Herbicide Treatment Analysis on *Potamogeton crispus*

Deer Lake, Polk County Wisconsin

WBIC: 2619400

2013

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Abstract

On May 28, 2013 21.24 acres of curly-leaf pondweed (CLP) was treated using 1.5 ppm endothall in Deer Lake, Polk County WI. The treatment was determined to be successful with a statistically significant reduction in frequency of occurrence in each of the treatment beds when comparing the pretreatment frequency to the post treatment frequency. The post treatment frequency in 2013 did not show a reduction when compared to the 2012 post treatment frequency. This is due to the fact that the 2012 treatment was also successful and resulted in a very low frequency. The pretreatment survey in 2013 showed a return in CLP growth from turion germination. There was also a significant reduction in four native species, but it is speculated that this may be due to a very late spring growing season with most native species still showing dormancy during the 2013 post treatment survey. A turion density analysis shows all beds with fairly high to very high turion density. No turion density has been done in prior years so no comparison or trend is available.

Introduction

In May 2013, an herbicide treatment targeting curly-leaf pondweed (*Potamogeton crispus*) was conducted. This analysis will outline the areas treated, the treatment protocol and analyze the effectiveness of the treatment.

The treatment areas for Deer Lake were made up of five beds, labeled A-E. Those beds with their areas are shown in figures 1 and 2. Portions or all of beds B, C and D have been treated since 2006, while beds A and E have been treated since 2010.

The herbicide endothall was used in the treatment of the CLP. The treatment occurred on May 28, 2013, with water temperature at 57 degrees F and winds southeast at 5-6 miles per hour.

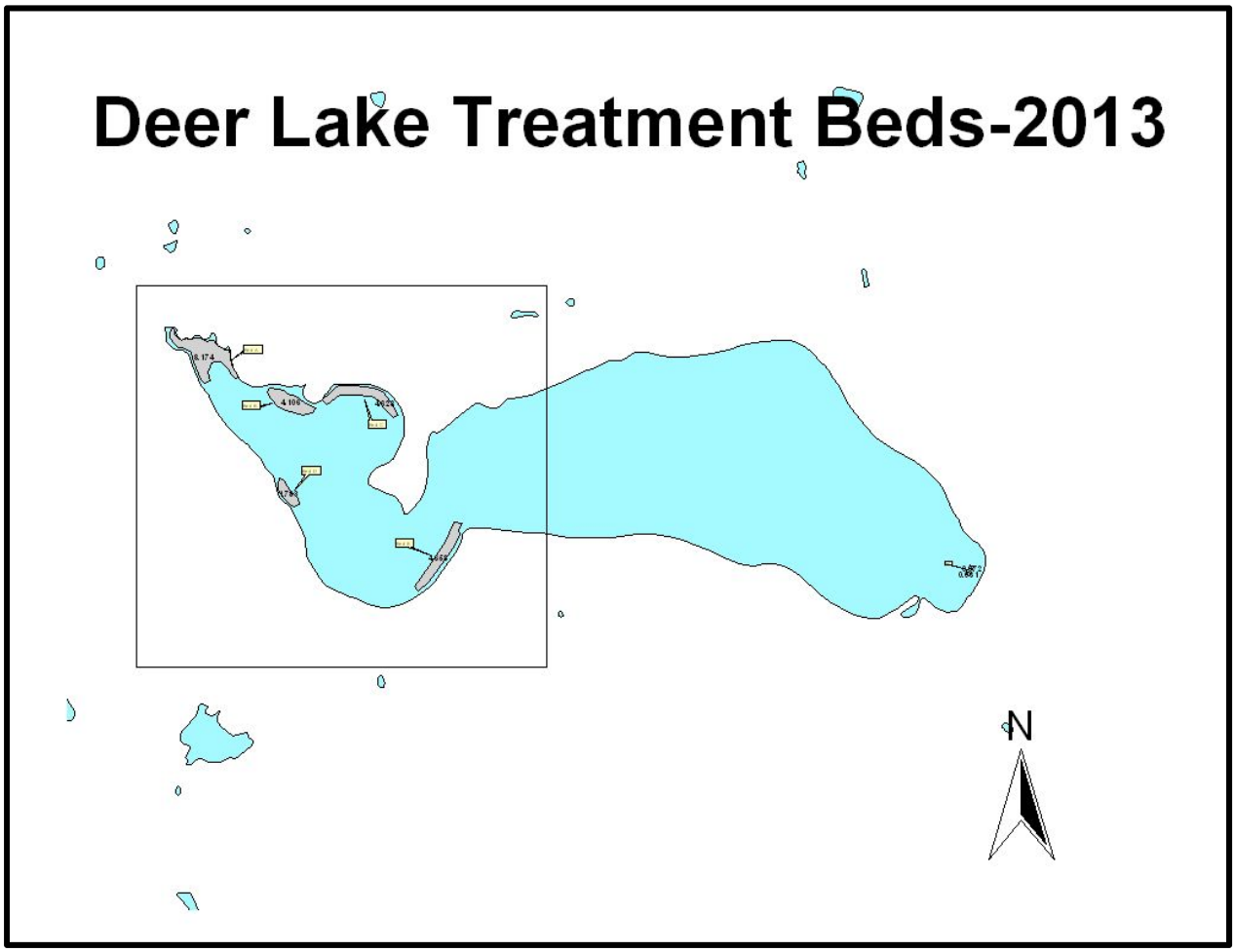


Figure 1: Large map showing the location of the treatment beds relative to the remaining lake.

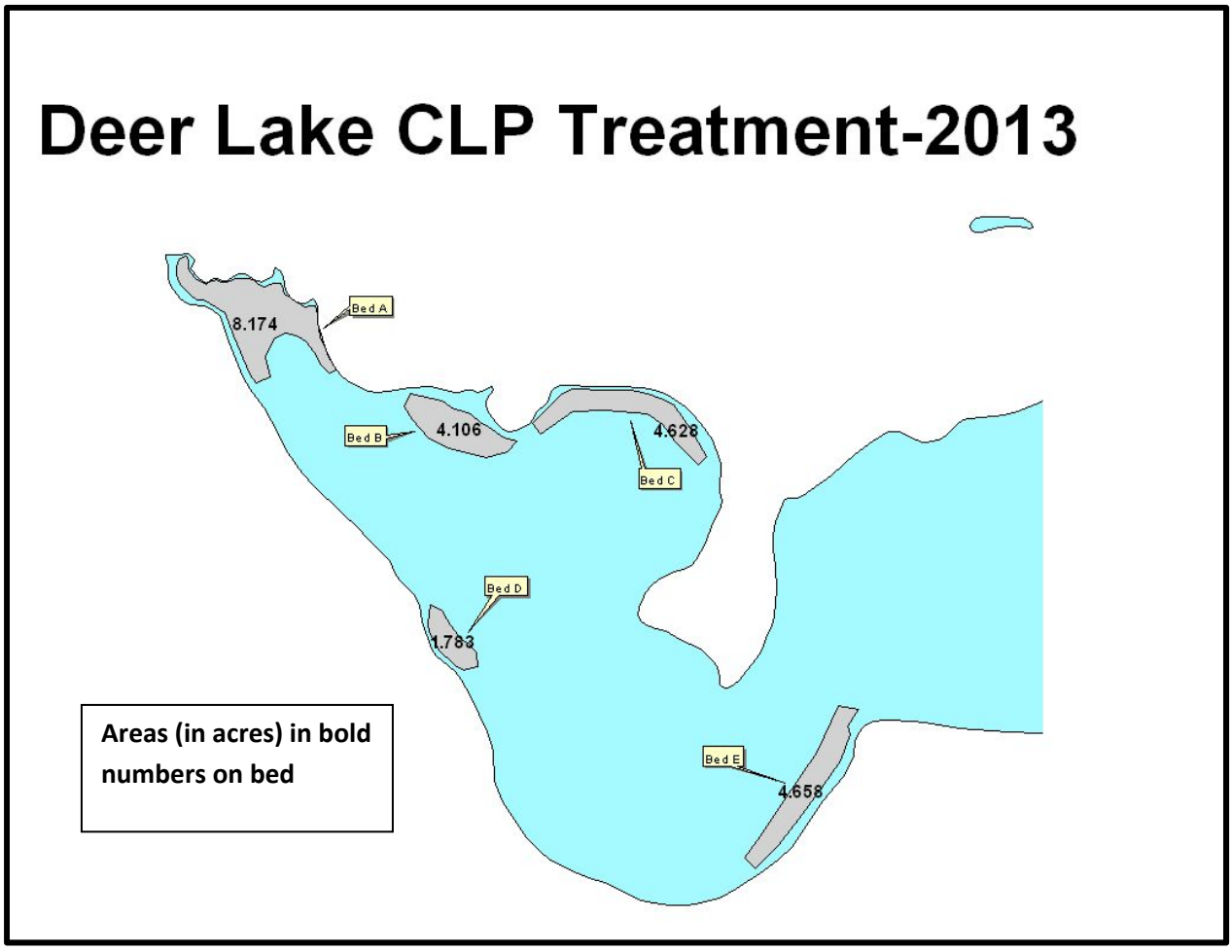


Figure 2: Close map of 2013 CLP treatment beds.

Deer Lake CLP Beds					
2013	**Area**	**Mean Depth**	**Acre-Feet**	**Application Rate**	**Wind conditions**
Bed A	8.2	5.2	42.64	1.5 ppm (42.64 gal)	5 mph/SE
Bed B	4.1	6.8	27.88	1.5 ppm (27.88 gal)	6 mph/SE
Bed C	4.6	7.8	35.88	1.5 ppm (35.88 gal)	6 mph/SE
Bed D	1.8	7.9	14.22	1.5 ppm (14.22 gal)	6 mph/SE
Bed E	4.7	8.1	38.07	1.5 ppm (38.07 gal)	5 mph/SE
Total	21.24		160.28	1.5 ppm (160.28 gal)	

Table 1: Summary of treatment beds, 2013.

Treatment Bed	Description
Bed A	Bed A is near the landing and extends out from the landing quite a distance. The area in the middle is too deep causing the CLP to spit the bed into two forks. The CLP has been quite dense except for the area just near the landing. The eastern fork of the bed has quite a large amount of floating vegetation. The bed has successful treatment in 2012 and has been treated since 2010.
Bed B	Bed B is located on the east shoreline just south of Bed A. This bed has been notoriously dense and has been treated since 2006. The bed has white-stem pondweed, forked duckweed and coontail in fairly high frequency. The bed gets quite scattered with CLP in the more shallow areas and is then quite dense in deeper water. The boundary has been very well defined. The treatment in 2012 was successful in 2012.
Bed C	This bed is south and east of Bed B. The bed is quite long curving along the shoreline to the north and west. This bed is narrow but long, bordered on the lake side by rather deep water, creating a rather defined boundary. The bed has been very dense in the 6-8 ft depths, with less density on the shore side of the bed. The ends have been sporadic, but very dense just inside. The treatment was successful on Bed C in 2012. This bed has been treated since 2006 in half of the bed and then the bed was increased in size and treated in 2010.
Bed D	This is a small bed on the western shore, just south of the landing. It changes in depth greatly over a rather short distance across the bed. It has been very dense in the middle and toward the north portion of the bed. The treatment was successful in 2012. This bed was one of the original beds treated starting in 2006.
Bed E	Bed E is a long and very narrow bed that changes from 2.5 feet to 12+ feet on the lake side boundary. The highest density has been on the eastern ½ of the bed, but quite dense throughout. This bed has a fairly large amount of northern milfoil mixed in with not floating vegetation. This bed has a successful 2012 treatment and has been treated since 2010.
Bed F	Bed F is a very small, two part bed. It is in very deep water (from 10-13 feet). Since very little CLP has been seen here, it was recommended to not treat in 2013 (which it was not).

Table 2: Treatment bed descriptions.

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 3 for reference). All other species are also recorded from the rake sample in order to verify no damage to the native plants.

Figure 3: 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 create 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 so 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 4: Pictures showing turion density methods. A shows sediment sample; b shows separation; c Shows separated turions.

c

Results

The results of the pretreatment and post treatment surveys from 2013 are summarized in table 3. Also the frequency result from the 2012 post treatment survey is included for comparison. The graph in figure 6 shows these changes also.

Treatment Bed	Pre-treat freq (2013)	Post treat freq (2013)	Post treat freq (2012)	Mean density post (2013)
Bed A	73%	0%	8%	0
Bed B	69%	8.6%	11%	0.085
Bed C	57%	7.1%	9%	0.07
Bed D	62.5%	25%	0%	0.38
Bed E	54%	11.4%	7%	0.26
All beds	63.9%	8.4%	8%	0.13(0.8 in 2012)

Table 3: Summary of CLP growth frequency and density.

As stated in the methods, a chi-square analysis is conducted on the frequency. The results of this are summarized in table 4.

Treatment Bed	2013 pre/2013 post freq reduction	Statistically significant reduction	2012 post/2013 post freq reduction	Statistically significant reduction
Bed A	-73%	Yes ($p=6.1 \times 10^{-12}$)	-8%	No
Bed B	-60.4%	Yes ($p=5.3 \times 10^{-8}$)	-2.4%	No
Bed C	-49.9%	Yes ($p=6.0 \times 10^{-5}$)	-1.9%	No
Bed D	-37.5%	Yes ($p=0.03$)	+25%*	increase
Bed E	-42.6%	Yes ($p=1.4 \times 10^{-4}$)	+4.4%	increase
All Beds	**-55.5%**	**Yes ($p=2.8 \times 10^{-24}$)**	**+0.4%**	**increase**

This increase looks very high, but is a small sample size so not of high concern.

Table 4: Summary of frequency reduction and significance after treatment.

The chi-square analysis shows a statistically significant reduction in each bed from before treatment to after treatment in 2013. There was no statistically significant reduction from 2012 to 2013.

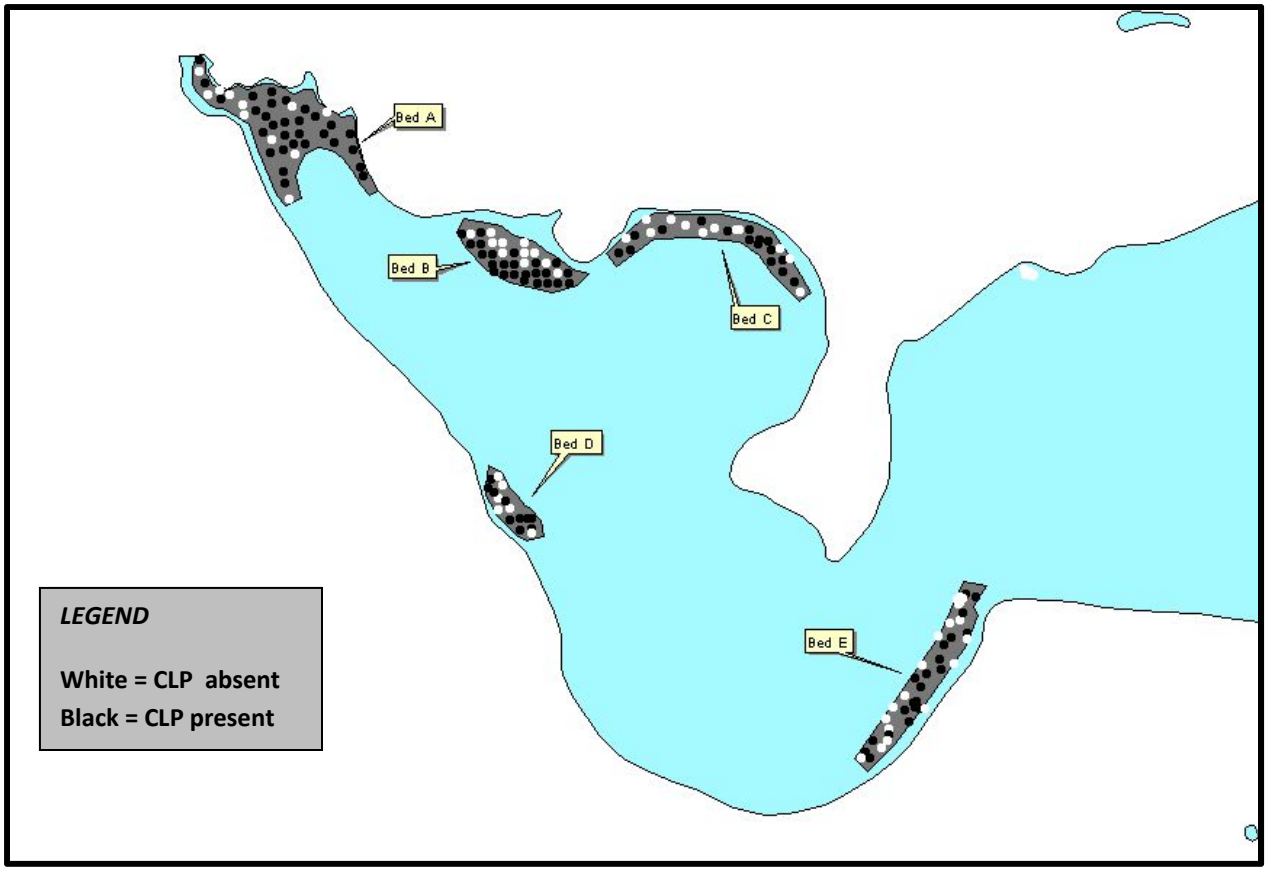


Figure 5: Pre-treatment map from 2013 pretreatment survey.

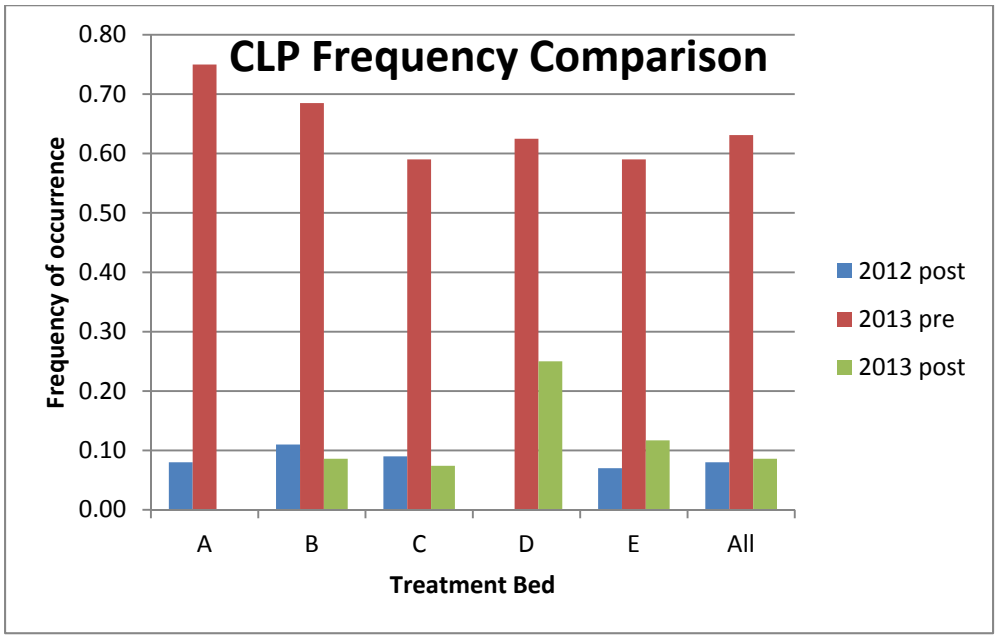


Figure 6: Graph showing the frequency comparison from 2012 and 2013.

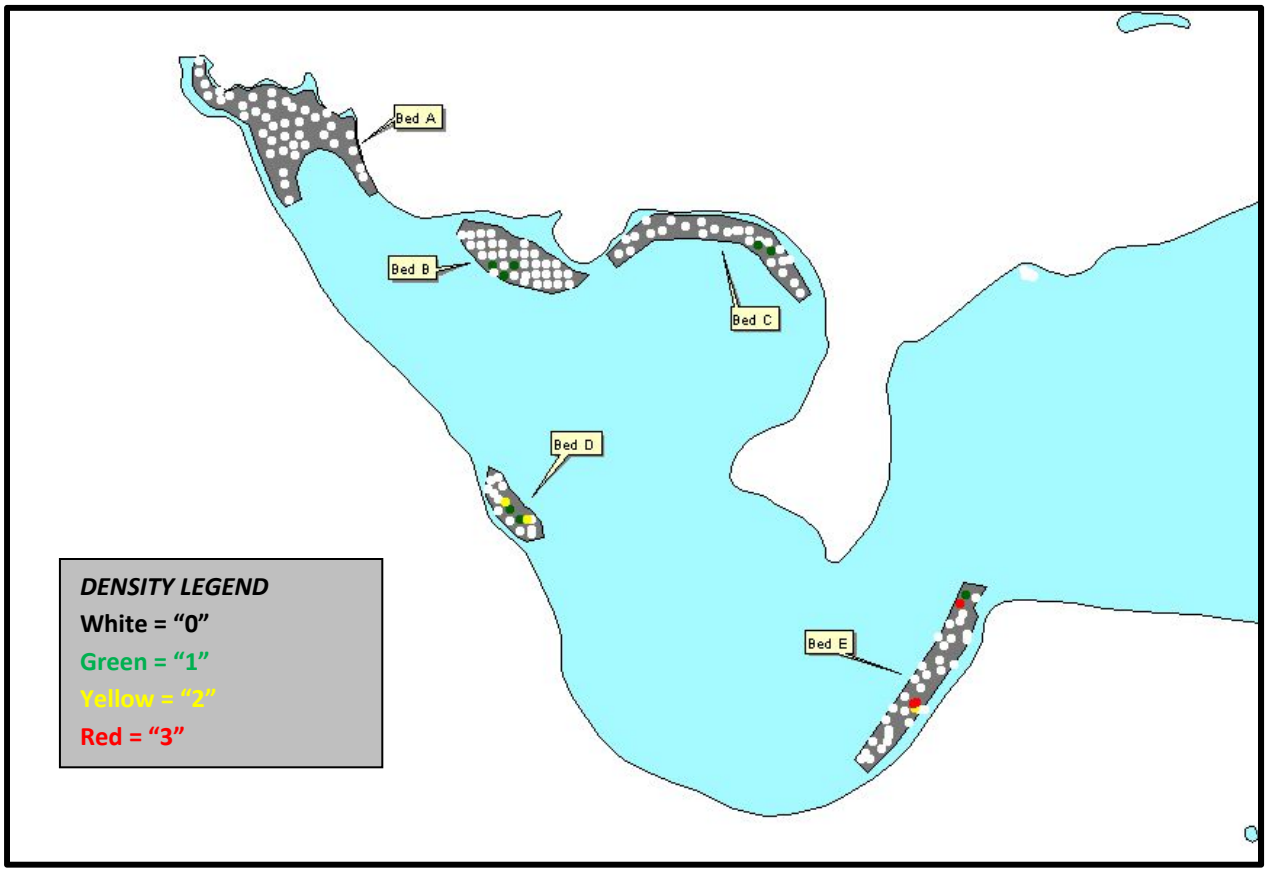


Figure 7: Map showing CLP density in 2013 post treatment survey.

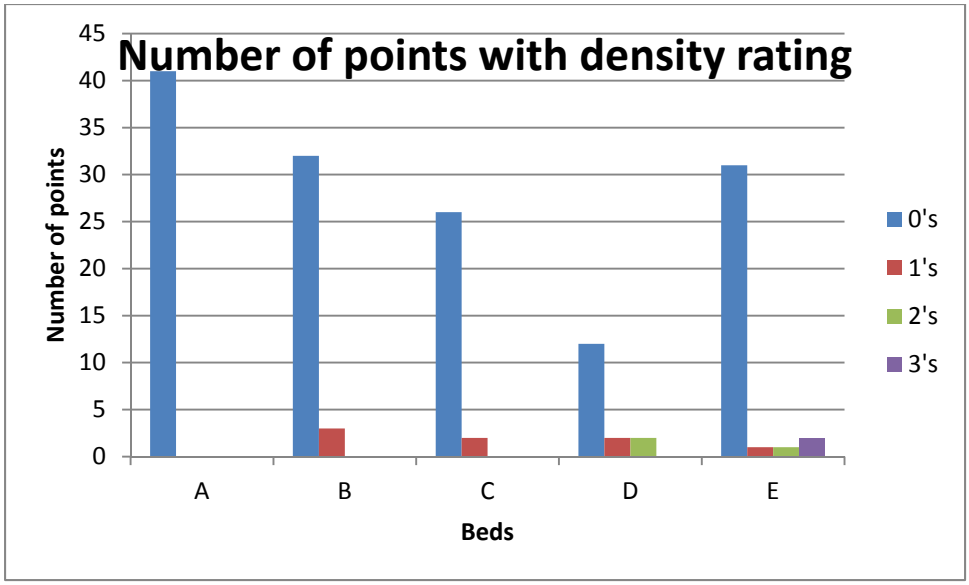


Figure 8: Graph showing density ratings by number of points with density ratings 0-3, 2013 post survey.

The mean density rating in 2013 was 0.13 while it was 0.08 on 2012. Basically there was no change.

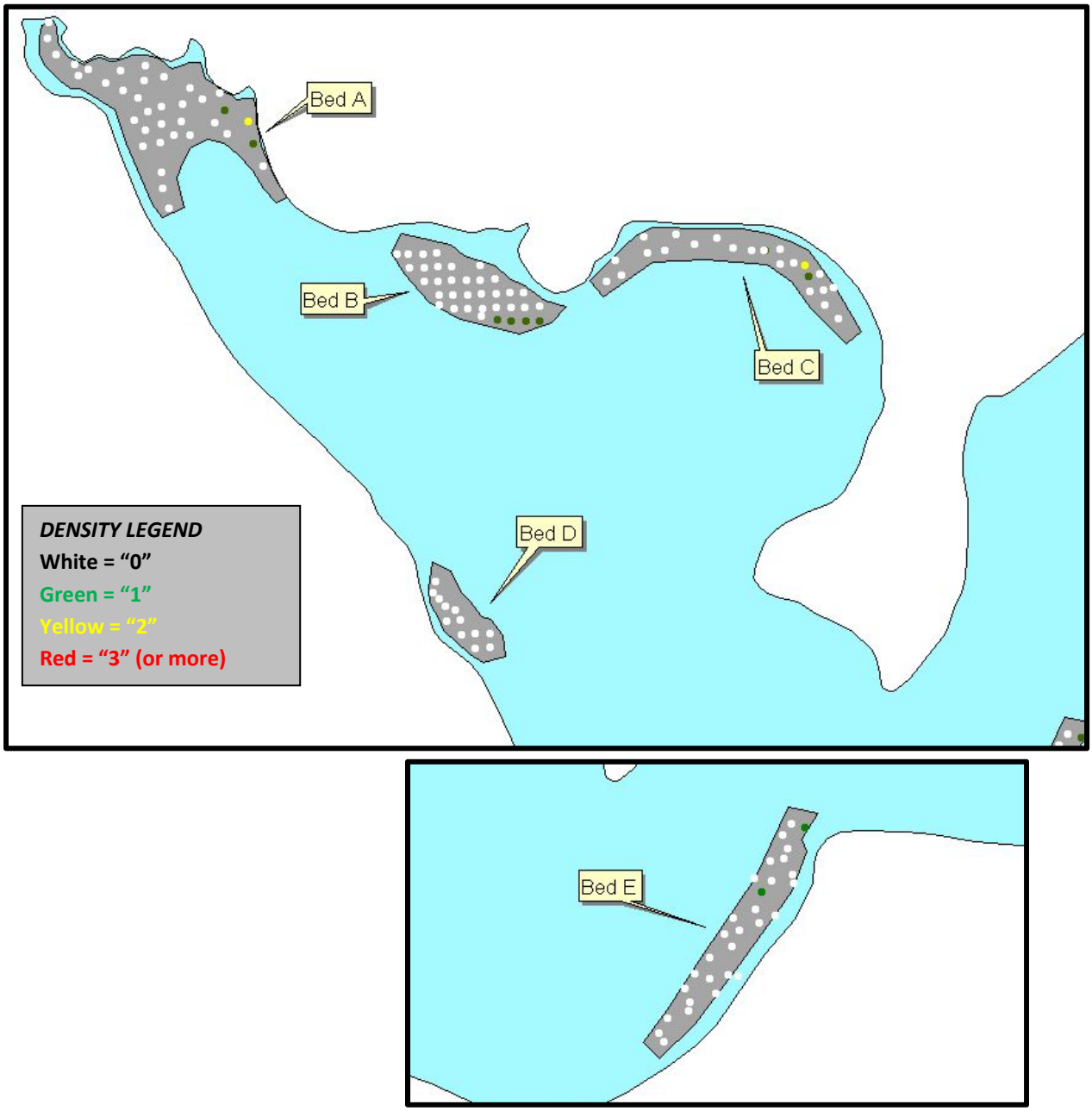


Figure 9: Map showing CLP density from 2012 post treatment survey.

The post treatment survey maps show very limited CLP growth after treatment in both 2012 and 2013, showing two successive years of effective CLP reduction.

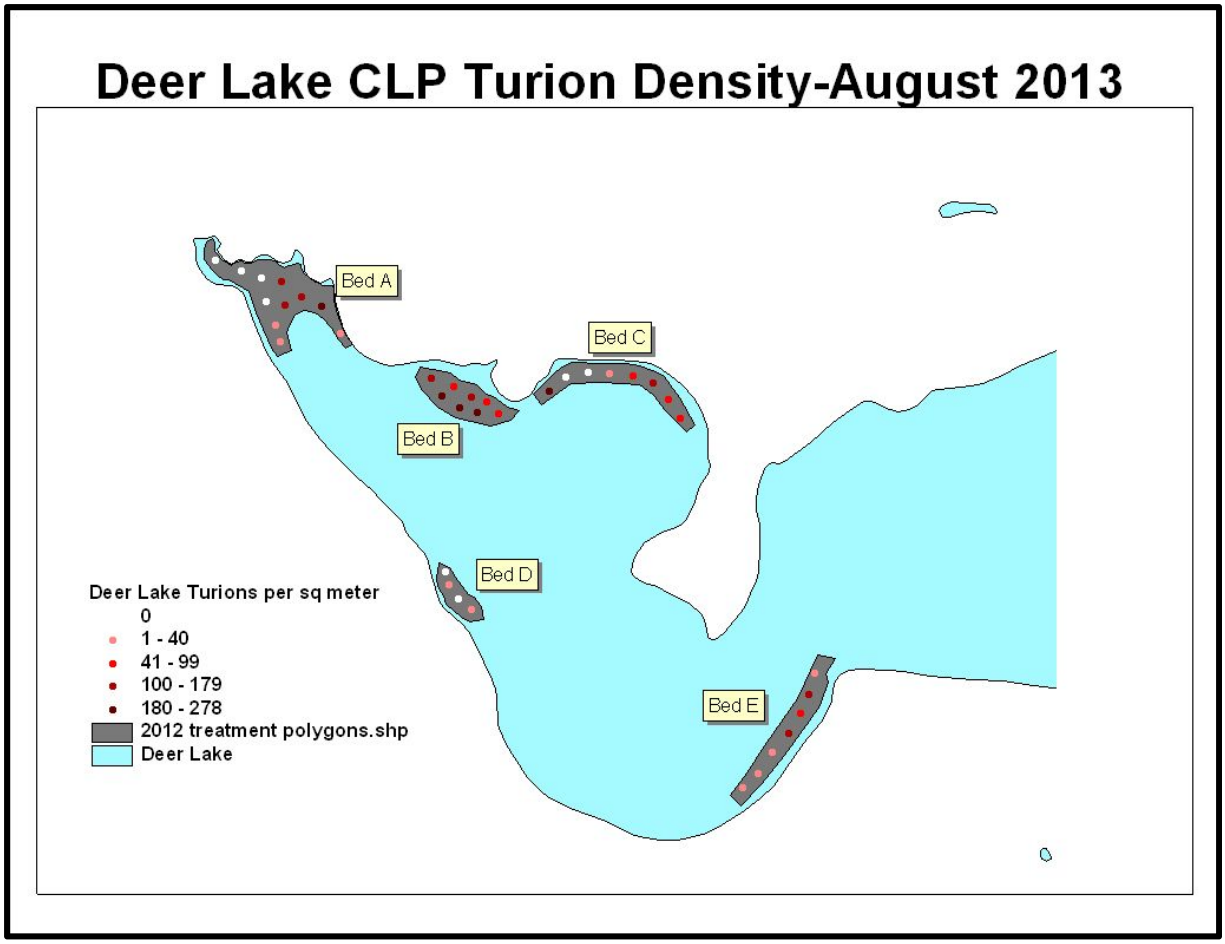


Figure 10: Turion density map at each bed from August 2013 turion density analysis.

The turion density analysis shows high turion density remaining in most all of the beds. This is an indication that there is still the potential for dense CLP growth in the next year in many portions of most beds. Since this is the first turion density analysis, there is no possible comparison to be made. The past treatments haven't been very successful at reducing CLP until 2012, where there was a significant reduction. It is likely that the turion density has gotten reduced the last two years (2012 and 2013) and with more successful treatments in the future, the turion density should continue to decrease.

Native species	Frequency 2012	Frequency 2012	P value	Significant	Change
Lemna trisulca,forked duckweed	**0.23**	**0.13**	**0.02**	**yes**	**-**
Nitella sp. ,stonewort	**0.00**	**0.01**	**0.33**	**no**	**+**
P. praelongus, White-stem pondweed	**0.19**	**0.22**	**0.48**	**no**	**+**
C. demersum, Coontail	**0.53**	**0.65**	**0.03**	**yes**	**+**
M. sibiricum, Northern milfoil	**0.16**	**0.09**	**0.07**	**no**	**-**
P. richardsonii, Clasping pondweed	**0.17**	**0.03**	**3×10^{-4}**	**yes**	**-**
V. americana, Wild celery	**0.06**	**0.00**	**0.002**	**yes**	**-**
filamentous algae	**0.01**	**0.58**	**0.002**	**yes**	**+**
Elodea canadensis, elodea	**0.18**	**0.20**	**0.76**	**no**	**+**
Heteranthera dubia, water stargrass	**0.23**	**0.09**	**0.002**	**yes**	**-**
Ranunculus aquatilis, stiff water crowfoot	**0.15**	**0.08**	**0.09**	**no**	**-**
P. pusillus, small pondweed	**0.03**	**0.00**	**0.30**	**no**	**-**
Chara sp., muskgrasses	**0.00**	**0.03**	**0.05**	**yes**	**+**
P. illinoensis, Illinois pondweed	**0.01**	**0.00**	**0.14**	**no**	**-**
Nymphaea odorata, white lily	**0.08**	**0.05**	**0.26**	**no**	**-**
S. Pectinata, sago pondweed	**0.01**	**0.00**	**0.30**	**no**	**-**

Table 5: Native species frequency and chi-square analysis-2012 to 2013.

The native plant survey data shows a reduction in 10 native species, of which four of them were a statistically significant reduction. The reason for this reduction is likely due to the growing conditions rather than the herbicide. This is due to a couple of observations. First, the coontail frequency increased. Coontail can grow during the cold months also (with CLP) and since many coontail plants would have been present during treatment, the effects of herbicide would have resulted in a decrease coontail. Second, the native plant population was still quite dormant during the post treatment survey. Many natives in lakes around the area were similar to Deer Lake in late native growth, likely due to the very late spring. It is possible that a reduction would have been observed when comparing the 2012 growth to the 2013 growth without any herbicide application due to the lack of growth at survey time.

After the post treatment survey is completed, the entire lake is surveyed looking for CLP beds. A bed is defined as an area of CLP that is dominated by CLP, has a mean CLP density >2, and can be delineated by sight. In order to be delineated by sight, the CLP must be growing at or near the lake surface. There were only two beds of CLP delineated in June 2013 during peak CLP growth. One of the beds is out of the treatment area and the other is contained within treatment Bed E. Figure 12 shows the map of the two CLP beds.

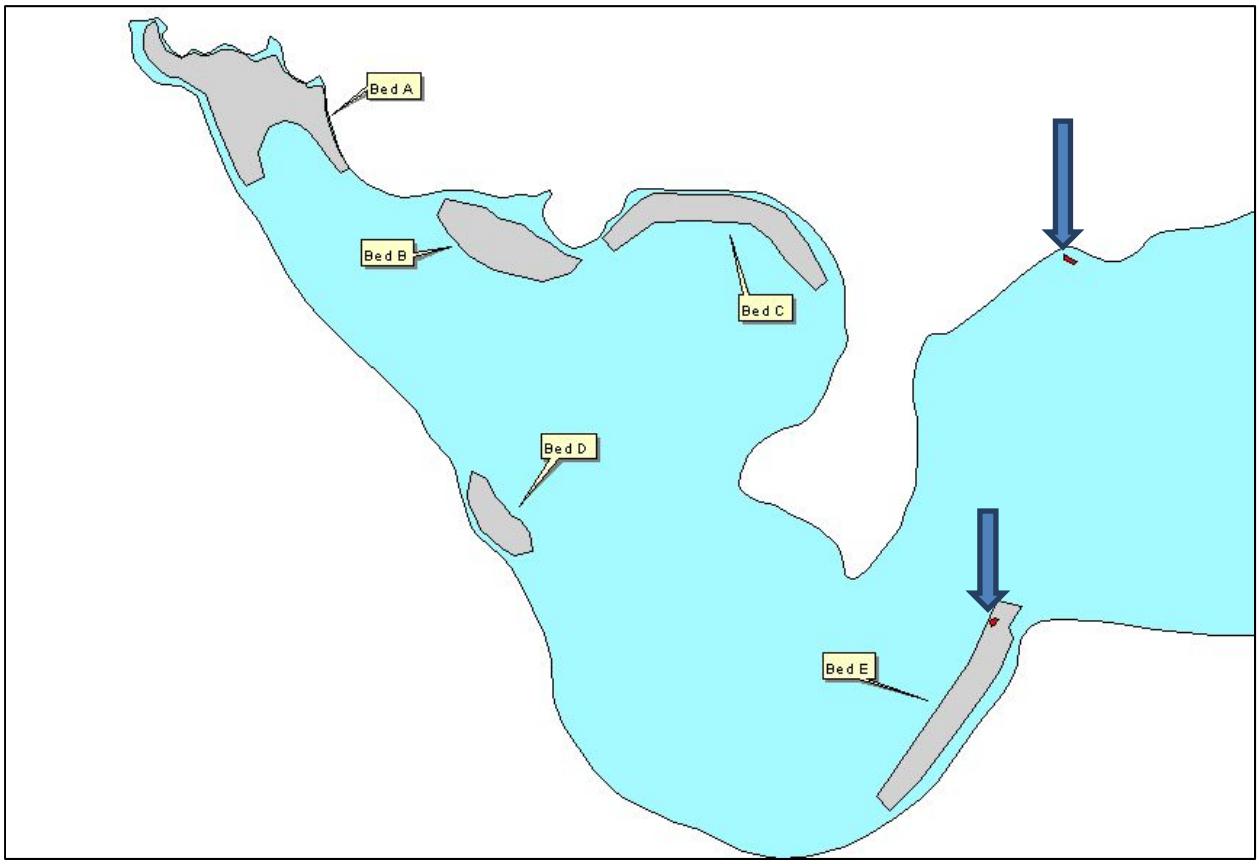


Figure 11: CLP beds from 2013 bed mapping. Arrows show two very small bed locations.

Discussion

The 2013 CLP herbicide treatment was a success. The frequency of occurrence of CLP was significantly reduced in each bed of CLP treated. When comparing the frequency of CLP just before treatment (pre - treatment survey 2013) it was much higher than after treatment (post treatment survey 2013). The reduction was substantial, with an overall frequency reduction of 55.5%. See figure 6 for graphic representation.

When comparing the post treatment frequency in 2012 to the post treatment frequency in 2013, there is little change. This shows that no overall reduction was achieved, but the CLP didn't increase either. Since the treatment in 2012 was also very effective, the post treatment frequency in 2012 was very low, thus giving little room for improvement. However, the pretreatment frequency in early spring 2013 shows that the beds filled back in with CLP due to turion germination. Therefore, even though the treatment was effective, the post treatment comparisons don't reflect any change. There was no

density reduction from 2012 to 2013 either. Density is not determined in the pretreatment survey so that is not comparable.

The native plant species did show reduction, of which four species had a significant reduction. However, this could be due to seasonal variation since the ice went out very late and the spring was very late. Many native plants were still dormant during the post treatment survey, which would result in reduced frequency. Also, since coontail (which can grow during the winter/spring) increased in frequency, it is unlikely herbicide affected coontail. This may indicate no effect on other native species.

Turion densities are still quite high in most portions of all treatment beds. This can allow the prediction of more CLP growth next spring, causing high frequency of CLP again. With continued successful treatments, this density should go done and hopefully lead to little or no CLP growth in major portions of the treatment beds.

It is recommended that these beds be treated again in 2014. A 2014 pretreatment survey may lead to a bed size reduction. The 2013 post treatment map and turion density maps will be used to help in this determination. It is important to continue reducing CLP growth prior to turion production as any turion production can result in future CLP growth. Since turions can remain viable for several years, it is possible treatment will need to continue for three years or more.

References

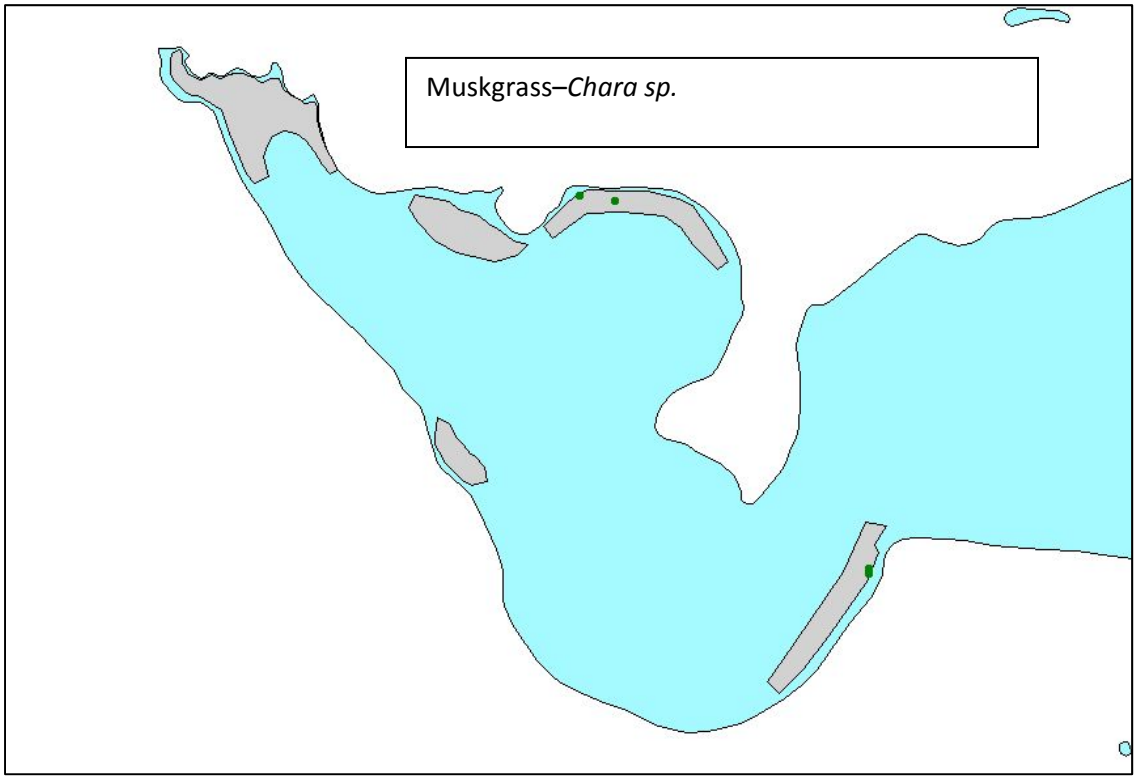
Borman, Susan, Robert Korth and Jo Tempte. *Through the Looking Glass.* University of Wisconsin-Extension. Stevens Point, Wisconsin. 1997. 248 p.

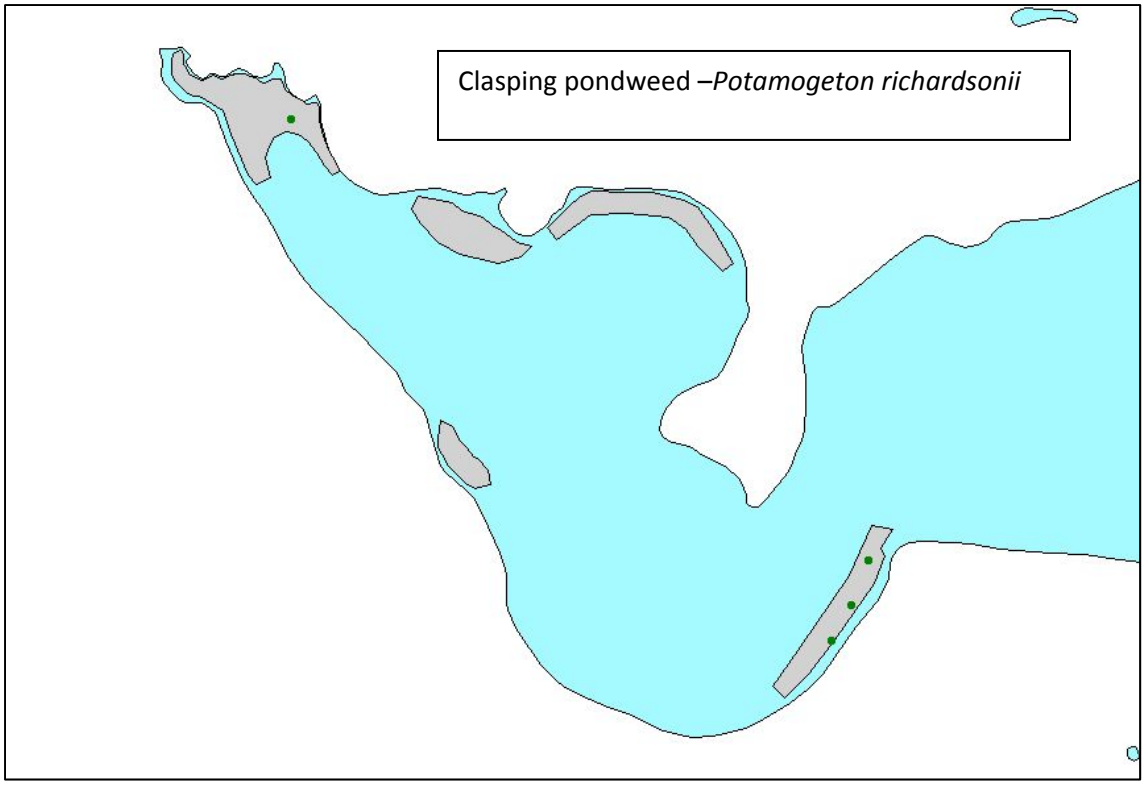
Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

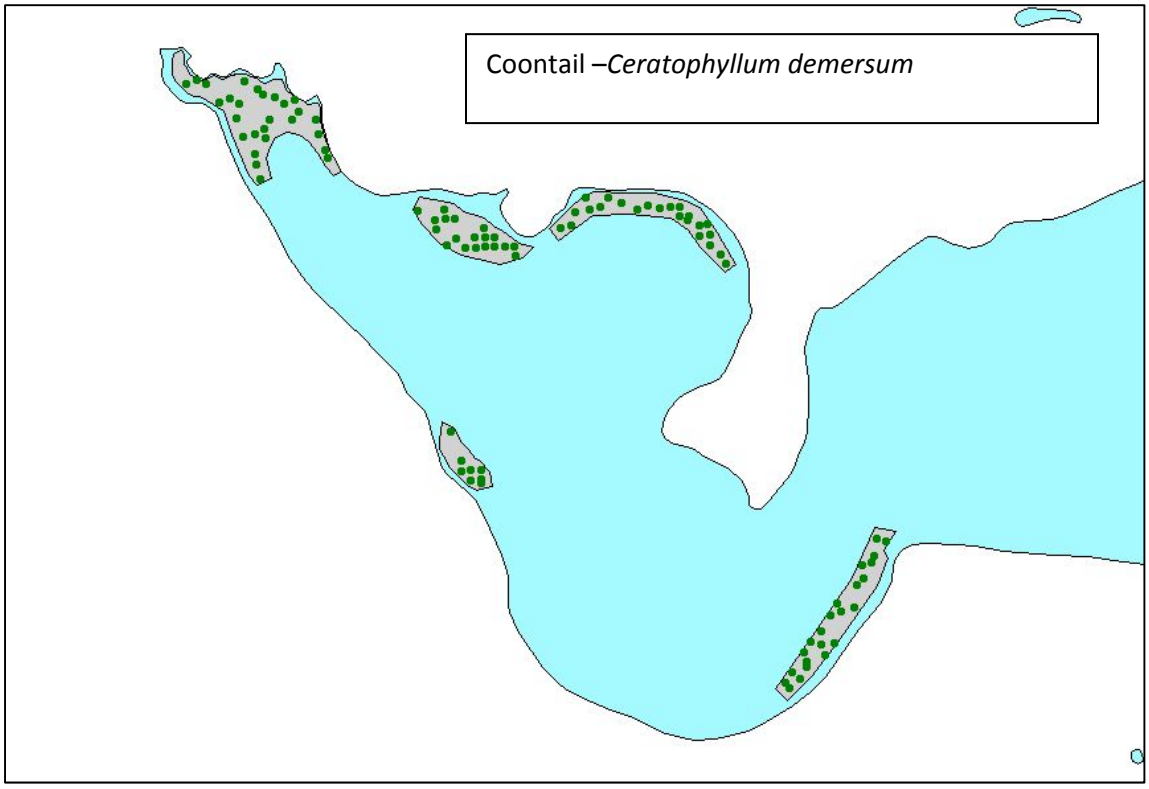
University of Wisconsin-Extension. *Aquatic Plant Management in Wisconsin*. April 2006 Draft. 46 p.

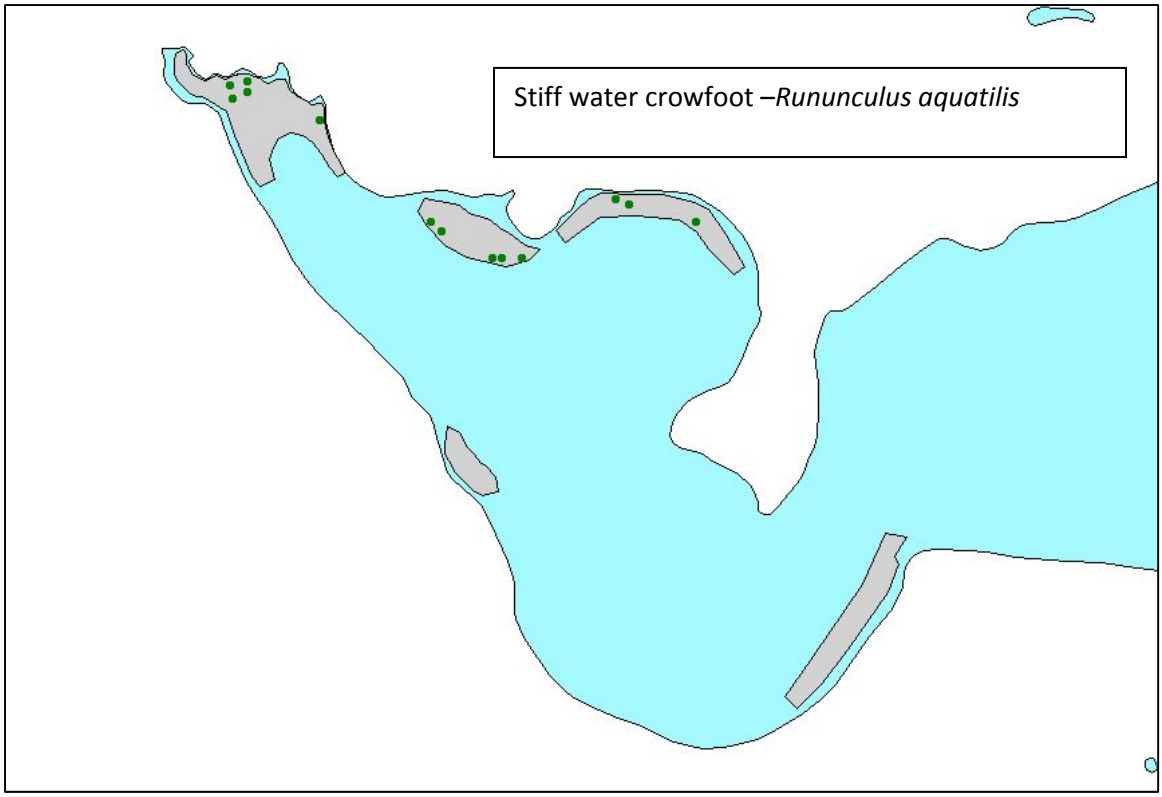
UW-Extension. Aquatic Plant Management website. http://www4.uwsp.edu/cnr/uwexlakes/ecology/apmguide.asp appendix d.

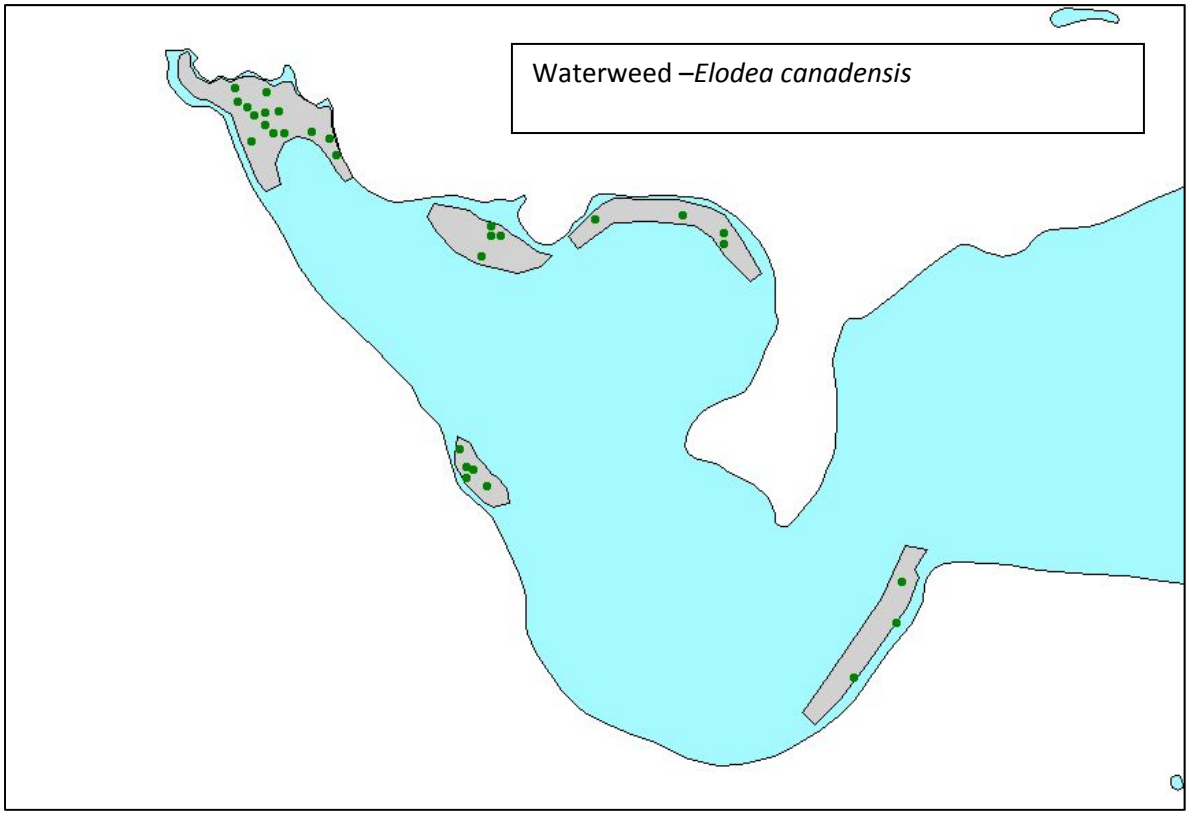
Appendix-Native plant maps from 2013.

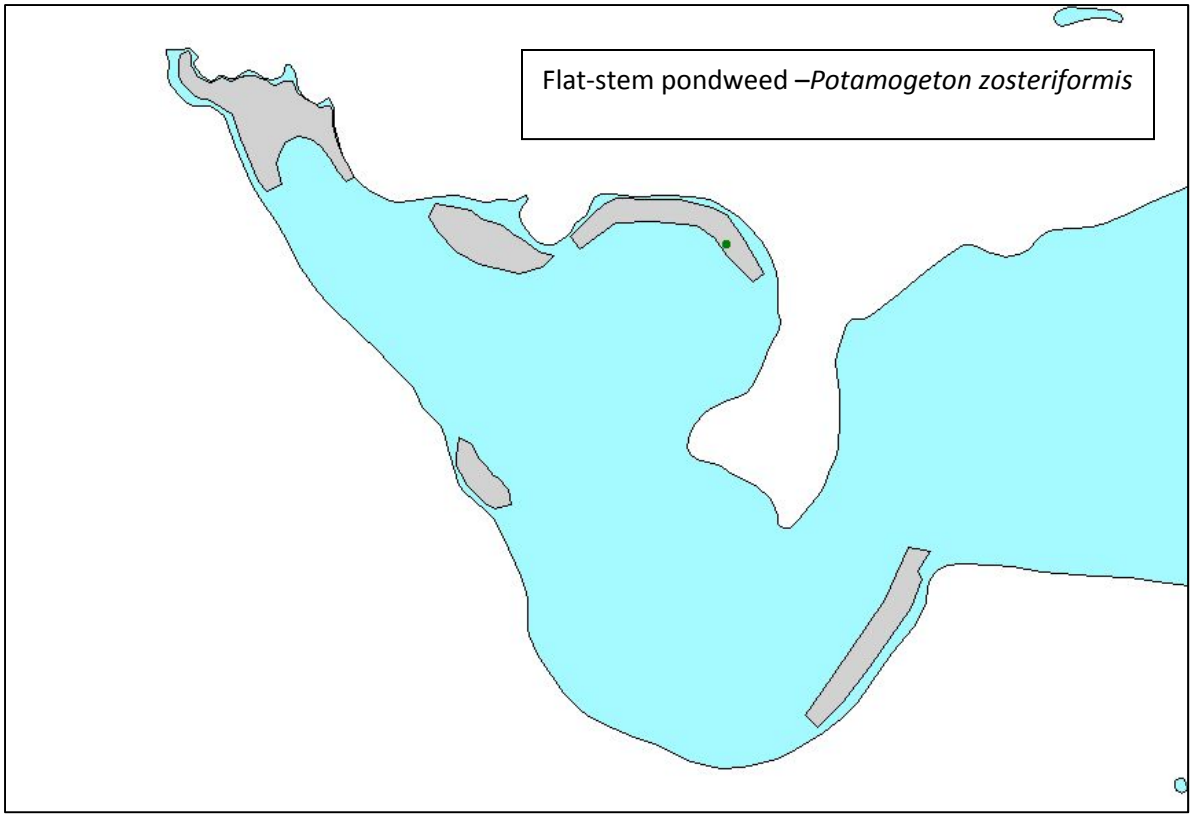


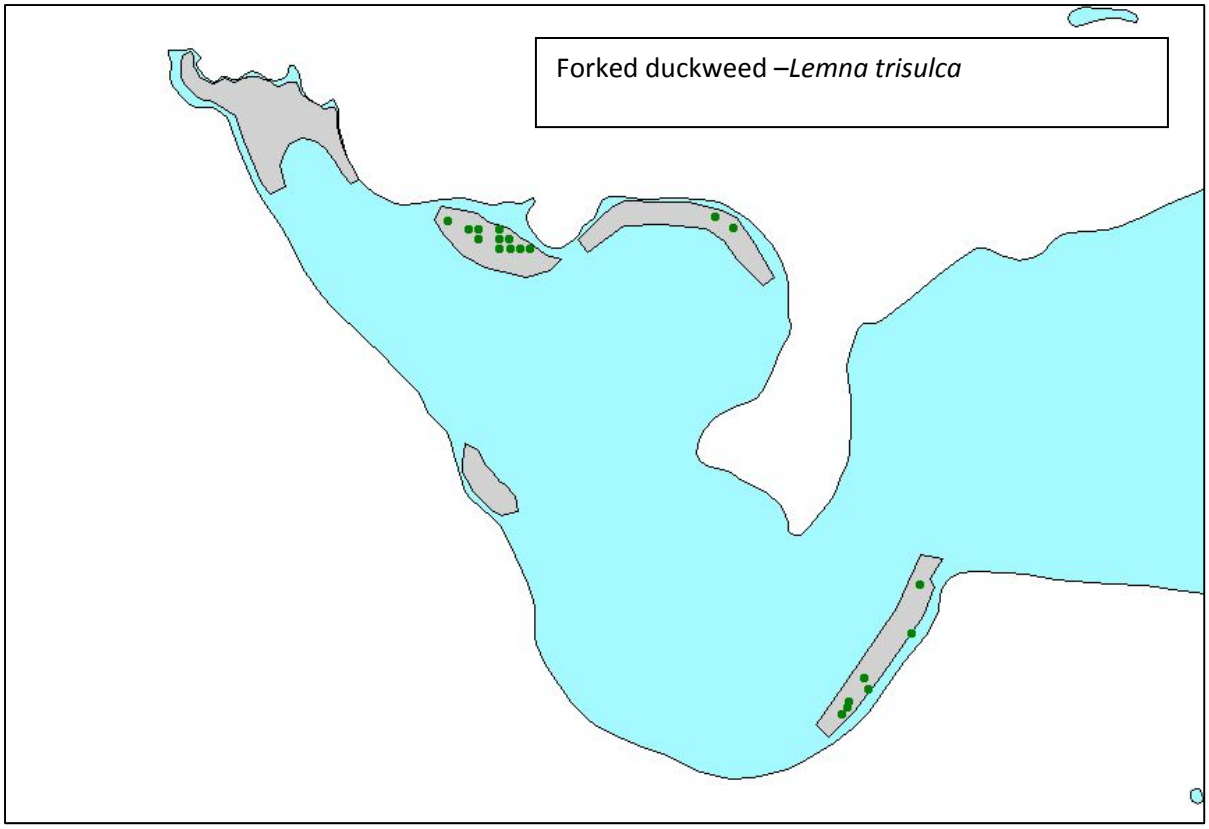

Clasping pondweed –*Potamogeton richardsonii*

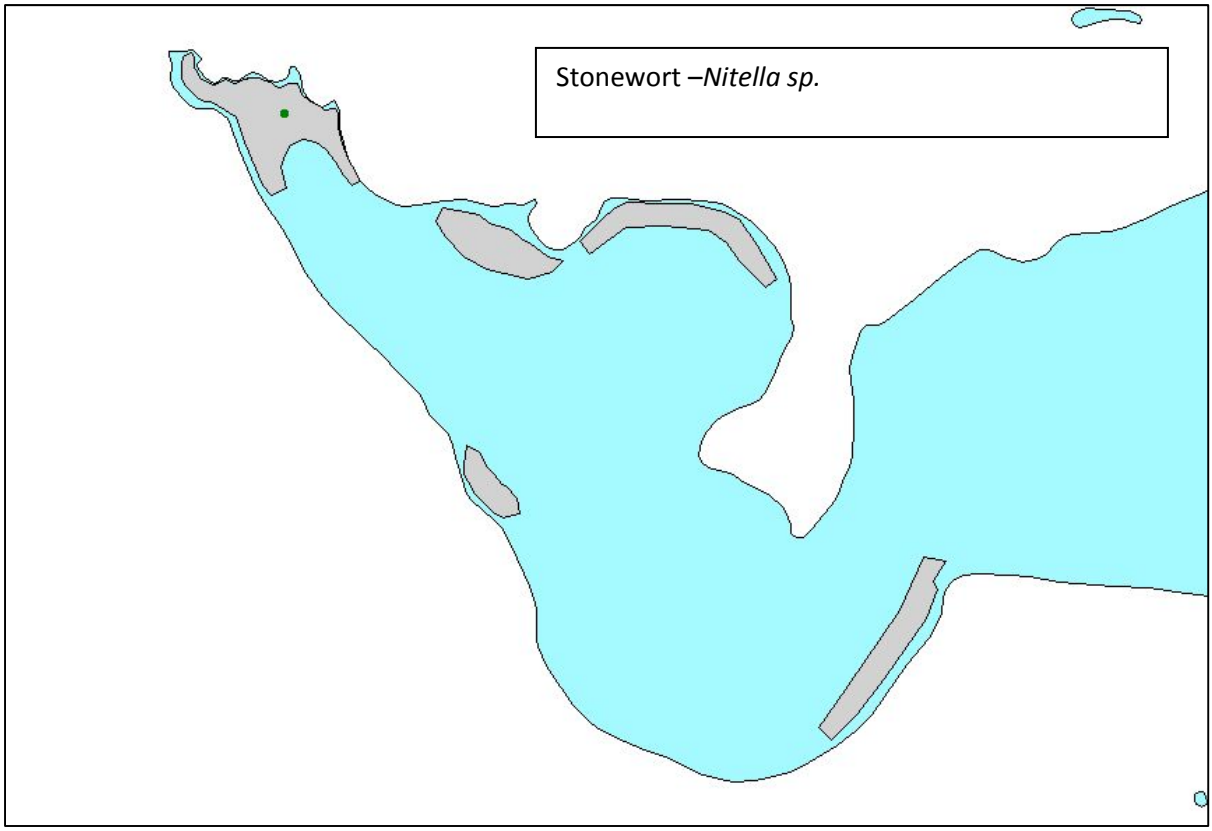

Coontail –*Ceratophyllum demersum*

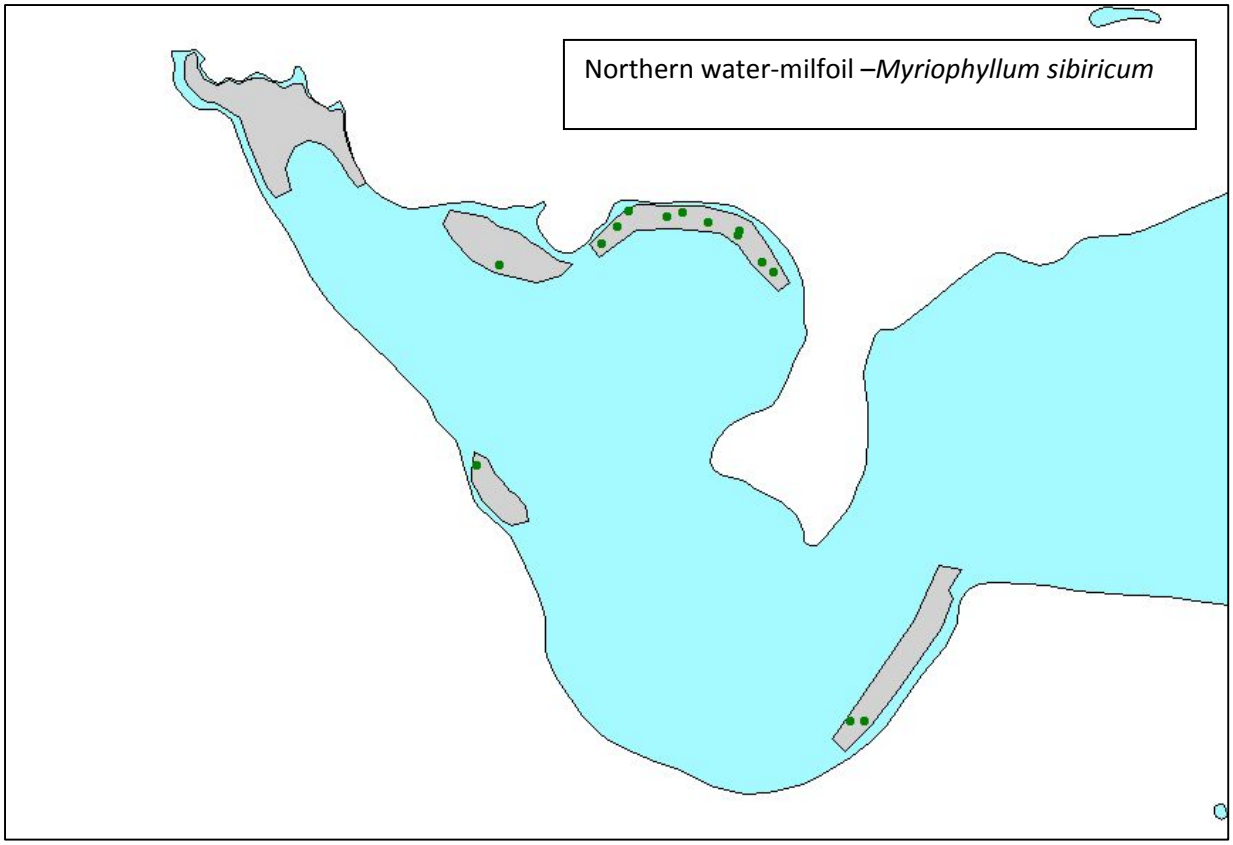

Stiff water crowfoot –*Rununculus aquatilis*

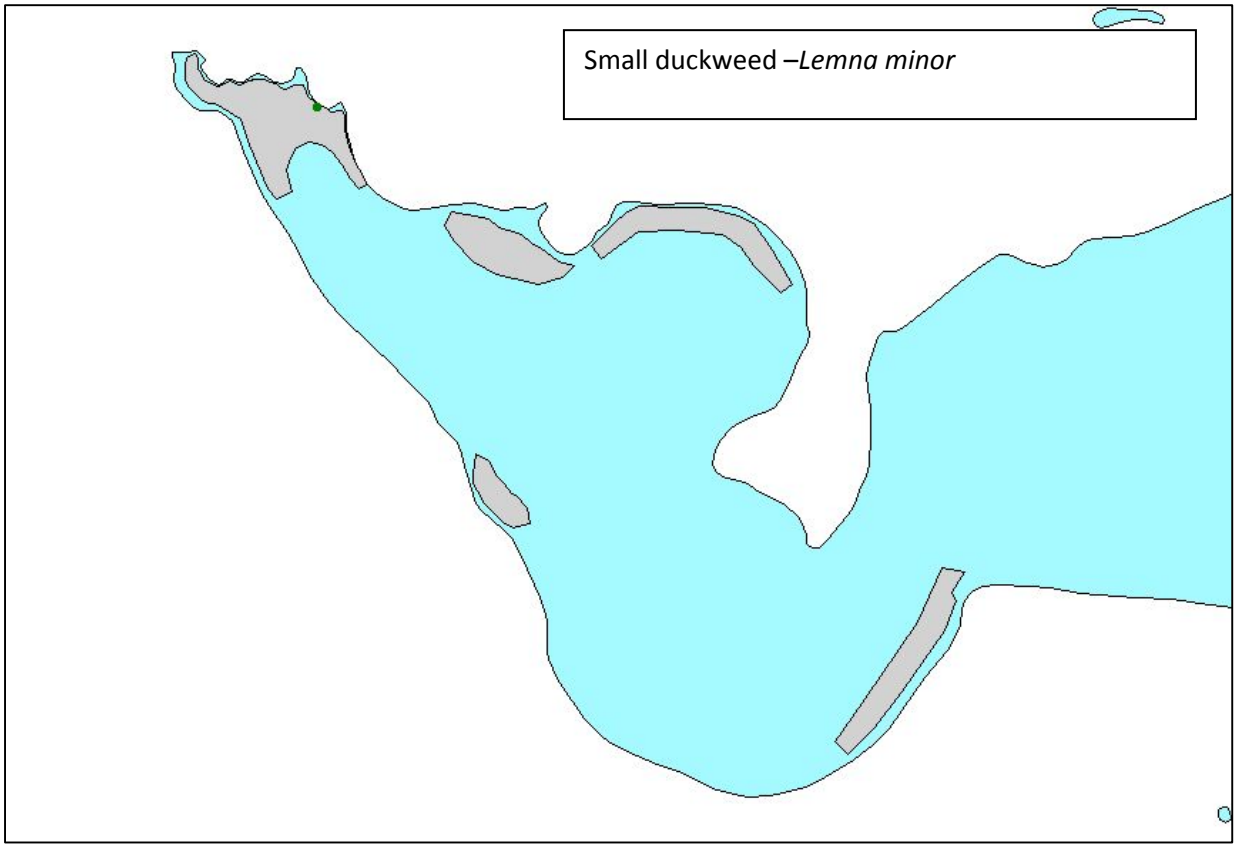

Waterweed –*Elodea canadensis*

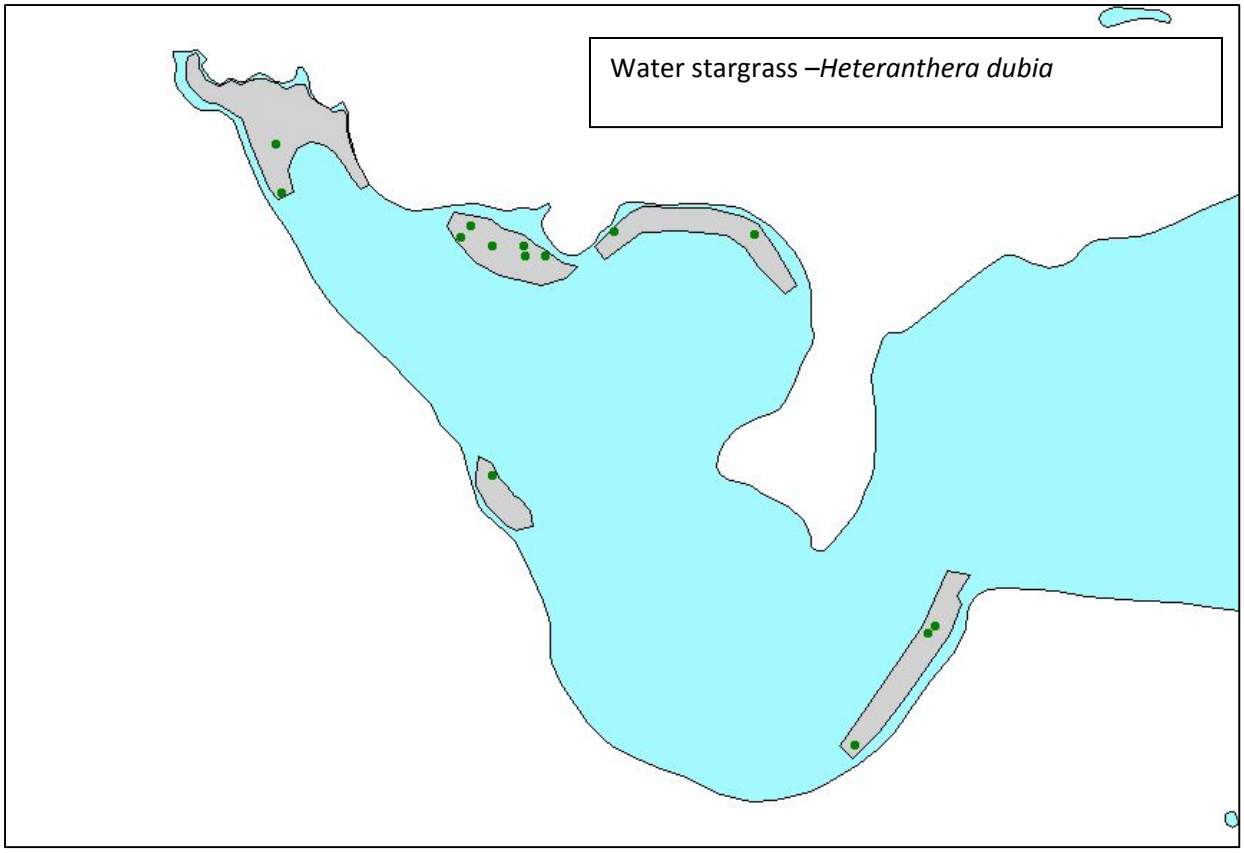

Flat-stem pondweed –*Potamogeton zosteriformis*

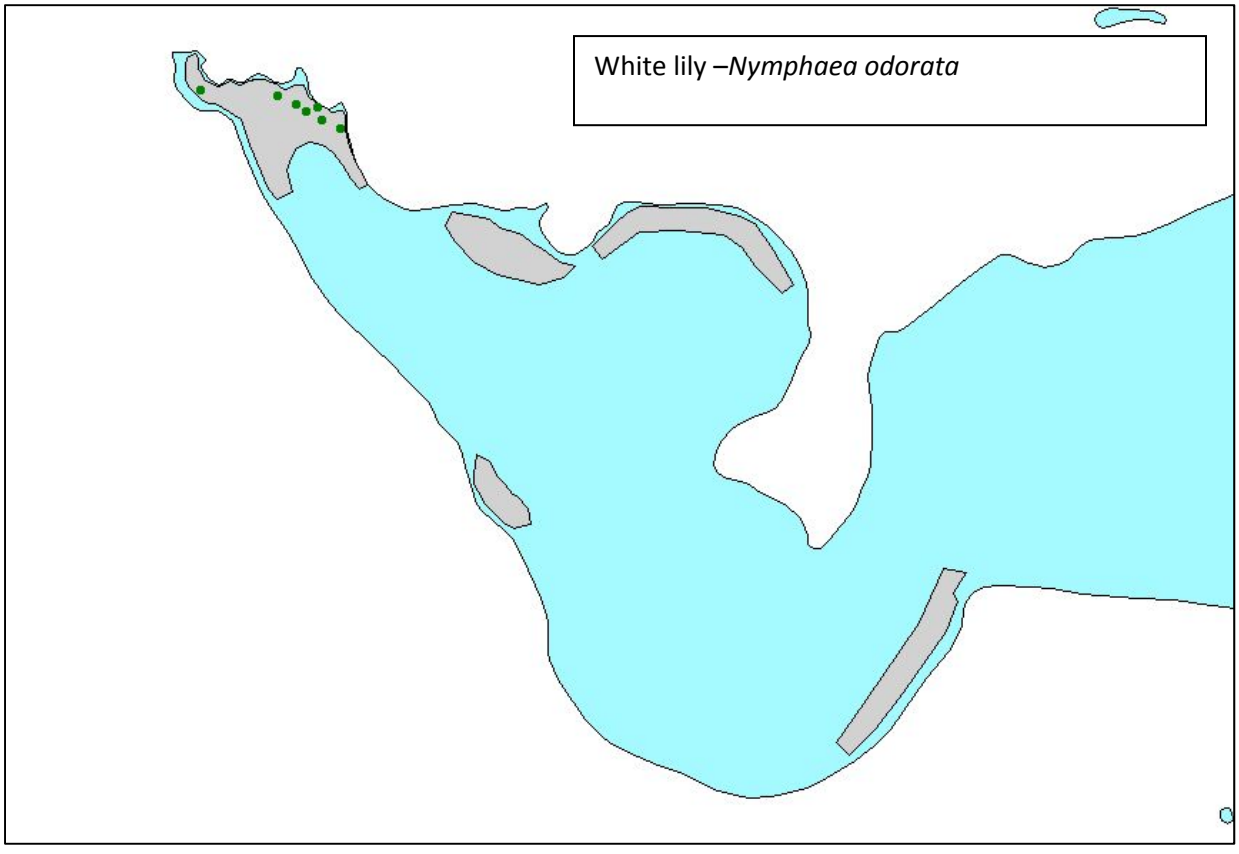

Forked duckweed –*Lemna trisulca*

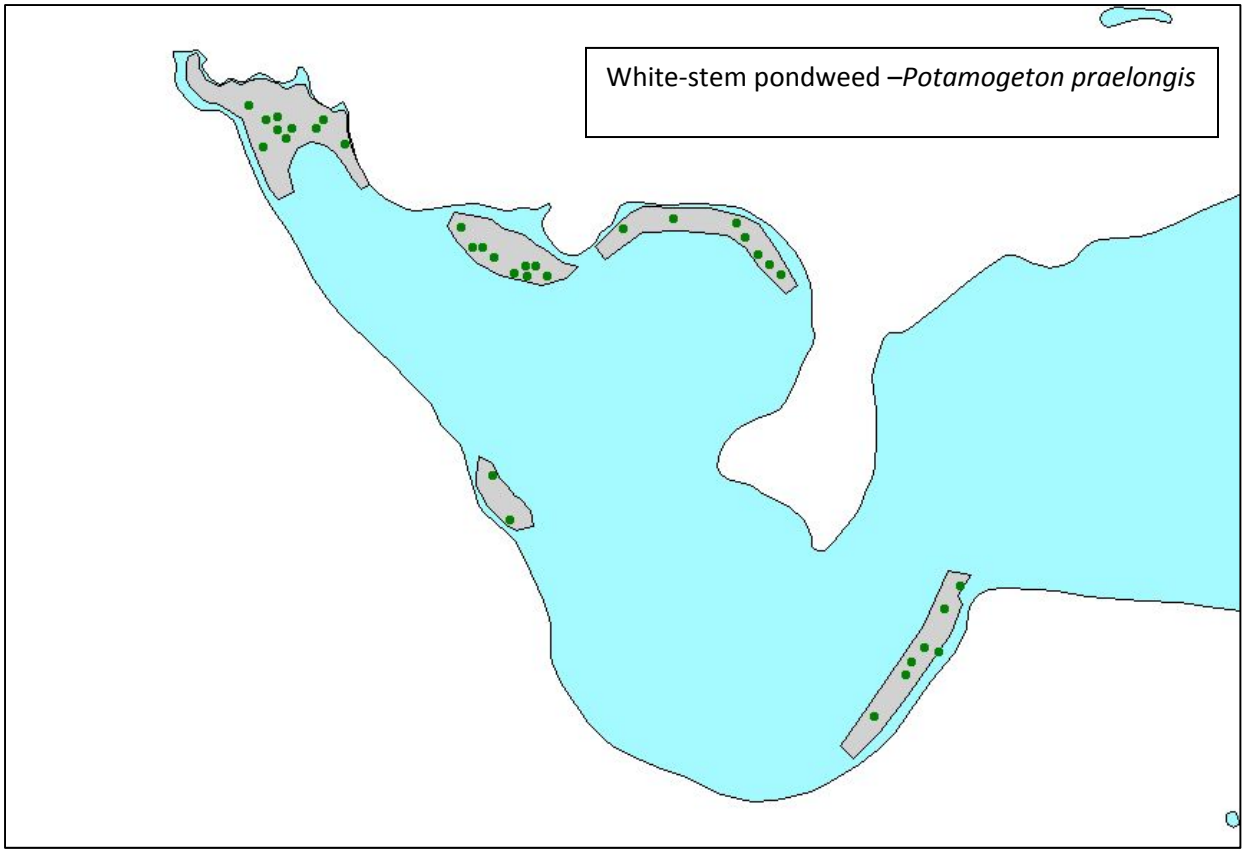

Stonewort –*Nitella sp.*


Northern water-milfoil –*Myriophyllum sibiricum*


Small duckweed –*Lemna minor*


Water stargrass –*Heteranthera dubia*


White lily –*Nymphaea odorata*


White-stem pondweed –*Potamogeton praelongis*