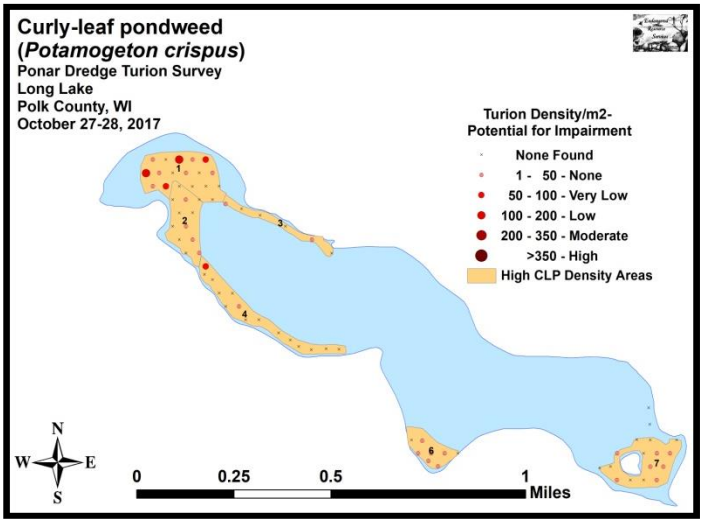
Curly-leaf pondweed (*Potamogeton crispus*)
Post Herbicide Turion Survey
Long Lake – WBIC: 2620600
Polk County, Wisconsin

Cleaning snow out of the boat – 10/27/17



2017 Posttreatment Turion Density

Project Funded by:

Long Lake Protection and Rehabilitation District and the
Wisconsin Dept. of Natural Resources

View from the Long Lake Landing - 10/27/17

Survey Conducted by and Report Prepared by:

Endangered Resource Services, LLC
Matthew S. Berg, Research Biologist
St. Croix Falls, Wisconsin
October 27-28, 2017

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

INTRODUCTION:

Long Lake (WBIC 2478200) is a 272 acre seepage lake in central Polk County, Wisconsin in the Town of Balsam Lake (T34N R17W S07 NE NE). It reaches a maximum depth of just over 17ft in the central basin and has an average depth of approximately 11ft (Busch et al. 1969) (Figure 1). Long Lake is eutrophic trending toward hypereutrophic, and visibility is generally poor with summer Secchi readings averaging 4.6ft since 1992 (WDNR 2017). The bottom substrate in the lake's bays and central basin is predominately thick organic muck, while exposed points and most north/south shorelines are dominated by gravel and sand.

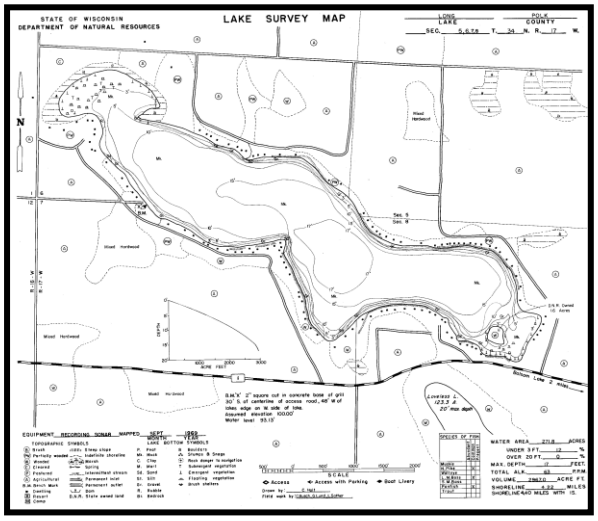


Figure 1: Long Lake Bathymetric Map

BACKGROUND AND STUDY RATIONALE:

Long Lake and the Long Lake Protection and Rehabilitation District (LLPRD) have an extended history of battling Curly-leaf pondweed (*Potamogeton crispus*) (CLP) - an exotic invasive species that thrives in the nutrient-rich sediments found in many parts of the lake. In the past, CLP often grew so densely in the spring and early summer that it made lake access and boating difficult for residents. CLP's late-June to early-July senescence was also cited in past studies by Barr Engineering and the Polk County Land and Water Conservation Department (PCLWCD) as a significant contributor to the lake's overall phosphorus load, and it was at least partially responsible for the lake's frequent late-summer toxic blue-green algae blooms. In 2010, after years of study, the LLPRD and the Wisconsin Department of Natural Resources (WDNR) authorized an initial lakewide herbicide treatment of over 65 acres of CLP. The LLPRD treated nearly 57 acres again in 2011, and 58 acres in 2012. After updating the District's WDNR approved Aquatic Plant Management Plan (APMP) in 2012, it was decided to treat just 27 acres in 2013, and only 20 acres in 2014. Although **the 2010-2013 treatments resulted in highly significant reductions** in both CLP coverage and density on the lake, **the 2014 treatment showed no significant change from pretreatment levels**. A follow-up survey of CLP turions in the lake's sediment also suggested 2015 CLP levels would likely be very low in most parts of the lake. Based on these data, and following a discussion with the lake's executive board and APMP director Cheryl Clemens (Harmony Environmental) in the fall of 2014, it was decided **not to treat CLP in 2015**.

An unusually early spring in 2015 apparently produced ideal growing conditions for CLP on Long Lake. Unexpectedly, the June 2015 point-intercept monitoring survey found **CLP was present at 45.1% of sample sites within historic CLP areas** (Figure 2). Of these, 139 had moderate to high density CLP suggesting **26.6% of these areas had the potential to impact navigation**. A concurrent bed mapping survey found 13 areas with canopied monotypic CLP of varying densities that covered 43.21 acres or approximately **15.9% of the lake's 272 acres** (Figure 2).

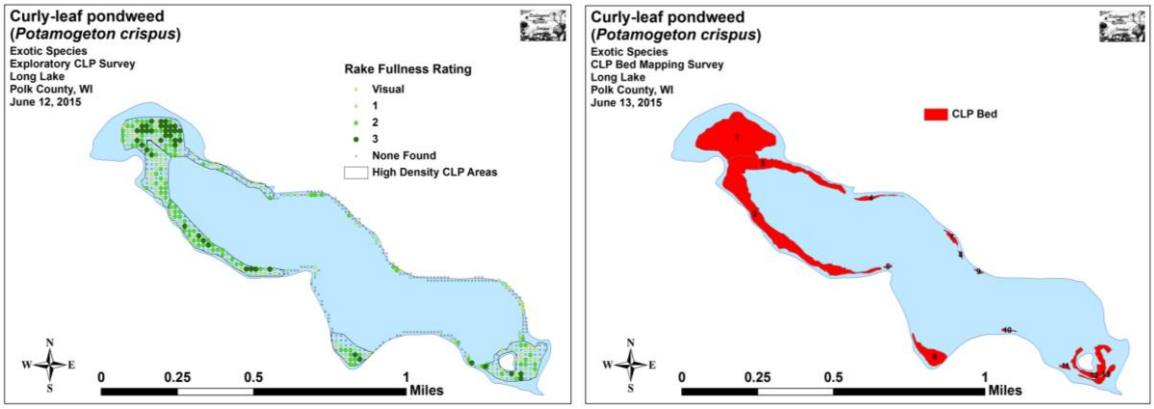


Figure 2: 2015 June CLP Exploratory and Bed Mapping Surveys

At the fall LLPRD board planning meeting led by president Michael Langer and APMP director Cheryl Clemens, concerns were raised about the June survey maps as well as the fall CLP turion sediment data that suggested CLP had made a significant rebound throughout much of the lake in 2015. After much discussion among board members, **it was decided that herbicide treatments (not to exceed 35 acres) would resume in 2016**.

As the fall 2016 turion survey showed turion levels were still higher than in 2014, the LLPRD decided to continue treatments in 2017. Following the May 3, 2017 Aquathol K ® application on 33.65 acres of CLP (12.4% of the lake's surface area) (Figure 3), our June 5-6th posttreatment survey found a highly significant **lakewide** reduction of CLP suggesting the treatment at this dosage/acreage impacted the entire littoral zone. Hoping turion levels would decline further, the LLPRD, requested a late fall survey to determine the level of any latent CLP turions remaining in the lake's substrate.

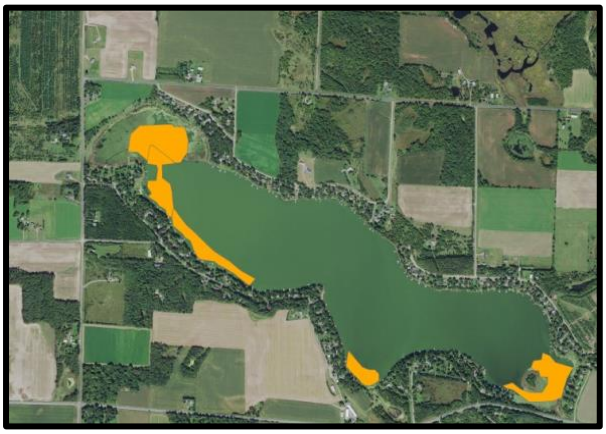


Figure 3: Long Lake with 2017 CLP Treatment Areas

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 4). 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 4: Germinating CLP Turion

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).

Following the 2017 summer growing season, we conducted a posttreatment turion survey. The goals of the survey were to determine the level of remaining CLP turions within the lake's historic high density CLP areas; and, if there were any present, to predict whether their numbers suggested there would likely be enough to cause navigation issues in 2018. This report is the summary analysis of that survey conducted on October 27-28, 2017.

METHODS:

Fall Ponar Dredge Turion Survey:

Within the initial 2013 proposed treatment area shapefile, we used Hawth's Analysis Tools Extension to ArcGIS 9.3.1 to generate offset regular points at the rate of 2/acre. We also added 10 additional points in thin areas of the polygons where there were no points, or in areas that fell outside the polygons that we thought had the potential for CLP growth. This same sampling grid was also used in 2014, 2015, 2016, and 2017 to allow for the most accurate comparisons possible (Figure 5) (Appendix I). For ease in determining the total impact of the current treatment program, we left the 2013, 2014, 2015, and 2016 narratives in the results section of this report.

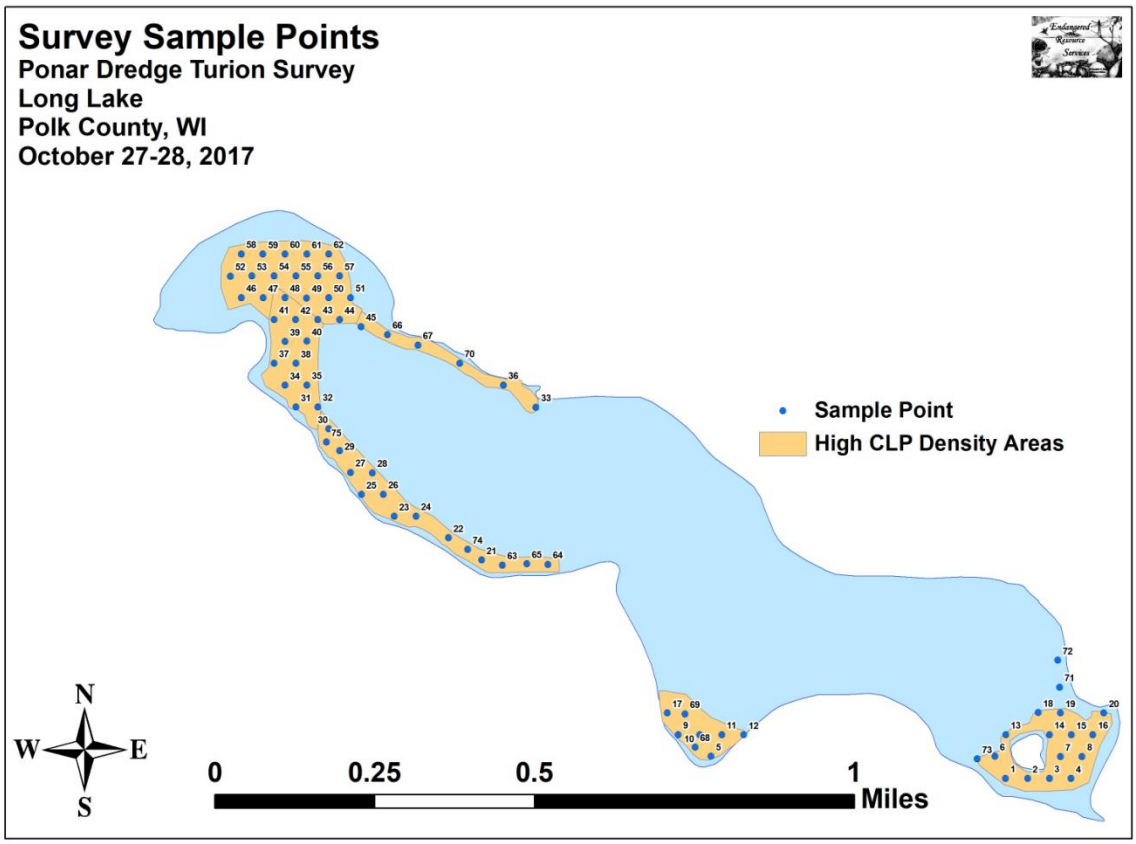


Figure 5: Turion Survey Sample Points

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 (Figure 6). Samples with high numbers of turions or significant amounts of detritus were bagged for later analysis; at which time we discarded all rotten turions, tallied all live turions, and multiplied the combined total live turions from the two samples by 21.53 to estimate turions/m^2 at each location. This value gives an idea of how many CLP plants will germinate in an area during the 2018 growing season.

Figure 6: 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 point.

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 the following year.

Points at or above nuisance level: This value gives the number of survey sites within the study area that were above the predicted nuisance threshold (Figure 7). Research suggests that when the turion density is at or above 200/m^2, the following year's CLP growth has the potential to at least moderately impair navigation (Johnson 2012).

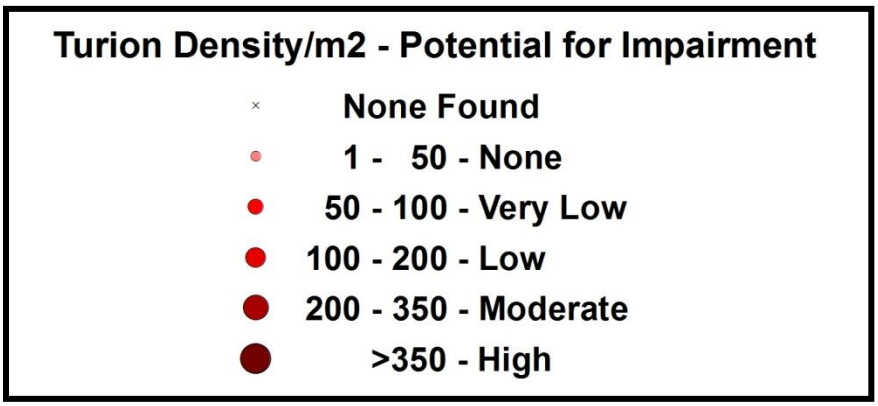


Figure 7: Predicted Navigation Impairment Based on Turion Density

Percent nuisance level: The percentage of nuisance points divided by the total number of survey points can be extrapolated to determine what percent of the study area has the potential to have at least moderate navigation impairment during the next 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.

2013-2014, 2014-2015, 2015-2016, and 2016-2017 Significant Differences:
Data from the 2013, 2014, 2015, 2016, and 2017 surveys was compared using paired t-tests as we returned to the same sites during each survey. Year-over-year differences were determined to be significant at $p < .05$, moderately significant at $p < .01$, and highly significant at $p < .001$ (Tables 1-4).

RESULTS AND DISCUSSION:

2013 Fall Ponar Dredge CLP Turion Survey:

During the November 10, 2013 Ponar dredge survey, we counted a total of 56 CLP turions at 28 of 75 survey points (37.3% coverage). Of these, none exceeded the expected "nuisance level" of 200/m^2, and only six points topped 50/m^2 (Figure 8) (Appendix II).

We found the overall mean density was just 16.07 turions/m^2 with Area 1 having the highest mean density at 34.19 turions/m^2. These low values suggest that, even at its worst, CLP was unlikely to cause significant navigation impairment in 2014. Broken down by area, it appeared the latent turion bank in Areas 3, 4, and 7 may have been nearly exhausted. We also noted that the deeper edges of Areas 2 and 6 looked to be nearly turion free. Only Area 1 seemed likely to have CLP over most of its area in 2014.

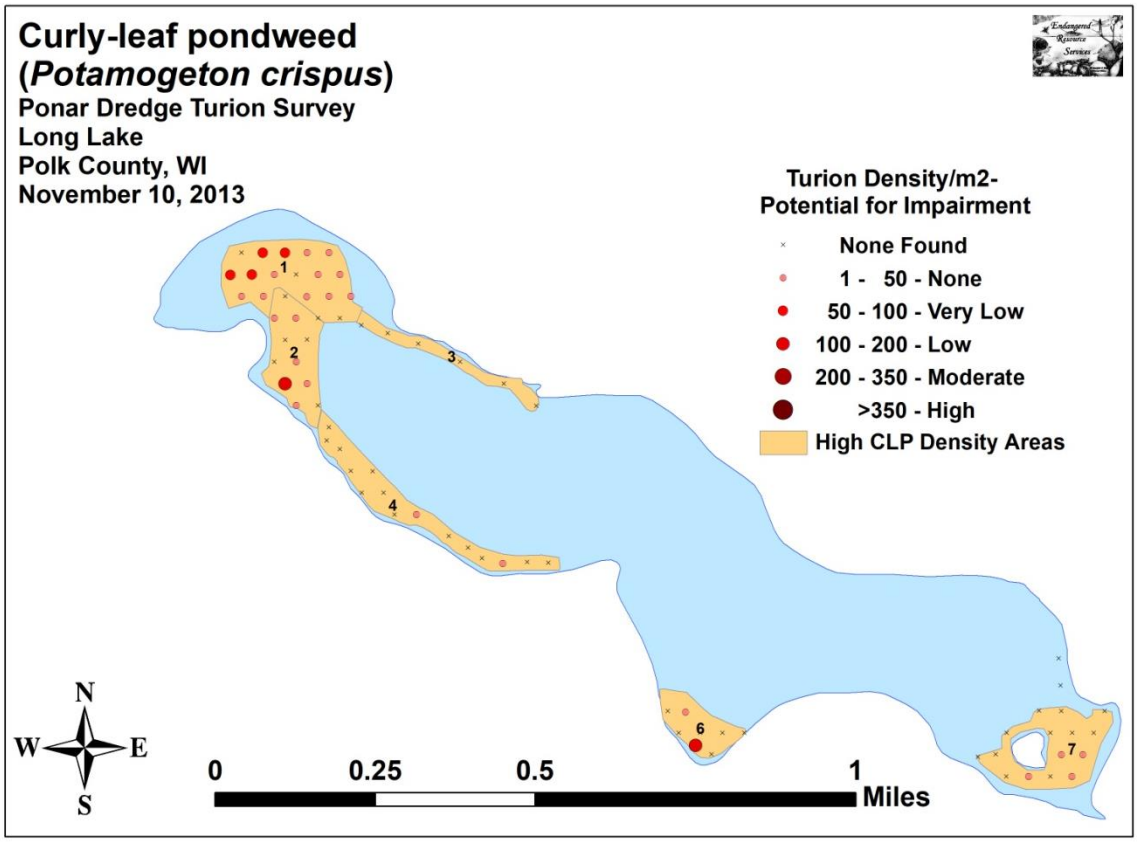


Figure 8: 2013 Fall CLP Turion Survey Density and Distribution

2014 Fall Ponar Dredge CLP Turion Survey:

Following the unsuccessful herbicide treatment in the spring of 2014, we found a total of 59 CLP turions at 27 of 75 survey points (36.0% coverage) during the October 19, 2014 survey (nearly identical to the 56 turions found at 28 points in 2013). Of these, none exceeded the expected "nuisance level" of 200/m^2, and just eight points (up from six in 2013) topped 50 turions/m^2 (Figure 9) (Appendix II). Comparing these results to the 2013 turion survey, we found that the increase in lakewide turion levels was not significant (p=0.43) as the mean density/m^2 increased only slightly from 16.07 turions/m^2 in 2013 to 16.94 turions/m^2 in 2014 (Table 1).

As in 2013, Area 1 had the highest mean density (32.92/m^2), and four points suggested the possibility of at least some very low to low navigation impairment. Areas 6 experienced a slight increase in density that was not significant (p=0.46), and Area 7 showed a nearly significant increase (p=0.05); however, neither of these two areas had any points that suggested there might be anything greater than a very low chance of navigation impairment in 2015. Area 2 also had regular turions, and, although the turion survey did not capture the data, the exploratory and posttreatment surveys suggested that CLP was reestablishing in the central and eastern ends of Area 4.

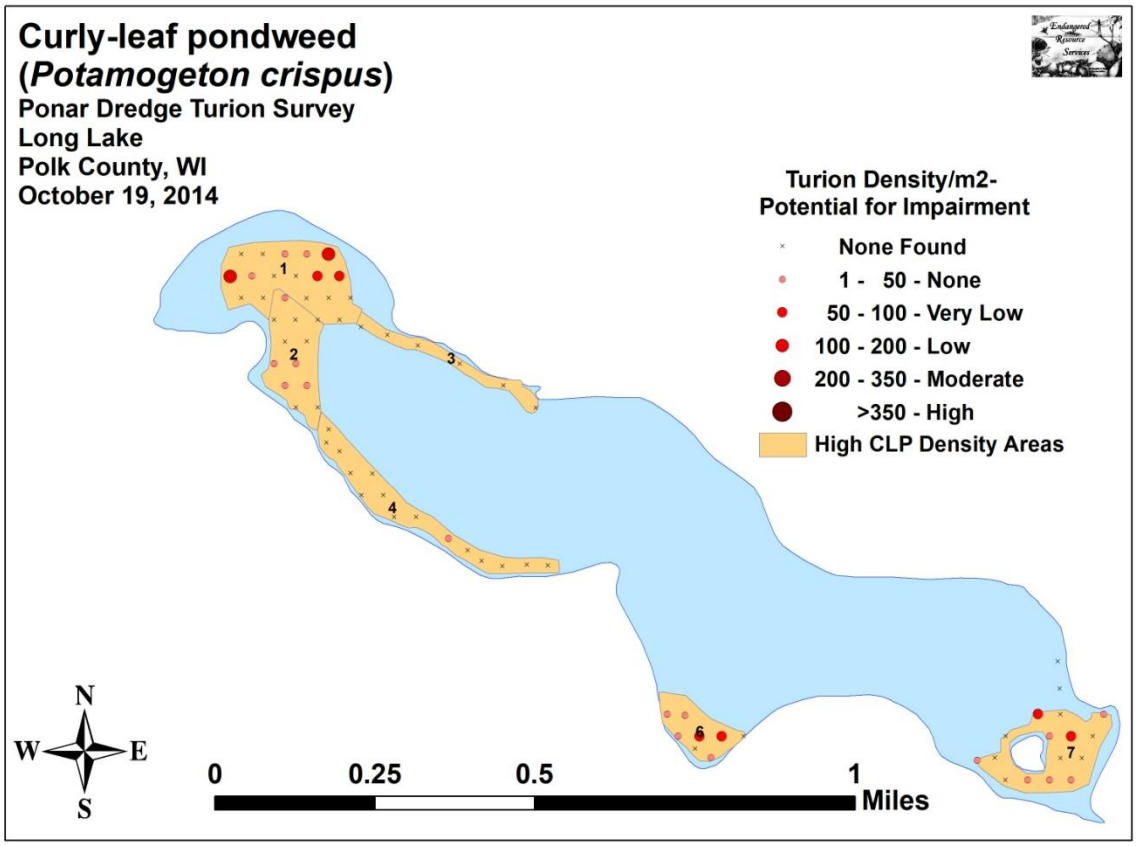


Figure 9: 2014 Fall CLP Turion Survey Density and Distribution

Table 1: CLP Turion Surveys - Summary Statistics
Long Lake, Polk County
November 10, 2013 and October 19, 2014

	2013							2014						
Summary Statistics:	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7
Total number of points sampled	75	17	12	6	15	8	17	75	17	12	6	15	8	17
Total live turions	56	27	12	0	2	10	5	59	26	6	0	1	11	15
Total # of points with live turions	28	14	6	0	2	2	4	27	7	5	0	1	6	8
Freq. of occurrence (in percent)	37.3	82.4	50.0	0.0	13.3	25.0	23.5	36.0	41.2	41.7	0.0	6.7	75.0	47.1
# at/above nuis. level (+200/m^2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% nuisance level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum turions/m^2	194	86	108	0	22	194	43	172	172	43	0	22	65	86
Mean turions/m^2	16.07	34.19	21.53	0.00	2.87	26.91	6.33	16.94	32.92	10.76	0.00	1.44	29.60	19.00
Standard deviation/m^2	31.07	27.50	31.80	0.00	7.57	67.83	12.66	33.63	58.02	14.51	0.00	5.56	25.57	26.24
Standard error of the paired diff.								0.23	0.65	0.44	0.00	0.12	1.37	0.34
Degrees of freedom								74	16	11	5	14	7	16
t-statistic								+0.18	-0.09	-1.15	Div/0	-0.56	+0.09	+1.71
p - value								0.43	0.46	0.14	Div/0	0.29	0.46	0.05

Significant differences = * $p < .05$, ** $p < .01$, *** $p < .001$

2015 Fall Ponar Dredge CLP Turion Survey:

Following a year without management, we found Curly-leaf pondweed turion numbers experienced a dramatic increase. During the October 25, 2015 survey, we counted 167 CLP turions at 55 of 75 survey points (73.3% coverage). This was nearly triple the total turions and double the distribution of CLP when compared to the 2014 and 2013 surveys (59 turions found at 27 survey points (36.0% coverage) in 2014 and 56 turions at 28 points (37.3% coverage) in 2013). In 2015, only one point (in Bed 1) exceeded the expected "navigation nuisance level" of 200/m^2, but 27 (up from eight in 2014 and six in 2013) topped 50/m^2 (Figure 10) (Appendix II).

As expected, the lakewide increase in mean density from 16.94 turions/m^2 in 2014 (16.07 in 2013) to 47.94 turions/m^2 in 2015 was highly significant **($p<0.001$)** (Table 2). We also noticed that the standard deviation in 2015 (51.11 turions/m^2) was only slightly higher than the mean, while the standard deviation in 2014 (33.63 turions/m^2) had been over twice the mean. This suggested that CLP coverage was more uniform in 2015 than in 2014.

Broken down by polygon, we found that the mean turion density increase in each of the six areas. This increase was highly significant in Area 4 **($p<0.001$)**, and significant in Area 1 **($p=0.02$)**, Area 3 **($p=0.04$)**, and Area 6 **($p=0.02$)**.

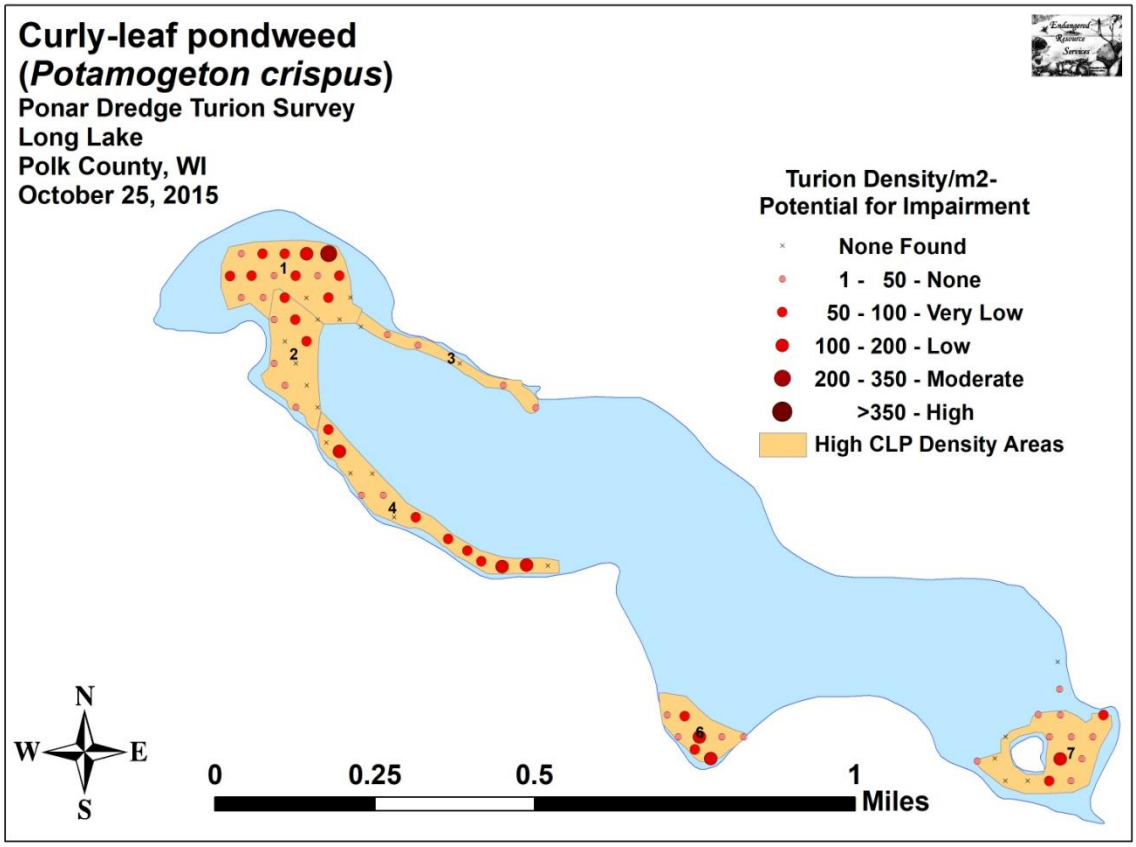


Figure 10: 2015 Fall CLP Turion Survey Density and Distribution

Table 2: CLP Turion Surveys - Summary Statistics
Long Lake, Polk County
October 19, 2014 and October 25, 2015

	2014							2015						
Summary Statistics:	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7
Total number of points sampled	75	17	12	6	15	8	17	75	17	12	6	15	8	17
Total live turions	59	26	6	0	1	11	15	167	45	15	5	43	30	29
Total # of points with live turions	27	7	5	0	1	6	8	55	14	7	4	10	8	12
Freq. of occurrence (in percent)	36.0	41.2	41.7	0.0	6.7	75.0	47.1	73.3	82.4	58.3	66.7	66.7	100.0	70.6
# at/above nuis. level (+200/m^2)	0	0	0	0	0	0	0	1	1	0	0	0	0	0
% nuisance level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	5.9	0.0	0.0	0.0	0.0	0.0
Maximum turions/m^2	172	172	43	0	22	65	86	237	237	86	43	194	194	194
Mean turions/m^2	16.94	32.92	10.76	0.00	1.44	29.60	19.00	47.94	56.99	26.91	17.94	61.71	80.73	36.72
Standard deviation/m^2	33.63	58.02	14.51	0.00	5.56	25.57	26.24	51.11	55.90	30.62	16.21	60.27	54.89	46.15
Standard error of the paired diff.								0.28	0.51	0.49	0.31	0.73	0.96	0.63
Degrees of freedom								74	16	11	5	14	7	16
t-statistic								+5.19	+2.18	+1.52	+2.71	+3.86	+2.47	+1.32
p - value								***<0.001	*0.02	0.08	*0.04	***<0.001	*0.02	0.10

Significant differences = * $p < .05$, ** $p < .01$, *** $p < .001$

2016 Fall Ponar Dredge CLP Turion Survey:

The 2016 spring treatment produced a highly significant reduction in CLP throughout the lake's entire littoral zone. Consequently, our October 28-29, 2016 survey found Curly-leaf pondweed turion numbers were greatly reduced. In total, we tallied 89 turions at 37 survey points (49.3% coverage). Although this was down sharply from the 2015 survey which found 167 turions at 55 of 75 survey points (73.3% coverage), it was still well above the 59 turions recorded at 27 points (36.0% coverage) in 2014 and the 56 turions at 28 points (37.3% coverage) in 2013. Our 2016 survey didn't find any points that were above the "navigation nuisance level" of 200/m^2, but 15 predicted 50 turions/m^2 or higher (Figure 11) (Appendix II). This was also down from 27 in 2015, but still much above the eight in 2014 and six in 2013.

The lakewide decline in mean density from 47.94 turions/m^2 (standard deviation of 51.11 turions/m^2) in 2015 to 25.55 turions/m^2 in 2016 (standard deviation of 38.40 turions/m^2) was highly significant **(p<0.001)** (Table 3). All areas experienced a year-over-year reduction in turion levels with the exception of Area 2 which was unchanged. Area 4 saw a moderately significant decline **(p<0.001)**, and Areas 3 and 7 showed significant declines **(p=0.02)**. Area 1's decline was also nearly significant (p=0.05).

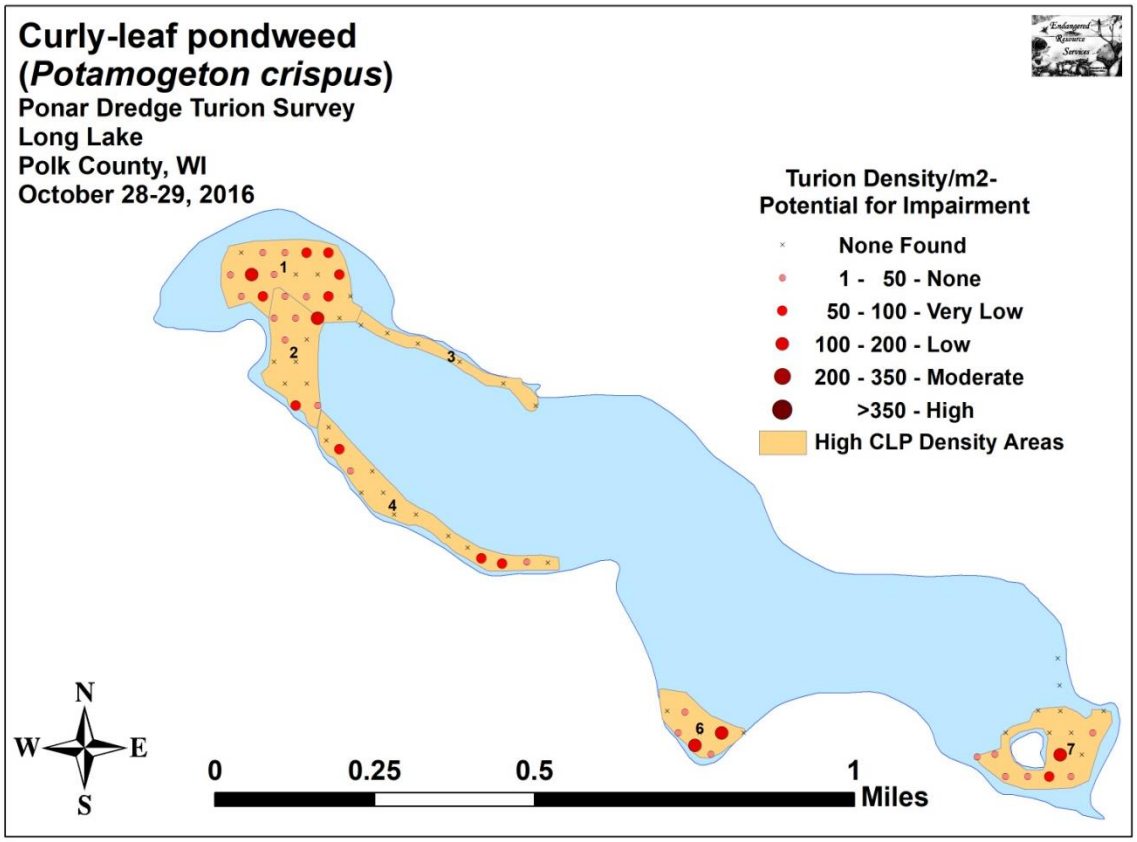


Figure 11: 2016 Fall CLP Turion Survey Density and Distribution

Table 3: CLP Turion Surveys - Summary Statistics
Long Lake, Polk County
October 25, 2015 and October 28-29, 2016

	2015							2016						
Summary Statistics:	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7
Total number of points sampled	75	17	12	6	15	8	17	75	17	12	6	15	8	17
Total live turions	167	45	15	5	43	30	29	89	28	15	0	12	16	18
Total # of points with live turions	55	14	7	4	10	8	12	37	12	7	0	5	5	8
Freq. of occurrence (in percent)	73.3	82.4	58.3	66.7	66.7	100.0	70.6	49.3	70.6	58.3	0.0	33.3	62.5	47.1
# at/above nuis. level (+200/m^2)	1	1	0	0	0	0	0	0	0	0	0	0	0	0
% nuisance level	1.3	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum turions/m^2	237	237	86	43	194	194	194	172	108	129	0	65	151	172
Mean turions/m^2	47.94	56.99	26.91	17.94	61.71	80.73	36.72	25.55	35.46	26.91	0.00	17.22	43.06	22.79
Standard deviation/m^2	51.11	55.90	30.62	16.21	60.27	54.89	46.15	38.40	33.99	37.99	0.00	27.23	60.89	42.70
Standard error of the paired diff.								0.28	0.58	0.70	0.31	0.61	1.50	2.18
Degrees of freedom								74	16	11	5	14	7	16
t-statistic								-3.78	-1.74	0.00	-2.57	-3.37	-1.17	-2.18
p - value								***<0.001	0.05	0.50	**0.02	**0.002	0.28	**0.02

Significant differences = * $p < .05$, ** $p < .01$, *** $p < .001$

2017 Fall Ponar Dredge CLP Turion Survey:

As in 2016, the May 2017 treatment of 33.65 acres produced a highly significant decline in Curly-leaf pondweed throughout the lake's entire littoral zone. During the October 27-28, 2017 survey, we found 54 turions at 31 survey points (41.3% coverage). This was a further reduction from the 89 turions at 37 points (49.3% coverage) we found in 2016 after the peak of 167 turions at 55 of 75 survey points (73.3% coverage) in 2015. It also represented a return to levels seen prior to the 2015 interruption in the treatment program (59 turions found at 27 points (36.0% coverage) in 2014 and 56 turions at 28 points (37.3% coverage) in 2013). Similar to 2016, our 2017 survey didn't find any points that were above the "navigation nuisance level" of 200/m^2; and the five points predicted to have 50 turions/m^2 or higher (Figure 11) (Appendix II) was the lowest since surveying began (15 in 2016; 27 in 2015; eight in 2014; and six in 2013).

The lakewide decline in mean density from 25.55 turions/m^2 in 2016 (standard deviation of 38.40 turions/m^2) in 2016 to 15.50 turions/m^2 in 2017 (standard deviation of 24.92 turions/m^2) was significant **(p=0.02)** (Table 3). All polygons experienced a year-over-year decline, but this was not significant for any one individual area.

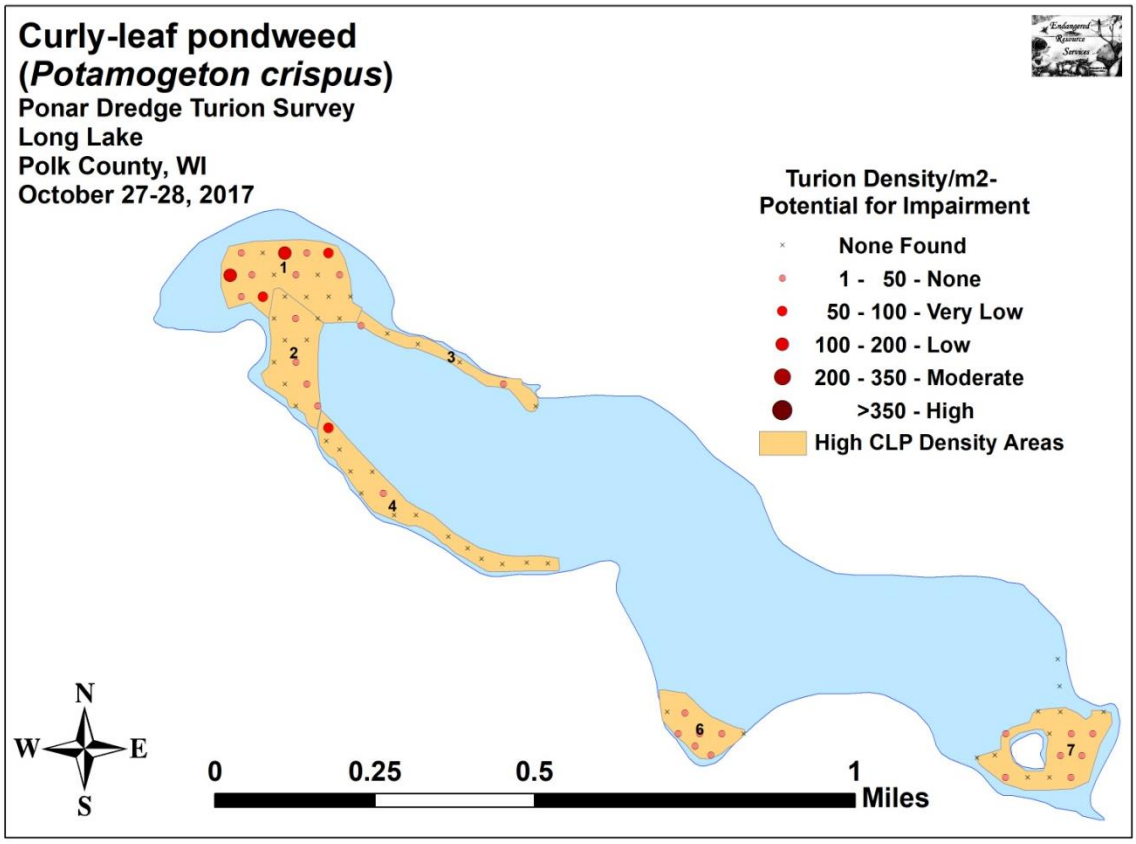


Figure 12: 2017 Fall CLP Turion Survey Density and Distribution

Table 4: CLP Turion Surveys - Summary Statistics
Long Lake, Polk County
October 28-29, 2016 and October 27-28, 2017

	2016							2017						
Summary Statistics:	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7	All	HDA 1	HDA 2	HDA 3	HDA 4	HDA 6	HDA 7
Total number of points sampled	75	17	12	6	15	8	17	75	17	12	6	15	8	17
Total live turions	89	28	15	0	12	16	18	54	26	6	2	5	8	7
Total # of points with live turions	37	12	7	0	5	5	8	31	10	4	2	2	6	7
Freq. of occurrence (in percent)	49.3	70.6	58.3	0.0	33.3	62.5	47.1	41.3	58.8	33.3	33.3	13.3	75.0	41.2
# at/above nuis. level (+200/m^2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% nuisance level	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum turions/m^2	172	108	129	0	65	151	172	108	108	43	22	86	43	22
Mean turions/m^2	25.55	35.46	26.91	0.00	17.22	43.06	22.79	15.50	32.92	10.76	7.18	7.18	21.53	8.86
Standard deviation/m^2	38.40	33.99	37.99	0.00	27.23	60.89	42.70	24.92	38.15	17.17	11.12	22.53	16.27	10.92
Standard error of the paired diff.								0.23	0.50	0.63	0.21	0.47	1.00	0.47
Degrees of freedom								74	16	11	5	14	7	16
t-statistic								-2.03	-0.24	-1.19	-1.58	-1.00	-1.00	-1.38
p - value								***0.02**	0.41	0.13	0.09	0.17	0.18	0.09

Significant differences = * $p < .05$, ** $p < .01$, *** $p < .001$

CONSIDERATIONS FOR FUTURE MANAGMENT:

The 2017 turion survey suggests there will again be Curly-leaf pondweed throughout much of Long Lake in 2017; however, densities are expected to be quite low in most areas. Although treatment is still planned in 2018 (pers. comm. with BLPRD board), the low turion levels, especially in deep water, suggest that the total surface acreage and volume of water treated may decline from 2017 levels. Ultimately, the results of the 2018 pretreatment survey coupled with the level of CLP growth the board is comfortable with will determine how much of the lake is treated.

LITERATURE CITED

Clemens, C. 2010. Aquatic Plant Management Plan - Long Lake Polk County, WI. Sponsored by Long Lake Protection and Rehabilitation District - Prepared by Harmony Environmental – October 2010. Available from http://www.blprd.com/docs/LongLakeAPMfinal101810.pdf (2017, November).

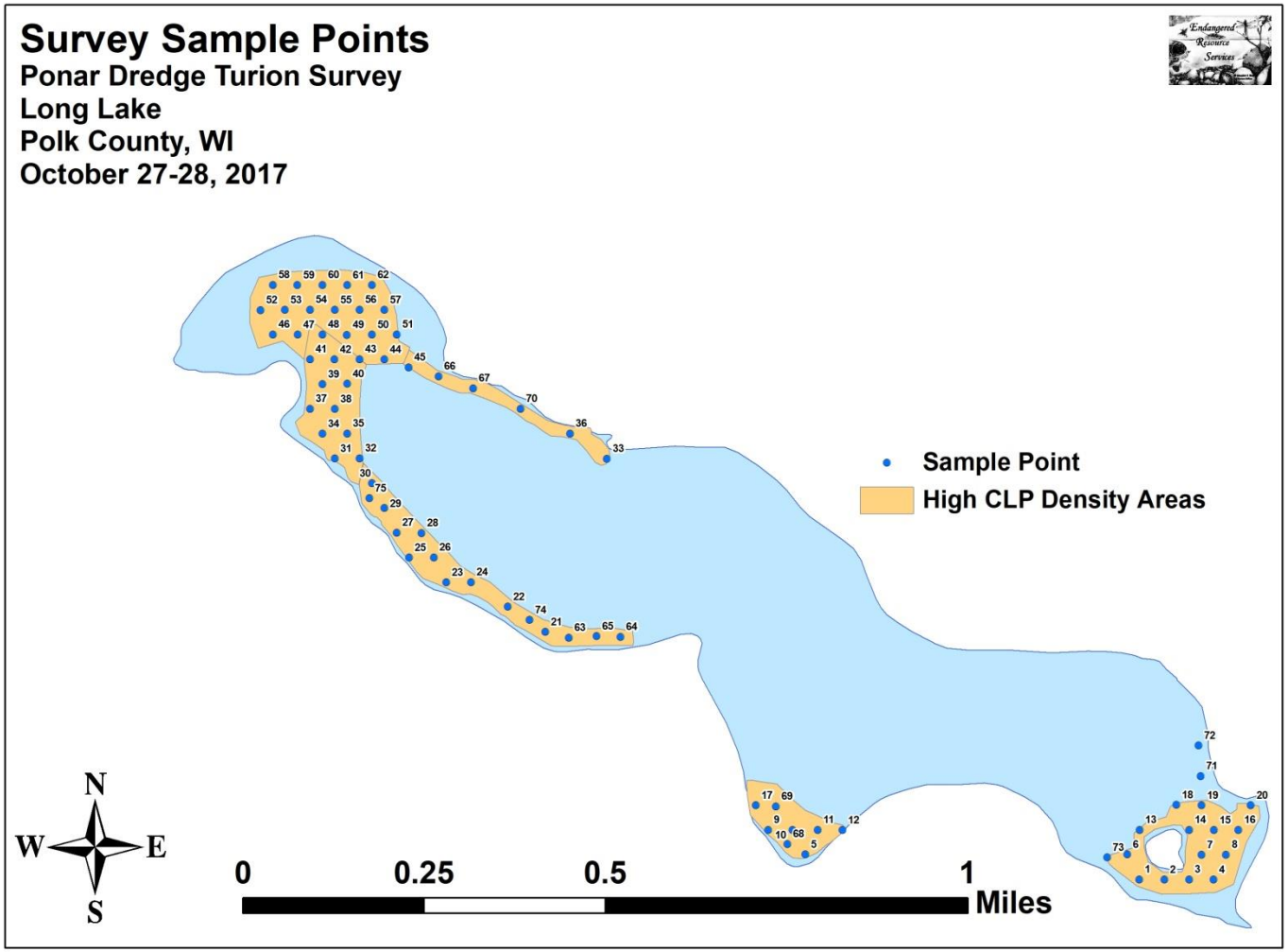
Hopke, R., E. Nelson, and E. Eaton [online]. 1964. Long Lake Map Bathymetric. Available from http://dnr.wi.gov/lakes/maps/DNR/2620600a.pdf (2017, November).

UWEX Lakes Program. [online]. 2010. Aquatic Plant Management in Wisconsin. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/ecology/aquaticplants/default.aspx (2017, November).

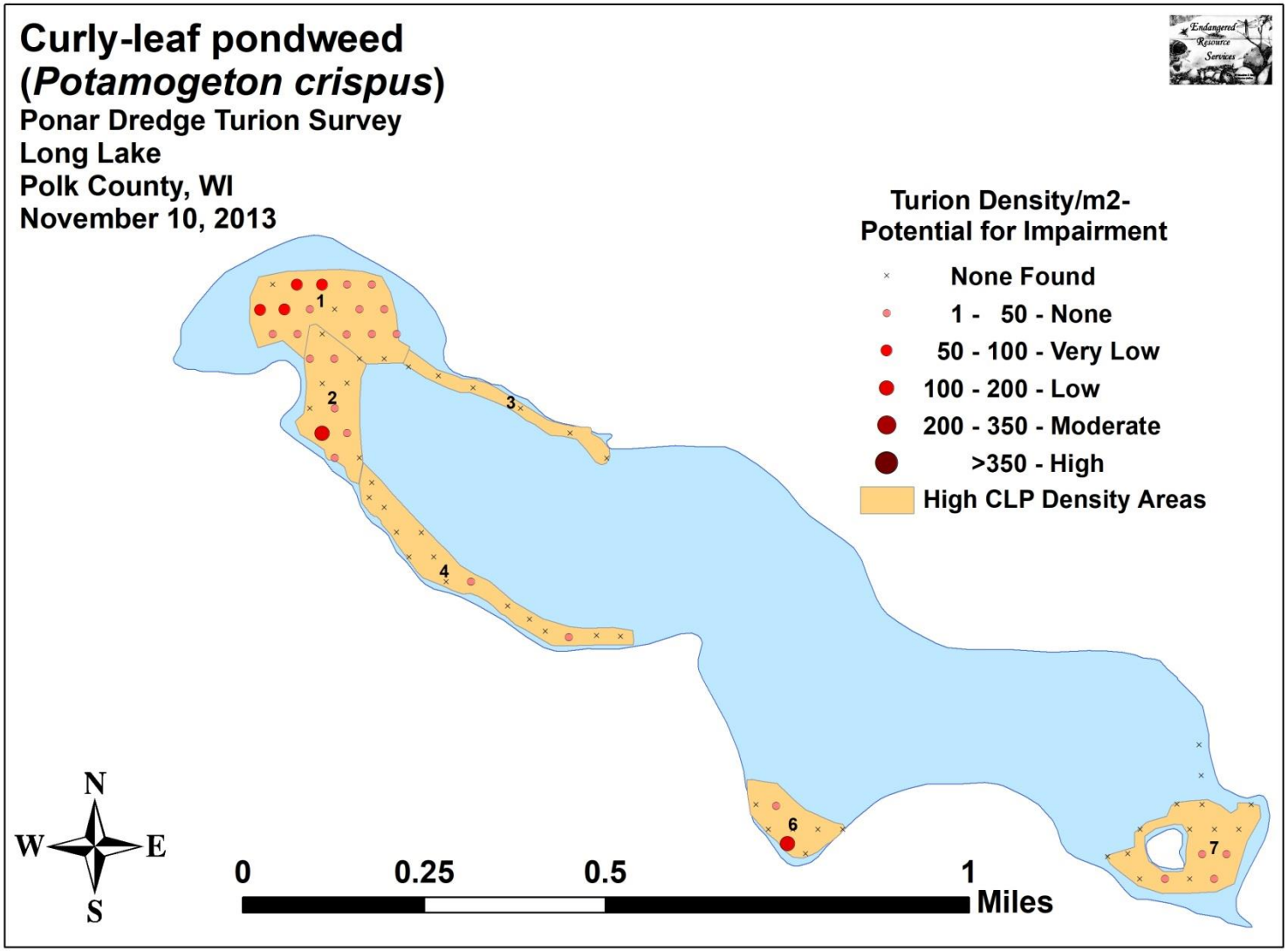
UWEX Lakes Program. [online]. 2010. Pre/Post Herbicide Comparison. Available from http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/Appendix-D.pdf (2017, November).

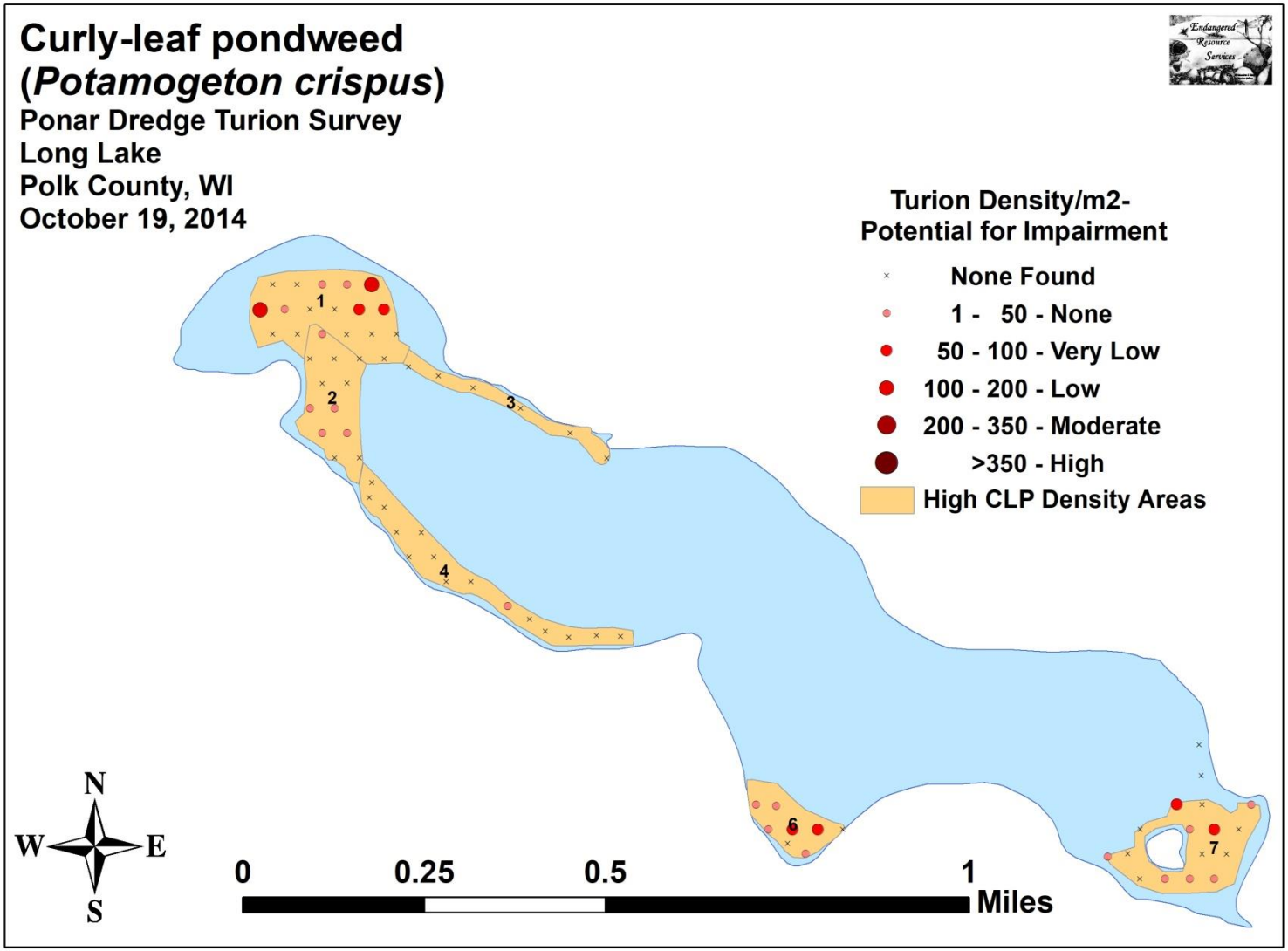
WDNR. [online]. 2017. Long Lake Citizen Monitoring Water Quality Database. Available from http://dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2620600&page=waterquality (2017, November).

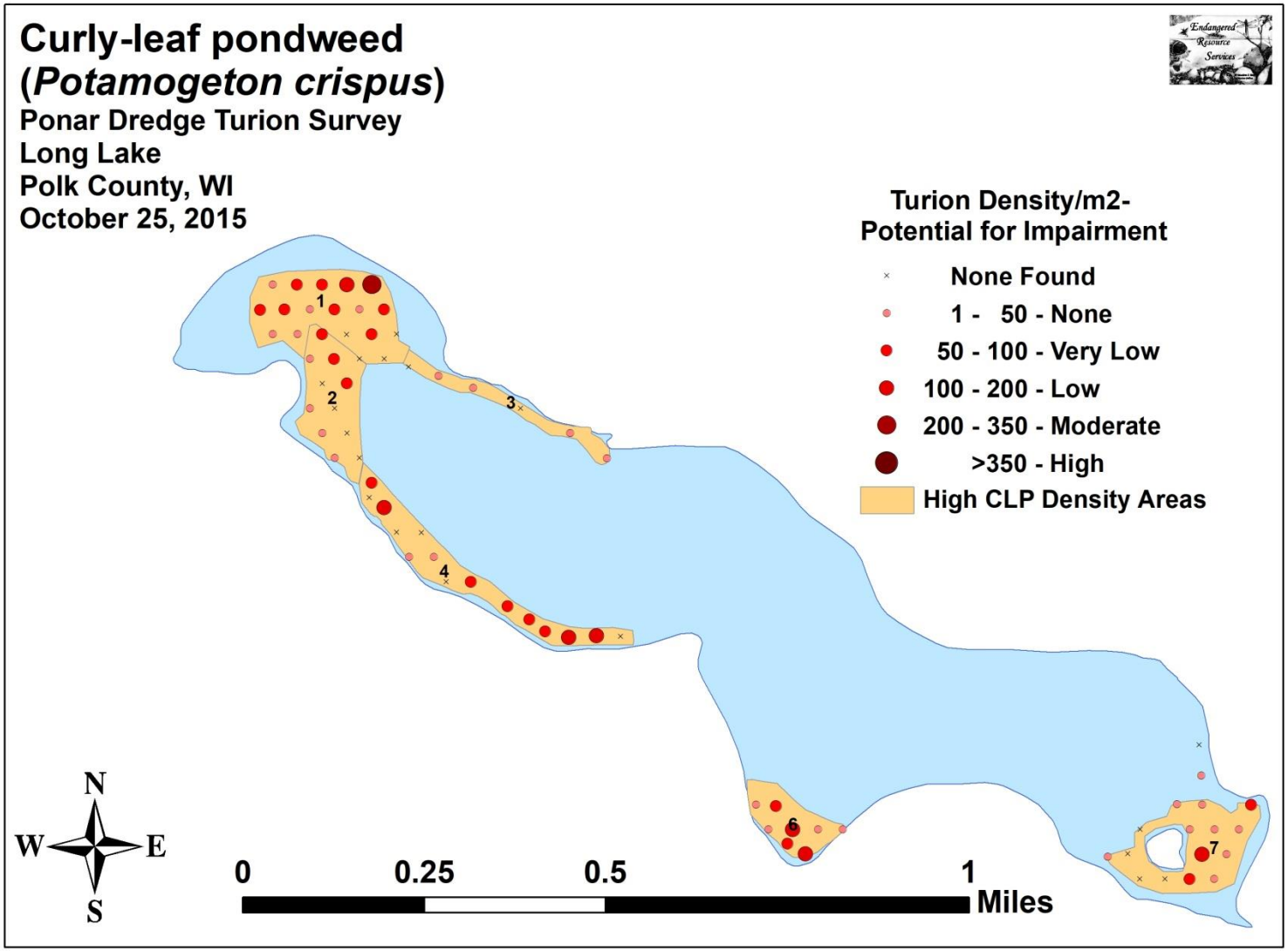
Appendix I: Survey Sample Points in Historic High CLP Density Areas

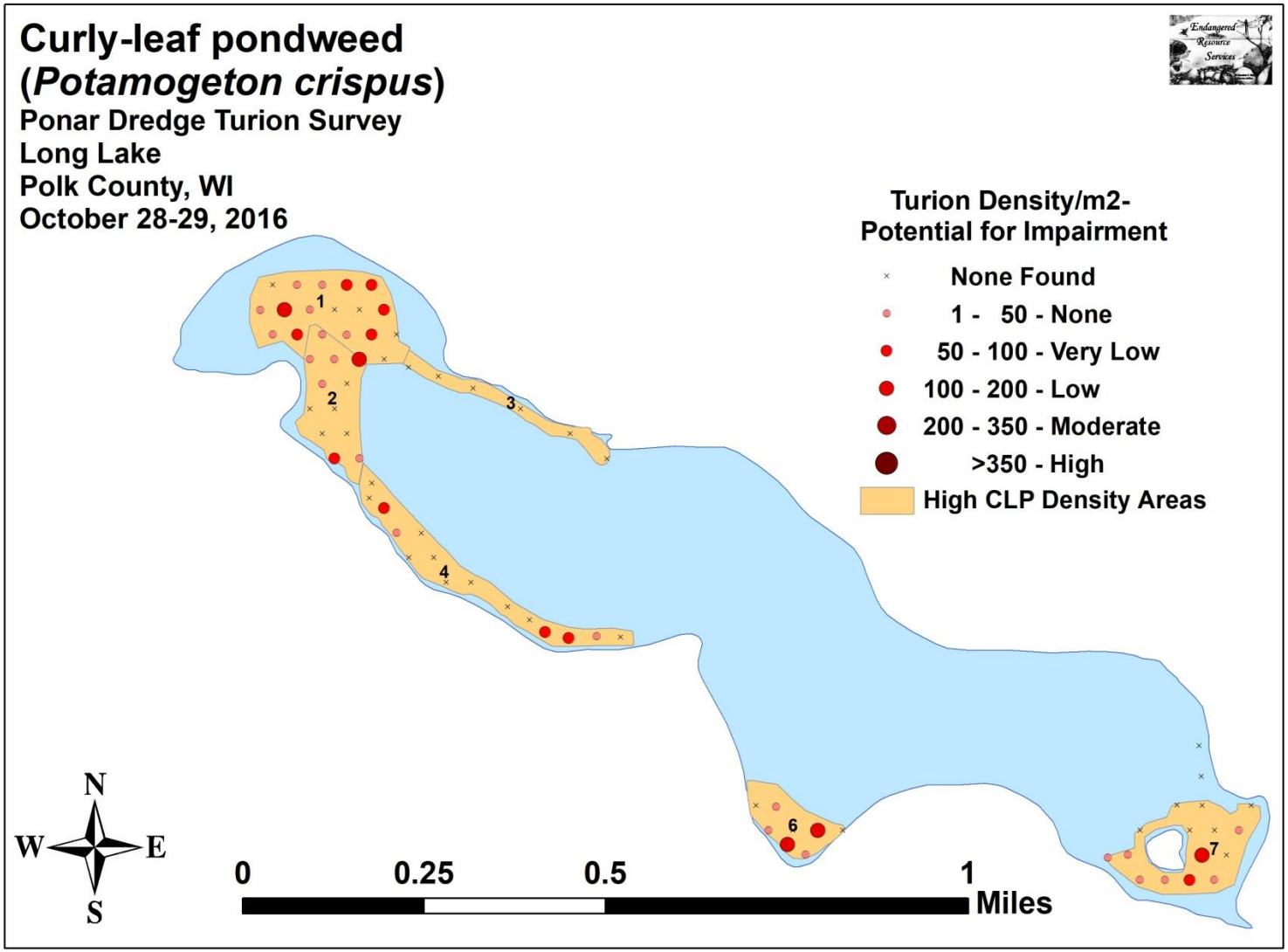

Survey Sample Points
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
October 27-28, 2017
Endangered Resource Services
Sample Point
High CLP Density Areas
N
W
E
S
0
0.25
0.5
1
Miles

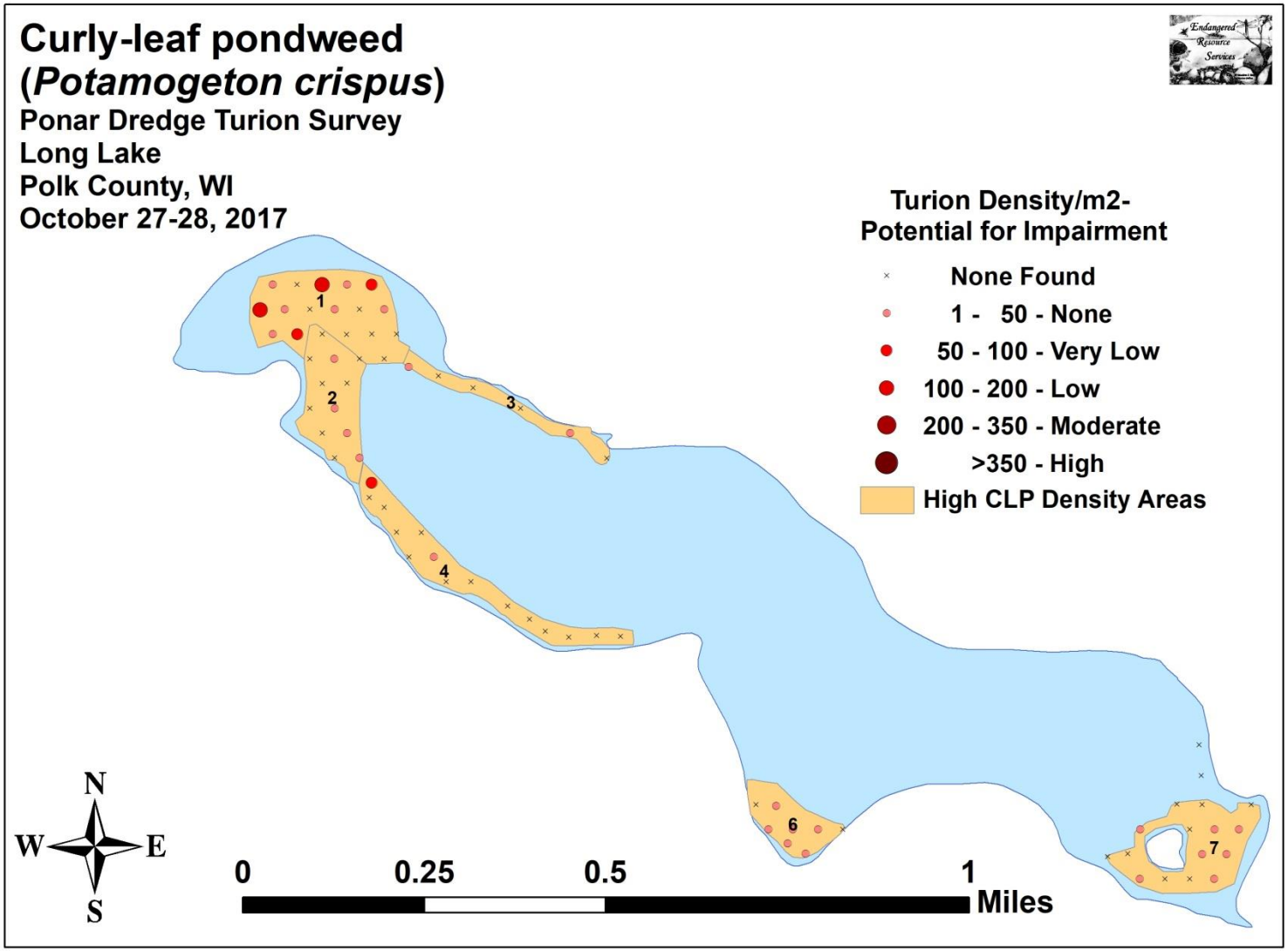
Appendix II: 2013, 2014, 2015, 2016, and 2017 Fall CLP Turion Density and Distribution Maps


Curly-leaf pondweed
(Potamogeton crispus)
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
November 10, 2013
Endangered Resource Services
Turion Density/m2-
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
High CLP Density Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
October 19, 2014
Endangered Resource Services
Turion Density/m2-
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
High CLP Density Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
October 25, 2015
Endangered Resource Services
Turion Density/m2-
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
High CLP Density Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
October 28-29, 2016
Endangered Resource Services
Turion Density/m2-
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
High CLP Density Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles


Curly-leaf pondweed
(Potamogeton crispus)
Ponar Dredge Turion Survey
Long Lake
Polk County, WI
October 27-28, 2017
Endangered Resource Services
Turion Density/m2-
Potential for Impairment
None Found
1 - 50 - None
50 - 100 - Very Low
100 - 200 - Low
200 - 350 - Moderate
>350 - High
High CLP Density Areas
1
2
3
4
6
7
N
W
E
S
0
0.25
0.5
1
Miles