Herbicide Treatment Analysis for *Potamogeton crispus* (CLP)

Big Lake

Polk County, WI

2016

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

Amery, WI

Abstract

On April 22, 2016 13.75 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 50 and 60 degrees F. A pretreatment survey was conducted on April 18 and a post treatment survey was conducted on June 6, 2015. 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 56.25% to 3.1%). A comparison of the post treatment survey of 2015 and the post treatment survey of 2016 showed a slight decrease from 4.8% to 3.1% which was not significant. Comparing the pretreatment survey of 2015 to the pretreatment survey of 2016 showed a statistically significant (chi-square) decrease from 79.8% in 2015 to 56.25% in 2016. A chi-square analysis revealed no statistically significant reduction in any native plant species. A turion analysis was conducted in October 2016 and resulted in a decrease in all beds combined compared to the 2015 density.

Introduction

On April 22, 2016 seven beds totaling 13.75 acres of *Potamogeton crispus*-curly leaf pondweed (CLP) beds were treated with herbicide (endothall-K) for the sixth 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.

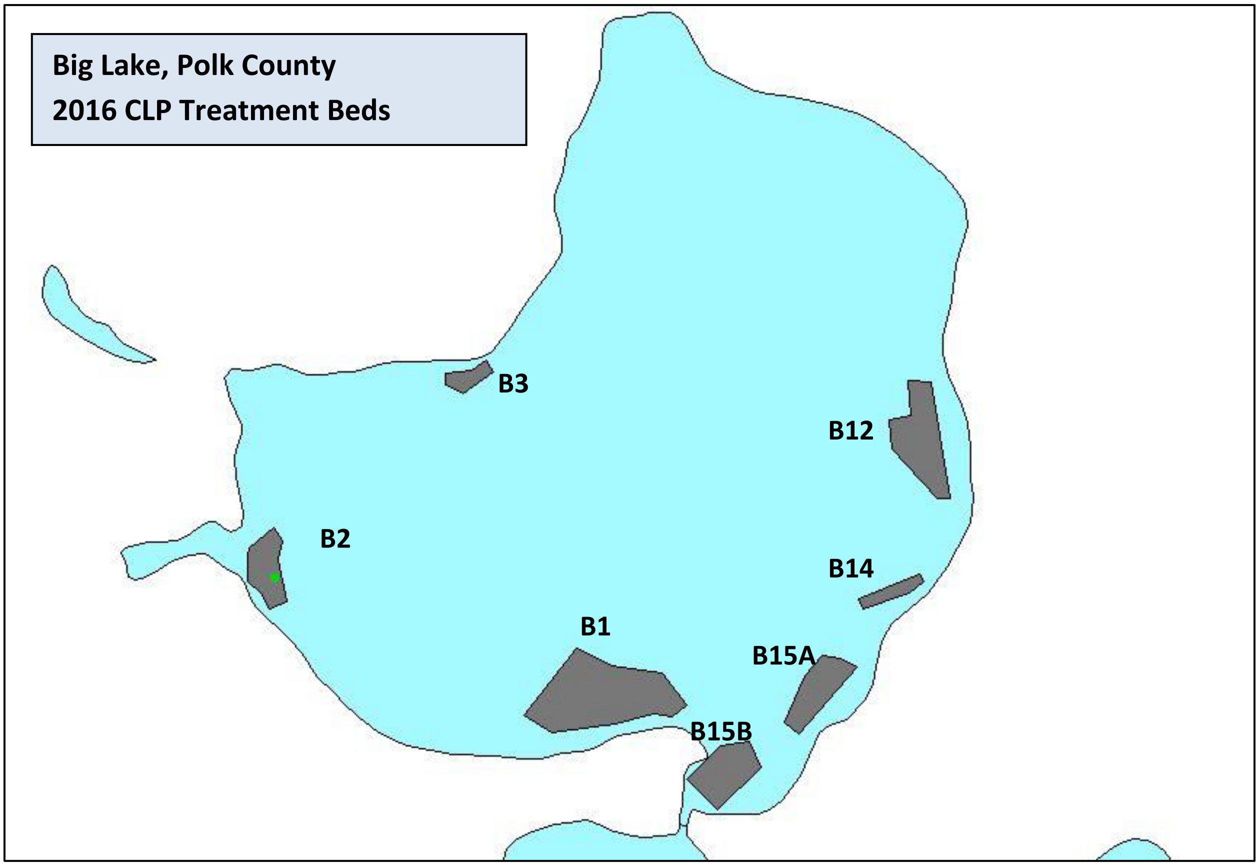

Figure 1: Map showing 2014 CLP treatment beds

Big Lake 2016 CLP 4/22/16	Winds 3-5 mph	Water temp:51°F			
Big Lake	**Acres**	**Mean Depth(ft)**	**Acre-feet**	**Gallons applied***	**Target conc.*** (ppm)
B1	5.20	5.9	30.68	30.7	1.5
B2	1.36	6.1	8.30	13.3	2.5
B3	0.51	8.0	4.08	6.5	2.5
B12	2.67	7.2	19.22	19.2	1.5
B14	0.52	5.8	3.02	4.8	2.5
B15A	1.64	7.0	11.48	11.5	1.5
B15B	1.85	4.4	8.14	13	2.5
Big Lake Total	**13.75**		**76.78**	--	--

*As reported by applicator

Table 1: Summary of 2016 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.
B12	Bed B12 came about from combining B12 and B13 from previous treatment years. CLP growing between these beds that was 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 ft to 11 ft 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.
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) this year (2016).

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 April 18, 2016. This survey found CLP growing in 56.25% of the sample points within the proposed treatment beds. A few changes were made in the bed borders, with the most dramatic separating Bed 15 into two beds. These beds (15A and 15B) are combined in the frequency summary chart in order to more easily compare from previous years. Table 2 shows the frequency summary from 2015 and 2016.

Bed	2015 pre treat freq (0-100%)	2015 post treat freq (0-100%)	2016 pre freq. (0-100%)	2016 post freq. 0-100%)	2015 nean Density (0-3)	2016 mean density (0-3)
B1	78.9%	7.9%	57.1%	2.8%	0.08	0.03
B2	87.5%	0.0%	55.6%	0%	0.0	0.0
B3	80.0%	0.0%	50%	0%	0.0	0.0
B12	84.2%	5.3%	66.7%	11.1%	0.05	0.11
B14	66.7%	16.7%	60%	0%	0.17	0.0
B15	78.5%	0.0%	47.8%	0%	0.0	0.0
All beds	**79.8%**	**4.8%**	**56.25%**	**3.12%**	**0.05**	**0.03**

Table 2: Frequency data from pre/post treatment surveys in 2015 and 2016.

Bed	Pre to post (2016)reduction and significance?	Post 2015 to Post 2016 reduction significance?	Pre 2015 to Pre 2016 Reduction Significance?	Mean Density Change 2015-2016 (post)
All beds	Yes($P=7.9X10^{-16}$)	No (P=0.47)	Yes ($P=3.7X10^{-6}$)	-0.02

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

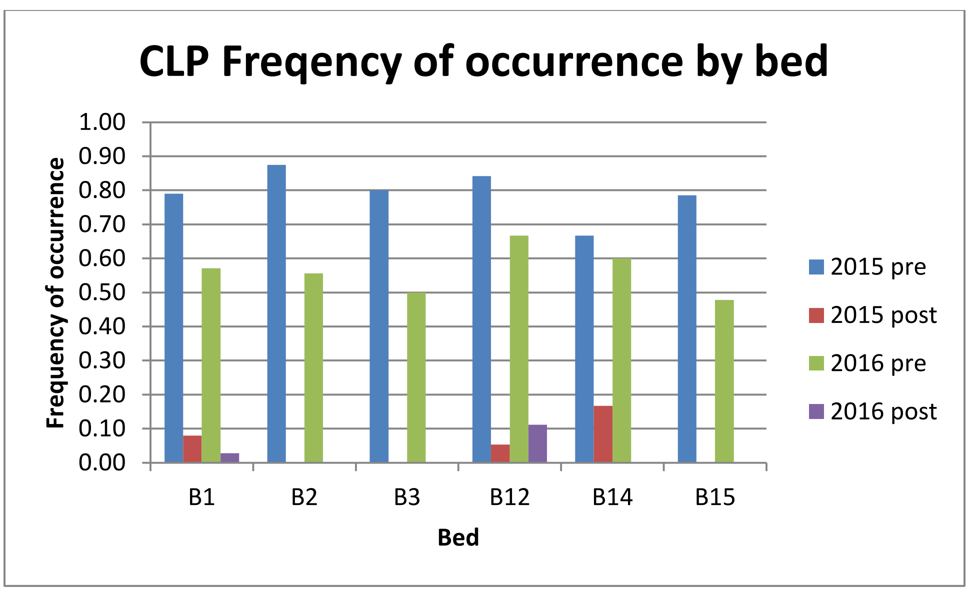

Figure 4: Graph showing the CLP frequency from pre/post treatment surveys for each bed 2016.

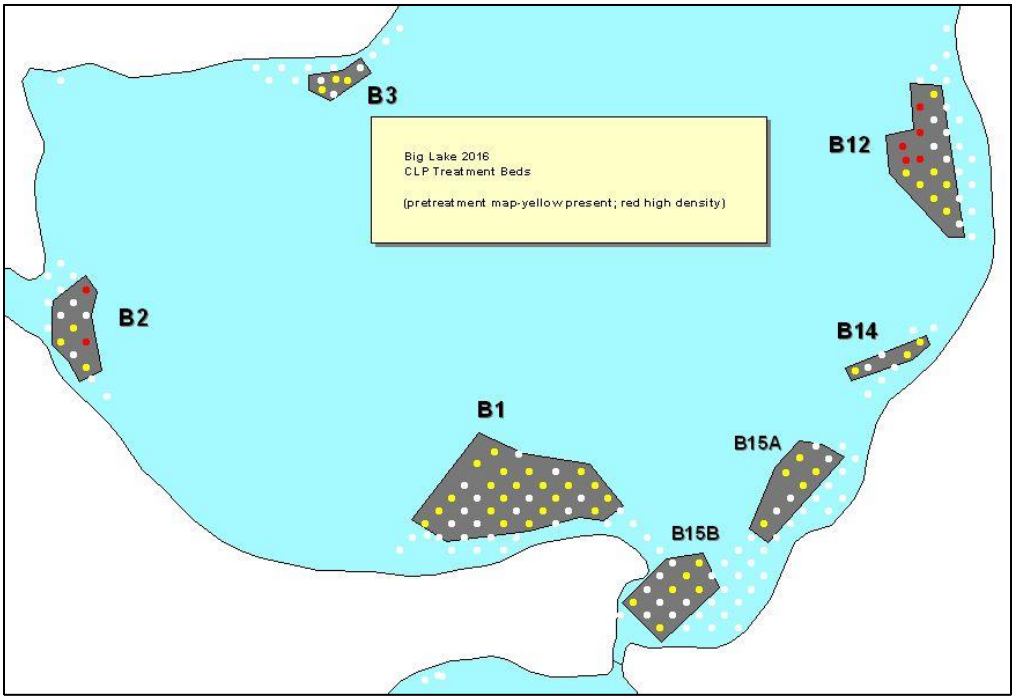

Figure 5: Map of CLP frequency from 2016 pretreatment survey.

Following treatment, a post treatment survey was conducted on June 6, 2016. 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 only 3.12% of the sample points. Figures 5 and 6 show the distribution of CLP within the treatment beds.

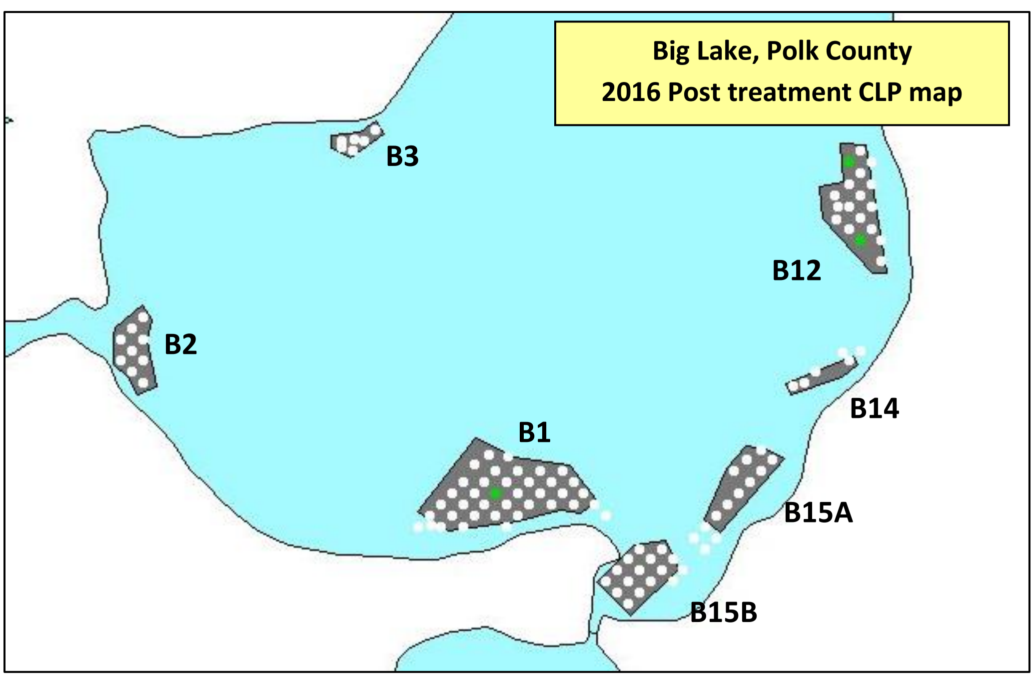

Figure 6: Map of CLP frequency from 2016 post treatment survey.

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 56.25 and was reduced to 3.12% after treatment. A chi-square analysis showed this was statistically significant. Comparing the 2015 frequency results to 2016 can show if an overall reduction occurred between those years. The post treatment frequency change was a very small reduction from 2015 to 2016, but is not statistically significant. 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 reduction from 2015 to 2016 (79.8% to 56.25%), which is the goal for long-term reduction. Figure 7 graphically demonstrates the changes in overall frequency from 2012 to 2016.

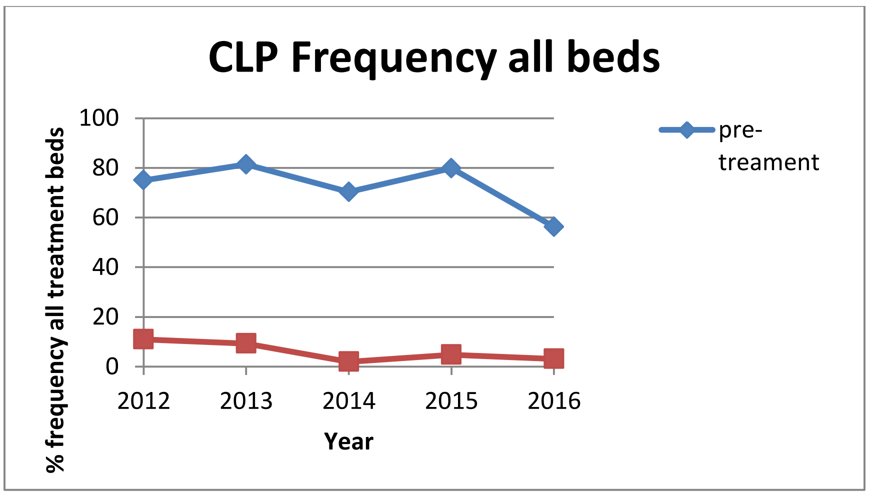

Figure 7: Graph showing CLP frequency changes from 2012 to 2016.

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 2016 chi-square analysis indicates there was no statistically significant reduction in any native plant species. This is the goal and shows that CLP was successfully reduced with no adverse effect on native plants. Table 4 shows a summary of the native plant frequencies for 2015 and 2016, along with the significance of any changes.

Species	2015 freq	2016 freq	change	Significant Reduction?
Ceratophyllum demersum(coontail)	0.54	0.62	**+**	increase
Elodea canadensis(waterweed)	0.72	0.64	**-**	No (p=0.22)
Heteranthera dubia(stargrass)	0.07	0.05	**-**	No (p=0.55)
Lemna trisulca(forked duckweed)	0.11	0.11	**n/c**	No change
Myriophyllum sibiricum(northern water-milfoil)	0.16	0.16	**n/c**	No change
Nymphae odorata(white lily)	0.05	0.06	**+**	increase
Potamogeton illinoensis(Illinois pondweed)	0.01	0.02	**+**	increase
Potamogeton praelongus(whitestem pondweed)	0.05	0.07	**+**	increase
Potamogeton amplifolius (large-leaf pondweed)	0.00	0.01	**+**	increase
Vallesnaria americana(wild celery)	0.02	0.01	**-**	No (p=0.31)
Rununculus aquatilis (crowfoot)	0.01	0.00	**-**	No (p=0.32)
Najas guadulupensis (southern naiad)	0.02	0.06	**+**	increase
Stuckenia pectinata(sago pondweed)	0.01	0.07	**+**	increase
Schoeonoplectus acutus (hardstem bulrush)	0.01	0.01	**n/c**	No change

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

Each year a turion analysis is conducted to look for long-term trends in CLP reduction. The turion analysis was conducted in October when 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**
B1	30.7	27	12.4	18.4	6.2
B2	32.28	4	10.9	0.0	28.7
B3	7.1	15	21.7	0.0	0.0
B8	0	6.7	n/a	n/a	n/a
B12	28.7	39.7	0	129	34.4
B14	0	20	0	0.0	21.5*
B15	30.7	16.7	0	8.6	17.2*
R1	0	20	n/a	n/a	n/a
All Treated	**12.8**	**13.6**	**6.4**	**24.3**	**18.7**

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

Table 5: Turion density summary from 2012 to 2016.

The overall turion density decreased from 2015 to 2016. This reduction follows an increase from 2014 to 2015. Since turions are likely still present in most of the beds, the density is decreasing and so future CLP growth in next spring (2017) should be no greater than the spring of 2016. The goal is to see little or no turions in all treatment beds. Table 5 summarizes the turion data from 2012 to 2016. Figure 8 graphically shows the change in turion density and figure 9 shows the map of turion density.

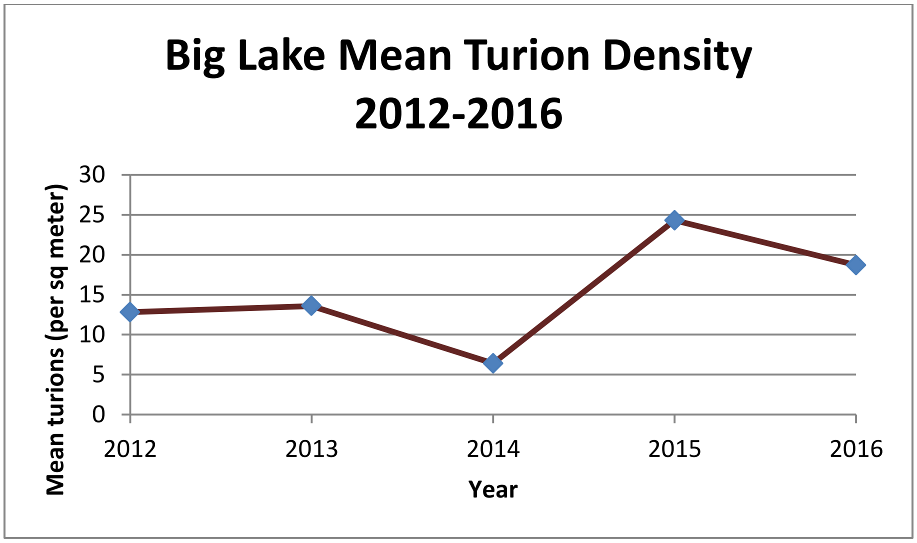

Figure 8: Graph showing turion density changes from 2012 to 2016.

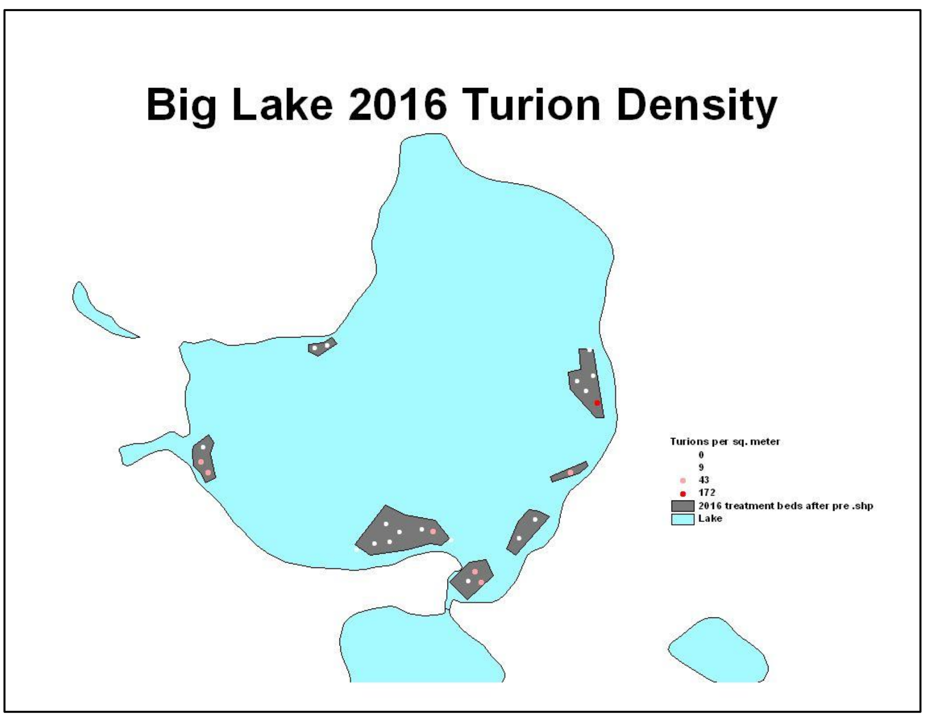

Figure 9: Map of turion density from turion analysis October, 2016.

Discussion

The 2016 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. A significant reduction occurred between 2015 and 2016 pretreatment surveys. This supports a longer term reduction in CLP coverage. The post treatment comparison between 2015 and 2016 resulted in a slight decrease, but was not statistically significant.

The October turion analysis resulted in an overall density reduction from 2015 to 2016. This should result in less CLP growth for spring 2017. Because turions can remain viable for several years, continued treatments are likely necessary to continue this reduction. The CLP treatments have been successful six years, and yet turion density is remaining consistent in recent years. It is unknown how long treatments will need to continue to get nearly zero turion density.

The post treatment showed no reduction in native species following treatment. This is the goal of herbicide treatment; reduce the CLP without harming the native plant community.

With six consecutive successful herbide 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. However, 2016 still showed over 50% of the sample points within the treatment areas had CLP growth in the pretreatment survey. It will have to be determined how long to commit to CLP treatment in future years and what is an acceptable goal.

References

Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass.* University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

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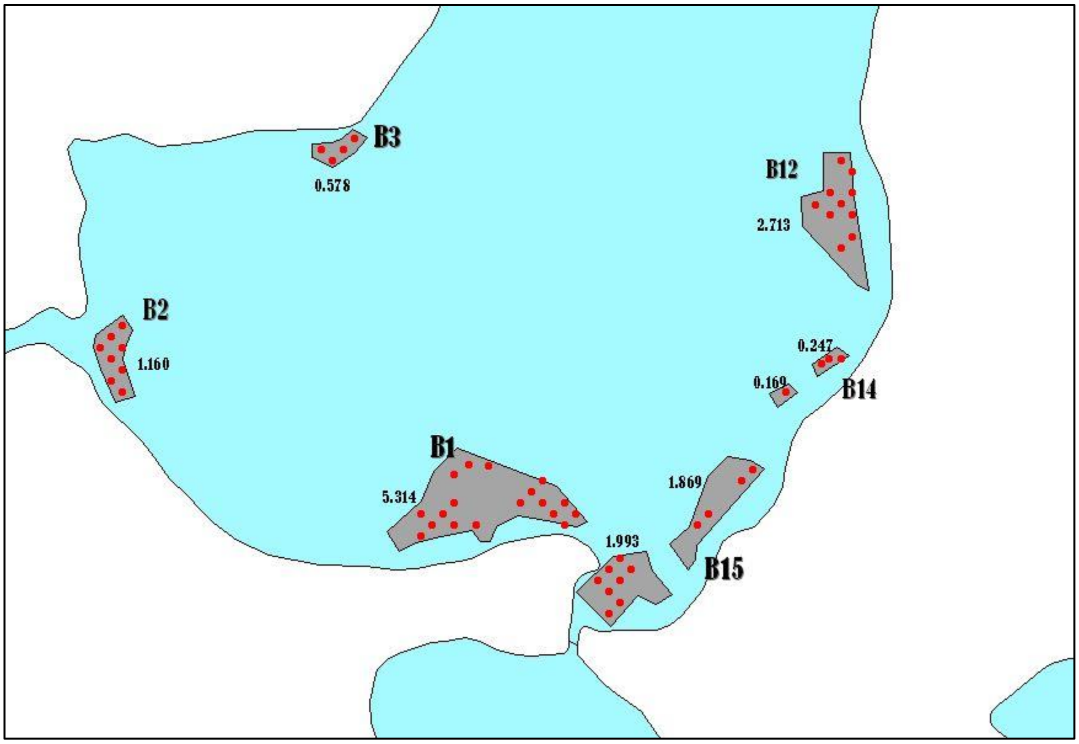
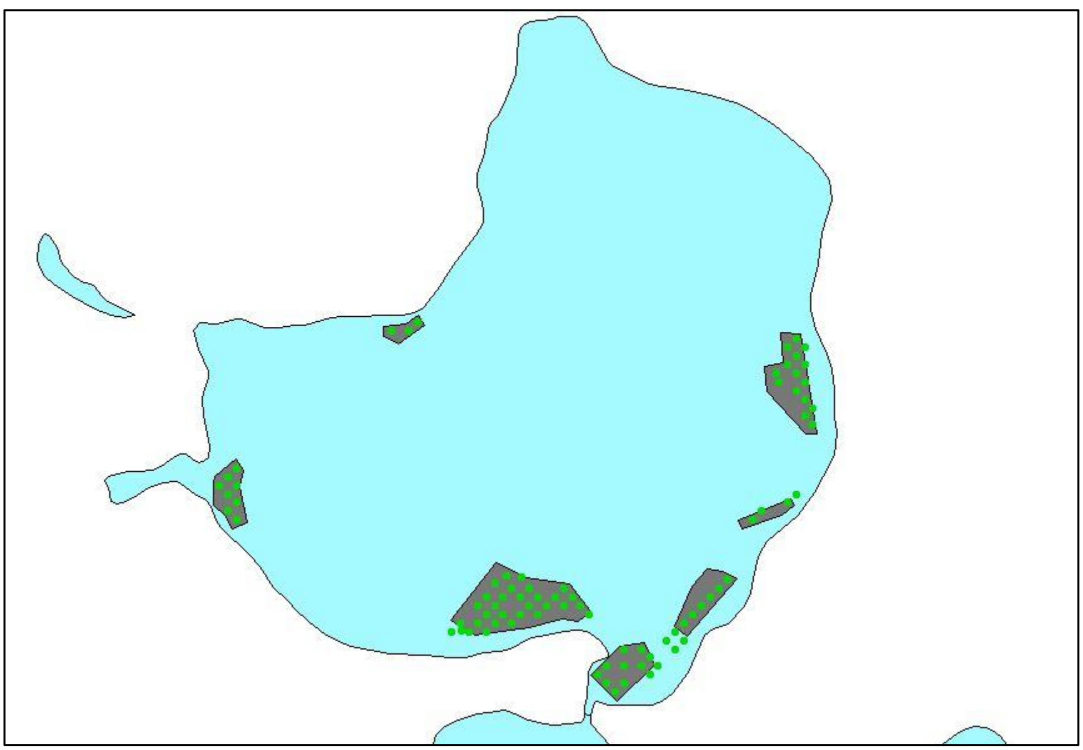
UW-Extension. Aquatic Plant Management website. http://www4.uwsp.edu/cnr/uwexlakes/ecology/apmguide.asp appendix D.

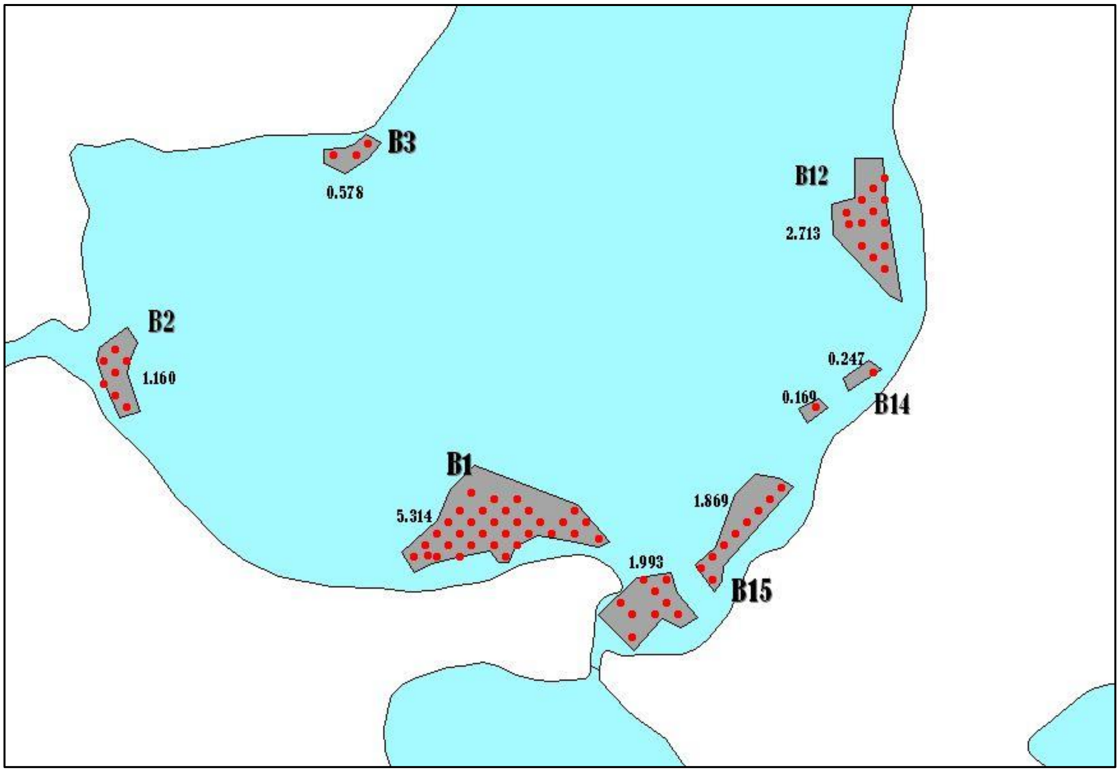
Appendix: Maps of native plant distributions from post treatment surveys, 2015 and 2016.



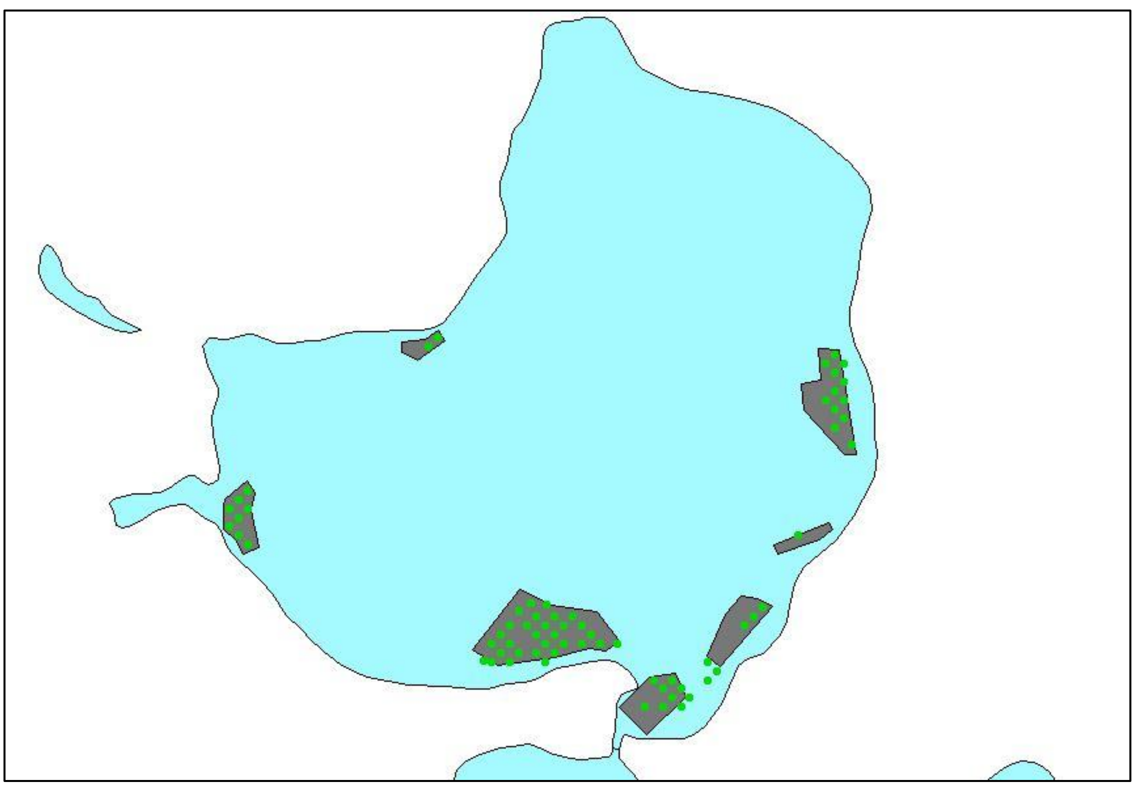
Coontail-*Ceratophyllum demersum*-2015



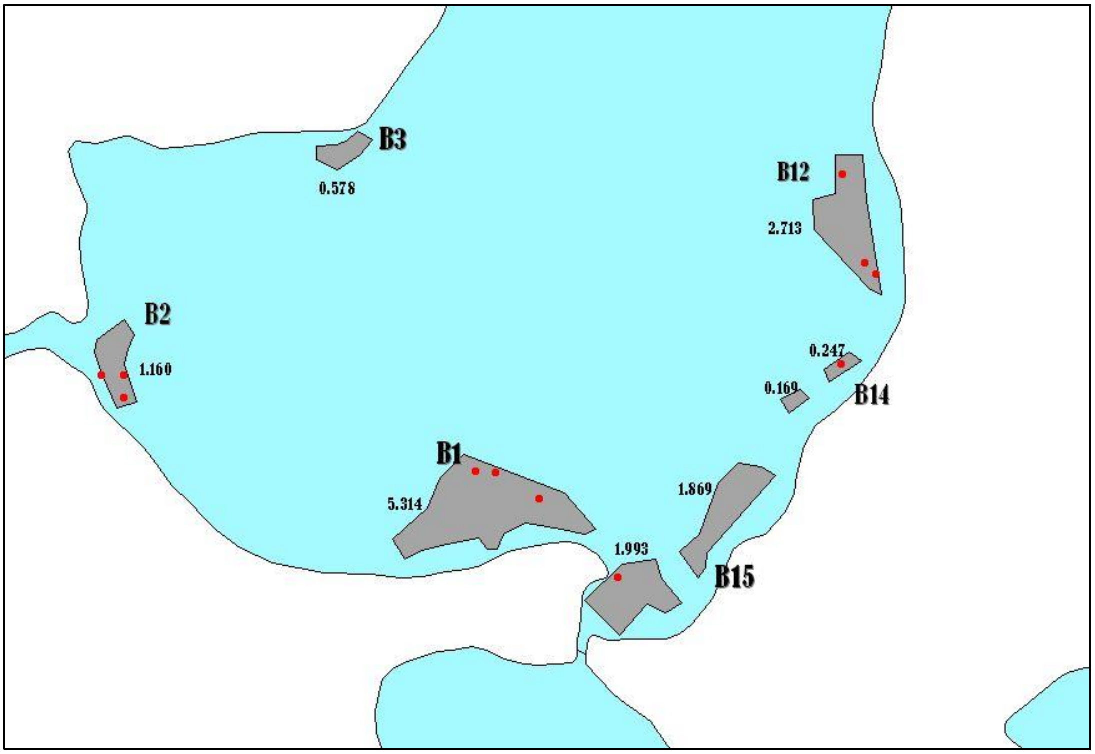
Coontail-*Ceratophyllum demersum*-2016



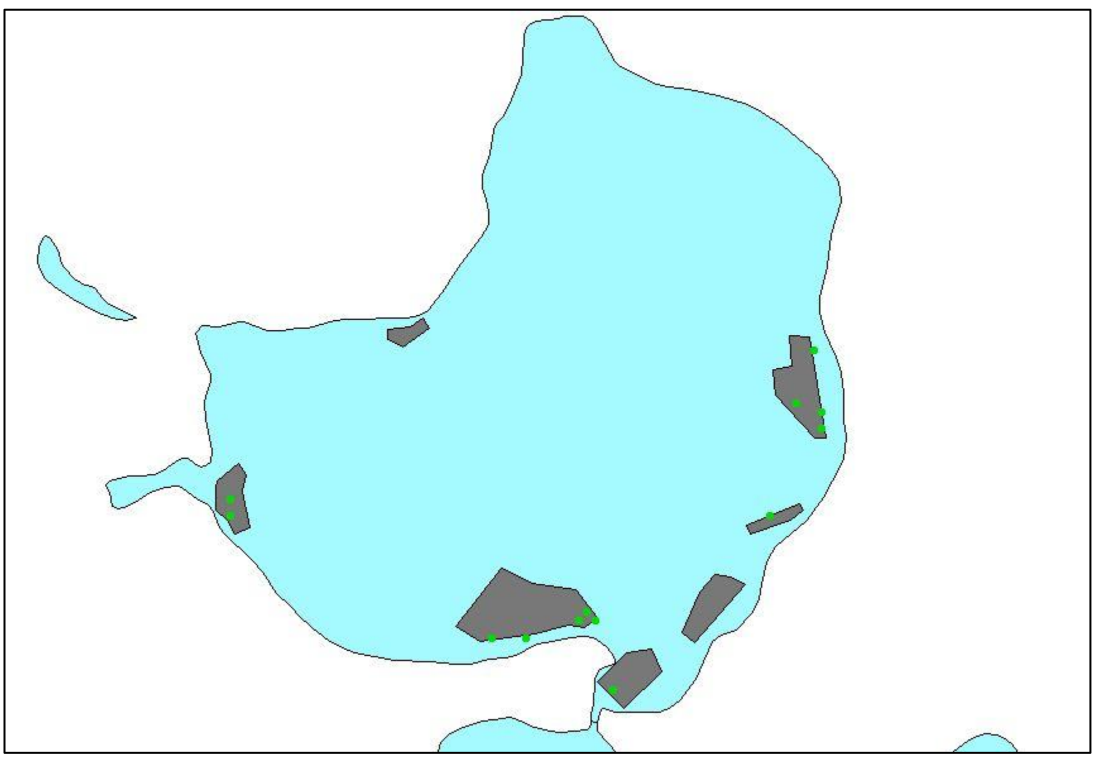
Waterweed or elodea-*Elodea Canadensis*-2015



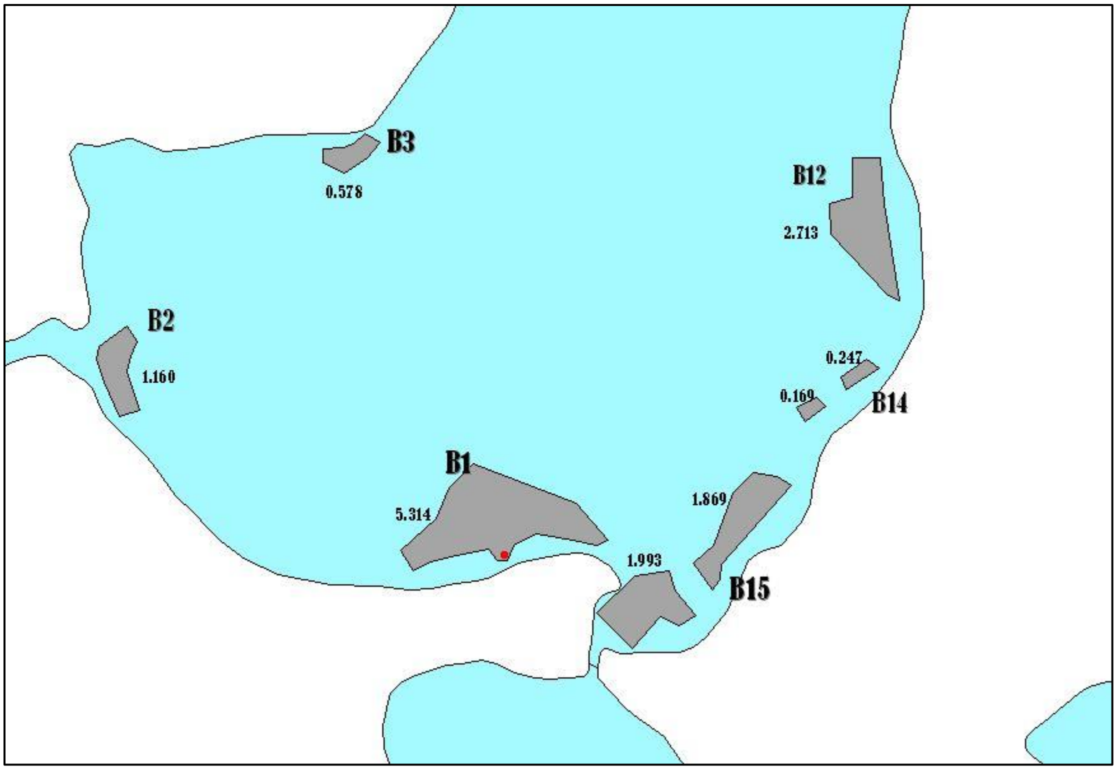
Waterweed or elodea-*Elodea Canadensis*-2016



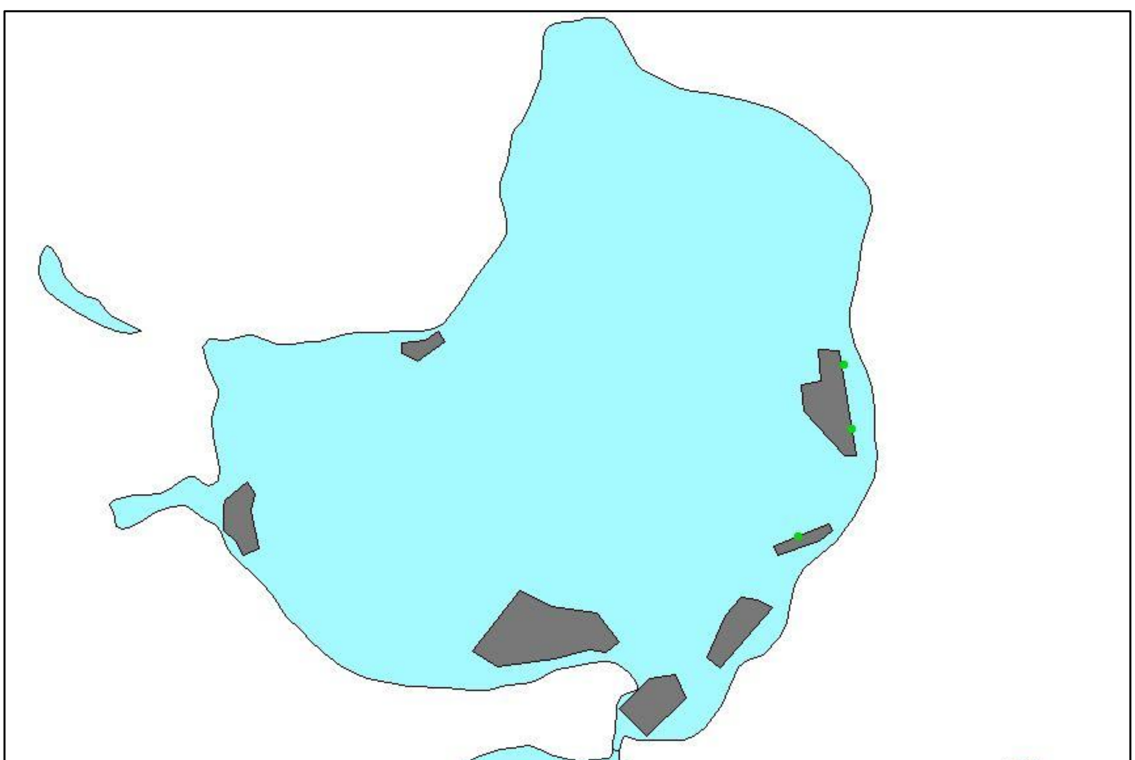
Forked duckweed-*Lemna trisulca*-2015



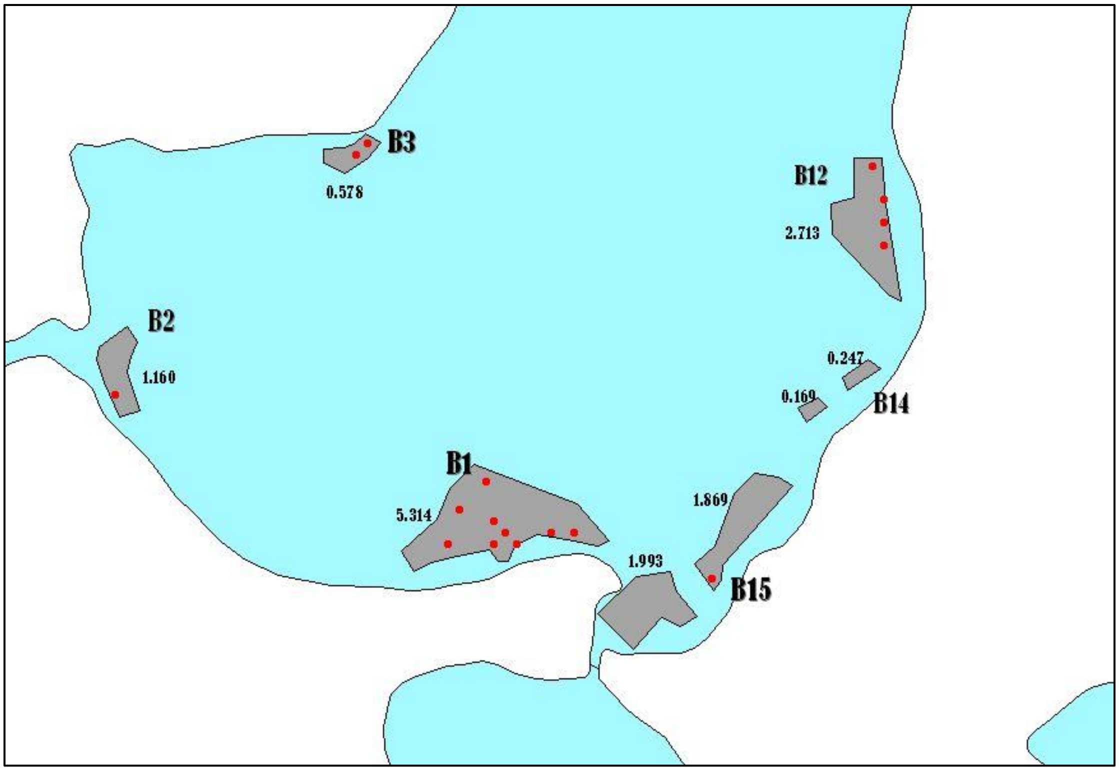
Forked duckweed-*Lemna trisulca*-2016



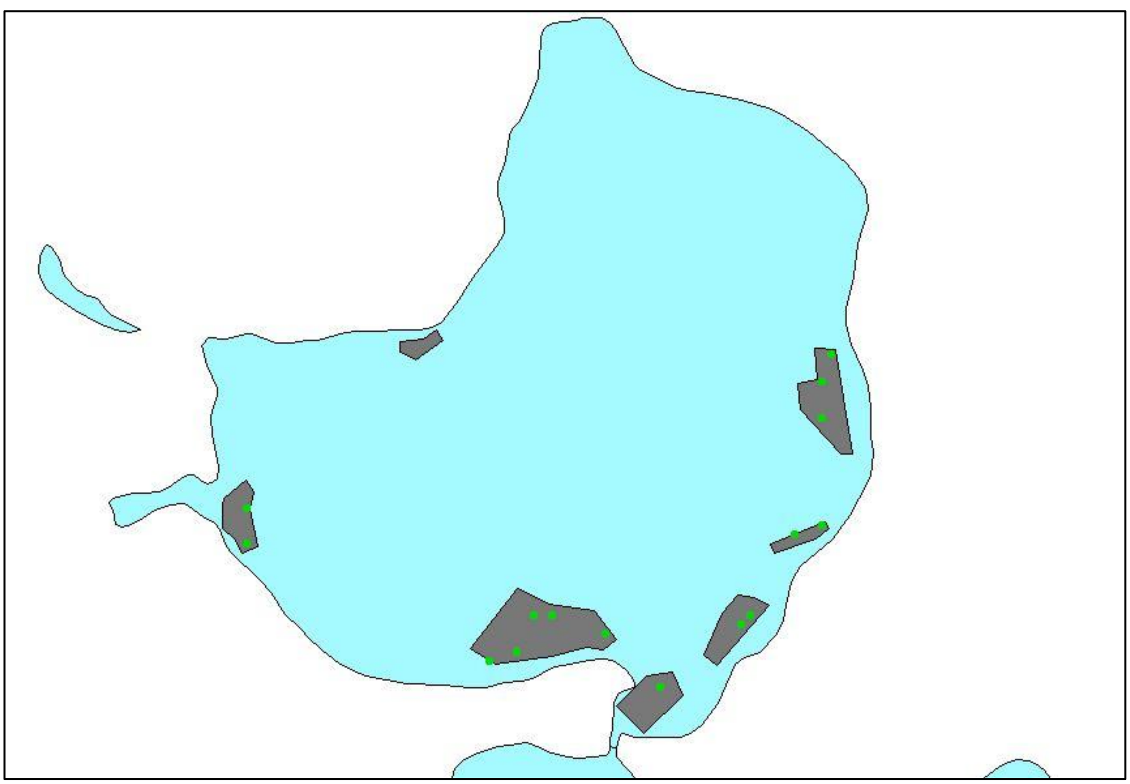
Illinois pondweed-*Potamogeton illinoensis*-2015



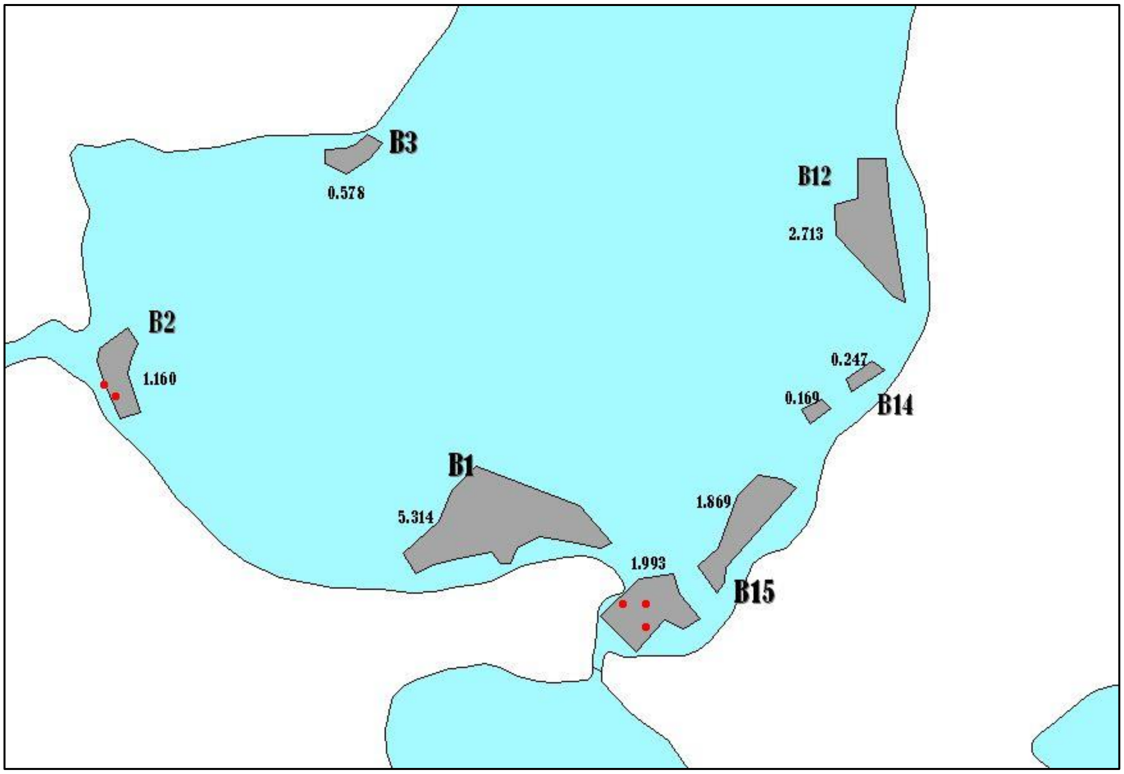
Illinois pondweed-*Potamogeton illinoensis*-2016



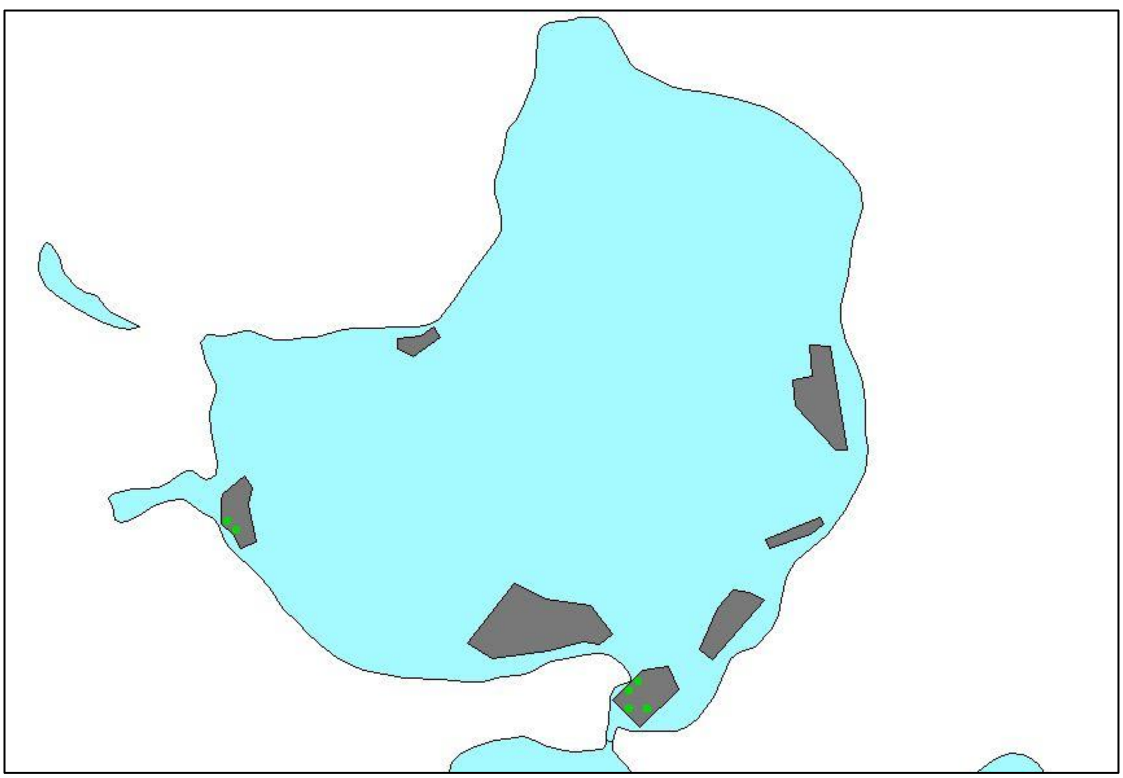
Northern water-milfoil-*Myriophyllum sibiricum*-2015



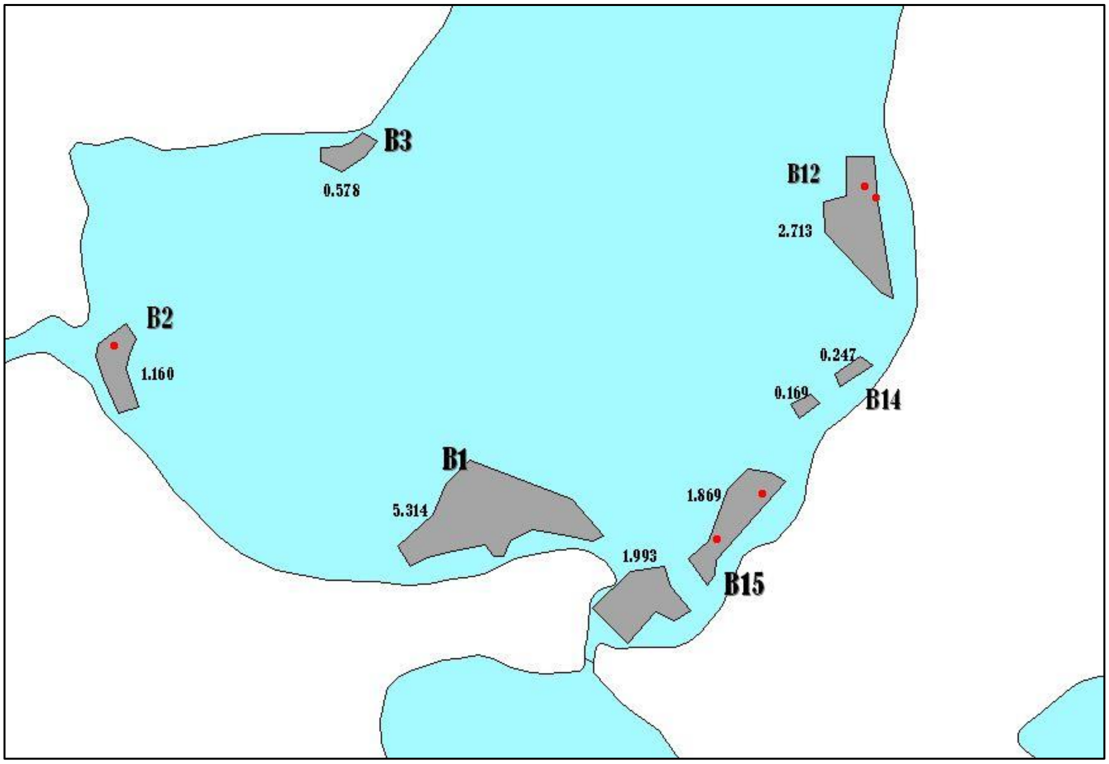
Northern water-milfoil-*Myriophyllum sibiricum*-2016



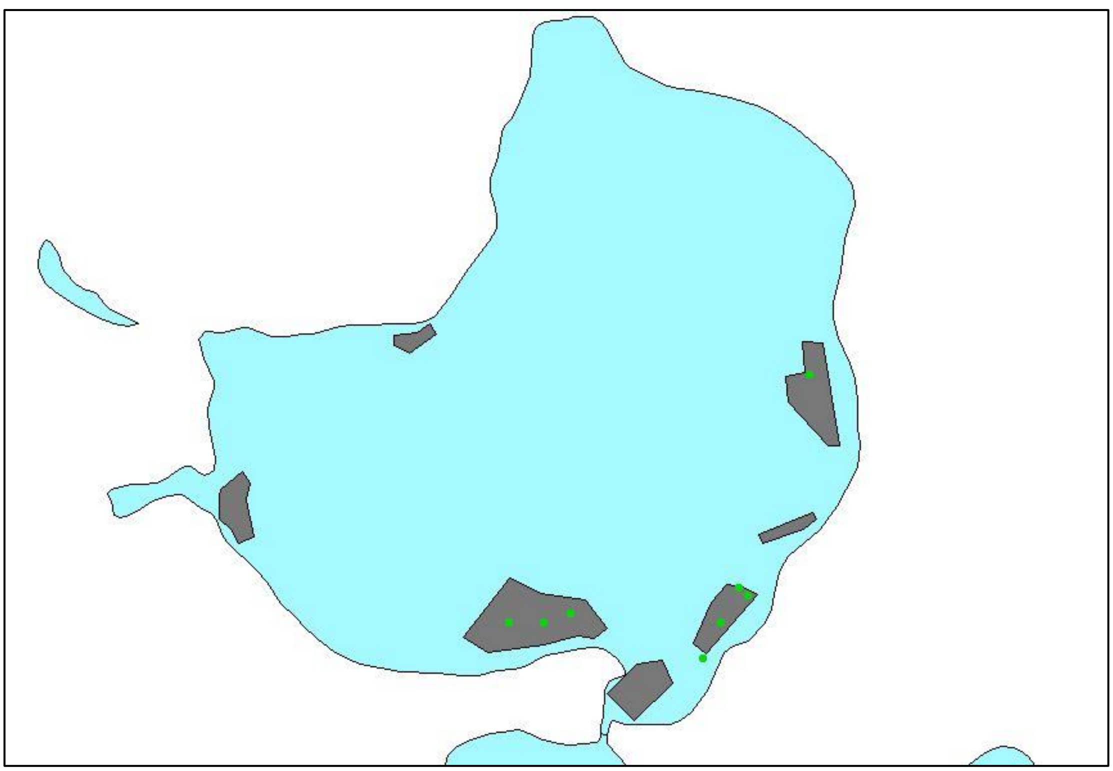
White water lily-*Nymphaea odorata*-2015



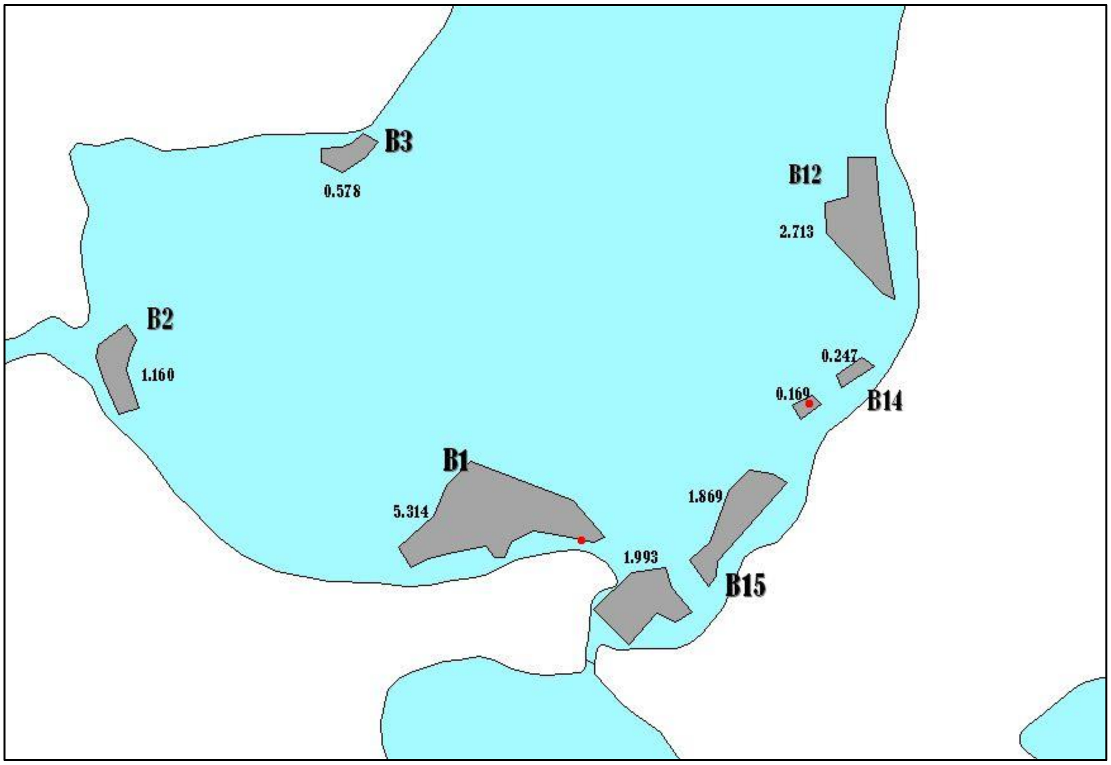
White water lily-*Nymphaea odorata*-2016



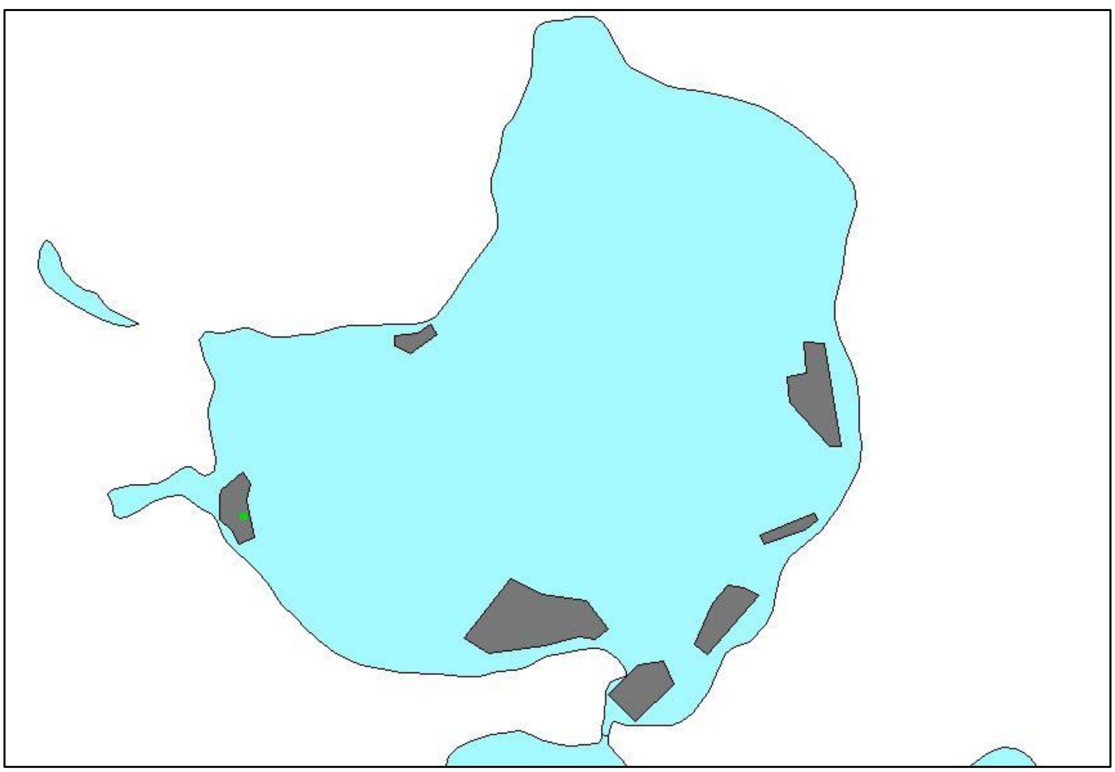
Whitestem pondweed-*Potamogeton praelongus*-2015



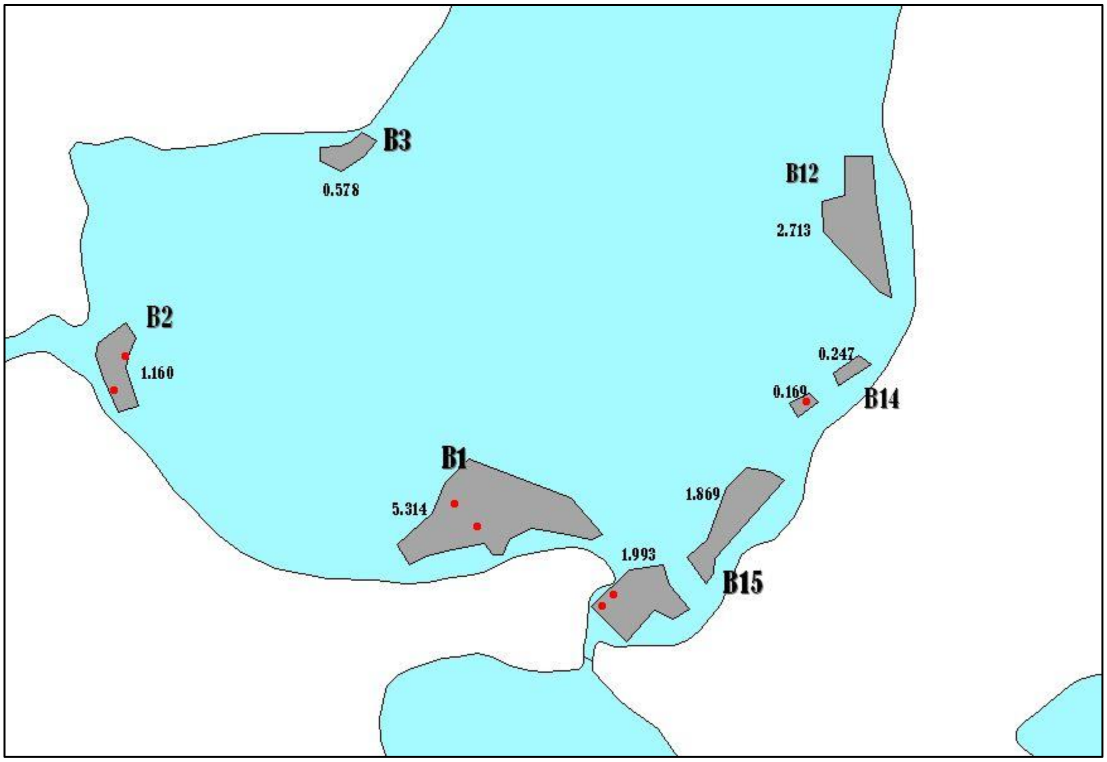
Whitestem pondweed-*Potamogeton praelongus*-2016



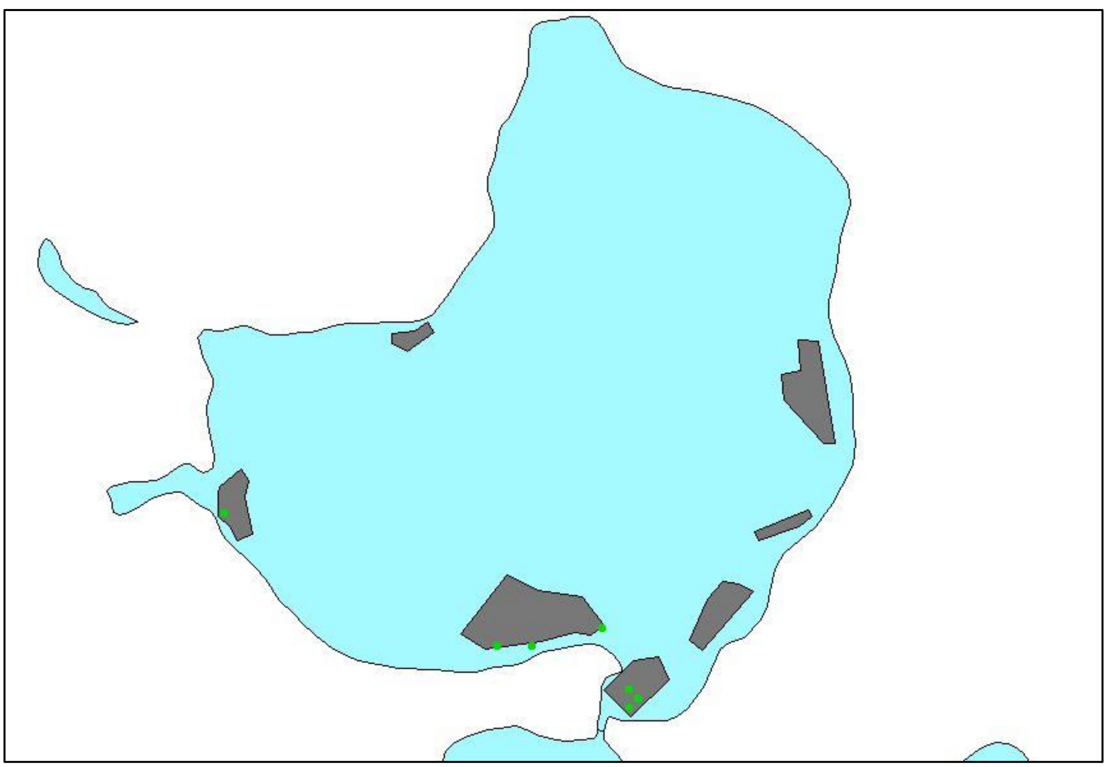
Wild celery-*Vallisneria americana*-2015



Wild celery-*Vallisneria americana*-2016



Water stargrass-*Heteranthera dubia*-2015



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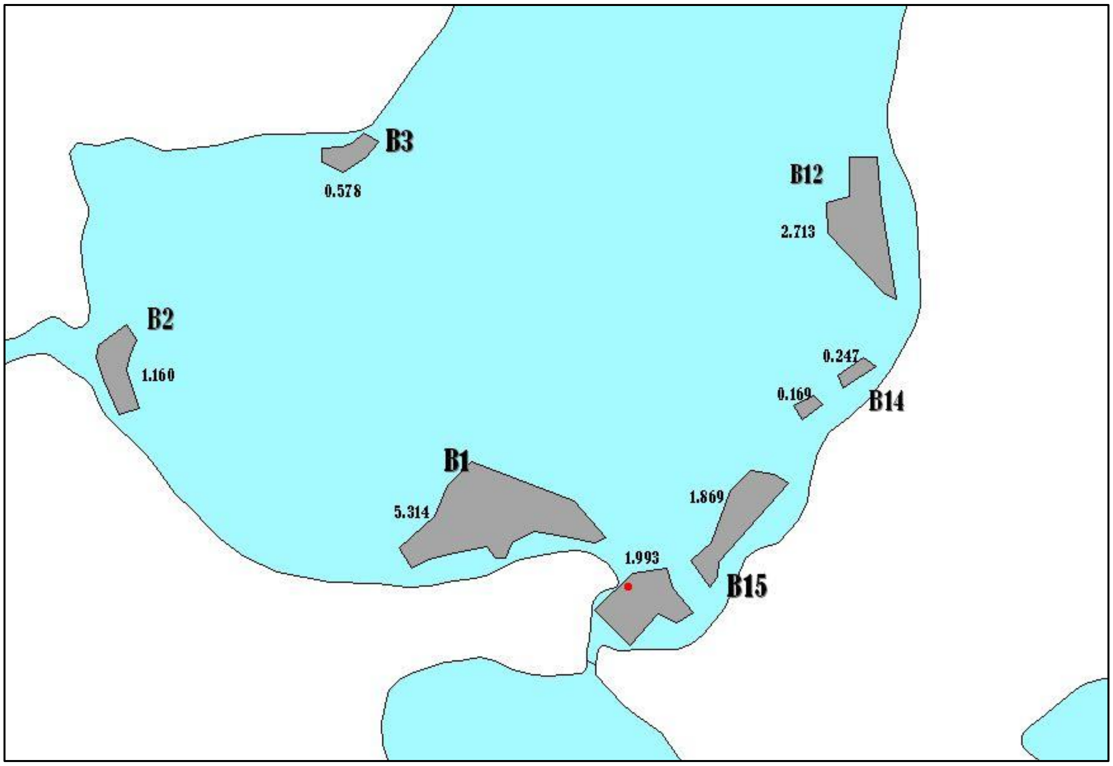
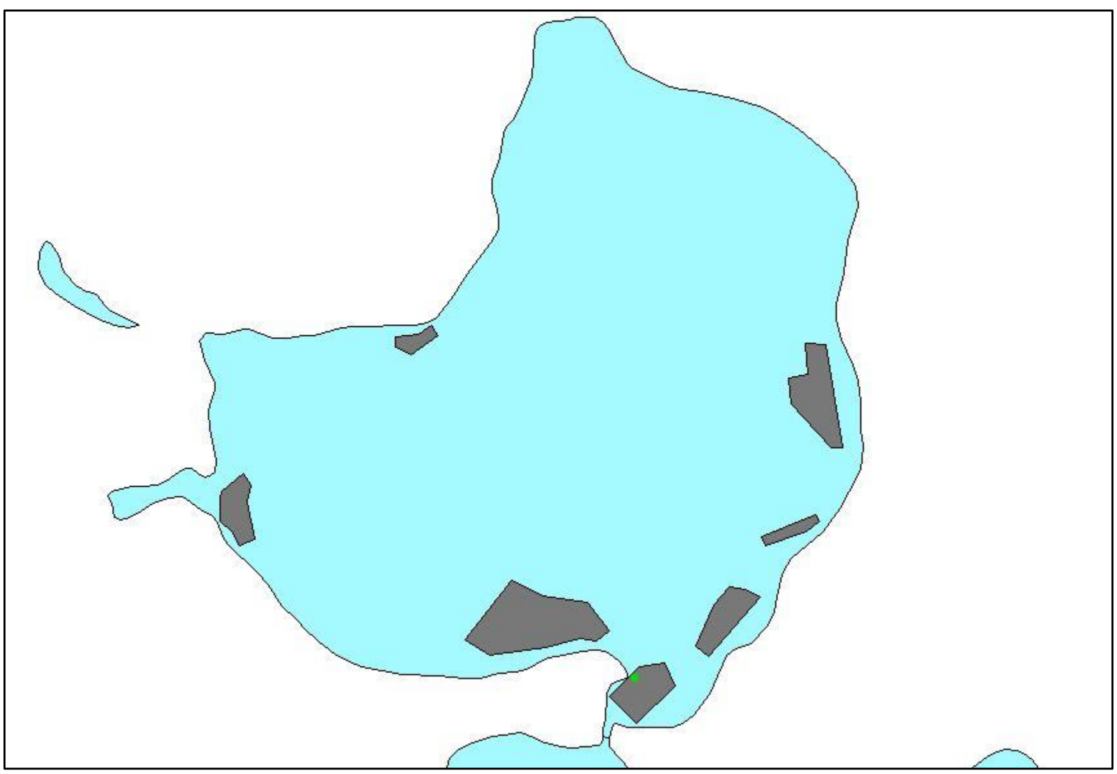
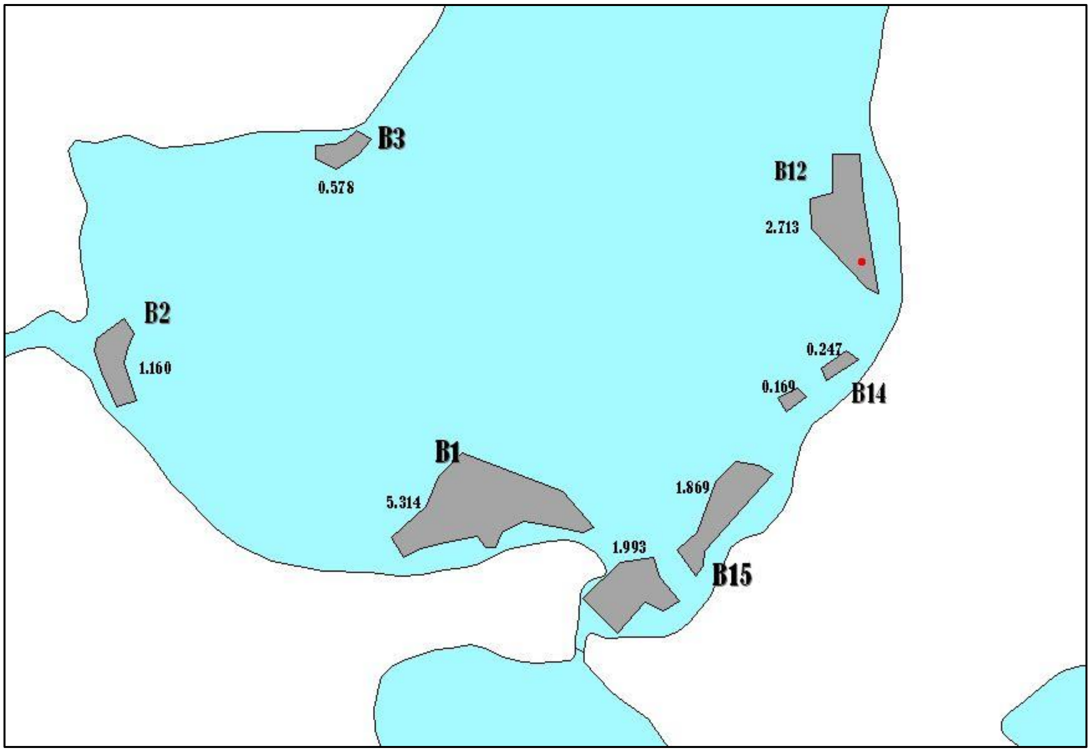


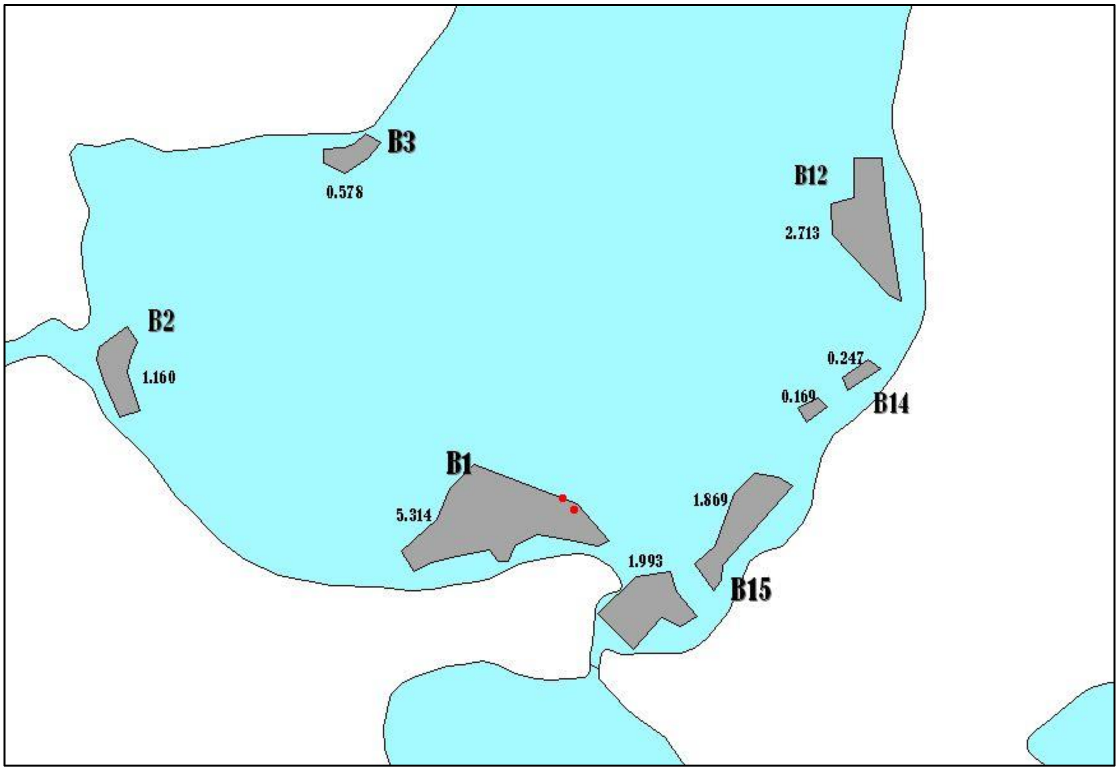
Hardstem bulrush-*Schoenoplecutus acutus*-2015



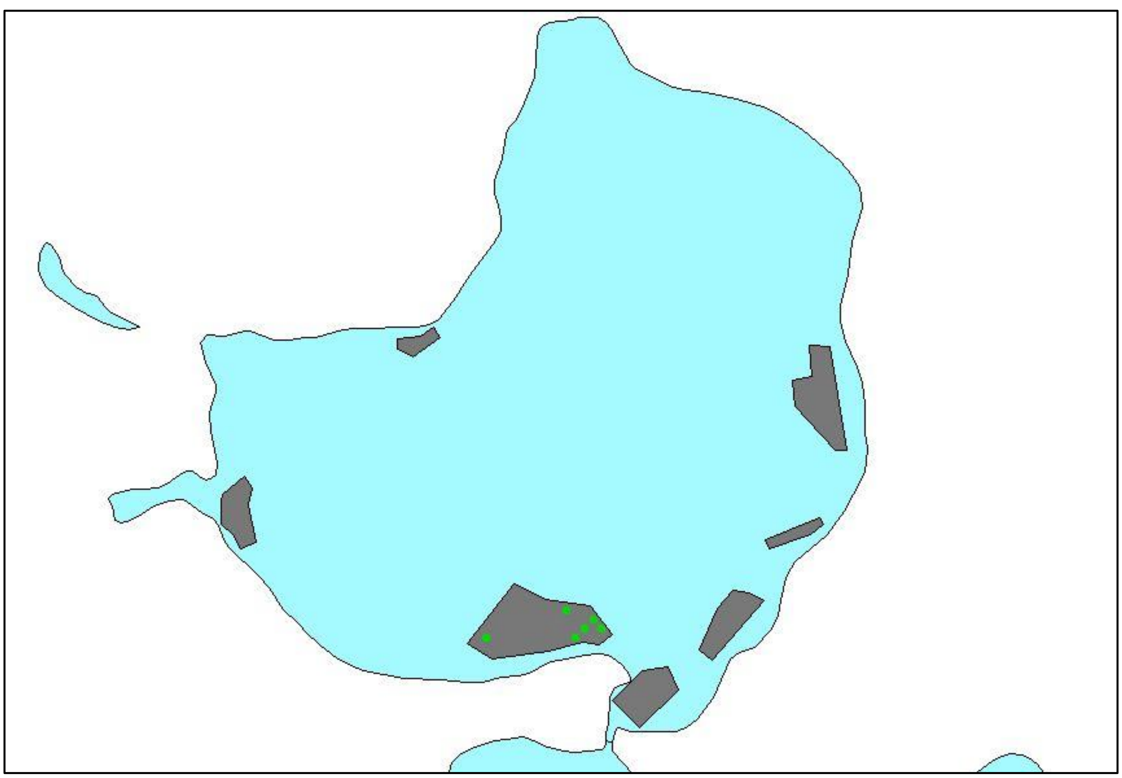
Hardstem bulrush-*Schoenoplecutus acutus*-2016



White water crowfoot-*Rununculus aquatilis*-2015…not sampled in 2016



Southern naiad-*Najas guadalupensis*-2015



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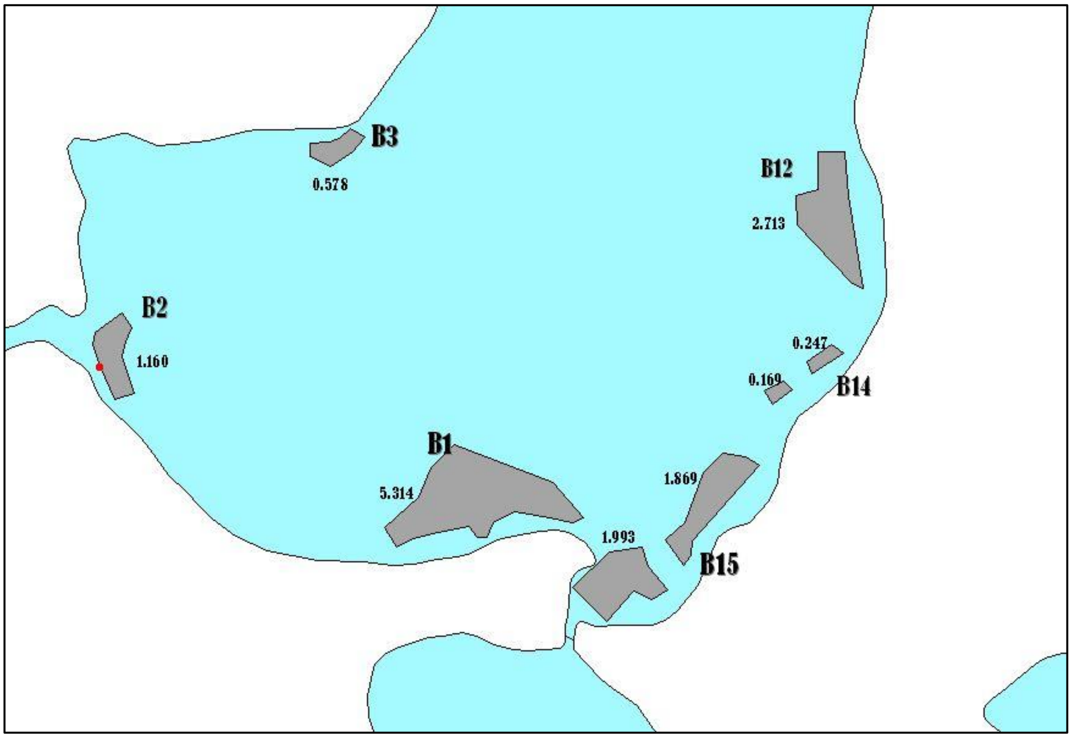
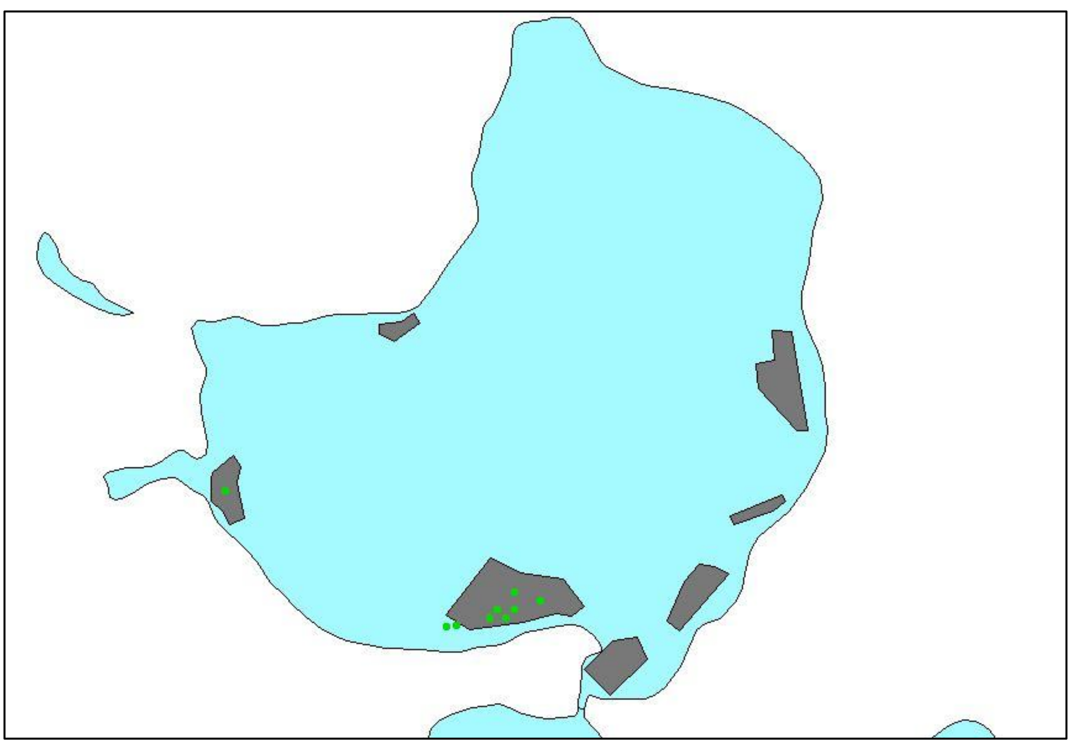


Sago pondweed-*Stuckenia pectinata*-2015



Sago pondweed-*Stuckenia pectinata*-2016