Herbicide Treatment Analysis- *Potamogeton crispus*

Spooner Lake
Washburn County WI
2017

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Abstract

On May 8 and 10, 2017 an herbicide treatment with endothall on five *Potamogeton crispus*-Curly leaf pondweed (CLP) beds occurred totaling 21.34 acres. A pretreatment survey and post treatment survey revealed a statistically significant reduction in the CLP after treatment (comparing the 2017 pretreatment CLP frequency to the 2017 post treatment CLP frequency) from 70.4% to 12.0% frequency of occurrence. The 2017 post treatment CLP frequency of occurrence was higher than the 2016 post treatment CLP frequency, from 4.6% in 2016 to 17.6% in 2017. The pretreatment survey from 2016 compared to the pretreatment survey from 2017 showed a small increase from 48.1% in 2016 to 54.0% in 2017. There was one native plant species with a significant reduction and one native species with a significant increase. The 2017 turion analysis resulted in an increase in turion density from 2016 (38.1 turions/m^2) to 2017 (71.2 turions/m^2). A whole lake meander survey was conducted for CLP and a new bed of CLP was located in the main lake basin. Other CLP locations from 2016 were not present in 2017.

Introduction

This report analyzes the effectiveness of an herbicide treatment for *Potamogeton crispus*-curly leaf pondweed (CLP). This treatment occurred on May 8 and 10, 2017. This analysis will review and compare treatment surveys of all beds treated in 2016, to the treatment surveys in 2017. It will also analyze the effectiveness comparing a pretreatment survey (conducted just before treatment) to the post treatment survey (conducted approximately four weeks after treatment) in 2017.

There were six beds of CLP treated with herbicide in 2017. They will be referred to as Beds 2, 3, 6, 7, 8 and 9. Figure 1 shows the bed locations and Table 1 summarizes bed statistics.

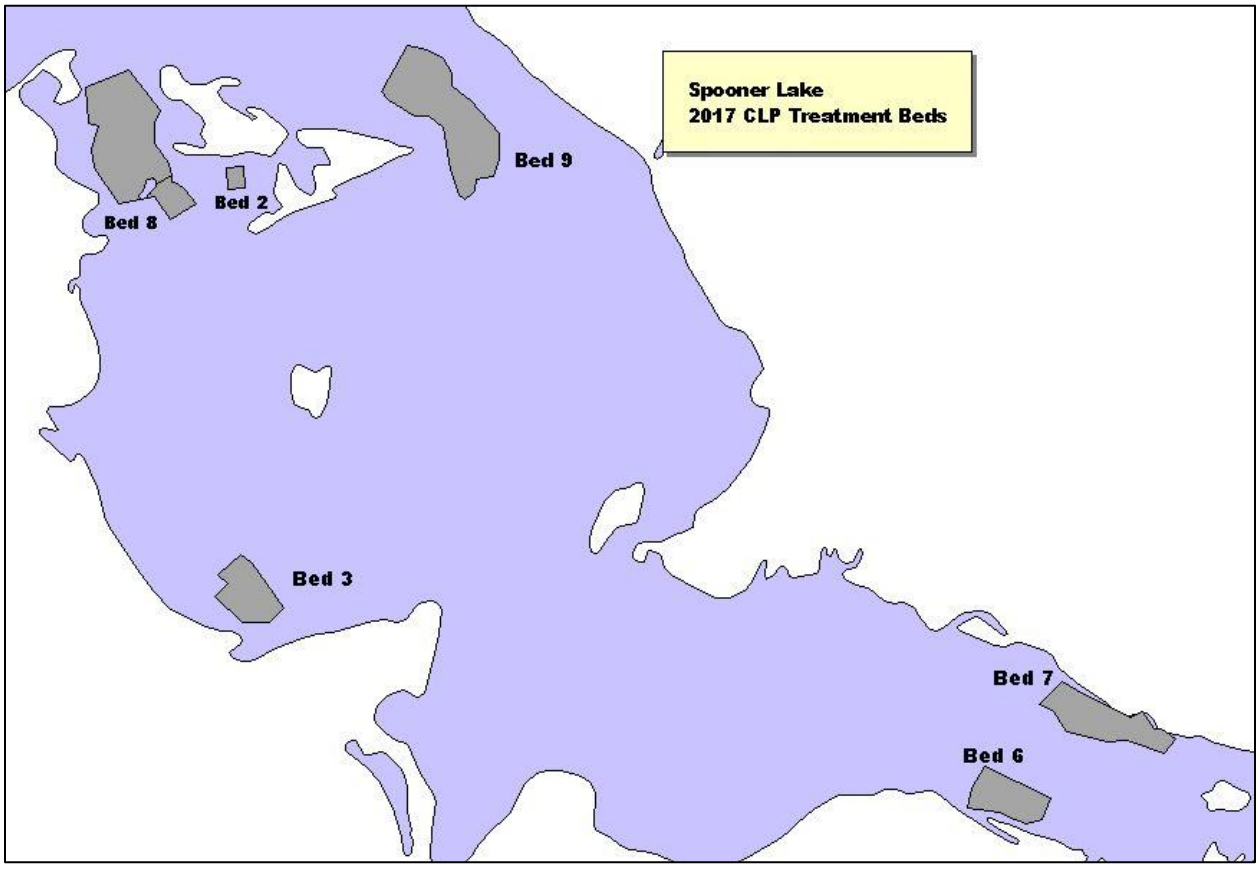

Figure 1: Map of 2017 CLP treatment beds-Spooner Lake.

Beds 2-7 have been treated in previous years. Beds 8 and 9 are new treatment beds for 2017, which were mapped in 2016.

Bed	*Acres*	*Mean Depth*	*Acre-ft*	*Wind (mph)*	*Water temp(°F)*	*Target Conc. (ppm)*
2 (May 8)	0.32	3.5	1.12	5-10 E/SE	55	1.5
3 (May 8)	2.24	4.5	10.08	5-10 E/SE	55	1.5
6 (May 8)	2.24	4.3	9.63	5-10 E/SE	55	1.5
7 (May 8)	3.29	4.3	14.15	5-10 E/SE	55	1.5
8 (May 8)	6.9	5.2	35.88	5-10 E/SE	55	1.5
9(May 10)	6.35	6.2	39.37	5 w/sw	58	1.5
All beds	**21.34**		**110.23**			

Table 1: Summary of treatment bed statistics.

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 Figure 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 two-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.

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 show a trend of reduced turion density each year. This way we know the treatments are killing plants prior to turion production, resulting in overall reduction in CLP in those beds.

a.

b.

Figure 3: Pictures showing turion density methods. a. shows sediment sample; b. shows separation; c. shows separated turions.

c.

Results

The pretreatment survey was completed on April 23, 2016. Two beds of CLP were added to the treatment this year (Beds 8 and 9) based upon mapped CLP in June 2016. This survey (coupled with the CLP observed in June 2016) resulted in the reduction of Bed 3. Bed 1 is covered over by Bed 8 starting this year. Beds 6 and 7 were left the same size. The pretreatment survey resulted in a frequency of 70.4%, after a frequency of 4.6% in the 2016 post treatment survey. This shows the turions germination returned CLP growth in all of the treatment beds from 2016. Figure 4 shows the pretreatment survey maps of each bed. Table 2 shows the frequency data breakdown.

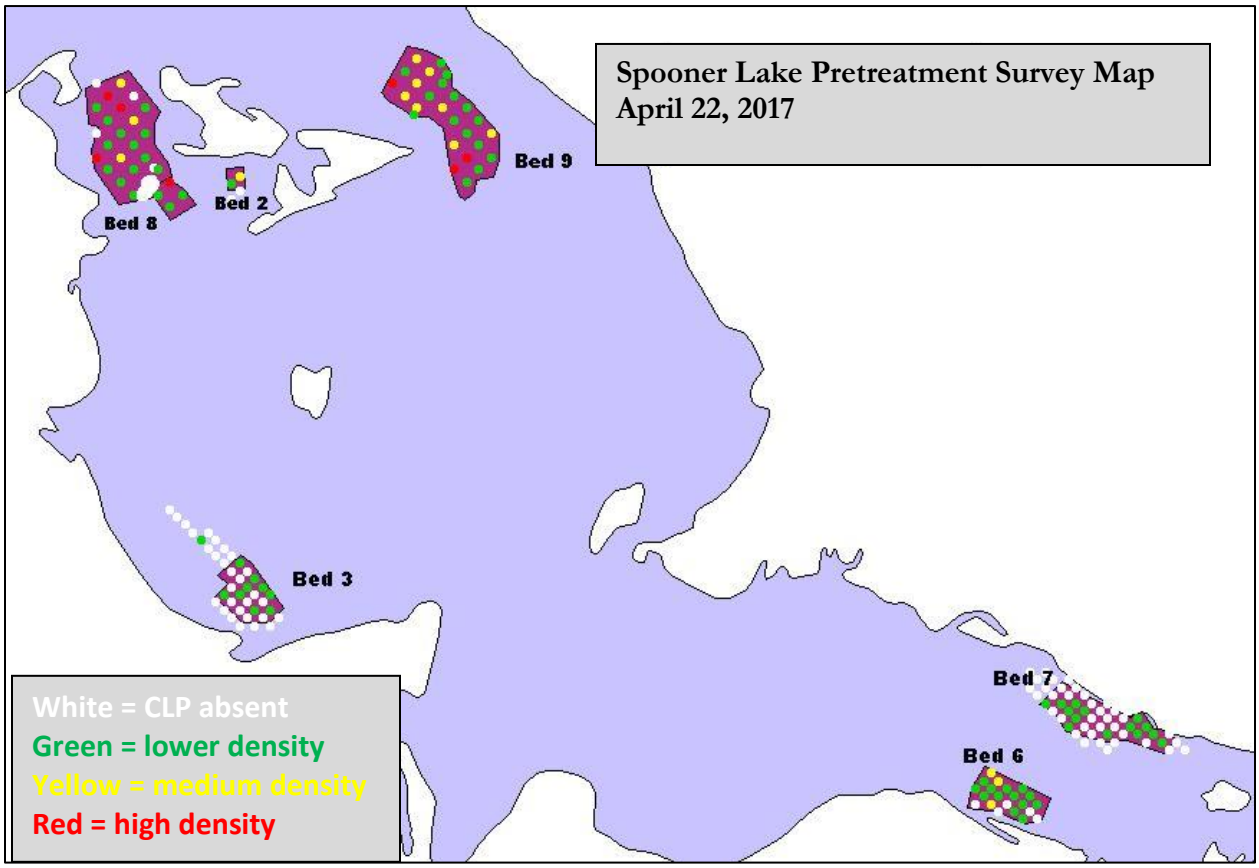

Figure 4: Pretreatment maps showing presence of CLP in each bed 2017.

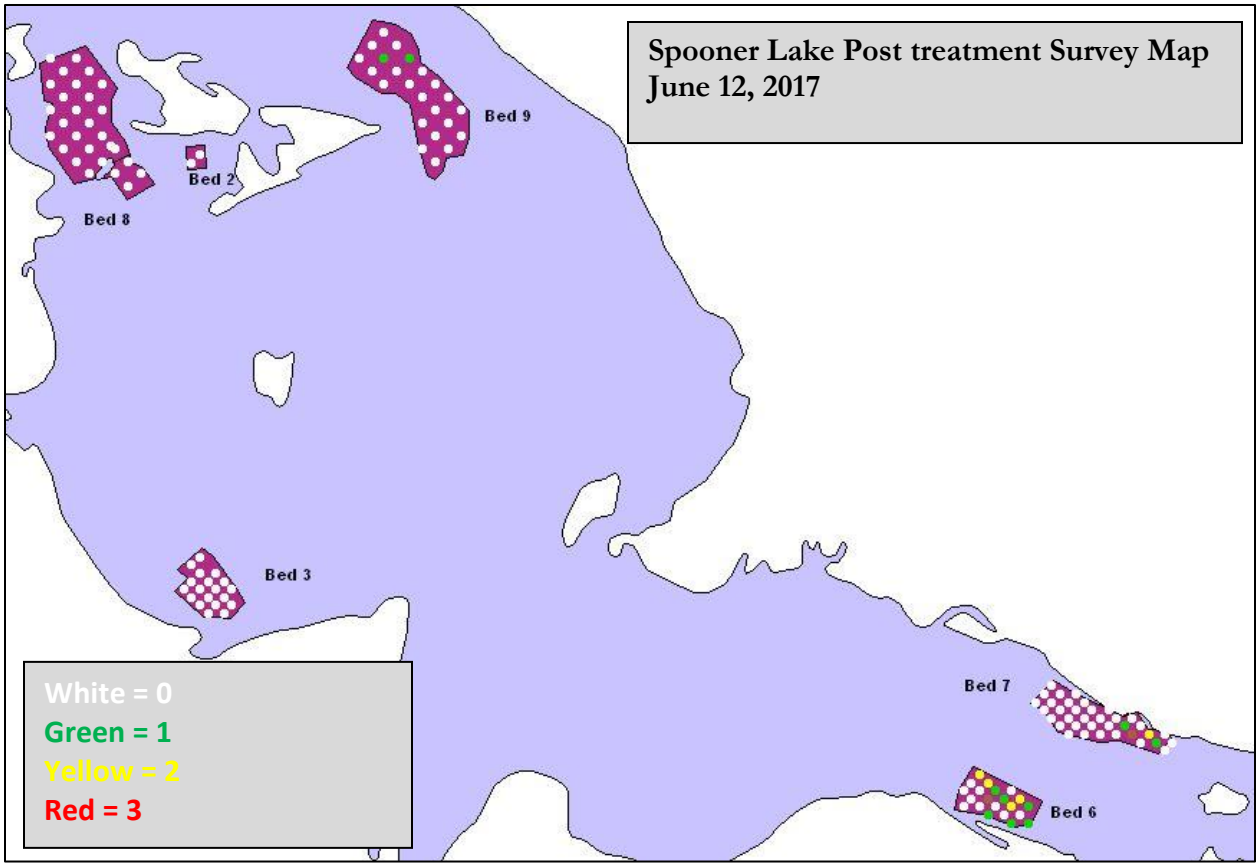

Figure 5: Post treatment density maps from post treatment survey-Spooner Lake 2016.

Bed	2016 Pre Freq	2016 Post Freq	2017 Pre Freq.	2017 Post Freq.	2017 Pre to 2017 Post change	2016 Post to 2017 Post (#not includeing 1,8,9)	2016 Pre to 2017 Pre(#not including 1,8,9)
1	100%	100%	n/a	n/a	n/a	n/a	n/a
2	75%	50%	66.7%	0.0%	-100%	decrease	decrease
3	62.5%	0.0%	47.3%	0.0%	-100%	n/c	decrease
6	42.8%	9.5%	75.0%	50.0%	-33.3%	increase	increase
7	36.2%	0.0%	43.8%	9.4%	-78.5%	increase	increase
8	n/a	n/a	89.3%	0.0%	-100%	n/a	n/a
9	n/a	n/a	100.0%	8.7%	-91.3%	n/a	n/a
All Beds	48.1%	4.6%	70.4% (54.0% old beds only)	12.0% (17.6% old beds only)	-82.95%***	#increase	#increase

Significance: *p<0.05, **p<0.001, ***p<0.0001

Table 2: Summary of treatment results with frequency from various surveys.

The 2017 post treatment survey was conducted on June 8, 2017. It shows that the treatment applied in 2017 was effective at reducing the CLP that was growing in the spring, 2017. The pretreatment frequency was reduced in each bed and showed a 83% frequency reduction in all beds together when comparing the pretreatment frequency to the post treatment frequency, which was a statistically significant reduction (based upon a chi-square analysis). The comparison between the 2016 post treatment frequency with the 2017 post treatment frequency resulted in an increase in frequency of occurrence (older beds 2-7 only). The pretreatment frequency comparison also shows an increase from 2016 to 2017 (see table 3). To compare the 2016 to the 2017 surveys, only the sample points that overlap treatments for both years were used. Since the CLP turions germinate in the fall and continue growing into the spring, the CLP often returns within beds that had successful reduction the prior year. The comparison of pretreatment frequency can show long-term reductions as the turion bed density gets reduced from successful treatments. This increase is small but is not desirable and can indicate reduced long-term reduction. See Figure 6 for a graphical comparison.

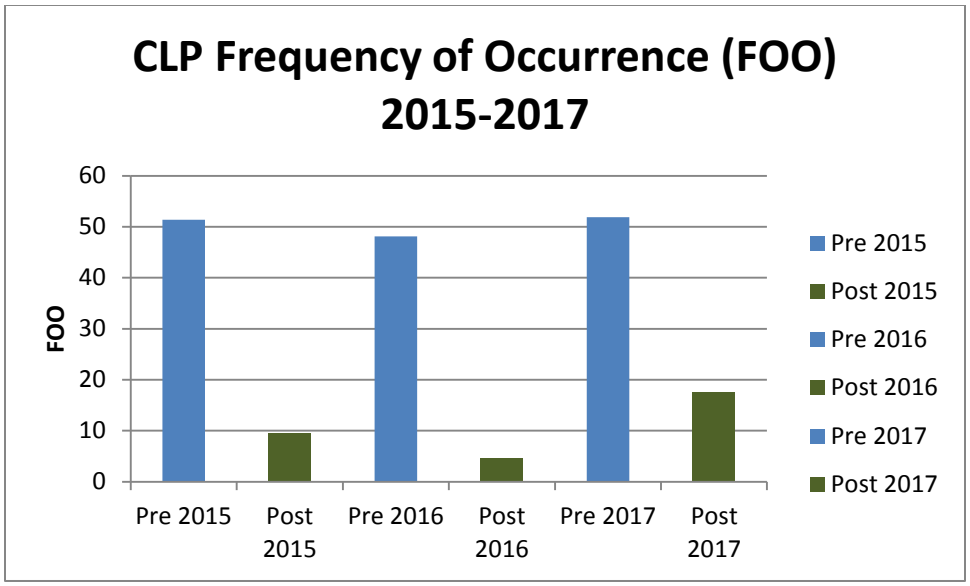

Figure 6: Graph showing frequencies from pretreatment and post treatment surveys.

The density increased from 2016 to 2017 as shown in the post treatment results.

Bed	2015 Density	2016 Density	2017 Density
1	n/a	1.0	n/a
2	n/a	0.5	0.0
3	0.0	0.0	0.0
6	0.0	0.095	0.7
7	0.17	0.0	0.125
8	n/a	n/a(2.3 when mapped 2016)	(0.0)
9	n/a	n/a (2.1 when mapped 2016)	(0.09)
All beds	0.09	0.046	0.24(0.16 with new beds))

Table 3: Summary of density in all treatment beds from 2015 and 2016 post treatment surveys.

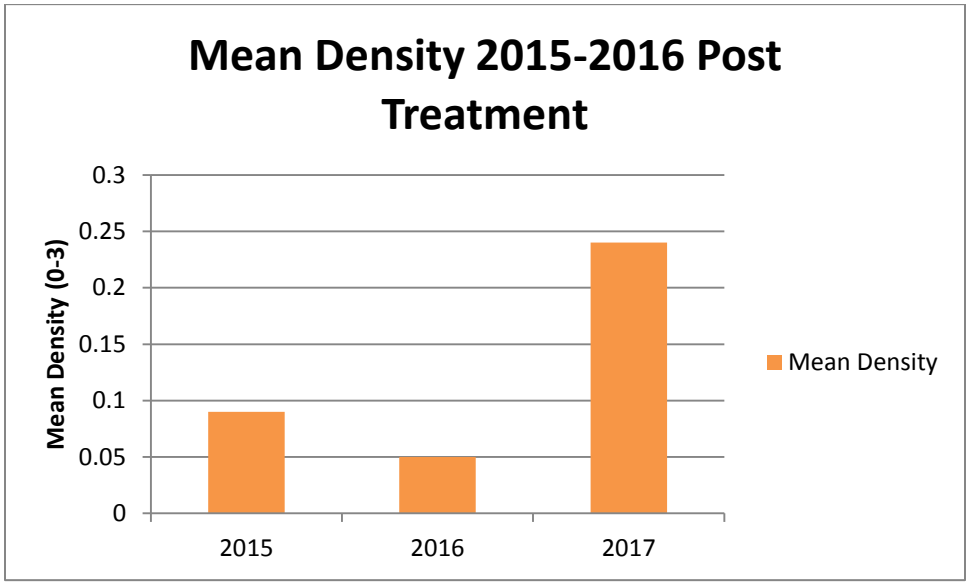

Figure 7: Mean density of all beds from 2015 to 2017. Data is adjusted in 2017 to compare only areas treated in 2016 also.

Native plant community

The frequency of native plants is also compared between the post treatment results to the previous year's post treatment results. This is to verify that the CLP was targeted with little or no adverse effects on the native plant community. Table 4 shows that there were decreases in three native species with one (*Najas flexilis*-slender naiad) that was statistically significant based upon a chi-square analysis (the sample points that were comparable for 2016 and 2017 treatment areas were used for chi-square). The cause of this reduction could be herbicide use, but it could also be due to season variation or sampling variation. The frequency of slender naiad was low in 2016, so this

decrease is not cause for major concern. There was an increase in several native species with one being significant, so it appears the herbicide did not have much effect on the native species.

Species	2016 Freq.*	2017 Freq.*	2017 Freq.#	Change 2016* to 2017* (Significance)
Waterweed *Elodea canadensis*	20.3%	35.1%	33.6%	Increase (*)
Coontail *Ceratophyllum demersum*	29.7%	31.1%	44.0%	Increase
Northern water-milfoil *Myriophyllum sibiricum*	44.6%	54.0%	48.8%	Increase
Sago pondweed *Stuckenia pectinatus*	4.0%	9.4%	10.4%	Increase
Water stargrass *Heteranthera dubia*	9.4%	9.4%	9.6%	n/c
Slender naiad *Najas flexilis*	6.8%	0.0%	0.0%	Decrease (*)
White lily *Nymphaea odorata*	1.4%	1.4%	0.8%	n/c
Wild celery *Vallisneria americana*	2.7%	0.0%	0.8%	Decrease
Flatstem pondweed *Potamogeton zosteriformis*	0.0%	1.4%	2.4%	Increase
Muskgrass *Chara sp.*	4.0%	2.7%	1.6%	Decrease
Clasping pondweed *Potamogeton richardsonii*	1.4%	1.4%	0.8%	n/c
Forked duckweed *Lemna trisulca*	0.0%	1.4%	0.8%	Increase
Spatterdock *Nuphar variegata*	0.0%	1.4%	0.8%	Increase
Arrowhead rosette *Sagittaria sp.*	n/a	n/a	0.8%	---
Whitestem pondweed *Potamogeton praelongus*	n/a	n/a	0.8%	---

Significance *p<0.05, **p<0.02, ***p<0.01
*Only sample points used that overlapped within treatment areas for both years.
#Uses all sample points in 2017 treatment beds for future reference.

Table 4: Summary of native plant frequencies 2016 and 2017.

Turion analysis

The turion density was analyzed on Oct. 7, 2017. Bed 1 was not analyzed as it became part of the new bed 8. Beds 8 and 9 were new to treatment in 2017, so this was the first year turion data was collected. In the table, all beds were averaged for the old beds as well as all beds including 8 and 9 separately for comparison purposes. Table 5 shows the historical means of turion density.

Bed	2013 Mean turion density (T/m^2)	2014 Mean turion density (T/m^2)	2015 Mean turion density(T/m^2)	2016 Mean turion density(T/m^2)	2017 Mean turion density(T/m^2)
1	39.6	22.0	43.0	86.0	n/a
2	49.5	11.0	22.0	0.0	0.0
3	13.2	58.0	57.7	3.7	21.5
6	84.2	59.5	48.4	16.3	54.25
7	82.0	86.7	73.7	82.7	115.7
8	n/a	n/a	n/a	n/a	27.4
9	n/a	n/a	n/a	n/a	77.2
All beds 2-7	62.7	63.9	56.1	38.1	71.2
All beds 2-9	n/a	n/a	n/a	n/a	58.6

Table 5: Turion density by bed, 2013 through 2017.

Figure 8 is a map that shows the turion density at each treatment bed. The turion data in 2017 had an increase in density in all old beds except bed 2. This could be due to some growth of CLP in 2017 after treatment that led to turion production. Bed 7 is the only bed with rather dense turions, with bed 9 also having relatively high density. Bed 9 is new to treatment and is to be expected. For comparison, some lakes have shown turion densities of 1200 turions/m^2, so the density in Spooner Lake is not extremely high by comparison. It does indicate that CLP should return in growth in all of these beds in 2018.

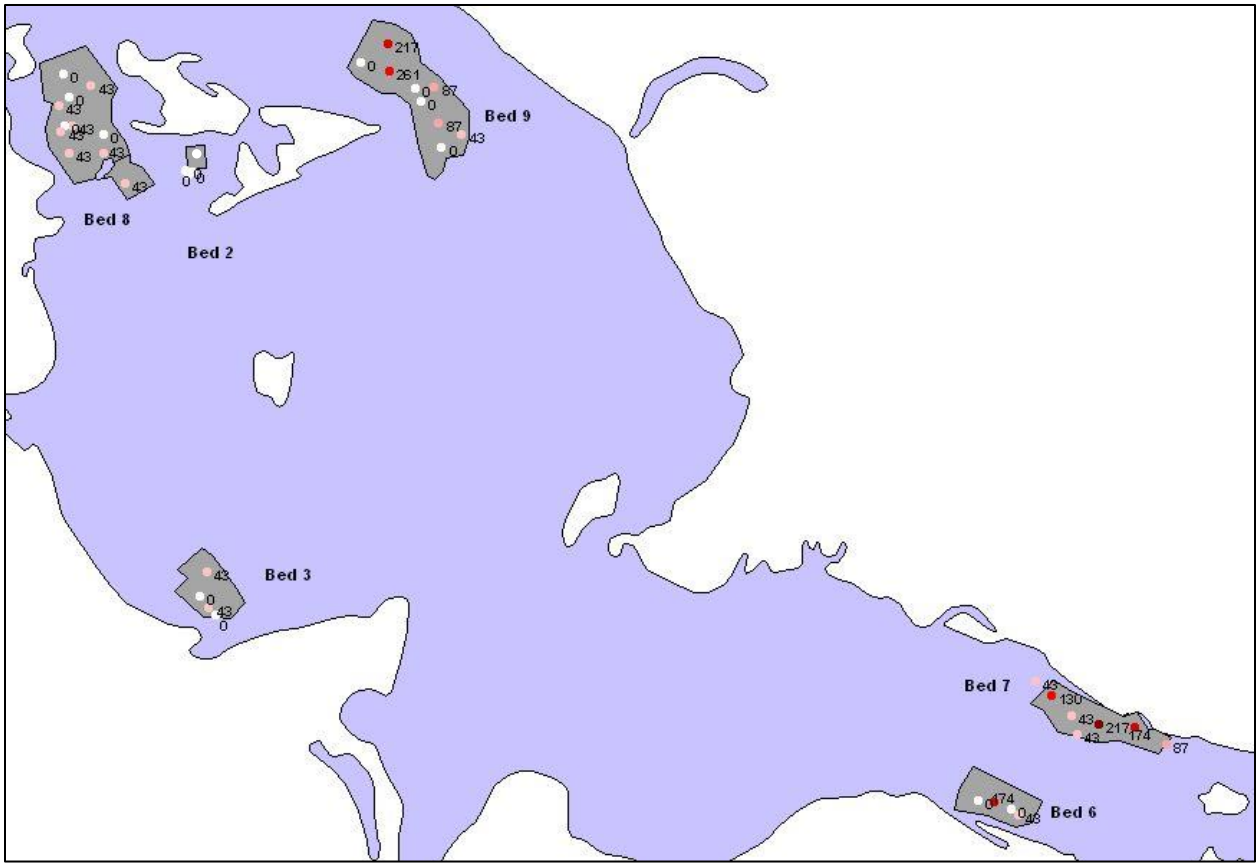

Figure 8: Map of turion density each bed, 2017.

As figure 10 shows, the overall turion density increased in 2017 from previous years. It does not show a major increase and therefore the CLP growth shouldn't show a major increase in 2018.

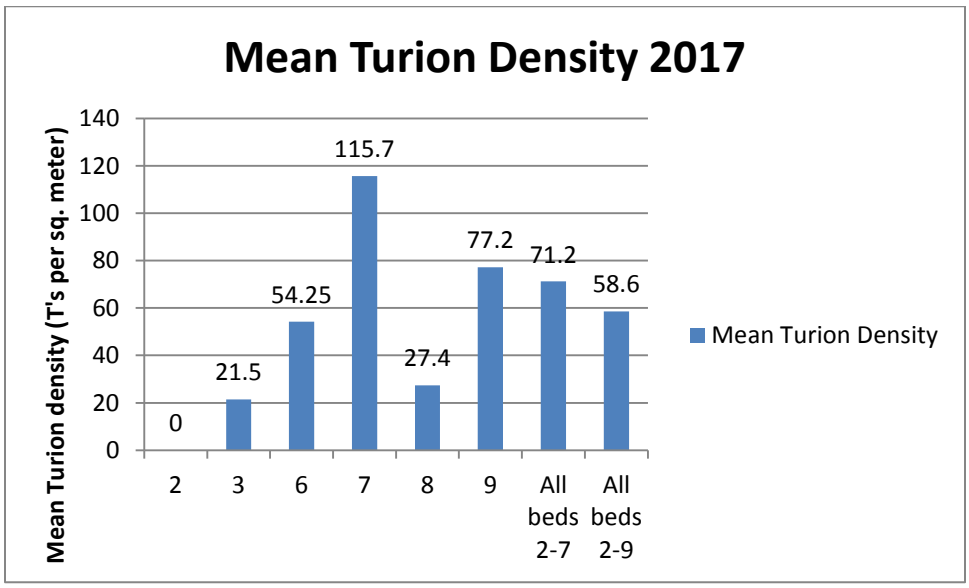

Figure 9: Graph showing turion density for each bed 2017.

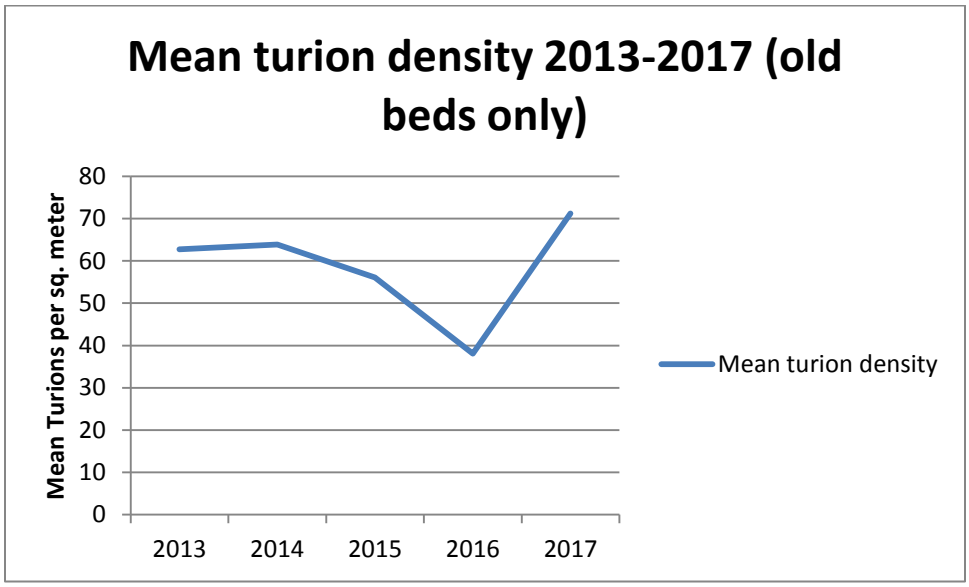

Figure 10: Mean turion density changes from 2013-17 for the old beds only (doesn't include beds 8 and 9 as they were treated for the first time in 2017).

CLP Mapping

Each year the CLP is remapped to determine the aerial coverage of dense CLP beds. Typically, beds that have a mean density greater than 2 and have CLP at or near the water surface are delineated and mapped on Spooner Lake. The CLP had been declining annually. This is due to successful treatments and some apparent natural variation that has been a decline overall.

2017 showed more CLP growth in the "main lake basin." The CLP management has historically focused on reducing CLP in this part of the lake. As the CLP disappeared, the management moved to other areas since the "main basin" had little or no CLP. In June 2017 CLP was observed in several locations in this main basin, while it has subsided in areas historically dense with CLP. In 2016, some rather large beds of CLP were observed and delineated. Two of the three largest beds were treated. The two beds treated had CLP reduced, but the third bed substantially reduced without treatment. Interestingly, the southeast end of the lake has been historically the only area with consistent CLP growth and there was very sparse CLP in this location in 2017. The new beds mapped totaled approximately 3.8 acres and figure 11 shows these locations.

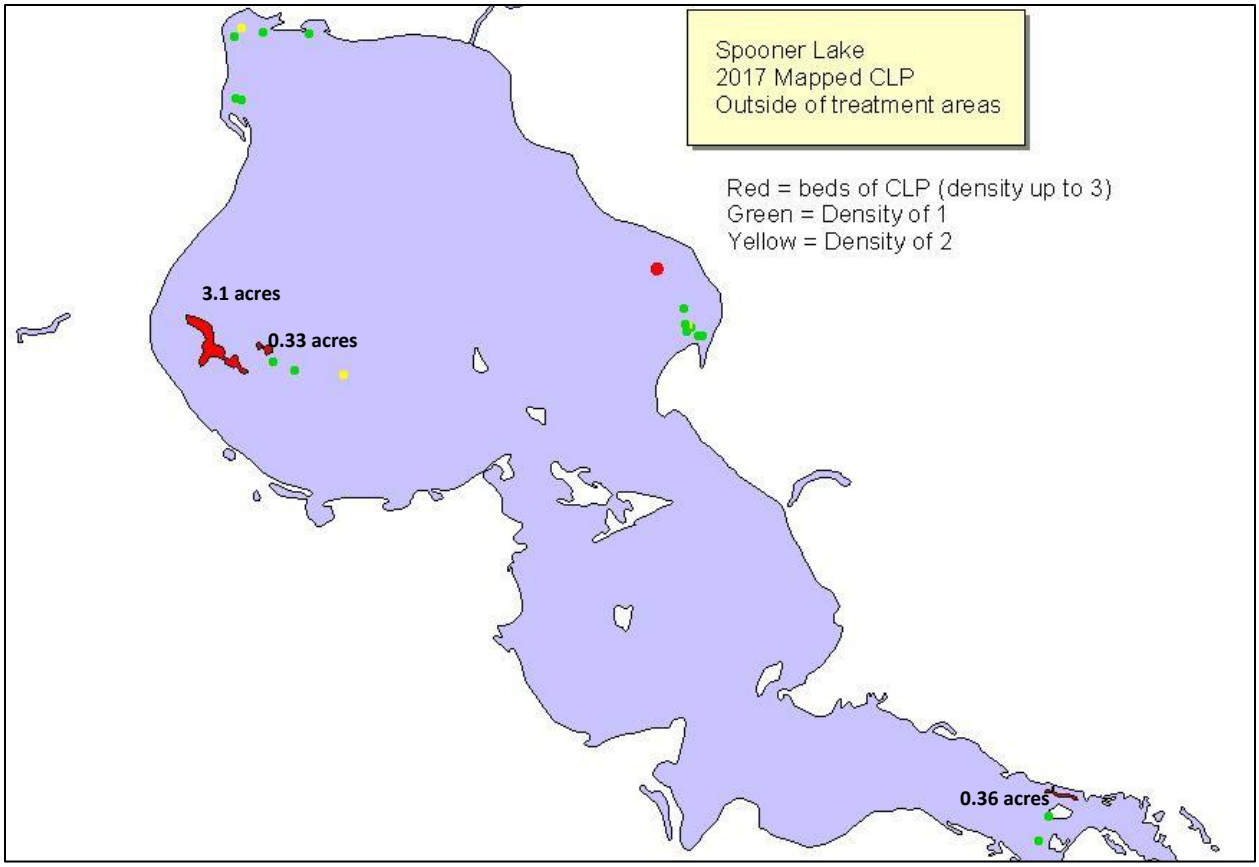

Figure 11: Map of CLP growth in 2017.

Discussion

The herbicide treatment in 2017 was successful at reducing CLP. There was very little CLP growth after treatment in all beds except for bed 6, in which there were four sample points with and density of "2". Overall, the reduction from what was growing before treatment to after treatment was statistically significant ($p<0.0001$). Comparing only beds treated in 2016, there was a small increase in frequency from pretreatment 2016 to pretreatment 2017 as well as post treatment 2016 to post treatment 2017. This is not desired as an annual decrease is the goal. Also, turions likely were produced by these plants, leading to increased growth in the future. The new beds could not be compared as a whole, but their frequency and density were reduced significantly after treatment as compared to the pretreatment.

The turion analysis showed an increase in turion density from 2016 to 2017. It is desired to see annual decreases in turion density as this shows long-term reduction.

The mapping of CLP in the whole lake resulted in a rather large bed appearing in the main lake. The management plan goal is to keep CLP from the main lake. As a result, this bed may need to be treated, depending on the spring growth. CLP growth in Spooner Lake has varied a great deal annually, so it may be wise to wait to see what this bed does in the future before treating.

If continued CLP reduction is desired, these treatment areas will need to have herbicide application occur again in 2018.

References

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Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America.* The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

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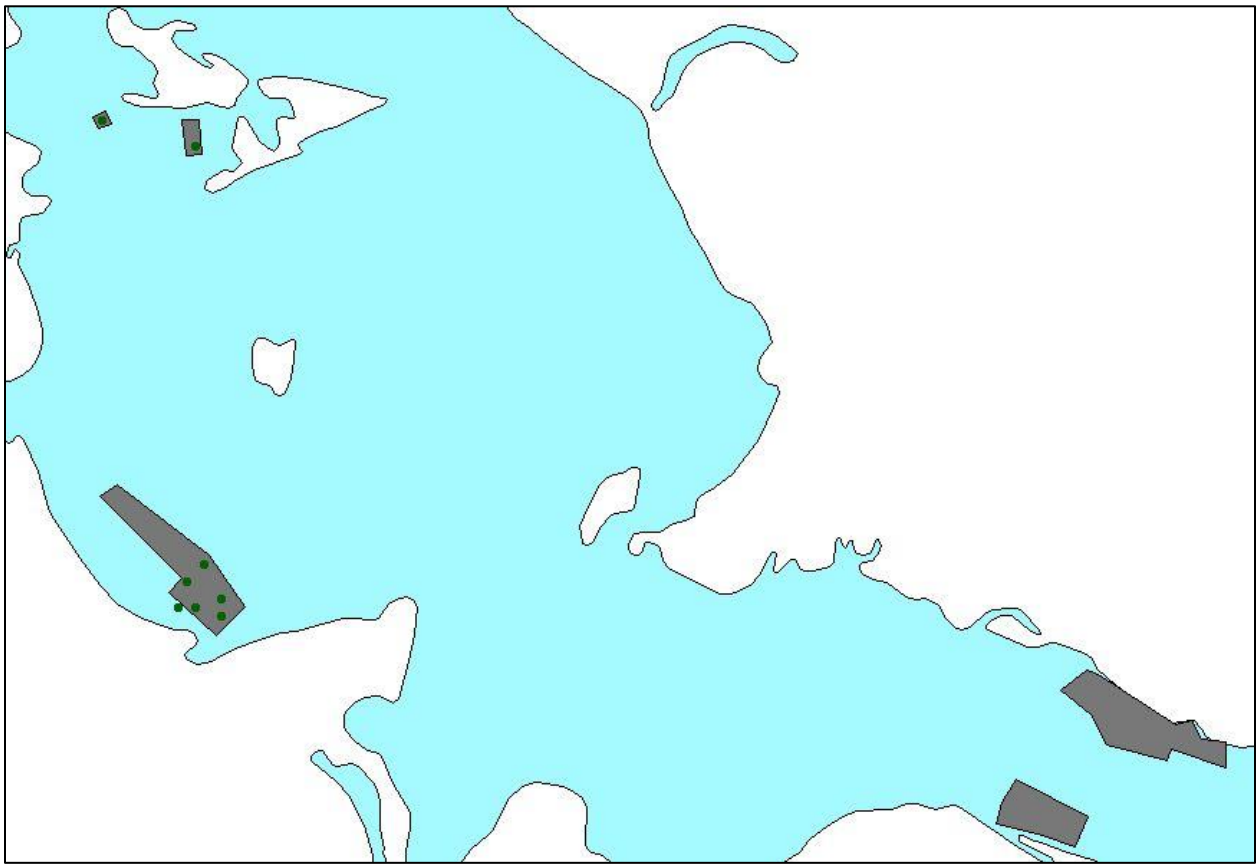
Appendix-Maps of native plants with reduction 2016-2017



***Najas flexilis*-slender naiad, June 2016**

***Najas flexilis* was not sampled in 2017.**