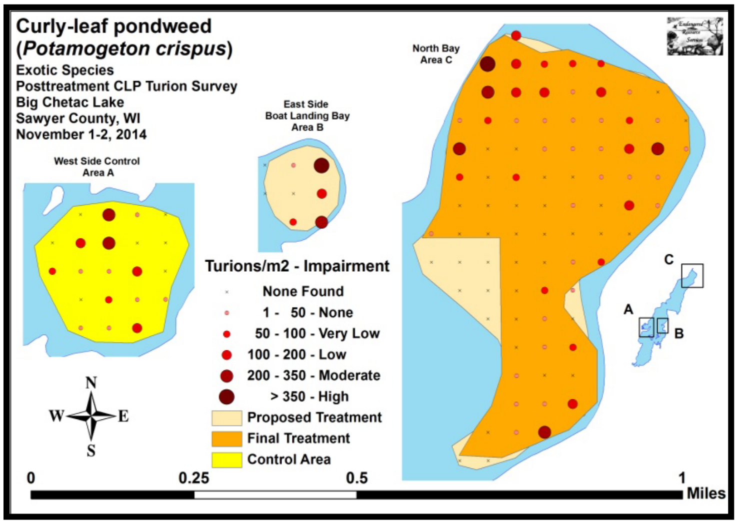
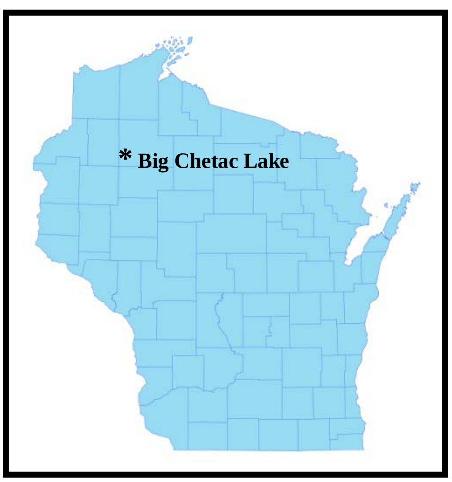
Curly-leaf pondweed (*Potamogeton crispus*) Pre/Post Herbicide Turion Surveys Big Chetac Lake – WBIC: 2113300 Sawyer County, Wisconsin



2014 - Posttreatment Turion Density

2014 Final CLP Treatment Area

Project Funded by:
Grant ACEI-133-13 - Big Chetac Chain Lake Association and the Wisconsin Department of Natural Resources



Sifting for Turions – Posttreatment North Bay – 11/1/14

Survey Conducted by and Report Prepared by:
Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
November 1-2, 2014

TABLE OF CONTENTS

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 12ft in the spring of 2014. 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. Following pretreatment surveys, the proposed north bay treatment area was trimmed to 90 acres in both 2013 and 2014 to more accurately reflect CLP's distribution in the area. Also, out of concern for the Northern wild rice (*Zizania palustris*) located in the "Bull Pen" bay immediately south of the boat landing area, it was decided to cancel treatment in the boat landing bay in both 2013 and 2014. As a follow up to the initial pre/posttreatment turions surveys in 2013, on November 1-2nd, 2014, we conducted a Petite Ponar dredge survey in both the treatment and control areas. The survey found CLP turions at 49 of 85 survey points (57.65%) in the north bay treatment area with a mean density of 46.29 turions/m^2 and a standard deviation of +/-74.52 turions. This was down from 56 points (65.88% coverage) in fall 2013 when we found a mean density of 71.33 turions/m^2 and a standard deviation of +/-142.93 turions. In the control bays, turions were present at 19 of 29 points (65.52%) - down from 21 points (72.41%) in fall 2013. However, the mean density and standard deviation were both much higher in 2014 as we found 86.74 turions/m^2 with a standard deviation of +/-138.68 (in fall 2013, we found 63.02 turions/m^2 with a standard deviation of +/-88.07). Although a majority of points in the treatment area still had viable turions, the nuisance level was reduced to just five points with densities >200 turions/m^2 – an over 80% reduction from the initial baseline of 26 nuisance points (30.59%) prior to treatment in 2013. In the control bays, there were four nuisance points which was identical to the pretreatment baseline. **These results demonstrated a significant reduction in mean turion density in the north bay treatment area (t = -1.74, *p* = .04)**, and a **significant increase in the control bays (t = +1.91, *p* = .03)**. Although the November 2014 turion survey suggests there will again be CLP plants in the north bay in 2015, the significant reduction in both density and coverage again demonstrates that large steps were taken in 2014 towards the goal of CLP reduction. As the project moves into its third year, all data from 2014 along with 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.

LIST OF FIGURES AND TABLES

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 2013). 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 (Treatment was also initially proposed in the east side public boat landing bay, but, out of concern for the Northern wild rice (*Zizania palustris*) in the "Bull Pen" bay directly south of the landing, no treatment occurred here in either 2013 or 2014). Following the posttreatment and fall CLP turion surveys in 2013, it was decided to treat the same 90 acre area in 2014 (Figure 1).

CLP LIFE HISTORY AND STUDY OBJECTIVES:

Although Curly-leaf pondweed occasionally reproduces by seed, the vast majority of plants resprout from stiff overwintering buds called turions that are normally produced in number by the plants prior to their late June/early July senescence (Figure 2). After the pinecone-like turions germinate in late fall or early winter, plants continue to grow slowly under the ice. Following ice out, growth accelerates, and plants rapidly canopy allowing them a competitive advantage over slower growing native species (Capers 2005).

Figure 2: Germinating CLP Turion – North Bay of Big Chetac

Research suggests approximately 50% of turions germinate in a growing season while the rest remain dormant until the following growing season when another 50% will germinate (Johnson 2012). Depending on the level of turions at a given location, and knowing that latent turions may be able to survive for over 5 years in the sediment, it may take several years of control to exhaust the "turion bank" (R. Newman – U of M unpublished data).

In 2013, we conducted a baseline Ponar dredge turion survey in the scheduled treatment and control areas, and a follow-up turion survey after the treatment and summer growing season. This survey demonstrated a highly significant reduction in turions in the north bay treatment area, but no significant change in the two control areas. Following the 2014 treatment and summer growing season, we again completed a turion survey to determine if it had had a further significant impact on the treatment area's turion "bank". This report is the summary analysis of that survey completed on November 1-2nd, 2014. For ease in understanding the changes that have taken place in the bay, we have included data from all three turion surveys conducted thus far.

METHODS:

Ponar Dredge Turion Survey:

Within the initial 2013 proposed treatment and control area shapefiles, we used Hawth's Analysis Tools Extension to ArcGIS 9.3.1 to generate regular points at the rate of approximately 1 point for every 1.25 acres. This resulted in a sampling grid totaling 114 points of which 85 were in the 97.5 acre north bay, 21 were in the 25 acre western control bay, and 8 were in the 7.5 acre boat landing bay (Figure 3) (Appendix I). This same sampling grid was used for each of the three surveys to allow for the most accurate comparison possible.

As previously mentioned, 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 cancelled in both 2013 and 2014. Because of this, the data from these points were pooled with the control data set for statistical analysis.

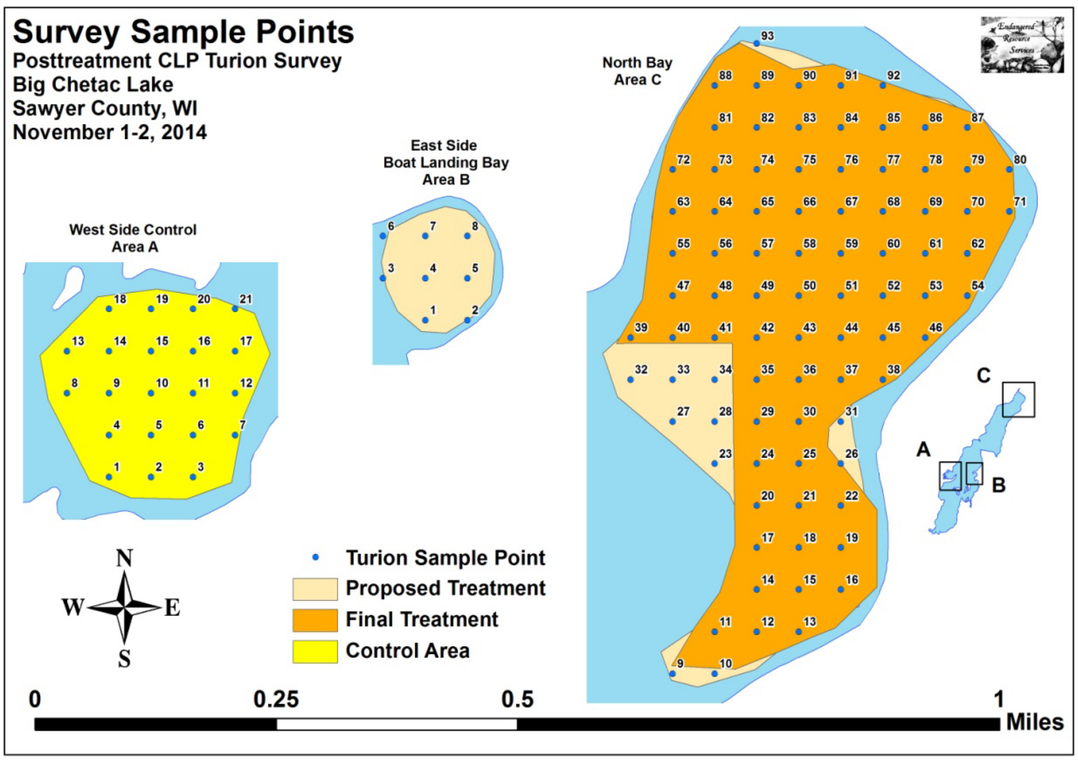


Figure 3: 2014 Turion Survey Sample Points and Final Treatment Area

During the surveys, we located each point with a handheld mapping GPS unit (Garmin 76CSx) and used a Petite Ponar dredge with a $0.0232m^2$ ($36in^2$) sample area to take a bottom sediment grab from each side of the boat at each location. These samples were then rinsed in a fine sieve to separate out the sediment and detritus (Figure 4). We discarded all rotten turions, tallied all live turions, and multiplied the combined total live turions from the two samples by 21.5 to get an estimate in turions/m^2 at each location. This value gives an idea of how many CLP plants will germinate in an area in 2015.

Figure 4: Ponar Grab and Turion Sieving

DATA ANALYSIS:

We entered all data collected into an Excel spreadsheet and used standard formulas in the data analysis tool pack to calculate the following:

Total number of points sampled: This value is the total number of points on the lake within each study area. We took two Ponar samples at each sample point during each survey.

Total number of live turions: This value includes all live turions found at all sites within a study area.

Total number of points with live turions: This number includes all survey sites that had at least one turion in **either** of the Ponar samples taken at the site.

Frequency of occurrence: The frequency of turions is generally reported as a percentage of occurrences at all sample points. The value is used to extrapolate coverage within the study area. For example, if 20% of all sample sites have turions, it suggests that 20% of the study area will have at least some Curly-leaf pondweed coverage.

Points at or above nuisance level: This value gives the number of survey sites within the study area that were above the moderate nuisance threshold (Figure 5). Research suggests that when the turion density is at or above 200/m^2, the resulting CLP growth is likely to at least moderately impair navigation (Johnson 2012).

Figure 5: Predicted Navigation Impairment Based on Turion Density

Percent nuisance level: The percentage of nuisance points divided by the total survey points can be extrapolated to determine what percent of the study area is likely to have at least moderate navigation impairment during the coming growing season.

Mean turions/m^2: This value is the average number of turions/m^2 when pooling the data from all survey sites regardless of whether or not they had turions present.

Standard deviation of turions/m^2: This value tells us how far apart the data is from the mean. A low standard deviation suggests most points have a turion density that was similar to the mean, while a high value suggests there was greater variability in turion density within the sample area.

Pre/Post Treatment and May/September Significance:
Data from the three surveys was compared using paired t-tests as we returned to the same sites during each survey. Pre/posttreatment and spring/fall differences in the untreated areas were determined to be significant at $p < .05$, moderately significant at $p < .01$, and highly significant at $p < .005$ (Table 1).

RESULTS AND DISCUSSION:

May 2013 Ponar Dredge Turion Survey:

During the initial May 11-12, 2013 pretreatment turion survey, we found Curly-leaf pondweed turions at 73 of 85 survey points (85.88%) in the north bay treatment area, and in 23 of 29 points (79.31%) in the control bays (Table 1). In the north bay treatment area, 26 points had densities of 200 turions/m^2 or higher suggesting that over 30% of the north bay would have experienced moderate to severe navigation impairment without management (Figure 6) (Appendix II). Results from the control bays suggested lower overall CLP densities with only four points or approximately 14% of the area reaching the nuisance level.

We found that initial turion densities were highly variable as the standard deviation in the north bay was +/- 151.88 around a mean density of 158.59 turions/m^2. In general, densities in the deeper water areas in the south-central parts of the bed and over sandy shoreline areas on the north and east sides of the bed had lower densities while areas over organic muck in the 4-8ft range had the highest densities (Figure 6). Mean densities in the control bays were 43% lower than in the north bay with an average of 68.21 turions/m^2; however, as in the north bay, turions densities varied widely as the standard deviation was +/- 71.32. In the boat landing bay, density appeared to be primarily a function of depth, while in the western bay, both the eastern and western sides of the bed had reduced densities. This is likely related to increasing depth on the east, and, potentially, competition from a diverse native plant community on the western edge.

September 2013 Ponar Dredge Turion Survey:

The September 28-29, 2013 posttreatment turion survey revealed an approximately 23% reduction in overall turion coverage in the north treatment area with 56 of 85 points having live turions present (65.88%) (Figure 7) (Appendix II). Coverage in the control bays was also down 8% with 21 of 29 sites having turions. Although a majority of points in the treatment area still had viable turions, the nuisance level was reduced almost 75% with only 7 points still having densities >200 turions/m^2. Interestingly, the control bays also experienced a 75% reduction in predicted nuisance coverage with a single point exceeding this threshold.

Overall mean turion density in the treatment area decreased 55% to 71.33 turions/m^2. Although a decline in density was not surprising, this was greater than the expected reduction of 50% based on predicted germination rates. Furthermore, this value suggests there was minimal survival or regrowth of CLP plants following treatment. In the control areas, mean density declined nearly 7% indicating that CLP plants produced turions at a rate slightly below replacement level. Densities continued to be highly variable in the treatment area as the standard deviation of +/- 142.93 was twice as high as the mean. The control areas' standard deviation of +/- 88.07 was also above the mean density of 63.02 turions/m^2.

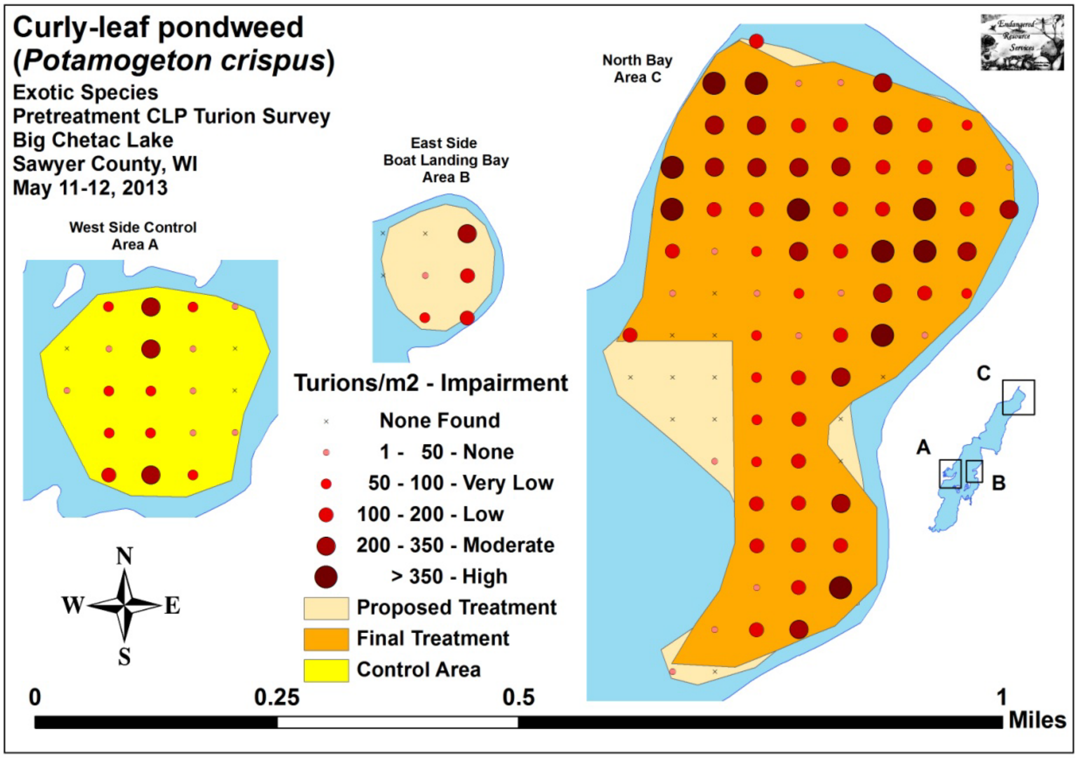


Figure 6: 2013 Pretreatment CLP Turion Density and Distribution

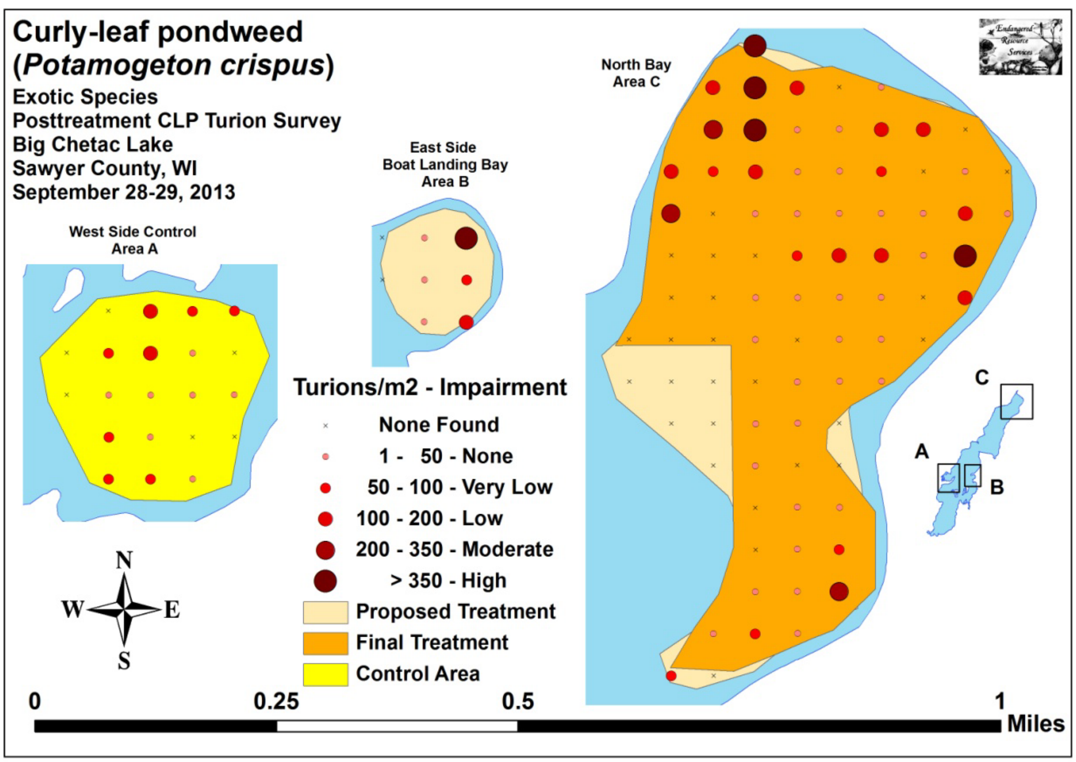


Figure 7: 2013 Posttreatment CLP Turion Density and Distribution

November 2014 Ponar Dredge Turion Survey:

When compared to September 2013, the November 2014 survey demonstrated a 12.5% reduction in overall turion coverage in the north treatment area with 49 of 85 points having live turions present (57.65%) (Figure 8) (Appendix II). This was also a nearly 33% reduction from the 73 points turions were found at during the original 2013 baseline pretreatment survey. In the control bays where coverage fell 8.7% in 2013, we found turions at 19 points suggesting a further 9.5% decline (17.5% overall when compared to the original survey). As in fall 2013, we found that the majority of points in the treatment area still had viable turions. However, only five points (5.88%) were predicted to be at the nuisance level with densities >200 turions/m^2. This was a reduction of over 80% when compared to the 26 nuisance points (30.59%) in the original pretreatment survey. The control bays, which had experienced a 75% reduction in predicted nuisance coverage in 2013, jumped back to their baseline total of four points (13.79%).

Overall mean turion density in the treatment area decreased by 35.1% (46.29 turions/m^2) when compared to fall 2013 (71.33 turions/m^2), and by 70.8% when compared to the pretreatment baseline (158.59 turions/m^2). Despite this positive outcome, we noted that it was less than the 50% decline we would have expected if the treatment had killed all turions that should have germinated. This may mean that some turions germinated after the treatment due to the late spring, or it could mean that conditions allowed for a “second crop” in late summer when additional CLP plants germinated, grow, and set turions. In the control areas, mean density increased 57.5% over fall 2013 levels to 138.68 turions/m^2. Densities in the treatment area were much less variable (+/-74.52) compared to fall 2013 (+/-142.93). The control areas’ standard deviation jumped sharply to +/-138.68 (up from +/- 88.07 in fall 2013).

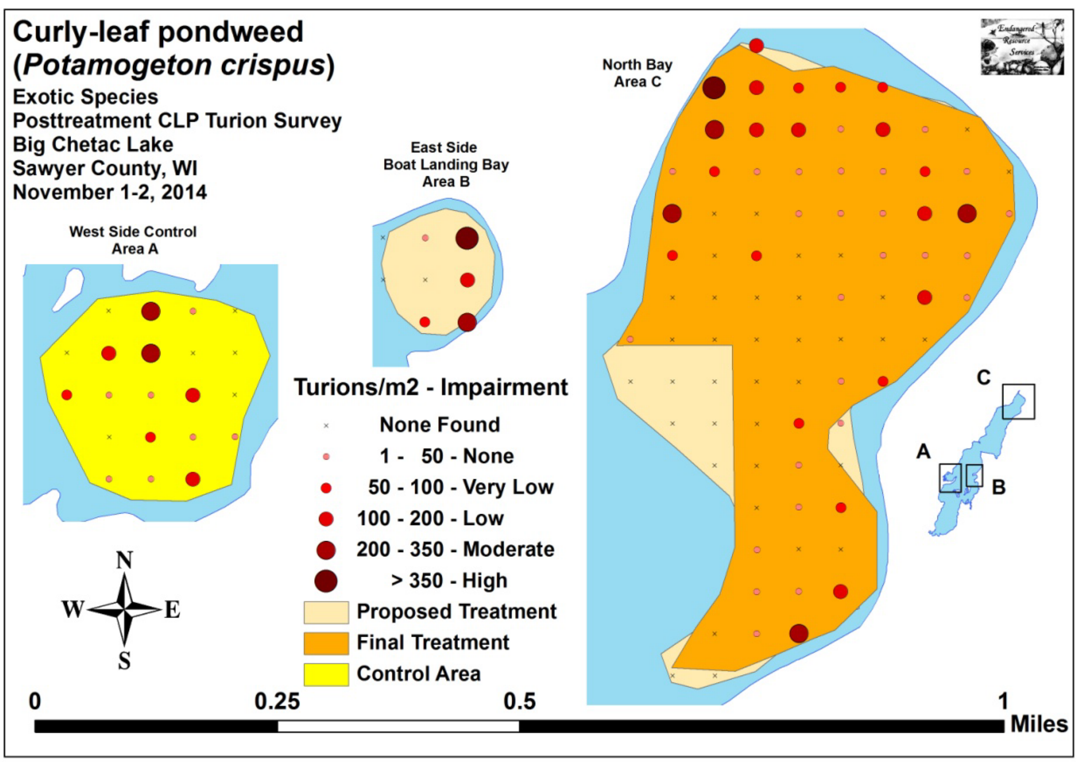


Figure 8: 2014 Posttreatment CLP Turion Density and Distribution

Table 1: CLP Turion Surveys - Summary Statistics
Big Chetac Lake, Sawyer County
May 11-12 and September 28-29, 2013 and November 1-2, 2014

Summary Statistics:	**North Bay Treatment Area** 2013 Pre	2013 Post	2014 Post	**Boat Landing and Western Control Bays** 2013 May	2013 Sept.	2014 Nov.
Total number of points sampled	85	85	85	29	29	29
Total live turions	627	282	183	92	85	117
Total number of points with live turions	73	56	49	23	21	19
Frequency of occurrence	85.88%	65.88%	57.65	79.31%	72.41%	65.52%
Points at or above nuisance level (+200/m^2)	26	7	5	4	1	4
% nuisance level	30.59%	8.24%	5.88%	13.79%	3.45%	13.79%
Maximum turions/m^2	731	1,011	387	237	430	645
Mean turions/m^2	158.59	71.33	46.29	68.21	63.02	86.74
Standard deviation/m^2	151.88	142.93	74.52	71.32	88.07	138.68
Standard error of the paired difference		0.72	0.67		0.46	0.57
Degrees of freedom		84	84		28	28
t-statistic		-5.65	-1.74		-0.51	+1.91
p-value		***<.001**	***0.04**		0.30	***0.03**

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

Statistical Analysis of Surveys:

Using a paired t-test to compare the results of the 2013 September and 2014 November surveys, we found that the decline in the north bay turion densities was significant ($p = 0.04$) after being highly significant ($p << .001$) in 2013. This again suggests that the reduction was a direct result of the herbicide treatment (Table 1).

The control areas, which had demonstrated a non-significant reduction in both coverage and density in 2013, showed a significant increase ($p = 0.03$) in turion density that was higher than the pretreatment baseline. However, when compared directly to the baseline, these changes were not significant and are likely due to normal year-over-year growing season fluctuations.

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 and 2014 herbicide applications have to be considered a success. Although the November turion survey suggests there will again be CLP plants in the north bay in 2015, the significant decline in both density and coverage in 2014 demonstrates that large steps were again taken towards the initial goal of CLP reduction. 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).

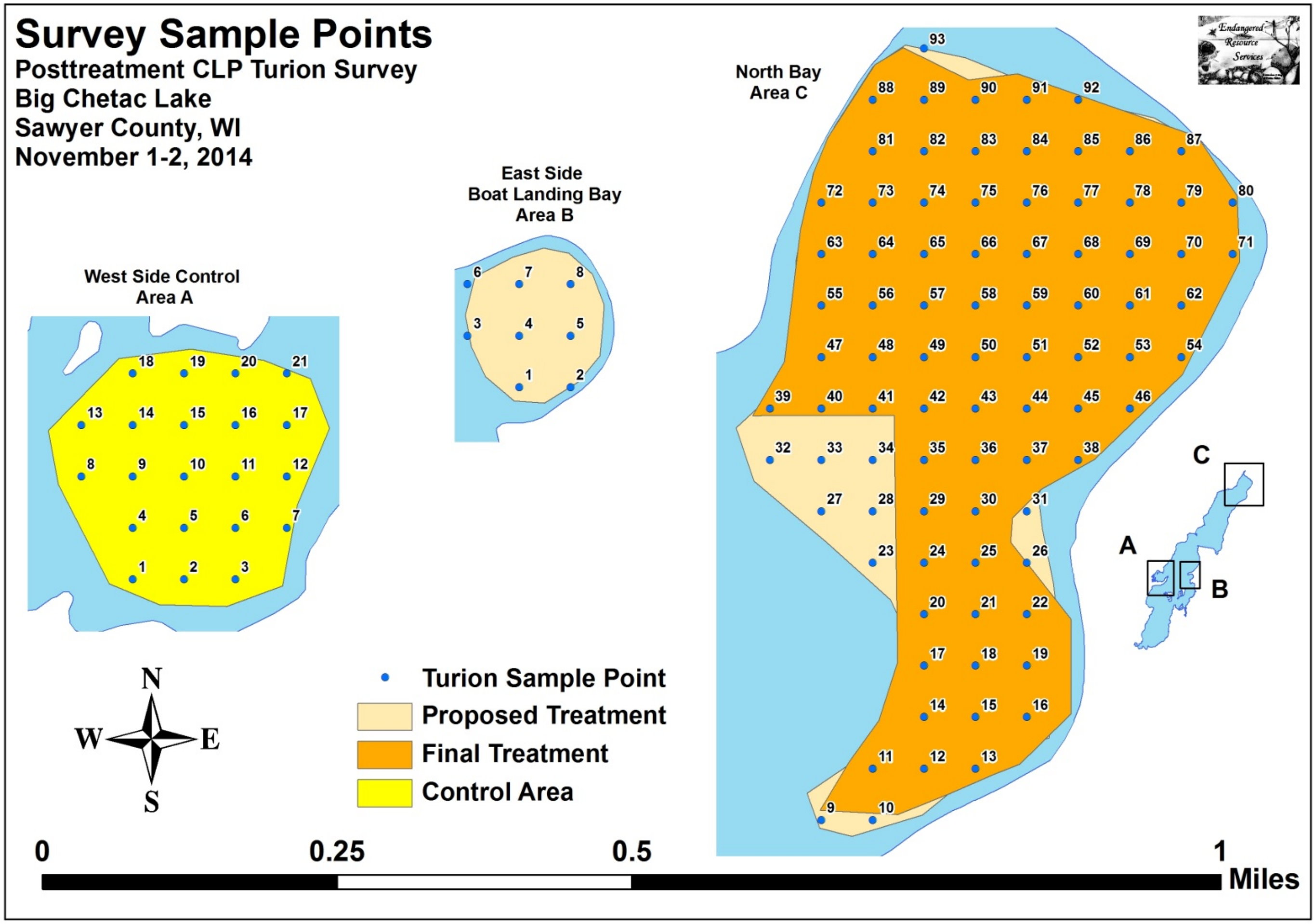
Capers, R.S., G.J. Bugbee, R. Selsky, and J.C. White. 2005. A guide to invasive aquatic plants of Connecticut. The Connecticut Agricultural Experiment Station. Bulletin 997, New Haven, Connecticut.

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

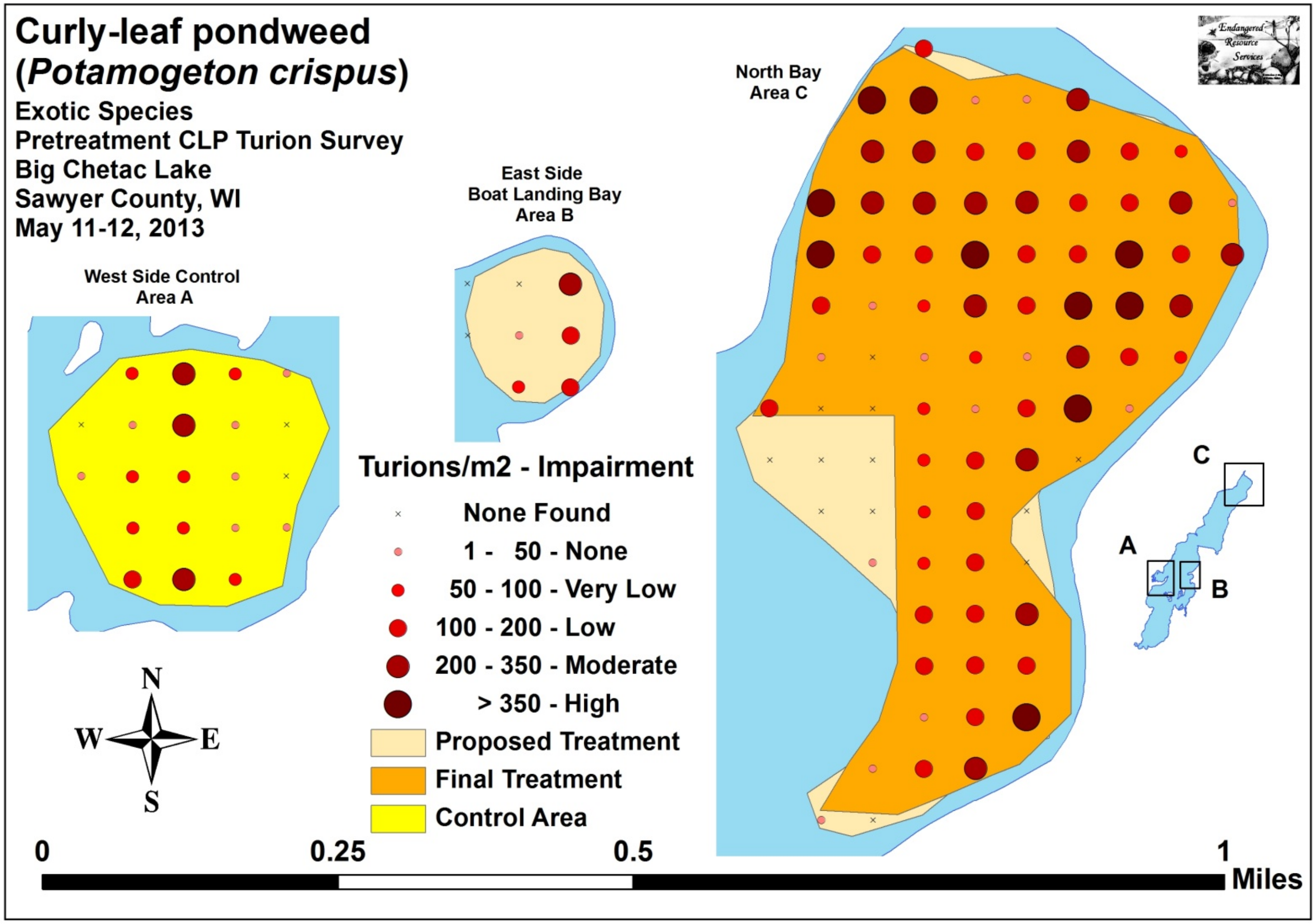
Johnson J.A., Jones A.R., Newman R.M. 2012. Evaluation of lake-wide, early-season herbicide treatments for controlling invasive Curly-leaf pondweed (*Potamogeton crispus*) in Minnesota lakes. Lake Reserv Manage. 28:4 (in press)

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, December).

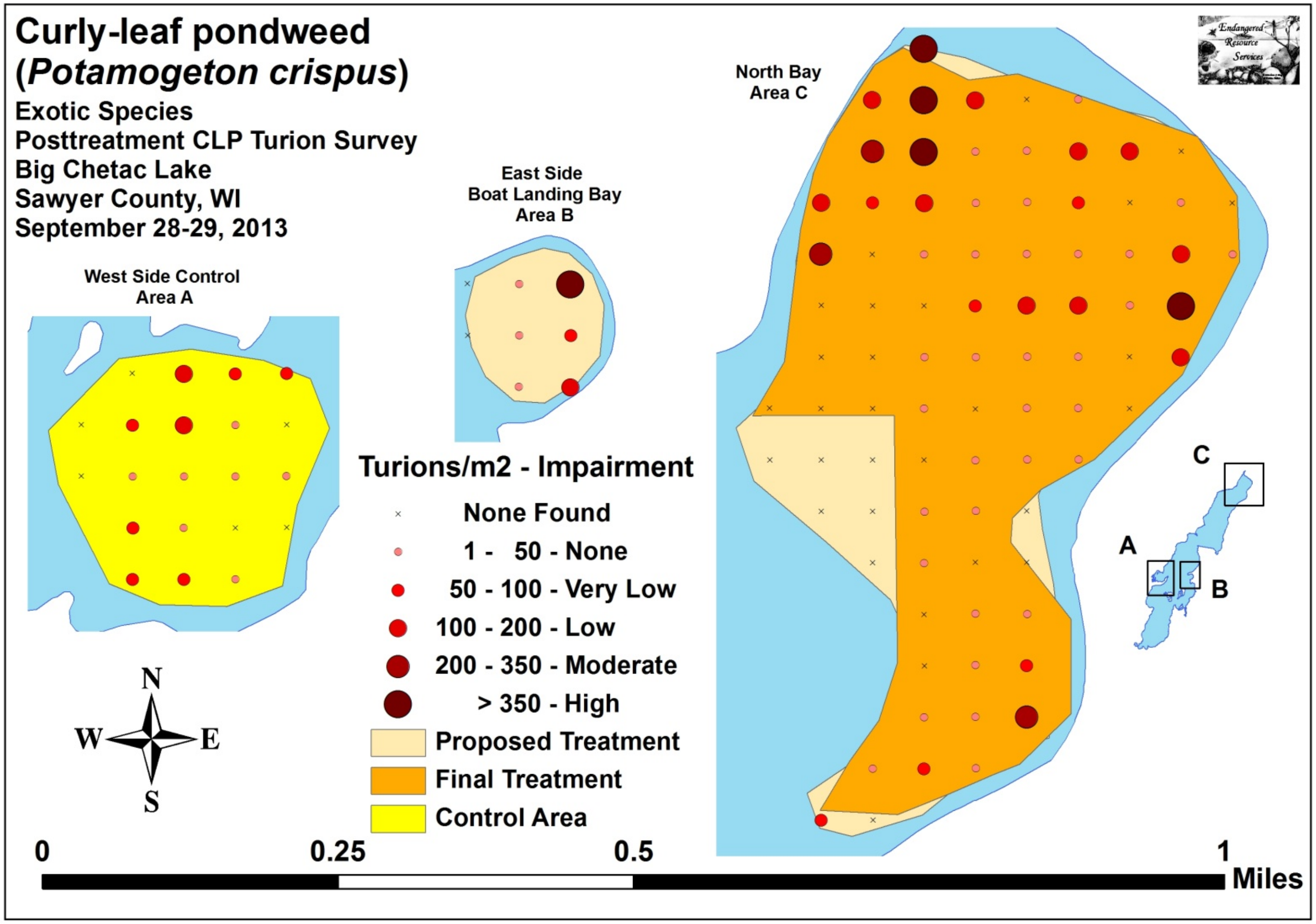
Appendix I: Survey Sample Points and CLP Treatment Area

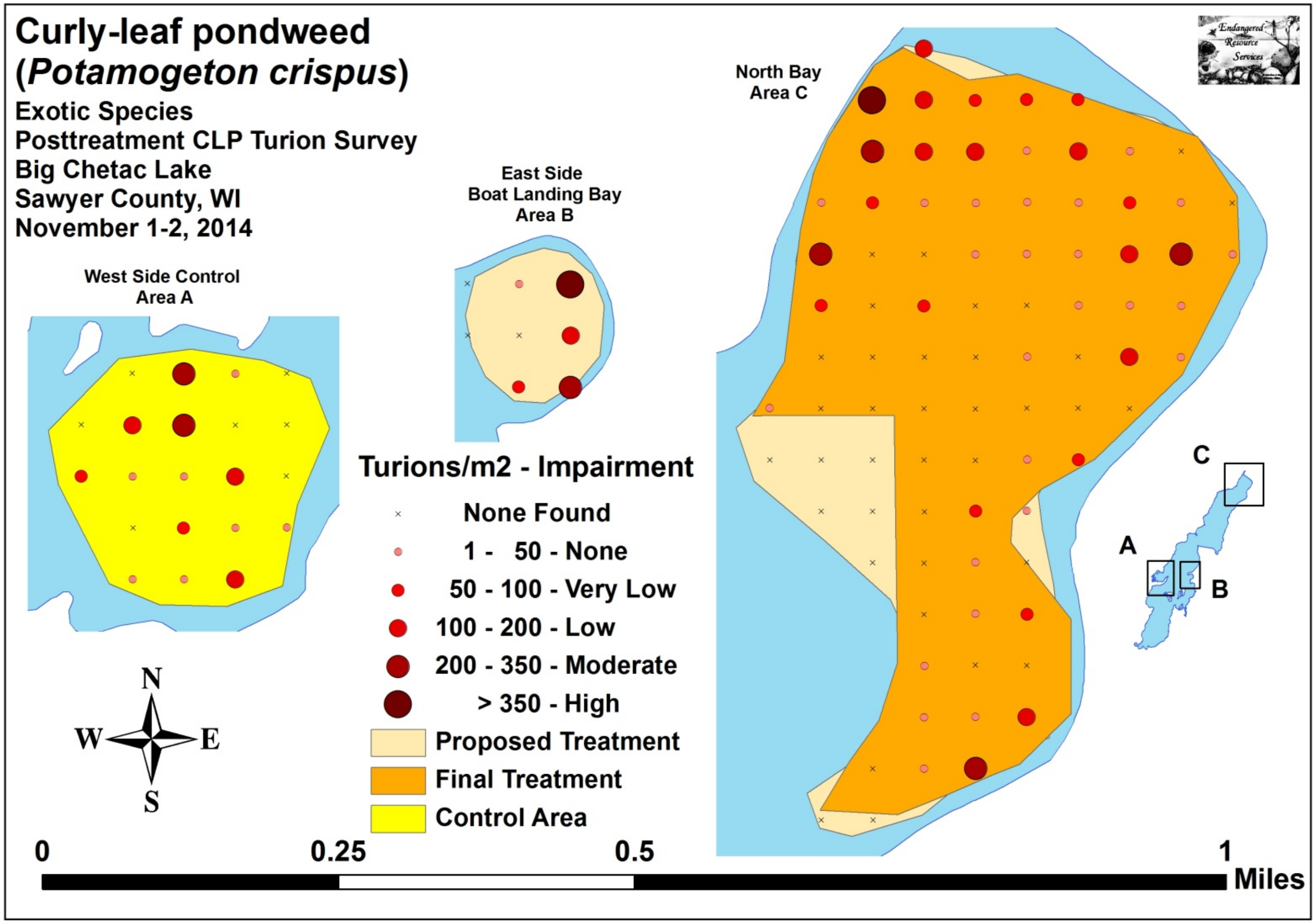

Survey Sample Points
Posttreatment CLP Turion Survey
Big Chetac Lake
Sawyer County, WI
November 1-2, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
N
W
E
S
Turion Sample Point
Proposed Treatment
Final Treatment
Control Area
A
B
C
0
0.25
0.5
1
Miles

Appendix II: 2013 Pre/Posttreatment and 2014 Posttreatment CLP Turion Density and Distribution Maps



Curly-leaf pondweed
(*Potamogeton crispus*)
Exotic Species
Pretreatment CLP Turion Survey
Big Chetac Lake
Sawyer County, WI
May 11-12, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Turions/m2 - Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
> 350 - High
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 CLP Turion Survey
Big Chetac Lake
Sawyer County, WI
September 28-29, 2013
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Turions/m2 - Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
> 350 - High
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 CLP Turion Survey
Big Chetac Lake
Sawyer County, WI
November 1-2, 2014
West Side Control
Area A
East Side
Boat Landing Bay
Area B
North Bay
Area C
Endangered Resource Services
Turions/m2 - Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
> 350 - High
Proposed Treatment
Final Treatment
Control Area
N
W
E
S
A
B
C
0
0.25
0.5
1
Miles