Chlorophyll $a$ concentrations in Otsego Lake, summer 2011

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INTRODUCTION

This study is a continuation of a long term limnological survey of chlorophyll $a$ concentrations in Otsego Lake. It is part of an annual analysis of biotic and abiotic factors of the lake (Harman et al. 1997). These factors are monitored to provide information regarding changes in the trophic state of the lake over time.

Chlorophyll $a$ is a pigment used in the process of photosynthesis. Due to the fact that chlorophyll $a$ is present in all types of algae, it is used as an indicator for the abundance of algae (Berkman and Canova 2007). The relative amount of algal biomass in a lake can be determined by measuring the chlorophyll $a$ content of a sample and comparing it to previous samples. Relative algal biomass is an indicator of the lake’s trophic status and water quality.

Since algae are the most abundant primary producers in Otsego Lake, they have a large impact on all of the populations above them in the food web, including fish. When algae die and sink through the hypolimnion, they undergo decomposition by bacteria. This process consumes oxygen and can jeopardize cold water game fish such as lake trout ($Salvelinus namaycush$) if algal populations are large (Wetzel 1975). Conversely, if algal production is low, the production at higher trophic levels, including game fish, would decline. This survey provides information on the abundance of algae at different depths in the lake.

Monitoring of chlorophyll $a$ concentrations in the Otsego Lake for the summer of 2011 has been concurrent to a study evaluating the overall chemical and physical parameters of Otsego Lake (Waterfield and Albright 2012).

METHODS AND MATERIALS

Chlorophyll $a$ samples were acquired bi-weekly from 28 June to 8 August at the deepest part of the lake (site TR4-C, Figure 1). Samples were collected at 1-meter intervals from the surface to twenty meters using a VanDorn sampler. Samples were then transferred into 500 mL Nalgene bottles and placed into a dark iced cooler to limit exposure of chlorophyll $a$ to light and heat.

Upon returning to the lab, a 200 mL aliquot of each sample was immediately filtered through a 47mm Whatman GF/A Glass Micro Fiber Filter using a low pressure vacuum pump under subdued light. The filters were then folded in half to protect the chlorophyll $a$ and patted dry with paper towels. Once folded and dried, the filters were placed in a clean 47mm Millipore

Petri dish. Each dish was covered with aluminum foil and labeled with site, depth, and date. Dishes were stored in a freezer at -20°C until processing resumed.

Processing continued by cutting each filter into small pieces using forceps and scissors. The cut pieces were placed into a 15mL glass grinding tube with approximately 4 mL of buffered acetone (90% acetone and 10% saturated MgCO3) and were then ground into a homogenous slurry using a power drill equipped with a Teflon pestle drill bit. After each sample was fully ground, they were transferred to a 15mL centrifuge tube and filled to 10 mL with buffered acetone. Each sample was shaken and centrifuged for 10 minutes at 10,000xG in order to take particulate matter out of suspension. Some of the sample was then poured into a 1 cm cuvette and placed in a Turner Designs TD-700 Fluorometer for analysis. Following the procedures of Arar and Collins (1997), chlorophyll \( a \) concentrations were determined.

Figure 1. A map of Otsego Lake with sample site TR4-C, used for collecting water samples for chlorophyll \( a \) analysis, summer 2011.
RESULTS AND DISCUSSION

Chlorophyll \(a\) concentrations this year on average were lower than all previous years on record at most of the tested depths. The average chlorophyll \(a\) concentration for 2011 was 1.32 ppb.

Figure 2 shows the average summer chlorophyll \(a\) concentrations from 2000 to 2011. This graph illustrates the yearly fluctuations that chlorophyll \(a\) concentrations experience. From 2000 to 2003, average chlorophyll \(a\) densities in Otsego Lake decreased steadily from 6.82 ppb in 2000 (Durie 2001) to 2.62 ppb in 2003 (Schmitt 2003). The trend then reversed and peaked in 2006 at 5.97 ppb (Stevens 2007). In 2007, chlorophyll \(a\) densities dropped to about 1.91 ppb; the same average density was noted in 2010 as well (Bauer 2011). Since data are incomplete for 2008 and 2009, it is unknown what the exact chlorophyll \(a\) densities were for those years. The data that are available from surface to 20 meter composite samples of Otsego Lake suggest that the average chlorophyll \(a\) concentration for 2008 was about 4 ppb (Albright and Waterfield 2009) and about 5 ppb for 2009 (Waterfield and Albright 2010). However, it should be noted that the composite sample data from previous years do not consistently correlate with the data from samples taken for their respective annual chlorophyll \(a\) reports.

Figure 2. Mean summer chlorophyll \(a\) concentrations for 2000 (Durie 2001), 2001 (Wayman 2002), 2002 (Wayman 2003), 2003 (Schmitt 2004), 2004 (Murray 2005), 2005 (Zurmuhlen 2006), 2006 (Stevens 2007), 2007 (Ottley 2008), 2008 (Albright and Waterfield 2009), 2009 (Waterfield and Albright 2010), 2010 (Bauer 2011), and 2011. Data from 2008 (Albright and Waterfield 2009) and 2009 (Waterfield and Albright 2010) are taken from surface to 20 meter composite samples because this survey was not completed during those years. The composite sample data may not be consistent with data collected for this survey.

A likely contributor to this decrease in chlorophyll \(a\) is the growing population of zebra mussels (\textit{Dreissena polymorpha}) in Otsego Lake. Zebra mussels are filter feeders that consume suspended material, primarily phytoplankton (Bensen et al. 2011). They were first discovered in Otsego Lake in 2007 (Waterfield 2009) and were considered widespread and abundant by 2010 (Albright and Zaengle 2012). Although zebra mussels consume algae, data from other areas that have been invaded suggest that zebra mussel activity may lead to blue-green algal blooms within
the next decade (LLRS 2009). This occurs because zebra mussels selectively avoid consuming blue-green algae. Since the other types of algae are eaten by zebra mussels, the blue-green varieties thrive in the absence of their competitors.

Another contributor to the decline in chlorophyll $a$ levels may be a recent increase in abundance of large-bodied cladoceran zooplankton (Albright and Leonardo 2011) resulting from a decrease in alewife abundance (Waterfield and Cornwell 2011). Zooplankton consume phytoplankton, so an increase in zooplankton mass and abundance would lead to increased grazing and therefore lower levels of phytoplanktonic algae.

Figure 3 shows chlorophyll $a$ levels for the summers of 2000 to 2011, excluding 2008 and 2009. Chlorophyll $a$ concentrations from 2011 are the lowest recorded at 15 of the 21 depths surveyed. The depth with the highest concentration of chlorophyll $a$ in 2011 was 10 meters with a density of 1.83 ppb. The lowest density for 2011, 0.64 ppb, was observed at a depth of 18 meters.

![Chlorophyll a Concentrations in Otsego Lake](image-url)
REFERENCES


Benson, A. J. and D. Raikow. 2011. Dreissena polymorpha. USGS Nonindigenous Aquatic Species Database, Gainesville, FL.


