Herbicide Treatment Analysis for

Potamogeton crispus (CLP)

Big Lake

Polk County, WI

2018

Survey conducted and analysis prepared by: Ecological Integrity Service, LLC

Amery, WI

Abstract

On May 24, 2018 11.81 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) were treated with the herbicide endothall at a target concentration of 1.5-2.5 ppm. The water temperature at the time of treatment was between 59 degrees F. A pretreatment survey was conducted on May 8 and a post treatment survey was conducted on June 4, 2018. A chi-square analysis was used to determine the significance of any reductions in frequency of occurrence. The frequency of occurrence from the pretreatment to the post treatment survey showed a statistically significant reduction (from 43.4% to 0%). A comparison of the post treatment survey of 2017 and the post treatment survey of 2018 showed a decrease from 1.2% to 0% which was not significant. Comparing the pretreatment survey of 2017 to the pretreatment survey of 2018 an increase occurred from 61.6% to 43.4%, which was statistically significant. A chi-square analysis revealed a statistically significant reduction in one native plant species. A turion analysis resulted in a mean turion density increase from 2017 to 2018. The mean turion density increased from 7.5 turions/m^2 to 10.3 turions/m^2.

Introduction

On May 24, 2018 five beds totaling 11.81 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) beds were treated with herbicide (endothall-K) for the eighth year on Big Lake in Polk County Wisconsin (Township 32,33, Range 18 Section 36). Figure 1 shows the location of the beds.

The treatment comprised of concentrations ranging from 1.5-2.5 ppm of endothall K. Table 1 shows the statistics for each treatment bed.

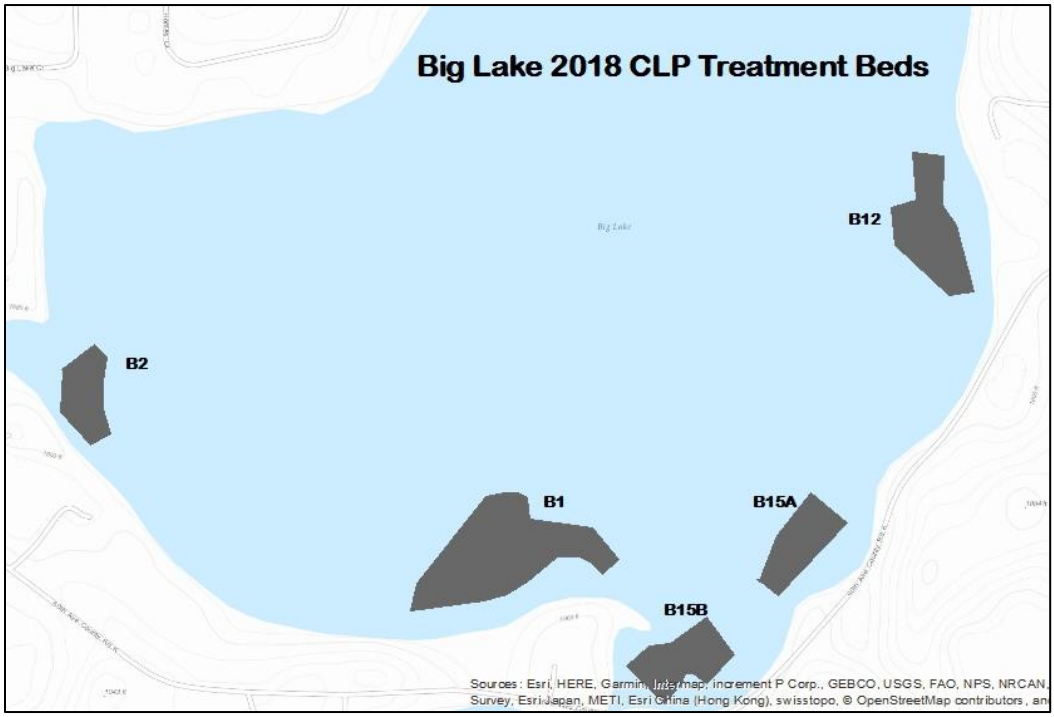

Figure 1: Map showing 2017 CLP treatment beds

Treatment date: *Bed*	*Acres*	*Mean depth*	*Acre-feet*	*Target Concentration*	*Water temp.*	*Wind/direction*
B1	**4.73**	**6.40**	**30.27**	**1.5 ppm**	**59**	**0-2/variable**
B2	**1.34**	**6.10**	**8.17**	**2.5 ppm**	**59**	**0-2/variable**
B12	**2.44**	**7.20**	**17.57**	**1.5 ppm**	**59**	**0-2/variable**
B15A	**1.57**	**7.00**	**10.99**	**1.5 ppm**	**59**	**0-2/variable**
B15B	**1.73**	**4.4**	**7.61**	**2.5 ppm**	**59**	**0-2/variable**
Total	**11.81**		**74.62**			

*As reported by applicator

Table 1: Summary of 2017 treatment bed statistics.

Bed	Description
B1	Bed B1 is just north of the narrows between Big Lake and Round Lake, This is the second largest bed and was very dense from the start of the treatment in 2011. The bed ranges from 3.5 feet to 11 feet in depth. The density/frequency has been declining each year but has had quite high turion densities. The pretreatment frequency is starting to go down, largely along the bed edges.
B2	This bed is on the western shoreline of Big Lake. It is 1.9 acres in size. The bed transitions quickly from a high nutrient, muck sediment to a hard, sandy substrate on the western edge of the bed. The CLP growth stops abruptly here. In 2010, this bed was quite dense in the middle portions of the bed, but has responded well to treatment.
B3	Bed B3 is on the northern shoreline of Big Lake. It originally had high density pockets of CLP with scattered growth between the pockets. The lake side edge borders very deep water and drops fast. There is no growth in this deeper water and defines the lake side boundary abruptly. This bed's treatment was ceased this year 2018 due to lack of CLP.
B12	Bed B12 came about from combining B12 and B13 from previous treatment years. CLP growing between these beds that were observed in quite high density in May 2013 warranted changing this bed (it is back to its original size from 2011). This bed responded less to treatment than other beds and had the highest frequency of CLP in 2013. It is a wider bed than ½ of the beds and ranges from about 4 feet to 11 feet in depth. The most CLP growth in this bed is the outer ½ of the bed in 7-10 feet of water depth.
B14	B14 is on the eastern shore. This narrow bed has been responding to treatment well, but keeps having CLP return, warranting more treatment. It ranges from 4 ft to about 7.5 feet in depth. The treatment for this bed was ceased this year 2018 due to lack of CLP.
B15(A and B)	B15 is the largest bed treated. It encompasses much of the southeastern shoreline and extends out to Bed B1 and into the channel between Big Lake and Round Lake. This bed has a history of dense CLP and high turion production. The CLP density and turion density have both declined steadily. Due to distinct differences in CLP growth in this bed, it was labeled as two beds (A and B) in 2016 and completely separated in 2017. This continued in 2018.

Table 2: Description of treatment beds.

Methods

To conduct and analyze the treatment, two surveys are conducted following the Wisconsin DNR treatment protocol outlined in 2009 by the Wisconsin DNR. The first survey is referred to a pretreatment survey. This involves going to predetermined GPS coordinates within the proposed treatment area. A high definition underwater camera as well as a rake is used to determine the presence of CLP at that sample point. Density is not measured as the plants are typically very small and density is very subjective. The presence of CLP is simply determined. There are many points checked outside of the bed delineation to assure the boundary is correct.

The second survey is referred to as the post treatment survey. This survey involves going to the same GPS coordinates as the pre-treatment survey and doing a rake sample at the point. If any CLP is on the rake, the density of the CLP is recorded (see fig 2 for reference). All other species are also recorded from the rake sample in order to verify no damage to the native plants.

Figure 2: Density rating system and example CLP rake sample.

When the surveys are complete, the frequency of occurrence is determined as well as the mean density for each bed as well as all beds combined. The frequency of occurrence for each native plant species sampled is also calculated. A chi-square analysis is then used to determine if the change in frequency is statistically significant ($p<0.05$). The goal is to find the chi-square analysis show that the frequency of CLP is significantly reduced and the native plants are not significantly reduced.

The comparison for reduction is three-fold. First, the result from the previous year's post treatment survey is compared to the present year post treatment survey. This reflects a long-term effectiveness. As more treatments are done in annual succession, these frequency values can become very similar since the CLP growth is reduced so much. This can make it appear the treatment is not progressing successfully since the frequency appears to not be reduced. Each year, new turions can germinate in the fall/winter creating new growth. The result is a low

frequency in the post treatment survey, but in the next spring the CLP has grown immensely, and results in a high frequency.

In order to reflect that new growth and the effect the treatment has on it, a second comparison is done. This compares the frequency of CLP in the spring, pre-treatment survey to the post treatment results in that same year. This shows what the CLP growth really was just before treating and the result after treatment. To show long-term reduction, the pretreatment frequency can be compared between treatment years. If the pretreatment frequency is going down from year to year, then the CLP is being reduced through turion reductions, thus resulting in less growth that spring.

In the end, we want to see a statistically significant reduction when comparing the pre-treatment frequency to the post treatment frequency. We would also like to see a consistent frequency reduction from year to year, depending on how low it is. If the frequency in any post treatment survey is very low (less than 10% as an example), then lowering it even more may not be realistic, but is the goal. Turions can remain viable for several years, which can affect reduction amounts achieved.

In order to further reflect potential future growth and the cumulative success of treatments, a turion analysis is conducted. This analysis involves going to sample points near the middle of the CLP bed (assuming this will reflect the highest density). At each sample point a sediment sampler is lowered to the lake sediment and a sediment sample is obtained. Two samples are obtained from each side of the boat at each location. The samples are then separated with a screened bucket to isolate the turions. The turions are then counted and the density of turions is calculated in turions/square meter. Consistently successful treatments should so a trend of reduced turion density each year. This way it is known the treatments are killing plants prior to turion production, resulting in overall reduction in CLP in those beds.

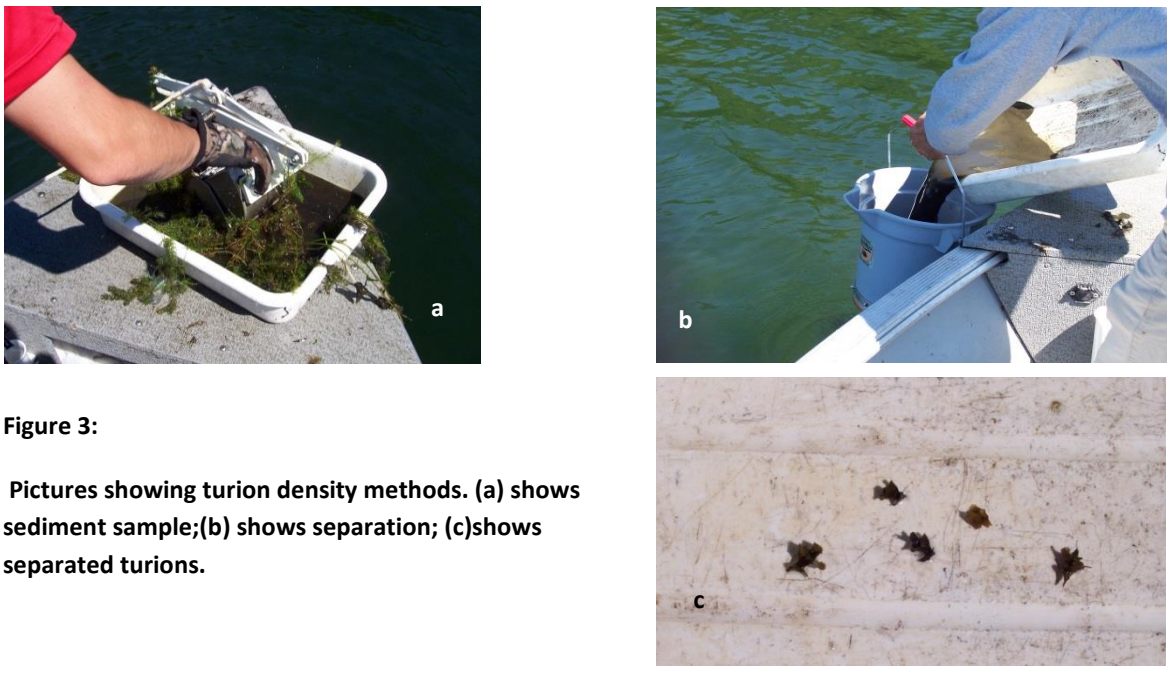

Figure 3:

Pictures showing turion density methods. (a) shows sediment sample;(b) shows separation; (c)shows separated turions.

Results

A pretreatment survey was conducted on May 8, 2018. This survey found CLP growing in 43.4% of the sample points within the proposed treatment beds. There was more CLP found between points, but not part of statistics and this information was used for determining treatment in the beds. A few changes were made in the bed borders, with the biggest change being the elimination of beds B3 and B14, both lacking CLP and being very small in area. Table 2 shows the frequency summary from 2017 and 2018.

Bed	2017 pre treat freq (0-100%)	2017 post treat freq (0-100%)	2018 pre freq. (0-100%)	2018 post freq. 0-100%)	2017 mean Density (0-3)	2018 mean density (0-3)
B1	70.0%	0.0%	46.7%	0%	0.0	0.0
B2	77.8%	11.1%	33.3%	0%	0.11	0.0
B3	67.0%	0.0%	No treat	n/a	0.0	n/a
B12	75.0%	0.0%	33.3%	0%	0.0	0.0
B14	67%	0.0%	No treat	n/a	0.0	n/a
B15(A/B)	60.0%	0.0%	50.0%	0%	0.0	0.0
All beds	**61.6%**	**1.2%**	**43.4%**	**0%**	**0.01**	**0.0**

Table 2: Frequency data from pre/post treatment surveys in 2017 and 2018.

Bed	Pre to post (2018)reduction and significance?	Post 2017 to Post 2018 reduction significance?	Pre 2017 to Pre 2018 Reduction Significance?	Mean Density Change 2017-2018 (post)
All beds	Yes ($p=1.78X10^{-9}$)	No($p=0.10$)	Yes ($p=0.025$)	Slight decrease

Table 3: Chi-square analysis results for pre/post treatment surveys.

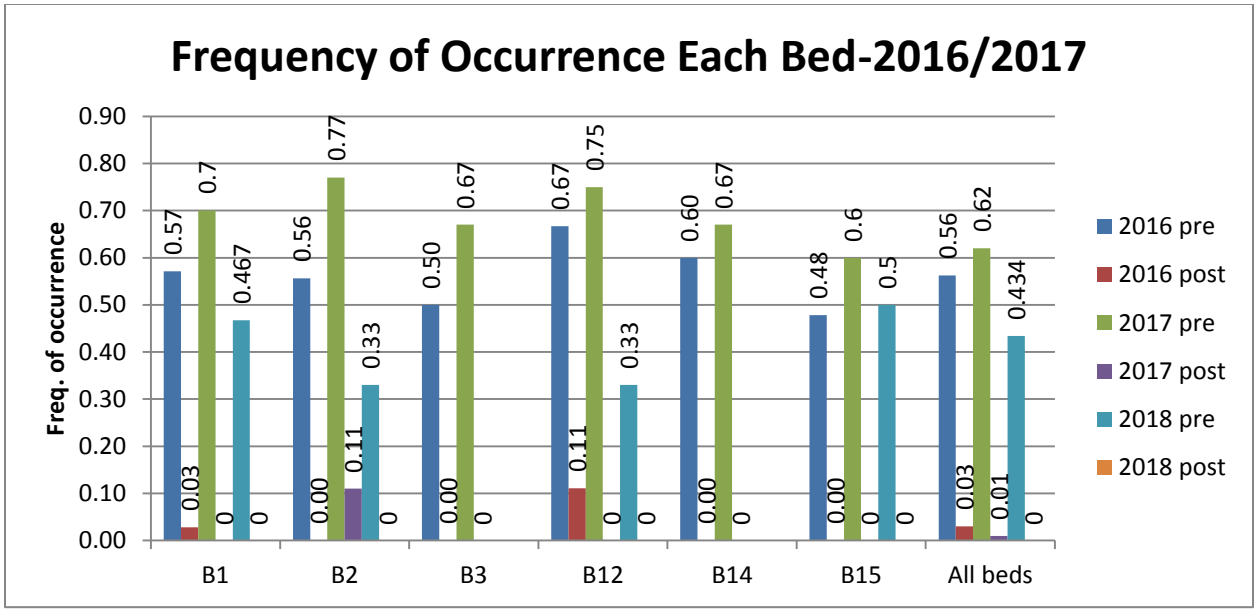

Figure 4: Graph showing the CLP frequency from pre/post treatment surveys for each bed 2016-2017.

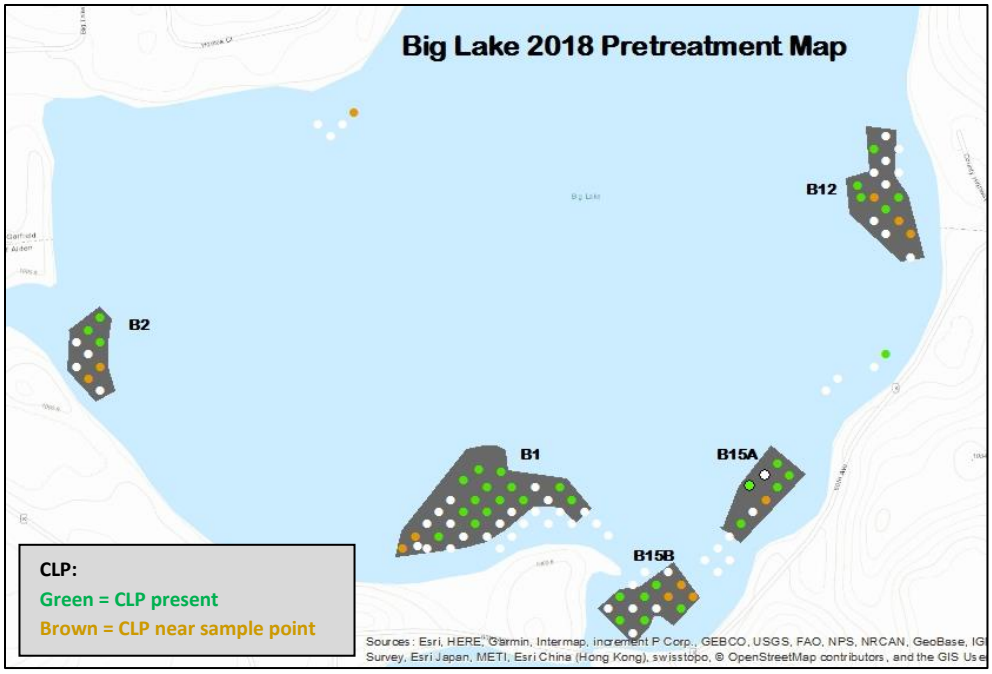

Figure 5: Map of CLP frequency from 2017 pretreatment survey.

Following treatment, a post treatment survey was conducted on June 4, 2018. This time corresponds with dense growth of CLP on other area lakes (can't compare untreated areas in Big Lake as no CLP growth was occurring). CLP was present in 0% of the sample points. Figures 5 and 6 show the distribution of CLP within the treatment beds at the post treatment survey.

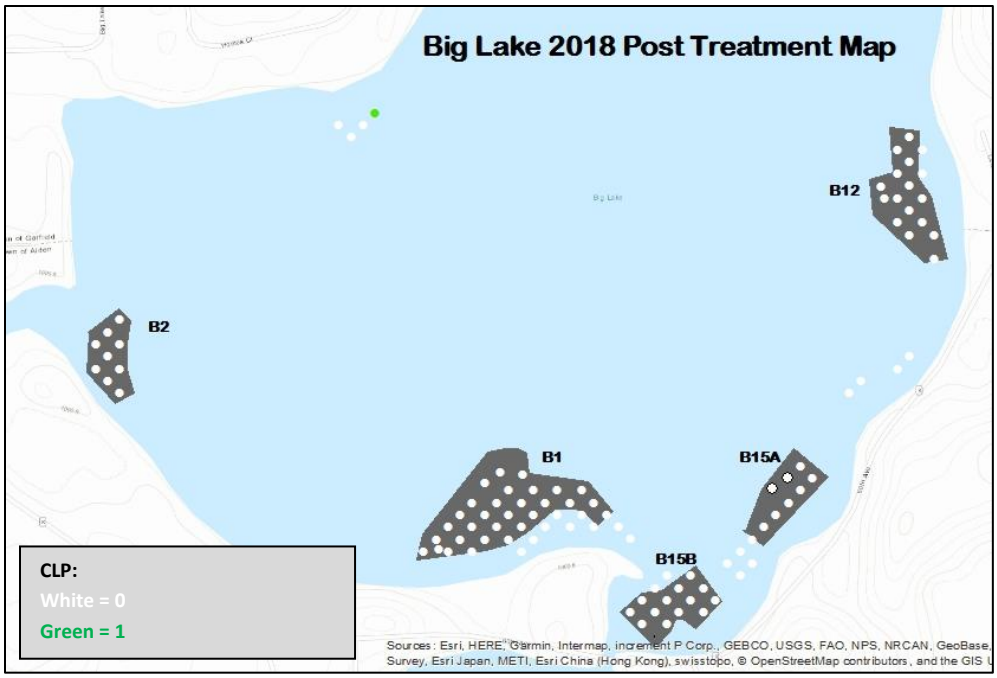

Figure 6: Map of CLP frequency from 2017 post treatment survey.

The data shows a significant reduction in CLP growth from before treatment occurred (pretreatment survey) and after treatment occurred (post treatment). The CLP frequency before treatment was 43.4% and was reduced to 0% after treatment. A chi-square analysis showed this was statistically significant ($p=1.78 \times 10^{-9}$). Comparing the 2017 frequency results to 2018 can show if an overall reduction occurred between those years. The post treatment frequency change was a very small reduction from 2017 to 2018, but is not statistically significant. The frequency was so low in 2017 after treatment, that there was no ability for the reduction to be significant as it is difficult to reduce such small frequency results. Statistics are calculated on all beds combined, but figure 4 graphically reflects frequencies in various surveys for each treatment bed.

Comparing pretreatment surveys show long-term changes as these surveys are conducted after CLP growth has resulted from turion germination in the winter/spring. There was a statistically significant decrease from 2017 to 2018 (61.2% to 44.3%, p=0.025). Figure 7 graphically demonstrates the changes in overall frequency from 2012 to 2018.

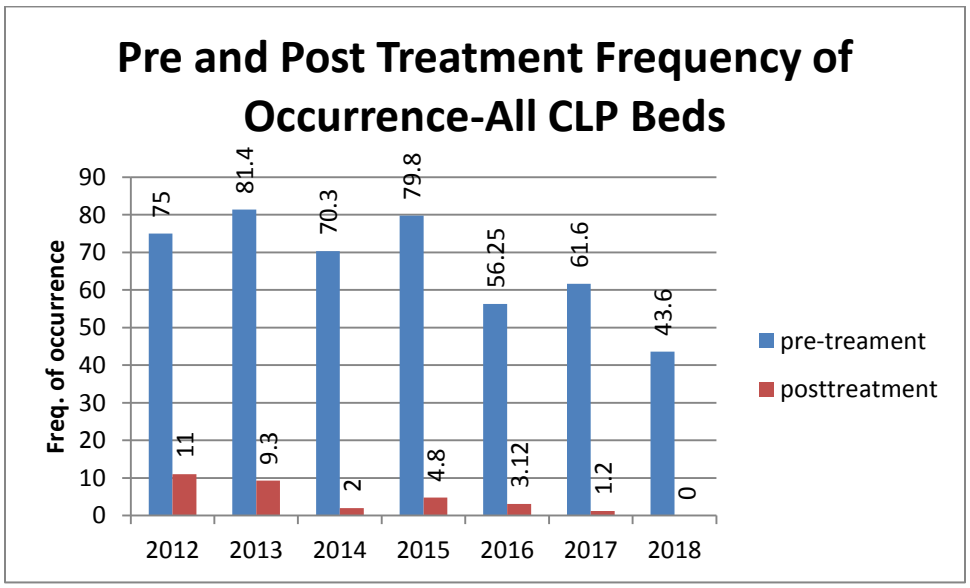

Figure 7: Graph showing CLP frequency changes from 2012 to 2017.

Another goal of herbicide treatment for invasive species is to target the invasive species with little adverse effect on native plant species. The native species are also surveyed within the treatment beds and a chi-square analysis is used to evaluate if the native species are reduced significantly.

The 2018 chi-square analysis indicates there was one statistically significant reduction in native plant species (*Mriophyllum sibiricum*). There were several increases in native plant frequency. The cause of the reduction could be due to herbicide use. It is also possible that natural variation and/or sampling variation could be a factor. Plants that are not dormant at the time of treatment are susceptible. Table 4 shows a summary of the native plant frequencies for 2017 and 2018, along with the significance of any changes.

Species	2017 freq	2018 freq	change	Significant Reduction?
Ceratophyllum demersum(coontail)	0.81	0.89	+	n/a
Elodea canadensis(waterweed)	0.40	0.45	+	n/a
Heteranthera dubia(stargrass)	0.02	0.01	-	No
Lemna trisulca(forked duckweed)	0.00	0.09	+	Yes
Myriophyllum sibiricum(northern water-milfoil)	0.22	0.08	-	Yes (p=0.014)
Nymphae odorata(white lily)	0.05	0.05	n/c	n/a
Potamogeton illinoensis(Illinois pondweed)	0.01	0.0	-	No
Potamogeton praelongus(whitestem pondweed)	0.09	0.03	-	No
Najas guadulupensis (southern naiad)	0.02	0.07	+	n/a
Stuckenia pectinata(sago pondweed)	0.03	0.0	-	No

Table 4: Frequency data of native plants from post treatment survey and chi-square analysis results.

Turion analysis

Each year a turion analysis is conducted to look for long-term trends in CLP reduction. The turion analysis was conducted on October 14 when some plant growth has subsided. The turions are release when the CLP plants die in July. These turions can remain viable for several years, so turion density can be used to predict the potential for future CLP growth in the subsequent spring.

Turions/m^2							
Bed	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
B1	30.7	27	12.4	18.4	6.2	6.1	6.1
B2	32.28	4	10.9	0.0	28.7	0.0	0.0
B3	7.1	15	21.7	0.0	0.0	0.0	0.0 Not treated
B8	0	6.7	n/a	n/a	n/a	n/a	n/a
B12	28.7	39.7	0	129	34.4	4.4	43.0
B14	0	20	0	0.0	21.5*	11.0	0.0 Not treated
B15	30.7	16.7	0	8.6	17.2*	17.7	0.0
R1	0	20	n/a	n/a	n/a	n/a	n/a
All Treated	**12.8**	**13.6**	**6.4**	**24.3**	**18.7**	**7.5**	**10.3**

*These two beds were adjusted from 2015 so samples slightly different.

Table 5: Mean turion density at each bed in turions/m^2.

The overall turion density increased slightly from 2017 to 2018, 7.5 turions/m^2 to 10.3 turions/m^2. There were only three locations with turions sampled, with one sample having 129 turions/m2. This likely increase the mean so there is no concern of increased CLP growth and subsequent turion release. Figure 8 shows the mean turion density from each year back to 2012. Since some turions remain, some growth can be expect in spring, 2019 in these areas.

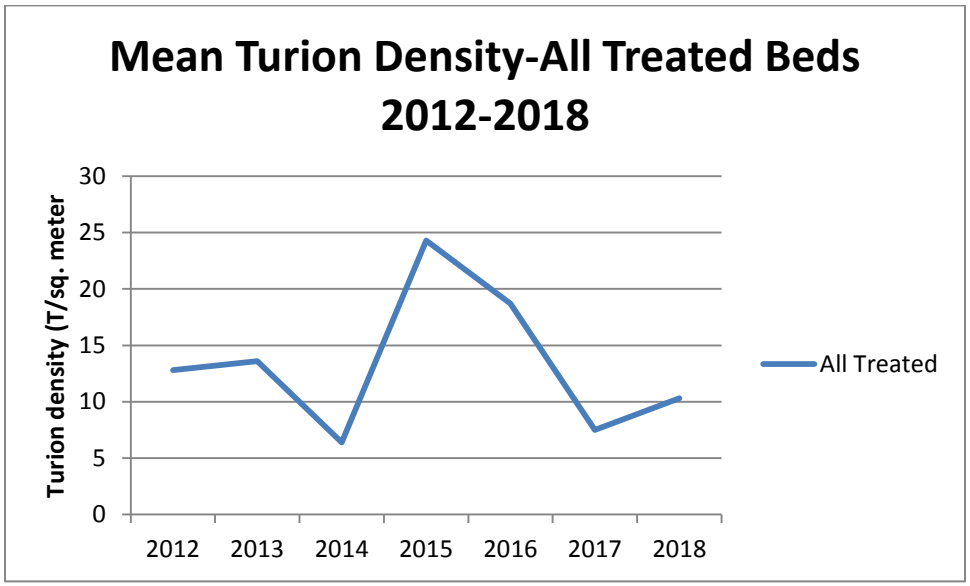

Figure 8: Graph showing turion density changes from 2012 to 2018.

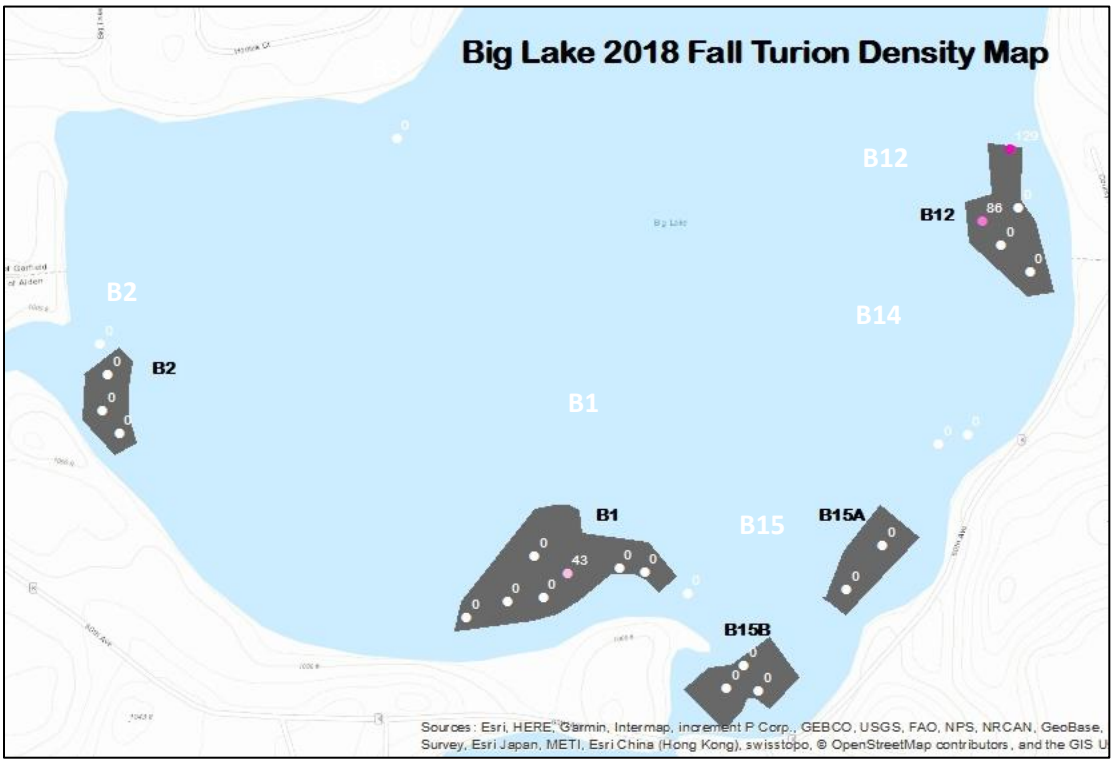

Figure 9: Map of turion density from turion analysis October, 2018.

Discussion

The 2018 herbicide treatment of CLP on Big Lake was found to be successful. A significant reduction occurred in all beds when frequency is compared before and after treatment in 2018. A comparison between the 2017 post treatment and 2018 post treatment revealed a small decrease from 1.2% frequency of occurrence in 2017 to 0% in 2018. The comparison of the pretreatment surveys from 2017 and 2018 showed a significant reduction. This indicates long term reduction in CLP and is the desired result in treatment regimens.

The October turion analysis resulted in an overall density increase from 2017 to 2018. There was only three locations with turions so this increase is likely due to one large sample at a sample point. The CLP treatments have been successful eight years, and yet turion density is remaining although it is low. It is unknown how long treatments would need to continue to get nearly zero turion density. There may be some CLP growing in between sample points that is not being observed.

The post treatment showed reduction in one native species following treatment. The goal is for no native species to be reduced. Since there was an increase in a few species, the reduction due to herbicide may not be the cause.

With eight consecutive successful herbicide treatments and so little CLP sampled in each post treatment survey, it would seem that the CLP would eventually be very limited in the spring pretreatment survey. The pretreatment survey still showed over 40% of the sample points within the treatment areas had CLP growth in the pretreatment survey. A decision will need to be made about continued treatment of CLP in Big Lake for 2019 and beyond. It is unknown how long the CLP would take to return with such limited turion density existing in these beds. Turions were only present in three sample locations, so CLP should be limited in the spring of 2019.

References

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