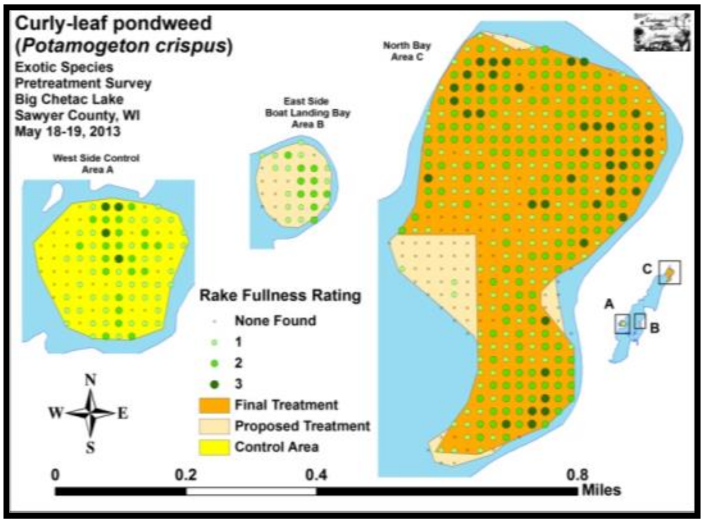
Curly-leaf pondweed (*Potamogeton crispus*)
Pre/Post Herbicide Treatment Surveys
Big Chetac Lake – WBIC: 2113300
Sawyer County, Wisconsin



2013 Final CLP Treatment Area

Project Funded by:

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

Solid Canopied Curly-leaf Pondweed Mat in the Control Area Bay

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May 18-19 and June 17-18, 2013

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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 2013. Following the acceptance of a three year exotic species control grant to actively manage Curly-leaf pondweed (*Potamogeton crispus*), the Big Chetac Chain Lake Association and the WDNR initiated plans to chemically treat 105 acres in the lake's north bay (97.5acres) and in the main east side boat landing bay (7.5 acres) where CLP nearly completely dominates the plant community. As a prerequisite to this treatment, we conducted a survey of 450 points in these areas. We also surveyed an additional 100 control points in a bay on the lake's west side. During the May18-19, 2013 survey, we found CLP at 340 of 416 sample points in the north bay (81.7%), at 24 of 34 points in the boat landing bay (70.6%), and in 70 of 100 points in the western control bay (70.0%). Using this data, we trimmed the north bay treatment area down to 90.8 acres. 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 was also cancelled. Following the May 28th application of Aquathol K at a concentration of 1.5ppm, we returned to the lake on June 17-18, 2013 to assess the effectiveness of the treatment. **CLP showed a highly significant reduction** in the north bay for all rake fullness values as well as overall as **it was nearly completely eliminated**. We found it at only two of the 416 survey points (0.5%), and each rake was represented by a single CLP plant. 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 control area and the east boat landing bay, CLP showed a significant increase in rake fullness rating of 3 as plants continued to grow and canopy during the growing season. Small pondweed (*Potamogeton pusillus*) and Coontail (*Ceratophyllum demersum*), the most common native plants in the north bay prior to treatment demonstrated highly significant declines; and Flat-stem pondweed (*Potamogeton zosteriformis*) exhibited a moderately significant decline. Conversely, Forked duckweed (*Lemna trisulca*) showed a highly significant increase, and filamentous algae a moderately significant increase. Native plants in the control area and boat landing bay were nearly unchanged. The 2013 treatment provided effective control of CLP throughout the lake's entire upper basin. As the project moves into its second year, all data from 2013 along with the 2014 pretreatment survey will be used to finalize 2014 treatment areas as we 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 16 years (WDNR 2013). This poor to very poor water clarity produced a littoral zone that extended to approximately 13ft in the spring of 2013. 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 2013 Spring CLP Treatment Areas

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 determined the expansive beds in the north bay and the boat landing bay would be chemically treated. Combined, these areas totaled 105 surface acres (Figure 1).

On May 18-19th, we conducted a pretreatment survey to gather baseline data from the scheduled treatment areas and to finalize treatment plans. Following the May 28th herbicide application, we conducted a June 17-18th posttreatment survey to evaluate the effectiveness of the treatment. This report is the summary analysis of these field surveys.

METHODS:
We generated a 450 point grid based on the size and shape of the proposed treatment areas that was just over the 4pts/acre threshold required by WDNR protocol for pre/post treatment sampling. Additionally, we created an additional 100 point sampling grid for the west-central bay area that was designated as a control site (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 hand held sonar (Vexilar LPS-1) or the metered survey rake, and the bottom substrate (bottom type) when we could see it or reliably determine it with the rake.

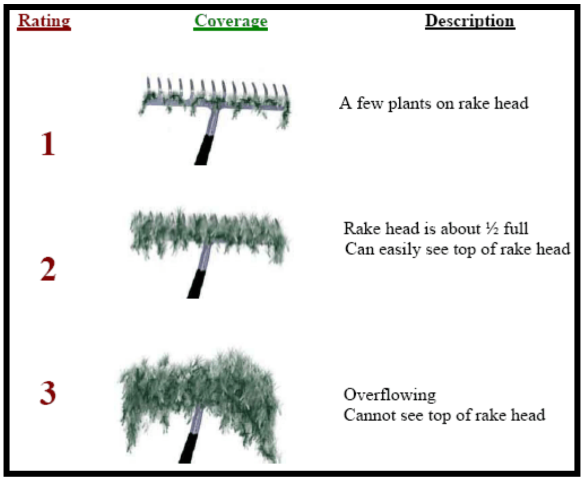


Figure 2: Rake Fullness Ratings

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.

Average number of species per site: 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.

Species richness: 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.**

Mean rake fullness: 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).

Relative frequency: This value shows a species' frequency relative to all other species. It is expressed as a percentage, and the total of all species' relative frequency will add up to 100%. Organizing species from highest to lowest relative frequency value 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.

Pre/Post Treatment and May/June Significance:
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:

Initial expectations were to treat two beds totaling 105.0 acres with Aquathol at a concentration of 1.5 ppm. However, due to concerns about Northern wild rice (*Zizania palustris*) presence in the “Bull Pen” bay directly south of the boat landing bay, treatment was cancelled in this area pending further review. In the north bay, the pretreatment survey determined that approximately 6.7 acres in deep water (>12ft) did not have sufficient CLP to warrant treatment. Because of this, the final treatment conducted by Midwest Aqua Care, Inc. on May 28th totaled 90.8 acres (Table 1). This decline of 14.2 acres represented a nearly 9% reduction from initial expectations (Figure 3) (Appendix I).

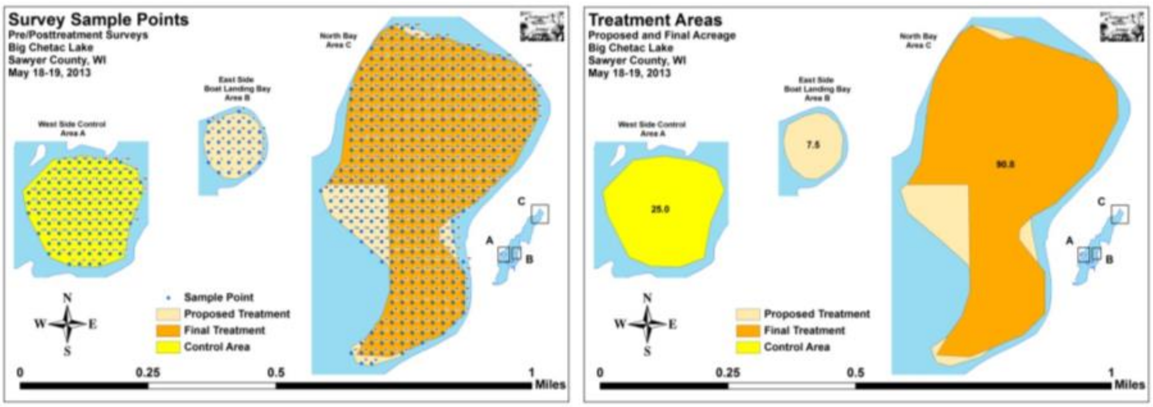


Figure 3: 2013 Survey Sample Points and Final Treatment Area

**Table 1: Spring CLP Treatment Summary
Big Chetac Lake – May 28, 2013**

CLP Bed Name	Proposed Acreage	Final Acreage	Difference +/-
North Bay	97.5	90.8	-6.7
Boat Landing Bay	7.5	0.0	-7.5
Control Bay	0.0	0.0	0.0
Total Acres	**105.0**	**90.8**	**-14.2**

CLP Pre/Post Herbicide Survey:

Depths in the survey areas ranged from 3-15ft with most of the CLP established in 5-10ft of water and canopied throughout this range. Although present in some sandy and rocky areas at low densities, most CLP was established over thick organic muck (Figure 4) (Appendix III).

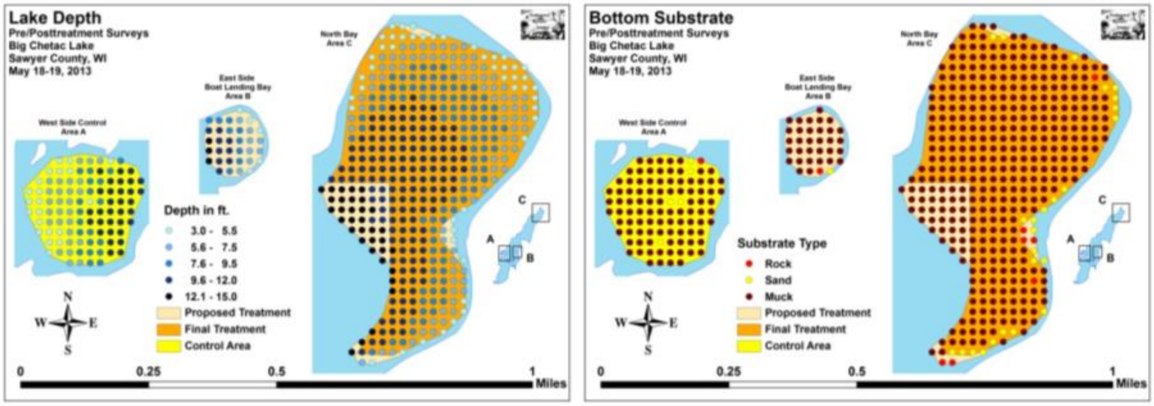


Figure 4: Treatment Area Depths and Bottom Substrate

The littoral zone for all three areas maxed out at 11-13ft 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 8.6ft and 9.0ft respectively during the pretreatment survey to 6.3 and 5.0ft in the posttreatment survey as CLP was eliminated from the deep water areas. In the boat landing bay and the control bay, these values were essentially unchanged at approximately 8.0ft (Table 2). As the growing season progressed into July, the lake's plant community became dominated by algae. Due to poor water clarity, there was 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. When these high algae levels block light penetration, it kills rooted macrophytes which then decompose, release even more nutrients into the water column, and produce even more algae. Despite the lake's current reality, we are optimistic that the continued reduction of CLP will facilitate an improvement in water clarity/quality over time. As light penetration improves, native plants will colonize deeper and deeper areas of the lake. As they absorb nutrients out of the water making them unavailable to algae, they will further promote water clarity.

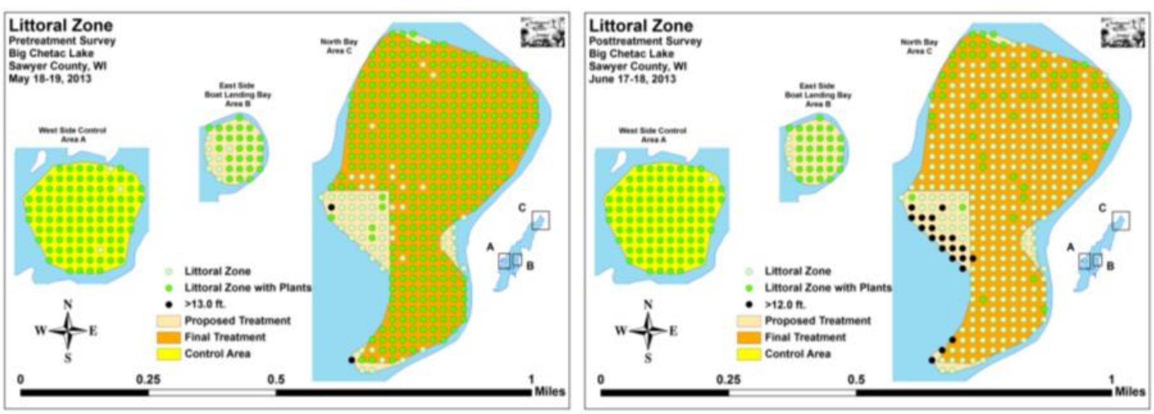


Figure 5: Pre/Post Littoral Zone

Initial diversity within the north bay was extremely low with a Simpson Diversity Index value of 0.41. This value increased significantly to 0.59 posttreatment. The boat landing bay also had a low index value of 0.51 in May that increased slightly to 0.55 in June. Although the control area had the highest values (0.73 in May and 0.76 in June), in our experience, these numbers are still quite low when compared to other lakes in northern Wisconsin with similar bottom type and clarity (Table 2).

Mean native species richness was extremely low in all three areas. The north bay treatment area averaged 0.27 natives species at littoral points pretreatment and only 0.13 posttreatment. Even at sites that had natives present, only the control area averaged more than 1.50 species/site. This was primarily due to higher native species richness on the west side of the bay where shallow water and proximity to a bog created conditions that didn't allow CLP to dominate the community as it did elsewhere. These habitats still had no point with more than four native species in any rake (Figure 6) (Appendix IV).

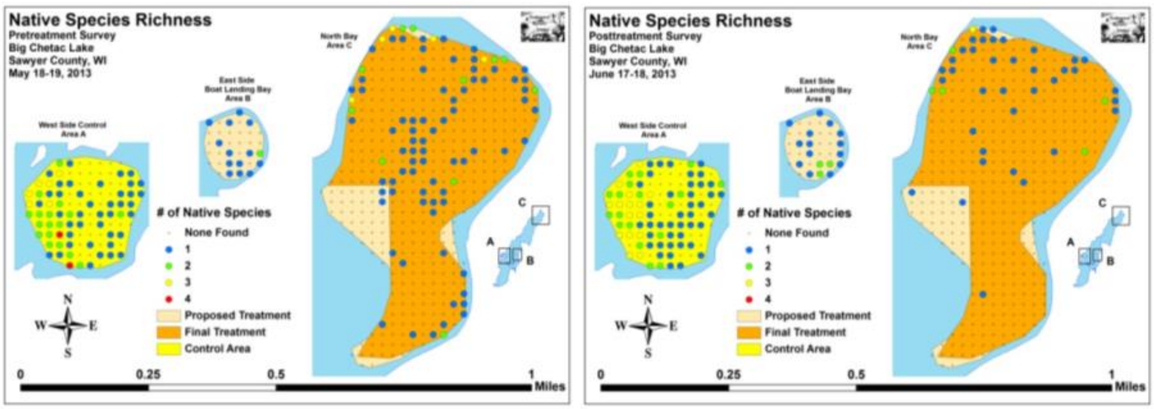


Figure 6: Pre/Post Native Species Richness

Despite being nearly four times bigger than the control area, the entire north bay treatment area actually had fewer total species. Similarly, the boat landing bay, where CLP dominated the littoral zone, showed just four species in May and three in June. Following treatment, the mean total rake fullness declined significantly in the north bay from 1.81 to 1.02. In the boat landing bay and the control area, these values increased slightly over this time as would be expected early in the growing season (Figure 7) (Table 2) (Appendix IV).

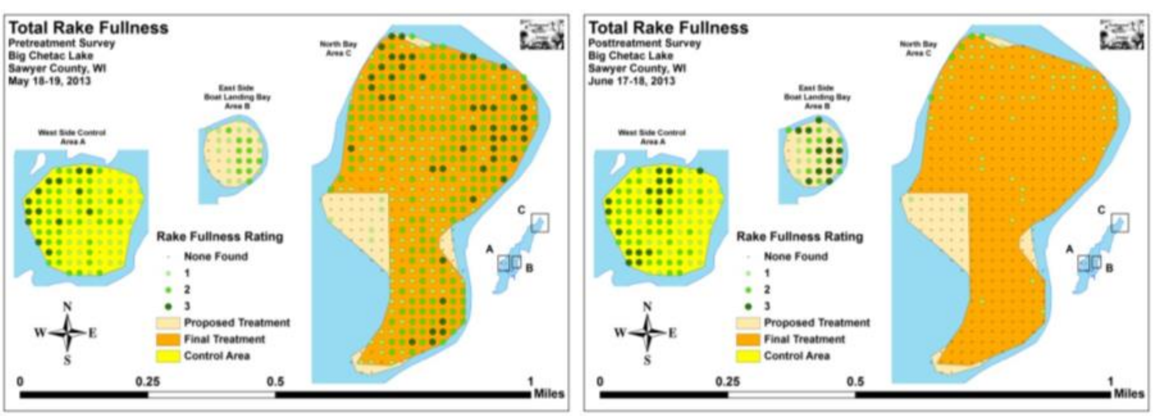


Figure 7: Pre/Post Total Rake Fullness

Table 2: Pre/Posttreatment and May/June Survey Summary Statistics
North Bay – Boat Landing Bay – Western Control Bay
Big Chetac Lake, Sawyer County
May 18-19 and June 17-18, 2013

	North Bay Treatment Area		Boat Landing Bay		Western Control Bay	
Summary Statistics:	Pre	Post	May	June	May	June
Total number of points sampled	416	416	34	34	100	100
Total number of sites with vegetation	354	45	26	30	97	99
Total number of sites shallower than the maximum depth of plants	414	396	31	30	100	99
Frequency of occurrence at sites shallower than maximum depth of plants	85.5	11.36	83.9	100	97.0	100
Simpson Diversity Index	0.41	0.59	0.51	0.55	0.73	0.76
Maximum depth of plants (ft)	13.0	12.0	11.5	11.0	12.0	11.5
Mean depth of plants (ft)	8.6	6.3	7.7	8.0	8.0	7.7
Median depth of plants (ft)	9.0	5.0	7.8	8.0	8.0	8.0
Number of sites sampled using pole rake (P)	416	416	34	34	100	100
Average number of all species per site (shallower than max depth)	1.09	0.13	1.26	1.63	1.70	2.06
Average number of all species per site (veg. sites only)	1.27	1.16	1.50	1.63	1.75	2.06
Average number of native species per site (shallower than max depth)	0.27	0.13	0.48	0.67	1.00	1.24
Average number of native species per site (veg. sites with natives only)	1.24	1.16	1.07	1.18	1.54	1.64
Species richness	8	8	4	3	5	9
Mean rake fullness (veg. sites only)	1.81	1.08	1.42	2.20	1.72	1.84

During the pretreatment survey of the north bay, we found CLP at 340 of 416 total points (81.7%) (Figures 8) (Appendix V). Of these, 43 had a rake fullness rating of 3, 177 rated a 2, and 120 rated a 1. During the posttreatment survey, we found only two surviving CLP plants. Both were two inches tall and appeared to have recently sprouted from turions. 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). CLP detritus was present throughout the treatment area, but we did not find any evidence of fresh green turions that would indicate any CLP plants survived long enough to develop these overwintering buds.

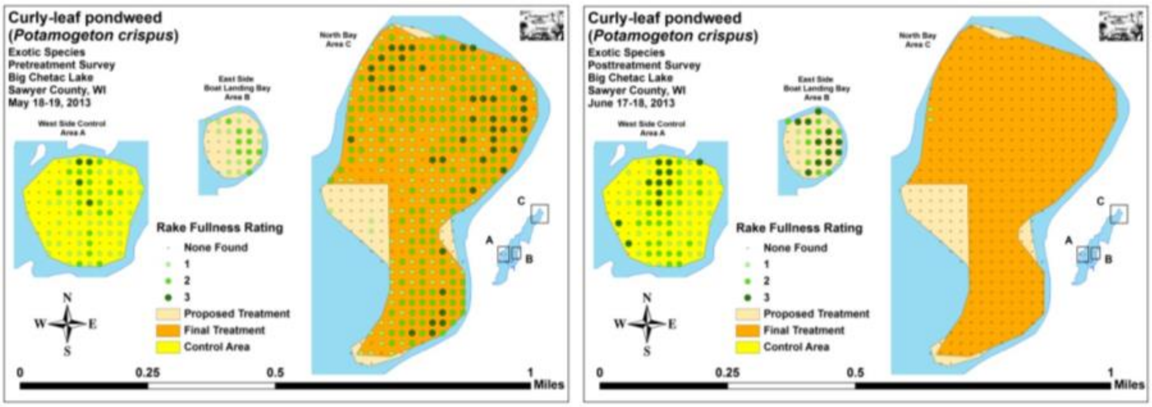
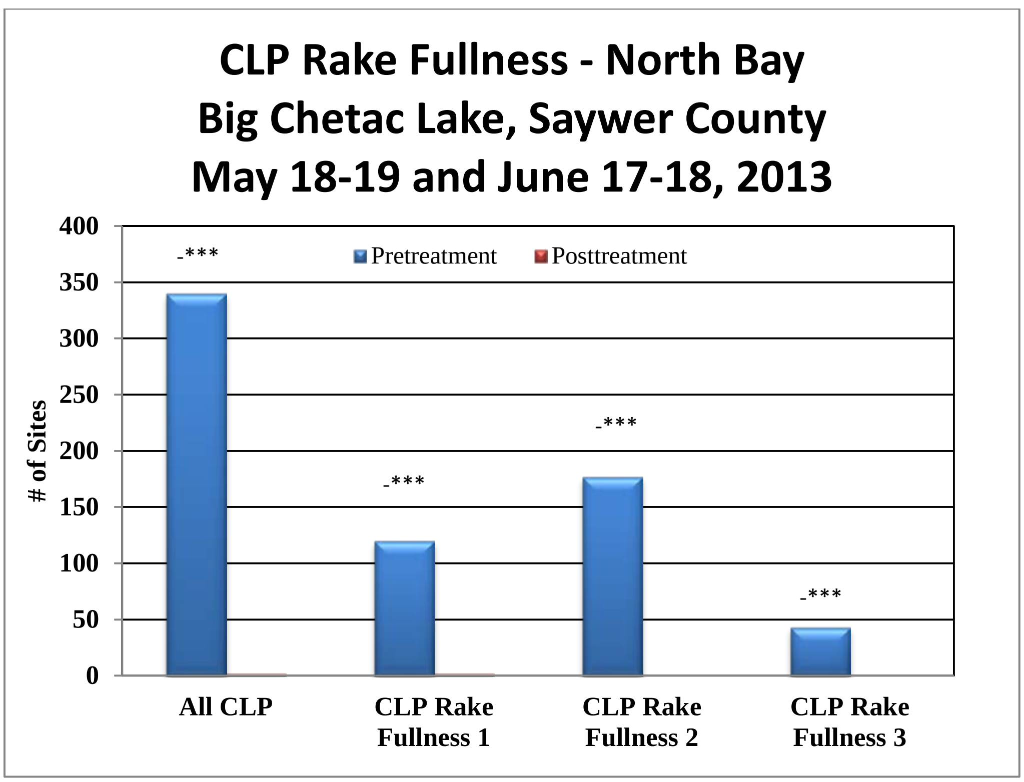


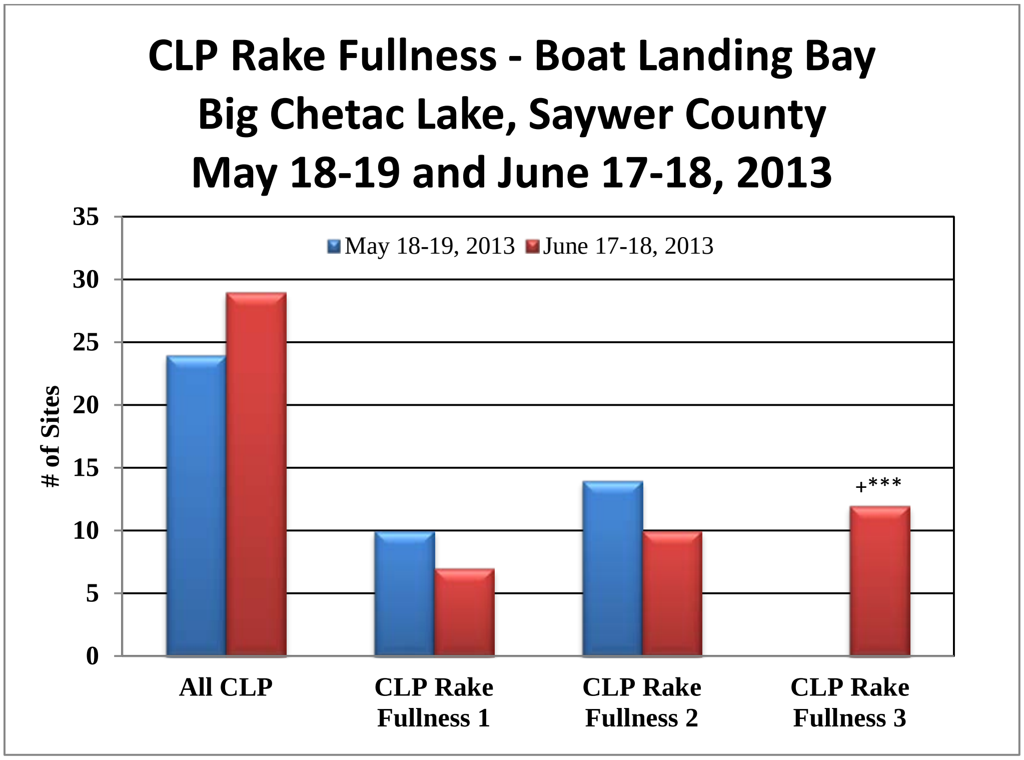
Figure 8: Pre/Post CLP Density and Distribution



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

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

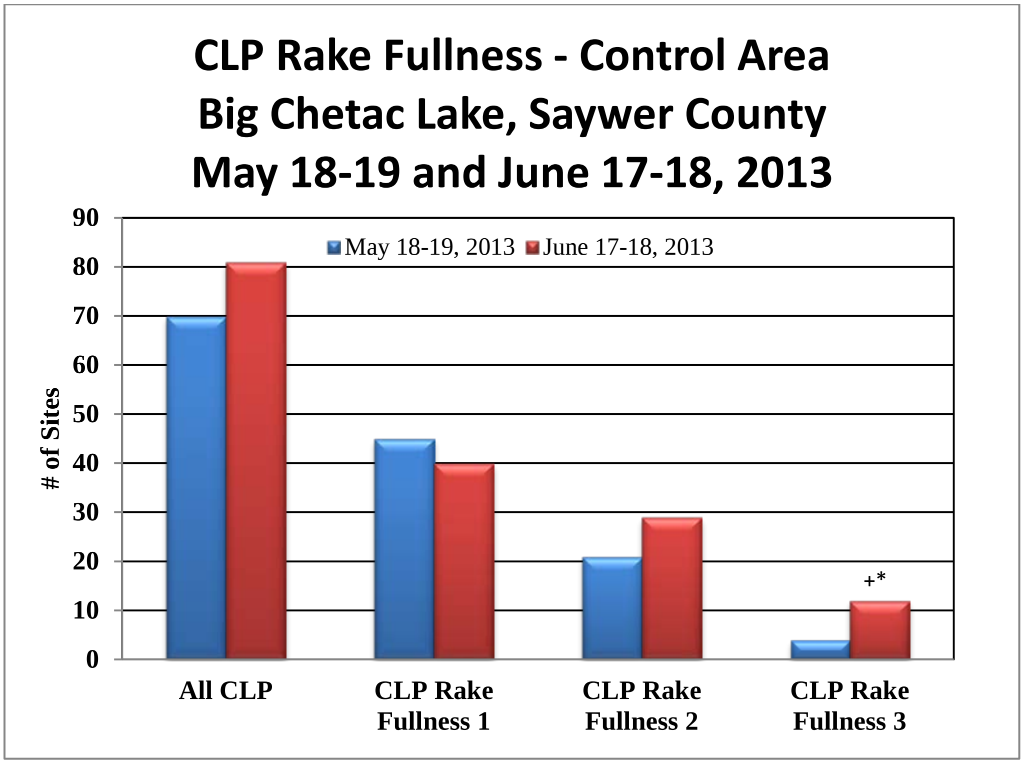
In the boat landing bay, the May survey found CLP at 24 of 34 points (70.6%) (Figure 8). Of these, none had a rake fullness rating of 3, 10 rated a 2, and 14 were a 1. By June, CLP had expanded in both distribution and density as we found it at 29 sites (85.3%) with the majority (12) now rating a 3. Ten others rating a 2, and the remaining 7 rated a 1. Our findings demonstrated a highly significant increase in CLP at the rake 3 level (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 70 of 100 points (70.0%) in the western control bay during the May survey (Figure 8). Initially, 4 rated a 3, 21 a 2, and 45 a 1. By June, CLP had expanded to 81 sites (81.0%) with 12 now rating a 3, 29 a 2, and the remaining 40 a 1. As in the boat landing bay, these findings demonstrated a significant increase in CLP at the rake 3 level (Figure 11) (Tables 7 and 8).



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

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

Small pondweed (*Potamogeton pusillus*) and Coontail (*Ceratophyllum demersum*) were the most common native species throughout all three areas during the May survey (Tables 3-8) (Figures 12 and 13). Within the treatment area, along with CLP, each of these species showed a highly significant decline posttreatment with Flat-stem pondweed (*Potamogeton* zosteriformis), the third most common native species, also demonstrating a moderately significant decline (Figure 14). Conversely, Forked duckweed (*Lemna trisulca*) showed a highly significant increases posttreatment and filamentous algae a moderately significant increase.

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, Flat-stem pondweed exhibited a significant increase and White-stem pondweed (*Potamogeton praelongus*) a moderately significant increase (Figure 16). Maps for all species pre and posttreatment are available in Appendixes VI and VII.

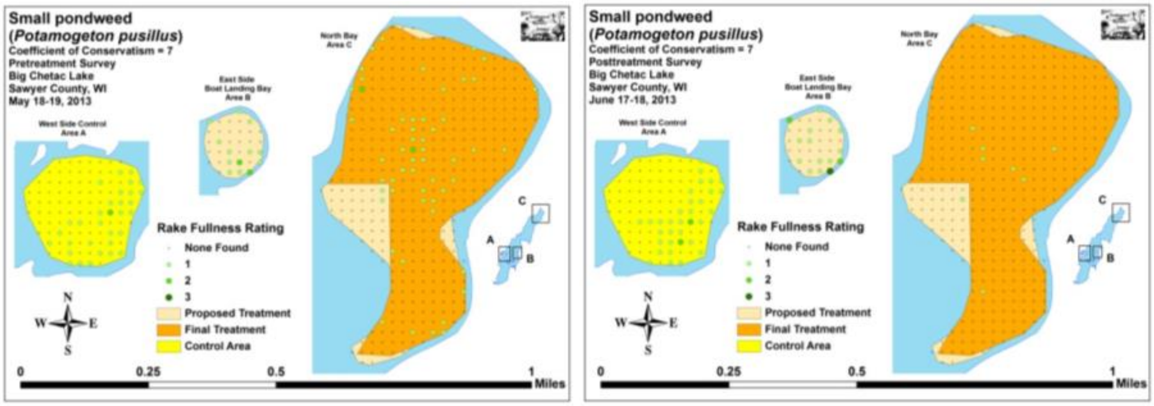


Figure 12: Pre/Post Small Pondweed Density and Distribution

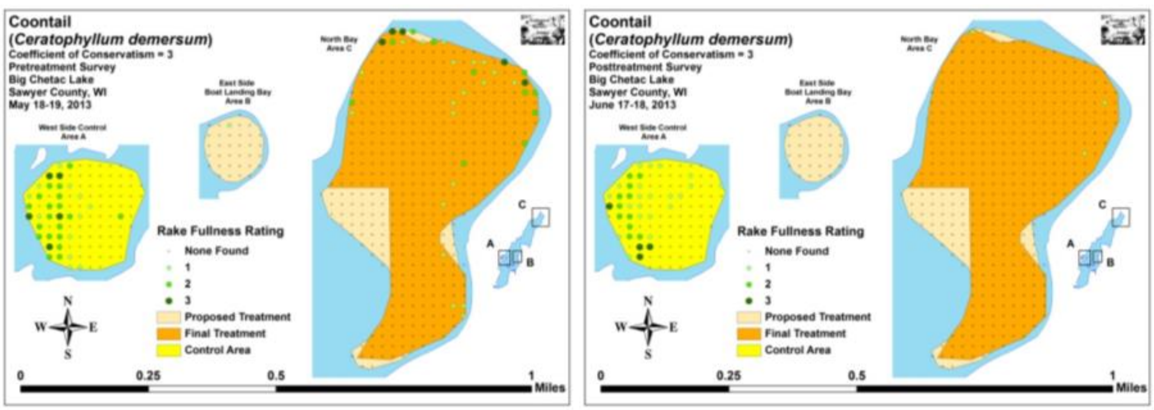
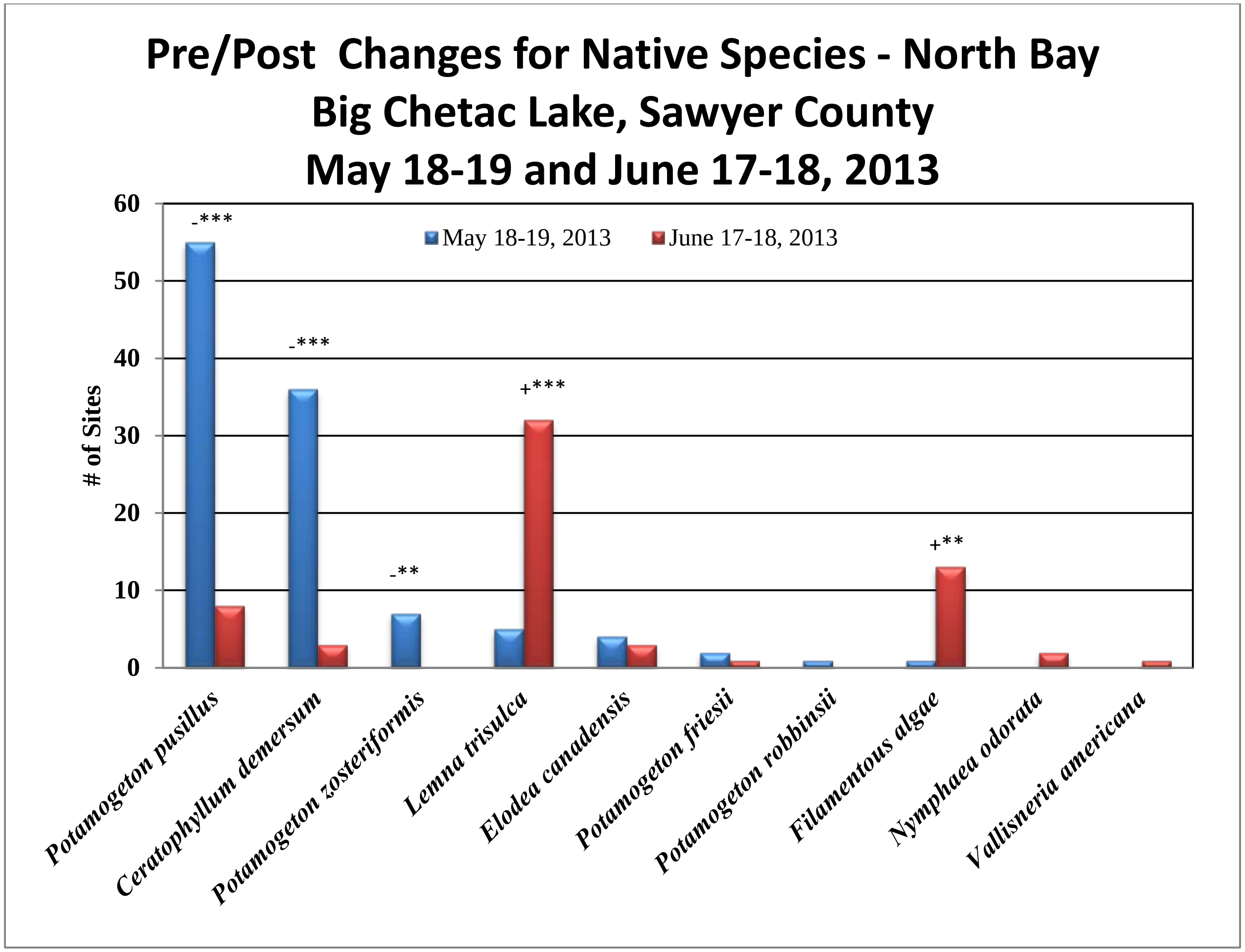
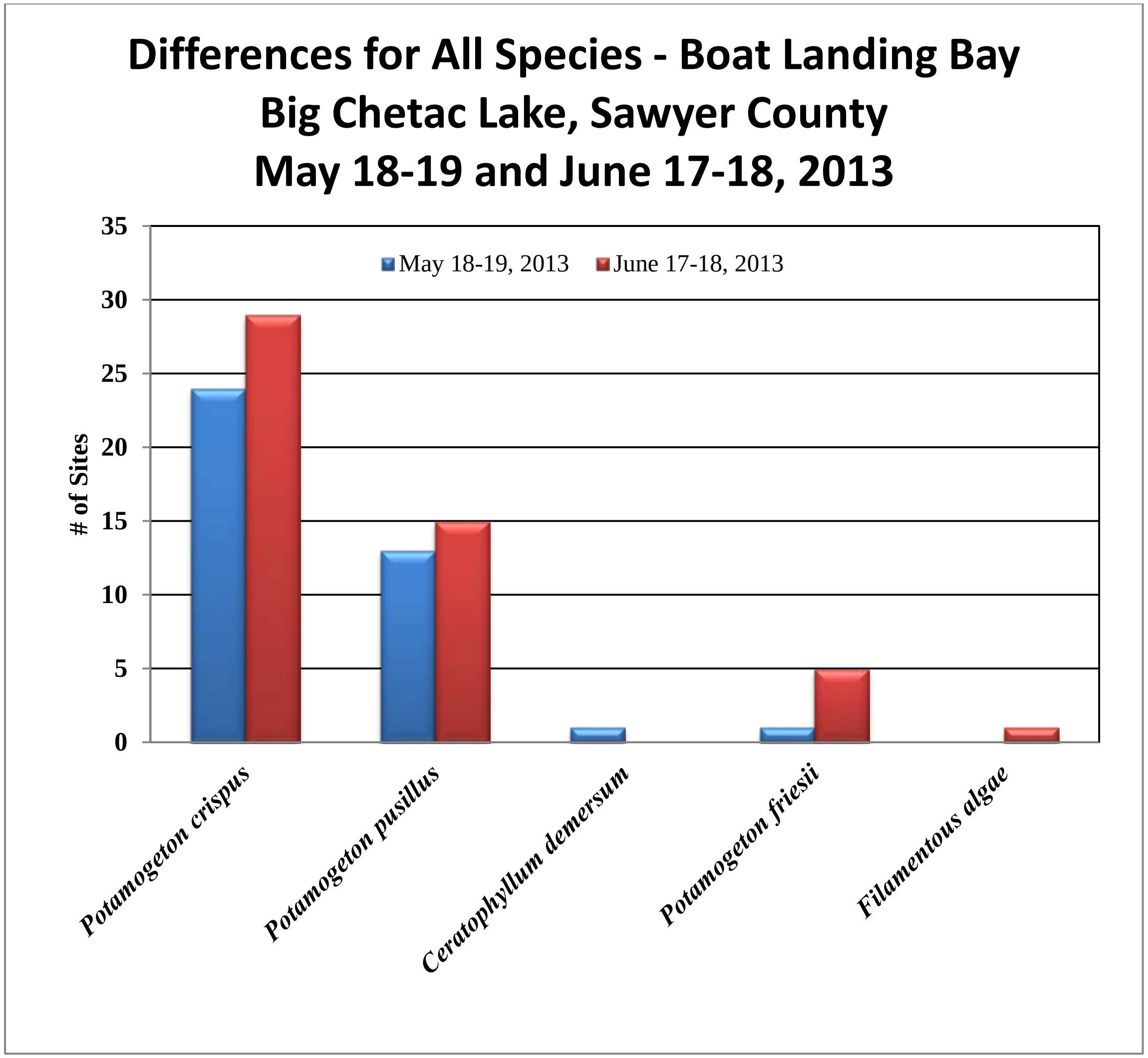


Figure 13: Pre/Post Coontail Density and Distribution



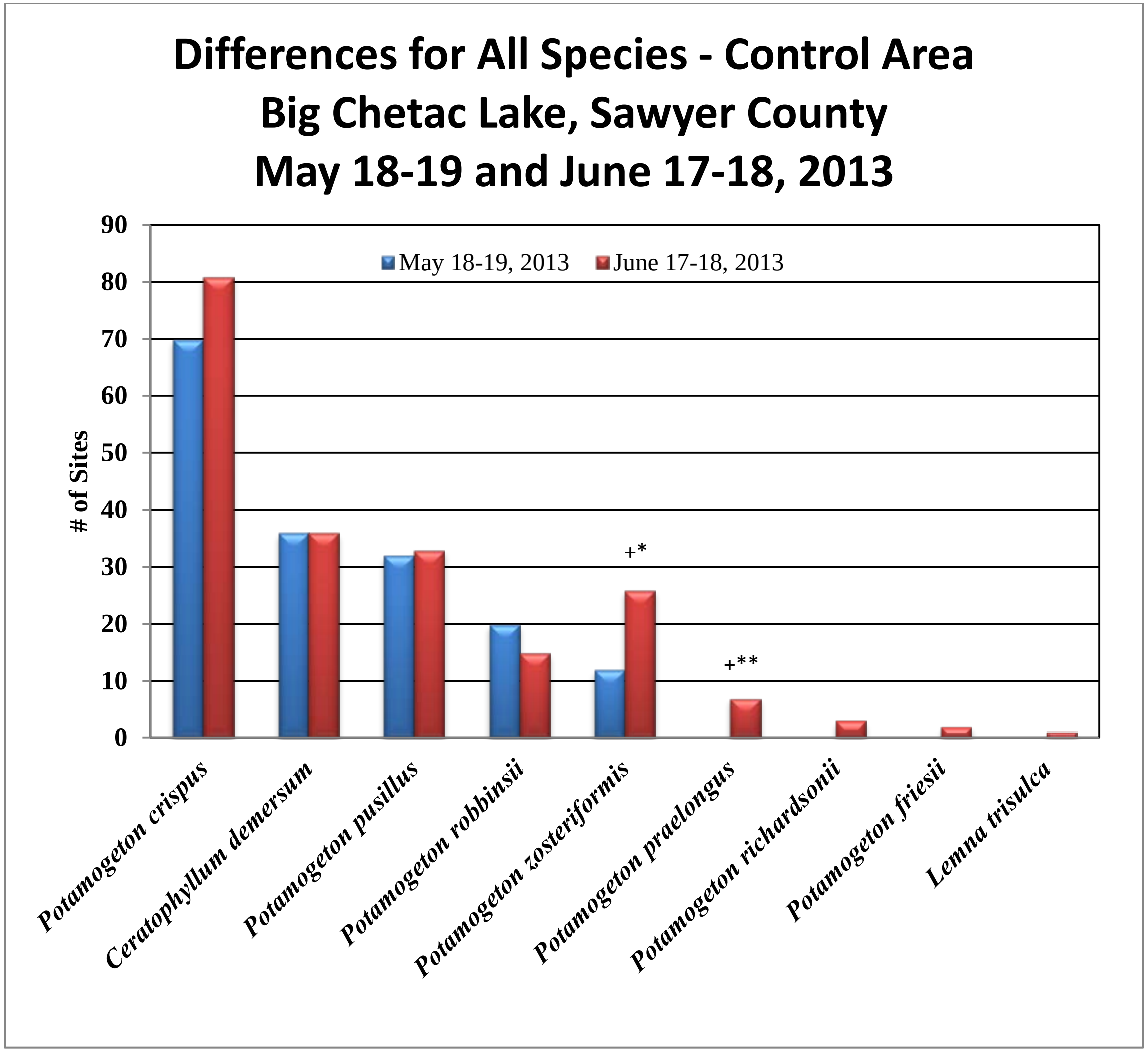
Significant differences = * p <. 05, ** p <. 01, *** p <. 005

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 18-19, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	340	75.56	96.05	82.13	1.77
Potamogeton pusillus	Small pondweed	55	12.22	15.54	13.29	1.04
Ceratophyllum demersum	Coontail	36	8.00	10.17	8.70	1.58
Potamogeton zosteriformis	Flat-stem pondweed	7	1.56	1.98	1.69	1.14
Lemna trisulca	Forked duckweed	5	1.11	1.41	1.21	1.40
Elodea canadensis	Common waterweed	4	0.89	1.13	0.97	1.00
Potamogeton friesii	Fries' pondweed	2	0.44	0.56	0.48	1.00
Potamogeton robbinsii	Fern pondweed	1	0.22	0.28	0.24	1.00
	Filamentous algae	1	*	0.28	0.24	1.00

Table 4: Frequencies and Mean Rake Sample of Aquatic Macrophytes
Posttreatment Survey – North Bay - Big Chetac Lake, Sawyer County
June 17-18, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Lemna trisulca	Forked duckweed	32	61.54	71.11	8.08	1.03
	Filamentous algae	13	*	28.89	3.28	1.15
Potamogeton pusillus	Small pondweed	8	15.38	17.78	2.02	1.00
Ceratophyllum demersum	Coontail	3	5.77	6.67	0.76	1.00
Elodea canadensis	Common waterweed	3	5.77	6.67	0.76	1.00
Nymphaea odorata	White water lily	2	3.85	4.44	0.51	1.00
Potamogeton crispus	Curly-leaf pondweed	2	3.85	4.44	0.51	1.00
Potamogeton friesii	Fries' pondweed	1	1.92	2.22	0.25	1.00
Vallisneria americana	Wild celery	1	1.92	2.22	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 18-19, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	24	61.54	92.31	77.42	1.42
Potamogeton pusillus	Small pondweed	13	33.33	50.00	41.94	1.15
Ceratophyllum demersum	Coontail	1	2.56	3.85	3.23	1.00
Potamogeton friesii	Fries' pondweed	1	2.56	3.85	3.23	1.00

Table 6: Frequencies and Mean Rake Sample of Aquatic Macrophytes
June Survey – Boat Landing Bay - Big Chetac Lake, Sawyer County
June 17-18, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	29	59.18	96.67	96.67	2.17
Potamogeton pusillus	Small pondweed	15	30.61	50.00	50.00	1.27
Potamogeton friesii	Fries' pondweed	5	10.20	16.67	16.67	1.00
	Filamentous algae	1	*	3.33	3.33	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 18-19, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	70	41.18	72.16	70.00	1.41
Ceratophyllum demersum	Coontail	36	21.18	37.11	36.00	1.81
Potamogeton pusillus	Small pondweed	32	18.82	32.99	32.00	1.03
Potamogeton robbinsii	Fern pondweed	20	11.76	20.62	20.00	1.70
Potamogeton zosteriformis	Flat-stem pondweed	12	7.06	12.37	12.00	1.17

Table 8: Frequencies and Mean Rake Sample of Aquatic Macrophytes
June Survey – Western Control Bay - Big Chetac Lake, Sawyer County
June 17-18, 2013

Species	Common Name	Total Sites	Relative Freq.	Freq. in Veg.	Freq. in Lit.	Mean Rake
Potamogeton crispus	Curly-leaf pondweed	81	39.71	81.82	81.82	1.65
Ceratophyllum demersum	Coontail	36	17.65	36.36	36.36	1.53
Potamogeton pusillus	Small pondweed	33	16.18	33.33	33.33	1.06
Potamogeton zosteriformis	Flat-stem pondweed	26	12.75	26.26	26.26	1.19
Potamogeton robbinsii	Fern pondweed	15	7.35	15.15	15.15	1.40
Potamogeton praelongus	White-stem pondweed	7	3.43	7.07	7.07	1.00
Potamogeton richardsonii	Clasping-leaf pondweed	3	1.47	3.03	3.03	1.00
Potamogeton friesii	Fries' pondweed	2	0.98	2.02	2.02	1.00
Lemna trisulca	Forked duckweed	1	0.49	1.01	1.01	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), the 2013 herbicide application has to be considered a success. 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 well as providing residual control as the herbicide moved downstream. We noted that CLP was completely eliminated as much as one mile downstream from the southern border of the treatment area. In fact, the herbicide provided enough of a jolt to CLP throughout the entire upper basin that, although not killed outright, these plants did not appear to be healthy enough to set flowers/seeds or turions (Figure 17). As the project moves into its second year, all data from 2013 along with the 2014 pretreatment survey will be used to finalize 2014 treatment areas as we continue to work towards these goals.

Figure 17: CLP Impacted by Herbicide at the South End of the Upper Basin

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).

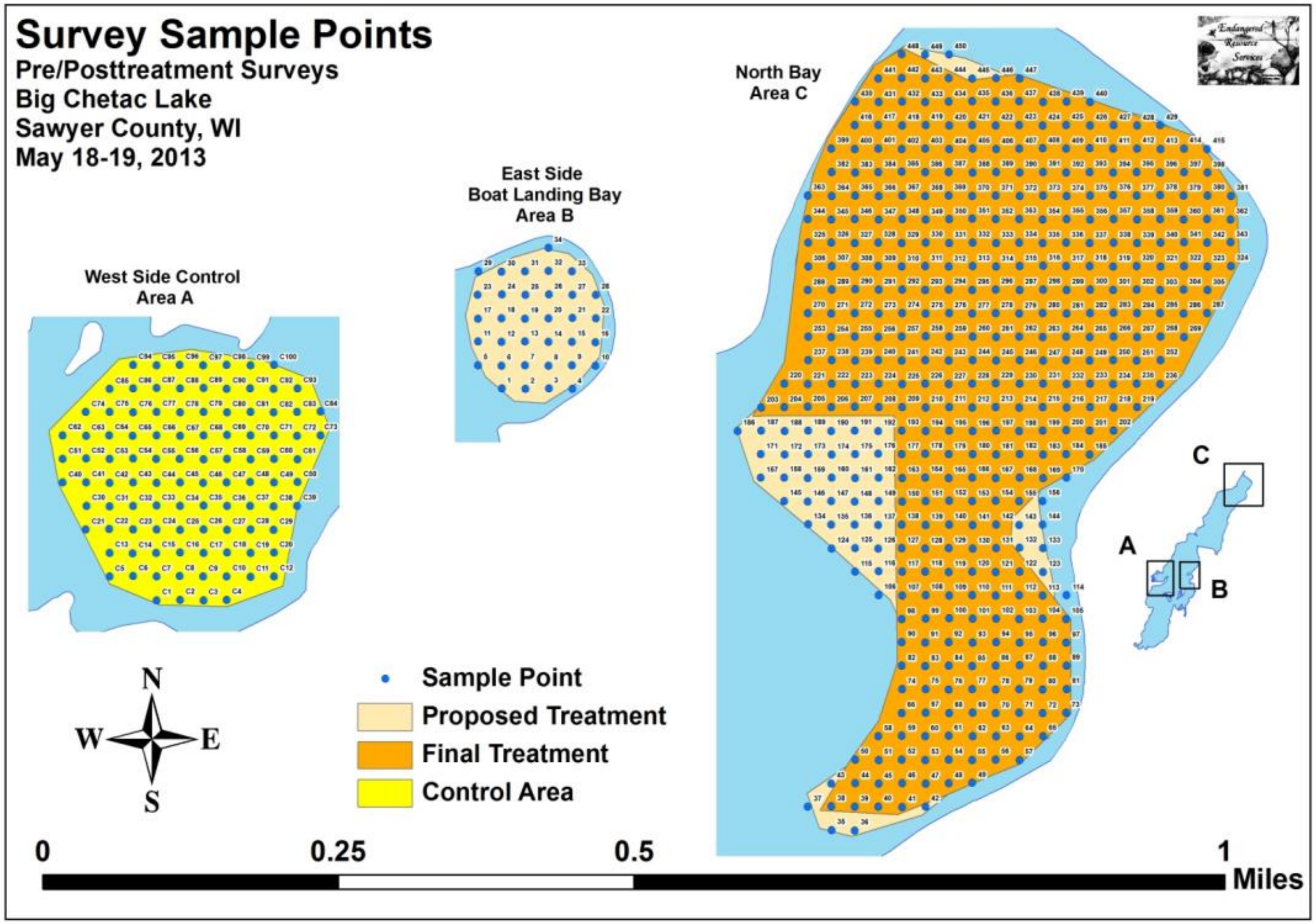
Busch, C., E. Eaton, N. Pokorny, and C. Holt. [online]. 1967. Big Chetac Lake Map. Available from http://dnr.wi.gov/lakes/maps/DNR/2113300a.pdf (2013, July).

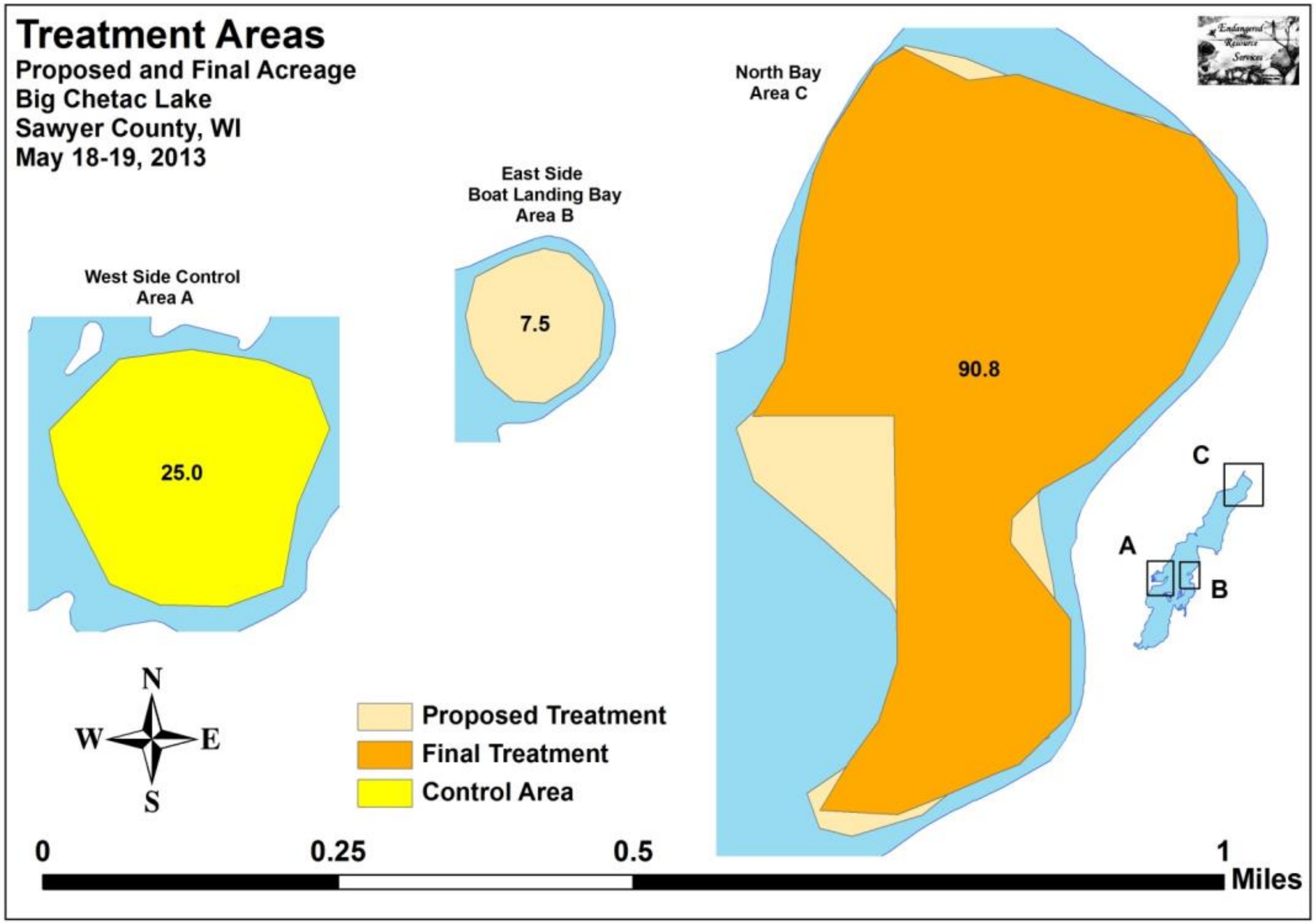
James, W.F., J.W. Barko, H.L. Eakin, and P.W. Sorge. 2002. Phosphorus budget and management strategies for an urban Wisconsin lake. Lake and Reserv. Manage. 18(2): 149-163

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr/uwexlakes/ecology/APMguide.asp (2013, July).

WDNR. [online]. 2013. Big Chetac Lake - Citizen Lake Water Quality Monitoring Database. Available from http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2113300&page=waterquality 2013, July).

Appendix I: Survey Sample Points and CLP Treatment Area

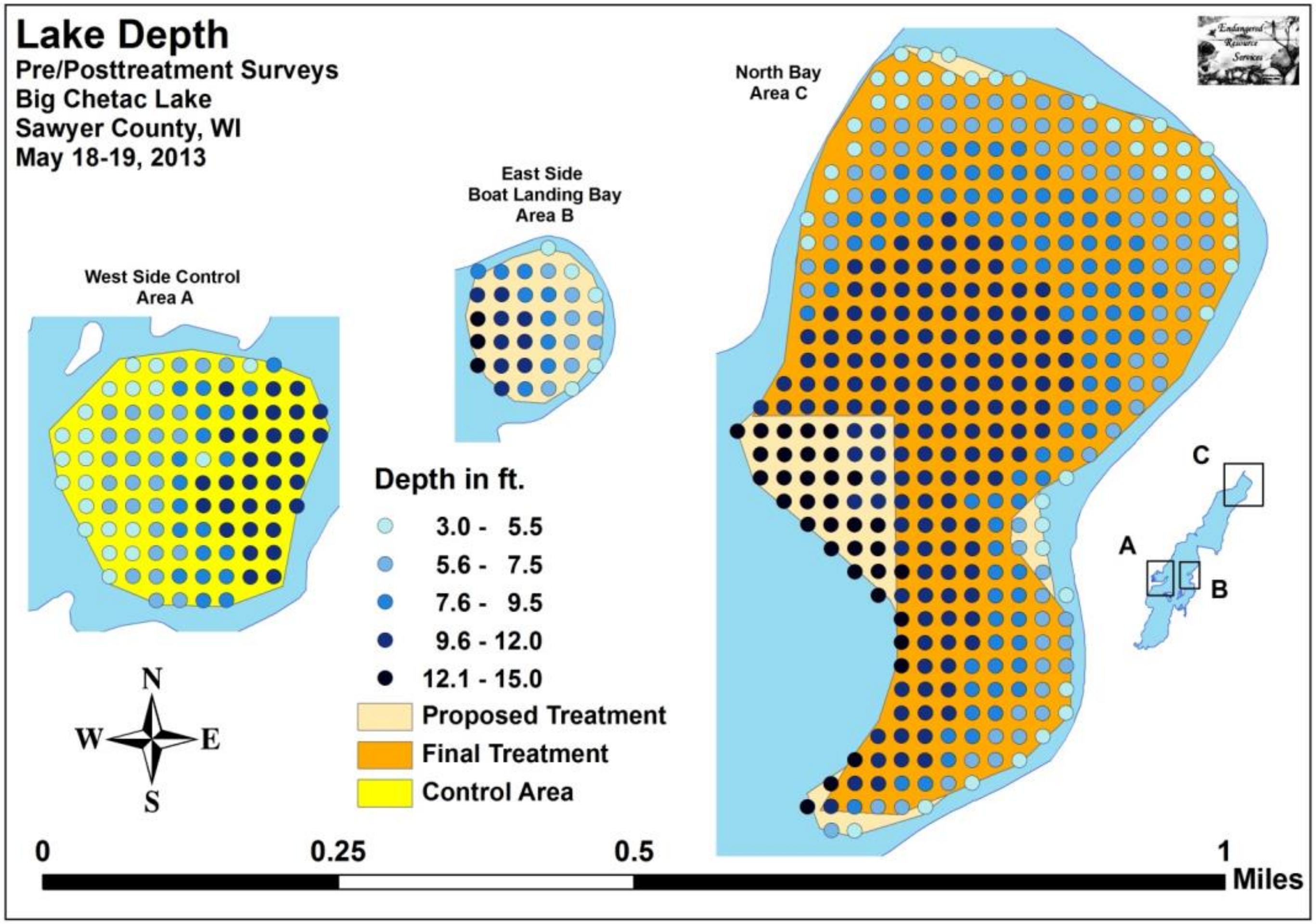

Survey Sample Points
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
N
W
E
S
Sample Point
Proposed Treatment
Final Treatment
Control Area
A
B
C
0
0.25
0.5
1
Miles


Treatment Areas
Proposed and Final Acreage
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
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

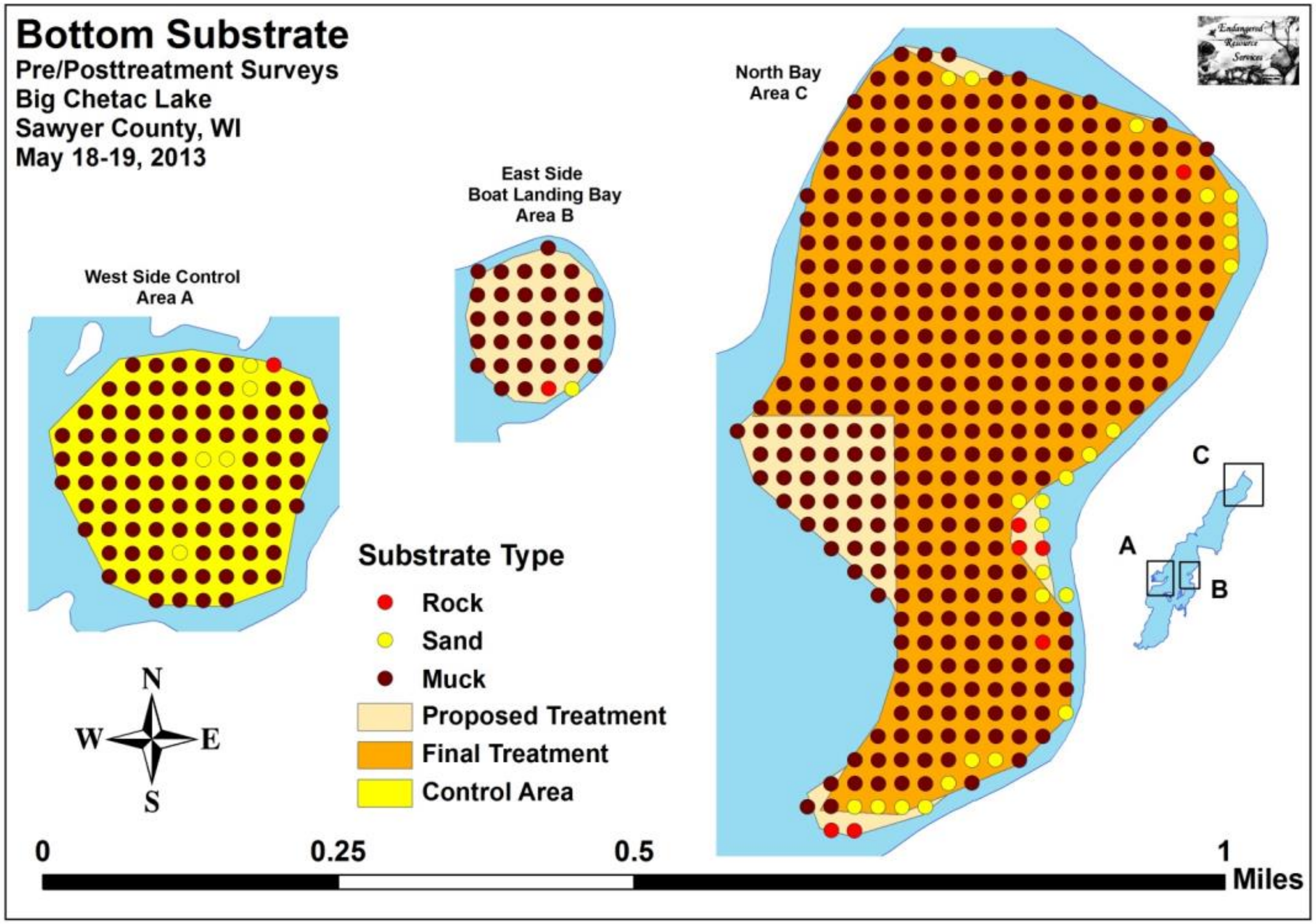
Appendix II: Vegetative Survey Data Sheet

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

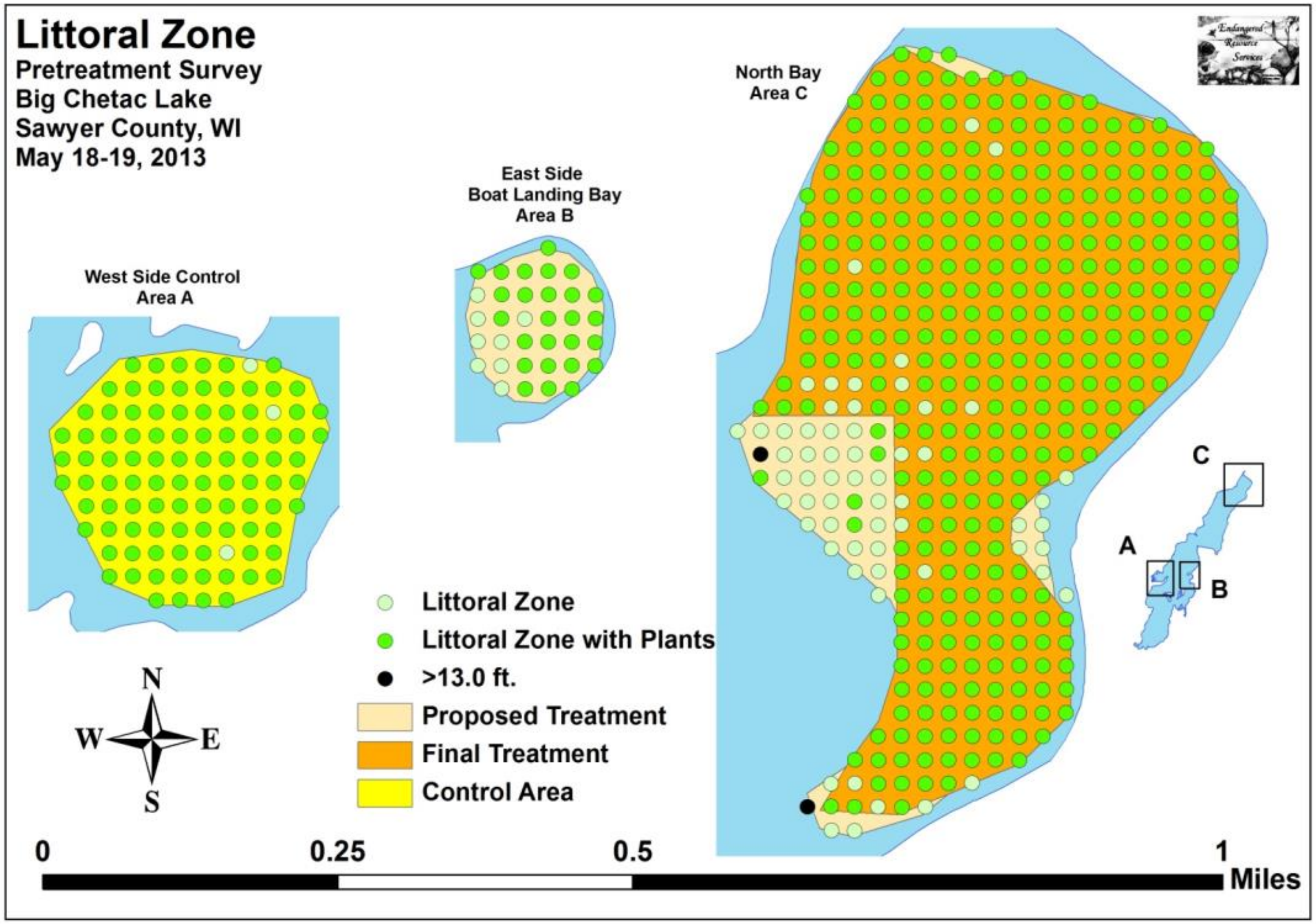


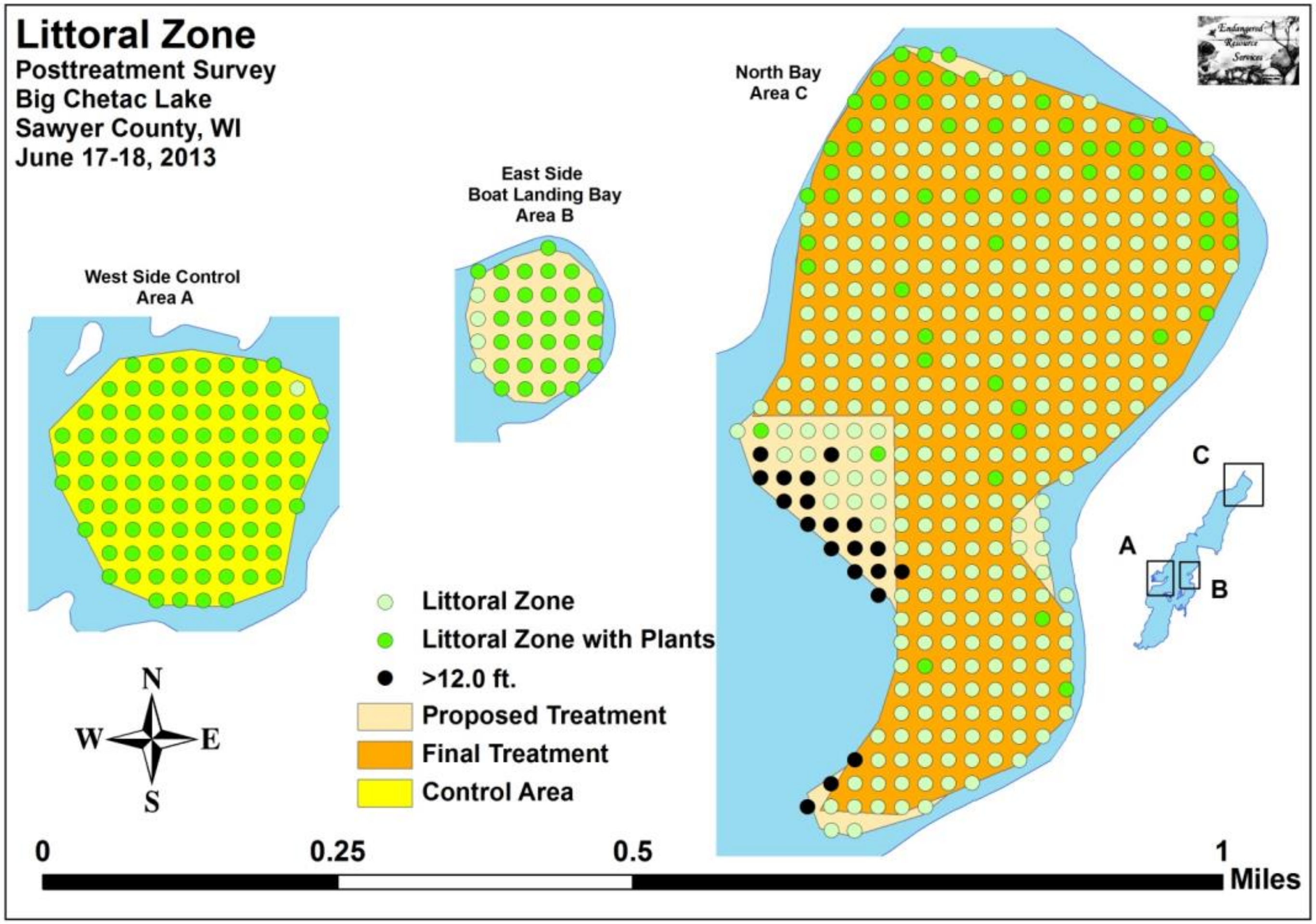
Lake Depth
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Depth in ft.
3.0 - 5.5
5.6 - 7.5
7.6 - 9.5
9.6 - 12.0
12.1 - 15.0
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

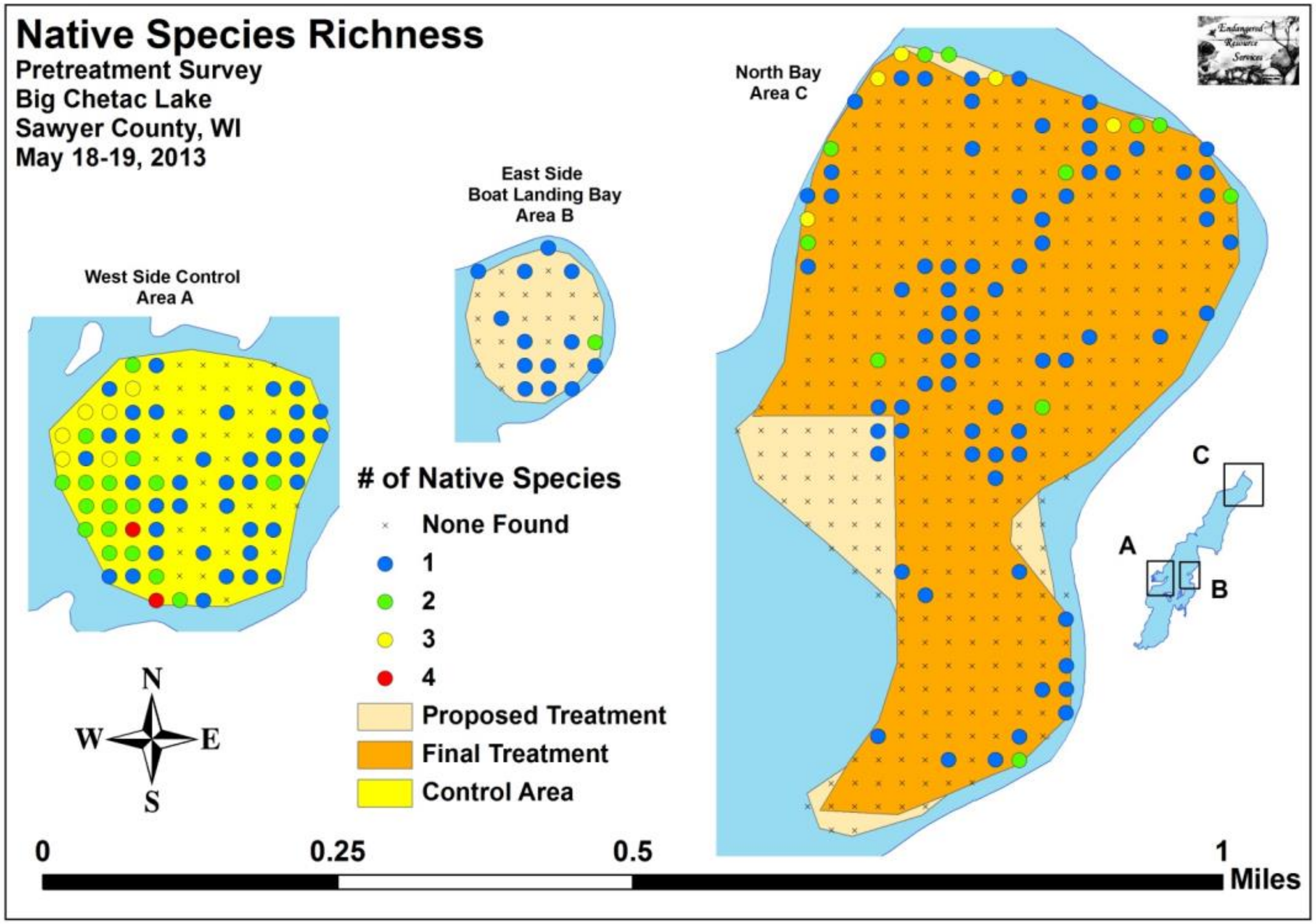


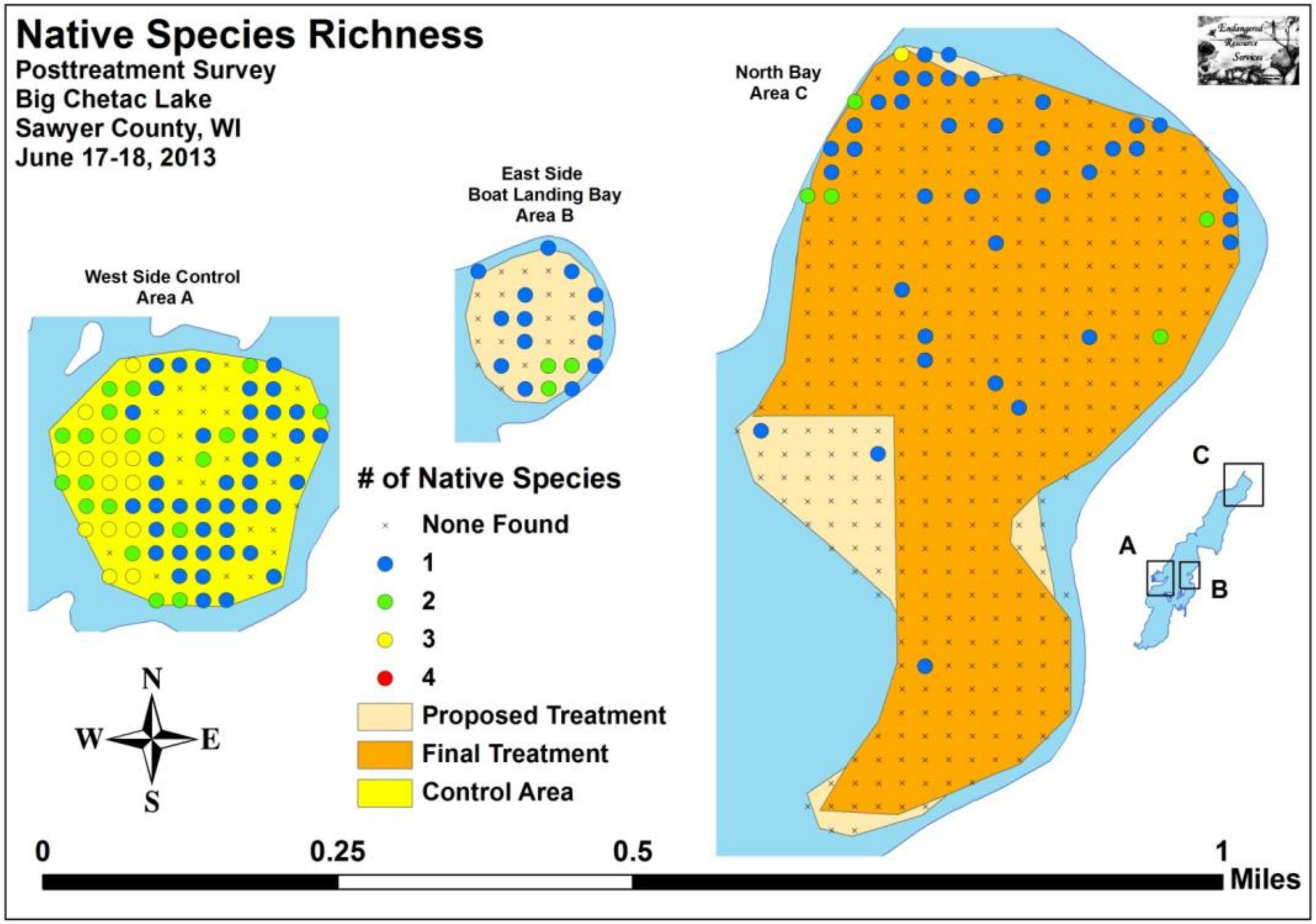
Bottom Substrate
Pre/Posttreatment Surveys
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Substrate Type
Rock
Sand
Muck
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

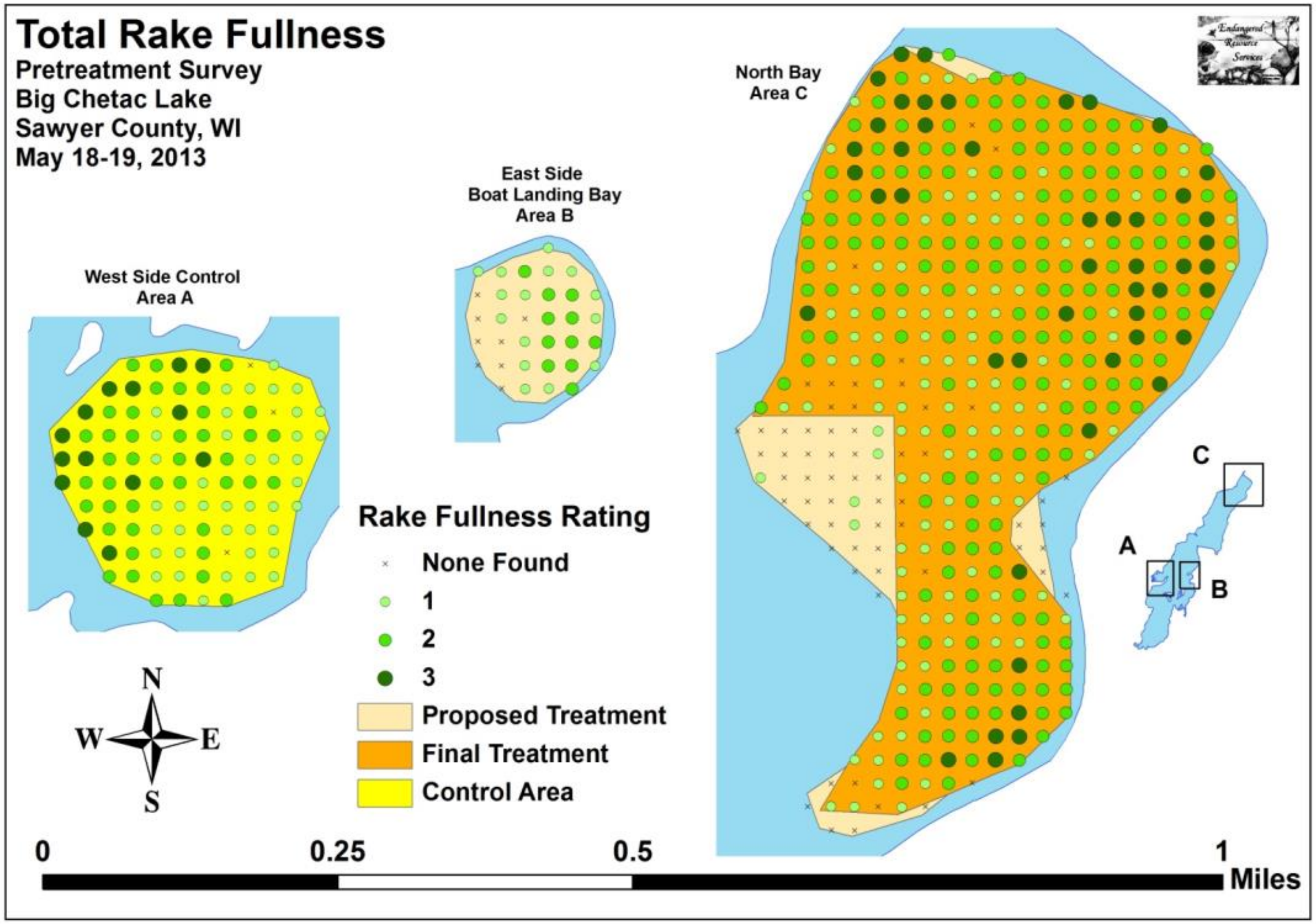
Appendix IV: Pre/Post Littoral Zone, Native Species Richness, and Total Rake Fullness

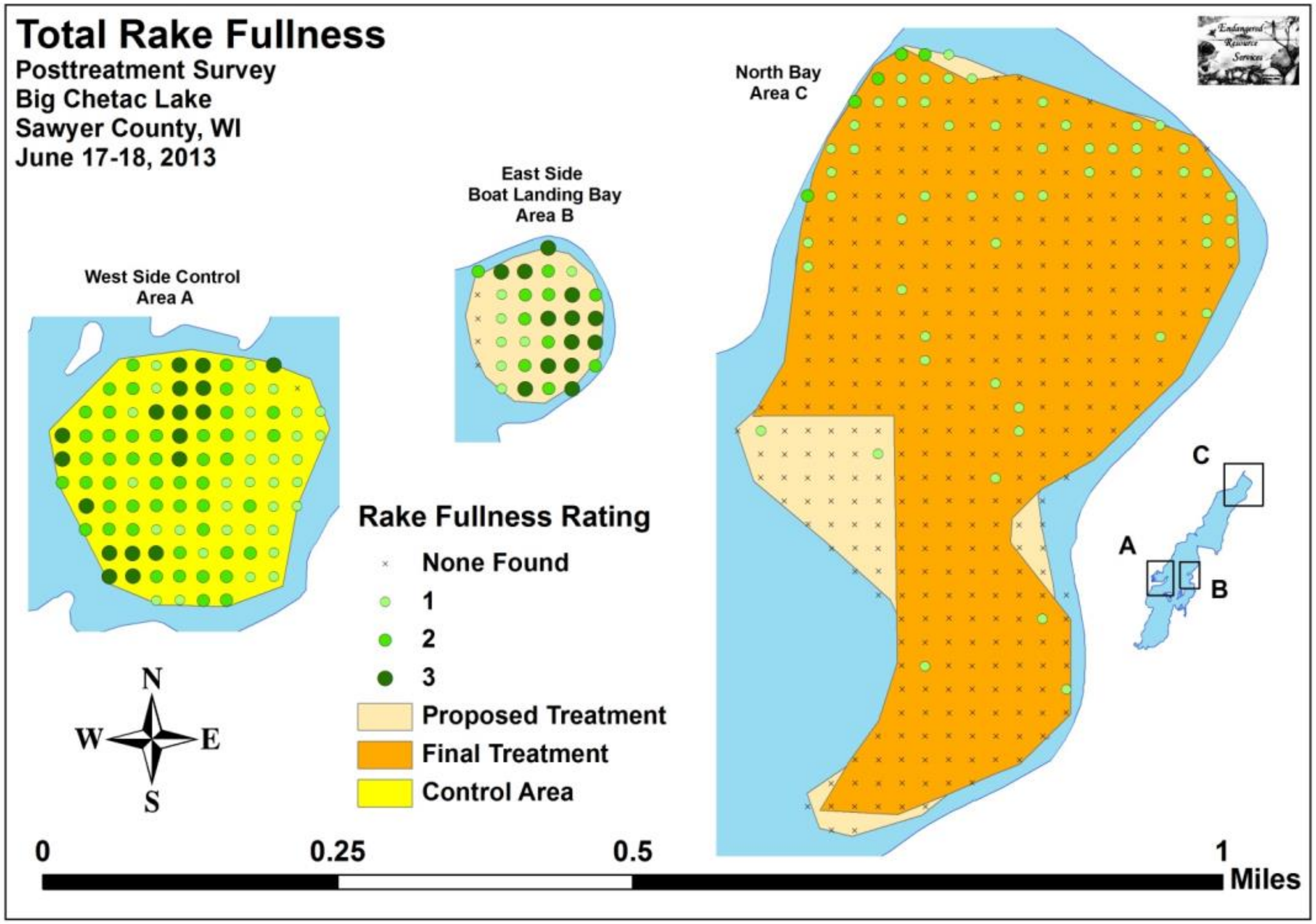

Littoral Zone
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
North Bay
Area C
East Side
Boat Landing Bay
Area B
West Side Control
Area A
Littoral Zone
Littoral Zone with Plants
>13.0 ft.
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
C
A
B
0
0.25
0.5
1
Miles


Littoral Zone
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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
0
0.25
0.5
1
Miles
A
B
C

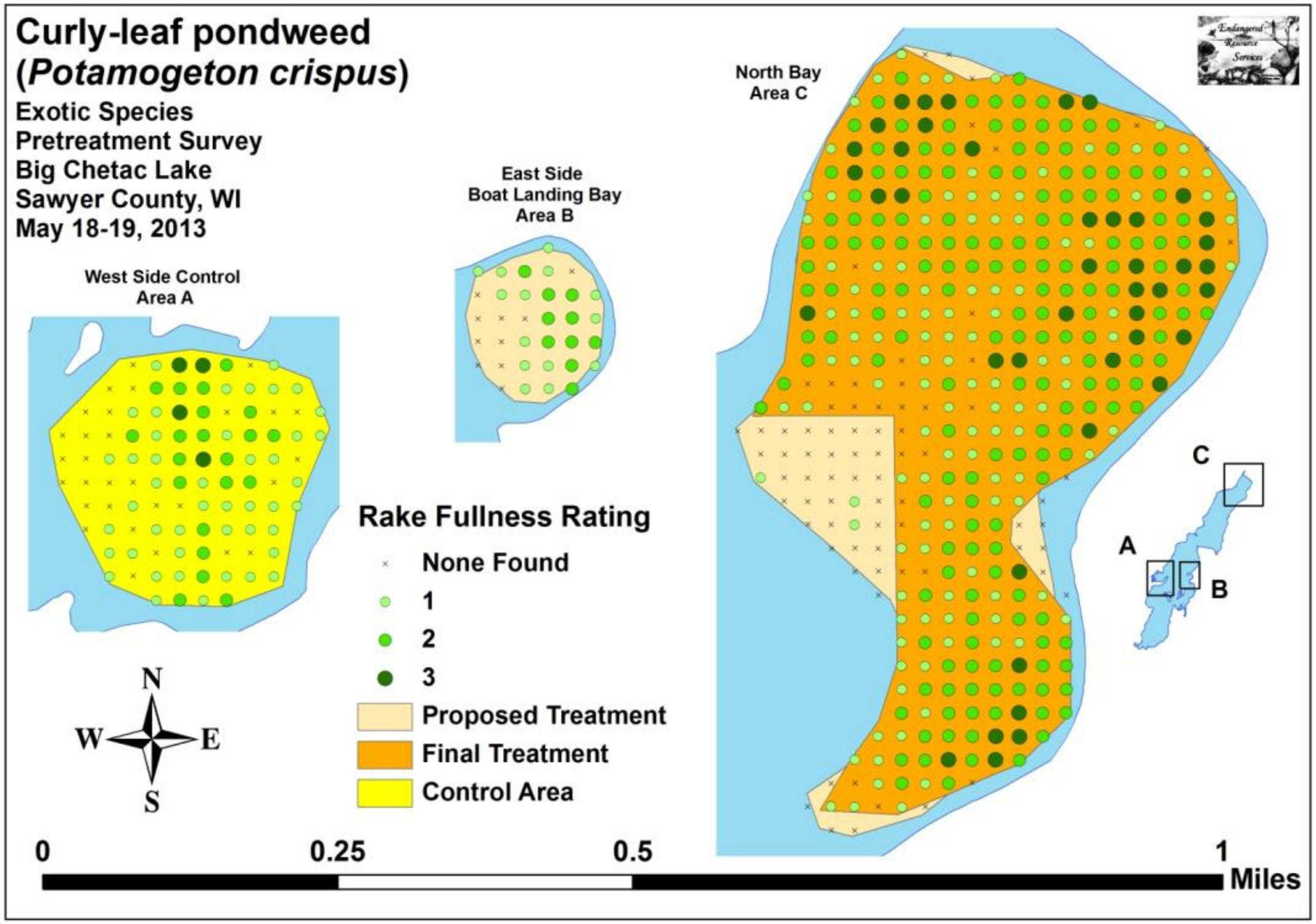

Native Species Richness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
# of Native Species
None Found
1
2
3
4
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Native Species Richness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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
0
0.25
0.5
1
Miles
A
B
C

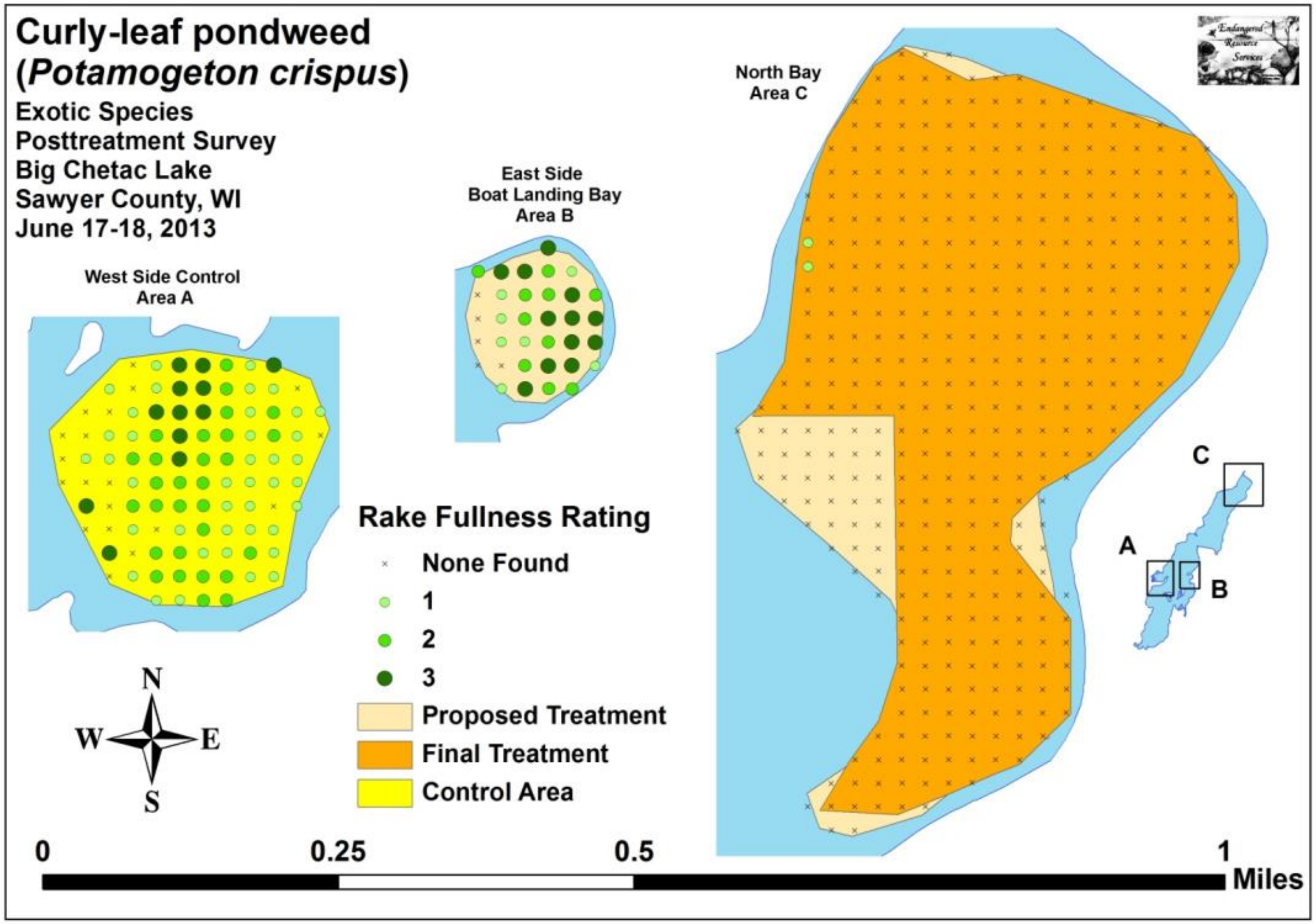

Total Rake Fullness
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
0
0.25
0.5
1
Miles
A
B
C


Total Rake Fullness
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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
C
A
B
0
0.25
0.5
1
Miles

Appendix V: CLP Pre/Post Density and Distribution

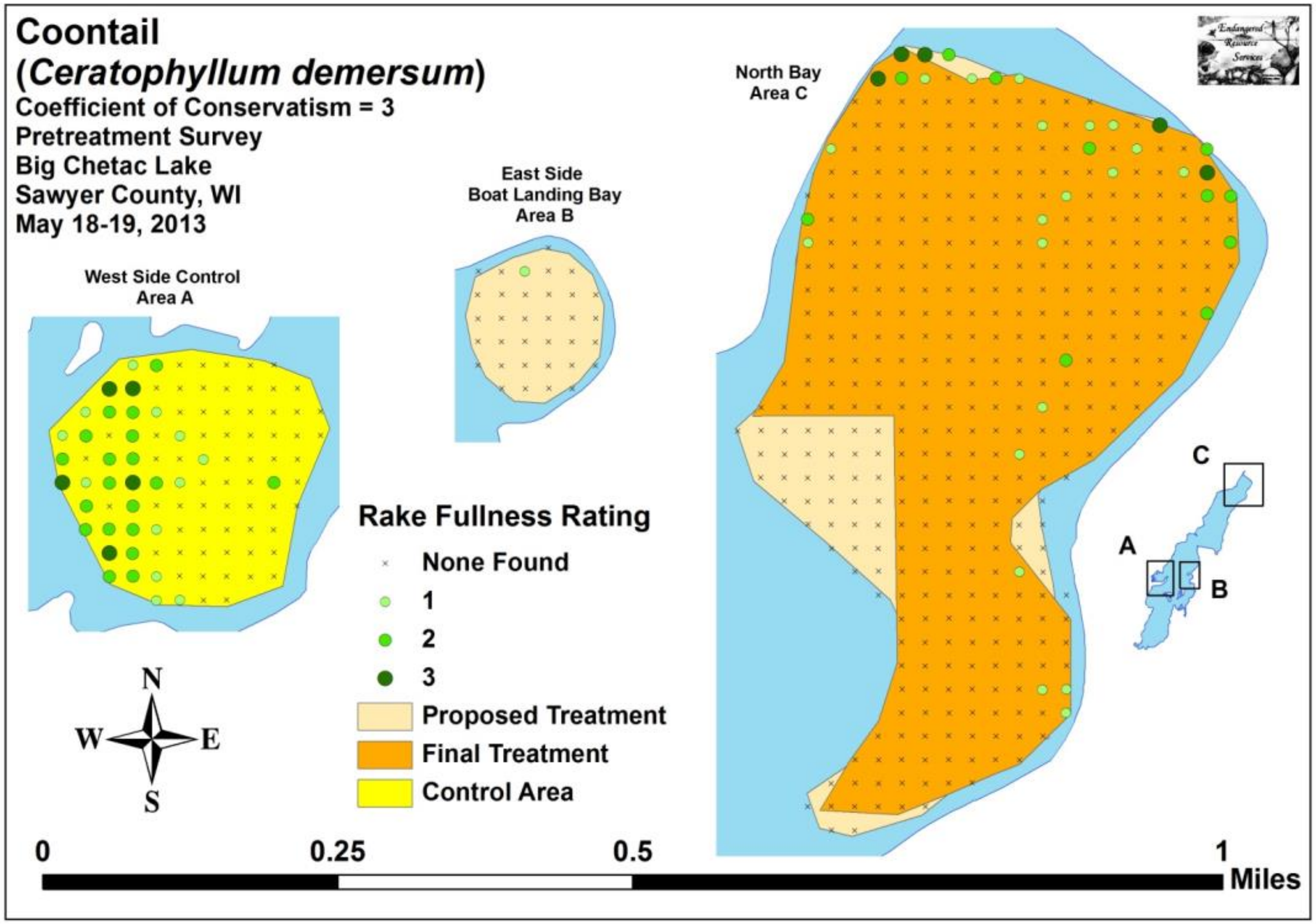


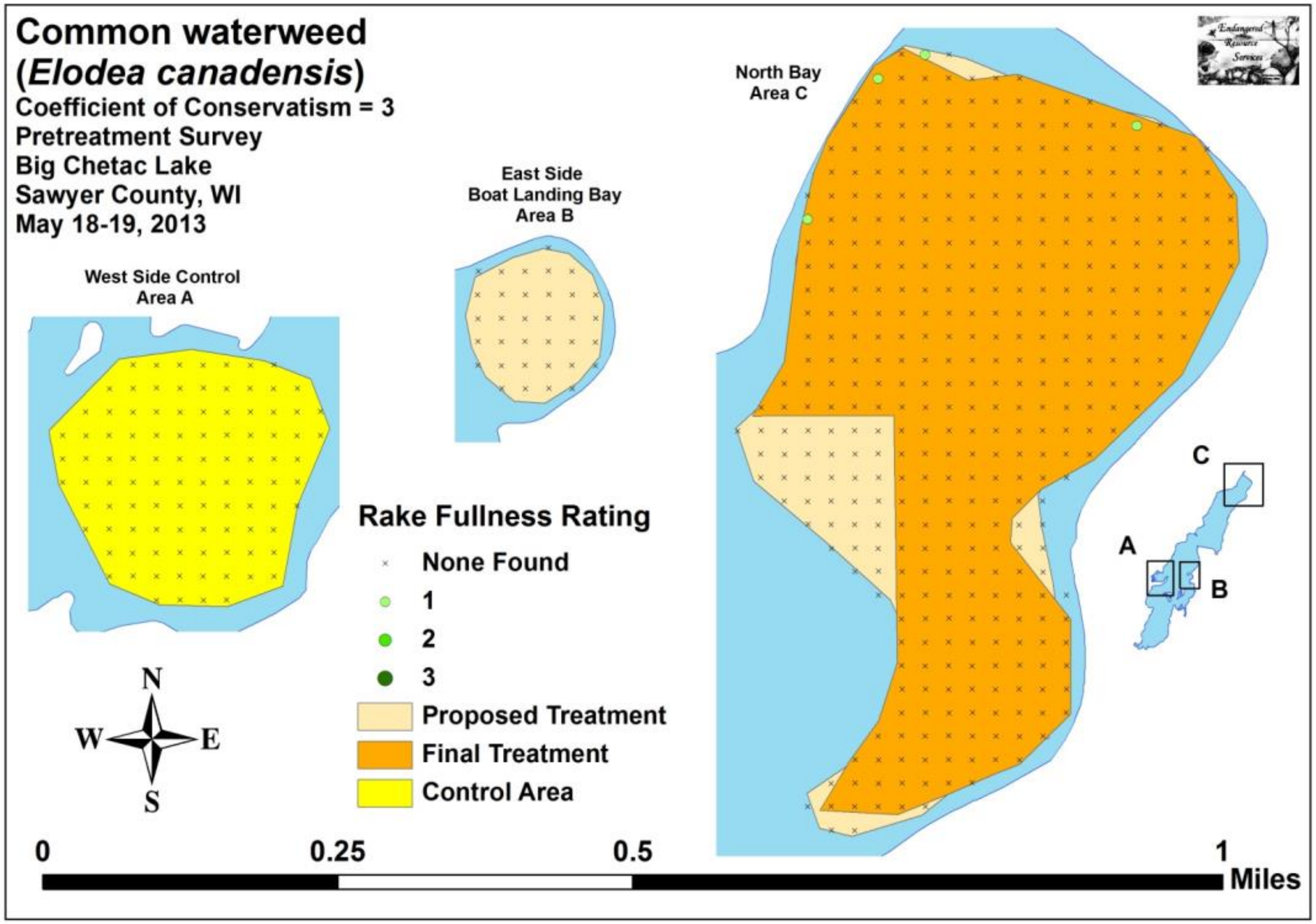
Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

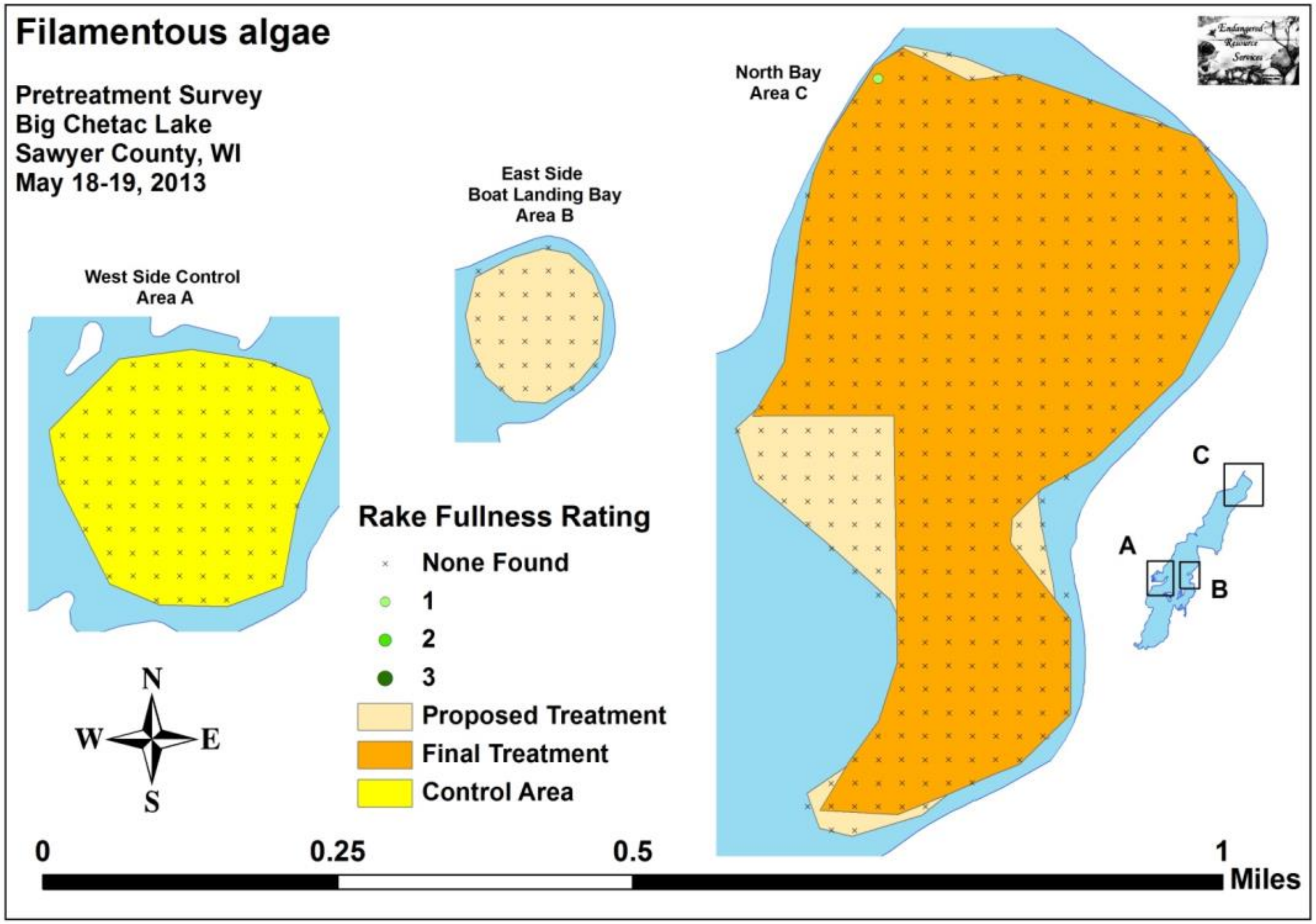


Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

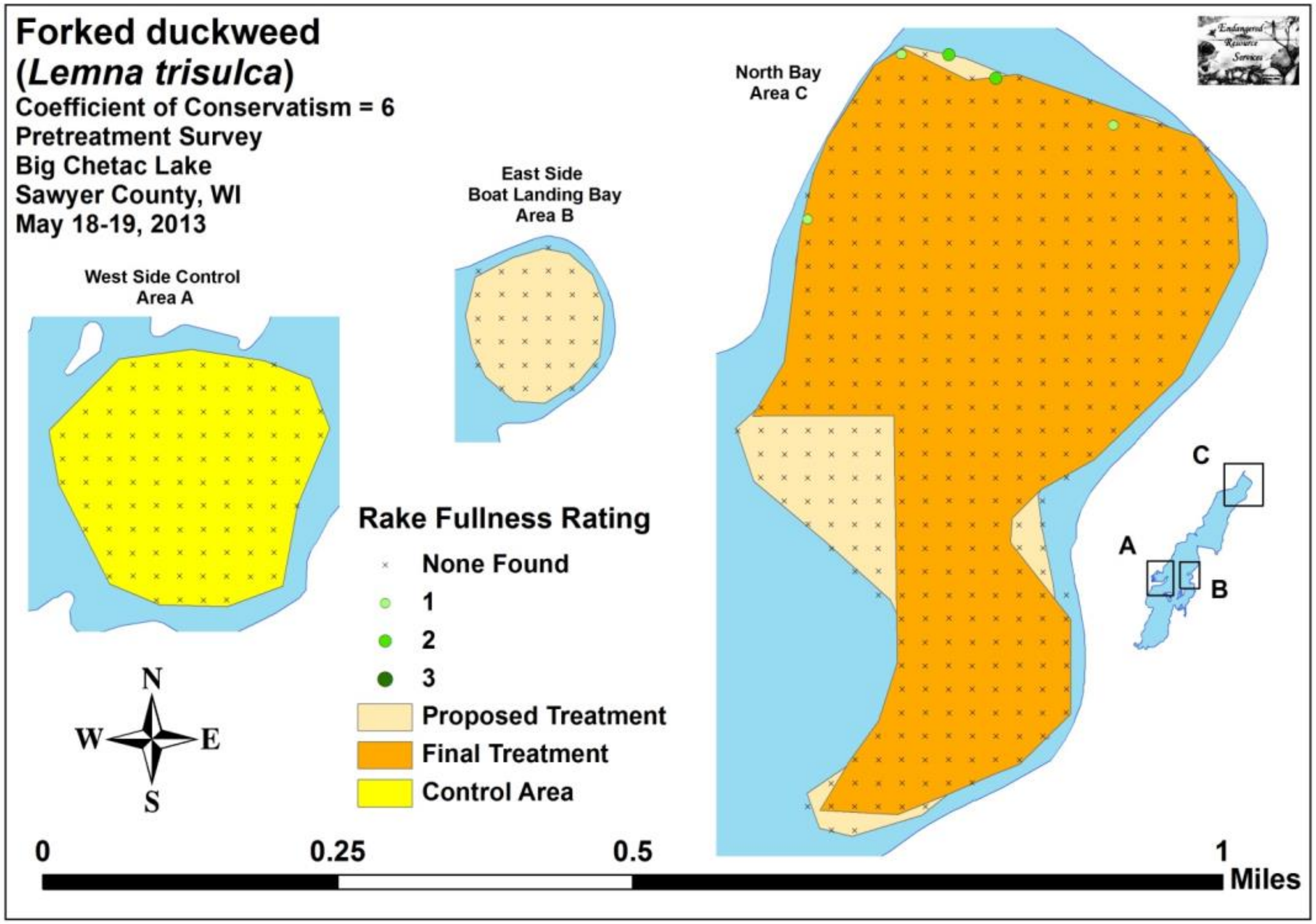
Appendix VI: Pretreatment Native Species Density and Distribution

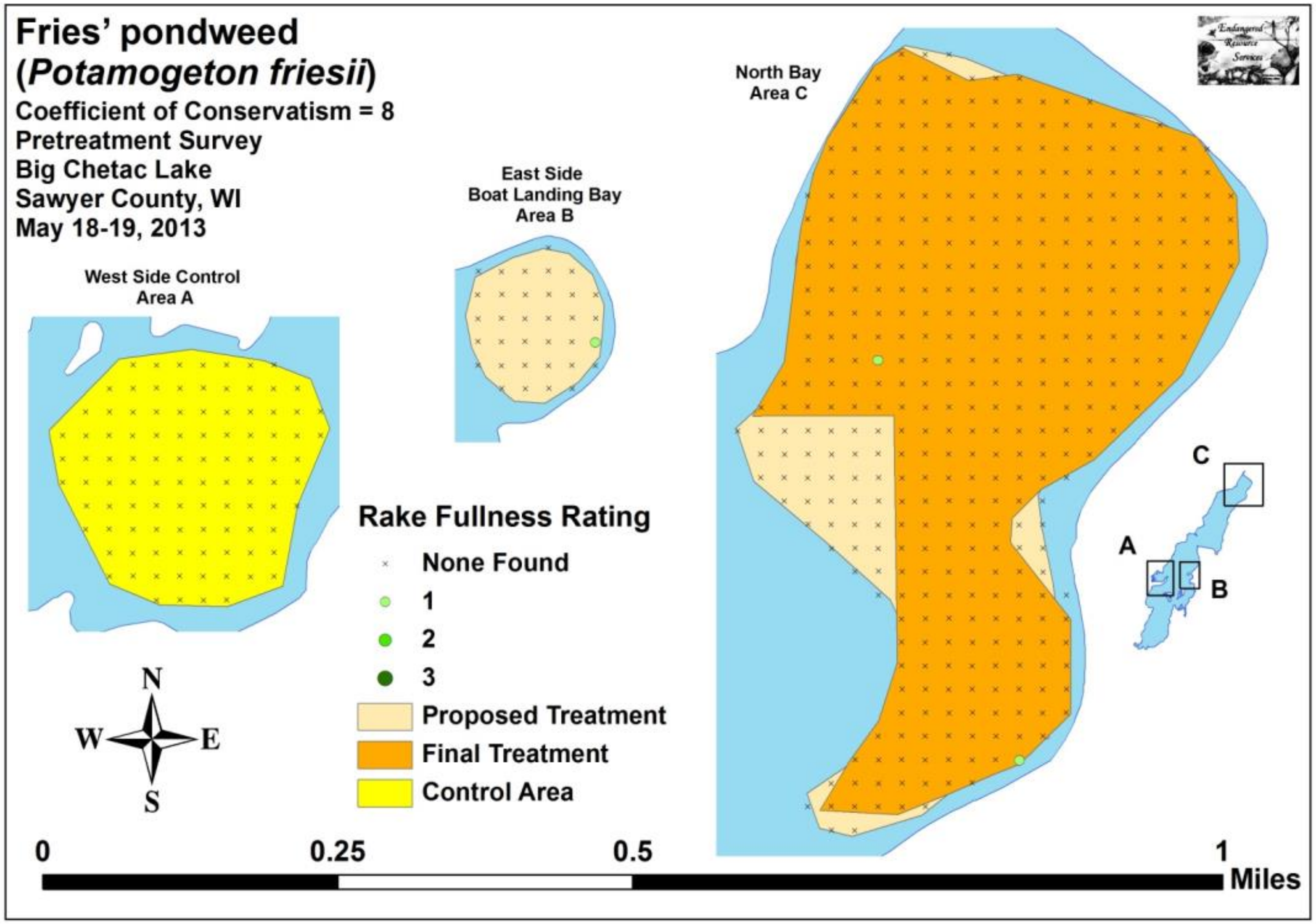

Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
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 18-19, 2013
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

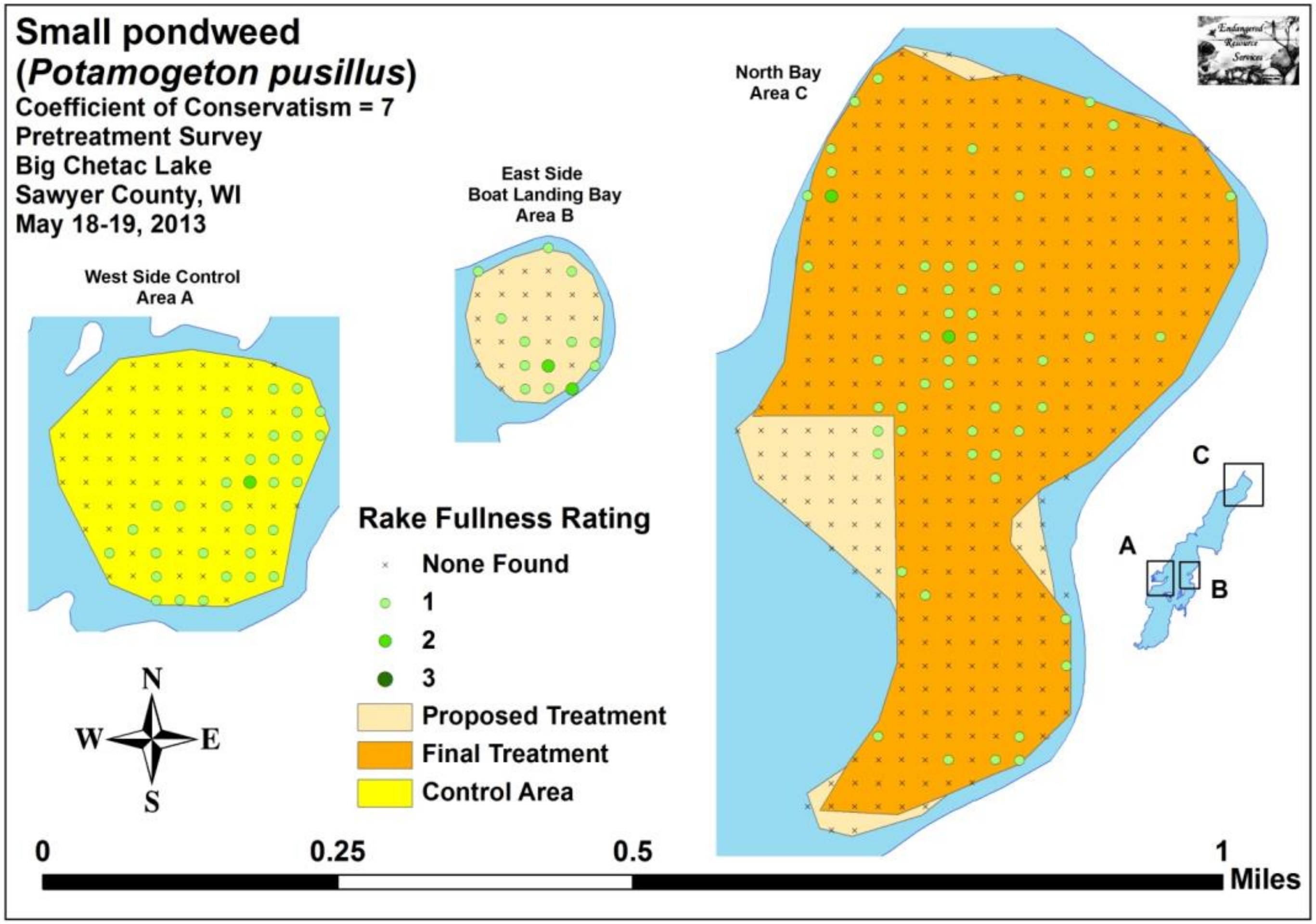


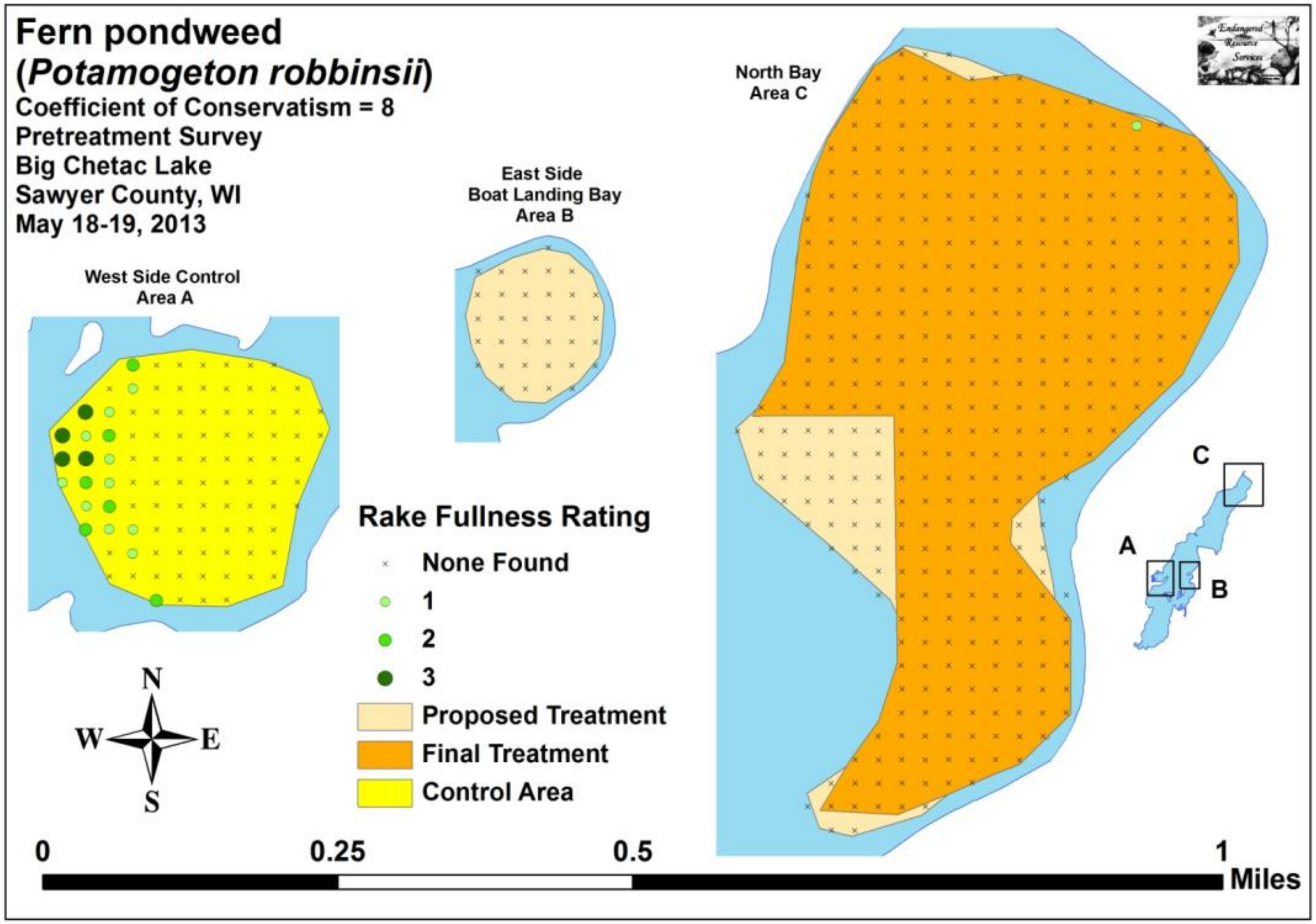
Filamentous algae
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles


Forked duckweed
(Lemna trisulca)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
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

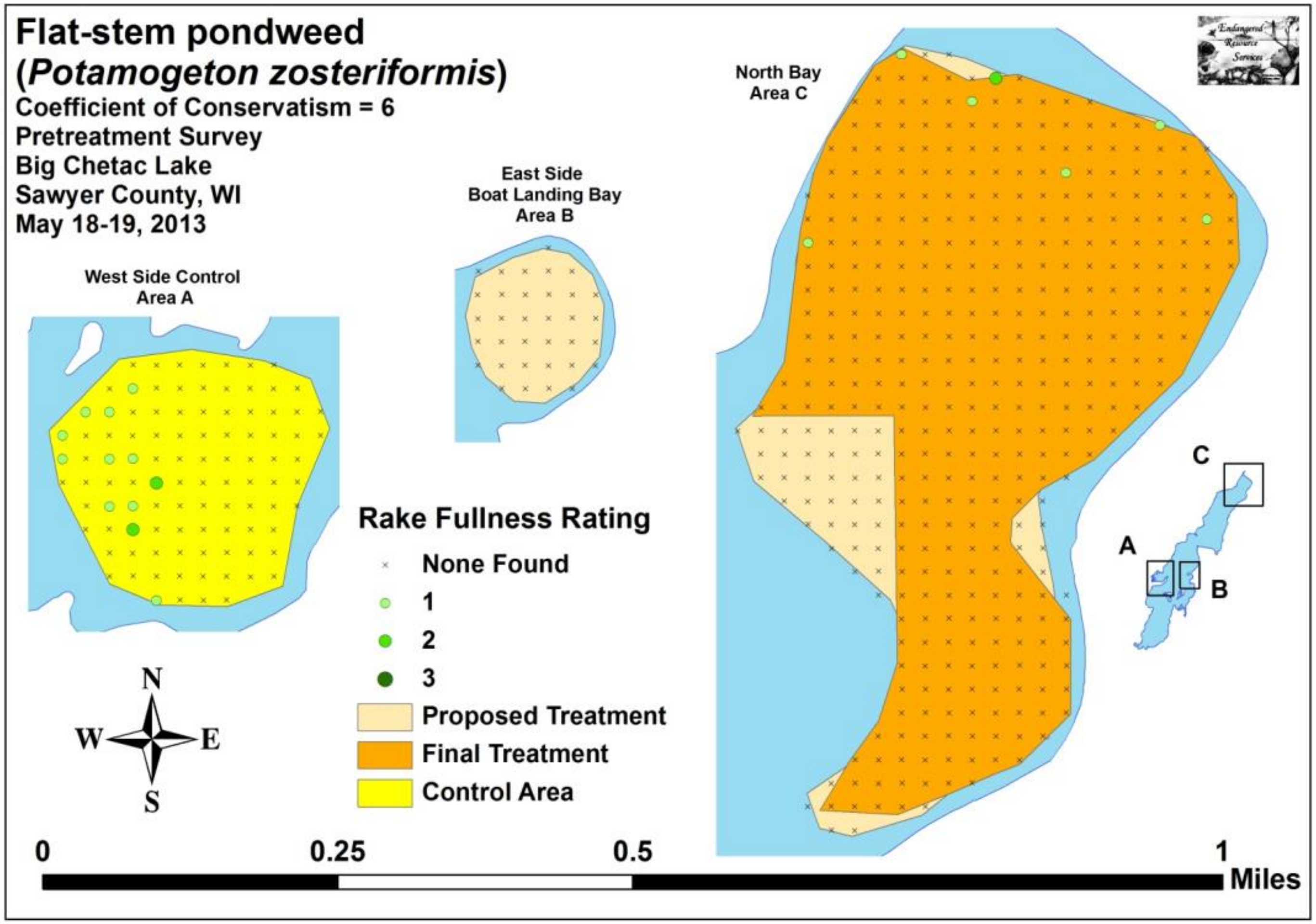


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
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 18-19, 2013
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

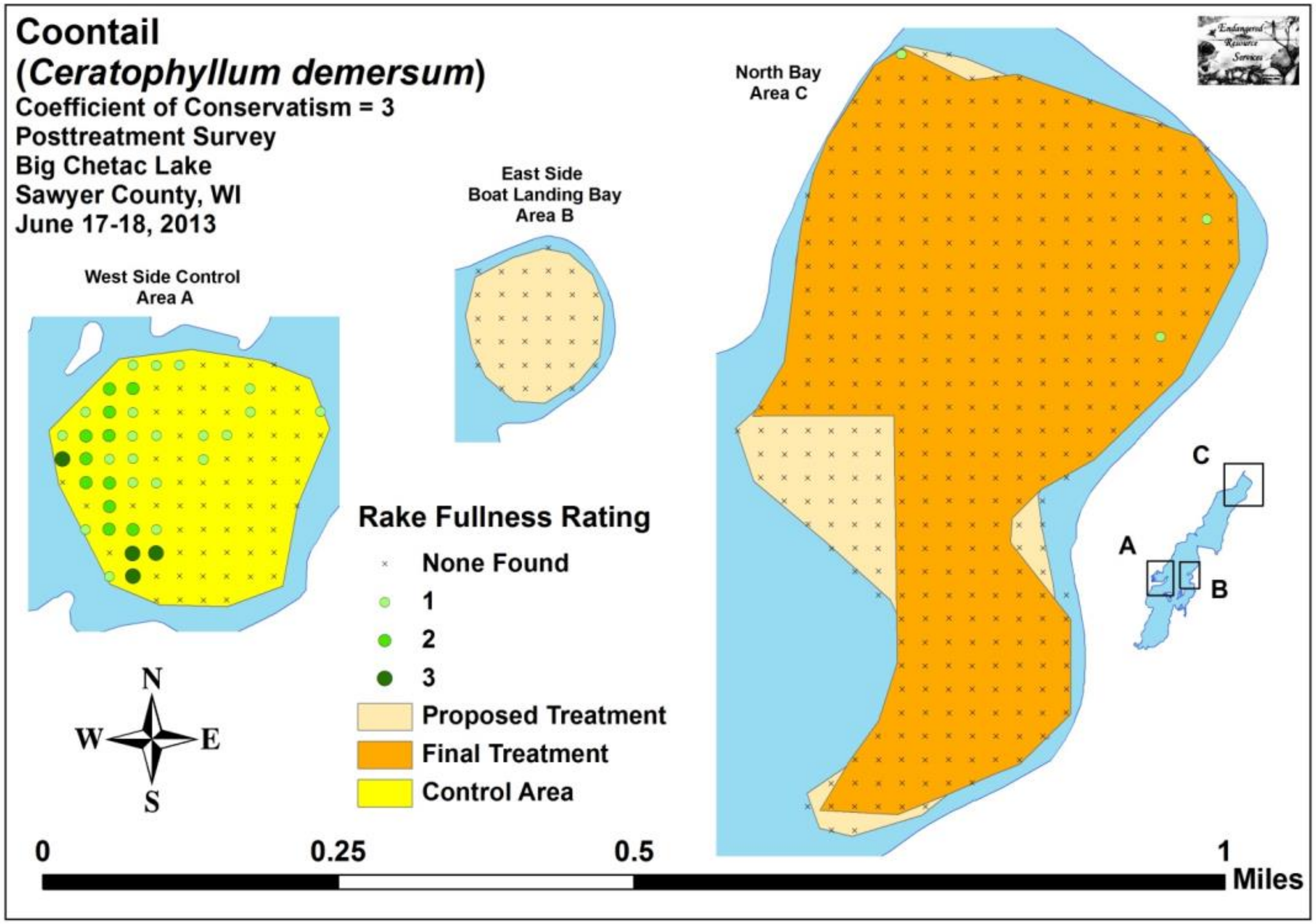


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

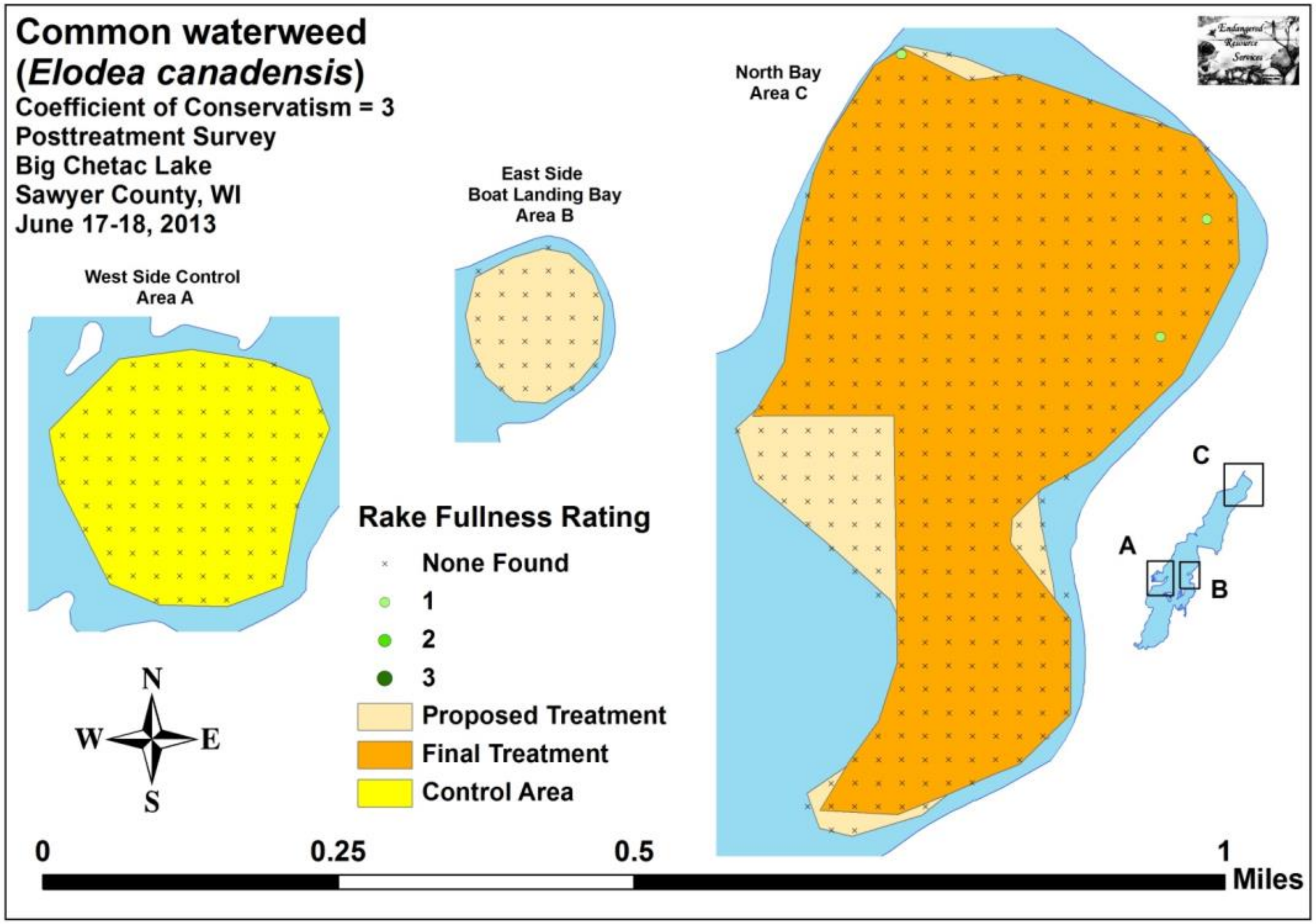


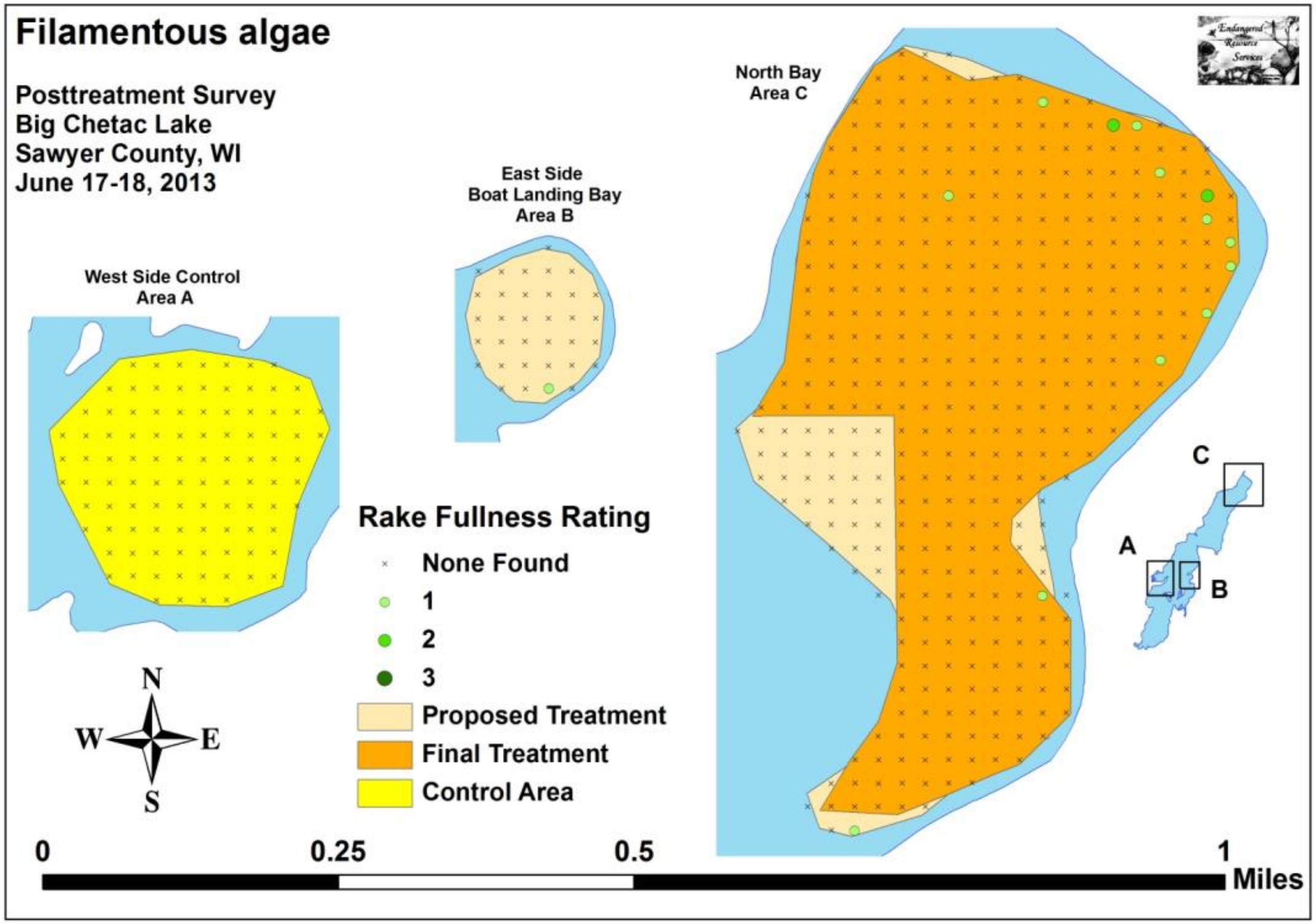
Flat-stem pondweed
(*Potamogeton zosteriformis*)
Coefficient of Conservatism = 6
Pretreatment Survey
Big Chetac Lake
Sawyer County, WI
May 18-19, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

Appendix VII: Posttreatment Native Species Density and Distribution

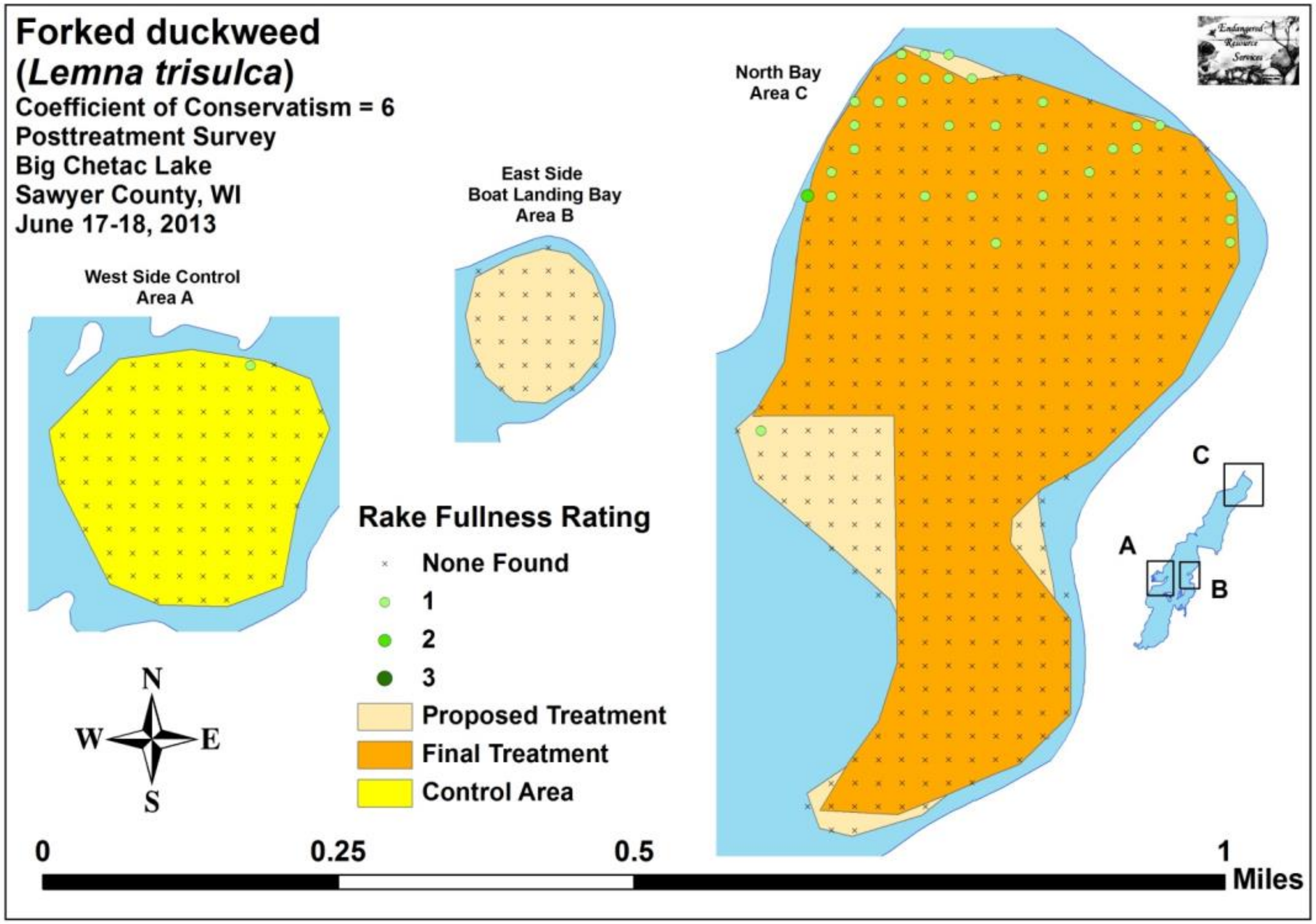


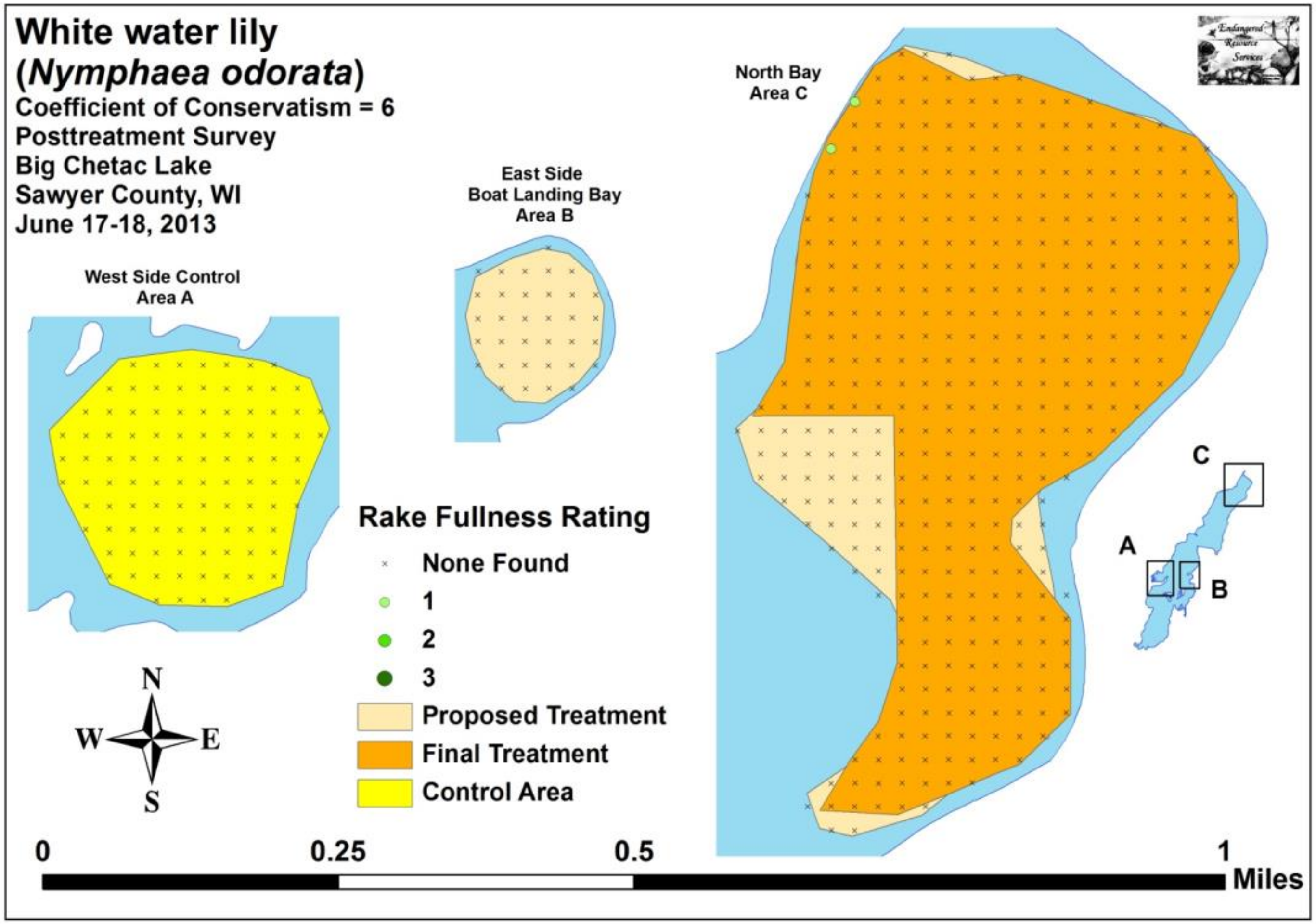
Coontail
(*Ceratophyllum demersum*)
Coefficient of Conservatism = 3
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles

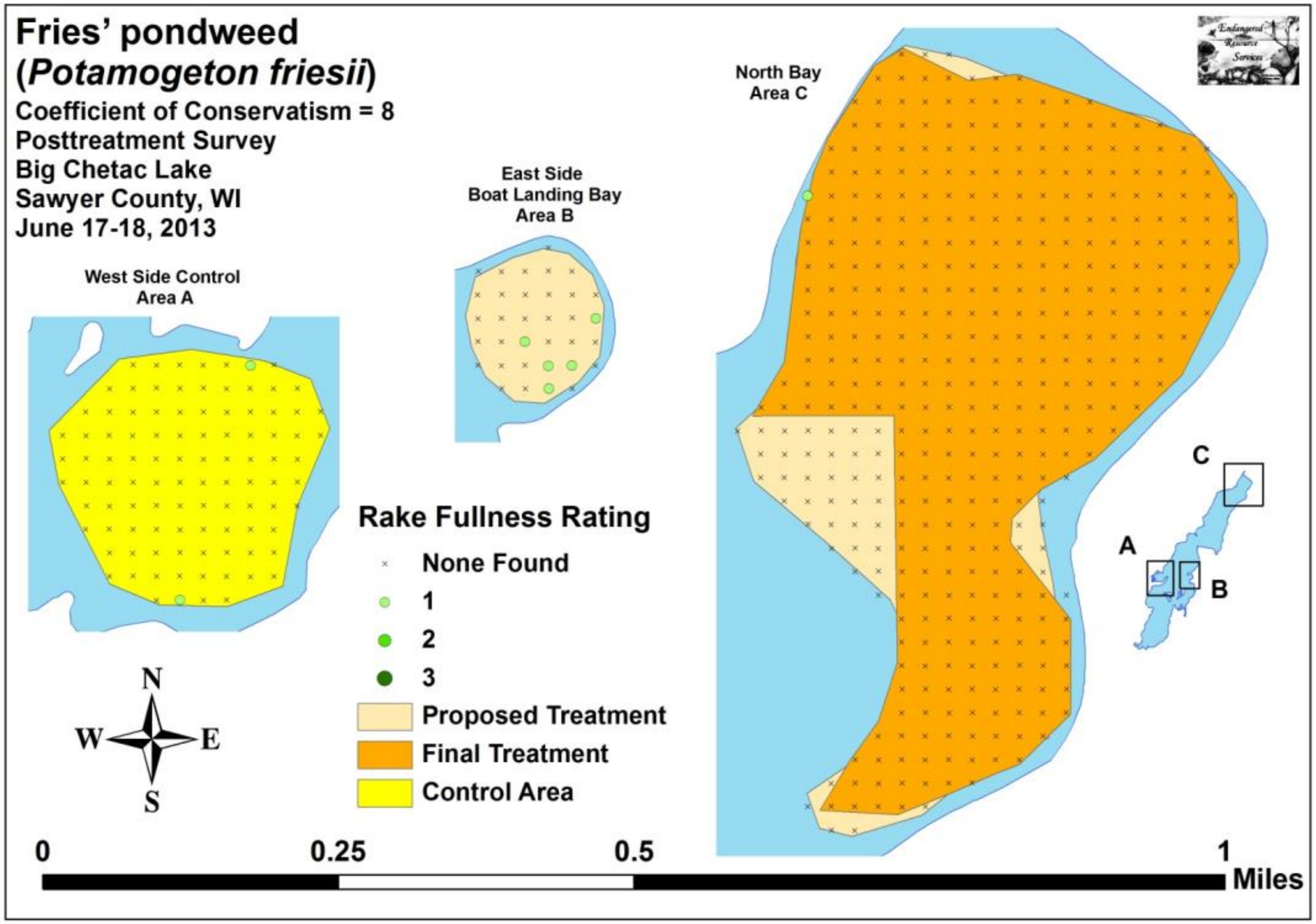

Common waterweed
(Elodea canadensis)
Coefficient of Conservatism = 3
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
2
3
Proposed Treatment
Final Treatment
Control Area
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 17-18, 2013
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
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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 lily
(Nymphaea odorata)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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
C
A
B
0
0.25
0.5
1
Miles


Fries' pondweed
(Potamogeton friesii)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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
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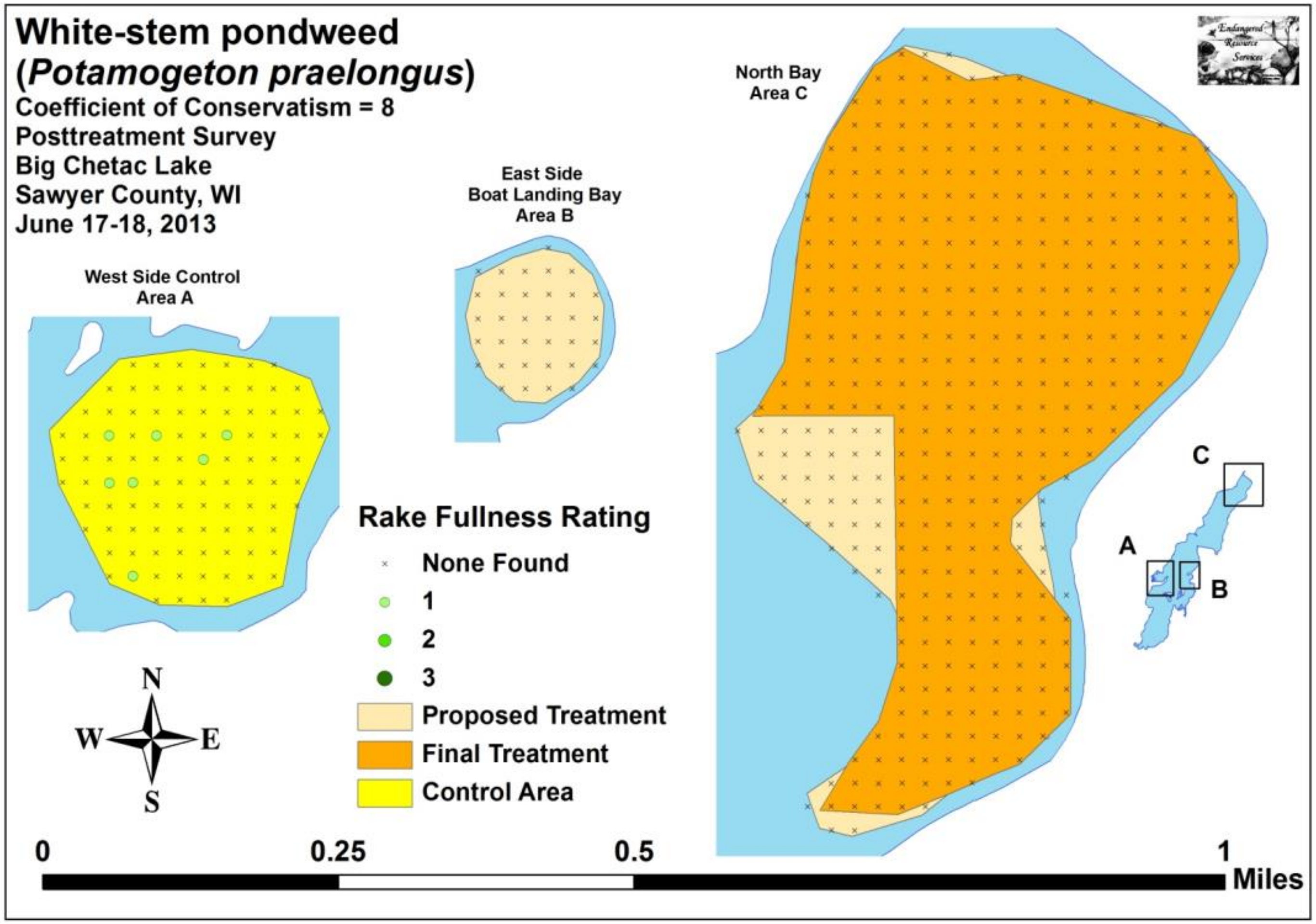
A
B
C
0
0.25
0.5
1
Miles


White-stem pondweed
(*Potamogeton praelongus*)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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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3
Proposed Treatment
Final Treatment
Control Area
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0
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1
Miles
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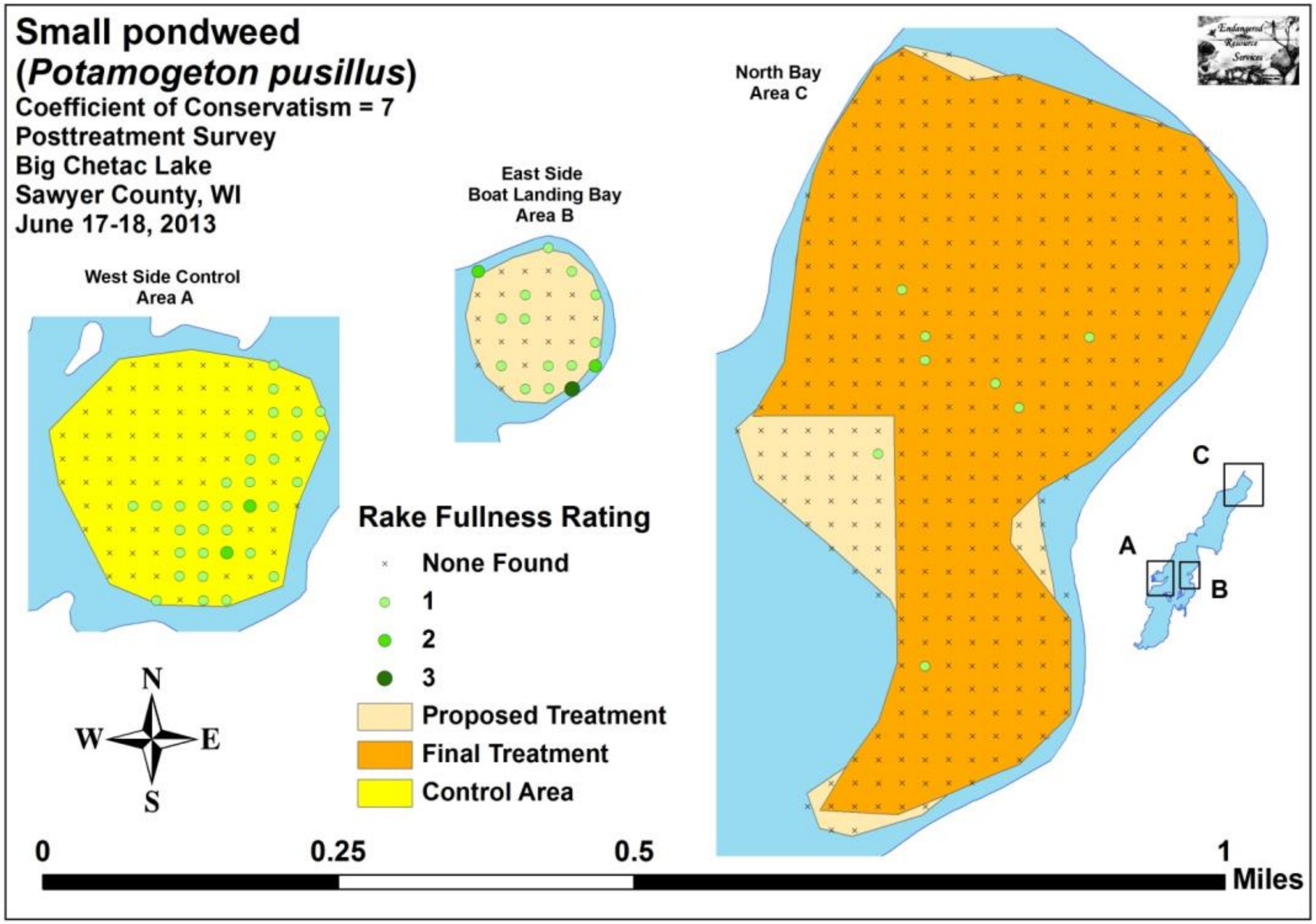
Small pondweed
(Potamogeton pusillus)
Coefficient of Conservatism = 7
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Rake Fullness Rating
None Found
1
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Proposed Treatment
Final Treatment
Control Area
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C
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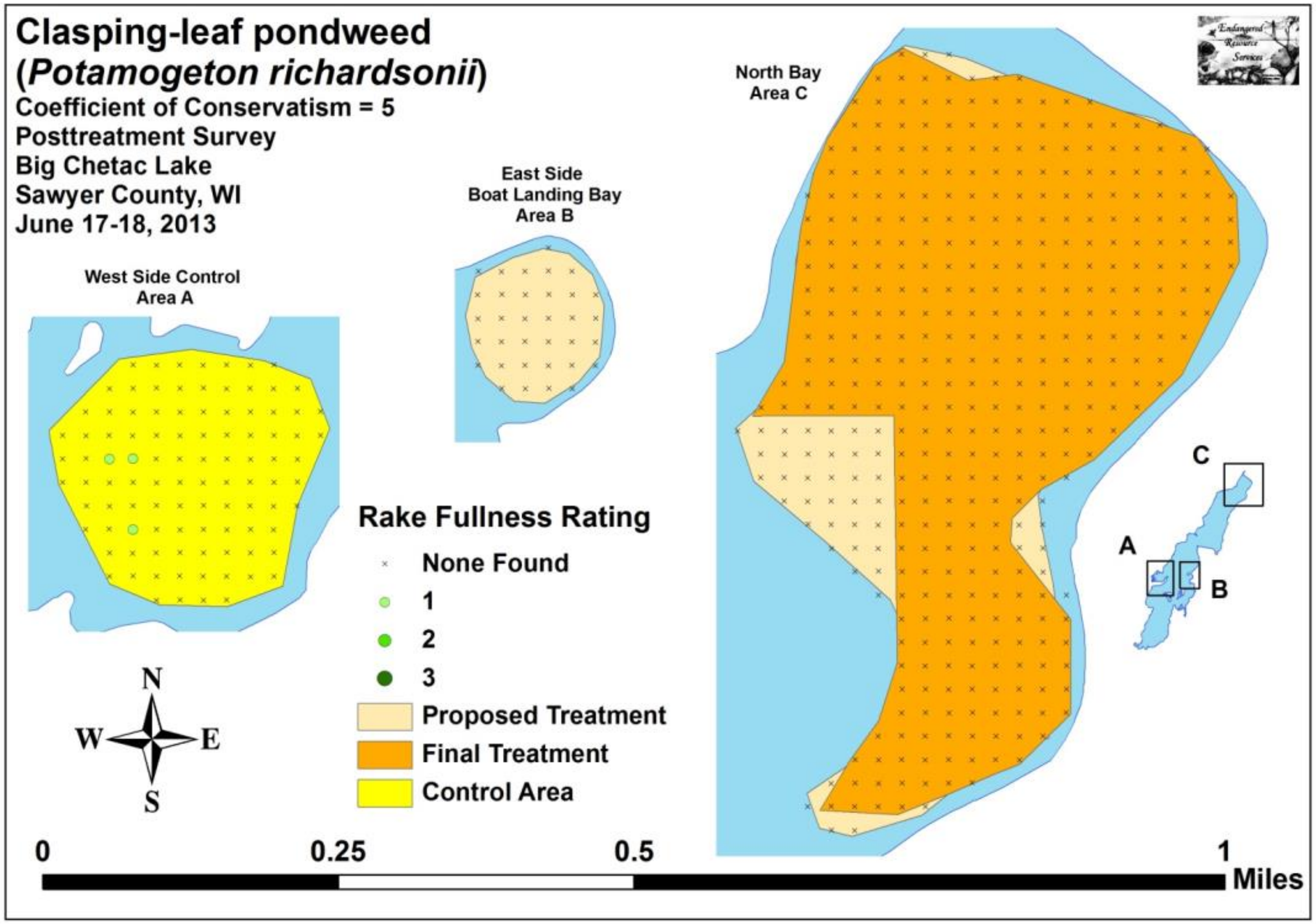
0.5
1
Miles


Clasping-leaf pondweed
(*Potamogeton richardsonii*)
Coefficient of Conservatism = 5
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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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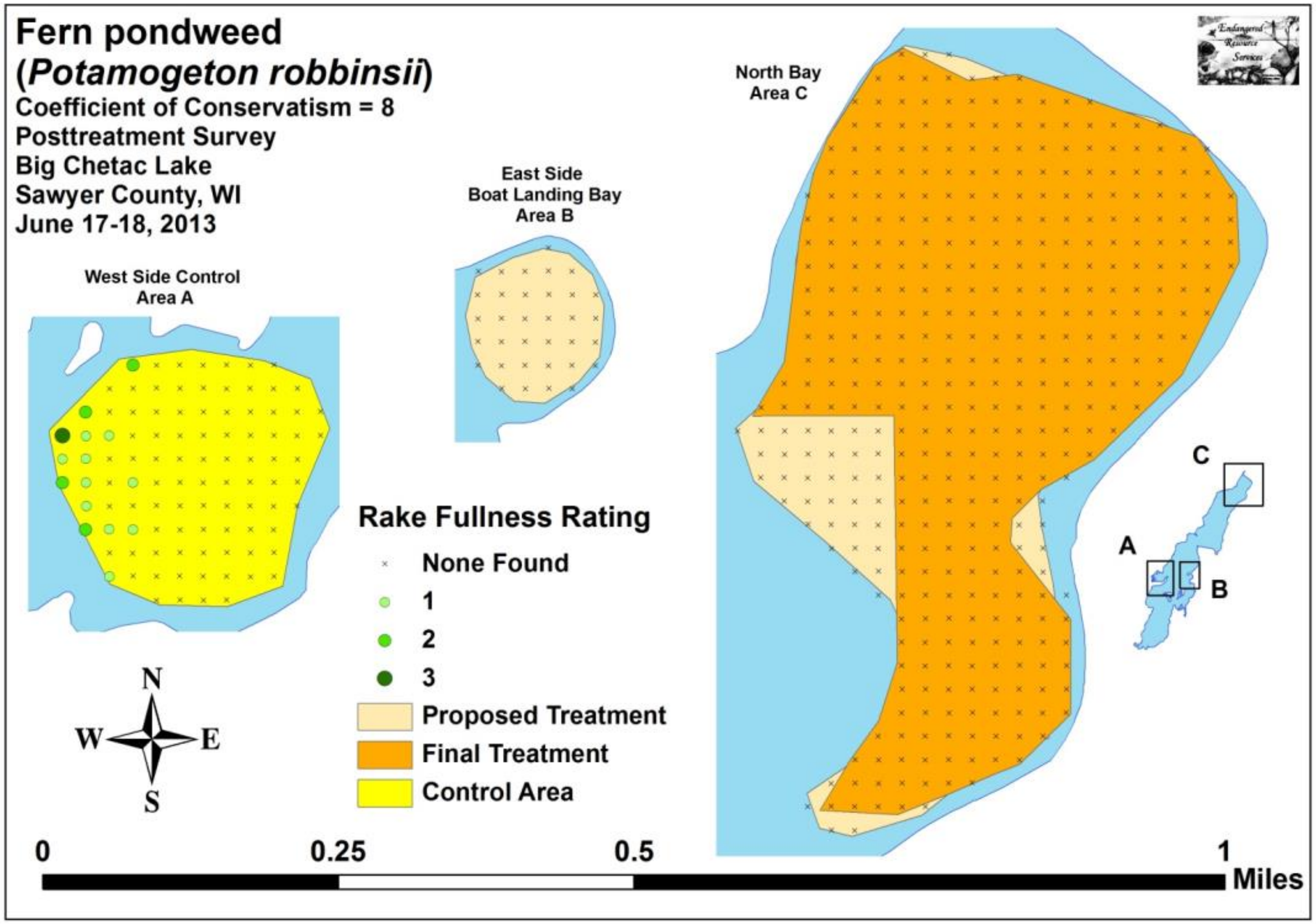
1
Miles


Fern pondweed
(Potamogeton robbinsii)
Coefficient of Conservatism = 8
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
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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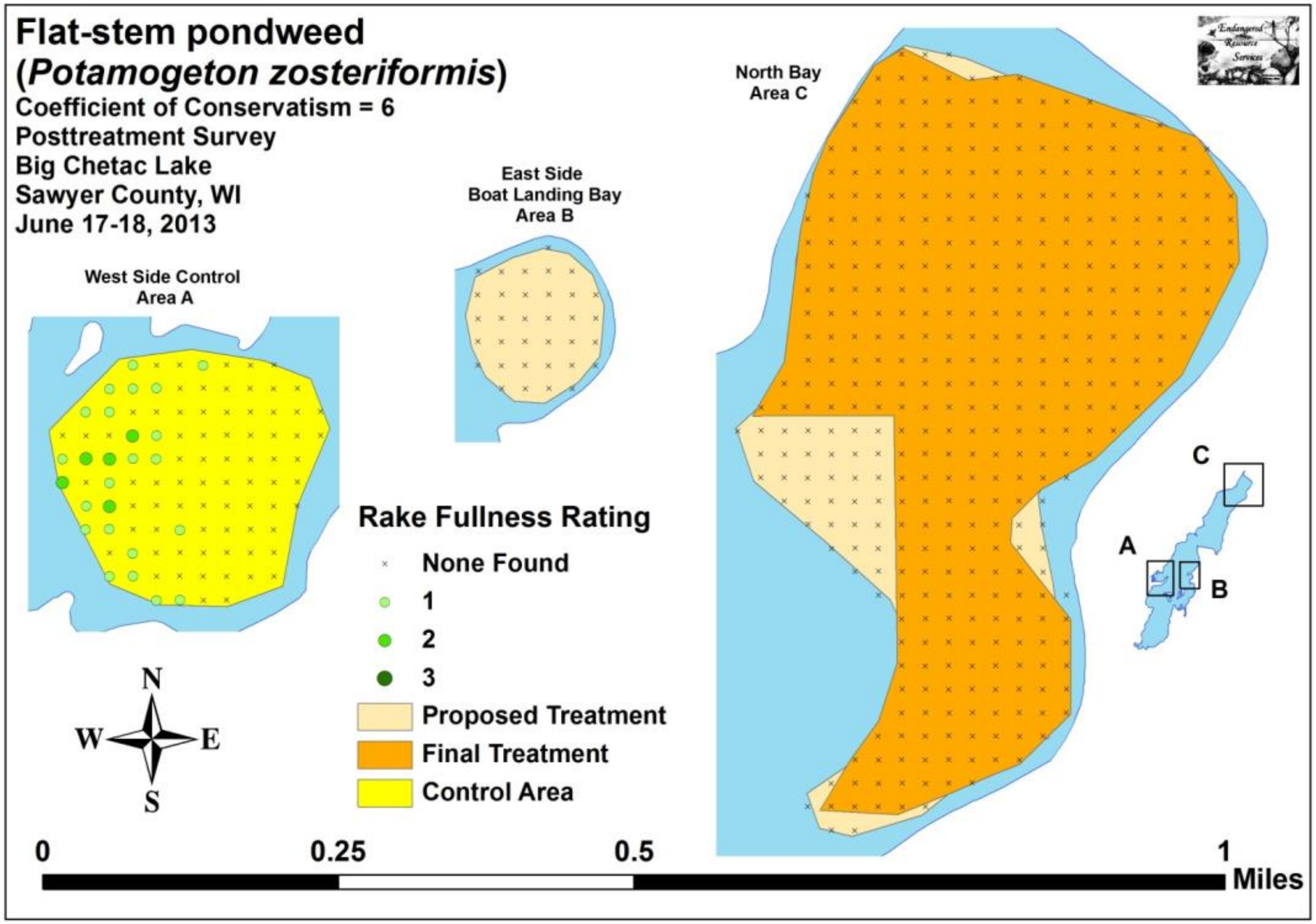
Miles



Flat-stem pondweed
(*Potamogeton zosteriformis*)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
Rake Fullness Rating
None Found
1
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Proposed Treatment
Final Treatment
Control Area
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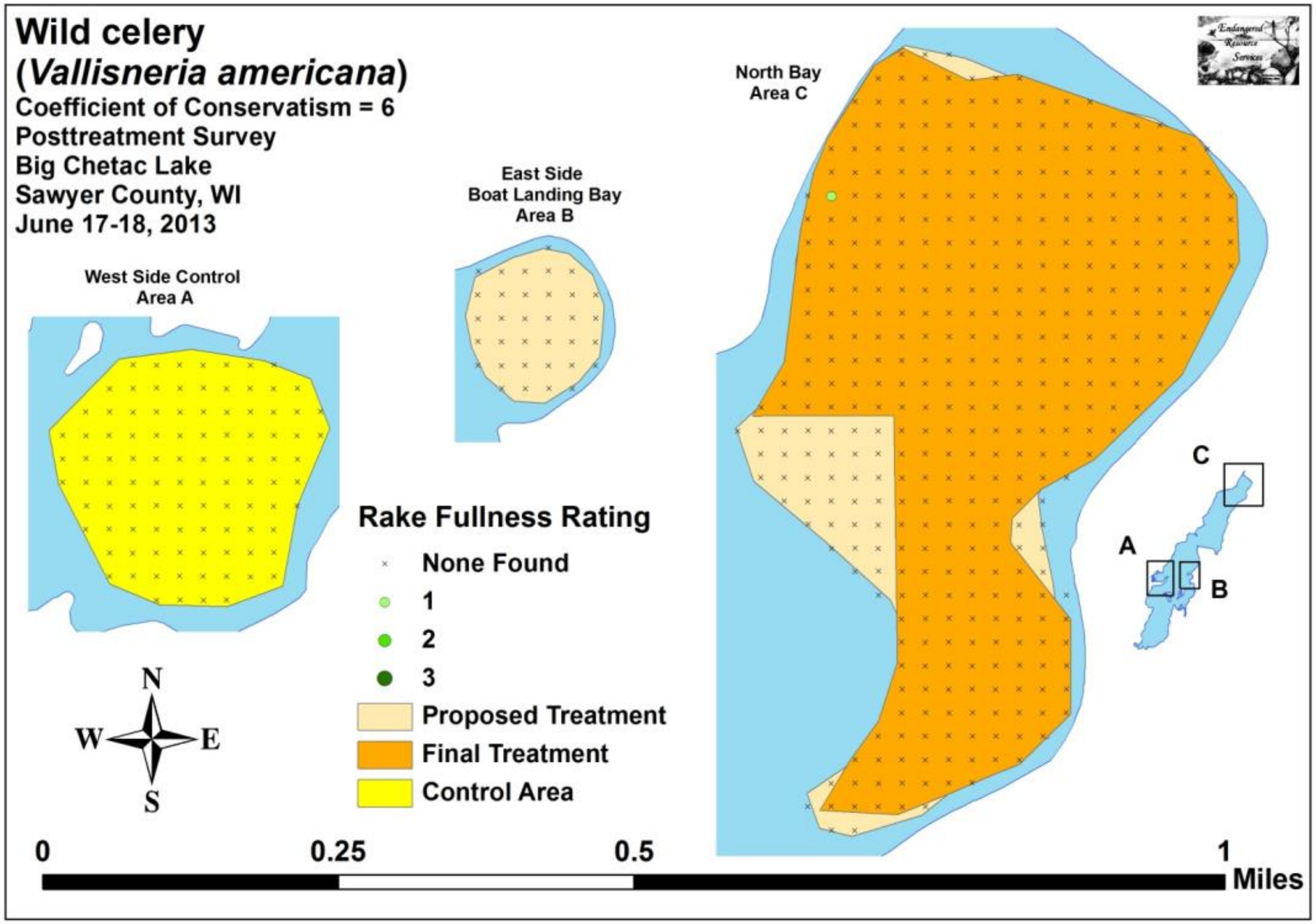
1
Miles



Wild celery
(Vallisneria americana)
Coefficient of Conservatism = 6
Posttreatment Survey
Big Chetac Lake
Sawyer County, WI
June 17-18, 2013
East Side
Boat Landing Bay
Area B
North Bay
Area C
West Side Control
Area A
Rake Fullness Rating
None Found
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Proposed Treatment
Final Treatment
Control Area
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0.25
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.