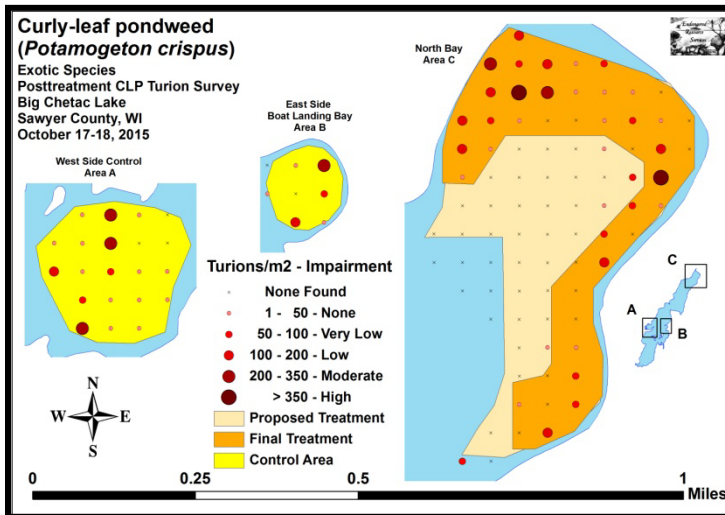


Curly-leaf pondweed (*Potamogeton crispus*) Pre/Post Herbicide Turion Surveys Big Chetac Lake – WBIC: 2113300 Sawyer County, Wisconsin



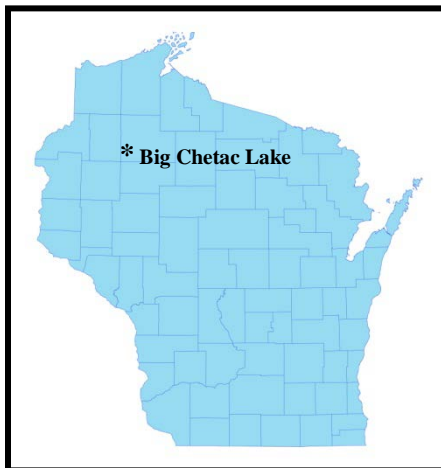
2015 - Posttreatment Turion Density



2015 Final CLP Treatment Area

Project Funded by:

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



Boat Landing Bay – Big Chetac 10/17/15

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
 Matthew S. Berg, Research Biologist
 St. Croix Falls, Wisconsin
 October 17-18, 2015

TABLE OF CONTENTS

	Page
ABSTRACT.....	ii
LIST OF FIGURES AND TABLES.....	iii
INTRODUCTION.....	1
CLP LIFE HISTORY AND STUDY OBJECTIVES.....	2
METHODS.....	3
DATA ANALYSIS.....	5
RESULTS AND DISCUSSION.....	6
May 2013 Ponar Dredge Turion Survey.....	6
September 2013 Ponar Dredge Turion Survey.....	6
November 2014 Ponar Dredge Turion Survey.....	8
October 2015 Ponar Dredge Turion Survey.....	8
Statistical Analysis of Surveys.....	11
LITERATURE CITED.....	11
APPENDIXES.....	12
I: Survey Sample Points and CLP Treatment Area.....	12
II: 2013 Pre/Post and 2014 and 2015 Posttreatment CLP Turion Density and Distribution Maps.....	14

ABSTRACT

Big Chetac Lake (WBIC 2113300) is a 1,920-acre stratified drainage lake in southwestern Sawyer Co., WI. The lake is eutrophic with a littoral zone that reached 12.5ft in the spring of 2015. 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 chemically treated 90 acres in the lake's north bay in both 2013 and 2014 – an area of the lake where CLP had nearly completely dominated the plant community. The fall 2014 and spring 2015 pretreatment surveys revealed CLP had been significantly reduced in the north bay, and, because of this, the proposed 2015 treatment area was trimmed to just over 55 acres to more accurately reflect CLP's distribution. As a follow up to the initial pre/posttreatment turions surveys in 2013 and 14, on October 17-18th, 2015, we conducted a Petite Ponar dredge survey in both the treatment and boat landing bay/western control bay areas. The survey found CLP turions at 37 of 85 survey points (43.53%) in the north bay treatment area. This was a 24.5% reduction from 2014 coverage (49 points – 57.65% coverage) and a nearly 50% reduction from the 73 points (85.88% coverage) they were found at prior to the 2013 treatment. Despite this overall decline in coverage, the mean turion density in the treatment area **increased** by 39.3% from 46.29 turions/m² with a standard deviation of +/-74.52 turions in 2014 to 64.50 turions/m² with a standard deviation of +/-203.48 turions/m² in 2015. This increase and high standard deviation were largely caused by two survey points that accounted for 46% of all turions found. In the control bays, turions were present at 24 of 29 points (82.76%) – an increase of 26% over fall 2014 when we found turions at 19 points (65.52%). However, we found the mean density and standard deviation both declined to an average of 69.69 turions/m² with a standard deviation of +/-91.88 (in fall 2014 as we found 86.74 turions/m² with a standard deviation of +/-138.68). Within the treatment area, the number of points predicted to be at the nuisance level (densities >200 turions/m²) was reduced from five in 2014 to four in 2015. Collectively, the three years of treatment produced a nearly 85% reduction from the initial baseline of 26 predicted nuisance points (30.59% of all points). In the control bays, there were four nuisance points which was identical to the pretreatment baseline. When comparing 2014 to 2015, **these results demonstrated a non-significant increase in mean turion density in the north bay treatment area (t = 0.87, p = .19), and a non-significant decrease in the control bays (t = -0.87, p = .20).**

LIST OF FIGURES AND TABLES

	Page
Figure 1: 2015 Spring CLP Treatment Area.....	1
Figure 2: Germinating CLP Turion – North Bay of Big Chetac.....	2
Figure 3: 2015 Turion Survey Sample Points and Final Treatment Area.....	3
Figure 4: Ponar Grab and Turion Sieving.....	4
Figure 5: Predicted Navigation Impairment Based on Turion Density.....	5
Figure 6: 2013 Pretreatment CLP Turion Density and Distribution.....	7
Figure 7: 2013 Posttreatment CLP Turion Density and Distribution.....	7
Figure 8: 2014 Posttreatment CLP Turion Density and Distribution.....	9
Figure 9: 2015 Posttreatment CLP Turion Density and Distribution.....	9
Table 1: CLP Turion Surveys - Summary Statistics - Big Chetac Lake, Sawyer County May 11-12 and September 28-29, 2013, November 1-2, 2014, and October 17-18, 2015...	10

INTRODUCTION:

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



Figure 1: 2015 Spring CLP Treatment Area

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

In 2013, after years of study and discussion among board members, residents, local businesses, and the WDNR, the Big Chetac Chain Lake Association applied for and received a three year WDNR exotic species control grant to begin actively managing CLP chemically and manually. After evaluating the 2008 maps, it was decided to treat 90 acres in the north bay in both 2013 and 2014. Following the posttreatment and fall CLP turion surveys in 2014, it was proposed to treat the same area in 2015. However, the 2015 pretreatment survey revealed there was minimal CLP growing in deep water so the final treatment area was decreased to just over 55 acres (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 and found the turion density had experienced a further significant decline while the two control areas had a significant increase. In 2015, we conducted a final posttreatment/post summer growing season survey to determine if the third treatment had had a further significant impact on the north bay’s turion “bank”. This report is the summary analysis of that survey completed on October 17-18, 2015. For ease in understanding the changes that have taken place in the bay, we have included data from all four turion surveys.

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 control bay (Figure 3) (Appendix I). This same sampling grid was used for each of the four surveys to allow for the most accurate comparison possible.

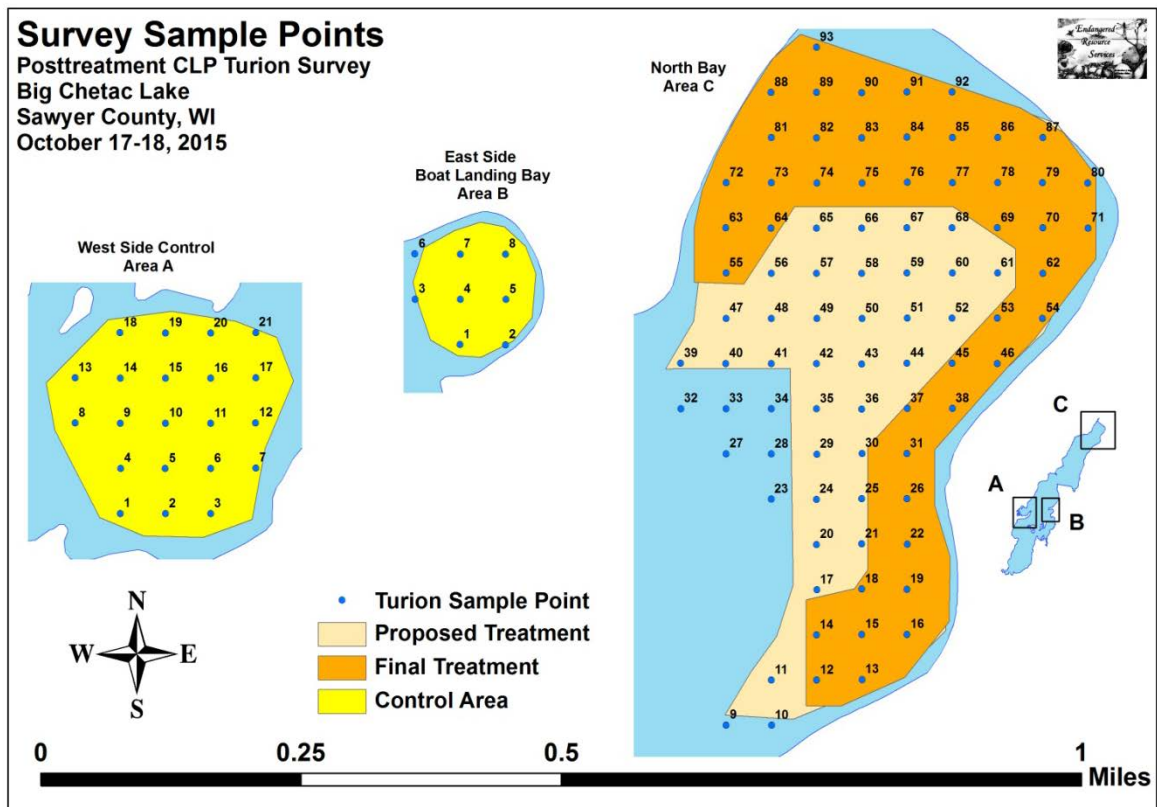


Figure 3: 2015 Turion Survey Sample Points and Final Treatment Area

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 are likely to germinate in an area in 2016.



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/m², 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/m²: This value is the average number of turions/m² when pooling the data from all survey sites regardless of whether or not they had turions present.

Standard deviation of turions/m²: 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 four 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/m² 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/m². In general, CLP 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/m²; 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/m². Interestingly, the control bays also experienced a 75.0% reduction in predicted nuisance coverage with a single point exceeding this threshold.

Overall mean turion density in the treatment area decreased 55.0% to 71.33 turions/m². 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/m².

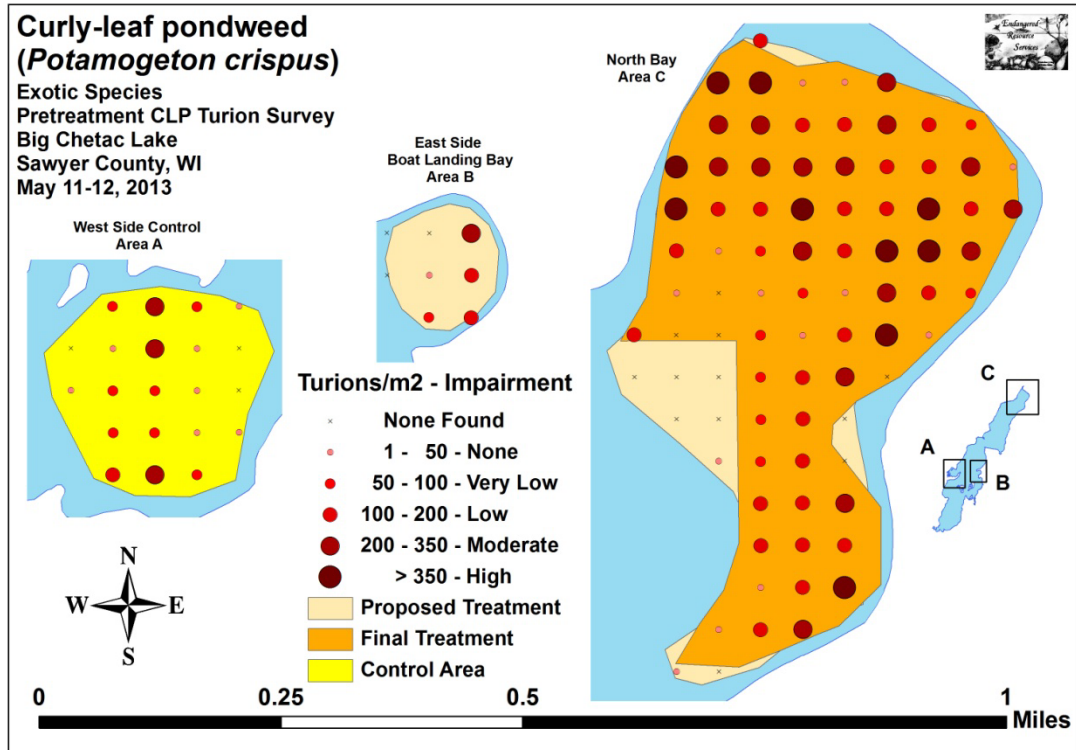


Figure 6: 2013 Pretreatment CLP Turion Density and Distribution

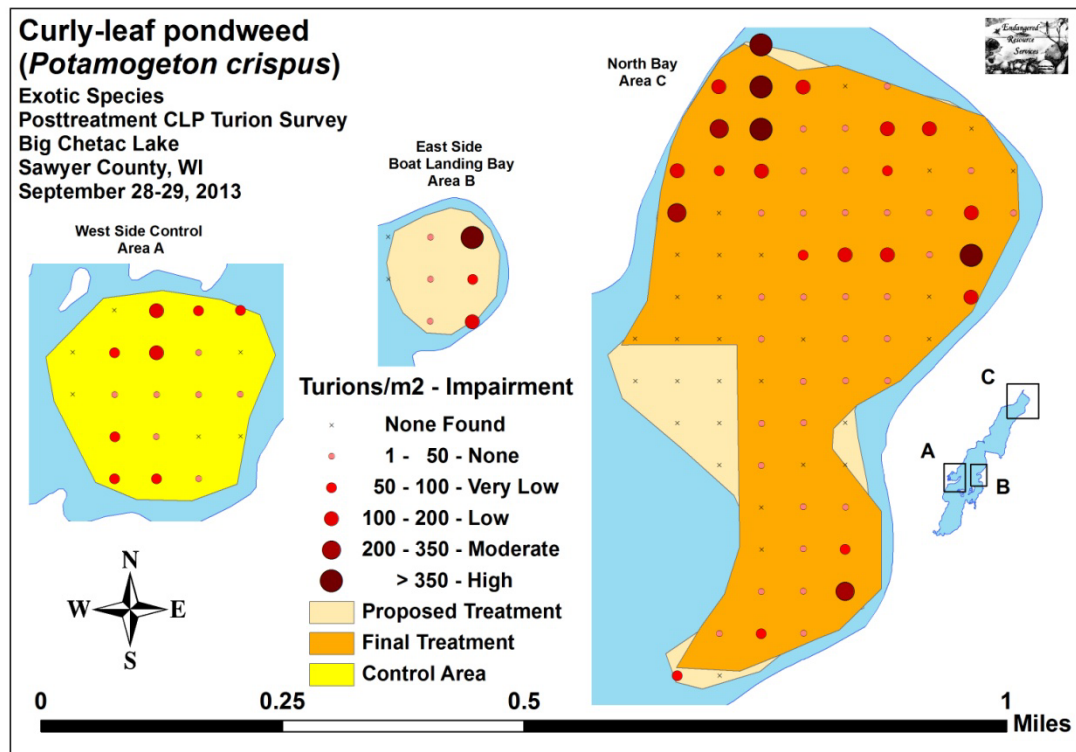


Figure 7: 2013 Posttreatment CLP Turion Density and Distribution

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/m². 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/m²) when compared to fall 2013 (71.33 turions/m²), and by 70.8% when compared to the pretreatment baseline (158.59 turions/m²). 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 37.6% over fall 2013 levels to 86.74 turions/m². 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).

October 2015 Ponar Dredge Turion Survey:

When compared to November 2014, the October 2015 survey demonstrated a further 24.5% reduction in overall turion coverage in the north treatment area with 37 of 85 points having live turions present (43.53%) (Figure 9) (Appendix II). This was also a nearly 50% reduction from the 73 points turions were found at during the original 2013 baseline pretreatment survey. In the control bays, coverage was the highest we have ever documented with live turions present at 24 points (82.76%). This was an increase of over 26% from November 2014 when we found turions at 19 points (65.52% coverage), and almost identical to the initial coverage in 2013 of 23 points (79.31%). In the north treatment area, four points (4.71%) (down from five points (5.88%) in 2014) were predicted to be at the nuisance level with densities >200 turions/m². This was a reduction of almost 85% when compared to the 26 nuisance points (30.59%) in the original pretreatment survey. In fall 2015, the control bays were again at their 2013 baseline total of four points (13.79%).

Despite the decline in overall coverage, mean turion density in the treatment area **increased** by 39.3% (64.50 turions/m²) when compared to fall 2014 (46.29 turions/m²). However, it was still almost 60% below 2013 pretreatment baseline (158.59 turions/m²). Although this was disappointing, it should be noted that two sites (point 62 – 43 turions and point 82 – 74 turions) accounted for 46% of all turions. In the control areas, mean density declined almost 20% over fall 2014 levels (86.74 turions/m²) to 69.69 turions/m². Densities in the treatment area were highly variable (+/-203.48) when compared to fall 2014 (+/-74.52). The control areas’ standard deviation dropped to +/-91.88 (down from +/- 138.68 in fall 2014).

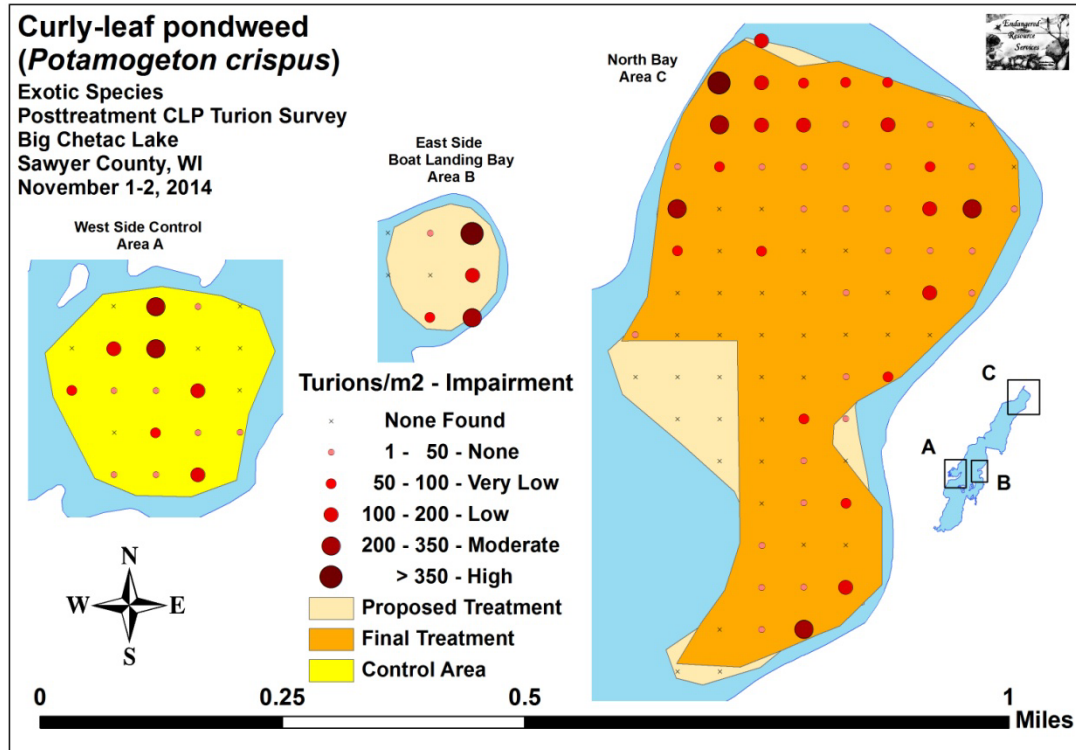


Figure 8: 2014 Posttreatment CLP Turion Density and Distribution

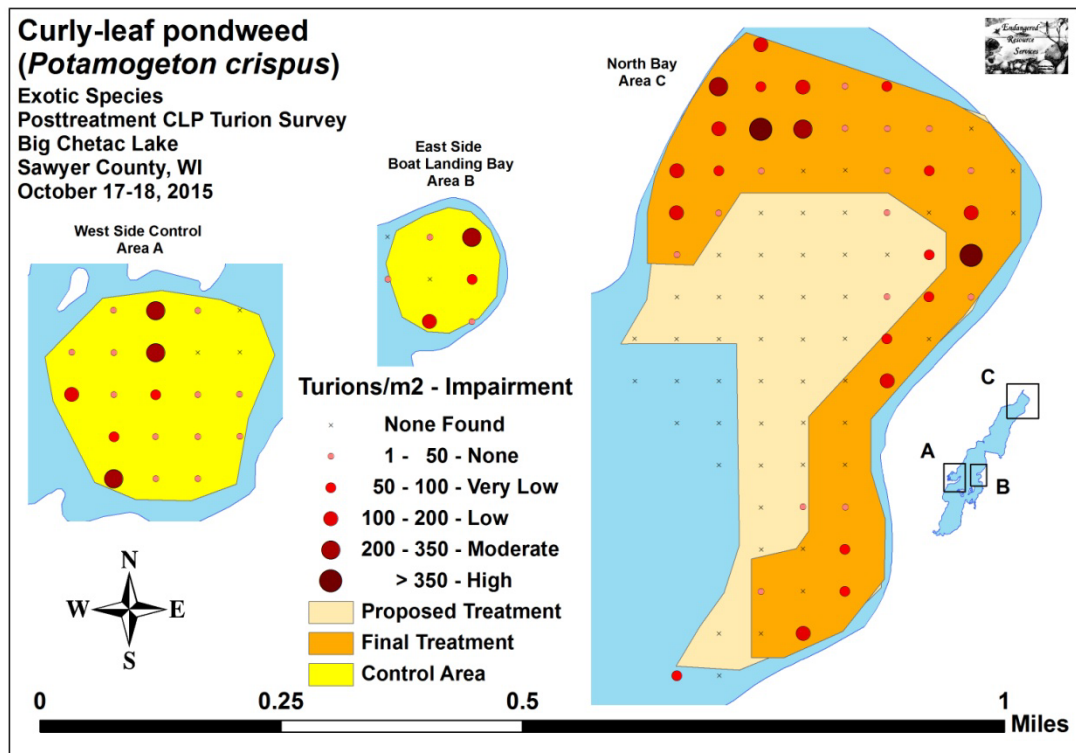


Figure 9: 2015 Posttreatment CLP Turion Density and Distribution

Table 1: CLP Turion Surveys - Summary Statistics
Big Chetac Lake, Sawyer County
May 11-12 and September 28-29, 2013, November 1-2, 2014, and October 17-18, 2015

Summary Statistics:	North Bay Treatment Area				Boat Landing and Western Control Bays			
	2013 Pre	2013 Post	2014 Post	2015 Post	2013 May	2013 Sept.	2014 Nov.	2015 Nov.
Total number of points sampled	85	85	85	85	29	29	29	29
Total live turions	627	282	183	255	92	85	117	94
Total number of points with live turions	73	56	49	37	23	21	19	24
Frequency of occurrence	85.88%	65.88%	57.65%	43.53%	79.31%	72.41%	65.52%	82.76%
Points at or above nuisance level (+200/m ²)	26	7	5	4	4	1	4	4
% nuisance level	30.59%	8.24%	5.88%	4.71%	13.79%	3.45%	13.79%	13.79%
Maximum turions/m ²	731	1,011	387	1,591	237	430	645	344
Mean turions/m ²	158.59	71.33	46.29	64.50	68.21	63.02	86.74	69.69
Standard deviation/m ²	151.88	142.93	74.52	203.48	71.32	88.07	138.68	91.88
Standard error of the paired difference		0.72	0.67	0.98		0.46	0.57	0.92
Degrees of freedom		84	84	84		28	28	28
t-statistic		-5.65	-1.74	+0.87		-0.51	+1.91	-0.87
p-value		*** <.001	* 0.04	0.19		0.30	* 0.03	0.20

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

Statistical Analysis of Surveys:

Using a paired t-test to compare the results of the 2014 November and 2015 October surveys, we found that the increase in the north bay turion densities was not significant ($p = 0.19$) (Table 1). The decline in the control areas turion densities was also found to be non-significant ($p = 0.20$).

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

Appendix I: Survey Sample Points and CLP Treatment Area

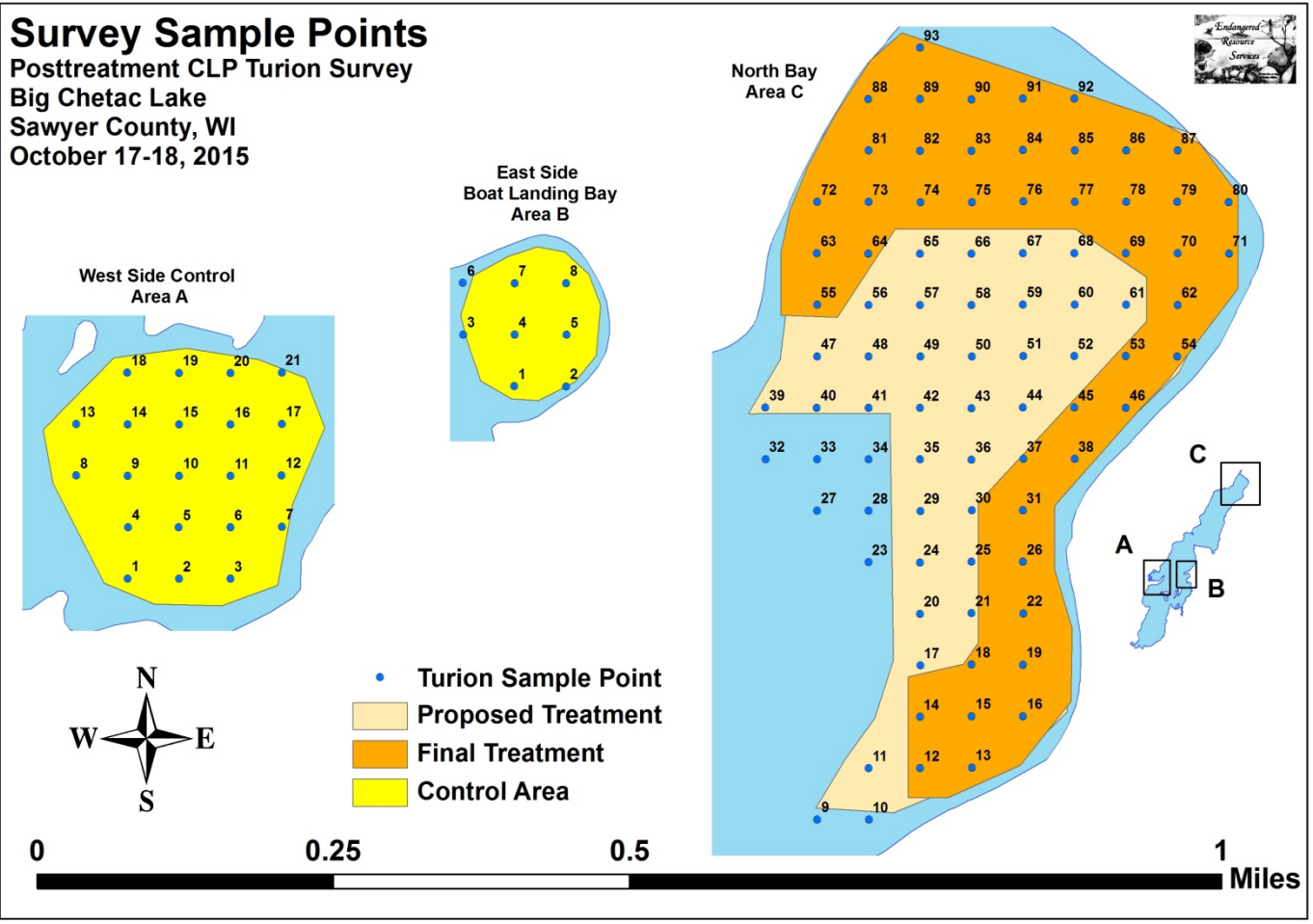
Survey Sample Points

Posttreatment CLP Turion Survey

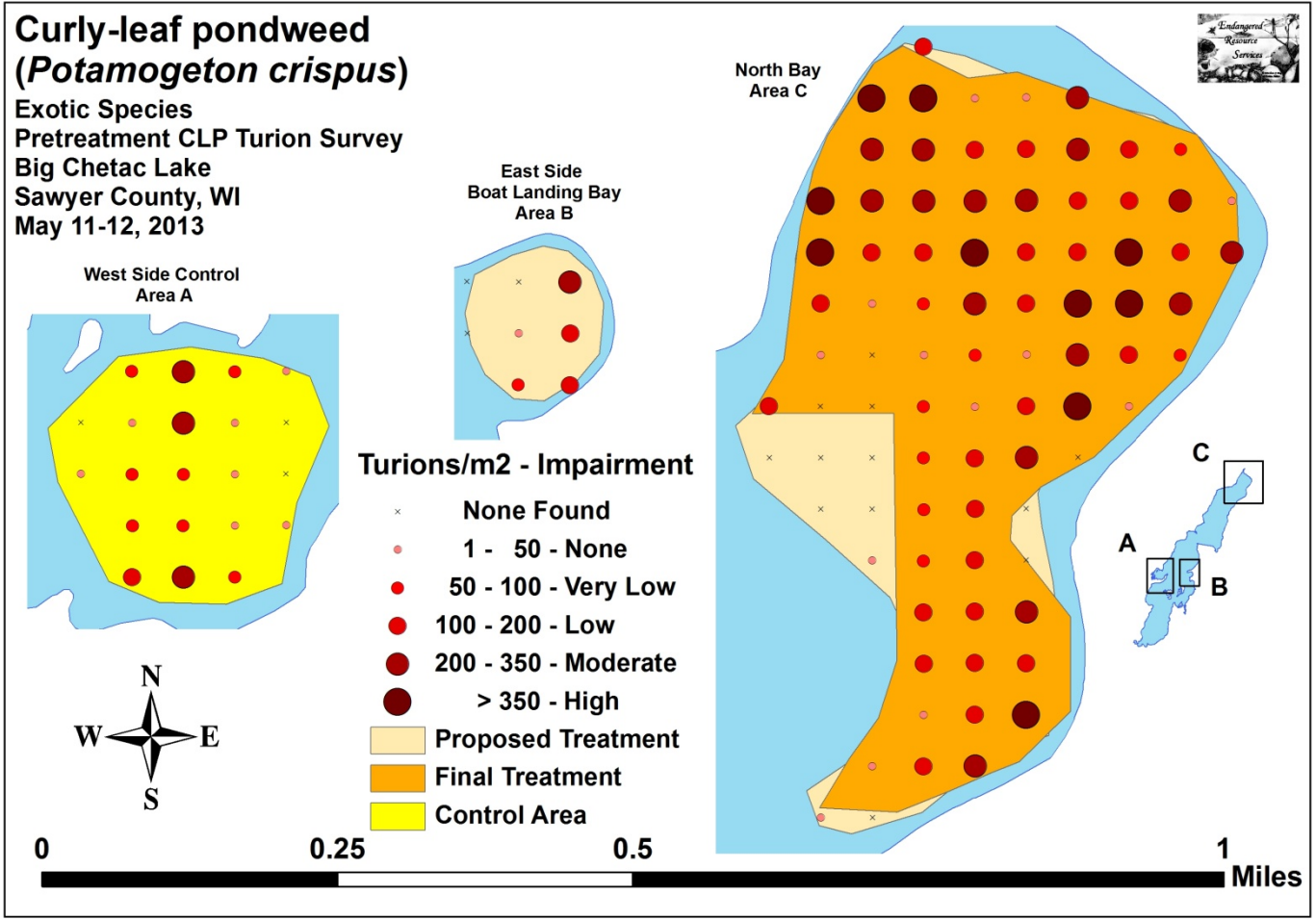
Big Chetac Lake

Sawyer County, WI

October 17-18, 2015

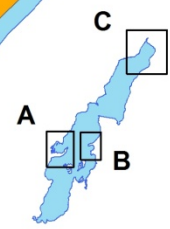
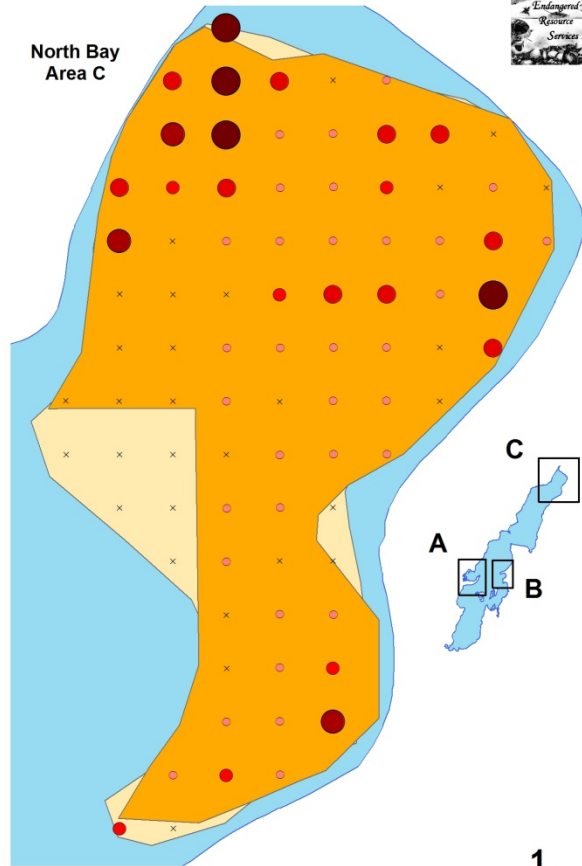
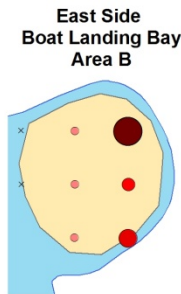
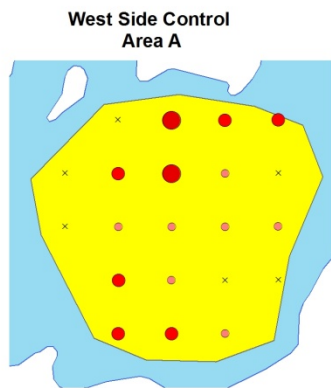


**Appendix II: 2013 Pre/Posttreatment and 2014 and 2015 Posttreatment
CLP Turion Density and Distribution Maps**



Curly-leaf pondweed (*Potamogeton crispus*)

Exotic Species
 Posttreatment CLP Turion Survey
 Big Chetac Lake
 Sawyer County, WI
 September 28-29, 2013



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

