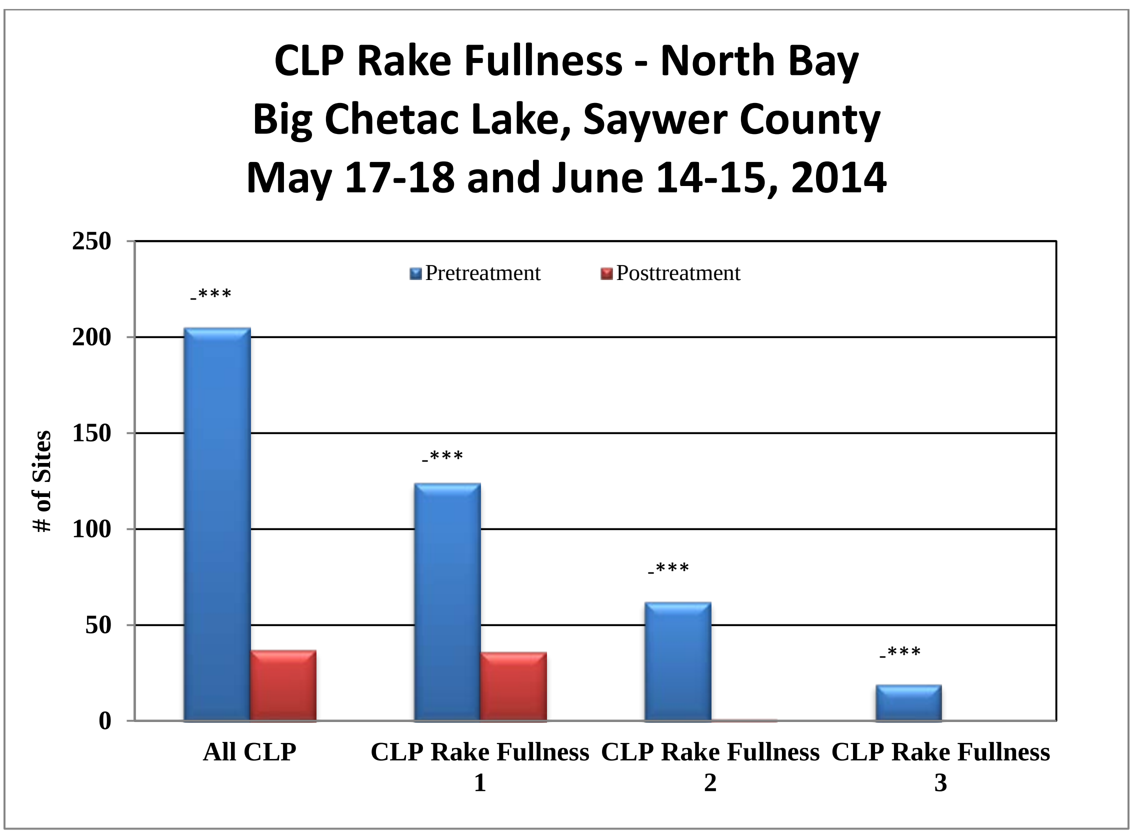


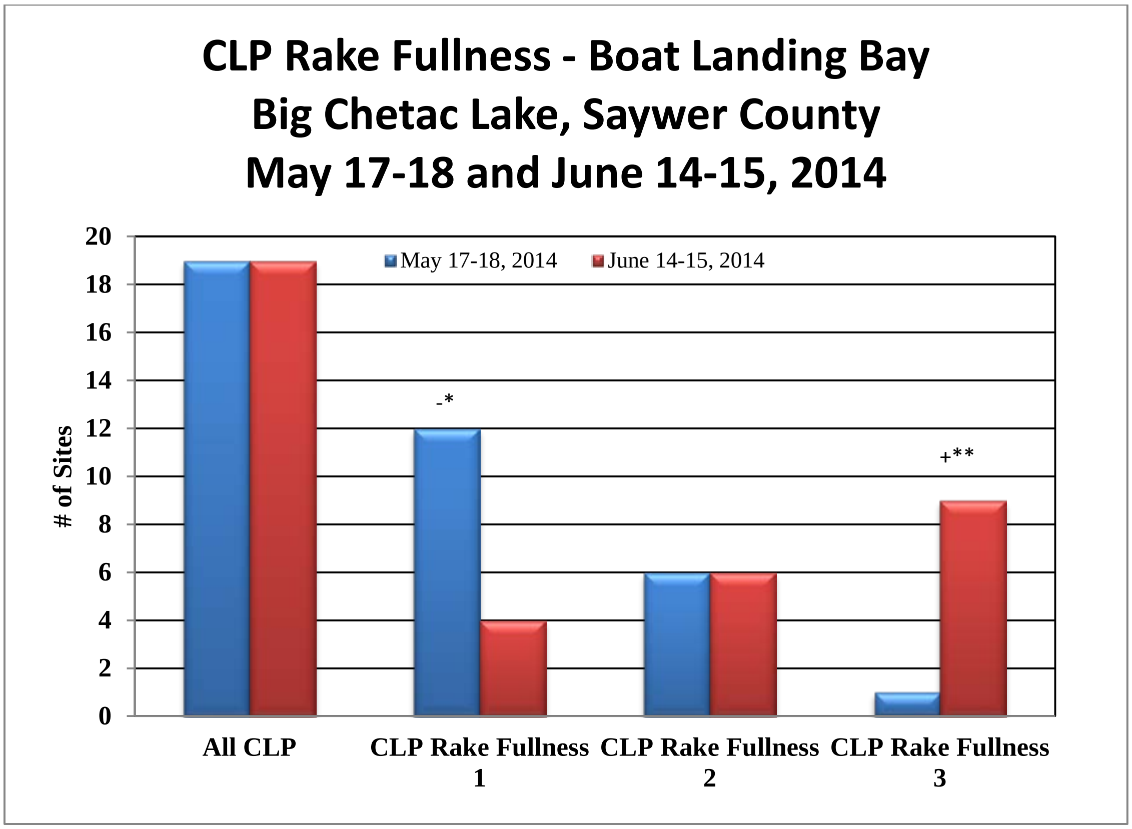
Figure 8: Pre/Post CLP Density and Distribution



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

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

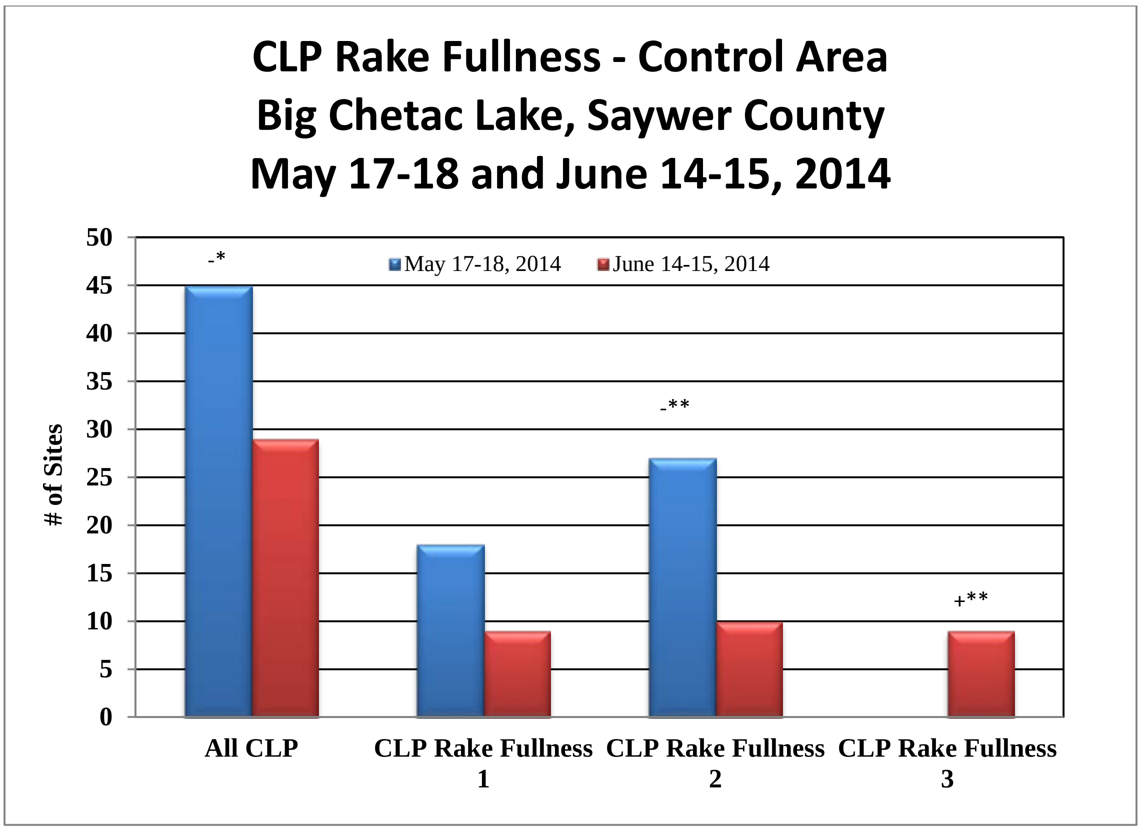
In the boat landing bay, the May survey found CLP at 19 of 34 points (55.9%) – down from 24 (70.6%) in 2013 (Figure 8). Of these, one had a rake fullness rating of 3, six rated a 2, and 12 were a 1 for a mean rake fullness of 1.42. In June, CLP was still found at 19 spots, but the density had increased as nine points rated a 3, six rated a 2, and the remaining four rated a 1 for a mean rake of 2.26. This was also down from 2013 when we found CLP at 29 points (85.3%) in June. Our findings demonstrated a significant decrease in CLP at rake fullness 1, but a moderately significant increase at rake fullness 3 (Figure 10) (Tables 5 and 6).



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

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

We documented CLP at 45 of 100 points (45.0%) in the western control bay during the May survey (Figure 8). This represented a highly significant reduction from the 70 points (70.0%) we found CLP at during the 2013 pretreatment survey. In 2014, none of the pretreatment points rated a 3, 27 were a 2, and 18 were a 1 producing a mean rake fullness of 1.60. By June, CLP had significantly declined to just 28 sites (28.0%) with nine sites rating a 3, ten a 2, and the remaining nine a 1 for a mean rake fullness of 2.00. In addition to the overall decline in CLP, rake fullness 2 demonstrated a moderately significant decline while rake fullness 3 showed a moderately significant increase (Figure 11) (Tables 7 and 8). Although the reason for this overall decline is uncertain, we noted that, at least on the eastern side of the bay, the CLP present appeared to have been chemically burned as plants were dark green with orange margins.



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

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

Forked duckweed (*Lemna trisulca*) and Coontail (*Ceratophyllum demersum*) were the most common native species in the three study areas during the May survey (Tables 3-8) (Figures 12 and 13). Within the treatment area, Coontail was unchanged, but, along with CLP, Forked duckweed showed a significant decline posttreatment. Conversely, filamentous algae showed a highly significant increase and Wild celery a significant increase (Figure 14).

Outside the treatment area, plants were little changed from May to June. In the boat landing bay, there were no significant changes (Figure 15), while in the control area, CLP exhibited a significant decline, and White-stem pondweed (*Potamogeton praelongus*) demonstrated a significant increase (Figure 16) (Maps for all native species pre and posttreatment are available in Appendixes VI and VII.)

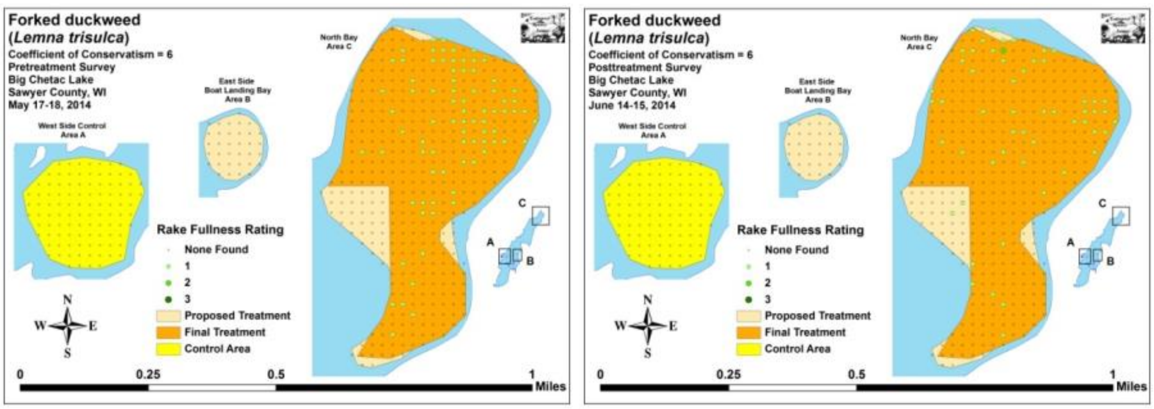


Figure 12: Pre/Post Forked Duckweed Density and Distribution

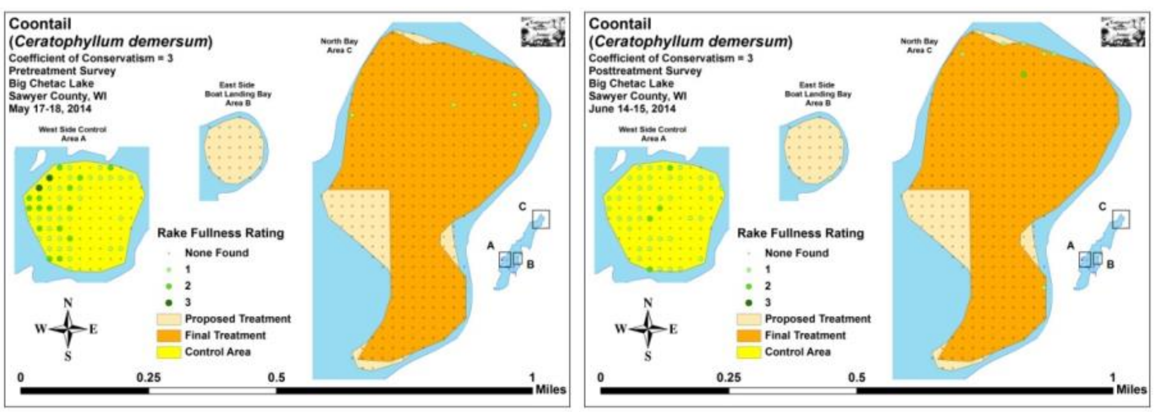
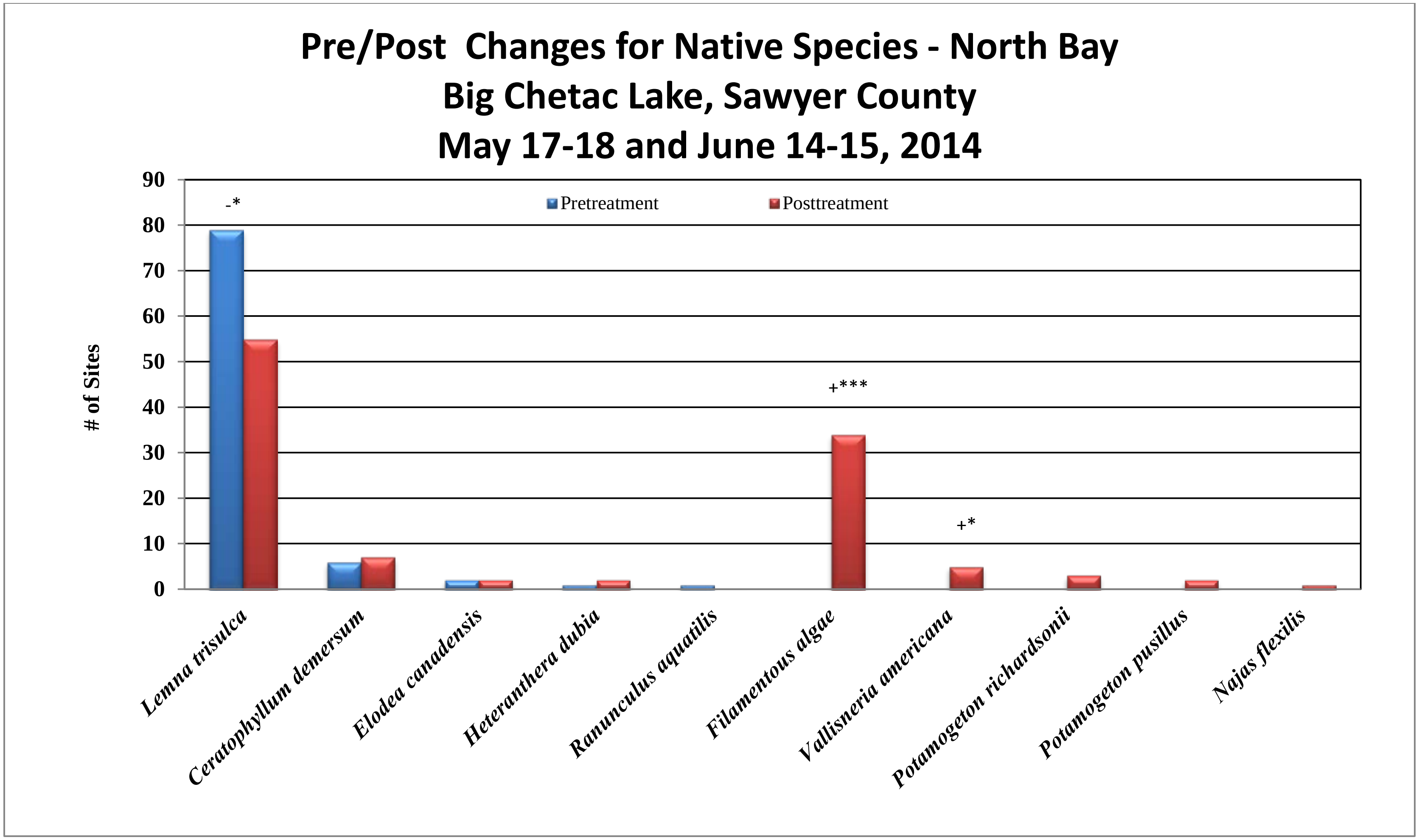
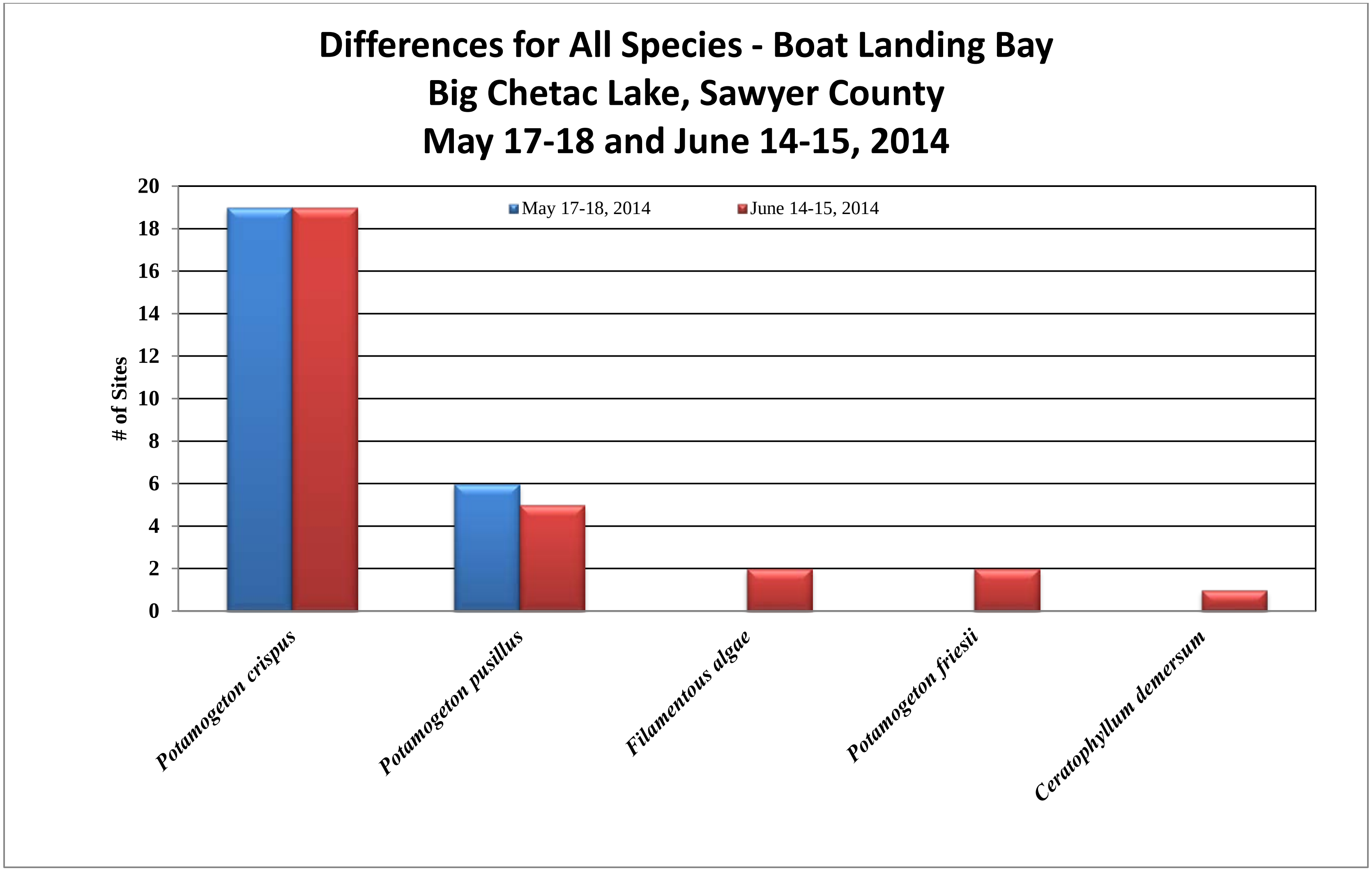


Figure 13: Pre/Post Coontail Density and Distribution



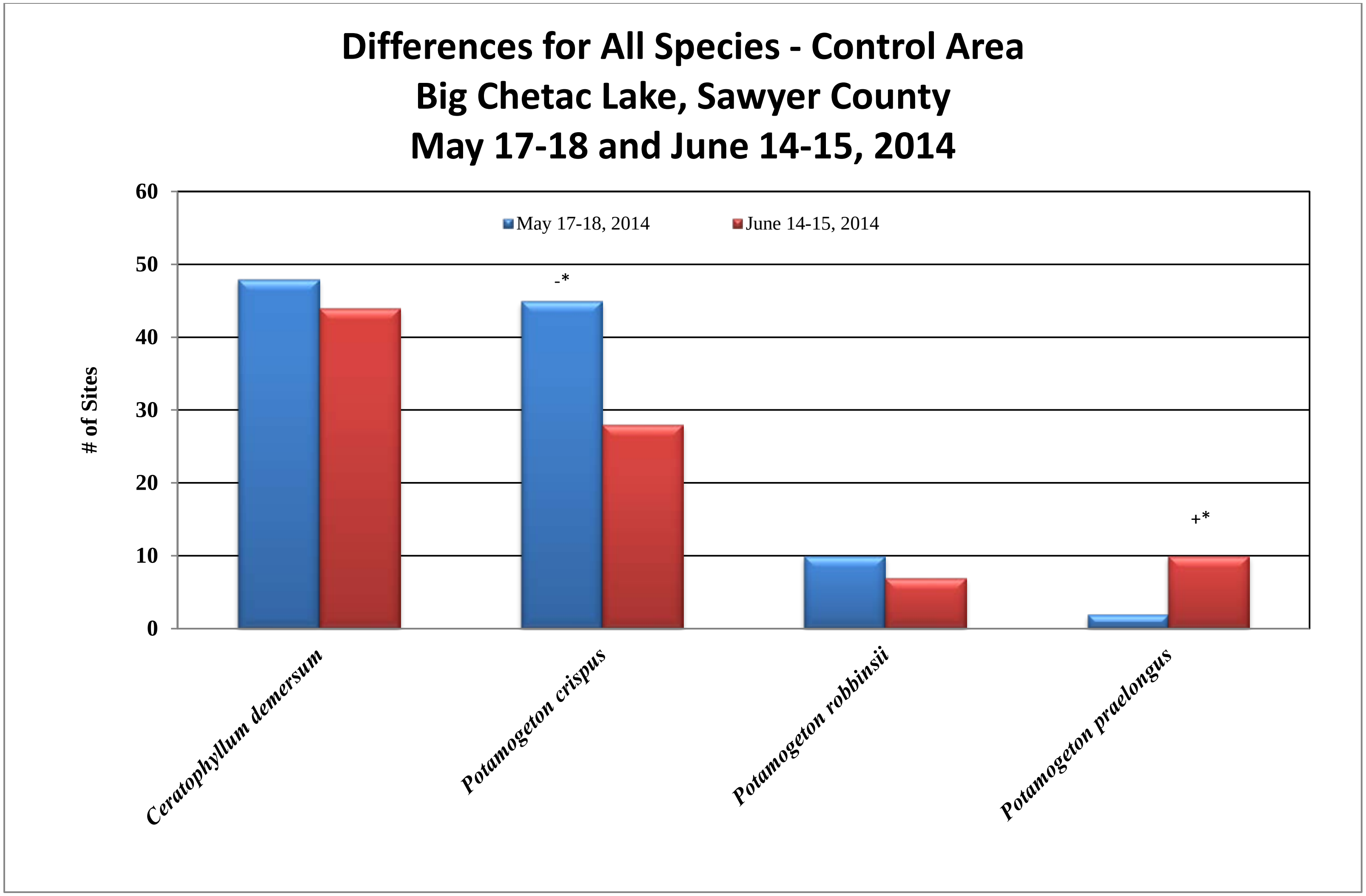
Significant differences = * $p < .05$, ** $p < .01$, *** $p < .005$

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



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

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



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

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

Table 3: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Pretreatment Survey – North Bay - Big Chetac Lake, Sawyer County
May 17-18, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	205	69.73	90.31	51.90	1.49
Lemna trisulca	Forked duckweed	79	26.87	34.80	20.00	1.00
Ceratophyllum demersum	Coontail	6	2.04	2.64	1.52	1.00
Elodea canadensis	Common waterweed	2	0.68	0.88	0.51	1.00
Heteranthera dubia	Water star-grass	1	0.34	0.44	0.25	1.00
Ranunculus aquatilis	White water crowfoot	1	0.34	0.44	0.25	1.00

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey – North Bay - Big Chetac Lake, Sawyer County
June 14-15, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Lemna trisulca	Forked duckweed	55	48.25	59.14	13.92	1.02
Potamogeton crispus	Curly-leaf pondweed	37	32.46	39.78	9.37	1.03
	Filamentous algae	34	*	36.56	8.61	1.91
Ceratophyllum demersum	Coontail	7	6.14	7.53	1.77	1.14
Vallisneria americana	Wild celery	5	4.39	5.38	1.27	1.40
Potamogeton richardsonii	Clasping-leaf pondweed	3	2.63	3.23	0.76	1.67
Elodea canadensis	Common waterweed	2	1.75	2.15	0.51	1.00
Heteranthera dubia	Water star-grass	2	1.75	2.15	0.51	1.00
Potamogeton pusillus	Small pondweed	2	1.75	2.15	0.51	1.00
Najas flexilis	Slender naiad	1	0.88	1.08	0.25	1.00

* Excluded from Relative Frequency Analysis

Table 5: Frequencies and Mean Rake Sample of Aquatic Macrophytes
May Survey – Boat Landing Bay - Big Chetac Lake, Sawyer County
May 17-18, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	19	76.00	100.00	61.29	1.42
Potamogeton pusillus	Small pondweed	6	24.00	31.58	19.35	1.33

Table 6: Frequencies and Mean Rake Sample of Aquatic Macrophytes
June Survey – Boat Landing Bay - Big Chetac Lake, Sawyer County
June 14-15, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	19	70.37	95.00	70.37	2.26
Potamogeton pusillus	Small pondweed	5	18.52	25.00	18.52	1.60
Potamogeton friesii	Fries' pondweed	2	7.41	10.00	7.41	1.00
	Filamentous algae	2	*	10.00	7.41	1.50
Ceratophyllum demersum	Coontail	1	3.70	5.00	3.70	1.00

* Excluded from Relative Frequency Analysis

Table 7: Frequencies and Mean Rake Sample of Aquatic Macrophytes
May Survey – Western Control Bay - Big Chetac Lake, Sawyer County
May 17-18, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Ceratophyllum demersum	Coontail	48	45.71	73.85	48.00	1.40
Potamogeton crispus	Curly-leaf pondweed	45	42.86	69.23	45.00	1.60
Potamogeton robbinsii	Fern pondweed	10	9.52	15.38	10.00	1.00
Potamogeton praelongus	White-stem pondweed	2	1.90	3.08	2.00	1.00

Table 8: Frequencies and Mean Rake Sample of Aquatic Macrophytes
June Survey – Western Control Bay - Big Chetac Lake, Sawyer County
June 14-15, 2014

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Ceratophyllum demersum	Coontail	44	49.44	70.97	44.00	1.09
Potamogeton crispus	Curly-leaf pondweed	28	31.46	45.16	28.00	2.00
Potamogeton praelongus	White-stem pondweed	10	11.24	16.13	10.00	1.10
Potamogeton robbinsii	Fern pondweed	7	7.87	11.29	7.00	1.00

CONSIDERATIONS FOR FUTURE MANAGMENT:

With a project goal being to significantly reduce CLP prior to beginning the restoration of native plants (BCABLA 2010), both the 2013 and the 2014 herbicide applications have to be considered successes. By starting the restoration process on the upstream/north end of the lake, the treatment provided the additional benefit of preventing recolonization of CLP from turions washing in from elsewhere. As the project moves into its third year, all data from the 2014 posttreatment survey, the 2014 CLP bed mapping and full lake point intercept surveys, the 2014 fall turion survey, and the 2015 pretreatment survey will be used to finalize 2015 treatment areas as shareholders continue to work towards these restoration goals.

LITERATURE CITED

BCABLA. 2010. Big Chetac and Birch Lake Aquatic Plant Management Plan. Available from http://bcabla.com/lake-management-plan-and-related-studies.html (2013, July).

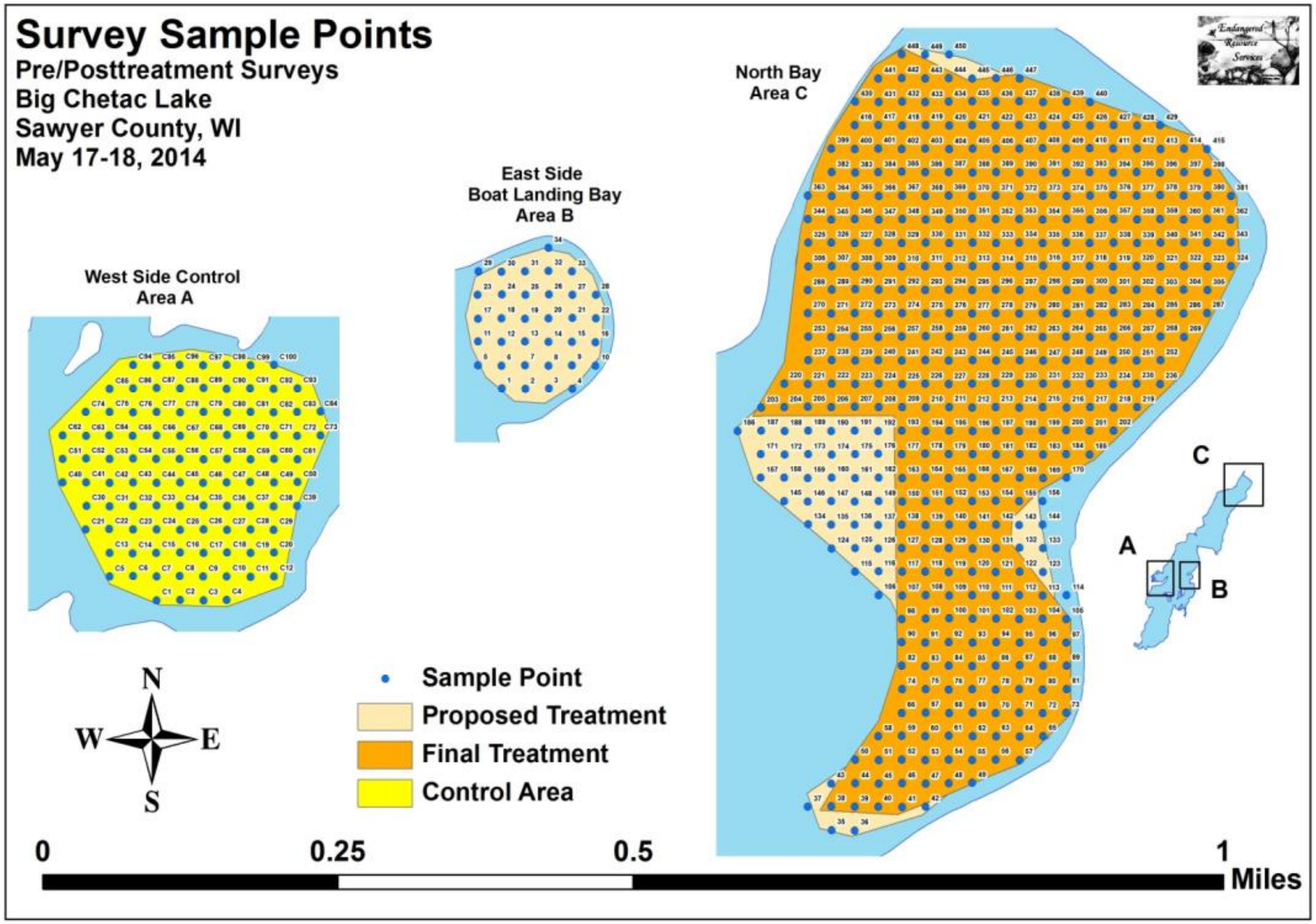
Busch, C., E. Eaton, N. Pokorny, and C. Holt. [online]. 1967. Big Chetac Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2113300a.pdf (2013, July).

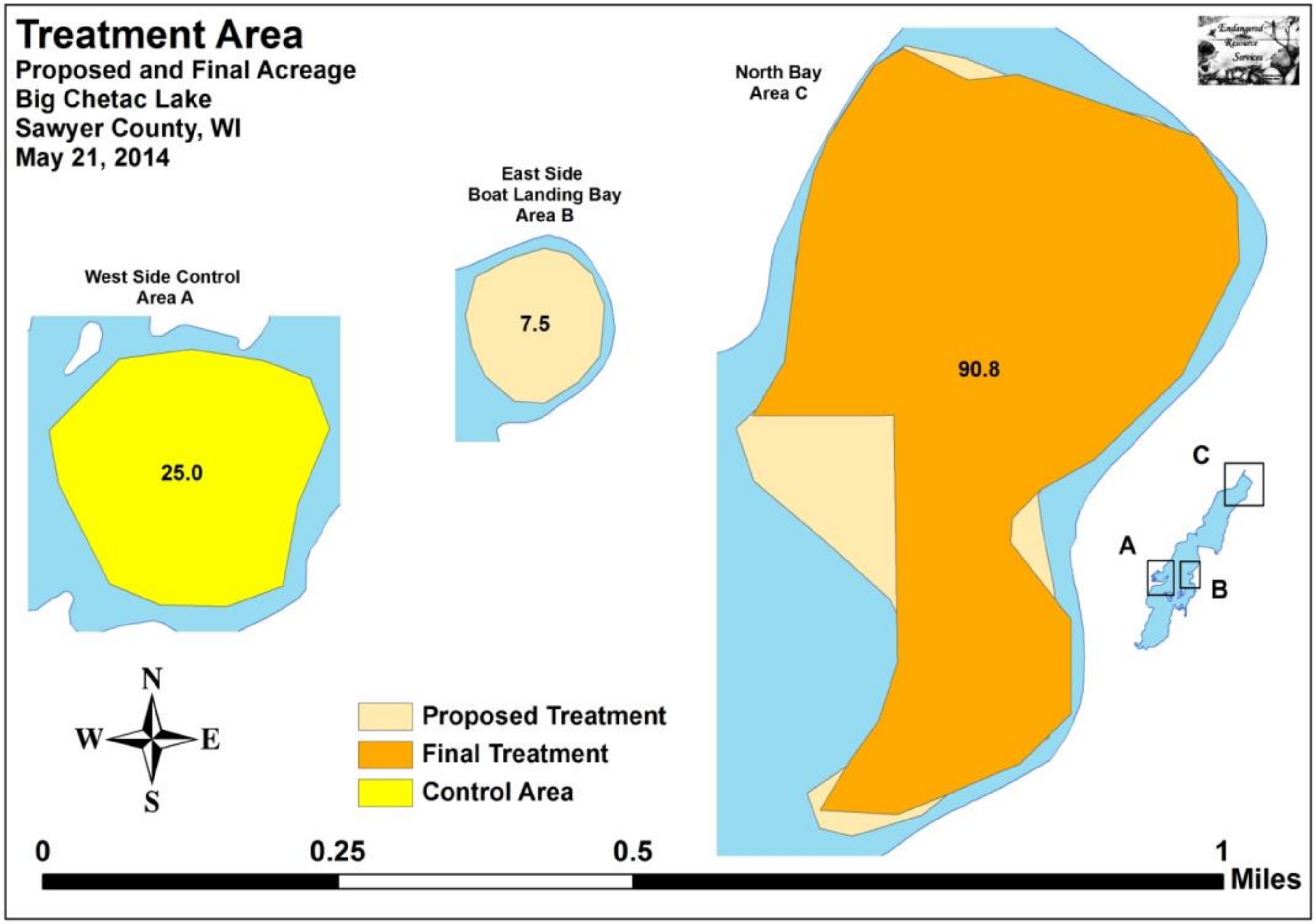
James, W.F., J.W. Barko, H.L. Eakin, and P.W. Sorge. 2002. Phosphorus budget and management strategies for an urban Wisconsin lake. Lake and Reserv. Manage. 18(2): 149-163

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp (2014, July).

WDNR. [online]. 2014. Big Chetac Lake - Citizen Lake Water Quality Monitoring Database. Available from http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2113300&page=waterquality 2014, August).

Appendix I: Survey Sample Points and CLP Treatment Area

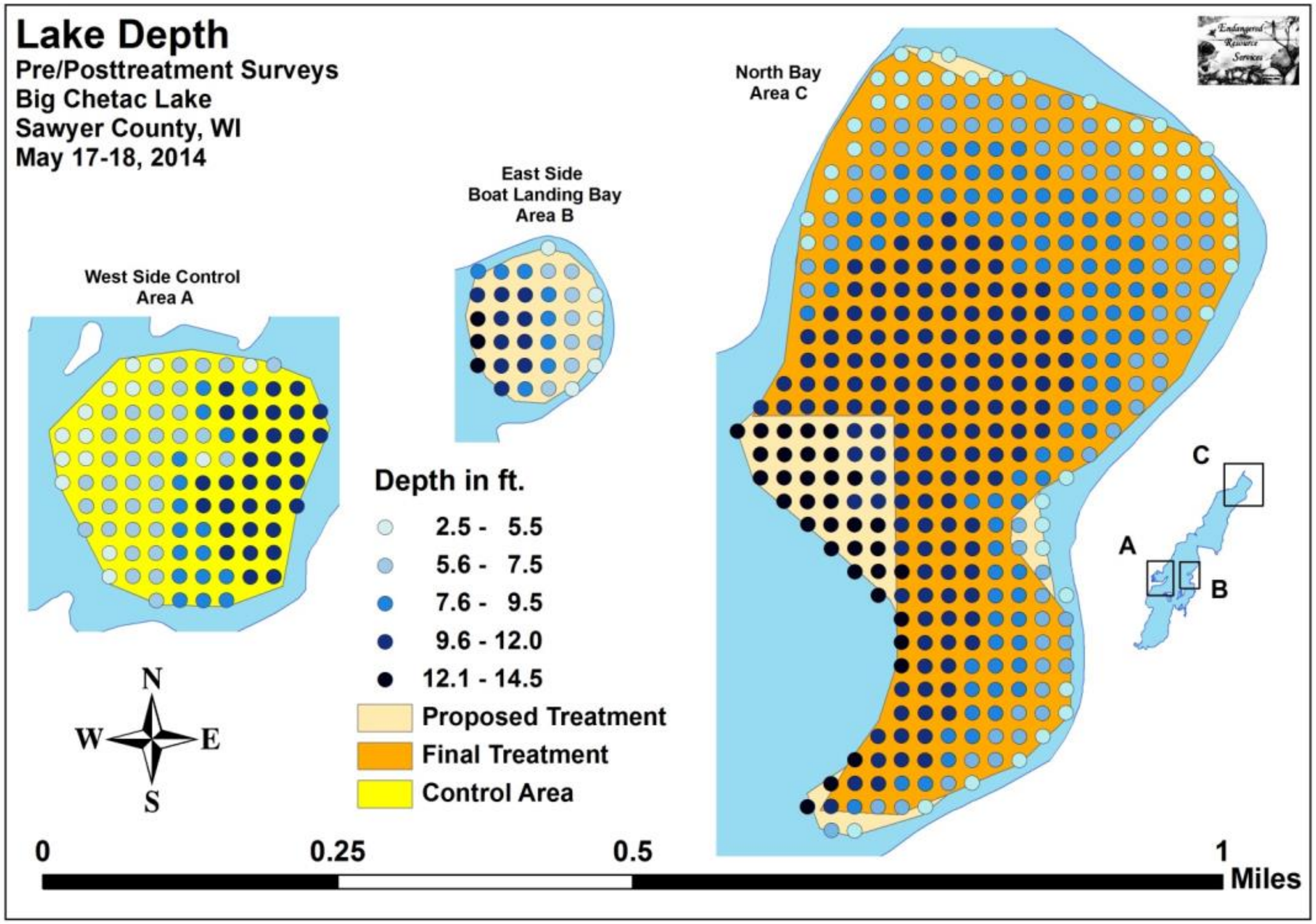

Survey Sample Points
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
N
W
E
S
Sample Point
Proposed Treatment
Final Treatment
Control Area
A
B
C
0
0.25
0.5
1
Miles

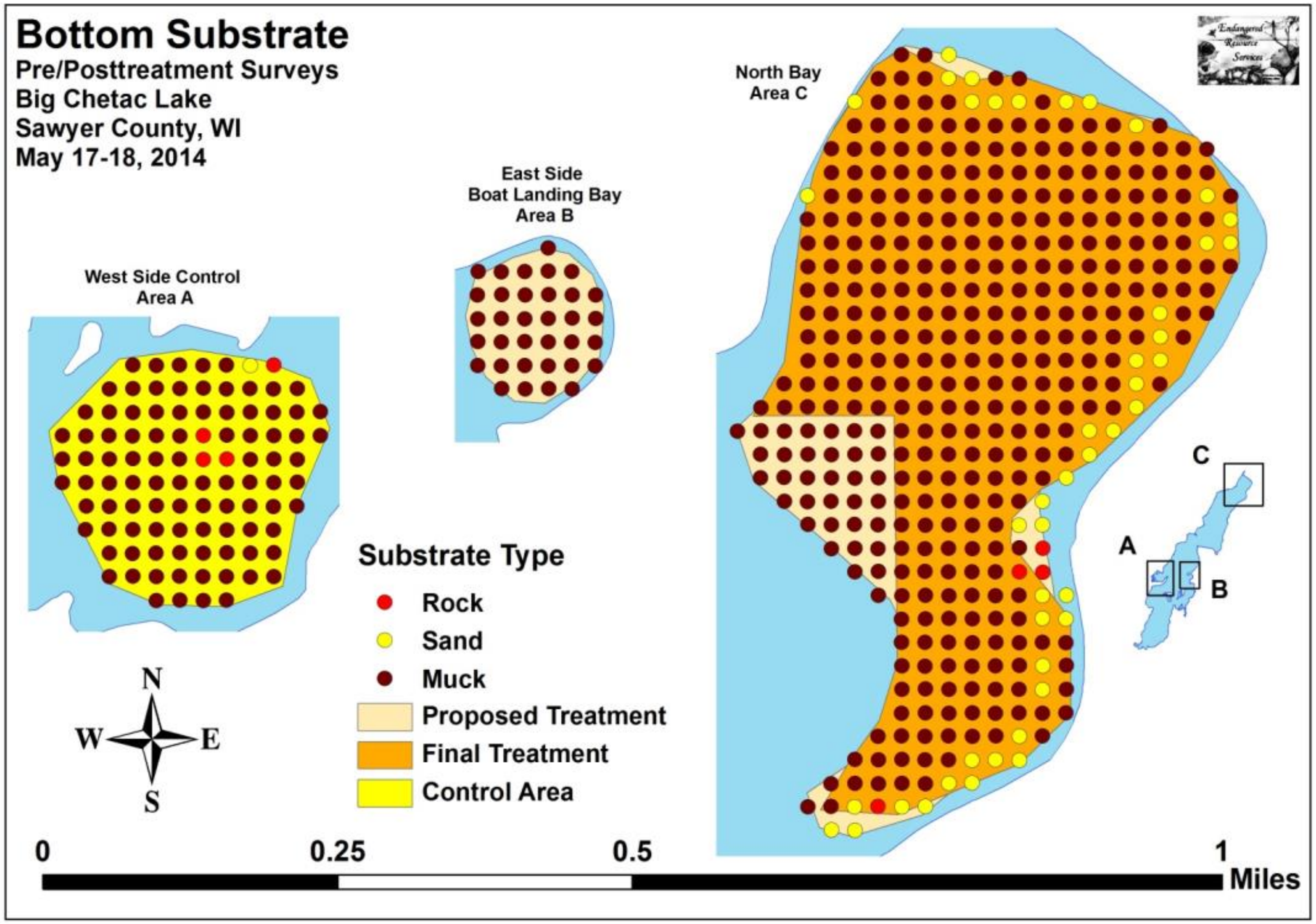

Treatment Area
Proposed and Final Acreage
Big Chetac Lake
Sawyer County, WI
May 21, 2014
West Side Control
Area A
25.0
East Side
Boat Landing Bay
Area B
7.5
North Bay
Area C
90.8
C
A
B
N
W
E
S
Proposed Treatment
Final Treatment
Control Area
0
0.25
0.5
1
Miles

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																								

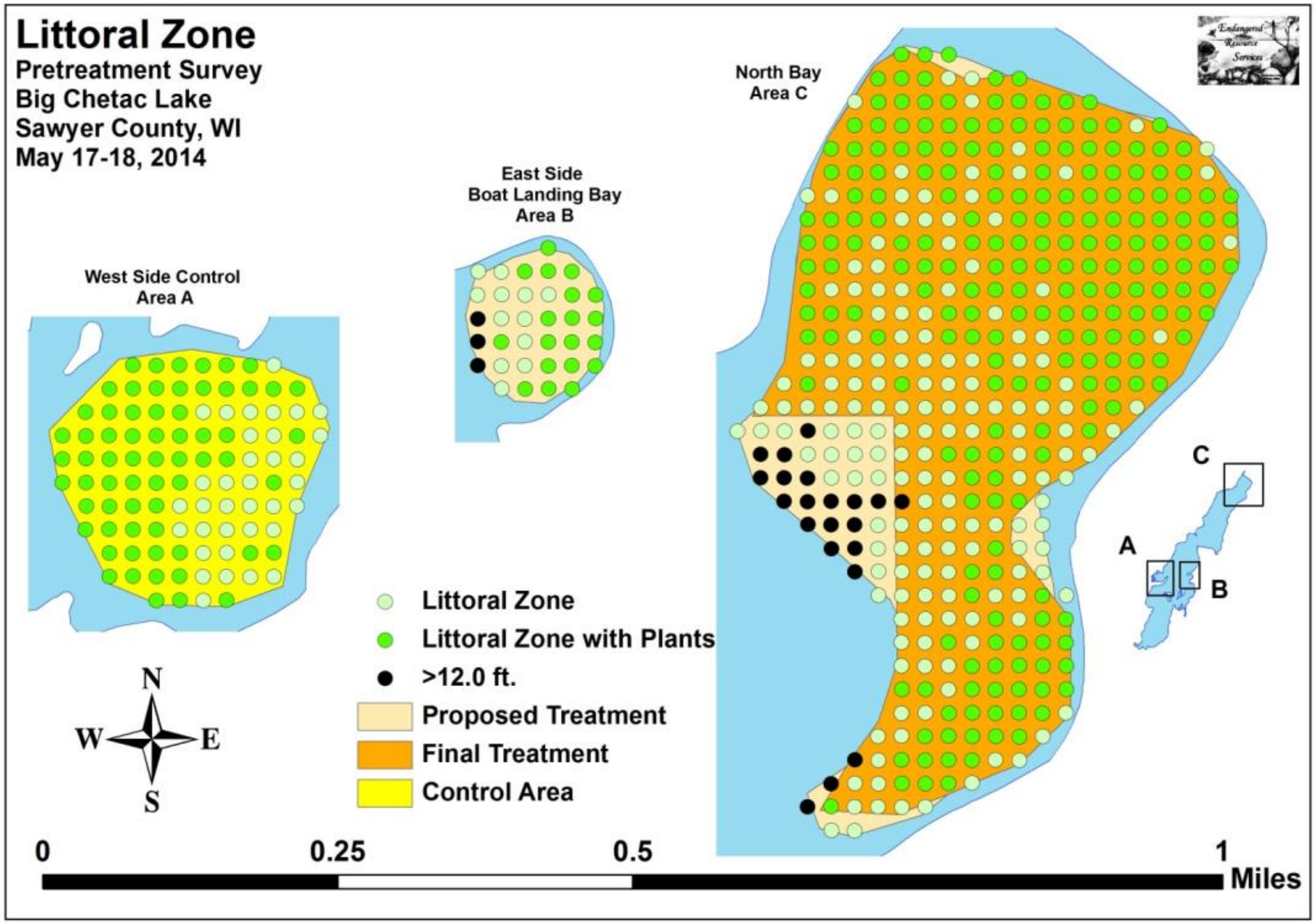
Appendix III: Pre/Post Habitat Variable Maps


Lake Depth
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
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
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

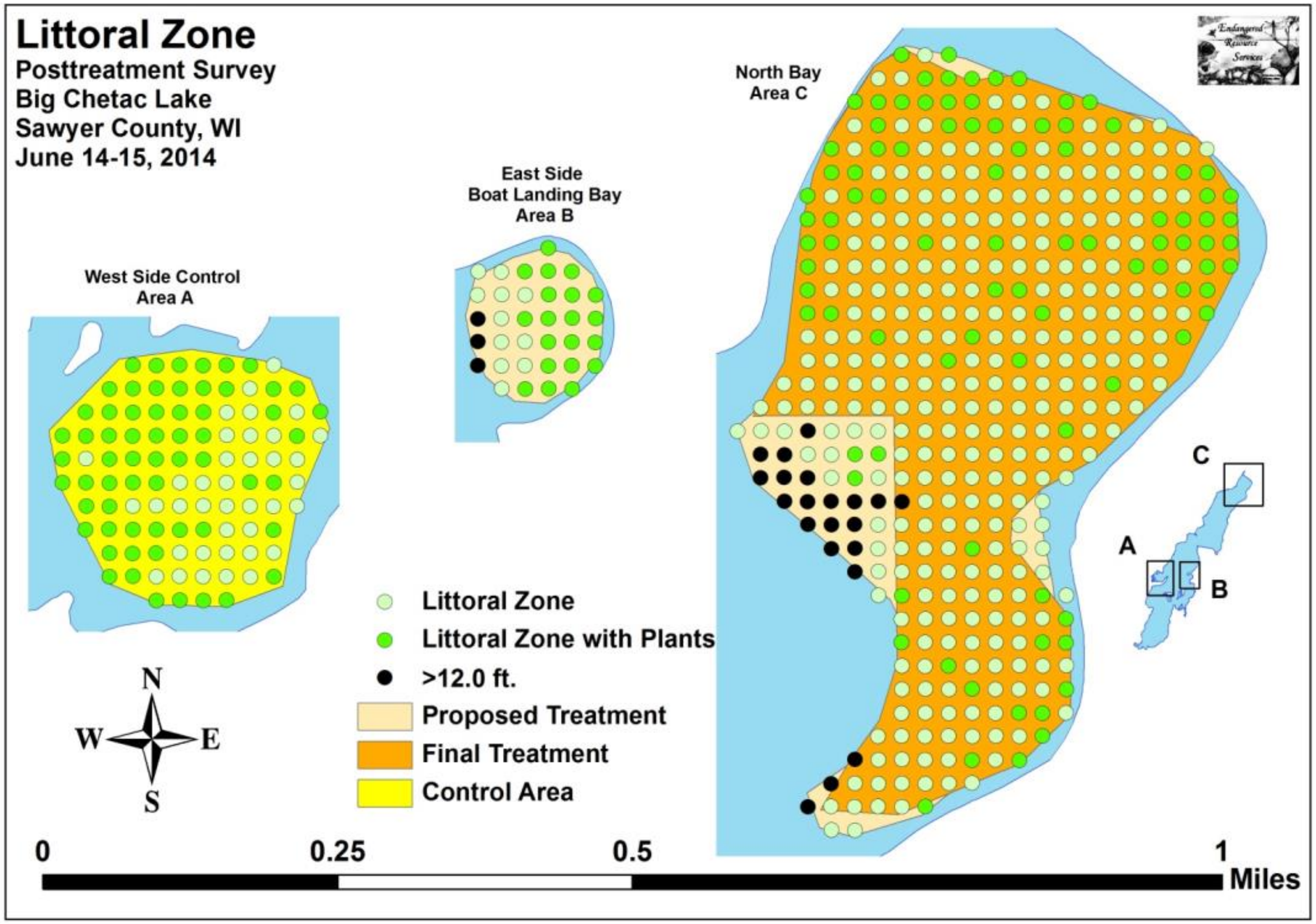


Bottom Substrate
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
North Bay
Area C
East Side
Boat Landing Bay
Area B
West Side Control
Area A
Substrate Type
Rock
Sand
Muck
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
C
A
B
0
0.25
0.5
1
Miles

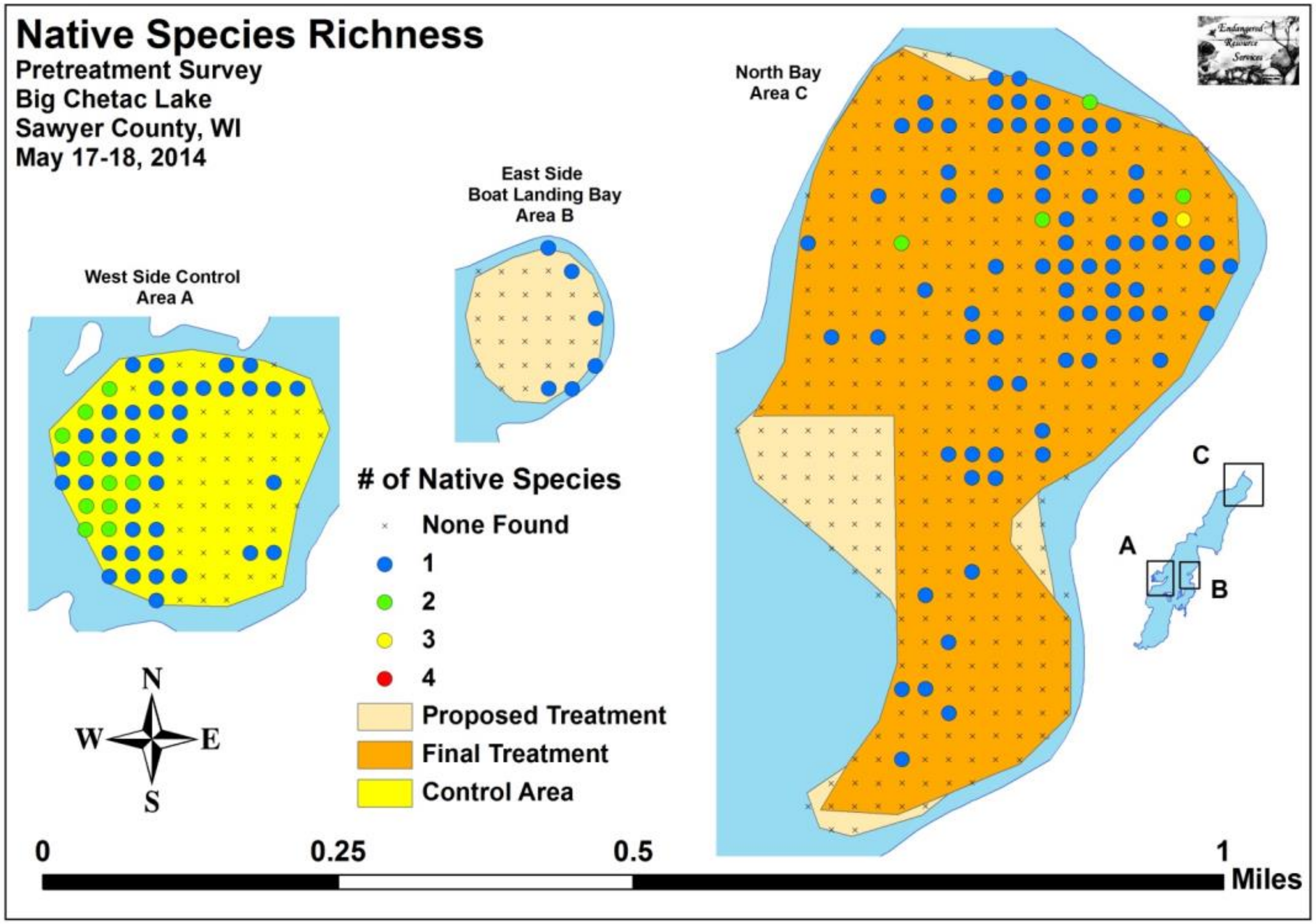
Appendix IV: Pre/Post Littoral Zone, Native Species Richness, and Total Rake Fullness

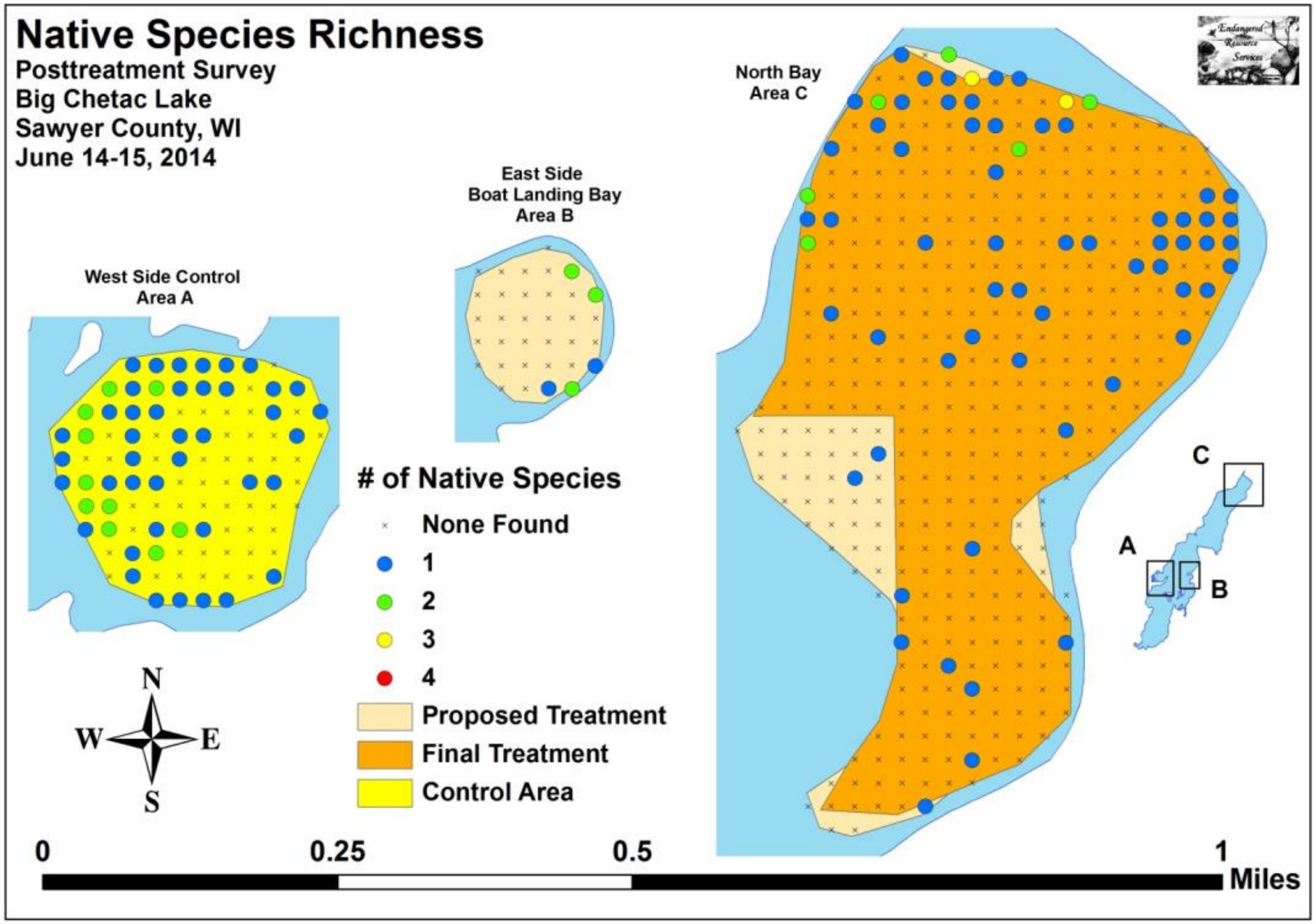


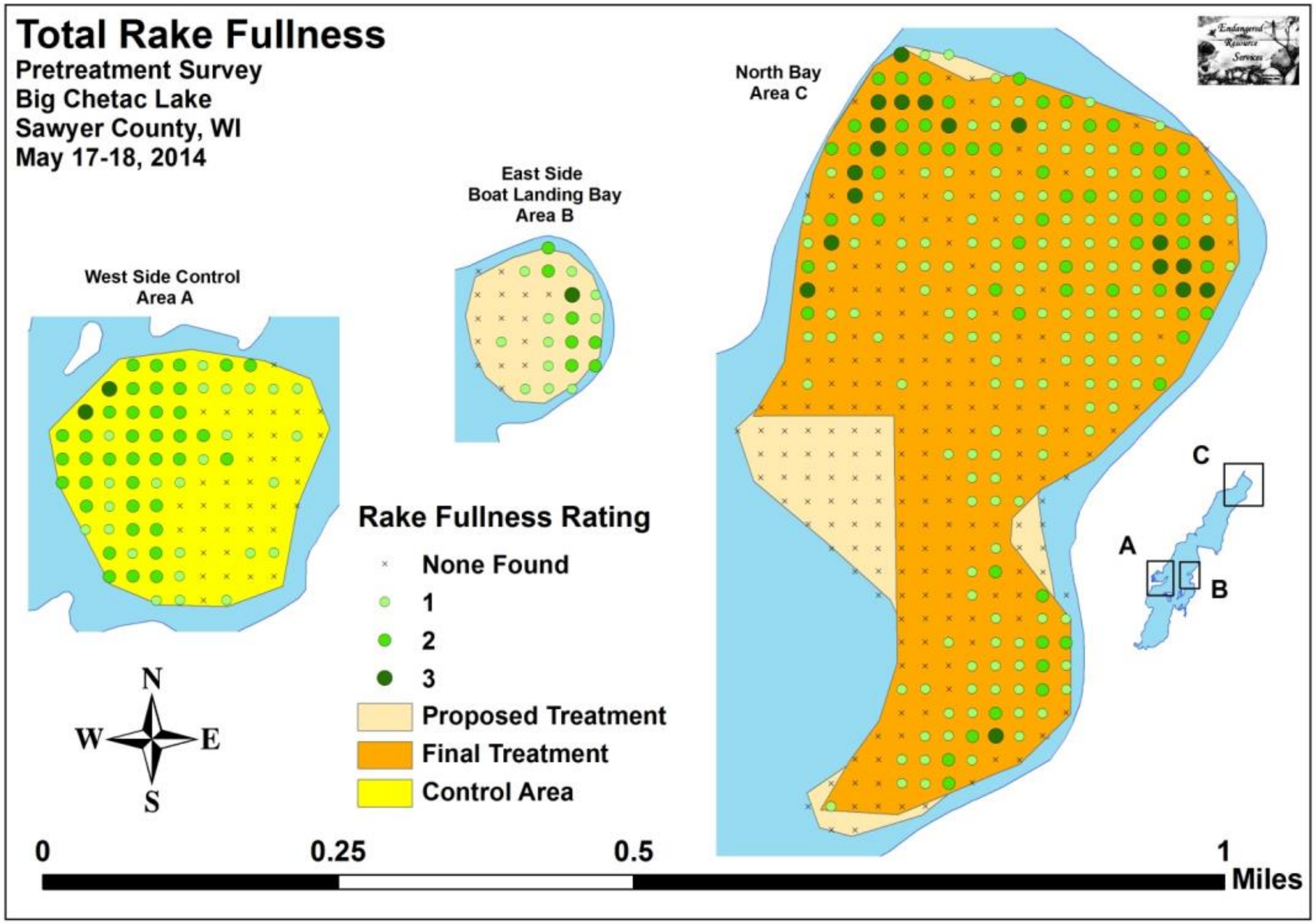
Littoral Zone
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Littoral Zone
Littoral Zone with Plants
>12.0 ft.
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
C
A
B
0
0.25
0.5
1
Miles

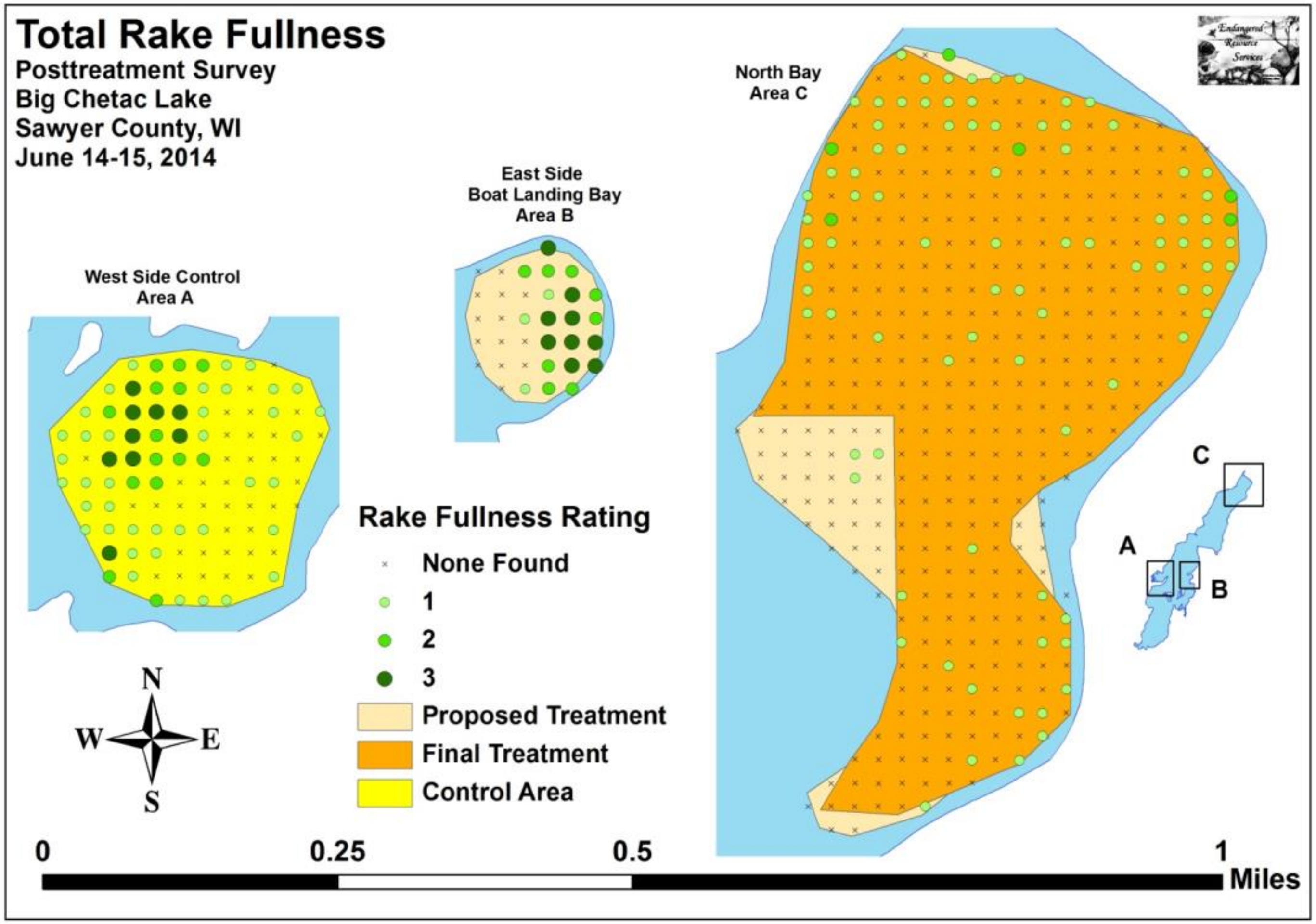


Littoral Zone
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
Endangered Resource Services
North Bay
Area C
East Side
Boat Landing Bay
Area B
West Side Control
Area A
Littoral Zone
Littoral Zone with Plants
>12.0 ft.
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
C
A
B
0
0.25
0.5
1
Miles

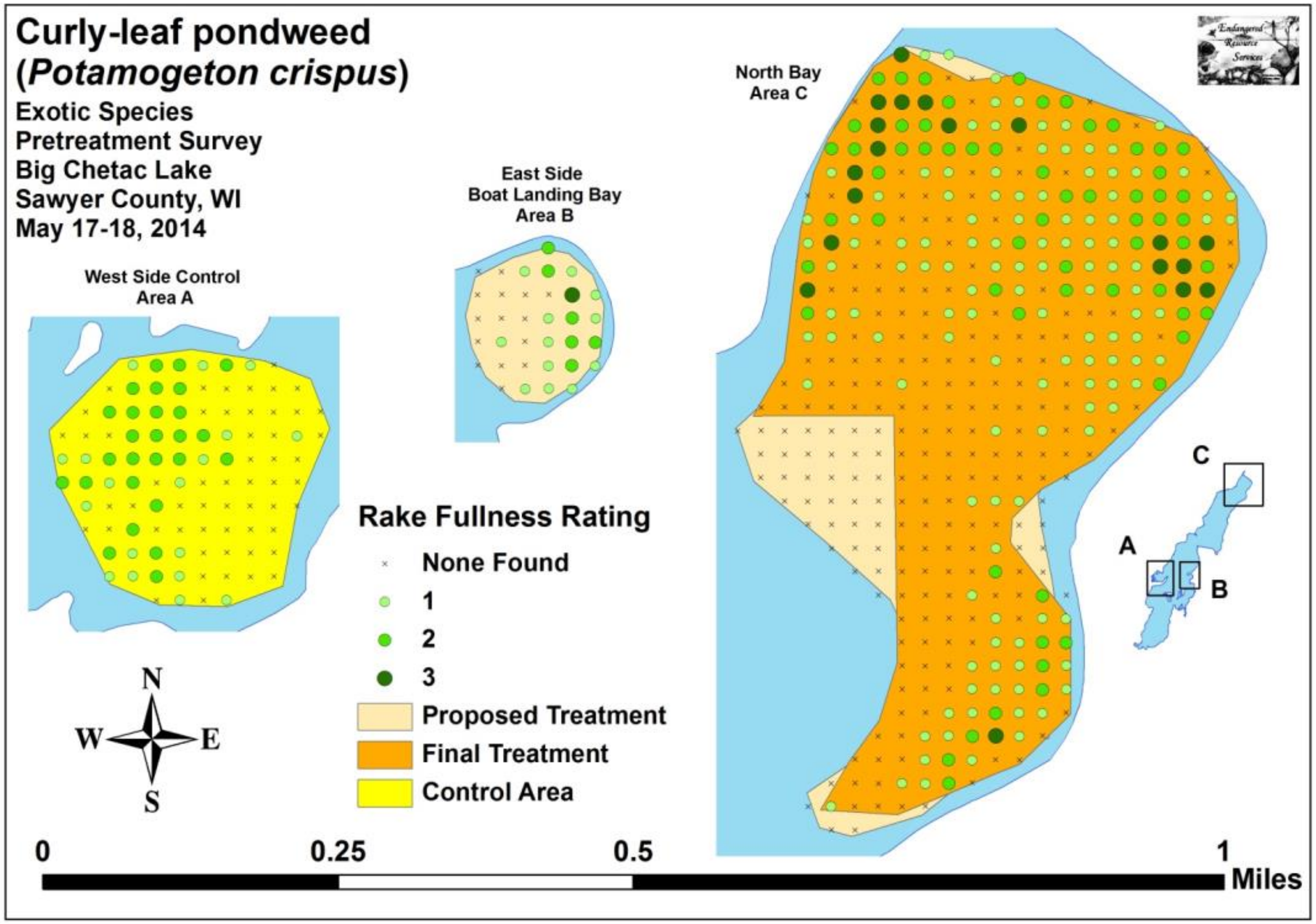

Native Species Richness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
# of Native Species
None Found
1
2
3
4
Proposed Treatment
Final Treatment
Control Area
N
S
E
W
A
B
C
0
0.25
0.5
1
Miles


Native Species Richness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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

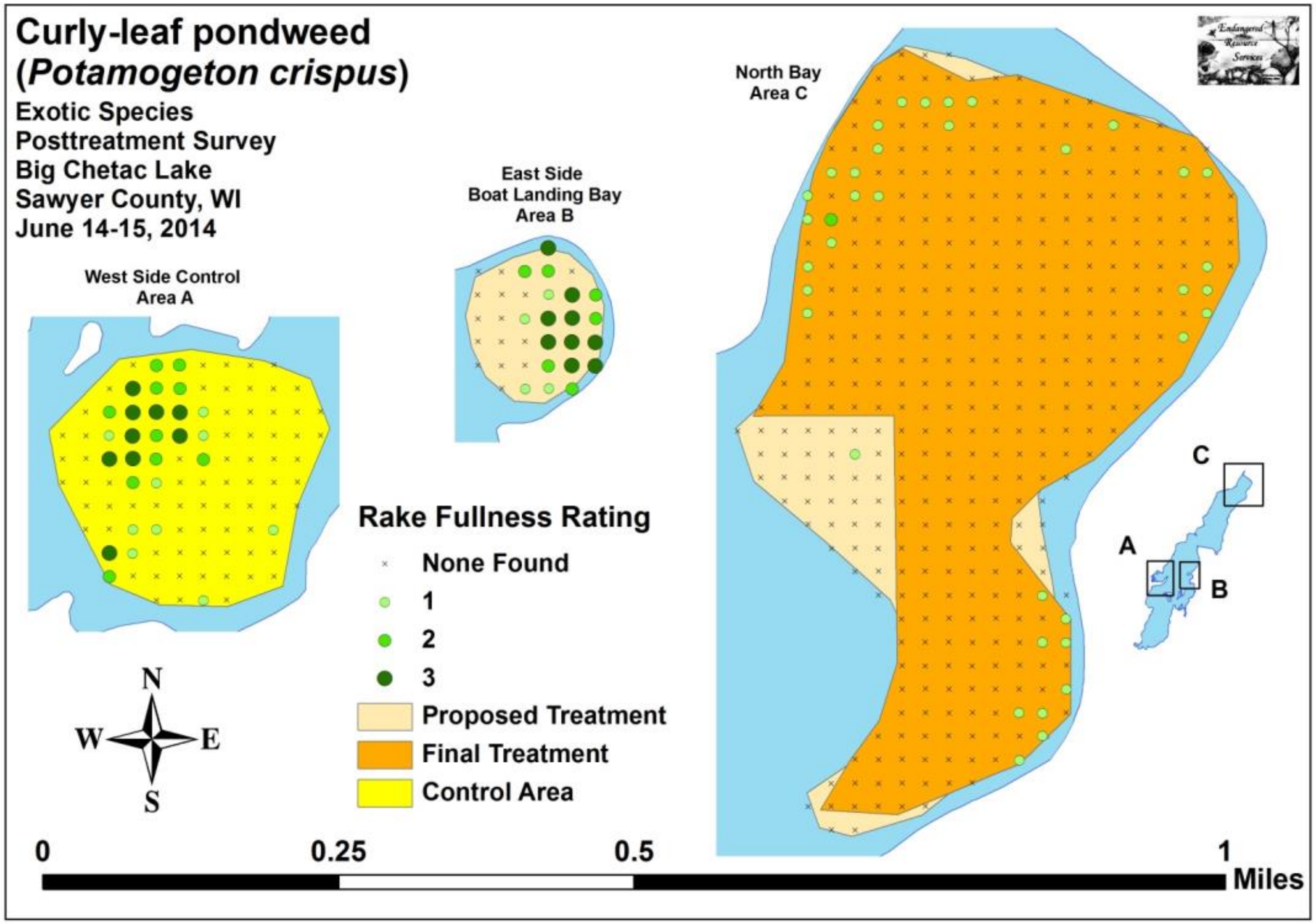

Total Rake Fullness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Total Rake Fullness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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 V: CLP Pre/Post Density and Distribution

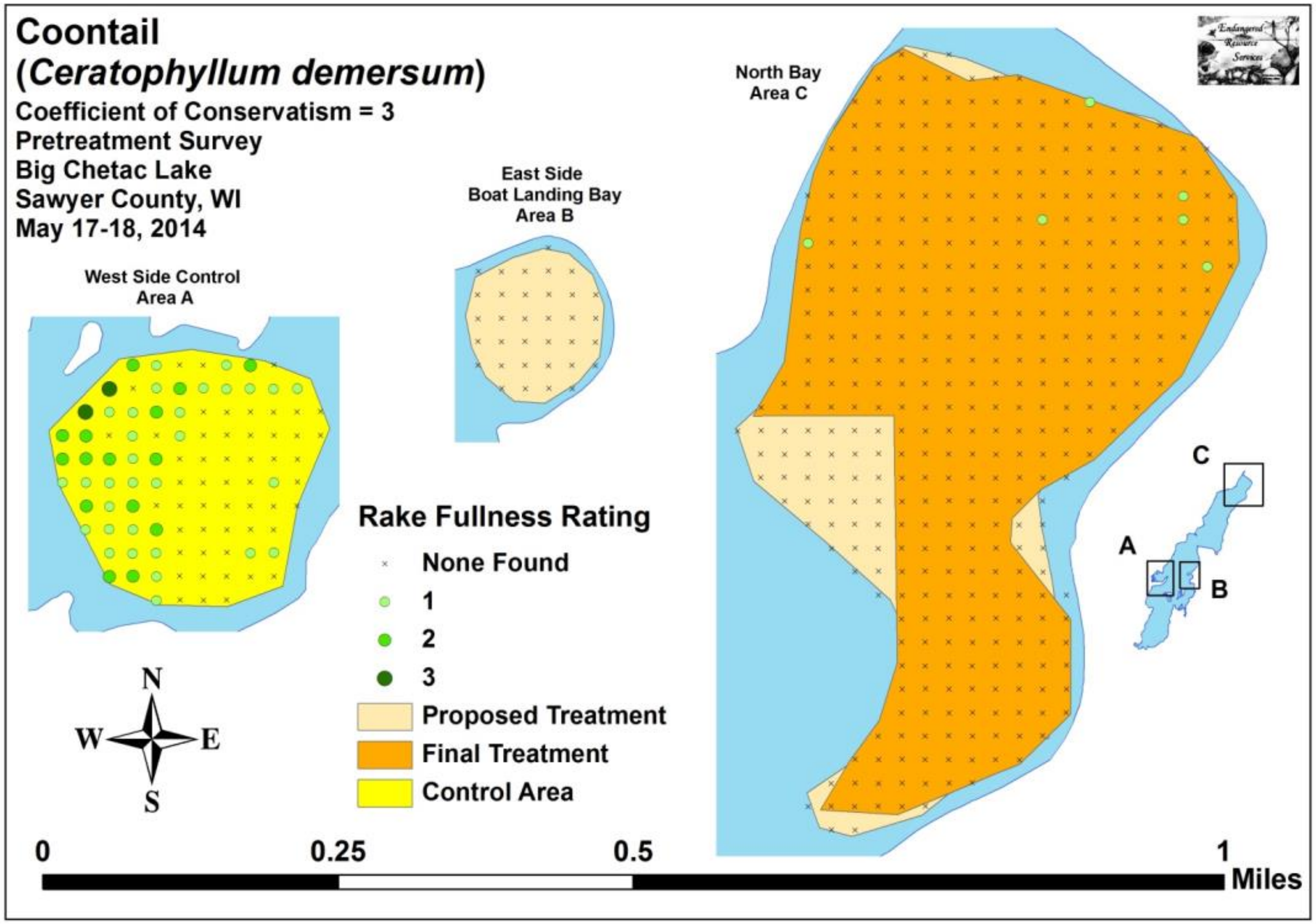


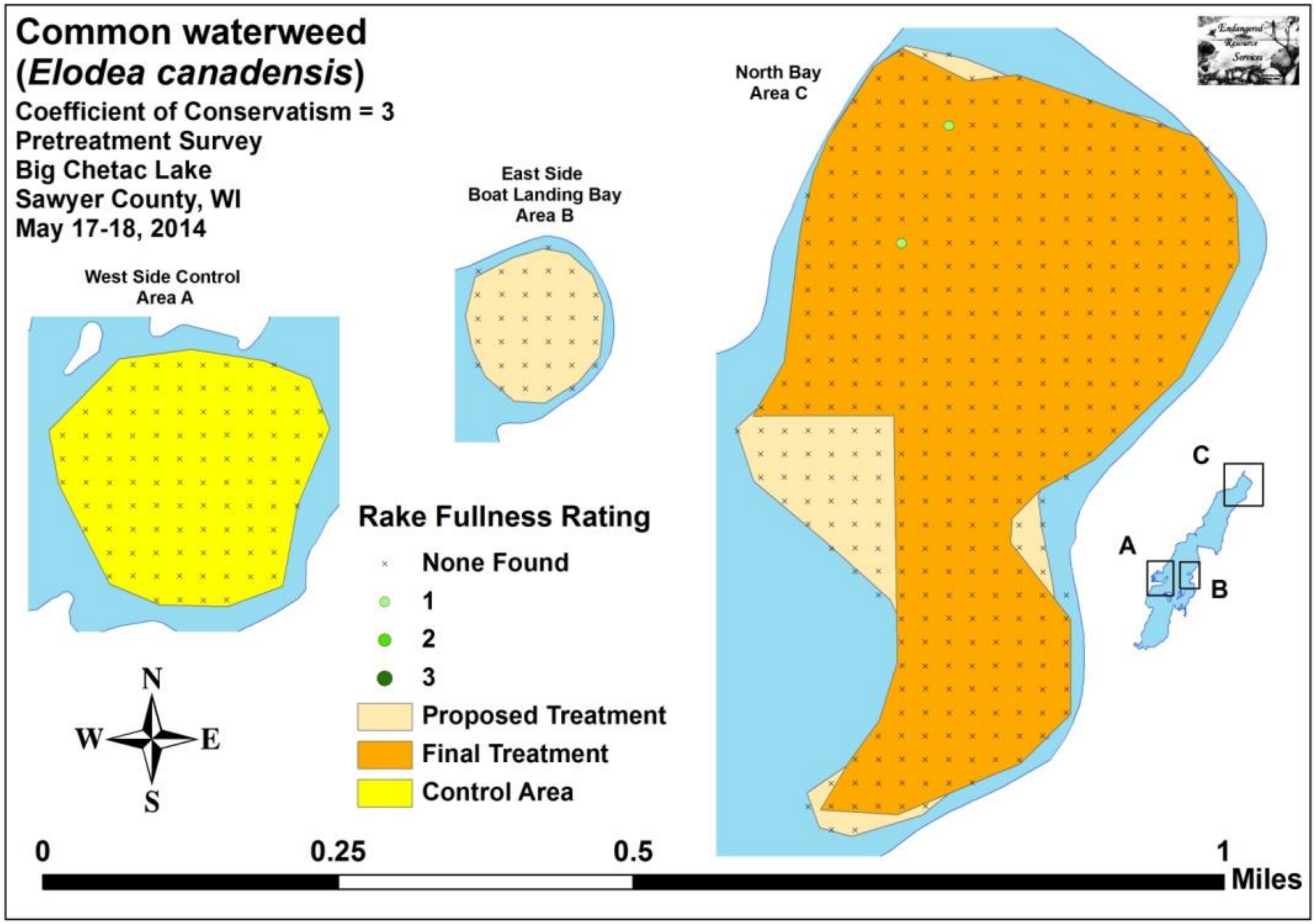
Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

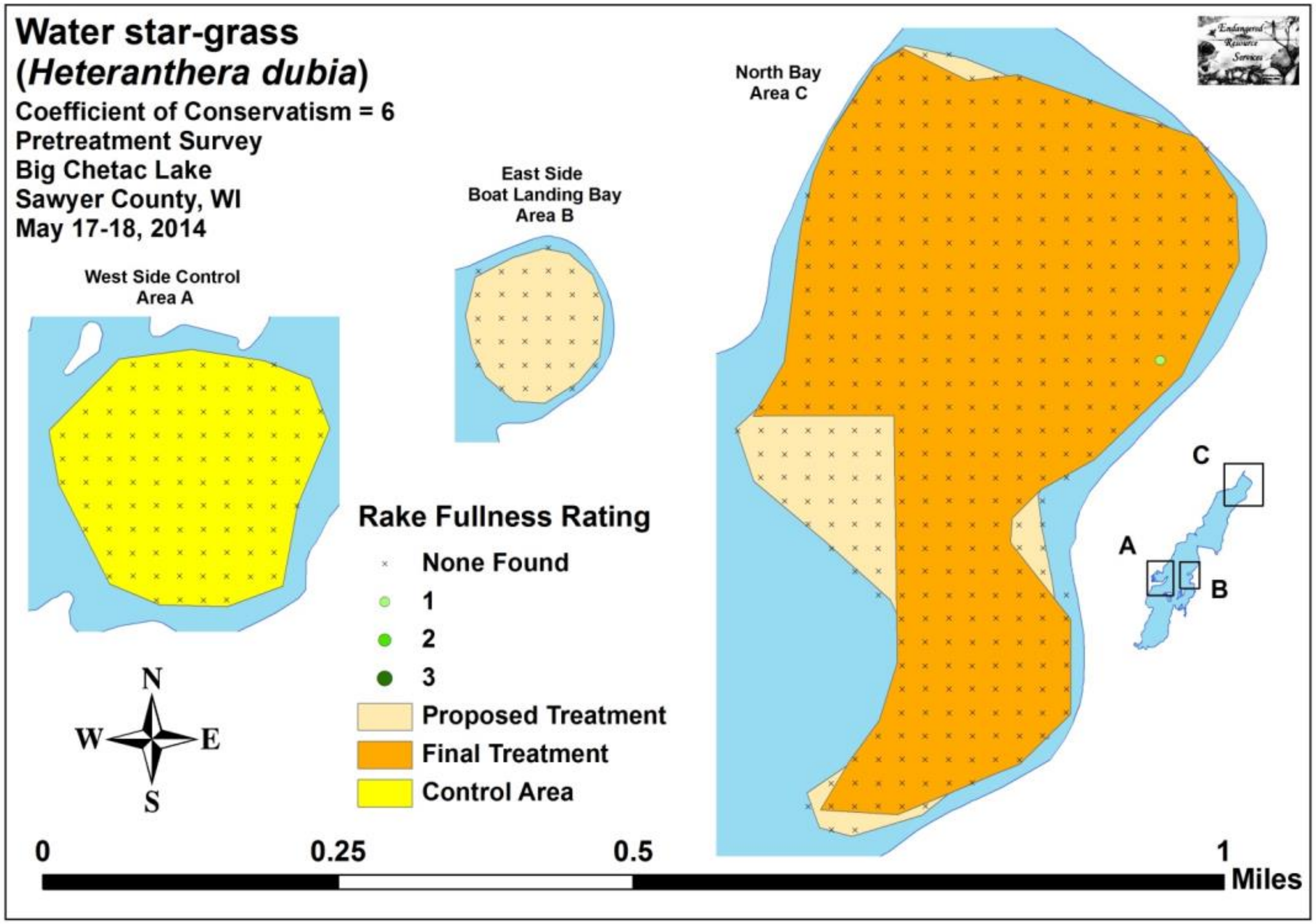


Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

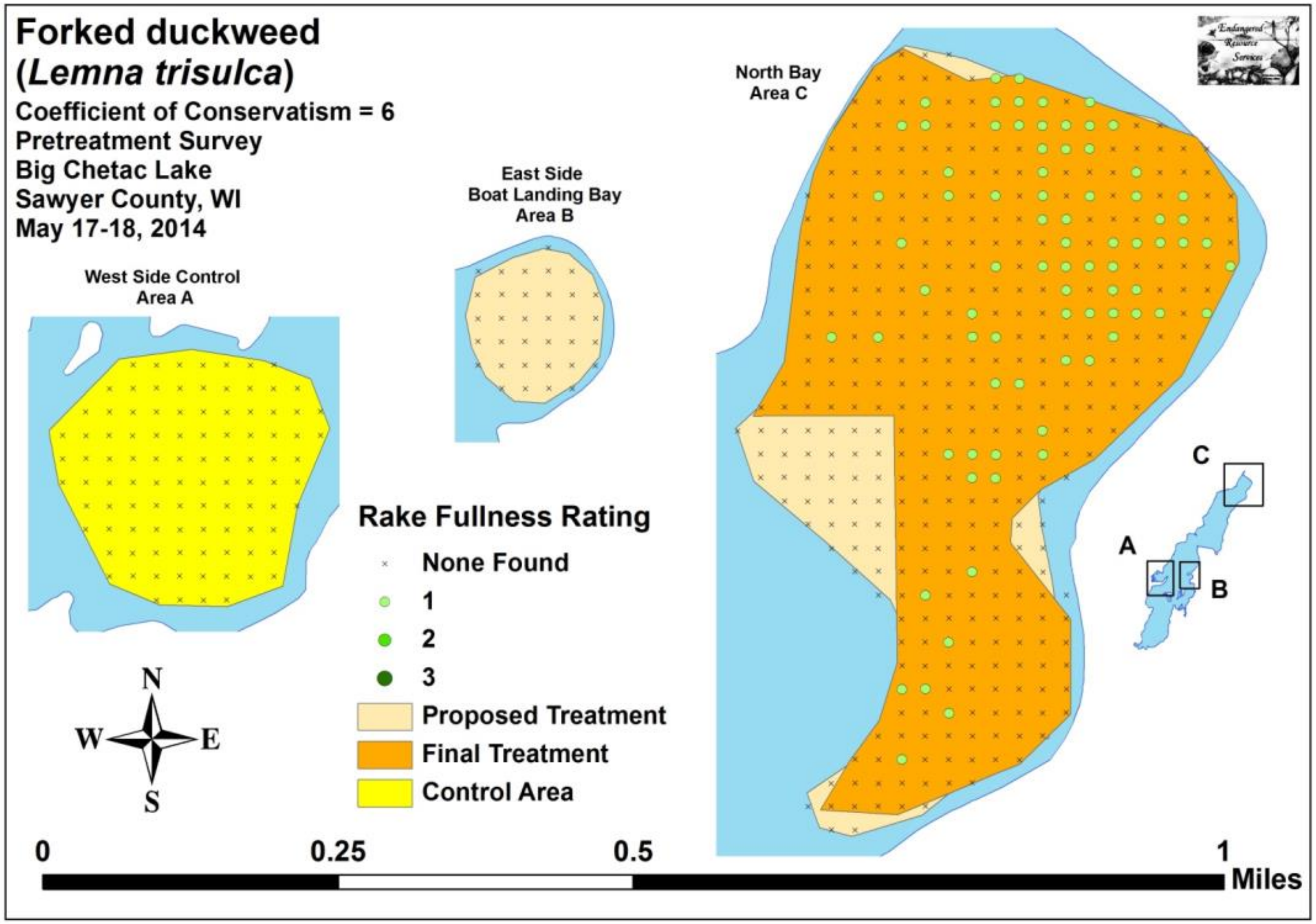
Appendix VI: Pretreatment Native Species Density and Distribution

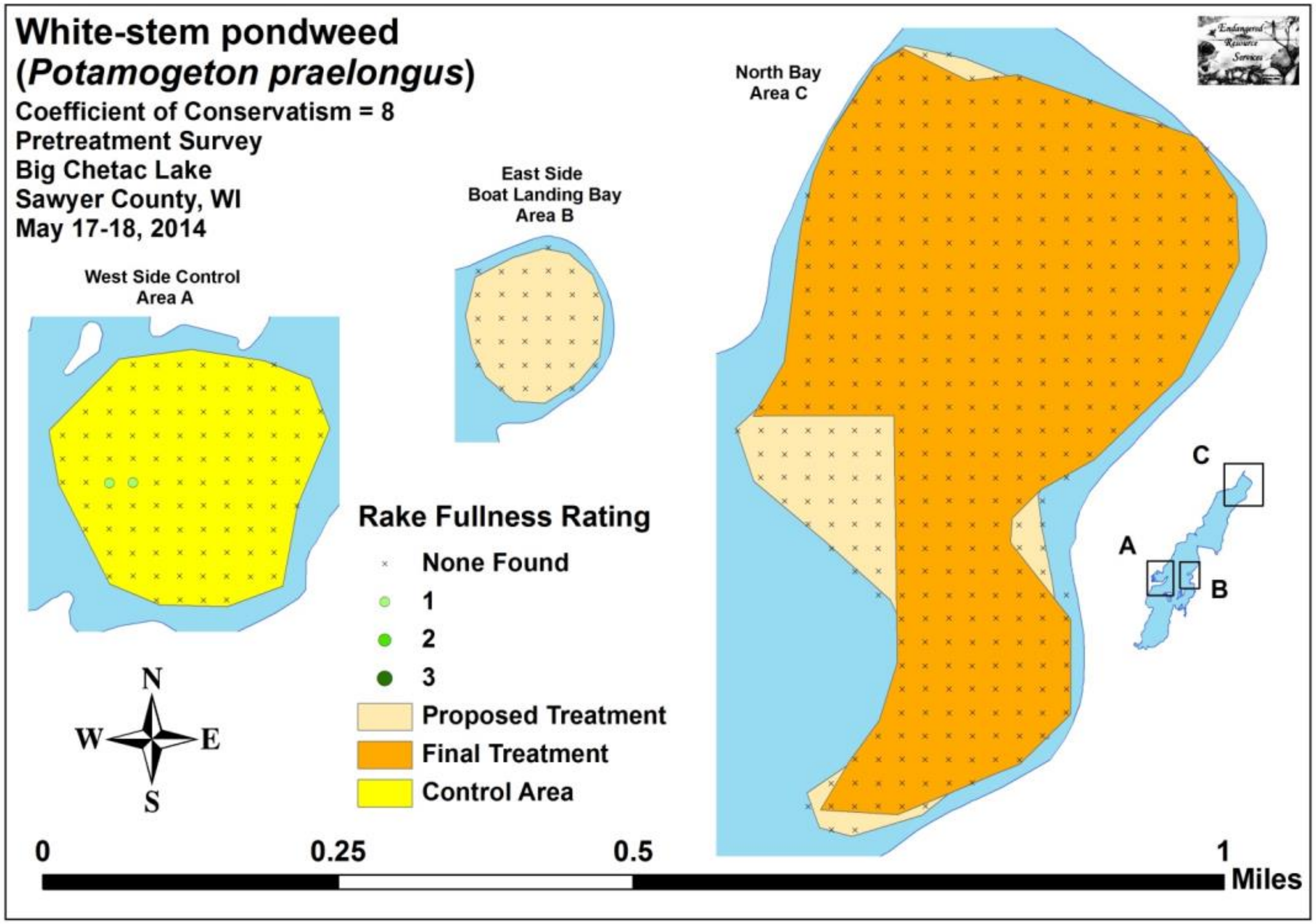

Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

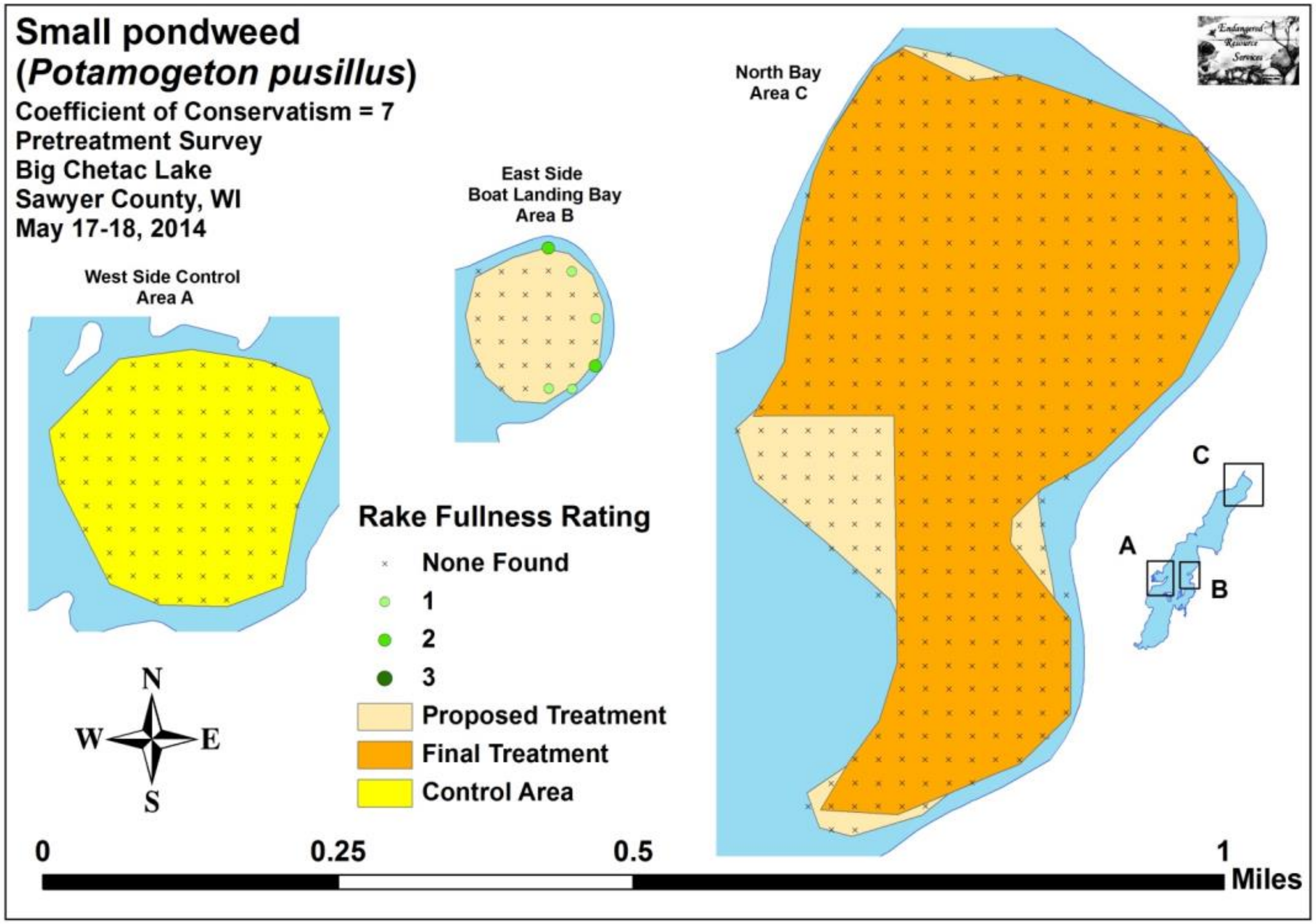

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

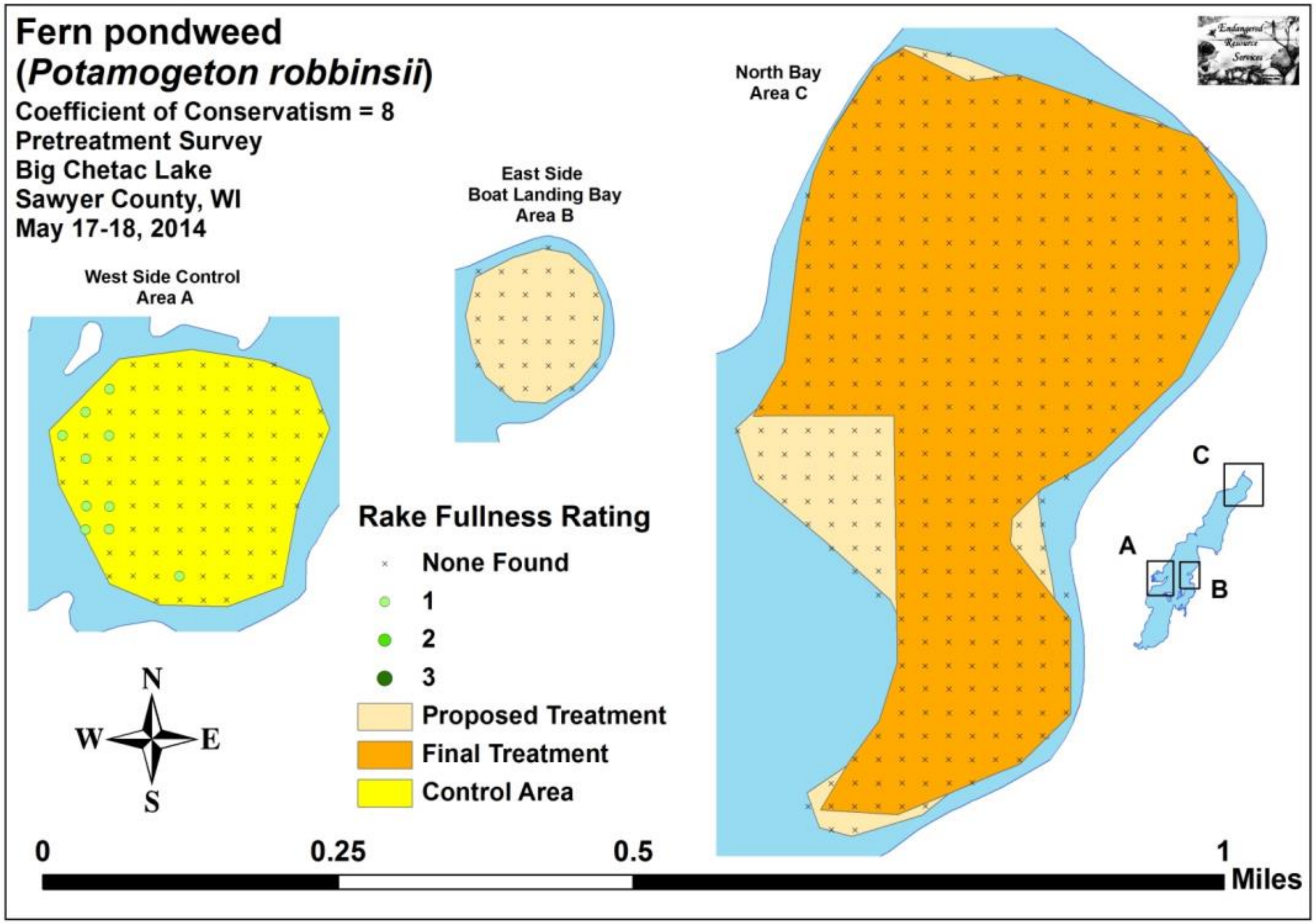


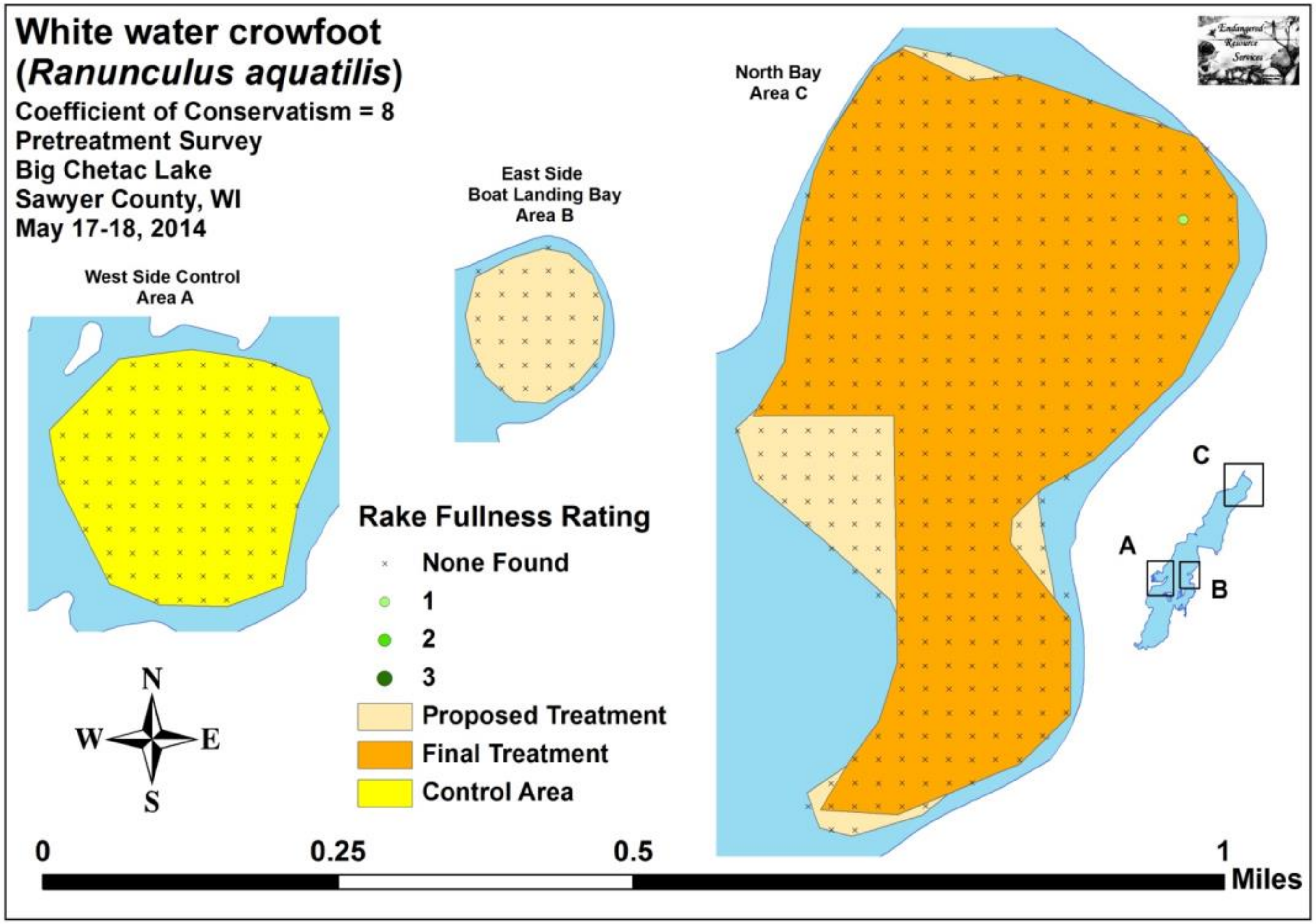
Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
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

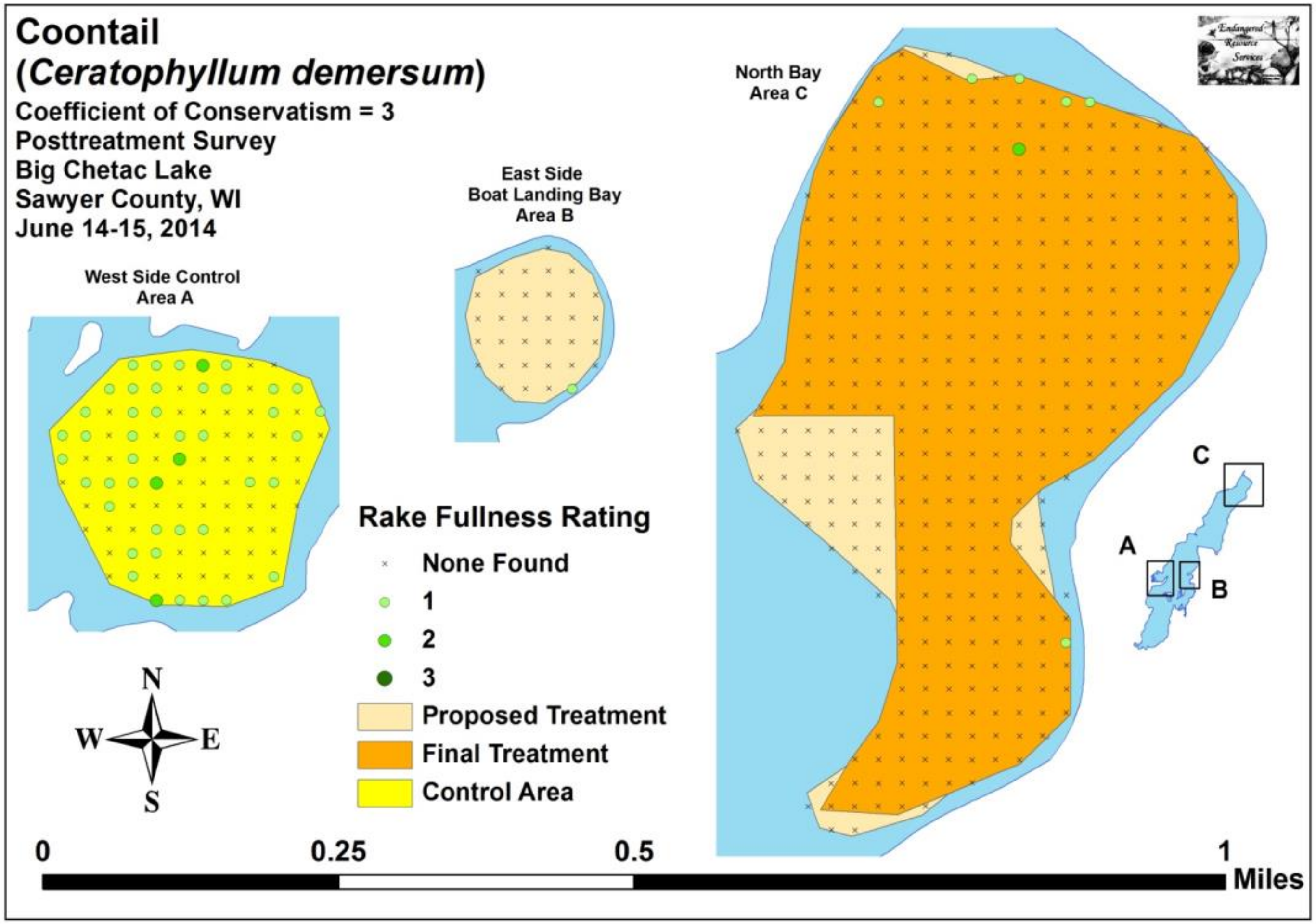

White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

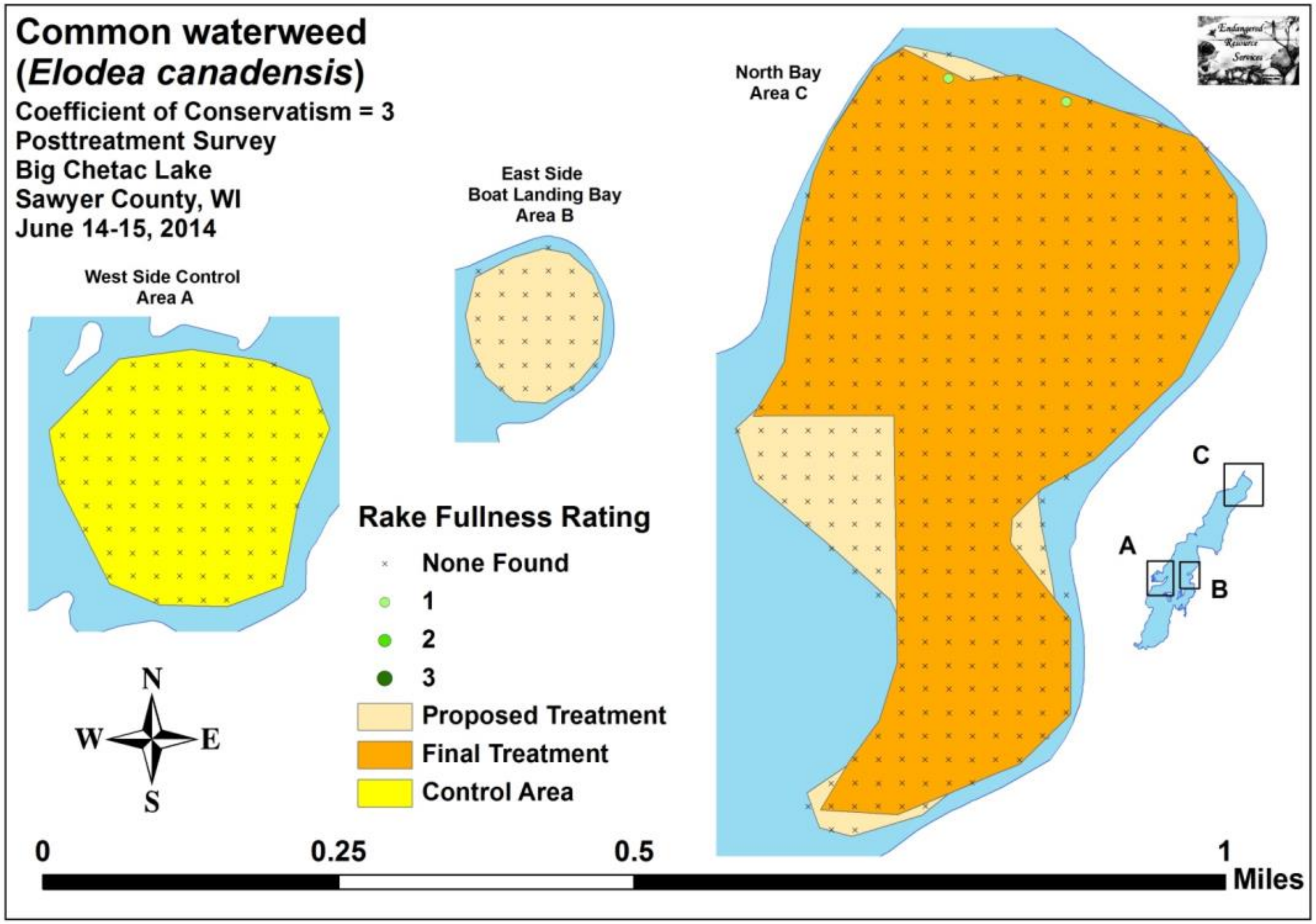

Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
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
May 17-18, 2014
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

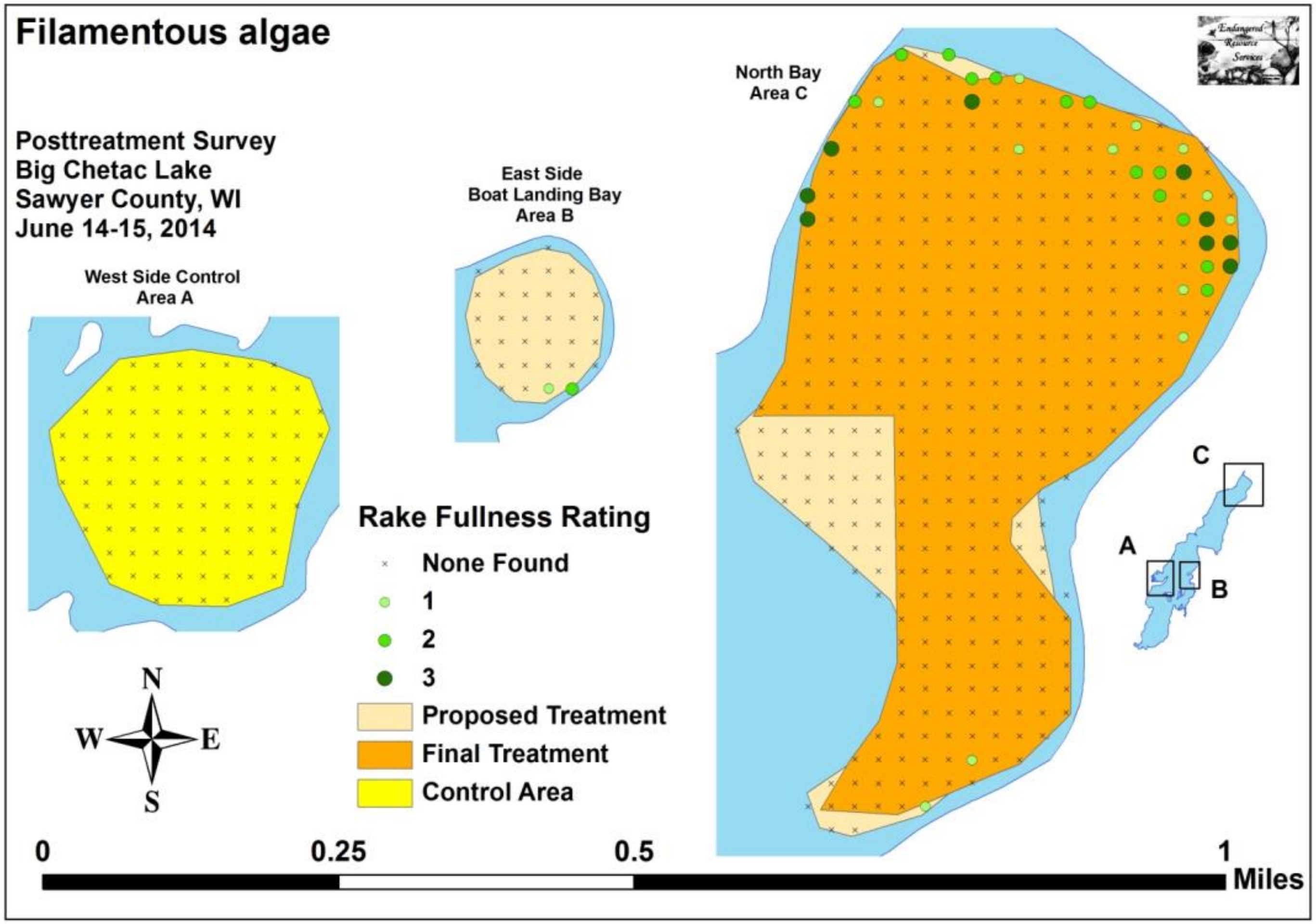

White water crowfoot
(Ranunculus aquatilis)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 17-18, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

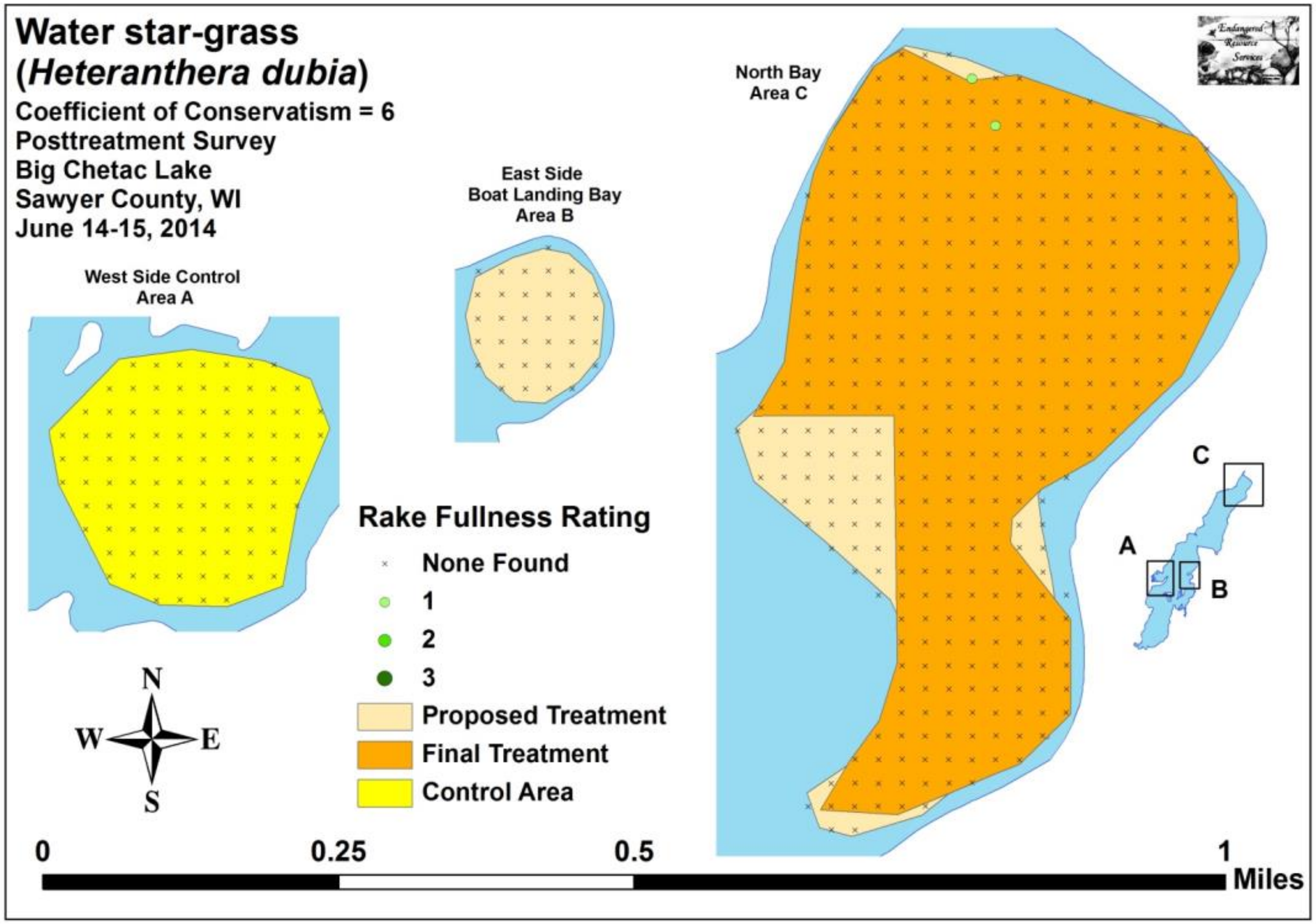
Appendix VII: Posttreatment Native Species Density and Distribution


Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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
June 14-15, 2014
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
June 14-15, 2014
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


Water star-grass
(Heteranthera dubia)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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
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A
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C
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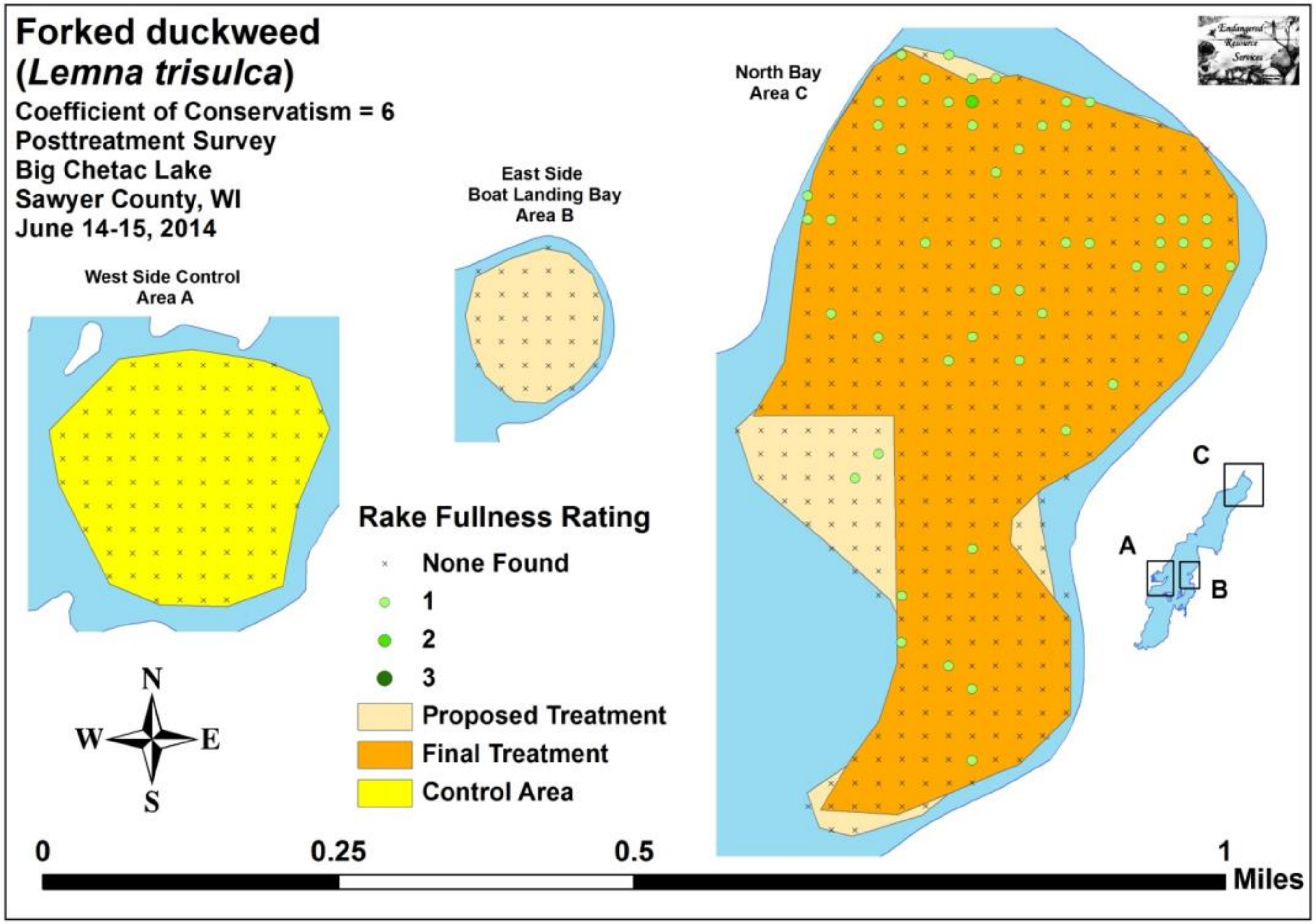
0.5
1
Miles


Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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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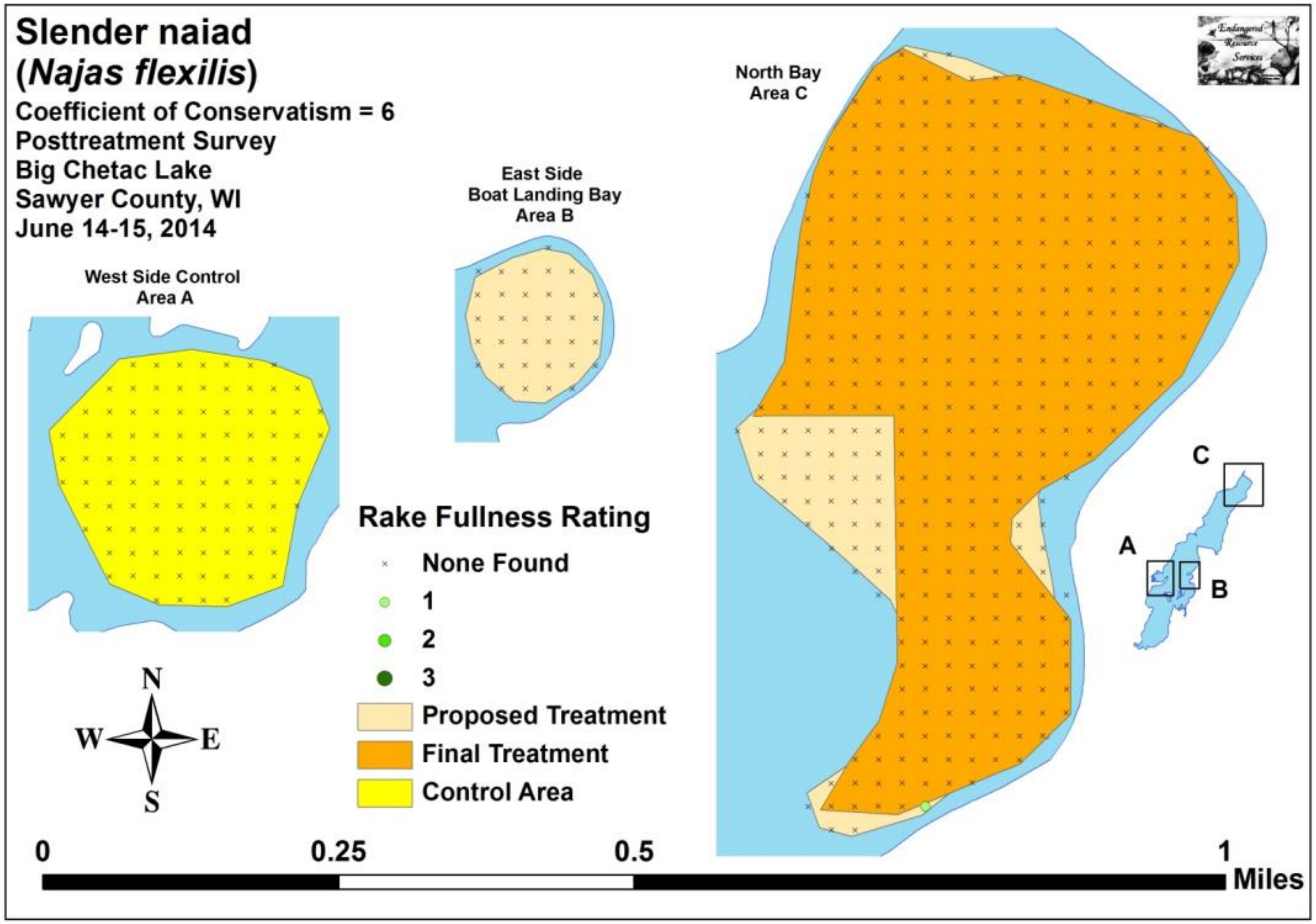
Miles



Slender naiad
(Najas flexilis)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
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Proposed Treatment
Final Treatment
Control Area
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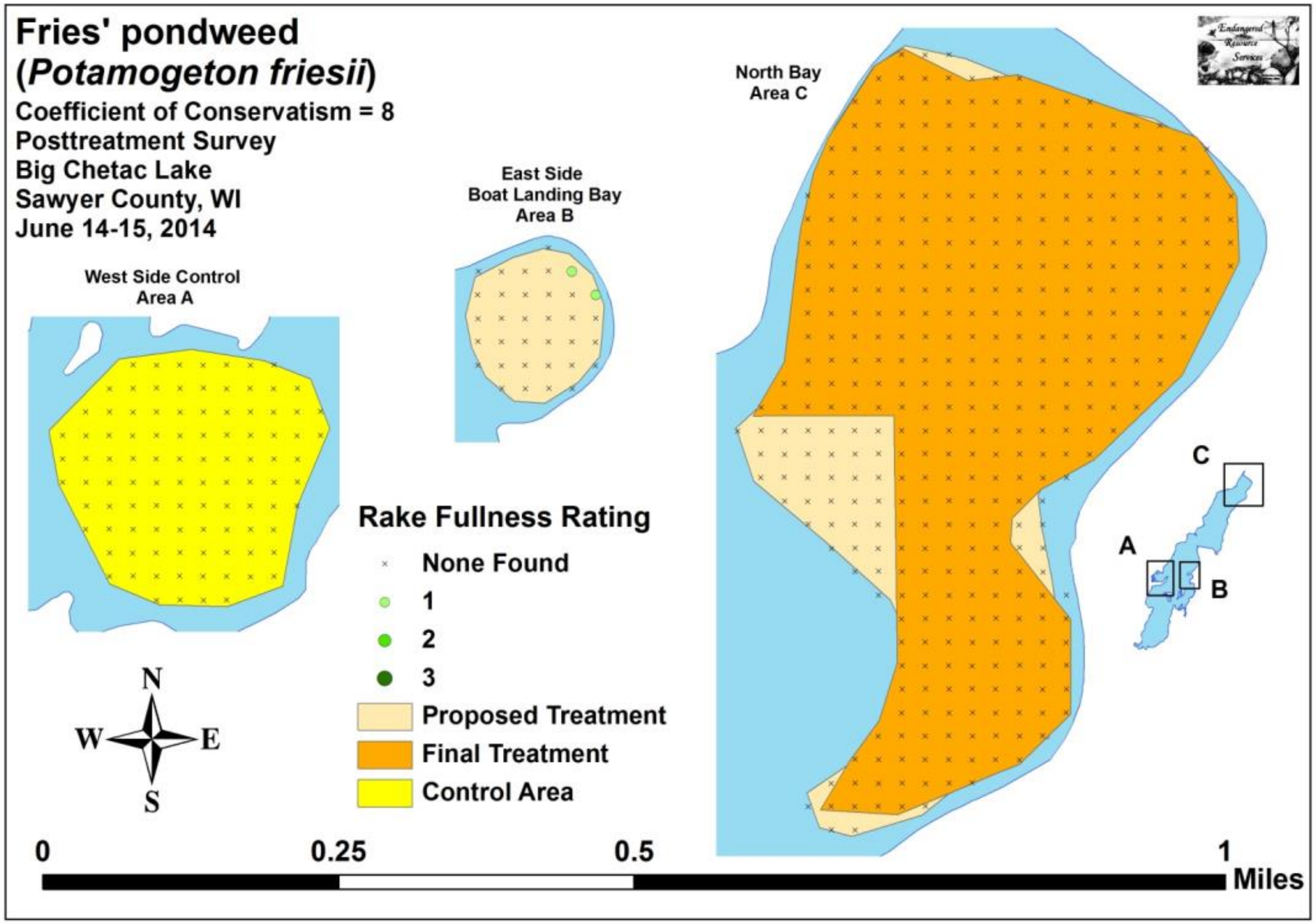
Miles


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
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Proposed Treatment
Final Treatment
Control Area
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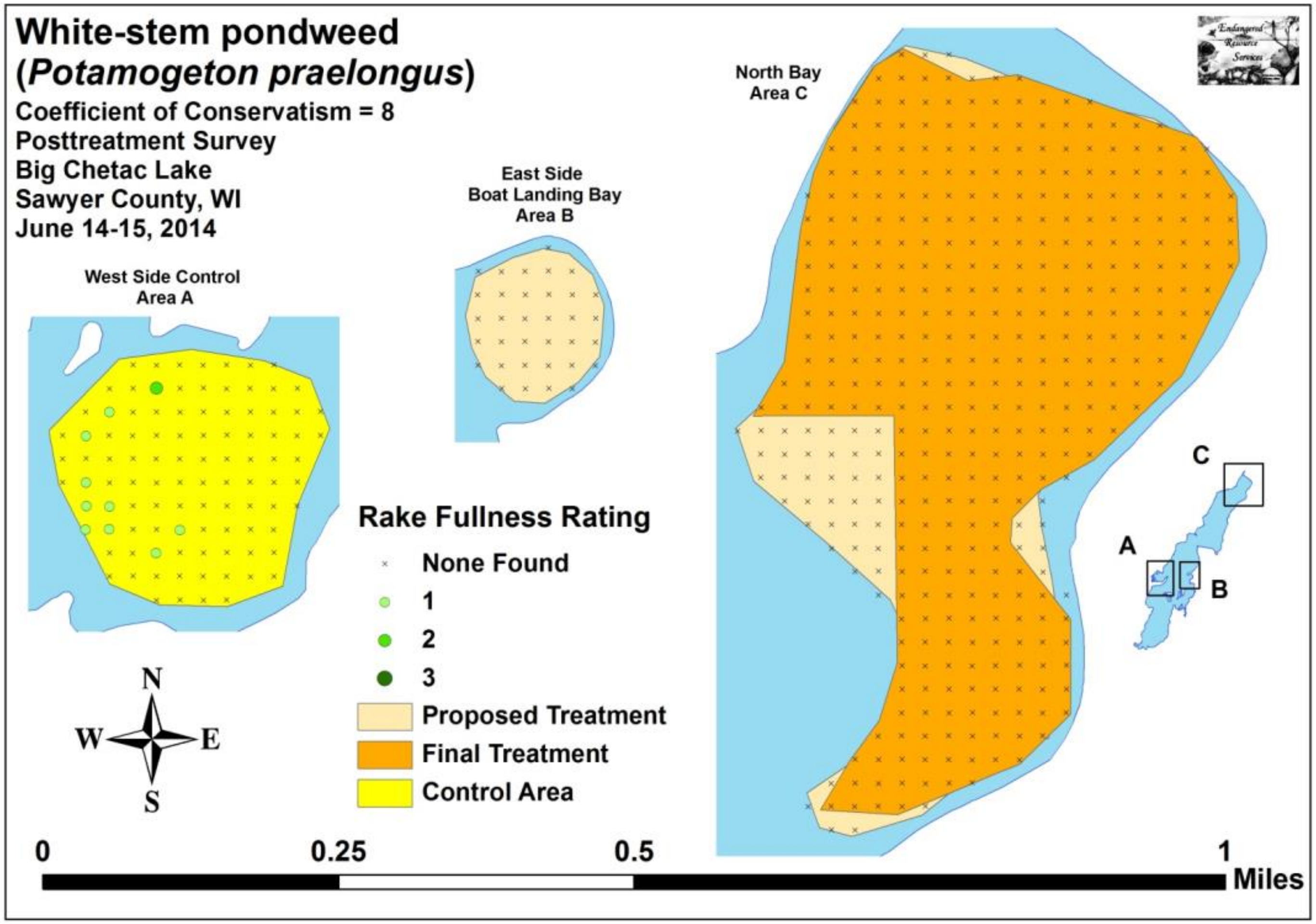
1
Miles


White-stem pondweed
(Potamogeton praelongus)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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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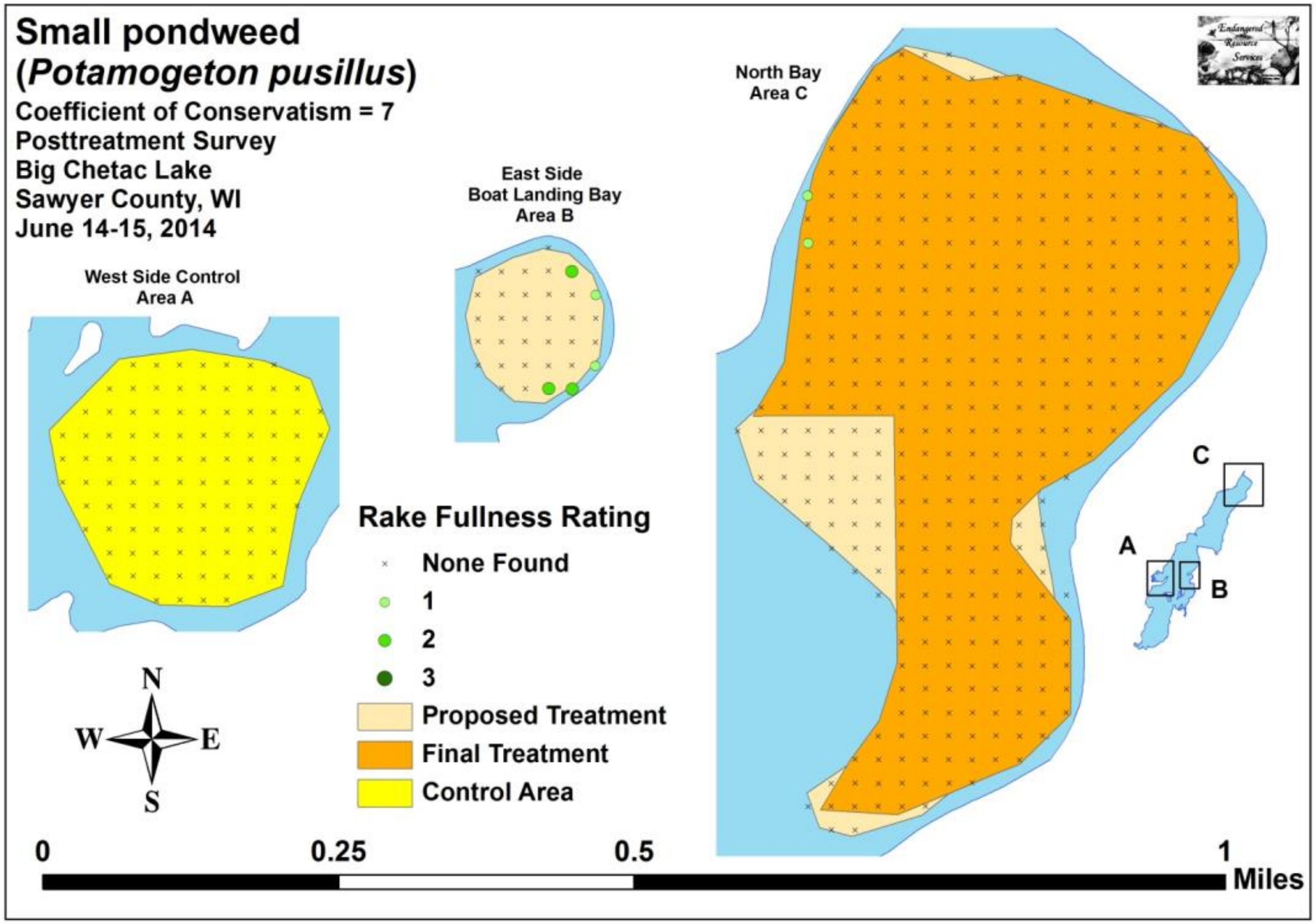
Miles



Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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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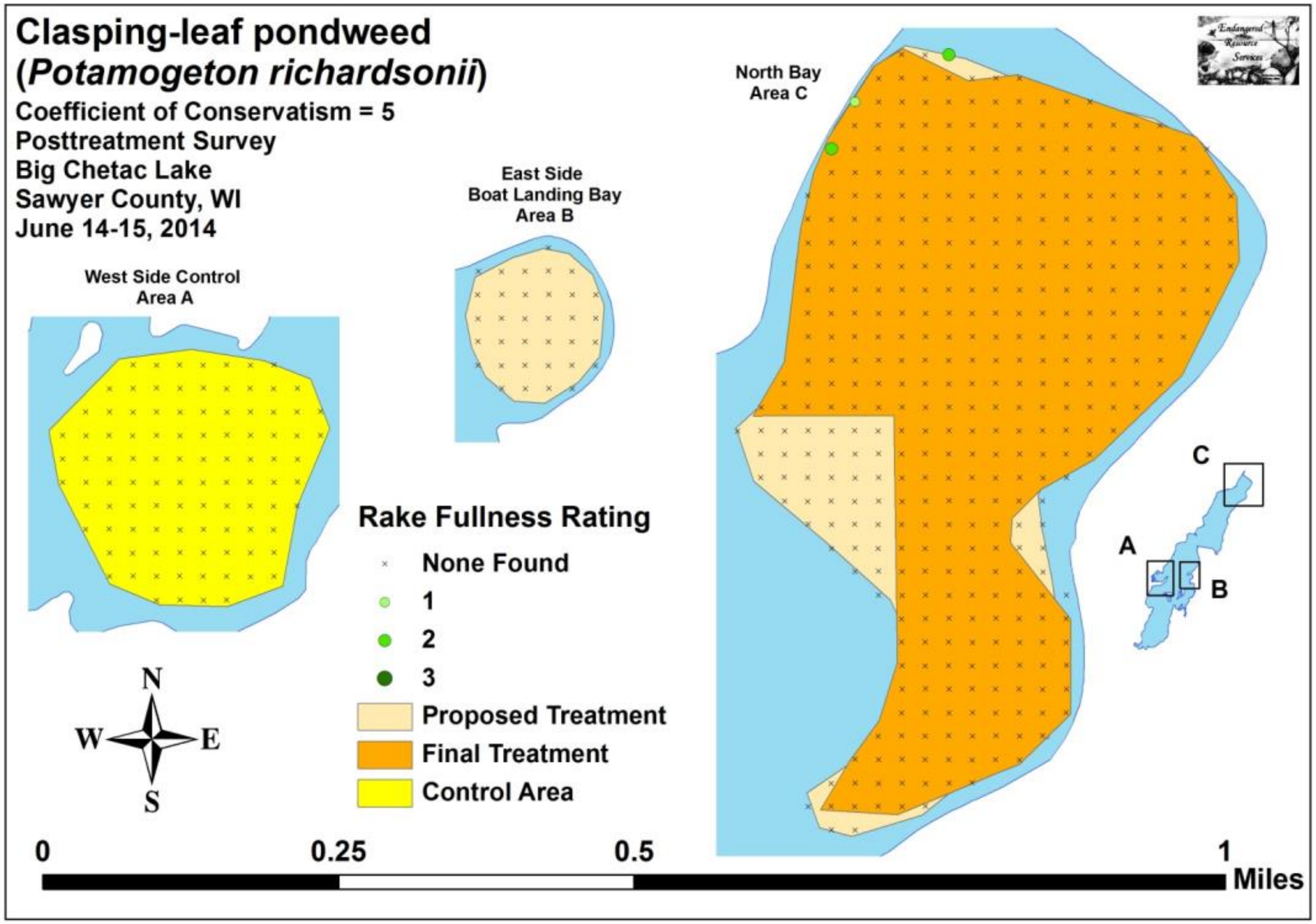
Miles


Clasping-leaf pondweed
(Potamogeton richardsonii)
Coefficient of Conservatism = 5
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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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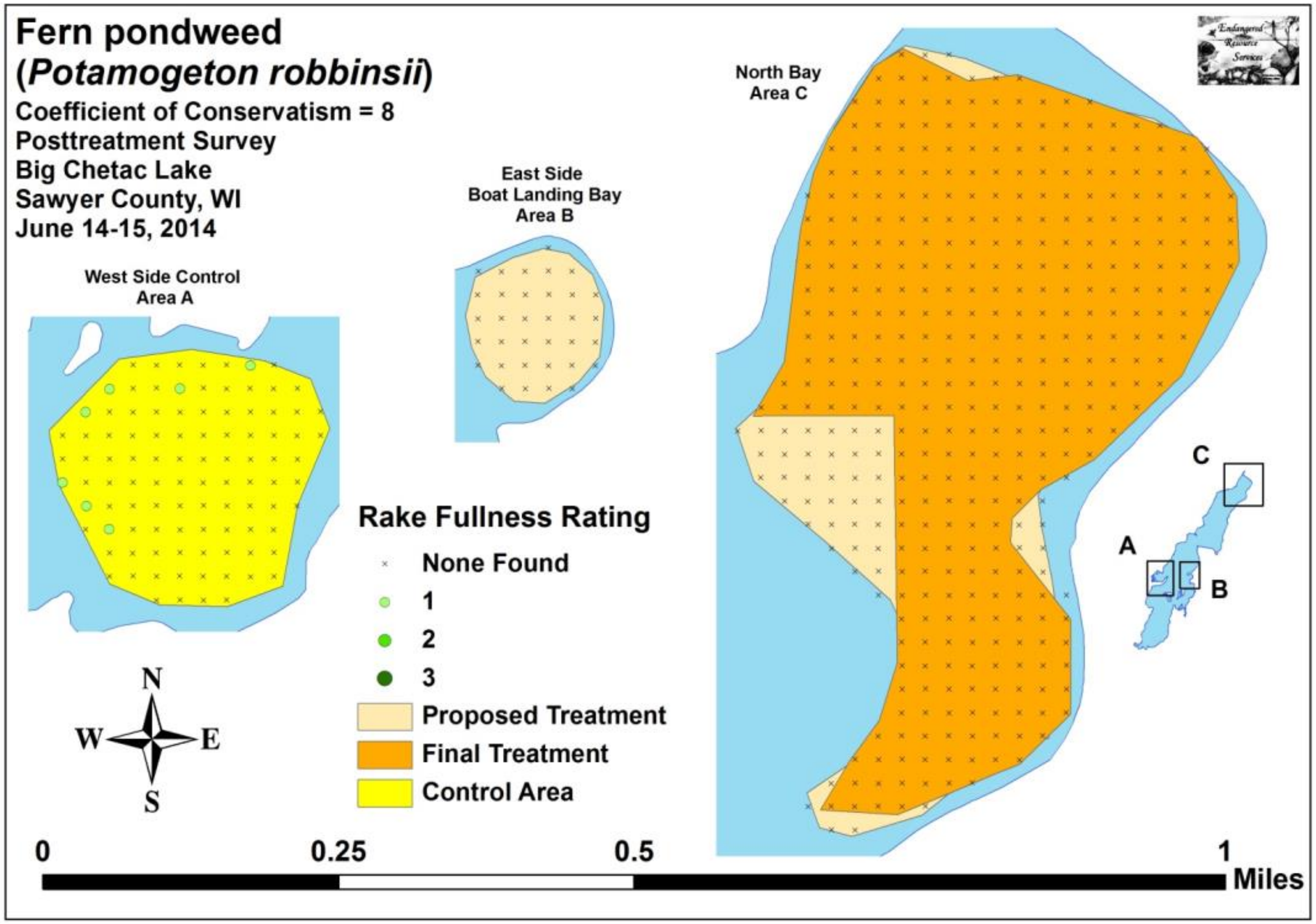
1
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
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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Final Treatment
Control Area
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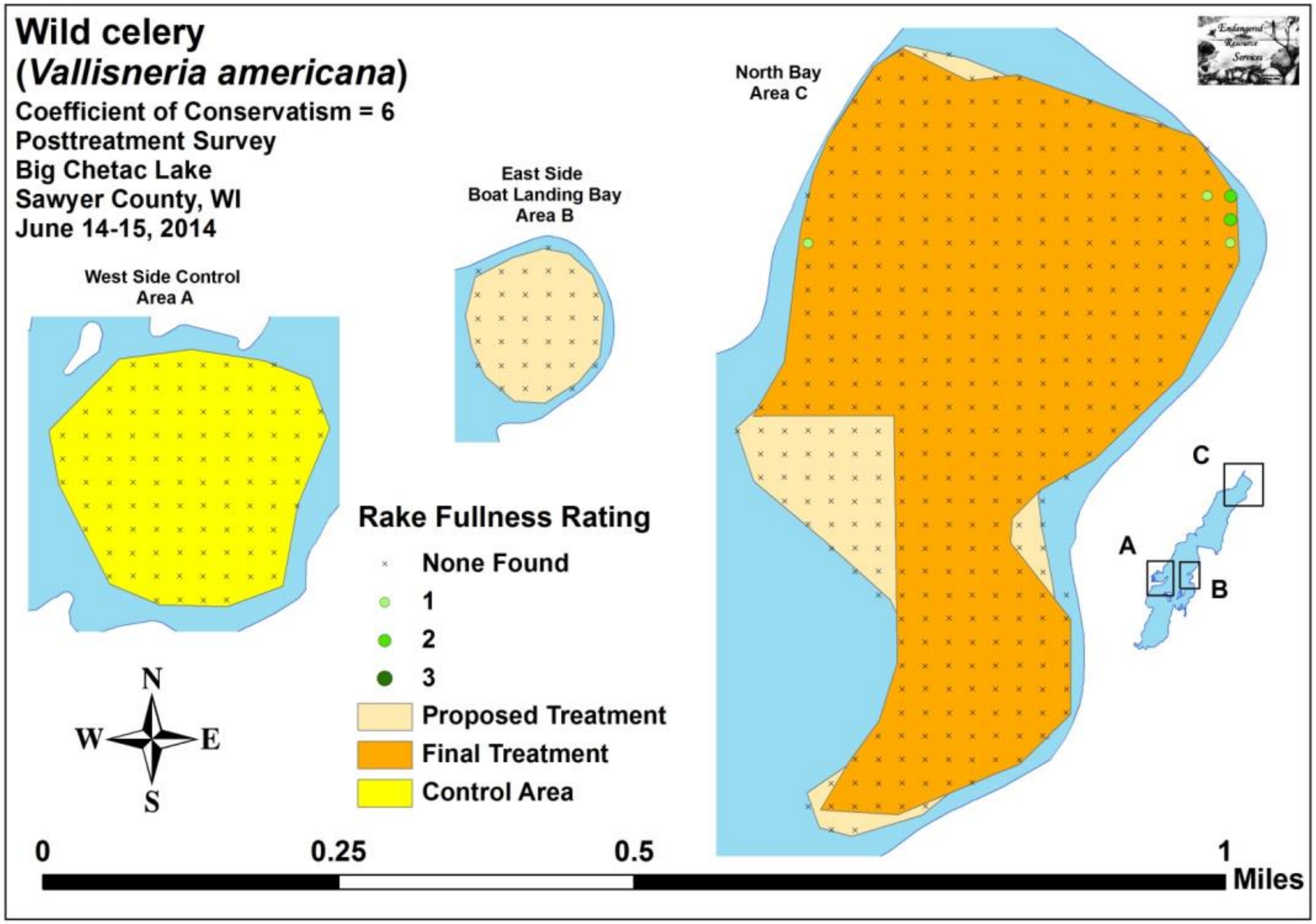
0.5
1
Miles



Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 14-15, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
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0.5
1
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 (CO2) dissolved in water to sugar and oxygen using sunlight for energy. Photosynthesis is essential in producing a lake's food base, and is an important source of oxygen for many lakes.

Phytoplankton:

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

Plankton:

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

ppm:

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

Richness:

number of species in a particular community or habitat.

Rooted Aquatic Plants:

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

Runoff:

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

Secchi Disc:

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

Seepage lakes:

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

Turbidity:

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

Watershed:

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

Zooplankton:

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