Chlorophyll \( a \) monitoring on Otsego Lake, Cooperstown, NY, summer 2015

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INTRODUCTION

Quantifying chlorophyll-\( \alpha \) concentration on a regular basis is quintessential to determining the health of a lake. Chlorophyll \( a \) is a pigment that facilitates photosynthesis and is found in species of algae in Otsego Lake (APHA 2012). Therefore, chlorophyll \( a \) concentration is indicative of the size of the algal standing crop (Harman et al. 2002); that, in conjunction with nutrient levels and lake morphology, determines the trophic state of the lake. The combination of the relatively low algal biomass and nutrients in Otsego Lake characterize the lake as meso-oligotrophic (Godfrey 1977). Furthermore, chlorophyll \( a \) contributes to or correlates with many other parameters that should be monitored as part of a lake management plan making it useful in identifying anomalies that warrant further investigation. One such parameter is dissolved oxygen, which is important when considering the biological capacity of a lake. Algae add oxygen as a byproduct of photosynthesis; however, it also removes oxygen when the algae die and decompose (Wetzel 2001).

Chlorophyll \( a \) levels have changed substantially since the late 1990s. This trend can be attributed to the reduction of alewife (\( Alosa psuedoharengus \)) and the introduction of zebra mussels (\( Dreissena polymorpha \)). Alewife, a planktivorous fish, contributed heavily to a larger algal crop since introduced to Otsego Lake in 1986 (Foster 1990). Alewife predation decreased the abundance of zooplankton thus resulting in increased phytoplankton biomass (Harman et al. 2002). Zebra mussels, exotic filter-feeders that were documented in 2007, filter the water of algae and thus reduce algal biomass (Waterfield 2009).

This study was conducted to ascertain the concentration of chlorophyll \( a \) in Otsego Lake thereby gaining a more complete understanding of the biogeochemical processes occurring the lake and helping to better address environmental issues threatening the lake.

METHODS

Samples were collected at site TR4-C, the deepest site on the lake, on a bi-weekly basis. A Kemmerer sampler was used to collect discrete samples at one meter intervals from zero to twenty meters. A composite sample was taken using two garden hoses attached to a weighted

line. It was lowered to 20 m and retrieved from the line attached to the hose bottom. Samples were stored in Nalgene® bottles and placed in a cooler until at the Biological Field Station.

Figure 1. Bathymetric map showing the sampling site for chlorophyll-α during the summer of 2015.
Once at the Biological Field Station, samples were filtered through a 47mm Whatman® GF/A Micro Fiber filter with a low-pressure vacuum pump that expedited the filtration process. The filters were then folded, blot-dried, and put in petri dishes. To prevent degradation of the chlorophyll \(a\) samples were stored in a freezer until further processing.

Individual filters were then cut into small pieces and combined with buffered acetone (90% acetone, 10% MgCO\(_3\)) in a 15mL grinding tube. The samples were ground into a homogeneous pulp with a drill and Teflon pestle drill. Samples were placed in a 15mL centrifuge tube and additional acetone was added so the sample would be approximately 10mL.

Samples were placed in the centrifuge for 10 minutes at 10,000 X G. The liquid portion of the centrifuged sample was placed in the Turner Designs™ TD-700 fluorometer. The final concentration, in parts per billion, was established with the following equation from the methods of Arar and Collins (1997).

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\frac{mL \text{ of filtered sample (~10mL) } \times \text{ ppb}}{mL \text{ of sample taken (125mL)}}
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RESULTS AND DISCUSSION

Chlorophyll \(a\) concentrations over the summer of 2015 have seemed to be somewhat higher than those of recent years (Figure 2). However, two issues may cause this to be misleading. First, the sampling period in 2015 was fairly short and limited to the peak season of algal growth (2 July to 12 August). Surface – 20 m composite samples collected both before (May-June) and after (late August-September) this study were markedly lower than the concentrations reported in Figure 2 (see Waterfield and Albright 2016). Secondly, during this study, the mean concentrations of the discrete profiles of samples consistently exceeded the composite sample concentrations by about 30% (Figure 3). No apparent reason for this can be suggested. The mean concentration of chlorophyll \(a\) from composite samples collected from 19 May to 16 September 2015 was 1.8 ug/l (Waterfield and Albright 2016), which is quite similar to concentrations reported since 2010.

The profile of chlorophyll \(a\) over the study is presented in Figure 4. Concentrations were constantly higher in the metalimnetic region (8-12 m depths). This region is an area of rapidly changing temperature. The deeper, cooler water is denser, so algae may passively settle out there. Some light sensitive species may actively prefer the reduced light of the thermocline in which to grown.

Figure 5 compares profiles of chlorophyll \(a\) measured in 2015 from those of 1997 through 2014.
Figure 2. Mean surface-2 m summer chlorophyll a concentrations, summers 1997, 2000-2015.

Figure 3. Average chlorophyll-α concentration for sampling dates, summer 2015, comparing mean values of the surface-20 m discrete profile samples and the measured values of the surface-20 m composite samples.
Figure 4. Summer 2015 data from site TR4-C shows fluctuations in chlorophyll-$\alpha$ concentrations. Spikes are associated with the thermocline.
Chlorophyll $\alpha$ levels have fluctuated since 1997. The high levels in the late 1990s and 2000s can be attributed to the high alewife ($Alosa$ $pseudoharengus$) population that ate zooplankton, thus significantly reducing algal grazing. The decline since 2005 coincides with the reduction of alewife following the re-establishment of walleye ($Sander$ $vitreus$) in the lake (Albright and Robinson 2016) The introduction of zebra mussels in 2007 (Waterfield 2009) likely increased filtration of lake water that resulted in lower chlorophyll $\alpha$. 

Figure 5. Data since 1997 to 2015, with the exception of 2008 and 2009, show fluctuations related to food web alterations. Data from 1997 were collected at two-meter intervals (King 1997) and are represented by markers only (no line).
Despite fluctuations, chlorophyll $a$ levels have remained consistent with a meso-oligotrophic lake. Furthermore, since the variation over time is largely attributed to nuisance species, the chemical health of the lake is consistent with years past, suggesting that management practices to reduce nutrient loading have been successful.

**CONCLUSION**

Algal standing crop, nutrient level, and morphological features of a lake determine the trophic state of the lake (Godfrey 1977). Furthermore, algae heavily influence biologically available dissolved oxygen. Because of the ecological importance of algae, chlorophyll $a$ should be monitored because it is telling of the health of the lake. Based on this year’s data in contrast with data from previous years, Otsego Lake can be classified as meso-oligotrophic.

**REFERENCES**


Korhonen et al. 2011. Productivity-diversity relationships in lake plankton communities. 10.1371/journal.pone.0022041


