Effectiveness of Endothall treatment in reducing *Potamogeton crispus* in Lake Julia

Jake Sorensen
Aquatic Biology Program
Biology Department
Bemidji State University

Curly leaf pondweed *Potamogeton crispus,* is a submerged aquatic plant non-native to North America. It was most likely introduced when common carp *Cyprinus carpio* were intentionally brought to the Midwest. Endothall is an aquatic herbicide commonly used to control curlyleaf pondweed in lakes. This study focused on collecting data from Lake Julia in Sherburne County, MN. Lake Julia is treated annually in the spring to control curlyleaf pondweed. The results show treatment areas saw a significant increase in vegetation density compared to control areas ($P < 0.01$). Changes in percent vegetation coverage by date were insignificant ($P = 0.24$). No significant signs of fish kills were observed. Because this study looked at overall vegetation coverage instead of specifically curlyleaf pondweed, we cannot conclude the increase in vegetation coverage was from curlyleaf pondweed alone. Based on the results from Poovey et al. (2002) we would expect lower vegetation coverage in treatment areas instead of the increased vegetation coverage observed in our study. This suggests the possibility that the endothall treatment successfully killed curlyleaf pondweed in treated areas, which allowed for new growth of submerged aquatic plants to take place as water temperatures increased.

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Introduction

Curly leaf pondweed *Potamogeton crispus,* is a submerged aquatic plant non-native to North America. It is considered an invasive aquatic plant in the state of Minnesota. Reproduction of curlyleaf pondweed is done by release of vegetative structures called turions. Turions will germinate in the fall and plants begin to grow in the spring (Bolduan et al. 1994). Curlyleaf pondweed most likely became present around the same time common carp *Cyprinus carpio* were being intentionally introduced in the Midwest (Heiskary and Valley 2012). This invasive species is now found in 730 lakes across Minnesota (Heiskary and Valley 2012). Curlyleaf pondweed has many damaging impacts to aquatic ecosystems and the economy in Minnesota as it grows in dense mats at the surface of the water and outcompetes other native aquatic vegetation (Johnson et al. 2012).

Endothall (7-oxabicyclo[2,2,1] heptane-2,3-dicarboxylic acid) is an herbicide used to control both terrestrial and aquatic plants. It is commonly used to control curlyleaf pondweed infestations in lakes. Treatment applications are usually applied during spring or early summer to nuisance areas when the plants are beginning to grow (Poovey et al. 2002). According to Netherland et al. (2000) results strongly suggest that both diquat and endothall are most effective at controlling curlyleaf pondweed at 25 °C. Early season treatments have been found to effectively control curlyleaf pondweed without any negative impacts on native aquatic macrophytes (Jones et al. 2012). Following proper application rates and techniques can avoid unintended effects of herbicide use. Despite its toxicity to early life stages of fish, endothall seems to have an adequate margin of safety between application rates (Paul et al.1994). Although some forms of endothall are available for homeowner purchase, application and treatment of infested lakes is usually done by licensed applicators.

Objectives of this experiment are to study the effectiveness of the aquatic herbicide endothall at reducing curlyleaf pondweed and whether the use of the herbicide can harm fish after treatment.

Methods

The study area is Lake Julia, a 62-hectare lake located in Sherburne County, Minnesota. Field work and sampling was done in the spring and summer of

2021. Official ice out occurred on March 26th. This experiment involved collecting data of percent vegetation coverage of the lake bottom, and observed dead fish counts in the study area. Water depth and surface temperature were also measured at each sample site. Data was collected by boat using visual observations and counts to quantify data. Surface temperature and depth were measured using a Lowrance fish finder mounted on the stern of the boat. Vegetation coverage was determined by how much of the lake bottom within a 5-meter square perimeter of the boat had submerged vegetation. Dead fish count was determined by observing the number of dead fish within a 5-meter perimeter of the boat. Treatment areas were randomized sites with high curlyleaf pondweed densities, that were treated annually with endothall each spring. Control sites were randomized sites where high densities of vegetation including curlyleaf pondweed was found but was not treated with endothall to establish a baseline of average vegetation percentage in the lake. Treatment sites were determined using data from Freshwater Scientific Services and the Briggs Lake Chain Association. On a sample day, a boat was used to drive throughout the littoral area of the study lake. Collecting one set of data would consist of stopping the boat at a random site, dropping a waypoint, recording depth and surface temperature, then observing the percent vegetation coverage of the lake bottom and counting the number of dead fish observed in a 5-meter radius of the boat. The process would be repeated until 20 data sets were recorded in a control area. Then 20 more data sets would be recorded from treatment areas resulting in a total of 40 data points. Those 40 data points completed one sample day. A sample day was taken approximately 1 week before treatment, 1 week after treatment, and approximately 1-month post treatment. Vegetation cover was measured through visual observation and quantified to a percent value. Surface temperatures and depth were recorded to observe any changes occurring during sampling. Endothall treatment in the study area was performed on 5 May 2021. Data was analyzed using a multi-factor ANOVA test to determine if percent vegetation coverage significantly differed among treatment and control areas.

Results

Average percent vegetation coverage in control areas ranged between 62% and 68%. While averages in treatment areas were higher, beginning at 81% pre-treatment, slightly increasing to 83% just 1 week after treatment and growing to 89.5% 1-month post treatment (Figure 1). Vegetation coverage did not change significantly by date (P = 0.24), however when vegetation coverage was compared by group, percent coverage in treatment areas significantly differed ($P < 0.01$). No dead fish were found during the first two sample dates. During the final sample date, 1-month post treatment, two dead fish were found in control areas and three were found in treatment areas. Dead fish counts were not significant enough to indicate a fish kill resulting from treatment.

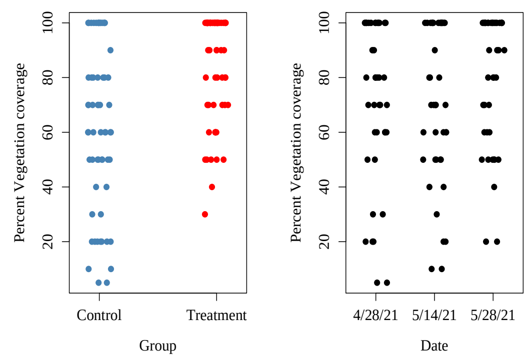

Figure 1. Left: Percent vegetation coverage in treatment and control areas. Right: Percent vegetation coverage by sample date.

Discussion

Visual surveys of aquatic vegetation were performed on Lake Julia during the spring and summer of 2021. Results provided evidence to suggest that areas treated with endothall saw a significant increase in vegetation density when compared with control areas. No similar findings have been reported in available literature.

Fish kills during the spring and summer are not uncommon on Lake Julia. Summer fish kills can be caused by low dissolved oxygen levels due to algal blooms. This can also occur when an area treated with endothall experiences a very rapid die off of vegetation causing low oxygen levels resulting in a fish kill. Although there are no reports of fish kills attributed to endothall in available literature, an oxygen sag attributed to plant decomposition was observed in a small pond in Wisconsin after being treated with endothall (Holmberg and Lee 1976). Very few dead fish were observed throughout the course of this study. Resulting in no significant effect between endothall use and fish kills.

The efficacy of Endothall in controlling curlyleaf pondweed infestations is well documented and cited in many studies and literature. According to a study by Poovey et al. (2002), all endothall treatments were effective in suppressing plant biomass compared to the reference areas. Also, Johnson et al. (2012) found that curlyleaf pondweed was successfully controlled by early season endothall treatments. When compared with this study, our results are conflicting with those in the aforementioned literature. This study differed in that overall vegetation coverage was measured instead of specific targeted macrophyte species and therefore, we cannot conclude the increase in vegetation coverage was from curlyleaf pondweed alone. Although this is a weakness in the study, untreated control sites provided a baseline for vegetation coverage in the lake during the study period. Based on the results from Poovey et al. (2002) we would expect lower vegetation coverage in treatment areas instead of the increased vegetation coverage observed in this study. According to a study by Holmberg and Lee (1976), the endothall treatment eliminated certain plant species from the pond while allowing others to thrive and infest the entire area. This suggests the possibility that the endothall treatment successfully killed curlyleaf pondweed in treated areas, which allowed for new growth of submerged aquatic plants to take place as water temperatures increased.

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