Curly leaf pondweed *(Potamogeton crispus)*

Post herbicide treatment analysis

Lake Wapogasset/Bear TrapLake 2009

Prepared by: ***Ecological Integrity Service, LLC***
Amery, WI

Abstract

In May 2009 one 8.9-acre bed of curly leaf pondweed was treated with herbicide on Lake Wapogasset in Polk County Wisconsin. Another curly leaf pondweed bed covering 6.7 acres was treated on Bear Trap Lake. It was determined through a post treatment survey conducted in June 2009 that there was significant reduction in the density of both beds. The bed in Lake Wapogasset also had a significant reduction in the frequency while the Bear Trap Lake bed had a reduction in frequency that was not significant (according to a chi-square analysis). It is recommended that both of these beds get treated in 2010 to reduce the growth of newly germinating turions.

Lake Wapogasset and Bear Trap Lake CLP Treatment Analysis-2009

Introduction

In May 2009 an 8.9-acre (Lake Wapogasset) bed and a 6.6-acre (Bear Trap Lake) bed of *Potamogeton crispus*-curly leaf pondweed (CLP) was treated with herbicide (endothall-K) (see figure 1). Prior to treatment, a pre-treatment survey was conducted at 39 predetermined sample points for Lake Wapogasset and 22 predetermined sample points for Bear Trap Lake. The density of CLP was recorded at each sample point, along with depth and dominant sediment type. See figure 2 for sample points. The native plants were not surveyed in the pre-treatment survey, so the 2007 PI macrophyte survey results were used to evaluate the native plant community's response.

Approximately 4 weeks after treatment took place, a post-treatment survey was conducted. Each of the sample points used in the pre-treatment survey was used. The CLP density was recorded as well as the density of each native plant species found.

To examine the effectiveness of an herbicide treatment, data collected one year prior to the treatment is compared to the post –treatment survey. The CLP density was recorded at the pre-determined sample points in each bed in 2008. These densities are then compared to the densities from the 2009 post treatment survey. Statistical analysis is then used to evaluate the effectiveness. A chi-square analysis is completed to evaluate the frequency of occurrence of CLP in the treatment beds. A t-test is completed on the density of CLP in each treatment bed to evaluate the density reduction. The native plants present in the PI survey one-year prior (2007) will be used to see how the native plants responded. The native plant data from this year's post treatment survey can be used in future years. A chi-square analysis is used to evaluate any changes in the frequency of occurrence of each native plant species surveyed.

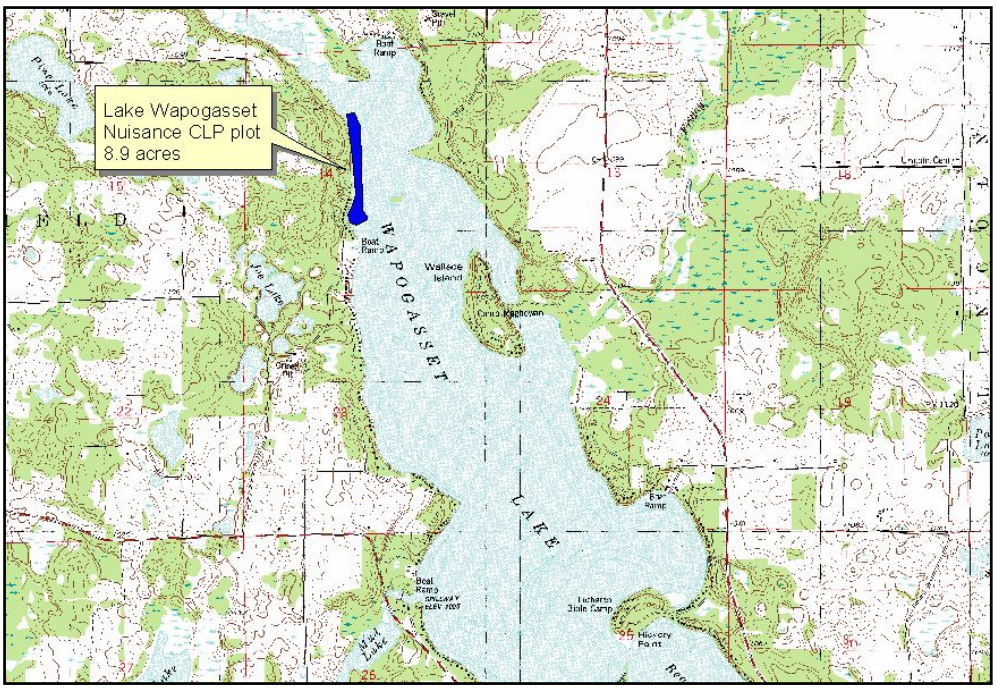


Figure 1: CLP treatment bed Lake Wapogasset-2009

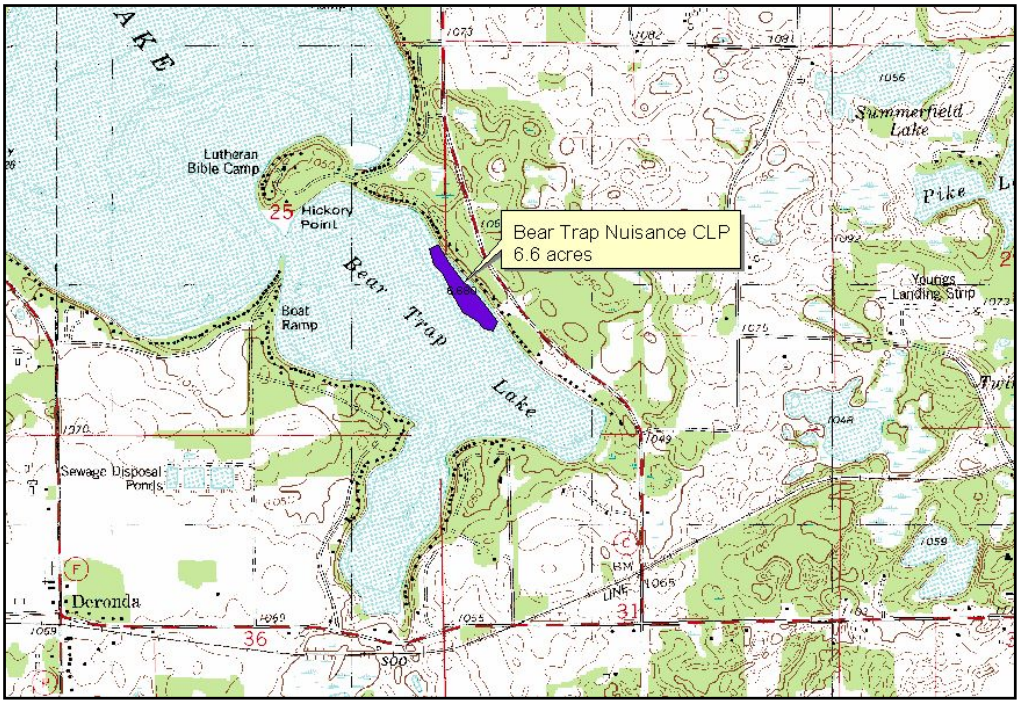


Figure 2: CLP treatment bed Bear Trap Lake-2009

Lake	Date of treat.	Acres	Herbicide	Application rate	Water temp	Wind speed
Lake Wapogasset	5-14-09	8.90	Aquathol-K	3.90 gal/acre	56.2	10-55 mph/NW
Bear Trap Lake	5-19-09	6.68	Aquathol-K	4.56 gal/acre	59.3	0-5 mph/E

Table 1: Treatment information summary-2009

At each sample point, a 1-meter rake tow is used to sample the plants. Each plant species is recorded along with its density (rated 1-3 based on the amount of the particular plant on the rake tines). The following chart displays the relative density categories:

Density of "1"---present on rake

Density of "2"---plant takes up ½+ of tine space on rake

Density of "3"---plant takes up all+ of tine space on rake

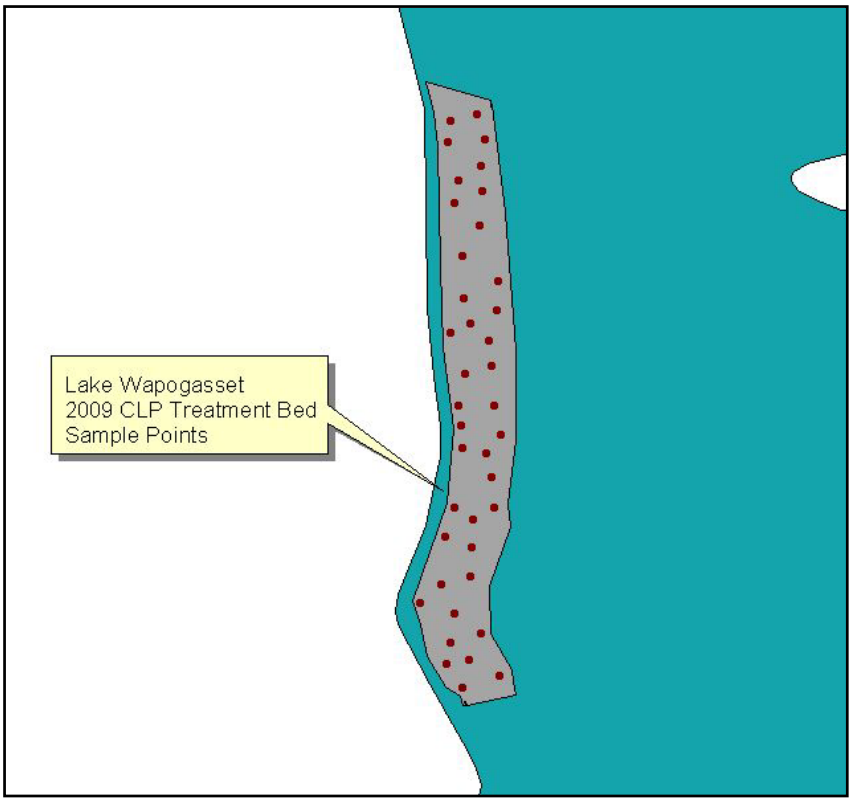


Figure 3: Pre and post treatment sample points Lake Wapogasset.

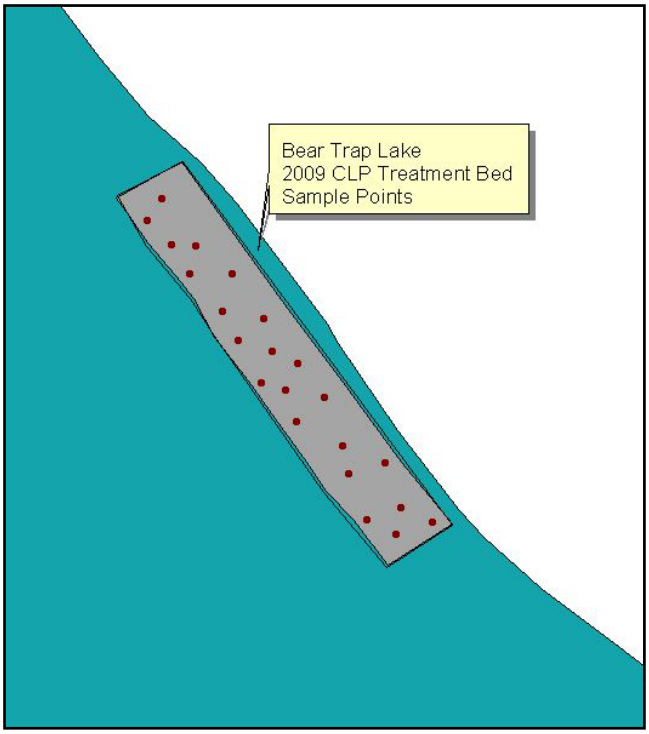


Figure 4: Pre and post treatment sample points Bear Trap Lake.

Results:

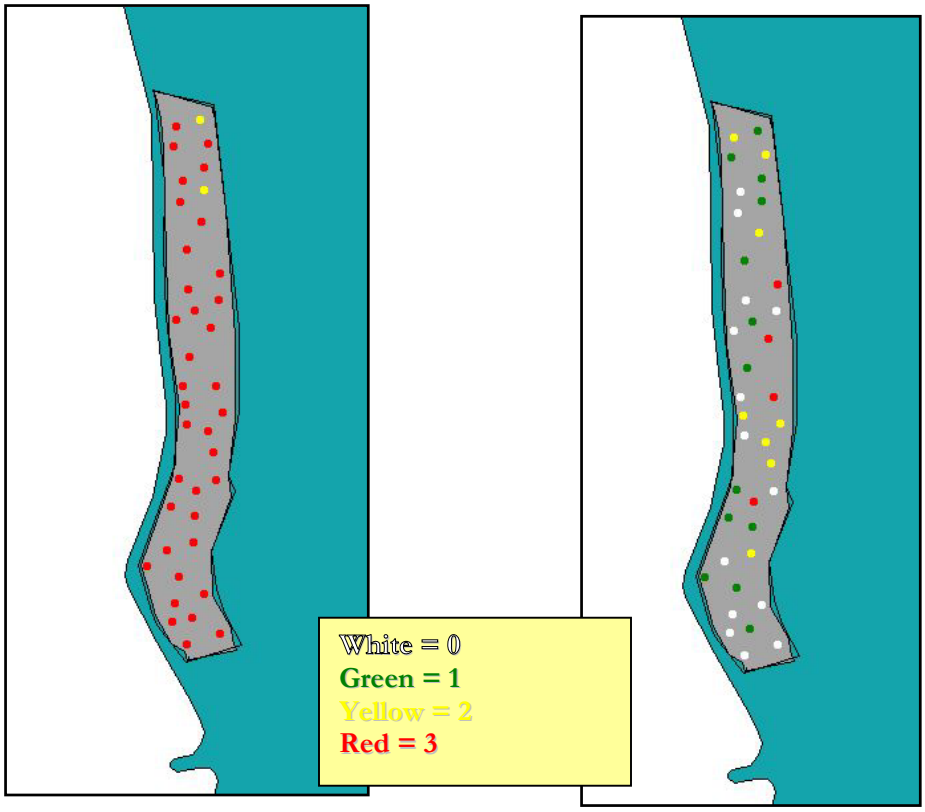


Figure 5: Pre treatment (2008) and post treatment (2009) CLP density

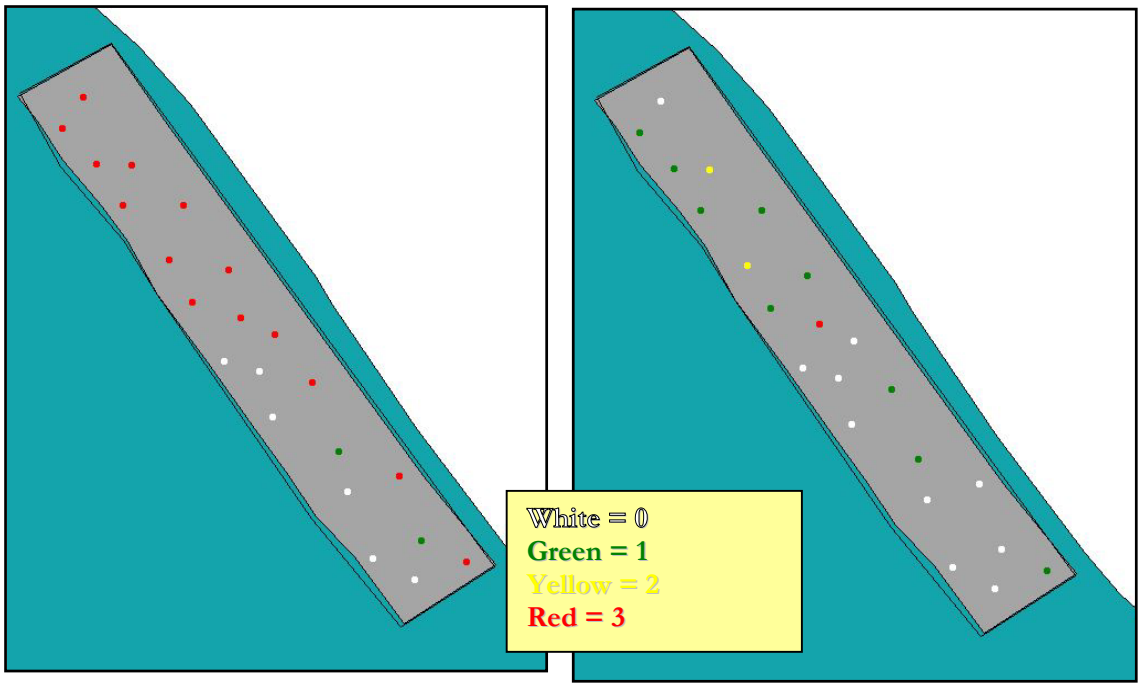


Figure 6: Pre treatment (2008) and post treatment (2009) CLP density.

The 2009 CLP herbicide treatment on Lake Wapogasset resulted in significant reduction in both the frequency and density of the CLP. In the chi-square analysis for CLP frequency reduction the change was determined to be significant. In addition, the CLP density was reduced significantly according to the t-test calculation with $p=1.3 \times 10^{-14}$.

The 2009 CLP herbicide treatment on Bear Trap Lake had more mixed results. According to the chi-square analysis for the change in frequency, there was a reduction but was found not to be significant ($p=0.21$). However, the density was reduced and found to be significant according to the t-test results ($p=0.0007$). A summary of the statistical results is in Table 2 below.

CLP Bed	Pre Frequency	Post Frequency	Pre Mean Density	Post Mean Density	Significant Freq. Change (Chi Square)	Significant Density Change (T-Test)
Lake Wapogasset	1.0	0.64	2.95	1.05	YES ($p=0.0001$)	YES ($p=1.3X10^{-14}$)
Bear Trap Lake	0.73	0.55	2.0	0.73	NO ($p=.21$)	YES ($p=0.0007$)

Table 2: Summary of CLP data comparing pre to post treatment survey.

The native plant community did not appear to get reduced as a result of the treatment. There was reduction of some plants, but the number significance may be invalid due to such small expected values. Also, due to the fact the treatment of these beds was unknown in 2008, a native plant analysis was not completed, only CLP density. As a result, the 2007 PI macrophyte survey results were used with sample points falling within the boundary of the treatment beds. This could affect the comparison results.

Plant	P	Significance	Change
coontail	0.30595	n.s.	-
northern milfoil	0.85497	n.s.	+
Crowfoot*	0.94645	n.s.	-
water stargrass*	0.94645	n.s.	-
White-stem pondweed	0.55978	n.s.	+
clasping pondweed*	0.13753	n.s.	-
Flat-stem pondweed*	0.00014	***	-
Wild celery*	0.03408	*	-
Elodea*	0.13753	n.s.	-

**Expected value may be too small making difference insignificant.*

Table 3: Chi-square analysis of native plants in treatment bed-Lake Wapogasset.

There was some observation of dead native plants in the Lake Wapogasset treatment beds. However, it is not known if this was the result of the herbicide treatment. Both treatments occurred when the water temperature was below 60 degrees F. This observation could be from dead plants from the previous growing season.

Plant	P	Significance	Change
coontail	0.63781	**n.s.**	**+**
flat stem	0.69211	**n.s.**	**-**
elodea	0.78392	**n.s.**	**-**
clasping pondweed	0.32043	**n.s.**	**-**
Coontail	0.00891	**	**-**
Northern milfoil*	0.22989	**n.s.**	**+**
Stiff water crowfoot	0.53820	**n.s.**	**-**
water stargrass	0.29158	**n.s.**	**-**
white-stem pondweed	0.50265	**n.s.**	**+**
small pondweed*	0.07825	**n.s.**	**-**
wild celery	0.00359	**	**-**
bushy pondweed*	0.07825	**n.s.**	**-**
illinois pondweed*	0.21954	**n.s.**	**-**

**Expected value may be too small making difference insignificant.*

Table 4: Chi-square analysis of native plants in treatment bed-Bear Trap Lake.

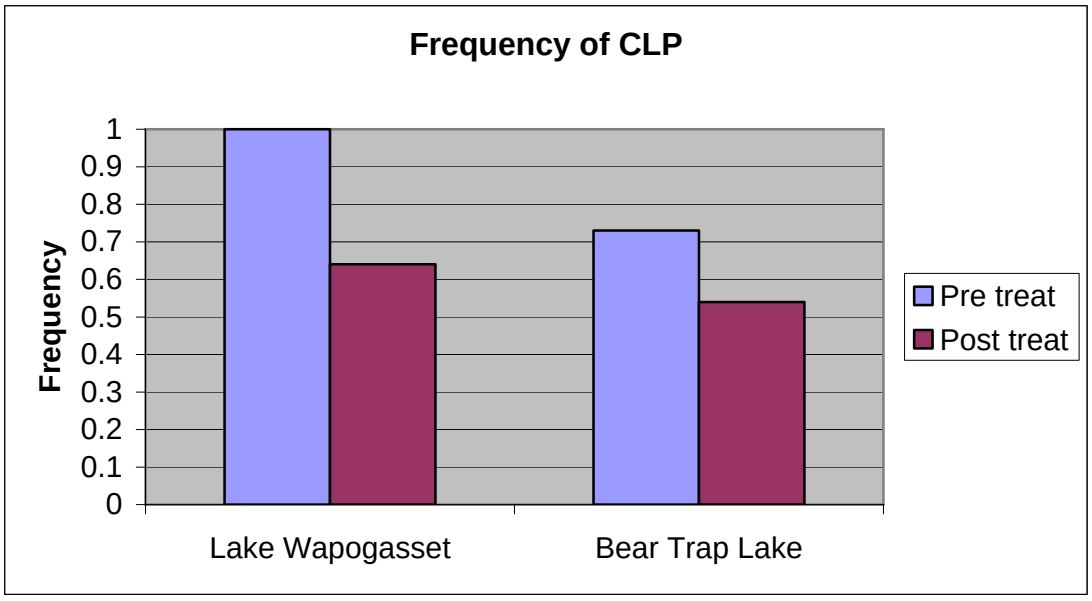


Figure 7: Frequency of CLP at pretreatment and post treatment.

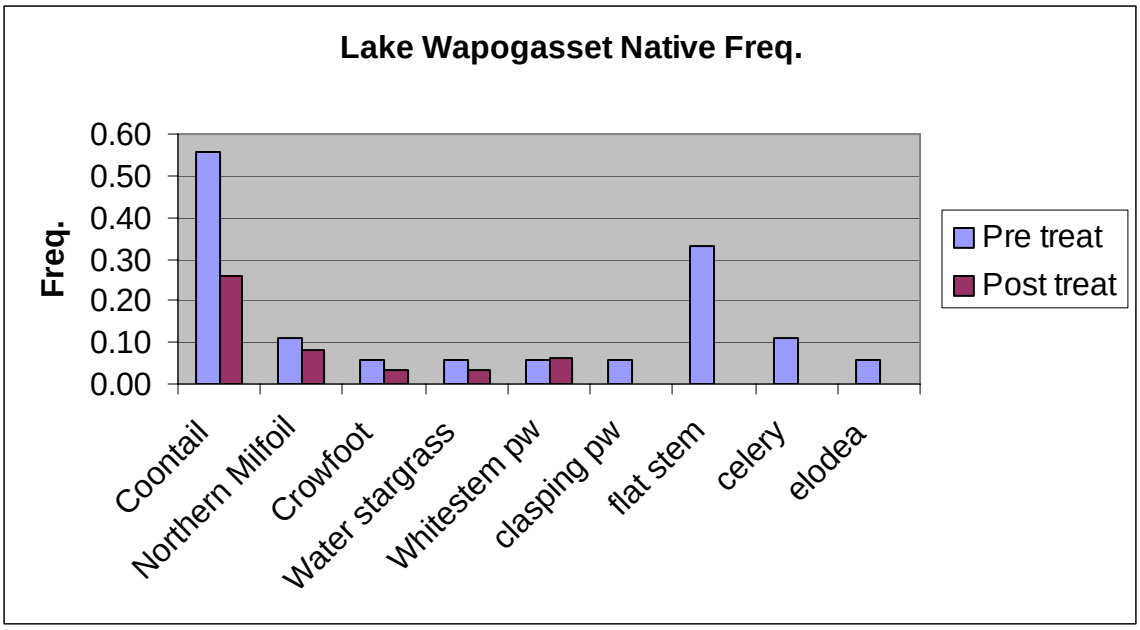


Figure 8: Lake Wapogasset frequency of occurrence for native plant species at pre and post treatment surveys.

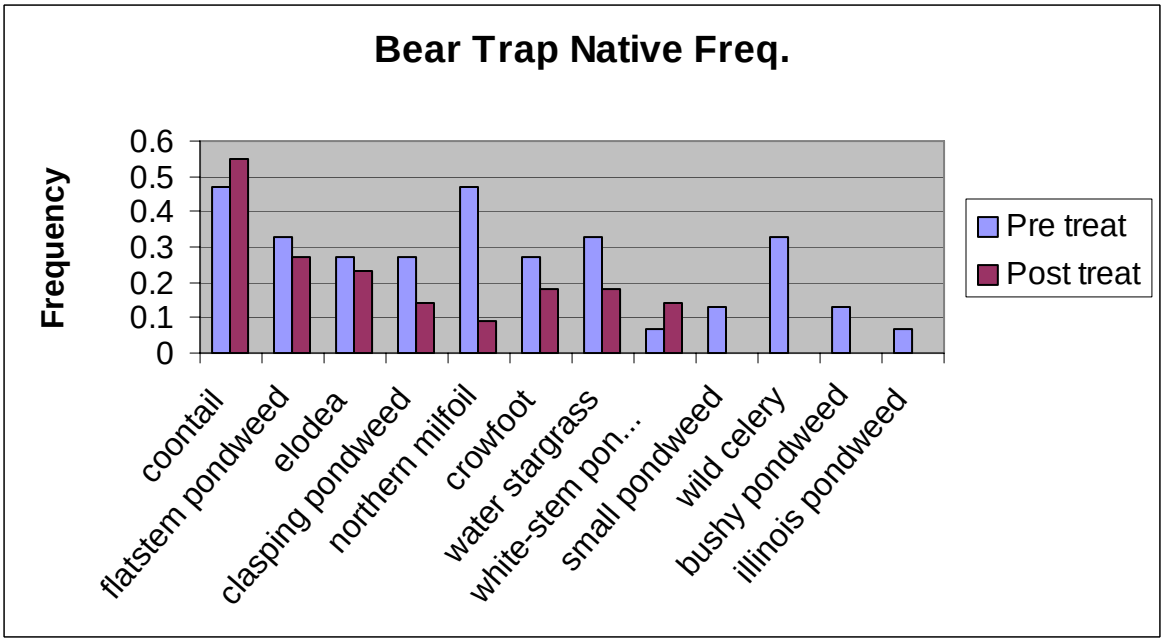


Figure 9: Bear Trap Lake frequency of occurrence of native plant species for pre and post treatment surveys.

Recommendations

Although the treatment was effective on Lake Wapogasset and the density reduction was effective on Bear Trap Lake, subsequent treatments must take place. There is still CLP present in the beds. In addition, there is most likely a substantial accumulation of turions in the sediment. These turions can remain viable for several years. As a result, if treatment was stopped, those turions could germinate and grow into adult plants resulting in more turion production. If treatment occurs, the turions that germinate into new plants can die from herbicide exposure, thus eliminating new turion production. This treatment will also need to occur for another year after 2010 at a minimum.

An early season treatment is again recommended with water temperature less than 60 degrees F. Also, it may be necessary to consider an increased application rate on Bear Trap Lake due to greater mean depths. The application rate may need to remain in depths of 5-8 feet and depths greater than 8 feet have the rate increased to provide higher exposure concentrations (precision application procedures).

Curly leaf pondweed *(Potamogeton crispus)*

Post herbicide treatment analysis

Lake Wapogasset/Bear TrapLake 2010

Prepared by: ***Ecological Integrity Service, LLC***
Amery, WI

Lake Wapogasset and Bear Trap Lake CLP Treatment Analysis-2010

Introduction

In May 2010 an9.9-acre (Lake Wapogasset) bed and a 5.6-acre (Bear Trap Lake) bed of *Potamogeton crispus*-curly leaf pondweed (CLP) was treated with herbicide (endothall-K) (see figures 1 and 2) for the second year. Prior to treatment, a pre-treatment survey was conducted at 40 predetermined sample points for Lake Wapogasset and 17 predetermined sample points for Bear Trap Lake. The presence of CLP was recorded at each sample point, along with depth and dominant sediment type. The treatment bed on Bear Trap Lake was adjusted for depth from the previous year treatment.

Approximately 4 weeks after treatment took place, a post-treatment survey was conducted. Each of the sample points used in the pre-treatment survey was used. The CLP density was recorded as well as the density of each native plant species found.

To examine the effectiveness of an herbicide treatment, data collected one year prior to the treatment is compared to the post –treatment survey. The CLP density was recorded at the pre-determined sample points in each bed in 2009. These densities are then compared to the densities from the 2010 post treatment survey. Statistical analysis is then used to evaluate the effectiveness. A chi-square analysis is completed to evaluate the frequency of occurrence of CLP in the treatment beds. A t-test is completed on the density of CLP in each treatment bed to evaluate the density reduction. The native plants present in the post-treatment survey one-year prior (2009) will be used to see how the native plants responded. A chi-square analysis is used to evaluate any changes in the frequency of occurrence of each native plant species surveyed.

Figure 1: CLP treatment bed Lake Wapogasset-2010

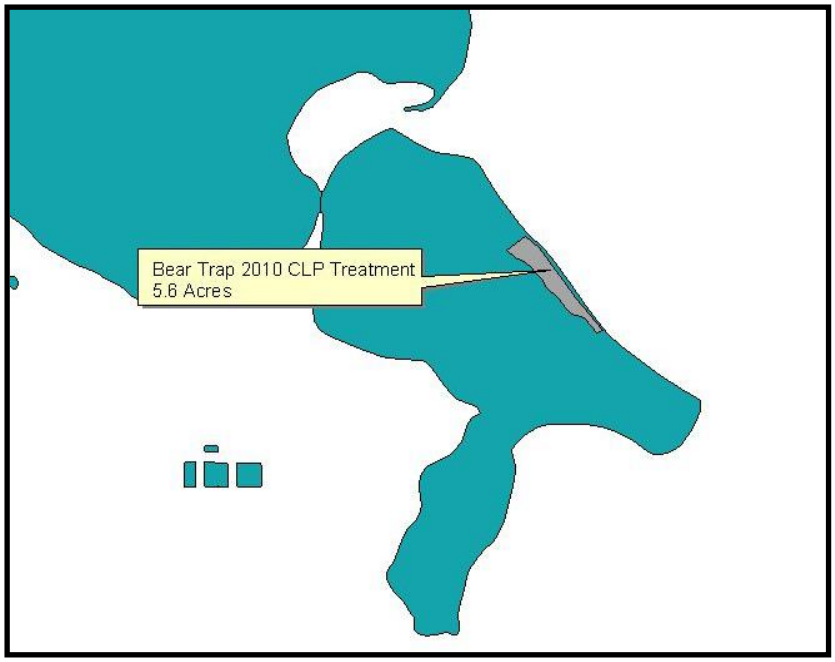


Figure 2: CLP treatment bed Bear Trap Lake-2010

Lake	Date of treat.	Acres	Herbicide	Application rate	Water temp (°F)	Wind speed
Lake Wapogasset	5-17-2010	8.9	Aquathol K	1.0 ppm (39.74 gal)	60.6	1-2
Bear Trap Lake	5-6-2010	5.6	Aquathol K	1.0 ppm (25.01 gal)	54.5	3.7-5.4

Table 1: Treatment information summary-2010

At each sample point, a 1-meter rake tow is used to sample the plants. Each plant species is recorded along with its density (rated 1-3 based on the amount of the particular plant on the rake tines). The following chart displays the relative density categories:

Density of "1"---present on rake

Density of "2"---plant takes up ½+ of tine space on rake

Density of "3"---plant takes up all+ of tine space on rake

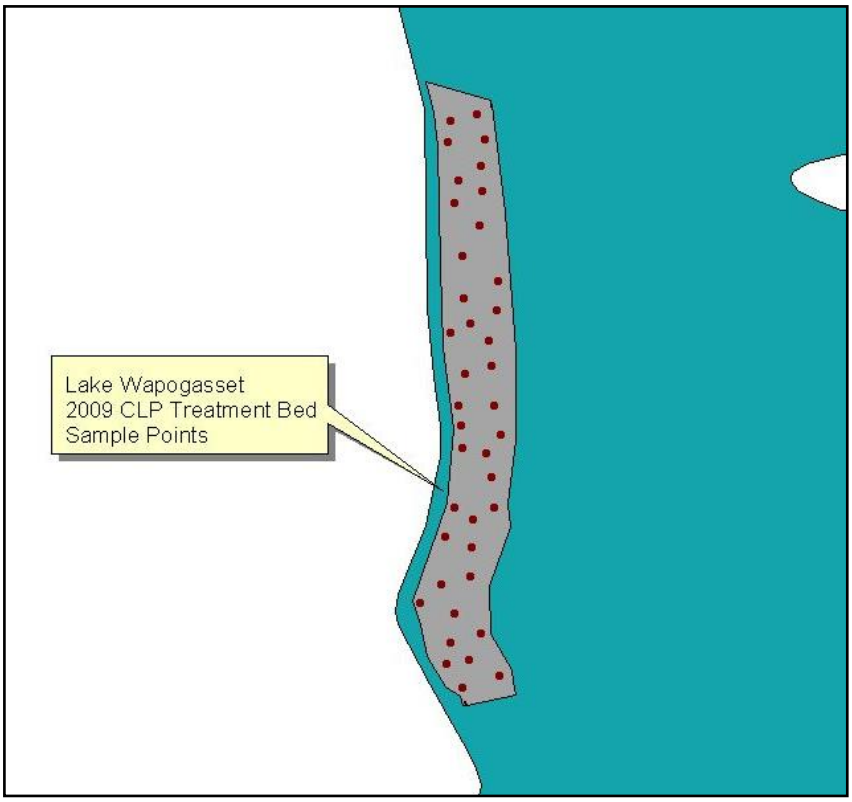


Figure 3: Pre and post treatment sample points Lake Wapogasset.

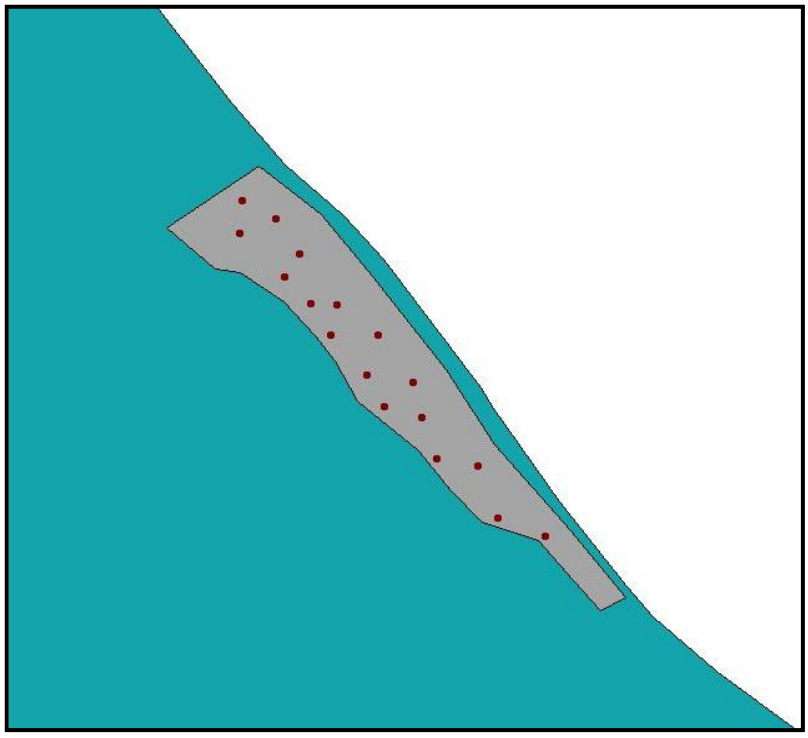


Figure 4: Pre and post treatment sample points Bear Trap Lake.

Results:

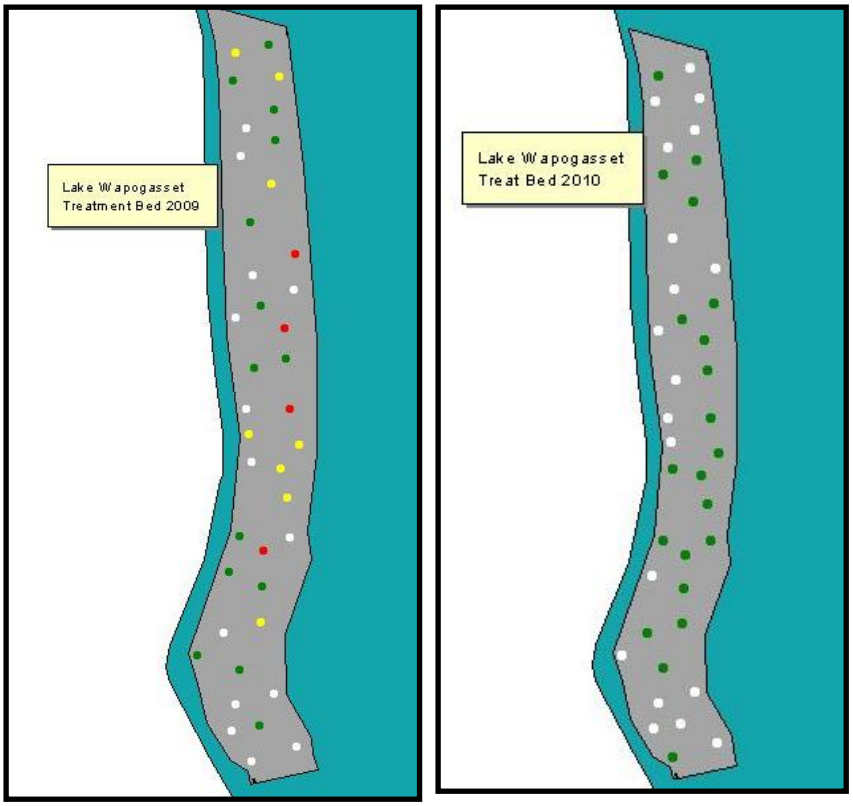


Figure 5: Post treatment (2009) and post treatment (2010) CLP density

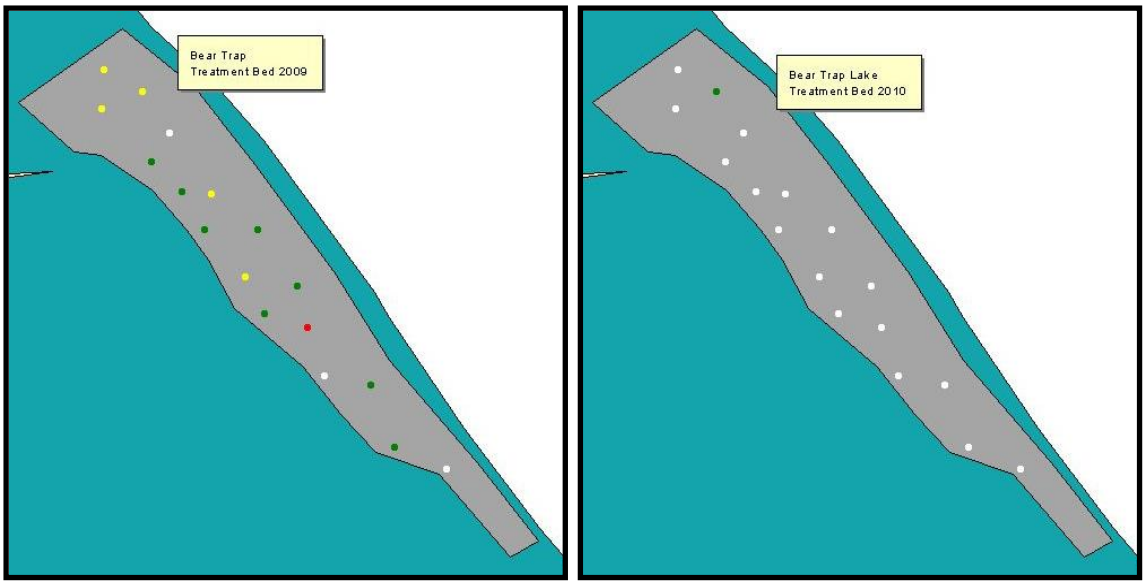


Figure 6: Pre treatment (2009) and post treatment (2010) CLP density.

The 2010 CLP herbicide treatment on Lake Wapogasset resulted in significant reduction in the density of the CLP (p=0.004) but not in the frequency (p=0.37). In the chi-square analysis for CLP frequency reduction the change was determined to not be significant. In addition, the CLP density was reduced significantly according to the t-test calculation. The 2010 treatment did result in a reduction in frequency it was just not found to be significant.

The 2010 CLP herbicide treatment on Bear Trap Lake also had good results. According to the chi-square analysis for the change in frequency, there was a reduction that is significant (p=0.00024). The density was reduced and found to be significant according to the t-test results ($p=2.24 \times 10^{-5}$). A summary of the statistical results is in Table 2 below.

CLP Bed	2009 Frequency	2010 Frequency	2009 Mean Density	2010 Mean Density	Significant Freq. Change (Chi Square)	Significant Density Change (T-Test)
Lake Wapogasset	0.64	0.53	1.05	0.53	NO (p=0.37)	YES (p=0.004[4])
Bear Trap Lake	0.55	0.06	0.73	0.06	YES (p=.00024)	YES ($p=2.24 \times 10^{-5}$)

Table 2: Summary of CLP data comparing pre to post treatment survey.

The native plant community did not appear to get reduced as a result of the treatment in Lake Wapogasset. There was reduction of two plants, one of which (elodea) was found to be significant. There was a significant increase in three plants (coontail, crowfoot, and water stargrass). This could reflect natives replacing the reduced CLP.

Plant	P	Significance	Change
coontail	0.0007	**Yes**	**+**
northern milfoil	0.29	**No**	**+**
Crowfoot	0.006	**Yes**	**+**
water stargrass	0.04	**Yes**	**+**
Forked duckweed	0.64	**No**	**-**
clasping pondweed	0.56	**No**	**+**
Flat-stem pondweed	0.15	**No**	**+**
Wild celery	0.00	**No change**	**No change**
Elodea	0.005	**Yes**	**-**
Filamentous algae	0.00	**No change**	**No change**

Table 3: Chi-square analysis of native plants in treatment bed-Lake Wapogasset.

In Bear Trap Lake there was no sign of adverse reaction of the native plants to the herbicide treatment. There was no significant reduction in native plants. In addition, there was significant increase in the frequency of coontail, northern milfoil, and wild celery. Again this may reflect replacement of natives for the reduced CLP.

Plant	P	Significance	Change
coontail	0.03	**Yes**	**+**
elodea	0.45	**No**	**-**
clasping pondweed	0.08	**No**	**-**
Northern milfoil*	0.42	**No**	**+**
Stiff water crowfoot	0.71	**No**	**-**
water stargrass	0.25	**No**	**+**
white-stem pondweed*	0.25	**No**	**+**
wild celery	0.001	**Yes**	**+**
Filamentous algae	0.02	**Yes**	**+**

**Expected value may be too small making difference insignificant.*

Table 4: Chi-square analysis of native plants in treatment bed-Bear Trap Lake.

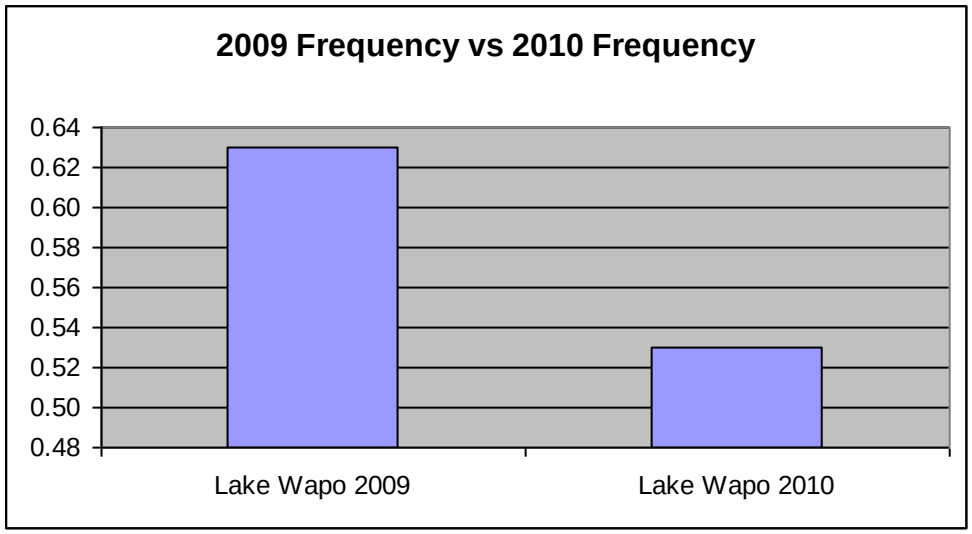


Figure 7: Frequency of CLP post treatment 2009 and 2010 Lake Wapogasset.

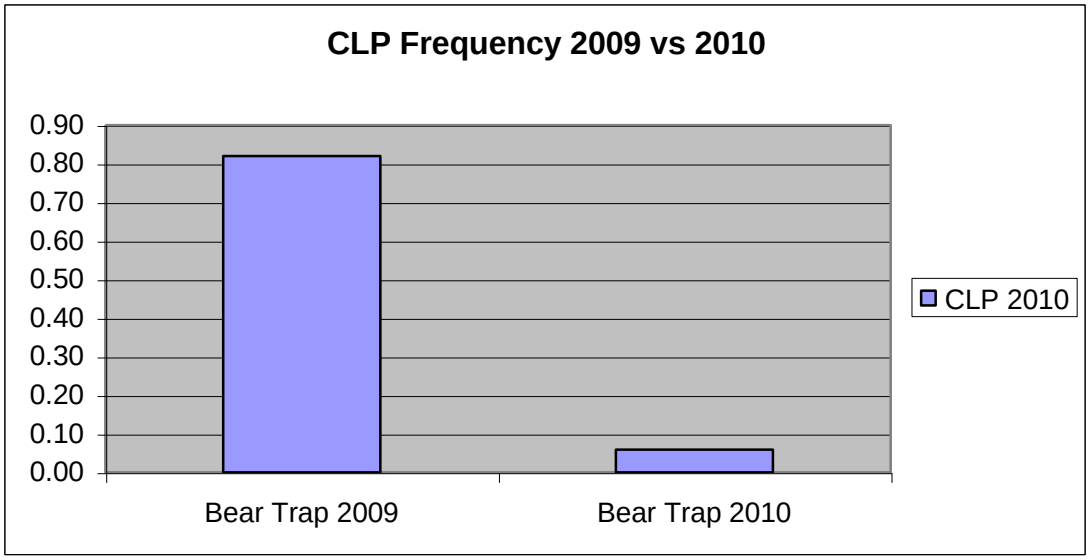


Figure 8: Frequency of CLP post treatment 2009 and 2010 Bear Trap Lake.

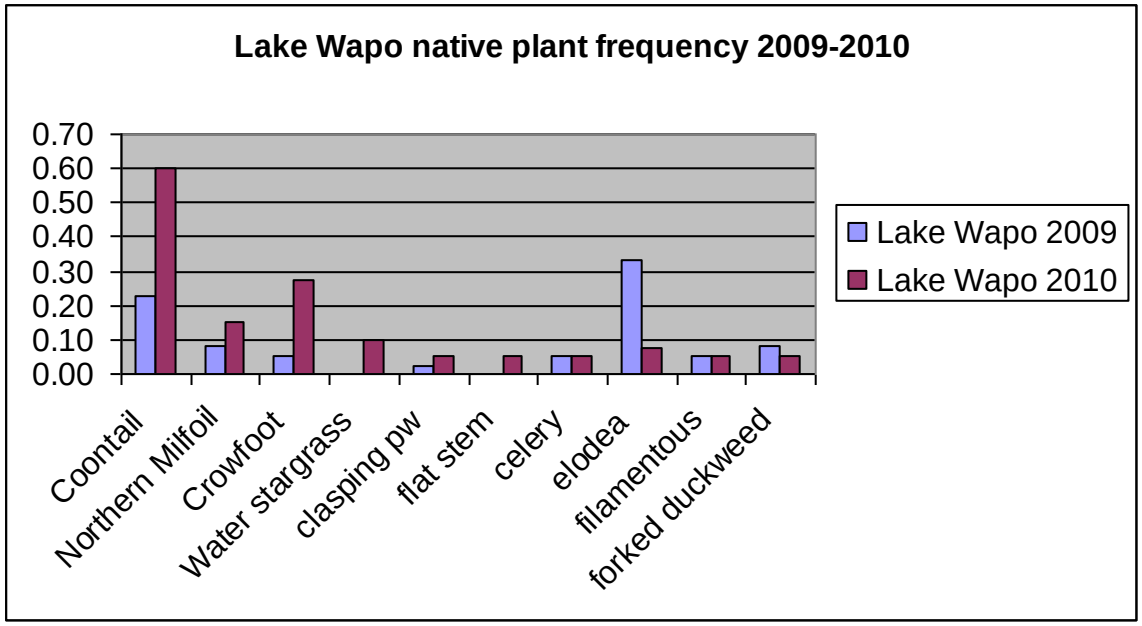


Figure 8: Lake Wapogasset frequency of occurrence for native plant species at pre and post treatment surveys.

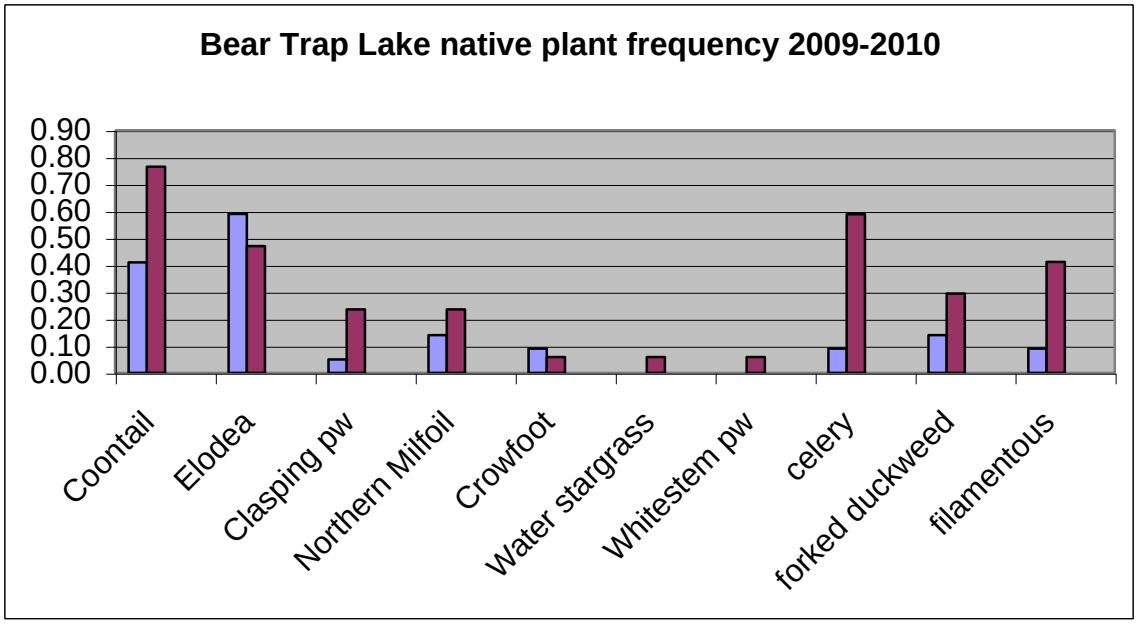


Figure 9: Bear Trap Lake frequency of occurrence of native plant species for pre and post treatment surveys.

Recommendations

Although the treatment was effective on Lake Wapogasset and on Bear Trap Lake, another treatment should take place on the Lake Wapogasset site. There is still CLP present in the bed and turions are present giving rise to new CLP plants. In addition, there is most likely is turions remaining in the Bear Trap site. The new growth of CLP in this site should be evaluated in the pretreatment survey and then determination of treatment made at that point. These turions can remain viable for several years. As a result, if treatment was stopped, those turions could germinate and grow into adult plants resulting in more turion production. If treatment occurs, the turions that germinate into new plants can die from herbicide exposure, thus eliminating new turion production. This treatment may also need to occur for another year after 2011 depending on turion density (should be evaluated in 2011).

An early season treatment is again recommended with water temperature less than 60 degrees F at a similar dosage rate.

Curly leaf pondweed
(Potamogeton crispus)
Herbicide treatment analysis

Lake Wapogasset/Bear Trap Lake, Polk County WI
2011

Prepared by: ***Ecological Integrity Service, LLC***
Amery, WI

Introduction

On May 6 and 11, 2011 an 8.9-acre (Lake Wapogasset) bed and a 5.6-acre (Bear Trap Lake) bed of *Potamogeton crispus*-curly leaf pondweed (CLP) was treated with herbicide (endothall-K) (see figures 1 and 2) for the third year. Prior to treatment, a pre-treatment survey was conducted at 42 predetermined sample points for Lake Wapogasset and 21 predetermined sample points for Bear Trap Lake. The presence of CLP was recorded at each sample point, along with depth and dominant sediment type. The treatment bed on Bear Trap Lake was adjusted for depth from the previous year treatment.

Approximately 4 weeks after treatment took place, a post-treatment survey was conducted. Each of the sample points used in the pre-treatment survey was used. The CLP density was recorded as well as the density of each native plant species found.

To examine the effectiveness of an herbicide treatment, data collected one year prior to the treatment is compared to the post –treatment survey of the following year. The CLP density and frequency was recorded at the pre-determined sample points in each bed in 2010. These data are then compared to the data from the 2011 post treatment survey. Statistical analysis is then used to evaluate the effectiveness. A chi-square analysis is completed to evaluate the frequency of occurrence of CLP in the treatment beds. A t-test is completed on the density of CLP in each treatment bed to evaluate the density reduction. The native plants present in the post-treatment survey one-year prior (2010) will be used to see how the native plants responded. A chi-square analysis is used to evaluate any changes in the frequency of occurrence of each native plant species surveyed.

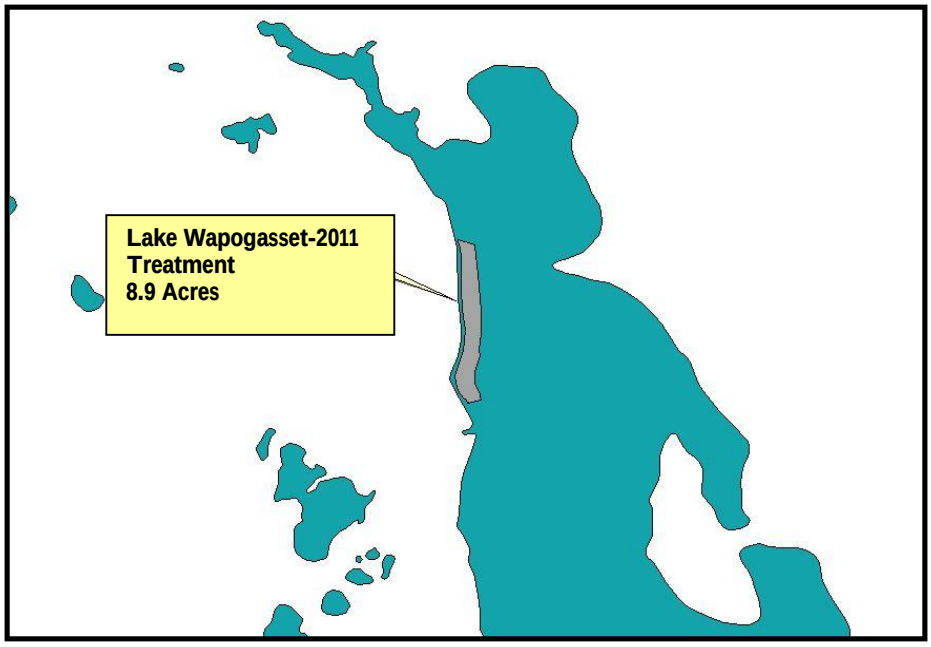


Figure 1: Treatment for Lake Wapogasset-2011

Figure 2: Treatment for Bear Trap Lake-2011

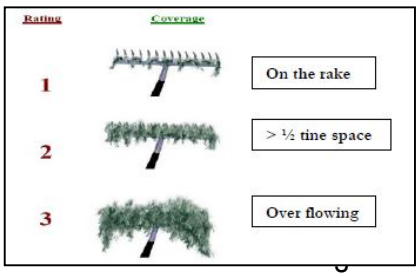
Lake	Date of treat.	Acres	Acre-feet	Herbicide	Application rate	Water temp (ºF)	Wind speed
Lake Wapogasset	5-6-2011	8.9	65.9	Aquathol K	0.86 ppm* (34.07 gal)	50.4	2-5
Bear Trap Lake	5-11-2011	5.6	36.1	Aquathol K	1.15ppm (25 gal)	54	Calm

***This is below the 1 ppm target for treatment.**

Table 1: Treatment information for Lake Wapogasset and Bear Trap Lake-2011

At each sample point, a 1-meter rake tow is used to sample the plants. Each plant species is recorded along with its density (rated 1-3 based on the amount of the particular plant on the rake tines). The following chart displays the relative density categories:

Density of "1"---present on rake
Density of "2"---plant takes up ½+ of tine space on rake
Density of "3"---plant takes up all+ of tine space on rake



Results

When comparing the 2010 post treatment frequency and density to the 2011 data, it is very evident that the treatment in 2011 was not successful. In both Lake Wapogasset and Bear Trap Lake the frequency of occurrence increased. In addition, the density also increased in both lakes from 2010 to 2011. Table 2 shows the changes that occurred by comparing the two year's data.

CLP Bed	2010 Frequency	2011 Frequency	2010 Mean Density	2011 Mean Density	Significant Freq. Change	Significant Density Reduction (T-Test)
Lake Wapogasset	0.53	0.93	0.53	1.95	Increase (+0.4)	Increase (+1.42)
Bear Trap Lake	0.06	0.38	0.06	0.81	Increase (+0.32)	Increase (+0.75)

Table 2: Post treatment data summary for CLP on Lake Wapogasset and Bear Trap Lake-2011

Figures 3 and 4 show the maps with density ratings for 2010 and 2011. The Bear Trap Lake polygon has a slightly different shape due to adjustments made in the 2011 pre-treatment survey. Also a few points were added since CLP was sampled in those locations while adjusting the bed polygon. In both lakes the maps reveal the increase in density.

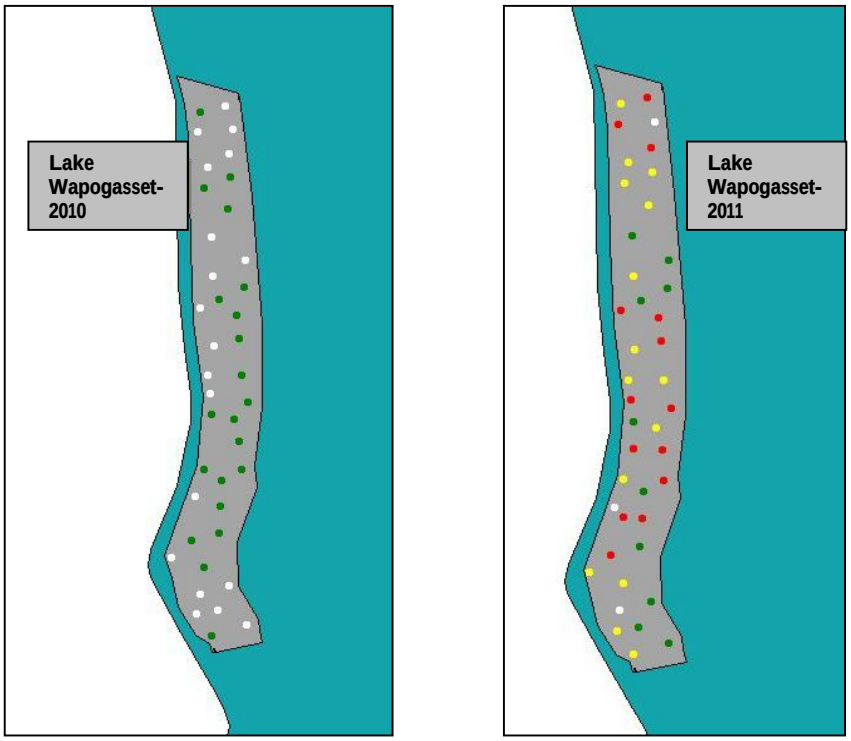


Figure 3: Lake Wapogasset density map 2010 (left) and 2011 (right).

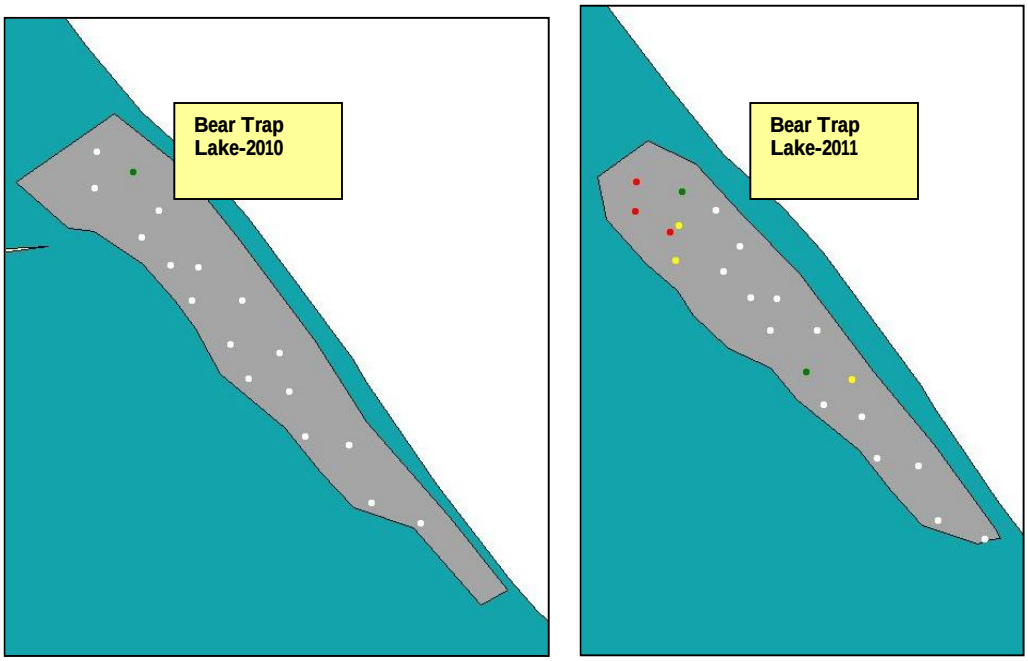


Figure 4: Bear Trap Lake density map 2010 (left) and 2011 (right)

Figure 5 shows the frequency comparison as a bar graph. Again the increase is evident after treatment.

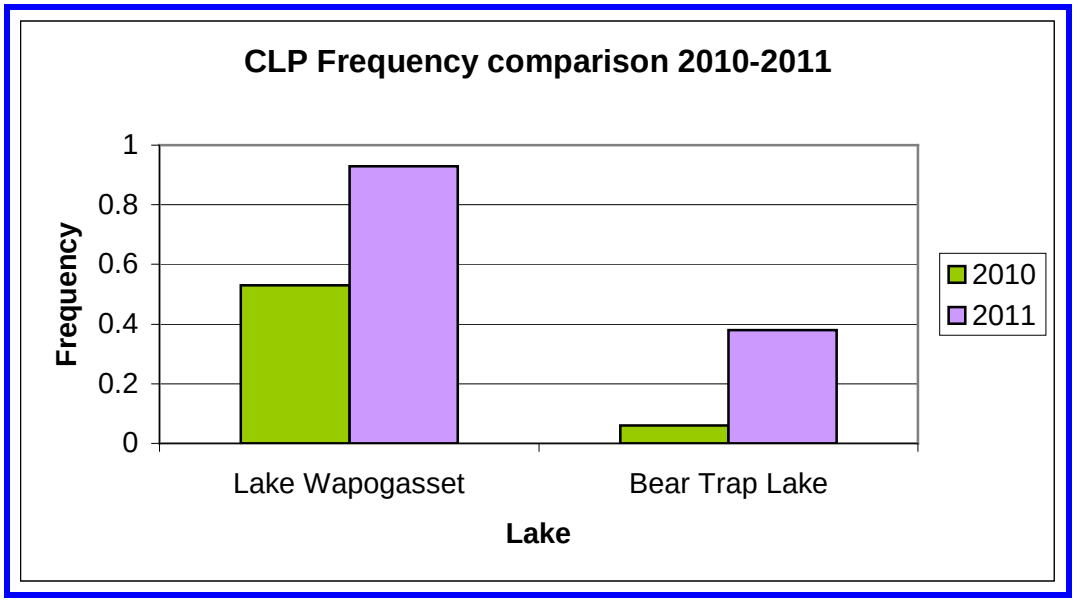


Figure 5: Graph showing frequency comparison between 2010 and 2011.

The acre-feet calculated based upon depths of each bed show that the application in gallons was below the target concentration of 1ppm (approximately 1 gallon of herbicide per 1 acre foot of water gives a concentration of 1ppm herbicide). In the Lake Wapogasset bed this concentration was 0.86 ppm, and the Bear Trap bed

received what appears to be about 1.15 ppm. The lower concentration in Wapogasset could make the treatment more susceptible to wind and dispersal factors, reducing the effectiveness. If treatment occurs in 2012, these concentrations will need to be adjusted to be 1 ppm or maybe even increased to 1.5 ppm.

Native Plant Species

In addition to analyzing the CLP frequency and density, the native plant species are also evaluated to assure that the herbicide treatment is not adversely affecting the native plants. The following tables (3 and 4) shows the change from 2010 to 2011 in the frequency within the treatment beds.

There was a reduction in 1 species in Bear Trap Lake and 4 species in Lake Wapogasset. This is unlikely due to the herbicide application since the herbicide didn't even seem to reduce the target species CLP. The reduction could likely be due to seasonal variation, sample location variation or the fact that the CLP was growing so thick, it was reducing the native species growth.

Native species-Bear Trap	Frequency 2010	Frequency 2011	P value	Significance	Change
Forked duckweed(*Lemna triscula*)	0.29	0.14	0.25545	no	-
Elodea(*Elodea canadensis*)	0.47	0.38	0.57789	no	-
Crowfoot(*Ranunculus aquatilis*)	0.06	0.1	0.67894	no	+
Whitestem pondweed(*Potamogeton praelongus*)	0.06	0.1	0.67894	no	+
Coontail(*Ceratophyllum demersum*)	0.76	0.57	0.21177	no	-
Northern milfoil(*Myriophyllum sibiricum)*	0.24	0.24	0.98389	no	+
Clasping pondweed(*Potamogeton richardsonii)*	0.24	0.1	0.23909	no	-
Wild celery(*Vallisneria americana)*	0.59	0.05	0.00026	yes	-
Filamentous algae	0.41	0.14	0.06124	no	-
Water stargrass*(Heteranthera dubia)*	0.06	0.00	0.26001	no	-
Illinois pondweed*(Potamogeton illinoensis)*	0.00	0.05	0.36187	no	+

Table 3: Native species data from post treatment surveys 2010 and 2011-Bear Trap Lake.

Native species-Lake Wapogasset	Frequency 2010	Frequency 2011	P value	Significance	Change
forked duckweed (*Lemna triscula)*	0.05	0.00	0.14234	no	-
Elodea(*Elodea canandensis)*	0.075	0.10	0.74304	no	+
Crowfoot(*Ranunculus aquatilis*)	0.28	0.07	0.01433	yes	-
white stem pondweed(*Potamogeton praelongus)*	0.00	0.05	0.16233	no	+
Coontail(*Ceratophyllum demersum*)	0.60	0.33	0.01550	yes	-
Northern milfoil*(Myriophyllum sibiricum)*	0.15	0.00	0.00913	yes	-
Clasping pondweed*(Potamogeton richardsonii)*	0.05	0.00	0.14234	no	-
Wild celery*(Vallineria americana)*	0.05	0.00	0.14234	no	-
Filamentous algae	0.05	0.07	0.68522	no	+
flat stem pondweed *(Potamogeton zosteriformis)*	0.05	0.00	0.14234	no	-
water stargrass*(Heteranthera dubia)*	0.10	0.00	0.03562	yes	-

Table 4: Native species data from post treatment surveys 2010 and 2011-Lake Wapogasset.

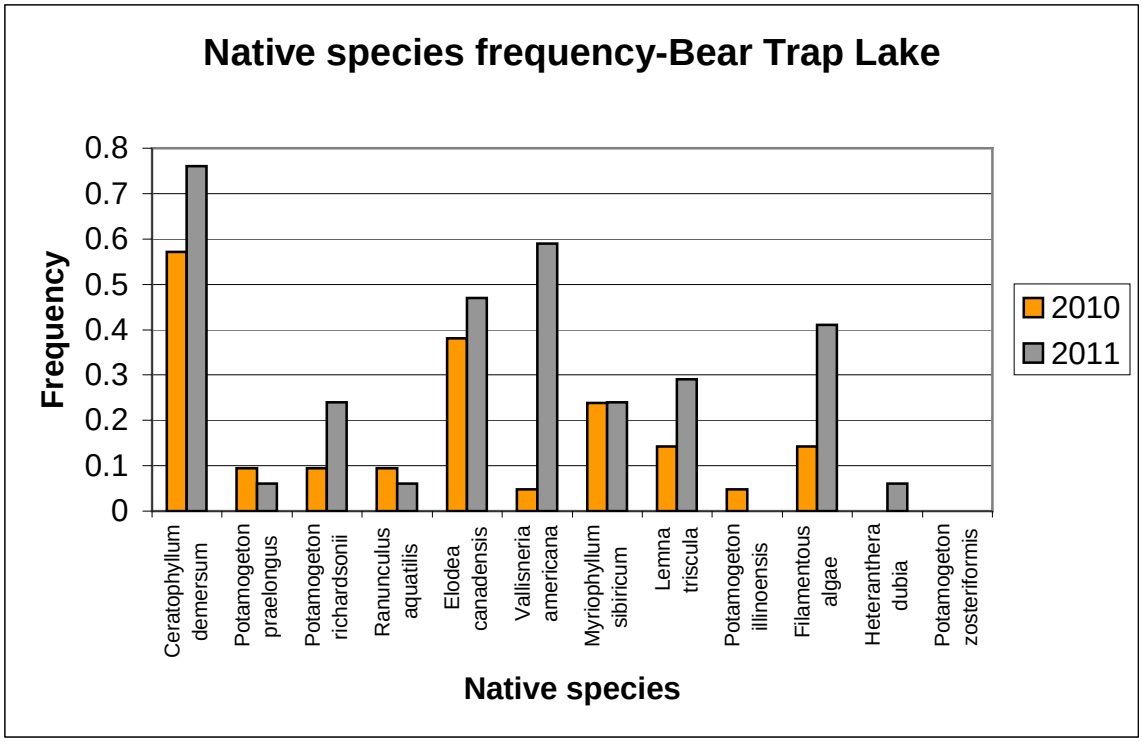


Figure 6: Graph comparing native species frequencies-Bear Trap Lake 2010 vs 2011.

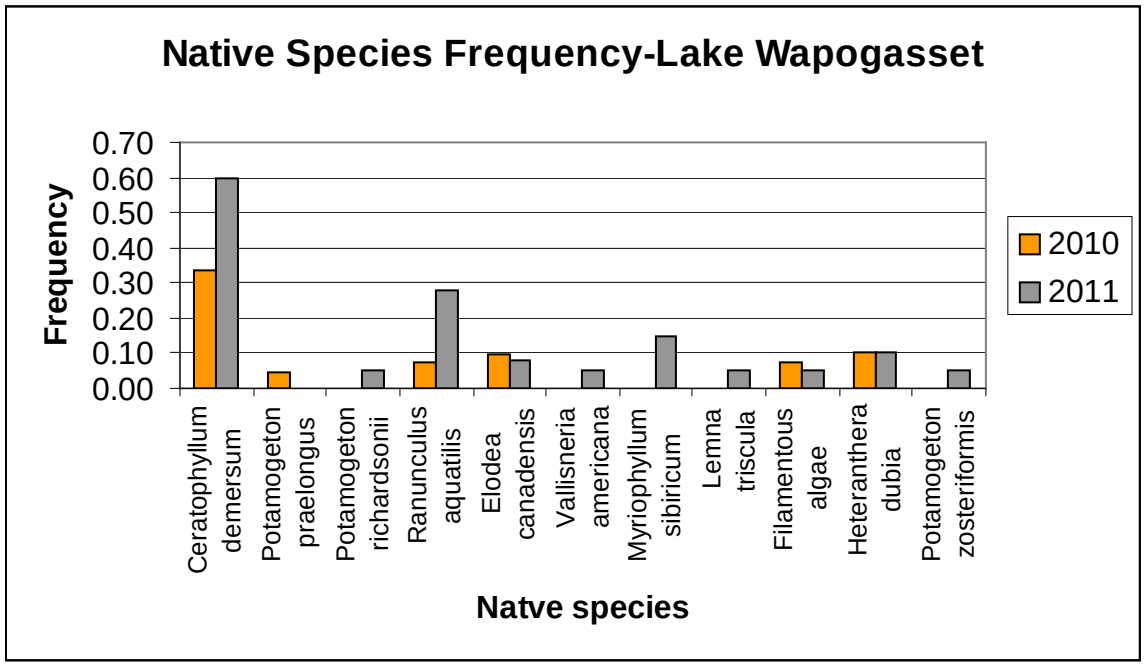


Figure 7: Graph comparing native species frequencies-Lake Wapogasset 2010 vs 2011.

Bear Trap

Sample Pt	Lat	Long			CLP-2011	*Ceratophyllum demersum*	*Potamogeton praelongus*	*Potamogeton richardsonii*	*Ranunculus aquatilis*	*Elodea canadensis*	*Vallisneria americana*	*Myriophyllum sibiricum*	*Lemna triscula*	*Potamogeton illinoensis*	Filamentous algae	*Heteranthera dubia*	*Potamogeton zosteriformis*
1	45.31478248	-92.40669929	5018090.00	546505.00	1	1											
2	45.31365754	-92.40501425	5017966.00	546638.00	0												
3	45.31448273	-92.40617934	5018057.00	546546.00	0	1						1		1			
4	45.31526999	-92.40697488	5018144.00	546483.00	0					1	1		1		1		
5	45.31378587	-92.40545943	5017980.00	546603.00	0												
6	45.31472622	-92.40626610	5018084.00	546539.00	2	1											
7	45.31546166	-92.40748320	5018165.00	546443.00	0	1		1	1	1							
8	45.31506330	-92.40704082	5018121.00	546478.00	0	1	1	1		1							
9	45.31506098	-92.40659432	5018121.00	546513.00	0				1	1		1			1		
10	45.31528031	-92.40722993	5018145.00	546463.00	0	1				1					1		
11	45.31456559	-92.40653570	5018066.00	546518.00	0												
12	45.31562288	-92.40732842	5018183.00	546455.00	0	1						1	3				
13	45.31414691	-92.40564702	5018020.00	546588.00	0	1	1			1							
14	45.31420297	-92.40604193	5018026.00	546557.00	0	1											
15	45.31585895	-92.40754813	5018210.00	546437.00	0	2				1		1					
16	45.31576172	-92.40789363	5018199.00	546410.00	2	2											
17	45.31571629	-92.40798625	5018193.90	546402.77	3												
18	45.31585417	-92.40830979	5018209.03	546377.30	3												
19	45.31605575	-92.40829286	5018231.44	546378.47	3												
20	45.31553079	-92.40793671	5018173.32	546406.81	2												
21	45.31598660	-92.40786572	5018224.00	546412.00	1	1				1		1	1				
		Total			**8**	**12**	**2**	**2**	**2**	**8**	**1**	**5**	**3**	**1**	**3**	**0.00**	**0**

		Freq 2011		0.80952381	0.38	0.57	0.1	0.1	0.1	0.38	0.05	0.24	0.14	0.05	0.14	0.00	0.00
		Freq 2010			0.06	0.76	0.06	0.24	0.06	0.47	0.59	0.24	0.29	0.00	0.41	0.06	0.00
Wapogasset																	
1	45.34452880	-92.43990856	5021376.00	543879.00	0										1		
2	45.34478926	-92.43979111	5021405.00	543888.00	2	1											
3	45.34358338	-92.43985406	5021271.00	543884.00	0					1							
4	45.34680272	-92.43920958	5021629.00	543932.00	1	2			2								
5	45.34703000	-92.43966689	5021654.00	543896.00	1	1			1	1							
6	45.34468006	-92.43954966	5021393.00	543907.00	1										1		
7	45.34598570	-92.43963889	5021538.00	543899.00	2	1	1			1							
8	45.34807267	-92.43936299	5021770.00	543919.00	0				3	1							
9	45.34409700	-92.43996388	5021328.00	543875.00	3	1											
10	45.34551790	-92.43969457	5021486.00	543895.00	3												
11	45.34605608	-92.43930631	5021546.00	543925.00	3												
12	45.34366245	-92.43945758	5021280.00	543915.00	1	3											
13	45.34804798	-92.43983556	5021767.00	543882.00	3												
14	45.34543439	-92.43918480	5021477.00	543935.00	3												
15	45.34783889	-92.43941636	5021744.00	543915.00	3												
16	45.34505691	-92.43930341	5021435.00	543926.00	3												
17	45.34730796	-92.43944713	5021685.00	543913.00	2												
18	45.34824581	-92.43979531	5021789.00	543885.00	2												
19	45.34477775	-92.43928064	5021404.00	543928.00	3												
20	45.34627223	-92.43932971	5021570.00	543923.00	3												
21	45.34526431	-92.43937795	5021458.00	543920.00	2												
22	45.34339455	-92.43989422	5021250.00	543881.00	2	1											
23	45.34750749	-92.43975153	5021707.00	543889.00	2												
24	45.34569804	-92.43971832	5021506.00	543893.00	2												
25	45.34569585	-92.43927157	5021506.00	543928.00	2												
26	45.34654175	-92.43922492	5021600.00	543931.00	1	1											
27	45.34442810	-92.43956491	5021365.00	543906.00	3												
28	45.34328328	-92.43923157	5021238.00	543933.00	1	2											

29	45.34317753	-92.43969213	5021226.00	543897.00	2	1												
30	45.34665183	-92.43964509	5021612.00	543898.00	2													
31	45.34383516	-92.43980052	5021299.00	543888.00	2	2												
32	45.34770526	-92.43969852	5021729.00	543893.00	2													
33	45.34342918	-92.43961306	5021254.00	543903.00	1	1									1			
34	45.34829819	-92.43946289	5021795.00	543911.00	3													
35	45.34634661	-92.43981404	5021578.00	543885.00	3	1												
36	45.34531975	-92.43967099	5021464.00	543897.00	1													
37	45.34761381	-92.43940582	5021719.00	543916.00	2		1											
38	45.34416719	-92.43959301	5021336.00	543904.00	1													
39	45.34393630	-92.44023352	5021310.00	543854.00	2	2												
40	45.34643537	-92.43955787	5021588.00	543905.00	1													
41	45.34442766	-92.43980161	5021365.73	543886.87	3													
42	45.34507290	-92.43966968	5021437.48	543896.71	3													
		Total		**1.952380952**	**39**	**14**	**2**	**0**	**3**	**4**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
		Freq 2011			**0.93**	**0.33**	**0.05**	**0.00**	**0.07**	**0.10**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.10**	**0.00**
		Freq 2010			**0.53**	**0.60**	**0.00**	**0.05**	**0.28**	**0.08**	**0.05**	**0.15**	**0.05**	**0.00**	**0.05**	**0.10**	**0.05**

Curly leaf pondweed
(Potamogeton crispus)
Herbicide treatment analysis

Lake Wapogasset/Bear Trap Lake, Polk County WI
June, 2012

Prepared by: ***Ecological Integrity Service, LLC***
Amery, WI

Introduction

On April 11, 2012 an 11.1-acre (Lake Wapogasset) bed and a 4.4-acre (Bear Trap Lake) bed of *Potamogeton crispus*-curly leaf pondweed (CLP) was treated with herbicide (endothall-K) (see figures 1 and 2) for the fourth year. Prior to treatment, a pre-treatment survey was conducted at 51 predetermined sample points for Lake Wapogasset and 19 predetermined sample points for Bear Trap Lake. The presence of CLP was recorded at each sample point, along with depth and dominant sediment type. The treatment bed on Bear Trap Lake was adjusted for depth from the previous year treatment.

Approximately 3 weeks after treatment took place, a post-treatment survey was conducted. Each of the sample points used in the pre-treatment survey was used. The CLP density was recorded as well as the density of each native plant species found.

To examine the effectiveness of an herbicide treatment, data collected one year prior to the treatment is compared to the post –treatment survey of the following year. The CLP density and frequency was recorded at the pre-determined sample points in each bed in 2011. These data are then compared to the data from the 2012 post treatment survey. Statistical analysis is then used to evaluate the effectiveness. A chi-square analysis is completed to evaluate the frequency of occurrence of CLP in the treatment beds. A t-test is completed on the density of CLP in each treatment bed to evaluate the density reduction. The native plants present in the post-treatment survey one-year prior (2011) will be used to see how the native plants responded. A chi-square analysis is used to evaluate any changes in the frequency of occurrence of each native plant species surveyed.

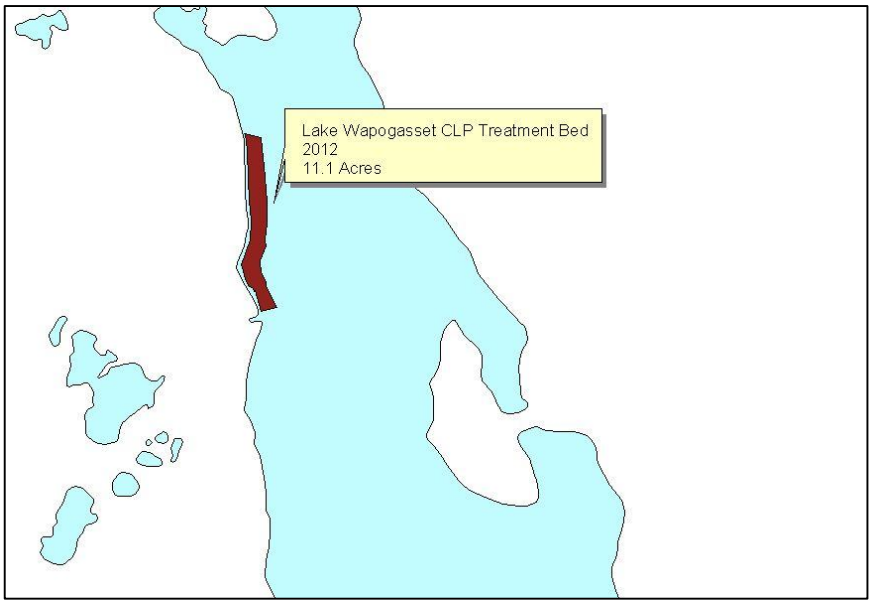


Figure 1: Treatment for Lake Wapogasset-2011

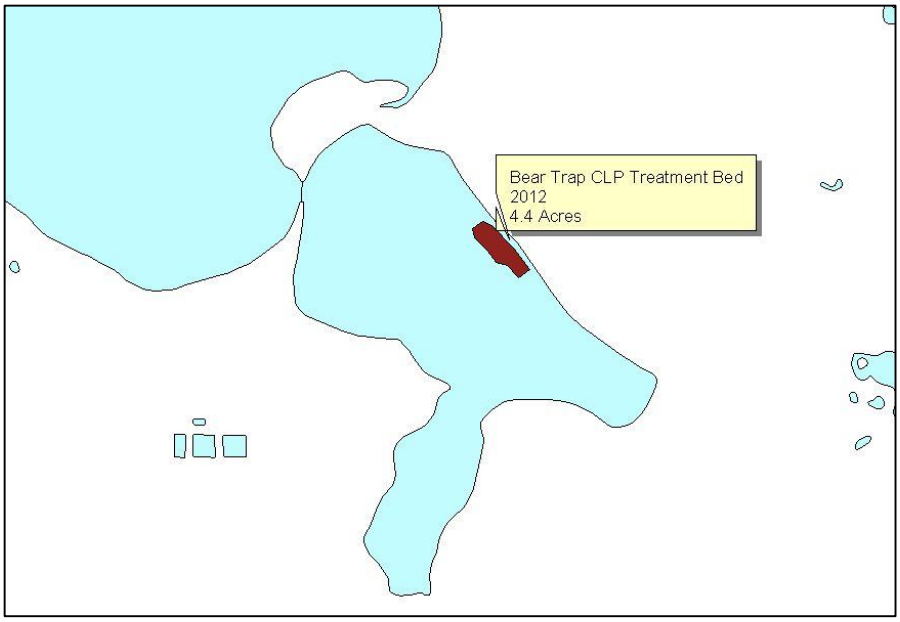


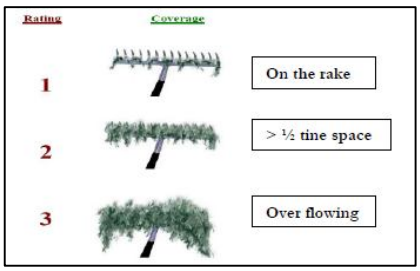
Figure 2: Treatment for Bear Trap Lake-2011

Lake	Date of treatment	Acres	Acre Feet	Herbicide	Application rate	Water temp (°F)	Wind speed
Lake Wapogasset	4-11-2012	11.1	86.6	Aquathol K	1.5 ppm* (86 gal)	49.0	2 mph
Bear Trap Lake	4-11-2012	4.4	26.0	Aquathol K	1.5ppm (26 gal)	48.0	3 mph

Table 1: Treatment information for Lake Wapogasset and Bear Trap Lake-2012

At each sample point, a 1-meter rake tow is used to sample the plants. Each plant species is recorded along with its density (rated 1-3 based on the amount of the particular plant on the rake tines). The following chart displays the relative density categories:

Density of "1"---present on rake
Density of "2"---plant takes up ½+ of tine space on rake
Density of "3"---plant takes up all+ of tine space on rake



Results

When comparing the 2012 post treatment frequency and density to the 2011 data, it is very evident that the treatment in 2012 was not successful. In Lake Wapogasset the frequency in CLP decreased slightly, but was not significant. In Bear Trap Lake the frequency of occurrence actually increased. In addition, the density also increased in Bear Trap Lake from 2011 to 2012, with a very small decrease (not significant) in Lake Wapogasset. Tables 2 and 3 show the changes that occurred by comparing the two year's data.

Post Treatment	Frequency Lake Wapogasset	Frequency Bear Trap Lake
2011	93%	38%
2012	88%	58%
Change	-5%(not significant p>0.05)	+20%

Note: Treatment from 2011was not successful as frequency and density was higher than 2010.

Table 2: Post treatment frequency data summary for CLP on Lake Wapogasset and Bear Trap Lake-2011 and 2012

Post Treatment	Mean Density 2011	Mean Density 2012	Change
Bear Trap Lake	0.81	0.89	+0.8
Lake Wapogasset	1.95	1.67	-0.18 (not significant as p> 0.05)

Table 3: Post treatment mean density data summary for CLP on Lake Wapogasset and Bear Trap Lake-2011 and 2012.

Figures 3 and 4 show the maps with density ratings for 2011 and 2012. The Bear Trap Lake polygon has a slightly different shape due to adjustments made in the 2012 pre-treatment survey. In Bear Trap Lake, the map reveal the increase in density and frequency. The Lake Wapogasset map reveals a slight decrease in frequency and density, but are not statistically significant (p>0.05)

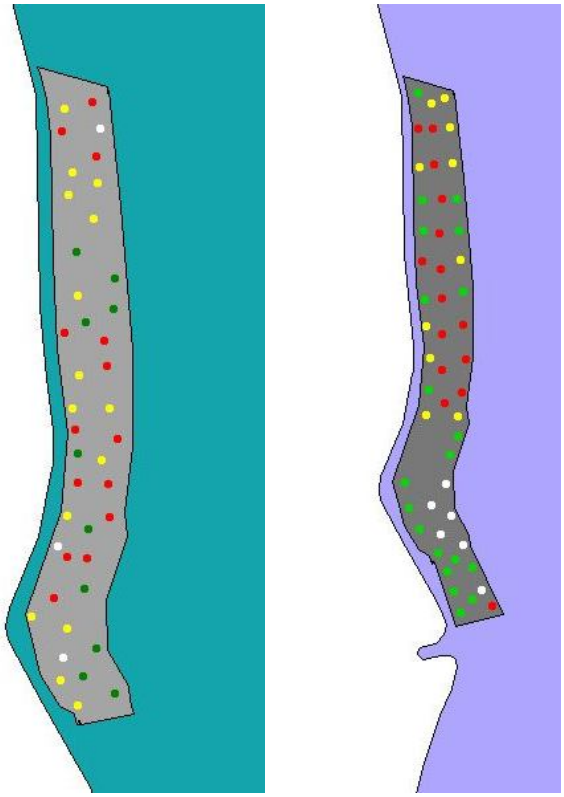


Figure 3: Lake Wapogasset density map 2011 (left) and 2012 (right).

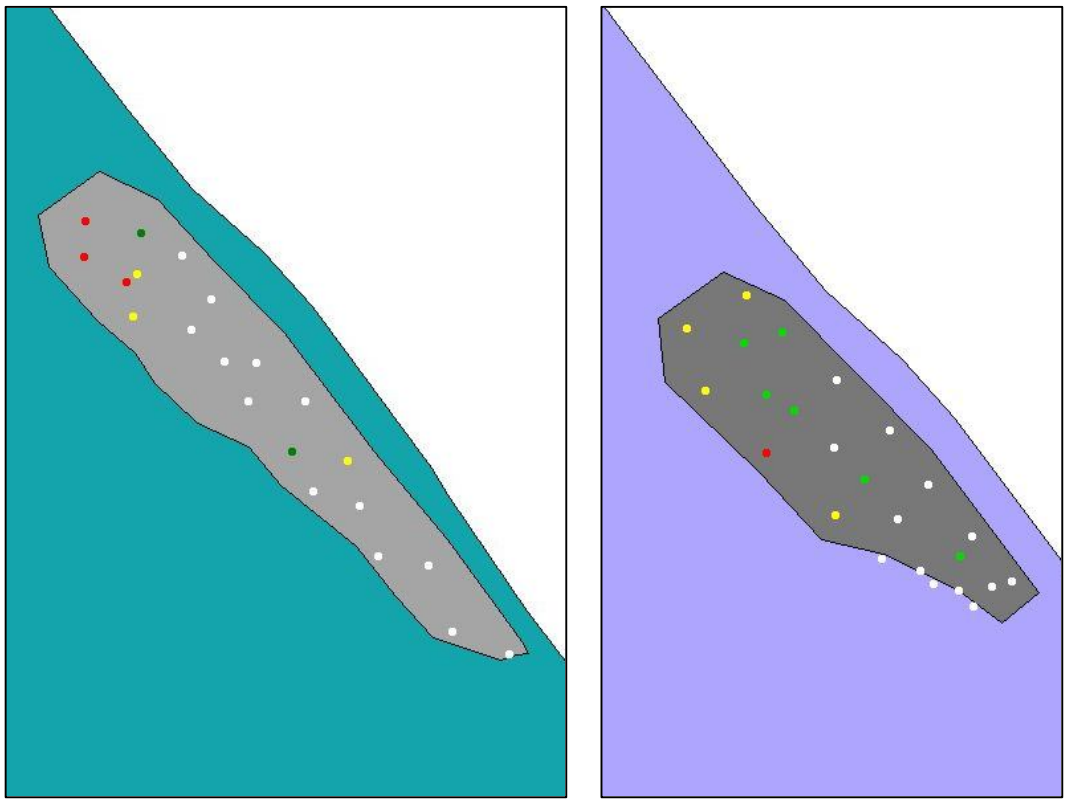


Figure 4: Bear Trap Lake density map 2011 (left) and 2012 (right)

Figure 5 shows the frequency comparison as a bar graph. Again the increase is evident after treatment in Bear Trap Lake and a very slight decrease in Lake Wapogasset.

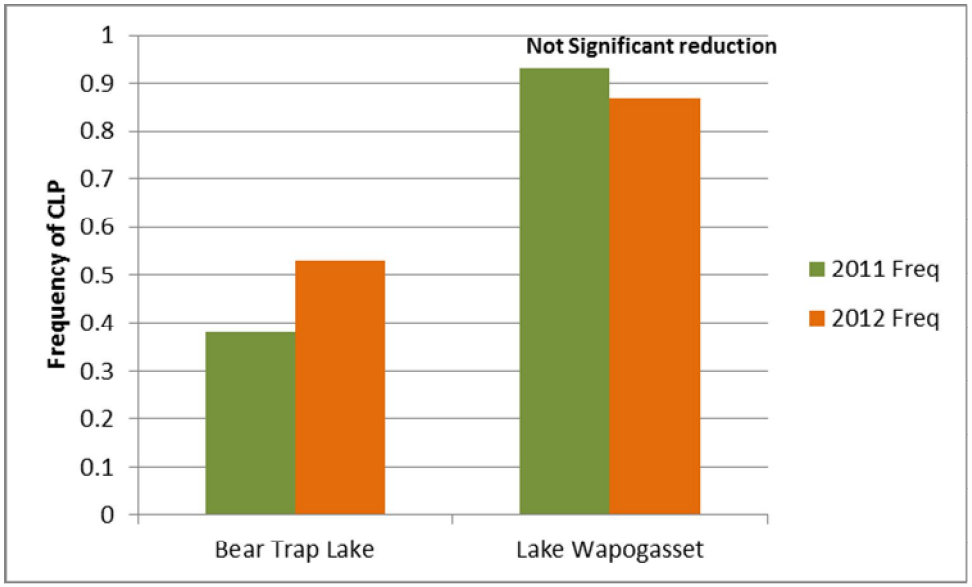


Figure 5: Graph showing frequency comparison between 2011 and 2012.

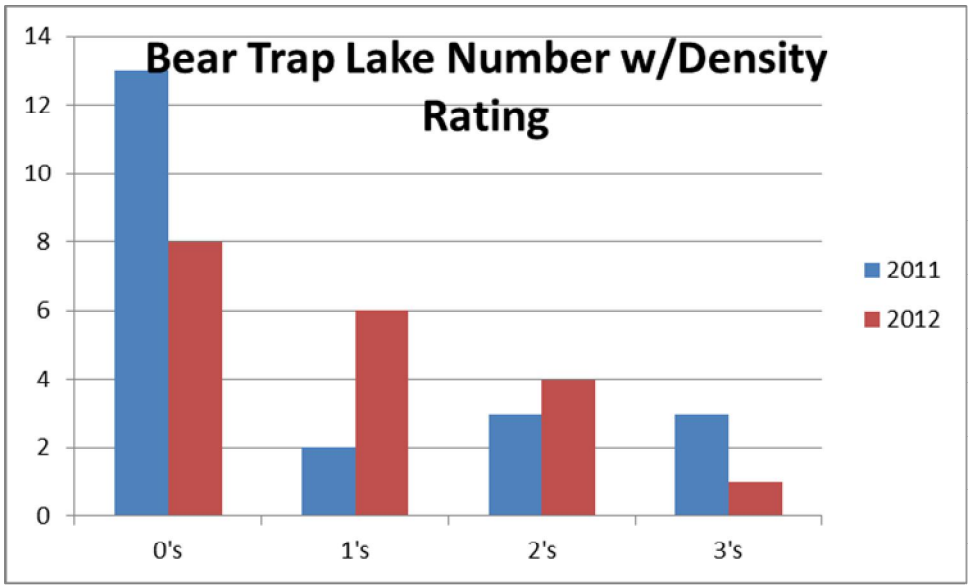


Figure 6: Bear Trap Lake number of sample points with various density ratings.

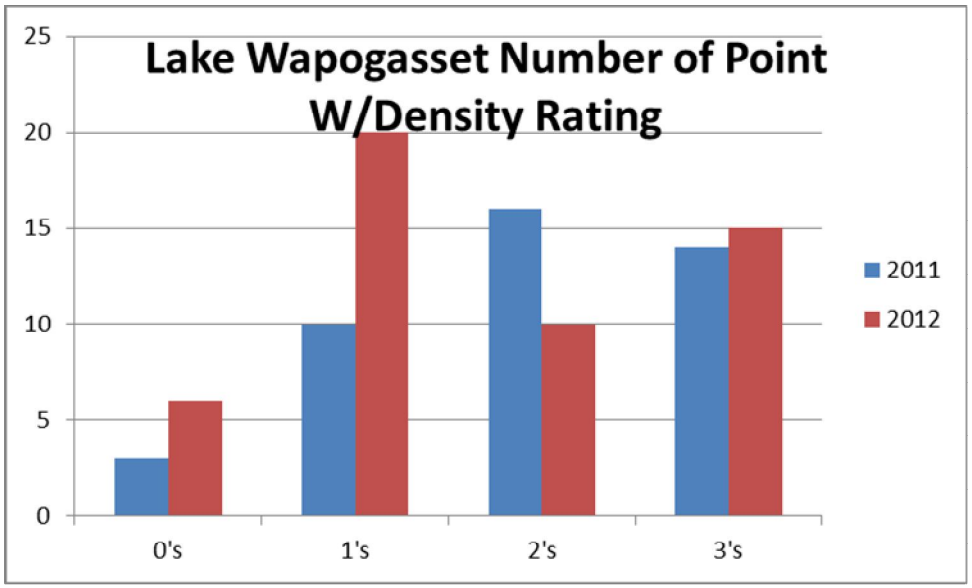


Figure 7: Lake Wapogasset number of sample points with various density ratings.

Native Plant Species

In addition to analyzing the CLP frequency and density, the native plant species are also evaluated to assure that the herbicide treatment is not adversely affecting the native plants. The following tables (3 and 4) show the change from 2011 to 2012 in the frequency within the treatment beds.

There was a reduction in five species in Bear Trap Lake and five species in Lake Wapogasset. All of these were not statistically significant ($p>0.05$). This is unlikely due to the herbicide application since the herbicide didn't even seem to reduce the target species CLP. The reduction is likely be due to seasonal variation, sample location variation or the fact that the CLP was growing so thick, it was reducing the native species growth. Since it is not statistically significant, there is no need for concern.

Lake Wapogasset	*C. demersum*	*E. canadensis*	*M sibiricum*	*P. richardsonii*	*P. zosteriformis*	*R. auquatilis*	*P. praelongis*	*H. dubia*
Freq. 2012	0.31	0.02	0.09	0.07	0.07	0.02	0.00	0.00
Freq. 2011	0.33	0.10	0.00	0.00	0.00	0.07	0.05	0.10
Change	-0.02	-0.08	+0.09	+0.07	+0.07	-0.05	-0.05	-0.10

Table 3: Native species data from post treatment surveys 2011 and 2012-Lake Wapogasset.

Bear Trap Lake	*C. demersum*	*E. canadensis*	*M sibiricum*	*V. americana*	*P. richardsonii*	*L. triscula*	*R. auquatilis*	*S. pectinatum*	*P. praelongis*	*P. illinoensis*
Freq. 2012	0.89	0.21	0.63	0.26	0.05	0.21	0.05	0.05	0.00	0.00
Freq. 2011	0.57	0.38	0.24	0.05	0.10	0.14	0.10	0.00	0.01	0.05
Change	+0.32	-0.17	+0.39	+0.21	-0.05	+0.07	-0.05	+0.05	-0.01	-0.05

Table 4: Native species data from post treatment surveys 2011 and 2012-Bear Trap Lake.

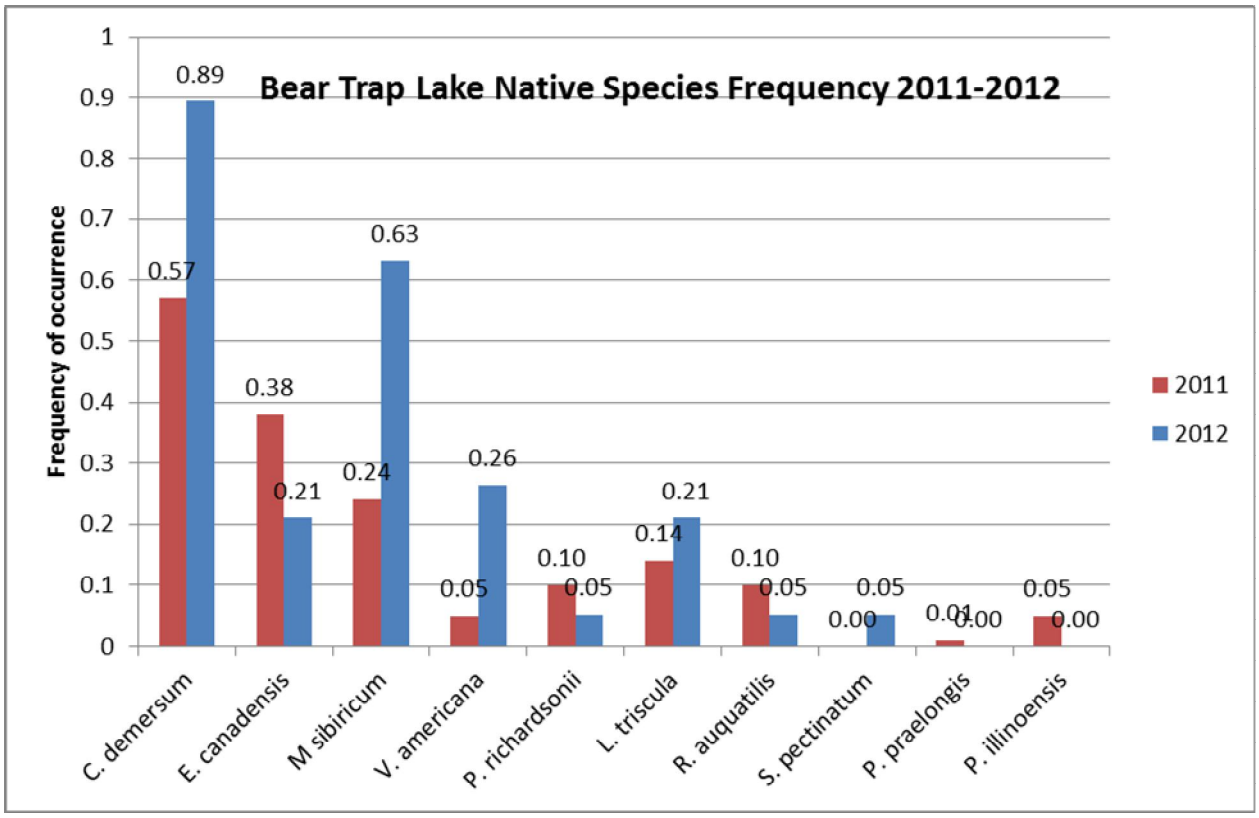


Figure 8: Graph comparing native species frequencies-Bear Trap Lake 2011 vs 2012.

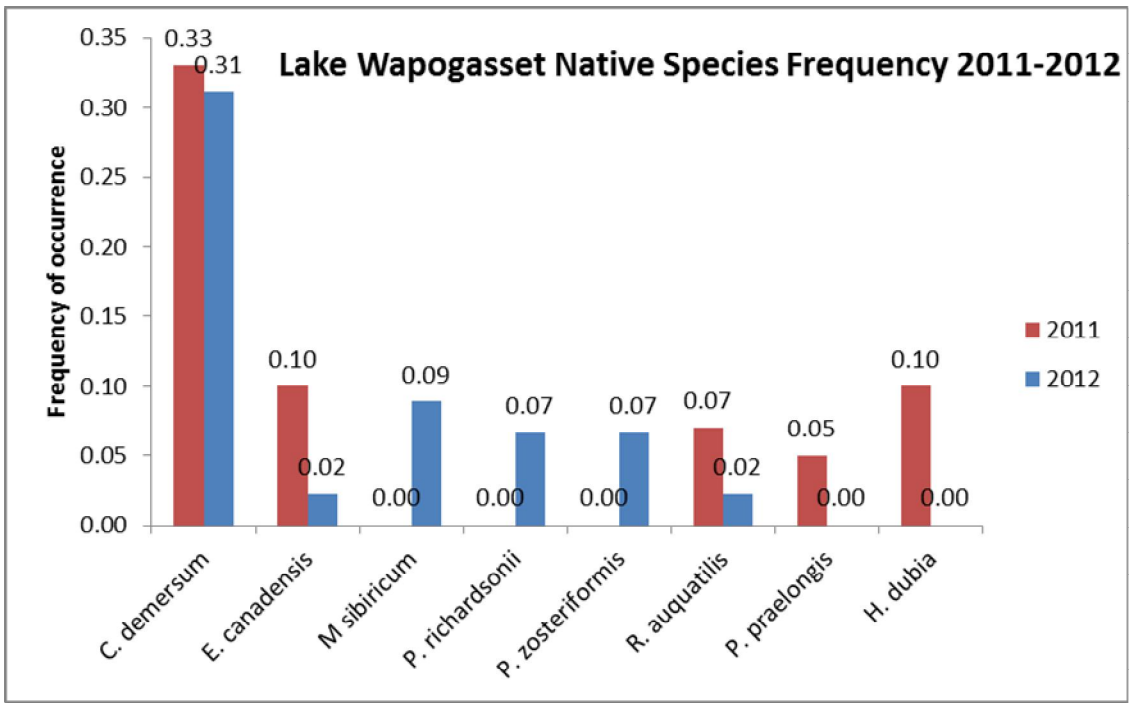


Figure 9: Graph comparing native species frequencies-Lake Wapogasset 2011 vs 2012.

Lake Wapogasset Pt	CLP		*C. demersum*	*E. canadensis*	*M sibiricum*	*V. americana*	*P. richardsonii*	*L. triscula*	*P. zosteriformis*	*R. auquatilis*	*S. pectinatum*	*P. praelongis*	*H. dubia*	*P. illinoensis*
	1	1		1										
	2	1												
	3	1												
	4	2								1				
	5	0	1						1					
	6	0												
	7	0					1		1					
	8	0	1				1							
	9	0	1				1							
	10	1												
	11	3												
	12	1	1											
	13	0	1											
	14	2												
	15	3												
	16	2												
	17	3												
	18	1			1									
	19	3												
	20	2												
	21	3												
	22	3	1											
	23	2												
	24	3												

25	3												
26	1	1		1									
27	1	1											
28	3												
29	3	1											
30	2												
31	1	1		1									
32	3	1											
33	1												
34	1	1											
35	3												
36	1	1		1				1					
37	3												
38	2												
39	2												
40	2												
41	3												
42	3												
43	2	1											
44	2												
45	1												
46	1												
47	1												
48	1												
49	1												
50	1												
51	1												
Number	45	14	1	4	0	3	0	3	1	0	0.00	0.00	0.00

Freq 2012	0.88	0.31	0.02	0.09	0.00	0.07	0.00	0.07	0.02	0.00	0.00	0.00	0.00
Freq 2011	0.93	0.33	0.10	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.05	0.10	0.00

Bear Trap Lake Pt	CLP	*C. demersum*	*E. canadensis*	*M sibiricum*	*V. americana*	*P. richardsonii*	*L. triscula*	*P. zosteriformis*	*R. auquatilis*	*S. pectinatum*	*P. praelongis*	*H. dubia*	*P. illinoensis*
1	1	1	1	1									
2	2	1		1									
3	2	1											
4	2	1		1									
5	0	1	1	1									
6	3	1											
7	1	1		1									
8	0	1		1									
9	0	1		1	1				1	1			
10	1	1											
11	1	1	1		1								
12	0			1			1						

13	1	1		1									
14	0												
15	1	1	1		1								
16	0	1		1		1	1						
17	0	1		1	1		1						
18	0	1			1		1						
19	2	1		1									
Number	11	17	4	12	5	1	4	0	1	1	0	0	0
Freq 2012	0.58	0.89	0.21	0.63	0.26	0.05	0.21	0.00	0.05	0.05	0.00	0.00	0.00
Freq 2011	0.38	0.57	0.38	0.24	0.05	0.10	0.14	0.00	0.10	0.00	0.01	0.00	0.05