Chlorophyll $a$ concentrations in Otsego Lake, summer 2012

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INTRODUCTION

As part of ongoing monitoring efforts to evaluate trophic parameters in Otsego Lake, chlorophyll $a$ concentrations in Otsego Lake are monitored annually in profiles of the water column. Chlorophyll $a$ is a photosynthetic pigment present in the dominant algae and thus can be used to estimate algal biomass (Harman et al. 2002). Higher chlorophyll $a$ concentrations often reflect higher nutrient levels, and are influenced by trophic interactions throughout the food web.

Historically, Otsego Lake has been considered meso-oligotrophic based upon its morphology, algal standing crop, transparency and hypolimnetic dissolved oxygen concentrations (Godfrey 1977). This was largely attributed to relatively high densities of larger bodied crustacean zooplankton, which were believed to effectively filter smaller-celled algae from the water. Godfrey (1977) prosthelytized that Otsego Lake would show signs of increased eutrophy should crustacean plankton be reduced by, for instance, the introduction of additional planktivorous fish species.

Alewife (*Alosa pseudoharengus*) were first documented in the lake in 1986 (Foster 1990) and were abundant by the early 1990s (Harman et al. 2002). Alewife are efficient planktivores which caused substantial reductions in crustacean zooplankton throughout the 1990s. The reduction in algal grazing lead to higher algal standing crops, reduced transparency and increased rates of hypolimnetic oxygen reduction (Harman et. al. 2002). Walleye (*Sander vitreus*) has been stocked into the lake since 2000 in an attempt to re-establish this gamefish (Cornwell 2007). Monitoring various trophic indicators has continued to evaluate the effects of alewife reduction, including rebounds in zooplankton and evidence of filtering by them. An additional variable in the lake’s ecology relates to the establishment of zebra mussels (*Dreissena polymorpha*); they were first documented in the lake in 2007 (Waterfield 2009) and were widespread by 2010 (Albright and Zaengle 2012). Zebra mussels are filter feeders and can decrease the algal biomass in the lake.

This work evaluated chlorophyll $a$ concentrations in profile at three sites in Otsego Lake over the summer of 2012. Concurrent with this work, Otsego Lake’s physical and chemical limnology were monitored (Waterfield and Albright 2013), alewife abundance was monitored hydroacoustically (Waterfield and Cornwell 2013) and the lake’s zooplankton community was evaluated (Albright 2013).

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METHODS

Water samples were collected from three sites on Otsego Lake bi-weekly from 6 June to 19 July at three sites historically monitored for water quality testing (Figure 1). Samples were collected at 1-meter intervals from the surface down to 20 meters using a Kemmerer sampler. A composite sample of the water column (0-20m) was also collected at each location. Samples were stored in Nalgene bottles and kept on ice in a dark cooler.

![Figure 1. Summer 2012 Otsego lake sample sites for water collection used in chlorophyll $\alpha$ analysis.](image)

Following collection, samples were immediately processed under low light to prevent chlorophyll degradation. Analysis followed the methods of Welschmeyer (1994). An aliquot of each sample (125 ml) was vacuum-filtered through a Whatman® GF/A Glass Micro Fiber filter. The filters were then folded in half, patted dry, and placed in individual labeled petri dishes which were stacked into beakers, wrapped in foil and stored in the freezer until processing resumed. Each filter was cut into pieces using forceps and scissors and put in a test tube with buffered acetone (90% acetone and 10% saturated MgCO$_3$). Using a teflon pestle attached to a drill, the filters were ground up to a slurry. The contents of the grinding tube were then transferred into a centrifuge tube and more acetone buffer was added to bring the volume of each to 10mL. After all filters were ground, the tubes were centrifuged for ten minutes at 10,000xG.
The supernatant was then transferred to a cuvette and the Turner Designs™ TD-700 fluorometer was used to measure chlorophyll $a$ concentration in ppb. Sample chlorophyll $a$ concentrations were calculated by multiplying the fluorometer reading by 10 (volume in the tube) and dividing by 125 (volume of sample filtered).

Additionally, data collected as outlined above were compared with field data collected with a YSI Inc.™ fluorometric field probe as part of routine monitoring (Waterfield and Albright 2013) to evaluate the probes accuracy at low algal densities. Data were taken from the YSI probe on the dates of 6 June, 4 July and 19 July 2012. Statistical paired t-tests were performed on the data for these three sample days. P-values for 2-tailed t-tests were calculated to determine if there was a significant difference between the field and lab data acquired on each day. If the P-value was found to be less than 0.05, there was a significant difference in the data (UCLA Academic Technology Services 2012).

RESULTS AND DISCUSSION

Figure 2 summarizes chlorophyll $a$ concentrations vs. depth at TR4C (the site with the most complete history of data) over the summers of 2002 to 2012. Concentrations have been low this summer compared to the past. Over 2012, the concentrations of chlorophyll $a$ are fairly consistent from surface to 20m, whereas in the past, concentrations often declined with depth.

Figure 3 depicts the mean chlorophyll $a$ concentrations throughout the summer, 2012 survey period for each of the three sample sites. The reason for the spike in concentration at 9m for TR5-C and at 19m for TR3-C is unknown.

On the four days samples were collected, composite samples were also taken at each site. Figure 4 depicts the composite samples at each site on the date of 6 June 2012. On this day the composite concentrations were significantly higher than on future testing days and were similar between sites (range= 2.28-2.56 ppb). Figure 5 shows the composite samples at each site on 21 June 2012. TR4-C and TR3-C were similar at 1.40 and 1.32 ppb, respectively, while the concentration at TR5-C was much lower with 0.72 ppb. Figure 6 depicts the composite samples at each site on the date of 4 July 2012. The concentrations of chlorophyll $a$ at TR3-C, TR4-C and TR5-C were 0.63, .42 and 1.0 ppb, respectively. Figure 7 shows the composite concentrations at each sample site on the date of 19 July 2012. Chlorophyll $a$ concentrations at TR3-C, TR4-C and TR5-C were 0.96, 1.64 and 0.76 ppb, respectively.

Figure 3. Average chlorophyll $a$ concentrations for each site (see Figure 1) throughout the water column over the summer of 2012.
Figure 4. Chlorophyll $a$ concentrations in composite samples at sample sites on June 6, 2012.

Figure 5. Chlorophyll $a$ concentrations in composite samples at sample sites on June 21, 2012.

Figure 6. Chlorophyll $a$ concentrations in composite samples at sample sites on July 4, 2012.
Figure 7. Chlorophyll $a$ concentrations in composite samples at sample sites on 19 July, 2012.

Figure 8 compares the field data, using a YSI Inc.™, to the lab data from June 6 2012. There was a mean -21.52% difference in the two sets of data on this day. The negative value indicates that the lab data provided concentrations lower than that of the field data. These data had a P-value of 0.132, indicating that there is an insignificant statistical difference between the data sets. Figure 9 compares field data and lab data from July 4 2012. For this day, there was a mean difference of -81.56% between the two sets of data. There was a P-value of 0.009, indicating a significant difference between the data for the two methods. Figure 10 compares the field data and the lab data from 19 July 2012. Here, there was a mean difference of -74.31%. The P-value for this data set was also 0.009, indicating that the difference between these two data sets was also significant. On two out of three of the sets of data, there was a significant statistical difference between the field and lab values.

Concentrations found in the lab using a fluorometer are expected to be more accurate than those determined in the field; this is because water can be filtered, resulting in elevated concentrations in the extraction, and the extraction process itself, which is proven to be an accurate method of analysis (APHA 1992). However, the process is time consuming and laborious; the advantage of a field probe include near-instantaneous data collection, with an admitted loss of accuracy (YSI Inc. 2009). When used in waters having higher chlorophyll $a$ concentrations, probe readings were in better agreement with lab extracted readings (Albright 2013). Therefore, lab methods should be continued, particularly when in low-algae waters, and at least to record the relative accuracy of the field probe on a regular basis.
Figure 8. Concentration of chlorophyll $a$ determined in the lab compared to data retrieved in the field using a YSI™ probe on the date of 6 June, 2012.

Figure 9. Concentration of chlorophyll $a$ determined in the lab compared to data retrieved in the field using a YSI™ probe on the date of 4 July, 2012.

Figure 10. Concentration of chlorophyll $a$ determined in the lab compared to data retrieved in the field using a YSI™ probe on the date of 19 July, 2012.
CONCLUSION

Compared to data from previous years, this year’s concentrations of chlorophyll $a$ in Otsego Lake are among the lowest ever recorded. This is likely resultant of increased density of daphnid zooplankton and the mean size of those animals (Albright 2013), which, in turn, is due to reduced alewife densities (Waterfield and Cornwell 2013). Grazing by the recently-established zebra mussel is undoubtedly reducing algal densities as well as, perhaps, the community make up.

REFERENCES


YSI Incorporated. 2009. 6-Series user’s manual. Yellow Springs. OH.