Analysis of Herbicide Treatment Targeting *Potamogeton crispus* –curly-leaf pondweed (CLP)

Big Lake (WBIC: 2615900)

Polk County, Wisconsin

2021

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

Amery, WI

Analysis summary

On April 30, 2021 two beds totaling 4.95 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) were treated with the herbicide endothall at a target concentration of 2.5 ppm. The water temperature at the time of treatment was 50 ^{o}F. A pretreatment survey was conducted earlier in April, and a post treatment survey was conducted in June 2021. A chi-square analysis was used to determine the significance of any reductions in the frequency of occurrence. The frequency of occurrence from the pretreatment to the post treatment survey showed a statistically significant frequency of occurrence reduction (from 75% to 35.7%) ($p=0.0025$). A comparison of the post treatment survey of 2020 and the post treatment survey of 2021 showed an increase. Comparing the pretreatment survey of 2020 to the pretreatment survey of 2021, a small decrease occurred and was not statistically significant based on chi-square analysis ($p=0.2$). A chi-square analysis revealed a statistically significant reduction in two native plant species; *Elodea canadensis*(waterweed) and *Najas guadulupensis* (southern naiad). A turion analysis resulted in a slight increase in turion density from 2020 to 2021 (4.3 to 6.9 turions/m^2). With the 2021 turion density data included, there has been a slight decrease trend in turion density since 2012.

Introduction

On April 30, 2020 two beds totaling 4.95 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) were treated with herbicide (endothall-K) on Big Lake in Polk County Wisconsin (Township 32N, Range 18W Section 36). Figure 1 shows the location of the beds.

The treatment comprised of a concentration target of 2.5 ppm of endothall K. Table 1 shows the statistics for each treatment bed.

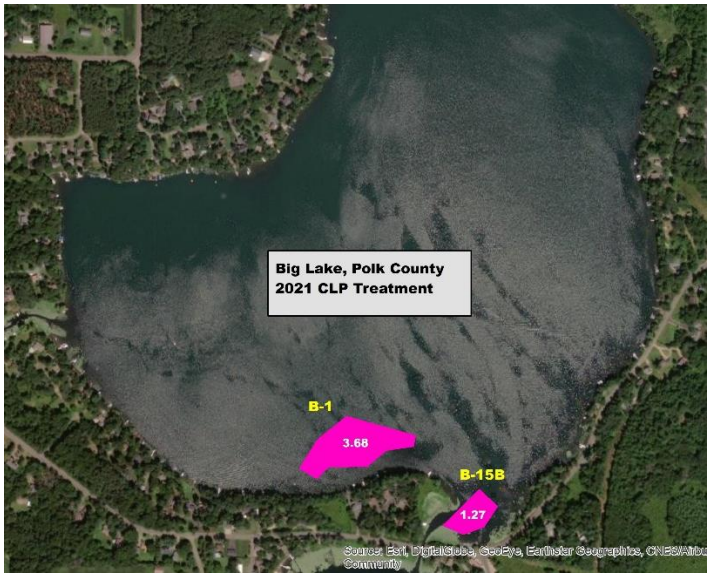

Figure 1: Map showing 2020 CLP treatment beds.

Big Lake 2021 Treatment Bed Stats						
Bed	**Acres**	**Mean Depth**	**Acre-feet**	**Target conc. (ppm)**	**Water temp. at treatment (°F)**	**Wind speed/direction**
B-1	3.68	6.1	22.45	2.5	55	1-2/NW
B15-B	1.27	4.5	5.72	2.5	55	1-2/NW
Total	4.95		28.17			

*As reported by applicator on herbicide treatment record (HTR)

Table 1: Summary of 2021 treatment bed statistics.

Methods

To conduct and analyze the treatment, two surveys are conducted following the 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.

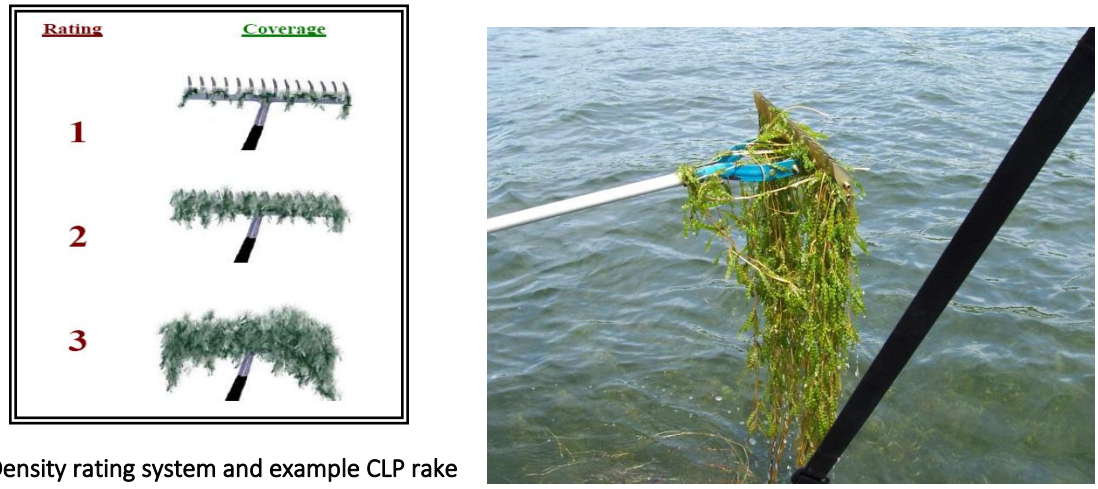

Figure 2: Density rating system and example CLP rake sample.

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.

a

b

c

Figure 3: Pictures showing turion density methods.

(a) shows sediment sample; (b) shows separation; (c)shows separated turions.

Results

The 2021 herbicide treatment to target and reduce *Potamogeton crispus* (CLP) was successful at reducing the frequency of CLP before treatment to after treatment (pre and post treatment surveys). The reduction was statistically significant according to a chi-square analysis (P=0.0025). Table 3 summarizes the frequency data from pre/post treatment surveys in 2020 and 2021. Table 4 summarizes the chi-square analysis results comparing surveys. Although the reduction was significant from pretreatment frequency to post treatment frequency, there was a larger frequency of CLP than in past post treatment surveys. Furthermore, the frequency of CLP in bed B15B actually increased after treatment which is not a good result.

Bed	Pretreat FOO 2020	Post treat FOO 2020	Pretreat FOO 2021	Post treat FOO 2021
B-1	71%	12.5%	76.9%	25.0%
B-12	75%	12.5%	0.0%	0.0% (not treated 2021)
B-15B	45.5%	0.0%	55.6%	60.0%
All Beds	67.4%	9.3%	53.2% (75% for B1 and B15B	27.6% (37.5% for B1 and B15B)

Table 3: Frequency of occurrence data for pre and post treatment surveys 2020 and 2021.

Effective treatment in the reduction of CLP can be shown by comparing various surveys. A comparison to indicate long-term reductions is the pretreatment survey frequencies. The frequency from 2020 to 2021 (in the pretreatment survey) decreased somewhat (if include untreated bed B12 which provides indicator from 2020), which is desirable but the decrease was not statistically significant. Also, comparing the post treatment from 2020 to 2021 showed a statistically significant increase. This is not a desirable result.

Bed	Pre to post (2021) reduction and significance	Post 2020 to Post 2021 reduction significance	Pre 2020 to Pre 2021 Reduction Significance	Mean Density Change 2019-2020 (post)
All beds	Yes (p=0.0025)	Increase (p=0.006)	No (p=0.2)	Increase

Table 4: Chi-square analysis results for pre/post treatment survey results to determine the statistical significance of reduction.

The mean density of CLP in the post treatment survey of 2021 was higher than the mean density in all years back to 2018.

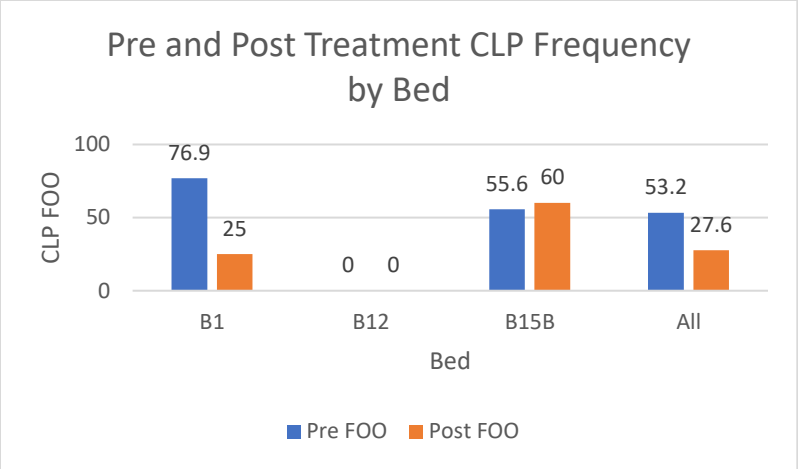

Figure 4: Graph representing the frequency of occurrence pre/post surveys 2021.

Bed	Mean Density 2021 (post)	Mean Density 2020 (post)	Mean Density 2019 (post)	Mean Density 2018 (post)
B-1	0.28	0.12	0.22	0
B-12	0	0.12	0.09	0
B-15B	0.9	0.0	0.08	0
All Beds	0.47	0.09	0.19	0

Table 5: Mean CLP density stats from post treatment surveys 2018 - 2020.

Table 5 also shows the increase in CLP growth after treatment compared to 2020, as the density is higher as well.

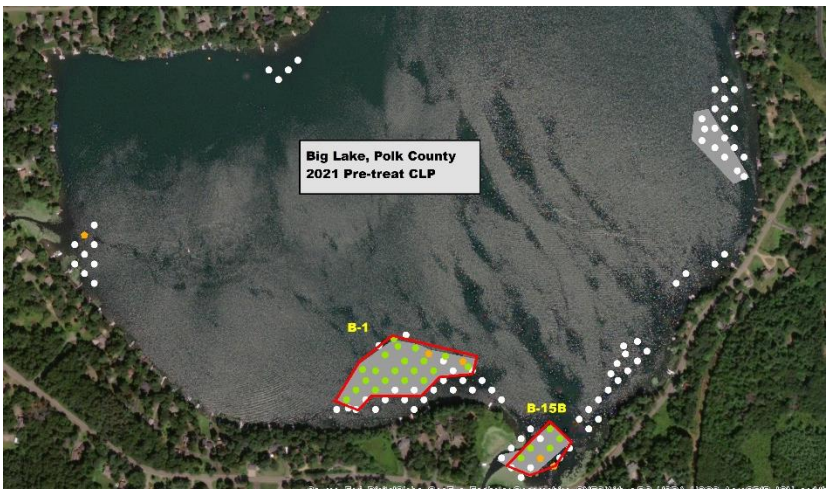

Figure 5: Map of CLP presence/absence from pretreatment survey, April 2021.

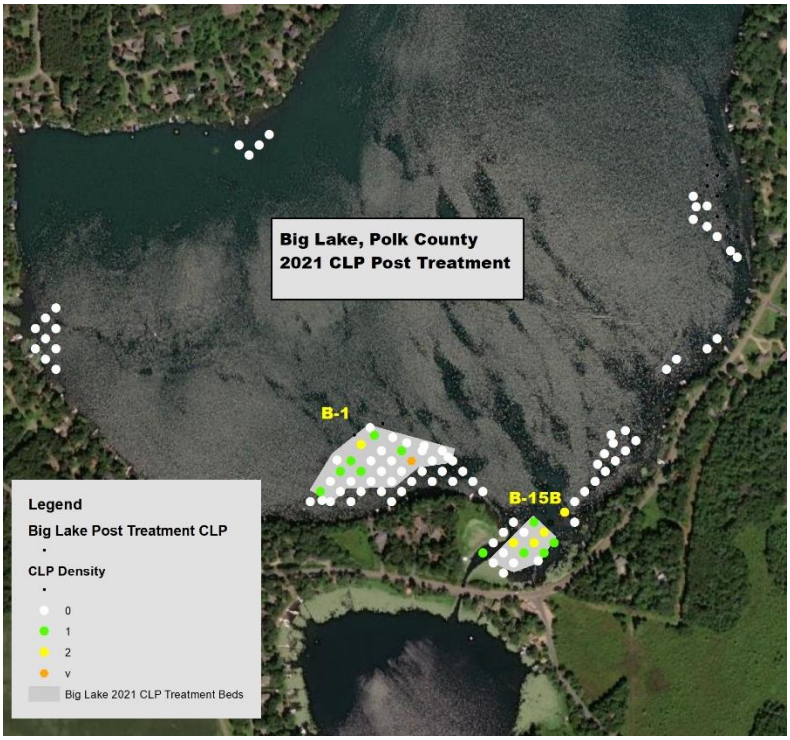

Figure 6: Map of CLP density from post treatment survey June, 2021.

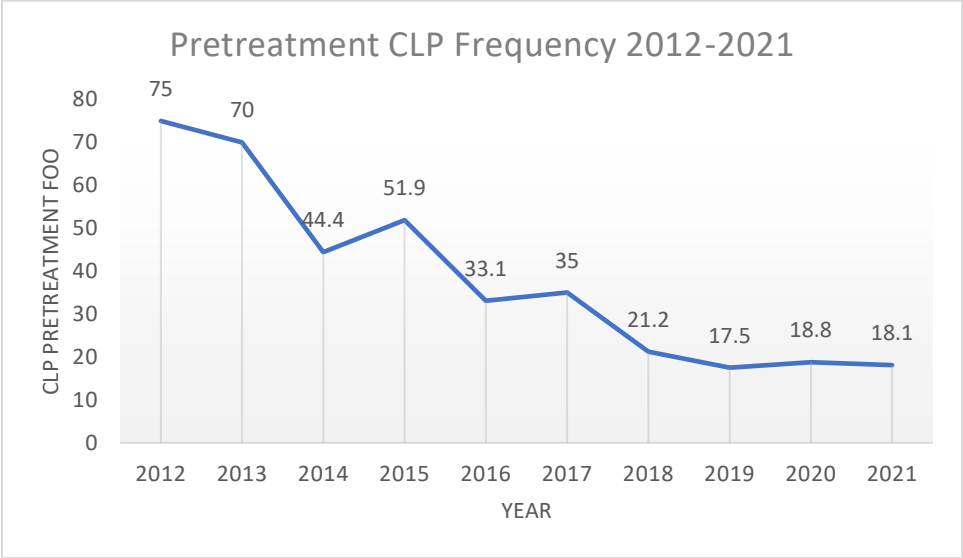

Figure 7: Pretreatment frequency of CLP using the same sample points from 2012 to 2021.

Figure 7 shows the pretreatment frequency of CLP for the same sample points starting in 2012 to 2021. It shows a long-term trend of frequency reduction, which clearly indicates that the herbicide treatments have significantly reduced CLP over the course of many years. The decrease has leveled in the last

couple of years, which shows some CLP is returning each spring. The turion analysis can help show where CLP may potentially return in the following spring.

Native species reduction analysis

A successful treatment not only results in the reduction of the target species, but also does not reduce native species. The frequency of occurrence for native species is compared to the previous year's frequency from the post treatment survey using a chi-square analysis. In the 2021 treatment, one native species *Elodea canadensis* (common waterweed) had a significant reduction. This reduction may be due to the herbicide. The reduction was from a frequency of 38% in 2020 to 0% in 2021, which is a large change. There was a statistically significant reduction in common waterweed in the 2020 treatment as well. The other significant reduction was with *Najas guadulupensis* (southern naiad). This plant has become much more frequent in Big Lake, so this reduction could be herbicide related or natural variation. Table 6 shows the results of the chi-square analysis for native plant species.

Species	2020 freq	2021 freq	change	Significant Reduction?
Ceratophyllum demersum(coontail)	0.75	0.90	+	Increase
Elodea canadensis(waterweed)	0.38	0.00	-	Yes ($p=2X10^{-5}$)
Heteranthera dubia(stargrass)	0.0	0.02	+	Increase
Myriophyllum sibiricum (northern water-milfoil)	0.33	0.25	-	No (p=0.46)
Nymphaea odorata (white lily)	0.05	0.05	n/c	n/a
Potamogeton praelongus (whitestem pondweed)	0.25	0.15	-	No (p=0.26)
Najas guadulupensis (southern naiad)	0.48	0.10	-	Yes (p=0.0002)
Stuckenia pectinata (sago pondweed)	0.02	0.00	-	No (p=0.31)
Potamogeton richardsonii (clasping pondweed)	0.02	0.00	-	No (p=0.31)
Vallesneria americana (wild celery)	0.02	0.00	-	No (p=0.31)
Potamogeton illinoensis (Illinois pondweed)	0.00	0.02	+	Increase

Table 6: Chi-square analysis summary for evaluation of native species potential response to herbicide.

Bed Mapping

Each year at the time the post treatment survey is conducted, the entire lake littoral zone is surveyed for CLP beds. All locations that CLP is observed are recorded with GPS and mapped. Any beds observed are delineated and mapped. A bed to be delineated is defined as any area of CLP that has growth at or near the surface, has a defined border (due to sufficient density of CLP) that can be observed from the boat and followed, and has at least 50% coverage of CLP within the defined border.

No beds of CLP were observed in Big Lake (as well as Round Lake and Church Pine Lake). There were a few individual plants/small clumps of plants observed in Big Lake and are shown in figure 8.

Figure 8: Map of CLP observed outside of treatment areas. No beds of CLP were present to delineate.

Turion Analysis

In October, 2021 a turion analysis was conducted. The results showed a small increase in the turion density bed B1, treated in 2021. This could be the result of some CLP growth after treatment that occurred in 2020. Note that in bed 15B, there were no turions sampled in 2020 and 2021. It is interesting that there was CLP growing in Bed 15B at the 2021 post treatment survey, but there was no increase in turion density. Hopefully the CLP present didn't release a large number of turions leading to none sampled but it is more likely turions were produced and the sampling didn't pick the turions up. There was also a small increase in turion density in all sample points (4.3 to 6.9 turions/m^2).

Bed	**2021 mean turions/m^2**	**2020 mean turions/m^2**
B1	7.8	6.1
B12	17.2	5.5
B15B	0	0
All locations (see map in figure 10)	6.88	4.30

Table 7: Summary of turion density by bed from 2020 and 2021.

The turion density data in 2020 showed a rather narrow range of data which indicates there are no longer high density turion areas remaining in the Big Lake sediment.

2021 turion density data using all historical turion sample points:
Mean turions/m^2 = 6.9
Min-maximum/m^2 = 0 - 64.5
Standard deviation = 14.8

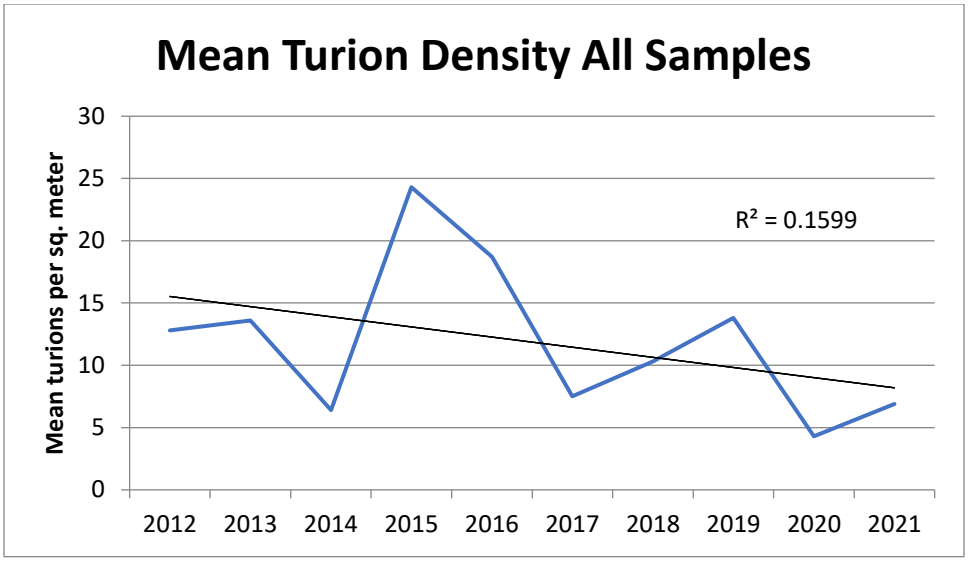

Figure 9: Graph showing turion density from 2012 to 2021, Big Lake with trendline and correlation.

To evaluate the long-term turion density trends, the data using all of the turion sample points originally set in 2012 can be compared. The data shows, including the small 2021 density increase, the overall trend since 2012 is a decrease. There are fluctuations, which make the correlation weaker (R^2=0.16), but the trend is still a decrease which is what is desired.

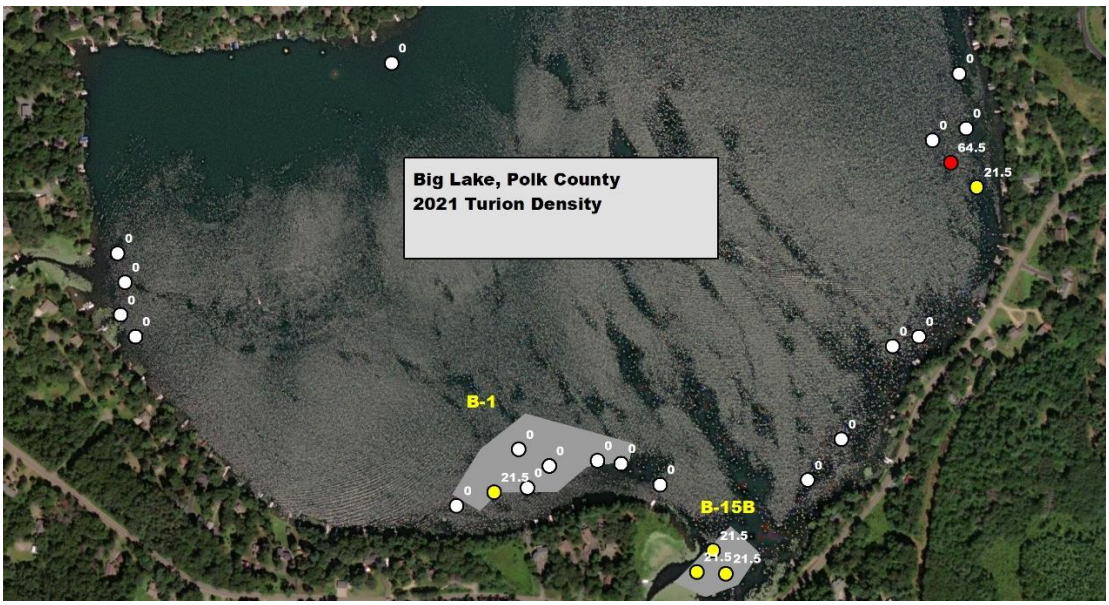

Figure 10: Map of turion density in 2021.

Discussion

The 2021 herbicide treatment was effective at reducing the frequency of CLP growing before treatment compared to after treatment. However, there was a higher frequency than desired in the two treatment beds, especially in Bed 15B. The comparison of the previous year's survey showed an increase in post treatment frequency in 2021, which is not desirable. There was a small decrease in the pretreatment frequency in 2021, which is desirable but was not significant. The CLP in Big Lake does remain very limited which is the result of several years of successful treatments. The frequencies are low so the treatment could still be reducing increase that would otherwise occur without treatment.

The reduction in two native species is not desirable, but the cause is not known. When using herbicide, the cause due to herbicide must be considered. The decrease in common waterweed (*Elodea canadensis*) was a big frequency change. The decrease in Southern naiad (*Najas guadulupensi)* is not as concerning as this plant has been very high in frequency and this could be natural variation with a relatively small decrease.

The bed mapping survey resulted in a few CLP plants found a few locations, but no beds were present to delineate and map. The CLP in Big Lake is limited.

The turion density increased slightly from 2020 to 2021. The turion density is still low and supports the long-term trend of CLP reduction, likely due to herbicide treatments.

The use of herbicide in the CLP beds in Big Lake in 2022 will need to be evaluated based upon the CLP frequency in the spring 2022. Since CLP was present (fairly high density in Bed 15B) in the 2021 post treatment survey, CLP could return within Bed B1 and B15B. The bed mapping survey did not show any indication that CLP is returning in historical beds. There were some turions sampled in some areas, which would suggest some CLP will grow in the future. The turion density is not very high, so the growth shouldn't increase significantly. The threshold for treatment developed in the Aquatic Plant Management Plan will be followed to make the herbicide use decision.

References

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.

Ecological Integrity Service. *Herbicide Treatment Analysis for Potamogeton crispus-curly leaf pondweed, Big Lake Polk County WI.* 2014.

University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft. 46 p.

UW-Extension. Aquatic Plant Management website. http://www4.uwsp.edu/cnr/uwexlakes/ecology/apmguide.asp appendix D.