# **A study of potential treatments for effective management of starry stonewort (*Nitellopsis obtusa)* in Lake Wawasee, Indiana**

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## ***Executive Summary***

Starry stonewort (*Nitellopsis obtusa)* is a non-native macroalgae from the division of Charophyta (freshwater green algae). It is a non-vascular, filamentous alga which has clear, colorless rhizoids that produce star-shaped bulbils. Starry stonewort can detach from bottom sediments to form a floating, dense, thick mat (Holeck & Mills, 2007). These mats can have a devastating effect on aquatic ecosystems as they outcompete virtually all other aquatic macrophytes which can result in a severe decrease in biodiversity; the mats can also act as benthic barriers which accumulate phytotoxins (Hackett et al. 2014; Pullman & Crawford, 2010).

The presence of starry stonewort has been confirmed throughout states in the Great Lakes Region including New York, Michigan, Minnesota, New York, Pennsylvania, Wisconsin, and Indiana. In 2008, starry stonewort was first discovered in Indiana in Lake Wawasee (Edgell, 2011; Aquatic Weed Control, 2015). Lake Wawasee is located within the St. Joseph Watershed near the town of Syracuse, IN in the northeastern part of Kosciusko County. It is the largest natural lake in Indiana with 3,060 surface acres, a maximum depth of 24.7 m (81 ft), and an average depth of 6.7 m (22 ft). The introduction of invasive species into Lake Wawasee can have a dramatic impact on the organisms that depend on the water for habitat and survival, and can also impact the economical, recreational, and social features for humans. With the frequency of starry stonewort almost doubling between 2014 and 2016 and starry stonewort acreage representing 7.6% of Lake Wawasee’s total acreage, a review of current treatment options was essential.

The purpose of this study was to put three different types of treatments through trials to evaluate their effectiveness in decreasing starry stonewort abundance. There were sixteen total plots broken up between Conklin Bay, Griffith’s Marina, Johnson Bay, and four different channels around Lake Wawasee. Each treatment, including the control, were replicated in four different plots. Treatment 1 was Clearigate; treatment 2 was a combination of Algimycin and Clipper; treatment 3 was a combination of Cutrine Ultra and Hydrothol; control plots did not receive any type of treatment. Each test plot received two treatment applications with the first application taking place on June 27, 2016 and the second application taking place on August 1, 2016.

While the results for overall effectiveness of each treatment were confounded by several factors, researchers learned that certain treatments were more effective in different

locations and in different application amounts in regard to reducing starry stonewort abundance. This research may indicate early treatment of starry stonewort as it begins to actively grow, but before it reaches large biomass levels, is important to management success. Furthermore, the research indicates that follow-up applications can be effective during active growth and moderate biomass levels. This research may also show increased effectiveness of Treatment 2 (Algimycin PWF and Clipper) and Treatment 3 (Cutrine Ultra and Hydrothol) in more sheltered and shallow lake areas, while Treatment 1 (Clearigate) might be most effective in more open or deeper lake areas.

Confounding factors that impacted results included treatment dilution, pH, treatment application timing, and abundance of starry stonewort. Some of these factors could be minimized in potential future related research. By studying each treatment and its effect on starry stonewort abundance, this data and future research can better guide lake associations, contracted applicators, and government agencies as to the most effective options for management of starry stonewort. A more effective approach to the management of starry stonewort could have a tremendous impact on efforts to mitigate and even drastically reduce the spread of starry stonewort.

## ***Introduction***

Starry stonewort (*Nitellopsis obtusa)* is a non-native macroalgae from the division of Charophyta (freshwater green algae). It is a filamentous alga that is non-vascular with stems composed of a few long cells, nodes of small cells that branch off with longer cells, and characteristic star-shaped bulbils produced on clear, colorless rhizoids (Jurek and Millaway, 2015). It also produces orange oocysts where eggs are developed that are visible to the naked eye (Hackett et al, 2014). The majority of stem and branch cells are around one mm (0.1 cm) in diameter and the stems can extend up to 80 cm (31.5 inch) tall (Hargeby, 1990). These rhizoids act like roots for starry stonewort and allow starry stonewort to sometimes detach from an aquatic bottom to form a floating, dense, thick mat (Holeck & Mills, 2007). In addition to floating mats, starry stonewort more commonly forms dense mats along the bottom of the lake occupying depths past 6 m (20 ft). Once these mats are formed along the bottom of the lake, starry stonewort can negatively impact an aquatic ecosystem by outcompeting virtually all other aquatic macrophytes, including other invasive species (Hackett et al, 2014). Most aquatic plants cannot push through the dense growth; therefore, the diversity of plants in an aquatic ecosystem can be severely reduced and impaired by starry stonewort mats. Starry stonewort mats are also harmful because they can act as benthic barriers which accumulate phytotoxins as well as make sediment conditions hostile toward plant growth (Pullman & Crawford, 2010). Dense starry stonewort mats have been observed to negatively affect fish nesting and feeding habitats, resulting in changed fish reproduction behaviors (Hackett et al, 2014). Starry stonewort also has negative recreational impacts. Starry stonewort has been observed growing taller than 1.5 m (5 ft) and has the ability to impact boating, fishing, and swimming in shallow waters and channels. Starry stonewort is aggressive as its fragments can easily be spread between lakes by boats, trailers, waterfowl, and anchors holding sediments (Ford-Steward, 2015).

The presence of starry stonewort has been confirmed throughout the Great Lakes Region in the states of New York, Michigan, Minnesota, New York, Pennsylvania, Wisconsin, and Indiana. As of 2015, starry stonewort had been found in 27 of New York's counties at 31 sites and there have been over 1,000 established occurrences of the species (Sleith et al. 2015; USDI, 2016). The state of Minnesota has had 11 known occurrences of starry stonewort while the state of Wisconsin has had 22 known occurrences (USDI, 2016). For both states, these occurrences have only happened in the past three years. In Indiana, there are 17 lakes with established starry stonewort populations. Lake Wawasee is the first lake in Indiana where starry stonewort was discovered in 2008 (Edgell, 2011; Aquatic Weed Control, 2015).

Lake Wawasee is located within the St. Joseph Watershed near the town of Syracuse, IN in the northeastern part of Kosciusko County. It is a 3,060 surface acre lake with a maximum depth of 24.7 m (81 ft) and an average depth of 6.7 m (22 ft). Lake Wawasee is also the largest natural lake in the state of Indiana. The stability of Lake Wawasee can have a dramatic impact on the many organisms that depend on the water for habitat and survival. This delicate balance can easily be disturbed through the introduction of an invasive species. The abundance of starry stonewort in Lake Wawasee has continued to grow over the last several years. In 2014, the frequency of starry stonewort was 18.9% and the total starry stonewort acreage was estimated at around 200.3 acres (Aquatic Weed Control, 2015). By 2015, the frequency had increased to 36.7% and an estimated 230.7 acres of dense starry stonewort beds were mapped (Aquatic Weed Control, 2016). Before treatments were performed in June 2016, the frequency had decreased to 32.5% and starry stonewort acreage was 231.0 acres, which represent 7.6% of the total lake acreage of 3,060 acres.

The purpose of this study was to test three different types of treatments to evaluate their effectiveness in decreasing starry stonewort abundance. By evaluating which treatments worked best under different conditions, this project completes another step in helping guide lake associations, contracted applicators, and government agencies as to the most effective options for management of starry stonewort.

## *Methods*

### Study sites

Due to starry stonewort's coverage throughout Lake Wawasee (Figure 1), study sites of open lake and channel plots were established for a total of 16 plots to represent various conditions around the lake where starry stonewort was commonly found. Plots 0-3 were established in Conklin Bay, an area of water located in the northwestern part of the lake (Figure 2). Plots 6-7 were established in an area of water located near Griffith's Marina in the southeastern part of the lake (Figure 3). Plots 8-13 were established in Johnson Bay, an area of water located in the northeastern part of the lake (Figure 4). Plots 15-18 were designated as the channel plots and were in three different locations (Figure 2). Plot 15 was located just outside of Conklin Bay near Oakwood Resort while plot 18 was located just off the main channel between Lake Wawasee and Syracuse Lake past the bridge for East Pickwick Road. Plots 16 and 17 were located in a side channel just off the main channel between Lake Wawasee and

Syracuse Lake. Open lake plots were one acre in size and square in shape (63.7 m x 63.7 m). Channel plots spanned the entire width of each individual channel with various lengths based on channel characteristics. All plots were at least 45.7 meters from any other plot.

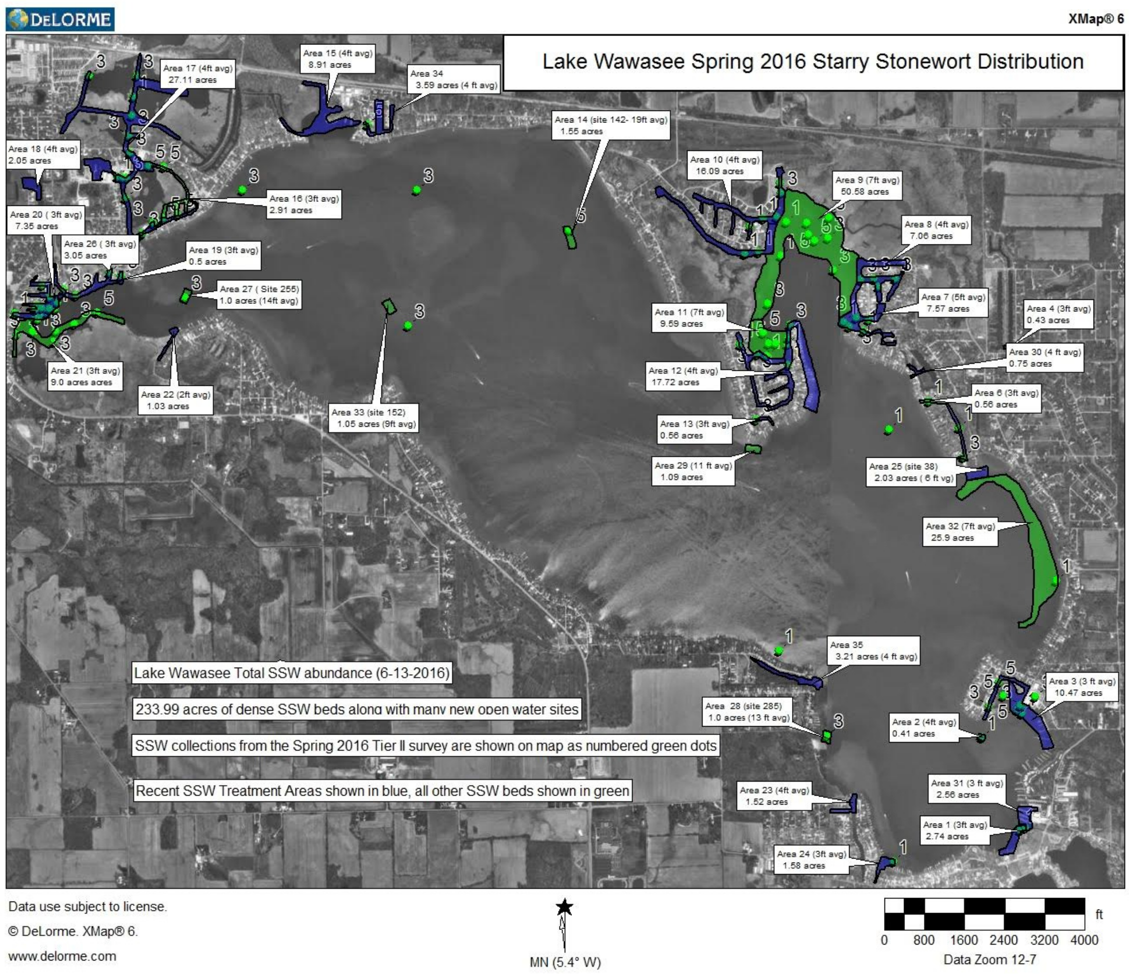


**Figure 1:** Map of Lake Wawasee showing 2016 spring starry stonewort distribution (in green) and previous treatment areas (in blue). Before treatments were used in June 2016, the frequency of starry stonewort was 32.5% and the starry stonewort acreage was 230.99 acres. Starry stonewort acreage was estimated on August 13, 2016 at 233.99 acres and 238.9 acres on August 22, 2016 along with several new open water sites.

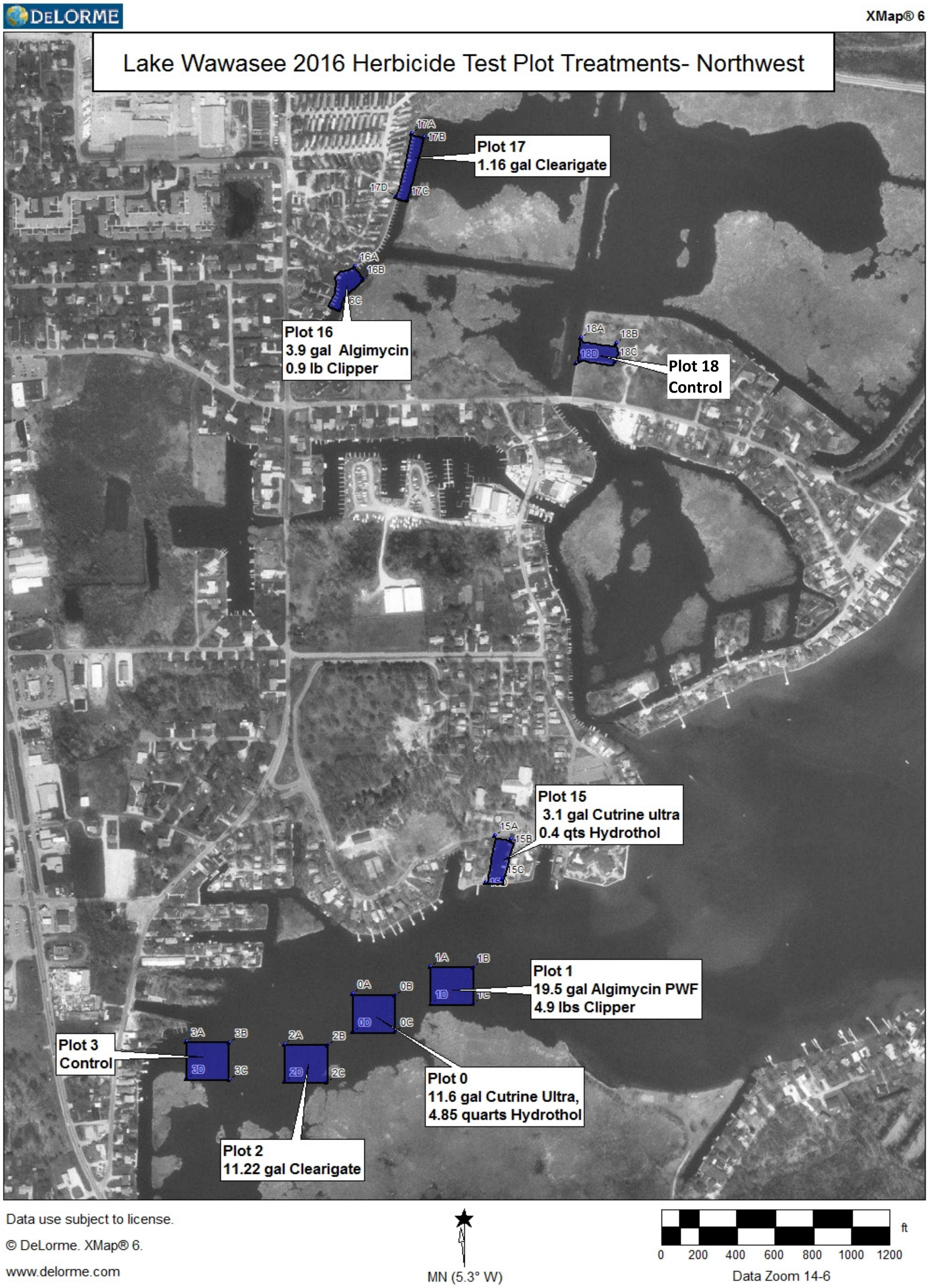


**Figure 2:** Map of Lake Wawasee showing plots 0-3 in Conklin Bay as well as the channel plots 15-18. Treatment types and their amounts are displayed.

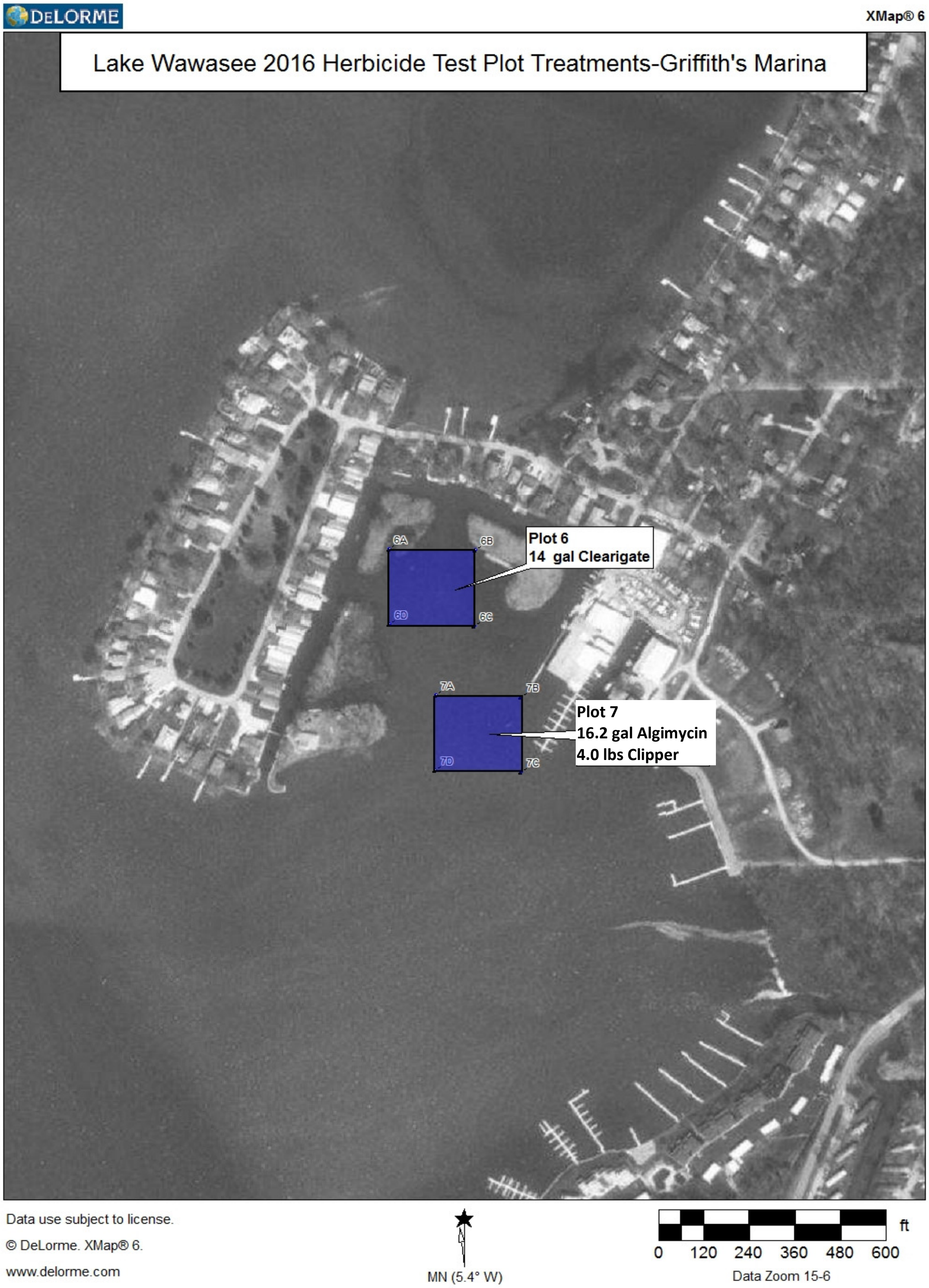


**Figure 3:** Map of Lake Wawasee showing plots 6 and 7 near Griffith's Marina. Treatment types and their amounts are displayed.

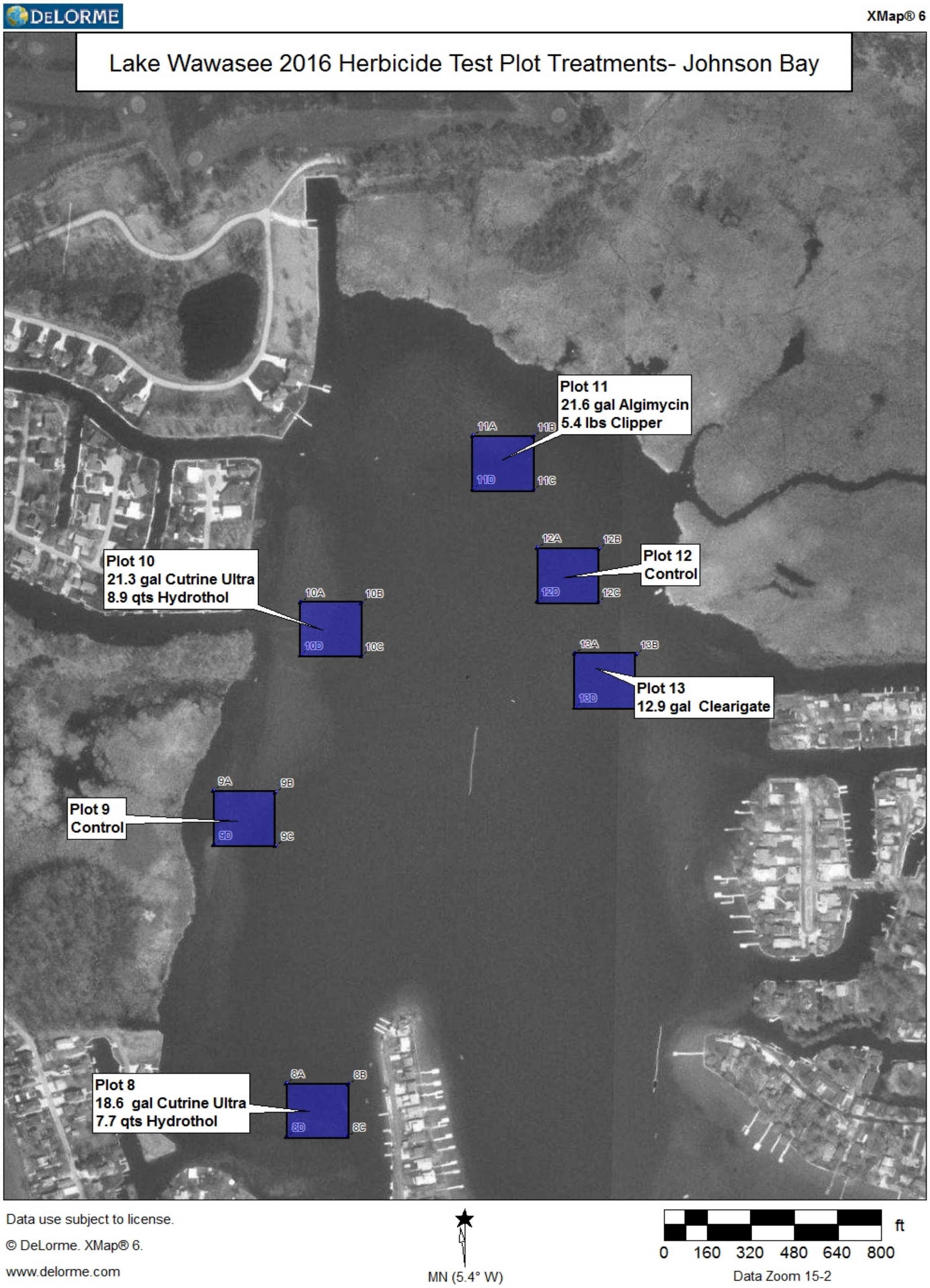


**Figure 4:** Map of Lake Wawasee showing plots 8-13 in Johnson Bay. Treatment types and their amounts are displayed.

## Treatment types and timing

Three different types of treatments were used in this study (Table 1). Treatment 1 was Clearigate (2.2 gal/ac-ft; approximately 0.3 ppm). Clearigate, an aquatic herbicide, is a chelated copper formulation containing an emulsified surfactant/penetrant for highly effective control of filamentous algae and planktonic algae. Treatment 1 was used in plots 2, 6, 13, and 17. Treatment 2 was a combination of Algimycin PWF (3.2 gal/ac-ft; 0.6 ppm) and Clipper (0.8 lbs/ac-ft; 150 ppb). Algimcycin PWF is a liquid, water-soluble copper formulation designed to effectively control a broad range of algae and cyanobacteria growth. Clipper is a broad spectrum herbicide which controls many species of algae and aquatic plants. Treatment 2 was used on plots 1, 7, 11, and 16. Treatment 3 was a combination of Cutrine Ultra (2.4 gal/ac-ft; 0.8 ppm) and Hydrothol (1 quart/ac-ft; 0.2 ppm). This type of treatment is considered the standard treatment used by the Indiana DNR for managing starry stonewort. Cutrine Ultra is a copper-based contact herbicide that breaks down the plant's cellular structure and interrupts its ability to photosynthesize. Hydrothol is an endothall-based contact herbicide that inactivates plant protein synthesis. Treatment 3 was used in plots 0, 8, 10, and 15. Plots 3, 9, 12, and 18 were used as the control plots in each location, so they did not receive any kind of treatment.

**Table 1:** Summary of the plot numbers, average depth for each plot (in m), plot location type, treatment type for each plot, and the chemical amount applied. Conklin Bay contained plots 0-3; Griffith's Marina contained plots 6 and 7; Johnson Bay contained plots 8-13; and there were four different channel plots around Lake Wawasee. Treatment 1 was Clearigate (2.2 gal/ac-ft; approximately 0.3 ppm). Treatment 2 was a combination of Algimycin PWF (3.2 gal/ac-ft; 0.6 ppm) and Clipper (0.8 lbs/ac-ft; 150ppb). Treatment 3 was a combination of Cutrine Ultra (2.4 gal/ac-ft; 0.8 ppm) and Hydrothol (1 quart/ac-ft; 0.2 ppm).

| Plot | Average depth (m) | Location type | Treatment type | Chemical amount |
|---:|---:|---|---|---|
| 0 | 1.20 | Main lake | T3 | 2.4 gal/ac-ft; 0.8 ppm, 1 quart/ac-ft; 0.2 ppm |
| 1 | 1.40 | Main lake | T2 | 3.2 gal/ac-ft; 0.6 ppm, 0.8 lbs/ac-ft; 150 ppb |
| 2 | 1.22 | Main lake | T1 | 2.2 gal/ac-ft; approx. 0.3 ppm |
| 3 | 1.79 | Main lake | C | N/A |
| 6 | 2.33 | Main lake | T1 | 2.2 gal/ac-ft; approx. 0.3 ppm |
| 7 | 0.64 | Main lake | T2 | 3.2 gal/ac-ft; 0.6 ppm, 0.8 lbs/ac-ft; 150 ppb |
| 8 | 1.59 | Main lake | T3 | 2.4 gal/ac-ft; 0.8 ppm, 1 quart/ac-ft; 0.2 ppm |
| 9 | 1.36 | Main lake | C | N/A |
| 10 | 1.49 | Main lake | T3 | 2.4 gal/ac-ft; 0.8 ppm, 1 quart/ac-ft; 0.2 ppm |
| 11 | 1.50 | Main lake | T2 | 3.2 gal/ac-ft; 0.6 ppm, 0.8 lbs/ac-ft; 150 ppb |
| 12 | 1.48 | Main lake | C | N/A |
| 13 | 1.49 | Main lake | T1 | 2.2 gal/ac-ft; approx. 0.3 ppm |
| 15 | 0.49 | Channel | T3 | 2.4 gal/ac-ft; 0.8 ppm, 1 quart/ac-ft; 0.2 ppm |
| 16 | 0.49 | Channel | T2 | 3.2 gal/ac-ft; 0.6 ppm, 0.8 lbs/ac-ft; 150 ppb |
| 17 | 0.46 | Channel | T1 | 2.2 gal/ac-ft; approx. 0.3 ppm |
| 18 | 0.50 | Channel | C | N/A |

Each test plot received two applications of the same treatment with the first application on June 27, 2016 and the second application on August 1, 2016. In order to better measure the effectiveness of each treatment, water samples were taken from each plot to analyze the amount of elemental copper following application. A water sample was collected from three locations in each plot at zero hours (immediately following application), six hours, 24 hours, 48 hours, and 96 hours after application. This process was repeated after the second application for a total of 480 samples. Plastic sampling bottles were filled approximately halfway and frozen prior to shipping for copper residue analysis. All samples were labeled according to the treatment plot number and treatment that the plot received. After collection, samples were shipped to Lonza for blind copper residue analysis. In addition to collecting water samples, the water chemistry (water temperature, conductivity, dissolved oxygen, and pH) was measured using the Quanta meter at three locations in each plot (see Appendix).

**Field sampling**

Starry stonewort sampling occurred three times in the study. The first round of sampling took place June 21-22, 2016 and was referred to as “pre-treatment.” The results of this first round of sampling established a baseline for the presence of starry stonewort before any application of treatments were used. The second round of sampling took place 35 days later on July 25-26, 2016 and was referred to as “Post 1 treatment.” The third round of sampling took place 37 days later on August 31, 2016 and was referred to as “Post 2 treatment.”

Researchers used a boat to travel from plot to plot and also conducted sampling from the boat. The presence or absence of starry stonewort and biomass (dry weight) measurements were used to track its distribution and abundance throughout the study. Sample collection was completed through utilization of the spinning rake method at ten plot locations for a total of ten samples (Johnson & Newman, 2011). The lone exception to this being during Post 1 treatment sampling, researchers were only able to collect two samples of starry stonewort in Plot 1. Rake samples were collected using a 0.36 m (14 inches), single-headed rake that was attached to an extendable pole which reached 2.5 m in length. The rake was lowered into the water until the rake made contact with the bottom of the lake bed. The rake was then rotated once clockwise 360 degrees while maintaining contact with the sediment and slowly lifted to the surface. If the rake was able to collect any specimen of starry stonewort, the specimen was put into a bucket, the excess water was drained from the bucket, the specimen was weighed with a tarred spring scale, and the weight was recorded as the total wet biomass. Each specimen that was retrieved from plots using the rake was referred to as the sample. After the total wet biomass weight was recorded, a subsample was collected in a plastic bag and weighed. The weight of each subsample had to fall within 5 and 15 g. A six-digit ID number was assigned to each subsample and written on the plastic bag. After the subsample was weighed, it was placed in a cooler and taken back to the lab for drying. Back at the lab, subsamples were placed in a freezer at 0˚C (32°F).

When it was time for subsamples to be dried, they were each put into an aluminum weigh boat. The six-digit ID number was written underneath the weigh boat to keep track of each subsample. The weigh boat was weighed on a scale and then the scale was zeroed out prior to subsamples being placed in the weigh boat. Once the subsample was put into a weigh boat, it was placed onto one of the two racks in an oven. After a period of one hour to allow the oven to reach 105˚C, subsamples were dried for 48 hours (Wetzel and Likens, 2000; Johnson & Newman, 2011). Because of the size of the oven, subsamples were divided into batches of 40 so the whole drying process for one round of sampling took eight days. After 48 hours of drying, each subsample was taken out of the oven and weighed; the process from freezer to oven was then repeated. The weights of the weigh boats, the subsample in the weigh boat before drying, and the subsample in the weigh boat after drying were all recorded electronically.

### Data analysis

For each plot, ten samples were taken in the field for efficiency and then the dry weight was determined by collecting a subsample from each sample to be dried in an oven. Due to the variability of results over the course of the study, an average dry sample weight and an average dry sample density were derived from each sampling trip for every plot (Tables 2 and 3).

In order to find the dry sample weight (in gm) for each individual sample collected, several calculations needed to be made. By dividing the dry subsample weight by the wet subsample weight, the dry:wet ratio could be calculated for the ten subsamples. The dry:wet ratio was then multiplied by the wet sample weight which resulted in calculating the dry sample weight for the ten samples. Because the dry:wet ratio was different for each subsample, the dry sample weight for the ten samples was averaged Therefore, there was one average dry sample weight from each sampling trip for every plot. To find the dry sample density for the ten samples, the area of the circle made when the rake was rotated clockwise 360 degrees was calculated. The area made by the rake was 0.099 $m^2$ and was multiplied by the dry sample weight to calculate the dry sample density (in $gm/m^2$). The dry sample density for the ten samples was averaged such that there was one average dry density from each sampling trip for every plot.

Finally, statistical analysis was applied to each plot's individual dry weight samples in order to determine significant differences within each plot. An ANOVA was run for each plot over their individual dry weight samples to identify a difference between pre-treatment, Post 1 treatment, and Post 2 treatment. If an ANOVA indicated any difference, then a Tukey test was used to determine which of the three sample means were significantly different. Individual box plots were used for each sample plot to display the results so the range for all data within the 95% confidence interval would be shown.

## *Results*

### Starry stonewort abundance

The starry stonewort biomass results varied with limited discernable patterns. Only plots 0, 7, 13, 15, and 18, showed a decrease in starry stonewort abundance from pre-treatment to Post 1 treatment, from Post 1 treatment to Post 2 treatment, and overall from pre-treatment to Post 2 treatment (Table 2; Table 3). Plots 1, 6, 12, 16, and 17, showed an initial decrease in starry stonewort abundance from pre-treatment to Post 1 treatment before increasing from Post 1 treatment to Post 2 treatment. Plots 2, 3, 8, 9, 10, and 11, showed an initial increase in starry stonewort abundance from pre-treatment to Post 1 treatment before decreasing from Post 1 treatment to Post 2 treatment. Within this group, every plot except plot 8 showed an overall decrease in starry stonewort abundance in comparing pre-treatment with Post 2 treatment.

**Table 2:** Summary of starry stonewort abundance as measured in average dry sample weight (in g) for every plot before any treatment, after the first application of treatment, and after the second application of treatment.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment | Treatment type |
|---|---|---|---|---|
| 0 | 110.5 | 55.7 | 5.7 | T3 |
| 1 | 87.3 | 0.8 | 10.7 | T2 |
| 2 | 330.9 | 361.9 | 277.7 | T1 |
| 3 | 119.6 | 226.9 | 182.0 | C |
| 6 | 337.4 | 306.1 | 402.9 | T1 |
| 7 | 710.2 | 507.2 | 304.8 | T2 |
| 8 | 108.6 | 183.6 | 182.8 | T3 |
| 9 | 103.5 | 123.3 | 38.5 | C |
| 10 | 79.7 | 144.9 | 41.3 | T3 |
| 11 | 77.5 | 79.4 | 75.7 | T2 |
| 12 | 127.7 | 57.0 | 64.9 | C |
| 13 | 148.3 | 35.8 | 32.7 | T1 |
| 15 | 337.3 | 174.0 | 105.0 | T3 |
| 16 | 169.7 | 69.7 | 73.1 | T2 |
| 17 | 87.4 | 45.1 | 59.6 | T1 |
| 18 | 599.2 | 157.3 | 140.0 | C |

**Table 3:** Summary of starry stonewort abundance as measured in average dry sample density (in $g/m^2$) for every plot before treatment, after the first application of treatment, and after the second application of treatment.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment | Treatment type |
|---|---|---|---|---|
| 0 | 1116.6 | 562.5 | 58.1 | T3 |
| 1 | 882.1 | 8.6 | 108.4 | T2 |
| 2 | 3342.3 | 3656.0 | 2804.7 | T1 |
| 3 | 1208.5 | 2291.8 | 1838.0 | C |
| 6 | 3408.5 | 3091.5 | 4069.6 | T1 |
| 7 | 7173.5 | 5122.8 | 3079.1 | T2 |
| 8 | 1097.1 | 1854.5 | 1846.6 | T3 |
| 9 | 1045.9 | 1245.6 | 388.4 | C |
| 10 | 804.8 | 1464.1 | 417.5 | T3 |
| 11 | 782.4 | 801.5 | 765.0 | T2 |
| 12 | 1290.2 | 575.6 | 655.5 | C |
| 13 | 1497.7 | 361.3 | 330.2 | T1 |
| 15 | 3407.2 | 1758.0 | 1060.8 | T3 |
| 16 | 1713.8 | 704.3 | 738.3 | T2 |
| 17 | 882.5 | 455.9 | 601.9 | T1 |
| 18 | 6052.5 | 1588.4 | 1414.4 | C |

Starry stonewort biomass changes as percentages were also evaluated. Plot 1 had the highest drop in starry stonewort abundance after the first application of Algimycin PWF and Clipper with a 99% decrease in average dry sample weight (Table 4). Researchers were only able to find two samples of starry stonewort in Plot 1 after the first application of treatment. Plot 0 had the highest drop in starry stonewort abundance after the second application of Cutrine Ultra and Hydrothol with an approximate 90% decrease in average dry sample weight as well. Plot 0 also had the highest overall drop from pre-treatment to Post 2 treatment with an approximate 95% decrease in average dry sample weight.

**Table 4:** Summary of the change (in %) in average dry sample weight for every plot from pre-treatment to Post 1 treatment, Post 1 treatment to Post 2 treatment, and overall from pre-treatment to Post 2 treatment.

| Plot | Pre-Post1 | Post1-Post2 | Pre-Post2 | Treatment type |
|---|---|---|---|---|
| 0 | -49.6 | -89.7 | -94.8 | T3 |
| 1 | -99.0 | 1165.6 | -87.7 | T2 |
| 2 | 9.4 | -23.3 | -16.1 | T1 |
| 3 | 89.6 | -19.8 | 52.1 | C |
| 6 | -9.3 | 31.6 | 19.4 | T1 |
| 7 | -28.6 | -39.9 | -57.1 | T2 |
| 8 | 69.0 | -0.4 | 68.3 | T3 |
| 9 | 19.1 | -68.8 | -62.9 | C |
| 10 | 81.9 | -71.5 | -48.1 | T3 |
| 11 | 2.5 | -4.6 | -2.2 | T2 |
| 12 | -55.4 | 13.9 | -49.2 | C |
| 13 | -75.9 | -8.6 | -78.0 | T1 |
| 15 | -48.4 | -39.7 | -68.9 | T3 |

Plot 10 had the highest increase in starry stonewort abundance after the first application of Cutrine Ultra and Hydrothol with an approximate 82% increase in average dry sample weight (Table 4). Plot 1 had the highest increase in starry stonewort abundance after the second application of Algimycin PWF and Clipper with an approximate increase of over 1,000% in average dry sample weight. Plot 8 had the highest overall increase in starry stonewort abundance from pre-treatment to Post 2 treatment of Cutrine Ultra and Hydrothol with a 68% increase in average dry sample weight.

**Statistical significance**

Statistical results were evaluated as well across plots and sampling events. Plots 2, 3, 6, 7, 8, 11, and 17 showed mostly measured decreases in average dry sample weight, but showed no statistical differences in any of the three sampling trips (Table 5). Plot 0 was the only plot that showed statistical differences between pre-treatment, Post 1 treatment, and Post 2 treatment (Figure 5). In plots 1, 13, 16, and 18, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment (Figure 6). In plots 9 and 10, Post 1 treatment and Post 2 treatment were statistically different (Figure 7). In plot 12, pre-treatment and Post 1 treatment were statistically different (Figure 8). In plot 15, pre-treatment was statistically different from Post 2 treatment (Figure 9). Three out of the four control plots (3, 9, and 12) showed no statistical differences between pre-treatment and Post 2 treatment (Table 5). Whereas five out of the twelve treatment plots (0, 1, 13, 15, and 18) showed a statistical decline from pre-treatment and Post 2 treatment.

**Table 5:** Summary of the change in average dry sample weight for every plot from pre-treatment to Post 1 treatment, Post 1 treatment to Post 2 treatment, and overall from pre-treatment to Post 2 treatment, signifying which changes were statistically different. A "+" signifies an increase while a "-" signifies a decrease. A box highlighted in gray indicates a change that was statistically different.

| Plot | Pre-Post1 | Post1-Post2 | Pre-Post2 | Treatment type |
|---|---|---|---|---|
| 0 | - | - | - | T3 |
| 1 | - | + | - | T2 |
| 2 | + | - | - | T1 |
| 3 | + | - | + | C |
| 6 | - | + | + | T1 |
| 7 | - | - | - | T2 |
| 8 | + | - | + | T3 |
| 9 | + | - | - | C |
| 10 | + | - | - | T3 |
| 11 | + | - | - | T2 |
| 12 | - | + | - | C |
| 13 | - | - | - | T1 |
| 15 | - | - | - | T3 |
| 16 | - | + | - | T2 |
| 17 | - | + | - | T1 |
| 18 | - | - | - | C |

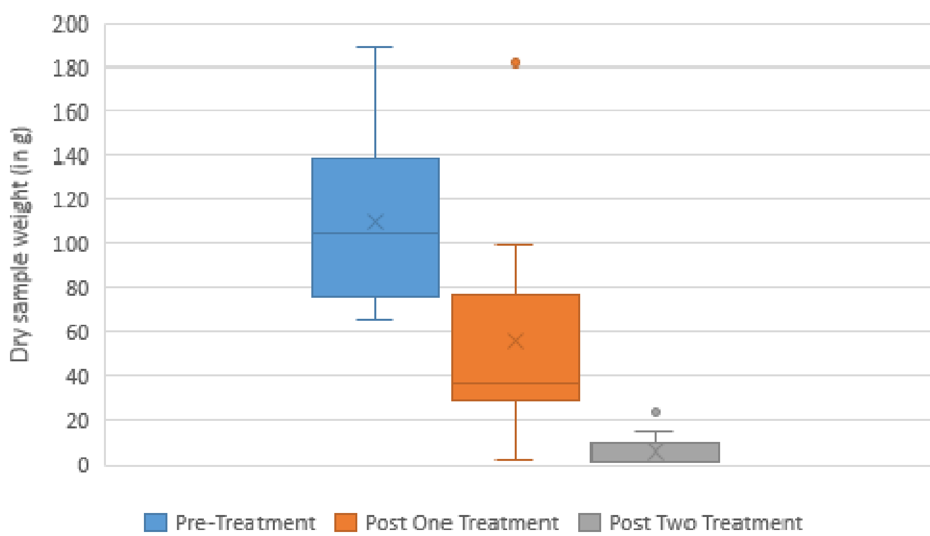


**Figure 5:** Summary of the average dry sample weight (in g) in plot 0 located in Conklin Bay. Plot 0 was the only plot that showed statistical differences between pre-treatment, Post 1 treatment, and Post 2 treatment. Therefore, Treatment 3 (Cutrine Ultra and Hydrothol) was successful in Conklin Bay after the first and second applications.

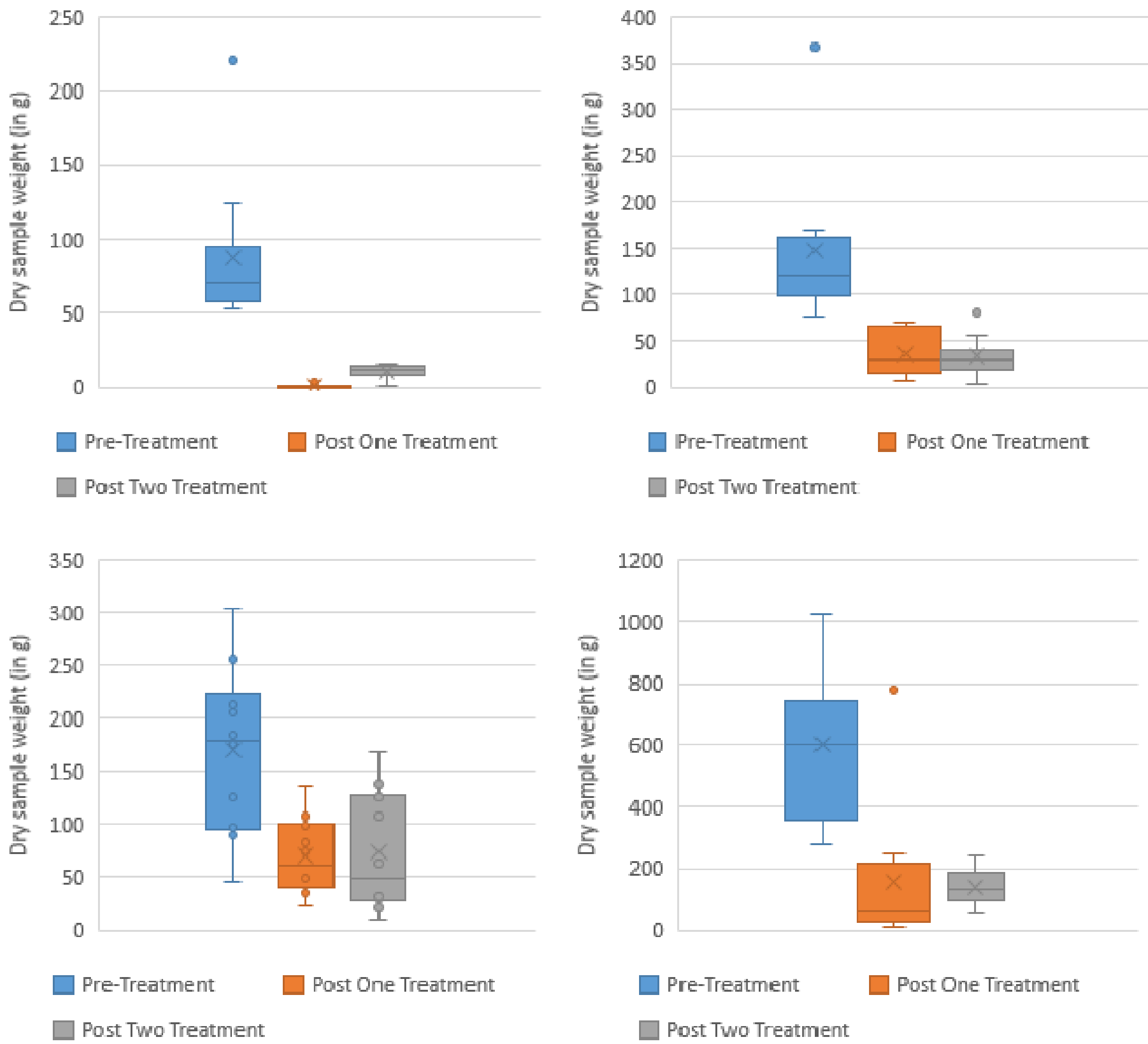


**Figure 6:** Summary of the average dry sample weight (in) in plots 1, 13, 16, and 18. In these plots, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment.

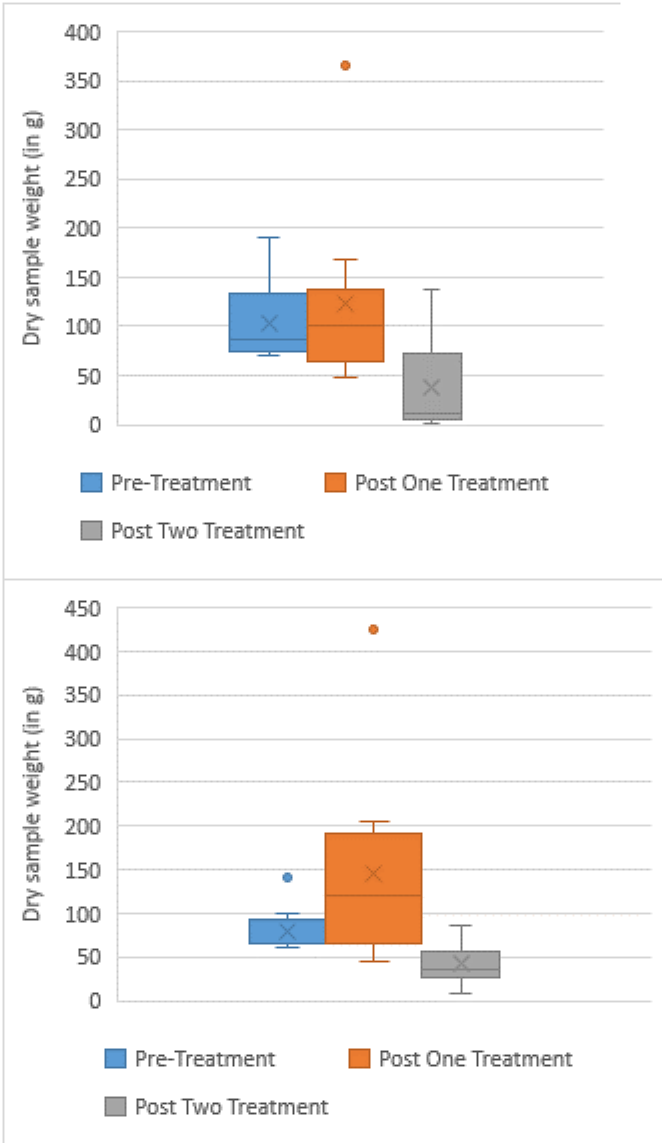


**Figure 7:** Summary of the average dry sample weight (in g) in plots 9 and 10 located in Johnson Bay. In plots 9 and 10, Post 1 treatment and Post 2 treatment were statistically different. Plot 9 was one of the four control plots while plot 10 received Treatment 3 (Cutrine Ultra and Hydrothol).

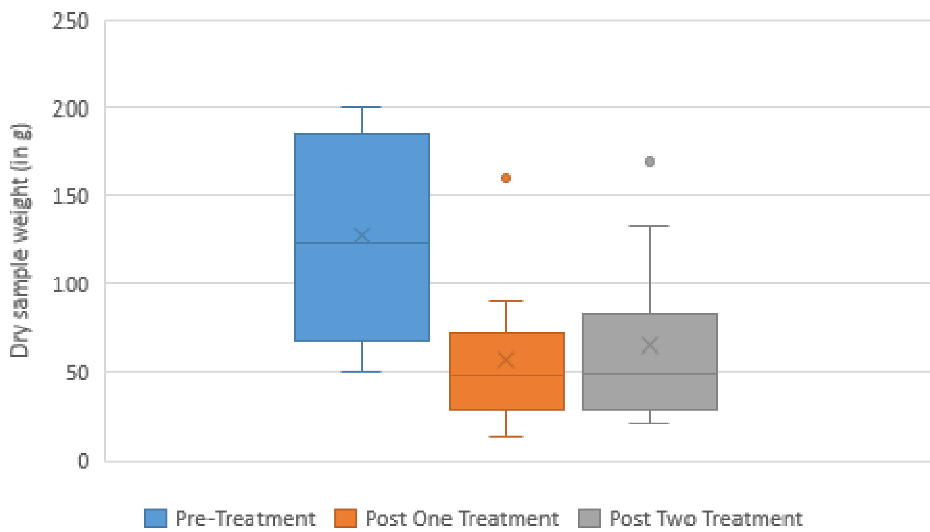


**Figure 8:** Summary of the average dry sample weight (in g) in plot 12 located in Johnson Bay. In plot 12, pre-treatment and Post 1 treatment were statistically different. Plot 12 was one of the four control plots.

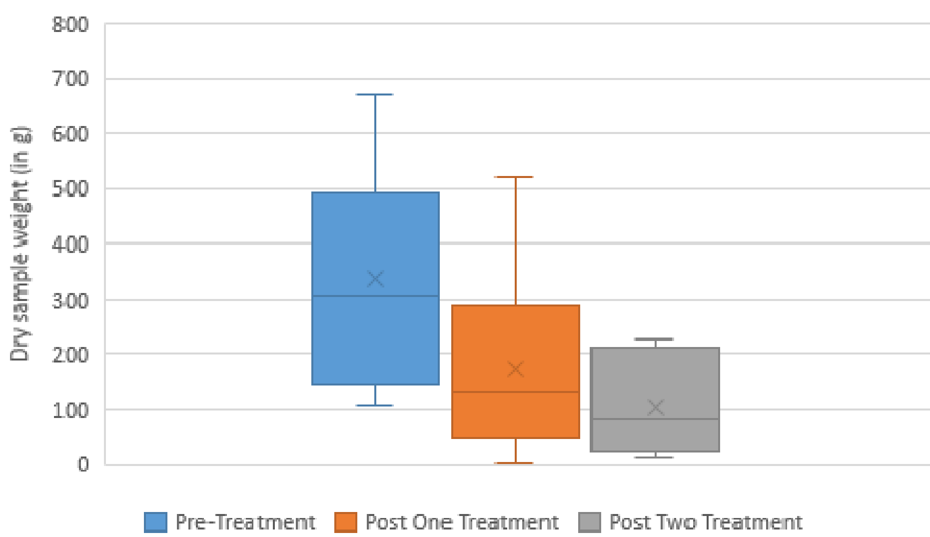


**Figure 9:** Summary of the average dry sample weight (in g) in plot 15 located in a channel just outside of Conklin Bay near Oakwood Resort. In plot 15, pre-treatment was statistically different from Post 2 treatment. Plot 15 received Treatment 3 (Cutrine Ultra and Hydrothol).

## *Discussion*

### Treatment assessment

Regardless of mixed results in how each treatment managed the growth of starry stonewort, each treatment showed an ability to reduce existing starry stonewort populations. Treatment 1 (Clearigate) was shown to reduce the average dry sample weight after one application in plots 13 and 17 and shown to reduce the average dry sample weight after two applications in plots 2 and 13 (Table 6). Overall, Treatment 1 reduced the average dry sample weight in three out of four plots (2, 13, and 17) in which it was used. It is important to note that in plot 13, pre-treatment was statistically different than both Post 1 treatment and Post 2 treatment (Figure 10). Therefore, Treatment 1 appeared to effectively decrease the starry stonewort populations in plot 13 after the first application but not after the second application.

**Table 6:** A breakdown of the plots that received Treatment 1 (Clearigate) and how the average dry weight sample (in g) changed after one application of treatment and after two applications of treatment. The standard deviation for each average dry weight sample is presented in parenthesis. Overall, Treatment 1 reduced the average dry sample weight in three out of four plots (2, 13, and 17) in which it was used.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment |
|---|---|---|---|
| 2 | 330.9 (243.2) | 361.9 (166.3) | 277.7 (173.8) |
| 6 | 337.4 (269.1) | 306.1 (92.7) | 402.9 (416.6) |
| 13 | 148.3 (83.0) | 35.8 (24.6) | 32.7 (21.5) |
| 17 | 87.4 (65.2) | 45.1 (51.7) | 59.6 (65.1) |

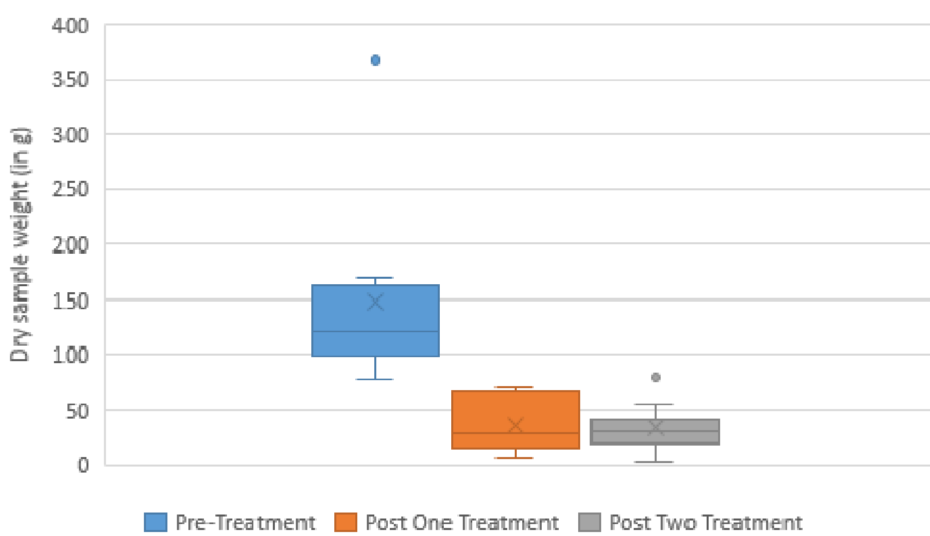


**Figure 10:** Summary of the average dry sample weight (in g) in plot 13 located in Johnson Bay. In plot 13, pre-treatment was statistically different than both Post 1 treatment and Post 2 treatment.

Treatment 2 (Algimycin PWF and Clipper) was shown to reduce the average dry sample weight after one application in plots 1, 7, and 16 and shown to reduce the average dry sample weight after two applications in plots 7 and 11 (Table 7). Overall, Treatment 2 reduced the average dry sample weight in all four plots (1, 7, 11, and 16) in which it was used. It is important to note that in plot 1, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment (Figure 11). This signifies that Treatment 2 appeared to significantly decrease starry stonewort populations in plot 1 after the first application but not after the second application.

**Table 7:** A breakdown of the plots that received Treatment 2 (Algimycin PWF and Clipper) and how the average dry weight sample (in g) changed after one application of treatment and after two applications of treatment. The standard deviation for each average dry weight sample is presented in parenthesis. Overall, Treatment 2 reduced the average dry sample weight in all four plots in which it was used.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment |
|---:|---:|---:|---:|
| 1 | 87.3 (51.3) | 0.8 (1.8) | 10.7 (4.4) |
| 7 | 710.2 (618.6) | 507.2 (212.9) | 304.8 (187.5) |
| 11 | 77.5 (38.7) | 79.4 (44.0) | 75.7 (114.3) |
| 16 | 169.7 (80.1) | 69.7 (35.9) | 73.1 (56.7) |

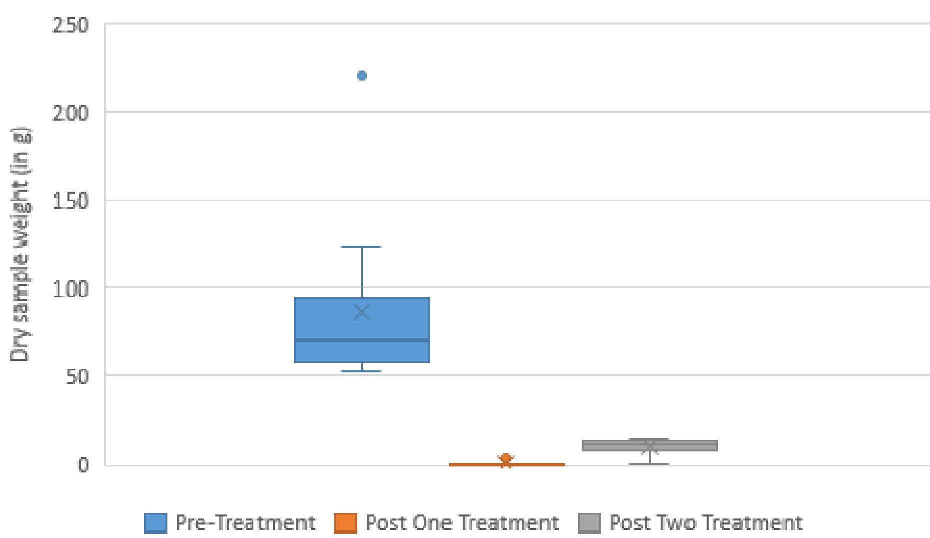


**Figure 11:** Summary of the average dry sample weight (in g) in plot 1 located in Conklin Bay. In plot 1, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment.

Treatment 3 (Cutrine Ultra and Hydrothol) was shown to reduce the average dry sample weight after one application in plots 0 and 15 and shown to reduce the average dry sample weight after two applications in all four plots (0, 8, 10 and 15) in which it was used (Table 8). Overall, Treatment 3 reduced the average dry sample weight from pre-treatment to Post 2 treatment in three of the four plots (0, 10, 15) in which it was used. Treatment 3 was the only treatment used in which statistical differences between pre-treatment, Post 1 treatment, and Post 2 treatment (plot 0) were observed. Therefore, plot 0 showed significant decreases in average dry sample weight after the first and second applications were used (Figure 5).

**Table 8:** A breakdown of the plots that received Treatment 3 (Cutrine Ultra and Hydrothol) and how the average dry weight sample (in g) changed after one application of treatment and after two applications of treatment. The standard deviation for each average dry weight sample is presented in parenthesis. Overall, Treatment 3 reduced the average dry sample weight in three of the four plots in which it was used.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment |
|---|---|---|---|
| 0 | 110.5 (40.6) | 55.7 (51.4) | 5.7 (7.8) |
| 8 | 108.6 (23.3) | 183.6 (157.7) | 182.8 (124.0) |
| 10 | 79.7 (25.2) | 144.9 (111.2) | 41.3 (22.4) |
| 15 | 337.3 (197.7) | 174.0 (161.3) | 105.0 (88.1) |

**Location assessment**

The sampling results indicated that the treatments used for each location in Lake Wawasee had mixed results.  Despite mixed results, there were no statistical differences between sampling performed at pre-treatment and Post 2 treatment time periods for the control plots in Conklin Bay and Johnson Bay, so more robust conclusions can be drawn from these test plots. Because plot 0 showed a statistical difference between pre-treatment, Post 1 treatment, and Post 2 treatment, Treatment 3 was proven to be effective in the more sheltered and isolated Conklin Bay (Figure 5). In plot 1, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment which highlights that Treatment 2 was initially effective after the first application in Conklin Bay (Figure 11).

In the larger and deeper Johnson Bay, plots 9 and 12 served as the control plots while Treatment 3 was used in plots 8 and 10. Both plots 8 and 10 showed increased average dry sample weight after one application and then both showed a decrease after two applications (Table 9). Because the average dry sample weight in control plot 9 did not change significantly and the average dry sample weight in control plot 12 actually decreased, it can be concluded that Treatment 3 was as ineffective as no treatment at all. The same could be said for Treatment 2 in that the average dry sample weight in plot 11 where it was used did not change significantly. This trend is reflected in the control plots 9 and 12 and it can be concluded that Treatment 2 was potentially worse than no treatment at all. Treatment 1 on the other hand, was shown to have a more favorable impact in plot 13. There was a statistical difference between the pre-treatment and Post 1 treatment and Post 2 treatment (Figure 10). Therefore, Treatment 1 was proven effective in Johnson Bay after the first application but was not effective after the second application.

**Table 9:** A breakdown of the plots in Johnson Bay and how the average dry weight sample (in g) changed after one application of treatment and after two applications of treatment.

| Plot | Pre-Treatment | Post 1 Treatment | Post 2 Treatment | Treatment type |
|---|---|---|---|---|
| 8 | 108.6 | 183.6 | 182.8 | T3 |
| 9 | 103.5 | 123.3 | 38.5 | C |
| 10 | 79.7 | 144.9 | 41.3 | T3 |
| 11 | 77.5 | 79.4 | 75.7 | T2 |
| 12 | 127.7 | 57.0 | 64.9 | C |
| 13 | 148.3 | 35.8 | 32.7 | T1 |

The results for Griffith's Marina and the channel plots were proven to be inconclusive. Even though plot 6 showed decreases in the average dry sample weight after the first application and plot 7 showed decreases in the average dry sample weight after the first and second applications, they were not statistically different and there was no control plot with which to compare the two plots (Table 5). The control plot for the channels (plot 18) actually showed a decline in the average dry sample weight after both plot samplings. This decline after the first application in plot 7 was actually statistically different which indicated that the treatments may have been ineffective in the channels (Figure 12) since control plot saw a more pronounced starry stonewort decrease than any of the treatment plots.

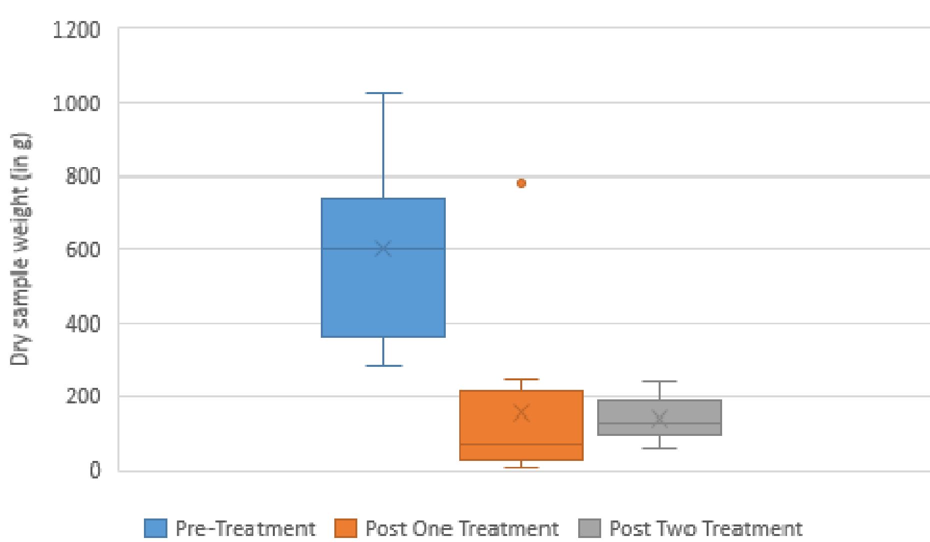


**Figure 12:** Summary of the average dry sample weight (in g) in plot 18 located in a channel just off the main channel between Lake Wawasee and Syracuse Lake past the bridge for East Pickwick Road. In plot 18, pre-treatment was statistically different from both Post 1 treatment and Post 2 treatment. Plot 18 was the control plot for the channel plots and actually showed a decline in the average dry sample weight after both times the plot was sampled.

### Confounding factors

There were several confounding factors that should be considered when reviewing these mixed results. One of the factors was that the quick decrease of each treatment's chemical concentration likely negatively impacted the treatment's effectiveness in treating starry stonewort. The chemical concentration may have decreased too quickly in the lake water below effective levels to maximize control of the starry stonewort. This quick decrease was measured in the copper samples taken by researchers after each application of treatments. Other than plot 15 after the first application and second application, and plot 16 after the second application, copper residues were below detection limits after just six hours. Both of these plots were in channels which would limit the dilution of chemical concentrations more than open lake locations. This is likely due to two influences: water movement and copper uptake related to plant biomass. Because there is more water movement within the lake than can be accounted for, treatments can be rapidly moved off-site before they have a chance to be effective. This influence would have specifically affected any plot that received Treatment 2 (Algimycin PWF and Clipper) because Clipper's effectiveness is maximized when it is used in quiescent or slow-moving bodies of water.

The other influence involved is that increased starry stonewort biomass within the plot can cause the treatment chemical to be taken out of the water more quickly and, therefore, decrease the amount of time the treatment has in the water to be effective. The amount of biomass surrounding the plot on the outside can also influence the effectiveness of the treatments. If a plot was placed in the middle of a large, dense, bed of starry stonewort, the copper would also be pulled out of the plot by plants growing along the edge. This can impact how we interpret results, specifically within Conklin Bay. In plot 2, it can be seen that the average dry sample weight increased slightly after the first application before decreasing slightly after the second application (Table 2; Table 3). Overall, it appears that Treatment 1 (Clearigate) did not significantly impact starry stonewort after either application in plot 2. But when the average dry sample weight for plot 2 is compared to plots 0 and 1 where Treatments 3 (Cutrine Ultra and Hydrothol) and 2 (Algimycin PWF and Clipper) were used, respectively, plot 2 had three times the pre-treatment average dry sample weight of plots 0 and 1 (Table 2: Table 3). Because plot 2 had more plant biomass, it can be hypothesized that Treatment 1 was taken up too quickly and would not be as effective compared to treatments two and three.

Another aspect that would have likely impacted the effectiveness of each treatment was related to pH levels. Clipper (Treatment 2) is more effective when it is applied to plants in water with a pH of less than 8.5. While pH levels over 8.5 were not found in plots where Clipper was used, the pH levels were very close to 8.5 during the first application which might have decreased Clipper's effectiveness.

Another factor that would have likely impacted the results was treatment application timing. Timing of the first application was delayed due to the fact that a reconnaissance trip in Lake Wawasee during the last week of May yielded little or no collection of starry stonewort. However, pre-treatment data collected during the third full week of June revealed that starry stonewort biomass was very high with an average dry density in all plots of 2147 $g/m^2$. This is a large amount of biomass to attempt to treat and control. Timing for the first application was chosen so treatments were not wasted in plots where starry stonewort biomass had not been given time to develop and grow. However, by waiting to give time for starry stonewort to grow and develop, the large amount of biomass might have made it more difficult for treatments to be effective. For future research and planning, the process of finding an optimal timing to perform the first treatment may be as important as the herbicides chosen.

Along with treatment application timing, the time of year might have affected starry stonewort growth which directly affects treatment uptake. If plants are not actively growing they will not absorb the treatments from the water at increased rates. It can be hypothesized that by treating late into the summer season in the month of August, the starry stonewort had begun to senesce and did not take up the treatments like it would have at times of normal growth. The senescence hypothesis is supported by the fact that three of the four control plots also decreased in biomass at rates similar to the treated plots. The Minnesota DNR experienced similar results in 2015 when they conducted a starry stonewort inspection and assessment report in Lake Koronis (Jurek and Millaway, 2015). This project took place in the fall when the Minnesota DNR attempted to treat Lake Koronis which suggests that the period of late summer to fall is too late to try to treat starry stonewort. Unfortunately, the senescence of starry stonewort can be caused by environmental factors and thus, is hard to predict and take into account.

Another factor that may have influenced results was the utilization of the spinning rake method for sample collection. Because of starry stonewort's growth pattern of dense, thick mats along the bottom of the lake, researchers could have been pulling up starry stonewort outside of the plot boundaries. Future research should consider using quadrants and collecting samples by diving.

## ***Conclusion***

The purpose of this study was to evaluate the effectiveness of three different types of treatments used to reduce starry stonewort abundance. While the results for overall effectiveness of each treatment were confounded by several factors, researchers learned that certain treatments were more effective in different locations and in different application amounts in regard to reducing starry stonewort abundance. This research suggests early treatment of starry stonewort as it begins to actively grow but before it reaches large biomass levels is likely critical to management success. Furthermore, the research indicates that follow-up applications can be effective during active growth and moderate biomass levels. This research may also show more effectiveness of Treatment 2 (Algimycin PWF and Clipper) and Treatment 3 (Cutrine Ultra and Hydrothol) in more sheltered and shallow lake areas while Treatment 1 (Clearigate) might be most effective in more open or deeper lake areas.

This current research suggests several improvements in potential future related research. More test plots to allow more replication of treatments and control plots with various lake conditions would be helpful. Timing of treatments could be optimized based on insights gained from the current research study. Staggering treatments over multiple days would allow analysis of copper residuals at smaller time intervals to better understand the dilution effect on treatment effectiveness.

By studying each treatment and its effect on starry stonewort abundance, this data along with information from future related research can better guide lake associations, contracted applicators, and government agencies as to the most effective options for management of starry stonewort. Better management of starry stonewort could go a long way to mitigating and even drastically reducing the spread of this invasive species.

## *Acknowledgements*

We wish to thank the Indiana Department of Natural Resources Lake and River Enhancement program and the Wawasee Property Owners Association for their project initiation, financial support, and data interpretation insights for this project. Furthermore, we thank Doug Keller, Rod Edgell, and Eric Fischer from the Indiana Department of Natural Resources for their careful review of this report. We thank Ryan Wersal from Lonza for providing analysis of copper residuals. We thank Kris Farwell from Grace College for statistical analysis efforts. We also thank Jim Donahoe and Dave Keister from Aquatic Weed Control for their expertise in study design and study treatment applications. Research assistants who helped gather data crucial for this project included Aaron Voirol, Ryan Duckworth, Will Lorenz, and Seth Bingham.

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## *Appendix*

See below for water samples and water chemistry measurements taken for each plot after treatments. Also included below is Tier 2 survey data provided by Aquatic Weed Control. Visit http://www.in.gov/dnr/fishwild/files/fw-LARE_Tier_II_Procedure_Manual.pdf for sampling guidelines related to Tier 2 survey data.

**Site 0 - Lat Long 41.40632  -85.73905**

| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
|---|---|---|---|---|---|---|---|---|---|
| 6/27/16 | 1:40 PM | 600001 | 0.7 | 27.58 | 0.324 | 9.95 | 8.41 | 125.2 | 0.18 |
| 6/27/16 | 1:48 PM | 600002 | 0.7 | 27.62 | 0.322 | 10.48 | 8.40 | 131.6 | 0.21 |
| 6/27/16 | 1:52 PM | 600003 | 0.3 | 27.97 | 0.322 | 10.36 | 8.42 | 132.5 | 0.12 |
| 6/27/16 | 6:52 PM | 600061 | 0.8 | 28.04 | 0.321 | 10.20 | 8.42 | 130.0 | <0.1 |
| 6/27/16 | 6:54 PM | 600062 | 0.9 | 27.84 | 0.326 | 9.92 | 8.40 | 124.7 | <0.1 |
| 6/27/16 | 6:56 PM | 600063 | 0.8 | 28.02 | 0.326 | 10.24 | 8.42 | 130.8 | <0.1 |
| 6/28/16 | 2:21 PM | 600241 | 0.8 | 25.62 | 0.327 | 9.78 | 8.36 | 119.7 | <0.1 |
| 6/28/16 | 2:23 PM | 600242 | 1.0 | 25.55 | 0.331 | 9.59 | 8.31 | 116.2 | <0.1 |
| 6/28/16 | 2:25 PM | 600243 | 1.0 | 25.53 | 0.327 | 9.54 | 8.31 | 110.8 | <0.1 |
| 6/29/16 | 1:06 PM | 600481 | 0.7 | 24.65 | 0.333 | 8.32 | 8.21 | 99.5 | <0.1 |
| 6/29/16 | 1:09 PM | 600482 | 1.0 | 24.65 | 0.335 | 8.57 | 8.17 | 99.2 | <0.1 |
| 6/29/16 | 1:11 PM | 600483 | 0.9 | 24.56 | 0.337 | 9.15 | 8.24 | 106.9 | <0.1 |
| 7/1/16 | 11:03 AM | 600961 | 0.7 | 24.51 | 0.336 | 9.63 | 8.20 | 112.9 | <0.1 |
| 7/1/16 | 11:05 AM | 600962 | 0.8 | 24.58 | 0.335 | 8.51 | 8.24 | 104.7 | <0.1 |
| 7/1/16 | 11:06 AM | 600963 | 0.9 | 24.61 | 0.335 | 8.73 | 8.28 | 101.4 | <0.1 |

| Site 1 - Lat Long 41.40672 -85.73755 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 1:04 PM | 601001 | 0.6 | 26.96 | 0.329 | 9.23 | 8.17 | 115.4 | 0.70 |
| 6/27/16 | 1:07 PM | 601002 | 1.0 | 26.58 | 0.331 | 9.06 | 8.31 | 112.3 | 0.23 |
| 6/27/16 | 1:09 PM | 601002 | 0.6 | 26.98 | 0.330 | 10.05 | 8.28 | 124.7 | 0.36 |
| 6/27/16 | 6:44 PM | 601061 | 1.0 | 27.73 | 0.326 | 10.24 | 8.42 | 130.1 | <0.1 |
| 6/27/16 | 6:46 PM | 601062 | 0.8 | 28.05 | 0.324 | 9.97 | 8.39 | 127.1 | <0.1 |
| 6/27/16 | 6:48 PM | 601063 | 1.0 | 27.69 | 0.325 | 10.07 | 8.44 | 127.5 | <0.1 |
| 6/28/16 | 2:11 PM | 601241 | 1.1 | 25.44 | 0.329 | 8.63 | 8.27 | 105.5 | <0.1 |
| 6/28/16 | 2:13 PM | 601242 | 1.2 | 25.45 | 0.328 | 8.95 | 8.28 | 108.5 | <0.1 |
| 6/28/16 | 2:16 PM | 601243 | 0.8 | 25.36 | 0.329 | 9.05 | 8.29 | 109.3 | <0.1 |
| 6/29/16 | 1:17 PM | 601481 | 1.0 | 24.97 | 0.332 | 8.54 | 8.23 | 103.3 | <0.1 |
| 6/29/16 | 1:19 PM | 601482 | 0.9 | 25.03 | 0.334 | 8.46 | 8.18 | 100.6 | <0.1 |
| 6/29/16 | 1:20 PM | 601483 | 1.0 | 24.94 | 0.334 | 8.27 | 8.19 | 99.8 | <0.1 |
| 7/1/16 | 10:56 AM | 601961 | 0.9 | 24.47 | 0.338 | 8.91 | 8.21 | 104.3 | <0.1 |
| 7/1/16 | 10:57 AM | 601962 | 0.7 | 24.54 | 0.335 | 8.21 | 8.22 | 103.2 | <0.1 |
| 7/1/16 | 11:00 AM | 601963 | 0.6 | 24.37 | 0.332 | 8.81 | 8.22 | 102.2 | <0.1 |

| Site 2 - Lat Long 41.40556 -85.74034 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 1:56 PM | 602001 | 0.6 | 27.81 | 0.325 | 9.41 | 8.32 | 118.2 | <0.1 |
| 6/27/16 | 1:59 PM | 602002 | 1.0 | 27.43 | 0.324 | 8.95 | 8.30 | 115.1 | <0.1 |
| 6/27/16 | 2:01 PM | 602003 | 0.8 | 27.56 | 0.323 | 9.25 | 8.30 | 117.7 | <0.1 |
| 6/27/16 | 6:59 PM | 602061 | 0.3 | 28.21 | 0.320 | 10.87 | 8.55 | 140.3 | <0.1 |
| 6/27/16 | 7:01 PM | 602062 | 0.8 | 27.92 | 0.322 | 9.38 | 8.43 | 125.6 | <0.1 |
| 6/27/16 | 7:03 PM | 602063 | 0.9 | 27.75 | 0.325 | 10.08 | 8.13 | 127.6 | <0.1 |
| 6/28/16 | 2:32 PM | 602241 | 1.1 | 25.71 | 0.326 | 9.75 | 8.35 | 116.9 | <0.1 |
| 6/28/16 | 2:34 PM | 602243 | 0.9 | 25.61 | 0.328 | 9.49 | 8.34 | 116.9 | <0.1 |
| 6/28/16 | 2:36 PM | 602243 | 1.0 | 25.78 | 0.326 | 9.61 | 8.33 | 116.1 | <0.1 |
| 6/29/16 | 1:24 PM | 602481 | 0.8 | 25.22 | 0.335 | 9.18 | 8.25 | 112.8 | <0.1 |
| 6/29/16 | 1:26 PM | 602482 | 0.8 | 25.10 | 0.324 | 11.32 | 8.47 | 139.0 | <0.1 |
| 6/29/16 | 1:27 PM | 602483 | 1.3 | 24.92 | 0.321 | 12.90 | 8.52 | 156.7 | <0.1 |
| 7/1/16 | 11:09 AM | 602961 | 0.7 | 24.54 | 0.335 | 8.65 | 8.25 | 98.5 | <0.1 |
| 7/1/16 | 11:10 AM | 602962 | 0.9 | 24.62 | 0.330 | 9.27 | 8.27 | 111.4 | <0.1 |
| 7/1/16 | 11:13 AM | 602963 | 1.2 | 24.63 | 0.331 | 8.37 | 8.26 | 97.8 | <0.1 |

| Site 3 - Lat Long 41.40560 -85.74223 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 2:06 PM | 603001 | 1.3 | 26.67 | 0.326 | 8.91 | 8.24 | 110.6 | <0.1 |
| 6/27/16 | 2:09 PM | 603002 | 1.0 | 26.72 | 0.325 | 9.65 | 8.29 | 118.1 | <0.1 |
| 6/27/16 | 2:13 PM | 603003 | 2.0 | 26.39 | 0.321 | 9.28 | 8.24 | 116.5 | <0.1 |
| 6/27/16 | 7:06 PM | 603061 | 1.2 | 27.77 | 0.325 | 9.97 | 8.40 | 125.3 | <0.1 |
| 6/27/16 | 7:08 PM | 603062 | 1.0 | 27.87 | 0.327 | 9.88 | 8.37 | 124.5 | <0.1 |
| 6/27/16 | 7:10 PM | 603063 | 1.1 | 27.40 | 0.329 | 9.79 | 8.35 | 122.7 | <0.1 |
| 6/28/16 | 2:39 PM | 603241 | 1.5 | 25.80 | 0.326 | 9.26 | 8.23 | 108.9 | <0.1 |
| 6/28/16 | 2:41 PM | 603242 | 2.0 | 25.50 | 0.333 | 8.94 | 8.20 | 110.0 | <0.1 |
| 6/28/16 | 2:43 PM | 603243 | 1.2 | 25.83 | 0.326 | 9.51 | 8.27 | 116.7 | <0.1 |
| 6/29/16 | 1:30 PM | 603481 | 1.5 | 24.49 | 0.333 | 8.87 | 8.10 | 104.1 | <0.1 |
| 6/29/16 | 1:31 PM | 603482 | 1.5 | 24.48 | 0.326 | 10.53 | 8.35 | 125.7 | <0.1 |
| 6/29/16 | | 603483 | | 24.65 | 0.336 | 8.82 | 8.13 | 99.5 | <0.1 |
| 7/1/16 | 11:16 AM | 603961 | 1.2 | 24.54 | 0.326 | 9.96 | 8.25 | 113.8 | <0.1 |
| 7/1/16 | 11:18 AM | 603962 | 2.0 | 24.50 | 0.329 | 8.95 | 8.21 | 103.8 | <0.1 |
| 7/1/16 | 11:19 AM | 603963 | 2.1 | 24.49 | 0.329 | 9.12 | 8.23 | 109.2 | <0.1 |

| **Site 6 - Lat Long 41.38584 -85.67131** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 4:30 PM | 606001 | 1.6 | 26.43 | 0.381 | 5.43 | 7.66 | 61.7 | <0.1 |
| 6/27/16 | 4:33 PM | 606002 | 1.0 | 27.42 | 0.377 | 8.94 | 7.99 | 111.0 | 0.27 |
| 6/27/16 | 4:35 PM | 606003 | 0.4 | 28.47 | 0.369 | 10.40 | 8.20 | 133.6 | 0.24 |
| 6/27/16 | 8:26 PM | 606061 | 1.3 | 27.14 | 0.374 | 8.18 | 8.07 | 99.7 | <0.1 |
| 6/27/16 | 8:30 PM | 606062 | 1.6 | 26.50 | 0.380 | 6.67 | 7.62 | 73.2 | <0.1 |
| 6/27/16 | 8:32 PM | 606063 | 0.4 | 27.81 | 0.378 | 10.22 | 8.30 | 130.1 | <0.1 |
| 6/28/16 | 3:48 PM | 606241 | 2.2 | 25.30 | 0.391 | 3.86 | 7.46 | 42.4 | <0.1 |
| 6/28/16 | 3:51 PM | 606243 | 0.4 | 25.87 | 0.372 | 6.63 | 7.77 | 81.1 | <0.1 |
| 6/28/16 | 3:53 PM | 606243 | 1.4 | 25.65 | 0.373 | 6.83 | 7.86 | 89.8 | <0.1 |
| 6/29/16 | 2:43 PM | 606481 | 1.4 | 24.20 | 0.381 | 7.44 | 7.88 | 88.1 | <0.1 |
| 6/29/16 | 2:44 PM | 606482 | 2.1 | 23.51 | 0.391 | 3.63 | 7.43 | 37.5 | <0.1 |
| 6/29/16 | 2:46 PM | 606483 | 1.2 | 24.35 | 0.378 | 7.12 | 8.01 | 87.1 | <0.1 |
| 7/1/16 | 2:06 PM | 606961 | 1.6 | 24.51 | 0.382 | 6.88 | 7.65 | 74.4 | <0.1 |
| 7/1/16 | 2:08 PM | 606962 | 1.3 | 24.55 | 0.382 | 6.62 | 8.05 | 82.3 | <0.1 |
| 7/1/16 | 2:09 PM | 606963 | 2.0 | 24.63 | 0.382 | 7.56 | 7.66 | 78.0 | <0.1 |

| Site 7 - Lat Long 41.38475 -85.67086 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 4:42 PM | 607001 | 0.8 | 27.89 | 0.372 | 10.37 | 8.32 | 140.9 | 0.14 |
| 6/27/06 | | 607002 | 1.0 | 27.37 | 0.378 | 9.63 | 8.27 | 121.5 | <0.1 |
| 6/27/16 | | 607003 | 0.5 | 28.03 | 0.373 | 11.45 | 8.34 | 144.5 | <0.1 |
| 6/27/16 | 8:34 PM | 607061 | 1.0 | 27.41 | 0.381 | 9.44 | 8.24 | 118.2 | <0.1 |
| 6/27/16 | 8:36 PM | 607062 | 1.0 | 27.42 | 0.382 | 9.30 | 8.27 | 117.9 | <0.1 |
| 6/27/16 | 8:40 PM | 607063 | 0.7 | 27.44 | 0.381 | 9.52 | 8.27 | 119.6 | <0.1 |
| 6/28/16 | 3:55 PM | 607241 | 0.6 | 25.50 | 0.387 | 11.79 | 8.13 | 140.0 | <0.1 |
| 6/28/16 | 3:56 PM | 607242 | 0.5 | 25.47 | 0.389 | 11.42 | 8.13 | 142.9 | <0.1 |
| 6/28/16 | 3:58 PM | 607243 | 1.6 | 25.41 | 0.405 | 8.60 | 7.99 | 95.5 | <0.1 |
| 6/29/16 | 2:50 PM | 607481 | 0.9 | 24.97 | 0.390 | 8.95 | 8.24 | 108.5 | <0.1 |
| 6/29/16 | 2:51 PM | 607482 | 0.9 | 24.83 | 0.391 | 9.03 | 8.16 | 108.0 | <0.1 |
| 6/29/16 | 2:53 PM | 607483 | 0.9 | 24.96 | 0.394 | 8.18 | 8.14 | 96.8 | <0.1 |
| 7/1/16 | 2:12 PM | 607961 | 0.8 | 24.78 | 0.393 | 9.95 | 8.34 | 122.0 | <0.1 |
| 7/1/16 | 2:14 PM | 607962 | 0.5 | 24.69 | 0.394 | 8.47 | 8.25 | 97.4 | <0.1 |
| 7/1/16 | 2:16 PM | 607963 | 1.1 | 24.62 | 0.395 | 9.19 | 8.33 | 112.2 | <0.1 |

| Site 8 - Lat Long 41.40469 -85.68794 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 2:37 PM | 608001 | 1.0 | 27.45 | 0.338 | 9.17 | 8.47 | 116.1 | 0.64 |
| 6/27/16 | 2:40 PM | 608002 | 0.7 | 27.39 | 0.340 | 9.65 | 8.55 | 122.0 | 0.29 |
| 6/27/16 | 2:43 PM | 608003 | 1.0 | 27.08 | 0.339 | 9.78 | 8.48 | 122.3 | 0.64 |
| 6/27/16 | 7:24 PM | 608061 | 1.0 | 27.71 | 0.340 | 9.28 | 8.44 | 117.2 | 0.10 |
| 6/27/16 | 7:26 PM | 608062 | 1.0 | 27.95 | 0.337 | 8.36 | 8.45 | 112.3 | <0.1 |
| 6/27/16 | 7:29 PM | 608063 | 1.7 | 27.10 | 0.338 | 9.56 | 8.45 | 120.7 | <0.1 |
| 6/28/16 | 2:56 PM | 608241 | 1.0 | 25.17 | 0.343 | 8.84 | 8.35 | 105.7 | <0.1 |
| 6/28/16 | 2:57 PM | 608242 | 1.6 | 25.38 | 0.342 | 8.77 | 8.36 | 106.3 | <0.1 |
| 6/28/16 | 2:59 PM | 608243 | 1.3 | 25.52 | 0.341 | 9.54 | 8.36 | 114.1 | <0.1 |
| 6/29/16 | 1:48 PM | 608481 | 1.1 | 25.29 | 0.346 | 8.52 | 8.34 | 103.5 | <0.1 |
| 6/29/16 | 1:50 PM | 608482 | 1.8 | 25.01 | 0.343 | 8.78 | 8.46 | 107.8 | <0.1 |
| 6/29/16 | 1:51 PM | 608483 | 2.1 | 24.79 | 0.342 | 10.61 | 8.42 | 126.6 | <0.1 |
| 7/1/16 | 1:04 PM | 608961 | 0.8 | 24.96 | 0.347 | 8.74 | 8.36 | 104.2 | <0.1 |
| 7/1/16 | 1:06 PM | 608962 | 0.9 | 24.99 | 0.342 | 8.46 | 8.37 | 102.2 | <0.1 |
| 7/1/16 | 1:07 PM | 608963 | 0.9 | 24.99 | 0.342 | 8.61 | 8.36 | 102.0 | <0.1 |

| Site 9 - Lat Long 41.40773 -85.68891 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 2:50 PM | 609001 | 2.4 | 26.22 | 0.340 | 8.65 | 8.38 | 106.4 | <0.1 |
| 6/27/12 | 2:55 PM | 609002 | 1.2 | 26.48 | 0.339 | 9.00 | 8.42 | 110.6 | <0.1 |
| 6/27/16 | 2:58 PM | 609003 | 2.2 | 26.33 | 0.343 | 8.66 | 8.40 | 106.7 | <0.1 |
| 6/27/16 | 7:37 PM | 609061 | 1.3 | 27.05 | 0.341 | 9.44 | 8.47 | 118.7 | <0.1 |
| 6/27/16 | 7:39 PM | 609062 | 0.6 | 27.15 | 0.335 | 9.94 | 8.51 | 124.8 | <0.1 |
| 6/27/16 | 7:43 PM | 609063 | 0.5 | 27.11 | 0.337 | 9.23 | 8.48 | 117.1 | <0.1 |
| 6/28/16 | 3:04 PM | 609241 | 1.0 | 25.49 | 0.343 | 8.71 | 8.36 | 105.3 | <0.1 |
| 6/28/16 | 3:05 PM | 609242 | 0.6 | 25.49 | 0.342 | 9.15 | 8.35 | 109.7 | <0.1 |
| 6/28/16 | 3:07 PM | 609243 | 0.7 | 25.50 | 0.338 | 9.24 | 8.38 | 109.3 | <0.1 |
| 6/29/16 | 1:57 PM | 609481 | 1.2 | 24.95 | 0.351 | 9.23 | 8.43 | 110.9 | <0.1 |
| 6/29/16 | 1:59 PM | 609482 | 0.8 | 25.10 | 0.346 | 9.54 | 8.42 | 113.9 | <0.1 |
| 6/29/16 | 2:00 PM | 609483 | 0.8 | 25.23 | 0.346 | 9.17 | 8.40 | 111.8 | <0.1 |
| 7/1/16 | 1:13 PM | 609961 | 2.1 | 25.00 | 0.346 | 7.48 | 8.37 | 90.3 | <0.1 |
| 7/1/16 | 1:16 PM | 609962 | 2.2 | 24.76 | 0.344 | 7.74 | 8.31 | 90.2 | <0.1 |
| 7/1/16 | | 609963 | 1.0 | 25.07 | 0.345 | 8.60 | 8.36 | 103.1 | <0.1 |

| Site 10 - Lat Long 41.40970 -85.68776 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 3:07 PM | 610001 | 1.8 | 26.85 | 0.339 | 8.86 | 8.51 | 112.0 | 0.25 |
| 6/27/16 | 3:10 PM | 610002 | 0.9 | 27.25 | 0.341 | 8.65 | 8.55 | 108.9 | 0.85 |
| 6/27/16 | 3:14 PM | 610003 | 0.9 | 27.12 | 0.339 | 8.78 | 8.56 | 109.9 | 0.6 |
| 6/27/16 | 7:46 PM | 610061 | 0.6 | 27.11 | 0.345 | 8.76 | 8.43 | 111.2 | <0.1 |
| 6/27/16 | 7:50 PM | 610062 | 0.5 | 26.69 | 0.340 | 9.07 | 8.42 | 112.6 | <0.1 |
| 6/27/16 | 7:52 PM | 610063 | 0.7 | 26.89 | 0.340 | 9.00 | 8.43 | 112.7 | <0.1 |
| 6/28/16 | 3:10 PM | 610241 | 1.3 | 25.59 | 0.345 | 9.19 | 8.37 | 115.5 | <0.1 |
| 6/28/16 | 3:12 PM | 610242 | 0.6 | 25.65 | 0.342 | 9.29 | 8.40 | 113.6 | <0.1 |
| 6/28/16 | 3:14 PM | 610243 | 0.5 | 25.62 | 0.343 | 9.12 | 8.38 | 109.4 | <0.1 |
| 6/29/16 | 2:03 PM | 610481 | 0.7 | 25.35 | 0.346 | 8.79 | 8.38 | 105.7 | <0.1 |
| 6/29/16 | 2:05 PM | 610482 | 1.0 | 25.26 | 0.350 | 9.17 | 8.37 | 110.3 | <0.1 |
| 6/29/16 | 2:07 PM | 610483 | 1.2 | 25.16 | 0.345 | 8.57 | 8.40 | 107.5 | <0.1 |
| 7/1/16 | 1:25 PM | 610961 | 0.6 | 25.63 | 0.344 | 8.44 | 8.35 | 100.1 | <0.1 |
| 7/1/16 | 1:26 PM | 610962 | 0.6 | 25.57 | 0.344 | 8.07 | 8.36 | 97.5 | <0.1 |
| 7/1/16 | 1:29 PM | 610963 | 0.5 | 25.60 | 0.346 | 8.27 | 8.37 | 101.0 | <0.1 |

| Site 11 - Lat Long 41.41144 -85.68545 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 3:20 PM | 611001 | 1.0 | 27.63 | 0.341 | 9.37 | 8.32 | 118.4 | 0.35 |
| 6/27/16 | 3:22 PM | 611002 | 0.8 | 27.79 | 0.336 | 8.79 | 8.39 | 112.3 | <0.1 |
| 6/27/16 | 3:26 PM | 611003 | 0.8 | 27.90 | 0.338 | 8.78 | 8.33 | 110.4 | <0.1 |
| 6/27/16 | 7:57 PM | 611061 | 1.7 | 25.57 | 0.347 | 8.79 | 8.37 | 105.9 | <0.1 |
| 6/27/16 | 8:00 PM | 611062 | 1.5 | 25.60 | 0.347 | 9.46 | 8.35 | 110.9 | <0.1 |
| 6/27/16 | 8:02 PM | 611063 | 1.2 | 26.62 | 0.340 | 8.37 | 8.29 | 102.9 | <0.1 |
| 6/28/16 | 3:20 PM | 611241 | 1.6 | 24.80 | 0.351 | 9.70 | 8.27 | 113.0 | <0.1 |
| 6/28/16 | 3:21 PM | 611242 | 0.9 | 24.87 | 0.349 | 10.31 | 8.27 | 125.7 | <0.1 |
| 6/28/16 | 3:23 PM | 611243 | 0.9 | 24.92 | 0.351 | 7.96 | 8.28 | 93.3 | <0.1 |
| 6/29/16 | 2:11 PM | 611481 | 1.0 | 25.01 | 0.349 | 8.60 | 8.39 | 104.5 | <0.1 |
| 6/29/16 | 2:14 PM | 611482 | 0.8 | 25.06 | 0.348 | 8.36 | 8.33 | 98.4 | <0.1 |
| 6/29/16 | 2:15 PM | 611483 | 1.2 | 24.93 | 0.350 | 8.81 | 8.36 | 107.2 | <0.1 |
| 7/1/16 | 1:31 PM | 611961 | 1.2 | 24.74 | 0.345 | 8.44 | 8.20 | 103.5 | <0.1 |
| 7/1/16 | 1:33 PM | 611962 | 0.9 | 24.84 | 0.346 | 7.82 | 8.27 | 91.5 | <0.1 |
| 7/1/16 | 1:36 PM | 611963 | 1.6 | 24.62 | 0.350 | 7.87 | 8.25 | 91.5 | <0.1 |

| Site 12 - Lat Long 41.41027 -85.68458 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 3:34 PM | 612001 | 0.6 | 27.99 | 0.342 | 8.15 | 8.30 | 103.4 | <0.1 |
| 6/27/16 | 3:36 PM | 612002 | 0.8 | 28.01 | 0.343 | 8.23 | 8.31 | 104.3 | <0.1 |
| 6/27/16 | 3:39 PM | 612003 | 0.9 | 28.06 | 0.344 | 8.09 | 8.30 | 103.2 | <0.1 |
| 6/27/16 | 8:05 PM | 612061 | 1.0 | 27.17 | 0.340 | 9.30 | 8.47 | 117.0 | <0.1 |
| 6/27/16 | 8:07 PM | 612062 | 0.8 | 27.46 | 0.335 | 9.47 | 8.48 | 119.7 | <0.1 |
| 6/27/16 | 8:10 PM | 612063 | 0.8 | 27.48 | 0.336 | 9.31 | 8.47 | 118.2 | <0.1 |
| 6/28/16 | 3:28 PM | 612241 | 1.2 | 24.89 | 0.344 | 9.16 | 8.34 | 118.9 | <0.1 |
| 6/28/16 | 3:30 PM | 612242 | 1.1 | 24.84 | 0.347 | 9.55 | 8.31 | 110.6 | <0.1 |
| 6/28/16 | 3:32 PM | 612243 | 1.4 | 24.81 | 0.350 | 8.89 | 8.33 | 103.7 | <0.1 |
| 6/29/16 | 2:21 PM | 612481 | 1.1 | 25.32 | 0.346 | 8.71 | 8.35 | 101.8 | <0.1 |
| 6/29/16 | 2:22 PM | 612482 | 1.0 | 25.35 | 0.347 | 8.43 | 8.33 | 100.0 | <0.1 |
| 6/29/16 | 2:23 PM | 612483 | 1.2 | 25.40 | 0.352 | 8.16 | 8.33 | 99.1 | <0.1 |
| 7/1/16 | 1:44 PM | 612961 | 0.9 | 24.71 | 0.342 | 8.99 | 8.27 | 107.7 | <0.1 |
| 7/1/16 | 1:45 PM | 612962 | 0.9 | 29.77 | 0.344 | 8.31 | 8.28 | 97.4 | <0.1 |
| 7/1/16 | 1:47 PM | 612963 | 0.5 | 24.95 | 0.343 | 7.72 | 8.29 | 94.7 | <0.1 |

| Site 13 - Lat Long 41.40917 -85.68408 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 3:50 PM | 613001 | 1.0 | 27.67 | 0.337 | 9.00 | 8.41 | 112.6 | <0.1 |
| 6/27/06 | 3:56 PM | 613002 | 0.8 | 27.62 | 0.337 | 9.29 | 8.46 | 117.7 | <0.1 |
| 6/27/16 | 3:59 PM | 613003 | 0.8 | 27.97 | 0.338 | 8.37 | 8.34 | 106.8 | <0.1 |
| 6/27/16 | 8:13 PM | 613061 | 1.0 | 27.11 | 0.338 | 8.01 | 8.43 | 113.2 | <0.1 |
| 6/27/16 | 8:14 PM | 613062 | 2.0 | 26.49 | 0.347 | 9.02 | 8.42 | 108.3 | <0.1 |
| 6/27/16 | 8:18 PM | 613063 | 1.0 | 27.48 | 0.340 | 9.19 | 8.42 | 115.9 | <0.1 |
| 6/28/16 | 3:35 PM | 613241 | 1.4 | 24.95 | 0.342 | 13.40 | 8.36 | 158.8 | <0.1 |
| 6/28/16 | 3:36 PM | 613242 | 1.0 | 24.94 | 0.348 | 8.99 | 8.37 | 108.7 | <0.1 |
| 6/28/16 | 3:38 PM | 613243 | 0.9 | 24.93 | 0.342 | 11.03 | 8.36 | 128.7 | <0.1 |
| 6/29/16 | 2:27 PM | 613481 | 0.7 | 25.42 | 0.347 | 8.37 | 8.31 | 102.1 | <0.1 |
| 6/29/16 | 2:29 PM | 613482 | 0.9 | 25.40 | 0.347 | 8.77 | 8.36 | 106.2 | <0.1 |
| 6/29/16 | 2:30 PM | 613483 | 1.0 | 25.36 | 0.350 | 8.61 | 8.35 | 106.2 | <0.1 |
| 7/1/16 | 1:51 PM | 613961 | 0.5 | 25.30 | 0.351 | 8.13 | 8.36 | 99.2 | <0.1 |
| 7/1/16 | 1:53 PM | 613962 | 0.8 | 25.03 | 0.349 | 8.64 | 8.29 | 104.9 | <0.1 |
| 7/1/16 | 1:54 PM | 613963 | 0.8 | 25.11 | 0.345 | 8.23 | 8.29 | 100.5 | <0.1 |

| Site 15 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 1:04 PM | 615001 | 0.3 | 27.31 | 0.327 | 9.64 | 8.39 | 121.3 | 0.62 |
| 6/27/16 | 1:07 PM | 615002 | | 27.17 | 0.319 | 8.47 | 8.96 | 113.0 | 0.73 |
| 6/27/16 | 1:09 PM | 615003 | 1.0 | 26.90 | 0.319 | 8.23 | 8.29 | 102.6 | 0.67 |
| 6/27/16 | 6:34 PM | 615061 | 0.5 | 27.84 | 0.329 | 11.41 | 8.47 | 192.7 | 0.18 |
| 6/27/16 | 6:37 PM | 615062 | 0.4 | 28.13 | 0.332 | 10.52 | 8.46 | 134.4 | <0.1 |
| 6/27/16 | 6:38 PM | 615063 | 0.4 | 28.85 | 0.332 | 9.92 | 8.38 | 124.9 | 0.26 |
| 6/28/16 | 4:45 PM | 615241 | 0.5 | 25.47 | 0.338 | 3.83 | 7.59 | 44.1 | 0.11 |
| 6/28/16 | 4:47 PM | 615242 | 0.4 | 25.46 | 0.339 | 4.65 | 7.61 | 48.9 | 0.11 |
| 6/28/16 | 4:49 PM | 615243 | 0.4 | 25.74 | 0.342 | 4.69 | 7.66 | 55.3 | <0.1 |
| 6/29/16 | 11:28 AM | 615481 | 0.2 | 23.80 | 0.353 | 0.75 | 7.44 | 7.0 | <0.1 |
| 6/29/16 | 11:32 AM | 615482 | 0.3 | 23.70 | 0.356 | 0.53 | 7.41 | 5.4 | 0.1 |
| 6/29/16 | 11:34 AM | 615483 | 0.4 | 23.60 | 0.357 | 0.51 | 7.38 | 4.7 | 0.1 |
| 7/1/16 | 8:38 AM | 615961 | 0.3 | 23.85 | 0.355 | 3.45 | 7.61 | 40.3 | <0.1 |
| 7/1/16 | 8:40 AM | 615962 | 0.4 | 23.94 | 0.356 | 3.53 | 7.61 | 41.4 | <0.1 |
| 7/1/16 | 8:44 AM | 615863 | 0.4 | 23.97 | 0.354 | 3.84 | 7.59 | 41.9 | <0.1 |

| Site 16 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 12:19 PM | 616001 | 0.6 | 26.01 | 0.348 | 2.82 | 7.19 | 34.4 | 0.33 |
| 6/27/16 | 12:23 PM | 616002 | 0.6 | 26.31 | 0.352 | 3.85 | 7.24 | 47.2 | 0.48 |
| 6/27/16 | 12:27 PM | 616003 | 0.4 | 26.37 | 0.354 | 3.30 | 7.16 | 40.2 | 0.33 |
| 6/27/16 | 5:55 PM | 616061 | 0.4 | 27.60 | 0.352 | 3.40 | 7.27 | 42.7 | 0.16 |
| 6/27/16 | 5:58 PM | 616062 | 0.6 | 27.40 | 0.353 | 5.34 | 7.31 | 68.9 | 0.14 |
| 6/27/16 | 6:03 PM | 616063 | 0.6 | 28.29 | 0.357 | 4.54 | 7.20 | 51.7 | 0.10 |
| 6/28/16 | 12:41 PM | 616241 | 0.3 | 25.51 | 0.358 | 1.43 | 7.27 | 17.0 | <0.1 |
| 6/28/16 | 12:48 PM | 616242 | 0.4 | 25.52 | 0.355 | 1.77 | 7.26 | 20.3 | <0.1 |
| 6/28/16 | 12:50 PM | 616243 | 0.4 | 25.34 | 0.356 | 1.78 | 7.24 | 20.9 | <0.1 |
| 6/29/16 | 11:48 AM | 616481 | 0.6 | 22.68 | 0.355 | 0.57 | 7.17 | 5.9 | <0.1 |
| 6/29/16 | 11:50 AM | 616482 | 0.5 | 23.04 | 0.357 | 0.77 | 7.07 | 8.4 | <0.1 |
| 6/29/16 | 11:53 AM | 616483 | 0.4 | 23.11 | 0.326 | 0.74 | 7.18 | 8.1 | <0.1 |
| 7/1/16 | 8:53 AM | 616961 | 0.4 | 22.81 | 0.373 | 0.90 | 7.26 | 9.6 | <0.1 |
| 7/1/16 | 8:55 AM | 616962 | 0.4 | 22.85 | 0.374 | 0.66 | 7.17 | 7.2 | <0.1 |
| 7/1/16 | 8:57 AM | 616963 | 0.5 | 22.75 | 0.367 | 0.91 | 7.17 | 9.6 | <0.1 |

| Site 17 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 12:33 PM | 617001 | 0.6 | 26.31 | 0.361 | 2.37 | 7.10 | 28.7 | 0.1 |
| 6/27/16 | 12:35 PM | 617002 | 0.5 | 25.93 | 0.366 | 2.10 | 7.06 | 25.0 | 0.16 |
| 6/27/16 | 12:39 PM | 617003 | 0.4 | 26.25 | 0.368 | 3.10 | 7.13 | 38.3 | 0.23 |
| 6/27/16 | 6:07 PM | 617061 | 0.6 | 28.24 | 0.367 | 4.26 | 7.14 | 51.2 | <0.1 |
| 6/27/16 | 6:10 PM | 617062 | 0.5 | 27.83 | 0.369 | 4.38 | 7.12 | 51.5 | <0.1 |
| 6/27/16 | 6:12 PM | 617063 | 0.6 | 26.58 | 0.371 | 3.17 | 7.18 | 41.1 | <0.1 |
| 6/28/16 | 1:04 PM | 617241 | 0.3 | 25.11 | 0.362 | 2.02 | 7.19 | 23.2 | <0.1 |
| 6/28/16 | 1:06 PM | 617242 | 0.5 | 25.08 | 0.364 | 2.15 | 7.15 | 25.0 | <0.1 |
| 6/28/16 | 1:10 PM | 617243 | 0.5 | 25.09 | 0.357 | 0.77 | 7.15 | 3.5 | <0.1 |
| 6/29/16 | 12:02 PM | 617481 | 0.5 | 22.90 | 0.364 | 1.29 | 7.18 | 14.3 | <0.1 |
| 6/29/16 | 12:07 PM | 617482 | 0.6 | 22.71 | 0.367 | 1.71 | 7.18 | 19.3 | <0.1 |
| 6/29/16 | 12:11 PM | 617483 | 0.4 | 23.02 | 0.365 | 2.59 | 7.13 | 29.7 | <0.1 |
| 7/1/16 | 9:04 AM | 617961 | 0.5 | 22.60 | 0.375 | 2.12 | 7.24 | 23.3 | <0.1 |
| 7/1/16 | 9:06 AM | 617962 | 0.4 | 22.57 | 0.372 | 1.32 | 7.12 | 14.0 | <0.1 |
| 7/1/16 | 9:08 AM | 617963 | 0.3 | 22.71 | 0.373 | 1.22 | 7.15 | 13.1 | <0.1 |

| Site 18 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 6/27/16 | 5:22 PM | 618001 | 0.4 | 29.26 | 0.340 | 8.62 | 8.14 | 112.1 | <0.1 |
| 6/27/16 | 5:26 PM | 618002 | 0.7 | 27.99 | 0.340 | 8.54 | 8.16 | 109.3 | <0.1 |
| 6/27/16 | 5:29 PM | 618003 | 0.4 | 28.52 | 0.347 | 8.63 | 7.83 | 112.8 | <0.1 |
| 6/27/16 | | | | | | | | | |
| 6/27/16 | | | | | | | | | |
| 6/27/16 | | | | | | | | | |
| 6/28/16 | 4:31 PM | 618241 | 0.4 | 26.11 | 0.343 | 5.41 | 7.69 | 63.3 | <0.1 |
| 6/28/16 | 4:32 PM | 618242 | 0.5 | 26.14 | 0.336 | 7.08 | 7.95 | 86.7 | <0.1 |
| 6/28/16 | 4:34 PM | 618243 | 0.6 | 26.08 | 0.336 | 6.25 | 7.85 | 76.6 | <0.1 |
| 6/29/16 | 12:20 PM | 618481 | 0.4 | 23.64 | 0.346 | 4.39 | 7.64 | 50.4 | <0.1 |
| 6/29/16 | 12:22 PM | 618482 | 0.3 | 23.85 | 0.344 | 5.50 | 7.71 | 64.1 | <0.1 |
| 6/29/16 | 12:24 PM | 618483 | 0.4 | 23.75 | 0.344 | 5.42 | 7.68 | 62.7 | <0.1 |
| 7/1/16 | 9:17 AM | 618961 | 0.2 | 23.69 | 0.342 | 7.07 | 7.95 | 83.1 | <0.1 |
| 7/1/16 | 9:19 AM | 618962 | 0.5 | 23.84 | 0.346 | 6.80 | 7.87 | 78.7 | <0.1 |
| 7/1/16 | 9:20 AM | 618963 | 0.6 | 23.89 | 0.341 | 7.10 | 7.94 | 82.3 | <0.1 |

**Site 0 - Lat Long 41.40632  -85.73905**

| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
|---|---|---|---|---|---|---|---|---|---|
| 8/1/16 | 10:06 AM | 800001 | 1.0 | 27.50 | 0.369 | 5.98 | 7.64 | 73.4 | 0.28 |
| 8/1/16 | 10:10 AM | 800002 | 0.8 | 27.55 | 0.369 | 6.10 | 7.64 | 77.0 | 0.36 |
| 8/1/16 | 10:13 AM | 800003 | 0.9 | 27.55 | 0.367 | 5.90 | 7.62 | 74.1 | 0.14 |
| 8/1/16 | 3:05 PM | 800061 | 0.7 | 28.82 | 0.364 | 6.82 | 7.66 | 88.6 | <0.1 |
| 8/1/16 | 3:07 PM | 800062 | 0.6 | 28.93 | 0.367 | 6.68 | 7.60 | 86.4 | <0.1 |
| 8/1/16 | | 800063 | | 28.54 | 0.368 | 6.58 | 7.57 | 84.9 | <0.1 |
| 8/2/16 | 12:36 PM | 800241 | 0.8 | 28.25 | 0.358 | 6.07 | 7.83 | 77.6 | <0.1 |
| 8/2/16 | 12:42 PM | 800242 | 0.8 | 28.48 | 0.350 | 6.20 | 7.85 | 79.7 | <0.1 |
| 8/2/16 | 12:43 PM | 800243 | 0.9 | 28.41 | 0.350 | 6.17 | 7.86 | 80.0 | <0.1 |
| 8/3/16 | 10:40 AM | 800481 | 0.8 | 28.32 | 0.359 | 5.33 | 7.71 | 69.2 | <0.1 |
| 8/3/16 | 10:43 AM | 800482 | 0.8 | 28.40 | 0.358 | 5.42 | 7.72 | 70.5 | <0.1 |
| 8/3/16 | 10:45 AM | 800483 | 0.9 | 28.30 | 0.362 | 5.75 | 7.71 | 72.0 | <0.1 |
| 8/5/16 | 11:15 AM | 800961 | 1.2 | 29.26 | 0.361 | 5.50 | 7.75 | 71.2 | <0.1 |
| 8/5/16 | 11:18 AM | 800962 | 0.8 | 29.24 | 0.366 | 5.39 | 7.74 | 70.1 | <0.1 |
| 8/5/16 | 11:21 AM | 800963 | 0.8 | 29.24 | 0.362 | 5.39 | 7.74 | 70.6 | <0.1 |

| Site 1 - Lat Long 41.40672 -85.73755 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 9:54 AM | 801001 | 1.1 | 27.37 | 0.363 | 6.39 | 7.60 | 81.6 | 0.20 |
| 8/1/16 | 9:57 AM | 801002 | 1.1 | 27.22 | 0.365 | 6.47 | 7.49 | 81.1 | 0.51 |
| 8/1/16 | 10:00 AM | 801002 | 1.1 | 27.26 | 0.365 | 6.34 | 7.49 | 79.9 | 0.26 |
| 8/1/16 | 2:54 PM | 801061 | 0.7 | 28.71 | 0.360 | 7.02 | 7.74 | 90.4 | <0.1 |
| 8/1/16 | 2:56 PM | 801062 | 1.0 | 28.54 | 0.360 | 7.06 | 7.69 | 90.9 | <0.1 |
| 8/1/16 | 2:59 PM | 801063 | 1.0 | 28.71 | 0.361 | 6.98 | 7.66 | 89.8 | <0.1 |
| 8/2/16 | 12:22 PM | 801241 | 1.0 | 28.32 | 0.354 | 6.22 | 7.87 | 80.3 | <0.1 |
| 8/2/16 | 12:27 PM | 801242 | 1.2 | 28.28 | 0.350 | 6.19 | 7.87 | 79.4 | <0.1 |
| 8/2/16 | 12:30 PM | 801243 | 1.0 | 28.39 | 0.354 | 6.40 | 7.89 | 81.9 | <0.1 |
| 8/3/16 | 10:30 AM | 801481 | 0.8 | 28.29 | 0.355 | 5.90 | 7.82 | 75.7 | <0.1 |
| 8/3/16 | 10:31 AM | 801482 | 0.8 | 28.32 | 0.357 | 5.91 | 7.81 | 75.9 | <0.1 |
| 8/3/16 | 10:34 AM | 801483 | 0.8 | 28.16 | 0.358 | 5.75 | 7.78 | 75.1 | <0.1 |
| 8/5/16 | 10:57 AM | 801961 | 1.0 | 29.10 | 0.352 | 6.76 | 8.14 | 87.3 | <0.1 |
| 8/5/16 | 10:59 AM | 801962 | 1.0 | 29.14 | 0.349 | 6.59 | 7.97 | 85.7 | <0.1 |
| 8/5/16 | 11:02 AM | 801963 | 1.0 | 29.14 | 0.351 | 6.43 | 7.95 | 84.4 | <0.1 |

| Site 2 - Lat Long 41.40556 -85.74034 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 10:20 AM | 802001 | 1.0 | 27.33 | 0.368 | 6.13 | 7.59 | 77.9 | <0.1 |
| 8/1/16 | 10:23 AM | 802002 | 1.0 | 27.35 | 0.366 | 5.95 | 7.55 | 75.2 | <0.1 |
| 8/1/16 | 10:26 AM | 802003 | 1.0 | 27.38 | 0.367 | 5.97 | 7.53 | 75.2 | <0.1 |
| 8/1/16 | 3:17 PM | 802061 | 0.7 | 28.72 | 0.365 | 7.36 | 7.66 | 93.0 | <0.1 |
| 8/1/16 | 3:19 PM | 802062 | 0.7 | 28.69 | 0.363 | 7.16 | 7.66 | 92.9 | <0.1 |
| 8/1/16 | 3:21 PM | 802063 | 1.0 | 28.77 | 0.365 | 6.84 | 7.61 | 88.6 | <0.1 |
| 8/2/16 | 12:49 PM | 802241 | 0.9 | 28.36 | 0.352 | 6.14 | 7.80 | 79.7 | <0.1 |
| 8/2/16 | 12:53 PM | 802243 | 0.9 | 28.46 | 0.355 | 6.34 | 7.83 | 81.8 | <0.1 |
| 8/2/16 | 12:57 PM | 802243 | 0.7 | 28.82 | 0.354 | 6.38 | 7.85 | 82.8 | <0.1 |
| 8/3/16 | 10:50 AM | 802481 | 0.8 | 28.45 | 0.361 | 5.51 | 7.72 | 71.1 | <0.1 |
| 8/3/16 | 10:51 AM | 802482 | 0.8 | 28.44 | 0.358 | 5.55 | 7.72 | 72.1 | <0.1 |
| 8/3/16 | 10:53 AM | 802483 | 0.8 | 28.35 | 0.359 | 5.68 | 7.73 | 73.1 | <0.1 |
| 8/5/16 | 11:28 AM | 802961 | 0.9 | 29.34 | 0.360 | 5.69 | 7.78 | 74.8 | <0.1 |
| 8/5/16 | 11:30 AM | 802962 | 0.7 | 29.34 | 0.360 | 5.95 | 7.76 | 77.7 | <0.1 |
| 8/5/16 | 11:34 AM | 802963 | 0.7 | 29.38 | 0.363 | 5.89 | 7.77 | 76.7 | <0.1 |

| Site 3 - Lat Long 41.40560 -85.74223 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 10:33 AM | 803001 | 0.8 | 27.48 | 0.366 | 6.41 | 7.60 | 80.7 | <0.1 |
| 8/1/16 | 10:37 AM | 803002 | 1.6 | 27.34 | 0.366 | 6.58 | 7.54 | 82.3 | <0.1 |
| 8/1/16 | 10:40 AM | 803003 | 1.4 | 27.45 | 0.367 | 6.40 | 7.52 | 80.0 | <0.1 |
| 8/1/16 | 3:27 PM | 803061 | 1.1 | 29.05 | 0.368 | 6.85 | 7.67 | 88.6 | <0.1 |
| 8/1/16 | 3:29 PM | 803062 | 1.6 | 28.60 | 0.363 | 8.38 | 7.71 | 108.3 | <0.1 |
| 8/1/16 | 3:32 PM | 803063 | 1.0 | 28.84 | 0.366 | 8.12 | 7.71 | 101.1 | <0.1 |
| 8/2/16 | 1:05 PM | 803241 | 1.3 | 28.54 | 0.350 | 6.28 | 7.78 | 81.0 | <0.1 |
| 8/2/16 | 1:08 PM | 803242 | 1.2 | 28.71 | 0.352 | 6.24 | 7.81 | 81.5 | <0.1 |
| 8/2/16 | 1:11 PM | 803243 | 1.0 | 28.67 | 0.352 | 6.67 | 7.82 | 85.7 | <0.1 |
| 8/3/16 | 10:56 AM | 803481 | 1.5 | 28.43 | 0.359 | 6.32 | 7.78 | 80.0 | <0.1 |
| 8/3/16 | | 803482 | | 28.54 | 0.359 | 6.28 | 7.79 | 80.6 | <0.1 |
| 8/3/16 | | 803483 | | 28.50 | 0.358 | 6.37 | 7.78 | 82.0 | <0.1 |
| 8/5/16 | 11:42 AM | 803961 | 1.1 | 29.19 | 0.358 | 6.51 | 7.81 | 84.7 | <0.1 |
| 8/5/16 | 11:44 AM | 803962 | 1.2 | 29.18 | 0.358 | 6.52 | 7.84 | 87.3 | <0.1 |
| 8/5/16 | 11:48 AM | 803963 | 1.5 | 29.16 | 0.363 | 5.70 | 7.74 | 74.5 | <0.1 |

| Site 6 - Lat Long 41.38584 -85.67131 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 12:49 PM | 806001 | 1.9 | 27.30 | 0.388 | 4.90 | 7.64 | 62.5 | <0.1 |
| 8/1/16 | 12:59 PM | 806002 | 0.7 | 28.00 | 0.385 | 7.93 | 7.80 | 102.4 | 0.25 |
| 8/1/16 | 1:01 PM | 806003 | 1.5 | 27.78 | 0.385 | 7.33 | 7.71 | 93.2 | 0.11 |
| 8/1/16 | 5:21 PM | 806061 | 2.3 | 27.38 | 0.394 | 5.52 | 7.60 | 69.8 | <0.1 |
| 8/1/16 | 5:24 PM | 806062 | 1.4 | 28.33 | 0.384 | 10.19 | 7.74 | 126.2 | <0.1 |
| 8/1/16 | 5:27 PM | 806063 | 1.6 | 27.81 | 0.380 | 8.85 | 7.73 | 117.2 | <0.1 |
| 8/2/16 | 4:14 PM | 806241 | 1.7 | 28.23 | 0.374 | 5.94 | 7.73 | 74.5 | <0.1 |
| 8/2/16 | 4:19 PM | 806243 | 1.2 | 28.70 | 0.376 | 7.08 | 7.82 | 92.0 | <0.1 |
| 8/2/16 | 4:21 PM | 806243 | 1.2 | 29.26 | 0.377 | 6.74 | 7.77 | 87.7 | <0.1 |
| 8/3/16 | 12:32 PM | 806481 | 1.3 | 28.49 | 0.387 | 4.66 | 7.62 | 60.0 | <0.1 |
| 8/3/16 | 12:37 PM | 806482 | 0.9 | 28.87 | 0.381 | 5.99 | 7.68 | 77.5 | <0.1 |
| 8/3/16 | 12:39 PM | 806483 | 0.8 | 29.09 | 0.379 | 5.22 | 7.71 | 68.5 | <0.1 |
| 8/5/16 | 1:45 PM | 806961 | 1.9 | 28.31 | 0.389 | 2.75 | 7.56 | 36.1 | <0.1 |
| 8/5/16 | 1:50 PM | 806962 | 1.6 | 28.81 | 0.383 | 4.90 | 7.69 | 63.3 | <0.1 |
| 8/5/16 | 1:54 PM | 806963 | 1.3 | 29.02 | 0.381 | 7.41 | 7.80 | 89.3 | <0.1 |

| Site 7 - Lat Long 41.38475 -85.67086 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 1:09 PM | 807001 | 0.9 | 28.29 | 0.383 | 8.77 | 7.89 | 113.7 | 0.12 |
| 8/1/16 | 1:12 PM | 807002 | 0.8 | 28.24 | 0.385 | 8.65 | 7.89 | 111.1 | 0.19 |
| 8/1/16 | 1:15 PM | 807003 | 0.8 | 28.53 | 0.383 | 9.00 | 7.85 | 118.3 | 0.21 |
| 8/1/16 | 5:31 PM | 807061 | 0.7 | 29.44 | 0.380 | 9.65 | 8.02 | 126.2 | <0.1 |
| 8/1/16 | 5:34 PM | 807062 | 0.8 | 29.60 | 0.389 | 9.91 | 8.02 | 130.6 | <0.1 |
| 8/1/16 | 5:35 PM | 807063 | 1.1 | 29.08 | 0.399 | 10.42 | 8.07 | 133.0 | <0.1 |
| 8/2/16 | 4:24 PM | 807241 | 0.4 | 30.21 | 0.367 | 9.42 | 8.29 | 125.6 | <0.1 |
| 8/2/16 | 4:27 PM | 807242 | 0.7 | 30.09 | 0.370 | 9.21 | 8.34 | 122.3 | <0.1 |
| 8/2/16 | 4:30 PM | 807243 | 0.8 | 30.00 | 0.366 | 9.54 | 8.32 | 125.6 | <0.1 |
| 8/3/16 | 12:44 PM | 807481 | 0.8 | 29.31 | 0.371 | 8.09 | 8.14 | 105.8 | <0.1 |
| 8/3/16 | 12:47 PM | 807482 | 1.0 | 29.44 | 0.391 | 8.26 | 8.25 | 107.7 | <0.1 |
| 8/3/16 | 12:49 PM | 807483 | 1.0 | 29.13 | 0.373 | 8.07 | 8.07 | 105.2 | <0.1 |
| 8/5/16 | 1:57 PM | 807961 | 0.7 | 29.43 | 0.367 | 7.88 | 8.20 | 103.3 | <0.1 |
| 8/5/16 | 1:59 PM | 807962 | 0.9 | 29.46 | 0.367 | 8.07 | 8.26 | 107.6 | <0.1 |
| 8/5/16 | 2:00 PM | 807963 | 0.8 | 29.38 | 0.367 | 8.02 | 8.24 | 104.6 | <0.1 |

| Site 8 - Lat Long 41.40469 -85.68794 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 11:12 AM | 808001 | 1.6 | 27.67 | 0.356 | 7.80 | 8.00 | 99.0 | 0.49 |
| 8/1/16 | 11:15 AM | 808002 | 0.8 | 27.66 | 0.357 | 7.66 | 8.03 | 96.2 | 0.58 |
| 8/1/16 | 11:17 AM | 808003 | 1.2 | 27.68 | 0.358 | 7.66 | 8.01 | 96.8 | 0.40 |
| 8/1/16 | 3:54 PM | 808061 | 0.9 | 28.77 | 0.357 | 8.38 | 7.81 | 107.5 | <0.1 |
| 8/1/16 | 3:56 PM | 808062 | 1.1 | 28.75 | 0.359 | 8.30 | 7.91 | 106.5 | <0.1 |
| 8/1/16 | 4:01 PM | 808063 | 2.0 | 28.13 | 0.359 | 8.51 | 7.94 | 108.7 | <0.1 |
| 8/2/16 | 2:43 PM | 808241 | 0.8 | 29.00 | 0.345 | 7.75 | 8.85 | 101.8 | <0.1 |
| 8/2/16 | 2:47 PM | 808242 | 1.0 | 28.84 | 0.345 | 8.02 | 8.77 | 105.1 | <0.1 |
| 8/2/16 | 2:50 PM | 808243 | 1.9 | 28.60 | 0.343 | 7.84 | 8.70 | 100.9 | <0.1 |
| 8/3/16 | 11:20 AM | 808481 | 0.9 | 28.53 | 0.350 | 7.18 | 8.12 | 91.9 | <0.1 |
| 8/3/16 | 11:22 AM | 808482 | 0.8 | 28.55 | 0.350 | 7.43 | 8.15 | 95.8 | <0.1 |
| 8/3/16 | 11:24 AM | 808483 | 1.1 | 28.40 | 0.350 | 6.98 | 8.12 | 90.2 | <0.1 |
| 8/5/16 | 12:27 PM | 808961 | 0.8 | 29.54 | 0.343 | 7.67 | 8.24 | 99.3 | <0.1 |
| 8/5/16 | 12:29 PM | 808962 | 0.8 | 29.55 | 0.343 | 7.71 | 8.25 | 101.2 | <0.1 |
| 8/5/16 | 12:31 PM | 808963 | 1.0 | 29.55 | 0.343 | 7.71 | 8.24 | 101.2 | <0.1 |

| Site 9 - Lat Long 41.40773 -85.68891 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 11:34 AM | 809001 | 0.6 | 27.89 | 0.356 | 8.36 | 7.98 | 104.3 | <0.1 |
| 8/1/16 | 11:39 AM | 809002 | 1.4 | 27.82 | 0.359 | 8.00 | 7.96 | 101.5 | <0.1 |
| 8/1/16 | 11:42 AM | 809003 | 1.1 | 27.84 | 0.358 | 8.23 | 7.99 | 105.2 | <0.1 |
| 8/1/16 | 4:07 PM | 809061 | 0.8 | 28.91 | 0.358 | 8.73 | 8.03 | 114.5 | <0.1 |
| 8/1/16 | 4:10 PM | 809062 | 1.6 | 28.18 | 0.355 | 9.05 | 8.05 | 117.3 | <0.1 |
| 8/1/16 | 4:13 PM | 809063 | 1.1 | 28.62 | 0.357 | 8.98 | 8.06 | 117.1 | <0.1 |
| 8/2/16 | 2:58 PM | 809241 | 0.9 | 28.67 | 0.338 | 9.57 | 8.85 | 123.4 | <0.1 |
| 8/2/16 | 3:04 PM | 809242 | 1.7 | 28.33 | 0.342 | 8.00 | 8.30 | 103.0 | <0.1 |
| 8/2/16 | 3:07 PM | 809243 | 1.0 | 28.77 | 0.342 | 8.39 | 8.31 | 108.9 | <0.1 |
| 8/3/16 | 11:31 AM | 809481 | 1.1 | 28.58 | 0.347 | 8.05 | 8.25 | 104.1 | <0.1 |
| 8/3/16 | 11:33 AM | 809482 | 1.5 | 28.54 | 0.347 | 7.84 | 8.23 | 101.6 | <0.1 |
| 8/3/16 | 11:36 AM | 809483 | 0.8 | 28.74 | 0.345 | 8.75 | 8.34 | 115.0 | <0.1 |
| 8/5/16 | 12:37 PM | 809961 | 0.7 | 29.56 | 0.341 | 7.92 | 8.25 | 103.8 | <0.1 |
| 8/5/16 | 12:39 PM | 809962 | 1.1 | 29.55 | 0.341 | 7.81 | 8.25 | 102.1 | <0.1 |
| 8/5/16 | 12:41 PM | 809963 | 1.0 | 29.48 | 0.341 | 7.71 | 8.25 | 100.9 | <0.1 |

| Site 10 - Lat Long 41.40970 -85.68776 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 11:48 AM | 810001 | 1.0 | 27.91 | 0.359 | 8.18 | 8.08 | 104.7 | 0.33 |
| 8/1/16 | 11:51 AM | 810002 | 1.6 | 27.75 | 0.360 | 8.07 | 8.05 | 103.6 | 0.30 |
| 8/1/16 | 11:54 AM | 810003 | 0.8 | 27.91 | 0.361 | 8.16 | 8.18 | 103.8 | 0.53 |
| 8/1/16 | 4:19 PM | 810061 | 0.9 | 29.10 | 0.358 | 8.35 | 8.03 | 109.0 | 0.12 |
| 8/1/16 | 4:22 PM | 810062 | 0.9 | 29.23 | 0.358 | 8.52 | 8.03 | 111.2 | 0.13 |
| 8/1/16 | 4:26 PM | 810063 | 1.1 | 29.27 | 0.357 | 8.35 | 8.00 | 109.5 | 0.13 |
| 8/2/16 | 3:14 PM | 810241 | 1.0 | 29.14 | 0.342 | 7.89 | 8.27 | 103.2 | <0.1 |
| 8/2/16 | 3:18 PM | 810242 | 1.9 | 28.69 | 0.342 | 7.92 | 8.28 | 102.6 | <0.1 |
| 8/2/16 | 3:22 PM | 810243 | 0.9 | 29.10 | 0.343 | 8.08 | 8.27 | 105.2 | <0.1 |
| 8/3/16 | 11:43 AM | 810481 | 1.4 | 28.56 | 0.346 | 8.24 | 8.27 | 105.5 | <0.1 |
| 8/3/16 | 11:46 AM | 810482 | 0.8 | 28.67 | 0.348 | 8.28 | 8.20 | 107.7 | <0.1 |
| 8/3/16 | 11:48 AM | 810483 | 0.8 | 28.70 | 0.348 | 7.91 | 8.22 | 101.8 | <0.1 |
| 8/5/16 | 12:49 PM | 810961 | 0.9 | 29.65 | 0.349 | 7.56 | 8.21 | 98.7 | <0.1 |
| 8/5/16 | 12:52 PM | 810962 | 1.8 | 29.39 | 0.343 | 7.57 | 8.27 | 99.2 | <0.1 |
| 8/5/16 | 12:55 PM | 810963 | 1.6 | 29.43 | 0.342 | 7.57 | 8.25 | 99.2 | <0.1 |

| Site 11 - Lat Long 41.41144 -85.68545 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 12:02 PM | 811001 | 1.6 | 27.65 | 0.356 | 8.62 | 8.02 | 108.3 | 0.17 |
| 8/1/16 | 12:05 PM | 811002 | 1.0 | 28.02 | 0.358 | 7.73 | 7.80 | 94.2 | 0.23 |
| 8/1/16 | 12:07 PM | 811003 | 1.4 | 27.74 | 0.358 | 8.67 | 7.86 | 110.9 | 0.52 |
| 8/1/16 | 4:32 PM | 811061 | 1.0 | 28.93 | 0.355 | 8.63 | 8.04 | 113.1 | <0.1 |
| 8/1/16 | 4:35 PM | 811062 | 1.5 | 28.66 | 0.358 | 8.34 | 7.96 | 109.4 | <0.1 |
| 8/1/16 | 4:38 PM | 811063 | 0.8 | 28.97 | 0.357 | 8.41 | 7.95 | 107.7 | <0.1 |
| 8/2/16 | 3:28 PM | 811241 | 1.4 | 29.09 | 0.344 | 7.58 | 8.25 | 98.6 | <0.1 |
| 8/2/16 | 3:32 PM | 811242 | 1.3 | 29.10 | 0.346 | 7.61 | 8.24 | 98.6 | <0.1 |
| 8/2/16 | 3:35 PM | 811243 | 0.8 | 29.40 | 0.342 | 7.68 | 8.27 | 100.7 | <0.1 |
| 8/3/16 | 11:54 AM | 811481 | 1.2 | 28.56 | 0.348 | 7.56 | 8.17 | 97.2 | <0.1 |
| 8/3/16 | | 811482 | 1.0 | 28.43 | 0.347 | 7.75 | 8.21 | 100.9 | <0.1 |
| 8/3/16 | | 811483 | 0.8 | 28.89 | 0.347 | 7.71 | 8.21 | 100.1 | <0.1 |
| 8/5/16 | 1:02 PM | 811961 | 1.6 | 29.57 | 0.348 | 7.21 | 8.20 | 94.3 | <0.1 |
| 8/5/16 | 1:07 PM | 811962 | 1.1 | 29.73 | 0.347 | 7.21 | 8.21 | 94.4 | <0.1 |
| 8/5/16 | 1:09 PM | 811963 | 1.0 | 29.71 | 0.346 | 7.14 | 8.20 | 94.0 | <0.1 |

| Site 12 - Lat Long 41.41027 -85.68458 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 12:15 PM | 812001 | 1.5 | 27.76 | 0.360 | 8.14 | 7.95 | 103.1 | <0.1 |
| 8/1/16 | 12:18 PM | 812002 | 1.0 | 27.88 | 0.357 | 7.54 | 7.90 | 95.5 | <0.1 |
| 8/1/16 | 12:20 PM | 812003 | 0.9 | 28.00 | 0.357 | 7.48 | 7.90 | 95.6 | <0.1 |
| 8/1/16 | 4:45 PM | 812061 | 1.1 | 29.09 | 0.360 | 8.45 | 7.99 | 109.8 | <0.1 |
| 8/1/16 | 4:47 PM | 812062 | 1.1 | 29.03 | 0.357 | 8.53 | 8.01 | 113.8 | <0.1 |
| 8/1/16 | 4:49 PM | 812063 | 1.9 | 28.51 | 0.359 | 8.66 | 7.99 | 111.6 | <0.1 |
| 8/2/16 | 3:43 PM | 812241 | 0.9 | 29.34 | 0.343 | 7.76 | 8.30 | 103.2 | <0.1 |
| 8/2/16 | 3:46 PM | 812242 | 1.1 | 29.14 | 0.342 | 7.95 | 8.31 | 104.1 | <0.1 |
| 8/2/16 | 3:49 PM | 812243 | 1.1 | 29.22 | 0.343 | 7.80 | 8.30 | 101.5 | <0.1 |
| 8/3/16 | 12:04 PM | 812481 | 1.3 | 28.72 | 0.346 | 7.82 | 8.24 | 101.6 | <0.1 |
| 8/3/16 | 12:06 PM | 812482 | 1.6 | 28.78 | 0.350 | 7.80 | 8.22 | 101.2 | <0.1 |
| 8/3/16 | 12:09 PM | 812483 | 0.7 | 29.19 | 0.346 | 8.29 | 8.26 | 105.7 | <0.1 |
| 8/5/16 | 1:17 PM | 812961 | 1.0 | 29.72 | 0.342 | 7.63 | 8.25 | 100.0 | <0.1 |
| 8/5/16 | 1:20 PM | 812962 | 0.9 | 29.72 | 0.343 | 7.56 | 8.24 | 98.9 | <0.1 |
| 8/5/16 | 1:23 PM | 812963 | 2.2 | 29.72 | 0.343 | 8.32 | 8.36 | 110.1 | <0.1 |

| Site 13 - Lat Long 41.40917 -85.68408 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 12:29 PM | 813001 | 1.1 | 27.91 | 0.357 | 8.65 | 8.09 | 110.6 | <0.1 |
| 8/1/16 | 12:33 PM | 813002 | 0.8 | 24.13 | 0.355 | 8.35 | 8.07 | 106.0 | 0.11 |
| 8/1/16 | 12:35 PM | 813003 | 1.0 | 27.89 | 0.355 | 8.47 | 8.09 | 110.1 | 0.12 |
| 8/1/16 | 4:59 PM | 813061 | 0.9 | 29.10 | 0.357 | 8.50 | 8.05 | 110.6 | <0.1 |
| 8/1/16 | 5:02 PM | 813062 | 0.9 | 28.96 | 0.358 | 8.59 | 8.03 | 111.7 | <0.1 |
| 8/1/16 | 5:06 PM | 813063 | 1.1 | 29.22 | 0.358 | 8.57 | 8.04 | 111.8 | <0.1 |
| 8/2/16 | 3:56 PM | 813241 | 0.9 | 29.16 | 0.339 | 9.11 | 8.39 | 117.9 | <0.1 |
| 8/2/16 | 4:00 PM | 813242 | 1.1 | 29.25 | 0.341 | 8.29 | 8.34 | 108.5 | <0.1 |
| 8/2/16 | 4:04 PM | 813243 | 0.9 | 29.53 | 0.343 | 7.76 | 8.30 | 102.5 | <0.1 |
| 8/3/16 | 12:16 PM | 813481 | 0.9 | 28.78 | 0.347 | 7.56 | 8.16 | 96.2 | <0.1 |
| 8/3/16 | 12:18 PM | 813482 | 0.8 | 29.10 | 0.344 | 8.09 | 8.31 | 105.3 | <0.1 |
| 8/3/16 | 12:20 PM | 813483 | 0.9 | 28.76 | 0.344 | 8.00 | 8.29 | 103.7 | <0.1 |
| 8/5/16 | 1:29 PM | 813961 | 0.9 | 29.89 | 0.345 | 8.50 | 8.36 | 112.7 | <0.1 |
| 8/5/16 | 1:31 PM | 813962 | 0.9 | 29.86 | 0.341 | 8.59 | 8.35 | 112.3 | <0.1 |
| 8/5/16 | 1:33 PM | 813963 | 0.9 | 29.91 | 0.340 | 8.65 | 8.37 | 114.2 | <0.1 |

| Site 15 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 9:39 AM | 815001 | 0.5 | 27.21 | 0.371 | 5.56 | 7.60 | 69.9 | 0.30 |
| 8/1/16 | 9:42 AM | 815002 | 0.4 | 27.27 | 0.363 | 5.87 | 7.60 | 73.0 | 0.37 |
| 8/1/16 | 9:45 AM | 815003 | 0.9 | 27.25 | 0.372 | 5.55 | 7.58 | 70.1 | 0.34 |
| 8/1/16 | 2:42 PM | 815061 | 0.5 | 29.20 | 0.368 | 6.71 | 7.80 | 87.5 | 0.13 |
| 8/1/16 | 2:45 PM | 815062 | 0.5 | 29.40 | 0.374 | 6.64 | 7.67 | 87.0 | <0.1 |
| 8/1/16 | | 815063 | 0.8 | 28.72 | 0.381 | 5.79 | 7.63 | 77.2 | 0.12 |
| 8/2/16 | 12:05 PM | 815241 | 0.5 | 28.64 | 0.357 | 3.72 | 7.70 | 49.7 | <0.1 |
| 8/2/16 | 12:08 PM | 815242 | 0.4 | 28.78 | 0.355 | 5.66 | 7.84 | 73.1 | <0.1 |
| 8/2/16 | 12:11 PM | 815243 | 0.6 | 28.22 | 0.356 | 4.99 | 7.87 | 64.7 | <0.1 |
| 8/3/16 | 10:20 AM | 815481 | 0.5 | 27.80 | 0.359 | 4.45 | 7.68 | 54.4 | <0.1 |
| 8/3/16 | 10:21 AM | 815482 | 0.5 | 27.69 | 0.372 | 2.35 | 7.57 | 29.1 | <0.1 |
| 8/3/16 | 10:24 AM | 815483 | 0.5 | 27.86 | 0.366 | 3.27 | 7.61 | 40.0 | <0.1 |
| 8/5/16 | 10:31 AM | 815961 | 0.5 | 28.91 | 0.361 | 5.19 | 8.15 | 66.2 | <0.1 |
| 8/5/16 | 10:34 AM | 815962 | 0.5 | 28.79 | 0.366 | 3.95 | 8.08 | 50.2 | <0.1 |
| 8/5/16 | 10:38 AM | 815863 | 0.8 | 28.64 | 0.363 | 3.60 | 8.11 | 47.0 | <0.1 |

| Site 16 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 8:50 AM | 816001 | 0.5 | 25.92 | 0.385 | 0.91 | 7.10 | 11.2 | 0.38 |
| 8/1/16 | 8:56 AM | 816002 | 0.4 | 25.98 | 0.385 | 1.44 | 7.01 | 17.8 | 0.77 |
| 8/1/16 | 8:59 AM | 816003 | | 25.96 | 0.385 | 1.61 | 7.03 | 19.4 | 0.33 |
| 8/1/16 | 1:52 PM | 816061 | 0.5 | 27.17 | 0.385 | 1.71 | 7.40 | 21.2 | 0.14 |
| 8/1/16 | 1:59 PM | 816062 | 0.5 | 27.20 | 0.388 | 1.29 | 7.09 | 16.2 | 0.17 |
| 8/1/16 | 2:02 PM | 816063 | 0.6 | 27.32 | 0.387 | 1.46 | 7.02 | 20.1 | 0.20 |
| 8/2/16 | 11:13 AM | 816241 | 0.5 | 26.75 | 0.378 | 0.65 | 7.63 | 7.9 | <0.1 |
| 8/2/16 | 11:17 AM | 816242 | 0.5 | 26.64 | 0.381 | 0.76 | 7.61 | 9.3 | 0.10 |
| 8/2/16 | 11:20 AM | 816243 | 0.6 | 26.51 | 0.382 | 0.52 | 7.62 | 6.5 | 0.10 |
| 8/3/16 | 9:34 AM | 816481 | 0.4 | 26.64 | 0.382 | 0.67 | 7.20 | 7.8 | <0.1 |
| 8/3/16 | 9:39 AM | 816482 | 0.3 | 26.75 | 0.382 | 0.46 | 7.20 | 5.2 | <0.1 |
| 8/3/16 | 9:40 AM | 816483 | 0.6 | 26.50 | 0.379 | 0.31 | 7.19 | 3.7 | <0.1 |
| 8/5/16 | 9:38 AM | 816961 | 0.5 | 27.21 | 0.385 | 0.43 | 7.47 | 4.5 | <0.1 |
| 8/5/16 | 9:40 AM | 816962 | 0.5 | 27.30 | 0.381 | 0.12 | 7.51 | 1.4 | <0.1 |
| 8/5/16 | 9:44 AM | 816963 | 0.6 | 27.26 | 0.382 | 0.45 | 7.59 | 5.9 | <0.1 |

| Site 17 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 9:03 AM | 817001 | | 25.60 | 0.383 | 1.19 | 7.06 | 13.7 | <0.1 |
| 8/1/16 | 9:06 AM | 817002 | | 25.53 | 0.385 | 1.64 | 7.04 | 16.8 | 0.19 |
| 8/1/16 | 9:10 AM | 817003 | | 25.50 | 0.381 | 1.52 | 7.09 | 18.1 | 0.17 |
| 8/1/16 | 2:06 PM | 817061 | 0.5 | 26.81 | 0.383 | 1.84 | 7.22 | 20.2 | <0.1 |
| 8/1/16 | 2:08 PM | 817062 | 0.3 | 26.80 | 0.383 | 2.80 | 7.08 | 33.8 | <0.1 |
| 8/1/16 | 2:12 PM | 817063 | 0.4 | 26.70 | 0.383 | 2.50 | 7.10 | 28.9 | <0.1 |
| 8/2/16 | 11:25 AM | 817241 | 0.5 | 25.78 | 0.376 | 0.97 | 7.62 | 11.4 | <0.1 |
| 8/2/16 | 11:30 AM | 817242 | 0.7 | 26.19 | 0.373 | 1.92 | 7.61 | 24.0 | <0.1 |
| 8/2/16 | 11:33 AM | 817243 | 0.4 | 26.13 | 0.374 | 1.16 | 7.57 | 13.1 | <0.1 |
| 8/3/16 | 9:45 AM | 817481 | 0.3 | 26.20 | 0.372 | 1.60 | 7.19 | 19.8 | <0.1 |
| 8/3/16 | 9:47 AM | 817482 | 0.5 | 26.04 | 0.377 | 0.70 | 7.14 | 9.0 | <0.1 |
| 8/3/16 | 9:49 AM | 817483 | 0.1 | 26.45 | 0.378 | 0.84 | 7.18 | 13.1 | <0.1 |
| 8/5/16 | 9:49 AM | 817961 | 0.5 | 27.04 | 0.378 | 0.71 | 7.56 | 9.1 | <0.1 |
| 8/5/16 | 9:54 AM | 817962 | 0.4 | 26.92 | 0.379 | 0.94 | 7.58 | 11.2 | <0.1 |
| 8/5/16 | 9:58 AM | 817963 | 0.5 | 26.80 | 0.381 | 0.59 | 7.56 | 7.4 | <0.1 |

| Site 18 - Channel | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Waypoint Number | Depth (m) | Temp (C°) | Cond. (spc) | DO (mg/L) | pH | DO (% sat) | Copper (µg/mL) |
| 8/1/16 | 9:18 AM | 818001 | 0.5 | 26.97 | 0.378 | 4.85 | 7.32 | 60.8 | <0.1 |
| 8/1/16 | 9:22 AM | 818002 | 0.5 | 26.99 | 0.383 | 4.16 | 7.28 | 51.5 | <0.1 |
| 8/1/16 | 9:25 AM | 818003 | | 27.02 | 0.385 | 3.97 | 7.27 | 48.7 | <0.1 |
| 8/1/16 | 2:21 PM | 818061 | 0.6 | 28.54 | 0.373 | 6.86 | 7.50 | 88.0 | <0.1 |
| 8/1/16 | 2:24 PM | 818062 | 0.6 | 28.48 | 0.373 | 6.98 | 7.45 | 90.3 | <0.1 |
| 8/1/16 | 2:27 PM | 818063 | 0.5 | 28.29 | 0.380 | 5.88 | 7.41 | 78.1 | <0.1 |
| 8/2/16 | 11:42 AM | 818241 | 0.4 | 28.52 | 0.362 | 5.35 | 7.41 | 70.2 | <0.1 |
| 8/2/16 | 11:45 AM | 818242 | 0.7 | 27.87 | 0.369 | 5.13 | 8.00 | 65.5 | <0.1 |
| 8/2/16 | 11:48 AM | 818243 | 0.6 | 27.82 | 0.370 | 4.61 | 7.97 | 58.1 | <0.1 |
| 8/3/16 | 9:59 AM | 818481 | 0.5 | 27.83 | 0.364 | 5.15 | 7.57 | 65.3 | <0.1 |
| 8/3/16 | 10:02 AM | 818482 | 0.5 | 27.86 | 0.369 | 4.93 | 7.60 | 62.1 | <0.1 |
| 8/3/16 | 10:05 AM | 818483 | 0.6 | 27.75 | 0.369 | 4.51 | 7.58 | 56.7 | <0.1 |
| 8/5/16 | 10:09 AM | 818961 | 0.5 | 28.25 | 0.373 | 3.43 | 7.73 | 43.4 | <0.1 |
| 8/5/16 | 10:11 AM | 818962 | 0.5 | 28.46 | 0.371 | 3.94 | 7.81 | 51.1 | <0.1 |
| 8/5/16 | 10:14 AM | 818963 | 0.5 | 28.64 | 0.372 | 4.69 | 7.96 | 60.2 | <0.1 |

| Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee. | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 6.5 | Mean species/site: | 1.48 |
| Date: | 6/13/2016 | Sites with plants: | 133 | SE Mean species/site: | 0.10 |
| Littoral Depth (ft): | 23.0 | Sites with native plants: | 97 | Mean native species/site: | 0.93 |
| Littoral Sites: | 168 | Number of species: | 17 | SE Mean natives/site: | 0.08 |
| Total Sites: | 169 | Number of native species: | 14 | Species diversity: | 0.86 |
| | | Maximum species/site: | 6 | Native species diversity: | 0.81 |

| **All Depths** | **Frequency of** | **Rake score frequency per species** | | | | **Plant** |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 34.9 | 65.1 | 18.3 | 15.4 | 1.2 | 14.1 |
| Starry stonewort | 32.5 | 67.5 | 10.1 | 16.0 | 6.5 | 18.1 |
| Eurasian watermilfoil | 16.6 | 83.4 | 7.1 | 5.3 | 4.1 | 8.8 |
| Coontail | 13.6 | 86.4 | 3.0 | 8.3 | 2.4 | 7.9 |
| Bladderwort | 9.5 | 90.5 | 4.7 | 4.7 | 0.0 | 3.8 |
| Whorled watermilfoil | 7.7 | 92.3 | 3.0 | 4.7 | 0.0 | 3.4 |
| Sago pondweed | 6.5 | 93.5 | 1.8 | 4.7 | 0.0 | 3.2 |
| Curly-leaf pondweed | 5.9 | 94.1 | 1.2 | 4.7 | 0.0 | 3.1 |
| Illinois pondweed | 4.7 | 95.3 | 2.4 | 2.4 | 0.0 | 1.9 |
| Eel grass | 3.6 | 96.4 | 1.8 | 1.8 | 0.0 | 1.4 |
| Richardson's pondweed | 3.6 | 96.4 | 1.2 | 2.4 | 0.0 | 1.7 |
| Small pondweed | 2.4 | 97.6 | 0.6 | 1.8 | 0.0 | 1.2 |
| Canada waterweed | 1.8 | 98.2 | 0.0 | 1.8 | 0.0 | 1.1 |
| American pondweed | 1.2 | 98.8 | 0.6 | 0.6 | 0.0 | 0.5 |
| Flat-stemmed pondweed | 1.2 | 98.8 | 0.0 | 1.2 | 0.0 | 0.7 |
| Nitella | 1.2 | 98.8 | 0.6 | 0.6 | 0.0 | 0.5 |
| Slender naiad | 1.2 | 98.8 | 1.2 | 0.0 | 0.0 | 0.2 |
| Large-leaved pondweed | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | | |
| Filamentous Algae | 4.1 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 6.5 | Mean species/site: | 1.81 |
| Date: | 6/13/2016 | Sites with plants: | 51 | SE Mean species/site: | 0.18 |
| Littoral Depth (ft): | 23.0 | Sites with native plants: | 41 | Mean native species/site: | 1.21 |
| Littoral Sites: | 62 | Number of species: | 16 | SE Mean natives/site: | 0.15 |
| Total Sites: | 62 | Number of native species: | 13 | Species diversity: | 0.86 |
| | | Maximum species/site: | 6 | Native species diversity: | 0.82 |

| **Depths: 0 to 5 ft** | **Frequency of** | **Rake score frequency per species** | | | | **Plant** |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 45.2 | 54.8 | 27.4 | 14.5 | 3.2 | 17.4 |
| Starry stonewort | 37.1 | 62.9 | 17.7 | 12.9 | 6.5 | 17.7 |
| Eurasian watermilfoil | 17.7 | 82.3 | 12.9 | 4.8 | 0.0 | 5.5 |
| Bladderwort | 12.9 | 87.1 | 9.7 | 3.2 | 0.0 | 3.9 |
| Coontail | 12.9 | 87.1 | 3.2 | 3.2 | 6.5 | 9.0 |
| Whorled watermilfoil | 11.3 | 88.7 | 8.1 | 3.2 | 0.0 | 3.5 |
| Illinois pondweed | 8.1 | 91.9 | 3.2 | 4.8 | 0.0 | 3.5 |
| Eel grass | 6.5 | 93.5 | 1.6 | 4.8 | 0.0 | 3.2 |
| Canada waterweed | 4.8 | 95.2 | 0.0 | 4.8 | 0.0 | 2.9 |
| Curly-leaf pondweed | 4.8 | 95.2 | 1.6 | 3.2 | 0.0 | 2.3 |
| Sago pondweed | 4.8 | 95.2 | 0.0 | 4.8 | 0.0 | 2.9 |
| American pondweed | 3.2 | 96.8 | 1.6 | 1.6 | 0.0 | 1.3 |
| Flat-stemmed pondweed | 3.2 | 96.8 | 0.0 | 3.2 | 0.0 | 1.9 |
| Slender naiad | 3.2 | 96.8 | 3.2 | 0.0 | 0.0 | 0.6 |
| Small pondweed | 3.2 | 96.8 | 1.6 | 1.6 | 0.0 | 1.3 |
| Richardson's pondweed | 1.6 | 98.4 | 0.0 | 1.6 | 0.0 | 1.0 |
| | | | | | | |
| Filamentous Algae | 9.7 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | |
|---|---|---|---|
| County: Kosciusko | Secchi (ft): 6.5 | Mean species/site: 1.40 |
| Date: 6/13/2016 | Sites with plants: 37 | SE Mean species/site: 0.18 |
| Littoral Depth (ft): 23.0 | Sites with native plants: 27 | Mean native species/site: 0.91 |
| Littoral Sites: 45 | Number of species: 12 | SE Mean natives/site: 0.15 |
| Total Sites: 45 | Number of native species: 9 | Species diversity: 0.78 |
| | Maximum species/site: 4 | Native species diversity: 0.65 |

| Depths: 5 to 10 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 51.1 | 48.9 | 24.4 | 26.7 | 0.0 | 20.9 |
| Starry stonewort | 35.6 | 64.4 | 8.9 | 22.2 | 4.4 | 19.6 |
| Bladderwort | 13.3 | 86.7 | 4.4 | 8.9 | 0.0 | 6.2 |
| Eurasian watermilfoil | 11.1 | 88.9 | 4.4 | 2.2 | 4.4 | 6.7 |
| Whorled watermilfoil | 6.7 | 93.3 | 0.0 | 6.7 | 0.0 | 4.0 |
| Eel grass | 4.4 | 95.6 | 4.4 | 0.0 | 0.0 | 0.9 |
| Illinois pondweed | 4.4 | 95.6 | 2.2 | 2.2 | 0.0 | 1.8 |
| Sago pondweed | 4.4 | 95.6 | 2.2 | 2.2 | 0.0 | 1.8 |
| Coontail | 2.2 | 97.8 | 0.0 | 2.2 | 0.0 | 1.3 |
| Curly-leaf pondweed | 2.2 | 97.8 | 2.2 | 0.0 | 0.0 | 0.4 |
| Richardson's pondweed | 2.2 | 97.8 | 2.2 | 0.0 | 0.0 | 0.4 |
| Small pondweed | 2.2 | 97.8 | 0.0 | 2.2 | 0.0 | 1.3 |
| | | | | | | |
| Filamentous Algae | 2.2 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | |
|---|---|---|
| County: Kosciusko | Secchi (ft): 6.5 | Mean species/site: 1.50 |
| Date: 6/13/2016 | Sites with plants: 22 | SE Mean species/site: 0.24 |
| Littoral Depth (ft): 23.0 | Sites with native plants: 17 | Mean native species/site: 0.96 |
| Littoral Sites: 28 | Number of species: 11 | SE Mean natives/site: 0.18 |
| Total Sites: 28 | Number of native species: 8 | Species diversity: 0.87 |
| | Maximum species/site: 4 | Native species diversity: 0.83 |

| Depths: 10 to 15 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Eurasian watermilfoil | 28.6 | 71.4 | 3.6 | 10.7 | 14.3 | 21.4 |
| Coontail | 25.0 | 75.0 | 7.1 | 17.9 | 0.0 | 12.1 |
| Chara | 21.4 | 78.6 | 7.1 | 14.3 | 0.0 | 10.0 |
| Starry stonewort | 21.4 | 78.6 | 3.6 | 14.3 | 3.6 | 12.9 |
| Richardson's pondweed | 14.3 | 85.7 | 3.6 | 10.7 | 0.0 | 7.1 |
| Sago pondweed | 14.3 | 85.7 | 3.6 | 10.7 | 0.0 | 7.1 |
| Bladderwort | 7.1 | 92.9 | 0.0 | 7.1 | 0.0 | 4.3 |
| Whorled watermilfoil | 7.1 | 92.9 | 0.0 | 7.1 | 0.0 | 4.3 |
| Curly-leaf pondweed | 3.6 | 96.4 | 0.0 | 3.6 | 0.0 | 2.1 |
| Illinois pondweed | 3.6 | 96.4 | 3.6 | 0.0 | 0.0 | 0.7 |
| Small pondweed | 3.6 | 96.4 | 0.0 | 3.6 | 0.0 | 2.1 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 6.5 | Mean species/site: | 1.08 |
| Date: | 6/13/2016 | Sites with plants: | 18 | SE Mean species/site: | 0.21 |
| Littoral Depth (ft): | 23.0 | Sites with native plants: | 9 | Mean native species/site: | 0.46 |
| Littoral Sites: | 24 | Number of species: | 8 | SE Mean natives/site: | 0.13 |
| Total Sites: | 24 | Number of native species: | 5 | Species diversity: | 0.82 |
| | | Maximum species/site: | 4 | Native species diversity: | 0.71 |

| Depths: 15 to 20 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Starry stonewort | 33.3 | 66.7 | 4.2 | 12.5 | 16.7 | 25.0 |
| Coontail | 20.8 | 79.2 | 0.0 | 20.8 | 0.0 | 12.5 |
| Curly-leaf pondweed | 16.7 | 83.3 | 0.0 | 16.7 | 0.0 | 10.0 |
| Eurasian watermilfoil | 12.5 | 87.5 | 4.2 | 8.3 | 0.0 | 5.8 |
| Chara | 8.3 | 91.7 | 4.2 | 4.2 | 0.0 | 3.3 |
| Sago pondweed | 8.3 | 91.7 | 4.2 | 4.2 | 0.0 | 3.3 |
| Nitella | 4.2 | 95.8 | 4.2 | 0.0 | 0.0 | 0.8 |
| Whorled watermilfoil | 4.2 | 95.8 | 0.0 | 4.2 | 0.0 | 2.5 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 6.5 | Mean species/site: | 0.70 |
| Date: | 6/13/2016 | Sites with plants: | 5 | SE Mean species/site: | 0.30 |
| Littoral Depth (ft): | 23.0 | Sites with native plants: | 3 | Mean native species/site: | 0.30 |
| Littoral Sites: | 9 | Number of species: | 5 | SE Mean natives/site: | 0.15 |
| Total Sites: | 10 | Number of native species: | 2 | Species diversity: | 0.78 |
| | | Maximum species/site: | 3 | Native species diversity: | 0.44 |

| Depths: 20 to 25 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Coontail | 20.0 | 80.0 | 10.0 | 10.0 | 0.0 | 8.0 |
| Starry stonewort | 20.0 | 80.0 | 0.0 | 20.0 | 0.0 | 12.0 |
| Curly-leaf pondweed | 10.0 | 90.0 | 0.0 | 10.0 | 0.0 | 6.0 |
| Eurasian watermilfoil | 10.0 | 90.0 | 0.0 | 0.0 | 10.0 | 10.0 |
| Nitella | 10.0 | 90.0 | 0.0 | 10.0 | 0.0 | 6.0 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 1.86 |
| Date: | 8/22/2016 | Sites with plants: | 150 | SE Mean species/site: | 0.10 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 117 | Mean native species/site: | 1.35 |
| Littoral Sites: | 165 | Number of species: | 17 | SE Mean natives/site: | 0.10 |
| Total Sites: | 169 | Number of native species: | 14 | Species diversity: | 0.87 |
| | | Maximum species/site: | 6 | Native species diversity: | 0.84 |

| **All Depths** | **Frequency of** | **Rake score frequency per species** | | | | **Plant** |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 43.8 | 56.2 | 26.0 | 14.8 | 3.0 | 17.0 |
| Starry stonewort | 38.5 | 61.5 | 14.8 | 9.5 | 14.2 | 22.8 |
| Eel grass | 16.0 | 84.0 | 10.1 | 3.6 | 2.4 | 6.5 |
| Illinois pondweed | 16.0 | 84.0 | 10.7 | 4.7 | 0.6 | 5.6 |
| Coontail | 15.4 | 84.6 | 5.9 | 8.3 | 1.2 | 7.3 |
| Bladderwort | 11.8 | 88.2 | 6.5 | 5.3 | 0.0 | 4.5 |
| Eurasian watermilfoil | 11.2 | 88.8 | 5.9 | 4.7 | 0.6 | 4.6 |
| Sago pondweed | 7.7 | 92.3 | 4.7 | 2.4 | 0.6 | 3.0 |
| Slender naiad | 7.7 | 92.3 | 7.1 | 0.6 | 0.0 | 1.8 |
| Richardson's pondweed | 5.9 | 94.1 | 3.0 | 2.4 | 0.6 | 2.6 |
| Whorled watermilfoil | 5.9 | 94.1 | 5.3 | 0.6 | 0.0 | 1.4 |
| Nitella | 1.8 | 98.2 | 0.6 | 1.2 | 0.0 | 0.8 |
| Spiny naiad | 1.8 | 98.2 | 1.8 | 0.0 | 0.0 | 0.4 |
| American pondweed | 1.2 | 98.8 | 0.0 | 1.2 | 0.0 | 0.7 |
| Elodea | 0.6 | 99.4 | 0.6 | 0.0 | 0.0 | 0.1 |
| Flat-stemmed pondweed | 0.6 | 99.4 | 0.0 | 0.6 | 0.0 | 0.4 |
| Water stargrass | 0.6 | 99.4 | 0.6 | 0.0 | 0.0 | 0.1 |
| | | | | | | |
| Filamentous Algae | 1.8 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 2.42 |
| Date: | 8/22/2016 | Sites with plants: | 61 | SE Mean species/site: | 0.18 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 54 | Mean native species/site: | 1.94 |
| Littoral Sites: | 62 | Number of species: | 16 | SE Mean natives/site: | 0.17 |
| Total Sites: | 62 | Number of native species: | 13 | Species diversity: | 0.86 |
| | | Maximum species/site: | 6 | Native species diversity: | 0.83 |

| **Depths: 0 to 5 ft** | **Frequency of** | **Rake score frequency per species** | | | | **Plant** |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 61.3 | 38.7 | 43.5 | 12.9 | 4.8 | 21.3 |
| Starry stonewort | 43.5 | 56.5 | 27.4 | 8.1 | 8.1 | 18.4 |
| Eel grass | 30.6 | 69.4 | 19.4 | 4.8 | 6.5 | 13.2 |
| Illinois pondweed | 27.4 | 72.6 | 14.5 | 11.3 | 1.6 | 11.3 |
| Bladderwort | 17.7 | 82.3 | 11.3 | 6.5 | 0.0 | 6.1 |
| Richardson's pondweed | 12.9 | 87.1 | 8.1 | 4.8 | 0.0 | 4.5 |
| Whorled watermilfoil | 11.3 | 88.7 | 9.7 | 1.6 | 0.0 | 2.9 |
| Coontail | 9.7 | 90.3 | 4.8 | 3.2 | 1.6 | 4.5 |
| Slender naiad | 9.7 | 90.3 | 9.7 | 0.0 | 0.0 | 1.9 |
| Sago pondweed | 4.8 | 95.2 | 3.2 | 1.6 | 0.0 | 1.6 |
| American pondweed | 3.2 | 96.8 | 0.0 | 3.2 | 0.0 | 1.9 |
| Eurasian watermilfoil | 3.2 | 96.8 | 3.2 | 0.0 | 0.0 | 0.6 |
| Elodea | 1.6 | 98.4 | 1.6 | 0.0 | 0.0 | 0.3 |
| Flat-stemmed pondweed | 1.6 | 98.4 | 0.0 | 1.6 | 0.0 | 1.0 |
| Spiny naiad | 1.6 | 98.4 | 1.6 | 0.0 | 0.0 | 0.3 |
| Water stargrass | 1.6 | 98.4 | 1.6 | 0.0 | 0.0 | 0.3 |
| | | | | | | |
| Filamentous Algae | 3.2 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 1.74 |
| Date: | 8/22/2016 | Sites with plants: | 41 | SE Mean species/site: | 0.22 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 34 | Mean native species/site: | 1.32 |
| Littoral Sites: | 47 | Number of species: | 13 | SE Mean natives/site: | 0.18 |
| Total Sites: | 47 | Number of native species: | 10 | Species diversity: | 0.82 |
| | | Maximum species/site: | 5 | Native species diversity: | 0.75 |

| Depths: 5 to 10 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Chara | 59.6 | 40.4 | 34.0 | 23.4 | 2.1 | 23.0 |
| Starry stonewort | 29.8 | 70.2 | 10.6 | 6.4 | 12.8 | 18.7 |
| Bladderwort | 17.0 | 83.0 | 8.5 | 8.5 | 0.0 | 6.8 |
| Illinois pondweed | 17.0 | 83.0 | 17.0 | 0.0 | 0.0 | 3.4 |
| Eurasian watermilfoil | 10.6 | 89.4 | 6.4 | 4.3 | 0.0 | 3.8 |
| Slender naiad | 10.6 | 89.4 | 10.6 | 0.0 | 0.0 | 2.1 |
| Coontail | 6.4 | 93.6 | 4.3 | 0.0 | 2.1 | 3.0 |
| Eel grass | 6.4 | 93.6 | 4.3 | 2.1 | 0.0 | 2.1 |
| Sago pondweed | 6.4 | 93.6 | 4.3 | 2.1 | 0.0 | 2.1 |
| Whorled watermilfoil | 4.3 | 95.7 | 4.3 | 0.0 | 0.0 | 0.9 |
| Nitella | 2.1 | 97.9 | 2.1 | 0.0 | 0.0 | 0.4 |
| Richardson's pondweed | 2.1 | 97.9 | 0.0 | 2.1 | 0.0 | 1.3 |
| Spiny naiad | 2.1 | 97.9 | 2.1 | 0.0 | 0.0 | 0.4 |
| | | | | | | |
| Filamentous Algae | 2.1 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 2.00 |
| Date: | 8/22/2016 | Sites with plants: | 27 | SE Mean species/site: | 0.21 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 20 | Mean native species/site: | 1.25 |
| Littoral Sites: | 28 | Number of species: | 11 | SE Mean natives/site: | 0.21 |
| Total Sites: | 28 | Number of native species: | 9 | Species diversity: | 0.86 |
| | | Maximum species/site: | 4 | Native species diversity: | 0.82 |

| Depths: 10 to 15 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Eurasian watermilfoil | 39.3 | 60.7 | 14.3 | 21.4 | 3.6 | 19.3 |
| Starry stonewort | 35.7 | 64.3 | 3.6 | 17.9 | 14.3 | 25.7 |
| Coontail | 32.1 | 67.9 | 3.6 | 28.6 | 0.0 | 17.9 |
| Chara | 25.0 | 75.0 | 3.6 | 17.9 | 3.6 | 15.0 |
| Sago pondweed | 25.0 | 75.0 | 14.3 | 7.1 | 3.6 | 10.7 |
| Eel grass | 17.9 | 82.1 | 10.7 | 7.1 | 0.0 | 6.4 |
| Illinois pondweed | 7.1 | 92.9 | 3.6 | 3.6 | 0.0 | 2.9 |
| Slender naiad | 7.1 | 92.9 | 3.6 | 3.6 | 0.0 | 2.9 |
| Bladderwort | 3.6 | 96.4 | 0.0 | 3.6 | 0.0 | 2.1 |
| Richardson's pondweed | 3.6 | 96.4 | 0.0 | 0.0 | 3.6 | 3.6 |
| Whorled watermilfoil | 3.6 | 96.4 | 3.6 | 0.0 | 0.0 | 0.7 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 1.18 |
| Date: | 8/22/2016 | Sites with plants: | 20 | SE Mean species/site: | 0.14 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 9 | Mean native species/site: | 0.50 |
| Littoral Sites: | 22 | Number of species: | 6 | SE Mean natives/site: | 0.14 |
| Total Sites: | 22 | Number of native species: | 3 | Species diversity: | 0.64 |
| | | Maximum species/site: | 3 | Native species diversity: | 0.43 |

| Depths: 15 to 20 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Starry stonewort | 59.1 | 40.9 | 9.1 | 13.6 | 36.4 | 46.4 |
| Coontail | 36.4 | 63.6 | 18.2 | 18.2 | 0.0 | 14.5 |
| Nitella | 9.1 | 90.9 | 0.0 | 9.1 | 0.0 | 5.5 |
| Chara | 4.5 | 95.5 | 0.0 | 4.5 | 0.0 | 2.7 |
| Eurasian watermilfoil | 4.5 | 95.5 | 4.5 | 0.0 | 0.0 | 0.9 |
| Spiny naiad | 4.5 | 95.5 | 4.5 | 0.0 | 0.0 | 0.9 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |

## Occurrence and Abundance of Submersed Aquatic Plants in Lake Wawasee.

| | | | | | |
|---|---|---|---|---|---|
| County: | Kosciusko | Secchi (ft): | 9 | Mean species/site: | 0.10 |
| Date: | 8/22/2016 | Sites with plants: | 1 | SE Mean species/site: | 0.10 |
| Littoral Depth (ft): | 21.0 | Sites with native plants: | 0 | Mean native species/site: | 0.00 |
| Littoral Sites: | 6 | Number of species: | 1 | SE Mean natives/site: | 0.00 |
| Total Sites: | 10 | Number of native species: | 0 | Species diversity: | 0.00 |
| | | Maximum species/site: | 1 | Native species diversity: | 0.00 |

| Depths: 20 to 25 ft | Frequency of | Rake score frequency per species | | | | Plant |
|---|---|---|---|---|---|---|
| **Species** | **Occurrence** | **0** | **1** | **3** | **5** | **Dominance** |
| Starry stonewort | 10.0 | 90.0 | 0.0 | 0.0 | 10.0 | 10.0 |
| | | | | | | |
| Filamentous Algae | 0.0 | | | | | |