Established Infestation Control Research and Demonstration Project
Turville Bay – Lake Monona, Dane County

Year 1 Progress Report
March 2009

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Project Summary

Dane County is collaborating with the US Army Corps of Engineers and the Wisconsin Department of Natural Resources on an exploratory research project in Lake Monona's Turville Bay. Our collaborative goal is to evaluate the efficacy of early-season control efforts on the distribution and density of Eurasian water milfoil (*Myriophyllum spicatum* or EWM). Using a controlled block design, we are currently assessing the results of early season application of selective herbicide 2,4-D (granular) and early season mechanical harvesting. We have quantified results of the first year of treatment using pre- and post-treatment point-intercept macrophyte surveys and periodic DO, temperature, Secchi, phosphorus and chlorophyll *a* monitoring. This comprehensive methodology was designed to allow us to evaluate not only the effect of the treatment on the EWM population, but also the ability of these management efforts to facilitate the growth and distribution of native macrophytes and the treatments' effects on water quality and clarity. We have now collected data in this system for two years, one-year pre-treatment, and one year post-treatment. The pre-treatment data collected during the 2007 growing season was used to evaluate plot placement and also serves as a baseline that we will use to contextualize post-treatment results. Treatments occurred in early 2008 and post-treatment results show a decrease in the frequency of occurrence in the chemically-treated plot and a statistically significant treatment effect. We recommend continuing treatment and assessment methodology through at least the end of the 2009 growing season.

Project Background – Existing Aquatic Plant Management

Study Site

Lake Monona is a 3,274-acre lake with a maximum depth of 64 feet and an average depth of 27 feet. Lake Monona is a drainage lake on the Yahara River found downstream from Lake Mendota (9,842 acres) and upstream of Lake Waubesa (2,080 acres). It is a fertile lake characterized by dense stands of rooted aquatic plant and filamentous algae growth and frequent summer blue-green algae blooms. The 80-acre Turville Bay is located on the southwestern side of the lake and has a maximum reported depth of around 7 feet (Figure 1).

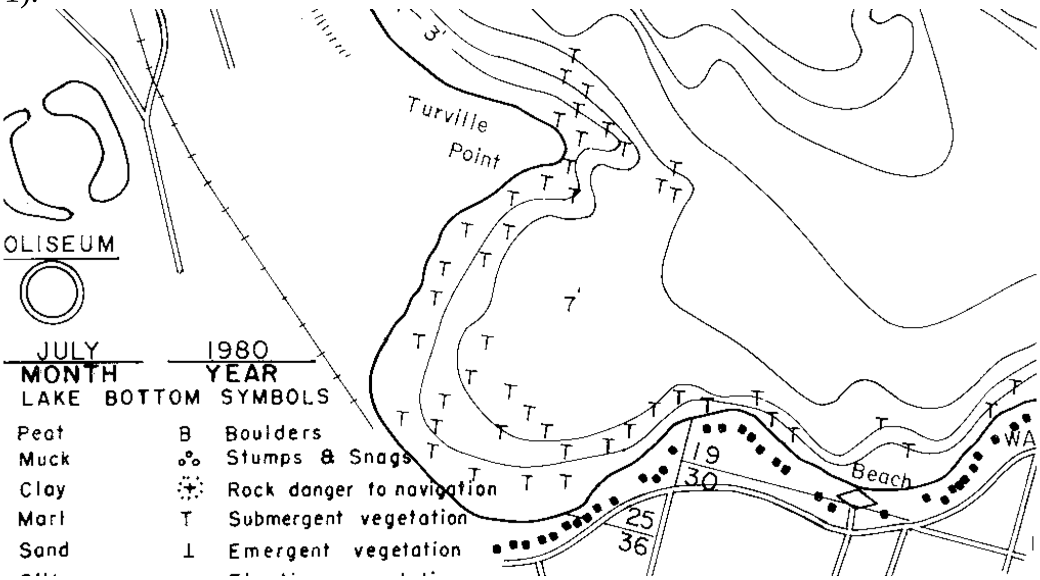

Figure 1. Turville Bay, Lake Monona

Eurasian water milfoil in Yahara Chain of Lakes

Dane County waters have supported populations of the exotic invasive aquatic plant Eurasian water milfoil (EWM*)* since at least the 1960’s. Eurasian water milfoil is found throughout the Yahara Chain of Lakes (Mendota, Monona, Waubesa, Kegonsa and Wingra), and the impacts of this plant have been far-reaching. EWM has been associated with a decrease in biodiversity in the Yahara system, decreased aesthetic value, and impeded recreational use in shallow areas and impacts to the Yahara fishery. In addition to the problems posed by the plant itself, heavy epiphytic growth of filamentous algae is often found in dense stands and may cause additional ecological and aesthetic problems.

Project Background

Formation of an Aquatic Plant Management Committee

In January of 2006 the Dane County Board, via a resolution, formed an Aquatic Plant Management Committee (Committee) to assess options for aquatic plant management in the Yahara lakes, including mechanical, chemical, and biological approaches. Committee selection was designed to cover a broad range of backgrounds to ensure diversity of representation and involvement. The Committee held a series of fact-gathering meetings. These meetings involved County staff, representatives of the aquatic herbicide industry, DNR staff representing management, fisheries, lake management and research, representatives from the U. S. Army Corps of Engineers (COE) and many others. These meetings were open to the public for both their information and participation. The Committee concluded that an experimental approach to early season herbicide use was a high priority.

Project Description

Project Goal

We have initiated a systematic, scientific evaluation of the strategic use of treatment methods already approved for use in the Yahara chain. Whereas historical treatments have been intended primarily to provide nuisance relief, we hope that strategic application early in the growing season will present heretofore unrealized opportunities for native plant restoration. The overall goal of this study is to determine if either or both of the evaluated management approaches (early season 2,4-D treatment and early season deep harvesting) are viable methods to control nuisance exotic plants and aid in restoration of native plant communities. The project is not designed to eliminate aquatic plants from the Yahara Chain of Lakes, rather, it is to further identify or refine management methods that can control exotic plants, like Eurasian water milfoil, while benefiting native plants.

Project Objectives

- Utilize a scientific approach in measuring impacts and results to determine if either control method is successful in facilitating an increase in distribution and density of native plants and a decrease in distribution and density of Eurasian water milfoil without impact to water quality.
- Prepare a final report to include recommendations, based on study results, to suggest how the County will work with DNR, recreational users and riparian property owners to implement possible management methods to seek native plant restoration and control of aquatic exotics.

Project Cooperators and Roles

- Dane County: project coordination, grant and permit application and administration, public information and coordination of public input, staff participation in mechanical harvesting aspects of the project, and collection of water quality data.
- Wisconsin Department of Natural Resources Integrated Science Services Bureau: baseline plant collection and analysis, staff participation in research design and implementation, and water quality analysis.
- U.S. Army Corps of Engineers (COE) Research and Development Center: staff participation in research design and implementation, loan of data collection equipment, supervision of herbicide application.

Project Area Selection and Test Plot Evaluation

Dane County, DNR, and COE delineated seven five-acre sites within and near Turville Bay and collected baseline plant information at approximately 40 sites within each five-acre plot. Figure 2 identifies the location of the seven experimental plots that were surveyed before any treatment occurred during the 2007 growing season and Table 1 summarizes the plant data collected.

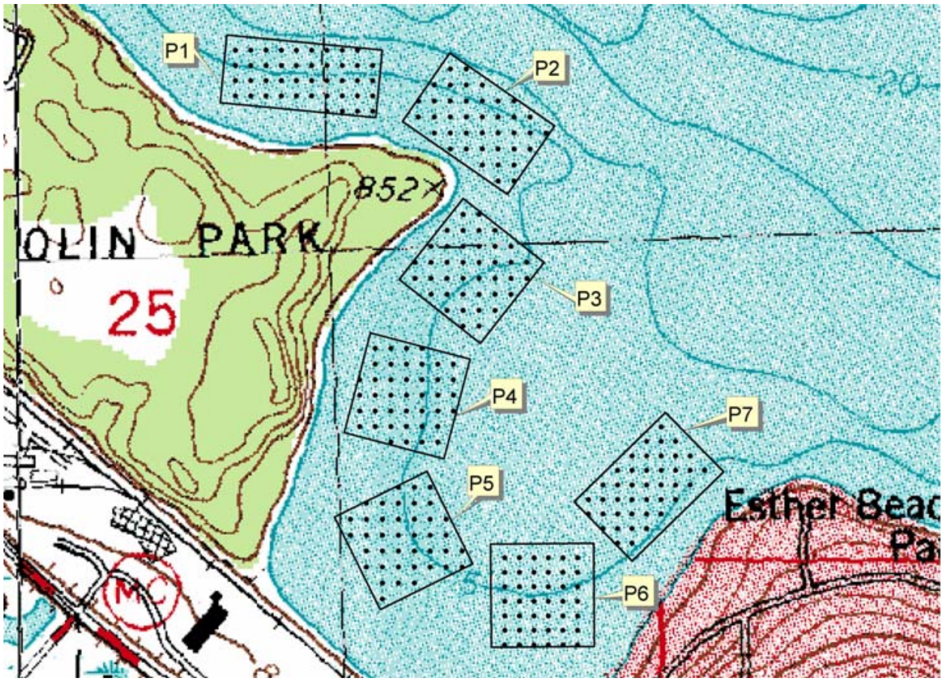

Figure 2. Seven test plots established in and near Turville Bay, Lake Monona

Table 1. Pre-treatment baseline macrophyte data collected in seven experimental plots in Turville Bay, Lake Monona, 2007.

		June Plots							August Plots						
		❶	❷	❸	❹	❺	❻	❼	❶	❷	❸	❹	❺	❻	❼
Summary	% vegetated	88	100	90	98	95	90	100	84	100	93	100	95	95	98
	Species richness	4	5	6	5	5	8	5	4	6	7	6	4	6	2
	Simpson Diversity Index	0.7	0.7	0.8	0.7	0.7	0.8	0.6	0.7	0.7	0.7	0.6	0.5	0.6	0.5
	Avg # species / vegetated site	2.7	3.0	2.8	2.2	2.0	2.7	2.2	2.2	2.5	2.4	2.1	1.8	2.1	2.0
	Avg # native species / vegetated site	1.7	1.8	1.9	1.2	1.3	1.7	1.1	1.3	1.5	1.6	1.2	1.0	1.2	1.0
	Avgerage rake fullness	2.0	2.0	1.8	1.7	1.2	1.7	2.3	2.4	2.3	1.8	2.0	1.6	2.1	2.6
	Mean biomass / point (g)	16.5	27.1	34.0	14.0	5.6	10.4	35.7	25.8	43.0	15.5	22.3	9.3	31.1	40.9
Frequency of occurrence (vegetated)	Eurasian water milfoil	97	100	78	68	53	84	98	92	100	84	93	87	95	95
	Chara										3				
	Clasping-leaf pondweed	18	3				8		19	18	30			8	
	Coontail	58	63	86	95	92	89	98	83	87	92	100	87	95	100
	Curly-leaf pondweed		18	11	35	21	18	12					3		
	Elodea				3	5	5								
	Filamentous algae	76	100	44	13	24	37	5		21		7			
	Sago pondweed	18	13	22		5	18	2	22	21	16	7	3	10	
	Stiff water crowfoot											2			
	Thin-leaved pondweed			14	3		3	2							
	Water star-grass						3				8			3	
	White-stem pondweed			25											
	Wild celery									3	5	2		3	
Avg rake fullness (vegetated)	Eurasian water milfoil	1.6	2.0	1.6	1.2	1.2	1.5	1.6	1.7	2.0	1.5	1.7	1.4	1.7	1.8
	Chara										1				
	Clasping-leaf pondweed	1	1				1		1	1	1.5			1.3	
	Coontail	1.5	1.2	1.4	1.4	1.1	1.3	1.4	1.9	1.7	1.6	1.6	1.4	1.7	2.3
	Curly-leaf pondweed		1	1.3	1.1	1.3	1.3	1					1		
	Elodea				1	1	1								
	Filamentous algae	1.1	1	1	1	1	1	1		1		1			
	Sago pondweed	1	1	1		1	1	1	1	1	1.3	1	1	1.5	
	Stiff water crowfoot											1			
	Thin-leaved pondweed			1	1		1	1							
	Water star-grass						1				1.3			1	
	White-stem pondweed			1.1											
	Wild celery									1	1.5	1		1	

Preliminary survey results indicate that all of the plots were largely vegetated and had similar characteristics: depth, substrate, plant diversity, native species richness and biomass, frequencies of occurrence and biomass of exotics were all comparable. An evaluation of this data concluded that any of these sites are acceptable from an experimental standpoint. Figure 3 shows a comparison of depths by plot.

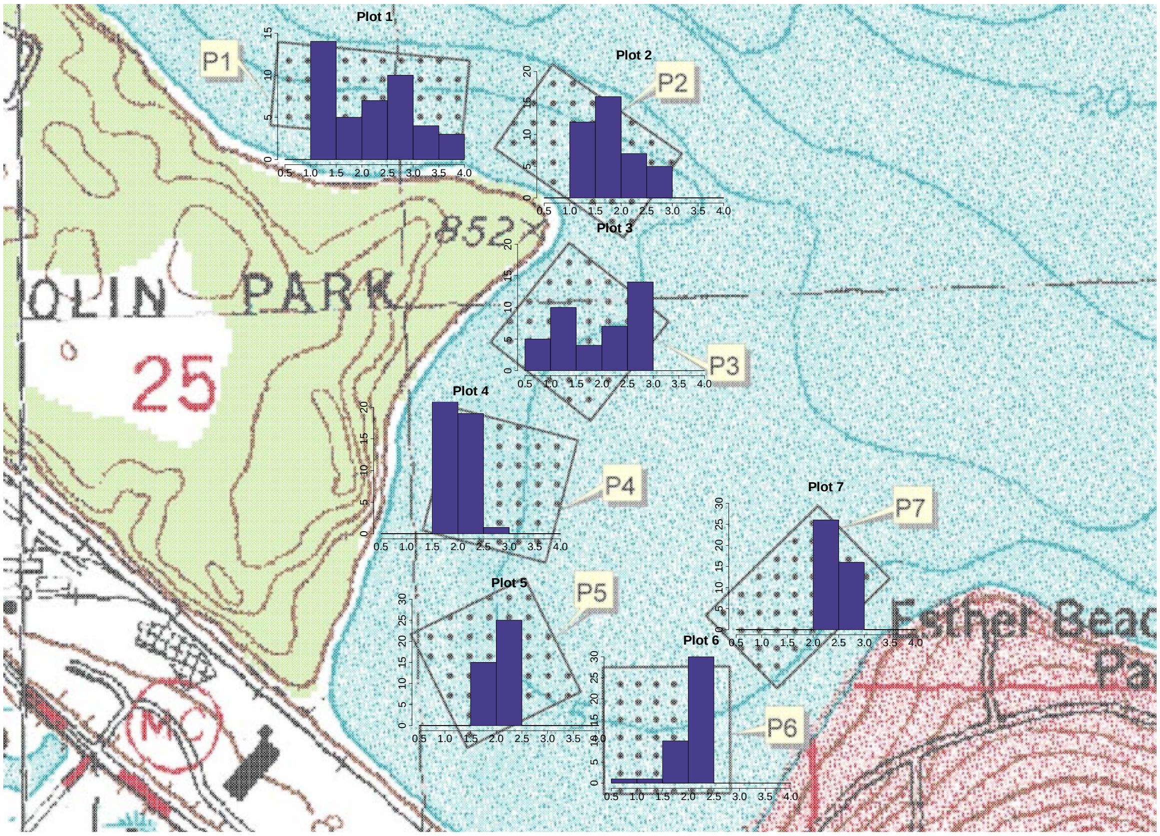

Figure 3. Depth frequency histograms of the seven experimental plots.

Project Methods

Experimental Treatments

The herbicide 2,4-D (applied as the granular formulation Navigate) was applied to plots 2 and 3 on 23 April 2008. The application rate was 150 lbs/acre in depths greater than 5 ft and 100 lbs/acre in depths less than 5 ft. Wind speed was less than 10 mph at the time of application. Marine Biochemists, using GPS controlled application equipment, conducted the herbicide application.

Plots 5 and 6 were mechanically harvested on 29 and 30 May 2008. Dane County Public Works - Lakes Management staff completed the harvesting using county-owned harvesters with a cutting bar that reached 5 to 6 feet below the water surface. Lake

Monona's water level was 845.5 feet above mean sea level at that time (0.3 ft above the DNR-ordered summer maximum level).

Water Quality Monitoring
Water samples were collected from all plots and analyzed for 2,4-D concentrations by Davy Laboratories using a 2,4-D immunoassay analysis. Three sample sites were located in each of the two herbicide treated plots (2 and 3), one sample site was located in each of the other plots, and one sample site was located outside of all the plots (Figure 4). Each sample site located in the herbicide treated plots was sampled at two depths, ¼ and ¾ of the total depth. All other sample sites were sampled at ½ of the total water depth. Samples were collected pretreatment to determine background levels and again 1, 2, 7, 14, and 21 days after treatment (DAT), 2,

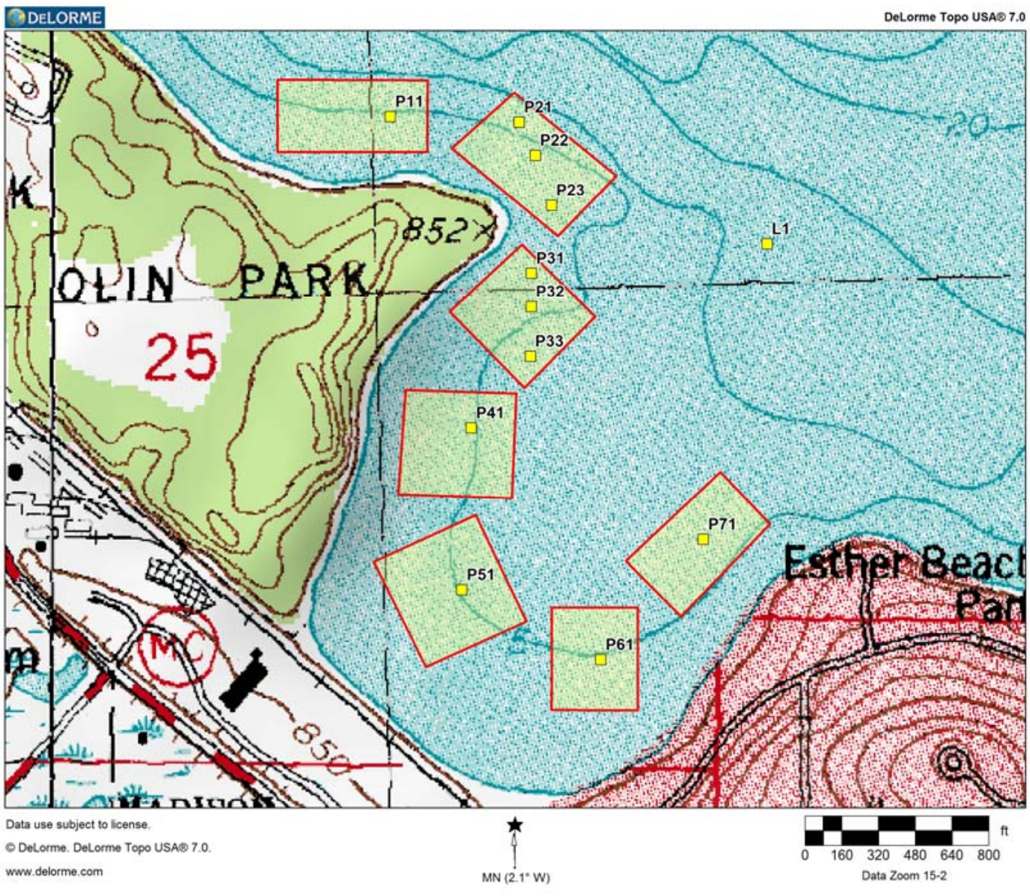

Figure 4. Water residue sample locations

Water temperature, dissolved oxygen (DO), pH, and conductivity were monitored from 23 April to 25 July using YSI data sondes. One data sonde was placed at mid depth in the center of each of the two herbicide treated plots, and one data sonde was placed in plot 5 and 7. The data sondes were set to collect data at 3 hour intervals. The data sondes were removed from the lake between 22 May and 5 June to download data, clean the sensors, and recalibration.

Aquatic Plant Monitoring

A modified point-intercept approach was taken in order that frequencies of occurrence of plants species could be easily compared over time. Point-intercept grids were created and geo-referenced for each of the seven experimental plots (Figure 2). Each plot contained a minimum of 40 points, (which will limit the amount of error in statistical analysis to an acceptable level). At each sample point we lowered a double-sided collection rake straight through the water column to rest lightly on the bottom, twisted the rake twice around and pulled it straight out of the water. We recorded depth and substrate and estimated the overall rake fullness for each sample (Figure 5). Each species on the rake was identified to specific level, and was assessed for rake fullness. Additionally, field crews estimated the % dry weight of each species present. Each sample collected was then placed in a paper bag and conveyed promptly to a drying oven. After drying for at least 48 hours at 70ºC, the samples were allowed to reach room temperature and then weighed. A random selection of 10% of sites from each plot was selected and sorted prior to drying in order to provide a quality control check on dry weight field assessments.

Fullness Rating	**Coverage**	**Description**
1		Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer.
2		Rake head is generally about half-full. There are enough plants to cover the length of the rake head in a single layer, but tines are still visible.
3		The rake is completely covered and tines are not visible.

Figure 5. Illustration of rake fullness ratings used during the PI survey

Preliminary Results and Discussion

Residuals

The maximum 2,4-D concentrations in the herbicide treated plots were observed at 1 day after treatment (DAT), and the maximum concentration was less than 35 ug/L (Figure 6). The average concentration in the treated plots was less than 10 ug/L by 14 DAT, and no concentrations in untreated areas exceeded 10 ug/L. By comparison the water use restrictions listed on the 2,4-D label were 100 ug/L for irrigation and 70 ug/L for human drinking.

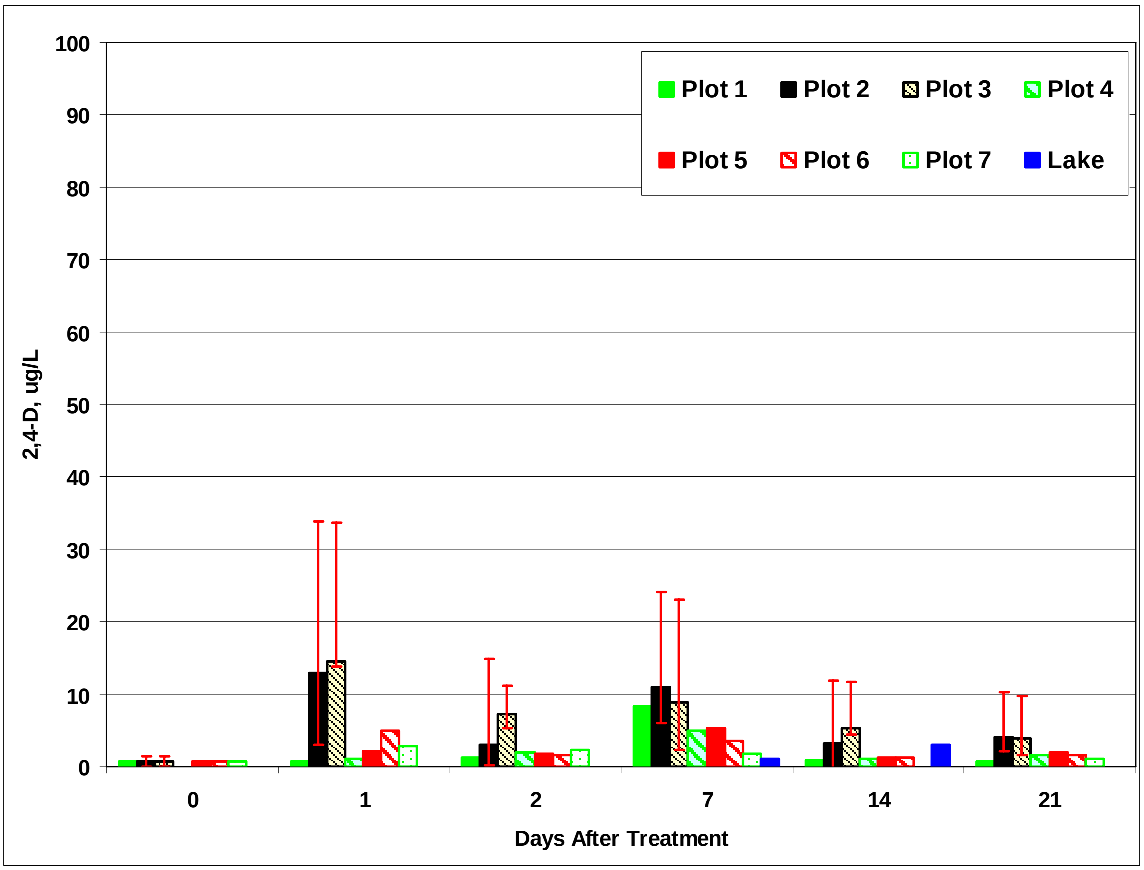

Figure 6. 2,4-D concentrations in water samples collected from study plots. Error bars represent the minimum and maximum values for the herbicide treated plots.

Harvesting

On 29 May 2008, 2.5 truck loads of EWM were harvested from plots 5 and 6, estimated to be 11.5 US tons of wet weight (1.9 US tons dry weight). On 30 May 2008, 3.0 truck loads of EWM were harvested from plots 5 and 6, estimated to be 13.8 US tons of wet weight (2.2 US tons dry weight).

Water Quality

Mean dissolved oxygen levels remained greater 6 mg/L in all plots for at least 60 DAT. Dissolved oxygen data (Figure 7) showed a decline in all plots as water temperatures increased (Figure 8), and were mostly less than 5 mg/L in the two herbicide treated plots and the untreated reference plot by late June and July.   Concentrations were less than 1 mg/L for sustained periods in July in one of the herbicide treated plots and in the untreated reference plot.

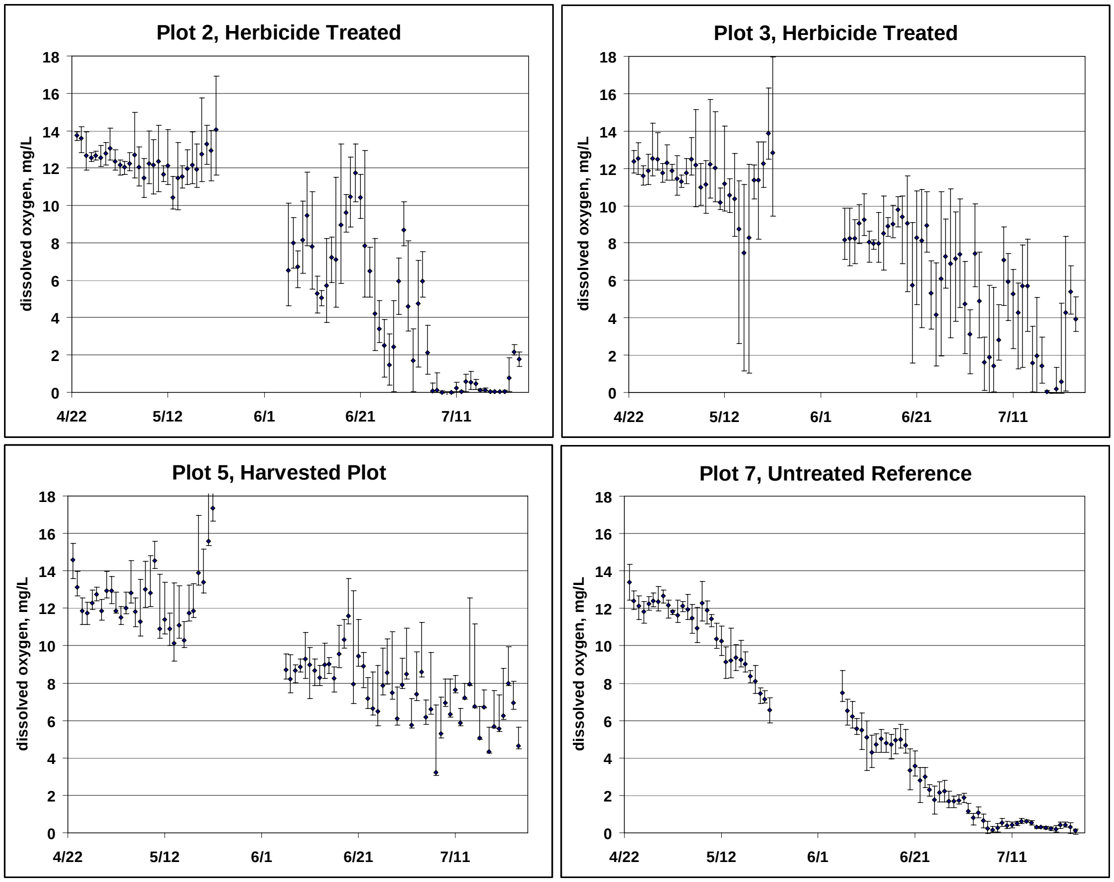

Figure 7. Dissolved oxygen concentrations in four study plots, 2 treated with herbicide and 2 untreated.

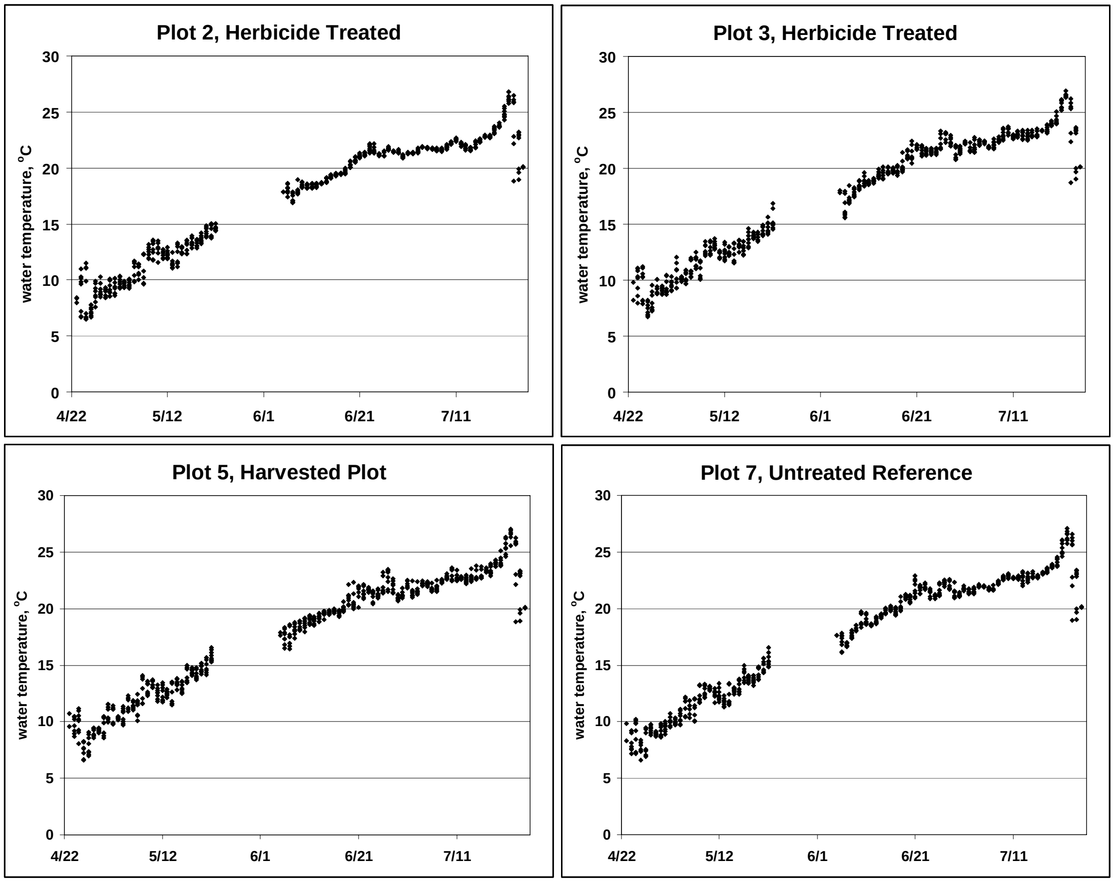

Figure 8. Water temperatures for 2 herbicide treated plots and 2 untreated plots.

Figures 9, 10 and 11 show sampling results for chlorophyll a, total phosphorus, and Secchi depth. The June sample results reflect a mesotrophic lake, using the three measurements typically used to classify lakes based on fertility. August and September sampling results are more reflective of Lake Monona's status as a eutrophic (very fertile) lake.

Chlorophyll a data for July does not seem to relate to the two other data parameters, which show worse water quality, and may indicate a sampling error.

High water levels coupled with cooler temperatures may have also impacted parameter values.

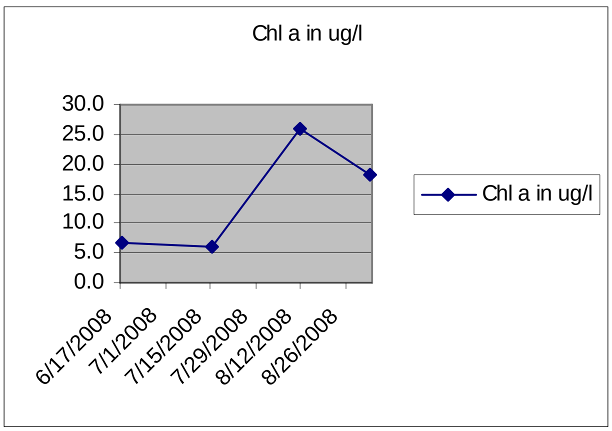

Figure 9 Chlorophyll a sampling results

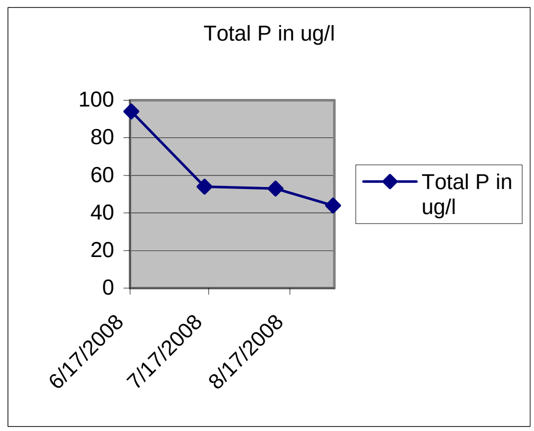

Figure 10 Total phosphorus sampling results

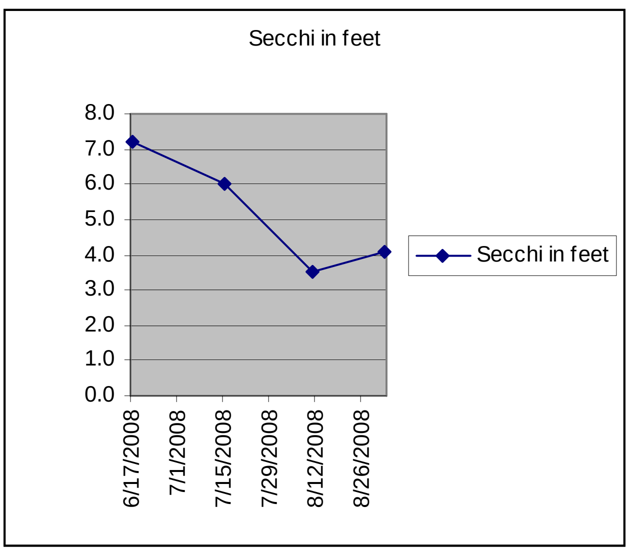

Figure 11 Secchi depth sampling results

Aquatic Plant Surveys
We found a significant treatment effect when comparing pre- and post- treatment August results (ANOVA, p = 0.005) although this relationship is largely driven by observations in the chemically-treated plots (Figure 12). Comparing levels of EWM presence over the full time course reveals a visual trend in only the herbicide plots, which lends additional support to that assumption (Figure 13). Due to the combinative effects of weather and high water levels, we believe the treatment effects may be, to some degree, obscured. Based on the field staff's observations and the opinions of the principal investigators, we suggest carrying out an additional year of treatment and analysis in order that the efficacy of the treatment regimes be fully assessed. These confounding environmental conditions may explain why we failed to see any significant trend in the biomass data (Figure 14). Analysis of variance failed to find any difference between the treatment and the control plots (p = 0.75). It could be expected that the lack of significance in the overall biomass data might be a result of native plants taking up niche space vacated by the exotic target species. To assess this possibility, we analyzed native and exotic biomass separately, however, we still did not see a significant difference in exotic or native biomass in treated plots relative to the control plots (Figure 15).

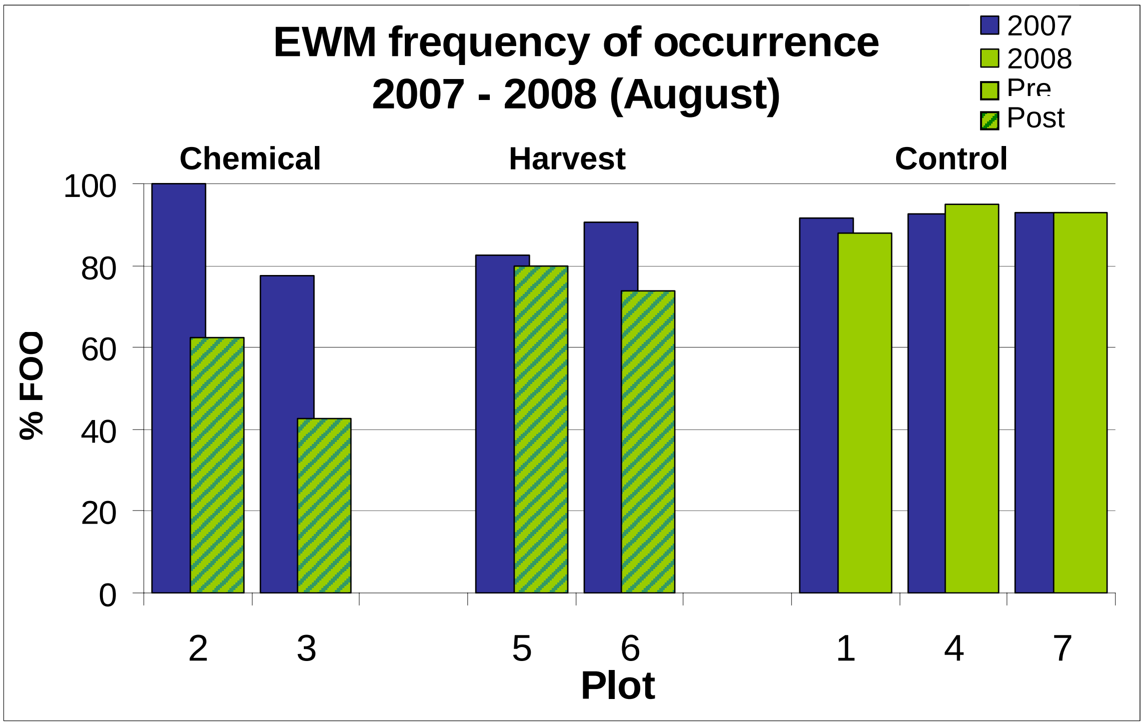

Figure 12. Pre- and post-treatment comparison of August % frequency of occurrence of Eurasian watermilfoil across the seven experimental plots. Analysis of Variance reveals significant treatment effect (p = 0.005).

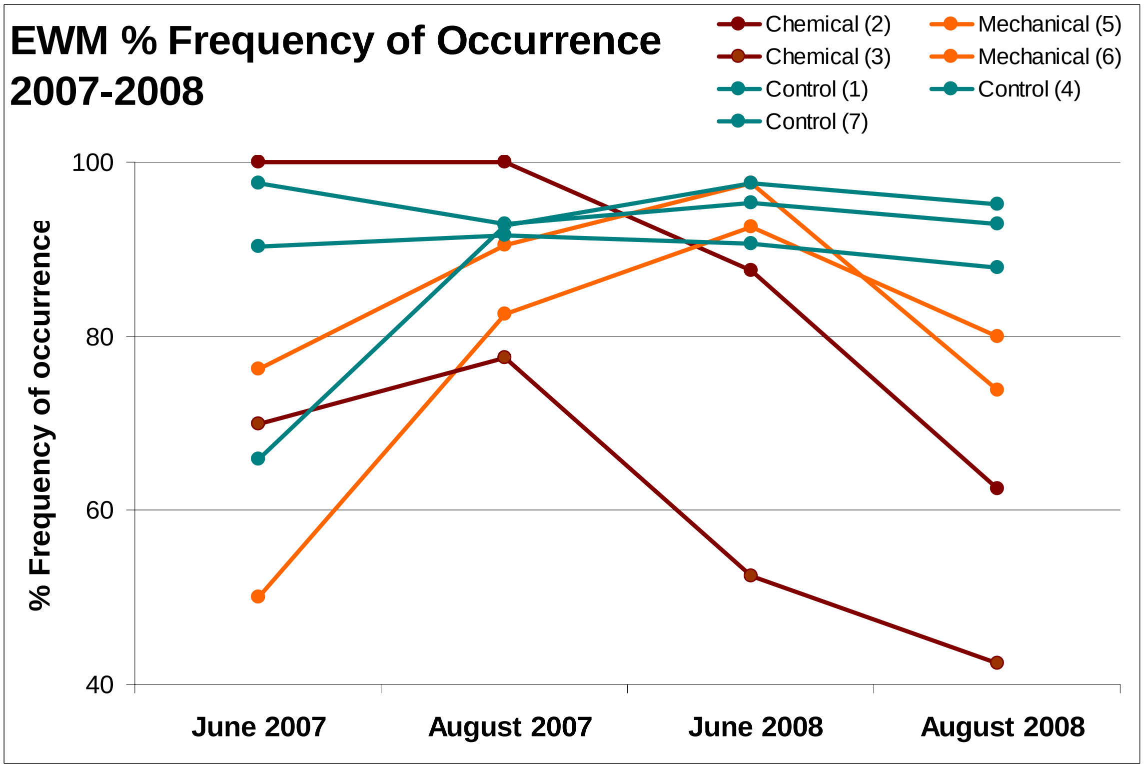

Figure 13. EWM Frequency of occurrence over the entire duration of study.

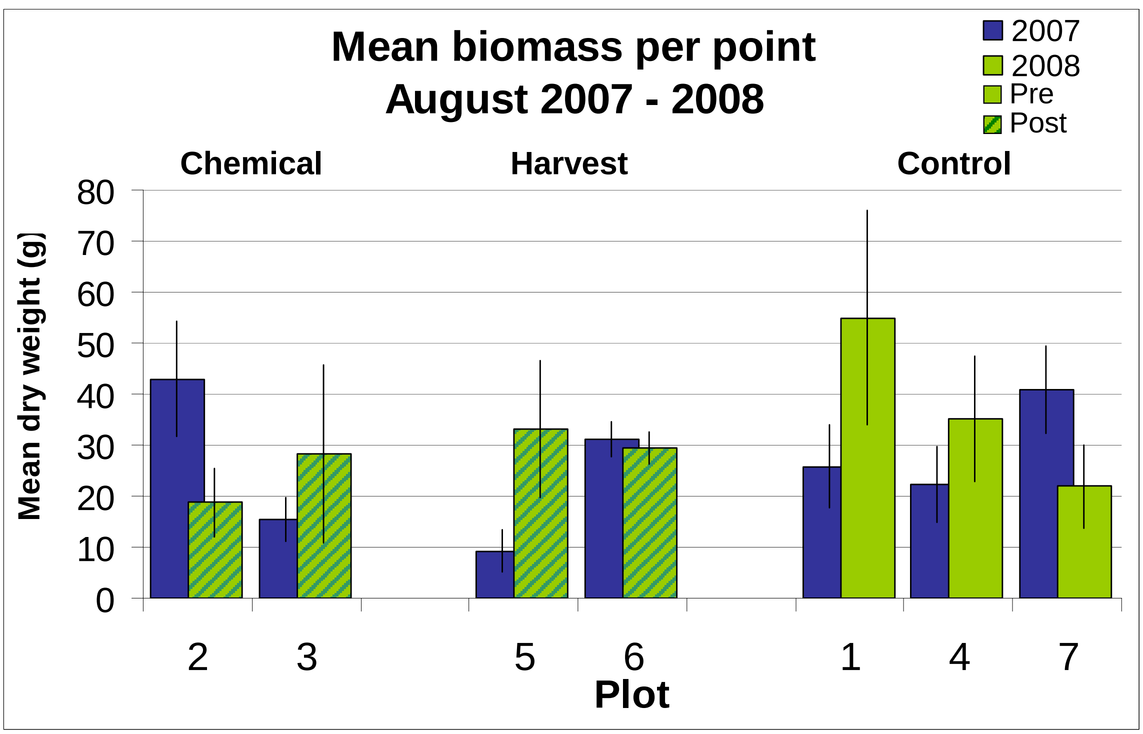

Figure 14. Pre- and post-treatment biomass data showing no significant difference between treatment and control plots (ANOVA, p = 0.75)

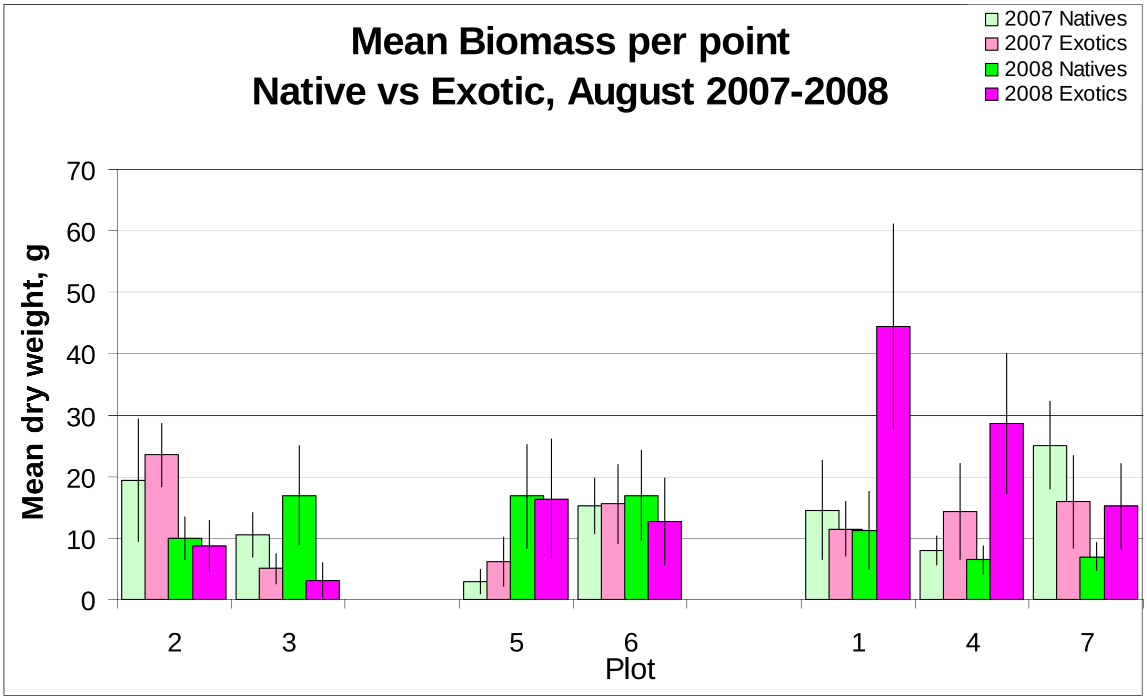

Figure 15. Pre- and post-treatment August biomass data showing some trends, but no statistically significant difference between treated and control plots (ANOVA, exotics: p = 0.69; natives: p = 0.99).

Discussion

High water levels, cold temperatures and high winds in 2008 complicated herbicide application and mechanical harvesting study methods. The original plan for 2008 was to conduct mechanical harvesting at the same time as the herbicide application. Several factors contributed to our decision to amend this approach in 2008. We determined, using presence and water temperature as guides, that Eurasian water milfoil was treatable with herbicides in late April, but was not yet close enough to the water surface to be harvested. The additional 18 inches of water on the lake resulting from heavy rains and snow melt combined with limited plant growth due to cool temperatures resulted in a harvesting delay until the end of May. The high water levels limited the range of harvesting since the cutting bar could only reach 5 to 6 feet below the surface.

We hope to be able to evaluate treatment methods during more typical water, wind and temperatures during subsequent study years.

Conclusion and 2009 Study Plans

Frequency of occurrence data showed a significant decline in frequency of occurrence of Eurasian watermilfoil in herbicide treated plots (up to about a 50% reduction in coverage) but no significant declines in biomass, and no impacts detected on native plants. Observations of milfoil density using a high quality Lowrance sonar indicated that treatment effectiveness in areas less than 5 ft of water and treated with 100 lbs/acre of

2,4-D was less than deeper areas treated with 150 lbs/acre. The plots were located in an exposed area to the much larger lake, so that rapid dissipation from strong winds helped to render the lover applications less effective.

We are only one year into a long-term study. After evaluating 2008 results, project cooperators have made the following changes in 2009 study implementation:

- We will treat the entire herbicide plots with 150 lbs/acre instead of the split rates of 150 lbs/acre at depths > 5ft and 100 lbs/acre at depths < 5 ft.

- We will not worry about having harvesting and herbicide application happen concurrently. We will use herbicides as soon as the plants are actively growing and water temperatures are above 50 degrees Fahrenheit. We will harvest when the EWM is within 2-2.5 feet of the water surface.

Appendix A -- Project Timetable

2007

March – April

- Seven five-acre plots in Lake Monona's Turville Bay were identified and targeted for evaluation during summer.

June

- 40 plus plant samples taken at each of seven possible test plots to characterize species composition/distribution and density.

August

- Repeat evaluation of the seven possible test plots to document changes and determine final site selections for each of the evaluation alternatives (harvesting/herbicide application and reference plot).

2008

Jan- Feb

- Meet with DNR/COE to finalize process and procedures.
- Ensure County Operations has equipment ready to go.
- Hold Public Informational Meeting

March – April

- Following ice-out initiate harvesting and herbicide treatment.

April – September

- Water quality sampling and evaluation using protocols
- Aquatic plant sampling and evaluation using protocols.
- Hold informational meetings prepare public informational notices as needed.

October – November

- Public meetings to discuss project/preliminary results/direction

2009 -- Repeat steps found under 2008

2010 -- Repeat steps found under 2008

Monitoring Phase 2011-2012

2011

Jan-Feb

- Meet with DNR/COE to discuss process and procedures
- Hold Public Information Meeting

April – September

- Water quality sampling and evaluation using protocols.
- Aquatic plant sampling and evaluation suing protocols.
- Hold informational meetings prepare public informational notices as needed

October – November

- Public meetings to discuss project/preliminary results/direction

2012 -- Repeat steps found under 2011

December

- Prepare final report

2013 – Project closeout

Appendix B -- Plan for Sharing Project Results

Dane County will schedule two public meetings yearly to discuss and describe the project. The first meeting will be held prior to each year's treatment and the second meeting to discuss the results collected during that treatment year.

The County will meet with various groups (i.e., Yahara Lakes Association, Fishing Clubs, neighborhood associations) as needed to continue the discussion about the project or describe results.

The County will prepare a minimum of two press releases per year to describe the project, results of the project or other information related to the project that will inform the public about ongoing efforts.

Prior to the project the County will also develop and finalize a process that will minimize disruption to the area(s) being studied. This may include, but not be limited to, a temporary slow-no-wake restriction, buoys that identify the area as a research area and ask boaters to minimize impacts, or buoys that specifically identify the individual sites.